POWERTECH™ 8.1 L Diesel Engines

Base Engine

TECHNICAL MANUAL
POWERTECH™ 8.1 L Diesel Engines — Base Engine

CTM86 06JUL06 (ENGLISH)

For complete service information also see:

POWERTECH® 8.1 L Diesel Engines—Mechanical Fuel Systems	CTM243
POWERTECH® 6.8 L & 8.1 L Diesel Engines—Level 3 Electronic Fuel Systems with Bosch In-Line Pump	CTM134
POWERTECH® 8.1 L Diesel Engines—Level 9 Electronic Fuel Systems with Denso In-Line Pump	CTM255
Electronic Fuel Injection Systems	CTM68
OEM Engine Accessories	CTM67
Alternators and Starting Motors	CTM77

John Deere Power Systems

LITHO IN U.S.A.

Introduction

Foreword

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 (CTM86) covers only the base engine. It is one of five volumes on 8.1 L engines. The following four companion manuals cover fuel system repair and diagnostics:

- CTM243—Mechanical Fuel Systems
- CTM134—Level 3 Electronic Fuel Systems
- CTM255—Level 9 Electronic Fuel Systems
- CTM68—Electronic Injection Fuel Systems

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

This manual covers the base engine for all 8.1L engines, including emission non-certified, Tier I certified, and Tier II certified (esn 200,000 —).

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 the introduction identifies engine-models/applications. See the machine technical manual for information on engine removal and installation, and gaining access to engine components.

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

Before beginning repair on an engine, clean the engine and mount on a repair stand. (See CLEAN ENGINE in Group 010 and see MOUNT ENGINE ON REPAIR STAND in 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 sized.

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 components that can be serviced without removing the engine from the machine and for engine removal and installation procedures.

Read each block of material completely before performing service to check for differences in 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.

Component Technical Manuals are concise service guides for specific components. Component technical manuals are written as stand-alone manuals covering multiple machine applications.

Fundamental service information is available from other sources covering basic theory of operation, fundamentals of troubleshooting, general maintenance, and basic types of failures and their causes.

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.

DPSG,OUO1004,912 –19–15JUN99–1/1

John Deere Dealers

The changes listed below make your CTM obsolete. Repair, operation, and diagnostics are now covered in five manuals. **Discard CTM86 dated 06JUL99 and replace with the following new manuals:**

- CTM86—Base Engine
- CTM243—Mechanical Fuel Systems
- CTM134—Level 3 Electronic Fuel Systems
- CTM255—Level 9 Electronic Fuel Systems
- CTM68—Electronic Fuel Injection Systems

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

SECTION 01, GROUP 001 (Engine Identification)

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

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

- Updated engine oil and coolant application guidelines.

SECTION 02, GROUP 010 (Engine Rebuild)

- Updated engine disassembly sequence.
- Updated engine assembly sequence.
- Updated sealant application guidelines.

SECTION 02, GROUP 020 (Cylinder Head and Valves Repair and Adjustment Serial Number (—199,999)

- Repair procedures for cylinder head and valves on engines with serial number (—199,999) are covered in this group.

SECTION 02, GROUP 021 (Cylinder Head and Valves Repair and Adjustment Serial Number (200,000—)

- Repair procedures for cylinder head and valves on engines with serial number (200,000—) are covered in this group.

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

- Eliminated procedure to check valve lift. Use appropriate procedure from Group 020 or Group 021.
- Revised specifications for installation of crankshaft gear-driven auxiliary drive.
- Revised procedure for installation of thrust washer and timing gear cover.

SECTION 02, GROUP 060 (Lubrication System Repair and Adjustment)

- Added information for top-load oil filter.

SECTION 02, GROUP 070 (Cooling System Repair and Adjustment)

- Added belt routing diagrams.
- Revised procedure for installation of coolant pump.

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

- Revised procedure for turbocharger inspection techniques.
- Eliminated procedure for adjusting turbocharger wastegate actuator.
- Revised specifications for installing turbocharger.

SECTION 02, GROUP 090 (Fuel System Repair and Adjustments)

NOTE: Repair procedures for fuel systems have been have been moved to Section 02, Group 090 in the three following technical manuals:

- *CTM243—Mechanical Fuel Systems*
- *CTM134—Level 3 Electronic Fuel Systems*
- *CTM255—Level 9 Electronic Fuel Systems*

SECTION 02, GROUP 100 (OEM Starting and Charging Systems)

DPSG,OUO1004,898 –19–19MAY99–1/2

- Starting and charging systems are covered in this new group.

SECTION 03, GROUP 120 (Base Engine Operation)

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

NOTE: Fuel system theory of operation has been moved to Section 03 in the three following technical manuals:

- *CTM243—Mechanical Fuel Systems*
- *CTM134—Level 3 Electronic Fuel Systems*
- *CTM255—Level 9 Electronic Fuel Systems*

SECTION 04, GROUP 150 (Observable Diagnostics and Tests)

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

NOTE: Fuel system diagnostics and testing has been moved to Section 04 in the three following technical manuals:

- *CTM243—Mechanical Fuel Systems*
- *CTM134—Level 3 Electronic Fuel Systems*
- *CTM255—Level 9 Electronic Fuel Systems*

SECTION 05 (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 06 (Specifications)

- All repair, test, and diagnostic specifications listed throughout this manual are consolidated in this section for ease of reference.
- Updated bolt and cap screw torque values.
- Updated General OEM specifications.
- Updated dynamometer specifications.
- Updated turbocharger boost specifications

DPSG,OUO1004,898 –19–19MAY99–2/2

About this Manual

This component technical manual (CTM) covers the base engine for *POWERTECH*® 8.1 L (494 cu. in.) diesel engines produced in Waterloo, Iowa. This manual's coverage includes: emissions non-certified, emissions certified Tier I, and emissions certified Tier II (esn 200,000 —) engines

This manual is a complete revision of CTM86 (06JUL99). Replace earlier manual with the following new manuals:

- CTM86 — *POWERTECH*® 8.1 L Diesel Engines—Base Engine
- CTM243 — *POWERTECH*® 8.1 L Diesel Engines—Mechanical Fuel Systems
- CTM134 — *POWERTECH*® 6.8 L & 8.1 L Diesel Engines—Level 3 Electronic Fuel Systems with Bosch In-Line Pump
- CTM255 — 8.1 L Diesel Engines—Level 9 Electronic Fuel Systems with Denso In-Line Pump
- CTM68 —Electronic Fuel Injection Systems

Direction of engine crankshaft rotation in this manual is referenced as clockwise, as viewed from the rear of the engine. Front of engine is fan drive end.

Read each procedure completely before performing any service.

IMPORTANT: For repair, diagnostics, and testing procedures on the fuel system, refer to the companion manuals:

- **CTM243 — *POWERTECH*® 8.1 L Diesel Engines—Mechanical Fuel Systems**
- **CTM134 — *POWERTECH*® 6.8 L & 8.1 L Diesel Engines—Level 3 Electronic Fuel Systems with Bosch In-Line Pump**
- **CTM255 — 8.1 L Diesel Engines—Level 9 Electronic Fuel Systems with Denso In-Line Pump**
- **CTM68 —Electronic Fuel Injection Systems**

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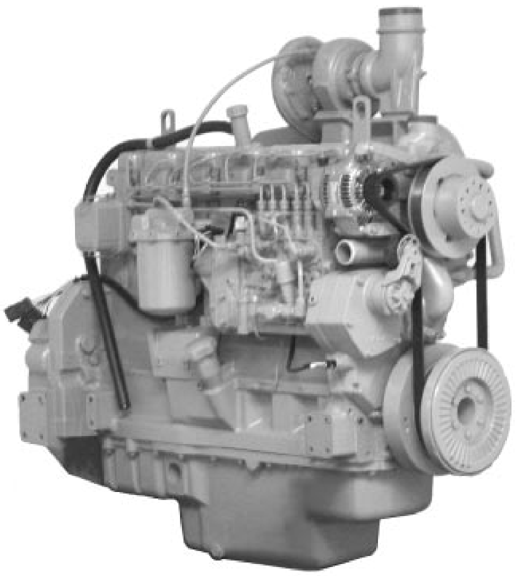
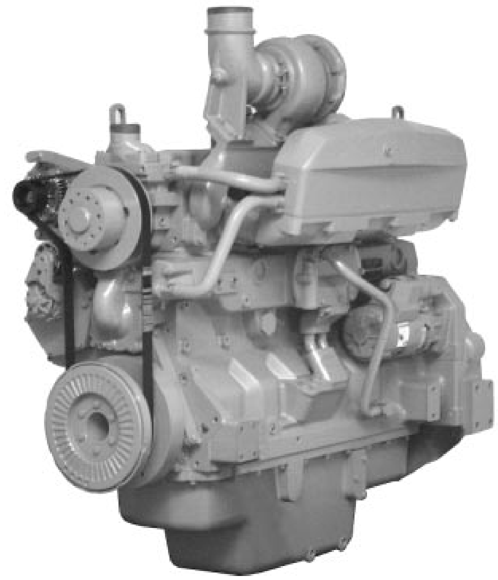
DPSG,OUO1004,913 –19–15JUN99–1/1

Identification Views Serial Number (—199,999) Non Emissions Certified, and Tier I Emissions Certified Engines



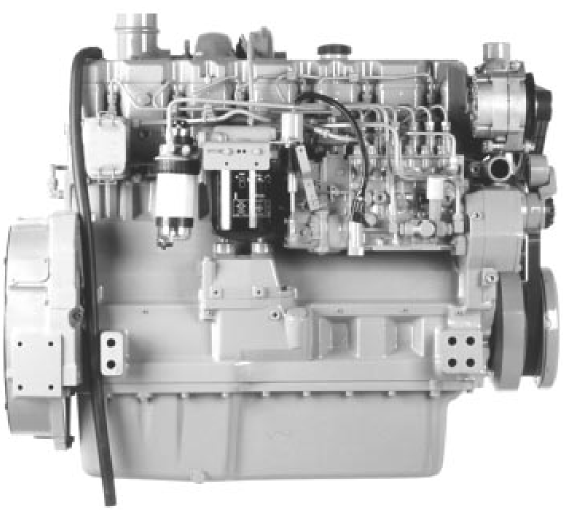
RG7362 –UN–05JAN98

8.1 L Diesel Engine Right Front View (Engines —199,999)



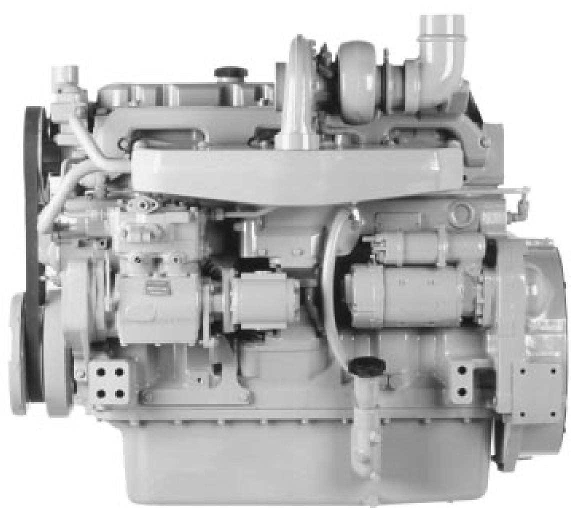
RG7363 –UN–05JAN98

8.1 L Diesel Engines Left Front View (Engines —199,999)



RG7385 –UN–05JAN98

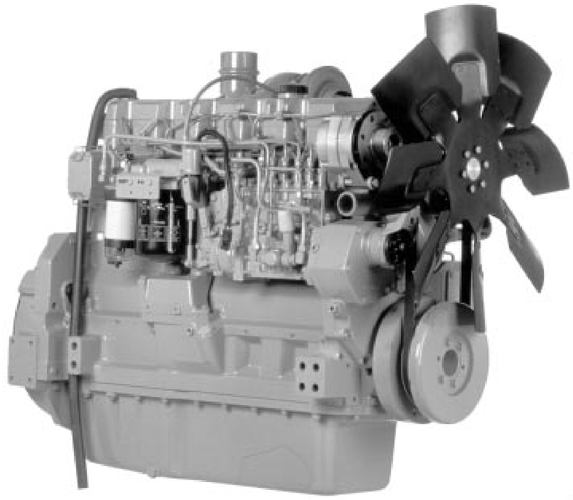
8.1 L Diesel Engines Right Side View (Engines —199,999)



RG7387 –UN–05JAN98

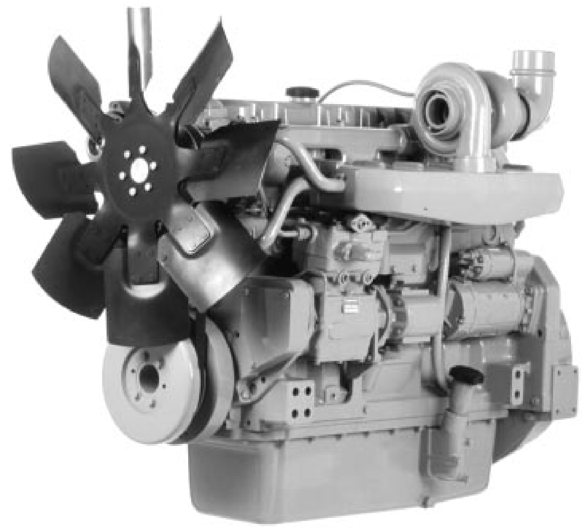
8.1 L Diesel Engines Left Side View (Engines —199,999)

RG,RG34710,4001 –19–14DEC00–1/2



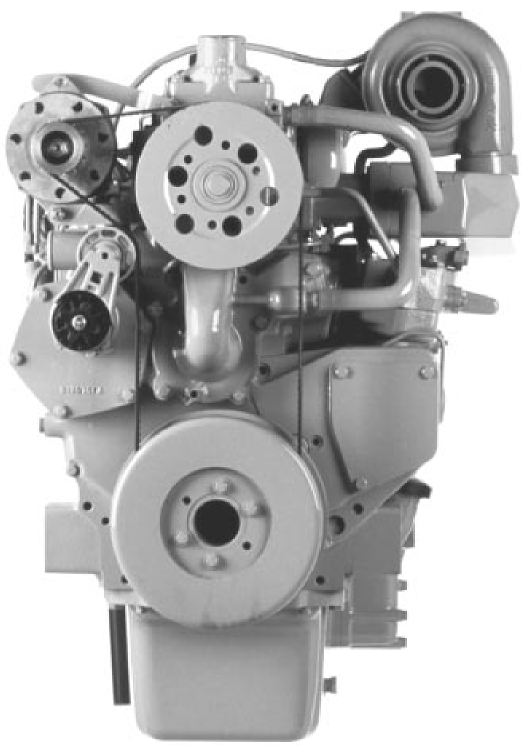
RG7388 –UN–20JUN00

8.1 L Diesel Engine Right Front View (Engines —199,999)



RG7386 –UN–20JUN00

8.1 L Diesel Engine Left Front View (Engines —199,999)



RG7383 –UN–05JAN98

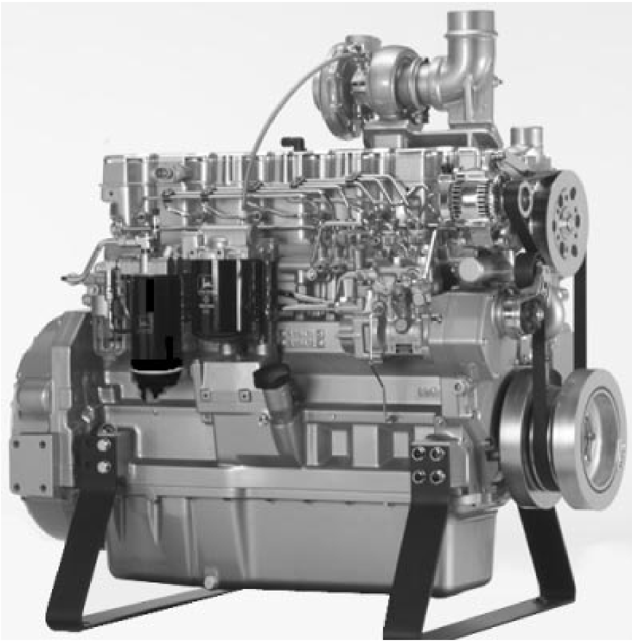
8.1 L Diesel Engine Front View (Engines —199,999)

RG7384 –UN–05JAN98

8.1 L Diesel Engine Rear View (Engines —199,999)

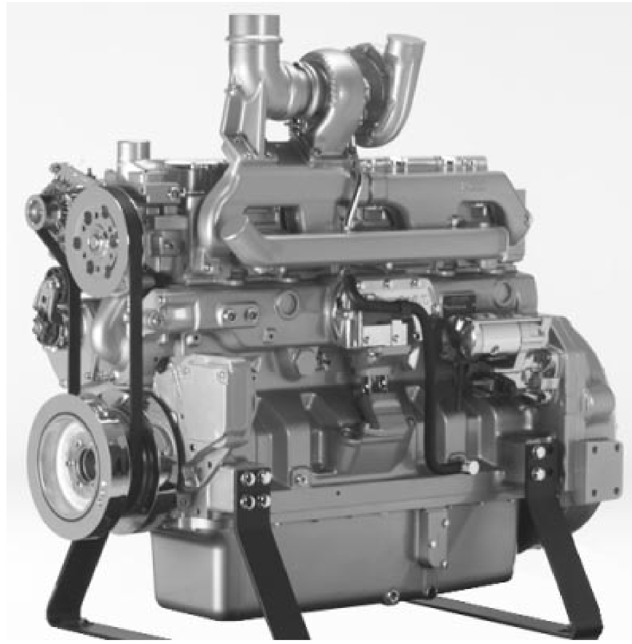
RG,RG34710,4001 –19–14DEC00–2/2

Identification Views Serial Number (200,000—) Tier II Emissions Certified Engines



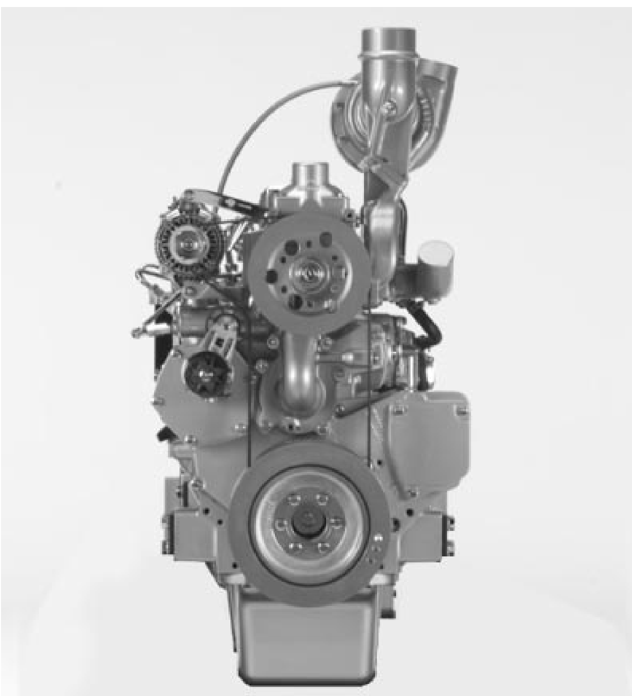
RG11511 –UN–13DEC00

8.1 L Diesel Engine Right Front View (Engines 200,000—)



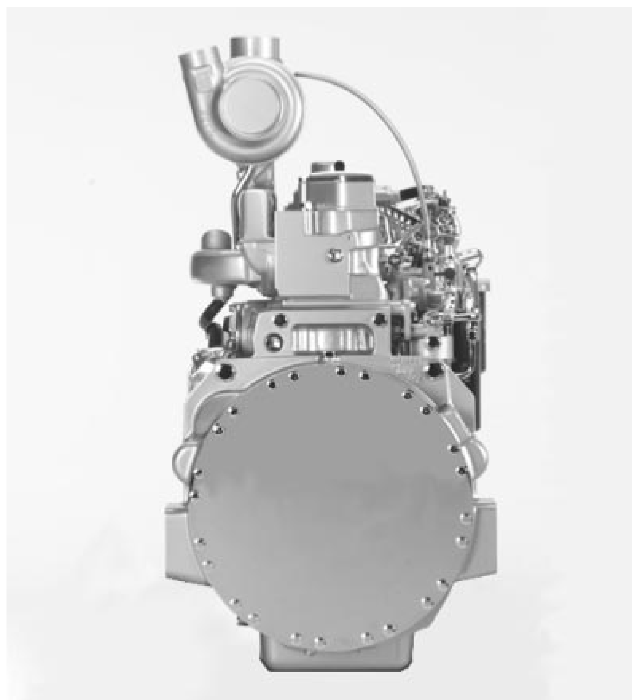
RG11512 –UN–31OCT00

8.1 L Diesel Engines Left Front View (Engines 200,000—)



RG11513 –UN–31OCT00

8.1 L Diesel Engine Front View (Engines 200,000—)



RG11514 –UN–31OCT00

8.1 L Diesel Engine Rear View (Engines 200,000—)

RG,OUOD007,4002 –19–01NOV00–1/1

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All information, illustrations and specifications in this manual are based on the latest information available at the time of publication. The right is reserved to make changes at any time without notice.

Section 01
General

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

Handle Starting Fluid Safely

Starting fluid is highly flammable.

Keep all sparks and flame away when using it. Keep starting fluid away from batteries and cables.

To prevent accidental discharge when storing the pressurized can, keep the cap on the container, and store in a cool, protected location.

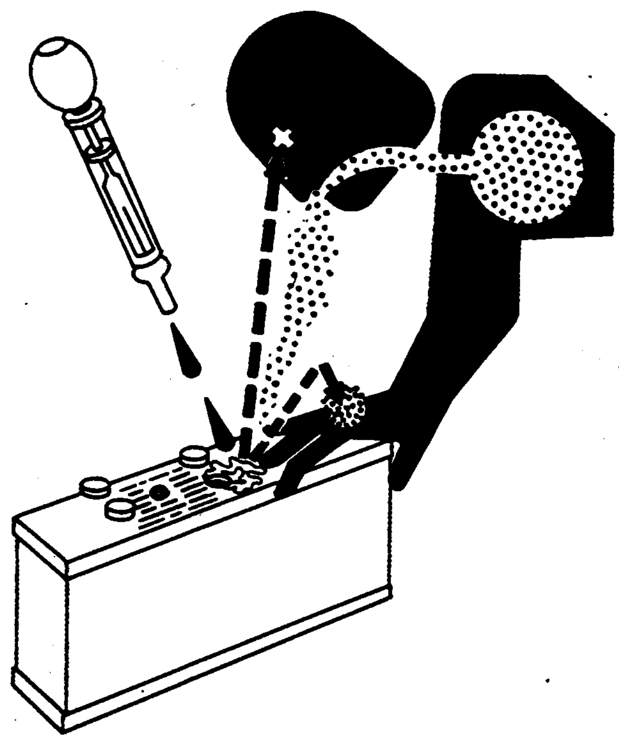
Do not incinerate or puncture a starting fluid container.

TS1356 –UN–18MAR92

DX,FIRE3 –19–16APR92–1/1

Handling Batteries Safely

TS204 —UN—23AUG88



TS203 —UN—23AUG88

Continued on next page DPSG,OUO1004,2758 –19–22DEC05–1/2

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.

Do not charge a frozen battery; it may explode. Warm battery to 16°C (60°F).

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.**

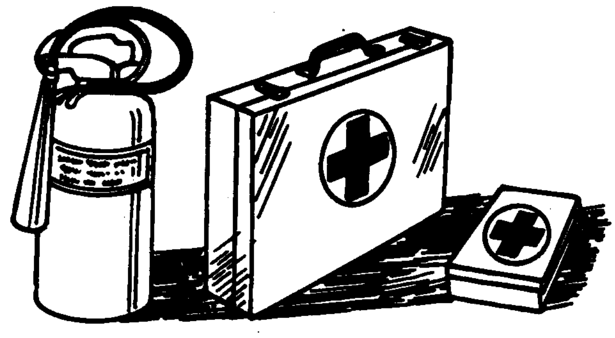
If acid is swallowed:

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.**

DPSG,OUO1004,2758 –19–22DEC05–2/2

Prepare for Emergencies



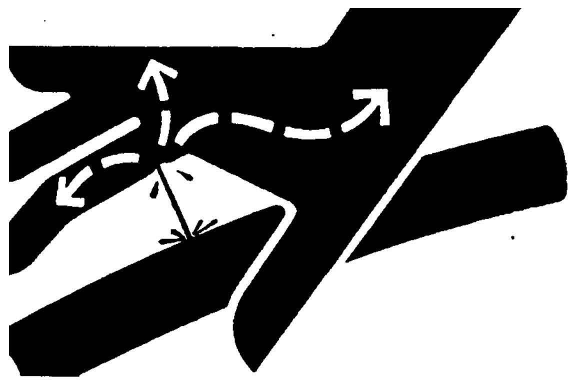
Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

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

DX,FIRE2 –19–03MAR93–1/1

Avoid High-Pressure Fluids



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

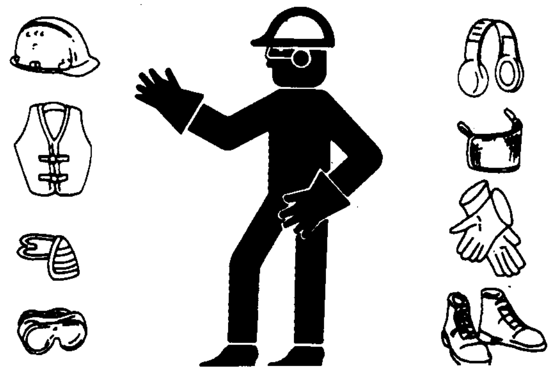
Wear Protective Clothing

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.



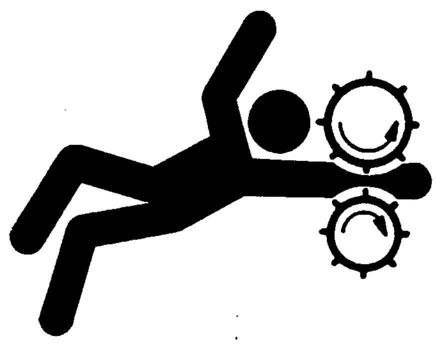
TS206 –UN–23AUG88

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.



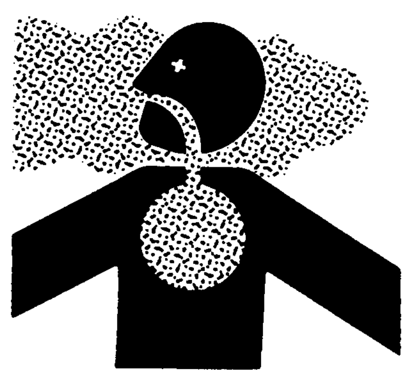
TS228 –UN–23AUG88

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



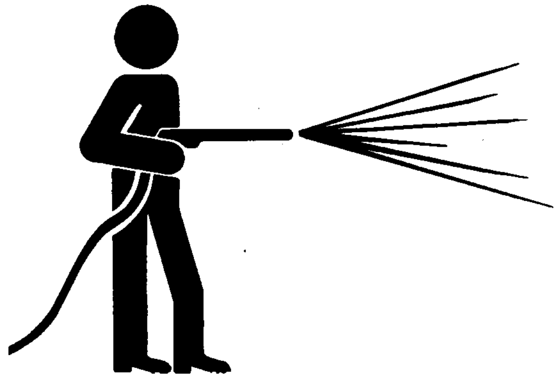
TS220 –UN–23AUG88

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.



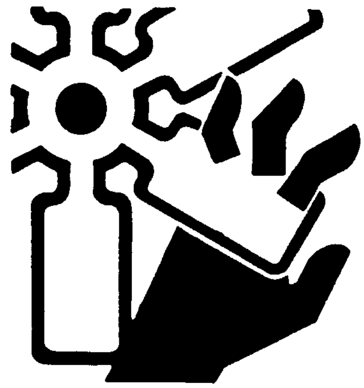
T6642EJ –UN–18OCT88

DX,CLEAN –19–04JUN90–1/1

Install Fan Guards

Rotating cooling system fans can cause serious injury.

Keep fan guards in place at all times during engine operation. Wear close fitting clothes. Stop the engine and be sure fan is stopped before making adjustments or connections, or cleaning near the front of the engine.



Rotating Fan

TS677 –UN–21SEP89

OUOD006,000009D –19–04DEC02–1/1

Avoid Hot Parts

Avoid skin contact with exhaust manifolds, turbochargers and mufflers. Keep flammable materials clear of the turbocharger.

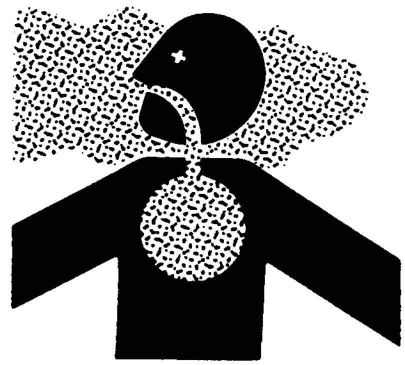
External dry exhaust parts become very hot during operation. Turbochargers may reach temperatures as high as 500°C (932°F) under full load, and naturally aspired exhaust manifolds may reach 600°C (1112°F) under full load. This may ignite paper, cloth or wooden materials. Parts on engines that have been at full load and reduced to no load idle will maintain approximately 150°C (302°F).

Hot Surface

TS271 –UN–23AUG88

OUOD006,000009E –19–04DEC02–1/1

Remove Paint Before Welding or Heating



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 100 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

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 accidentally burst when heat goes beyond the immediate flame area.

DX,TORCH –19–10DEC04–1/1

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.

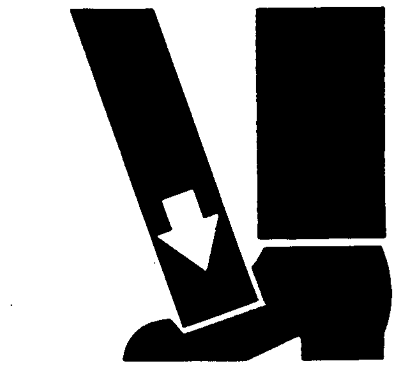
TS223 –UN–23AUG88

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.



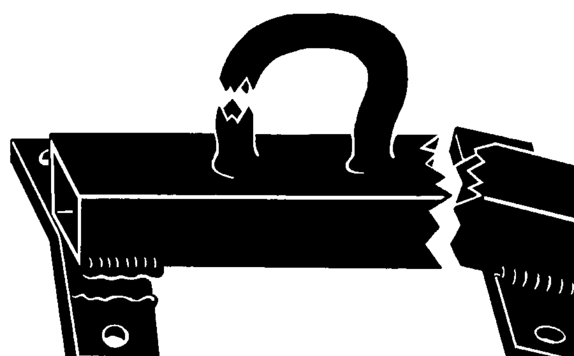
TS226 –UN–23AUG88

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.



LX1016749

Construct Dealer-Made Tools Safely

LX1016749 –UN–01JUL97

DPSG,OUO1004,899 –19–19MAY99–1/1

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

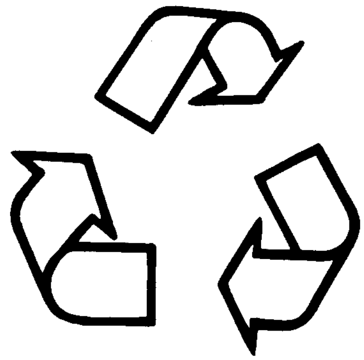
Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries.

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.



TS1133 –UN–26NOV90

DX,DRAIN –19–03MAR93–1/1

Live With Safety

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

TS231 –19–07OCT88

DX,LIVE –19–25SEP92–1/1

Engine Model Designation

JOHN DEERE ENGINE MODEL—6081

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

6081 HRW01 Engine

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

Aspiration Code

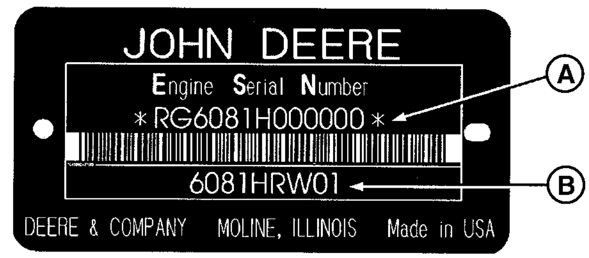
T	Turbocharged, no aftercooling
A	Turbocharged and coolant-to-air aftercooled
H	Turbocharged and air-to-air aftercooled

User Code

CQ	S.L.C. Horizontina (Brazil)
DW	Davenport
F	OEM (Original Equipment Manufacturer)
FF	Kernersvill Deere-Hitachi (North Carolina)
FM	OEM Marine
H	Harvester
N	Des Moines
RW	Waterloo (Tractors)
T	Dubuque, and Cameco (Thibodaux, Louisiana)
TJ	Ontario (Canada) - Timberjack
Z	Zweibrucken (Germany)

Application Code

001, etc. ..... See ENGINE APPLICATION CHART, later in this Group



RG7010 –UN–26NOV97

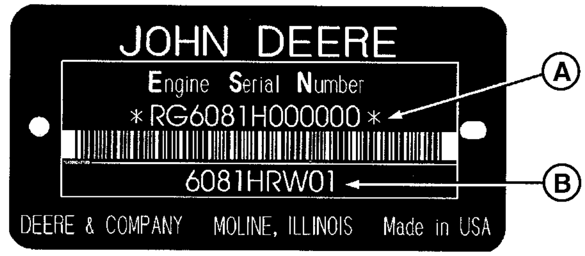
Engine Serial Number Plate

A—Engine Serial Number
B—Engine Model Designation

RG,RG34710,1021 –19–23OCT97–1/1

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.



RG7010 –UN–26NOV97

Engine Serial Number Plate

A—Engine Serial Number
B—Engine Application Data

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:

RG6081H000000
RG .... Factory code producing engine
6081H .... Engine model designation
000000 .... Sequential serial number
Factory Code
RG .... Waterloo Engine Works
Engine Model Designation
6801H .... (See ENGINE MODEL DESIGNATION.)
Sequential Number
000000 .... 6-digit sequential number

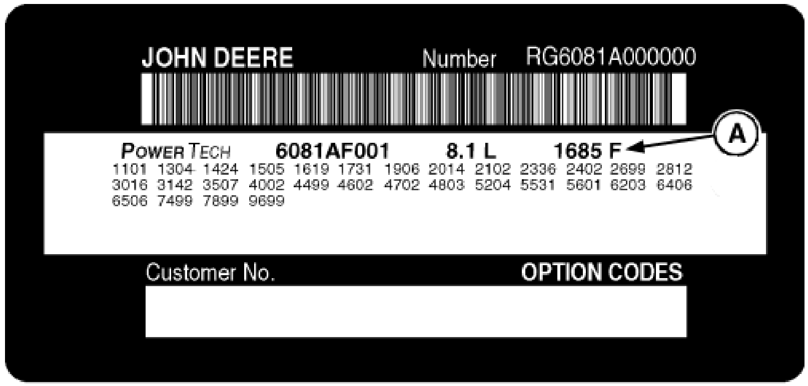
The engine serial number plate is located either on the right-hand side of engine between the oil filter base and fuel injection pump (viewed from flywheel end) or on the left-hand side of the engine directly above the starter motor.

Engine Application Data (B)

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

RG,RG34710,1022 –19–19MAY99–1/1

Engine Option Code Label



RG11074 –UN–14AUG00

Option Code Label

In addition to the serial number plate, later 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,OUO1004,900 –19–19MAY99–1/1

Engine Application Chart (John Deere Agricultural Equipment)

Machine Model	
DES MOINES—COTTON PICKERS & SPRAYERS	
9970 Cotton Picker	6081AN001
9976 Cotton Picker	6081HN001, 003
9986 Cotton Picker	6081HN003
4920 Sprayer	6081HN005
HARVESTER—COMBINES	
9510 Low Power Combine	6081HH001
9510 High Power Combine	6081HH002
9550 Low Power Combine	6081HH008
9550 High Power Combine	6081HH009
9610 Combine	6081HH003
9650 and 9650CTS Combine	6081HH010
9650 CTS-(Europe) Combine	6081HH011
9650 STS Combine	6081HH006
9750 STS Combine	6081HH005
CTS II Combine (Europe-1998 Model Year	6081HH003
CTS II Combine (Europe-1999 Model Year)	6081HH004
CTS II Combine (North America)	6081HH003
Amadus Peanut Combine	6081HH007

Continued on next page

RE38635,000003B –19–18JUL05–1/3

WATERLOO—TRACTORS

7710 Tractor 6081TRW01, 03, 05, 07, 09
7810 Tractor 6081TRW02, 04, 06, 08, 10, 11
7710/7810 Tractor .... 6081HRW43 (Tier II)
7820 Tractor 6081HRW41
7920 Tractor 6081HRW42
8100 Tractor 6081HRW06
8200 Tractor 6081HRW07
8300 Tractor 6081HRW08
8400 Tractor 6081HRW01, 04
8100T (Tracks) Tractor 6081HRW10
8200T (Tracks) Tractor 6081HRW02
8300T (Tracks) Tractor 6081HRW09
8400T (Tracks) Tractor 6081HRW03
8110 Tractor 6081HRW11
8210 Tractor 6081HRW13
8310 Tractor 6081HRW15
8410 Tractor 6081HRW17
8110T (Tracks) Tractor 6081HRW12
8210T (Tracks) Tractor 6081HRW14
8310T (Tracks) Tractor 6081HRW16
8410T (Tracks) Tractor 6081HRW18
8120/8220 Wheel/Tracks (W/T)Tractor 6081HRW23
8120/8220 Front Suspended Axle North America 6081HRW31
8120/8220 Front Suspended Axle Region II 6081HRW32
8320 W/T Tractor 6081HRW25
8320 Front Suspended Axle North America 6081HRW33
8320 Front Suspended Axle Region II 6081HRW34
8420W CIS Tractor (Wheels Only) 6081HRW26
8420 W/T Tractor 6081HRW27
8420 Front Suspended Axle Tractor North America 6081HRW35
8420 Front Suspended Axle Tractor Region II 6081HRW36
8520 W/T Tractor 6081HRW28
8520 Front Suspended Axle Tractor North America 6081HRW37
8520 Front Suspended Axle Tractor Region II 6081HRW38
9100 4-Wheel Drive Tractor 6081HRW05
9120 4-WD Wheels Tractor 6081HRW30

Continued on next page RE38635,000003B –19–18JUL05–2/3

ZWEIBRUCKEN—COMBINES/FORAGE HARVESTERS

2256 Combine 6081HZ003, 007
2258 Combine 6081HZ002, 05
2264 Combine 6081HZ002
2266 Combine 6081HZ001
2268 Combine 6081HZ006
9640/9640HM 6081HZ009
9640/9640HM & 9850/9850HM Combine ....
.... 6081HZ017 (replaces HZ009)
9680/9680HM Combine 6081HZ011
9780/9780HM Combine 6081HZ012
9680/9680HM & 9780/9780HM Combine ....
.... 6081HZ019 (replaces HZ011 & HZ012)
9660/9660HM Combine 6081HZ010
9660/9660HM Combine .... 6081HZ018 (replaces HZ010)
6650 Self-Propelled Forage Harvester 6081HZ004
7200 Self-Propelled Forage Harvester . 6081HZ013 (European Model)
7200 Self-Propelled Forage Harvester ....
.... 6081HZ016 (North American Model)

S.L.C. HORIZONTINA (BRAZIL)—COMBINES

1185A Combine 6081ACQ01

RE38635,000003B –19–18JUL05–3/3

Engine Application Chart (John Deere Construction Equipment)

Machine Model	
DAVENPORT	
644G Loader	6081HDW04
644H Loader	6081HDW05
644H-MH Loader	6081HDW06 (Tier I)
644H-MH Loader	6081HDW08 (Tier II)
724J Loader	6081HDW09 (Tier II)
740G/748G/748G II/748G III Skidder	6081TDW01
770C (Late)/770CH/772CH Motor Grader	6081HDW01
770C Motor Grader (Early)	6081HDW03
870C/872CH Motor Grader	6081HDW013
DUBUQUE	
762B Series II Scraper	6081AT001
850C Series II Crawler Dozer (822868—)	6081AT002
850J Crawler Dozer	6081HT006 Tier II
BELL EQUIPMENT - SOUTH AFRICA	
250D/300D Articulated Truck	6081HT003
L2006/L2306 Bell Loaders	6081HT007
DEERE-HITACHI (CANADA)	
2054 Logger (based on JD200 Excavator)	6081HT053
2554 Logger (based in JD230 Excavator	6081HT054
DEERE-HITACHI (JAPAN)	
330/370 Logger (based on JD330 Excavator)	6081HT002
WOODSTOCK, ON. (TIMBERJACK) & THIBODAUX, LA. (CAMECO)	
660D Skidder	6081ATJ02
530B/535 Log Loader	6081ATJ01, 03
608B Feller Buncher	6081HTJ07 (Tier II)
608S Feller Buncher	6081HTJ08 (Tier II)
1710 Forwarder	6081HTJ02
1270 Harvester	6081HTJ03
2500 Cane Harvester	6081HT801

RG41183,0000024 –19–25JAN01–1/1

Engine Application Chart (OEM) (Outside Equipment Manufacturers)

Application	Engine Model
OEM Engine (Tier I Emissions Certified)	**6081TF001**
OEM Engine (Tier I Emissions Certified)	6081AF001
OEM Engine (Tier I Emissions Certified)	6081HF001
Marine Engine	6081AFM01
OEM Engine (Tier II Emissions Certified)	6081HF070

RG41183,000003A –19–28FEB01–1/1

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 40 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%.

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

RG41165,0000071 –19–13MAR01–1/1

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 PS121, DIN 51606 or equivalent specification.

It has been found that bio-diesel fuels may improve lubricity in concentrations up to a 5% blend 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 the oil becomes diluted with fuel, shorten oil change intervals accordingly.

IMPORTANT: Raw pressed vegetable oils are NOT acceptable for use for 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

RG41183,0000046 –19–18DEC01–1/1

Lubricity of Diesel Fuel

Most diesel fuels manufactured in the United States, Canada, and the European Union have adequate lubricity to ensure proper operation and durability of fuel injection system components. However, diesel fuels manufactured in some areas of the world may lack the necessary lubricity.

IMPORTANT: Make sure the diesel fuel used in your machine demonstrates good lubricity characteristics.

Fuel lubricity should pass a minimum load level of 3100 grams as measured by ASTM D6078 or a 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 –19–27OCT05–1/1

Testing Diesel Fuel

DIESELSCAN™ is a John Deere fuel analysis program that can be used to monitor the quality of your fuel. The DIESELSCAN analysis verifies fuel type, cleanliness, water content, suitability for cold weather operation, and whether the fuel meets specifications.

Check with your John Deere dealer for availability of DIESELSCAN kits.

DIESELSCAN is a trademark of Deere & Company

DX,FUEL6 –19–14NOV05–1/1

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 Classification CE
- API Service Classification CD
- API Service Classification 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 PLUS	**API CF**
API CI-4	**ACEA E7**
API CH-4	**ACEA E6**
API CG-4	**ACEA E5**
API CF-4	**ACEA E4**
API CF-2	**ACEA E3**

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

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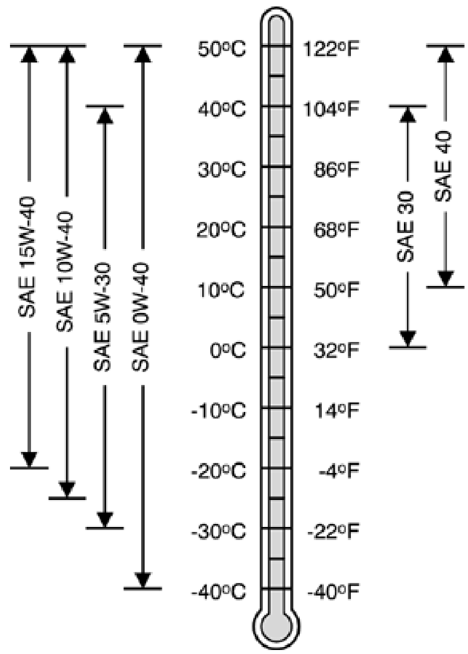
DX,ENOIL4 –19–19DEC05–1/1

Diesel Engine Oil



TS1681 –UN–18DEC03

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

John Deere PLUS-50™ oil is preferred

Oils meeting one of the following specifications are also recommended:

- ACEA Oil Sequence E7
- ACEA Oil Sequence E6
- ACEA Oil Sequence E5
- ACEA Oil Sequence E4

Extended service intervals may apply when John Deere PLUS-50, ACEA E7, ACEA E6, ACEA E5, or ACEA E4 engine oils are used. Consult your John Deere dealer for more information.

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

- John Deere TORQ-GARD SUPREME™
- API Service Category CI-4 PLUS
- API Service Category CI-4
- API Service Category CH-4
- API Service Category CG-4
- API Service Category CF-4
- ACEA Oil Sequence E3
- ACEA Oil Sequence E2

If oils meeting API CG-4, API CF-4, or ACEA E2 are used, reduce the service interval by 50%.

Multi-viscosity diesel engine oils are preferred.

Diesel fuel quality and fuel 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 0.50% (5000 ppm) is used, reduce the service interval by 50%. DO NOT use diesel fuel with sulfur content greater than 1.00% (10 000 ppm).

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

DX,ENOIL –19–23NOV05–1/1

Extended Diesel Engine Oil Service Intervals

When John Deere PLUS-50™, ACEA E7, ACEA E6, ACEA E5, or ACEA E4 oils are used with 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 E7, ACEA E6, 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 PLUS, API CI-4, API CH-4, or ACEA E3 oils are used, change the engine oil and filter at the normal service interval.

If API CG-4, API CF-4, or ACEA E2 oils are used, change the engine oil and filter at 50% of the normal service interval.

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

DX,ENOIL6 –19–19DEC05–1/1

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.

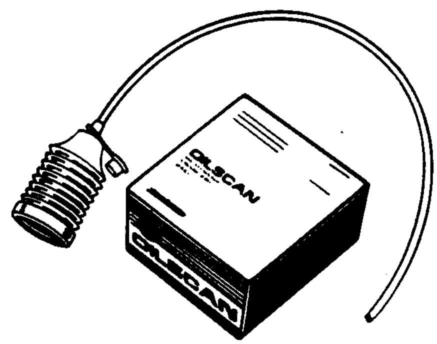
DX,LUBMIX –19–18MAR96–1/1

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.



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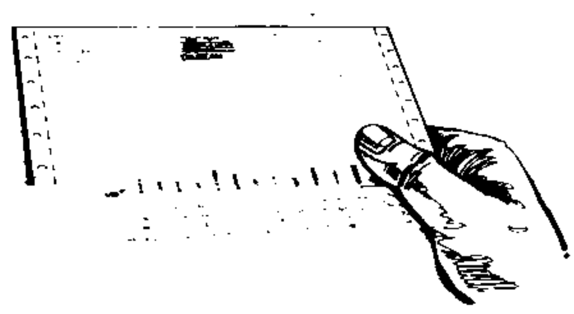

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OILSCAN is a registered trademark of Deere & Company.
CoolScan is a registered trademark of Deere & Company.

DPSG,OUOD002,1824 –19–02AUG00–1/1

Grease

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

John Deere SD POLYUREA GREASE is preferred.

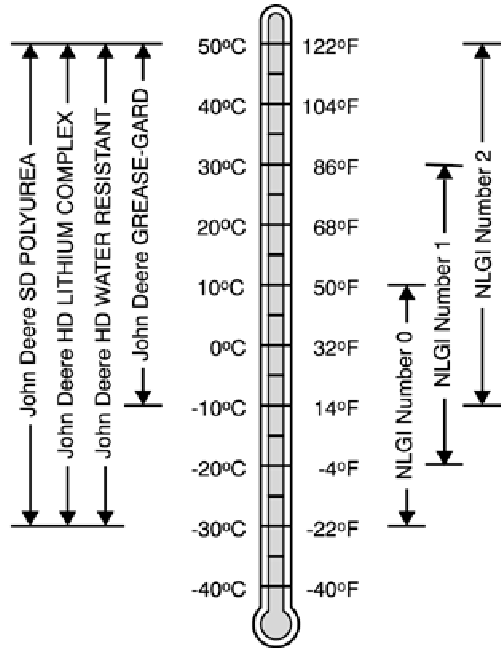
The following greases are also recommended

- 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 thickeners are not compatible with others. Consult your grease supplier before mixing different types of grease



TS1673 –UN–31OCT03

GREASE-GARD is a trademark of Deere & Company

DX,GREA1 –19–07NOV03–1/1

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 a concentration of either 50% ethylene glycol or 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

It is possible that neither John Deere COOL-GARD nor coolants meeting one of the coolant standards listed above is available in the geographical area where service is performed. If these coolants are unavailable, use a coolant concentrate or prediluted coolant with a quality additive package that provides cylinder liner cavitation protection and protects the cooling system metals (cast iron, aluminum alloys, and copper alloys such as brass) from corrosion.

The additive package must be part of one of the following coolant mixtures:

- 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

Water quality

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Continued on next page

DX,COOL3 –19–27OCT05–1/2

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.

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 –19–27OCT05–2/2

Diesel Engine Coolants, Supplemental Additive Information

Engine coolants are a combination of three chemical components: ethylene glycol (antifreeze), inhibiting coolant additives, and quality water.

Coolant Specifications

Some products, including John Deere COOL-GARD Prediluted Coolant, are fully formulated coolants that contain all three components in their correct concentrations. Do not add an initial charge of supplemental coolant additives to these fully formulated products.

Some coolant concentrates, including John Deere COOL-GARD Coolant Concentrate, contain both ethylene glycol antifreeze and inhibiting coolant additives. Mix these products and quality water, but do not add an initial charge of supplemental coolant additives.

Coolants meeting ASTM D5345 (prediluted coolant) or ASTM D4985 (coolant concentrate) require an initial charge of supplemental coolant additives.

Replenish Coolant Additives

The concentration of coolant additives is gradually depleted during engine operation. Periodic replenishment of inhibitors is required, even when John Deere COOL-GARD is used. Follow the recommendations in this manual for the use of supplemental coolant additives.

Why Use Supplemental Coolant Additives?

Operating without proper coolant additives will result in increased corrosion, cylinder liner erosion and pitting, and other damage to the engine and cooling system. A simple mixture of ethylene glycol and water will not give adequate protection.

Use of supplemental coolant additives reduces corrosion, erosion, and pitting. These chemicals reduce the number of vapor bubbles in the coolant and help form a protective film on cylinder liner surfaces. This film acts as a barrier against the harmful effects of collapsing vapor bubbles.

Avoid Automotive-Type Coolants

Never use automotive-type coolants (such as those meeting ASTM D3306 or ASTM D4656). These coolants do not contain the correct additives to protect heavy-duty diesel engines. They often contain a high concentration of silicates and may damage the engine or cooling system.

Non-Aqueous Propylene Glycol

Non-aqueous propylene glycol should not be used with John Deere diesel engines. This coolant works best with coolant temperatures above the acceptable engine operating range. This could decrease engine life due to lower engine oil viscosity. In addition, electronically controlled engines could experience premature power de-rate due to high coolant temperature.

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 base engine coolant concentrate. All water used in the cooling system should meet the following minimum specifications for quality:

Chlorides	40 mg/L or less
Sulfates	100 mg/L or less
Total Dissolved Solids	340 mg/L or less
Total Hardness	170 mg/L or less
pH Level	5.5 to 9.0

Freeze Protection

The relative concentrations of ethylene glycol and water in the engine coolant determine its freeze protection limit. Refer to the chart on the following page.

Continued on next page

DPSG,OUOD002,1835 –19–03AUG00–1/2

Ethylene Glycol	Freeze Protection Limit
40%	-24°C (-12°F)
50%	-37°C (-34°F)
60%	-52°C (-62°F)

DO NOT use a coolant-water mixture greater than 60% ethylene glycol.

DPSG,OUOD002,1835 –19–03AUG00–2/2

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.

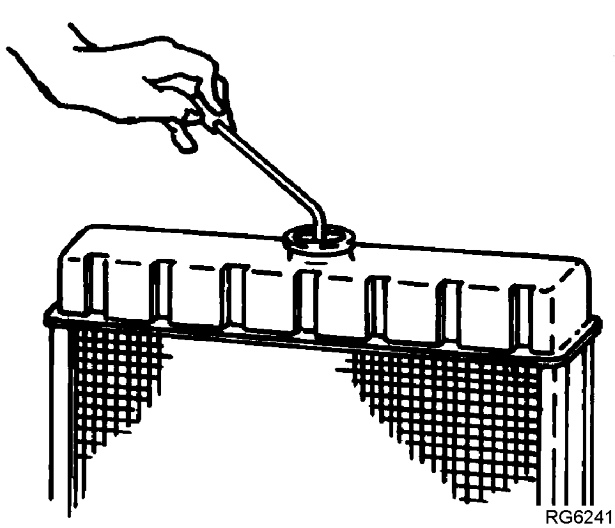
Compare the results to the supplemental coolant additive (SCA) chart to determine the amount of inhibiting additives in your coolant and whether more John Deere COOLANT CONDITIONER should be added.

CoolScan

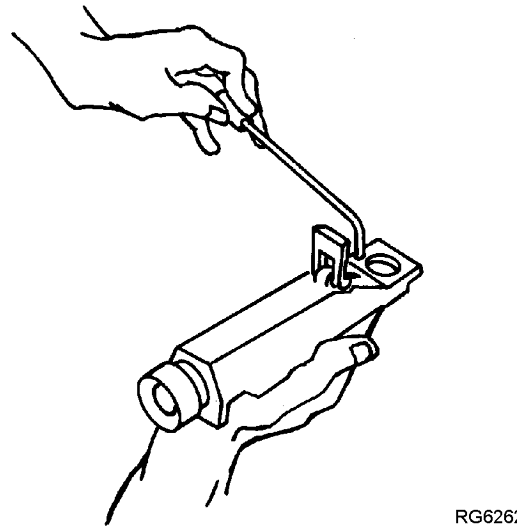
For a more thorough evaluation of your coolant, perform a CoolScan analysis. See your John Deere dealer for information about CoolScan.

DPSG,OUOD002,1825 –19–02AUG00–1/1

Replenishing Supplemental Coolant Additives (SCAs) Between Coolant Changes



RG6241 RG6261 –UN–08DEC97



RG6262 RG6262 –UN–05DEC97

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.

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 Coolant/Battery Tester.

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, 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. See CHECKING COOLING SYSTEM in 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. See LUBRICATION AND MAINTENANCE SERVICE INTERVAL CHART in operator's manual.

Flush cooling system as described in your operator's manual. See FLUSHING COOLING SYSTEM in 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 DIESEL ENGINE COOLANT, 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

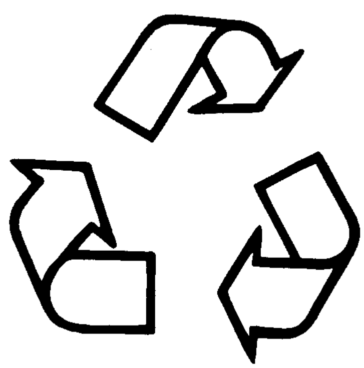
Disposing of Coolant

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.



TS1133 –UN–26NOV90

RG,01,DT7032 –19–29OCT97–1/1

Section 02
Repair and Adjustments

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02

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.

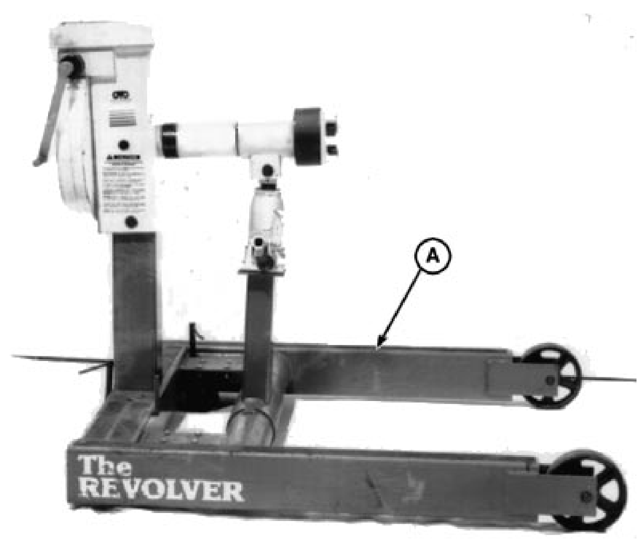
DPSG,OUO1032,3410 –19–15JUN00–1/1

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 SAE Grade 8 or higher socket head cap screws must be used to mount adapters or engine. Use LOCTITE® 242 Thread Lock and Sealer on cap screws when installing lifting straps on engine. Tighten cap screws to 170 N•m (125 lb-ft).

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.

To avoid an unsafe off-balance load condition, 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 low and the possibility of tipping low.

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

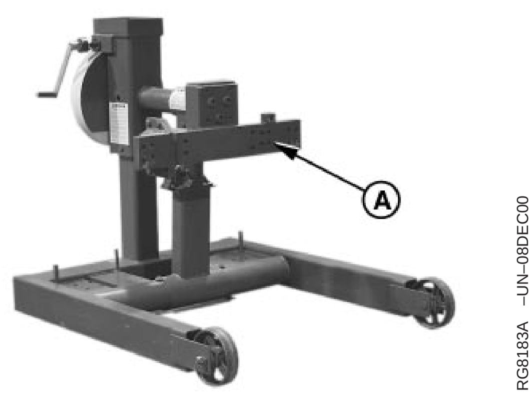
LOCTITE is a registered trademark of Loctite Corp.

RG,RG34710,1044 –19–23OCT97–1/1

Install Adapters on Engine Repair Stand

Attach the No. 205466 Engine Adapter (A) to mounting hub of the engine repair stand using SAE Grade 8 socket-head screws. Tighten screws to 135 N•m (100 lb-ft).

A—Engine Adapter



Adapter for Engine Repair Stand

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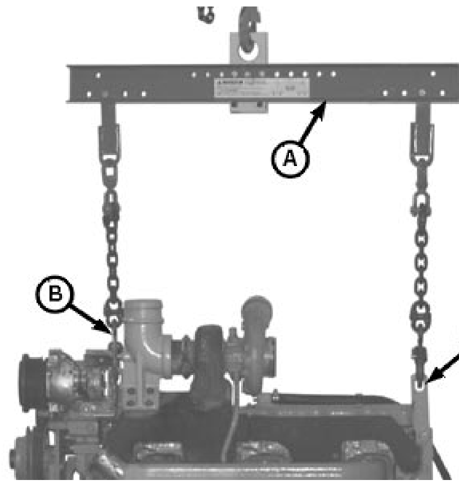
Engine Lifting Procedure



RG10053 –UN–23JUN99

Engine Lifting Sling and Straps

A—Engine Lifting Sling
B—Engine Lifting Straps

CAUTION: The only recommended method for lifting the 6081 engine is with JDG23 Engine Lifting Sling and safety approved lifting straps that come with engine. 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.

1. Install lift straps provided with engine and torque to the following specifications.

Specification

Engine Lift Straps (Provided with engine from factory)—Torque .... 197 N•m (145 lb-ft)

2. Attach JDG23 Engine Lifting Sling (A) to engine lifting straps (B) and to overhead hoist or floor crane.

Continued on next page DPSG,OUO1004,902 –19–13DEC00–1/2

NOTE: If engine lifting straps are misplaced, they should be procured through service parts or SERVICEGARD™. Use of an engine lifting sling (as shown) is the ONLY APPROVED method for lifting engine.

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.

3. Carefully lift engine to desired location.

DPSG,OUO1004,902 –19–13DEC00–2/2

Clean Engine

1. Cap or plug all openings on engine. If electrical components (starter, alternator, etc.) are not removed prior to cleaning, cover with plastic and tape securely to prevent moisture from entering.

2. Steam-clean engine thoroughly.

IMPORTANT: Never steam clean or pour cold water on an injection pump while it is still warm. To do so may cause seizure of pump parts. Also, avoid electrical components, wiring, the ECU, and sensors.

RG,RG34710,1047 –19–23OCT97–1/1

Disconnect Turbocharger Oil Inlet Line

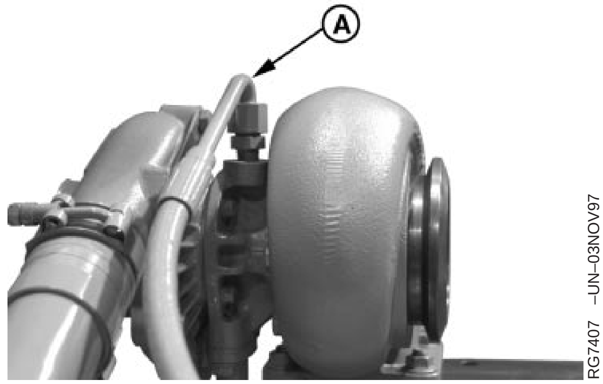
1. Drain all engine oil and coolant, if not previously done.

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.



Turbocharger Oil Inlet Line

A—Turbocharger Oil Inlet Line

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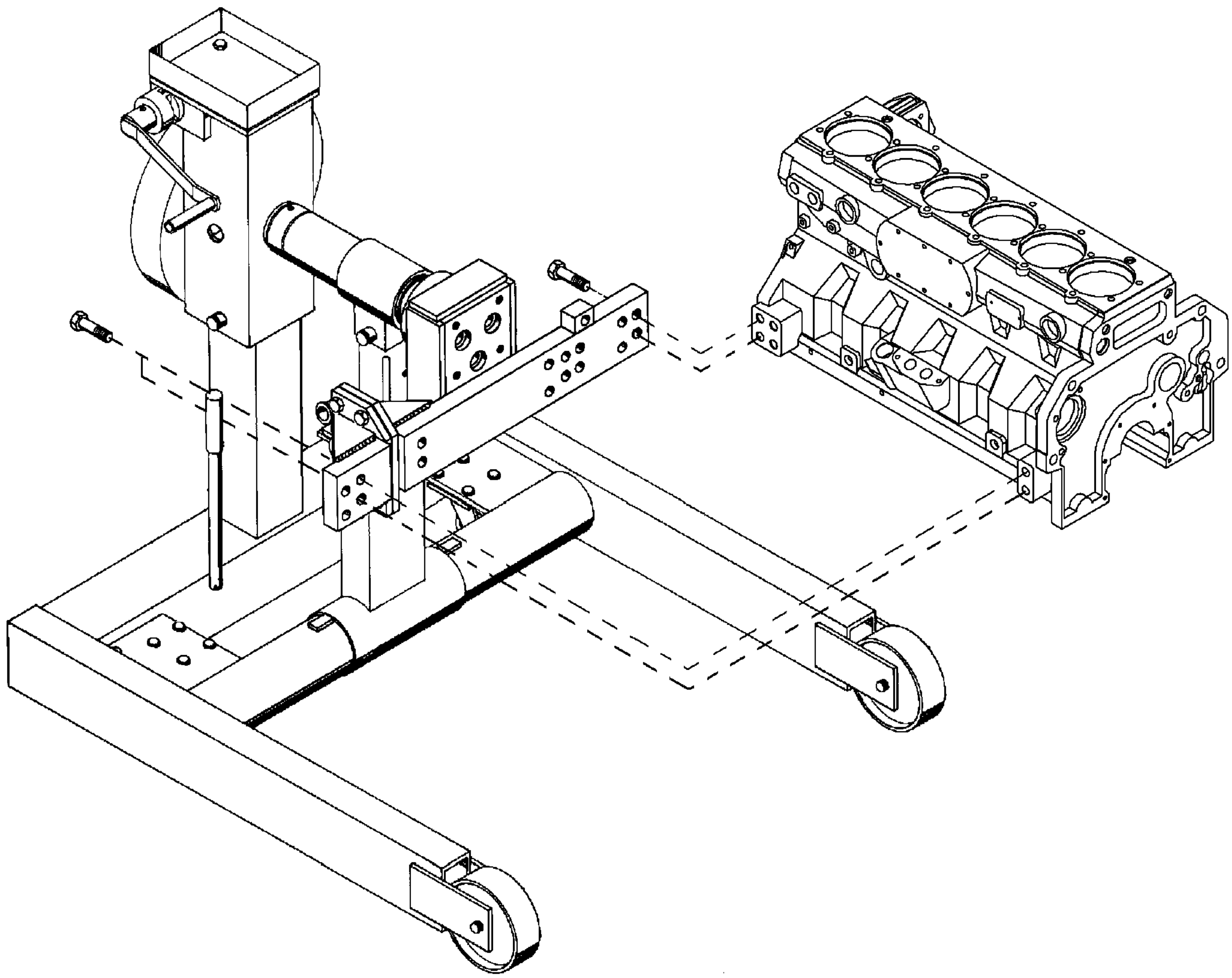
Mount Engine on Repair Stand



Mounting Engine on Repair Stand

Continued on next page RG,RG34710,1049 –19–08JUN99–1/2

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.

NOTE: If starter motor or crankshaft driven auxiliary drive accessory is to be removed from engine, remove before mounting engine onto repair stand.

1. Mount the starter side of the engine to the engine adapter with four SAE Grade 8 (or higher grade) cap screws in the following sizes:

Engine-to-Stand Cap Screws

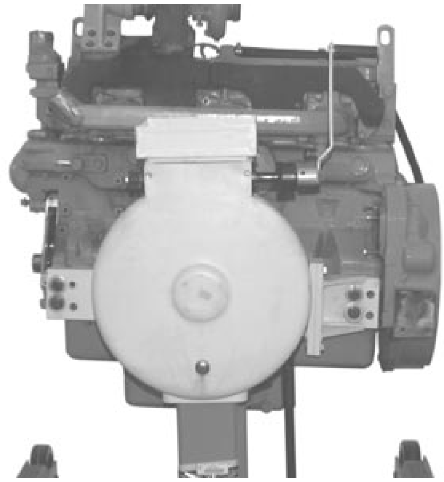
6081AT001	5/8-11UNC x 2-1/2 in.
6081TDW01	5/8-11UNC x 2-1/2 in.
6081TRW01	5/8-11UNC x 2-1/2 in.
6081TRW02	5/8-11UNC x 2-1/2 in.
6081TRW09	5/8-11UNC x 2-1/2 in.
6081TRW10	5/8-11UNC x 2-1/2 in.
6081TRW11	5/8-11UNC x 2-1/2 in.
All Other 6081 Engines	5/8-11UNC x 3-1/2 in.

2. Tighten cap screws to 203 N•m (150 lb-ft).

3. Carefully remove lift sling from engine.

   To remove engine from repair stand, reverse the installation procedure.

   To install engine in vehicle, refer to machine technical manual.



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Engine on Repair Stand

RG,RG34710,1049 –19–08JUN99–2/2

Engine Disassembly Sequence for Overhaul

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

1. Drain all coolant and engine oil. Check engine oil for metal contaminates.

2. Remove turbocharger oil inlet line and oil return line. Remove turbocharger.

3. Remove fan pulley and coolant manifold assembly.

4. Remove coolant pump assembly from timing gear cover.

NOTE: DO NOT damage option code label (if equipped), when removing rocker arm cover.

5. Remove breather hose from rocker arm cover. Remove rocker arm cover. Remove carrier, if equipped.

6. Remove rocker arm assembly(ies) and push rods. Identify parts for reassembly.

7. Remove front crankshaft pulley and damper assembly.

8. Remove fuel injection lines, fuel connectors, and injection nozzles.

9. Remove engine oil filter, filter base, and valve housing.

10. Remove fuel filter and mounting base. Remove injection pump gear cover and remove injection pump. Remove all remaining fuel lines.

11. Remove high pressure common rail, if equipped.

12. Remove engine oil cooler assembly.

13. Remove front and rear exhaust manifolds.

14. Remove air intake manifold.

NOTE: ALWAYS bolt down liners when rotating engine flywheel with cylinder head removed.

15. Remove cylinder head with assembly. Remove head gasket.

16. Revolve engine on repair stand and remove engine oil pump assembly.

17. Remove front timing gear cover.

18. Revolve engine to vertical position. Remove pistons and connecting rods. Identify for reassembly. Perform bearing-to-journal wear checks with PLASTIGAGE®.

19. On SAE No. 3 flywheel housings, remove flywheel housing and then remove flywheel.

20. On SAE No. 1 and 2 flywheel housings, remove flywheel and then remove flywheel housing.

21. Remove main bearing caps and remove crankshaft. Perform bearing-to-journal wear checks with PLASTIGAGE®.

22. Remove camshaft and cam followers. Identify for reassembly.

23. Revolve engine to horizontal position, remove liners, O-rings, and packings. Mark liners for reassembly in same bore from which removed.

24. Remove piston cooling orifices from cylinder block.

25. Remove any sensors/gauges, cylinder block plugs and engine serial number plate, if block is to be put in a “hot tank”.

26. Refer to appropriate group for inspection and repair of engine components.

PLASTIGAGE is a registered trademark of 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 assure hardware retention. ALWAYS use the following recommended sealants when assembling your John Deere Diesel Engine to assure 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 exists, clean with solvent. Refer to John Deere Merchandise and Parts Sales Manual for ordering information.

AR31790 SCOTCH-GRIP® EC1099 Plastic Adhesive:

- AR31790 118 ml (4 oz)

Rocker arm cover gasket

LOCTITE® 242—Thread Lock & Sealer (Medium Strength) (Blue):

- TY9370 6 ml (0.2 oz) tube
- T43512 50 ml (1.7 oz) bottle

Plugs and fittings: fuel filter base, intake manifold, cylinder block (oil galley).

Injection pump timing hole plug.

Cap screws: injection pump access cover, electronic tachometer cover, oil filler inlet, oil filter adapter, flywheel, coolant manifold.

Oil pressure sending unit.

LOCTITE® 592 Pipe Sealant with TEFLON® (White):

- TY9374 6 ml. (0.2 oz) tube
- TY9375 50 ml. (1.7 oz) bottle

Pipe plugs: cylinder block (coolant manifold), thermostat housing, air intake manifold, and coolant pump.

Coolant pump and block coolant drain valves

Injection pump governor cover fitting (fuel return)

Fuel filter drain and bleed plugs

Threaded nipples and elbows in coolant pump housing

Temperature sending unit and switch

Oil pan (drain hose, drain valve and elbow)

Connectors: turbo line and turbo drain

Adapter fitting for turbo oil inlet line

LOCTITE® 680 Retaining Compound (Green):

- TY15969 50 ml. (1.7 oz) bottle

Expansion (frost) plugs in cylinder block

Wear sleeve-to-crankshaft

PERMATEX Aviation (Form-A-Gasket No. 3):

- TY6299 227 g (8oz) container

Rear camshaft bore steel cap plug

Oil pan gasket surfaces

PT569 NEVER-SEEZ® Compound:

- PT569 227 g (8 oz) Brush
- PT506 453 g (16 oz) Spray

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SCOTCH-GRIP is a registered trademark of 3M Co.
TEFLON is a registered trademark of Du Pont Co.
NEVER-SEEZ is a registered trademark of Emhart Chemical Group.

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Cap Screws: turbocharger mounting and aftercooler cover.

Cap Screws: reinstallation of special 12-point flange head cap screws on exhaust manifold of 8000 Series tractors.[1]

Injection nozzle gland nut threads and barrel

LOCTITE® 51048 Moly Paste

Camshaft nose (gear installation)

[1]Special 12-point flange head cap screws have pre-applied anti-sieze compound. Apply additional compound for reuse only.

RG,RG34710,1051 –19–23OCT97–2/2

6081 Engine Assembly Sequence After Overhaul

The following assembly sequence is suggested when engine has been completely disassembled. Be sure to check run-out specifications, clearance tolerances, torques, etc. as engine is assembled. Refer to the appropriate repair group when assembling engine components.

6081 Engine Assembly Sequence After Overhaul Serial Number (—199,999)

1. Install all plugs in cylinder block that were removed to service block. Install engine serial number plate.

2. Install piston cooling orifices.

3. Install cylinder liners without O-rings and measure liner stand-out. Install liner O-rings in block and packings on liners. Install liners.

NOTE: If new piston and liner kit assemblies are being installed, install the crankshaft first.

4. Install main bearings and crankshaft. Rotate crankshaft to assure correct assembly. Check crankshaft end play.

NOTE: ALWAYS bolt liners down before rotating engine with cylinder head removed.

   If installing new piston/liner kits, assemble kits onto the respective connecting rods using NEW snap rings. Bolt liners down as each kit is installed.

5. Install engine flywheel and housing, if applicable:

   - SAE 3: Flywheel goes on before housing.
   - SAE 1 and SAE 2: Housing goes on before flywheel.

6. Install piston and rod assemblies. Bolt liners down after each piston assembly is installed.

7. Install crankshaft rear oil seal housing and check runout. Install rear oil seal and wear sleeve.

8. Install cam followers in hole from which originally removed.

9. Install camshaft. Align timing marks (camshaft-to-crankshaft gears) with No. 1 piston at “TDC” compression stroke.

10. Install engine oil pump assembly.

11. Install fuel injection pump and drive gear.

12. Install engine oil cooler assembly.

13. Install filter base, valve housing, and new oil filter.

14. Install cylinder head, push rods, and rocker arm assembly. Measure valve lift and adjust valve clearance.

15. Install rocker arm cover. Install breather hose.

16. Install air intake manifold.

17. Install front and rear exhaust manifolds.

18. Install timing gear cover. Install front crankshaft wear sleeve and oil seal.

19. Install coolant pump assembly and coolant manifold.

20. Install turbocharger. Install turbocharger oil inlet line and oil return line.

21. Install fuel injection nozzles and delivery line assembly.

22. Install fuel filter base, supply lines, and filter.

23. Install front pulley and new damper as an assembly.

24. Install fan pulley assembly. Install starter motor.

Continued on next page

RG,RG34710,1052 –19–08JUN99–1/3

25. Fill engine with clean oil. Install dipstick.

26. Flush cooling system and refill with proper coolant.

27. Perform engine break-in and normal standard performance checks. See ENGINE BREAK-IN GUIDELINES later in this group.

6081 Engine Assembly Sequence After Overhaul Serial Number (200,000—)

1. Install all plugs in cylinder block that were removed to service block. Install engine serial number plate.

2. Install piston cooling orifices.

3. Install cylinder liners without O-rings and measure liner stand-out. Install liner O-rings in block and packings on liners. Install liners.

NOTE: If new piston and liner kit assemblies are being installed, install the crankshaft first.

4. Install main bearings and crankshaft. Rotate crankshaft to assure correct assembly. Check crankshaft end play.

NOTE: ALWAYS bolt liners down before rotating engine with cylinder head removed.

   If installing new piston/liner kits, assemble kits onto the respective connecting rods using NEW snap rings. Bolt liners down as each kit is installed.

5. Install engine flywheel and housing, if applicable:

   - SAE 3: Flywheel goes on before housing.
   - SAE 1 and SAE 2: Housing goes on before flywheel.

6. Install piston and rod assemblies. Bolt liners down after each piston assembly is installed.

7. Install crankshaft rear oil seal housing and check runout. Install rear oil seal and wear sleeve.

8. Install cam followers in hole from which originally removed.

9. Install camshaft. Align timing marks (camshaft-to-crankshaft gears) with No. 1 piston at “TDC” compression stroke.

10. Install engine oil pump assembly.

11. Install high pressure common rail.

12. Install fuel injection pump and drive gear.

13. Install engine oil cooler assembly.

14. Install fuel filter base, supply lines, and filter.

15. Install oil filter base, valve housing, and new oil filter.

16. Install cylinder head, push rods, rocker arm assemblies, electronic injectors, and fuel connectors.

17. Install carrier, rocker arm cover, and breather hose.

18. Install air intake manifold.

19. Install front and rear exhaust manifolds.

20. Install timing gear cover. Install front crankshaft wear sleeve and oil seal.

21. Install coolant pump assembly and coolant manifold.

22. Install turbocharger. Install turbocharger oil inlet line and oil return line.

23. Install fuel leak-off lines and high pressure fuel delivery lines.

24. Install front pulley and new damper as an assembly.

25. Install fan pulley assembly. Install starter motor.

26. Fill engine with clean oil. Install dipstick.

27. Flush cooling system and refill with proper coolant.

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28. Perform engine break-in and normal standard performance checks. See ENGINE BREAK-IN GUIDELINES later in this group.

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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. (Check and reset valve clearance.)

Injection pump has been removed or critical adjustments have been made while it is on the engine. (Primary objective is to check power).

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Perform Engine Break-In

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.

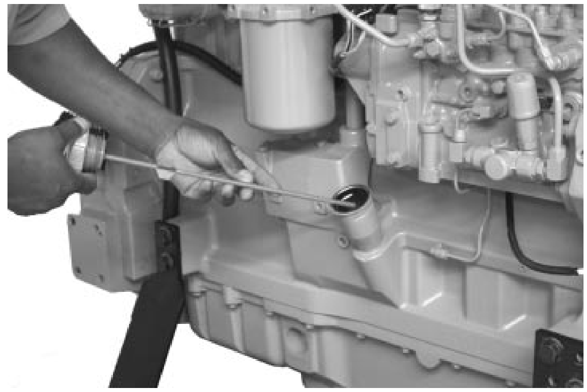
DO NOT fill above the crosshatch pattern or FULL mark. Oil levels anywhere within the crosshatch are acceptable.

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.



RG7359 –UN–20JUN00

Check Engine Oil Level

RG5895 –UN–13AUG91

Engine Oil Level Dipstick

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RG,100,JW7645 –19–21NOV97–1/3

PRELIMINARY ENGINE BREAK-IN AFTER MAJOR OVERHAUL

Time	Load	Engine Speed
1 minute	No load	850 rpm
2 minutes	No load	Fast Idle
15 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.

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.

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

Continued on next page

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.

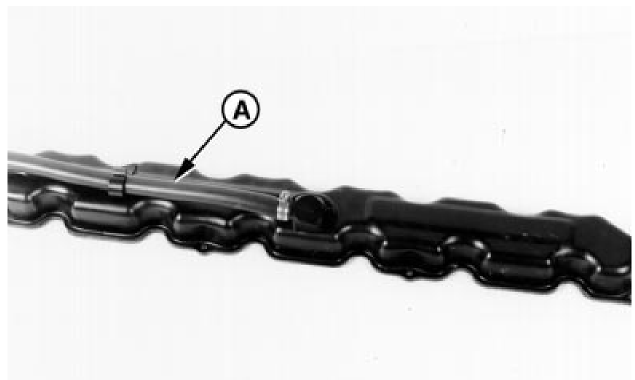
RG,100,JW7645 –19–21NOV97–3/3

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



Crankcase Vent Tube

RG,RG34710,1055 –19–23OCT97–1/1

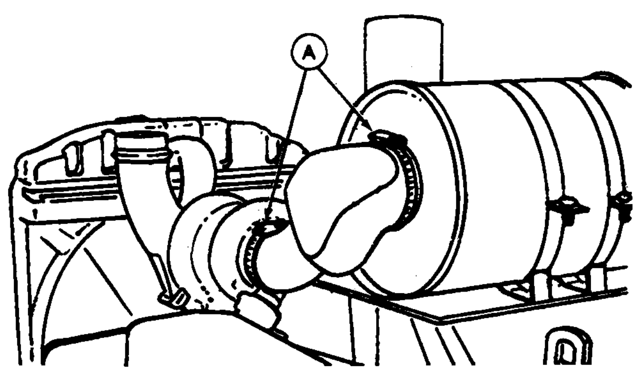
Check Air Intake System

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

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

3. Check hose clamps (A) 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.

A—Hose Clamps



Air Intake Hose Clamps

RG,RG34710,1056 –19–23OCT97–1/1

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

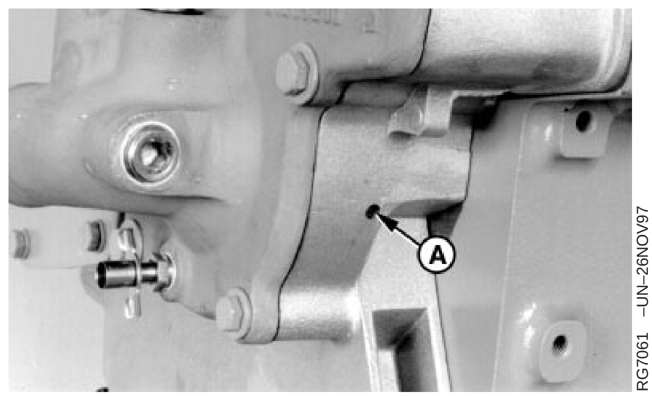
1. Remove trash that has accumulated on or near radiator.

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 timing gear cover.



Cooling System Weep Hole with Foam Filter

A—Weep Hole

Continued on next page

RG,RG34710,1058 –19–23OCT97–1/2

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

IMPORTANT: Both coolant pump drain valve and block drain valve must be opened to completely drain the engine.

6. Remove and check thermostat(s). See REMOVE AND TEST THERMOSTATS in Group 070.

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.

8. Fill cooling system with coolant. See DIESEL ENGINE COOLANT in Group 002.

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

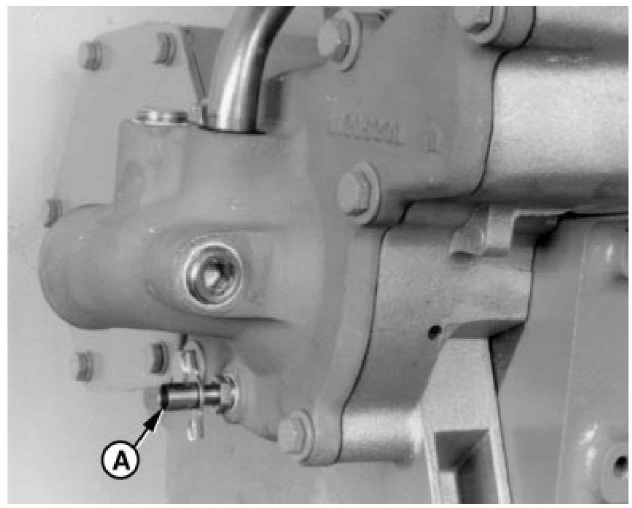
10. After engine cools, check coolant level.

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 Group 150.

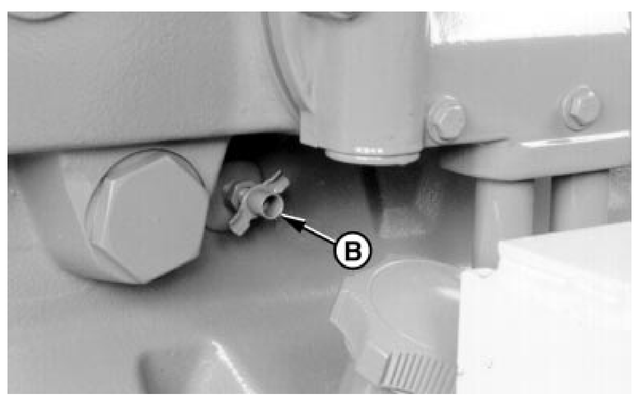
TS281 –UN–23AUG88

Service Cooling System Safely



RG7044 –UN–26NOV97

Coolant Pump Drain Valve



RG7143 –UN–26NOV97

Cylinder Block Coolant Drain Valve

A—Coolant Pump Drain Valve
B—Block Drain Valve

RG,RG34710,1058 –19–23OCT97–2/2

Check Electrical System

TS204 –UN–23AUG88

Prevent Battery Explosions

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.

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.**

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 CHECKING BELT TENSIONER SPRING TENSION AND BELT WEAR in Group 070.

Continued on next page

7. Check operation of starter motor and instruments.

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

RG,RG34710,1059 –19–23OCT97–2/2

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: Engines that are equipped with electronically-controlled governors have a diagnostic feature that will display detailed codes to alert operator of specific performance problems. Refer to CTM68, Electronic Fuel Injection Systems, for diagnostic code troubleshooting procedures on Bosch ECU control systems. Refer to CTM134 for John Deere Level 3 ECU controls. Refer to CTM255 for John Deere Level 9 ECU controls.

Operation	Detailed Reference
Change engine oil and filters.	Operator's Manual
Lubricate PTO clutch internal levers and linkage, if equipped.	Operator's Manual
Replace fuel filter.	CTM134/CTM243/CTM255/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.	Group 150
Check fuel injection system: Check engine/injection pump timing: check and adjust speed advance; clean injection nozzles, and adjust opening pressure.	CTM134/CTM243/CTM255
Check engine oil pressure. Correct as necessary.	Group 150
Check engine valve clearance. Adjust if necessary.	Group 020/Group 021
Check engine speeds. Correct as necessary.	Authorized Servicing Dealer
Check engine performance on dynamometer.	This Group

RG,RG34710,1061 –19–08JUN99–1/1

Check and Adjust Valve Clearance Serial Number (—199,999)

NOTE: For later engines (Tier II, ESN 200,000 —) with the High Pressure Common Rail (HPCR) fuel systems, see Group 21 - Cylinder Head and Valves Repair and Adjustment S.N.(200,000 —)

Too little valve clearance throws valves out of time. Valves open too early and close too late. This causes the valves to overheat due to hot combustion gases rushing past valves when out of time. Overheating lengthens valve stems which prevents proper seating of valves. The valves seat so briefly or poorly that normal heat transfer into the cooling system does not have time to take place, causing burned valves and low power.

Too much valve clearance causes a lag in valve timing causing engine valve train imbalance. The fuel-air mixture enters the cylinders late during intake stroke. The exhaust valve closes early and prevents waste gases from being completely removed from cylinders. Also, the valves close with a great deal of impact, which may crack or break the valves and scuff the camshaft and followers.

CAUTION: To prevent accidental starting of engine while performing valve adjustments, always disconnect NEGATIVE (—) battery terminal.

IMPORTANT: Valve clearance MUST BE checked and adjusted with engine COLD.

1. Remove rocker arm cover with ventilator tube.

IMPORTANT: Visually inspect contact surfaces of valve tips and rocker arm wear pads. Check all parts for excessive wear, breakage, or cracks. Replace parts that show visible damage.

Rocker arms that exhibit excessive valve clearance should be inspected more thoroughly to identify damaged parts.

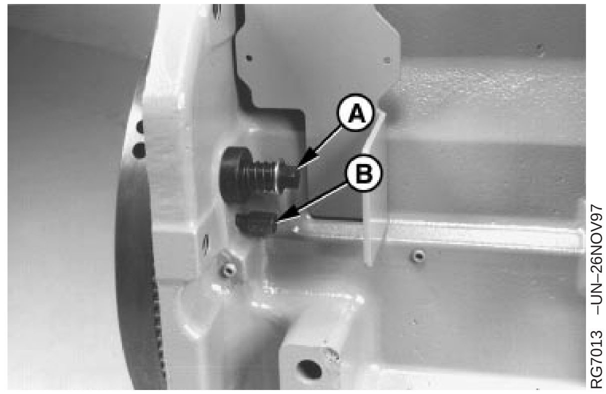
Continued on next page
DPSG,OUO1004,829 –19–13DEC00–1/4

2. Remove plastic plug from cylinder block bores and install JDE81-1 or JDG820 Flywheel Turning Tool (A) and JDE81-4 Timing Pin (B).

3. Rotate engine with the flywheel turning tool until timing pin engages timing hole in flywheel.

   If the rocker arms for No. 1 (front) cylinder are loose, the engine is at No. 1 "TDC-Compression."

   If the rocker arms for No. 6 (rear) cylinder are loose, the engine is at No. 6 "TDC-Compression." Rotate the engine one full revolution (360°) to No. 1 "TDC-Compression."



Flywheel Turning Tool and Timing Pin

A—Flywheel Turning Tool
B—Timing Pin

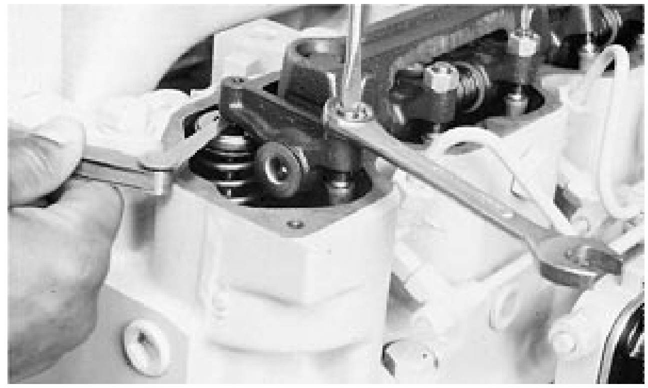
Continued on next page DPSG,OUO1004,829 –19–13DEC00–2/4

4. With engine lock-pinned at “TDC” of No. 1 piston’s compression stroke, check valve clearance on Nos. 1, 3, and 5 exhaust valves and Nos. 1, 2, and 4 intake valves.

Specification

Intake Valve Clearance Checking (Rocker Arm-to-Valve Tip With Engine Cold)—Clearance .... 0.41—0.51 mm (0.016—0.020 in.)

Exhaust Valve Clearance Checking (Rocker Arm-to-Valve Tip With Engine Cold)—Clearance .... 0.66—0.76 mm (0.026—0.030 in.)



RG5241 –UN–06DEC88

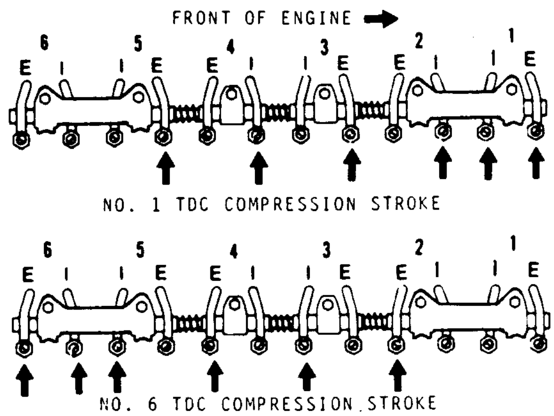
Adjusting Valve Clearance

5. Rotate flywheel 360° until No. 6 piston is at “TDC” of its compression stroke. Rocker arms for No. 6 piston should be loose.

6. Check valve clearance to the same specifications on Nos. 2, 4, and 6 exhaust and Nos. 3, 5, and 6 intake valves.

NOTE: *Adjust valve clearance in the same sequence used for checking clearance.*

7. If valve clearance needs to be adjusted, loosen the lock nut on rocker arm adjusting screw. Turn adjusting screw until feeler gauge slips with a slight drag. Hold the adjusting screw from turning with screwdriver and tighten lock nut to specifications.



RG4295 –19–21AUG91

Valve Adjusting Sequence

Specification

Valve Adjusting Screw Lock Nut—Torque .... 27 N•m (20 lb-ft)

Recheck clearance again after tightening lock nut and compare to the following specifications. Readjust clearance as necessary.

Specification

Intake Valve Clearance Adjustment (Rocker Arm-to-Valve Tip With Engine Cold)—Clearance .... 0.46 mm (0.018 in.)

Exhaust Valve Clearance Adjustment (Rocker Arm-to-Valve Tip With Engine Cold)—Clearance .... 0.71 mm (0.028 in.)

Continued on next page

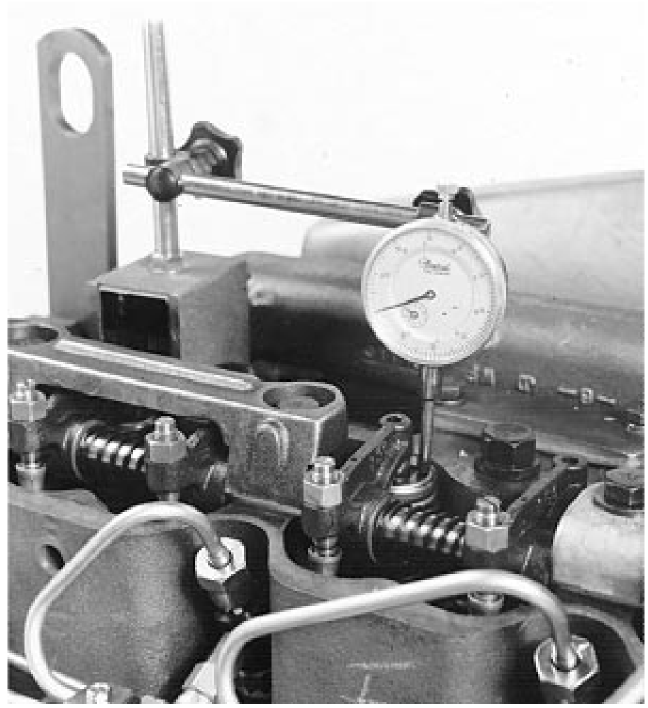
8. Install rocker arm cover and tighten cap screws to specifications.

Specification

Rocker Arm Cover-to-Cylinder
Head Cap Screws—Torque .... 8 N•m (6 lb-ft) (72 lb-in.)

DPSG,OUO1004,829 –19–13DEC00–4/4

Check Valve Lift Serial Number (—199,999)



Checking Valve Lift

IMPORTANT: For a more accurate measurement, it is recommended that valve lift be measured at 0.00 mm (in.) valve clearance and with engine COLD.

NOTE: Measuring valve lift can give an indication of wear on camshaft lobes and cam followers or bent push rods.

1. Remove turbocharger oil inlet clamp and rocker arm cover. Loosen lock nut on rocker arm. Set valve clearance at 0.00 mm (in.) on valve being checked. Tighten lock nut.

2. Put dial indicator tip on valve rotator, as shown. Be sure that valve is fully closed.

3. Check pre-set on dial indicator. Set dial indicator pointer at zero.

4. Manually turn engine in running direction, using the engine rotation tools previously mentioned for checking valve clearance.

5. Observe dial indicator reading as valve is moved to fully open position. Record reading and valve number.

Specification

Intake Valve—Lift	13.53—13.71 mm (0.533—0.540 in.) at 0.00 mm (in.)
Wear Tolerance	12.65 mm (0.498 in.) at 0.00 mm (in.) clearance
Exhaust Valve—Lift	14.52—14.70 mm (0.572—0.579 in.) at 0.00 mm (in.)
Wear Tolerance	13.64 mm (0.537 in.) at 0.00 mm (in.) clearance

6. Repeat procedure on all remaining valves.

7. Reset valve clearance to specification after measuring lift. See CHECK AND ADJUST VALVE CLEARANCE SERIAL NUMBER (—199,999) earlier in this group.

DPSG,OUO1004,830 –19–27APR99–1/1

Remove Cylinder Head Serial Number (—199,999)

It is not necessary to remove engine from machine to service cylinder head on all applications. Refer to your Machine Technical Manual for engine removal procedure, if required.

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

DO NOT drain coolant until the coolant temperature is below operating temperature. Always loosen drain valve slowly to relieve any excess pressure.

TS218 –UN–23AUG88

Service Cooling System Safely

1. Drain engine oil and coolant. Disconnect turbocharger oil inlet line at turbocharger or oil filter base. See DISCONNECT TURBOCHARGER OIL INLET LINE in Group 010.

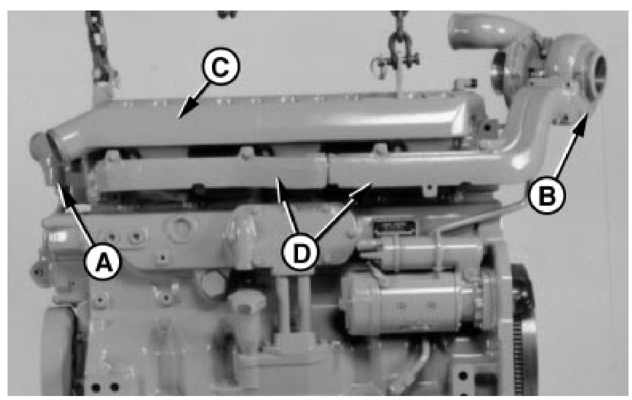
NOTE: If cylinder head is being removed for piston and liner repairs or any other service that does not require disassembly of head, cylinder head can be removed with coolant manifold (A), turbocharger (B), intake manifold (C), and exhaust manifold (D) installed.

2. Remove coolant manifold and all coolant piping. See REMOVE COOLANT MANIFOLD in Group 070.

3. Remove turbocharger. See REMOVE TURBOCHARGER in Group 080. Remove front and rear exhaust manifold (D). See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD in Group 080.

4. Remove air intake manifold. See REMOVE, INSPECT AND INSTALL INTAKE MANIFOLD in Group 080.

5. Remove fuel injection delivery lines and injection nozzles. If mechanical fuel system, see REMOVE FUEL INJECTION NOZZLES in Group 090 of CTM243. If Level 3 Electronic fuel system, see REMOVE FUEL INJECTION NOZZLES in Group 090 of CTM134.



RG7014 –UN–26NOV97

Removing Cylinder Head

A—Coolant Manifold
B—Turbocharger
C—Intake Manifold
D—Exhaust Manifold Assembly

Continued on next page

DPSG,OUO1004,787 –19–27APR99–1/4

6. Remove rocker arm cover with ventilator outlet hose assembly.

7. Loosen all rocker arm adjusting screws before removing assembly.

02
020
7

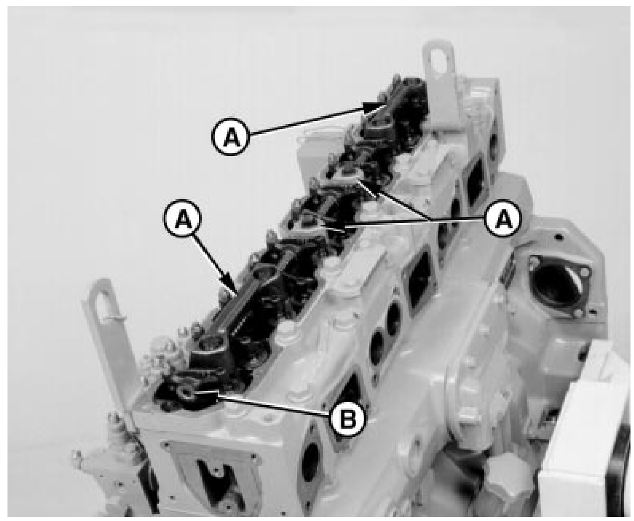
DPSG,OUO1004,787 –19–27APR99–2/4

8. Remove six cap screws and remove all four rocker arm shaft clamps (A). Lift rocker arm assembly (B) up and remove. Remove wear caps from valve stems.

9. Remove all 12 push rods and identify for reassembly.

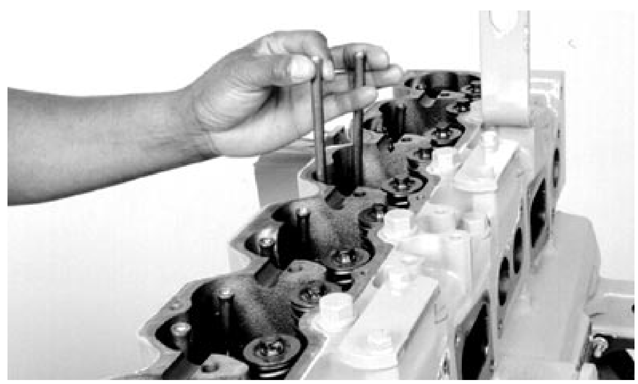
NOTE: Clean and inspect push rods. See CLEAN AND INSPECT PUSH RODS SERIAL NUMBER (—199,999) later in this group.

A—Rocker Arm Shaft Clamps
B—Rocker Arm Assembly



RG7017 –UN–26NOV97

Removing Rocker Arm Assembly



RG7018 –UN–05DEC97

Removing Push Rods

Continued on next page DPSG,OUO1004,787 –19–27APR99–3/4

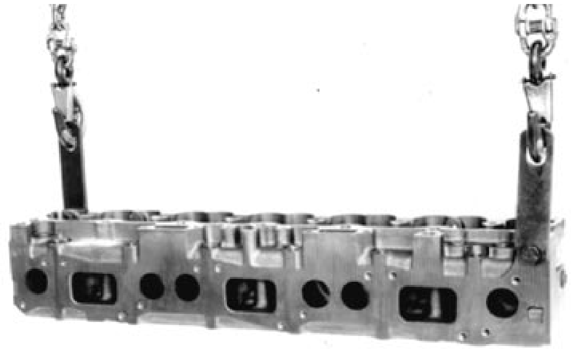
10. Remove all 26 cylinder head cap screws. Discard cap screws, they are not reusable.

IMPORTANT: DO NOT use screwdrivers or pry bars between cylinder block and cylinder head to loosen head-to-block gasket seal.

11. Lift cylinder head from block. If cylinder head sticks, use a soft hammer to tap the cylinder head.

12. Remove cylinder head gasket. Inspect for possible oil, coolant, or combustion chamber leaks. Also, check for evidence of incorrect or defective head gasket being used.

NOTE: Do not rotate crankshaft with cylinder head removed unless all cylinder liners are secured with cap screws and large flat washers as described in Group 030. See REMOVE PISTONS AND CONNECTING ROD ASSEMBLIES in Group 030.

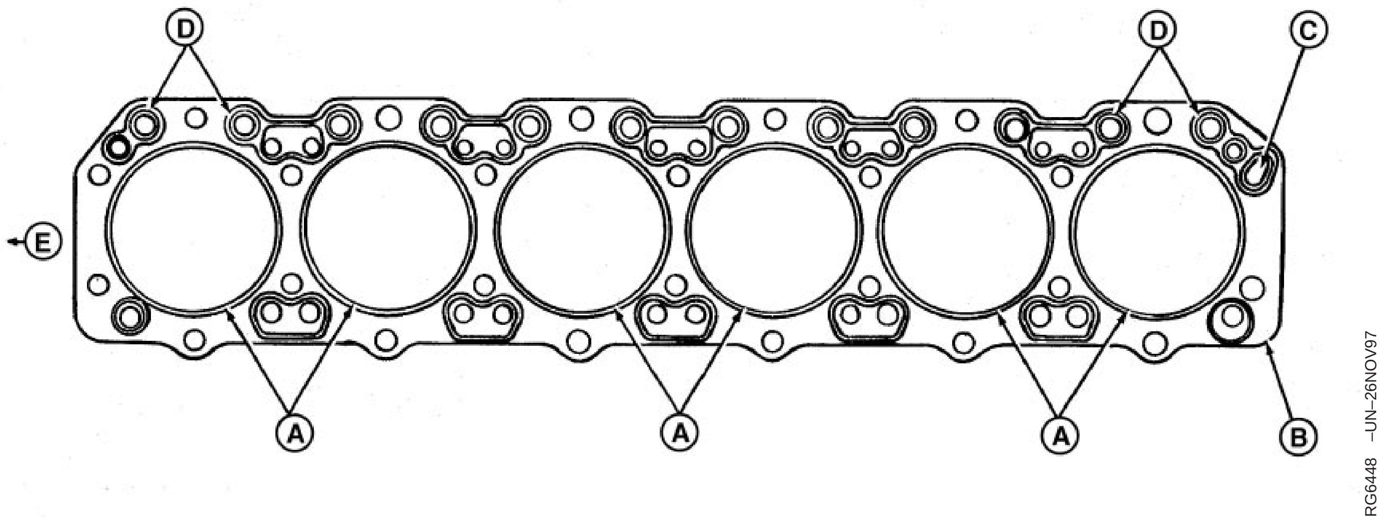


RG5245 –UN–05DEC97

Lifting Cylinder Head From Block

DPSG,OUO1004,787 –19–27APR99–4/4

Head Gasket Inspection and Repair Sequence Serial Number (—199,999)



Inspecting Cylinder Head Gasket

A—Combustion Seals (Flange)
B—Gasket Body
C—Rocker Arm Oil Port
D—Elastomer Beading Strips
E—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 SERIAL NUMBER (—199,999) in Group 020.

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/abraded/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.
   - O-ring seal missing/damaged in port area (C).
   - Elastomer missing/damaged in port area (D).
   - 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 block, head, liners, and cap screws. (Groups 020 and 030.)

Continued on next page RG,RG34710,1074 –19–23OCT97–1/2

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

   Cylinder Head (Group 020.)

   - Check surface flatness/finish.
   - Inspect for surface damage.
   - Check cylinder head thickness, if resurfacing.

   Cylinder Block and Liners (assembled and clamped) (Group 020 or 030.)

   - 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 (Group 020.)

   - Inspect for corrosion damage.
   - Inspect condition of threads.
   - Inspect for straightness.
   - 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 repair groups of this manual.

RG,RG34710,1074 –19–23OCT97–2/2

Disassemble and Inspect Rocker Arm Shaft Assembly Serial Number (—199,999)

NOTE: Make preliminary inspection during disassembly. Look for:

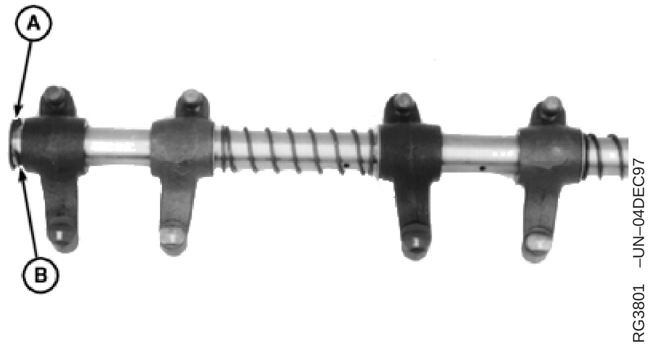
—Worn or scored rocker arms, shaft, and shaft support.

—Weak or broken springs

—Lube oil restriction

1. Remove plugs (A) and washers (B) from ends of rocker arm shaft.

2. Slide springs, rocker arms, and rocker arm supports off rocker arm shaft identifying their parts for reassembly in the same sequence they were in before disassembly.



Rocker Arm Shaft Assembly

A—Plugs
B—Washers

RG,RG34710,1075 –19–23OCT97–1/3

3. Inspect rocker arm shaft (A) for severe scratching, scoring, or excessive wear at points of rocker arm contact. Measure rocker arm and shaft. Compare with specifications given below.

Specification

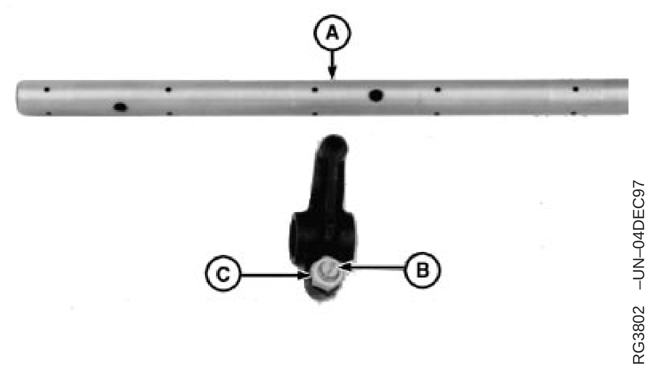
Rocker Arm Assembly—I.D.	19.07—19.10 mm (0.7507—0.7520 in.)
Shaft O.D.	19.01—19.05 mm (0.7484—0.7500 in.)

NOTE: Wear could indicate weak valve springs, bent push rods, or loose rocker arm shaft clamps.

4. Check rocker arm adjusting nut (C) and screw (B) for damage. Visually inspect rocker arm for hairline cracks. Replace if necessary.

IMPORTANT: Be sure all oil holes in rocker arm shaft are clean and open.

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



Rocker Arm Parts

A—Rocker Arm Shaft
B—Screw
C—Rocker Arm Adjusting Nut

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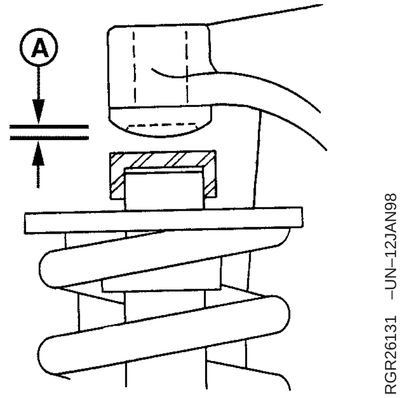
RG,RG34710,1075 –19–23OCT97–2/3

6. Check for cups or concave wear (A) on ends of rocker arms where they contact wear caps.

7. Examine spacer springs on shaft between rocker arms. Be sure they are strong enough to exert a positive pressure on rocker arms.

NOTE: If the rocker arm has been damaged by a valve failure, replace it and the push rods when replacing valves.

8. Roll rocker arm shaft and push rods on a flat surface to check for bends or distortion. Replace parts as necessary.



Rocker Arm Wear Area

A—Wear Area

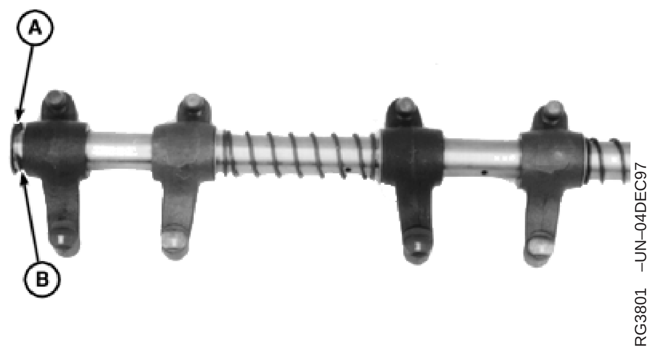
RG,RG34710,1075 –19–23OCT97–3/3

Assemble Rocker Arm Shaft Assembly Serial Number (—199,999)

Assemble parts on rocker arm shaft in reverse of removal procedure.

Make sure rocker arm shaft end plugs (A) are firmly seated against end of shaft, and washers (B) are installed on shaft.

A—Rocker Arm Shaft End Plugs
B—Washers



Rocker Arm Shaft Assembly

RG,RG34710,1076 –19–23OCT97–1/1

Measure Valve Recess Serial Number (—199,999)

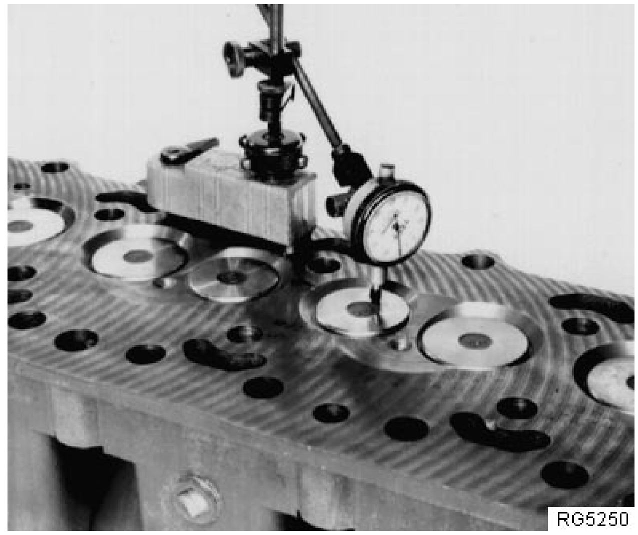
Measure and record valve recess dimensions for all valves using JDG451 Gauge with D17526CI (English, in.) or D17527CI (Metric, mm) Dial Indicator or KJD10123 Gauge. Compare measurements to specifications given below.

Specification

Exhaust Valve—Recess	1.19—1.70 mm (0.047—0.067 in.) below cylinder head
Maximum Recess	2.46 mm (0.097 in.) below cylinder head
Intake Valve—Recess	3.35—3.86 mm (0.132—0.152 in.) below cylinder head
Maximum Recess	4.62 mm (0.182 in.) below cylinder head

NOTE: Thoroughly clean all gasket material from cylinder head combustion face before measuring.

If measurement does not meet specifications, check valve face angle and valve seat angle. If valve is recessed beyond the maximum specification, install either new valves, valve seat inserts, or both to obtain proper valve recess. See REMOVE VALVE SEAT INSERTS SERIAL NUMBER (—199,999) later in this group.



RG5250 –UN–07NOV97

Measuring Valve Recess

RG,RG34710,1077 –19–27APR99–1/1

Preliminary Cylinder Head and Valve Checks Serial Number (—199,999)

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.
- 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.
- Bent push rods.
- 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 guides.
- Bent valves.
- Debris passed through valve train.

RG,RG34710,1078 –19–27APR99–1/1

Remove Valve Assembly Serial Number (—199,999)

Refer to PRELIMINARY CYLINDER HEAD AND VALVE CHECKS SERIAL NUMBER (—199,999), earlier in this group as valves are removed from head.

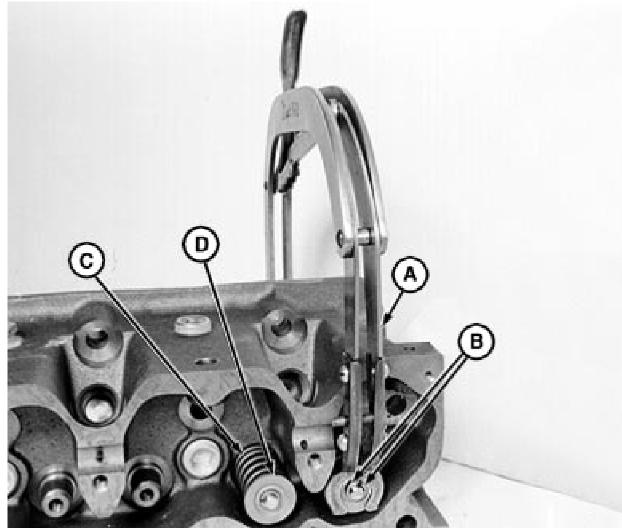
IMPORTANT: Identify all usable parts for correct reassembly in same location as removed.

1. Compress valve spring using JDE138 Valve Spring Compressor (A) as shown.

2. Remove retaining locks (B) using a small magnet.

3. Remove valve spring compressor from head.

4. Remove valve spring cap (D) and valve spring (C).



RG7228 –UN–05DEC97

Removing Valve Assemblies

A—JDE138 Valve Spring Compressor
B—Retainer Locks
C—Valve Springs
D—Valve Spring Caps

02
020
15

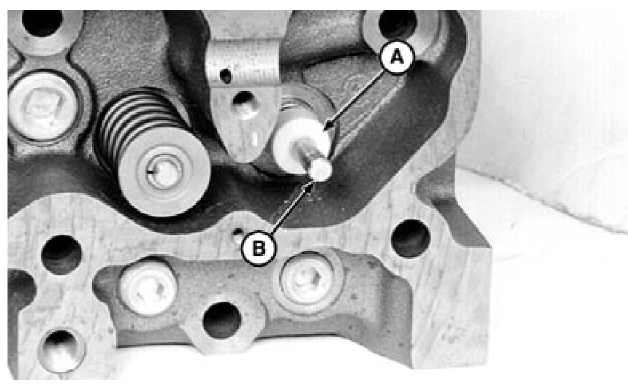
RG,RG34710,1079 –19–23OCT97–1/2

5. Remove oil shield (A) from exhaust valves. Remove valve (B) from cylinder head. Identify valve for reassembly, if valve is to be reused.

NOTE: Intake valves do not have stem seals.

6. Repeat procedure on remaining valves.

A—Oil Shield
B—Valve



RG7229 –UN–05DEC97

Removing Valves

RG,RG34710,1079 –19–23OCT97–2/2

Inspect and Measure Valve Springs Serial Number (—199,999)

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

2. Put springs on a flat surface to see that they are square and parallel.

NOTE: Free spring length of 65 mm (2.56 in.) springs differ slightly, but compressed height must be the same.

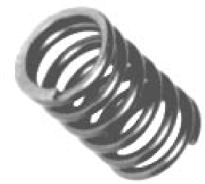
3. Check valve spring tension using D01168A Spring Compression Tester.

Specification

Intake Valve Spring—Height	38.1 mm (1.50 in.)@810—880 N (182—198 lb-force) with valve open
Height	52.5 mm (2.07 in.)@345—399 N (78—90 lb-force) with valve closed

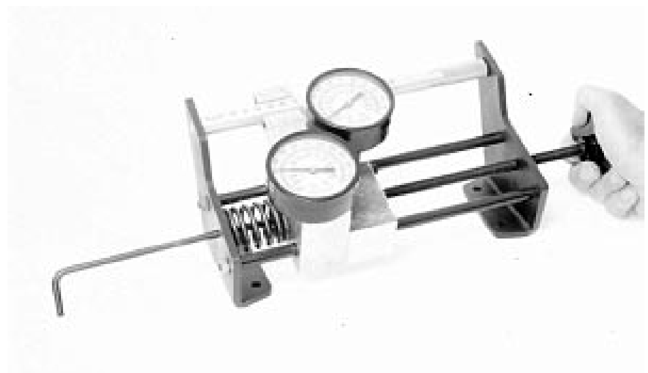
Specification

Exhaust Valve Spring—Height	38.5 mm (1.52 in.)@797—867 N (179—195 lb-force) with valve open
Height	54.5 mm (2.15 in.)@284—338 N (64—76 lb-force) with valve closed



RG2732 –UN–04DEC97

Valve Spring



T82054 –UN–08NOV88

Checking Valve Spring Tension

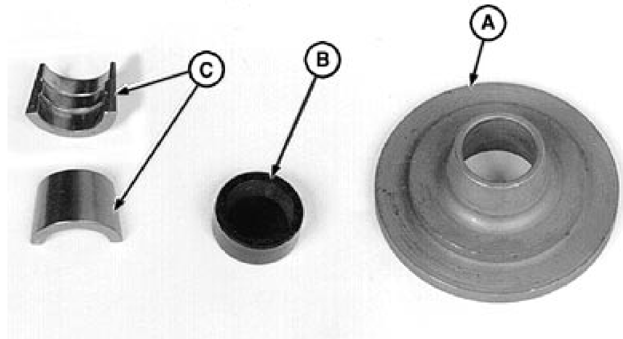
RG,RG34710,1080 –19–27APR99–1/1

Inspect Valve Spring Caps, Wear Caps, and Retainer Locks Serial Number (—199,999)

1. Inspect valve spring caps (A) in area where valve springs and retaining locks seat for excessive wear. Replace as needed.

2. Inspect retainer locks (C) for excessive wear. Replace as needed.

3. Inspect valve wear cap (B) contact surfaces. Replace wear caps if pitted or worn.



RG7230 –UN–05DEC97

Inspecting Valve Parts

A—Valve Spring Caps
B—Valve Wear Cap
C—Retainer Locks

RG,RG34710,1081 –19–23OCT97–1/1

Clean Valves Serial Number (—199,999)

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

2. Make sure all carbon is removed from valve head, face and stem. Polish valve stem with steel wool or crocus cloth to remove scratch marks left by wire brush.

IMPORTANT: Any carbon left on valve stem will affect alignment in refacer if valves need to be refaced.

RG,RG34710,1082 –19–23OCT97–1/1

Inspect and Measure Valves Serial Number (—199,999)

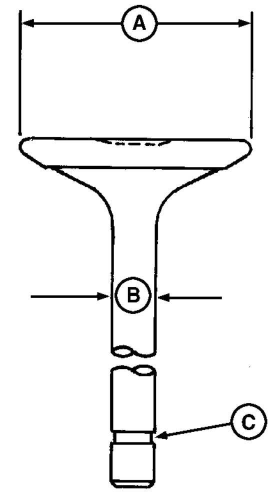
1. Thoroughly clean and inspect valves to help determine if they can be restored to a serviceable condition. Replace valves that are burned, cracked, eroded, or chipped.

2. Inspect valve retainer lock groove (C) on valve stem for damage. Also inspect stems for signs of scuffing, which may indicate insufficient valve guide-to-valve stem clearance. Replace if defects are evident.

3. Measure valve head O.D. (A). Compare valve stem O.D. (B) with guide I.D. to determine clearance, as outlined later in this group.

Specification

Intake Valve Stem—OD	9.461—9.487 mm (0.3725—0.3735 in.)
Exhaust Valve Stem—OD	9.436—9.462 mm (0.3715—0.3725 in.)
Intake Valve Head—OD	50.87—51.13 mm (2.002—2.012 in.)
Exhaust Valve Head—OD	46.87—47.13 mm (1.845—1.856 in.)



RG5795 –UN–05DEC97

Measuring Valves

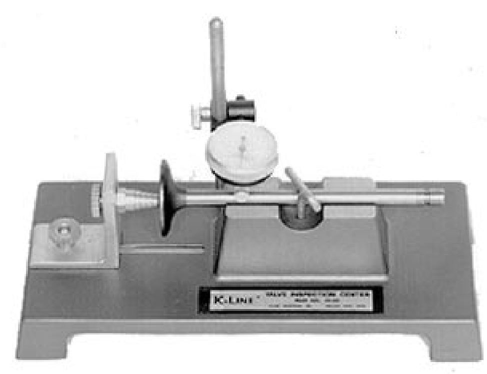
A—Valve Head OD
B—Valve Stem OD
C—Valve Retainer Lock Groove

DPSG,OUO1004,833 –19–27APR99–1/2

4. Use D05058ST Valve Inspection Center to determine if valves are out of round, bent or warped.

Specification

Valve Face—Runout	0.05 mm (0.002 in.) maximum permissible



RG4234 –UN–05DEC97

Valve Face Runout Check

DPSG,OUO1004,833 –19–27APR99–2/2

Grind (Reface) Valves Serial Number (—199,999)

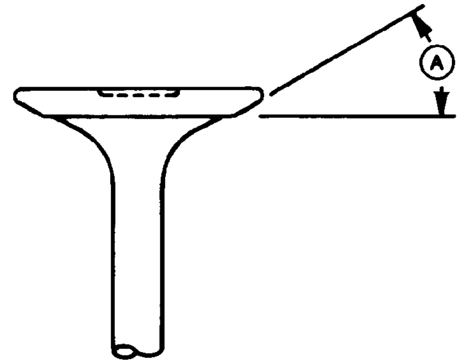
IMPORTANT: Valve grinding should only be done by experienced personnel familiar with equipment and capable of maintaining required specifications.

If necessary to reface valve, grind valve face angle (A) to following specification.

Specification

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

IMPORTANT: When valve faces are ground, it is important not to nick valve head-to-stem radius with facing stone. A nick could cause the valve to break. Radius all sharp edges after grinding.



RG5247 –UN–05DEC97

Valve Face Angle

A—Valve Face Angle

RG,RG34710,1084 –19–27APR99–1/1

Inspect and Clean Cylinder Head Serial Number (—199,999)

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. Scrape gasket material, oil, carbon, and rust from head. Use a powered brass or copper wire brush to clean sealing surfaces.

IMPORTANT: Be sure to remove all plugs before cleaning head, as parts can be damaged or destroyed by hot tank solutions.

3. Clean cylinder head in a chemical hot tank, or with solvent and a brush.

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

5. Reinstall plugs removed from cylinder head and tighten to the following specifications.

Specification

Cylinder Head Plugs—Torque .... 60 N•m (44 lb-ft)

RG,RG34710,1085 –19–27APR99–1/1

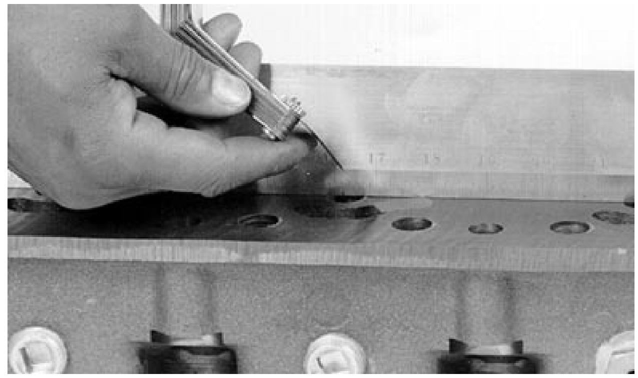
Check Cylinder Head Combustion Face Flatness Serial Number (—199,999)

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

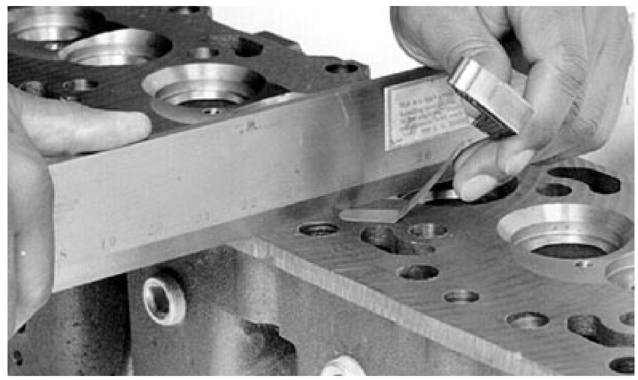
If any measurement exceeds specification, the cylinder head must be either resurfaced or replaced. See MEASURE CYLINDER HEAD THICKNESS SERIAL NUMBER (—199,999) later in this group.

Specification

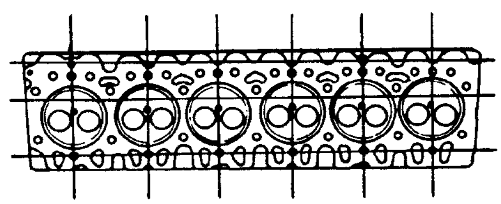
Cylinder Head—Maximum Acceptable Out-of-Flat Over Entire Length or Width .... 0.08 mm (0.003 in.)
Straightness Per Any 305 mm (12 in.) Length .... Within 0.025 mm (0.001 in.)


RG7231 –UN–05DEC97

Checking Flatness of Cylinder Head (1)


RG7232 –UN–05DEC97

Checking Flatness of Cylinder Head (2)



RG4629 –UN–05DEC97

Location to Check for Head Flatness

RG,RG34710,1086 –19–27APR99–1/1

Measure Cylinder Head Thickness Serial Number (—199,999)

Measure head thickness (A) from valve cover gasket rail-to-combustion face.

Specification

Cylinder Head—Thickness	155.45—155.71 mm (6.120—6.130 in.)
Wear Limit	154.69 mm (6.09 in.)
Combustion Face Surface Finish (Surface Mill Only to AA Finish)	1.5—2.8 micrometers (60—110 micro-in.)
Maximum Wave Depth	0.012 mm (0.0005 in.)

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

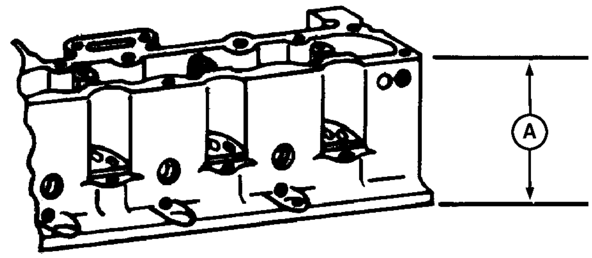
Specification

Resurfacing Head—Maximum Material Removal	0.762 mm (0.030 in.)

NOTE: If necessary to resurface cylinder head, a MAXIMUM of 0.762 mm (0.030 in.) can be ground from new part dimension. Remove ONLY what is necessary to restore flatness.

IMPORTANT: After resurfacing, check flatness as described earlier and check surface finish on combustion face of head.

Check valve recess after grinding. See MEASURE VALVE RECESS SERIAL NUMBER (—199,999) earlier in this group. Valve face may be ground to bring this characteristic within specification.



Cylinder Head Thickness

A—Head Thickness

02
020
21

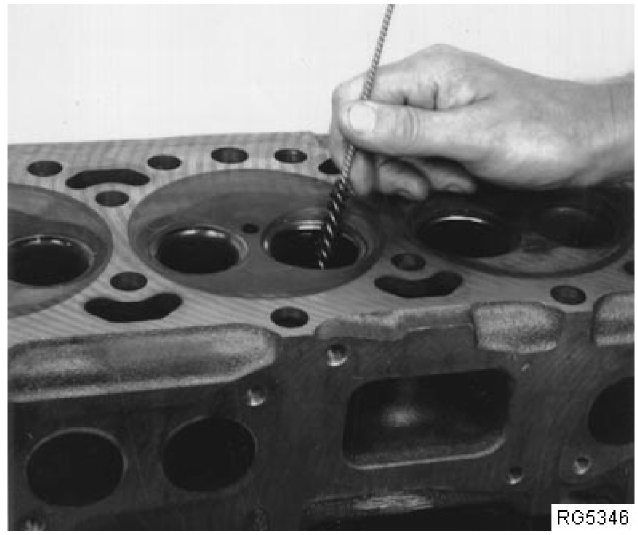
RG,RG34710,1087 –19–27APR99–1/1

02
020
22

Clean Valve Guides Serial Number (—199,999)

Use a D17024BR End Brush to clean valve guides before inspection or repair.

NOTE: A few drops of light oil or kerosene will help to fully clean the guide.



RG5346 –UN–07NOV97

Cleaning Valve Guides

RG,RG34710,1088 –19–23OCT97–1/1

Measure Valve Guides Serial Number (—199,999)

Measure valve guides (A) for wear using a telescope gauge (B) and micrometer.

Specification

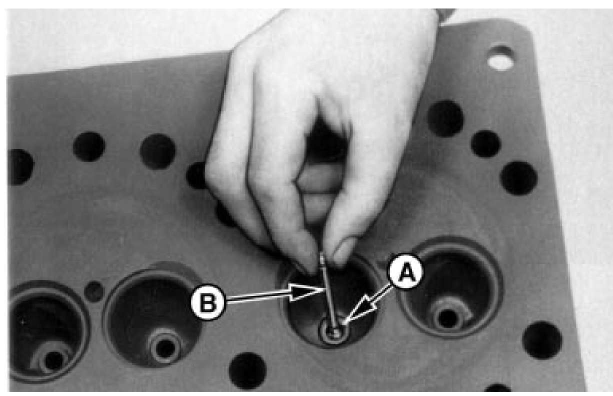
Valve Guide—ID	9.51—9.54 mm (0.3745—0.3755 in.) in new head
New Guide-to-Exhaust Valve Stem—Clearance	0.051—0.102 mm (0.002—0.004 in.)

Specification

New Guide-to-Intake Valve Stem—Clearance	0.025—0.076 mm (0.001—0.003 in.)

NOTE: Worn guides can allow a clearance of 0.15 mm (0.006 in.) and still be acceptable. Worn guides may be knurled to return them to specified clearance if valve-to-guide clearance is 0.25 mm (0.010 in.) or less. If clearance exceeds 0.25 mm (0.010 in.), install oversize valves.

IMPORTANT: ALWAYS knurl exhaust valve guides before reaming to assure proper valve guide-to-stem clearance.



RGR23984 –UN–12JAN98

A—Valve Guides
B—Telescope Gauge

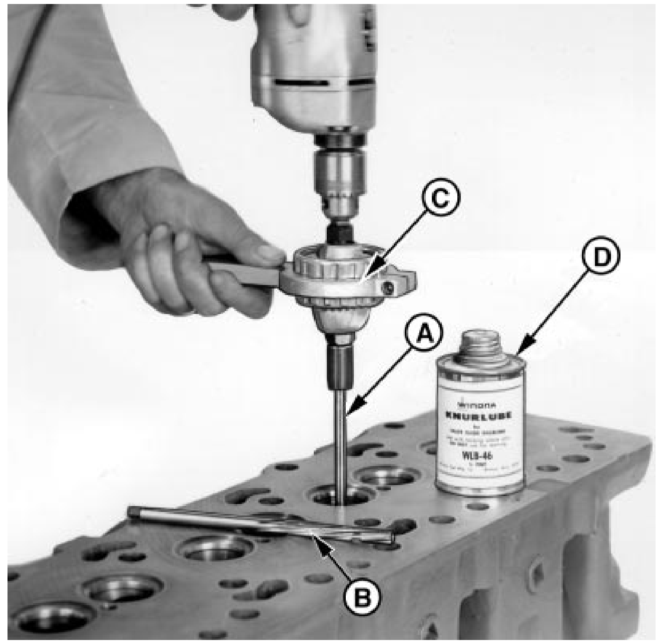
RG,RG34710,1089 –19–23OCT97–1/1

Knurl Valve Guides Serial Number (—199,999)

1. Use JT05949 (formerly D20002) Valve Guide Knurler Kit to knurl valve guides.

NOTE: Use tool set exactly as directed by the manufacturer.

2. After knurling, ream valve guide to finished size to provide specified stem-to-guide clearance.



RGR26141 –UN–12JAN98

Knurling Valve Guides

A—Knurler
B—Reamer
C—Speed Reducer
D—Lubricant

RG,RG34710,1090 –19–23OCT97–1/1

Clean and Inspect Valve Seats Serial Number (—199,999)

1. Use an electric hand drill with D17024BR Wire Cleaning Brush or equivalent brush to remove all carbon on valve seats.

2. Check seats for cracks, pits, or excessive wear.

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

R26142N –UN–09DEC88

Cleaning Valve Seats

RG,RG34710,1091 –19–23OCT97–1/1

Measure Valve Seats Serial Number (—199,999)

1. Measure valve seats for proper specifications listed below.

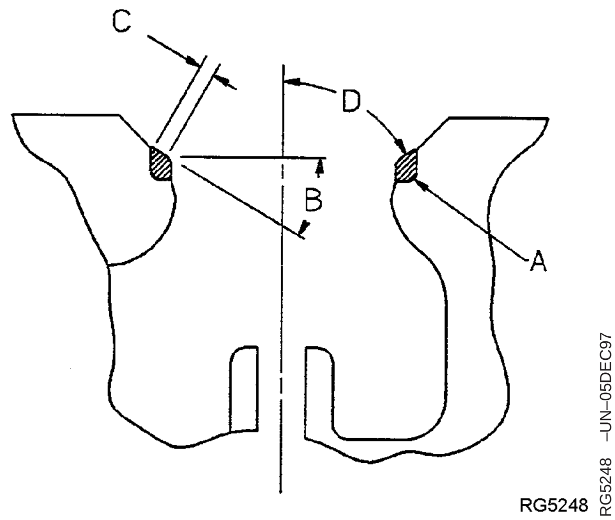
2. Using D11010KW Eccentrimeter, measure valve seat runout (D).

3. If valve seat is not within specification, recondition valve seat by grinding or replace valve seat inserts (A) if reconditioning is not possible. See GRIND VALVE SEATS SERIAL NUMBER (—199,999) or see INSTALL VALVE SEAT INSERTS SERIAL NUMBER (—199,999), later in this group.

Specification	
Valve Seat—Angle	30° ± 0.50°
Maximum Runout	0.051 mm (0.0020 in.)

Specification	
Exhaust Valve Seat—Width	2.0—3.8 mm (0.079—0.150 in.)

Specification	
Intake Valve Seat—Width	1.4—3.8 (0.055—0.150 in.)



Measuring Valve Seats

A—Valve Seat Insert
B—Valve Seat Angle
C—Valve Seat Width
D—Valve Seat Runout

RG,RG34710,1092 –19–23OCT97–1/1

Grind Valve Seats Serial Number (—199,999)

IMPORTANT: Valve seat grinding should only be done by experienced personnel familiar with equipment and capable of maintaining required specifications. ALWAYS keep work area clean when grinding valve seats. A 120-grit stone MUST BE used for grinding both intake and exhaust valve seat inserts (A).

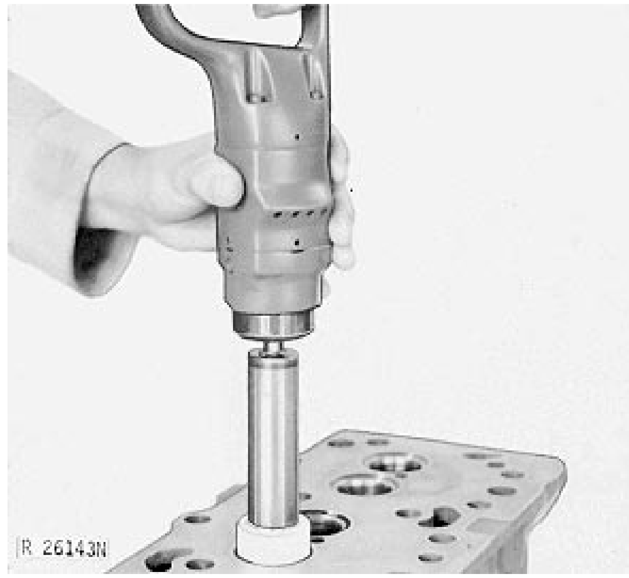
Using JT05893 Heavy-Duty Seat Grinder Set, grind valve seats to obtain correct valve recess in cylinder head. See MEASURE VALVE RECESS SERIAL NUMBER (—199,999) earlier in this group. Be sure valve guide bores are clean before grinding valve seats. See CLEAN VALVE GUIDES SERIAL NUMBER (—199,999) earlier in this group.

If valve seats need grinding, only a few seconds are required to recondition the average valve seat. Avoid the tendency to grind off too much. Do not use excessive pressure on the grinding stone.

1. Check the seat width (C) and contact pattern between the seat and valve with bluing. Seat width MUST BE maintained within specification. Use a vernier caliper or scale to measure seat width. Thoroughly clean seat area after grinding and replace valves and valve seat inserts as necessary.

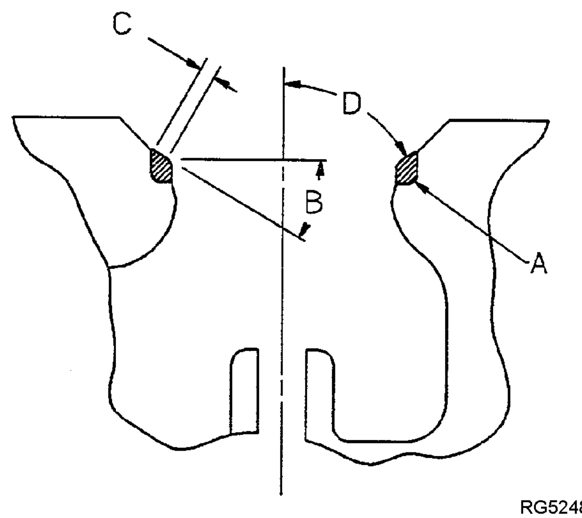
NOTE: Valve seat width can be reduced with a narrowing stone. This will change the angle (B) at the top of the seat and increase the diameter. If valve seat width is too narrow, valve may burn or erode. Varying the width changes the fine contact between valve face and seat.

2. ALWAYS measure valve seat runout after grinding using D11010KW Eccentrimeter and check recess in cylinder head after grinding as described later.



R26143N –UN–09DEC88

Grinding Valve Seats



RG5248 –UN–05DEC97

Measuring Valve Seats

A—Valve Seat Insert
B—Valve Seat Angle
C—Valve Seat Width
D—Valve Seat Runout

Continued on next page

RG,RG34710,1093 –19–23OCT97–1/2

Specification

Valve Seat Grinding—Angle	30° ± 0.50°
Exhaust Width	2.0—3.8 mm (0.079—0.150 in.)
Intake Width	1.4—3.8 mm (0.055—0.150 in.)
Maximum Seat Runout	0.051 mm (0.0020 in.)

RG,RG34710,1093 –19–23OCT97–2/2

Remove Valve Seat Inserts Serial Number (—199,999)

In some cases the valve seat bore in the cylinder head may become damaged or oversized and will require machining. In this case, oversize inserts are available in 0.25 mm (0.010 in.) oversize only.

Specification

Oversize Inserts—Width	0.25 mm (0.010 in.)

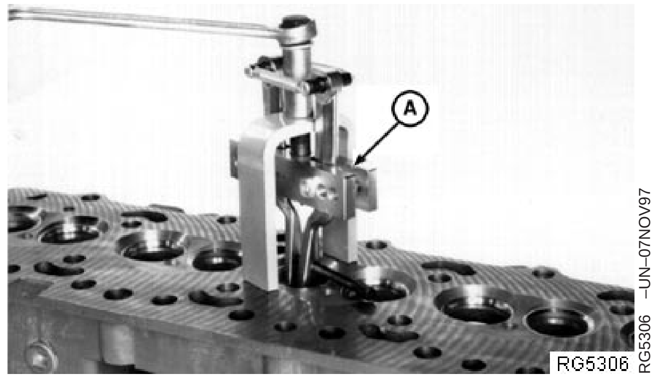
IMPORTANT: Be careful not to damage cylinder head when removing seats.

1. Remove valve seat insert (if necessary) with JDE41296 Valve Seat Puller (A). Adjusting screw on puller may need to be retightened during removal of inserts.

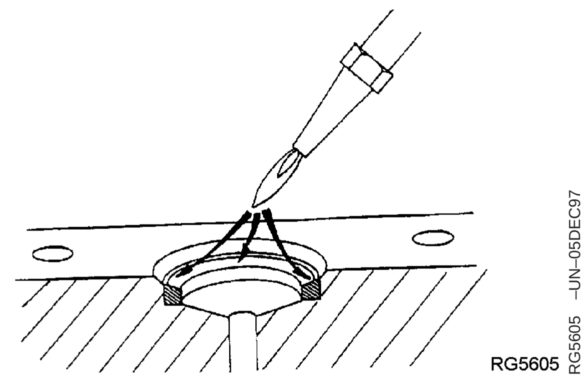
   Valve seat inserts may be also removed using the following method:

   - Carefully heat insert at four points around face until insert becomes red hot. Allow seat to cool and carefully pry out the insert(s) with a screwdriver.

2. After removal of inserts, thoroughly clean area around valve seat bore and inspect for damage or cracks.



Removing Valve Seat Inserts

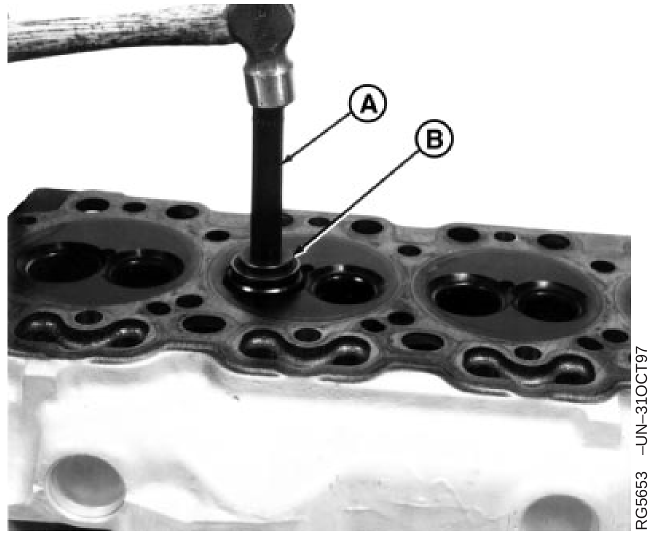


Heating Valve Seat Inserts

A—Valve Seat Puller

RG,RG34710,1094 –19–23OCT97–1/1

Install Valve Seat Inserts Serial Number (—199,999)



Installing Valve Seat Inserts

1. Use the JDE7 Driver (A) along with JDG605 Valve Seat Installer (B) to drive inserts into place. The larger end of JDG605 Installer is used to install intake valves and the smaller end is used to install exhaust valves.

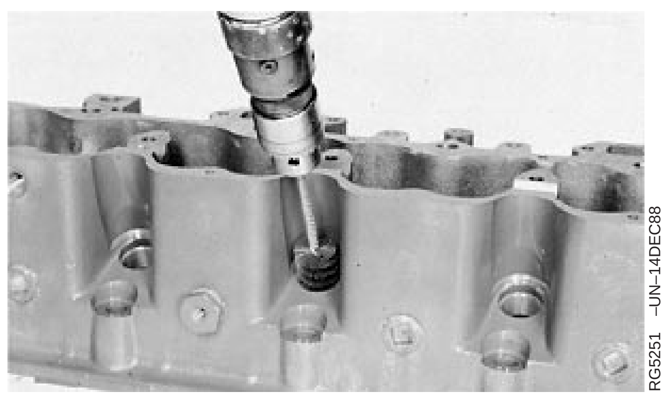
2. Install new or refaced valves and check valve recess. See MEASURE VALVE RECESS SERIAL NUMBER (—199,999) earlier in this group.

3. Grind valve seats as required to maintain correct valve recess and valve-to-seat seal. See GRIND VALVE SEATS SERIAL NUMBER (—199,999) earlier in this group.

A—Driver
B—Valve Seat Installer

RG,RG34710,1095 –19–23OCT97–1/1

Inspect and Clean Cylinder Head Nozzle Bore Serial Number (—199,999)



Cleaning Cylinder Head Nozzle Bores

1. Inspect condition of threads for gland nut. Threads are metric (M28 x 1.5).

2. Inspect condition of nozzle seating surface in cylinder head.

   Cylinder head threads and nozzle seating surface must be free of debris and carbon deposits.

IMPORTANT: If the injection nozzle gland nut threads are not clean, a false torque reading may be obtained when the injection nozzle is installed. This may prevent the injection nozzle from seating properly in the cylinder head.

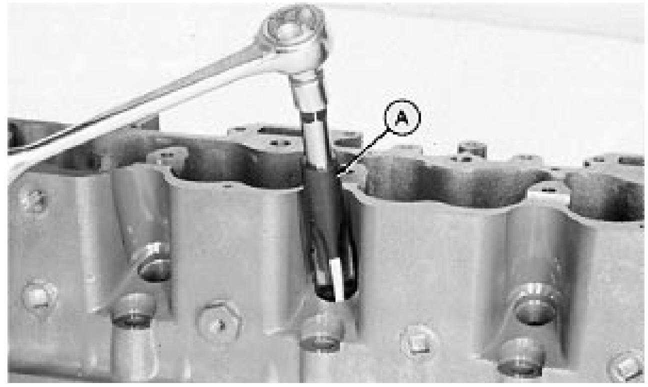
3. Clean threads which have light foreign deposits using a drill and the D17030BR Thread Cleaning Brush. Work brush up and down several times to clean threads.

Continued on next page

RG,RG34710,1096 –19–23OCT97–1/3

4. Clean threads with heavy foreign deposits or clean up damaged threads using the JDF5 Tap (M28 x 1.5 mm) or an equivalent M28 x 1.5 mm (metric) tap (A). Be sure to start tap straight to avoid possible cross-threading. A light coat of grease on tap will help collect foreign deposits on tap and prevent them from falling into the nozzle bore.

A—Tap



RG5252 –UN–06DEC88

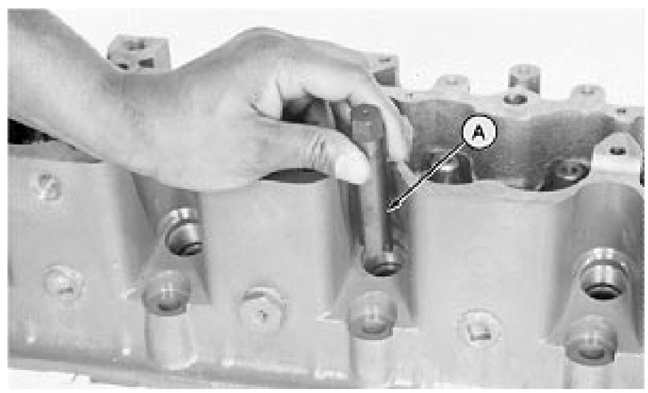
Using Tap on Nozzle Bore Threads

RG,RG34710,1096 –19–23OCT97–2/3

5. Clean nozzle seating surface by using the JDG609 Nozzle Seat Reamer (A) to remove carbon.

6. Blow out debris with compressed air and thoroughly clean all nozzle bores.

A—Nozzle Seat Reamer



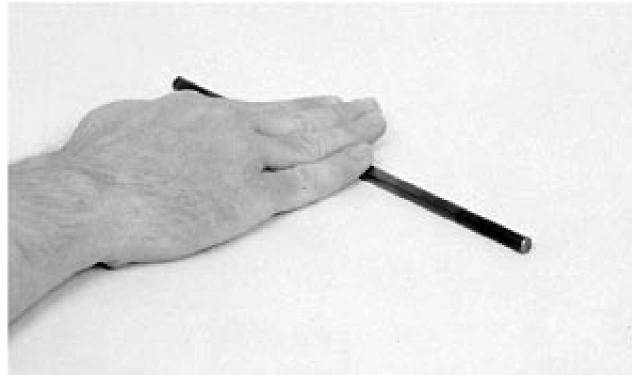
RG5253 –UN–06DEC88

Cleaning Nozzle Seating Surface

RG,RG34710,1096 –19–23OCT97–3/3

Clean and Inspect Push Rods Serial Number (—199,999)

1. Clean push rods with solvent and compressed air.
2. Check push rods for straightness by rolling on a flat surface.
3. Inspect contact ends for wear and damage.
4. Replace defective push rods.



T81233 –UN–01NOV88

Checking Valve Push Rods for Straightness

RG,RG34710,1097 –19–23OCT97–1/1

Inspect and Clean Ventilator Outlet Hose Serial Number (—199,999)

1. Check ventilator outlet hose on rocker arm cover for bent or damaged condition. Replace if necessary.
2. Clean ventilator hose if restricted.

RG,RG34710,1098 –19–23OCT97–1/1

Clean and Inspect Top Deck of Cylinder Block Serial Number (—199,999)

1. Remove gasket material, rust, carbon, and other foreign material from top deck. Gasket surface must be clean.

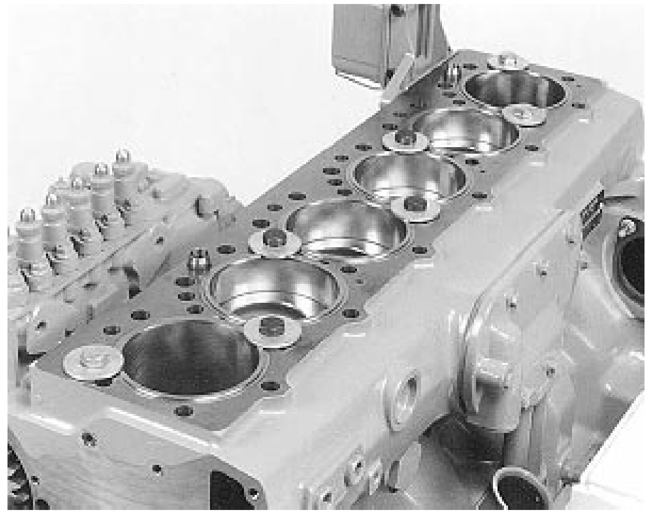
2. Use compressed air to remove all loose foreign material from cylinders and top deck.

3. Clean all cylinder head mounting cap screw holes using JDG681 or an equivalent 9/16-12 UNC-2A tap about 88.9 mm (3.5 in.) long. Use compressed air to remove debris and any fluids which may be present in the cap screw holes.

4. Measure top deck flatness. See MEASURE CYLINDER BLOCK in Group 030.

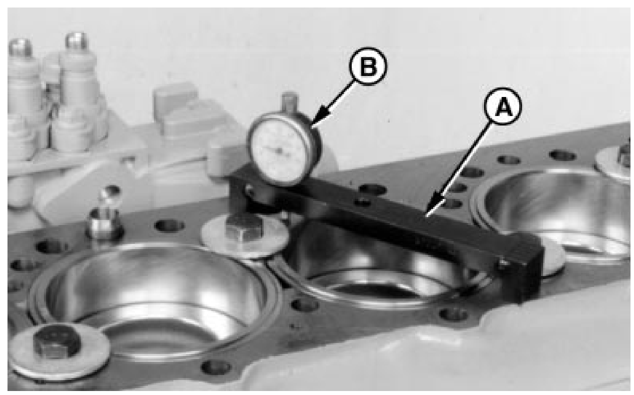
RG,RG34710,1099 –19–23OCT97–1/1

Measure Cylinder Liner Standout (Height Above Block) Serial Number (—199,999)



RG7144 –UN–28JUL94

Bolting Down Cylinder Liners



RG7145 –UN–26NOV97

Checking Cylinder Liner Height Above Block

A—JDG451 Gauge
B—Dial Indicator

1. Bolt down liners using cap screws and flat washers in the seven locations as shown. Flat washers should be at least 3.18 mm (1/8 in.) thick. Tighten cap screws to 68 N•m (50 lb-ft) to achieve an accurate standout reading.

NOTE: Liners having obvious defects must be replaced.

2. Using JDG451 Gauge (A) along with D17526CI (English) or D17527CI (Metric scale) Dial Indicator (B) or KJD10123 Gauge, measure the height of bolted down liners that are not obviously defective before removal from block.

NOTE: Variations in measurement readings may occur within one cylinder and/or between adjacent cylinders.

3. Measure each liner in four places, approximately at 1, 5, 7 and 11 O'clock positions as viewed from the rear of the engine (flywheel end). Record all measurements by cylinder number and compare to the following specifications.

Specification

Liner—Height Above Block .... 0.051—0.127 mm (0.002—0.005 in.) above block

4. Remove any liner that does not meet standout specification at any location and install liner shims or replace piston/liner sets as necessary. SeeINSTALL LINER SHIMS—IF REQUIRED in Group 030.

RG,RG34710,1100 –19–23OCT97–1/1

Assemble Valve Assembly Serial Number (—199,999)

Remember valve stem seals (A) are installed onto exhaust valve stems (B) only.

Valves are marked on the head as follows: Intake (“I 30”). Exhaust (“E 30”).

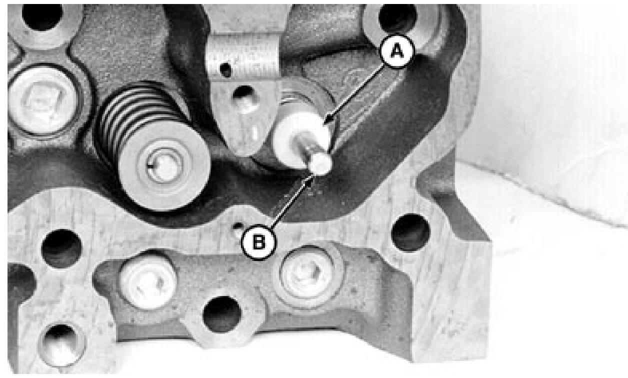
1. Apply AR44402 Valve Stem Lubricant or clean engine oil to valve stems and guides.

NOTE: Exhaust valve stem oil shields will not seat on valve guide tower; they ride up and down with valve stem.

2. Install reconditioned or new valves in head. Reconditioned valves MUST BE installed in same location from which removed.

NOTE: Valve stems must move freely in guide bore and seat properly with insert.

3. Install oil shield onto exhaust valve stem until shield bottoms on valve guide tower.



RG7229 –UN–05DEC97

Seal on Exhaust Valve Stem

A—Valve Stem Seals
B—Exhaust Valve Stems

RG,RG34710,1101 –19–23OCT97–1/3

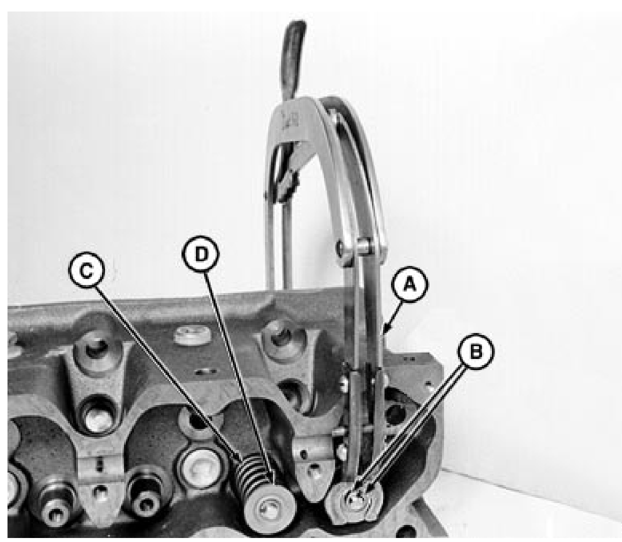
NOTE: There is no top or bottom to valve springs (C); they may be installed either way.

4. Install valve spring and spring cap (D). Spring must seat in machined counterbore of head.

5. Compress valve springs with JDE138 Valve Spring Compressor (A) and install retainer locks (B).

NOTE: Install wear caps just before installing rocker arm assembly.

A—JDE138 Valve Spring Compressor
B—Valve Retainer Locks
C—Valve Spring
D—Valve Spring Cap



RG7228 –UN–05DEC97

Installing Valve Assemblies

Continued on next page

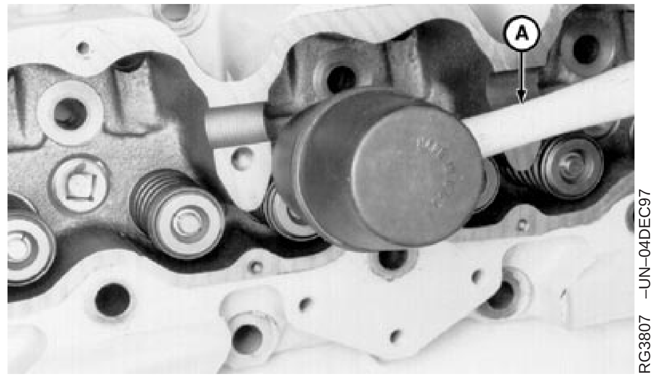
RG,RG34710,1101 –19–23OCT97–2/3

6. Strike each valve assembly with a soft mallet (A) three or four times to insure retainer locks are properly seated.

   Repeat procedure for all remaining valves.

7. Measure valve recess in head as directed earlier in this group.

A—Mallet



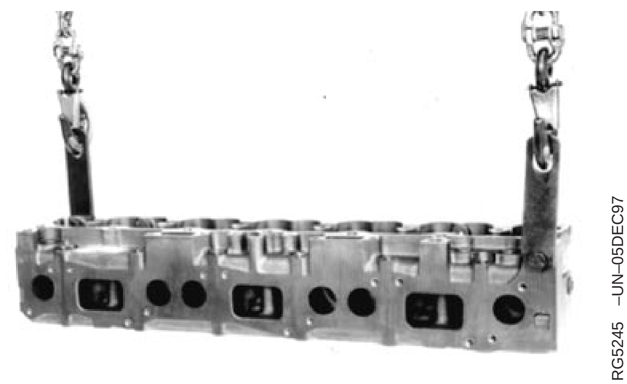
Seating Retainer Locks on Valves

RG,RG34710,1101 –19–23OCT97–3/3

Install Cylinder Head and Cap Screws Serial Number (—199,999)

IMPORTANT: ALWAYS thoroughly inspect new cylinder head gasket for possible manufacturing imperfections. Return any gasket that does not pass inspection.

Be sure cylinder head and block gasket surfaces are clean, dry, and free of any oil.



Installing Cylinder Head

1. Put a new head gasket on cylinder block. Do not use sealant on gasket; install dry.

IMPORTANT: If cylinder head is lowered onto cylinder block and 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 may possibly be damaged.

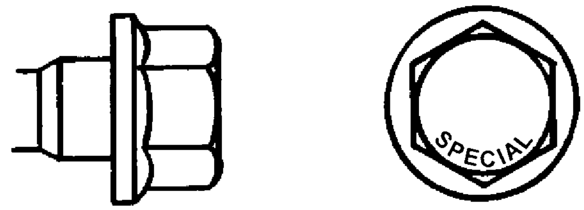
2. Lower cylinder head evenly to correct position on block using appropriate lifting equipment. Make sure that head is positioned correctly over dowels and sits flat on cylinder block top deck.

Continued on next page

RG,RG34710,1102 –19–23OCT97–1/2

IMPORTANT: Only ASTM Grade 180 Flanged-Head cap screws marked "SPECIAL" (upper illustration) are recommended for use on 6081 engines. ALWAYS use NEW cap screws when installing cylinder head. Cap screws may be used only one time.

DO NOT use multi-viscosity oils to lubricate cap screws, SAE30 is recommended.

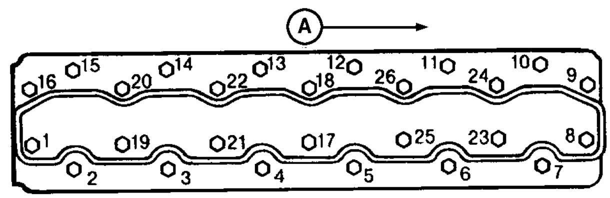


Special Cap Screw for Cylinder Head

3. Dip entire cap screw in clean SAE30 engine oil. Allow excess oil to drip off.

4. Install correct length cap screws marked "SPECIAL" in proper locations shown and tighten using the TORQUE-TO-YIELD tightening procedure, described next in this group. See TORQUE-TO-YIELD FLANGE-HEAD CAP SCREWS—GRADE 180 MARKED "SPECIAL" SERIAL NUMBER (—199,999) in this group.

   Arrow (A) points toward front of engine.



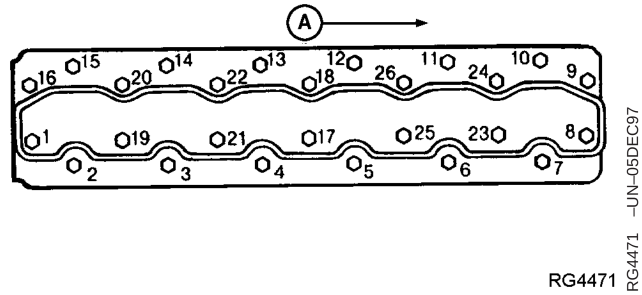
Head Cap Screw Locations

A—Front of Engine

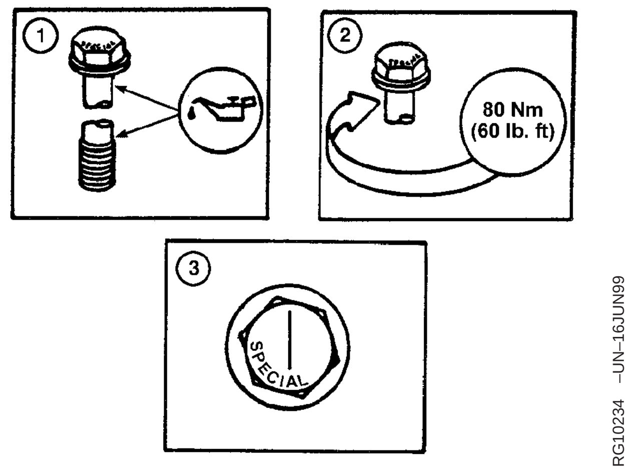
Cylinder Head Cap Screws	
Length	**Location in Cylinder Head**
134 mm (5.2 in.)	2, 3, 4, 5, 6, 7
149 mm (5.9 in.)	23, 25, 17, 21, 19
175 mm (6.9 in.)	1, 15, 14, 13, 12, 11, 10, 8
203 mm (8.0 in.)	16, 20, 22, 18, 26, 24, 9

RG,RG34710,1102 –19–23OCT97–2/2

Torque-to-Yield Flanged-Head Cap Screws—Grade 180 Marked "SPECIAL" Serial Number (—199,999)



Head Cap Screw Locations



Tightening Head Cap Screws

A—Front of Engine

Arrow (A) points toward front of engine.

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

1. Lubricate cap screws with clean SAE30 engine oil and install in their proper locations as outlined previously.

2. Tighten cap screw No. 17 to 80 N•m (60 lb-ft), then sequentially start at cap screw No. 1 and proceed through cap screw No. 26, tightening all cap screws to specifications.

Specification	
Cylinder Head Flanged-Head "SPECIAL" Cap Screws (No Washers)—Initial Torque	80 N•m (60 lb-ft)

3. 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.

Continued on next page RG,RG34710,1103 –19–27APR99–1/2

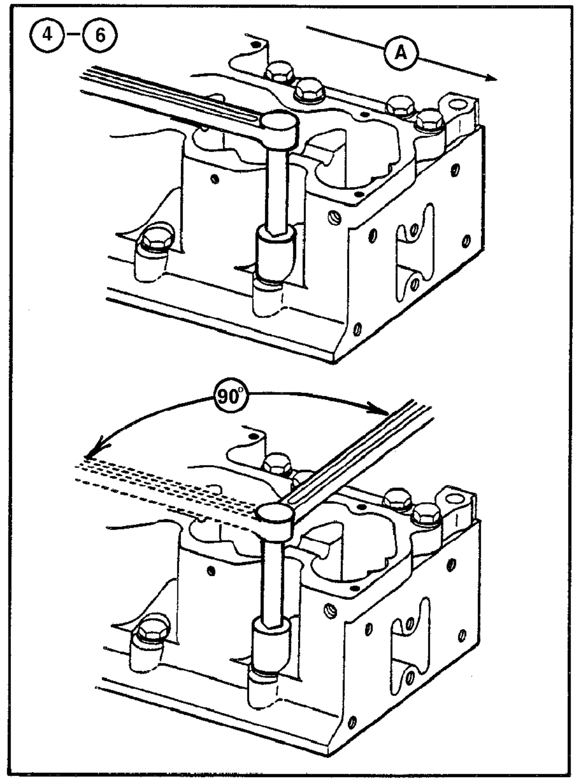
IMPORTANT: If a cap screw is accidentally tightened more than 90° in any one sequence, DO NOT loosen cap screw but make adjustments in the next tightening sequence.

4. 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.

5. Again, 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 now be parallel to crankshaft.

6. Finally, sequentially (start at cap screw No. 1 and proceed through cap screw No. 26). Turn each cap screw 90°, SO THAT LINE ON TOP OF CAP SCREW IS AS CLOSE AS POSSIBLE TO BEING PERPENDICULAR TO THE CRANKSHAFT. It is not necessary to obtain the final turn in one swing of the wrench. TOTAL AMOUNT OF TURN FROM STEPS 4, 5, AND 6 IS 270° ± 5°.

IMPORTANT: Cap screws MUST NOT be tightened more than a total of 270° ± 5°.



RG10235 –UN–16JUN99

Torque-to-Yield Tightening of Head Cap Screws

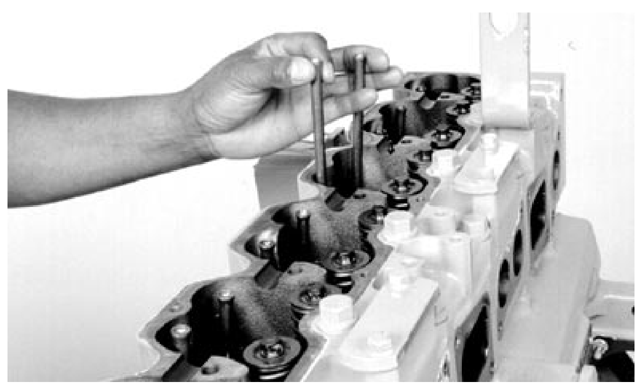
A—Front of Engine

RG,RG34710,1103 –19–27APR99–2/2

Install Rocker Arm Assembly Serial Number (—199,999)

1. Install push rods in holes from which removed.

2. Install wear caps on valve stem tips, make certain caps rotate freely on valve stems.



RG7018 –UN–05DEC97

Installing Push Rods and Caps

Continued on next page

RG,RG34710,1104 –19–23OCT97–1/2

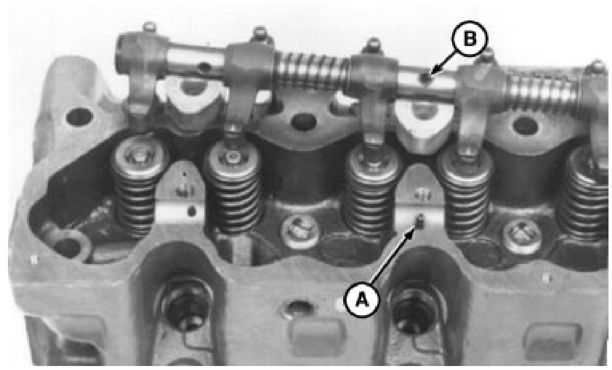
3. Make sure spring pin (A) engages with hole (B) in shaft.

4. Install shaft clamps and all six cap screws. Tighten cap screws to 75 N•m (55 lb-ft).

Specification

Rocker Arm Shaft Clamps—
Torque .... 75 N•m (55 lb-ft)

5. Adjust engine valve clearance. See CHECK AND ADJUST VALVE CLEARANCE SERIAL NUMBER (—199,999) earlier in this group.



RG3810 –UN–04DEC97

Installing Rocker Arm Assembly

A—Spring Pin
B—Hole

RG,RG34710,1104 –19–23OCT97–2/2

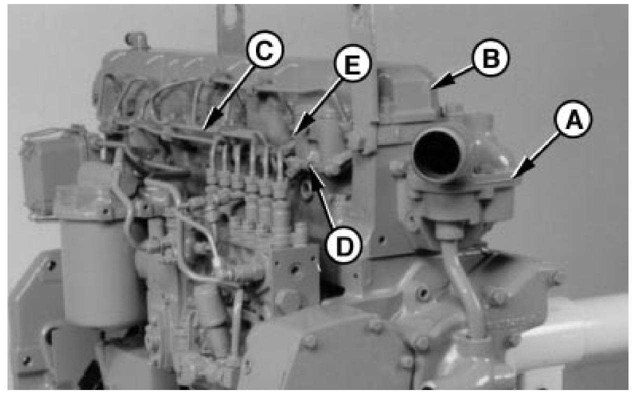
Inspect and Clean Ventilator Outlet Hose Serial Number (—199,999)

1. Check ventilator outlet hose on rocker arm cover for bent or damaged condition. Replace if necessary.

2. Clean ventilator hose if restricted.

RG,RG34710,1098 –19–23OCT97–1/1

Complete Final Assembly of Injection Pump Side of Engine Serial Number (—199,999)



Final Assembly of Injection Pump Side of Engine

A—Coolant Manifold
B—Rocker Arm Cover
C—Fuel Delivery (Pressure) Lines
D—Fuel Leak-off Lines
E—Fuel Injection Nozzles

1. Adjust valve clearance, if not previously done.

NOTE: Apply AR31790 SCOTCH-GRIP® Adhesive or equivalent to seal gasket to rocker arm cover (B). Follow manufacturer's directions on the package for correct application procedure and curing time.

2. Position rocker arm cover gasket on cylinder head and install rocker arm cover. Tighten cap screws to specifications.

Specification

Rocker Arm Cover-to-Cylinder
Head Cap Screw—Torque .... 8 N•m (6 lb-ft) (72 lb-in.)

3. Install fuel injection nozzles (E), fuel leak-off lines (D) and fuel delivery lines (C). If mechanical fuel system, see INSTALL FUEL INJECTION NOZZLES in Group 090 of CTM243. If Level 3 Electronic fuel system, see INSTALL FUEL INJECTION NOZZLES in Group 090 of CTM134.

NOTE: Make sure ventilator outlet hose is open and adapter is clean. A restriction could cause high oil pressure and possible loss of oil.

4. Connect ventilator outlet hose to adapter on rocker arm cover and tighten clamp securely.

5. Install coolant manifold (A). See INSTALL COOLANT MANIFOLD in Group 070.

SCOTCH-GRIP is a registered trademark of 3M Co.

RG,RG34710,1105 –19–23OCT97–1/1

Complete Final Assembly on Exhaust Manifold Side of Engine Serial Number (—199,999)

NOTE: APPLY PT569 NEVER-SEEZ® Compound or equivalent to all turbocharger cap screws. NEVER-SEEZ® is not needed on exhaust manifold cap screws. Guide studs may be used to aid assembly.

1. Install intake manifold (B) using new gaskets. Tighten cap screws to specifications.

Specification

Intake Manifold-to-Cylinder Head—Torque .... 47 N•m (35 lb-ft)

2. Install a new sealing ring (A) in groove of rear exhaust manifold (C).

3. Assemble front exhaust manifold (D) and rear exhaust manifold.

4. Install exhaust manifold assembly using new gaskets and guide studs. Tighten cap screws to specifications.

Specification

Exhaust Manifold-to-Cylinder Head—Torque .... 47 N•m (35 lb-ft)

5. Install turbocharger using a new metal gasket. Apply PT569 NEVER-SEEZ® Compound and tighten cap screws to specifications.

Specification

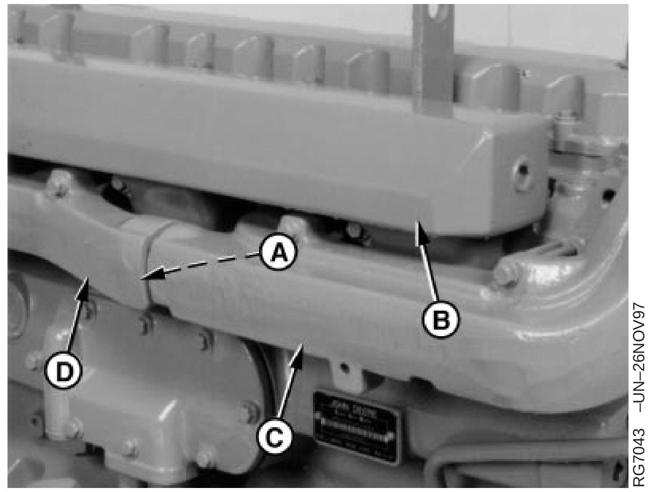
Turbocharger Cap Screws—Torque .... 24 N•m (18 lb-ft)

6. Connect turbocharger oil return pipe to turbocharger using a new gasket. Tighten cap screws to specifications.

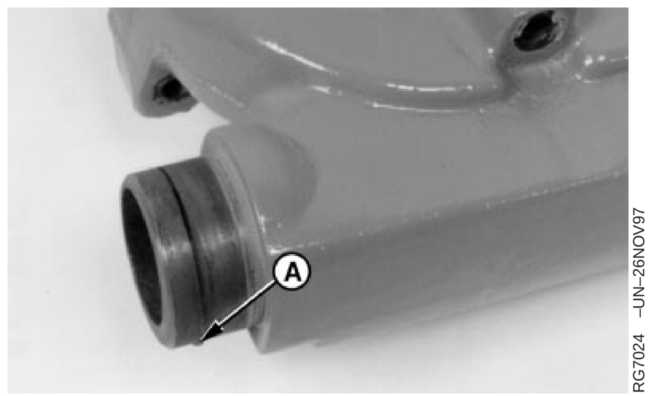
Specification

Turbocharger Oil Return Pipe-to-Turbocharger Cap Screws—Torque .... 27 N•m (20 lb-ft)

7. Connect turbocharger oil inlet and tighten securely.



Installing Intake and Exhaust Manifolds



Sealing Ring in Exhaust Manifold

A—Sealing Ring
B—Intake Manifold
C—Rear Exhaust Manifold
D—Front Exhaust Manifold

NEVER-SEEZ is a registered trademark of Emhart Chemical Group.

Continued on next page

RG,RG34710,1106 –19–23OCT97–1/2

8. If engine oil was drained from crankcase, install new oil filter and fill with clean oil of correct grade and viscosity. See DIESEL ENGINE OIL in Group 002.

9. Fill cooling system with clean coolant. See DIESEL ENGINE COOLANT in Group 002.

10. Perform engine break-in. See PERFORM ENGINE BREAK-IN SERIAL NUMBER (—199,999) later in this group.

RG,RG34710,1106 –19–23OCT97–2/2

Perform Engine Break-In Serial Number (—199,999)

1. Run engine at slow idle no load for 2 minutes. Check for liquid leaks.

2. Increase RPM to fast idle, then load down to 50 rpm above rated speed for 20 minutes.

NOTE: Dynamometer is the preferred load control, but engine can be loaded by matching drag loads to gear selection.

3. Recheck valve clearance and adjust as necessary. See CHECK AND ADJUST VALVE CLEARANCE SERIAL NUMBER (—199,999) earlier in this group.

4. Install rocker arm cover gasket and cover. Tighten rocker arm cover cap screws to specifications.

Specification	
Rocker Arm Cover-to-Cylinder Head Cap Screw—Torque	8 N•m (6 lb-ft) (72 lb-in.)

Retorque of cylinder head cap screws after engine break-in is not required.

IMPORTANT: After engine break-in, follow ALL recommended hourly service intervals outlined in your Operator’s Manual.

RG,RG34710,1107 –19–23OCT97–1/1

Check Valve Clearance — Serial Number (200,000—)

NOTE: For earlier engines (Tier I, ESN — 199,000) with the High Pressure Common Rail (HPCR) fuel systems, see Group 20 - Cylinder Head and Valves Repair and Adjustment S.N.(—199,000)

Too little valve clearance throws valves out of time. Valves open too early and close too late. This causes the valves to overheat due to hot combustion gases rushing past valves when out of time. Overheating lengthens valve stems which prevents proper seating of valves. The valves seat so briefly or poorly that normal heat transfer into the cooling system does not have time to take place, causing burned valves and low power.

Too much valve clearance causes a lag in valve timing, causing engine valve train imbalance. The fuel-air mixture enters the cylinders late during intake stroke. The exhaust valve closes early and prevents waste gases from being completely removed from cylinders. Also, the valves close with a great deal of impact, which may crack or break the valves and scuff the camshaft and followers.

Continued on next page RG41165,0000044 –19–22DEC00–1/4

CAUTION: To prevent accidental starting of engine while performing valve adjustments, always disconnect NEGATIVE (—) battery terminal.

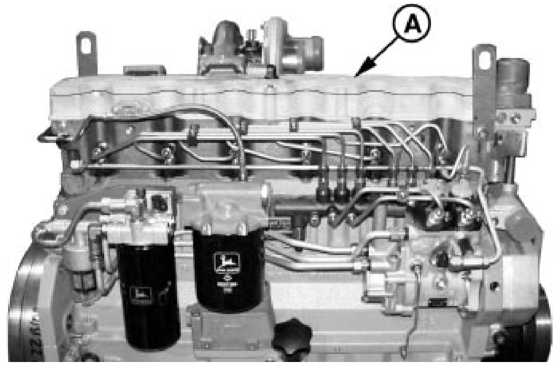
IMPORTANT: Valve clearance MUST BE checked and adjusted with engine COLD.

1. Disconnect carrier wiring harness (shown removed).

2. Remove rocker arm cover (A) with vent tube.

IMPORTANT: Visually inspect contact surfaces of valve tips and rocker arm wear pads. Check all parts for excessive wear, breakage, or cracks. Replace parts that show visible damage.

Rocker arms that exhibit excessive valve clearance should be inspected more thoroughly to identify damaged parts.



Remove Rocker Arm Cover

A—Rocker Arm Cover

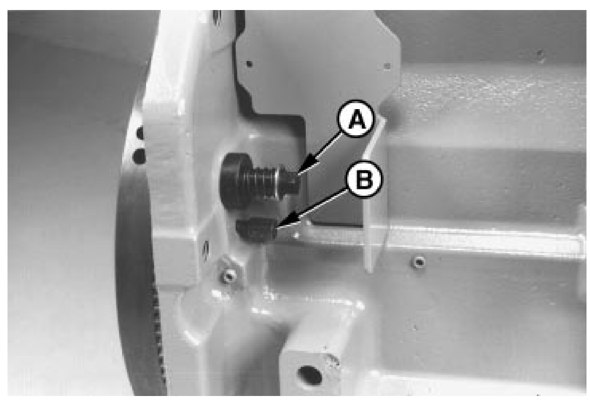
RG41165,0000044 –19–22DEC00–2/4

3. Remove plastic plug from cylinder block bores and install JDE81-1 or JDG820 Flywheel Turning Tool (A) and JDE81-4 Timing Pin (B).

4. Rotate engine with the flywheel turning tool until timing pin engages timing hole in flywheel.

5. If the rocker arms for No. 1 (front) cylinder are loose, the engine is at No. 1 “TDC-Compression.”

6. If the rocker arms for No. 6 (rear) cylinder are loose, the engine is at No. 6 “TDC-Compression.” Rotate the engine one full revolution (360°) to No. 1 “TDC-Compression.”



Flywheel Turning Tool and Timing Pin

A—Flywheel Turning Tool
B—Timing Pin

Continued on next page RG41165,0000044 –19–22DEC00–3/4

7. With engine lock-pinned at “TDC” of No. 1 piston’s compression stroke, use a bent feeler gauge to check valve clearance on Nos. 1, 3, and 5 exhaust valves and Nos. 1, 2, and 4 intake valves.

Specification

Intake Valve Clearance Checking (Rocker Arm-to-Valve Tip With Engine Cold)—Clearance .... 0.41—0.51 mm (0.016—0.020 in.)

Exhaust Valve Clearance Checking (Rocker Arm-to-Valve Tip With Engine Cold)—Clearance .... 0.66—0.76 mm (0.026—0.030 in.)

8. Rotate flywheel 360° until No. 6 piston is at “TDC” of its compression stroke. Rocker arms for No. 6 piston should be loose.

9. Check valve clearance to the same specifications on Nos. 2, 4, and 6 exhaust and Nos. 3, 5, and 6 intake valves.

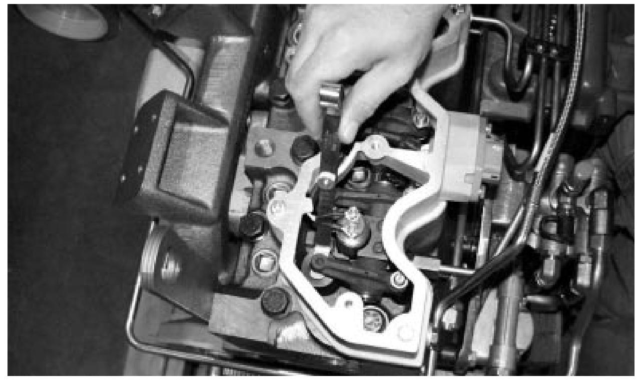
10. If valve clearance needs to be adjusted, see ADJUST VALVE CLEARANCE SERIAL NUMBER (200,000—), later in this section.

11. Install rocker arm cover with vent tube and tighten cap screws to specifications in order shown.

Specification

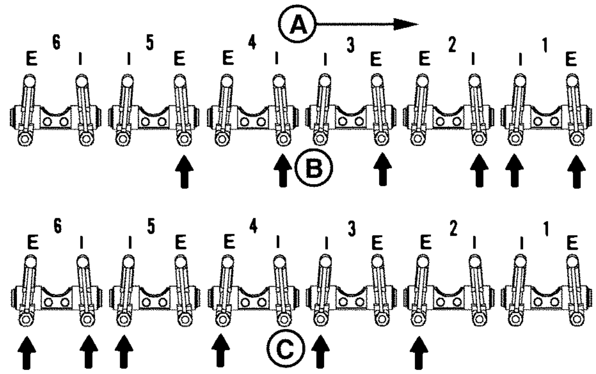
Rocker Arm Cover-to-Carrier Cap Screws—Torque .... 8 N•m (5.9 lb-ft)

A—Front of Engine
B—No. 1 Cylinder “TDC”
C—No. 6 Cylinder “TDC”
D—Front of Engine



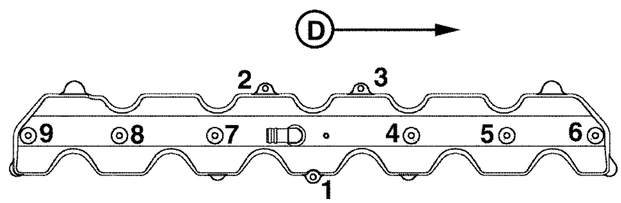
RG11559 —UN–07NOV00

Checking Valve Clearance Using Bent Feeler Gauge



RG11569 —UN–14NOV00

Valve Checking Sequence



RG11620 —UN–11DEC00

Order to Tighten Rocker Arm Cover Cap Screws

RG41165,0000044 –19–22DEC00–4/4

Adjust Valve Clearance Serial Number (200,000—)

Too little valve clearance throws valves out of time. Valves open too early and close too late. This causes the valves to overheat due to hot combustion gases rushing past valves when out of time. Overheating lengthens valve stems which prevents proper seating of valves. The valves seat so briefly or poorly that normal heat transfer into the cooling system does not have time to take place, causing burned valves and low power.

Too much valve clearance causes a lag in valve timing, causing engine valve train imbalance. The fuel-air mixture enters the cylinders late during intake stroke. The exhaust valve closes early and prevents waste gases from being completely removed from cylinders. Also, the valves close with a great deal of impact, which may crack or break the valves and scuff the camshaft and followers.

Continued on next page RG41165,0000045 –19–22DEC00–1/7

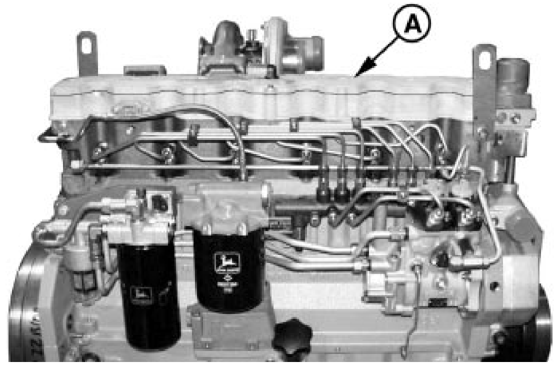
CAUTION: To prevent accidental starting of engine while performing valve adjustments, always disconnect NEGATIVE (—) battery terminal.

IMPORTANT: Valve clearance MUST BE checked and adjusted with engine COLD.

1. Disconnect carrier wiring harness (shown removed).
2. Remove rocker arm cover (A) with vent tube.
3. Remove wires from electronic injectors.
4. Remove carrier (B).

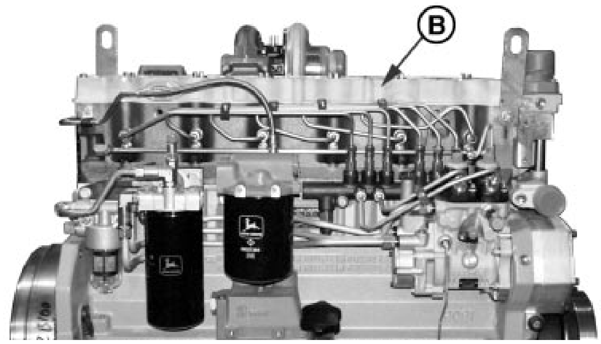
IMPORTANT: Visually inspect contact surfaces of valve tips and rocker arm wear pads. Check all parts for excessive wear, breakage, or cracks. Replace parts that show visible damage.

Rocker arms that exhibit excessive valve clearance should be inspected more thoroughly to identify damaged parts.



RG11562B –UN–17NOV00

Remove Rocker Arm Cover



RG11574A –UN–20NOV00

Remove Carrier

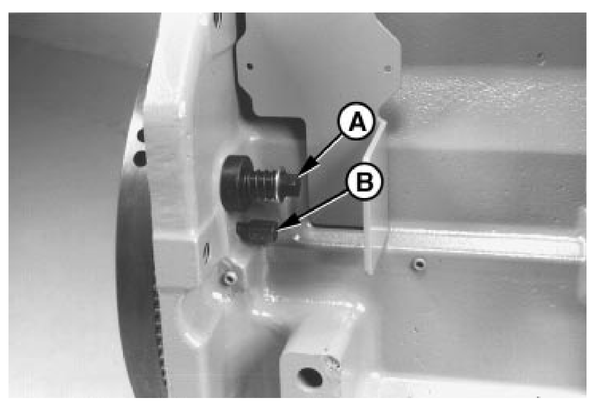
A—Rocker Arm Cover
B—Carrier

RG41165,0000045 –19–22DEC00–2/7

5. Remove plastic plug from cylinder block bores and install JDE81-1 or JDG820 Flywheel Turning Tool (A) and JDE81-4 Timing Pin (B).
6. Rotate engine with the flywheel turning tool until timing pin engages timing hole in flywheel.

   If the rocker arms for No. 1 (front) cylinder are loose, the engine is at No. 1 "TDC-Compression."

   If the rocker arms for No. 6 (rear) cylinder are loose, the engine is at No. 6 "TDC-Compression." Rotate the engine one full revolution (360°) to No. 1 "TDC-Compression."



RG7013 –UN–26NOV97

Flywheel Turning Tool and Timing Pin

A—Flywheel Turning Tool
B—Timing Pin

Continued on next page

RG41165,0000045 –19–22DEC00–3/7

7. With engine lock-pinned at "TDC" of No. 1 piston's compression stroke, adjust valve clearance on Nos. 1, 3, and 5 exhaust valves and Nos. 1, 2, and 4 intake valves to specifications. Loosen lock nut on rocker arm adjusting screw. Turn adjusting screw until feeler gauge slips with a slight drag. Hold the adjusting screw from turning with screwdriver and tighten lock nut to specifications.

Specification

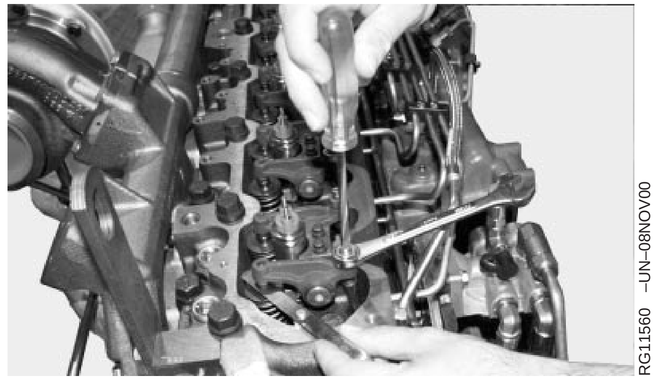
Intake Valve Clearance Adjustment (Rocker Arm-to-Valve Tip With Engine Cold)—Clearance .... 0.46 mm (0.018 in.)
Exhaust Valve Clearance Adjustment (Rocker Arm-to-Valve Tip With Engine Cold)—Clearance .... 0.71 mm (0.028 in.)
Valve Adjusting Screw Lock Nut—Torque .... 27 N•m (20 lb-ft)

Recheck clearance again after tightening lock nut. Readjust clearance as necessary.

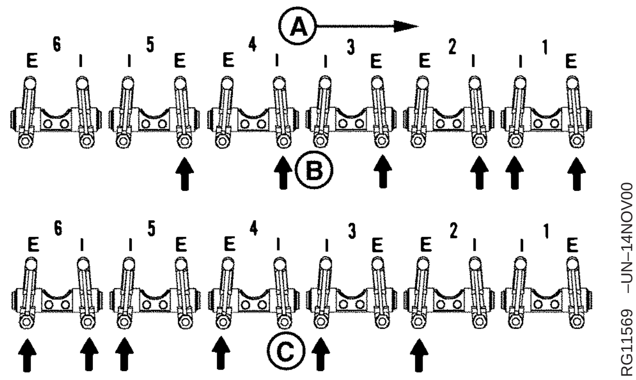
8. Rotate flywheel 360° until No. 6 piston is at "TDC" of its compression stroke. Rocker arms for No. 6 piston should be loose.

9. Adjust valve clearance to the same specifications on Nos. 2, 4, and 6 exhaust and Nos. 3, 5, and 6 intake valves.

   Recheck clearance again after tightening lock nut. Readjust clearance as necessary.



Adjusting Valve Clearance



Valve Adjusting Sequence

A—Front of Engine
B—No. 1 Cylinder "TDC"
C—No. 6 Cylinder "TDC"

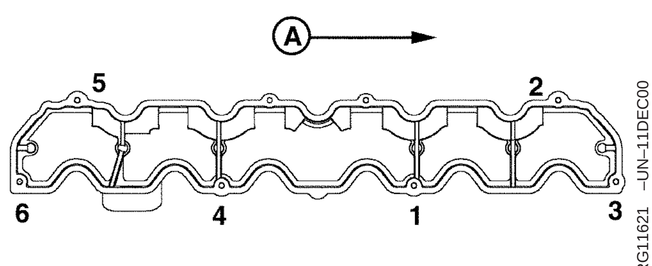
RG41165,0000045 –19–22DEC00–4/7

10. Install carrier. Tighten cap screws in order shown to specifications.

Specification

Carrier-to-Cylinder Head Cap Screws—Torque .... 8 N•m (5.9 lb-ft)

A—Front of Engine



Order to Tighten Carrier Cap Screws

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RG41165,0000045 –19–22DEC00–5/7

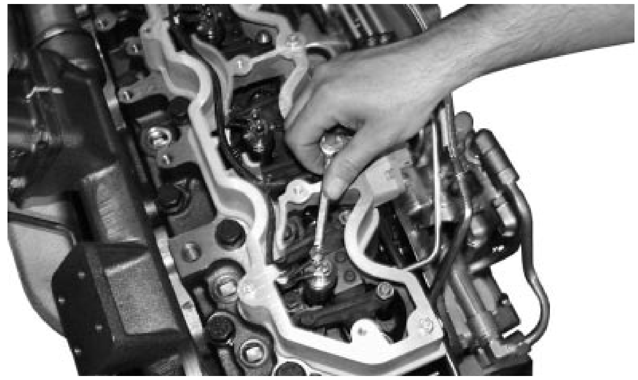
11. Install injector wiring leads on injector studs.

12. Apply LOCTITE® 222 to injector studs.

13. Install solenoid wire retaining nuts to injector studs and tighten to specifications.

Specification

Solenoid Wire Retaining Nuts—
Torque .... 1.75 N•m (1.29 lb-ft)



Install Solenoid Wire Retaining Nuts to Injector Studs

LOCTITE is a trademark of Loctite Corp.

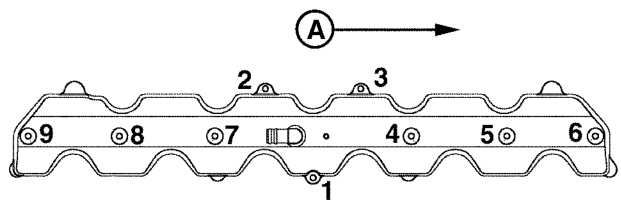
RG41165,0000045 –19–22DEC00–6/7

14. Install rocker arm cover with vent tube. Tighten capscrews in order shown to specifications.

Specification

Rocker Arm Cover Capscrews—
Torque .... 8 N•m (5.9 lb-ft)

A—Front of Engine



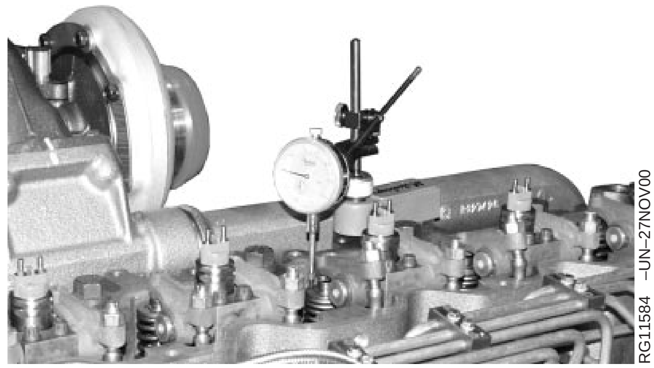
Order to Tighten Rocker Arm Cover Cap Screws

RG41165,0000045 –19–22DEC00–7/7

Check Valve Lift Serial Number (200,000—)

IMPORTANT: For a more accurate measurement, it is recommended that valve lift be measured at 0.00 mm (in.) valve clearance and with engine COLD.

NOTE: Measuring valve lift can give an indication of wear on camshaft lobes and cam followers or bent push rods.



Checking Valve Lift

1. Remove turbocharger oil inlet clamp and rocker arm cover. Loosen lock nut on rocker arm. Set valve clearance at 0.00 mm (in.) on valve being checked. Tighten lock nut.

2. Put dial indicator tip on valve spring cap. Be sure that valve is fully closed.

3. Check preset on dial indicator. Set dial indicator pointer at zero.

4. Manually turn engine in running direction, using the engine rotation tools previously mentioned for checking valve clearance.

5. Observe dial indicator reading as valve is moved to fully open position. Record reading and valve number.

Specification

Intake Valve—Lift	13.53—13.71 mm (0.533—0.540 in.) at 0.00 mm (in.) clearance
Wear—Tolerance	12.65 mm (0.498 in.) at 0.00 mm (in.) clearance
Exhaust Valve—Lift	14.52—14.70 mm (0.572—0.579 in.) at 0.00 mm (in.) clearance
Wear—Tolerance	13.64 mm (0.537 in.) at 0.00 mm (in.) clearance

6. Repeat procedure on all remaining valves.

7. Reset valve clearance to specification after measuring lift. (See ADJUST VALVE CLEARANCE SERIAL NUMBER (200,000—) earlier in this group.)

Remove Cylinder Head Serial Number (200,000—)

It is not necessary to remove engine from machine to service cylinder head on all applications. Refer to your Machine Technical Manual for engine removal procedure, if required.

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

DO NOT drain coolant until the coolant temperature is below operating temperature. Always loosen drain valve slowly to relieve any excess pressure.

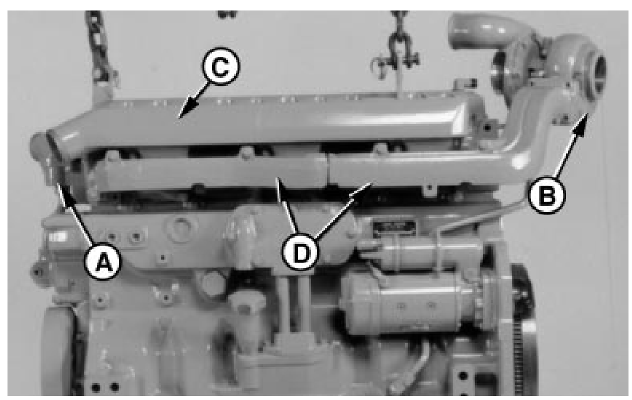
TS218 –UN–23AUG88

Service Cooling System Safely

1. Drain engine oil and coolant. Disconnect turbo inlet line at turbocharger or at oil filter base. (See DISCONNECT TURBOCHARGER OIL INLET LINE in Group 010.)

NOTE: If cylinder head is being removed for piston and liner repairs or any other service that does not require disassembly of head, cylinder head can be removed with coolant manifold (A), turbocharger (B), intake manifold (C), and exhaust manifold (D) installed.

2. Remove coolant manifold and all coolant piping. See REMOVE COOLANT MANIFOLD in Group 070.
3. Remove turbocharger. See REMOVE TURBOCHARGER in Group 080.
4. Remove front and rear exhaust manifold (D). See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD in Group 080.
5. Remove air intake manifold. See REMOVE, INSPECT AND INSTALL INTAKE MANIFOLD in Group 080.
6. Remove fuel injection delivery lines, and fuel leak-off lines.
7. Remove rocker arm cover and carrier.



RG7014 –UN–26NOV97

Removing Cylinder Head

A—Coolant Manifold
B—Turbocharger
C—Intake Manifold Assembly
D—Exhaust Manifold Assembly

Continued on next page

8. Loosen all rocker arm adjusting screws before loosening rocker arm pedestals. Remove rocker arm assemblies.

9. Remove fuel inlet connectors, fuel leak-off connectors, and electronic injectors. See REMOVE ELECTRONIC INJECTORS in Group 090 of CTM 255.

10. Remove push rods and identify for reassembly.

NOTE: Clean and inspect push rods. See CLEAN AND INSPECT PUSH RODS SERIAL NUMBER (200,000—) later in this group.

RG41165,0000047 –19–22DEC00–2/3

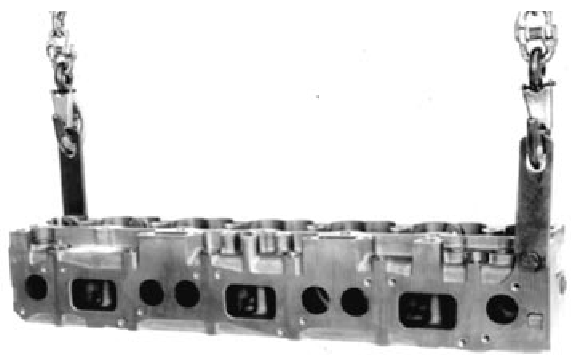
11. Remove all cylinder head cap screws. Discard cap screws, they are not reusable.

IMPORTANT: DO NOT use screwdrivers or pry bars between cylinder block and cylinder head to loosen head-to-block gasket seal.

12. Lift cylinder head from block. If cylinder head sticks, use a soft hammer to tap the cylinder head.

13. Remove cylinder head gasket. Inspect for possible oil, coolant, or combustion chamber leaks. Also, check for evidence of incorrect or defective head gasket being used.

NOTE: Do not rotate crankshaft with cylinder head removed unless all cylinder liners are secured with cap screws and large flat washers as described in Group 10. See REMOVE PISTONS AND CONNECTING ROD ASSEMBLIES in Group 030.



RG5245 –UN–05DEC97

Lifting Cylinder Head From Block

RG41165,0000047 –19–22DEC00–3/3

Diagnosing Head Gasket Joint Failures - Serial Number (200,000—)

Head gasket failures generally fall into three categories:

- Combustion seal failures.
- Coolant seal failures.
- Oil seal failures.

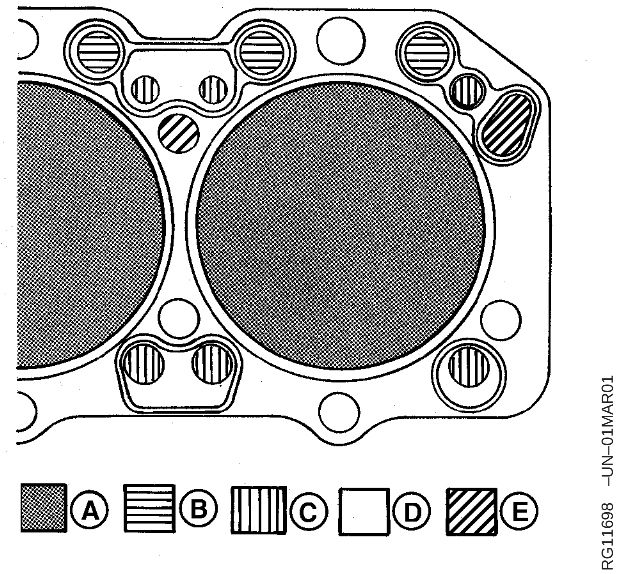
Combustion seal failures occur when combustion gases escape between cylinder head and head gasket combustion flange, or between combustion flange and cylinder liner. Leaking combustion gases may vent to an adjacent cylinder, to a coolant or oil passage, or externally.

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 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. 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 radiator pressure cap.
    - Presence of oil in coolant.
    - Low coolant levels.
    - Improper coolant.
    - Unusually high or low oil levels.
    - Unburned fuel or coolant in exhaust system.
    - Oil degradation, dilution, or contamination.



Diagnosing Cylinder Head Gasket Joints

A—Combustion Sealing Areas
B—Oil Sealing Areas (Push Rod)
C—Coolant Sealing Areas
D—Cylinder Head Cap Screws
E—Oil Sealing Areas (Cylinder Head Cap Screws)

Continued on next page RG41165,0000048 –19–22DEC00–1/2

- Incorrectly specified injection pump.
- Indications of fuel or timing adjustments.

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 measuring equipment, check for the following:

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

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 following diagnostic charts.

   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.

RG41165,0000048 –19–22DEC00–2/2

Head Gasket Diagnostic Charts - Serial Number (200,000—)

COMBUSTION SEAL LEAKAGE

Symptoms	Possible Causes
Exhaust from head gasket crevice	Insufficient liner standout
Air bubbles in radiator/overflow tank	Excessive liner standout differential between cylinders
Coolant discharge from overflow tube	Low head bolt clamping loads
Engine overheating	Rough/damaged liner flange surface
Power loss	Cracked/deformed gasket combustion flange
Engine runs rough	Out-of-flat/damaged/rough cylinder head surface
White exhaust smoke	Missing/mislocated gasket fire ring
Loss of cab heat (vehicle engines)	Block cracked in liner support area
Gasket section dislodged, missing (blown)	Excessive fuel delivery
Coolant in cylinder	Advanced injection pump timing
Coolant in crankcase oil	Hydraulic or mechanical disturbance of combustion seal
Low coolant level	Leaks in cooling system or engine overheating
	Cracked cylinder head or liners may also allow combustion gas leakage into coolant.

COOLANT SEAL LEAKAGE

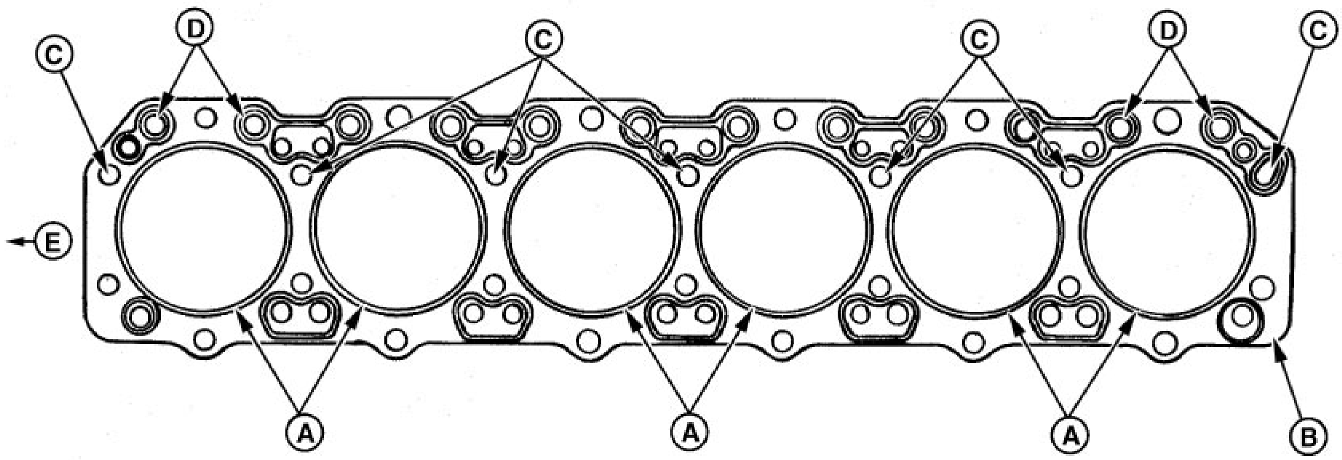
Symptoms	Possible Causes
Coolant discharge from head gasket crevice	Excessive liner standout
Coolant in crankcase oil	Excessive liner standout differential between cylinders
Low coolant level	Low head bolt clamping loads
High oil level	Out-of-flat/damaged/rough block surface
Coolant discharge from crankcase vent	Out-of-flat/damaged/rough cylinder head surface
	Oil or coolant overheating
	Cracks/creases in gasket body surfaces
	Damage/voids in elastomer beading of gasket
	Cracked cylinder head, liners, liner packings, defective oil cooler or aftercooler may also allow coolant leakage into crankcase.

OIL SEAL LEAKAGE

Symptoms	Possible Causes
Oil discharge from head gasket crevice	Excessive liner standout
Oil in coolant	Excessive liner standout differential between cylinders
Low crankcase oil level	Low head bolt clamping loads
Reduced oil to rocker arms (noisy)	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 of gasket
	Damaged/missing O-ring seal at oil port to rocker arms
	Defective oil cooler may also allow oil leakage into coolant.

RG41165,0000049 –19–22DEC00–1/1

Head Gasket Inspection and Repair Sequence - Serial Number (200,000—)



Inspecting Cylinder Head Gasket

A—Combustion Seals (Flange)
B—Gasket Body
C—Rocker Arm Oil Columns
D—Elastomer Beading Strips
E—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 SERIAL NUMBER (200,000—) earlier 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/abraded/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.
   - O-ring seal missing/damaged in port area (C).
   - Elastomer missing/damaged in port area (D).
   - 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 block, head, liners, and cap screws. (This group and Group 030.)

Continued on next page

RG41165,000004A –19–22DEC00–1/2

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) (This group, Group 030.)

   - 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 for corrosion damage.
   - Inspect condition of threads.
   - Inspect for straightness.
   - 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 repair groups of this manual.

RG41165,000004A –19–22DEC00–2/2

Inspect Rocker Arm Assembly - Serial Number (200,000—)

Rocker Arm Assembly

1. Inspect rocker arms, snap rings, pedestal, and shaft for damage. Look for:

   —Loose, bent, twisted, or worn snap rings.

   —Rotation of rocker arm on shaft. Rocker arms should rotate freely on shaft, but there should not be noticeable space between rocker bore and shaft.

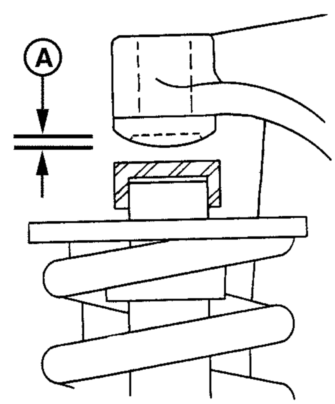
NOTE: Wear could indicate weak valve springs, bent push rods, or loose rocker pedestal cap screws.

2. If rocker arms, snap rings, pedestal, or shaft are damaged, rocker arm assembly MUST BE replaced as an assembly.

3. Check rocker arm adjusting nut and screw for damage. Visually inspect rocker arm for hairline cracks. Replace if necessary.

4. Clean rocker arm assembly with clean solvent. Dry with compressed air.

RG41165,000004B –19–22DEC00–1/2



Rocker Arm Wear Area

5. Check for cups or concave wear (A) on ends of rocker arms where they contact wear caps.

NOTE: If the rocker arm has been damaged by a valve failure, replace it and the push rods when replacing valves.

6. Roll push rods on a flat surface to check for bends or distortion. Replace parts as necessary.

A—Wear Area

RG41165,000004B –19–22DEC00–2/2

Disassemble and Assemble Rocker Arm Assembly - Serial Number (200,000—)


RG11703 –UN–06MAR01

Rocker Arm Assembly

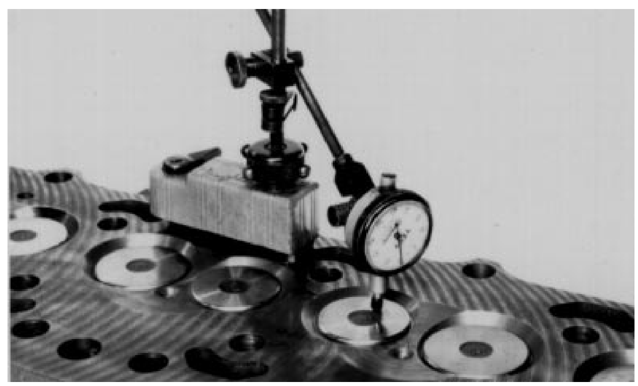
Rocker arm assembly cannot be disassembled and assembled.

Rocker arm assembly is NOT serviceable, and MUST BE replaced as a unit.

Rocker arm mountng screws **cannot** be re-used. Replace rocker arm mounting screws removed from engine with new screws.

RG41165,000004C –19–22DEC00–1/1

Measure Valve Recess - Serial Number (200,000—)


RG11696 –UN–26FEB01

Measuring Valve Recess

Measure and record valve recess dimensions for all valves using JDG451 Gauge with D17526CI (English, in.) or D17527CI (Metric, mm) Dial Indicator or KJD10123 Gauge. Compare measurements to specifications given below.

Specification

Exhaust Valve—Recess	1.19—1.70 mm (0.047—0.067 in.) below cylinder head
Maximum Recess	2.46 mm (0.097 in.) below cylinder head
Intake Valve—Recess	3.35—3.86 mm (0.132—0.152 in.) below cylinder head
Maximum Recess	4.62 mm (0.182 in.) below cylinder head

NOTE: Thoroughly clean all gasket material from cylinder head combustion face before measuring.

If measurement does not meet specifications, check valve face angle and valve seat angle. If valve is recessed beyond the maximum specification, install either new valves, valve seat inserts, or both to obtain proper valve recess. See REMOVE VALVE SEAT INSERTS AND MEASURE BORES IN CYLINDER HEAD SERIAL NUMBER (200,000—) later in this group.

RG41165,000004D –19–22DEC00–1/1

Preliminary Cylinder Head and Valve Checks - Serial Number (200,000—)

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.
- 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.
- Bent push rods.
- 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 guides.
- Bent valves.
- Debris passed through valve train.

RG41165,000004E –19–22DEC00–1/1

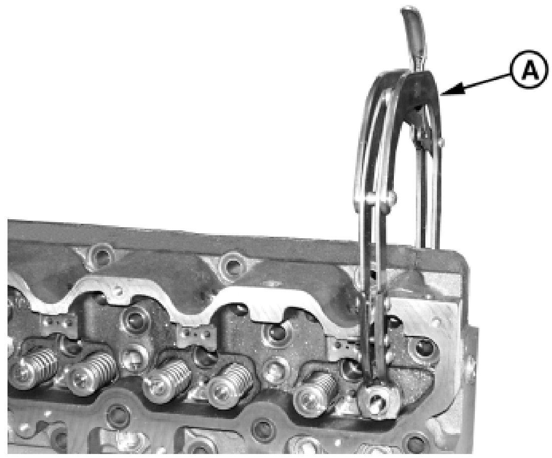
Remove Valve Assembly - Serial Number (200,000—)

Refer to PRELIMINARY CYLINDER HEAD AND VALVE CHECKS SERIAL NUMBER (200,000—), earlier in this group as valves are removed from head.

IMPORTANT: Identify all usable parts for correct reassembly in same location as removed.

1. Compress valve spring using JDE138 Valve Spring Compressor (A) as shown.
2. Remove retaining locks (B) using a small magnet.
3. Remove valve spring compressor from head.
4. Remove valve spring cap (D) and valve spring (C).
5. Repeat procedure on remaining valves.

A—JDE138 Valve Spring Compressor
B—Retainer Locks
C—Valve Springs
D—Valve Spring Caps



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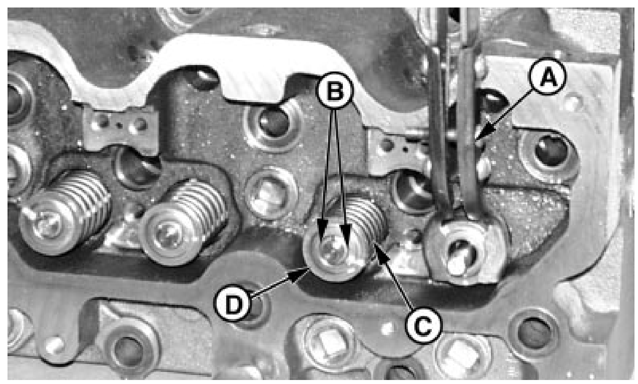
Removing Valve Assemblies



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Close View of Removing Valve Assemblies

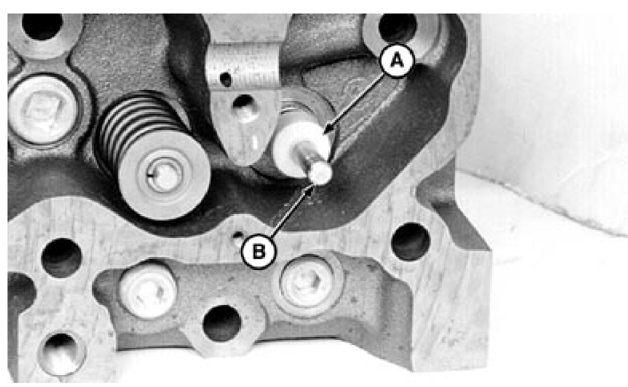
RG41165,000004F –19–22DEC00–1/2

Remove oil shield (A) from exhaust valves. Remove valve (B) from cylinder head. Identify valve for reassembly, if valve is to be reused.

NOTE: Intake valves do not have stem seals.

6. Repeat procedure on remaining valves.

A—Oil Shield
B—Valve



RG7229 –UN–05DEC97

Removing Valves

RG41165,000004F –19–22DEC00–2/2

Inspect and Measure Valve Springs - Serial Number (200,000—)

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

2. Put springs on a flat surface to see that they are square and parallel.

NOTE: Free spring length of 57 mm (2.24 in.) springs differ slightly, but compressed height must be the same.

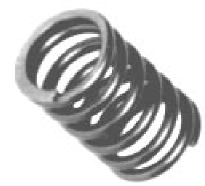
3. Check valve spring tension using D01168A Spring Compression Tester.

Specification

Intake Valve Spring—Height	33.8 mm (1.33 in.)@797—917 N (168—206 lb-force) with valve open
Height	47.7 mm (1.88 in.)@312—366 N (70—82 lb-force) with valve closed

Specification

Exhaust Valve Spring—Height	34.6 mm (1.36 in.)@748—868 N (168—195 lb-force) with valve open
Height	49.4 mm (1.94 in.)@258—312 N (58—70 lb-force) with valve closed



RG2732 –UN–04DEC97

Valve Spring

T82054 –UN–08NOV88

Checking Valve Spring Tension

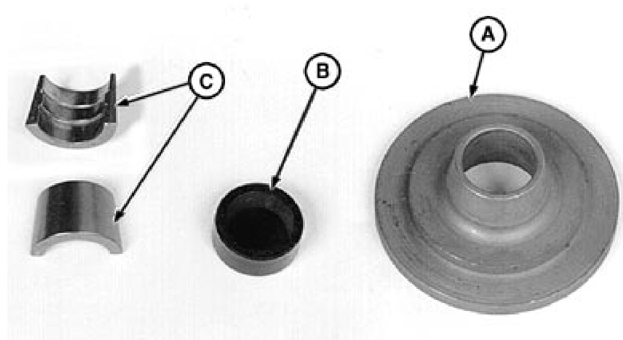
RG41165,0000050 –19–22DEC00–1/1

Inspect Valve Spring Caps, Wear Caps, and Retainer Locks Serial Number (200,000—)

1. Inspect valve spring caps (A) in area where valve springs and retaining locks seat for excessive wear. Replace as needed.

2. Inspect retainer locks (C) for excessive wear. Replace as needed.

3. Inspect valve wear cap (B) contact surfaces. Replace wear caps if pitted or worn.



RG7230 –UN–05DEC97

Inspecting Valve Parts

A—Valve Spring Caps
B—Valve Wear Cap
C—Retainer Locks

RG41165,0000051 –19–22DEC00–1/1

Clean Valves - Serial Number (200,000—)

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

2. Make sure all carbon is removed from valve head, face and stem. Polish valve stem with steel wool or crocus cloth to remove scratch marks left by wire brush.

IMPORTANT: Any carbon left on valve stem will affect alignment in refacer if valves need to be refaced.

RG41165,0000052 –19–22DEC00–1/1

Inspect and Measure Valves - Serial Number (200,000—)

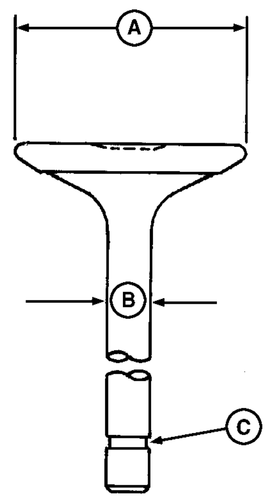
1. Thoroughly clean and inspect valves to help determine if they can be restored to a serviceable condition. Replace valves that are burned, cracked, eroded, or chipped.

2. Inspect valve retainer lock groove (C) on valve stem for damage. Also inspect stems for signs of scuffing, which may indicate insufficient valve guide-to-valve stem clearance. Replace if defects are evident.

3. Measure valve head O.D. (A). Compare valve stem O.D. (B) with guide I.D. to determine clearance, as outlined later in this group.

Specification

Intake Valve Stem—OD	9.461—9.487 mm (0.3725—0.3735 in.)
Exhaust Valve Stem—OD	9.436—9.462 mm (0.3715—0.3725 in.)
Intake Valve Head—OD	50.87—51.13 mm (2.002—2.012 in.)
Exhaust Valve Head—OD	46.87—47.13 mm (1.845—1.856 in.)



Measuring Valves

A—Valve Head OD
B—Valve Stem OD
C—Valve Retainer Lock Groove

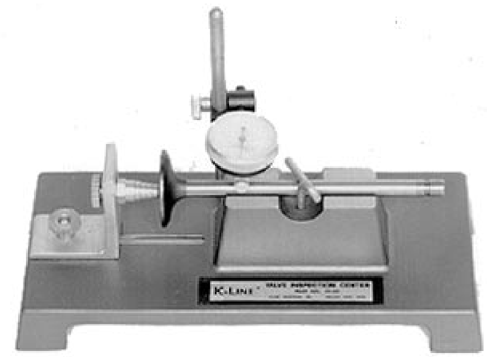
Continued on next page

RG41165,0000053 –19–22DEC00–1/2

4. Use D05058ST Valve Inspection Center to determine if valves are out of round, bent or warped.

Specification

Valve Face—Runout .... 0.05 mm (0.002 in.) maximum permissible



RG4234 –UN–05DEC97

Valve Face Runout Check

RG41165,0000053 –19–22DEC00–2/2

Grind (Reface) Valves - Serial Number (200,000—)

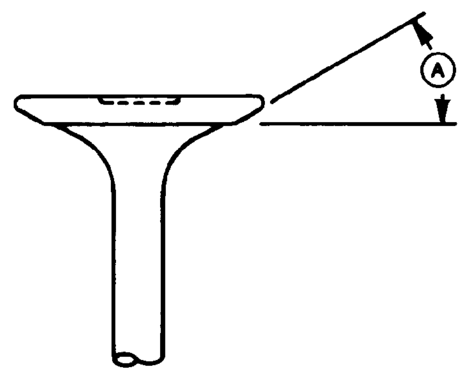
IMPORTANT: Valve grinding should only be done by experienced personnel familiar with equipment and capable of maintaining required specifications.

If necessary to reface valve, grind valve face angle (A) to following specification.

Specification

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

IMPORTANT: When valve faces are ground, it is important not to nick valve head-to-stem radius with facing stone. A nick could cause the valve to break. Radius all sharp edges after grinding.



RG5247 –UN–05DEC97

Valve Face Angle

A—Valve Face Angle

RG41165,0000054 –19–22DEC00–1/1

Inspect and Clean Cylinder Head - Serial Number (200,000—)

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. Scrape gasket material, oil, carbon, and rust from head. Use a powered brass or copper wire brush to clean sealing surfaces.

IMPORTANT: Be sure to remove all plugs before cleaning head, as parts can be damaged or destroyed by hot tank solutions.

3. Clean cylinder head in a chemical hot tank, or with solvent and a brush.

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

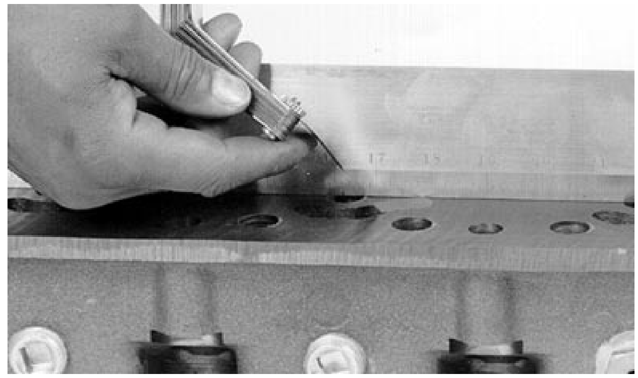
5. Reinstall plugs removed from cylinder head and tighten to the following specifications.

Specification

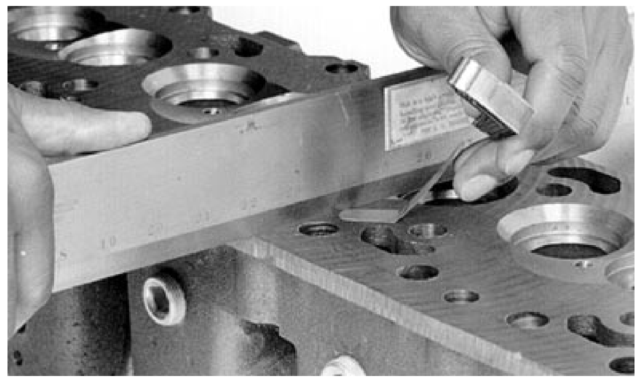
Cylinder Head Plugs—Torque................................. 60 N•m (44 lb-ft)

RG41165,0000055 –19–22DEC00–1/1

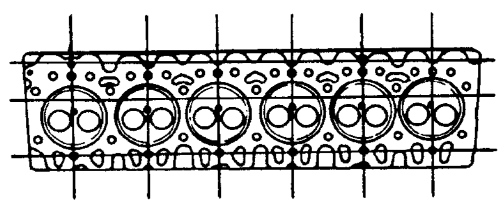
Check Cylinder Head Combustion Face Flatness - Serial Number (200,000—)


RG7231 –UN–05DEC97

Checking Flatness of Cylinder Head (1)


RG7232 –UN–05DEC97

Checking Flatness of Cylinder Head (2)


RG4629

RG4629 –UN–05DEC97

Location to Check for Head Flatness

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

If any measurement exceeds specification, the cylinder head must be either resurfaced or replaced. See MEASURE CYLINDER HEAD THICKNESS (200,000—) later in this group.

Specification

Cylinder Head—Maximum Acceptable Out-of-Flat Over Entire Length or Width	0.08 mm (0.003 in.)
Straightness Per Any 305 mm (12 in.) Length	Within 0.025 mm (0.001 in.)

RG41165,0000056 –19–22DEC00–1/1

Measure Cylinder Head Thickness - Serial Number (200,000—)

Measure head thickness (A) from valve cover gasket rail-to-combustion face.

Specification

Cylinder Head—Thickness	155.45—155.71 mm (6.120—6.130 in.)
Wear Limit	154.69 mm (6.09 in.)
Combustion Face Surface Finish (Surface Mill Only to AA Finish)	1.5—2.8 micrometers (60—110 micro-in.)
Maximum Wave Depth	0.012 mm (0.0005 in.)

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

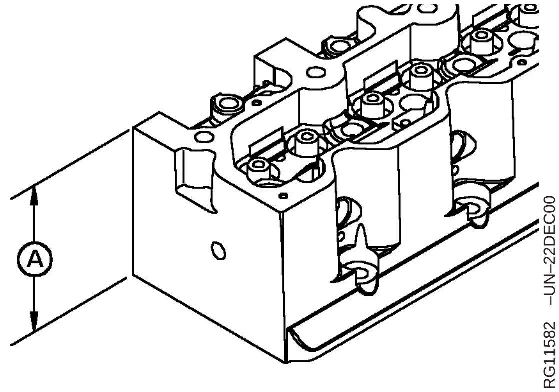
Specification

Resurfacing Head—Maximum Material Removal	0.762 mm (0.030 in.)

NOTE: If necessary to resurface cylinder head, a MAXIMUM of 0.762 mm (0.030 in.) can be ground from new part dimension. Remove ONLY what is necessary to restore flatness.

IMPORTANT: After resurfacing, check flatness as described earlier and check surface finish on combustion face of head.

Check valve recess after grinding. (See MEASURE VALVE RECESS SERIAL NUMBER (200,000—) earlier in this group.) Valve face may be ground to bring this characteristic within specification.



Cylinder Head Thickness

A—Head Thickness

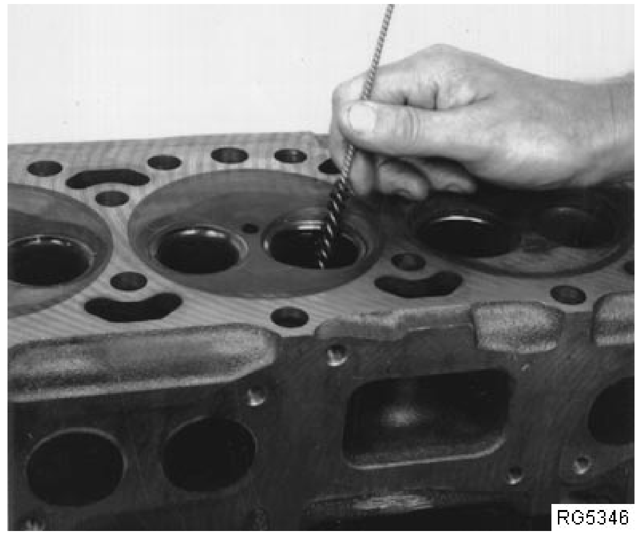
02
021
25

RG41165,0000057 –19–22DEC00–1/1

Clean Valve Guides - Serial Number (200,000—)

Use a D17024BR End Brush to clean valve guides before inspection or repair.

NOTE: A few drops of light oil or kerosene will help to fully clean the guide.



RG5346 –UN–07NOV97

Cleaning Valve Guides

RG41165,0000058 –19–22DEC00–1/1

Measure Valve Guides - Serial Number (200,000—)

Measure valve guides (A) for wear using a telescope gauge (B) and micrometer.

Specification

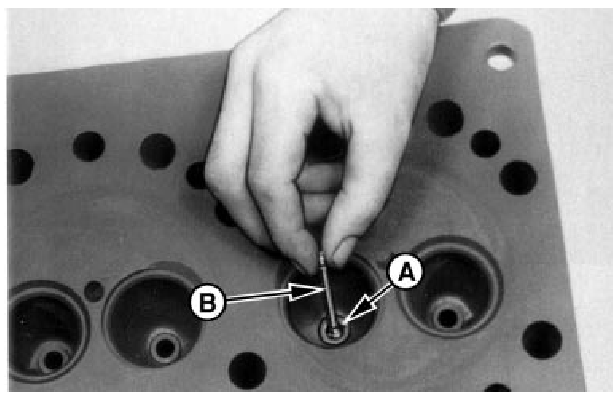
Valve Guide—ID	9.51—9.54 mm (0.3745—0.3755 in.) in new head
New Guide-to-Exhaust Valve Stem—Clearance	0.051—0.102 mm (0.002—0.004 in.)

Specification

New Guide-to-Intake Valve Stem—Clearance	0.025—0.076 mm (0.001—0.003 in.)

NOTE: Worn guides can allow a clearance of 0.15 mm (0.006 in.) and still be acceptable. Worn guides may be knurled to return them to specified clearance if valve-to-guide clearance is 0.25 mm (0.010 in.) or less. If clearance exceeds 0.25 mm (0.010 in.), install oversize valves.

IMPORTANT: ALWAYS knurl exhaust valve guides before reaming to assure proper valve guide-to-stem clearance.



RGR23984 –UN–12JAN98

A—Valve Guides
B—Telescope Gauge

RG41165,0000059 –19–22DEC00–1/1

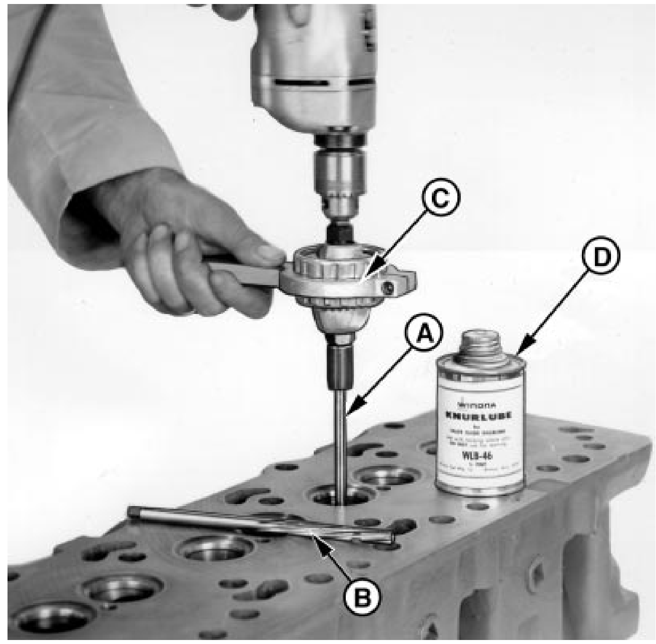
Knurl Valve Guides - Serial Number (200,000—)

1. Use JT05949 (formerly D20002) Valve Guide Knurler Kit to knurl valve guides.

NOTE: Use tool set exactly as directed by the manufacturer.

2. After knurling, ream valve guide to finished size to provide specified stem-to-guide clearance.

A—Knurler
B—Reamer
C—Speed Reducer
D—Lubricant



RGR26141 –UN–12JAN98

Knurling Valve Guides

RG41165,000005A –19–22DEC00–1/1

Clean and Inspect Valve Seats - Serial Number (200,000—)

1. Use an electric hand drill with D17024BR Wire Cleaning Brush or equivalent brush to remove all carbon on valve seats.

2. Check seats for cracks, pits, or excessive wear.

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

R26142N –UN–09DEC88

Cleaning Valve Seats

RG41165,000005B –19–22DEC00–1/1

Measure Valve Seats - Serial Number (200,000—)

1. Measure valve seats for proper specifications listed below.

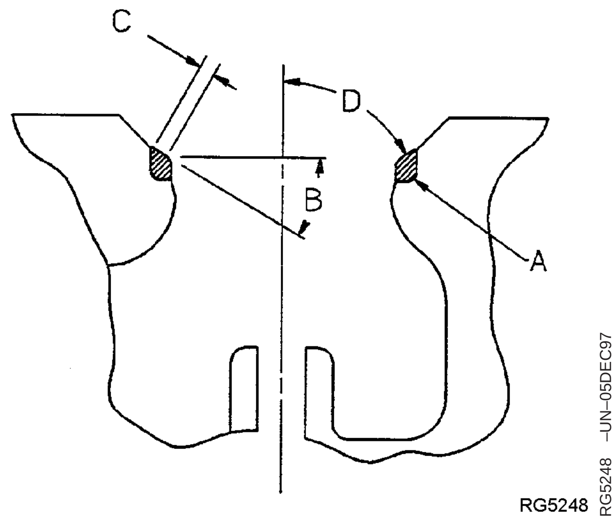
2. Using D11010KW Eccentrimeter, measure valve seat runout (D).

3. If valve seat is not within specification, recondition valve seat by grinding or replace valve seat inserts (A) if reconditioning is not possible. See GRIND VALVE SEATS SERIAL NUMBER (200,000—), or see INSTALL VALVE SEAT INSERTS SERIAL NUMBER (200,000—), later in this group.

Specification	
Valve Seat—Angle	30° ± 0.50°
Maximum Runout	0.051 mm (0.0020 in.)

Specification	
Exhaust Valve Seat—Width	2.0—3.8 mm (0.079—0.150 in.)

Specification	
Intake Valve Seat—Width	1.4—3.8 (0.055—0.150 in.)



Measuring Valve Seats

A—Valve Seat Insert
B—Valve Seat Angle
C—Valve Seat Width
D—Valve Seat Runout

RG41165,000005C –19–22DEC00–1/1

Grind Valve Seats - Serial Number (200,000—)

IMPORTANT: Valve seat grinding should only be done by experienced personnel familiar with equipment and capable of maintaining required specifications. ALWAYS keep work area clean when grinding valve seats. A 120-grit stone MUST BE used for grinding both intake and exhaust valve seat inserts (A).

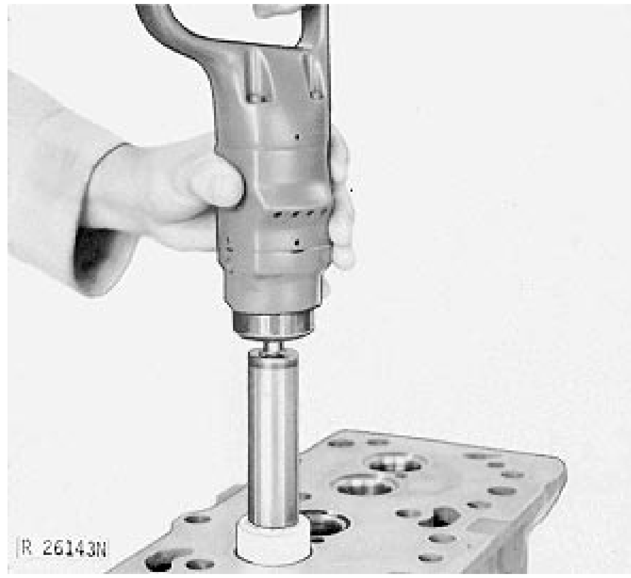
Using JT05893 Heavy-Duty Seat Grinder Set, grind valve seats to obtain correct valve recess in cylinder head. See MEASURE VALVE RECESS SERIAL NUMBER (200,000—) earlier in this group. Be sure valve guide bores are clean before grinding valve seats. See CLEAN VALVE GUIDES SERIAL NUMBER (200,000—) earlier in this group.)

If valve seats need grinding, only a few seconds are required to recondition the average valve seat. Avoid the tendency to grind off too much. Do not use excessive pressure on the grinding stone.

1. Check the seat width (C) and contact pattern between the seat and valve with bluing. Seat width MUST BE maintained within specification. Use a vernier caliper or scale to measure seat width. Thoroughly clean seat area after grinding and replace valves and valve seat inserts as necessary.

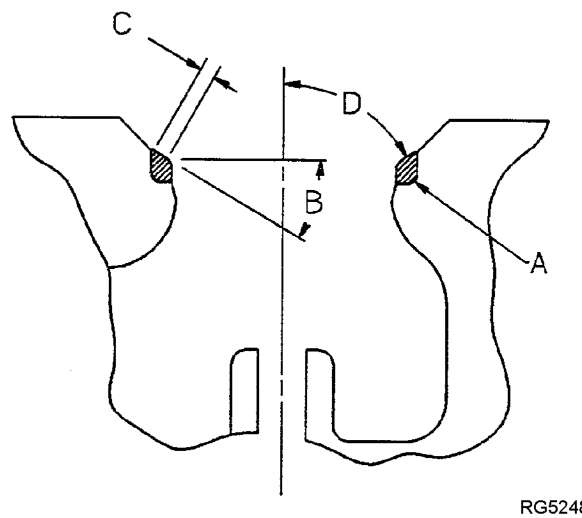
NOTE: Valve seat width can be reduced with a narrowing stone. This will change the angle (B) at the top of the seat and increase the diameter. If valve seat width is too narrow, valve may burn or erode. Varying the width changes the fine contact between valve face and seat.

2. ALWAYS measure valve seat runout after grinding using D11010KW Eccentrimeter and check recess in cylinder head after grinding as described later.



R26143N –UN–09DEC88

Grinding Valve Seats



RG5248 –UN–05DEC97

Measuring Valve Seats

A—Valve Seat Insert
B—Valve Seat Angle
C—Valve Seat Width
D—Valve Seat Runout

Continued on next page

RG41165,000005D –19–22DEC00–1/2

Specification

Valve Seat Grinding—Angle .... 30° ± 0.50°
Exhaust Width .... 2.0—3.8 mm (0.079—0.150 in.)
Intake Width .... 1.4—3.8 mm (0.055—0.150 in.)
Maximum Seat Runout.. 0.051 mm (0.0020 in.)

RG41165,000005D –19–22DEC00–2/2

Remove Valve Seat Inserts and Measure Bores in Cylinder Head - Serial Number (200,000—)

In some cases the valve seat bore in the cylinder head may become damaged or oversized and will require machining. In this case, oversize inserts are available in 0.25 mm (0.010 in.) oversize only.

Specification

Oversize Inserts—Width.. 0.25 mm (0.010 in.)

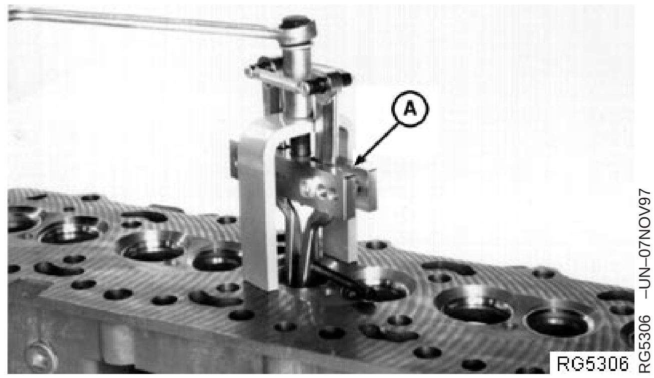
IMPORTANT: Be careful not to damage cylinder head when removing seats.

1. Remove valve seat insert (if necessary) with JDE41296 Valve Seat Puller (A). Adjusting screw on puller may need to be retightened during removal of inserts.

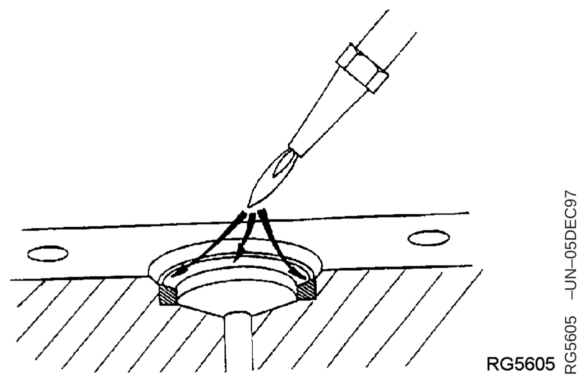
   Valve seat inserts may be also removed using the following method:

   - Carefully heat insert at four points around face until insert becomes red hot. Allow seat to cool and carefully pry out the insert(s) with a screwdriver.

2. After removal of inserts, thoroughly clean area around valve seat bore and inspect for damage or cracks.



Removing Valve Seat Inserts

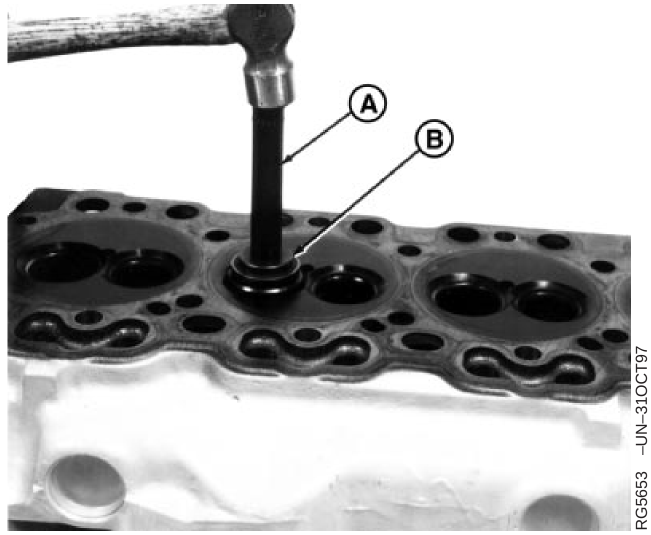


Heating Valve Seat Inserts

A—Valve Seat Puller

RG41165,000005E –19–22DEC00–1/1

Install Valve Seat Inserts - Serial Number (200,000—)



Installing Valve Seat Inserts

1. Use the JDE7 Driver (A) along with JDG605 Valve Seat Installer (B) to drive inserts into place. The larger end of JDG605 Installer is used to install intake valves and the smaller end is used to install exhaust valves.

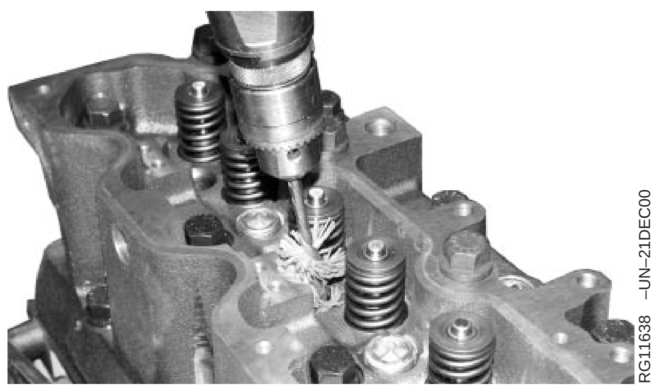
2. Install new or refaced valves and check valve recess. See MEASURE VALVE RECESS SERIAL NUMBER (200,000—) earlier in this group.

3. Grind valve seats as required to maintain correct valve recess and valve-to-seat seal. See GRIND VALVE SEATS SERIAL NUMBER (200,000—) earlier in this group.

A—Driver
B—Valve Seat Installer

RG41165,000005F –19–22DEC00–1/1

Inspect and Clean Cylinder Head Nozzle Bore - Serial Number (200,000—)



Cleaning Cylinder Head Nozzle Bores

1. Inspect condition of nozzle seating surface and bore in cylinder head.

   Cylinder head nozzle seating surface and bore must be free of debris and carbon deposits.

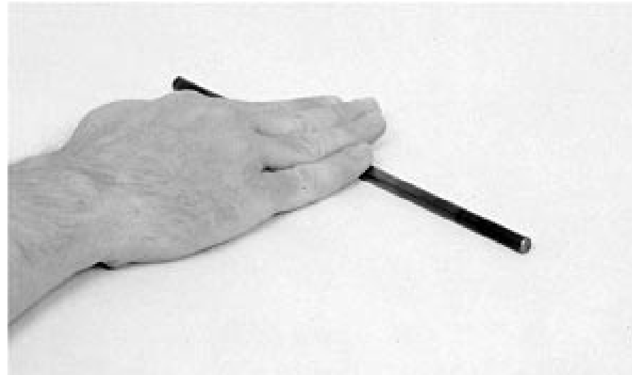
2. Clean bore of light foreign deposits using a drill and the D17030BR Thread Cleaning Brush. Work brush up and down several times to clean threads.

3. Blow out debris with compressed air and thoroughly clean all nozzle bores.

RG41165,0000060 –19–22DEC00–1/1

Clean and Inspect Push Rods - Serial Number (200,000—)

1. Clean push rods with solvent and compressed air.
2. Check push rods for straightness by rolling on a flat surface.
3. Inspect contact ends for wear and damage.
4. Replace defective push rods.


T81233 –UN–01NOV88

Checking Valve Push Rods for Straightness

RG41165,0000061 –19–22DEC00–1/1

Clean and Inspect Top Deck of Cylinder Block - Serial Number (200,000—)

1. Remove gasket material, rust, carbon, and other foreign material from top deck. Gasket surface must be clean.
2. Use compressed air to remove all loose foreign material from cylinders and top deck.
3. Clean all cylinder head mounting cap screw holes using JDG681 or an equivalent 9/16-12 UNC-2A tap about 88.9 mm (3.5 in.) long. Use compressed air to remove debris and any fluids which may be present in the cap screw holes.
4. Measure top deck flatness. See MEASURE CYLINDER BLOCK in Group 030.

RG41165,0000062 –19–22DEC00–1/1

Measure Cylinder Liner Standout (Height Above Block) - Serial Number (200,000—)

1. Bolt down liners using cap screws and flat washers in the seven locations as shown. Flat washers should be at least 3.18 mm (1/8 in.) thick. Tighten cap screws to 68 N•m (50 lb-ft) to achieve an accurate standout reading.

NOTE: Liners having obvious defects must be replaced.

2. Using JDG451 Gauge (A) along with D17526CI (English) or D17527CI (Metric scale) Dial Indicator (B) or KJD10123 Gauge, measure the height of bolted down liners that are not obviously defective before removal from block.

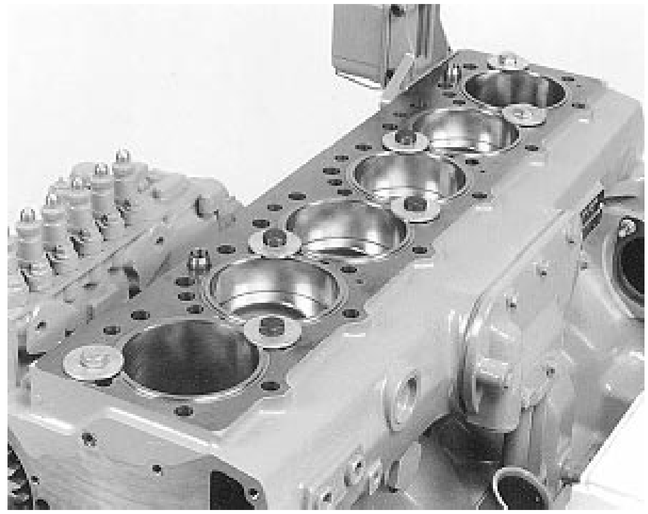
NOTE: Variations in measurement readings may occur within one cylinder and/or between adjacent cylinders.

3. Measure each liner in four places, approximately at 1, 5, 7 and 11 O'clock positions as viewed from the rear of the engine (flywheel end). Record all measurements by cylinder number and compare to the following specifications.

Specification

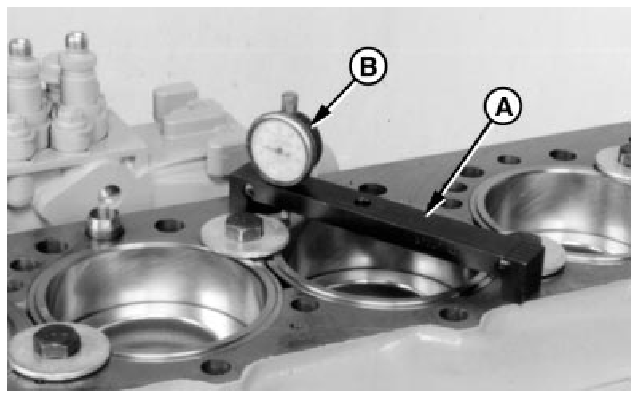
Liner—Height Above Block .... 0.051—0.127 mm (0.002—0.005 in.) above block

4. Remove any liner that does not meet standout specification at any location and install liner shims or replace piston/liner sets as necessary. See INSTALL LINER SHIMS—IF REQUIRED in Group 030



RG7144 –UN–28JUL94

Bolting Down Cylinder Liners



RG7145 –UN–26NOV97

Checking Cylinder Liner Height Above Block

A—JDG451 Gauge
B—Dial Indicator

RG41165,0000063 –19–22DEC00–1/1

02
021
33

Assemble Valve Assembly - Serial Number (200,000—)

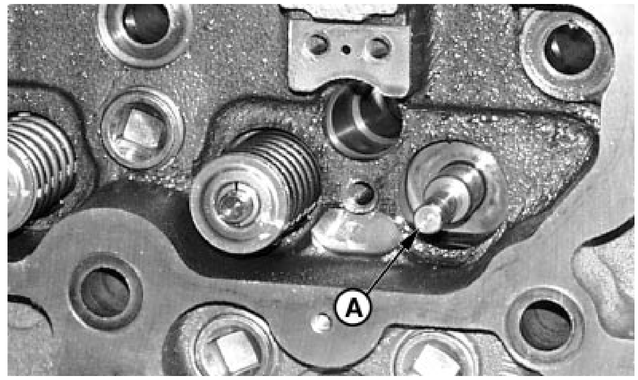
Valves are marked on the head as follows: Intake ("I 30"). Exhaust ("E 30").

1. Apply AR44402 Valve Stem Lubricant or clean engine oil to valve stems and guides.

2. Install reconditioned or new valves in head. Reconditioned valves MUST BE installed in same location from which removed.

NOTE: Valve stems must move freely in guide bore and seat properly with insert.

3. Install oil shields over exhaust valve guide towers before installing springs.



RG11694A –UN–01MAR01

Seal on Exhaust Valve Stem

A—Exhaust Valve Stems

Continued on next page RG41165,0000064 –19–22DEC00–1/3

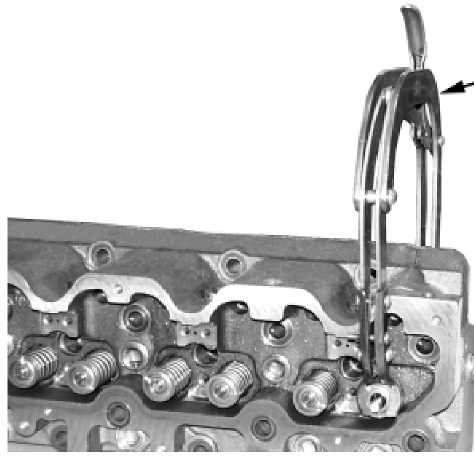
NOTE: The valve springs (C) must be installed with the damper coil end (identified with pink paint) down, toward the cylinder head.

4. Install valve spring and spring cap (D). Spring must seat in machined counterbore of head, with the pink painted end of the spring toward the cylinder head.

5. Compress valve springs with JDE138 Valve Spring Compressor (A) and install retainer locks (B).

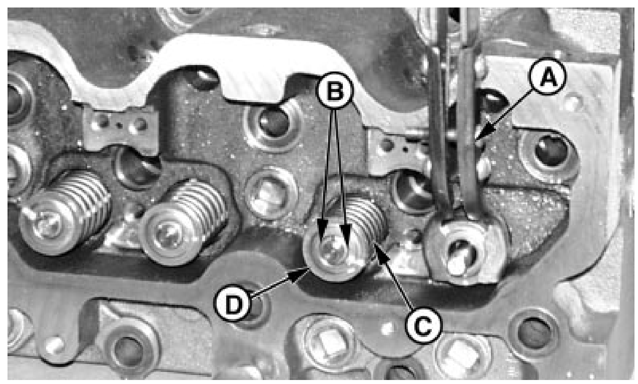
NOTE: Install wear caps just before installing rocker arm assembly.

A—JDE138 Valve Spring Compressor
B—Valve Retainer Locks
C—Valve Spring
D—Valve Spring Cap



RG11692A –UN–26FEB01

Installing Valve Assemblies



RG11693A –UN–22FEB01

Close View of Installing Valve Assemblies

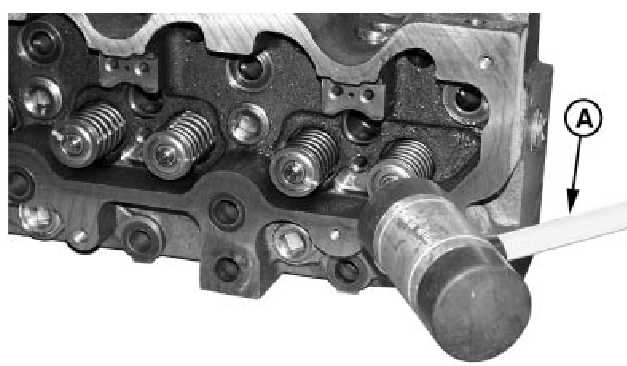
RG41165,0000064 –19–22DEC00–2/3

6. Strike each valve assembly with a soft mallet (A) three or four times to insure retainer locks are properly seated.

   Repeat procedure for all remaining valves.

7. Measure valve recess in head as directed earlier in this group.

A—Mallet

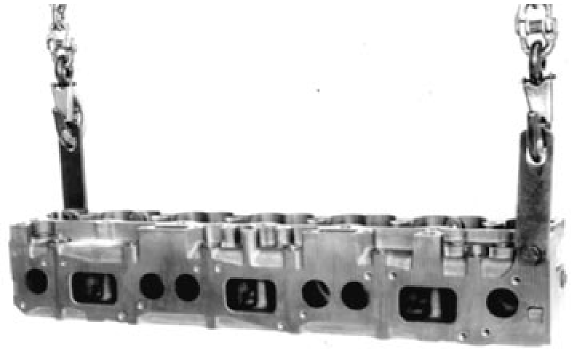


RG11695A –UN–23FEB01

Seating Retainer Locks on Valves

RG41165,0000064 –19–22DEC00–3/3

Install Cylinder Head and Cap Screws - Serial Number (200,000—)



Installing Cylinder Head

IMPORTANT: ALWAYS thoroughly inspect new cylinder head gasket for possible manufacturing imperfections. Return any gasket that does not pass inspection.

Be sure cylinder head and block gasket surfaces are clean, dry, and free of any oil.

1. Put a new head gasket on cylinder block. Do not use sealant on gasket; install dry.

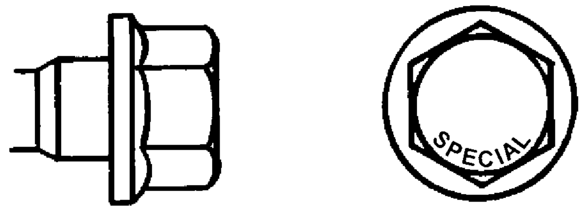
IMPORTANT: If cylinder head is lowered onto cylinder block and the head is not positioned correctly on locating dowels, remove cylinder head and install a new gasket. DO NOT try to reposition cylinder head on the same gasket again since the fire ring may possibly be damaged.

2. Lower cylinder head evenly to correct position on block using appropriate lifting equipment. Make sure that head is positioned correctly over dowels and sits flat on cylinder block top deck.

Continued on next page RG41165,0000065 –19–22DEC00–1/2

IMPORTANT: Only ASTM Grade 180 Flanged-Head cap screws marked "SPECIAL" (upper illustration) are recommended for use on 6081 engines. ALWAYS use NEW cap screws when installing cylinder head. Cap screws may be used only one time.

DO NOT use multi-viscosity oils to lubricate cap screws, SAE30 is recommended.



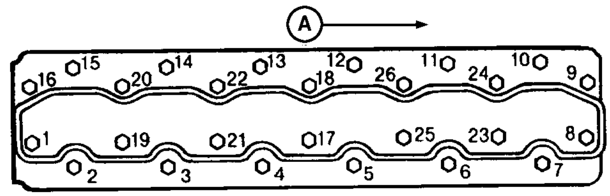
RG7137 RG7137 –UN–05DEC97

Special Cap Screw for Cylinder Head

3. Dip entire cap screw in clean SAE30 engine oil. Allow excess oil to drip off.

4. Install correct length cap screws marked "SPECIAL" in proper locations shown and tighten using the TORQUE-TO-YIELD tightening procedure, described next in this group. See TORQUE-TO-YIELD FLANGE-HEAD CAP SCREWS—GRADE 180 MARKED "SPECIAL" SERIAL NUMBER (200,000—) in this group.

   Arrow (A) points toward front of engine.



RG4471 RG4471 –UN–05DEC97

Head Cap Screw Locations

A—Front of Engine

Cylinder Head Cap Screws	
Length	**Location in Cylinder Head**
121.7 mm (4.8 in.)	2, 3, 4, 5, 6, 7
163.7 mm (6.4 in.)	23, 25, 17, 21, 19
175 mm (6.9 in.)	1, 15, 14, 13, 12, 11, 10, 8
203 mm (8.0 in.)	16, 20, 22, 18, 26, 24, 9

RG41165,0000065 –19–22DEC00–2/2

Torque-to-Yield Flanged-Head Cap Screws—Grade 180 Marked "SPECIAL" - Serial Number (200,000—)

Arrow (A) points toward front of engine.

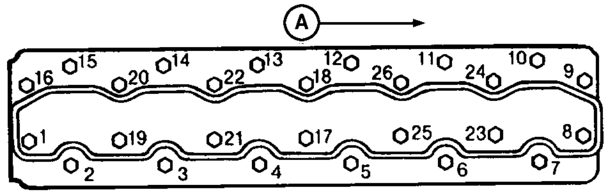
IMPORTANT: DO NOT use multi-viscosity oils to lubricate cap screws.

1. Lubricate cap screws with clean SAE30 engine oil and install in their proper locations as outlined previously.

2. Tighten cap screw No. 17 to 80 N•m (60 lb-ft), then sequentially start at cap screw No. 1 and proceed through cap screw No. 26, tightening all cap screws to specifications.

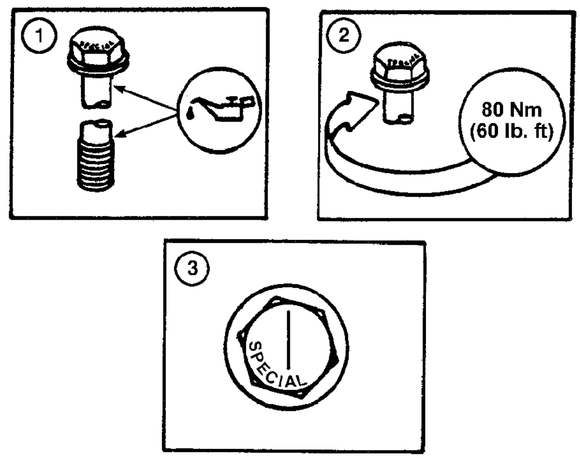
Specification	
Cylinder Head Flanged-Head "SPECIAL" Cap Screws (No Washers)—Initial Torque	80 N•m (60 lb-ft)

3. 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.



RG4471 –UN–05DEC97

Head Cap Screw Locations



RG10234 –UN–16JUN99

Tightening Head Cap Screws

A—Front of Engine

Continued on next page RG41165,0000066 –19–22DEC00–1/2

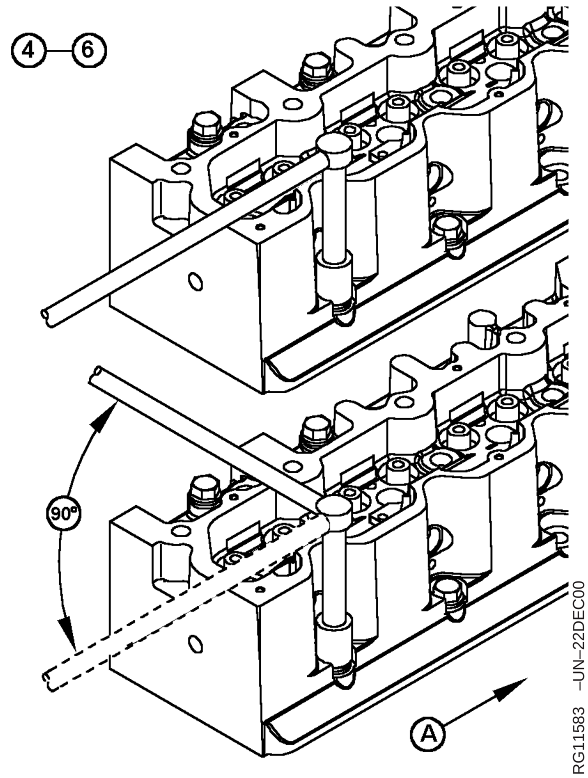
IMPORTANT: If a cap screw is accidentally tightened more than 90° in any one sequence, DO NOT loosen cap screw but make adjustments in the next tightening sequence.

4. 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.

5. Again, 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 now be parallel to crankshaft.

6. Finally, sequentially (start at cap screw No. 1 and proceed through cap screw No. 26). Turn each cap screw 90°, SO THAT LINE ON TOP OF CAP SCREW IS AS CLOSE AS POSSIBLE TO BEING PERPENDICULAR TO THE CRANKSHAFT. It is not necessary to obtain the final turn in one swing of the wrench. TOTAL AMOUNT OF TURN FROM STEPS 4, 5, AND 6 IS 270° ± 5°.

IMPORTANT: Cap screws MUST NOT be tightened more than a total of 270° ± 5°.

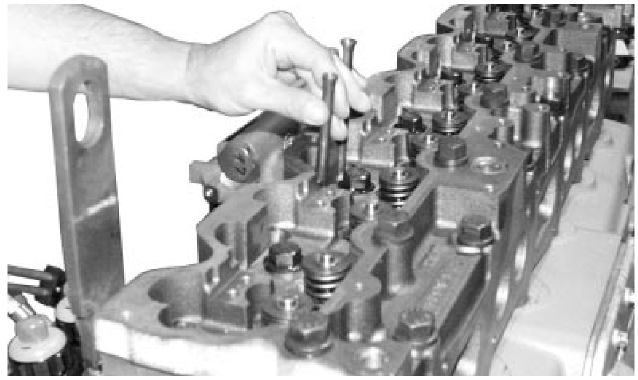


Torque-to-Yield Tightening of Head Cap Screws

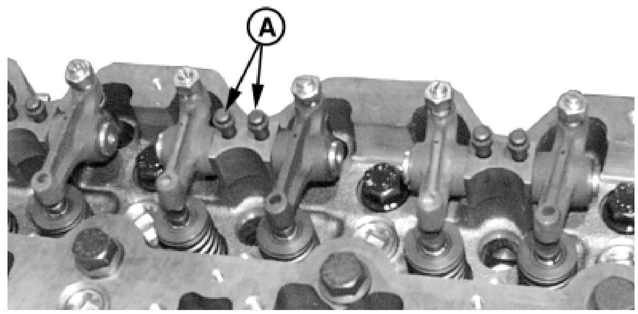
A—Front of Engine

RG41165,0000066 –19–22DEC00–2/2

Install Rocker Arm Assembly - Serial Number (200,000—)



Installing Push Rods and Caps



Installing Rocker Arm Assembly

1. Install push rods in holes from which removed.

2. Install wear caps on valve stem tips, make certain caps rotate freely on valve stems.

3. Align rocker arms centered on wear pads.

IMPORTANT: Rocker arm mounting screws *cannot* be re-used. Replace rocker arm mounting screws removed from engine with new screws.

4. Tighten both rocker arm clamp-to-cylinder head capscrews (A) to specifications below:

Specification

Initial Rocker Arm
Clamp-to-Cylinder Head Cap
Screw—Torque .... 30 N•m (22 lb-ft)

5. Loosen one cap screw completely.

6. Tighten loose cap screw to following specification:

Specification

Final Rocker Arm
Clamp-to-Cylinder Head Cap
Screw—Torque Turn .... 10 N•m + 60° (7 lb-ft + 60°)

7. Repeat loosening and torque turn procedure for second cap screw. If rocker arm is not centered on wear pads, loosen both cap screws, and repeat procedure.

8. Adjust engine valve clearance. See ADJUST VALVE CLEARANCE SERIAL NUMBER (200,000—) earlier in this group.

RG41165,0000067 –19–22DEC00–1/1

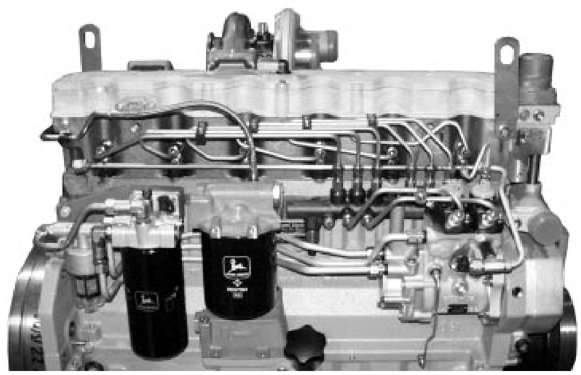
Inspect and Clean Ventilator Outlet Hose - Serial Number (200,000—)

1. Check ventilator outlet hose on rocker arm cover for bent or damaged condition. Replace if necessary.

2. Clean ventilator hose if restricted.

RG41165,0000068 –19–22DEC00–1/1

Complete Final Assembly of Fuel Pump Side of Engine - Serial Number (200,000—)



RG11704 –UN–06MAR01

Final Assembly of Fuel Pump Side of Engine

1. Adjust valve clearance, if not previously done.

2. Install electronic injectors, fuel inlet connectors, fuel leak-off connectors, fuel delivery lines, and fuel leak-off lines. See INSTALL ELECTRONIC INJECTORS, in Group 090 of CTM255.

3. Install carrier and rocker arm cover. Tighten cap screws to specifications.

Specification	
Carrier-to-Cylinder Head Cap Screws—Torque	8 N•m (6 lb-ft) (72 lb-in.)
Rocker Arm Cover-to-Carrier Cap Screws—Torque	8 N•m (6 lb-ft) (72 lb-in.)

NOTE: Make sure ventilator outlet hose is open and adapter is clean. A restriction could cause high oil pressure and possible loss of oil.

4. Connect ventilator outlet hose to adapter on rocker arm cover and tighten clamp securely.

5. Install coolant manifold. See INSTALL COOLANT MANIFOLD in Group 070.

RG41165,0000069 –19–22DEC00–1/1

Complete Final Assembly on Exhaust Manifold Side of Engine - Serial Number (200,000—)

NOTE: APPLY PT569 NEVER-SEEZ® Compound or equivalent to all turbocharger cap screws. NEVER-SEEZ® is not needed on exhaust manifold cap screws. Guide studs may be used to aid assembly.

1. Install intake manifold (B) using new gaskets. Tighten cap screws to specifications.

Specification

Intake Manifold-to-Cylinder Head—Torque .... 47 N•m (35 lb-ft)

2. Install a new sealing ring (A) in groove of rear exhaust manifold (C).

3. Assemble front exhaust manifold (D) and rear exhaust manifold.

4. Install exhaust manifold assembly using new gaskets and guide studs. Tighten cap screws to specifications.

Specification

Exhaust Manifold-to-Cylinder Head—Torque .... 47 N•m (35 lb-ft)

5. Install turbocharger using a new metal gasket. Apply PT569 NEVER-SEEZ® Compound and tighten cap screws to specifications.

Specification

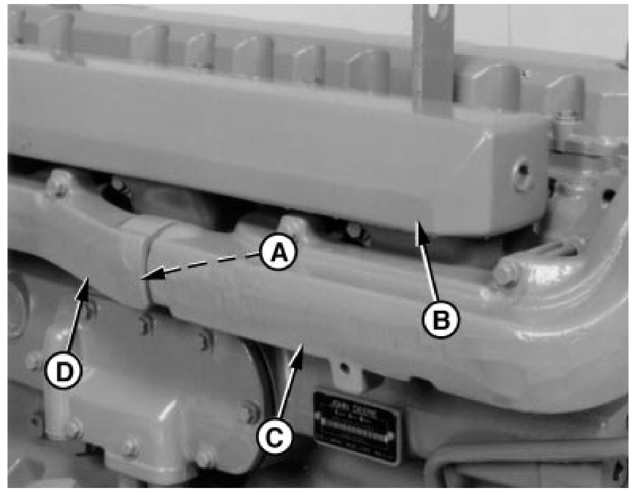
Turbocharger Cap Screws—Torque .... 24 N•m (18 lb-ft)

6. Connect turbocharger oil return pipe to turbocharger using a new gasket. Tighten cap screws to specifications.

Specification

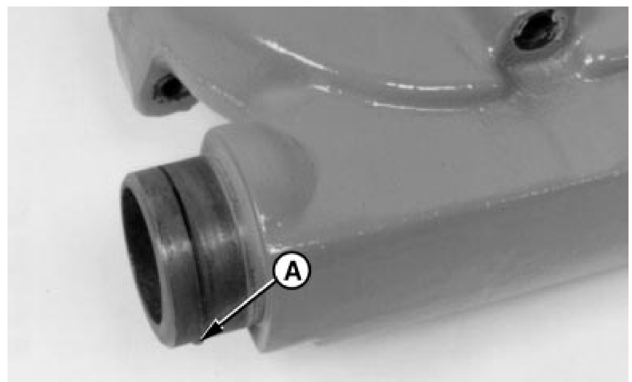
Turbocharger Oil Return Pipe-to-Turbocharger Cap Screws—Torque .... 27 N•m (20 lb-ft)

7. Connect turbocharger oil inlet and tighten securely.



RG7043 –UN–26NOV97

Installing Intake and Exhaust Manifolds



RG7024 –UN–26NOV97

Sealing Ring in Exhaust Manifold

A—Sealing Ring
B—Intake Manifold
C—Rear Exhaust Manifold
D—Front Exhaust Manifold

NEVER-SEEZ is a registered trademark of Emhart Chemical Group.

Continued on next page

RG41165,000006A –19–22DEC00–1/2

8. If engine oil was drained from crankcase, install new oil filter and fill with clean oil of correct grade and viscosity. See DIESEL ENGINE OIL in Group 002.

9. Fill cooling system with clean coolant. See DIESEL ENGINE COOLANT in Group 002.

10. Perform engine break-in. See PERFORM ENGINE BREAK-IN SERIAL NUMBER (200,000—) later in this group.

RG41165,000006A –19–22DEC00–2/2

Perform Engine Break-In - Serial Number (200,000—)

1. Run engine at slow idle no load for 2 minutes. Check for liquid leaks.

2. Increase RPM to fast idle, then load down to 50 rpm above rated speed for 20 minutes.

NOTE: Dynamometer is the preferred load control, but engine can be loaded by matching drag loads to gear selection.

3. Recheck valve clearance and adjust as necessary. See CHECK VALVE CLEARANCE SERIAL NUMBER (200,000—) earlier in this group.

4. Install rocker arm cover gasket and cover. Tighten rocker arm cover cap screws to specifications.

Specification	
Rocker Arm Cover-to-Cylinder Head Cap Screw—Torque	8 N•m (6 lb-ft) (72 lb-in.)

Retorque of cylinder head cap screws after engine break-in is not required.

IMPORTANT: After engine break-in, follow ALL recommended hourly service intervals outlined in your Operator’s Manual.

RG41165,000006B –19–22DEC00–1/1

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 line.
- 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.

RG,RG34710,1112 –19–06MAY99–1/1

Connecting Rods—General Information

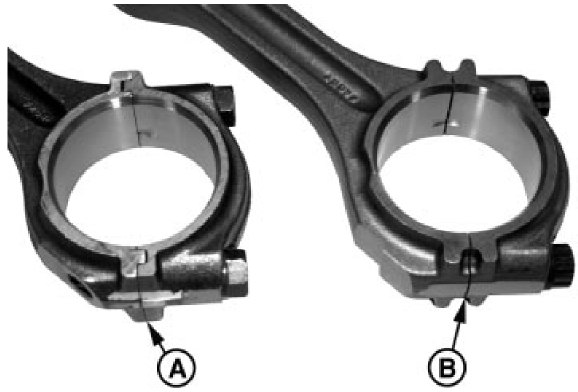
Earlier engines have the traditional tongue-and-groove between the connecting rod and cap (A). Later engines have the Precision Joint™ rod and cap (B).

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).

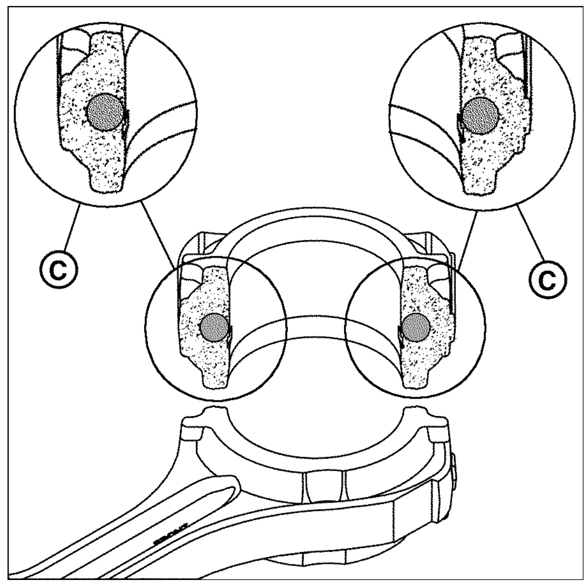
Both types of rods provide a strong joint. Removal and installation is similar, with differences noted, including different torque specifications for cap screws. See INSPECT ROD AND CAP and see INSTALL PISTON AND CONNECTING ROD later in this Group.

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

DPSG,OUO1004,871 –19–06MAY99–1/1

Remove Pistons and Connecting Rod Assemblies

6081HRW Engines must be removed from 8100-8400 and 8110-8410 Tractors to service the pistons and connecting rods. Refer to machine technical manual TM1575 (Repair) for engine removal procedure. (For 8000T Tracks Tractors, refer to TM1621.)

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.

CAUTION: Do not drain engine coolant until it cools below operating temperature. Then slowly loosen coolant pump cover drain valve (A) and block drain valve (B) to relieve any pressure. Drain coolant and engine oil.

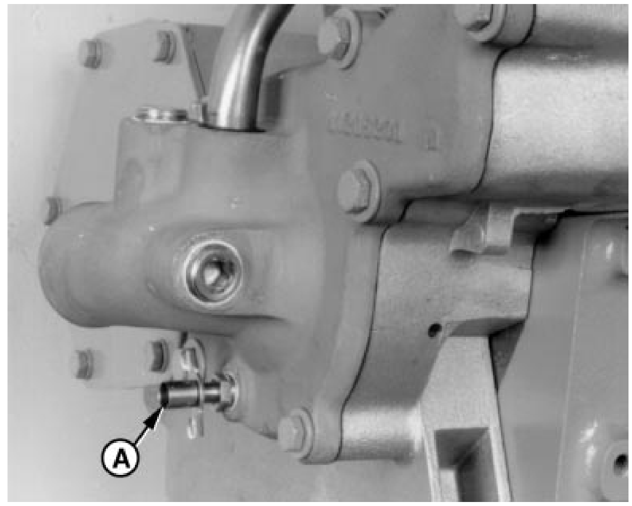
IMPORTANT: Both drain valves must be opened to completely drain engine block.

1. Drain all engine coolant and engine oil.

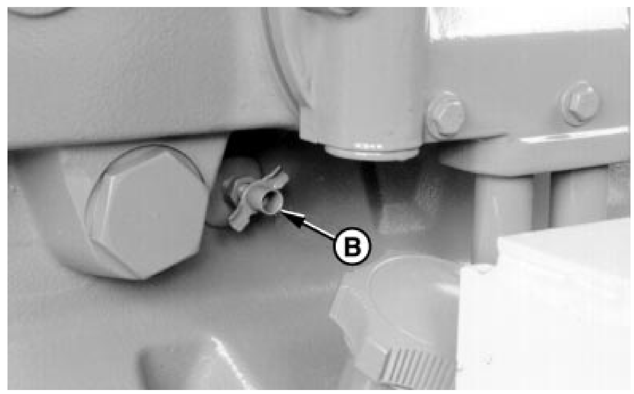
NOTE: If engine is to be completely disassembled, see ENGINE DISASSEMBLY SEQUENCE in Group 010.

2. Remove cylinder head. See REMOVE CYLINDER HEAD SERIAL NUMBER (—199,999) in Group 020, or see REMOVE CYLINDER HEAD SERIAL NUMBER (200,000—) in Group 021.

3. Remove oil pan and oil pump. See REMOVE ENGINE OIL PUMP in Group 060.



Coolant Pump Drain Valve



Cylinder Block Drain Valve

A—Coolant Pump Cover Drain Valve
B—Block Drain Valve

Precision Joint is a trademark of Deere & Company

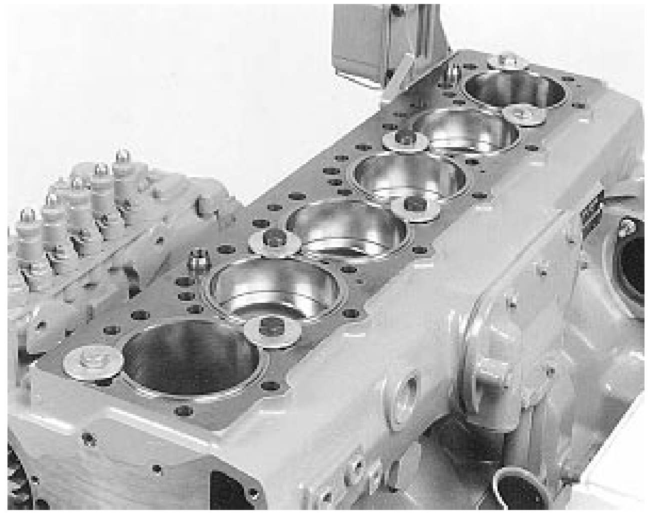
Continued on next page

RG,RG34710,1113 –19–08JUN99–1/5

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 the following specifications to achieve an accurate reading when measuring liner standout (height above block). See MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK), later in this group.

4. Use 9/16-18 cap screws, approximately 51 mm (2.0 in.) long and 5/8 in. I.D. 1-3/4 in. O.D. x 3.18 mm (1/8 in.) thick washers to bolt down cylinder liners in the seven locations as shown. Tighten cap screws to specifications.



Bolting Down Cylinder Liners

Specification

Cylinder Liner Cap Screws (For Checking Standout)—Torque .... 68 N•m (50 lb-ft)

Continued on next page RG,RG34710,1113 –19–08JUN99–2/5

As the cylinder liner wears, a ridge is formed at the top of piston ring travel zone. If this ridge gets too high, pistons and rings can be damaged when they are removed. Remove any ridges from liner bores with a scraper or ridge reamer before removing pistons.

5. Before removing pistons, visually inspect condition of cylinder liners with pistons at bottom dead center “BDC”. Liners will require replacement if:

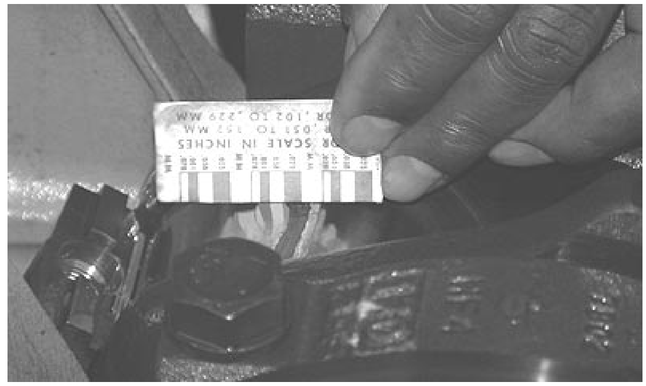
   - The crosshatch honing pattern is not visible immediately below the top ring turn around area.
   - Liners are pitted or contain deep vertical scratches that can be detected by the fingernail.

   No further inspection is required if any one of the above conditions are found.

NOTE: Connecting rod bearing-to-journal oil clearance should be measured before removing piston/rod assembly.

Use PLASTIGAGE® as directed by the manufactured. Remember, the use of PLASTIGAGE® will determine bearing-to-journal oil clearance, but will not indicate the condition of either surface.

6. Rod bearing-to-journal oil clearance can be checked with PLASTIGAGE® if rod is connected to crankshaft. If rod is out of engine, measure I.D. of assembled connecting rod bearings and compare with O.D. of crankshaft journal.



RG10208 –UN–18JUN99

Measuring Rod Bearing-to-Journal Clearance

PLASTIGAGE is a registered trademark of DANA Corp.

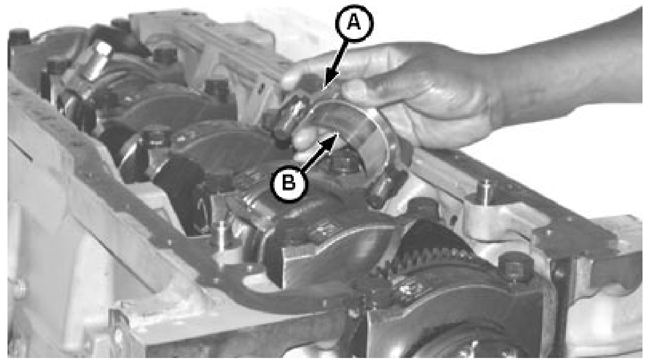
Continued on next page

RG,RG34710,1113 –19–08JUN99–3/5

IMPORTANT: DO NOT use pneumatic wrenches to tighten rod cap screws. Using pneumatic wrenches may cause thread damage.

Keep bearing inserts with their respective rods and caps. Mark rods, pistons, and caps to insure correct assembly in same location as removed.

7. Remove rod cap screws and rod caps (A) with bearings (B).



RG10209 –UN–18JUN99

Removing Connecting Rod Caps

A—Rod Caps
B—Bearings

RG,RG34710,1113 –19–08JUN99–4/5

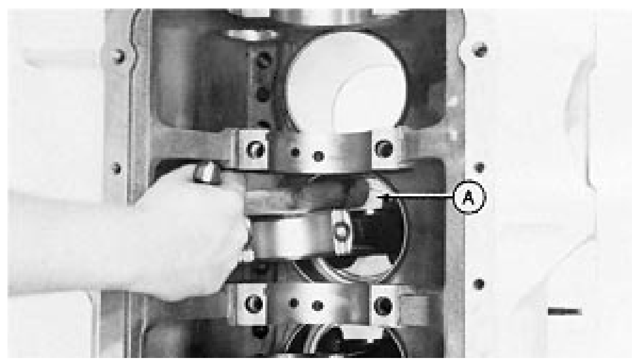
Crankshaft is shown removed, but piston and rod assembly can be removed with crankshaft installed.

IMPORTANT: Be careful not to let rod nick crankshaft bearing surface as piston and rod assembly is removed.

If liners are to be reused, be extremely careful not to let connecting rod hit liner bore when removing piston and rod assembly.

Piston and liners are selectively fitted to maintain piston-to-liners clearance. Always keep matched pistons and liners together as a set and each set MUST BE installed in the same cylinder as removed.

8. Gently tap piston (A) through top of cylinder block from the bottom. Once piston rings have cleared cylinder liner bore, hold on to piston to prevent piston from dropping.



RG3821 –UN–07DEC88

Removing Pistons

A—Piston

RG,RG34710,1113 –19–08JUN99–5/5

Measure Cylinder Liner Standout (Height Above Block)

IMPORTANT: Remove all old gasket material, rust, carbon, and other foreign material from top deck of block. Gasket surface MUST BE CLEAN. Use compressed air to remove all loose foreign material from cylinder and top deck.

NOTE: Liners having obvious defects must be replaced as a matched piston and liner set.

1. Bolt liners down using cap screws and flat washers. Flat washers should be at least 3.18 mm (1/8 in.) thick. Tighten cap screws to specifications.

Specification

Cylinder Liner Cap Screws (For Checking Liner Standout)—
Torque .... 68 N•m (50 lb-ft)

2. Use JDG451 Gauge Block (C) along with D17526CI (English, in.) or D17527CI (Metric, mm) Dial Indicator (B) or KJD10123 Gauge to measure the height (A) of bolted down liners that are not obviously defective before removal from block.

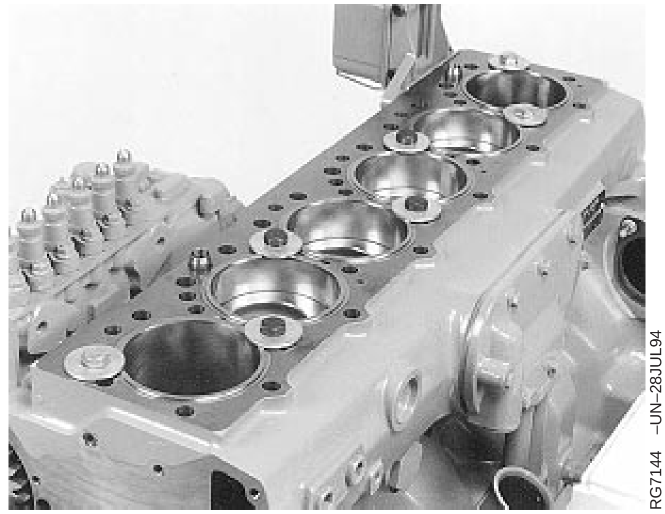
NOTE: Variations in measurement readings may occur within one cylinder and/or between adjacent cylinders.

3. Measure each liner in four places, approximately at 1, 5, 7, and 11 O'clock positions as viewed from the rear of the engine (flywheel end). Record all measurements.

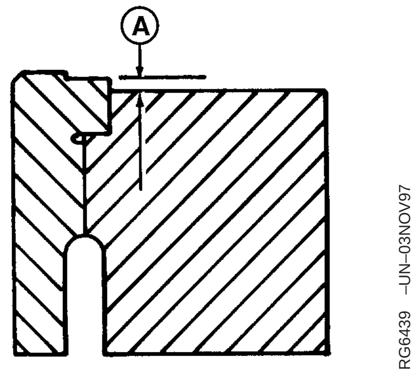
4. Remove any liner that does not meet standout specification at any location and measure liner flange thickness, as explained later in this group. Use liner shims or replace piston/liner sets as necessary.

Specification

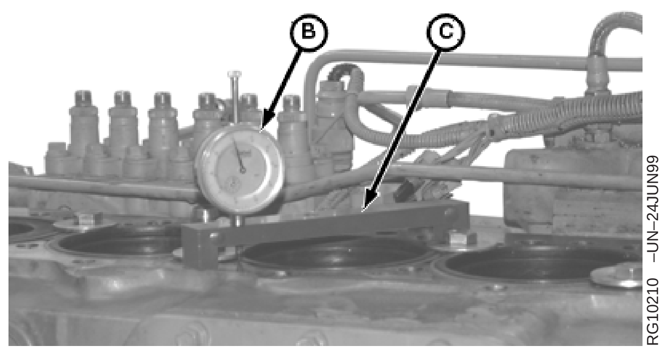
Cylinder Liners—Standout (Height Above Block) .... 0.051—0.127 mm (0.002—0.005 in.)



Bolting Down Cylinder Liners



Liner Height



Checking Cylinder Liner Height Above Block

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

RG,RG34710,1114 –19–10JUN99–1/1

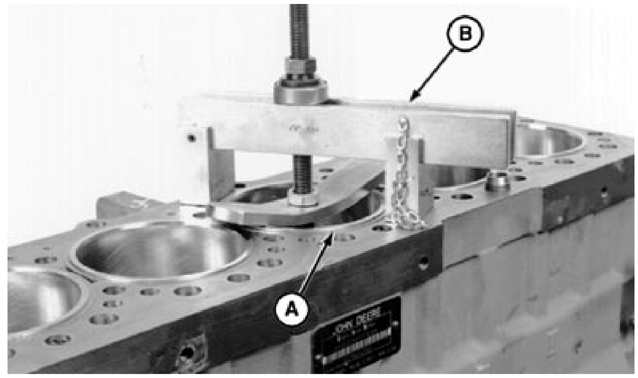
Remove Cylinder Liners

1. Remove cap screws and washers securing liners to cylinder block.

2. Number cylinder liners and mark fronts to assure correct assembly.

IMPORTANT: Keep matched pistons and liners together. Liners must be reinstalled in same cylinder bore.

3. Use D1062AA or D01073AA Cylinder Liner Puller (B) to remove cylinder liner (A).



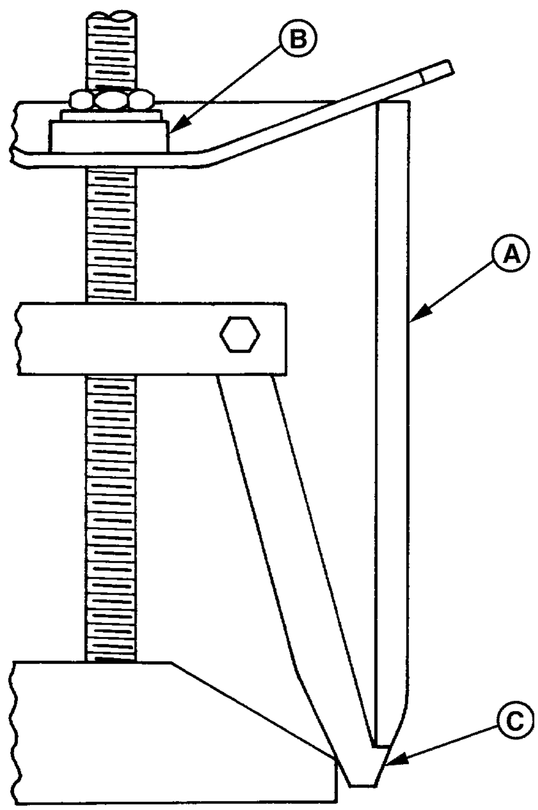
Removing Cylinder Liners

A—Cylinder Liner
B—Cylinder Liner Puller

RG,RG34710,1115 –19–23OCT97–1/3

IMPORTANT: When using D01062AA (or D01073AA) Cylinder Liner Puller (B) to remove liners (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.



D01062AA or D017073AA Cylinder Liner Puller

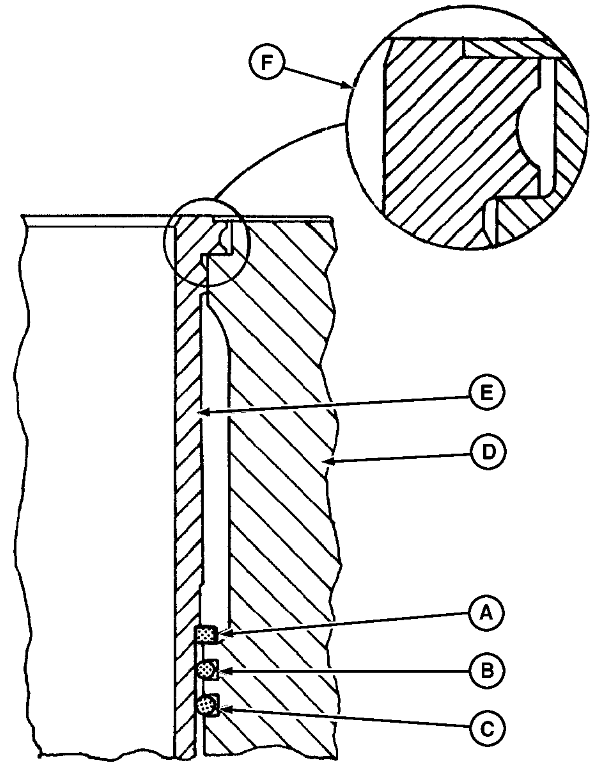
Continued on next page

RG,RG34710,1115 –19–23OCT97–2/3

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 and Seals

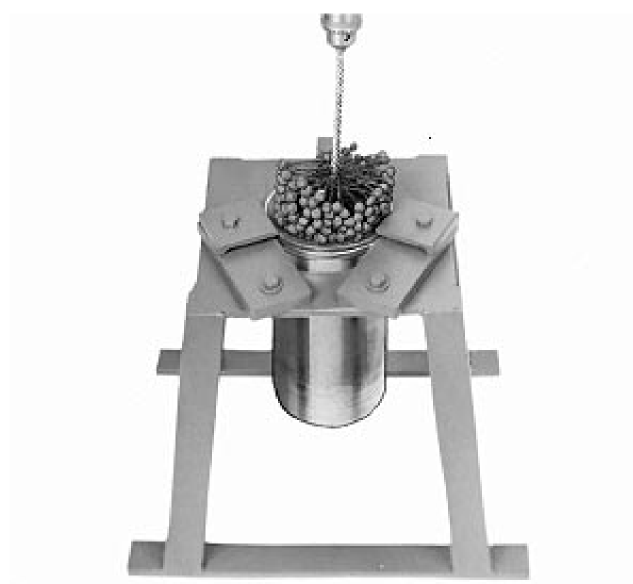
RG,RG34710,1115 –19–23OCT97–3/3

Deglaze Cylinder Liners

1. Secure cylinder liner in a holding fixture. See DFRG3—CYLINDER LINER HOLDING FIXTURE, Group 190, for assembly of holding fixture.

2. Use D17005BR Flexible Cylinder Hone to deglaze cylinder liner.

NOTE: Use honing oil along with flex hone when deglazing liners.



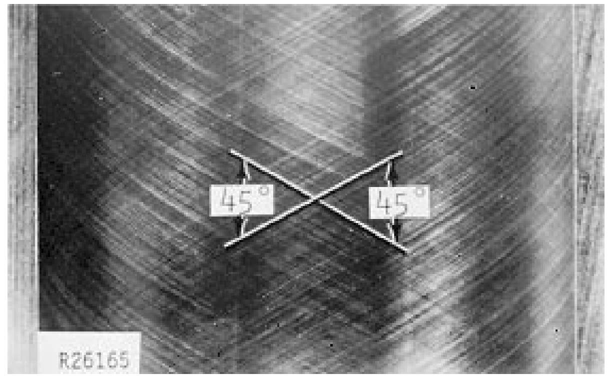
Deglazing Cylinder Liners

Continued on next page

RG,RG34710,1116 –19–11MAY99–1/2

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, later in this group.



R26165 –UN–13DEC88

Honing Pattern on Cylinder Liners

RG,RG34710,1116 –19–11MAY99–2/2

Clean Cylinder Liners

1. Use a stiff bristle brush to remove all debris, rust, and scale from O.D. 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 I.D. 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,RG34710,1117 –19–23OCT97–1/1

Disassemble Piston and Rod Assembly

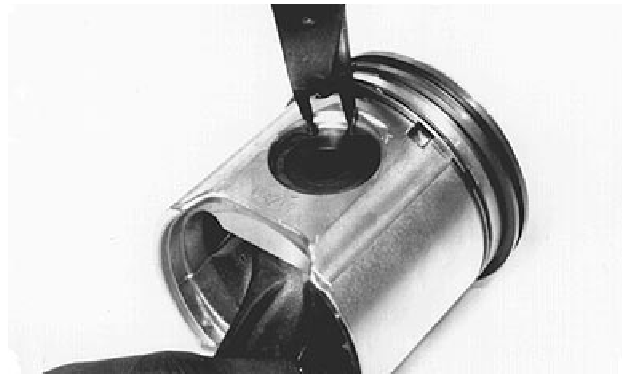
1. Remove piston snap rings. Remove piston pin and connecting rod from piston.

NOTE: Discard snap rings, DO NOT reuse.

If checking rings to determine cause of engine trouble, ring gap should be as follows:

Specification

No. 1 Piston Compression Ring—
End Gap .... 0.43—0.69 mm (0.017—0.027 in.)
No. 2 Piston Compression Ring—
End Gap .... 1.01—1.27 mm (0.040—0.050 in.)


RG5228 –UN–05DEC97

Disassembling Piston and Rod

RG,RG34710,1118 –19–23OCT97–1/2

2. Remove piston rings (B) using the JDE93 Piston Ring Expander (A). Discard all rings.

A—Piston Ring Expander
B—Piston Ring

RG5229 –UN–05DEC97

Removing Piston Rings

RG,RG34710,1118 –19–23OCT97–2/2

Clean Pistons

CAUTION: Always follow manufacturer's instructions, and safety steps exactly.

1. 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.

2. 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.

RG6088 –UN–05DEC97

Cleaning Piston Ring Grooves

RG,RG34710,1119 –19–23OCT97–1/1

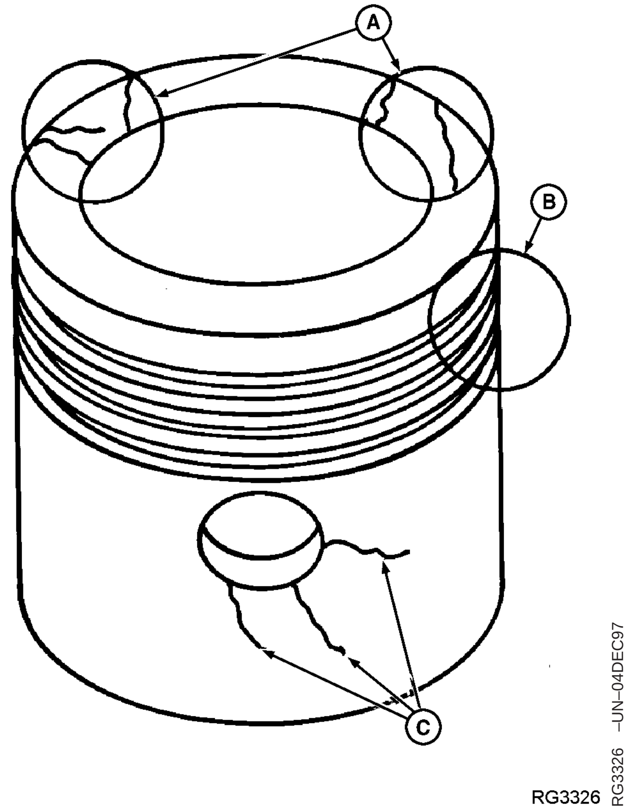
Visually Inspect Pistons

Carefully inspect pistons under magnification. Check for:

- Signs of fatigue
- Fine cracks in the piston head (A)
- Bent or broken ring lands (B)
- Cracks in the skirt (C) at inner and outer ends of piston pin bore
- Excessive piston skirt wear. (Original machining marks must be visible.)

If any imperfections are found, replace the piston.

A—Piston Head
B—Ring Lands
C—Skirt



Piston Defects (Exaggerated)

RG,RG34710,1120 –19–05MAR04–1/1

Check Piston Ring Groove Wear

Check grooves at several locations around the circumference of piston.

1. Use the JDE55 Ring Groove Wear Gauge (A) to check wear of top full keystone (compression) ring groove.

2. Use JDG852 Ring Groove Wear Gauge (B) to check wear of middle half-keystone (compression) ring groove.

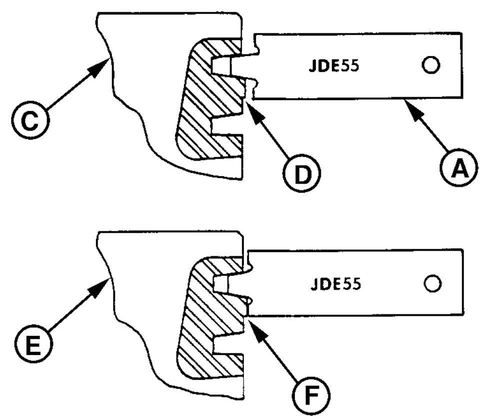
   If gauge shoulder contacts ring land of piston, ring groove is worn. Replace piston and liner as a set.

   If ring grooves are good (D), proceed with piston inspection.

A—JDE55 Keystone Ring Groove Wear Gauge
B—JDG852 Half-Keystone Ring Groove Wear Gauge
C—Piston With Good Ring Groove
D—Acceptable Clearance
E—Piston With Worn Ring Groove
F—Gauge Shoulder Contacting Piston Ring Land

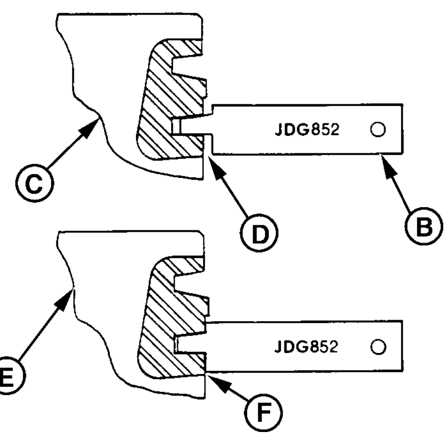
RG5230 –UN–05DEC97

Checking Piston Ring Groove Wear



RG7058 –UN–26NOV97

Checking Piston Top Ring Groove



RG7059 –UN–26NOV97

Checking Piston Middle Ring Groove

Continued on next page RG,RG34710,1121 –19–23OCT97–1/2

3. Check oil control ring-to-groove clearance by installing a new ring in groove.

4. Measure clearance with a feeler gauge at several points. Compare measurements with specifications given below.

Specification

Piston Oil Control Ring-to-Groove—New Part Clearance	0.064—0.102 mm (0.0025—0.0040 in.)
Maximum Serviceable Clearance	0.165 mm (0.0065 in.)

NOTE: Replace piston and liner (as a set) if oil control ring clearance exceeds specifications given.

Checking Piston Oil Control Ring Clearance

RG,RG34710,1121 –19–23OCT97–2/2

Inspect Piston Pin and Bore

NOTE: Piston pin must be in good condition and not worn beyond specification given below.

1. Dip piston in clean engine oil.

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).

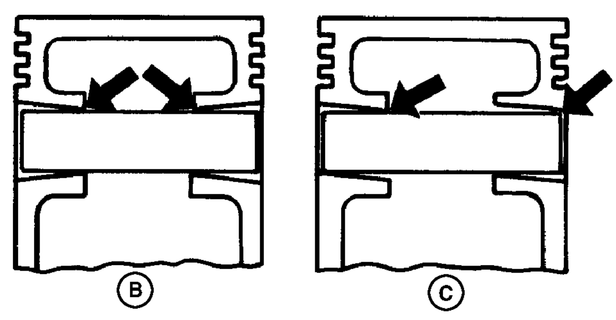
4. Insert pin in piston to check for bore alignment. Pin should not “click” or need to be forced into bore on opposite side (C).

5. Measure piston pin and piston bore specifications. If either are not within specification, replace pin, piston, and liner.

Specification

Piston Pin—OD	47.597—47.613 mm (1.8739—1.8745 in.)
Piston Pin Bore—ID	47.62—47.63 mm (1.8748—1.8752 in.)

Installing Pin in Piston



Inspecting for Piston Pin Bore Wear

A—Pin
B—Tapered Bore Wear
C—Bore Out-of-Alignment

RG,RG34710,1122 –19–23OCT97–1/1

Visually Inspect Cylinder Liners

IMPORTANT: If liner pitting has occurred, check condition of coolant.

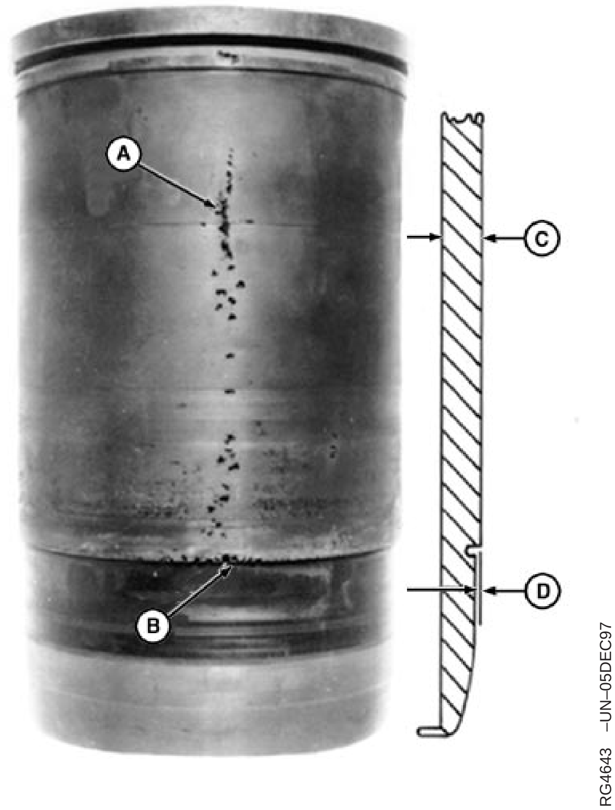
1. Inspect exterior length of liner for pitting (A). Check packing step for erosion (B). If pitting or erosion is observed, measure depth of pits with a fine wire or needle. Replace piston and liner if:

   - Depth of any pit is one-half or more of liner thickness (C).
   - Depth of erosion is one-half or more of the packing step (D).

Specification

Cylinder Liner—Thickness	6.05—6.15 mm (0.238—0.242 in.)
Packing Step Dimension	1.45—1.55 mm (0.057—0.061 in.)

NOTE: Liners are reusable if the depth of pits or erosion is less than one-half the amount specified. When installing reusable liners, rotate 90° from original position. The liners should be also deglazed and new ring sets installed in pistons.



Inspecting Cylinder Liners

A—Liner Pitting
B—Liner Erosion
C—Liner Thickness
D—Packing Step

Continued on next page RG,RG34710,1123 –19–23OCT97–1/2

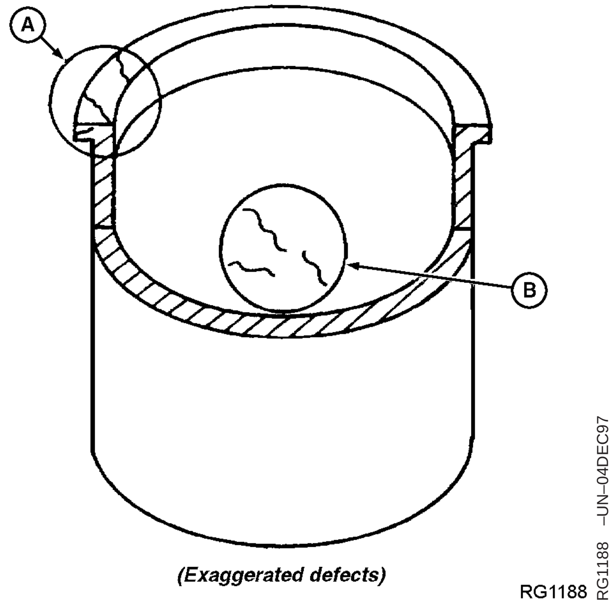
2. Visually examine liner I.D. Replace piston and liner if:

   - 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.

A—Flange Area
B—Ring Travel Area



Cylinder Liner Defects (Exaggerated)

RG,RG34710,1123 –19–23OCT97–2/2

Cylinder Liner Manufacturing Date Code Explanation

A manufacturing four-digit date code will appear on each liner. For example, HJ94 means the liner has a hardened bore and was manufactured in October of 1994.

HJ94
H .... Liner Material Type
J .... Month Liner was Manufactured
94 .... Year Liner was Manufactured

Liner Material Specification:
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:
94 1994
95 1995
etc.


RG6091 –UN–27JAN92

Four-Digit Date Code on Cylinder Liner

RG,RG34710,1124 –19–23OCT97–1/1

Determine Piston-to-Liner Clearance

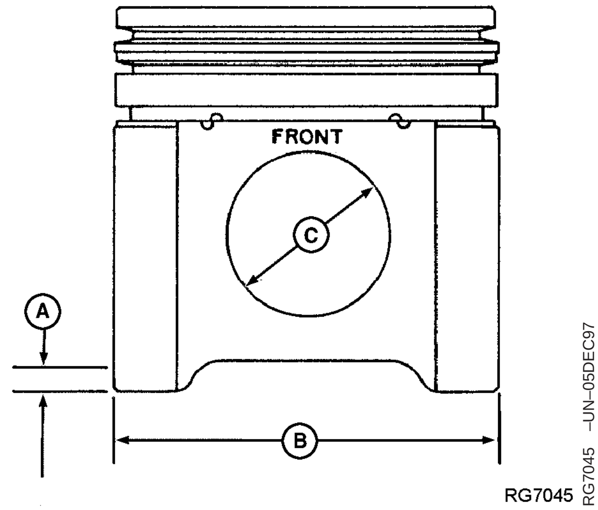
1. Measure piston skirt diameter (B) at right angles to piston pin bore (C), 15.16 mm (0.597 in.) from the bottom of the piston (A).

2. Record measurement and compare measurement obtained from matching liner.

Specification

Piston Skirt—OD 15.16 mm
(0.597 in.) from Bottom of Piston.......................... 115.771—115.789 mm
(4.5579—4.5586 in.)

A—15.16 mm (0.597 in.) From The Bottom Of The Piston
B—Piston Skirt Diameter
C—Right Angles To Piston Pin Bore



Measuring Piston Skirt Diameter

Continued on next page RG,RG34710,1125 –19–23OCT97–1/2

IMPORTANT: ALWAYS measure liners at room temperature.

3. Measure liner bore parallel to piston pin at top end of ring travel (A).

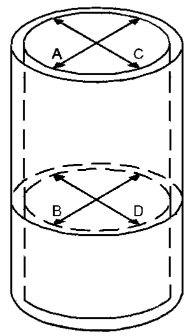
4. Measure bore in same position at bottom end of ring travel (B).

5. Measure bore at right angle to piston pin at top end of ring travel (C).

6. Measure bore in same position at bottom end of ring travel (D).

7. Compare measurements A, B, C, and D to determine if liner is tapered or out-of-round.

8. Compare liner I.D. with matched piston O.D.



Measure Liner

Specification

Cylinder Liner—ID	115.865—115.895 mm (4.5616—4.5628 in.)
OD (Coolant Jacket Area)	127.94—128.24 mm (5.037—5.049 in.)
OD (At Upper Bore)	129.08—129.14 mm (5.082—5.084 in.)
OD (At Lower Bore)	125.044—125.120 mm (4.923—4.926 in.)
ID of Upper Bore in Block for Seating Liners	129.155—129.205 mm (5.085—5.087 in.)
ID of Lower Bore in Block for Seating Liners	125.133—125.183 mm (4.9265—4.9285 in.)
Liner-to-Block Clearance at Upper Bore	0.026—0.126 mm (0.001—0.005 in.)
Liner-to-Block Clearance at Lower Bore	0.012—0.140 mm (0.0005—0.0055 in.)
Maximum Out-of-Round	0.051 mm (0.0020 in.)
Maximum Wear or Taper in Ring Travel Area	0.051 mm (0.0020 in.) maximum
Piston-to-Liner—New Part Clearance (At Bottom of Skirt)	0.076—0.124 mm (0.0030—0.0049 in.)
Maximum Clearance	0.152 mm (0.0060 in.)

Replace piston and liners (as a set) if they exceed wear specifications given.

RG,RG34710,1125 –19–23OCT97–2/2

Inspect 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 assure proper seating. Never scrape joint surfaces (C) with a wire brush or other tool; the interlocking mating surfaces must be preserved.

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.

3. Carefully clamp rod in a soft-jawed vise (cap end upward).

4. Install cap WITHOUT bearing.

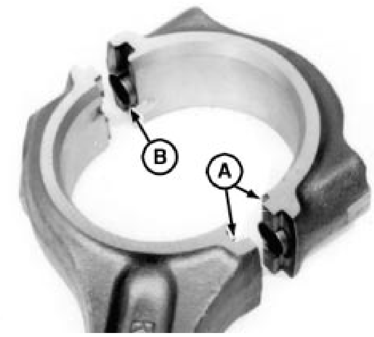
IMPORTANT: Never use new connecting rod cap screws when checking rod bore I.D. Use new cap screws only for final assembly of connecting rods.

5. **On tongue-and-groove connecting rods**: Initially tighten blind-hole cap screw, then, tighten open-hole cap screw to the following specifications.

Specification

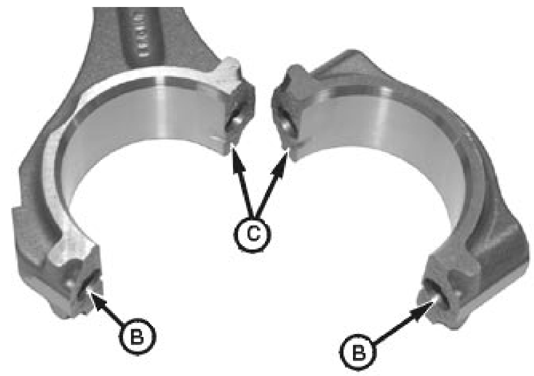
Tongue-and-Groove Connecting Rod Cap Screw—Initial Torque....................................... 27 N•m (20 lb-ft)

Next, tighten rod cap screws to the following specifications.



RG3749 –UN–04DEC97

Tongue-and-Groove Rod and Cap



RG10052 –UN–09JUN99

Precision Joint™ Rod and Cap

RG4982 –UN–05DEC97

Clamping Rod in Vise

A—Tongue-And-Groove Joints
B—Cap Screw Holes
C—Precision Joint™ Mating Surfaces

Precision Joint is a trademark of Deere & Company

Continued on next page

DPSG,OUO1004,884 –19–08JUN99–1/4

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, described 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 .... 95 N•m (71 lb-ft) plus 90–100° turn clockwise

See TORQUE-TURN CONNECTING ROD CAP SCREWS , described later in this group.

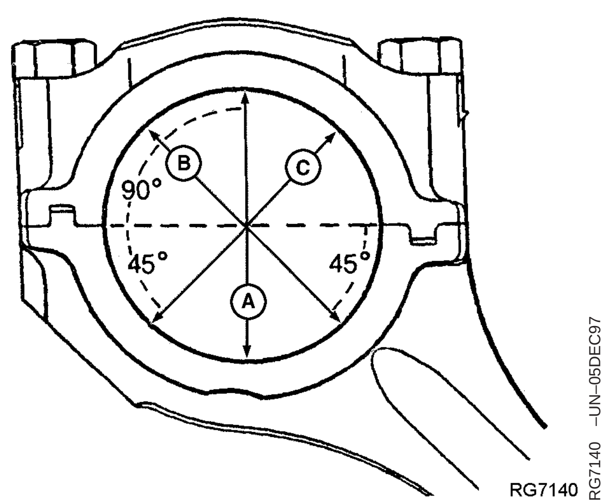
Precision Joint is a trademark of Deere & Company

DPSG,OUO1004,884 –19–08JUN99–2/4

7. Using an inside micrometer, measure rod bore at center of bore and record measurements as follows:

   - At right angle to rod/cap joint (A).
   - At 45° left of measurement step “A” (B).
   - At 45° right of measurement step “A” (C).

Specification
Connecting Rod Bore (Without
Bearings)—ID .... 81.051—81.077 mm (3.191—3.192 in.)



Measuring Connecting Rod and Cap Bore

8. Compare the measurements. If difference between the greatest and least measurement is more than 0.04 mm (0.0016 in.), the rod and cap are out-of-round. Replace both connecting rod and cap.

Specification
Connecting Rod Bore—Maximum
Out-of-Round .... 0.025 mm (0.0010 in.)

Continued on next page

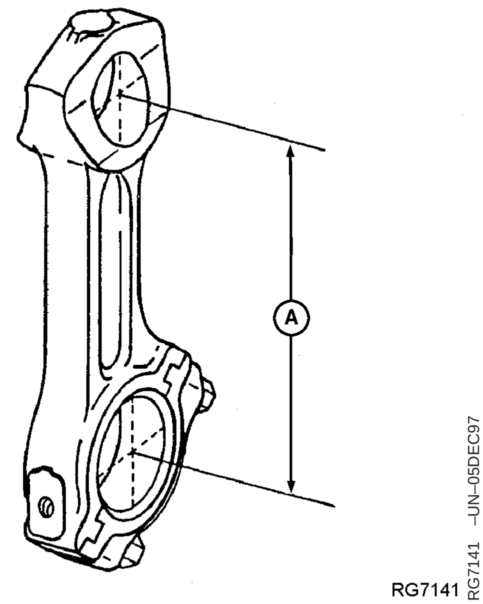
DPSG,OUO1004,884 –19–08JUN99–3/4

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

Centerline of Piston Pin Bore-to-Crankshaft Bore—Dimension.. 222.20—222.30 mm (8.748—8.752 in.)

A—Center-to-Center Dimension



Measuring Pin Bore-to-Crankshaft Bore

DPSG,OUO1004,884 –19–08JUN99–4/4

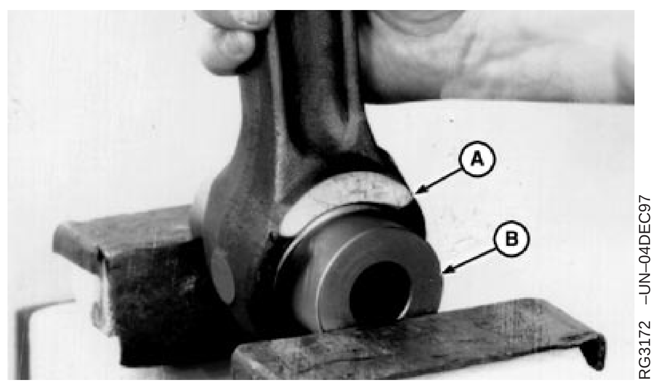
Inspect Piston Pins and Bushings

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.

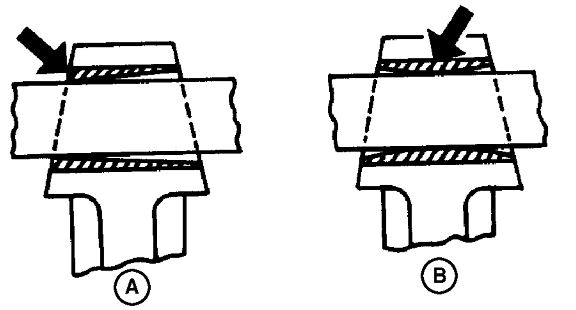
A—Connecting Rod
B—Piston Pin



Checking Piston Pin and Rod

Continued on next page DPSG,OUO1004,891 –19–18MAY99–1/2

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).



Inspecting Piston Pin Bores

A—Tapered Bore
B—Bell-Mouthed Bore

5. Measure I.D. of rod pin bushing and O.D. of piston pin. Compare measurements with specifications given below:

Specification

Piston Pin—OD	47.597—47.613 mm (1.8739—1.8745 in.)
Piston Pin Bore in Piston—ID	47.620—47.630 mm (1.8748—1.8752 in.)
Installed Connecting Rod Pin Bushing (After Boring)—ID	47.655—47.681 mm (1.8762—1.8772 in.)
Connecting Rod Pin-to-Bushing—Oil Clearance	0.042—0.084 mm (0.0017—0.0033 in.)
Wear Limit	0.102 mm (0.0040 in.)

6. If necessary, remove and replace piston pin bushing. See REMOVE PISTON PIN BUSHING, CLEAN AND INSPECT PIN BORE, later in this group.

DPSG,OUO1004,891 –19–18MAY99–2/2

Remove Piston Pin Bushing, Clean and Inspect Pin Bore

1. If necessary, remove pin bushing with the JDG337 and JDE98A Connecting Rod Bushing Service Sets.

   Use the following tools from the service sets:

   - JDG339 Cup (A)
   - JDG338 Adapter (B)
   - JDE98-4 Driver (C)
   - STD36104 Forcing Screw with Washer (D)

IMPORTANT: Use care to properly align the JDE98-4 Driver with bushing so that the connecting rod bushing bore is not damaged.

2. Clean rod bushing bore using a medium grit emery cloth, as burrs will distort bushing. Install bushing on opposite side of rod burr.

3. Measure rod bushing bore in three places approximately 45° apart. Compare the measurements with the specifications given below:

Specification	
Connecting Rod Pin Bore—Diameter without Bushing	52.354—52.380 mm (2.0612—2.0622 in.)
Connecting Rod Pin Bore-to-Bushing—Press Fit	0.084—0.147 mm (0.0033—0.0058 in.)
Installed Service Connecting Rod Pin Bushing (Before Boring)—ID	47.58—47.63 mm (1.8732—1.8751 in.)
Installed Service Connecting Rod Pin Bushing (After Boring)—ID	47.655—47.681 mm (1.8762—1.8772 in.)

IMPORTANT: If piston pin bushing bore diameter in rod is not within specification or bushing has spun in rod, discard rod and replace with a new one.

Removing Piston Pin Bushing from Rod

A—JDG339 Cup
B—JDG338 Adapter
C—JDE98-4 Driver
D—STD36104 Forcing Screw With Washer

RG,RG34710,1130 –19–23OCT97–1/1

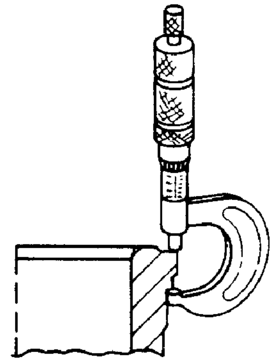
Measure Liner Flange

Measure cylinder liner flange thickness at several locations and compare with specification given below.

If liner flange is not within specification, either use liner shims as needed or replace piston and liner as a set if shims don’t bring liner standout within specification. See RECHECK CYLINDER LINER STANDOUT and see INSTALL LINER SHIMS—IF REQUIRED, later in this group.)

Specification

Cylinder Liner Flange—Thickness	11.989—12.039 mm (0.472—0.474 in.)
OD	135.10—135.16 mm (5.319—5.321 in.)



RG4727 RG4727 –UN–05DEC97

Measuring Liner Flange

RG,RG34710,1126 –19–18MAY99–1/1

Inspect and Measure Connecting Rod Bearings

Inspect connecting rod bearings for wear or damage.

IMPORTANT: Each rod bearing half has a built-in "relief" or lube oil pocket on the inner surface. This relief must not be confused as a worn/damaged spot.

IMPORTANT: Never use new connecting rod cap screws when checking rod bearing I.D. 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 I.D. of connecting rod bearings and compare with O.D. of crankshaft journal.

1. With crankshaft removed, measure connecting rod journal O.D. at several points.

2. Carefully clamp rod in a soft-jawed vise and 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

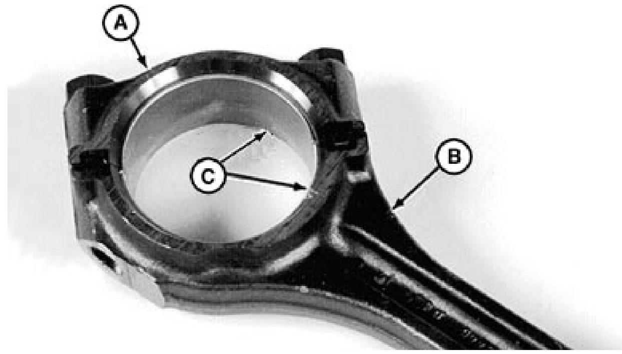
Tongue-and-Groove Connecting Rod Cap Screw—Initial Torque .... 27 N•m (20 lb-ft)

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, described later in this group.



Connecting Rod Bearings

A—Rod Cap
B—Rod
C—Bearings

PLASTIGAGE is a registered trademark of DANA Corp.

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	95 N•m (71 lb-ft) plus 90–100° turn clockwise

See TORQUE-TURN CONNECTING ROD CAP SCREWS , described later in this group.

Precision Joint is a trademark of Deere & Company

DPSG,OUO1004,885 –19–14MAY99–2/3

5. Using an inside micrometer (A) measure I.D. of bearing.

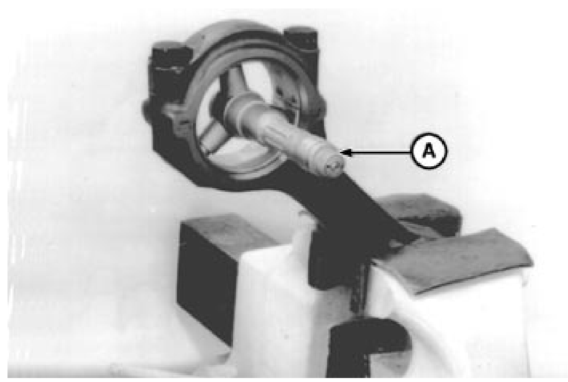
6. Subtract O.D. of crankshaft journals from I.D. of rod bearings to obtain oil clearance.

7. Compare measurements with the following specifications.

Specification

Crankshaft Rod Journal—OD	76.150—76.180 mm (2.9980—2.9992 in.)
Assembled Connecting Rod Bearing—ID	76.210—76.260 mm (3.0004—3.0024 in.)
Connecting Rod Bearing-to-Journal (New Parts)—Oil Clearance	0.030—0.110 mm (0.0012—0.0044 in.)

8. If bearings are worn or not within specification, replace connecting rod bearings.



Measuring Connecting Rod Bearings

A—Inside Micrometer

DPSG,OUO1004,885 –19–14MAY99–3/3

Install Piston Pin Bushing in Connecting Rod

IMPORTANT: Always push new bushing into rod from back side and burnish bushing after installation for proper form and seating in rod bore.

1. Lubricate rod bushing bore and bushing with clean engine oil. Install bushing using the JDG337 and JDE98A Connecting Rod Bushing Service Sets.

   Use the following tools from the above sets and assemble in sequence as shown:

   - STD36104 Forcing Screw With Washer (A)
   - JDE98A Drive (B)
   - JDG338 Adapter (C)
   - Service Bushing (D)
   - JDE98-3 Pilot (E)
   - JDE339 Cup (F)

IMPORTANT: Boring of the rod bushing should be done ONLY by experienced personnel on equipment capable of maintaining bushing specification.

2. After installation, bore I.D. of newly installed bushing to the following specifications.

Specification

Connecting Rod Pin Bushing (After Boring)—ID	47.655—47.681 mm (1.8762—1.8772 in.)

Remove all residue from boring operation.

3. Check rod pin-to-bushing clearance. See INSPECT PISTON PINS AND BUSHINGS, earlier in this group.

4. Replace rod pin as required.

Installing Piston Pin Bushing in Rod

A—STD36104 Forcing Screw With Washer
B—JDE98A Driver
C—JDG338 Adapter
D—Service Bushing
E—JDE98-3 Pilot
F—JDE339 Cup

RG,RG34710,1131 –19–23OCT97–1/1

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. (Group 040.)

2. Remove all remaining lubrication system components. (Group 060.)

3. Remove coolant pump and all remaining cooling system components (Group 070.)

4. Remove timing gear train and camshaft. (Group 050.)

5. Remove fuel injection pump and fuel filter assembly. (Group 090.)

6. If necessary to "Hot Tank" the block, remove oil gallery plugs, coolant gallery plugs, piston cooling orifices and the engine serial number plate.

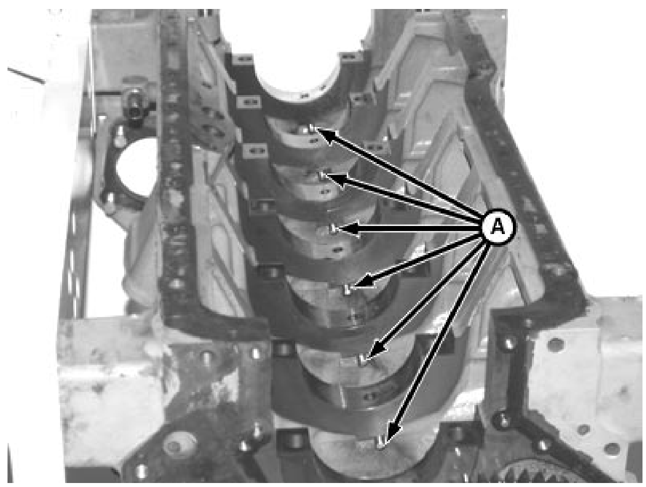
RG,RG34710,1132 –19–23OCT97–1/1

Remove and Clean Piston Cooling Orifices

1. Remove all six (four shown) piston cooling orifices (A) and inspect each cooling orifice to make sure it is not plugged or damaged.

2. Use a soft wire and compressed air to clean orifice. Replace if condition is questionable.

IMPORTANT: A piston cooling orifice failure could cause damage to pistons, piston pins, rod pin bushings, and liners. If a piston cooling orifice is left out, low or no oil pressure will result.



Piston Cooling Orifices in Block

A—Piston Cooling Orifices

RG,RG34710,1133 –19–23OCT97–1/1

Inspect and Clean Cylinder Block

Tap for Head Mounting Holes in Block

NOTE: All components (including piston cooling orifices), coolant 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 Bore 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 JDG681 Tap or an equivalent 9/16-12 UNC-2A tap approximately 88.9 mm (3.5 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.

Continued on next page RG,RG34710,1134 –19–23OCT97–1/2

3. Clean block thoroughly using cleaning solvent, pressure steam, or a hot tank.

4. Inspect liner support flange (C) for burrs. If burrs are present, use a small half-moon file and LIGHTLY file (in a circular motion) burr off at approximately a 60° angle. DO NOT let file hit top deck of cylinder block (B) while filing.

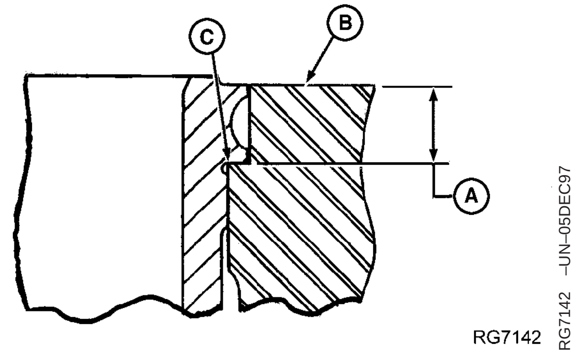
NOTE: DO NOT file liner support flange excessively. Excess filing can damage liner support flange and allow an improper liner fit. Thoroughly clean all filings from cylinder block.

5. Measure liner flange counterbore depth (A) in block and compare with specification given below.

Specification

Cylinder Block Flange
Counterbore—Depth.. 11.913—11.963 mm
(0.469—0.471 in.)

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.



Measuring Liner Flange Counterbore Depth in Block

A—Liner Flange Counterbore Depth
B—Top Deck Of Cylinder Block
C—Liner Support Flange

RG,RG34710,1134 –19–23OCT97–2/2

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

Crankshaft Main Bearing—Bore ID without Bearing	101.651—101.67 mm (4.0020—4.0030 in.)
Surface Width	36.28—36.78 mm (1.428—1.448 in.)
Crankshaft Thrust Bearing—Bore ID without Bearing	101.651—101.67 mm (4.0020—4.0030 in.)
Surface Width (No. 5 Main)	37.44—37.54 mm (1.474—1.478 in.)
Overall Cap Width	41.81—42.31 mm (1.646—1.666 in.)

If any main or thrust bearing cap assembled I.D. is not within specification, blank (generic) bearing caps are available and must be line bored to specification by a qualified machine shop. See MAIN BEARING CAP LINE BORE SPECIFICATIONS in Group 040.

2. Measure camshaft follower bore diameter at all bore locations.

Specification

Camshaft Follower—Bore ID in Block	17.384—17.440 mm (0.6845—0.6865 in.)
Follower OD (New)	17.33—17.35 mm (0.682—0.683 in.)
Follower-to-Bore Clearance	0.114 mm (0.0045 in.)

If any one camshaft follower bore is not within specification, install a new cylinder block.

3. Measure camshaft bore diameter at all locations and record readings. Compare measurements with specifications given in chart below:

Specification

Camshaft Bushing—Installed ID	67.076—67.102 mm (2.6408—2.6418 in.)
Bushing Bore in Block	69.987—70.013 mm (2.7554—2.7564 in.)
Minimum Runout of Bore in Block	0.038 mm (0.0015 in.)
Bushing-to-Journal Clearance	0.0063—0.115 mm (0.0025—0.0045 in.)

If camshaft bushing bore diameter in block is more than specified, install a new cylinder block.

IMPORTANT: The centerline of the main bearing bore-to-top deck of cylinder block MUST BE 352.35—352.50 mm (13.872—13.878 in.). If not, replace cylinder block.

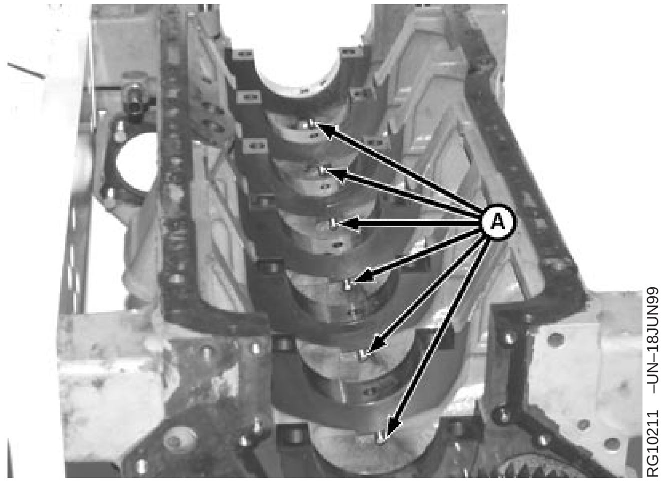
4. Measure cylinder block top deck flatness using D05012ST Precision Straightedge and feeler gauge and compare to following specifications. Resurface as required.

Specification

Cylinder Block Top Deck—Maximum Out-of-Flat	0.10 mm (0.004 in.) over entire length or width
Straightness	0.025 mm (0.001 in.) per any 305 mm (12.0 in) of Length
Maximum Wave Depth	2.0 micrometers (79 micro-inch)
Main Bearing Bore Centerline-to-Top Deck Distance	352.35—352.50 mm (13.872—13.878 in.)

RG,RG34710,1135 –19–23OCT97–1/1

Install Piston Cooling Orifices and Gallery Plugs



Piston Cooling Orifices in Block

A—Piston Cooling Orifices

1. Use a soft wire and compressed air to clean orifices. Replace if condition is questionable.

IMPORTANT: A piston cooling orifice failure could cause damage to pistons, piston pins, rod pin bushings, and liners. If a piston cooling orifice is left out, low or no oil pressure will result.

2. Install all six (four shown) piston cooling orifices (A) and tighten to specifications.

Specification

Piston Cooling Orifice into
Cylinder Block—Torque.................................... 11 N•m (97 lb-in.) (8 lb-ft)

3. Install new oil and coolant gallery plugs as required, if removed.

RG,RG34710,1136 –19–23OCT97–1/1

Recheck Cylinder Liner Standout

NOTE: If a new liner assembly is being installed in a new or used cylinder block, liner height must be checked.

Be sure liner bore in cylinder block and top deck of block are clean.

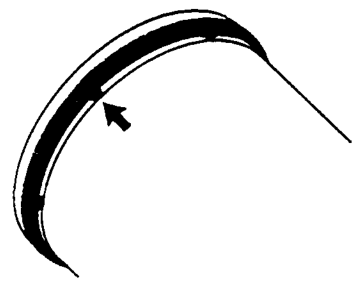
Install liners without packing. Secure with cap screws and washers and measure liner standout. See MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK) earlier in this group.

Liner shims may be used to bring standout within specification. See INSTALL LINER SHIMS—IF REQUIRED later in this group.

RG,RG34710,1137 –19–23OCT97–1/1

Install Liner Shims—If Required

If the liner flange thickness is within specification, but recorded standout was no more than 0.08 mm (0.003 in.) BELOW top deck of block, install liner shims on bottom of liner flange.



RG4728 –UN–04MAY89

Liner Shims

Liner shim thickness is as follows:

Specification	
Cylinder Liner Shim—Thickness	0.05 mm (0.002 in.)

A maximum of two liner shims may be used per cylinder, as required. Shims have tangs in the I.D. to help hold them in place against bottom of liner flange during liner installation.

1. Make sure counterbore in block is clean and free of burrs. Install liner(s), and shim(s), in block bore without O-rings. Secure liners with cap screws and washers as done previously. Tighten cap screws to 68 N•m (50 lb-ft).

   Liner standout should be within the following range but MUST NOT exceed 0.127 mm (0.005 in.) after shim installation.

Specification	
Cylinder Liners—Standout (Height Above Block)	0.051—0.127 mm (0.002—0.005 in.)

2. Measure liner standout again at 1, 5, 7, and 11 O'clock positions. Record measurements.

   If standout is still not within specification, remove liner and determine cause.

   If standout is within specification, proceed to next step.

RG,RG34710,1138 –19–17MAY99–1/1

Install Packing on Cylinder Liner and O-Rings in Block

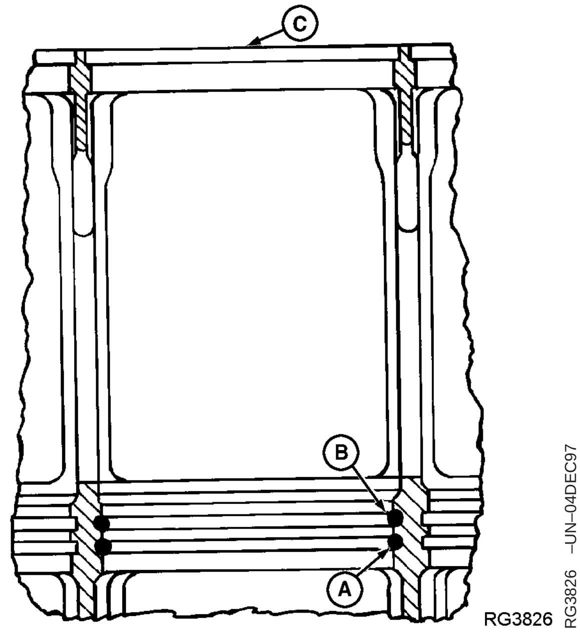
IMPORTANT: DO NOT use oil on cylinder liner packing or O-rings. Oil can cause the red packing to swell, which squeezes liner and could possibly cause a scored piston.

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-ring in soap to soak.

3. Install the black viton O-ring (A) in the lower O-ring groove in the cylinder block (C).

4. Install the red silicone O-ring (B) in the upper O-ring groove in the cylinder block.



Cylinder Liner Seals

A—O-Ring
B—O-Ring
C—Cylinder Block

RG,RG34710,1139 –19–23OCT97–1/2

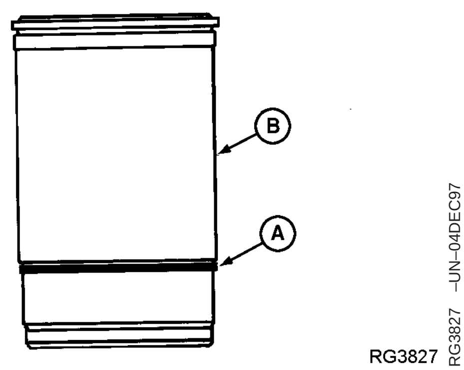
5. Turn cylinder liner (B) upside-down and install the square neoprene packing (A) over outside of liner.

6. Slide packing down firmly against second shoulder on liner.

NOTE: Make sure the square packing is not twisted.

7. Coat the liner packing sealing area of the cylinder liner and block O-rings with liquid soap.

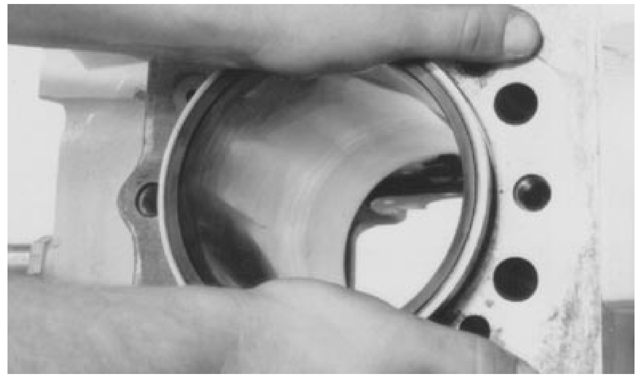
A—Square Neoprene Packing
B—Cylinder Liner



Installing Cylinder Liner Packing

RG,RG34710,1139 –19–23OCT97–2/2

Install Cylinder Liner in Block


RG2772 –UN–04DEC97

Installing Cylinder Liners in Block

IMPORTANT: Install cylinder liners into same cylinder block bore as removed.

DO NOT scuff the liner packing across the upper counterbore.

Pitted or eroded liners that meet reuse guidelines should be rotated 90° from their removed position. See VISUALLY INSPECT CYLINDER LINERS earlier in this group for reuse guidelines.

1. Install liner in block bore with manufacturing data code (stamped on flange) toward front of engine, unless liner O.D. is pitted or eroded.

   If liner O.D. is pitted or eroded, but still within acceptable service limits, rotate liner 90° from it's removed position. Pitted sections of the liner should be facing the front or rear of engine.

2. A resistance will be felt when cylinder liner is aligned in pilot bore.

3. Using only the pressure of both palms, the cylinder liner should drop to a point nearly flush with upper flange of the cylinder liner and cylinder block.

Continued on next page RG,RG34710,1140 –19–23OCT97–1/2

4. Finish seating cylinder liners using a clean, hardwood block and hammer.

5. Gently tap hardwood block over top of cylinder liner with mallet.

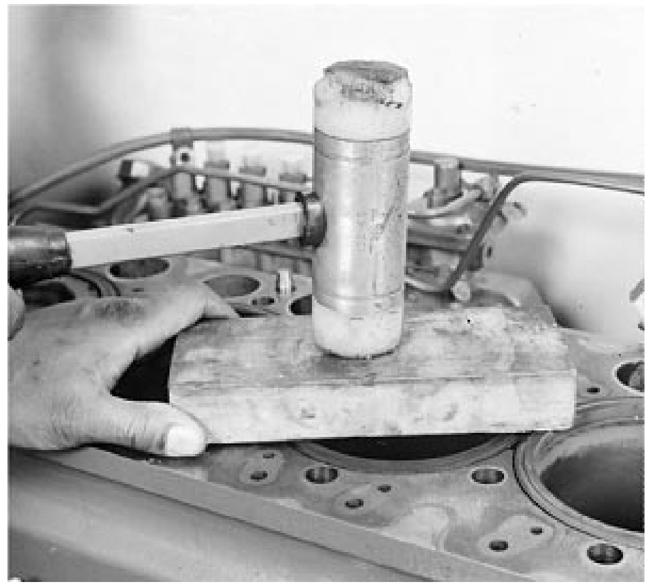
NOTE: Cylinder liner will protrude over top of cylinder block more than normal due to uncompressed packings and O-rings.

IMPORTANT: If you suspect a packing may have sheared or displaced during liner installation, remove and examine the liner and packing assembly. If no damage is found, check packings for proper position. Resoap packings and reinstall liner assembly.

6. Hold liners in place with large flat washers and cap screws. Turn cap screws snug but do not tighten.

7. Clean cylinder liner bores with waterless hand cleaner after installation. Wipe dry with clean towels.

8. Apply clean engine oil to liner bores immediately to prevent corrosion.



RG6092 –UN–27JAN92

Seating Cylinder Liners in Block

RG,RG34710,1140 –19–23OCT97–2/2

Install Piston and Connecting Rod

1. Earlier engines have the traditional tongue-and-groove joint between the connecting rod and cap (A). Later engines have the Precision Joint™ rod and cap (B).

   Installation of the different rods is similar, with differences noted in the following instructions.

IMPORTANT: Do Not mix tongue-and-groove rods and Precision Joint™ rods in the same engine. See parts catalog for recommendations.

RG9617 –UN–02DEC98

Connecting Rods

A—Tongue and Groove Rod (Earlier Engines)
B—Precision Joint™ Rod (Later Engines)

Precision Joint is a trademark of Deere & Company

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RE38635,0000124 –19–30JUN06–1/6

IMPORTANT: Piston must be installed on same connecting rod 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.

2. Lubricate piston pin (A) and bushing with clean engine oil.

3. Install piston pin through piston (B) and connecting rod (C). Be sure “FRONT” of rod aligns with arrow or “FRONT” of piston.

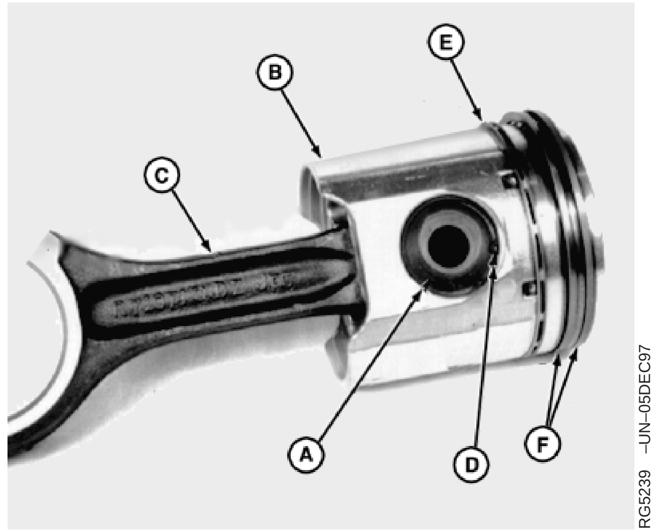
4. Install NEW piston pin snap rings (D) in grooves. Make certain snap rings have expanded in grooves of piston.

NOTE: Full keystone compression ring (one “Pip” mark) goes in top piston ring groove. Half keystone ring (two “Pip” or “Top” marks) goes in second ring groove of piston.“Pip” mark(s) on No. 1 and No. 2 compression rings must face top of piston.

KS piston rings are color coded. The No. 1 ring is blue, No. 2 is Pink and No. 3 is Orange. The expander ring is orange.Be sure the orange paint stripe on the expander ring is visible in the oil ring gap.

5. Use the JDE93 Ring Expander to install oil control ring with expander ring (E) and then compression rings.

NOTE: New rings are furnished with the correct end gap, therefore, fitting to the liner is not necessary.



Installing Piston and Connecting Rod

A—Piston Pin
B—Piston
C—Connecting Rod
D—Snap Rings (2 used)
E—Oil Control Ring with Expander Ring
F—Compression Rings

Continued on next page RE38635,0000124 –19–30JUN06–2/6

NOTE: See specification for ring gap in REPAIR AND GENERAL OEM SPECIFICATIONS in Group 200.

6. Stagger ring gaps on piston as shown, with gap of top ring facing the front of the engine.

NOTE: If crankshaft was removed, see INSTALL MAIN BEARINGS AND CRANKSHAFT in Group 040.

7. Coat piston, liners and I.D. of JDE96 Piston Ring Compressor with clean engine oil.

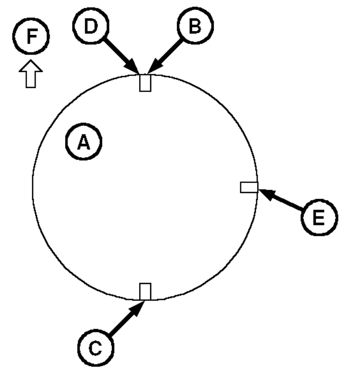
8. Carefully place ring compressor with piston and rod over liner.

IMPORTANT: Be sure crankshaft journals and liner walls are not damaged when installing piston and rod in liner.

NOTE: Be sure the word "FRONT" on piston and rod face toward the front of the engine.

9. With piston centered in ring compressor and rings staggered correctly, push piston into liner, as shown, until top ring is inside the liner.

A—Top of Piston
B—Top Compression Ring Gap
C—Oil Control Ring Gap
D—Expander Ring Gap
E—Bottom Compression Ring Gap
F—Front of Engine



RG10050 –UN–21MAY99

Position of Piston Ring Gaps

RG5816 –UN–05DEC97

Installing Piston in Cylinder Liners

Continued on next page RE38635,0000124 –19–30JUN06–3/6

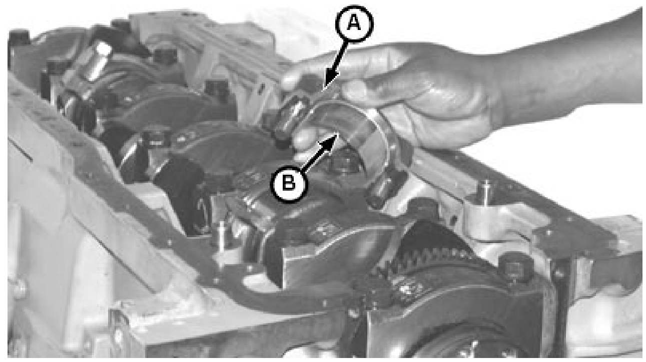
10. Apply clean engine oil to bearing inserts (B) and matching crankshaft rod journals.

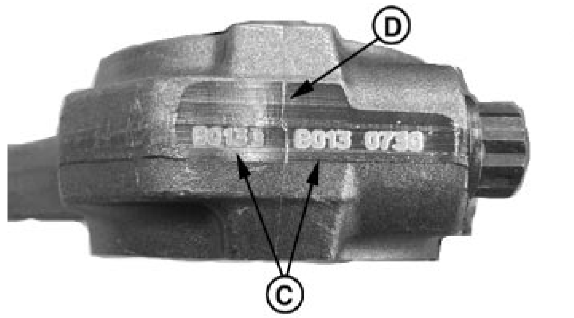
IMPORTANT: On Precision Joint™ rods, make sure cap is properly aligned on rod with interlocking surfaces sealing tightly and edges aligned (D). DO NOT reverse cap on rod. Match pads on side of rod and cap.

When installing caps, BE CERTAIN stamped numbers (C) on rod and cap match. If numbers do not match, major engine failure will result.

11. Install connecting rod caps (A).

A—Connecting Rod Caps
B—Bearing Inserts
C—Stamped Numbers
D—Precision Joint





Installing Rod Caps w/Bearings

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Continued on next page RE38635,0000124 –19–30JUN06–4/6

IMPORTANT: 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 must not be reused for another final assembly.

12. Dip NEW cap screws and washers in clean engine oil. Make sure bore threads and all threads on cap screws are thoroughly oiled.

IMPORTANT: DO NOT use pneumatic wrenches to install connecting rod cap screws. Doing so may damaged threads. Use speed-handle wrench instead.

13. **On tongue-and-groove connecting rods**: Initially, tighten cap screw (A) closest to piston end 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)

Secondly, tighten all cap screws to the following specifications, then TORQUE-TURN all cap screws 90-100°.

Specification

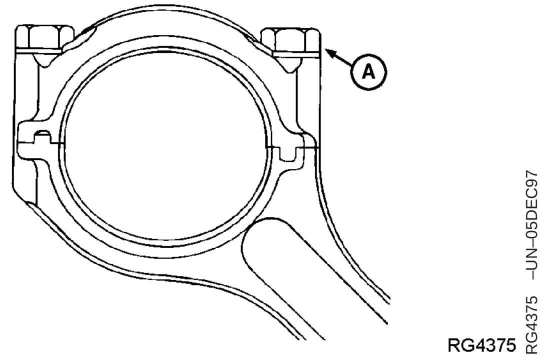
Tongue-and-Groove Connecting
Rod Cap Screw—Final Torque .... 75 N•m (55 lb-ft) plus 90–100° turn clockwise

See TORQUE-TURN CONNECTING ROD CAP SCREWS, described next in this group.

14. **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................................. 95 N•m (71 lb-ft) plus 90–100° turn clockwise



Cap Screw in Rod Cap (Tightened First)

A—Cap Screw (Tighten First)

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See TORQUE-TURN CONNECTING ROD CAP SCREWS, described next in this group.

RE38635,0000124 –19–30JUN06–6/6

Torque-Turn Connecting Rod Cap Screws

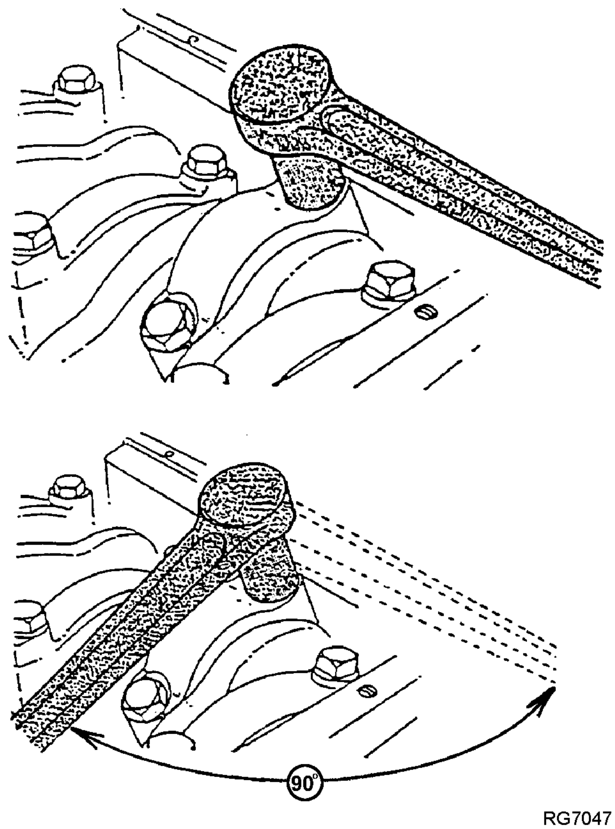
Using Engine Axis Method to Torque-Turn Connecting Rod Cap Screws:

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—Parallel to Centerline of Crankshaft Axis
B—Perpendicular to Centerline of Crankshaft Axis



RG7047 –UN–05DEC97

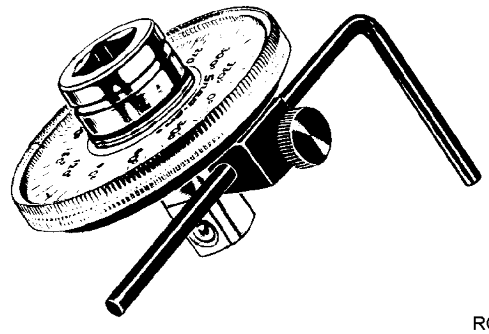
Tightening Rod Cap Screws by TORQUE-TURN Method

Continued on next page

RG,RG34710,1142 –19–23OCT97–1/2

Using JT05993 Torque Angle Gauge to Torque-Turn Connecting Rod Cap Screws:

After tightening cap screws to initial torque values provided earlier, follow directions provided with gauge and TORQUE-TURN each cap screw 90°–100°.



RG5698 RG5698 –UN–05DEC97

JT05993 Torque Angle Gauge

RG,RG34710,1142 –19–23OCT97–2/2

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,RG34710,1143 –19–23OCT97–1/1

Complete Final Assembly

NOTE: Refer to the proper group for installation of components.

1. Install camshaft, and timing gear cover. (Group 050.)

2. Install oiling system components. (Group 060.)

3. Install cylinder head using a new gasket and cap screws. Install valve train components. (Group 020 S.N. (—199,999).) (Group 021 S.N. (200,000—).)

4. Install fuel injection system components. (See Group 090 in appropriate CTM for specific fuel system.)

5. Install thermostat housing and coolant bypass pipe, if removed. (Group 070.)

6. Install vibration damper and crankshaft pulley. (Group 040.)

7. Install alternator. (Group 100.) To install fan and fan belt, see machine Technical Manual.

8. Install exhaust manifold and intake assembly. (Group 080.)

9. Install starting motor. (Group 100.)

10. Fill engine with clean oil and proper coolant.

11. Install engine in vehicle (if removed). (See machine Technical Manual.)

12. Perform engine break-in. (Group 020 S.N. (—199,999).) (Group 021 S.N. (200,000—).)

RG,RG34710,1144 –19–03JAN01–1/1

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,RG34710,1149 –19–23OCT97–1/1

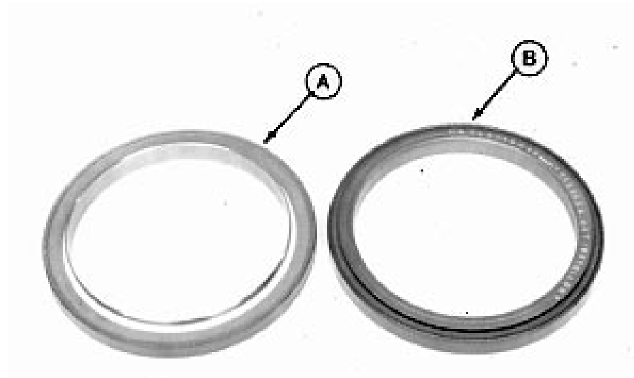
Crankshaft Rear Oil Seal and Wear Sleeve General Information

Two types of oil seal and wear sleeve assemblies are used:

- Earlier engine applications used a two-piece oil seal and wear sleeve assembly (A) that can easily be separated by hand.
- Current production engines use a unitized (non-separable) oil seal and wear sleeve assembly (B).

Removal of the two oil seal and wear sleeve types are different; refer to the appropriate procedure when servicing rear crankshaft oil seal and wear sleeve assembly.

The unitized (non-separable) oil seal assembly is the only type that is currently available through service parts.



RG5634 –UN–02APR90

A—Two Piece Seal and Sleeve
B—Unitized Seal and Sleeve

CTM8,GR15,18 –19–16FEB95–1/1

Remove Crankshaft Rear Oil Seal and Wear Sleeve

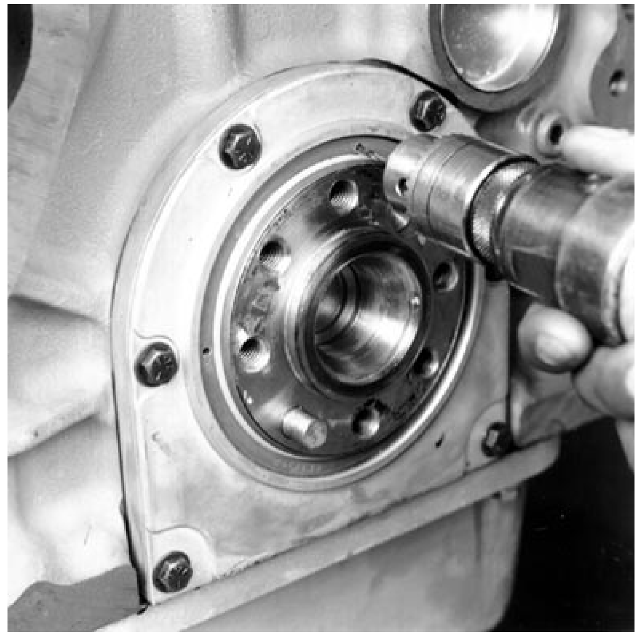
Using JDG719 Seal Puller Adapter along with JDE38-2 Shank and JDE38-3 Slide Handle is the preferred method for removing the crankshaft rear oil seal. If JDG719, JDE38-2, and JDE38-3 are not available, JDG22 Seal Remover can be used to remove the seal. Follow same procedure for both pullers.

1. Remove rear drive hub (if equipped) and flywheel. See REMOVE FLYWHEEL later in this group.

2. Drill two small holes approximately 20° apart in bottom of seal casing. Install sheet metal screws in seal casing with JDG22 Seal Remover attached.

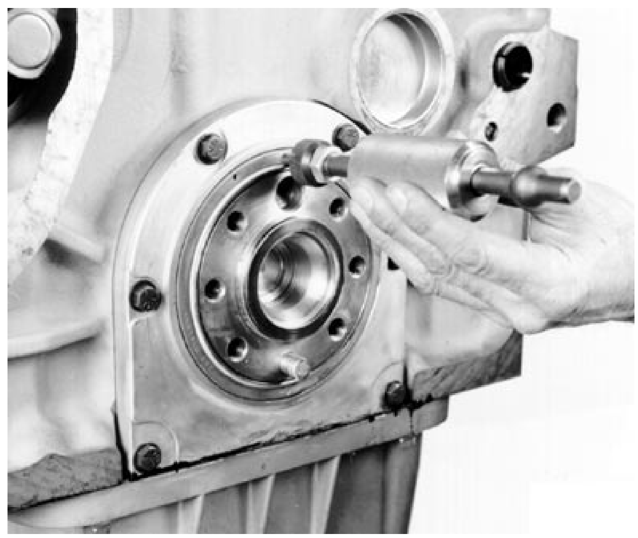
NOTE: It may be necessary to drill a small hole in seal at one or two other locations to aid in removal.

3. Cock seal at 6 o'clock position (180° opposite drilled hole) using a small punch and carefully pull seal from housing.



RG5819 –UN–05DEC97

Drilling Holes in Rear Oil Seal Casing



RG6467 –UN–05DEC97

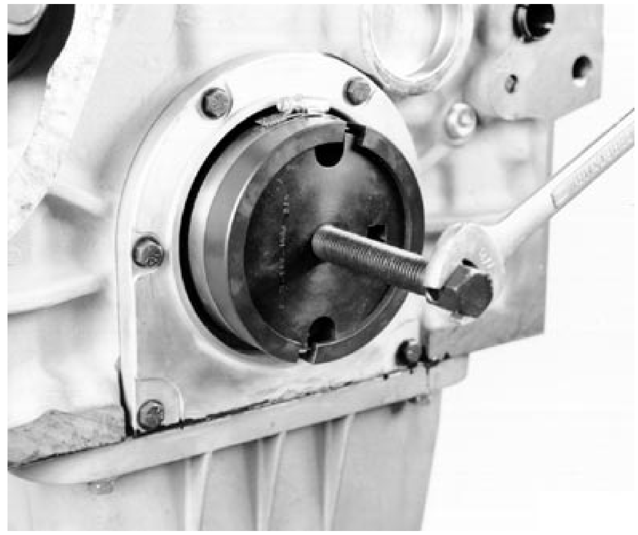
Removing Rear Oil Seal

Continued on next page RG,RG34710,1150 –19–23OCT97–1/3

4. Assemble JDG790 Rear Wear Sleeve Puller and position onto crankshaft flange with wear sleeve seated in jaws.

5. Securely tighten band clamp in groove on O.D. of jaws.

6. Tighten forcing screw with disk centered in crankshaft flange until wear sleeve is removed from crankshaft.



RG6468 –UN–05DEC97

Removing Crankshaft Wear Sleeve

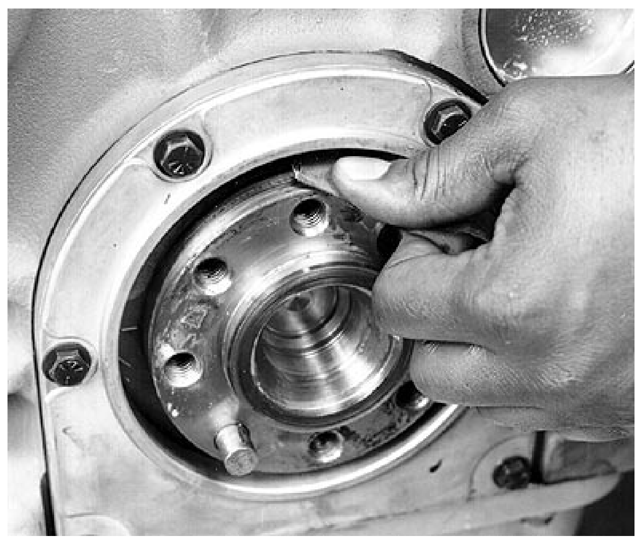
RG,RG34710,1150 –19–23OCT97–2/3

Clean O.D. of crankshaft flange with cleaning solvent, acetone, or any other suitable cleaner that will remove sealant. (Brake Kleen or Ignition Cleaner and Drier are examples of commercially available solvents that will remove sealant from flange.)

Look for nicks or burrs on wear ring surface and bore in flywheel housing. If necessary, use a polishing cloth.

Finish cleaning by wiping flange with a clean rag. Any small nicks should be removed with 180-grit or finer polishing cloth.

Check oil seal housing runout as explained later in this group.



RG5822 –UN–05DEC97

Cleaning Crankshaft Flange

RG,RG34710,1150 –19–23OCT97–3/3

Crankshaft Rear Oil Seal and Wear Sleeve Handling Precautions

Use the following precautions for handling seal and wear sleeve:

Seal (A) and wear sleeve (B) are assembled. DO NOT SEPARATE. If parts become separated, discard and replace with a new assembly. Attempts to reassemble will cause the wear sleeve to damage the seal allowing engine oil to leak past seal.

Always install seal and wear sleeve assembly immediately after removal from plastic bag to avoid possible dirt contamination.

No lubricant of any kind is to contact seal when installing. Use of a lubricant may result in premature seal failure.

Install oil seal/wear sleeve assembly with the open side of seal and wear sleeve I.D. chamfer toward the engine. If seal is reversed, engine oil may be lost because grooves in oil seal lip would be incorrect with respect to direction of crankshaft rotation.

Oil seal/wear sleeve assembly MUST BE installed with the JDG476(85) Crankshaft Rear Oil Seal Installation Tool Set. Tool set consists of JDG477 (85) Pilot and JDG478 Driver.

RG5640A –UN–31OCT97

Rear Oil Seal and Wear Sleeve

A—Oil Seal and Wear Sleeve

RG,RG34710,1151 –19–17MAY99–1/1

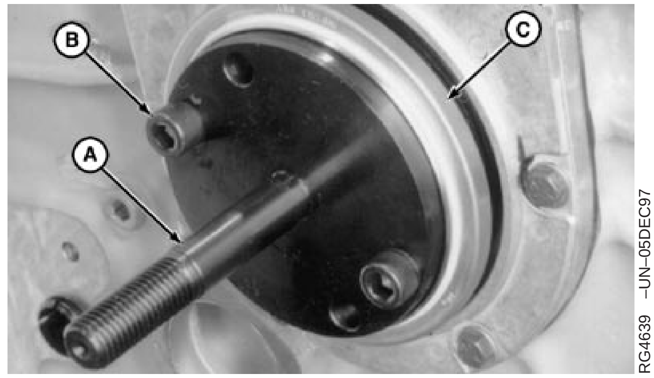
Install Crankshaft Rear Oil Seal and Wear Sleeve

NOTE: These instructions are for use when the oil seal housing and oil pan would not be removed.

1. **For separable type seal:** Apply a light coating of LOCTITE® 680 Retaining Compound, or equivalent, completely around the leading edge of crankshaft flange. Wipe away any sealant that may have gotten on I.D. of seal housing bore.

   For unitized seal: Apply a light coating of clean engine oil around rubber OD of seal. DO NOT apply a sealant to the crankshaft, as with the two piece seal above. The seal on the unitized rear oil seal is coated with a sealant material.

2. Install JDG477 (85) Pilot (A) on end of crankshaft using the Allen head cap screws (B) supplied with tool set. Tighten cap screws securely.



Installing Crankshaft Rear Oil Seal/Wear Sleeve

A—Pilot
B—Allen Head Cap Screws
C—Oil Seal/Wear Sleeve Assembly

LOCTITE is a registered trademark of Loctite Corp.

Continued on next page

RG,RG34710,1152 –19–17MAY99–1/3

IMPORTANT: Handle seal and wear sleeve assembly carefully. If assembly becomes separated, discard these parts and install a new assembly. See CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE HANDLING PRECAUTIONS, earlier in this group.

When installing the JDG478 Driver on JDG477 (85) Pilot and crankshaft flange to position oil seal/wear sleeve assembly, locate crossbar of installer at right angle (90°) to Allen head cap screws. This allows the crossbar to bottom on pilot, not head of cap screws, assuring correct installation.

NOTE: Unitized seal and wear sleeve assembly must be installed with wear sleeve flange away from engine. Part number and stamped instructions should be readable when installed.

3. Carefully start oil seal/wear sleeve assembly (C) over JDG477 (85) Pilot and crankshaft with open side of seal toward engine.

RG,RG34710,1152 –19–17MAY99–2/3

4. Position JDG478 Driver (A) so that hole in the cross plate goes over threaded stud of pilot. Install washer and nut on stud.

5. Tighten nut to draw JDG478 Driver in until crossbar bottoms on JDG477 (58) Pilot. When the tool bottoms, seal and wear ring assembly (B) will be correctly positioned.

6. Remove JDG476 (85) Tool Set from engine.

A—Driver
B—Wear Ring Assembly

RG4640 –UN–05DEC97

Crankshaft Rear Oil Seal/Wear Sleeve Installed

RG,RG34710,1152 –19–17MAY99–3/3

Inspect Vibration Damper

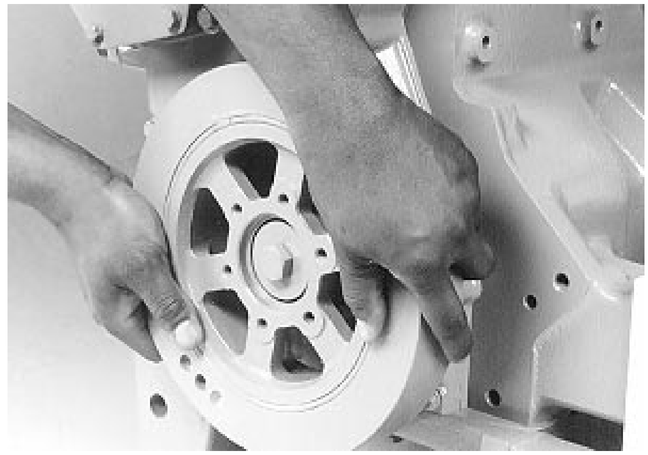
IMPORTANT: The damper assembly is not repairable and should be replaced every 5 years or 4500 hours, whichever occurs first. Also, replace damper whenever crankshaft is replaced or major engine overhaul is performed. Dual dampers should always be replaced as a matched set.

Do not immerse the vibration damper or the damper pulley in cleaning solvent. Doing so may damage the rubber portions of this assembly.

Never apply thrust on outer ring of damper. Damper is sensitive to impact damage, such as being dropped or struck with a hammer.

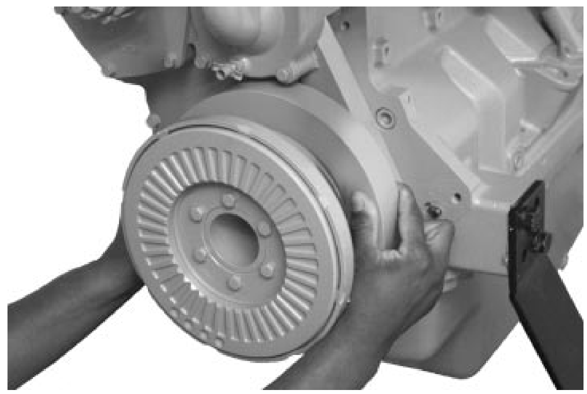
1. Relieve tension or remove V-belts (shown removed).

2. 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.



RG7208 –UN–28JUL94

Single Damper



RG7369 –UN–05JAN98

Dual Damper

Continued on next page DPSG,OUOE003,28 –19–17DEC98–1/2

3. Check vibration damper radial runout by positioning a dial indicator so preloaded probe (A) contacts damper O.D.

4. Rotate crankshaft using JDE81-1 or JDG820 Flywheel Turning Tool.

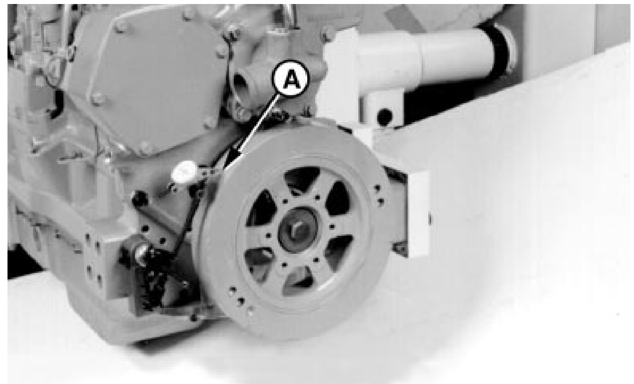
5. Note total dial indicator movement. Compare reading with specification below.

Specification

Vibration Damper—Maximum
Radial Runout... 1.02 mm (0.040 in.)

If runout exceeds specifications, replace vibration damper. See REMOVE CRANKSHAFT VIBRATION DAMPER later in this group.

A—Preloaded Probe



RG7065 –UN–26NOV97

Measuring Runout of Single Damper


RG7370 –UN–05JAN98

Measuring Runout of Dual Damper

DPSG,OUOE003,28 –19–17DEC98–2/2

Check Crankshaft End Play

1. Completely engage then release the clutch lever.

2. Place a dial indicator on damper face.

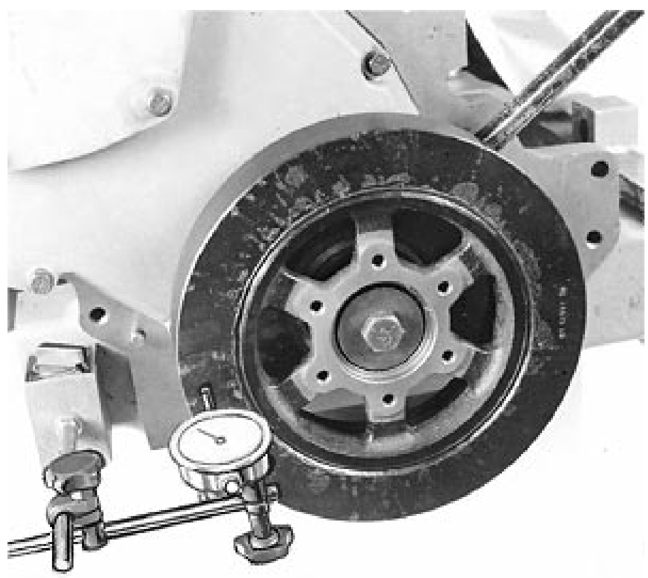
IMPORTANT: Use care not to damage or distort the timing gear cover or bearing inserts when prying. Do not pry on outer inertia ring of damper.

3. Pry with flat bar between the damper pulley and timing gear cover.

Specification

Crankshaft—End Play .... 0.038—0.380 mm (0.0015—0.0150 in.)

NOTE: New thrust bearings will usually restore proper end play.


RG5934 –UN–28AUG91

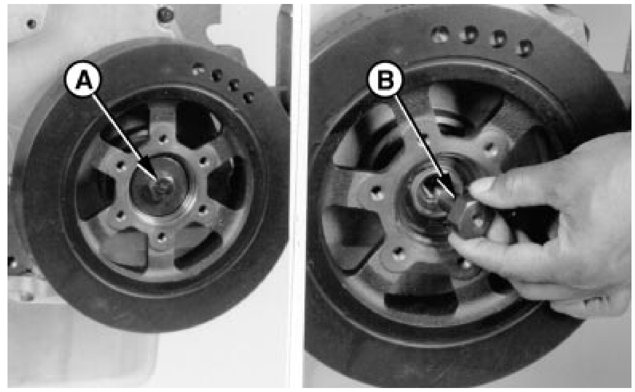
Checking Crankshaft End Play

RG,RG34710,1153 –19–23OCT97–1/1

Remove Crankshaft Vibration Damper

IMPORTANT: DO NOT use a jaw-type puller to remove vibration damper. Damage could result to the damper. Never apply thrust on outer ring of damper. Do not drop or hammer on damper.

1. Remove pulley from damper, if equipped (shown removed).
2. Remove cap screw (A) and washer securing damper to crankshaft.
3. Install JDG787 Thread Protector (B) in nose of crankshaft.



Preparing to Remove Crankshaft Vibration Damper

A—Cap Screw
B—Thread Protector

RG,RG34710,1154 –19–23OCT97–1/2

CAUTION: Plan a safe handling procedure to avoid personal injury or damage to damper.

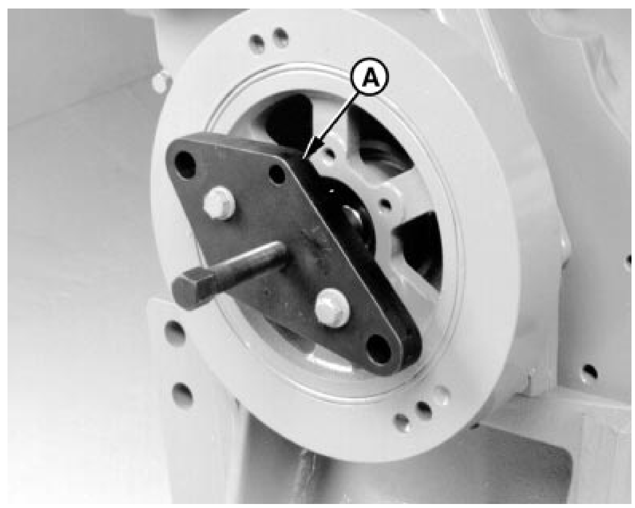
4. Remove damper from crankshaft using JDG721 Hub Puller (A).

NOTE: D01207AA (OTC518) Puller Set (not shown) may also be used to remove damper.

5. Check crankshaft pulley ID and crankshaft OD for pulley.

Specification

Crankshaft Pulley—ID	47.594—47.630 mm (1.8738—1.8752 in.)
Crankshaft—OD for Front Pulley	47.650—47.676 mm (1.8759—1.8770 in.)



Removing Crankshaft Vibration Damper

A—JDG721 Hub Puller

RG,RG34710,1154 –19–23OCT97–2/2

Remove Crankshaft Front Oil Seal and Wear Sleeve

IMPORTANT: Whenever front oil seal is replaced, the wear sleeve must also be replaced.

NOTE: If timing gear cover is going to be removed from engine, remove front seal and wear sleeve after timing gear cover is removed.

To Remove Front Oil Seal:

1. Check oil seal and wear sleeve for wear, damage, or leakage.

2. Center punch seal casing at 12 O'clock position.

RG6471 –UN–05DEC97

Center Punching Front Oil Seal Casing

RG,RG34710,1155 –19–23OCT97–1/5

3. Drill 3.175 mm (1/8 in.) hole in casing.

RG6472 –UN–05DEC97

Drilling Hole in Front Oil Seal Casing

RG,RG34710,1155 –19–23OCT97–2/5

4. Using JDG719 Seal Puller along with JDE38-2 Shank, JDE38-3 Hammer, and metal screw, remove seal.

5. Remove keyway from keyslot of crankshaft.

RG6473 –UN–05DEC97

Removing Front Oil Seal

Continued on next page

RG,RG34710,1155 –19–23OCT97–3/5

To Remove Wear Sleeve Using JDG786:

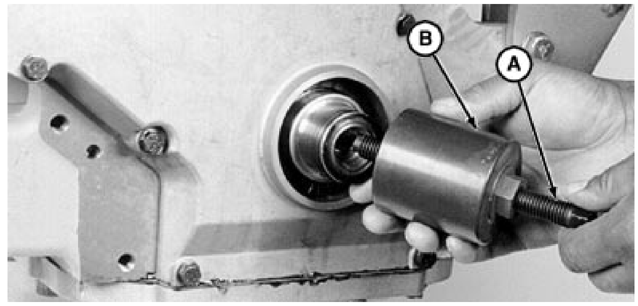
1. Start fully threaded centering screw (A) through hex head end of puller (B) from JDG786 Front Wear Sleeve Puller until head of screw is approximately 1/2 in. from hex on puller.

2. Thread centering screw into nose of crankshaft until it bottoms. Back screw out one full turn after it bottoms.

3. Tighten puller until it is securely threaded onto wear sleeve. Back centering screw out one full turn and tighten threaded puller onto wear sleeve again.

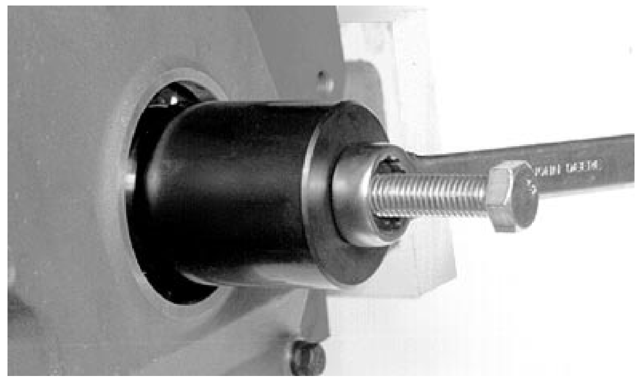
4. Remove centering screw from nose of crankshaft and puller.

A—Centering Screw
B—Hex End of Puller



RG6753 –UN–05DEC97

Assembling Puller to Remove Front Wear Sleeve



RG7728 –UN–05DEC97

Installing Puller to Remove Front Wear Sleeve

RG,RG34710,1155 –19–23OCT97–4/5

5. Install partially threaded forcing screw (A) into puller and tighten until bottoms in nose of crankshaft. There in no thread engagement in crankshaft; just with puller.

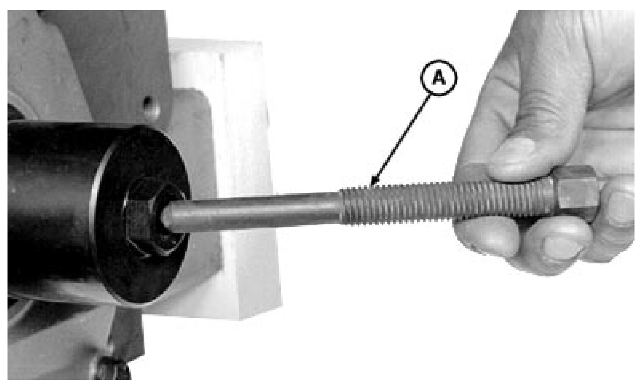
6. Continue to tighten forcing screw until puller and wear sleeve are free from crankshaft flange.

7. Inspect crankshaft flange for nicks or burrs. Clean up flange with a light file and emery cloth.

8. Measure front oil seal bore runout in timing gear cover and compare to the following specifications.

Specification

Crankshaft Front Oil Seal Bore in
Timing Gear Cover—Maximum
Radial Runout.. 0.254 mm (0.010 in.) Maximum



RG7729 –UN–05DEC97

Removing Front Wear Sleeve

A—Forcing Screw

RG,RG34710,1155 –19–23OCT97–5/5

Remove and Install Timing Gear Cover—Engine Installed in Vehicle (8000 Series Tractors)

6081HRW Engines on 8100, 8200, 8300, and 8400 tractors are equipped with front frame/oil sump. Refer to TM1575 (8100, 8200, 8300, and 8400 Tractors—Repair) for access to front frame/oil sump-to-engine block cap screws. (For 8000T Tracks tractors, refer to TM1621.)

To Remove Timing Gear Cover:

1. Remove viscous fan drive, drive housing, and coupler. (Refer to TM1575.)
2. Remove crankshaft vibration damper as detailed earlier in this group.
3. Disconnect coolant piping and remove coolant pump cover with coolant bypass tube. Remove and discard gaskets.
4. Back out all front frame/oil sump-to-engine block cap screws 9.5 mm (3.8 in.).
5. Disconnect engine speed sensor connector from sensor.
6. Remove injection pump drive gear cover.
7. Slowly lift engine block assembly approximately 6.4 mm (0.25 in.) using safety approved lifting equipment.

IMPORTANT: The timing gear cover must not be “dragged” horizontally while in contact with front frame/oil sump gasket. Doing so may damage gasket sealing bead.

8. Remove remaining cap screws and carefully remove timing gear cover with coolant pump. Remove and discard timing gear cover gasket.
9. Remove front oil seal from timing gear cover and discard seal.
10. Remove front wear sleeve from crankshaft flange and discard sleeve.

To Install Timing Gear Cover:

1. Thoroughly clean all timing gear cover gasket surfaces and front oil seal bore.

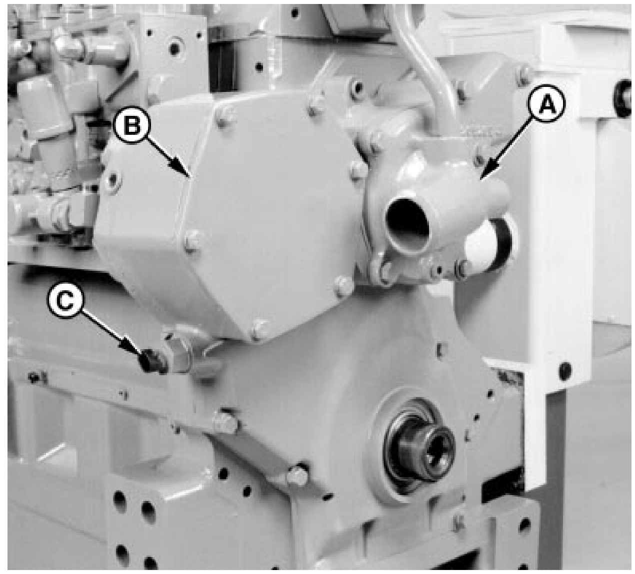
NOTE: Front wear sleeve can be installed with timing gear cover removed or installed.

2. Install a new front wear sleeve on crankshaft flange. See INSTALL FRONT WEAR SLEEVE later in this group.
3. Install timing gear cover. See INSTALL TIMING GEAR COVER later in this group.
4. Install front oil seal. See INSTALL CRANKSHAFT FRONT OIL SEAL earlier in this group.
5. Install vibration damper. See INSTALL VIBRATION DAMPER later in this group.
6. Tighten front frame/oil sump cap screws. See TIGHTEN CAP SCREWS ON FRONT FRAME/OIL SUMP in Group 060 or TM1575.
7. Complete final assembly as outlined in TM1575.

RG,RG34710,1156 –19–23OCT97–1/1

Remove Timing Gear Cover—Engine Removed

1. Remove engine oil pan. Remove engine oil pump assembly if crankshaft is to be removed.
2. Disconnect engine speed sensor connector (shown disconnected) from sensor (C).
3. Remove injection pump drive gear cover (B).
4. Disconnect coolant piping and remove coolant pump cover (A) with coolant bypass tube. Remove and discard gaskets.
5. Remove front auxiliary drive assembly, if equipped. See REMOVE, INSPECT AND INSTALL CRANKSHAFT GEAR-DRIVEN AUXILIARY DRIVE in Group 050.
6. Remove remaining cap screws and remove timing gear cover with coolant pump. Remove and discard gasket.
7. Remove front oil seal from timing gear cover and discard seal.
8. Remove front wear sleeve from crankshaft flange and discard sleeve.



RG7210 –UN–26NOV97

Removing Timing Gear Cover

A—Coolant Pump Cover
B—Injection Pump Drive Gear Cover
C—Sensor

RG,RG34710,1157 –19–23OCT97–1/1

Inspect and Measure Flywheel

1. Inspect the clutch contact face for scoring, overheating, or cracks. Replace flywheel if defective.

2. Examine flywheel ring gear for worn or broken teeth. Replace ring gear if defective, as described later in this group.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel or housing face.

3. Measure flywheel housing face run-out, flywheel face flatness, and pilot bearing bore concentricity, as outlined later in this group. Resurface flywheel face or replace as required.

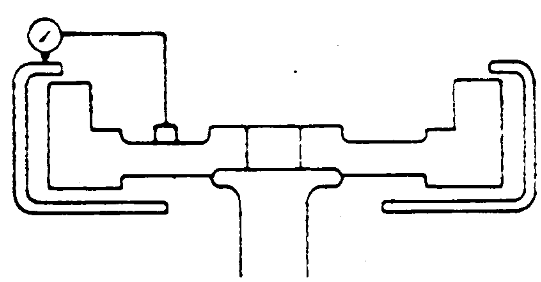
RG,RG34710,1158 –19–23OCT97–1/1

Check Flywheel Housing Face Runout

1. Mount dial indicator on flywheel. Set pointer to contact PTO mounting surface on flywheel housing at right angles. 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.



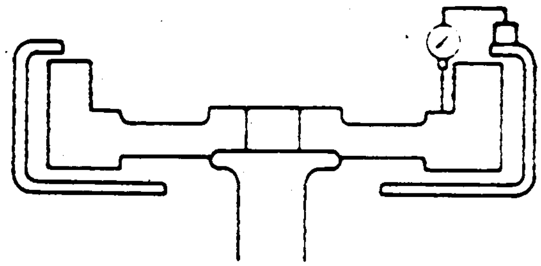
Checking Flywheel Housing Face Runout

Specification

Flywheel Housing Face—Runout.............. 0.20 mm (0.008 in.) Maximum Variation

RG,RG34710,1159 –19–23OCT97–1/1

Check Flywheel Face Flatness


R22213 –UN–14DEC88

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 runout.

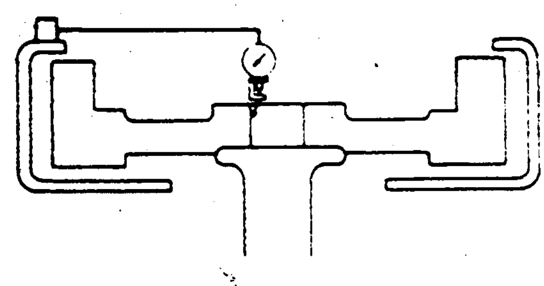
2. Rotate flywheel by turning crankshaft. Read total dial indicator movement. Resurface flywheel face or replace as required.

Specification

Flywheel Face—Flatness .... 0.23 mm (0.009 in.) Maximum Variation
Flatness .... 0.013 mm (0.0005 in.) Maximum Variation per 25 mm (1.0 in.) of Travel

RG,RG34710,1160 –19–23OCT97–1/1

Check Pilot Bearing Bore Concentricity


R22214 –UN–14DEC88

Checking Flywheel Pilot Bearing Bore

1. Mount dial indicator on flywheel housing face and position pointer to contact I.D. of pilot bearing bore in flywheel.

2. Rotate flywheel by turning crankshaft. Read total dial indicator movement.

Specification

Flywheel Pilot Bearing Bore—
Concentricity .... 0.127 mm (0.005 in.) Maximum Variation

RG,RG34710,1161 –19–23OCT97–1/1

Remove Flywheel

CAUTION: Flywheel is heavy. Plan a proper lifting procedure to avoid injury.

NOTE: SAE 1 flywheel housings MUST BE removed before flywheel can be removed from engine. See REMOVE SAE 1 FLYWHEEL HOUSING, later in this group.

1. Remove two flywheel attaching cap screws (A), and install two pilot studs in their place.

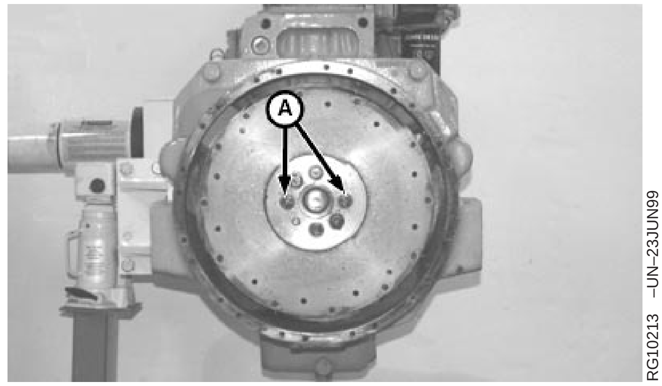
2. Remove remaining cap screws, remove drive hub (if equipped), and carefully pull flywheel from crankshaft.

3. Check condition of dowel pin in crankshaft rear flange. Dowel pin must not be cracked or chipped. Measure protrusion of dowel pin from face of flange. If dowel pin is damaged, or protrusion is not within specifications, replace dowel pin.

NOTE: When replacing dowel pin, crankshaft must be removed to prevent damage to crankshaft thrust bearings.

Specification

Crankshaft Dowel Pin—Protrusion.......... 13.5—14.5 mm (0.53—0.57 in.) From Crankshaft Rear Flange



Removing Flywheel

A—Cap Screws

RG,RG34710,1162 –19–10JUN99–1/1

Remove SAE 1 Flywheel Housing

CAUTION: Flywheel housing is heavy. Plan a proper lifting procedure to avoid injury.

1. Remove attaching cap screws.

2. Remove flywheel housing.

3. Inspect mounting holes in flywheel housing for thread damage.

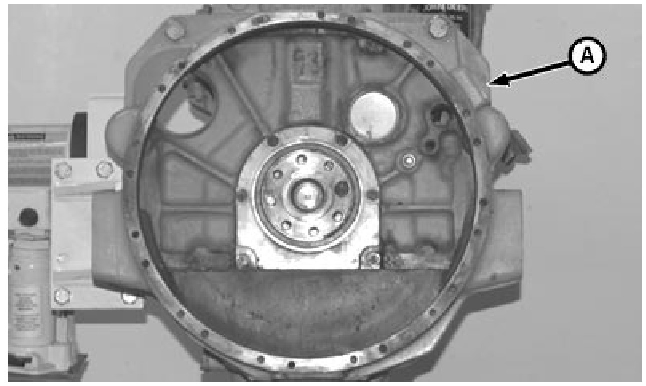
RG,RG34710,1163 –19–23OCT97–1/1

Remove SAE 2 and 3 Flywheel Housing

CAUTION: Flywheel housing (A) is heavy. Plan a proper lifting procedure to avoid injury.

NOTE: The flywheel MUST be removed before removing SAE 2 or 3 flywheel housings. See REMOVE FLYWHEEL earlier in this group.

1. Remove flywheel housing attaching cap screws.
2. Remove flywheel housing.
3. Inspect mounting holes in flywheel housing for thread damage.



RG10214 –UN–23JUN99

Removing Flywheel Housing

A—Flywheel Housing

RG,RG34710,1164 –19–23OCT97–1/1

Replace Flywheel Ring Gear

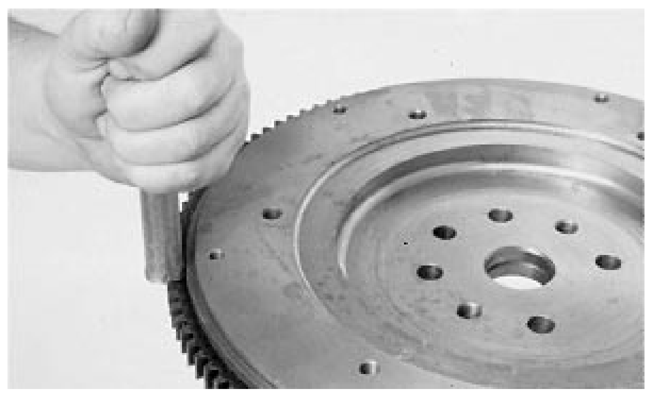
CAUTION: Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer and do not exceed 182°C (360°F). Do not allow a flame or heating element to be in direct contact with the oil. Heat the oil in a well ventilated area. Plan a safe handling procedure to avoid burns.

1. If ring gear is damaged, place the flywheel on a solid flat surface.
2. Remove ring gear with a brass drift and hammer.

IMPORTANT: If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT. Overheating may destroy original heat treatment of gear. SEE CAUTION.

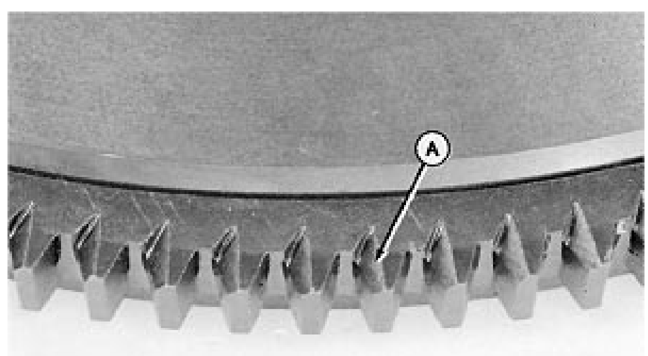
3. Heat new ring gear to 148°C (300°F) using either heated oil, oven heat, or flame heat.
4. Install ring gear against shoulder of flywheel so chamfered side (A) is on engine side of flywheel.

A—Chamfered Side



T90596 –UN–14OCT88

Removing Flywheel Ring Gear



RG3838 –UN–14OCT88

Installing Flywheel Ring Gear

RG,RG34710,1165 –19–23OCT97–1/1

Remove and Install Rear Oil Seal Housing—Engine Installed in Vehicle (8000 Series Tractors)

IMPORTANT: Remove rear oil seal housing for replacement purposes only. It is not necessary to remove seal housing for rear seal and wear sleeve replacement.

6081HRW engines used in 8100, 8200, 8300 and 8400 tractors are equipped with front frame/oil sump. Refer to TM1575 (8100, 8200, 8300, and 8400 Tractors—Repair) for access to front frame/oil sump-to-engine block cap screws. (For 8000T Tracks tractors, refer to TM1621.)

To Remove Rear Oil Seal Housing:

NOTE: Refer to TM1575 for access to rear crankshaft seal housing area.

1. Remove flywheel cover.
2. Remove transmission input shaft coupler bolts and pry coupler rearward.

NOTE: Use a set screw to separate damper from flywheel, if necessary.

3. Remove torsional damper from flywheel.
4. Remove flywheel from right side of tractor.
5. Back out all front frame/oil sump-to-engine block cap screws 9.5 mm (0.38 in.).
6. Slowly lift engine block assembly approximately 6.4 mm (0.25 in.) using safety approved lifting equipment.

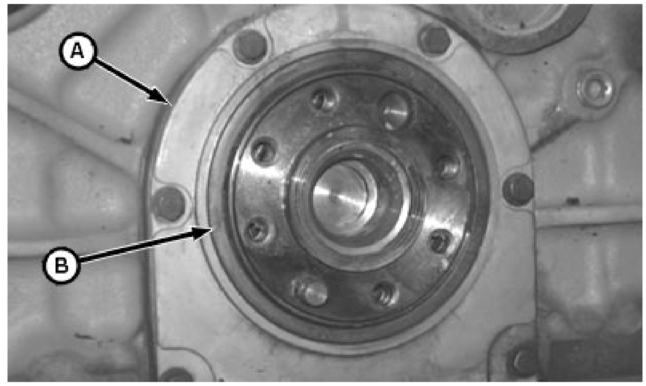
IMPORTANT: The rear oil seal housing must not be “dragged” horizontally while in contact with front frame/oil sump gasket. Doing so may damage gasket sealing bead.

7. Remove rear oil seal housing (A).
8. Remove rear wear sleeve from crankshaft flange with JDG790 Wear Sleeve Puller Kit as detailed earlier in this group. Clean flange with emery cloth.

To Install Rear Oil Seal Housing:

1. Install rear oil seal housing and check runout. See INSTALL CRANKSHAFT REAR OIL SEAL HOUSING and see CHECK CRANKSHAFT REAR OIL SEAL HOUSING RUNOUT, later in this group.)
2. Carefully lower engine onto locating dowels of front frame/oil sump.
3. Tighten front frame/oil sump cap screws. See TIGHTEN CAP SCREWS ON FRONT FRAME/OIL SUMP in Group 060 or TM1575.
4. Install a new rear oil seal and wear sleeve assembly. See INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE, later in this group.)
5. Install flywheel. See INSTALL FLYWHEEL later in this group.
6. Install torsional damper onto flywheel. (See TM1575.)
7. Pull transmission input shaft coupler forward, install cap screws and tighten to specified torque. (See TM1575.)
8. Install flywheel cover. (See TM1575.)
9. Start engine and check for leaks.

Remove Rear Oil Seal Housing—Engine Removed



Removing Rear Oil Seal Housing

A—Rear Oil Seal Housing
B—Rear Oil Seal

1. Remove flywheel. See REMOVE FLYWHEEL in this group.

2. Remove engine oil pan. See REMOVE OIL PAN in Group 060.

3. Remove rear oil seal housing (A).

IMPORTANT: Whenever rear oil seal is replaced, also replace rear wear sleeve as a matched assembly.

4. Rear oil seal (B) will come off with housing. Use a small punch and hammer to remove oil seal from housing. Discard seal.

IMPORTANT: The preferred method of removing the rear wear sleeve is with JDG790 Rear Wear Sleeve Puller. If removing wear sleeve with a chisel, DO NOT gouge crankshaft flange. Nicks or burrs should be removed with a medium-grit stone. A polishing cloth (180-grit or finer) may also be used when a stone is not available.

5. Remove rear wear sleeve from crankshaft flange.

Crankshaft rear wear sleeve can be removed using one of the following procedures. However, the preferred method is using JDG790 Wear Sleeve Puller Kit.

- Use JDG790 Wear Sleeve Puller to remove wear sleeve from crankshaft flange, as described earlier in this group. See REMOVE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE in this group.
- Use the ball side of a ballpeen hammer and tap wear sleeve across its width in a straight line (to deform and stretch sleeve).
- Score the wear sleeve in several places around O.D. (but do not cut) with a blunt chisel.

Remove wear sleeve from crankshaft flange. Clean flange with a light file and emery cloth.

RG,RG34710,1167 –19–10JUN99–1/1

Remove Main Bearing Caps

IMPORTANT: Before removing main bearing caps (A), 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 bosses. Keep matched main bearings with their respective main bearing cap for comparison with crankshaft journal (surface wear) from which removed.

If arrows are stamped on main bearing caps, note direction arrows are pointing to aid in reassembly.

NOTE: When removing main bearings and caps, leave No. 1 and 7 main bearing caps installed until all of the connecting rod caps have been removed.

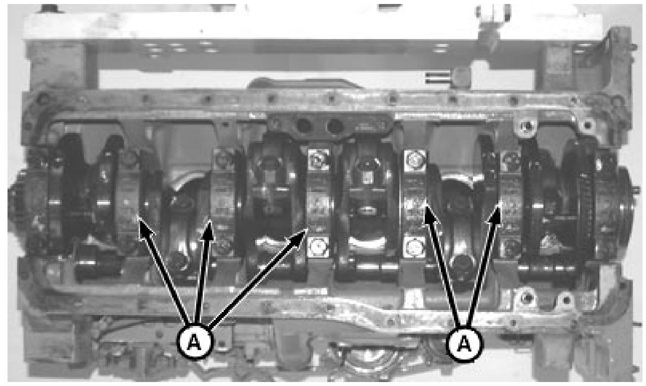
1. Remove main bearing cap screws.

2. Install JDG1069 Puller (B) so that tips (C) of blind hole puller legs are below bearing cap half.

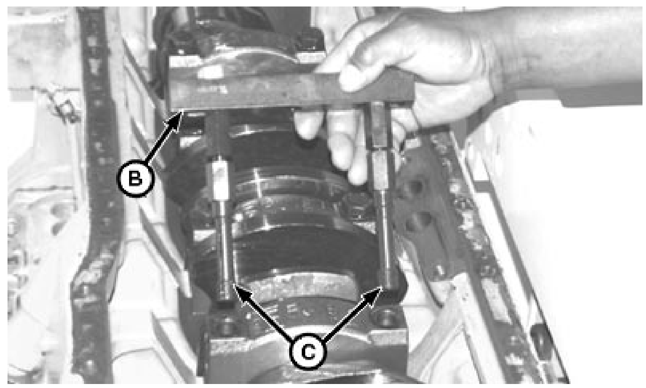
3. Tighten hex of actuator pin securely while holding collet portion of puller leg with second wrench.

4. Tighten both cap screws (D) on cross block finger tight.

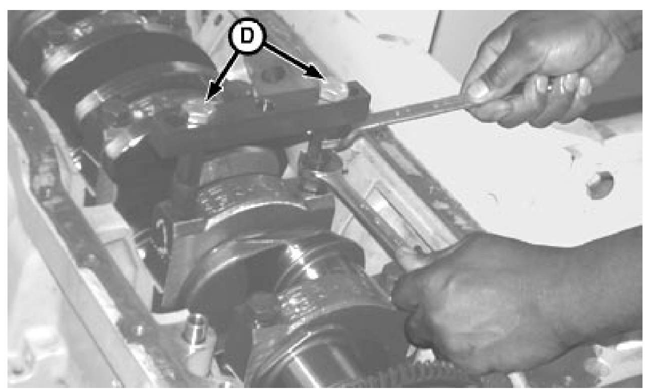
A—Main Bearing Caps
B—Puller
C—Tips
D—Cap Screws



Checking Torques Before Removing Main Bearing Caps



Installing Main Bearing Cap Puller



Tightening Main Bearing Cap Puller

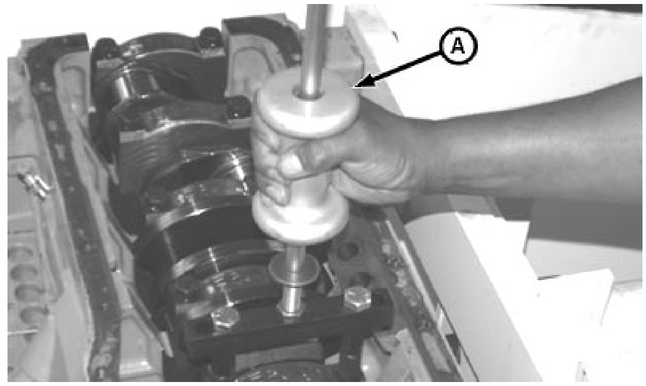
Continued on next page RG,RG34710,1168 –19–10JUN99–1/2

5. Attach D01300AA Slide Hammer (A) to cross block, tighten nut securely.

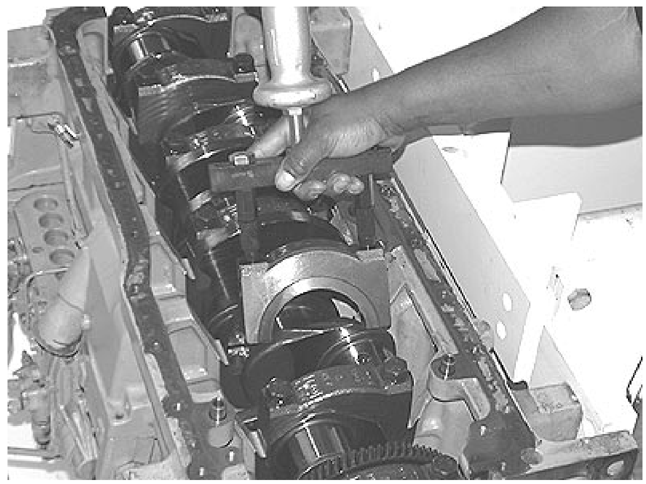
6. Remove main bearing cap by sliding up on hammer weight.

7. Use PLASTIGAGE® to measure journal-to-bearing oil clearance on each main bearing as they are removed. See CHECK MAIN BEARING OIL CLEARANCE later in this group.

A—Slide Hammer



Using Slide Hammer to Loosen Bearing Cap



Removing Main Bearing Cap

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RG,RG34710,1168 –19–10JUN99–2/2

Check Main Bearing Oil Clearance

The use of PLASTIGAGE® will determine bearing-to-journal wear (oil clearance) but will not determine condition of the bearing or journal surfaces.

1. Place a strip of PLASTIGAGE® in the center of the main bearing cap (with insert) about three-fourths of the width of the bearing.

2. Use oil (SAE30) on PLASTIGAGE® to prevent smearing.

3. Install cap and tighten to specifications.

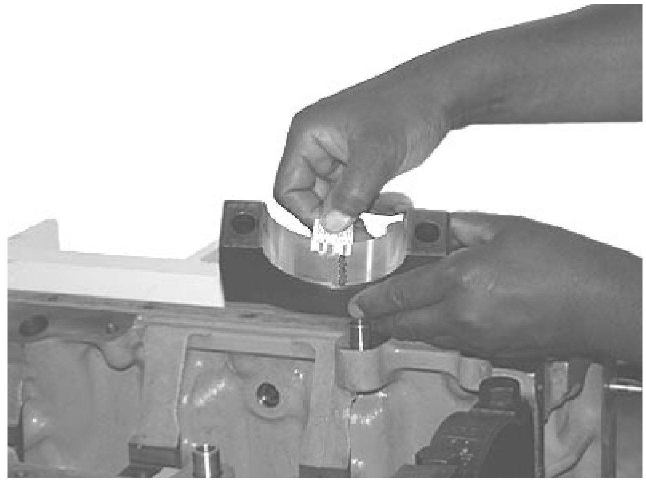
Specification

Main Bearing Caps—Torque....................................... 230 N•m (170 lb-ft)

4. Remove cap and compare width of PLASTIGAGE® with scale provided on wrapper to determine oil clearance.

Specification

Crankshaft Main
Bearing-to-Journal—Oil
Clearance .... 0.030—0.107 mm
(0.0012—0.0042 in.)


RG10237 –UN–24JUN99

Checking Main Bearing Oil Clearance

PLASTIGAGE is a registered trademark of DANA Corp.

RG,RG34710,1169 –19–24JUN99–1/1

Remove Connecting Rod Caps and Remove Crankshaft

1. Rotate crankshaft using JDG820 or JDE81-1 Flywheel Turning Tool until connecting rod caps can be removed easily. You will be able to remove rod caps at each position.

2. Remove all connecting rod caps (A) with bearings (B), then remove No. 1 and 7 main bearing caps and bearings. See REMOVE PISTONS AND CONNECTING ROD ASSEMBLIES in Group 030.

CAUTION: Crankshaft is very heavy. Plan a proper handling procedure to avoid injury.

NOTE: Install a screw on each end of crankshaft to aid in lifting crankshaft.

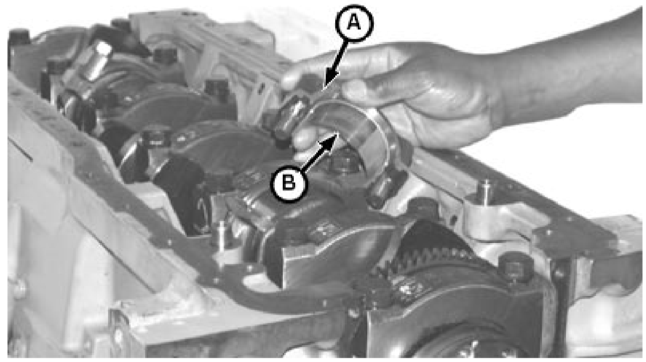
3. Install a cap screw in each end of crankshaft and attach a lifting strap to crankshaft as shown. Using proper lifting equipment, carefully raise crankshaft out of cylinder block.

4. Clean crankshaft, especially oil passages, using solvent and compressed sir.

5. Put crankshaft on clean V-blocks.

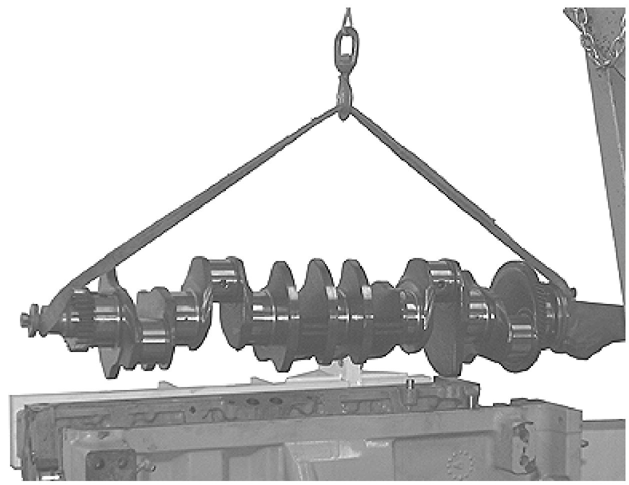
6. Remove rear wear sleeve from crankshaft flange, if not previously done, using one of the following methods:

    - Use JDG790 Wear Sleeve Puller to remove wear sleeve from crankshaft, as described earlier in this group. Position crankshaft rod journals in V-blocks so that crankshaft does not rotate while removing wear sleeve.
    - Use the ball side of a ballpeen hammer and tap wear sleeve across its width in a straight line (to deform and stretch sleeve).
    - Score (but do not cut) the wear sleeve in several places around O.D. with a blunt chisel.



RG10209 –UN–18JUN99

Removing Connecting Rod Caps



RG10222 –UN–18JUN99

Removing Crankshaft

A—Connecting Rod Caps
B—Bearing

RG,RG34710,1170 –19–10JUN99–1/1

Inspect Crankshaft

NOTE: If crankshaft damper damage was discovered during teardown, the crankshaft should be magna-fluxed. This will verify whether of not it has microscopic cracks or fissures. See INSPECT VIBRATION DAMPER, in this group.

1. Thoroughly clean crankshaft. Clear restrictions from all oil passages.

2. Inspect crankshaft for signs of load stress, cracks, 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.

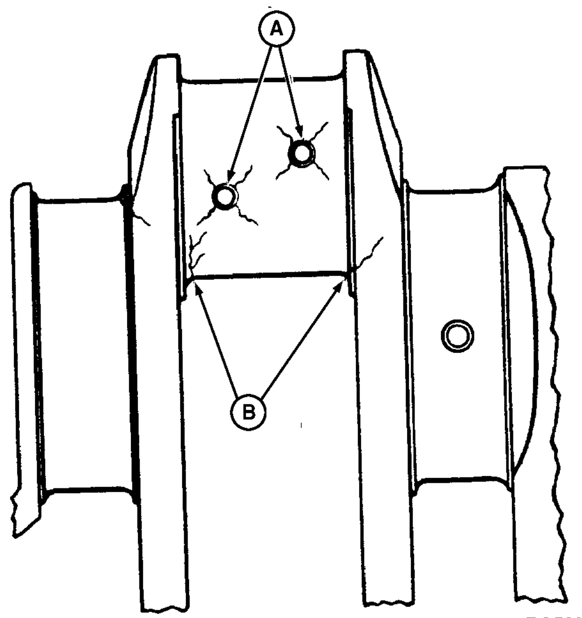
3. Inspect (front) crankshaft gear and (rear) oil pump drive gear for cracks, chipped teeth, or excessive wear. Replace gear(s) as required. See REPLACE CRANKSHAFT GEAR and REPLACE (CRANKSHAFT) OIL PUMP DRIVE GEAR, later in this group.

4. Inspect the keyway for evidence of cracks or wear. Replace crankshaft as necessary.

5. Carefully inspect rear hub of crankshaft in area of wear sleeve contact surface for evidence of rough or grooved condition. Any imperfections here will result in oil leaks. Slight ridges may be cleaned up with emery or crocus cloths.

6. Check each journal for evidence of excessive overheating or discoloration. If either condition exists, replace crankshaft since heat treatment has probably been destroyed.

7. Carefully check the crankshaft for cracks in the area of rod journal holes (A) and at journal fillets (B). Replace crankshaft if any cracks are found.



Inspecting Crankshaft

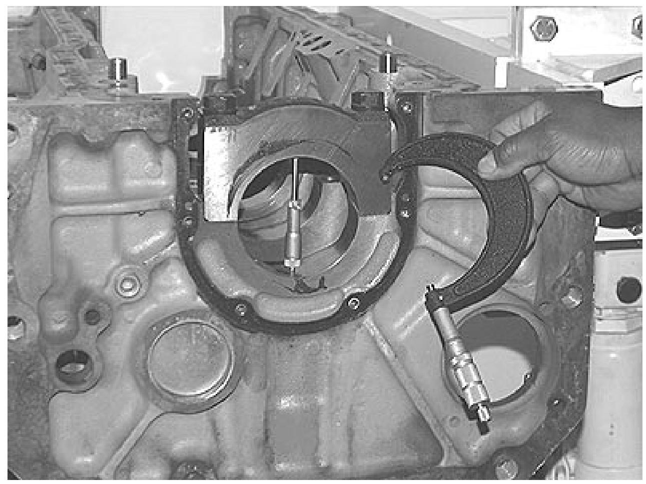
A—Rod Journal Holes
B—Journal Fillets

Continued on next page RG,RG34710,1171 –19–23OCT97–1/2

IMPORTANT: Small cracks may not be visible to the eye. Use a method such as the Fluorescent Magnetic Particle method. This method magnetizes the crank, using magnetic particles which are fluorescent and glow under 'black light'. The crankshaft must be de-magnetized after inspection.

RG,RG34710,1171 –19–23OCT97–2/2

Measure Assembled I.D. of Bearings and O.D. of Crankshaft Journals


RG10223 –UN–18JUN99

Measuring Main Bearings

NOTE: Also inspect and measure assembled I.D. of connecting rod bearings. Compare measurements with connecting rod journal O.D. on crankshaft. See INSPECT AND MEASURE CONNECTING ROD BEARINGS in Group 030.

1. With crankshaft removed from engine, install main bearing caps with bearing inserts. Be sure inserts are installed correctly.

2. Tighten main bearing cap screws to specifications.

Specification

Crankshaft Main Bearing Cap
Screws—Torque .... 230 N•m (170 lb-ft)

3. Measure I.D. of all assembled bearings in four locations 90° apart with an inside micrometer. Compare measurements with the following specifications.

Specification

Crankshaft Main Bearing—ID
With Bearing .... 95.270—95.320 mm (3.7508—3.7528 in.)
ID Without Bearing .... 101.651—101.677 mm (4.0020—4.0030 in.)

Continued on next page RG,RG34710,1172 –19–10JUN99–1/2

4. Measure O.D. of all respective crankshaft main journals in four locations 90° apart. Compare measurements with the following specifications.

Specification

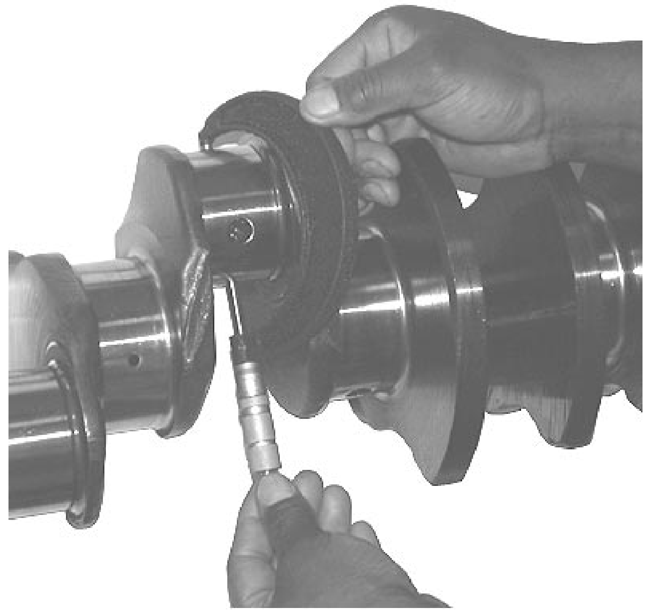
Crankshaft Main Journal—OD .... 95.196—95.222 mm (3.7479—3.7490 in.)

NOTE: If engine has previously had a major overhaul and undersized bearing inserts were used, I.D. and O.D. dimensions may not be the same as those recorded. However, oil clearance must be 0.030—0.107 mm (0.0012-0.0042 in.). Replace bearings as needed.

Use crankshaft journal O.D. measurements to determine if journal is out-of-round or tapered.

Specification

Crankshaft Main Journal—Taper
per 25.4 mm (1.0 in.) length .... 0.0025 mm (0.0001 in.)
Out-of-Roundness .... 0.025 mm (0.0010 in.)

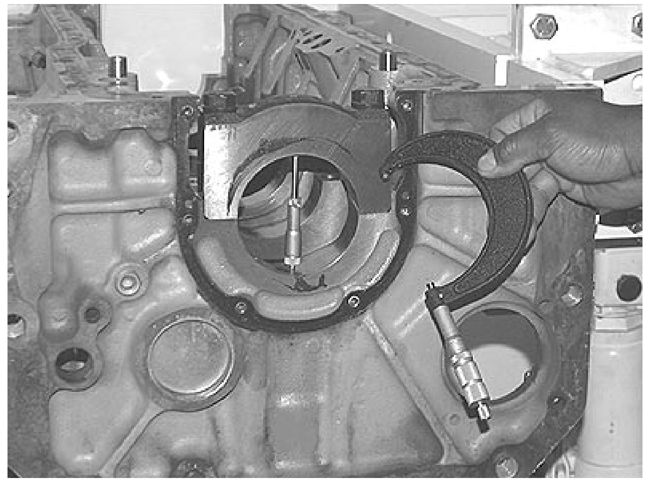


RG10224 –UN–18JUN99

Measuring Crankshaft Main Journals

RG,RG34710,1172 –19–10JUN99–2/2

Main Bearing Cap Line Bore Specifications



Measuring Main Bearing Cap Bores

If any main bearing cap assembled I.D. is not within specification, blank (generic) bearing caps are available and must be line bored to specification. Replace individual bearing caps as needed.

1. Measure main bearing cap surface width.

Specification
Crankshaft Main Bearing Cap—
Surface Width.. 36.28—36.78 mm (1.428—1.448 in.)

2. With crankshaft removed from cylinder block, install main bearing caps without bearing inserts.

3. Tighten main bearing cap screws to specifications.

Specification
Crankshaft Main Bearing Cap
Screws—Torque.. 230 N•m (170 lb-ft)

4. Measure I.D. of all bearing caps with an inside micrometer. Main bearing cap I.D. should be as follows:

Specification
Main Bearing Assembled ID—ID .... 95.270—95.320 mm (3.7508—3.7528 in.)

If any main bearing cap assembled I.D. is not within specification, blank (generic) bearing caps are available and must be line bored to finished specification. Replace individual bearing caps as needed.

Continued on next page RG,RG34710,1173 –19–10JUN99–1/2

IMPORTANT: Main bearing cap line boring should be done ONLY by experienced personnel on equipment capable of maintaining bore specifications.

Specification

Main Bearing Cap Bore—ID
Without Bearings (Standard)................................ 101.651—101.677 mm (4.0020—4.0030 in.)
Diameter Variation................................. 0.013 mm (0.0005 in.) maximum
Diameter Taper...................................... 0.008 mm (0.0003 in.) maximum
Straightness Variation (Any
Bore-to-Adjacent Bore).......................... 0.038 mm (0.0015 in.) maximum
Straightness Variation (5 Center
Bore-to-End Bore................................... 0.076 mm (0.0030 in.) maximum
Centerline of Bore-to-Top Deck .... 352.35—352.50 mm (13.872—13.878 in.)

RG,RG34710,1173 –19–10JUN99–2/2

Thrust Bearing New Part Specifications

IMPORTANT: Install thrust bearing in cylinder block and tighten to specification before regrinding or polishing thrust surfaces to assure that all surfaces on bearing and on block web are correctly aligned.

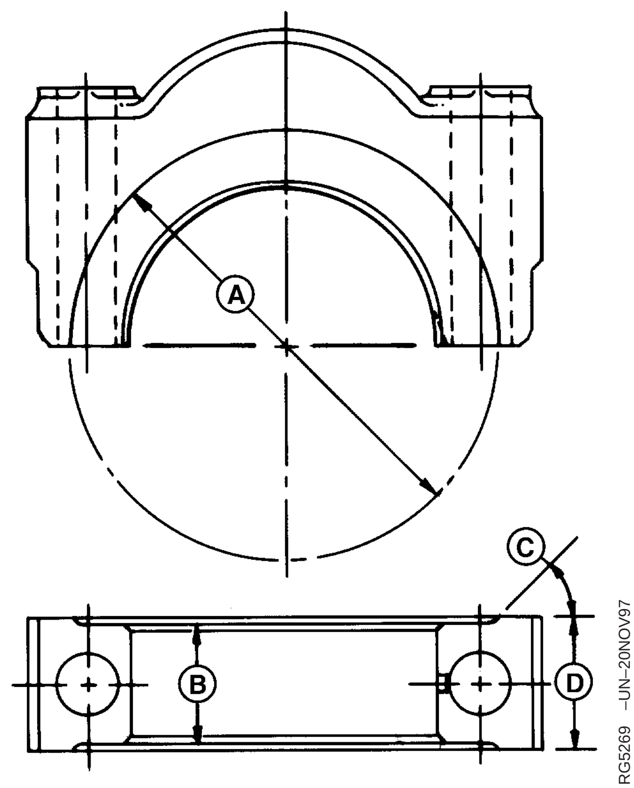
Specification

A—Thrust Washer Clearance[1]—
Base Circle OD .... 129.286—130.810 mm (5.09—5.15 in.)
B—Thrust Bearing Cap—Surface
Width... 37.44—37.54 mm (1.474—1.478 in.)
C—Thrust Washer Clearance—
Relief Angle .... 45°
D—Thrust Bearing Cap—Overall
Width (—1995) .... 41.81—42.31 mm (1.646—1.666 in.)
Overall Width (1995—)......................... 39.16—39.66 mm (1.542—1.561 in.)

Maximum runout for thrust surface is as follows:

Specification

Thrust Bearing Surface—
Maximum Runout .... 0.25 mm (0.0010 in.)



Thrust Bearing Measurements

A—Thrust Washer Clearance Base Circle
B—Thrust Surface Thickness
C—Relief Angle
D—Bearing Cap Overall Width

[1] *Thrust (washer) surfaces on bearing cap must be flat in respect to mating thrust (washer) surfaces in cylinder block.*

RG,RG34710,1174 –19–10JUN99–1/1

Crankshaft Grinding Guidelines

IMPORTANT: Crankshaft grinding should be done ONLY be experienced personnel on equipment capable of maintaining crankshaft size and finish specifications.

Crankshaft rod (pin) journals have an undercut fillet radius. DO NOT grind within this undercut area when undersize bearings are used.

In addition to the standard size main bearings, 0.292 mm (0.0115 in.) and 0.552 mm (0.0217 in.) undersize bearings are available for main bearing journals.

Specification	
Undersized Main Bearings Available—OD	0.292 mm (0.0115 in.) and 0.552 mm (0.0217 in.)

Rod (pin) journals have only 0.292 mm (0.0115 in.) undersize bearings only.

Specification	
Undersized Rod (Pin) Journal Bearings Available—OD	0.292 mm (0.0115 in.)

If journals are tapered, out-of-round, scored, or damaged, grind the crankshaft and install the proper undersize bearings.

IMPORTANT: 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.

If the crankshaft is to be reground, use the following recommended guidelines:

1. Compare the crankshaft journal measurements taken during inspection and determine the size to which the journals are to be reground.

2. Grind all main journals or all connecting rod journals to the same required size. See CRANKSHAFT GRINDING SPECIFICATIONS later in this group.

IMPORTANT: All main journal (tangential) fillets radii must be free of any sharp grind marks or scratches. The fillet must blend smoothly into the journal and crank cheek. Check the radii with a fillet gauge.

Care must be taken to avoid localized heating which often produces grinding cracks. Cool the crankshaft while grinding by using coolant generously. DO NOT crowd the grinding wheel into the work.

Grind crankshaft with journals turning counterclockwise, as viewed from the front end of the crankshaft. Lap or polish journals in opposite direction of grinding.

3. Polish or lap the ground surfaces to the specified finish to prevent excessive wear of the journals.

Continued on next page

DPSG,OUO1004,907 –19–16JUN99–1/2

NOTE: Production crankshafts are induction hardened and shotpeened at the factory. Field shotpeening is not recommended due to the equipment required and part geometry.

When thrust surfaces are reground and an oversized washer is 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.

4. 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 oversized thrust washer and two 0.18 mm (0.007 in.) oversized washers are available. See THRUST BEARING NEW PART SPECIFICATIONS earlier in this group.

Specification

Oversize Thrust Washer Available—OD	0.18 mm (0.007 in.)
Crankshaft—End Play	0.038—0.380 mm (0.0015—0.0150 in.)

5. Stone the edge of all oil holes in the journal surfaces smooth to provide a radius of approximately 1.50 mm (0.060 in.).

6. When finished grinding, inspect the crankshaft for cracks with the Fluorescent Magnetic Particle method, or similar method. De-magnetize crankshaft after inspection.

7. Thoroughly clean the crankshaft and oil passages with solvent. Dry with compressed air.

DPSG,OUO1004,907 –19–16JUN99–2/2

Crankshaft Grinding Specifications

Item	Measurement	Specification
Engine Stroke	Length	128.5 mm (5.059 in.)
Main and Rod Journal	Surface Finish	Lap 0.20 Um (8 AA)
Thrust Journal	Surface Finish	Lap 0.40 Um (16 AA)
Rod Journal (Undercut) Fillet	Radius	4.10—4.37 mm (0.158—0.172 in.)
Main Journal (Tangential) Fillet	Radius	3.94—4.44 mm (0.155—.0175 in.)
Thrust Journal (Tangential) Fillet	Radius	3.56—4.06 mm (0.140—0.160 in.)
Thrust Journal	Width	44.387—44.487 mm (1.7475—1.7515 in.)
Crankshaft Main Journal	Maximum Runout Relative to No. 1 and No. 7 Journals	0.13 mm (0.0051 in.)
Crankshaft Main Journal	Maximum Runout Between Adjacent Cylinders	0.06 mm (0.0024 in.)
Crankshaft Main Journal (Using Standard Bearings)	OD	95.201—95.227 mm (3.7480—3.7491 in.)
Crankshaft Rod Journal (Using Standard Bearings)	OD	76.149—76.175 mm (2.9980—2.9990 in.)
Crankshaft Main Journal (Using 0.292 mm (0.0115 in.) Undersize Bearings)	OD	94.909—94.935 mm (3.73666—3.7376 in.)
Crankshaft Rod Journal (Using 0.292 mm (0.0115 in.) Undersize Bearings)	OD	75.857—75.883 mm (2.9865—2.9875 in.)
Crankshaft Main Journal (Using 0.552 mm (0.0217 in.) Undersize Bearings)[1]	OD	94.649—94.675 mm (3.7263—3.7274 in.)

[1]0.552 mm (0.0217 in.) undersize bearing sizes are available for crankshaft main journals only.

RG,RG34710,1176 –19–23OCT97–1/1

Replace (Crankshaft) Oil Pump Drive Gear

IMPORTANT: Protect all machined surfaces of crankshaft from grinding debris and weld spatter when removing old gear and installing new gear. DO NOT use a cutting torch to remove failed gear.

1. Using a rotary grinding wheel or parting disc, grind weld beads (A) until flush with crankshaft flange.

2. Remove gear (B) by alternately striking gear at each weld location using a brass drift and soft lead mallet.

3. After removal of gear, clean up O.D. of crankshaft flange and remove any burrs or remaining weld bead to eliminate interference when installing new gear.

CAUTION: Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer and do not exceed 182°C (360°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.

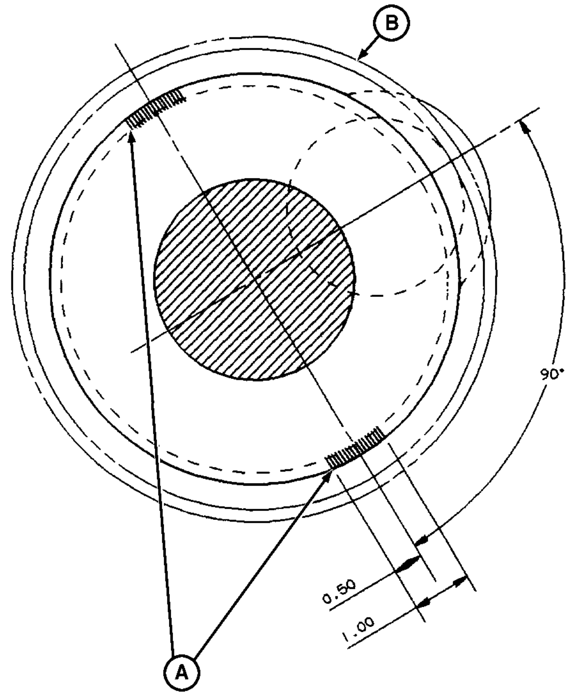
IMPORTANT: DO NOT OVERHEAT GEAR. SEE CAUTION. Overheating may also destroy original heat treatment of gear.

4. Heat crankshaft gear to 148°C (300°F) using either heated oil or oven heat.

5. Drive gear onto crankshaft flange until flush against shoulder.

NOTE: When driving oil pump onto crankshaft flange, the beveled edge of gear teeth should face the flywheel end of crankshaft.

6. Weld two 25.4 mm (1 in.) beads according to illustration using 1/8 in. diameter 7018 welding rod. Grind away excess weld to eliminate the possibility of interference with cylinder block.



RG5018 RG5018 –UN–05DEC97

Removing Crankshaft Oil Pump Drive Gear

A—Weld Beads
B—Gear

RG,RG34710,1177 –19–23OCT97–1/1

Replace Crankshaft Gear

NOTE: Remove crankshaft gear for replacement only; it is not necessary to remove gear for crankshaft removal.

1. Install JDG787 Thread Protector in nose of crankshaft.
2. Protect crankshaft wear sleeve surface with masking tape.
3. Remove crankshaft gear using D01251AA[1] Puller or an equivalent puller.
4. Discard gear after removal.
5. Remove Woodruff key from crankshaft keyway.
6. Remove masking tape.

CAUTION: Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer and do not exceed 182°C (360°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.

If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT. See CAUTION. Overheating may also destroy original heat treatment of gear.

7. Heat crankshaft gear (if removed) to 148°C (300°F), using either heated oil or oven heat.
8. Install Woodruff key in crankshaft.
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. Use JDH7 Driver to firmly seat gear against crankshaft flange.
11. Once gear cools, reseat gear using JDH7 Driver.

[1]Part of D01047AA 17-1/2 and 30-Ton Puller Set.

RG,RG34710,1178 –19–23OCT97–1/1

Inspect Thrust Bearings

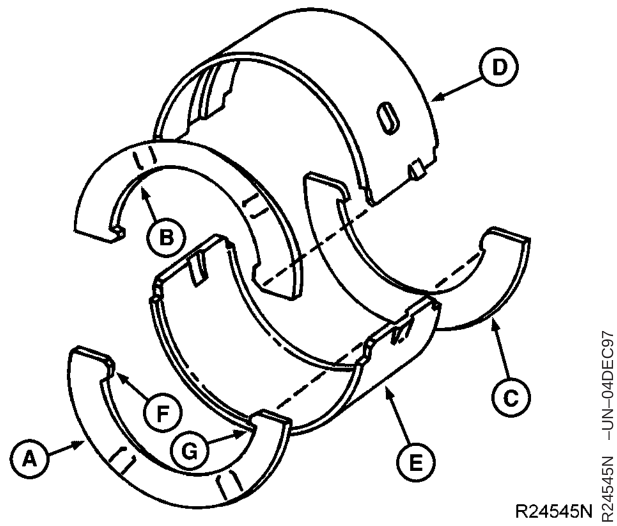
Check thrust surfaces of the thrust bearing and the thrust bearing journal on crankshaft and replace as necessary.

Thrust bearing are available in each of the previously mentioned insert undersizes. An oversized thrust washer set containing one regular size washer and two 0.18 mm (0.007 in.) oversized washers is also available.

Specification

Crankshaft Oversize Thrust
Washers Available—OD.. 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.



Crankshaft Main 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,RG34710,1179 –19–23OCT97–1/1

Remove and Clean Piston Cooling Orifices

1. Remove all six (four shown) piston cooling orifices (A) and inspect each cooling orifice to make sure it is not plugged or damaged.

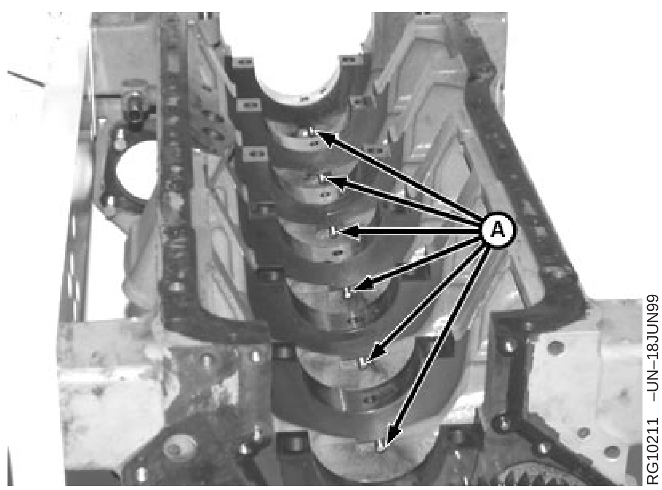
2. Use a soft wire and compressed air to clean orifice. Replace if condition is questionable.

IMPORTANT: A piston cooling orifice failure could cause damage to pistons, piston pins, rod pin bushings, and liners. If a piston cooling orifice is left out, low or no oil pressure will result.

3. Install orifices and tighten to specifications.

Specification

Piston Cooling Orifices into
Cylinder Block—Torque... 11 N•m (97 lb-in.)



Piston Cooling Orifices in Block

A—Piston Cooling Orifices

DPSG,OUO1004,893 –19–10JUN99–1/1

Install Main Bearings and Crankshaft

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:

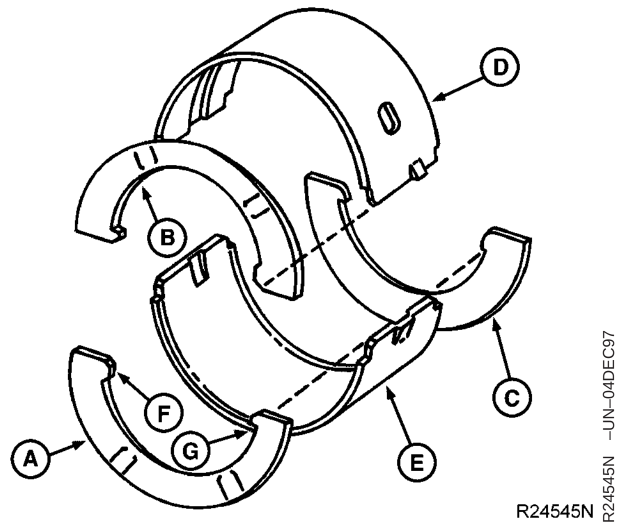
- All main bearing webs in block
- Both sides of main bearing inserts and thrust bearing inserts
- Entire O.D. of crankshaft main bearing journal

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, C) go on both sides of bearing cap. Thrust washer (B) goes on rear side 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.



No. 5 Main 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

Continued on next page RG,RG34710,1181 –19–10JUN99–1/3

CAUTION: Crankshaft is heavy. Plan a proper lifting procedure to avoid injuries.

4. Carefully position crankshaft onto main bearing inserts using a hoist and lift sling, as shown.

5. Dip entire main bearing cap screws in clean engine oil and position them in main bearing caps. Apply a liberal amount of oil to bearing inserts in caps.

6. Install each bearing cap (B), bearings (C), and cap screws with washer (A) with the recesses and tabs aligned in matching order. Make sure bearing tabs also match up before tightening cap screws.

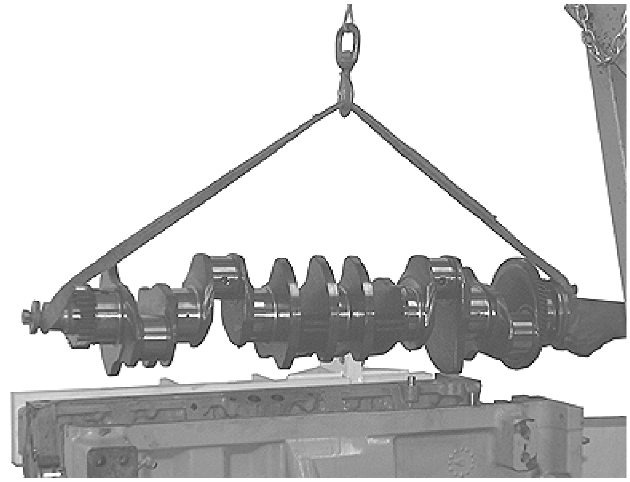
NOTE: *Make sure main bearing caps are installed on the bearing bosses from which they were removed. The numbers (D) stamped on the caps should be on the same side as the numbers on the block. Bearing caps on later engines have the numbers 1—7 stamped on top face and block castings have only the No. 1 and No. 7 cylinders stamped for reference.*

If there is an arrow (E) on cap, arrow is normally on the camshaft side of the block and should be pointing towards the front of the engine. On some engines, arrows on caps may be pointing towards the rear of the engine. Reinstall these caps with arrows pointing toward rear of engine. If bearing caps have been rebored, make sure bearing caps have numbers stamped on them.

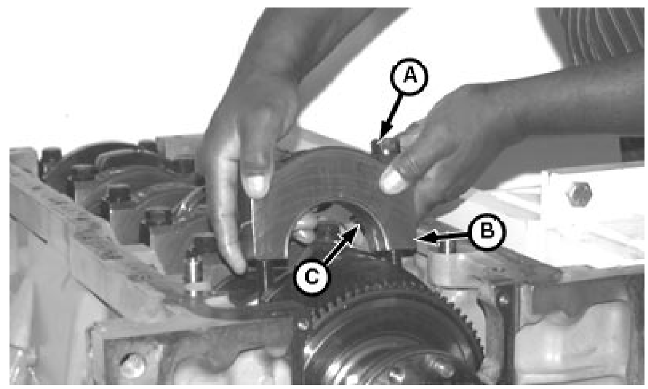
IMPORTANT: Do not use pneumatic wrench to install main bearing cap screws, as damage may occur to threads.

7. 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.

8. Tighten No.'s 1, 2, 3, 4, 6, and 7 main bearing cap screws to initial torque specifications.

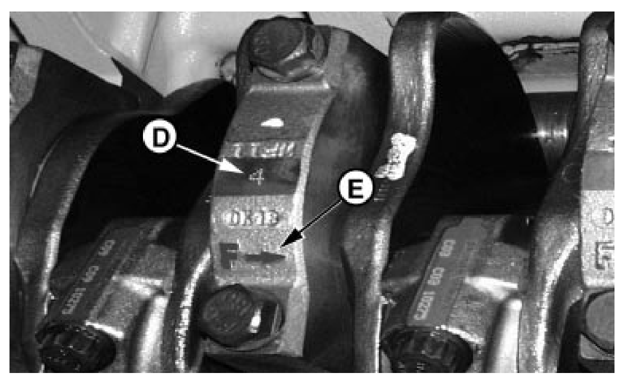

RG10222 –UN–18JUN99

Installing Crankshaft



RG10226 –UN–18JUN99

Installing Main Bearing Caps



RG11640 –UN–22DEC00

Stamped Main Bearing Cap

A—Cap Screw with Washer
B—Bearing Cap
C—Bearing
D—Stamped Cylinder Number
E—Stamped Arrow

Continued on next page

RG,RG34710,1181 –19–10JUN99–2/3

Specification

Crankshaft Main Bearing Cap Screws—Initial Torque .... 68 N•m (50 lb-ft)

Hand-tighten No. 5 main thrust bearing cap screws.

9. Gently pry crankshaft rearward and then forward to align thrust washers on No. 5 main thrust bearing.

NOTE: DO NOT PRY crankshaft on No. 5 main thrust bearing.

10. Tighten No. 5 main thrust bearing cap screws to specification above.

11. Tighten all main bearing cap screws (including No. 5) to final torque specification.

Specification

Crankshaft Main Bearing Cap Screws—Final Torque .... 230 N•m (170 lb-ft)

12. Turn crankshaft by hand. If it does not turn easily, disassemble parts and determine the cause.

13. Install connecting rod bearings and connecting rods caps. See INSTALL PISTON AND CONNECTING ROD in Group 030.

14. Check crankshaft for specified end play.

Specification

Crankshaft—End Play .... 0.038—0.380 mm (0.00150—0.0150 in.)

15. Install oil pump and check drive gear-to-crankshaft clearance. See INSTALL ENGINE OIL PUMP in Group 060.

Specification

Oil Pump Drive Gear-to-Crankshaft—Backlash Clearance .... 0.38 mm (0.015 in.)

RG,RG34710,1181 –19–10JUN99–3/3

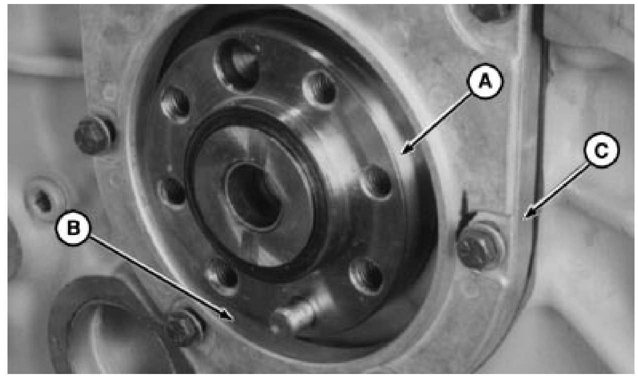
Install Crankshaft Rear Oil Seal Housing

NOTE: On engines with John Deere (Funk) rear PTO, see CTM67, OEM Engine Accessories for procedure to install rear oil seal housing.

These instructions are for when oil seal housing and oil pan have been removed from cylinder block.

1. Make sure the O.D. of crankshaft flange (A) and I.D. of seal housing (B) are free from nicks or burrs. Restore damaged surfaces with a fine file or emery cloth. Clean with compressed air.

2. Install oil seal housing (C) on cylinder block using a new gasket. Install all six cap screws with washers, using LOCTITE® 242 on threads. Tighten screws finger tight.



RG4637 –UN–05DEC97

Installing Crankshaft Rear Oil Seal Housing (Engine Shown Upside Down in Stand)

A—Crankshaft Flange
B—Oil Seal Housing ID
C—Oil Seal Housing

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Continued on next page

RG,RG34710,1182 –19–23OCT97–1/2

IMPORTANT: Alignment and installation tools must be clean to hold runout within specification and to assure proper positioning on crankshaft flange so oil seal does not fail prematurely.

3. Slip the JDG796 Alignment Tool (A) over crankshaft flange and into seal housing bore to center oil seal housing.

   The tool is designed to center the oil seal housing in relation to crankshaft flange. However, measuring the seal housing runout after installation with a magnetic base dial indicator is recommended. Runout should not exceed specification.

Specification

Crankshaft Rear Oil Seal Housing
ID—Maximum Runout .... 0.152 mm (0.006 in.)

4. Using a straightedge, position bottom of oil seal housing so it is recessed 0.000—0.050 mm (0.000—0.002 in.) inside cylinder block-oil pan rail.

Specification

Rear Oil Seal Housing-to-Oil Pan
Rail—Recess .... 0.000—0.050 mm (0.000—0.002 in.) Inside Block Oil Pan Rail

Tighten seal housing cap screws to specifications using sequence shown in bottom illustration, beginning with cap screw No. 1.

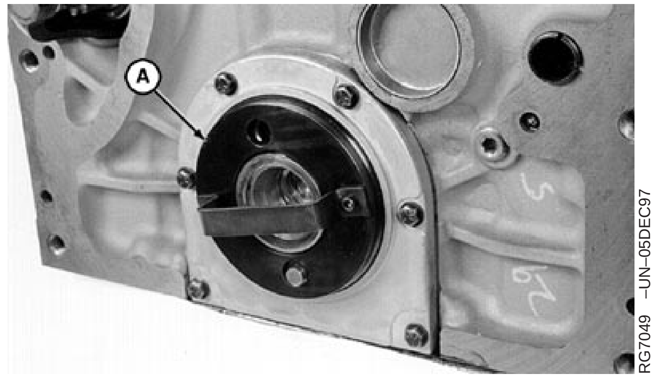
Specification

Rear Crankshaft Oil Seal
Housing—Torque.. 27 N•m (20 lb-ft)

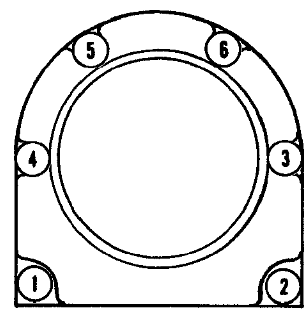
5. Remove alignment tool from end of crankshaft flange.

6. Check oil seal housing runout with a magnetic base dial indicator. See CHECK CRANKSHAFT REAR OIL SEAL HOUSING RUNOUT later in this group.

7. Trim off excess gasket material extending below bottom of oil seal housing.



Centering Rear Oil Seal Housing



Cap Screw Tightening Sequence for Rear Oil Seal Housing

A—JDG796 Alignment Tool

Check Crankshaft Rear Oil Seal Housing Runout

IMPORTANT: On service "short block" assemblies, rear oil seal housing runout is preset at the factory. Do not remove housing from block.

1. Position magnetic base dial indicator (A) on end of crankshaft flange as shown. Preset dial indicator tip on I.D. of oil seal housing bore (B).

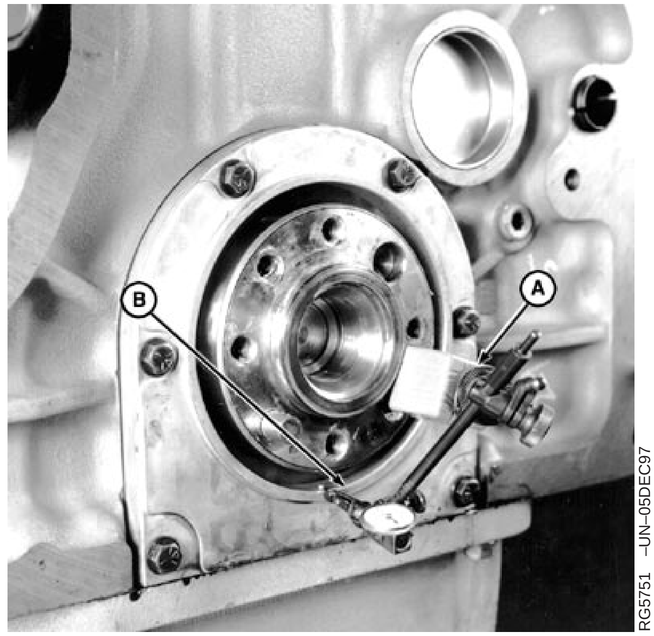
2. Zero dial indicator and rotate crankshaft one full revolution, observe full indicator movement. The maximum oil seal housing bore runout is as follows:

Specification

Crankshaft Rear Oil Seal Housing—Maximum Runout	0.152 mm (0.006 in.)

If runout exceeds specification, loosen cap screws and adjust housing to obtain an acceptable runout while keeping bottom of seal housing flush with oil pan mating surface.

3. Recheck oil seal housing bore runout. If runout still exceeds specification, oil seal housing bore is possibly distorted and should be replaced. See INSTALL CRANKSHAFT REAR OIL SEAL HOUSING, earlier in this group.



Checking Rear Oil Housing Runout

A—Magnetic Base Dial Indicator
B—Oil Seal Housing Bore

RG,RG34710,1183 –19–23OCT97–1/1

Crankshaft Rear Oil Seal and Wear Sleeve Handling Precautions

Use the following precautions for handling seal and wear sleeve:

Seal (A) and wear sleeve (B) are assembled. DO NOT SEPARATE. If parts become separated, discard and replace with a new assembly. Attempts to reassemble will cause the wear sleeve to damage the seal allowing engine oil to leak past seal.

Always install seal and wear sleeve assembly immediately after removal from plastic bag to avoid possible dirt contamination.

No lubrication of any kind is to contact seal when installing. Use of a lubricant may result in premature seal failure.

Install oil seal/wear sleeve assembly with the open side of seal and wear sleeve I.D. chamfer toward the engine. If seal is reversed, engine oil may be lost because grooves in oil seal lip would be incorrect with respect to direction of crankshaft rotation.

Oil seal/wear sleeve assembly MUST BE installed with the JDG476 (85) Crankshaft Rear Oil Seal Installation Tool Set.

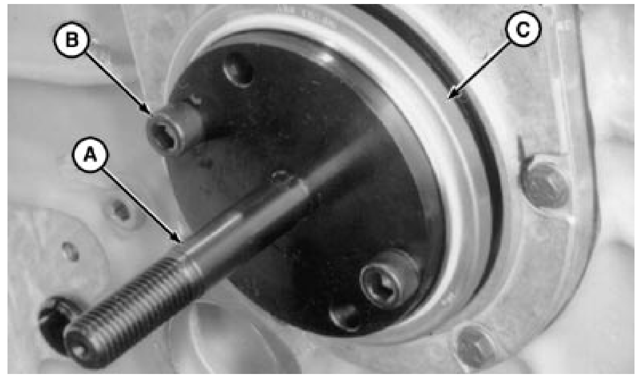
RG5640A –UN–31OCT97

Rear Oil Seal and Wear Sleeve

A—Oil Seal and Wear Sleeve

RG,RG34710,1151 –19–17MAY99–1/1

Install Crankshaft Rear Oil Seal and Wear Sleeve Assembly



Installing Rear Oil Seal and Wear Sleeve

A—Pilot
B—Allen Head Cap Screws
C—Oil Seal/Wear Sleeve Assembly

NOTE: On engines with John Deere (Funk) rear PTO, see CTM67, OEM Engine Accessories for procedure to install rear oil seal and wear sleeve.

IMPORTANT: DO NOT allow sealant to get on any part of wear sleeve O.D. or on oil seal.

1. **For separable type seal:** Apply a light coating of LOCTITE® 680 Retaining Compound, or equivalent, completely around the leading edge of crankshaft flange. Wipe away any sealant that may have gotten on I.D. of seal housing bore.

   For unitized seal: Apply a light coating of clean engine oil around rubber OD of seal.

2. Install JDG477 (85) Pilot (A) on end of crankshaft using the Allen head cap screws (B) supplied with tool set. Tighten cap screws securely.

IMPORTANT: Handle seal and wear sleeve assembly carefully. If assembly becomes separated, discard these parts and install a new assembly.

When installing the JDG478 Driver on JDG477 (85) Pilot and crankshaft flange to position oil seal/wear sleeve assembly, locate crossbar of installer at right angle (90°) to Allen head cap screws. This allows the crossbar to bottom on pilot, not head of cap screws, assuring correct installation.

3. Carefully start oil seal/wear sleeve assembly (C) over JDG477 (85) Pilot and crankshaft with open side of seal toward engine.

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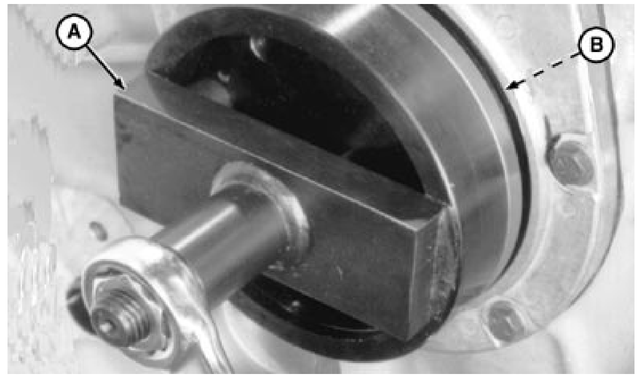
RG,RG34710,1185 –19–05MAR05–1/2

4. Position JDG478 Driver (A) so that hole in the cross plate goes over threaded stud of pilot. Install washer and nut on stud.

5. Tighten nut to draw JDG478 Driver in until crossbar bottoms on JDG477 (58) Pilot. When the tool bottoms, seal and wear ring assembly (B) will be correctly positioned.

6. Remove JDG476 (85) Tool Set from engine.



RG4640 –UN–05DEC97

Rear Oil Seal and Wear Sleeve Installed

A—JDG478 Driver
B—Seal and Wear Sleeve Assembly

RG,RG34710,1185 –19–05MAR05–2/2

Install Timing Gear Cover

IMPORTANT: Tightening the timing gear cover (A) cap screws one through six in numerical sequence controls the total runout of the crankshaft flange-to-oil seal bore.

On engines with auxiliary front drive, tighten those cap screws (Group 050) before tightening timing cover screws.

1. Lubricate thrust washer (bold arrow) with TY6333 or TY6347 High Temperature Grease and install in timing gear cover tabs.

2. Install a new gasket on engine block. Apply a light film of grease to the gasket to hold it in place.

3. Install timing gear cover. Tighten cap screws one through six to specifications in numerical sequence, as shown.

Specification	
Timing Gear Cover-to-Cylinder Block Cap Screws—Torque	27 N•m (20 lb-ft)

4. Install injection pump drive gear cover (B) using a new gasket and tighten cap screws to specifications.

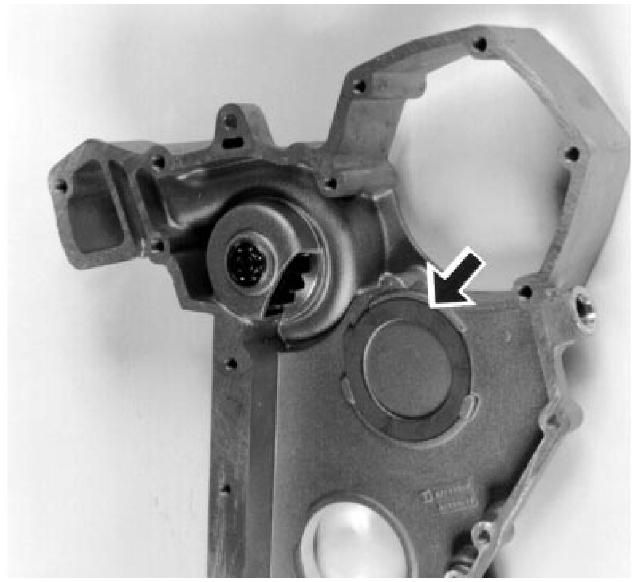
Specification	
Injection Pump Gear Cover-to-Timing Gear Cover—Torque	27 N•m (20 lb-ft)

5. Install coolant pump cover (C) using a new gasket. Tighten cap screws to specifications.

Coolant Pump Cover-to-Timing Gear Cover—Specification	
5/16-in. Cap Screws—Torque	27 N•m (20 lb-ft)
3/8-in. Cap Screws—Torque	47 N•m (35 lb-ft)

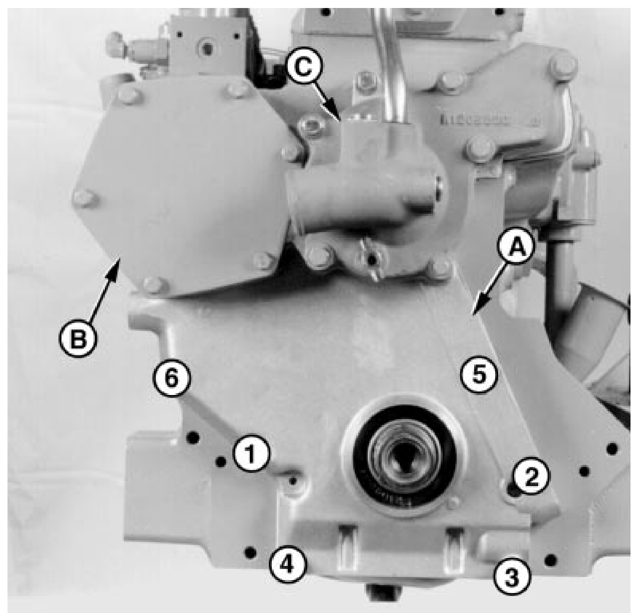
6. Trim timing gear cover gasket flush with oil pan gasket rail.

7. Install front auxiliary drive assembly using a new idler bushing. SeeREMOVE, INSPECT AND INSTALL CRANKSHAFT GEAR-DRIVEN AUXILIARY DRIVE in Group 050.



RG7060 –UN–26NOV97

Thrust Washer in Timing Gear Cover



RG7050 –UN–26NOV97

1-6- Tightening Sequence for Cover Cap Screws

A—Timing Gear Cover
B—Injection Pump Drive Gear Cover
C—Coolant Pump Cover

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RG,RG34710,1186 –19–10JUN99–1/2

8. Using a new O-ring, install magnetic speed sensor in timing gear cover, if removed.

9. Install crankshaft front wear sleeve and oil seal. See INSTALL CRANKSHAFT FRONT OIL SEAL later in this group.

RG,RG34710,1186 –19–10JUN99–2/2

Install Front Wear Sleeve

NOTE: Front wear sleeve can be installed with timing gear cover removed or installed.

1. Coat I.D. of new wear sleeve with LOCTITE® 680 Retaining Compound or equivalent. Position wear sleeve on crankshaft flange.

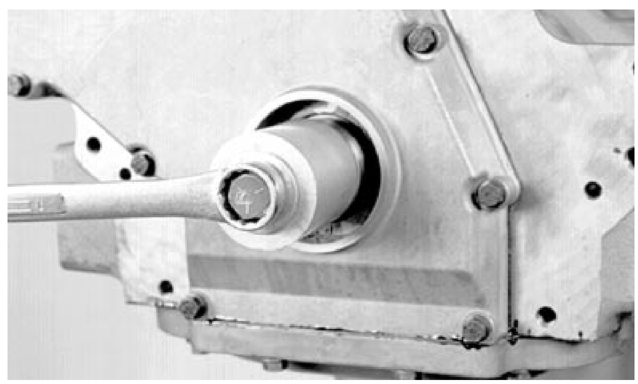
2. Use the JDG467 Driver (from JDE3 Installer Set), along with large washer and cap screw that secures damper to crankshaft.

   Tighten cap screw until driver bottoms.

3. Remove installation tools. Clean any sealant from O.D. of wear sleeve and I.D. of seal bore.

RG6476 –UN–05DEC97

Tool for Installing Front Wear Sleeve



RG6477 –UN–05DEC97

Installing Front Wear Sleeve

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RG,RG34710,1187 –19–23OCT97–1/1

Install Crankshaft Front Oil Seal

IMPORTANT: Whenever front oil seal is replaced, the wear sleeve MUST also be replaced.

1. Place JDG720-2 Seal Protector (A) on nose of crankshaft.

   Lubricate I.D. of front oil seal lips with clean engine oil. Slide seal with spring side of seal facing engine onto seal protector. Be careful not to roll oil seal lips.

2. Place JDG720-5 Seal Installer onto seal protector against seal. Do not use spacer ring provided with tool set.

3. With nut and washer installed onto JDG720-1 Forcing Screw, thread forcing screw into nose of crankshaft until it bottoms.

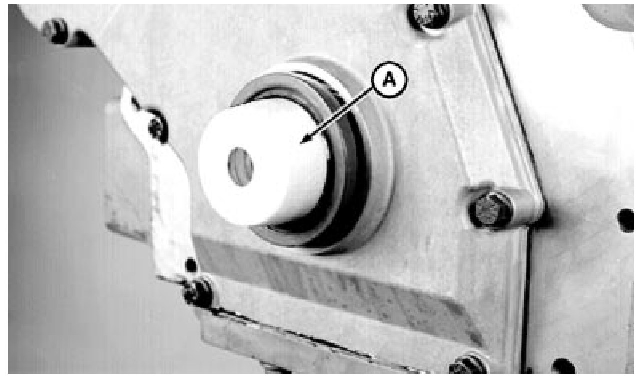
4. Tighten nut against crossplate of installer until installer bottoms onto front face of timing gear cover.

5. Remove installation tools. Verify seal is installed square in bore and that seal lips are not rolled on wear sleeve.

   Oil seal should be installed to following specification.

Specification

Front Oil Seal Installed Below
Front Lip of Seal Bore—Recess .... 8.9 mm (0.35 in.)



Protector for Installing Front Oil Seal

Installing Front Oil Seal

A—JDG720-2 Seal Protector

RG,RG34710,1188 –19–23OCT97–1/1

Install Vibration Damper

NOTE: On engines with dual dampers, ALWAYS replace both dampers as a matched set.

IMPORTANT: The vibration damper assembly is not repairable and should be replaced every 4500 hours or 60 months, whichever occurs first.

1. Install crankshaft Woodruff key with tab facing toward front of engine and key firmly seated in keyway. Position damper (B) onto crankshaft.

IMPORTANT: Always use new cap screws when installing damper to crankshaft and fan pulley to damper.

2. Use hardened washer (part of damper assembly) and insert a cap screw that is 25 mm (1 in.) longer than original cap screw (A). Tighten cap screw until it just bottoms out.

3. Remove cap screw and install original cap screw with same hardened washer.

4. Tighten cap screw to specifications.

Specification

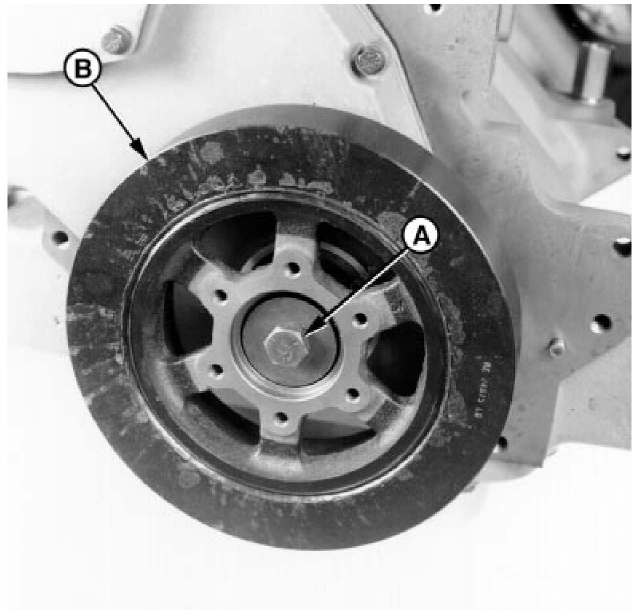
Vibration Damper-to-Crankshaft
Cap Screws—Torque .... 230 N•m (170 lb-ft)

5. Install crankshaft pulley (if equipped) to damper. Tighten cap screws to specifications.

Specification

Crankshaft Pulley-to-Damper Cap
Screws (Single Dampers for
Gen-Set Applications)—Torque....................................... 61 N•m (45 lb-ft)
Crankshaft Pulley-to-Damper Cap
Screws (All Other Applications)—
Torque .... 70 N•m (52 lb-ft)

NOTE: On later engines, damper and pulley are a one-piece unit.



RG5882 –UN–26NOV97

Installing Vibration Damper

A—Cap Screw
B—Damper

Install SAE 2 and 3 Flywheel Housing

On SAE 1 and all aluminum flywheel housings, the flywheel housing is installed AFTER the flywheel.

CAUTION: Flywheel housing (A) is heavy. Plan a handling procedure to avoid personal injuries.

NOTE: Engines not requiring a gasket are usually dry clutch applications and are metal to metal connection.

1. On engines requiring a gasket between block and flywheel housing, inspect cylinder block and flywheel housing gasket surfaces to see that they are clean. Scrape off all old gasket material.

2. Place a bead of LOCTITE®515 across the “T Joint” where the rear of the block and oil pan joint is located.

3. Position flywheel housing gasket over the two dowel pins, with the rubber bead side of the gasket toward the block.

4. Apply Loctite 515 once again on the “T Joint” area on the block. The gasket will thus have sealant on both sides in the T Joint areas.

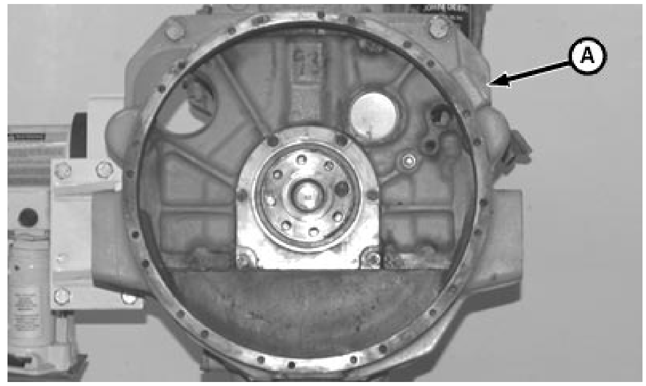
5. Install flywheel housing on cylinder block.

NOTE: Use new cap screws when installing flywheel housing.

6. Dip threads of cap screw in engine oil before installing. Install and tighten cap screws to specifications.

Specification

SAE 2 and 3 Flywheel Housing-to-Cylinder Block Cap Screws—Torque	365 N•m (269 lb-ft)
SAE 3 Flywheel Housing-to-Oil Pan 1/2 in. Cap Screws—Torque	129 N•m (95 lb-ft)
SAE 3 Flywheel Housing-to-Oil Pan 3/8 in. Cap Screws—Torque	47 N•m (35 lb-ft)



RG10214 –UN–23JUN99

Installing SAE 3 Flywheel Housing

A—Flywheel Housing

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Specification

SAE 2 Flywheel
Housing-to-Cylinder Block 3/4-in.
Cap Screws (With Rear PTO)—
Torque .... 325 N•m (240 lb-ft)

SAE 2 Flywheel
Housing-to-Cylinder Block 5/8-in.
Cap Screws (With Rear PTO)—
Torque .... 275 N•m (203 lb-ft)

RG,RG34710,1190 –19–11JAN06–2/2

Install Flywheel & Flex Plates - Option Code 1502

CAUTION: Flywheel is heavy. Plan a handling procedure to avoid personal injuries.

IMPORTANT: ALWAYS use new cap screws when installing flywheel. DO NOT use plated cap screws.

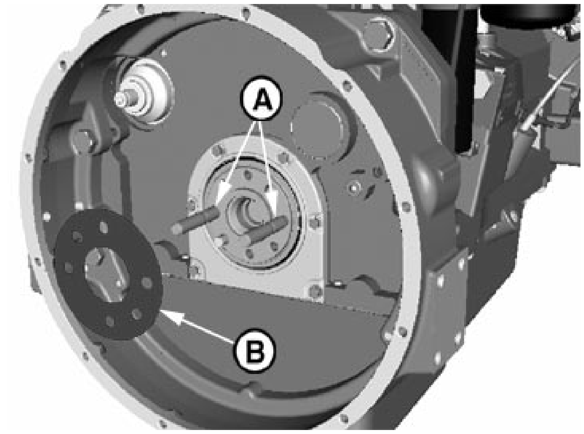
IMPORTANT: Flywheel must be clean and free of oil before installing. Clean threaded holes in crankshaft carefully. DO NOT blow them out with compressed air. These are through holes and debris could be blown into the engine crankcase.

1. Install 2 guide pins (A) in position shown.
2. Install inner flywheel diamond spacer (B) over the guide pins and locate to crankshaft hub.
3. Install flywheel (C) and outer diamond spacer (D) over guide pins.
4. Lock flywheel into position to prevent turning during torque-turn of cap screws.

IMPORTANT: BE CERTAIN the small pilot hole and all cap screw holes line up properly with flywheel holes when installing flex plates and retainer plate. Alignment MUST be maintained for torque converter assembly.

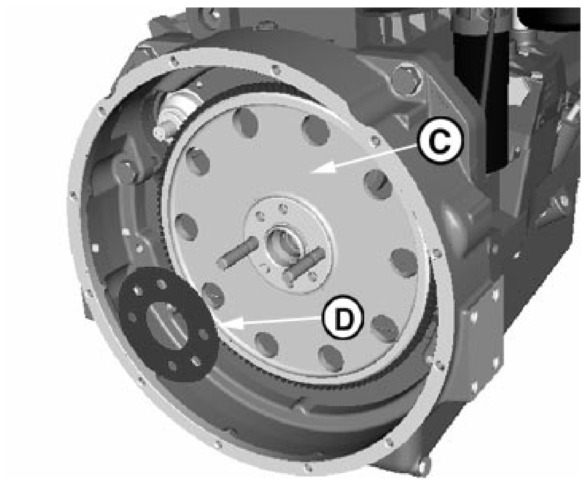
5. Install 4 flex plates (E) and retainer plate (F) over guide pins.

A—Guide Pins
B—Inner Spacer
C—Flywheel
D—Outer Spacer
E—Flex Plates
F—Retainer



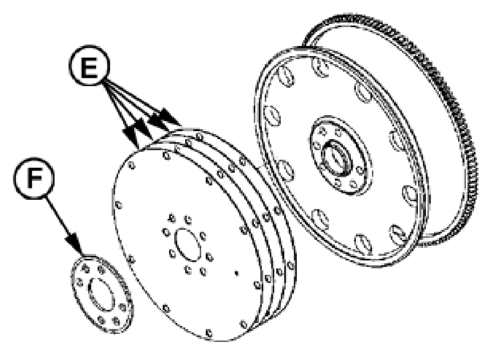
RG14913 –UN–16JUN06

Install Guide Pins and Inner Spacer



RG14914 –UN–16JUN06

Install Flywheel and Outer Spacer



RG14915 –UN–16JUN06

Install Flex Plates and Retainer

Continued on next page

RE38635,000011E –19–12JUN06–1/2

6. Install 2 cap screws (G) through flex plate assembly into flywheel finger tight.

7. Torque-turn the cap screws to specification.

Specification
Flywheel to Crankshaft Flange—
Torque Turn.. 40 N•m (30 lb-ft) PLUS 60°

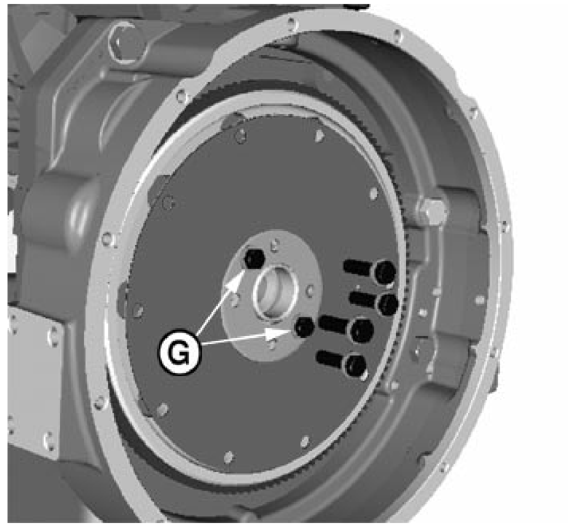
8. Remove the 2 guide pins and install remaining 4 cap screws finger tight.

9. Torque-turn cap screws to specification.

Specification
Flywheel to Crankshaft Flange—
Torque Turn.. 40 N•m (30 lb-ft) PLUS 60°

10. Remove lock from flywheel.

G—Cap Screws



RG14916 –UN–16JUN06

Install Flywheel Cap Screws

RE38635,000011E –19–12JUN06–2/2

Install Flywheel

Two guide studs may be used at cap screw locations (A) opposite each other to aid in flywheel installation.

CAUTION: Flywheel is heavy. Plan a handling procedure to avoid personal injuries.

NOTE: ALWAYS use new cap screws when installing flywheel. DO NOT use plated cap screws.

IMPORTANT: Flywheel must be clean and free of oil before installing. Clean threaded holes in crankshaft carefully. DO NOT blow them out with compressed air. These are through holes and debris could be blown into the engine crankcase.

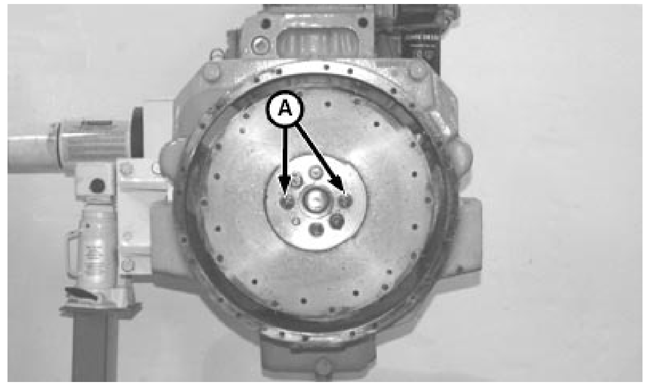
1. **On engines without rear PTO**, coat threads of flywheel attaching cap screws with LOCTITE® 242 or its equivalent.

2. Position flywheel over dowel pin and install drive hub (if equipped). Start four cap screws. Remove guide studs and install remaining cap screws.

3. Install remaining flywheel attaching cap screws.

4. Tighten flywheel attaching cap screws to specifications.

Specification	
Drive Hub-to-Flywheel Cap Screws—Torque	115 N•m (85 lb-ft)
Flywheel-to-Crankshaft Cap Screws (With Rear PTO)—Torque	162 N•m (120 b-ft)
Flywheel-to-Crankshaft Cap Screws (All Other Applications)—Torque	115 N•m (85 lb-ft)



Installing Flywheel

A—Locations for Guide Studs

RG,RG34710,1191 –19–10JUN99–1/1

Install SAE 1 Flywheel Housing

CAUTION: Flywheel housing is heavy. Plan a handling procedure to avoid personal injuries.

On SAE 2 and 3 cast-iron flywheel housings, the housing MUST be installed BEFORE installing flywheel.

1. Scrape off all old gasket material. Install a new gasket without sealant between block and flywheel housing.

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

SAE 1 Flywheel
Housing-to-Cylinder Block Cap
Screws—Torque .... 365 N•m (269 lb-ft)

RG,RG34710,1192 –19–10JUN99–1/1

Complete Final Assembly

1. Install oil pump assembly and oil pan (Group 20). Fill engine with clean engine oil.

2. Fill cooling system with proper coolant after engine installation and perform engine break-in. See PERFORM ENGINE BREAK-IN SERIAL NUMBER (—199,999) at end of Group 020, or see PERFORM ENGINE BREAK-IN SERIAL NUMBER (200,000—) at end of Group 021.

RG,RG34710,1193 –19–23OCT97–1/1

Check Camshaft End Play and Measure Gear Backlash

NOTE: Camshaft end play must be measured before removing timing gear cover, as thrust washer in back side of timing gear cover limits camshaft end play.

1. Remove injection pump drive gear cover (shown removed).

2. Install magnetic base dial indicator on front face of cylinder block and position dial indicator tip on front face of camshaft gear, as shown. Set dial indicator to zero.

3. Move camshaft gear back and forth and observe end play reading. Compare reading with specification given below.

Specification

Camshaft—End Play	0.010—0.6 mm (0.0004—0.024 in.) new
Wear Limit	0.65 mm (0.0260 in.) maximum allowable

If end play is excessive, remove timing gear cover and crankshaft and measure thickness of thrust washers.

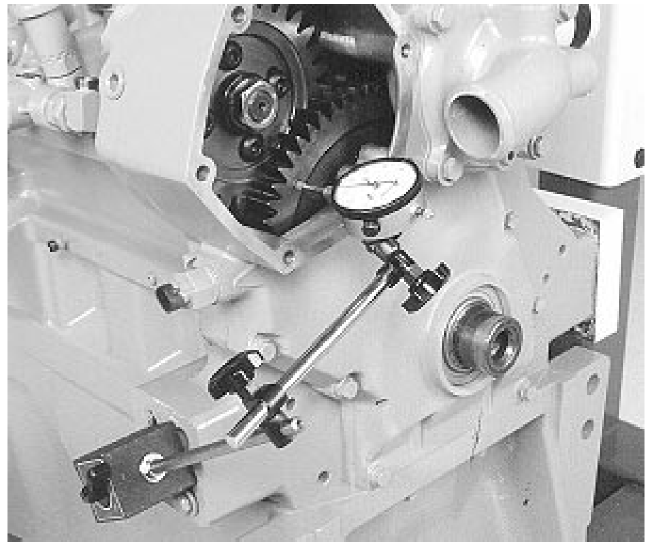
4. Position indicator plunger tip against camshaft gear tooth with a preload.

5. Measure backlash between camshaft drive gear and crankshaft gear in three (3) different positions around the camshaft gear. Compare readings with specifications given below.

Specification

Camshaft Drive Gear-to-Crankshaft Gear—Backlash	0.076 mm (0.003 in.) min.

Replace gear if backlash does not equal or exceed specification.



Measuring Camshaft End Play

RE38635,0000073 –19–05MAR05–1/1

Remove Vibration Damper and Timing Gear Cover

For timing cover removal procedure with engine installed in vehicle (8000 Tractors), refer to REMOVE AND INSTALL TIMING GEAR COVER—ENGINE INSTALLED IN VEHICLE, in Group 040.

1. Drain oil (if not previously done), and remove oil pan. Remove oil pump if crankshaft is to be removed. See REMOVE ENGINE OIL PUMP in Group 060.

2. Remove cap screw and washer on damper pulley. Install JDG787 Thread Protector in nose of crankshaft.

IMPORTANT: DO NOT use a jaw-type puller to remove vibration damper. Damage could result to the damper. Never apply thrust on outer ring of damper. Do not drop damper or strike with a hammer.

3. Remove damper from crankshaft using JDG721 Hub Puller (A).

NOTE: D01207AA (OTC518) Puller Set (not shown) may also be used to remove damper.

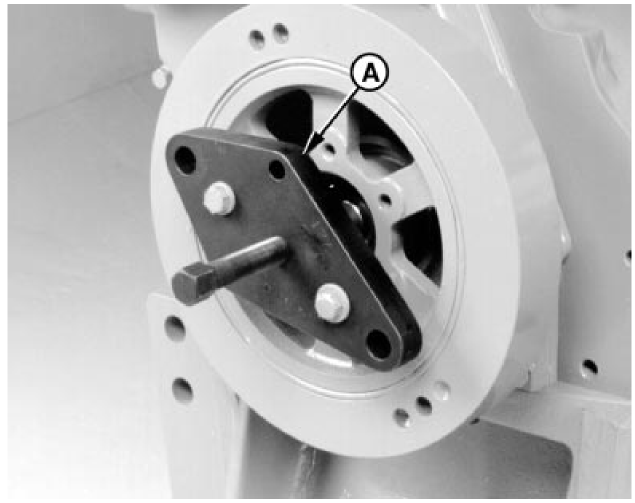
4. Disconnect speed sensor wiring connector (D) (shown disconnected), and remove injection pump drive gear cover (C).

5. Check camshaft end play. See CHECK CAMSHAFT END PLAY AND MEASURE GEAR BACKLASH earlier in this group.

IMPORTANT: Whenever timing gear cover is removed, ALWAYS install a new front oil seal and wear sleeve.

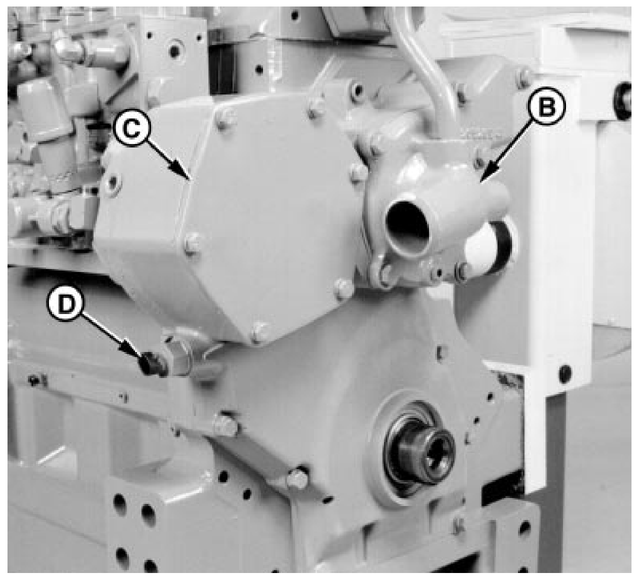
6. Remove coolant pump cover (B).

7. If equipped, remove crankshaft gear-driven auxiliary drive. See REMOVE, INSPECT AND INSTALL CRANKSHAFT GEAR-DRIVEN AUXILIARY DRIVE later in this group.



RG7209 –UN–26NOV97

Removing Crankshaft Vibration Damper



RG7210A –UN–08FEB01

Removing Timing Gear Cover

A—JDG721 Hub Puller
B—Coolant Pump Cover
C—Injection Pump Drive Gear Cover
D—Speed Sensor Wiring Connector

Continued on next page

8. Remove all remaining cap screws and remove timing gear cover.

9. Remove front oil seal from timing gear cover. Install a new seal after timing gear cover is installed. See INSTALL CRANKSHAFT FRONT OIL SEAL in Group 040.

10. Remove crankshaft front wear sleeve. See REMOVE CRANKSHAFT FRONT OIL SEAL AND WEAR SLEEVE in Group 040.

RG,RG34710,1200 –19–08JUN99–2/2

Remove, Inspect, and Install Crankshaft Gear-Driven Auxiliary Drive—If Equipped

NOTE: Various auxiliary drive options are available; removal and installation of all options are similar. The auxiliary drive is integrated into the engine front timing gear cover. Refer to CTM67-OEM Engine Accessories for removal of auxiliary drive accessories and repair of auxiliary drive components.

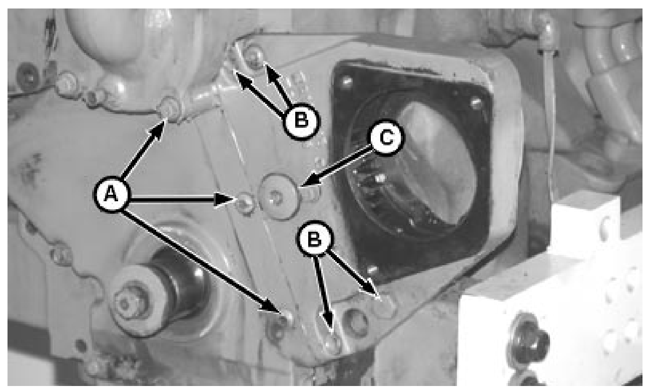
1. If equipped, remove auxiliary drive accessory (air compressor, hydraulic pump, etc.) (shown removed).

2. Remove vibration damper (shown removed).

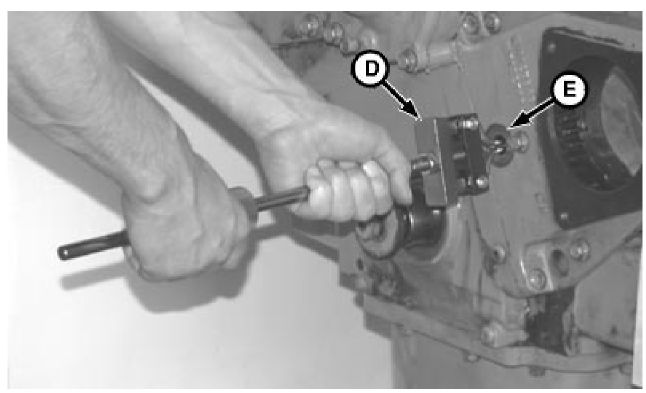
3. Loosen idler housing cap screws (B) and timing gear cover cap screws (A).

4. Remove button head cap screw (C).

5. Remove idler gear bushing/spacer (E) from timing gear cover using D01209AA Slide Hammer and Attachment (D) and discard bushing/spacer.



Button Head Cap Screw



Auxiliary Drive Idler Bushing/Spacer

A—Timing Gear Cover Cap Screws
B—Idler Housing Cap Screws
C—Button Head Cap Screw
D—D01209AA Puller
E—Idler Gear Bushing/Spacer

Continued on next page

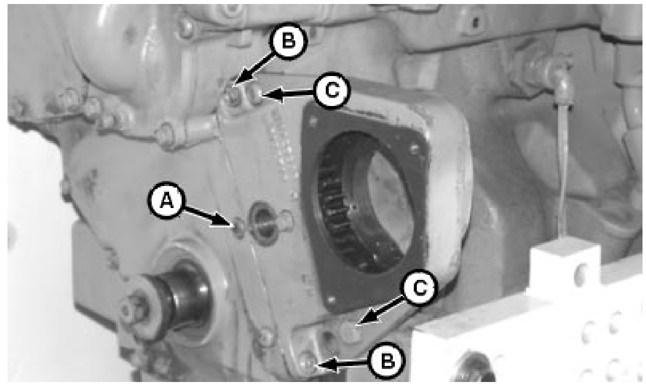
DPSG,OUO1004,911 –19–10JUN99–1/7

6. Remove cap screws (A—C) and remove idler housing and gear.

7. Remove idler housing-to-timing gear housing face seal and O-ring. Face seal may be reused if not damaged.

8. Clean and inspect auxiliary drive assembly for cracked housing, worn or damaged bearings and damaged gear or spline. Replace components as required.

A—Timing Gear Cover-to-Cylinder Block Cap Screw
B—Idler Housing-to-Timing Gear Cover Cap Screws
C—Idler Housing-to-Cylinder Block Cap Screws



Remove Auxiliary Drive Assembly

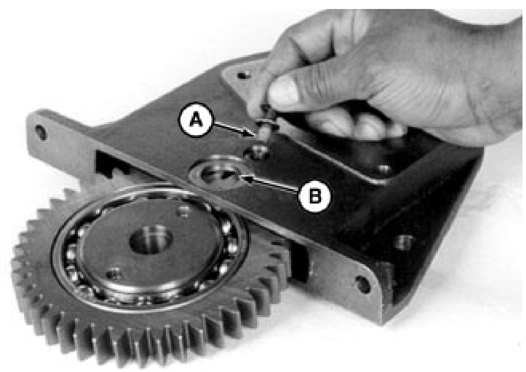
DPSG,OUO1004,911 –19–10JUN99–2/7

9. Grease and install O-ring in housing bore (B).

NOTE: Inner idler bearing support has one threaded hole, and is installed toward block side of housing.

10. If removed, install idler gear into idler housing. Install cap screw with seal (A) to hold idler gear in place.

A—Cap Screw
B—Housing Bore



Idler Gear

Continued on next page DPSG,OUO1004,911 –19–10JUN99–3/7

11. Insert idler shaft through idler housing and idler gear until flush with block side of housing.

IMPORTANT: White dot on one end of shaft must face out toward front of engine.

12. Grease O-ring groove (A) in back side of idler housing. Insert O-ring.

A—O-Ring Groove

O-Ring Groove

DPSG,OUO1004,911 –19–10JUN99–4/7

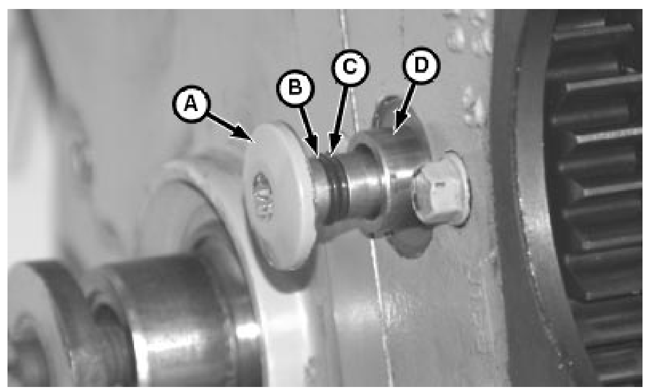
NOTE: Face seal may be reused if it is not cut, nicked, or damaged.

13. Using a short guide stud, place face seal on timing gear cover opening. Gauge hole in seal must be positioned toward bottom of opening.

IMPORTANT: Be careful not to damage face seal or displace O-ring on back side of idler housing during assembly.

14. Carefully insert idler gear into opening of timing gear cover until idler gear meshes with crankshaft gear, and housing is seated against face seal. Push idler bushing/spacer (D) into block.

15. Check condition of O-rings (B) and (C) on large button head cap screw (A). Grease O-rings and install cap screw through idler shaft. Thread into block until finger tight.



Button Head Cap Screw

A—Button Head Cap Screw
B—Large O-Ring
C—Small O-Ring
D—Idler Bushing/Spacer

Continued on next page

DPSG,OUO1004,911 –19–10JUN99–5/7

NOTE: Center timing gear cover-to-cylinder block cap screw must have a seal.

16. Remove guide stud. Install timing gear cover cap screws (E), idler housing cap screws (A and B) and cap screw (D) finger tight.

17. Tighten cap screws to specifications in the following sequence:

- Idler housing-to-timing gear cover (A):

Specification

Auxiliary Drive Idler Housing-to-Timing Gear Cover (3/8 in.)—Torque .... 41 N•m (30 lb-ft)

- Idler housing-to-cylinder block (B) 3/8 inch cap screws:

Specification

Auxiliary Drive Idler Housing-to-Cylinder Block (3/8 in.)—Torque.. 41 N•m (30 lb-ft)

- Idler housing-to-cylinder block (D) 1/2 inch cap screws:

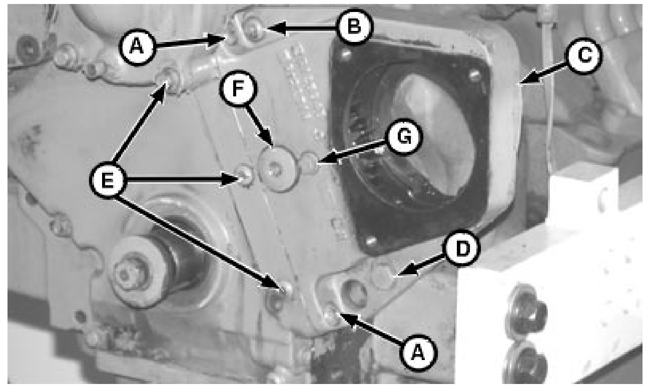
Specification

Auxiliary Drive Idler Housing-to-Cylinder Block (1/2 in.)—Torque.. 127 N•m (94 lb-ft)

- Idler bushing/spacer button head cap screw (F):

Specification

Auxiliary Drive Idler Shaft Button Head Cap Screw—Torque .... 150 N•m (110 lb-ft)



Install Auxiliary Drive Assembly

A—Idler Housing-to-Timing Gear Cover Cap Screws
B—Idler Housing-to-Cylinder Block Cap Screw
C—Idler Housing
D—Idler Housing-to-Cylinder Block Cap Screw
E—Timing Gear Cover-to-Cylinder Block Cap Screws
F—Idler Bushing Button Head Cap Screw
G—Idler Housing-to-Idler Bearing Cap Screw

Continued on next page DPSG,OUO1004,911 –19–10JUN99–6/7

- Timing gear cover-to-cylinder block (E):

Specification

Timing Gear Cover-to-Cylinder Block Cap Screws (5/16 in.)—Torque .... 27 N•m (20 lb-ft)

- Idler housing-to-idler bearing (G):

Specification

Auxiliary Drive Idler Housing-to-Idler Bearing (5/16 in.)—Torque .... 27 N•m (20 lb-ft)

18. Check idler gear-to-crankshaft gear backlash. Backlash must be as follows:

Specification

Auxiliary Drive Idler Gear-to-Crankshaft Gear—Backlash .... 0.11—0.7 mm (0.004—0.028 in.)

19. Install vibration damper.

DPSG,OUO1004,911 –19–10JUN99–7/7

Remove Camshaft

NOTE: It is not necessary to remove cylinder head from engine for camshaft removal. If push rods are bent or show excessive scuffing, it may be necessary to remove cylinder head for inspection of block, head, cam lobes and cam followers.

1. Drain engine oil and coolant, if not previously done. Remove timing gear cover as detailed earlier in this group. See REMOVE VIBRATION DAMPER AND TIMING GEAR COVER in this group.

2. Rotate engine flywheel with JDE81-1 or JDG820 Flywheel Rotation Tool and lock engine at No. 1 cylinder's "TDC-Compression" stroke with JDE81-4 Timing Pin. Timing marks (A) on camshaft gear and crankshaft gear should be aligned.

   If timing marks are not aligned, remove timing pin and continue to rotate engine until marks align. Timing pin should enter hole in flywheel. Engine will be locked at No. 1 "TDC-Compression" stroke.

3. Remove rocker arm assembly and push rods. See REMOVE CYLINDER HEAD SERIAL NUMBER (—199,999) in Group 020, or see REMOVE CYLINDER HEAD SERIAL NUMBER (200,000—) in Group 021.

4. When removing camshaft with engine on rollover stand, roll engine to a position where followers fall away from camshaft lobes (oil pan side up) or hold cam followers away from lobes with D15001NU Magnetic Holding Set.

Timing Marks—Camshaft and Crankshaft Gears

A—Timing Marks

Continued on next page RG,RG34710,1202 –19–23OCT97–1/3

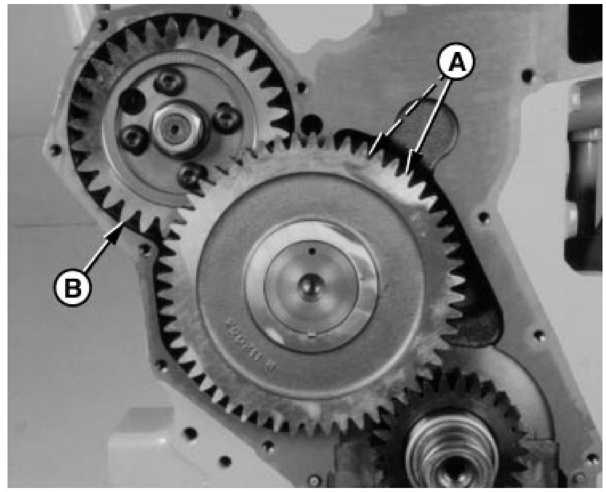
5. Examine both camshaft gears (A) and injection pump drive gear (B) for worn or damaged gear teeth. Gears should have a minimum backlash as follows:

Specification

Camshaft Gear-to-Injection Pump
Drive Gear Backlash—Backlash .... 0.051 mm (0.0020 in.) minimum

NOTE: Timing marks on crankshaft and camshaft gear should be aligned and No. 1 cylinder locked at “TDC Compression” stroke when removing camshaft.

A—Camshaft Gear
B—Injection Pump Drive Gear



Camshaft Gears

RG,RG34710,1202 –19–23OCT97–2/3

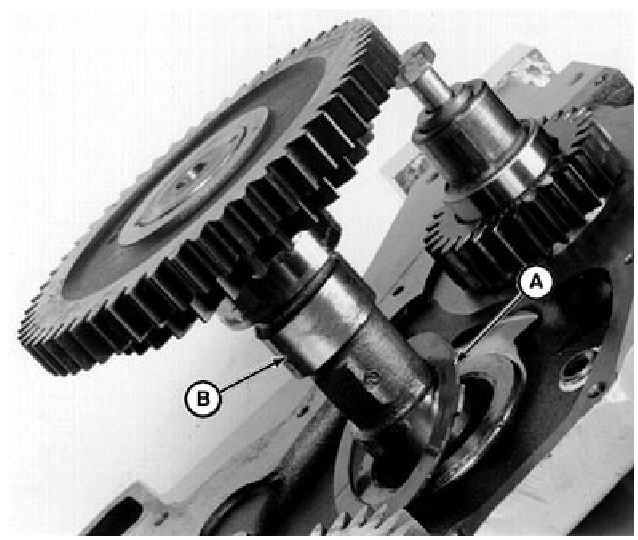
6. Carefully remove camshaft (B) from cylinder block so that camshaft lobes do not drag in bores.

NOTE: Rotate camshaft carefully to aid in removing.

7. Remove thrust washer (A) from behind cam gears.

8. Remove cam followers from cylinder block.

A—Thrust Washer
B—Camshaft



Removing Camshaft

RG,RG34710,1202 –19–23OCT97–3/3

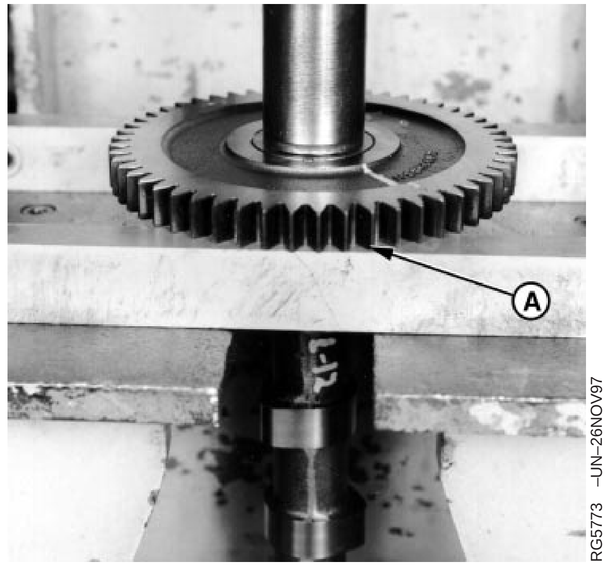
Remove Camshaft Gears

IMPORTANT: Prevent camshaft from striking floor when pushing camshaft nose out of gear. Camshaft may be damaged if it is allowed to fall to the floor.

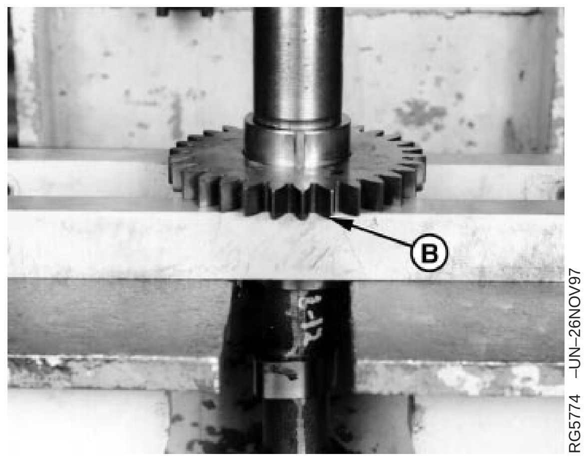
NOTE: Camshaft gears are pressed onto the camshaft. Removal of gears from camshaft will require approximately a 10-ton press.

1. Support outer camshaft gear (A) in a press.
2. Remove outer gear from camshaft.
3. Support inner camshaft gear (B) in a press.
4. Remove inner gear from camshaft.
5. Clean camshaft and gears in solvent. Dry with compressed air.

A—Outer Camshaft Gear
B—Inner Camshaft Gear



Removing Outer Camshaft Gear



Removing Inner Camshaft Gear

RG,RG34710,1203 –19–23OCT97–1/1

Measure Thrust Washer Thickness

1. After removal of camshaft, check the two thrust washers individually for proper thickness.

Specification

Thrust Washer—Thickness .... 2.24—2.34 mm (0.088—0.092 in.)

2. Replace washers if worn or damaged.

RG5775 –UN–05DEC97

Measuring Camshaft Thrust Washers

RG,RG34710,1204 –19–23OCT97–1/1

Inspect and Measure Camshaft Followers

1. Inspect camshaft followers for uneven wear or damage. Also inspect corresponding camshaft lobe for wear or damage. Replace as necessary.

2. Measure follower O.D. and follower bore I.D. in cylinder block.

Specification

Camshaft Follower—OD... 17.33—17.35 mm (0.682—0.683 in.)

Camshaft Follower Bore in Block—ID.. 17.384—17.440 mm (0.6845—0.6865 in.)

Replace cam followers that are not within specification. Replace cylinder block if any one follower bore is not within specification.

RG2745 –UN–04DEC97

Inspecting Camshaft Followers

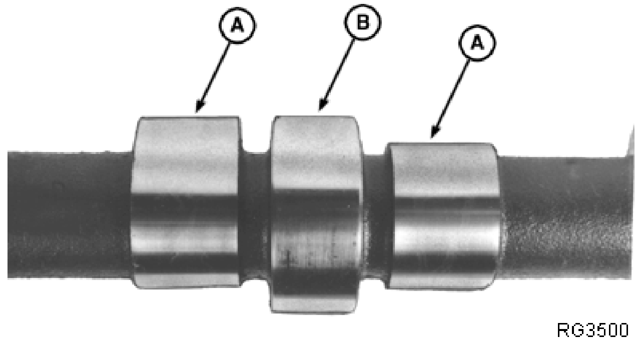
RG,RG34710,1205 –19–23OCT97–1/1

Visually Inspect Camshaft

1. Clean camshaft in solvent. Dry with compressed air.

2. Inspect all camshaft lobes (A) and journals (B) for wear or damage. Replace camshaft as necessary. New camshaft followers can be used with old camshaft (if camshaft is serviceable). DO NOT reuse old camshaft followers with a new camshaft.

NOTE: Very light score marks may be found but are acceptable if valve lift is within specification. Pitting or galling dictates replacement. (See CHECK VALVE LIFT SERIAL NUMBER (—199,999) in Group 020 or see CHECK VALVE LIFT SERIAL NUMBER (200,000—) in Group 021.)



RG3500 –UN–03NOV97

Inspecting Camshaft

A—Camshaft Lobes
B—Journals

RG,RG34710,1206 –19–23OCT97–1/1

Measure Camshaft Journal O.D. and Bushing I.D.

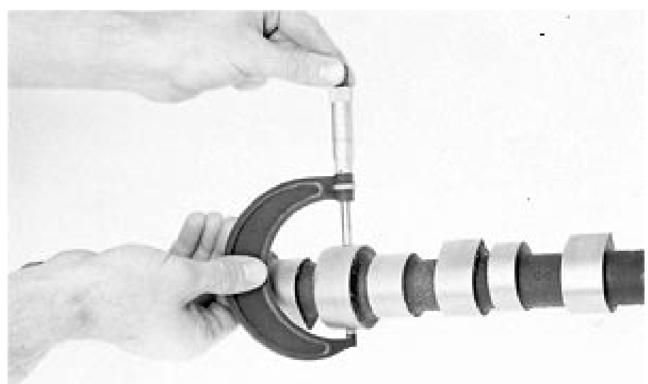
1. Measure each camshaft journal O.D. If camshaft journal O.D. is not within specification, install a new camshaft.

2. Measure each camshaft bushing I.D. when installed in cylinder block.

   Compare measurements with specs given below. Replace camshaft and bushings as needed.

Specification

Camshaft Journal—OD	66.987—67.013 mm (2.6373—2.6383 in.) new
Camshaft Bushing—I.D.	67.076—67.102 mm (2.6408—2.6418 in.) new



T81260 –UN–07NOV88

Measuring Camshaft Journals

RG,RG34710,1207 –19–23OCT97–1/1

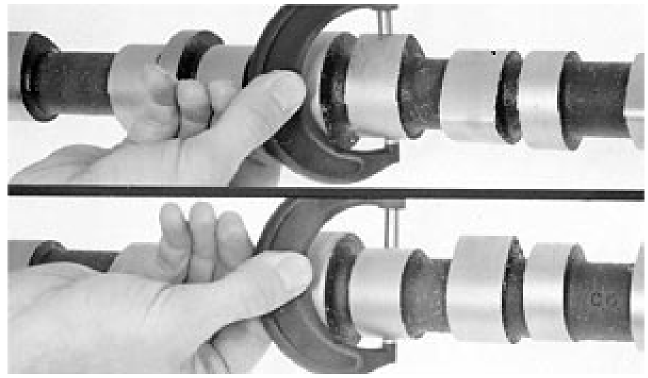
Measure Camshaft Lobe Lift

Measure each camshaft lobe at its highest point and at its narrowest point. Subtract narrowest dimension from highest dimension to find camshaft lobe lift.

If camshaft lobe lift is not within the wear specification on any one lobe, install a new camshaft.

Specification

Intake Camshaft Lobe—Lift................. 7.69—7.79 mm (0.303—0.307 in.)
Wear Limit .... 7.19 mm (0.283 in.)
Exhaust Camshaft Lobe—Lift............. 8.25—8.35 mm (0.325—0.329 in.)
Wear Limit .... 7.75 mm (0.305 in.)


T81262 –UN–01NOV88

Measuring Camshaft Lobes

RG,RG34710,1208 –19–23OCT97–1/1

Install Camshaft Gears

1. Support camshaft under first bearing journal in a hydraulic press.

2. Install Woodruff key (A). Lubricate camshaft nose with LOCTITE® 51048 Moly Paste.

3. Set inner gear (B) on camshaft with thrust washer surface to the inside (toward the camshaft). Align Woodruff key and keyway.

4. Install gear onto nose of camshaft. Push inner gear on until tight against the camshaft bearing journal.

5. Set outer gear on camshaft with timing mark upward (away from the camshaft). Align Woodruff key and keyway (C) of outer gear (D).

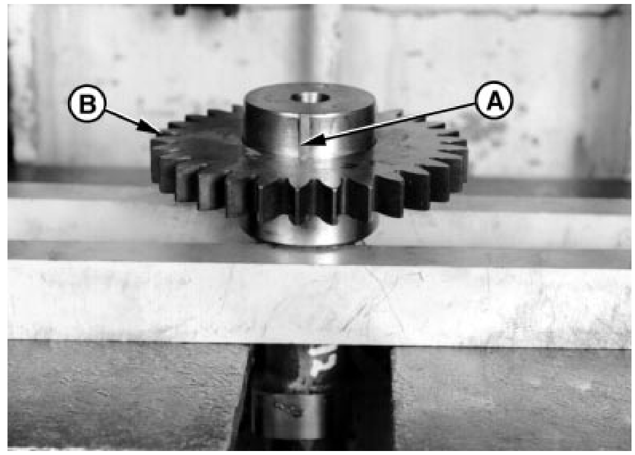
6. Push outer gear onto camshaft nose until tight against inner gear.

7. Support each end of the camshaft on centers. Use a dial indicator with plunger resting on the thrust surface of the camshaft gears.

8. Check the runout of the inner and outer gear thrust surfaces.

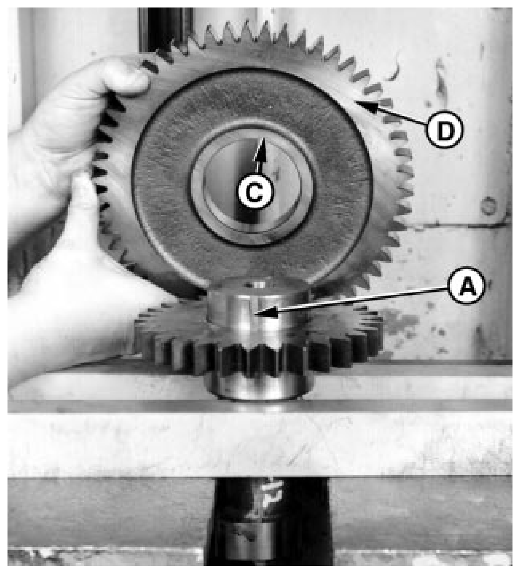
Specification

Camshaft Gear Thrust Surfaces—
Runout .... 0.10 mm (0.004 in.) maximum



RG5776 –UN–26NOV97

Installing Camshaft Inner Gear



RG5777 –UN–26NOV97

Installing Camshaft Outer Gear

A—Woodruff Key
B—Inner Gear
C—Keyway
D—Outer Gear

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RG,RG34710,1209 –19–23OCT97–1/1

Service Camshaft Bushings Using JDG602 Adapter Set

1. Inspect camshaft journals and bushings for wear or damage. Measure cam journals and bushings to determine if proper oil clearance exists. Replace camshaft and/or bushings as necessary.

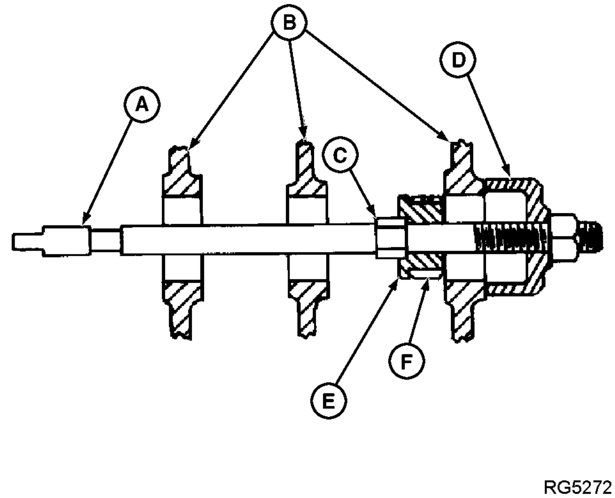
Specification

Camshaft Bushing—ID	67.076—67.102 mm (2.6408—2.6418 in.)
Bore in Block	69.987—70.013 mm (2.7554—2.7564 in.)
Camshaft Bore—Runout	0.038 mm (0.0015 in.) maximum
Camshaft Journal—OD	66.987—67.013 mm (2.6373—2.6383 in.)
Camshaft Bushing-to-Journal—Oil Clearance	0.063—0.115 mm (0.0025—0.0045 in.)

NOTE: The front two bushings can be reached from the front of the engine. The flywheel and rear camshaft bore plug (G) must be removed to reach the other two bushings.

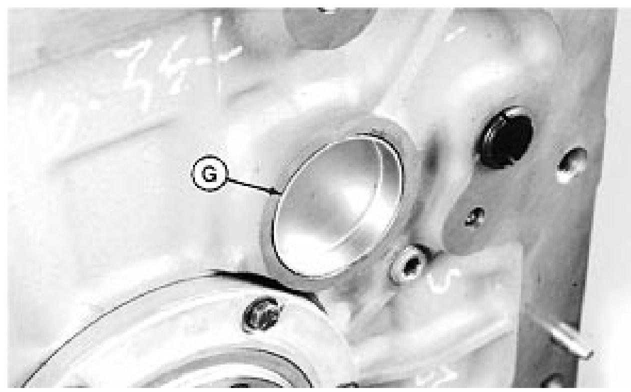
2. Remove camshaft bushings (F) using JDG603 Bushing Driver (E) and JDG604 Receiver Cup (D) along with the components shown from JDE6 Camshaft Bushing Replacement Set (A and C).

3. Tighten nut on end of bushing screw until bushing is pulled out of camshaft bushing bore. Inspect and measure camshaft bushing bore in block (B). Follow same procedure for remaining bushings to be replaced.



RG5272 –UN–07NOV97

Removing Camshaft Bushings



RG5949 –UN–30AUG91

Camshaft Rear Bore Plug

A—Bushing Screw (JDE6-1)
B—Cylinder Block Web
C—Lock Bushing (No. 25916)
D—Receiver Cup (JDG604)
E—Bushing Driver (JDG603)
F—Camshaft Bushing
G—Camshaft Bore Plug

Continued on next page

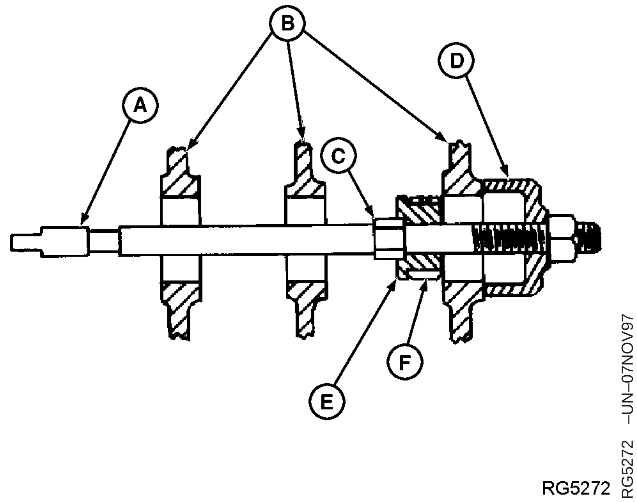
DPSG,OUOE003,29 –19–18DEC98–1/2

IMPORTANT: Oil holes in bushings and cylinder block must be aligned after installation or oil starvation will occur. The elongated hole in bushing must be toward the top. After installation, use a small mirror with extension to be sure oil holes are properly aligned.

4. Slide a new camshaft bushing (F) onto JDG603 Bushing Driver (E). Assemble driver and JDGF604 Receiver Cup (D) along with components shown from JDE6 Camshaft Bushing Replacement Set (A and C).

5. Be sure bushing is started square in bore and oil holes are aligned with holes in block. Tighten nut to pull bushing in until it is properly positioned in bore.

6. Check bushing-to-cylinder block oil hole alignment using a small mirror with extension.



Installing Camshaft Bushings

A—Bushing Screw (JDE6-1)
B—Cylinder Block Web
C—Lock Bushing (No. 25916)
D—Receiver Cup (JDG604)
E—Bushing Driver (JDG603)
F—Camshaft Bushing

DPSG,OUOE003,29 –19–18DEC98–2/2

Service Camshaft Bushings Using JDG606 Adapter Set

1. Inspect camshaft journals and bushings for wear or damage. Measure cam journals and bushings to determine if proper oil clearance exists. Replace camshaft and/or bushings as necessary.

Specification

Camshaft Bushing—ID	67.076—67.102 mm (2.6408—2.6418 in.)
Bore in Block	69.987—70.013 mm (2.7554—2.7564 in.)
Camshaft Bore—Runout	0.038 mm (0.0015 in.) maximum
Camshaft Journal—OD	66.987—67.013 mm (2.6373—2.6383 in.)
Camshaft Bushing-to-Journal—Oil Clearance	0.063—0.115 mm (0.0025—0.0045 in.)

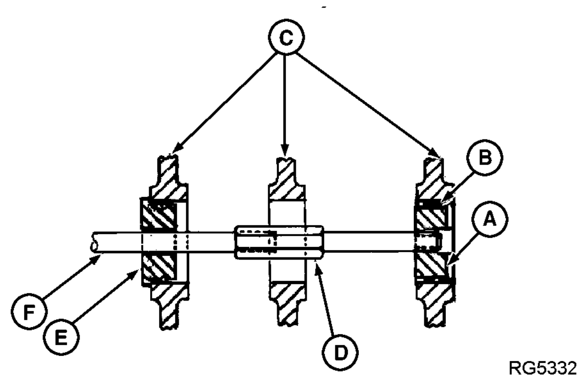
NOTE: The front two bushings can be reached from the front to the engine. The flywheel and rear camshaft bore plug (G) must be removed to reach the other two bushings.

Lubricate O-ring on JDG608 Bushing Pilot with clean engine oil before installing in cylinder block web (C).

2. Remove camshaft bushings (B) using JDG607 Bushing Driver (A) and JDG408 Slide Hammer Adapter (D) (from JDG405 camshaft Bushing Service Set). Also use JDG608 Bushing Pilot (E), and D01299AA Slide Hammer (F).

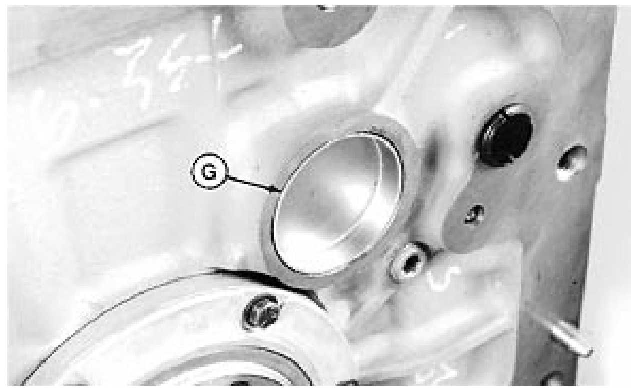
NOTE: End bushing at front and rear of cylinder block may be removed with just JDG607 Bushing Driver and D01299AA Slide Hammer.

3. Inspect and measure each camshaft bushing bore in block as bushings are removed.



RG5332 –UN–07NOV97

Removing Camshaft Bushings



RG5949 –UN–30AUG91

Camshaft Rear Bore Plug

A—Bushing Driver (JDG607)
B—Camshaft Bushing
C—Cylinder Block Web
D—Slide Hammer Adapter (JDG408)
E—Bushing Pilot (JDG608)
F—Slide Hammer (D01299AA)
G—Camshaft Bore Plug

Continued on next page

DPSG,OUOE003,30 –19–18DEC98–1/2

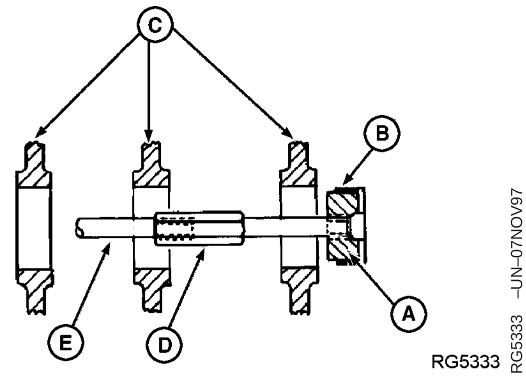
IMPORTANT: Oil holes in bushings and cylinder block must be aligned after installation. The elongated hole in bushing must be toward the top. After installation, use a small mirror with extension to be sure oil holes are properly aligned.

4. Slide a new camshaft bushing (B) onto JDG603 Bushing Driver (A). With JDG608 Bushing Pilot installed in outside cylinder block web (C), assemble D01299AA Slide Hammer (E) and JDG408 Slide Hammer Adapter (D) with bushing driver as shown.

5. Be sure bushing is started square in bore and oil holes are aligned with holes in block. Pull bushing into bore with slide hammer until properly positioned.

6. Check bushing-to-cylinder block oil hole alignment using a small mirror with extension.

7. Apply PERMATEX® AVIATION (Form-A-Gasket No. 3) to new camshaft bore steel cap plug and install plug in bore. Plug edge must be seated below edge of bore.



Installing Camshaft Bushings

A—Bushing Driver (JDG607)
B—Camshaft Bushing
C—Cylinder Block Web
D—Slide Hammer Adapter (JDG408)
E—Slide Hammer (D01299AA)

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DPSG,OUOE003,30 –19–18DEC98–2/2

Install Camshaft

IMPORTANT: Set engine at TDC of No. 1 piston's compression stroke before installing camshaft so timing marks on camshaft and crankshaft gears will be aligned.

1. If camshaft followers were removed with engine on a rollover stand, reinstall followers but do not obstruct camshaft bore. Roll engine to an angle where followers fall away from camshaft bores.

NOTE: If D15001NU Magnetic Holding Tool Set is used, hold camshaft followers away from camshaft bore until camshaft is installed.

2. Lubricate thrust washer (A) with TY6333 or TY6347 High Temperature Grease and install on camshaft behind inner gear.

3. Lubricate camshaft lobes with TY6333 or TY6347 High Temperature Grease and bearing journals with clean engine oil.

4. Carefully install camshaft in cylinder block so that camshaft lobes do not drag in bores. Rotate camshaft during installation to avoid obstruction in any bore.

RG5780 –UN–26NOV97

Camshaft Thrust Washer

A—Thrust Washer

RG,RG34710,1210 –19–23OCT97–1/2

5. With No. 1 piston on "TDC" compression, align timing marks (A) on camshaft and crankshaft gears. Check injection pump timing.

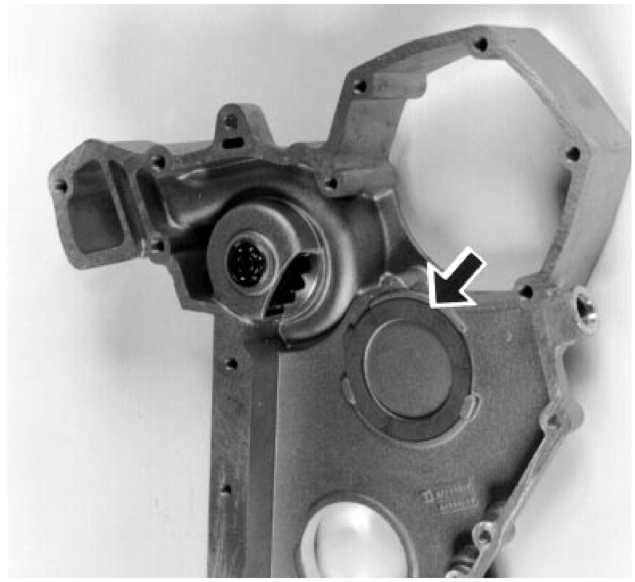
A—Timing Marks

RG6614 –UN–05DEC97

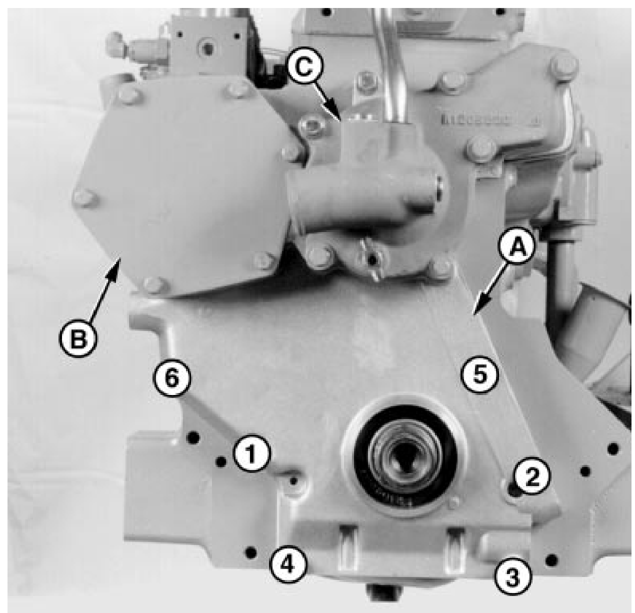
Timing Marks—Camshaft and Crankshaft Gears

RG,RG34710,1210 –19–23OCT97–2/2

Install Thrust Washer and Timing Gear Cover



Thrust Washer in Timing Gear Cover



1-6 - Sequence for Tightening Cover Cap Screws

A—Timing Gear Cover
B—Injection Pump Drive Gear Cover
C—Coolant Pump and Cover Assembly

1. Lubricate thrust washer (bold arrow) with TY6333 or TY6347 High Temperature Grease and install in timing gear cover (A) tabs.

2. Install a new gasket on engine block. Apply a light film of grease to the gasket to hold it in place.

3. Using a new gasket, install the auxiliary drive housing with gear onto the timing gear cover. See REMOVE, INSPECT AND INSTALL CRANKSHAFT GEAR-DRIVEN AUXILIARY DRIVE, earlier in this group.)

IMPORTANT: Tightening the timing gear cover cap screws in proper sequence controls the total runout of the crankshaft flange-to-oil seal bore.

Tighten auxiliary drive housing to timing gear cover and to cylinder block prior to tightening the timing gear cover to cylinder block. See REMOVE, INSPECT AND INSTALL CRANKSHAFT GEAR-DRIVEN AUXILIARY DRIVE earlier in this group.

4. Install timing gear cover. Tighten cap screws one through six to specifications.

Specification	
Timing Gear Cover-to-Cylinder Block Cap Screws—Torque	27 N•m (20 lb-ft)

5. Install coolant pump and cover assembly (C) using a new gasket. Tighten cap screws to specifications.

Coolant Pump Cover-to-Timing Gear Cover—Specification	
5/16-in. Cap Screws—Torque	27 N•m (20 lb-ft)
3/8-in. Cap Screws—Torque	47 N•m (35 lb-ft)

6. Check camshaft endplay. See CHECK CAMSHAFT END PLAY AND MEASURE GEAR BACKLASH earlier in this group.)

7. Install injection pump drive gear cover (B) using a new gasket and tighten cap screws to specifications.

Continued on next page RG,RG34710,1211 –19–10JUN99–1/2

Specification

Injection Pump Drive Gear Cover—Torque .... 27 N•m (20 lb-ft)

8. Trim timing gear cover gasket flush with oil pan gasket rail.

RG,RG34710,1211 –19–10JUN99–2/2

Complete Final Assembly

1. Install a new crankshaft front wear sleeve and oil seal. See INSTALL CRANKSHAFT FRONT OIL SEAL in Group 040.

2. Connect the magnetic speed sensor wiring lead.

3. Install crankshaft vibration damper. See INSTALL VIBRATION DAMPER in Group 040.

4. Install valve train and rocker arm assembly. See INSTALL CYLINDER HEAD AND CAP SCREWS SERIAL NUMBER (—199,999) in Group 020 or see INSTALL CYLINDER HEAD AND CAP SCREWS SERIAL NUMBER (200,000—) in Group 021.

5. Install oil pan using a new gasket or install engine into vehicle if equipped with a structural oil pan. See INSTALL ENGINE OIL PAN in Group 060. Fill engine with clean engine oil.

6. Perform engine break-in as required. See PERFORM ENGINE BREAK-IN SERIAL NUMBER (—199,999) in Group 020, or see PERFORM ENGINE BREAK-IN SERIAL NUMBER (200,000—) in Group 021.

RG,RG34710,1212 –19–23OCT97–1/1

Diagnosing Lubrication System Malfunctions

Engine oil pressure (with engine warm) should be as follows:

Specification	
Engine—Oil Pressure (Engine Warm)	280—400 kPa (2.8—4.0 bar) (40—58 psi) @ 1800-2000 rpm

Low Oil Pressure:

- Low oil level.
- Clogged cooler or filter.
- Excessive oil temperature.
- Incorrect oil.
- Oil pressure regulating valve failure.
- Excessive main or rod bearing clearance.
- Clogged oil pump screen.
- Excessive clearance between oil pump gears and cover.
- Piston cooling orifice not installed.

High Oil Pressure:

- Improper oil classification.
- Clogged oil lines.
- Crimped or clogged ventilator outlet hose and adapter on rocker arm cover.
- Oil pressure regulating valve failure.

Oil Sludge and Dilution:

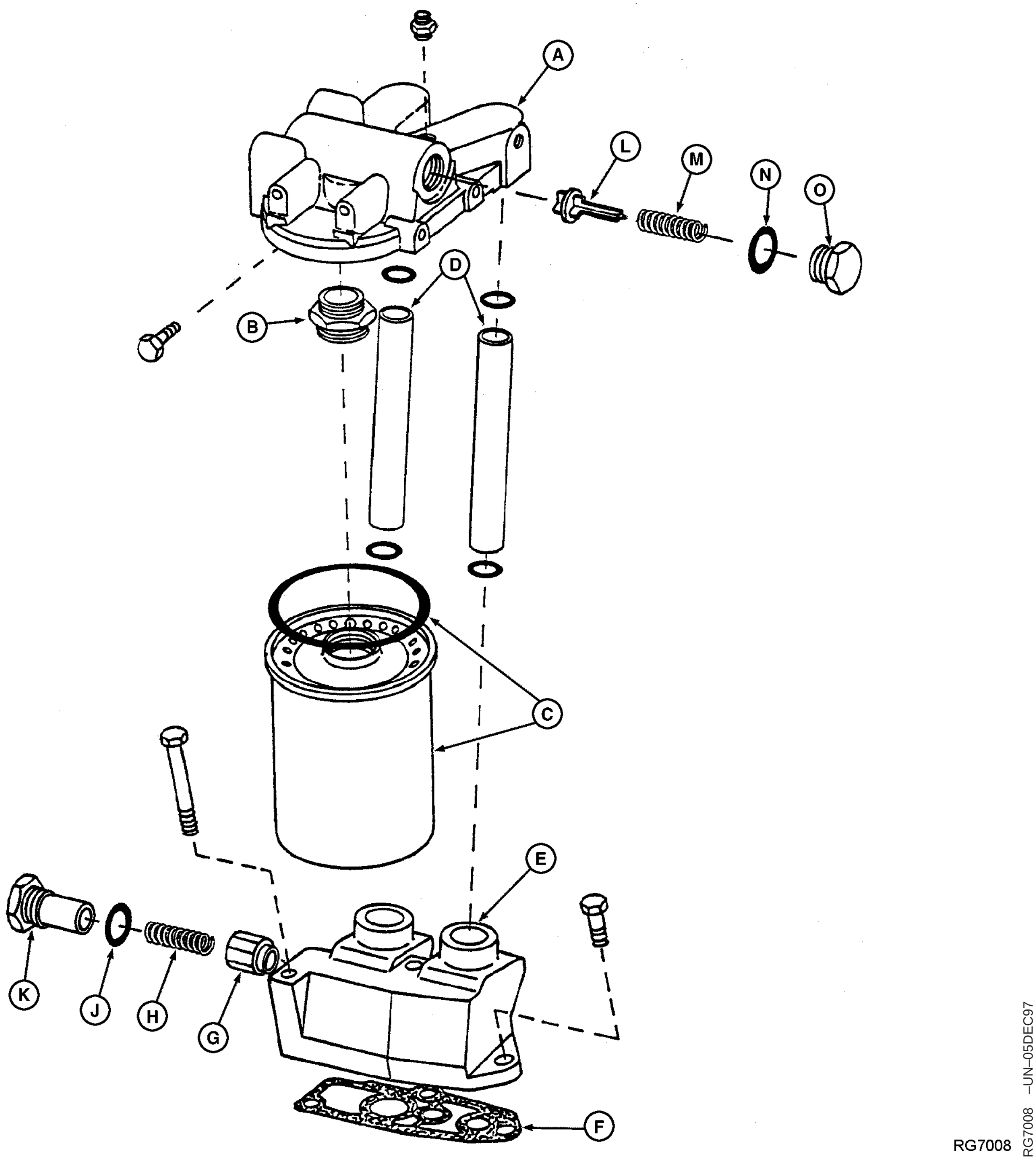
- Improper operation and servicing.
- Coolant leakage into lubrication system.
- Incomplete combustion.
- Excessive oil consumption.
- Defective injection pump (failed internal O-ring seals).

Low Oil Pressure at Slow Idle:

- Bypass oil check valve failure.

RG,RG34710,1215 –19–27APR99–1/1

Oil Filter Base and Oil Pressure Regulating Valve Housing Assembly



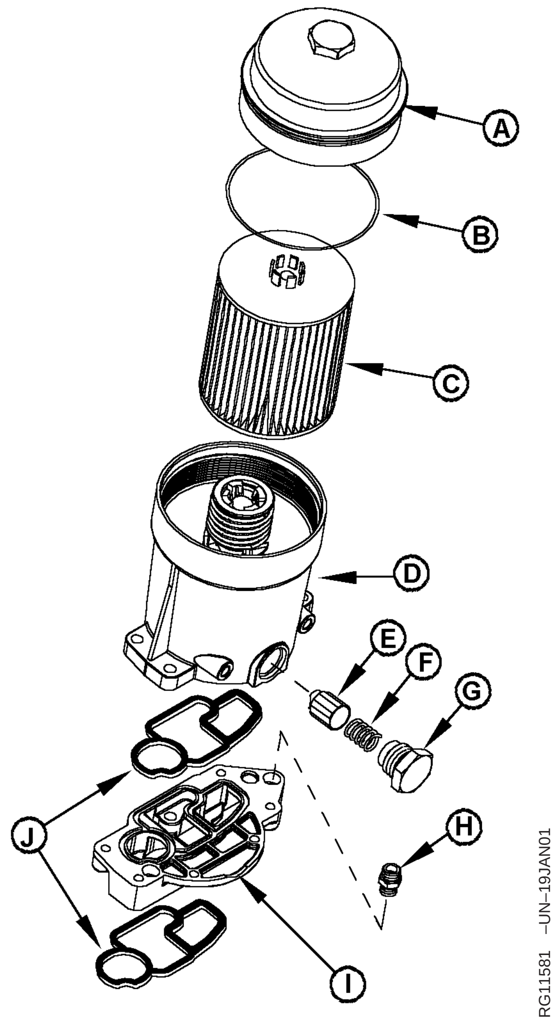
Oil Filter Base and Oil Pressure Regulating Valve Housing Assembly

A—Oil Filter Base
B—Oil Filter Adapter
C—Oil Filter With Packing
D—Oil Tubes
E—Oil Pressure Regulating Valve Housing
F—Gasket
G—Oil Pressure Regulating Valve
H—Spring
J—O-Ring
K—Plug
L—Oil Filter Bypass Valve
M—Spring
N—O-Ring
O—Plug

RG,RG34710,1216 –19–23OCT97–1/1

Top-Load Oil Filter Assembly

Top Load Oil Filter - Theory of Operation



Top-Load Oil Filter Assembly

A—Screw Cap
B—O-ring
C—Filter Element
D—Oil Filter Housing
E—Pressure Regulating Valve
F—Spring
G—Plug
H—Flex Fitting
I—Adapter Plate Assembly
J—Seal

Continued on next page
RE38635,0000072 –19–08MAR05–1/2

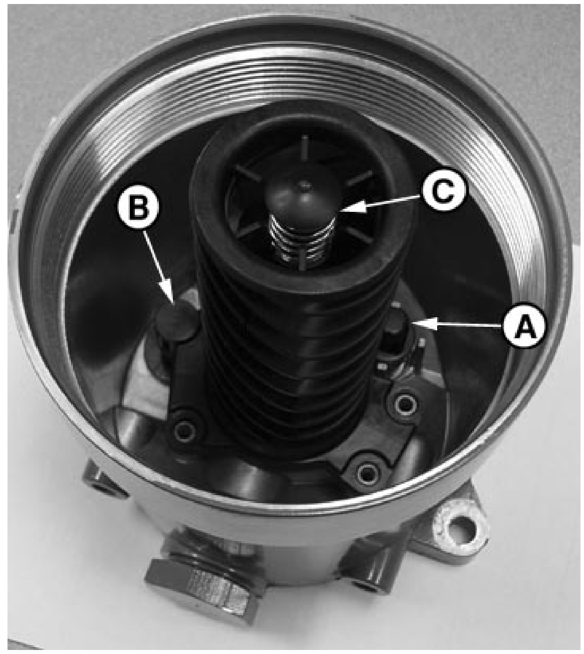
The top load oil filter assembly derives its name from the way the filter element "top loads"into the filter canister. The design is such that the filter element can be changed without the typical oil spill resulting from removal of the filter canister from the filter base. With the top load design, the filter canister remains on the filter base. Valves inside the filter canister regulate oil flow into the filter canister, pressure, and dump to sump when the filter element is changed.

When the filter element is in place and the system thus "closed", the pressure of the filter element keeps the return to sump valve (A) pressed downward, and thus closed. This prevents pressurized oil from being dumped back to sump prior to being filtered. If this valve is missing or not closed, low oil pressure will result.

Pressurized oil from the oil pump opens the inlet valve (B). This allows dirty, unfiltered oil from the sump to fill the canister and flow through the filter element. When the engine is turned off, this valve closes due to pressure from the oil within the canister, thus keeping the filter full of oil for the next start.

The bypass valve (C) protects the engine when the filter element becomes plugged, allowing unfiltered oil to reach engine components via the oil galley until the filter element can be changed.

When the oil filter element is removed for service replacement, pressure on the dump valve (A) is released, allowing oil in the canister to drain back to sump.



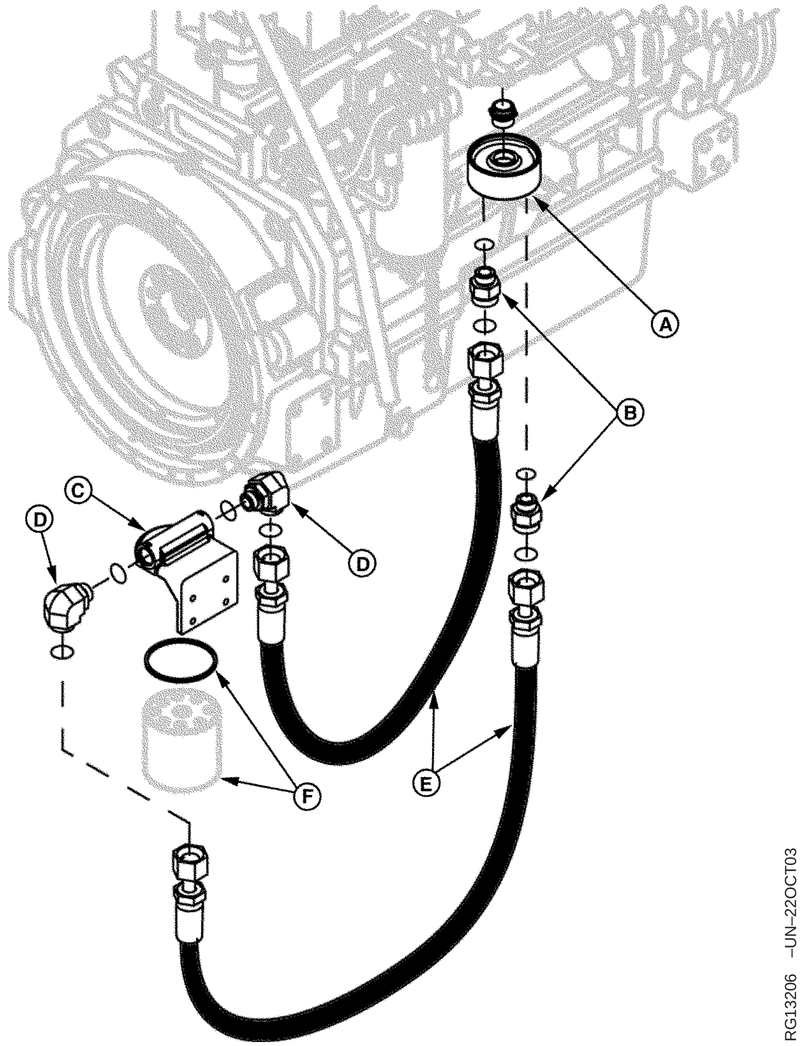
RG13823 –UN–16NOV04

Filter Canister Valve Operation

A—Return to Sump Valve
B—Inlet Valve
C—Bypass Valve

RE38635,0000072 –19–08MAR05–2/2

Remote Oil Filter Assembly



Remote Oil Filter Assembly

A—Adapter to Oil Filter Base
B—Straight Fittings
C—Remote Mount Filter Header
D—90° Elbow Fitting
E—Hoses for Remote Filter Location
F—Remote Oil Filter and Packing

RE38635,0000050 –19–16SEP03–1/1

Changing Top-Load Oil Filter

1. Use a wrench to unscrew cap (A). Wait 30 seconds to allow oil filter housing to drain. Remove cap and filter assembly.

2. While holding on to screw cap, strike filter element against a solid surface as shown to disconnect filter from cap. Discard used filter.

3. Remove o-ring seal and replace with new o-ring provided with new filter element.

4. Press new filter into cap until it snaps into place.

5. Insert cap and filter assembly into oil filter housing. Screw cap in place.

6. Use wrench to tighten cap to specification.

Specification

Top-Load Oil Filter Cap—Torque.................... 40—50 N•m (30—37 lb-ft)

A—Cap

RG11629A –UN–20DEC00

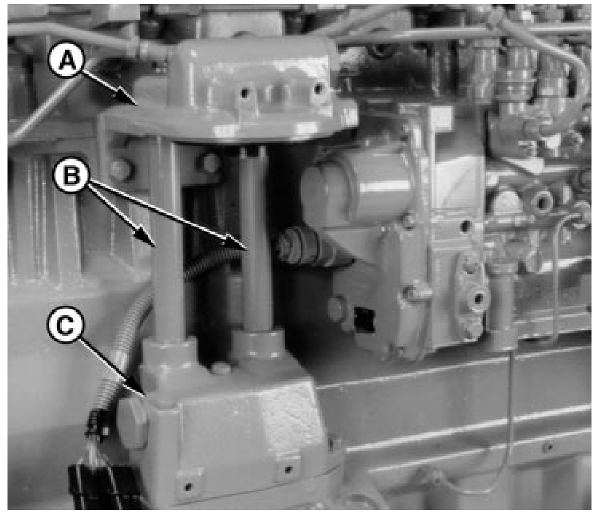
Top-Load Oil Filter Cap

RG11628 –UN–01FEB01

Strike on Surface to Remove Filter

RG41165,0000034 –19–20DEC00–1/1

Remove and Install Oil Filter Base and Oil Pressure Regulating Valve Housing



Oil Filter Base and Regulating Valve Housing

A—Oil Filter Base
B—Oil Tubes
C—Oil Pressure Regulating Valve Housing

Remove Oil Filter Base and Pressure Regulating Valve Housing:

1. Disconnect turbocharger oil inlet line connector from top of oil filter base (A) (shown disconnected).

2. Remove oil filter using a suitable filter wrench (shown removed).

3. Remove two cap screws securing oil filter base to cylinder block. Remove oil filter base and oil tubes (B). Remove and discard four O-rings.

4. Remove three cap screws securing oil pressure regulating valve housing (C) to cylinder block and remove housing. Clean all gasket material from both mating surfaces.

Install Oil Filter Base and Pressure Regulating Valve Housing:

NOTE: Refer to OIL FILTER BASE AND OIL PRESSURE REGULATING VALVE HOUSING ASSEMBLY, earlier in this group.

1. Install oil pressure regulating valve housing (E) using a new gasket. Install new, stronger-grade cap screws. Tighten new screws to specifications.

Specification	
Oil Pressure Regulating Valve Housing-to-Cylinder Block (External)—Torque	61 N•m (45 lb-ft)

2. Install new O-ring in housing O-ring bores, lubricate O-rings with clean engine oil, and install oil tubes.

3. Lubricate new O-rings with clean engine oil and install in oil filter base O-ring bores. Install base onto oil tubes.

4. Position filter base (A) on cylinder block, install cap screws, and tighten cap screws to specifications.

Continued on next page

Specification

Oil Filter Housing-to-Cylinder Block—Torque .... 80 N•m (60 lb-ft)

5. Connect turbocharger oil line connector at top of filter base and tighten securely.

6. If removed, install new O-rings and tighten valve plugs (K and O) to specifications.

Specification

Oil Filter Bypass Valve Plug—Torque .... 100 N•m (74 lb-ft)
Oil Pressure Regulating Valve Plug—Torque .... 100 N•m (74 lb-ft)

7. If oil filter adapter (B) was removed, coat threads of adapter with LOCTITE® 242 Thread Lock and Sealer and reinstall adapter.

8. Spread a layer of clean engine oil on new filter packing. Install filter and tighten until packing contacts filter base. Tighten an additional 1/2—3/4 turn after packing contacts base. DO NOT overtighten oil filter.

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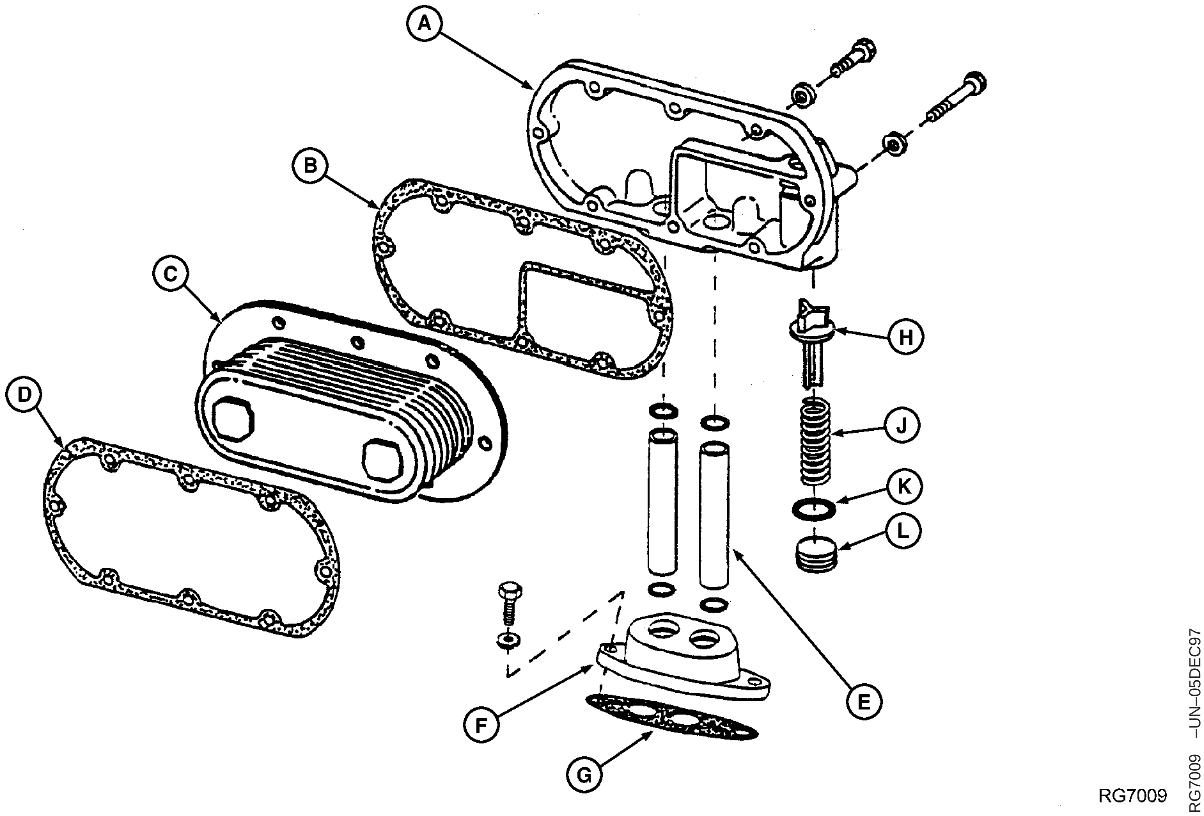
DPSG,OUO1004,842 –19–27APR99–2/2

Engine Oil Cooler Assembly



Engine Oil Cooler Assembly

A—Oil Cooler Cover/Bypass Valve Housing
B—Cover-to-Cooler Gasket
C—Oil Cooler
D—Cooler-to-Block Gasket
E—Oil Cooler Tubes (2 used)
F—Tube Adapter
G—Adapter-to-Block Gasket
H—Oil Cooler Bypass Valve
J—Spring
K—O-Ring
L—Plug

RG,RG34710,1218 –19–23OCT97–1/1

Remove, Inspect, and Install Engine Oil Cooler

See ENGINE OIL COOLER ASSEMBLY, earlier in this group for exploded view of engine oil cooler assembly.

Remove Oil Cooler Assembly:

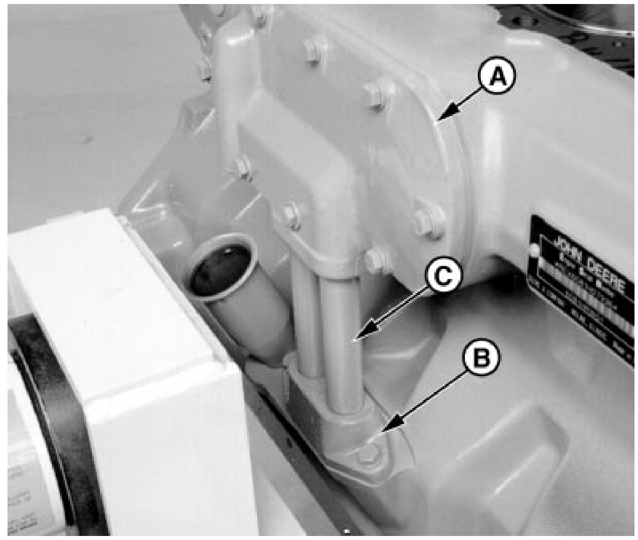
1. Remove eight cap screws securing oil cooler cover (A).
2. Remove two cap screws securing oil cooler tube adapter (B). Remove cover, tubes (C), and adapter as an assembly.
3. Remove oil cooler (D) from block bore. Clean all gasket material from mating surfaces.

Inspect Oil Cooler Assembly:

1. Inspect oil cooler for physical damage, plugging, or leakage which may allow mixing of oil and coolant.
2. Back flush oil cooler to clean all debris from core.
3. Pressure test oil cooler in liquid and compressed air if mixing of oil and coolant is suspected.

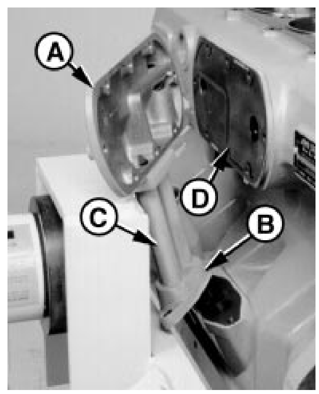
   Oil cooler should show no leakage when 140-170 kPa (1.4—1.7 bar) (20—25 psi) air pressure is applied for a minimum of 30 seconds.
4. Inspect all remaining parts of oil cooler assembly.

   Replace parts as needed. DO NOT attempt to repair oil cooler.



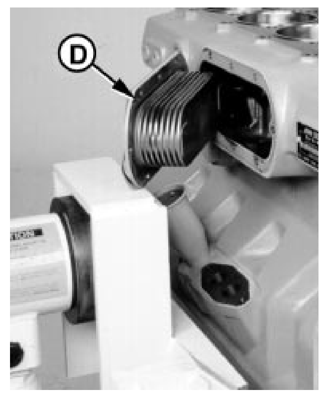
RG7217 –UN–12JAN98

Removing Oil Cooler



RG7218 –UN–26NOV97

Removing Oil Cooler



RG7219 –UN–28NOV97

Oil Cooler Removed

A—Oil Cooler Cover/Bypass Valve Housing
B—Oil Cooler Tube Adapter
C—Oil Cooler Tubes
D—Oil Cooler

Continued on next page DPSG,OUO1004,821 –19–27APR99–1/2

Install Oil Cooler Assembly:

1. Install oil cooler using a new gasket on each side of cooler. Be sure gaskets are properly aligned with cap screw holes.

NOTE: If cover, tubes, and adapter were disassembled, lubricate new O-rings with clean engine oil.

2. Install a new gasket on cylinder block and install oil cooler cover, tubes, and adapter as an assembly. Tighten adapter cap screws to specifications.

Specification

Oil Cooler Adapter Cap Screws—
Torque .... 47 N•m (35 lb-ft)

3. Tighten oil cooler cover (A) cap screws in sequence shown (1-8). Apply initial torque as follows:

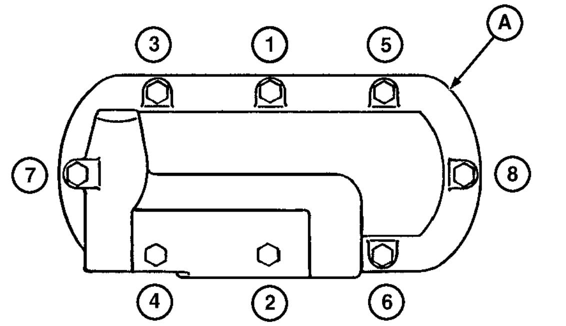
Specification

Oil Cooler Cover-to-Cylinder
Block Cap Screws—Initial Torque.................................. 20 N•m (15 lb-ft)

Then retighten in same sequence to final torque specification.

Specification

Oil Cooler Cover-to-Cylinder
Block—Final Torque... 37 N•m (27 lb-ft)



Sequence for Tightening Cover Screws

A—Oil Cooler Cover

DPSG,OUO1004,821 –19–27APR99–2/2

Remove, Inspect, and Install Oil Pressure Regulating Valve, Oil Filter Bypass Valve, and Oil Cooler Bypass Valve

See OIL FILTER BASE AND OIL PRESSURE REGULATING VALVE HOUSING ASSEMBLY and see ENGINE OIL COOLER ASSEMBLY, earlier in this group, for illustration of valves.

Oil Pressure Regulating Valve:

1. Remove plug (K), O-ring (J), spring (H), oil pressure regulating valve (G) from housing (E). Discard O-ring.

2. Inspect valve and valve bore for damage. Replace if necessary.

3. Check spring for proper compression. Replace spring if not within specification.

Specification

Pressure Regulating Valve
Spring—Compressed Length .... 43.0 mm (1.69 in.) @ 66—74 N (15—17 lb-force)
Free Length .... 85.0 mm (3.35 in.)

4. Dip all parts in clean engine oil; insert valve and spring in housing.

5. Install plug (K) using a new O-ring and tighten to specifications.

Specification

Oil Pressure Regulating Valve
Plug—Torque... 100 N•m (74 lb-ft)

NOTE: Pressure regulating valve starts to operate at 340 kPa (3.4 bar) (49 psi).

Specification

Oil Pressure Regulating
Valve—Operating Pressure
(Starts to Operate).................................... 340 kPa (3.4 bar) (49 psi)

Oil Filter Bypass Valve:

1. Remove plug (O) with O-ring (N), spring (M), and oil filter bypass valve (L) from oil filter base (A). Discard O-ring.

2. Inspect valve and housing bore for scoring or damage. Replace if necessary.

3. Check spring for proper compression. Replace spring if not within specification.

Specification

Oil Filter Bypass Valve
Spring—Compressed Length .... 30.0 mm (1.18 in.) @ 64—78 N (14—18 lb-force)
Free Length .... 44.0 mm (1.73 in.)

4. Dip all parts in clean engine oil; insert valve and spring in filter base.

5. Install new O-ring on plug (O). Install plug and tighten to specifications.

Specification

Oil Filter Bypass Valve Plug—
Torque.. 100 N•m (74 lb-ft)

NOTE: Filter bypass valve operating pressure is 220 kPa (2.20 bar) (32 psi).

Specification

Oil Filter Bypass Valve—
Operating Pressure................................. 220 kPa (2.20 bar) (32 psi)

Oil Cooler Bypass Valve:

1. Remove plug (L), O-ring (K), spring (J), and oil cooler bypass valve (I) from oil cooler cover/bypass valve housing (A). Discard O-ring.

2. Check housing for clogged passages and all other parts for scale build-up.

3. Clean all parts with a stiff bristle brush and solvent, if necessary. Dry with compressed air.

4. Inspect bypass valve for damage. Replace if necessary.

Continued on next page

5. Check bypass valve spring for proper specifications. Replace spring if not within specification.

Specification

Oil Cooler Bypass Valve
Spring—Compressed Length .... 30.0 mm (1.18 in.) @ 64—78 N (14—18 lb-force)
Free Length .... 44.0 mm (1.73 in.)

6. Dip all parts in clean engine oil; insert valve (I) and spring (J) in housing bore.

7. Install new O-ring on plug (L) and tighten to specifications.

Specification

Oil Cooler Bypass Valve Plug—
Torque... 100 N•m (74 lb-ft)

NOTE: Cooler bypass valve operating pressure is 220 kPa (2.20 bar) (32 psi).

Specification

Oil Cooler Bypass Valve—
Operating Pressure................................. 220 kPa (2.20 bar) (32 psi)

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RG,RG34710,1220 –19–23OCT97–2/2

Remove Engine from 8000 Tractors for Access to Engine Oil Pump

6081HRW Engines used in 8000 Series Tractors are equipped with a front frame/oil sump which is also a structural member of the vehicle. For access to the engine oil pump, the engine must be removed from the vehicle. Refer to TM1575 (8100, 8200, 8300, and 8400 Tractors—Repair) for engine removal instructions. (For Tracks models, refer to TM1621.)

RG,RG34710,1221 –19–23OCT97–1/1

Remove Oil Pan

Removing oil pan will allow access to engine oil pump.

1. Drain engine oil.

2. Remove oil pan and discard gasket.

3. Remove all gasket material from oil pan rail and cylinder block mounting surfaces.

IMPORTANT: Oil pan cap screws should have only one flat washer and no lockwasher. If cap screws have flat washers with lock washers, discard them and replace with new hardened flat washers.

DPSG,OUO1004,822 –19–21APR99–1/1

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Check Crankshaft Gear-to-Oil Pump Drive Gear Backlash

IMPORTANT: Backlash must be at least 0.08 mm (0.003 in.) for helical gear and at least 0.10 mm (0.004 in.) for spur gear. If backlash is less than specification, replace the oil pump drive gear.

Before removing oil pump, determine if there is adequate backlash between oil pump and crankshaft drive gears.

Specification

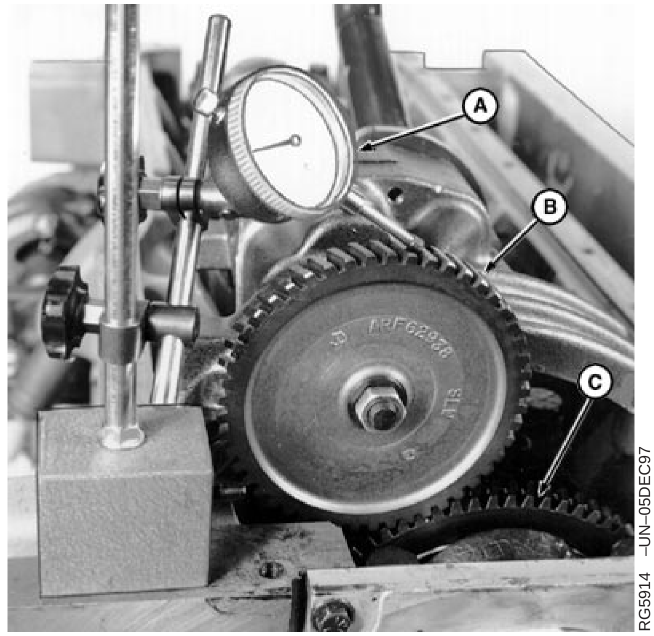
Crankshaft Helical Gear-to-Oil Pump Drive Gear—Backlash .... 0.08 mm (0.003 in.) minimum
Crankshaft Spur Gear-to-Oil Pump Drive Gear—Backlash .... 0.10 mm (0.004 in.) minimum

Mount dial indicator (A) and measure backlash between pump drive gear (B) and crankshaft gear (C).

Check oil pump gear-to-crankshaft throw clearance.

Specification

Oil Pump Helical Gear-to-Crankshaft Throw—Clearance .... 0.38 mm (0.0015 in.) minimum



Measuring Oil Pump Drive Gear Backlash

A—Dial Indicator
B—Pump Drive Gear
C—Crankshaft Gear

DPSG,OUO1004,843 –19–27APR99–1/1

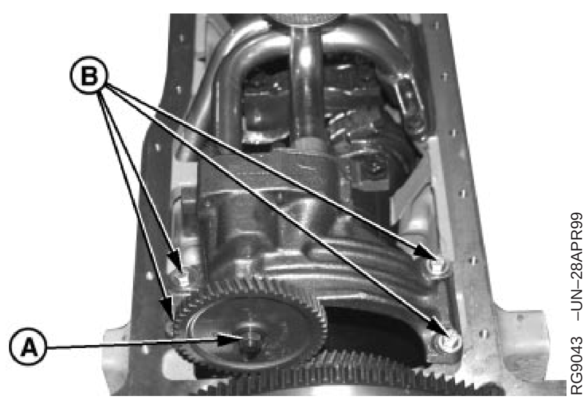
Remove Engine Oil Pump

1. Loosen drive gear retaining nut (A) one full turn.

2. Remove four oil pump housing cap screws with washers (B).

IMPORTANT: Some early engines used grade 5 oil pump mounting cap screws. Replace these cap screws with new grade 8 cap screws when reinstalling pump.

3. Lift up on oil pump assembly and wiggle assembly left-to-right to disengage housing from mounting dowels.



Remove Oil Pump

A—Drive Gear Retaining Nut
B—Oil Pump Housing Cap Screws

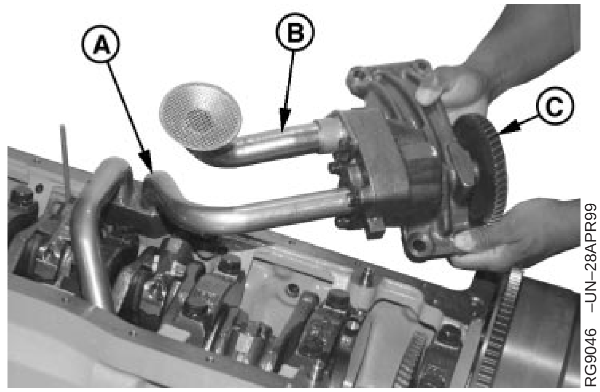
Continued on next page

DPSG,OUO1004,844 –19–27APR99–1/2

4. Once pump assembly is free from dowels, swing assembly to the right (as viewed from flywheel end) and disengage outlet tube (A) from pump housing.

5. Remove oil pump drive gear (C) and oil pickup tube (B) from pump.

A—Outlet Tube
B—Pickup Tube
C—Oil Pump Drive Gear



Remove Oil Pump

DPSG,OUO1004,844 –19–27APR99–2/2

Inspect and Clean Oil Pump

1. Visually inspect oil pump for wear or damage.

IMPORTANT: DO NOT disassemble engine oil pump for flushing, inspection, or performing wear checks. Individual components of oil pump are not available through service parts. Replace pump as a complete assembly.

Never hammer directly on oil pump housing as it could cause binding of gears.

2. Flush pump assembly internally with clean solvent to remove oil. Spin pump gears to help remove solvent. *Pump gears should move freely*.

3. Place oil pump on a work bench with pump-to-cylinder block mounting surface facing upward (same as when mounted on engine).

IMPORTANT: To help insure accurate wear measurements, be sure the oil pump is clean and faces the same way as when mounted on the cylinder block.

NOTE: Leave pump drive gear installed when making checks.

RG,RG34710,1225 –19–23OCT97–1/1

Check Drive Shaft End Play

1. Mount dial indicator with indicator plunger resting against end of pump drive shaft.

2. Move shaft toward and away from indicator.

   If end play exceeds specification, there is excessive wear on pump cover and/or wear on end of pump drive gear.

Specification

Oil Pump Drive Shaft—Maximum
End Play .... 0.15 mm (0.006 in.)

Replace oil pump if end play exceeds specification.

RG5916 –UN–05DEC97

Checking Pump Shaft End Play

RG,RG34710,1226 –19–23OCT97–1/1

Check Drive Shaft Side Movement

1. Mount dial indicator with indicator plunger resting on one of the hex nut flats.

2. Move shaft from side-to-side.

   If shaft side movement exceeds specification, there is excessive wear in drive shaft bushing and/or drive shaft.

Specification

Oil Pump Drive Shaft—Maximum
Side Movement .... 0.17 mm (0.0065 in.)

Replace oil pump if shaft side movement exceeds specification.

RG5917 –UN–05DEC97

Checking Pump Shaft Side Movement

RG,RG34710,1227 –19–23OCT97–1/1

Check Pumping Gear Backlash

1. Mount dial indicator with plunger resting against side of gear tooth.

2. Hold idler gear stationary. Slowly rotate drive gear back and forth until contact with idler gear is left.

   If backlash is not within specification, there is excessive pumping gear wear and/or idler shaft and gear bushing wear.

Specification

Oil Pump Drive Gear—Backlash......... 0.33—2.00 mm (0.013—0.079 in.)

If there is less than 0.33 mm (0.013 in.) backlash, re-clean gears and check backlash again.

3. Replace oil pump if pumping gear backlash exceeds 2.00 mm (0.079 in.).

RG5918 –UN–05DEC97

Checking Backlash of Pumping Gear

RG,RG34710,1228 –19–23OCT97–1/1

Inspect Oil Pump Drive Gear

NOTE: Oil pump does not need to be removed from engine, when inspecting drive gear.

Inspect drive gear teeth for chips, cracks, or wear. Replace as necessary.

RG6435 –UN–05DEC97

Inspecting Pump Drive Gear

RG,RG34710,1229 –19–23OCT97–1/1

Adjust Oil Pump Set Screw

IMPORTANT: Normally the set screw (A) should NOT be adjusted; but if the set screw is altered, the following steps should be followed.

1. Assemble drive gear and idler gear into pump housing.

2. Install oil pump cover (B) and tighten cover-to-housing cap screws to specifications.

Specification

Oil Pump Cover-to-Housing—
Torque .... 41 N•m (30 lb-ft)

3. Tighten set screw until it contacts idler shaft.

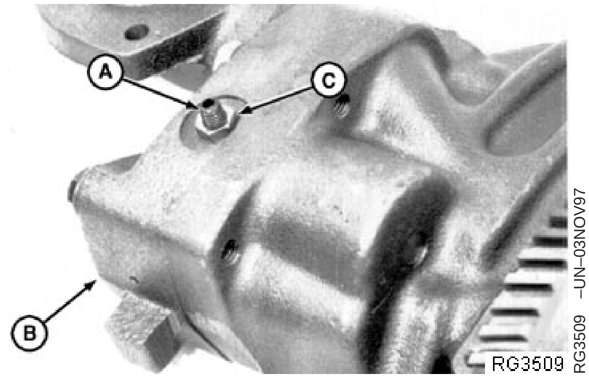
4. Continue to hold set screw and tighten lock nut (C) to specifications.

Specification

Oil Pump Set Screw Lock Nut—
Torque .... 8 N•m (6 lb-ft)

Do not overtighten set screw or lock nut.

5. Spin drive gear by hand to assure shaft turns freely in housing. Readjust set screw if shaft does not turn freely.



Inspecting Pump Drive Gear

A—Set Screw
B—Oil Pump Cover
C—Lock Nut

DPSG,OUO1004,845 –19–27APR99–1/1

Install Engine Oil Pump

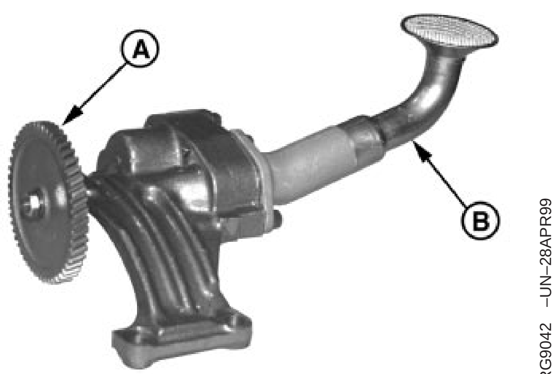
1. Install gear (A) onto pump and tighten snug using nut and washer. Final torque will be accomplished after installing pump.

2. Using a new gasket, install oil pickup tube (B) onto oil pump and tighten cap screws to specifications.

Specification

Oil Pump Intake (Pickup)
Tube-to-Cover—Torque.. 47 N•m (35 lb-ft)

A—Oil Pump Drive Gear
B—Oil Pickup Tube



Install Oil Pump Gear and Pickup

Continued on next page

DPSG,OUO1004,823 –19–21APR99–1/2

3. Install new O-ring in groove of oil pump housing and lubricate with clean engine oil. Install oil pump outlet tube into oil pump housing.

4. Swing oil pump assembly over locating dowels and carefully position assembly onto dowels without applying pressure to or causing binding of outlet tube.

IMPORTANT: Do not hammer directly on pump housing as it could cause binding of gears.

5. Seat pump onto dowels using a hard rubber hammer on outer edge of housing near mounting holes (as shown). Make sure drive gear is properly meshed with crankshaft gear and oil pump outlet tubes are properly positioned (with no binding) in O-ring bores.

IMPORTANT: Some early engines used grade 5 oil pump mounting cap screws. Replace these cap screws with new grade 8 cap screws when reinstalling pump.

6. Install and tighten oil pump housing-to-cylinder block cap screws to specifications.

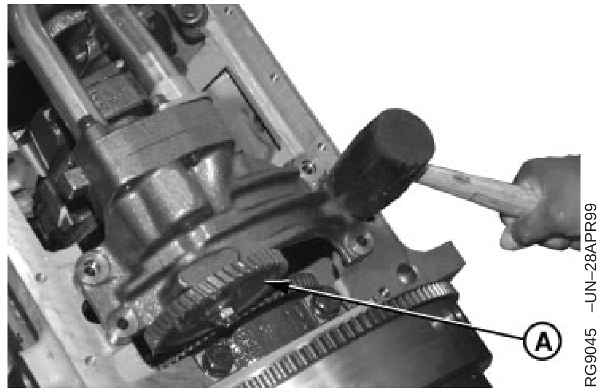
Specification

Oil Pump Housing-To-Cylinder Block—Torque .... 42 N•m (31 lb-ft)

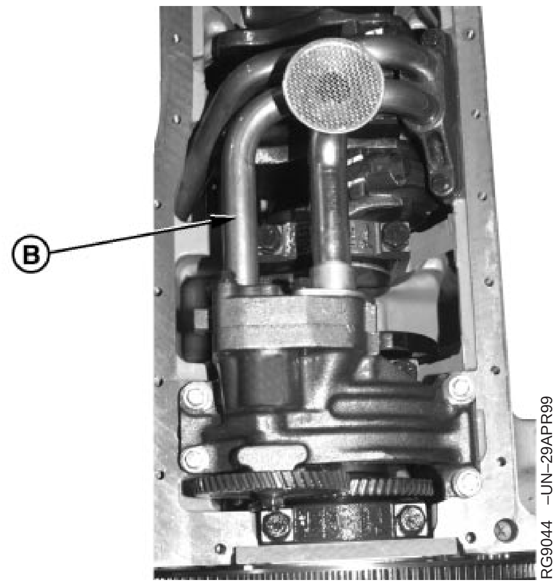
7. Tighten oil pump drive gear retaining nut to specifications.

Specification

Oil Pump Drive Gear Retaining Nut—Torque .... 54 N•m (40 lb-ft)



Oil Pump Gear



Install Oil Pump Outlet Tube

A—Oil Pump Drive Gear
B—Oil Pump Outlet Tube

DPSG,OUO1004,823 –19–21APR99–2/2

Remove and Install Oil Pump Outlet Tube and Oil Cooler Crossover Tube Adapter

Remove Adapter:

1. Remove oil pump (shown removed). See REMOVE ENGINE OIL PUMP earlier in this group.

2. Remove two cap screws securing adapter (A) to cylinder block and remove adapter with oil cooler cross-over tube (B).

3. Clean all gasket material from mating surfaces and discard.

Install Adapter:

NOTE: Be sure gasket is positioned so that offset matches adapter to avoid blocking oil passages.

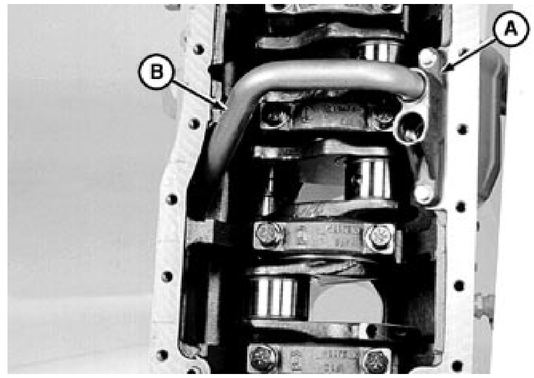
1. Lubricate new O-ring with clean engine oil and install adapter (with cross-over tube) using a new gasket. Make sure tubes are properly positioned in each O-ring bore.

2. Tighten cap screws to specifications.

Specification

Oil Pump Outlet and Oil Cooler Cross-Over Tube-to-Cylinder Block Adapter (Internal)—Torque .... 54 N•m (40 lb-ft)

3. Install engine oil pump assembly. See INSTALL ENGINE OIL PUMP earlier in this group.



RG7221 –UN–05DEC97

Oil Cooler Crossover Tube and Adapter

A—Adapter
B—Oil Cooler Cross-Over Tube

RG,RG34710,1232 –19–23OCT97–1/1

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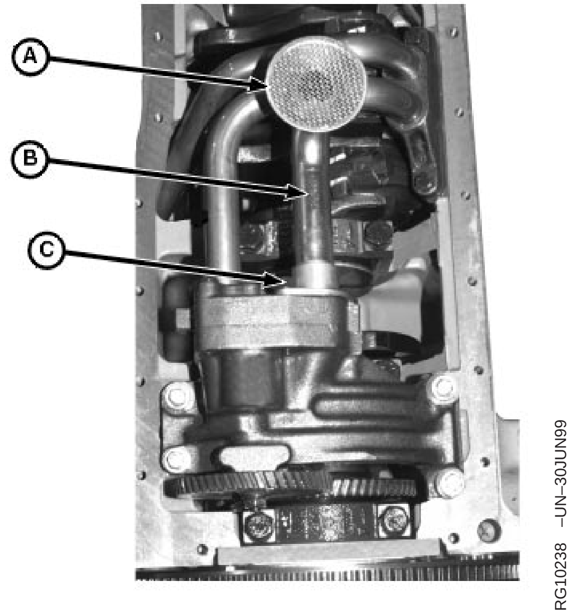
Remove, Inspect, and Install Oil Pump Pickup Tube

1. Remove oil pan. See REMOVE OIL PAN earlier in this group.
2. Remove cap screws (C) and remove oil pickup tube assembly (B) and gasket.
3. Clean and flush tube and pickup screen (A).
4. Inspect tube for cracks or restrictions. Replace as required.
5. Install pickup tube assembly with new gasket and tighten cap screws to specifications.

Specification

Oil Pump Pickup Tube Cap Screws—Torque .... 41 N•m (30 lb-ft)

6. Install oil pan. See INSTALL ENGINE OIL PAN later in this group.

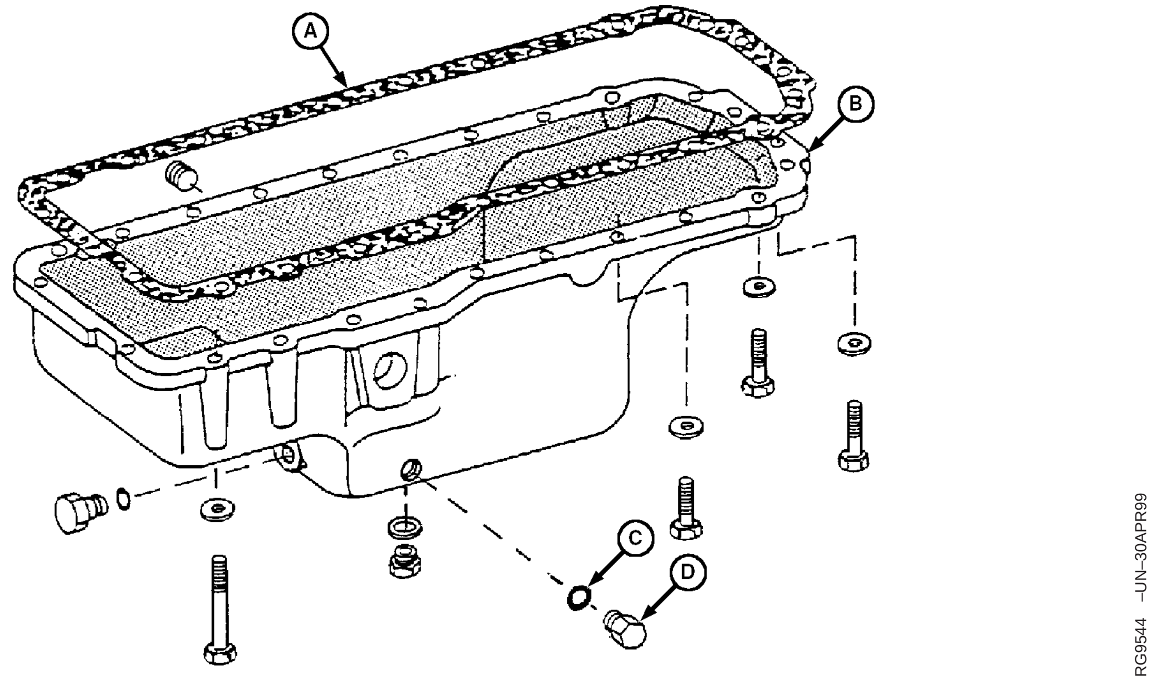


Oil Pickup Tube

A—Screen
B—Oil Pickup Tube
C—Cap Screws (3 used)

DPSG,OUO1004,914 –19–29JUN99–1/1

Install Engine Oil Pan



Install Oil Pan

A—Oil Pan Gasket **B—Oil Pan** **C—O-Ring** **D—Drain Plug**

All oil pan and cylinder block (including timing gear cover and rear seal housing) gasket sealing surfaces MUST BE free of gasket material or oil, and dry.

1. Apply a thin layer of PERMATEX® Aviation (Form-A-Gasket No. 3, TY6299) at timing gear cover-to-cylinder block mating surfaces.

2. Apply a thin layer of PERMATEX® Aviation (Form-A-Gasket No. 3, TY6299) at rear oil seal housing-to-cylinder block mating surfaces.

3. Position new oil pan gasket (A) on cylinder block.

4. Apply a thin layer of PERMATEX® Aviation (Form-A-Gasket No. 3, TY6299) to gasket at same location as cylinder block in Step Nos. 1, 2 above.

IMPORTANT: Oil pan cap screws should have only one flat washer and no lockwasher. If cap screws have flat washers with lock washers, discard them and replace with new hardened flat washers.

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 (B) on cylinder block and tighten all oil pan-to-cylinder block cap screws as follows:

   a. First tighten 1/2-inch cap screws to the following specification.

Specification

Oil Pan 1/2 in. Cap Screws—
Torque.. 156 N•m (115 lb-ft)

   b. Next tighten 3/8-inch cap screws to specifications.

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Specification

Oil Pan 3/8 in. Cap Screws—
Torque........ 68 N•m (50 lb-ft)

6. Trim oil pan gasket flush at rear surface of cylinder block and oil pan.

7. Retighten all oil pan cap screws as follows:

   a. First retighten 3/8-inch cap screws to specification.

   b. Finally, retighten all 1/2-inch cap screws to specification.

8. Install pan drain plug (D) using a new O-ring (C) and tighten to specifications.

Specification

Oil Pan Drain Plug Aluminum
Pans—Torque........ 101 N•m (75 lb-ft)

9. Some engine oil pans may be equipped with an elbow and drain hose.

NOTE: On engines equipped with elbow fittings and drain hose, the threads and sealing surfaces must be free of any oil film to insure an effective seal. Apply a light coat of LOCTITE® 592 to fittings except for the leading one to three threads.

If equipped, tighten elbow lock nut to the following specification.

Specification

Oil Pan Elbow Lock Nut—
Torque........ 81 N•m (60 lb-ft)

DPSG,OUO1004,824 –19–21APR99–2/2

Tighten Cap Screws on Front Frame/Oil Sump (8000 Series Tractors)

NOTE: Refer to illustration on following page.

1. Be sure all four sump-to-block locating dowels are in place.

IMPORTANT: DO NOT apply gasket sealant to gasket, front frame/oil sump, trimmed edges of timing gear cover gasket, oil seal housing gasket, or cylinder block mating surfaces. Before installing engine, be sure mating surfaces of engine and front frame/oil sump are clean and dry.

2. Install front frame/oil sump-to-cylinder block gasket.

3. Carefully lower engine block onto front frame/oil sump locating dowels.

4. Install all 3/8 in. and 1/2 in. cap screws in their appropriate locations as shown by A-F.

5. Tighten all 1/2 in. cap screws to specifications.

Specification

Front Frame/Oil Sump (8000 Tractors) 1/2 in. Cap Screws—Torque .... 133 N•m (98 lb-ft)

Tighten all 3/8 in. cap screws to specifications.

Specification

Front Frame/Oil Sump (8000 Tractors) 3/8 in. Cap Screws—Torque .... 58 N•m (43 lb-ft)

6. Re-tighten all 3/8 in. cap screws to specifications.

   Re-tighten all 1/2 in. cap screws to specifications.

7. Apply clean engine oil to new O-ring for bottom drain plug and install drain plug, if removed. Tighten plug to specifications.

Specification

Oil Pan Drain Plug Cast Iron Pans (Sumps)—Torque .... 47 N•m (35 lb-ft)

NOTE: Refer to TM1575 (8000 Tractors—Repair) for engine installation instructions after servicing engine oil pump assembly. (For Tracks models, refer to TM1621.)

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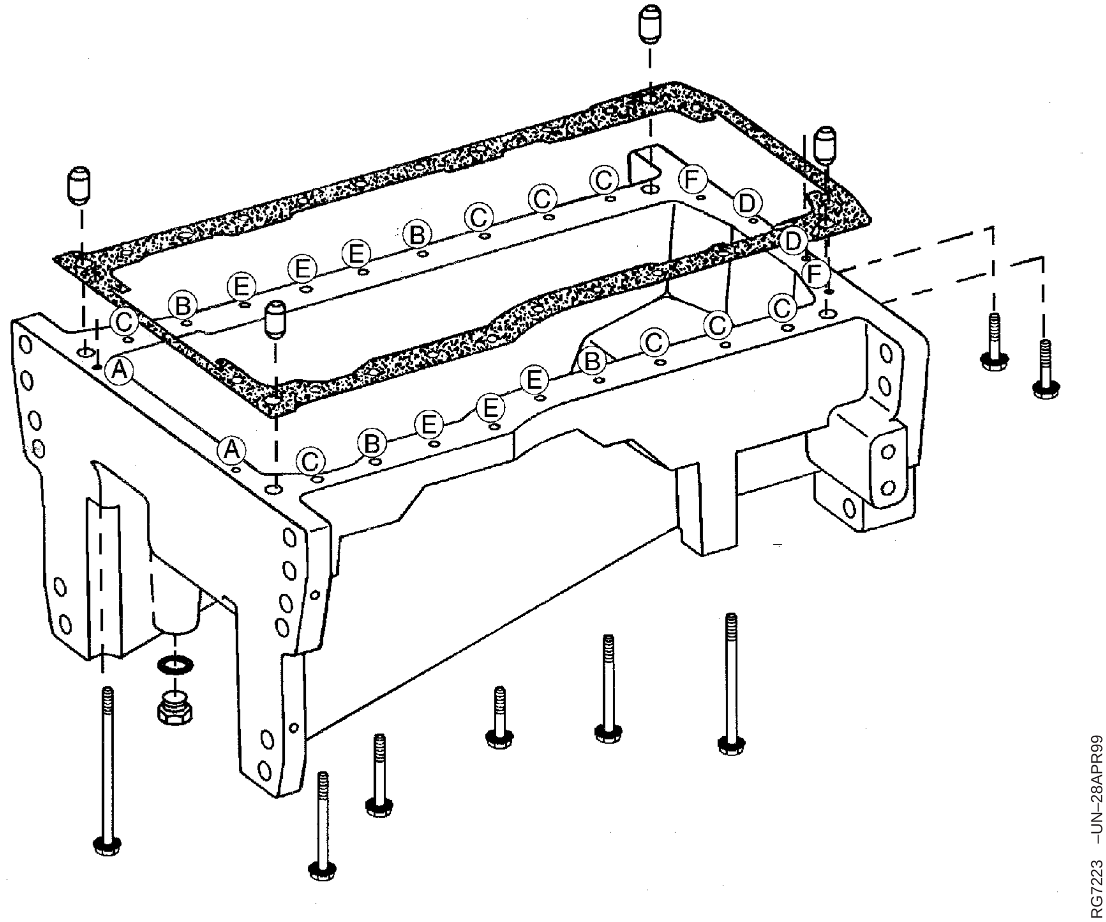
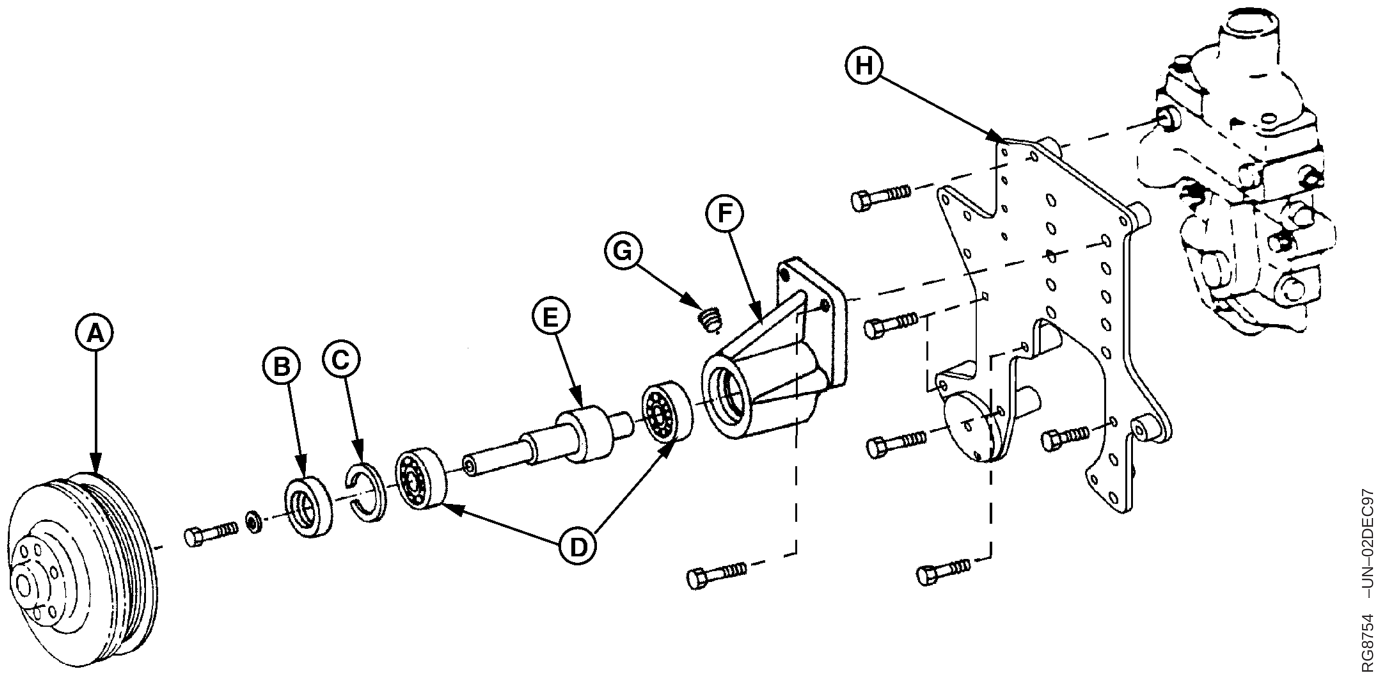


Front Frame/Oil Pump for 8000 Tractors

A—0.3775 x 7.500 in. (2 used)
B—0.500 x 4.000 in. (4 used)
C—0.500 x 6.000 in. (8 used)
D—0.375 x 2.250 in. (2 used)
E—0.500 x 2.500 in. (6 used)
F—0.375 x 1.875 in. (2 used)

RG,RG34710,1234 –19–23OCT97–2/2

Inspect Fan Hub & Replace Bearings in Heavy-Duty, Adjustable Fan Drive Assembly



Heavy-Duty Adjustable Fan Drive Assembly

A—Fan Hub/Pulley
B—Grease Seal
C—Snap Ring
D—Ball Bearing (2 Used)
E—Shaft
F—Bearing Housing
G—Pipe Plug
H—Support Plate

To Disassemble Fan Drive:

1. Remove belts and remove fan. Remove fan drive assembly from engine.

2. Check run-out of fan hub using a dial indicator on outer face of hub. If run-out exceeds specification, replace fan drive assembly.

Specification

Fan Drive Hub—Radial Runout	0.038 mm (0.0015 in.)

3. Clamp fan hub/pulley (A) in a soft-jawed vise. Support fan hub (so it does not fall to floor), and remove cap screw securing hub to shaft (E). Remove fan hub.

4. Remove pipe plug (G), grease seal (B), and snap ring (C). Discard seal and snap ring.

5. Remove shaft with bearings (D) by lightly tapping with a rubber mallet or brass hammer.

6. Remove bearings from shaft using a press and discard bearings.

7. Thoroughly clean and inspect shaft and bearing housing (F) for cracks or any other damage. Measure parts and compare with specifications given below.

Specification

Adjustable Fan Drive Housing—ID	71.999—72.025 mm (2.8346—2.8356 in.)
Adjustable Fan Drive Shaft—OD	35.001—35.017 mm (1.3780—1.3786 in.)
Adjustable Fan Drive Bearing—ID.	34.987—35.013 mm (1.3774—1.3785 in.)
OD	71.987—72.013 mm (2.8341—2.8351 in.)

Replace parts that are cracked or not within specification.

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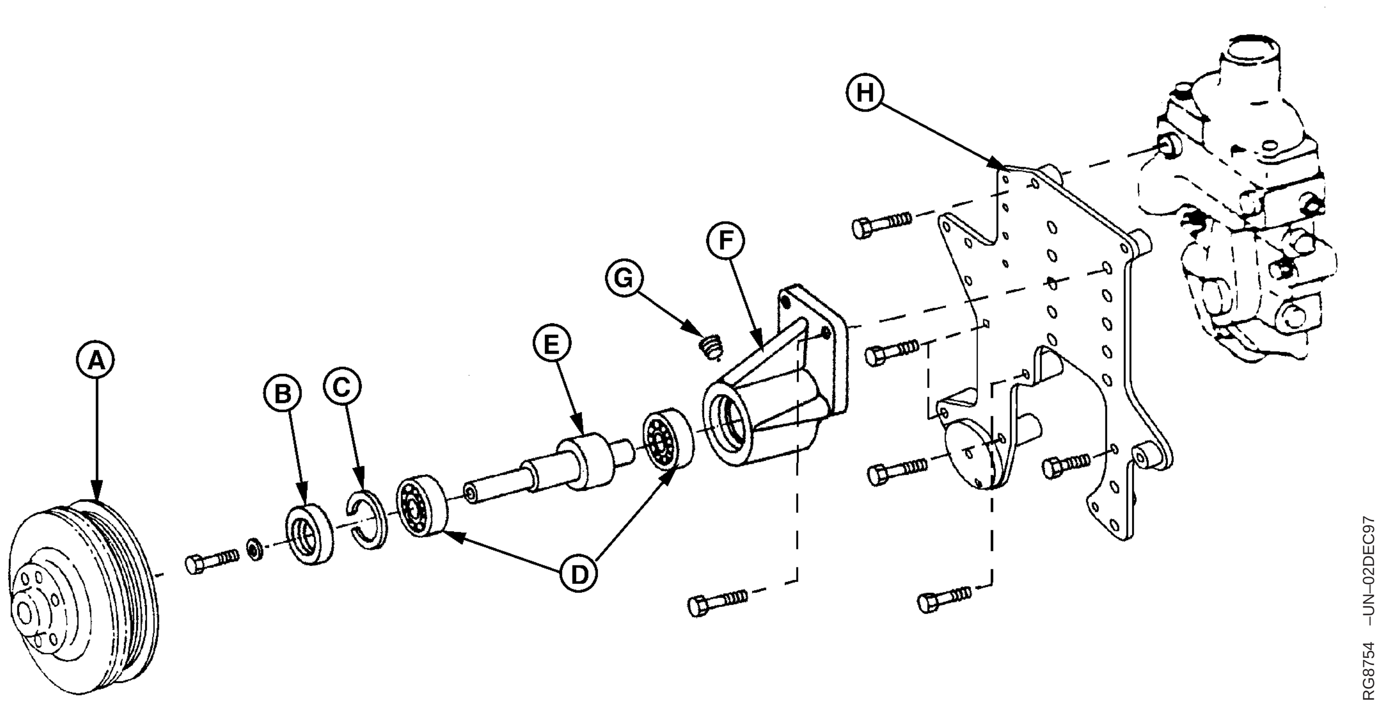

Heavy-Duty Adjustable Fan Drive Assembly

A—Fan Hub/Pulley
B—Grease Seal
C—Snap Ring
D—Ball Bearing (2 Used)
E—Shaft
F—Bearing Housing
G—Pipe Plug
H—Support Plate

To Assemble Fan Drive:

1. Pack inner and outer bearings (D) with TY6333 or TY6347 High Temperature Grease. Apply clean engine oil to bearing I.D. and shaft O.D.

2. Support end of shaft (E) and install bearings against shoulder. *Apply force to bearing inner race only*.

3. Support bearing housing (F) on a firm flat surface with bearing bore in the upward position.

4. Install bearing and shaft assembly into housing. Small end of shaft should extend through housing.

5. Determine proper snap ring (C) thickness needed to obtain specified end play.

Specification

Adjustable 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.

7. Apply a thin coat of clean engine oil to O.D. of seal casing (B) and to seal lips. Install seal in housing bore until metal casing is to specified depth below housing face.

Specification

Adjustable Fan Drive Housing
Seal—Depth... Flush-to-0.50 mm (0.020 in.) below housing face

8. Apply clean engine oil to I.D. of fan hub/pulley (A). Support end of shaft through pipe plug hole in bearing housing and push onto other end of shaft until it bottoms against shoulder.

Continued on next page

DPSG,OUO1004,848 –19–27APR99–2/3

NOTE: If engine is equipped with a fan/hub pulley-to-fan spacer, tighten hub/pulley-to-spacer cap screws to the following specification.

Specification

Fan/Hub Pulley-to-Fan Spacer Cap Screws—Torque .... 60 N•m (45 lb-ft)

9. Install washer and cap screw. Tighten cap screw to specifications.

Specification

Fan Hub/Pulley-to-Fan Shaft—Torque... 80 N•m (60 lb-ft)

10. Apply LOCTITE® 592 Pipe Sealant to threads of pipe plug (G). Install and tighten plug in bearing housing.

11. Install fan drive assembly onto support plate (H).

12. Install support plate assembly onto engine and tighten cap screws to the following specifications.

Fan Drive Support Plate-to-Engine—Specification

5/16-in. Mounting Cap Screws (To Injection Pump Access Cover)—Torque .... 24 N•m (18 lb-ft)
5/16-in. Mounting Cap Screws (All Others)—Torque.. 35 N•m (26 lb-ft)
3/8-in. Mounting Cap Screws—Torque.. 61 N•m (45 lb-ft)
1/2-in. Mounting Cap Screws—Torque.. 101 N•m (74 lb-ft)

13. Install fan and belts and adjust tension. See REPLACING FAN/ALTERNATOR V-BELT in operator's manual.

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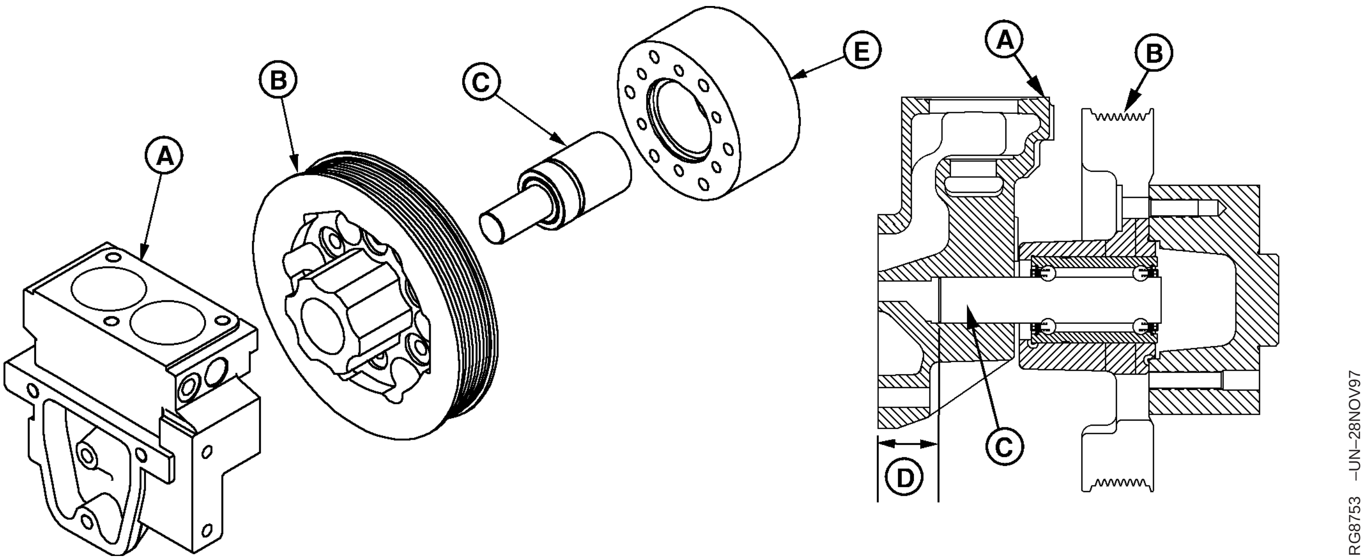
DPSG,OUO1004,848 –19–27APR99–3/3

Replace Bearings in Coolant Manifold-Mounted, Fixed Fan Drive Assembly



Fixed Fan Drive Assembly

A—Coolant Manifold
B—Fan Pulley
C—Bearing Shaft
D—Bearing Shaft Installed Dimension
E—Fan Spacer Hub[1]

To Disassemble Fan Drive:

1. Remove three coolant manifold-to-cylinder head cap screws. Remove coolant manifold (A) and fan pulley (B) assembly from cylinder head and lift to dislodge coolant bypass pipe from manifold.

2. Support front face of coolant manifold and use a press to push bearing (C) and pulley out of manifold.

3. Support front face of fan pulley and push bearing out of pulley, and fan spacer (if equipped). Discard bearing.

4. Thoroughly inspect coolant manifold and pulley for cracks or damage. Measure parts and compare readings with specifications shown. Replace parts as necessary.

IMPORTANT: Support fan pulley on a flat, firm surface and press only on bearing outer race to prevent damage to the bearing.

5. Install new bearing into pulley until outer race bottoms in bore of pulley. End of shaft will extend through bearing stop.

Coolant Manifold-Mounted Fixed Fan Drive Specifications

Coolant Manifold-Mounted Fixed Fan Drive Specifications—Specification	
Fixed Fan Drive Shaft—OD	25.387—25.400 mm (0.9995—1.0000 in.)
Fixed Fan Drive Bearing—OD	47.612—47.625 mm (1.8745—1.8750 in.)

[1] *In some applications, bearing is pressed into hub (E). The fan spacer and pulley are then bolted to hub. In some applications, the fan spacer is press-fit into the pulley. Dimension (D) is the same for all applications.*

Continued on next page

Fixed Fan Drive Pulley (Bearing End)—ID .... 47.576—47.612 mm (1.8731—1.8745 in.)
Fixed Fan Drive Pulley (Fan Spacer End)[2]—ID .... 49.485—49.518 mm (1.9482—1.9495 in.)
Fan Spacer[2]—O.D. .... 49.457—49.483 mm (1.9471—1.9481 in.)
Fixed Fan Drive Manifold—I.D. .... 25.336—25.362 mm (0.9975—0.9985 in.)
Fixed Fan Drive Shaft (Installed)—Dimension From Manifold Mounting Face to End of Shaft .... 32.51—32.77 mm (1.280—1.290 in.)

To Assemble Fan Drive:

IMPORTANT: Support coolant manifold on machined surface and press only on inner shaft to prevent damage to bearing.

1. On units with a press-fit fan spacer, press spacer (E) into pulley (B) to the following depth.

Specification
Adjustable Fan Drive Housing Seal—Depth........ Flush-to-0.50 mm (0.020 in.) below housing face

2. Press bearing shaft (C) into coolant manifold (A) to the following specification.

Specification
Fixed Fan Drive Bearing Shaft—Depth .... 33.31—33.57 mm (1.311—1.322 in.) below manifold mounting surface

Hold coolant manifold firmly and turn fan pulley by hand to be sure bearings rotate freely.

3. Install a new gasket and O-rings. Insert coolant bypass pipe in manifold and install assembly onto locating pin in front face of cylinder head. Tighten cap screws to specifications.

Specification
Fixed Fan Drive (Coolant Manifold Mounted) Cap Screws—Torque .... 60 N•m 45 (lb-ft)

4. Install fan and belts. Refer to appropriate operator's manual for proper belt tensioning.

02
070
5

[2] *Units with press-fit fan spacer only.*

DPSG,OUO1004,809 –19–27APR99–2/2

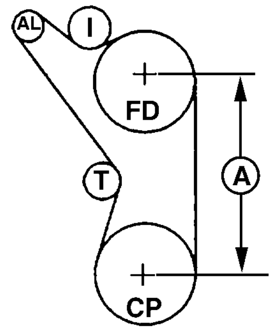
Fan Drive Assembly

Use the following tables to determine proper fan drive height.

Continued on next page

RG41165,000006D –19–30JAN01–1/10

Adjustable Fan Drives (A)		
Fan Belt Option	Fan Drive Option	Fan Height
2404	23BL, 23BM	354 mm (13.9 in.)
2405, 2416	23AL, 23AN	317 mm (12.5 in.)
2415	23BU	354 mm (13.9 in.)
2415	23CU	391 mm (15.4in.)
2417	23CL, 23CM	391 mm (15.4 in.)

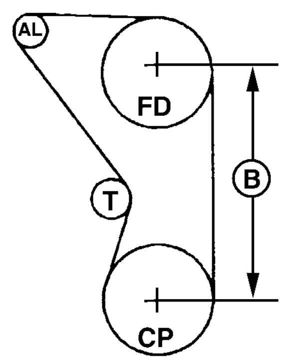


RG11666 –UN–31JAN01

A—Fan Drive Height
AL—Alternator
I—Idler
FD—Fan Drive
T—Tensioner
CP—Crank Pulley

RG41165,000006D –19–30JAN01–2/10

Adjustable Fan Drives (B)		
Fan Belt Option	Fan Drive Option	Fan Height
2403	23DU	425 mm (1637 in.)
2404, 2406	23DL, 23DM	425 mm (16.7 in.)
2405	23EL, 23EM	462 mm (18.2 in.)
2417	23EU	462 mm (18.2 in.)
2419	23FU	499 mm (19.6 in.)
2441	23FL, 23FM	499 mm (19.6 in.)



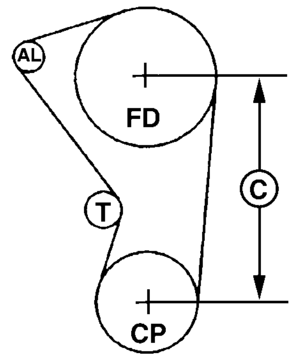
RG11667 –UN–31JAN01

B—Fan Drive Height
AL—Alternator
FD—Fan Drive
T—Tensioner
CP—Crank Pulley

Continued on next page

RG41165,000006D –19–30JAN01–3/10

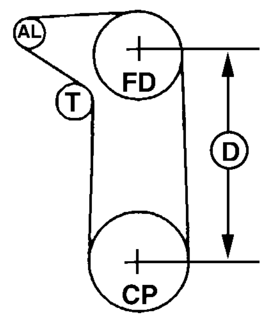
Adjustable Fan Drives (C)		
Fan Belt Option	Fan Drive Option	Fan Height
2410	23FC	499 mm (19.6 in.)
2418	23CC	391 mm (15.4in.)
2440	23DC	425 mm (16.7 in.)
2442	23EC	499 mm (19.6 in.)



C—Fan Drive Height
AL—Alternator
FD—Fan Drive
T—Tensioner
CP—Crank Pulley

RG41165,000006D –19–30JAN01–4/10

Fixed Fan Drives (D)		
Fan Belt Option	Fan Drive Option	Fan Height
2401, 2402, 2438, 2439	236A, 236B, 236C, 237A, 237B, 237C, 238A, 238B	425 mm (16.7 in.)



D—Fan Drive Height
AL—Alternator
FD—Fan Drive
T—Tensioner
CP—Crank Pulley

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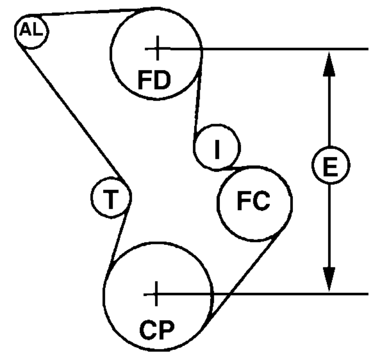
RG41165,000006D –19–30JAN01–5/10

Adjustable Fan Drives (E)		
Fan Belt Option	Fan Drive Option	Fan Height
2411, 2437	23DL, 23DM	425 mm (16.7 in.)
2411	23EU	462 mm (18.2 in.)
2414	23FL, 23FM	499 mm (19.6 in.)
2421	23DU	425 mm (16.7 in.)
2428	23FU	499 mm (19.6 in.)
2443	23EL, 23EM	462 mm (18.2 in.)

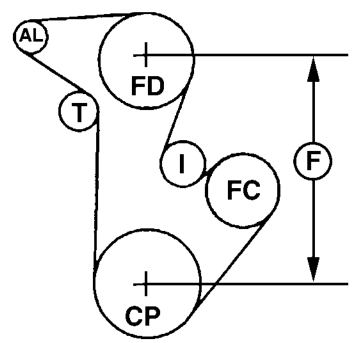


RG11670 –UN–31JAN01

E—Fan Drive Height
AL—Alternator
I—Idler
FD—Fan Drive
T—Tensioner
CP—Crank Pulley

RG41165,000006D –19–30JAN01–6/10

Fixed Fan Drives (F)		
Fan Belt Option	Fan Drive Option	Fan Height
2412, 2413, 2435, 2444	236A, 236B, 236C, 237A, 237B, 237C, 238A, 238B	425 mm (16.7 in.)



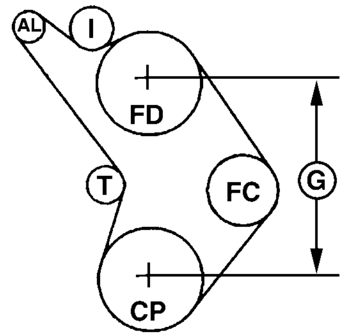
RG11671 –UN–31JAN01

F—Fan Drive Height
AL—Alternator
I—Idler
FD—Fan Drive
T—Tensioner
CP—Crank Pulley

Continued on next page

RG41165,000006D –19–30JAN01–7/10

Adjustable Fan Drives (G)		
Fan Belt Option	Fan Drive Option	Fan Height
2407	23BU	354 mm (13.9 in.)
2407	23CU	391 mm (15.4 in.)
2408	23AL, 23AN	317 mm (12.5 in.)
2408	23BL, 23BM	354 mm (13.9 in.)
2408	23CL, 23CM	391 mm (15.4 in.)



RG11672 –UN–31JAN01

G—Fan Drive Height
AL—Alternator
I—Idler
FD—Fan Drive
T—Tensioner
CP—Crank Pulley
FC—Freon Compressor

Continued on next page RG41165,000006D –19–30JAN01–8/10

6081 AGRICULTURAL APPLICATIONS

ENGINE MODEL TO AG APPLICATION

010	INTRODUCTION	
200	6081HH012	9760STS COMBINE
210	6081HH013	9660STS COMBINE
220	6081HH019	9560STS COMBINE

RGP11673

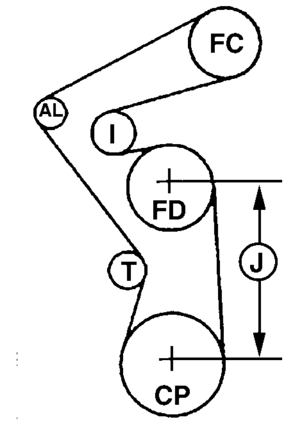
RG11673 –UN–10NOV05

H—Fan Drive Height
AL—Alternator
FD—Fan Drive
T—Tensioner
CP—Crank Pulley
FC—Freon Compressor

Adjustable Fan Drives (H)		
Fan Belt Option	Fan Drive Option	Fan Height
2409	23CC	391 mm (15.4 in.)
2420	23DC	425 mm (16.7 in.)
2422	23EC	462 mm (18.2 in.)
2423	23FC	499 mm (19.6 in.)

Continued on next page RG41165,000006D –19–30JAN01–9/10

Adjustable Fan Drives (J)		
Fan Belt Option	Fan Drive Option	Fan Height
2429, 2430, 2434	23AL, 23AM, 23AN	317 mm (12.5 in.)
2431, 2432	23BL, 23BM	354 mm (13.9 in.)
2445, 2446	23CL, 23CM	391 mm (15.4 in.)
2429, 2430	23BU	354 mm (13.9 in.)
2431, 2432	23CU	391 mm (15.4 in.)
2426, 2427, 2433, 2436	23DL, 23DM	425 mm (146.7 in.)
2424, 2425	23DU	425 mm (16.7 in.)
2447, 2448	23CF	391 mm (15.4 in.)



RG11674 –UN–31JAN01

J—Fan Drive Height
AL—Alternator
I—Idler
FD—Fan Drive
T—Tensioner
CP—Crank Pulley
FC—Freon Compressor

RG41165,000006D –19–30JAN01–10/10

Checking Belt Tensioner Spring Tension and Belt Wear

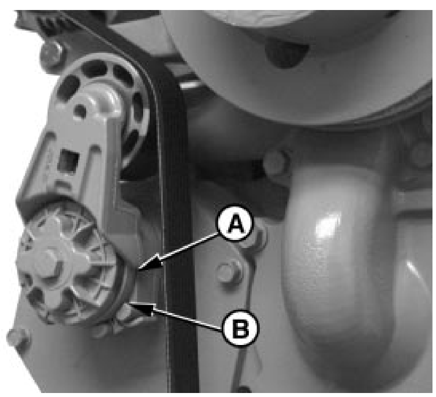
Belt drive systems equipped with automatic (spring) belt tensioners cannot be adjusted or repaired. The automatic belt tensioner is designed to maintain proper belt tension over the life of the belt. If tensioner spring tension is not within specification, replace tensioner assembly.

Checking Belt Wear

The belt tensioner is designed to operate within the limit of arm movement provided by the cast stops (A and B) when correct belt length and geometry are used.

Visually inspect cast stops (A and B) on belt tensioner assembly.

If the tensioner stop on swing arm (A) is hitting the fixed stop (B), check mounting brackets (alternator, belt tensioner, idler pulley, etc.) and the belt length. Replace belt as needed (see operator's manual).



RG7380 –UN–28NOV97

Belt Tensioner

A—Cast Stop
B—Cast Stop

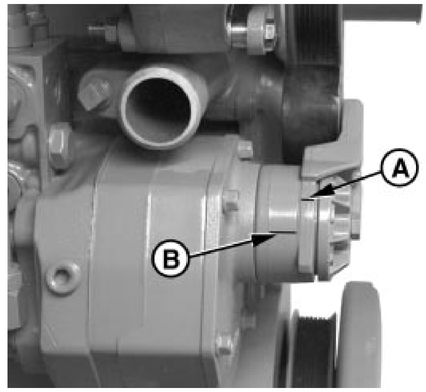
Continued on next page

RG,RG34710,1241 –19–23OCT97–1/3

Checking 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 (A) and put a mark (B) on tensioner mounting base.



Checking Belt Tensioner

A—Mark on Swing
B—Mark on Tensioner Mounting Base

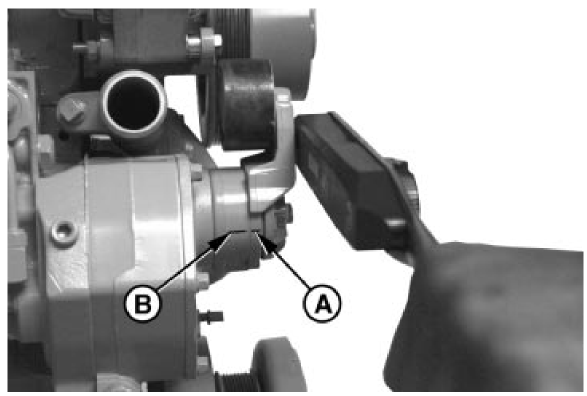
RG,RG34710,1241 –19–23OCT97–2/3

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 Spring—Tension .... 24-28 N•m (17-21 lb-ft)

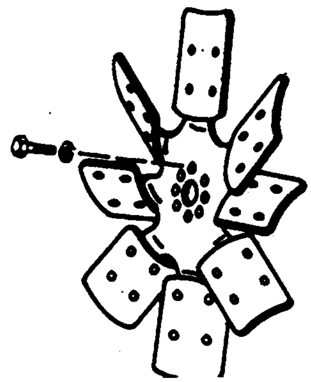
A—Mark
B—Mark



Measuring Belt Tensioner

RG,RG34710,1241 –19–23OCT97–3/3

Inspect and Install Fan Assembly



RG4797 –UN–14DEC88

Fan Assembly

Several fan drive ratios are available, allowing a closer matching of fan speed to application.

1. Inspect fan blades for bent or damaged condition. Bent blades reduce cooling system efficiency and throw the fan out of balance. Replace fan if blades are bent or damaged.

NOTE: Engines may be equipped with either suction-type fan or a blower-type fan, depending on application.

2. Install fan on pulley or pulley spacer hub. Tighten cap screws (with lock washers) to specifications.

Specification

Fan-to-Fan Hub/Pulley—Torque .... 47 N•m (35 lb-ft)

RG,RG34710,1242 –19–23OCT97–1/1

Visually Inspect Coolant Pump

Inspect Weep Hole:

Inspect coolant pump weep hole (A) in timing gear cover for oil or coolant leakage.

Oil leakage indicates a damaged rear seal.

Coolant leakage indicates a damaged front seal.

Replace complete coolant pump assembly if leakage is detected; individual repair parts are not available.

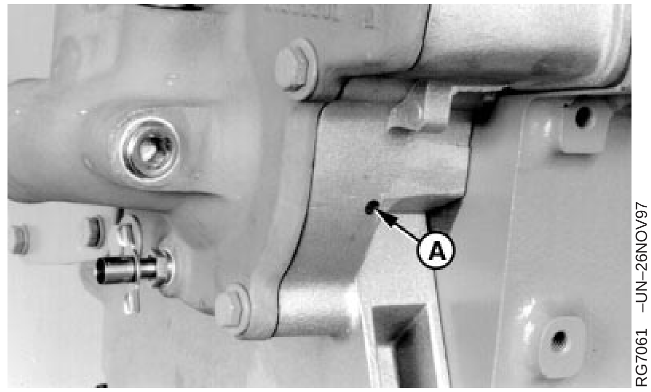
Inspect for Impeller Contact with Cover:

1. Remove radiator-to-coolant pump hose from coolant pump inlet elbow.

2. Using a flashlight, inspect I.D. of coolant pump cover for internal impeller contact.

   Impeller contact with cover usually indicates that impeller has moved on shaft or there is a damaged bearing.

   Replace coolant pump assembly and cover as necessary if impeller contact is detected.



Coolant Pump Weep Hole

A—Weep Hole

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RG,RG34710,1243 –19–23OCT97–1/2

Inspect Timing Gear Cover for Cavitation

1. Any time repair of the coolant pump is necessary, check the timing gear cover for erosion, or cavitation.

2. Cavitation has the appearance of small holes, or “pock marks” on any surface where coolant flow exists. John Deere Coolants have cavitation preventatives added, but aluminum can still be susceptible to cavitation.

3. Cavitation can also occur from a leaking radiator cap or coolant system.. A leak can lower the boiling point of the coolant and accelerate the erosion of aluminum components.

IMPORTANT: Always change coolant when the coolant pump is replaced, since the cavitiation preventatives in the coolant have been depleted.

Timing Gear Cover

RG,RG34710,1243 –19–23OCT97–2/2

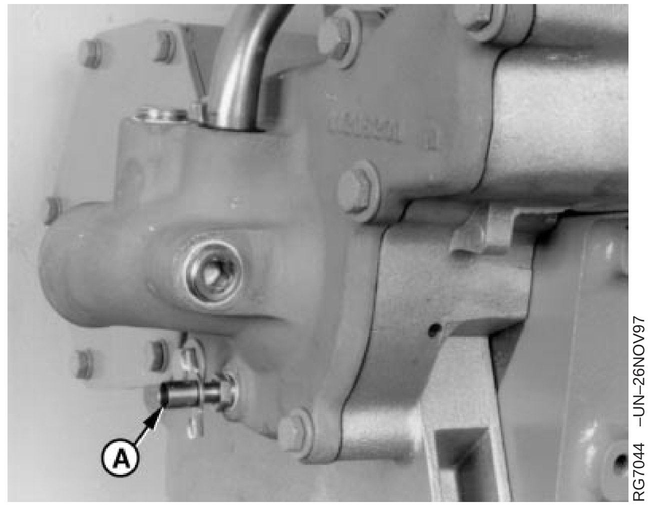
Remove Coolant Pump Assembly

The coolant pump should be removed from the timing gear cover for replacement purpose only. There are no service parts available to repair coolant pump, replace as a complete assembly.

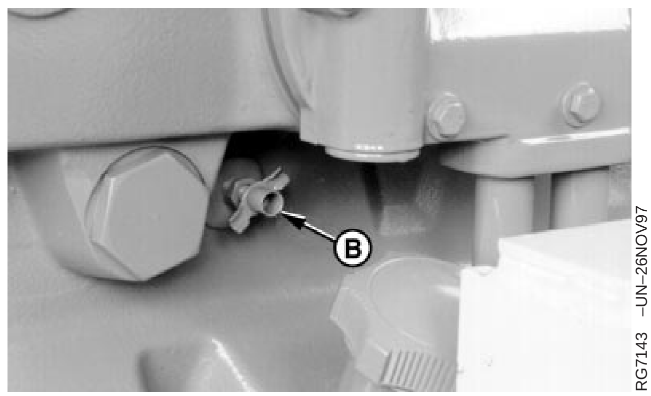
CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Wait until engine coolant is cool enough to touch with bare hands before draining. Slowly loosen radiator cap to first stop to relieve pressure.

1. Open coolant pump drain valve (A) and block drain valve (B) to drain coolant from engine.

A—Coolant Pump Drain Valve
B—Drain Valve



Coolant Pump Drain Valve



Cylinder Block Drain Valve

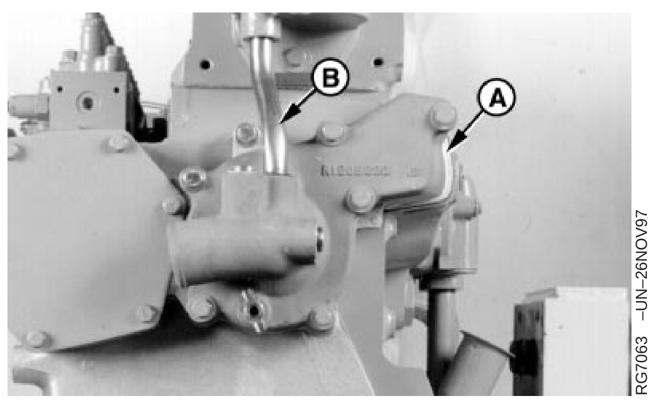
RG,RG34710,1244 –19–23OCT97–1/3

2. Remove hose from coolant pump cover inlet elbow, shown removed.

3. Remove six cap screws securing coolant pump cover (A) to timing gear cover and remove coolant pump cover with bypass tube (B).

4. Remove gasket from timing gear cover and discard. Remove bypass tube from cover. Inspect bypass tube seal in coolant pump cover, replace seal as needed. See REPLACE BYPASS TUBE SEAL IN COOLANT PUMP COVER later in this group.

A—Coolant Pump Cover
B—Bypass Tube



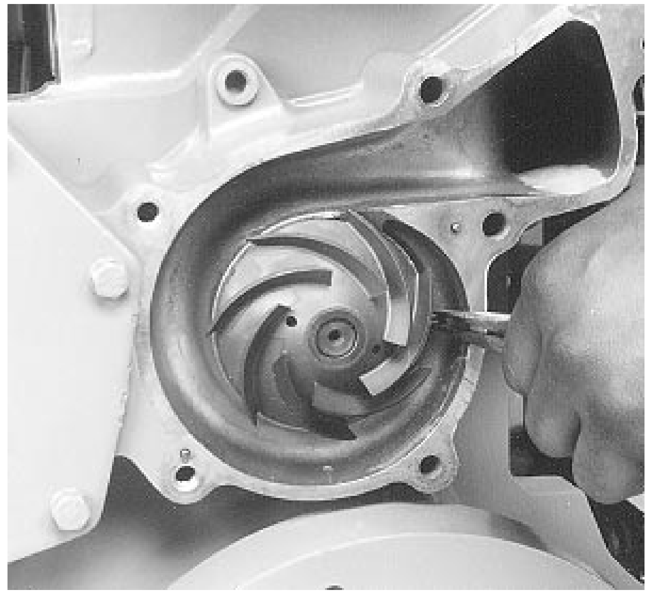
Removing Coolant Pump Cover

Continued on next page

RG,RG34710,1244 –19–23OCT97–2/3

5. Compress retaining ring ends with a small needle-nose pliers as shown.

6. Grasp impeller with a large pliers and pull coolant pump from timing gear cover using a slight rocking motion until assembly is removed from timing gear cover. Discard coolant pump assembly.



Removing Coolant Pump

RG,RG34710,1244 –19–23OCT97–3/3

Install Coolant Pump Assembly

1. Thoroughly clean and inspect coolant pump mounting bore in timing gear cover before installing pump assembly.

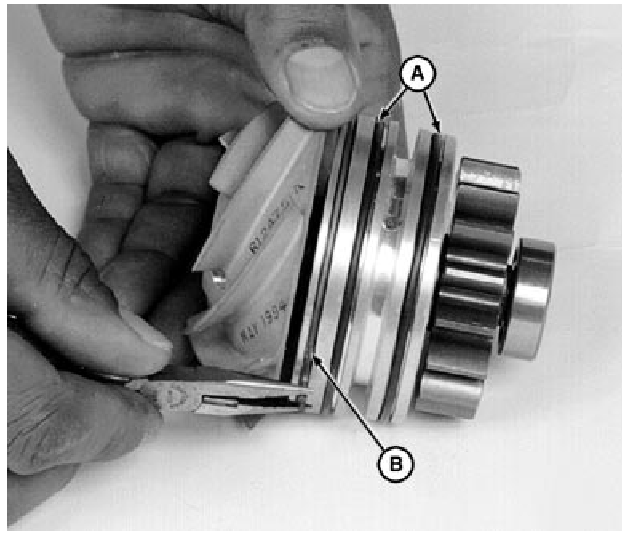
NOTE: *An improved coolant pump with a steel bearing carrier and stainless steel impeller has been designed and adopted. Additionally, color coded O-rings are now used for improved sealing. BE CERTAIN to assemble the O-rings in their proper position.*

2. Install two new O-rings (A) in rear grooves of coolant pump housing (as looking at the picture, the pink o-ring goes with the RH groove, and the blue o-ring the LH groove, closest the impeller) and apply a light coat of clean engine oil to O-rings.

3. Install a new retaining ring (B) in front (smallest) groove of coolant pump housing and compress both ends of retaining ring together with a small needle-nose pliers.

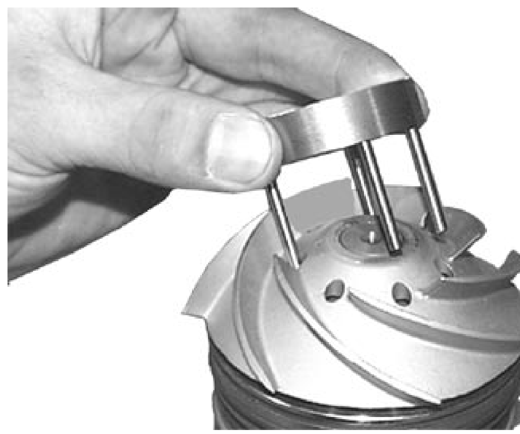
4. Install a new foam filter into coolant pump weep hole.

5. Using the Coolant Pump Service Tool provided in the service replacement kits, insert the four legs (as shown) of the tool into the holes of the impeller, allowing pressure to be applied, during assembly, to the body of the pump, and thus preventing damage to the shaft seal.



RG7227 –UN–05DEC97

Assembling Coolant Pump



RG13205 –UN–15SEP03

Coolant Pump Service Tool

Continued on next page RG,RG34710,1245 –19–23OCT97–1/2

NOTE: Retaining ring ends should be at 3 o'clock position and coolant pump weep hole should align with hole in timing gear cover when installing coolant pump assembly.

6. Compress retaining ring ends and install coolant pump assembly into pilot bore of timing gear cover. Apply pressure, using a pry bar, to the service tool (D). Make sure that pump drive gear properly meshes with crankshaft gear.

7. Release retaining ring ends and verify that retaining ring is firmly seated in groove of timing gear cover.

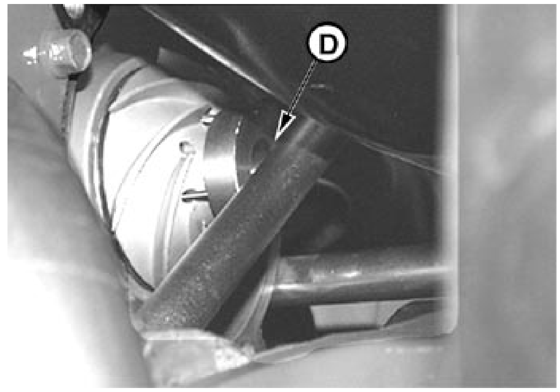
NOTE: Tier II 6081 engines have a cast iron coolant pump cover. The cast iron cover replaces the previous aluminum material cover to improve durability (reduce cavitation). Service covers for all 6081 engines are cast iron.

8. Install coolant pump cover with bypass tube using a new gasket. Tighten cap screws to specifications.

Coolant Pump Cover Mounting Cap Screws—Specification

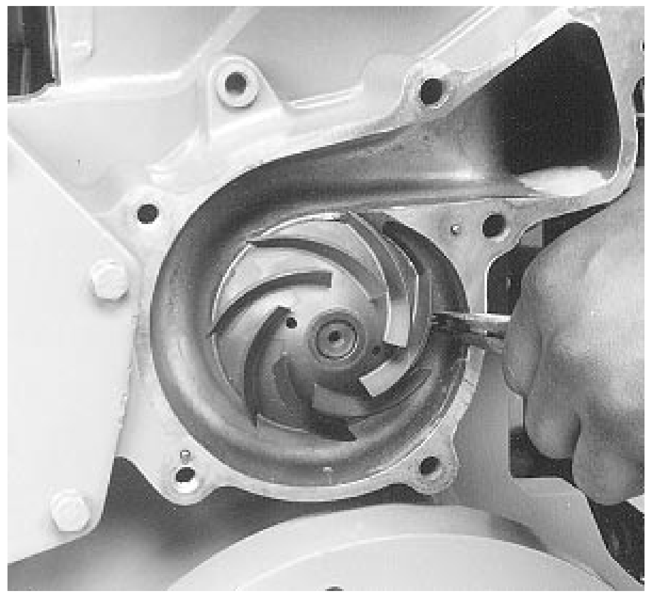
5/16-in. Mounting Cap Screws—Torque	27 N•m (20 lb-ft)
3/8-in. Cap Screws—Torque	47 N•m (35 lb-ft)

IMPORTANT: If a new aluminum coolant pump cover has been installed, the cooling system must be completely drained and flushed. Refer to operators manual for flushing procedure and the recommended coolant solution.



RG13204 –UN–15SEP03

Installation of Coolant Pump w/Pry Bar



RG7062 –UN–07SEP94

Installing Coolant Pump

RG,RG34710,1245 –19–23OCT97–2/2

Replace Bypass Tube Seal in Coolant Pump Cover

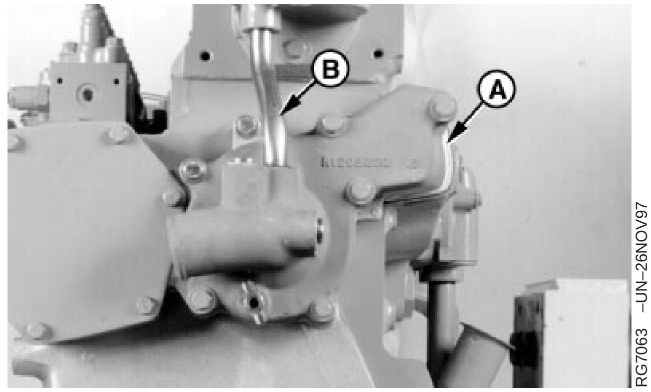
1. Drain cooling system and remove coolant pump cover (A) with bypass tube (B). Discard cover gasket.

2. Carefully clamp cover in a soft-jawed vise and remove bypass tube seal. Be careful not to damage machined gasket surface of cover.

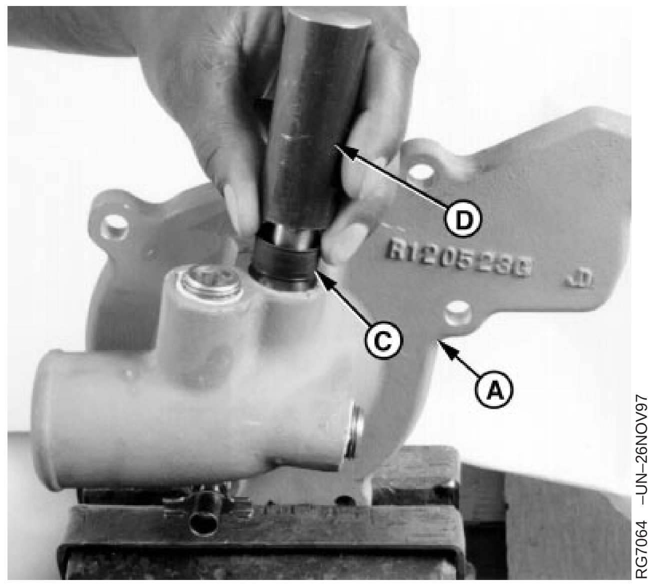
3. Install new seal (C) using JDG908 Seal Driver (D). Drive seal into bore until driver bottoms.

4. Remove cover from vise and inspect seal installation and also machined gasket surfaces.

A—Coolant Pump Cover
B—Bypass Tube
C—Bypass Tube Seal
D—JDG908 Seal Driver



Bypass Tube in Coolant Pump Cover



Installing Bypass Tube Seal

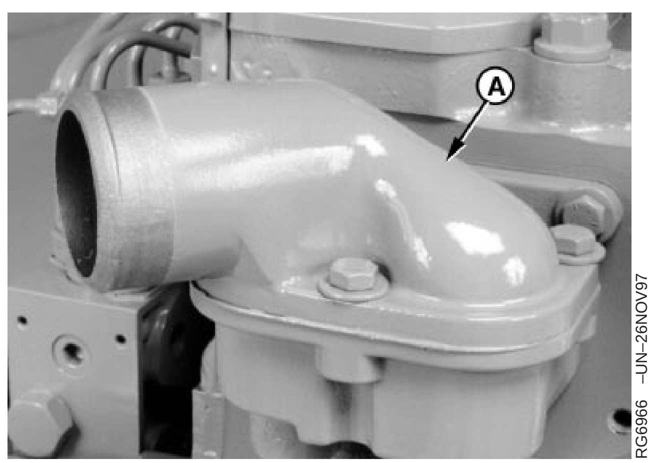
RG,RG34710,1246 –19–23OCT97–1/1

Remove and Test Thermostats

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

1. Visually inspect the area around the coolant manifold for leaks. Partially drain coolant from the cooling system.

2. Remove thermostat cover (A) with gasket. Remove and discard all gasket material.



Removing Thermostat Cover

A—Thermostat Cover

Continued on next page

RG,RG34710,1247 –19–23OCT97–1/2

3. Remove thermostats.

4. Inspect thermostats for debris or damage, and test each thermostat using an approved testing procedure. See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE in Group 150 for testing procedure. Thermostats should start to open within the range specified below.

Specification

Thermostat 82°C (180°F)—
Opening Temperature .... 80—84°C (175—182°F)

If either thermostat fails to open within this range, replace both thermostats as a set.

Removing Thermostats

RG,RG34710,1247 –19–23OCT97–2/2

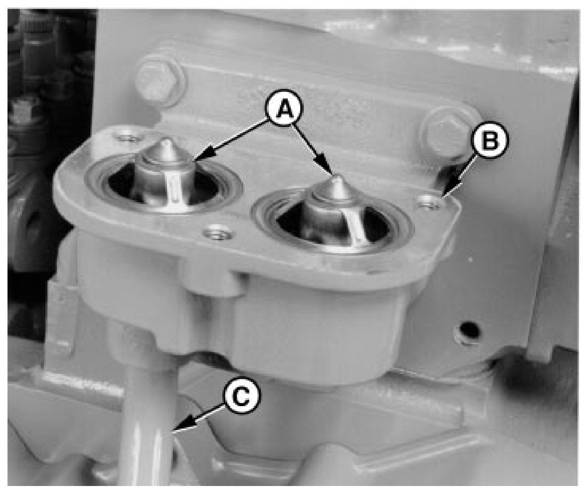
Remove Coolant Manifold

1. Drain coolant and remove thermostat cover from coolant manifold (shown removed). Remove thermostats (A).

2. Remove three coolant manifold-to-cylinder head cap screw, remove coolant manifold (B) and dislodge coolant bypass tube as manifold is removed.

NOTE: Pull coolant manifold straight out (toward front of engine) approximately 6.35 mm (0.25 in.) to disengage from locator (spring) pin, then lift straight up to disengage from bypass tube (C).

3. Remove and discard O-ring from bore of coolant manifold.



Removing Coolant Manifold

A—Thermostats
B—Bore of Coolant Manifold
C—Bypass Pipe

RG,RG34710,1249 –19–23OCT97–1/1

Install Thermostats

NOTE: Install thermostats in groove in housing first. Then install gasket after thermostat is properly seated in grooves.

1. Install thermostats. Install a new gasket on housing or in cover, as applicable.

2. Install cover and tighten cap screws to specifications.

Specification

Cast Iron Thermostat
Cover-to-Cylinder Head—Torque.................................... 47 N•m (35 lb-ft)
Aluminum Thermostat
Cover-to-Cylinder Head—Torque.................................... 30 N•m (22 lb-ft)

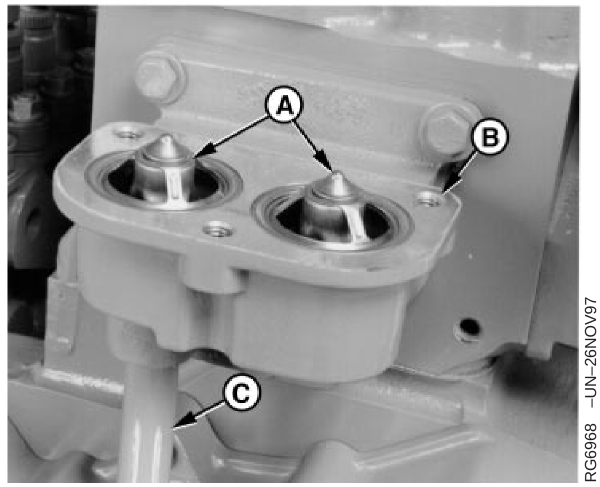
IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing to allow air to escape when filling system. Retighten fitting when all the air has been expelled.


RG6967 –UN–28JUL94

Installing Thermostats

RG,RG34710,1248 –19–23OCT97–1/1

Install Coolant Manifold



Installing Coolant Manifold

A—Thermostats
B—Bore of Coolant Manifold
C—Bypass Pipe

1. Install a new O-ring into coolant manifold O-ring bore. Lubricate O-ring with grease to ease bypass pipe installation. Install bypass pipe (C) into bore of coolant manifold (B). Be careful not to cut O-ring.

2. Install coolant manifold assembly. Be sure coolant manifold is properly positioned on spring pin (in front face of cylinder head) and that bypass pipe is fully seated in coolant manifold and coolant pump cover bores.

3. Apply LOCTITE® 242 Thread Sealer to coolant manifold-to-cylinder head cap screw threads 360 degrees (except for the leading one to three threads). Tighten coolant manifold cap screws to specifications.

Specification

Coolant Manifold-to-Cylinder
Head Cap Screws—Torque .... 35 N•m (25 lb-ft)

4. Install thermostats and cover. See INSTALL THERMOSTATS, earlier in this group.

LOCTITE is a registered trademark of Loctite Corp.

RG,RG34710,1250 –19–23OCT97–1/1

Remove and Install Coolant Temperature Switch

1. Disconnect wiring and remove switch.

2. Coat threads of switch with TY9375 Pipe Sealant with TEFLON®.

3. Install switch and tighten to the following specifications.

Specification

Coolant Temperature Switch—
Torque .... 45 N•m (33 lb-ft)

TEFLON is a registered trademark of Du Pont Co.

DPSG,OUO1004,807 –19–21APR99–1/1

Servicing of Engine Coolant Heater

Refer to CTM67, Engine Accessories, Group 25, for service of the block-type engine coolant heater. See REMOVE COOLANT HEATER—BLOCK TYPE in Group 25 of CTM67.

RG,RG34710,1251 –19–23OCT97–1/1

Complete Final Assembly

NOTE: Consult your engine operator's manual or see Group 002 of this CTM for coolant recommendations in your area. See DIESEL ENGINE COOLANT in Group 002.

1. Fill cooling system to proper level with the proper coolant.

2. Start engine and run for several minutes to check for leaks in the cooling system.

3. After fan belts cool, check belt tension as detailed in your operator's manual.

RG,RG34710,1252 –19–23OCT97–1/1

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:

- **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 principle 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 procedure.

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 possibly damage bearings. 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 –19–28APR99–1/2

Ingestion of Foreign Objects

The third cause of turbocharger damage is the ingestion of foreign objects. These 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 –19–28APR99–2/2

Remove Turbocharger

IMPORTANT: Any time there has been a turbocharger failure, it is absolutely necessary to make certain that the Charge Air Cooler (CAC), lines, and/or hoses have been thoroughly cleaned. All contamination, especially oil, must be removed. FAILURE TO CLEAN ALL OIL OUT OF CAC AND LINES MAY RESULT IN MAJOR ENGINE DAMAGE.

Procedure for cleaning CAC: Remove CAC from machine. Uses John Deere Coolant System Cleaner PMCC2638, or equivalent, per the instructions, to clean oil residue from CAC. Use compresses air to completely dry inside of CAC.

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

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 INSPECTION later in this group.

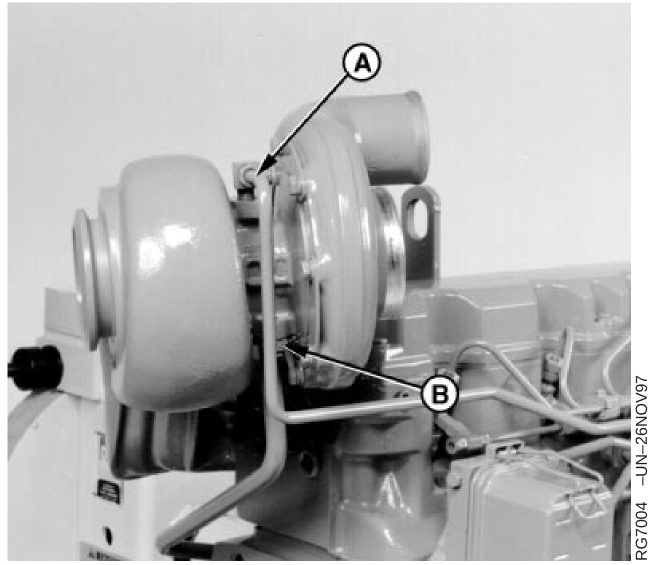
Thoroughly clean exterior of turbocharger and surrounding area to prevent entry of dirt into the air intake system during removal.

1. Disconnect air intake and exhaust piping from turbocharger (shown disconnected).

2. Disconnect turbocharger oil inlet line (A) from elbow adapter.

3. Disconnect turbocharger oil return (drain) tube (B). Remove and discard gasket.

4. If equipped, disconnect wastegate diaphragm hose.



Removing Turbocharger

A—Oil Inlet Line
B—Oil Return Tube

Continued on next page

5. Remove four turbocharger mounting cap screws with washers securing turbocharger to rear exhaust manifold and remove turbocharger.

6. Cap or plug all openings on engine (exhaust and intake manifold related) and place turbocharger on a clean flat table for inspection.

7. Perform turbocharger seven-step inspection, as described later, if failure mode has not been determined. See TURBOCHARGER INSPECTION later in this group.

RG,RG34710,1257 –19–18JUL05–2/2

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. **Make certain to check all ail lines/hoses for oil residue. If oil is found, it is ABSOLUTELY NECESSARY to make certain the lines and Charge Air Cooler or Heat Exchanger have been thoroughly cleaned out. Failure to do so can result in engine failure. Remove CAC and use John Deere Coolant System Cleaner PMCC2638, or equivalent. Dry the components with compressed air and BE CERTAIN all water is removed.**
	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. Check injection pump timing.

Continued on next page
RE38635,000002E –19–15JUL05–1/2

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. .
	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.

RE38635,000002E –19–15JUL05–2/2

Turbocharger 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 recommended inspection steps, which are explained in detail on 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.
- Perform Axial End Play 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.

RG,RG34710,1259 –19–23OCT97–1/12

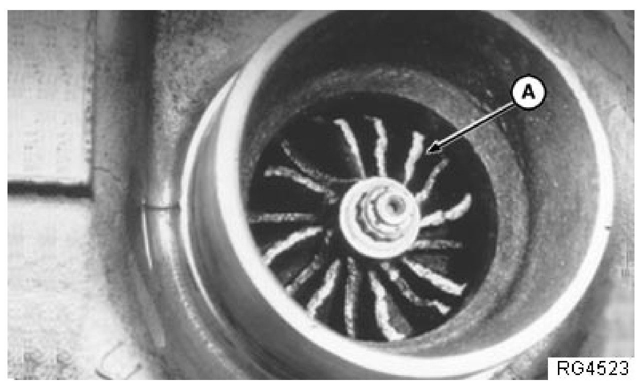
Compressor Housing Inlet and Compressor Wheel

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



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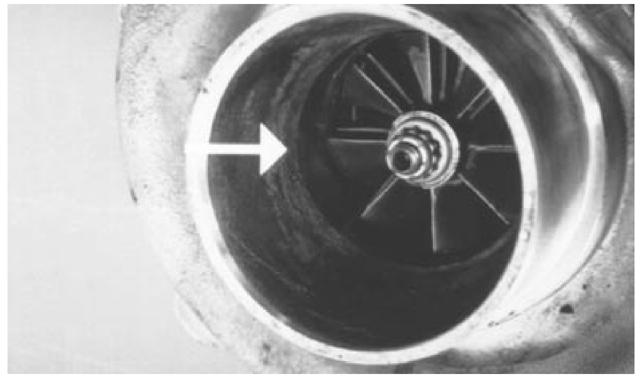
Checking Inlet and Compressor Wheel

Continued on next page RG,RG34710,1259 –19–23OCT97–2/12

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.



Checking Compressor Inlet

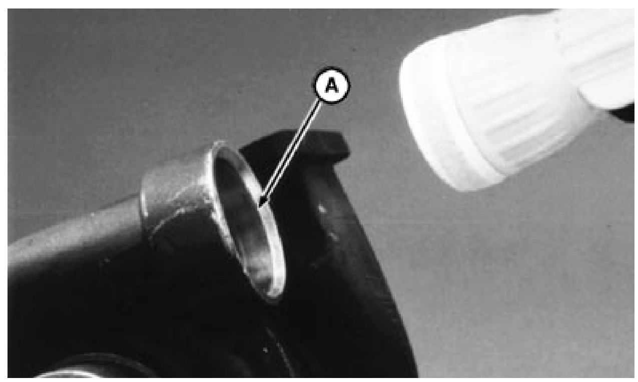
RG,RG34710,1259 –19–23OCT97–3/12

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



Checking Compressor Outlet

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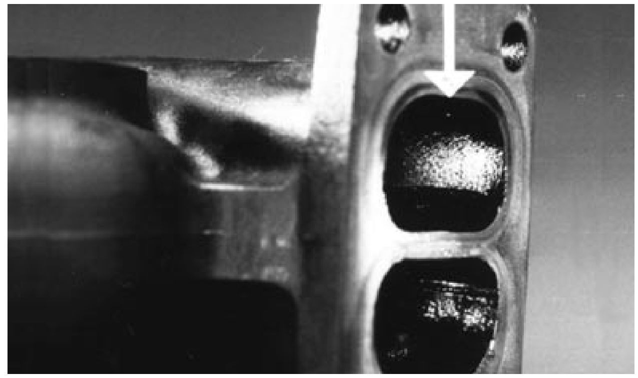
RG,RG34710,1259 –19–23OCT97–4/12

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), indicate excessive exhaust temperature.



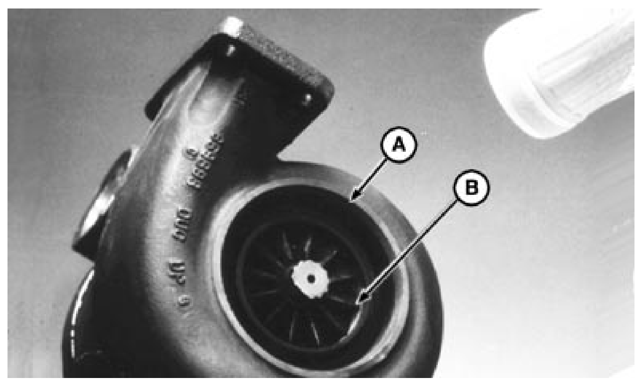
Checking Turbine Housing Inlet Ports

RG,RG34710,1259 –19–23OCT97–5/12

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.

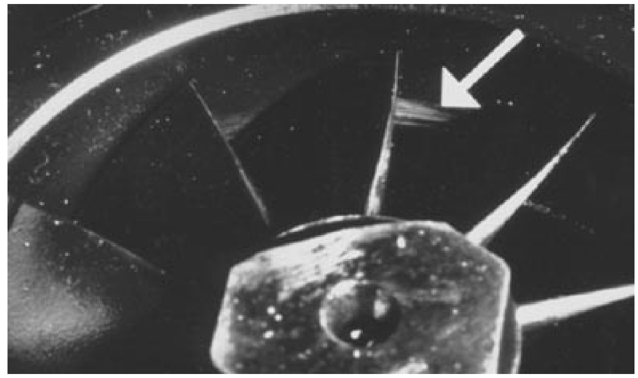
A—Turbine Housing Outlet
B—Blades



Checking Turbine Wheel and Outlet

Continued on next page RG,RG34710,1259 –19–23OCT97–6/12

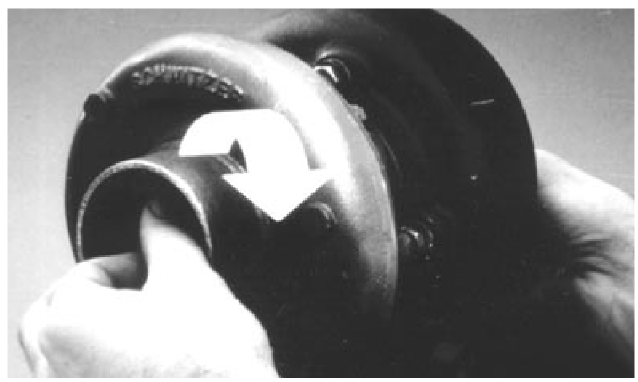
2. Inspect the wheel blades and housing for evidence of wheel rub (arrow). Wheel rub can bend the tips of the blades with the housing showing wear or damage.


RG4528 –UN–05DEC97

Checking Turbine Wheel Blades

RG,RG34710,1259 –19–23OCT97–7/12

3. 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.


RG4532 –UN–05DEC97

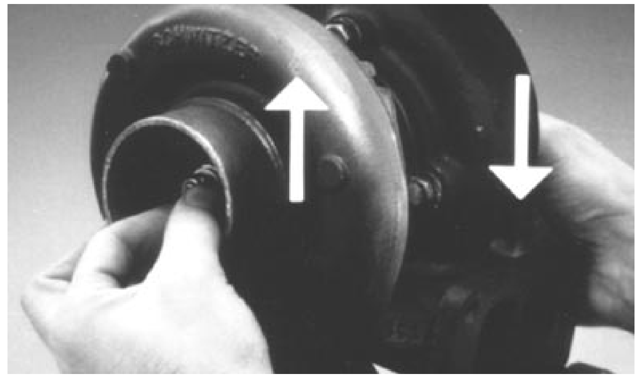
Checking Shaft Rotation and Clearance

Continued on next page RG,RG34710,1259 –19–23OCT97–8/12

IMPORTANT: Use only moderate hand force (3-4 pounds) on each end of shaft.

4. 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.


RG4533 –UN–05DEC97

Checking for Contact of Compressor and Turbine Wheels

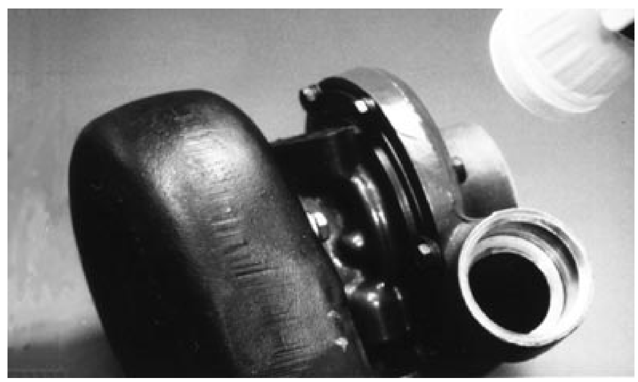
RG,RG34710,1259 –19–23OCT97–9/12

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.

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 endplay with a dial indicator be performed. These procedures are not required if a failure mode has already been identified.


RG4529 –UN–05DEC97

Checking Center Housing

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RG,RG34710,1259 –19–23OCT97–10/12

Perform Axial Bearing End Play Test

This test will give an indication of the condition of the thrust bearing within the center housing and rotating assembly.

1. Mount magnetic base dial indicator (black arrow) so that indicator tip rests on flat surface on turbine end of shaft. Preload indicator tip and zero dial on indicator.

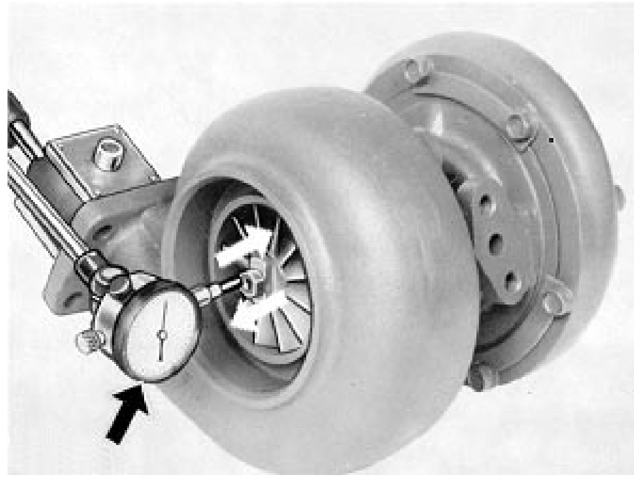
2. Move shaft axially back and forth by hand.

3. Observe and record total dial indicator movement.

Specification

Turbocharger Shaft—Axial
Bearing End Play .... 0.064—0.114 mm
(0.0025—0.0045 in.)

If bearing end play is not within specification, install a replacement turbocharger.

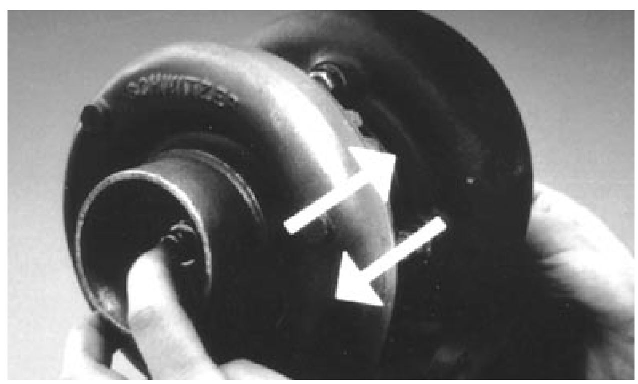


Checking Axial Bearing End Play

RG,RG34710,1259 –19–23OCT97–11/12

4. Next, check shaft endplay by moving the shaft back and forth (white arrows) while rotating. There will be some endplay but not to the extent that the wheels contact the housings.

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 outlined 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.*



Checking Shaft End Play

RG,RG34710,1259 –19–23OCT97–12/12

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.

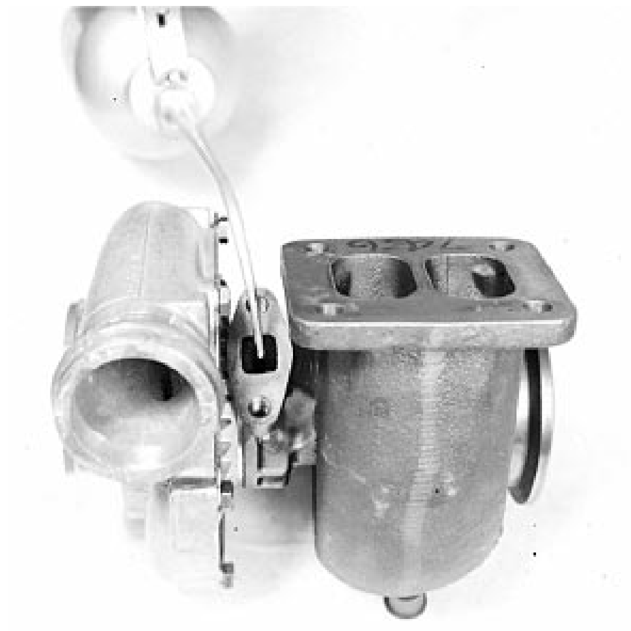
RG,30,JW7571 –19–20NOV97–1/1

Prelube Turbocharger

IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

Fill oil return (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

RG,RG34710,1266 –19–23OCT97–1/1

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.

On 6081A engines, visually inspect the aftercooler and clean if necessary. Oil may have accumulated from the failed turbo.

If not previously done, prime (prelube) turbocharger rotating assembly prior to installing turbocharger on engine. Prelube center housing with clean engine oil through oil return (drain) hole as shown. Turn rotating assembly by hand to lubricate bearings.

NOTE: Two threaded guide studs may be used to hold turbocharger-to-exhaust manifold gasket in place and aid in turbocharger installation.

1. Put a new gasket on turbocharger-to-exhaust manifold mounting surface (not shown).

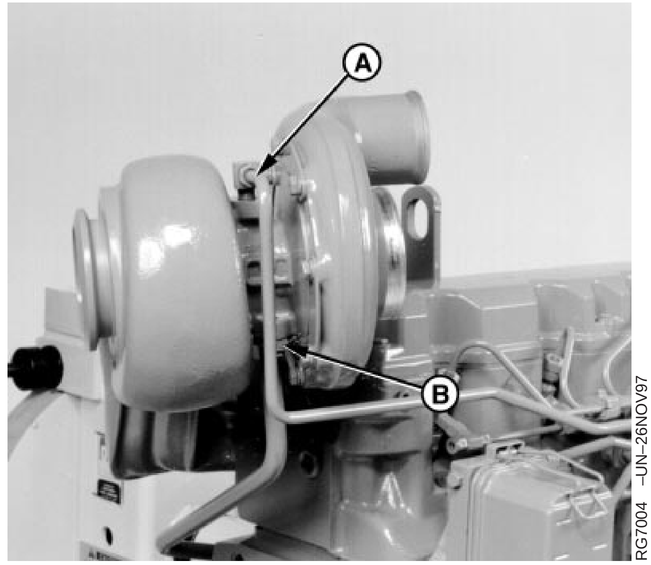
2. Position turbocharger against gasket on exhaust manifold.

3. Apply PT569 NEVER-SEEZ® Compound to all turbocharger mounting cap screws. Install cap screws and tighten to specifications.

Specification	
Turbocharger-to-Exhaust Manifold Nuts (Marine Only)—Torque	40 N•m (30 lb-ft)
Turbocharger-to-Exhaust Manifold Cap Screws—Torque	24 N•m (18 lb-ft)

NOTE: Remove all caps or plugs from turbocharger openings.

4. Install turbocharger oil return (drain) tube (B) using a new gasket. Tighten cap screws to specifications.



Installing Turbocharger

A—Oil Line
B—Oil Return Tube

NEVER-SEEZ is a registered trademark of Emhart Chemical Group.

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Specification

Turbocharger Oil Return Line—
Torque .... 34 N•m (25 lb-ft)

5. Connect oil line (A) to elbow adapter and tighten securely.

6. If equipped, connect wastegate diaphragm hose. (If replacing hose, cut to length from roll furnished by Parts.)

7. Connect air intake and exhaust piping to turbocharger. Tighten all connections securely. (For vehicle engines, refer to machine Technical Manual.)

IMPORTANT: BEFORE STARTING an engine with a new or repaired turbocharger, crank the engine over (but do not start) for several seconds to allow engine oil to reach turbocharger bearings. DO NOT crank engine longer than 30 seconds at a time to avoid damaging starting motor.

8. Start and run engine at low idle while checking oil inlet and air piping connections for leaks.

RG,RG34710,1268 –19–28APR99–2/2

Remove, Inspect, and Install Exhaust Manifold

1. Remove turbocharger (A) from exhaust manifold. See REMOVE TURBOCHARGER earlier in this group.

2. Remove cap screws and remove rear exhaust manifold (B) and front exhaust manifold (C). Remove manifold gaskets and discard.

3. Remove and discard front-to-rear exhaust manifold sealing ring (D).

4. Remove all residue and gasket material from gasket surfaces.

5. Thoroughly clean passages in exhaust manifold and exhaust below.

6. Inspect each exhaust manifold for cracks or damage. Inspect machined mounting surfaces for burrs or other defects which might prevent gaskets from sealing properly. Replace parts as needed.

7. To install exhaust manifold, reverse removal procedure and use new gaskets.

NOTE: It is not necessary to use an anti-seize compound on stainless steel exhaust manifold cap screws.

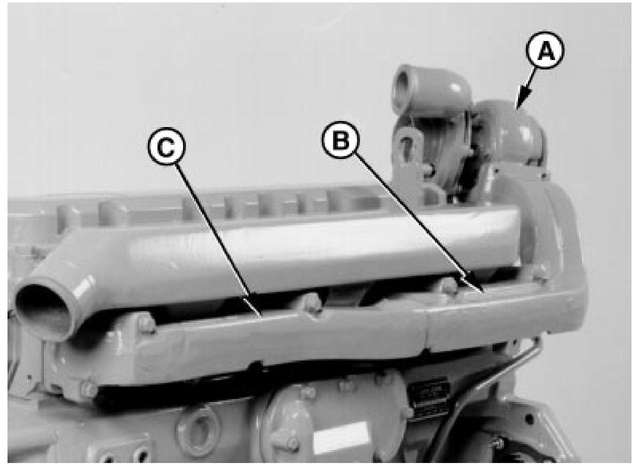
The special 12-point flange head cap screws used on 8000 Series tractors have pre-applied anti-sieze compound.

8. On 8000 series tractors using special 12-point flange head cap screws, apply PT569 NEVER-SEEZ® Compound, **only to cap screws being reused**.

   Tighten exhaust manifold mounting cap screws by starting with the middle cap screws (nos. 3 and 4 cylinders) and alternately tighten the remaining cap screws at either side.

Specification

Exhaust Manifold-to-Cylinder
Head Cap Screws—Torque .... 47 N•m (35 lb-ft)



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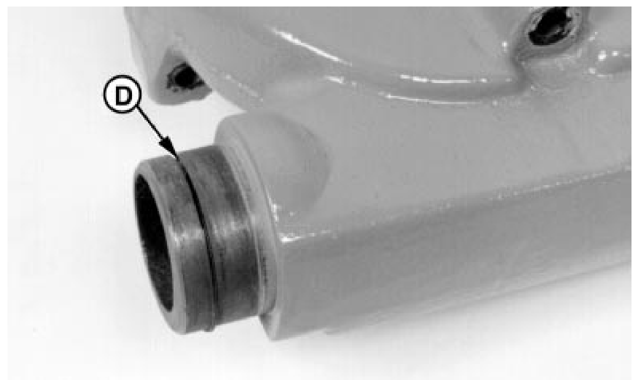
Removing Exhaust Manifold



RG7006 –UN–26NOV97

Sealing Ring for Front-to-Rear Exhaust Manifolds

A—Turbocharger
B—Rear Exhaust Manifold
C—Front Exhaust Manifold
D—Sealing Ring

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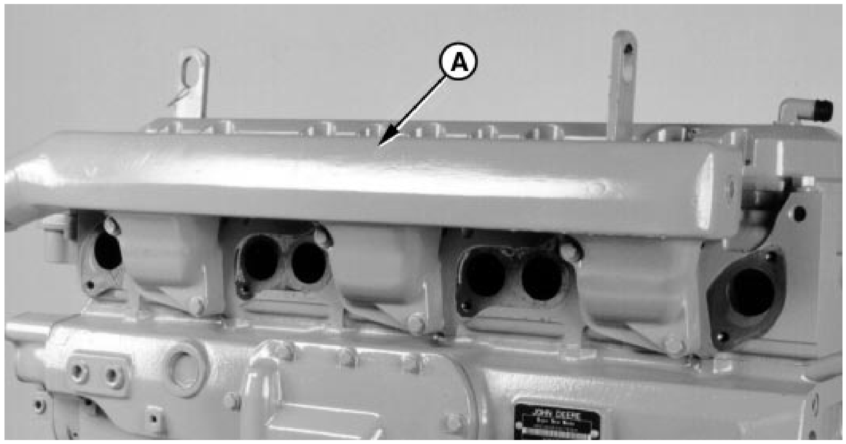
DPSG,OUO1004,815 –19–28APR99–1/1

Remove, Inspect, and Install Intake Manifold (6081T and 6081H Engines)



RG7007 —UN–26NOV97

Removing Intake Manifold

A—Intake Manifold

IMPORTANT: All intake manifold connections at the turbocharger and engine cylinder head must be tight to prevent loss of power resulting from lack of intake manifold pressure.

Intake manifold hose and cap screw connections should be inspected periodically for tightness.

Whenever a tune-up has been performed on the engine, or whenever it is suspected that the horsepower output might be low, the intake manifold pressure (turbo-boost) should be checked. See MEASURE INTAKE MANIFOLD PRESSURE in Group 150.

1. Remove exhaust manifold, shown removed. See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD earlier in this group.

2. Remove air intake connections from intake manifold (A) as detailed in machine Technical Manual.

3. Disconnect air heater wire from manifold, if equipped.

4. Remove six cap screws and remove intake manifold from cylinder head. Remove and discard manifold gaskets.

5. Inspect the intake manifold for serviceability. Replace if it is cracked or otherwise damaged.

6. Inspect the machined mating surfaces of cylinder head and intake manifold. Clean, as required, by using a scraper and/or wire brush, and compressed air.

7. To install intake manifold, reverse removal procedures and use new gaskets.

8. Tighten intake manifold cap screws to specifications.

Specification

Intake Manifold-to-Cylinder Head—Torque .... 47 N•m (35 lb-ft)

9. Install exhaust manifold assembly and turbocharger as detailed earlier in this group.

10. Connect all air intake and exhaust piping. (For vehicle engines, refer to machine Technical Manual.)

RG,RG34710,1270 –19–23OCT97–1/1

Remove Vertically-Mounted Aftercooler and Intake Manifold (6081A Engines)

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Wait until engine coolant is cool enough to touch with bare hands before draining. Slowly loosen radiator cap to first stop to relieve pressure.

1. Open coolant pump and block drain valves to completely drain engine coolant.

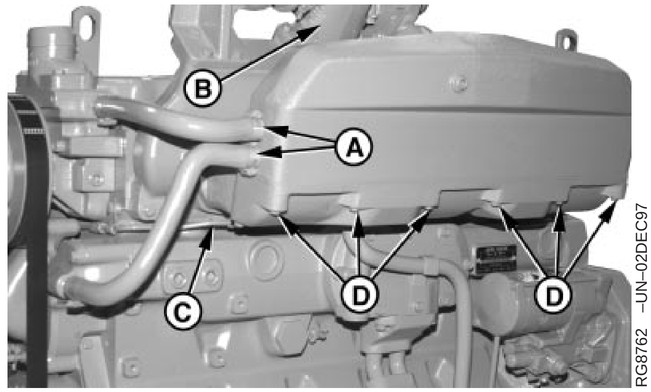
2. Thoroughly clean exterior of turbocharger (B), intake manifold and adjacent areas to prevent entry of dirt into the engine when parts are removed.

3. Remove turbocharger as described earlier in this group.

4. Loosen clamps (A) on inlet and outlet hose. Remove coolant hoses from aftercooler.

5. Remove aneroid-to-intake manifold connector (C), if equipped.

6. Remove air intake cover cap screws (D).



Removing Aftercooler and Intake Manifold

A—Clamps
B—Turbocharger
C—Aneroid-to-Intake Manifold Connector
D—Air Intake Cover Cap Screws

RG,RG34710,1271 –19–23OCT97–1/3

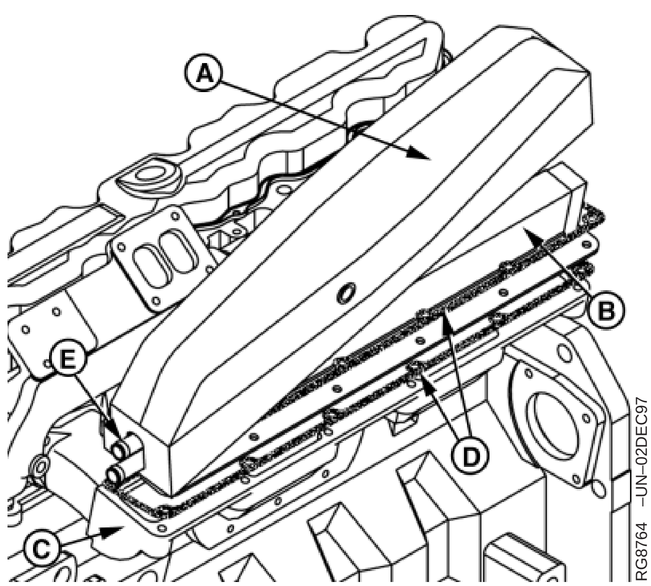
7. Carefully lift air intake cover (A) from intake manifold (C).

8. Remove aftercooler (B).

9. Remove and discard gasket (D).

10. Inspect aftercooler end seal (E) and replace as needed.

A—Air Intake Cover
B—Aftercooler
C—Intake Manifold
D—Gaskets
E—Aftercooler End Seal



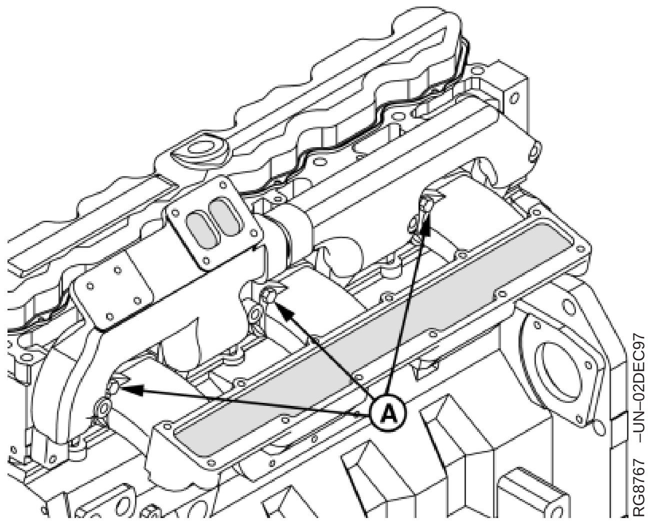
Removing Aftercooler

Continued on next page

RG,RG34710,1271 –19–23OCT97–2/3

11. Remove the six intake manifold-to-cylinder head caps screws (A) and remove intake manifold. Remove and discard all manifold gaskets.

12. Inspect and repair aftercooler. See INSPECT AND REPAIR AFTERCOOLER (6081A ENGINES), later in this group.



Removing Intake Manifold

RG,RG34710,1271 –19–23OCT97–3/3

Remove and Disassemble Horizontally-Mounted Aftercooler (6081A Engines)

1. Completely drain engine coolant from aftercooler.

2. Disconnect turbocharger oil inlet line (A) and return line (B).

3. Remove four turbocharger-to-exhaust manifold cap screws.

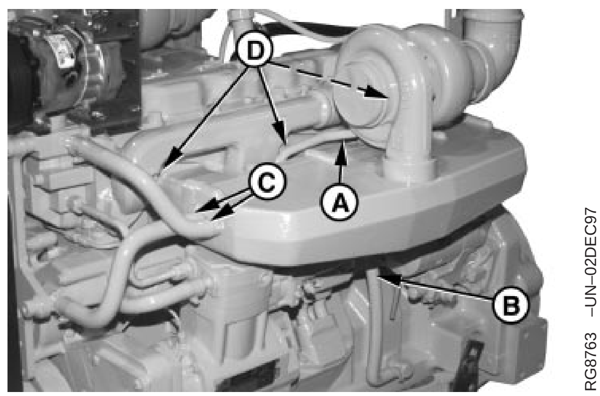
4. Remove coolant inlet and outlet hoses (C) from aftercooler.

5. Remove top three intake manifold cap screws (D). Install guide studs at the three locations. Remove remaining cap screws.

6. Remove intake manifold and aftercooler as an assembly.

7. Remove and discard intake manifold gaskets.

8. Remove turbocharger from aftercooler.



Removing Aftercooler

A—Turbocharger Oil Inlet Line
B—Turbocharger Oil Return Line
C—Coolant Inlet and Outlet Hoses
D—Intake Manifold Cap Screws

Continued on next page

RG,RG34710,1272 –19–23OCT97–1/2

9. Install JDG683 Sealing Ring Compression Tool (A) onto aftercooler coolant tubes with cross bar across slot.

10. Remove intake manifold cover (B).

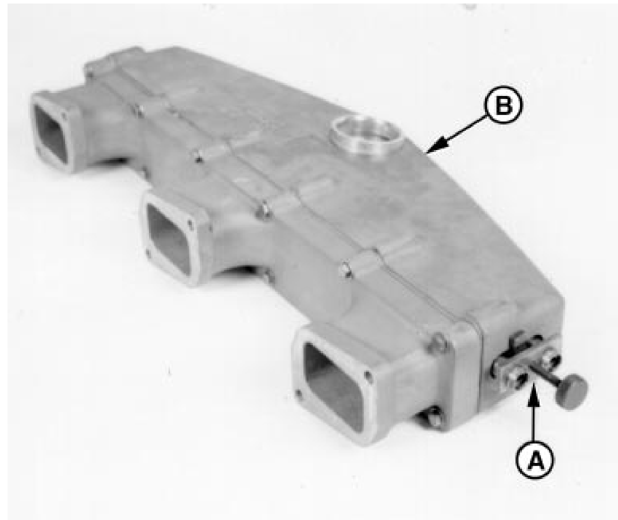
11. Remove JDG683 tool.

12. Remove aftercooler core from intake manifold.

13. Inspect aftercooler end seal and replace as needed.

14. Inspect and repair aftercooler. See INSPECT AND REPAIR AFTERCOOLER (6081A ENGINES) later in this group.

A—Sealing Ring Compression Tool
B—Intake Manifold Cover



Removing Aftercooler Cover and Core

RG,RG34710,1272 –19–23OCT97–2/2

Inspect and Repair Aftercooler (6081A Engines)

1. Inspect aftercooler for overall condition. The fins should be reasonably straight, and cross straps should be free of cracks.

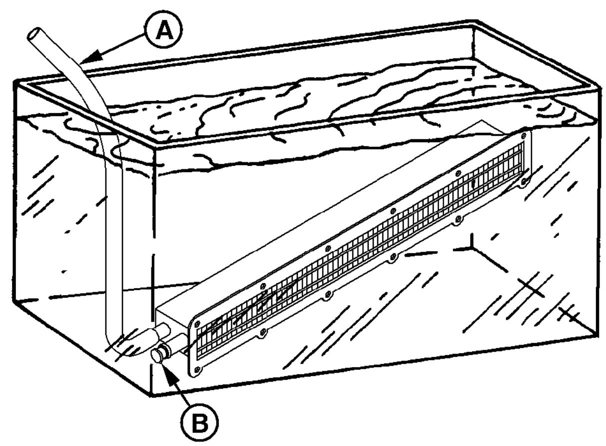
2. Inspect aftercooler inlet and outlet hoses. Replace either hose if cracked or damaged.

3. Test the aftercooler for leaks by plugging one of the tubes (B).

4. Apply compressed air (A) to the other tube while unit is submerged under coolant. Use 140—170 kPa (1.4—1.7 bar) (20-25 psi) air pressure for testing.

IMPORTANT: Coolant leakage from the aftercooler may cause severe engine damage.

A minor leak that is accessible may be repaired. However, if the condition of the core is questionable, replace the aftercooler.



Testing Aftercooler Core for Leaks

A—Compressed Air
B—Plug

RG,RG34710,1273 –19–23OCT97–1/1

Inspect and Repair Intake Manifold and Air Intake Cover (6081A Engines)

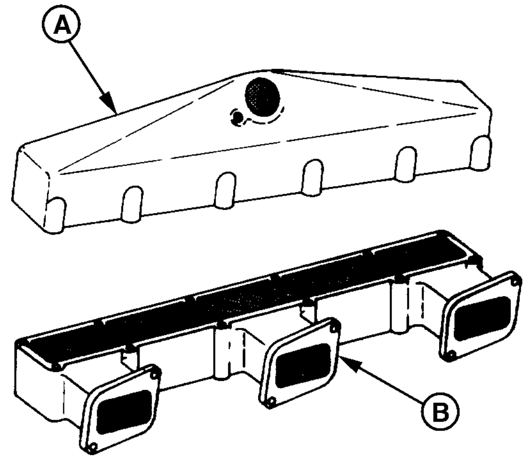
1. Inspect air intake cover (A) for cracks or damage. Replace as necessary.

2. Check intake manifold (B) for damage. Inspect machined mounting surfaces for burrs or other defects which might prevent gaskets from sealing properly. Repair as required.

3. Thoroughly steam clean interior of intake manifold and covers.

IMPORTANT: Do not use a hot tank to clean aluminum parts as damage and severe deterioration can occur.

4. Scrape all gasket material from cylinder head and intake manifold mounting surfaces.



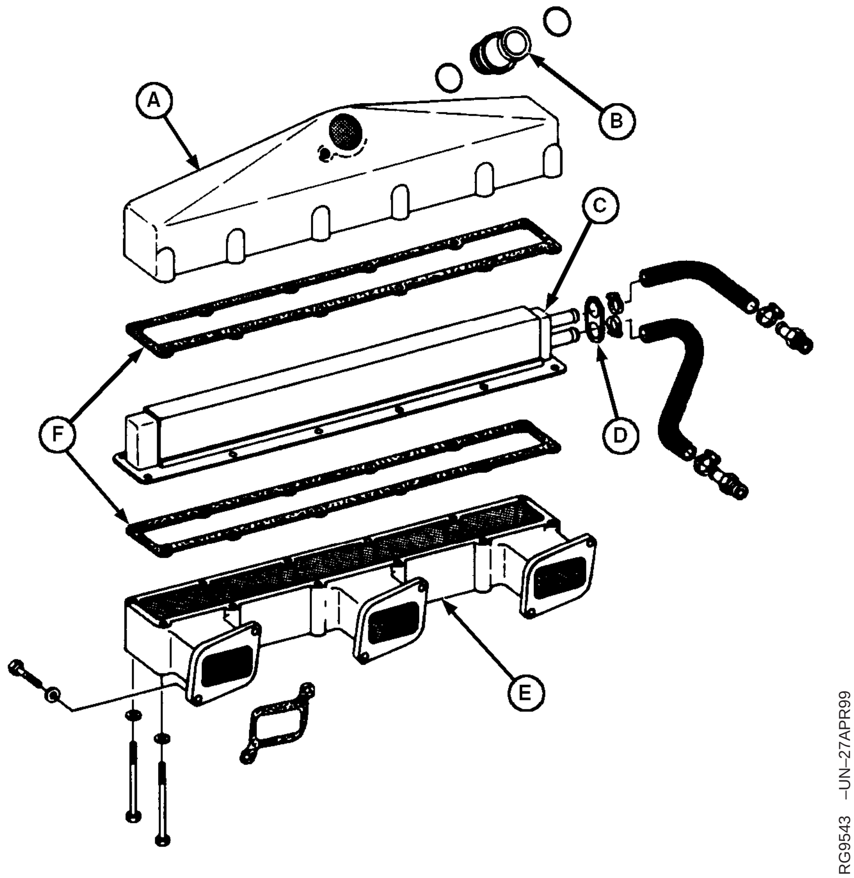
RG5750 –UN–22NOV97

Inspecting Intake Manifold and Cover

A—Air Intake Cover
B—Intake Manifold

RG,RG34710,1274 –19–23OCT97–1/1

Install Intake Manifold and Vertically-Mounted Aftercooler (6081A Engines)



Vertically-Mounted Aftercooler—6081A Engines

A—Air Intake Cover
B—Intake Coupling
C—Aftercooler Core
D—End Seal
E—Intake Manifold
F—Gasket (2 Used)

IMPORTANT: Debris left in intake manifold can cause engine damage. Make sure that the inside of manifold is clean before assembly.

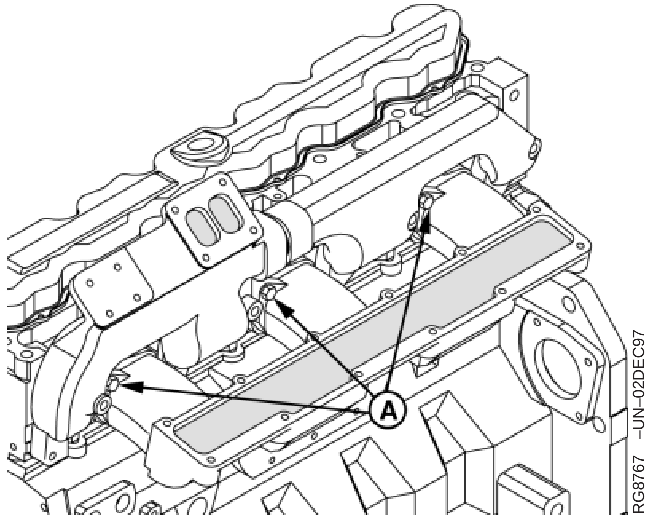
1. Install the intake manifold (E) on cylinder head using new gaskets.

Continued on next page RG,RG34710,1275 –19–23OCT97–1/4

2. Tighten the six cap screws (A) to specifications

Specification	
Intake Manifold-to-Cylinder Head—Torque	47 N•m (35 lb-in.)

A—Cap Screws



Installing Intake Manifold

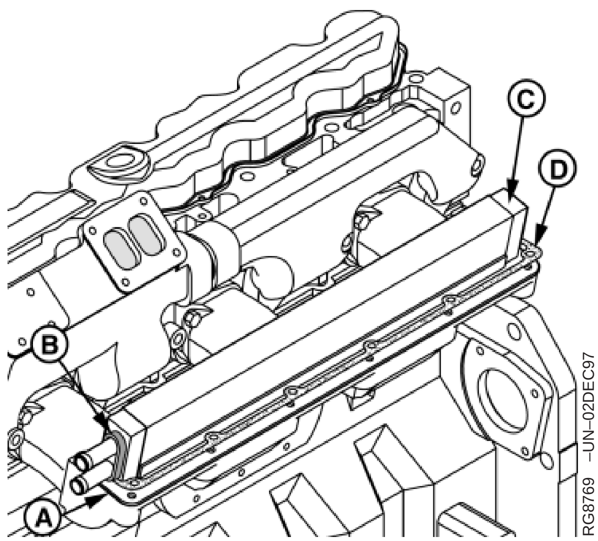
RG,RG34710,1275 –19–23OCT97–2/4

3. Install a new gasket (A) on top of intake manifold.

4. Install aftercooler end seal (B) on inlet and outlet tubes.

5. Install aftercooler (C) on top of intake manifold. Put a new gasket (D) on top of aftercooler. Carefully align cap screw holes in aftercooler, intake manifold, and gaskets.

A—Gaskets
B—End Seal
C—Aftercooler
D—Gasket



Installing Aftercooler

Continued on next page RG,RG34710,1275 –19–23OCT97–3/4

6. Install air intake cover (A) over aftercooler so inlet and outlet tubes are protruding through hole in cover.

IMPORTANT: Improperly seated or crimped end seal can result in loss of power and possible engine damage. Make sure end seal is properly seated.

7. Install JDG683 Sealing Ring Compression Tool (B) onto aftercooler coolant tubes (C) with crossbar across slot as shown.

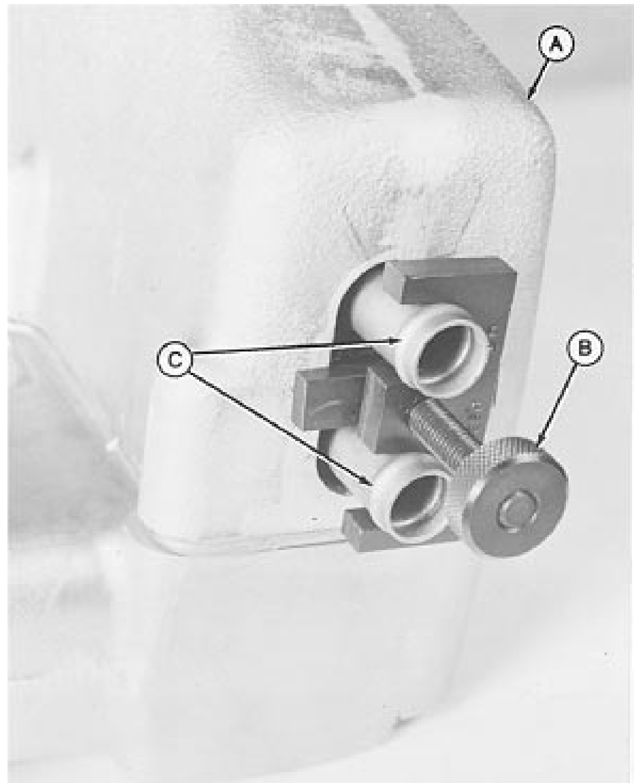
8. Tighten tool until air intake cover cap screw holes are aligned with holes in gaskets, aftercooler, and intake manifold.

IMPORTANT: All intake manifold and aftercooler connections at the turbocharger and engine cylinder head must be tight to prevent loss of power resulting from lower manifold pressure, and possible engine damage.

9. Apply PT569 NEVER-SEEZ to all intake manifold-to-aftercooler cover cap screws. Install cap screws and tighten to specifications.

Specification	
Aftercooler Cover-to-Intake Manifold—Torque	34 N•m (25 lb-ft)

Remove seal compression tool.



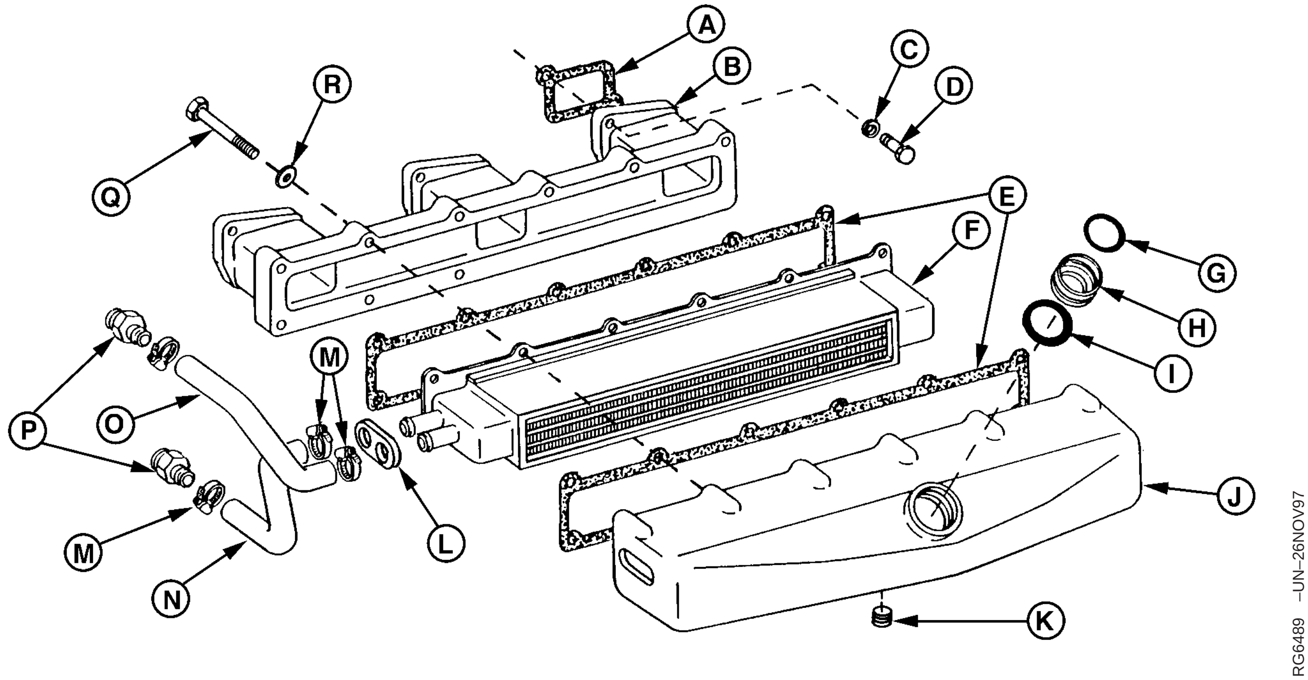
RG5570 –UN–09JAN90

Aligning Aftercooler Parts

A—Air Intake Cover
B—JDG683 Tool
C—Aftercooler Coolant Tubes

RG,RG34710,1275 –19–23OCT97–4/4

Assemble and Install Horizontally-Mounted Aftercooler Assembly (6081A Engines)



Horizontally-Mounted Aftercooler—6081A Engines

A—Gasket (3 Used)
B—Intake Manifold
C—Washer (6 Used)
D—Cap Screw (6 Used)
E—Gasket (2 Used)
F—Aftercooler Core
G—O-Ring
H—Intake Coupler
I—O-Ring
J—Aftercooler Cover
K—Pipe Plug
L—End Seal
M—Clamps (4 Used)
N—Hose
O—Hose
P—Nipple (2 Used)
Q—Cap Screw (12 Used)
R—Washer (12 Used)

IMPORTANT: Improperly seated or crimped aftercooler end seal can result in loss of power and possible engine damage. Make sure end seal is properly seated.

1. Install aftercooler end seal on coolant tubes.

IMPORTANT: Debris left in intake manifold can cause engine damage. Make sure that inside of manifold is clean before assembly.

2. Position aftercooler core into intake manifold using new gaskets.
3. Install JDG683 Sealing Ring Compression Tool onto aftercooler coolant tubes with cross bar across slot (see illustration on preceding page).
4. Tighten tool until intake manifold cover cap screw holes are aligned with holes in gaskets, aftercooler, and intake manifold. Use guide studs as needed to hold alignment.
5. Apply PT569 NEVER-SEEZ Compound to all aftercooler cover-to intake cap screws. Tighten cap screws to specifications.

Specification
Aftercooler Cover-to-Intake
Manifold—Torque .... 34 N•m (25 lb-ft)

Remove seal compression tool.

6. Install turbocharger See INSTALL TURBOCHARGER earlier in this group.

Continued on next page

7. Install three guide studs (A) in locations shown.

IMPORTANT: All intake manifold connections must be tight to prevent loss of power resulting from lower manifold pressure, and possible engine damage.

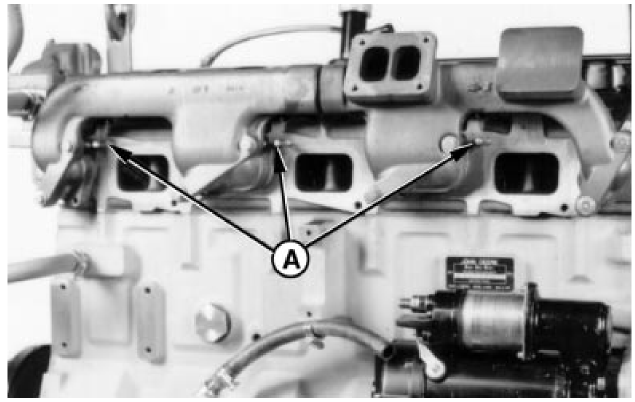
8. Using new gaskets, install aftercooler assembly to cylinder head. Tighten cap screws to specifications.

Specification

Aftercooler Assembly-to-Cylinder Head—Torque .... 47 N•m (35 lb-ft)

9. Connect coolant inlet and outlet hoses to aftercooler and tighten clamps.

10. Connect turbocharger oil inlet and return lines.



Installing Aftercooler

A—Guide Studs

RG,RG34710,1276 –19–23OCT97–2/2

Servicing of Air Heater (If Equipped)

For service of air heater option, refer to CTM67, OEM Engine Accessories. See REMOVE AND INSTALL AIR HEATER in Group 24 of CTM67.

DPSG,OUO1004,816 –19–21APR99–1/1

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 (B).

3. Remove alternator belt using a 1/2 in. drive ratchet on the belt tensioner (C).

4. Remove mounting cap screws from bracket (D) and remove alternator.

5. Install alternator in reverse order.

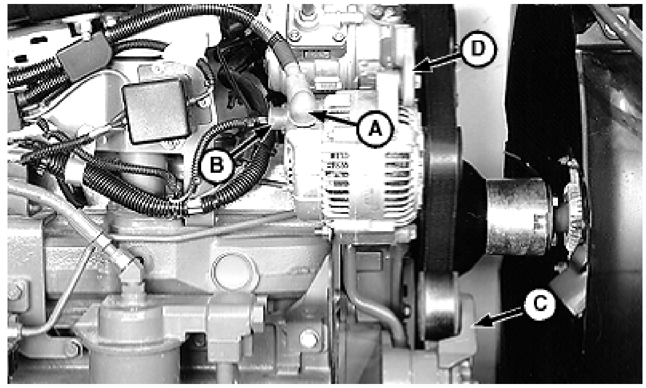
6. Torque alternator mounting hardware to the following specifications.

Specification	
Alternator Mounting Hardware (Upper)—Torque	27 N•m (20 lb-ft)

Specification	
Alternator Mounting Hardware (Lower)—Torque	80 N•m (60 lb-ft)

7. If alternator mounting bracket or strap are removed and reinstalled, torque cap screws to the following specifications.

Alternator Mounting Bracket and Strap Hardware—Specification	
Alternator Adjusting Strap-to-Thermostat Housing (7/8 in. long) Cap Screws—Torque	35 N•m (26 lb-ft)
Alternator Adjusting Strap-to-Thermostat Housing (2 in. long) Cap Screws—Torque	61 N•m (45 lb-ft)
Alternator Front Support-to-Alternator Rear Support (1-3/4 in. long) Cap Screws—Torque	61 N•m (45 lb-ft)



RW70017 –UN–22SEP97

Alternator

A—Positive Wire
B—Regulator Connector
C—Belt Tensioner
D—Alternator Bracket

Continued on next page

DPSG,OUO1004,854 –19–28APR99–1/2

Alternator Bracket-to-Alternator Support (1 in. and 1-1/4 in. long) Cap Screws—Torque .... 35 N•m (26 lb-ft)
Alternator Support-to-Thermostat Housing (1 in. and 1-1/4 in. long) Cap Screws—Torque .... 61 N•m (45 lb-ft)

8. Inspect alternator belt for cracks and wear.

DPSG,OUO1004,854 –19–28APR99–2/2

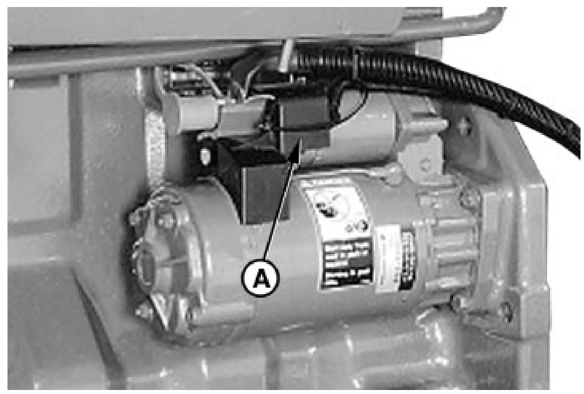
Remove and Install Starter Motor (OEM Engines)

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).
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 (Upper)—Torque.. 44 N•m (33 lb-ft)

Specification
Starter Motor Mounting Hardware (Lower)—Torque.. 27 N•m (20 lb-ft)



RG8768 –UN–02DEC97

Starter Motor

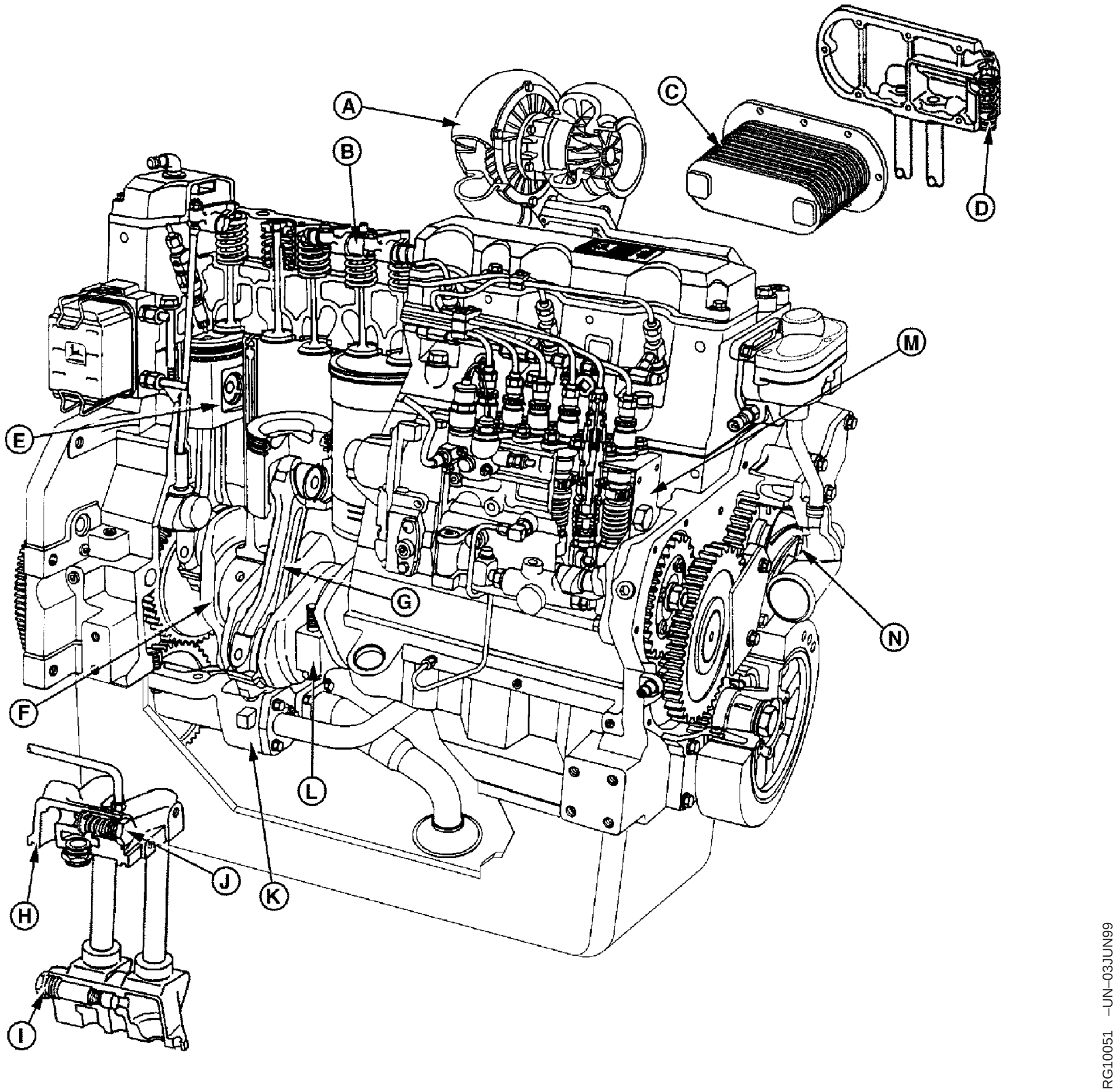
A—Starter Solenoid

DPSG,OUO1004,802 –19–28APR99–1/1

Section 03
Theory of Operation

Contents

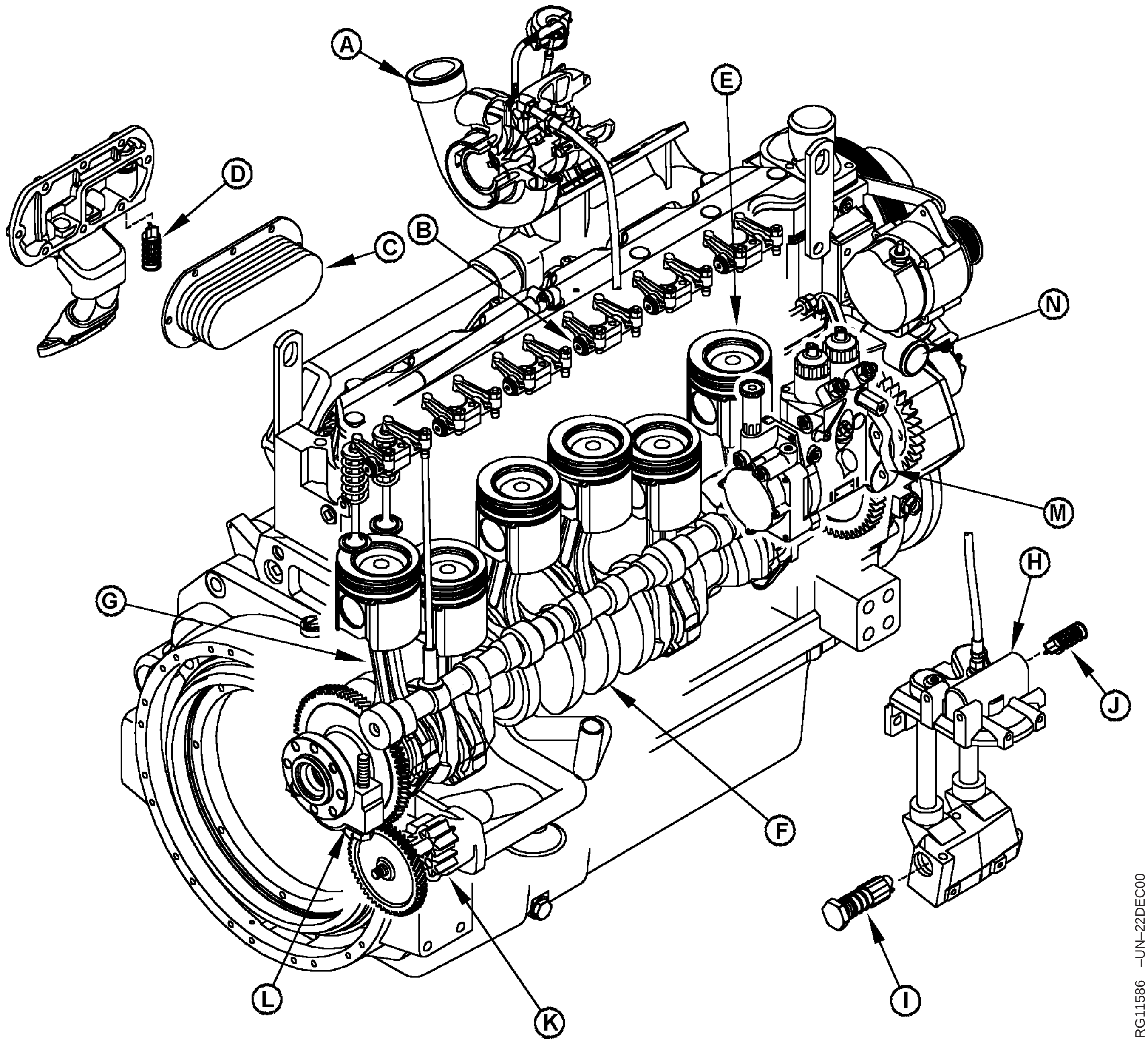
Engine Sectional View Serial Number (—199,999)



A—Turbocharger
B—Rocker Arm Shaft
C—Oil Cooler
D—Oil Cooler Bypass Valve
E—Piston
F—Crankshaft
G—Connecting Rod
H—Oil Filter Base
I—Oil Pressure Regulating Valve
J—Oil Filter Bypass Valve
K—Oil Pump Assembly
L—Main Bearing Cap
M—Fuel Injection Pump
N—Coolant Pump

DPSG,OUO1004,901 –19–19MAY99–1/1

Engine Sectional View Serial Number (200,000—)



A—Turbocharger
B—Rocker Arm Assembly
C—Oil Cooler
D—Oil Cooler Bypass Valve
E—Piston
F—Crankshaft
G—Connecting Rod
H—Oil Filter Base
I—Oil Pressure Regulating Valve
J—Oil Filter Bypass Valve
K—Oil Pump Assembly
L—Main Bearing Cap
M—Fuel Injection Pump
N—Coolant Pump

RG41165,000006E –19–08FEB01–1/1

General Engine Operation

All 6081 Engines are vertical stroke, in-line, valve-in-head, 6-cylinder diesel engines. The cylinder firing order is 1-5-3-6-2-4.

For engines with serial numbers (—199,999), direct fuel injection is provided by an in-line injection pump and 21 mm injection nozzles mounted in cylinder head. The pump is driven by an intermediate gear in the timing gear train meshing with the camshaft gear. The injection pump has an engine-driven camshaft which rotates at one-half engine speed. Roller cam followers, which ride on the camshaft lobes, operate the plungers to supply high-pressure fuel through the delivery valves to the injection nozzles. An electronically-controlled governor has programmable software and a control unit that determines the fuel rack position and fuel delivery based on engine system inputs.

For engines with serial numbers (200,000—), fuel is supplied by a high pressure fuel pump to a high pressure common rail. The high pressure common rail supplies the electronic injectors with fuel.

All engines are turbocharged. Operated by exhaust gases, the turbocharger compresses intake air from the air cleaner and routes it to each cylinder’s combustion chamber.

On air-to-coolant aftercooled engines (6081A), the turbocharger compressor discharge air is cooled by routing it through a heat exchanger mounted within the intake manifold. Liquid coolant circulates to cool the charged air.

On air-to-air aftercooled engines (6081H), the turbocharger compressor discharge air is cooled by routing it through a heat exchanger (usually mounted in front of radiator) before it enters the intake manifold. This heat exchanger uses no liquid coolant, but relies on air flow to cool the charge air.

The camshaft and followers are made of chilled iron. The cam lobes are individually flame hardened to provide excellent wear characteristics. Spherically ground followers which ride on tapered cam lobes help insure positive follower rotation. The front timing gear train consists of high contact ratio spur gears, allowing for two gear teeth contact at all times.

Cam followers, push rods, and rocker arm assembly operate intake and exhaust valves. Cylinder heads have replaceable inserts and valves, and they have exhaust valve stem seals.

The crankshaft is a one-piece, heat treated, dynamically balanced steel forging which rotates in replaceable two-piece main bearings. The main thrust bearing has a flange on each side to reduce crankshaft deflection and to limit end play during high load operation.

Cylinder liners are of a wet sleeve, flanged, and centrifugally cast design. O-ring type packings are used to seal the connection between cylinder block and liners. Liners are induction hardened and can be individually replaced (as a matched piston and liner set).

Pistons are cast with high-silicone aluminum alloy and have a three-ring configuration. The top two rings are compression rings, and the lower ring is an oil control ring. A double Ni-Resist ring carrier is cast integrally in the piston to greatly improve the life of the compression ring grooves. A deep “Reentrant” combustion chamber design provides maximum combustion efficiency and lower emissions. Top of piston is ceramic fiber reinforced to accommodate higher firing pressures generated from higher horsepower output.

The highly polished, hardened piston pins are fully-floating and held in position by means of snap rings. Spray jets (piston cooling orifices) in cylinder block direct pressure oil to lubricate piston pins and cool pistons.

Continued on next page

DPSG,RG33894,1 –19–17JUN98–1/2

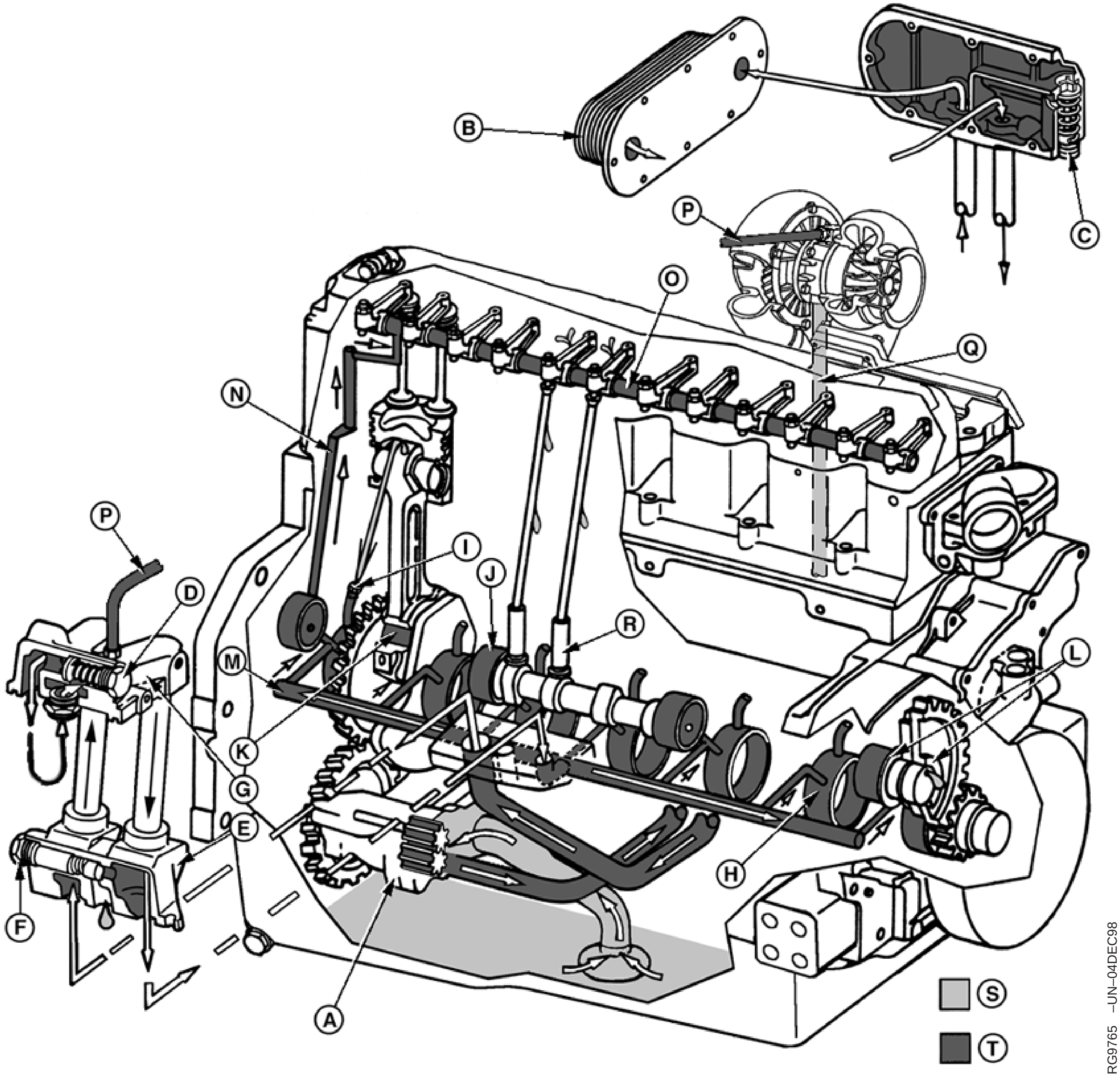
Connecting rods are of forged steel and have replaceable bushing and bearing inserts. They are weight controlled (by machining) on both ends to minimize engine vibration. Early production engines have the traditional machined joint between the rod and cap. Later engines have the non-machined, Precision Joint™ rod and cap.

The engine is supplied with lubricating oil by a spur gear pump driven off the rear of the crankshaft. Oil is conditioned by a full-flow filter and a housing located on the right side of the engine. Oil temperature is limited by an oil cooler located on left side of engine. Individual oil cooler and oil filter bypass valves protect the system and insure engine lubrication during times of high restriction; such as cold starts. Oil pressure is controlled by a pressure regulating valve located before the main oil gallery.

Precision Joint is a trademark of Deere & Company

DPSG,RG33894,1 –19–17JUN98–2/2

Lubrication System Operation



Engine Lubrication System Serial Number (—199,999)

A—Oil Pump
B—Oil Cooler
C—Oil Cooler Bypass Valve
D—Oil Filter Bypass Valve
E—Oil Pressure Regulating Valve Housing
F—Oil Pressure Regulating Valve
G—Oil Filter Base
H—Crankshaft Main Bearings
I—Piston Cooling Orifices
J—Camshaft Bushings
K—Connecting Rod Bearings
L—Camshaft Thrust Washers (2 used)
M—Main Oil Gallery
N—Drilled Oil Passage
O—Rocker Arm Shaft
P—Turbocharger Lube Line
Q—Turbocharger Oil Return
R—Camshaft Followers
S—Return Oil
T—Pressurized Oil

Continued on next page

RE38635,0000071 –19–05MAR05–1/5

Lubrication System Serial Number (—199,999)

The engine lubrication system consists of a crank-driven oil pump (A), oil cooler (B), oil filter, oil cooler bypass valve (C), oil filter bypass valve (D), and oil pressure regulating valve (F).

Oil is drawn up from the sump through the oil pump and on to the oil cooler by way of the oil cooler cover which houses the oil cooler bypass valve. Oil proceeds through the oil cooler where it exchanges heat with the engine coolant, unless high restriction is sensed in which case the oil cooler is bypassed. Oil goes to the oil filter base (G) which houses the oil filter bypass valve. Oil passes through the oil filter (not shown), unless high restriction is sensed in which case the oil filter is bypassed.

The oil then moves to the oil pressure regulating valve housing (E) where the regulating valve regulates the main oil gallery (M) pressure and permits excess oil to be returned to the sump. After flowing past the regulating valve, cooled, clean pressurized oil is supplied to the main oil gallery then distributed to the crankshaft main bearings (H) and piston cooling orifices (I) through drilled passages in the cylinder block.

The main bearings work to send oil to the camshaft bushings (J) while passages in the crankshaft allow pressurized oil to also lubricate the connecting rod bearings (K). The piston cooling orifices direct oil onto the piston skirt and piston/wrist pin assembly.

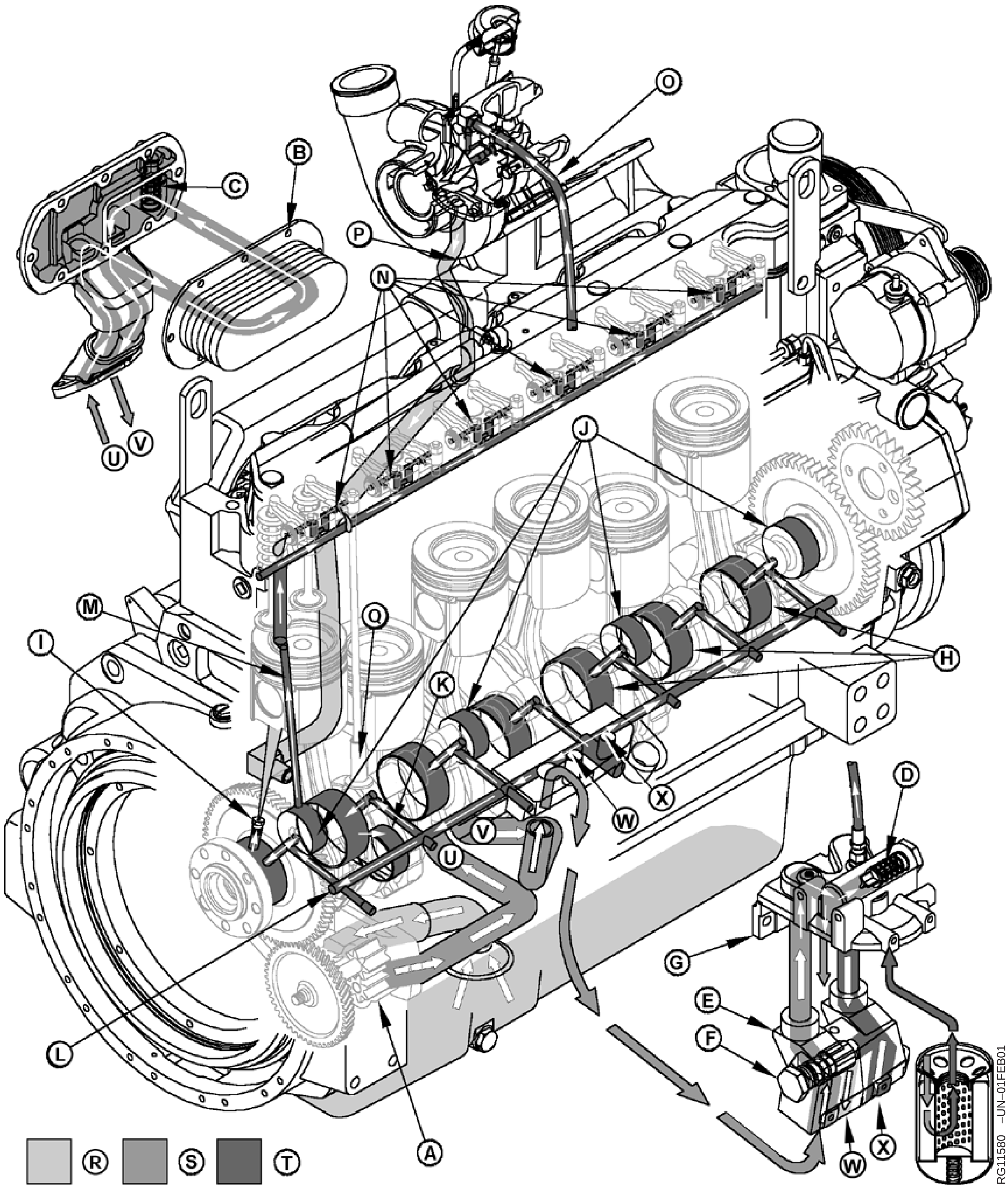
Oil from the front camshaft bushing travels through drilled passages in the camshaft nose to lubricate the camshaft thrust washers (L) and front gear drive train.

Oil from the rear camshaft bushing feeds through drilled passages (N) in the cylinder block and cylinder head into passages in the rocker arm shaft (O) which lubricate the rocker arms, which in turn provide oil to the other valve train components as well as the camshaft followers (R).

Some oil is routed from the top of the oil filter base through an external line (P) to the turbocharger and is returned to the cylinder block crankcase through another external line (Q).

The fuel injection pump is pressure lubricated by way of an external line which taps into the main oil gallery.

Continued on next page RE38635,0000071 –19–05MAR05–2/5



Engine Lubrication System Serial Number (200,000—)

Continued on next page RE38635,0000071 –19–05MAR05–3/5

A—Oil Pump
B—Oil Cooler
C—Oil Cooler Bypass Valve
D—Oil Filter Bypass Valve
E—Oil Pressure Regulating Valve Housing
F—Oil Pressure Regulating Valve
G—Oil Filter Base
H—Crankshaft Main Bearings
I—Piston Cooling Orifices
J—Camshaft Bushings
K—Connecting Rod Bearings
L—Main Oil Gallery
M—Drilled Oil Passage
N—Rocker Arm Assemblies
O—Turbocharger Lube Line
P—Turbocharger Oil Return
Q—Camshaft Followers
R—Return Oil
S—Medium Pressure Oil
T—High Pressure Oil

Lubrication System Serial Number (200,000—)

The engine lubrication system consists of a crank-driven oil pump (A), oil cooler (B), oil filter, oil cooler bypass valve (C), oil filter bypass valve (D), and oil pressure regulating valve (F).

Oil is drawn up from the sump through the oil pump and on to the oil cooler by way of the oil cooler cover which houses the oil cooler bypass valve. Oil proceeds through the oil cooler where it exchanges heat with the engine coolant, unless high restriction is sensed in which case the oil cooler is bypassed. Oil goes to the oil filter base (G) which houses the oil filter bypass valve. Oil passes through the oil filter, unless high restriction is sensed in which case the oil filter is bypassed.

The oil then moves to the oil pressure regulating valve housing (E) where the regulating valve regulates the main oil gallery (L) pressure and permits excess oil to be returned to the sump. After flowing past the regulating valve, cooled, clean pressurized oil is supplied to the main oil gallery then distributed to the crankshaft main bearings (H) and piston cooling orifices (I) through drilled passages in the cylinder block.

The main bearings work to send oil to the camshaft bushings (J) while passages in the crankshaft allow pressurized oil to also lubricate the connecting rod bearings (K). The piston cooling orifices direct oil onto the piston skirt and piston/wrist pin assembly.

Oil from the front camshaft bushing travels through drilled passages in the camshaft nose to lubricate the camshaft thrust washers (not shown) and front gear drive train.

Oil from the rear camshaft bushing feeds through drilled passages (M) in the cylinder block and cylinder head into passages in the rocker arm assemblies (N) which lubricate the rocker arms, which in turn provide oil to the other valve train components as well as the camshaft followers (Q).

Some oil is routed from the top of the oil filter base through an external line (O) to the turbocharger and is returned to the cylinder block crankcase through another external line (P).

The fuel injection pump is pressure lubricated by way of an external line (not shown) which taps into the main oil gallery.

Continued on next page RE38635,0000071 –19–05MAR05–4/5

Top Load Oil Filter

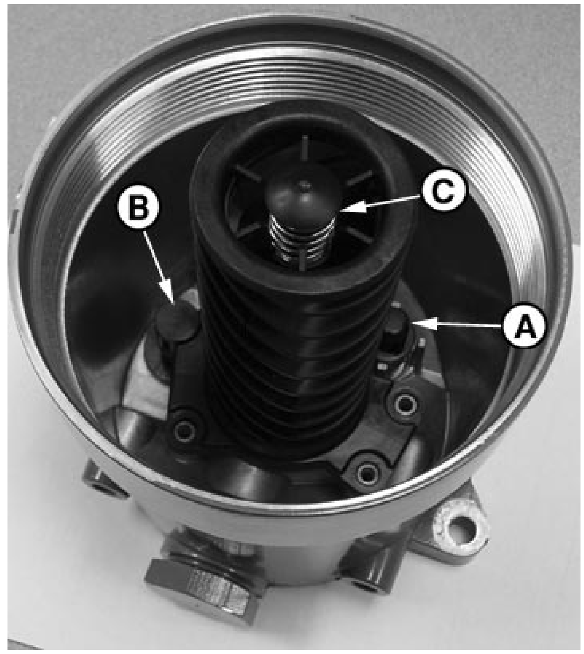
The top load oil filter assembly derives its name from the way the filter element "top loads"into the filter canister. The design is such that the filter element can be changed without the typical oil spill resulting from removal of the filter canister from the filter base. With the top load design, the filter canister remains on the filter base. Valves inside the filter canister regulate oil flow into the filter canister, pressure, and dump to sump when the filter element is changed.

When the filter element is in place and the system thus "closed", the pressure of the filter element keeps the return to sump valve (A) pressed downward, and thus closed. This prevents pressurized oil from being dumped back to sump prior to being filtered. If this valve is missing or not closed, low oil pressure will result.

Pressurized oil from the oil pump opens the inlet valve (B). This allows dirty, unfiltered oil from the sump to fill the canister and flow through the filter element. When the engine is turned off, this valve closes due to pressure from the oil within the canister, thus keeping the filter full of oil for the next start.

The bypass valve (C) protects the engine when the filter element becomes plugged, allowing unfiltered oil to reach engine components via the oil galley until the filter element can be changed.

When the oil filter element is removed for service replacement, pressure on the dump valve (A) is released, allowing oil in the canister to drain back to sump.



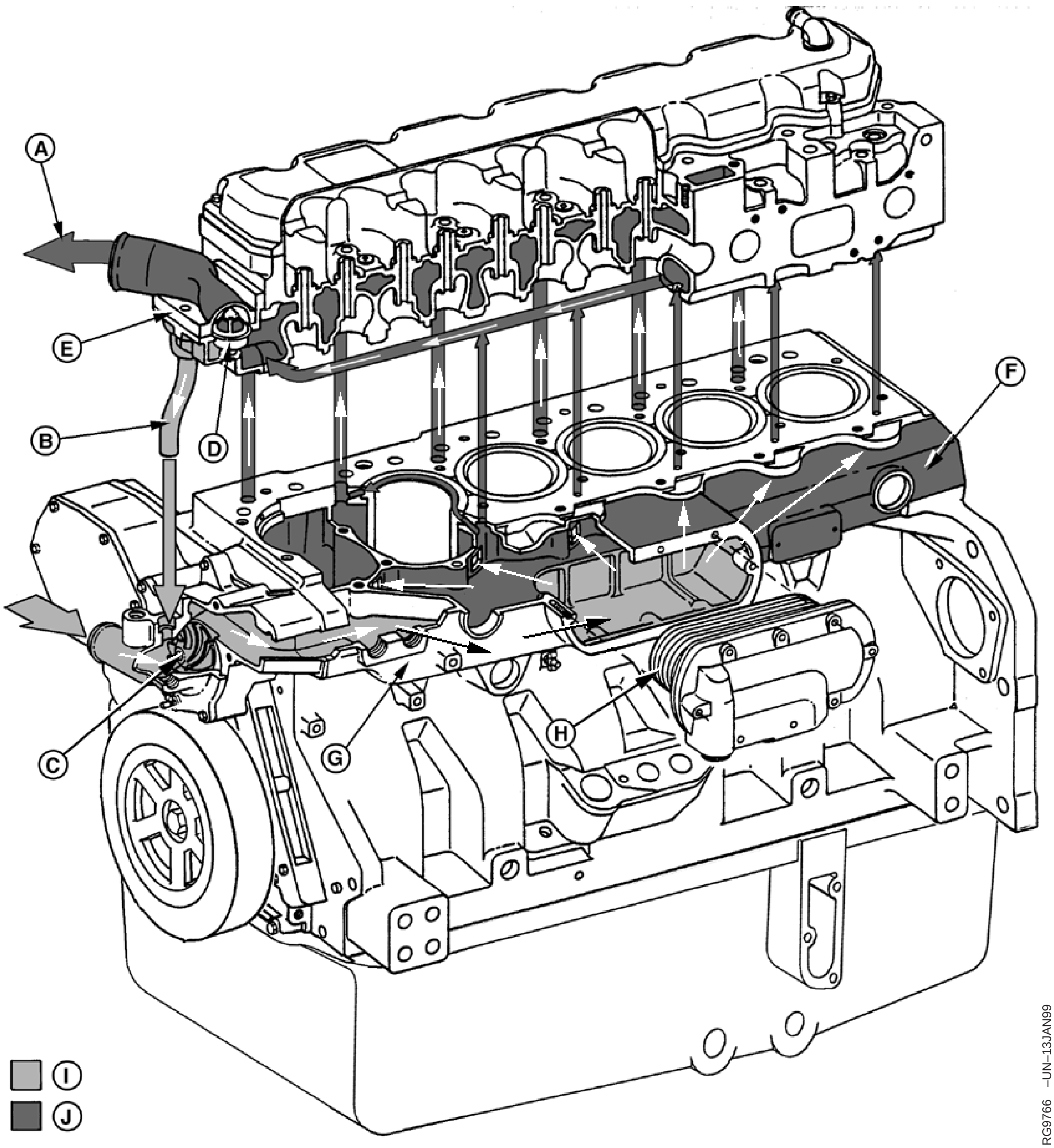
RG13823 –UN–16NOV04

Top Load Oil Filter Valves

A—Fill Valve
B—Drain Valve
C—Bypass Valve

RE38635,0000071 –19–05MAR05–5/5

Cooling System Operation



A—To Radiator
B—Coolant Bypass Tube
C—Coolant Pump
D—Thermostats (2 used)
E—Thermostat Housing
F—Coolant Manifold
G—Inlet Manifold
H—Engine Oil Cooler
I—Low Temperature Engine Coolant
J—High Temperature Engine Coolant

Continued on next page

RG,CTM86,G105,7 –19–16SEP94–1/2

The pressurized cooling system consists of a conventional radiator (A), coolant pump (C), thermostats (D), thermostat housing (E), and cylinder block with coolant cavities.

The pump draws coolant from the bottom of the radiator and discharges it through the lower inlet manifold (G) on the left-hand side of the engine block. The inlet directs coolant to the engine oil cooler (H) and provides the cooling capability from the coolant flow around it. Coolant passes through the oil cooler cavity and enters the upper coolant manifold (F). At this time, the coolant flow will move in one of three directions. Each cylinder is unitized and has a separate flow circuit.

The main coolant passage flows through a rectangular port and around the cylinder liner, then exits the block through a vertical passage into the right-hand side of the cylinder head.

The second circuit involves flowing coolant from the upper coolant manifold through a small vertical passage into the left-hand side of the cylinder head.

The third circuit is called the “directed cooling” system. Coolant flows through a small port and into a groove at the top of the cylinder liner. Coolant passes around groove in liner, and exits into the vertical passage of the main circuit, then into the right-hand side of the cylinder head.

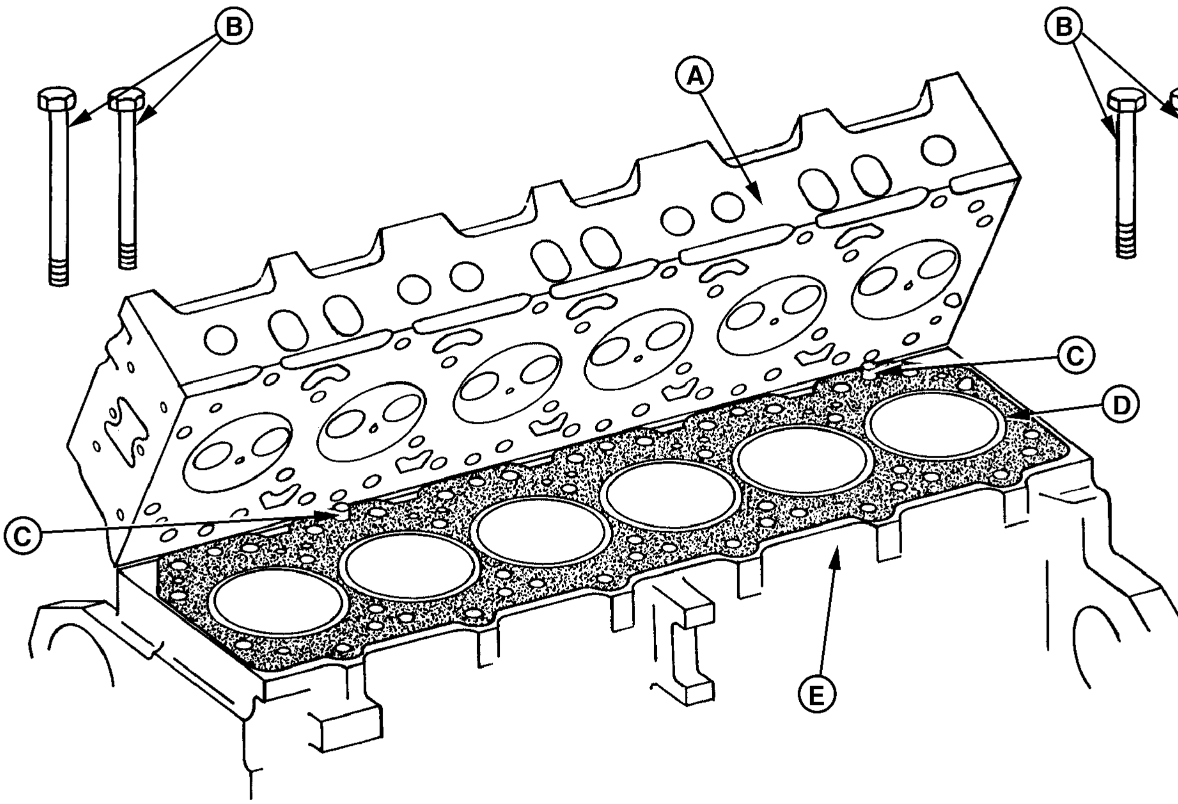
Once the coolant is in the cylinder head, all flow is towards the front. Coolant passes into the thermostat housing, past the two open thermostats (engine at normal operating temperature), and then returns to the radiator.

If the thermostats are closed (as during warm-up periods), coolant is directed back to the pump through the bypass tube (B) to be recirculated. This provides a faster and more uniform warm-up. Some coolant is passing through the bypass tube even while the thermostats are open.

On air-to-coolant aftercooled engines (6081A), coolant is taken from the upper left cylinder block coolant gallery and routed into an aftercooler where it circulates through the aftercooler core and back to the thermostat housing. Coolant circulating through the aftercooler absorbs heat from the pressurized intake air and carries the heat back to the engine cooling system to be dissipated to the radiator.

RG,CTM86,G105,7 –19–16SEP94–2/2

Head Gasket Joint Construction and Operation



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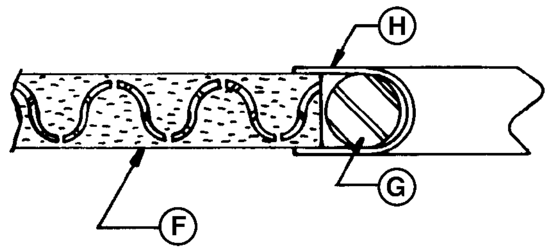
The head gasket joint consist of:

- Cylinder head gasket
- Cylinder head (A)
- Cylinder block (E)
- Cylinder liners (D)
- Cylinder head cap screws (B)

Refer to following page for explanation of illustration.



RG6430 –UN–03NOV97

A—Cylinder Head
B—Cylinder Head Cap Screws
C—Dowel Pins
D—Cylinder Liners
E—Cylinder Block
F—Gasket Body
G—Fire Ring Combustion Seal
H—Stainless Flange

Continued on next page RG,RG34710,1072 –19–27APR99–1/2

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 thin, formed sheets of steel-inserted, non-asbestos material (F). 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 from moving in the joint. Dowels (D) are used to properly locate head gasket on block.

The cylinder liners 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 must be proper length, made of proper material, and be tightened to proper torque in order to provide an adequate clamp local 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 specifications, 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 pressures persist.

RG,RG34710,1072 –19–27APR99–2/2

Air 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 secondary (safety) filter elements in the air cleaner canister. Clean air travels through the air intake hose to the turbocharger and intake manifold to the engine.

Exhaust, as it is expelled out the exhaust elbow, 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 air-to-air aftercooled engines (6081H), the turbocharger compressor discharge air is routed through a heat exchanger (located in front of radiator) before it enters the engine. The heat exchanger uses no liquid coolant but relies on air flow to cool the charge air.

On air-to-coolant aftercooled engines (6081A), the turbocharger compressor discharge air is routed through the aftercooler. The aftercooler is located in the intake manifold, so the intake air is cooled prior to entering the engine.

On engines that don't have an aftercooler but do have a turbocharger (6081T), the intake air flows directly into the intake manifold from turbocharger. The exhaust air flows out the exhaust manifold.

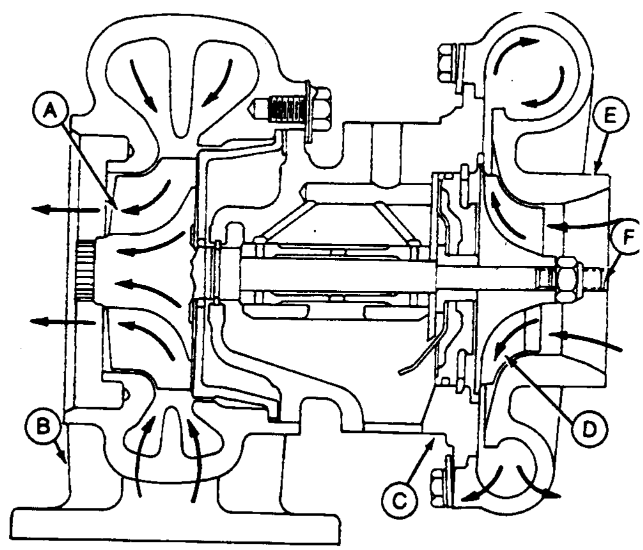
RG,CTM86,G110,1 –19–16SEP94–1/1

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 precisely matched to meet performance and emission requirements of each specific application.

Exhaust gases from the engine pass through the turbine housing (B) causing the turbine wheel (A) to rotate before the exhaust gas is discharged to the atmosphere. The turbine wheels mounted on a shaft (F) to drive the compressor wheel (D) which is also mounted on the shaft.

As the compressor wheel rotates in the compressor housing (E), an increased volume of (compressed) inlet air is drawn into the housing and delivered to the intake manifold (through an aftercooler or heat exchanger, if so equipped). All rotating components of the turbocharger are lubricated within the center housing (C).



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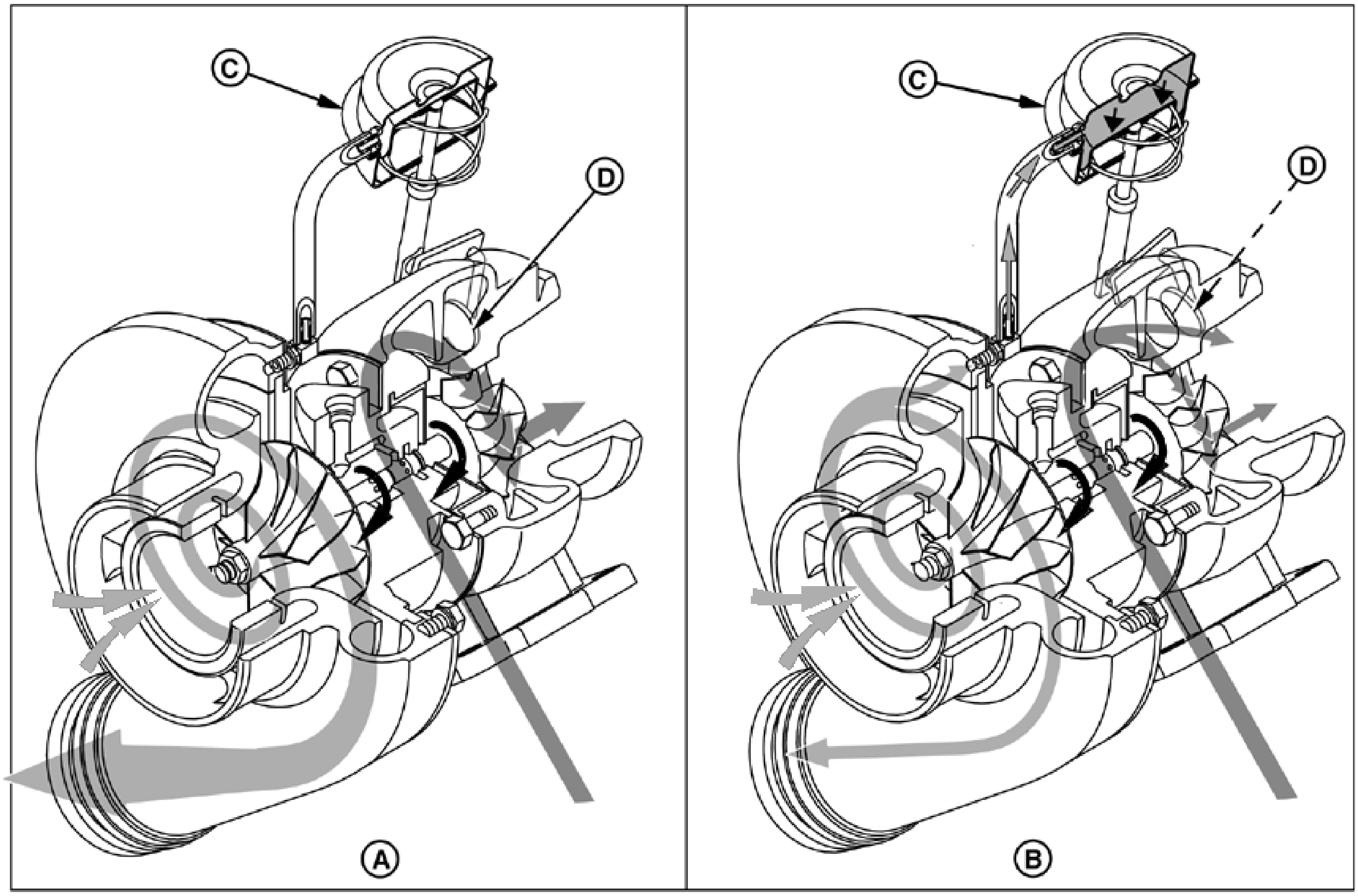
A—Turbine Wheel
B—Turbine Housing
C—Center Housing
D—Compressor Wheel
E—Compressor Housing
F—Shaft

RG,CTM86,G110,3 –19–16SEP94–1/1

Wastegate Operation



A—Wastegate Closed **B—Wastegate Open** **C—Diaphragm** **D—Valve**

Some applications of the 6081 engine have a wastegate actuator (bypass) valve (D) to help control turbine speed and boost at high engine rpm operation. This device is integral to the turbine housing and is diaphragm (C) activated.

The wastegate actuator is precisely calibrated and opens a valve to direct some (excess) exhaust gas flow around the turbine wheel to be released from the turbine housing. This limits shaft speed which in turn controls boost pressure.

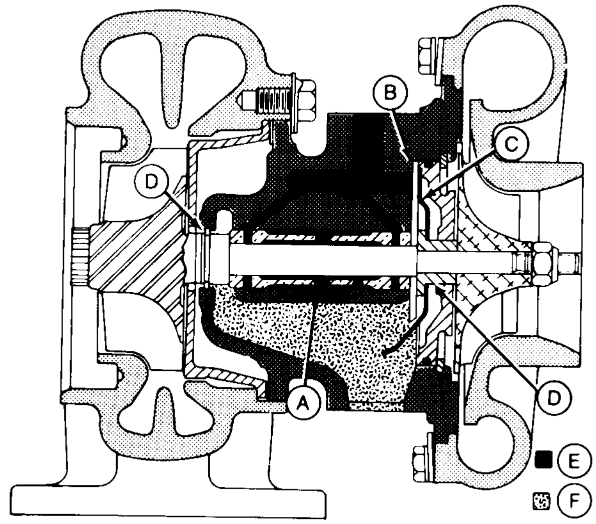
The valve allows the system to develop peak charge-air pressures for maximum engine boost response while eliminating the chance of excessive manifold pressure (over-boost) at high speeds or loads.

DPSG,RG34710,13 –19–11JAN99–1/1

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 bearing (A), thrust plate (B), and thrust sleeve (C). Oil is sealed from the compressor and turbine by a piston ring (D) at both ends of bearing housing.

The turbocharger contains a single floating bearing. This bearing has clearance between the bearing OD and the housing wall as well as clearance between the bearing ID and the shaft OD. These clearances are lubricated by the oil supply and the bearings are protected by a cushion of oil. Discharge oil drains by gravity from the bearing housing to the engine crankcase.



RG4646 –UN–29AUG94

A—Bearing
B—Thrust Plate
C—Thrust Sleeve
D—Piston Ring
E—Pressure Oil
F—Discharge Oil

RG,CTM61,G110,5 –19–16SEP94–1/1

Section 04
Diagnostics

Contents

About This Group of the Manual

This section of the manual contains necessary information to diagnose some base engine, all lubrication system, and all cooling system problems. This section is divided into two areas: diagnosing malfunctions and testing procedures. The diagnostic malfunctions area is further divided into the following headings, containing the following systems:

- **(L)** Diagnosing Lubrication System Malfunctions:
  - L1 - Excessive Oil Consumption
  - L2 - Engine Oil pressure Low
  - L3 - Engine Oil Pressure High
- **(C)** Diagnosing Cooling System Malfunctions
  - C1 - Engine Coolant Temperature Above Normal
  - C2 - Engine 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 problems 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:

- Base Engine Testing Procedures:
  - Test Engine Compression Pressure
  - Check Engine Cranking Speed
- Lubrication 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 (Turbocharged Engines)
  - Test Turbocharger Wastegate
  - Adjust Turbocharger Wastegate Actuator

DPSG,RG39774,34 –19–27JAN99–1/1

8.1L - L1 - Excessive Oil Consumption

DPSG,RG39774,32 –19–26JAN99–1/1

8.1L - L1 - Excessive Oil Consumption

Before using this diagnostic procedure:

Check for too low or too high engine oil level.

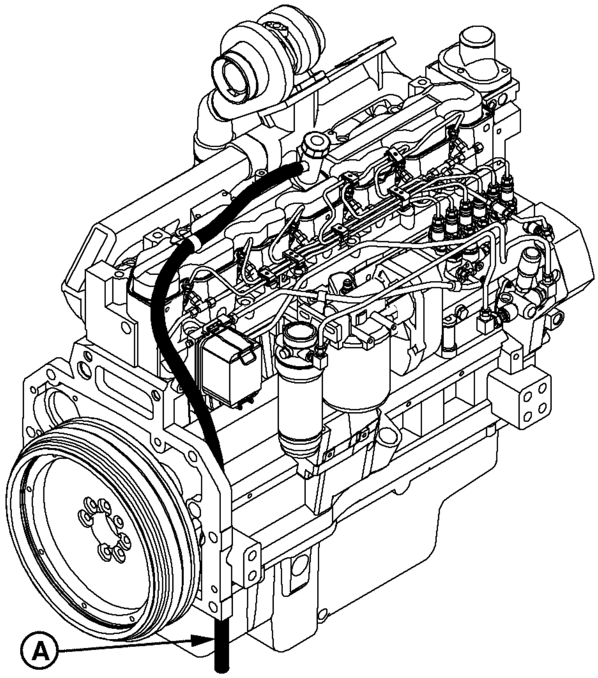
Check for too low viscosity, or coolant or fuel diluted engine oil.

Check for excessive external oil leaks.

– – –1/1

❶ **Oil In Coolant Check**	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 **Crankcase Breather Tube Check**	 RG9720 –UN–04DEC98 A restricted crankcase breather tube (A) can cause excessive pressure to build up and force oil into the combustion chamber. Check the breather tube to make sure there is no blockage, no kinks, and no restrictions.	**Breather tube NOT restricted:** GO TO ❸ **Restriction found in breather tube:** Remove restriction or replace breather tube and retest. – – –1/1

❸ **Excessive Crankcase Pressure Check**	Check for excessive crankcase pressure. See CHECK FOR EXCESSIVE ENGINE CRANKCASE PRESSURE (BLOW-BY) later in this Group.	**No fumes and no dripping oil observed:** GO TO ❹ **Excessive fumes or dripping oil observed; appears to be caused by boost pressure (if equipped with turbocharger):** Check the turbocharger, repair/replace as needed. See TURBOCHARGER FAILURE ANALYSIS in Section 02, Group 080 of this manual. **Excessive fumes or dripping oil observed; does NOT appear to be caused by boost pressure (if equipped with turbocharger):** 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 is the case. See TEST ENGINE COMPRESSION PRESSURE later in this Group. – – –1/1

❹ **Turbocharger Oil Seal Leak Check**	*NOTE: This check is not needed for non-turbocharged ("D" engines), for these engines GO TO* ❺. Check for turbocharger oil seal leaks. See CHECK FOR TURBOCHARGER OIL SEAL LEAK later in this Group.	**NO signs of oil leakage:** GO TO ❺ **Signs of oil leakage present:** Investigate problems associated with oil leakage as outlined it the test procedure, perform necessary repairs, and retest. – – –1/1

❺ **Pistons, Rings, Cylinder Liners Check**	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 grooves excessively worn • Piston rings sticking in ring grooves • Insufficient piston ring tension • Piston ring gaps not staggered • Cylinder liners glazed (insufficient load during engine break-in) • Worn valve guides or stems	**Problem found with pistons, rings, and/or liners or valve guides:** Repair problem as necessary.

– – –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.
- Perform compression test to find low compression cylinders.
- 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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PLUS-50 is a registered trademark of Deere & Company

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8.1L - L2 - Engine Oil Pressure Low

Symptom	Problem	Solution
8.1L - L2 - Engine Oil Pressure Low	Low crankcase oil level	Fill crankcase to proper level.
	Incorrect oil	Drain crankcase and refill with proper grade and viscosity oil. See DIESEL ENGINE OIL in Section 01, Group 002 of this manual.
	Plugged oil filter	Change oil and oil filter
	Faulty oil pressure switch/sensor or oil pressure indicator light/gauge	Measure engine oil pressure with a mechanical gauge to verify pressure is low. See CHECK ENGINE OIL PRESSURE later in this Group.
	Excessive oil temperature	Remove and inspect engine oil cooler. See REMOVE, INSPECT, AND INSTALL ENGINE OIL COOLER in Section 02, Group 060 of this manual.
	Faulty oil pressure regulating valve	Remove and inspect engine oil pressure regulating valve. See REMOVE, INSPECT, AND INSTALL OIL PRESSURE REGULATING VALVE in Section 02, Group 060 of this manual.
	Plugged oil pump screen or cracked pick-up tube	Remove oil pan and clean screen. Replace oil intake (pick-up) tube. See REMOVE, INSPECT, AND INSTALL OIL PUMP PICKUP TUBE in Section 02, Group 060 of this manual.
	Faulty oil pump	Remove and inspect engine oil pump. See REMOVE ENGINE OIL PUMP and INSPECT AND CLEAN OIL PUMP in Section 02, Group 060 of this manual.

Continued on next page

DPSG,RG40854,710 –19–03AUG00–1/2

Symptom	Problem	Solution
	Faulty or missing piston cooling orifice	Check piston cooling orifices.
	Excessive main or connecting rod bearing clearance	Determine bearing clearance. See CHECK MAIN BEARING OIL CLEARANCE in Section 02, Group 050 of this manual.

DPSG,RG40854,710 –19–03AUG00–2/2

8.1L - L3 - Engine Oil Pressure High

Symptom	Problem	Solution
8.1L - L3 - Engine Oil Pressure High	Incorrect oil	Drain crankcase and refill with proper grade and viscosity oil. See DIESEL ENGINE OIL in Section 01, Group 002 of this manual.
	Faulty oil pressure sensor or gauge	Measure engine oil pressure with a mechanical gauge to verify pressure is high. See CHECK ENGINE OIL PRESSURE later in this Group.
	Faulty oil pressure regulating valve	Remove and inspect engine oil pressure regulating valve. See REMOVE, INSPECT, AND INSTALL OIL PRESSURE REGULATING VALVE, OIL FILTER BYPASS VALVE, AND OIL COOLER BYPASS VALVE in Section 02, Group 060 of this manual.
	Stuck oil filter bypass valve	Remove and inspect engine oil filter bypass valve. See REMOVE, INSPECT, AND INSTALL OIL PRESSURE REGULATING VALVE, OIL FILTER BYPASS VALVE, AND OIL COOLER BYPASS VALVE in Section 02, Group 060 of this manual.
	Stuck oil cooler bypass valve	Remove and inspect engine oil cooler bypass valve. See REMOVE, INSPECT, AND INSTALL OIL PRESSURE REGULATING VALVE, OIL FILTER BYPASS VALVE, AND OIL COOLER BYPASS VALVE in Section 02, Group 060 of this manual.

DPSG,RG40854,711 –19–03AUG00–1/1

8.1L - C1 - Engine Coolant Temperature Above Normal

Symptom	Problem	Solution
8.1L - C1 - Engine Coolant Temperature Above Normal	Low coolant level	Add coolant to proper level.
	Plugged radiator core and/or side shields	Clean radiator and/or side shields as required.
	Engine overloaded	Reduce engine load.
	Low crankcase oil level	Fill crankcase to proper level.
	Loose or faulty fan belt	Replace/tighten fan belt as required.
	Faulty coolant temperature switch/sensor or coolant temperature indicator light/gauge	Measure coolant temperature with a gauge of known accuracy to determine if coolant temperature is above normal.
	Faulty radiator cap	Test radiator cap. See PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP later in this Group.
	Faulty thermostats	Test thermostat opening temperature. See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE later in this Group.
	Faulty cylinder head gasket	Look for signs of a head gasket failure. See CHECK FOR HEAD GASKET FAILURES later in this Group.
	Faulty coolant pump	Remove and inspect coolant pump. See VISUALLY INSPECT COOLANT PUMP and REMOVE COOLANT PUMP ASSEMBLY in Section 02, Group 070 of this manual.

DPSG,RG40854,707 –19–03AUG00–1/1

8.1L - C2 - Engine Coolant Temperature Below Normal

Symptom	Problem	Solution
8.1L - C2 - Engine Coolant Temperature Below Normal	Faulty coolant temperature switch/sensor or coolant temperature indicator light/gauge	Measure coolant temperature with a gauge of known accuracy to determine if coolant temperature is below normal.
	Faulty thermostats	Test thermostat opening temperature. See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE later in this Group.

DPSG,RG40854,708 –19–03AUG00–1/1

8.1L - C3 - Coolant In Oil or Oil In Coolant

Symptom	Problem	Solution
8.1L - C3 - Coolant In Oil or Oil In Coolant	Faulty cylinder head gasket	Look for signs of a head gasket failure. See CHECK FOR HEAD GASKET FAILURES later in this Group.
	Faulty oil cooler	Remove and inspect engine oil cooler. See REMOVE, INSPECT, AND INSTALL ENGINE OIL COOLER in Section 02, Group 060 of this manual.
	Leaking cylinder liner seals	Remove and inspect cylinder liners. See REMOVE CYLINDER LINERS in Section 02, Group 030 of this manual.
	Cracked cylinder head or block	Locate crack, repair/replace components as required.

DPSG,RG40854,709 –19–03AUG00–1/1

Test Engine Compression Pressure

IMPORTANT: Compression pressures are affected by the cranking speed of the engine. Before beginning the test, ensure that batteries are fully charged and injection nozzle area is thoroughly cleaned.

1. Start engine and run at rated speed until it warms up to normal operating temperature. (From a cold start, operate engine 10-15 minutes at slow idle.)

2. Remove injection lines, leak-off lines, and injection nozzles. If mechanical fuel system, see REMOVE FUEL INJECTION NOZZLES in Group 090 of CTM243. If Level 3 Electronic fuel system, see REMOVE FUEL INJECTION NOZZLES in Group 090 of CTM134.

3. Install the JT01675A Nozzle adapter and JT01677 Adapter Nut (A) into injection nozzle bore. Tighten adapter nut to 80 N•m (60 lb-ft).

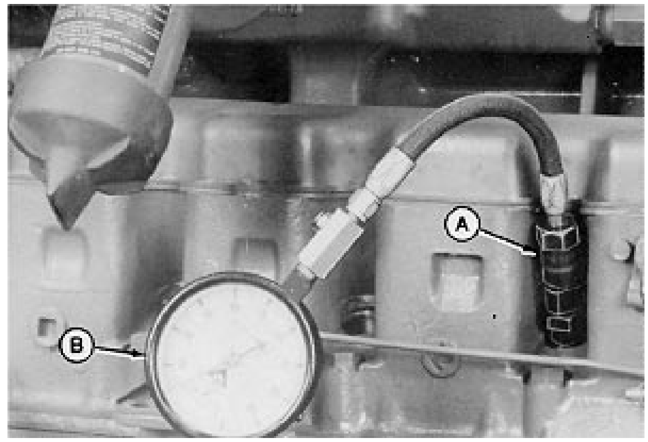
4. Connect JT01682 Gauge and Hose Assembly (B) to nozzle adapter.

5. If engine is equipped with an electronic governor, remove battery power supply to the Engine Control Unit (ECU) by removing the ECU power supply fuse, or by disconnecting the ECU from the wiring harness. If engine is equipped with a mechanical governor, disconnect the electrical connection to the fuel shut-off solenoid.

6. Crank engine over with starting motor for approximately 10 seconds and record compression readings. Compare readings with specifications listed below:

Specification

ENGINE COMPRESSION PRESSURE—Compression Pressure .... 2,380—2,790 kPa (23.8—27.9 bar) (345—405 psi)



RG4118 –UN–27OCT88

A—Nozzle Adapter
B—Gauge and Hose Assembly

04
150
11

Continued on next page

DPSG,RG40854,2 –19–24NOV98–1/2

NOTE: Pressure given was taken at 300 m (1000 ft) above sea level. A 3.6% reduction in gauge pressure will result for each additional 300 m (1000 ft) of altitude.

All cylinders within an engine should have approximately the same pressure. There should be less than 340 kPa (3.4 bar) (50 psi) difference between cylinders.

7. If pressure is much lower than the specification, remove gauge and apply oil to ring area of piston through injection nozzle bore. Do not use too much oil and do not get oil on valves.

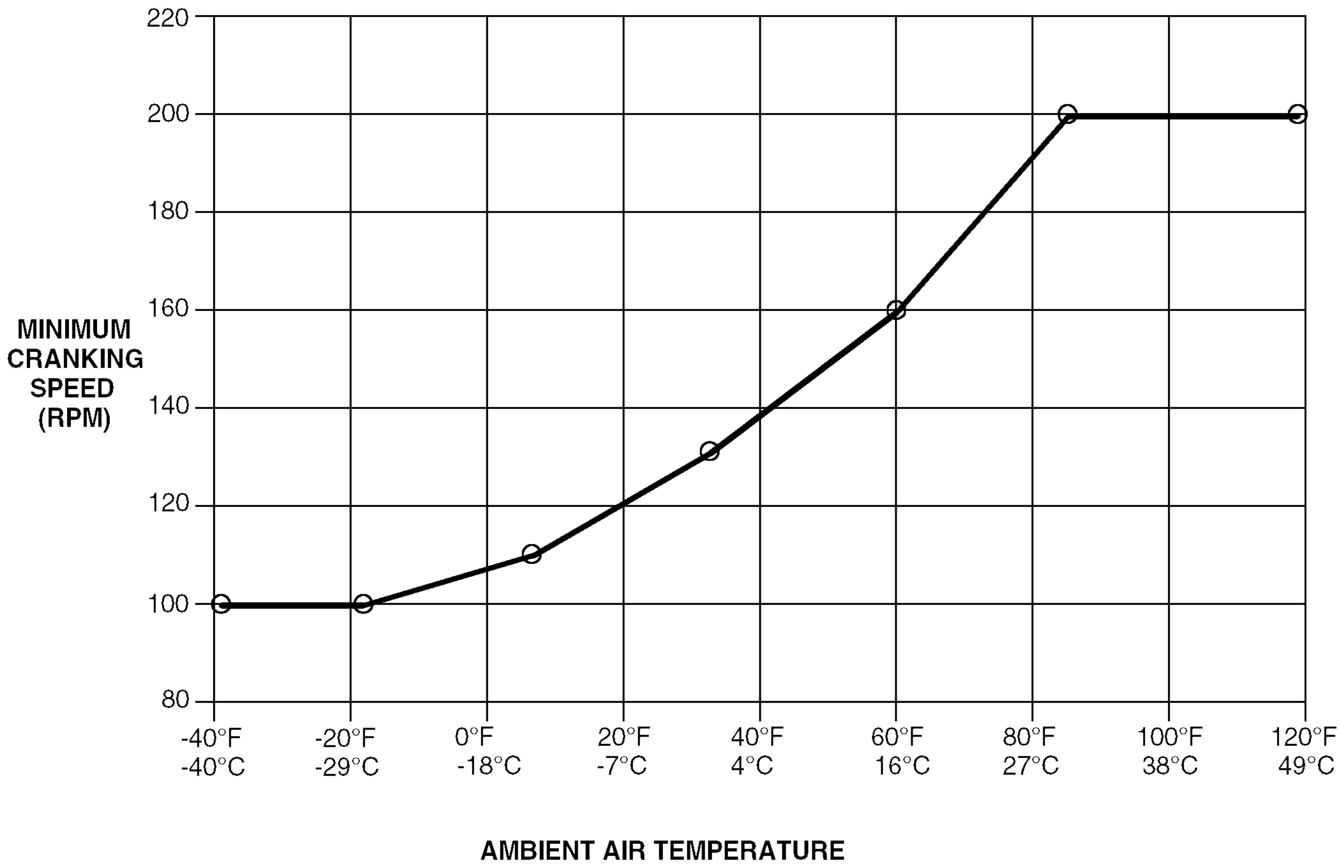
8. Crank engine over and record compression reading again.

   - If pressure is significantly higher than the first compression reading taken, worn or stuck rings are indicated. Either replace piston rings or install new piston and liner set as needed. See INSTALL CYLINDER LINER IN BLOCK and INSTALL PISTON AND CONNECTING ROD and Section 02, Group 030 of this manual.
   - If pressure remains much lower than the specification, it is possible that valve lash is incorrect or valves are worn or sticking. Measure valve lash to specifications or recondition cylinder as needed. See CHECK AND ADJUST VALVE CLEARANCE SERIAL NUMBER (—199,999) in Section 02, Group 020 of this manual, or see CHECK VALVE CLEARANCE SERIAL NUMBER (200,000—).

9. Measure compression pressure in all remaining cylinders and compare readings. Recondition power cylinders and cylinder head as required.

DPSG,RG40854,2 –19–24NOV98–2/2

Check Engine Cranking Speed



IMPORTANT: Make sure that batteries are fully charged before performing this test.

1. Disable the fuel supply system at the injection pump so fuel delivery is in the OFF position.

2. If not using the machine tachometer, install a photo tachometer.

3. Crank engine for 15 seconds and record engine speed.

4. Compare recorded engine speed to chart above.

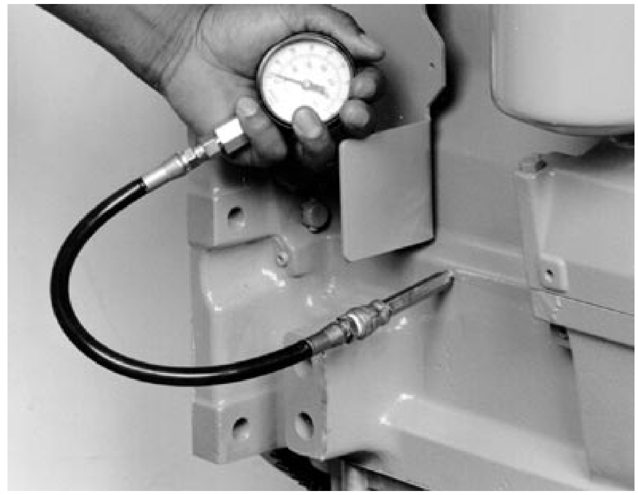
Cranking speed should meet or exceed specified engine rpm for a given ambient air temperature. For example, at 85°F (29°C) ambient temperature, cranking speed should be at least 200 rpm.

If cranking speed is below specifications, check the following:

- Starting system problems (low battery, loose or defective wiring, defective starter, etc.)
- Excessive engine loads (hydraulic pumps/thick oil, thick engine oil, etc.).

DPSG,RG40854,4 –19–24NOV98–1/1

Check Engine Oil Pressure



RG7067 –UN–20AUG98

1. Check engine crankcase oil level. Adjust as necessary.
2. Check overall condition of oil (viscosity, presence of coolant, etc.). Change engine oil and replace oil filter if necessary.
3. Remove pipe plug from main oil gallery using JDG782 Oil Gallery Plug Tool.
4. Attach pressure gauge to oil galley.

IMPORTANT: To achieve an accurate oil pressure reading, warm up engine to 105°C (220°F).

5. Start engine, run at speeds given below, measure oil pressure, and compare readings.

Specification	
OIL PRESSURE SPECIFICATIONS—Minimum No Load at 850 rpm (Slow Idle)	138 kPa (1.38 bar) (20 psi)
Maximum Full Load at 2200 rpm (Rated Speed)	400 kPa (4.0 bar) (58 psi)

6. Refer to “Engine Oil Pressure Low” and/or “Engine Oil Pressure High” as detailed under DIAGNOSING ENGINE MALFUNCTIONS, earlier in this group if oil pressure is not within specification.

NOTE: The oil pressure regulating valve is designed so that adjustment of oil pressure should not be required using shims.

DPSG,RG40854,6 –19–24NOV98–1/1

Check for Excessive Engine Crankcase Pressure (Blow-by)

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.

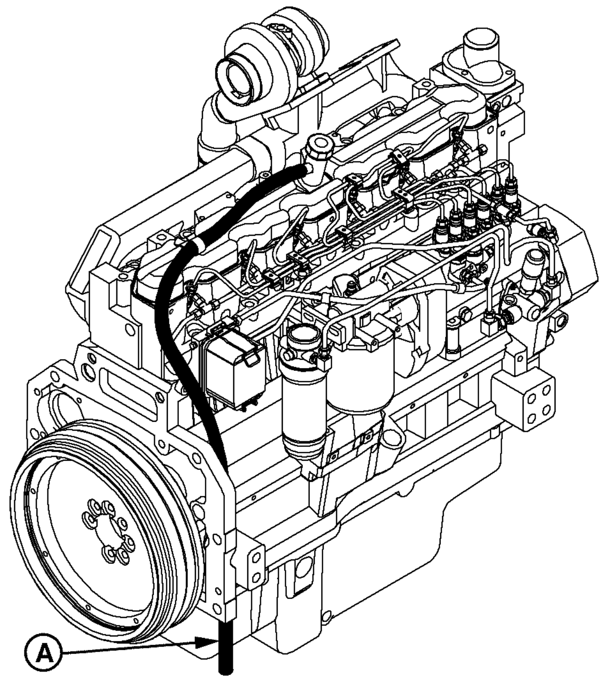
Run engine at high idle and check crankcase breather tube. Look for significant fumes and/or dripping oil coming out of the breather tube at fast idle, with no load.

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.

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.



A—Breather Tube

DPSG,RG40854,7 –19–24NOV98–1/1

Check for Turbocharger Oil Seal Leak

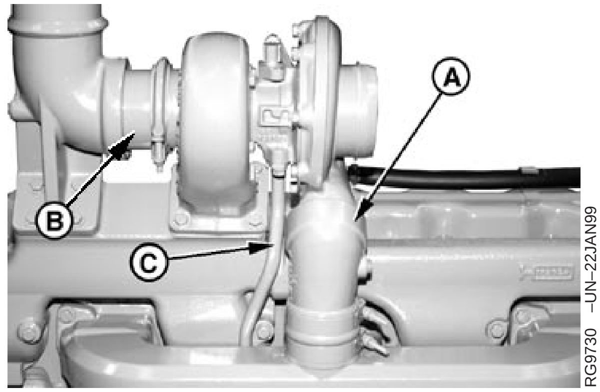
CAUTION: After operating engine, allow exhaust system to cool before removing turbocharger.

IMPORTANT: Any time there has been a turbocharger failure, it is ABSOLUTELY NECESSARY to check turbo housings and air tubes or lines for signs of residual oil. If oil is found, MAKE CERTAIN that all air hoses, tubes, lines, Charge Air Coolers (CAC) or Heat Exchangers have been thoroughly cleaned. All contamination, especially oil, MUST BE REMOVED.

FAILURE TO THOROUGHLY CLEAN ALL OIL OUT OF THE CAC AND LINES CAN RESULT IN AN ENGINE OVER SPEED SITUATION, RESULTING IN SEVERE ENGINE DAMAGE.

Procedure for cleaning CAC: Remove CAC from machine. Use John Deere Coolant System Cleaner PMCC2638, or equivalent, per the instructions, to clean the oil residue from the CAC. Use compressed air to completely dry the inside of the CAC and lines.

All water MUST BE REMOVED from the CAC.



A—Intake Hose
B—Exhaust Pipe
C—Oil Return Line

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).

Continued on next page

DPSG,RG40854,8 –19–24NOV98–1/2

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.

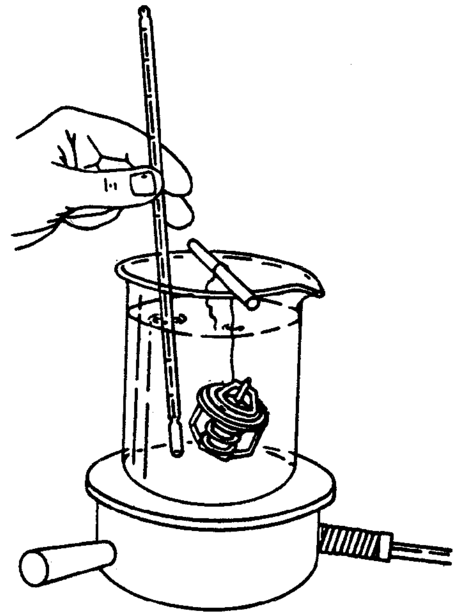
   If oil leakage is present, perform the following:

   - 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.

DPSG,RG40854,8 –19–24NOV98–2/2

Inspect Thermostat and Test Opening Temperature


RG5971 –UN–23NOV97

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. Suspend thermostat and a thermometer in a container of water.

2. Stir the water as it heats. Observe opening action of thermostats 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

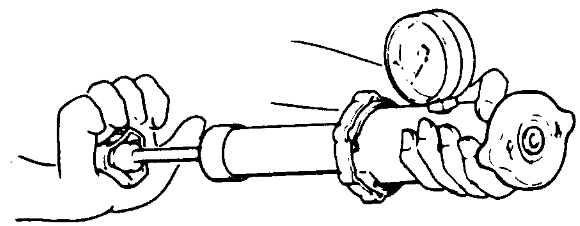
Rating	Initial Opening (Range)	Full Open (Nominal)
71°C (160°F)	69—72°C (156—162°F)	84°C (182°F)
77°C (170°F)	74—78°C (166—172°F)	89°C (192°F)
82°C (180°F)	80—84°C (175—182°F)	94°C (202°F)
89°C (192°F)	86—90°C (187—194°F)	101°C (214°F)
90°C (195°F)	89—93°C (192—199°F)	103°C (218°F)
92°C (197°F)	89—93°C (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)

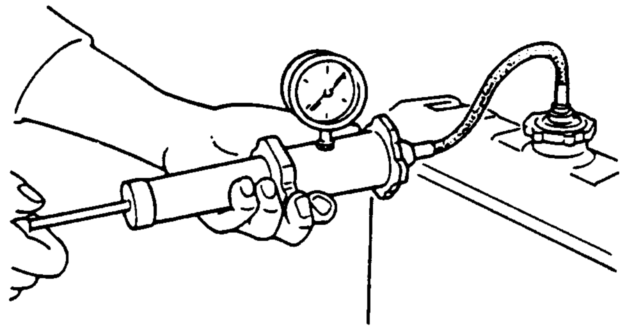
3. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.

4. If any thermostat is defective on a multiple thermostat engine, replace all thermostats.

DPSG,RG40854,10 –19–25NOV98–1/1

Pressure Test Cooling System and Radiator Cap


RG6557 –UN–20JAN93


RG6558 –UN–20JAN93

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 Pressure:

1. Remove radiator cap and attach to D05104ST Tester as shown.

2. Pressurize cap to 50 kPa (0.5 bar) (7 psi)[1] . Gauge should hold pressure for 10 seconds within normal range if cap is acceptable.

3. Remove the cap from gauge, turn it 180°, and retest cap. This will verify that the first measurement was accurate.

Test Cooling System for Leaks:

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.

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 50 kPa (0.5 bar) (7 psi)[2].

[1]If gauge does not hold pressure, replace radiator cap.

[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.

Continued on next page

DPSG,RG40854,11 –19–25NOV98–1/2

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 later in this Group.

DPSG,RG40854,11 –19–25NOV98–2/2

Check for Head Gasket Failures

NOTE: Booklet DB1119-CYLINDER HEAD GASKET FAILURES for 6466 and 6076 Engines can be used as a guide for diagnosing head gasket failures on POWERTECH® 8.1 L Engines. However, use specifications provided in this manual (CTM134).

Head gasket failures generally fall into three categories:

- Combustion seal failures
- Coolant seal failures
- Oil seal failures

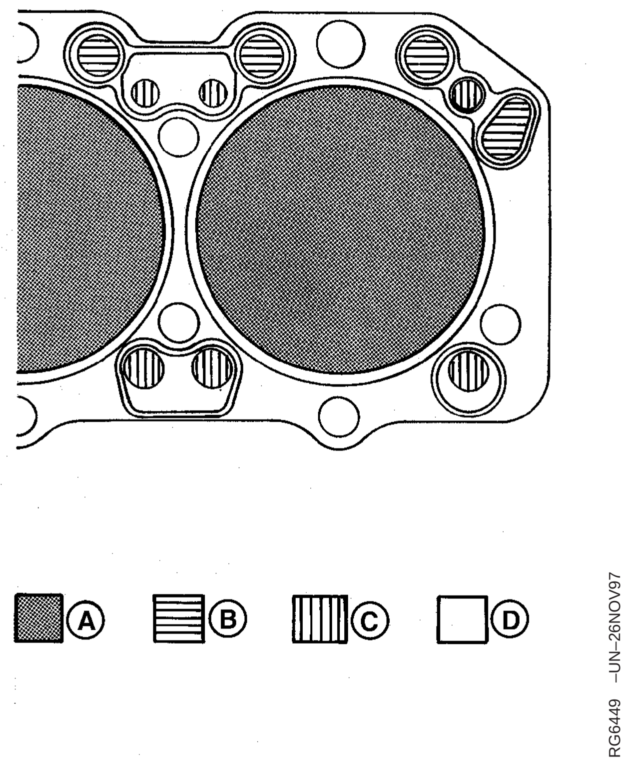
Combustion seal failures occur when combustion gases escape between cylinder head and head gasket combustion flange, or between combustion flange and cylinder liner. Leaking combustion gases may vent to an adjacent cylinder, to a coolant or oil passage, or externally.

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)



A—Combustion Sealing Areas
B—Oil Sealing Areas (Push Rod)
C—Coolant Sealing Areas
D—Cylinder Head Cap Screws

Continued on next page

DPSG,RG40854,12 –19–25NOV98–1/4

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.
- 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.
- Advanced injection pump timing.
- Hydraulic or mechanical disturbance or combustion seal.

Continued on next page

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 SERIAL NUMBER (—199,999) in Section 02, Group 020 of this manual.

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 SERIAL NUMBER (—199,999) in Section 02, Group 020 of this manual, or see HEAD GASKET INSPECTION AND REPAIR SEQUENCE SERIAL NUMBER (200,000—) in Section 02, Group 021 of this manual.

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:

Continued on next page

- 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.

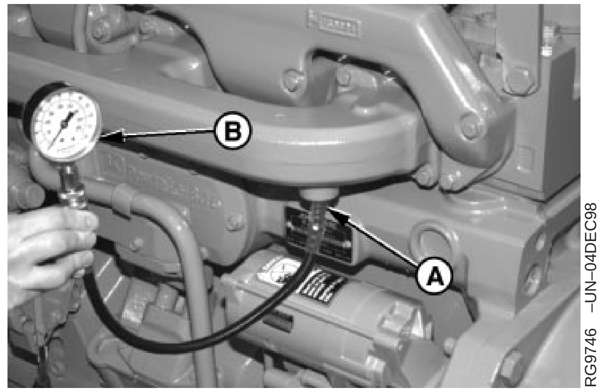
If above symptoms are found, see HEAD GASKET INSPECTION AND REPAIR SEQUENCE SERIAL NUMBER (—199,999) in Section 02, Group 020 of this manual.

NOTE: Defective oil cooler may also allow oil leakage into coolant.

DPSG,RG40854,12 –19–25NOV98–4/4

Measure Intake Manifold Pressure (Turbo Boost)

NOTE: See INTAKE MANIFOLD PRESSURE (TURBOCHARGER BOOST) SPECIFICATIONS in Section 06, Group 210 of this manual.



A—Fitting
B—Pressure Gauge

1. Remove plug from intake manifold and install the appropriate fitting (A) from JDE147 Manifold Pressure Test Kit or FKM10002 Universal Pressure Test Kit. Connect gauge (B) and hose assembly to fitting. 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 the gauge works properly and familiarize yourself with the use of the gauge.

Turbo boost pressure checks are only a guide to determine if there is an engine problem (Valve leakage, faulty nozzle, etc.). Low-pressure readings are not a conclusive reason for increasing injection pump fuel delivery. Pump adjustment should be with the specifications as established by an authorized diesel repair station.

On some vehicles, it may be impossible to meet the turbo boost pressure due to the inability to reach full rated speed. In these cases, see the machine's Operation and Test manual for the appropriate test method and pressure.

3. Observe pressure reading on gauge. Boost pressure should be within ranges 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.

Continued on next page DPSG,RG40854,13 –19–25NOV98–1/2

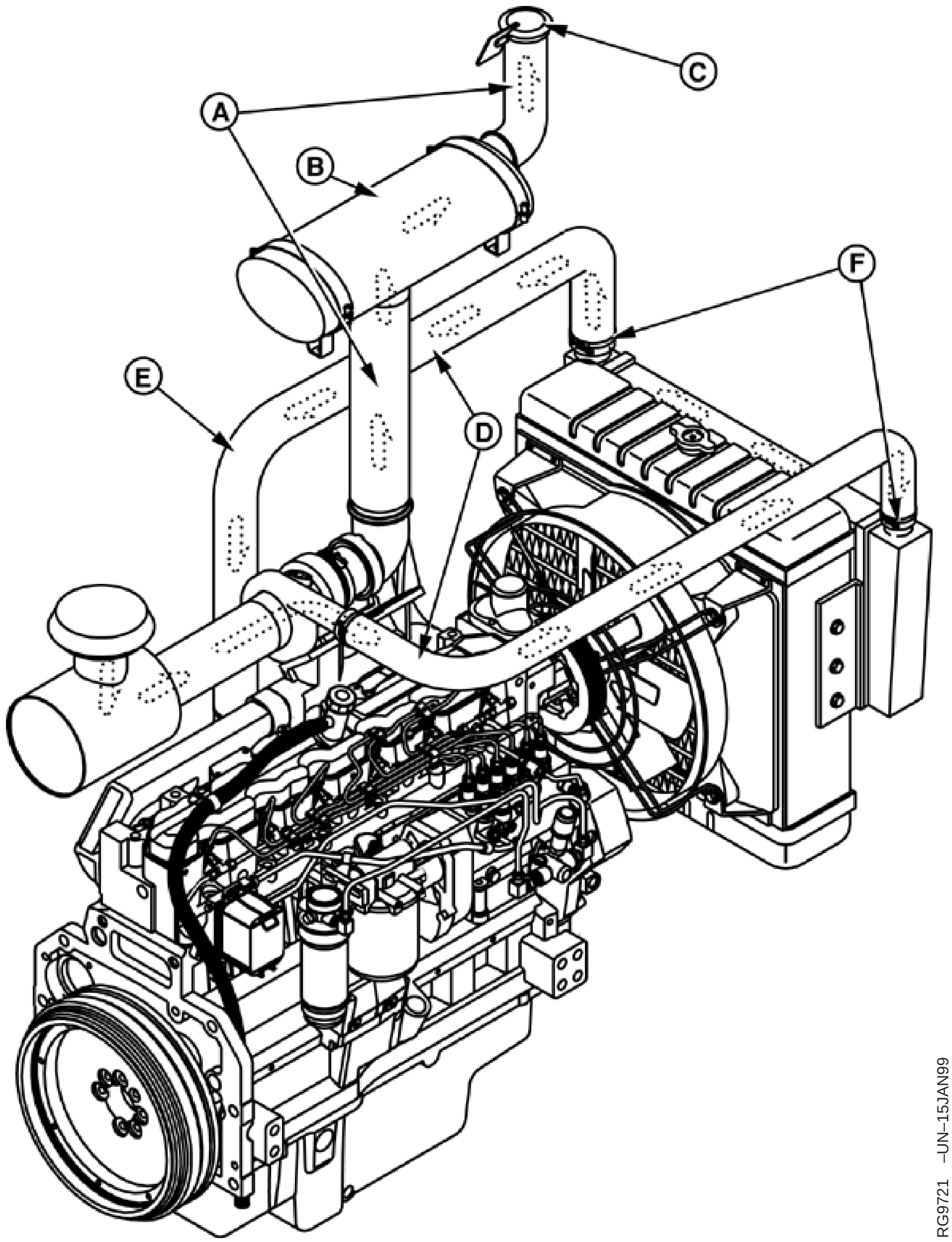
4. If boost pressure is too high, remove fuel injection pump and have it checked for high fuel delivery by an authorized diesel repair station.

If boost pressure is too low, check for the following:

- Restriction in air cleaner.
- Leak in air intake between turbocharger and cylinder head.
- Leak in exhaust manifold gasket.
- Restricted exhaust.
- Leak in fuel system piping.
- Restricted fuel filter elements.
- Incorrect injection pump timing.
- Low fuel injection pump delivery.
- Faulty fuel supply pump.
- Low cylinder compression pressure.
- Faulty fuel injection nozzles.
- Carbon build-up in turbocharger.
- Turbocharger compressor or turbine wheel rubbing housing.

DPSG,RG40854,13 –19–25NOV98–2/2

Check for Intake and Exhaust Restrictions



A—Exhaust Piping
B—Muffler
C—Rain Cap
D—Intake Piping
E—Elbows
F—Connections

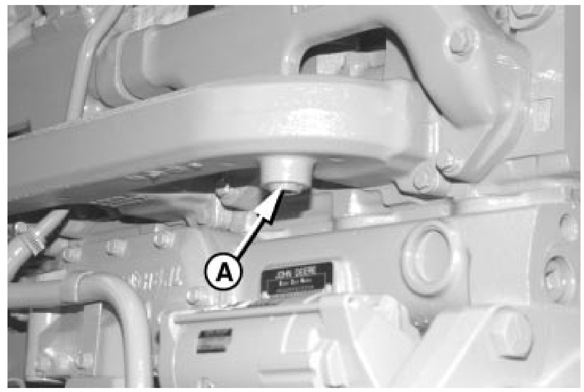
Low power, low boost pressure, and excessive black exhaust smoke can be caused by an intake air or exhaust restriction.

1. Inspect the exhaust piping (A), the muffler (B), and the rain cap (C) for damage or any possible restrictions.
2. Inspect the intake piping (D), any elbows (E), and any connections (F). Look for collapsed pipes, dented pipes and loose connections. Replace components as needed.

DPSG,RG40854,14 –19–25NOV98–1/1

Test for Intake Air Leaks


T5906AP –UN–23FEB89



RG9747 –UN–04DEC98

A—Intake Manifold 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 from loose connections or cracks on the pressure side of the turbocharger can cause excessive smoke and low power.

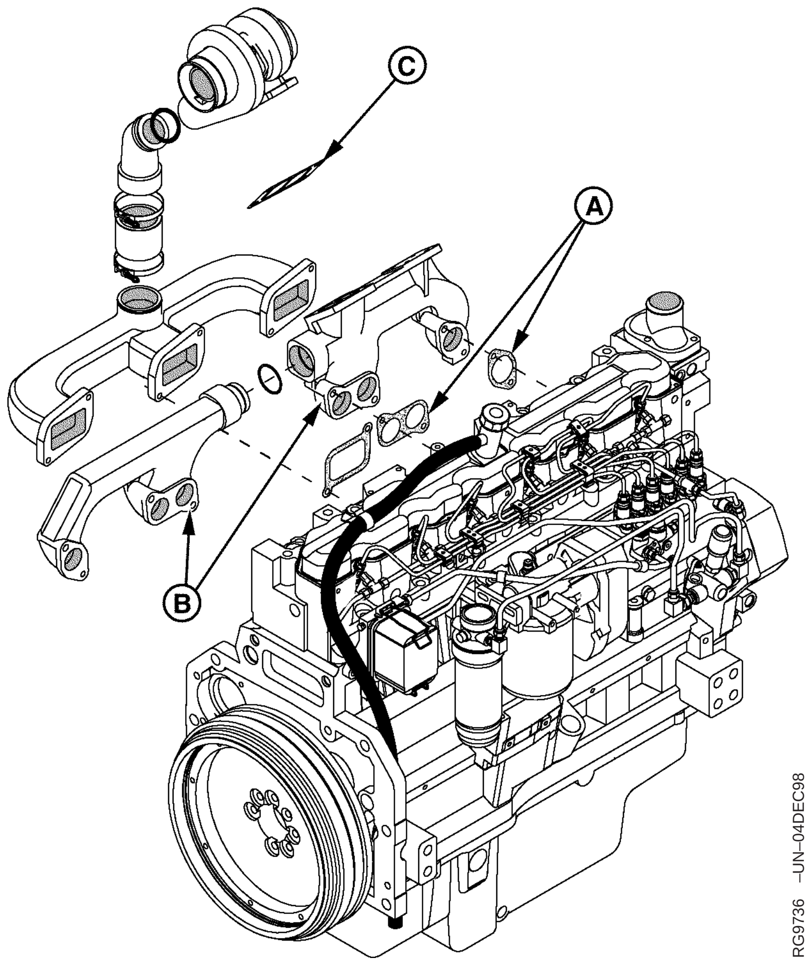
NOTE: The following test procedure requires that the air intake be sealed off to pressurize the system. Using a plastic bag to seal the air intake filter is used as an example.

CAUTION: Do not start engine during this test procedure. Plastic bag (or whatever material/object 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 (A) from manifold and using a suitable adapter, connect a regulated air source.
4. Pressurize air intake system to 13.8-20.7 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,RG40854,15 –19–25NOV98–1/1

Check for Exhaust Air Leaks (Turbocharged Engines)



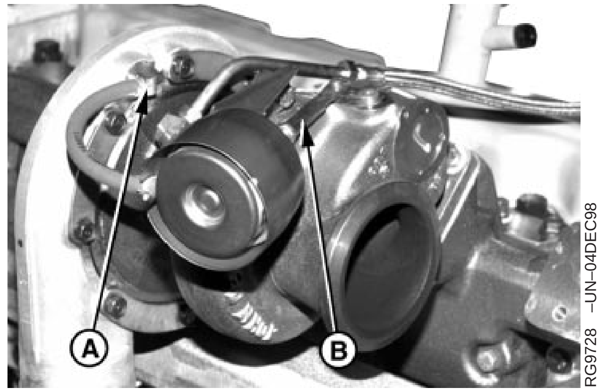
A—Exhaust Manifold Gasket **B—Exhaust Manifold** **C—Turbocharger Gasket**

Exhaust leaks, upstream of the turbocharger will cause the turbocharger turbine to rotate at a reduced speed resulting in low boost pressure, low power, and excessive black smoke.

Inspect the exhaust manifold gasket (A), the exhaust manifold (B), and the turbocharger gasket (C) for damage and any signs of leakage. Replace components as needed.

DPSG,RG40854,16 –19–25NOV98–1/1

Test Turbocharger Wastegate Actuator



A—Actuator Fitting
B—Actuator Rod

1. Check hose to wastegate actuator for kinks and cracks. Replace if damaged.

2. Disconnect hose from wastegate actuator.

3. Connect a regulated air source to actuator fitting (A).

4. Vary pressure to wastegate actuator depending on engine model number:

WASTEGATE ACTUATOR PRESSURE SPECIFICATION

Engine Model Number	Pressure Applied to Actuator
6081AT001	144.28 kPa (14.4 bar) (20.92 psi)
6081HDW04	144.28 kPa (14.4 bar) (20.92 psi)
6081HDW05	144.28 kPa (14.4 bar) (20.92 psi)
6081HDW01	184.83 kPa (18.5 bar) (26.8 psi)
6081HT001	193.10 kPa (19.3 bar) (28.0 psi)
6081HDW13	199.00 kPa (19.9 bar) 28.6 psi)

Actuator rod (B) should move in and out freely as pressure is varied. If rod does not move freely, check wastegate adjustment. See ADJUST TURBOCHARGER WASTEGATE ACTUATOR later in this Group.

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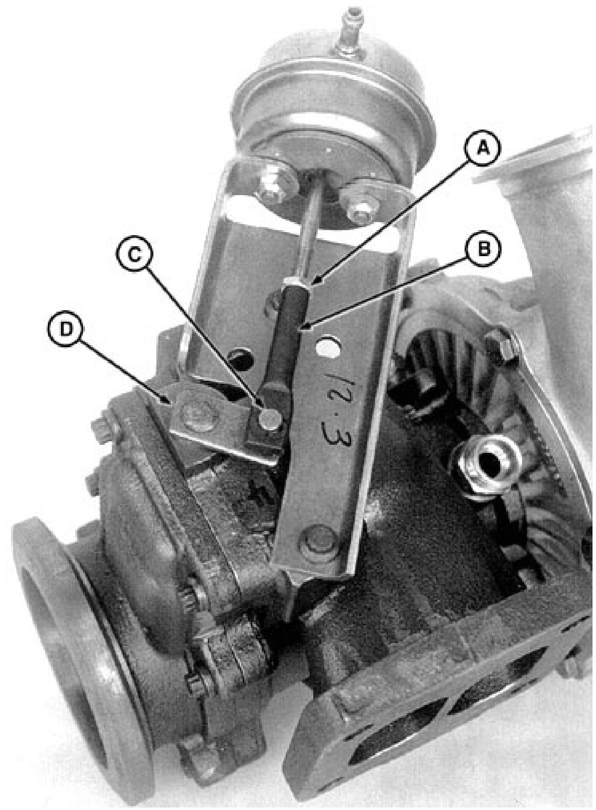
Adjust Turbocharger Wastegate Actuator



RG9084 –UN–16MAR98

A—Jam Nut
B—Rod End
C—Retainer Clip
D—Bypass Lever

1. Loosen jam nut (A).

   Disconnect hose and pressurize actuator to specified pressure for application being used. Hold pressure to particular application's calibration pressure.

WASTEGATE ACTUATOR PRESSURE SPECIFICATION

Engine Model Number	Pressure Applied to Actuator
6081AT001	144.28 kPa (14.4 bar) (20.92 psi)
6081HDW04	144.28 kPa (14.4 bar) (20.92 psi)
6081HDW05	144.28 kPa (14.4 bar) (20.92 psi)
6081HDW01	184.83 kPa (18.5 bar) (26.8 psi)
6081HT001	193.10 kPa (19.3 bar) (28.0 psi)

2. Push bypass lever (D) as far as possible toward the actuator and apply pressure to keep lever in that position.

IMPORTANT: Twisting or forcing the entire rod in or out will change the calibration, causing damage to engine from overboost.

3. Turn rod end (B) in either direction until rod eye can be slipped over bypass lever pin. Loosen rod end an additional half turn, install onto pin and secure with retainer clip (C). Release pressure on actuator.

4. Pressurize the actuator to pressure depending on application. Measure the end play with a dial indicator, moving the bypass assembly back and forth in a direction perpendicular to the actuator rod. End play should be within specifications listed. If necessary to adjust, set end play at 0.5 mm (0.020 in.).

5. Vary pressure in a range around pressure specification a few times to verify smooth and free operation of the bypass assembly.

6. Attach hose to actuator and secure with hose clamp.

DPSG,RG40854,18 –19–25NOV98–1/1

Section 05
Tools and Other Materials

Contents

05

Group 020 — Cylinder Head and Valves Essential Tools S. N. (—199,999)

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

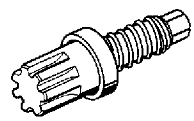
SERVICEGARD is a trademark of Deere & Company

RG41183,0000008 –19–03JAN01–1/13

RG5068 –UN–05DEC97

Flywheel Turning Tool JDG820

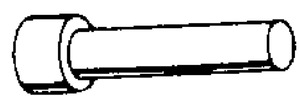
Used to rotate engine to check damper radial runout and time engine. JDE81-1 may be used also if JDG820 is not available.



JDG820

Timing Pin JDE81-4

Lock engine at TDC when timing valve train, adjusting valve clearance, and installing fuel injection pump. Use with JDG820, JDE81-1 Flywheel Turning Tools.



RG5068

JDE81-4

RG41183,0000008 –19–03JAN01–2/13

RG6246 –UN–05DEC97

Dial Indicator . . . (English, in.) D17526CI or (Metric, mm) D17527CI

Use with JDG451 to measure valve recess and cylinder liner height-to-cylinder block top deck.

RG6246

D17526CI or D17527CI

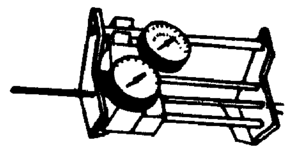
Continued on next page

RG41183,0000008 –19–03JAN01–3/13

RG5061 –UN–05DEC97

Spring Compression Tester D01168AA

Test valve spring compression.



RG5061

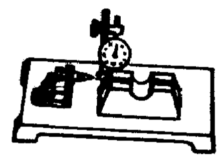
D01168AA

RG41183,0000008 –19–03JAN01–4/13

RG5062 –UN–05DEC97

Valve Inspection Center D05058ST

Check valves for out-of-round.



RG5062

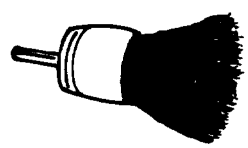
D05058ST

RG41183,0000008 –19–03JAN01–5/13

RG5063 –UN–05DEC97

End Brush D17024BR

Clean valve seat and bores.



RG5063

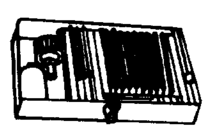
D172024BR

RG41183,0000008 –19–03JAN01–6/13

RG5064 –UN–05DEC97

Valve Guide Knurler Kit JT05949

Knurl valve guides.



RG5064

JT05949

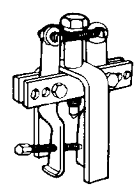
Continued on next page

RG41183,0000008 –19–03JAN01–7/13

RG5071 –UN–05DEC97

Valve Seat Puller .JDE41296

Remove valve seats.



JDE41296

RG41183,0000008 –19–03JAN01–8/13

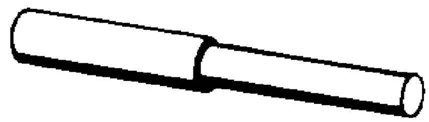
RG5065 –UN–05DEC97

Valve Seat Pilot Driver JDE7

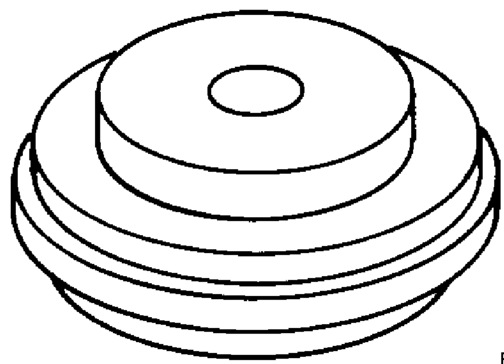
Install replacement valve seat inserts. Use with JDG605.

Valve Seat Installer JDG605

Install intake and exhaust valve seat inserts. Use with JDE7.



JDE7



RG5240 –UN–05DEC97

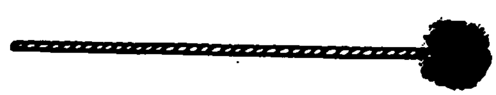
JDG605

RG41183,0000008 –19–03JAN01–9/13

RG5099 –UN–23AUG88

Nozzle Threads Cleaning Brush D17030BR

Used to clean nozzle threads in cylinder head.



D17030BR

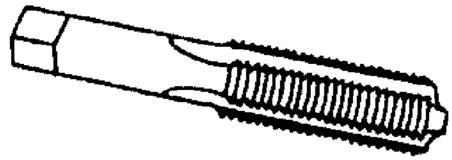
Continued on next page

RG41183,0000008 –19–03JAN01–10/13

RG5100 –UN–05DEC97

Tap JDF5

Used to restore nozzle threads in cylinder head.



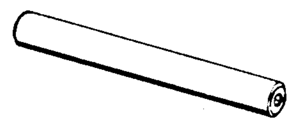
JDF5

RG41183,0000008 –19–03JAN01–11/13

RG5612 –UN–12APR90

Nozzle Seat Reamer JDG609

Used to clean carbon from nozzle seats in cylinder head.



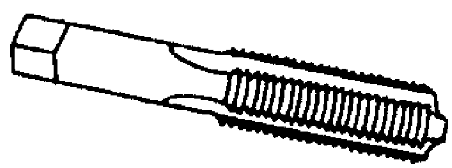
JDG609

RG41183,0000008 –19–03JAN01–12/13

RG5100 –UN–05DEC97

Tap JDG681A

Used to restore threaded holes in cylinder block for cylinder head cap screws.



JDG681A

RG41183,0000008 –19–03JAN01–13/13

Group 020 — Cylinder Head and Valves Service Equipment and Tools S. N. (—199,999)

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

RG41183,0000009 –19–03JAN01–1/5

Valve Spring Compressor JDE138

Compress valve springs when removing and installing valves.

RG41183,0000009 –19–03JAN01–2/5

Precision “Bevelled Edge” Straightedge D05012ST

Check cylinder head flatness.

RG41183,0000009 –19–03JAN01–3/5

Eccentrimeter D11010KW

Measure valve seat-to-stem runout.

RG41183,0000009 –19–03JAN01–4/5

Heavy-Duty Seat Grinder Set. JT05893

Grind valve seats.

RG41183,0000009 –19–03JAN01–5/5

Group 020 — Cylinder Head and Valves Other Materials S. N. (—199,999)

Number	Name	Use
AR44402 (U.S.)	Valve Stem Lubricant	Lubricate valve stems.
AR31790 (U.S.)	SCOTCH-GRIP® Plastic Adhesive	Rocker arm cover gasket.
PT569 (U.S.)	NEVER-SEEZ® Compound	Turbocharger-to-exhaust manifold cap screws.

SCOTCH-GRIP is a registered trademark of 3M Co.
NEVER-SEEZ is a registered trademark of Emhart Chemical Group.

RG41183,000000A –19–03JAN01–1/1

Group 021 — Cylinder Head and Valves S. N. (200,000—) Essential Tools

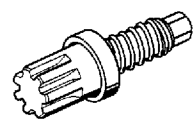
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

SERVICEGARD is a trademark of Deere & Company

RG41165,0000013 –19–12OCT00–1/11

RG5068 –UN–05DEC97

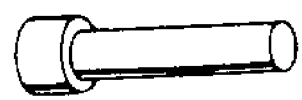
Flywheel Turning Tool JDG820



JDG820

Used to rotate engine to check damper radial runout and time engine. JDE81-1 may be used also if JDG820 is not available.

Timing Pin JDE81-4



RG5068

JDE81-4

Lock engine at TDC when timing valve train, adjusting valve clearance, and installing fuel injection pump. Use with JDG820, JDE81-1 Flywheel Turning Tools.

RG41165,0000013 –19–12OCT00–2/11

RG6246 –UN–05DEC97

Dial Indicator . . . (English, in.) D17526CI or (Metric, mm) D17527CI

RG6246

D17526CI or D17527CI

Use with JDG451 to measure valve recess and cylinder liner height-to-cylinder block top deck.

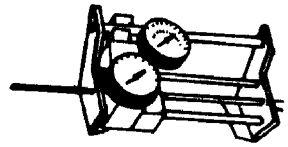
Continued on next page

RG41165,0000013 –19–12OCT00–3/11

RG5061 –UN–05DEC97

Spring Compression Tester D01168AA

Test valve spring compression.



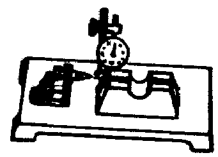
D01168AA

RG41165,0000013 –19–12OCT00–4/11

RG5062 –UN–05DEC97

Valve Inspection Center D05058ST

Check valves for out-of-round.



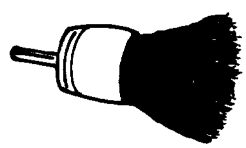
D05058ST

RG41165,0000013 –19–12OCT00–5/11

RG5063 –UN–05DEC97

End Brush D17024BR

Clean valve seat and bores.



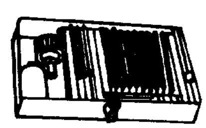
D172024BR

RG41165,0000013 –19–12OCT00–6/11

RG5064 –UN–05DEC97

Valve Guide Knurler Kit JT05949

Knurl valve guides.



JT05949

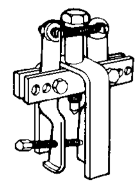
Continued on next page

RG41165,0000013 –19–12OCT00–7/11

RG5071 –UN–05DEC97

Valve Seat Puller .JDE41296

Remove valve seats.


RG5071

JDE41296

RG41165,0000013 –19–12OCT00–8/11

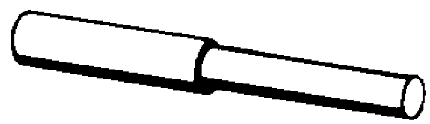
RG5065 –UN–05DEC97

Valve Seat Pilot Driver JDE7

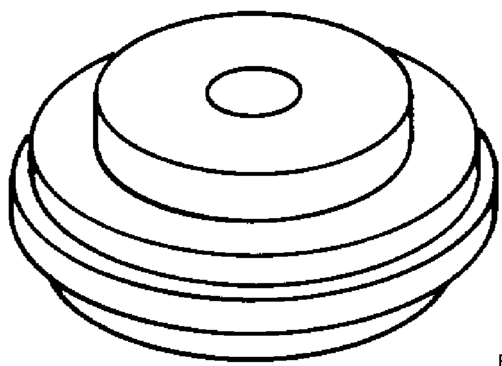
Install replacement valve seat inserts. Use with JDG605.

Valve Seat Installer JDG605

Install intake and exhaust valve seat inserts. Use with JDE7.


RG5065

JDE7


RG5240 RG5240 –UN–05DEC97

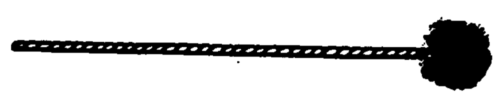
JDG605

RG41165,0000013 –19–12OCT00–9/11

RG5099 –UN–23AUG88

Nozzle Threads Cleaning Brush D17030BR

Used to clean electronic injector bore.



D17030BR

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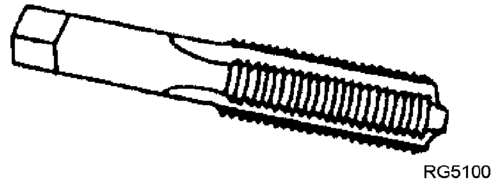
RG41165,0000013 –19–12OCT00–10/11

RG5100 –UN–05DEC97

Tap JDG681A

Used to restore threaded holes in cylinder block for cylinder head cap screws.



JDG681A

RG41165,0000013 –19–12OCT00–11/11

Group 021 — Cylinder Head and Valves S. N. (200,000—) 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

RG41165,000001A –19–20OCT00–1/5

Valve Spring Compressor JDE138

Compress valve springs when removing and installing valves.

RG41165,000001A –19–20OCT00–2/5

Precision “Bevelled Edge” Straightedge D05012ST

Check cylinder head flatness.

RG41165,000001A –19–20OCT00–3/5

Eccentrimeter D11010KW

Measure valve seat-to-stem runout.

RG41165,000001A –19–20OCT00–4/5

Heavy-Duty Seat Grinder Set. JT05893

Grind valve seats.

RG41165,000001A –19–20OCT00–5/5

Group 021 — Cylinder Head and Valves S. N. (200,000—) Other Materials

Number	Name	Use
AR44402 (U.S.)	Valve Stem Lubricant	Lubricate valve stems.
TY24311 (U.S.) CXTY24311 (Canadian) 222 (LOCTITE®)	Thread Lock and Sealer (Low Strength)	Electronic Injector Stud Nuts
PT569 (U.S.)	NEVER-SEEZ® Compound	Turbocharger-to-exhaust manifold cap screws.

LOCTITE is a trademark of Loctite Corp.
NEVER-SEEZ is a registered trademark of Emhart Chemical Group.

RG41165,000001B –19–20OCT00–1/1

05
170
10

Group 030 — Cylinder Block, Liners, Pistons, and Rods 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

RG41183,000000B –19–03JAN01–1/14

RG6246 –UN–05DEC97

Dial Indicator . . . (English, in.) D17526CI or (Metric, mm) D17527CI

Use with JDG451 to measure valve recess and cylinder liner height-to-cylinder block top deck.

RG6246

D17526CI or D17527CI

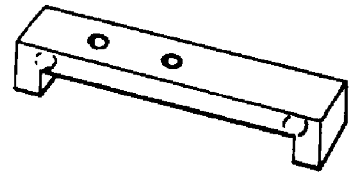
Continued on next page

RG41183,000000B –19–03JAN01–2/14

RG7029 –UN–05DEC97

Piston and Liner Height Gauge JDG451

Use with dial indicator to measure piston and liner heights above cylinder block.



RG7029

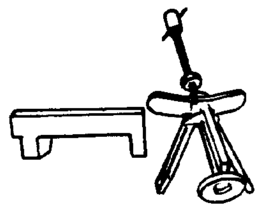
JDG451

RG41183,000000B –19–03JAN01–3/14

RG5019 –UN–05DEC97

Cylinder Liner Puller . . . . D01062AA orD01073AA.

Remove cylinder liners.



RG5019

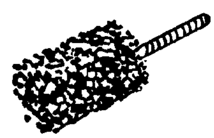
D01062AA or D01073AA.

RG41183,000000B –19–03JAN01–4/14

RG5074 –UN–07NOV97

Flexible Cylinder Hone D17005BR

Hone cylinder liners.



RG5074

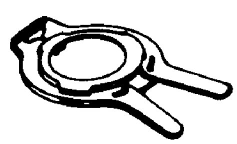
D17005BR

RG41183,000000B –19–03JAN01–5/14

RG5077 –UN–07NOV97

Piston Ring Expander JDE93

Remove and install piston rings.



RG5077

JDE93

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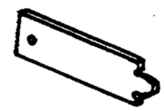
RG41183,000000B –19–03JAN01–6/14

RG5076 –UN–23AUG88

No. 1 Ring Groove Wear Gauge. JDE55

Check upper compression ring groove wear.



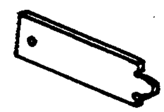
JDE55

RG41183,000000B –19–03JAN01–7/14

RG5076 –UN–23AUG88

No. 2 Ring Groove Wear Gauge. JDG852

Check lower compression ring groove wear.

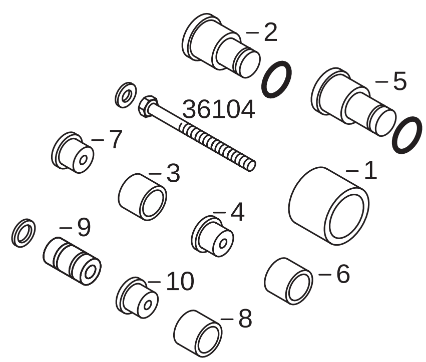


JDG852

RG41183,000000B –19–03JAN01–8/14

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 (10) and STD36104 Forcing Screw.



RG5078 –UN–25APR02

JDE98A

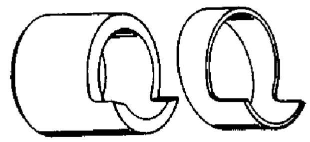
Continued on next page

RG41183,000000B –19–03JAN01–9/14

RG5079 –UN–07NOV97

Connecting Rod Bushing Service Set JDG337

Use with JDE98A Bushing Service Set to remove and install connecting rod bushings.

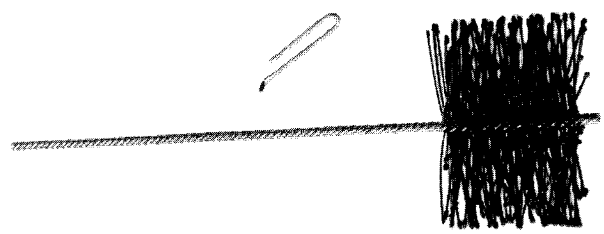


JDG337

RG41183,000000B –19–03JAN01–10/14

O-Ring Groove Cleaning Brush D17015BR

Clean cylinder liner O-ring groove in block.



RG5075 –UN–07NOV97

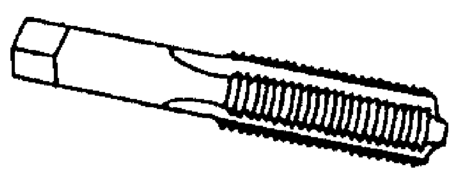
D17015BR

RG41183,000000B –19–03JAN01–11/14

RG5100 –UN–05DEC97

Tap JDG681

Used to restore threaded holes in cylinder block for cylinder head cap screws.



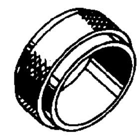
JDG681

Continued on next page RG41183,000000B –19–03JAN01–12/14

RG5031 –UN–05DEC97

Piston Ring Compressor JDE96

Compress rings while installing pistons.

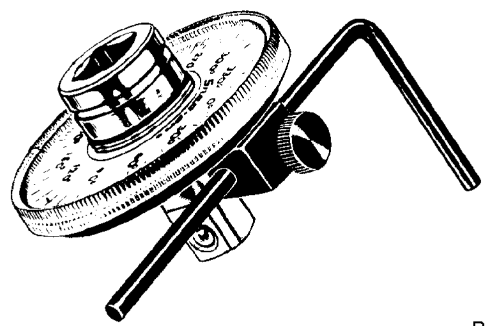


JDE96

RG41183,000000B –19–03JAN01–13/14

Torque Angle Gauge JT05993

Used to TORQUE-TURN flanged-head cylinder head and connecting rod cap screws.



RG5698 –UN–05DEC97

JT05993

RG41183,000000B –19–03JAN01–14/14

Group 030 — Cylinder Block, Liners, Pistons, and Rods Other Materials

Number	Name	Use
	PLASTIGAGE®	Determine connecting rod bearing-to-journal oil clearance.
AR54749 (U.S.)	Soap Lubricant	Coat O-rings on cylinder liners.

PLASTIGAGE is a registered trademark of DANA Corp.

RG41183,000000C –19–03JAN01–1/1

Group 040 — Crankshaft, Main Bearings and Flywheel Essential Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

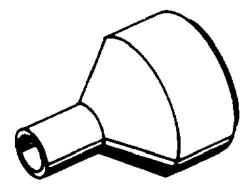
SERVICEGARD is a trademark of Deere & Company

RG41183,000000D –19–03JAN01–1/13

RG6214 –UN–05DEC97

Seal Puller Adapter JDG719

Used with a standout metal screw, JDE38-2 Shank, and JDE38-3 Slide Handle to remove front crankshaft oil seal with timing gear cover installed. Also used to remove rear crankshaft oil seal with seal housing installed.



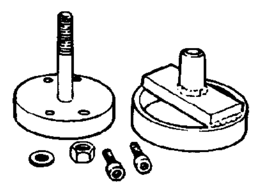
JDG719

RG41183,000000D –19–03JAN01–2/13

RG5106 –UN–05DEC97

Seal and Wear Sleeve Installer JDG476 (85)

Used to simultaneously install the new teflon unitized oil seal and wear sleeve on the rear crankshaft flange. Set consists of JDG477 (85) Pilot and JDG478 Driver. Also use with JDG796 Alignment Tool to install rear oil seal housing, eliminating need for dial indicator to measure runout.



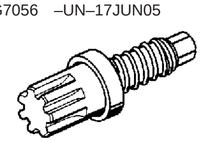
JDG476 (85)

RG41183,000000D –19–03JAN01–3/13

RG7056 –UN–17JUN05

Flywheel Turning Tool JDG820

Used to rotate engine to check damper radial runout and time engine. JDE81-1 may be used also if JDG820 is not available.



JDG820

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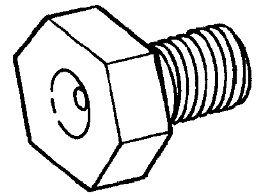
RG41183,000000D –19–03JAN01–4/13

Thread Protector JDG787

Used with JDG721 Hub Puller Kit to remove vibration damper puller assembly. Tool may be used with any puller set where limited space makes it difficult to use puller without a thread protector.



JDG787

RG41183,000000D –19–03JAN01–5/13

Hub Puller Kit JDG721

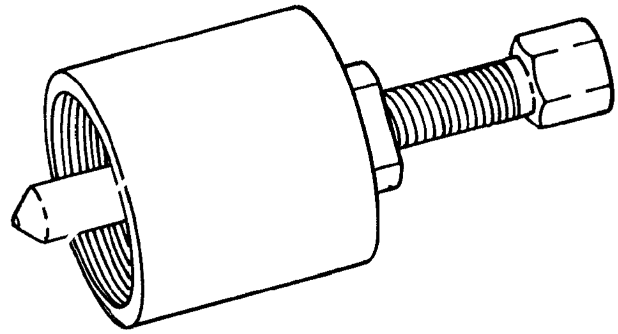
Used with JDG787 Thread Protector to remove vibration damper pulley assembly.

JDG721

Continued on next page RG41183,000000D –19–03JAN01–6/13

Front Wear Sleeve Puller JDG786

Used to remove front crankshaft wear sleeve with timing gear cover installed.



RG6428 RG6428 –UN–05DEC97

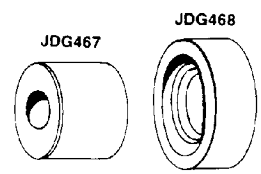
JDG786

RG41183,000000D –19–03JAN01–7/13

RG5508 –UN–05DEC97

Front Wear Sleeve Installer Set JDE3

Install front crankshaft wear sleeve.



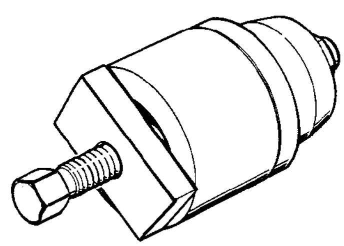
RG5508

JDE3

RG41183,000000D –19–03JAN01–8/13

Seal Protector JDG720A

Used to install front crankshaft oil seal with timing gear cover installed. Set consists of JDG720-1 Forcing Screw, JDG720-2 Seal Protector, JDG720-5 Seal Installer and JDG720-4 Ring (500 Series Engines).



RG6215 RG6215 –UN–05DEC97

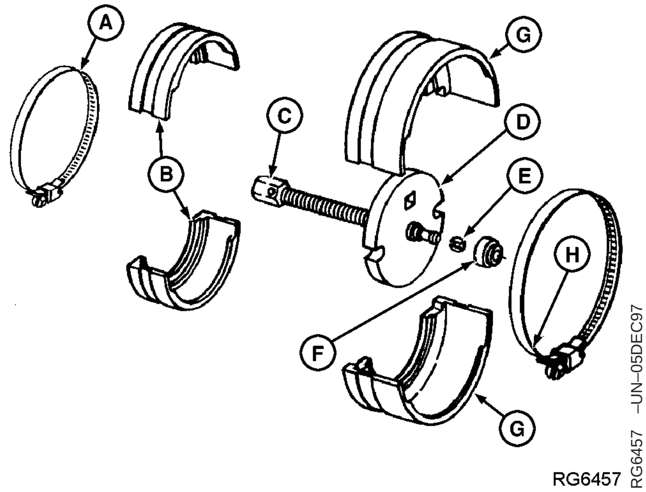
JDG720A

Continued on next page

RG41183,000000D –19–03JAN01–9/13

Rear Wear Sleeve Puller Kit JDG790

Used to remove rear wear sleeve with oil seal housing installed on Series 400, 450, and 500 Engines. Set consists of 219469 Hose Clamp (Series 500), JDG790-1 Collet Halves (Series 400/450), 35945 Forcing Screw, JDG790-2 Pulling Plate (Series 400/450/500), 13876 Retainer Clip (Series 400/450/500, 215177 Shaft Protector (Series 400/450/500), JDG790-3 Collet Halves (Series 500), 19311 Hose Clamp (Series 400/450).

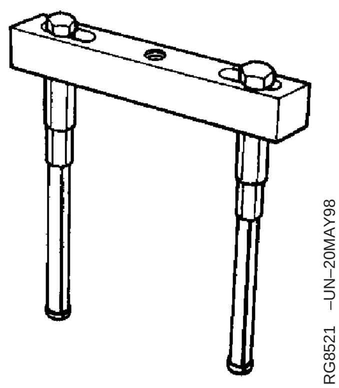


JDG790

RG41183,000000D –19–03JAN01–10/13

Main Bearing Cap Puller/Installer JDG1069

Use to remove and install the main bearing caps. Due to wider bearing surface, these caps are installed with an increased interference fit.

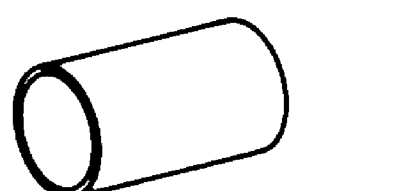


JDG1069

RG41183,000000D –19–03JAN01–11/13

Gear Driver JDH7

Install crankshaft drive gear.



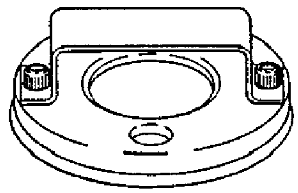
JDH7

Continued on next page RG41183,000000D –19–03JAN01–12/13

RG6590 –UN–05DEC97

Oil Seal Housing Alignment Tool JDG796

Use with crankshaft rear oil seal housing casting numbers R115050 and R125027.



RG6590

JDG796

RG41183,000000D –19–03JAN01–13/13

Group 040 — Crankshaft, Main Bearings and Flywheel 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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RG41183,000000E –19–03JAN01–1/3

Slide Hammer D01300AA

Use with JDG1069 to remove main bearing caps.

RG41183,000000E –19–03JAN01–2/3

Puller[1]. D01251AA

Remove crankshaft gear.

[1]Part of D01047AA 17-1/2 and 30 Ton Puller Set

RG41183,000000E –19–03JAN01–3/3

Group 040 — Crankshaft, Main Bearings and Flywheel Other Materials

Number	Name	Use
TY15969 (U.S.) TY9479 (Canadian) 680 (LOCTITE®)	Retaining Compound (Maximum Strength)	Used to coat ID of new wear sleeve.
	PLASTIGAGE®	Check main bearing-to-crankshaft journal oil clearance during engine disassembly.
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Coat threads of flywheel mounting cap screws.
TY6333 or TY6347 (U.S.)	High Temperature Grease	Used to install timing gear cover tabs.
	Brake Kleen or Ignition Cleaner	Remove sealant from crankshaft flange.

LOCTITE is a registered trademark of Loctite Corp.
PLASTIGAGE is a registered trademark of DANA Corp.

RG41183,000000F –19–03JAN01–1/1

Group 050 — Camshaft and Timing Gear Train 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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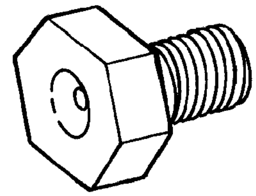
Continued on next page

DPSG,OUO1004,838 –19–27APR99–1/11

Thread Protector JDG787

Used with JDG721 Hub Puller Kit to remove vibration damper puller assembly.



JDG787

DPSG,OUO1004,838 –19–27APR99–2/11

Hub Puller Kit JDG721

Used with JDG787 Thread Protector to remove vibration damper pulley assembly on some engine applications.

JDG721

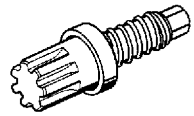
Continued on next page

DPSG,OUO1004,838 –19–27APR99–3/11

RG5066 –UN–05DEC97

Flywheel Turning Tool JDG820

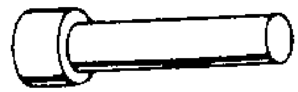
Used to rotate engine to check damper radial runout and time engine. JDE81-1 may be used also if JDG820 is not available.



JDG820

Timing Pin JDE81-4

Lock engine at TDC when timing valve train, adjusting valve clearance, and installing fuel injection pump. Use with JDG820 and JDE81-1 Flywheel Turning Tools.



RG5068

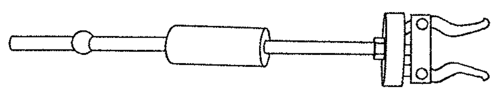
JDE81-4

DPSG,OUO1004,838 –19–27APR99–4/11

RG10060 –UN–10JUN99

Slide Hammer and Attachment. D01209AA

Used to remove auxiliary drive idler bushing/spacer from timing gear cover.



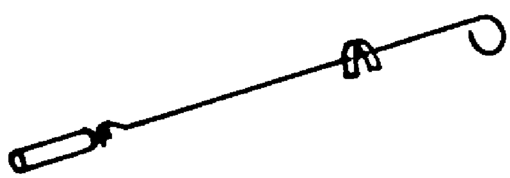
D01209AA

DPSG,OUO1004,838 –19–27APR99–5/11

RG5073 –UN–05DEC97

Magnetic Follower Holder Kit D15001NU

Hold cam followers when removing or installing camshaft.



RG5073

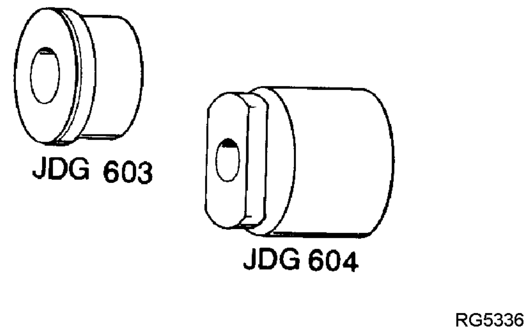
D15001NU

Continued on next page

DPSG,OUO1004,838 –19–27APR99–6/11

Camshaft Bushing Adapter Set JDG602

Used with JDE6 Camshaft Bushing Service Set to service camshaft bushings. JDG602 consists of JDG603 Driver and JDG604 Receiver Cup.



JDG602

DPSG,OUO1004,838 –19–27APR99–7/11

Camshaft Bushing Service Set. JDE6

Used with JDG602 Camshaft Bushing Adapter Set to service camshaft bushings. **JDG405 Service Set may be used along with JDG606 Adapter Set if JDE6 is not available.**

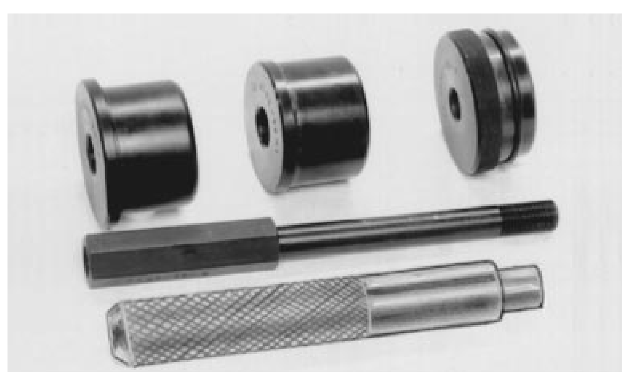
R26149N –UN–04DEC97

JDE6

DPSG,OUO1004,838 –19–27APR99–8/11

Camshaft Bushing Service Set. JDG405

Used with JDG606 Camshaft Bushing Adapter Set and D102999AA Slide Hammer to service camshaft bushings. **JDE6 Service Set may be used along with JDG602 Adapter Set if JDG405 in not available.**



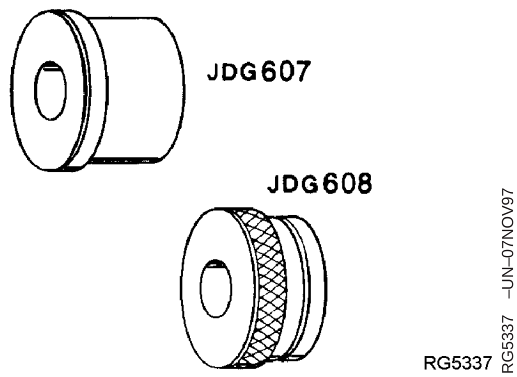
JDG405

Continued on next page

DPSG,OUO1004,838 –19–27APR99–9/11

Camshaft Bushing Adapter Set JDG606

Used with JDG405 Camshaft Bushing Service Set and D01299AA Slide Hammer to service camshaft bushings. JDG606 consists of JDG607 Driver and JDG608 Pilot.

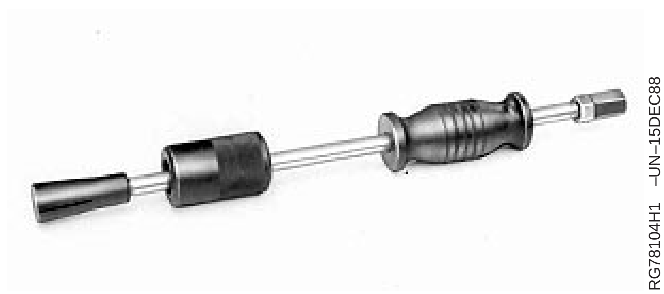


JDG606

DPSG,OUO1004,838 –19–27APR99–10/11

Slide Hammer D01299AA

Used with JDG405 Camshaft Bushing Service Set and JDG606 Camshaft Bushing Adapter Set to service camshaft bushings.



D01299AA

DPSG,OUO1004,838 –19–27APR99–11/11

Group 050 — Camshaft and Timing Gear Train Other Materials

Number	Name	Use
51048 (LOCTITE®)	Moly Paste	Lubricate camshaft nose to provide lubrication to aid in camshaft gear installation.
TY6299 (U.S.)	PERMATEX® AVIATION (Form-A-Gasket No. 3)	Apply to camshaft bore steel cap plug.
TY6333 or TY6347 (U.S.)	High Temperature Grease	Used to lubricate camshaft lobes and thrust washer when installing camshaft.

LOCTITE is a registered trademark of Loctite Corp.
PERMATEX is a registered trademark of Loctite Corporation.

DPSG,OUO1004,840 –19–27APR99–1/1

Group 060 — Lubrication System Other Materials

Number	Name	Use
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Coat threads of oil filter adapter.
AVIATION (TY6299) (U.S.)	Form-A-Gasket No. 3	Oil pan gasket surfaces.
TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®)	Pipe Sealant with TEFLON®	To seal oil pan elbow drain fitting.

LOCTITE is a registered trademark of Loctite Corp.
PERMATEX is a registered trademark of Loctite Corporation.
TEFLON is a registered trademark of Du Pont Co.

DPSG,OUO1004,846 –19–27APR99–1/1

Group 070 — Cooling System 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,OUO1004,810 –19–21APR99–1/2

Coolant Bypass Tube Seal Driver JDG908

Used to install bypass tube seal in coolant pump cover.

JDG908

DPSG,OUO1004,810 –19–21APR99–2/2

Group 070 — Cooling System Other Materials

Number	Name	Use
TY6333 or TY6345 (U.S.)	High-Temperature Grease	Fan drive bearings.
TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®)	Pipe Sealant with TEFLON®	Coolant pump and block drain valves and coolant temperature switch.
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Coolant manifold-to-cylinder head cap screws.

LOCTITE is a registered trademark of Loctite Corp.
TEFLON is a registered trademark of Du Pont Co.

DPSG,OUO1004,849 –19–27APR99–1/1

Group 080 — Air Intake and Exhaust System 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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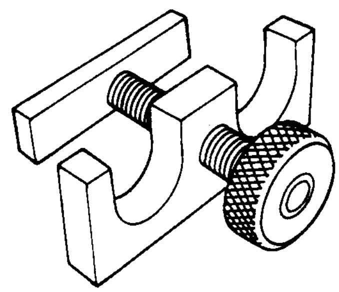
DPSG,OUO1004,817 –19–21APR99–1/2

Sealing Ring Compression Tool JDG683

Used to compress aftercooler sealing ring for cover-to-intake manifold alignment during assembly (6081A engines).



RG5571 –UN–04JUL89

JDG683

DPSG,OUO1004,817 –19–21APR99–2/2

Group 080 — Air Intake and Exhaust System Other Materials

Number	Name	Use
PT569 (U.S.)	NEVER-SEEZ® Compound	Turbocharger-to-exhaust manifold cap screws, and aftercooler cover-to-intake manifold cap screws. Also apply to special 12-point flange head exhaust manifold cap screws being reused on 8000 series tractors.[1]

[1]Special 12-point flange head cap screws used on exhaust manifold of 8000 Series tractors have pre-applied anti-sieze compound. Reapply compound only when reusing cap screws.

DPSG,OUO1004,819 –19–21APR99–1/1

Group 100 — Starting and Charging Systems Essential Tools

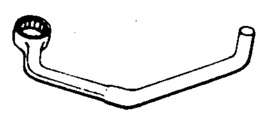
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

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

Base Engine Diagnostic 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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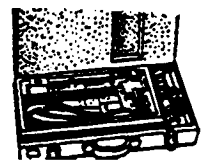
DPSG,OUO1004,201 –19–07JUL98–1/7

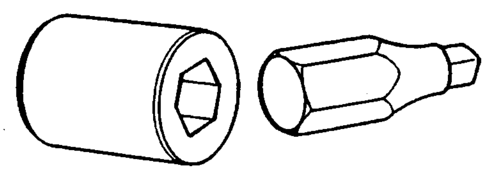
RG5161 –UN–23AUG88



Compression Test Set . . JT01674 (formerly D14546BA or FKM10021)

Used to check cylinder compression pressure. Use adapter and gauge/hose assembly from set.

DPSG,OUO1004,201 –19–07JUL98–2/7



RG6612 –UN–29JAN93

Oil Galley Plug Tool. JDG782

Used to remove and install oil galley plug when measuring engine oil pressure.

Continued on next page

DPSG,OUO1004,201 –19–07JUL98–3/7

Universal Pressure Test Kit . . . . JT05470 (formerly D15027NU or FKM10002)

Used for testing engine oil pressure, intake manifold pressure (turbo boost), and fuel supply pump pressure.

RG5162 –UN–14OCT05

DPSG,OUO1004,201 –19–07JUL98–4/7

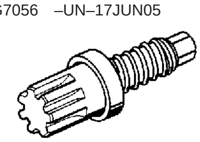
Cooling System Pressure Pump D05104ST

Used to pressure test radiator cap and cooling system.

R26406N –UN–29NOV88

DPSG,OUO1004,201 –19–07JUL98–5/7

RG7056 –UN–17JUN05



Flywheel Turning Tool JDG820

Used to rotate engine flywheel to lock engine at “TDC” to check fuel injection pump timing. Use with JDE81-4 Timing Pin.

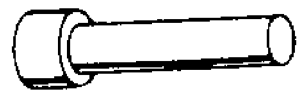
Continued on next page

DPSG,OUO1004,201 –19–07JUL98–6/7

RG5068 –UN–05DEC97

Timing Pin JDE81-4

Used to lock engine at “TDC”. Use with JDG820 Flywheel Turning Tool.



RG5068

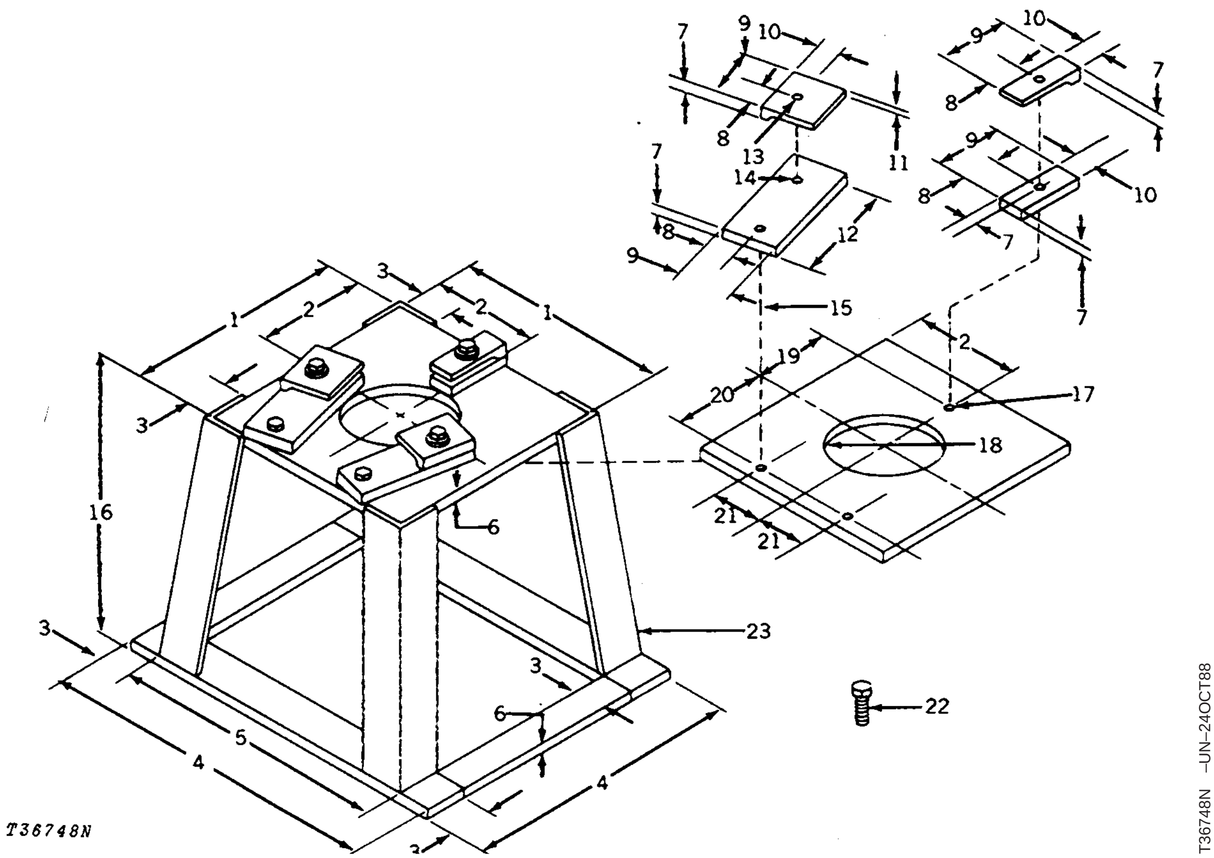
DPSG,OUO1004,201 –19–07JUL98–7/7

How to Make Tools

This tool can be made in a service shop using common shop tools and locally obtained materials.

RG,RG34710,1338 –19–23OCT97–1/1

DFRG3—Cylinder Liner Holding Fixture



Cylinder 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 (2.5 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. x 1 in. Cap Screw
23—38.1 mm (1.5 in.) Angle Iron

RG,RG34710,1339 –19–23OCT97–1/1

Section 06
Specifications

Contents

General OEM Engine Specifications

NOTE: For John Deere vehicle engines, see Machine Technical Manual.

ITEM	UNIT OF MEASURE	6081TF	6081AF
General Data			
Engine Type	——	In-line, 4 cycle diesel	In-line, 4 cycle diesel
Aspiration	——	Turbocharged	Turbocharged, water-to-air aftercooled
Number of Cylinders	——	6	6
Bore	mm (in.)	116 (4.56)	116 (4.56)
Stroke	mm (in.)	129 (5.06)	129 (5.06)
Displacement	L (cu in.)	8.1 (496)	8.1 (496)
Combustion System	——	Direct Injection	Direct Injection
Compression Ratio	——	16.5:1	16.5:1
Physical Dimensions:			
Width	mm (in.)	599 (23.8)	698 (27.5)
Height	mm (in.)	1138 (44.8)	1138 (44.8)
Length	mm (in.)	1200 (47.6)	1200 (47.6)
Basic Dry Weight	kg (lb)	735 (1620)	796 (1755)
Performance Data (Industrial Applications)			
Net Rated Power (Cont.) at 2200 rpm	kW (hp)	127 (170)	160 (215)
Net Peak Torque(Cont.) at 1200 rpm	N•m (lb-ft)	758 (559)	967 (713)
Net Rated Power (Intermit.) at 2200 rpm	kW (hp)	149 (200)	168 (225)
Net Peak (Intermit) at 1200 rpm	N•m (lb-ft)	891 (656)	1012 (747)
Low Idle Speed	rpm	850	850
Fast Idle Speed	rpm	2300	2300
Performance Data (Generator Applications)			
Net Rated Power (Prime) at 1800 rpm	kW (hp)	142 (190)	168 (225)
Net Rated Power (Standby) at 1800 rpm	kW (hp)	157 (211)	187 (250)
Net Rated Power (Prime) at 1500 rpm	kW (hp)	119 (160)	142 (190)
Net Rated Power (Standby) at 1500 rpm	kW (hp)	130 (175)	157 (210)
Low Idle Speed	rpm	850	850
Fast Idle Speed	rpm	1900/1600	1900/1600
Lubrication System			
Oil Pressure at Rated rpm	kPa (psi)	345 (50)	345 (50)
Oil Pressure at Low Idle	kPa (psi)	210 (30)	210 (30)
In-Crankcase Oil Temp at Rated rpm	°C (°F)	115°C (240°F)	115°C (240°F)
Cooling System (Liquid, pressurized with centrifugal pump)			
Recommended Pressure Cap	kPa (psi)	69 (10)	69 (10)
Coolant Temperature Operating Range	°C (°F)	82°-94°C (180°-202F°)	82°-94°C (180°-202F°)
Coolant Flow (Industrial)	L/min (gal/min)	330 (87)	330 (87)
Coolant Flow (Generator)			
at 1800 rpm	L/min (gal/min)	270 (71)	270 (71)
at 1500 rpm	L/min (gal/min)	210 (55)	210 (55)
Engine Operation System			

06
200
1

Continued on next page

RG,RG34710,4095 –19–01JAN96–1/2

ITEM	UNIT OF MEASURE	6081TF	6081AF
Hot Cylinder Compression Pressure with Injection Nozzles Removed	kPa (psi)	2380-2790 (345-405)	2380-2790 (345-405)
Valve Clearance (Cold)			
Intake	mm (in.)	0.46 (0.018)	0.46 (0.018)
Exhaust	mm (in.)	0.71 (0.028)	0.71 (0.028)
Fuel System			
Nozzle Opening Pressure New	kPa (psi)	29000 (4200)	29000 (4200)
Nozzle Opening Pressure Used (min.)	kPa (psi)	26200 (3800)	26200 (3800)
Injection Pump Timing			
Timing Lines aligned with flywheel at TDC			

RG,RG34710,4095 –19–01JAN96–2/2

General OEM Engine Specifications—Continued

NOTE: For John Deere vehicle engines, see Machine Technical Manual.

ITEM	UNIT OF MEASURE	6081HF001 Engine S.N. (—199,999)	6081HF070 Engine S.N. (200,000—)
General Data			
Engine Type	——	In-line, 4 cycle diesel	In-line, 4 cycle diesel
Aspiration	——	Turbocharged and air-to-air after cooled	Turbocharged and air-to-air after cooled
Number of Cylinders	——	6	6
Bore	mm (in.)	116 (4.56)	116 (4.56)
Stroke	mm (in.)	129 (5.06)	129 (5.06)
Displacement	L (cu in.)	8.1 (496)	8.1 (496)
Combustion System	——	Direct Injection	Direct Injection
Compression Ratio	——	15.7:1	15.7:1
Physical Dimensions:			
Width	mm (in.)	597 (23.5)	597 (23.5)
Height	mm (in.)	1152 (45.3)	1152 (45.3)
Length	mm (in.)	1200 (47.6)	1200 (47.6)
Basic Dry Weight	kg (lb)	776 (1710)	776 (1710)
Performance Data (Industrial Applications)			
Net Rated Power (Cont.) at 2200 rpm	kW (hp)	190 (255)	206 (276)
Net Peak Torque(Cont.) at 1200 rpm	N•m (lb-ft)	1184 (873)	928 (1259)
Net Rated Power (Intermit.) at 2200 rpm	kW (hp)	224 (300)	242 (325)
Net Peak (Intermit) at 1200 rpm	N•m (lb-ft)	1393 (1027)	1280 (944)
Low Idle Speed	rpm	850	850
Fast Idle Speed	rpm	2300	2300
Performance Data (Generator Applications)			
Net Rated Power (Prime) at 1800 rpm	kW (hp)	218 (292)	308 (413)
Net Rated Power (Standby) at 1800 rpm	kW (hp)	240 (322)	345 (462)
Net Rated Power (Prime) at 1500 rpm	kW (hp)	182 (244)	220 (295)
Net Rated Power (Standby) at 1500 rpm	kW (hp)	200 (268)	259 (347)
Low Idle Speed	rpm	850	850
Fast Idle Speed	rpm	1900/1600	1900/1600
Lubrication System			
Oil Pressure at Rated rpm	kPa (psi)	345 (50)	345 (50)
Oil Pressure at Low Idle	kPa (psi)	210 (30)	210 (30)
In-Crankcase Oil Temp at Rated rpm	°C (°F)	115°C (240°F)	115°C (239°F)
Cooling System (Liquid, pressurized with centrifugal pump)			
Recommended Pressure Cap	kPa (psi)	69 (10)	69 (10)
Coolant Temperature Operating Range	°C (°F)	82°-94°C (180°-202F°)	82°-94°C (180°-202F°)
Coolant Flow (Industrial)	L/min (gal/min)	330 (87)	330 (87)
Coolant Flow (Generator)			
at 1800 rpm	L/min (gal/min)	270 (71)	270 (71)
at 1500 rpm	L/min (gal/min)	210 (55)	210 (55)

Continued on next page

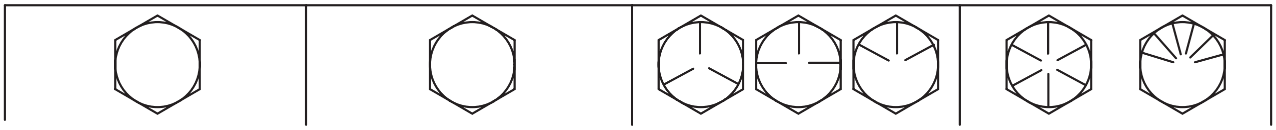
DPSG,OUOD007,3504 –19–28NOV00–1/2

ITEM	UNIT OF MEASURE	6081HF001 Engine S.N. (—199,999)	6081HF070 Engine S.N. (200,000—)
Engine Operation System			
Hot Cylinder Compression Pressure with Injectors Removed	kPa	2380-2790 (345-405)	2380-2790 (345-405)
Valve Clearance (Cold)			
Intake	mm (in.)	0.46 (0.018)	0.46 (0.018)
Exhaust	mm (in.)	0.71 (0.028)	0.71 (0.028)
Fuel System			
Injector Opening Pressure New	kPa (psi)	29000 (4200)	ECU Programed
Injector Opening Pressure Used (min.)	kPa (psi)	26200 (3800)	ECU Programed
Injection Pump Timing S.N. (—199,999)		Timing lines aligned with flywheel at TDC	
Injection Pump Timing S.N. (200,000—)			Timing pin inserted with flywheel at TDC

DPSG,OUOD007,3504 –19–28NOV00–2/2

Unified Inch Bolt and Screw Torque Values

TS1671 –UN–01MAY03



Bolt or	SAE Grade 1				SAE Grade 2[a]				SAE Grade 5, 5.1 or 5.2				SAE Grade 8 or 8.2			
Screw	**Lubricated[b]**		**Dry[c]**		**Lubricated[b]**		**Dry[c]**		**Lubricated[b]**		**Dry[c]**		**Lubricated[b]**		**Dry[c]**	
Size	**N•m**	**lb-in**	**N•m**	**lb-in**	**N•m**	**lb-in**	**N•m**	**lb-in**	**N•m**	**lb-in**	**N•m**	**lb-in**	**N•m**	**lb-in**	**N•m**	**lb-in**
1/4	3.7	33	4.7	42	6	53	7.5	66	9.5	84	12	106	13.5	120	17	150
													N•m	**lb-ft**	**N•m**	**lb-ft**
5/16	7.7	68	9.8	86	12	106	15.5	137	19.5	172	25	221	28	20.5	35	26
									N•m	**lb-ft**	**N•m**	**lb-ft**				
3/8	13.5	120	17.5	155	22	194	27	240	35	26	44	32.5	49	36	63	46
			N•m	**lb-ft**	**N•m**	**lb-ft**	**N•m**	**lb-ft**								
7/16	22	194	28	20.5	35	26	44	32.5	56	41	70	52	80	59	100	74
	N•m	**lb-ft**														
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

Torque values listed are for general use only, based on the strength of the bolt or screw. DO NOT use these values if a different torque value or tightening procedure is given for a specific application. For plastic insert or crimped steel type lock nuts, for stainless steel fasteners, or for nuts on U-bolts, see the tightening instructions for the specific application. Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Replace fasteners with the same or higher grade. If higher grade fasteners are used, tighten these to the strength of the original. Make sure fastener threads are clean and that you properly start thread engagement. When possible, lubricate plain or zinc plated fasteners other than lock nuts, wheel bolts or wheel nuts, unless different instructions are given for the specific application.

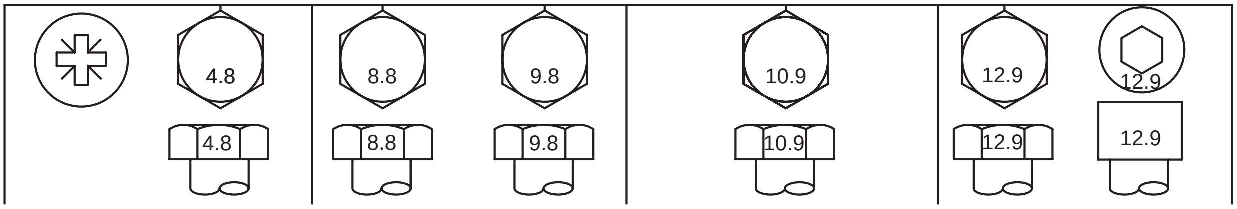
[a]Grade 2 applies for hex cap screws (not hex bolts) up to 6. in (152 mm) long. Grade 1 applies for hex cap screws over 6 in. (152 mm) long, and for all other types of bolts and screws of any length.

[b]"Lubricated" means coated with a lubricant such as engine oil, fasteners with phosphate and oil coatings, or 7/8 in. and larger fasteners with JDM F13C zinc flake coating.

[c]"Dry" means plain or zinc plated without any lubrication, or 1/4 to 3/4 in. fasteners with JDM F13B zinc flake coating.

DX,TORQ1 –19–24APR03–1/1

Metric Bolt and Screw Torque Values



TS1670 –UN–01MAY03

Bolt or	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
Screw	Lubricated[a]		Dry[b]		Lubricated[a]		Dry[b]		Lubricated[a]		Dry[b]		Lubricated[a]		Dry[b]	
Size	N•m	lb-in	N•m	lb-in	N•m	lb-in	N•m	lb-in	N•m	lb-in	N•m	lb-in	N•m	lb-in	N•m	lb-in
M6	4.7	42	6	53	8.9	79	11.3	100	13	115	16.5	146	15.5	137	19.5	172
									N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
M8	11.5	102	14.5	128	22	194	27.5	243	32	23.5	40	29.5	37	27.5	47	35
			N•m	lb-ft	N•m	lb-ft	N•m	lb-ft								
M10	23	204	29	21	43	32	55	40	63	46	80	59	75	55	95	70
	N•m	lb-ft														
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

Torque values listed are for general use only, based on the strength of the bolt or screw. DO NOT use these values if a different torque value or tightening procedure is given for a specific application. For stainless steel fasteners or for nuts on U-bolts, see the tightening instructions for the specific application. Tighten plastic insert or crimped steel type lock nuts by turning the nut to the dry torque shown in the chart, unless different instructions are given for the specific application.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical property class. Replace fasteners with the same or higher property class. If higher property class fasteners are used, tighten these to the strength of the original. Make sure fastener threads are clean and that you properly start thread engagement. When possible, lubricate plain or zinc plated fasteners other than lock nuts, wheel bolts or wheel nuts, unless different instructions are given for the specific application.

[a]"Lubricated" means coated with a lubricant such as engine oil, fasteners with phosphate and oil coatings, or M20 and larger fasteners with JDM F13C zinc flake coating.

[b]"Dry" means plain or zinc plated without any lubrication, or M6 to M18 fasteners with JDM F13B zinc flake coating.

DX,TORQ2 –19–24APR03–1/1

Group 020 — Cylinder Head and Valves S. N. (—199,999) Repair Specifications

Item	Measurement	Specification
Intake Valve Clearance Checking (Rocker Arm-to-Valve Tip With Engine Cold)	Clearance	0.41—0.51 mm (0.016—0.020 in.)
Exhaust Valve Clearance Checking (Rocker Arm-to-Valve Tip With Engine Cold)	Clearance	0.66—0.76 mm (0.026—0.030 in.)
Valve Adjusting Screw Lock Nut	Torque	27 N•m (20 lb-ft)
Intake Valve Clearance Adjustment (Rocker Arm-to-Valve Tip With Engine Cold)	Clearance	0.46 mm (0.018 in.)
Exhaust Valve Clearance Adjustment (Rocker Arm-to-Valve Tip With Engine Cold)	Clearance	0.71 mm (0.028 in.)
Rocker Arm Cover-to-Cylinder Head Cap Screws	Torque	8 N•m (6 lb-ft) (72 lb-in.)
Intake Valve	Lift	13.53—13.71 mm (0.533—0.540 in.) at 0.00 mm (in.)
	Wear Tolerance	12.65 mm (0.498 in.) at 0.00mm (in.) clearance
Exhaust Valve	Lift	14.52—14.70 mm (0.572—0.579 in.) at 0.00 mm (in.)
	Wear Tolerance	13.64 mm (0.537 in.) at 0.00mm (in.) clearance
Rocker Arm Assembly	I.D.	19.07—19.10 mm (0.7507—0.7520 in.)
	Shaft O.D.	19.01—19.05 mm (0.7484—0.7500 in.)
Exhaust Valve	Recess	1.19—1.70 mm (0.047—0.067 in.) below cylinder head
	Maximum Recess	2.46 mm (0.097 in.) below cylinder head

Continued on next page

DPSG,OUO1004,834 –19–13DEC00–1/3

Item	Measurement	Specification
Intake Valve	Recess	3.35—3.86 mm (0.132—0.152 in.) below cylinder head
	Maximum Recess	4.62 mm (0.182 in.) below cylinder head
Intake Valve Spring	Height	38.1 mm (1.50 in.)@810—880 N (182—198 lb-force) with valve open
	Height	52.5 mm (2.07 in.)@345—399 N (78—90 lb-force) with valve closed
Exhaust Valve Spring	Height	38.5 mm (1.52 in.)@797—867 N (179—195 lb-force) with valve open
	Height	54.5 mm (2.15 in.)@284—338 N (64—76 lb-force) with valve closed
Intake Valve Stem	OD	9.461—9.487 mm (0.3725—0.3735 in.)
Exhaust Valve Stem	OD	9.436—9.462 mm (0.3715—0.3725 in.)
Intake Valve Head	OD	50.87—51.13 mm (2.002—2.012 in.)
Exhaust Valve Head	OD	46.87—47.13 mm (1.845—1.856 in.)
Valve Face	Runout	0.05 mm (0.002 in.) maximum permissible
Valve Face (Intake and Exhaust)	Angle	29.25° ± 0.25°
Cylinder Head Plugs	Torque	60 N•m (44 lb-ft)
Cylinder Head	Maximum Acceptable Out-of-Flat Over Entire Length or Width	0.08 mm (0.003 in.)
	Straightness Per Any 305 mm (12 in.) Length	Within 0.025 mm (0.001 in.)
Cylinder Head	Thickness	155.45—155.71 mm (6.120—6.130 in.)
	Wear Limit	154.69 mm (6.09 in.)
	Combustion Face Surface Finish (Surface Mill Only to AA Finish)	1.5—2.8 micrometers (60—110 micro-in.)
	Maximum Wave Depth	0.012 mm (0.0005 in.)
Resurfacing Head	Maximum Material Removal	0.762 mm (0.0300 in.)

Continued on next page

DPSG,OUO1004,834 –19–13DEC00–2/3

Item	Measurement	Specification
Valve Guide	ID	9.51—9.54 mm (0.3745—0.3755 in.) in new head
New Guide-to-Exhaust Valve Stem	Clearance	0.051—0.102 mm (0.002—0.004 in.)
New Guide-to-Intake Valve Stem	Clearance	0.025—0.076 mm (0.001—0.003 in.)
Valve Seat	Angle Maximum Runout	30° ± 0.50° 0.051 mm (0.0020 in.)
Exhaust Valve Seat	Width	2.0—3.8 mm (0.079—0.150 in.)
Intake Valve Seat	Width	1.4—3.8 (0.055—0.150 in.)
Valve Seat Grinding	Angle Exhaust Width Intake Width Maximum Seat Runout	30° ± 0.50° 2.0—3.8 mm (0.079—0.150 in.) 1.4—3.8 mm (0.055—0.150 in.) 0.051 mm (0.0020 in.)
Oversize Inserts	Width	0.25 mm (0.010 in.)
Liner	Height Above Block	0.051—0.127 mm (0.002—0.005 in.) above block
Cylinder Head Flanged-Head "SPECIAL" Cap Screws (No Washers)	Initial Torque	80 N•m (60 lb-ft)
Cylinder Head Flanged-Head "SPECIAL" Cap Screws (No Washers)	Final Torque	See Torque-to-Yield Procedure in this Group for Final Torque Specifications and Sequence
Rocker Arm Shaft Clamps	Torque	75 N•m (55 lb-ft)
Intake Manifold-to-Cylinder Head	Torque	47 N•m (35 lb-ft)
Exhaust Manifold-to-Cylinder Head	Torque	47 N•m (35 lb-ft)
Turbocharger Cap Screws	Torque	24 N•m (18 lb-ft)
Turbocharger Oil Return Pipe-to-Turbocharger Cap Screws	Torque	27 N•m (20 lb-ft)
Cylinders (No. 1 is front of engine)	Firing Order	1-5-3-6-2-4

DPSG,OUO1004,834 –19–13DEC00–3/3

Group 021 — Cylinder Head and Valves S. N. (200,000—) Repair Specifications

Item	Measurement	Specification
Intake Valve Clearance Checking (Rocker Arm-to-Valve Tip With Engine Cold)	Clearance	0.41—0.51 mm (0.016—0.020 in.)
Exhaust Valve Clearance Checking (Rocker Arm-to-Valve Tip With Engine Cold)	Clearance	0.66—0.76 mm (0.026—0.030 in.)
Rocker Arm Cover-to-Carrier Cap Screws	Torque	8 N•m (5.9 lb-ft)
Intake Valve Clearance Checking (Rocker Arm-to-Valve Tip With Engine Cold)	Clearance	0.41—0.51 mm (0.016—0.020 in.)
Exhaust Valve Clearance Checking (Rocker Arm-to-Valve Tip With Engine Cold)	Clearance	0.66—0.76 mm (0.026—0.030 in.)
Valve Adjusting Screw Lock Nut	Torque	27 N•m (20 lb-ft)
Carrier-to-Cylinder Head Cap Screw	Torque	8 N•m (5.9 lb-ft)
Solenoid Wire Retaining Nuts	Torque	1.75 N•m (1.29 lb-ft)
Rocker Arm Cover Cap Screws	Torque	8 N•m (5.9 lb-ft)
Intake Valve	Lift	13.53—13.71 mm (0.533—0.540 in.) at 0.00 mm (in.)
	Wear Tolerance	12.65 mm (0.498 in.) at 0.00mm (in.) clearance
Exhaust Valve	Lift	14.52—14.70 mm (0.572—0.579 in.) at 0.00 mm (in.)
	Wear Tolerance	13.64 mm (0.537 in.) at 0.00mm (in.) clearance
Exhaust Valve	Recess	1.19—1.70 mm (0.047—0.067 in.) below cylinder head
	Maximum Recess	2.46 mm (0.097 in.) below cylinder head

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RE38635,000002D –19–15JUL05–1/4

Item	Measurement	Specification
Intake Valve	Recess	3.35—3.86 mm (0.132—0.152 in.) below cylinder head
	Maximum Recess	4.62 mm (0.182 in.) below cylinder head
Intake Valve Spring	Height	33.8 mm (1.33 in.)@797—917 N (168—206 lb-force) with valve open
	Height	47.7 mm (1.88 in.)@312—366 N (70—82 lb-force) with valve closed
Exhaust Valve Spring	Height	34.6 mm (1.36 in.)@748—868 N (168—195 lb-force) with valve open
	Height	49.4 mm (1.94 in.)@258—312 N (58—70 lb-force) with valve closed
Intake Valve Stem	OD	9.461—9.487 mm (0.3725—0.3735 in.)
Exhaust Valve Stem	OD	9.436—9.462 mm (0.3715—0.3725 in.)
Intake Valve Head	OD	50.87—51.13 mm (2.002—2.012 in.)
Exhaust Valve Head	OD	46.87—47.13 mm (1.845—1.856 in.)
Valve Face	Runout	0.05 mm (0.002 in.) maximum permissible
Valve Face (Intake and Exhaust)	Angle	29.25° ± 0.25°
Cylinder Head Plugs	Torque	60 N•m (44 lb-ft)
Cylinder Head	Maximum Acceptable Out-of-Flat Over Entire Length or Width	0.08 mm (0.003 in.)
	Straightness Per Any 305 mm (12 in.) Length	Within 0.025 mm (0.001 in.)
Cylinder Head	Thickness	155.45—155.71 mm (6.120—6.130 in.)
	Wear Limit	154.69 mm (6.09 in.)
	Combustion Face Surface Finish (Surface Mill Only to AA Finish)	1.5—2.8 micrometers (60—110 micro-in.)
	Maximum Wave Depth	0.012 mm (0.0005 in.)
Resurfacing Head	Maximum Material Removal	0.762 mm (0.0300 in.)

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RE38635,000002D –19–15JUL05–2/4

Item	Measurement	Specification
Valve Guide	ID	9.51—9.54 mm (0.3745—0.3755 in.) in new head
New Guide-to-Exhaust Valve Stem	Clearance	0.051—0.102 mm (0.002—0.004 in.)
New Guide-to-Intake Valve Stem	Clearance	0.025—0.076 mm (0.001—0.003 in.)
Valve Seat	Angle Maximum Runout	30° ± 0.50° 0.051 mm (0.0020 in.)
Exhaust Valve Seat	Width	2.0—3.8 mm (0.079—0.150 in.)
Intake Valve Seat	Width	1.4—3.8 (0.055—0.150 in.)
Valve Seat Grinding	Angle Exhaust Width Intake Width Maximum Seat Runout	30° ± 0.50° 2.0—3.8 mm (0.079—0.150 in.) 1.4—3.8 mm (0.055—0.150 in.) 0.051 mm (0.0020 in.)
Oversize Inserts	Width	0.25 mm (0.010 in.)
Liner	Height Above Block	0.051—0.127 mm (0.002—0.005 in.) above block
Cylinder Head Flanged-Head “SPECIAL” Cap Screws (No Washers)	Initial Torque	80 N•m (60 lb-ft)
Cylinder Head Flanged-Head “SPECIAL” Cap Screws (No Washers)	Final Torque	See Torque-to-Yield Procedure in this Group for Final Torque Specifications and Sequence
Initial Rocker Arm Clamp-to-Cylinder Head Cap Screw	Torque	30 N•m (22 lb-ft)
Final Rocker Arm Clamp-to-Cylinder Head Cap Screw	Torque Turn	10 N•m + 60° (7 lb-ft + 60°)
Rocker Arm Cover-to-Cylinder Head Cap Screw	Torque	8 N•m (5.9 lb-ft)
Intake Manifold-to-Cylinder Head	Torque	47 N•m (35 lb-ft)
Exhaust Manifold-to-Cylinder Head	Torque	47 N•m (35 lb-ft)
Turbocharger Cap Screws	Torque	24 N•m (18 lb-ft)

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RE38635,000002D –19–15JUL05–3/4

Item	Measurement	Specification
Turbocharger Oil Return Pipe-to-Turbocharger Cap Screws	Torque	27 N•m (20 lb-ft)
Rocker Arm Cover-to-Cylinder Head Cap Screw	Torque	8 N•m (5.9 lb-ft)

RE38635,000002D –19–15JUL05–4/4

Group 030 — Cylinder Block, Liners, Pistons and Rods Repair Specifications

Item	Measurement	Specification
Cylinder Liner Cap Screws (For Checking Standout)	Torque	68 N•m (50 lb-ft)
Cylinder Liners	Standout (Height Above Block)	0.051—0.127 mm (0.002—0.005 in.)
Maximum Piston Protrusion Above Block	Protrusion	0.051—0.787 mm (0.002—0.031 in.)
No. 1 Piston Compression Ring	End Gap	0.43—0.69 mm (0.017—0.027 in.)
No. 2 Piston Compression Ring	End Gap	1.01—1.27 mm (0.040—0.050 in.)
Piston Oil Control Ring-to-Groove	New Part Clearance	0.064—0.102 mm (0.0025—0.0040 in.)
	Maximum Serviceable Clearance	0.165 mm (0.0065 in.)
Cylinder Liner	Thickness	6.05—6.15 mm (0.238—0.242 in.)
	Packing Step Dimension	1.45—1.55 mm (0.057—0.061 in.)
Piston Skirt	OD 15.16 mm (0.597 in.) from Bottom of Piston	115.771—115.789 mm (4.5579—4.5586 in.)
Cylinder Liner	ID	115.865—115.895 mm (4.5616—4.5628 in.)
	OD (Coolant Jacket Area)	127.94—128.24 mm (5.037—5.049 in.)
	OD (At Upper Bore)	129.08—129.14 mm (5.082—5.084 in.)
	OD (At Lower Bore)	125.044—125.120 mm (4.923—4.926 in.)
	ID of Upper Bore in Block for Seating Liners	129.155—129.205 mm (5.085—5.087 in.)
	ID of Lower Bore in Block for Seating Liners	125.133—125.183 mm (4.9265—4.9285 in.)
	Liner-to-Block Clearance at Upper Bore	0.026—0.126 mm (0.001—0.005 in.)
	Liner-to-Block Clearance at Lower Bore	0.012—0.140 mm (0.0005—0.0055 in.)
	Maximum Out-of-Round	0.051 mm (0.0020 in.)
	Maximum Wear or Taper in Ring Travel Area	0.051 mm (0.0020 in.) maximum

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DPSG,OUO1004,892 –19–13DEC00–1/4

Item	Measurement	Specification
Piston-to-Liner	New Part Clearance (At Bottom of Skirt)	0.076—0.124 mm (0.0030—0.0049 in.)
	Maximum Clearance	0.152 mm (0.0060 in.)
Cylinder Liner Flange	Thickness	11.989—12.039 mm (0.472—0.474 in.)
	OD	135.10—135.16 mm (5.319—5.321 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	95 N•m (71 lb-ft) plus 90–100° turn clockwise
Crankshaft Rod Journal	OD	76.150—76.180 mm (2.9980—2.9992 in.)
Assembled Connecting Rod Bearing	ID	76.210—76.260 mm (3.0004—3.0024 in.)
Connecting Rod Bearing-to-Journal (New Parts)	Oil Clearance	0.030—0.110 mm (0.0012—0.0044 in.)
Connecting Rod Bore (Without Bearings)	ID	81.051—81.077 mm (3.191—3.192 in.)
Connecting Rod Bore	Maximum Out-of-Round	0.025 mm (0.0010 in.)
Centerline of Piston Pin Bore-to-Crankshaft Bore	Dimension	222.20—222.30 mm (8.748—8.752 in.)
Piston Pin	OD	47.597—47.613 mm (1.8739—1.8745 in.)
Piston Pin Bore in Piston	ID	47.620—47.630 mm (1.8748—1.8752 in.)
Connecting Rod Pin-to-Bushing	Oil Clearance	0.042—0.084 mm (0.0017—0.0033 in.)
	Wear Limit	0.102 mm (0.0040 in.)

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DPSG,OUO1004,892 –19–13DEC00–2/4

Item	Measurement	Specification
Connecting Rod Pin Bore	Diameter without Bushing	52.354—52.380 mm (2.0612—2.0622 in.)
Connecting Rod Pin Bore-to-Bushing	Press Fit	0.084—0.147 mm (0.0033—0.0058 in.)
Installed Service Connecting Rod Pin Bushing (Before Boring)	ID	47.58—47.63 mm (1.8732—1.8751 in.)
Installed Service Connecting Rod Pin Bushing (After Boring)	ID	47.655—47.681 mm (1.8762—1.8772 in.)
Cylinder Block Flange Counterbore	Depth	11.913—11.963 mm (0.469—0.471 in.)
Crankshaft Main Bearing	Bore ID without Bearing	101.651—101.67 mm (4.0020—4.0030 in.)
	Surface Width	36.28—36.78 mm (1.428—1.448 in.)
Crankshaft Thrust Bearing	Bore ID without Bearing	101.651—101.67 mm (4.0020—4.0030 in.)
	Surface Width (No. 5 Main)	37.44—37.54 mm (1.474—1.478 in.)
	Overall Cap Width	41.81—42.31 mm (1.646—1.666 in.)
Camshaft Follower	Bore ID in Block	17.384—17.440 mm (0.6845—0.6865 in.)
	Follower OD (New)	17.33—17.35 mm (0.682—0.683 in.)
	Follower-to-Bore Clearance	0.114 mm (0.0045 in.)
Camshaft Bushing	Installed ID	67.076—67.102 mm (2.6408—2.6418 in.)
	Bushing Bore in Block	69.987—70.013 mm (2.7554—2.7564 in.)
	Minimum Runout of Bore in Block	0.038 mm (0.0015 in.)
	Bushing-to-Journal Clearance	0.063—0.115 mm (0.0025—0.0045 in.)
Cylinder Block Top Deck	Maximum Out-of-Flat	0.10 mm (0.004 in.) over entire length or width
	Straightness	0.025 mm (0.001 in.) per any 305 mm (12.0 in) of Length
	Maximum Wave Depth	2.0 micrometers (79 micro-inch)
	Main Bearing Bore Centerline-to-Top Deck Distance	352.35—352.50 mm (13.872—13.878 in.)

Continued on next page

DPSG,OUO1004,892 –19–13DEC00–3/4

Item	Measurement	Specification
Piston Cooling Orifice into Cylinder Block	Torque	11 N•m (97 lb-in.) (8 lb-ft)
Cylinder Liner Shim	Thickness	0.05 mm (0.002 in.)

DPSG,OUO1004,892 –19–13DEC00–4/4

Group 040 — Crankshaft, Main Bearings and Flywheel Repair Specifications

Item	Measurement	Specification
Vibration Damper	Maximum Radial Runout	1.02 mm (0.040 in.)
Crankshaft	End Play	0.038—0.380 mm (0.0015—0.0150 in.)
Crankshaft Pulley	ID	47.594—47.630 mm (1.8738—1.8752 in.)
Crankshaft	OD for Front Pulley	47.650—47.676 mm (1.8759—1.8770 in.)
Crankshaft Front Oil Seal Bore in Timing Gear Cover	Maximum Radial Runout	0.254 mm (0.010 in.) Maximum
Front Oil Seal Installed Below Front Face of Seal Bore	Distance	8.9 mm (0.35 in.)
Flywheel Housing Face	Runout	0.20 mm (0.008 in.) Maximum Variation
Flywheel Face	Flatness	0.23 mm (0.009 in.) Maximum Variation
	Flatness	0.013 mm (0.0005 in.) Maximum Variation per 25 mm (1.0 in.) of Travel
Flywheel Pilot Bearing Bore	Concentricity	0.127 mm (0.005 in.) Maximum Variation
Crankshaft Dowel Pin	Protrusion	13.5—14.5 mm (0.53—0.57 in.) From Crankshaft Rear Flange
Crankshaft Main Bearing-to-Journal	Oil Clearance	0.030—0.107 mm (0.0012—0.0042 in.)
Crankshaft Main Bearing	ID With Bearing	95.270—95.320 mm (3.7508—3.7528 in.)
	ID Without Bearing	101.651—101.677 mm (4.0020—4.0030 in.)
Crankshaft Main Journal	OD	95.196—95.222 mm (3.7479—3.7490 in.)

Continued on next page

DPSG,OUO1004,906 –19–21MAY99–1/4

Item	Measurement	Specification
Crankshaft Main Journal	Taper per 25.4 mm (1.0 in.) length	0.0025 mm (0.0001 in.)
	Out-of-Roundness	0.025 mm (0.0010 in.)
Crankshaft Main Bearing Cap	Surface Width	36.28—36.78 mm (1.428—1.448 in.)
Main Bearing Cap Bore	ID Without Bearings (Standard)	101.651—101.677 mm (4.0020—4.0030 in.)
	Diameter Variation	0.013 mm (0.0005 in.) maximum
	Diameter Taper	0.008 mm (0.0003 in.) maximum
	Straightness Variation (Any Bore-to-Adjacent Bore)	0.038 mm (0.0015 in.) maximum
	Straightness Variation (5 Center Bore-to-End Bore	0.076 mm (0.0030 in.) maximum
	Centerline of Bore-to-Top Deck	352.35—352.50 mm (13.872—13.878 in.)
Thrust Washer Clearance[1]	Base Circle OD	129.286—130.810 mm (5.09—5.15 in.)
Thrust Bearing Cap	Surface Width	37.44—37.54 mm (1.474—1.478 in.)
Thrust Washer Clearance	Relief Angle	45°
Thrust Bearing Cap	Overall Width (—1995)	41.81—42.31 mm (1.646—1.666 in.)
	Overall Width (1995—)	39.16—39.66 mm (1.542—1.561 in.)
Thrust Bearing Surface	Maximum Runout	0.25 mm (0.0010 in.)
Undersized Main Bearings Available	OD	0.292 mm (0.0115 in.) and 0.552 mm (0.0217 in.)
Undersized Rod (Pin) Journal Bearings Available	OD	0.292 mm (0.0115 in.)
Oversize Thrust Washer Available	OD	0.18 mm (0.007 in.)
Crankshaft	End Play	0.038—0.380 mm (0.0015—0.0150 in.)
Piston Cooling Orifices into Cylinder Block	Torque	11 N•m (97 lb-in.)

[1] *Thrust (washer) surfaces on bearing cap must be flat in respect to mating thrust (washer) surfaces in cylinder block.*

Continued on next page

Item	Measurement	Specification
Crankshaft Main Bearing Cap Screws	Initial Torque	68 N•m (50 lb-ft)
Crankshaft Main Bearing Cap Screws	Final Torque	230 N•m (170 lb-ft)
Oil Pump Drive Gear-to-Crankshaft	Backlash Clearance	0.38 mm (0.015 in.)
Crankshaft Rear Oil Seal Housing ID	Maximum Runout	0.152 mm (0.006 in.)
Rear Oil Seal Housing-to-Oil Pan Rail	Recess	0.000—0.050 mm (0.000—0.002 in.) Inside Block Oil Pan Rail
Rear Crankshaft Oil Seal Housing	Torque	27 N•m (20 lb-ft)
Timing Gear Cover-to-Cylinder Block Cap Screws[2]	Torque	27 N•m (20 lb-ft)
Injection Pump Gear Cover-to-Timing Gear Cover	Torque	27 N•m (20 lb-ft)
Coolant Pump Cover-to-Timing Gear Cover		
5/16-in. Cap Screws	Torque	27 N•m (20 lb-ft)
3/8-in. Cap Screws	Torque	47 N•m (35 lb-ft)
Front Oil Seal Installed Below Front Lip of Seal Bore	Recess	8.9 mm (0.35 in.)
Vibration Damper-to-Crankshaft Cap Screws	Torque	230 N•m (170 lb-ft)
Crankshaft Pulley-to-Damper Cap Screws (Single Dampers for Gen-Set Applications)	Torque	61 N•m (45 lb-ft)
Crankshaft Pulley-to-Damper Cap Screws (All Other Applications)	Torque	70 N•m (52 lb-ft)
Drive Hub-to-Flywheel Cap Screws	Torque	115 N•m (85 lb-ft)

[2]*See INSTALL TIMING GEAR COVER, later in this group, for proper cap screw tightening sequence.*

Continued on next page

DPSG,OUO1004,906 –19–21MAY99–3/4

Item	Measurement	Specification
Flywheel-to-Crankshaft Cap Screws (With Rear PTO)	Torque	162 N•m (120 b-ft)
Flywheel-to-Crankshaft Cap Screws (All Other Applications)	Torque	115 N•m (85 lb-ft)
SAE 2 Flywheel Housing-to-Cylinder Block 3/4-in. Cap Screws (With Rear PTO)	Torque	325 N•m (240 lb-ft)
SAE 2 Flywheel Housing-to-Cylinder Block 5/8-in. Cap Screws (With Rear PTO)	Torque	275 N•m (203 lb-ft)
SAE 2 (w/o Rear PTO) and SAE 3 Flywheel Housing-to-Cylinder Block Cap Screws	Torque	365 N•m (269 lb-ft)
SAE 3 Flywheel Housing-to-Oil Pan 1/2 in. Cap Screws	Torque	129 N•m (95 lb-ft)
SAE 3 Flywheel Housing-to-Oil Pan 3/8 in. Cap Screws	Torque	47 N•m (35 lb-ft)
SAE 1 Flywheel Housing-to-Cylinder Block Cap Screws	Torque	365 N•m (269 lb-ft)

DPSG,OUO1004,906 –19–21MAY99–4/4

Group 050 — Camshaft and Timing Gear Train Repair Specifications

Item	Measurement	Specification
Intake Valve	Lift	13.53—13.71 mm (0.533—0.540 in.) at 0.00 mm (in.) clearance
	Wear Limit	12.65 mm (0.498 in.) at 0.00 mm (in.) clearance
Exhaust Valve	Lift	14.52—14.70 mm (0.572—0.579 in.) at 0.00 mm (in.) clearance
	Wear Limit	13.64 mm (0.537 in.) at 0.00 mm (in.) clearance
Camshaft	End Play	0.013—0.500 mm (0.0005—0.0200 in.) new
	Wear Limit	0.65 mm (0.0260 in.) maximum allowable
Camshaft Drive Gear-to-Crankshaft Gear	Backlash	0.076 mm (0.003 in.) min.
Auxiliary Drive Cover Cap Screws	Torque	47 N•m (35 lb-ft)
Auxiliary Drive Idler Housing-to-Timing Gear Cover (3/8 in.)	Torque	41 N•m (30 lb-ft)
Auxiliary Drive Idler Housing-to-Cylinder Block (3/8 in.)	Torque	41 N•m (30 lb-ft)
Auxiliary Drive Idler Housing-to-Cylinder Block (1/2 in.)	Torque	127 N•m (94 lb-ft)
Auxiliary Drive Idler Shaft Button Head Cap Screw	Torque	150 N•m (110 lb-ft)
Auxiliary Drive Idler Housing-to-Idler Bearing (5/16 in.)	Torque	27 N•m (20 lb-ft)
Auxiliary Drive Idler Gear-to-Crankshaft Gear	Backlash	0.11—0.7 mm (0.004—0.028 in.)
Camshaft Gear-to-Injection Pump Drive Gear Backlash	Backlash	0.051 mm (0.0020 in.) minimum
Thrust Washer	Thickness	2.24—2.34 mm (0.088—0.092 in.)

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DPSG,OUO1004,841 –19–27APR99–1/2

Item	Measurement	Specification
Camshaft Follower	OD	17.33—17.35 mm (0.682—0.683 in.)
Camshaft Follower Bore in Block	ID	17.384—17.440 mm (0.6845—0.6865 in.)
Camshaft Journal	OD	66.987—67.013 mm (2.6373—2.6383 in.) new
Camshaft Bushing	I.D.	67.076—67.102 mm (2.6408—2.6418 in.) new
Intake Camshaft Lobe	Lift Wear Limit	7.69—7.79 mm (0.303—0.307 in.) 7.19 mm (0.283 in.)
Exhaust Camshaft Lobe	Lift Wear Limit	8.25—8.35 mm (0.325—0.329 in.) 7.75 mm (0.305 in.)
Camshaft Gear Thrust Surfaces	Runout	0.10 mm (0.004 in.) maximum
Camshaft Bushing	ID	67.076—67.102 mm (2.6408—2.6418 in.)
	Bore in Block	69.987—70.013 mm (2.7554—2.7564 in.)
Camshaft Bore	Runout	0.038 mm (0.0015 in.) maximum
Camshaft Journal	OD	66.987—67.013 mm (2.6373—2.6383 in.)
Camshaft Bushing-to-Journal	Oil Clearance	0.063—0.115 mm (0.0025—0.0045 in.)
Timing Gear Cover-to-Cylinder Block Cap Screws	Torque	27 N•m (20 lb-ft)
Coolant Pump Cover-to-Timing Gear Cover		
5/16-in. Cap Screws	Torque	27 N•m (20 lb-ft)
3/8-in. Cap Screws	Torque	47 N•m (35 lb-ft)
Injection Pump Drive Gear Cover	Torque	27 N•m (20 lb-ft)

DPSG,OUO1004,841 –19–27APR99–2/2

Group 060 — Lubrication System Repair Specifications

Item	Measurement	Specification
Engine Oil Pressure[1]	Oil Pressure	280—400 kPa (2.8—4.0 bar) (40—58 psi) @ 1800-2000 rpm
Oil Pressure Regulating Valve Housing-to-Cylinder Block (External)[2]	Torque	61 N•m (45 lb-ft)
Oil Filter Housing-to-Cylinder Block	Torque	80 N•m (60 lb-ft)
Oil Filter Bypass Valve Plug	Torque	100 N•m (74 lb-ft)
Oil Pressure Regulating Valve Plug	Torque	100 N•m (74 lb-ft)
Oil Cooler Adapter Cap Screws	Torque	47 N•m (35 lb-ft)
Oil Cooler Cover-to-Cylinder Block Cap Screws[3]	Initial Torque	20 N•m (15 lb-ft)
Oil Cooler Cover-to-Cylinder Block Cap Screws[3]	Final Torque	37 N•m (27 lb-ft)
Pressure Regulating Valve Spring	Compressed Length	43.0 mm (1.69 in.) @ 66—74 N (15—17 lb-force)
	Free Length	85.0 mm (3.35 in.)
Oil Pressure Regulating Valve Plug	Torque	100 N•m (74 lb-ft)
Oil Pressure Regulating Valve	Operating Pressure (Starts to Operate)	340 kPa (3.4 bar) (49 psi)
Oil Filter Bypass Valve Spring	Compressed Length	30.0 mm (1.18 in.) @ 64—78 N (14—18 lb-force)
	Free Length	44.0 mm (1.73 in.)
Oil Filter Bypass Valve Plug	Torque	100 N•m (74 lb-ft)

[1]Oil pressure with oil sump temperature of 105° C (220° F).

[2]Use new, stronger grade cap screws when reinstalling oil pressure regulating valve housing.

[3]Refer to REMOVE, INSPECT AND INSTALL ENGINE OIL COOLER, later in this group for cap screw tightening sequence.

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DPSG,OUO1004,847 –19–27APR99–1/3

Item	Measurement	Specification
Oil Filter Bypass Valve	Operating Pressure	220 kPa (2.20 bar) (32 psi)
Oil Cooler Bypass Valve Spring	Compressed Length	30.0 mm (1.18 in.) @ 64—78 N (14—18 lb-force)
	Free Length	44.0 mm (1.73 in.)
Oil Cooler Bypass Valve Plug	Torque	100 N•m (74 lb-ft)
Oil Cooler Bypass Valve	Operating Pressure	220 kPa (2.20 bar) (32 psi)
Crankshaft Helical Gear-to-Oil Pump Drive Gear	Backlash	0.08 mm (0.003 in.) minimum
Crankshaft Spur Gear-to-Oil Pump Drive Gear	Backlash	0.10 mm (0.004 in.) minimum
Oil pump gear-to-crankshaft throw	Clearance	0.38 mm (0.0015 in.)
Oil Pump Drive Shaft	Maximum End Play	0.15 mm (0.006 in.)
Oil Pump Drive Shaft	Maximum Side Movement	0.17 mm (0.0065 in.)
Oil Pump Drive Gear	Backlash	0.33—2.00 mm (0.013—0.079 in.)
Oil Pump Cover-to-Housing	Torque	41 N•m (30 lb-ft)
Oil Pump Set Screw Lock Nut	Torque	8 N•m (6 lb-ft)
Oil Pump Intake (Pickup) Tube-to-Cover	Torque	47 N•m (35 lb-ft)
Oil Pump Housing-To-Cylinder Block	Torque	42 N•m (31 lb-ft)
Oil Pump Drive Gear Retaining Nut	Torque	54 N•m (40 lb-ft)
Oil Pump Outlet and Oil Cooler Cross-Over Tube-to-Cylinder Block Adapter (Internal)	Torque	54 N•m (40 lb-ft)
Oil Pump Pickup Tube Cap Screws	Torque	41 N•m (30 lb-ft)
Oil Pan 1/2 in. Cap Screws[4]	Torque	156 N•m (115 lb-ft)

[4] *See INSTALL ENGINE OIL PAN later in this group, for cap screw tightening sequence.*

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DPSG,OUO1004,847 –19–27APR99–2/3

Item	Measurement	Specification
Oil Pan 3/8 in. Cap Screws[4]	Torque	68 N•m (50 lb-ft)
Oil Pan Drain Plug Aluminum Pans	Torque	101 N•m (75 lb-ft)
Oil Pan Elbow Lock Nut	Torque	81 N•m (60 lb-ft)
Front Frame/Oil Sump (8000 Tractors) 1/2 in. Cap Screws[5]	Torque	133 N•m (98 lb-ft)
Front Frame/Oil Sump (8000 Tractors) 3/8 in. Cap Screws[5]	Torque	58 N•m (43 lb-ft)
Oil Pan Drain Plug Cast Iron Pans (Sumps)	Torque	47 N•m (35 lb-ft)

[4]See INSTALL ENGINE OIL PAN later in this group, for cap screw tightening sequence.

[5]See TIGHTEN CAP SCREWS ON FRONT FRAME/OIL SUMP (8000 SERIES TRACTORS) later in this group, for cap screw tightening sequence.

DPSG,OUO1004,847 –19–27APR99–3/3

Group 070 — Cooling System Repair Specifications

Item	Measurement	Specification
Adjustable Fan Drive Housing	ID	71.999—72.025 mm (2.8346—2.8356 in.)
Adjustable Fan Drive Shaft	OD	35.001—35.017 mm (1.3780—1.3786 in.)
Adjustable Fan Drive Bearing	ID.	34.987—35.013 mm (1.3774—1.3785 in.)
	OD	71.987—72.013 mm (2.8341—2.8351 in.)
Adjustable Fan Drive Shaft	End Play	0.10 mm (0.004 in.)
Adjustable Fan Drive Housing Seal	Depth	Flush-to-0.50 mm (0.020 in.) below housing face
Fan/Hub Pulley-to-Fan Spacer Cap Screws	Torque	60 N•m (45 lb-ft)
Fan Hub/Pulley-to-Fan Shaft	Torque	80 N•m (60 lb-ft)
Fan Drive Support Plate-to-Engine		
5/16-in. Mounting Cap Screws (To Injection Pump Access Cover)	Torque	24 N•m (18 lb-ft)
5/16-in. Mounting Cap Screws (All Others)	Torque	35 N•m (26 lb-ft)
3/8-in. Mounting Cap Screws	Torque	61 N•m (45 lb-ft)
1/2-in. Mounting Cap Screws	Torque	101 N•m (74 lb-ft)
Coolant Manifold-Mounted Fixed Fan Drive Specifications		
Fixed Fan Drive Shaft	OD	25.387—25.400 mm (0.9995—1.0000 in.)
Fixed Fan Drive Bearing	OD	47.612—47.625 mm (1.8745—1.8750 in.)

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DPSG,OUO1004,850 –19–27APR99–1/3

Item	Measurement	Specification
Fixed Fan Drive Pulley (Bearing End)	ID	47.576—47.612 mm (1.8731—1.8745 in.)
Fixed Fan Drive Pulley (Fan Spacer End)[1]	ID	49.485—49.518 mm (1.9482—1.9495 in.)
Fan Spacer[1]	O.D.	49.457—49.483 mm (1.9471—1.9481 in.)
Fixed Fan Drive Manifold	I.D.	25.336—25.362 mm (0.9975—0.9985 in.)
Fixed Fan Drive Shaft (Installed)	Dimension From Manifold Mounting Face to End of Shaft	32.51—32.77 mm (1.280—1.290 in.)
Adjustable Fan Drive Housing Seal	Depth	Flush-to-0.50 mm (0.020 in.) below housing face
Fixed Fan Drive Bearing Shaft	Depth	33.31—33.57 mm (1.311—1.322 in.) below manifold mounting surface
Fixed Fan Drive (Coolant Manifold Mounted) Cap Screws	Torque	60 N•m 45 (lb-ft)
Belt Tensioner Spring	Tension	24-28 N•m (17-21 lb-ft)
Fan-to-Fan Hub/Pulley	Torque	47 N•m (35 lb-ft)
Coolant Pump Cover Mounting Cap Screws		
5/16-in. Mounting Cap Screws	Torque	27 N•m (20 lb-ft)
3/8-in. Cap Screws	Torque	47 N•m (35 lb-ft)
Thermostat 82°C (180°F)	Opening Temperature	80—84°C (175—182°F)
Cast Iron Thermostat Cover-to-Cylinder Head	Torque	47 N•m (35 lb-ft)

[1]*Units with press-fit fan spacer only.*

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DPSG,OUO1004,850 –19–27APR99–2/3

Item	Measurement	Specification
Aluminum Thermostat Cover-to-Cylinder Head	Torque	30 N•m (22 lb-ft)
Coolant Manifold-to-Cylinder Head Cap Screws	Torque	35 N•m (25 lb-ft)
Coolant Temperature Switch	Torque	45 N•m (33 lb-ft)

DPSG,OUO1004,850 –19–27APR99–3/3

Group 080 — Air Intake and Exhaust System Repair Specifications

Item	Measurement	Specification
Turbocharger Shaft	Radial Bearing Clearance (Allowable Movement)	0.13—0.18 mm (0.005—0.007 in.)
Turbocharger Shaft	Axial Bearing End Play	0.064—0.114 mm (0.0025—0.0045 in.)
Turbocharger Wastegate	Actuator End Play	0.05—0.056 mm (0.002-0.022 in.)
Turbocharger-to-Exhaust Manifold Cap Screws	Torque	24 N•m (18 lb-ft)
Turbocharger Oil Return Line	Torque	34 N•m (25 lb-ft)
Exhaust Manifold-to-Cylinder Head Cap Screws (6081HRW Engines)	Torque	80 N•m (60 lb-ft)
Exhaust Manifold-to-Cylinder Head Cap Screws (All Other Engines)	Torque	47 N•m (35 lb-ft)
Intake Manifold-to-Cylinder Head	Torque	47 N•m (35 lb-ft)
Aftercooler Cover-to-Intake Manifold	Torque	34 N•m (25 lb-ft)
Aftercooler Cover-to-Intake Manifold	Torque	34 N•m (25 lb-ft)
Aftercooler Assembly-to-Cylinder Head	Torque	47 N•m (35 lb-ft)

DPSG,OUO1004,853 –19–28APR99–1/1

Group 100 — OEM Starting and Charging Systems Repair Specifications

Item	Measurement	Specification
Alternator Mounting Hardware (Upper)	Torque	27 N•m (20 lb-ft)
Alternator Mounting Hardware (Lower)	Torque	80 N•m (60 lb-ft)
Alternator Mounting Bracket and Strap Hardware		
Alternator Adjusting Strap-to-Thermostat Housing (7/8 in. long) Cap Screws	Torque	35 N•m (26 lb-ft)
Alternator Adjusting Strap-to-Thermostat Housing (2 in. long) Cap Screws	Torque	61 N•m (45 lb-ft)
Alternator Front Support-to-Alternator Rear Support (1-3/4 in. long) Cap Screws	Torque	61 N•m (45 lb-ft)
Alternator Bracket-to-Alternator Support (1 in. and 1-1/4 in. long) Cap Screws	Torque	35 N•m (26 lb-ft)
Alternator Support-to-Thermostat Housing (1 in. and 1-1/4 in. long) Cap Screws	Torque	61 N•m (45 lb-ft)
Starter Motor Mounting Hardware (Upper)	Torque	44 N•m (33 lb-ft)
Starter Motor Mounting Hardware (Lower)	Torque	27 N•m (20 lb-ft)

DPSG,OUO1004,858 –19–28APR99–1/1

Group 150 — Base Engine Diagnostic Specifications (Includes Dynamometer Specifications (OEM) and Turbocharger Boost Specifications)

Engine Compression Pressure

NOTE: Pressure given was taken at 300 m (1000 ft) above seal level. A 3.6% reduction in gauge pressure will result for each additional 300 m (1000 ft) above sea level.

	Specification
ENGINE COMPRESSION PRESSURE—Compression Pressure	2,380—2,790 kPa (23.8—27.9 bar) (345—405 psi)

rs within engine should have approximately the same pressure. There should be less than 340 kPa (3.4 bar) (50 psi) difference between cylinders.

Oil Pressure

	Specification
OIL PRESSURE SPECIFICATIONS—Minimum No Load at 850 rpm (Slow Idle)	138 kPa (1.38 bar) (20 psi)
Maximum Full Load at 2200 rpm (Rated Speed)	400 kPa (4.0 bar) (58 psi)

Turbocharger Wastegate Actuator

NOTE: The specifications below are the air pressures required to move the actuator on the wastegate.

TURBOCHARGER WASTEGATE ACTUATOR PRESSURE SPECIFICATION

Engine Model Number	Pressure Applied to Actuator
6081AT001	144.28 kPa (14.4 bar) (20.92 psi)
6081HDW04	144.28 kPa (14.4 bar) (20.92 psi)
6081HDW05	144.28 kPa (14.4 bar) (20.92 psi)
6081HDW01	184.83 kPa (18.5 bar) (26.8 psi)
6081HT001	193.10 kPa (19.3 bar) (28.0 psi)

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DPSG,RG40854,702 –19–02AUG00–1/2

Thermostat

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)

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Dynamometer Test Specifications

Power ratings for various injection pump options are provided for OEM applications on the charts that follow. For Construction Equipment applications, refer to SP458 Specifications Handbook. For North American Agricultural applications, refer to DB1216 Specifications Handbook.

NOTE: The power specifications shown apply to Waterloo-built OEM engines. Specifications are subject to change. Refer to factory DTAC for assistance.

Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset depending upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.

Power ratings specify flywheel power without fan or accessories such as air compressor.

If specifications are not listed in handbooks, refer to factory DTAC for assistance.

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POWER RATINGS ON DYNAMOMETER FOR OEM ENGINES[1]							
Engine Model	**Injection Pump Option Code**	**Injection Pump (Part No.)**	**Injection Pump Supplier**	**Governor Regulation**	**Rated Speed[2] (rpm)**	**Fast Idle[3] (rpm)**	**Power Rating kW (BHP)**
6081AF001	1601	RE502438	Bosch	STD	2200	2420	149 (200)
	1602	RE502438	Bosch	STD	2200	2420	149 (200)
	1603	RE66449	Bosch	3-5%	1500	1575	182 (244)
	1604	RE66456	Bosch	3-5%	1500	1575	182 (244)
	1605	RE66456	Bosch	3-5%	1500	1575	182 (244)
	1606	RE502439	Bosch	STD	2200	2420	149 (200)
	1607	RE66450	Bosch	3-5%	1500	1575	219 (292)
	1608	RE66457	Bosch	3-5%	1500	1575	219 (292)
	1609	RE66457	Bosch	3-5%	1500	1575	219 (293)
	1610	RE62642	Bosch	STD	2200	2420	187 (250)
	1611	RE66243	Bosch	STD	2200	2420	205 (275)
	1612	RE62644	Bosch	3-5%	1800	1890	205 (275)
	1613	RE501785	Bosch	STD	2200	2420	205 (275)[4]
	1615	RE501785	Bosch	STD	2200	2420	205 (275)[4]
	1616	RE503346	Bosch	Electronic	2200	2420	159 (213)[4]
					2200	2420	187 (250)[4]
	1617	RE66244	Bosch	STD	2200	2420	168 (225)[4]
					2200	2420	205 (275)
	1618	RE63766	Bosch	STD	2200	2420	187 (250)
	1619	RE63767	Bosch	3-5%	1800	1870	168 (225)
					2200	2420	205 (275)
	1620	RE501786	Bosch	STD	2200	2420	205 (275)[4]
	1621	RE503345	Bosch	Electronic	2200	2420	175 (235)[4]
					2200	2420	205 (275)[4]
	1622	RE64162	Bosch	3-5%	1800	1890	224 (300)
	1623	RE64214	Bosch	3-5%	1800	1890	224 (300)
	1624	RE64214	Bosch	3-5%	1800	1890	224 (300)
	1632	RE503346	Bosch	Electronic	2200	2420	187 (250)[4]
	1633	RE503348	Bosch	Electronic	2200	2420	205 (275)[4]
	1634	RE503346	Bosch	Electronic	2200	2420	187 (250)[4]
	1635	RE503348	Bosch	Electronic	2200	2420	205 (275[4])
	1640	RE62642	Bosch	STD	2200	2420	187 (250)[4]
	1641	RE503346	Bosch	Electronic	2200	2420	187 (250)[4]
	1642	RE503348	Bosch	Electronic	2200	2420	205 (275)[4]
	1643	RE503346	Bosch	Electronic	2200	2420	187 (250)[4]
	1644	RE503346	Bosch	Electronic	2200	2420	205 (275)[4]
	1645	RE503346	Bosch	Electronic	2200	2420	187 (250)[4]
	1646	RE503346	Bosch	Electronic	2200	2420	187 (250)[4]
	1647	RE503346	Bosch	Electronic	2200	2420	187 (250)[4]
	1648	RE503346	Bosch	Electronic	2200	2420	187 (250)[4]
	1649	RE503346	Bosch	Electronic	2200	2420	187 (250)[4]
	1650	RE503346	Bosch	Electronic	2200	2420	187 (250)[4]
	1651	RE503348	Bosch	Electronic	2200	2420	205 (275)[4]
	1652	RE503348	Bosch	Electronic	2200	2420	205 (275)[4]
	1653	RE503348	Bosch	Electronic	2200	2420	205 (275)[4]
	1654	RE503348	Bosch	Electronic	2200	2420	205 (275)[4]
	1655	RE503348	Bosch	Electronic	2200	2420	205 (275)[4]
	1656	RE503348	Bosch	Electronic	2200	2420	168 (225)[4]
					2200	2420	205 (275)
	1657	RE66243	Bosch	Electronic	2200	2420	205 (275)[4]
	1658	RE503348	Bosch	Electronic	2200	2420	205 (275)[4]

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POWER RATINGS ON DYNAMOMETER FOR OEM ENGINES[1]							
Engine Model	**Injection Pump Option Code**	**Injection Pump (Part No.)**	**Injection Pump Supplier**	**Governor Regulation**	**Rated Speed[2] (rpm)**	**Fast Idle[3] (rpm)**	**Power Rating kW (BHP)**
	1659	RE503348	Bosch	Electronic	2200	2420	205 (275)[4]
	1660	RE503175	Bosch	Electronic	2200	2420	187 (250)[4]
	1661	RE503346	Bosch	Electronic	2200	2420	187 (250)
	1662	RE503346	Bosch	Electronic	2200	2420	187 (250)
	1663	RE503346	Bosch	Electronic	2200	2420	187 (250)
	1664	RE503346	Bosch	Electronic	2200	2420	187 (250)
	1665	RE503346	Bosch	Electronic	2200	2420	187 (250)
	1666	RE503346	Bosch	Electronic	2200	2420	187 (250)
	1667	RE503346	Bosch	Electronic	2200	2420	205 (275)
	1668	RE503348	Bosch	Electronic	2200	2420	205 (275)
	1669	RE503348	Bosch	Electronic	2200	2420	205 (275)
	1670	RE503348	Bosch	Electronic	2200	2420	205 (275)
	1671	RE503348	Bosch	Electronic	2200	2420	205 (275)
	1672	RE503348	Bosch	Electronic	2200	2420	205 (275)
	1673	RE506419	Motorpal	STD	2200	2420	168 (225)
	1674	RE506419	Motorpal	STD	2200	2420	168 (225)
	1676	RE62644	Bosch	3-5%	1800	1890	187 (250)
					2200	2420	205 (275)
	1681	RE502806	Bosch	STD	2100	2320	205 (275)
	1682	RE503822	Bosch	3-5%	1700	1890	258 (344)
	1683	RE503822	Bosch	3-5%	1700	1890	258 (344)
	1684	RE503823	Bosch	3-5%	1700	1890	258 (344)
	1685	RE505672	Bosch	3-5%	1500	1560	225 (300)
	1686	RE505672	Bosch	3-5%	1500	1560	225 (300)
	1687	RE503823	Bosch	3-5%	1500	1560	225 (300)
	1688	RE506543	Bosch	STD	2200	2420	205 (273)
6081HF001	1601	RE62686	Bosch	STD	2200	2420	224 (300)[4]
	1602	RE62686	Bosch	STD	2200	2420	224 (300)[4]
	1603	RE62687	Bosch	3-5%	1800	1890	240 (320)
	1604	RE62687	Bosch	3-5%	1800	1890	240 (320)
	1605	RE63769	Bosch	STD	2200	2420	224 (300)[4]
	1606	RE63770	Bosch	3-5%	1800	1890	240 (320)
	1621	RE503345	Bosch	Electronic	2200	2420	190 (255)[4]
					2200	2420	224 (300)[4]
	1622	RE66458	Bosch	3-5%	1500	1575	200 (267)
	1623	RE66458	Bosch	3-5%	1500	1575	200 (267)
	1624	RE66451	Bosch	3-5%	1500	1560	200 (267)
					1500	1560	245 (328)
	1633	RE503345	Bosch	Electronic	2200	2420	224 (300)[4]
	1639	RE503345	Bosch	Electronic	2200	2420	224 (300)[4]
	1640	RE503345	Bosch	Electronic	2200	2420	224 (300)[4]
	1641	RE503345	Bosch	Electronic	2100	2420	224 (300)[4]
	1642	RE503345	Bosch	Electronic	2100	2420	224 (300)[4]
	1643	RE503345	Bosch	Electronic	2100	2420	224 (300)[4]
	1644	RE503345	Bosch	Electronic	2100	2420	224 (300)[4]
	1645	RE503345	Bosch	Electronic	2100	2420	224 (300)[4]
	1646	RE503345	Bosch	Electronic	2100	2420	224 (300)[4]
	1647	RE503345	Bosch	Electronic	2100	2420	224 (300)[4]
	1648	RE503345	Bosch	Electronic	2100	2420	224 (300)[4]
	1661	RE503812	Bosch	3-5%	1500	1575	255 (342)
	1662	RE503812	Bosch	3-5%	1500	1575	255 (342)

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POWER RATINGS ON DYNAMOMETER FOR OEM ENGINES[1]							
Engine Model	**Injection Pump Option Code**	**Injection Pump (Part No.)**	**Injection Pump Supplier**	**Governor Regulation**	**Rated Speed[2] (rpm)**	**Fast Idle[3] (rpm)**	**Power Rating kW (BHP)**
	1663	RE503813	Bosch	3-5%	1500	1575	255 (342)
	1680	RE501861	Bosch	STD	2100	2320	224 (300)
	1681	RE505670	Bosch	3-5%	1800	1890	263 (353)
	1682	RE505670	Bosch	3-5%	1800	1890	263 (353)
	1683	RE505475	Bosch	3-5%	1800	1890	263 (353)
	1684	RE503812	Bosch	3-5%	1500	1575	268 (357)
	1685	RE505670	Bosch	3-5%	1500	1575	225 (302)
	1686	RE503812	Bosch	3-5%	1500	1575	268 (359)
	1687	RE505670	Bosch	3-5%	1800	1890	308 (413)
	1688	RE503345	Bosch	Electronic	2200	2420	224 (300)
	1689	RE503345	Bosch	Electronic	2200	2420	224 (300)
	1690	RE503345	Bosch	Electronic	2200	2420	224 (300)
	1691	RE503345	Bosch	Electronic	2200	2420	224 (300)
	1692	RE503345	Bosch	Electronic	2200	2420	224 (300)
	1693	RE503345	Bosch	Electronic	2200	2420	224 (300)
6081TF001	1601	RE66241	Bosch	STD	2200	2420	149 (200)
	1602	RE66241	Bosch	STD	2200	2420	149 (200)
	1603	RE62837	Denso	3-5%	1800	1890	157 (210)
	1604	RE62837	Denso	3-5%	1800	1890	157 (210)
	1605	RE66242	Bosch	STD	2200	2420	157 (210)
	1606	RE63750	Denso	3-5%	1800	1890	157 (210)
					2200	2420	149 (200)
	1608	RE66459	Denso	3-5%	1500	1575	131 (175)
					1500	1575	187 (250)
	1609	RE66459	Denso	3-5%	1500	1575	131 (175)
					1500	1575	187 (250)
	1610	RE66448	Denso	3-5%	1500	1575	131 (175)
	1611	RE501016	Denso	STD	2200	2420	128 (171)
					2200	2420	168 (225)
	1612	RE501016	Denso	STD	2200	2420	128 (171)
	1613	RE501198	Denso	STD	2200	2420	128 (171)
	1614	RE505268	Bosch	3-5%	1800	1890	194 (260)
	1615	RE505268	Bosch	3-5%	1800	1890	194 (260)
	1616	RE505269	Bosch	3-5%	1800	1890	194 (260)
	1617	RE506416	Motorpal	STD	2200	2420	149 (200)
	1618	RE506416	Motorpal	STD	2200	2420	149 (200)
	1619	RE505486	Bosch	3-5%	1500	1575	169 (227)
	1620	RE505671	Bosch	3-5%	1500	1575	169 (227)
	1621	RE505671	Bosch	3-5%	1500	1575	169 (227)
6081HF070	166A	RE501640	Denso	HPCR	2200	2350	242 (325)[4]
	166B	RE508233	Denso	HPCR	2200	2350	242 (325)[4]
	166C	RE501640	Denso	HPCR	2200	2350	242 (325)[4]
	166D	RE508233	Denso	HPCR	2200	2350	242 (325)[4]
	166E	RE501640	Denso	HPCR	2200	2350	242 (325)[4]
	166F	RE508233	Denso	HPCR	2200	2350	242 (325)[4]
	166G	RE501640	Denso	HPCR	2200	2350	242 (325)[4]
	166H	RE508233	Denso	HPCR	2200	2350	242 (325)[4]
	16GA	RE501640	Denso	HPCR	1000	1800	259 (347)
	16GB	RE508233	Denso	HPCR	1800	1800	259 (347)
	16GC	RE501640	Denso	HPCR	1800	1800	259 (347)
	16GD	RE508233	Denso	HPCR	1800	1800	259 (347)

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POWER RATINGS ON DYNAMOMETER FOR OEM ENGINES[1]

Engine Model	Injection Pump Option Code	Injection Pump (Part No.)	Injection Pump Supplier	Governor Regulation	Rated Speed[2] (rpm)	Fast Idle[3] (rpm)	Power Rating kW (BHP)
	16JA	RE501640	Denso	HPCR	1800	1800	308 (413)
	16JB	RE508233	Denso	HPCR	1800	1800	308 (413)
	16JC	RE501640	Denso	HPCR	1800	1800	308 (413)
	16JD	RE508233	Denso	HPCR	1800	1800	308 (413)

[1] Engine speeds listed are preset to factory specification for application. Therefore, speeds may vary depending upon specific vehicle application requirements. Refer to your machine operator's manual for engine speeds that are different from those preset at the factory.
[2] Generator set engines (3-5% governor) usually run at 1500 rpm (50 Hz) or 1800 (60 Hz) when operating under load depending on cycles of AC current.
[3] For engines with standard governor, fast idle is 7-10% above rated speed. For engines with generator set governors, fast idle is 3-5% above rated speed.
[4] These engines have a 7% power bulge which allows for INTERMITTENT operation of 7% above rated power.

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Intake Manifold Pressure (Turbocharger Boost) Specifications

TURBO BOOST PRESSURES (JOHN DEERE AGRICULTURAL EQUIPMENT)					
Machine Model	**Engine Model**	**Injection Pump Part #**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
Des Moines					
9976 Cotton Picker	RG6081HN001	RE61658	219 (294)	2200	183—200 kPa (1.83—2.00 bar) (26—29 psi)
	RG6081HN003	RE501867	240 (321)	2200	200—245 kPa (2.00—2.45 bar) (29—36 psi)
9970 Cotton Picker	RG6081AN001	RE500742	187 (251)	2200	135—165 kPa (1.35—1.65 bar) (19—24 psi)
9986 Cotton Picker	RG6081HN003	RE507692	244 (328)	2200	200—245 kPa (2.00—2.45 bar) (29—36 psi)
4920 Sprayer	RG6081HN005 (Tier II)	RE518423	224 (300)	2200	162—198 kPa (1.62—1.98 bar) (23—29 psi)
Harvester					
9510 Low Power Combine	RG6081HH001	RE62645	167 (223)	2200	106—130 kPa (1.06—1.30 bar) (15—19 psi)
		RE61658	207 (278)	2200	184—226 kPa (1.84—2.26 bar) (26—33 psi)
9510 High Power Combine	RG6081HH002	RE62645	182 (244)	2200	122—150 kPa (1.22—1.50 bar) (17—22 psi)
9610 /CTSII/CTSIIE(98) Combine	RG6081HH003	RE61658	206 (276)	2200	136—167 kPa (1.36—1.67 bar) (19—25 psi)
		RE62645	187 (251)	2200	149—183 kPa (1.49—1.83 bar) (21—27 psi)
CTSIIE(99)	RG6081HH004	RE501867	240 (321)	2200	203—249 kPa (2.03—2.49 bar) (29—36 psi)
		RE61658	240 (321)	2200	183—225 kPa (1.83—2.25 bar) (27—33 psi)
9750STS Combine	RG6081HH005	RE501867	240 (321)	2200	197—241 kPa (1.97—2.41 bar) (29—35 psi)
9650STS Combine	RG6081HH006	RE61658	224 (300)	2200	158—194 kPa (1.58—1.94 bar) (23—28 psi)
Amadus Peanut Combine	RG6081HH007	RE62645	181 (243)	2200	124—152 kPa (1.24—1.52 bar) (18—22 psi)
Amadus Peanut Combine	RG6081HH022	RE507687	183 (245)	2200	124—152 kPa (1.24—1.52 bar) (18—22 psi)
9550 Low Power Combine	RG6081HH008	RE503876	173 (232)	2200	171—211 kPa (1.71—2.11 bar) (25—31 psi)
9550 Low Power Combine	RG6081HH020 (Tier I)	RE507687	173 (232)	2200	171—211 kPa (1.71—2.11 bar) (25—31 psi)

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TURBO BOOST PRESSURES (JOHN DEERE AGRICULTURAL EQUIPMENT)					
Machine Model	**Engine Model**	**Injection Pump Part #**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
		RE503347	173 (232)	2200	171—211 kPa (1.71—2.11 bar) (25—31 psi)
9550 High Power Combine	RG6081HH009	N/A[a]	183 (245)	2200	122—150 kPa (1.22—1.50 bar) (18—22 psi)
9550 High Power Combine	RG6081HH021	RE507687	183 (245)	2200	122—150 kPa (1.22—1.50 bar) (18—22 psi)
9650 Combine	RG6081HH010	RE503345	210 (281)	2200	172—211 kPa (1.72—2.11 bar) (25—31 bar)
		RE61658	210 (281)	2200	136—167 kPa (1.36—1.67 bar) (20—24 psi)
9650CTS Combine	RG6081HH010	RE503345	210 (281)	2200	172—211 kPa (1.72—2.11 bar) (25—31 psi)
		RE61658	210 (281)	2200	136—167 kPa (1.36—1.67 bar) (20—24 psi)
9650CTSE Combine	RG6081HH011	RE507692	242 (324)	2200	207—254 kPa (2.07—2.54 bar) (30—37 psi)
9560STS Combine	RG6081HH019	RE518423	202 (271)	2200	136—167 kPa (1.36—1.67 bar) (20—24 psi)
9560 Low Power Combine	RG6081HH054	RE518423	173 (232)	2200	149—183 kPa (1.49—1.83 bar) (21—27 psi)
9560 High Power Combine	RG6081HH055	RE518423	183 (245)	2200	149—183 kPa (1.49—1.83 bar) (21—27 psi)
9650/9660STS Combine	RG6081HH013	RE518423	221 (296)	2200	162—198 kPa (1.62—1.98 bar) (23—29 psi)
9660/96600CTS Combine	RG6081HH017	RE518423	214 (287)	2200	162—198 kPa (1.62—198 bar) (23—29 psi)
9750STS/9760STS Combine (Tier II)	RG6081HH012	RE518423	245 (328)	2200	192—235 kPa (1.92—2.35 bar) (28—34 psi)
Zweibrucken, Germany					
2056 Combine	RG6081HZ003	RE62646	169 (226)	2200	123—151 kPa (1.23—1.51 bar) (17—22 psi)
2256 Combine	RG6081HZ007	RE501996	174 (234)	2200	128—158 kPa (1.28—1.58 bar) (18—23 psi)
2258/2058 Combine	RG6081HZ005	RE67359	188 (252)	2200	135—165 kPa (1.35—1.65 bar) (19—24 psi)
2264/2064 Combine	RG6081HZ002	RE62647	201 (270)	2200	149—183 kPa (1.49—1.83 bar) (21—27 psi)
2266/2066 Combine	RG6081HZ001	RE67358	212 (284)	2200	162—198 kPa (1.62—1.98 bar) (23—29 psi)
		RE62686	224 (300)	2200	176—216 kPa (1.76—2.16 bar) (25—32 psi)
[a]N/A = Not Available at time of publication					

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TURBO BOOST PRESSURES (JOHN DEERE AGRICULTURAL EQUIPMENT)					
Machine Model	**Engine Model**	**Injection Pump Part #**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
		RE61658	207 (278)	2200	157—193 kPa (1.57—1.93 bar) (22—28 psi)
		RE57373	207 (278)	2200	157—193 kPa (1.57—1.93 bar) (22—28 psi)
2268 Combine	RG6081HZ006	RE501867	233 (312)	2200	192—235 kPa (1.92—2.35 bar) (28—34 psi)
9560/9560HM Combine	RG6081HZ008	RE518423	183 (245)	2200	154—193 kPa (1.54—1.93 bar) (22—28 psi)
9580/9580HM & 9640/9640HM Combine	RG6081HZ009	RE518423	203 (272)	2200	154—193 kPa (1.54—1.93 bar) (22—28 psi)
9680/9680HM & 9780/9780HM Combine	RG6081HZ011	RE518423	244 (317)	2200	192—235 kPa (1.92—2.35 bar) (28—34 psi)
9780/9780HM Combine	RG6081HZ012	RE518423	224 (300)	2200	176—216 kPa (1.76—2.16 bar) (25—32 psi)
9850/9850HM & 9640/9640HM Combines	RG6081HZ017 (replaces HZ009)	RE518423	219 (294)	2200	176—216 kPa (1.76—2.16 bar) (25—32 psi)
9680/9680HM & 9780/9780HM Combines	RG6081HZ019 (replaces HZ011 & HZ012	RE518423	257 (335)	2200	192—235 kPa (1.92—2.35 bar) (28—34 psi)
9660/9660HM Combine	RG6081HZ018 (replaces HZ010)	RE518423	234 (314)	2200	192—235 kPa (1.92—2.35 bar) (28—34 psi)
6650 Self-Propelled Forage Harvester	RG6081HZ004	RE61658	223 (299)	2100	171—209 kPa (1.71—2.09 bar) (24—31 psi)
7200 Self Propelled Forage Harvester	RG6081HZ013 (European Version)	RE518423	224 (300)	2100	171—209 kPa (1.71—2.09 bar) (24—31 psi)
	RG6081HZ016 (North American Version	RE518423	226 (303)	2100	171—209 kPa (1.71—2.09 bar) (24—31 psi)
Horizontina, Brazil					
1185A Combine	RG6081ACQ01	RE66243	168 (225)	2200	153—188 kPa (1.53—1.88 bar) (22—27 psi)

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TURBO BOOST PRESSURES (JOHN DEERE AGRICULTURAL EQUIPMENT) CONTINUED					
Machine Model	**Engine Model**	**Injection Pump Part #**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
Waterloo					
7710 Tractors	RG6081TRW01, 03, 05, 07, 09	RE507685	124 (165)	2100	100—124 kPa (1.00—1.24 bar) (14—18 psi)
7810 Tractors	RG6081TRW02, 04, 06, 08, 10	RE507685	135 (181)	2100	121—149 kPa (1.21—1.49 bar) (17—22 psi)
7820 Tractors	RG6081HRW41	RE518423 Hi Pressure Pump	140 (188)	2100	111—154 kPa (1.11—1.54 bar) (16—22 psi)
7920 Tractor	RG6081HRW42	RE518423 Hi Pressure Pump	152 (204)	2100	120—162 kPa (1.20—1.62 bar) (17—23 psi)
8100/8100T Tractor	RG6081HRW06, 10	RE67771	141 (189)	2200	110—136 kPa (1.10—1.36 bar) (16—20 psi)
8110/8110T Tractor	RG6081HRW11, 12	RE501859	152 (203)	2200	117—144 kPa (1.17—1.44 bar) (17—21 psi)
8200/8200T Tractor	RG6081HRW02, 07	RE62645	159 (213)	2200	121—149 kPa (1.21—1.49 bar) (17—22 psi)
8210/8210T Tractor	RG6081HRW13, HRW14	RE501859	168 (226)	2200	133—163 kPa (1.33—1.63 bar) (19—24 psi)
8120/8220 Wheel & Track Tractor	RG6081HRW23	RE518423	153/171 (205/229)	2200	138—190 kPa (1.38—1.90 bar) (20—28 psi)
8300/8300T Tractor	RG6081HRW08, 09	RE62645	176 (236)	2200	135—166 kPa (1.35—1.66 bar) (19—24 psi)
8310/8310T Tractor	RG6081HRW15, 16	RE501859	190 (255)	2200	159—195 kPa (1.59—1.95 bar) (23—28 psi)
8320 Wheels/Tracks, and FSA (Front Suspended Axle)Tractor - N/A and Region II	RG6081HRW25, 33, 34	RE518423	193 (259)	2200	159—195 kPa (1.59—1.95 bar) (23—28 psi)
8400/8400T Tractor	RG6081HRW01, 03, 04	RE61658	195 (261)	2200	140—172 kPa (1.40—1.72 bar) (20—25 psi)
8410/8410T Tractor	RG6081HRW17, 18	RE501676	212 (284)	2200	156—191 kPa (1.56—1.91 bar) (23—28 psi)
8420 Wheels/Tracks & FSA Region II and N/A Tractors	RG6081HRW27, 35, 36	RE518423	209 (280)	2200	See Above
8420W CIS (Commonwealth of Independent States) Tractor	RG6081HRW26	RE507691 (Bosch P7100)	209 (279)	2200	See Above

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TURBO BOOST PRESSURES (JOHN DEERE AGRICULTURAL EQUIPMENT) CONTINUED					
Machine Model	**Engine Model**	**Injection Pump Part #**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
8520 Region II Quad Link Suspension Tractor	RG6081HRW38	RE518423	224 (300)	2200	156—198 kPa (1.56—1.98 bar) (23—29 psi)
9100 Tractor	RG6081HRW05	RE61658	191 (256)	2100	144—176 kPa (1.44—1.76 bar) (20—26 psi)
9120 Tractor	RG6081HRW30 (Tier II)	RE518423	213 (286)	2100	156—191 kPa (1.56—1.91 bar) (23—28 psi)

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TURBO BOOST PRESSURES (JOHN DEERE CONSTRUCTION EQUIPMENT)					
Machine Model	**Engine Model**	**Injection Pump Part #**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
Davenport					
740G/748G Skidder	RG6081TDW01	RE65102	128 (172)	2200	131—161 kPa (1.31—1.61 bar) (19—24 psi)
JD718/TJ560D Skidder	RG6081HTJ06 (Tier II)	RE518423	135 (181)	2200	See above
770CH/772CH Motor Grader	RG6081HDW01	RE68148	162 (217)	2000	154—190 kPa (1.54—1.90 bar) (22—28 psi)
770 C Motor Grader	RG6081HDW01	RE68148	162 (217)	2000	154—190 kPa (1.54—1.90 bar) (22—28 psi)
	RG6081HDW03	RE66421	122 (163)	2000	114—140 kPa (1.14—1.40 bar) (16—21 psi)
770/772 Grader	RG6081HDW10	RE507693	160 (214)	2200	114—140 kPa (1.14—1.40 bar) (16-21 psi
870 & 872 Motor Grader	RG6081HDW13	RE518807	177 (237)	2200	160—196 kPa (1.60—1.96 bar) (23—29 psi)
644G Loader	RG6081HDW04	RE66248	134 (179)	2200	113—139 kPa (1.13—1.39 bar) (16—20 psi)
	RG6081ADW01	RE64251	125 (167)	2100	111—137 kPa (1.11—1.37 bar) (16—20 psi)
644H Loader	RG6081HDW05	RE62645	166 (223)	1800	130—160 kPa (1.30—1.60 bar) (18—24 psi)
		RE62645	178 (238)	2200	160—196 kPa (1.60—1.96 bar) (23—29 psi)
644H/MH Loader	RG6081HDW06	RE62645	191 (257)	1800	141—173 kPa (1.41—1.73 bar) (20—25 psi)
		RE62645	178 (238)	2200	160—196 kPa (1.60—1.96 bar) (23—29 psi)
644H Loader	RG6081HDW08 (Tier II)	RE518807	134 (180)	2200	111—154 kPa (1.11—1.54 bar) (16—22 psi)
724J Loader	RG6081HDW09 (Tier II)	RE518807	153 (205)	2200	120—162 kPa (1.20—1.62 bar) (17—23 psi)
LX150 Loader	6081HDW70	RE62645	166 (223)	1800	130—160 kPa (1.30—1.60 bar) (18—24 psi)
		RE62645	150 (201)	2200	150—184 kPa (1.50—1.84 bar) (21—27 psi)
Dubuque & Bell Truck					
762B Scraper	RG6081AT001	RE66245	139 (187)	2100	138—170 kPa (1.38—1.70 bar) (20—25 psi)
850C Crawler	RG6081AT002	RE67448	132 (177)	2100	149—183 kPa (1.49—1.83 bar) (21—27 psi)
330LC/370 Excavator	RG6081HT001	RE71286	184 (247)	2000	162—198 kPa (1.62—1.98 bar) (23—29 psi)

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TURBO BOOST PRESSURES (JOHN DEERE CONSTRUCTION EQUIPMENT)					
Machine Model	**Engine Model**	**Injection Pump Part #**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
330CLC/370C Excavator	RG6081HT002 (Tier II)	RE518423	195 (261)	2000	154—198 kPa (1.54—1.98 bar) (22—29 psi)
250D/300D Articulated Dump Truck	RG6081HT004 (Tier I)	RE507686	190 (255)	2200	149—185 kPa (1.49—1.85 bar) (21—27 psi)
250D/300D Articulated Dump Truck (ADT)	RG6081HT005 (Tier II - replaces HT004)	RE518807	213 (285)	2200	156—191 kPa (1.56—1.91 bar) (22—28 psi)
L2006 & L2306 Loader	RG6081HT007 (Tier I)	RE507687	153 (203)	2200	111—149 kPa (1.11—1.49 bar) (16—21 psi)
Timberjack & Cameco					
530B/535Log Loader	RG6081ATJ01	RE62642	187 (251)	2200	162—198 kPa (1.62—1.98 bar (23—29 psi)
530B/535 Log Loader	RG6081ATJ03	RE504619	168 (225)	2200	120—162 kPa (1.20—1.62 bar) (17—23 psi)
660D Skidder	RG6081ATJ02	RE502438	149 (200)	2200	111—149 kPa (1.11—1.50 bar) (16—21 psi)
1710 Forwarder	RG6081HTJ02 (Tier II)	RE518423	160 (214)	2000	120—162 kPa (1.20—1.62 bar) (17—23 psi)
1270D Harvester	RG6081HTJ03	RE518423	160 (214)	2000	See above
1470D Harvester	RG6081HTJ04	Re518423	180 (241)	2000	149—183 kPa (1.49—1.83 bar) (21—27 psi)
850/950 Feller Buncher	RG6081HTJ05	RE518423	190 (255)	2000	154—198 kPa (1.54—1.98 bar) (22—29 psi)
608B Tracked Feller Buncher	RG6081HTJ07 (Tier II)	RE518423	135 (181)	2000	111—154 kPa (1.11—1.54 bar) (16—22 psi)
608S Timberjack & 753G and GL Tracked Feller Buncher	RG6081HTJ08 (Tier II)	RE518423	160 (215)	2000	135—170 kPa (1.35—1.70 bar) (19—25 psi)
2500 Cane Harvester	RG6081HT801 (Tier II)	RE518423	242 (325)	2200	192—235 kPa (1.92—2.35 bar) (28—34 psi)

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TURBO BOOST PRESSURES (JOHN DEERE OEM/OUTSIDE EQUIPMENT MANUFACTURERS)					
Engine Number	**Option Code**	**Injection Pump Part No.**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
RG6081AF001	1601, 1602	RE502438	149 (200)	2200	137—169 kPa (1.37—1.69 bar) (20—25 psi)
	1603	RE66449	157 (211)	1500	142—174 kPa (1.42—1.74 bar) (20—25 psi)
	1604, 1605	RE66456	157 (211)	1500	142—174 kPa (1.42—1.74 bar) (20—25 psi)
	1606	RE503430	149 (200)	2200	137—169 kPa (1.37—1.69 bar) (20—25 psi)
	1607	RE66450	187 (251)	1500	179—219 kPa (1.79—2.19 bar) (26—32 psi)
	1608, 1609	RE66457	187 (251)	1500	179—219 kPa (1.79—2.19 bar) (26—32 psi)
	1610	RE62642	187 (251)	2200	171—209 kPa (1.71—2.09 bar) (24—30 psi)
	1611	RE66243	168 (227)	2200	171—209 kPa (1.71—2.09 bar) (24—30 psi)
	1612, 1676	RE62644	187 (251)	1800	174—214 kPa (1.74—2.14 bar) (25—31 psi)
	1613	RE501785	205 (275)	2200	186—228 kPa (1.86—2.28 bar) (27—33 psi)
	1615	RE501785, RE62648	205 (275)	2200	186—228 kPa (1.86—2.28 bar) (27—33 psi)
	1617	RE66244	168 (227)	2200	171—209 kPa (1.71—2.09 bar) (24—30 psi)
	1618	RE63766	187 (251)	2200	171—209 kPa (1.71—2.09 bar) (24—30 psi)
	1619	RE63767	187 (251)	2200	174—214 kPa (1.74—2.14 bar) (25—31 psi)
	1620	RE501786, RE63768	205 (275)	2200	190—233 kPa (1.90—2.33 bar) (27—33 psi)
	1621	RE503345, RE507686, RE61658	Intermittent: 205 (275) Continuous: 174 (233)	2200	Intermittent: 190—234 kPa (1.90—2.34 bar) (27—34 psi) Continuous: N/A[a]
	1622	RE64162	224 (300)	1800	202—248 kPa (2.02—2.48 bar) (29—36 psi)
	1623, 1624	RE64214	224 (300)	1800	202—248 kPa (2.02—2.48 bar) (29—36 psi)

[a]N/A = Not Available at time of publication

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TURBO BOOST PRESSURES (JOHN DEERE OEM/OUTSIDE EQUIPMENT MANUFACTURERS)					
Engine Number	**Option Code**	**Injection Pump Part No.**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
	1633, 1635, 1642, 1651, 1652, 1653, 1654, 1655, 1656, 1658, 1659, 1662, 1668, 1669, 1670, 1671, 1672	RE503348, RE507696, RE66463	Intermittent: 205 (275) Continuous: 174 (233)	2200	Intermittent: 190—234 kPa (1.90—2.34 bar) (27—34 psi) Continuous: N/A[a]
	1640	RE62642, RE 62646	187 (251)	2200	171—209 kPa (1.71—2.09 bar) (24—30 psi)
	1616, 1625, 1632, 1634, 1641, 1643, 1644, 1645, 1646, 1647, 1648, 1649, 1650, 1661, 1663, 1664, 1665, 1666, 1667	RE503346, RE507695, RE62643	Intermittent: 187 (251) Continuous: 159 (213)	2200	Intermittent: 171—209 kPa (1.71—2.09 bar) (24—30 psi) Continuous: N/A[a]
	1657	RE66463	Intermittent: 205 (275) Continuous: 174 (233)	2200	Intermittent: 190—234 kPa (1.90—2.34 bar) (27—34 psi) Continuous: N/A[a]
	1660	RE503175, RE503356, RE507697	Intermittent: 187 (251) Continuous: 159 (213)		Intermittent: 171—209 kPa (1.71—2.09 bar) (24—30 psi) Continuous: 142—174 kPa (1.42—1.74 bar) (20—25 psi)
	1673, 1674	RE506419	168 (227)	2200	171—209 kPa (1.71—2.09 bar) (24—30 psi)
	1681	RE502806	224 (300)	2350, 3100	226—277 kPa (2.26—2.77 bar) (33—40 psi)
			216 (290)	1760	N/A[a]
			179 (240)	1470	N/A[a]
	1682, 1683	RE503822	246 (330)	1800	249—305 kPa (2.49—3.05 bar) (36—44 psi)
	1684, 1687	RE503823	246 (330)	1800	249—305 kPa (2.49—3.05 bar) (36—44 psi)
	1685, 1686	RE505672	225 (302)	1500	N/A[a]
	1688	RE506543	205(275)	2200	190—234 kPa (1.90—2.34 bar) (27—34 psi)
RG6081HF001	1601, 1602	RE62686	224 (300)	2200	176—216 kPa (1.76—2.16 bar) (25—31 psi)
[a]N/A = Not Available at time of publication					

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TURBO BOOST PRESSURES (JOHN DEERE OEM/OUTSIDE EQUIPMENT MANUFACTURERS)					
Engine Number	**Option Code**	**Injection Pump Part No.**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
	1603, 1604	RE62687	240 (322)	1800	209—257 kPa (2.09—2.57 bar) (30—38 psi)
	1605	RE63769	224 (300)	2200	176—216 kPa (1.76—2.16 bar) (25—31 psi)
	1606	RE63770	240 (322)	1800	209—257 kPa (2.09—2.57 bar) (30—38 psi)
	1621, 1633, 1640, 1641, 1642, 1643, 1644, 1645, 1646, 1647, 1648, 1688, 1689, 1690, 1691, 1692, 1693	RE503345, RE507686, RE61658	Intermittent: 224 (300) Continuous: 190 (255)	2200	Intermittent: 176—216 kPa (1.76—2.16 bar) (25—31 psi) Continuous: 171—209 kPa (1.71—2.09 bar) (24—30 psi)
	1622, 1623	RE66458	200 (268)	1500	188—230 kPa (1.88—2.30 bar) (27—33 psi)
	1624	RE66451	200 (268)	1500	188—230 kPa (1.88—2.30 bar) (27—33 psi)
	1639	RE503345, RE61658	Intermittent: 224 (300) Continuous: 190(255)	2200	Intermittent: 176—216 kPa (1.76—2.16 bar) (25—31 psi) Continuous: 171—209 kPa (1.71—2.09 bar) (24—30 psi)
	1661, 1662, 1684, 1686	RE503812	268 (360)	1500	N/A[a]
	1663	RE503813	268 (360)	1500	N/A[a]
	1680	RE501861	224 (300)	2350	N/A[a]
			224 (300)	2100	214—263 kPa (2.14—2.63 bar) (31—38 psi)
			216 (290)	1760	183—263 kPa (1.83—2.63 bar) (26—33 psi)
			179 (240)	1470	183—225 kPa (1.83—2.25 bar) (26—33 psi)
	1681, 1682, 1685, 1687	RE505670	308 (413)	1800	258—316 kPa (2.58—3.16 bar) (37—46 psi)
	1683	RE505475	308 (413)	1800	258—316 kPa (2.58—3.16 bar) (37—46 psi)
RG6081TF001	1601, 1602	RE66241	149 (200)	2200	137—168 kPa (1.37—1.68 bar) (20—24 psi)
	1603, 1604	RE62837	157 (211)	1800	207—253 kPa (2.07—2.53 bar) (30—37 psi)

[a]N/A = Not Available at time of publication

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TURBO BOOST PRESSURES (JOHN DEERE OEM/OUTSIDE EQUIPMENT MANUFACTURERS)					
Engine Number	**Option Code**	**Injection Pump Part No.**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
	1605	RE66242	149 (200)	2200	157—193 kPa (1.57—1.93 bar) (22—28 psi)
	1606	RE63750	157 (211)	1800	207—253 kPa (2.07—2.53 bar) (30—37 psi)
	1608, 1609	RE66459	131 (176)	1500	157—193 kPa (1.57—1.93 bar) (22—28 psi)
	1610	RE66448	131 (176)	1500	157—193 kPa (1.57—1.93 bar) (22—28 psi)
	1611, 1612	RE501016	128(172)	2200	127—156 kPa (1.27—1.56 bar) (18—23 psi)
	1613	RE501198	128(172)	2200	127—156 kPa (1.27—1.56 bar) (18—23 psi)
	1614, 1615	RE505268	185(248)	1800	183—225 kPa (1.83—2.25 bar) (26—33 psi)
	1616	RE505269	185(248)	1800	183—225 kPa (1.83—2.25 bar) (26—33 psi)
RG6081AFM01	1601, 1602	N/A[a]	280 (375)	2400	200—250 kPa (2.0—2.5 bar) (29—36 psi)
		N/A[a]	246 (330)	2300	160—195 kPa (1.6—1.95 bar) (23—28 psi)
		N/A[a]	224 (300)	2200	125—175 kPa (1.25—1.75 bar) (18—25 psi)
		N/A[a]	175 (235)	2100	95—115 kPa (0.95—1.15 bar) (13—16 psi)
	1603, 1604	N/A[a]	168 (225)	1800	128—157 kPa (1.28—1.57 kPa) (18.6—23.0 psi)
	1605, 1606	N/A[a]	139 (186)	1500	117—144 kPa (1.17—1.44 kPa) (17—21 psi)
RG6081HF070	16GA, 16GB, 16GC, 16GD	N/A[a]	Prime: 220 (295) Standby: 259 (347)	1800	Prime: 183—225 kPa (1.83—2.25 bar) (26.5—32 psi) Standby: 216—264 kPa (2.16—2.64 bar) (31—38 psi)
	16JA, 16JB, 16JC, 16JD	N/A[a]	Prime: 263 (353) Standby: 308 (413)	1800	Prime: 217—266 kPa (2.17—2.66 bar) (31—38 psi) Standby: 243—297 kPa (2.43—2.97 bar) (35—42 psi)
	166A, 166B, 166C, 166D, 166E, 166F, 166G, 166H	N/A[a]	Intermittent: 242 (325) Continuous: 224 (300)	2200	Intermittent: 194—238 kPa (1.94—2.38 bar) (28—34 psi) Continuous: 181—221 kPa (1.81—2.21 bar) (26—32 psi)

[a]N/A = Not Available at time of publication

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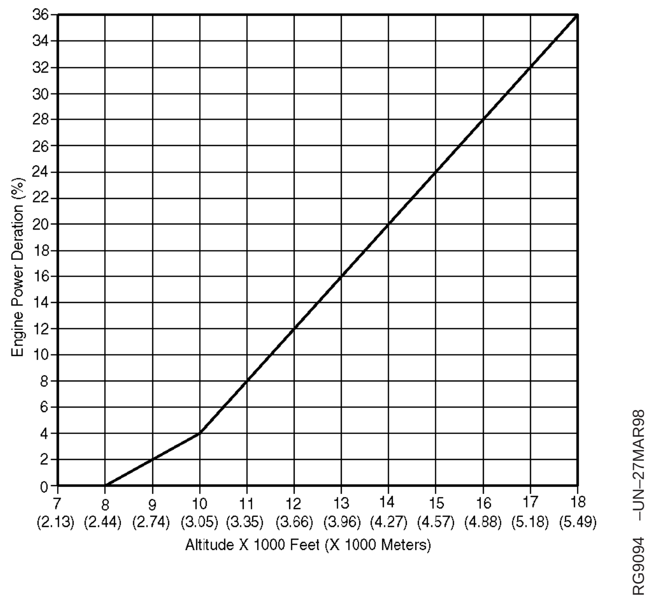
TURBO BOOST PRESSURES (JOHN DEERE OEM/OUTSIDE EQUIPMENT MANUFACTURERS)					
Engine Number	**Option Code**	**Injection Pump Part No.**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
	166L, 166M, 166N, 166P, 166R, 166S, 166T, 166U	N/A[a]	Intermittent: 224 (300) Continuous: 205 (275)	2200	Intermittent: 181—221 kPa (1.81—2.21 bar) (26—32 psi) Continuous: 167—204 kPa (1.67—2.04 bar) (24—29 psi)
	72A1/ 162A	RE518423	149 (200) 12 Volt	2200	137—169 kPa (1.39—1.69 bar) (20—25 psi)
	72A2/ 162B	RE518807	149 (200) 24 Volt	2200	See Above
	72B1/ 162A	RE518423	168 (225) 12 Volt	2200	171—209 kPa (1.71—2.09 bar) (24—30 psi)
	72B2/ 162B	RE518807	168 (225) 24 Volt	2200	See Above
	72C1/ 163A	RE518423	187 (250) 12 Volt	2200	179—219 kPa (1.79—2.19 bar) (26—32 psi)
	72C2/ 163B	RE518807	187 (250) 24 Volt	2200	See Above
	72D1/ 164A	RE518423	205 (275) 12 Volt	2200	186—228 kPa (1.86—2.28 bar) (27—33 psi)
	72D2/ 164B	RE518807	205 (275) 24 Volt	2200	See Above
	72E1 164A	RE518423	224 (300) 12 Volt	2200	186—228 kPa (1.86—2.28 bar) (27—33 psi)
	72E2/ 164B	RE518807	224 (300) 24 Volt	2200	See Above
	72F1/ 164A	RE518423	242 (325) 12 Volt	2200	See Above
	72F2/ 164B	RE518807	242 (325) 24 Volt	2200	See Above
	72H1/ 165A	RE518423	261 (350) 12 Volt	2200	200—250 kPa (2.0—2.5 bar) (29—35 psi)
	72H2/ 165B	RE518807	261 (350) 24 Volt	2200	See Above
	721A/ 165A	RE518423	231 (310) 12 Volt	1800	202—248 kPa (2.02—2.48 bar) (29—36 psi)
	721B/ 165B	RE518807	231 (310) 24 Volt	1800	See Above
	722A/ 165A	RE518423	260 (350) 12 Volt	1800	209—257 kPa (2.09—2.57 bar) (30—38 psi)
	722B/ 165B	RE518807	260 (350) 24 Volt	1800	See Above
	723A/ 166A	RE518423	318 (426) 12 Volt	1800	249—305 kPa (2.49—3.05 bar) (36—44 psi)
	723B/ 166B	RE518807	318 (426) 24 Volt	1800	See Above
	724A/ 166A	RE518423	289 (388) 12 Volt	1800	209—257 kPa (2.09—2.57 bar) (30—38 psi)
	724B/ 166B	RE518807	289 (388) 24 Volt	1800	See Above

[a]N/A = Not Available at time of publication

Effects of Altitude and Temperature on Engine Performance

Altitude, fuel temperature, air temperature, and humidity may affect engine performance. As a general rule, atmospheric changes will usually cause a decrease in engine power by the percentages shown in chart below.

ATMOSPHERIC CHANGE	% POWER DECREASE
Fuel Temperature Rise of 1°C (1.8°F) above 40° C (104°F)	0.29
Air Temperature Rise of 5.5°C (10°F) above 25°C (77°F)	0.50
Naturally Aspirated Engines:	
Altitude Rise of 300 m (1000 ft) above 180 m (600 ft)	3.00
Turbocharged Engines:	
Altitude Rise of 300 m (1000 ft) above 180 m (600 ft)	0.50
Relative Humidity Rise of 10% above 0%	0.07



Turbocharged Engines

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