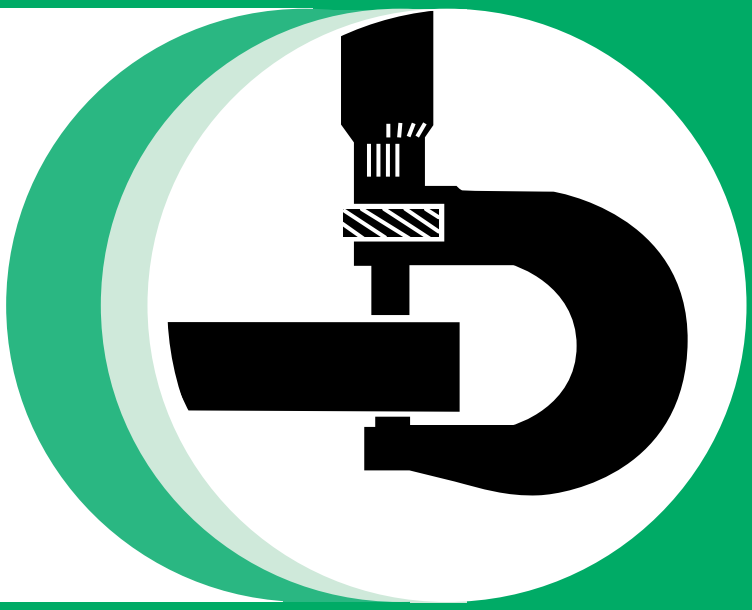
PowerTech® 6.8 L 6068 Compressed Natural Gas Engine

Repair

COMPONENT TECHNICAL MANUAL



For complete service information also see:

PowerTech® 6.8 L 6068 & 8.1 L 6081 Compressed Natural Gas Engines—Operation & Diagnostics CTM113

Deere Power Systems Group
CTM146 (09OCT98)
LITHO IN U.S.A.
ENGLISH

JOHN DEERE

DEERE POWER

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.

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 vehicle technical manual. An application listing in the introduction identifies product-model/component type-model relationship. See the vehicle technical manual for information on component removal and installation, and gaining access to the components.

This manual contains the necessary instructions for removal, repair and installation of various engine components.

Information is organized in groups for the various components requiring service instruction. At the beginning of each group are summary listings of service tools and other materials needed to do the job. Specifications and torques are also listed at the beginning of each group.

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

Refer to the companion manual, CTM113 for diagnostic and testing of 6.8 L engine systems, including electronic engine controls.

Theory of operation for various engine systems is also covered in CTM113.

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

RG,CTM146,IFC –19–08JAN98–1/1

ABOUT THIS MANUAL

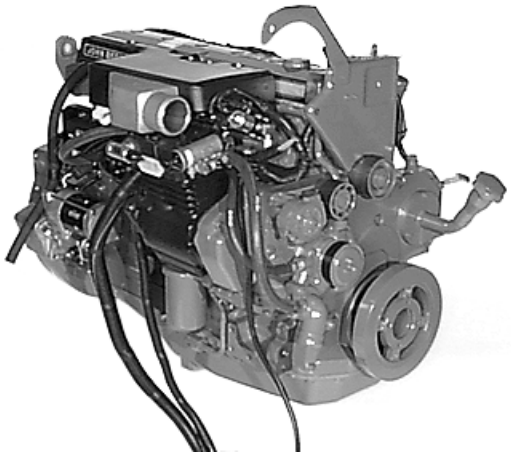
This component technical manual (CTM) covers the recommended repair procedure for 6068 HFN, 6.8 L (414 cu. in.) Compressed Natural Gas (CNG) engines produced in Dubuque, Iowa.

Before beginning repair of an engine, clean the engine and mount on a repair stand. (See Group 03)—Engine Mounting.)

Direction of engine crankshaft rotation in this manual is referenced facing the flywheel looking toward the vibration damper. Front of engine is vibration damper end.

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

Read each repair procedure completely before performing any service.



RG8870 –UN–

6.8 L CNG Engine—3/4 Left Front View

RG8869 –UN–

6.8 L CNG Engine—3/4 Right Rear View

DPSG,OUOE003,20 –19–25FEB98–1/1

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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.

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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–

Handle Fluids Safely

DX,FLAME –19–04JUN90–1/1

HANDLE NATURAL GAS SAFELY

Handle natural gas with care; it is highly flammable. Do NOT smoke while working on or around natural gas equipment.

Natural gas fumes may cause sickness or death. Work in well ventilated area.

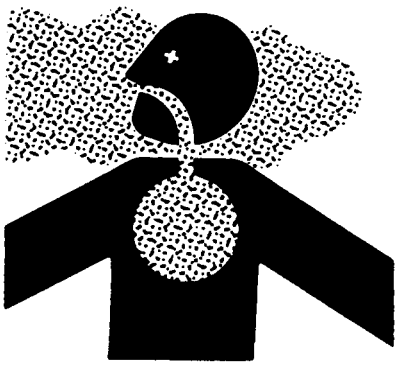
Shut off natural gas supply before servicing equipment.

Have a manual valve installed away from the engine to shut off gas supply in case of an emergency.

Prevent fires by keeping machine clean of accumulated trash, grease, and debris.

TS227 –UN–

Handle Natural Gas Safely



TS220 –UN–

Work in Ventilated Area

RG,01,DT7005 –19–29OCT97–1/1

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PREVENT BATTERY EXPLOSIONS

Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.

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

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

TS204 –UN–

Prevent Battery Explosions

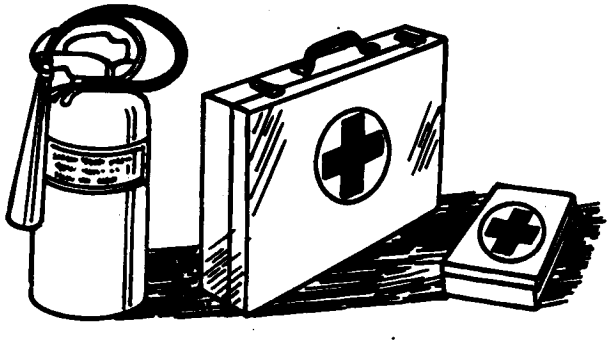
DX,SPARKS –19–03MAR93–1/1

PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

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



TS291 –UN–

Prepare for Emergencies

DX,FIRE2 –19–03MAR93–1/1

PREVENT ACID BURNS

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:

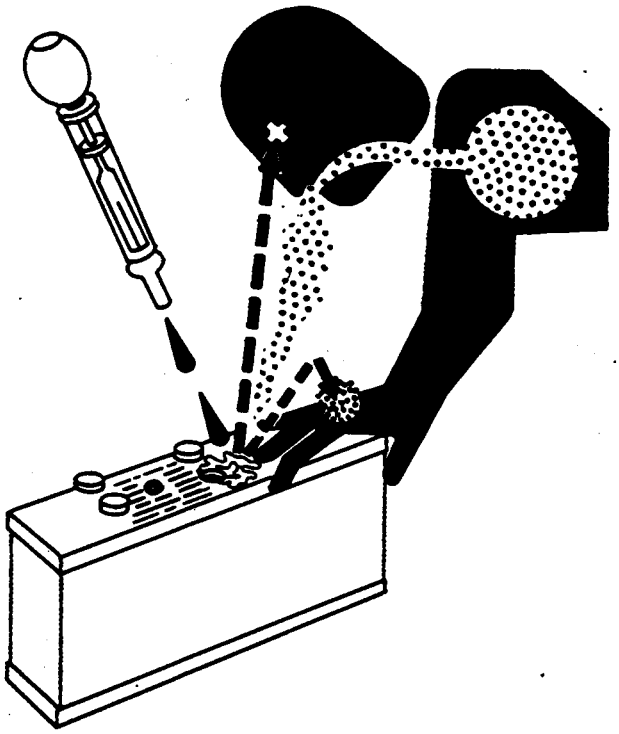
1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Use proper jump start procedure.

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.



TS203 –UN–

Prevent Acid Burns

DX,POISON –19–21APR93–1/1

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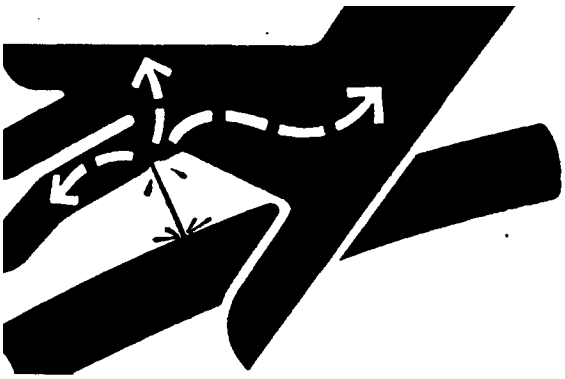
AVOID HIGH-PRESSURE FLUIDS

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.



X9811 –UN–

Avoid High-Pressure Fluids

DX,FLUID –19–03MAR93–1/1

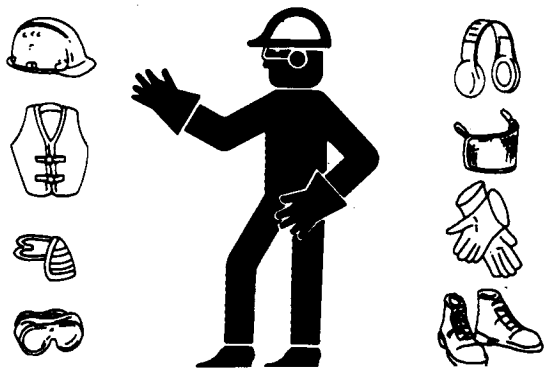
WEAR PROTECTIVE CLOTHING

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–

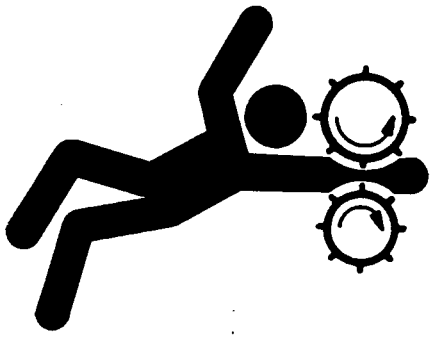
Protective Clothing and Equipment

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–

Service Machines Safely

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–

Work in Ventilated Area

DX,AIR –19–04JUN90–1/1

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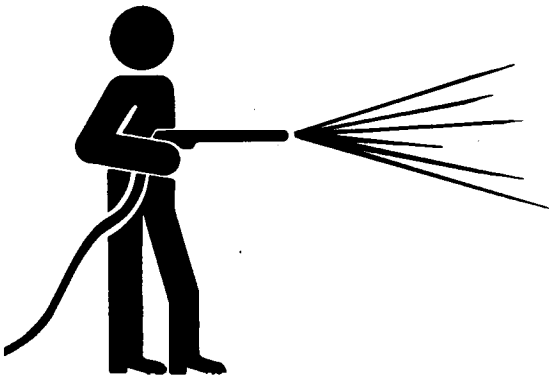
6

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–

Work in Clean Area

DX,CLEAN –19–04JUN90–1/1

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.

Do all work outside or in a well ventilated area. Dispose of paint and solvent properly.

Remove paint before welding or heating:

- 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.

TS220 –UN–

Work in Ventilated Area

DX,PAINT –19–03MAR93–1/1

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 be accidentally cut when heat goes beyond the immediate flame area.

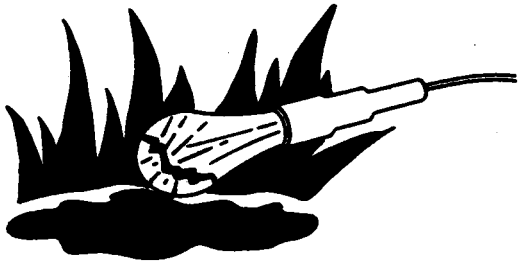
TS953 –UN–

Avoid Heating Near Pressurized Fluid Lines

DX,TORCH –19–03MAR93–1/1

ILLUMINATE WORK AREA SAFELY

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



TS223 –UN–

Illuminate Work Area Safely

DX,LIGHT –19–04JUN90–1/1

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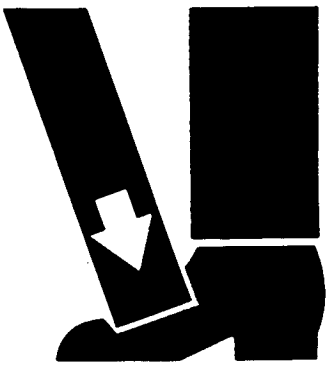
USE PROPER LIFTING EQUIPMENT

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–

Use Proper Lifting Equipment

DX,LIFT –19–04JUN90–1/1

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.

Disconnect battery ground cable (-) before making adjustments on electrical systems or welding on machine.

TS218 –UN–

Practice Safe Maintenance

DX,SERV –19–03MAR93–1/1

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–

Use Proper Tools

DX,REPAIR –19–04JUN90–1/1

DISPOSE OF WASTE PROPERLY

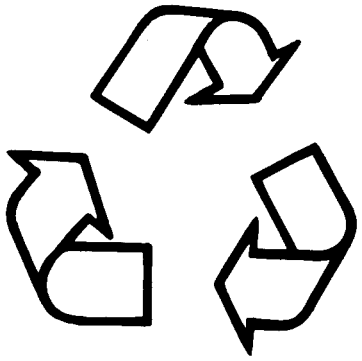
Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries.

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–

Dispose of Waste Properly

DX,DRAIN –19–03MAR93–1/1

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10

HANDLE COMPRESSED NATURAL GAS (CNG) SAFELY

CNG is methane (natural gas) stored at high pressure. It spreads into air quickly.

Natural gas fumes can cause sickness or death. Always work in a well ventilated area.

Do not smoke when refueling or working on or around natural gas vehicles or equipment.

Keep natural gas vehicles away from sparks, flames, and electrical devices in operation, especially if you suspect a natural gas leak.

TS227 –UN–

Handle Compressed Natural Gas (CNG) Safely

TS220 –UN–

Work in Ventilated Area

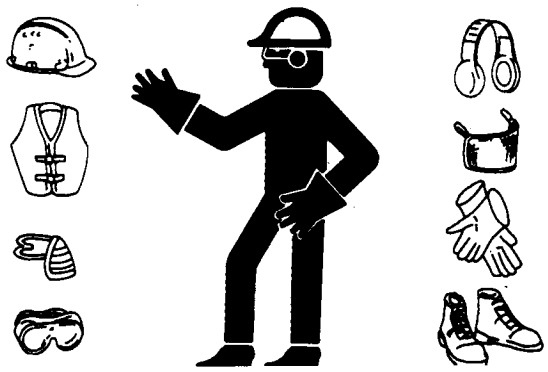
RG,01,DT7011 –19–29OCT97–1/1

SERVICE COMPRESSED NATURAL GAS (CNG) SYSTEMS SAFELY

Improper installation, service, or operation of CNG storage and delivery components can result in fire, explosion, and/or serious injury.

See FUEL PRESSURE LEAK-OFF PROCEDURE in Group 35 of this manual before servicing the CNG fuel system.

Relieve CNG fuel system pressure before working on the system. Properly tighten connections and check for leaks before pressurizing the CNG fuel system.



TS206 –UN–

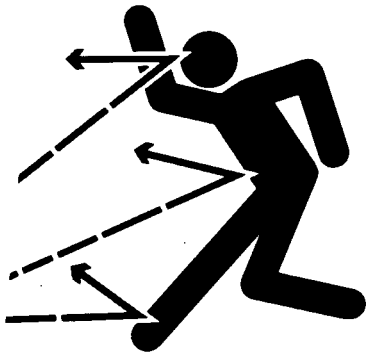
Protective Clothing and Equipment

RG,01,DT7010 –19–29OCT97–1/1

PROTECT AGAINST HIGH PRESSURE

CNG fuel systems operate at high pressures. DO NOT disassemble or remove any CNG fuel system components under pressure. Explosive separation of components, and the escaping natural gas can cause serious injury.

Relieve CNG fuel system pressure before disconnecting any fuel system component.



TS265 –UN–

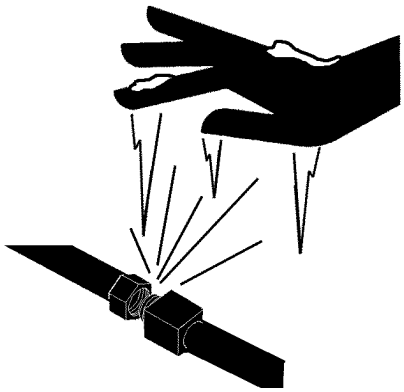
Protect Against High Pressure

RG,01,DT7009 –19–29OCT97–1/1

PROTECT AGAINST EXTREMELY COLD CNG LEAKAGE

Gas escaping from the CNG fuel system is very cold. Frostbite and skin damage can occur for contact with cold escaping gas or surrounding components.

Inspect for leaks by spraying a soap and water solution on joints, fittings, and other areas. Look for bubbles that indicate leakage from the system.



RG8110 –UN–

Protect Against Extremely Cold CNG Leakage

RG,01,DT7008 –19–29OCT97–1/1

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12

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–

Live With Safety

DX,LIVE –19–25SEP92–1/1

UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES

SAE Grade and Head Markings	NO MARK	1 or 2[b]	5 5.1 5.2	8 8.2
SAE Grade and Nut Markings	NO MARK	2	5	8

Size	Grade 1				Grade 2[b]				Grade 5, 5.1, or 5.2				Grade 8 or 8.2			
	Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]	
	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft
1/4	3.7	2.8	4.7	3.5	6	4.5	7.5	5.5	9.5	7	12	9	13.5	10	17	12.5
5/16	7.7	5.5	10	7	12	9	15	11	20	15	25	18	28	21	35	26
3/8	14	10	17	13	22	16	27	20	35	26	44	33	50	36	63	46
7/16	22	16	28	20	35	26	44	32	55	41	70	52	80	58	100	75
1/2	33	25	42	31	53	39	67	50	85	63	110	80	120	90	150	115
9/16	48	36	60	45	75	56	95	70	125	90	155	115	175	130	225	160
5/8	67	50	85	62	105	78	135	100	170	125	215	160	240	175	300	225
3/4	120	87	150	110	190	140	240	175	300	225	375	280	425	310	550	400
7/8	190	140	240	175	190	140	240	175	490	360	625	450	700	500	875	650
1	290	210	360	270	290	210	360	270	725	540	925	675	1050	750	1300	975
1-1/8	400	300	510	375	400	300	510	375	900	675	1150	850	1450	1075	1850	1350
1-1/4	570	425	725	530	570	425	725	530	1300	950	1650	1200	2050	1500	2600	1950
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2150	1550	2700	2000	3400	2550
1-1/2	1000	725	1250	925	990	725	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Fasteners should be replaced with the same or higher grade. If higher grade fasteners are used, these should only be tightened to the strength of the original.

Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

[a] "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.

[b] Grade 2 applies for hex cap screws (not hex bolts) up to 152 mm (6-in.) long. Grade 1 applies for hex cap screws over 152 mm (6-in.) long, and for all other types of bolts and screws of any length.

TS1656 –19–

DX,TORQ1 –19–20JUL94–1/1

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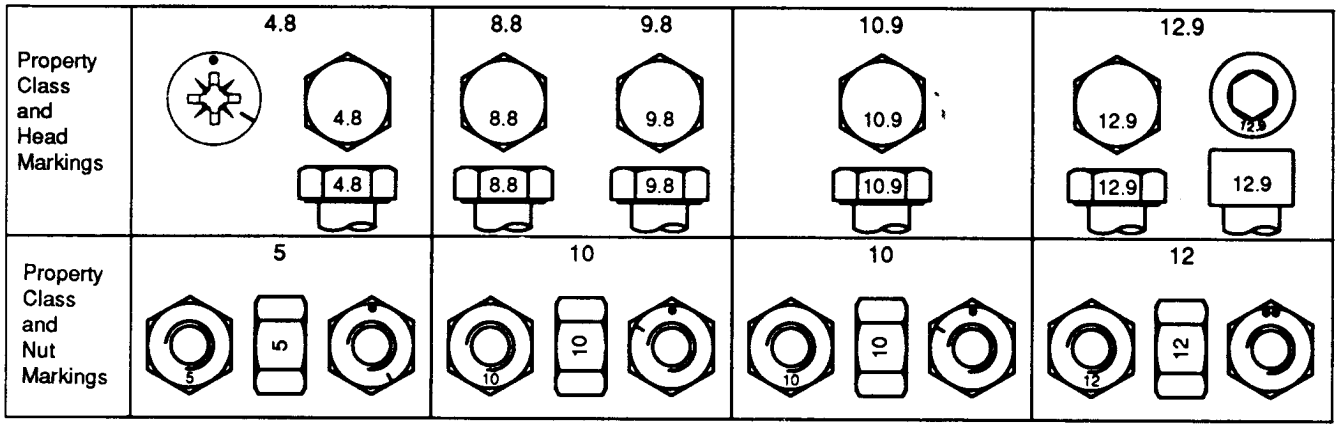
METRIC BOLT AND CAP SCREW TORQUE VALUES



Size	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]	
	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft
M6	4.8	3.5	6	4.5	9	6.5	11	8.5	13	9.5	17	12	15	11.5	19	14.5
M8	12	8.5	15	11	22	16	28	20	32	24	40	30	37	28	47	35
M10	23	17	29	21	43	32	55	40	63	47	80	60	75	55	95	70
M12	40	29	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	47	80	60	120	88	150	110	175	130	225	165	205	150	260	190
M16	100	73	125	92	190	140	240	175	275	200	350	255	320	240	400	300
M18	135	100	175	125	260	195	330	250	375	275	475	350	440	325	560	410
M20	190	140	240	180	375	275	475	350	530	400	675	500	625	460	800	580
M22	260	190	330	250	510	375	650	475	725	540	925	675	850	625	1075	800
M24	330	250	425	310	650	475	825	600	925	675	1150	850	1075	800	1350	1000
M27	490	360	625	450	950	700	1200	875	1350	1000	1700	1250	1600	1150	2000	1500
M30	675	490	850	625	1300	950	1650	1200	1850	1350	2300	1700	2150	1600	2700	2000
M33	900	675	1150	850	1750	1300	2200	1650	2500	1850	3150	2350	2900	2150	3700	2750
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2750	4750	3500

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[a] *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.*

TS1657 –19–

DX,TORQ2 –19–20JUL94–1/1

ENGINE MODEL DESIGNATION

John Deere Engine Model—6068 HFN

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

6068HFN51 Engine	
6	Number of cylinders
6.8	Liter displacement
H	Aspiration code
FN	User code
51	OEM code
Aspiration Code	
H	Turbocharged and air-to-air aftercooled
User Code	
FN	OEM (Natural Gas)
OEM Code	
51	End user designation

RG,01,DD8011 –19–08JAN98–1/1

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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.

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:

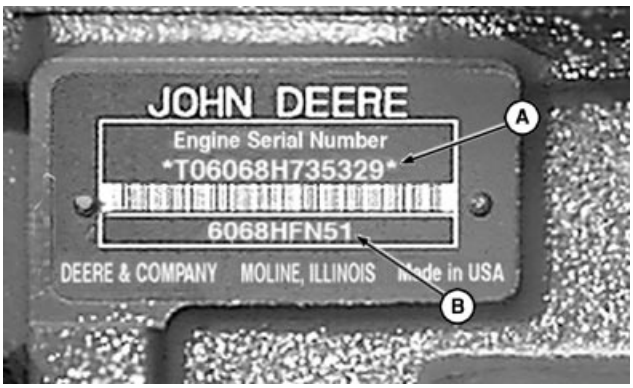
T06068H000000	
T0	Factory code producing engine
6068H	Engine Model Designation
000000	Sequential Number
Factory Code Producing Engine	
T0	Dubuque, Iowa
Engine Model Designation	
6068H	Definition explained previously. (See ENGINE MODEL DESIGNATION.)
Sequential Number	
000000	6-digit sequential number.

NOTE: The 6.8 L Compressed Natural Gas engines start with build sequence number 700,000.

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

ENGINE APPLICATION DATA

The second line of information on the engine serial number plate identifies the engine/Deere vehicle relationship.



Engine Serial Number Plate

RG,01,DT7029 –19–11FEB98–1/1

NATURAL GAS RECOMMENDATIONS

NOTE: Dry natural gas is a mixture of methane, ethane, propane, butane, and other inert gases. Dry natural gas is also referred to as Commercial Pipeline Natural Gas.

Dry natural gas that meets SAE J1616 Fuel Quality Specification is recommended for use in John Deere Natural Gas engines.

Maximum Propane Content	5 percent
Maximum Ethane Content	3 percent
Maximum Butane Content	1 percent
Maximum Hydrogen Sulfile (H_2S) Content	10 ppm
Minimum Octane Rating	118
Recommended Heating Value (LHV)	33.82kJ/L (905 BTU/cu ft)

RG,01,DT7030 –19–29OCT97–1/1

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NATURAL GAS ENGINE OIL

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

Viscosity grade SAE 15W-40 is preferred.

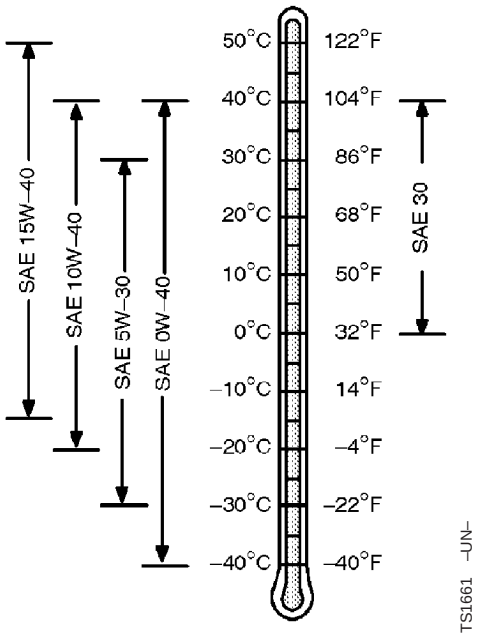
The use of heating devices may permit extension of the lower temperature limits, but requires special precautions. See your John Deere engine distributor or John Deere machinery dealer for recommendations.

Operation service interval for changing engine oil and filter is 12 months or 25,000 miles.

Oils with the following specifications are recommended:

API Service Classification CG-4 with 0.5 to 1.0% sulfated ash content.

Other oils claiming natural gas engine performance may be used, but the drain interval is reduced to 12 months or 20,000 miles, whichever occurs first. Ashless natural gas engine oils are not allowed.



DPSG,OUOE003,179 –19–10APR98–1/1

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 2500 miles 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 natural gas engine oil meeting the specifications listed previously during the first 2500 miles of operation.

After the break-in period, always use John Deere natural gas engine oil as recommended previously.

IMPORTANT: Do not use engine oils meeting API CF-4 or CCMC D5 performance levels during the first 2500 hours of operation of a new or rebuilt engine. These oils will not allow the engine to break-in properly.

RG,02,SO128 –19–19JAN98–1/1

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 engine servicing 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.

RG,01,DT7038 –19–29OCT97–1/1

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 engine servicing dealer to obtain specific information and recommendations.

RG,01,DT7037 –19–29OCT97–1/1

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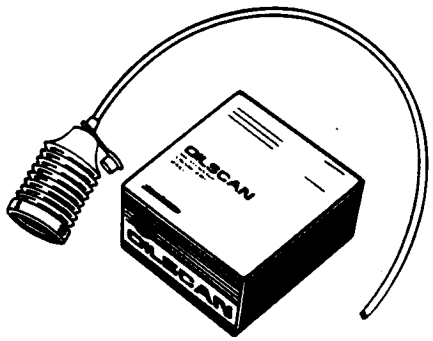
OILSCAN® AND COOLSCAN™

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

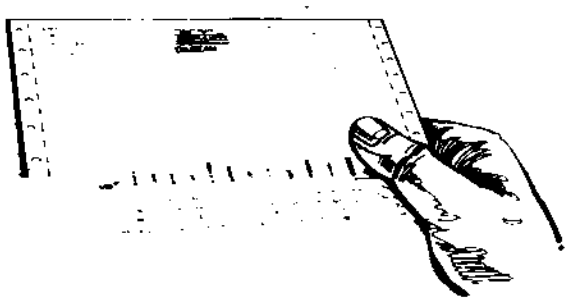
Oil and coolant samples should be taken from each system prior to its recommended change interval.

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



T6828AB –UN–

Sampling Programs



T6829AB –UN–

Recommended Change Interval

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

DX,OILSCAN –19–16APR92–1/1

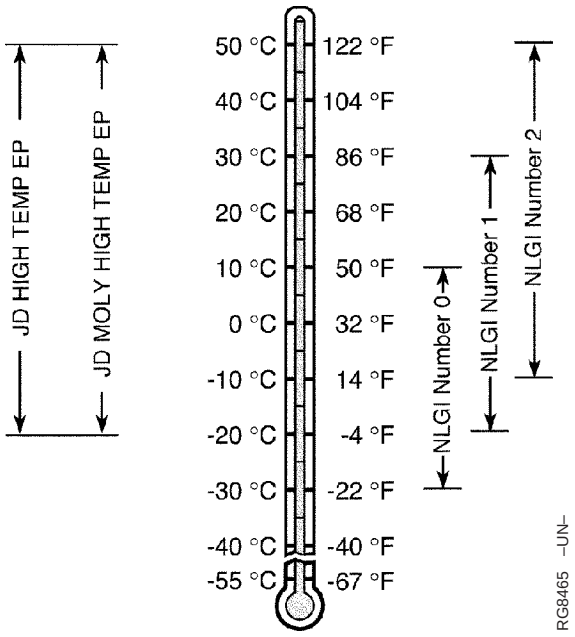
GREASE

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

The following greases are preferred:

- John Deere HIGH TEMPERATURE EP GREASE
- John Deere MOLY HIGH TEMPERATURE EP GREASE

Other greases may be used if they meet one of the NLGI Performance Classification GC-LB.



Grease Selection

RG,01,DT7041 –19–29OCT97–1/1

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RECOMMENDED ENGINE COOLANT

Solutions of antifreeze and supplemental coolant additives MUST be used year-round for freeze protection, boil-over protection, and to provide a stable, noncorrosive environment for seals, hoses, and metal engine parts.

John Deere PREDILUTED ANTIFREEZE/SUMMER COOLANT is preferred for service.

John Deere ANTIFREEZE/SUMMER COOLANT CONCENTRATE in a 40 to 60 percent mixture of concentrate with quality water is also recommended.

JOHN DEERE PREDILUTED ANTIFREEZE/SUMMER COOLANT

This product contains all the necessary ingredients that make up the proper coolant solution: chemically pure water, ethylene glycol (low silicate antifreeze), and supplemental coolant additives (SCAs). It is ready to use; no mixing is required.

John Deere Prediluted Antifreeze/Summer Coolant permits extended service life to 36 months or 75,000 miles of operation.

JOHN DEERE ANTIFREEZE/SUMMER COOLANT CONCENTRATE

This product contains ethylene glycol (low silicate antifreeze) and supplemental coolant additives (SCAs). It must be mixed with quality water, as described later in this section, before adding to the engine cooling system. The proportion of water to be used depends upon the lowest freeze protection temperature desired according to the following table:

% CONCENTRATE	FREEZE PROTECTION LIMIT
40	-24° C (-12° F)
50	-37° C (-34° F)
60	-52° C (-62° F)

John Deere Antifreeze/Summer Coolant Concentrate has a service life of 24 months or 50,000 miles of operation.

RG,01,DT7042 –19–29OCT97–1/1

ENGINE COOLANT SPECIFICATIONS

Contact your engine servicing dealer to determine what the cooling system of this engine is filled with and the winter freeze protection level.

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

Coolant solutions of quality water, ethylene glycol concentrate (antifreeze), and supplemental coolant additives (SCAs) MUST be used year-round to protect against freezing, boil-over, liner erosion or pitting, and to provide a stable, noncorrosive environment for seals, hoses, and metal engine parts.

Some products, including John Deere PREDILUTED ANTIFREEZE/SUMMER 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 ANTIFREEZE/SUMMER 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 coolants additives.

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

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:

Water Quality Specifications

Item	Parts Per Million	Grains Per U.S. Gallon
Chlorides (maximum)	40	2.5
Sulfates (maximum)	100	5.9
Total Dissolved Solids (maximum)	340	20
Total Hardness (maximum)	170	10
ph Level	5.5—9.0	

ETHYLENE GLYCOL CONCENTRATE (ANTIFREEZE)

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

The use of John Deere coolant products, as outlined on the previous page, is **strongly recommended.**

If John Deere coolant products are not used, other low silicate ethylene glycol base coolants for heavy-duty engines may be used when mixed with quality water and supplemental coolant additives (SCAs), if they meet one of the following specifications:

- ASTM D5345 (prediluted coolant)
- ASTM D4985 (coolant concentrate) in a 40% to 60% mixture of concentrate with quality water.

Coolants meeting these specifications require addition of supplemental coolant additives (SCAs), formulated for heavy-duty diesel engines, for protection against corrosion and cylinder liner erosion and pitting.

Continued on next page

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SUPPLEMENTAL COOLANT ADDITIVES (SCAS)

IMPORTANT: 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 engines. They often contain a high concentration of silicates and may damage the engine or cooling system.

IMPORTANT: DO NOT over-inhibit antifreeze solutions, as this can cause silicate-dropout. When this happens, a gel-type deposit is created which retards heat transfer and coolant flow causing engine to overheat.

NOTE: John Deere Prediluted Antifreeze/Summer Coolant, and John Deere Antifreeze/Summer Coolant Concentrate contain supplemental coolant additives (SCAs). However, as the coolant solution loses its effectiveness, additives will need to be added.

Operating without proper coolant additive 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.

The 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.

Inhibit the antifreeze-coolant mix with a non-chromate inhibitor. John Deere Liquid Coolant Conditioner is recommended as a supplemental coolant additive in John Deere engines.

RG7276 –UN–

John Deere Liquid Coolant Conditioner

Continued on next page

RG,01,DT7036 –19–26JAN98–2/3

IMPORTANT: Check inhibitors between drain intervals every 6 months or 30,000 miles at low speed operation service interval or 12 months or 25,000 miles at normal operation service interval. Replenish inhibitors by the addition of a supplemental coolant additive as necessary.

DO NOT use soluble oil.

Additives eventually lose their effectiveness and must be recharged with additional supplemental coolant additives available in the form of liquid coolant conditioner. See TESTING DIESEL ENGINE COOLANT and REPLENISHING SUPPLEMENTAL COOLANT ADDITIVES (SCAs) BETWEEN COOLANT CHANGES, as described later in this group.

RG,01,DT7036 –19–26JAN98–3/3

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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 12 month/25,000 mile normal operation intervals and whenever excessive coolant is lost through leaks or overheating to ensure the necessary protection.

COOLANT TEST STRIPS

Coolant test strips are available from your engine servicing 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 Liquid Coolant Conditioner should be added.

COOLSCAN™

For a more thorough evaluation of your coolant, perform a CoolScan™ analysis. See your engine servicing dealer for information about CoolScan™.

RG7297 –UN–

John Deere Coolant Test Kit

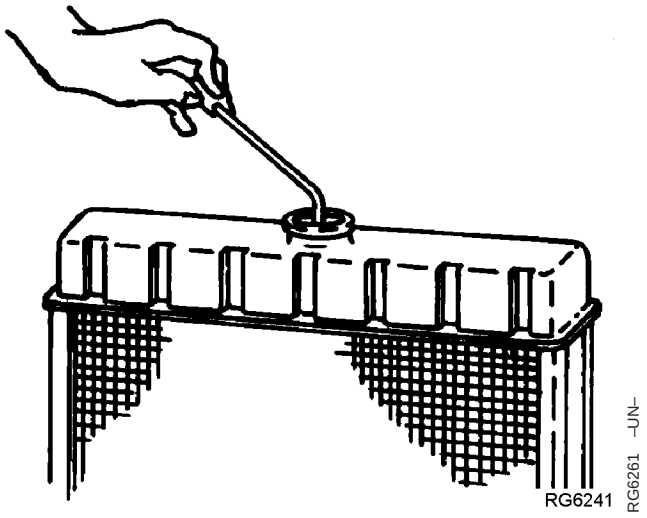
RG7397 –UN–

Coolant and Oil Sampling Siphon

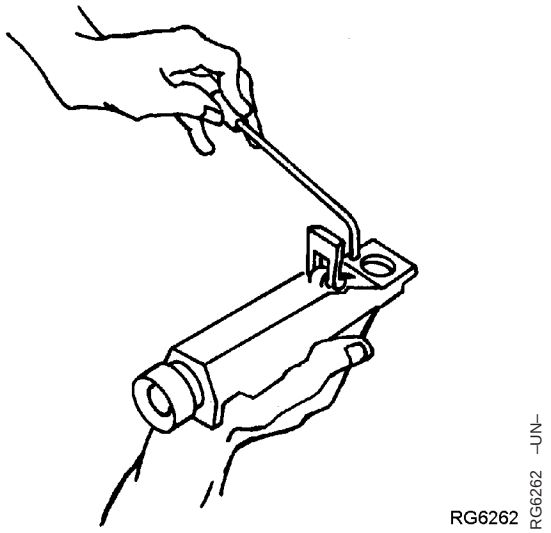
CoolScan is a trademark of Deere & Company.

RG,01,DT7043 –19–29OCT97–1/1

REPLENISHING SUPPLEMENTAL COOLANT ADDITIVES (SCA'S) BETWEEN COOLANT CHANGES



Testing the Coolant



Coolant Tester

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

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.

Test the coolant solution at 12 months or 25,000 miles at normal operation service interval 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.

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 JT05460 Refractometer to assure that the desired freeze point is maintained. Follow manufacturer's instructions provided with refractometer.

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

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

CoolScan is a trademark of Deere & Company.

Continued on next page

RG,01,DT7035 –19–29OCT97–1/2

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

See ENGINE COOLANT SPECIFICATIONS earlier in this group for proper mixing of coolant ingredients before adding to the cooling system.

RG,01,DT7035 –19–29OCT97–2/2

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.

RG,01,DT7034 –19–29OCT97–1/1

FLUSH AND SERVICE COOLING SYSTEM

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

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

TS281 –UN–

Service Cooling System Safely

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

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

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

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

Continued on next page

RG,01,DT7033 –19–29OCT97–1/2

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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

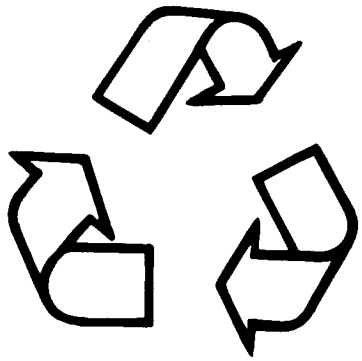
DISPOSING OF COOLANT

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.



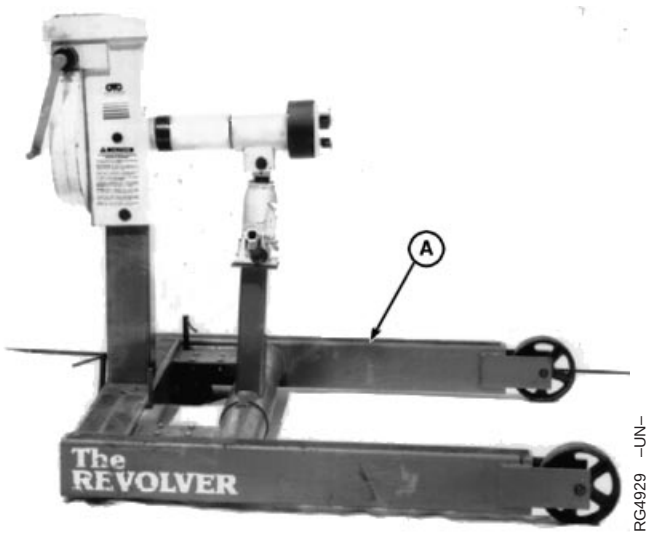
TS1133 –UN–

Disposing of Coolant

RG,01,DT7032 –19–29OCT97–1/1

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.



Engine Repair Stand

RG,01,DT7044 –19–29OCT97–1/1

03
2

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 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.

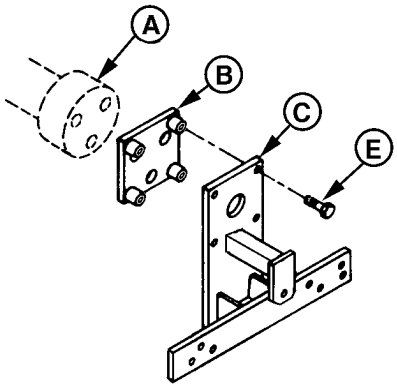
LOCTITE is a trademark of the Loctite Corp.

RG,01,DT7050 –19–29OCT97–1/1

INSTALL ADAPTERS ON ENGINE REPAIR STAND

1. Attach the D05226ST Special Adapter (B) to mounting hub (A) of the engine repair stand using SAE Grade 8 socket-head cap screws (D). Tighten cap screws to 135 N•m (100 lb-ft).

2. Attach the 62835[1] Engine Adapter (C) to the special adapter, using four 5/8-11 x 2 in. SAE Grade 8 cap screws (E). Tighten screws to 135 N•m (100 lb-ft).



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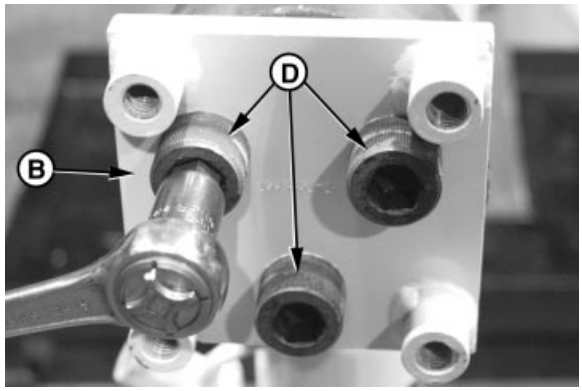
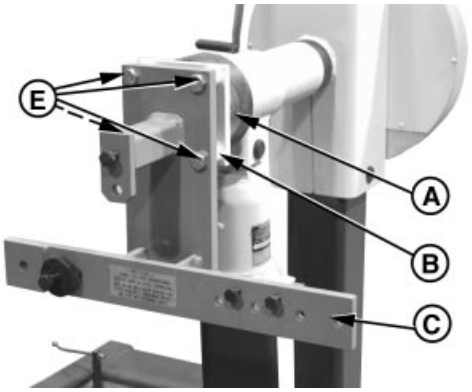
Install Special Adapter



RG7938 –UN–

Special Adapter Cap Screws



RG7781 –UN–

Installing Engine Adapter on Stand

A—Mounting Hub
B—D05226ST Special Adapter
C—62835 Engine Adapter
D—Cap Screws (3 used)
E—Cap Screws (4 used)

[1]*Part of JT07268 Engine Adapter Kit*

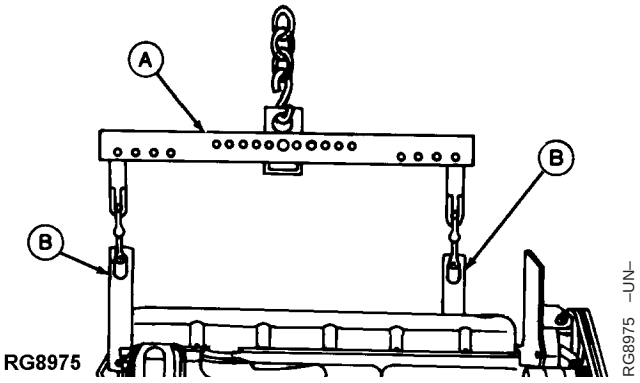
RG,03,DD8012 –19–11FEB98–1/1

03
4

ENGINE LIFTING PROCEDURE

CAUTION: 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.



Lifting Engine Using Engine Sling

1. Attach the JDG23 Engine Lifting Sling (A) or other suitable sling to engine lifting straps (B) and overhead hoist on floor crane.

NOTE: If engine does not have lifting straps, they can be procured through service parts network. Use of an engine lifting sling (as shown) is the ONLY APPROVED method for lifting engine.

2. Carefully lift engine and slowly lower to desired location.

RG,03,JW7723 –19–01DEC97–1/1

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.

RG,01,DT7047 –19–29OCT97–1/1

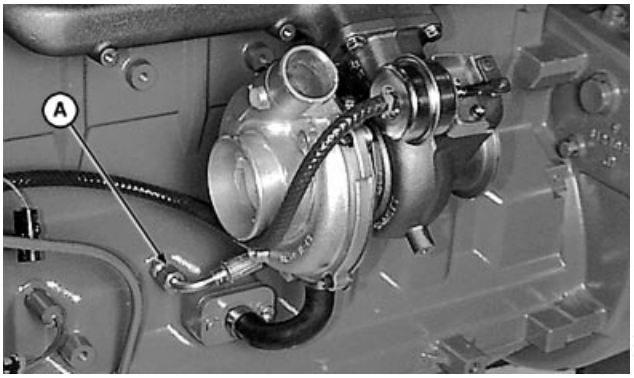
DISCONNECT TURBOCHARGER OIL INLET LINE

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

RG,01,DT7046 –19–29OCT97–1/2

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.



Disconnecting Turbocharger Oil Line

RG,01,DT7046 –19–29OCT97–2/2

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6

MOUNT ENGINE ON REPAIR STAND

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

Remove turbocharger before attaching engine to repair stand.

NOTE: See next module for illustration of an engine that has been mounted on repair stand.

Mount the engine to 62835[1] Engine Adapter as described below.

NOTE: No. 221668[1] Spacer (G) is used on the outside of the engine adapter.

6068 Engines

Hole D—(2) No. 214490[1] (M12 x 1.75 x 35 mm)

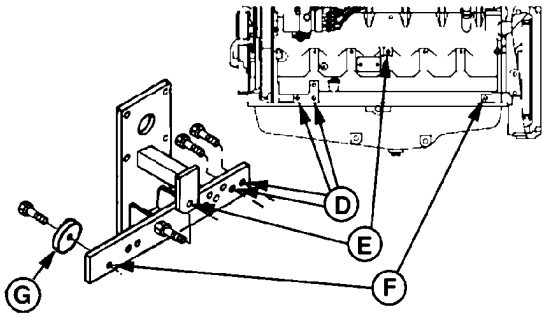
Hole E—(1) No. 221664[1] (M14 x 2.00 x 35 mm)

Hole F—(1) No. 221665[1] (M14 x 2.00 x 60 mm) with No. 221668[1] Spacer outside.

NOTE: Four threaded holes in engine mounting adapter are for storing mounting hardware.

M12 and M14 Cap Screw—Specification

Torque (M12)	104 N•m (105 lb-ft)
Torque (M14)	225 N•m (165 lb-ft)



RG7787A –UN–

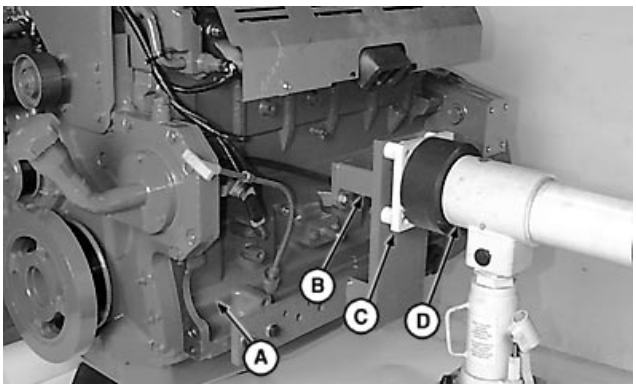
6068 Engine Mounting

[1]Part of JT07268 Engine Adapter Kit

RG,03,JW7724 –19–10APR98–1/1

ENGINE MOUNTED ON REPAIR STAND

Proper mounting of 6068 engine on repair stand using adapters is shown.



6068 Engine Mounted on Repair Stand

A—Engine
B—62835 Engine Adapter
C—D05226ST Special Adapter
D—Engine Repair Stand

RG,03,DT7334 –19–11FEB98–1/1

ENGINE DISASSEMBLY SEQUENCE

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

1. Mount engine on a safety approved repair stand. (Group 03)
2. Drain coolant and oil. Perform John Deere OILSCAN® and CoolScan™ analysis. (Group 02)
3. Remove fan belt, belt tensioner, and alternator. (Group 25)
4. Remove exhaust manifold. (Group 30)
5. Remove rocker arm cover and vent tube. If option code label is located on rocker arm cover, be careful not to damage label. (Group 05)
6. On applications where the water manifold is not an integral part of cylinder head, remove water manifold or thermostat housing. (Group 25)
7. Remove oil cooler piping and water pump. (Groups 20 and 25)
8. Remove dipstick, oil filter, oil cooler, and adapter housing (if equipped). (Group 20)
9. Remove ignition module, ignition coils, mounting bracket, spark plug boots and spark plugs.
10. Remove gas regulator, fuel mixer and fuel metering valve.
11. Remove electronic throttle and speed sensor.
12. Remove oil pressure regulating valve assembly. (Group 20)
13. Remove starting motor.
14. Remove rocker arm assembly and push rods. Keep rods in order (Group 05). Check for bent push rods and condition of wear pad contact surfaces on rockers.
15. Remove cylinder head. Check piston protrusion. (Groups 05 and 10)
16. Remove cam followers. Keep followers in order. (Groups 05 and 16)
17. Remove flywheel and flywheel housing. (Group 15)
18. Remove oil pan. (Group 20)
19. Remove crankshaft pulley. (Group 15)
20. Remove timing gear cover. (Group 16)
21. Remove oil pump drive gear, outlet tube, and pump body. (Group 20)
22. Remove timing gears and camshaft. Perform wear checks. (Group 16)
23. Remove engine front plate. (Group 16)
24. Remove oil by-pass valve. (Group 20)
25. Stamp cylinder number on connecting rod. Remove pistons and rods. Perform wear checks with PLASTIGAGE®. (Group 10)
26. Remove crankshaft and main bearings. Perform wear checks with PLASTIGAGE®. (Group 15)

Continued on next page

04
2

27. Remove cylinder liners and mark each one with cylinder number. (Group 10)
28. Remove piston cooling orifices. (Groups 10 and 15)
29. Remove camshaft bushing. (Group 16)
30. Remove cylinder block plugs and serial number plate when block is to be put in a “hot tank”. (Group 10)
31. Clean upper and lower liner bores with nylon brush. (Group 10)
32. Measure cylinder block. (Groups 10, 15, and 16)

RG,04,JW7725 –19–01DEC97–2/2

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 Natural Gas Engine to assure quality performance.

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

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 fitting: fuel filter base, intake manifold, cylinder block (oil gallery).
- Cap Screws: electronic tachometer cover, oil filler inlet, flywheel.
- Oil pressure sending unit.

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

TY9371 6 ml (0.2 oz) tube
T43513 50 ml (1.7 oz) bottle

Studs: exhaust manifold-to-turbocharger.

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 (water manifold), thermostat housing, air intake manifold, and water pump.
- Threaded nipples and elbows in water pump housing.
- Oil pan (drain hose and drain valve).
- Connectors: turbo line and drain line.
- Adapter fitting for turbo oil inlet line.

LOCTITE® 609 Retaining Compound (green):

T43515 50 ml (1.7 oz) bottle

Wear ring-to-crankshaft.

PERMATEX®AVIATION (Form-A-Gasket No. 3):

TY6299 227 g (8 oz) container

Rear camshaft bore steel cap plug.

PT569 NEVER-SEEZ® COMPOUND:

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

Cap Screws: turbocharger mounting

FEL-PRO® C-670 Molybdenum Disulfide Paste

Camshaft nose (gear installation)

LOCTITE is a trademark of the Loctite Corp.
TEFLON is a trademark of the DuPont Co.
PERMATEX is a trademark of the Loctite Corp.
NEVER-SEEZ is a trademark of the Emhart Chemical Group.
FEL-PRO is a trademark of FEL-PRO.

RG,01,DT7052 –19–29OCT97–1/1

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ENGINE ASSEMBLY SEQUENCE

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.

1. Install all plugs and serial number plate in cylinder block (if removed). (Groups 10 and 15)
2. Install piston cooling orifices. (Group 10)
3. Install new balancer shaft bushings (4045 engines) and a new camshaft bushing. (Group 16)
4. Install cylinder liners without O-rings. Measure liner height. Install liners with O-rings. (Group 10)
5. Install main bearings and crankshaft PLASTIGAGE® bearings. (Group 15)
6. Install flywheel housing, rear oil seal, and flywheel. (Group 15)
7. Install pistons and rods. Measure piston protrusion. (Group 10)
8. Install oil by-pass valve. (Group 20)
9. Install front plate. (Group 16)
10. Install oil outlet tube, O-ring in block, and oil pump. (Group 20)
11. Install camshaft and timing gears. (Group 16)
12. Time all gears with No. 1 cylinder at TDC compression stroke. (Group 16)
13. Install timing gear cover. Install new front seal. (Group 16)
14. Install oil pan. (Group 20)
15. Install oil pressure regulating valve. (Group 20)
16. Install cam followers in same order as removed. (Group 16)
17. Install cylinder head gasket, cylinder head, push rods, and rocker arm assembly. (Group 05)
18. Install starting motor.
19. Install oil cooler, new oil filter, and dipstick. (Group 20)
20. Install water manifold or thermostat housing and thermostat. (Group 25)
21. Install exhaust manifold and turbocharger. Prelube the turbocharger. (Group 30)
22. Install electronic throttle and speed sensor.
23. Install fuel metering valve and hose. (Group 35)
24. Install gas regulator, fuel mixer and fuel metering valve. (Group 35)
25. Install ignition module, ignition coils, mounting bracket, spark plug boots and spark plugs. (Group 45)
26. Install water pump and houses. (Group 25)
27. Install crankshaft pulley or vibration damper. (Group 15)
28. Install alternator, belt tensioner, fan, and fan belts. (Group 25)
29. Adjust valves and install rocker arm cover. (Group 05)

PLASTIGAGE is a trademark of the DANA Corp.

Continued on next page

RG,04,DT7335 –19–11NOV97–1/2

30. Install vent tube.
31. Fill engine with clean oil and proper coolant. (Group 02)
32. Perform engine break-in and standard performance checks. (CTM113)

RG,04,DT7335 –19–11NOV97–2/2

SPECIAL OR ESSENTIAL TOOLS

NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

SERVICE-GARD is a trademark of Deere & Company.

RG,05,DT7336 –19–11FEB98–1/13

RG6246 –UN–

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

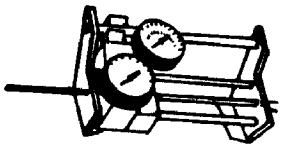
D17526CI or D17527CI

RG,05,DT7336 –19–11FEB98–2/13

RG5061 –UN–

Spring Compression Tester D01168AA

Test valve spring compression.



RG5061

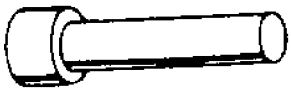
D01168AA

RG,05,DT7336 –19–11FEB98–3/13

RG5068 –UN–

Timing Pin JDE81-4

Lock engine at TDC when timing valve train. Use with JDE83 Flywheel Turning Tool.



RG5068

JDE81-4

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RG,05,DT7336 –19–11FEB98–4/13

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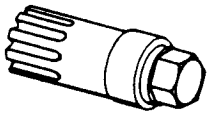
2

Flywheel Turning Tool JDE83

Used to rotate flywheel on engines with 142-tooth flywheel ring gear and a 26.5 mm (1.04 in.) ID flywheel housing guide bore diameter. Use with JDE81-4 Timing Pin.



RG6251 –UN–

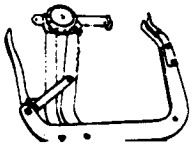
JDE83

RG,05,DT7336 –19–11FEB98–5/13

RG5070 –UN–

Valve Spring Compressor JDE138

Use to compress valve springs when removing and installing valves.



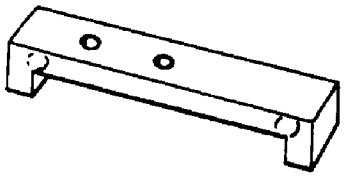
JDE138

RG,05,DT7336 –19–11FEB98–6/13

RG7029 –UN–

Piston and Liner Height Gauge . . . . . .JDG451[1]

Measure piston and liner heights.



RG7029

JDG451

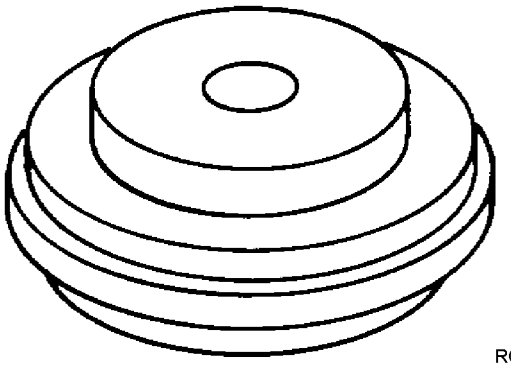
[1]A dial indicator is not supplied with JDG451. Use D17526CI (English, in.) or D17527CI (Metric, mm) Dial Indicator with JDG451.

Continued on next page

RG,05,DT7336 –19–11FEB98–7/13

Valve Seat Insert Installing Adapter. JDG675

Use with JDG676 Pilot Driver to install intake and exhaust valve seat inserts.



RG5240 –UN–

RG5240

JDG675

RG,05,DT7336 –19–11FEB98–8/13

RG5065 –UN–

Valve Seat Driver JDG676

Use with JDG675 Adapter to install intake and exhaust valve seat inserts in cylinder head.

RG5065

JDG676

RG,05,DT7336 –19–11FEB98–9/13

RG5612 –UN–

Valve Stem Seal Installer JDG678

Use to install valve stem seals.

JDG678

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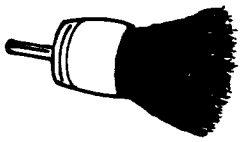
RG,05,DT7336 –19–11FEB98–10/13

RG5063 –UN–

End Brush D17024BR

Clean valve seat and bores.



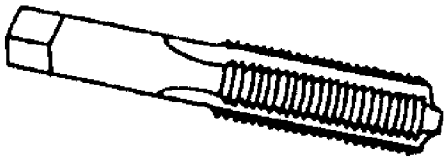
RG5063

RG,05,DT7336 –19–11FEB98–11/13

RG5100 –UN–

Tap JDG680

Used to restore threaded holes in cylinder block for cylinder head cap screws.



RG5100

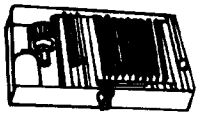
JDG680

RG,05,DT7336 –19–11FEB98–12/13

RG5064 –UN–

Valve Guide Knurler Kit JT05949

Knurl valve guides.



RG5064

JT05949

RG,05,DT7336 –19–11FEB98–13/13

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICE-GARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
D05012ST Precision “Bevelled Edge” Straightedge	Check cylinder head flatness.
Plastic Brush	Clean valve guides.
Eccentrimeter	Measure valve seat runout.
JT05893 Heavy-Duty Seat Grinder	Grind valve seats.
D17024BR End Brush	Remove carbon on valve seats.
JDG714 Valve Guide Cutting Tool	Machine exhaust valve towers.
JT05993 Torque Angle Gauge	Tighten flanged-head cylinder head cap screws.
Valve Inspection Center	Check valves for out of round.
JDG966 Crankshaft Front/Rear Rotation Adapter	Rotate crankshaft from front and rear with flywheel removed.

SERVICE-GARD is a trademark of Deere & Company.

RG,05,DT7337 –19–11NOV97–1/1

OTHER MATERIAL

Number	Name	Use
AR44402 (U.S.)	Valve Stem Lubricant	Lubricate valve stems.
PT569 (U.S.)	NEVER-SEEZ® Compound	Apply to exhaust manifold cap screws.

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

RG,05,DT7378 –19–11NOV97–1/1

CYLINDER HEAD AND VALVES SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Cylinder Head Reconditioning:		
Thickness of New Cylinder Head	104.87—105.13 mm	104.24 mm
	(4.129—4.139 in.)	(4.104 in.)
Maximum Material Removal for Resurfacing Head	0.76 mm (0.030 in.)	——
Maximum Acceptable Head Out-of-Flat:		
For Entire Length or Width	0.08 mm (0.003 in.)	——
For Every 150 mm (5.90 in.) Length or Width	0.03 mm (0.001 in.)	——
Combustion Face Surface Finish (surface grind only) (AA)	0.7—3.2 micrometers	——
	(31—125 micro-in.)	——
Maximum Wave Depth	0.012 mm (0.0005 in.)	——
Standard Valve Stem OD:		
Intake Valve	7.864—7.884 mm	——
	(0.3096—0.3104 in.)	——
Exhaust Valve	7.848—7.874 mm	——
	(0.3090—0.3100 in.)	——
Oversize Valve Stems Available	0.38 mm (0.015 in.)	——
	0.76 mm (0.030 in.)	——
Valve Guide ID	7.912—7.938 mm	——
	(0.312—0.313 in.)	——
Valve Stem-to-Guide Clearance	0.05—0.10 mm	0.15 mm
	(0.002—0.004 in.)	(0.006 in.)
Valve Angle (Intake and Exhaust):		
Seat	20°	——
Face	19.25° ± 0.25°	——
Maximum Valve Runout (Intake and Exhaust):		
Valve Seat	0.08 mm (0.003 in.)	——
Valve Face	0.038 mm (0.0015 in.)	——
Valve Recess in Cylinder Head:		
Intake Valve	0.61—1.11 mm	1.63 mm
	(0.024—0.044 in.)	(0.064 in.)
Exhaust Valve	1.22—1.72 mm	2.26 mm
	(0.048—0.068 in.)	(0.089 in.)
Valve Seat Width (intake and exhaust)	1.50—2.00 mm	——
	0.059—0.079 in.)	——
Valve Head OD:		
Intake Valve	46.47—46.73 mm	——
	(1.830—1.840 in.)	——
Exhaust Valve	42.37—42.63 mm	——
	(1.668—1.678 in.)	——
Cylinder Firing Order	1-5-3-6-2-4	——
Valve Clearance (Engine Cold):		
Rocker Arm-to-Valve Tip		
Intake Valve	0.35 mm (0.014 in.)	——
Exhaust Valve	0.46 mm (0.018 in.)	——
Valve Lift at 0.00 mm (in.) Clearance:		
Intake Valve	11.77—12.21 mm	11.34 mm
	(0.463—0.481 in.)	(0.446 in.)
Exhaust Valve	11.51—11.94 mm	11.08 mm
	(0.453—0.470 in.)	(0.436 in.)

Continued on next page

RG,05,DT7376 –19–11FEB98–1/3

ITEM	SPECIFICATION	WEAR LIMIT
Rocker Arm:		
Shaft OD	19.99—20.02 mm	19.94 mm
	(0.787—0.788 in.)	(0.785 in.)
Bore ID	20.07—20.12 mm	20.17 mm
	(0.790—0.792 in.)	(0.794 in.)
Shaft Spring Compressed Height	46 mm @ 18—27 N	——
	(1.81 in. @ 4—6 lb-force)	——
Shaft Support ID (Maximum)	20.17 mm (0.794 in.)	——
Valve Spring:		
Free Length[a]	54.0 mm (2.125 in.)	——
Compressed Height:		
Closed	46.0 mm @ 240—280 N	——
	(1.81 in. @ 54—62 lb-force)	——
Open	34.5 mm @ 590—680 N	——
	(1.36 in. @ 133—153 lb-force)	——
Cylinder Liner:		
Height Above Block	0.030—0.100 mm	——
	(0.0010—0.0040 in.)	——
Maximum Permissible Height Difference at Nearest Point of Two Adjacent Liners	0.051 mm (0.0020 in.)	——
Cam Follower OD	31.61—31.64 mm	——
	(1.245—1.246 in.)	——
Valve Bore Specifications:		
Seatbore:		
Intake	47.104—47.130 mm	——
	(1.8545—1.8555 in.)	——
Exhaust	42.987—43.013 mm	——
	(1.6570—1.6934 in.)	——
Installed Depth:		
Intake	3.45 mm (0.136 in.)	——
	Reference	——
Exhaust	3.82 mm (0.150 in.)	——
	Reference	——
Bore Depth:		
Intake	9.936—10.064 mm	——
	(0.3912—0.3962 in.)	——
Exhaust	9.936—10.064 mm	——
	(0.3557—0.3962 in.)	——
Bore Angle:		
Intake	38—42°	——
Exhaust	38—42°	——
Radius at Lower Bore:		
Intake Maximum Radius	0.5 mm (0.019 in.)	——
Exhaust Maximum Radius	0.5 mm (0.019 in.)	——

[a]Free length may vary slightly between valve springs.

Continued on next page

RG,05,DT7376 –19–11FEB98–2/3

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ITEM	SPECIFICATION	WEAR LIMIT
Replacement Valve Seat Insert OD:		
Intake	47.155—47.181 mm	——
	(1.8565—1.8575 in.)	——
Exhaust	43.038—43.064 mm	——
	(1.6944—1.6954 in.)	——
Maximum Surface Finish of Bore	.00158 (0.000062 in.)	——
		——

TORQUES

Rocker Arm Support Studs	80 N•m (59 lb-ft)
Rocker Arm Lock Nuts	27 N•m (20 lb-ft)
Rocker Arm Cover Stud Nuts	35 N•m (26 lb-ft)
Cylinder Head Cap Screws:	
Step 1	100 N•m (75 lb-ft)
Step 2	150 N•m (110 lb-ft)
Step 3	Wait 5 Minutes and Verify 150 N•m (110 lb-ft)
Step 4	Tighten Additional 60° ± 10°
Air Inlet Manifold-to-Cylinder Head	70 N•m (52 lb-ft)
Exhaust Manifold-to-Cylinder Head	70 N•m (52 lb-ft)[a]
Alternator Top Cap Screw	70 N•m (52 lb-ft)
Alternator Bottom Cap Screw	70 N•m (52 lb-ft)

[a]See REMOVE, INSPECT, AND INSTALL EXHAUST MANIFOLD in Group 30 for cap screw tightening sequence.

RG,05,DT7376 –19–11FEB98–3/3

CHECK AND ADJUST VALVE CLEARANCE

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

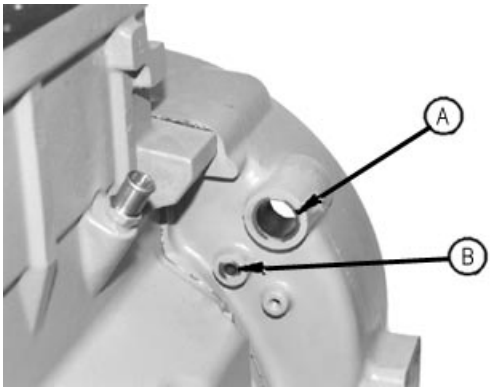
IMPORTANT: Valve clearance MUST BE checked and adjusted with engine COLD.

1. Remove rocker arm cover and crankcase 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.

2. Remove plastic plug or cover plate from engine timing hole (A).

3. Remove plug from timing hole (B).



RG7408 –UN–

Removing Plastic Plugs From Holes

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RG,05,DT7375 –19–11NOV97–1/3

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NOTE: Some engines are equipped with flywheel housings which do not allow use of an engine flywheel rotation tool. These engines may be rotated from front nose of engine, using JDG966 Crankshaft Rotation Tool.

4. Using engine rotation tool, rotate engine flywheel in running direction (clockwise viewed from front) until No. 1 cylinder is at “TDC” Compression stroke.

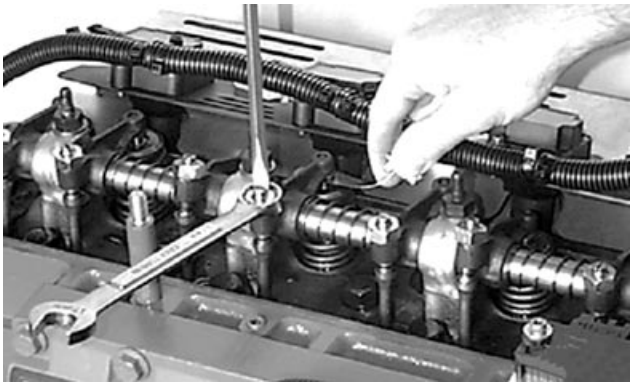
   If No.1 cylinder rocker arms are loose, the engine is at No. 1 “TDC” Compression. If No. 1 cylinder rocker arms are not loose, rotate engine one full revolution (360°) to No. 1 “TDC” Compression.

5. Check and adjust valve clearance to specifications.

Rocker Arm-to-Valve Tip Clearance—Specification

Intake Valve Clearance	0.36 mm (0.014 in.)
Exhaust Valve Clearance	0.46 mm (0.018 in.)

6. Tighten jam nut to 27 N•m (20 lb-ft) after adjusting valve clearance.



RG8952 –UN–

Adjusting Valve Clearance

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RG,05,DT7375 –19–11NOV97–2/3

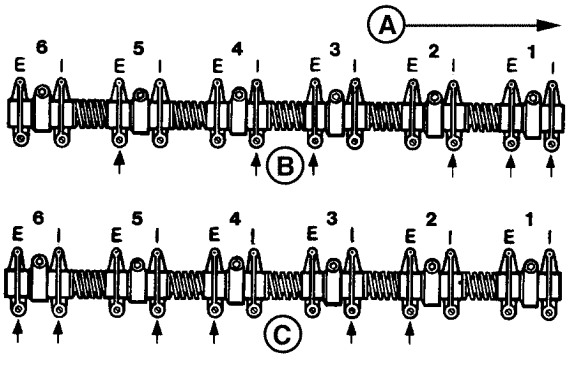
7. Lock No. 1 piston at TDC compression stroke (B).

NOTE: Firing order is 1-5-3-6-2-4.

8. Adjust valve clearance on No. 1, 3 and 5 exhaust valves and No. 1, 2, and 4 intake valves.

9. Turn crankshaft 360°. Lock No. 6 piston is at TDC compression stroke (C).

10. Adjust valve clearance on No. 2, 4 and 6 exhaust valve and No. 3, 5, and 6 intake valves.



Valve Adjusting Sequence

A—Front of Engine
B—No. 1 Piston TDC Compression
C—No. 6 Piston TDC Compression
E—Exhaust Valve
I—Intake Valve

RG,05,DT7375 –19–11NOV97–3/3

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MEASURE VALVE LIFT

IMPORTANT: For a more accurate measurement, measure valve lift at 0.00 mm (in.) rocker arm-to-valve tip clearance and with engine COLD.

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

1. Remove rocker arm cover.
2. Set No. 1 piston at TDC compression stroke and install JDE81-4 Timing Pin in flywheel.
3. Set rocker arm-to-valve tip clearance to 0.00 mm (in.) for No. 1, 3, and 5 exhaust and No. 1, 2, and 4 intake valves.
4. Place dial indicator tip on top of valve spring cap (retainer) or rotator. Preload indicator tip and set dial at 0.00 mm (in.).
5. Remove timing pin from flywheel and manually rotate engine one full revolution (360°) in running direction using appropriate flywheel turning tool.
6. Observe dial indicator reading as valve is moved to full open. Record maximum reading and compare with specifications given below.

Intake Valve at 0.00 mm (in.) Clearance—Specification

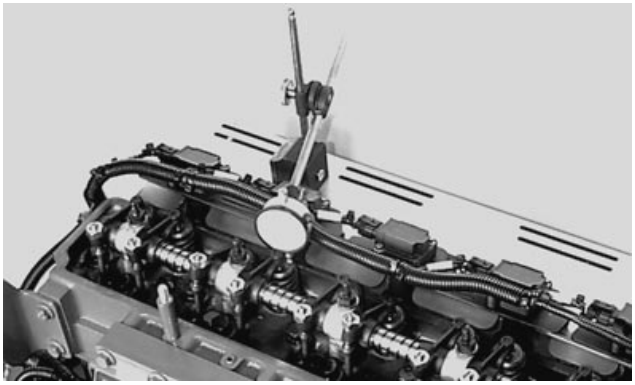
Valve Lift	11.77—12.21 mm (0.463—0.481 in.)
Wear Limit	11.34 mm (0.446 in.)

Exhaust Valve at 0.00 mm (in.) Clearance—Specification

Valve Lift	11.51—11.84 mm (0.453—0.470 in.)
Wear Tolerance	11.08 mm (0.436 in.)

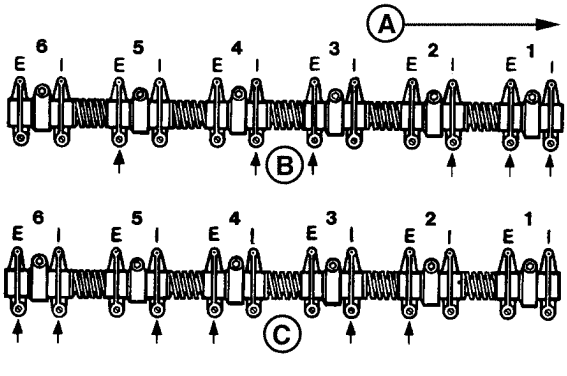
7. Follow same procedure for all remaining valves and record readings.

   If valve lift on all valves is within specifications, adjust valve lash to specified clearance. (See CHECK AND ADJUST VALVE CLEARANCE earlier in this group.)



RG8863 –UN–

Measure Valve Lift



RG4777 –UN–

6-Cylinder Engine

A—Front of Engine
B—No. 1 Piston TDC Compression
C—No. 4 Piston or No. 6 Piston TDC Compression
E—Exhaust Valve
I—Intake Valve

Continued on next page

If valve lift on one or more valves is not within specification, remove and inspect entire valve train and camshaft.

8. Rotate engine one full revolution (360°). Lock engine at TDC No. 6 compression stroke.

9. Set rocker arm-to-valve tip clearance to 0.00 mm (in.) for No. 2, 4, and 6 exhaust and No. 3, 5, and 6 intake valves.

10. Repeat steps 4—7.

RG,05,DT7374 –19–11FEB98–2/2

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REMOVE CYLINDER HEAD

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

CAUTION: After operating engine, allow exhaust system to cool before removal. DO NOT drain coolant until the coolant is below operating temperature. Always loosen drain valve slowly to relieve any excess pressure.

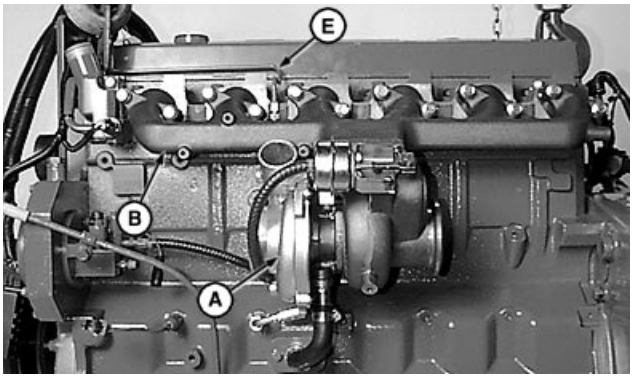
1. Drain all engine oil and coolant. Disconnect turbocharger oil inlet line at turbocharger or oil filter base. (See DISCONNECT TURBOCHARGER OIL INLET LINE in Group 03.)

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 turbocharger (A), intake manifold (C), and exhaust manifold (B) installed.

2. Remove wiring harness clamps. Remove wiring harness.
3. Remove coils, coil rails, spark plug boots, and spark plugs. (See Group 45, Electronic Engine Controls.)
4. Disconnect pre-turbine pressure line (E).
5. Remove turbocharger heat shields, turbocharger, and exhaust manifold. (See Group 30, Air Intake and Exhaust System.)
6. Disconnect gas regulator coolant hose (D).
7. Remove water manifold and all coolant piping. (See Group 25, Cooling System.)
8. Remove air intake manifold. (See Group 30, Air Intake and Exhaust System.)

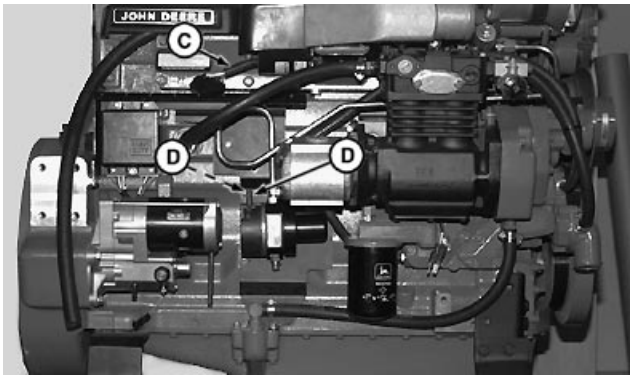
TS281 –UN–

Service Cooling System Safety



RG8872A –UN–

Removing Cylinder Head



RG8973A –UN–

Removing Cylinder Head

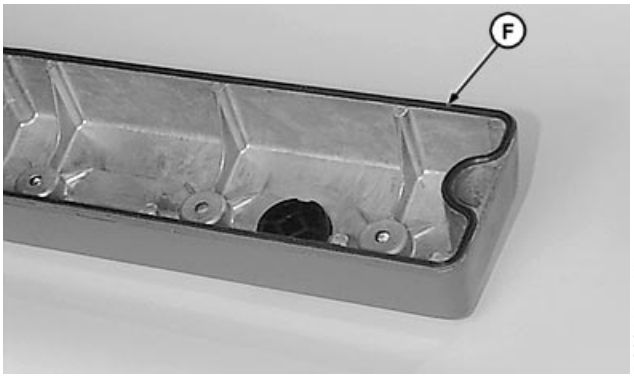
A—Turbocharger
B—Exhaust Manifold
C—Intake Manifold
D—Regulator Coolant Hose
E—Pre-Turbine Pressure Line

Continued on next page

RG,05,DD8013 –19–11FEB98–1/7

IMPORTANT: Rocker arm cover sealing ring (F) can be reused if there is no evidence of physical damage. Remove sealing ring from groove for replacement only.

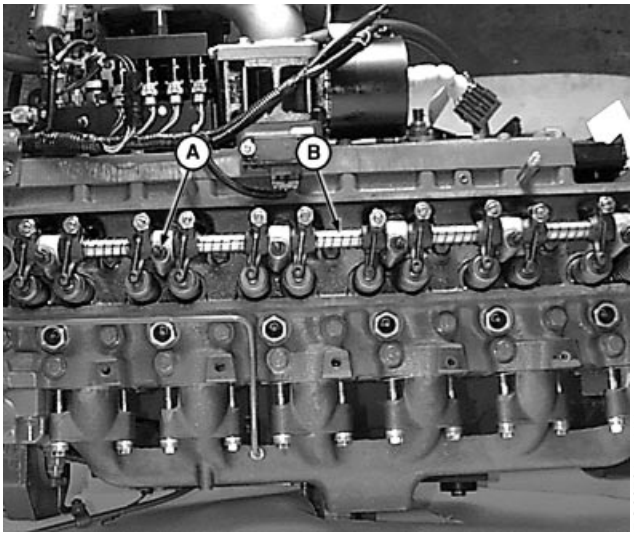
9. Remove rocker arm cover with ventilator outlet hose assembly.



Rocker Arm Cover Sealing Ring

RG,05,DD8013 –19–11FEB98–2/7

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



Rocker Arm Shaft Clamp and Assembly

Continued on next page

RG,05,DD8013 –19–11FEB98–3/7

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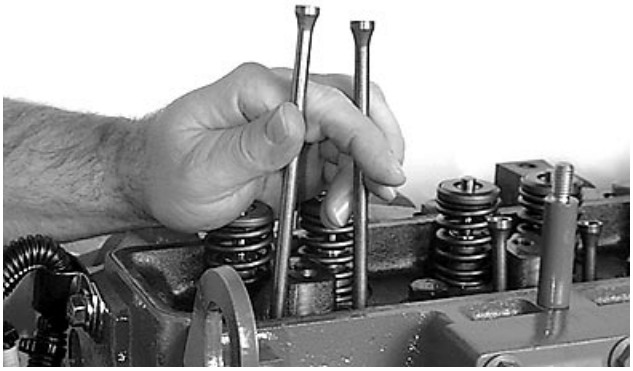
11. Remove all 12 push rods and identify for reassembly.

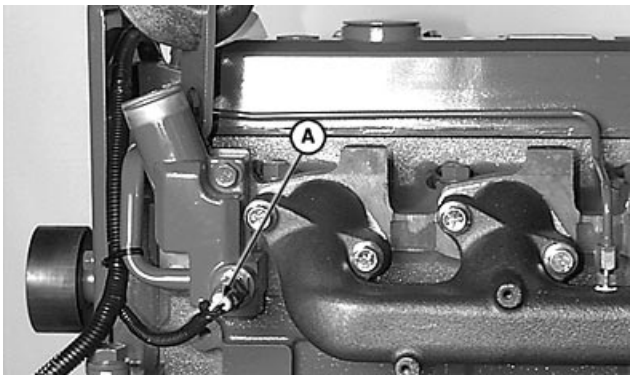
NOTE: Clean and inspect push rods as explained later in this group.



Removing Push Rods

RG,05,DD8013 –19–11FEB98–4/7

12. Disconnect coolant temperature connector (A) from sensor.



Coolant Temperature Connector

Continued on next page

RG,05,DD8013 –19–11FEB98–5/7

13. If a cylinder head gasket failure has occurred, check and record torque on each cylinder head cap screw before removing.

    To check cylinder head cap screw torque:

    - Make a reference mark (in line) on socket (A) and cylinder head surface (B).
    - Loosen cap screw at least 1/2 turn.
    - Retighten cap screw (using a torque wrench) until reference marks align and record torque).

14. Remove all 26 cylinder head cap screws. Discard cap screws; they are not reusable.

Making Torque Reference Line

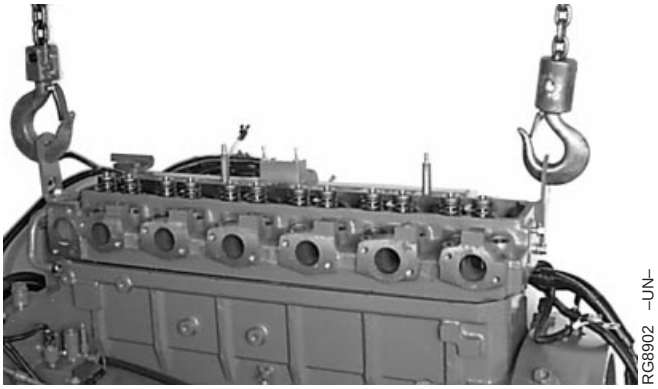
RG,05,DD8013 –19–11FEB98–6/7

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

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

16. 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, Cylinder Block, Liners, Pistons, and Rods - Repair & Replacement Procedures.



Lifting Cylinder Head

RG,05,DD8013 –19–11FEB98–7/7

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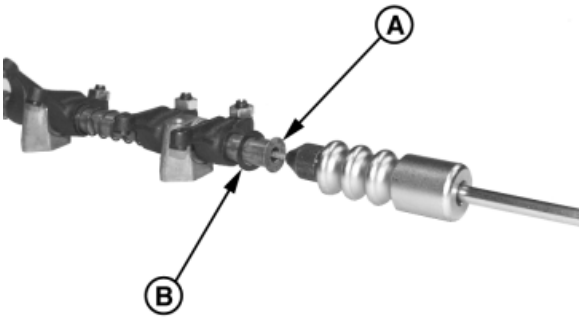
DISASSEMBLE AND INSPECT ROCKER ARM SHAFT ASSEMBLY

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

2. Disassemble and inspect all parts for wear or damage. Replace any parts that are damaged or not within specifications.

Rocker Arm, Shaft, Spring, and Support—Specification

Spring tension at 46 mm (1.81 in.) compressed height	18—27 N (4—6 lb-force)
Rocker Arm Shaft OD	19.99—20.02 mm (0.787—0.788 in.)
Shaft Support ID (Maximum)	20.17 mm (0.794 in.)
Rocker Arm Bore ID	20.07—20.12 mm (0.790—0.792 in.)
Wear Limit	20.17 mm (0.794 in.)

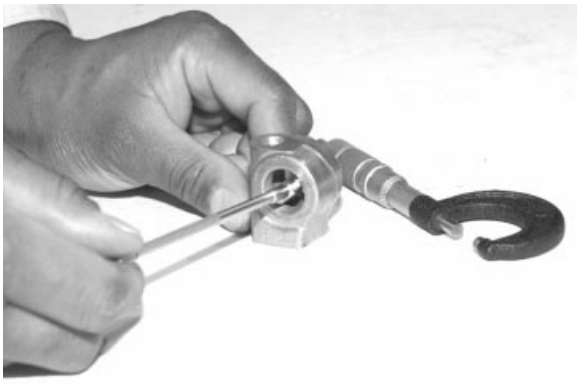


RG7417 –UN–

Rocker Arm Shaft Plugs and Washers

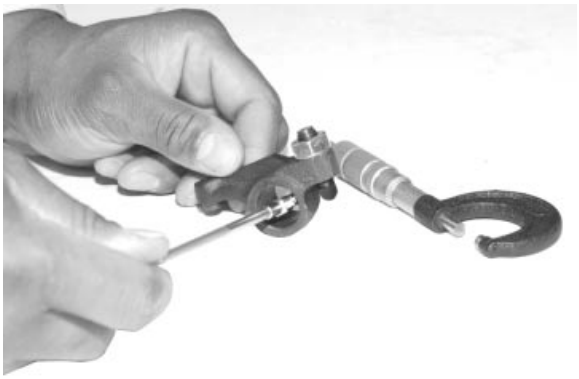
RG7418 –UN–

Measure Rocker Arm Shaft OD



RG7419 –UN–

Measure Rocker Arm Shaft Support ID



RG7420 –UN–

Measure Rocker Arm Bore ID

RG,05,DT7372 –19–11NOV97–1/1

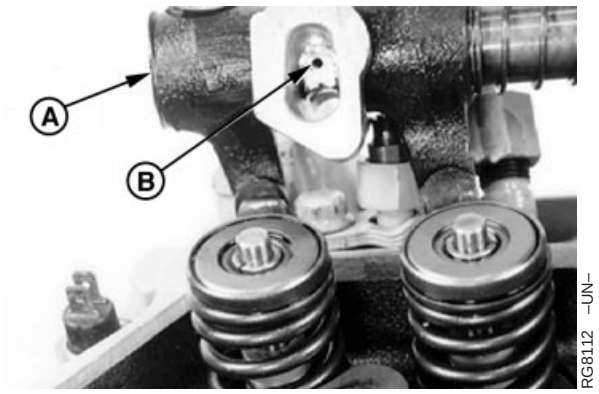
ASSEMBLE ROCKER ARM ASSEMBLY

1. Lubricate shaft OD, rocker arm bores, and rocker arm supports with clean engine oil.

IMPORTANT: The oil supply hole (B) on the rocker arm shaft must be toward the flywheel end of the engine.

2. Assemble springs, rocker arms, and rocker arm supports onto shaft in the same location as removed from.

3. Install bowed washers and new end plugs (A) firmly in end of shaft.



Assemble Rocker Arm Assembly

RG,05,DT7371 –19–11NOV97–1/1

INSPECT, MEASURE, AND ASSEMBLE CAMSHAFT FOLLOWERS

1. Remove and clean camshaft followers. Label for reassembly in same location.

Removing and Cleaning Camshaft Followers

Continued on next page

RG,05,DT7369 –19–11FEB98–1/3

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2. Measure camshaft follower OD. If camshaft follower OD is less than specified, install a new follower.

Camshaft Follower—Specification

Camshaft Follower OD	31.61—31.64 mm (1.245—1.246 in.)

RG7422 –UN–

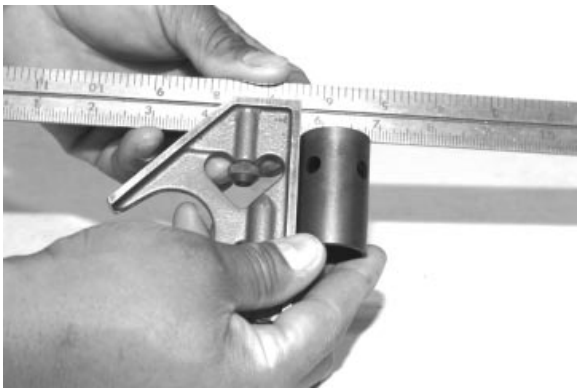
Measuring Camshaft Follower OD

RG,05,DT7369 –19–11FEB98–2/3

3. Check crown on follower face. If flat or concave, replace follower and check camshaft lobes for wear. (See Group 16.)

4. Measure camshaft follower bore in block and determine if clearance is within specification. (See Group 10.)

5. Lubricate camshaft followers in clean engine oil and install in same bore from which removed.



RG7423 –UN–

Checking Crown on Follower Face

RG,05,DT7369 –19–11FEB98–3/3

MEASURE VALVE RECESS IN CYLINDER HEAD

Measure and record valve recess (A) using a depth micrometer or magnetic base dial indicator (B). Measurements must be made a maximum of 3.0 mm (0.12 in.) in from edge of valve head.

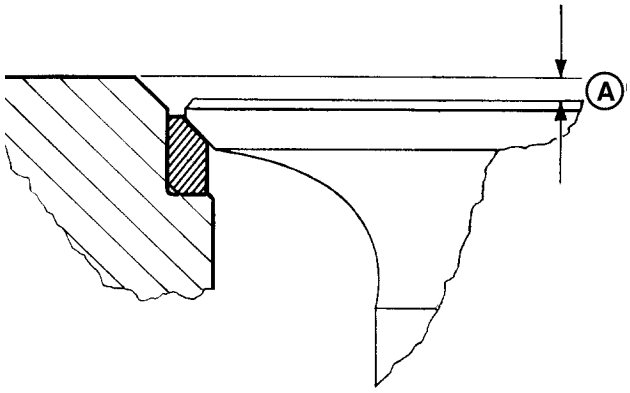
Intake Valve—Specification

Valve Recess	0.61—1.11 mm (0.024—0.044 in.)
Wear Limit	1.63 mm (0.064 in.)

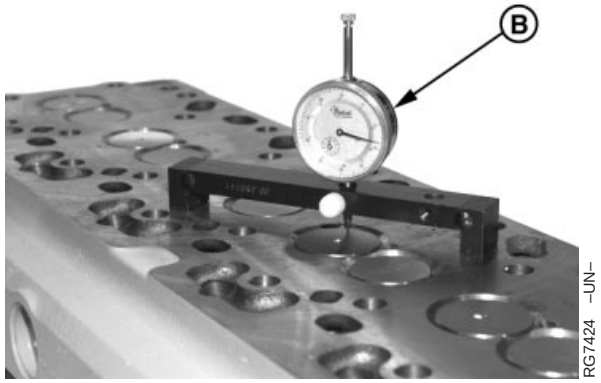
Exhaust Valve—Specification

Valve Recess	1.22—1.72 mm (0.048—0.068 in.)
Wear Limit	2.26 mm (0.089 in.)

Install new valves, inserts, or grind existing valves and inserts, as necessary, to obtain proper valve recess. Grind valve seat inserts as required. (See REMOVE VALVE SEAT INSERTS later in this group.)



Valve Recess Dimension



Measuring Valve Recess

RG,05,DT7368 –19–11FEB98–1/1

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PRELIMINARY CYLINDER HEAD AND VALVE CHECKS

Make preliminary inspection of cylinder head and valve assembly during disassembly. Look for the following conditions:

Sticking Valves:

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

Warped, Worn, or Distorted Valve Guides:

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

Distorted Cylinder Head and Gasket Leakage:

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

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

RG,05,DT7367 –19–11NOV97–1/1

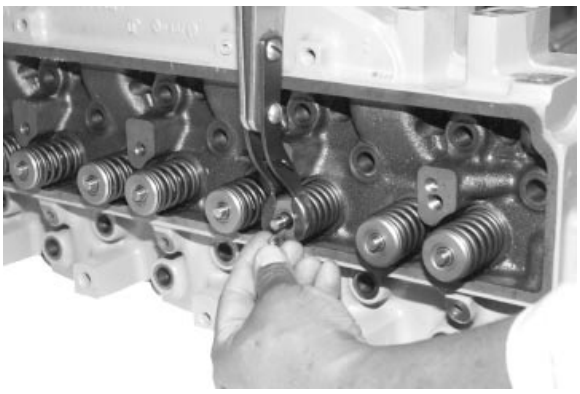
REMOVE VALVE ASSEMBLY

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

1. Using JDE138 Valve Spring Compressor, compress valve springs far enough to remove retainer locks (D).
2. Release spring tension and remove valve rotator (C) and valve spring (B).
3. Remove valves from cylinder head.

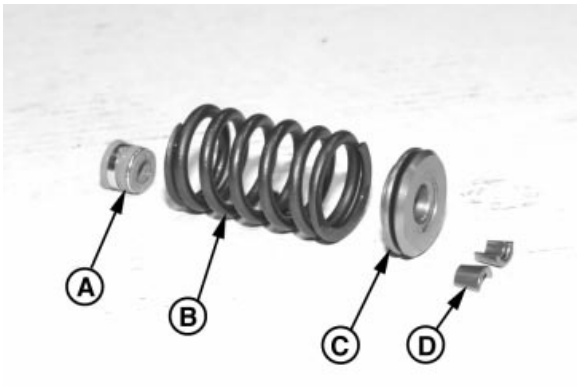
NOTE: Identify all parts for assembly in same location.

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



RG7425 –UN–

Compressing Valve Springs



RG7426 –UN–

Removing Valve Stem Seals

A—Valve Stem Seal
B—Valve Spring
C—Valve Rotator
D—Retainer Locks

RG,05,DT7366 –19–11NOV97–1/1

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INSPECT AND MEASURE VALVE SPRINGS

1. Inspect valve springs for alignment, wear, and damage.
2. Using D01168AA Spring Compression Tester, check valve spring tension. Compressed height must be within specification given below.

Valve Spring Specifications

Compression	Height
Free Length[a]	
0 N (0 lb-force)	54.0 mm (2.125 in.)
240—280 N (54—62 lb-force)	46.0 mm (1.81 in.)
590—680 N (133—153 lb-force)	34.5 mm (1.36 in.)

[a]Free length of springs may vary slightly between springs.

RG2732 –UN–

Valve Spring

RG7427 –UN–

Checking Valve Spring Tension

RG,05,DT7365 –19–11NOV97–1/1

INSPECT VALVE ROTATORS

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

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

RG7428 –UN–

Inspecting Valve Rotators

RG,05,DT7364 –19–11NOV97–1/1

CLEAN VALVES

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

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

2. Make sure all carbon is removed from valve head, face and unplated portion of stem.

RG,05,DT7363 –19–11NOV97–1/1

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INSPECT AND MEASURE VALVES

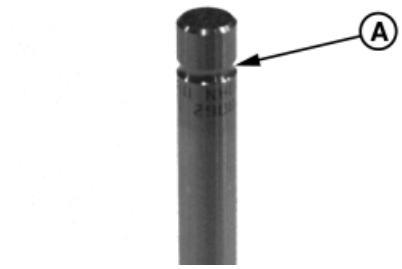
1. Clean and inspect valves, valve stems, stem tips, and retainer lock groove (A). Replace valves that are worn or damaged.

NOTE: Intake valve has a larger head OD and is also identified with a dimple (B) on valve head.

2. Measure valve stem OD. Record measurements and compare with valve guide ID. (See MEASURE VALVE GUIDES later in this group.)

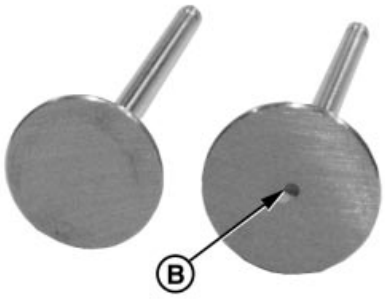
Valve Stem—Specification

Intake Valve Stem OD	7.864—7.884 mm (0.3096—0.3104 in.)
Exhaust Valve Stem OD	7.848—7.874 mm (0.3090—0.3100 in.)



RG7429 –UN–

Clean and Inspect Retainer Lock Groove



RG7759 –UN–

Identifying Valves

RG7430 –UN–

Measuring Valve Guide OD

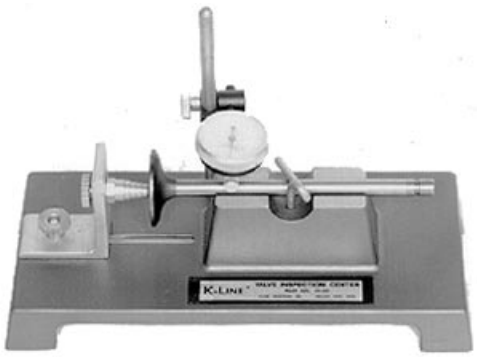
Continued on next page

RG,05,DT7362 –19–11NOV97–1/2

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

Intake and Exhaust Valve—Specification

Maximum Valve Face Runout	0.038 mm (0.0015 in.)



RG4234 –UN–

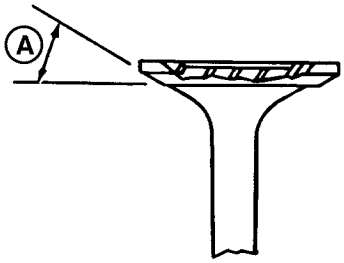
Valve Face Runout Check

RG,05,DT7362 –19–11NOV97–2/2

GRIND VALVES

Reface serviceable valves to specified angle (A). Face angle on intake and exhaust valves is 19.25° ± 0.25°.

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



RG4755 –UN–

Resurfacing Valve Angle

RG,05,DT7361 –19–11FEB98–1/1

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INSPECT AND CLEAN CYLINDER HEAD

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 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.

RG,05,DT7073 –19–30OCT97–1/1

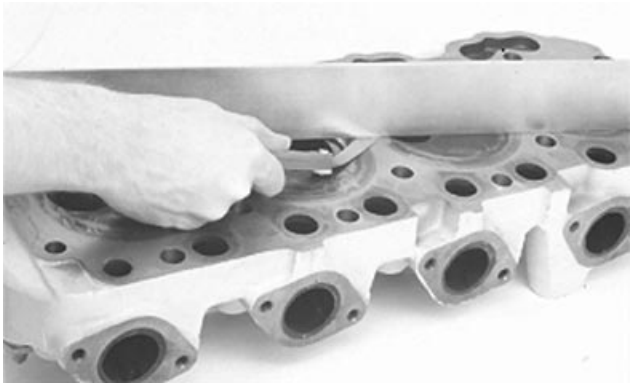
CHECK CYLINDER HEAD FLATNESS

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

Cylinder Head Maximum Acceptable Out-of-Flat—Specification

Flatness (For Entire Length or Width)	0.08 mm (0.003 in.)
Flatness (For Every 150 mm [5.90 in.])	0.03 mm (0.001 in.)

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



Checking Cylinder Head Flatness

RG,05,DT7359 –19–11NOV97–1/1

MEASURE CYLINDER HEAD THICKNESS

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

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

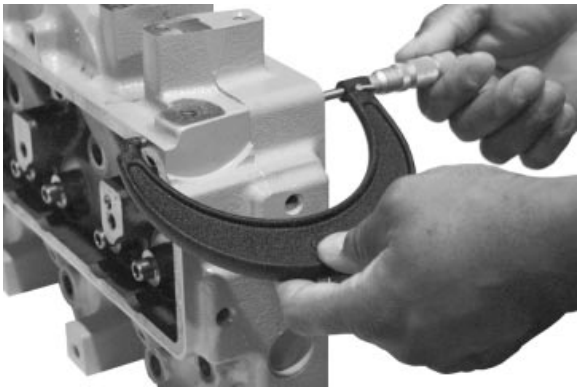
When resurfacing cylinder head, remove ONLY what is necessary to restore flatness.

Cylinder Head—Specification

New Cylinder Head Thickness	104.87—105.13 mm (4.129—4.139 in.)
Minimum Acceptable Thickness	104.24 mm (4.104 in.)
Combustion Face Surface Finish (Surface Grind Only) (AA)	0.7—3.2 micrometers (31—125 micro-in.)
Maximum Wave Depth	0.012 mm (0.0005 in.)

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

Measure and record valve recess in cylinder head. (See CHECK VALVE RECESS IN CYLINDER HEAD earlier in this group.)



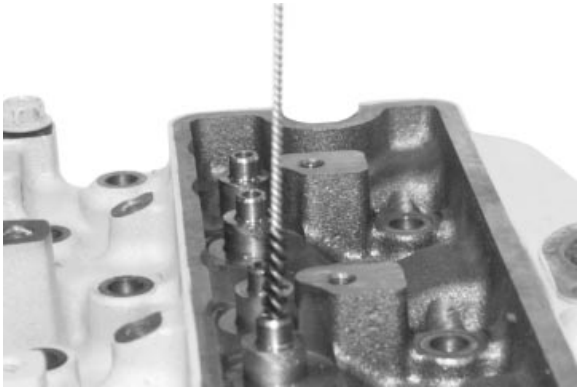
Measuring Cylinder Head Thickness

RG,05,DT7358 –19–11NOV97–1/1

CLEAN VALVE GUIDES

Clean valve guides before inspection or repair, with a plastic brush.

NOTE: A few drops of light oil or kerosene will help clean the guides.



Cleaning Valve Guides

RG,05,DT7356 –19–11NOV97–1/1

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MEASURE VALVE GUIDES

Using a telescopic gauge, measure valve guide wear.

Valve Guide—Specification

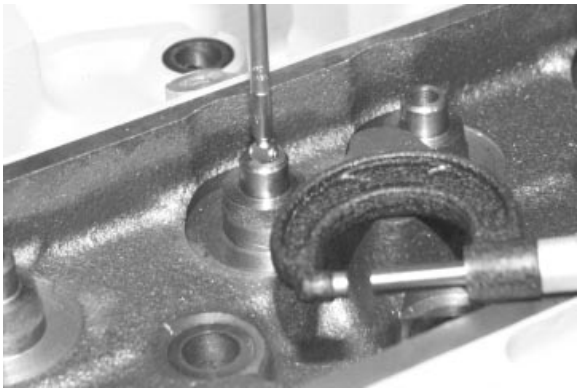
Valve Guide Bore I.D. (New)	7.912—7.938 mm (0.312—0.313 in.)
Valve Guide-to-Valve Stem Clearance (New)	0.05—0.10 mm (0.002—0.004 in.)
Wear Limit	0.15 mm (0.006 in.)

NOTE: Valves are available with 0.38 mm (0.015 in.) and 0.76 mm (0.030 in.) oversize stems.

If valve guide-to-stem oil clearance exceeds the wear limit, oversize valve stems are available. Have a qualified machine shop ream valve guides to assure guide-to-stem clearance is within specification.

If valve guide-to-stem oil clearance exceeds the wear limit, but is less than 0.20 mm (0.008 in.), it is acceptable to knurl guides and ream to size. However, installing oversize valve stems is preferred. (See KNURL VALVE GUIDES, later in this group.)

IMPORTANT: Production valve guides have a 5/6-24NF modified internal thread the entire length of guide with major diameter of 8.052—8.128 mm (0.3170—0.3199 in.) Have qualified machine shop thread valve guides accordingly after reaming for oversize valve stems.



Measuring Valve Guide

RG,05,DT7355 –19–11NOV97–1/1

KNURL VALVE GUIDES

IMPORTANT: Valve guide knurling should only be done by experienced personnel familiar with equipment and capable of maintaining required specification. ALWAYS knurl valve guides before reaming to assure proper valve guide-to-stem clearance.

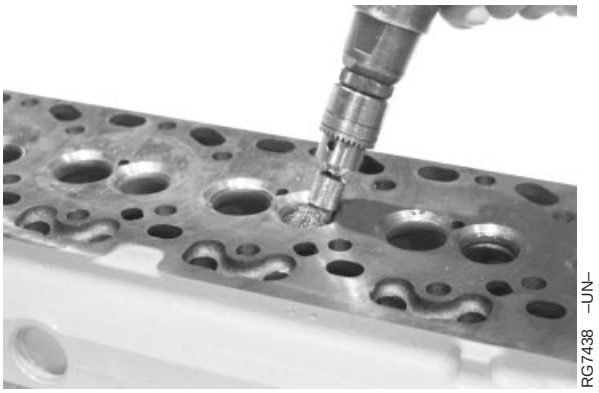
1. Use JT05949 Valve Guide Knurler Kit to knurl valve guides. Use kit exactly as directed by the manufacturer.
2. After knurling, ream valve guide to finished size to provide specified stem-to-guide clearance.

Knurling Valve Guides

RG,05,DT7354 –19–11NOV97–1/1

CLEAN AND INSPECT VALVE SEATS

1. Use an electric hand drill with D17024BR End Brush to remove all carbon on valve seats.
2. Inspect seats for excessive wear, cracks, or damage.
3. Check entire combustion face for rust, scoring, pitting, or cracks.



Cleaning Valve Seats

RG,05,DT7379 –19–11NOV97–1/1

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GRIND VALVE SEATS

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

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

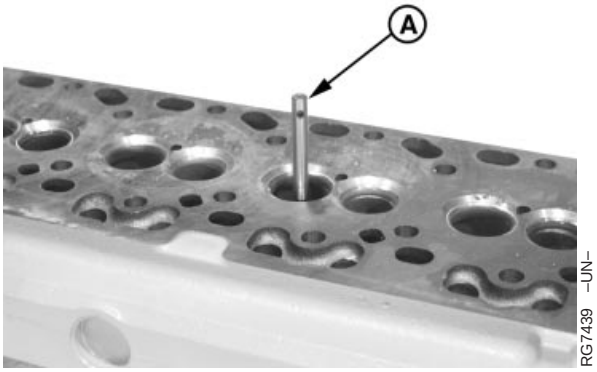
Support the weight of grinder to avoid excessive pressure on the stone.

Blend or radius all sharp edges after grinding valve seats for a more effective valve face-to-seat seal.

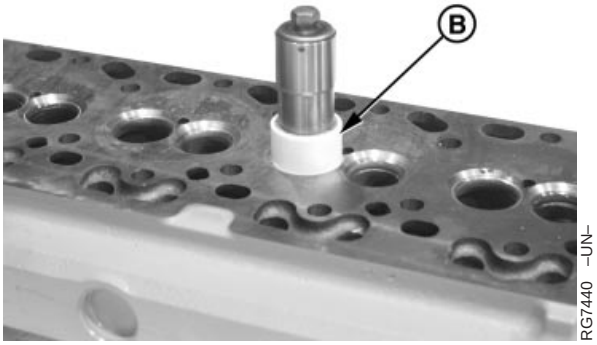
1. Install appropriate pilot (A) in valve guide bore.
2. Install appropriate grinding stone (B) on arbor (C) and position onto valve seat.
3. Using drill from JT05893 Heavy Duty Seat Grinder Set, grind valve seats to the following specifications:

Valve Seat Grinding—Specification

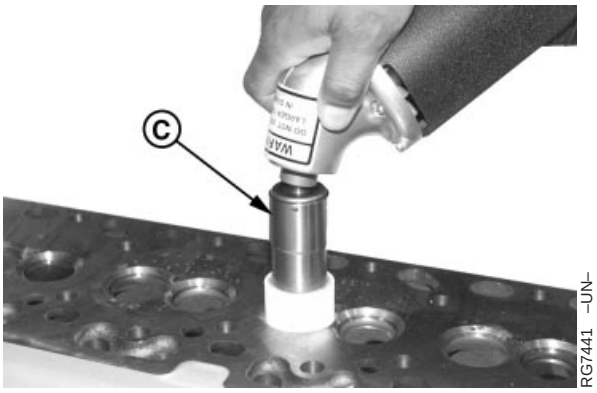
Angle (D)	20°
Width (E)	1.50—2.00 mm (0.059—0.079 in.)
Maximum Valve Seat Runout (F)	0.8 mm (0.003 in.)



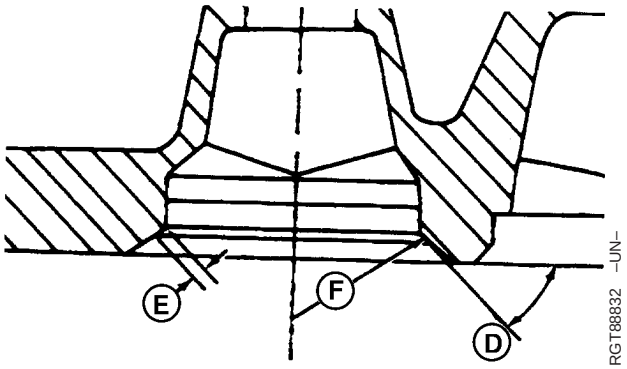
Installing Pilot



Installing Grinding Stone



Installing Arbor on Stone



Valve Seat Angles

A—Pilot
B—Grinding Stone
C—Arbor
D—Valve Seat Angle
E—Valve Seat Width
F—Valve Seat Runout

Continued on next page

RG,05,DT7353 –19–11FEB98–1/3

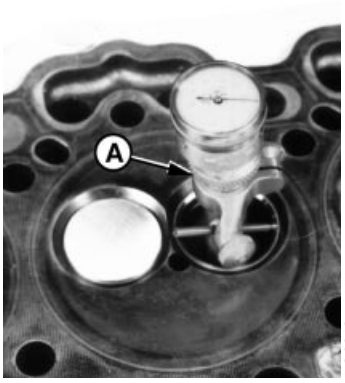
4. Use a vernier caliper or scale to measure seat width. If valve seat is too wide, reduce the width with a narrowing stone.

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

RG,05,DT7353 –19–11FEB98–2/3

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

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



Measuring Valve Seat Runout

RG,05,DT7353 –19–11FEB98–3/3

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REMOVE VALVE SEAT INSERTS

IMPORTANT: Be careful not to damage cylinder head when removing valve seats. Valve seat removal should only be done by experienced personnel familiar with procedures.

Valve seat inserts are made of sintered (powdered) metal. Remove inserts by one of the following methods:

IMPORTANT: DO NOT use an oxy-acetylene torch to remove valve seat inserts, as it alters the hardness of the cylinder head.

RAISING BURR ON VALVE SEAT INSERT

1. Using a carbide deburring tool, (A) raise a burr (B) on bottom of valve seat insert.

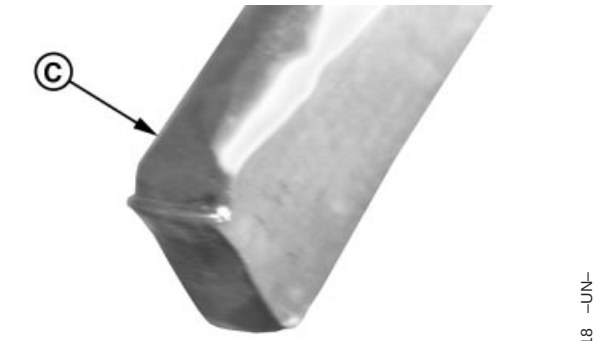
2. Protect surface of cylinder head with cardboard or cloth. Using a chisel with special ground end (C), tap handle of chisel with hammer until valve seat insert (D) comes loose.

RG7816 –UN–

Using Deburring Tool on Valve Seat

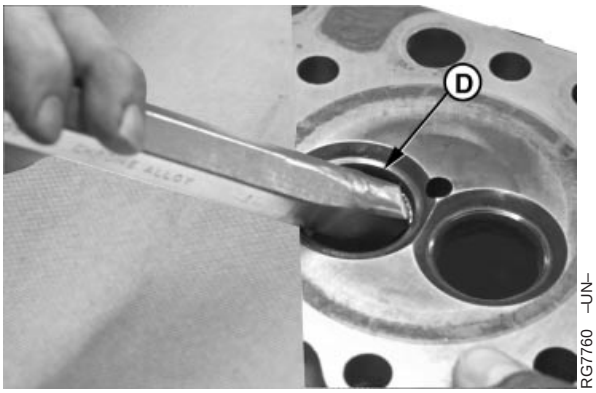
RG7817 –UN–

Raising a Burr on Valve Seat



RG7818 –UN–

Modified Chisel



RG7760 –UN–

Tapping Valve Seat Insert

A—Deburring Tool
B—Burr
C—Special Ground Chisel
D—Valve Seat Insert

Continued on next page

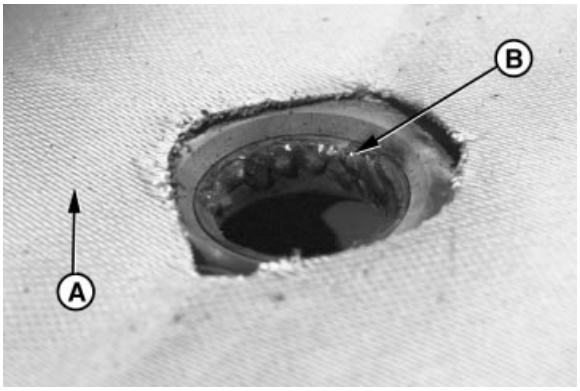
RG,05,DT7352 –19–11NOV97–1/2

USING AN ARC WELDER

1. Protect the valve guide by installing a cap screw or dowel in guide to protect from weld spatter.

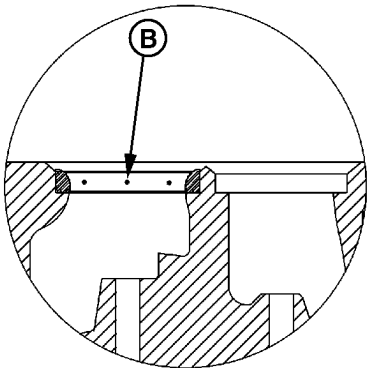
2. Protect the cylinder head surface with a non-flammable welder's cloth (A). Apply a thin bead of weld (B) around ID of valve seat insert. Allow insert to cool and use a screwdriver (C) or similar tool and carefully pry insert from bore.

3. After removal of inserts, thoroughly clean area around valve seat bore and inspect for damage or cracks. Replace cylinder head as necessary.



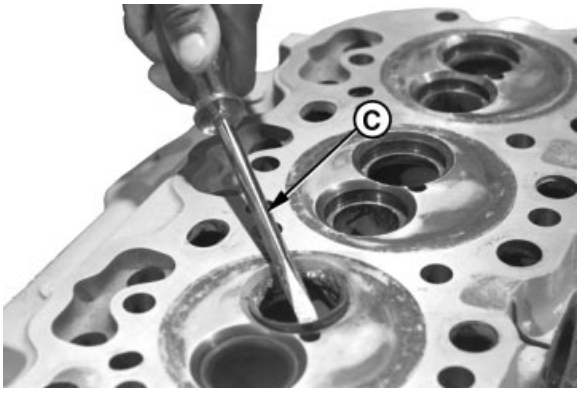
RG7761 –UN–

Welding Around ID of Valve Seat Insert



RG7813 –UN–

Resealing Around Seat



RG7763 –UN–

Prying Insert From Bore

RG,05,DT7352 –19–11NOV97–2/2

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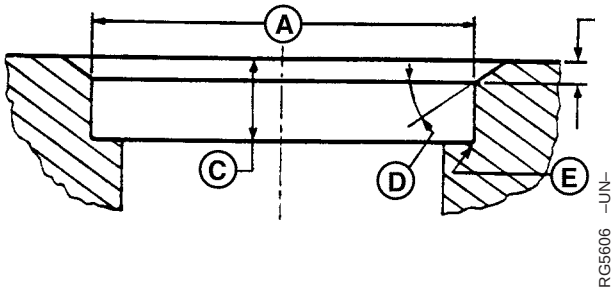
MEASURE VALVE SEAT BORE IN CYLINDER HEAD

If bore dimensions are not within specification, machine head to the following specifications:



Measuring Valve Seat Bore

Exhaust Valve Seat Insert Bore—Specification

Seat Bore (A)	42.987—43.013 mm (1.6924—1.6934 in.)
Installed Depth (B)	3.82 mm (0.150 in.) Reference
Bore Depth (C)	9.936—10.064 mm (0.3912—0.3962 in.)
Bore Angle (D)	38—42°
Maximum Radius at Lower Bore (E)	0.5 mm (0.019 in.)
Maximum Surface Finish of Bore (A)	0.00158 mm (0.000062 in.)

Intake Valve Seat Insert Bore—Specification

Seat Bore (A)	47.104—47.130 mm (1.8545—1.8555 in.)
Installed Depth (B)	3.45 mm (0.136 in.) Reference
Bore Depth (C)	9.936—10.064 mm (0.3912—0.3962 in.)
Bore Angle (D)	38—42°
Maximum Radius at Lower Bore (E)	0.5 mm (0.019 in.)
Maximum Surface Finish of Bore (A)	0.00158 mm (0.000062 in.)

Replacement Valve Seat Insert—Specification

OD (Intake Valve)	47.155—47.181 mm (1.8565—1.8575 in.)
OD (Exhaust Valve)	43.038—43.064 mm (1.6944—1.6954 in.)

RG,05,DT7351 –19–11FEB98–1/1

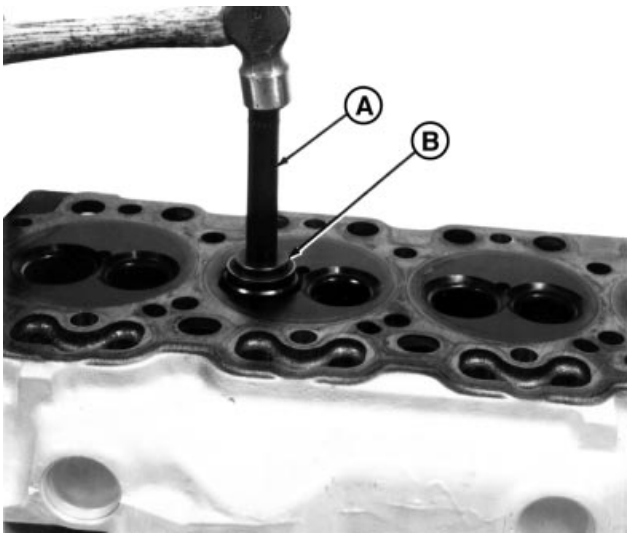
INSTALL VALVE SEAT INSERTS

1. Use JDG676 Pilot Driver (A) and JDG675 Valve Seat Insert Installing Adapter (B) to install valve seat inserts in cylinder head.

   Use one end of JDG675 Adapter to install intake valve seat inserts and the other end to install exhaust valve seat inserts.

2. Install valves and measure valve recess. (See MEASURE VALVE RECESS IN CYLINDER HEAD, earlier in this group.)

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



Installing Valve Seat Inserts

RG,05,DT7350 –19–11NOV97–1/1

INSTALL VALVES

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

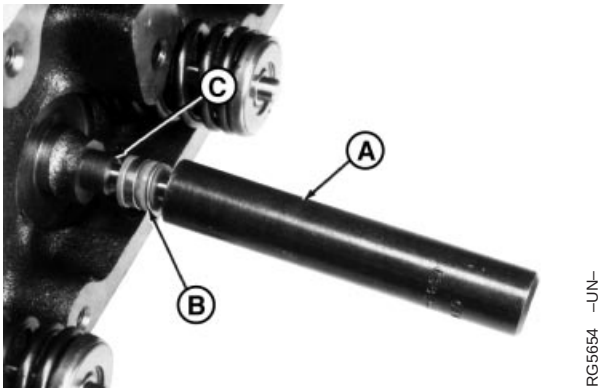
NOTE: Valves must move freely in guide and seat properly in head to form an effective seal.

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

3. Use JDG678 Valve Stem Seal Installer (A) to slide valve stem seals (B) over valve stems and onto valve guide tower (C).

NOTE: JDG678 Installer may also be used to install oversize valve stem seals on oversize valve stems.

4. Install valve springs and rotators.



Installing Valves and Valve Stems

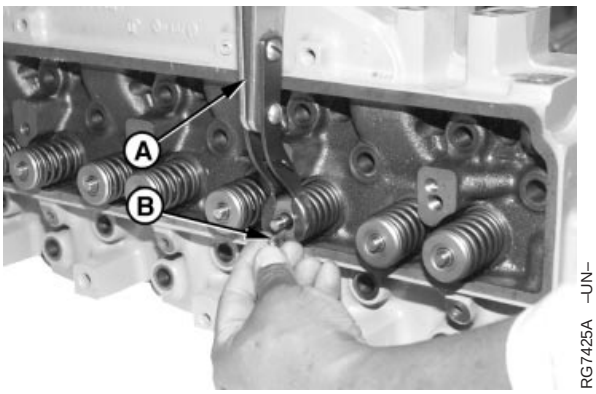
Continued on next page

RG,05,DT7349 –19–11NOV97–1/2

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

6. Strike end of each valve three or four times with a soft mallet (non-metallic) to insure proper positioning of the retainer locks.

7. Recheck valve recess. (See MEASURE VALVE RECESS IN CYLINDER HEAD, earlier in this group.)



Installing Valve Stems

RG,05,DT7349 –19–11NOV97–2/2

INSPECT AND CLEAN EXHAUST MANIFOLD

1. Thoroughly clean all passages and gasket surfaces in exhaust manifold and exhaust elbow.

2. Inspect entire exhaust manifold for cracks or damage. Replace parts as necessary.

RG,05,DT7347 –19–11NOV97–1/1

CLEAN AND INSPECT TOP DECK OF CYLINDER BLOCK

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

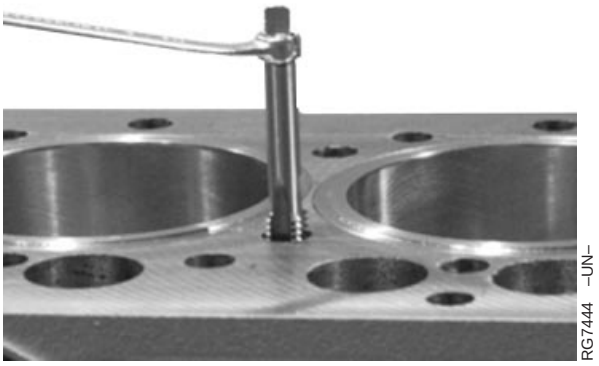
2. Clean threaded holes in cylinder block using JDG680 Tap or any 1/2-13 UNC-2A tap about 76 mm (3.0 in.) long. Use compressed air to remove debris and fluids from the cap screw holes. Replace block if there is evidence of damage.

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

IMPORTANT: All debris must be cleaned from the camshaft followers before assembling the engine.

4. If not previously done, remove camshaft followers from block and wash in solvent. Lubricate with clean engine oil and install in the same bore.

5. Inspect top deck for flatness and serviceability. (See Group 10.)



Cleaning Threaded Holes in Cylinder Head

Removing Camshaft Followers

RG,05,DT7346 –19–11FEB98–1/1

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MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

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

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

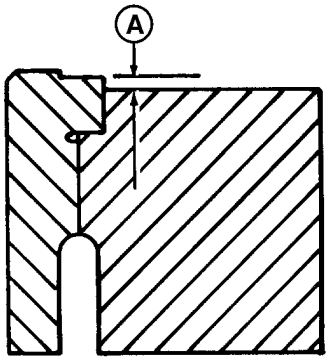
Liner Standout—Specification

Liner Height Above Block	0.030—0.100 mm (0.0010—0.0040 in.)
Maximum Permissible Height	0.051mm (0.0020 in.)
Difference at Nearest Point of Two Adjacent Liners, or Within One Liner	

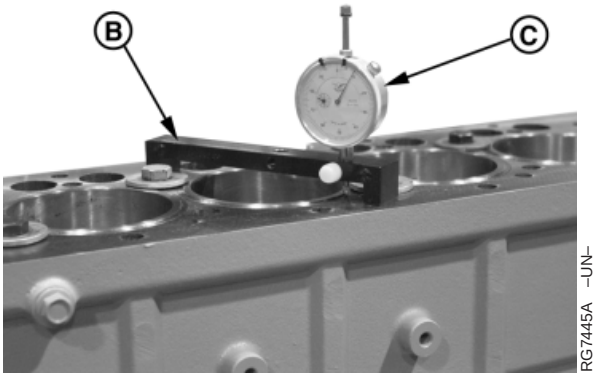
IMPORTANT: ONE LINER SHIM ONLY may be installed under each liner flange.

3. Remove and shim, or replace, any liner that does not meet height specifications.

NOTE: Two sizes of shims are available: 0.05 mm (0.002 in.) and 0.10 mm (0.004 in.).



Measuring Cylinder Liner



Measuring Liner Height with Dial Indicator

RG,05,DT7345 –19–11NOV97–1/1

INSTALL CYLINDER HEAD AND CAP SCREWS

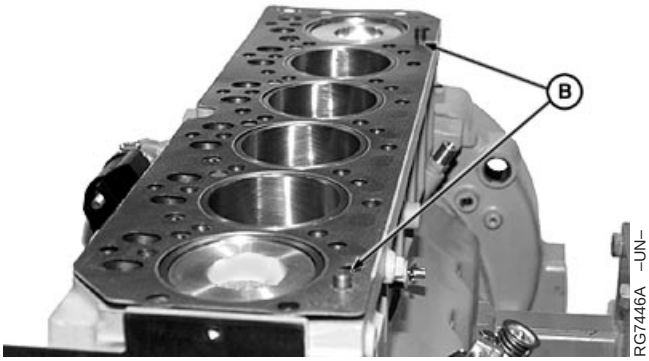
IMPORTANT: ALWAYS thoroughly inspect new cylinder head gasket for possible manufacturing imperfections. Return any gasket that does not pass inspection. Be sure cylinder head and block gasket surfaces are clean, dry, and free of any oil.

1. Install two guide studs (B) in cylinder block at locating holes.

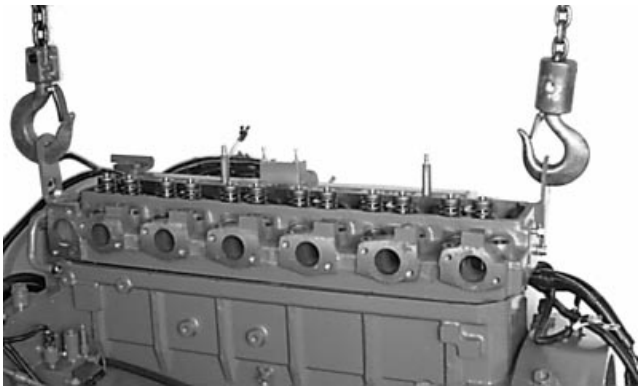
2. Place new head gasket on cylinder block. Do not use sealant; install dry.

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.

3. Position cylinder head over guide studs and lower onto cylinder block.



Installing Guide Studs



Lowering Cylinder Head on Block

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RG,05,DT7344 –19–11FEB98–1/2

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

5. Remove guide studs. Install flanged-head cylinder head cap screws.

6. Tighten all cap screws to specified torque (in sequence, beginning with No. 1) before proceeding to next step:

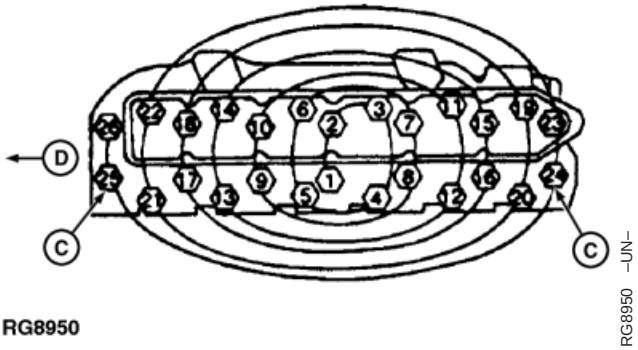
   Step 1 - Tighten all cap screws to 100 N•m (75 lb-ft).

   Step 2 - Tighten all cap screws to 150 N•m (110 lb-ft).

   Step 3 - Wait 5 minutes. Verify 150 N•m (110 lb-ft).

   Step 4 - Tighten each screw an additional 60° ± 10°. (See TORQUE-TURN METHOD FOR PROPER TORQUE next in this group.)

Retorque of cylinder head cap screws after engine break-in is not required when using the recommended torque procedure along with flanged-head cap screw.



RG8950

Torquing Cylinder Head

C—Locating Holes (Guide Stud Locations)
D—Arrow Toward Front of Engine

RG,05,DT7344 –19–11FEB98–2/2

TORQUE-TURN METHOD FOR PROPER TORQUE

After tightening cap screws to 150 N•m (110 lb-ft), use JT05993 Torque Angle Gauge or the line scribe method below to tighten each cap screw an additional 60°.

Line scribe method:

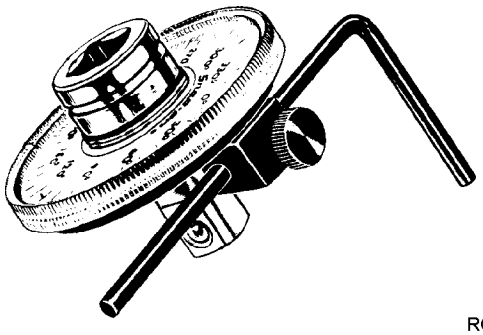
Step A—Make two marks on socket 1/6 turn (60°±10°) apart.

Step B—Make a mark on cylinder head next to each cap screw.

Step C—Place socket on cap screw so first mark aligns with mark on cylinder head.

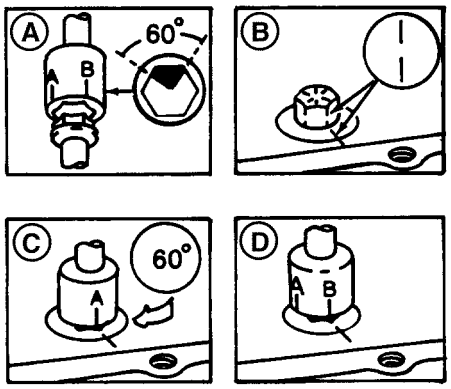
Step D—Tighten (in sequence) all cap screws until second mark on socket aligns with mark on cylinder head.

Retorque of cylinder head cap screws after engine break-in is not required when using the recommended torque procedure along with flanged-head cap screws.



RG5698 –UN–

Torque Turning Tool



RG5587 –UN–

Using the Line Scribe Method

RG,05,DT7343 –19–11NOV97–1/1

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INSTALL ROCKER ARM ASSEMBLY

1. Install push rods in same location from which removed.

NOTE: Valve stem tips are specially hardened. Wear caps are not required.

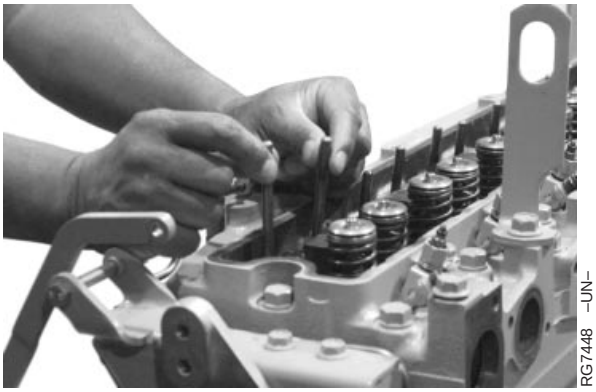
IMPORTANT: Relieve tension on rocker arm adjusting screw to avoid damaging rocker arm shaft during installation.

2. Position rocker arm assembly on engine.

IMPORTANT: Oil supply hole in rocker arm shaft must be positioned at the flywheel end of engine and facing downward when rocker shaft is installed.

3. Lubricate all rocker arms with engine oil and make sure they move freely. Tighten rocker arm support studs to 80 N•m (59 lb-ft).

4. Adjust valve clearance. (See CHECK AND ADJUST VALVE CLEARANCE earlier in this group.)



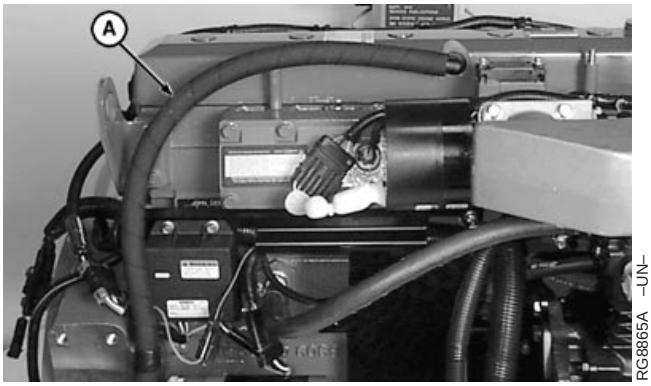
Installing Rocker Arm Push Rods

RG,05,DT7342 –19–11NOV97–1/1

INSPECT AND CLEAN VENTILATOR OUTLET HOSE

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

2. Clean ventilator hose and tube if they are restricted.



Inspect and Clean Ventilator Outlet Hose

RG,05,DT7341 –19–11NOV97–1/1

INSTALL ROCKER ARM COVER

IMPORTANT: Dispose of sealing ring (A) if there is evidence of damage. Otherwise, do NOT remove seal from groove.

If the sealing ring is defective, the following procedure should be used to install a new sealing ring:

- Carefully remove the old sealing ring from rocker arm cover. Do not use any cutting tool that could damage the cover.
- Clean the groove with acetone. Dry with compressed air.
- When installing new ring in groove, start at ends and work toward the center of the cover. Do not use sealant on seal ring.

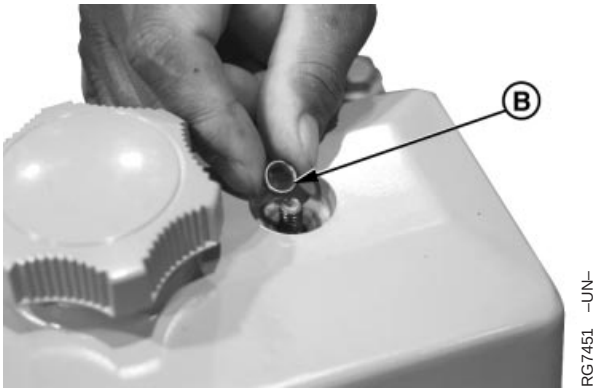
1. Install rocker arm cover with seal ring.

Rocker Arm Cover Sealing Ring

RG,05,DT7340 –19–11NOV97–1/3

2. Install O-rings (B) and nuts.

3. Tighten all nuts to 35 N•m (26 lb-ft), starting at the center and alternate sides until reaching the ends. DO NOT OVERTIGHTEN.



Install Rocker Arm Cover O-rings

Continued on next page

RG,05,DT7340 –19–11NOV97–2/3

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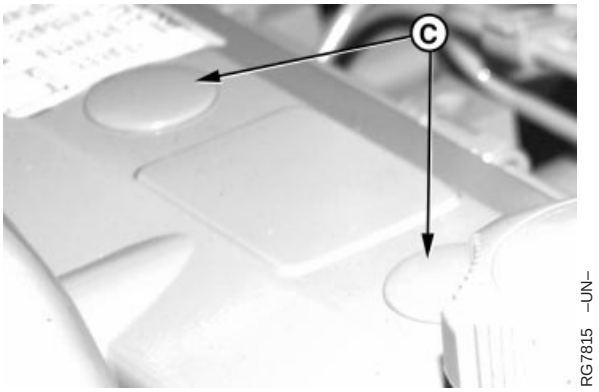
4. Install rocker arm cover button plugs (C).

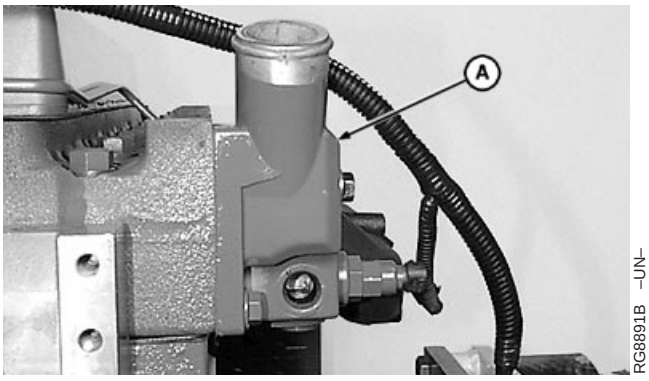


Installing Rocker Arm Cover Plugs

RG,05,DT7340 –19–11NOV97–3/3

COMPLETE FINAL ASSEMBLY

1. Install thermostat housing/water manifold (A). (See Group 25.)

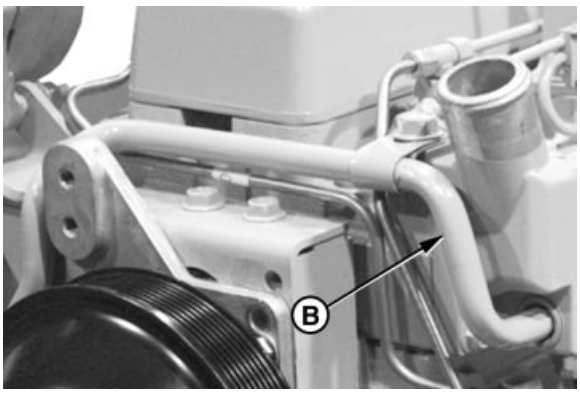


Thermostat Housing

Continued on next page

RG,05,DT7339 –19–11FEB98–1/3

2. Install thermostat housing-to-water pump tube (B).



Thermostat Housing-to-Water Pump Tube

Continued on next page

RG,05,DT7339 –19–11FEB98–2/3

05
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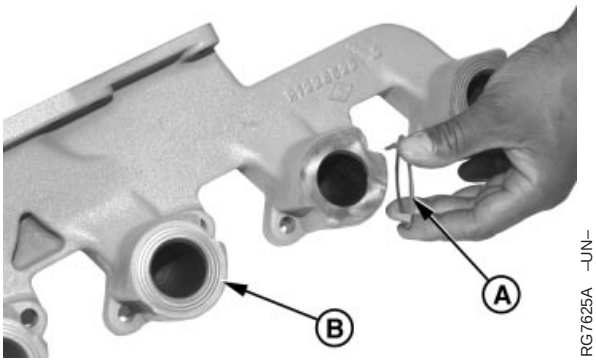
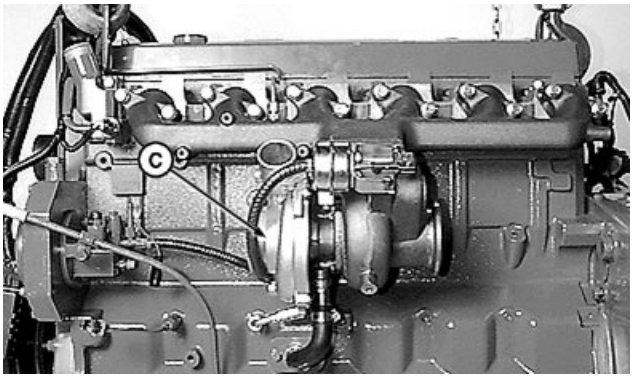
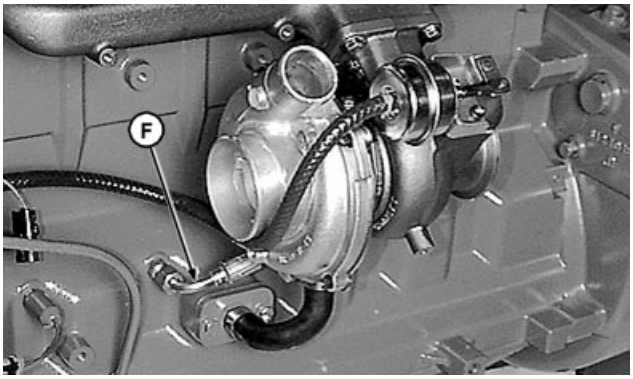
3. Using guide studs, install exhaust manifold (B) with gaskets (A). (See Group 30.)
4. Install turbocharger and exhaust elbow (shown removed). (See Group 30.)
5. Install air intake elbow. (See Group 30.)
6. Connect turbocharger oil inlet line (F).
7. Install alternator if removed. Tighten top and bottom cap screws to 70 N•m (52 lb-ft).
8. If engine oil was drained from crankcase, install new oil filter and fill engine with clean oil of correct grade and viscosity. (See Group 02.)
9. Fill cooling system with clean coolant. (See Group 02.)



Exhaust Manifold and Gaskets



Installing Turbocharger



Turbocharger Oil Inlet Line

A—Exhaust Gasket
B—Exhaust Manifold
C—Turbocharger
F—Turbocharger Oil Inlet Line

RG,05,DT7339 –19–11FEB98–3/3

PERFORM ENGINE BREAK-IN

1. Run engine at slow idle no load for 1 minute. Check for fuel, coolant, and oil leaks.

2. Increase RPM to fast idle, then load down to 50 rpm above rated speed for 10 minutes.

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

3. Recheck valve clearances and adjust as necessary after engine cools. (See CHECK AND ADJUST VALVE CLEARANCE, earlier in this group.)

4. Install rocker arm cover. Tighten rocker arm cover nuts to 35 N•m (26 lb-ft). (See INSTALL ROCKER ARM COVER earlier in this group.)

   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,05,DT7338 –19–11NOV97–1/1

SPECIAL OR ESSENTIAL TOOLS

NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

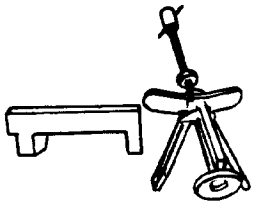
SERVICE-GARD is a trademark of Deere & Company.

RG,10,DT7321 –19–11FEB98–1/13

RG5019 –UN–

Cylinder Liner Puller . . . . . .D01062AA, D01073AA or KCD1001

Used to remove and install cylinder liners.



RG5019

D01062AA, D01073AA or KCD10001

RG,10,DT7321 –19–11FEB98–2/13

RG5074 –UN–

Flexible Cylinder Hone D17004BR

Hone cylinder liners.

RG5074

D17004BR

Continued on next page

RG,10,DT7321 –19–11FEB98–3/13

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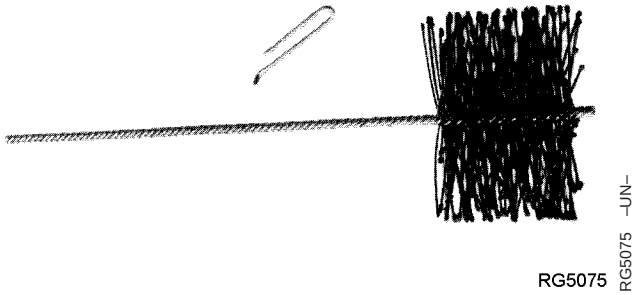
2

O-Ring Groove Cleaning Brush D17015BR

Clean cylinder liner O-ring groove in block.



D17015BR

RG,10,DT7321 –19–11FEB98–4/13

RG5031 –UN–

Piston Ring Compressor. . . . . .JDE84[1]

Compress rings while installing pistons.

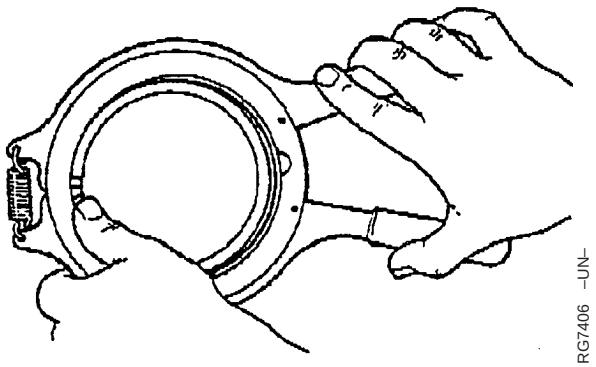
JDE84

[1]Depending on engine application and the piston used, one or the other gauge will be used.

RG,10,DT7321 –19–11FEB98–5/13

Piston Ring Expander . . . JDE85, JDE135, or KJD10140

Remove and install piston rings.



JDE85, JDE135 or KJD10140

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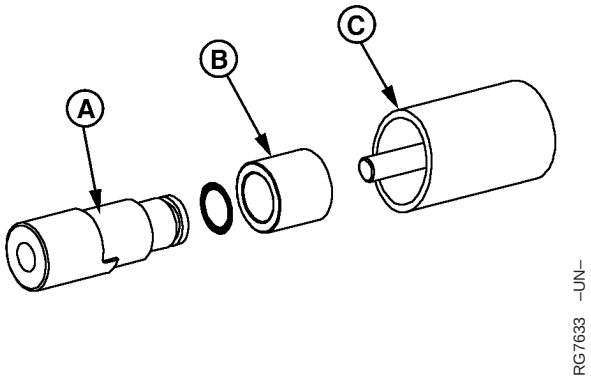
RG,10,DT7321 –19–11FEB98–6/13

Connecting Rod Bushing Service Set JDG953

Replace pin bushing in connecting rods with tapered pin-end.



JDG953

RG,10,DT7321 –19–11FEB98–7/13

Replace pin bushing in connecting rods with tapered pin-end.

JDG953 Connecting Rod Bushing Service Set consists of:

A—Remover/Replacer Driver JDG953-1
B—Installer Pilot JDG738-2
C—Receiver Cup JDG953-2

RG,10,DT7321 –19–11FEB98–8/13

RG6246 –UN–

Dial Indicator . . D17526CI (English) or D17527CI (Metric)

Use with JDG451 to measure valve recess and cylinder liner height-to-cylinder block top deck.

RG6246

D17526CI or D17527CI

Continued on next page

RG,10,DT7321 –19–11FEB98–9/13

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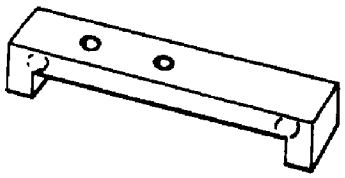
4

RG7029 –UN–

Piston and Liner Height Gauge . . . . . .JDG451[1]

Measure piston and liner heights.



RG7029

JDG451

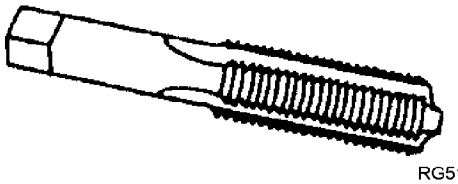
[1]A dial indicator is not supplied with JDG451. Use D17526CI (English, in.) or D17527CI (Metric, mm) Dial Indicator with JDG451.

RG,10,DT7321 –19–11FEB98–10/13

RG5100 –UN–

Tap JDG680

Used to restore threaded holes in cylinder block for cylinder head cap screws.



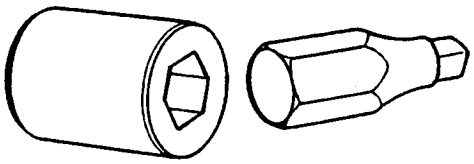
RG5100

JDG680

RG,10,DT7321 –19–11FEB98–11/13

Oil Galley Plug Tool. JDG782

Used to remove and install oil galley plug.



RG6612 –UN–

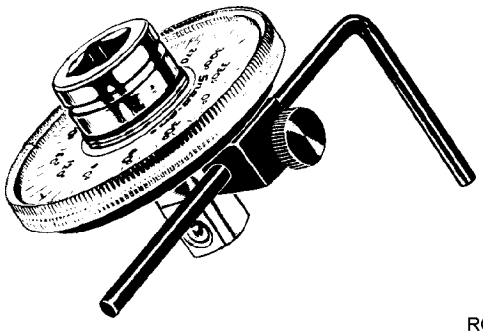
JDG782

Continued on next page

RG,10,DT7321 –19–11FEB98–12/13

Torque Angle Gauge JT05993

Used to TORQUE-TURN flanged-head cylinder head and connecting rod cap screws.



JT05993

RG,10,DT7321 –19–11FEB98–13/13

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICE-GARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
D05012ST Precision “Bevelled Edge” Straightedge	Check cylinder head flatness.
Piston Ring Groove Cleaner	Clean piston ring grooves.
Cylinder Bore Ridge Reamer	Remove carbon from liner bore.
DFRG3[a]	Secure cylinder liner when deglazing.

[a]Dealer Fabricated Tool. See Section 99 for instructions to make tool.

SERVICE-GARD is a trademark of Deere & Company.

RG,10,DT7382 –19–11NOV97–1/1

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OTHER MATERIAL

Number	Name	Use
AR54749 (U.S.)	Soap Lubricant	Coat O-rings on cylinder liners.
— (U.S.)	PLASTIGAGE®	Determine connecting rod bearing-to-journal oil clearance.
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Coat threads of oil gallery plugs.

PLASTIGAGE is a trademark of the DANA Corp.
LOCTITE is a trademark of the Loctite Corp.

RG,10,DT7423 –19–12NOV97–1/1

CYLINDER BLOCK, LINERS, PISTONS, AND RODS SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Main Bearing Bore in Cylinder Block	84.455—84.481 mm	——
	(3.3250—3.3260 in.)	——
Centerline of Main Bearing Bore-to-Top Deck of Block	337.896—337.972 mm	——
	(13.3029—13.3059 in.)	——
Maximum Acceptable Top Deck Out-of-Flat:		
For Entire Length or Width	0.08 mm (0.003 in.)	——
For Every 150 mm (5.90 in.) Length or Width	0.025 mm (0.001 in.)	——
Top Deck Surface Finish (Surface Grind Only) (AA)	0.8—3.2 micrometers	——
	(32—125 micro-in.)	——
Maximum Wave Depth	0.012 mm (0.0005 in.)	——
Liner Flange Counterbore Depth in Block	5.952—5.988 mm	——
	(0.2343—0.2357 in.)	——
Camshaft Follower Bore ID in Block	31.70—31.75 mm	——
	(1.248—1.250 in.)	——
Camshaft Follower OD	31.61—31.64 mm	——
	(1.245—1.246 in.)	——
Camshaft Follower-to-Bore Clearance	0.06—0.13 mm	——
	(0.002—0.005 in.)	——
Camshaft Bore ID:		
[a]Front (No. 1) in Block (without bushing)	59.961—59.987 mm	——
	(2.3607—2.3617 in.)	——
Front (No. 1) in Block (with bushing)	55.961—55.987 mm	——
	(2.2031—2.2042 in.)	——
All Except No. 1	55.986—56.012 mm	——
	(2.2042—2.2052 in.)	——
Camshaft Journal-to-Bushing Oil Clearance:		
No. 1 Bore with Bushing	0.063—0.115 mm	——
	(0.0025—0.0045 in.)	——
All Except No. 1 Bore	0.088—0.140 mm	——
	(0.0035—0.0055 in.)	——
Cylinder Liner:		
Lower Block Bore for Seating	115.75—115.80 mm	——
	(4.557—4.559 in.)	——
Upper Block Bore for Seating	120.70—120.75 mm	——
	(4.752—4.754 in.)	——
Flange ID in Block	126.33—126.35 mm	——
	(4.973—4.974 in.)	——
OD at Upper Bore	120.61—120.69 mm	——
	(4.7484—4.7516 in.)	——
Clearance Between Liner and Cylinder Block:		
At Lower Bore	0.035—0.100 mm	——
	(0.001—0.004 in.)	——
At Upper Bore	0.10—0.14 mm	——
	0.004—0.005 in.)	——
Flange Thickness	5.875—6.375 mm	——
	(0.2313—0.2510 in.)	——
Height Above Block	0.030—0.100 mm	——
	(0.001—0.004 in.)	——

[a]Front cam bore in block has a replaceable bushing; remaining machined bores do not have bushings.

Continued on next page

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8

ITEM	SPECIFICATION	WEAR LIMIT
Maximum Permissible Height Difference at Nearest Point of Two Adjacent Liners or Within a Single Liner	0.05 mm (0.002 in.)	——
Packing Step Dimension	2.0185—2.2865 mm	——
	(0.07947—0.09002 in.)	——
Thickness of Liner Shim CD15466	0.05 mm (0.002 in.)	——
Thickness of Liner Shim R65833	0.10 mm (0.004 in.)	——
Cylinder ID	106.48—106.52 mm	——
	(4.192—4.194 in.)	
Maximum Permissible Wear	0.10 mm (0.004 in.)	——
Maximum Permissible Taper	0.05 mm (0.002 in.)	——
Maximum Permissible Out-of-Round	0.05 mm (0.002 in.)	——
Piston-to-Liner Clearance (Measured at Bottom of Piston Skirt):		
All Turbocharged Engines	0.08—0.15 mm	——
	(0.003—0.006 in.)	——
Piston:		
OD at 28 mm (1.1 in.) from Bottom of Skirt and Measured 90° to Piston Pin	106.38—106.40 mm	——
	(4.188—4.189 in.)	——
Protrusion Above Block Deck	0.08—0.30 mm	——
	(0.003—0.012 in.)	——
Height (Measured from Center of Piston Pin Bore-to-Top of Piston)	71.64—71.70 mm	——
	(2.820—2.823 in.)	——
Piston Ring:		
Maximum Allowable Clearance Between Second and Third Piston Ring and Ring Groove	0.20 mm (0.008 in.)	——
Piston Ring End Gap[a]		
No. 1 Compression Ring	0.33—0.58 mm	——
	(0.013—0.023 in.)	——
No. 2 Compression Ring	1.24—1.49 mm	——
	(0.049—0.059 in.	——
No. 3 Oil Control Ring	0.30—0.56 mm	——
	(0.011—0.022 in.)	——
Piston Pin:		
Bore ID	41.285—41.295 mm	——
	(1.6254—1.6258 in.)	——
OD	41.270—41.280 mm	41.257 mm
	(1.6248—1.6252 in.)	(1.6243 in.)
Length	71.51—72.11 mm	——
	(2.815—2.839 in.)	——
Connecting Rod Pin Bushing (Assembled):		
ID	41.300—41.326 mm	41.376 mm
	(1.6260—1.6270 in.)	(1.6290 in.)
Connecting Rod Pin Bore ID (Without Bushing)	46.025—46.051 mm	——
	(1.1820—1.8130 in.)	——

[a]When measuring piston ring end gap, the No. 2 compression ring gap should be greater than the No. 1 compression ring.

Continued on next page

RG,10,DT7422 –19–12NOV97–2/3

ITEM	SPECIFICATION	WEAR LIMIT
Piston Pin-to-Bushing Oil Clearance	.0.020—0.056 mm (0.0007—0.0022 in.)	0.102 mm (0.0040 in.)
Connecting Rods:		
Bore ID (Without Bearings)	82.677—82.703 mm (3.2550—3.2560 in.)	—— ——
Maximum Permissible Bore Out-of-Round	0.038 mm (0.0015 in.)	——
Bearing Bore-to-Pin Bushing Bore (Center-to-Center) Distance	202.95—203.05 mm (7.990—7.994 in.)	—— ——
Bearing-to-Journal Oil Clearance	0.050—0.127 mm (0.0020—0.0050 in.)	0.152 mm (0.0060 in.)
Maximum Journal Taper	0.010 mm (0.0004 in.)	——
Crankshaft Rod Journal OD	77.800—77.826 mm (3.0629—3.0640 in.)	—— ——
Assembled Bearing ID	77.876—77.927 mm (3.0659—3.0679 in.)	—— ——
Maximum Crankshaft Rod Journal Out-of-Roundness	0.005 mm (0.0002 in.)	——
Undersize Connecting Rod Bearings Available:[a]	0.25 mm (0.010 in.)	——

[a]See CRANKSHAFT GRINDING GUIDELINES later in this group.

TORQUES

Cylinder Liner Retainer Cap Screws	68 N•m (50 lb-ft)
Connecting Rod Cap Screws, to Measure Rod Bearing ID Connecting Rod Removed From Engine):	
Step 1	58 N•m (43 lb-ft)
Step 2	Tighten additional 90—100°
Connecting Rod Cap Screws:	
Step 1 Blind Hole Cap Screw Only	27 N•m (20 lb-ft)
Step 2	75 N•m (55 lb-ft)
Step 3	Tighten additional 90—100°
Piston Cooling Orifices	11 N•m (8 lb-ft)

RG,10,DT7422 –19–12NOV97–3/3

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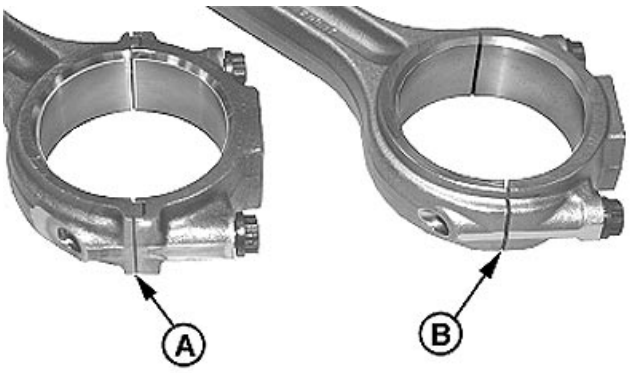
CONNECTING RODS—GENERAL INFORMATION

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).

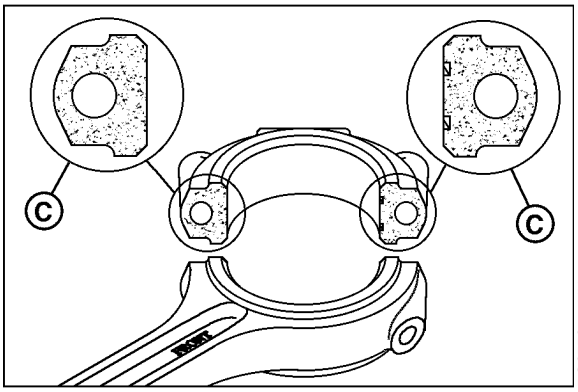
To create the Precision Joint™, the connecting rod is notched with a laser beam. Then a precision mandrel in the rod bore is powered to separate the cap from the rod at the joints (C).

Both types of rods provide a strong joint and torque on cap screws is the same. Removal and installation is similar, with differences noted. See INSPECT ROD AND CAP and INSTALL PISTON AND CONNECTING ROD later in this Group.



RG9447 –UN–

Tongue-and-Groove Joint



RG9556 –UN–

Precision Joint

A—Tongue-and-Groove Joint (Early Engines)
B—Precision Joint™ (Later Engines)
C—Precision Joint™ Details

Precision Joint is a trademark of Deere & Company

DPSG,RG34710,1 –19–15SEP98–1/1

REMOVE PISTONS AND CONNECTING RODS

If engine is to be removed from the vehicle, see your vehicle technical manual.

CAUTION: Do not drain engine coolant until it cools below operating temperature. Then slowly loosen block drain valve to relieve any pressure.

1. Drain coolant and engine oil.

NOTE: If engine is to be completely disassembled, see ENGINE DISASSEMBLY SEQUENCE in Group 04.

2. Remove cylinder head. (See REMOVE CYLINDER HEAD in Group 05.)

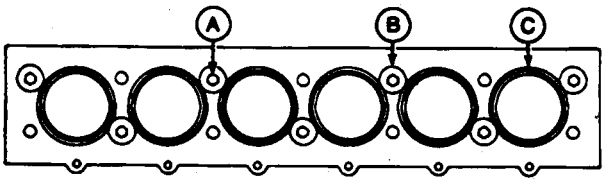
3. Remove camshaft followers and keep in order for reassembly in same position.

4. Clean all foreign material from cylinder block top deck.

RG,10,DT7421 –19–11FEB98–1/5

IMPORTANT: Cap screws and washers must be tightened to the correct specification to achieve an accurate reading when checking liner standout (height above block), as detailed later in this group.

5. Use short cap screws (A) and 3 mm (1/8 in.) thick washers (B) to bolt down cylinder liners (C). Fasten each liner in two locations. Tighten cap screws to 68 N•m (50 lb-ft).



RG3819 –UN–

Fasten Each Liner

Cap Screws—Specification

Torque ..... 68 N•m (50 lb-ft)

NOTE: Do not rotate crankshaft with cylinder head removed unless liners are fastened down.

Continued on next page

RG,10,DT7421 –19–11FEB98–2/5

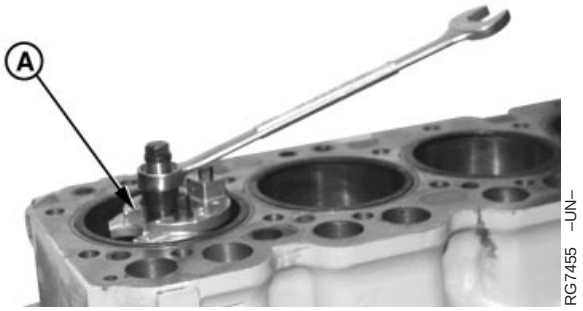
10
12

NOTE: Always follow manufacturer's directions provided with ridge reamer.

6. Remove carbon from liner bore with a scraper or ridge reamer (A). Use compressed air to remove loose material from cylinders.

7. Remove oil pan, oil pump, and outlet tube. (See Group 20.)

8. Mark rods, pistons, and caps to insure correct assembly in same location.



Removing Carbon With Ridge Reamer

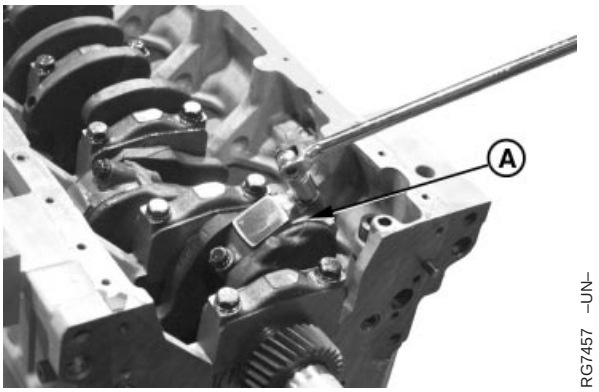
RG,10,DT7421 –19–11FEB98–3/5

IMPORTANT: Keep inserts with their respective caps for rod and main bearings.

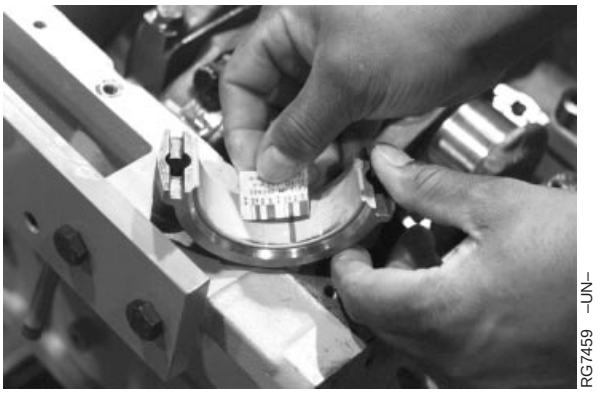
9. Remove all rod caps (A) with bearings.

10. Measure rod bearing-to-journal oil clearance with PLASTIGAGE® before removing piston and rod assembly. Record measurements. (See INSPECT AND MEASURE CONNECTING ROD BEARINGS, later in this group.)

NOTE: Use PLASTIGAGE® as directed by the manufacturer. PLASTIGAGE® will determine bearing-to-journal oil clearance, but will not indicate the condition of either surface.



Removing Rod Caps with Bearings



Measure Bearing Clearance with PLASTIGAGE

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PLASTIGAGE is a trademark of the DANA Corp.

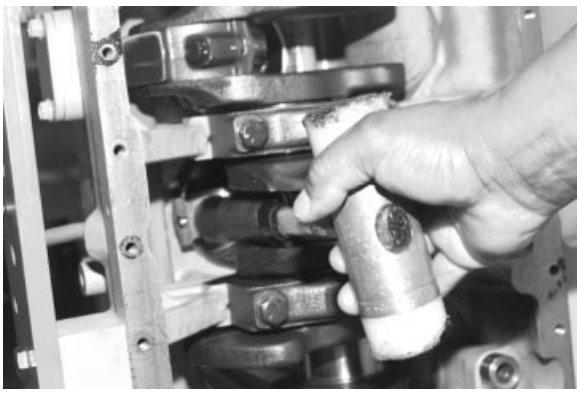
Continued on next page

RG,10,DT7421 –19–11FEB98–4/5

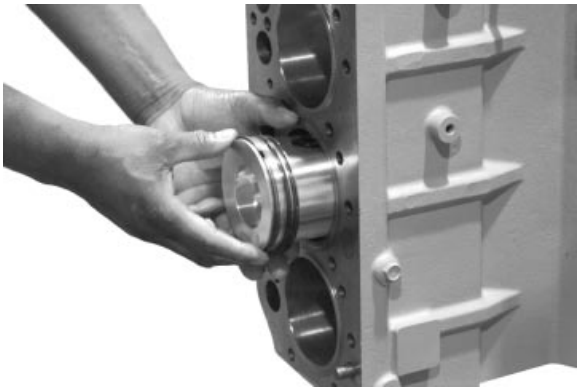
IMPORTANT: Hold on to piston to prevent piston from dropping. Piston will drop once piston rings have cleared cylinder liner.

If liners are to be reused, be extremely careful not to let connecting rod hit liner bore when removing piston and rod assembly.

11. Gently tap piston through top of cylinder block from the bottom.
12. Remove pistons and rods from engine.
13. Remove all main bearing caps with bearings. Remove crankshaft from engine.



Tapping Piston



Removing Piston

RG,10,DT7421 –19–11FEB98–5/5

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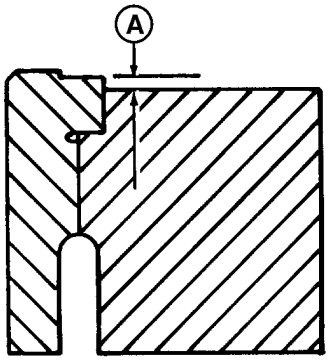
REMOVE CYLINDER LINERS

IMPORTANT: Cap screws and washers must be tight to achieve an accurate liner height reading.

1. Using D17526CI (or D17527CI) Dial Indicator and JDG451 Gauge (or KJD10123 Gauge), measure height (A) of each liner at 1, 5, 7, and 11 o'clock positions as viewed from rear of engine. Record all measurements.

Cylinder Liner Height—Specification

Liner Height Above Block	.0.030—0.100 mm (0.001—0.004 in.)
Maximum permissible difference between readings within one cylinder or between adjacent cylinders	0.05 mm (0.002 in.)



RG6439 –UN–

Measuring Liner Height

2. Remove cap screws and washers securing liners to cylinder block.

IMPORTANT: DO NOT stamp top of piston. Piston may be damaged.

3. Number cylinder liners and pistons. Stamp front of liner to ensure correct assembly. Do not stamp liner flange; stamp on fire dam only.

RG7461 –UN–

Number Cylinder Liners and Pistons

RG,10,DT7420 –19–12NOV97–1/3

IMPORTANT: Keep matched pistons and liners together. Liners must be reinstalled in same cylinder bore.

4. Pull liners out of cylinder block with D01062AA or KCD10001 Puller.

NOTE: If the KCD10001 Puller is used, secure puller with two cylinder head cap screws. If the D01062AA or D01073AA Puller is used, see next module.

RG7462 –UN–

Removing Cylinder Liners

Continued on next page

RG,10,DT7420 –19–12NOV97–2/3

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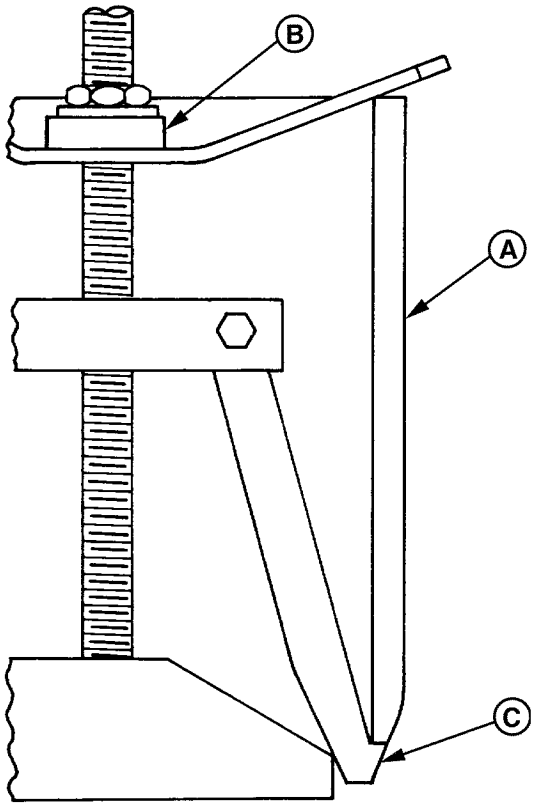
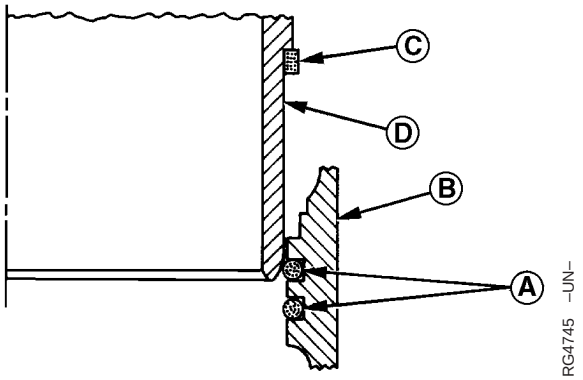
IMPORTANT: When using D01062AA (or D01073AA) Cylinder Liner Puller (B) to remove liners (A), be sure jaw (C) of puller is correctly positioned before attempting to remove liner. DO NOT over-tighten liner puller to remove liners. Doing so could easily break liners.

5. Remove cylinder liner O-rings (A) from grooves in cylinder block (B). Also remove packing (C) from cylinder liner (D).



Cylinder Liner Puller



Removing Cylinder Liner O-Rings

A—O-Rings
B—Cylinder Block
C—Packing
D—Cylinder Liner

RG,10,DT7420 –19–12NOV97–3/3

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COMPLETE DISASSEMBLY OF CYLINDER BLOCK (IF REQUIRED)

If not previously removed, also remove:

1. Crankshaft pulley. (Group 15)
2. Oil pressure regulating plug, valve, and spring in timing gear cover. (Group 16)
3. Timing gear cover, timing gears, and camshaft. (Group 16)
4. Camshaft bushing. (Group 16)
5. Balancer shafts and balancer shaft bushings (if equipped). (Group 16)
6. Front plate and oil-bypass valve. (Group 16)
7. Crankshaft and main bearings. (Group 15)
8. Piston cooling orifices.
9. Remove water gallery plugs.
10. If necessary to “Hot Tank” the block, also remove screw-in type oil gallery plugs and the engine serial number plate.

RG,10,DT7419 –19–12NOV97–1/1

PRELIMINARY LINER, PISTON AND ROD CHECKS

Scuffed or Scored Pistons:

- Insufficient lubrication.
- Insufficient cooling.
- Improper piston-to-liner clearance.
- Coolant leakage in 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 break-in.
- Worn piston.
- Contaminated oil.
- Distorted cylinder liner.

Worn or Broken Compression Rings:

- Insufficient lubrication.
- Insufficient cooling.
- Improper ring installation.
- Improper combustion.
- Improper timing.
- Abrasives in combustion chamber.

Clogged Oil Control Ring:

- Improper oil.
- Excessive blow-by.
- Contaminated oil.
- Improper periodic service.
- Low operating temperature.

Dull Satin Finish and Fine Vertical Scratches on Rings:

Dirt and abrasive in air intake system.

Stuck Rings:

- Improper oil classification.
- Improper periodic service.
- Poor operating conditions.
- Coolant leakage in crankcase.
- Excessive cylinder liner taper.

Cylinder Liner Wear and Distortion:

- Incorrectly installed compression rings.
- Insufficient lubrication.
- Uneven cooling around liner.
- Improper piston-to-liner clearance.
- Liner bore damage.

Warped Cylinder Block:

Insufficient cooling.

Broken Connecting Rod:

- Inadequate piston-to-liner clearance.
- Worn connecting rod bearing.
- Distorted cylinder liner.
- Piston pin failure.

Piston Pin and Snap Ring Failure:

- Misaligned connecting rod.
- Excessive crankshaft end play.
- Incorrect snap rings.

Mottled, Grayish or Pitted Compression Rings:

Internal coolant leaks.

RG,10,DT7418 –19–12NOV97–1/1

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DISASSEMBLE PISTON AND ROD ASSEMBLY

IMPORTANT: DO NOT reuse piston rings.

1. Remove piston rings using the JDE135 (shown), JDE85, or KJD10140 Piston Ring Expander.

Removing Piston Rings

RG,10,DT7417 –19–11FEB98–1/2

2. Remove and discard piston pin snap rings.
3. Separate piston and rod. Keep these parts in place with their respective cylinder liner.

Removing Piston Snap Rings

RG,10,DT7417 –19–11FEB98–2/2

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.

Cleaning Piston Ring Grooves

RG,10,DT7424 –19–12NOV97–1/1

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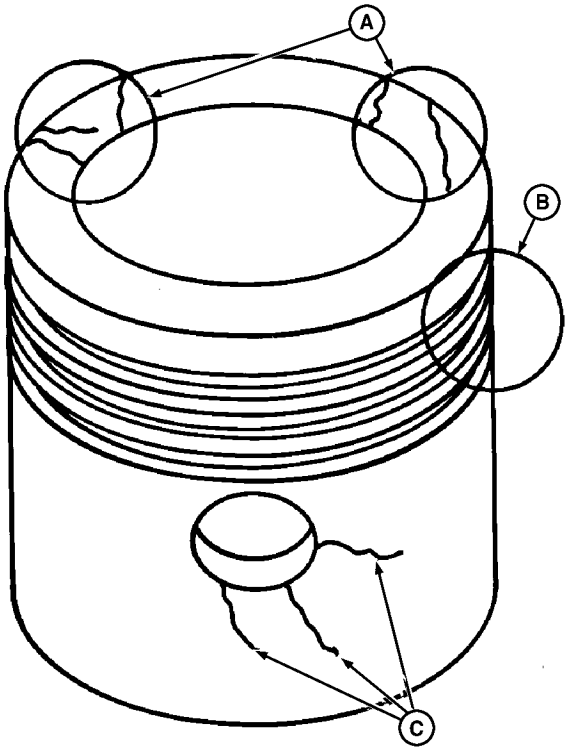
VISUALLY INSPECT PISTONS

Carefully inspect clean pistons under magnification. Check for:

- Signs of fatigue
- Fine cracks in piston head (A)
- Bent or broken ring lands (B)
- Cracks in the skirt (C) at the inner and outer ends of the piston pin bore
- Original machining marks must be visible
- Excessive piston skirt wear

If any defects are found, replace the piston and liner as a set.



Piston Defects (Exaggerated)

RG,10,DT7105 –19–31OCT97–1/1

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 solvents 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 a liner as many times as necessary with clean SAE 10W oil.

5. Clean liner until a white rag shows no discoloration.

RG,10,DT7107 –19–31OCT97–1/1

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22

VISUALLY INSPECT CYLINDER LINERS

IMPORTANT: If liner pitting has occurred, check condition of coolant.

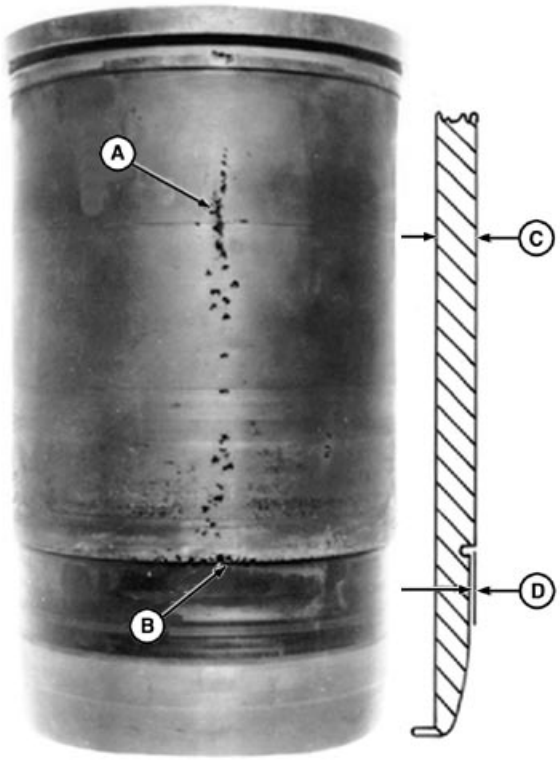
NOTE: When installing reusable liners, rotate 90° from original position. The liners should be deglazed and ring sets installed in pistons.

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).

Cylinder Liner—Specification

Cylinder Liner Thickness	5.875—6.375 mm (0.2313—0.2510 in.)
Packing Step Dimension	2.0185—2.2865 mm (0.07947—0.09002 in.)



Inspecting Cylinder Liner

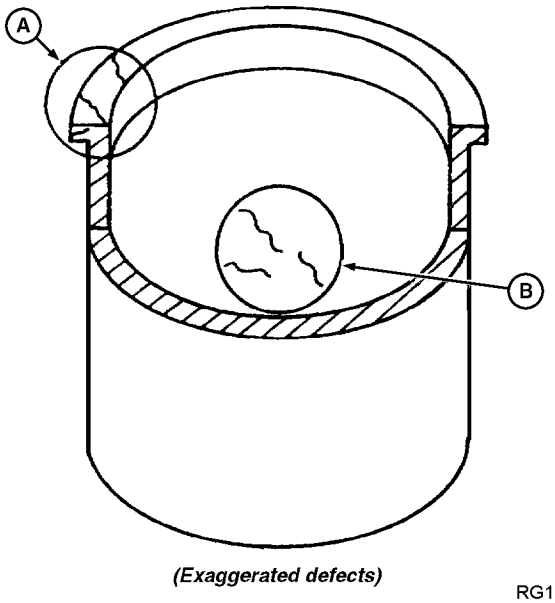
A—Liner Pitting
B—Liner Erosion
C—Liner Thickness
D—Packing Step

Continued on next page

RG,10,DT7415 –19–12NOV97–1/2

2. Visually inspect liner ID. Replace piston and liner if:
   - The crosshatch honing pattern is not visible immediately below the top ring turn-around area for turbocharged engines.
   - The hone pattern is not visible all the way around the liner in over 75 percent of the ring travel area for naturally aspirated engines.
   - 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.)



Cylinder Liner Defects (Exaggerated)

RG,10,DT7415 –19–12NOV97–2/2

CHECK PISTON RING GROOVE WEAR

If ring groove is worn, replace piston and liner as a matched set.

1. Check first and second ring grooves using a new piston ring and a feeler gauge. Measure clearance at several points. Compare measurements with specification.

   Replace piston and liner (as a set) if clearance exceeds specification.

Piston Ring-to-Groove—Specification

Maximum piston ring-to-groove clearance with new piston ring (first and second ring grooves)	0.075 mm (0.003 in.)

Measure Piston Ring-to-Groove Clearance

Continued on next page

RG,10,DT7104 –19–11FEB98–1/2

2. Check oil control ring-to-groove clearance by installing a new rings in groove.

3. Measure clearance with a feeler gauge at several points. Compare measurements with specifications.

Oil Control Ring-to-Groove—Specification

New Part Clearance ..... 0.111—0.136 mm (0.0044—0.0054 in.)
Maximum Serviceable Clearance..... 0.2210 mm (0.0087 in.)

NOTE: Replace piston and liner (as a set) if oil control ring clearance exceeds specifications given.

Measuring Clearance with Feeler Gauge

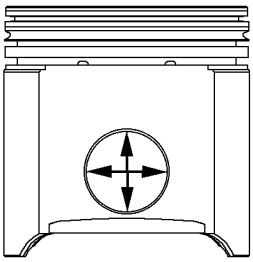
RG,10,DT7104 –19–11FEB98–2/2

MEASURE PISTON PIN BORE

Measure piston pin bore. If bore is not within specification, replace piston and liner set.

Piston Pin Bore—Specification

Bore ID ..... 41.285—41.295 mm (1.6254—1.6258 in.)



Measuring Piston Bore

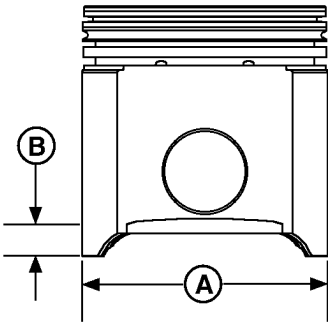
RG,10,DT7413 –19–12NOV97–1/1

MEASURE PISTON SKIRT

1. Measure piston skirt (A) 90° to piston pin bore and 28 mm (1.1 in.) from bottom of piston (B). Record measurement.
2. Measure cylinder liner as directed later in this group and compare with piston measurement.

Piston Pin Skirt—Specification

Diameter (Bottom of skirt 28 mm (1.1 in.) from bottom of piston)	106.38—106.40 mm (4.188—4.189 in.)



RG7403 –UN–

Measure Piston Skirt

RG,10,DT7412 –19–12NOV97–1/1

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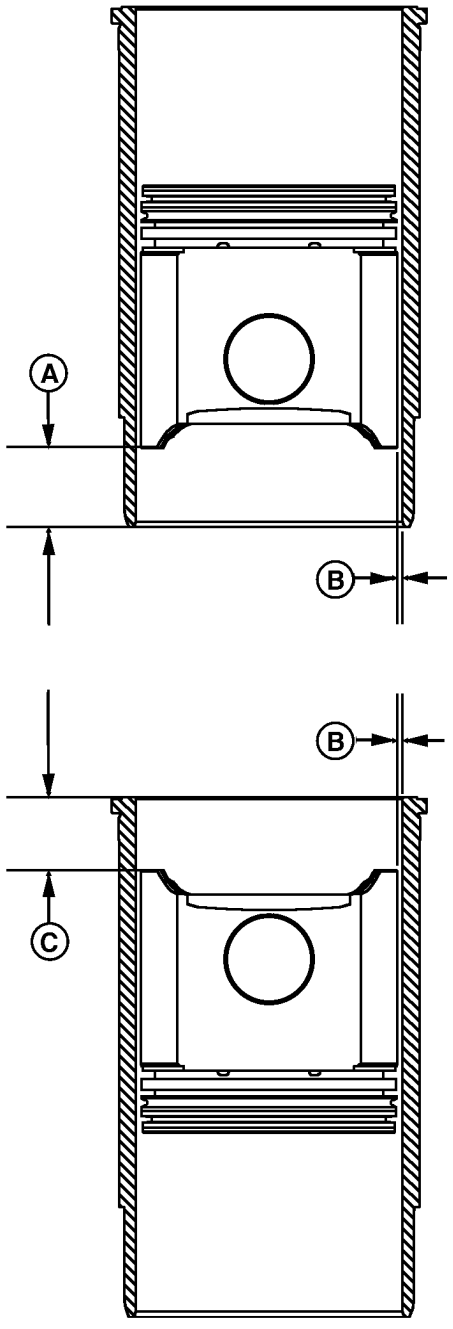
DETERMINE PISTON-TO-LINER CLEARANCE

1. Put piston (without rings) in matched liner with piston “front” and liner “front”[1] aligned. Move piston down until bottom edge of piston skirt is 25.4 mm (1.00 in.) (A) from bottom of liner. Use a feeler gauge to measure clearance (B) between piston skirt and liner 90° to pin bore. Record the measured clearance.
2. Turn piston 90° in liner. Measure clearance between piston skirt and liner 90° to pin bore. Record the clearance.
3. Put piston upside down in liner with piston “front” and liner “front” aligned. Move piston so bottom edge of piston skirt is 25.4 mm (1.00 in.) (C) below top of liner. Measure clearance (B) between piston skirt and liner at 90° to pin bore. Record the clearance.
4. Turn piston 90° in liner. Measure clearance between piston skirt and liner 90° to pin bore. Record the clearance.
5. The difference between clearances in Steps 1 and 2 is the amount liner is out-of-round at bottom of the liner.
6. The difference between clearances in Steps 3 and 4 is the amount liner is out-of-round at top of the liner.
7. The difference between clearances in Steps 1 and 3 is the amount liner is tapered.

Piston and Cylinder Liner—Specification

Piston-to-Cylinder Liner Clearance (Measured at Bottom of Piston Skirt)	0.08—0.15 mm (0.003—0.006 in.)
Maximum Cylinder Out-of-Round (Top or Bottom)	0.05 mm (0.002 in.)
Maximum Cylinder Taper	0.05 mm (0.002 in.)

8. If cylinder liner geometry is not within specifications, replace piston and liner set.



RG7404 –UN–

Determine Piston-to-Liner Clearance

[1] *As marked during liner removal from engine.*

RG,10,DT7411 –19–11FEB98–1/1

DEGLAZE CYLINDER LINERS

1. Secure cylinder liner in DRFG3 Cylinder Liner Holding Fixture.
2. Use D17005BR Flexible Cylinder Hone to deglaze cylinder liner.

NOTE: Use honing oil along with flex hone when deglazing liners.

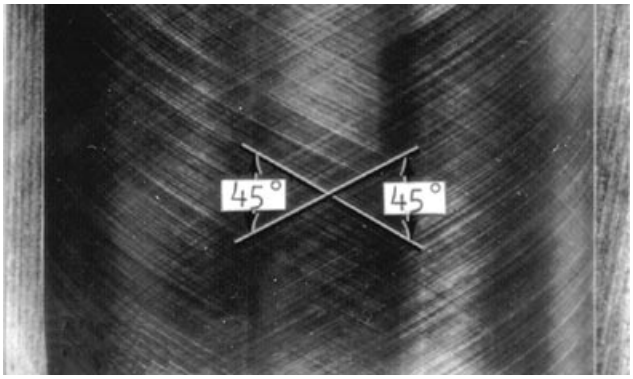
RGR26164 –UN–

Cylinder Liner Holding Fixture

RG,10,DT7108 –19–31OCT97–1/2

3. Use D17005BR 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, for proper cleaning procedures.



RGR26165 –UN–

Honing Crosshatch Pattern

RG,10,DT7108 –19–31OCT97–2/2

REPLACE PISTON AND LINER SETS

IMPORTANT: ALWAYS install a new (matched set) liner when replacing a piston. DO NOT stamp top of piston. Piston may be damaged.

Mark matched piston and liner for placement in the same cylinder location.

RG,10,DT7426 –19–12NOV97–1/1

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INSPECT AND MEASURE CONNECTING ROD BEARINGS

Inspect rod bearings for damage or wear.

Measure bearing-to-journal clearance with PLASTIGAGE® if rod and crankshaft are assembled in engine. If rod is out of engine, measure rod bearing ID and crankshaft journal OD to determine oil clearance.

ROD REMOVED FROM ENGINE:

1. Measure crankshaft rod journal OD at several points.
2. Assemble connecting rod, cap, and bearings with OLD cap screws. Tighten cap screws to 68 N•m (50 lb-ft). Tighten cap screw an additional 90—100°. (See TORQUE-TURN CONNECTING ROD CAP SCREWS later in this group.)
3. Measure assembled rod bearing ID.
4. Subtract crankshaft journal OD from rod bearing ID to determine oil clearance. Replace bearings if oil clearance is out of specification.

Connecting Rod Journal and Bearing—Specification

Crankshaft Rod Journal OD	77.800—77.826 mm (3.0629—3.0640 in.)
Assembled Rod Bearing ID	77.876—77.927 mm (3.0659—3.0679 in.)
Rod Bearing-to-Journal Oil Clearance (New Parts)	0.050—0.127 mm (0.0020—0.0050 in.)
Wear Limit	0.152 mm (0.0600 in.)

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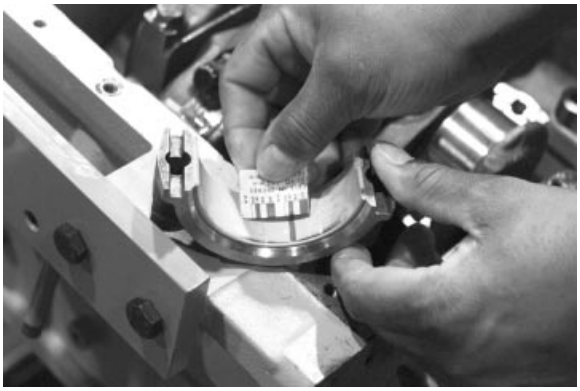
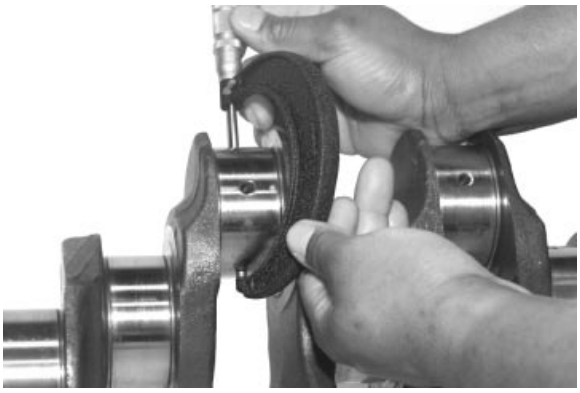
Measuring Connecting Rod



Measuring Rod Bearing With PLASTIGAGE



Measuring Crankshaft Rod Journal

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RG,10,DT7409 –19–12NOV97–1/2

ROD AND CRANKSHAFT ASSEMBLED IN ENGINE

IMPORTANT: Use hand wrenches, pneumatic wrenches may cause thread damage.

NOTE: Use PLASTIGAGE® as directed by manufacturer. PLASTIGAGE® will determine oil clearance, but will not indicate condition of either surface.

1. Remove rod cap. Place a piece of PLASTIGAGE® in center of bearing. Install rod cap using OLD cap screws. Tighten cap screws to 58 N•m (43 lb-ft). Tighten cap screw an additional 90—100°. (See TORQUE-TURN CONNECTING ROD CAP SCREWS later in this group.)

2. Remove rod cap. Compare width of PLASTIGAGE® with scale provided on package to determine clearance. Replace bearings if oil clearance is out of specification.

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RG,10,DT7409 –19–12NOV97–2/2

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INSPECT ROD AND CAP

1. Inspect rod and cap for wear or damage, such as chips or nicks in the joint area (A).

IMPORTANT: Do not nick the joint surfaces of the rod and cap. This is very critical on Precision Joint™ rods to ensure proper seating. Never scrape these surfaces (C) with a wire brush or other tool. The interlocking mating surfaces must be preserved.

2. Inspect in and around cap screw holes in cap (B). If any imperfections are found, replace rod and cap.

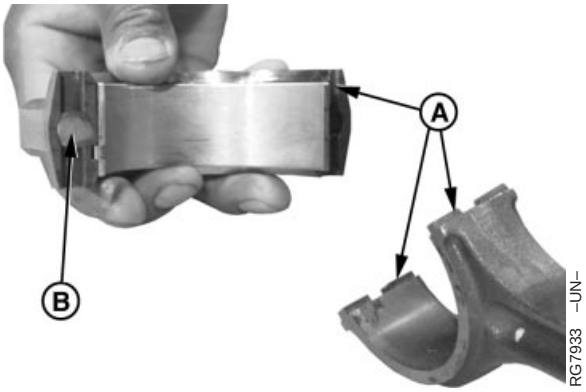
3. Carefully clamp rod in a soft-jawed vise (cap end upward).

IMPORTANT: Never use new connecting rod cap screws when checking rod bore ID. Use new cap screws only for final assembly of connecting rods.

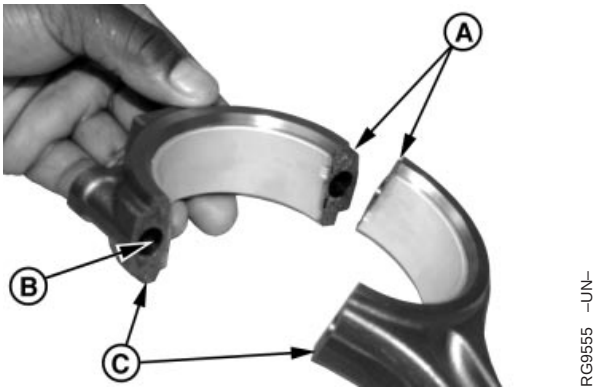
4. Install cap WITHOUT bearing inserts. Use old cap screws.

5. Tighten cap screws to 58 N•m (43 lb-ft). Turn cap screw an additional 90—100°.

   See TORQUE-TURN CONNECTING ROD CAP SCREWS later in this group.



Tongue-and-Groove Joint Rod and Cap



Precision Joint Rod and Cap

A—Joint Area
B—Cap Holes
C—Precision Joint™ Surfaces

Precision Joint is a trademark of Deere & Company

Continued on next page

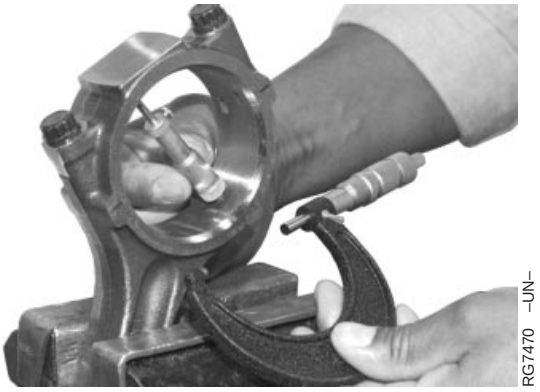
RG,10,DT7408 –19–12NOV97–1/2

6. Using an inside micrometer, measure rod bore at center of bore and record measurements as follows:
   - At right angle to rod-to-cap joint.
   - At 45 degrees left of measurement step “A”.
   - At 45 degrees right of measurement step “A”.
7. Subtract OD of crankshaft rod journals from ID of rod bearings to obtain oil clearance.

Rod Bore (Without Bearing Inserts)—Specification

Rod Bore ID	82.677—82.703 mm (3.2550—3.2560 in.)
Maximum Permissible Bore Out-of-Round	0.038 mm (0.0015 in.)

8. If difference between the greatest and least measurement exceeds out-of-round specification, replace connecting rod.



Measuring Rod Bore

RG,10,DT7408 –19–12NOV97–2/2

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INSPECT PISTON PINS AND BUSHINGS

1. Visually inspect piston pin. Pin must be in good condition with no visible wear.

IMPORTANT: Do not attempt to polish or refinish piston pin. Pin has a highly polished surface.

2. Dip piston pin in clean engine oil.

3. Install pin (A) through piston. Pin should pass through piston using only light thumb pressure.

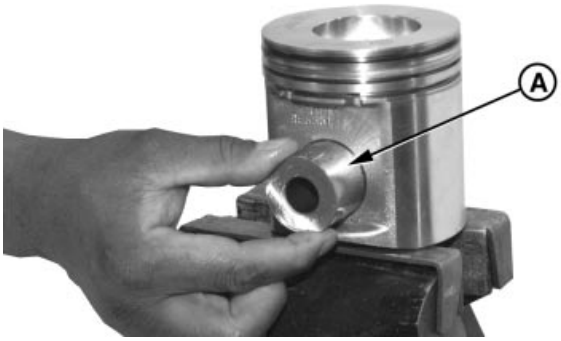
4. Insert pin from both sides. If pin enters freely, but binds in the center, the bore could be tapered (B).

5. Insert pin to check for bore alignment (C). Pin should not “click” or need to be forced into bore on opposite side.

6. Measure piston pin OD. Replace if not within specification.

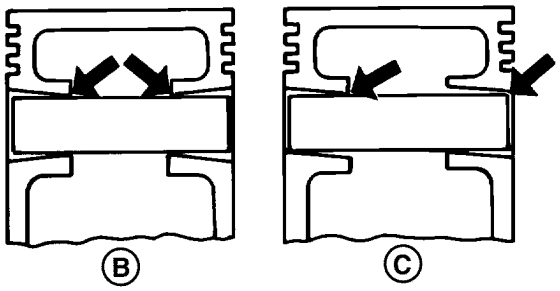
Piston Pin—Specification

OD	41.285—41.2985 mm (1.6254—1.6258 in.)
Wear Limit	41.2725 mm (1.6249 in.)



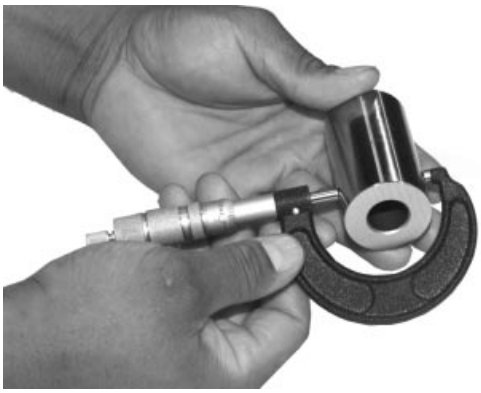
RG7466 –UN–

Installing Piston Pin



RG4747 –UN–

Checking Pin Bore Alignment



RG7473 –UN–

Measuring Pin OD

Continued on next page

RG,10,DT7407 –19–12NOV97–1/2

7. Measure pin bushing ID and compare to pin OD to determine oil clearance.

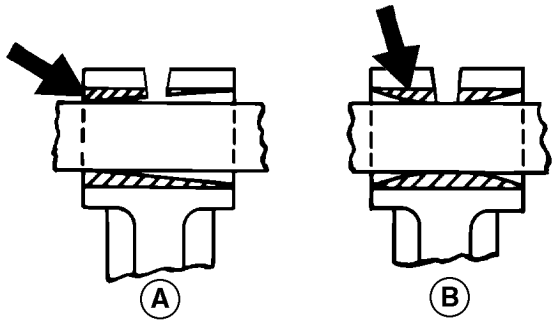
8. Insert pin from either side of rod bushing. If pin is free on one end, but tight on the other, the bore could be tapered (A). If pin enters freely from both sides, but is tight in the center, bore is bell mouthed (B).

Piston Pin Bushing—Specification

ID (Installed)	41.300—41.326 mm (1.6260—1.6270 in.)
Wear Limit	41.376 mm (1.6290 in.)
Piston Pin-to-Bushing Oil Clearance	0.020—0.056 mm (0.0007—0.0022 in.)
Wear Limit	0.102 mm (0.0040 in.)

RG7474 –UN–

Measuring Pin Bushing ID



RG7647 –UN–

Inspecting Bore Taper

RG,10,DT7407 –19–12NOV97–2/2

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REMOVE PISTON PIN BUSHING

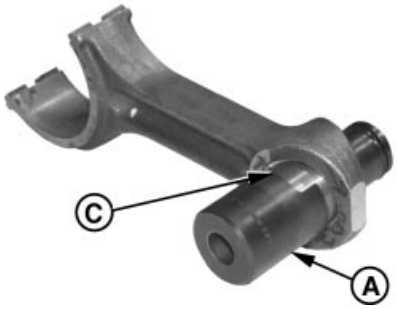
1. Select Driver JDG953-1 (A) and Receiver Cup JDG953-2 (B) to remove bushing (C) from tapered rod.
2. Slide driver into one side of rod bushing. Turn driver until taper on driver flange matches up with taper on the bushing.
3. Install receiver cup onto opposite side of rod bushing.

NOTE: Stud in cup keeps rod properly located on the cup.

4. Using hydraulic press, press bushing out of the rod until driver and bushing fall into receiver cup.

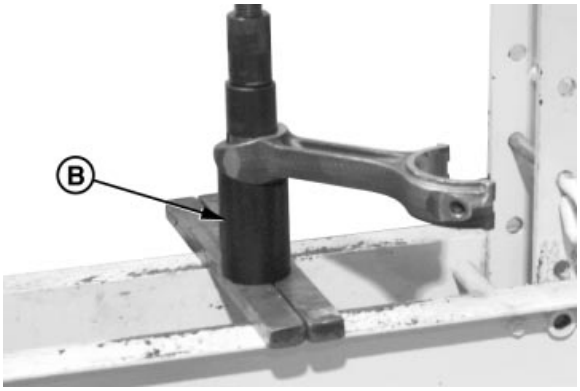
IMPORTANT: If bushing is heavily worn, the driver may contact the I.D. of the rod bore. Be careful not to damage the rod bore.

Clean, inspect, and measure I.D. of rod pin bore, as described later in this group.



RG7475 –UN–

Removing Piston Pin Bushing from Rod



RG7477 –UN–

Removing Piston Pin Bushing from Rod

RG,10,DT7406 –19–12NOV97–1/1

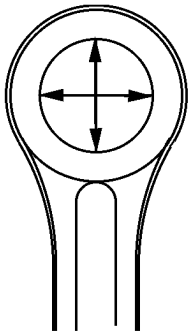
CLEAN AND INSPECT CONNECTING ROD PIN BORE

1. Clean bore of rod with medium grit emery cloth.
2. Inspect for cracks or other damage.
3. Measure bore diameter in two places, 90° apart. Replace rod if not within specification.

IMPORTANT: If bushing has spun in rod, replace connecting rod.

Connecting Rod—Specification

Pin Bore ID	46.025—46.051 mm (1.8120—1.8130 in.)



RG7478 –UN–

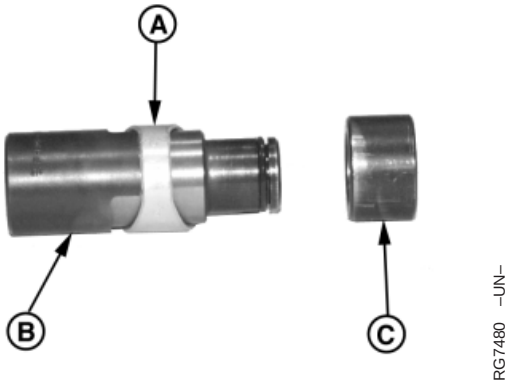
Inspecting Bore of Connecting Rod

RG,10,DT7405 –19–10APR98–1/1

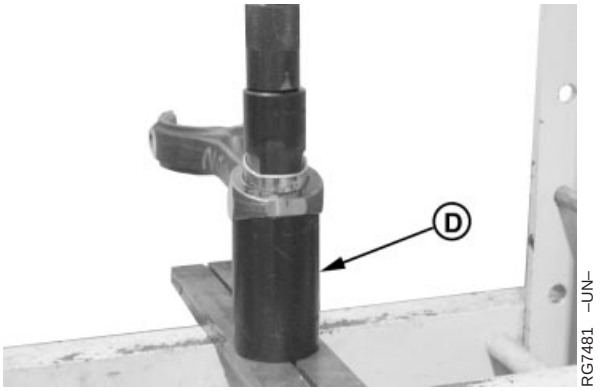
INSTALL PISTON PIN BUSHING IN CONNECTING ROD

Carefully file a slight chamfer on edge of rod pin bore. Remove any burrs or sharp edges from edge of bushing bore.

1. Slide bushing (A) onto JDG953-1 Driver (B) and install JDG738-2 Installer Pilot (C) onto O-ring end of driver. Apply clean engine oil or grease to O.D. of new bushing, O.D. of pilot ring, and I.D. of rod pin bore.
2. Insert driver into rod pin bore so pilot ring pilots in rod bore, and bushing taper aligns with taper on driver flange.
3. Install JDG953-2 Receiver Cup (D) onto the opposite side of rod.
4. Press bushing into rod bore until edge of bushing is flush or just slightly below rod face.
5. If necessary, precision bore bushing to obtain an oil clearance of 0.020—0.056 mm (0.0007—0.0022 in.) with piston pin.



Slide Bushing onto Driver



Install Receiver Cup and Install Bushing

A—Piston Pin Bushing
B—JDG953-1 Driver
C—JDG738-2 Installer Pilot
D—JDG953-3 Receiver Cup

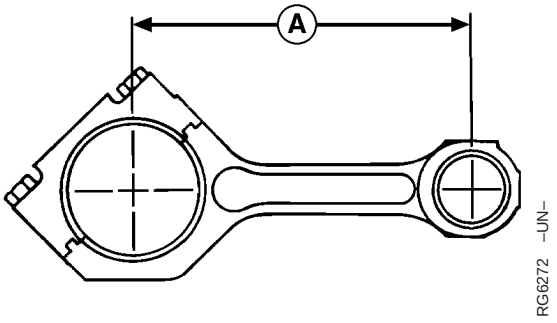
RG,10,DT7404 –19–12NOV97–1/1

MEASURE ROD CENTER-TO-CENTER BORES

Measure rod center-to-center bores (with bushings removed). Compare to specifications given below. Replace rod if necessary.

Bearing Bore-to-Pin Bushing Bore—Specification

(Center-to-Center) Length (A) ..... 202.95—203.05 mm (7.990—7.994 in.)



Measuring Rod Center-to-Center Bores

RG,10,DT7403 –19–12NOV97–1/1

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INSPECT AND CLEAN CYLINDER BLOCK

Before inspecting and cleaning cylinder block, remove all of the following:

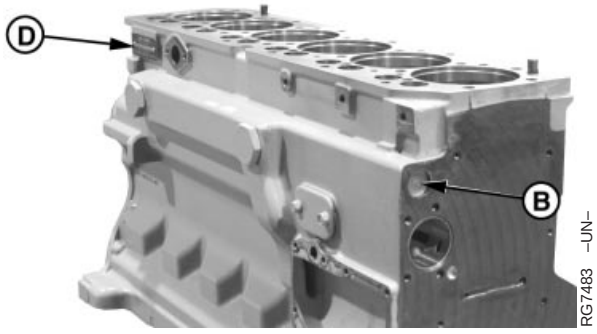
- piston cooling orifices (A)
- soft plugs (B)
- oil galley plugs (C) (using JDG782 Oil Galley Plug Tool)
- all external and internal mounted components [refer to the proper group for removal procedures]

IMPORTANT: If block is cleaned in a hot tank, be sure to remove any aluminum parts (such as nameplates [D]). Aluminum parts can be damaged or destroyed by hot tank solutions.

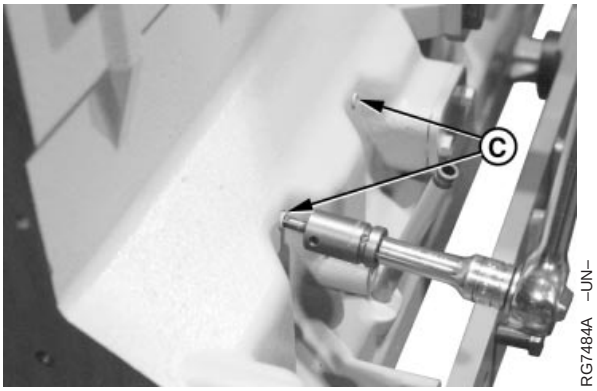
1. Clean block thoroughly using cleaning solvent, pressure steam, or a hot tank.

2. All passages and crevices must be clear of sludge, and grease.

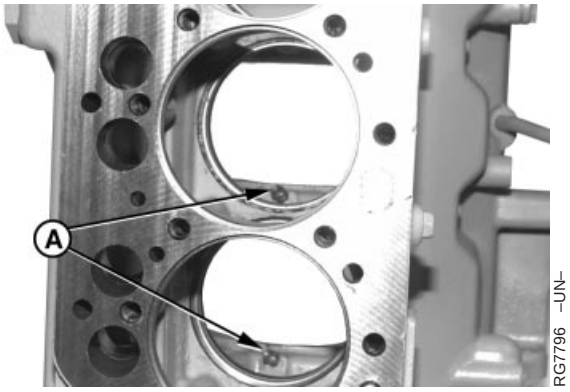
3. All coolant passages must be clear of lime deposits and scale.



Removing Nameplate and Soft Plugs



Removing Oil Galley Plugs



Removing Piston Cooling Orifices

A—Piston Cooling Orifice
B—Soft Plug
C—Oil Galley Plug
D—Nameplate

Continued on next page

RG,10,DT7402 –19–11NOV97–1/2

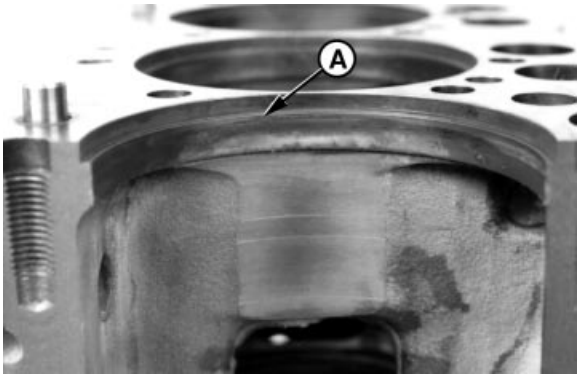
IMPORTANT: DO NOT file liner support flange excessively. Excess filing can damage liner support flange and allow an improper liner fit. Thoroughly clean all filings from cylinder block.

4. Inspect liner support flange (A) for burrs. If burrs are present, use a small half-moon file and LIGHTLY file (in a circular motion) burr off at a 60° angle. DO NOT let file hit top of cylinder block while filing.

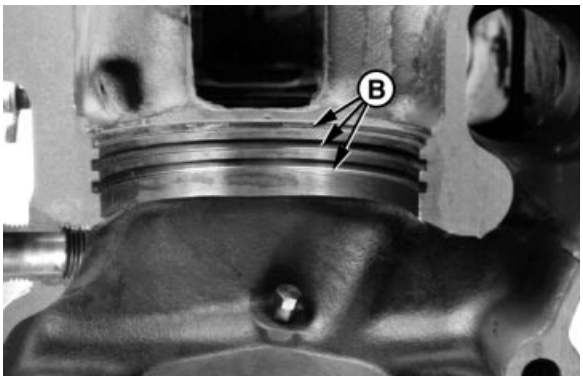
5. Carefully inspect block for cracks or damage. If a cracked block is suspected, pressure-test the block. A procedure for pressure testing is outlined in FOS (Fundamentals of Service) Manual-ENGINES. Check for erosion or cracks in the liner O-ring/packing area (B). Replace cracked or damaged blocks.

6. If cylinder block is serviceable, clean out all threaded holes for cylinder head mounting cap screws in top deck of cylinder block, using JDG680 Tap (C) or an equivalent 1/2-13 UNC-2A x 76 mm (3.0 in.) long tap. Remove debris or fluid from tapped holes with compressed air.

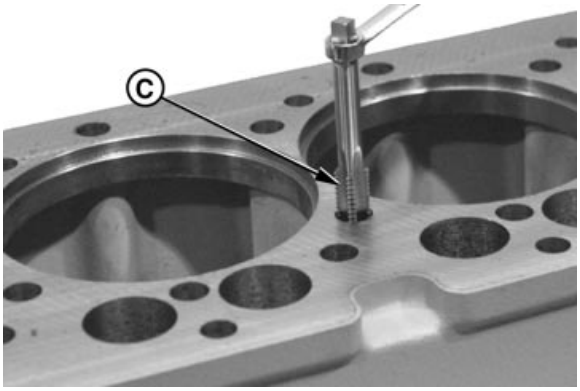
7. Install soft plugs. Apply LOCTITE® 242 (TY9370) Thread Lock and Sealer (Medium Strength) to oil galley plug threads and install using JDG782 Oil Galley Plug Tool.



Inspecting Flange for Burrs



Checking for Cracks and Damage



Tapping Threaded Holes

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RG,10,DT7402 –19–11NOV97–2/2

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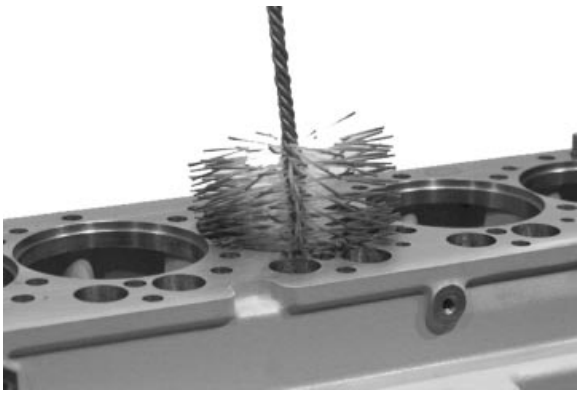
CLEAN CYLINDER LINER O-RING BORE

Use D17015BR O-Ring Bore Cleaning Brush to thoroughly clean lower liner O-ring bore.

NOTE: Use brush exactly as directed by the manufacturer.



Cleaning Cylinder Liner O-Ring Bore

RG,10,DT7401 –19–11NOV97–1/1

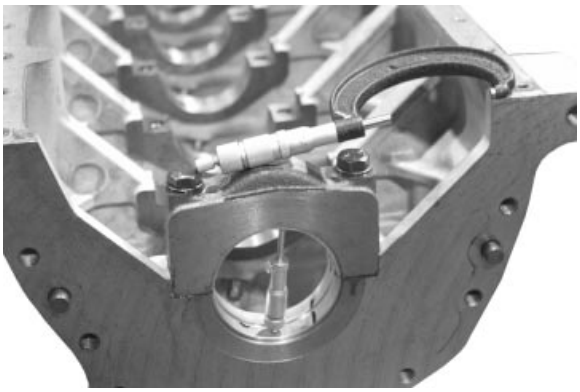
MEASURE CYLINDER BLOCK MAIN BEARING BORE

Measure main bearing bore diameter.

Cylinder Block Main Bearing—Specification

Bore Diameter	84.455—84.481 mm (3.3250—3.3260 in.)

If bearing caps are damaged, or bore is not within specification, replace caps and line bore to specifications. (See MEASURE ASSEMBLED ID OF MAIN BEARING CAPS in Group 15.)



Measure Cylinder Block Main Bearing Bore

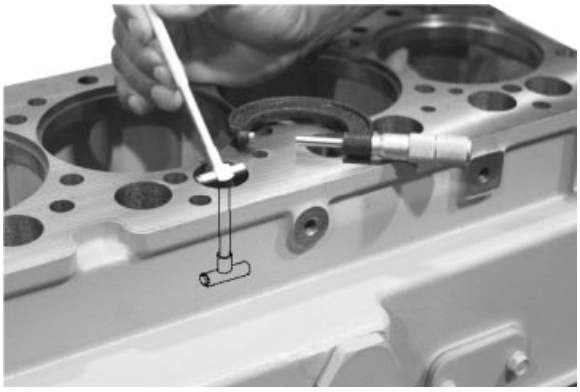
RG,10,DT7427 –19–12NOV97–1/1

MEASURE CAMSHAFT FOLLOWER MACHINED BORE IN BLOCK

Measure camshaft follower bore diameter at all bore locations.

Camshaft Follower Bore—Specification

ID in Block	31.70—31.75 mm (1.248—1.250 in.)
OD (New)	31.61—31.64 mm (1.245—1.246 in.)
Follower-to-Bore Clearance	0.06—0.13 mm (0.002—0.005 in.)



Measuring Camshaft Follower Machined Bore

If any one camshaft follower bore ID and follower-to-bore clearance exceed specified maximum, install a new cylinder block.

RG,10,DT7400 –19–11NOV97–1/1

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MEASURE CAMSHAFT BUSHING BORES IN BLOCK

Replaceable bushings (A) are installed in front camshaft bore only. Remaining bores in cylinder block act as camshaft bushings.

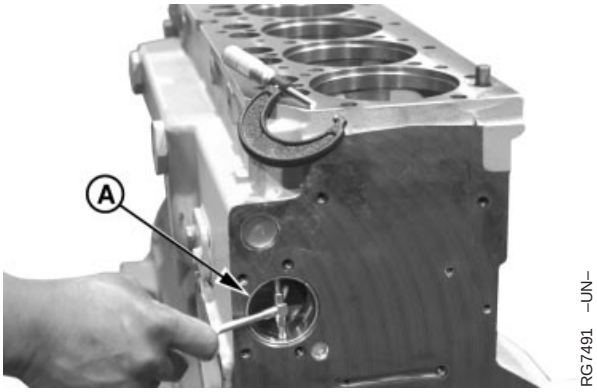
1. Visually inspect and measure front camshaft bushing ID. If bushing is worn or not within specification, install new bushings. (See REMOVE AND INSTALL CAMSHAFT BUSHING in Group 16.)

2. If necessary to replace bushing, remove bushing and measure bore diameter in block. If bushing bore (B) in block is not within specification, repair or replace cylinder block as required.

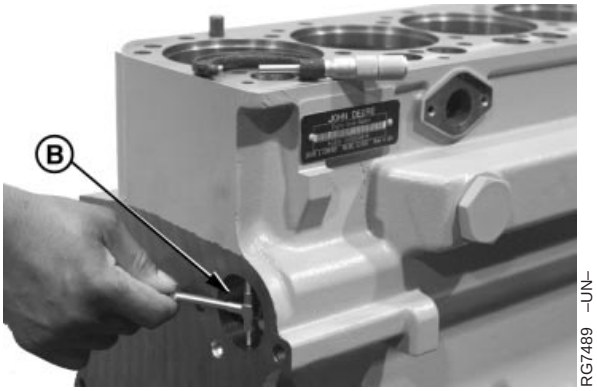
3. Measure remaining camshaft bores in block and compare with specification given. Repair or replace cylinder block as required.

Camshaft Bushing and Bore—Specification

Bore ID (Front [No. 1] in Block [without housing])	59.961—59.987 mm (2.3607—2.3617 in.)
Bore ID (All Except No. 1)	55.986—56.012 mm (2.2042—2.2052 in.)
Bore ID (Front [No. 1] in Block [with Bushing])	55.961—55.987 mm (2.2031—2.2042 in.)
Journal-to-Bushing Oil Clearance (No 1. Bore with Bushing)	0.063—0.115 mm (0.0025—0.0045 in.)
Journal-to-Bushing Oil Clearance (No 1. Bore with Bushing)	0.088—0.140 mm (0.0035—0.0055 in.)



Measuring Camshaft Bushing Bore



Measure Bushing Bore

RG,10,DT7399 –19–11NOV97–1/1

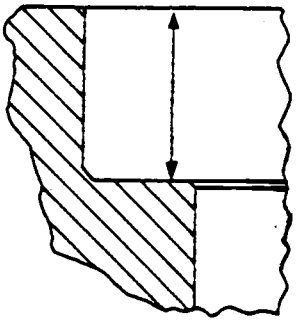
MEASURE LINER FLANGE COUNTERBORE DEPTH IN BLOCK

Measure liner flange counterbore depth in block and compare to specification given below. If depth is not within specification, liner shims are available.

Liner Flange—Specification

Counterbore Depth in Block..... 5.952—5.988 mm (0.2343—0.2357 in.)

Measuring Liner Flange Counterbore Depth



Counterbore Depth

RG,10,DT7397 –19–11NOV97–1/1

MEASURE LINER FLANGE THICKNESS

Measure cylinder liner flange thickness at several locations. If liner flange is not within specifications, liner shims are available or replace piston and liner set.

Liner Flange—Specification

Thickness..... 6.022—6.058 mm (0.2371—0.2385 in.)

Measuring Liner Flange Thickness

RG,10,DT7396 –19–11NOV97–1/1

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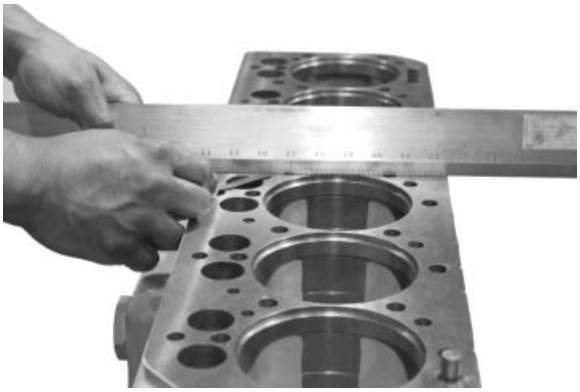
MEASURE CYLINDER BLOCK TOP DECK FLATNESS

Measure cylinder block top deck flatness using D05012ST Precision Straightedge and feeler gauge. If flatness is not as specified, clean up top deck of cylinder block.

Cylinder Block Top Deck Flatness—Specification

Maximum Acceptable Out-of-Flat (Entire Length or Width [Used])	0.08 mm (0.003 in.)
Maximum Acceptable Out-of-Flat (Any 150 mm [5.90 in.] Length)	0.025 mm (0.001 in.)
Top Deck Surface Finish (Surface Grind Only) (AA)	0.8—3.2 micrometers (32—125 micro-in.)
Maximum Wave Depth	0.012 mm (0.0005 in.)
Main Bearing Bore	337.896—337.972 mm
Centerline-to-Cylinder Block Top Deck Distance	(13.3029—13.3059 in.)

IMPORTANT: When cylinder block top deck or main bearing bores are machined, the dimension from crankshaft centerline to top deck will be changed. Make sure this dimension is within specifications, otherwise, piston may contact cylinder head.



RG7492 –UN–

Measuring Cylinder Block Top Deck Flatness

RG,10,DT7395 –19–11NOV97–1/1

REMOVE, INSPECT, AND INSTALL PISTON COOLING ORIFICES

1. Remove and clean each piston cooling orifice (A) to make sure it is not plugged or damaged. Replace if questionable.

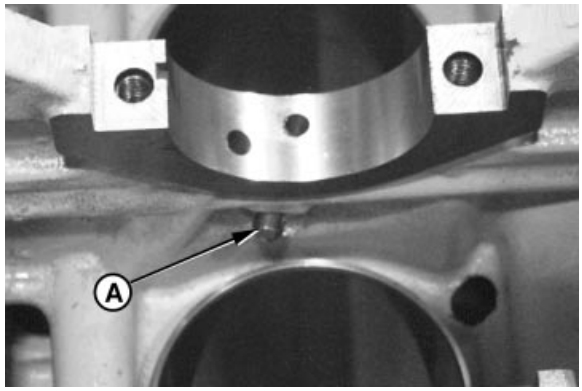
IMPORTANT: A piston cooling orifice failure could cause damage to pistons, piston pins, rod pin bushings, and liners. If a piston cooling orifice is left out, low or no oil pressure will result.

2. Install and tighten orifices to 11 N•m (8 lb-ft).

3. Install new oil and water galley plugs as required, if removed.

RG7493 –UN–

Inspecting Piston Cooling Orifice



RG7543A –UN–

Cleaning Cooling Orifice

RG,10,DT7394 –19–11NOV97–1/1

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MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

NOTE: If a new liner assembly is being installed in a new or used cylinder block, liner height must be checked.

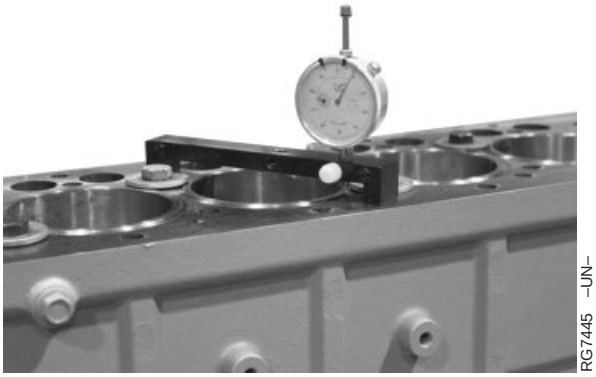
1. Be sure liner bore in cylinder block and top deck of block are clean.

IMPORTANT: Liner should rotate smoothly by hand when installed without O-rings or packing. If not, remove liner and clean block.

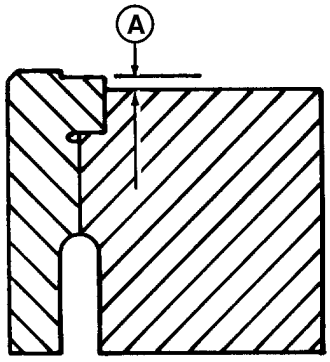
2. Install liner without O-rings and packing. If liner does not rotate smoothly by hand, remove liner and polish lower pilot bore in block with emery cloth or D17015BR Brush. Use a shop towel or other suitable means to collect debris when polishing bore.

   Locate liner mark toward the front of the engine. Secure with cap screws and washers (approximately 3 mm [1/8 in.] thick). Tighten screws to 68 N•m (50 lb-ft).

3. Using JDG451 or KJD10123 Gauge and D17526CI or D17527CI Dial Indicator, measure height (A) of liner at 1, 5, 7, and 11 o'clock positions as viewed from flywheel end of engine.



Measuring Liner Height



Height of Liner

Liner—Specification

Height Above Block	0.030—0.100 mm (0.001—0.004 in.)
Maximum Permissible Height	0.05 mm (0.002 in.)
Difference at Nearest Point of Two Adjacent Liners, or Within a Single Liner	

If liner height is above specification, check cylinder block for burrs on liner support flange or incorrect counterbore depth.

IMPORTANT: ONE LINER SHIM ONLY may be installed under each liner flange. If liner requires more than one shim, install a new liner or cylinder block.

If liner height is no more than 0.08 mm (0.003 in.) below top deck of block, install one liner shim under liner flange.

Continued on next page

RG,10,DT7392 –19–11NOV97–1/2

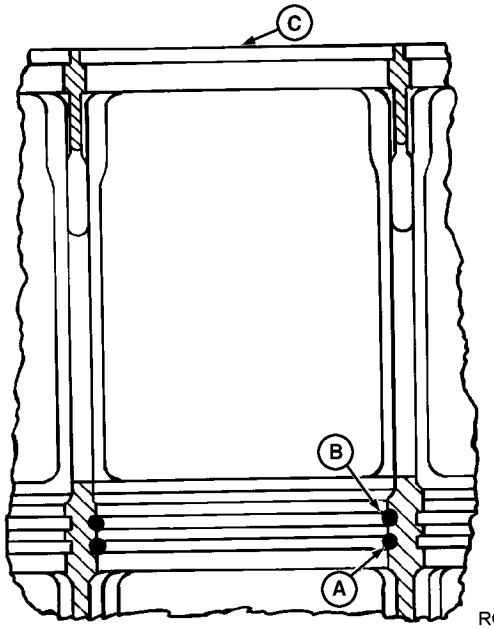
NOTE: Two shim sizes are available; 0.05 mm (0.002 in.) and 0.10 mm (0.004 in.).

RG,10,DT7392 –19–11NOV97–2/2

INSTALL PACKING ON CYLINDER LINER AND O-RINGS IN BLOCK

IMPORTANT: DO NOT use oil or hand cleaner soap on cylinder liner packing or O-rings. Petroleum products will cause the red (or white) O-ring to swell, which may result in O-ring damage during liner installation.

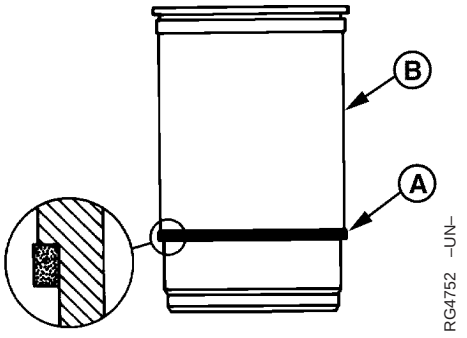
1. Pour AR54749 Soap Lubricant into a suitable container.
2. Dip O-rings in AR54749 Soap Lubricant.
3. Install the black O-ring (A) in the lower O-ring groove in the cylinder block (C).
4. Install the red (or white) O-ring (B) in the upper O-ring groove in the cylinder block.



Install O-Rings in Cylinder Block

RG,10,DT7391 –19–11NOV97–1/2

5. Turn cylinder liner (B) upside-down. Dip square packing (A) in soap and install over outside of liner.
6. Slide packing down firmly against shoulder on liner. Make sure packing is not twisted.
7. Coat the liner packing sealing area of the cylinder liner and block O-rings with liquid soap.



Install Cylinder Lining Packing

RG,10,DT7391 –19–11NOV97–2/2

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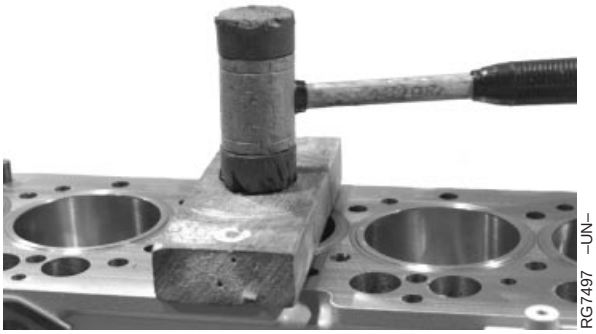
INSTALL CYLINDER LINER IN BLOCK

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.)

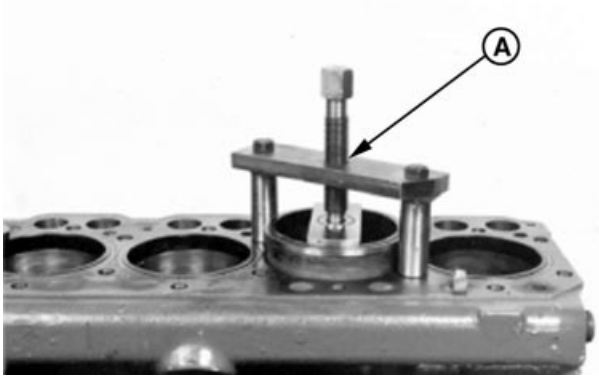

RG7497 –UN–

Installing Cylinder Liner in Block

1. Install liner in block bore with mark made during disassembly toward front of engine, unless liner OD is pitted or eroded.

   If liner OD is pitted or eroded, but still within acceptable service limits, rotate liner 90° from its 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. Finish seating liners using clean, hardwood block and mallet. Gently tap hardwood block over top of cylinder liner with mallet. KCD10001 Puller (A) may also be used to seat liners.



RGCD6373 –UN–

Using Puller to Seat Liners

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.

3. Hold liners in place with large flat washers and cap screws. Turn cap screws snug but do not tighten.

4. Clean cylinder liner bores with waterless hand cleaner after installation. Wipe dry with clean towels.

Continued on next page

RG,10,DT7390 –19–11NOV97–1/2

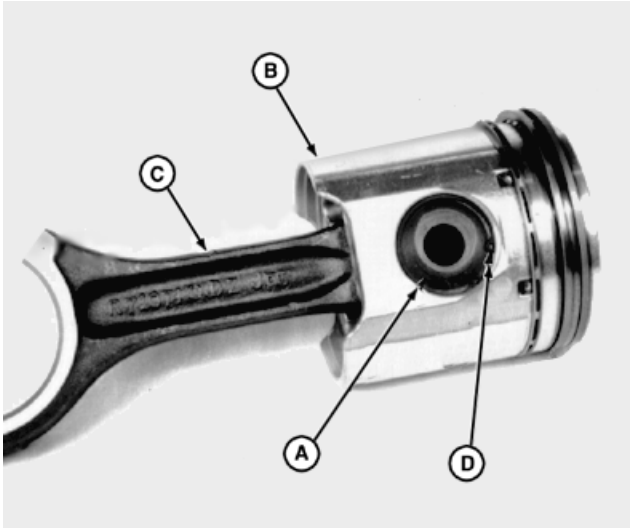
5. Apply clean engine oil to liner bores immediately to prevent corrosion.

RG,10,DT7390 –19–11NOV97–2/2

ASSEMBLE CONNECTING RODS ONTO PISTON

IMPORTANT: Pistons 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.

1. Lubricate piston pin (A) and bushing with clean engine oil.
2. Install piston pin through piston (B) and connecting rod (C). Be sure “FRONT” of rod aligns with arrow or “FRONT” of piston.
3. Install NEW piston pin snap rings (D) in grooves. Make certain snap rings have expanded in grooves of piston.



RG8976 –UN–

Assemble Connecting Rods onto Pistons

A—Piston Pin
B—Piston
C—Connecting Rod
D—Snap Rings

DPSG,OUOE003,345 –19–23APR98–1/1

INSTALL PISTON RINGS

IMPORTANT: Piston rings can be damaged if expanded too far. Expand piston rings only as far as necessary to install rings on piston.

1. When installing new piston rings, use JDE85, JDE135, or KJD10140 Piston Ring Expander. Install oil ring expander in bottom ring groove. Position end gap toward either side of piston pin.
2. Install oil control ring (C) in bottom ring groove over ring expander. Install with end gap on opposite side (180°) of piston from ring expander gap.

RG8977 –UN–

Installing Piston Rings

A—Top Compression Ring
B—Second Compression Ring
C—Oil Control Ring

Continued on next page

DPSG,OUOE003,347 –19–23APR98–1/3

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3. Identify top side of compression rings. Top side of the two compression rings will be identified by depression marks (A and B) and a white or orange stripe on the top side of two rings.

NOTE: Rectangular compression ring (B) with two depression marks and a white stripe goes in the second groove from top of piston.

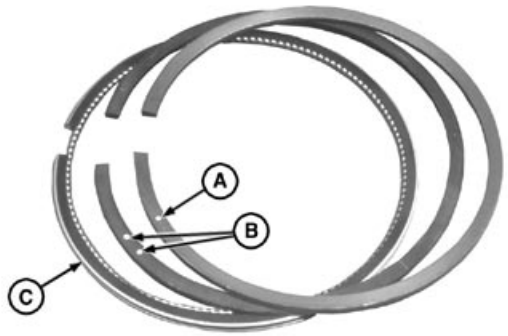
Barrel-faced compression ring (A) with one depression mark and an orange stripe goes in the first groove from top of piston.

NOTE: Top piston ring may have a paint stripe instead of a depression mark. In this case, install ring with stripe to the left side of ring gap as it faces you.

4. Install rectangular No. 2 compression ring in center ring groove with top of ring toward top of piston.

5. Position gap in rectangular compression ring on opposite side of piston from oil control ring (C) gap.

6. Install top (No. 1) compression ring in top ring groove with top of ring toward top of piston.



RG8978 –UN–

Compression Ring Identification

A—One Depression Mark
B—Two Depression Marks
C—Oil Control Ring

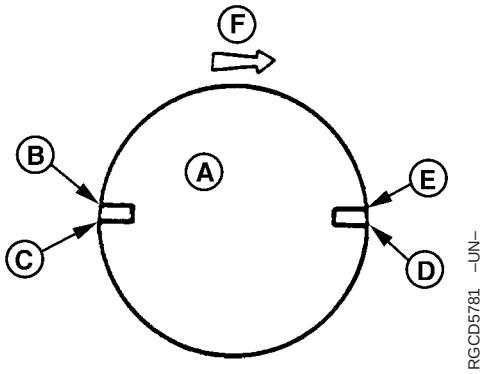
Continued on next page

DPSG,OUOE003,347 –19–23APR98–2/3

7. Position gap in top compression ring on opposite side of piston from second compression ring gap.

8. Stagger ring gaps on pistons as shown.

NOTE: New rings are furnished with correct end gap, therefore, fitting to the liner is not necessary.



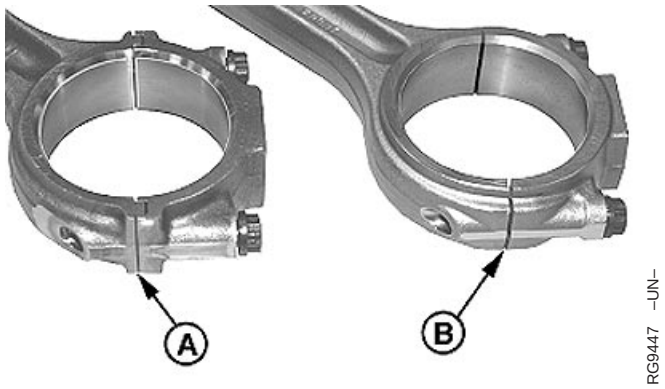
Stagger Ring Gaps on Piston

A—Piston Head
B—Top Compression Ring
C—Oil Control Ring Gap
D—Expander Ring Gap
E—Bottom Compression Ring Gap
F—Front of Engine

DPSG,OUOE003,347 –19–23APR98–3/3

CONNECTING RODS—GENERAL INFORMATION

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 each rod is similar, with differences noted in the following procedure.



Connecting Rod Joints

A—Tongue-and-Groove Joint
B—Precision Joint™

Precision Joint is a trademark of Deere & Company

DPSG,RG34710,2 –19–21SEP98–1/1

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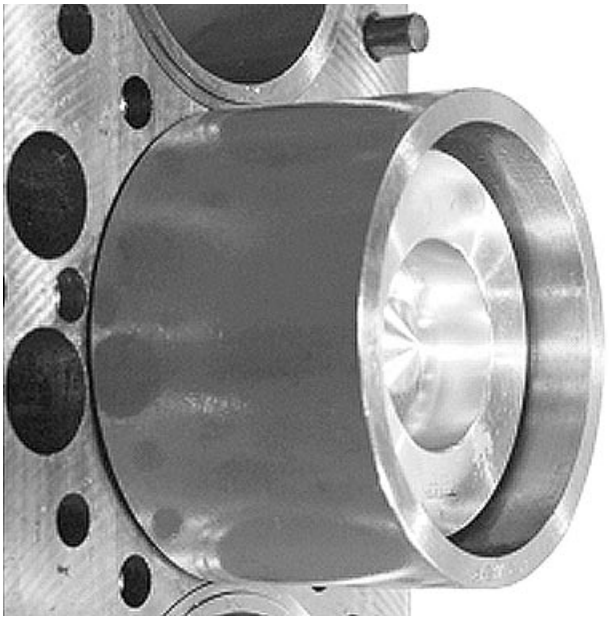
INSTALL PISTON AND ROD ASSEMBLY

IMPORTANT: Be careful so crankshaft journals and liner walls are not damaged by connecting rod when installing piston and rod in liner.

1. Carefully place JDE84 Piston Ring Compressor with piston and rod over liner so the word “FRONT” on side of rod and on the side of piston faces toward the front of the engine.

NOTE: If arrow indicating “FRONT” is not visible on top of pistons, install piston and rod so combustion bowl in piston is offset toward fuel injection pump side of engine, and the long side of the connecting rod is toward camshaft side of engine.

2. With piston centered in ring compressor and rings staggered correctly, push piston into liner.



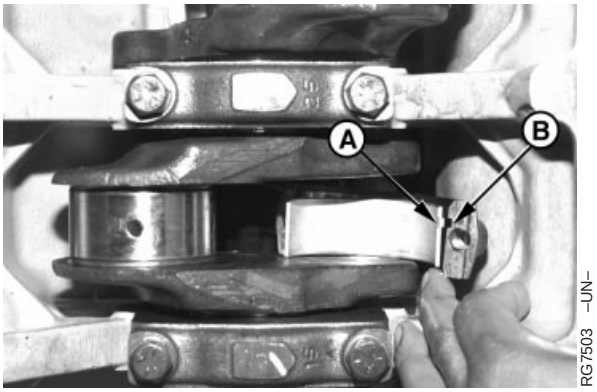
RG9445 –UN–

JDE84 Piston Ring Compressor

DPSG,OUOE003,346 –19–23APR98–1/4

3. Install bearing insert in connecting rod with tang (A) in groove (B).

4. Apply clean engine oil on insert and crankshaft journal. Carefully pull connecting rod and insert against crankshaft journal.



RG7503 –UN–

Tongue-and-Groove Rod Shown

A—Tang
B—Groove

Continued on next page

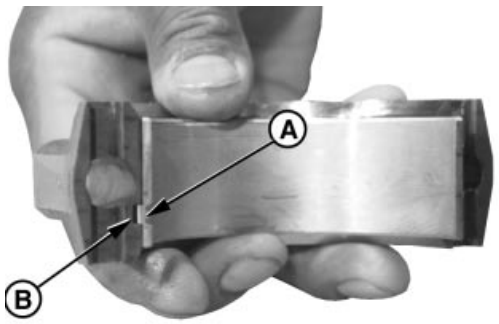
DPSG,OUOE003,346 –19–23APR98–2/4

NOTE: Due to the manufacturing process Precision Joint™ joint rod and cap both have a groove, while the bearing insert has a single tang. Only the groove in the cap is used for the bearing tang.

5. Install bearing insert in connecting rod cap with tang (A) in groove (B).

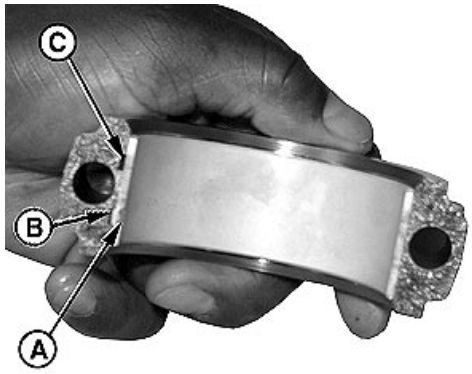
IMPORTANT: On Precision Joint™ joint connecting rods, make sure cap is properly aligned on rod with edges flush and interlocking surfaces sealed tightly.

6. Apply clean engine oil to bearing insert. Install cap on connecting rod with tangs to same side.



RG7504 –UN–

Tongue-and-Groove Joint Rod



RG9448 –UN–

Precision Joint Rod

A—Tang
B—Groove
C—Extra Groove (Not Used)

Precision Joint is a trademark of Deere & Company

Continued on next page

DPSG,OUOE003,346 –19–23APR98–3/4

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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 specification, they must not be reused for another final assembly.

Cap screws for Precision Joint™ joint rod and cap are 3 mm (0.12 in.) shorter than tongue-and-groove joint cap screws. DO NOT mix hardware.

Tighten Connecting Rod Cap Screw

7. Dip NEW connecting rod cap screws in clean oil and install.

8. Tighten cap screws alternately to initial torque specification.

Connecting Rod Cap Screws—Specification

Initial Torque..... 58 N•m (43 lb-ft)

9. Secondly, TORQUE-TURN all cap screws to 90—100 degrees. (See TORQUE-TURN CONNECTING ROD CAP SCREWS next in this group.)

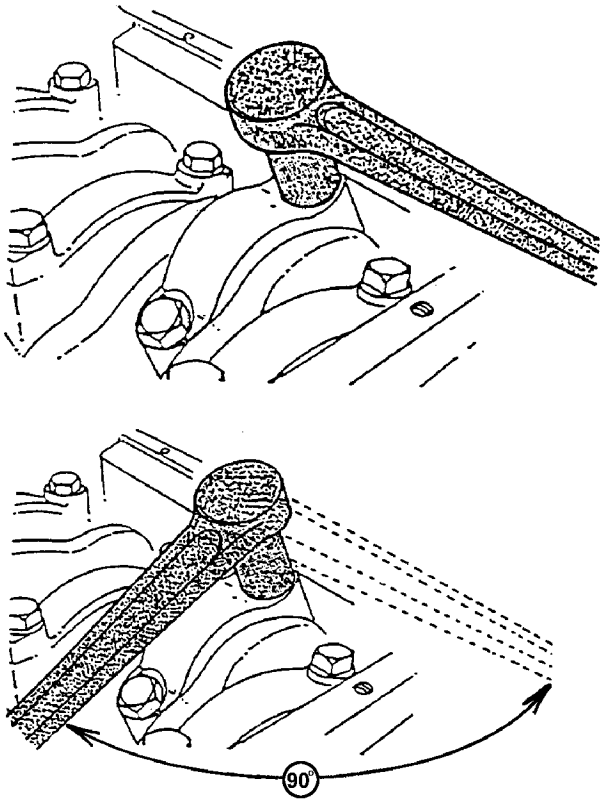
Precision Joint is a trademark of Deere & Company

DPSG,OUOE003,346 –19–23APR98–4/4

TORQUE-TURN CONNECTING ROD CAP SCREWS

USING ENGINE AXIS METHOD TO TORQUE-TURN CONNECTING ROD CAP SCREWS

1. After tightening cap screws to initial 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.



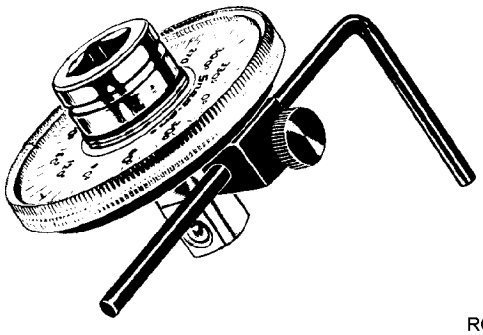
RG7047 –UN–

Torque-Turn Connecting Rod Cap Screws

RG,10,DT7386 –19–11NOV97–1/2

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 –UN–

Torque Angle Gauge

RG,10,DT7386 –19–11NOV97–2/2

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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,10,DT7385 –19–11NOV97–1/1

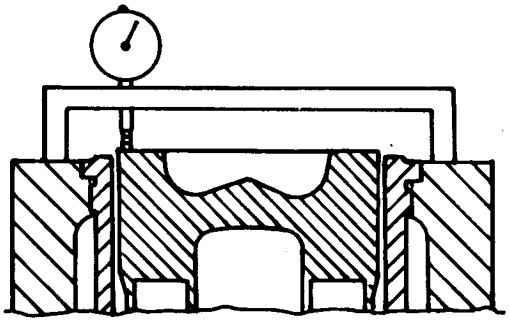
MEASURE PISTON PROTRUSION

1. Press down on top of piston to remove oil clearances before measuring piston protrusion.
2. Use JDG451 or KJD10123 Gauge (or use a magnetic base dial indicator) to measure piston protrusion. Place gauge on top of cylinder block so dial indicator can be set to “zero” with top of block.
3. Position gauge across piston. While pressing gauge downward, rotate crankshaft until piston is at TDC position. Measure piston height at several positions around the piston. If using JDG451 Gauge, piston height must be checked at outer most diameter of piston.
4. Piston protrusion must be within the following specifications to prevent piston-to-exhaust valve contact.

Piston—Specification

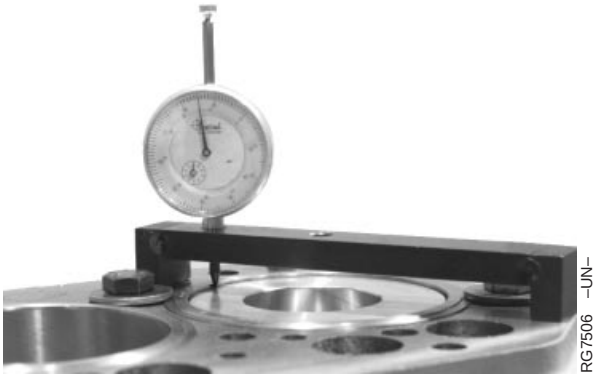
Protrusion (Above Block Deck)	0.08—0.30 mm (0.003—0.012 in.)

If protrusion does not meet specifications, check dimensions of piston, connecting rod, cylinder block, crankshaft, and bearings to determine the cause.



RG6440 –UN–

Measuring Piston Protrusion



RG7506 –UN–

Zeroing Dial Indicator

RG,10,DT7384 –19–11NOV97–1/1

COMPLETE FINAL ASSEMBLY

1. Install oil pump outlet tube O-ring in cylinder block. Install oil pump and outlet tube. (See Group 20.)
2. Install camshaft bushings. (See Group 16.)
3. Install oil bypass valve (in front of block) and front plate. (See Group 16.)
4. Install camshaft, timing gears, and timing gear cover. (See Group 16.)
5. Install oil pressure regulator valve, spring, and plug in timing gear cover. (See Group 16.)
6. Install oil pan. (See Group 20.)
7. Install crankshaft pulley. (See Group 15.)
8. Install camshaft followers. (See Group 16.)
9. Install cylinder head with new gasket. (See Group 05.)
10. Fill engine with clean oil and proper coolant.
11. Perform engine break-in.

RG,10,DT7383 –19–11NOV97–1/1

SPECIAL OR ESSENTIAL TOOLS

NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

SERVICE-GARD is a trademark of Deere & Company.

RG,15,DT7428 –19–11FEB98–1/14

RG6246 –UN–

Dial Indicator . . . . . .D17526CI (English, in.), D17527CI (Metric, mm) or FKM10103[1]

Use with JDG451 to measure valve recess and cylinder liner height-to-cylinder block top deck.

RG6246

D17526CI, D17527CI or FKM10103

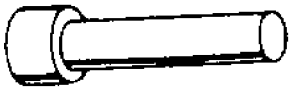
[1]*Part of KJD10123 Piston/Liner Height Gauge.*

RG,15,DT7428 –19–11FEB98–2/14

RG5068 –UN–

Timing Pin JDE81-4

Lock engine at TDC when installing valve train and adjusting valve clearance. Use with JDE83 Flywheel Turning Tool.



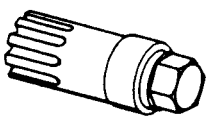
RG5068

JDE81-4

RG,15,DT7428 –19–11FEB98–3/14

Flywheel Turning Tool JDE83

Used to rotate flywheel on engines with 142-tooth flywheel ring gear and a 26.5 mm (1.04 in.) ID flywheel housing guide bore diameter. Use with JDE81-4 Timing Pin.



RG6251 –UN–

JDE83

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RG,15,DT7428 –19–11FEB98–4/14

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RG5109 –UN–

Seal Remover JDG22

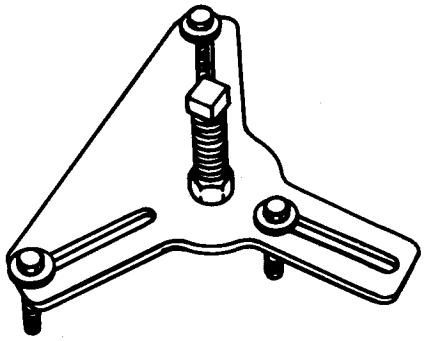
Remove crankshaft rear oil seal without removing flywheel housing.

JDG22

RG,15,DT7428 –19–11FEB98–5/14

Seal and Wear Sleeve Remover. JDG698A

Remove unitized (non-separable) crankshaft rear oil seal and wear sleeve.



RG5631 –UN–

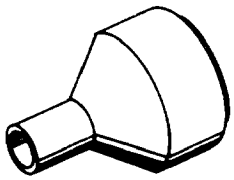
JDG698A

RG,15,DT7428 –19–11FEB98–6/14

RG6214 –UN–

Seal Puller Adapter JDG719

Used with a standard 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.



RG6214

JDG719

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RG,15,DT7428 –19–11FEB98–7/14

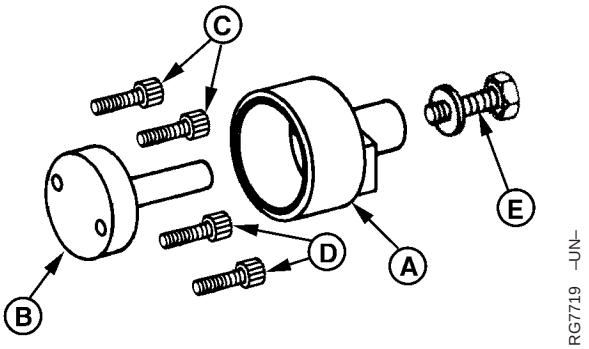
JDG719 Seal Puller Adapter Set consists of:

Adapter JDG719-1
Screw (not shown) 11200

RG,15,DT7428 –19–11FEB98–8/14

Rear Seal and Wear Sleeve Installer Set . . . JT30040B or KCD10002

Install crankshaft rear oil seal and wear sleeve assembly.



JT30040B or KCD10002

RG,15,DT7428 –19–11FEB98–9/14

JT30040B Set consists of:

A—Driver JT30042
B—Pilot JT30041A
C—English Socket-Head Cap Screws 10903
D—Metric Socket Head Cap Screws 221663
E—Screw with Washer 10870

Continued on next page

RG,15,DT7428 –19–11FEB98–10/14

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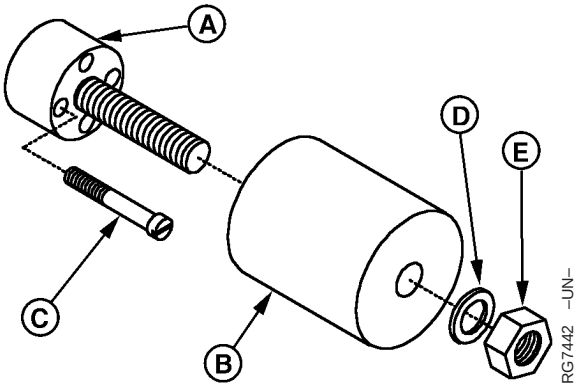
Crankshaft Gear and Front Oil Seal Installer JDG954

Used to install crankshaft gear either prior to, or after, installing crankshaft into engine. Also used to install front oil seal with timing gear cover installed on engine.



JDG954

RG,15,DT7428 –19–11FEB98–11/14

NOTE: JDG954-1 Installer may be used to install the crankshaft gear when the crankshaft is REMOVED from the engine.

JDG954 Crankshaft Gear and Front Oil Seal Installer Set consists of:

A—Adapter	JDG954-2
B—Installer	JDG954-1
C—Special Cap Screws	JDG954-3
D—Thrust Washer	206747
E—Hex Nut	22301

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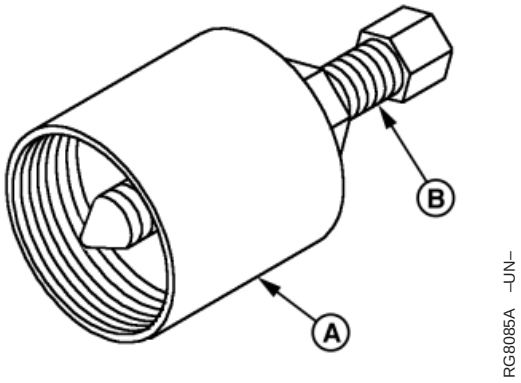
RG,15,DT7428 –19–11FEB98–12/14

Front Wear Sleeve Puller JDG992

Used to remove front wear sleeve with timing gear cover installed.



JDG992

RG,15,DT7428 –19–11FEB98–13/14

JDG992 Front Wear Sleeve Puller Set consists of:

A—Threaded Collet JDG992-1
B—Forcing Screw 311099

RG,15,DT7428 –19–11FEB98–14/14

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICE-GARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
D01047AA 17-1/2 and 30-Ton Puller Set	Remove crankshaft gear from crankshaft.
D01045AA Bushing, Bearing, and Seal Driver Set	Install pilot bearing in flywheel.
Cylinder Bore Ridge Reamer	Remove carbon from liner bore.
JDG966Crankshaft Front/Rear Rotation Adapter	Rotate crankshaft from front and rear with flywheel removed.
D01200AA Push Puller	Remove crankshaft gear.

SERVICE-GARD is a trademark of Deere & Company.

RG,15,DT7429 –19–14NOV97–1/1

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OTHER MATERIAL

Number	Name	Use
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Coat threads of flywheel mounting cap screws.
TY6304 (U.S.) TY9484 (Canadian) 515 (LOCTITE®)	Flexible Sealant	Serves as flywheel housing-to-cylinder block gasket.
609 (LOCTITE®) TY43515 (U.S.)	Retaining Compound	Coat OD of crankshaft flange for installation of rear oil seal/water sleeve. Coat ID of front wear sleeve prior to installation.
— (U.S.)	PLASTIGAGE®	Check main bearing-to-crankshaft journal oil clearance during engine disassembly.
— (U.S.)	Brake Kleen or Ignition Cleaner	Remove sealant from crankshaft flange.

LOCTITE is a trademark of the Loctite Corp.
PLASTIGAGE is a trademark of the DANA Corp.

RG,15,DT7463 –19–14NOV97–1/1

CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Vibration Damper:		
Maximum Radial Runout	1.50 mm (0.060 in.)	_____
Maximum Wobble:		
(Outer Ring)	1.50 mm (0.060 in.)	_____
(Inner Ring)	0.50 mm (0.020 in.)	_____
Crankshaft:		
Main Bearing Journal OD	79.324—79.350 mm	_____
	(3.1229—3.1240 in.)	_____
Main Bearing Assembled ID	79.391—79.433 mm	_____
	(3.1256—3.1273 in.)	_____
Main Bearing-to-Journal Clearance	0.041—0.109 mm	_____
	(0.0016—0.0043 in.)	_____
Thrust Bearing Journal Width	38.952—39.028 mm	_____
	(1.5335—1.5365 in.)	_____
Thrust Bearing Overall Width	38.79—38.87 mm	_____
	(1.527—1.530 in.)	_____
Crankshaft End Play (Thrust Bearing Clearance):		
Engine with Two-Piece Thrust Bearing	0.05—0.25 mm	_____
	(0.002—0.010 in.)	_____
Maximum Main or Rod Journal Taper	0.010 mm (0.0004 in.)	_____
Maximum Main or Rod Journal Out-of-Roundness	0.005 mm (0.0002 in.)	_____
Undersize Main and Rod Bearing Available	0.25 mm (0.010 in.)	_____
Main Bearing Bore Specifications:		
ID Without Bearing Inserts	84.455—84.481 mm	_____
	(3.3250—3.3260 in.)	_____
Rod Bearing Journal OD	77.800—77.826 mm	_____
	(3.0629—3.0640 in.)	_____
Bore Centerline-to-Top Deck of Block	337.896—337.972 mm	_____
	(13.3029—13.3059 in.)	_____
Engine Stroke	127 mm (5.00 in.)	_____
Flywheel Housing Face Run-Out:		
12 O'clock position	0.30 mm (0.012 in.)	_____
3 and 9 O'clock positions	0.25 mm (0.010 in.)	_____
Flywheel:		
Pilot Bushing Bore ID	50.940—50.990 mm	_____
	(2.005—2.007 in.)	_____
Housing Seal Bore Run-Out (Maximum)	0.152 mm (0.006 in.)	_____

TORQUES

Pulley or Damper with Pulley-to-Crankshaft[a]:	
Step 1	20 N•m (15 lb-ft)
Step 2	80 N•m (59 lb-ft)
Main Bearing Cap Screw	135 N•m (100 lb-ft)
Flywheel-to-Crankshaft	138 N•m (102 lb-ft)
Flywheel Housing-to-Cylinder Block	138 N•m (102 lb-ft)
Piston Cooling Orifices	11 N•m (8 lb-ft)

[a]Tighten cap screws in a cross sequence.

RG,15,DT7456 –19–11FEB98–1/1

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CRANKSHAFT GRINDING SPECIFICATIONS

Bearing Size	Crankshaft Main Journal OD	Crankshaft Rod Journal OD
Standard	79.324—79.350 mm (3.1229—3.1240 in.)	77.800—77.826 mm (3.0629—3.0640 in.)
0.25 mm (0.010 in.) Undersize	79.074—79.100 mm (3.1131—3.1141 in.)	77.550—77.576 mm (3.0531—3.0541 in.)

Main and Connecting Rod Journal Surface Finish (AA)	Lap 0.20 um (8 AA)
Thrust Surface Finish (AA)	Lap 0.40 um (16 AA)
Thrust Bearing Journal Width	38.952—39.028 mm (1.5335—1.5365 in.)
Direction of Crankshaft Rotation (viewed from flywheel end):	
Grinding	clockwise
Lapping	counterclockwise

RG,15,DT7435 –19–14NOV97–1/1

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:

- Coolant in lubrication system (cracked block, liner seal failure, or leaking water pump seal with plugged hole).
- Insufficient bearing oil clearance.
- Parts not lubricated prior to engine operation.
- Wrong bearing size.

Inconsistent Wear Pattern:

- Misaligned or bent connecting rod.
- Warped or bowed crankshaft.
- Distorted cylinder block.

Broken Main Bearing Caps:

- Improper installation.
- Dirt between bearing and crankshaft journal.
- Low oil pressure.
- Oil pump failure.

Cracked, Chipped or Broken Bearings:

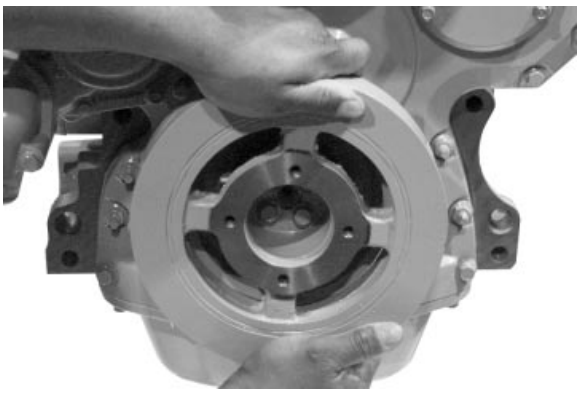
- Overspeeding.
- Excessive idling.
- Lugging.
- Excessive oil clearance.
- Improper installation.

RG,15,DT7149 –19–03NOV97–1/1

INSPECT VIBRATION DAMPER

IMPORTANT: Do not immerse the vibration damper in cleaning solvent or any petroleum product. Rubber portion of damper may be damaged. Never apply thrust on outer ring. Damper is sensitive to impact damage, such as being dropped or struck with a hammer. The damper assembly is not repairable. Replace damper every 5 years or 4500 hours, whichever occurs first. Also, replace damper whenever crankshaft is replaced or after major engine overhaul.

1. Grasp outer ring of damper and attempt to turn it in both directions. If rotation is felt, damper is defective and should be replaced. Also, if rubber is separated, partially missing, or displaced, replace damper.



RG7507 –UN–

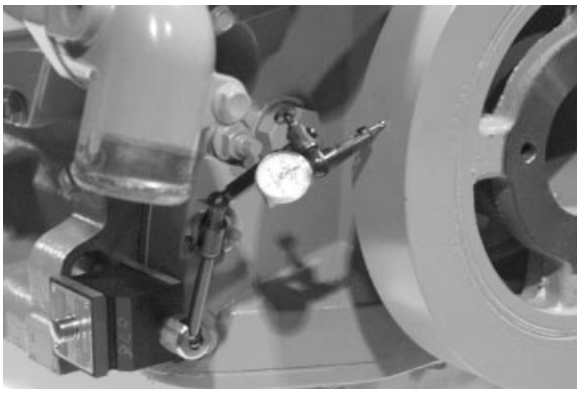
Inspecting Vibration Damper

RG,15,DT7460 –19–11FEB98–1/3

2. Check vibration damper radial runout by positioning a dial indicator so probe contacts damper OD.
3. With engine at operating temperature, rotate crankshaft using engine rotation tool.
4. Note dial indicator reading. If runout exceeds specifications given below, replace vibration damper.

Vibration Damper—Specification

Maximum Radial Runout	1.50 mm (0.060 in.)



RG7508 –UN–

Checking Vibration Damper Radial Runout

Continued on next page

RG,15,DT7460 –19–11FEB98–2/3

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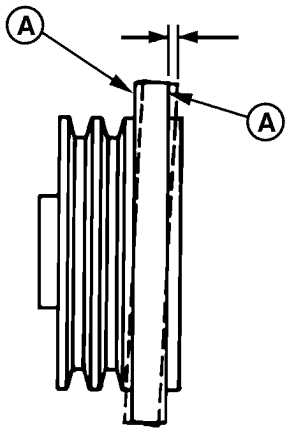
5. Check vibration damper wobble using a dial indicator. Measure wobble at the outer edges of damper face (A).

6. Rotate crankshaft one complete revolution using engine rotation tool, and note total dial indicator movement. Compare readings with specifications below.

Vibration Damper—Specification

Outer Ring (Maximum) Pulley Wobble	1.50 mm (0.060 in.)
Inner Ring (Maximum) Pulley Wobble	0.50 mm (0.020 in.)



Checking Damper Wobble

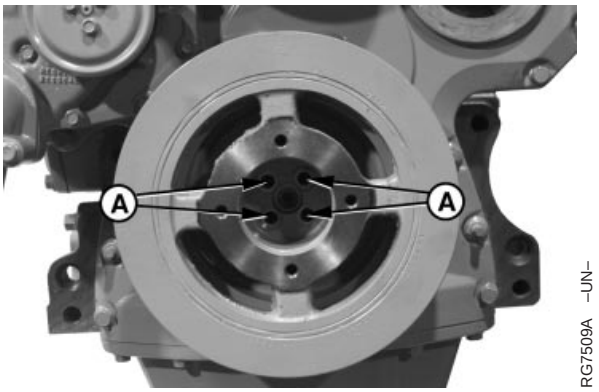
RG,15,DT7460 –19–11FEB98–3/3

REMOVE PULLEY OR VIBRATION DAMPER AND PULLEY

IMPORTANT: Never apply thrust on outer ring of damper. Do not drop or hammer on damper.

1. Remove four cap screws (A) from vibration damper.

2. Grasp damper and remove from crankshaft.

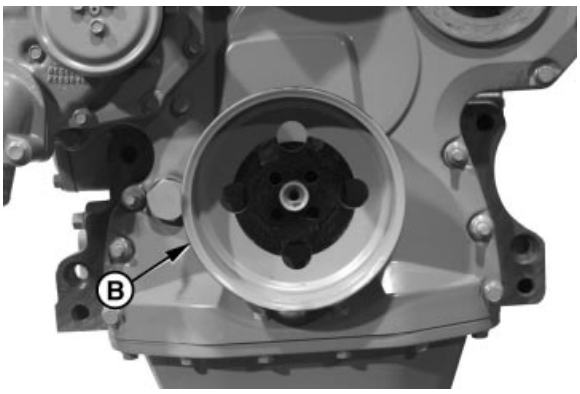


Removing Damper Cap Screws

Continued on next page

RG,15,DT7459 –19–14NOV97–1/2

3. Remove belt pulley (B).



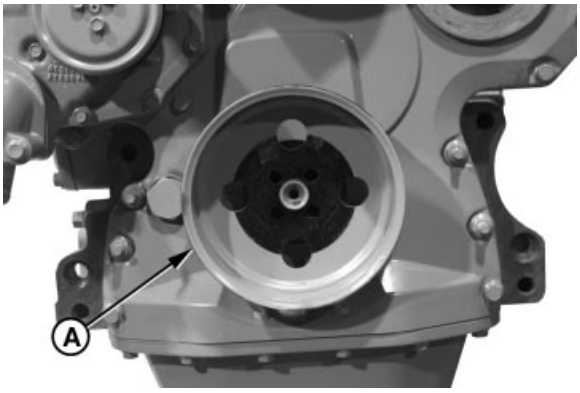
RG7510B –UN–

Removing Belt Pulley

RG,15,DT7459 –19–14NOV97–2/2

INSTALL PULLEY OR VIBRATION DAMPER PULLEY

1. Install belt pulley (A).
2. Position damper on crankshaft. Handle vibration damper with care to avoid impact damage.



RG7510A –UN–

Installing Belt Pulley

Continued on next page

RG,15,DT7458 –19–14NOV97–1/2

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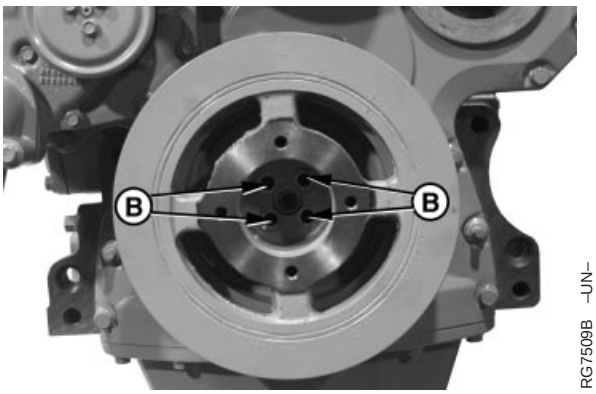
IMPORTANT: Damper or pulley-to-crankshaft cap screw must be SAE Grade 8 or higher.

3. Dip cap screws (B) in clean SAE30 engine oil.

4. Install cap screws and tighten in a cross sequence to 20 N•m (15 lb-ft). Final tighten cap screws to 80 N•m (59 lb-ft).



Installing Damper Cap Screws

RG,15,DT7458 –19–14NOV97–2/2

CHECKING VIBRATION DAMPER OR PULLEY

NOTE: When cleaning damper, never soak in a cleaning solvent. Use a steam cleaner, soap solution or water only.

1. Prior to disassembly, check the following specifications:

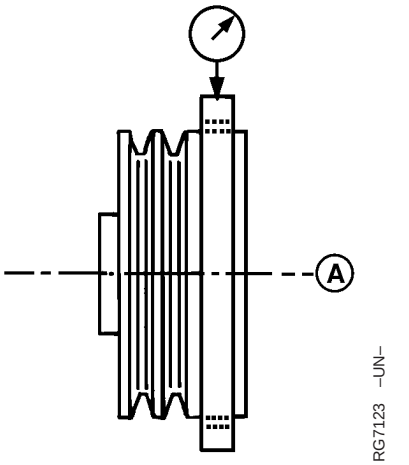
Vibration Damper—Specification

Maximum Radial Run-Out (A)	1.50 mm (0.060 in.)
Maximum Wobble (B)	1.50 mm (0.060 in.)

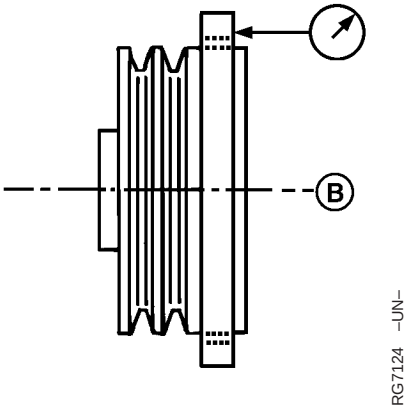
2. Replace damper if total run-out (A) or wobble (B) exceeds specifications, or if outer ring has slipped relative to rubber member or drive hub.

3. Grasp damper and attempt to turn in both directions (clockwise and counterclockwise). If rotation is felt, replace damper.

IMPORTANT: Replace damper after 4500 hours or every five years, whichever occurs first.



Measuring Damper Runout



Measuring Damper Wobble

RG,15,DT7457 –19–14NOV97–1/1

REPLACE FRONT CRANKSHAFT OIL SEAL AND WEAR SLEEVE (WITHOUT REMOVING TIMING GEAR COVER)

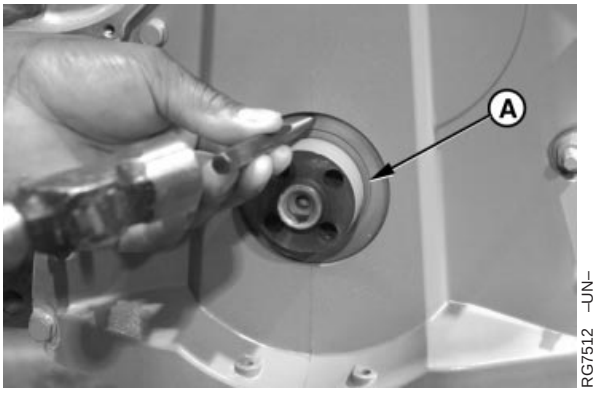
REMOVE FRONT CRANKSHAFT OIL SEAL

1. Remove poly-vee belts.
2. Remove vibration damper/pulley or pulley from crankshaft as previously instructed in this group.

RG,15,DT7455 –19–14NOV97–1/6

IMPORTANT: Whenever front oil seal is replaced, the wear sleeve must also be replaced.

3. Check oil seal (A) for wear, damage, or leakage.
4. Center punch seal casing at 12 o'clock position and drill 1/8 in. hole in casing.



Center Punch Front Oil Seal Casing

Continued on next page

RG,15,DT7455 –19–14NOV97–2/6

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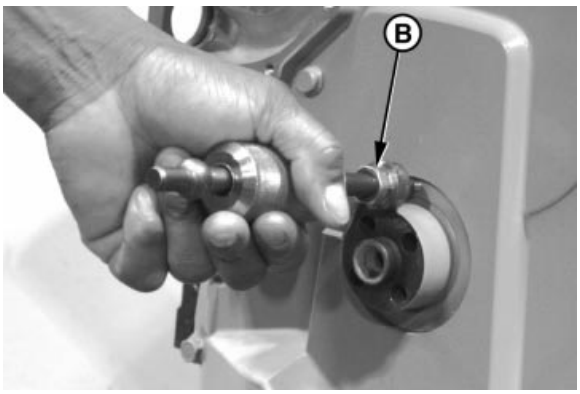
5. Remove seal from timing gear cover using JDG22 Seal Remover or JDG719 Seal Puller along with JDE38-2 Shank and JDE38-3 Slide Hammer (B). Be careful not to damage seal bore in timing gear cover.



Removing Front Oil Seal

Continued on next page

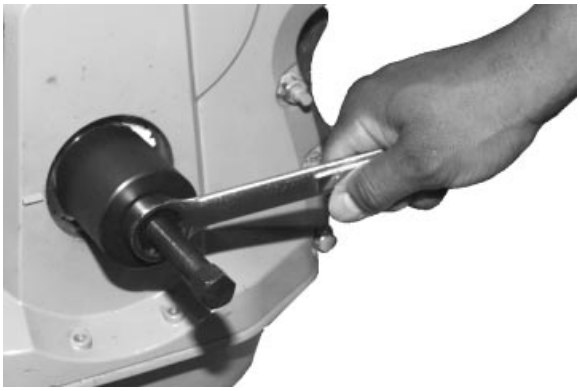
RG,15,DT7455 –19–14NOV97–3/6

REMOVE CRANKSHAFT WEAR SLEEVE

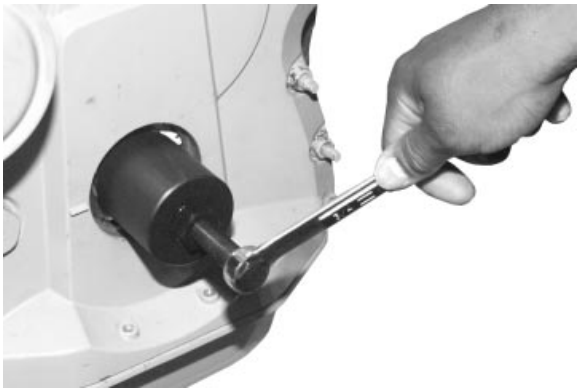
NOTE: You may want to apply inward pressure on collet as it is threaded onto wear sleeve.

1. Lock flywheel with JDE81-4 Timing Pin.
2. Back out forcing screw and position JDG992-1 Collet onto crankshaft flange until threaded ID contacts wear sleeve.
3. Thread collet onto wear sleeve and securely tighten until wear sleeve can be removed from crankshaft flange.
4. Lubricate threads of forcing screw. Tighten forcing screw until wear sleeve is removed from front crankshaft flange.
5. Clean crankshaft flange using Brake Kleen, Ignition Cleaner, or equivalent.

Installing Collet on Crankshaft



Tightening Forcing Screw



Tighten Forcing Screw Until Wear Sleeve Is Removed

Continued on next page RG,15,DT7455 –19–14NOV97–4/6

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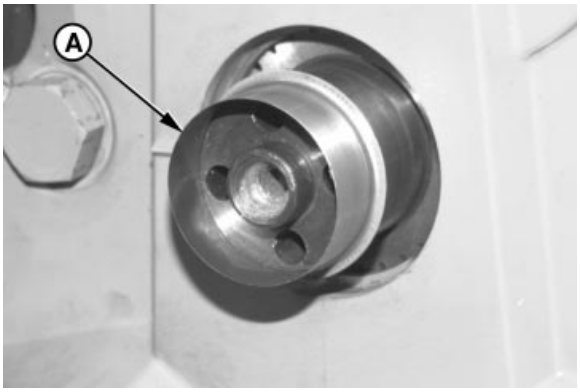
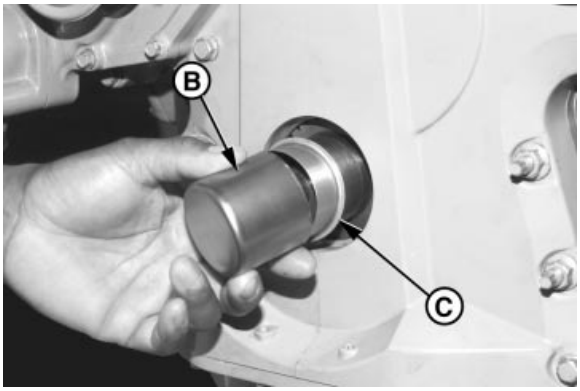
INSTALL CRANKSHAFT WEAR SLEEVE:

1. Coat ID of new wear sleeve with LOCTITE® 609 (T43515) Retaining Compound.
2. Install wear sleeve (A) on nose of crankshaft with flange of sleeve toward crankshaft.
3. Position installation tool (B) provided in kit over wear sleeve. Install wear sleeve until tool bottoms on nose of crankshaft, using a dead blow hammer. Flange on wear sleeve should contact crankshaft gear.
4. Clean any sealant from OD of crankshaft flange (C) and wear sleeve.



Installing Wear Sleeve on Crankshaft



Positioning Installation Tool

Hammering Wear Sleeve On

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RG,15,DT7455 –19–14NOV97–5/6

INSTALL FRONT CRANKSHAFT OIL SEAL

1. Inspect and clean seal bore in timing gear cover. Check for nicks or burrs. Use a medium-grit emery cloth to smooth rough areas.

IMPORTANT: To assure proper sealing, the OD of the crankshaft and wear sleeve MUST BE cleaned with Brake Kleen, Ignition Cleaner, or equivalent and dry prior to installing seal (C).

2. Slide JDG954-2 Adapter (A) on nose of crankshaft and tighten cap screws.

IMPORTANT: DO NOT allow oil to contact coating on OD of seal.

3. Apply a light coating of clean engine oil to lips of seal and position seal on crankshaft flange. (The spring-loaded side of seal goes into timing gear cover first.)

4. Place JDG954-1 Installer (B) over adapter. Tighten screw until driver bottoms on nose of crankshaft.

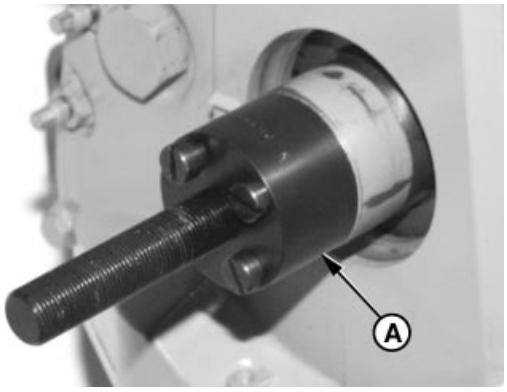
5. Install belt pulley

6. Place damper on crankshaft. Handle vibration damper with care to avoid impact damage.

7. Dip cap screws in clean SAE30 engine oil.

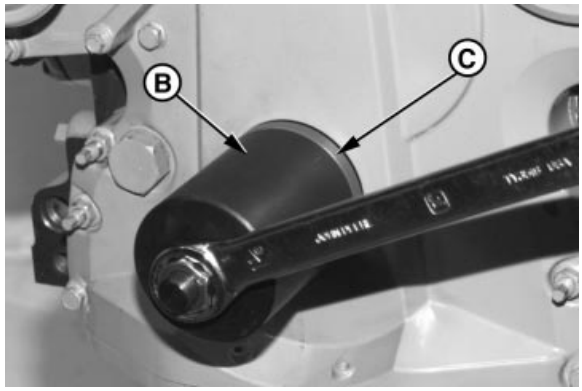
8. Install cap screws and tighten in a cross sequence to 20 N•m (15 lb-ft). Final tighten cap screws to 80 N•m (59 lb-ft).

9. Install poly-vee belts.



RG7515A –UN–

Installing Oil Seal Adapter



RG7516A –UN–

Placing Installer Over Adapter

RG7511 –UN–

Installed Seal

RG,15,DT7455 –19–14NOV97–6/6

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CHECK CRANKSHAFT END PLAY

Measure end play prior to removing crankshaft to determine condition of thrust bearings.

1. Position dial indicator on contact face of flywheel, on front crankshaft nose, on damper, or front pulley assembly if installed.

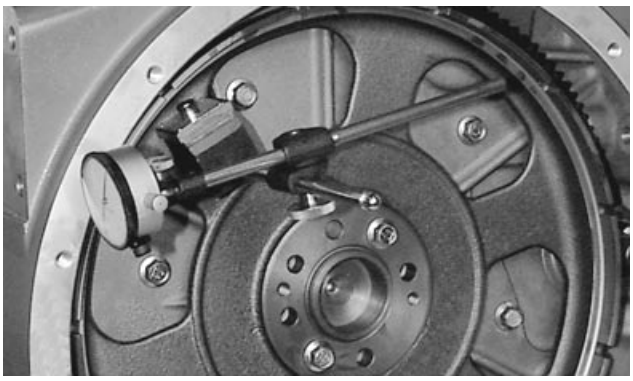
IMPORTANT: Do not apply too much pressure with pry bar (A), as this could damage bearings.

2. Using a pry bar, gently push crankshaft as far to rear of engine as possible.
3. Zero the dial indicator.
4. Gently pry the crankshaft as far forward as possible. Note indicator reading. If end play is not within specifications, install new thrust bearing.

Two-Piece Thrust Bearing (New Parts)—Specification

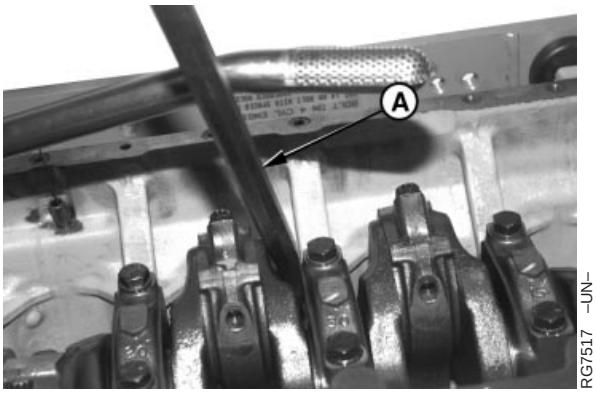
Crankshaft End Play ..... 0.05—0.25 mm (0.002—0.010 in.)

If new thrust bearing does not restore proper end play, install a two-piece thrust bearing with oversize thrust washers.



RG8972 –UN–

Checking Crankshaft End Play



RG7517 –UN–

Moving Crankshaft With Pry Bar

RG7542 –UN–

New Thrust Bearing

RG,15,DT7454 –19–11FEB98–1/1

INSPECT FLYWHEEL

1. Inspect the clutch contact face for scoring, overheating, or cracks. Replace or resurface flywheel if defective.
2. Examine flywheel ring gear for worn or broken teeth. Replace ring gear if defective, as described later in this group.

RG,15,DT7465 –19–14NOV97–1/1

REMOVE FLYWHEEL

CAUTION: Flywheel is heavy. Plan a proper lifting procedure to avoid personal injury.

1. Remove two cap screws and install guide studs (A) in their place (shown installed). Remove the other cap screws and install them into the threaded holes, to push flywheel off crankshaft.
2. Remove flywheel. Remove guide studs from crankshaft.

Removing Flywheel

RG,15,DT7452 –19–11FEB98–1/1

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. Place the flywheel on a solid flat surface.

Continued on next page

RG,15,DT7451 –19–11FEB98–1/3

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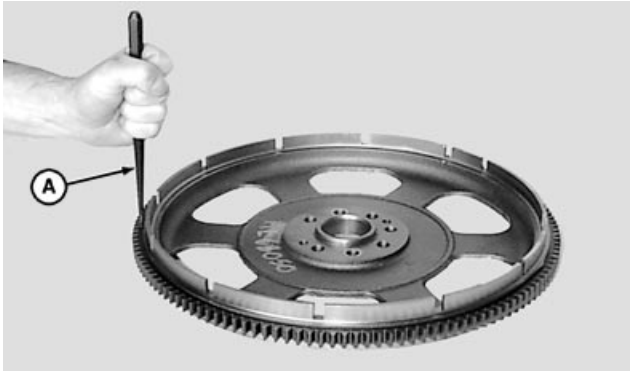
2. Drive ring gear off with a brass drift (A) and hammer.

IMPORTANT: 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.

3. Heat new ring gear to 148°C (300°F) using either heated oil, oven heat, or flame heat.

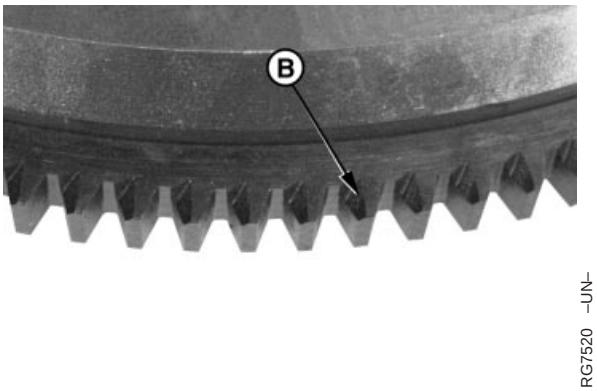


Drive Ring Gear Off Flywheel

RG,15,DT7451 –19–11FEB98–2/3

4. Turn gear so side with chamfer (B) is toward engine with flywheel installed.

5. Install ring gear against shoulder of flywheel.



Installing Ring Gear on Flywheel

RG,15,DT7451 –19–11FEB98–3/3

INSTALL FLYWHEEL

CAUTION: Flywheel is heavy. Plan a proper handling procedure to avoid injuries.

IMPORTANT: Flywheel MUST BE clean and free of any oil, grease or debris.

1. Install two guide studs (A) in crankshaft cap screw threaded holes. Place flywheel on studs and slide into position against crankshaft.

IMPORTANT: ALWAYS install new flywheel cap screws when flywheel has been removed.

2. Apply LOCTITE® 242 (TY9370) to threads of all flywheel mounting cap screws. Start cap screws in crankshaft. Do not tighten until guide studs are removed and all cap screws are started. Tighten cap screws to 138 N•m (102 lb-ft).

Installing Flywheel

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RG,15,DT7449 –19–11FEB98–1/1

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CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE HANDLING PRECAUTIONS

Use the following precautions for handling seal and wear sleeve assembly (A):

- Seal and wear sleeve 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 ID 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.

RG5640A –UN–

Crankshaft Rear Oil Seal

RG,15,DT7448 –19–14NOV97–1/1

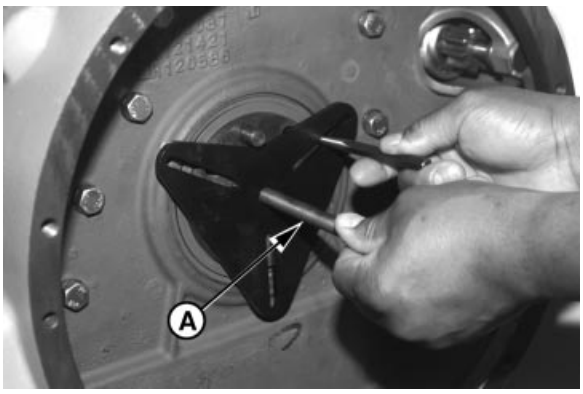
REMOVE UNITIZED (NON-SEPARABLE) CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE

The unitized (non-separable) oil seal and wear sleeve MUST BE removed before removing flywheel housing.

1. Remove flywheel.
2. Adjust forcing screw (A) on JDG698A Seal and Wear Sleeve Remover and position screw so it centers tool on crankshaft flange.
3. Use the slots in JDG698A Remover as a template, mark three locations on seal casing where screws should be installed for removal purposes. Remove tool from crankshaft flange.

IMPORTANT: Holes must be drilled at outer edge of seal case. Screws will pull seal against wear ring, thereby removing both pieces.

4. Drill a 5/32 in. hole through wear sleeve lip and seal casing at the three marked locations.
5. Position JDG698A Remover on end of crankshaft.
6. Install three 2-1/2 in. (approximate) sheet metal screws with washers (B) into slots of removal tool and thread screws into holes in seal casing. Evenly tighten screws until plate is flush with rear face of crankshaft.
7. Tighten forcing screw (plate should pull evenly against the three screws) until seal and wear sleeve assembly is removed from engine.

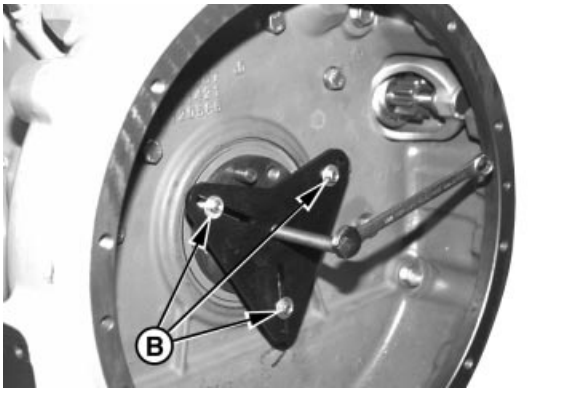


RG7399 –UN–

Marking Location Holes

RG7400 –UN–

Drilling Location Holes



RG7401 –UN–

Installing Sheet Metal Screws

Continued on next page

RG,15,DT7447 –19–14NOV97–1/2

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8. Clean OD of crankshaft flange and ID of flywheel housing with cleaning solvent, trichloroethylene, acetone, or any other suitable cleaner that will remove sealant.

9. Look for nicks or burrs on wear ring surface and bore in flywheel housing. If necessary, use polishing cloth to remove nicks or burrs.

   Finish cleaning by wiping flange with a clean rag.


RG7522 –UN–

Cleaning Crankshaft Flange

RG,15,DT7447 –19–14NOV97–2/2

INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE

IMPORTANT: No lubrication of any kind is to contact seal when installing. Use of a lubricant may result in premature seal failure. Install seal and wear sleeve assembly immediately after removal from plastic bag to avoid possible dirt contamination.

RG5640A –UN–

Crankshaft Rear Oil Seal

1. If not previously done, clean OD of crankshaft flange and ID of wear sleeve with trichloroethylene or equivalent just prior to application of sealant. Make sure that OD of crankshaft flange and ID of seal housing bore are free from nicks or burrs.

2. Apply a light coating of LOCTITE® 609 (T43515) Retaining Compound completely around the leading edge of crankshaft flange. Wipe away sealant that may have gotten on flywheel housing seal bore.

LOCTITE is a trademark of the Loctite Corp.

Continued on next page

RG,15,CH169 –19–30DEC97–1/4

3. Install JT30041A Pilot (A) from the JT30040B Seal and Wear Sleeve Installer Set on end of crankshaft using two socket-head cap screws. Tighten both cap screws until they touch base of pilot then back them off approximately 1/2 turn.

Installing Pilot on Crankshaft

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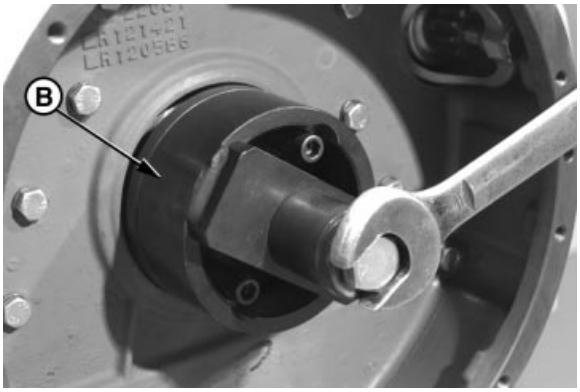
4. Install JT30042 Driver (B) over JT30041A Pilot as shown until driver cross-plate bottoms on pilot. This will properly center pilot with crankshaft flange.

NOTE: It may be necessary to lift up on pilot to install driver to full depth over pilot and crankshaft flange.

5. Tighten two pilot socket head cap screws securely. Remove driver from pilot.

IMPORTANT: Handle the rear oil seal and sleeve assembly carefully. If wear sleeve surface is scratched, gouged or any sealant (liquid) is present, order a new seal assembly.

6. Carefully start oil seal and wear sleeve over pilot and crankshaft flange with open side of seal toward engine.



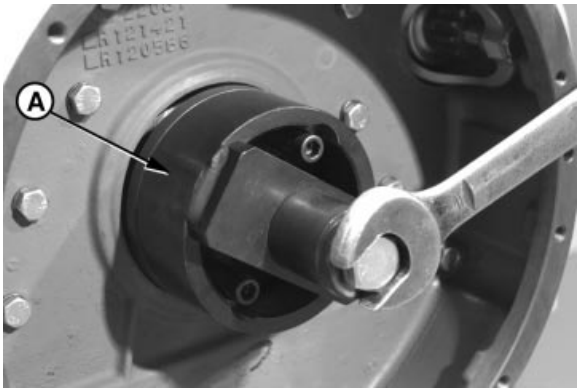
Installing Driver On Pilot

Continued on next page

RG,15,CH169 –19–30DEC97–3/4

7. Attach JT30042 Driver (A) and thrust washer to the guide plate with cap screw. Tighten the cap screw until driver bottoms on pilot.

8. Remove seal driver and pilot plate Check that seal and wear sleeve assembly is properly positioned on crankshaft flange and installed square in flywheel housing bore.



Tightening Guide Plate Cap Screw

RG,15,CH169 –19–30DEC97–4/4

REMOVE FLYWHEEL HOUSING

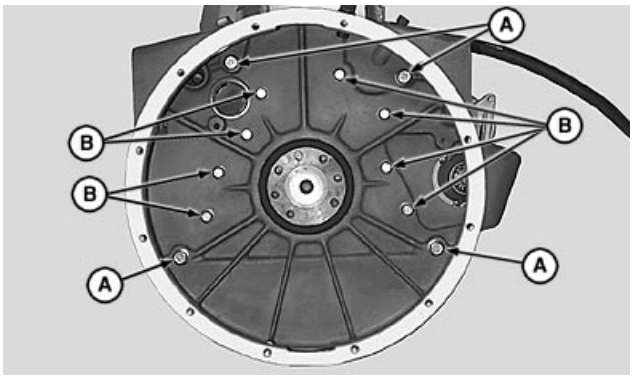
1. Remove flywheel. (See REMOVE FLYWHEEL earlier in this group.)

2. Remove starter if desired. Starter and flywheel housing may be removed as an assembly.

3. Remove crankshaft real oil seal as described earlier in this group.

CAUTION: The flywheel housing is heavy. Plan a proper handling procedure to avoid injuries.

4. Remove flywheel housing-to-cylinder block cap screws (A and B). Remove flywheel housing from block.



Flywheel Housing

RG,15,DT7445 –19–11FEB98–1/1

REMOVE CRANKSHAFT MAIN BEARINGS

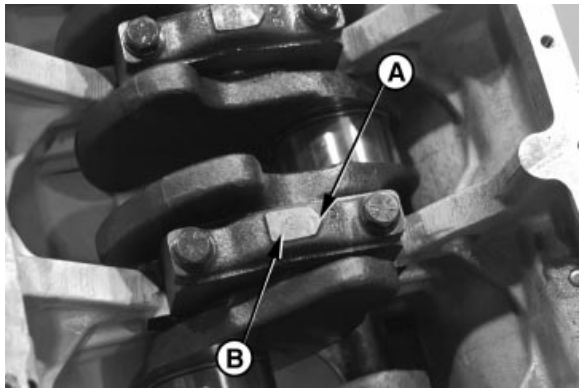
1. Drain oil from engine crankcase and remove oil pan. (See Group 20.)
2. Remove timing gear cover and front plate. (See Group 16.)
3. Remove flywheel housing. (See Group 15.)
4. Remove connecting rods from crankshaft. (See Group 10.)

RG,15,DT7444 –19–14NOV97–1/3

IMPORTANT: Before removing main bearing caps, check for proper torque on all main bearings.

NOTE: When crankshaft is to be removed, leave front and rear main bearing caps installed until all connecting rod caps have been removed.

5. Check main bearing caps for arrows (A, cast in main bearing cap) and numbers (B) stamped on cap and oil pan rail. Arrow points toward camshaft side of engine. If there are no numbers, stamp corresponding numbers on cap and oil pan rail to assure correct placement of bearing caps during reassembly.



Checking Bearing Caps for Arrows and Numbers

Continued on next page

RG,15,DT7444 –19–14NOV97–2/3

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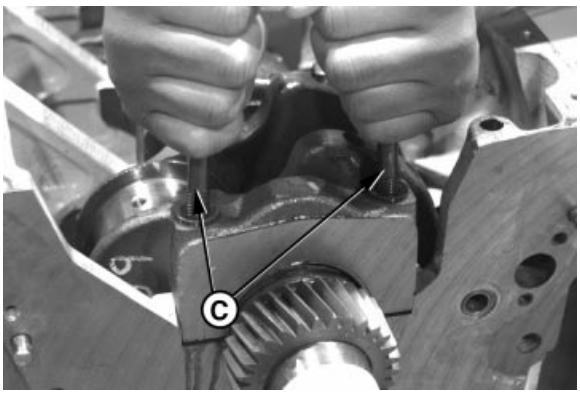
6. Remove main bearing caps by extending cap screws (C) and forcing heads of screws together. Wiggle bearing cap back and forth while applying an upward force with cap screws until free from main bearing cap support.

IMPORTANT: Keep matched bearings with their respective main bearing cap for comparison with crankshaft journal (surface wear) from which removed.

7. Visually inspect condition of bearing inserts and crankshaft main journals as bearing caps are removed.



Removing Main Bearing Caps

RG,15,DT7444 –19–14NOV97–3/3

CHECK MAIN BEARING OIL CLEARANCE

NOTE: The use of PLASTIGAGE® will determine wear (crankshaft-to-bearing oil clearance) but will not determine condition of either bearing or journal surface.

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 or on crankshaft journal to measure oil clearance.

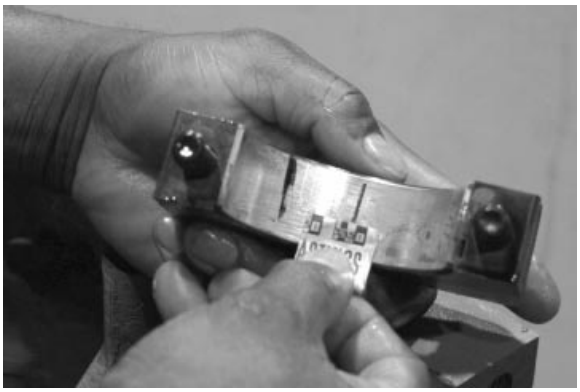
2. Use clean (SAE30) oil on PLASTIGAGE® to prevent smearing.

3. Install cap and tighten cap screws to 135 N•m (100 lb-ft).

4. Remove cap and compare width of PLASTIGAGE® with scale provided on wrapper to determine clearance.

Main Bearing—Specification

Main Bearing-to-Journal Oil Clearance	0.041—0.109 mm (0.0016—0.0043 in.)



Placing PLASTIGAGE on Bearing Cap

PLASTIGAGE is a trademark of the DANA Corp.

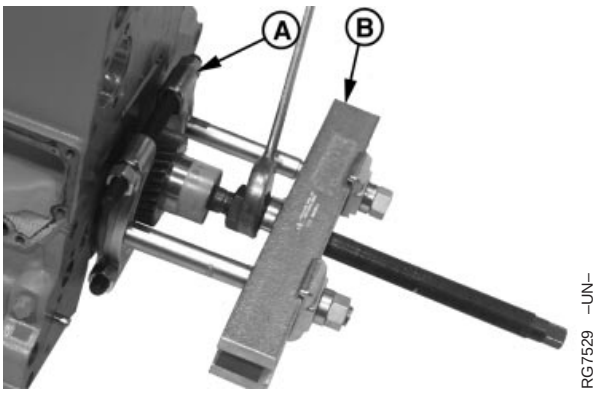
RG,15,DT7443 –19–14NOV97–1/1

REMOVE AND INSTALL CRANKSHAFT GEAR (CRANKSHAFT INSTALLED IN ENGINE)

NOTE: Remove crankshaft gear for replacement only; it is not necessary to remove gear for crankshaft removal.

TO REMOVE CRANKSHAFT GEAR

1. Lock engine at No. 1 “TDC” compression.
2. Remove timing gear cover. (See Group 16.)
3. Remove oil pump. (See Group 20.)
4. Remove upper idler gear and lower idler gear and shaft. (See Group 16.)
5. Remove front plate. (See Group 16.)
6. Install D01047AA Puller (A) or larger onto crankshaft gear.
7. Install D01200AA Push Puller (B). Remove crankshaft gear.



Removing Crankshaft Gear

Continued on next page

RG,15,DT7442 –19–11FEB98–1/2

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TO INSTALL CRANKSHAFT GEAR

IMPORTANT: 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.

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.

NOTE: Chamfered side of gear should be installed toward engine.

1. Heat crankshaft gear to 148°C (300°F) using either heated oil or oven heat.

2. Install JDG954-2 Adapter (A) on nose of crankshaft. Tighten cap screws securely.

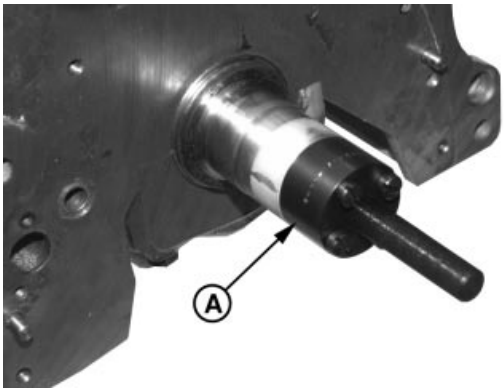
IMPORTANT: When installing gear, do not gouge or nick crankshaft flange or wear sleeve.

3. Place gear on crankshaft flange. Be sure Woodruff key (B) on crankshaft is properly aligned with keyway in gear

4. Install JDG954-1 Installer (C) over adapter.

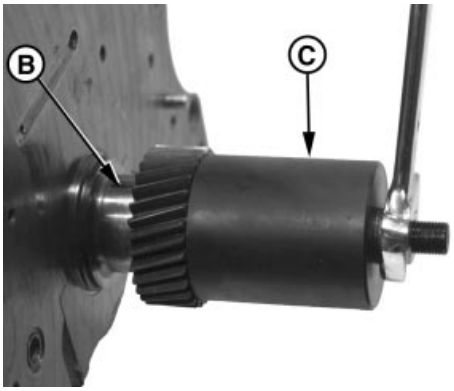
5. Tighten nut clockwise until gear firmly seats against crankshaft flange. Allow gear to cool before removing installer.

6. Refer to appropriate group to complete final assembly of parts removed to access crankshaft gear.



RG7533 –UN–

Installing Adapter on Crankshaft Nose



RG7534 –UN–

Installing Installer Over Adapter

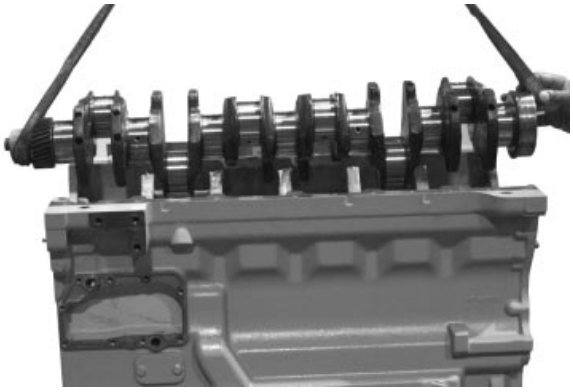
RG,15,DT7442 –19–11FEB98–2/2

REMOVE CRANKSHAFT

1. Remove engine front plate. (See Group 16.)
2. Remove flywheel housing and flywheel. (See REMOVE FLYWHEEL HOUSING earlier in this group.)
3. Remove main bearing caps and connecting rod caps, as described earlier in this group.

CAUTION: Crankshaft is very heavy. Plan a proper handling procedure to avoid injury.

4. Attach a lifting sling to crankshaft. Using proper lifting equipment, carefully raise crankshaft out of cylinder block.
5. Clean crankshaft, especially oil passages, using solvent and compressed air.
6. Place crankshaft on clean V-blocks.
7. If main bearing inserts are to be replaced, remove inserts from cylinder block. Otherwise, leave bearing inserts in block until assembled ID has been measured.



Lifting Crankshaft

RG,15,DT7441 –19–14NOV97–1/1

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INSPECT CRANKSHAFT

NOTE: If vibration damper damage was discovered during teardown, it is recommended that the crankshaft be magna-fluxed. This will verify whether of not it has microscopic cracks or fissures. See INSPECT VIBRATION DAMPER earlier in this group.

1. Thoroughly clean crankshaft. Clear restrictions from all oil passages.

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, employs magnetic particles which are fluorescent and glow under 'black light'. The crankshaft must be de-magnetized after inspection.

2. Inspect crankshaft for signs of load stress, cracks, scoring, or journal scratches. Replace crankshaft if cracks are found.

3. Check each journal for evidence of excessive overheating or discoloration. If either condition exists, replace crankshaft since heat treatment has probably been destroyed.

4. Inspect front crankshaft gear for cracks, chipped teeth, or excess wear. Replace gear as required.

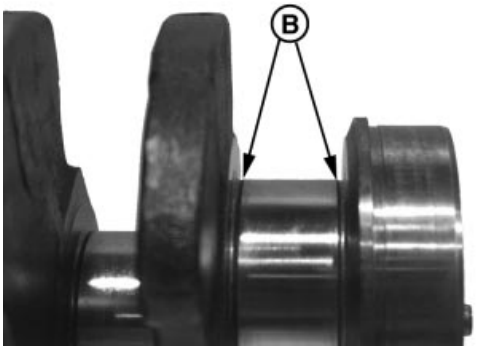
5. Inspect the keyway for evidence of cracks or wear. Replace crankshaft as necessary.

6. Carefully inspect the rear hub of the crankshaft in the area of the wear sleeve contact surface for evidence of a rough or grooved condition. Any imperfections in this area will result in oil leakage. Slight ridges may be cleaned up with emery cloth or crocus cloth.

Continued on next page

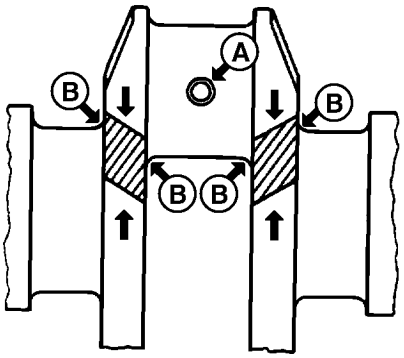
RG,15,DT7440 –19–14NOV97–1/2

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.



RG7536B –UN–

Inspecting Crankshaft Journals



RGCD7147 –UN–

Checking for Cracks

RG,15,DT7440 –19–14NOV97–2/2

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MEASURE ASSEMBLED MAIN BEARING ID AND OD OF CRANKSHAFT MAIN JOURNAL AND ROD JOURNAL

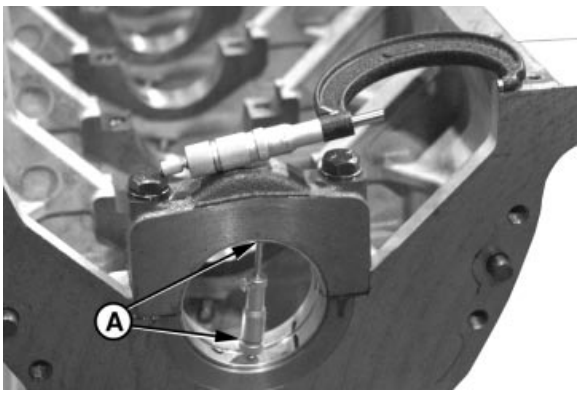
1. With crankshaft removed from engine, assemble main bearing caps with bearing inserts. Be sure inserts are installed correctly.
2. Tighten main bearing cap screws to 135 N•m (100 lb-ft).
3. Measure and record main bearing assembled ID (A) at several points with an inside micrometer.
4. Measure and record crankshaft main journal OD (B) and rod journal OD (C) at several points around each journal.
5. Compare measurements with specifications given below.

Main Bearing and Crankshaft Journal—Specification

Main Bearing ID	79.391—79.433 mm (3.1256—3.1273 in.)
Crankshaft Main Journal OD	79.324—79.350 mm (3.1229—3.1240 in.)
Crankshaft Rod Journal OD	77.800—77.826 mm (3.0629—3.0640 in.)
Main Bearing-to-Journal Oil Clearance	0.041—0.109 mm (0.0016—0.0043 in.)
Maximum Main or Rod Journal Taper	0.010 mm (0.0004 in.)
Maximum Main or Rod Journal Out-of-Roundness	0.005 mm (0.0002 in.)

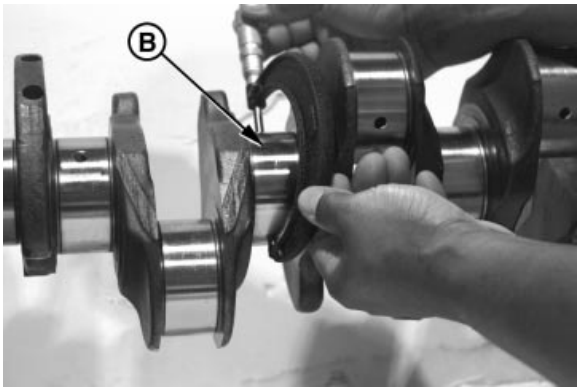
Replace or recondition crankshaft if it does not fall within above specifications.

NOTE: If an undersized crankshaft has been installed, measured dimensions will not meet above specifications. However, bearing-to-journal oil clearance must be within specification. See CRANKSHAFT GRINDING GUIDELINES later in this group.



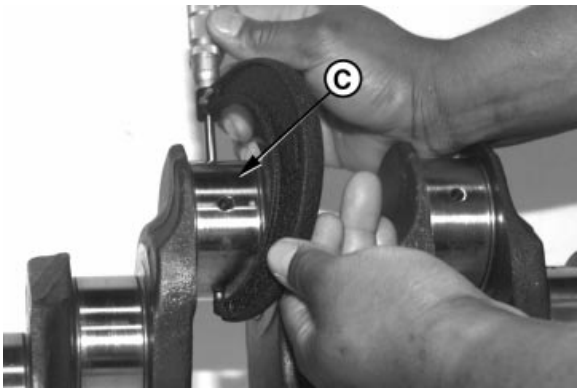
RG7648 –UN–

Measuring Assembled Main Bearing ID



RG7538 –UN–

Measuring Crankshaft Main Journal OD



RG7539 –UN–

Measuring Rod Journal OD

RG,15,DT7439 –19–14NOV97–1/1

MEASURE MAIN THRUST JOURNAL WIDTH AND THRUST BEARING WIDTH

NOTE: If crankshaft has been previously reconditioned, thrust journal width may not be within above specifications. However, oil (side) clearance must be within specification.

1. Measure and record crankshaft main thrust journal width.

   If crankshaft thrust journal width is not within specifications, recondition crankshaft and use an oversize thrust washer set or install a new crankshaft.

2. Measure and record width of main thrust bearing. Oil (side) clearance between thrust bearing and thrust journal must be within specifications.

Main Thrust Journal and Thrust Bearing—Specification

Thrust Bearing Journal Width (New)	38.952—39.028 mm (1.5335—1.5365 in.)
Thrust Bearing Overall Width	38.79—38.87 mm (1.527—1.530 in.)

RG7540 –UN–

Measuring Main Journal Width

RG7541 –UN–

Measuring Thrust Bearing Width

RG7542 –UN–

Checking Bearing

RG,15,DT7438 –19–14NOV97–1/1

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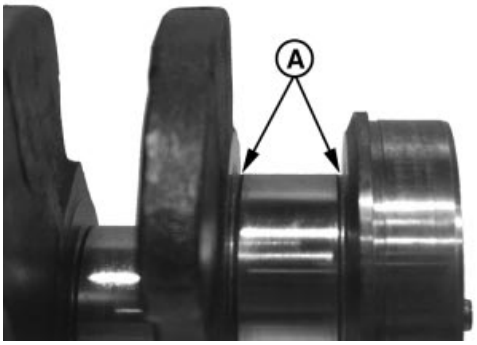
CRANKSHAFT GRINDING GUIDELINES

IMPORTANT: Crankshaft grinding should be done ONLY by experienced personnel on equipment capable of maintaining crankshaft size and finish specifications. Undercut and rolled fillets (A) have taken the place of ground (tangential) fillets. DO NOT grind within this undercut area when undersize bearings are used.



RG7536A –UN–

Undercut Area

Crankshafts have micro-finished journal surfaces.

IMPORTANT: If undersize bearings are installed, recheck bearing-to-journal clearance. If oil clearance is not within specifications, premature wear of bearings and journals will result.

RG7542 –UN–

Two-Piece Bearings

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 which the journals are to be reground. (See Specifications chart on following page.)

2. Grind all main journals or all connecting rod journals to the same required size.

IMPORTANT: Care must be taken to avoid localized heating which often produces grinding cracks. Use coolant generously to cool the crankshaft while grinding. 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

RG,15,DT7437 –19–26FEB98–1/2

CRANKSHAFT GRINDING SPECIFICATIONS

Bearing Size	Crankshaft Main Journal OD	Crankshaft Rod Journal OD
Standard	79.324—79.350 mm (3.1229—3.1240 in.)	77.800—77.826 mm (3.0629—3.0640 in.)
0.25 mm (0.010 in.) Undersize	79.074—79.100 mm (3.1131—3.1141 in.)	77.550—77.576 mm (3.0531—3.0541 in.)

Main and Connecting Rod Journal Surface Finish (AA)	Lap 0.20 um (8 AA)
Thrust Surface Finish (AA)	Lap 0.40 um (16 AA)
Thrust Bearing Journal Width	38.952—39.028 mm (1.5335—1.5365 in.)
Direction of Crankshaft Rotation (viewed from flywheel end):	
Grinding	clockwise
Lapping	counterclockwise
Engine Stroke	127 mm (5.00 in.)

IMPORTANT: When thrust surfaces are reground and an oversize washer is used, crankshaft end play specification must be maintained.

4. If the thrust surfaces of the crankshaft are worn or grooved excessively, they must be reground and polished. Care must be taken to maintain the specified radius between each thrust surface and the bearing journal. An oversize thrust washer set is available.

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 by the fluorescent magnetic particle method, or other similar method to determine if cracks have originated due to the grinding operation.

7. De-magnetize the crankshaft after inspection.

8. Thoroughly clean the crankshaft and oil passages with solvent. Dry with compressed air.

RG,15,DT7437 –19–26FEB98–2/2

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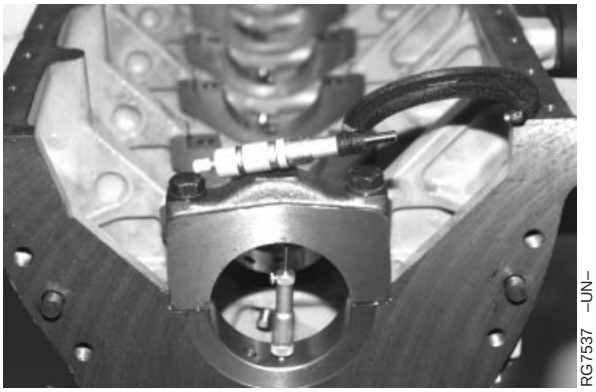
MEASURE ASSEMBLED ID OF MAIN BEARING CAPS

1. Remove bearing inserts from caps and cylinder block. Keep inserts in correct order if they are to be reused.
2. Clean and inspect caps for damage. Small burrs or nicks on flat surfaces may be removed with a file. Use a medium-grit polishing cloth to dress curved bearing surfaces.
3. Install bearing caps (without bearings) in cylinder block. Tighten cap screws to 135 N•m (100 lb-ft).
4. Measure ID of bearing cap bores.



Measuring Bearing Cap Bore ID

Main Bearing Cap—Specification

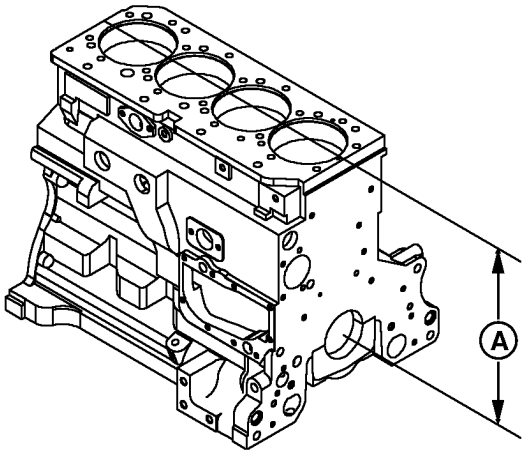
Bore Without Bearing Inserts	84.455—84.481 mm (3.3250—3.3260 in.)
Bore Centerline-to-Top Deck Distance	337.896—337.972 mm (13.3029—13.3059 in.)

RG,15,DT7436 –19–11FEB98–1/2

IMPORTANT: When cylinder block is line bored, dimension (A) from centerline of main bearing bore to cylinder block top deck will be changed. Piston may contact cylinder head if this dimension is less than specified above. Main bearing line boring should be done ONLY by experienced personnel on equipment capable of maintaining bore specifications.

5. If bearing caps are damaged or bore is not within specification, install a new cap and line bore to specified size. (See MEASURE MAIN BEARING ID AND CRANKSHAFT JOURNAL OD, earlier in this group.)

NOTE: Replacement bearing caps are supplied with unfinished bearing bore.



Centerline Dimension

A—Centerline Dimension

RG,15,DT7436 –19–11FEB98–2/2

REMOVE, INSPECT, AND INSTALL PISTON COOLING ORIFICES

1. Remove and inspect each cooling orifice to make sure it is not plugged or damaged.

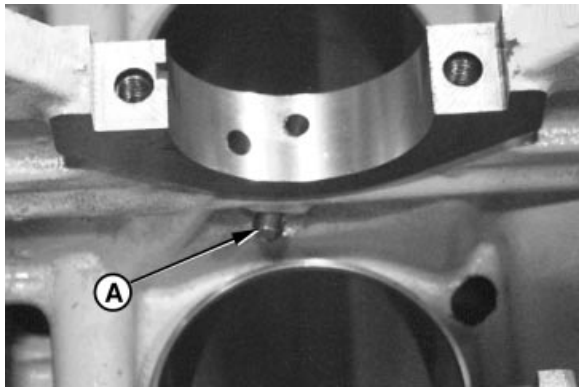
2. Use a soft wire and compressed air to clean orifice. Replace if condition is questionable.

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 (A) in block and tighten to 11 N•m (8 lb-ft).

RG7493 –UN–

Inspecting Cooling Orifices



RG7543A –UN–

Installing Orifice in Block

RG,15,DT7434 –19–14NOV97–1/1

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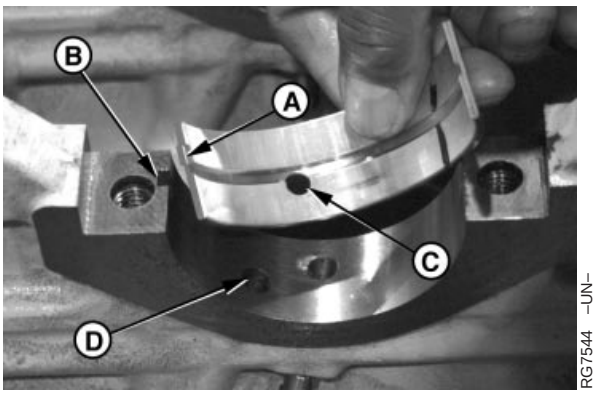
INSTALL MAIN AND THRUST BEARING INSERTS IN BLOCK

NOTE: Lower half of bearing insert with oil hole goes in block.

1. Install main bearing inserts. Make sure that tang (A) in insert is engaged with slot (B) in the cylinder block and main bearing caps. Also make sure oil holes in insert (C) line up with oil passages in block (D).



RG7544 –UN–

Installing Bearing Insert

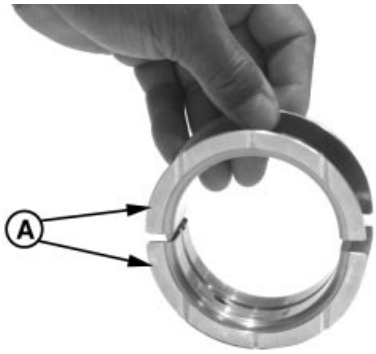
A—Tang in Insert
B—Slot in Block
C—Oil Holes in Insert
D—Oil Passages in Block

RG,15,DT7433 –19–11FEB98–1/3

NOTE: Only two-piece bearings (A) are provided for service.

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 OD of crankshaft main bearing journal*



RG7542A –UN–

Two-Piece Bearings

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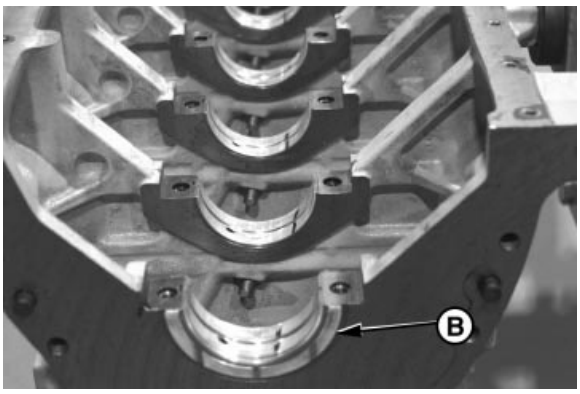
RG,15,DT7433 –19–11FEB98–2/3

2. Install main thrust bearing (B) in thrust web of cylinder block.



Installing Main Thrust Bearing

RG,15,DT7433 –19–11FEB98–3/3

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INSTALL CRANKSHAFT

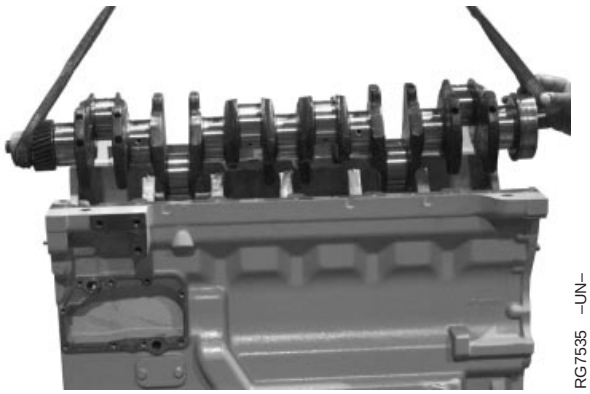
CAUTION: Crankshaft is heavy. Plan a proper lifting procedure to avoid injuries.

1. Carefully position crankshaft onto main bearing inserts using a hoist and lift sling.

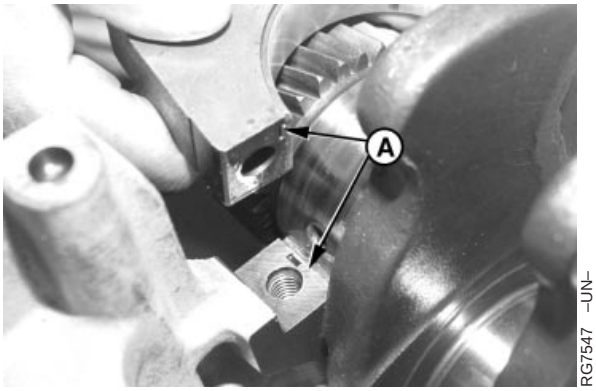
2. Apply a liberal amount of clean oil to bearing insert. Dip entire main bearing cap screws in clean engine oil and position them in main bearing caps.

IMPORTANT: Make sure main bearing caps are installed in locations from which they were removed. Numbers (B) stamped on the caps should match number stamped on pan rail of block. Arrow (C) on cap must point toward camshaft side of block.

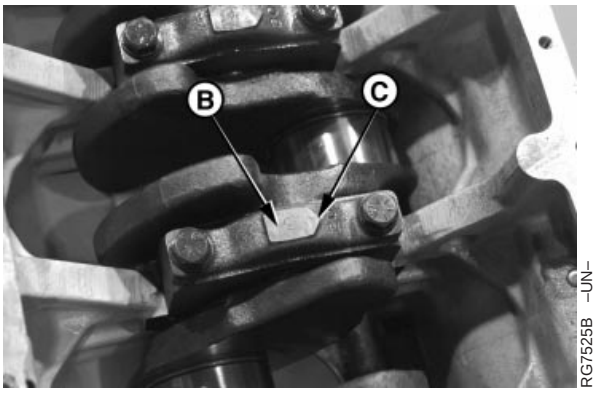
3. Install main bearing caps so bearing tang (A) in cap and cylinder block are together on same side of cylinder block.



Lifting Crankshaft



Installing Main Bearing Caps



Checking Bearing Cap Direction and Number

Continued on next page

RG,15,DT7432 –19–14NOV97–1/3

IMPORTANT: Do not use pneumatic wrench to install main bearing cap screws, as damage may occur to threads.

4. Tighten all main bearing cap screws to 135 N•m (100 lb-ft).

IMPORTANT: DO NOT pry on thrust washer when forcing crankshaft back and forth to align thrust bearings.

5. Align upper and lower main bearing inserts by tapping on front end of crankshaft, then on rear end.

6. Turn crankshaft by hand. If crankshaft does not turn easily, disassemble parts and determine the cause.

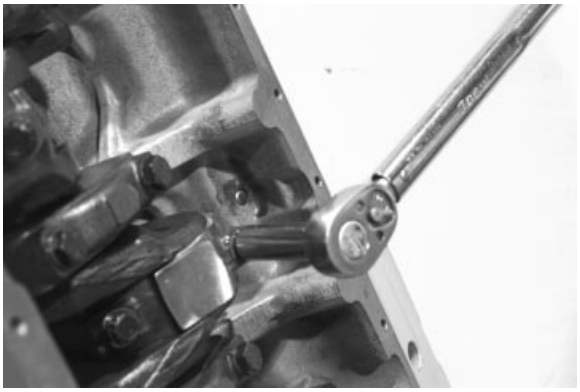
Torquing Main Bearing Caps

RG,15,DT7432 –19–14NOV97–2/3

IMPORTANT: Using pneumatic wrenches to install cap screws may cause damage to the threads. Never reuse connecting rod cap screws.

7. Install connecting rod caps and bearings. Install new cap screws and tighten to specification. (See Group 10.)

8. Check crankshaft for 0.05—0.25 mm (0.002—0.010 in.) end play.



Torquing Connecting Rod Caps

RG,15,DT7432 –19–14NOV97–3/3

15
44

INSTALL FLYWHEEL HOUSING

1. Inspect and clean cylinder block and flywheel housing gasket surfaces using a brass scraper and/or steam cleaner. Remove any previously applied sealant.

2. Rinse well with plain water to remove all soap residue from gasket surfaces.

IMPORTANT: Gasket surfaces MUST BE free of oil, dirt, or cleaning agents.

3. Use new gasket and install over cap screw holes and dowels.

4. Install flywheel housing on cylinder block.

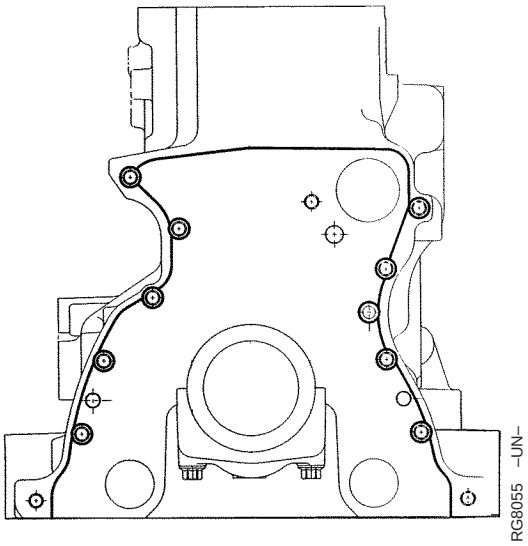
IMPORTANT: Tighten cap screws to 138 N•m (102 lb-ft) using a cross pattern.

5. Check flywheel housing seal bore run-out. If run-out exceeds specification; replace housing.

Flywheel Housing Run-Out—Specification

Maximum Permissible Run-Out of ..... 0.152 mm (0.006 in.)
Flywheel Housing Seal Bore

6. Install crankshaft rear oil seal assembly. (See INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE earlier in this group.)



Rear Engine View

RG,15,DT7431 –19–11FEB98–1/1

COMPLETE FINAL ASSEMBLY

Use new gaskets and O-rings during final engine assembly. Clean all engine components as necessary prior to assembly.

1. Install oil bypass valve assembly in front face of block. (Group 20)
2. Install front plate, timing gear train, and camshaft. (Group 16)
3. Install oil pump assembly. (Group 20)
4. Install timing gear cover gasket, timing gear cover, oil pressure regulating valve assembly, and front oil seal. (Groups 15 and 16)
5. Install oil pan. (Group 20)
6. Install crankshaft pulley, or vibration damper. (Group 15)
7. Install push rods, and rocker arm assembly. (Groups 05)
8. Install natural gas components. (Group 35)
9. Install starting motor.
10. Adjust valve clearance. (Group 05)
11. Install poly-vee belts. (Group 25)
12. Fill engine with clean oil and proper coolant. (Group 02)
13. Perform engine break-in. (Group 05)

RG,15,DT7430 –19–14NOV97–1/1

SPECIAL OR ESSENTIAL TOOLS

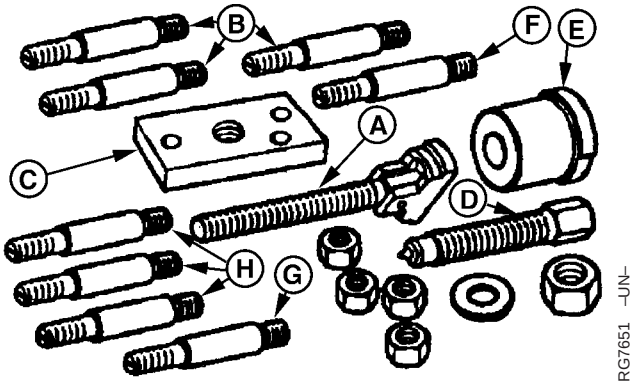
NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

SERVICE-GARD is a trademark of Deere & Company.

RG,16,DT7468 –19–11FEB98–1/12

Camshaft Bushing Service Set. JDG739B

Used to remove and install front camshaft bushing.



JDG739B

RG,16,DT7468 –19–11FEB98–2/12

JDG739B Camshaft Bushing Service Set consists of:

A—Bushing Remover JDG739-1
B—Flat Bottom Legs (3/8-16) (3) JDG739-2
C—Removing/Installing Plate JDG739-3
D—Bushing Installer Screw JDG739-4
E—Bushing Installer JDG739-5B
F—Tapered Bottom Leg (3/8-16) JDG739-6
G—Tapered Bottom Leg (M8 x 1.25) ..... JDG739-7[a]
H—Flat Bottom Leg (M8 x 1.25) (3) ..... JDG739-8[a]

[a]If you already have JDG739A Camshaft Bushing Service Set, you may order JDG739-7 and JDG739-8 metric hardware individually.

Continued on next page

RG,16,DT7468 –19–11FEB98–3/12

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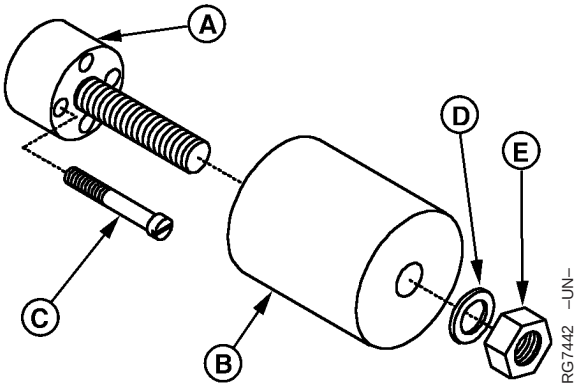
Crankshaft Gear and Front Oil Seal Installer JDG954

Used to install crankshaft gear either prior to, or after, installing crankshaft into engine. Also used to install front oil seal with timing gear cover installed on engine.



JDG954

RG,16,DT7468 –19–11FEB98–4/12

NOTE: JDH7 Driver may be used to install the crankshaft gear when the crankshaft is REMOVED from the engine.

JDG954 Crankshaft Gear and Front Oil Seal Installer Set consists of:

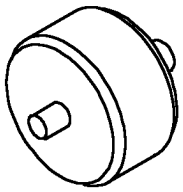
A—Adapter JDG954-2
B—Installer JDG954-1
C—Special Cap Screws JDG954-3
D—Thrust Washer 206747
E—Hex Nut 2230

RG,16,DT7468 –19–11FEB98–5/12

RG7939 –UN–

Idler Gear Installer Pilot JDG791A

Guide upper idler gear onto idler shaft.



JDG791A

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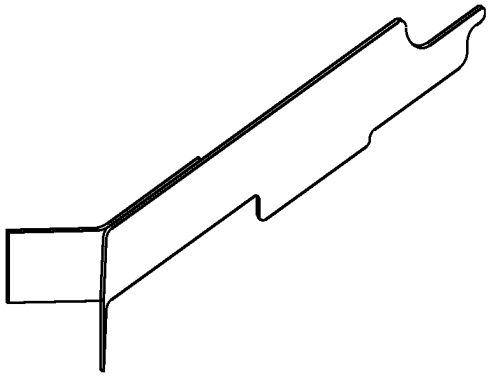
RG,16,DT7468 –19–11FEB98–6/12

Gear Timing Tool JD254A

Time camshaft gear and idler gears.



RG7443 –UN–

JD254A

RG,16,DT7468 –19–11FEB98–7/12

RG5109 –UN–

Seal Remover JDG22

Remove crankshaft rear oil seal without removing flywheel housing.

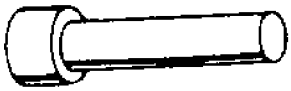
JDG22

RG,16,DT7468 –19–11FEB98–8/12

RG5068 –UN–

Timing Pin JDE81-4

Lock engine at TDC when installing or timing valve train. Use with JDE83 Flywheel Turning Tool.



RG5068

JDE81-4

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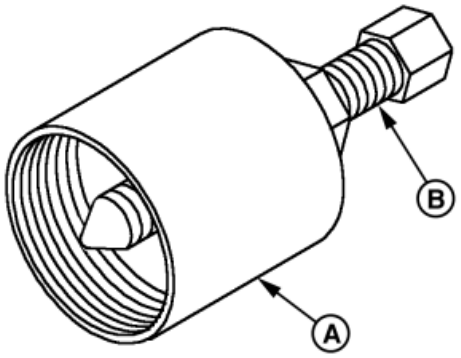
RG,16,DT7468 –19–11FEB98–9/12

16
4

Front Wear Sleeve Puller JDG992

Used to remove front wear sleeve with timing gear cover installed.



RG8085A –UN–

JDG992

RG,16,DT7468 –19–11FEB98–10/12

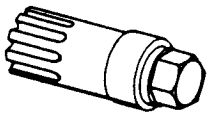
JDG992 Front Wear Sleeve Puller Set consists of:

A—Threaded Collet JDG992-1
B—Forcing Screw 311099

RG,16,DT7468 –19–11FEB98–11/12

Flywheel Turning Tool JDE83

Used to rotate flywheel on engines with 142-tooth flywheel ring gear and a 26.5 mm (1.04 in.) ID flywheel housing guide bore diameter. Use with JDE81-4 Timing Pin.



RG6251 –UN–

JDE83

RG,16,DT7468 –19–11FEB98–12/12

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICE-GARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
D15001NU Magnetic Follower Holder Kit	Hold cam followers when removing and installing cam.
TORX® Drive Set	Remove and install front plate mounting hardware.
JDG966 Crankshaft Front/Rear Rotation Adapter	Rotate crankshaft from front and rear with flywheel removed.
D01045AA Bushing, Bearing, and Seal Driver Set	Remove and install idler gear bushings.
JDG537 Handle	Remove and install idler gear bushings.

SERVICE-GARD is a trademark of Deere & Company.
TORX is a trademark of Camcar/Textron.

RG,16,DT7513 –19–14NOV97–1/1

OTHER MATERIAL

Number	Name	Use
609 (LOCTITE®) T43515 (U.S.)	Retaining Compound	Front crankshaft wear sleeve (ID).
TY6304 (U.S.) TY9484 (Canadian) 515 (LOCTITE®)	Flexible Sealant	Apply to front face of cylinder block before installing front plate.
TY6333 (U.S.) TY6347 (U.S.)	High Temperature Grease	Coat cam followers, camshaft lobes, journals, and bushings during installation. Coat idler gear, bushing, and shaft during installation.

LOCTITE is a trademark of the Loctite Corp.

RG,16,DT7512 –19–14NOV97–1/1

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CAMSHAFT AND TIMING GEAR TRAIN SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Camshaft:		
Journal OD	55.872—55.898 mm	55.85 mm
	(2.1997—2.2007 in.)	(2.199 in.)
Bore ID:		
Front (No. 1) in Block (without bushing)	59.961—59.987 mm	——
	(2.3607—2.3617 in.)	——
Front (No. 1) in Block (with bushing)	55.961—55.987 mm	——
	(2.2031—2.2042 in.)	——
All Except No.1	55.986—56.012 mm	——
	(2.2042—2.2052 in.)	——
Journal-to-Bushing Oil Clearance:		
No. 1 Bore with Bushing	0.063—0.115 mm	——
	(0.0025—0.0045 in.)	——
All Except No. 1 Bore	0.088—0.140 mm	——
	(0.0035—0.0055 in.)	——
End Play	0.08—0.23 mm	0.38 mm
	(0.003—0.009 in.)	(0.015 in.)
Thrust Plate Thickness	3.96—4.01 mm	3.83 mm
	(0.156—0.158 in.)	(0.151 in.)
Thrust Plate Clearance	0.08—0.23 mm	——
	(0.003—0.009 in.)	——
Follower OD	31.61—31.64 mm	——
	(1.245—1.246 in.)	——
Follower Bore Diameter in Cylinder Block	31.70—31.75 mm	——
	(1.248—1.250 in.)	——
Follower-to-Bore Clearance	0.06—0.13 mm	——
	(0.002—0.005 in.)	——
Camshaft Lobe Height:		
Intake Lobe	7.05—7.31 mm	6.68 mm
	(0.278—0.288 in.)	(0.263 in.)
Exhaust Lobe	6.89—7.15 mm	6.50 mm
	(0.271—0.281 in.)	(0.256 in.)
Valve Lift at 0.00 mm (in.) Clearance:		
Intake	11.77—12.21 mm	11.13 mm
	(0.463—0.481 in.)	(0.438 in.)
Exhaust	11.51—11.94 mm	10.85 mm
	(0.453—0.470 in.)	(0.427 in.)
Cylinder Block Bore Diameter for Balancer Shaft Bushing (Standard)	43.262—43.288 mm	——
	(1.7032—1.7042 in.)	——
Upper Idler Gear Shaft OD	69.757—69.777 mm	——
	(2.7463—2.7471 in.)	——
Upper Idler Gear Bushing ID	69.802—69.832 mm	——
	(2.7481—2.7493 in.)	——
Lower Idler Gear Shaft OD	44.437—44.463 mm	——
	(1.7495—1.7505 in.)	——
Lower Idler Gear Bushing ID	44.489—44.539 mm	——
	(1.7515—1.7535 in.)	——
Upper Idler Gear End Play	0.07—0.17 mm	——
	(0.0028—0.0067 in.)	——
Lower Idler Gear End Play	0.07—0.33 mm	——
	(0.0028—0.0130 in.)	——

Continued on next page

RG,16,DT7511 –19–11FEB98–1/2

ITEM	SPECIFICATION	WEAR LIMIT
Spring Pin Protrusion from Shaft:		
On Lower and Upper Idler Gear	2.79—4.83 mm	——
	(0.11—0.19 in.)	——
Oil Clearance:		
Upper Idler Gear Bushing-to-Shaft	0.075—0.125 mm	——
	(0.0030—0.0049 in.)	——
Lower Idler Gear Bushing-to-Shaft	0.026—0.102 mm	——
	(0.0010—0.0040 in.)	——
Timing Gear Backlash:		
Upper Idler Gear-to-Camshaft Gear	0.077—0.412 mm	——
	(0.0030—0.0162 in.)	——
Camshaft Gear-to-Auxiliary Drive Gear	0.053—0.681 mm	——
	(0.0021—0.0145 in.)	——
Upper Idler Gear-to-Crankshaft Gear	0.065—0.322 mm	——
	(0.0025—0.0127 in.)	——
Lower Idler Gear-to-Crankshaft Gear	0.067—0.606 mm	——
	(0.0026—0.0132 in.)	——
Lower Idler Gear-to-Oil Pump Gear	0.081—0.603 mm	——
	(0.0032—0.0135 in.)	——

TORQUES

Camshaft Thrust Plate-to-Cylinder Block	35 N•m (26 lb-ft)
Front Plate-to-Cylinder Block:	
Flat Head (TORX®) Screws (no washers)	25 N•m (18 lb-ft)
Studs	35 N•m (26 lb-ft)
Oil Pump Drive Gear-to-Shaft, Retaining Nut (Staked)	50 N•m (37 lb-ft)
Upper Idler Gear Cap Screw	80 N•m (59 lb-ft)
Lower Idler Gear Cap Screw	80 N•m (59 lb-ft)
Oil Pressure Regulating Valve in Timing Gear Cover	95 N•m (70 lb-ft)
Timing Gear Cover-to-Front Plate and Cylinder Block	35 N•m (26 lb-ft)
Auxiliary Gear Cover-to-Timing Gear Cover	95 N•m (70 lb-ft)
Oil Pan-to-Timing Gear Cover	35 N•m (26 lb-ft)
Oil Pan-to-Cylinder Block	35 N•m (26 lb-ft)
Oil Fill Tube-to-Cylinder Block	35 N•m (26 lb-ft)
Tachometer (Magnetic Pick-up) Sensor	20 N•m (15 lb-ft)
Pulley or Damper with Pulley-to-Crankshaft[a]:	
1st Step	60 N•m (44 lb-ft)
Final Step	80 N•m (59 lb-ft)
Rocker Arm Cover	35 N•m (26 lb-ft)
Water Pump-to-Timing Gear Cover	16 N•m (12 lb-ft)

[a]Tighten cap screws in a cross sequence.

TORX is a trademark of Camcar/Textron.

RG,16,DT7511 –19–11FEB98–2/2

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MEASURE VALVE LIFT

IMPORTANT: For a more accurate measurement, measure valve lift at 0.00 mm (in.) rocker arm-to-valve tip clearance.

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

1. Remove rocker arm cover.
2. Lock No. 1 piston at TDC compression stroke and install JDE81-4 Timing Pin in flywheel.

   See CHECK AND ADJUST VALVE CLEARANCE in Group 05 for engine valve locations.
3. Set rocker arm-to-valve tip clearance to 0.00 mm (in.) for No. 1, 3, and 5 exhaust and No. 1, 2, and 4 intake valves.
4. Place dial indicator tip on top of valve rotator. Preload indicator tip and set dial at 0.0 mm (in.).
5. Remove timing pin from flywheel and manually rotate engine one full revolution (360°) in running direction.
6. Observe dial indicator reading as valve is moved to full open. Record maximum reading and compare with specifications given below.

Intake Valves—Specification

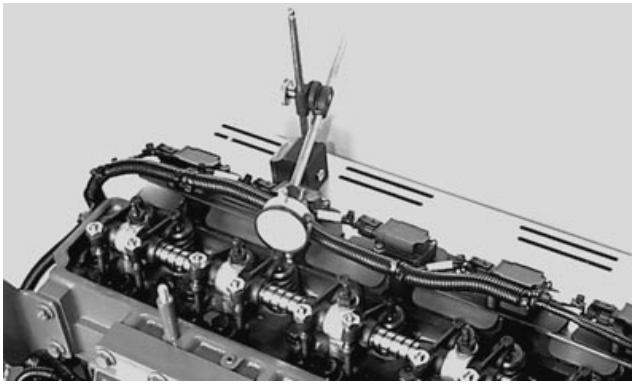
Valve Lift	11.77—12.21 mm (0.463—0.481 in.)
Wear Limit	11.34 mm (0.446 in.)

Exhaust Valves—Specification

Valve Lift	11.51—11.94 mm (0.453—0.470 in.)
Wear Limit	11.08 mm (0.436 in.)

7. If valve lift on all valves is within specifications, adjust valve lash to specified clearance. (See CHECK AND ADJUST VALVE CLEARANCE in Group 05.)

   If valve lift on one or more valves is not within specification, remove and inspect entire valve train and camshaft.



Measuring Valve Lift

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RG,16,DT7507 –19–11FEB98–1/2

8. Rotate engine one full revolution (360°). Lock engine at TDC No. 6 compression stroke.

9. Set rocker arm-to-valve tip clearance to 0.0 mm (0 in.) for No. 2, 4, and 6 exhaust and No. 3, 5, and 6 intake valves.

10. Repeat steps 4—7.

RG,16,DT7507 –19–11FEB98–2/2

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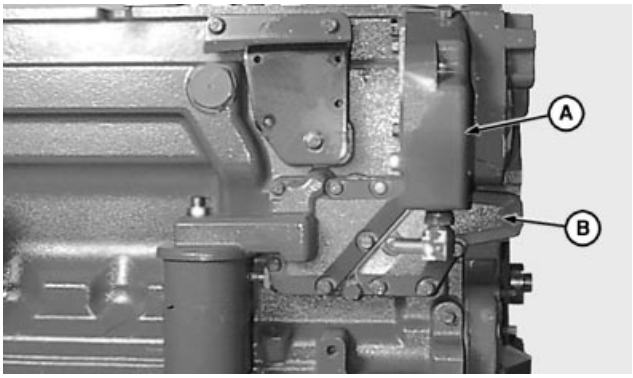
10

REMOVE TIMING GEAR COVER

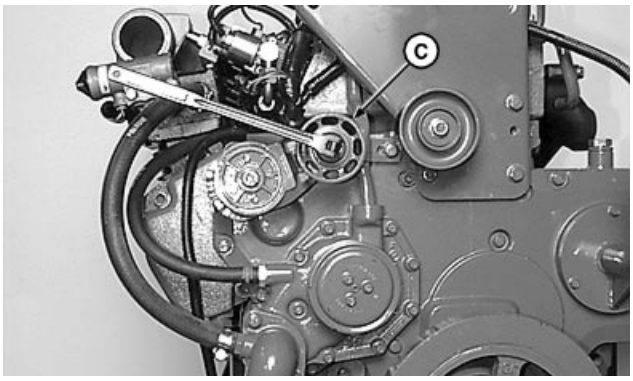
NOTE: It is not necessary to remove water pump pulley, water pump, or belt tightener when removing timing gear cover.

1. Drain oil from engine crankcase.
2. Remove fan.
3. Remove oil pan.
4. Loosen oil cooler-to-water manifold elbow (B) and rest against air compressor drive gear housing (A).
5. Release fan belt tensioner (C) and remove fan belt.
6. Remove alternator and alternator mounting bracket.
7. Remove water pump (D), if desired.
8. Remove crankshaft pulley or damper (E). (See Group 15.)



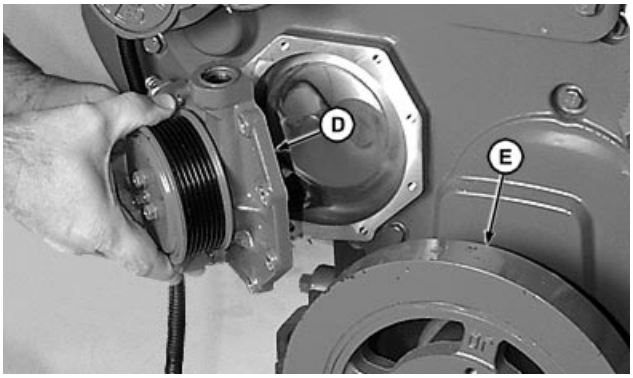
RG8968C –UN–

Remove Timing Gear Cover



RG8892D –UN–

Release Fan Belt Tensioner



RG8908D –UN–

Removing Water Pump

A—Air Compressor Drive Housing
B—Oil Cooler-to-Water Manifold Elbow
C—Fan Belt Tensioner
D—Water Pump
E—Damper Pulley

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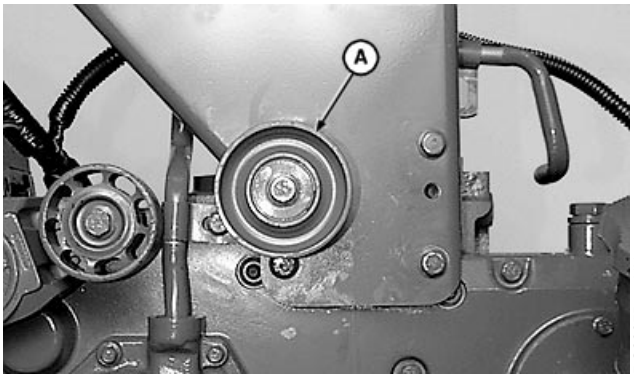
RG,16,DT7506 –19–26FEB98–1/5

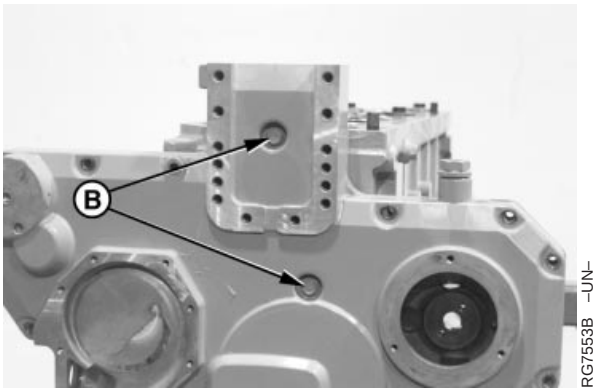
9. Remove idler pulley assembly (A).



Removing Idler Pulley Assembly

RG,16,DT7506 –19–26FEB98–2/5

10. Remove cap screws (B).



Removing Cap Screws

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RG,16,DT7506 –19–26FEB98–3/5

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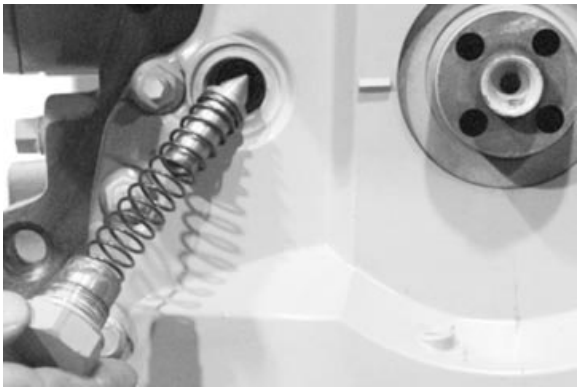
11. Unscrew oil pressure regulating valve plug. Remove spring and valve.
12. Remove auxiliary drive cover and gears, if equipped, as described later in this group.
13. Remove wear sleeve. (See Group 15.)

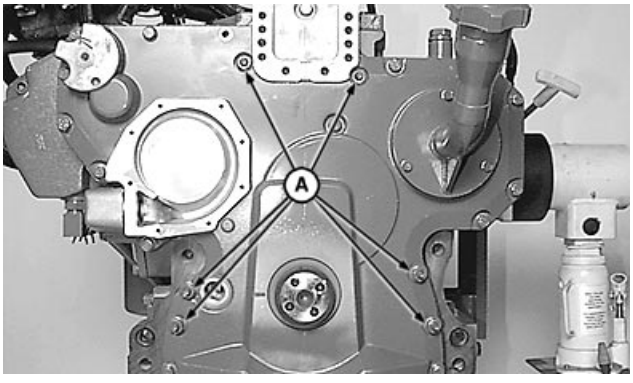
Unscrewing Oil Pressure Regulating Valve Plug



Removing Spring and Valve

RG,16,DT7506 –19–26FEB98–4/5

14. Remove timing gear cover-to-cylinder block stud nuts and washers (A). Remove cover.
15. Remove oil seal from timing gear cover.



Removing Block Stud Nuts and Washers

RG,16,DT7506 –19–26FEB98–5/5

REMOVE AND INSTALL CAMSHAFT BUSHING WITH FRONT PLATE INSTALLED

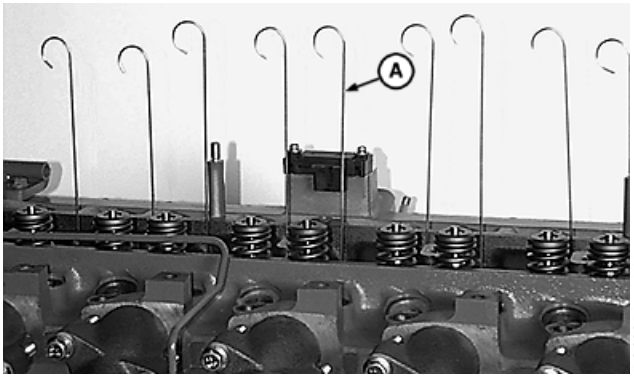
NOTE: A camshaft bushing is installed in front (No. 1) camshaft bore only. The front plate has a chamfered edge allowing camshaft bushing removal and installation with the front plate installed.

REMOVE CAMSHAFT BUSHING

1. Set engine at No. 1 “TDC” compression.
2. Disconnect the turbocharger oil inlet line. (See DISCONNECT TURBOCHARGER OIL INLET LINE in Group 03.)
3. Remove timing gear cover, as described earlier in this group.
4. Remove rocker arm cover and rocker arm assembly. (See procedure in Group 05.)
5. Remove push rods. (See procedure in Group 05.)

RG,16,DT7505 –19–14NOV97–1/4

6. Revolve engine to an angle where camshaft followers fall away from camshaft or use D15001NU Magnetic Holding Set (A) to hold followers.



Magnetic Holders

Continued on next page

RG,16,DT7505 –19–14NOV97–2/4

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IMPORTANT: Engine MUST remain in a position where camshaft followers rest against cylinder head or are held in up position by magnetic holders so that followers do not fall into engine crankcase. If camshaft followers fall into crankcase, cylinder head removal will be required.

7. Remove camshaft. (See procedure later in this group.)

8. Remove countersunk TORX® cap screw (A). Install JDG739-7 (M8 x 1.25) tapered bottom leg (B) from JDG739B Camshaft Bushing Service Kit into hole that has chamfered screw and star washer.

IMPORTANT: Cylinder block bore may be damaged if puller is not properly piloted in bushing. Be sure puller is properly piloted before pulling bushing.

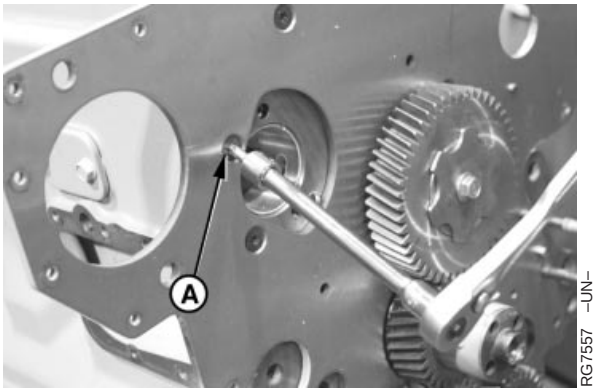
9. Install JDG739-8 (M8 x 1.25) flat bottom legs and JDG739-3 Removing/Installing Plate (C) to cylinder block so plate is parallel with front plate and centered over camshaft bore. Tighten legs and hex nuts securely.

10. Insert JDG739-1 Bushing Remover into camshaft bore so puller pilots in bushing ID and JDG739-4 Bushing Installer Screw (D) extends through plate.

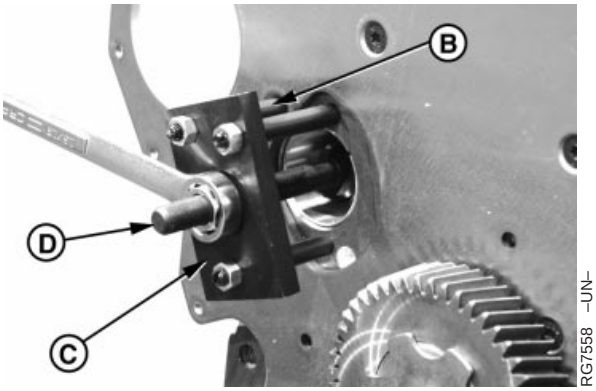
IMPORTANT: Block must be replaced if camshaft bore is damaged. Be careful when removing or installing bushing.

11. Install thrust washer and hex nut. Tighten hex nut until bushing is free of block bore. Remove puller and discard bushing.

12. Clean and inspect bore in cylinder block. If bore is damaged, replace cylinder block.



Removing TORX Cap Screw



Removing Camshaft Bearing

A—TORX® Cap Screw
B—JDG739-7 Tapered Bottom Leg (8 mm)
C—JDG739-3 Removing/Installing Plate
D—JDG739-4 Bushing Installer Screw

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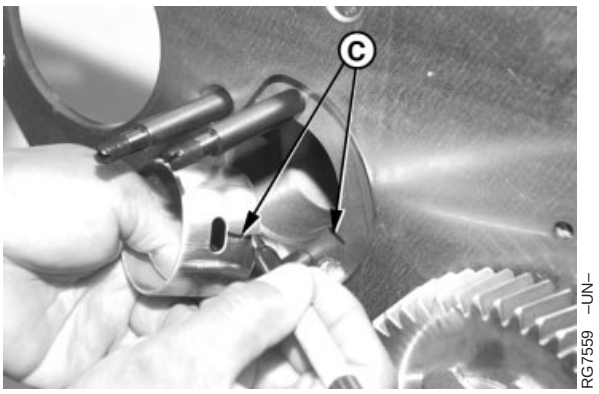
Continued on next page

RG,16,DT7505 –19–14NOV97–3/4

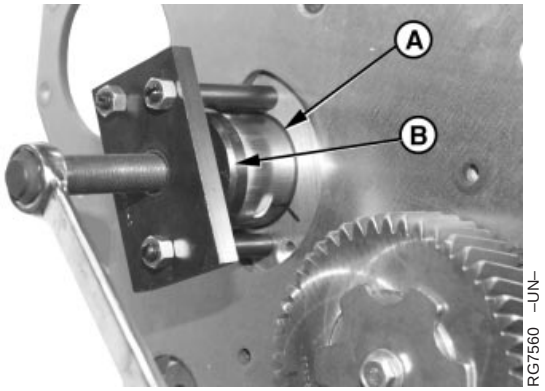
INSTALL CAMSHAFT BUSHING

IMPORTANT: Bushings must be installed so oil supply hole in bushing aligns with oil drilling in block bore.

1. Mark orientation of oil supply hole (C) on front face of block and on bushing to help with bushing alignment during installation.
2. Apply TY6333 High-Temperature Grease to ID and OD of new bushing (A), and to ID of bushing bore. Slide bushing onto JDG739-5B Bushing Installer (B) so notched end of bushing will be toward front end of engine when installed.
3. Thread JDG739-4 Bushing Installer Screw into JDG739-3 Removing/Installing Plate. With bushing started, square in bore and oil hole aligned, tighten forcing screw until flange of bushing driver bottoms against face of block.
4. Remove bushing tool from cylinder block and check oil supply hole for correct alignment. If holes are not aligned, remove and discard bushing. Install a new bushing.



Mark Oil Supply Hole Orientation



Installing Bushing

RG,16,DT7505 –19–14NOV97–4/4

MEASURE CAMSHAFT END PLAY

Measure camshaft end play.

Camshaft—Specification

End Play	0.08—0.23 mm (0.003—0.009 in.)

If end play is excessive, check thrust plate thickness with camshaft removed. (See MEASURE CAMSHAFT THRUST PLATE CLEARANCE, later in this group.)

Measuring Camshaft End Play

RG,16,DT7503 –19–14NOV97–1/1

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MEASURE IDLER GEAR END PLAY

Check end play of upper and lower idler gears.

Idler Gear—Specification

End Play (Upper)	0.07—0.17 mm (0.0028—0.067 in.)
End Play (Lower)	0.07—0.33 mm (0.0028—0.0130 in.)

If idler gear end play does not meet specifications, check idler gear, idler shaft, and thrust washer for wear. (See MEASURE IDLER GEAR, BUSHING AND SHAFT later in this group.)

Measuring Idler Gear End Play

RG,16,DT7501 –19–11FEB98–1/1

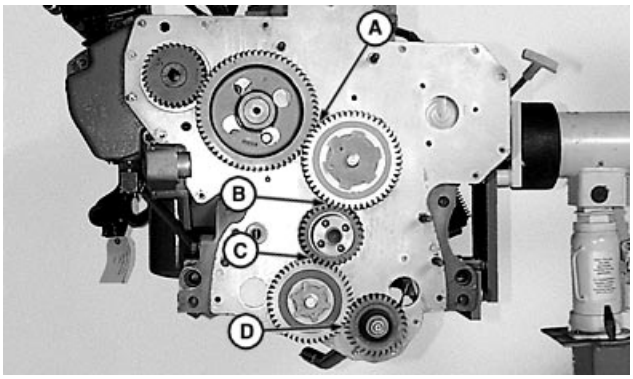
MEASURE TIMING GEAR BACKLASH

NOTE: All gears have helical cut teeth.

Measure timing gear backlash. Compare against the following specifications.

Timing Gear Backlash—Specification

Camshaft-to-Upper Idler (A)	0.077—0.412 mm (0.0030—0.0162 in.)
Upper Idler-to-Crankshaft (B)	0.065—0.322 mm (0.0025—0.0127 in.)
Crankshaft-to-Lower Idler (C)	0.067—0.336 mm (0.0026—0.0132 in.)
Oil Pump-to-Lower Idler (D)	0.081—0.342 mm (0.0032—0.0135 in.)
Camshaft-to-Auxiliary Drive (Not shown)	0.053—0.368 mm (0.0021—0.0145 in.)



Measuring Timing Gear Backlash

A—Camshaft Gear-to-Upper Idler Gear
B—Upper Idler Gear-to-Crankshaft Gear
C—Crankshaft Gear-to-Lower Idler Gear
D—Oil Pump Gear-to-Lower Idler Gear

RG,16,DT7500 –19–11FEB98–1/1

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 followers. (See REMOVE CYLINDER HEAD in Group 05.)

1. Drain engine oil and coolant, if not previously done.
2. Measure valve lift. (See MEASURE VALVE LIFT, earlier in this group).
3. Remove rocker arm assembly and push rods. (See Group 05.)
4. Remove timing gear cover. (See REMOVE TIMING GEAR COVER, earlier in this group.)

Continued on next page

RG,16,DT7499 –19–14NOV97–1/3

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5. Rotate engine gear train until cap screws (A) can be removed.

IMPORTANT: Engine MUST remain in a position where camshaft followers rest against cylinder head or are held in up position with magnetic holders so that followers do not fall into engine crankcase. If camshaft followers fall into crankcase, cylinder head removal is required.

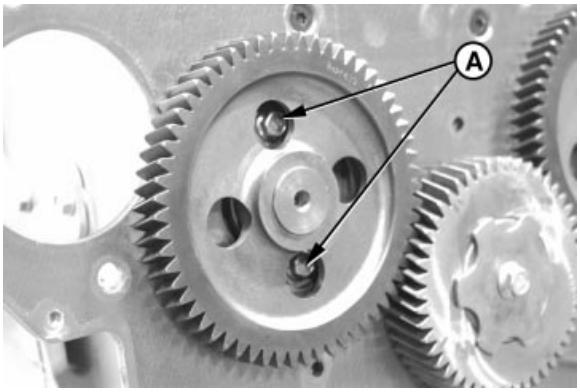
6. Revolve engine on repair stand to an angle where camshaft followers fall away from camshaft lobes.

NOTE: D15001NU Magnetic Follower Holder Kit (C) may also be used to hold camshaft followers away from lobes.

IMPORTANT: DO NOT allow camshaft lobes to drag in bushing or honed bores.

7. Carefully pull camshaft straight up, out of cylinder block.

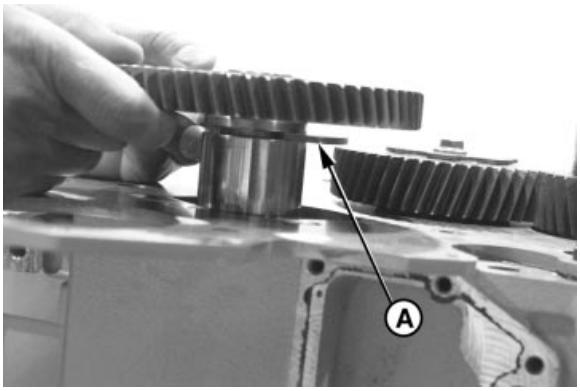
NOTE: Rotate camshaft carefully to aid in removing.



Removing Cap Screws

RG,16,DT7499 –19–14NOV97–2/3

8. Remove thrust plate (A) from slot behind camshaft gear.



Remove Thrust Plate

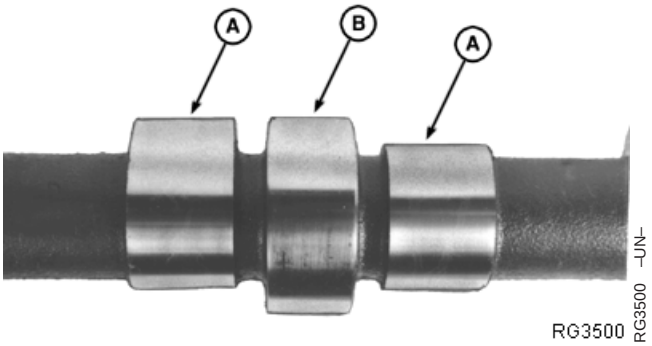
RG,16,DT7499 –19–14NOV97–3/3

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.

IMPORTANT: New camshaft followers can be used with old camshaft. DO NOT reuse old camshaft followers with a new camshaft. (See Group 05 for camshaft follower replacement.)

NOTE: Very light score marks are acceptable if valve lift is within specification. If pitting or galling exists, replace camshaft. (See MEASURE VALVE LIFT earlier in this group.)



Inspecting Camshaft Lobes

RG,16,DT7498 –19–14NOV97–1/1

MEASURE CAMSHAFT THRUST PLATE CLEARANCE

Clean camshaft thrust plate and check clearance using a feeler gauge. Replace parts as necessary.

Camshaft Thrust Plate—Specification

Clearance	0.08—0.23 mm (0.003—0.009 in.)

NOTE: Thrust plate clearance determines camshaft end play.

Measuring Camshaft Thrust Plate Clearance

RG,16,DT7514 –19–15NOV97–1/1

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INSPECT AND MEASURE CAMSHAFT BUSHING ID AND JOURNAL OD

All engine camshafts have a (replaceable) bushing installed in No. 1 (front) camshaft bore.

1. Measure camshaft journals. If a camshaft journal is damaged or does not meet specification, install a new camshaft.

Camshaft Bearing Bore and Journal—Specification

Journal OD	55.872—55.898 mm (2.1997—2.2007 in.)
Bore ID (Front [No.1] in Block [without bushing])	59.961—59.987 mm (2.3607—2.3617 in.)
Bore ID (Front [No. 1] in Block [with bushing])	55.961—55.987 mm (2.2031—2.2042 in.)
Bore ID (All Except No. 1)	55.986—56.012 mm (2.2042—2.2052 in.)
Journal-to-Bushing Oil Clearance (No. 1 Bore with Bushing)	0.063—0.115 mm (0.0025—0.0045 in.)
Journal-to-Bushing Oil Clearance (All Except No. 1 Bore)	0.088—0.140 mm (0.0035—0.0055 in.)

2. Measure camshaft bushing ID and remaining bores in cylinder block. If camshaft bore is damaged or is not within specification, have a qualified machine shop install new bushings.

If No. 1 camshaft bushing ID does not meet specifications, replace camshaft bushing. (See REMOVE AND INSTALL CAMSHAFT BUSHING earlier in this group.)

Measuring Camshaft Journal

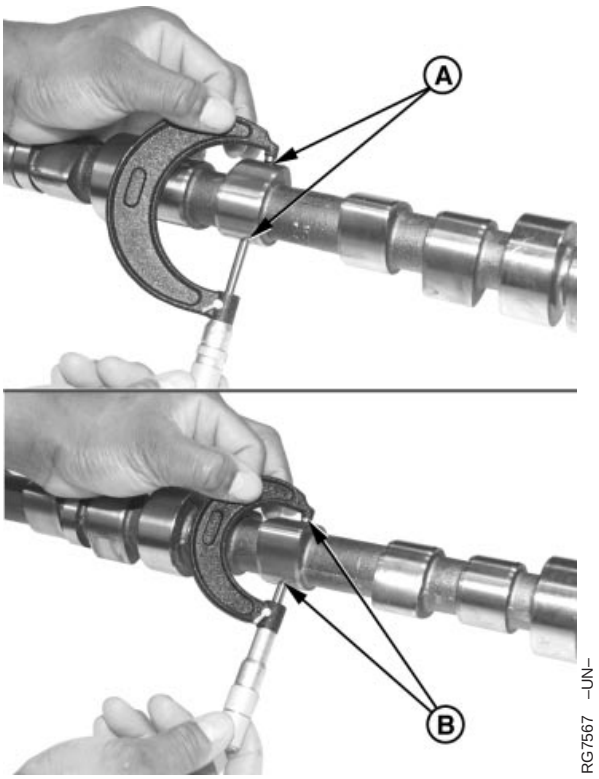
RG,16,DT7497 –19–14NOV97–1/1

MEASURE CAMSHAFT LOBE HEIGHT

Measure each camshaft lobe at highest point (A) and at narrowest point (B). The difference between these dimensions is camshaft lobe height. If height is not within specification on any lobe, install a new camshaft.

Camshaft Lobe—Specification

Height (Intake)	7.05—7.31 mm (0.278—0.288 in.)
Height (Exhaust)	6.89—7.15 mm (0.271—0.281 in.)



Measuring Camshaft Lobe Height

RG,16,DT7496 –19–11FEB98–1/1

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REMOVE AND INSTALL CAMSHAFT GEAR

IMPORTANT: Camshaft must be replaced if dropped or damaged, do not allow camshaft to strike floor when removing gear.

1. Press camshaft out of gear.
2. Clean camshaft and gears in solvent. Dry with compressed air.
3. Inspect cam journals for nicks and scratches. Replace camshaft if damage is found.
4. Support camshaft under first bearing journal in a hydraulic press.
5. Heat gear to 60—71°C (140—160°F).
6. Apply LOCTITE® 609 (TY43515) to camshaft nose and gear ID to ease installation.
7. Install Woodruff key in camshaft nose.

Pressing Gear Off Camshaft

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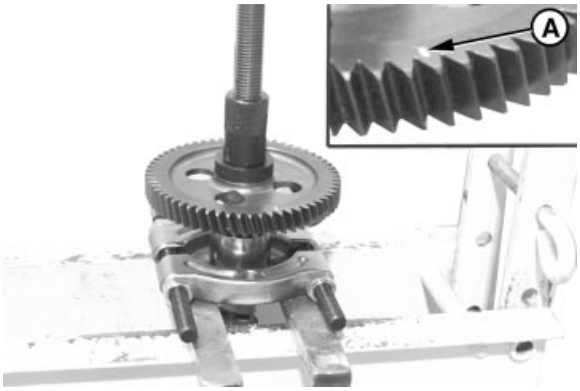
RG,16,DT7495 –19–14NOV97–1/2

8. Install gear with timing mark (A) away from camshaft (towards front timing gear cover). Press gear onto camshaft with a tubular driver until gear bottoms against camshaft shoulder.



Installing Gear Onto Camshaft

RG,16,DT7495 –19–14NOV97–2/2

INSPECT CAMSHAFT FOLLOWERS

NOTE: Cylinder head must be removed before camshaft followers can be removed from engine. (See Group 05.)

1. Inspect followers for uneven wear or damage. Also inspect corresponding camshaft lobe for wear or damage. Replace as necessary.

2. Measure follower OD and follower bore ID in cylinder block.

Camshaft Follower and Bore—Specification

Follower OD	31.61—31.64 mm (1.245—1.246 in.)
Follower Bore ID in Block	31.70—31.75 mm (1.248—1.250 in.)

Replace cam followers that are not within specification.

Replace cylinder block if any one cam follower bore is not within specification.

RG6324 –UN–

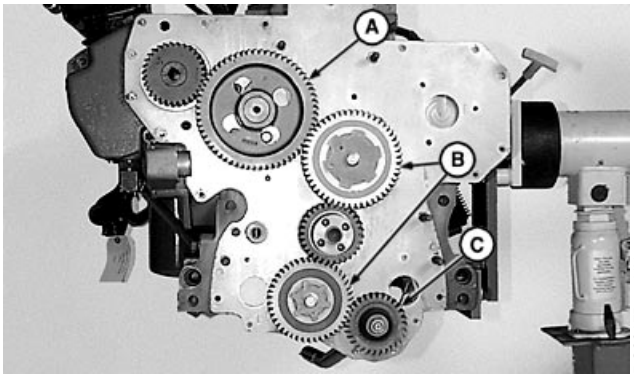
Inspecting Camshaft Followers

RG,16,DT7494 –19–14NOV97–1/1

REMOVE CYLINDER BLOCK FRONT PLATE

Before the front plate can be removed, the following components must first be removed:

- Timing gear cover.
- Camshaft and gear (A)
- Oil pump drive gear (C)
- Oil pump (See Group 20.)
- Idler gears (B)



RG8917B –UN–

Timing Gear Train Components

A—Camshaft and Gear
B—Idler Gear
C—Oil Pump Drive Gear

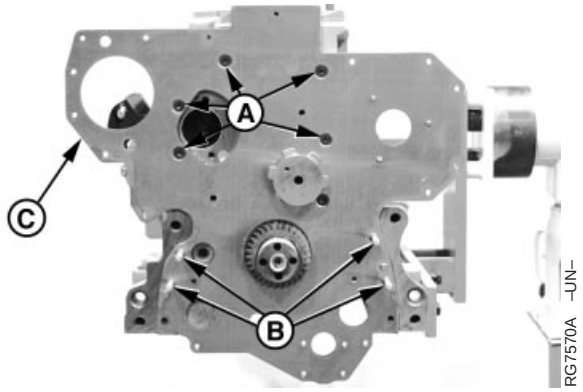
Continued on next page

RG,16,DT7486 –19–14NOV97–1/2

1. Remove four countersunk, TORX® screws (A) and two studs from front plate using T-40 TORX® adapter.
2. Remove four threaded studs (B) using E-8 TORX® socket.
3. Remove front plate (C).

IMPORTANT: All surfaces must be free of oil and dirt.

4. Thoroughly clean front face of cylinder block.



Removing Front Plate

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RG,16,DT7486 –19–14NOV97–2/2

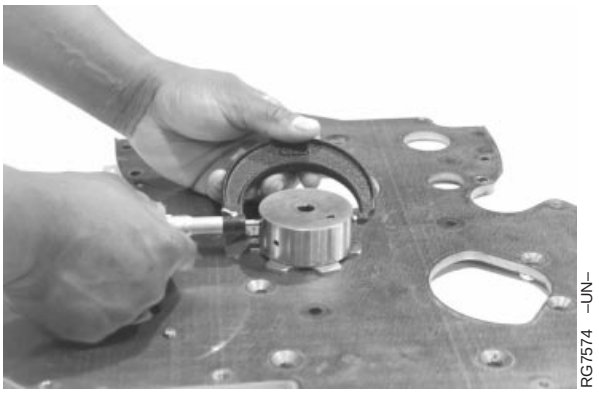
MEASURE IDLER GEAR BUSHING AND SHAFT

1. Measure idler gear bushing ID and shaft OD to determine oil clearance. If oil clearance exceeds specification, replace worn parts.

Idler Gear, Bushing and Shaft—Specification

Bushing ID (Upper)	69.802—69.832 mm (2.7481—2.7493 in.)
Bushing ID (Lower)	44.489—44.539 mm (1.7515—1.7535 in.)
Shaft OD (Upper)	69.757—69.777 mm (2.7463—2.7471 in.)
Shaft OD (Lower)	44.437—44.463 mm (1.7495—1.7505 in.)
Bushing-to-Shaft Oil Clearance (Upper)	0.075—0.125 mm (0.0030—0.0049 in.)
Bushing-to-Shaft Oil Clearance (Lower)	0.026—0.102 mm (0.0010—0.0040 in.)
End Play (Upper and Lower)	0.095—0.145 mm (0.0037—0.057 in.)

Measuring Idler Gear Bushing ID



Measuring Shaft OD

2. If idler gear end play, measured earlier in this group, was out of specification, remove idler shaft and thrust washer from front plate. (See REMOVE LOWER AND UPPER IDLER SHAFTS, later in this group.)
3. Check thrust washer for wear.
4. Measure idler gear hub width and shaft width. Replace worn parts that are out of specification.

RG,16,DT7484 –19–14NOV97–1/1

REMOVE AND INSTALL IDLER GEAR BUSHING

NOTE: Bushing for upper idler gear is not replaceable. If bushing is worn, replace gear assembly.

1. Press worn lower idler gear bushing out of gear using D01045AA Master Driver Set and JDG537 (OTC815) Handle.

IMPORTANT: Lower idler gear bushings are splash lubricated and have a spiral oil groove; upper idler gear bushings are pressure lubricated and DO NOT have oil grooves.

2. Coat ID and OD of lower idler gear bushing and ID of gear with TY6333 High-Temperature Grease. Install bushing into idler gear using Discs and Driver from D01045AA Master Driver Set.

Lower Idler Gear

RG,16,DT7483 –19–14NOV97–1/1

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REMOVE LOWER AND UPPER IDLER SHAFTS

1. Remove lower idler shaft and thrust washer by driving or pressing on shaft from block side of front plate.
2. Remove upper idler shaft and thrust washer by driving or pressing on shaft from block side of front plate.

RG7579 –UN–

Upper Idler Shaft

RG7580 –UN–

Lower Idler Shaft

RG,16,DT7482 –19–14NOV97–1/1

CLEAN AND INSPECT FRONT PLATE

IMPORTANT: All surfaces must be free of oil and dirt.

1. Clean front plate with hot soapy water.
2. Rinse well with plain water to remove all soap residue from gasket surface.
3. Inspect front plate for damage.

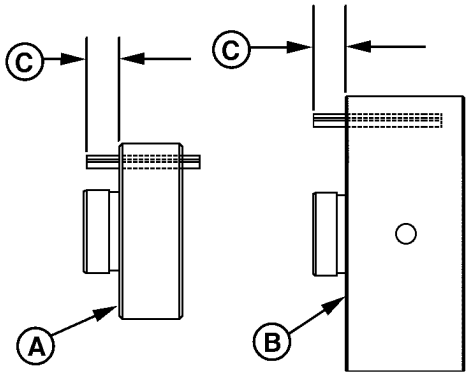
RG,16,DT7481 –19–14NOV97–1/1

INSTALL IDLER SHAFT SPRING PINS

Install spring pins in lower (A) and upper (B) idler gear shaft which locks thrust washer to shaft to allow 4.32 mm (0.170 in.) (C) projection above front face of each shaft. The pin on idler shafts extends through both rear and front thrust washer.

Upper and Lower Idler Shaft Spring Pin—Specification

Protrusion ..... 2.79—4.83 mm (0.11—0.19 in.)



RG7942 –UN–

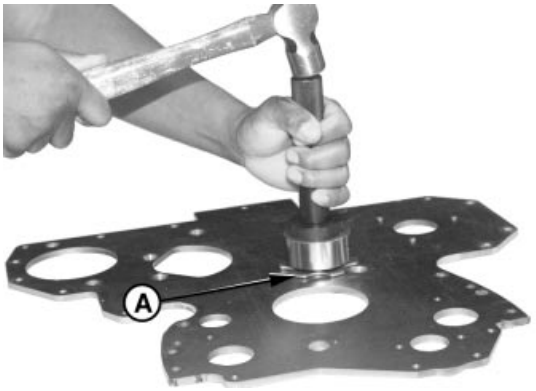
Measuring Spring Pins

RG,16,DT7479 –19–14NOV97–1/1

INSTALL UPPER IDLER SHAFT IN FRONT PLATE

IMPORTANT: Oil holes in idler shaft must be properly indexed to provide adequate lubrication to idler gear bushing.

1. Install thrust washer (A) and upper idler shaft into front plate. Spring pin must extend through hole in thrust washer and front plate.
2. Drive or press shaft into front plate until thrust washer is fully seated.



RG7581 –UN–

Installing Thrust Washer

RG,16,DT7478 –19–14NOV97–1/1

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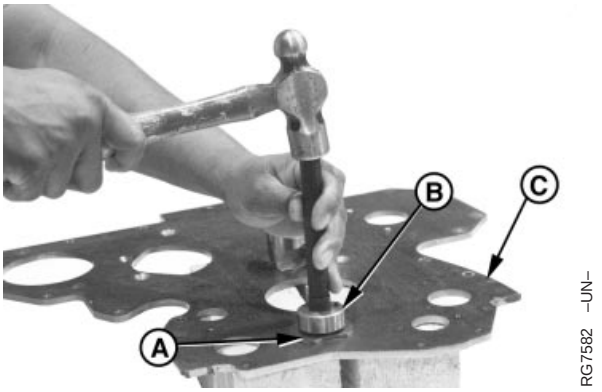
INSTALL LOWER IDLER SHAFT IN FRONT PLATE

1. Install thrust washer (A) and lower idler shaft with spring pin (B). Spring pin must extend through hole in thrust washer and front plate.
2. Drive shaft into plate (C) until thrust washer is fully seated.



Lower Idler Shaft

RG,16,DT7477 –19–14NOV97–1/1

INSTALL ENGINE FRONT PLATE

1. If not previously done, use a brass scraper and remove any previously applied sealant.

IMPORTANT: Be sure cylinder block and front plate surfaces are free of oil, dirt, previously applied sealant, and cleaning agents.

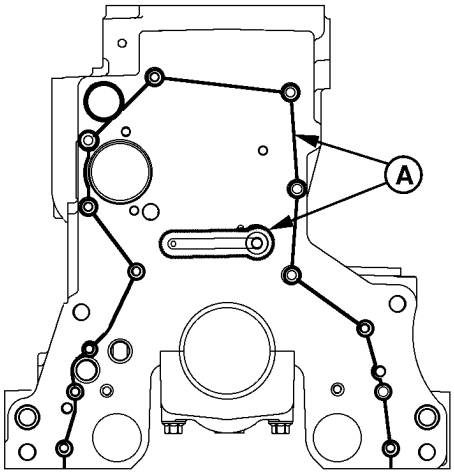
2. Wash gasket surfaces with a steam cleaner using hot soapy water. Rinse well with plain water to remove all soap residue from gasket surface.

Continued on next page

RG,16,DT7476 –19–14NOV97–1/3

3. Apply LOCTITE® 515 Flexible Form-In-Place Gasket (TY6304) in a continuous 1.5—2.0 mm bead (A) to cylinder block.

4. Locate bead in the center of the mating surfaces and completely encircle cap screw and dowel holes.



Apply Gasket Material

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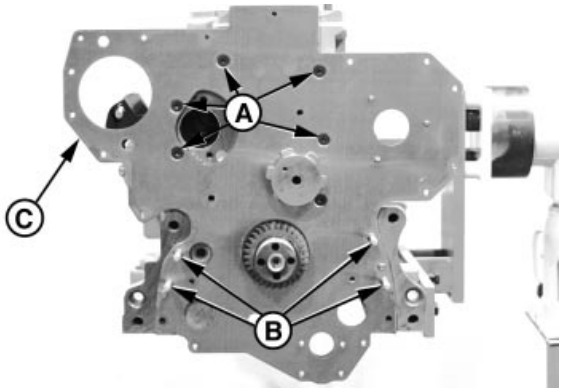
RG,16,DT7476 –19–14NOV97–2/3

5. Install front plate (A).

IMPORTANT: Tighten screws to specified torque using a cross pattern, within 10 minutes after parts are assembled.

Torque—Specification

Countersunk TORX Screws (B)	25 N•m (18 lb-ft)
Threaded Studs (C)	35 N•m (26 lb-ft)



Installing Front Plate

RG,16,DT7476 –19–14NOV97–3/3

16
30

INSTALL AND TIME CAMSHAFT

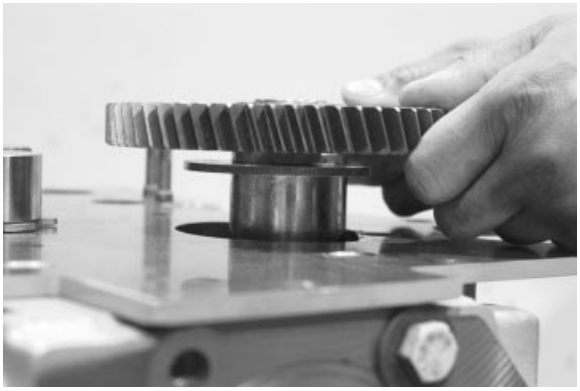
1. Lock engine with No. 1 piston at TDC compression stroke.

2. Lubricate camshaft bearing journals, lobes, and followers with TY6333 High-Temperature Grease.

IMPORTANT: DO NOT allow camshaft lobes to drag on camshaft bore or bushing surfaces while installing camshaft. Bearing surfaces may become scratched or scored. Rotate camshaft during installation to avoid obstruction in any bore.

3. Install camshaft and thrust plate in cylinder block. Be careful not to damage bushing ID.

4. Install thrust plate cap screws and tighten to 35 N•m (26 lb-ft).



Installing Camshaft Gear

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RG,16,DT7474 –19–14NOV97–1/2

5. With JD254A Timing Tool resting on nose of crankshaft and center of camshaft (as shown), turn camshaft until timing mark (A) on camshaft gear aligns with timing tool.

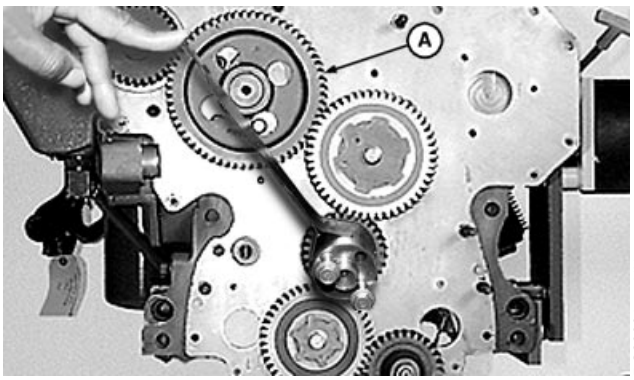
IMPORTANT: Use the timing mark corresponding to the number of cylinders the engine has that is being timed.

IMPORTANT: To ensure proper lubrication of new upper idler gear bushing and camshaft bushing, install new upper idler gear with the reference number facing away from engine.

6. Lubricate upper idler gear bushing ID and shaft OD with TY6333 High-Temperature Grease. Using JDG791A Idler Gear Installer Pilot, install idler gear without turning camshaft gear.

7. Install upper idler gear thrust washer and cap screw. Tighten cap screw to 80 N•m (59 lb-ft).

8. Recheck camshaft gear (A) to make sure it is correct.



Align Timing Mark on Camshaft Gear

RG,16,DT7474 –19–14NOV97–2/2

CLEAN AND INSPECT TIMING GEAR COVER

1. Drive crankshaft front oil seal out of cover.

2. Remove material and sealant from cylinder block and timing gear cover gasket surfaces. If necessary, remove oil filler neck and gasket.

CAUTION: Do not spin bearings when drying with compressed air.

3. Remove auxiliary drive as described earlier in this group.

4. Clean timing gear cover in solvent. Dry with compressed air.

5. Inspect cover for cracks or damage. Make sure seal bore is clean and free of nicks.

RG,16,DT7472 –19–14NOV97–1/1

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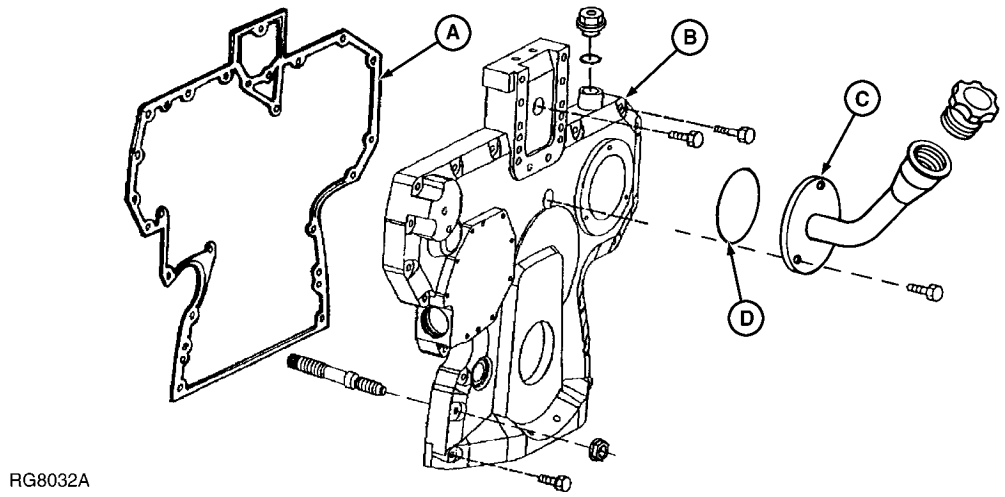
INSTALL TIMING GEAR COVER



RG8032A –UN–

Installing Timing Gear Cover

A—Gasket **B—Timing Gear Cover** **C—Cover Plate** **D—Seal Ring**

1. Make sure gasket surfaces on cover and front plate are clean. See CLEAN AND INSPECT ENGINE FRONT PLATE, earlier in this group.
2. Install plate (C) using a new seal ring (D), if necessary. Tighten screws to 2 N•m (18 lb-in.).
3. Install timing gear cover (B) on engine and apply the following torques:

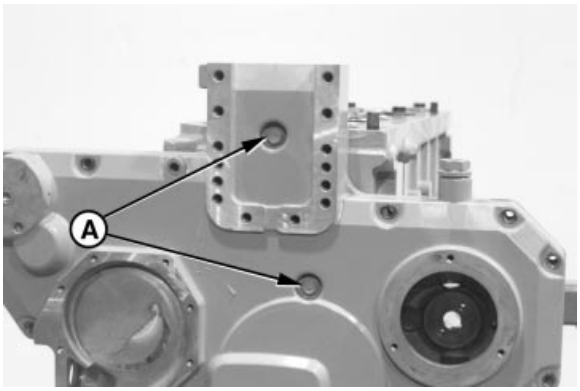
Timing Gear Cover—Specification

Timing Gear Cover-to-Front Plate and Cylinder Block Torque	35 N•m (26 lb-ft)
Oil Pan-to-Timing Gear Cover Torque	35 N•m (26 lb-ft)

4. Install oil pressure regulating valve assembly. (See Group 20.)

RG,16,DT7471 –19–11FEB98–1/5

5. Install cap screws (A) and tighten to 35 N•m (26 lb-ft).



–UN–

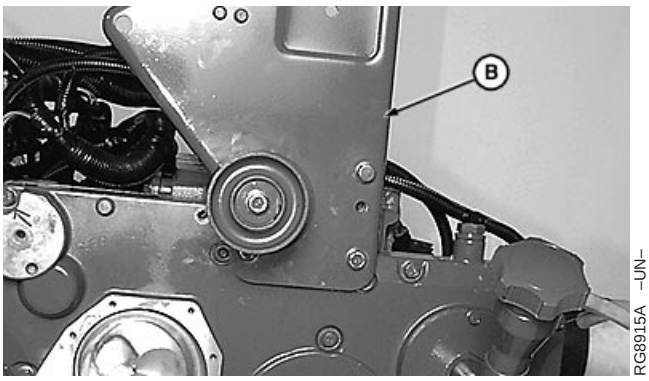
Installing Timing Gear Cover Cap Screws

Continued on next page

RG,16,DT7471 –19–11FEB98–2/5

6. Install adjustable fan drive and fan pulley (B). (See Group 25.)

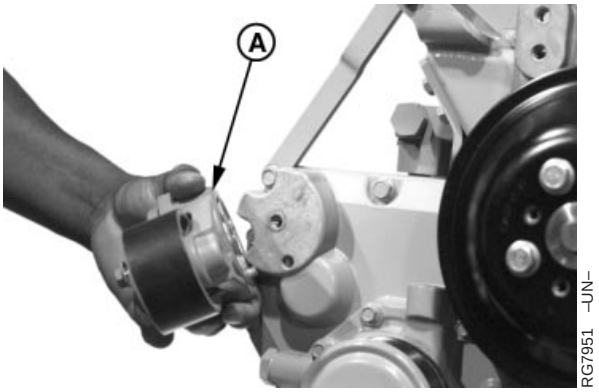
7. Install water pump, if removed. (See Group 25.)



Adjustable Fan Drive

RG,16,DT7471 –19–11FEB98–3/5

8. Install belt tensioner (A), if removed. (See Group 25.)



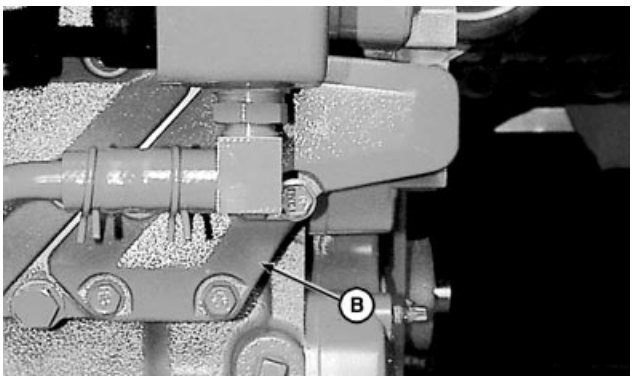
Installing Belt Tensioner

Continued on next page

RG,16,DT7471 –19–11FEB98–4/5

9. Install oil cooler-to-water manifold elbow (B) at front plate. (See Group 20.)

10. Install oil pan. (See Group 20.)



Installing Elbow

RG,16,DT7471 –19–11FEB98–5/5

INSTALL CRANKSHAFT FRONT WEAR SLEEVE AND OIL SEAL

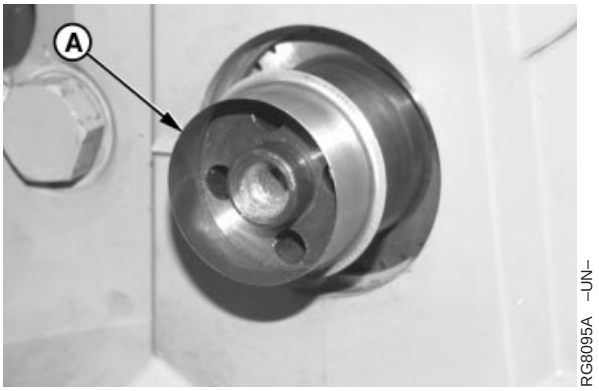
1. Coat ID of new wear sleeve with LOCTITE® 609 (T43515) Retaining Compound.

LOCTITE is a trademark of the Loctite Corp.

RG,16,DT7470 –19–14NOV97–1/4

2. Install wear sleeve (A) on nose of crankshaft with lip of sleeve toward crankshaft.

NOTE: Flange on wear sleeve should be seated against crankshaft drive gear when properly installed.



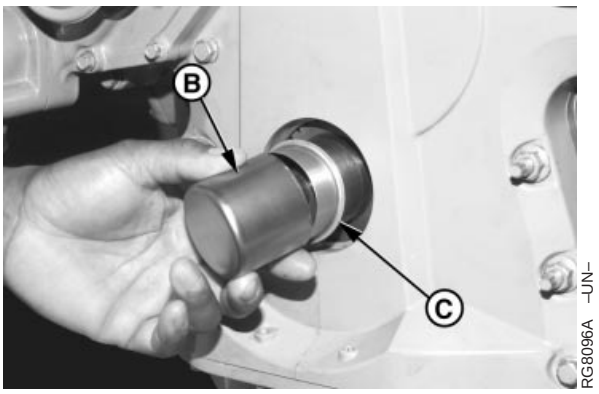
Positioning Wear Sleeve

Continued on next page

RG,16,DT7470 –19–14NOV97–2/4

3. Position installation tool (B) provided in front wear sleeve kit over wear sleeve. Install wear sleeve until tool bottoms on nose of crankshaft, using a dead blow hammer.

4. Clean any sealant from OD of crankshaft flange (C) and wear sleeve.



Positioning Installation Tool

Installing Wear Sleeve

Continued on next page

RG,16,DT7470 –19–14NOV97–3/4

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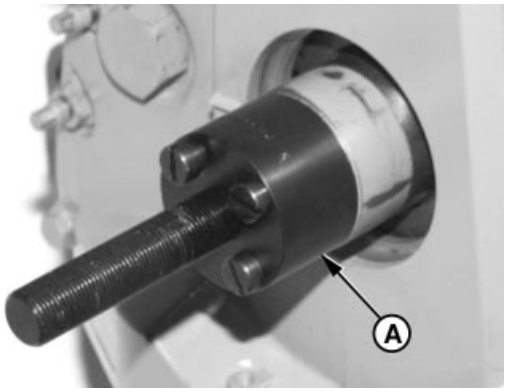
INSTALL FRONT CRANKSHAFT OIL SEAL

IMPORTANT: To assure proper sealing, the OD of the crankshaft and wear sleeve MUST BE cleaned with Brake Kleen, Ignition Cleaner, or equivalent and dry prior to installing seal (C).

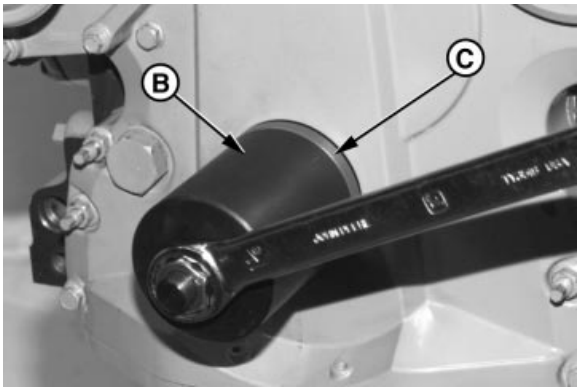
1. Inspect and clean seal bore in timing gear cover. Check for nicks or burrs. Use a medium-grit emery cloth to smooth rough areas.
2. Slide JDG954-2 Adapter (A) on nose of crankshaft and tighten cap screws.

IMPORTANT: DO NOT allow oil to contact coating on OD of seal.

3. Apply a light coating of clean engine oil to lips of seal and position seal on crankshaft flange. (The spring-loaded side of seal goes into timing gear cover first.)
4. Place JDG954-1 Installer (B) over adapter. Tighten screw until driver bottoms on nose of crankshaft.
5. Install belt pulley.
6. Place damper on crankshaft. Handle vibration damper with care to avoid impact damage.
7. Dip cap screws in clean SAE30 engine oil.
8. Install cap screws and tighten in a cross sequence to 60 N•m (44 lb-ft). Final tighten cap screws to 80 N•m (59 lb-ft).
9. Install poly-vee belts.



Installing Adapter on Crankshaft



Installing Installer

Installed Seal

RG,16,DT7470 –19–14NOV97–4/4

COMPLETE FINAL ASSEMBLY

1. Remove cam follower holding tools (if used for camshaft removal).
2. Install push rods and rocker arm assembly. (Group 05)
3. Adjust valve clearance and install rocker arm cover and sealing ring. (Group 05)
4. Install alternator. (Group 25)
5. Fill engine crankcase with clean oil having correct viscosity and grade specifications. (Group 02)
6. Perform engine break-in.

RG,16,DT7469 –19–14NOV97–1/1

SPECIAL OR ESSENTIAL TOOLS

NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

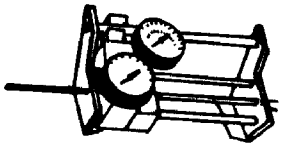
SERVICE-GARD is a trademark of Deere & Company.

RG,20,DT7518 –19–17NOV97–1/3

RG5061 –UN–

Spring Compression Tester D01168AA

Test oil bypass valve spring and oil pressure regulating valve spring compression.



RG5061

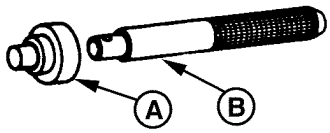
D01168AA

RG,20,DT7518 –19–17NOV97–2/3

RG5183 –UN–

Bushing Driver (A) and Handle (B) . . . . . JD248A and JDG536(OTC813)

Install oil pressure relief valve bushing.



JD248A and JDG536 (OTC813)

RG,20,DT7518 –19–17NOV97–3/3

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2

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICE-GARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
D01061AA Blind Hole Puller Set	Remove oil pressure regulating valve seat and dipstick tube from block.
JT01727 Collet	Remove pressure regulating valve.

SERVICE-GARD is a trademark of Deere & Company.

RG,20,DT7534 –19–17NOV97–1/1

OTHER MATERIAL

Number	Name	Use
TY6304 (U.S.) TY9484 (Canadian) 515 (LOCTITE®)	Flexible Sealant	To seal oil pan gasket surfaces.
TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®)	Pipe Sealant with TEFLON®	To seal oil pan elbow drain fitting.
TY15969 (U.S.) TY9479 (Canadian) 680 (LOCTITE®)	Retaining Compound (Maximum Strength)	To seal dipstick tube.
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	To seal cooler-to-oil cooler housing cap screws.

LOCTITE is a trademark of the Loctite Corp.
TEFLON is a trademark of the DuPont Co.

RG,20,DT7535 –19–17NOV97–1/1

LUBRICATION SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Oil Pump:		
Drive shaft bore in pump housing	16.052—16.102 mm	——
	(0.6320—0.6339 in.)	——
Diameter of idler shaft journal	12.316—12.332 mm	——
	(0.4849—0.4855 in.)	——
ID of Idler Gear	12.355—12.363 mm	
	(0.4864—0.4867 in.)	
Diameter of drive shaft journal	16.017—16.037 mm	——
	(0.6306—0.6314 in.)	——
Thickness of gears	35.975—36.025 mm	——
	(1.4163—1.4183 in.)	——
Gears-to-pump housing radial clearance	0.131—0.211 mm	——
	(0.005—0.008 in.)	——
Gears-to-pump cover axial clearance	0.045—0.165 mm	——
	(0.0018—0.0065 in.)	——
Spring for Oil Pressure Regulating Valve:		
Free length (approx.)	119 mm (4.68 in.)	——
		——
Tension at length of 42.5 mm (1.68 in.)	66 N (13.5—16.5 lb-force)	——
		——
Bypass Valve Spring:		
Free length	51 mm (2.00 in.)	——
		——
Tension at length of 29 mm (1.14 in.)	87.8 N (20 lb-force)	——
Minimum oil pressure at 850 rpm and engine oil temperature at 93°C (200°F)	100 kPa (1 bar) (14 psi)	——

TORQUES

Oil Pump-to-Front Plate[a]	35 N•m (26 lb-ft)
Oil Pump Drive Gear-to-Shaft, Retaining Nut (Staked)	50 N•m (37 lb-ft)
Oil Suction Tube-to-Oil Pump	35 N•m (26 lb-ft)
Oil Pan-to-Cylinder Block	35 N•m (26 lb-ft)
Oil Pan-to-Timing Gear Cover	35 N•m (26 lb-ft)
Oil Fill Tube-to-Cylinder Block	35 N•m (26 lb-ft)
Oil Pan Drain Plug	47 N•m (35 lb-ft)
Oil Pressure Regulating Valve Plug in Timing Gear Cover	95 N•m (70 lb-ft)
Oil Cooler Housing-to-Cylinder Block	35 N•m (26 lb-ft)
Oil Cooler Covers-to-Cylinder Block	35 N•m (26 lb-ft)
Oil Filter Housing-to-Cylinder Block	35 N•m (26 lb-ft)
Oil Cooler-to-Oil Cooler Housing	12 N•m (9 lb-ft)
Oil Pump Drive Gear Retaining Nut (Staked)	50 N•m (37 lb-ft)
Lower Idler Gear-to-Oil Pump Housing	80 N•m (59 lb-ft)

[a]See INSTALL ENGINE OIL PUMP, later in this group, for proper cap screw tightening sequence.

RG,20,DT7536 –19–11FEB98–1/1

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4

DIAGNOSING LUBRICATION SYSTEM MALFUNCTIONS

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.
- Oil pressure regulating valve failure.

Oil Sludge and Dilution

- Improper operation and servicing.
- Coolant leakage into lubrication system.
- Incomplete combustion.
- Excessive oil consumption.

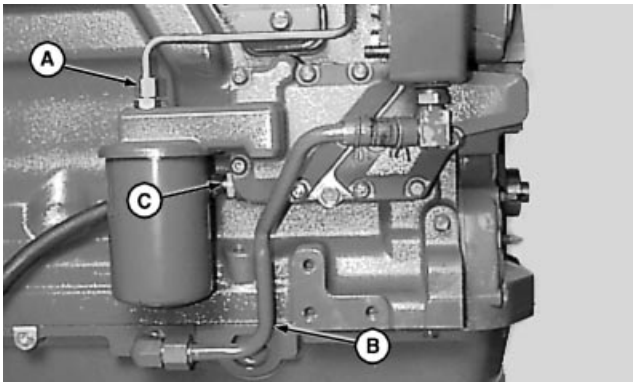
Low Oil Pressure at Slow Idle

- Bypass oil check valve failure.

RG,20,LG107 –19–15DEC97–1/1

REMOVE, INSPECT, AND INSTALL OIL FILTER BASE

1. Disconnect air compressor oil inlet line (A) from oil filter header.
2. Disconnect oil return line (B) and (C).

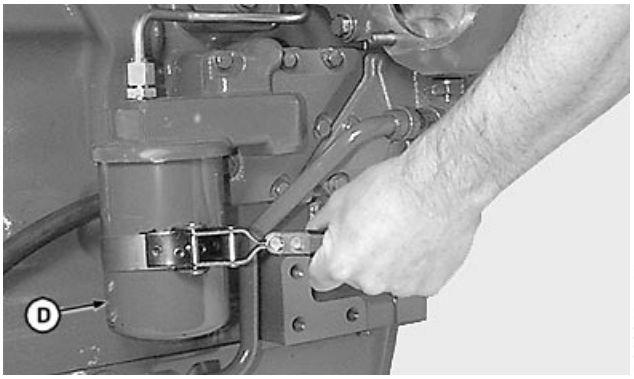


Disconnecting Air Compressor Inlet Line

A—Oil Inlet Line
B—Oil Return Line
C—Oil Return Line

RG,20,DT7532 –19–11FEB98–1/3

3. Remove oil filter (D) using a suitable filter wrench.

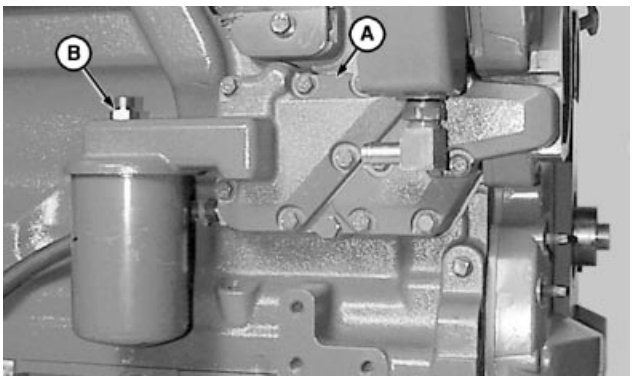


Removing Oil Filter

Continued on next page

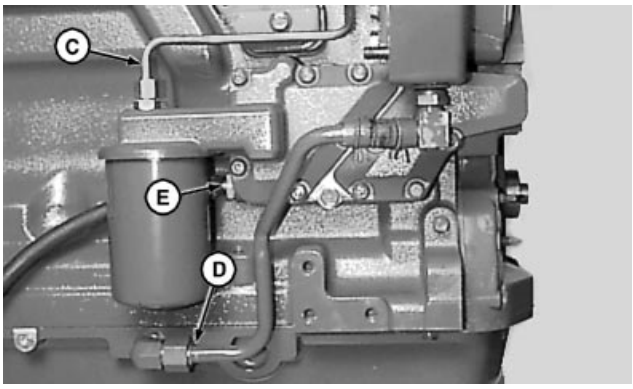
RG,20,DT7532 –19–11FEB98–2/3

4. Remove oil filter header/rear adapter (A). Remove oil tube adapter (B), if equipped.
5. Clean all gasket material from mating surfaces. Inspect all parts and replace if needed.
6. Using a new gasket, install oil filter header. Tighten cap screws to 35 N•m (26 lb-ft).
7. Using a new gasket, install adapter, if equipped. Tighten cap screws to 35 N•m (26 lb-ft).
8. Connect air compressor oil inlet line (C), oil return line (D) and (E).
9. 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.



RG8965A –UN–

Removing Oil Tube Adapter



RG8963B –UN–

Connecting Oil Inlet Line

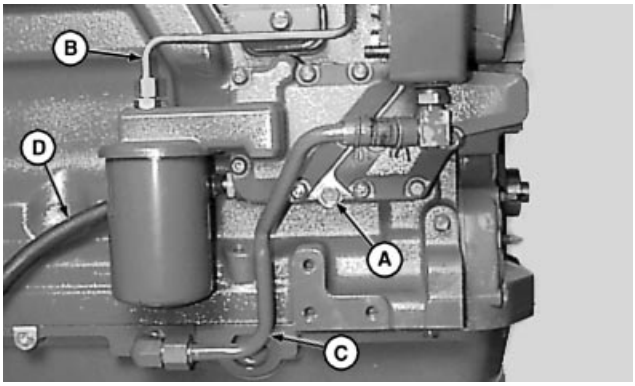
A—Oil Filter Header/Rear Adapter
B—Tube Adapter
C—Oil Inlet Line
D—Oil Return Line
E—Oil Return Line

RG,20,DT7532 –19–11FEB98–3/3

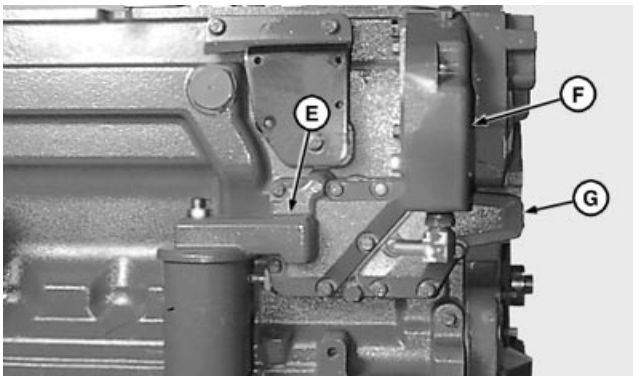
REMOVE, INSPECT, AND INSTALL OIL COOLER

REMOVE OIL COOLER ASSEMBLY

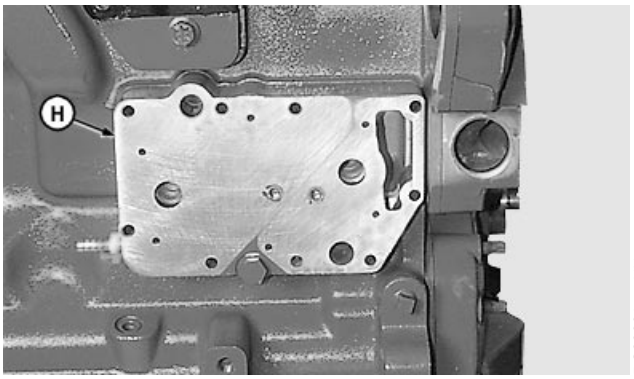
1. Remove oil cooler drain plug (A) and drain coolant.
2. Remove air compressor inlet line (B), return line (C) and coolant line (D).
3. Remove oil filter header (E) and air compressor drive gear housing (F).
4. Remove elbow adapter (G) and housing (H).
5. Remove oil cooler (I).



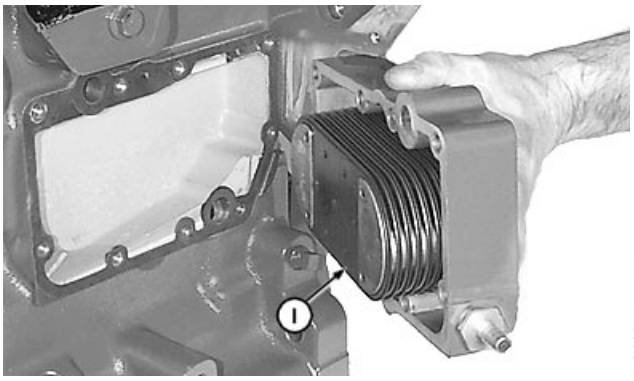
Removing Oil Cooler Drain Plug



Removing Elbow Adapter



Removing Housing



Removing Oil Cooler

A—Oil Cooler Drain Plug
B—Compressor Inlet Oil Line
C—Return Line
D—Coolant Line
E—Oil Filter Header
F—Compressor Drive Housing
G—Elbow Adapter
H—Housing
I—Oil Cooler

Continued on next page

RG,20,DT7531 –19–11FEB98–1/5

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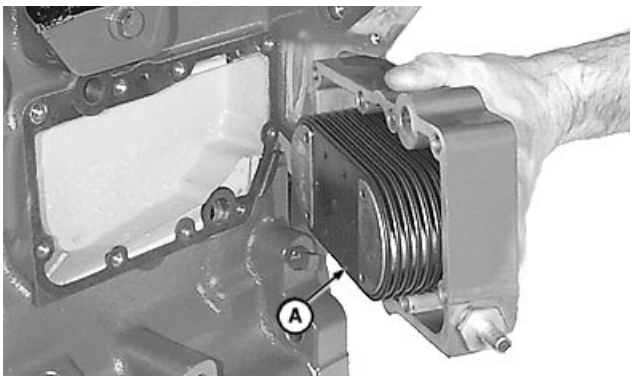
8

INSPECT OIL COOLER ASSEMBLY

1. Inspect oil cooler (A) 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.

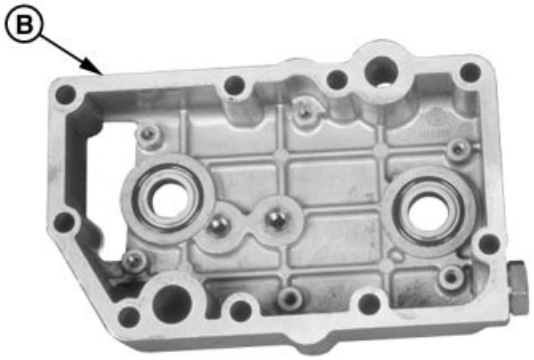


RG8967B –UN–

Inspecting Oil Cooler

RG,20,DT7531 –19–11FEB98–2/5

4. Inspect oil cooler housing (B).
5. Replace parts as needed. DO NOT attempt to repair oil cooler.



RG7969 –UN–

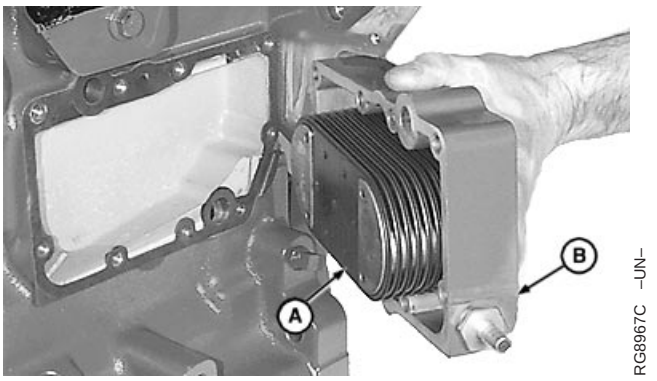
Inspecting Oil Cooler

Continued on next page

RG,20,DT7531 –19–11FEB98–3/5

INSTALL OIL COOLER ASSEMBLY

1. Lubricate new O-rings with clean engine oil.
2. Install oil cooler (A) in oil cooler housing (B).
3. Apply LOCTITE® 242 Thread Lock and Sealer to oil cooler-to-oil cooler housing cap screws. Tighten to 12 N•m (9 lb-ft).
4. Using a new gasket, install oil cooler assembly. Be sure gasket is properly aligned with cap screw holes.



Installing Oil Cooler and Housing

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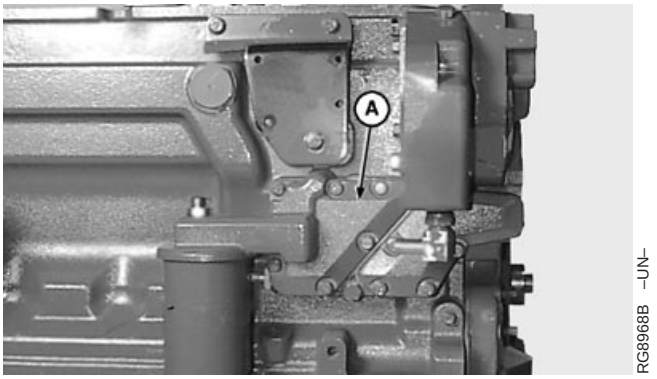
RG,20,DT7531 –19–11FEB98–4/5

5. Install oil filter header/oil cover (A). Tighten cap screws to 35 N•m (26 lb-ft).
6. Install coolant and oil lines. See REMOVE, INSPECT, AND INSTALL OIL FILTER BASE, earlier in this group.



Install Oil Tube Adapter/Oil Cooler Cover

RG,20,DT7531 –19–11FEB98–5/5

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10

REMOVE, INSPECT, AND INSTALL OIL BYPASS VALVE

1. Remove timing gear cover and front plate as described in Group 16.
2. Remove oil bypass valve and spring.
3. Inspect valve and spring for damage. Replace parts if necessary.
4. Check bypass valve spring free length and compression strength using D01168AA Spring Compression Tester. Replace parts if not within specification.

Bypass Valve Spring—Specification

Free Length ..... 51 mm (2.00 in.)
Spring Load at 29 mm (1.14 in.) ..... 87.8 N (20 lb-force)
Compressed Length

5. Install oil bypass valve and spring in cylinder block.
6. Install front plate and timing gear cover as described earlier in Group 16.

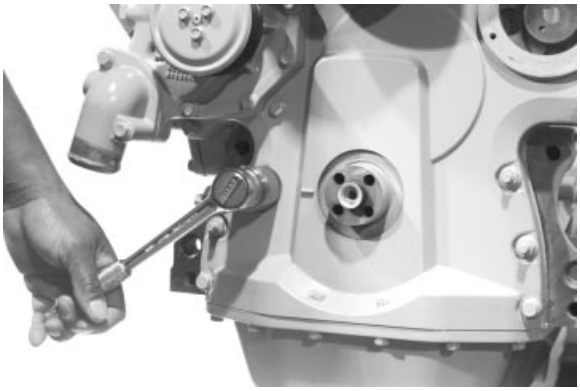
RG7571 –UN–

Removing Oil Bypass Valve and Spring

RG,20,DT7530 –19–17NOV97–1/1

REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT

1. Remove oil pressure regulating valve plug from timing gear cover.



RG7554 –UN–

Removing Oil Press. Regulating Valve Plug

Continued on next page

RG,20,DT7529 –19–17NOV97–1/5

2. Remove oil pressure regulating valve and spring.

3. Check valve cone for excessive wear and damaged sealing face.

4. Check oil pressure regulating spring free length and compression strength using D01168AA Spring Compression Tester. Replace parts if not within specification.

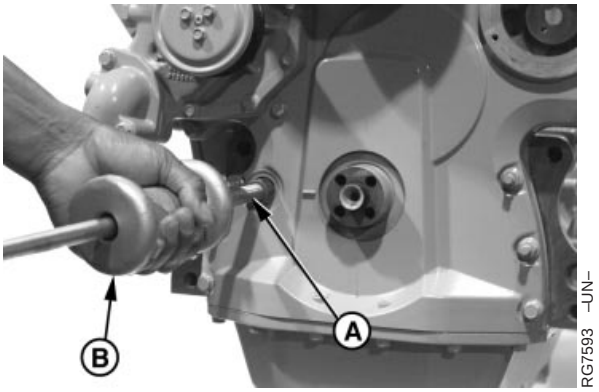
Pressure Regulating Valve Spring—Specification

Free Length	119 mm (4.68 in.)
Spring Tension at 42.5 mm (1.68 in.)	66 N (13.5—16.5 lb-force)

Removing Oil Pressure Valve and Spring

RG,20,DT7529 –19–17NOV97–2/5

5. Pull valve seat out of cylinder block with JT01727 Collet (A) and JT01718 Slide Hammer (B) from D01061AA Blind-Hole Puller Set, or equivalent.



Pulling Valve Seat Out of Block

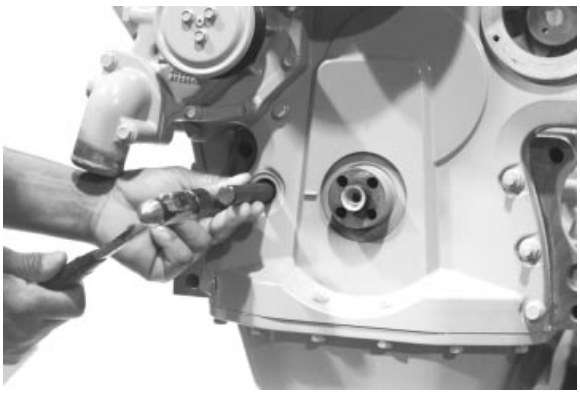
Continued on next page

RG,20,DT7529 –19–17NOV97–3/5

20
12

IMPORTANT: DO NOT drive against raised inner rim of valve seat so that valve seat bore is not damaged.

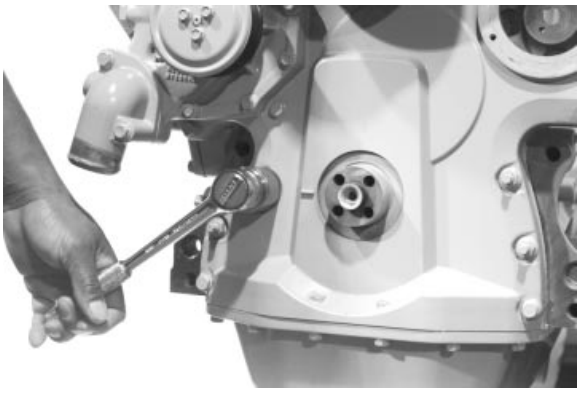
6. Drive valve seat into cylinder block with JD248A Oil Pressure Relief Valve Bushing Driver and JDG536 (OTC813) Handle until the seat bottoms in bore.



Driving Valve Seat Into Block

RG,20,DT7529 –19–17NOV97–4/5

7. Install valve, spring, washer, and plug in timing gear cover. Tighten plug to 95 N•m (70 lb-ft).

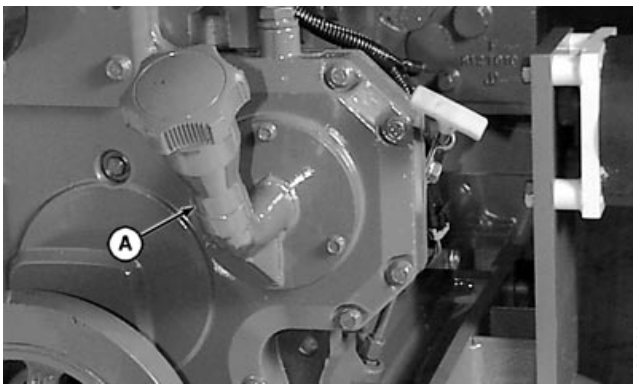


Installing Valve, Spring, Washer, and Plug

RG,20,DT7529 –19–17NOV97–5/5

REMOVE AND INSTALL OIL FILL TUBE

1. Remove oil fill tube (A).
2. Inspect and replace tube as needed.
3. Using a new gasket, install oil fill tube.
4. Apply LOCTITE® 242 Thread Lock and Sealer to threads of cap screws.
5. Tighten cap screws to 35 N•m (26 lb-ft).



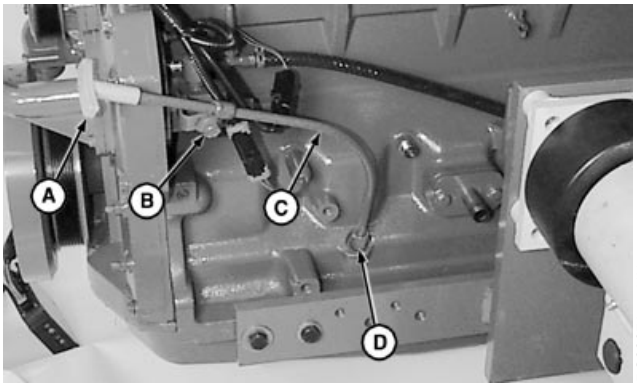
Removing Oil Fill Tube

LOCTITE is a trademark of the Loctite Corp.

RG,20,DT7528 –19–17NOV97–1/1

REMOVE AND INSTALL DIPSTICK TUBE WITH OIL PAN INSTALLED

1. Remove dipstick (C).
2. Remove bracket cap screw (B) and dipstick retaining nut (D).
3. Orient dipstick tube and install cap screw. Tighten dipstick tube retaining nut. Tighten bracket cap screw.
4. Install dipstick.



Removing Dipstick

RG,20,DT7527 –19–17NOV97–1/1

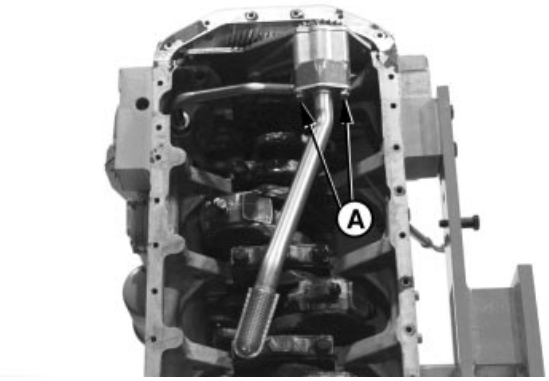
REPLACE OIL PUMP PICK-UP TUBE ASSEMBLY

1. Remove oil pan. (See procedure in this group.)

Continued on next page

RG,20,DT7526 –19–17NOV97–1/2

2. Loosen cap screws (A) and remove oil pump pick-up tube assembly.
3. Install new assembly with new O-ring and tighten cap screws to 35 N•m (26 lb-ft).
4. Reinstall oil pan. See INSTALL OIL PAN, as described later in this group.

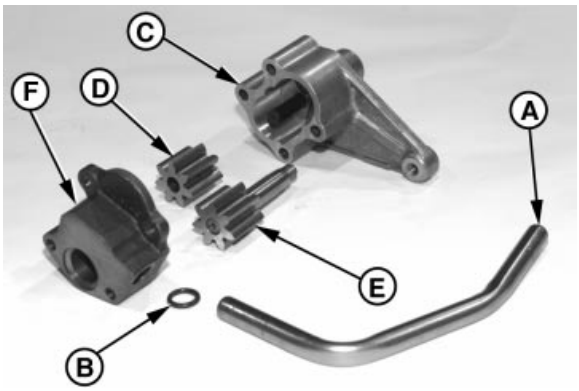


RG7596 –UN–

Loosen Oil Pump Tube Cap Screws

RG,20,DT7526 –19–17NOV97–2/2

ENGINE OIL PUMP ASSEMBLY



RG7610A –UN–

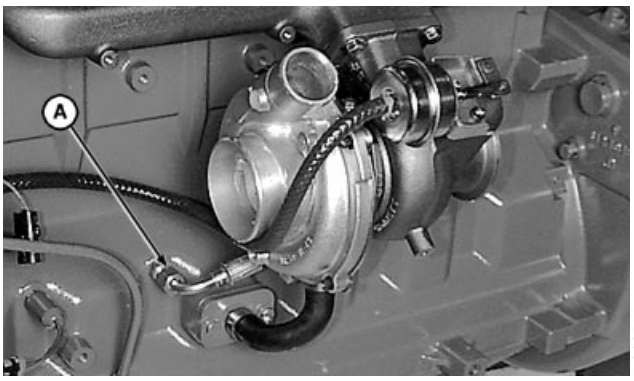
Engine Oil Pump

A—Outlet Tube
B—O-Ring
C—Pump Housing
D—Idler Gear
E—Drive Gear
F—Cover

RG,20,DT7525 –19–17NOV97–1/1

REMOVE ENGINE OIL PUMP

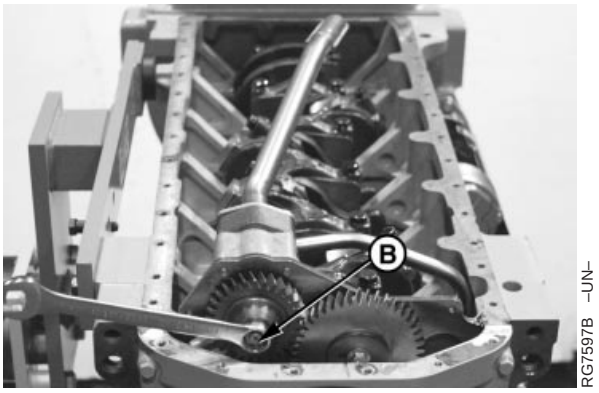
1. Drain oil and disconnect turbocharger oil inlet line (A) at the turbocharger.
2. Remove oil pan. (See Procedure in This Group).
3. Remove gasket from oil pan and oil pan rail.



Disconnect Oil Inlet Line

RG,20,DT7524 –19–17NOV97–1/4

4. Remove nut (B) and pull gear from tapered oil pump drive shaft. To remove oil pump gear, loosen nut several turns and apply force between the front plate and gear on two sides of gear with small pry bars. If above method does not work, loosen oil pump housing cap screws and strike the nut on end of shaft with a small lead hammer while applying force to gear until gear is free of tapered shaft.
5. Remove oil pump pick-up tube, as described earlier in this group.

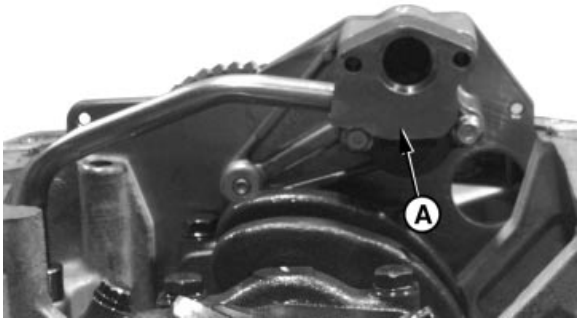


Removing Oil Pump Gear Nut

Continued on next page

RG,20,DT7524 –19–17NOV97–2/4

6. Remove upper two cap screws and remove cover (A).

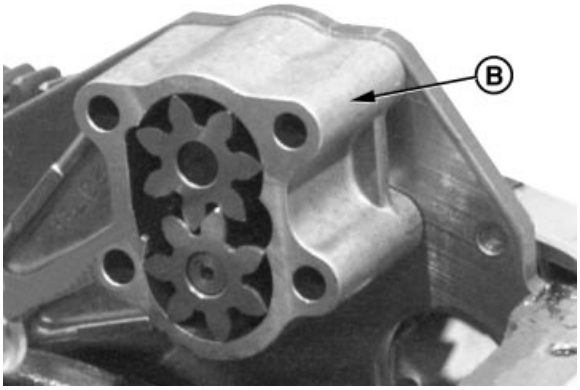


Removing Cap Screws and Cover

RG,20,DT7524 –19–17NOV97–3/4

NOTE: The lower idler gear cap screw has to be removed to remove the oil pump housing.

7. Remove oil pump housing assembly (B).



Removing Oil Pump Housing Assembly

RG,20,DT7524 –19–17NOV97–4/4

INSPECT AND MEASURE CLEARANCES

Inspect oil pump components for excessive wear. Replace parts or oil pump assembly, as necessary.

Continued on next page

RG,20,DT7523 –19–11FEB98–1/5

1. Check gear-to-pump cover axial clearance.

Gear—Specification

Thickness of Gears	35.975—36.025 mm (1.4163—1.4183 in.)
Gear-to-Pump Cover Axial Clearance	0.045—0.165 mm (0.0018—0.0065 in.)

Checking Gear-to-Cover Axial Clearance

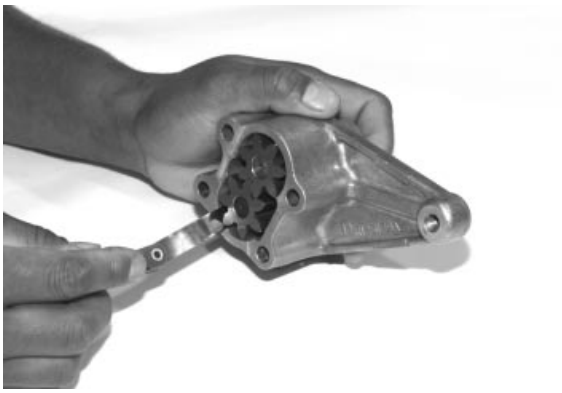
Checking Gear Thickness

RG,20,DT7523 –19–11FEB98–2/5

2. Check gear-to-pump housing radial clearance.

Gear-to-Pump Housing—Specification

Radial Clearance	0.131—0.211 mm (0.005—0.008 in.)



Checking Gear-to-Housing Radial Clearance

Continued on next page

RG,20,DT7523 –19–11FEB98–3/5

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3. Check housing and cover bore ID and shaft OD. Inspect cover and housing for evidence of gear rub. Light contact is acceptable.

4. Measure bushing ID in housing and bore in cover.

Pump Shaft OD and Bore ID—Specification

Drive Shaft OD	16.017—16.037 mm (0.6306—0.6314 in.)
Bushing ID in Housing	16.052—16.102 mm (0.6320—0.6339 in.)

RG7605 –UN–

Checking Shaft OD

RG7606 –UN–

Checking Bushing ID

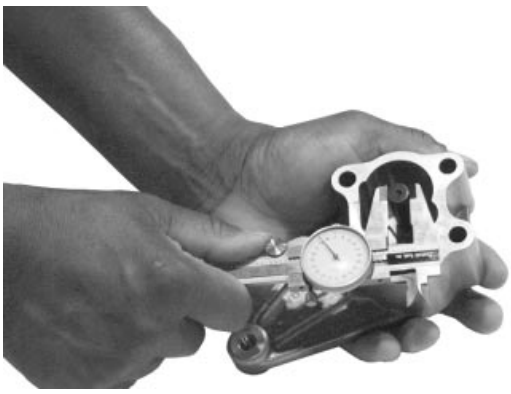
Continued on next page

RG,20,DT7523 –19–11FEB98–4/5

5. Measure idler shaft OD and idler gear ID.

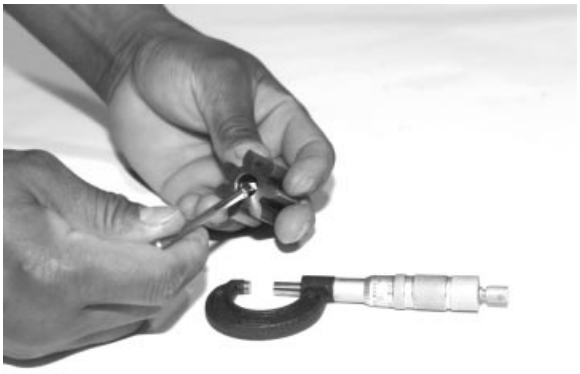
Idler Shaft OD and Idler Gear ID—Specification

Idler Shaft OD	12.316—12.332 mm (0.4849—0.4855 in.)
Idler Gear ID	12.355—12.363 mm (0.4864—0.4867 in.)



RG7607 –UN–

Measuring Idler Shaft OD



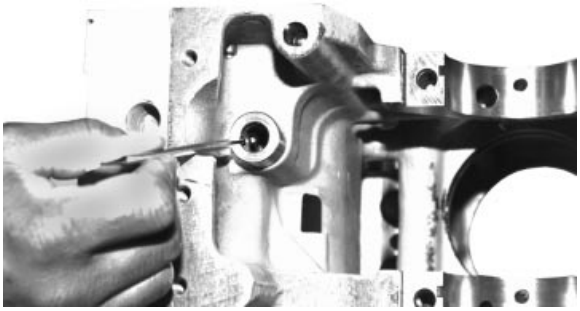
RG7608 –UN–

Measuring Idler Gear ID

RG,20,DT7523 –19–11FEB98–5/5

COMPLETE OIL PUMP DISASSEMBLY

1. Remove O-ring from pump housing and cylinder block (for outlet tube).
2. Remove O-ring from oil pick-up tube.
3. Clean oil pump parts in solvent. Dry with compressed air.
4. Inspect pick-up tube. Check flange-to-pick-up tube weld for cracks. If cracks or other defects are found, replace pick-up tube. See REPLACE OIL PUMP PICK-UP TUBE ASSEMBLY, earlier in this group.



RG7609 –UN–

Removing Oil Tube O-Ring

RG,20,DT7522 –19–17NOV97–1/1

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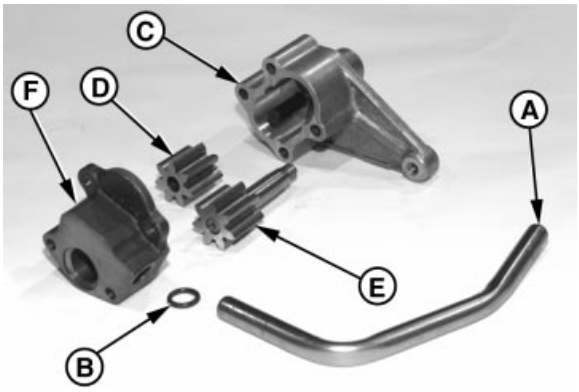
ASSEMBLE ENGINE OIL PUMP

IMPORTANT: Lubricate gears and shaft with clean engine oil before assembling.

1. Install new O-ring (B) in pump cover (F).
2. Put idler gear (D) and drive gear (E) in pump housing (C).



RG7610A –UN–

Engine Oil Pump

A—Outlet Tube
B—O-Ring
C—Pump Housing
D—Idler Gear
E—Drive Gear
F—Cover

RG,20,DT7521 –19–17NOV97–1/1

INSTALL ENGINE OIL PUMP

NOTE: This procedure is for installing the oil pump with timing gear cover installed.

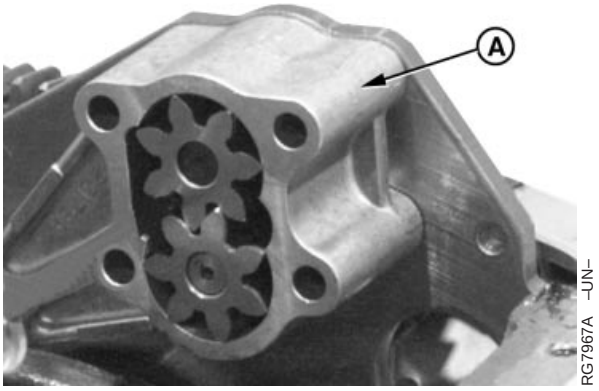
1. Install new O-rings in cylinder block and oil pump cover (for outlet tube). Install tube into cover and block.

Continued on next page

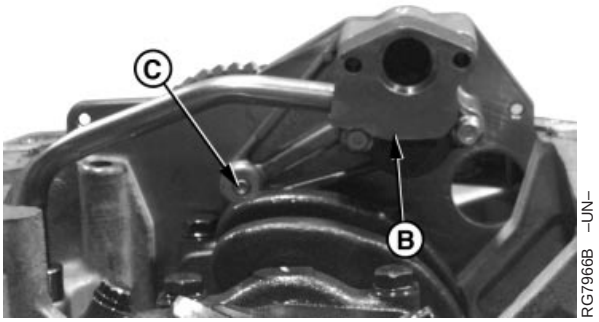
RG,20,DT7520 –19–17NOV97–1/4

2. Install oil pump housing with gears (A) onto front plate. Install lower idler gear cap screw (C) into leg of housing finger tight.

3. Swing (position) oil pump cover (B) onto pump housing and install two lower cap screws finger tight.



Installing Oil Pump Housing



Installing Oil Pump Cover

Continued on next page

RG,20,DT7520 –19–17NOV97–2/4

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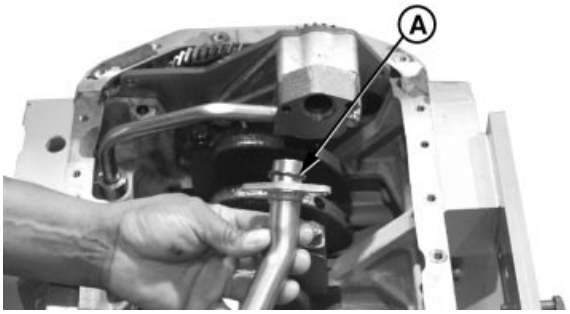
22

4. Install new O-ring (A) on neck of pick-up tube. Install pick-up tube.

5. Tighten four cap screws and lower idler gear cap screw to specified torque according to sequence shown.

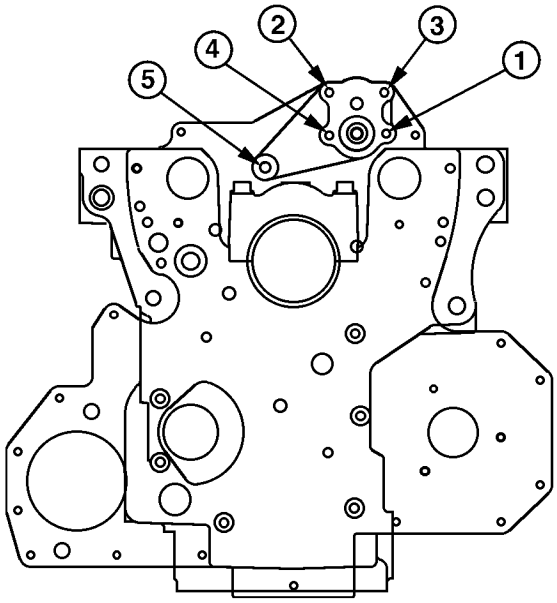
Cap Screw—Specification

Oil Pump Pick-Up Tube Torque	35 N•m (26 lb-ft)
Lower Idler Gear Torque	80 N•m (59 lb-ft)



RG7599 –UN–

Install Oil Tube O-Ring



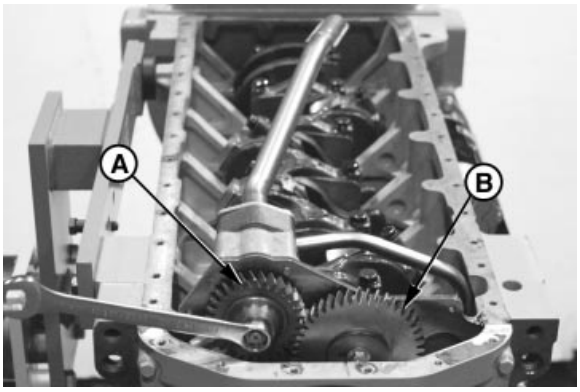
RG8090 –UN–

Oil Pump Torque Sequence

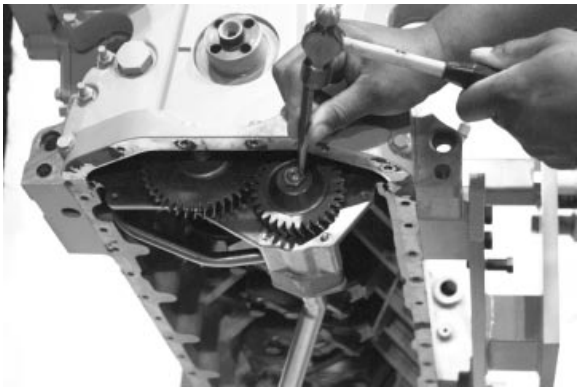
Continued on next page

RG,20,DT7520 –19–17NOV97–3/4

6. Install oil pump drive gear (A) so that it meshes with lower idler gear (B) without altering gear train timing.
7. Install new retaining nut and tighten to 50 N•m (37 lb-ft).
8. Stake nut to shaft by applying three center punch marks near ID of the nut.



Installing Oil Pump Drive Gear



Staking Retainer Nut

RG,20,DT7520 –19–17NOV97–4/4

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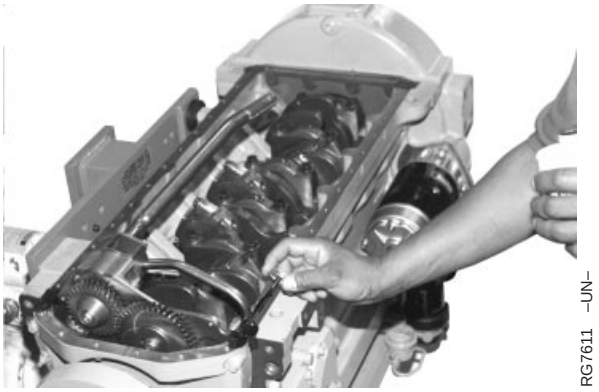
INSTALL OIL PAN

1. Apply LOCTITE® 515 (TY6304) Form-In-Place Gasket on oil pan rail where flywheel housing, front plate, and timing gear cover attach to cylinder block.
2. Install oil pan gasket.
3. Install oil pan and tighten cap screws to 35 N•m (26 lb-ft).
4. Install aluminum or copper washer on drain plug with raised center against plug. Install plug in oil pan. Tighten drain plug to 47 N•m (35 lb-ft) If equipped with elbow drain fittings, the threads and sealing surfaces must be free of oil film to insure an effective seal. Apply LOCTITE® 592 (TY9374) TEFLON® to fitting except for the leading one to three threads. Install and tighten fitting.
5. Fill engine crankcase with correct grade and viscosity engine oil. (See Group 02.)



Apply Gasket Material

LOCTITE is a trademark of the Loctite Corp.
TEFLON is a trademark of the DuPont Co.

RG,20,DT7519 –19–17NOV97–1/1

SPECIAL OR ESSENTIAL TOOLS

NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

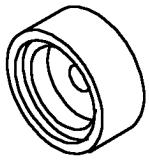
SERVICE-GARD is a trademark of Deere & Company.

RG,25,JW7545 –19–20NOV97–1/2

RG7950 –UN–

Water Pump Bearing Installer JDG956

Install bearing and shaft assembly into housing.



JDG956

RG,25,JW7545 –19–20NOV97–2/2

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICE-GARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

Name	Use
D01045AA Bushing, Bearing, and Seal Driver Set	Remove inner seal in water pump housing.
D01047AA 17-1/2 and 30-Ton Puller Set	Remove pulley from water pump shaft.

SERVICE-GARD is a trademark of Deere & Company.

RG,25,JW7727 –19–02DEC97–1/1

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2

OTHER MATERIAL

Number	Name	Use
PT507 (U.S.)	Multi-Purpose Grease	Thermostat housing O-rings.

RG,25,JW7564 –19–20NOV97–1/1

COOLING SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Clearance between bearing housing and impeller	1.016—1.270 mm	——
	(0.040—0.050 in.)	——
Bearing Shaft OD:		
Impeller End	12.025—12.038 mm	
	(0.4734—0.4739 in.)	
Pulley End	39.997—40.013 mm	——
	(1.5747—1.5753 in.)	——
Impeller Bore	11.973—11.999 mm	——
	(0.4714—0.4724 in.)	——
Pump Housing Bearing Bore	61.961—61.987 mm	——
	(2.4394—2.4404 in.)	——
Impeller (with fins on both sides)-to-End of Shaft	2.46—2.58 mm below	——
	end of shaft	——
	(0.096—0.102 in.)	
Impeller (with fins on one side)-to-End of Shaft	flush ± 0.13 mm (0.005 in.)	——
	with end of shaft	——
Minimum Clearance between Housing and Impeller	0.27 mm	——
	(0.010 in.)	——
Thermostat Opening Temperature:		
89° C (192°F) Thermostat	80°—89°C (187—212°F)	——
Deaeration Method	Across thermostat in housing. Air must be bled from system when refilled with coolant. See operator's manual.	

TORQUES

Water Pump-to-Timing Gear Cover	16 N•m (12 lb-ft)
Water Pump Inlet Elbow-to-Water Pump	35 N•m (26 lb-ft)
Water Pump Pulley-to-Water Pump	16 N•m (12 lb-ft)
Fan Pulley-to-Fan Pulley Hub:	
M8 cap screws	35 N•m (26 lb-ft)
M10 cap screws	70 N•m (52 lb-ft)
Idler Pulley Assembly-to-Alternator Bracket	80 N•m (60 lb-ft)
Water Manifold or Thermostat Housing-to-Cylinder Head	42 N•m (35 lb-ft)
Heating Element Retaining Nut	34 N•m (25 lb-ft)
Fan Belt Tensioner-to-Timing Gear Cover	50 N•m (37 lb-ft)
Cold Advance Switch (Sensor)	5 N•m (3.5 lb-ft)
Spring Tensioner	18—22 N•m (13—16 lb-ft)

RG,25,JW7563 –19–11FEB98–1/1

25
4

DIAGNOSING COOLING SYSTEM MALFUNCTIONS

Engine Overheats:

- Loose or broken fan belt
- Dirty radiator
- Low coolant level
- Low oil level
- Engine overload
- Defective head gasket
- Faulty thermostat
- Faulty water pump
- Corroded coolant passages

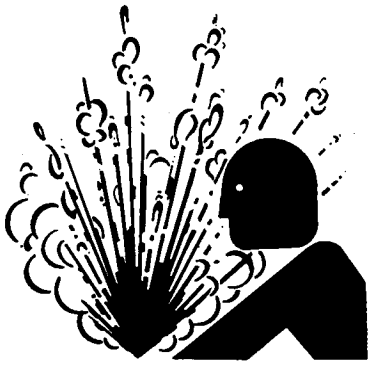
Low Coolant Level:

- Improper maintenance
- Improper operation
- Damaged radiator
- Water pump seal leakage
- Leakage
- Faulty radiator cap

RG,25,DT7208 –19–04NOV97–1/1

REMOVE WATER MANIFOLD/THERMOSTAT COVER AND THERMOSTAT

1. Partially drain coolant from system.
2. Loosen idler pulley center bolt and move aside to remove tube hold-down bolt.



TS281 –UN–

Service Cooling System Safety

Continued on next page

RG,25,JW7561 –19–20NOV97–1/3

3. Remove thermostat cover-to water pump tube (A) and seal.

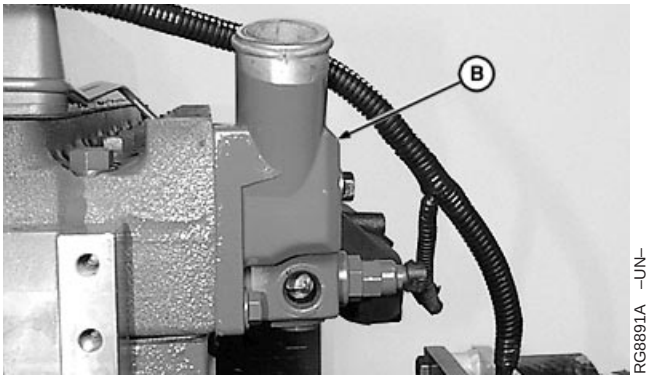
CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

4. Visually inspect area around water manifold/thermostat cover for leaks.

Removing Water Pump Tube

RG,25,JW7561 –19–20NOV97–2/3

5. Remove water manifold/thermostat cover (B) with gasket.
6. Remove thermostat.
7. Remove and discard all gasket material. Clean gasket surfaces.
8. Clean and inspect cover for cracks or damage.



Removing Thermostat Cover

RG,25,JW7561 –19–20NOV97–3/3

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6

TEST THERMOSTAT

Inspect thermostat for debris or damage, and test thermostat using an approved testing procedure. See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE in Group 105 for testing procedure. Thermostat should start to open within the range specified. Replace if defective.

89°C (192°F) Thermostat—Specification

Thermostat Opening Temperature ..... 80—89°C (187—212°F)

NOTE: Deaeration is accomplished by a jiggle wire or dimple in thermostat flange area (positioned at top).

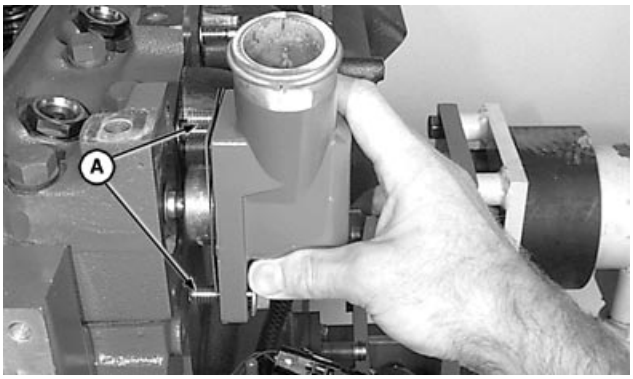
RG,25,JW7560 –19–20NOV97–1/1

INSTALL WATER MANIFOLD/THERMOSTAT COVER AND THERMOSTAT

1. Using cap screws (A) to keep gasket in place, install a new gasket on cylinder head.

NOTE: Thermostat must be positioned with jiggle wire or dimple facing up in the 12 o'clock position.

2. Using a screwdriver to hold thermostat in place, install thermostat and water manifold/thermostat cover. Tighten cover cap screws to 47 N•m (35 lb-ft).



Install New Cylinder Head Gasket

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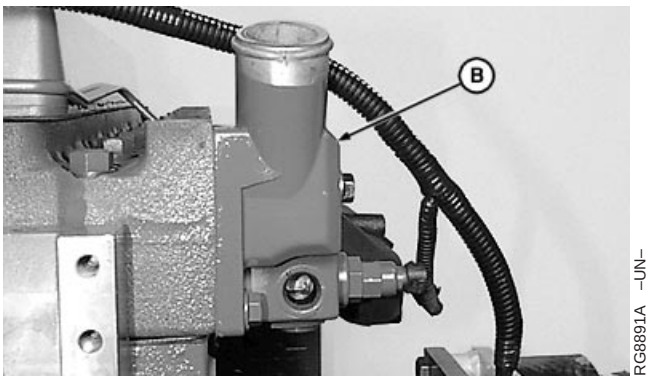
RG,25,JW7559 –19–11FEB98–1/3

3. Lubricate new O-ring with multi-purpose grease. Install seal (B) in thermostat cover.



Installing Thermostat Cover Seal

RG,25,JW7559 –19–11FEB98–2/3

4. Install water manifold/thermostat cover-to-water pump tube (A). Tighten clamps.

IMPORTANT: Air must be expelled from cooling system when filling. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing to allow air to escape when filling system. Tighten fitting or plug when all air has been expelled.

5. Fill cooling system and check for leaks.

Installing Water Pump Tube

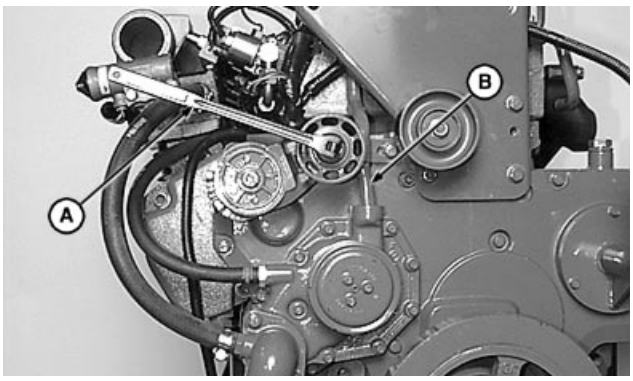
RG,25,JW7559 –19–11FEB98–3/3

25
8

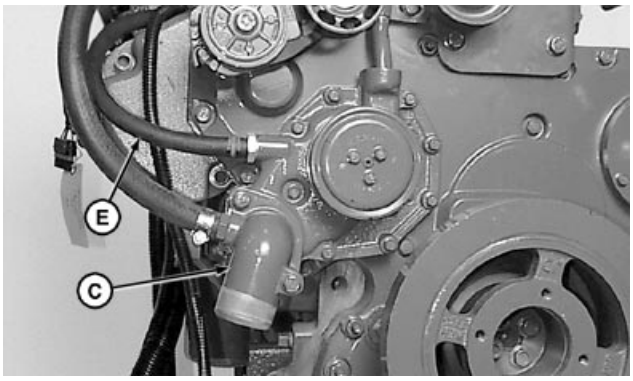
REMOVE WATER PUMP

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until the coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

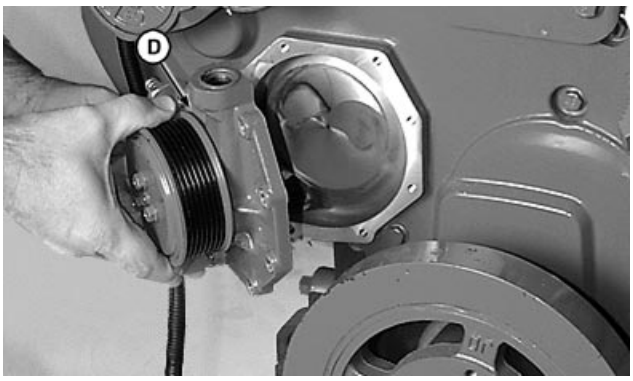
1. Drain coolant.
2. Remove fan (shown removed).
3. Release tension on belt using a breaker bar and socket (A).
4. Remove poly-vee belt from pulleys.
5. Remove thermostat housing-to-water pump tube (B).
6. Remove fuel regulator coolant return line (E).
7. Remove water pump inlet elbow (C) and O-ring, if desired.
8. Remove water pump (D).
9. Remove pulley from water pump.



Water Pump Belt and Inlet Elbow



Remove Water Pump Inlet Elbow

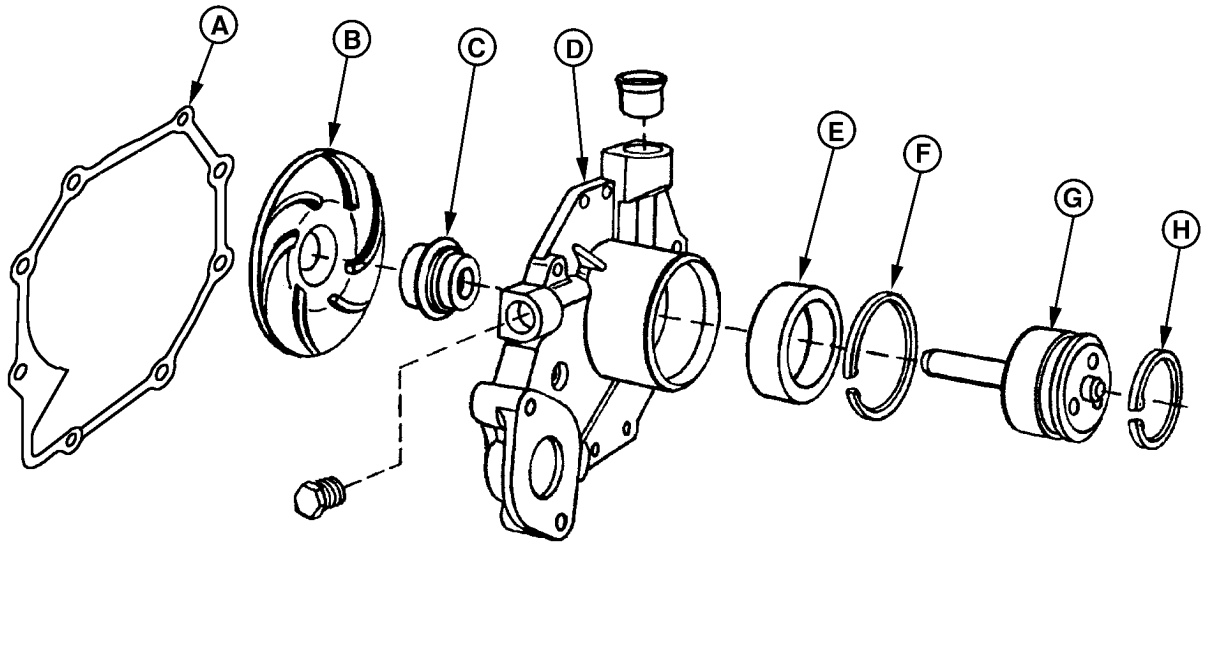


Remove Water Pump

A—Belt
B—Thermostat Housing-to-Water Pump Tube
C—Inlet Elbow
D—Water Pump
E—Fuel Regulator Coolant Return Line

RG,25,JW7558 –19–11FEB98–1/1

WATER PUMP ASSEMBLY



Water Pump Assembly

A—Gasket
B—Impeller
C—Seal
D—Housing
E—Bearing
F—External Snap Ring
G—Shaft
H—Internal Snap Ring

RG,25,JW7557 –19–20NOV97–1/1

DISASSEMBLE WATER PUMP

1. Using appropriate external snap ring pliers, remove internal snap ring from front bore of pump housing.

Continued on next page

RG,25,JW7556 –19–20NOV97–1/4

25
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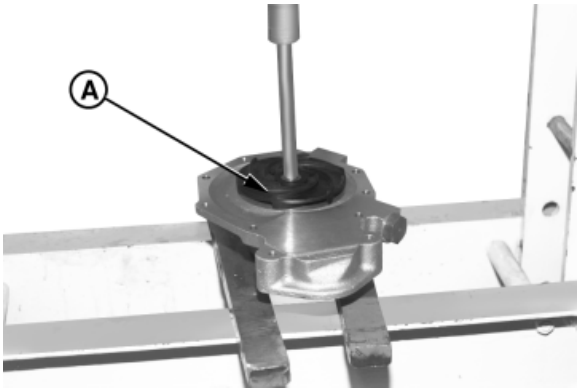
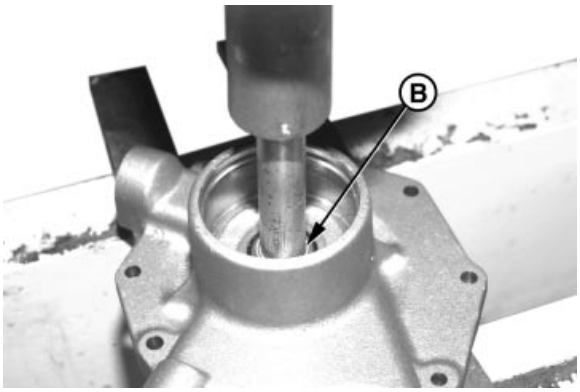
2. Support nose of water pump housing and press shaft through impeller (A) until impeller is free from shaft and bearing/shaft assembly is removed from housing. Discard impeller.



Pressing Shaft Through Impeller

RG,25,JW7556 –19–20NOV97–2/4

3. Drive or press seal (B) from pump housing using D01045AA Driver.

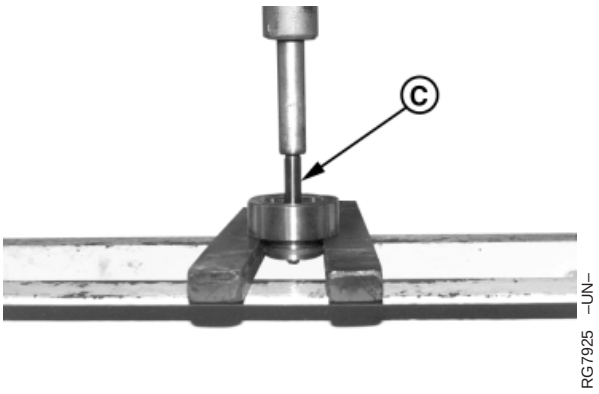


Pressing Seal From Pump Housing

Continued on next page

RG,25,JW7556 –19–20NOV97–3/4

4. Support inner bearing race and press shaft (C) out of bearing. Discard bearing.



Pressing Shaft Out of Bearing

RG,25,JW7556 –19–20NOV97–4/4

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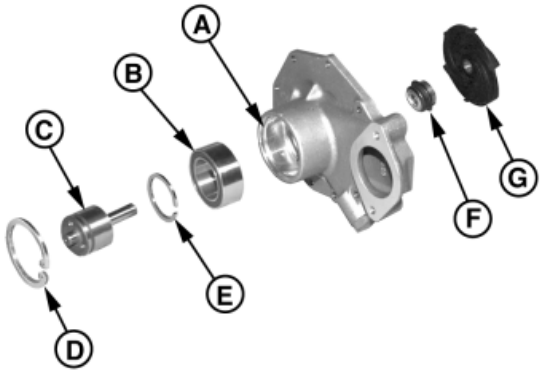
INSPECT, CLEAN, AND MEASURE WATER PUMP PARTS

1. Inspect water pump housing (A) for cracks or damage.
2. Remove gasket material from housing and clean with solvent. Dry with compressed air.
3. Clean out weep hole in housing. Inspect weep hole for oil or coolant leakage.
   - Oil leakage indicates a damaged sealed bearing (B).
   - Coolant leakage indicates a damaged housing seal (F).

Water Pump—Specification

Impeller Bore	11.973—11.999 mm (0.4714—0.4724 in.)
Bearing Shaft OD (Impeller End)	12.025—12.038 mm (0.4734—0.4739 in.)
Bearing Shaft OD (Pulley End)	39.997—40.013 mm (1.5747—1.5753 in.)
Pump Housing Bearing Bore	61.961—61.987 mm (2.4394—2.4404 in.)



RG7926 –UN–

Water Pump

RG7927 –UN–

Measuring Impeller Bore

A—Housing
B—Bearing
C—Shaft
D—Internal Snap Ring
E—External Snap Ring
F—Seal
G—Impeller

RG,25,JW7555 –19–20NOV97–1/1

ASSEMBLE WATER PUMP

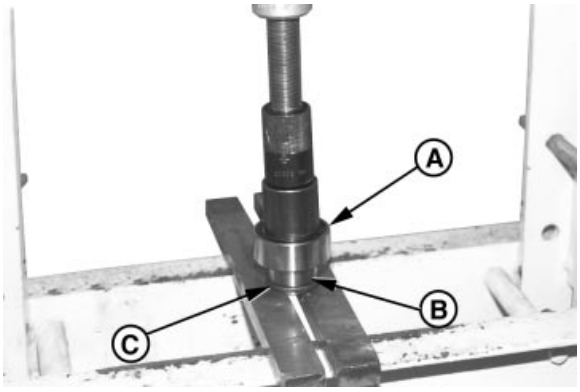
1. Thoroughly clean and inspect water pump mounting surface in timing gear cover before installing water pump assembly.
2. Using appropriate snap ring pliers, install external snap ring (C) into groove in shaft (B).
3. Using appropriate driver which bears on inner bearing race, install bearing (A) onto shaft against snap ring.

IMPORTANT: Do not push against end of bearing shaft. Push against outer race only, when installing bearing and shaft assembly into housing.

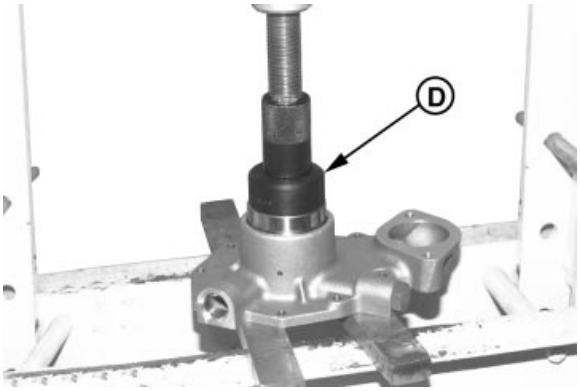
4. Using JDG956 Water Pump Bearing Installer (D), install bearing and shaft assembly into housing until it bottoms in housing bore.
5. Install large internal snap ring into groove in front bore of pump housing.

NOTE: Water pumps have a unitized (one-piece) water seal.

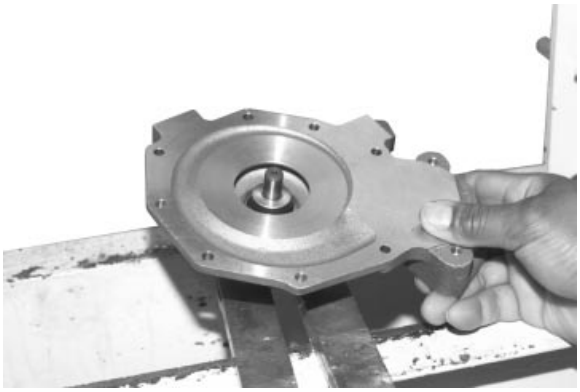
6. Using installation tool provided in D01045AA Driver Set, install seal (dry) onto water pump shaft and into housing until it is firmly seated.



Installing Bearing and Snap Ring



Installing Shaft Assembly



Installing Seal Into Housing

A—Bearing
B—Shaft
C—Snap Ring
D—JDG956 Water Pump Bearing Installer

Continued on next page

RG,25,JW7554 –19–20NOV97–1/3

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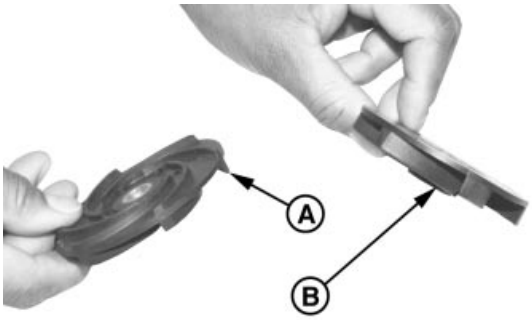
NOTE: Water pumps are available with two different types of impellers to ensure adequate coolant flow for a given engine application. Fins can be present on both sides of impeller (A) or on just one side of impeller (B). Be sure to replace impeller with the same type of impeller to ensure proper engine cooling.

7. Support front nose of water pump shaft.



RG7932 –UN–

Checking Impeller Type

RG,25,JW7554 –19–20NOV97–2/3

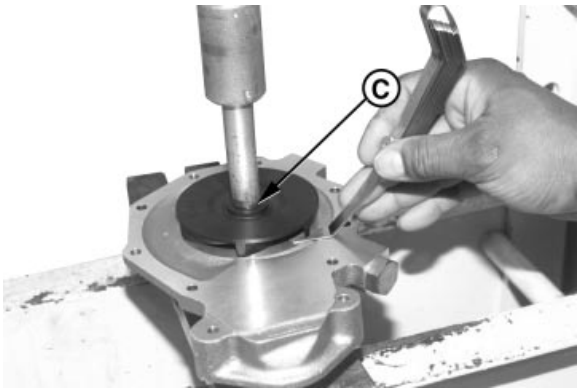
IMPORTANT: When installing impeller, press only on brass bushing (C) as impeller could crack.

8. Using an appropriate driver, install impeller onto shaft to the specified dimension below.

Water Pump—Specification

Impeller (with fins on both sides)-to-End of Shaft	2.46—2.58 mm (0.096—0.102 in.) below end of shaft
Impeller (with fins on one side)-to-End of Shaft	Flush ± 0.13 mm (0.005 in.) with end of shaft
Minimum Clearance between Housing and Impeller	0.27 mm (0.010 in.)

9. Rotate impeller complete revolution by hand and check with feeler gauge for impeller-to-housing clearance.



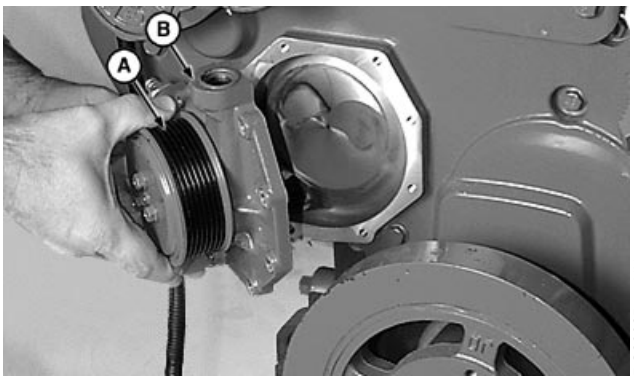
RG7931 –UN–

Pressing Impeller

RG,25,JW7554 –19–20NOV97–3/3

INSTALL WATER PUMP

1. Install pulley (A) onto water pump (B). Tighten cap screws to 16 N•m (12 lb-ft).
2. Clean gasket surfaces. Using a new gasket, install water pump onto timing gear cover. Tighten cap screws to 16 N•m (12 lb-ft).



Installing Pulley onto Pump

RG,25,JW7553 –19–20NOV97–1/2

3. Using a new O-ring, install water pump inlet elbow (C), if removed. Tighten cap screws to 35 N•m (26 lb-ft).
4. Install poly-vee belts. Be sure that belt is correctly seated in all pulley grooves.

Poly-Vee Belt—Specification

Spring Tension ..... 18—22 N•m (13—16 lb-ft)

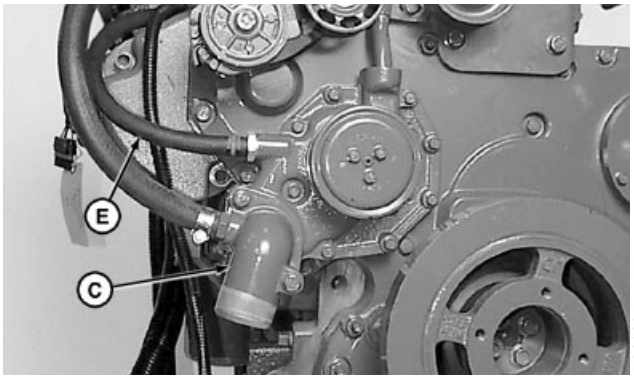
5. Install fan and tighten cap screws with lock washers to the following specification:

Cap Screw Fan-to-Pully Hub—Specification

Torque (M8)..... 35 N•m (26 lb-ft)
Torque (M10)..... 70 N•m (52 lb-ft)

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

6. Fill cooling system with proper coolant. (See Fuels, Lubricants, and Coolant—Group 02.)



Installing Water Pump Inlet Elbow

RG,25,JW7553 –19–20NOV97–2/2

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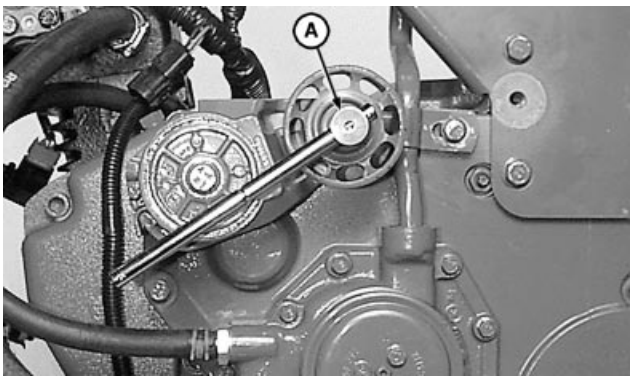
REMOVE AND INSTALL AUTOMATIC (SPRING) BELT TENSIONER

NOTE: Belt tensioner cap screw (A) is left-hand threaded.

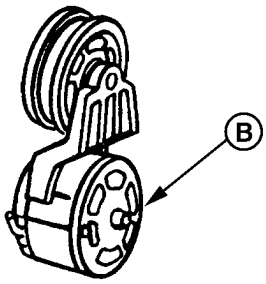
1. Release tension on belts using a breaker bar and socket.
2. Remove poly-vee belts from pulleys.
3. Remove belt tensioner.



Belt Tensioner Cap Screw

RG,25,JW7552 –19–20NOV97–1/2

4. Inspect sheave (B).
5. Install belt tensioner and tighten cap screws to 50 N•m (37 lb-ft).
6. Install poly-vee belts. Be sure that belt is correctly seated in all pulley grooves.



Inspect Sheave

RG,25,JW7552 –19–20NOV97–2/2

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.

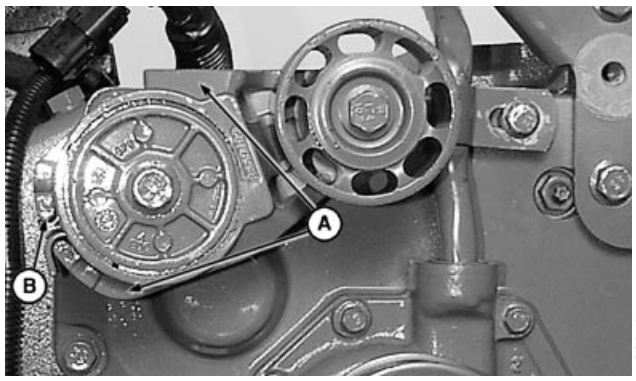
Continued on next page

RG,25,JW7551 –19–20NOV97–1/3

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 is used.

1. Visually inspect cast stops (A and B) on belt tensioner assembly.
2. If the tensioner stop on swing arm (A) is hitting the fixed stop (B), check mounting brackets (alternator, belt tensioner, etc.) and the belt length. Replace belt as needed.



Checking Spring Tensioner

RG,25,JW7551 –19–20NOV97–2/3

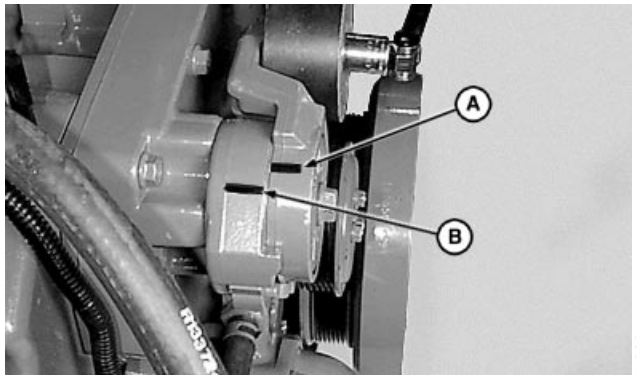
CHECKING TENSIONER SPRING TENSION

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:

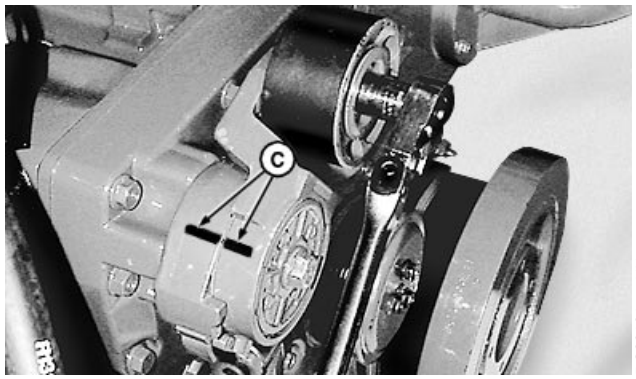
1. Release tension on belt using a breaker bar and socket on tension arm. Remove belt from pulleys.
2. Release tension on tension arm and remove breaker bar.
3. Put a mark (A) on swing arm of tensioner as shown.
4. Measure 21 mm (0.83 in.) from (A) and put a mark (B) on tensioner mounting base.
5. Rotate the swing arm using a torque wrench until marks (A and B) are aligned (C).
6. Record torque wrench measurement and compare with specification below. Replace tensioner assembly as required.

Tensioner—Specification

Spring Tension ..... 18—22 N•m (13—16 lb-ft)



Marking Belt Tensioner



Aligning Belt Tensioner Marks

RG,25,JW7551 –19–20NOV97–3/3

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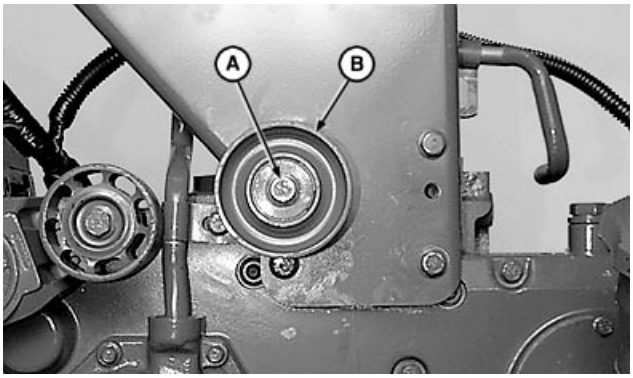
REMOVE AND INSPECT IDLER PULLEY ASSEMBLY

1. Release tension on belt and remove poly-vee belt from pulleys.

RG,25,JW7549 –19–20NOV97–1/2

2. Remove idler pulley cap screw (A) and remove pulley (B).

3. Inspect pulley and check bearing for play.



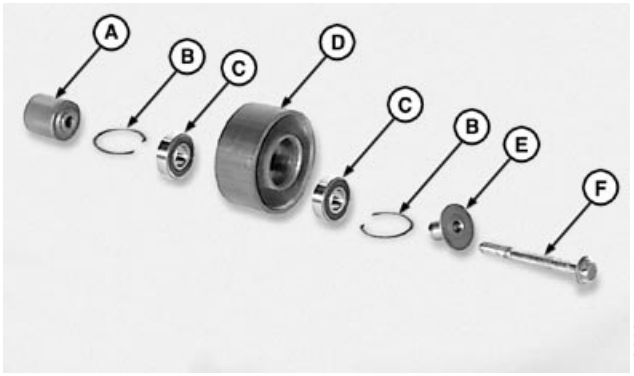
RG8905A –UN–

Idler Pulley Assembly

RG,25,JW7549 –19–20NOV97–2/2

REPLACE BEARING IN IDLER PULLEY ASSEMBLY

1. Remove snap rings (C) from both sides of pulley.
2. Support sides of idler pulley (A) and press both bearings out of hub.
3. Thoroughly clean and inspect pulley hub for cracks or any other damage.
4. Replace bearings as necessary.
5. Install bearings in hub.
6. Install snap rings.



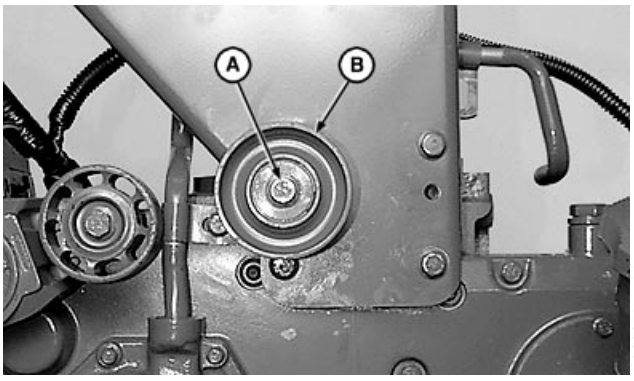
Idler Pulley Parts

A—Idler Pulley
B—Sealed Bearing (2 used)
C—Snap Ring (2 used)
D—Front Spacer
E—Cap Screw

RG,25,LG108 –19–16DEC97–1/1

INSTALL IDLER PULLEY ASSEMBLY

1. Install idler pulley assembly (B) and tighten cap screw (A) to 80 N•m (60 lb-ft).
2. Install poly-vee belt. Be sure that belt is correctly seated in all pulley grooves.



Idler Pulley Assembly

RG,25,JW7547 –19–20NOV97–1/1

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REMOVE AND INSTALL COOLANT HEATER

CAUTION: To avoid shock or hazardous operation, always use a three-wire heavy-duty electrical cord equipped with three-wire connectors. If a two-to-three contact adapter is used at the wall receptacle, always connect green wire to a good ground. Keep electrical connectors clean to prevent arcing. Only plug coolant heater into electrical power if heating element is immersed in coolant. Sheath could burst and result in personal injury.

TS210 –UN–

Avoid Shock or Hazardous Operation

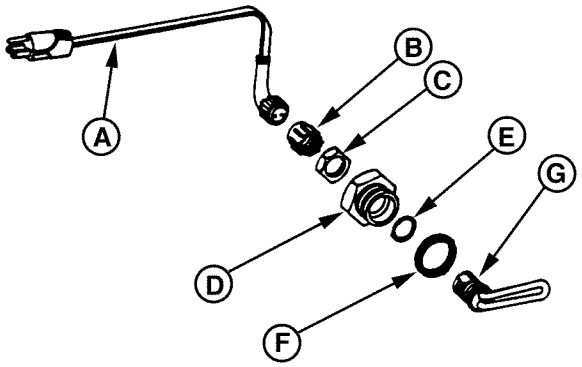
1. Unplug heater from electrical power source.
2. Drain cooling system.
3. Remove electrical cord, loosen nut, and pull heater element out of block.

NOTE: The heater element (G) cannot be repaired. If defective, replace it.

4. Assemble coolant heater (110 volt or 220 volt) as shown in illustration.
5. Place heater element in block so flats on the threaded part of the element are vertical. The element must not touch the internal walls of the block.

NOTE: If heater has been ordered as an attachment only, it will include a dust cover (B). The cover is used to protect the electrical connectors when cord assembly (A) has been removed.

6. Tighten retaining nut (C) to 34 N•m (25 lb-ft).
7. Install cord.



RG5619 –UN–

Coolant Heater Parts

A—Cord
B—Dust Cap
C—Retaining Nut
D—Adapter
E—Gasket
F—O-Ring
G—Heater Element

RG,25,JW7546 –19–20NOV97–1/1

OTHER MATERIAL

Number	Name	Use
PT569 (U.S.)	NEVER-SEEZ® Compound	Turbine housing-to-center housing cap screws and exhaust manifold-to-cylinder head cap screws.

NEVER-SEEZ is a trademark of Emhart Chemical Group.

RG,30,JW7565 –19–20NOV97–1/1

AIR INTAKE AND EXHAUST SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION
Intake Manifold Pressure (Turbocharger Boost)	See Group 110.
Exhaust Adapter, Minimum End Play	0.8—1.6 mm (0.03—0.06 in.)
Turbocharger:	
Radial Bearing Clearance (Maximum)	0.08—0.18 mm (0.003—0.007 in.)
Axial Bearing End Play (Maximum)	0.0130—0.089 mm (0.0005—0.0035 in.)
Wastegate Actuator Rod End Play	0.05—0.56 mm (0.002—0.022 in.)
Wastegate Actuator Adjustment	0.38 mm (0.015 in.)

TORQUES

Turbocharger-to-Exhaust Manifold	70 N•m (52 lb-ft)
Turbocharger Heat Shield Cap Screws	6 N•m (4 lb-ft)
Intake Manifold Cap Screws	48 N•m (35 lb-ft)
Wastegate Actuator Mounting Nuts	6 N•m (50 lb-ft)
Exhaust Adapter-to-Exhaust Manifold	47 N•m (35 lb-ft)
Exhaust Manifold-to-Cylinder Head	39—55 N•m (29—41 lb-ft)[a]
Exhaust Elbow-to-Exhaust Manifold	47 N•m (35 lb-ft)
Oil Inlet Line-to-Turbocharger	27 N•m (20 lb-ft)
Oil Return Line-to-Turbocharger	24 N•m (18 lb-ft)
Turbine Housing-to-Center Housing:	
Initial	10 N•m (7 lb-ft)
Final	17 N•m (13 lb-ft)
Compressor Housing-to-Center Housing:	
Initial	10 N•m (7 lb-ft)
Final	17 N•m (13 lb-ft)

[a]Tighten cap screws on cylinders No. 3 and No. 4 first.

RG,30,JW7584 –19–11FEB98–1/1

EXTENDING TURBOCHARGER LIFE

Turbochargers are designed to last the life of the engine, but, because they operate at such high speeds (100,000 rpm or more); a moment's carelessness can cause them to fail in seconds.

The major causes of turbocharger failures are attributed to:

- Lack of lube oil (quick starts and hot shutdowns)
- Oil contamination
- Ingestion of foreign objects
- Restricted oil drainage
- Low oil level
- Operation on excessive side slopes
- Abnormally high exhaust temperatures

LACK OF LUBE OIL

Oil not only lubricates the turbocharger's spinning shaft and bearings, it also carries away heat. When oil flow stops or is reduced, heat is immediately transferred from the hot turbine wheel to the bearings, which are also heating up because of the increase 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 possible bearing damage. It can also cause carbon and varnish deposits to form.

OIL CONTAMINATION

A second cause of turbocharger failures is contaminated oil. It can be caused by a worn or damaged oil filter or not changing the lube oil at recommended intervals. Expecting the oil filter to remove dirt, sand, metal chips, etc. from the oil before they reach the engine or turbocharger can be a costly mistake because contaminated oil may completely bypass the engine oil filter if the oil filter or oil cooler is clogged, if the filter element is improperly installed, or if the oil is thick during cold weather.

Four good ways of avoiding oil contamination are:

- Always inspect the engine thoroughly during major overhaul. Look especially for any sludge or debris left in lube oil galleries.
- Change lube oil at recommended intervals. Analysis of oil samples at filter change periods can help identify potentially harmful contaminants in the oil.
- Clean the area around the oil fill cap before adding oil.
- Use a clean container when adding oil.

Continued on next page

INGESTION OF FOREIGN OBJECTS

The third cause of turbocharger damage is the ingestion of foreign objects. Foreign objects or particles can be ingested and cause damage to the turbocharger on both compressor and turbine sides. This is easy to avoid.

On the compressor side, foreign objects usually take the form of dust, sand or shreds of air cleaner element that enter through improperly installed air cleaner elements. Leaky air inlet piping (loose clamps or torn rubber joints) or torn pleats in dry-type air cleaner elements also create problems.

The result is erosion of compressor blades that can cause the delicately balanced wheel to wobble.

IMPORTANT: Whenever an internal engine failure (valve, valve seat, piston) occurs, a thorough inspection of the turbocharger MUST BE performed before returning engine to service.

RESTRICTED OIL DRAINAGE

A fourth cause of turbocharger damage is restricted lube oil drainage. The lubricating oil carries away heat generated by friction of the bearings and from the hot exhaust gases. If drainage back to the sump is impeded, the bearings will overheat with damage that will ultimately lead to failure.

There are two primary reasons for restricted drainage. A blocked drain tube, due to either damage or a buildup of sludged oil or high crankcase pressure which can be due to restricted crankcase breather or excessive engine blowby.

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.

Over-temperature on a natural gas engine can result from a rich air/fuel mixture, overpowering the engine, or restricted air flow. With a rich air/fuel mixture or restricted air flow, the engine is burning more fuel than necessary to produce the desired power level. The excess energy exits through the exhaust system in the form of heat.

6068 Natural gas engines are lean-burn engines, so more air than necessary is available for combustion. Higher efficiency and lower exhaust temperature will result with a leaner air/fuel mixture. The turbocharger center housing on natural gas engines is water-cooled to protect the turbocharger bearings from extreme exhaust temperatures.

If over-temperature operation is identified, check air inlet and exhaust systems, coolant lines, engine load, air/fuel adjustment, and ignition timing.

RG,30,DT7229 –19–11FEB98–2/2

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REMOVE TURBOCHARGER

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

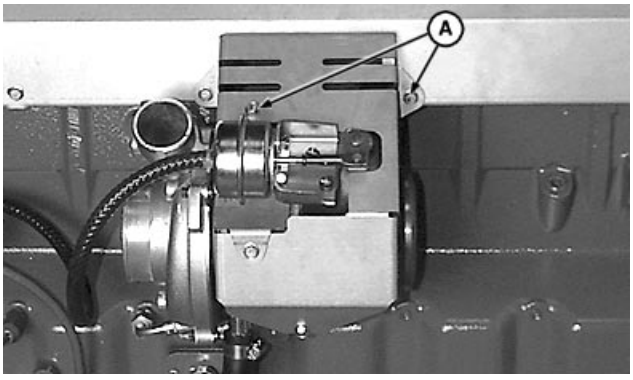
Thoroughly clean exterior of turbocharger and surrounding area to prevent entry of dirt into the air intake system during removal.

IMPORTANT: When cleaning turbocharger, do not spray directly into compressor cover or turbine housing. If turbocharger inspection is required, do not clean exterior prior to removal. Doing so may wash away evidence of a potential failure mode. (See TURBOCHARGER SEVEN-STEP INSPECTION later in this group.)

1. Disconnect air intake hose and exhaust piping from turbocharger.

RG,30,JW7582 –19–20NOV97–1/3

2. Remove heat shield cap screws (A). Remove heat shield.



Remove Heat Shield

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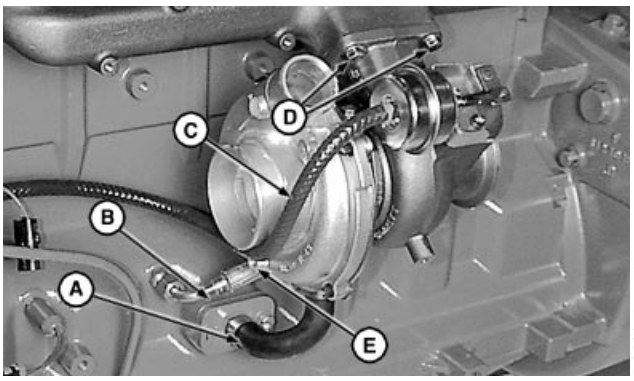
RG,30,JW7582 –19–20NOV97–2/3

3. Disconnect turbocharger oil inlet line (B).
4. Disconnect turbocharger oil return (drain) line (A).
5. Disconnect hose (E) from PCV orifice fitting.
6. Disconnect turbocharger wastegate diaphragm hose (C).
7. Remove turbocharger mounting cap screws (D) securing turbocharger to exhaust manifold. Remove turbocharger. Remove stainless steel gasket.
8. Place turbocharger on a clean flat surface. Cap or plug all air intake and exhaust openings.
9. Perform turbocharger seven-step inspection as described later, if failure mode has not yet been determined. See TURBOCHARGER SEVEN-STEP INSPECTION later in this group.



Removing Turbocharger

A—Oil Return Line
B—Oil Inlet Line
C—Hose
D—Cap Screw (4 used)
E—Hose

RG,30,JW7582 –19–20NOV97–3/3

TURBOCHARGER FAILURE ANALYSIS

The following is a guide for diagnosing the cause of turbocharger failures after removal from the engine.

Continued on next page

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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.
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 clean oil drain line as required.
	Leaking air intake system.	Correct as required (this group).
Oil and/or Excessive Carbon	Internal engine failure.	Verified by oil in turbine housing. Correct as required.
	Turbine seal failure.	Inspect for excessive heat from overfueling and/or restricted air intake.
	Prolonged periods of low RPM engine idling.	Verify with operator to run engine under load or a higher RPM. (Operator's Manual).
	Restricted oil drain line.	Inspect and clear oil drain line as required.

Continued on next page

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TURBINE HOUSING INLET DEFECTS		
Oil in Housing	Internal engine failure.	Inspect and repair engine as required.
	Oil leaking from compressor housing seal.	Verify that oil is in compressor housing and refer to "Compressor Housing Outlet Defects" as listed earlier in this chart.
Center Wall Deteriorated	Excessive operating temperature.	Check for restricted air intake. Check engine for overfueling.
		Check ignition.
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.
	Object left in intake system.	Disassemble and inspect air intake system.
	Leaking air intake system.	Correct as required (this group).
Oil and/or Excessive Carbon	Internal engine failure.	Verified by oil in turbine housing. Correct as required.
	Turbine seal failure.	Inspect for excessive heat from overfueling and/or restricted air intake.
	Prolonged periods of low RPM engine idling.	Verify with operator to run engine under load or a higher RPM. (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 that leaks are not occurring at gasket joints.
Leaks from Joints	Loose attaching screws.	Tighten to specifications in CTM (this group).
	Defective gasket.	Inspect and repair as required.

Continued on next page

INTERNAL CENTER HOUSING DEFECTS

Excessive Carbon Build up in Housing or on Shaft	Hot engine shut-down.	Review proper operation with operator as shown in the Operator's manual.
	Excessive operating temperature.	Restricted air intake, air/fuel mixture too rich, overfueling, or mistimed engine.
	Restricted oil drain line.	Inspect and clean oil drain lines as required.
	Operating engine at high speeds & loads immediately after start-up	Idle engine for a few minutes to allow oil to reach bearings before applying heavy loads.

RG,30,DT7244 –19–04NOV97–4/4

TURBOCHARGER SEVEN-STEP INSPECTION

The following inspection procedure is recommended for systematic failure analysis of a suspected failed turbocharger. This procedure will help to identify when a turbocharger has failed, and why it has failed so the primary cause of the failure can be corrected.

Proper diagnosis of a non-failed turbocharger is important for two reasons. First, identification of a non-failed turbocharger will lead to further investigation and repair of the cause of a performance complaint.

Second, proper diagnosis eliminates the unnecessary expense incurred when a non-failed turbocharger is replaced.

The seven recommended inspection steps, which are explained in detail on the following pages, are:

- Compressor Housing Inlet and Compressor Wheel.
- Compressor Housing Outlet.
- Turbine Housing Inlet.
- Turbine Housing Outlet and Turbine Wheel.
- External Center Housing and Joints.
- Internal Center Housing.
- Turbocharger Bench Test.

Continued on next page

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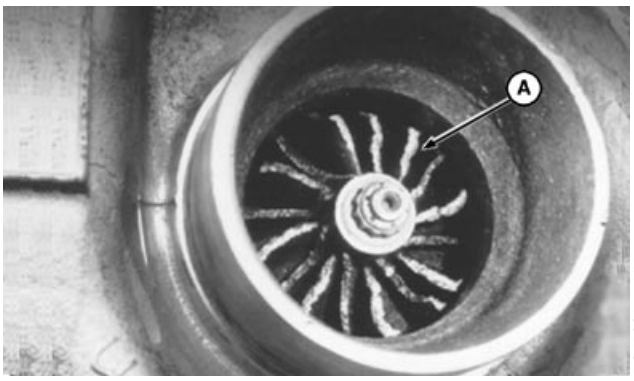
NOTE: To enhance the turbocharger inspection, an inspection sheet (Form No. DF-2280 available from Distribution Service Center) can be used that lists the inspection steps in the proper order and shows potential failure modes for each step. Check off each step as you complete the inspection and record any details or problems obtained during inspection. Retain this with the work order for future reference.

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 damages.

2. Mark findings on your checklist and continue the inspection.



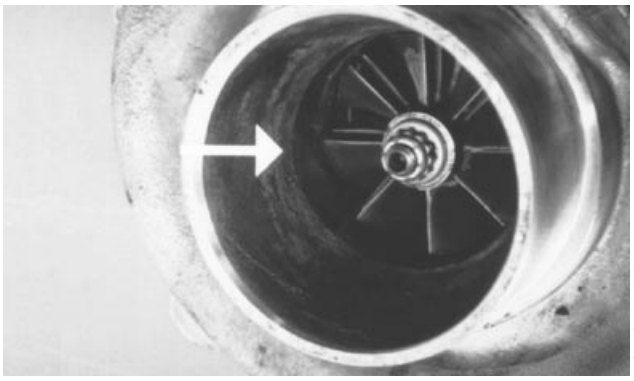
RG4523A –UN–

Check Compressor Housing Inlet and Wheel

RG,30,DT7238 –19–04NOV97–2/13

NOTE: You will need a good light source for this check.

3. Check compressor inlet for wheel rub on the housing (arrow). Look very closely for any score marks on the housing itself and check the tips of the compressor wheel blades for damage.



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Check Compressor Inlet

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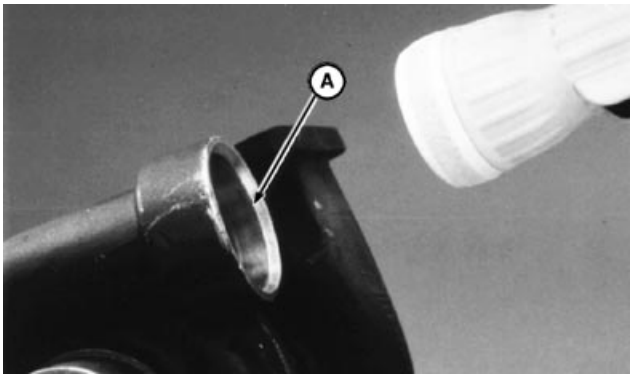
COMPRESSOR HOUSING OUTLET

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.



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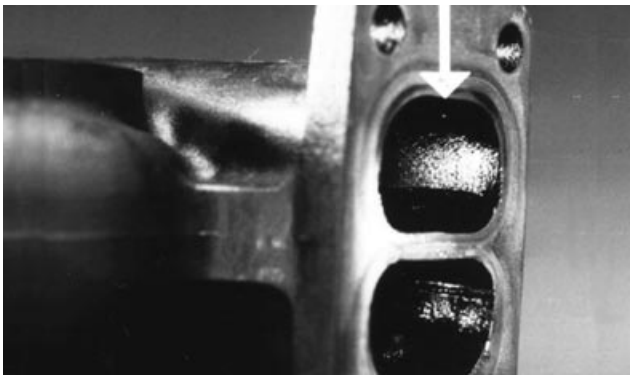
Check Compressor Housing Outlet

RG,30,DT7238 –19–04NOV97–4/13

TURBINE HOUSING INLET

Check the turbine housing inlet ports (arrow) for oil in housing, excessive carbon deposit or erosion of center walls.

NOTE: If the inlet is wet with oil, or has excessive carbon deposits, an engine problem is likely. Center wall erosion (cracking or missing pieces), indicate excessive exhaust temperature.



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Check Turbine Housing Inlet Ports

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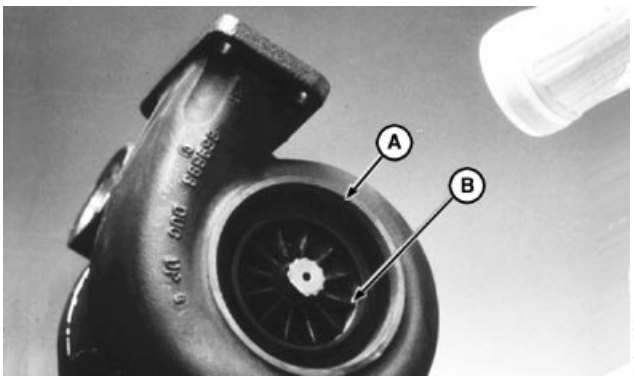
RG,30,DT7238 –19–04NOV97–5/13

TURBINE HOUSING OUTLET AND TURBINE WHEEL

1. Use a flashlight to look up inside the turbine housing outlet (A) and check blades (B) for foreign object damage.



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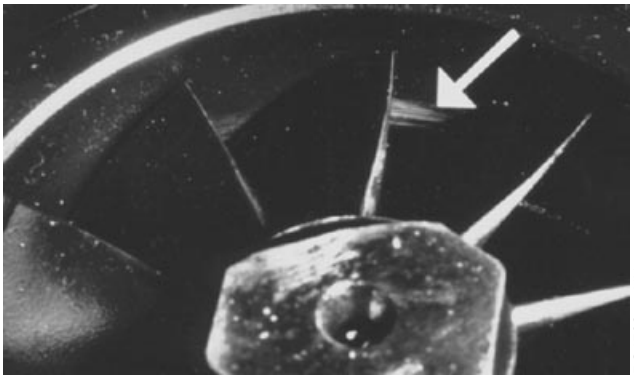
Check Turbine Housing Outlet and Blades

RG,30,DT7238 –19–04NOV97–6/13

2. Inspect the wheel blades and housing for evidence of wheel rub (arrow). Wheel rub can bend the tips of the blades with the housing showing wear or damage.



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Inspect Blades and Housing for Wheel Rub

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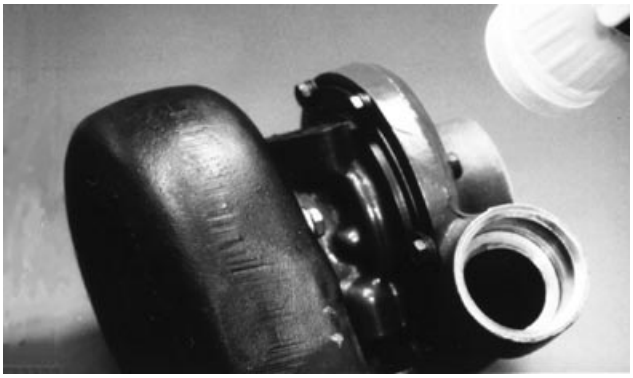
EXTERNAL CENTER HOUSING AND JOINTS

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.

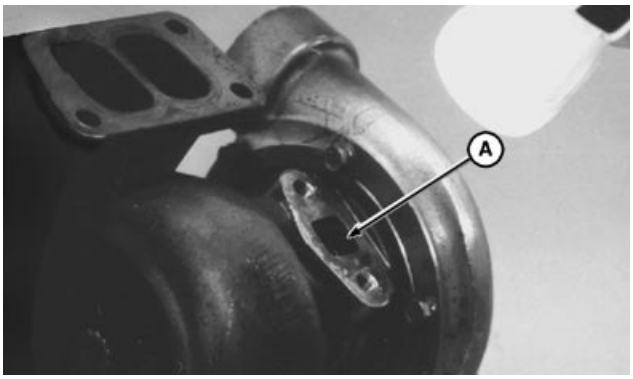


Visually Check Outside Center Housing

RG,30,DT7238 –19–04NOV97–8/13

INTERNAL CENTER HOUSING

1. Using a flashlight, look through the oil return hole (A), to check the condition of the shaft and/or bearings. There should not be excess carbon deposits on the shaft or in the housing.



Check Oil Return Hole, Shaft & Bearings

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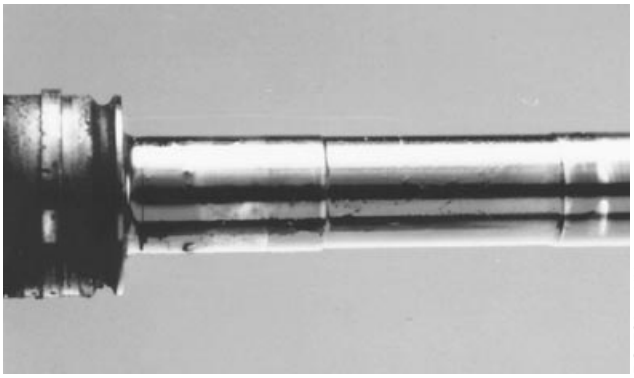
RG,30,DT7238 –19–04NOV97–9/13

2. Excessive “blueing” or “coking” of oil along the complete length of the shaft (A) indicates a possible lack of lubrication caused by an engine failure, or improper operation, such as hot shutdowns.



Check for Oil “Coking” on Shaft

RG,30,DT7238 –19–04NOV97–10/13

TURBOCHARGER BENCH TEST

1. Mount the turbocharger in a vise.

2. Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely, however, there may be a slight amount of drag.

Check Shaft Rotation and Clearance

Continued on next page

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3. Next, pull up on the compressor end of the shaft and press down on the turbine end while rotating shaft. Neither the compressor wheel nor the turbine wheel should contact the housing at any point.

NOTE: There will be some "play" because the bearings inside the center housing are free floating.

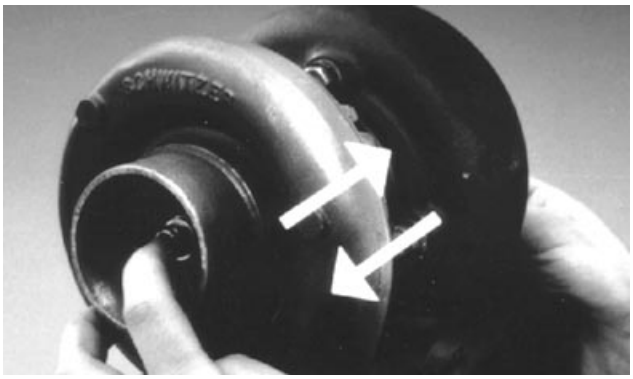
Check Clearance Between Housing and Wheels

RG,30,DT7238 –19–04NOV97–12/13

4. Next, check shaft end play by moving the shaft back and forth while rotating. There will be some endplay but not to the extent that the wheels contact the housings.

IMPORTANT: Before you finalize your conclusion that the turbocharger has not failed, it is strongly recommended that the following procedure of checking axial bearing end play with a dial indicator be performed. This procedure is not required if a failure mode has already been identified.

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.



Check Shaft End Play

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PERFORM AXIAL BEARING END PLAY TEST

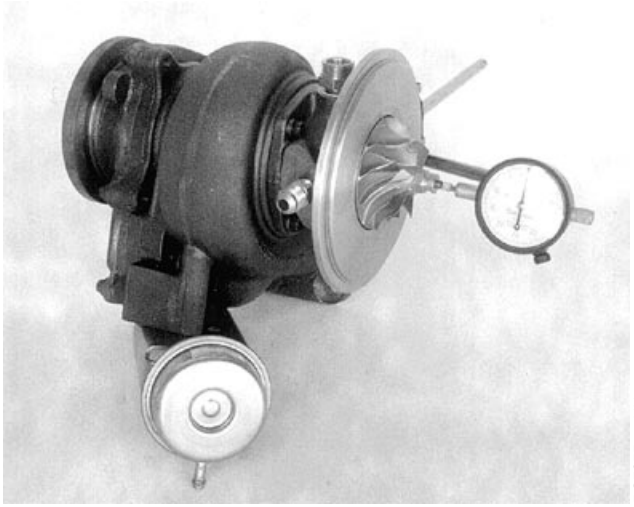
This test will give an indication of the condition of the thrust bearing within the center housing and rotating assembly.

1. Remove compressor housing cover, as shown.
2. Mount magnetic base dial indicator so indicator tip rests on end of the rotating shaft on the compressor side. Preload indicator tip and zero dial on indicator.
3. Move shaft axially back and forth by hand.
4. Observe and record total dial indicator movement.

Garret GT35 Turbocharger Shaft—Specification

Axial End Play	0.0130—0.089 mm (0.0005—0.0035 in.)

If bearing end play is not within specifications, install a replacement turbocharger.



Perform Axial Bearing End Play Test

RG,30,DT7237 –19–11FEB98–1/1

REPAIR TURBOCHARGER

Turbochargers used on the engine 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

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CLEAN AND INSPECT TURBINE AND COMPRESSOR HOUSINGS

1. Thoroughly clean compressor housing (D) and turbine housing (A) using a commercially approved solvent only. Caustic solutions may damage housings. Dry housings with compressed air after cleaning. After a part is cleaned, place it on a clean flat surface and inspect as outlined below.

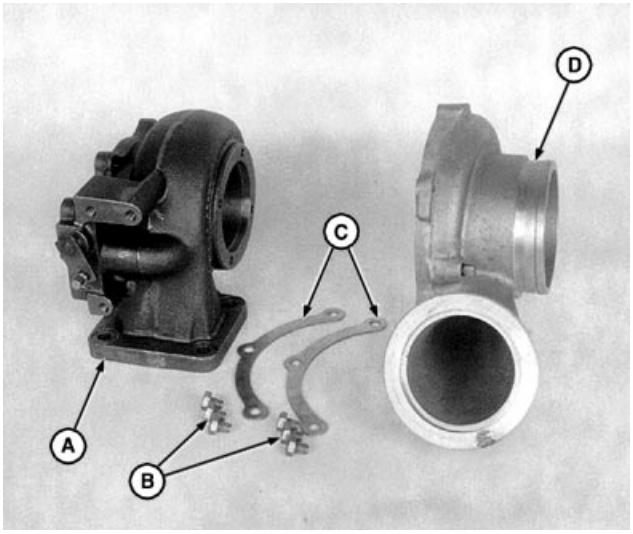
   - Inspect turbine housing for:
     - Wheel rub damage within the contour area that cannot be polished out with 60-grit silicon carbide abrasive cloth.
     - Nicks, dents or warpage that could prevent proper sealing between the turbine housing and center housing.
     - Corroded or stripped threaded mounting holes.

   - Inspect compressor housing for:
     - Wheel rub damage within the contour area that cannot be polished out with 80-grit silicon carbide abrasive cloth.
     - Nicks, dents, or warpage that could prevent proper sealing between the compressor housing and center housing
     - Corroded or stripped threaded mounting holes.

NOTE: Use new mounting cap screws when turbocharger is reassembled.

2. Clean all threads in housings with a tap.

3. Replace turbocharger if any of the above defects is found.



Inspect Turbine & Compressor Housing

A—Turbine Housing
B—Cap Screw (6 used)
C—Clamp Plate (2 used)
D—Compressor Housing

RG,30,DT7235 –19–04NOV97–1/1

ADJUST TURBOCHARGER WASTEGATE ACTUATOR

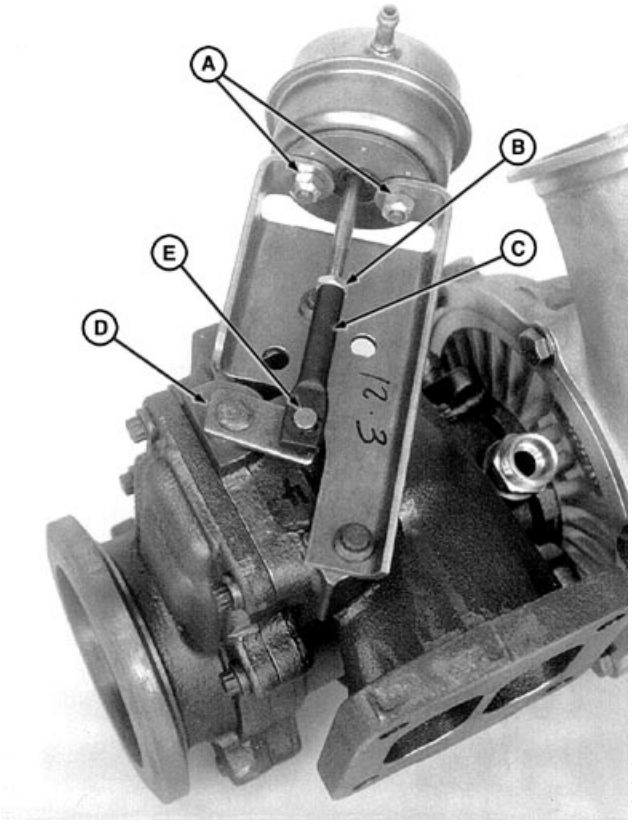
1. Tighten actuator mounting nuts (A) to 6 N•m (50 lb-in.).
2. Install jam nut (B) and rod end (C) onto threaded portion of actuator rod.
3. Disconnect hose to actuator and pressurize actuator to 12 psi and hold at this calibration pressure.
4. Push bypass lever (D) as far as possible toward the actuator 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.

5. Turn rod end (C) in either direction until rod end eye can just be slipped over bypass lever pin. Loosen rod end an additional half turn, install onto pin and secure with retainer clip (E). Release pressure on actuator.
6. Pressurize the actuator to 12 psi. 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 0.05—0.56 mm (0.002—0.022 in.). If necessary to adjust, set end play to 0.38 mm (0.015 in.).

NOTE: If unable to adjust, replace wastegate actuator.

7. Vary the pressure from 9 psi to 12 psi a few times to verify smooth and free operation of the bypass assembly.
8. Attach hose to actuator and secure with hose clamp.



Adjust Turbocharger Wastegate Actuator

RG,30,DT7234 –19–04NOV97–1/1

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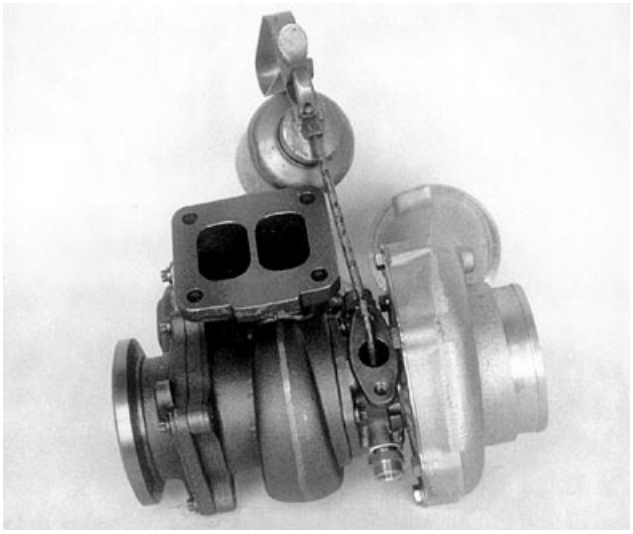
PRELUBE TURBOCHARGER

IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

Fill oil 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.



Prelube Turbocharger

RG,30,DT7233 –19–04NOV97–1/1

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.

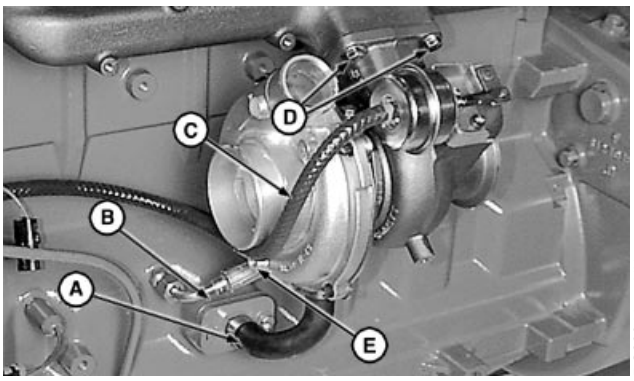
If not previously done, prime (prelube) turbocharger rotating assembly prior to installing turbocharger on engine. Prelube center housing with clean engine oil through oil return (drain) hole. Turn rotating assembly by hand to lubricate bearings.

NOTE: Two threaded guide studs may be used to hold turbocharger-to-exhaust manifold gasket in place and aid turbocharger installation.

1. Put a new gasket on turbocharger-to-exhaust manifold mounting surface (not shown). Position turbocharger against gasket.
2. Apply PT569 NEVER-SEEZ® Compound to all turbocharger mounting cap screws (D). Install cap screws and tighten to 24 N•m (18 lb-ft).

NOTE: Remove all caps or plugs from turbocharger openings.

3. Install turbocharger PCV hose (E) and oil return line (A).
4. Connect oil inlet line (B) and tighten securely.
5. Connect turbocharger diaphragm hose (C).



Installing Turbocharger

A—Oil Return Line
B—Oil Inlet Line
C—Hose
D—Cap Screw (4 used)
E—Hose

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

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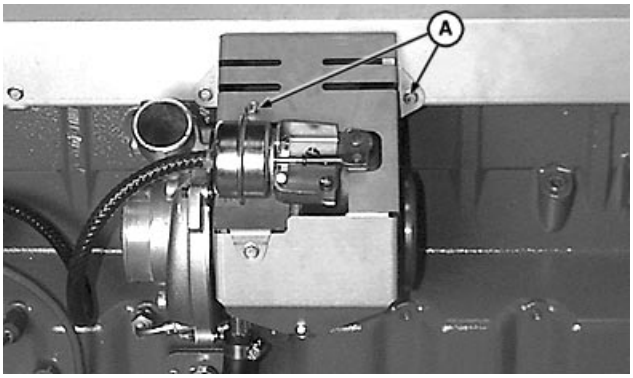
RG,30,DD112 –19–11FEB98–1/2

6. Install turbocharger heat shield. Install cap screws (A) and tighten to 6 N•m (4 lb-ft).

7. Refer to your vehicle technical manual to connect air intake and exhaust piping to turbocharger. Tighten all connections securely to specifications given.

IMPORTANT: BEFORE STARTING an engine with a new or remanufactured 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.



Installing Heat Shield

RG,30,DD112 –19–11FEB98–2/2

CLEANING PCV ORIFICE

IMPORTANT: Be sure air cleaner is not restricted.

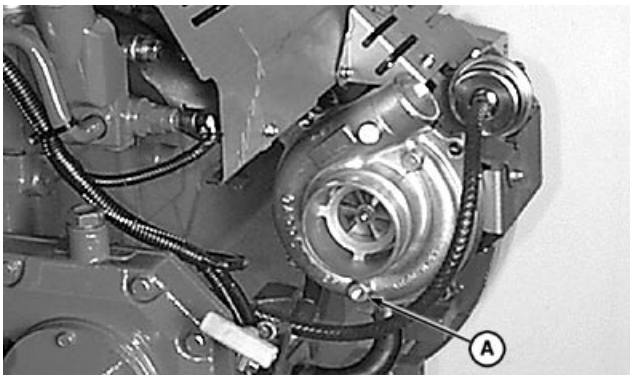
1. Remove turbocharger compressor housing-to-oil pan line.

NOTE: 0.040 in. orifice is in turbocharger compressor housing.

2. Inspect orifice (A).

3. Clean as necessary. Be careful not to enlarge hole or get foreign material in housing.

4. Install turbocharger compressor housing-to-oil pan line.

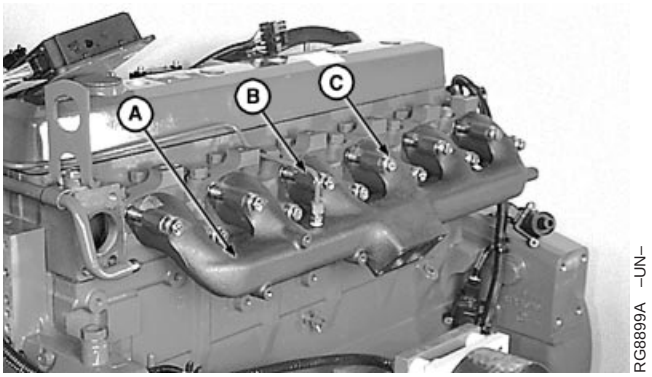


Inspect PCV Orifice

RG,30,LG112 –19–11FEB98–1/1

REMOVE, INSPECT, AND INSTALL EXHAUST MANIFOLD

1. Remove turbocharger from exhaust manifold. (See REMOVE TURBOCHARGER, earlier in this group.)
2. Disconnect exhaust back pressure (EBP) sensor line (B).
3. Remove cap screws (C) and remove exhaust manifold (A). Remove manifold gaskets and discard.
4. Remove all residue and gasket material from gasket surfaces.
5. Thoroughly clean passages in exhaust manifolds.
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 necessary.
7. To install exhaust manifold, reverse removal procedures and use new gaskets and sealing rings.
8. Tighten exhaust manifold mounting cap screws to 70 N•m (52 lb-ft).



Removing Exhaust Manifold

A—Exhaust Manifold
B—EBP Sensor Tube
C—Cap Screw (12 used)

RG,30,DD113 –19–11FEB98–1/1

30
22

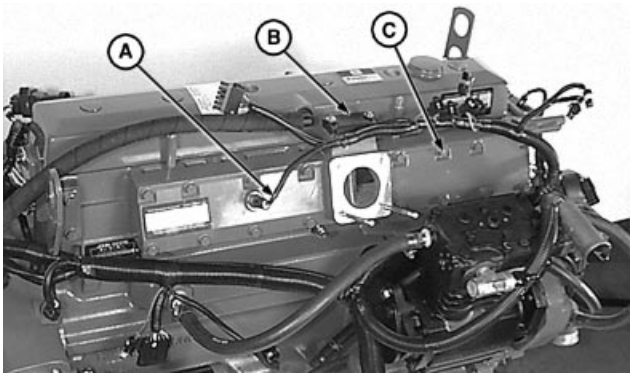
REMOVE, INSPECT, AND INSTALL INTAKE MANIFOLD

IMPORTANT: All intake manifold connections at the turbocharger and engine cylinder head must be tight to prevent loss of power resulting from insufficient intake manifold pressure.

Intake manifold 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.

1. Disconnect MAT temperature sensor wiring lead (A).
2. Disconnect MAP sensor wiring lead (B).
3. Remove throttle actuator assembly, shown removed.
4. Remove sixteen cap screws (C) and remove intake manifold from cylinder head. Remove and discard manifold gaskets.
5. Inspect intake manifold for serviceability. Replace if it is cracked or otherwise damaged.
6. Inspect 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 48 N•m (35 lb-ft).
9. Install exhaust manifold assembly and turbocharger as detailed earlier in this group.



Removing Intake Manifold

RG,30,DD114 –19–12JAN98–1/1

SPECIFICATIONS

TORQUES

Regulating Mounting Bracket Cap Screws	47 N•m (35 lb-ft)
Fuel Mixer-to-Intake Manifold Cap Screws	27 N•m (20 lb-ft)
Fuel Metering Block Inlet Line Fitting	34 N•m (25 lb-ft)
Fuel Inlet and Outlet Line Nuts-to-Regulator	14 N•m (10 lb-ft)
Fuel Metering Valve Inlet Elbow Cap Screws	30 N•m (22 lb-ft)
Fuel Metering Valve Mounting Cap Screws	17 N•m (12 lb-ft)

RG,198,DT7315 –19–11FEB98–1/1

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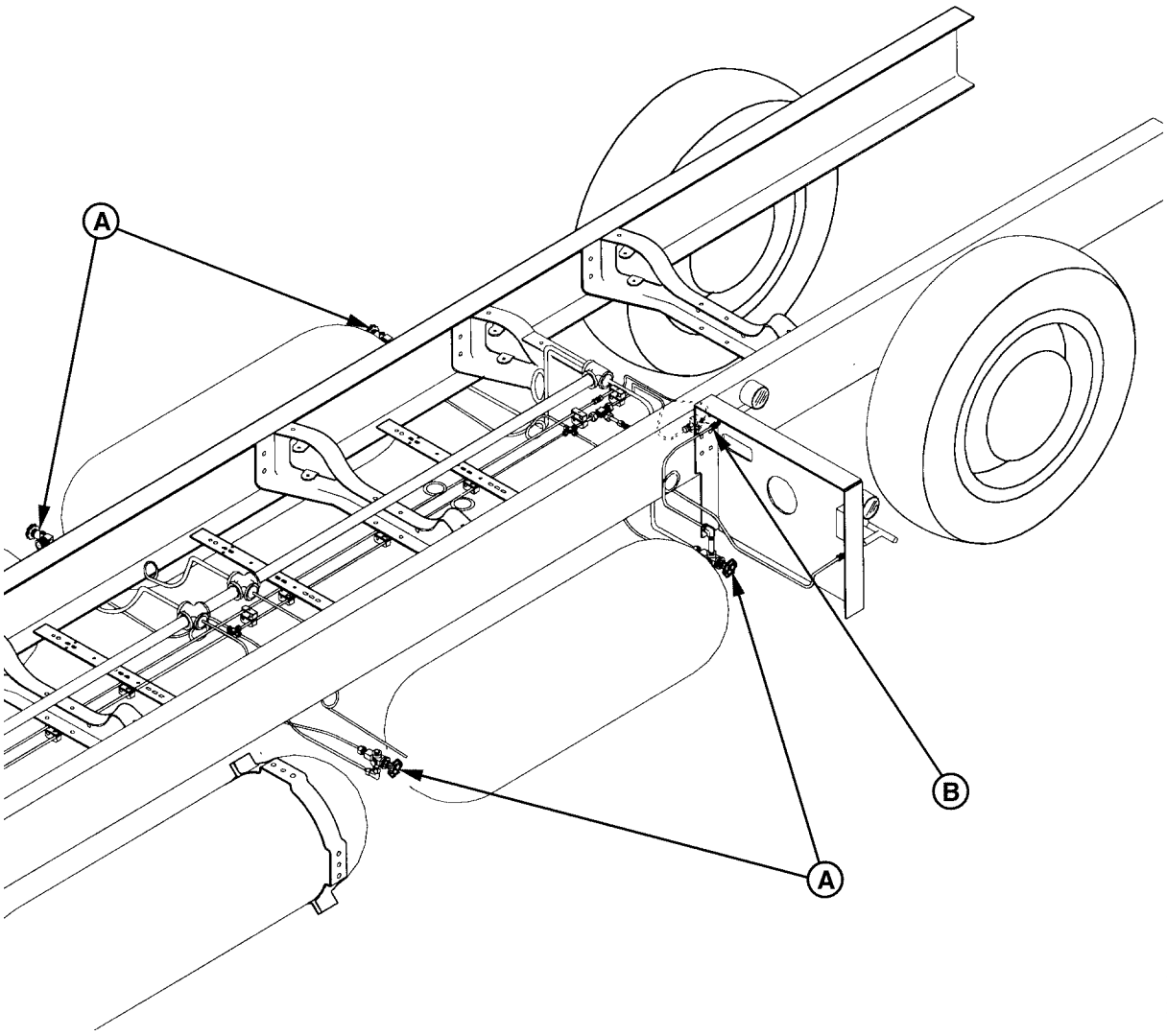
2

FUEL PRESSURE LEAK-OFF PROCEDURE



Fuel Valve Locations

IMPORTANT: Always relieve the natural gas pressure by closing each fuel cylinder manual shutoff valve (A). DO NOT relieve the natural gas pressure by closing the 1/4-turn valve (B).

NOTE: The illustration above is a typical application and does not show all of the shutoff valves. Refer to vehicle operator's manual to help locate all fuel cylinder shutoff valves.

The valve is closed when turned fully clockwise viewed from the top, and open when turned counterclockwise viewed from the top.

1. Close all fuel cylinder manual shutoff valves (A). Proceed to step 2 OR step 3

2. If the engine WILL start, let it run until it dies from running out of fuel. Make sure pressure is completely relieved by attempting to start engine several more times.

Continued on next page

RG,35,DT7247 –19–04NOV97–1/2

CAUTION: CNG is methane (natural gas) stored at high pressure. It spreads into air quickly.

Natural gas fumes can cause sickness or death. Always work in a well ventilated area.

Do not smoke when refueling or working on or around natural gas vehicles or equipment.

Keep natural gas vehicles away from sparks, flames, and electrical devices in operation, especially if you suspect a natural gas leak.

Improper installation, service, or operation of CNG storage and delivery components can result in fire, explosion, and/or serious injury.

Relieve CNG fuel system pressure before working on the system. Properly tighten connections and check for leaks before pressurizing the CNG fuel system.

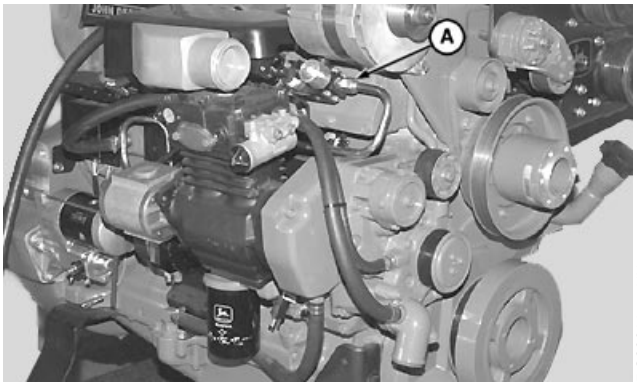
CNG fuel systems operate at high pressures. DO NOT disassemble or remove any CNG fuel system components under pressure. Explosive separation of components, and the escaping natural gas can cause serious injury.

Relieve CNG fuel system pressure before disconnecting any fuel system component.

Gas escaping from the CNG fuel system is very cold. Frostbite and skin damage can occur for contact with cold escaping gas or surrounding components.

Inspect for leaks by spraying a soap and water solution on joints, fittings, and other areas. Look for bubbles that indicate leakage from the system.

3. If the engine WILL NOT start and run, make sure the vehicle is outside, away from heat, flames, or sparks. Slowly loosen fuel metering block inlet fitting (A) just until escaping gas is heard. Let fuel escape until fuel pressure is completely relieved.



Loosen Fuel Fitting

A—Fuel Metering Block Inlet Fitting

RG,35,DT7247 –19–04NOV97–2/2

35
4

LEAK CHECK PROCEDURE

1. Open fuel cylinder manual shutoff valves.
2. Cycle the ignition to the “ON” position for 3—4 seconds, then back to the “OFF” position.
3. Use a non-ammonia soap solution or a commercial leak detector solution and wet all fuel lines and fittings. If bubbles form, the fuel line or fitting is leaking.
4. If a leak is detected, inspect all lines and fittings for damage. Check also for damaged or missing O-ring.
5. Repair and repeat procedure until no leaks are detected.

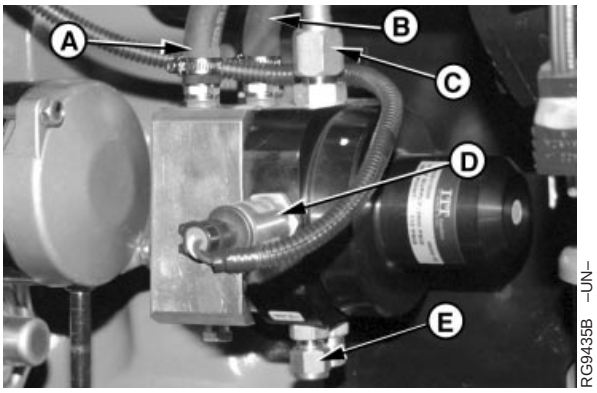
RG,35,DT7254 –19–04NOV97–1/1

REMOVE AND INSTALL NATURAL GAS REGULATOR

REMOVE REGULATOR

CAUTION: Natural gas is highly flammable. DO NOT smoke while working on or near natural gas equipment. Natural gas fumes may cause sickness or death. Work in well ventilated area and shut off natural gas supply and relieve internal regulator pressure before servicing equipment.

1. Close all fuel cylinder manual shutoff valves. Refer to vehicle operator’s manual for location of all fuel cylinder shutoff valves.
2. Start engine and run until engine stalls from running out of fuel. Make sure pressure is completely relieved by attempting to start engine several more times.
3. If vehicle will not start and run to relieve system pressure, make sure vehicle is outside, away from heat, flames, or sparks.



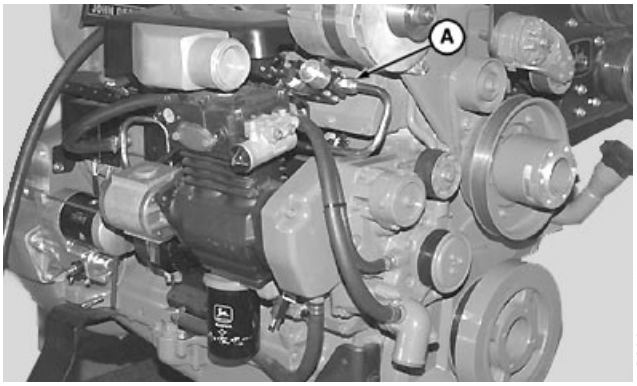
Natural Gas Regulator

A—Coolant Hose
B—Coolant Hose
C—Fuel Outlet Line
D—NGTB Sensor Wiring Harness
E—Fuel Inlet Line

Continued on next page

DPSG,OUOE003,181 –19–11FEB98–1/4

4. Slowly loosen fuel metering block inlet fitting (A) until escaping gas is heard.
5. Allow fuel to escape until fuel pressure is completely relieved.
6. Disconnect batteries.



Loosen Fuel Fitting

Continued on next page

DPSG,OUOE003,181 –19–11FEB98–2/4

7. Disconnect NGTP sensor wiring harness connector (D).

8. Disconnect natural gas fuel inlet line (E) and outlet line (C).

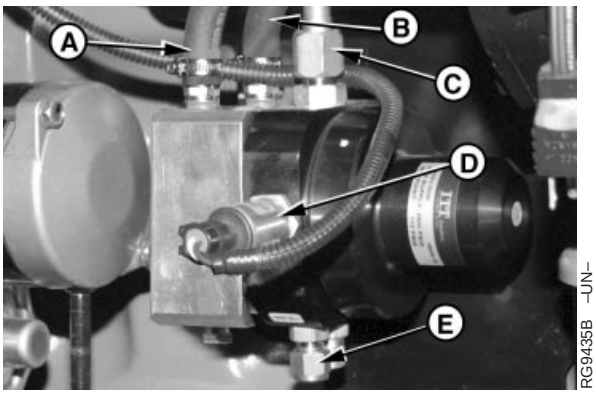
NOTE: Wrap jaws of vise grips with duct tape to protect coolant hoses from damage.

9. Pinch coolant hoses (A and B) with vise grips so coolant is not lost while hoses are disconnected.

10. Remove coolant hoses using lineman's pliers. Discard hose clamps.

11. Remove cap screws, washers, and spacers securing regulator support bracket to cylinder block. Lift off regulator.

12. Replace parts as necessary. Check screen in fuel inlet of regulator.



Remove Natural Gas Regulator

A—Coolant Hose
B—Coolant Hose
C—Fuel Outlet Line
D—NGTP Sensor Wiring Harness
E—Fuel Inlet Line

INSTALL REGULATOR

1. Reinstall parts as follows:

   a. Install regulator support bracket to cylinder block.

   b. Install cap screws and washers finger tight.

2. Install coolant hoses (A and B) to same connectors as when removed. Secure hoses with new clamps.

3. Remove vise grips from hoses and inspect hose O.D. for damage. Replace hose(s) as necessary.

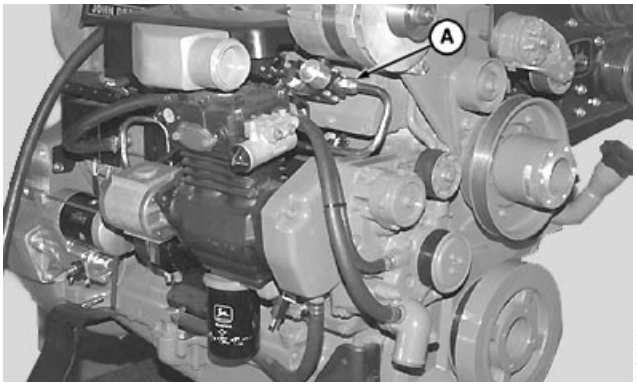
4. Connect NGTP sensor wiring harness connector (D).

5. Install fuel lines (C and E). Tighten to 14 N•m (10 lb-ft).

6. Tighten regulator mounting bracket-to-cylinder block cap screws to 47 N•m (35 lb-ft).

Continued on next page

7. Connect fuel metering block inlet fitting (A). Tighten connection to 34 N•m (25 lb-ft).
8. Secure clamp at middle of fuel line.
9. Double check that all gas and coolant connections are securely tightened.



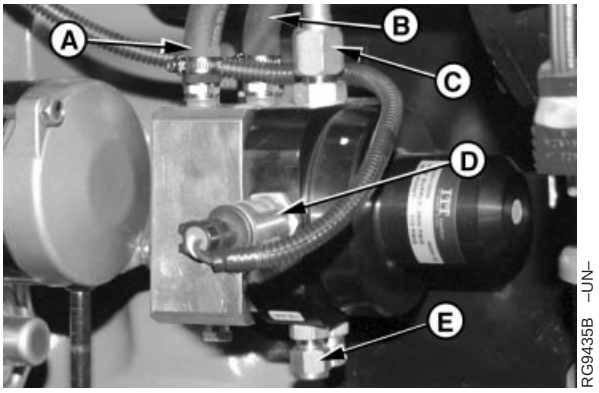
Install Natural Gas Regulator

DPSG,OUOE003,181 –19–11FEB98–4/4

REPAIR NATURAL GAS REGULATOR

IMPORTANT: Clean fuel inlet filter in regulator with dry compressed air if supply system has been contaminated. To do this, disconnect fuel inlet line (E) to access filter.

NOTE: No serviceable parts are available for the natural gas regulator. Replacement of natural gas regulator assembly is required for repair.



Repair Natural Gas Regulator

A—Coolant Hose
B—Coolant Hose
C—Fuel Outlet Line
D—NGTP Sensor Wiring Harness
E—Fuel Inlet Line

DPSG,OUOE003,182 –19–11FEB98–1/1

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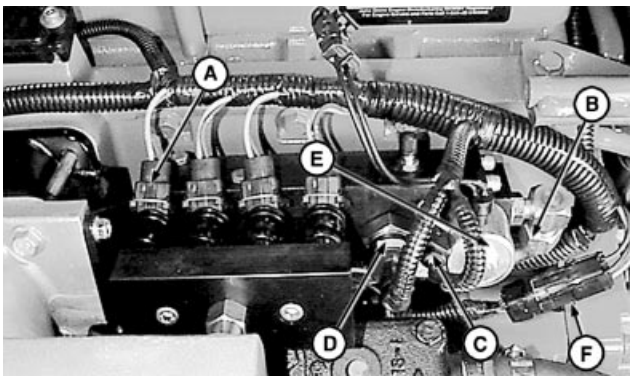
8

REMOVE AND INSTALL FUEL METERING VALVE

CAUTION: Natural gas is highly flammable. DO NOT smoke while working on or near natural gas equipment. Natural gas fumes may cause sickness or death. Work in well ventilated area and shut off natural gas supply and relieve pressure before servicing equipment.

1. Shut off natural gas supply. (See FUEL PRESSURE LEAK-OFF PROCEDURE in this group.)
2. Disconnect top four fuel injector wiring harness connectors (A) and 4-way sub-harness (F).
3. Disconnect fuel lockoff solenoid wiring harness connector (E).
4. Disconnect natural gas pressure (NGP) sensor wiring harness connector (D).
5. Disconnect natural gas temperature (NGT) sensor wiring harness connector (C).
6. Remove hose (B).
7. Remove the fuel metering valve-to-inlet manifold cap screw (located on the underside of metering valve).
8. Remove two nuts and two cap screws on inlet elbow. Remove elbow and metering valve as a unit.
9. Remove metering valve-to-inlet elbow cap screw.
10. Carefully separate metering valve from inlet elbow.
11. Inspect O-ring seal in inlet elbow before reassembly. Apply small amount of lubricant to O-ring.
12. Loosely assemble metering valve to elbow. Install elbow to engine. Ensure clearance of elbow to air compressor. Tighten inlet elbow cap screws to 30 N•m (22 lb-ft).. Then tighten fuel metering valve.



Remove and Install Fuel Metering Valve

A—Wiring Connectors (8 used)
B—Hose
C—NGT Sensor Connector
D—NGP Sensor Connector
E—Fuel Lockoff Solenoid Connector
F—Four-Way Sub-Harness

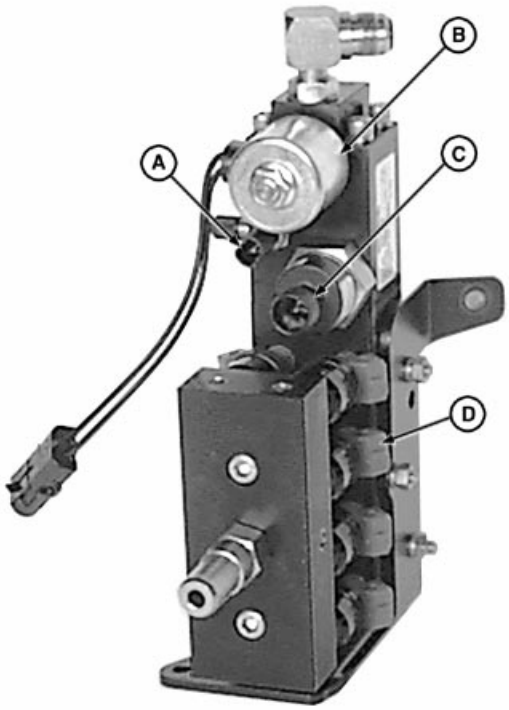
Continued on next page

13. Install fuel metering valve. Tighten mounting hardware to 17 N•m (12 lb-ft).
14. Connect hose.
15. Connect wiring harness connectors.
16. Open gas supply valve.
17. Check for gas leaks. (See LEAK CHECK PROCEDURE in this group.)

DPSG,OUOE003,183 –19–11FEB98–2/2

REPAIR FUEL METERING VALVE

NOTE: No serviceable parts are available for the fuel metering valve. Replacement of fuel metering valve assembly is required for repair.



RG8894A –UN–

Fuel Metering Valve Assembly

A—Natural Gas Temperature (NGT) Sensor
B—Fuel Lockoff Solenoid
C—Natural Gas Pressure (NGP) Sensor
D—Pulse-Width-Modulated Fuel Injectors (8 used)

RG,35,DD116 –19–12JAN98–1/1

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10

REMOVE AND INSTALL FUEL MIXER

CAUTION: Natural gas is highly flammable. DO NOT smoke while working on or near natural gas equipment. Natural gas fumes may cause sickness or death. Work in well ventilated area and shut off natural gas supply and relieve pressure before servicing equipment.

CNG is methane (natural gas) stored at high pressure. It spreads into air quickly.

Natural gas fumes can cause sickness or death. Always work in a well ventilated area.

Do not smoke when refueling or working on or around natural gas vehicles or equipment.

Keep natural gas vehicles away from sparks, flames, and electrical devices in operation, especially if you suspect a natural gas leak.

Improper installation, service, or operation of CNG storage and delivery components can result in fire, explosion, and/or serious injury.

See FUEL PRESSURE LEAK-OFF PROCEDURE in this group before servicing the CNG fuel system.

Relieve CNG fuel system pressure before working on the system. Properly tighten connections and check for leaks before pressurizing the CNG fuel system.

CNG fuel systems operate at high pressures. DO NOT disassemble or remove any CNG fuel system components under pressure. Explosive separation of components, and the escaping natural gas can cause serious injury.

Relieve CNG fuel system pressure before disconnecting any fuel system component.

Gas escaping from the CNG fuel system is very cold. Frostbite and skin damage can occur for contact with cold escaping gas or surrounding components.

Inspect for leaks by spraying a soap and water solution on joints, fittings, and other areas. Look for bubbles that indicate leakage from the system.

Natural Gas Supply Valve

1. Shut off natural gas supply valve (shown).

Continued on next page

DPSG,OUOE003,184 –19–11FEB98–1/2

2. Remove air intake hose from fuel mixer elbow, shown removed.

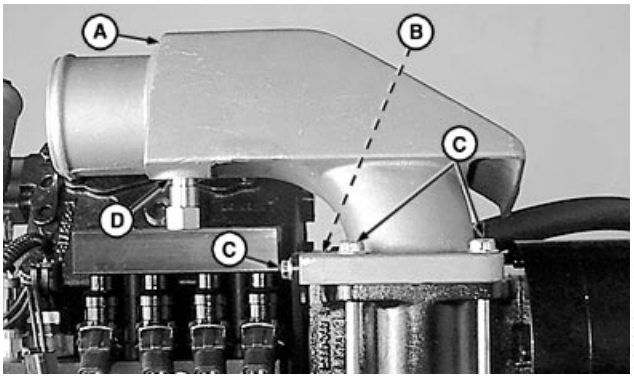
3. Remove three cap screws (C) and two nuts (B). Remove fuel mixer (A). Discard gasket.

4. Install fuel mixer using a new gasket.

NOTE: Inspect O-ring (D) (recessed in groove). Apply small amount of assembly lubricant.

5. Tighten fuel mixer-to-intake manifold cap screws to 27 N•m (20 lb-ft).

6. Open gas supply valve.



Remove and Install Fuel Mixer

DPSG,OUOE003,184 –19–11FEB98–2/2

SPECIAL OR ESSENTIAL TOOLS

NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

SERVICE-GARD is a trademark of Deere & Company.

RG,198,DT7302 –19–05NOV97–1/2

Digital Multimeter JT05791

Test electrical components for voltage, resistance, or current flow. It is especially good for measuring low voltage or high resistance circuits.

JT05791

RGR11274 –UN–

RG,198,DT7302 –19–05NOV97–2/2

SPECIFICATIONS

JOHN DEERE/NIPPONDENSO GEAR REDUCTION STARTING MOTOR SPECIFICATIONS

			No-Load Test	
John Deere Part No.	**Model No.**	**Rating**	**Solenoid Current Draw**	**Armature RPM**
RE61406	228000-5280	4.0 kW/12V	220 amps @ 11V	4200

TORQUES

Alternator Top Cap Screw	70 N•m (52 lb-ft)
Alternator Bottom Cap Screw	70 N•m (52 lb-ft)

RG,198,DT7318 –19–06NOV97–1/1

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2

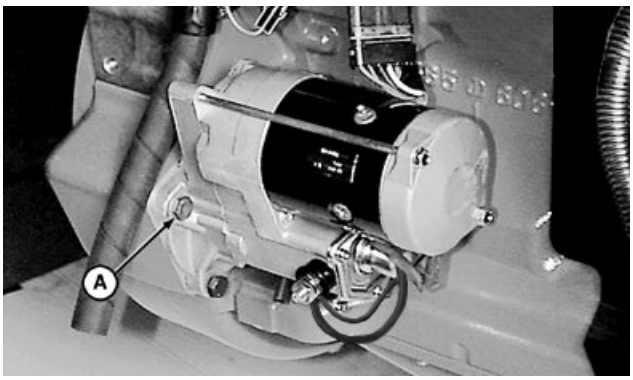
REMOVE AND INSTALL STARTER

CAUTION: Disconnect battery ground strap or serious injury could result if tools ground electrical system.

1. Disconnect ground strap from battery.
2. Disconnect wiring harness-to-starter motor wires, shown removed.
3. Remove three mounting cap screws (A).
4. Remove starting motor.

NOTE: There are no serviceable parts available. Replacement of entire starter motor is necessary.

5. Install starting motor. Tighten cap screws and nut.
6. Connect wiring harness-to-starting motor wires.
7. Connect ground strap.



Remove and Install Starter

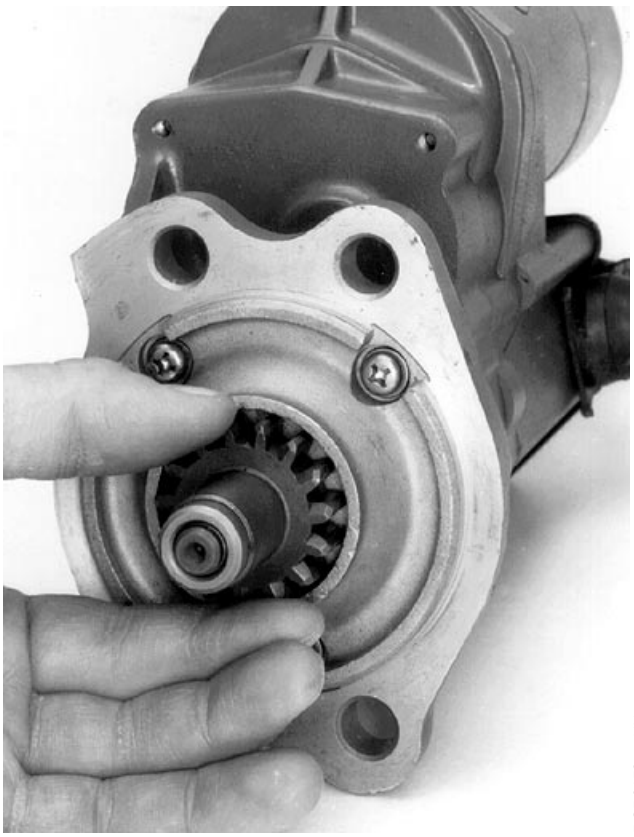
RG,40,DT7255 –19–11FEB98–1/1

BENCH TEST STARTING MOTOR

IMPORTANT: Never operate motor longer than 30 seconds. Allow at least two minutes for cooling and battery recovery before operating again. Overheating, caused by excessive operation, will seriously damage starting motor.

NOTE: Perform bench tests to determine if the starting motor is the cause of the problem.

1. Turn overrunning clutch drive clockwise by hand. Pinion should turn freely.
2. Turn pinion counterclockwise. A definite resistance should be felt. If clutch assembly is defective, replace starting motor.
3. If armature turns freely and the clutch is not defective, test starter under no-load conditions.



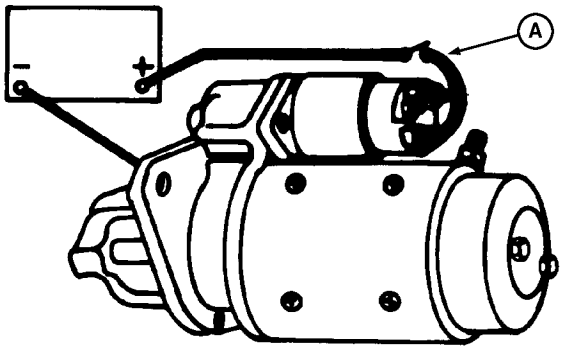
RGR2158 –UN–

Bench Test Starting Motor

RG,40,DT7265 –19–04NOV97–1/1

MAKE SOLENOID RETURN TEST

1. Make connections as shown.
2. Close switch (A).
3. Pull the drive out until the pinion contacts the pinion stop. When released, the drive should return without hesitation.



RG3896 –UN–

RG3896

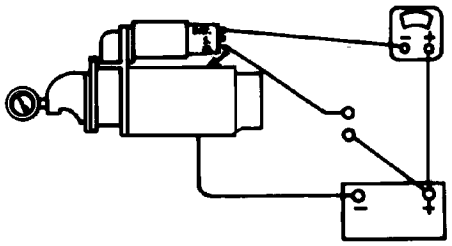
Solenoid Return Test

RG,40,DT7264 –19–04NOV97–1/1

40
4

MAKE NO LOAD TEST

1. Make connections as shown, and use a ammeter capable of measuring several hundred amps.
2. Measure current draw and compare with specifications. (See starting motor specifications at beginning of this group.)
3. If speed and current are slightly low, connect a voltmeter between motor terminal and frame. Observe voltage during test. Voltage may be reduced because of high current draw on battery.
4. If speed or current draw is significantly different than specified, diagnose problem as follows.



Connections for No Load Test

A—Ammeter
B—Battery
C—Starter Frame
D—Tachometer
E—Battery Terminal
F—Switch
G—Field Coil Connector

RG,40,DT7263 –19–10APR98–1/1

DIAGNOSE NO LOAD TEST

FAILS TO OPERATE-LOW CURRENT DRAW

- Open series field circuit.
- Open armature coils.
- Defective brush contact with commutator.

FAILS TO OPERATE-HIGH CURRENT DRAW

- Grounded terminal or fields.
- Seized bearings.

LOW SPEED-LOW CURRENT DRAW

- High internal resistance.
- Defective brush contact with commutator.

LOW SPEED-HIGH CURRENT DRAW

- Excessive friction.
- Shorted armature.
- Grounded armature or fields.

HIGH SPEED-LOW CURRENT DRAW

Open shunt field circuit.

HIGH SPEED-HIGH CURRENT DRAW

Shorted series field coils.

RG,40,DT7266 –19–04NOV97–1/1

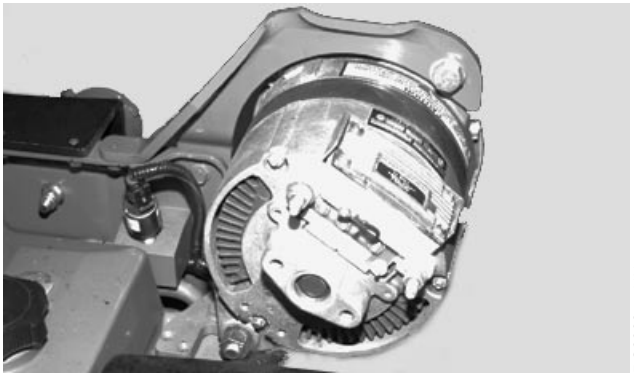
REMOVE AND INSTALL ALTERNATOR

IMPORTANT: Always disconnect battery negative (-) cables before removing alternator or a short circuit could result.

1. Disconnect battery ground (—) cable.
2. Disconnect positive (+) red wire and regulator connector.
3. Remove belt guard.
4. Remove alternator belt using 1/2 in. drive ratchet on belt tensioner.
5. Remove alternator mounting hardware.
6. Remove alternator.

NOTE: There are no serviceable parts available. Replacement of entire alternator is necessary.

7. Install alternator. Tighten top and bottom cap screws to 70 N•m (52 lb-ft).
8. Install alternator belt using 1/2 in. drive ratchet on belt tensioner.
9. Install belt guard.
10. Connect positive (+) red wire and regulator connector.
11. Connect battery ground (—) cable.



Alternator Removal

RG,40,DT7261 –19–11FEB98–1/1

CHARGING SYSTEM FAILURE

Causes of Charging System Failure:

Charging system malfunction is identified by battery condition.

Undercharged batteries caused by one or a combination of the following:

- Loose belts; corroded, broken, loose, or dirty terminals; broken wiring; undersize wiring; defective batteries.
- Alternator field circuit malfunction caused by one or a combination of the following:
  - Poor contacts between regulator and brushes.
  - Defective diode trio.
  - No residual magnetism in rotor.
  - Defective or improperly adjusted regulator.
  - Damaged or worn brushes.
  - Damaged or worn slip rings.
  - Poor connection between slip ring assembly and field coil leads.
  - Rotor coil shorted, open, or grounded.
- Alternator generating section malfunction caused by one or a combination of the following:
  - Stator phase(s) shorted, open, or grounded.
  - Rectifier assembly grounded.
  - Rectifier(s) shorted or open.

Overcharged batteries caused by one or a combination of the following:

- Defective battery.
- Defective diode trio.
- Defective or improperly adjusted regulator.
- Poor sensing lead contact to regulator or rectifier assembly.

RG,40,DT7260 –19–04NOV97–1/1

ALTERNATOR TROUBLESHOOTING

NOTE: For fast and accurate troubleshooting perform the following test procedures. Ensure that belts are properly tensioned, and that wiring and terminals are in good working condition. Check batteries per manufacturer's specifications to establish if they are defective. Ensure that batteries are 95—100% charged.

RG,40,DT7259 –19–04NOV97–1/1

ALTERNATOR OUTPUT TEST

1. Shut off all electrical accessories and run engine at approximately 1000—1200 rpm.

CAUTION: Use an accurate voltmeter to measure output voltage. DO NOT rely on dashboard gauges.

2. Connect a DC voltmeter to the battery terminals and measure voltage. Make a note of the readings, Compare to the values specified by the vehicle manufacturer. If reading is above specified voltage, then an OVERCHARGE condition is present.

3. If the reading is below specified voltage, then an UNDERCHARGE condition is present.

If either condition is observed, perform DIODE TRIO TEST in this group.

NOTE: The following tests are designed to identify the source of alternator failure. Refer to the manufacturer's service manual for detailed descriptions on how to disassemble, test, and properly assemble the alternator.

RG,40,DT7258 –19–04NOV97–1/1

40
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DIODE TRIO TEST

1. Remove the diode trio from the alternator.

2. Connect the negative (-) ohmmeter test lead to the diode trio lead terminal. Connect the positive (+) test lead to each of the three copper contact pads, one at a time. Observe the resistance at each contact pad and write down the resistance for each contact for later reference.

3. Reverse the leads so the positive (+) lead is connected to the diode trio lead terminal and the negative (-) test lead connects to the contact pads. Again observe the resistance at each of the contact pads and record the results for each contact.

NOTE: The diode trio is OK when a LOW resistance reading is observed in one direction and a HIGH resistance is observed in the other direction. Occasionally the diode trio malfunctions under operating conditions only.

4. If the diode trio is malfunctioning, replace alternator. Otherwise, reinstall the diode trio on the alternator.

NOTE: There are no serviceable parts available. Replacement of entire alternator is necessary if failure is detected.

RG,40,DT7257 –19–04NOV97–1/1

FULL FIELD TEST

1. Run engine at approximately 1000 RPM with all electrical accessories “OFF.” Measure the output voltage across the alternator terminals and write it down for later reference.

NOTE: Use a digital voltmeter with .01-volt reading capabilities.

2. Attach a short jumper to a 51 mm (2 in.) piece of stiff wire (a paper clip is suitable).

3. Connect the other end of the jumper to the negative (-) alternator output terminal and insert the wire in the FULL FIELD ACCESS HOLE. Hold the wire firmly against the brush terminal inside the housing.

4. With the jumper in place, connect a voltmeter across the alternator terminals and run the engine at approximately 1000 RPM. Compare this voltage reading with the voltage reading obtained in Step 1.

5. With the jumper still hooked up and the wire in the FULL FIELD ACCESS HOLE, connect an AC voltmeter across terminals 1&2, 1&3, and 2&3, and note the voltages. If all of the voltages are approximately the same, they are considered “balanced.”

6. Remove the jumper and wire from the alternator. If the voltage in Step 4 is higher than the voltage in Step 1, and the voltages measured in Step 5 are balanced, the stator and alternator are OK.

If the voltage in Step 4 is higher than the voltage in Step 1, and the voltages measured in Step 5 are not balanced, the alternator stator or rectifier(s) defective. Replace alternator.

If the voltage in Step 4 is lower or equal to the voltage in Step 1, and the voltages measured in Step 5 are balanced, the alternator is defective. Replace alternator.

If the voltage in Step 4 is lower or equal to the voltage in Step 1, and the voltages measured in Step 5 are not balanced, alternator stator or rectifier(s) are defective. Replace alternator.

RG,40,DT7256 –19–04NOV97–1/1

SPECIAL OR ESSENTIAL TOOLS

NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

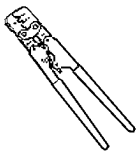
SERVICE-GARD is a trademark of Deere & Company.

RG,198,DT7303 –19–05NOV97–1/12

RW25542 –UN–

WEATHER PACK™ Crimping Tool JDG783

Used to crimp WEATHER PACK terminals.



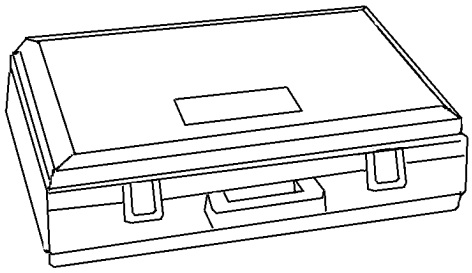
JDG783

WEATHER PACK is a trademark of Packard Electric.

RG,198,DT7303 –19–05NOV97–2/12

Electrical Repair Tool Kit. JDG155

Use for repair and installation of wires into electrical connectors.



RW25558 –UN–

JDG155

Continued on next page

RG,198,DT7303 –19–05NOV97–3/12

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2

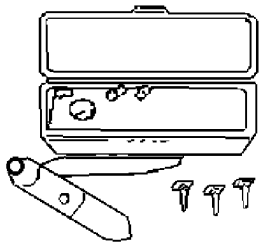
JDG155 Electrical Repair Tool Kit consists of:

Holding Plate	JDG107
Contact Insertion Tool	JDG139
Contact Extraction Tool	JDG140
Contact Extraction Tool	JDG141
Contact Extraction Tool	JDG142
Contact Extraction Tool	JDG143
Crimping Pliers	JDG144
Electrician's Pliers	JDG145
Carry Case	JDG146

RG,198,DT7303 –19–05NOV97–4/12

Deutsch Electrical Repair Tool Kit. JDG359

Repair Deutsch electrical connector bodies.



JDG359

RW25540 –UN–

RG,198,DT7303 –19–05NOV97–5/12

Repair Deutsch electrical connector bodies—Includes:

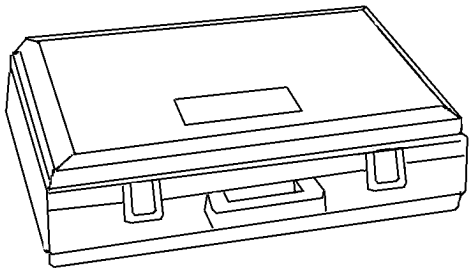
Crimper	JDG360
12—14 Gauge Extractor (Set of Two)	JDG361
16—18 Gauge Extractor (Set of Two)	JDG361
20—24 Gauge Extractor (Set of Two)	JDG363

Continued on next page

RG,198,DT7303 –19–05NOV97–6/12

Technician's Electrical Repair Kit JT07195A

Remove and install wires into connectors.



RW25558 –UN–

JT07195A

RG,198,DT7303 –19–05NOV97–7/12

Remove and install wires into connectors—Includes:

Contact Extraction Tool	JDG140
Contact Extraction Tool	JDG141
12—14 Gauge Extractor	JDG361
16—18 Gauge Extractor	JDG362
WEATHER PACK™ Extractor	JDG364
METRI-PACK™ Extractor	JDG776
WEATHER PACK™ METRI-PACK™ Narrow Extractor	JDG777
6—8 Gauge Deutsch Extractor	JDG785
Carrying Case	307382

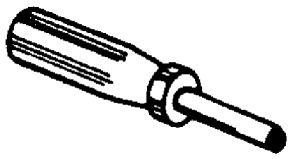
WEATHER PACK is a trademark of Packard Electric.
METRI-PACK is a trademark of Delphi Packard Electric Systems.

RG,198,DT7303 –19–05NOV97–8/12

RG6783 –UN–

WEATHER PACK™ Extraction Tool JDG364

Use to replace terminal contact in WEATHER PACK™ connector body.



RG6783

JDG364

WEATHER PACK is a trademark of Packard Electric.

Continued on next page

RG,198,DT7303 –19–05NOV97–9/12

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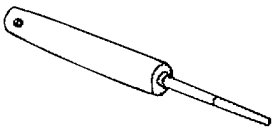
RW25541 –UN–

WEATHER PACK™ Extractor (Wide). . . . . .JDG776[1]

Remove terminals from METRI-PACK™ connectors.



JDG776

WEATHER PACK is a trademark of Packard Electric.
METRI-PACK is a trademark of Delphi Packard Electric Systems.

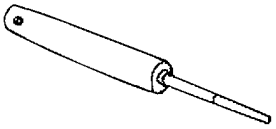
[1]Included in JT07195A Electrical Repair Kit.

RG,198,DT7303 –19–05NOV97–10/12

RW25541 –UN–

WEATHER PACK™ Extractor (Narrow) . . . . . .JDG777[1]

Remove terminals from METRI-PACK™ connectors.



JDG777

WEATHER PACK is a trademark of Packard Electric.
METRI-PACK is a trademark of Delphi Packard Electric Systems.

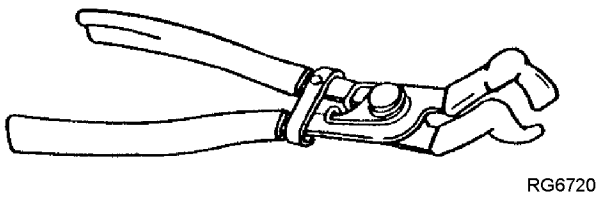
[1]Included in JT07195A Electrical Repair Kit.

RG,198,DT7303 –19–05NOV97–11/12

RG6720 –UN–

Spark Plug Boot Puller Pliers. JDG815

Use to remove and install spark plug boots.



RG6720

JDG815

RG,198,DT7303 –19–05NOV97–12/12

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICE-GARD™ Catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

SERVICE-GARD is a trademark of Deere & Company.

RG,45,SO124 –19–16JAN98–1/2

Spark Plug Removal Tool JDG1193

To remove frozen spark plugs.

RG,45,SO124 –19–16JAN98–2/2

OTHER MATERIAL

Number	Name	Use
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to threads of ignition coil-to-bracket cap screws and ICU mounting cap screws.
TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®)	Pipe Sealant with TEFLON®	Apply to threads of Preturbine Pressure, Exhaust Back Pressure sensors and oil pressure switch.
	Silicon Dielectric Grease	Apply to spark plug terminal and spark plug boot.
PT569 (U.S.)	NEVER-SEEZ® Compound	Apply to threads of Universal Exhaust Gas Oxygen sensor (for UEGO sensor reuse only).
AT66865 (U.S.)	Electrical Insulating Compound	Apply to connector terminals.

LOCTITE is a trademark of the Loctite Corp.
TEFLON is a trademark of the DuPont Co.
NEVER-SEEZ is a trademark of the Emhart Chemical Group.

RG,45,DT7267 –19–04NOV97–1/1

SPECIFICATIONS

TORQUES

ICU-to-Bracket Cap Screw	16 N•m (12 lb-ft)
Ignition Timing Sensor	22 N•m (16 lb-ft)
Ignition Timing Sensor Plate-to-Timing Gear Housing Cap Screw	34 N•m (25 lb-ft)
MAP Sensor-to-Intake Manifold Cap Screw	3.3 N•m (30 lb-in.)
Spark Plug Gland Nuts	41 N•m (30 lb-ft)
Ignition Coil Mounting Cap Screws	2 N•m (17.7 lb-in.)
Cam Sensor	30 N•m (22 lb-ft)
Crank Sensor	30 N•m (22 lb-ft)

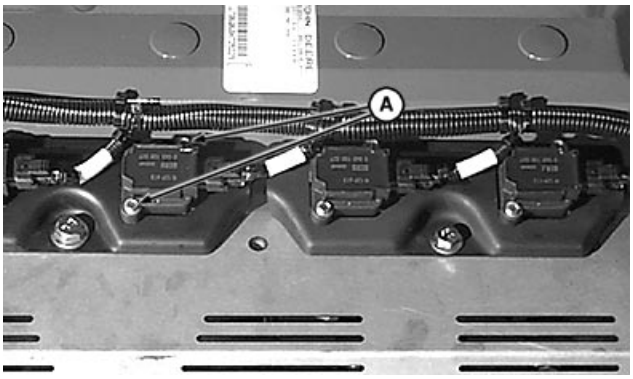
RG,198,DT7317 –19–11FEB98–1/1

REMOVE AND INSTALL SPARK PLUGS

CAUTION: Electrical shock may occur if you contact live electrical components. Disconnect power before servicing ignition system.

NOTE: Spark plugs should be replaced every 25,000 miles—regardless of months of operation. Also replace spark plug boots at every other plug change, or every 50,000 miles.

1. Remove two cap screws (A). Remove ignition coils. Then remove boots from spark plugs. Use compressed air to remove any debris from plug bore.



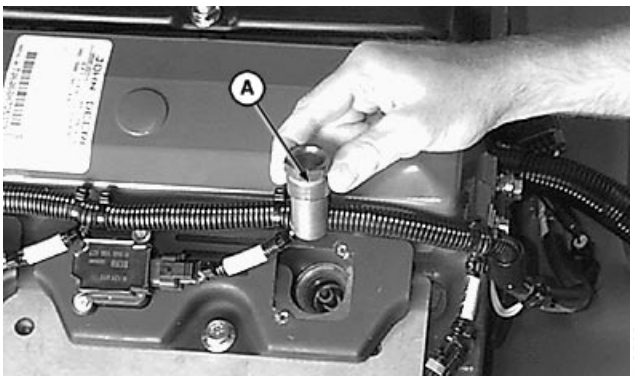
Removing Coils

Continued on next page

RG,45,CH165 –19–11FEB98–1/6

IMPORTANT: Avoid damage to spark plug boots. Pull straight out on coils when removing. Then remove boots from spark plugs.

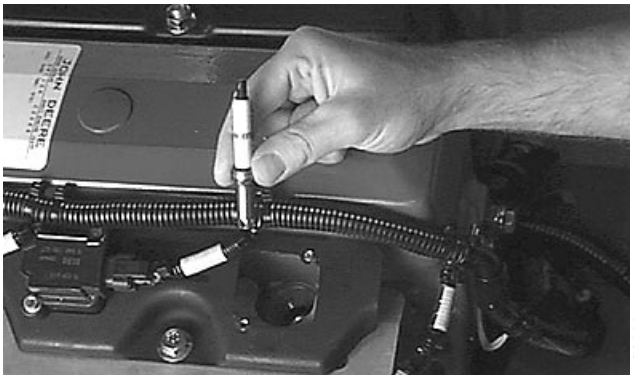
2. Remove gland nut (A) from around plug.



Removing Gland Nut

RG,45,CH165 –19–11FEB98–2/6

3. Use pliers to pull up and free plug. Use shop towel to protect threads of plugs. DO NOT rock plug back and forth. Use a gentle twisting motion if necessary.



Removing Spark Plug

Continued on next page

RG,45,CH165 –19–11FEB98–3/6

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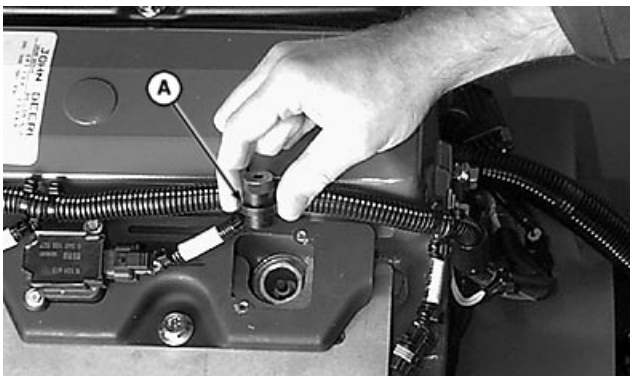
4. If spark plug is frozen in bore, reinstall gland nut and then screw JDG1193 (A) tool (knurled end up) onto threads of plug.

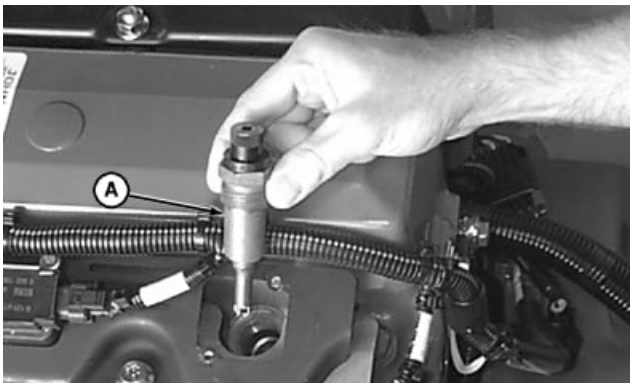


Removing Spark Plug

RG,45,CH165 –19–11FEB98–4/6

5. Remove gland nut (A). Spark plug will now be freed for removal.

IMPORTANT: Platinum spark plugs are used to attain maximum plug life. John Deere Part Number RE66144 (marked JDZOFR) MUST BE used. Always replace spark plugs, once removed.



Removing Gland Nut

Continued on next page

RG,45,CH165 –19–11FEB98–5/6

NOTE: If old spark plugs were hard to remove, use a bore cleaning brush to clean plug bore. Blow debris from bore with compressed air.

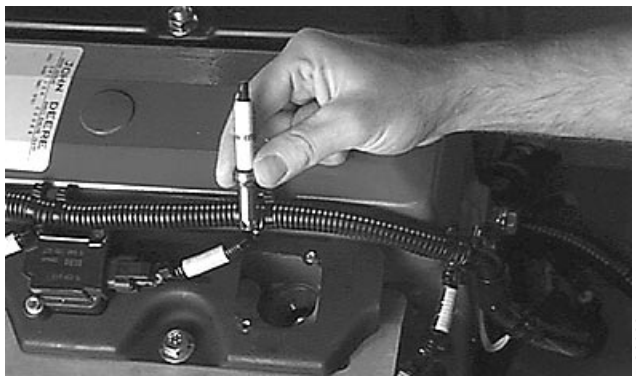
6. Install new spark plugs in bores. Install gland nuts and tighten to 41 N•m (30 lb-ft).

7. Apply a small amount of silicon di-electric grease around top shoulder of each spark plug.

8. Reinstall spark plug springs and boots on each plug.

IMPORTANT: Replace spark plug boots at every other spark plug replacement interval.

9. Reinstall ignition coils.



Installing Spark Plug

RG,45,CH165 –19–11FEB98–6/6

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REMOVAL OF SEIZED SPARK PLUGS (TOOL JDG1193 NOT AVAILABLE OR SPARK PLUG CERAMIC STEM HAS BROKEN OFF)

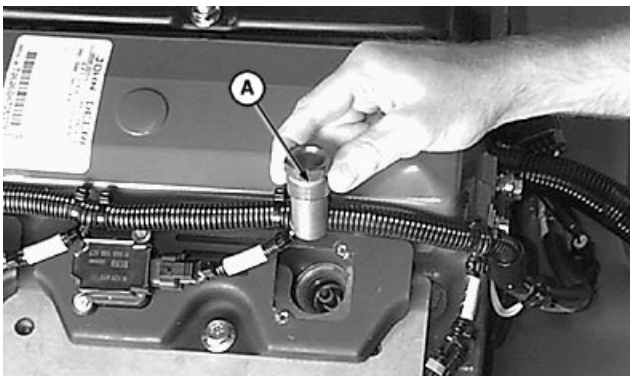
CAUTION: Electrical shock may occur if you contact live electrical components. Disconnect power before servicing ignition system.

IMPORTANT: This procedure requires destruction of the spark plug for removal. Use this procedure only when the conventional Remove and Install Spark Plug procedure earlier in this group using tool JDG1193 will not work or spark plug ceramic stem has broken off.

1. Remove gland nut (A).
2. Break spark plug ceramic stem from plug as close to base of spark plug as possible.
3. Use compressed air to remove any debris from around spark plug bore.
4. Drive a 13 mm 12 point deep well socket down around the metal base of spark plug.
5. Install appropriate extension bar and handle onto socket.

NOTE: Spark plugs are not threaded and may be twisted in either a clockwise or counterclockwise direction to remove.

6. Using a twisting motion, twist and remove plug from spark plug bore.



Removing Gland Nut

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DPSG,OUOE003,332 –19–17APR98–1/2

IMPORTANT: Do NOT use anti-seize compound on spark plugs. Compound may become lodged on the spark plug electrode causing plug to misfire.

NOTE: If old spark plugs were hard to remove, use a bore cleaning brush to clean plug bore. Blow debris from bore with compressed air.

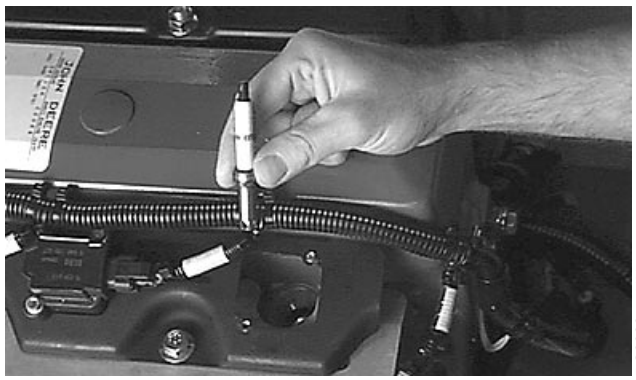
7. Install new spark plugs in bores. Install gland nuts and tighten to 41 N•m (30 lb-ft).

8. Apply a small amount of dielectric grease around top shoulder of each spark plug.

9. Reinstall spark plug springs and boots on each plug.

IMPORTANT: Replace spark plug boots at every other spark plug replacement interval.

10. Reinstall ignition coils.



Installing Spark Plug

DPSG,OUOE003,332 –19–17APR98–2/2

REMOVE AND INSTALL IGNITION COILS

CAUTION: Electrical shock may occur if you contact live electrical components. Disconnect power before servicing ignition system.

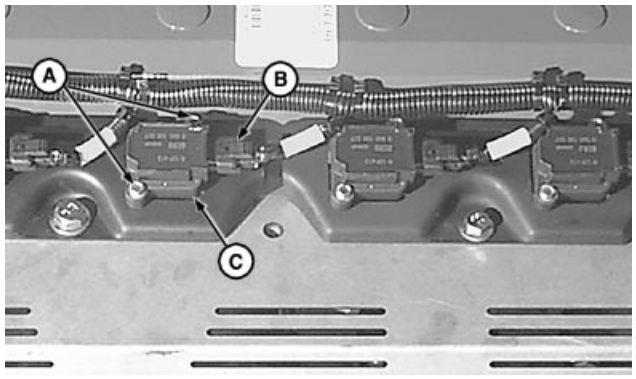
1. Disconnect ignition coil electrical connector (B).

IMPORTANT: Avoid damage to spark plug boot or ignition coil. Pull ignition coil straight out when removing.

2. Loosen two cap screws (A) and remove ignition coil (C).

3. Install coil and tighten cap screws to 2 N•m (17.7 lb-in.).

4. Connect electrical connector.



Remove and Install Ignition Coils

A—Cap Screw (2 used)
B—Connector
C—Ignition Coil

RG,45,DT7285 –19–11FEB98–1/1

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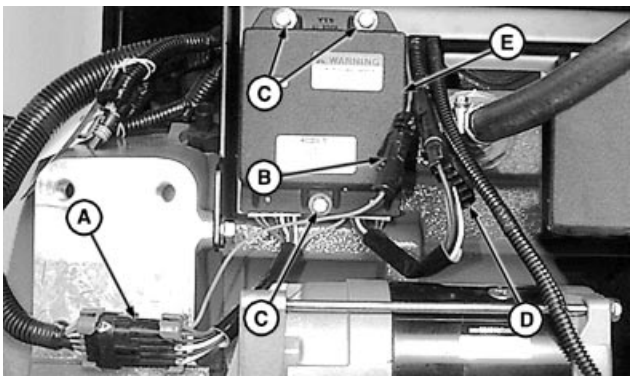
REMOVE AND INSTALL IGNITION CONTROL UNIT (ICU)

IMPORTANT: Before welding on the vehicle remove the positive (+) and negative (-) battery cables from the battery. Attach the welder ground 2 feet or less away from the part being welded. NEVER attach the welder ground cable to the Electronic Control Unit or to the engine. It is NOT recommended to weld on the engine.

IMPORTANT: DO NOT connect jump starting cables or battery charging cables to the engine or to the Electronic Control Unit.

CAUTION: Electrical shock may occur if you contact live electrical components. Disconnect power before servicing ignition system.

1. Disconnect wire harness connectors (A, B, and D).
2. Remove cap screws (C) and remove ICU (E) from mounting plate.
3. Connect wire harness connectors.



Remove and Install Ignition Control Unit

A—Connector
B—Connector
C—Cap Screw (3 used)
D—Connector
E—Ignition Control Unit (ICU)

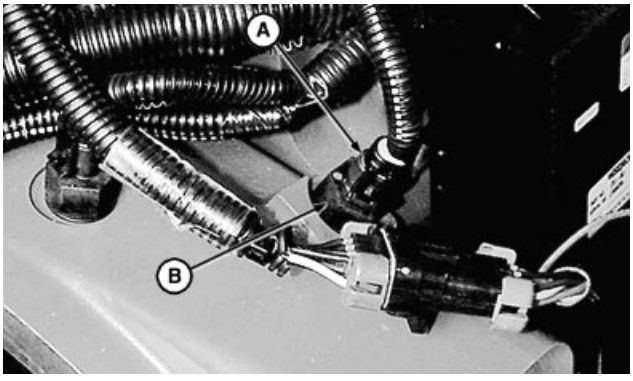
RG,45,DD8014 –19–11FEB98–1/1

REMOVE AND INSTALL CAM SENSOR

1. Disconnect electrical connector (A).
2. Remove cam sensor (B).
3. Inspect sensor. Replace as necessary

IMPORTANT: DO NOT overtighten sensor. Sensor may be damaged during installation

4. Install sensor. Tighten to 30 N•m (22 lb-ft).
5. Connect electrical connector.



Remove and Install Cam Sensor

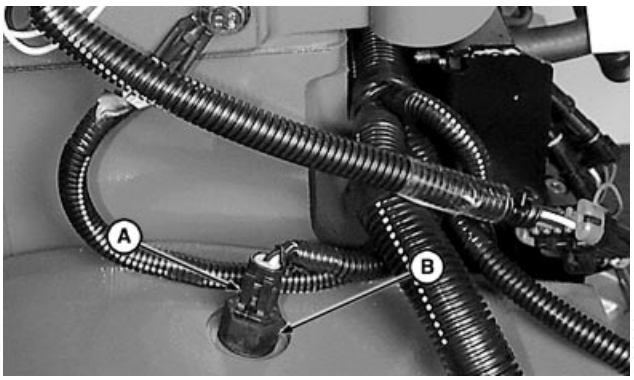
RG,45,CH166 –19–11FEB98–1/1

REMOVE AND INSTALL CRANK SENSOR

1. Disconnect electrical connector (A).
2. Remove crank sensor (B).
3. Inspect sensor. Replace as necessary.

IMPORTANT: Do not overtighten sensor. Sensor may be damaged during installation.

4. Install sensor. Tighten to 30 N•m (22 lb-ft).

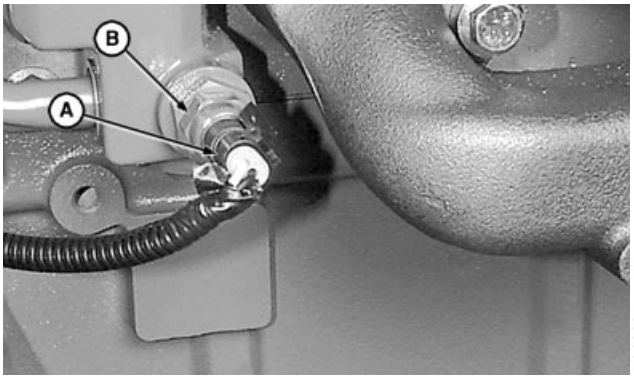


Remove and Install Crank Sensor

RG,45,CH167 –19–11FEB98–1/1

REMOVE AND INSTALL ENGINE COOLANT TEMPERATURE (ECT) SENSOR

1. Disconnect ECT sensor electrical connector, as shown.
2. Remove ECT sensor (A) and O-ring.
3. Apply LOCTITE® 242 Thread Lock and Sealer to sensor threads. Install ECT using new O-ring.
4. Connect electrical connector.



Remove and Install Engine Coolant Temperature (ECT) Sensor

LOCTITE is a trademark of the Loctite Corp.

RG,45,DD8015 –19–09JAN98–1/1

REMOVE AND INSTALL FOOT PEDAL POSITION SENSOR

The foot pedal position sensor is located on the operator's accelerator pedal. See Vehicle Repair manual for replacement procedures.

The foot pedal sensor has no serviceable parts. If it fails, replace the complete foot pedal assembly.

RG,45,DT7280 –19–04NOV97–1/1

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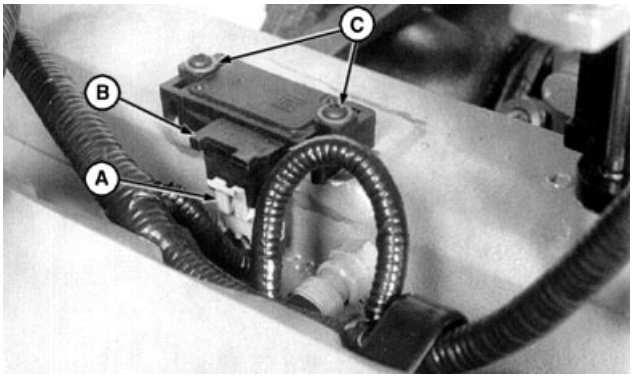
REMOVE AND INSTALL MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

NOTE: Manifold Absolute Pressure (MAP) sensor is located on the top of the intake manifold.

1. Disconnect MAP wiring harness connector (A).
2. Remove cap screws (B). Remove MAP sensor (C) and O-ring.
3. Install MAP sensor using new O-ring. Tighten cap screws to 3.3 N•m (30 lb-in.).
4. Connect wiring harness connector.



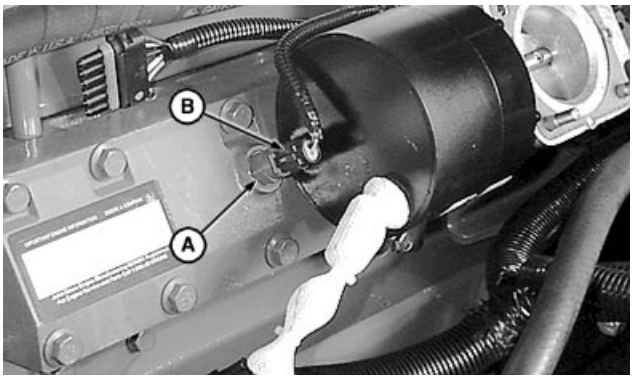
Manifold Absolute Pressure Sensor

RG,45,DT7279 –19–11FEB98–1/1

REMOVE AND INSTALL MANIFOLD AIR TEMPERATURE (MAT) SENSOR

NOTE: Manifold air temperature (MAT) sensor is located on the inside vertical side of the intake manifold.

1. Disconnect MAT sensor wiring harness connector (B).
2. Remove MAT sensor (A) and O-ring.
3. Install MAT sensor using new O-ring and tighten.
4. Connect wiring harness connector.



Manifold Air Temperature (MAT) Sensor

RG,45,CH137 –19–16DEC97–1/1

REMOVE AND INSTALL NATURAL GAS TANK TEMPERATURE (NGTT) SENSOR

The natural gas tank temperature (NGTT) sensor is located on the gas tank. See Vehicle Repair manual for replacement procedures.

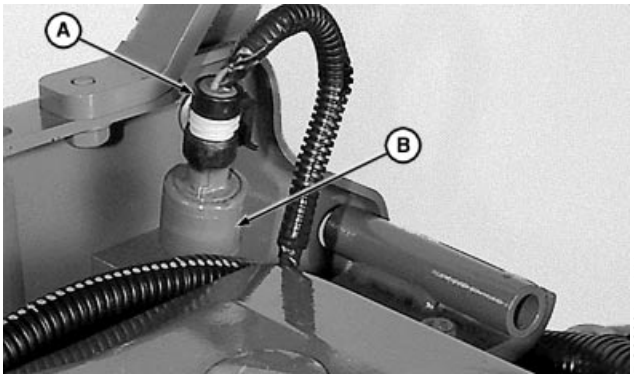
RG,45,DT7277 –19–04NOV97–1/1

REMOVE AND INSTALL PRETURBINE PRESSURE (PTP) SENSOR

1. Disconnect PTP sensor wiring harness connector (A).
2. Remove PTP sensor (B).

IMPORTANT: DO NOT allow sealant to enter pressure sensing hole in sensor.

3. Apply LOCTITE® 592 Pipe Thread Sealant with TEFLON® to sensor threads except first 1—3 threads.
4. Install PTP sensor in mounting block and tighten.
5. Connect wiring harness connector.



Preturbine Pressure Sensor

LOCTITE is a trademark of the Loctite Corp.
TEFLON is a trademark of the DuPont Co.

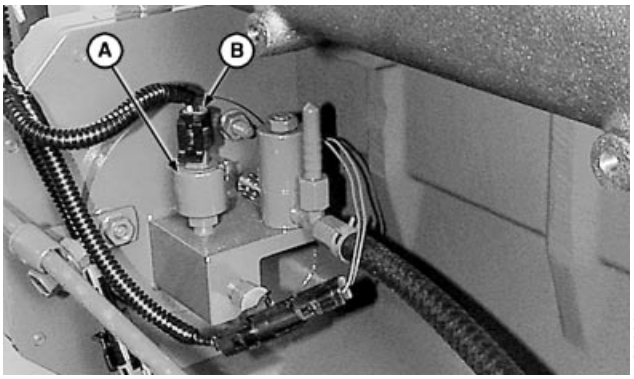
RG,45,CH138 –19–11FEB98–1/1

REMOVE AND INSTALL EXHAUST BACK PRESSURE (EBP) SENSOR

1. Disconnect EBP sensor wiring harness connector (B).
2. Remove EBP sensor (A).

IMPORTANT: DO NOT allow sealant to enter pressure sensing hole in sensor.

3. Apply LOCTITE® 592 Pipe Thread Sealant with TEFLON® to sensor threads except first 1—3 threads.
4. Install EBP sensor in mounting block and tighten.
5. Connect wiring harness connector.



Exhaust Back Pressure (EBP) Sensor

LOCTITE is a trademark of the Loctite Corp.
TEFLON is a trademark of the DuPont Co.

RG,45,CH139 –19–11FEB98–1/1

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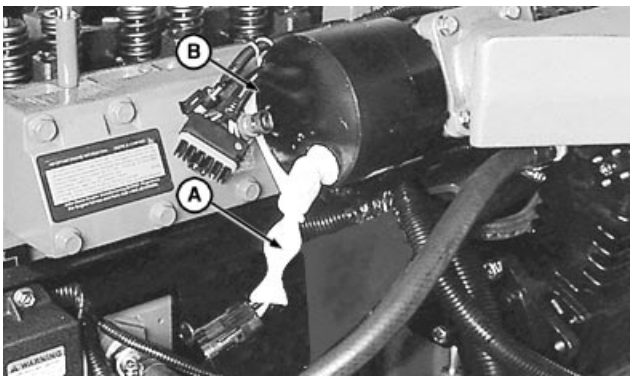
REMOVE AND INSTALL ELECTRONIC THROTTLE AND THROTTLE POSITION SENSOR

NOTE: Throttle position sensor is located within the electronic throttle assembly (B).

1. Remove fuel mixer. (See REMOVE AND INSTALL FUEL MIXER in Group 35.)
2. Disconnect electronic throttle assembly wiring harness connector (A).
3. Remove electronic throttle assembly (B). Discard gasket.
4. Using a new gasket, install electronic throttle assembly.
5. Connect wiring harness connector.
6. Install fuel mixer. (See REMOVE AND INSTALL FUEL MIXER in Group 35.)



Electronic Assembly and Connector

RG,45,DD8016 –19–09JAN98–1/1

REMOVE AND INSTALL UNIVERSAL EXHAUST GAS OXYGEN (UEGO) SENSOR

NOTE: The UEGO sensor is located in the exhaust piping downstream of the turbocharger.

IMPORTANT: DO NOT attempt to remove wires from UEGO sensor. Sensor can be easily damaged by rough handling, chemicals, water, etc.

1. Disconnect wire harness from UEGO sensor.
2. Turn UEGO sensor out of exhaust.
3. Coat threads of sensor with NEVER-SEEZ® if reusing. Threads of new sensor are already coated with antiseeze.
4. Install UEGO and tighten.
5. Connect wiring harness.

NEVER-SEEZ is a trademark of Emhart Chemical Group.

RG,45,DT7274 –19–11FEB98–1/1

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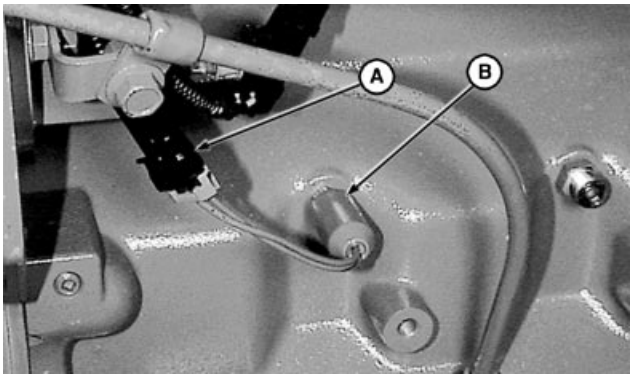
REMOVE AND INSTALL OIL PRESSURE SWITCH

1. Disconnect wiring harness connector (A).
2. Remove oil pressure switch (B).

IMPORTANT: DO NOT allow sealant to enter pressure sensing hole in switch.

3. Apply LOCTITE® 242 Thread Lock and Sealer to switch threads except first 1—3 threads.
4. Install oil pressure switch and tighten.
5. Connect wiring harness connector.



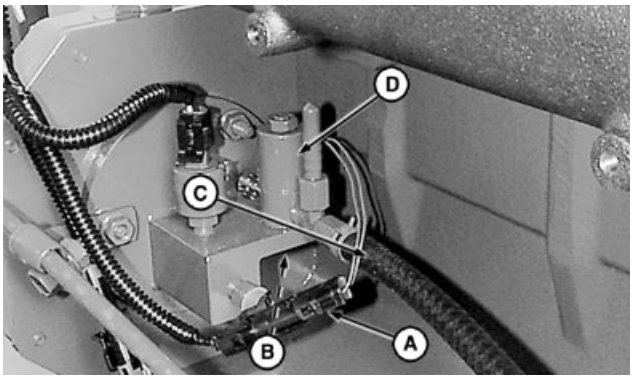
Oil Pressure Switch and Connector

LOCTITE is a trademark of the Loctite Corp.

RG,45,CH140 –19–16DEC97–1/1

REMOVE AND INSTALL TURBOCHARGER WASTEGATE CONTROL VALVE

1. Disconnect wiring harness connector (A).
2. Remove inlet hose, shown removed.
3. Remove hose (C).
4. Remove cap screws (B). Remove wastegate control valve (D).
5. Inspect orifice in inlet fitting for debris. Clean if necessary.
6. Install valve and tighten.
7. Connect hoses.
8. Connect wiring harness connector.



Turbocharger Wastegate Control Valve

A—Wiring
B—Cap Screw (2 used)
C—Hose
D—Wastegate Control Valve

RG,45,CH141 –19–11FEB98–1/1

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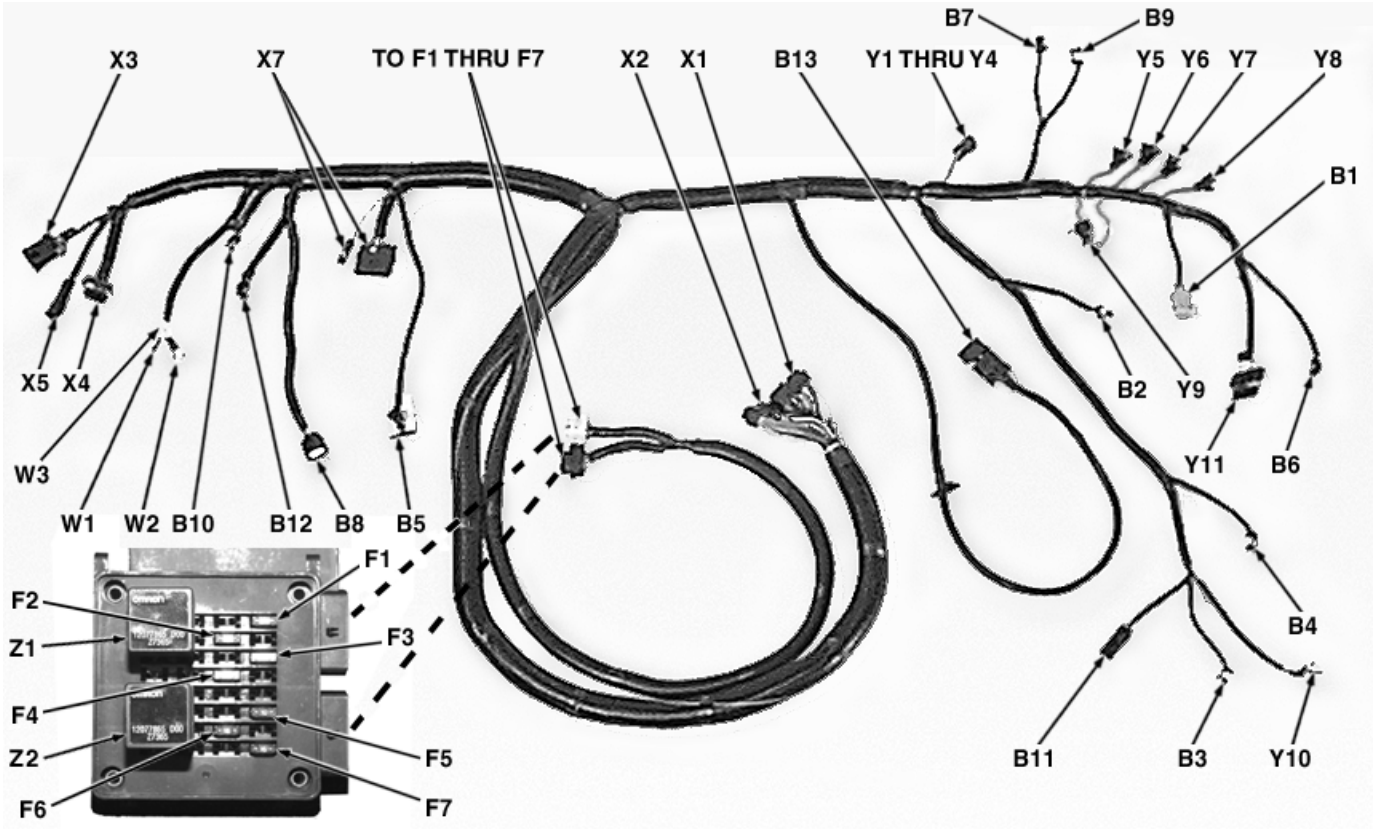
20

NATURAL GAS ENGINE WIRING HARNESS



Natural Gas Engine Wiring Harness

B1—Manifold Absolute Pressure (MAP) Sensor Connector
B2—Preturbine Pressure (PTP) Sensor Connector (Red Marking)
B3—B3 Exhaust Back Pressure (EBP) Sensor Connector (Green Marking)
B4—Engine Coolant Temperature (ECT) Sensor Connector
B5—Natural Gas Tank Pressure (NGTP) Sensor Connector
B6—Manifold Air Temperature (MAT) Sensor Connector
B7—Natural Gas Temperature (NGT) Sensor Connector
B8—Universal Exhaust Gas Oxygen (UEGO) Sensor Connector
B9—Natural Gas Pressure (NGP) Sensor Connector
B10—Cam Position Sensor Connector
B11—Oil Pressure Switch Connector
B12—Crank Position Sensor Connector
B13—Communication Connector
F1—Fuse (5A)
F2—Fuse (15A)
F3—Fuse (20A)
F4—Fuse (20A)
F5—Fuse (10A)
F6—Fuse (15A)
F7—Fuse (15A)
W1—Ground (2 wires)
W2—Ground (2 wires)
W3—Ground (1 wire)
X1—Electronic Control Module (ECM) Connector
X2—Electronic Control Module (ECM) Connector
X3—Vehicle Interconnect #3
X4—Vehicle Interconnect #4
X5—Vehicle Interconnect #5
X7—Ignition Control Unit (ICU) Connectors
Y1—To Fuel Injector
Y2—To Fuel Injector
Y3—To Fuel Injector
Y4—To Fuel Injector
Y5—To Fuel Injector
Y6—To Fuel Injector
Y7—To Fuel Injector
Y8—To Fuel Injector
Y9—Low Pressure Lockoff Solenoid Connector
Y10—Turbocharger Wastegate Control Solenoid Connector
Y11—To Electronic Throttle Connector
Z1—Relay 1-Coil Power
Z2—Relay 2-Electrical System

Continued on next page

RG,45,CH142 –19–11FEB98–1/2

IMPORTANT: For diagnosis of engine wiring and electronic controls and sensors, refer to companion manual, CTM113.

This manual also contains detailed wiring diagrams.

RG,45,CH142 –19–11FEB98–2/2

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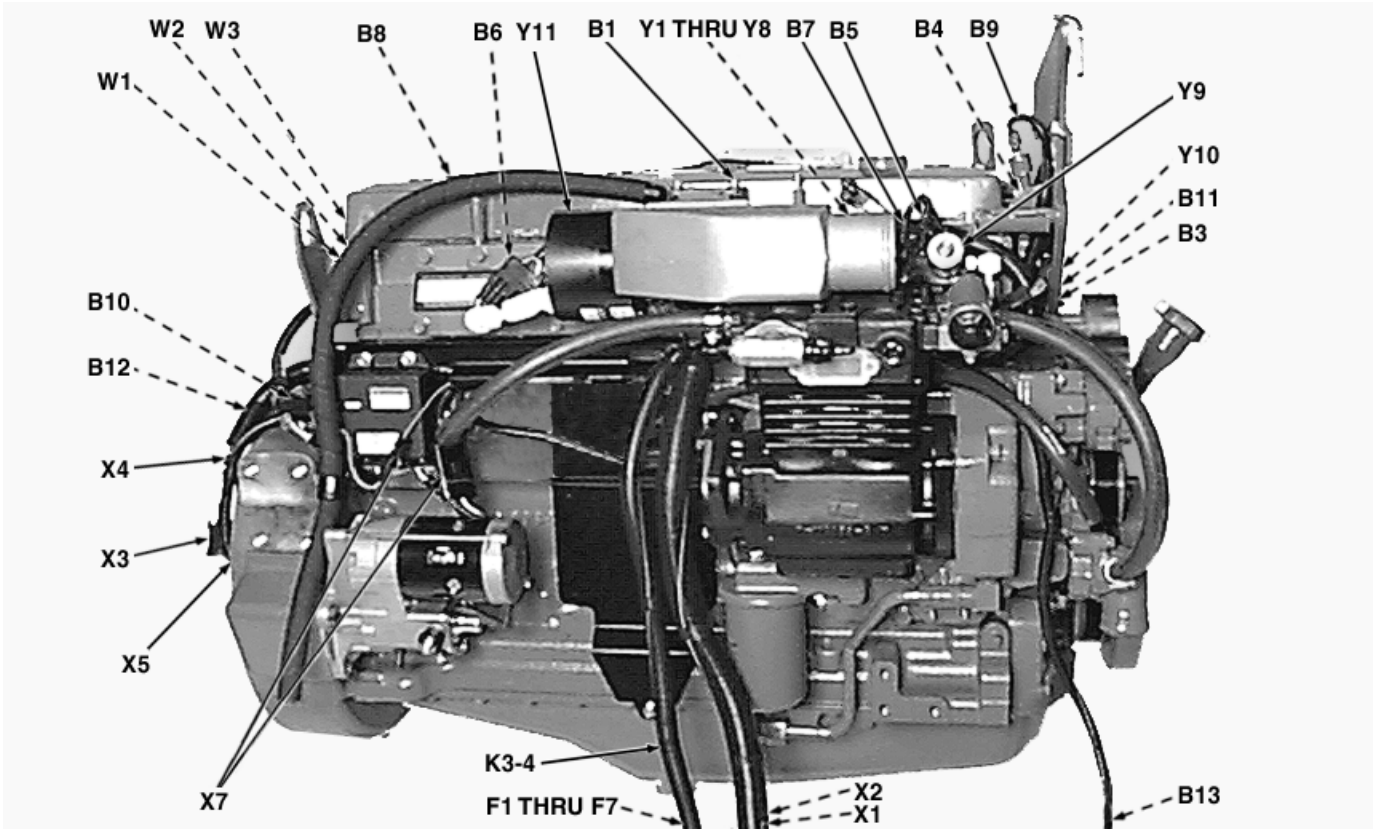
NATURAL GAS ENGINE COMPONENT LOCATION DIAGRAM



Natural Gas Engine Component Location

B1—Manifold Absolute Pressure (MAP) Sensor
B3—Exhaust Back Pressure (EBP) Sensor
B4—Engine Coolant Temperature (ECT) Sensor
B5—Natural Gas Pressure (NGP) Sensor
B6—Manifold Air Temperature (MAT) Sensor
B7—Natural Gas Temperature (NGT) Sensor
B8—Universal Exhaust Gas Oxygen (UEGO) Sensor
B9—Preturbine Pressure (PTP) Sensor
B10—Cam Position Sensor
B11—Oil Pressure Switch
B12—Crank Position Sensor
B13—Communication Connector
F1—Fuse (5A)
F2—Fuse (15A)
F3—Fuse (20A)
F4—Fuse (20A)
F5—Fuse (10A)
F6—Fuse (15A)
F7—Fuse (15A)
K3—Coil Power and Electrical System Relays (2 relays)
W1—Ground (2 wires)
W2—Ground (2 wires)
W3—Ground (1 wire)
X1—Electronic Control Module (ECM) Connector
X2—Electronic Control Module (ECM) Connector
X3—Vehicle Interconnect #3
X4—Vehicle Interconnect #4
X5—Vehicle Interconnect #5
X7—Ignition Control Unit (ICU) Connectors
Y1—Fuel Injector
Y2—Fuel Injector
Y3—Fuel Injector
Y4—Fuel Injector
Y5—Fuel Injector
Y6—Fuel Injector
Y7—Fuel Injector
Y8—Fuel Injector
Y9—Low Pressure Lockoff Solenoid
Y10—Turbocharger Wastegate Control Solenoid
Y11—Electronic Throttle

RG,45,CH143 –19–11FEB98–1/1

CONNECTORS

Connectors are devices that provide for assembly and disassembly of systems. Connectors should always be serviced using tools designed for that type of connector. A good crimp is important to mechanical and electrical soundness. Repaired connectors should be physically tested by pulling to be sure the contact is firmly attached to the conductor.

IMPORTANT: If for some reason the connectors are not connected, it is important to protect the connectors from debris.

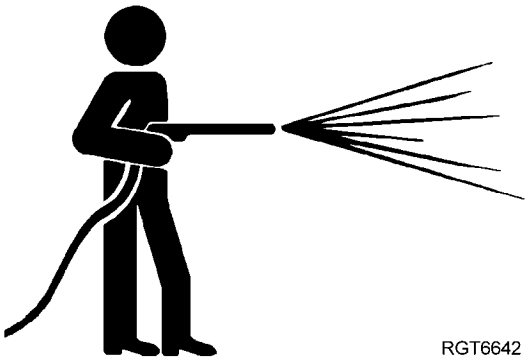
NOTE: See earlier in this group for a diagram showing location of all sensor connectors. For vehicle engines, refer to machine Operation and Tests manual for complete wiring diagrams, including connectors.

Refer to the procedures that follow for repair of various type of connectors.

RG,45,LG97 –19–24NOV97–1/1

USING HIGH-PRESSURE WASHER

IMPORTANT: Reduce pressure when directing pressurized water at electronic or electrical components and connectors as this may cause the components to malfunction. Always reduce pressure, and spray at a 45 to 90 degree angle.



Using High-Pressure Washer

RG,45,LG98 –19–24NOV97–1/1

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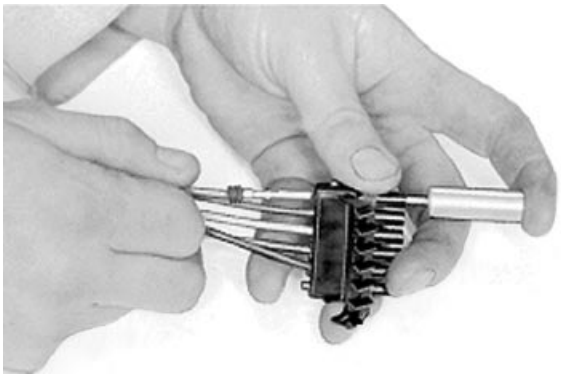
24

REPLACE WEATHER PACK™ CONNECTOR

IMPORTANT: Identify wire color locations with connector terminal letters.

1. Open connector body.
2. Insert JDG364 Extraction Tool[1] over terminal contact in connector body.
3. Hold extractor tool fully seated and pull wire from connector body.

NOTE: If terminal cannot be removed, insert wire or nail through extractor tool handle and push terminal contact from connector.



RGTS0129 –UN–

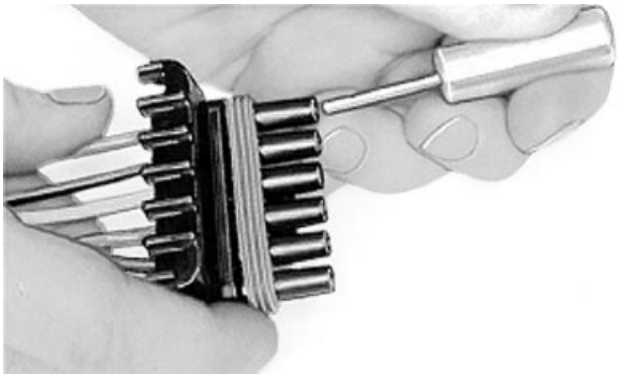
Removing Wire from Weather Pack Connector

WEATHER PACK is a trademark of Packard Electric.

[1]Included in JT07195A Electrical Repair Kit.

ECONN,O –19–03NOV94–1/4

4. Insert JDG364 Extraction Tool over terminal contact in connector body.



RGTS0128 –UN–

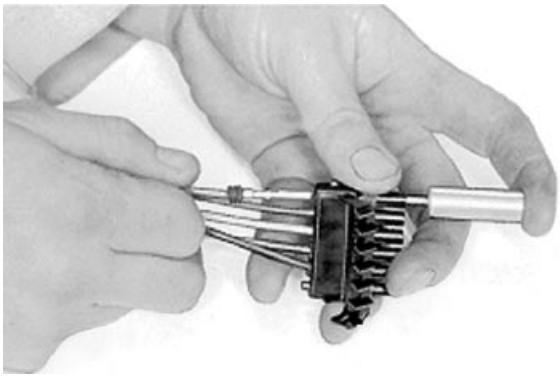
Inserting JDG364 Extraction Tool

Continued on next page

ECONN,O –19–03NOV94–2/4

5. Hold extractor tool fully seated and pull wire from connector body.

NOTE: If terminal cannot be removed, insert wire or nail through extractor tool handle and push terminal contact from connector.



RGTS0129 –UN–

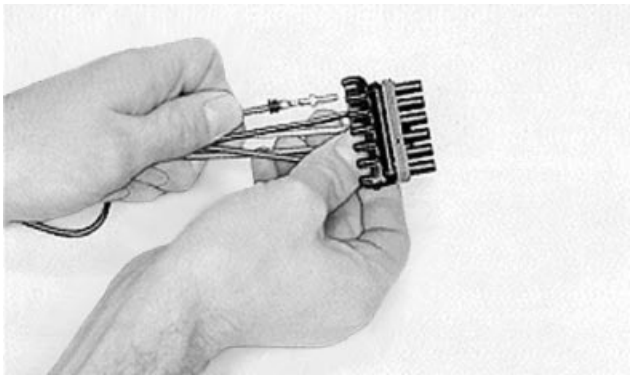
Pulling Wire from Connector Body

ECONN,O –19–03NOV94–3/4

IMPORTANT: Carefully spread contact lances to assure good seating on connector body.

NOTE: Connector bodies are "keyed" for proper contact mating. Be sure contacts are in proper alignment.

6. Push contact into new connector body until fully seated.
7. Pull on wire slightly to insure contact is locked in position.
8. Transfer remaining wires to correct terminal in new connector.
9. Close connector body.



RGTS0130 –UN–

Pushing Contact into Connector Body

ECONN,O –19–03NOV94–4/4

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26

INSTALL WEATHER PACK™ CONTACT

NOTE: Cable seals are color coded for three sizes of wire:

- *Green - 18 to 20 gauge wire*
- *Gray - 14 to 16 gauge wire*
- *Blue - 10 to 12 gauge wire*

1. Slip correct size cable seal on wire.

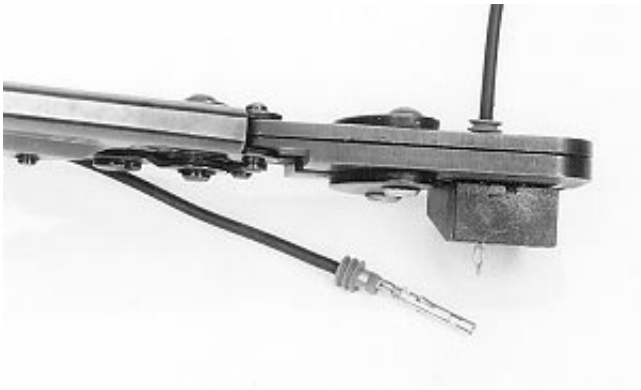
2. Strip insulation from wire to expose 6 mm (1/4 in.) and align cable seal with edge of insulation.

NOTE: Contacts have numbered identification for two sizes of wire:

- *#15 for 14 to 16 gauge wire*
- *#19 for 18 to 20 gauge wire*

3. Put proper size contact on wire and crimp in place with a “W” type crimp, using JDG783 Terminal Applicator.

Correct Size Cable



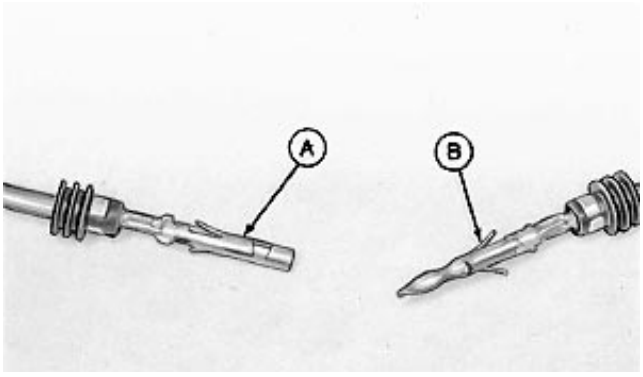
Strip Insulation

WEATHER PACK is a trademark of Packard Electric.

ECONN,AA –19–04JUN90–1/2

IMPORTANT: Proper contact installation for “sleeve” (A) and “pin” (B) is shown.

4. Secure cable seal to contact as shown, using JDG783 Terminal Applicator.

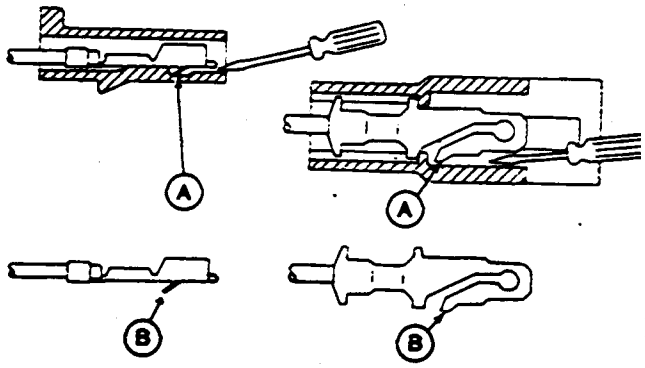


Contact Installation

ECONN,AA –19–04JUN90–2/2

REMOVE CONNECTOR BODY FROM BLADE TERMINALS

1. Depress locking tang (A) on terminal, using a small screw driver. Slide connector body off.
2. Be sure to bend locking tang back to its original position (B) before installing connector body.



RW4218 –UN–

Connector Body and Locking Tang

DX,ECONN,V1 –19–02NOV94–1/1

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REPLACE (PULL TYPE) METRI-PACK™ CONNECTORS

NOTE: The Deere Engine Control Unit (ECU) has this type of connector.

Disconnect the METRI-PACK™ connector (A). Remove tie bands and tape.

Insert a “T” pin (B) 6.4 mm (1/4 in.) into connector body socket (C).

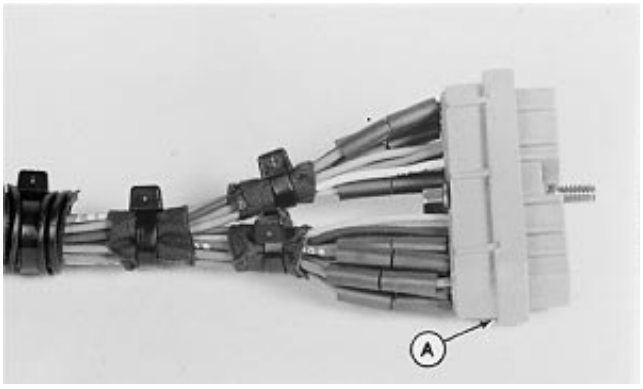
NOTE: Use JDG777 WEATHER PACK™ Extractor (Narrow)[1] or “T” pin to remove terminals.

Remove “T” pin and push terminal (E) out of socket.

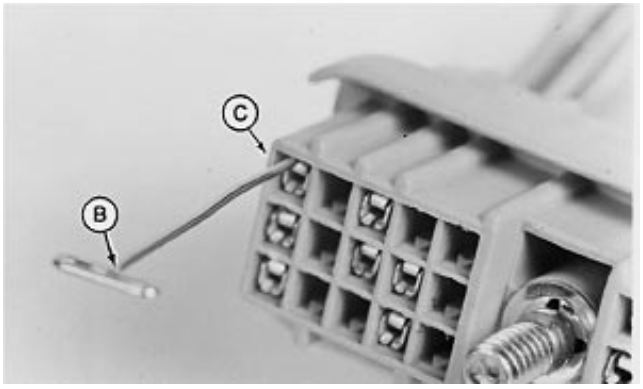
Remove terminal, cut, strip, and crimp wire through connector.

Check to make sure locking tab (D) on new terminal is in outward position, then pull on wire until terminal locks in connector body socket.

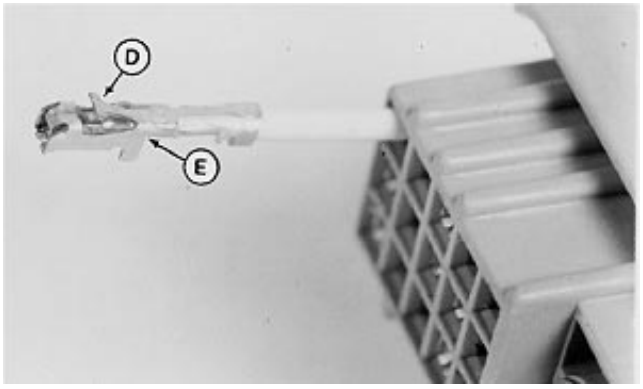
NOTE: Terminal will seat only one way. If terminal does not pull into the connector body socket, check to make sure terminal is aligned correctly.



Disconnect (Pull Type) Connector



Insert T-Pin into Socket



Remove Terminal from Socket

A—Connector
B—“T” Pin
C—Body Socket
D—Locking Tab
E—Push Terminal

METRI-PACK is a trademark of Packard Electric.
WEATHER PACK is a trademark of Packard Electric.

[1]Included in JT07195A Electrical Repair Kit.

RG,45,LG100 –19–24NOV97–1/1

REPLACE (PUSH TYPE) METRI-PACK™ CONNECTORS

Disconnect the METRI-PACK™ connector. Remove the tie bands and tape.

Remove the connector lock (A), and mark wire colors for identification.

Identify wire locations with connector terminal letters.

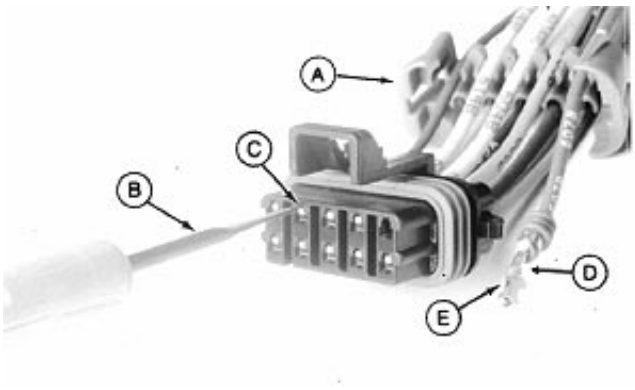
Insert JDG776 or JDG777 WEATHER PACK™ Extractor (B) into connector body socket (C) pushing the terminal locking tab inward.

NOTE: Use JDG776 Extractor (Wide) with 56, 280, and 630 series METRI-PACK™ terminals. Use JDG777 Extractor (Narrow) with 150 series METRI-PACK™ terminals.

Remove extractor and pull terminal (D) out of the socket.

Replace terminal. Make sure locking tab (E) on the new terminal is in the outward position.

Push terminal into connector body socket until terminal locks.



RW21325 –UN–

Replace (Push Type) Connector

A—Connector Lock
B—Extraction Tool JDG777 Included in JT07195A Electrical Repair Kit.
C—Connector Body Socket
D—Terminal
E—Locking Tab

METRI-PACK is a trademark of Packard Electric.
WEATHER PACK is a trademark of Packard Electric.

RG,45,LG101 –19–24NOV97–1/1

USE ELECTRICAL INSULATING COMPOUND

Apply AT66865 Compound directly to the terminals between the wire seal and connector body. This provides a moisture barrier, especially in wet and humid conditions.

TX,45,LG102 –19–24NOV97–1/1

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REPLACE DEUTSCH™ CONNECTORS

Select correct size extractor tool for size of wire to be removed.

- JDG361Extractor Tool[1] for 12 to 14 gauge wire
- JDG362 Extractor Tool[1] for 16 to 18 gauge wire.
- JDG363 Extractor Tool[1] for 20 gauge wire.

DEUTSCH is a trademark of the Deutsch Co.

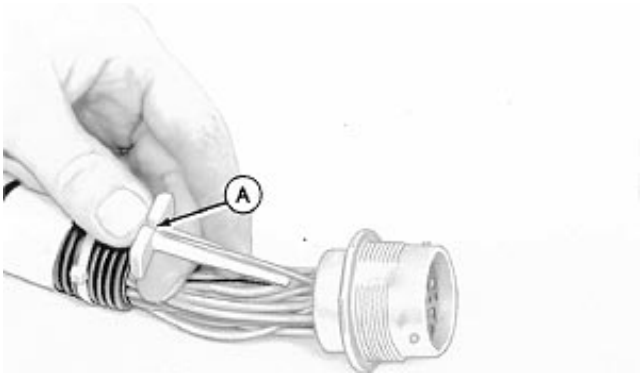
[1]Included in JDG359 DEUTSCH Electrical Repair Kit.

RG,45,LG103 –19–24NOV97–1/6

1. Start correct size extractor tool over wire at handle (A).
2. Slide extractor tool rearward along wire until tool tip snaps onto wire.

IMPORTANT: DO NOT twist tool when inserting in connector.

3. Slide extractor tool along wire into connector body until tool is positioned over terminal contact.
4. Pull wire from connector body using extractor tool.

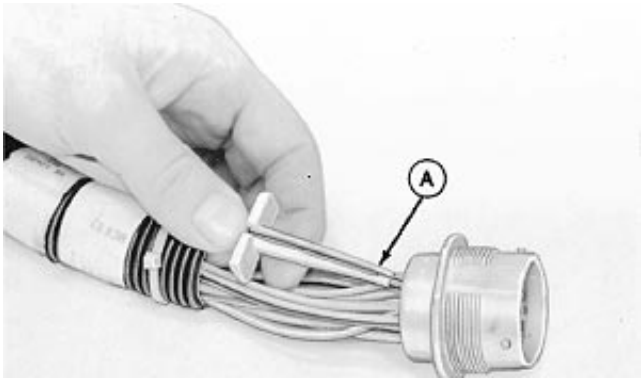


Extractor Tool for DEUTSCH Connectors

Continued on next page

RG,45,LG103 –19–24NOV97–2/6

5. Slide extractor tool rearward along wire until tool tip (A) snaps onto wire.

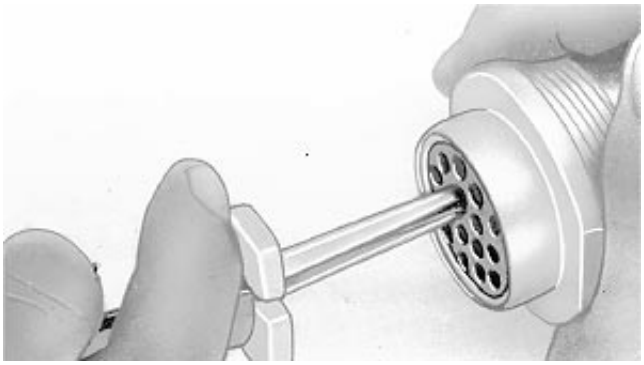


Sliding Extractor Tool Along Wires

RG,45,LG103 –19–24NOV97–3/6

IMPORTANT: DO NOT twist tool when inserting on connector.

6. Slide extractor tool along wire into connector body until tool is positioned over terminal contact.



Extractor Tool Position Over Contact

RG,45,LG103 –19–24NOV97–4/6

7. Pull wire, with extractor tool, from connector body.

Remove Wire from Connector Body

Continued on next page

RG,45,LG103 –19–24NOV97–5/6

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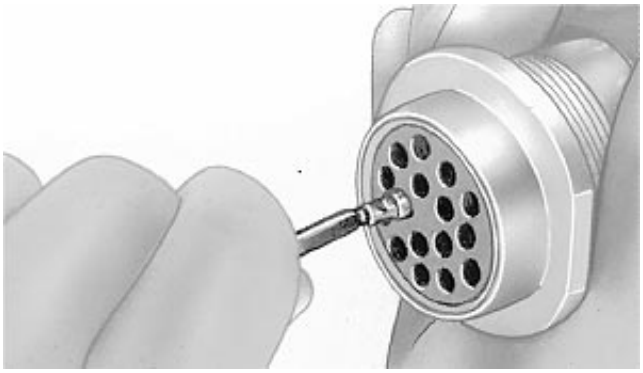
32

IMPORTANT: Install contact in correct location using correct size grommet.

8. Push contact straight into connector body until positive stop is felt.
9. Pull on wire slightly to insure contact is locked in position.
10. Transfer remaining wires to correct terminal in new connector.

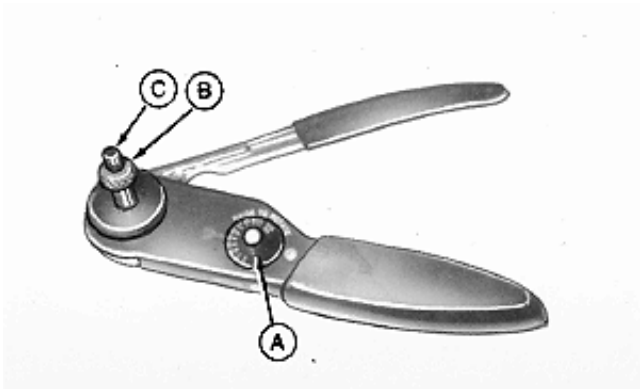


Install Contact in DEUTSCH Connector

RG,45,LG103 –19–24NOV97–6/6

INSTALL DEUTSCH™ CONTACT

1. Strip 6 mm (1/4 in.) insulation from wire.
2. Adjust selector (A) on JDG360 Crimper[1] for correct wire size.
3. Loosen lock nut (B) and turn adjusting screw (C) in until screw stops.



Crimping DEUTSCH Contact

DEUTSCH is a trademark of the Deutsch Co.

[1]Included in JDG359 Deutsch Electrical Repair Kit.

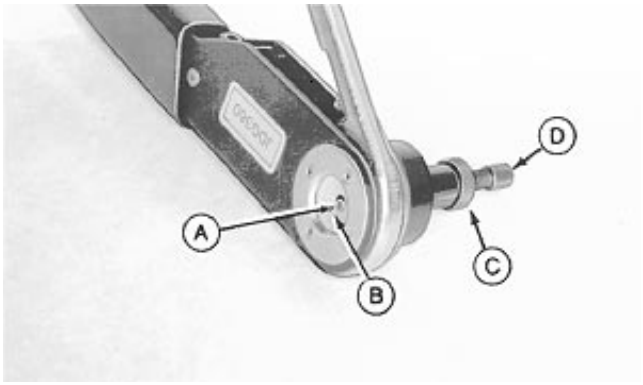
Continued on next page

TX,45,LG104 –19–24NOV97–1/4

IMPORTANT: Select correct size contact sleeve or pin to fit connector body.

4. Insert contact (A) and turn adjusting screw (D) until contact is flush with cover (B).

5. Tighten lock nut (C).



TS0134 –UN–

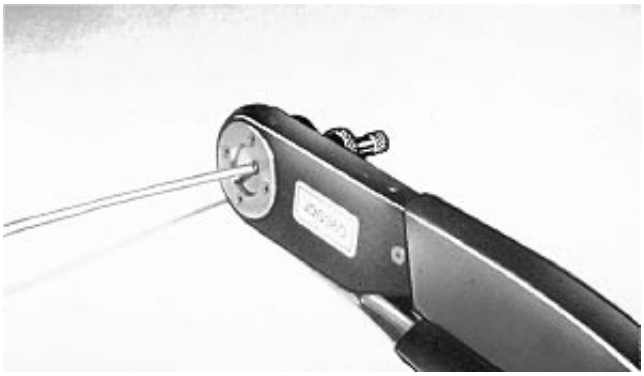
Insert Contact into Crimping Tool

TX,45,LG104 –19–24NOV97–2/4

IMPORTANT: Contact must remain centered between indentors while crimping.

6. Insert wire in contact and crimp until handle touches stop.

7. Release handle and remove contact.



TS118 –UN–

Crimping DEUTSCH Contact

Continued on next page

TX,45,LG104 –19–24NOV97–3/4

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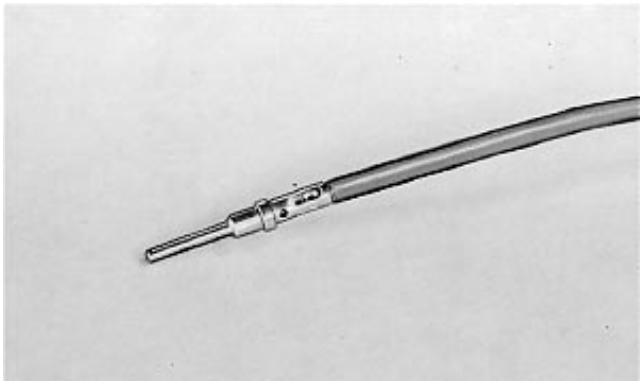
34

IMPORTANT: If all wire strands are not crimped into contact, cut off wire at contact and repeat contact installation procedures.

NOTE: Readjust crimping tool for each crimping procedure.

8. Insert contact to be certain all wires are in crimped barrel.



DEUTSCH Connector Replaced

TX,45,LG104 –19–24NOV97–4/4

OTHER MATERIAL

Number	Name	Use
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to threads of auxiliary drive housing cap screws.

LOCTITE is a trademark of the Loctite Corp.

RG,50,DT7290 –19–05NOV97–1/1

MISCELLANEOUS ACCESSORIES SPECIFICATIONS

TORQUES

Idler Housing Cover Cap Screws	37 N•m (27 lb-ft)
Idler Housing Mounting Cap Screws	95 N•m (70 lb-ft)
Air Compressor-to-Gear Housing Cap Screws	95 N•m (70 lb-ft)
Air Compressor-to-Bracket Cap Screws	40 N•m (30 lb-ft)

RG,50,SO125 –19–11FEB98–1/1

REMOVE AIR COMPRESSOR

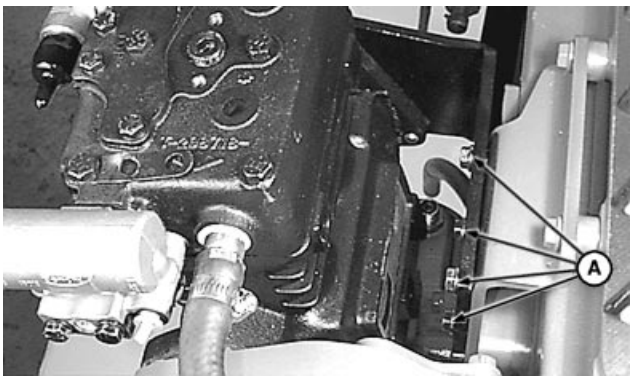
1. Disconnect air and coolant lines from air compressor.
2. Remove oil supply line.

Continued on next page

RG,50,DD8017 –19–09JAN98–1/4

50
2

3. Remove four cap screws (A).

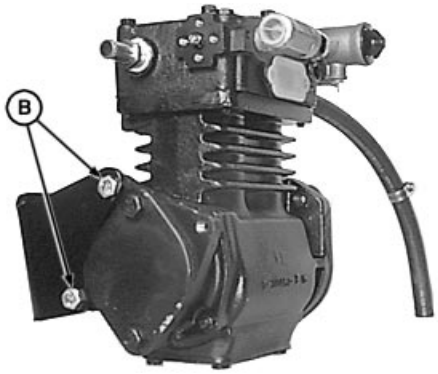


RG8922A –UN–

Removing Air Compressor

RG,50,DD8017 –19–09JAN98–2/4

4. Remove two cap screws (B) from back of compressor bracket.



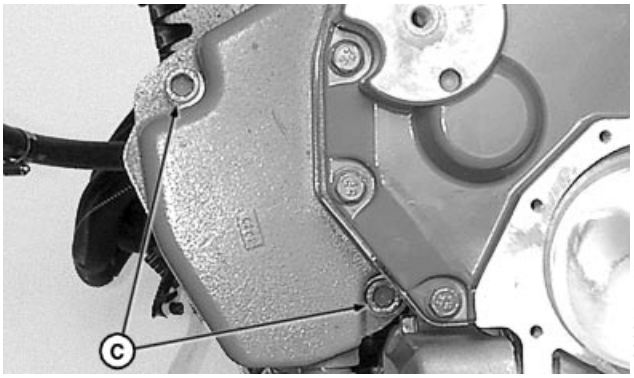
RG8923A –UN–

Removing Air Compressor Bracket

Continued on next page

RG,50,DD8017 –19–09JAN98–3/4

5. Remove two cap screws (C). Remove air compressor from gear housing. Discard gasket.



Removing Air Compressor

RG,50,DD8017 –19–09JAN98–4/4

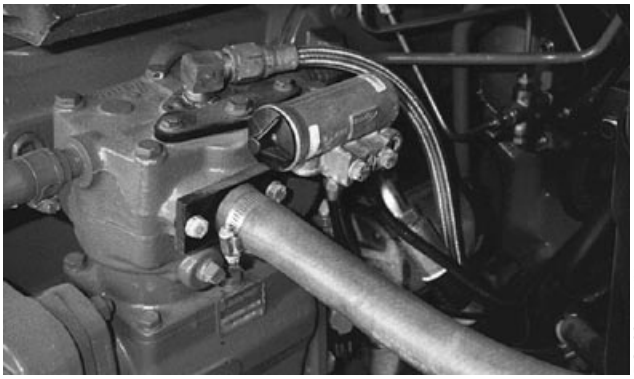
INSPECTING AIR COMPRESSOR

Normal lubrication of air compressor cylinders and piston rings will result in small amount of oil getting into the air system. Normal compressed air temperatures are high enough to result in carboning of the air discharge line.

Relieve pressure from the air system by opening purge valve. Remove and inspect:

- discharge line for carbon build-up
- intake hose
- unloader valve
- governor

Clean lines and components that are fouled with carbon.



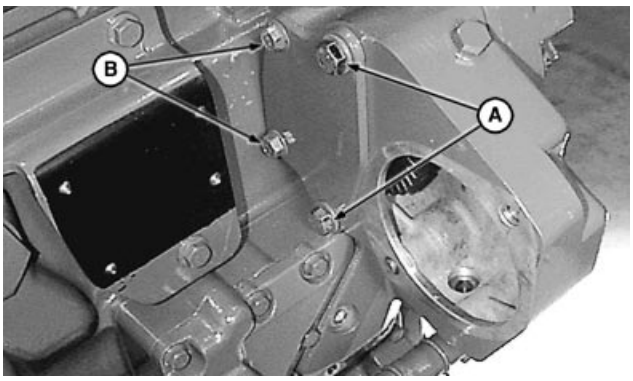
Inspect Air Compressor

RG,50,DT7294 –19–05NOV97–1/1

50
4

REMOVE IDLER HOUSING

1. Remove two cap screws (A) and remove housing.
2. Remove two cover cap screws (B) and remove cover.



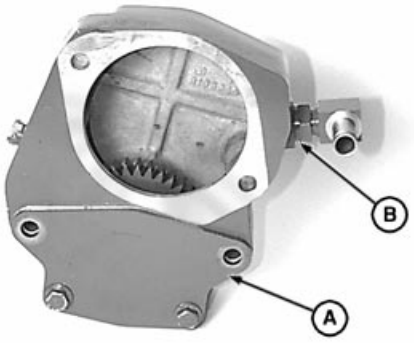
RG8924A –UN–

Removing Idler Housing

RG,50,CH145 –19–16DEC97–1/1

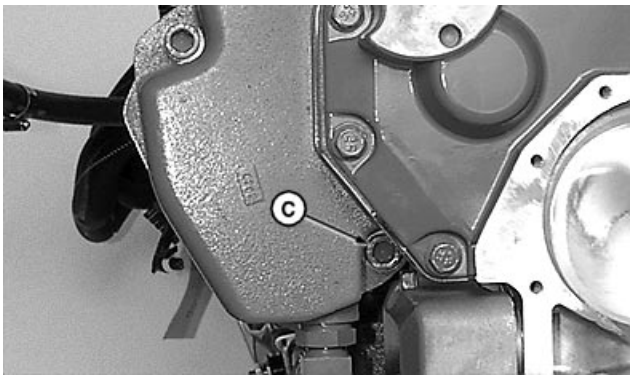
INSTALL IDLER HOUSING

1. Install idler housing cover (A) using two cap screws (B). Torque cap screws to 37 N•m (27 lb-ft).
2. Position gasket on flange along with lower cap screw (C).
3. Install assembly in cylinder block plate. Install two cap screws and washers and torque to 95 N•m (70 lb-ft).
4. Install face seal O-ring in adapter elbow (B) and tighten fitting.



RG8928A –UN–

Installing Idler Housing Cover



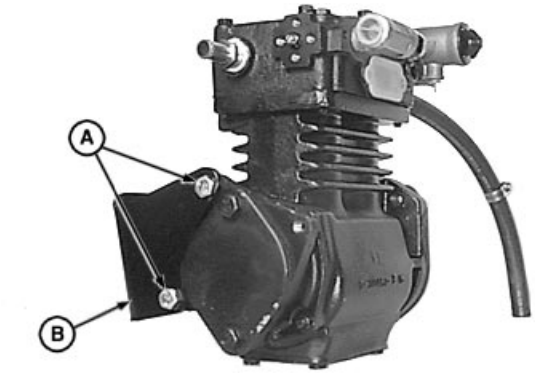
RG8921B –UN–

Installing Idler Housing

RG,50,CH146 –19–16DEC97–1/1

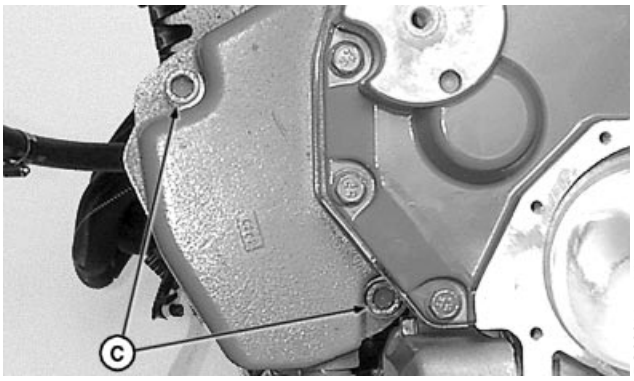
INSTALL AIR COMPRESSOR

1. Loosely install bracket (B) and cap screws (A).
2. Using a new gasket, install the air compressor to the gear housing. Install cap screws (C).
3. Install four cap screws (D).
4. Tighten cap screws (C) to 95 N•m (70 lb-ft) and cap screws (D) to 40 N•m (30 lb-ft).
5. Install oil supply line.
6. Connect air and coolant lines to air compressor.



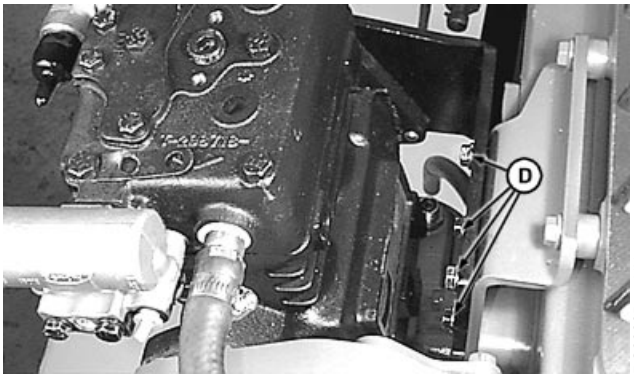
RG8923B –UN–

Installing Bracket



RG8921A –UN–

Installing Compressor



RG8922B –UN–

Installing Compressor Bracket Cap Screws

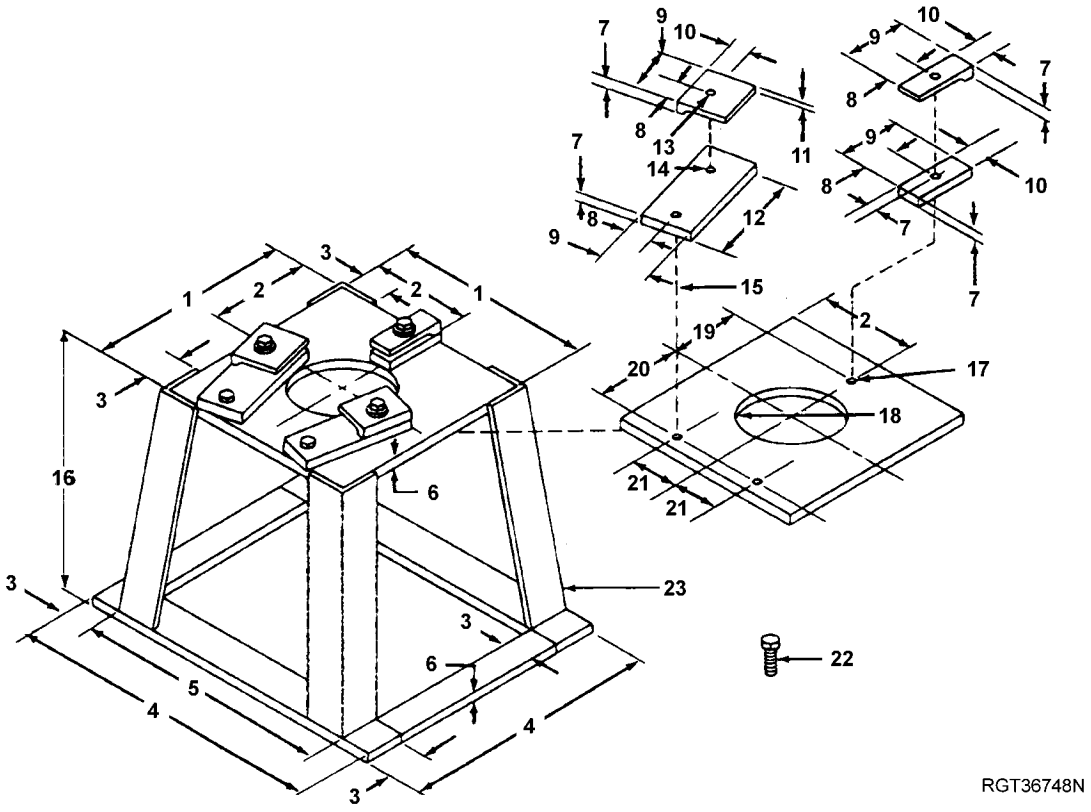
RG,50,CH163 –19–11FEB98–1/1

DEALER FABRICATED TOOLS

These tools can be made in a service shop using common shop tools and locally obtained materials.

RG,198,DT7305 –19–05NOV97–1/1

DFRG3 CYLINDER LINER HOLDING FIXTURE



RGT36748 –UN–

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.) Radius
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.) Screw
19—101.6 mm (4 in.) Angle
20—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

RG,198,DT7306 –19–05NOV97–1/1

Index


SAFETY
live with it