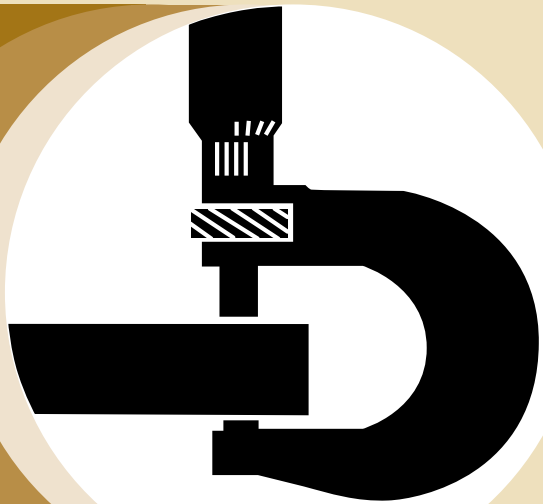
Series 500
6101 Diesel Engines
Serial No. (499999)

COMPONENT TECHNICAL MANUAL



Deere Power Systems Group
CTM20 (20NOV95)
LITHO IN U.S.A.
ENGLISH

JOHN DEERE

DEERE POWER

Series 500
6101 Diesel Engines
Serial Number (—499999)

CTM20 (20NOV95)

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

This manual is divided in two parts: repair and operation and tests. Repair sections contain necessary instructions to repair the component. Operation and tests sections help you identify the majority of routine failures quickly.

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

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

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

DX,CTMIFC -19-22MAY92

ABOUT THIS MANUAL

This Component Technical Manual (CTM20) covers the recommended repair procedure for all 6101, 10.1 L (619 cu. in.) diesel engines Serial No. (—499999), produced in Waterloo, Iowa. Before beginning repair of an engine, clean engine and mount on a repair stand. (See Group 03.)

This manual contains SI Metric units of measure, followed immediately by the U.S. customary units of measure.

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 module completely before performing service to check for differences in procedure or specifications. Follow only the procedures that apply to the engine model number you are working on. If only one procedure is given, that procedure applies to all 6101 diesel engines in this manual.

S55,0000,K -19-17NOV95

HANDLE FLUIDS SAFELY—AVOID FIRES

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

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

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

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

TS227 -UN-23AUG88

DX,FLAME -19-04JUN90

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-23AUG88

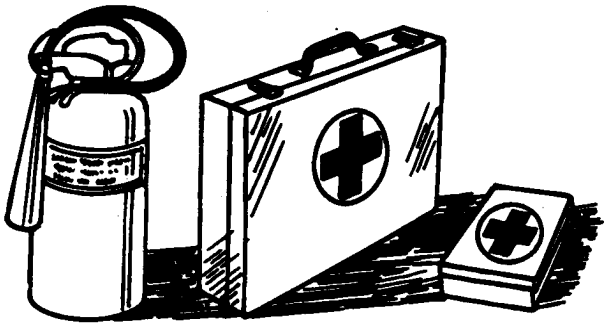
DX,SPARKS -19-03MAR93

PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

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



TS291 -UN-23AUG88

DX,FIRE2 -19-03MAR93

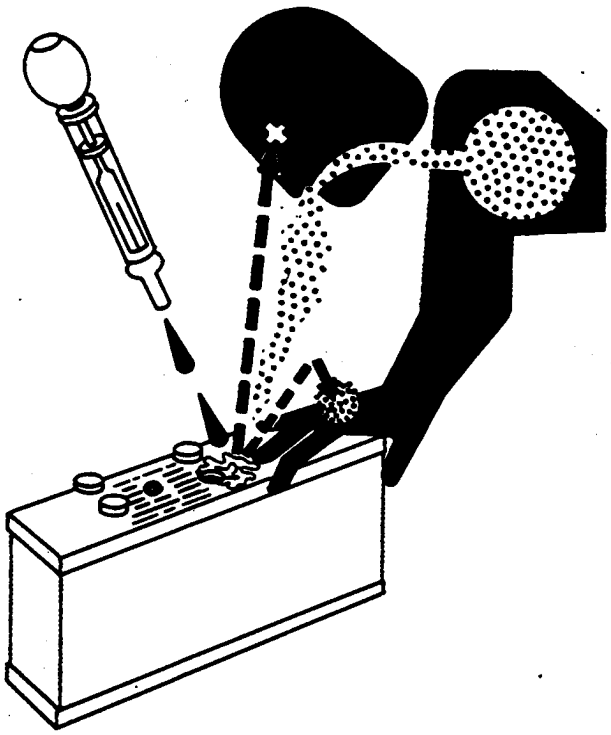
PREVENT ACID BURNS

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.

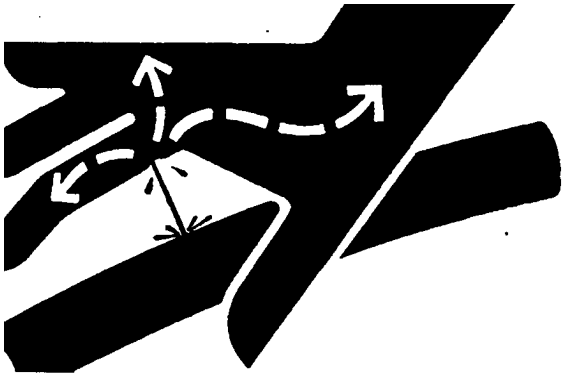
If acid is swallowed:
1. Do not induce vomiting.
2. Drink large amounts of water or milk, but do not exceed 2 L (2 quarts).
3. Get medical attention immediately.



TS203 -UN-23AUG88

DX,POISON -19-21APR93

AVOID HIGH-PRESSURE FLUIDS



X9811 -UN-23AUG88

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

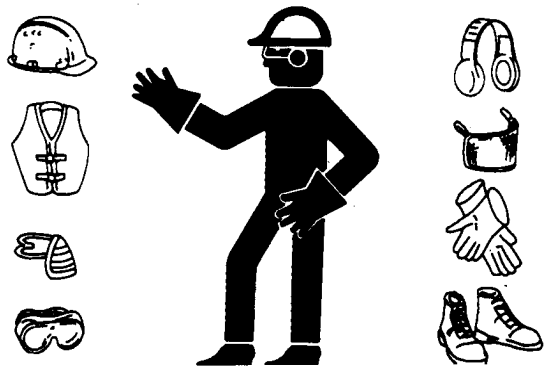
Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

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

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

DX,FLUID -19-03MAR93

WEAR PROTECTIVE CLOTHING



TS206 -UN-23AUG88

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

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

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

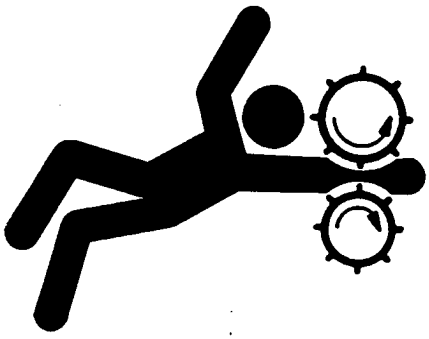
Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.

DX,WEAR -19-10SEP90

SERVICE MACHINES SAFELY

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

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



TS228 -UN-23AUG88

DX,LOOSE -19-04JUN90

WORK IN VENTILATED AREA

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

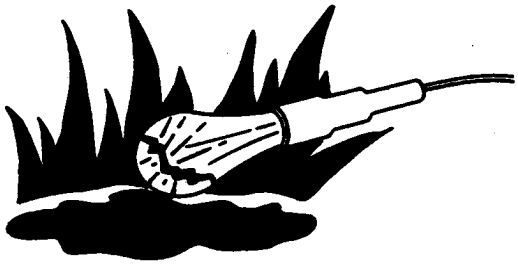
If you do not have an exhaust pipe extension, open the doors and get outside air into the area.

TS220 -UN-23AUG88

DX,AIR -19-04JUN90

ILLUMINATE WORK AREA SAFELY

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



TS223 -UN-23AUG88

DX,LIGHT -19-04JUN90

REMOVE PAINT BEFORE WELDING OR HEATING

TS220 -UN-23AUG88

Avoid potentially toxic fumes and dust.

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

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.

DX,PAINT -19-03MAR93

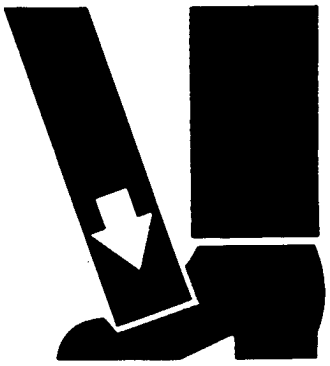
AVOID HEATING NEAR PRESSURIZED FLUID LINES

TS953 -UN-15MAY90

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

DX,TORCH -19-03MAR93

USE PROPER LIFTING EQUIPMENT



TS226 -UN-23AUG88

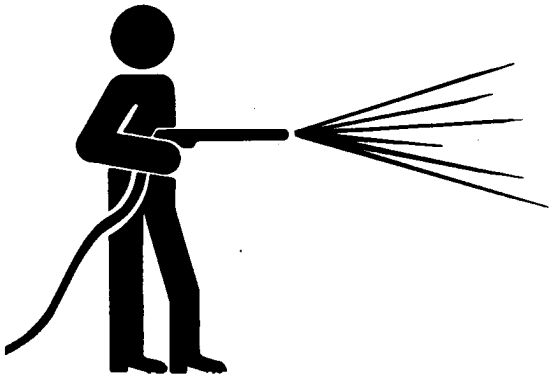
Lifting heavy components incorrectly can cause severe injury or machine damage.

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

DX,LIFT -19-04JUN90

WORK IN CLEAN AREA

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



T6642EJ -UN-18OCT88

DX,CLEAN -19-04JUN90

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-23AUG88

DX,SERV -19-03MAR93

USE PROPER TOOLS

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

Use power tools only to loosen threaded parts and fasteners.

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

Use only service parts meeting John Deere specifications.

TS779 -UN-08NOV89

DX,REPAIR -19-04JUN90

DISPOSE OF WASTE PROPERLY

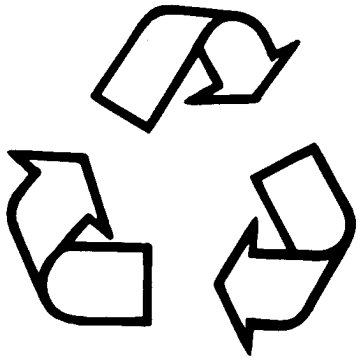
Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries.

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

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

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

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



TS1133 -UN-26NOV90

DX,DRAIN -19-03MAR93

LIVE WITH SAFETY

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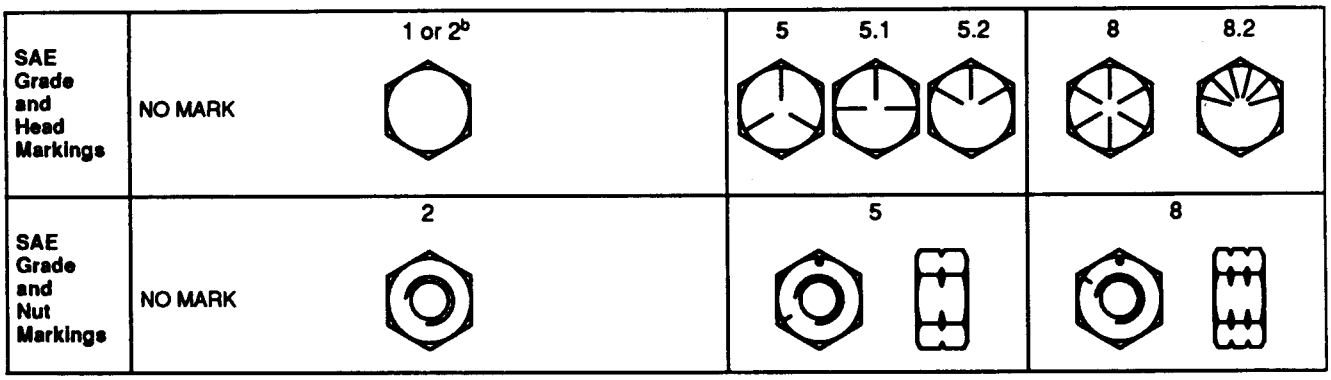
8

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

TS231 -19-07OCT88

DX,LIVE -19-25SEP92

UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES



TS1162 -19-04MAR91

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.

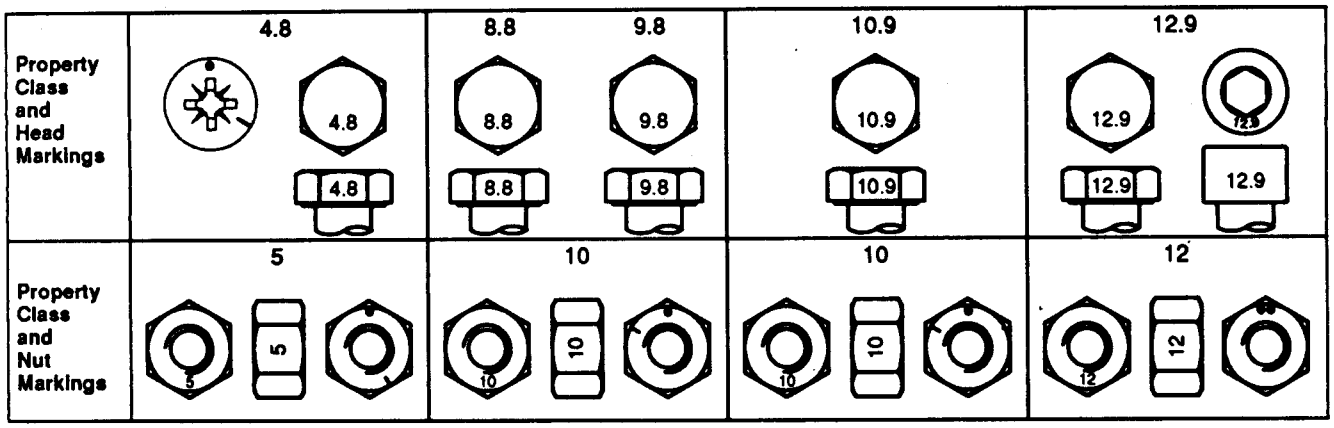
Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

[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.

DX,TORQ1 -19-20JUL94

METRIC BOLT AND CAP SCREW TORQUE VALUES



-19-04MAR91
TS1163

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

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

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

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

Make sure 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.

DX,TORQ2 -19-20JUL94

ENGINE MODEL DESIGNATION

JOHN DEERE ENGINE MODEL—6101 ENGINES

Engine model designation includes number of cylinders, displacement in liters, aspiration, and application code. For example:

6101HRW01 ENGINE

6 . . . . . Number of cylinders (C)
101 . . . . . Liter displacement (10.1)
H . . . . . Aspiration code
RW . . . . . User factory code (1 or 2 digits)
01 . . . . . Application (2 or 3 digits)

Aspiration Code

A . . . . . Turbocharged and liquid-to-air aftercooled
H . . . . . Turbocharged and air-to-air aftercooled

JD User Factory Code

RW . . . . . Waterloo Works Vehicle Assembly Div.*
T . . . . . Dubuque

Application Code

01 . . . . . 8760 Tractor w/Standard Governor
02 . . . . . 8760 Tractor w/Electronic Governor

**Formerly Waterloo Tractor Works*

S55,0000,K1 -19-14JUN89

ENGINE NAMEPLATE INFORMATION

1. Engine Serial Number (A)

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

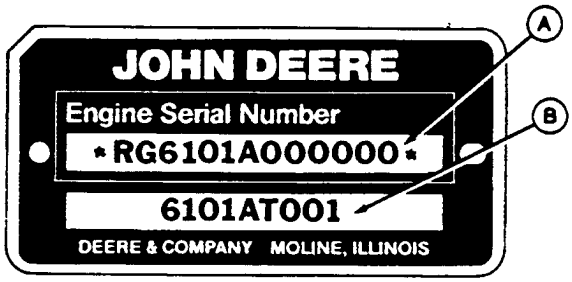
RG6101A000000
RG6101H000000

RG . . . . . Factory code producing
6101A/6101H . . . . . Engine Model designation
000000 . . . . . Sequential number

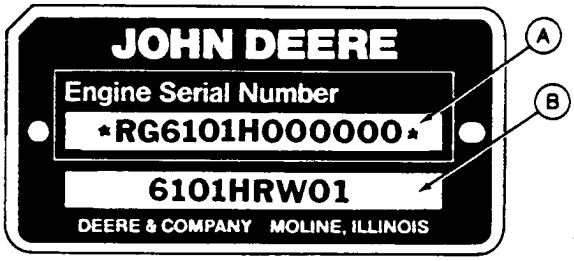
Factory Code Producing Engine
RG . . . . . Waterloo Engine Works

Engine Model Designation
6101A/6101H . . . . . Definition explained previously
See Engine Model Designation)

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



RG5541 -19-21JUL89



RG5542 -19-21JUL89

2. Engine Application Data (B)

The second line of information on the nameplate identifies the engine/machine relationship. (See “Engine application Chart” later in this group.)

S55,0000,L -19-17NOV95

6101 ENGINE APPLICATION CHART

Machine Model No.	Engine Model
John Deere Agricultural Equipment Applications	
Tractors	
8760	6101HRW01, 02
John Deere Industrial Equipment Applications	
744E Loader	6101AT001

S55,0000,M -19-17NOV95

BASIC 6101 ENGINE SPECIFICATIONS

Item	Unit of Measure	6101A	6101H
Number of Cylinders	--	6	6
Fuel	--	Diesel	Diesel
Bore	mm (in.)	130 (5.12)	130 (5.12)
Stroke	mm (in.)	127 (5)	127 (5)
Displacement	L (cu. in.)	10.15 (619)	10.15 (619)
Piston Speed	m/min (ft/min)	533 (1750)	533 (1750)
Compression Ratio	--	14.7:1	14.7:1
Firing Order	--	1-5-3-6-2-4	1-5-3-6-2-4
Rated Speed	rpm	2100	2100
Slow Idle Speed	rpm	800	800
Normal Working Range (Std. Gov.)	rpm	1400-2100	1400-2100
Number of Mains	--	7	7
Main ID	mm (in.)	95.2 (3.75)	95.2 (3.75)
Main Width	mm (in.)	36.6 (1.44)	36.6 (1.44)
Thrust Width	mm (in.)	40.7 (1.60)	40.7 (1.60)
Rod Journal OD	mm (in.)	88.9 (3.50)	88.9 (3.50)
Rod Journal Width	mm (in.)	47.6 (1.87)	47.6 (1.87)
FUEL SYSTEM			
Supply Pump Pressure	kPa (bar) (psi)	200 (2.0) (29)	200 (2.0) (29)
Injection Nozzle Size	mm	21	21
Fuel Filter Area	cm^2 (sq in.)	3,542 (549)	3.542 (549)
Filter Particle Size - 97% Efficiency	Microns	12—15	12—15
LUBRICATION SYSTEM			
Pump Capacity	L/min (gpm)	109.5 (29)	109.5 (29)
Oil Pressure-Slow Idle	kPa (psi)	206 (30)	206 (30)
-Rated Speed	kPa (psi)	310 (45)	310 (45)

S55,0000,N -19-17NOV95

DIESEL FUEL

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

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

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

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

• **Cetane Number 40 minimum.** Cetane number greater than 50 is preferred, especially for temperatures below -20° C (-4° F) or elevations above 1500 m (5000 ft).

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

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

Bio-diesel fuels meeting DIN 51606 or equivalent specification may be used.

RG,FUEL1 -19-06OCT95

LUBRICITY OF DIESEL FUELS

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

Diesel fuels for highway use in the United States now require sulfur content less than 0.05%. Diesel fuel in the European Union will require sulfur content less than 0.05% by 1 October 1996.

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

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

Fuel lubricity should pass a minimum of 3300 gram load level as measured by the BOCLE scuffing test.

ASTM D975 and EN 590 specifications do not require fuels to pass a fuel lubricity test. Diesel fuels meeting U.S. Military Specification VV—F—800E pass a fuel lubricity test.

If fuel of low or unknown lubricity is used, add John Deere ALL-SEASON DIESEL FUEL CONDITIONER or equivalent at the specified concentration.

RG,FUEL5 -19-06OCT95

ENGINE BREAK-IN OIL

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

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

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

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

- API Service Classification CE
- CCMC Specification D4

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

IMPORTANT: Do not use John Deere PLUS-50 oil or engine oils meeting API CG4, API CF4, or CCMC D5 performance levels during the first 100 hours of operation of a new or rebuilt engine. These oils will not allow the engine to break-in properly.

DX,ENOIL4 -19-17OCT94

DIESEL ENGINE OIL

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

The following oil is preferred.

- **John Deere PLUS-50®**

If John Deere PLUS-50 engine oil and a John Deere oil filter are used, the service interval for oil and filter changes may be extended by 50 hours.

The following oil is also recommended:

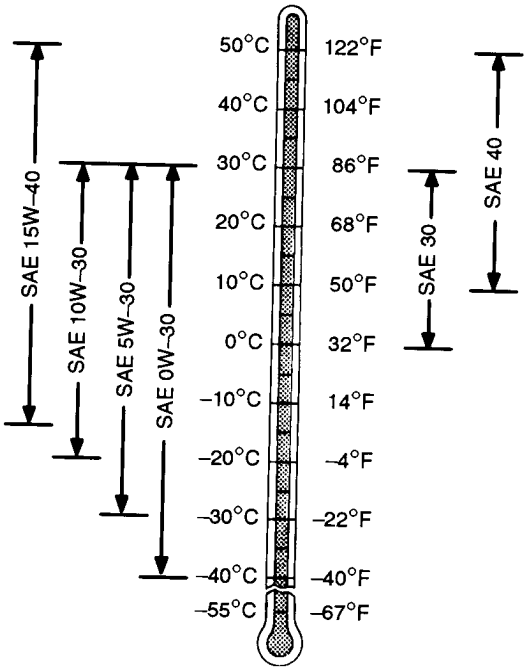
- John Deere TORQ-GARD SUPREME®

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

- John Deere UNI-GARD™
- API Service Classification CG-4
- API Service Classification CF-4
- API Service Classification CE
- CCMC Specification D5 and Mercedes Benz MB228.3
- CCMC Specification D4 and Mercedes Benz MB228.1

Viscosity grade SAE 15W-40 is preferred.

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



TS1619 -UN-12SEP94

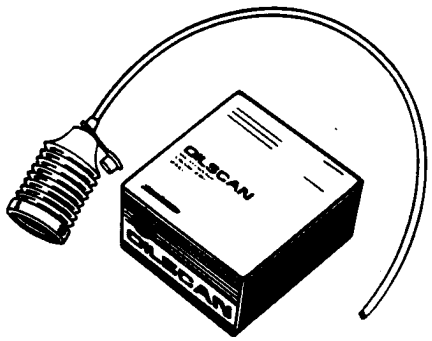
DX,ENOIL -19-16SEP94

OILSCAN® AND COOLSCAN™

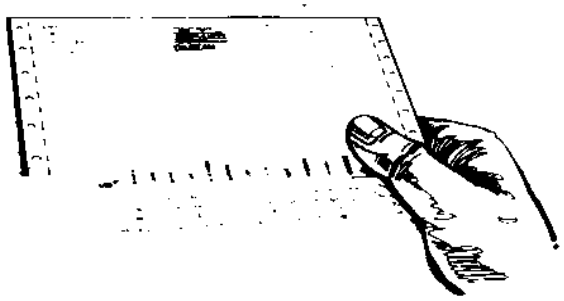
OILSCAN and COOLSCAN are John Deere sampling programs to help you monitor machine performance and identify potential problems before they cause serious damage.

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

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



T6828AB -UN-15JUN89



T6829AB -UN-18OCT88

DX,OILSCAN -19-16APR92

ALTERNATIVE AND SYNTHETIC LUBRICANTS

Conditions in certain geographical areas may require lubricant recommendations different from those printed in this manual. Some John Deere lubricants may not be available in your location. Consult your John Deere dealer to obtain information and recommendations.

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

DX,ALTER -19-01FEB94

GREASE

Use grease based on the expected air temperature range during the service interval.

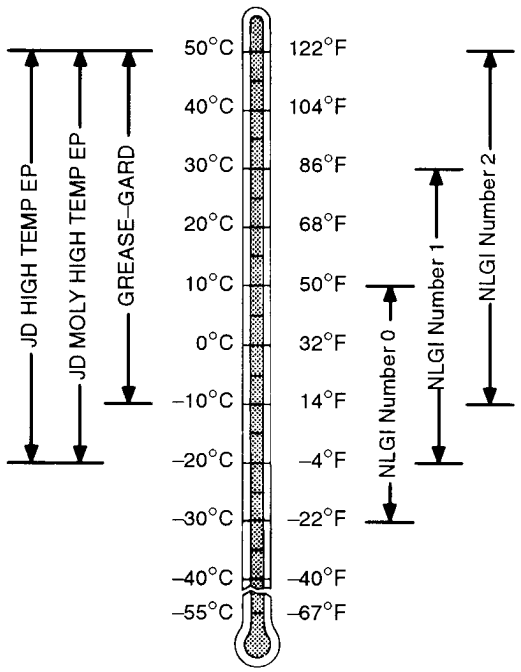
The following greases are preferred:

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

Other greases may be used if they meet one of the following:

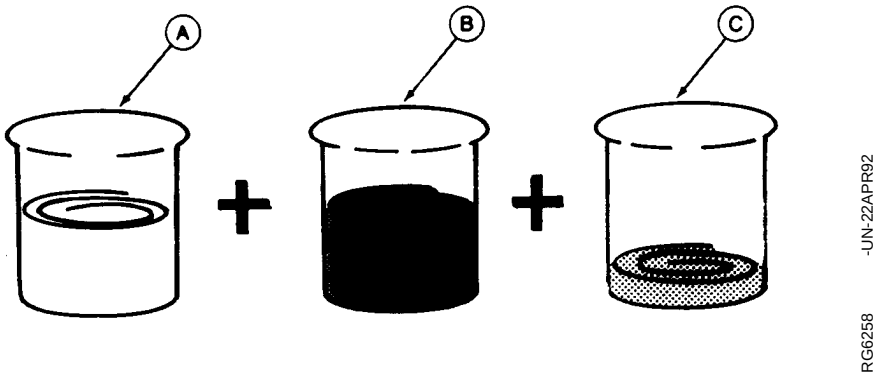
- SAE Multipurpose EP Grease with a maximum of 5% molybdenum disulfide
- SAE Multipurpose EP Grease

Greases meeting Military Specification MIL-G-10924F may be used as arctic grease.



DX,GREA1 -19-02NOV94

ENGINE COOLANT REQUIREMENTS



A—Quality Water

B—Ethylene Glycol Concentrate (Antifreeze)

C—Supplemental Coolant Additives (SCA's)

Engine Coolant

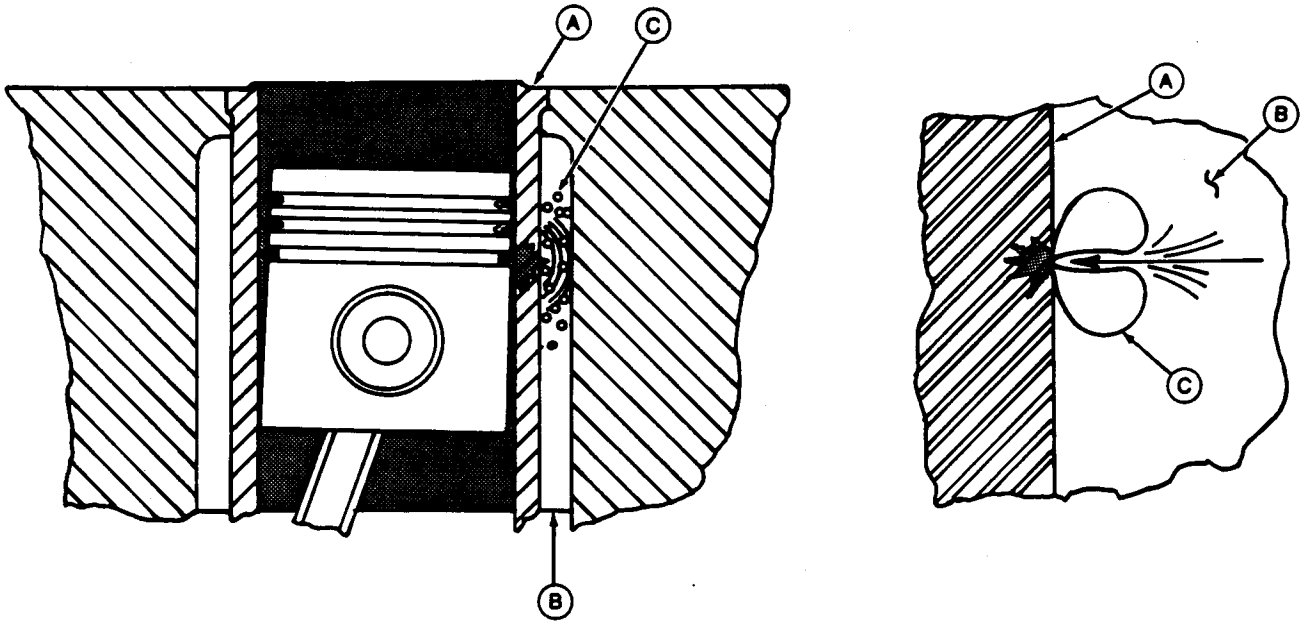
To meet cooling system protection requirements, the coolant MUST consist of a 50/50 mixture of quality water and ethylene glycol concentrate (antifreeze). Supplemental coolant additives (SCA's) must be added to this mixture. Add 3% (by volume) TY16004 or TY16005 Liquid Coolant Conditioner. If an equivalent product is used, always follow the supplier's recommendations printed on the container. See ENGINE COOLANT SPECIFICATIONS, later in this group, for further definition.

Makeup of the coolant between changes MUST consist of the same requirements as during a complete change. Performing a CoolScan analysis is the recommended method for determining the amount of quality water, ethylene glycol concentrate, and supplemental coolant additives that should be added.

IMPORTANT: Supplemental coolant additives MUST be added to the coolant solution. Ethylene glycol concentrate (antifreeze) DOES NOT contain chemical inhibitors needed to control liner pitting or erosion, rust, scale, and acidity.

RG,COOL1 -19-01NOV95

ENGINE COOLANT REQUIREMENTS—CONTINUED



RG6263 -UN-22APR92

A—Cylinder Liner Walls **B—Engine Coolant** **C—Vapor Bubbles**

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

Water pump impellers and cylinder liner walls (A) which are in contact with engine coolant (B) can be eroded or pitted unless the proper concentration and type of SCA's are present in the coolant solution.

Vapor bubbles (C) are formed when piston impacts against liner ID causing walls to vibrate; sending compression waves into the coolant.

Erosion or pitting is caused by the formation and collapse of tiny vapor bubbles in the coolant on the surface of metal parts. Over a period of time, this pitting will progress completely through the metal. Generally, the most critical erosion occurs in the cylinder liner area of wet-sleeve, heavy-duty engines. If coolant is allowed to enter the combustion chamber, engine failure or other serious damage will result.

Use of SCA's will reduce the effects of erosion and pitting. The chemicals in the additives form a protective film on cylinder liner surface. This film acts as a barrier against collapsing vapor bubbles and also reduces the quantity of bubbles formed.

RG,COOL1A -19-06OCT95

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, non-corrosive environment for seals, hoses and metal engine parts.

John Deere Prediluted Antifreeze/Summer Coolant is preferred. John Deere Antifreeze/Summer Coolant Concentrate and John Deere COOL-GARD™, where available, are also recommended.

Refer to your vehicle operator's manual for the service life of these products.

• 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 (SCA's). It is ready to use; no mixing is required.

• JOHN DEERE ANTIFREEZE/SUMMER COOLANT CONCENTRATE

This product contains ethylene glycol (low silicate antifreeze) and supplemental coolant additives (SCA's). 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 COOL-GARD™

In certain geographical areas, John Deere COOL-GARD is marketed for use in the engine cooling system. 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 (SCA's). It is ready to add to cooling system as is; no mixing or supplemental coolant additives required. Contact your John Deere Parts Network for local availability.

RG,COOL2,CTM -19-06OCT95

ENGINE COOLANT SPECIFICATIONS

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

If John Deere coolant products are not used, other low silicate ethylene glycol base coolants for heavy-duty diesel engines may be used when mixed with quality water and supplemental coolant additives (SCA's), 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 (SCA's), formulated for heavy-duty diesel engines, for protection against corrosion and cylinder liner erosion and pitting.

Water Quality:

Distilled, de-ionized, or demineralized water is preferred for use in cooling systems. Mineral (hard/tap) water should NEVER be put in a cooling system unless first tested. However, water that meets the following water quality specifications is acceptable.

Water Quality Specifications

Item	Parts Per Million	Grains Per 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	

If Chlorides, Sulfates, or Total Dissolved Solids are higher than the above given specifications, the water must be distilled, de-mineralized, or de-ionized before using in cooling system.

If Total Hardness is higher than the above given specification and all other parameters are within the given specifications, the water must be softened before using in cooling system.

Ethylene Glycol Concentrate (Antifreeze):

IMPORTANT: DO NOT use ethylene glycol concentrate containing sealer or stop-leak additives.

RG,COOL3 -19-06OCT95

ENGINE COOLANT SPECIFICATIONS—CONTINUED

-UN-13FEB95
RG7298

Supplemental Coolant Additives (SCA's):

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.

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

Inhibit the antifreeze-coolant mix with a non-chromate inhibitor such as John Deere Liquid Coolant Conditioner. SCA's guard against rust, corrosion, and liner pitting. ALWAYS follow the supplier's recommendations printed on the container.

John Deere Liquid Coolant Conditioner is available in the following sizes:

—TY16004 473 mL (16 oz) container
—TY16005 3.8 L (1 US gal) container

IMPORTANT: Check inhibitors between drain intervals. Replenish inhibitors by the addition of a supplemental coolant additive as necessary. See your vehicle operator's manual for details.

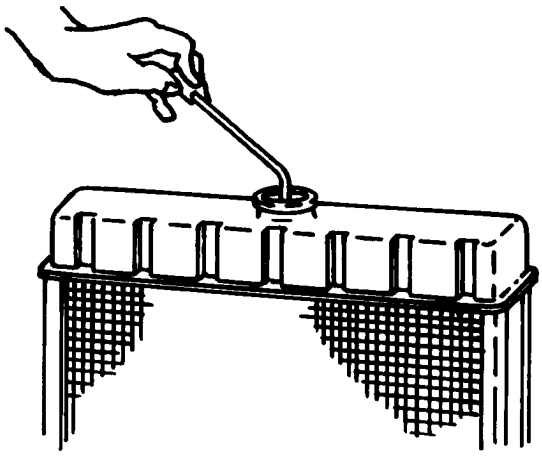
DO NOT use soluble oil.

Additives eventually lose their effectiveness and must be recharged with additional liquid coolant conditioner. See label on container for recommended service intervals and concentration rates. See REPLENISHING SUPPLEMENTAL COOLANT ADDITIVES (SCA'S) BETWEEN COOLANT CHANGES, later in this group.

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

RG,COOL3A,CTM -19-06OCT95

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



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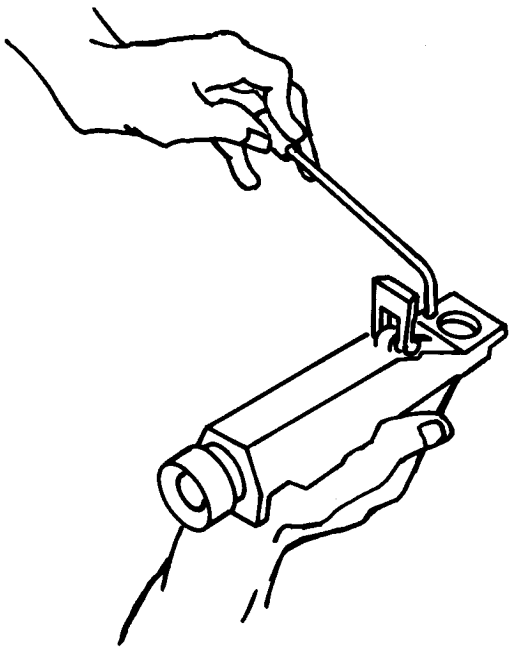


RG6262 -UN-22APR92

Through time and use, original additives eventually lose their effectiveness and must be recharged with additional supplemental coolant additives available in the form of liquid coolant conditioner.

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

A coolant strip test, available from your dealer, provides a simple, effective way to check freeze point and molybdate/nitrite levels. These results can be compared to the SCA chart to determine the amount of coolant conditioner in your system.

NOTE: Refer to your vehicle operator's manual for specific service intervals for checking and charging your coolant.

For a more thorough evaluation of your coolant, perform a CoolScan analysis. If a CoolScan analysis is not available, recharge system per instructions printed on label of TY16004 or TY16005 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 make-up 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.

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

RG,COOL4,CTM -19-06OCT95

OPERATING IN TROPICAL CONDITIONS

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

IMPORTANT: Water only may be used as coolant in emergency situations only. Foaming and hot surface aluminum and iron corrosion, scaling, cavitation, will occur when water is used as the coolant, even when coolant conditioners are added. Drain system and refill the cooling system with recommended glycol base engine coolant as soon as possible.

02
12

RG,COOL6,CTM -19-01NOV95

FLUSH AND SERVICE COOLING SYSTEM

TS281 -UN-23AUG88

02
13

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

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

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

The ethylene glycol base (antifreeze) can become depleted of SCA's 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 within 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 and replace thermostats as described in your operator's manual. Clean cooling system with clean water and TY15979 John Deere Heavy-Duty Cooling System Cleaner or an equivalent cleaner such as FLEETGUARD® RESTORE™. Follow the instructions provided with the cleaner. Refill cooling system with the appropriate coolant solution. See ENGINE COOLANT SPECIFICATIONS, earlier in this group.

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.

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 authorized servicing dealer or engine distributor, if there are further questions.

FLEETGUARD® is a registered trademark of Cummins Engine Company.

RESTORE™ is a trademark of FLEETGUARD®.

RG,COOL,REQ8B -19-17AUG94

DISPOSING OF COOLANT

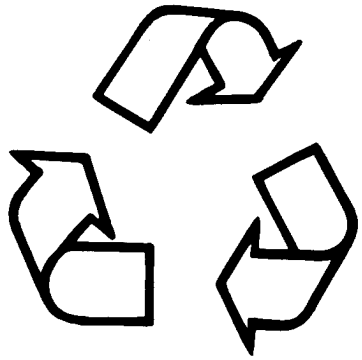
Improperly disposing of engine coolant can threaten the environment and ecology.

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

02
14

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 John Deere dealer.

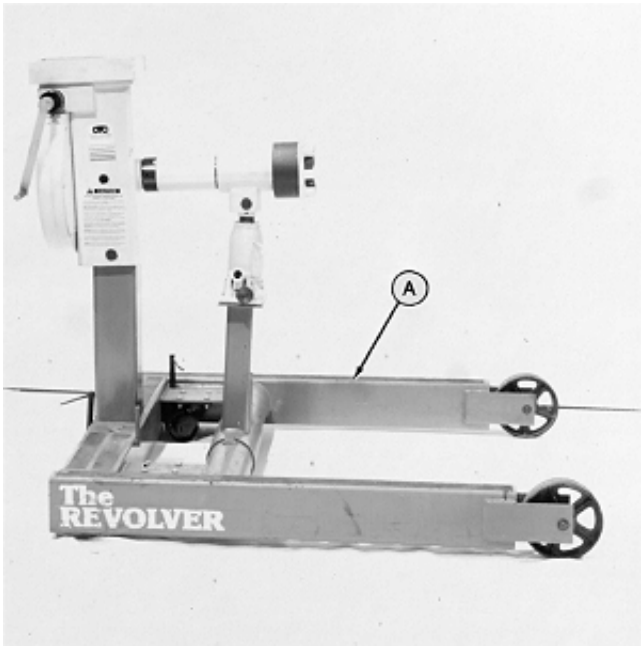


TS1133 -UN-26NOV90

RG,COOL5 -19-06OCT95

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.



RG4929 -UN-15DEC88

S11,2000,EM -19-08MAR94

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 cap screws must be used to mount adapters and engine to repair stand. Use LOCTITE 242 Thread Lock and Sealer on cap screws when installing lifting straps on engine. Tighten cap screws to 245 N·m (180 lb-ft).

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

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

• To avoid an unsafe off-balance load condition, the center of balance of an engine must be located within 51 mm (2 in.) of the engine stand rotating shaft. Engine center of balance is generally located a few millimeters above the crankshaft.

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

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

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

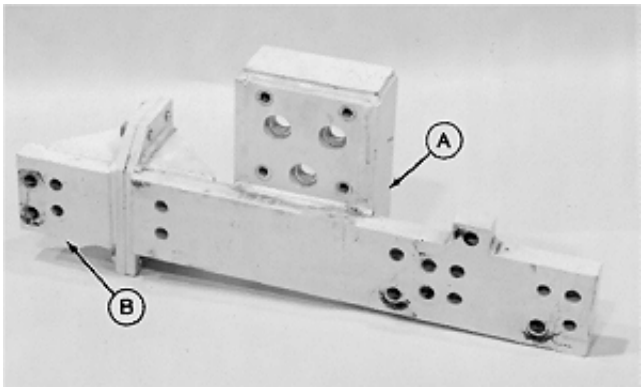
• To prevent possible personal injury due to sudden engine movement, lower engine by operating jack release valve slowly. Do not unscrew release valve knob more than two turns from its closed position.

LOCTITE® is a registered trademark of Loctite Corporation.

S11,2000,DZ -19-06OCT95

INSTALL 500 SERIES ENGINE ADAPTERS ON REPAIR STAND

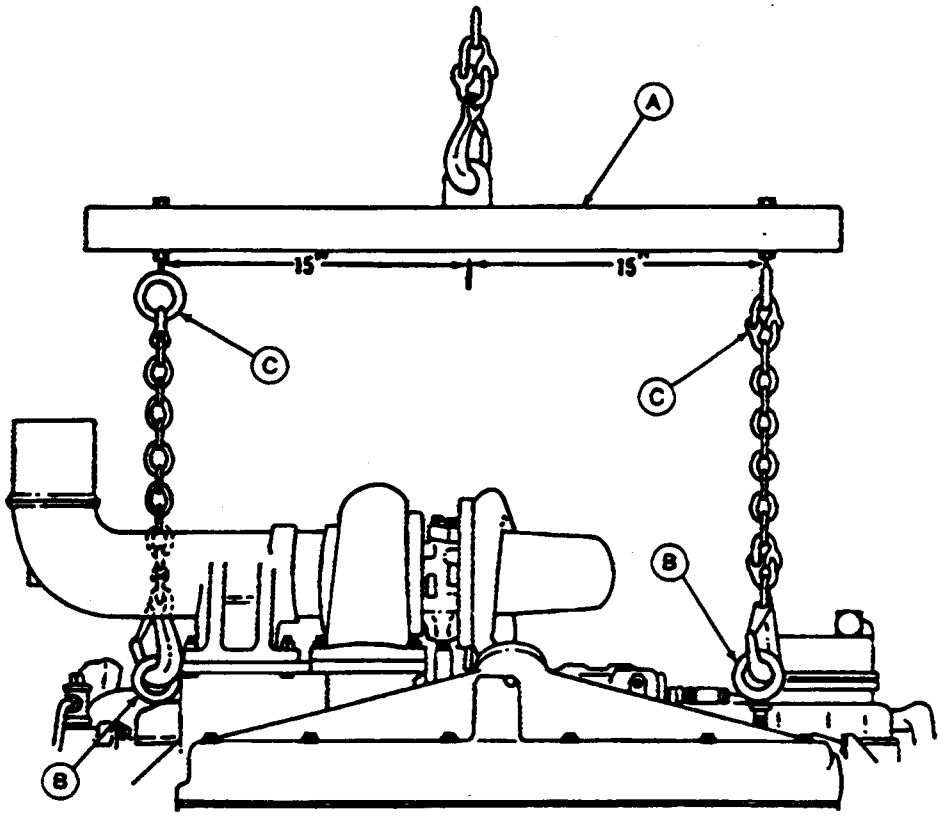
1. Attach the No. 60581 Engine Adapter (A) to mounting hub of engine repair stand using three SAE Grade 8 socket head screws. Tighten screws to 135 N·m (100 lb-ft).



RG4930 -UN-15DEC88

S55,0000,P -19-14MAR89

ENGINE LIFTING PROCEDURE



CAUTION: The only recommended method for listing the 6101 Engine is with the use of JDG23 Lifting Sling and R60980 Eyebolts with locknuts. Use extreme caution when lifting and NEVER permit any part of the body to be positioned under a load being lifted or suspended.

1. Screw both eyebolts (B) to fullest depth in cylinder head and securely tighten locknuts.

NOTE: Lift chains (C) spacing on sling is adjustable. Position chains 381 mm (15 in.) from center of bar as shown.

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

3. Carefully lift engine to desired location.

S55,0000,Q -19-14JUN89

CLEAN ENGINE

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

2. Steam-clean engine thoroughly.

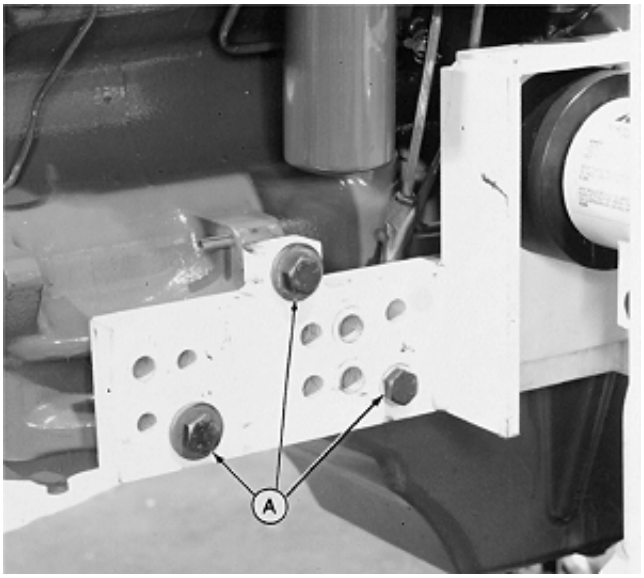
IMPORTANT: Never steam clean or pour cold water on an injection pump while it is still warm. To do so may cause seizure of pump parts.

S11,2000,EC -19-20AUG92

MOUNT ENGINE ON REPAIR STAND

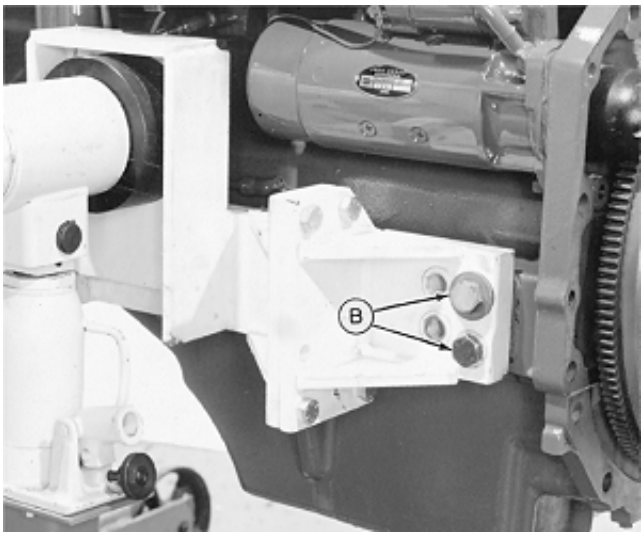
NOTE: If complete engine disassembly is required, remove starting motor before installing engine into repair stand.

1. Mount engine to front engine adapter using three 3/4-10 x 2-3/4 in. cap screws (A). Tighten cap screws to 365 N·m (270 lb-ft).



RG4931 -UN-19JAN90

2. Mount engine to rear engine adapter using two 3/4-10 x 2-3/4 in. cap screws (B). Tighten cap screws to 365 N·m (270 lb-ft).



RG4932 -UN-19JAN90

S55,0000,O,1 -19-15NOV95

DISCONNECT TURBOCHARGER OIL INLET LINE

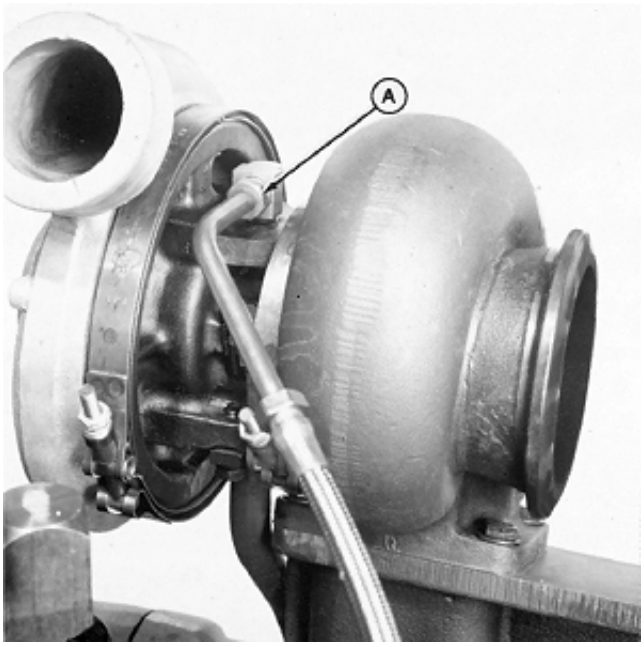
1. Drain all engine oil and coolant, if not previously done.

IMPORTANT: When servicing the 6101 Engine on a rollover stand, disconnect turbo oil inlet line (A) before rolling engine over. Failure to do so may cause a hydraulic lock upon starting the engine. Hydraulic lock may cause possible engine failure.

Hydraulic lock occurs when trapped oil in the oil filter head 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 oil filter housing or turbocharger.



RG5520 -UN-09JAN90

RG,CTM61,G3,1 -19-16APR92

6101 ENGINE DISASSEMBLY SEQUENCE

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

NOTE: Remove starting motor, flywheel and flywheel housing before mounting engine into repair stand.

1. Mount engine on a safety approved repair stand. (See Group 03.)

2. Drain all coolant and engine oil. Check oil for metal contaminants.

3. Remove fan, fan belts and alternator. (Machine Technical Manual.)

4. On 6101H Engines, remove fan drive assembly. (See Group 15.)

5. Remove exhaust elbow and turbocharger (See Group 30.)

6. Disconnect water piping, remove intake manifold cover and aftercooler (6101A Engines). Remove air intake manifold and coolant filter conditioner assembly. (See Groups 25 and 30.)

7. Remove exhaust manifold. Remove water manifold and thermostats. (See Groups 25 and 30.)

8. Disconnect water piping and remove water pump (See Group 25).

9. Remove full flow and bypass oil filters. (See Group 20.) Disconnect fuel lines, remove fuel filter and mounting base. (See Group 35).

10. Remove oil and fuel filter mounting plate assembly from block.

11. Remove oil dipstick and tube assembly. Remove oil pressure regulating housing and valve assembly. Remove oil bypass valve housing oil cooler assembly. (See Group 20.)

12. Remove injection pump drive gear cover. Remove injection pump drive gear. (See Group 35.)

13. Remove fuel injection lines, fuel injection pump, and fuel injection nozzles. (See Group 35.)

14. Remove rocker arm cover with vent tube assembly. (See Group 05.)

15. Check valve lift at zero (0.0) valve clearance. Remove rocker arm assembly and push rods. Remove cylinder head and cam followers. Identify parts for reassembly. (See Group 05.)

16. Check vibration damper for rotation and remove damper assembly. Remove timing gear cover. (See Group 15.)

17. Check camshaft endplay. Remove camshaft. (See Group 16.)

18. Remove engine oil pan and oil pump. (See Group 20.)

19. Rotate engine to vertical position. Remove pistons and connecting rods. Identify for reassembly. (See Group 10.)

20. Check crankshaft endplay. Remove main bearings and crankshaft. Perform wear checks. (See Group 15.)

21. Remove cylinder liners and piston cooling orifices. Mark liners for reassembly in same bore from which removed. (See Group 10.)

22. Remove cylinder block plugs and serial number plate (as required if block is to be put in a “hot tank”).

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

S55,0000,U -19-14JUN89

SEALANT APPLICATION GUIDELINES

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

LOCTITE® 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.

04
2

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

TY9370 6 mL (0.2 oz) tube
T43512 50 mL (1.7 oz) tube

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

—Capscrews: injection pump access cover, electronic tachometer cover, oil filler inlet, flywheel, starter, oil filter manifold mounting plate.

—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: Injection pump-to-block and exhaust manifold-to-turbocharger.

• LOCTITE 277 Plastic Gasket (High Strength) (red):

T43514 50 mL (1.7 oz) bottle

—Steel cap plugs: cylinder block, cylinder head, and water pump.

—O-ring adapter for oil pump outlet tube.

—Bypass oil check valve adapter.

—Coolant conditioner filter adapter.

• LOCTITE 515 Flexible Sealant (General Purpose) (purple):

TY6304 50 mL (1.7 oz) bottle

—Water pump, water manifold and thermostat cover gaskets.

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

TY9374 6 mL (0.2 oz) tube
TY9375 50 mL (1.7 oz) tube

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

—Injection pump governor cover fitting (fuel return).

—Threaded nipples and elbows in water pump housing.

—Threads of water pump and coolant conditioner lines.

—Temperature sending unit.

—Oil pan (drain hose and drain valve).

—Connectors: turbo line and turbo drain.

—Adapter fitting for turbo oil inlet line.

• LOCTITE 609 Retaining Compound (green):

TY9372 6 mL (0.2 oz) tube
T43515 50 mL. (1.7 oz) bottle

—Crankshaft flange for rear oil seal/wear sleeve installation.

—Front wear sleeve ID.

RG,CTM61,G4,1 -19-06OCT95

SEALANT APPLICATION GUIDELINES—CONTINUED

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

TY6299 227 g (8 oz) container

—Timing gear cover-to oil pan.

—Timing gear cover-to-cylinder block.

—Rear crankshaft oil seal housing-to-cylinder block.

—Oil pressure regulating housing.

—Flywheel housing-to-oil pan.

—Camshaft bore steel cap plug.

• **PT569 NEVER-SEEZ®** COMPOUND:

PT569 227 g (8 oz) Brush

PT506 453 g (16 oz) Spray

—Cap Screws: exhaust manifold, aftercooler cover, turbocharger cap screws/nuts, turbine housing-to-center housing v-bands.

—Injection nozzle gland nuts.

• **AR31790 SCOTCH-GRIP®** EC-1099 Plastic Adhesive:

AR31790 141 g (5 oz) tube

—Rocker arm cover gasket.

LOCTITE® and PERMATEX® are registered trademarks of Loctite Corporation.

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

TEFLON® is a registered trademark of DuPont Company.

SCOTCH-GRIP® is a registered trademark of 3M Company.

RG,CTM61,G4,4 -19-17NOV95

04
3

6101 ENGINE ASSEMBLY SEQUENCE

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

IMPORTANT: International Compound No. 2 must not be used as a thread sealant, use LOCTITE® 242 Thread Sealant.

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

2. Install clean piston cooling orifices. (See Group 10.)

3. Install cylinder liners without O-rings, in bores from which removed, and measure liner stand-out. Install liner O-rings in block and position square packing on liners. Install liners. (See Group 10.)

IMPORTANT: If new piston and liner kit assemblies are being installed, install the crankshaft and DO NOT remove pistons from matched liners.

4. Install crankshaft (with new front wear sleeve) and main bearings. Rotate crankshaft by hand to assure correct assembly. Check crankshaft end play. (See Group 15.)

5. Install pistons and connecting rods. Rotate crankshaft by hand to verify correct assembly. (See Group 10.)

6. Install camshaft. Check camshaft end play. Install timing gear cover with new oil seal. Check runout. (See Group 16.)

7. Install rear crankshaft oil seal housing and check runout. Install rear crankshaft oil seal/wear sleeve assembly. (See Group 15.)

8. Install oil pump assembly and engine oil pan. (See Group 20.)

9. Install damper pulley assembly, flywheel and flywheel housings. (See Group 15.)

10. Install cam followers in their respective bores. (See Group 16.)

11. Install cylinder head gasket, cylinder head, valve assembly, push rods and rocker arm assembly. Adjust valve clearance. Install rocker arm cover. (See Group 05.)

12. Install fuel injection pump, injection pump drive gear, and injection pump drive gear cover. (See Group 35.)

13. Install water pump and water manifold. (See Group 25.)

14. Install engine oil cooler and bypass valve housing assembly, connect all water piping. (See Group 20.)

15. Install oil pressure regulating housing and valve assembly. Install dipstick assembly. Install oil filter header, oil tubes and mounting plates. (See Group 20.)

S55,0000,V -19-09JAN92

6101 ENGINE ASSEMBLY SEQUENCE—CONTINUED

16. Install fuel filter base and fuel filter. Connect fuel lines. (See Group 35.)

17. Install exhaust elbow. Install turbocharger oil return pipe. (See Group 30.)

18. Install air intake manifold with coolant conditioner filter bracket. On 6101A Engines, install aftercooler and aftercooler cover. (See Group 30.)

19. Install turbocharger and exhaust elbow. (See Group 30.)

20. Connect and securely tighten all fuel, coolant, air, and oil line connections.

21. On 6101H Engines, install fan drive assembly. (See Group 15.)

22. Install alternator, fan, and fan belts.

23. Install starting motor.

24. Fill engine to proper level with clean engine oil and 50% mixture of soft water and low silicate antifreeze. (See your Operator's manual.)

25. Perform engine break-in and normal standard performance checks.

S55,0000,W -19-09JAN92

SPECIAL OR ESSENTIAL TOOLS

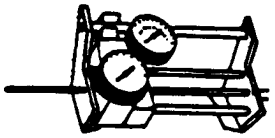
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-20JUL95

RG5061 -UN-23AUG88

Spring Compression Tester D01168AA

Test valve spring compression.

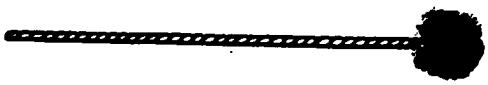


S53,D01168,AA -19-13MAR92

RG5099 -UN-23AUG88

Nozzle Thread Cleaning Brush D17030BR

Used to clean nozzle threads in cylinder head.



S53,D17030,BR -19-16FEB87

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1

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 -UN-27MAR92

RG,D17526CI -19-29OCT92

RG5064 -UN-23AUG88

Valve Guide Knurler Kit JT05949

Knurl valve guides.

S53,D20002,WI -19-16SEP92

RG5065 -UN-23AUG88

Valve Guide Pilot Driver JDE7-1

Install replacement valve seat inserts. Use with JDE72 and/or JDE73.

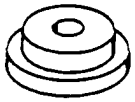
NOTE: May also be used with JDE75 to install replacement valve guides.

S53,JDE71 -19-13JUL89

RG5066 -UN-23AUG88

Exhaust Valve Insert Adapter JDE72

Install exhaust valve seat inserts. Use with JDE7-1.

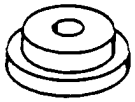


S53,JDE72 -19-14JUN95

RG5066 -UN-23AUG88

Intake Valve Insert Adapter JDE73

Install intake valve seat inserts. Use with JDE7-1.



S53,JDE73 -19-14JUN95

RG5067 -UN-06APR89

Valve Guide Driver JDE75

Install replacement valve guides. Use with JDE7-1.

S53,JDE75 -19-14JUN95

RG5069 -UN-06APR89

Torque Wrench Adapter JDE141

Retighten cylinder head cap screws when rocker arm assembly is installed.

S53,JDE141 -19-24APR92

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

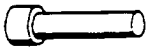
Rotate engine flywheel. Use with JDE81-4.

S53,JDE811 -19-06OCT95

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Lock engine at TDC when timing valve train. Use with JDE81-1 or JDE83.

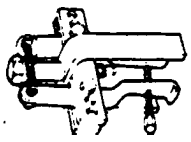


S53,JDE814 -19-06APR90

RG5071 -UN-23AUG88

Valve Seat Puller JDE41296

Remove valve seats.



S53,JDE,41296 -19-26JAN87

RG5100 -UN-23AUG88

Tap JDF5

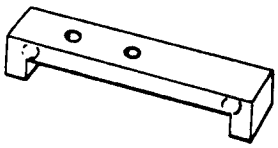
Used to restore nozzle threads in cylinder head.

S53,JDF5 -19-08MAR94

Piston and Liner Height Gauge JDG451

Measure piston and liner heights.

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



RG7029 -UN-30SEP94

RG,JDG451 -19-28SEP94

RG5100 -UN-23AUG88

Tap JDG682

Clean cylinder head mounting threads on top deck of cylinder block.

S55,JDG682 -19-24APR92

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SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from your SERVICE-GARD™ Catalog. Some tools may be available from a local supplier.

Name	Use
JDE138 Valve Spring Compressor	Compress valve springs when removing and installing valves
D05012ST Precision “Bevelled Edge” Straightedge	Check cylinder head flatness
Plastic Brush	Clean valve guides
D11010KW Eccentrimeter	Measure valve seat-to-stem runout
JT05893 Heavy-Duty Seat Grinder Set	Grind valve seats

S55,2505,AH,1 -19-17NOV95

OTHER MATERIAL

Name	Use
AR44402 Valve Stem Lubricant	Lubricate valve stems.
PT569 NEVER-SEEZ® Compound	Lubricate exhaust manifold cap screws.
AR31790 SCOTCH-GRIP® Plastic Adhesive	Rocker arm cover gasket.

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

SCOTCH GRIP is a trademark of 3M Co.

S11,2505,BW -19-06OCT95

05
4

CYLINDER HEAD AND VALVES SPECIFICATIONS

Item	New Part Specification	Wear Tolerance
Valve Clearance (Engine Cold):		
Intake Valve	0.33—0.43 mm (0.013—0.017 in.)	--
Exhaust Valve	0.58—0.68 mm (0.023—0.027 in.)	--
Valve Lift, at 0.00 mm (in.) Clearance:		
Intake Valve	13.20—13.62 mm (0.520—0.536 in.)	--
Exhaust Valve	11.83—12.25 mm (0.466—0.482 in.)	--
Valve Springs—Compressed:		
Inner Spring	45 mm @ 187—205 N	--
	(1.77 in. @ 42—46 lb-force)	--
	31.5 mm @ 376—437 N	--
	(1.24 in. @ 84—98 lb-force)	--
Outer Spring	51.1 mm @ 311—347 N	--
	(2.01 in. @ 70—78 lb-force)	--
	37.6 mm @ 721—836 N	--
	(1.48 in. @ 162—188 lb-force)	--
Valve Stem OD	11.018—11.036 mm (0.4338—0.4345 in.)	--
Valve Guide ID	11.074—11.100 mm (0.4360—0.4370 in.)	--
Valve Stem-to-Guide Clearance	0.038—0.089 mm (0.0015—0.0035 in.)	0.102 mm (0.0040 in.)
Valve Guide Installed Height	48.0 mm (1.89 in.) from bottom of head	--
Oversize Inserts:		
Intake Valve Seat Bore	53.62—53.72 mm (2.1110—2.1150 in.)	
Exhaust Valve Seat Bore	49.91—50.01 mm (1.9650—1.9690 in.)	
Valve Face Angle:		
Intake Valve	19.5°	--
Exhaust Valve	29.5°	--
Valve Head OD:		
Intake Valve	51.46—51.71 mm (2.026—2.036 in.)	--
Exhaust Valve	47.50—47.75 mm (1.870—1.880 in.)	--
Valve Seat Angle:		
Intake Valve	20°	--
Exhaust Valve	30°	--
Valve Seat Width	2.77—3.20 mm (0.109—0.126 in.)	--
Valve Seat Concentricity with Guide	0.051 mm (0.020 in.)	--
Valve Relation to Head Surface		
Intake Valve	0.06—0.56 mm (0.002—0.022 in.) above	--
Exhaust Valve	0.32—0.82 mm (0.012—0.032 in.) below	1.04 mm (0.041 in.) below
Max. Valve Seat Runout	0.051 mm (0.002 in.)	--
Max. Permissible Runout Of Valve Face	0.05 mm (0.002 in.)	--
Nominal Cylinder Head Thickness (rocker arm cover gasket to combustion face)	166.55—166.80 mm (6.557—6.567 in.)	--
Max. Material Removed to Resurface Head	--	1.02 mm (0.040 in.)
Max. Head Warpage for Entire Length of head	--	0.10 mm (0.004 in.)
Combustion Face Surface Finish	60 AA min.—110 AA max.	
Rocker Arm ID	25.418—25.458 mm (1.0007—1.0023 in.)	--
Rocker Arm Shaft OD	25.360—25.400 mm (0.9984—1.0000 in.)	--

S55,2505,A -19-17NOV95

CYLINDER HEAD AND VALVES SPECIFICATIONS—CONTINUED

TORQUES

Cylinder Head Cap Screws:	
Initial	200 N·m (150 lb-ft)
Final*	Tighten additional 90°—100°
Rocker Arm Shaft Clamps	88 N·m (65 lb-ft)
Valve Adjusting Screw Lock Nut	27 N·m (20 lb-ft)
Rocker Arm Cover Cap Screws	11 N·m (8 lb-ft)
Intake Manifold-to-Cylinder Head	75 N·m (55 lb-ft)
Exhaust Manifold-to-Cylinder Head	95 N·m (70 lb-ft)
Coolant Conditioner Filter Bracket-to-Cylinder Head	75 N·m (55 lb-ft)
Water Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Turbocharger Mounting Stud Nuts	47 N·m (35 lb-ft)

*See TORQUE-TURN Method, no retorque required.

S55,2505,B -19-17NOV95

05
6

DISCONNECT TURBOCHARGER OIL INLET LINE

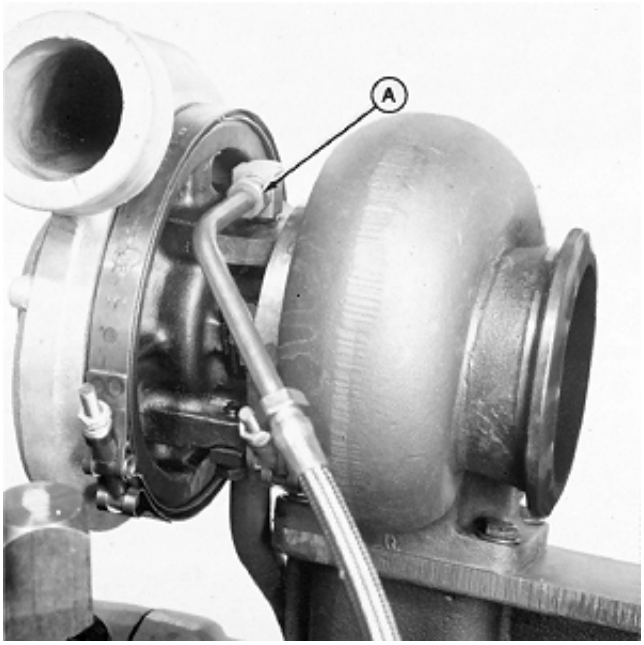
1. Drain all engine oil and coolant, if not previously done.

IMPORTANT: When servicing the 6101 Engine on a rollover stand, disconnect turbo oil inlet line (A) before rolling engine over. Failure to do so may cause a hydraulic lock upon starting the engine. Hydraulic lock may cause possible engine failure.

Hydraulic lock occurs when trapped oil in the oil filter head 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.

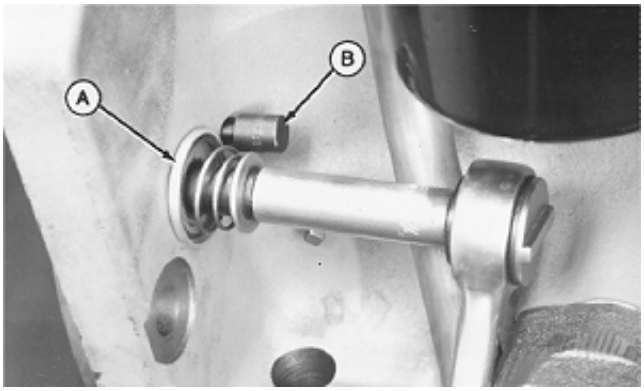
2. Disconnect turbocharger oil inlet line at oil filter housing or turbocharger.



RG5520 -UN-09JAN90

RG,CTM61,G3,1 -19-16APR92

CHECK AND ADJUST VALVE CLEARANCE



RG55521 -UN-09JAN90

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

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

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

NOTE: Valve clearance MUST BE checked with engine cold.

1. Remove rocker arm cover from cylinder head.

2. Remove plastic plugs from timing holes. Install JDE81-1 Flywheel Turning Tool (A) and JDE81-4 Timing Pin (B).

3. Rotate engine until timing pin engages timing hole in flywheel.

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

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

S55,2505,D -19-13NOV95

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

VALVE CLEARANCE SPECIFICATIONS

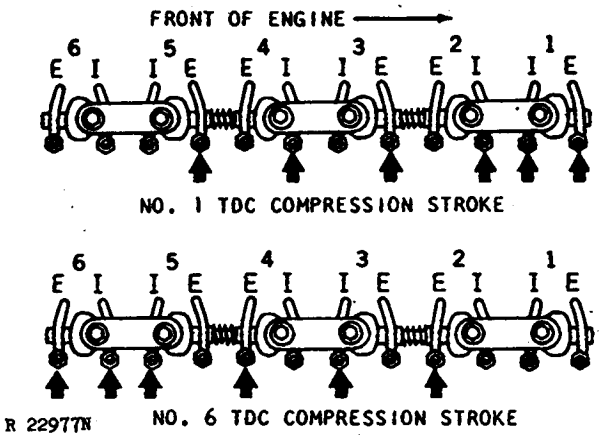
Intake Valves	0.33—0.43 mm (0.013—0.017 in.)
Exhaust Valves	0.58—0.68 mm (0.023—0.027 in.)

5. If valve clearance needs to be adjusted, loosen the locknut on rocker arm adjusting screw. Turn adjusting screw until feeler gauge slips with a slight drag. Hold the adjusting screw from turning with screwdriver and tighten locknut to 27 N.m (20 lb-ft). Recheck clearance again after tightening locknut. Readjust clearance as necessary.

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

7. Check and adjust (as needed) valve clearance to the same specifications on Nos. 2, 4 and 6 exhaust valves and Nos. 3, 5 and 6 intake valves. Tighten valve adjusting screw locknut to 27 N.m (20 lb-ft).

8. Recheck clearance on all valves again after locknut is tightened.



S11,2505,A -19-06OCT95

MEASURE VALVE LIFT

Measuring valve lift can give an indication of wear on cam lobes or cam followers.

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

1. Remove rocker arm cover.

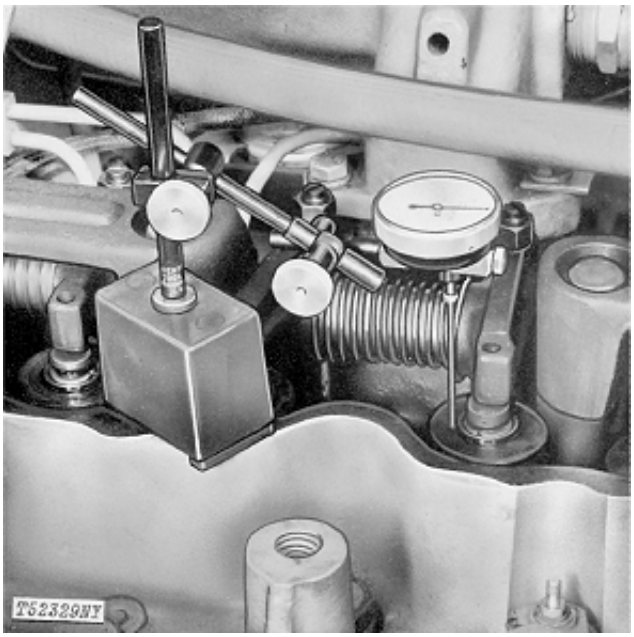
2. Remove vent tube from hole in block. Remove plastic plugs.

3. Loosen lock nut on rocker arm shaft and set valve clearance at zero (0.00) using a wrench and screwdriver. Tighten lock nut.

4. Place dial indicator tip on top of valve spring cap, as shown. Preload indicator tip and set dial at zero (0.00).

5. Manually turn engine in running direction one full revolution using the JDE81-1 Flywheel Turning Tool.

6. Observe dial indicator reading as valve is moved to full open. Record readings and compare with specifications given below.



T52329NY -UN-28JUL89

VALVE LIFT SPECIFICATIONS
[at 0.00 mm (in.) Valve Clearance]

Intake Valves	13.20—13.62 mm (0.520—0.536 in.)
Exhaust Valves	11.83—12.25 mm (0.466—0.482 in.)

7. Follow same procedure for all remaining valves and adjust valve clearance when valve lift measurements are complete. (See CHECK AND ADJUST VALVE CLEARANCE in Group 05.)

S55,2505,X -19-17NOV95

REMOVE CYLINDER HEAD AND VALVES

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

CAUTION: After operating the engine, allow enough time for the exhaust system to cool before removal.

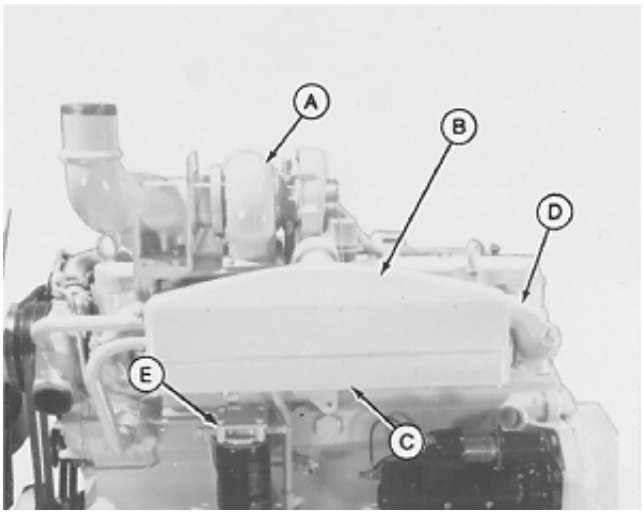
1. Drain engine coolant.

2. Remove turbocharger (A). (See remove Turbocharger in Group 30.)

3. On 6101A Engines, remove intake manifold cover and aftercooler (B).

4. Remove intake manifold (C). Remove turbocharger oil return pipe from block.

5. Remove exhaust manifolds (D) and coolant conditioner filter assembly (E).



RG5522 -UN-09JAN90

A—Turbocharger
B—Intake Cover and Aftercooler
C—Intake Manifold
D—Exhaust Manifold
E—Coolant Conditioner Filter Assembly

S55,2505,E -19-17NOV95

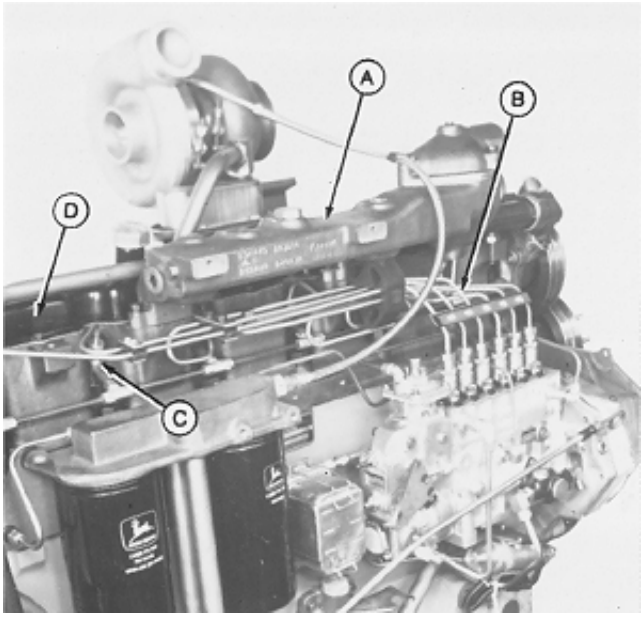
6. Disconnect water piping and remove water manifold (A). (See Group 25.)

7. Remove fuel injection line assembly (B) from engine. Cap all fittings on injection pump and injection nozzles. (See Group 35.)

8. Remove fuel injection nozzles (C). Plug nozzle bores in cylinder head. (See Group 35.)

9. Remove rocker arm cover (D), if not previously removed.

A—Water Manifold
B—Fuel Injection Lines
C—Fuel Injection Nozzles
D—Rocker Arm Cover



RG5523 -UN-09JAN90

S55,2505,F -19-08MAR89

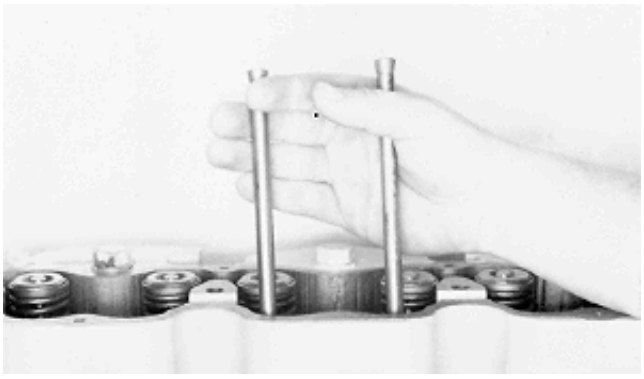
10. Remove six rocker arm shaft clamp cap screws with washers (A).

11. Remove all three clamps (B).

12. Lift and remove rocker arm assembly.

S11,2505,F,1 -19-13NOV95

13. Remove push rods and identify for reassembly at same location.



S11,0401,J,1 -19-13NOV95

14. Remove all 26 cylinder head cap screws.

NOTE: If desired, check and record each cylinder head cap torque before removing.

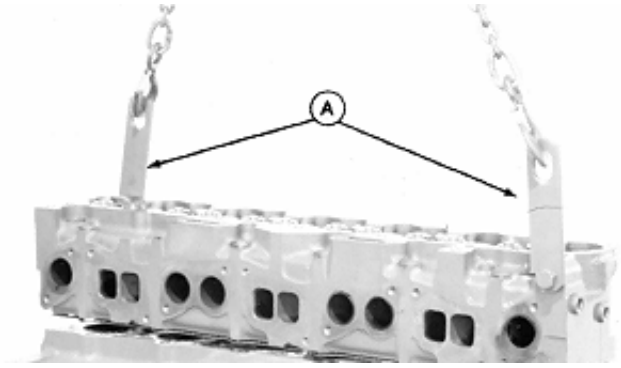
IMPORTANT: DO NOT use screwdrivers or pry bars between cylinder block and cylinder head to loosen head-to-block gasket seal.

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

15. Remove cylinder head and gasket. Inspect 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.

16. If desired, check valve height in relation to cylinder head and record measurements as described later in this group.



-UN-10NOV89
RG3492

S55,2505,G -19-14JUN89

CHECK VALVE HEIGHT IN RELATION TO CYLINDER HEAD

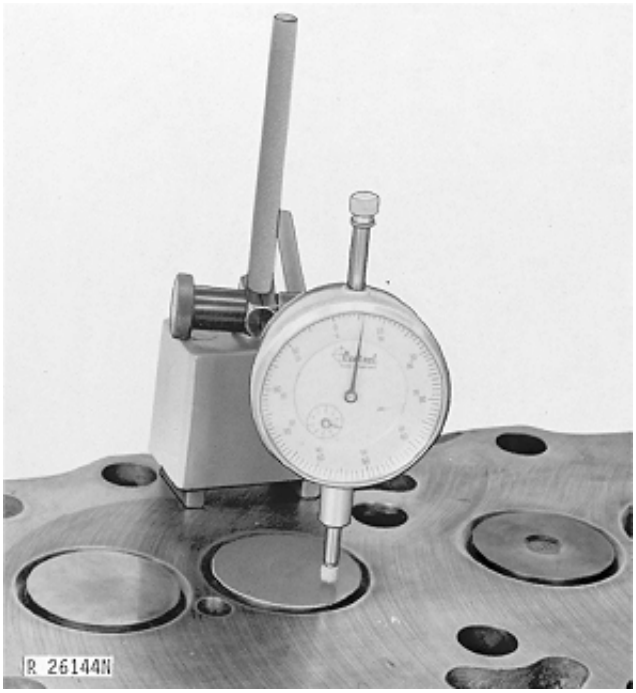
1. Measure and record all valve-to-cylinder head dimensions using a magnetic base dial indicator and compare measurements to specifications given below.

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

VALVE-TO-CYLINDER HEAD HEIGHT SPECIFICATIONS

Exhaust . . . . . 0.32—0.82 mm (0.012—0.032 in.) Below Max. . . . . 1.04 mm (0.041 in.) Below
Intake . . . . . 0.06—0.56 mm (0.002—0.022 in.) Above

NOTE: If valve height is not within specification, check valve face angle and valve seat angle. If valve is recessed beyond the maximum specification, install either new valves, valve seats or both to obtain proper valve height. (See Replace Valve Seat Inserts, later in this group.)



R26144N -UN-09DEC88

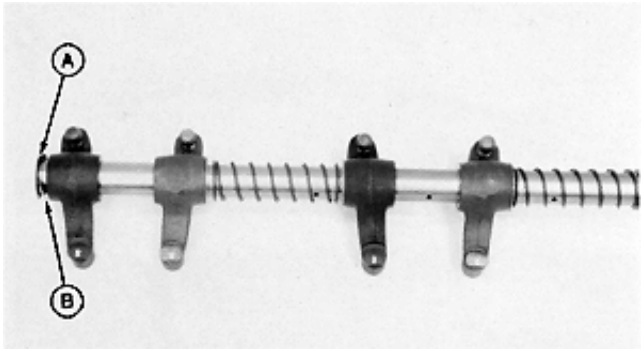
S55,2505,H -19-17NOV95

DISASSEMBLE AND INSPECT ROCKER ARM SHAFT ASSEMBLY

NOTE: Make preliminary inspection during disassembly. Look for:
—Worn or scored rocker arms, shaft, and shaft support.
—Weak or broken springs
—Lube oil restriction

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

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



RG3801 -UN-23FEB89

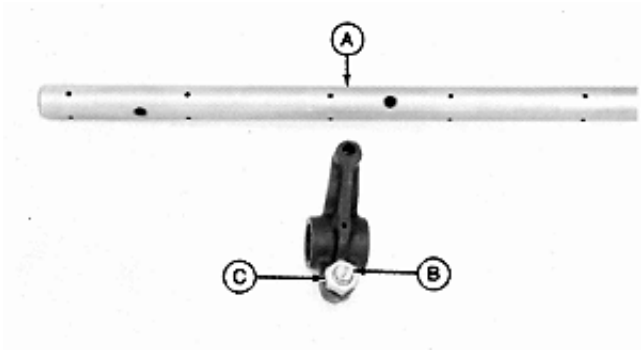
S11,2005,HY1 -19-14JUN95

3. Inspect rocker arm shaft (A) for severe scratching, scoring, or excessive wear at points of rocker arm contact.

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

ROCKER ARM ASSEMBLY SPECIFICATIONS

Rocker Arm ID	25.418—25.458 mm (1.0007—1.0023 in.)
Rocker Arm Shaft OD	25.360—25.400 mm (0.9984—1.0000 in.)



RG3802 -UN-23FEB89

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

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

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14

IMPORTANT: Be sure all oil holes in rocker arm shaft are open and clean. Remove end plug and clean center hole in shaft.

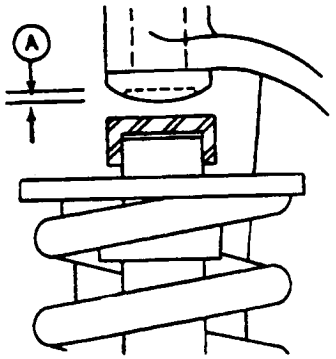
S11,2505,I -19-13MAY93

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

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

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

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



R26131 -UN-09DEC88

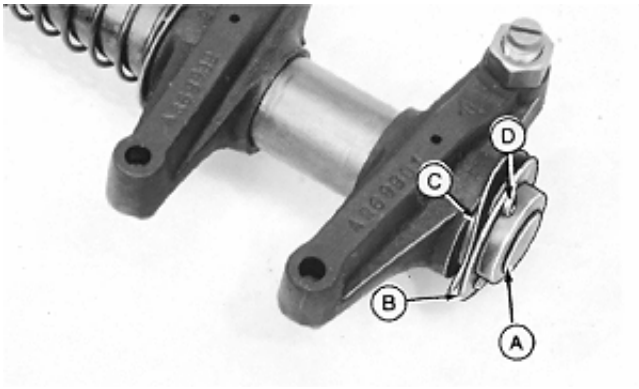
S11,0401,N -19-05FEB85

ASSEMBLE ROCKER ARM SHAFT ASSEMBLY

1. Assemble parts on rocker arm shaft in reverse of sequence removed.

2. Make sure rocker arm shaft end plugs (A) are firmly seated in shaft.

3. Check for proper installation of washer (B) and spring washer (C). Be sure cotter pin (D) is bent securely.



RG3031 -UN-17JUL89

A—End Plug
B—Washer
C—Spring Washer
D—Cotter Pin

S11,2505,J -19-14JUN95

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MAKE PRELIMINARY VALVE CHECKS

During disassembly inspect the valve train for the following malfunctions and causes:

• Sticking Valves:

Carbon deposits on valve stem.
Worn valve guides.
Warped valve stems.
Cocked 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.

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16

• Distorted Cylinder Head And Cylinder Head Gasket Leakage:

Improperly tightened cylinder head cap screws.
Faulty gasket installation.
Incorrect gasket.
Excessive oil pressure.
Improper cylinder liner height above cylinder block.

• 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.

• Burned, Pitted, Worn Or Broken Valves:

Worn or distorted 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.

S11,0401,B -19-22JUN95

REMOVE VALVE ASSEMBLY

NOTE: Refer to MAKE PRELIMINARY VALVE CHECKS earlier in this group.

1. Remove rocker arm assembly as previously described.

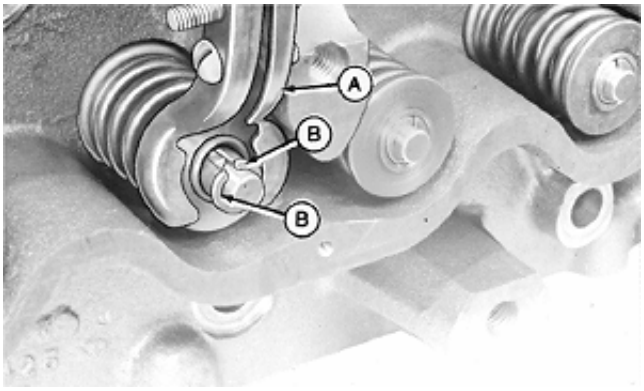
2. Remove cylinder head as previously described.

NOTE: When removing valves, valve springs, and valve rotators identify from them for reassembly in original positions.

3. Compress valve spring compressor (A) over valves.

4. Remove wear cap (shown removed) and retaining locks (B).

5. Remove valve spring compressor.

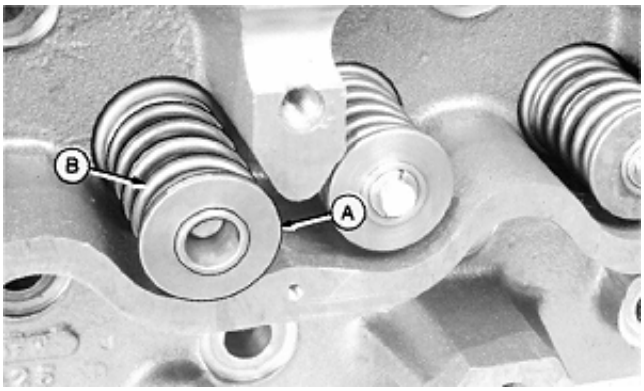


RG3032 -UN-16OCT91

S11,2505,K,1 -19-17NOV95

6. Remove spring cap (A).

7. Remove inner and outer valve springs (B).

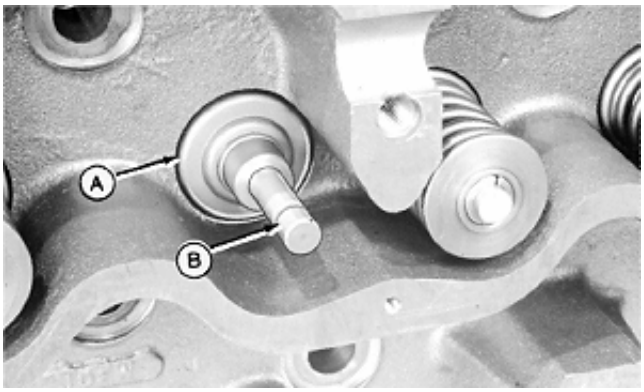


RG3033 -UN-17JUL89

S11,2505,L -19-25OCT91

8. Remove valve rotator (A).

9. Remove valve (B).



RG3034 -UN-17JUL89

S11,2505,M -19-25OCT91

INSPECT VALVE SPRINGS

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

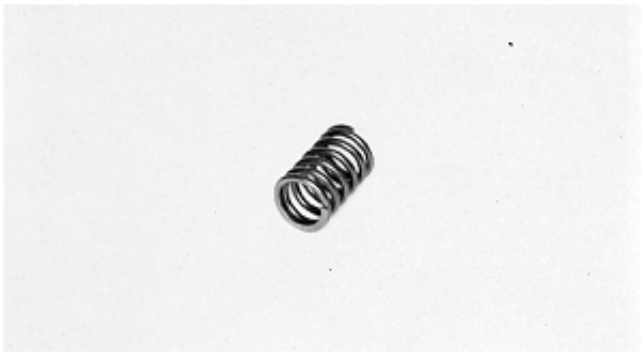
2. Place springs on a flat surface to see that they are square and parallel.

3. Check valve spring tension using D01168AA Spring Compression Tester.

NOTE: Free length of springs differ slightly, but compressed height must be the same.

VALVE SPRING NEW PART SPECIFICATIONS

Compression	Height
Inner Spring	
187—205 N	45 mm
(42—46 lb force)	(1.77 in.)
376—437 N	31.5 mm
(84—98 lb force)	(1.24 in.)
Outer Spring	
311—347 N	51.1 mm
(70—78 lb force)	(2.01 in.)
721—836 N	37.6 mm
(162—188 lb force)	(1.48 in.)



RG2732 -UN-23FEB89

T82054 -UN-08NOV88

S11,2505,N -19-14JUN95

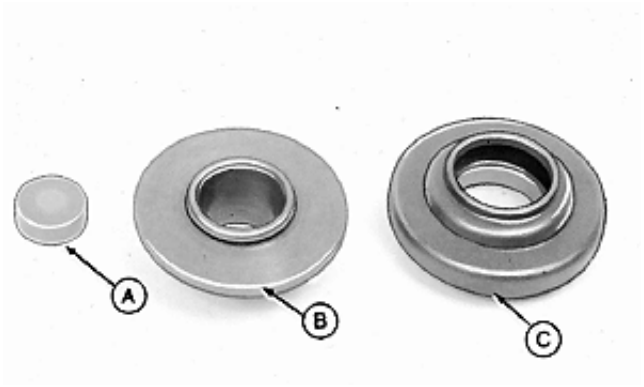
INSPECT SPRING CAPS, WEAR CAPS AND VALVE ROTATORS

1. Inspect wear caps (A) for wear or damage.

2. Inspect spring caps (B) for concave wear on face or for damage.

3. Insure that valve rotators (C) will turn freely in one direction only.

4. Replace parts if they are worn or show any signs of damage.



RG3035 -UN-17JUL89

S11,2505,O -19-14JUN95

CLEAN VALVES

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

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

IMPORTANT: Any carbon left on the stem will affect alignment in valve refacer if valves need to be refaced. Do not use wire wheel on plated portion of valve stem.

S11,0401,U -19-13MAR92

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MEASURE VALVES

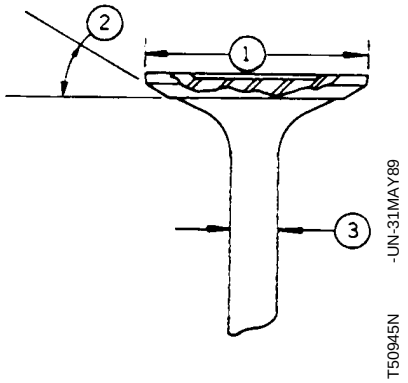
1. Compare valve stem OD (3) with guide ID to determine stem-to-guide clearance. Measure valve face angle (2). Regrind valve face angle or replace valves as necessary.

VALVE SPECIFICATIONS

1—OD of Valve Head
- Intake . . . . . 51.46—51.71 mm (2.026—2.036 in.)
- Exhaust . . . . . 47.50—47.75 mm (1.870—1.880 in.)

2—Angle of Valve Face
- Intake . . . . . 19.5°
- Exhaust . . . . . 29.5°

3—OD of Valve Stem . . . . . 11.018—11.036 mm (0.4338—0.4345 in.)



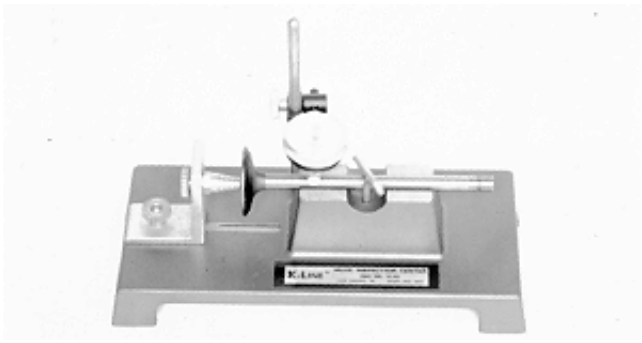
IMPORTANT: When valve faces are ground be extremely careful not to nick radius (from valve head-to-stem) with facing stone. A nick in this area will cause valve to break.

S55,2505,I -19-08MAR89

2. Use D0508ST Valve Inspection Center to determine if valves are out of round, bent or have excessive runout.

Maximum permissible runout of
valve face . . . . . 0.05 mm (0.002 in.)

3. Valves determined to be serviceable should be refaced to specifications given above.



RG4234 -UN-23FEB89

S11,0401,W -19-13MAR92

INSPECT AND CLEAN CYLINDER HEAD

Inspect all cylinder head passages for restrictions. Heads with restricted or clogged passages can be cleaned by soaking them in a tank of hot caustic solution.

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Scrape all old gasket material from head. Use a powered wire brush to clean sealing surfaces.

If cylinder head is not put in a chemical hot tank for cleaning, clean with solvent and a brush. Dry with compressed air and be sure to blow out all passages.

S11,2005,KW -19-16AUG94

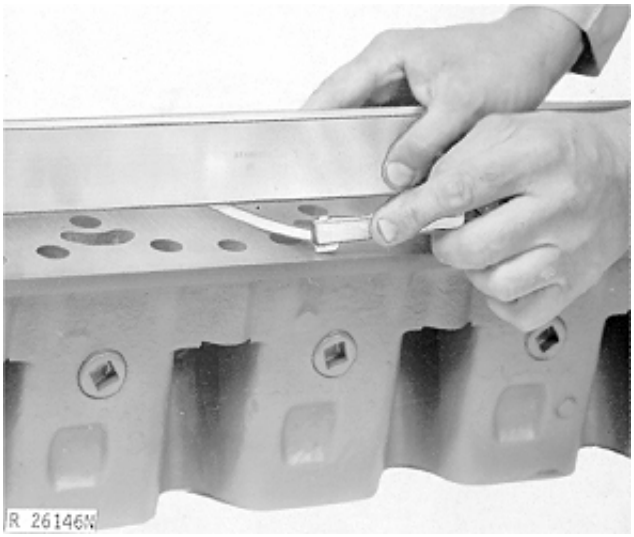
CHECK CYLINDER HEAD COMBUSTION FACE FLATNESS

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

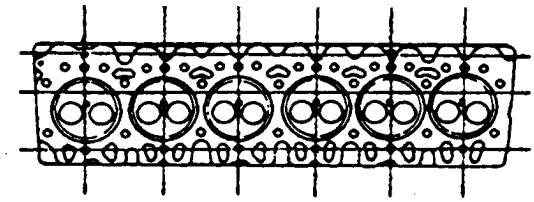
If any measurement exceeds this specification, the cylinder head must be either resurfaced or replaced. (See MEASURE CYLINDER HEAD THICKNESS, later in this group.)

CYLINDER HEAD TOP DECK FLATNESS SPECIFICATION

Maximum Out-of-Flat
(Over Entire Length or Width) . . . . . 0.102 mm (0.0040 in.)



-UN-09DEC88 R26146



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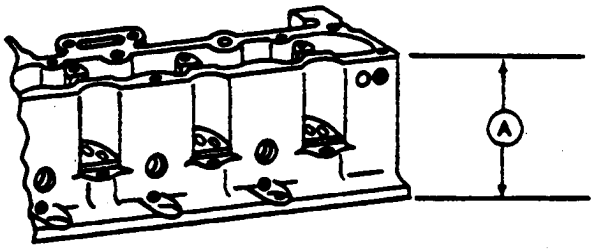
S11,2005,KY,1 -19-17NOV95

MEASURE CYLINDER HEAD THICKNESS

1. Measure cylinder head thickness (A) and compare with specifications below to determine if head has been previously reconditioned by surface grinding.

CYLINDER HEAD THICKNESS SPECIFICATIONS

New Part Thickness . . . . . 166.55—166.80 mm (6.557—6.567 in.)
Minimum Thickness After Reconditioning . . . . . 165.53 mm (6.517 in.)
Surface Finish . . . . . 60—110 AA



-UN-23FEB89 RG4421

2. Recondition cylinder head to restore surface finish or correct flatness only if absolutely necessary. Remove ONLY what is necessary to correct damage.

IMPORTANT: Check valve height in relation to cylinder head after grinding as explained later in this group. Valve seat or valve face may be ground to bring this characteristic within specification.

S55,2505,K -19-17NOV95

CLEAN VALVE GUIDES

1. Use a plastic brush to clean valve guides before inspection or repair.

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

-UN-09FEB90
R26140N

S11,0401,X -19-14JUN95

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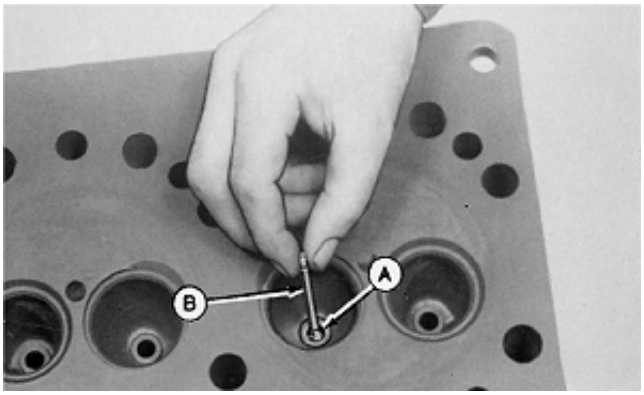
MEASURE VALVE GUIDES

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

NOTE: Worn guides can allow a clearance of 0.102 mm (0.0040 in.) and still be acceptable. Worn guides may be knurled to return them to specified clearance if valve-to-guide clearance is 0.25 mm (0.010 in.) or less. If clearance exceeds 0.25 mm (0.010 in.), replacement valve guides are available. (See REPLACE VALVE GUIDES, later in this group.)

VALVE GUIDE SPECIFICATIONS

ID of guide in a new head	11.074—11.100 mm (0.4360—0.4370 in.)
New guide-to-stem clearance	0.038—0.089 mm (0.0015—0.0035 in.)



-UN-09DEC88
R23984

S11,2505,Q,1 -19-17NOV95

KNURL VALVE GUIDES

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

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

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

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

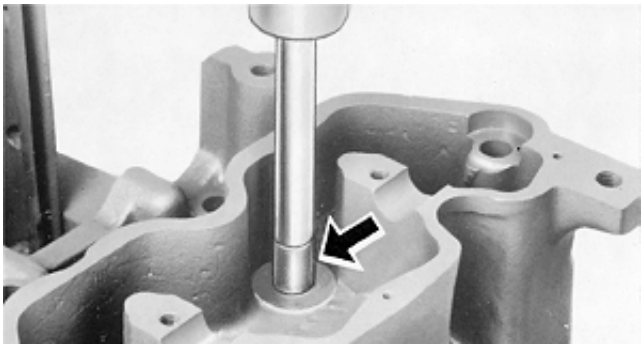
S11,0401,Z -19-08MAR94

05
23

REPLACE VALVE GUIDES

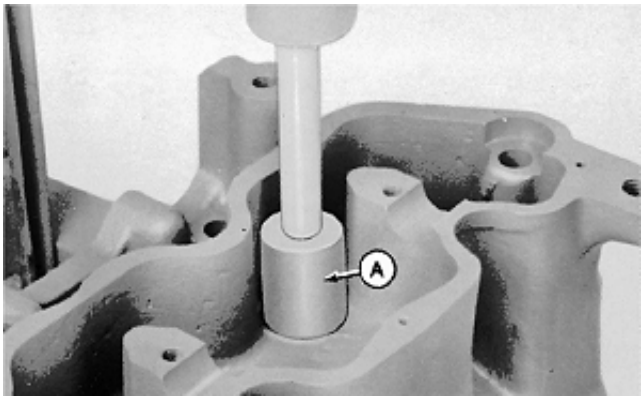
IMPORTANT: OD of driver must be smaller than valve guide insert to prevent damage to valve guide bores.

1. Guides allowing more than 0.25 mm (0.010 in.) clearance should be replaced. Remove valve guide (arrow) with a press and driver.



S11,2505,S -19-14JUN95

2. Install new guide with JDE75 Driver (A) and JDE7-1 Pilot Driver. Drive new guide to 48 mm (1.89 in.) from bottom of cylinder head. If reconditioned valves are used, new guides can be knurled to provide a more uniform fit.



S11,2505,T -19-14JUN89

CLEAN AND INSPECT VALVE SEATS

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

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

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

-UN-09DEC88
R26142N

S11,0401,AA -19-14JUN95

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24

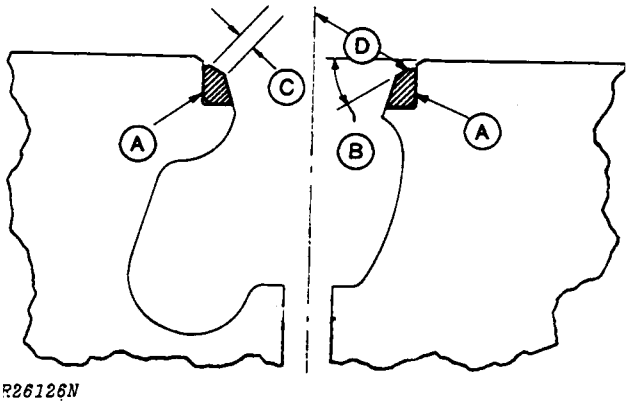
MEASURE VALVE SEATS

1. Measure valve seats for proper specification.

VALVE SEAT SPECIFICATIONS

A—Valve Seat Insert
B—Valve Seat Angle:
Intake . . . . . 20˚
Exhaust . . . . . 30˚
C—Valve Seat Width . . . . . 2.77—3.20 mm (0.109—0.126 In.)
D—Max. Valve Seat Runout . . . . . 0.051 mm (0.0020 in.) max.

2. If valve seats are not within specification, recondition valve seats or replace valve seat inserts if reconditioning is not possible. (See Grind Valve Seats or Replace Valve Seat Inserts, later in this group.)



-UN-11APR89
R26126N

S55,2505,L -19-08MAR89

GRIND VALVE SEATS

IMPORTANT: Grind valve seats to obtain correct valve recess in cylinder head. (See Check Valve Height.) Be sure valve guide bores are clean before grinding valve seats. (See Clean Valve Guides earlier in this group.)

1. If valve seats need grinding, do not grind too long. Only a few seconds are required to recondition the average valve seat. Avoid the tendency to grind off too much.

2. Do not use too much pressure. While grinding, support the weight of the driver to avoid excessive pressure on the stone.

NOTE: ALWAYS keep work area clean when grinding valve seats.

3. Check the seat width and contact pattern between the seat and valve with bluing. Seat width should be within specification. Maintain valve seat width. Use a vernier caliper or scale to measure seat width. Replace valves and valve seat inserts as necessary.

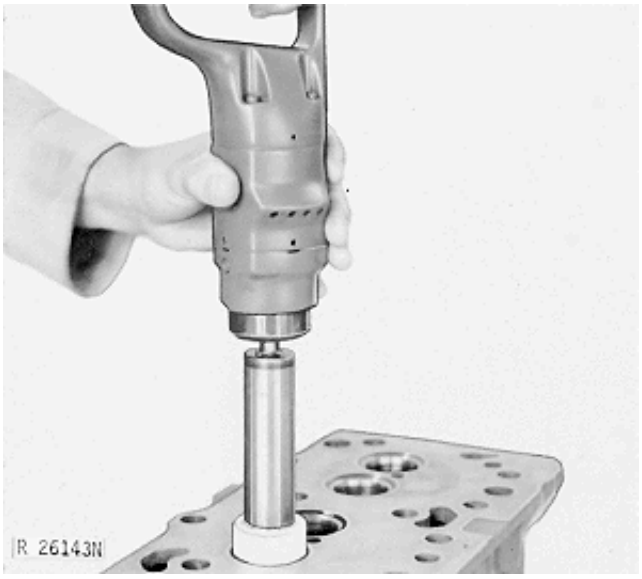
NOTE: Valve seat width can be reduced with a narrowing stone. This will change the angle at the top of the seat and increase the diameter.

If valve seat width is too narrow, valve may burn or erode.

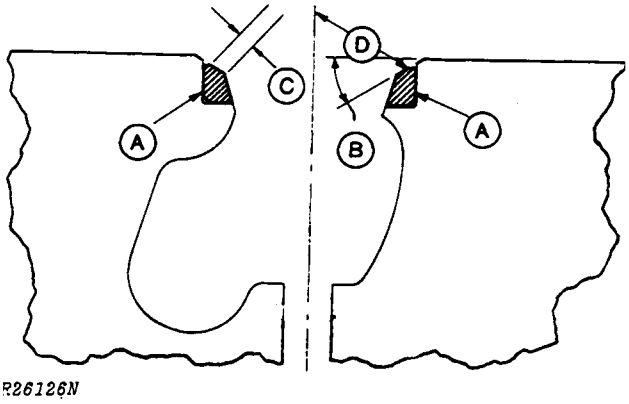
Varying the valve seat width changes the fine contact between valve face and seat.

VALVE SEAT SPECIFICATIONS

A—Valve Seat Insert	
B—Valve Seat Angle	30°
C—Valve Seat Width	2.77—3.20 mm (0.109—0.126 in.)
D—Max. Valve Seat Runout	0.051 mm (0.0020 in.)



R26143N -UN-09DEC88

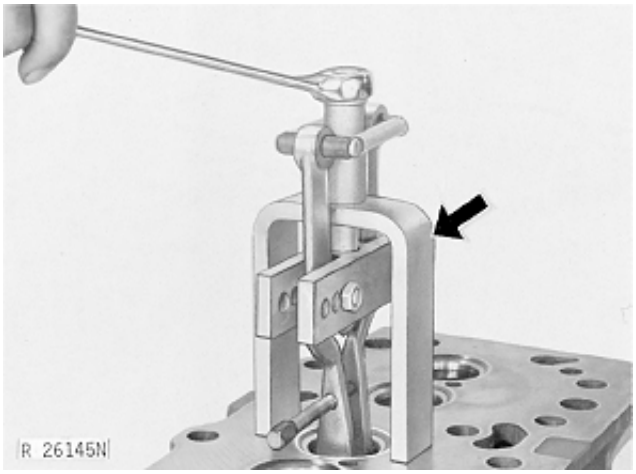


R26126N

R26126N -UN-11APR89

S55,2505,M -19-19JUL89

REPLACE VALVE SEAT INSERTS



In some cases the inside diameter of the valve seat bore may become damaged and require machining. In this case, oversize inserts are available in 0.25 mm (0.010 in.) oversize only.

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

1. Remove valve seat insert with the JDE41296 Valve Seat Puller.

IMPORTANT: If an arc welder is used to remove valve seat inserts, protect entire combustion face and valve throat area from weld spatter.

05
26

NOTE: On some engines, removal of the valve seat inserts with the JDE41296 Puller may not be possible. An alternate removal method is to weld two or three short beads (use an arc welder-beads) equidistant from each other around the ID of insert. Allow seat to cool and carefully pry out the insert(s) with a screwdriver.

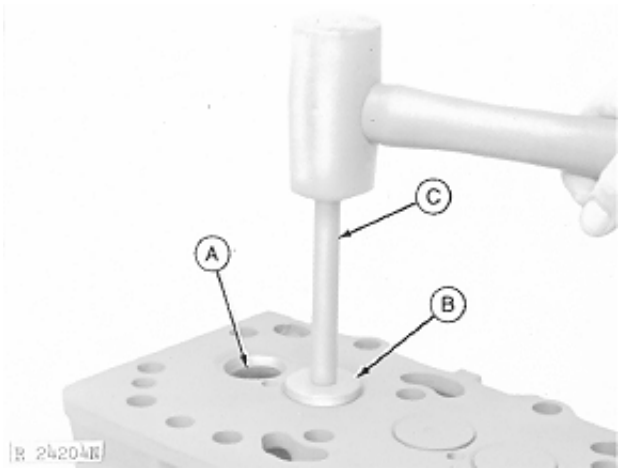
2. After removal of inserts, thoroughly clean area around valve seat bore and inspect for damage or cracks. Install oversize inserts as required. (See INSTALL OVERSIZE VALVE SEAT INSERTS, later in this group.)

S55,2505,N -19-31MAY95

3. Use JDE72 (intake valve seats) and JDE73 (exhaust valve seats) replacement rings (B) to install new valve seat inserts (A).

4. Use JDE7-1 Driver (C) and replacement rings to drive inserts into place.

5. Grind valve seats. Be careful not to over-grind valve seat. (See GRIND VALVE SEATS, earlier in this group.)



S55,2505,O -19-25OCT91

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27

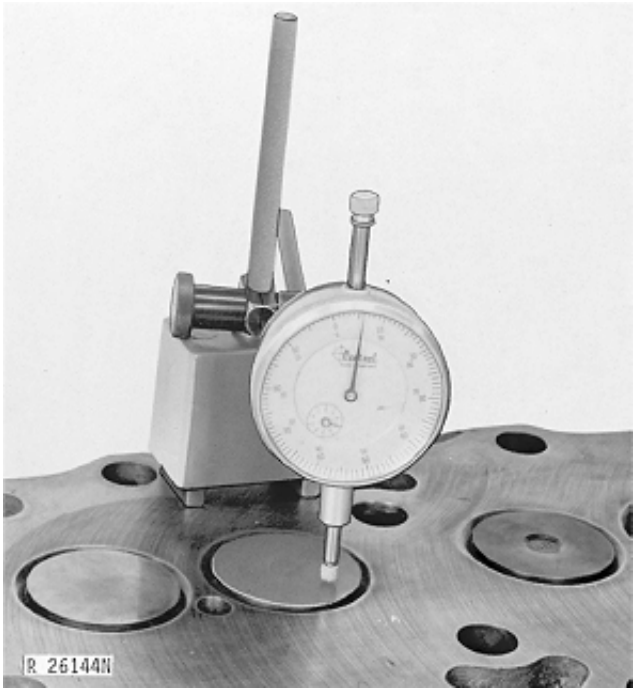
RECHECK VALVE HEIGHT IN RELATION TO CYLINDER HEAD

1. After reconditioning the cylinder head, valves or valve seats, reverse removal procedure and install valves in their respective bore.

2. Use a magnetic base dial indicator to measure valve-to-cylinder head heights and compare with specifications below.

VALVE-TO-CYLINDER HEAD HEIGHT SPECIFICATIONS

Exhaust	0.32—0.82 mm (0.012—0.032 in.) below
Max.	1.04 mm (0.041 in.) below
Intake	0.06—0.56 mm (0.002—0.022 in.) above



S55,2505,Q -19-13NOV95

INSTALL OVERSIZE VALVE SEAT INSERTS

NOTE: If the valve seat insert bore is damaged, it will require machining. In this case, oversize inserts are available in 0.25 mm (0.010 in.) oversize only.

1. Remove valve seats. (See REPLACE VALVE SEAT INSERTS in this group.)

2. Machine seat inside bore to 53.62 to 53.72 mm (2.1110 to 2.1150 in.) for intake valves and 49.91 to 50.01 mm (1.9650 to 1.9690 in.) for exhaust valves.

3. Install valve seat inserts.

S11,2505,Y -19-31MAY95

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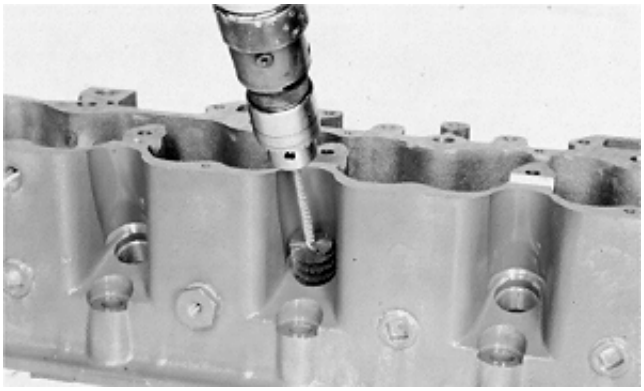
28

CLEAN AND INSPECT CYLINDER HEAD NOZZLE BORE


RG5251 -UN-14DEC88

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

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

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

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

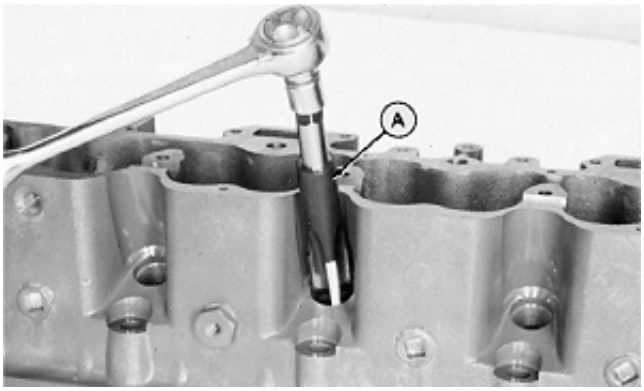
3. Clean threads which have light foreign deposits using a drill and the D17030BR Thread Cleaning Brush. Work brush up and down several times to clean threads.

S11,2005,NS -19-14JUN95

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

5. After cleaning threads, insert a 13 mm (1/2 in.) tapered hardwood dowel into nozzel bore.

6. Blow out debris from nozzel cavity; then remove dowel.



-UN-06DEC88
RG5252

S11,2005,NT -19-14JUN95

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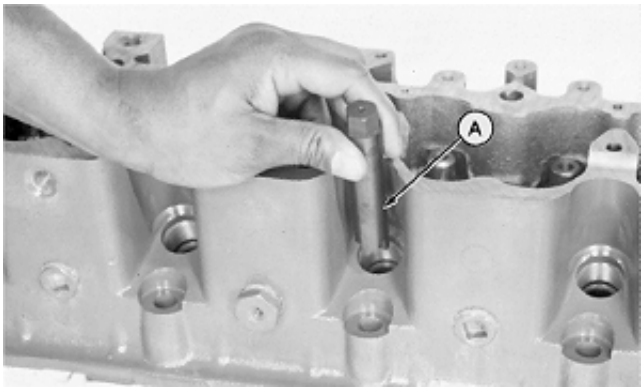
29

CLEAN AND INSPECT NOZZLE SEATING SURFACE

1. Inspect nozzle seating surface for carbon deposits.

2. If seat is not clean, use the JDE99 Nozzle Seat Reamer to remove carbon.

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



-UN-06DEC88
RG5253

S55,2505,P -19-14JUN95

CLEAN AND INSPECT PUSH RODS

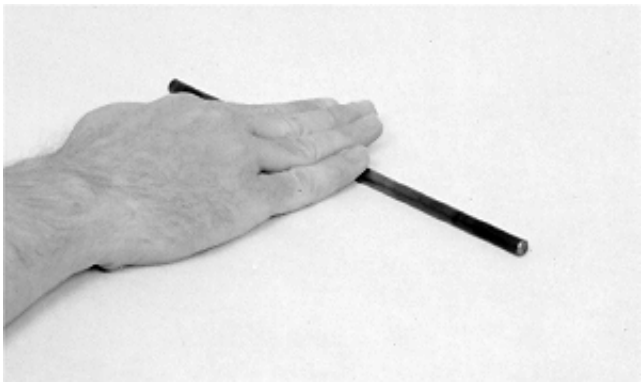
1. Clean push rods with solvent and compressed air.

NOTE: Flaired end of push rod should extend off edge of flat surface.

2. Check push rods for straightness by rolling on a flat surface.

3. Inspect contact ends for wear and damage.

4. Replace defective push rods.



-UN-01NOV88
T81233

S11,2005,JN -19-01NOV95

CLEAN AND INSPECT CYLINDER HEAD CAP SCREWS

1. Inspect cap screws for corrosion damage and condition of threads. Any cap screw with corrosion or other defects must be replaced.

2. Clean up cap screws with a wire brush. Wash with solvent and dry with compressed air. Dip cap screws and washers entirely in clean engine oil before installation.

S11,2005,JO -19-13MAR92

INSPECT VENTILATOR ASSEMBLY

1. Remove outlet tubes (A) and (B). Discard O-ring (C).

2. Remove cover (D), gasket (E), deflector (F), filter element (G), and isolator (H). Discard gasket.

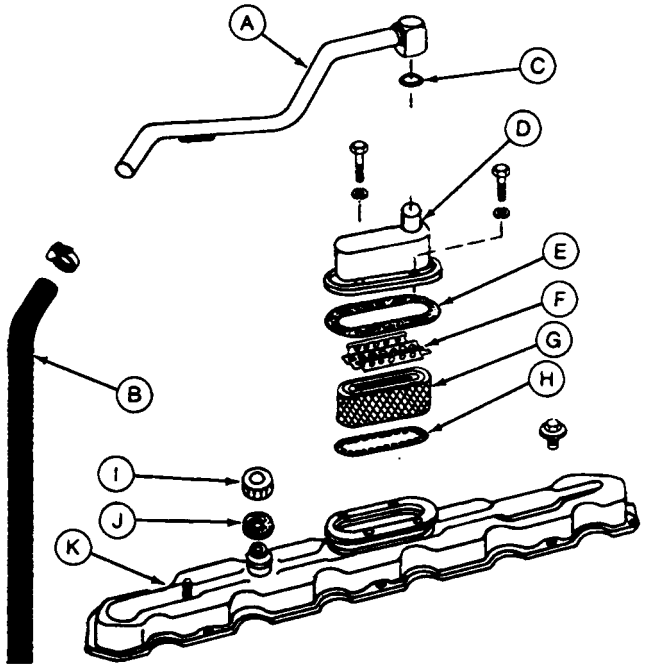
3. Remove oil filler cap (I) and discard gasket (J).

4. Inspect components for restrictions or damage. Clean or replace as necessary.

5. Use new gaskets and O-ring when reassembling ventilation assembly.

NOTE: Be sure filter element is clean and all gasket material is removed before installing on engine.

6. Reverse order to assemble ventilation components.



A—Outlet Tube
B—Outlet Tube
C—O-Ring
D—Cover
E—Gasket
F—Deflector
G—Filter Element
H—Isolator
I—Oil Filler Cap
J—Gasket
K—Rocker Arm Cover

S11,2505,CF,1 -19-17NOV95

INSPECT AND CLEAN EXHAUST MANIFOLD

1. Remove all residue and gasket material from gasket surfaces.

2. Thoroughly clean passages in exhaust manifold and exhaust elbow.

3. Inspect entire exhaust manifold for cracks or damage and replace parts as necessary.

S11,0401,AJ -19-06OCT95

CLEAN AND INSPECT TOP DECK OF CYLINDER BLOCK

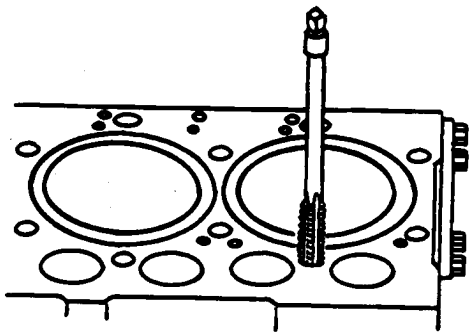
1. Remove gasket material, rust, carbon, and other foreign material from top deck. Gasket surface must be clean.

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

IMPORTANT: Remove cam followers from block. Wash in solvent. Lubricate with engine oil and reinstall in the same order as removed.

3. Clean threaded holes in cylinder block (for cylinder head cap screws) using JDG682 or an equivalent 9/16-12 UNC-2A tap approximately 127 mm (5.0 in.) long. Use compressed air to remove debris and any fluids which may be present in the cap screw holes.

4. Measure top deck flatness. See MEASURE CYLINDER BLOCK in Group 10.

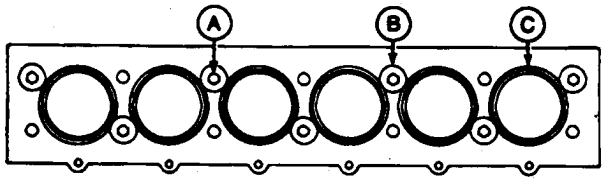


RG4718 -UN-13DEC88

S11,2005,GZ,1 -19-13NOV95

MEASURE CYLINDER LINER HEIGHT

1. Use short cap screws (A) and 3.18 mm (1/8 in.) thick washers (B) to bolt down cylinder liners (C) in the seven locations as shown. Tighten cap screws to 68 N·m (50 lb-ft).



NOTE: Do not rotate crankshaft with cylinder head removed unless liners are bolted down. Bolt liners down removing pistons.

IMPORTANT: Cap screws and washers must be tightened to the above specification to achieve an accurate reading when checking liner height above block.

S55,2505,AM -19-31MAY95

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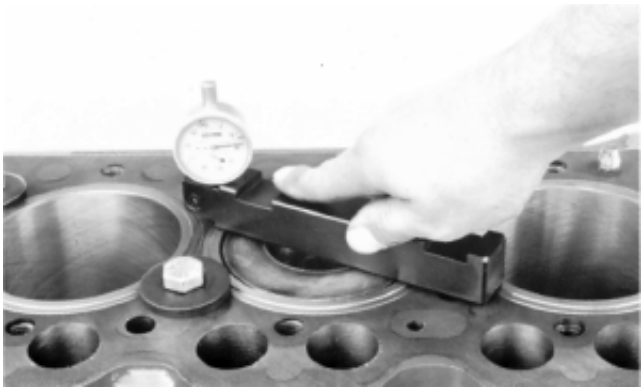
IMPORTANT: All old gasket material, rust, carbon and other foreign material from top deck of cylinder block. Use compressed air to remove all loose foreign material from cylinders and top deck.


CD6371 -UN-23FEB89

2. Bolt liners down in seven locations using cap screws and washers as previously outlined. Tighten cap screws to 68 N·m (50 lb-ft).

3. Using JDG451 Gauge along with D17526CI (English scale) or D17527CI (metric scale) Dial Indicator or KJD10123 Gauge or a magnetic base dial indicator assembly, measure liner height for all cylinders.

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

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

5. Replace any liner that does not meet standout (height) specification at any location. (See Group 10 for liner replacement instructions.)

LINER HEIGHT SPECIFICATION

Height Above Block	0.025—0.10 mm (0.001—0.004 in.)

S55,2505,AN -19-13NOV95

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33

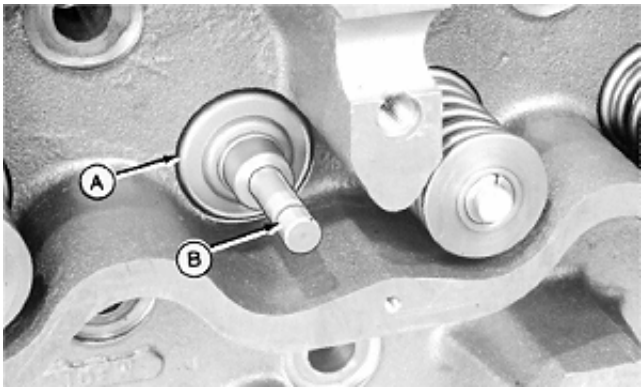
INSTALL VALVE ASSEMBLY

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

NOTE: Valves must move freely and seat properly.

2. Install valves (B) in guides from which they were removed.

3. Install valve rotators (A), making certain that cylinder head end of rotator is located properly in machined counterbore of head.

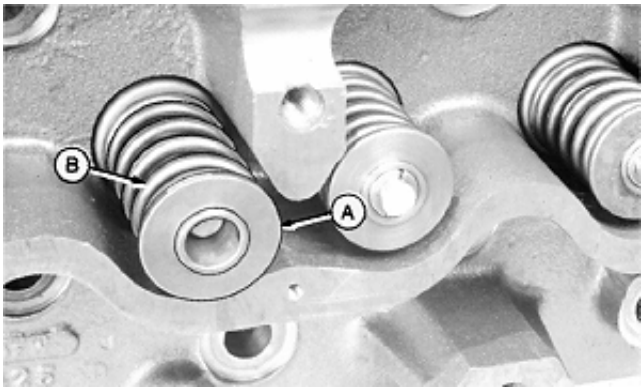


-UN-17JUL89
RG3034

S11,2505,AC -19-14JUN95

4. Install both inner and outer springs (B).

5. Install spring cap (A).



-UN-17JUL89
RG3033

S11,2505,AD -19-14JUN95

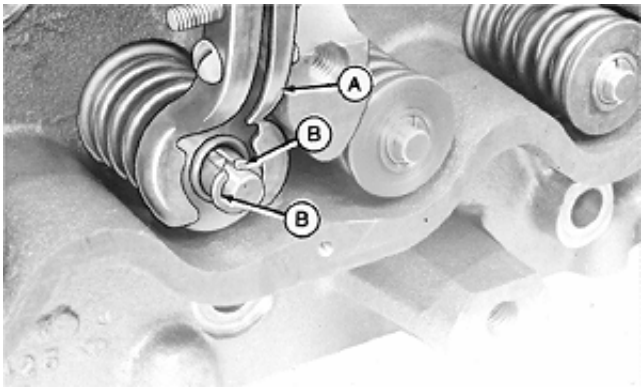
6. Compress valve springs with valve spring compressor (A).

7. Install retaining locks (B).

8. Remove valve spring compressor.

9. Strike end of each valve with a soft mallet, three or four times to insure proper seating of the retaining locks.

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



-UN-16OCT91
RG3032

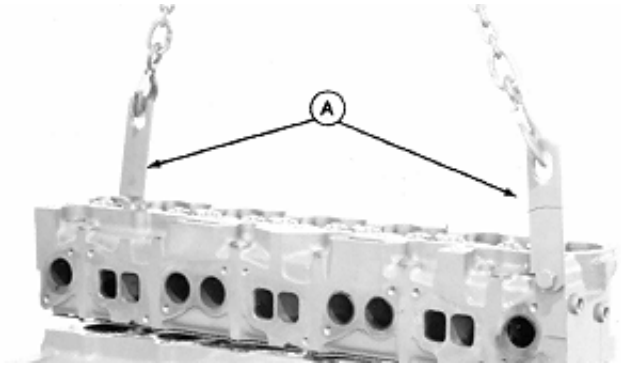
S11,2505,AE -19-14JUN95

INSTALL CYLINDER HEAD

1. Place a new head gasket on top of cylinder block. Do not use sealant on gasket.

2. Place cylinder head in correct position on block using appropriate lifting equipment (A). Make sure that head is positioned correctly over dowels and that it is all the way down on gasket.

3. Clean cap screws to remove rust and scale. Clean the entire length of screw. Inspect cap screws for corrosion damage and condition of threads. Any cap screw with corrosion or other defects must be replaced.



-UN-10NOV89
RG3492

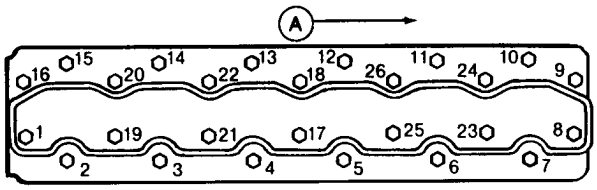
S55,2505,R -19-09MAR89

4. Dip entire cap screws and washers in clean engine oil. Remove excess oil.

CAP SCREW LENGTH	LOCATION ON CYLINDER HEAD
197 mm (7.75 in.)	23, 25, 17, 21, 19, 9, 24, 11 26, 12, 18, 22, 14, 20, 16
171 mm (6.75 in.)	7, 6, 5, 4, 3, 2, 10, 13, 15
248 mm (9.75 in.)	8, 1

5. Install washers on cap screws.

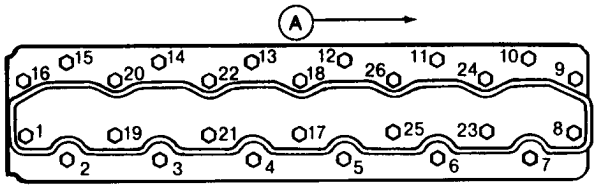
6. Install cap screws and washers in proper location.



-UN-28FEB94
RG4471

S55,2505,S -19-09MAR89

TIGHTEN CYLINDER HEAD CAP SCREWS



RG4471 -UN-28FEB94

1. Initially tighten cap screw No. 17 (illustration) to 200 N·m (150 lb-ft) first. This will prevent the cylinder head from tipping during tightening sequence.

2. Tighten the remaining cap screws to 200 N·m (150 lb-ft), following the numerical sequence shown and begin at No. 1.

3. Finally “Torque-Turn” all cap screws 90—100 degress using the same numerical sequence, beginning with No. 1 and proceeding through No. 26. (See Torque-Turn Method for Proper Cylinder Head Torque, later in this group.)

S55,2505,T -19-13NOV95

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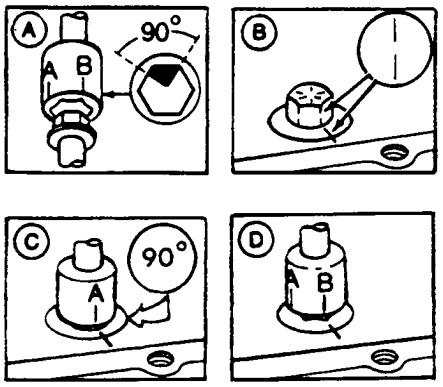
36

TORQUE-TURN METHOD FOR PROPER CYLINDER HEAD TORQUE



RG5563 -UN-04JUL89

1. After tightening cap screws (in proper sequence) to 200 N·m (150 lb-ft), follow the steps below for each cap screw in same sequence as outlined earlier:

Step A—Make a mark on socket and make a second mark 1/4 turn (90 degrees) counterclockwise from the first.

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

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

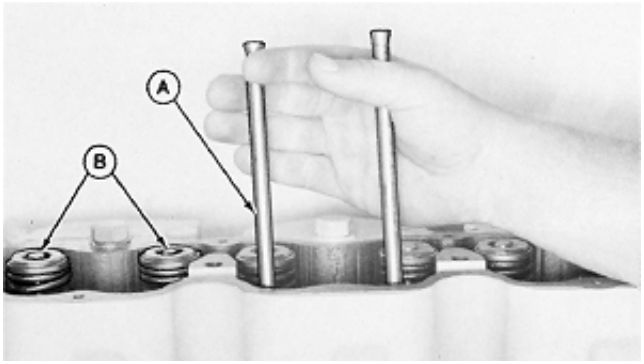
Step D—Tighten all cap screws until second mark on socket aligns with mark on cylinder head.

S55,2505,U -19-13NOV95

INSTALL ROCKER ARM ASSEMBLY

1. Install push rods (A) in holes from which removed.

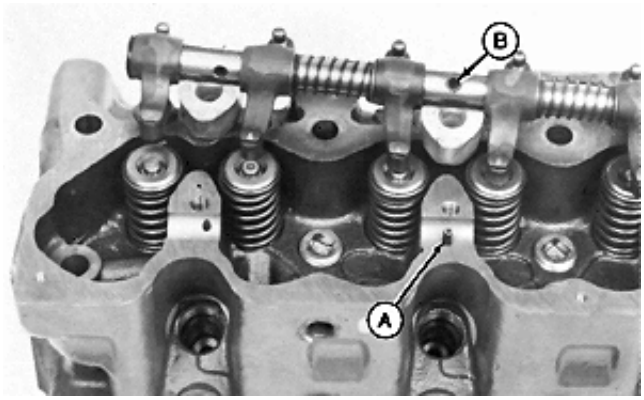
2. Install wear caps (B) on valves, making certain caps rotate freely.



RG3809 -UN-23FEB89

S11,2005,HT -19-12JUL94

3. Install rocker arm shaft assembly. Make sure spring pin (A) engages with hole (B) in shaft.



RG3810 -UN-23FEB89

S55,2505,V -19-09MAR89

4. Install rocker arm shaft clamps (B) and all six cap screws (A) with washers. Tighten cap screws to 88 N·m (65 lb-ft).

RG4336 -UN-09NOV89

S55,2505,W -19-09MAR89

COMPLETE FINAL ASSEMBLY ON INJECTION PUMP SIDE

1. Adjust valve clearance as outlined earlier in this group.

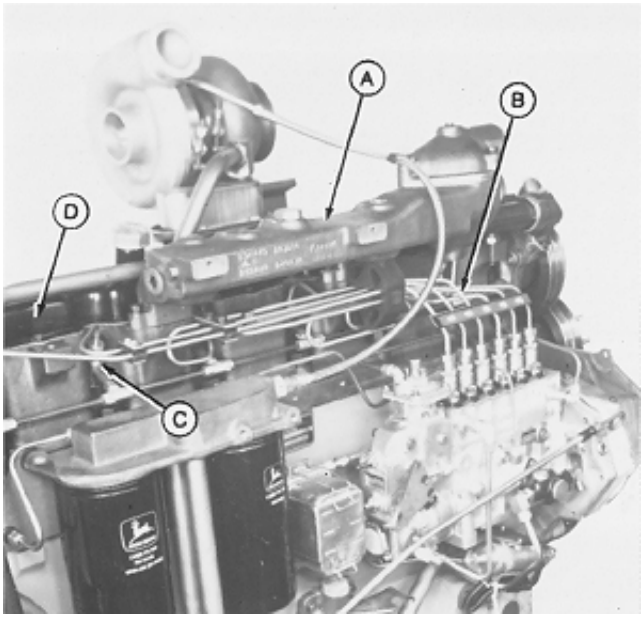
2. Using Scotch-Grip® 1099 Plastic Adhesive (or equivalent), cement new gasket to rocker arm cover (D) and allow to set approximately 10 minutes.

3. Install rocker arm cover and tighten cap screws to 11 N·m (8 lb-ft).

4. Install fuel injection nozzles (C) and fuel injection lines (B). (See Group 35.)

5. Install water manifold (A) and connect water piping. (See Group 25.)

A—Water Manifold
B—Fuel Injection Lines
C—Fuel Injection Nozzles
D—Rocker Arm Cover



RG5523 -UN-09JAN90

S55,2505,AI -19-17NOV95

COMPLETE FINAL ASSEMBLY ON EXHAUST MANIFOLD SIDE

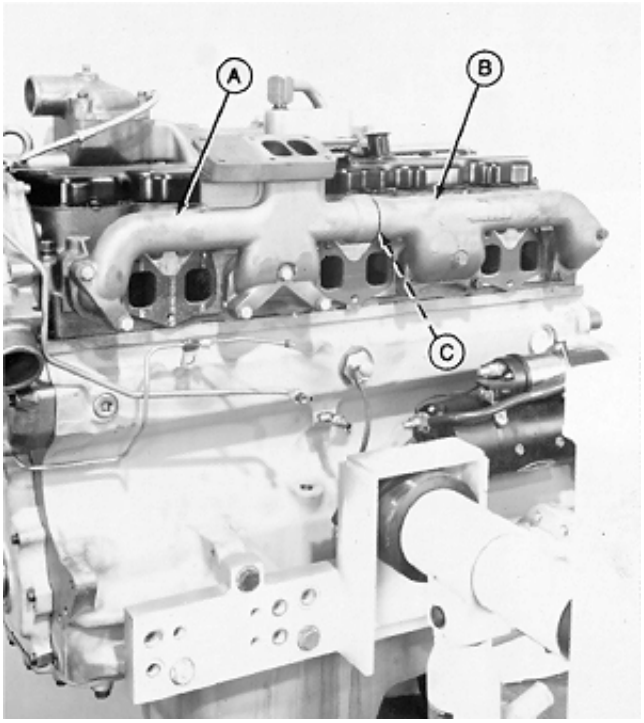
Apply NEVER-SEEZ® to all exhaust manifold cap screws during assembly.

1. Install rear exhaust manifold (C) using new gaskets. Tighten cap screws to 95 N·m (70 lb-ft).

2. Install a new sealing ring (B) in groove on front end of rear exhaust manifold.

3. Install front exhaust manifold (A) using new gaskets. Tighten cap screws to 95 N·m (70 lb-ft).

4. Install turbocharger oil return tube, if removed (not shown).



RG5558 -UN-09JAN90

S55,2505,AJ -19-13JUL89

On 6101H Engines:

5. Install intake manifold using new gaskets along with coolant conditioner filter assembly. Tighten cap screws to 75 N·m (55 lb-ft).

On 6101A Engines:

6. Install intake manifold (C) using new gaskets along with coolant conditioner filter assembly (E). Tighten cap screws to 75 N·m (55 lb-ft).

NOTE: Guide studs may be used for aligning intake manifold, gaskets, aftercooler and cover during assembly.

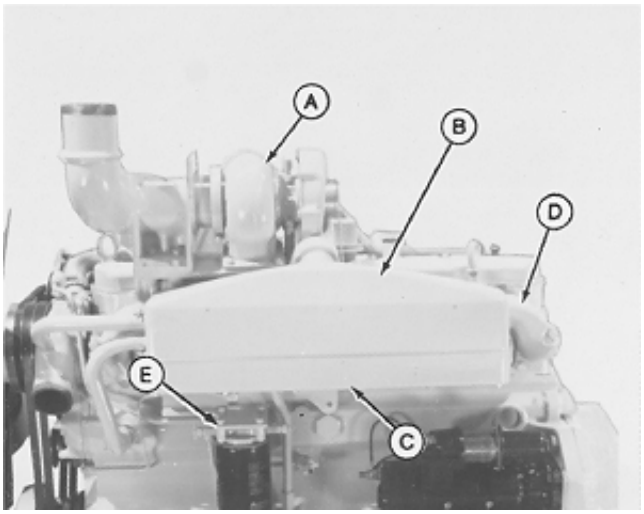
7. Install aftercooler assembly and cover (B). Tighten cap screws to 47 N·m (35 lb-ft). (See Group 30.)

8. Install turbocharger (A) and tighten cap screws to 47 N·m (35 lb-ft). Connect all exhaust and air intake piping, tighten connections securely. (See Group 30 and machine technical manual.)

9. Fill engine with proper oil and coolant to the proper levels.

10. Perform engine break-in as outlined next.

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



RG5522 -UN-09JAN90

A—Turbocharger
B—Intake Cover and Aftercooler
C—Intake Manifold
D—Exhaust Manifold
E—Coolant Conditioner Filter Assembly

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39

S55,2505,AK -19-15JUN89

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 clearance 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 cap screws to 11 N·m (8 lb-ft). (See COMPLETE FINAL ASSEMBLY ON INJECTION PUMP SIDE OF ENGINE, earlier in this group.)

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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,CTM20,G05,5 -19-17NOV95

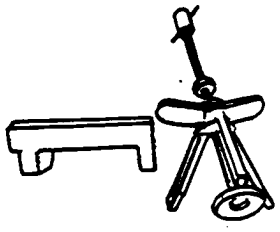
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

Cylinder Liner Puller D01062AA
(or D01073AA)

Remove cylinder liners.



RG5019 -UN-23AUG88

S53,D01062,AA -19-07AUG91

RG5073 -UN-23AUG88

Magnetic Follower Holder Kit D15001NU

Hold cam followers when removing or installing camshaft.

S53,D15001,NU -19-24APR92

RG5074 -UN-23AUG88

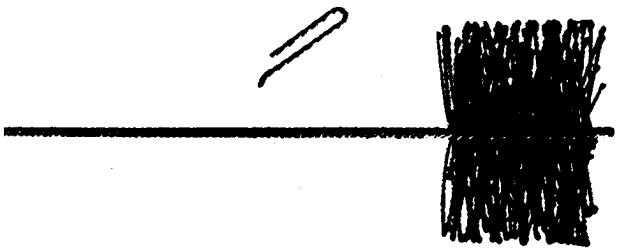
Flexible Cylinder Hone D17006BR

Hone cylinder liners.

S53,D17006,BR -19-14JUN89

O-Ring Groove Cleaning Brush D17015BR

Clean cylinder liner O-ring groove in block.



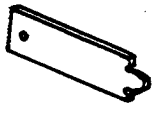
RG5075 -UN-23AUG88

S53,D17015,BR -19-25MAR91

RG5076 -UN-23AUG88

Ring Groove Wear Gauge JDE55

Check wear of keystone ring groove on pistons.

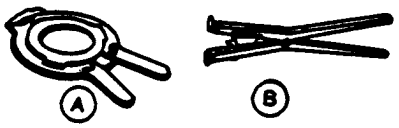


S53,JDE55 -19-25MAR91

RG6244 -UN-23MAR92

Piston Ring Expander . . . . . A—JDE94
B—JDE135

Remove and install piston rings.



S55,JDE94 -19-27APR92

RG5031 -UN-23AUG88

Piston Ring Compressor JDE97

Compress rings while installing pistons.

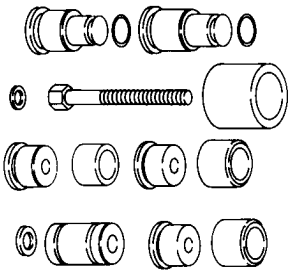
S53,JDE97 -19-14JUN89

Connecting Rod Bushing Service Set JDE98A

Remove and install connecting rod bushings.

Set consists of:

1—Cup	JDE98-1
2—Driver	JDE98-2
3—Pilot	JDE98-3
4—Driver	JDE98-4
5—Driver	JDE98-5
6—Pilot	JDE98-6
7—Driver	JDE98-7
8—Cup	JDE98-8
9—Pilot	JDE98-9
10—Remover Bushing	JDE98-10
Forcing Screw	STD36104



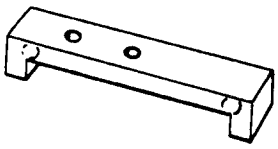
RG5078 -UN-16FEB94

S53,JDE98A -19-16AUG94

Piston and Liner Height Gauge JDG451

Measure piston and liner heights.

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



RG7029 -UN-30SEP94

RG,JDG451 -19-28SEP94

RG5100 -UN-23AUG88

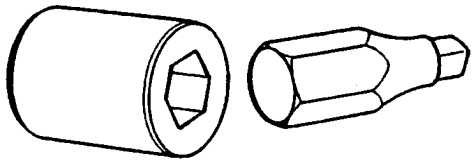
Tap JDG682

Clean cylinder head mounting threads on top deck of cylinder block.

S55,JDG682 -19-24APR92

Oil Galley Plug Tool JDG782

Used to remove and install oil galley plug.



RG6612 -UN-29JAN93

RG,JDG782 -19-02APR93

OTHER MATERIAL

Number	Name	Use
AR54749	Soap Lubricant	Coat O-rings on cylinder liners.
	PLASTIGAGE®	Determine connecting rod bearing-to-journal oil clearance.

PLASTIGAGE is a trademark of the TRW Company.

S11,2010,BS -19-16JUN95

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SERVICE EQUIPMENT AND TOOLS

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

Name	Use
JT05993 Torque Angle Gauge	TORQUE-TURN connecting rod cap screws
D05012ST Precision “Bevelled Edge” Straightedge	Check cylinder block flatness
Piston Ring Groove Cleaner	Clean piston ring grooves
Cylinder Bore Ridge Reamer	Remove carbon from liner bore

RG,CTM20,G10,1 -19-17NOV95

CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS

Item	New Part Specification	Wear Tolerance
Cylinder Liner Height above Block	0.025—0.102 mm (0.001—0.004 in.)	--
Liner Counterbore Depth	9.46—9.51 mm (0.3725—0.3745 in.)	--
Max. Height of Piston Above Block	0.254 mm (0.010 in.)	--
Piston Oil Control Ring Clearance	0.06—0.10 mm (0.0025—0.0040 in.)	0.165 mm (0.0065 in.)
Piston skirt OD at 49.53 mm (1.95 in.) from bottom		
6101AT001 Engines Serial No. (100000—8.89*) and 6101HRW01,02 Engines Serial No. (100000—100168):		
"L"	130.022—130.035 mm (5.1190—5.1195 in.)	
"M"	130.035—130.048 mm (5.1195—5.1200 in.)	
"H"	130.048—130.060 mm (5.1200—5.1205 in.)	
6101HRW01,02 Engines Serial No. (100169—8.89*):		
"H3"	130.048—130.060 mm (5.1200—5.1205 in.)	
6101AF, 6101AT001 and 6101HRW01, 02 Engines (8-89*—):		
"P"	130.033—130.043 mm (5.1194—5.1198 in.)	
"Q"	130.043—130.053 mm (5.1198—5.1202 in.)	
"R"	130.053—130.063 mm (5.1202—5.1206 in.)	
"S"	130.063—130.073 mm (5.1206—5.1210 in.)	
Cylinder liner ID at 75 mm (2.95 in.) from top (average of two measurements)		
6101AT001 Engines Serial No. (100000—8-89*) and 6101HRW01,02 Engines Serial No. (100000—100168):		
"LL" and "L2"	130.162—130.175 mm (5.1245—5.1251 in.)	
"MM" or "M2"	130.175—130.193 mm (5.1251—5.1257 in.)	
"HH" or "H2"	130.193—130.205 mm (5.1257—5.1263 in.)	
6101HRW01,02 Engines Serial No. (100169—8-89)		
"H"	130,183—130.190 mm (5.1253—5.1256 in.)	
6101AF, 6101AT001 and 6101HRW01,02 Engines (8-89*—)		
"P"	130.165—130.175 mm (5.1246—5.1250 in.)	
"Q"	130.175—130.185 mm (5.1250—5.1254 in.)	
"R"	130.185—130.195 mm (5.1254—5.1258 in.)	
"S"	130.195—130.205 mm (5.1258—5.1262 in.)	
Piston-to-Liner Clearance		
"L-LL/L2"	0.127—0.155 mm (0.0050—0.0061 in.)	
"M-MM/M2"	0.130—0.157 mm (0.0051—0.0062 in.)	
"H-HH/H2"	0.132—0.160 mm (0.0052—0.0063 in.)	
"H-H3", "P-P", "Q-Q", "R-R" and "S-S"	0.122—0.142 mm (0.0048—0.0056 in.)	
Cylinder Liner Thickness	7.16—7.42 mm (0.266—0.292 in.)	--
Packing Step Dimension	2.13—2.29 mm (0.084—0.090 in.)	--
Piston Pin OD	50.772—50.787 mm (1.9989—1.9995 in.)	--
Piston Pin Bore ID in Piston	50.793—50.801 mm (1.9997—2.0000 in.)	--

**Approximate availability date at time of printing. Serial numbers will be assigned at next revision.*

S55,2510,A -19-17NOV95

CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS—CONTINUED

Item	New Part Specification	Wear Tolerance
Lower Bore for Seating Liners	140.465—140.515 mm (5.530—5.532 in.)	--
Upper Bore For Seating Liners	145.845—145.895 mm (5.742—5.744 in.)‘	--
Outer Dia. Of Liner at Upper Bore	145.795—145.845 mm (5.740—5.742 in.)	--
Outer Dia. of Liner at Lower Bore	140.398—140.448 mm (5.527—5.529 in.)	--
Liner-to-Block Clearance at Lower Bore	0.014—0.114 mm (0.0005—0.0045 in.)	--
Liner-to-Block Clearance at Upper Bore	0.00—0.10 mm (0.000—0.004 in.)	--
Centerline of Main Bearing Bore-to-Top Deck of Cylinder Block	374.57—374.73 mm (14.747—14.753 in.)	--
Liner Counterbore Depth	9.46—9.51 mm (0.3725—0.3745 in.)	--
Cylinder Liner Out-of Round (Max.)		0.05 mm (0.002 in.)
Cylinder Liner Wear or Taper		0.038 mm (0.0015 in.)
Cylinder Liner Taper in Ring Travel Area (Max.)		0.038 mm (0.0015 in.)
Liner Flange Thickness	9.538—9.563 mm (0.3755—0.3765 in.)	--
Liner Shim Thickness		
R81276	0.05 mm (0.002 in.)	--
R81277	0.10 mm (0.004 in.)	--
Shim Thickness Per Cylinder (Max.)	0.10 mm (0.004 in.)	--
Piston Pin OD	50.772—50.787 mm (1.9989—1.9995 in.)	--
Piston Pin Bore ID in Piston	50.795—50.805 mm (1.9998—2.0002 in.)	--
Connecting Rod Pin Bushing Bore	55.529—55.555 mm (2.1862—2.1872 in.)	--
Press Fit of Bushing in Rod Pin Bore	0.100—0.163 mm (0.0039—0.0064 in.)	--
Connecting Rod Pin Bushing ID	50.805—50.830 mm (2.0002—2.0012 in.)	--
Pin-to-Bushing Oil Clearance	0.017—0.059 mm (0.0007—0.0023 in.)	0.076 mm (0.0030 in.)
Connecting Rod Bearing Assembled ID	88.93—88.98 mm (3.501—3.503 in.)	--
Connecting Rod Bearing Bore	93.76—93.79 mm (3.6915—3.6925 in.)	--
Crankshaft Rod Journal OD	88.844—88.874 mm (3.4980—3.4990 in.)	--
Bearing-to-Journal Clearance	0.06—0.13 mm (0.002—0.005 in.)	0.15 mm (0.006 in.)
Connecting Rod Bore Out-of-Round		0.038 mm (0.0015 in.)
Camshaft Bushing Bore in Block	63.487—63.513 mm (2.4995—2.5005 in.)	
Camshaft Bushing ID	60.389—60.439 mm (2.3775—2.3795 in.)	
Torques		
Connecting Rod Caps:		
Initial (Blind Hole Cap Screws)	27 N·m (20 lb-ft)	--
Final (All Cap Screws)	75 N·m (55 lb-ft) plus 90˚—100˚	--
Piston Cooling Orifices	11 N·m (8 lb-ft) (97 lb-in.)	--
Cylinder Liner Cap Screws (For Checking Liner Standout)	68 N·m (50 lb-ft)	--
Oil Pressure Regulating Housing	47 N·m (35 lb-ft)	--
Block Heating Element Nut	34 N·m (25 lb-ft)	--

S55,2510,B -19-17NOV95

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.

S11,0402,A -19-16JUN95

DISCONNECT TURBOCHARGER OIL INLET LINE

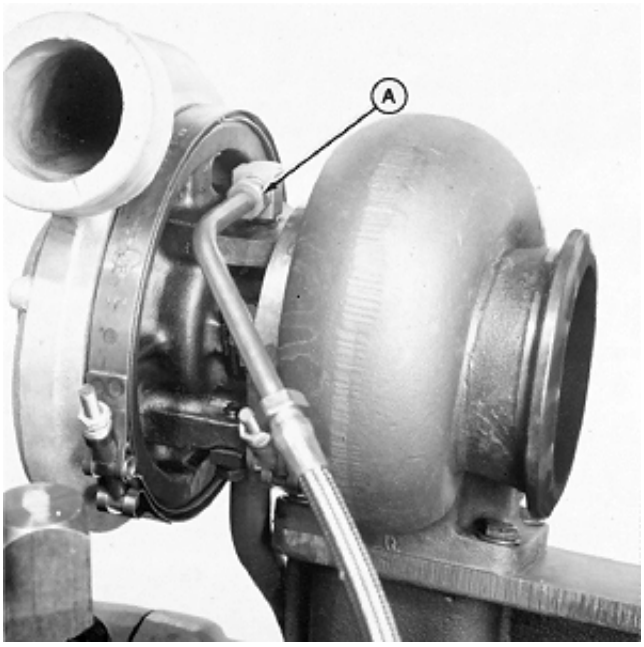
1. Drain all engine oil and coolant, if not previously done.

IMPORTANT: When servicing the 6101 Engine on a rollover stand, disconnect turbo oil inlet line (A) before rolling engine over. Failure to do so may cause a hydraulic lock upon starting the engine. Hydraulic lock may cause possible engine failure.

Hydraulic lock occurs when trapped oil in the oil filter head 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 oil filter housing or turbocharger.



RG5520 -UN-09JAN90

RG,CTM61,G3,1 -19-16APR92

REMOVE PISTONS AND CONNECTING RODS

The engine does not always have to be removed from the machine to service the pistons and connecting rods. If engine is to be removed, see your Machine Technical Manual.

CAUTION: DO NOT drain engine coolant until the temperature is below operating temperature. Then slowly loosen water pump drain valve and block drain valve to relieve any pressure.

1. Drain all coolant and engine oil.

Disconnect turbocharger oil inlet line. See DISCONNECT TURBOCHARGER OIL INLET LINE earlier in this group.

NOTE: If engine is to be completely disassembled, follow Disassembly Sequence in Group 04.

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

3. Remove oil pan and oil pump. (See REMOVE OIL PUMP in Group 20.)

4. Remove crankshaft (if desired). (See REMOVE CRANKSHAFT in Group 15.)

-UN-13DEC88
RG3657

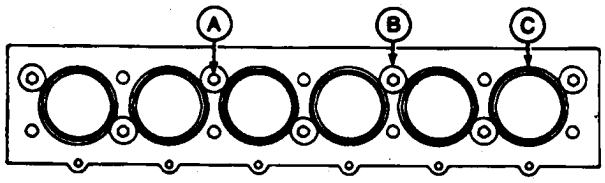
A—#1 Keystone Compression Ring
B—#2 Keystone Compression Ring
C—Oil Control Ring with Expander
D—Snap Ring (2 used)
E—Piston
F—Piston Pin
G—Piston Pin Bushing
H—Connecting Rod
I—Bearings
J—Connecting Rod Cap
K—Special Cap Screw

S11,2010,FD,1 -19-17NOV95

5. Use approximately 51 mm (2.0 in.) long cap screws (A) and 5/8 in. ID x 1-3/4 in. OD x 3.18 mm (1/8 in.) thick washers (B) to bolt down cylinder liners (C) in the seven locations as shown. Tighten cap screws to 68 N·m (50 lb-ft).

NOTE: Do not rotate crankshaft with cylinder head removed unless liners are bolted down. Bolt liners down before removing pistons.

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



-UN-07DEC88
RG3819

S11,2010,EV -19-07AUG91

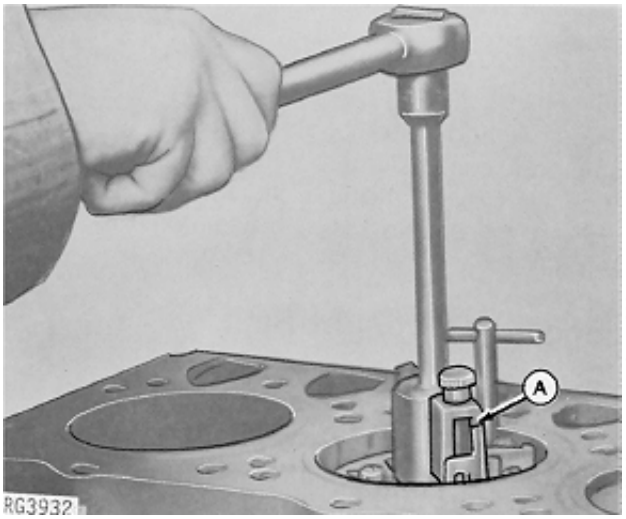
6. Remove carbon from liner bore with a scraper or ridge reamer (A) before removing pistons. Use compressed air to remove loose material from cylinders.

NOTE: Before removing pistons visually inspect condition of cylinder liners with pistons at bottom dead center "BDC". Liners will require replacement if:

A—The crosshatch honing pattern is not visible immediately below the top ring turn around area.

B—Liners are pitted or contain deep vertical scratches that can be detected by the fingernail.

No further inspection is required if any one of the above conditions are found.



S11,2010,IV -19-29OCT92

NOTE: Connecting rod bearing clearance should be measured before removing piston/rod assembly.

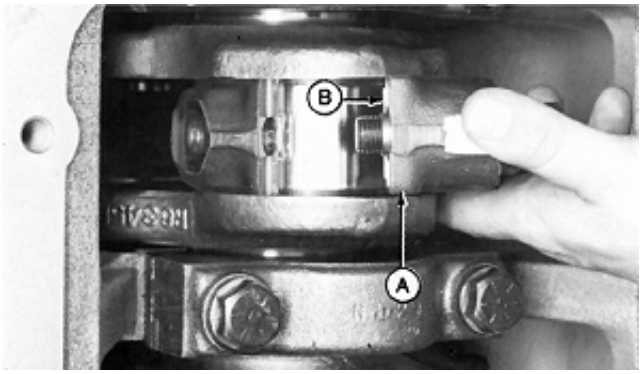
Rod bearing-to-journal oil clearance can be checked with PLASTIGAGE™ if rod is connected to crankshaft. If rod is out of engine, measure ID of assembled connecting rod bearings and compare with OD of crankshaft journal.

NOTE: Use PLASTIGAGE™ as directed by the manufacturer. Remember, the use of PLASTIGAGE™ will determine bearing journal clearance, but will not indicate the condition of either surface.

IMPORTANT: Using pneumatic wrenches may cause thread damage.

Keep bearing inserts with their respective rods and caps. Mark rods, pistons, and caps to insure correct assembly in same location.

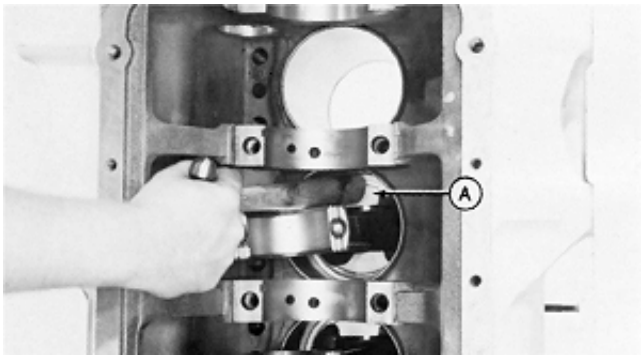
7. Remove rod cap screws and rod caps (A) with bearings (B).



S11,2010,KC -19-13MAR92

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

Pistons and liners are selectively fitted to maintain piston-to-liner clearance. Always keep matched pistons and liners together as a set. Each set MUST BE installed in the same cylinder it was removed from.



RG3821 -UN-07DEC88

8. Mark piston and liner as a set.

9. Gently tap piston (A) through top of cylinder block from the bottom. (Crankshaft shown removed.)

NOTE: Once piston rings have cleared cylinder liner, hold on to piston to prevent piston from dropping.

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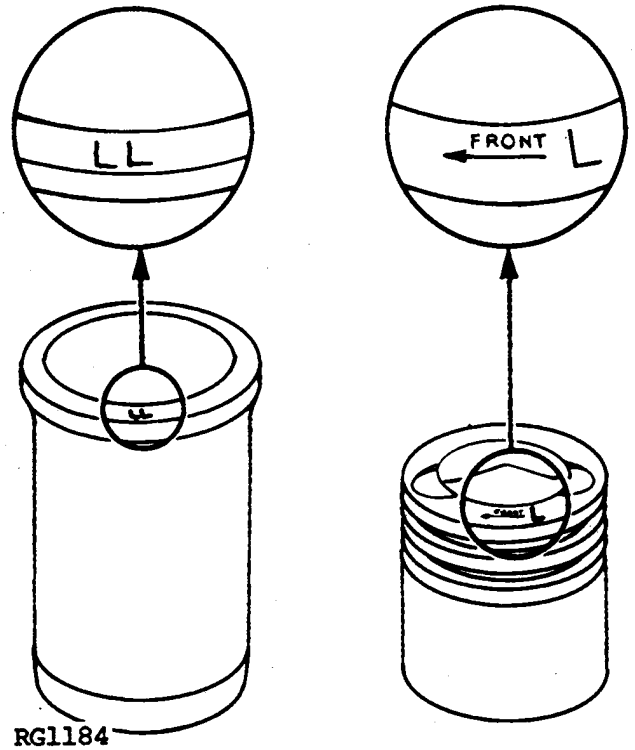
S11,0402,G -19-16JUN95

Piston and liners are selectively fitted to maintain piston-to-liner clearance. Always keep matched pistons and liners together.

Pistons and liners are stamped for identification purposes. Engine MUST have one of the following piston/liner MATCHED SET combinations to assure proper clearance specification:

PISTON-TO-LINER MATCHED COMBINATIONS

Piston Stamping	Liner Stamping
L	LL or L2
M	MM or M2
H	HH,H2 or H3
P	P
Q	Q
R	R
S	S

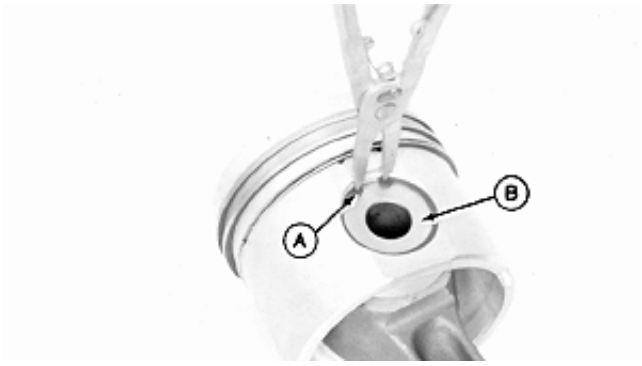


RG11184 -UN-20APR89

S11,2010,DA,1 -19-17NOV95

10. Remove piston snap rings (A), piston pins (B) and connecting rods.

NOTE: Discard snap rings; DO NOT reuse.

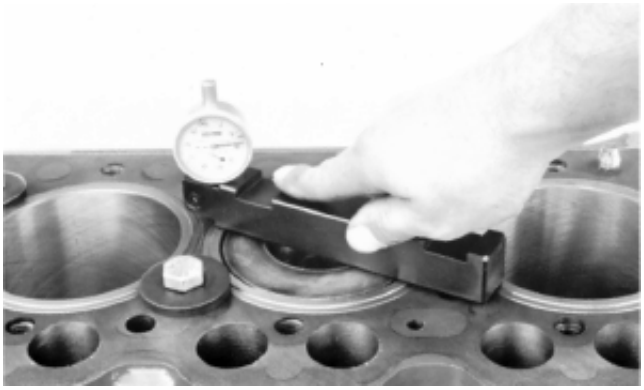


-UN-28JUL89
RG3171

S11,2010,DA1 -19-16JUN95

MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

IMPORTANT: Remove all old gasket material, rust, carbon and other foreign material from top deck of cylinder block. Use compressed air to remove all loose foreign material from cylinders and top deck.



-UN-23FEB89
CD6371

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1. Bolt liners down in seven locations using cap screws and washers as previously outlined. Tighten cap screws to 68 N·m (50 lb-ft).

2. Using JDG451 Gauge along with D17526CI (English scale) or D17527CI (Metric scale) or KJD10123 Gauge or a magnetic base dial indicator assembly, measure liner height for all cylinders.

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

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

4. Replace any liner that does not meet standout (height) specification at any location.

LINER HEIGHT SPECIFICATION

Height Above Block	0.025—0.10 mm (0.001—0.004 in.)

S55,2510,J -19-17NOV95

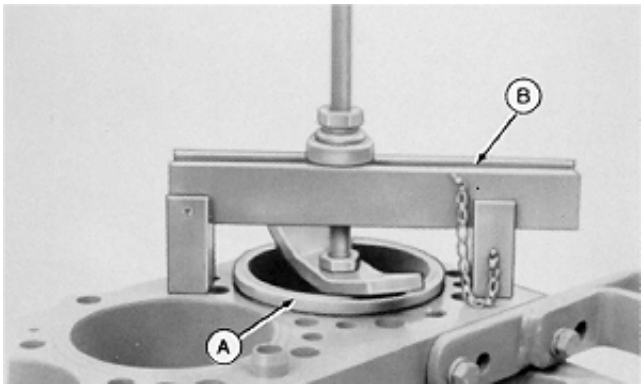
REMOVE CYLINDER LINERS

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

2. Number cylinder liners and mark fronts to assure correct assembly.

NOTE: Each cylinder liner must be reinstalled in same cylinder bore from which removed. Always keep matched pistons and liners together.

3. Use D01062AA or D01073AA Cylinder Liner Puller (B) to remove cylinder liner (A).



S11,2010,IX -19-02APR93

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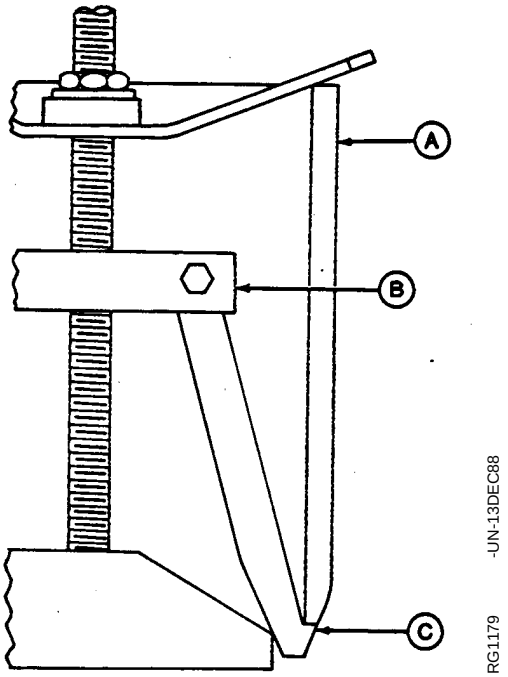
IMPORTANT: When using D01062AA (or D01073AA) Cylinder Liner Puller (B) to remove liners (A), be sure jaw (C) of puller is correctly positioned before attempting to remove liner.

DO NOT over-tighten liner puller to remove liners. Doing so could easily break liners.

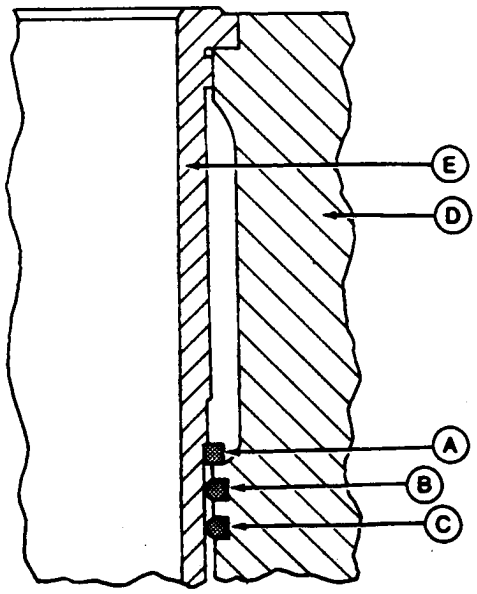


S11,0402,AK -19-22SEP95

4. Remove the cylinder liner square packing (A) from liner (E).

5. Remove red O-ring (B) and black O-ring (C) from cylinder block (D).

A—Square Packing (Neoprene)
B—Red O-Ring (Silicone)
C—Black O-Ring (Viton)
D—Cylinder Block
E—Cylinder Liner



RG3825 -UN-13DEC88

S11,0402,AL,1 -19-13NOV95

REMOVE PISTON RINGS

1. Remove piston rings (B) using the JDE94 Piston Ring Expander (A). Discard rings.

NOTE: The JDE135 Universal Piston Ring Expander (not shown) may also be used.

R26155 -UN-09FEB90

S11,2510,AX -19-16JUN95

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CLEAN PISTONS

Clean pistons by any of the following methods:

- Immersion-Solvent “D-Part”
- Hydra-Jet Rinse Gun
- Glass bead blasting machine
- Hot water with liquid detergent soap

DO NOT bead blast ring groove areas.

CAUTION: Always follow manufacturer’s instructions, and safety steps exactly. When washing pistons, always use a stiff bristle brush—NOT A WIRE BRUSH—to loosen carbon residue.

If cleaning with hot water and liquid detergent, soak pistons in a 50 per cent solution of liquid household detergent and hot water for 30 to 60 minutes. Use a stiff bristle brush—BUT NOT A WIRE BRUSH—to loosen carbon residue. Dry with compressed air.

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S11,2010,DD,1 -19-17NOV95

VISUALLY INSPECT PISTONS

1. Carefully inspect the clean pistons under magnification for signs of fatigue.

2. Look for fine cracks in piston head (A).

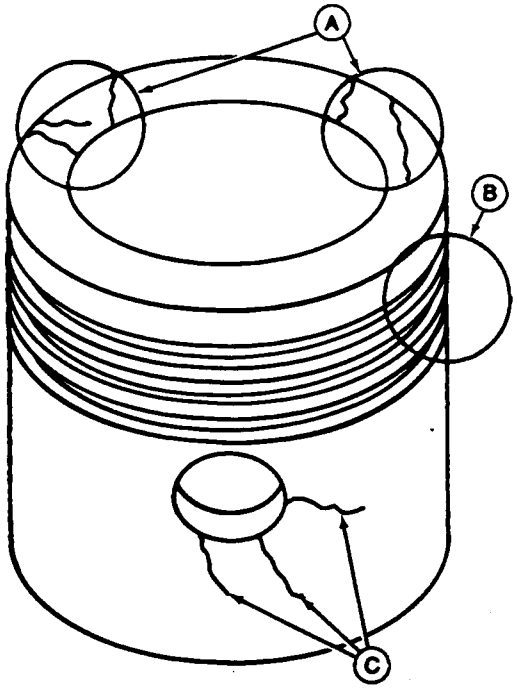
3. Inspect for bent or broken ring lands (B).

4. Inspect the inner and outer ends of the piston pin bore for cracks in the skirt (C).

5. If the original machining marks are not visible, or the piston skirt is worn to the depth of the original machining marks, replace both piston and liner.

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

If no defects are found, proceed to next step.



-UN-13DEC88
RG3326

(Defects Exaggerated)

S11,2010,DE,1 -19-17NOV95

CLEAN CYLINDER LINERS

1. Carefully use a stiff bristle brush to remove all debris and scale from the O.D. of the liners. Make certain there are no nicks or burrs in areas where packings will seat.

2. Thoroughly clean liner I.D. with a 50 per cent solution of hot water and liquid detergent.

3. Rinse thoroughly and wipe dry with a clean, dry rag.

4. Swab out liner as many times as necessary with clean SAE 10W oil.

5. Continue to clean liner until a clean, white rag shows no discoloration.

IMPORTANT: Do not use gasoline, kerosene or commercial solvents to clean liners. Solvents will not remove all the abrasives from liner walls.

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S11,2010,DD1,1 -19-17NOV95

VISUALLY INSPECT CYLINDER LINERS

1. Inspect exterior length of liner for pitting (A). Check packing step for erosion (B). If pitting or erosion is observed, measure the depth of pits and erosion with a fine wire or needle.

IMPORTANT: If pitting has occured, check condition of coolant.

Replace 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).

LINER SPECIFICATIONS

Cylinder Liner Thickness	7.26—7.42 mm (0.286—0.292 in.)
Packing Step Dimension	2.13—2.29 mm (0.084—0.090 in.)

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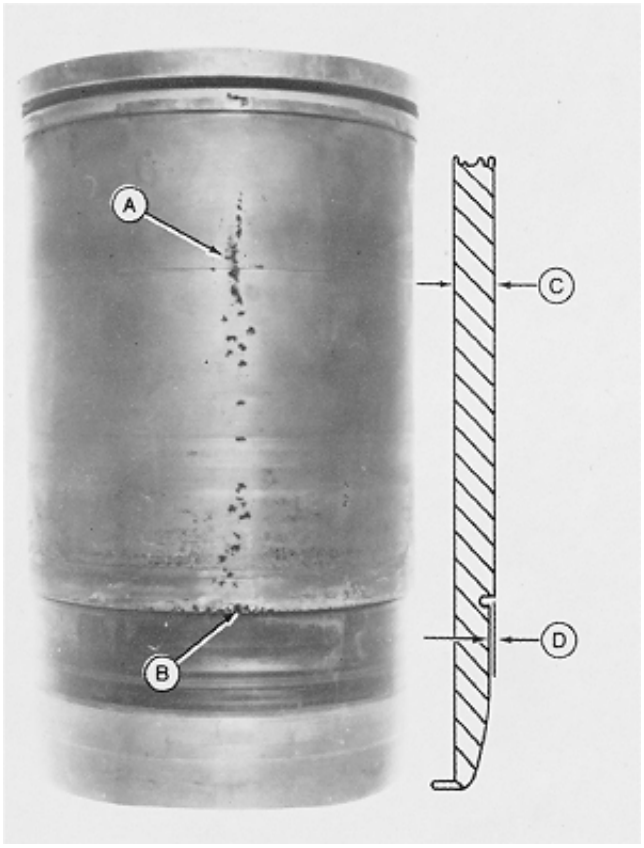
NOTE: Liners are reusable if the depth of pits or erosion is less than one-half the amount specified. When installing these liners, rotate 90˚ from original position. The liners should be deglazed and ring sets installed on pistons.

If no defects are found, proceed to next step.



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

RG,CTM61,G10,13-19-16JUN95

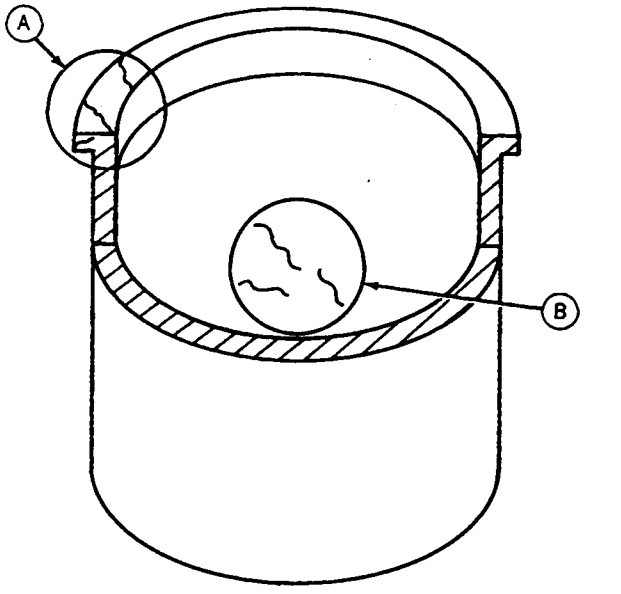
2. Visually examine liner ID. Replace piston and liner if:

— The crosshatch honing pattern is not visible immediately below the top ring turn-around area.

— Liners are pitted or contain deep vertical scratches that can be detected by the fingernail.

3. Carefully examine liner for signs of fatigue, such as fine cracks in the flange area (A) and cracks in the ring travel area (B).

NOTE: Inspect block for cracks or erosion in the O-ring packing areas. See INSPECT AND CLEAN CYLINDER BLOCK, later in this group.

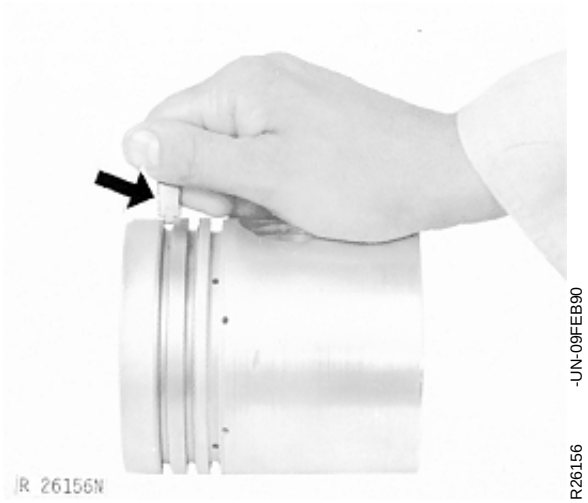


(Exaggerated defects)

RG,CTM61,G10,14-19-16JUN95

CHECK PISTON RING GROOVE WEAR

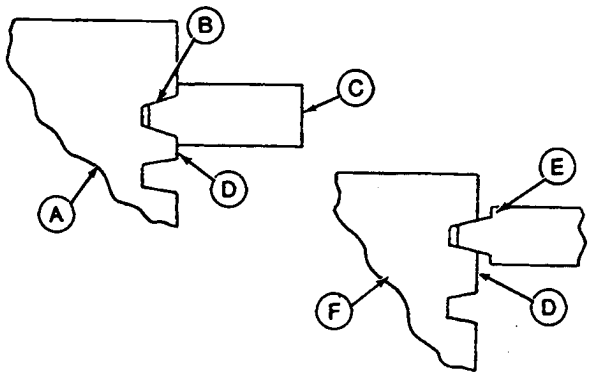
Use JDE55 Ring Groove Wear Gauge (arrow) to check wear of keystone ring grooves. Check each groove at several locations.



S11,2010,DF -19-08MAR94

Gauge shoulders should not contact ring land (D) of piston. If ring grooves are worn, replace piston and liner as a set. If ring grooves are good, proceed to next step.

A—Piston with Worn Ring Groove
B—Keystone Ring Groove
C—JDE55 Ring Groove Wear Gauge
D—Ring Land
E—Gauge Shoulder
F—Piston with Good Ring Groove



S11,2010,DG -19-17FEB87

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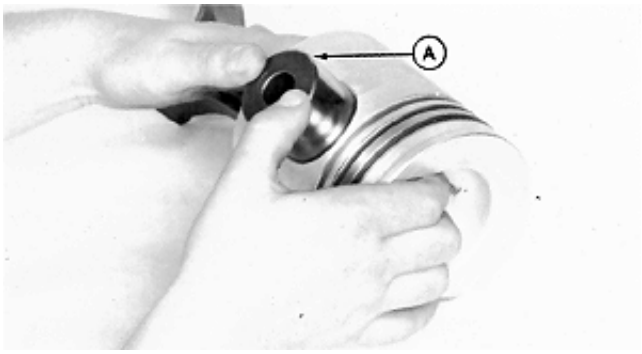
INSTALL PISTON PIN IN PISTON



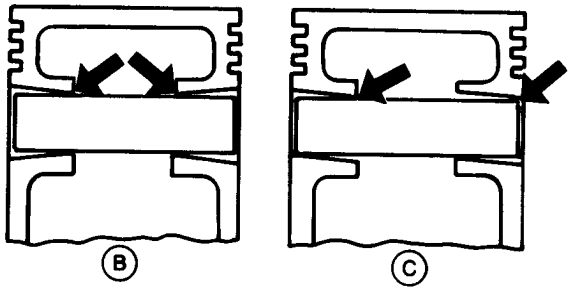
RG3747 -UN-13DEC88

NOTE: Piston pin must be in good condition and not worn beyond specification given below.

1. Dip piston pin in clean engine oil.

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

3. Check taper in piston pin bore by inserting pin from both sides. If pin enters freely, but binds in the center, the bore could be tapered (B). If bore is not tapered, insert pin to check for bore alignment. Pin should not "click" or need to be forced into bore on opposite side (C).



RG4984 -UN-26JUL94

4. Check piston pin and piston bore specifications. If either are not within specification, replace pin, piston, and liner.

PISTON PIN/BORE SPECIFICATIONS

Piston Pin OD	50.772—50.787 mm (1.9989—1.9995 in.)
Piston Pin Bore ID	50.795—50.805 mm (1.9998—2.0002 in.)

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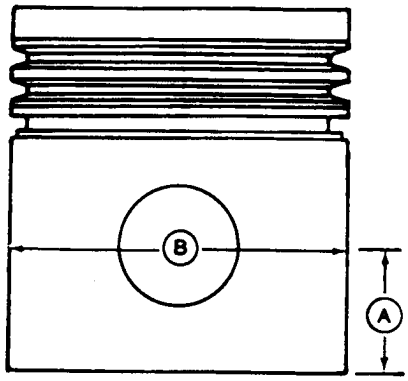
S11,2510,AM,1 -19-17NOV95

MEASURE PISTON OD

1. Measure piston at right angles to piston pin bore (B) at 49.53 mm (1.95 in.) from bottom of piston skirt (A). Record measurements.



RG5581 -UN-11JUL89

PISTON OD SPECIFICATIONS

L	130.022—130.035 mm (1.1190—5.1195 in.)
M	130.035—130.048 mm (5.1195—5.1200 in.)
H, H3	130.048—130.060 mm (5.1200—5.1205 in.)
P	130.033—130.043 mm (5.1194—5.1198 in.)
Q	130.043—130.053 mm (5.1198—5.1202 in.)
R	130.053—130.063 mm (5.1202—5.1206 in.)
S	130.063—130.073 mm (5.1206—5.1210 in.)

Replace piston and liner as a set if piston does not meet specifications.

S11,2510,X -19-16JUN95

DETERMINE PISTON-TO-LINER CLEARANCE

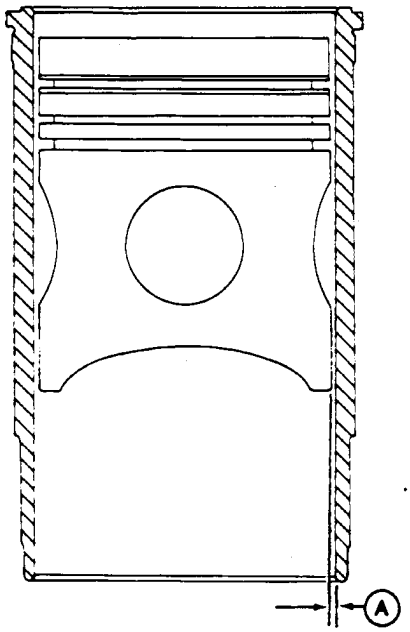
1. Place piston (without rings) in matched liner.

2. Measure piston-to-liner clearance (A). Compare measurements to specifications below. Replace piston and liner as a matched set if clearance exceeds limit.

PISTON-TO-LINER CLEARANCE SPECIFICATIONS

L-LL/L2	0.127—0.155 mm (0.0050—0.0061 in.)
M-MM/M2	0.130—0.157 mm (0.0051—0.0062 in.)
H-HH/H2	0.132—0.160 mm (0.0052—0.0063 in.)
H-H3, P-P, Q-Q, R-R, and S-S	0.122—0.142 mm (0.0048—0.0065 in.)

NOTE: Pistons and liners require replacement if liner taper or out-of-roundness (top to bottom in ring travel area) exceeds 0.051 mm (0.0020 in.). Recheck piston-to-liner measurements with liners removed. See MEASURE CYLINDER LINERS later in this group.



RG3655 -UN-22NOV89

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S11,2010,DL,1 -19-17NOV95

MEASURE OIL CONTROL RING GROOVE

1. Check oil control ring groove clearance by installing a new ring in groove.

2. Measure clearance with a feeler gauge at several points. Compare measurements with specifications given below.

OIL CONTROL RING-TO-GROOVE CLEARANCE SPECIFICATIONS

New Part Clearance	0.061—0.102 mm (0.0024—0.0040 in.)
Maximum Serviceable Clearance	0.165 mm (0.0065 in.)

NOTE: Replace piston and liner (as a set) if oil control ring clearance does not meet specifications given.

R26157 -UN-09FEB90

S11,2010,CA -19-16JUN95

MEASURE CYLINDER LINERS

IMPORTANT: ALWAYS measure liners at room temperature.

• Measure Taper and Out-of-Round

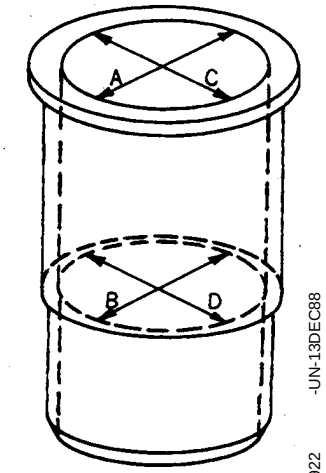
A—Measure liner bore parallel to piston pin at top end of ring travel.

B—Measure bore in same position at bottom end of ring travel.

C—Measure bore at right angle to piston pins at top end of ring travel.

D—Measure bore in same position at bottom end of ring travel.

Compare measurements A, B, C, and D to determine if liner is tapered or out-of-round.



CYLINDER LINER SPECIFICATIONS

Maximum Wear or Taper in Ring Travel Area	0.038 mm (0.0015 in.)
Maximum Liner Out-of-Round	0.05 mm (0.002 in.)

Replace piston and liner as a set if they exceed wear specifications given.

S11,2510,Y -19-06OCT95

DEGLAZE CYLINDER LINERS

1. Secure cylinder liner in a holding fixture. See Dealer Fabricated Tools, Group 199 for assembly of holding fixture.

2. Use D17006BR Flexible Cylinder Hone to deglaze cylinder liner.

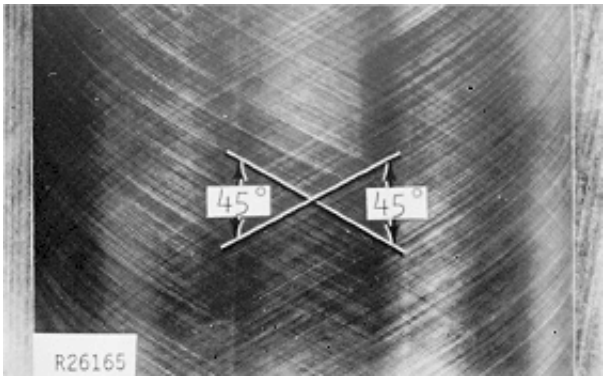
NOTE: Use honing oil along with flex hone when deglazing liners.

R26164 -UN-13DEC88

S11,2510,K -19-16JUN95

3. Use D17006BR Hone according to instructions supplied with tool to obtain a 45˚ cross-hatch pattern.

Thoroughly clean liners after deglazing. (See CLEAN CYLINDER LINERS, in this group.)



R26165 -UN-13DEC88

S11,0402,AT -19-16JUN95

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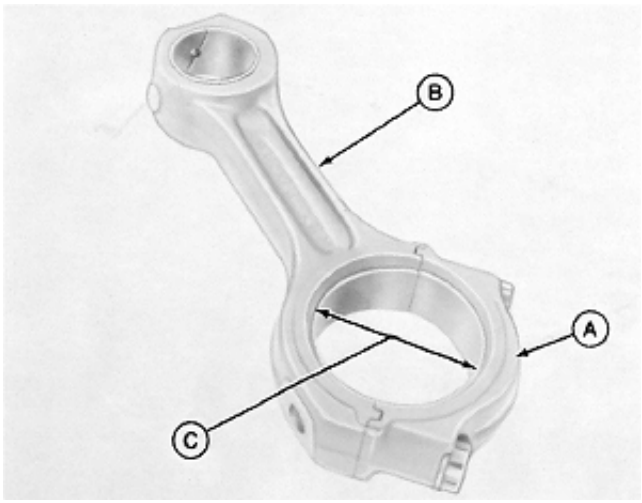
INSPECT AND MEASURE CONNECTING ROD BEARINGS



-UN-13DEC88
RG3823

Inspect rod bearings for damage or wear.

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

Rod bearing-to-journal oil clearance can be checked with PLASTIGAGE, if rod is connected to crankshaft. If rod is out of engine, measure ID of connecting rod bearings and compare with OD of crankshaft journal.

1. With crankshaft removed, measure connecting rod journal OD at several points.

2. Install connecting rod cap (A) on rod (B) with bearings (C) in correct position.

3. Tighten rod cap-to-rod using TORQUE-TURN method. (See USE TORQUE-TURN METHOD FOR PROPER TORQUE, as described later in this group.)

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S11,2010,KD -19-02APR93

4. Using an inside micrometer (A), measure assembled ID of bearing.

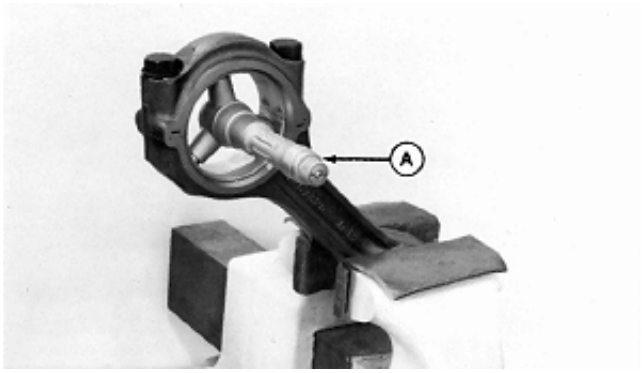
5. Subtract OD of each crankshaft journal from ID of each respective rod bearing to obtain oil clearance.

6. Compare measurements with the specifications given.

CONNECTING ROD BEARING-TO-JOURNAL SPECIFICATIONS

Crankshaft Rod Journal OD	88.844—88.874 mm (3.4980—3.4990 in.)
Connecting Rod Bearing Assembled ID	88.93—88.98 mm (3.501—3.503 in.)
Bearing-to-Journal Oil Clearance	0.06—0.13 mm (0.002—0.005 in.)
Maximum Serviceable Clearance	0.15 mm (0.006 in.)

7. Inspect connecting rod bearings for wear or damage. If bearings are worn or not within specification, replace both connecting rod bearing and rod pin bearing.



RG3824 -UN-13DEC88

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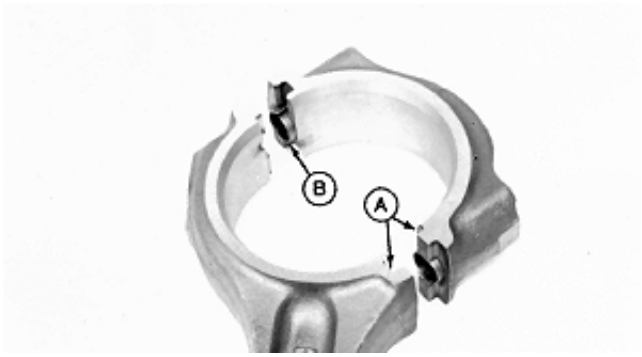
S11,2510,H -19-16JUN95

INSPECT CONNECTING ROD AND CAP

1. Inspect rod and cap for wear or damage, such as chips or cracks in the area of the tongue-and-groove joints (A).

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



RG3749 -UN-13DEC88

S11,0402,AE -19-16JUN95

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

4. Install cap WITHOUT bearing inserts.

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

5. Initially tighten blind hole cap screw to 27 N·m (20 lb-ft), then tighten open hole cap screw to same torque.

6. Tighten cap screws to 75 N·m (55 lb-ft), then tighten each cap screw an additional 90˚—100˚. (See TORQUE-TURN CONNECTING ROD CAP SCREWS, later in this group.)

RG4982 -UN-13DEC88

S11,2010,JS -19-14FEB95

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7. Using an inside micrometer, measure rod bore at center of bore and record measurements as follows:

(A) At right angle to rod/cap joint.

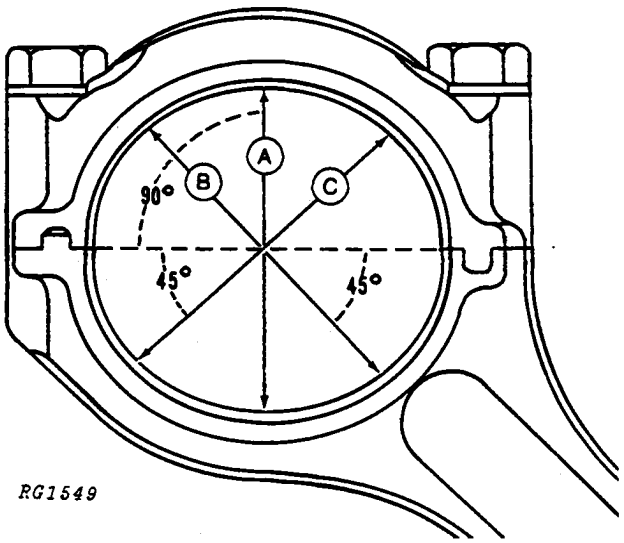
(B) At 45 degrees left of measurement (A).

(C) At 45 degrees right of measurement (A).

ROD BORE SPECIFICATIONS

Connecting Rod Bore (for crankshaft journal bearing)	93.76—93.79 mm (3.6915—3.6925 in.)

8. Compare the measurements. If difference between the greatest and least measurement is more than 0.038 mm (0.0015 in.), the rod and cap are out of round. Replace both connecting rod and cap.



RG1549 -UN-13DEC88

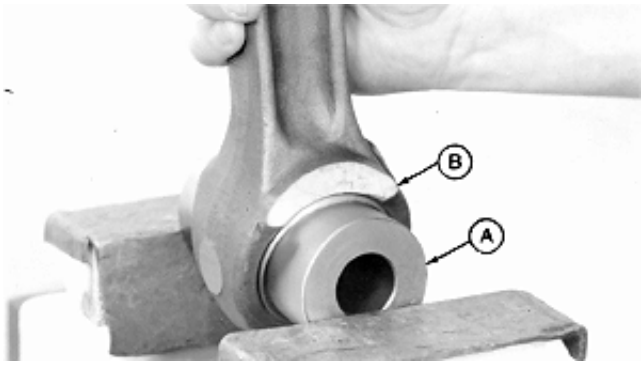
S11,2010,FO,1 -19-17NOV95

INSPECT PISTON PINS AND BUSHINGS

1. Insert piston pin (A) through piston pin bushing and carefully clamp in a soft-jawed vise.

2. Rotate connecting rod (B) back and forth several times to make sure connecting rod moves freely on piston pin.

3. Remove piston pin from connecting rod.



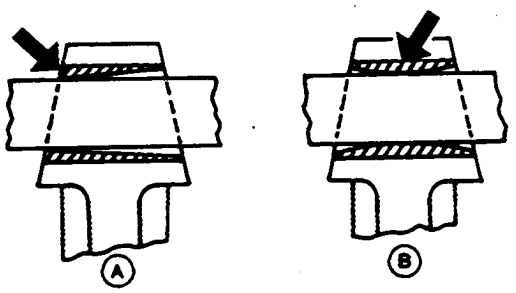
RG3172 -UN-13DEC88

S11,2010,DM -19-16JUN95

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

5. Inspect piston pin bushing lubrication hole in rod for damage, excessive wear or contaminants.

6. Measure pin bushing ID for specified clearance.



RG4924 -UN-06APR89

PISTON PIN BORE SPECIFICATIONS

Piston Pin OD	50.772—50.787 mm (1.9989—1.9995 in.)
Piston Pin Bore ID in Piston	50.793—50.801 mm (1.9997—2.0000 in.)
Rod Pin Bore Without Bushing	55.529—55.555 mm (2.1862—2.1872 in.)
ID of Installed Rod Pin Bushing (Before Boring)	50.729—50.781 mm (1.9972—1.9992 in.)
ID of Installed Rod Pin Bushing (After Boring)	50.805—50.830 mm (2.0002—2.0012 in.)
Rod Pin-to-Bushing Oil Clearance	0.017—0.059 mm (0.0007—0.0023 in.)
Maximum Serviceable Clearance	0.076 mm (0.0030 in.)
Press Fit of Bushing in Rod Pin Bore	0.100—0.163 mm (0.0039—0.0064 in.)

7. If necessary, remove and replace piston pin bushing.(See REMOVE PISTON PIN BUSHING in this group.)

S11,2510,AN -19-16JUN95

REMOVE PISTON PIN BUSHING

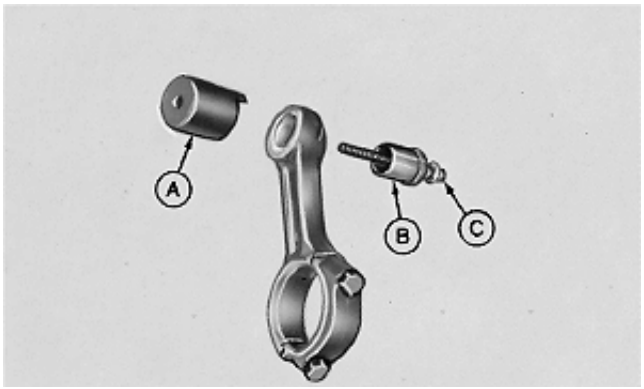
IMPORTANT: Do not use any power tools to remove or install piston pin bushing.

1. Remove the used pin bushing with the JDE98A Connecting Rod Bushing Service Set.

Use the following tools from tool set:

A—JDE98-8 Cup
B—JDE98-10 Driver
C—STD36104 Forcing Screw

IMPORTANT: Use care to properly align the JDE98-10 Driver with bushing so that the connecting rod bushing bore is not damaged.



RG4723 -UN-09APR90

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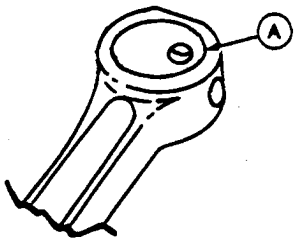
S55,2510,D -19-02APR93

CLEAN AND INSPECT PISTON PIN BUSHING BORE IN CONNECTING ROD



RG5227 -UN-13DEC88

1. Clean rod bushing bore using a medium grit emery cloth, as burrs will distort bushing. Install bushing on side opposite rod burr.

2. If necessary, file a slight chamfer (A) around bore to remove any sharp edges. Chamfer will also aid in bushing installation.

3. Measure rod bushing bore in three or more places approximately 45° apart.

CONNECTING ROD PIN BUSHING SPECIFICATIONS

Connecting Rod Pin Bushing Bore	55.529—55.555 mm (2.1862—2.1872 in.)
Press Fit of Bushing in Rod Pin Bore	0.100—0.163 mm (0.0039—0.0064 in.)

IMPORTANT: If piston pin bushing bore diameter is not within specification or bushing has spun in rod, discard rod and replace with a new one.

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S11,2510,AZ -19-16JUN95

INSTALL PISTON PIN BUSHING IN ROD

1. Lubricate connecting rod bushing bore with clean engine oil.

2. Assemble JDE98-10 Drive (B) with JDE98-9 Pilot (C). Install new bushing (E) onto driver. Lubricate OD of bushing. Install and lubricate STD36104 Forcing Screw threads (D).

3. Assemble JDE98-6 Pilot (F) onto driver.

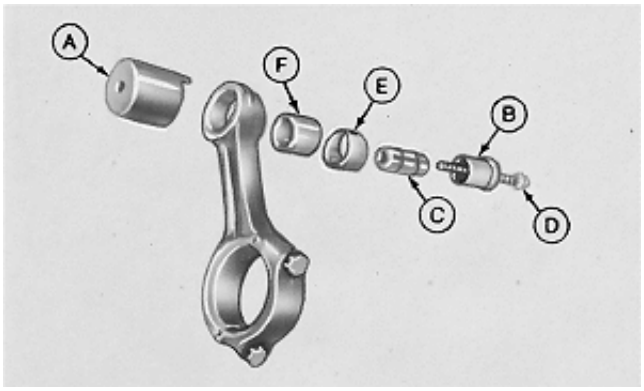
NOTE: Be sure lubrication holes (E, lower photo) in bushing and rod are properly aligned.

4. Engage forcing screw threads with threads in JDE98-8 Cup (A) to install new bushing.

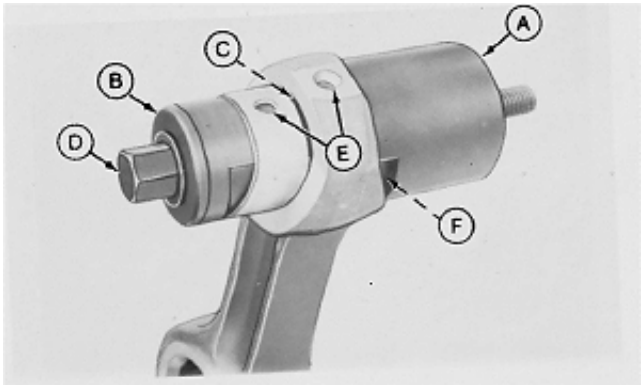
IMPORTANT: Honing the piston pin bushing should be done ONLY by experienced personnel on equipment capable of maintaining bushing specification.

5. If necessary, hone ID of newly installed bushing to 50.805—50.830 mm (2.0002—2.0012 in.) after installation. Remove all debris from honing operation.

6. Check rod pin-to-bushing clearance. See CLEAN AND INSPECT PISTON PIN BUSHING BORE IN CONNECTING ROD, as described earlier in this group. Replace rod pin as required.



RG4722 -UN-26JAN90



RG7815311 -UN-09JAN90

A—JDE98-8 Cup
B—JDE98-10 Driver
C—JDE98-9 Pilot
D—STD36104 Forcing Screw
E—Pin Bushing
F—JDE98-6 Pilot

S55,2510,E,1 -19-17NOV95

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COMPLETE DISASSEMBLY OF CYLINDER BLOCK (IF REQUIRED)

If complete inspection and “Hot Tank” cleaning of cylinder block is required, refer to the appropriate group for removal of all external and internal mounted components listed below:

1. Remove crankshaft and pulley if not previously removed. (Group 15.)

2. Remove all remaining lubrication system components. (Group 20.)

3. Remove starting motor. (See Machine Technical Manual.)

4. Remove water pump and all remaining cooling system components. (Group 25.)

5. Remove timing gear train and camshaft. (Group 16).

6. Remove fuel injection pump and fuel filter assembly (Group 35.)

7. Remove all components (including piston cooling orifices, water galley plugs, oil galley plugs, bushings, and engine serial number plate) before inspecting and cleaning cylinder block. Use JDG782 Oil Galley Plug Tool to remove and install galley plugs. See REMOVE AND CLEAN PISTON COOLING ORIFICES, later in this group, for servicing piston cooling orifices.

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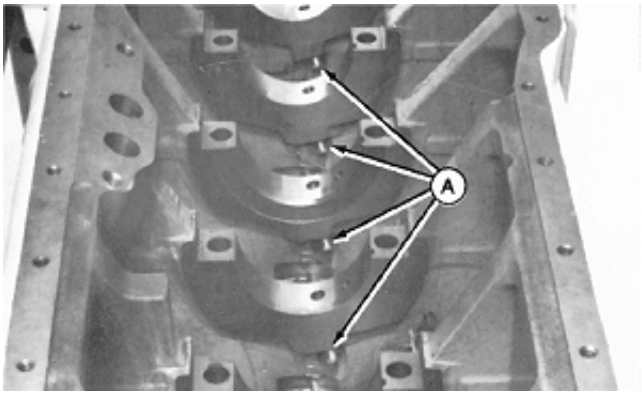
S55,2510,F -19-16JUN95

REMOVE AND CLEAN PISTON COOLING ORIFICES

1. Remove all six (four shown) piston cooling orifices (A) and inspect each cooling orifice to make sure it is not plugged or damaged.

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

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



RG3752 -UN-14DEC88

S11,2010,KF -19-13MAR92

INSPECT AND CLEAN CYLINDER BLOCK

NOTE: All components (including piston cooling orifices), water gallery plugs and oil gallery plugs must be removed from the cylinder block for inspection and cleaning. Refer to the proper group for removal of all external and internal mounted components.

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

IMPORTANT: If cylinder block is cleaned in a hot tank, be sure to remove any aluminum parts. Aluminum parts can be damaged or destroyed by hot tank solutions. Remove all serial number plates.

2. Make sure all passages and crevices are cleared of sludge and grease.

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

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S11,2010,KG -19-13MAR92

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

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

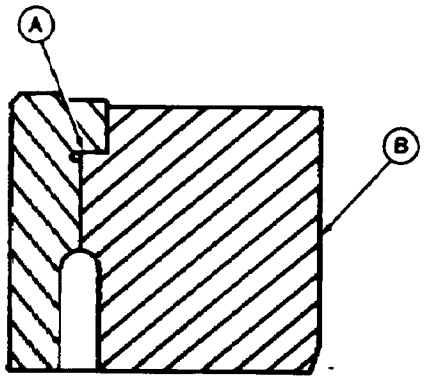
5. Inspect block for cracks or damage. If a cracked block is suspected, pressure-test the block. A procedure for pressure testing is outlined in FOS (Fundamentals of Service) Manual-ENGINES. Replace cracked or damaged block.

COUNTERBORE DEPTH AND LINER FLANGE SPECIFICATIONS

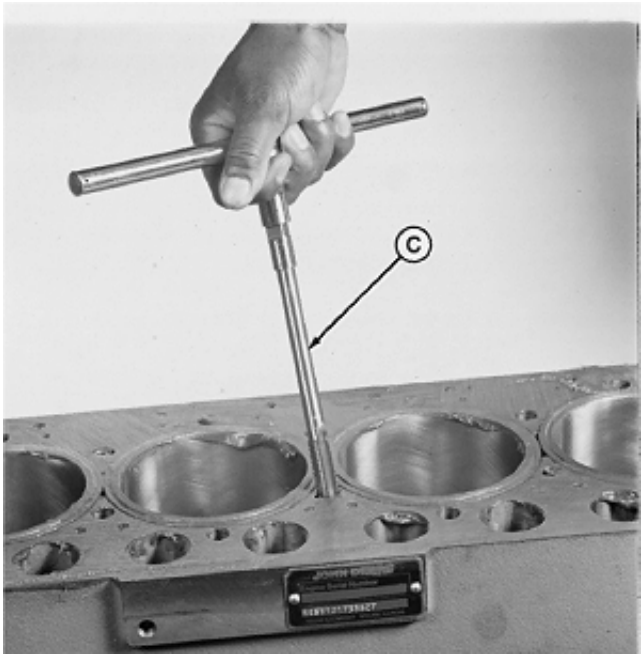
Cylinder Liner Counterbore Depth	9.46—9.51 mm (0.3725—0.3745 in.)
Liner Flange Thickness	9.538—9.563 mm (0.3755—0.3765 in.)

6. When determined that the cylinder block is serviceable, clean out threads for cylinder head cap screws in top deck of cylinder block using JDG682 Tap (C).

7. Install new locating dowel pins in cylinder block.



RG3329 -UN-13DEC88



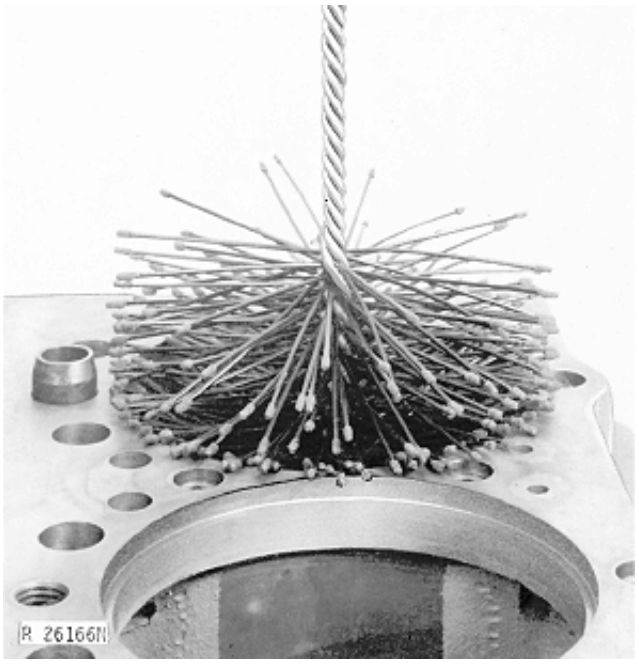
RG5580 -UN-09JAN90

S11,0402,CL -19-16JUN95

CLEAN CYLINDER LINER O-RING BORES IN BLOCK

1. Use D17015BR O-Ring Bore Cleaning Brush to thoroughly clean all debris from O-ring bore.

NOTE: Use brush exactly as directed by the manufacturer.



-UN-13DEC88
R26166

S11,0402,AY -19-16JUN95

MEASURE CYLINDER BLOCK

Refer to the appropriate groups for a more detailed description of the components being measured below.

1. Measure main bearing bore diameter (without bearings). Main bearing bore diameter is 101.651—101.677 mm (4.0020—4.0030 in.). Also measure cylinder block main thrust bearing cap width (thrust washer clearance cut). Width must be 40.62—40.72 mm (1.599—1.603 in.).

2. Measure cam follower bore diameter at all bore locations. Record measurements by bore location. Cam follower bore diameter specification is 34.975—35.025 mm (1.3770—1.3790 in.).

If any one cam follower bore is not within specification, install a new cylinder block.

3. Measure cam follower OD. Follower OD is 34.874—34.900 mm (1.3730—1.3740 in.). Maximum cam follower-to-bore clearance is 0.152 mm (0.0060 in.).

4. Measure camshaft bore diameter at all locations and record readings. Bore diameter is 63.487—63.513 mm (2.495—2.505 in.) without bushings, and 60.389—60.439 mm (2.3775—2.3795 in.) with bushings.

Replace bushings and/or camshaft as needed.

5. Check cylinder block top deck for flatness using D05012ST Precision Straightedge and feeler gauge. The maximum out-of-flat measurement must not exceed 0.10 mm (0.004 in.) for the entire length or width of top deck.

If cylinder block-to-deck flatness is not within specification, resurface as required.

IMPORTANT: The center line of the main bearing bore-to-top deck of cylinder block MUST be 374.57—374.73 mm (14.747—14.753 in.).

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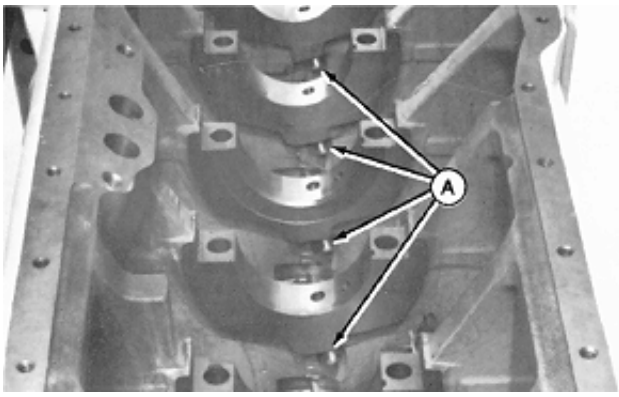
S11,2510,BA,1 -19-17NOV95

INSTALL PISTON COOLING ORIFICES AND GALLEY PLUGS

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.

1. Install all six (four shown) piston cooling orifices (A) and tighten to 11 N·m (8 lb-ft) (97 lb-in.).

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



RG3752 -UN-14DEC88

RG,CTM61,G10,18-19-02APR93

RECHECK CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

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

Be sure liner bore in cylinder block (D) and top deck of cylinder block are clean.

1. Install liners (B) without O-ring and secure with cap screws and washers, as outlined earlier in this group. (See REMOVE PISTONS in this group.)

NOTE: Install liner with the identifying mark toward the front of the engine. Rotate 90° if pits or erosion exceed limits outlined during liner inspection.

2. Measure liner standout. (See MEASURE CYLINDER LINER STANDOUT in this group.)

LINER STANDOUT (HEIGHT ABOVE BLOCK) SPECIFICATION

Liner Standout	0.025—0.102 mm (0.001—0.004 in.)

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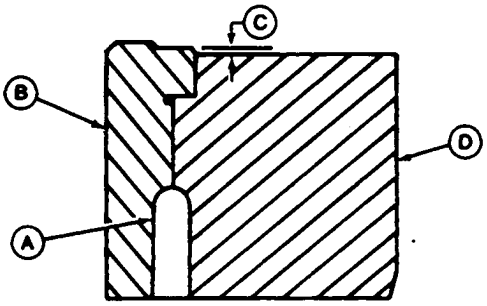
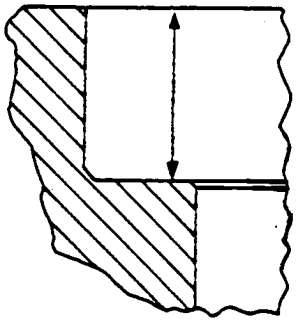
If liner standout is above specification, recheck liner support flange for possible remaining burrs or incorrect counterbore depth in block. If burrs are present, file support flange vertically again until burr is gone. Completely clean cylinder liner bore of any filings.

If liner standout is below specifications, liner shims may be used. (See INSTALL LINER SHIMS in this group.)

Counterbore depth as shown in bottom illustration is 9.46—9.51 mm (0.3725—0.3745 in.).



RG3330 -UN-06APR89



RG4726 -UN-13DEC88

A—Water Jacket
B—Cylinder Liners
C—Liner Height
D—Cylinder Block

S11,2510,AF -19-06OCT95

MEASURE LINER FLANGE THICKNESS

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

LINER FLANGE SPECIFICATION

Flange Thickness . . . . . 9.538—9.563 mm (0.3755—0.3765 in.)

RG6090 -UN-27JAN92

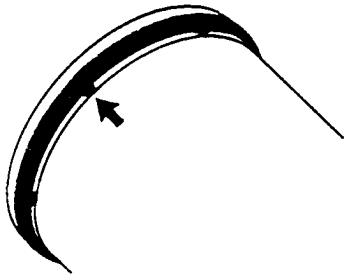
S11,2510,AG -19-16JUN95

INSTALL LINER SHIMS—IF REQUIRED

1. If the liner flange thickness is within specification, but recorded standout was no more than 0.08 mm (0.003 in.) BELOW top deck of block, install shims on bottom of liner flange. Two sizes of shims are available:

LINER SHIM SPECIFICATIONS

R81276 . . . . . 0.05 mm (0.002 in.)
R81277 . . . . . 0.10 mm (0.004 in.)
Maximum Shim Thickness
per Cylinder . . . . . 0.10 mm (0.004 in.)



RG4728 -UN-04MAY89

2. Install a maximum of **two thin** shims or **one thick** shim on liner. Shims have tangs on the ID to help hold them in place against bottom of liner flange when installing liner.

3. Make sure counterbore of block is clean and free of burrs. Install liner(s) in block without O-rings and secure liners with cap screws and washers as done previously. (See REMOVE PISTONS in this group.) Tighten cap screws to 68 N·m (50 lb-ft).

4. Measure liner standout again at 1, 5, 7, and 11 O'clock positions. Record measurements.

5. If standout is still not within specification, remove liner and determine cause.

S11,2510,AH -19-16JUN95

INSTALL CYLINDER LINER O-RINGS AND PACKINGS

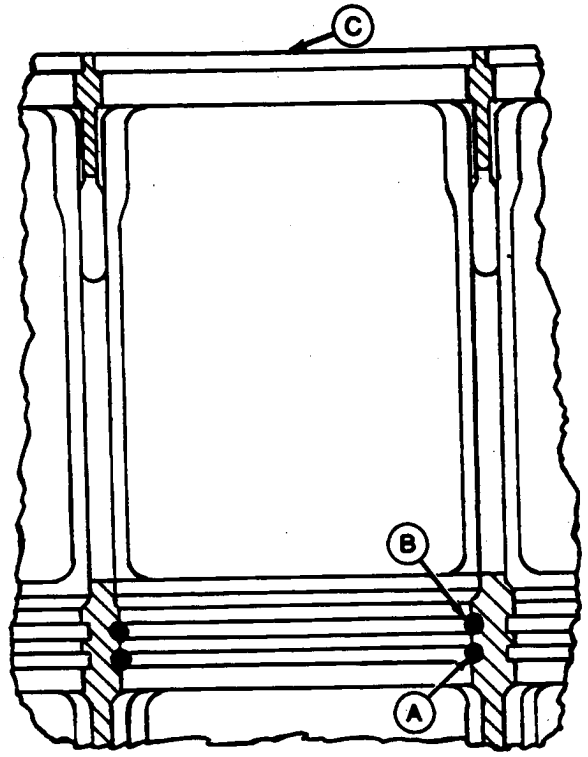
IMPORTANT: DO NOT use oil on cylinder liner packing or O-rings. Oil can cause the red packing to swell, which squeezes liner and could possibly cause a scored piston.

1. Pour AR54749 Soap Lubricant into a suitable container.

2. Dip new packings and O-rings in soap before installation. Do not leave packings or O-rings in soap to soak.

3. Install the black viton O-ring (A) in the lower O-ring groove of the cylinder block (C).

4. Install the red silicone O-ring (B) in the upper O-ring groove of the cylinder block.



RG3826 -UN-13DEC88

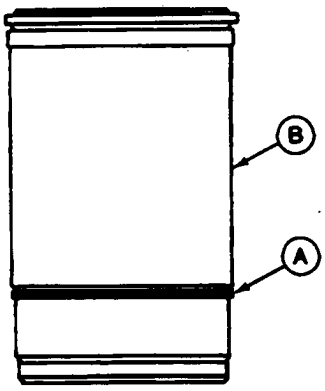
S11,0402,BA -19-16JUN95

5. Turn cylinder liner (B) upside-down and install the neoprene square packing (A) over outside of liner.

6. Slide packing down firmly against second shoulder on the liner.

NOTE: Make sure the packing is not twisted.

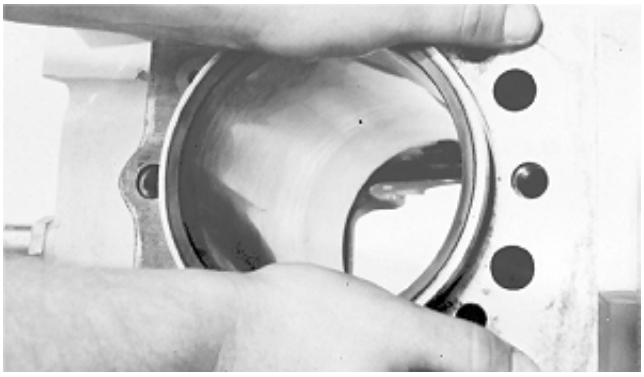
7. Coat the liner packings, sealing area of the cylinder liner and cylinder block O-rings with liquid soap.



RG3827 -UN-13DEC88

S11,0402,BB -19-02APR93

INSTALL CYLINDER LINERS


RG2772 -UN-23FEB89

IMPORTANT: Install cylinder liner into same cylinder block bore as removed. DO NOT scuff the packing across the upper bore.

When liner OD's are pitted or eroded and are under one-half the liner thickness, rotate liners 90° from their removed position. Rotate the pitted section of the liner either toward the front or rear of the engine.

If liners are not pitted or eroded, rotation will not be necessary. Install liners with the identifying mark (stamped on flange), toward the front of the engine.

1. Carefully place the cylinder liner, with packing installed into the cylinder block bore.

NOTE: A resistance will be felt when cylinder liner is aligned in pilot bore.

2. Using only the pressure of both palms, the cylinder liner should drop to a point nearly flush at the upper flange of the cylinder liner and cylinder block.

S11,2510,N -19-16JUN95

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NOTE: Cylinder liner will protrude over top of cylinder block more than normal due to uncompressed packings and O-rings.

3. Finish seating cylinder liners using a clean hardwood block and hammer.

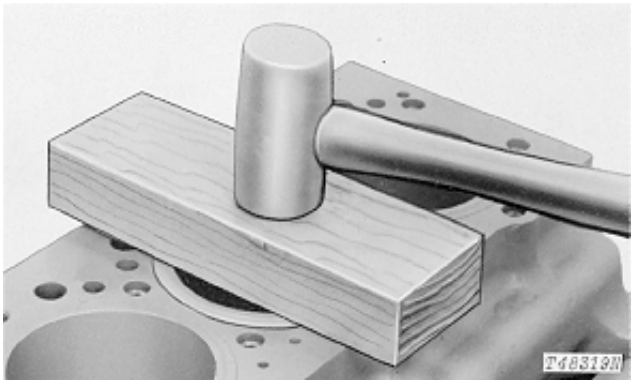
4. Gently tap hardwood block over top of cylinder liner with mallet.

IMPORTANT: If you suspect that a packing may have sheared or displaced during liner installation, remove liner and packing assembly. If no damage is found, check packing and O-rings for proper position. Resoap packings and reinstall liner assembly.

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

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

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



-UN-23FEB89
T48319

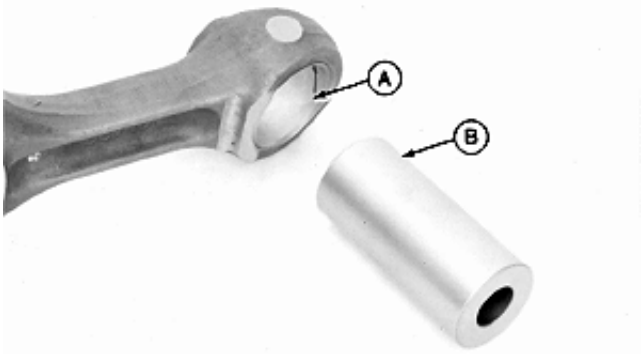
S11,0402,BD -19-06OCT95

INSTALL PISTONS AND CONNECTING RODS

NOTE: Pistons must be installed on same connecting rods from which they were removed.

IMPORTANT: 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 (B) and bushing (A) with clean engine oil.



-UN-28JUL89
RG3180

S11,0402,BE -19-16JUN95

2. Install piston pin (A) through piston (B) and connecting rod (C). Be sure front of rod aligns with front of piston.

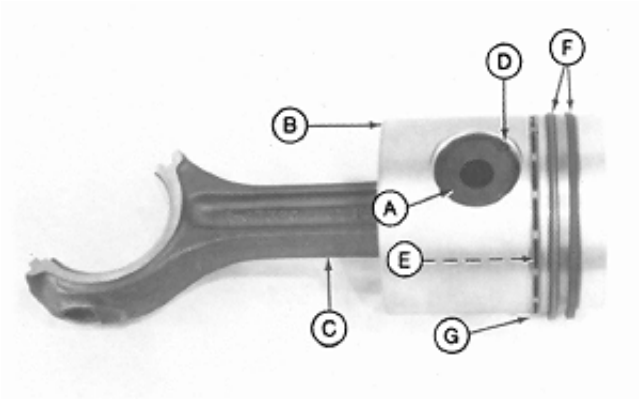
3. Insert NEW piston pin snap rings (D) in grooves. Make certain snap rings have expanded in grooves of piston.

4. Install expander ring (E) in bottom ring groove.

NOTE: "Pip" marks on No. 1 and No. 2 compression rings must face top of piston.

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

5. Use JDE94 or JDE135 Ring Expander to install piston rings (F) and oil control ring (G).



RG3828 -UN-25SEP89

A—Piston Pin
B—Piston
C—Connecting Rod
D—Snap Rings (2 used)
E—Expander Ring
F—Compression Rings
G—Oil Control Ring

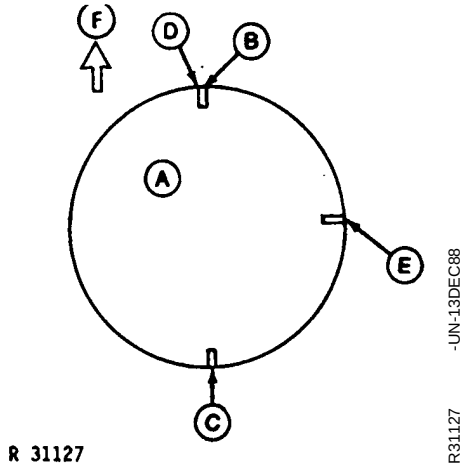
10 39

S11,2510,AY -19-16JUN95

6. Stagger ring gaps on pistons as shown.

7. Coat pistons, liners and inside of JDE97 Piston Ring Compressor with clean engine oil.

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



R31127 -UN-13DEC88

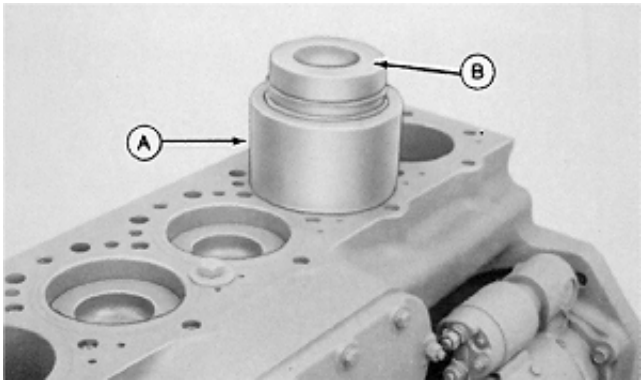
S11,2510,AT -19-05MAY93

8. Carefully place ring compressor (A) with piston (B) and rod over liner.

IMPORTANT: Be sure crankshaft journals and liner walls are not damaged when installing piston and rod in liner.

NOTE: Be sure the word "FRONT" on piston and rod faces toward the front of the engine.

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



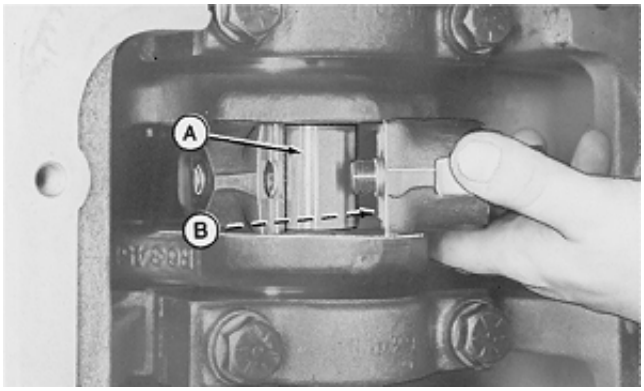
R26127 -UN-13DEC88

S11,0402,BH -19-08AUG94

10. Apply clean engine oil to bearing inserts (B) and crankshaft rod journals (A).

IMPORTANT: NEVER use connecting rod cap screws more than once for final engine assembly. Once rod cap screws have been tightened, they cannot be reused for final assembly.

11. Install connecting rod caps.



RG3829 -UN-13DEC88

S11,0402,BI -19-08MAR94

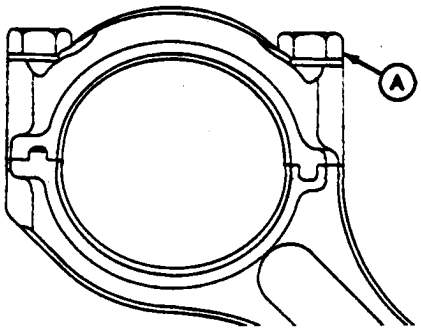
12. Dip new cap screws and washers in clean engine oil. Make sure top of cap screws have oil on them also.

IMPORTANT: Do not use a pneumatic wrench to install cap screws. It can cause damage to the threads.

13. Initially tighten all blind-hole cap screws (A) to 27 N·m (20 lb-ft).

14. Secondly, tighten all cap screws to 75 N·m (55 lb-ft).

15. Finally TORQUE-TURN all cap screws 90—100 degrees. (See TORQUE-TURN CONNECTING ROD CAP SCREWS in this group.)



RG4375 -UN-13DEC88

S11,0402,BI1 -19-16JUN95

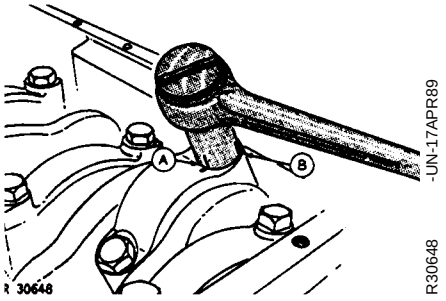
TORQUE-TURN CONNECTING ROD CAP SCREWS

• Using line scribe method to TORQUE-TURN connecting rod cap screws:

1. After tightening cap screws to 75 N·m (55 lb-ft), mark connecting rod cap and socket (A).

2. Make a second mark on socket (B) 90˚ counterclockwise from the first mark.

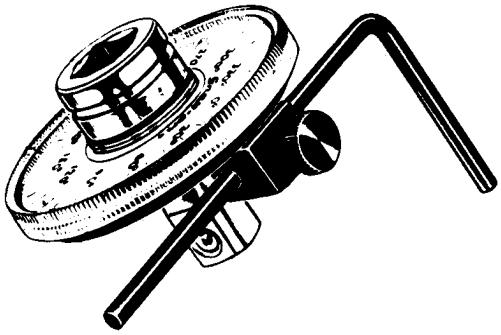
3. Tighten 1/4 turn (90—100˚) clockwise until mark (B) is in line with reference mark on rod cap.



S11,2010,CE -19-16JUN95

• Using JT05993 Torque Angle Gauge to TORQUE-TURN connecting rod cap screws:

1. After tightening cap screws to 75 N·m (55 lb-ft), follow directions provided with gauge and TORQUE-TURN each cap screw 90˚—100˚.



JT05993 Torque Angle Gauge

RG,CTM6,G10,4 -19-22AUG91

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41

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.

S11,0402,BK -19-16JUN95

COMPLETE FINAL ASSEMBLY

NOTE: Refer to the proper group for installation of components.

1. Install camshaft, valve actuators, timing gears and timing gear cover. (Group 16).

2. Install the lubrication system components. (Group 20)

3. Install the cylinder head with new head gasket. (Group 05)

4. Install fuel injection system components. (Group 35)

5. Install the water pump and water piping. (Group 25)

6. Install crankshaft pulley. (Group 15)

7. Install the alternator, fan, and fan belts.

8. Install the exhaust manifold and intake assembly. (Group 30)

9. Install the starting motor.

10. Fill engine with clean oil and proper coolant. (Group 02)

11. Install engine in unit and perform engine break-in. (Group 05 or Machine Technical Manual)

S55,2510,G -19-02APR93

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

RG5080 -UN-23AUG88

Front Wear Sleeve Installer JDE3

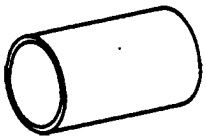
Install front oil seal in timing gear cover.

S53,JDE3A -19-16AUG94

RG5108 -UN-23AUG88

Gear Driver JDH7

Install crankshaft drive gear.



S53,JDH7 -19-04AUG94

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

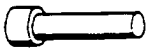
Rotate engine flywheel. Use with JDE81-4.

S53,JDE811 -19-06OCT95

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Lock engine at TDC when timing valve train. Use with JDE81-1 or JDE83.



S53,JDE814 -19-06APR90

RG5109 -UN-23AUG88

Seal Remover JDG22

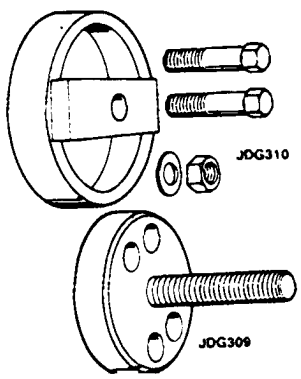
Remove front and rear crankshaft oil seals without engine disassembly.

S53,JDG22A -19-07JUL89

Oil Seal and Wear Sleeve Installer JDG300

Used to install rear crankshaft oil seal/wear sleeve assembly.

Set consists of:
- Pilot JDG309
- Installer JDG310



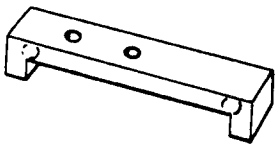
RG5022 -UN-06APR89

S53,JDG300 -19-16MAR92

Piston and Liner Height Gauge JDG451

Measure piston and liner heights.

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



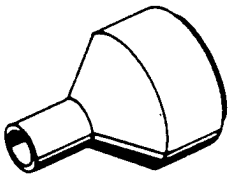
RG7029 -UN-30SEP94

RG,JDG451 -19-28SEP94

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.

Set consists of:
- 1—Adapter JDG719-1
- 2—Screw (not shown) 11200



RG6214 -UN-06MAR92

RG,JDG719 -19-29OCT92

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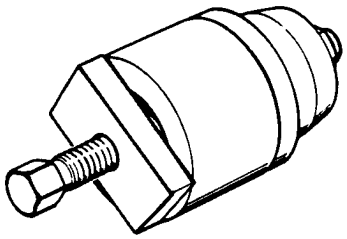
Front Seal Installer JDG720

Used to install front crankshaft oil seal with timing gear cover installed.

Set consists of:
- 1—Forcing Screw JDG720-1
- 2—Seal Protector JDG720-2
- 3—Seal Driver JDG720-3
- 4—Spacer Ring (500 Series Engines) JDG720-4



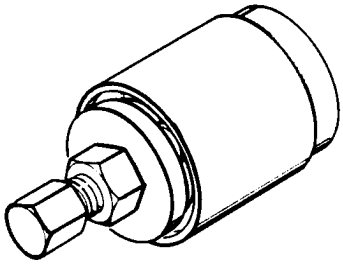
RG6215 -UN-06MAR92

RG,JDG720 -19-06OCT95

Front Wear Sleeve Puller JDG726

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

Set consists of:
- 1—End Cap JDG726-1
- 2—Sleeve JDG726-2
- 3—Forcing Screw JDG726-3
- 4—Half Collet (2 Used) JDG726-4

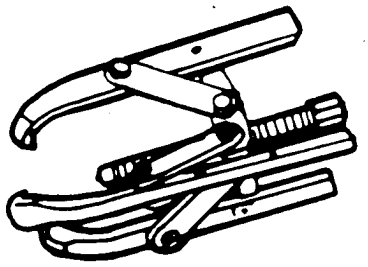


RG6216 -UN-06MAR92

RG,JDG726 -19-02APR93

Vibration Damper and Pulley Puller Set JDG728

Used to remove multi-groove vibration damper and pulley

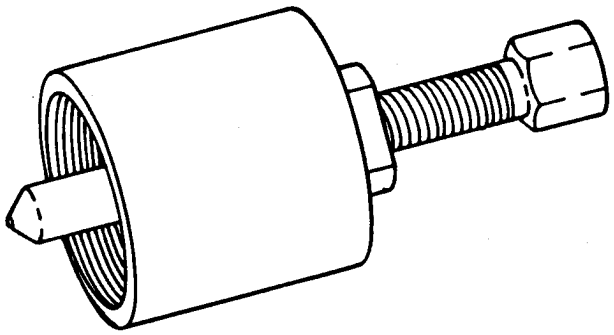


-UN-06MAR92
RG6218

RG,JDG728 -19-06OCT95

Front Wear Sleeve Puller JDG786

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



-UN-13OCT92
RG6428

RG,JDG786 -19-29OCT92

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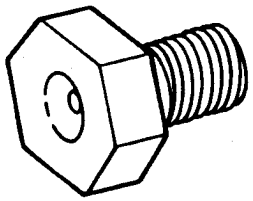
Thread Protector JDG787

Used with any puller set to remove vibration damper and pulley assembly.



-UN-13OCT92
RG6429

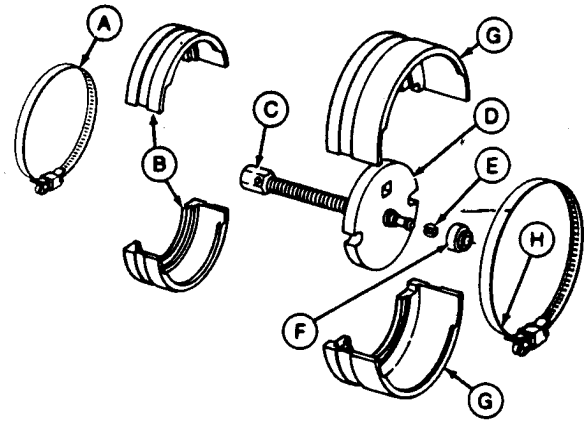
RG,JDG787 -19-06OCT95

Rear Wear Sleeve Puller Kit JDG790

Used to remove rear wear sleeve with oil seal housing installed on 400, 450, and 500 Series Engines.

Set consists of:

A—Hose Clamp (500 Series) 219469
B—Collet Halves (400/450 Series) JDG790-1
C—Forcing Screw (400/450/500 Series) 35945
D—Pulling Plate (400/450/500 Series) JDG790-2
E—Retainer Clip (400/450/500 Series) 13876
F—Shaft Protector (400/450/500 Series) 215177
G—Collet Halves (500 Series) JDG790-3
H—Hose Clamp (400/450 Series) 19311



RG6457 -UN-22OCT92

RG,JDG790 -19-03OCT94

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from the U.S. SERVICEGARD™ 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	Install front oil seal in timing gear cover
D01047AA 17-1/2 and 30-Ton Puller Set	Remove crankshaft gear.

S55,2515,A -19-16MAR92

OTHER MATERIAL

Name	Use
LOCTITE 242 (TY9370/T43512) Thread Lock and Sealer	Coat threads of flywheel mounting cap screws.
LOCTITE 609 (TY9372/T43515) Retaining Compound	Coat OD of crankshaft flange for installation of rear oil seal/wear sleeve. Coat ID of front wear sleeve for installation.
PLASTIGAGE	Check main bearing-to-crankshaft journal oil clearance during engine disassembly.
Brake Kleen or Ignition Cleaner and Drier	Remove sealant from crankshaft flange.

S55,2515,B -19-08AUG94

CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL SPECIFICATIONS

Item	New Part Specification
Crankshaft End Play	0.038—0.380 mm (0.0015—0.0150 in.)
Main Bearing Journal OD	95.200—95.225 mm (3.7480—3.7490 in.)
Main Bearing Assembled ID	95.270—95.320 mm (3.7508—3.7528 in.)
Main Bearing Cap Surface Width	36.28—36.78 mm (1.428—1.448 in.)
No. 5 Main (Thrust) Bearing Surface Width	
(thrust washer-to-bearing clearance)	40.615—40.716 mm (1.559—1.603 in.)
Overall Cap Width	41.81—42.31 mm (1.646—1.666 in.)
Base Circle OD for Thrust Washer Clearance*	129.28—130.81 mm (5.09—5.15 in.)
Crankshaft Thrust Journal Width	47.57—47.67 mm (1.873—1.877 in.)
Main Bearing-to-Journal Oil Clearance	0.046—0.122 mm (0.0018—0.0048 in.)
Maximum Serviceable Clearance	0.152 mm (0.0060 in.)
Journal Taper Per Inch of Journal Length	0.0025 mm (0.0001 in.)
Journal Out-of-Round	0.025 mm (0.001 in.)
Maximum Serviceable	0.038 mm (0.0015 in.)
Undersize Bearings Available	0.05, 0.25, 0.51, 0.76 mm (0.002, 0.010, 0.020, 0.030 in.)
Oversize Thrust Washer Available	0.18 mm (0.007 in.)
Crankshaft Rod Journal OD	88.844—88.874 mm (3.4980—3.4990 in.)
Main Bearing Cap Bore Specifications	
ID (Without Bearings)	101.651—101.677 mm (4.0020—4.0030 in.)
Max. Bore Diameter Variation	0.013 mm (0.0005 in.)
Max. Bore Diameter Taper	0.005 mm (0.0002 in.)
Max. Straightness	
(Any Bore-to-Adjacent Bore)	0.038 mm (0.0015 in.)
Centerline of Bore-to-Top Deck	374.57—374.73 mm (14.744—14.750 in.)
Damper Pulley Radial Runout (Max)	0.76 mm (0.030 in.)
Rear Oil Seal Housing Runout (Max)	0.152 mm (0.0060 in.)
Clutch Shaft Pilot Bushing ID	25.50—25.55 mm (1.004—1.006 in.)
Flywheel Face Flatness (Max. Variation)	0.23 mm (0.009 in.)
Flywheel Housing Face Runout (Max. Variation)	0.20 mm (0.008 in.)
Engine Stroke	127 mm (5.00 in.)
Main and Rod Journal Surface Finish	Lap 0.25 Um (9.8AA)
Thrust Journal Surface Finish	Lap 0.40 Um (16SAA)
Rod Journal Fillet Radius	4.49—4.85 (0.177—0.191 in.)
Main and Thrust Journal Fillet Radius	3.94—4.44 mm (0.155—0.175 in.)

**Thrust (washer) surfaces on bearing cap must be flat in respect to mating thrust (washer) surfaces in cylinder block.*

S55,2515,C -19-13NOV95

CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL SPECIFICATIONS—CONTINUED

Torques

Pulley-to-Crankshaft	230 N·m (170 lb-ft)
Damper-to-Pulley	61 N·m (45 lb-ft)
Fan Drive Support Plate	68 N·m (50 lb-ft)
Main and Thrust Bearing Caps	285 N·m (210 lb-ft)
Rear Crankshaft Oil Seal Housing	27 N·m (20 lb-ft)
Flywheel-to-Crankshaft	176 N·m (130 lb-ft)
Piston Cooling Orifices	11 N·m (8 lb-ft) (97 lb-in.)
Timing Gear Cover Cap Screws	41 N·m (30 lb-ft)
Flywheel Housing-to-Cylinder Block	407 N·m (300 lb-ft)
Flywheel Housing-to-Oil Pan	325 N·m (240 lb-ft)
Starting Motor-to-Flywheel Housing	102 N·m (75 lb-ft)
Injection Pump Gear Cover	68 N·m (50 lb-ft)

S55,2515,D -19-17NOV95

CRANKSHAFT AND MAIN BEARING FAILURE ANALYSIS

• Scored Main Bearing:
(Diagnosis also applies to connecting rod bearing.)

Oil starvation.
Contaminated oil.
Engine parts failure.
Excessive heat.
Poor periodic service.

• Galled or "Wiped" Bearings:

Fuel in lubricating oil (incomplete combustion).
Coolant in lubrication system (cracked block, liner seal failure, or leaking 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.

S11,2515,A -19-06OCT95

DISCONNECT TURBOCHARGER OIL INLET LINE

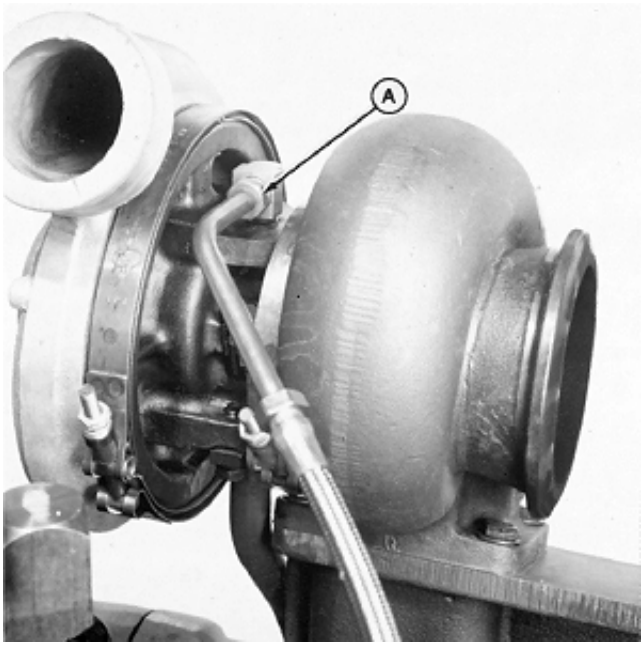
1. Drain all engine oil and coolant, if not previously done.

IMPORTANT: When servicing the 6101 Engine on a rollover stand, disconnect turbo oil inlet line (A) before rolling engine over. Failure to do so may cause a hydraulic lock upon starting the engine. Hydraulic lock may cause possible engine failure.

Hydraulic lock occurs when trapped oil in the oil filter head 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.

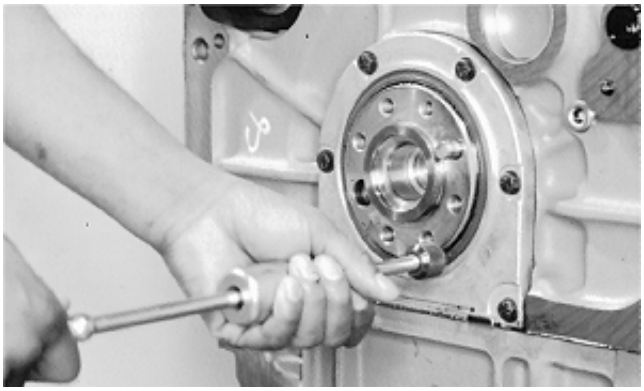
2. Disconnect turbocharger oil inlet line at oil filter housing or turbocharger.



RG5520 -UN-09JAN90

RG,CTM61,G3,1 -19-16APR92

REPLACE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE (WITH OIL SEAL HOUSING INSTALLED)


-UN-14DEC88
RG5210

IMPORTANT: Whenever rear oil seal is replaced, wear sleeve MUST be replaced also.

NOTE: If oil seal housing is to be removed, remove seal and wear sleeve after housing is removed.

The JDG719 Seal Puller Adapter along with JDE38-2 Shank and JDE38-3 Slide Handle is the preferred method for removing the crankshaft rear oil seal. If these tools are not available, JDG22 Seal Remover can be used to remove the seal. Follow same procedure for both pullers.

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

2. Drill two small holes approximately 20˚ apart in bottom of seal casing. Install sheet metal screws in seal casing with JDG22 Seal Remover attached.

NOTE: It may be necessary to drill a small hole in seal at one or two other locations to aid in removal.

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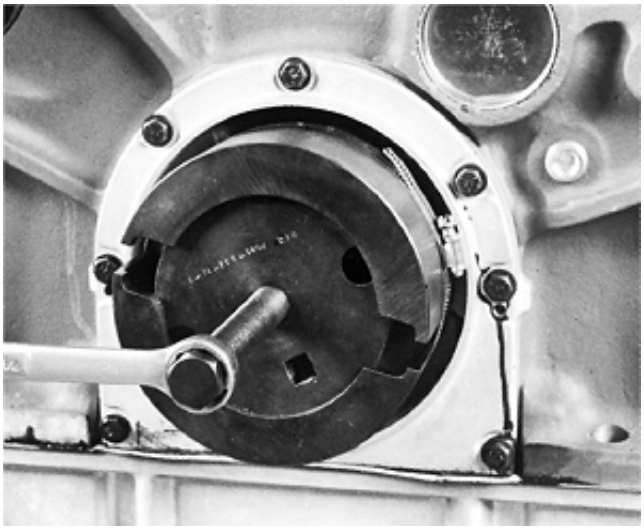
3. Cock seal at 12 o'clock position (180˚ opposite drilled hole) using a small punch and carefully pull seal from housing.

S11,2515,BM -19-06OCT95

4. Assemble JDG790 Rear Wear Sleeve Puller and position onto crankshaft flange with wear sleeve seated in jaws.

5. Securely tighten band clamp in groove on OD of jaws.

6. Tighten forcing screw with disc centered in crankshaft flange until wear sleeve is removed from crankshaft.

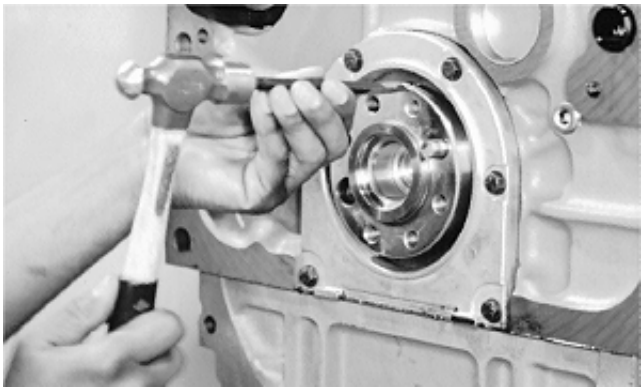


-UN-17FEB93
RG6615

RG,CTM61,G15,23-19-02APR93

IMPORTANT: Do not gouge flange of crankshaft with the chisel. Nicks or burrs should be removed with a medium-grit stone. Polishing cloth (180-grit or finer) may also be used when a stone is not available.

If JDG790 Rear Wear Sleeve Puller is not available, carefully cut wear sleeve off crankshaft flange using a small, sharp hardened chisel.



-UN-14DEC88
RG5211

S11,2515,BN -19-03JUL95

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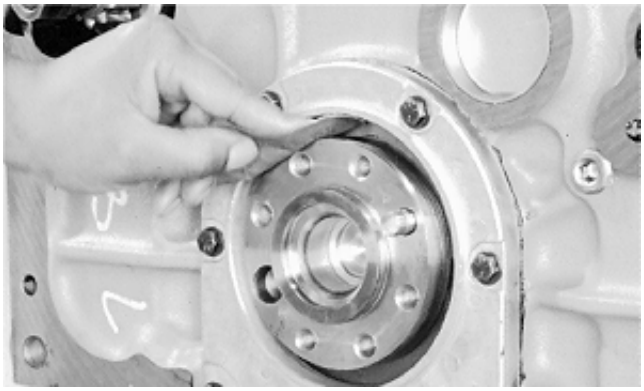
7. Clean OD of crankshaft flange with cleaning solvent, acetone, or any other suitable cleaner that will remove sealant. (Brake Kleen, Ignition Cleaner and Drier are examples of commercially available solvents that will remove sealant from flange.)

8. Look for nicks or burrs on wear ring surface and bore in flywheel housing. Any small nicks should be removed with 180-grit or finer polishing cloth. Finish cleaning by wiping flange with a clean rag.

9. Check oil seal housing runout. (See CHECK OIL SEAL HOUSING RUNOUT later in this group.)

10. Rear oil seal and wear sleeve are installed as an assembly. Use appropriate precautions for handling. (See CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE HANDLING PRECAUTIONS later in this group.)

11. Install rear oil seal and wear sleeve assembly. (See INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE ASSEMBLY later in this group.)



RG5212 -UN-14DEC88

S11,2515,BO,1 -19-17NOV95

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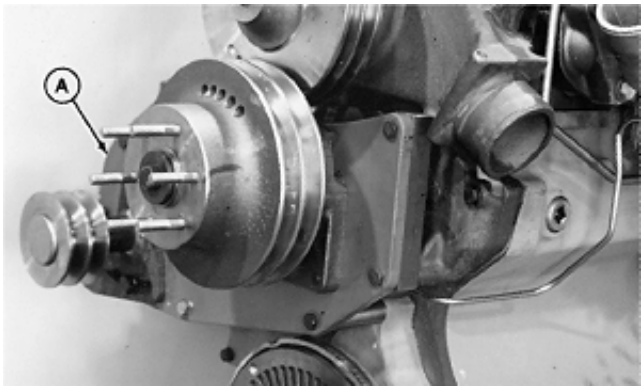
10

REMOVE FAN DRIVE ASSEMBLY (IF EQUIPPED)

6101HRW01 Engine Shown

1. Remove fan and fan belts (shown removed).

2. Remove cap screws and remove fan drive assembly (A). Note location of spacer and strap for assembly.



RG5524 -UN-10NOV89

S55,2515,E -19-15JUN89

INSPECT VIBRATION DAMPER

IMPORTANT: Never apply thrust on outer ring of damper. Damper is sensitive to impact damage, such as being dropped or struck with a hammer.

NOTE: The vibration damper assembly is not repairable and should be replaced every 5 years or 4500 hours, whichever occurs first.

1. Grasp vibration damper with both hands and attempt to turn it in both directions. If rotation is felt, damper is defective and should be replaced.

S55,2515,F -19-10MAR89

2. Check vibration damper radial runout by positioning a dial indicator so probe (A) contacts damper OD.

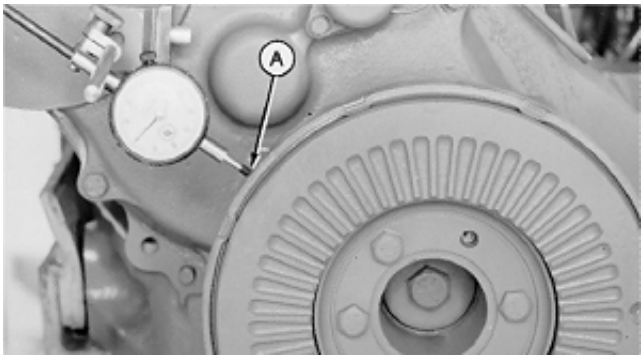
3. With engine at operating temperature, rotate crankshaft using JDE81-1 Flywheel Rotation Tool.

4. Note dial indicator reading.

DAMPER RADIAL RUNOUT SPECIFICATION

Maximum	0.76 mm (0.030 in.)

If runout exceeds specifications, replace vibration damper.



S55,2515,G -19-07JUL89

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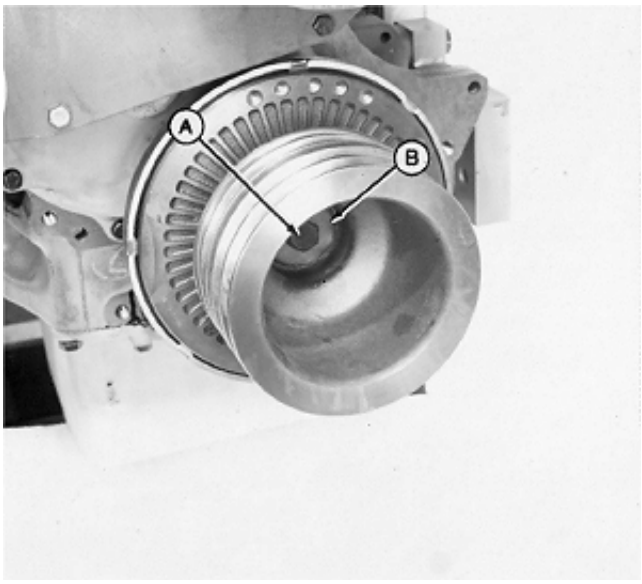
REMOVE DAMPER/PULLEY ASSEMBLY



(6101HRW01 Engine shown.)

1. Drain engine oil (if not previously done), remove oil pan and oil pump at this time, if desired.

CAUTION: Damper/pulley assembly is very heavy. Plan a proper handling procedure to avoid injuries.

2. On 6101AT001 Engines, remove six cap screws securing damper to pulley and remove damper and pulley plate.

IMPORTANT: Be extremely careful when using a jaw-type puller to remove vibration damper. Never apply thrust on outer ring of damper or, damage could result to damper. Pull only on back side of pulley closest to the engine. DO NOT drop or hammer on damper.

3. Remove cap screw (A) and washer securing damper assembly (B) to end of crankshaft.

IMPORTANT: DO NOT immerse damper assembly in cleaning solution. Doing so may damage the rubber portion of the assembly.

4. Install JDG787 Thread Protector into nose of crankshaft.

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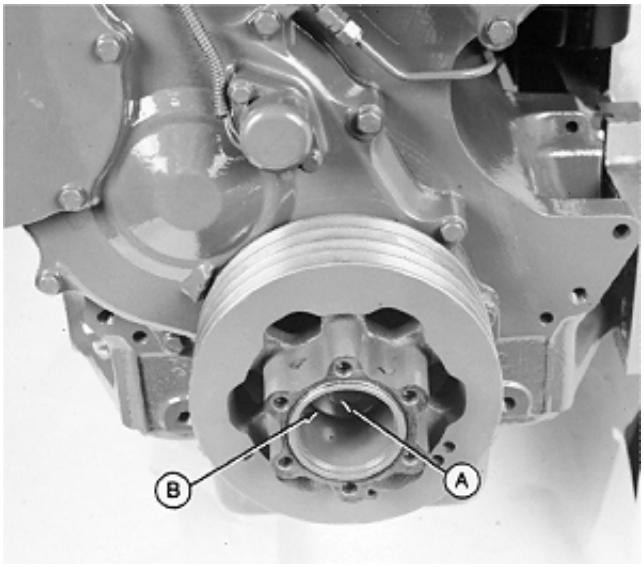
S55,2515,H -19-17NOV95

5. Using JDG728 Puller (A), remove pulley from crankshaft. Be sure JDG787 Thread Protector (B) is in ID of pulley to protect threads in nose of crankshaft from damage and pulling jaws are securely clamped on back side of pulley closest to engine.

IMPORTANT: Carefully and thoroughly inspect the pulley for cracks or any visible damage. Replace pulley as needed.



RG6101 -UN-27JAN92

S55,2515,H1 -19-17NOV95

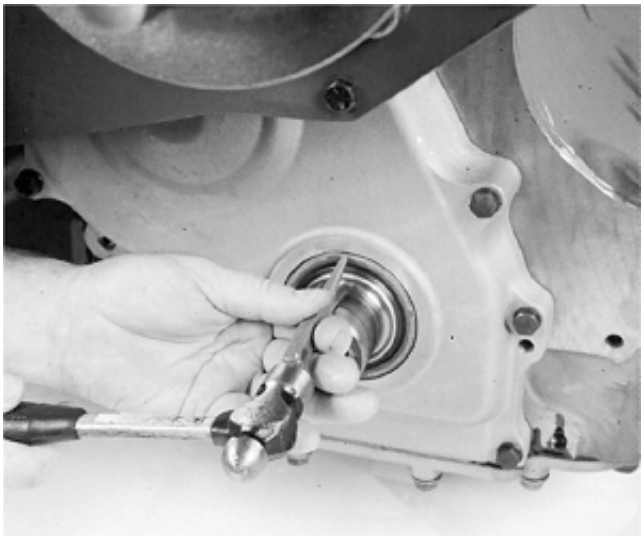
REMOVE CRANKSHAFT FRONT OIL SEAL (WITH TIMING GEAR COVER INSTALLED)

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

NOTE: If timing gear cover is going to be removed from engine, remove front seal after timing gear cover is removed.

1. Check oil seal and wear sleeve for wear, damage, or leakage.

2. Center punch seal casing at 12 o'clock position.



RG6105 -UN-27JAN92

RG,CTM61,G15,9 -19-06OCT95

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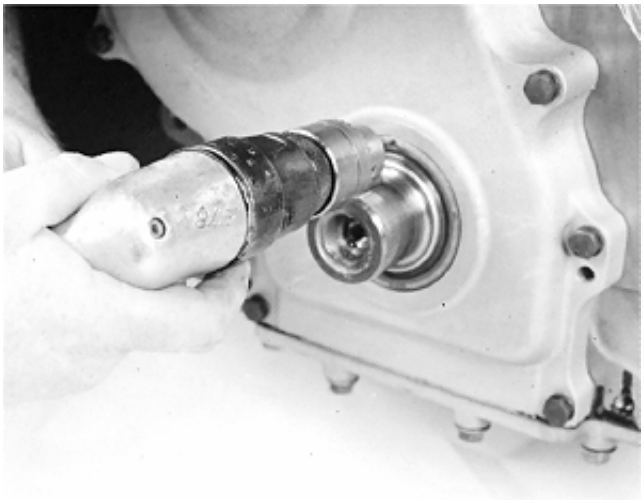
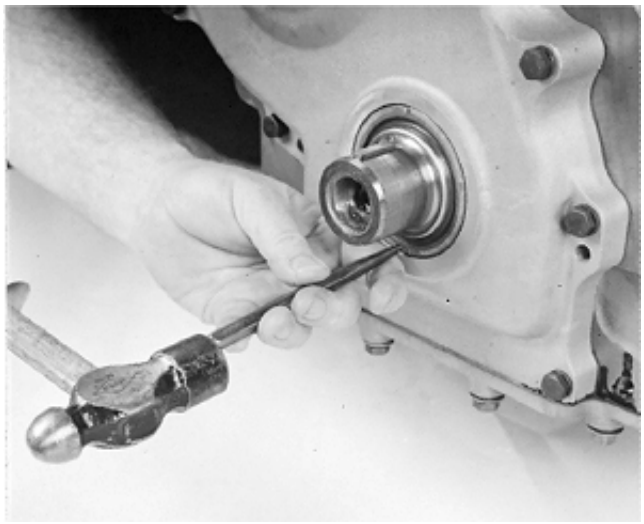
3. Drill hole at 12 o'clock position.



RG6106 -UN-27JAN92

RG,CTM61,G15,17-19-06OCT95

4. Using a punch, cock seal at 6 o'clock position.

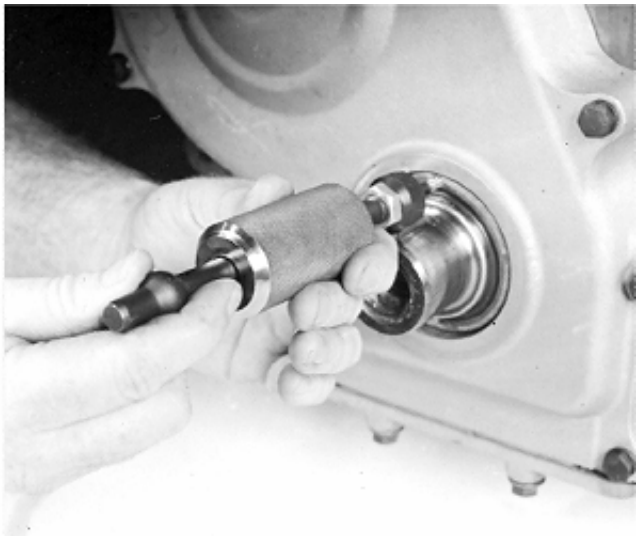


RG6107 -UN-27JAN92

RG,CTM61,G15,18-19-06OCT95

5. The JDG719 Seal Puller Adapter along with JDE38-2 Shank and JDE38-3 Slide Handle is the preferred method for removing crankshaft front oil seal. If these tools are not available, JDG22 Seal Remover can be used to remove the seal. Follow same procedure for both pullers.

6. Remove keyway on stub of crankshaft.



RG6108 -UN-27JAN92

RG,CTM61,G15,10-19-06OCT95

REMOVE CRANKSHAFT FRONT WEAR SLEEVE (WITH TIMING GEAR COVER INSTALLED)

NOTE: Front wear sleeve can be removed with timing gear cover installed or removed using either JDG726 or JDG786 puller set.

- **Remove Wear Sleeve Using JDG726:**

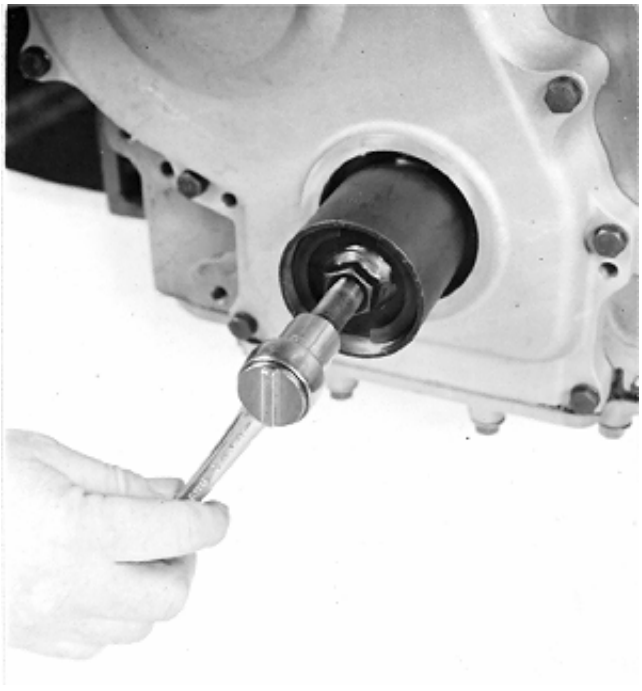
1. Position pulling jaws and jack screw assembly onto lip of wear sleeve. Slide collar over pulling jaws.

2. Hold collar onto pulling jaws and tighten jack screw until wear sleeve is free from crankshaft flange.

3. Inspect crankshaft flange for nicks or burrs.

4. Clean up flange with a light file and emery cloth.

5. Measure crankshaft front oil seal bore runout. Maximum allowable runout is 0.254 mm (0.010 in.).



RG6109 -UN-27JAN92

RG,CTM61,G15,11-19-03JUL95

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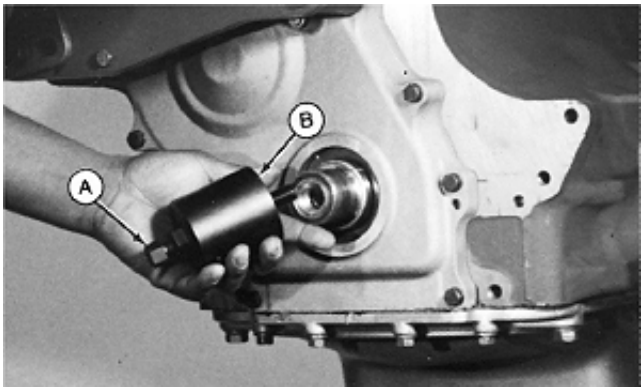
• **Remove Wear Sleeve Using JDG786:**

1. Start fully threaded centering screw (A) through hex head end of puller (B) until head of screw is approximately 12 mm (0.5 in.) from hex on puller.

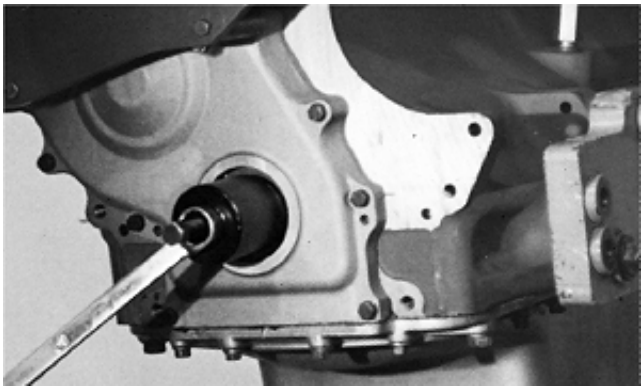
2. Thread centering screw into nose of crankshaft and tighten until it bottoms.

3. Tighten puller until it is securely threaded onto wear sleeve.

4. Remove centering screw from nose of crankshaft and puller.



RG6713 -UN-02APR93



RG6714 -UN-02APR93

RG,CTM61,G15,25-19-03JUL95

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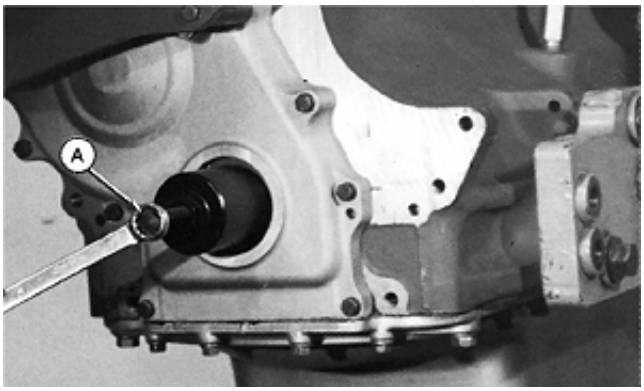
5. Install forcing screw (A) into puller and tighten until it bottoms in nose of crankshaft. There is no thread engagement in crankshaft; just with puller.

6. Continue to tighten forcing screw until puller and wear sleeve are free from crankshaft flange.

7. Inspect crankshaft flange for nicks or burrs.

8. Clean up flange with a light file and emery cloth.

9. Measure crankshaft front oil seal bore runout. Maximum allowable runout is 0.254 mm (0.010 in.).



RG6715 -UN-02APR93

RG,CTM61,G15,26-19-03JUL95

INSTALL CRANKSHAFT FRONT WEAR SLEEVE (WITH TIMING GEAR COVER INSTALLED ON ENGINE)

NOTE: Wear sleeve may be installed with timing gear cover removed or installed.

1. Coat ID of new wear sleeve with LOCTITE 609 Retaining Compound.

2. Using JDG467 Driver from JDE3 Installer along with washer and cap screw that secures damper pulley assembly to crankshaft, install wear sleeve.

3. Remove installation tools and clean any sealant from OD of wear sleeve or ID of seal bore.

RG6110 -UN-27JAN92

RG,CTM61,G15,12-19-02APR93

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INSTALL CRANKSHAFT FRONT OIL SEAL

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

1. Place JDG720-2 Seal Protector (A) on nose of crankshaft. Lubricate ID of front oil seal (B) lips with clean engine oil and slide seal onto seal protector. Be careful not to roll oil seal lips.

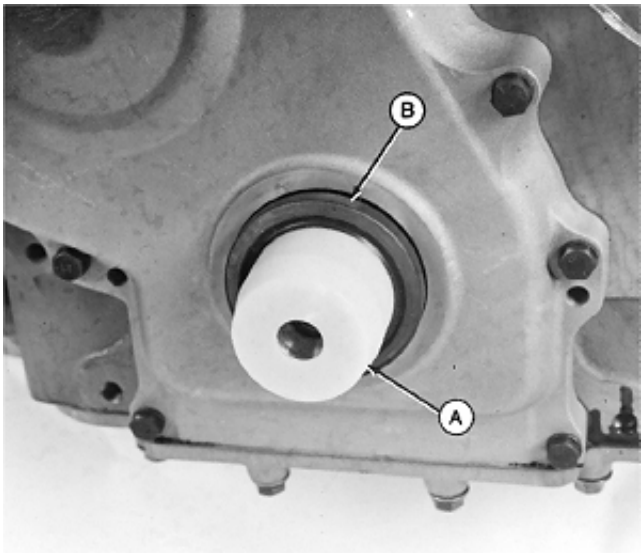
2. Position JDG720-4 Spacer Ring on end of JDG720-3 Seal Installer and place installer onto seal protector against seal.

3. With nut installed onto JDG720-1 Forcing Screw, thread forcing screw into nose of crankshaft until it bottoms.

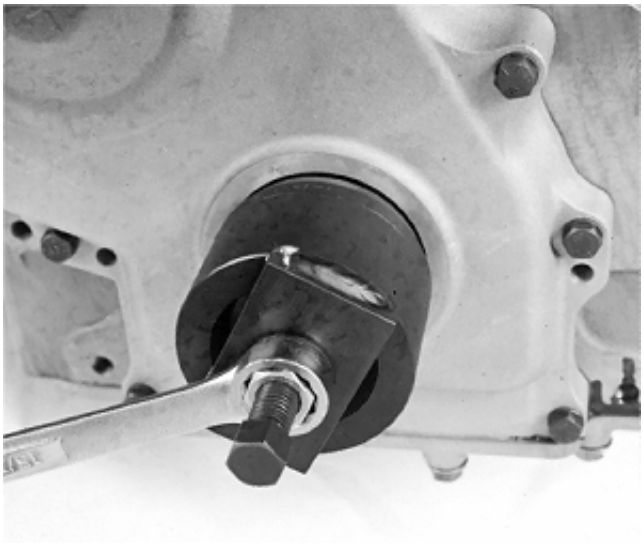
4. Tighten nut against crossplate of installer until installer bottoms on front face of timing gear cover.

5. Remove installation tools.

IMPORTANT: Verify seal is installed squarely in bore, flush with front face of timing gear cover, and that seal lips are not rolled on wear sleeve.



RG6111 -UN-27JAN92



RG6112 -UN-27JAN92

RG,CTM61,G15,13-19-06OCT95

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REMOVE TIMING GEAR COVER

1. Remove vibration damper as detailed earlier. See REMOVE DAMPER/PULLEY ASSEMBLY as described earlier in this group.

2. Drain engine oil, if not previously done. Remove engine oil pan and oil pump. (See Group 20.)

3. Remove idler pulley assembly, if equipped.

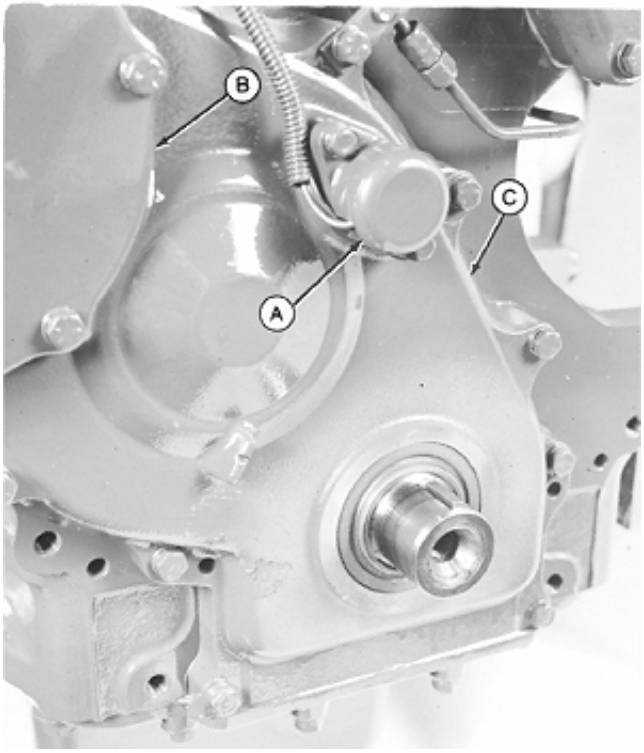
4. Remove magnetic pickup (A), if equipped.

5. Remove injection pump drive gear cover (B). Discard gasket.

6. Remove timing gear cover (C). Discard gasket.

7. Remove front oil seal from timing gear cover using a small punch. Remove wear sleeve from crankshaft flange.

8. Thoroughly clean and inspect seal bore in cover. Check for nicks and burrs. Smooth rough areas with a medium-grit emery cloth.



RG6103 -UN-27JAN92

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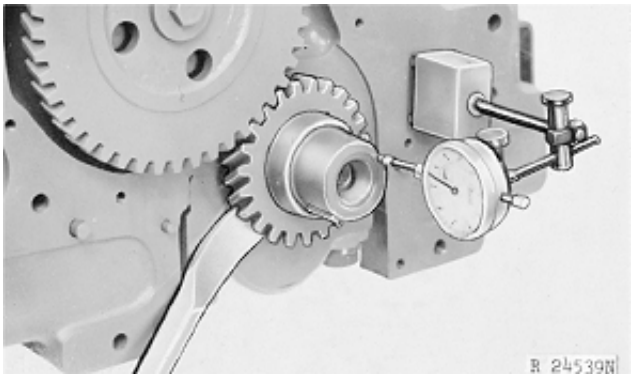
RG,CTM20,G15,14-19-15NOV95

CHECK CRANKSHAFT END PLAY



R24539N -UN-15DEC88

1. Position dial indicator on end of crankshaft.

2. Push crankshaft as far to rear of engine as possible.

3. Preload and zero the dial indicator.

4. Using a bar, gently pry the crankshaft as far forward as possible.

IMPORTANT: Do not apply too much pressure with bar, as this could damage thrust bearings.

CRANKSHAFT END PLAY SPECIFICATIONS

New Parts . . . . . 0.038-0.380 mm (0.0015-0.0150 in.)

NOTE: New thrust bearings will usually restore proper end play.

S55,2515,J -19-10MAR89

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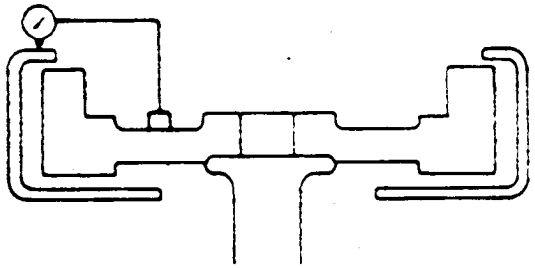
CHECK FLYWHEEL HOUSING FACE RUNOUT



R22212 -UN-14DEC88

1. Mount dial indicator on flywheel. Set pointer to contact PTO mounting surface on flywheel housing at right angles. Pointer should not contact holes in flywheel housing.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel housing face runout.

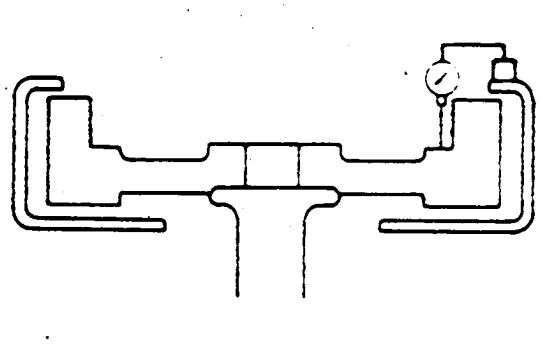
2. Rotate flywheel by turning crankshaft. Read total dial indicator movement.

FLYWHEEL HOUSING FACE RUNOUT SPECIFICATION

Maximum Variation . . . . . 0.20 mm (0.008 in.)

S55,2015,L -19-03JUL95

CHECK FLYWHEEL FACE FLATNESS


R22213 -UN-14DEC88

1. Mount dial indicator base on flywheel housing. Position pointer to contact driving ring mounting surface. Do not allow pointer to contact driving ring mounting holes.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel face runout.

2. Rotate flywheel by turning crankshaft. Read total dial indicator movement. Resurface flywheel face or replace as required.

FLYWHEEL FACE FLATNESS SPECIFICATION

Maximum Variation	0.23 mm (0.009 in.)
Maximum Variation per 25 mm (1.0 in.) of Travel	0.013 mm (0.0005 in.)

S11,5005,AM -19-02FEB94

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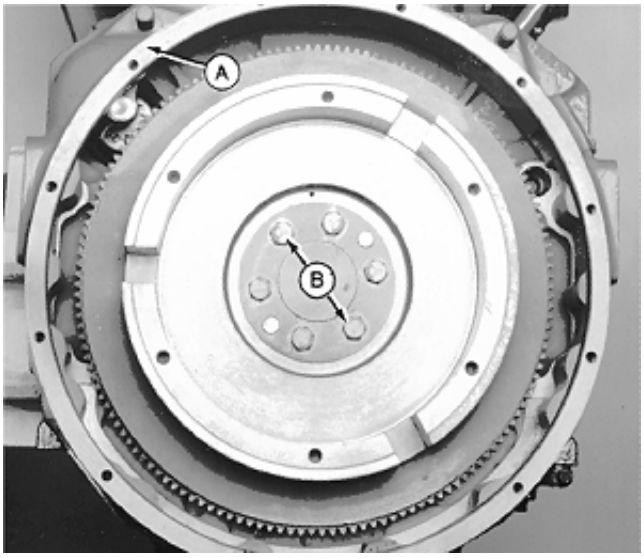
REMOVE FLYWHEEL AND FLYWHEEL HOUSING



RG4323 -UN-09NOV89

1. Disconnect clutch housing and clutch, if not previously done.

2. Remove starting motor.

CAUTION: Flywheel housing and flywheel are very heavy. Plan proper handling procedure to avoid injuries.

3. Remove flywheel housing (A).

4. Remove two flywheel attaching cap screws (B), and install two pilot studs in their place.

5. Remove the remaining cap screws, and carefully pull flywheel from crankshaft.

S11,2515,G -19-02APR93

INSPECT AND REPAIR FLYWHEEL

1. Inspect the clutch contact face for scoring, overheating or cracks.

2. Replace a defective flywheel.

3. Examine ring gear for worn or broken teeth. If ring gear is damaged, replace gear.

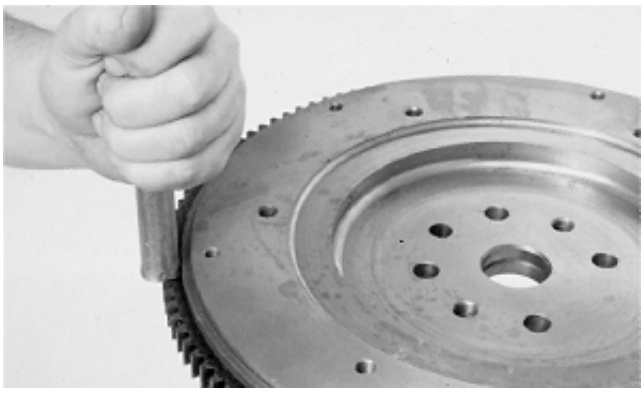
S11,0403,S -19-03JUL95

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.

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



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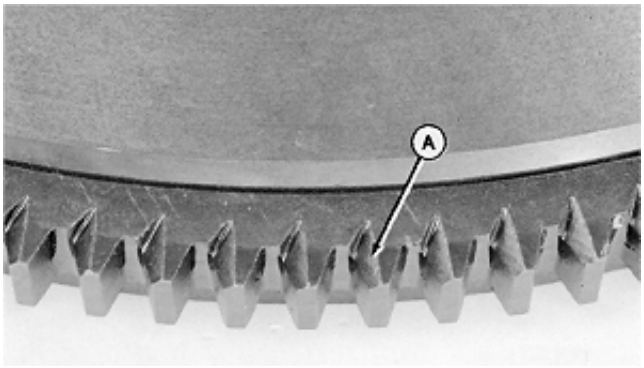
22

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

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.



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

5. Install ring gear against shoulder of flywheel.

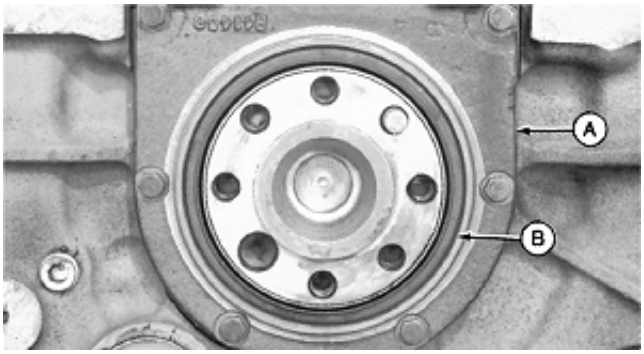
S11,2015,FX -19-03JUL95

REMOVE REAR OIL SEAL HOUSING

1. Remove cap screws and rear oil seal housing (A).

NOTE: Rear oil seal (B) will come off with housing.

2. Inspect rear oil seal and wear sleeve. Replace if necessary. (See REMOVE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE/WITH OIL SEAL HOUSING REMOVED in this group.)



S11,2020,G,1 -19-13NOV95

REMOVE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE (WITH OIL SEAL HOUSING REMOVED)

NOTE: These instructions are for use when the oil seal housing and oil pan will be removed.

1. Remove rear oil seal from housing using a small punch and chisel.

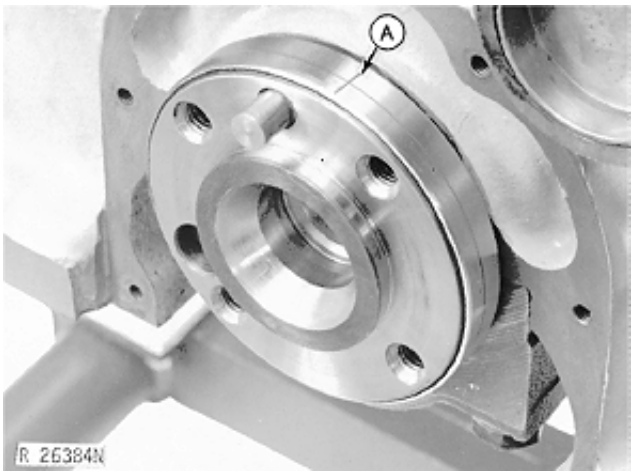
NOTE: The JDG790 Rear Wear Sleeve Puller is the preferred method for removing the rear wear sleeve. (See REPLACE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE/WITH OIL SEAL HOUSING INSTALLED in this group.)

2. If JDG790 Rear Wear Sleeve Puller is unavailable, remove rear wear sleeve by scoring lightly (A) the full width of wear sleeve in several places with a dull chisel. DO NOT cut through wear sleeve with chisel.

3. Gently pry wear sleeve from crankshaft.

4. Inspect crankshaft flange for burrs or nicks.

5. Clean flange with a light file and emery cloth.



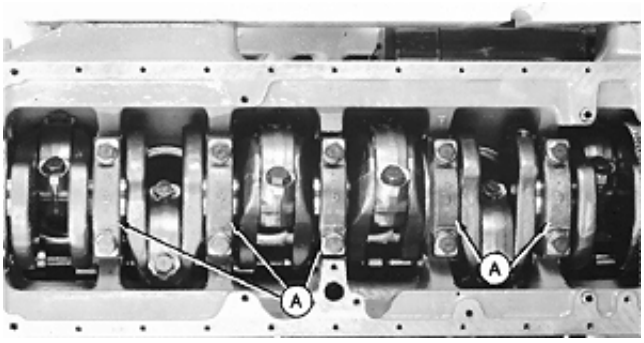
S11,2020,H -19-13NOV95

REMOVE CRANKSHAFT MAIN BEARINGS

NOTE: A drop in oil pressure, engine knock, or excessive crankshaft end play are indications of main bearing and main thrust bearing washer failures.

IMPORTANT: Before removing main bearing caps (A, five shown), check for proper torque on all main bearings. Also, check each bearing cap to make sure they are numbered for reassembly on the same numbered main bearing bosses. Keep matched bearing inserts with their respective main bearing cap for comparison with crankshaft journal (surface) from which removed.

NOTE: When removing main bearings and caps, leave No. 1 and 7 main bearing caps installed until all connecting rod caps have been removed.



RG3751 -UN-14DEC88

S11,2515,H -19-08MAR94

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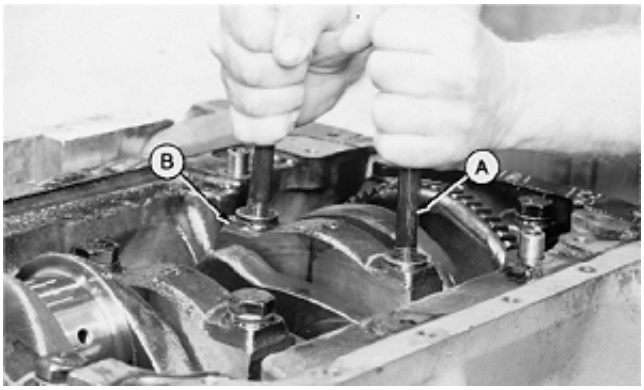
1. Loosen main bearing cap screws and washers.

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

3. Use PLASTIGAGE to measure oil clearance on each main bearing as they are removed. See CHECK MAIN BEARING CLEARANCE later in this group.



RG4469 -UN-14DEC88

S11,2515,AJ -19-08MAR94

CHECK MAIN BEARING CLEARANCE

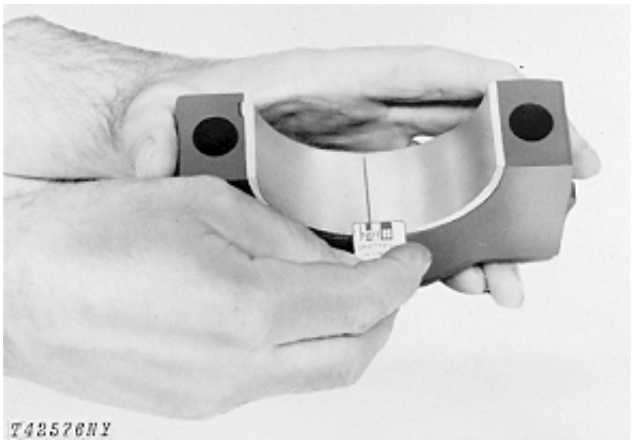
1. Place a strip of PLASTIGAGE in the center of the main bearing cap about three-fourths of the width of the bearing.

2. Use clean engine oil on PLASTIGAGE to prevent smearing.

3. Install cap and tighten cap screws to 285 N·m (210 lb-ft).

4. Remove cap and compare width of PLASTIGAGE with scale provided to determine 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.



T42576NY -UN-09NOV88

MAIN BEARING CLEARANCE SPECIFICATION

Main Bearing-to-Journal Clearance	0.046—0.122 mm (0.0018—0.0048 in.)
Maximum Acceptable Oil Clearance	0.152 mm (0.0060 in.)

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S11,2515,J -19-03JUL95

REMOVE CRANKSHAFT

1. Rotate crankshaft using the JDE81-1 Flywheel Rotation Tool until connecting rod caps can be removed easily. You will be able to remove two rod caps at each position.

2. Remove all connecting rod caps (A) with bearings, then remove No. 1 and 7 main bearing caps and bearings. See REMOVE PISTONS AND CONNECTING RODS in Group 10.

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

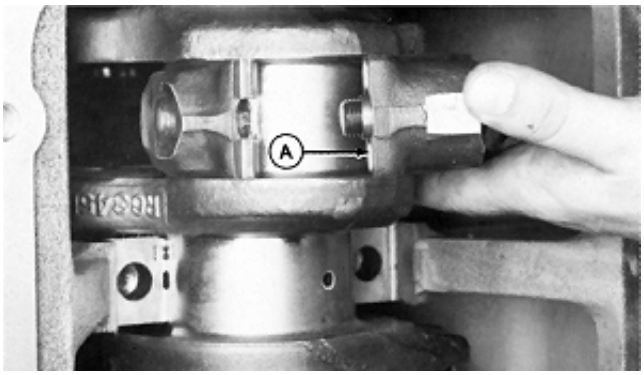
NOTE: Install a screw on each end of crankshaft to aid in lifting crankshaft.

3. Attach a lifting strap to crankshaft.

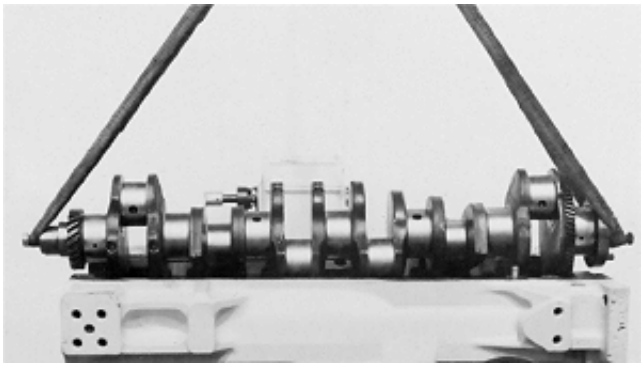
4. Using proper lifting equipment, carefully raise crankshaft out of cylinder block.

5. Clean crankshaft, especially oil passages, using solvent and compressed air.

6. Put crankshaft on clean V-blocks.



RG3840 -UN-14DEC88



RG2794 -UN-23FEB89

S11,0403,AA -19-08MAR94

INSPECT CRANKSHAFT

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

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

2. Inspect crankshaft for signs of load stress, cracks, or scratches on journals. Also check each journal for evidence of excessive overheating or discoloration. If either condition exists, replace crankshaft since heat treatment has probably been destroyed.

3. Inspect (front) crankshaft gear and (rear) oil pump drive gear for cracks, chipped teeth, or excess wear. Replace gear(s) as required. (See REPLACE CRANKSHAFT TIMING GEAR and REPLACE CRANKSHAFT OIL PUMP DRIVE GEAR, later in this group.)

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

5. Carefully inspect 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 and crocus cloth.

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

IMPORTANT: The vibration damper MUST BE replaced whenever the crankshaft is replaced.

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RG,CTM9,G15,93 -19-06OCT95

7. Carefully check the crankshaft for cracks in the area of rod journal oil holes (A) and at journal fillets (B). Replace crankshaft if any cracks are found.

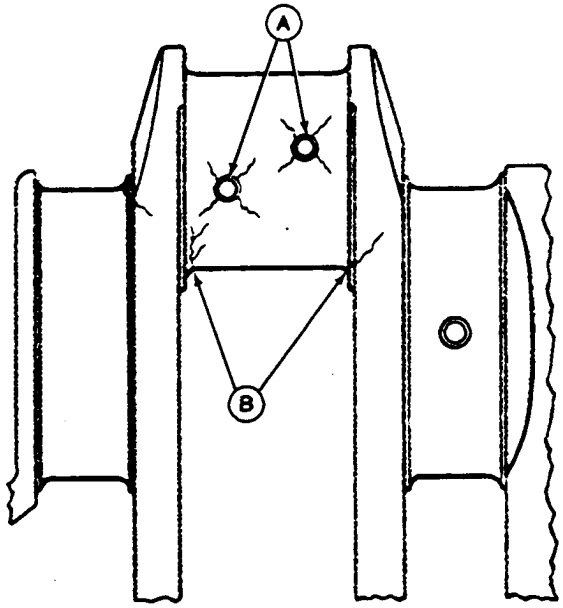
IMPORTANT: Small cracks may not be visible to the eye. Use a procedure such as the Fluorescent Magnetic Particle method. This method magnetizes the crank, employing magnetic particles which are fluorescent and glow under "black light". The crankshaft must be de-magnetized after the test.

8. Check condition of dowel pin in crankshaft rear flange. Dowel pin must not be cracked or chipped. Measure protrusion of dowel pin from face of flange. If dowel pin is damaged, or protrusion is not within specifications, replace dowel pin. If dowel pin is damaged, also inspect flywheel for damage.

NOTE: If replacing dowel pin, crankshaft must be removed to prevent damage to crankshaft thrust bearings.

CRANKSHAFT DOWEL PIN SPECIFICATIONS

Dowel Pin Protrusion From
Rear Flange . . . . . 13.5—14.5 mm (0.53—0.57 in.)



RG5093 -UN-15DEC88

RG,CTM9,G15,94 -19-03JUL95

MEASURE ASSEMBLED I.D. OF BEARINGS AND O.D. OF CRANKSHAFT JOURNALS

1. With crankshaft out of cylinder block, install main bearing inserts and caps (be sure inserts are installed correctly).

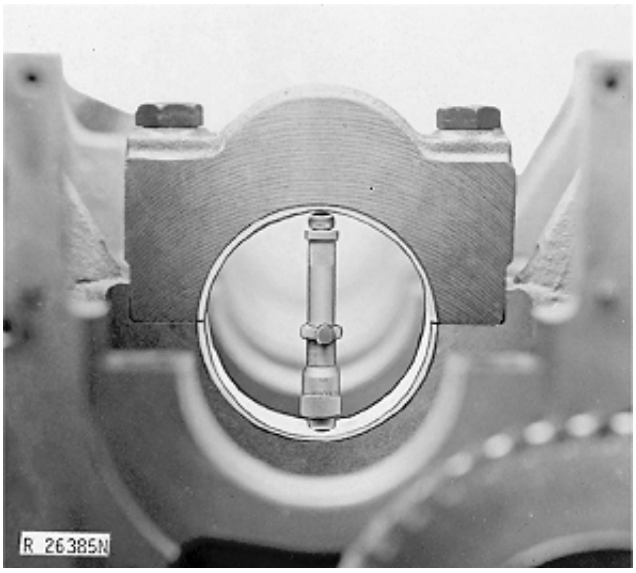
2. Tighten main bearing cap screws to 285 N·m (210 lb-ft).

3. Measure I.D. of all bearings with an inside micrometer.

MAIN BEARING ID SPECIFICATIONS

With Bearing	95.270—95.320 mm (3.7508—3.7528 in.)
Without Bearing	101.651—101.677 mm (4.0020—4.0030 in.)

NOTE: Inspect and measure assembled ID of connecting rod bearings. Compare measurements with connecting rod journal OD on crankshaft (See Group 10.)



-UN-15DEC88
R26385N

S11,2515,M -19-03JUL95

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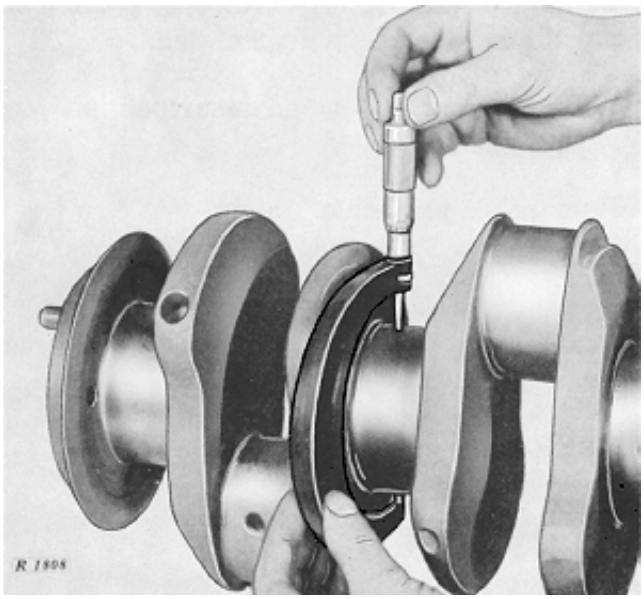
4. Measure OD of all respective crankshaft journals at several points around journal.



RG1808 -UN-14DEC88

CRANKSHAFT SPECIFICATIONS

OD of Main Bearing Journal	95.200—95.225 mm (3.7480—3.7490 in.)
ID of Main Bearing (assembled)	95.270—95.320 mm (3.7508—3.7528 in.)

NOTE: If engine has previously had a major overhaul and undersized bearing inserts were used, above listed ID and OD dimensions may not be the same as those recorded. However, oil clearance should be within specifications. Oil clearance is 0.046—0.122 mm (0.0018—0.0048 in.). The maximum serviceable clearance is 0.152 mm (0.0060 in.).

Use crankshaft journal OD measurements to determine if journal is out-of-round or tapered.

CRANKSHAFT WEAR SPECIFICATIONS

Journal Taper per 25.4 mm (1.0 in.) of Journal Length	0.0025 mm (0.0001 in.)
Journal Out-of-Roundness	0.025 mm (0.0010 in.)

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S11,2515,N -19-06OCT95

MEASURE ASSEMBLED I.D. OF MAIN BEARING CAPS (WITHOUT BEARINGS)

1. With crankshaft removed from cylinder block, install main bearing caps without bearing inserts.

2. Tighten main bearing cap screws to 285 N·m (210 lb-ft).

3. Measure I.D. of all bearing caps with an inside micrometer. Compare to specifications given.

If any main bearing cap assembled I.D. is not within specification, blank (generic) bearing caps are available and must be line bored to specification. Replace individual bearing caps as needed.

IMPORTANT: Main bearing cap line boring should be done ONLY by experienced personnel on equipment capable of maintaining bore specifications.

MAIN BEARING CAP BORE SPECIFICATION

I.D. Without Bearings	101.651—101.677 mm (4.0020—4.0030 in.)
Maximum Bore Diameter Variation	0.013 mm (0.0005 in.)
Maximum Bore Diameter Taper	0.005 mm (0.0002 in.)
Maximum Straightness (Any bore-to-adjacent bore)	0.038 mm (0.0015 mm)
Maximum Straightness (5 center bores-to-adjacent bore)	0.076 mm (0.0030 in.)
Centerline of Bore-to-Top Deck	374.57—374.73 mm (14.747—14.753 in.)

S11,2515,BX -19-06OCT95

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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.

In addition to the standard size main and connecting rod bearings, 0.05, 0.25, 0.51 and 0.76 mm (0.002, 0.010, 0.020 and 0.030 in.) undersize bearings are available. If journals are tapered, out-of-round, scored or damaged, grind the crankshaft and install the proper undersize bearings.

NOTE: The 0.05 mm (0.002 in.) undersize bearings are used normally to compensate for slight un-even wear on crankshafts. Regrinding is usually unnecessary when this size bearing is used.

IMPORTANT: If undersize bearings are used, check bearing clearance after bearing caps have been tightened to specified torque. If undersize bearings are too tight and clearance is not within specifications, the journal and bearing will be wiped clean of all oil. This would result in premature wear of parts.

If the crankshaft is to be reground, use the following recommended procedure:

1. Compare the crankshaft journal measurements taken during inspection and determine the size which the journals are to be reground.

2. If one or more main or connecting rod journals require grinding, then grind all of the main journals or all of the connecting rod journals to the same required size.

3. All journal fillets radii must be free of any sharp grind marks or scratches. The fillet must blend smoothly into the journal and crank cheek. Check the radius with a fillet gage.

IMPORTANT: Care must be taken to avoid localized heating which often produces grinding cracks.

S11,2015,DM -19-03JUL95

CRANKSHAFT GRINDING GUIDELINES—CONTINUED

4. Cool the crankshaft while grinding by using coolant generously. DO NOT crowd the grinding wheel into the work.

IMPORTANT: Grind crankshaft with journals turning clockwise, as viewed from the front end of crankshaft. Lap or polish journals in opposite direction of grinding.

5. Polish or lap the ground surfaces to the specified finish to prevent excessive wear of the journals.

NOTE: Production crankshafts are induction hardened and shotpeened at the factory. Field shotpeening is not recommended due to the equipment required and port geometry.

6. If the thrust surfaces of the crankshaft are worn or grooved excessively, regrind and polish. Maintain the specified radius between each thrust surface and the bearing journal. An oversize thrust washer set containing one standard washer and two 0.18 mm (0.007 in.) oversize washers is available. (See THRUST BEARING NEW PART SPECIFICATIONS, later in this group.)

NOTE: When thrust surfaces are reground and oversize washers used, crankshaft end play specification must be maintained to within 0.038—0.380 mm (0.0015—0.0150 in.). See CHECK CRANKSHAFT END PLAY, earlier in this group.

7. Stone the edge of all oil holes in the journal surfaces smooth to provide a radius of approximately 1.50 mm (0.060 in.).

8. When finished grinding, inspect the crankshaft for cracks with the Florescent Magnetic Particle method, or similar method.

9. De-magnetize the crankshaft.

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

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33

S11,2015,HH -19-03JUL95

CRANKSHAFT GRINDING SPECIFICATIONS

Engine Stroke . . . . . 127 mm (5.0 in.)
Main and Rod Journal Surface Finish . . . . . Lap 0.25 Um (9.8 AA)
Thrust Journal Surface Finish . . . . . Lap 0.40 Um (16 AA)
Rod Journal Fillet Radius . . . . . 4.49—4.85 mm (0.177—0.191 in.)
Main and Thrust Journal Fillet Radius . . . . . 3.94—4.44 mm (0.155—0.175 in.)
Thrust Journal Width . . . . . 47.57—47.67 mm (1.873—1.877 in.)

Bearing Size	Crankshaft Main Journal OD	Crankshaft Rod Journal OD
Standard	95.000—95.225 mm (3.7480—3.7490 in.)	88.844—88.874 mm (3.4980—3.4990 in.)
0.05 mm (0.002 in.) Undersize	94.950—95.175 mm (3.7460—3.7470 in.)	88.794—88.824 mm (3.4960—3.4970 in.)
0.25 mm (0.010 in.) Undersize	94.750—94.975 mm (3.7380—3.7390 in.)	88.594—88.624 mm (3.4880—3.4890 in.)
0.51 mm (0.020 in.) Undersize	94.490—94.715 mm (3.7280—3.7290 in.)	88.334—88.364 mm (3.4780—3.4790 in.)
0.76 mm (0.030 in.) Undersize	94.240—94.465 mm (3.7180—3.7190 in.)	88.064—88.114 mm (3.4680—3.4690 in.)

S11,2515,BZ -19-03JUL95

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34

THRUST BEARING NEW PART SPECIFICATIONS

IMPORTANT: Install thrust bearing in cylinder block and tighten to specification before regrinding or polishing thrust surfaces to assure that all surfaces on bearing and on block web are correctly aligned.

THRUST BEARING NEW PART SPECIFICATION

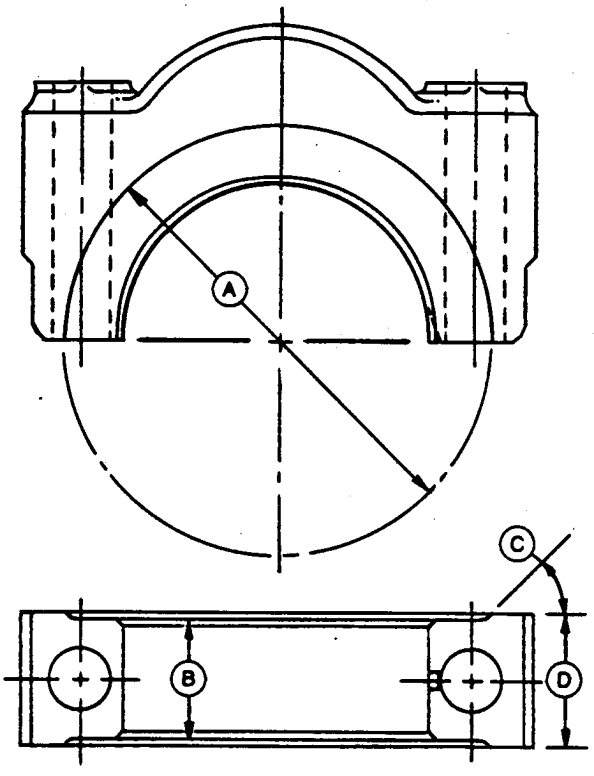
A—Thrust Washer Clearance Base Circle . . . . . 129.28—130.81 mm (5.09—5.15 in.)

B—Thrust Surface Width . . . . . 40.615—40.716 mm (1.559—1.603 in.)

C—Relief Angle . . . . . 45˚

D—Bearing Cap Overall Width . . . . . 41.81—42.31 mm (1.646—1.666 in.)

Maximum runout for thrust surface is 0.025 mm (0.0010 in.)



RG5269 -UN-14DEC88

S55,2515,K -19-06OCT95

REPLACE CRANKSHAFT GEAR

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

1. Install JDG787 Thread Protector in nose of crankshaft.

2. Protect crankshaft wear sleeve surface with masking tape.

3. Remove crankshaft gear using D01251AA* Puller or an equivalent puller.

4. Discard gear after removal.

5. Remove Woodruff key from crankshaft keyway.

6. Remove masking tape.

IMPORTANT: Crankshaft gear must be installed on crankshaft before crankshaft is installed in engine, otherwise damage to thrust bearings could occur.

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.

7. Heat crankshaft gear (if removed) to 148˚C (300˚F), using either heated oil or oven heat.

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.

8. Install Woodruff key in crankshaft.

9. Place gear on crankshaft flange. Be sure key on crankshaft is properly aligned with keyway in gear.

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

10. Use JDH7 Driver to firmly seat gear against crankshaft flange.

11. Once gear cools, reseat gear using JDH7 Driver.

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**Part of D01047AA 17-1/2 and 30-Ton Puller Set.*

RG,CTM61,G15,27-19-30APR93

REPLACE (CRANKSHAFT) OIL PUMP DRIVE GEAR

IMPORTANT: Protect all machined surfaces of crankshaft from grinding debris and weld spatter when removing old gear and installing new gear. DO NOT use a cutting torch to remove failed gear.

1. Using a rotary grinding wheel or parting disc, grind weld beads (A) until flush with crankshaft flange.

2. Remove gear (B) by alternately striking gear at each weld location using a brass drift and soft lead mallet.

3. After removal of gear, clean up OD of crankshaft flange and remove any burrs or remaining weld bead to eliminate interference when installing new gear.

CAUTION: Oil fumes or oil can ignite above 193˚C (380˚F). Use a thermometer and do not exceed 182˚C (360˚F). Do not allow a 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.

4. Heat new gear to 148˚C (300˚F) using either heated oil or oven heat.

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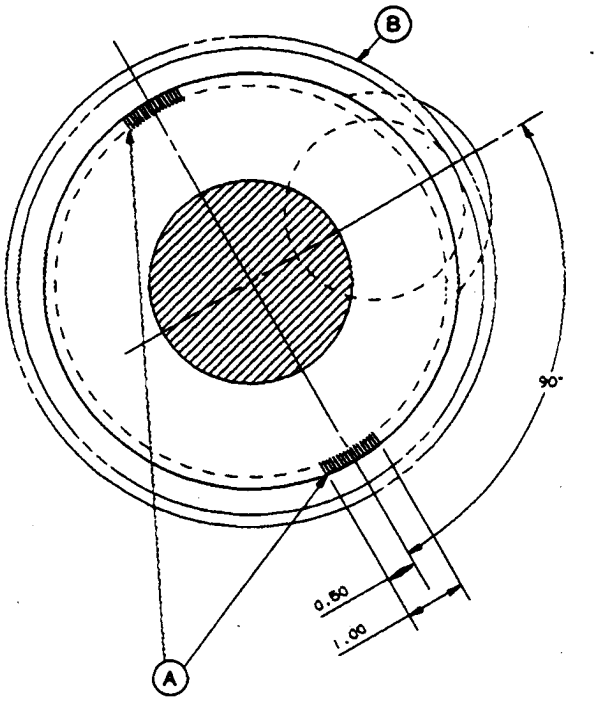
IMPORTANT: DO NOT OVERHEAT GEAR. SEE CAUTION. Overheating may also destroy original heat treatment of gear.

5. Drive gear onto crankshaft flange until flush against shoulder.

NOTE: When driving oil pump drive gear onto crankshaft flange. The beveled edge of gear teeth should face the flywheel end of crankshaft.

6. Weld two 25.4 mm (1 in.) beads according to illustration using 1/8 in. diameter 7018 welding rod. Grind away excess weld to eliminate the possibility of interference with cylinder block.



RG5018 -UN-14DEC88

S11,2515,BG -19-06OCT95

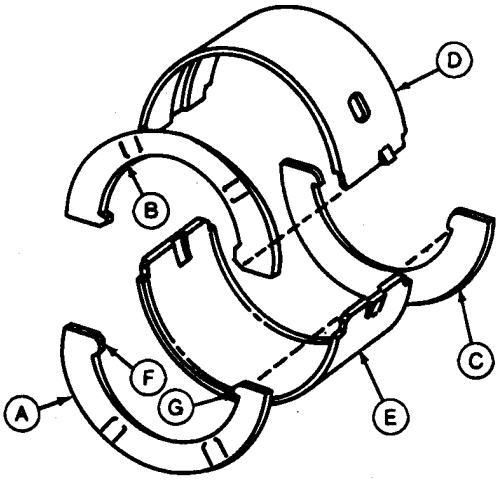
INSPECT THRUST BEARINGS

1. Check thrust surfaces of the thrust bearing and the thrust bearing journal on crankshaft and replace as necessary.

Thrust bearings are available in each of the previously mentioned insert undersizes. An oversize thrust washer set containing one regular size washer and two 0.18 mm (0.007 in.) oversize washers is also available.

NOTE: Thrust bearings must be installed with slots facing crankshaft flange. Two halves (A) and (C) go on cap side, not block.

A—Lower Rear Thrust Washer
B—Upper Rear Thrust Washer
C—Lower Front Thrust Washer
D—Main Bearing Block Thrust Bearing
E—Main Bearing Cap Thrust Bearing
F—Large Tang
G—Small Tang



R24545 -UN-15DEC88

S11,0403,AF -19-03JUL95

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37

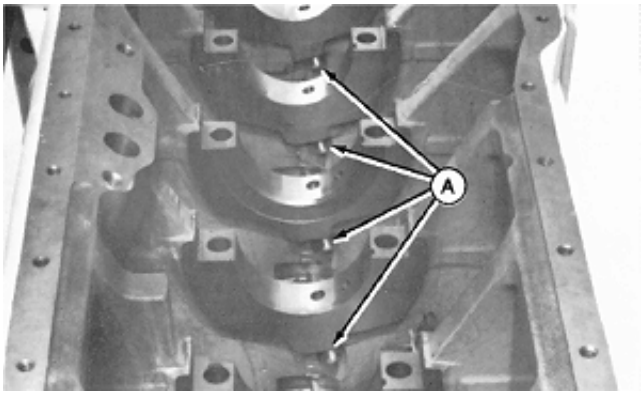
REMOVE AND CLEAN PISTON COOLING ORIFICES

1. Remove all six (four shown) piston cooling orifices (A) and inspect each cooling orifice to make sure it is not plugged or damaged.

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

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

3. Install orifices in block and tighten to 11 N·m (8 lb-ft) (97 lb-in.).



RG3752 -UN-14DEC88

S11,2015,CN,1 -19-17NOV95

INSTALL MAIN BEARING INSERTS IN BLOCK

IMPORTANT: If new main or thrust bearing inserts or thrust washers are installed, they must be installed as a matched set.

During assembly, apply a liberal coating of clean engine oil to:

—All main bearing webs in block

—Both sides of main bearing inserts, thrust bearing inserts, and thrust washers

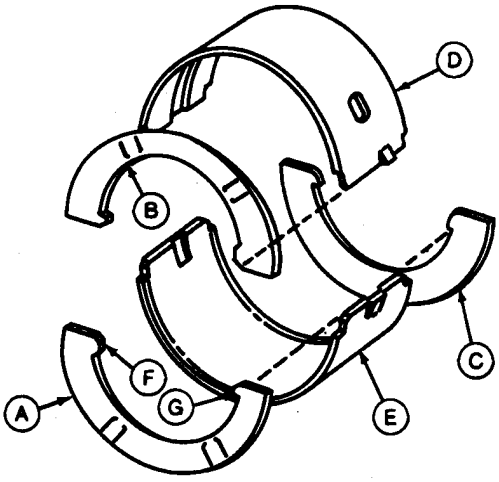
—Entire OD of crankshaft main bearing journals

1. Install six main bearing inserts in block except No. 5 thrust bearing insert. Be sure locating tabs on inserts are properly positioned with slot in block web.

IMPORTANT: Thrust washers (A) and (C) go on both sides of bearing cap and thrust washer (B) on rear side of block web only with the slots facing the crankshaft.

2. Install No. 5 main thrust bearing insert (D) in block. Install upper thrust washer on bearing insert at rear of block web. Be sure tangs on washer are properly positioned on thrust bearing insert.

3. Check to make sure that oil holes in main bearing web are properly aligned with oil holes in bearing inserts.



R24545 —UN—15DEC88

A—Lower Rear Thrust Washer
B—Upper Rear Thrust Washer
C—Lower Front Thrust Washer
D—Main Bearing Block Thrust Bearing
E—Main Bearing Cap Thrust Bearing
F—Large Tang
G—Small Tang

S11,0403,AI -19-06OCT95

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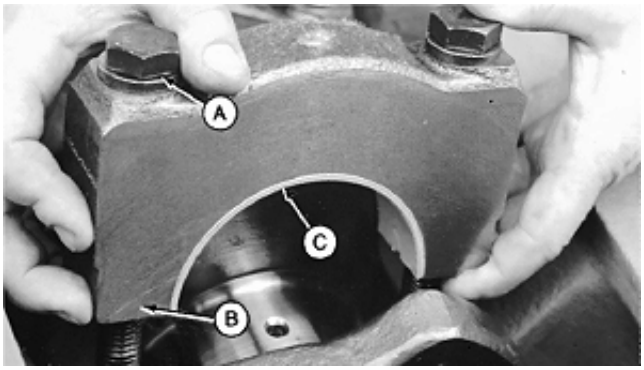
38

INSTALL CRANKSHAFT



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

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

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

3. Install each bearing cap (B), bearings (C), and cap screws with washer (A) with the recesses and tabs aligned in matching order. Make sure bearing tabs also match up before tightening cap screws.

NOTE: Make sure main bearing caps are installed on the bearing bosses from which they were removed. The numbers stamped on the caps should be on the same side as the numbers on the block. If there is an arrow on cap, arrow must point toward front of engine. If bearing caps have been rebored, make sure new bearing caps have numbers stamped on them.

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

4. Before tightening cap screws on main bearing caps, align upper and lower thrust flanges on main thrust bearings. Using a pry bar between block web and crankshaft throw, gently pry crankshaft to the rear and then to the front to line up thrust bearing flanges.

5. Tighten No. 1, 2, 3, 4, 6 and 7 main bearing cap screws to 68 N·m (50 lb-ft). Hand tighten No. 5 main bearing cap screws.

6. Gently pry crankshaft rearward then forward to align thrust washers on No. 5 main bearing. DO NOT pry crankshaft at No. 5 main.

7. Tighten all main bearing cap screws to 285 N·m (210 lb-ft).

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

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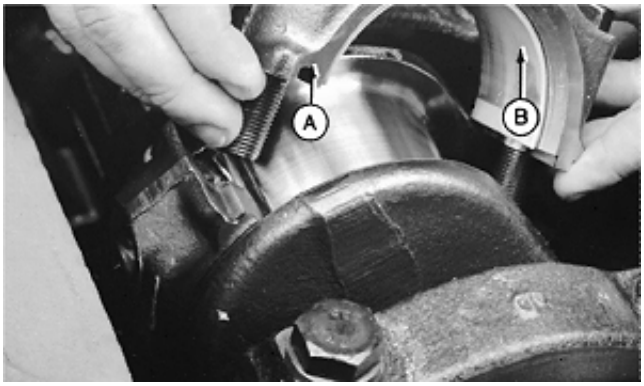
39

S55,2515,L -19-02APR93

9. Install connecting rod caps (A) with bearings (B), using new cap screws and tighten to 75 N·m (55 lb-ft). Tighten an additional 90°—100° after initial tightening. (See TORQUE TURN CONNECTING ROD CAP SCREWS in Group 10.)

IMPORTANT: Do not use pneumatic wrenches to tighten connecting rod cap screws. Threads can be damaged.

10. Check crankshaft end play. (See CHECK CRANKSHAFT ENDPLAY earlier in this group.)



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S11,2515,AU,1 -19-17NOV95

INSTALL OIL PUMP AND CHECK DRIVE GEAR-TO-CRANKSHAFT CLEARANCE

1. Install engine oil pump at this time. (See INSTALL OIL PUMP in Group 20.)

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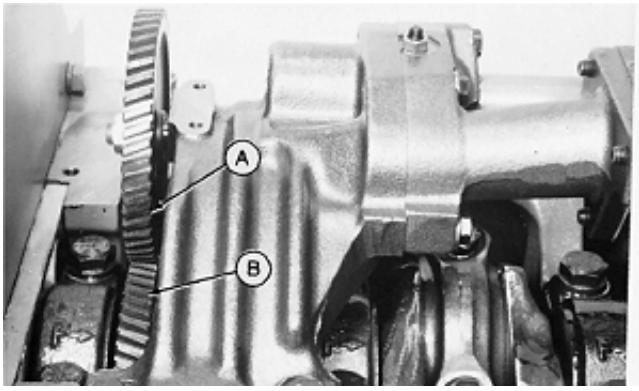
IMPORTANT: Gently pry crankshaft forward and check that oil pump drive gear (A) and crankshaft gear (B) are properly meshed.

Gently pry crankshaft rearward (toward flywheel end), and check for clearance between oil pump drive gear face and throw of crankshaft. There should be at least 0.38 mm (0.015 in.) clearance. If clearance is below specification, check thrust bearing for proper placement.



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S55,2515,M -19-03JUL95

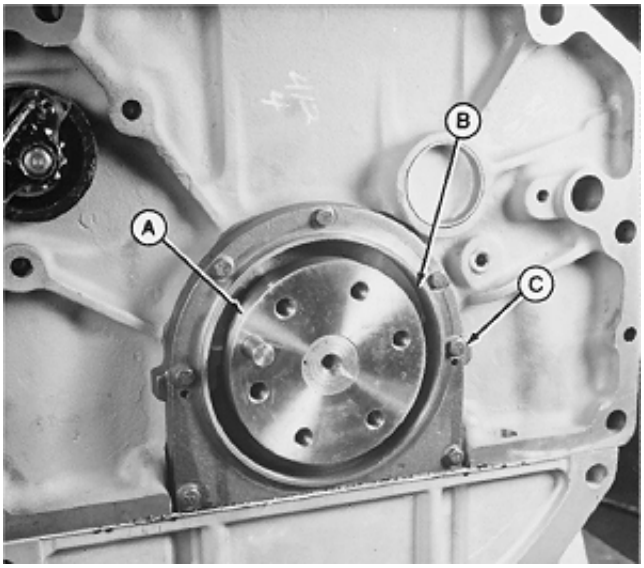
INSTALL CRANKSHAFT REAR OIL SEAL HOUSING

NOTE: Oil pan (shown installed) must be either removed or cap screws loosened and pan lowered to accurately install crankshaft rear oil seal housing.

Make sure the OD of crankshaft flange (A) and ID of seal housing (B) are free from nicks or burrs. Restore damaged surfaces with file or emery cloth. Clean with compressed air.

1. Using a new gasket, install oil seal housing (C) on locating dowels in cylinder block. Install all seven cap screws and tighten to 27 N·m (20 lb-ft).

2. Check oil seal housing runout. (See CHECK OIL SEAL HOUSING RUNOUT, later in this group.)



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S55,2515,N,1 -19-13NOV95

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CHECK OIL SEAL HOUSING RUNOUT

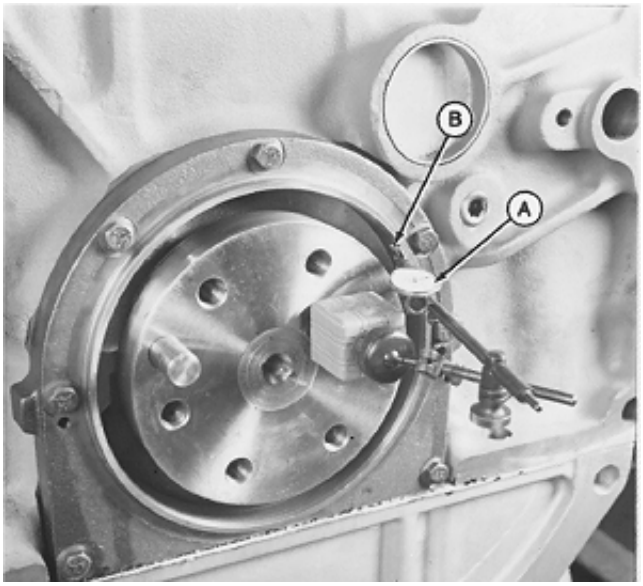
IMPORTANT: Rear oil seal housing is positioned by two locating dowel pins in cylinder block. If housing bore run-out is not within specification, install a new housing; there is not adjustment for runout specification.

1. Position magnetic base dial indicator (A) on end of crankshaft flange. Preset dial indicator tip on ID of oil seal housing bore (B).

2. Zero dial indicator and rotate crankshaft one full revolution. Observe full indicator movement. The maximum oil seal housing runout is 0.152 mm (0.0060 in.).

If runout exceeds specification, install a new housing and check run-out.

3. Recheck oil seal bore runout. If runout still exceeds specification, oil seal housing bore is possibly distorted and should be replaced.



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RG5528

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42

S55,2515,P -19-13NOV95

CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE HANDLING PRECAUTIONS

Use the following precautions for handling seal and wear sleeve:

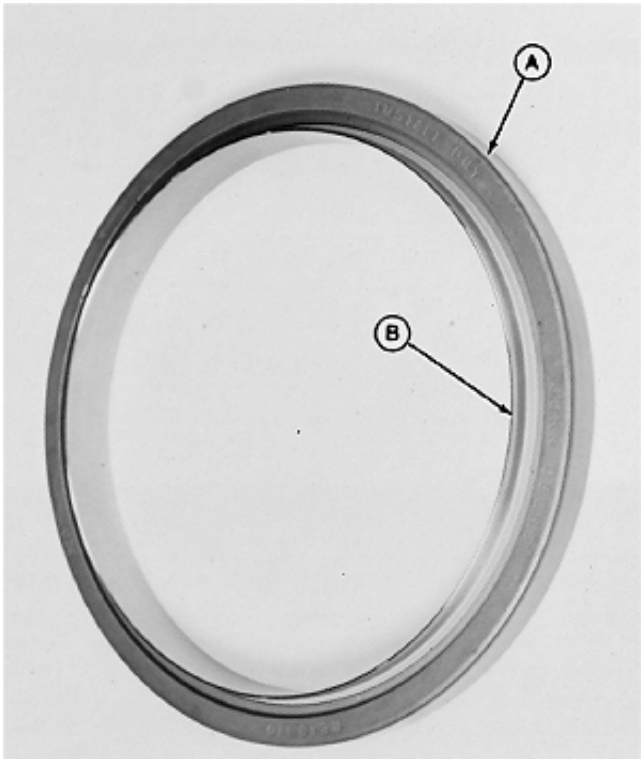
—Seal (A) and wear sleeve (B) are assembled. DO NOT SEPARATE. If parts become separated, discard and replace with a new assembly. Attempts to reassemble will cause the wear sleeve to damage the seal allowing engine oil to leak past seal.

—Always install seal and wear sleeve assembly immediately after removal from plastic bag to avoid possible dirt contamination.

—No lubrication of any kind is to contact seal when installing. Use of a lubricant may result in premature seal failure.

—Install oil seal/wear sleeve assembly with the black seal lip 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.

—Oil seal/wear sleeve assembly MUST be installed with the JDG300 Oil Seal and Wear Sleeve Installer. Tool set consists of JDG309 Pilot and JDG310 Installer.



RG5575 -UN-07JUL89

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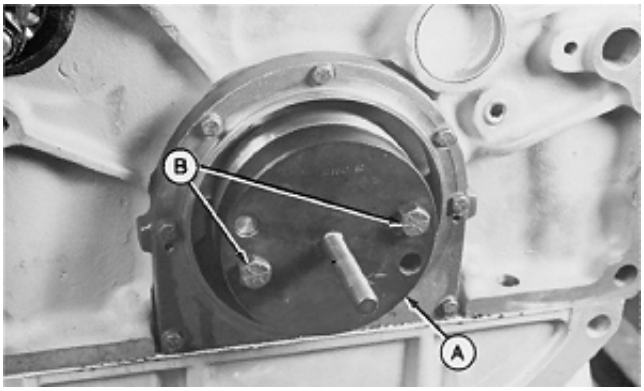
S11,2515,AL -19-03JUL95

INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE ASSEMBLY

IMPORTANT: Installation tools must be clean to assure proper positioning on crankshaft flange and to hold run-out within specification so oil seal does not fail prematurely.

1. Install JDG309 Pilot (A) over dowel pin on rear end of crankshaft.

2. Tighten two cap screws (B) securely.

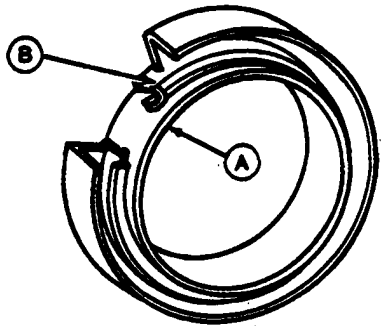


RG5576 -UN-10NOV89

S11,2515,AM -19-03JUL95

IMPORTANT: Handle seal and wear sleeve carefully. If assembly becomes separated, discard these parts and install a new assembly. See CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE HANDLING PRECAUTIONS, earlier in this group.

Chamfer on wear sleeve (A), upper illustration, and open side of seal (B, upper illustration) must be on the same side.

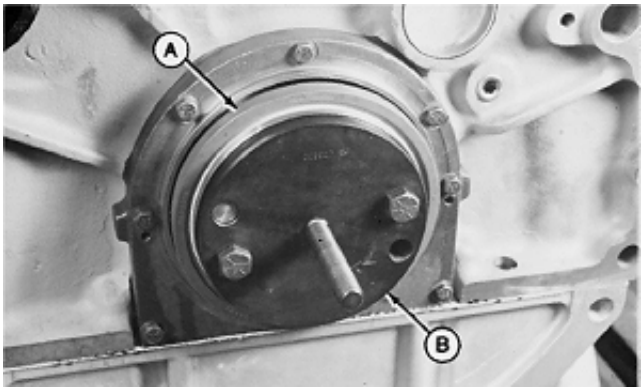


T88560 -UN-14OCT88

3. Apply a light coating of LOCTITE 609 Retaining Compound around the leading edge of crankshaft.

IMPORTANT: DO NOT allow sealant to get on any part of wear sleeve OD or oil seal.

4. Carefully install oil seal/wear sleeve assembly (A) over JDG309 Pilot (B) on crankshaft flange with black seal lip toward engine.



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S11,2515,AN -19-03JUL95

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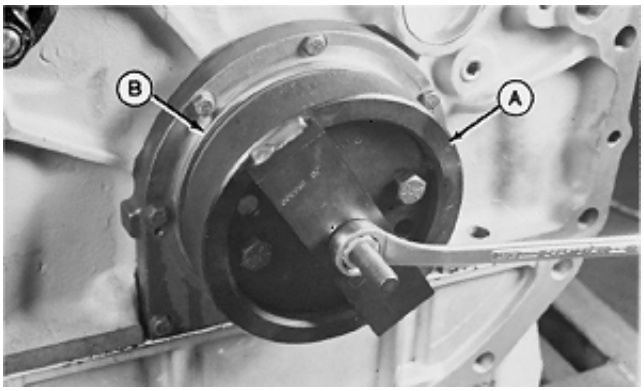
5. Position JDG310 Installer (A) so that hole in the installer cross plate goes over threaded stud of pilot and that cross plate can not bottom on cap screws of pilot. Install washer and nut on stud.

6. Tighten nut to draw JDG310 Installer in until it bottoms on oil seal housing flange (B). When the tool bottoms, seal and wear sleeve assembly will be correctly positioned.

7. Remove JDG309 and JDG310 Tools from end of crankshaft.

8. Run engine for 5—10 minutes and check for leaks, after completing final assembly.



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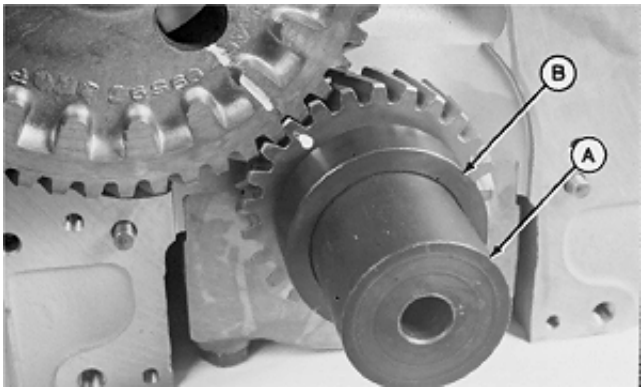
S11,2515,AO -19-20NOV95

INSTALL CRANKSHAFT FRONT WEAR SLEEVE

NOTE: Front wear sleeve can be installed with timing gear cover removed or installed on engine.

1. Coat ID of new wear sleeve with LOCTITE 609 Retaining Compound or equivalent.

2. Use the JDG467 Driver (A) and JDG468 Spacer (B), from the JDE3 Front Wear Sleeve Installer Set to properly seat wear sleeve on crankshaft flange.



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RG5529

S55,2515,Q -19-06OCT95

INSTALL TIMING GEAR COVER

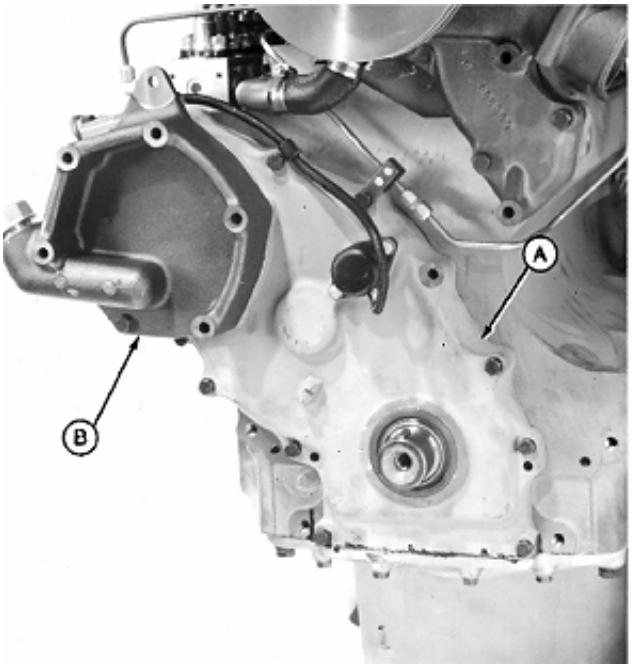
NOTE: Coat threads of lower two cap screws for injection pump gear cover with LOCTITE 242 Thread Lock and Sealer to prevent oil leakage.

1. Using a new gasket, install timing gear cover (A) and injection pump gear cover (B).

2. Tighten timing gear cover cap screws to 41 N·m (30 lb-ft). Tighten injection pump gear cover cap screws to 68 N·m (50 lb-ft).

3. Trim gasket flush with oil pan mounting face.

4. Install magnetic pickup, if equipped.



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RG6619

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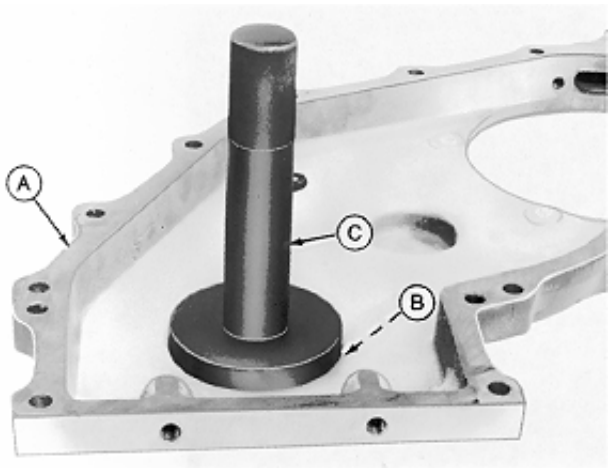
INSTALL CRANKSHAFT FRONT OIL SEAL IN TIMING GEAR COVER (WITH TIMING GEAR COVER REMOVED)



RG78139B1 -UN-09JAN90

1. Install front oil seal in timing gear cover (A) with spring side of seal facing engine.

2. Support timing gear cover around seal bore.

3. Drive seal (B) in from backside of cover using No. 27522, JTO1613 Disks, and 27488 Driver from the D01045AA Bushing, Bearing, and Seal Driver Set (C). Drive seal until JTO1613 Disk bottoms against cover.

NOTE: If installing seal from front side of cover, use No. 27522, 27536 Disks, and No. 27488 Handle. Closed side of seal should be flush to 0.25 mm (0.010 in.) from front of cover.

4. Lubricate seal ID thoroughly with engine oil before installing timing gear cover.

S11,2515,U -19-03JUL95

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46

INSTALL DAMPER PULLEY ASSEMBLY

IMPORTANT: Improper damper installation may cause damper inertia ring/crankshaft pulley contact. This contact severely hampers damper operation and can result in gear train failures.

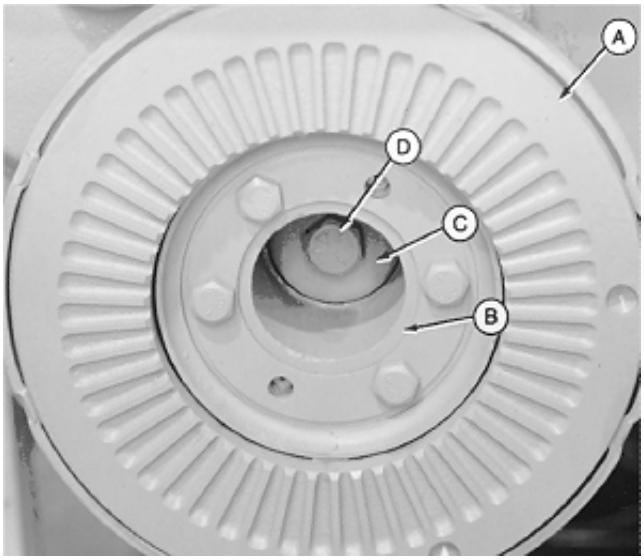
1. If vibration damper (A) was removed from damper pulley (B), refer to the following application diagrams to assure all parts are assembled in the correct sequence for your engine application. Tighten NEW cap screws to 61 N·m (45 lb-ft).

2. Make sure Woodruff key on crankshaft is in place. Position damper pulley assembly onto crankshaft.

3. Use the special washer (C) and insert a /58-11 UNC-2A x 3.00 in. cap screw that is 25.4 mm (1 in.) longer than original cap screw (D). Tighten cap screw until it just bottoms out.

4. Remove longer cap screw and insert original cap screw with special washer.

5. Tighten cap screw to 230 N·m (170 lb-ft).



RG4347 -UN-09APR90

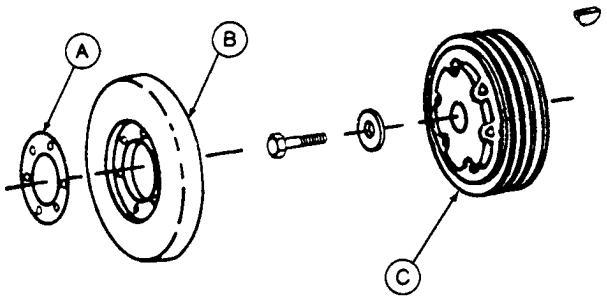
A—Vibration Damper
B—Damper Pulley
C—Washer
D—Cap Screw

S55,2515,S -19-14MAR89

Engine Application: 6101AT001

NOTE: Damper pulley (C) and vibration damper (B) may be removed and installed individually or as an assembly for this application. Fin side of vibration damper MUST face engine.

A—Washer
B—Vibration Damper
C—Damper Pulley



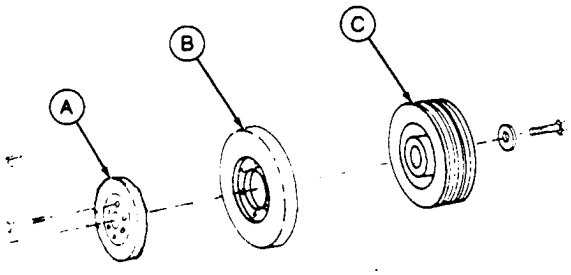
RG5567 -UN-07JUL89

S55,2515,U -19-15JUN89

Engine Application: 6101HRW01,02

NOTE: Damper pulley (C), vibration damper (B) and sheave (A) must be removed and installed as an assembly. Radius side of vibration damper MUST face engine.

A—Sheave
B—Vibration Damper
C—Damper Pulley



-UN-07JUL89
RG5568

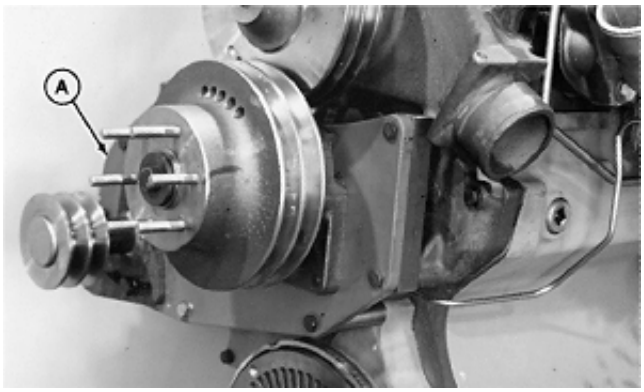
S55,2515,V -19-15JUN89

INSTALL FAN DRIVE ASSEMBLY

NOTE: Coat threads of fan drive support plate-to-injection pump gear cover cap screws with LOCTITE® 242 Thread Lock and Sealer before installing.

1. Install fan drive support plate (A) with spacer and strap at correct location and tighten cap screws to 68 N·m (50 lb-ft).

2. Install fan and fan belts. Tighten fan belts as described in Group 25 Cooling System.



-UN-10NOV89
RG5524

S55,2515,T -19-16MAR92

INSTALL FLYWHEEL HOUSING AND FLYWHEEL

1. Coat threads of NEW flywheel attaching cap screws with LOCTITE 242 Thread Lock and Sealer or its equivalent.

2. Position flywheel over dowel pin and start two cap screws (B). Do not tighten.

3. Install remaining flywheel attaching cap screws.

4. Tighten flywheel attaching cap screws to 176 N·m (130 lb-ft).

NOTE: For wet clutch applications, use a new gasket while installing flywheel housing.

5. Install flywheel housing (A) and tighten flywheel housing-to-cylinder block cap screws with lock washers to 407 N·m (300 lb-ft). Tighten flywheel housing-to-oil pan cap screws to 325 N·m (240 lb-ft).

IMPORTANT: Perform flywheel-to-flywheel housing runout checks as outlined earlier in this group.

6. Coat threads of cap screws with LOCTITE 242 and install starting motor, if removed. Tighten cap screws to 102 N·m (75 lb-ft).

RG4323 -UN-09NOV89

S11,2515,X -19-06OCT95

COMPLETE FINAL ASSEMBLY

1. Install oil pan and clean engine oil. (See Lubrication System, Group 20.)

2. Fill cooling system with proper coolant. (See Fuels, Lubricants, and Coolant, Group 02.)

3. Perform engine break-in as instructed in Group 05 or your machine technical manual.

S11,2515,AX -19-03JUL95

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

Slide Hammer D01299AA

Used with JDG405 Camshaft Bushing Service Set to remove camshaft bushings.

RG78104H1 -UN-15DEC88

S53,D01299,AA -19-15JUN89

RG5073 -UN-23AUG88

Magnetic Follower Holder Kit D15001NU

Hold cam followers when removing or installing camshaft.

S53,D15001,NU -19-24APR92

RG5080 -UN-23AUG88

Front Wear Sleeve Installer JDE3

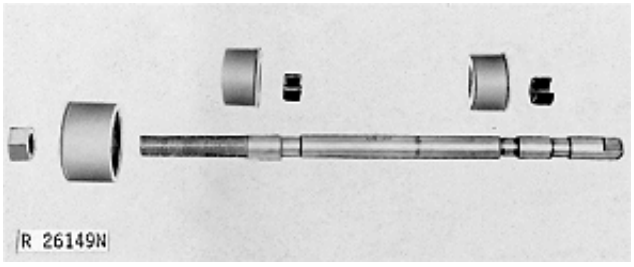
Install front oil seal in timing gear cover.

S53,JDE3 -19-09FEB87

Camshaft Bushing Replacement Set JDE6

Used to remove and install camshaft bushings.

NOTE: JDG405 Camshaft Bushing Replacement Set may also be used if JDE6 is not available.



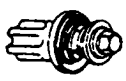
R26149N -UN-23AUG88

S53,JDE6 -19-15JUN89

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

Rotate engine flywheel. Use with JDE81-4.

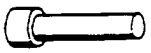


S53,JDE811 -19-06OCT95

RG5068 -UN-23AUG88

Timing Pin JDE81-4

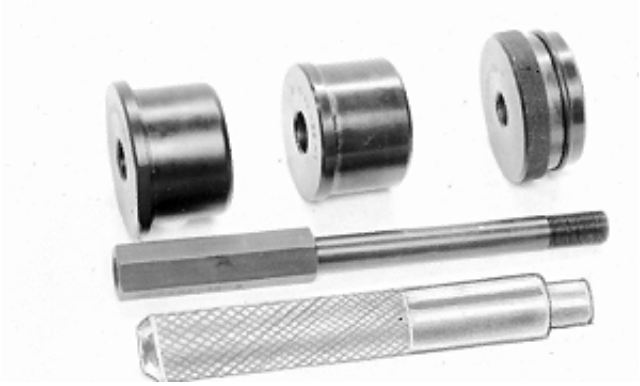
Lock engine at TDC when timing valve train. Use with JDE81-1 or JDE83.



S53,JDE814 -19-06APR90

Camshaft Bushing Service Set JDG405

Used with D01299AA Slide Hammer to remove and install camshaft bushings.



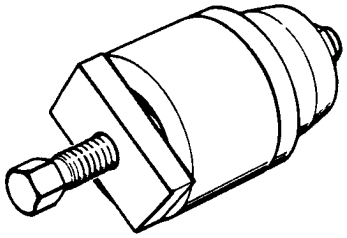
RG4228 -UN-27JAN92

S53,JDG405 -19-16MAR92

Front Seal Installer JDG720

Used to install front crankshaft oil seal with timing gear cover installed.

Set consists of:
- 1—Forcing Screw JDG720-1
- 2—Seal Protector JDG720-2
- 3—Seal Driver JDG720-3
- 4—Spacer Ring (500 Series Engines) JDG720-4

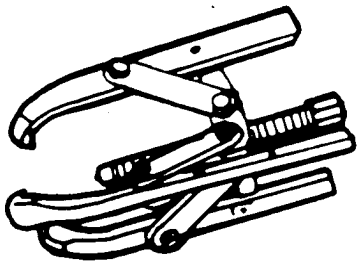


RG6215 -UN-06MAR92

RG,JDG720 -19-06OCT95

Vibration Damper and Pulley Puller Set JDG728

Used to remove multi-groove vibration damper and pulley

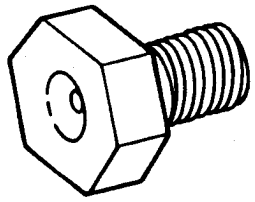


RG6218 -UN-06MAR92

RG,JDG728 -19-06OCT95

Thread Protector JDG787

Used with any puller set to remove vibration damper and pulley assembly.



RG6429 -UN-13OCT92

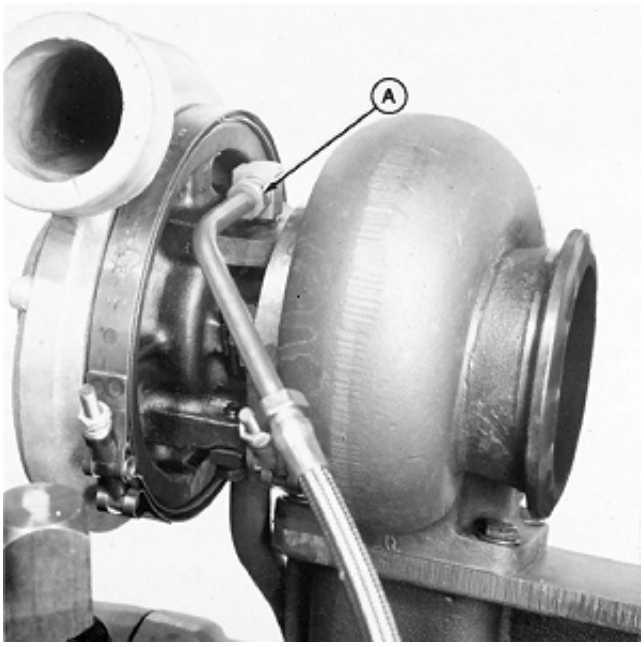
RG,JDG787 -19-06OCT95

CAMSHAFT AND TIMING GEAR TRAIN SPECIFICATIONS

Item	New Part Specification
Valve Lift at 0.00 mm (in.) Clearance:	
Intake Valve	13.20—13.62 mm (0.520—0.536 in.)
Exhaust Valve	11.83—12.25 mm (0.446—0.482 in.)
Cam Lobe Lift:	
Intake Lobe	8.0518—8.3058 mm (0.317—0.327 in.)
Exhaust Lobe	7.2136—7.4676 mm (0.284—0.294 in.)
Camshaft End Play	0.063—0.279 mm (0.0025—0.0110 in.)
Maximum Serviceable	0.38 mm (0.0150 in.)
Thrust Plate Thickness	4.724—4.800 mm (0.1860—0.1890 in.)
Maximum Serviceable	4.623 mm (0.1820 in.)
Thrust Spacer Thickness	4.915—4.965 mm (0.1935—0.1955 in.)
Cam Follower Diameter	34.874—34.900 mm (1.3730—1.3740 in.)
Cam Follower Bore Diameter in Block	34.976—35.026 mm (1.377—1.379 in.)
Camshaft Bushing Bore in Block (without bushing)	63.487—63.513 mm (2.4995—2.5005 in.)
Camshaft Bushing ID	60.389—60.439 mm (2.3775—2.3795 in.)
Maximum Runout	0.038 mm (0.0015 in.)
Camshaft Journal OD	60.312—60.338 mm (2.3745—2.3755 in.)
Camshaft Bushing-to-Journal Clearance	0.051—0.127 mm (0.0020—0.0050 in.)
Maximum Serivceable	0.152 mm (0.0060 in.)
Front Camshaft Journal-to-Thrust Plate Clearance	0.115—0.241 mm (0.0045—0.0095 in.)
Maximum Serviceable	0.342 mm (0.0135 in.)
Camshaft Gear-to-Injection Pump Drive Gear Backlash	0.05 mm (0.002 in.) Minimum
Camshaft Drive Gear-to-Crankshaft Gear Backlash	0.08 mm (0.003 in.) Minimum
Torques	
Camshaft Thrust Plate	27 N·m (20 lb-ft)
Camshaft Drive Gear-to-Camshaft	163 N·m (120 lb-ft)
Timing Gear Cover	41 N·m (30 lb-ft)
Injection Pump Gear Cover-to-Timing Gear Cover	68 N·m (50 lb-ft)
Fan Support Plate	68 N·m (50 lb-ft)

S55,2505,Y -19-17NOV95

DISCONNECT TURBOCHARGER OIL INLET LINE



RG5520 -UN-09JAN90

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

IMPORTANT: When servicing the 6101 Engine on a rollover stand, disconnect turbo oil inlet line (A) before rolling engine over. Failure to do so may cause a hydraulic lock upon starting the engine. Hydraulic lock may cause possible engine failure.

Hydraulic lock occurs when trapped oil in the oil filter head 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 oil filter housing or turbocharger.

16 5

RG,CTM61,G3,1 -19-16APR92

MEASURE VALVE LIFT

Measuring valve lift can give an indication of wear on cam lobes or cam followers.

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

1. Remove rocker arm cover.

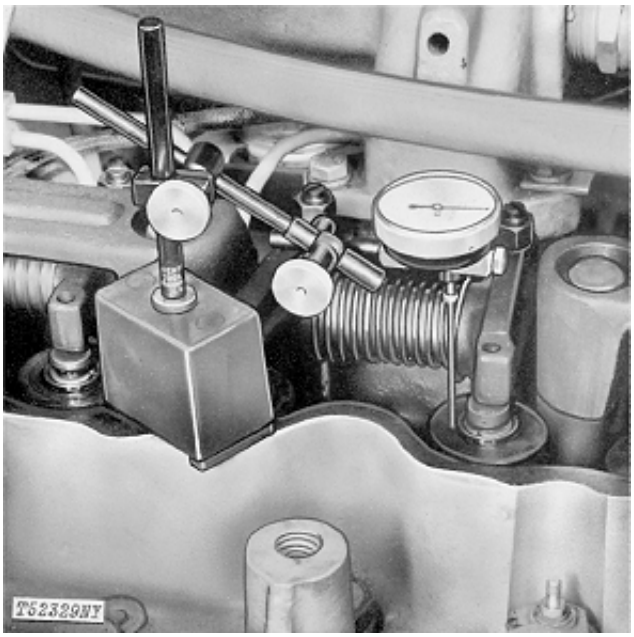
2. Remove vent tube from hole in block. Remove plastic plugs.

3. Loosen lock nut on rocker arm shaft and set valve clearance at zero (0.00) using a wrench and screwdriver. Tighten lock nut.

4. Place dial indicator tip on top of valve spring cap, as shown. Preload indicator tip and set dial at zero (0.00).

5. Manually turn engine in running direction one full revolution using the JDE81-1 Flywheel Turning Tool.

6. Observe dial indicator reading as valve is moved to full open. Record readings and compare with specifications given below.



T52329NY -UN-28JUL89

VALVE LIFT SPECIFICATIONS
[at 0.00 mm (in.) Valve Clearance]

Intake Valves	13.20—13.62 mm (0.520—0.536 in.)
Exhaust Valves	11.83—12.25 mm (0.466—0.482 in.)

7. Follow same procedure for all remaining valves and adjust valve clearance when valve lift measurements are complete. (See CHECK AND ADJUST VALVE CLEARANCE in Group 05.)

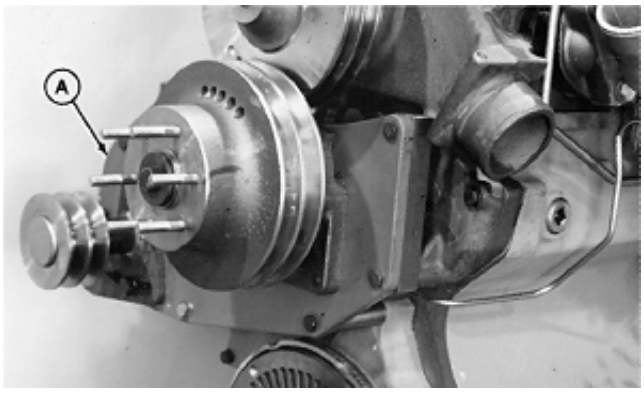
S55,2505,X -19-17NOV95

REMOVE FAN DRIVE ASSEMBLY (IF EQUIPPED)

6101HRW01 Engine Shown

1. Remove fan and fan belts (shown removed).

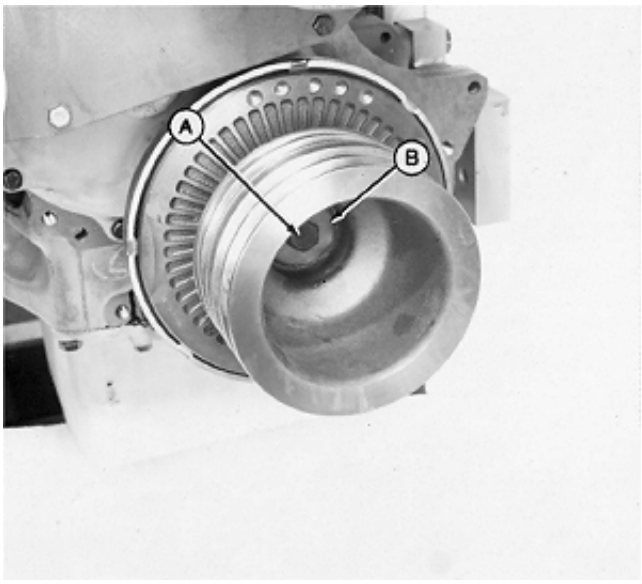
2. Remove cap screws and remove fan drive assembly (A). Note location of spacer and strap for assembly.



RG5524 -UN-10NOV89

S55,2515,E -19-15JUN89

REMOVE DAMPER/PULLEY ASSEMBLY



(6101HRW01 Engine shown.)

1. Drain engine oil (if not previously done), remove oil pan and oil pump at this time, if desired.

CAUTION: Damper/pulley assembly is very heavy. Plan a proper handling procedure to avoid injuries.

2. On 6101AT001 Engines, remove six cap screws securing damper to pulley and remove damper and pulley plate.

IMPORTANT: Be extremely careful when using a jaw-type puller to remove vibration damper. Never apply thrust on outer ring of damper or, damage could result to damper. Pull only on back side of pulley closest to the engine. DO NOT drop or hammer on damper.

3. Remove cap screw (A) and washer securing damper assembly (B) to end of crankshaft.

IMPORTANT: DO NOT immerse damper assembly in cleaning solution. Doing so may damage the rubber portion of the assembly.

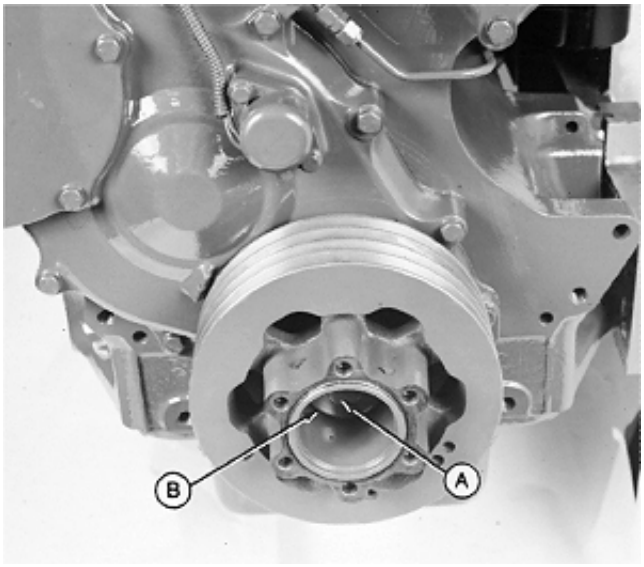
4. Install JDG787 Thread Protector into nose of crankshaft.

16
7

S55,2515,H -19-17NOV95

5. Using JDG728 Puller (A), remove pulley from crankshaft. Be sure JDG787 Thread Protector (B) is in ID of pulley to protect threads in nose of crankshaft from damage and pulling jaws are securely clamped on back side of pulley closest to engine.

IMPORTANT: Carefully and thoroughly inspect the pulley for cracks or any visible damage. Replace pulley as needed.



RG6101 -UN-27JAN92

S55,2515,H1 -19-17NOV95

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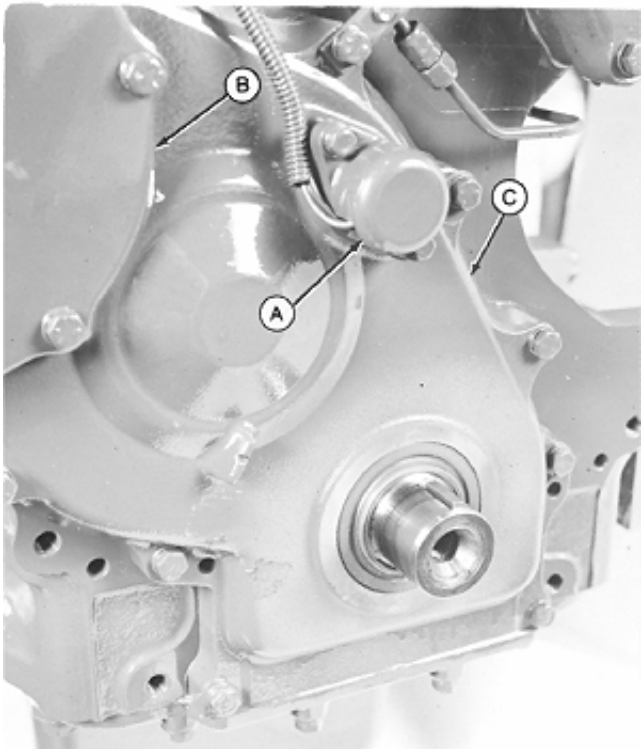
8

REMOVE TIMING GEAR COVER



RG6103 -UN-27JAN92

1. Remove vibration damper as detailed earlier. See REMOVE DAMPER/PULLEY ASSEMBLY as described earlier in this group.

2. Drain engine oil, if not previously done. Remove engine oil pan and oil pump. (See Group 20.)

3. Disconnect turbocharger oil inlet line. See DISCONNECT TURBOCHARGER OIL INLET LINE as described earlier in this group.

4. Remove idler pulley assembly, if equipped.

5. Remove magnetic pickup (A), if equipped.

6. Remove injection pump drive gear cover (B). Discard gasket.

7. Remove timing gear cover (C). Discard gasket.

IMPORTANT: Whenever timing gear cover is removed, ALWAYS install a new front oil seal and wear sleeve.

8. Thoroughly clean and inspect seal bore in cover. Check for nicks and burrs. Smooth rough areas with a medium-grit emery cloth.

9. Remove front oil seal and wear sleeve as described later in this group.

RG,CTM20,G16,14-19-17NOV95

REMOVE FRONT WEAR SLEEVE (WITH TIMING GEAR COVER REMOVED)

IMPORTANT: Whenever front oil seal is replaced, also replace wear sleeve.

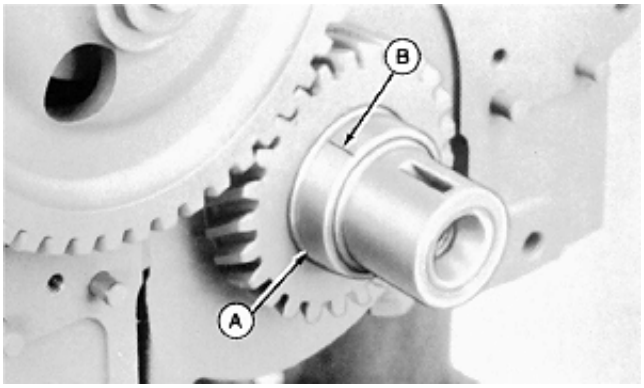
1. Remove front wear sleeve (A) from crankshaft using JDG726 or JDG786 Front Wear Sleeve Puller. (See REMOVE FRONT WEAR SLEEVE/WITH TIMING GEAR COVER INSTALLED earlier in this group.)

NOTE: Wear sleeve can also be removed with a dull chisel. DO NOT score too deeply or cut through wear sleeve with chisel.

2. Score (B) LIGHTLY around OD of wear sleeve.

3. Remove crankshaft Woodruff key and gently pry wear sleeve from crankshaft.

4. Inspect crankshaft flange for nicks or burrs. Clean up flange with a light file and emery cloth.



R24579 -UN-15DEC88

S11,0403,N -19-03JUL95

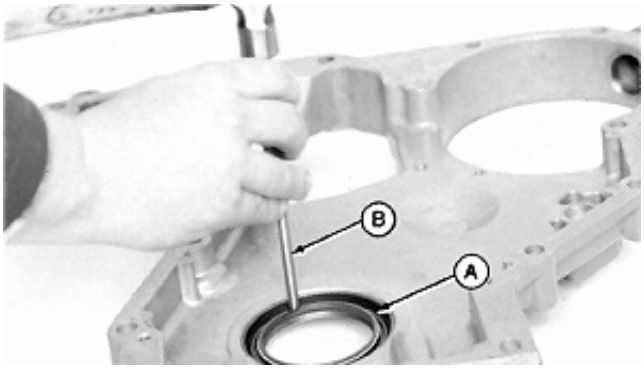
REMOVE FRONT OIL SEAL (WITH TIMING GEAR COVER REMOVED)

16
10

NOTE: Whenever front oil seal is replaced, also replace wear sleeve.

1. Use a small punch (B), to tap around metal edge of seal (A) to remove. Be careful not to damage timing gear cover.

2. Clean and inspect seal bore in cover. Check for nicks or burrs. Use medium grit emery cloth to smooth rough edges.



RG3835 -UN-14DEC88

S11,0403,P -19-06OCT95

CHECK CAMSHAFT END PLAY

1. Place dial indicator on camshaft.

2. Move camshaft gear forward and backwards while reading dial indicator.

CAMSHAFT END PLAY SPECIFICATION

New Parts End Play	0.063—0.279 mm (0.0025—0.0110 in.)
Allowable End Play	0.380 mm (0.0150 in.)

NOTE: If end play exceeds specifications, check thrust washer thickness during disassembly.

RG78139M1 -UN-09JAN90

S11,2505,AQ -19-03JUL95

MEASURE CAMSHAFT DRIVE GEAR-TO-CRANKSHAFT GEAR MINIMUM BACKLASH

Measure backlash between camshaft drive gear and crankshaft using a magnetic base dial indicator.

CAMSHAFT DRIVE GEAR-TO-CRANKSHAFT GEAR BACKLASH SPECIFICATION

New Part Backlash Specification	0.076 mm (0.003 in.) Minimum

Replace gears if backlash is not within specification.

S55,2016,E -19-11APR91

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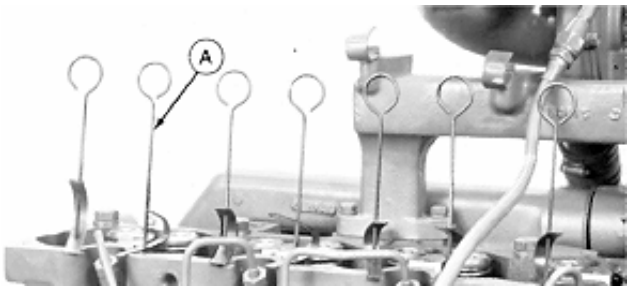
11

REMOVE CAMSHAFT



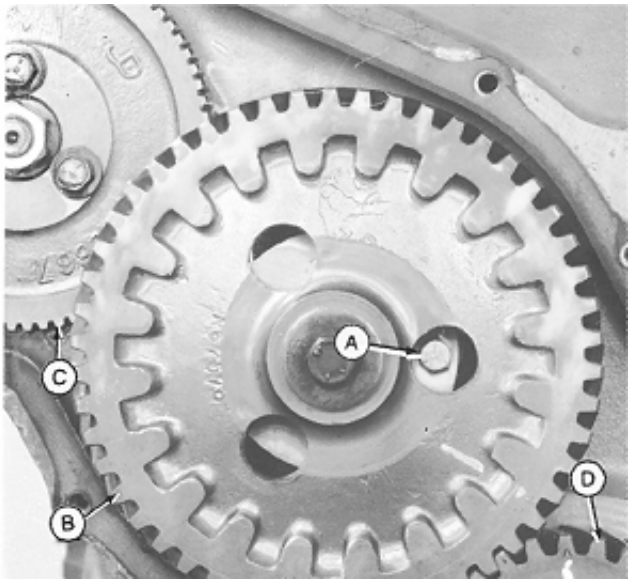
NOTE: It is not necessary to remove cylinder head from engine to remove camshaft. If camshaft lobes show excessive wear, then cylinder head should be removed so block, head, cam lobes, cam followers, and push rods can be inspected.

1. Remove turbocharger heat shield (if equipped) and rocker arm cover, if not previously done.

2. Remove rocker arm assembly, push rods, and wear caps. (See Group 05.)

3. Revolve engine to an angle where cam followers fall away from camshaft lobes and hold camshaft followers with D15001NU Magnetic Follower Holder Kit (A).

RG,CTM61,G16,20-19-05MAY93



4. Use the JDE81-1 and JDE81-4 Engine Rotation Tools and rotate flywheel to align thrust plate cap screws (A) with camshaft gear. Remove all four cap screws.

NOTE: Do not remove nut securing gear to camshaft unless gear is being replaced.

5. Examine camshaft gear (B), injection pump drive gear (C), and crankshaft gear (D) for unusual wear, chips or cracks.

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12

IMPORTANT: Set No. 1 Piston at TDC on compression stroke, using the JDE81-1 and JDE81-4 Engine Rotation Tools. This will align timing marks on crankshaft and camshaft gears and aid in correct timing during assembly.

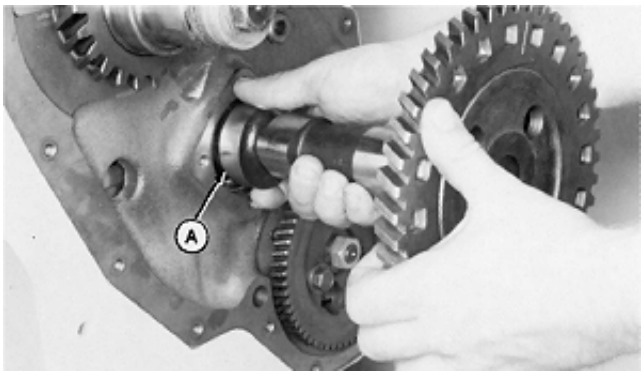
A—Thrust Plate Cap Screws (4 used)
B—Camshaft Gear
C—Injection Pump Drive Gear
D—Crankshaft Gear

S11,2505,AR,1 -19-13NOV95

NOTE: Rotate camshaft carefully to aid in removing.

6. Carefully remove camshaft (A) from cylinder block so that camshaft lobes do not drag in bores.

NOTE: If camshaft followers are to be removed, the cylinder head MUST BE removed. See REMOVE CYLINDER HEAD in Group 05.



RG3818 -UN-23FEB89

RG,CTM61,G16,21-19-01APR93

REMOVE CAMSHAFT GEAR, SPACER, AND THRUST PLATE

NOTE: Camshaft gears are installed onto the camshaft using a press.

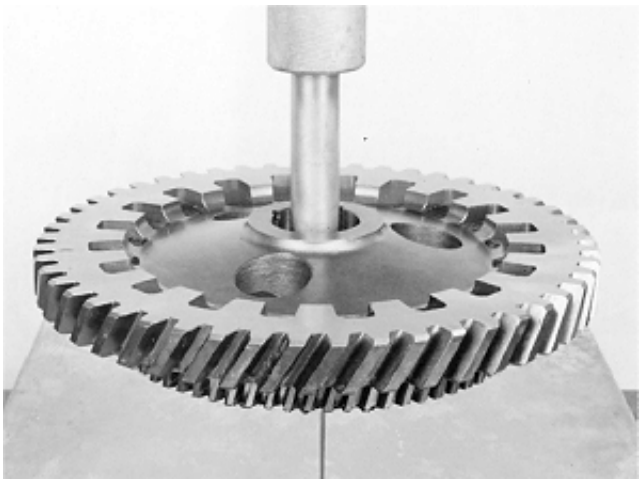
1. Remove cap screw with special washer and support camshaft gear in a press.

IMPORTANT: Prevent camshaft from striking floor when pressing camshaft from gear.

2. Press camshaft out of gear.

3. Remove spacer and thrust plate from camshaft.

4. Clean camshaft, thrust plate, and thrust spacer in solvent. Dry with compressed air.



RG78153H1 -UN-09JAN90

16
13

S11,2505,AS -19-03JUL95

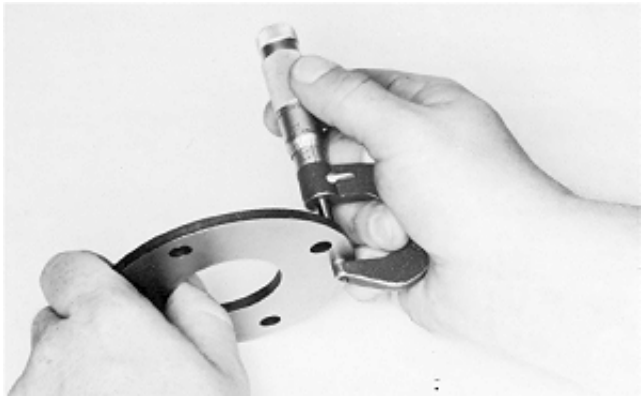
MEASURE THRUST PLATE AND SPACER

1. After removal of camshaft gear, measure thrust plate and spacer for proper thickness.

THRUST PLATE AND SPACER SPECIFICATIONS

Thrust Plate Thickness	4.724—4.800 mm (0.1860—0.1890 in.)
Allowable Wear Thickness	4.623 mm (0.1820 in.)
Thrust Spacer Thickness	4.915—4.965 mm (0.1935—0.1955 in.)

Replace parts as required.



RG2743 -UN-17JUL89

S55,2505,Z -19-24APR92

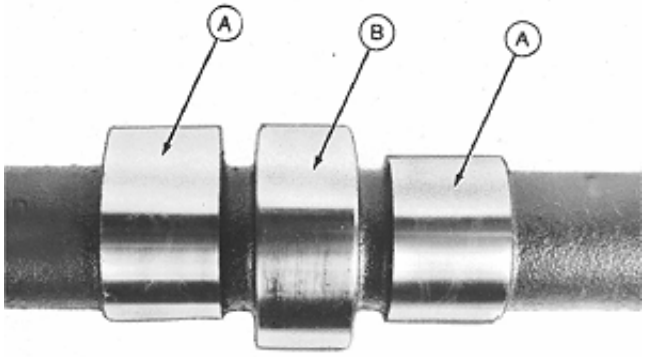
INSPECT CAMSHAFT

1. Inspect camshaft lobes (A) and journals (B) for wear or damage. Replace camshaft as necessary.

IMPORTANT: Very light score marks may be found, but are acceptable if valve lift is within specification. Pitting or galling dictates replacement. (See MEASURE VALVE LIFT, earlier in this group.)

It is not always necessary to replace cam followers when camshaft is replaced. (See REMOVE, INSPECT, AND MEASURE CAMSHAFT FOLLOWERS, later in this group.)

2. If camshaft lobes show excessive pitting or galling, remove cylinder head. Remove and thoroughly inspect camshaft followers.



RG3500 -UN-06AUG91

S11,2505,CY1,1 -19-17NOV95

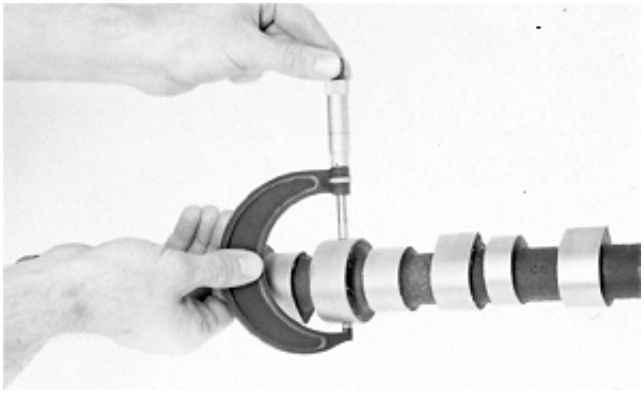
MEASURE CAMSHAFT JOURNAL O.D. AND BUSHING I.D.

1. Measure each camshaft journal OD. If not within specification, install a new camshaft.

2. Measure each camshaft bushing ID when installed in cylinder block. Replace bushings if not within specifications. (See REPLACE CAMSHAFT BUSHINGS in this group.)

CAMSHAFT JOURNAL AND BUSHING SPECIFICATIONS

Journal OD	60.312—60.338 mm (2.3745—2.3755 in.)
Bushing ID	60.389—60.439 mm (2.3775—2.3795 in.)
Bushing-to-Journal Clearance	0.051—0.127 mm (0.0020—0.0050 in.)



T81260 -UN-07NOV88

S11,2505,DG,1 -19-17NOV95

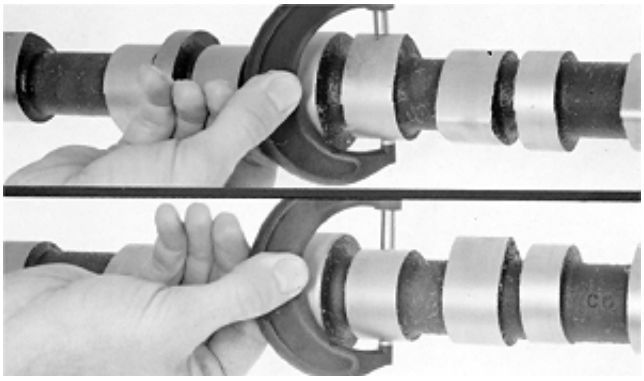
MEASURE CAMSHAFT LOBE LIFT

1. Measure each camshaft lobe at its highest point and at its narrowest point. Subtract narrowest height from highest to find cam lobe lift.

If camshaft lobe lift is not within specification on any lobe, install a new camshaft.

CAM LOBE LIFT NEW PART SPECIFICATION

Intake Lobe	8.0518—8.3758 mm (0.317—0.327 in.)
Exhaust Lobe	7.2136—7.4676 mm (0.284—0.294 in.)



T81262 -UN-01NOV88

S11,2505,DH,1 -19-17NOV95

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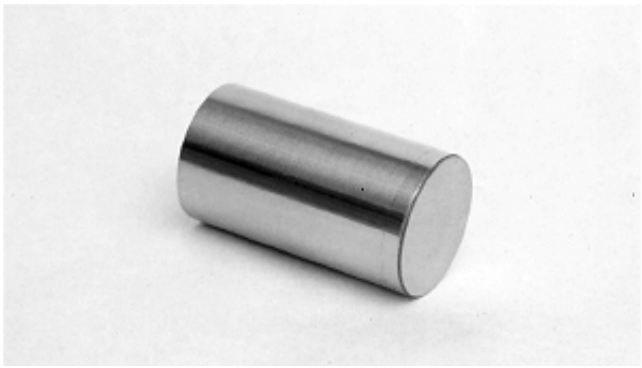
REMOVE, INSPECT, AND MEASURE CAMSHAFT FOLLOWERS


RG3041 -UN-17JUL89

IMPORTANT: It is not always necessary to replace camshaft followers when a camshaft is replaced.

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

2. Remove camshaft followers from bores in block.

3. Inspect camshaft followers for uneven wear or damage. Also inspect corresponding camshaft lobe for wear or damage.

4. Measure camshaft follower and bore in block. Compare measurements with specifications given. Replace camshaft followers or cylinder block as necessary.

CAMSHAFT FOLLOWER AND BORE SPECIFICATIONS

Camshaft Follower OD	34.874—34.900 mm (1.3730—1.3740 in.)
Camshaft Follower Bore in Block	34.976—35.026 mm (1.3770—1.3790 in.)

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S11,2505,AV -19-03JUL95

ASSEMBLE CAMSHAFT

1. Support camshaft under first journal in a hydraulic press.

2. Apply TY6333 or TY6347 High Temperature Grease to both sides of thrust plate around center hole.

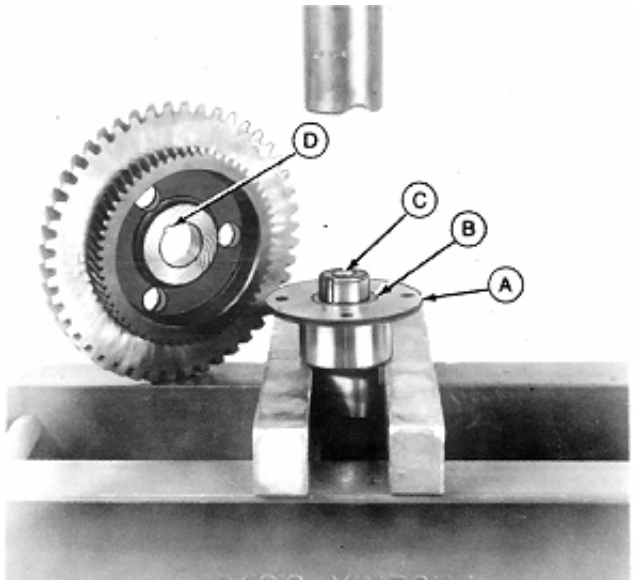
3. Install thrust plate (A) and spacer (B).

4. Install Woodruff key (C).

5. Apply TY6333 or TY6347 High Temperature Grease to center hole and teeth of gear.

6. Align Woodruff key and keyway (D) and place gear on camshaft with timing mark facing away from camshaft.

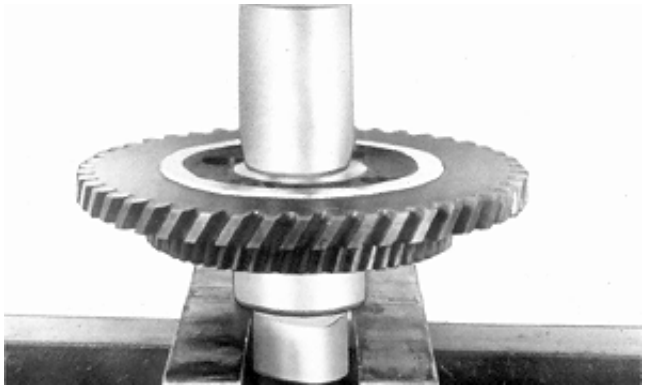
A—Thrust Plate
B—Spacer
C—Woodruff Key
D—Keyway



-UN-17JUL89
RG3042

S11,2505,AW -19-03JUL95

7. Press gear on until tight against spacer.



-UN-23FEB89
RG3501

S11,0401,BO -19-03JUL95

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SERVICE CAMSHAFT BUSHINGS USING JDE6 CAMSHAFT BUSHING REPLACEMENT SET

1. Inspect mating surfaces of camshaft journals and bushings for wear or damage. Measure cam journals and bushings to determine if proper oil clearance exists. Replace camshaft and/or bushings as necessary.

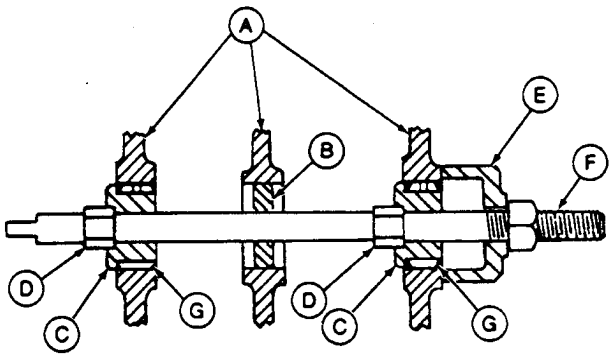
CAMSHAFT JOURNAL AND BUSHING NEW PART SPECIFICATIONS

Camshaft Bushing Bore in Block	63.487—63513 mm (2.4995—2.5005 in.)
Camshaft Journal OD	60.312—60.338 mm (2.3745—2.3755 in.)
Camshaft Bushing ID	60.389—60.439 mm (2.3775—2.3795 in.)
Oil Clearance	0.051—0.127 mm (0.002—0.005 in.)
Max. Serviceable Oil Clearance	0.152 mm (0.006 in.)

NOTE: The front two bushings can be reached from the front of the engine. The flywheel must be removed to reach the other two bushings.

2. Remove camshaft bushings (G) using components from the JDE6 Camshaft Bushings Service Set as shown.

3. Tighten nut on end of bushings screw (F) until bushings are free from bore. Inspect and measure camshaft bushing bore in block. Follow same procedure for remaining bushings to be replaced.



RG5270 -UN-04JUL89

A—Cylinder Block Web
B—Camshaft Bushing Washer (JDE6-5)
C—Camshaft Bushing Collar (JDE6-4)
D—Collar Lock (25916)
E—Camshaft Bushing Cup (JDE6-3)
F—Camshaft Bushing Screw (JDE6-1)
G—Camshaft Bushing

S55,2505,AA -19-15JUN89

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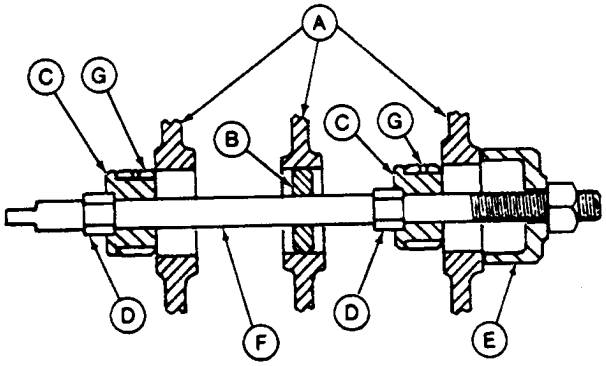
IMPORTANT: Be sure that oil holes in bushings and cylinder block align during bushing installation. Position the elongated hole in bushing toward top. After installation, use a small mirror with extension handle and a good light source to check bushing-to-block oil holes for proper alignment.

4. Position new camshaft bushings (G) on bushing collars (C). Assemble remaining components of JDE6 Camshaft Bushing Replacement Set as shown.

5. Be sure bushings are started square in bore and oil holes align with holes in block. Tighten nut to draw bushings in until properly positioned in bore.

6. Check bushing-to-cylinder block oil hole alignment using a small mirror with extension handle.

7. Apply sealant to new camshaft bore plug and install plug in bore. Plug edge must be seated below edge of bore.



RG5271 -UN-04JUL89

A—Cylinder Block Web
B—Camshaft Bushing Washer (JDE6-5)
C—Camshaft Bushing Collar (JDE6-4)
D—Collar Lock (25916)
E—Camshaft Bushing Cup (JDE6-3)
F—Camshaft Bushing Screw (JDE6-1)
G—Camshaft Bushing

S55,2505,AB -19-16MAR92

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SERVICE CAMSHAFT BUSHINGS USING JDG405 CAMSHAFT BUSHING SERVICE SET

1. Inspect mating surfaces of camshaft journals and bushings for wear or damage. Measure cam journals and bushings to determine if proper oil clearance exists. Replace camshaft and/or bushings as necessary.

CAMSHAFT JOURNAL AND BUSHING NEW PART SPECIFICATIONS

Camshaft Bushing Bore in Block	63.487—63.513 mm (2.4995—2.5005 in.)
Camshaft Journal OD	60.312—60.338 mm (2.3745—2.3755 in.)
Camshaft Bushing ID	60.389—60.439 mm (2.3775—2.3795 in.)
Oil Clearance	0.051—0.127 mm (0.002—0.005 in.)
Max. Serviceable Oil Clearance	0.152 mm (0.006 in.)

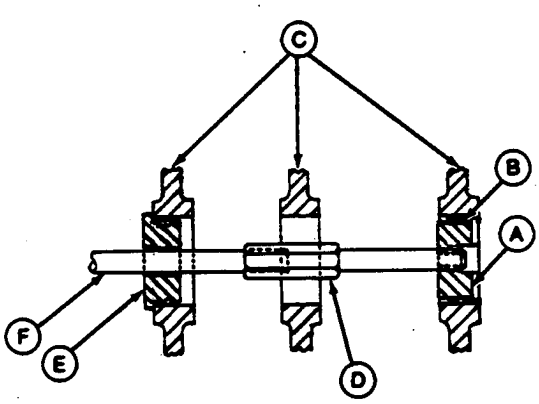
NOTE: The front two bushings can be reached from the front of the engine. The flywheel must be removed to reach the other two bushings.

Lubricate O-ring on JDG409 Guide (E) with clean engine oil before installing in cylinder block web bore.

2. Remove camshaft bushing (B) using components from the JDG405 Camshaft Bushings Service Set along with D01299AA Slide Hammer (F) as shown.

NOTE: End bushings at front and rear of cylinder block may be removed with just JDG406 Bushing Removal Pilot (A) and D01299AA Slide Hammer.

3. Inspect and measure each camshaft bushing bore in block as bushings are removed.



RG5332 -UN-06DEC88

A—Bushing Removal Pilot (JDG406)
B—Camshaft Bushing
C—Cylinder Block Web
D—Slide Hammer Adapter (JDG408)
E—Guide (JDG409)
F—Slide Hammer (D01299AA)

S55,2505,AC -19-19JUL89

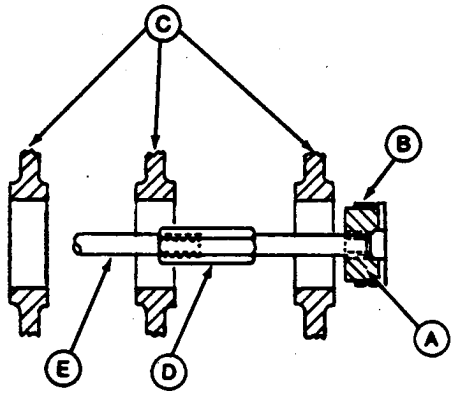
4. Position a new camshaft bushing (B) onto JDG407 Bushing Installation Pilot (A). Install JDG409 Guide (not shown) in cylinder block web. Assemble D01299AA Slide Hammer (E) and JDG409 Slide Hammer Adapter (D) on bushing pilot as shown.

IMPORTANT: Be sure that oil holes in bushings and cylinder block align during bushing installation. Position the elongated hole in bushing toward top. After installation, use a small mirror with extension handle and a good light source to check bushing-to-block oil holes for proper alignment.

5. Be sure bushing is started square in bore and oil holes align with holes in block. Pull bushing in with slide hammer until proper positioned.

6. Check bushing-to-cylinder block oil hole alignment using a small mirror with extension handle.

7. Apply sealant to new camshaft bore plug and install plug in bore. Plug edge must be seated below edge of bore.



RG5333 -UN-06DEC88

A—Bushing Installation Pilot (JDG407)
B—Camshaft Bushing
C—Cylinder Block Web
D—Slide Hammer Adapter (JDG408)
E—Slide Hammer (D01299AA)

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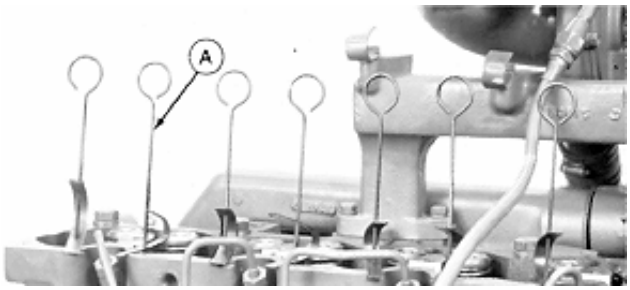
S55,2505,AD -19-16MAR92

INSTALL CAMSHAFT

IMPORTANT: Set engine at TDC of No. 1 piston's compression stroke before installing camshaft so timing marks on camshaft and crankshaft gears will be aligned.



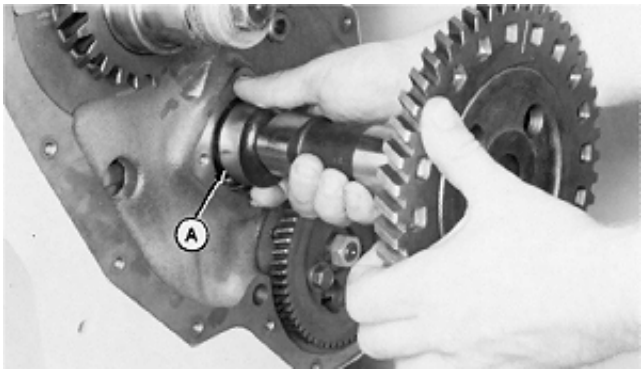
1. If camshaft followers were removed with engine on a rollover stand, reinstall followers but do not obstruct camshaft bore. Roll engine to an angle where followers fall away from camshaft bores.

NOTE: If D15001NU Magnetic Follower Holder Kit (A) is used, hold camshaft followers away from camshaft bore until camshaft is installed.

2. Lubricate camshaft lobes with TY6333 or TY6347 High Temperature Grease and lubricate bearings, bushings and gear with clean engine oil.

S11,0401,BP,1 -19-14NOV95

3. Carefully install camshaft (A) in cylinder block so that camshaft lobes do not drag in bores. Rotate camshaft during installation to avoid obstruction in any bore.



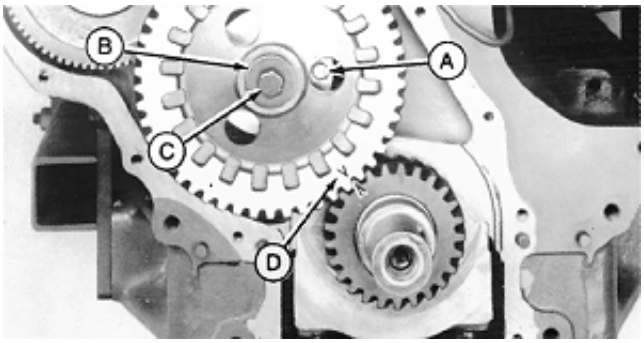
S55,2016,R -19-11APR91

4. With No. 1 piston on “TDC” compression stroke, align timing marks (D) on camshaft and crankshaft gears.

5. Turn camshaft gear to align thrust plate holes with threads in cylinder block.

6. Tighten thrust plate-to-cylinder block cap screws (A) to 27 N·m (20 lb-ft).

7. Install special washer (B) and cap screw (C). Tighten cap scerw to 163 N·m (120 lb-ft).



RG4322 -UN-09NOV89

A—Cap Screws (4 used)
B—Special Washer
C—Cap Screw
D—Timing Marks

S55,2505,AE -19-13NOV95

8. Check camshaft for 0.063—0.279 mm (0.0025—0.011 in.) end play. (See CHECK CAMSHAFT ENDPLAY earlier in this group.) Replace thrust plate and/or thrust washer if end play is not within specification.

9. Check injection pump timing and reset as required. (See CHECK AND ADJUST INJECTION PUMP TIMING in Group 35.)

RG78139M1 -UN-09JAN90

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S11,2505,AY,1 -19-17NOV95

INSTALL TIMING GEAR COVER

1. Install timing gear cover using new gasket and tighten cap screws to 41 N·m (30 lb-ft).

2. Install injection pump drive gear cover using new gasket and tighten cap screws to 68 N·m (50 lb-ft).

3. Check crankshaft front oil seal bore runout. Maximum allowable runout is 0.254 mm (0.010 in.).

4. Install magnetic pickup in timing gear cover, if equipped.

5. Trim timing gear cover gasket flush with oil pan mounting surface. Install oil pan as outlined in Group 20. Fill engine with clean engine oil.

S55,2505,AF -19-17NOV95

INSTALL CRANKSHAFT FRONT WEAR SLEEVE (WITH TIMING GEAR COVER INSTALLED ON ENGINE)

NOTE: Wear sleeve may be installed with timing gear cover removed or installed.

1. Coat ID of new wear sleeve with LOCTITE 609 Retaining Compound.

2. Using JDG467 Driver from JDE3 Installer along with washer and cap screw that secures damper pulley assembly to crankshaft, install wear sleeve.

3. Remove installation tools and clean any sealant from OD of wear sleeve or ID of seal bore.

RG6110 -UN-27JAN92

RG,CTM61,G15,12-19-02APR93

INSTALL CRANKSHAFT FRONT OIL SEAL

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

1. Place JDG720-2 Seal Protector (A) on nose of crankshaft. Lubricate ID of front oil seal (B) lips with clean engine oil and slide seal onto seal protector. Be careful not to roll oil seal lips.

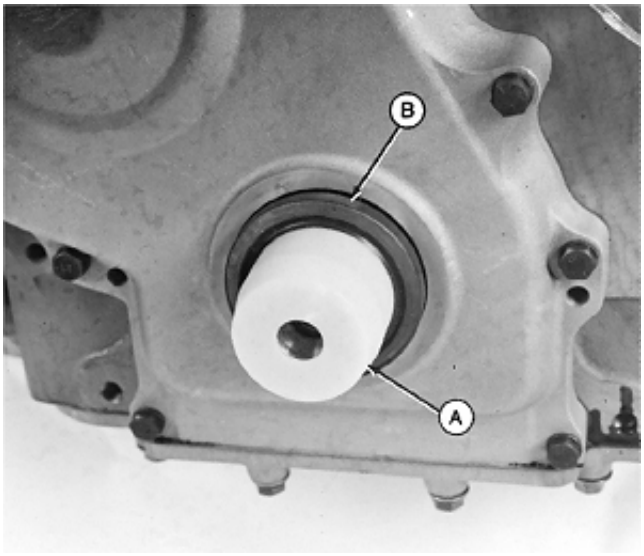
2. Position JDG720-4 Spacer Ring on end of JDG720-3 Seal Installer and place installer onto seal protector against seal.

3. With nut installed onto JDG720-1 Forcing Screw, thread forcing screw into nose of crankshaft until it bottoms.

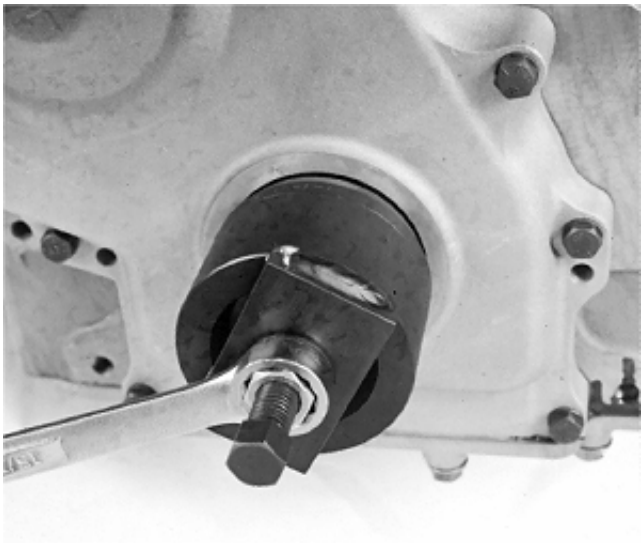
4. Tighten nut against crossplate of installer until installer bottoms on front face of timing gear cover.

5. Remove installation tools.

IMPORTANT: Verify seal is installed squarely in bore, flush with front face of timing gear cover, and that seal lips are not rolled on wear sleeve.



RG6111 -UN-27JAN92



RG6112 -UN-27JAN92

RG,CTM61,G15,13-19-06OCT95

COMPLETE FINAL ASSEMBLY

1. Install damper pulley and vibration damper. (See Group 15.)

2. Install camshaft followers and cylinder head, if removed. (See Group 05.)

3. Install push rods, wear caps, and rocker arm shaft assembly. (See Group 05.)

4. Measure valve lift and compare readings with specifications. (See MEASURE VALVE LIFT earlier in this group.)

5. Adjust engine valve clearance and install rocker arm cover. (See Group 05.)

6. Perform engine break-in as required. (See Group 05.)

RG,CTM20,G16,13-19-17NOV95

OTHER MATERIAL

Name	Use
PERMATEX® AVIATION (Form-A-Gasket No. 3)	To seal gasket surfaces.
LOCTITE® 242 (TY9370/T43512) Thread Lock and Sealer	To coat oil filter manifold mounting plate cap screws and oil pan drain plug.
TY6343 or TY6347 High Temperature Grease	To lubricate oil pump components.

RG,CTM20,G20,1 -19-17NOV95

LUBRICATION SYSTEM SPECIFICATIONS

Item	New Part Specification
Engine Oil Pressure @ Rated Speed	280—380 kPa (2.8—3.80 bar) (40—55 psi)
Oil Filter Bypass Valve Operating Pressure	210 kPa (2.10 bar) (30 psi)
Oil Filter Bypass Valve Spring:	
Compressed	35 mm @ 80—98 N (1.38 in. @ 18—22 lb-force)
Free Length	51.5 mm (2.03 in.)
Oil Cooler Bypass Valve Spring:	
Compressed	35 mm @ 80—98 N (1.38 in. @ 18—22 lb-force)
Free Length	74.2 mm (2.92 in.)
Oil Pressure Regulating Valve Spring:	
Compressed	48.5 mm @ 83—98 N (1.91 in. @ 19—22 lb-force)
Free Length	74.2 mm (2.92 in.)
Oil Pressure Relief Valve Spring:	
Compressed	65 mm @ 180—220 N (2.56 in. @ 40.5—49.5 lb-force)
Free Length	79 mm (3.11 in.)
Oil Pump:	
Driveshaft End Play (Max.)	0.15 mm (0.006 in.)
Driveshaft Side Movement (Max.)	0.17 mm (0.0065 in.)
Pump Gear Backlash	0.33—2.00 mm (0.013—0.079 in.)
Crankshaft Gear-To-Oil Pump Drive Gear Backlash (Min.)	0.08 mm (0.003 in.)

S55,2520,A -19-15JUN89

LUBRICATION SYSTEM SPECIFICATIONS—CONTINUED

Torques

Bypass Valve Housing-to-Cylinder Block	41 N·m (30 lb-ft)
Pressure Regulating Housing-to-Cylinder Block	47 N·m (35 lb-ft)
Oil Cooler-to-Bypass Valve Housing	47 N·m (35 lb-ft)
Pressure Relief Valve Housing-to-Cylinder Block	41 N·m (30 lb-ft)
Oil Pump:	
Drive Gear-to-Pump Drive Shaft Nut	54 N·m (40 lb-ft)
Pump Cover-to-Housing	41 N·m (30 lb-ft)
Pump-to-Cylinder Block	47 N·m (35 lb-ft)
Outlet Elbow-to-Cylinder Block	47 N·m (35 lb-ft)
Intake Elbow-to-Pump Cover	41 N·m (30 lb-ft)
Pickup Screen-to-Intake Elbow	24 N·m (18 lb-ft)
Set Screw Lock Nut	8 N·m (6 lb-ft)
Oil Pan:*	
3/8 in. cap screws	68 N·m (50 lb-ft)
1/2 in. cap screws	156 N·m (115 lb-ft)
Oil Pan-to-Flywheel Housing	325 N·m (240 lb-ft)
Oil Cooler End Caps	41 N·m (30 lb-ft)
Oil Filter Manifold Mounting Cap Screws	41 N·m (30 lb-ft)
Oil Pan Drain Plug	102 N·m (75 lb-ft)

**Initially tighten all cap screws to 54 N·m (40 lb-ft), starting at right rear corner of oil pan (facing toward flywheel end) and proceed counterclockwise. Finish tightening cap screws to torques specified above, using the same sequence and tighten all 3/8 in. cap screws first.*

S55,2520,A1 -19-17NOV95

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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.
  Defective injection pump (Failed internal O-ring seals)

- **Low Oil Pressure at Slow Idle:**

  Bypass oil check valve failure.

S11,0404,A -19-08AUG94

DISCONNECT TURBOCHARGER OIL INLET LINE

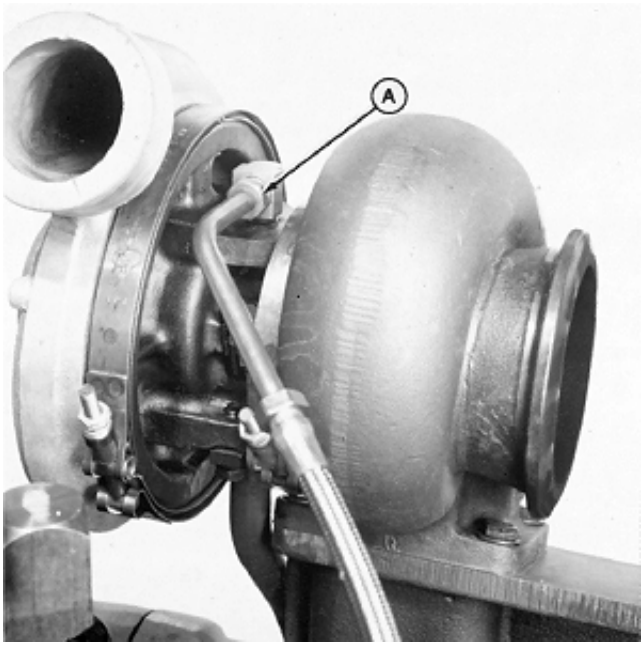
1. Drain all engine oil and coolant, if not previously done.

IMPORTANT: When servicing the 6101 Engine on a rollover stand, disconnect turbo oil inlet line (A) before rolling engine over. Failure to do so may cause a hydraulic lock upon starting the engine. Hydraulic lock may cause possible engine failure.

Hydraulic lock occurs when trapped oil in the oil filter head 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 oil filter housing or turbocharger.



RG5520 -UN-09JAN90

RG,CTM61,G3,1 -19-16APR92

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4

DRAIN ENGINE OIL, COOLANT, AND REMOVE OIL PAN

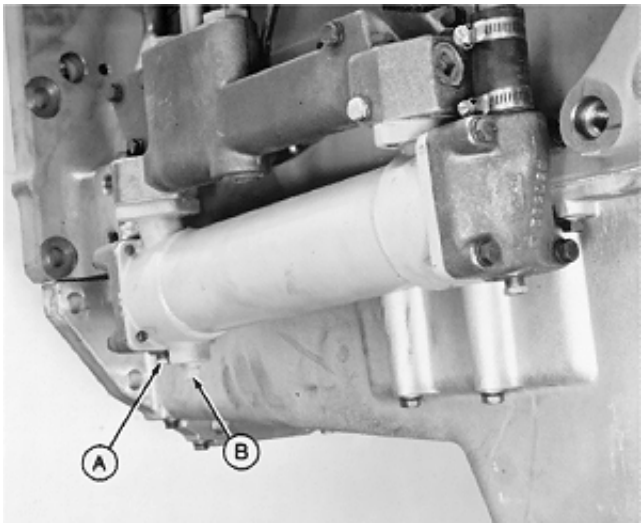
1. Disconnect turbocharger oil inlet line as described previously.

2. Remove drain plug from bottom of oil pan and drain engine oil.

3. Remove oil drain plug (B) from rear of oil cooler and drain all oil from cooler.

4. Remove coolant drain plug (A) from rear end cap of engine oil cooler and drain coolant. Drain all remaining coolant from engine block.

5. Remove engine oil pan and discard all gasket material.

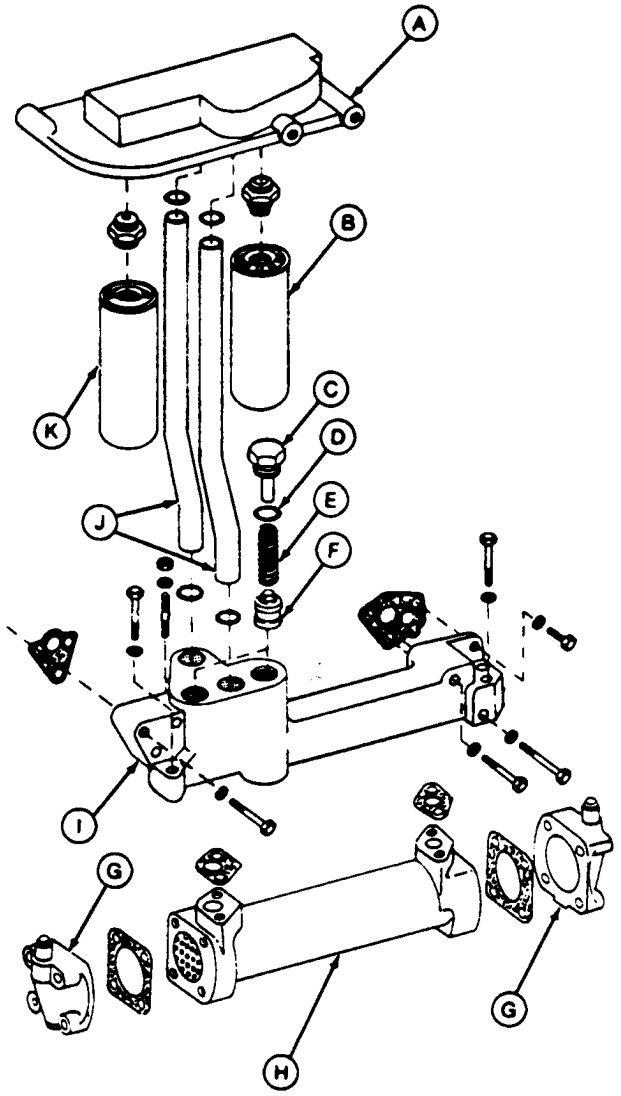


RG5531 -UN-10NOV89

S55,2520,B,1 -19-17NOV95

ENGINE OIL BYPASS VALVE HOUSING, OIL COOLER AND OIL FILTRATION SYSTEM

A—Oil Filter Manifold
B—Fuel-Flow Oil Filter
C—O-Ring Plug (2 used)
D—O-Ring (2 used)
E—Spring (2 used)
F—Bypass Valve (2 used)
G—Oil Cooler End Caps (2 used)
H—Oil Cooler
I—Bypass Valve Housing
J—Oil Tubes (2 used)
K—Bypass Oil Filter



RG5514 -UN-04JUL89

S55,2520,Q -19-15JUN89

REMOVE OIL BYPASS VALVE HOUSING AND OIL COOLER ASSEMBLY

Be sure all coolant and oil is drained from oil cooler/oil bypass valve housing assembly before removing from engine.

1. Remove bypass filter (A) and full flow filter (B) or combination bypass/full flow filter.

NOTE: Oil filter manifold (G) may be removed for easier removal and installation of bypass valve housing and oil cooler assembly.

2. Disconnect fuel lines at fuel filter base. Disconnect turbocharger oil line.

3. Disconnect lube line and remove hollow screw from oil filter manifold mounting plate (H). Remove allen head countersunk cap screw and remove plate with oil filter manifold attached.

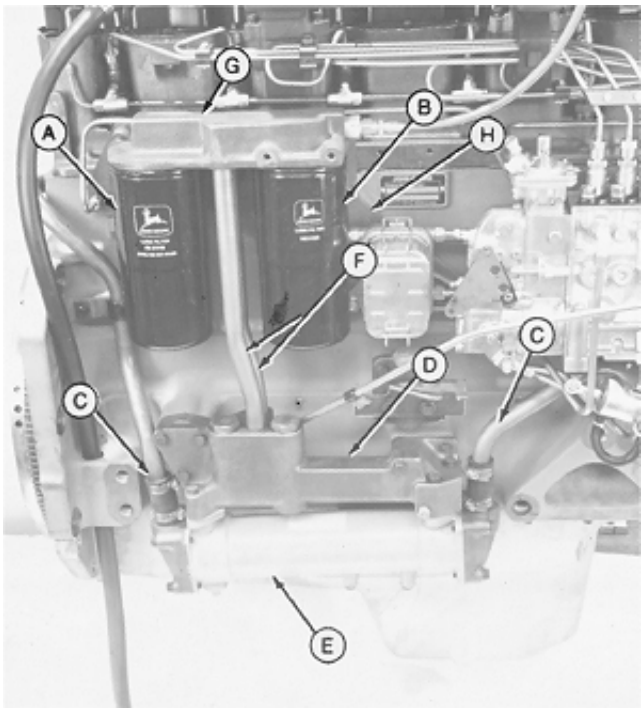
4. Remove oil tubes (F) and discard O-rings.

5. Loosen lower hose clamp on both oil cooler coolant tubes (C) and remove hoses from oil cooler end caps.

CAUTION: Oil bypass valve housing (D) and oil cooler (E) are heavy. Plan a proper handling procedure to avoid injuries.

NOTE: As mounting cap screws are removed, install guide studs in three or four locations to aid removal of assembly.

6. Remove six oil bypass valve housing cap screws and dislodge oil tubes as assembly is removed from engine.



-UN-09JAN90
RG5533

A—Bypass Filter
B—Full Flow Filter
C—Coolant Tubes
D—Bypass Valve Housing
E—Oil Cooler
F—Oil Tubes
G—Oil Filter Manifold
H—Oil Filter Manifold Mounting Plate

S55,2520,C -19-01APR93

REMOVE AND INSPECT OIL COOLER BYPASS AND OIL FILTER BYPASS VALVES

NOTE: Before disassembling oil cooler/oil pressure regulating housing assembly, inspect all mating surfaces and plugs for evidence of oil or coolant leaks. Correct as necessary. When installing pipe plugs, always coat threads with a teflon sealant.

1. Remove oil cooler (A) from oil bypass valve housing (B).

2. Remove oil cooler bypass valve (C) and oil filter bypass valve (D) from bypass valve housing.

3. Thoroughly inspect valves and valve bores for wear or damage. Replace as necessary.

NOTE: If mixing of oil and coolant is suspected, pressure test oil cooler in solvent (not water) and compressed air. Use 140—170 kPa (1.4—1.7 bar) (20—25 psi) air pressure for testing. Replace oil cooler as necessary.

4. Check oil cooler bypass valve spring and oil filter bypass valve spring tension. If either or both springs do not meet specifications, replace as necessary.

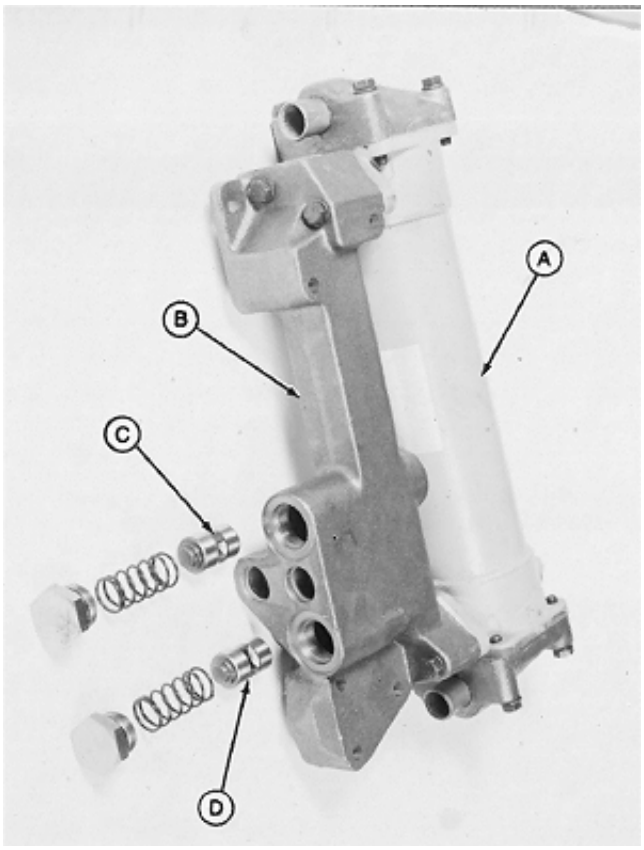
SPRING TENSION SPECIFICATION

Oil Filter Bypass Valve Spring:
Compressed . . . . . 35 mm @ 80—98 N (1.38 in. @ 18—22 lb force)
Free Length . . . . . 51.5 mm (2.03 in.)

Oil Cooler Bypass Valve Spring:
Compressed . . . . . 35 mm @ 80—98 N (1.38 in. @ 18—22 lb force)
Free Length . . . . . 51.5 mm (2.03 in.)

5. Make sure all passages in bypass valve housing and oil cooler are clean.

NOTE: Under normal conditions, the oil cooler need not be removed to clean water passages. Remove oil cooler end caps, clean and inspect tubes with a brush and compressed air.



RG5534 -UN-10NOV89

A—Oil Cooler
B—Bypass Valve Housing
C—Oil Cooler Bypass Valve
D—Oil Filter Bypass Valve

S55,2520,D -19-05MAY93

ASSEMBLE BYPASS VALVE HOUSING AND OIL COOLER ASSEMBLY

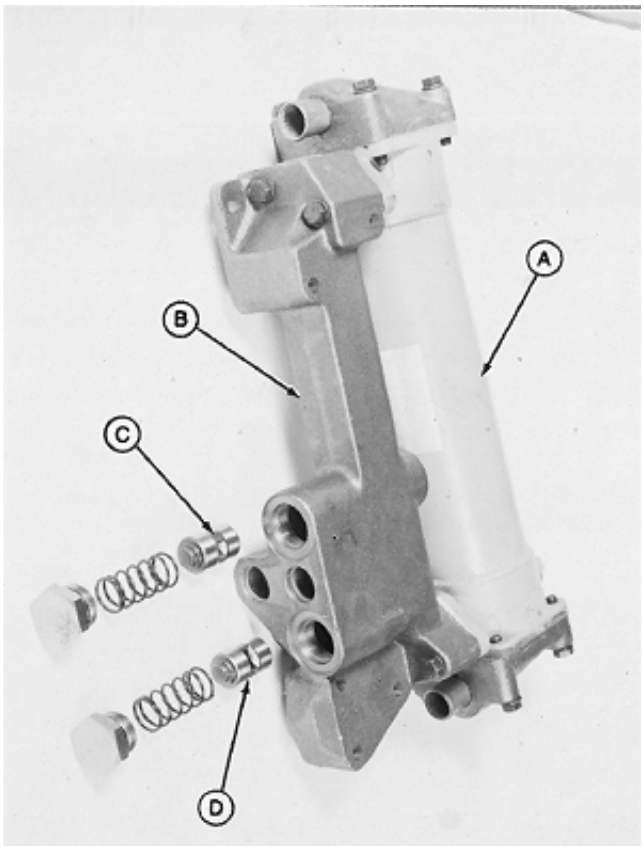
1. Using new gaskets install oil cooler end caps and tighten cap screws to 41 N·m (30 lb-ft), if removed.

2. Using new gaskets assemble oil cooler (A) onto bypass valve housing (B). Tighten cap screws 47 N·m (35 lb-ft).

NOTE: Dip valves in clean engine oil before installing.

3. Using new O-rings on plugs, install oil cooler bypass valve (C) and oil filter bypass valve (D) assemblies as shown. Tighten plugs securely.

A—Oil Cooler
B—Bypass Valve Housing
C—Oil Cooler Bypass Valve
D—Oil Filter Bypass Valve



RG5534 -UN-10NOV89

RG,CTM61,G20,7 -19-16MAR92

INSTALL OIL BYPASS VALVE HOUSING AND OIL COOLER ASSEMBLY

1. Install guide studs at each side of bypass valve housing mounting location.

CAUTION: Bypass valve housing (D) and oil cooler (E) assembly is very heavy. Plan a proper handling procedure to avoid injuries.

2. Using new gaskets, install bypass valve housing and oil cooler assembly onto cylinder block by sliding over guide studs. Guide studs will support assembly while cap screws are installed.

3. Install mounting cap screws and tighten to 41 N·m (30 lb-ft). Remove guide studs and install remaining cap screws and tighten to 41 N·m (30 lb-ft).

4. Lubricate new O-rings with clean engine oil and install both oil tubes (F) into bypass valve housing. Bend in tubes must be closest to bypass valve housing.

5. Install oil filter manifold onto mounting plate (H) and tighten cap screws to 41 N·m (30 lb-ft), if removed.

6. Lubricate new O-rings with clean engine oil and install upper end of oil tubes into oil filter manifold (G).

NOTE: Apply LOCTITE 242 Thread Lock and Sealer to threads of mounting plate screws. Leading three threads of hollow screw must be free of sealant.

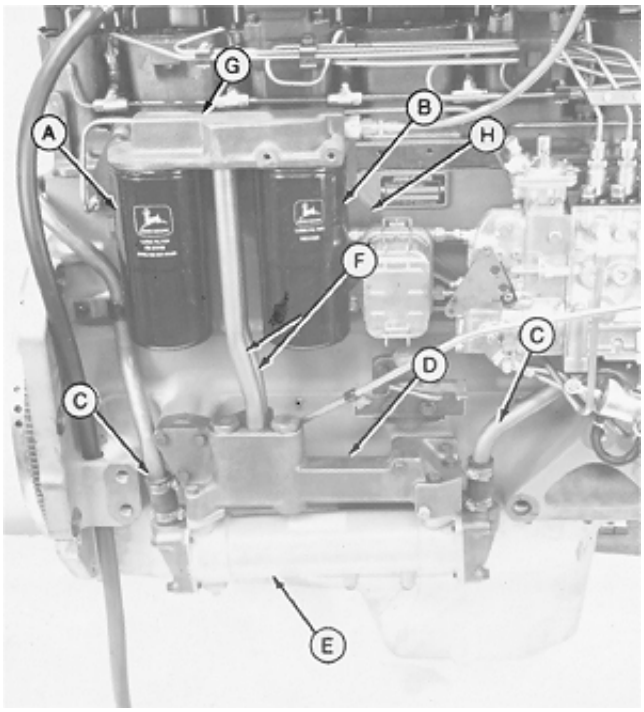
7. Position mounting plate onto cylinder block, tighten allen head countersunk screw and hollow cap screw securely.

8. Connect oil lines to oil filter manifold and tighten securely. Connect fuel lines to fuel filter base using new packing and tighten securely.

9. Position hoses onto coolant tubes (C) and tighten hose clamps securely.

10. Lubricate new packing on bypass oil filter (A) with clean engine oil. Install filter and tighten until packing contacts mounting base. Tighten one additional full turn.

11. Lubricate new packing on full flow oil filter (B) with clean engine oil. Install filter and tighten until packing contact mounting base. Tighten an additional 1/2 to 3/4 turn.



RG5533 -UN-09JAN90

A—Bypass Oil Filter
B—Full Flow Oil Filter
C—Coolant Tubes
D—Bypass Valve Housing
E—Oil Cooler
F—Oil Tubes
G—Oil Filter Manifold
H—Oil Filter Manifold Mounting Plate

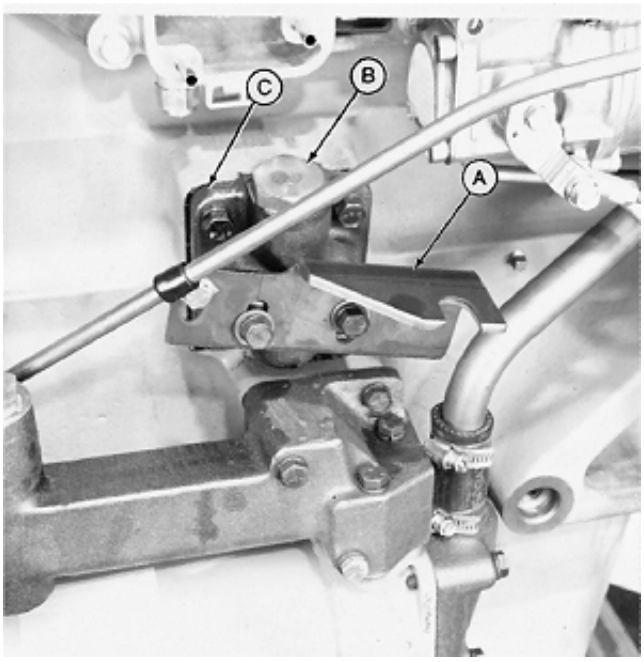
S55,2520,R -19-17NOV95

REMOVE, DISASSEMBLE, INSPECT, AND INSTALL OIL PRESSURE REGULATING VALVE AND HOUSING

1. Remove two cap screws and remove dipstick tube bracket (A).

NOTE: The pressure regulating valve (B) may be removed without removing pressure regulating housing (C) from engine, however, the fuel filter canister (shown removed) must be removed first.

2. Remove four cap screws securing pressure regulating valve housing to engine and remove housing. Remove and discard all gasket material.



-UN-09JAN90
RG5535

S55,2520,F -19-07JUL89

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10

3. Remove plug (A) with spring pin (J), O-ring (B), shims (C), spring (I), and valve (D) from housing (F).

4. Count shim(s) for reassembly.

NOTE: If valve housing, or spring is replaced, assembly must be re-shimmed until correct oil pressure is achieved. Do not exceed five shims.

5. Inspect valve and valve housing bore for damage. Replace parts as necessary.

6. Check spring for proper compression. Replace as necessary.

VALVE SPRING SPECIFICATION

Compressed	48.5 mm @ 83—98 N (1.91 in. at 19—22 lb-force)
Free Length	74.2 mm (2.92 in.)

7. Dip valve in clean engine oil and install valve and spring in housing.

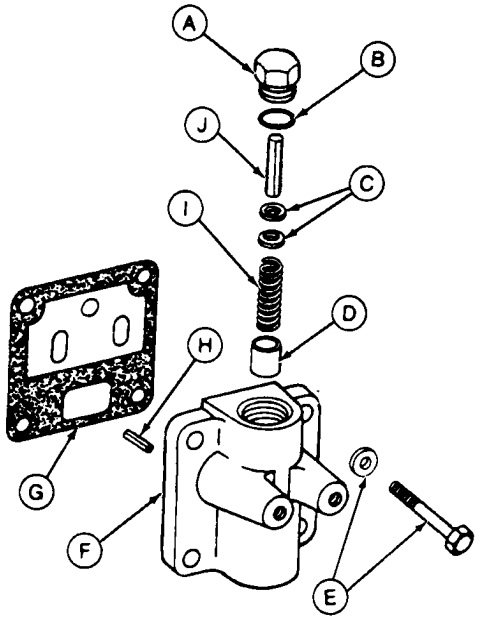
8. Position shim(s) on plug with spring pin.

NOTE: It may be easier to tighten plug after housing assembly is installed on block.

9. Install plug using a new O-ring and tighten securely.

IMPORTANT: Coat both sides of gasket (G) with PERMATEX AVIATION (Form-A-Gasket No. 3) before installing.

10. With spring pin (H) positioned in cylinder block, use a new gasket and install valve housing assembly. Tighten cap screws with washers (E) to 47 N·m (35 lb-ft) in diagonal sequence. Retighten each cap screw to 47 N·m (35 lb-ft) in diagonal sequence.



RG5511 -UN-04JUL89

A—Plug
B—O-ring
C—Shims (As required)
D—Valve
E—Cap Screws and Washer (4-used)
F—Valve Housing
G—Gasket
H—Spring Pin
I—Spring
J—Spring Pin

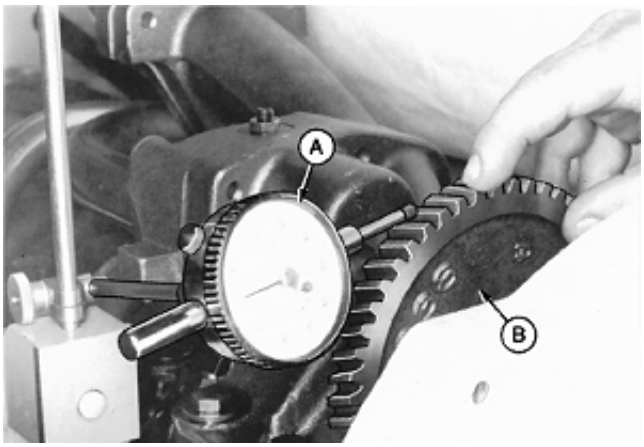
RG,CTM20,G20,10-19-17NOV95

CHECK CRANKSHAFT GEAR-TO-OIL PUMP DRIVE GEAR BACKLASH

Before removing oil pump, determine if there is adequate backlash between oil pump drive gear and crankshaft drive gear.

1. Mount dial indicator (A) and measure backlash between pump drive gear (B) and crankshaft gear.

IMPORTANT: Backlash must be at least 0.08 mm (0.003 in.). If backlash is less than 0.08 mm (0.003 in.), replace the oil pump drive gear.



RG3849 -UN-29NOV88

S55,2520,H -19-16MAR92

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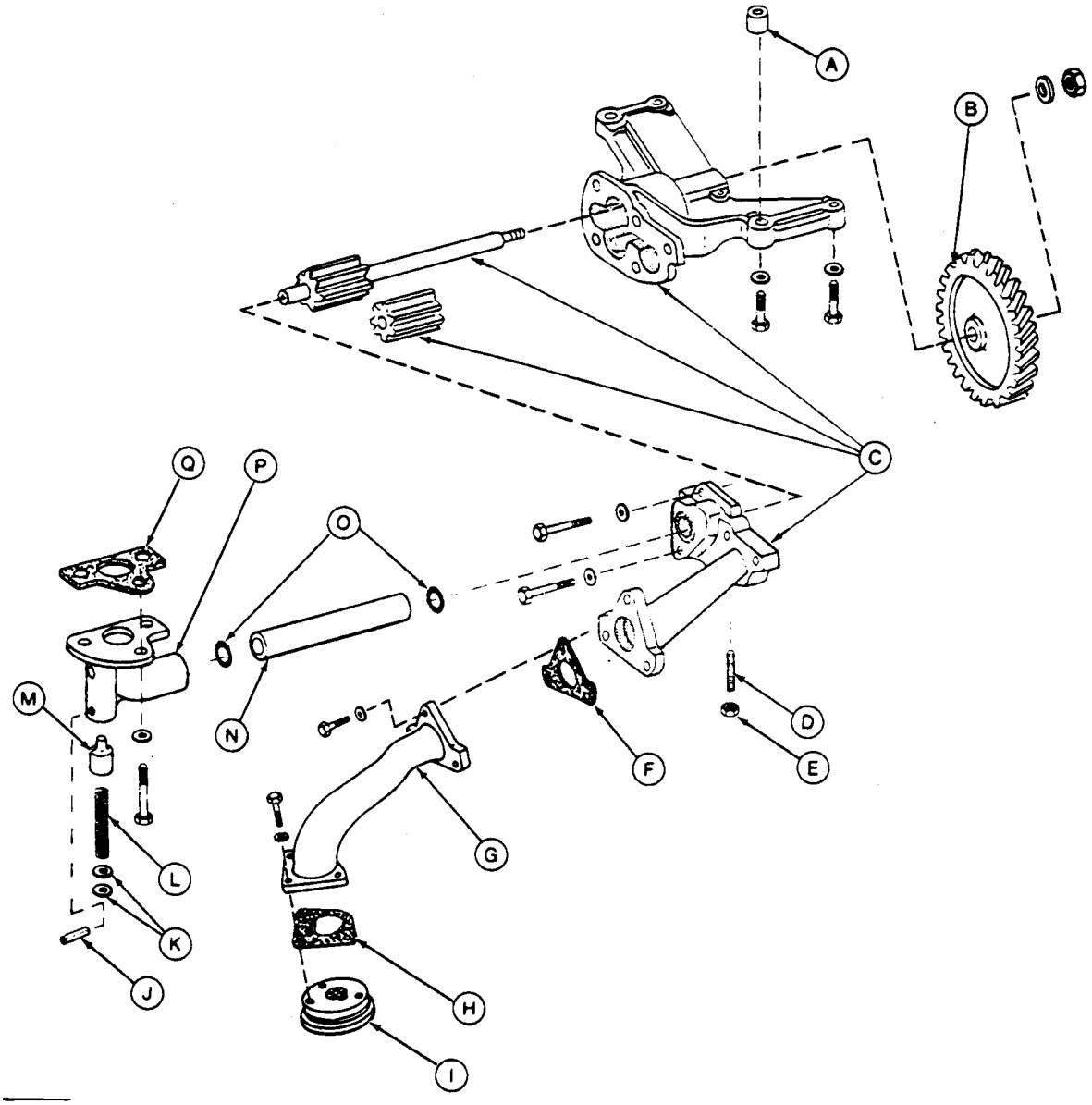
12

ENGINE OIL PUMP ASSEMBLY



A—Hollow Dowel (2 used)
B—Drive Gear
C—Oil Pump Assembly
D—Set Screw
E—Lock Nut
F—Gasket
G—Intake Elbow
H—Gasket
I—Pickup Screen
J—Spring Pin
K—Shim(s)
L—Spring
M—Valve
N—Outlet Tube
O—O-Rings (2 used)
P—Oil Pressure Relief Valve Housing/Outlet Elbow
Q—Gasket

S55,2520,I -19-24APR92

REMOVE ENGINE OIL PUMP

1. Remove oil pressure relief valve housing/outlet elbow (A) and outlet tube (B) with O-rings. Discard used gasket and O-rings.

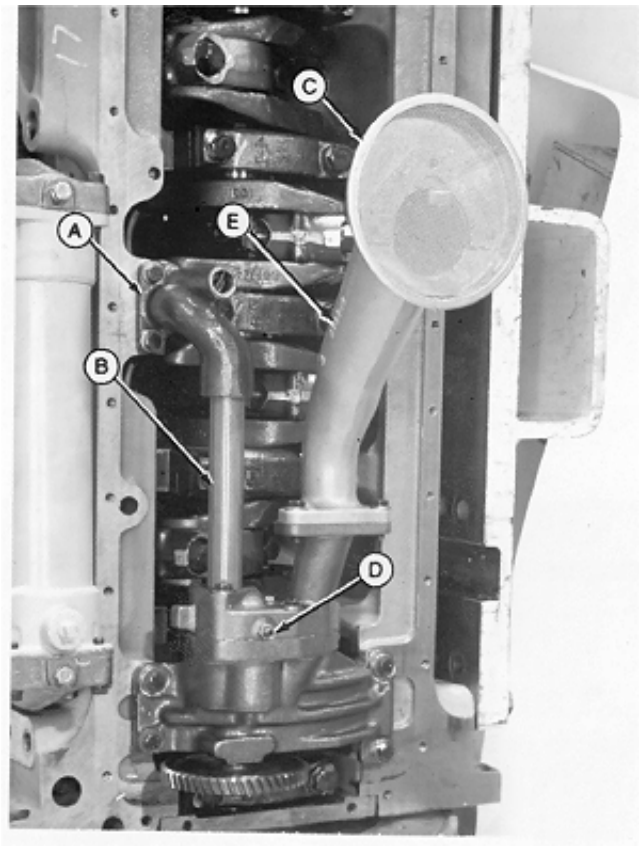
2. Remove intake elbow (E) with pickup screen (C) attached.

3. Remove four oil pump-to-cylinder block cap screws and carefully lift pump assembly from cylinder block. Remove two hollow dowels.

4. Place pump assembly on a clean flat table and remove all gasket material.

IMPORTANT: Do not alter adjustment of set screw and lock nut (D). If adjustment has been altered, follow procedure during assembly. (See ADJUST OIL PUMP SET SCREW, later in this group.)

A—Oil Pressure Relief Valve Housing/Outlet Elbow
B—Outlet Tube
C—Pickup Screen
D—Set Screw and Lock Nut
E—Intake Elbow



RG5536 -UN-09JAN90

S55,2520,J -19-24APR92

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14

INSPECT AND CLEAN OIL PUMP

1. Visually inspect oil pump for wear or damage.

IMPORTANT: Do not disassemble oil pump for inspection, flushing, or making any wear checks.

2. Flush pump assembly internally with clean solvent to remove oil. Spin pump gears to help remove solvent.

3. Place oil pump on a work bench with pump-to-cylinder block mounting surface facing upward (same as when mounted on engine).

NOTE: Leave pump drive gear installed when making checks.

IMPORTANT: To help insure accurate wear measurements, be sure the oil pump is clean and faces the same way as when mounted on the cylinder block.

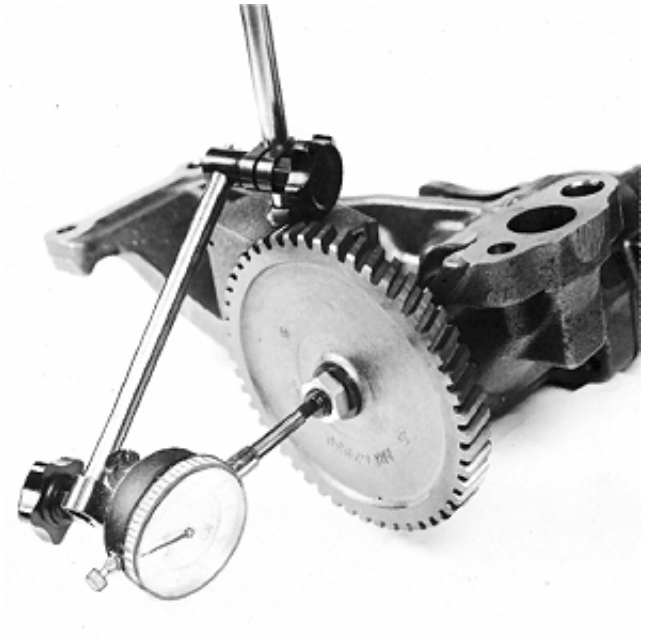
S11,0404,T,1 -19-17NOV95

CHECK DRIVE SHAFT END PLAY

1. Mount dial indicator with plunger tip resting against end of pump drive shaft.

2. Move shaft toward and away from indicator.

If end play exceeds 0.15 mm (0.006 in.), there is excessive wear on pump cover and/or wear on end of pump drive gear. Replace oil pump.



RG5916 -UN-16AUG91

S11,0404,U,1 -19-17NOV95

CHECK DRIVE SHAFT SIDE MOVEMENT

1. Mount dial indicator with plunger tip resting on one of the hex nut flats.

2. Move shaft from side-to-side.

If shaft side movement exceeds 0.17 mm (0.007 in.), there is excessive wear on drive shaft bushing and/or drive shaft. Replace oil pump.

RG5917 -UN-16AUG91

S11,0404,V,1 -19-17NOV95

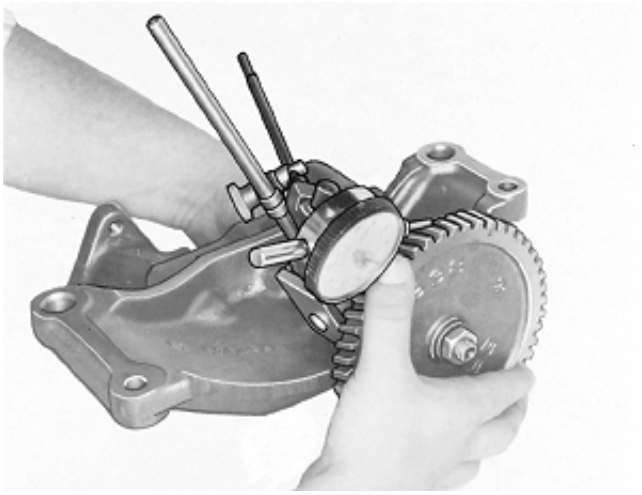
CHECK PUMPING GEAR BACKLASH

1. Mount dial indicator with indicator plunger resting against side of gear tooth.

2. Hold idler gear stationary (by reaching through oil discharge hole) and slowly rotate drive gear back and forth until contact with idler gear is felt.

If backlash is not within 0.33—2.00 mm (0.013—0.079 in.), there is excessive pumping gear wear and/or idler shaft and gear bushing wear. If there is less than 0.33 mm (0.013 in.) backlash, re-clean gears and check backlash again.

3. Replace oil pump if pumping gear backlash exceeds 2.00 mm (0.079 in.).



RG3106 -UN-29NOV88

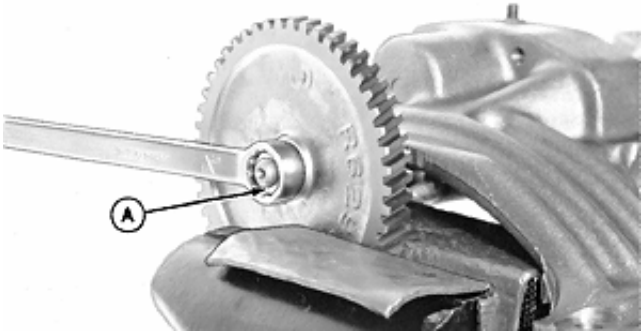
S11,0404,W,1 -19-17NOV95

INSPECT OIL PUMP DRIVE GEAR

NOTE: Oil pump does not need to be removed from engine, when inspecting drive gear.

1. Inspect drive gear teeth for chips, cracks, or wear.

2. Remove nut (A) to replace gear, if necessary.



RG3507 -UN-29NOV88

S11,0404,X,1 -19-14NOV95

ADJUST OIL PUMP SET SCREW

IMPORTANT: Normally the set screw (A) should NOT be adjusted; but if the set screw is altered, perform the following steps.

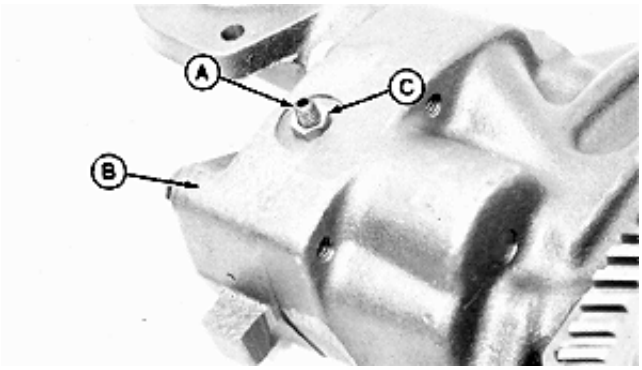
1. Install drive gear and idler gear into oil pump housing.

2. Install oil pump cover (B) onto housing and tighten cover-to-housing cap screws to 41 N·m (30 lb-ft).

3. Loosen lock nut (C) and tighten set screw until it lightly contacts idler gear shaft. Shaft should spin freely with limited axial movement.

4. Hold set screw stationary and tighten lock nut to 8 N·m (6 lb-ft). Do not overtighten set screw or lock nut.

5. Spin drive gear to assure shaft turns freely in housing. Readjust set screw if shaft does not turn freely.



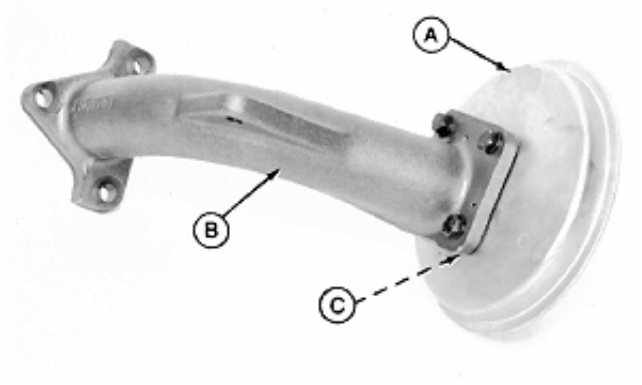
-UN-29NOV88
RG3509

S11,2020,BZ,1 -19-17NOV95

INSTALL ENGINE OIL PUMP

1. Install pickup screen (A) with a new gasket (C) to intake elbow (B).

2. Tighten cap screws to 24 N·m (18 lb-ft).



-UN-25SEP89
RG3756

S55,2520,K -19-16MAR92

3. Lubricate bottom surface of oil pump housing gear pocket bores, idler shaft, gear teeth on drive shaft, and oil pump cover ends of both gears with TY6343 or TY6347 High Temperature Grease.

4. Install intake elbow (A) with new gasket onto oil pump cover (B). Tighten cap screws to 41 N·m (30 lb-ft).

5. Mount oil pump onto engine block using two hollow dowels as locators.

IMPORTANT: Be sure oil pump drive gear is properly meshed with crankshaft gear.

6. Install oil pump mounting cap screws and finger tighten.

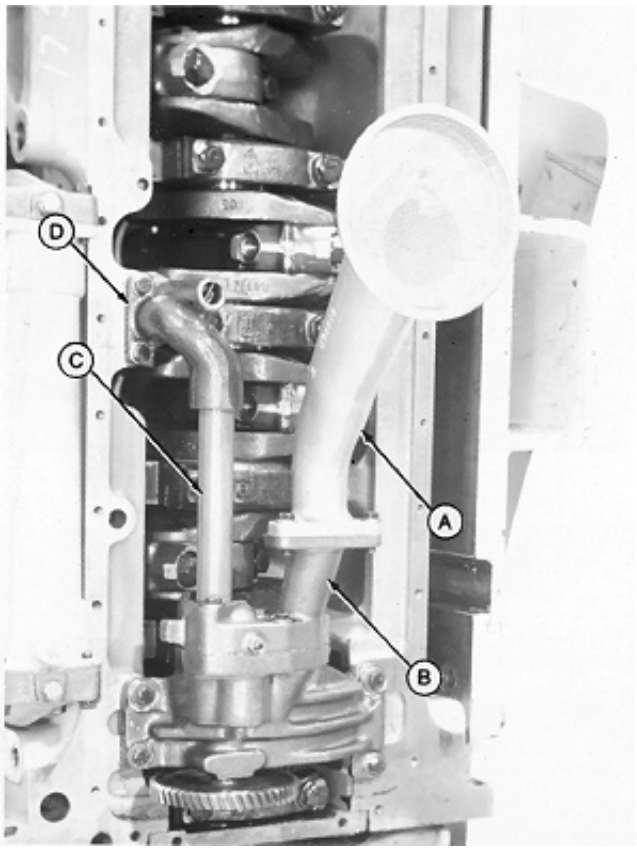
IMPORTANT: Be careful not to cut or dislodge O-ring when installing outlet tube.

7. Lubricate new O-rings with clean engine oil. Install O-rings on each end of outlet tube (C) and install tube into cover and oil pressure relief valve housing outlet elbow (D).

8. Install oil pressure relief valve housing/outlet elbow onto cylinder block using a new gasket. Tighten cap screws to 41 N·m (30 lb-ft).

9. Tighten oil pump mounting cap screws to 47 N·m (35 lb-ft).

10. Tighten oil pump drive gear nut to 54 N·m (40 lb-ft).



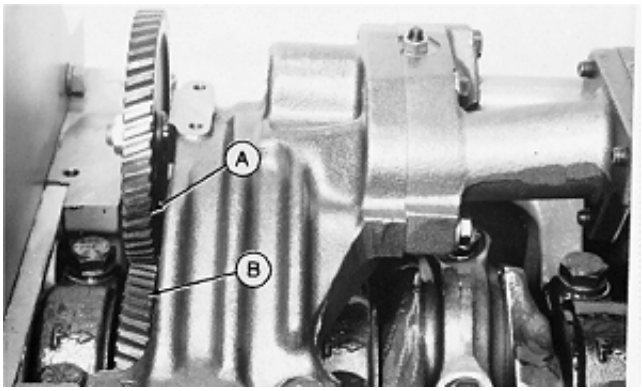
RG5537 -UN-09JAN90

A—Intake Elbow
B—Oil Pump Cover
C—Outlet Tube
D—Oil Pressure Relief Valve Housing/Outlet Elbow

S55,2520,L -19-05MAY93

IMPORTANT: Push crankshaft rearward (toward flywheel end). Check clearance between oil pump drive gear face and throw of crankshaft. There should be a clearance of at least 0.38 mm (0.0015 in.). If clearance is below specification, check thrust bearing for proper placement.

Gently pry crankshaft forward and check (after oil pump is installed) the oil pump drive gear (A), and crankshaft gear (B) to see that they are properly meshed.



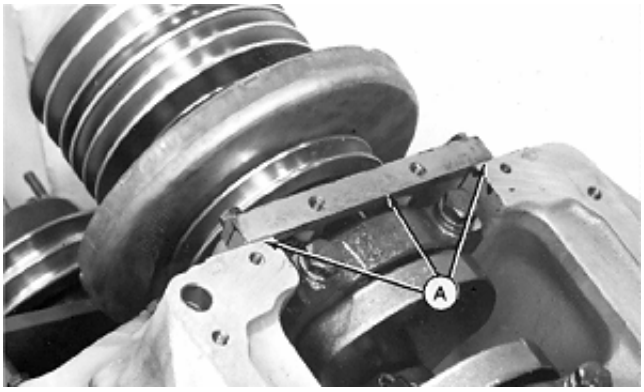
RG5509 -UN-10NOV89

S55,2520,N -19-16MAR89

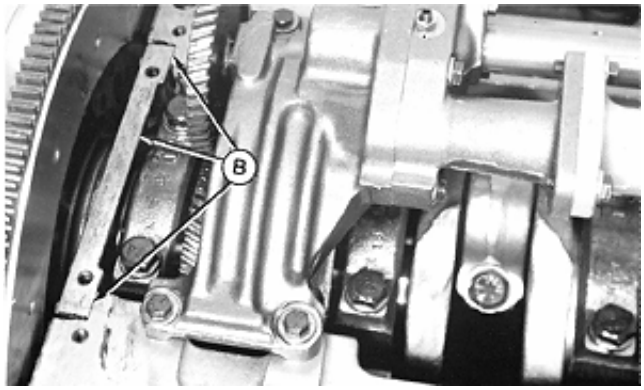
INSTALL OIL PAN

Before installing the engine oil pan, remove old gasket material and sealant from pan and cylinder block mating surfaces. Be sure all gasket surfaces are clean and dry before assembly.

IMPORTANT: Apply a thin layer of PERMATEX AVIATION (Form-A-Gasket No. 3) at timing gear cover-to-cylinder block mating surfaces, along entire surface of timing gear cover (A), at rear crankshaft oil seal housing-to-cylinder block mating surfaces, and entire rear face of block (B) before installing oil pan gasket.

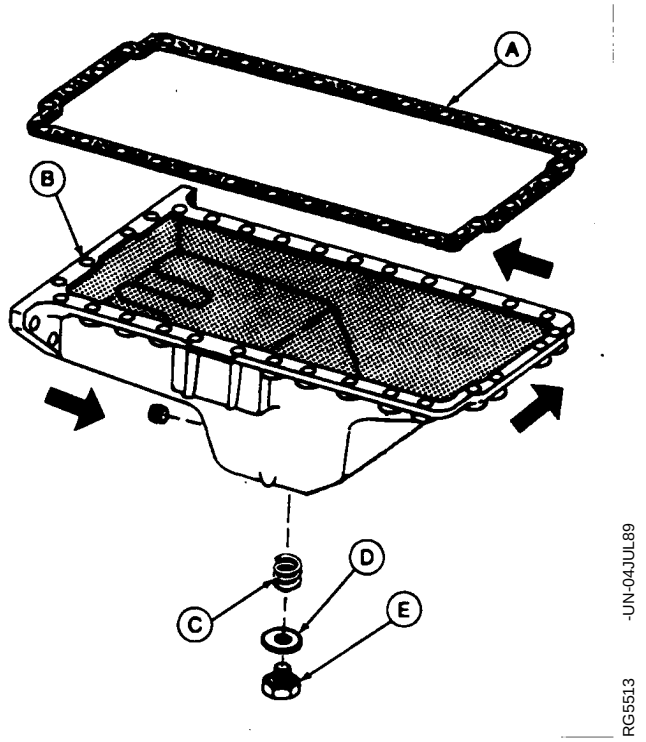


RG5539 -UN-09JAN90



RG5540 -UN-09JAN90

S55,2520,O -19-01APR93



A—Oil Pan Gasket
B—Location Of First Cap Screw
C—HELICOIL® Insert
D—O-Ring
E—Drain Plug

1. Place a new gasket (A) on cylinder block and install oil pan. Be sure oil pan is flush with flywheel end of cylinder block. Guide studs may be used, if desired.

NOTE: Use a straightedge against flywheel end of oil pan and cylinder block to assure a flush to ± 0.05 mm (0.002 in.) alignment.

2. Insert all 3/8 in. and 1/2 in. cap screws in their appropriate hole location. Initially tighten all 3/8 in. cap screws to 54 N·m (40 lb-ft), starting at right rear corner of oil pan (B) and proceed counterclockwise (bold arrows). Follow same procedure for all 1/2 in. cap screws.

3. Finish tightening cap screws to specifications listed below, start at (B) and proceed counterclockwise as outlined earlier. Tighten all 3/8 in. cap screws before tightening 1/2 in. cap screws.

OIL PAN CAP SCREW FINAL TORQUE SPECIFICATION

3/8 in. Cap Screws	68 N·m (50 lb-ft)
1/2 in. Cap Screws	156 N·m (115 lb-ft)

NOTE: Check torque on all 3/8 in. cap screws after final torque of 1/2 in. cap screws.

4. Install all 3/4 in. oil pan-to-flywheel housing cap screws and tighten to 325 N·m (240 lb-ft).

NOTE: If oil pan drain plug threads are damaged, replacement HELICOIL® inserts (C) are available. Use JDG706 HELICOIL® Repair Kit and follow manufacturer's installation instructions very carefully.

5. Lubricate O-ring (D) with clean engine oil and install on drain plug (E). Install drain plug and tighten to 102 N·m (75 lb-ft).

NOTE: On engines equipped with an elbow fitting and drain hose on oil pan, the threads and sealing surfaces must be free of any film to insure an effective seal. Apply a light coat of LOCTITE® 242 Thread Lock and Sealer to fittings except for the leading one to three threads. Tighten fittings securely.

S55,2520,P -19-16MAR92

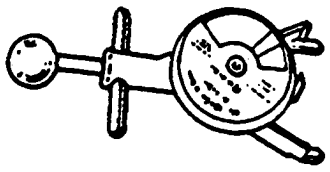
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

Belt Tension Gauge JDG529

Used to check and adjust fan belt tension.

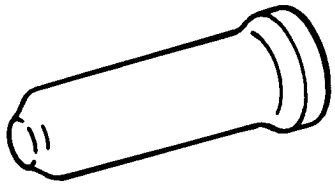


RG5082 -UN-23AUG88

S53,JDG529 -19-06APR94

Water Pump Bearing Driver JDG743

Used to install bearings on water pump shaft and the water pump bearing shaft assembly into the water pump housing.



RG6219 -UN-06MAR92

RG,JDG743 -19-22APR92

RG5588 -UN-13SEP89

Belt Tension Gauge JDST28

Used with a straightedge to check fan belt tension.

RG,CTM61,G25,26-19-17MAR92

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1

OTHER MATERIAL

Name	Use
LOCTITE 515 Flexible Sealant (TY6304)	Water pump, thermostat cover and water manifold gaskets.
High Temperature Grease (TY6341)	Pack water pump bearings.
High Temperature Grease (TY6333 or TY6347)	Pack bearings in fan drive.
LOCTITE 592 Pipe Sealant with TEFLON (TY9374/TY9375)	Coat threads of water pump pipe plugs and fan drive pipe plug.

RG,CTM61,G25,1 -19-05MAY93

COOLING SYSTEM SPECIFICATIONS

Item	New Part Specification
Water Pump:	
Impeller Bore ID	15.85—15.88 mm (0.624—0.625 in.)
Shaft OD Impeller End	15.90—15.93 mm (0.626—0.627 in.)
Shaft OD Pulley End	30.20—30.23 mm (1.189—1.190 in.)
Pulley Bore ID	30.15—30.18 mm (1.187—1.188 in.)
Bearing Bore in Water Pump Housing	71.996—72.017 mm (2.8345—2.8353 in.)
Maximum Serviceable	72.047 mm (2.8365 in.)
Impeller-to-Housing Clearance	0.39—0.89 mm (0.015—0.035 in.)
Pump Shaft Max. End Play	0.25 mm (0.010 in.)
Pulley-to-Shaft Interference Press Fit	0.0381—0.0889 mm (0.0015—0.0035 in.)
Thermostat Opening Temperature	80—84˚C (175—182˚F)
Fan Belt Tension (2-Belt System, Tension Front Belt Only)	
New Belts	422—463 N (95—104 lb)
Belts in Service (minimum 10-minutes use)	378—418 N (85—94 lb)
Pulley Installed Dimension (Pulley Front Face-To-Housing Rear Face)	
6101HRW01, 6101HRW02	154.5 mm (6.08 in.) Ref.—Pulley ID should contact shoulder on shaft.
6101AT001	204.5 mm (8.05 in.) Ref.—Pulley ID should contact should on shaft.

Torques

Water Pump Cover-to-Housing	24 N·m (18 lb-ft)
Water Pump-to-Cylinder Block	68 N·m (50 lb-ft)
Fan Support Plate	68 N·m (50 lb-ft)
Bypass Elbow-to-Water Pump	27 N·m (20 lb-ft)
Water Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Thermostat Housing-to-Water Manifold	47 N·m (35 lb-ft)
Coolant Filter Conditioner Mounting Bracket-to-Intake Manifold	75 N·m (55 lb-ft)
Coolant Filter Conditioner Base-to-Mounting Bracket	47 N·m (35 lb-ft)
Coolant Heater Nut	34 N·m (25 lb-ft)
Fan Pulley-to-Water Pump Shaft—6101AT001	115 N·m (85 lb-ft)

S55,2525,B -19-17NOV95

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SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools from your SERVICE-GARD™ Catalog. Some tools may be available from a local supplier.

Name	Use
D01045AA—Bushing, Bearing and Seal Driver Set	Install inner seal in water pump housing and bearing in fan belt tightener pulley.
D01173AA—17-1/2 Ton Puller Set	Remove pulley from water pump shaft.

S55,2525,A -19-27JUN95

DIAGNOSING COOLING SYSTEM MALFUNCTIONS

- **Engine Overheats:**

  Loose or broken fan belt
  Dirty radiator
  Low coolant level
  Low oil level
  Engine overloaded
  Defective head gasket
  Incorrect timing (engine/injection pump)
  Faulty thermostats
  Faulty water pump
  Corroded coolant passages
  Improper grade of fuel
  Excessive fuel delivery

- **Low Coolant Level:**

  Improper maintenance
  Improper operation
  Damaged radiator
  Water pump seal leakage
  Leakage
  Faulty radiator cap

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S11,2025,DH -19-17AUG94

GENERAL COOLING SYSTEM INFORMATION

6101 Engines are equipped with a heavy-duty, belt-driven water pump which utilize a shaft with two roller bearings pressed on each end of shaft. Water pump housings and water piping to the pump may vary by application, but repair to all internal components are the same.

S55,2525,C -19-17NOV95

REMOVE AND INSTALL HEAVY DUTY FAN DRIVE ASSEMBLY

1. Remove fan belts and fan.

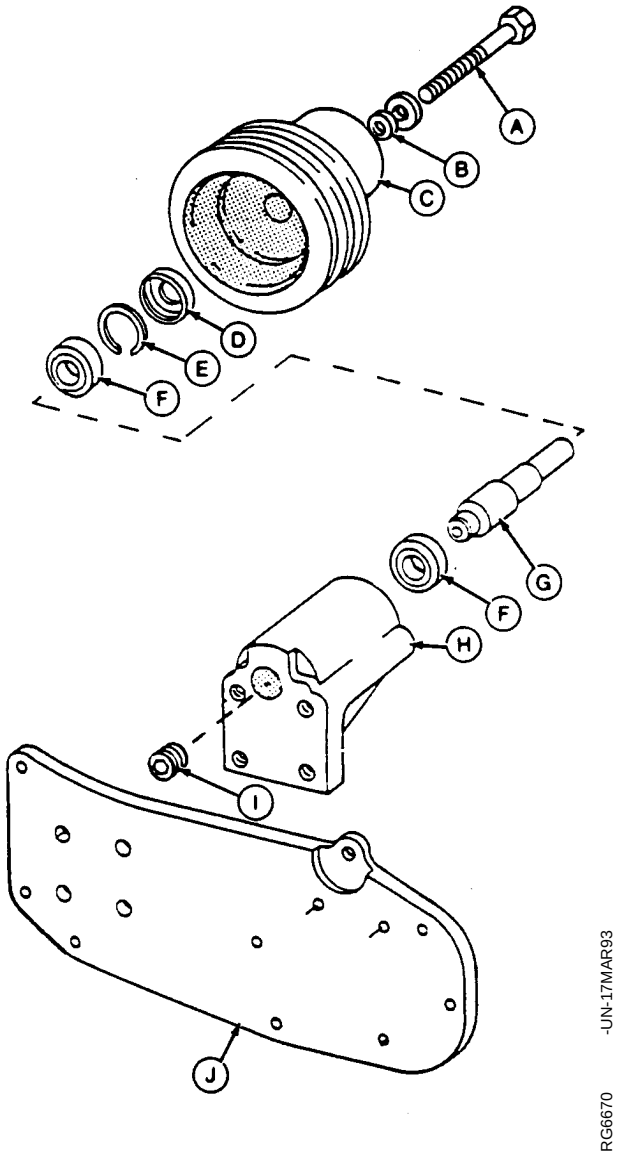
2. Remove fan support plate with fan drive assembly from engine.

3. Reverse removal steps and install fan support plate. Tighten mounting cap screws to 68 N·m (50 lb-ft).

4. Install fan and fan belts. Refer to the appropriate operator's manual for proper belt tensioning.

RG,CTM61,G25,32-19-05MAY93

REMOVE FAN DRIVE BEARINGS



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A—Cap Screw
B—Spacer
C—Fan Pulley
D—Grease Seal
E—Snap Ring
F—Ball Bearing (2 used)
G—Shaft
H—Bearing Housing
I—Pipe Plug
J—Support Plate

1. Remove fan drive assembly from fan support plate (J).

2. Clamp fan pulley (C) in a soft-jawed vise. Support fan pulley (so it does not fall to floor), and remove cap screw (A) securing pulley to shaft (G). Remove fan pulley.

3. Remove pipe plug (I), grease seal (D), and snap ring (E). Discard seal and snap ring.

4. Remove shaft with bearings (F) by tapping lightly with a rubber mallet or brass hammer.

5. Remove bearings from shaft using a press and discard bearings.

RG,CTM61,G25,33-19-05MAY93

6. Thoroughly clean and inspect shaft and bearing housing for cracks or any other damage. Measure parts and compare with specifications given below.

HEAVY DUTY FAN DRIVE SPECIFICATIONS

Housing ID	71.999—72.025 mm (2.8346—2.8356 in.)
Shaft OD	35.001—35.017 mm (1.3780—1.3786 in.)
Bearing ID	34.987—35.013 mm (1.3774—1.3785 in.)
Bearing OD	71.987—72.013 mm (2.8341—2.8351 in.)

RG,CTM61,G25,44-19-05MAY93

INSTALL FAN DRIVE BEARINGS

Refer to artwork in REMOVE FAN DRIVE BEARINGS, earlier in this group.

1. Pack inner and outer bearings with TY6333 or TY6347 High Temperature Grease. Apply clean engine oil to bearing ID and shaft OD.

2. Support end of shaft (G) and install bearings (F) against shoulder. Using a press and JDG743 Driver, apply force to bearing inner race only.

3. Support bearing housing (H) on a firm flat surface with bearing bore in the upward position.

4. Install bearing and shaft assembly into housing. Small end of shaft should extend through housing.

5. Determine proper snap ring thickness needed to obtain 0.10 mm (0.004 in.) end play.

6. Install snap ring (E) in housing groove. Visually inspect snap ring installation for proper seating in housing groove.

7. Apply a thin coat of clean engine oil to OD of seal casing and to seal lips. Install seal (D) in housing bore until metal casing is flush-to-0.50 mm (0.020 in.) below housing face.

8. Apply clean engine oil to ID of fan pulley (C). Support end of shaft through pipe plug hole in bearing housing and push hub onto other end of shaft until it bottoms against shoulder.

9. Install spacer (B). Install cap screw with washer (A). Tighten cap screw to 102 N·m (75 lb-ft).

10. Apply LOCTITE 592 Pipe Sealant to threads of pipe plug (I). Install and tighten plug in bearing housing.

11. Install fan drive assembly onto support plate (J). Tighten cap screws to 115 N·m (85 lb-ft).

12. Depending on application, install fan support plate to timing gear cover or cylinder block. Tighten cap screws to 68 N·m (50 lb-ft).

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RG,CTM61,G25,34-19-05MAY93

REMOVE WATER PUMP—6101AT001 ENGINES

CAUTION: DO NOT drain engine coolant until the temperature is below operating temperature. Always loosen drain cock (on left-hand side of block) slowly to relieve any pressure.

1. Drain coolant from cylinder block if not previously done.

2. Remove fan and fan belts.

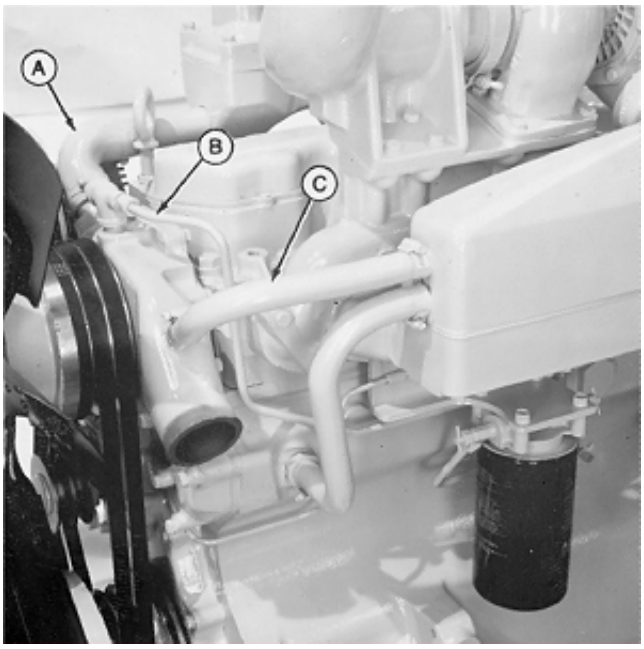
3. Loosen hose clamp and remove bypass hose (A) from water pump.

4. Disconnect coolant filter conditioner line (B).

5. Loosen hose clamp and remove aftercooler inlet hose (C) from water pump.

6. Loosen hose clamp and remove oil cooler-to-water pump hose (not shown).

7. Remove four mounting cap screws and remove water pump from engine.



RG5515 -UN-09JAN90

S55,2525,D -19-15JUN89

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REMOVE WATER PUMP—6101HRW01, 02 ENGINES

CAUTION: DO NOT drain engine coolant until the temperature is below operating temperature. Always loosen drain cock (on left-hand side of block) slowly to relieve any pressure.

1. Drain coolant from cylinder block if not previously done.

2. Remove fan and fan belts.

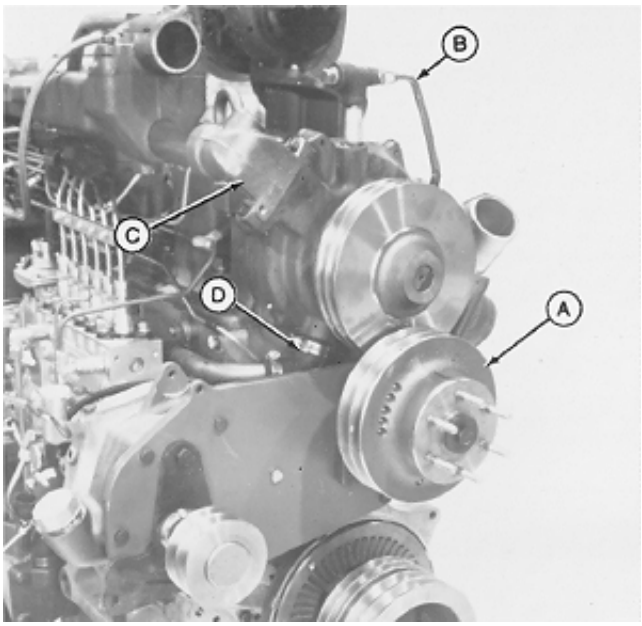
3. Remove fan drive assembly (A). Note location of spacer and strap for correct re-assembly.

4. Disconnect coolant filter conditioner line (B).

5. Remove bypass elbow (C).

6. Loosen hose clamp and remove oil cooler-to-water pump hose (D).

7. Remove four mounting cap screws and remove water pump from engine.



RG5516 -UN-09JAN90

A—Fan Drive Assembly
B—Coolant Filter Conditioner Line
C—Bypass Elbow
D—Oil Cooler-to-Water Pump Hose

S55,2525,E -19-15JUN89

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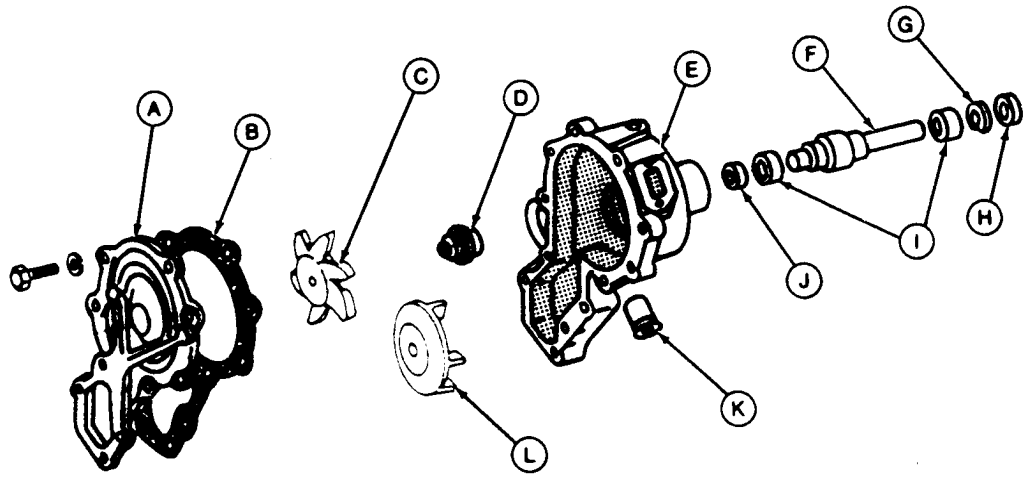
WATER PUMP ASSEMBLY



-UN-04JUL89
RG5517

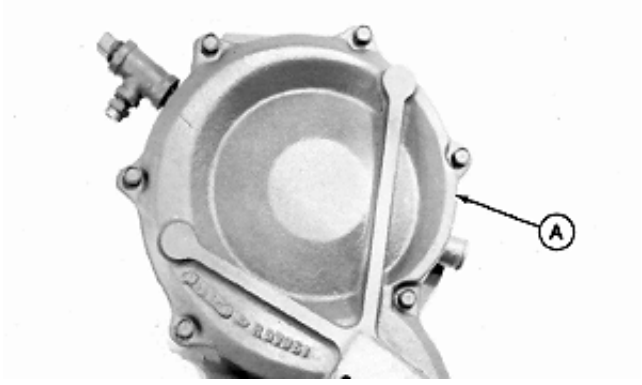
A—Cover
B—Gasket
C—Impeller (6101HRW01,02 Only)
D—Seal
E—Housing
F—Shaft
G—Snap Ring
H—Seal
I—Ball Bearing (2 used)
J—Seal
K—Tube
L—Impeller (6101AT001 Only)

S55,2525,F -19-17NOV95

DISASSEMBLE WATER PUMP

1. Remove six cap screws and remove cover (A). Scrape all gasket material from cover and housing face.

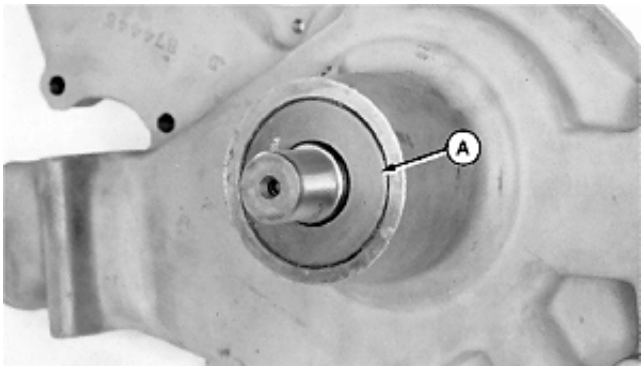
2. Remove water pump pulley using D01047AA 17-1/2 and 30-Ton Puller Set.



-UN-31JUL89
RG3571

S55,2525,G -19-17NOV95

3. Use a small sharp punch and punch a hole through outer seal (A). Pry outer grease seal from housing. Discard seal.



-UN-31JUL89
RG3560

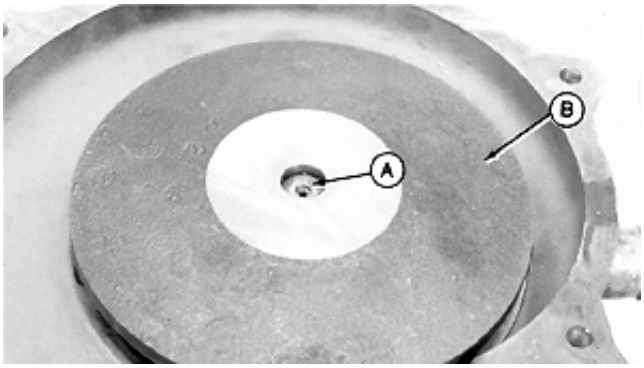
S11,2525,AC,1 -19-13NOV95

4. Remove snap ring (A).

S11,2525,AD,1 -19-13NOV95

5. Use a press and press shaft (A) through impeller (B). Press on shaft only. Remove impeller.

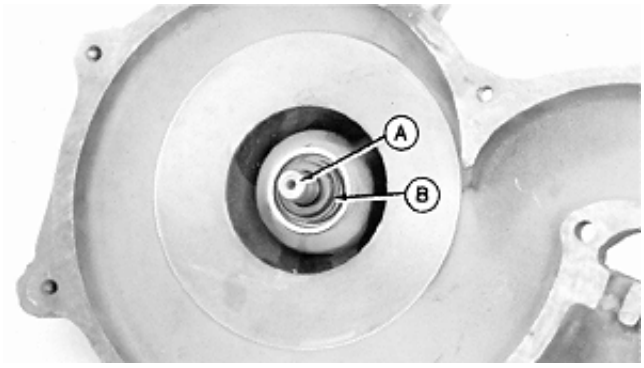
NOTE: 6101AT001 Engine's impeller shown, use the same procedure for 6101HRW01,02 Engines.



S11,2525,AE,1 -19-13NOV95

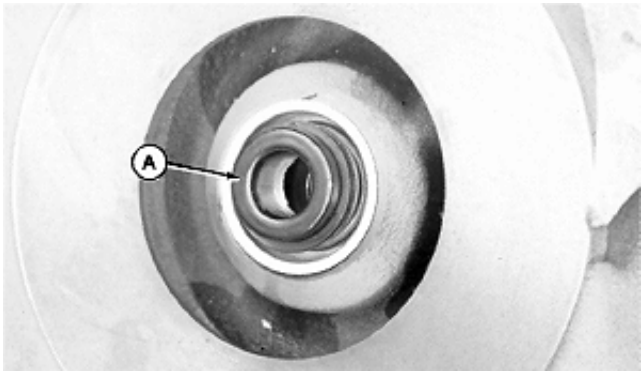
6. Use a press to remove shaft and bearing assembly (A). Press until bearing and shaft assembly are clear from pump housing.

NOTE: Press only on diameter of shaft and not on water pump seal (B).



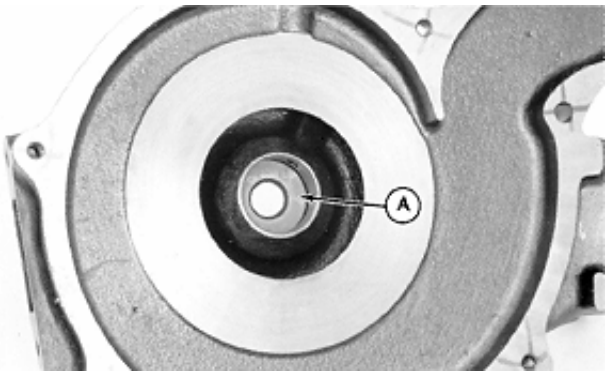
S11,2525,AF,1 -19-13NOV95

7. Use a small punch to drive unitized seal (A) from housing. Discard seal.



S11,2525,AG,1 -19-13NOV95

8. Use a driver with approximately the same O.D. as the O.D. of the inner grease seal (A) and drive seal from housing. Discard seal.



S11,2525,AH,1 -19-13NOV95

MEASURE BEARING BORE IN WATER PUMP HOUSING

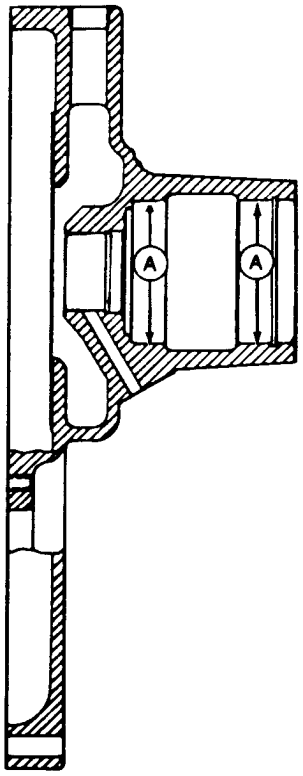
NOTE: Thoroughly clean housing bores before measuring to achieve an accurate measurement.

1. Measure bearing bore in pump housing at both bearing locations (A) using a telescoping gauge or dial bore gauge. Take the average of three readings at each bearing location.

WATER PUMP HOUSING SPECIFICATIONS

Bearing Bore in	
Housing	71.996—72.017 mm (2.8345—2.8353 in.)
Maximum Serviceable	72.047 mm (2.8365 in.)
Shaft OD Impeller End	15.90—15.93 mm (0.626—0.627 in.)
Shaft OD Pulley End	30.20—30.23 mm (1.189—1.190 in.)
Pulley Bore ID	30.15—30.18 mm (1.187—1.188 in.)
Impeller Bore ID	15.85—15.88 mm (0.624—0.625 in.)
Pulley-to-Shaft Interference	
Press Fit	0.0381—0.0889 mm (0.0015—0.0035 in.)

If pump housing bearing bore is not within maximum service specification, install a new water pump assembly.



S55,2525,H -19-13NOV95

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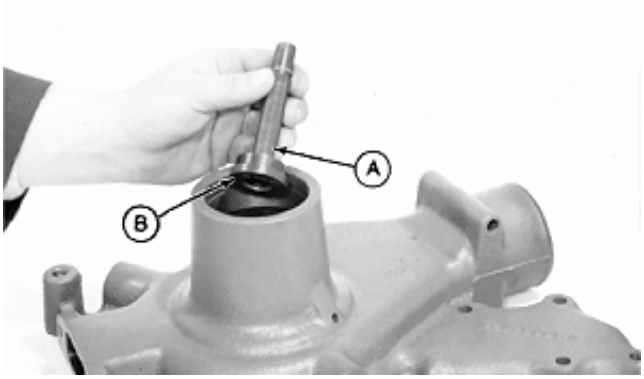
ASSEMBLE WATER PUMP

1. Use handle and driver (A) from D01045AA Bushing, Bearing and Seal Driver Set to install inner grease seal (B) into housing bore until seal bottoms against shoulder.



S55,2525,I,1 -19-13NOV95

2. Pack bearings with TY6341 High Temperature Grease. Install bearings onto shaft with a press and JDG743 Water Pump Bearing Driver which bears on INNER and OUTER bearing race.

3. Fill the cavity between bearings about half full with grease around the entire OD of bearing shaft before installing into housing.

4. Install shaft and bearing assembly into water pump housing using JDG743 Driver and lightly tap with a hard RUBBER mallet until inner bearing bottoms in housing bore.

IMPORTANT: The bearing shaft assembly should slip into housing with little resistance. DO NOT use excessive force to install assembly.

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RG,CTM61,G25,9 -19-05MAY93

5. Install 1.96 mm (0.077 in.) thick green snap ring (A) in housing groove with sharp edge of snap ring facing up.

S11,2525,BN -19-17MAR92

6. Use a magnetic base dial indicator and measure shaft end play. The maximum end play allowed is 0.25 mm (0.010 in.).

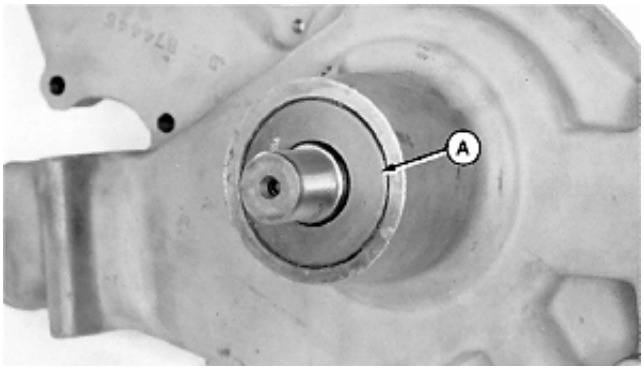
7. Install the correct thickness of snap ring which will achieve the proper end play.

Snap Ring Thickness
1.57 mm (0.062 in.)
1.70 mm (0.067 in.)
1.96 mm (0.077 in.)
2.21 mm (0.087 in.)
2.46 mm (0.097 in.)

S11,2525,BO -19-06APR94

IMPORTANT: Generously lubricate ID of seal lip and fill the entire seal casing with grease prior to installing seal onto shaft. As seal is being installed over shoulder of pump shaft, rotate seal to prevent damage to lip.

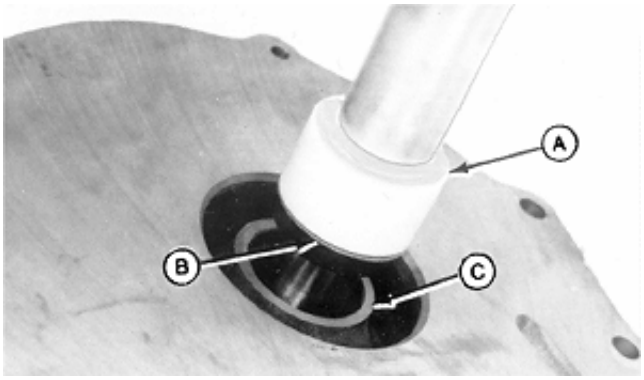
8. Install outer grease seal (A) onto housing with spring loaded lip facing bearings. Tap lightly with small hammer until seal is flush with housing face.



S11,2525,AO -19-17MAR92

IMPORTANT: Use R78350 Driver (A), that is included with water pump seal kit, to drive seal to proper depth.

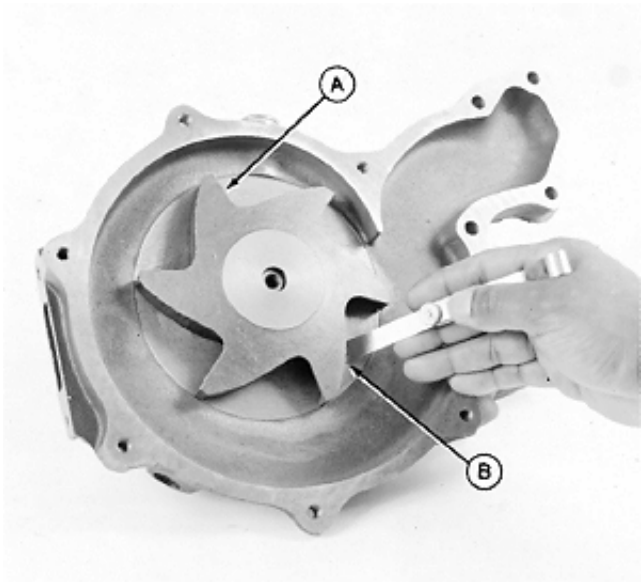
9. Support pump assembly on front pulley shaft. Place a new seal (B) onto impeller shaft. Position R78350 Driver on seal and drive seal until it bottoms on water pump housing lip (C).



S11,2525,BP -19-25JUL95

IMPORTANT: Pump seal should NOT touch impeller.

10. Support pulley end of shaft and press impeller (A) onto shaft until there is 0.039—0.89 mm (0.015—0.035 in.) clearance (B) between machined surface of housing and impeller.



RG6159 -UN-24FEB92

S11,2525,BQ -19-25JUL95

11. Support bearing shaft assembly through impeller bore. Press pulley (B) onto shaft until pulley ID bottoms on shoulder on shaft. At this point reference dimension (A), from front fact of pulley-to-rear housing face will be achieved. Refer to the application chart below for reference dimension to assure correct pulley alignment.

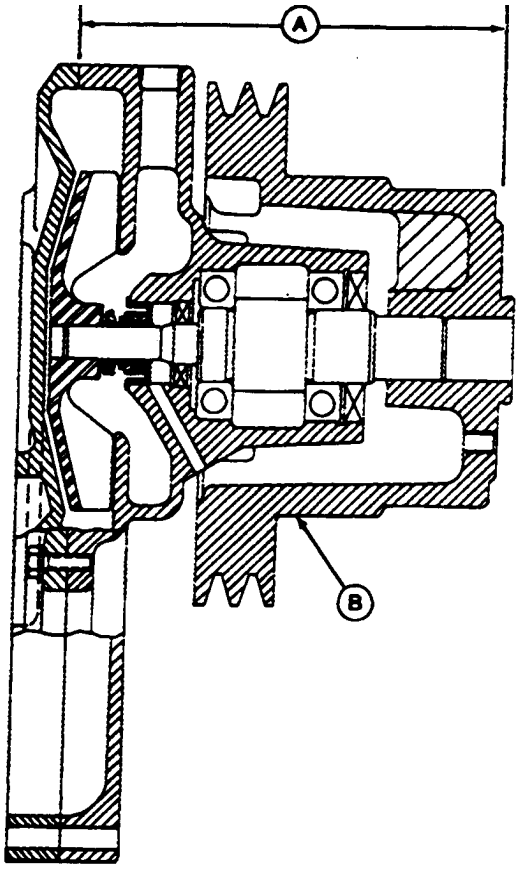
IMPORTANT: The interference press of pulley must be 0.0381 mm (0.0015 in.) minimum to 0.0889 mm (0.0035 in.) maximum. Replace pulley and/or shaft if interference press fit is not within this range.

PULLEY FRONT FACE-TO-REAR HOUSING FACE REFERENCE DIMENSION (A):

6101AT001 . . . . . 204.5 mm (8.05 in.)*

6101HRW01,02 . . . . . 154.5 mm (6.08 in.)*

*Reference dimension only. Press pulley onto shaft until ID of pulley bottoms on should of shaft.



RG4944 -UN-06APR89

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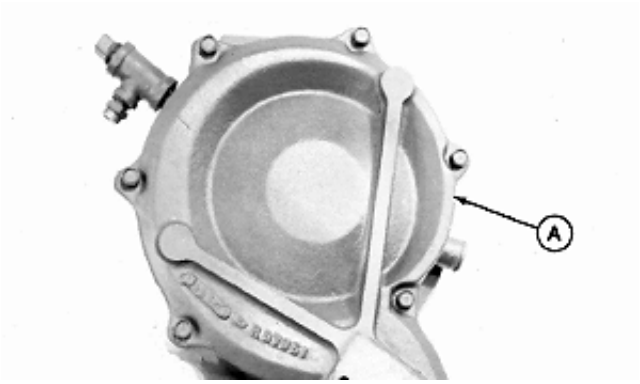
S55,2525,J -19-15JUN89

12. Using a new gasket, install pump housing cover (A). Tighten cap screws to 24 N·m (18 lb-ft).

13. Turn pump pulley by hand to be sure there is no interference between rotating parts. Disassemble and correct any interference problems.



RG3571 -UN-31JUL89

S55,2525,M -19-15JUN89

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16

INSTALL WATER PUMP—6101AT001 ENGINES

NOTE: Guide studs may be used as an aid when installing water pump.

1. Using a hoist or an assistant, install water pump onto cylinder block with a new gasket.

2. Tighten four mounting cap screws to 68 N·m (50 lb-ft).

3. Install oil cooler-to-water pump hose (not shown) on pump elbow and tighten hose clamp securely.

4. Install bypass hose (A) on pump elbow and tighten hose clamp securely.

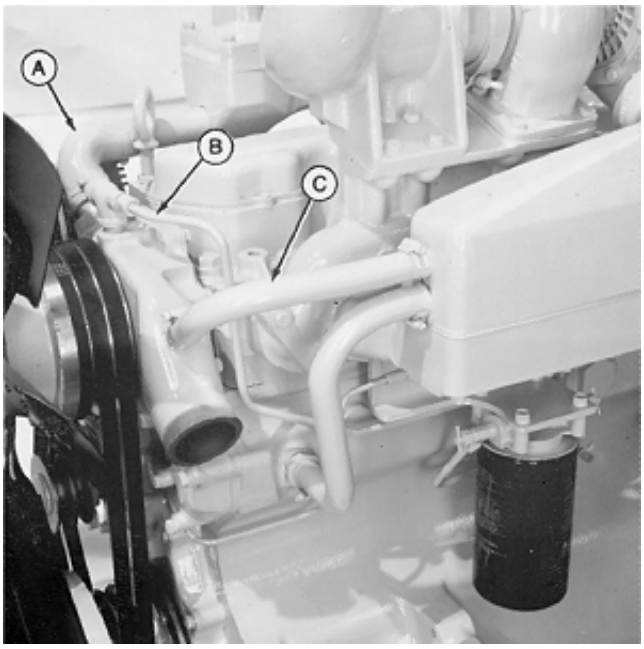
5. Install aftercooler inlet hose (C) onto water pump and tighten hose clamp securely.

6. Connect coolant filter conditioner line (B) using new packing and tighten securely.

7. Install fan and fan belts. Adjust belts to proper specification. (See CHECK AND ADJUST V-BELT TENSION, later in this group.)

8. Install washer and cap screw onto end of water pump shaft. Tighten cap screw to 115 N·m (85 lb-ft).

IMPORTANT: Air must be expelled from cooling system when refilling system. Loosen temperature sending unit fitting at rear of cylinder head or plug in water manifold to allow air to escape when filling system. Retighten fitting or plug when the cooling system is full and all the air has been expelled.



RG5515 -UN-09JAN90

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S55,2525,K -19-18NOV95

INSTALL WATER PUMP—6101HRW01, 02 ENGINES

NOTE: Guide studs may be used as an aid when installing water pump.

1. Using a hoist or an assistance, install water pump onto cylinder block with a new gasket.

2. Tighten four mounting cap screws to 68 N·m (50 lb-ft).

3. Install oil cooler-to-water pump hose (D). Tighten hose clamp securely.

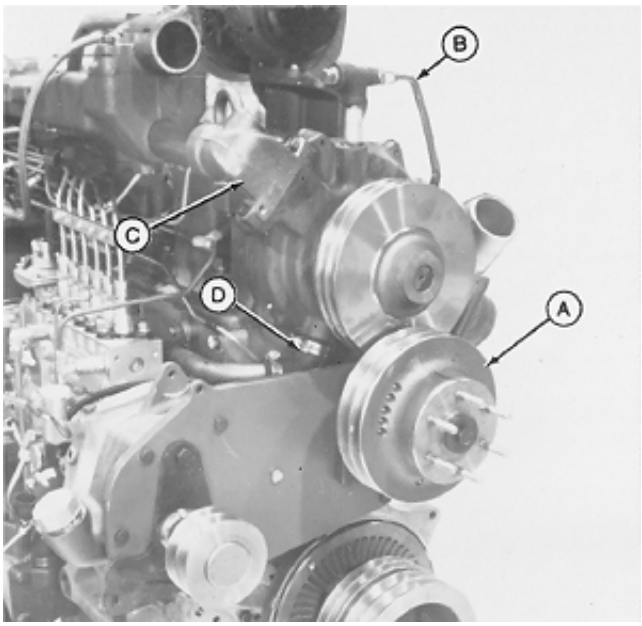
4. Install bypass elbow (C) using a new gasket and O-ring. Tighten cap screws to 27 N·m (20 lb-ft).

5. Connect coolant filter conditioner line (B) using new packing and tighten securely.

6. Install fan drive assembly (A). Be sure strap and spacer are in correct location and tighten cap screws to 68 N·m (50 lb-ft).

7. Install fan and fan belts. Adjust belts to proper specification. (See Adjust Fan Belt Tension, later in this group.)

IMPORTANT: Air must be expelled from cooling system. When refilling system. Loosen temperature sending unit fitting at rear of cylinder head or plug in water manifold to allow air to escape when filling system. Retighten fitting or plug when the cooling system is full and all the air has been expelled.



RG5516 -UN-09JAN90

A—Fan Drive Assembly
B—Coolant Filter Conditioner Line
C—Bypass Elbow
D—Oil Cooler-to-Water Pump Hose

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S55,2525,L -19-15JUN89

REMOVE WATER MANIFOLD

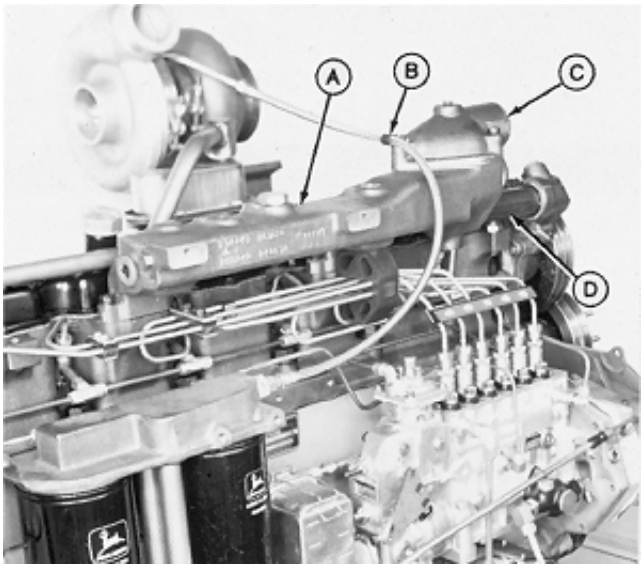
1. Drain coolant from the cooling system, if not previously done.

CAUTION: Do not drain engine coolant until the coolant temperature is below operating temperature. Always open drain cock slowly to relieve any excess pressure.

2. Remove turbocharger oil line clamp (B) from thermostat cover (C).

3. Remove four mounting cap scres to remove water manifold (A). Dislodge O-ring and bypass tube (D) from water manifold bore as manifold is being removed.

NOTE: Thermostat cover may be removed without removing water manifold. (See Remove and Test Thermostats, later in this group.)



RG5518 -UN-09JAN90

A—Water Manifold
B—Turbocharger Oil Line Clamp
C—Thermostat Cover
D—Bypass Tube

S55,2525,N -19-15JUN89

INSPECT AND CLEAN WATER MANIFOLD

1. Remove thermostat cover and thermostats.

2. Remove all gasket material and debris from manifold and cylinder head.

3. Inspect water manifold for cracks or damage.

4. Clean all passages to remove debris with clean solvent. Dry with compressed air.

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S11,2525,BV -19-21OCT86

INSTALL WATER MANIFOLD

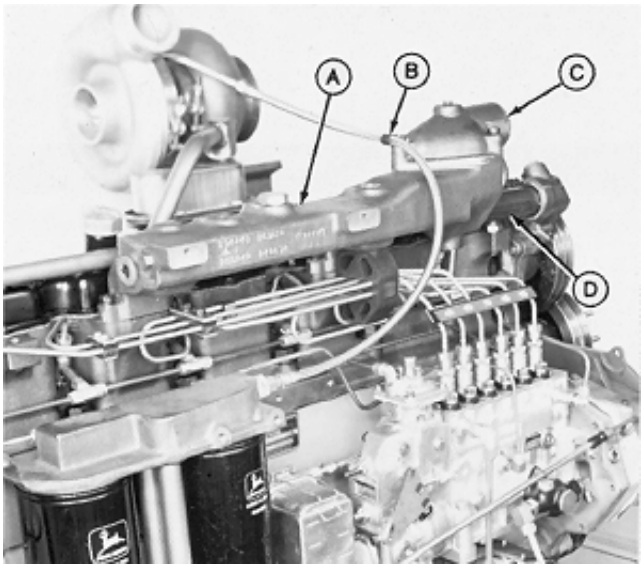
1. Install thermostats and thermostat cover (C) using a new gasket and LOCTITE 242, if removed. Tighten cap screws to 27 N·m (20 lb-ft).

2. Apply LOCTITE 242 to both water manifold mounting surfaces position a new gasket at each location.

3. Using a new O-ring install bypass tube (D) into bore of water manifold (A).

4. Position water manifold at the appropriate mounting surface and tighten cap screws to 47 N·m (35 lb-ft).

5. Install turbocharger oil line clamp (B) onto thermostat cover and tighten cap screw at 27 N·m (20 lb-ft).



RG5518 -UN-09JAN90

A—Water Manifold
B—Turbocharger Oil Line Clamp
C—Thermostat Cover
D—Bypass Tube

S55,2525,O -19-17NOV95

REMOVE THERMOSTATS

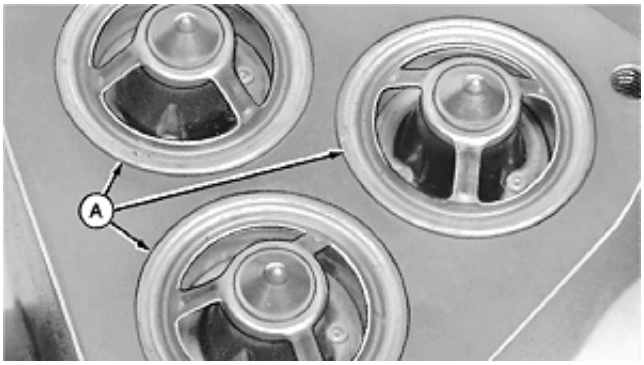
NOTE: Thermostats may be removed without removing water manifold.

1. Remove thermostat cover (shown removed). Inspect cover for cracks or damage.

2. Remove thermostats (A) from water manifold. Remove all gasket material from water manifold.

3. Clean and inspect thermostats. If required, test each thermostat. (See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE in Group 105.)

If any thermostat is defective, replace all thermostats.



RG3735 -UN-25SEP89

S11,2525,BX,1 -19-17NOV95

INSTALL THERMOSTATS

1. Apply LOCTITE 515 Flexible Sealant on water manifold-to-thermostat cover gasket surfaces.

2. Install thermostats where previously removed, using a new gasket.

3. Install thermostat cover and tighten cap screws to 27 N·m (20 lb-ft).

S11,2525,S -19-25JUL95

REMOVE COOLANT FILTER CONDITIONER

CAUTION: Do not remove coolant filter conditioner until coolant temperature is below operating temperature. Always loosen drain cock slowly to relieve any excess pressure. If coolant is to be reused put in a clean container and cover to prevent entry of contaminants.

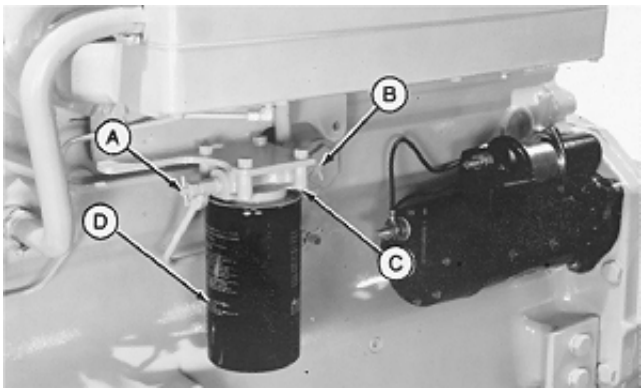
1. Close outlet shut-off valve (A) and inlet shut-off valve (B).

2. Remove and discard coolant filter element (D).

3. Remove attaching hardware and remove both inlet and outlet lines.

4. Remove filter base (C).

5. Clean and inspect coolant filter conditioner components as outlined later in this group.



RG5519 -UN-09JAN90

A—Outlet Shut-Off Valve
B—Inlet Shut-Off Valve
C—Filter Base
D—Filter Element

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S55,2525,P -19-15MAR89

INSPECT COOLANT FILTER CONDITIONER COMPONENTS

1. Inspect all hoses for cranks or pin holes. Replace as necessary.

2. Inspect filter base and shut-off valves for debris and damage. Replace as necessary.

3. Clean all coolant filter conditioner component parts using liquid household soap and water. Rinse thoroughly.

4. Dry with compressed air.

S11,2525,V -19-11FEB92

INSTALL COOLANT FILTER CONDITIONER

IMPORTANT: Apply joint sealing compound to all fittings before installation.

1. Install coolant conditioner filter base (C) to mounting bracket. Tighten cap screws to 47 N·m (35 lb-ft).

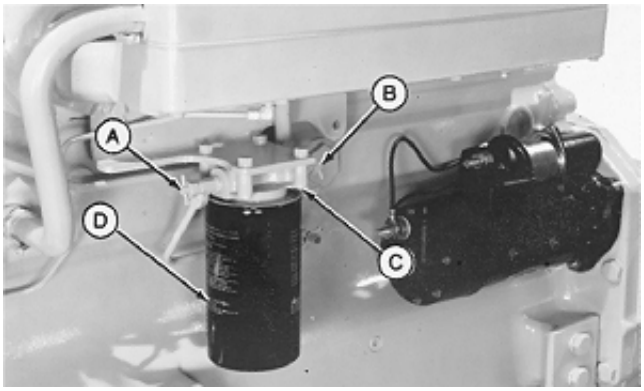
NOTE: Replace all packings at coolant line connections.

2. Install inlet shut-off valve (B) and outlet shut-off valve (A). Tighten all connections securely.

3. Install inlet and outlet lines. Tighten connections securely.

4. Apply a thin layer of clean engine oil on new coolant conditioner filter element gasket and install filter element (D).

5. Hand tighten filter element until gasket contacts filter base. Tighten element another 1/2—3/4 turn. DO NOT overtighten.



RG5519 -UN-09JAN90

A—Outlet Shut-Off Valve
B—Inlet Shut-Off Valve
C—Filter Base
D—Filter Element

S55,2525,Q -19-15MAR89

COMPLETE FINAL ASSEMBLY

1. Fill cooling system to proper level with the proper coolant. (See ENGINE COOLANT AND GENERAL COOLANT RECOMMENDATIONS in Group 02.)

2. Start engine and run for several minutes to check for leaks in the cooling system.

3. After fan belts cool, check belt tension. (See CHECK AND ADJUST V-BELT TENSION, later in this group.)

S11,2525,CD -19-25JUL95

CHECK AND ADJUST V-BELT TENSION

IMPORTANT: Do not check tension or release belts when hot.

NOTE: Measure tension on long part of front belt. Replace both belts if either of the pair is to be replaced. The belts must be a matched set to obtain satisfactory service life.

1. Check belt tension and replace belts as required. If adjustment is necessary, use JDG529 Belt Tension Gauge (A) for standard V-belts. Follow manufacturer's instructions.

2. Loosen alternator mounting cap screws.

IMPORTANT: DO NOT pry against alternator rear frame as this may damage the alternator housing.

3. Apply outward force to the front frame of the alternator until belt tension is correct.

4. Tighten alternator mounting cap screws securely.

After installing a new belt, run engine for about 10 minutes. Stop engine and check belt tension. If tension is not within new belt specifications, wait 10 minutes, loosen belt and adjust to used belt specifications.

• JDG529 Gauge Method:

V-BELT TENSION SPECIFICATIONS

	New Belt	Belt in Service*
2-Belt System (Front belt only)	422—463 N (95—104 lb-force)	378—418 N (85—94 lb-force)

• JDST28 Belt Tension Gauge/Straightedge Method:

On new and used standard V-belts, an 89 N (20 lb-force) halfway between the pulleys should deflect the belt 19 mm (3/4 in.).

*Belts are considered used after 10 minutes of operation.

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S11,2525,CE -19-06OCT95

REMOVE COOLANT HEATER—IF EQUIPPED

CAUTION: DO NOT plug coolant heater into electrical power unless element is completely immersed in water or coolant. Heater element sheath could burst and result in personal injury.

1. Unplug heater from electrical power source.

2. Drain cooling system.

3. Remove electrical cord, loosen nut, and pull heater element out of block.

RG,CTM61,G25,25-19-17MAR92

INSTALL COOLANT HEATER—IF EQUIPPED

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.

NOTE: The heater element (A) cannot be repaired. If defective, replace with a new one.

1. Lubricate O-ring (B) with clean engine oil and install onto groove of flange nut (D). Install gasket (C) onto heater element and install element into flange nut.

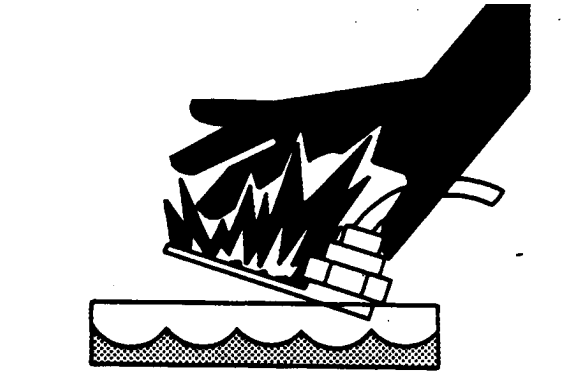
2. Install nut (E) onto threads of heater element finger tight only.

3. Install assembly into threaded heater hole in block. While holding heater element in the upward, vertical position, tighten flange nut to 68 N·m (50 lb-ft) making sure O-ring seals against block.

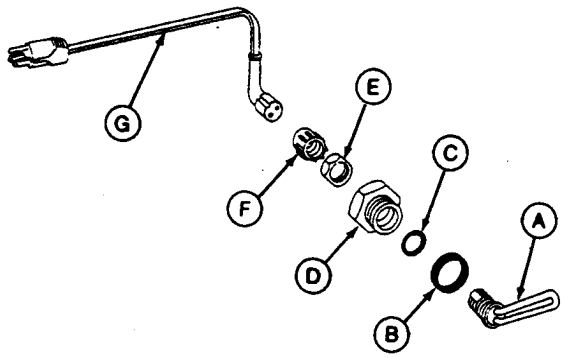
IMPORTANT: HEATER element must remain in upright vertical position after installation. Heater element may be damaged if it touches internal walls of block.

4. Hold assembly so that flats on threaded end of heater element are vertical. Tighten nut to 34 N·m (25 lb-ft).

5. Install wiring lead (G) or dust cap (F) when wiring lead is not being used.



TS210 -UN-23AUG88



RG5275 -UN-14DEC88

A—Heating Element
B—O-Ring
C—Gasket
D—Flange Nut Adapter
E—Nut
F—Cap
G—Wiring Lead

RG,CTM42,G25,30-19-05MAY93

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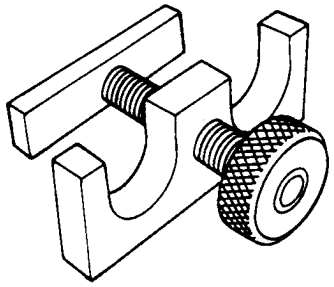
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

Sealing Ring Compression Tool JDG683

Used to compress aftercooler sealing ring for cover-to-intake manifold alignment during assembly.



RG5571 -UN-04JUL89

S53,JDG683 -19-20JUN89

AIR INTAKE AND EXHAUST SYSTEM SPECIFICATIONS

TURBOCHARGER SCHWITZER S3A (6101H ENGINES)

Item	Specification
Total Indicator Reading Limits	
Radial Bearing Clearance (Max.)	0.84 mm (0.0331 in.)
Bearing End Play	0.081—0.119 mm (0.0032—0.0047 in.)
Compressor V-Band Clamp Nut Torque	9.5—11 N·m (7—8 lb-ft)
Turbine V-Band Clamp Nut Torque	9.5—11 N·m (7—8 lb-ft)
Turbocharger Mounting Cap Screw Torque	47 N·m (35 lb-ft)
Turbocharger Oil Return Line Torque	47 N·m (35 lb-ft)
Exhaust Elbow Mounting Cap Screw Torque	47 N·m (35 lb-ft)

TURBOCHARGER GARRET/AIRESEARCH T45 (6101A ENGINES)

Total Indicator Reading Limits	
Radial Bearing Clearance	0.122—0.173 mm (0.0048—0.0068 in.)
Bearing End Play	0.051—0.081 mm (0.0020—0.0032 in.)
Turbine V-Band Clamp Nut Torque	Tighten to 18 N·m (13 lb-ft) Loosen to 5.5 N·m (4 lb-ft) Retighten to 13.5 N·m (10 lb-ft)
Compressor Housing-to-Center Housing Clamp Torque	15.3—18.7 N·m (11—14 lb-ft)
Turbocharger Mounting Cap Screw Torque	47 N·m (35 lb-ft)
Turbocharger Oil Return Line Torque	47 N·m (35 lb-ft)
Exhaust Elbow Mounting Cap Screw Torque	47 N·m (35 lb-ft)

AFTERCOOLER, INTAKE AND EXHAUST MANIFOLD TORQUES

Exhaust Manifold-to-Cylinder Head	95 N·m (70 lb-ft)
Intake Manifold-to-Cylinder Head	
6101A Engines	75 N·m (55 lb-ft)
6101H Engines	75 N·m (55 lb-ft)
Intake Manifold (Aftercooler) Cover-6101A Engines	60 N·m (44 lb-ft)

S55,3005,AL -19-17NOV95

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OTHER MATERIAL

Name	Use
PT569 NEVER-SEEZ® Compound	Exhaust manifold cap screws and aftercooler cover-to-intake manifold cap screws
TY9375 (LOCTITE 592) Pipe Sealant with TEFLON®	Turbocharger oil supply and drain lines.

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

S11,3005,MT -19-09SEP91

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**

S55,3005,E -19-06APR94

- **Lack of Lube Oil**

Oil not only lubricates the turbocharger's spinning shaft and bearings, it also carries away heat. When oil flow stops or is reduced, heat is immediately transferred from the hot turbine wheel to the bearings, which are also heating up because of the increased friction due to the lack of oil. This combination causes the turbocharger shaft temperature to increase rapidly.

If oil flow does not increase and the process continues, bearings will fail. Once the bearings fail (which can happen in just seconds) seals, shaft, turbine and compressor wheels can also be damaged.

The principle causes of turbocharger bearing lubrication problems are low oil pressure, a bent, plugged or undersized oil lube supply line, plugged or restricted oil galleries in the turbocharger, or improper machine start-up and shutdown procedure.

Oil levels and pressure should always be closely monitored and all worn hoses and lines should be replaced. The turbocharger oil supply line should be checked frequently to make sure it is not kinked or bent and it should always be replaced with a line of equal size, length and strength.

The easiest way to damage a turbocharger is through improper start-up and shutdown procedures. Always idle the engine for at least 30 seconds (no load) after start-up and before shutdown. Warming the engine up before applying a load allows oil pressure to build up and lines to fill with oil.

Idling the engine before shutdown allows the engine and turbocharger to cool. "Hot" shutdowns can cause the turbocharger to fail because after high-speed operation the turbocharger will continue to rotate long after the engine has been shut off and oil pressure has dropped to zero. This will cause heat to build up and possible bearing damage. It can also cause carbon and varnish deposits to form.

S55,3005,F -19-04JUN93

• 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.

S11,3005,MK -19-04JUN93

• 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.

S11,3005,ML -19-07JUL95

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• 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.

RG,CTM8,G30,R1 -19-07JUL95

- **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 case wheel burst.

There are two basic causes of over-temperature. The first is restricted air flow and the second is overpowering the engine. In either case the engine has more fuel than available air for proper combustion, this overfueled condition leads to elevated exhaust temperatures.

Causes of restricted air flow can include damaged inlet piping, clogged air filters, excessive exhaust restriction, or operation at extreme altitudes. Overpowering generally is due to improper fuel delivery or injection timing. If overtemperature operation has been identified, an inspection of the air inlet and exhaust systems should be performed. Also, check the fuel delivery and timing.

RG,CTM8,G30,R2 -19-19AUG92

REMOVE TURBOCHARGER (GARRETT/AIRESEARCH T45 AND SCHWITZER S3A)

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

NOTE: Currently 6101A Engines are equipped with a Garrett/AiResearch turbocharger and 6101H Engines are equipped with a Schwitzer turbocharger. Removal and installation procedures are similar for both turbochargers; but service inspection limits differ. Refer to the proper service/inspection group when servicing turbochargers.

IMPORTANT: When cleaning a 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.)

Clean exterior of turbocharger and surrounding area to prevent entry of dirt into the air intake system during removal.

S55,3005,AO -19-17NOV95

(6101H Engine shown, 6101A similar)

1. Remove exhaust elbow and exhaust adapter (shown removed).

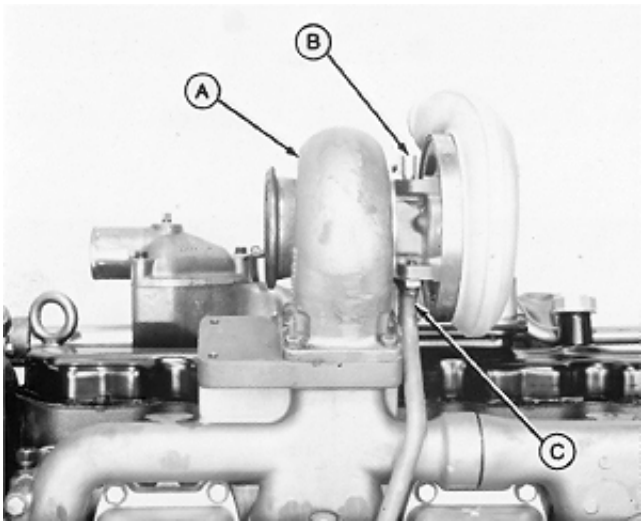
2. Disconnect oil inlet line (B). Disconnect oil return tube (C).

3. Remove four turbocharger mounting cap screws. Disengage turbocharger (A) from intake manifold coupling and carefully lift turbocharger from exhaust manifold.

4. Place turbocharger on a clean flat surface.

5. Cap or plug all air intake and exhaust openings.

6. Perform turbocharger seven-step inspection as described later in this group, if failure mode has not yet been determined.



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S55,3005,AP -19-17NOV95

DIAGNOSING TURBOCHARGER MALFUNCTIONS

The following is a guide for diagnosing air intake system malfunctions by inspection of the turbocharger when removed from the engine. Refer to Operation and Tests section of the machine technical manual for diagnosis of air intake system malfunctions BEFORE removal of turbocharger from engine.

Symptom	Problem	Solution
COMPRESSOR HOUSING INLET DEFECTS:		
Foreign Object Damage	Objects left in intake system.	Disassemble and inspect intake system for foreign objects (this group).
	Leaking and/or defective intake system.	Inspect air intake system connections including air filter; repair as required (this group).
		Inspect air intake related engine components
Compressor Wheel Rub	Bearing failure.	Determine if engine and/or operator contributed to lack of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in progress. Correct as required.
	Manufacturing defects.	Correct as required.
COMPRESSOR HOUSING OUTLET DEFECTS:		
Oil and/or Dirt in Housing	Restricted air intake system.	Inspect and clean air cleaner.
	Prolonged periods of low RPM engine idling.	Check with operator to confirm conditions. (See Operators manual.)
	Defective oil seal ring.	Repair as required. (This group.)
	Restricted oil drain line.	Inspect and clear oil drain line as required.
TURBINE HOUSING INLET DEFECTS:		
Oil in Housing	Internal engine failure.	Inspect and repair engine as required.

Continued on next page

Symptom	Problem	Solution
	Oil leaking from compressor housing seal.	Verify that oil is in compressor housing and refer to “Compressor Housing Outlet Defects” as listed earlier in this chart.
Center Wall Deteriorated	Excessive operating temperature.	Check for restricted air intake.
		Check engine for overfueling.
		Check injection pump timing.
TURBINE HOUSING OUTLET DEFECTS:		
Turbine Wheel Rub	Bearing Failure.	Determine if engine and/or operator contributed to lack of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in progress. Correct as required.
	Manufacturing defect.	Correct as required (this group).
Foreign Object Damage	Internal engine failure.	Inspect and repair engine as required.
	Objects left in intake or exhaust system.	Disassemble and inspect air intake or exhaust system, (this group).
	Leaking air intake system.	Correct as required, (this group).
Oil and/or Excessive Carbon in Housing	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 high 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).

Continued on next page

Symptom	Problem	Solution
	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.
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 Operator's manual.
	Excessive operating temperature.	Restricted air intake; Overfueling or Mistimed engine
	Restricted oil drain line.	Inspect and clean oil drain lines as required.
	Operating engine at high speeds and loads immediately after start-up.	Idle engine for a few minutes to allow oil to reach bearings before applying heavy loads.

RG,CTM42,G30,10-19-24APR92

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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 following pages, are:

—Compressor Housing Inlet and Compressor Wheel.
—Compressor Housing Outlet.
—Turbine Housing Inlet.
—Turbine Housing Outlet and Turbine Wheel.
—External Center Housing and Joints.
—Internal Center Housing.
—Turbocharger Bench Test.

NOTE: To enhance the turbocharger inspection, an inspection sheet (Form No. DF-2280 available from Distribution Service Center) 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.

S11,3005,IF -19-07JUL95

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.

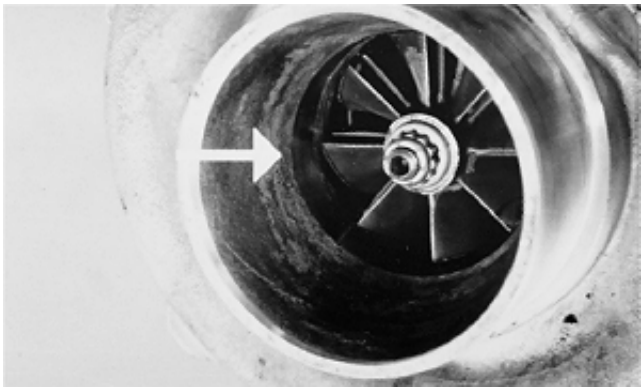
2. Mark findings on your checklist and continue the inspection.

RG4523 -UN-20DEC88

S11,3005,IG -19-07AUG92

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.

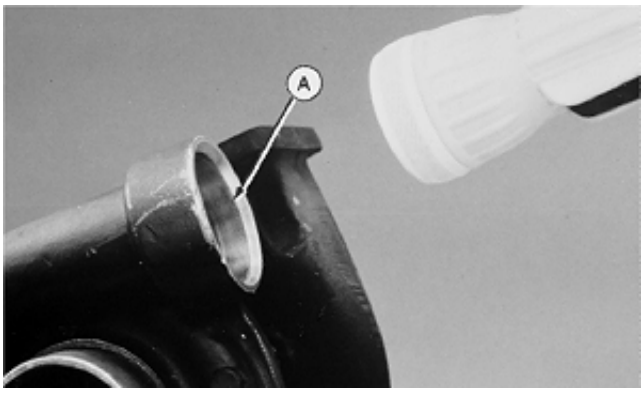


S11,3005,IH -19-07AUG92

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.

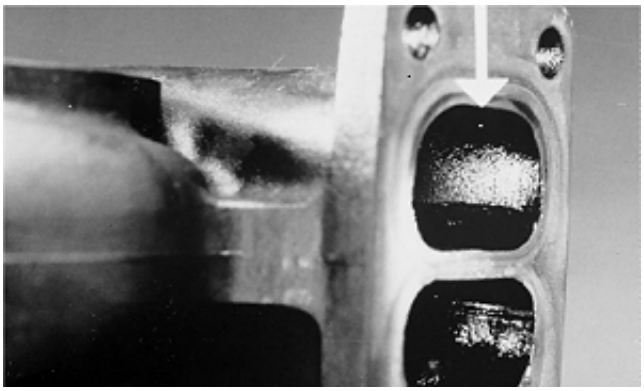


S11,3005,II -19-07AUG92

Turbine Housing Inlet

1. 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.



S11,3005,IJ -19-11SEP92

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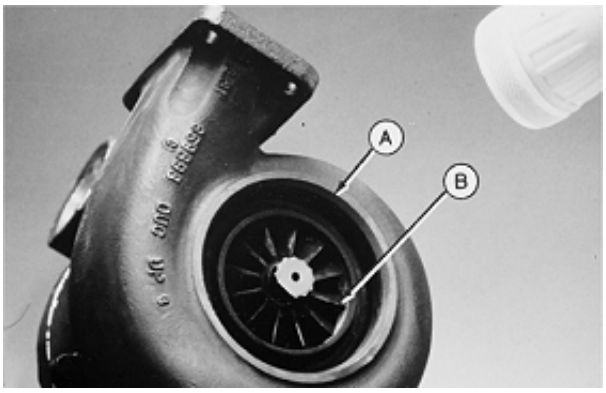
11

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.



S11,3005,IK -19-11SEP92

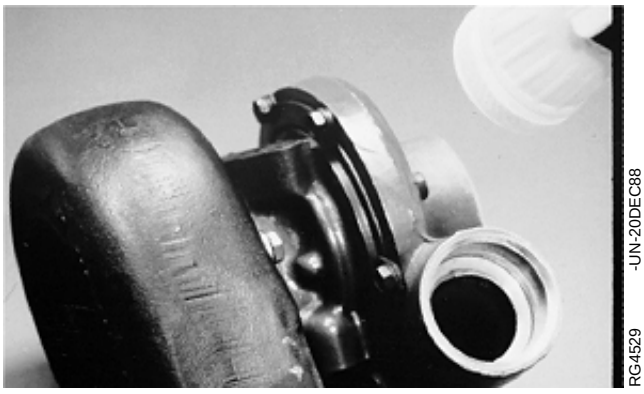
2. Inspect the wheel blades and housing for evidence of wheel rub (arrow). Wheel rub can bend the tips of the blades with the housing showing wear or damage.

S11,3005,IL -19-11SEP92

External Center Housing and Joints

1. Visually check the outside of the center housing, all connections to the compressor, and turbine housing for oil.

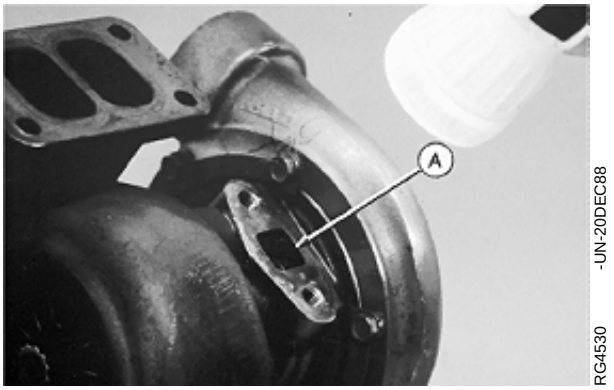
NOTE: If oil is present, make sure it is not coming from a leak at the oil supply or return line.



S11,3005,IM -19-07AUG92

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.



S11,3005,IN -19-07AUG92

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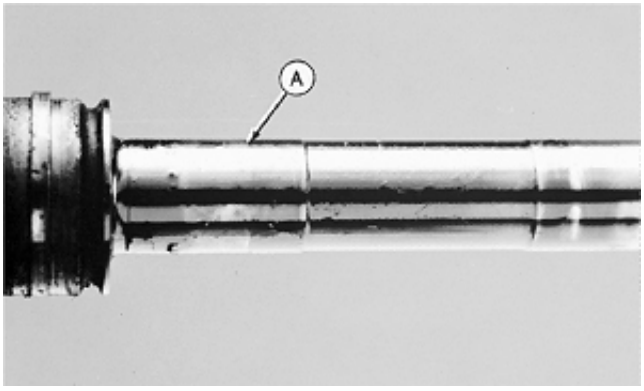
2. Excessive “blueing” or “coking” of oil along the complete length of the shaft (A) indicates a possible lack of lubrication caused by an engine failure, or improper operation, such as hot shutdowns.

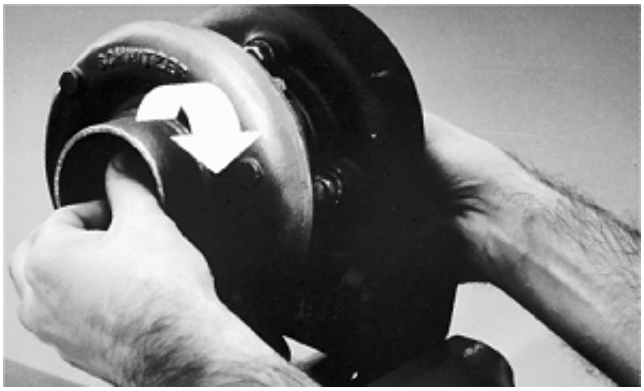


S11,3005,IO -19-07AUG92

Turbocharger Bench Test

1. Mount the turbocharger in a vise.

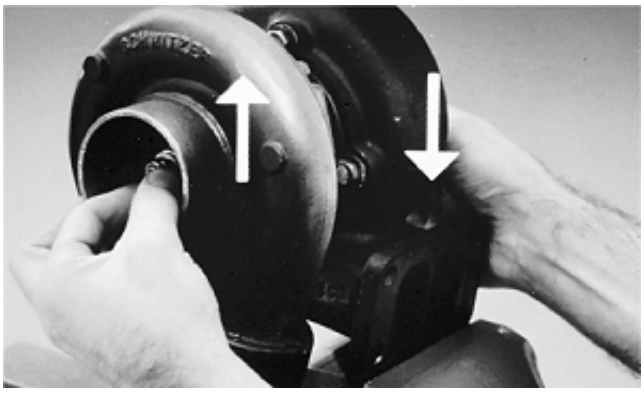
2. Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely, however, there may be a slight amount of drag.



S11,3005,IP -19-29APR93

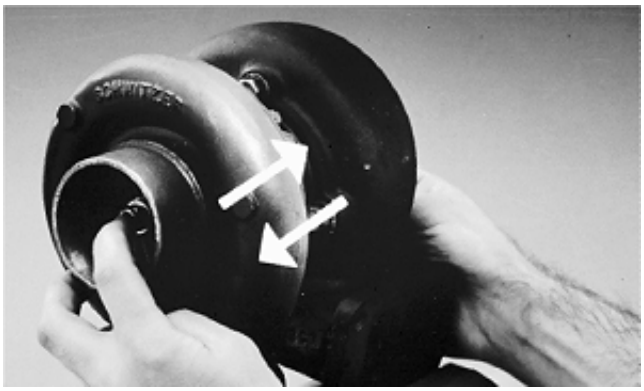
3. Next, pull up on the compressor end of the shaft and press down on the turbine end while rotating shaft. Neither the compressor wheel nor the turbine wheel should contact the housing at any point.

NOTE: There will be some "play" because the bearings inside the center housing are free floating.



S11,3005,IQ -19-07AUG92

4. Next, check shaft endplay 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.



S11,3005,IR -19-07AUG92

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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.

IMPORTANT: Before you finalize your conclusion that the turbocharger has not failed, it is strongly recommended that the following procedures of checking radial bearing clearance and axial bearing endplay with a dial indicator be performed. These procedures are not required if a failure mode has already been identified.

S11,3005,IS -19-14OCT94

PERFORM RADIAL BEARING CLEARANCE TEST (GARRET/AIRESEARCH T45)

This test will give an indication of the condition of the radial bearings within the center housing and rotating assembly.

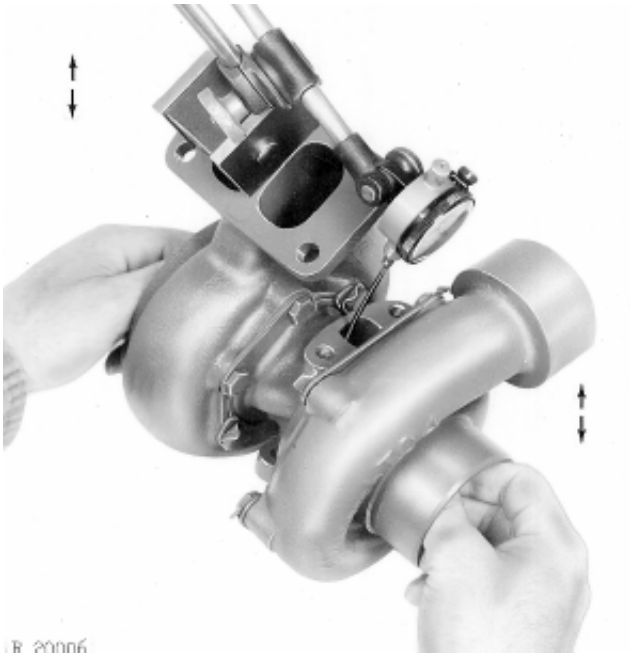
1. Fasten a magnetic base (plunger-type) dial indicator to turbocharger mounting base. Assemble an extension adapter and a 51 mm (2.0 in.) indicator extension rod onto dial indicator.

2. Position indicator tip (through center housing oil return) on center of shaft. Preload indicator tip and zero dial on indicator.

3. Grasp rotating shaft at both ends and move the shaft toward the indicator then away from the indicator (arrows). Use care to move the shaft in the same direction as the dial indicator tip travels and apply equal pressure at both ends of the shaft.

4. Observe and record total dial indicator reading. Bearing clearance specification is 0.122—0.173 mm (0.0048—0.0068 in.).

If total indicator reading is not within specification, replace center housing and rotating assembly. (See Replace Center Housing and Rotating Assembly (Garret/AiResearch T45) later in this group.)



R20006 -UN-20DEC88

S55,3005,AQ -19-10APR89

PERFORM AXIAL END PLAY BEARING TEST (GARRETT/AIRESEARCH T45)

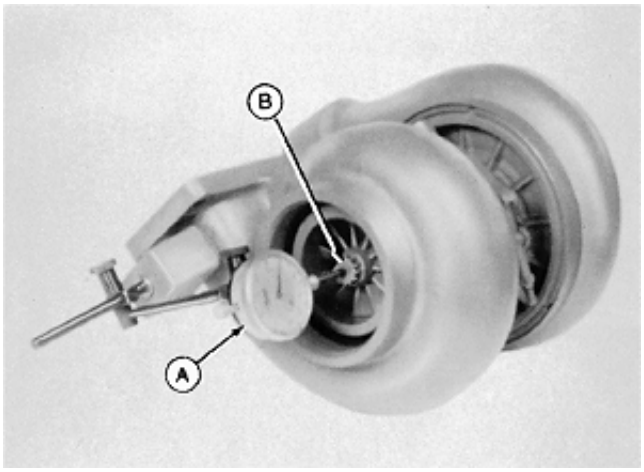
This test will give an indication of the condition of the thrust bearing within the center housing and rotating assembly.

1. Mount magnetic base dial indicator (A) so that indicator tip (B) restson end of shaft. Preload indicator tip and zero dial on indicator.

2. Move shaft axially back and forth by hand.

3. Observe and record total dial indicator reading. Bearing end play specification is 0.051—0.081 mm (0.0020—0.0032 in.).

If bearing end play is not within specification, replace center housing and rotating assembly as outlined later in this group.



R24641 -UN-09FEB90

S55,3005,AR -19-10APR89

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PERFORM RADIAL BEARING CLEARANCE TEST (SCHWITZER S3A)

This test will give an indication of the condition of the radial bearings within the center housing and rotating assembly.

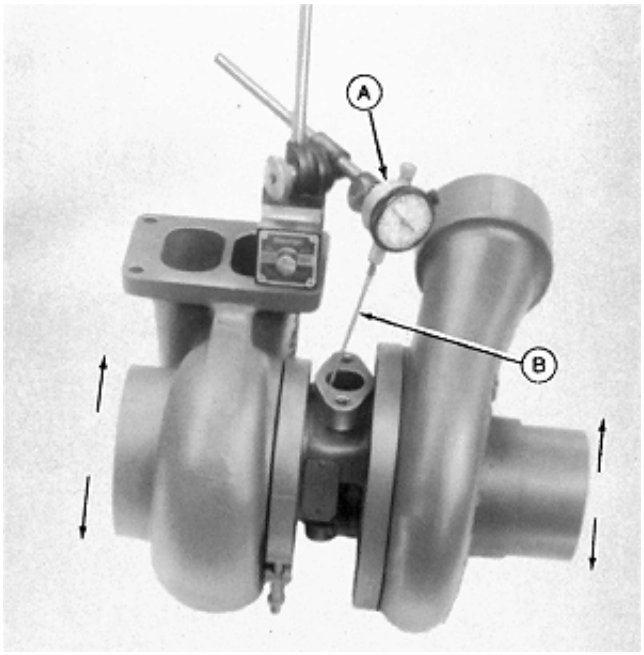
1. Fasten a magnetic base (plunger-type) dial indicator (A) to turbocharger mounting base. Assemble an extension adapter and a 51 mm (2.0 in.) indicator extension rod (B) onto dial indicator.

2. Position indicator tip (thru center housing oil return) on center of shaft. Preload indicator tip and zero dial on indicator.

3. Grasp rotating shaft at both ends and move the shaft toward the indicator then away from the indicator (arrows). Use care to move the shaft in the same direction as the dial indicator tip travels and apply equal pressure at both ends of the shaft.

4. Observe and record the total dial indicator reading. Maximum acceptable bearing clearance is 0.84 mm (0.033 in.).

If clearance exceeds specification given above replace center housing and rotating assembly. (See REPLACE CENTER HOUSING AND ROTATING ASSEMBLY (SCHWITZER S3A), later in this group.)



R24640 -UN-09FEB90

S55,3005,AS -19-17MAR92

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16

PERFORM AXIAL END PLAY BEARING TEST (SCHWITZER S3A)

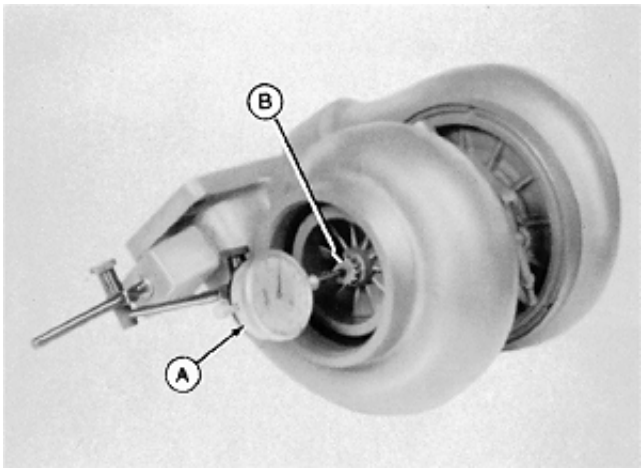
This test will give an indication of the condition of thrust bearing within the center housing and rotating assembly.

1. Mount magnetic base dial indicator (A) so that indicator tip (B) rests on end of shaft. Preload indicates tip and zero dial on indicator.

2. Move shaft axially back and forth by hand.

3. Observe and record total dial indicator reading. Bearing end play specification is 0.081—0.119 mm (0.0032—0.0047 in.).

If bearing end play is not within specification, replace center housing and rotating assembly as outlined later in this group.



R24641 -UN-09FEB90

S55,3005,AT -19-17MAR92

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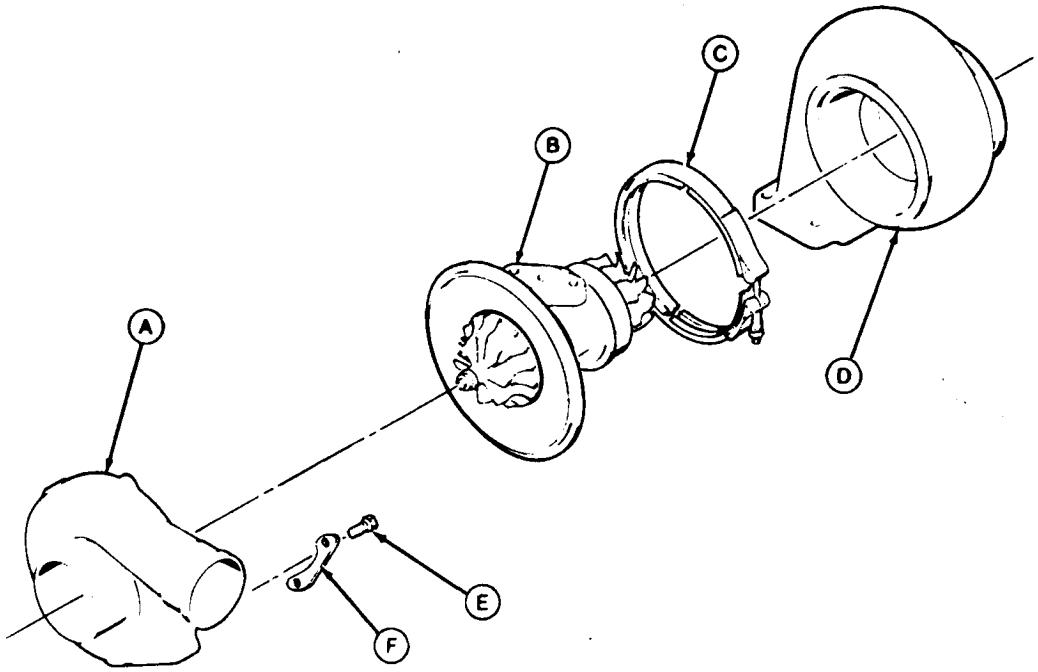
17

DISASSEMBLE AND INSPECT TURBOCHARGER (GARRETT/AIRESEARCH T45)



A—Compressor Housing
B—Center Housing and Rotating Assembly
C—Turbine V-Band Clamp
D—Turbine Housing
E—Cap Screw (8 used)
F—Clamp (4 used)

S55,3005,AU -19-13NOV95

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IMPORTANT: Use a scribe to mark related index positions of the compressor, center and turbine housings and/or V-band prior to disassembly. These reference marks are essential for proper index angles during reassembly.

1. Loosen V-band clamp nut (D). Remove locknut if necessary.

NOTE: DO NOT press on the rotating assembly and carefully remove housings to eliminate any further component damage.

2. Remove the turbine housing (C) from center housing and rotating assembly (B).

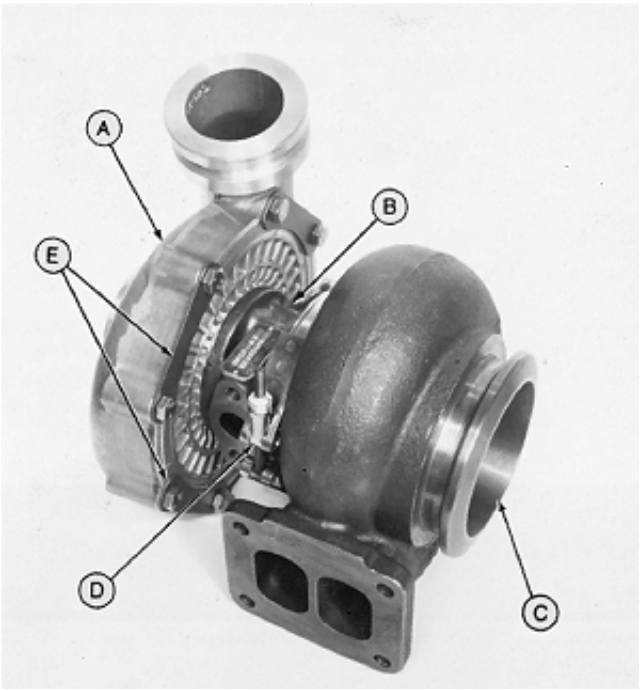
3. Remove four clamps (E) securing compressor housing (A) to center housing. If necessary, tap the housing with a soft hammer and carefully remove.

4. Thoroughly clean the compressor and turbine housings using a commercially approved solvent only. A caustic solution may damage housings. Dry housings with compressed air.

5. 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.

6. 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 center housing mounting holes.

Replace either housing if either of the above defects are found.



RG5554 -UN-09JAN90

A—Compressor Housing
B—Center Housing and Rotating Assembly
C—Turbine Housing
D—V-Band Clamp
E—Clamp (4 used)

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19

S55,3005,AV -19-17MAR92

REPLACE CENTER HOUSING AND ROTATING ASSEMBLY (GARRETT/AIRESEARCH T45)

1. Carefully transfer the scribed marks from the original center housing (B) to the replacement assembly, if necessary. Use the same procedure for compressor (A) and turbine (C) housings if they are being replaced.

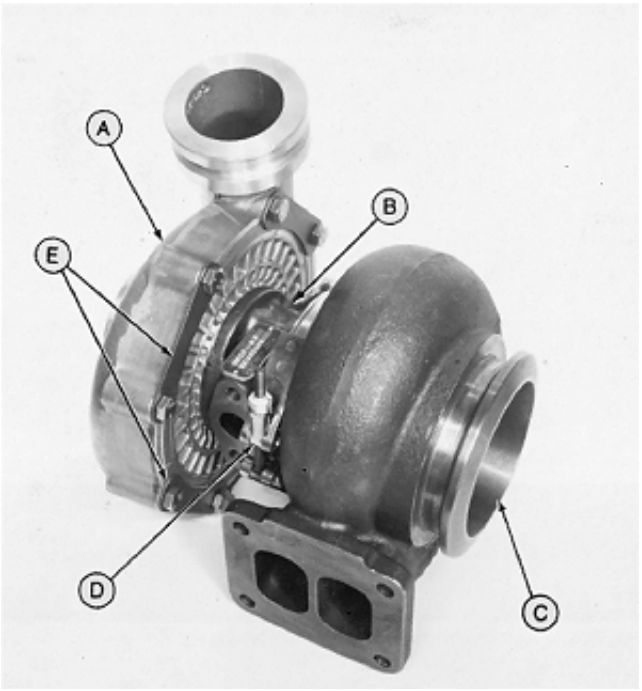
2. Install V-band clamp (D) loosely on turbine side of center housing. Align the turbine and center housing scribed marks and position V-band clamp.

NOTE: Coat T-bolt threads on V-band clamps and all clamp cap screws with PT569 NEVER-SEEZ® during assembly.

3. Tighten clamp nut to 18 N·m (13 lb-ft). Next, loosen the nut to 5.5 N·m (4 lb-ft), then retighten to 13.5 N·m (10 lb-ft).

4. Align compressor and center housing scribed marks. Coat threads of cap screws with PT569 NEVER-SEEZ®, position clamps (E) and install cap screws. Tighten cap screws to 15.3—18.7 N·m (11—14 lb-ft).

5. After assembly, check the center housing and rotating assembly for binding and wheel rub. If either condition exists, disassemble turbocharger and correct the cause.

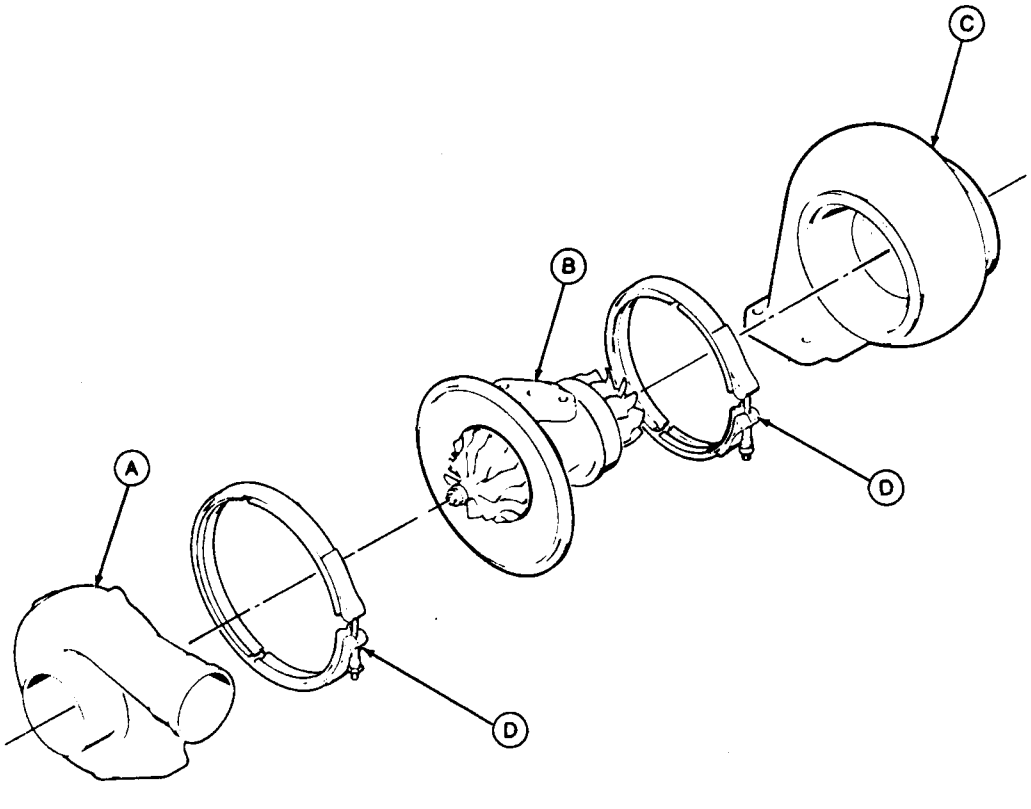


RG5554 -UN-09JAN90

A—Compressor Housing
B—Center Housing and Rotating Assembly
C—Turbine Housing
D—V-Band Clamp
E—Clamp (4 used)

S55,3005,AW -19-17NOV95

DISASSEMBLE AND INSPECT TURBOCHARGER (SCHWITZER S3A)



A—Compressor Housing

B—Center Housing and Rotating Assembly

C—Turbine Housing

D—V-Band Clamps (2 used)

S55,3005,AX -19-14APR89

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21

IMPORTANT: Use a scribe to mark index positions of the compressor, center and turbine housings prior to disassembly. These reference marks are essential for proper indexing of turbine and compressor housings, when turbocharger is reassembled.

1. Loosen V-band clamp nut (A) on both clamps. Remove locknut if necessary.

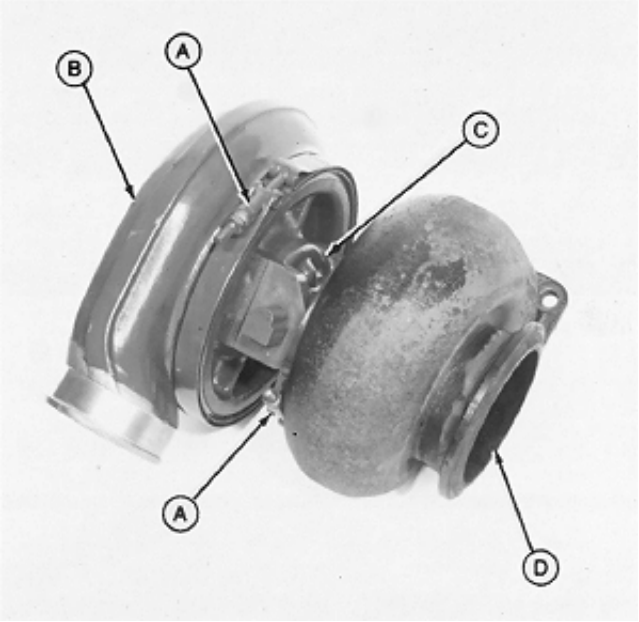
NOTE: DO NOT press on rotating assembly and carefully remove housings to eliminate any further component damage.

2. Remove the compressor housing (B) and turbine housing (D) from center housing and rotating assembly (C).

3. Thoroughly clean compressor and turbine housings using a commercially approved solvent only. A caustic solution may damage housings. Dry housings with compressed air.

4. Inspect the compressor and turbine housings for:
—Wheel rub damage within the contour area that cannot be polished out with 80-grit (60-grit for turbine housing) silicon carbide abrasive cloth.
—Nicks, dents or warpage that could prevent proper sealing between the turbine/compressor housing and center housing.

Replace either housing if either of the above defects are found.



RG5569 -UN-09JAN90

A—V-Band Clamp (2 used)
B—Compressor Housing
C—Center Housing and Rotating Assembly
D—Turbine Housing

S55,3005,AY -19-16APR93

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22

REPLACE CENTER HOUSING AND ROTATING ASSEMBLY (SCHWITZER S3A)

1. Carefully transfer the scribed marks from the original center housing (C) to the replacement assembly, if necessary. Use the same procedure for compressor (B) and turbine (D) housings if they are being replaced.

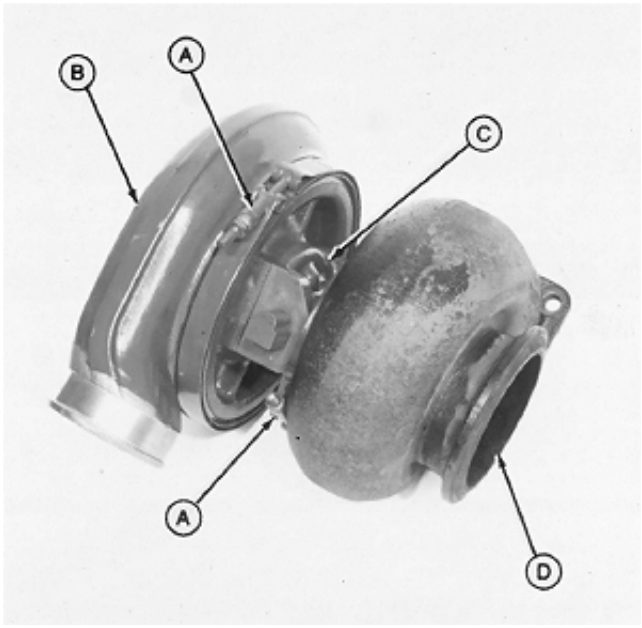
2. Install both V-band clamps (A) loosely on center housing. Align the turbine and center housing scribed marks and position the V-band clamp.

NOTE: Coat T-bolt threads on V-band clamps with PT569 NEVER-SEEZ® during assembly.

3. Tighten V-band clamp nut 9.5—11 N·m (7—8 lb-ft).

4. Follow the same above procedure and install the compressor housing. Tighten V-band clamp nut 9.5—11 N·m (7—8 lb-ft).

5. After assembly, check the center housing and rotating assembly for binding and wheel rub. If either condition exists, disassemble turbocharger and correct the cause.



RG5569 -UN-09JAN90

A—V-Band Clamp (2 used)
B—Compressor Housing
C—Center Housing and Rotating Assembly
D—Turbine Housing

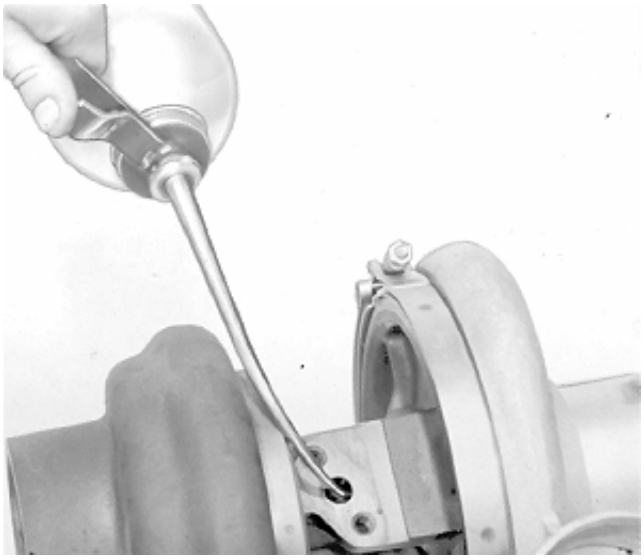
S55,3005,AZ -19-17MAR92

PRELUBE TURBOCHARGER

IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

Fill oil inlet or drain port with clean engine oil and spin rotating assembly by hand to properly lubricate bearings.

If turbocharger is to be stored for an extended period of time, lubricate internally and install protective covers on all openings.



RG4361 -UN-20DEC88

S55,3005,BA -19-07JUL95

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.

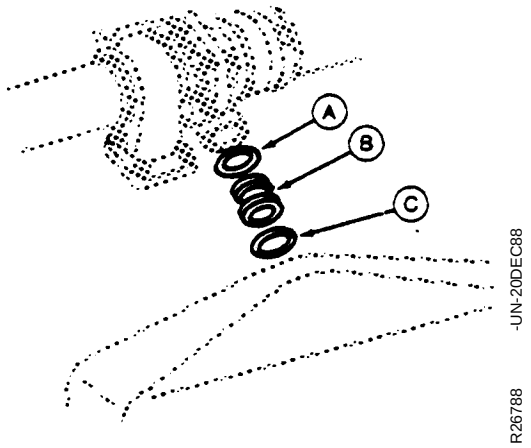
Just prior to mounting the turbocharger, prime the turbocharger lubrication system. Fill the center housing with new engine oil through the oil drain hole. Turn the rotating assembly by hand to lubricate the bearings and thrust washer.

Inspect the air cleaner-to-turbocharger air intake hose to see that it is in good condition. Replace hose if it is hard or shows any sign of deterioration.

NOTE: Turbocharger installation procedure for 6101A and 6101H Engines are similar, differences will be noted.

1. On 6101A Engines, coat O-rings (A and C) with liquid soap or grease and install on coupling (B).

2. Place a new gasket on turbocharger-to-exhaust manifold mounting surface (not illustrated).



S55,3005,BB -19-12FEB92

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3. Mount turbocharger on engine, making sure coupling (E) is properly seated in compressor housing.

NOTE: Guide studs may be used to position exhaust gasket during turbocharger installation.

4. Apply PT569 NEVER-SEEZ® or equivalent to all turbocharger mounting cap screws. Install cap screws and tighten to 47 N·m (35 lb-ft).

NOTE: Remove all caps or plugs from turbocharger openings.

5. Using a new gasket, install oil return tube (D). Tighten cap screws securely. Connect oil inlet line (C) and tighten securely.

6. Install exhaust adapter (B) to turbine housing outlet with V-band clamp. Tighten clamp securely.

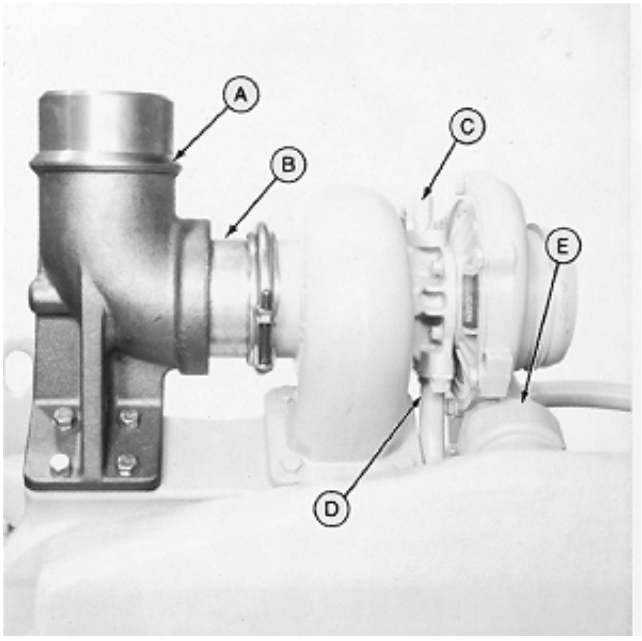
7. Install exhaust elbow (A). Apply PT569 NEVER-SEEZ® Compound or equivalent to mounting cap screws and tighten to 47 N·m (35 lb-ft).

8. On 6101H Engines, refer to your machine technical manual for details on all air intake hose connections.

9. Inspect the air cleaner-to-turbocharger hoses to see that they are in good condition. If they are not, replace as needed. Install air intake hose and tighten hose clamps securely.

IMPORTANT: BEFORE STARTING an engine with a new or repaired turbocharger, crank the engine over (but do not start) for several seconds to allow engine oil to reach turbocharger bearings.

10. Start and run engine at low idle while checking oil inlet and air passage connections for leaks.



RG5283 -UN-20DEC88

A—Exhaust Elbow
B—Exhaust Adapter
C—Oil Inlet Line
D—Oil Return Line
E—Coupling

S55,3005,BC -19-17NOV95

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REMOVE AFTERCOOLER ASSEMBLY AND INTAKE MANIFOLD (6101A ENGINES)

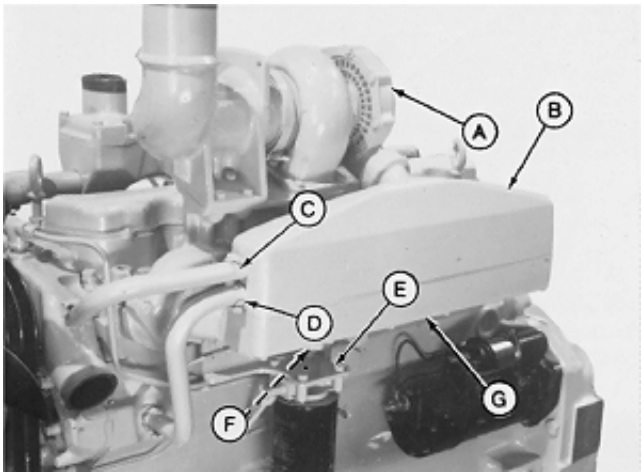
1. Remove turbocharger (A) as described earlier in this group.

2. Remove coolant outlet hose (C) and inlet hose (D) from aftercooler.

3. Remove aftercooler cover (B). Carefully lift aftercooler from intake manifold. Remove and discard both gaskets and sealing ring.

4. Remove aneroid-to-intake manifold line (F).

5. Remove intake manifold (G) along with coolant conditioner filter mounting bracket (E).



RG5555 -UN-04JUL89

A—Turbocharger
B—Aftercooler Cover
C—Coolant Outlet
D—Coolant Inlet
E—Coolant Conditioner Filter Assembly
F—Aneroid-to-Intake Manifold Line
G—Intake Manifold

S55,3005,BD -19-14APR89

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26

INSPECT AND REPAIR AFTERCOOLER (6101A ENGINES)

1. Inspect aftercooler for overall condition. The fins should be reasonably straight.

2. Inspect aftercooler inlet and outlet hoses. Replace either hose if cracked or damaged.

3. Test the aftercooler for leaks by plugging either nipple (A or B).

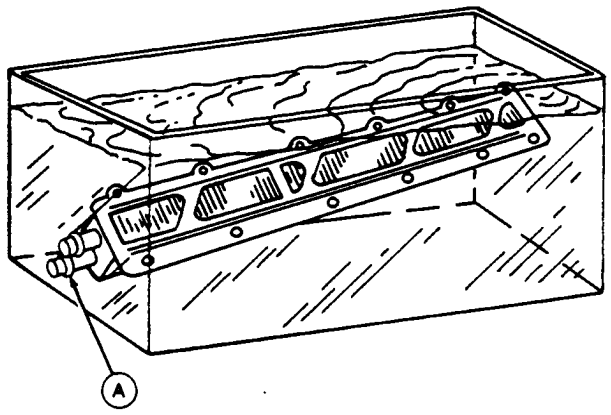
4. Apply compressed air to the other nipple while unit is submerged under water. Use 140—170 kPa (1.4—1.7 bar) (20—25 psi) air pressure for testing.

A minor leak that is accessible may be repaired. However, if the condition of the core is questionable, replace aftercooler.

IMPORTANT: Coolant leakage from the aftercooler may cause severe engine damage.

5. Inspect air intake cover for cracks or damage. Replace as necessary.

6. Clean cover with clean solvent and dry with compressed air.



RG5572 -UN-04JUL89

S55,3005,BE -19-17MAR92

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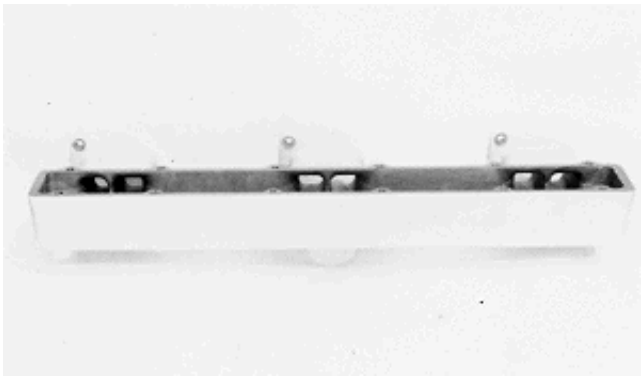
INSPECT AND REPAIR INTAKE MANIFOLD (6101A ENGINES)



1. Check intake manifold for damage.

2. Inspect machined mounting surfaces for burrs or other defects which might prevent gaskets from sealing properly. Repair as required.

3. Thoroughly steam clean interior of intake manifold and covers.

IMPORTANT: Do not use a hot tank to clean aluminum parts as damage and severe deterioration can occur.

4. Scrape all gasket material from cylinder block and intake manifold.

S55,3005,BF -19-14APR89

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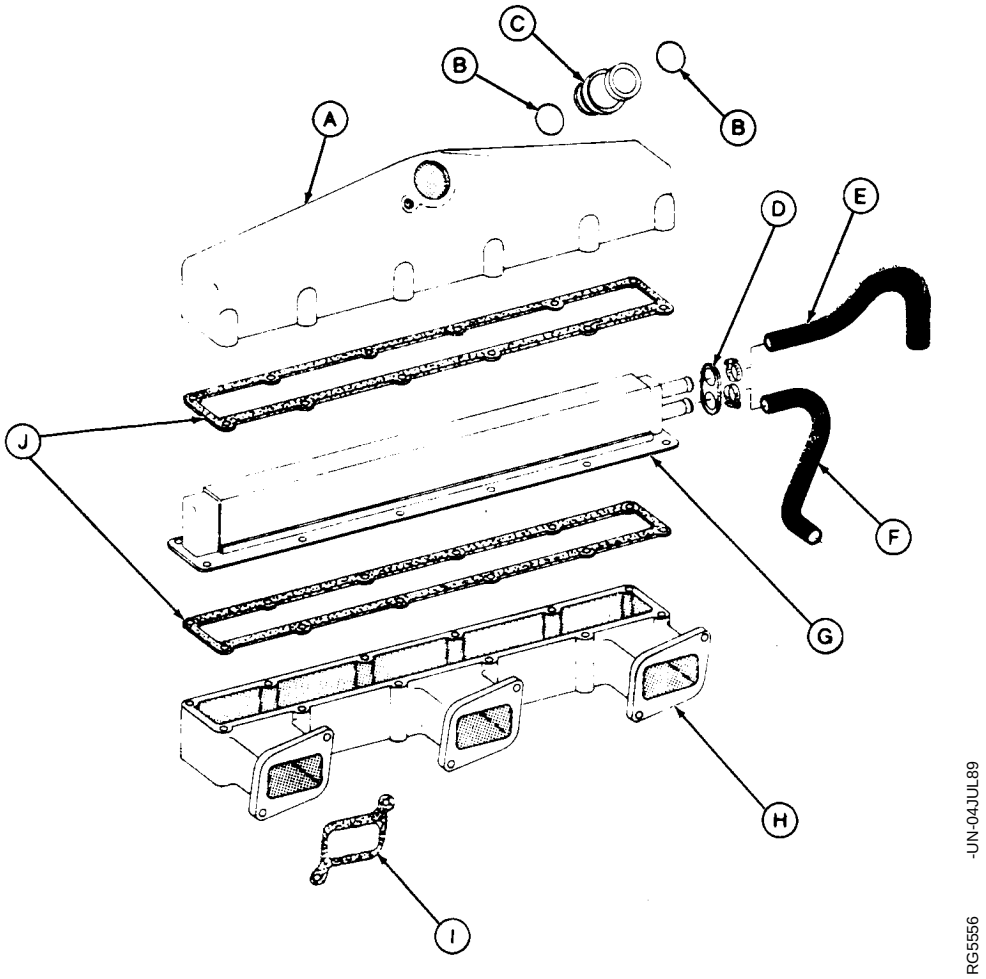
28

INSTALL INTAKE MANIFOLD AND AFTERCOOLER ASSEMBLY (6101A ENGINES)



A—Aftercooler Cover
B—O-Ring (2 used)
C—Adapter (Coupling)
D—Sealing Ring
E—Outlet Hose
F—Inlet Hose
G—Aftercooler
H—Intake Manifold
I—Gasket (3 used)
J—Gasket (2 used)

1. Install coolant conditioner filter mounting bracket (not shown) as intake manifold is being installed.

2. Using new gaskets (I) install intake manifold (H) and tighten cap screws with washers to 75 N·m (55 lb-ft).

3. Using new gaskets (J) and a new sealing ring (D), install aftercooler (G) into intake manifold.

IMPORTANT: Make sure sealing ring is properly positioned in intake manifold and not crimped.

4. Position cover (A) over aftercooler assembly using JDG683 Sealing Ring Compression Tool. Apply PT569 NEVER-SEEZ to cap screws and tighten to 60 N·m (44 lb-ft). (See Install Aftercooler Cover, next in this group.)

5. Install coolant inlet (F) and outlet (E) hoses. Tighten clamps securely.

6. Install aneroid-to-intake manifold pipe.

IMPORTANT: All intake manifold and aftercooler connections at the turbocharger and engine cylinder head must be tight to prevent loss of power resulting from low manifold pressure.

7. Install turbocharger as described earlier in this group.

S55,3005,BG -19-17NOV95

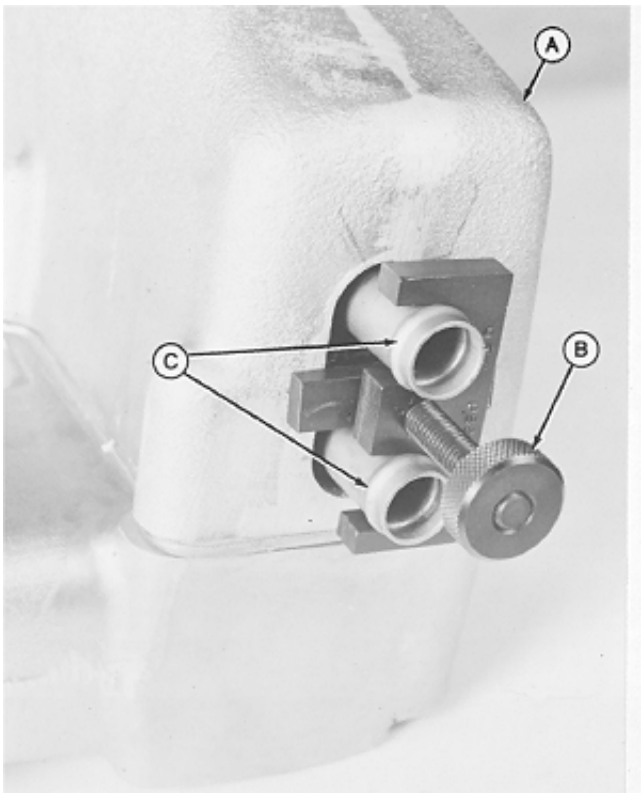
INSTALL AFTERCOOLER COVER (6101A ENGINES)

1. Position gaskets and aftercooler (with new sealing ring) onto intake manifold and install aftercooler cover (A) as detailed in previous module. (See Install Intake Manifold and Aftercooler Assembly, 6101A Engines.)

2. Install JDG683 Sealing Ring Compression Tool (B) onto aftercooler nipples (C) with crossbar across slot as shown.

3. While pulling on aftercooler nipple, crossbar will push on aftercooler cover (as tool is tightened).

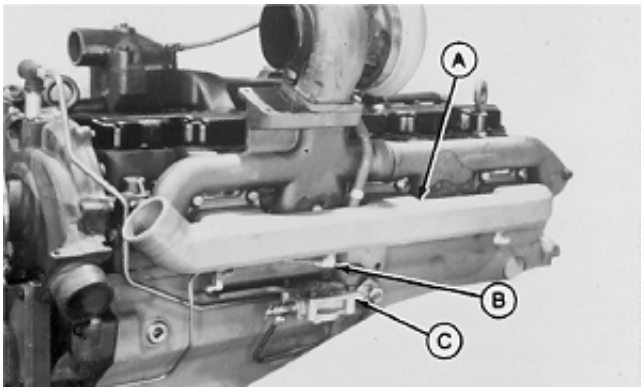
4. When cover, aftercooler, gaskets and intake manifold are in alignment, apply PT569 NEVER-SEEZ to cap screws and tighten to 60 N·m (44 lb-ft).



RG5570 -UN-09JAN90

S55,3005,BJ -19-17NOV95

REMOVE, INSPECT, INSTALL INTAKE MANIFOLD (6101H ENGINES)



RG5557 -UN-09JAN90

1. Refer to your machine technical manual and disconnect air intake piping at intake manifold (A).

2. Disconnect aneroid-to-intake manifold line (B).

3. Remove cap screws and remove intake manifold with coolant conditioner filter bracket (C).

4. Check intake manifold for damage. Scraper all gasket material from cylinder block and intake manifold.

5. Inspect machined mounting surfaces for burrs or other defects which might prevent gaskets from sealing properly. Repair or replace as required.

IMPORTANT: Make sure intake manifold is clean and debris-free before assembly.

6. To install intake manifold, reverse removal procedure and use new gaskets.

7. Tighten intake manifold cap screws to 75 N·m (55 lb-ft).

S55,3005,BH -19-14APR89

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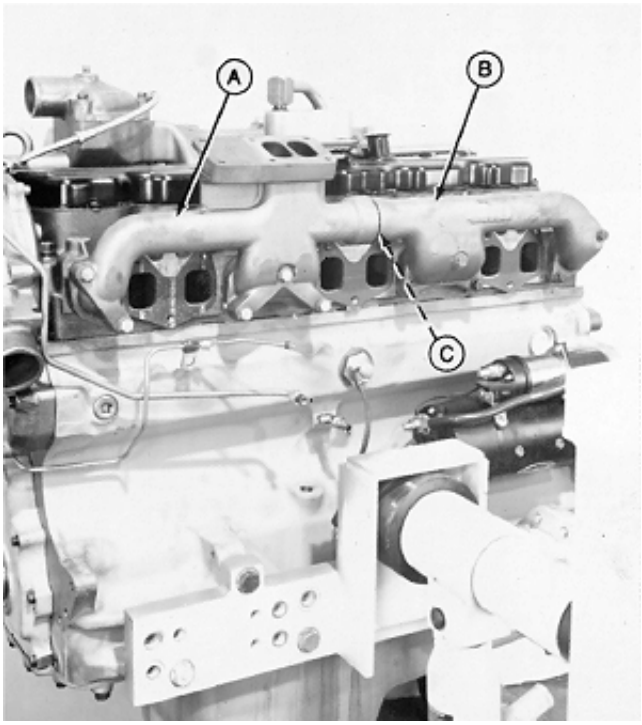
31

REMOVE, INSPECT, AND INSTALL EXHAUST MANIFOLD ASSEMBLY



RG5558 -UN-09JAN90

1. On 6101A Engines, remove after cooler assembly and intake manifold (shown removed) as described earlier in this group.

2. On 6101H Engines, refer to your machine technical manual to disconnect air intake piping at intake manifold and remove manifold (shown removed) as described earlier in this group.

3. Remove rear exhaust manifold (B) and front exhaust manifold (A). Remove and discard sealing ring (C).

4. Scrape all gasket material from cylinder head and exhaust manifolds. Check exhaust manifolds for damage or cracks.

5. Inspect machined mounting surfaces and front-to-rear mating surfaces for burrs or other defects which might prevent gaskets from sealing properly. Repair or replace as required.

6. To install exhaust manifolds, install new sealing ring in groove on front end of rear exhaust manifold section.

NOTE: Apply PT569 NEVER-SEEZ® compound or its equivalent to all exhaust manifold cap screws.

7. Install front exhaust manifold using new gaskets. Install, but do not tighten cap screws.

8. Install rear exhaust manifold using new gaskets. Sealing ring should be in place at this time.

9. Tighten exhaust manifold-to-cylinder head cap screws to 75 N·m (55 lb-ft).

10. Reverse remaining removal procedures to complete final assembly. Refer to appropriate groups.

30
32

S55,3005,BI -19-17NOV95

SPECIAL OR ESSENTIAL TOOLS

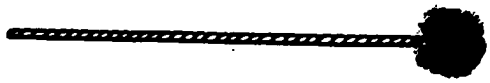
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-20JUL95

RG5099 -UN-23AUG88

Nozzle Thread Cleaning Brush D17030BR

Used to clean nozzle threads in cylinder head.



S53,D17030,BR -19-16FEB87

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

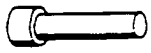
Rotate engine flywheel. Use with JDE81-4.

S53,JDE811 -19-06OCT95

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Lock engine at TDC when timing valve train. Use with JDE81-1 or JDE83.

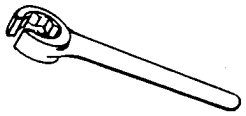


S53,JDE814 -19-06APR90

RG5290 -UN-15OCT92

Serrated Wrench JDE90

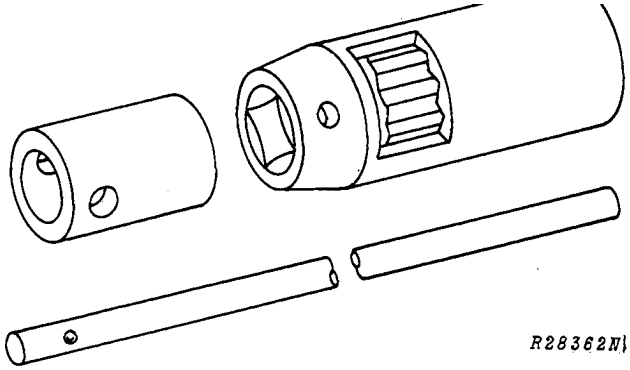
Use to hold injection pump fuel outlet fittings from turning when loosening and tightening fuel pipe connections.



S53,JDE90 -19-13MAY93

Nozzle Socket JDE92

Used to remove and install 21 mm injection nozzles.



-UN-20DEC88

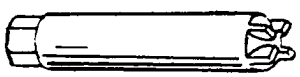
R28362N

S11,3010,OU -19-16AUG94

RG5289 -UN-23AUG88

Nozzle Seat Reamer JDE99

Used to clean carbon from nozzle seats in cylinder head.



S53,JDE99 -19-08AUG94

RG5100 -UN-23AUG88

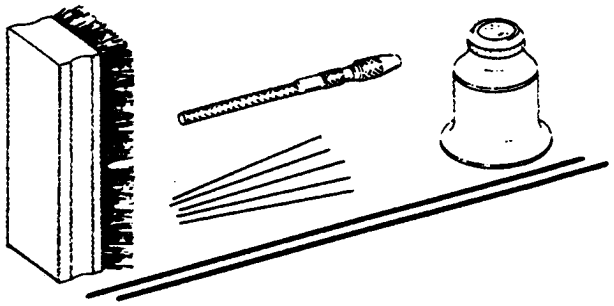
Tap JDF5

Used to restore nozzle threads in cylinder head.

S53,JDF5 -19-08MAR94

Nozzle Cleaning Kit JDF13 (JDE105)

Used to clean injection nozzles.



-UN-14DEC88
RG4953

S11,3010,OW -19-09SEP91

RG5154 -UN-23AUG88

3/4 in. Special Crowsfoot Wrench JDF22

Tighten injection lines at pump and nozzles.

S53,JDF22 -19-10JUL89

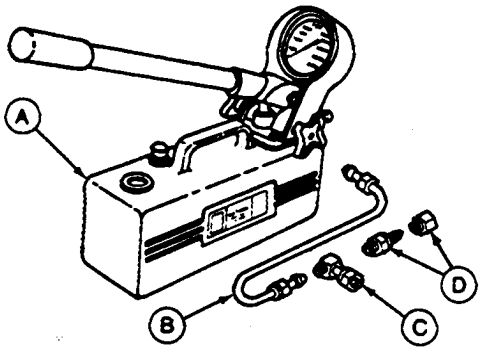
A—Fuel Injection Nozzle Tester D01109AA

B—Fuel Line Assembly 36352*

C—Adapter Nut 208369**

D—Straight Adapters . . . . . 23623* and 23693*

Used to test operational performance and opening pressure of nozzles.



-UN-14DEC88
RG4954

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2

**Included in D01110AA (Y910A) Adapter Set.*

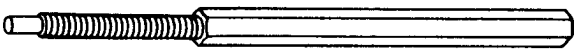
***May be used instead of 23623 or 23693.*

S11,3010,OX -19-20JUL95

RG7212 -UN-23JUL94

Injection Pump Timing Pin JDG886

Used to set in-line fuel injection pump timing prior to removal of pump.



RG,JDG886 -19-10AUG94

OTHER MATERIAL

Name	Use
PT569 NEVER-SEEZ Compound	Gland nut threads and fuel injection nozzle barrel.
LOCTITE 242 Thread Lock and Sealer (TY9370/T43512)	Injection pump timing hole plug.
LOCTITE 592 Pipe Sealant with TEFLON (TY9374/TY9375)	Fuel filter drain plug and bleed plug.

S55,3010,BB -19-05APR93

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3

FUEL SYSTEM SPECIFICATIONS

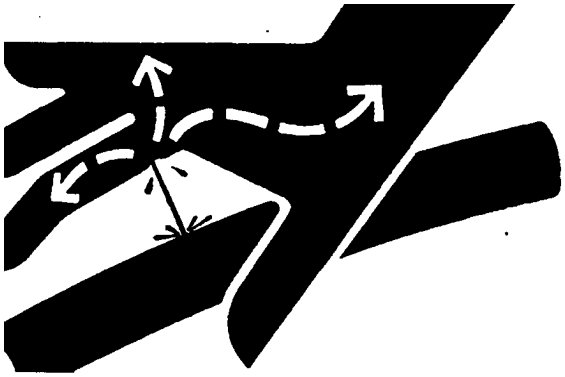
Item	Specification
Engine Speeds	See applicable Machine TM
Fuel Injection Pump Timing to Engine	TDC
Overflow Valve Opening Pressure	130—180 kPa (1.3—1.8 bar) (19—26 psi)
Hydraulic Aneroid Activator Opening Pressure*	100 kPa (1.0 bar) (14.5 psi)
Fuel Supply Pump Minimum Operating Pressure	200 kPa (2.0 bar) 29.0 psi)
Fuel Shut-Off Solenoid Adjustment Gap*	0.25—0.51 mm (0.01—0.02 in.)
Fuel Injection Nozzles:	
Model	KDEL—21 mm
Nozzle Tip Size	6 x 0.285 mm
New Nozzle Opening Pressure	29000—29800 kPa (290—298 bar) (4200—4300 psi)
Used Nozzle Minimum Opening Pressure	26200 kPa (262 bar) (3800 psi)
Torques	
Injection Pump Drive Hub	100—110 N·m (74—81 lb-ft)
Injection Pump Oil Filter Plug	25 N·m (18 lb-ft)
Aneroid Activator Special Screw*	14 N·m (10 lb-ft)
Fuel Line Connections @ Filter Base	17—20 N·m (12—15 lb-ft)
Fuel Filter Base Mounting	34—54 N·m (25—40 lb-ft)
Supply Pump-to-Injection Pump	5—7 N·m (4—6 lb-ft)
Injection Pump-to-Cylinder Block	47 N·m (35 lb-ft)
Injection Pump Drive Gear Cover Cap Screws	47 N·m (35 lb-ft)
Fuel Delivery Line Nuts (@ nozzles and delivery values)	27 N·m (20 lb-ft)
Injection Nozzle Gland Nut	74—88 N·m (55—65 lb-ft)
Injection Nozzle Retaining Nut	88 N·m (65 lb-ft)
Leak-Off Connectors	Tighten Securely
Fuel Temperature Sensor Connector**	7—15 N·m (5—11 lb-ft)
Actuator Connector**	10—20 N·m (7—11 lb-ft)

*—Mechanical Governor Applications Only

**—Electronic Governor Applications Only

S55,3010,CA -19-17NOV95

RELIEVE SYSTEM PRESSURE



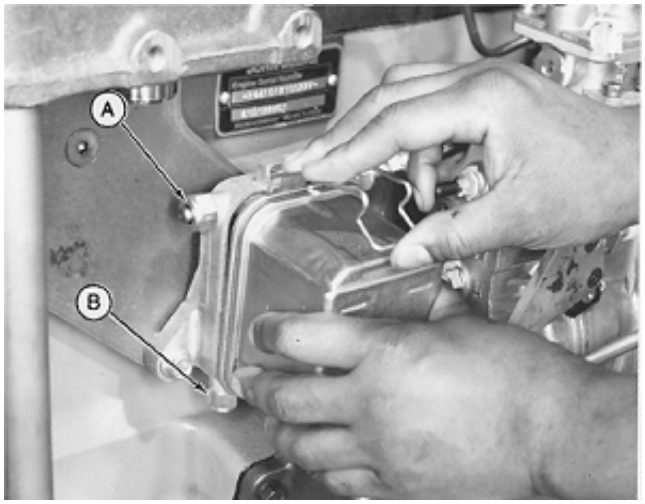
X9811 -UN-23AUG88

CAUTION: 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.

S11,3010,OZ -19-02MAR94

REPLACE RECTANGULAR FINAL FUEL FILTER



RG5543 -UN-10NOV89

Full flow oil filter shown removed for photographic purposes.

NOTE: Refer to your operator's manual for proper servicing and (hourly) replacement intervals.

1. Close fuel shut-off valve at bottom of fuel tank, if equipped.

2. Loosen bleed plug (A) and remove drain plug (B) to drain fuel from filter. Remove and discard packing from drain plug.

NOTE: Keep a small container under drain plug to catch draining fuel.

3. With fuel filter held firm against base, lift up on top retaining spring and pull down on bottom retaining spring. Pull fuel filter off guide pins of fuel filter base. Discard filter.

S55,3010,CB -19-05APR93

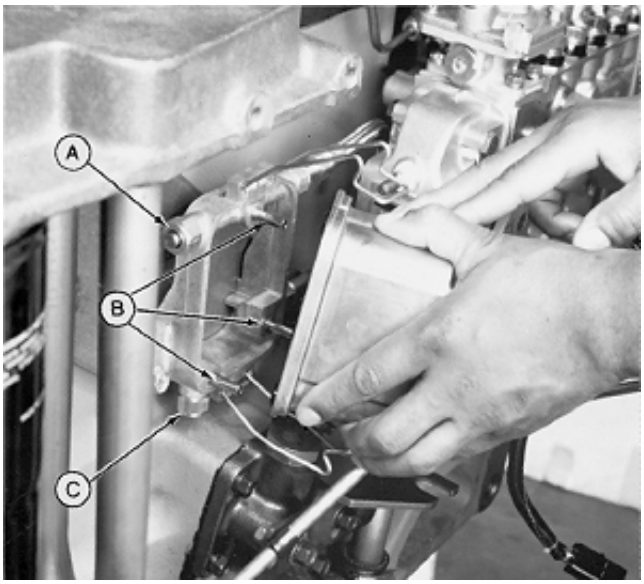
4. Install new fuel filter onto guide pins (B) of fuel filter base. Hold filter firmly against base.

NOTE: Secure retaining spring by pushing on center (at highest point) until spring seats in groove.

5. Secure bottom retaining spring first, then top spring.

6. Install drain plug (C) using new packing, shown installed. Tighten bleed plug (A) and drain plug securely. Do not overtighten.

7. Open fuel shut-off valve and bleed the fuel system as described in Group 115.



RG5544 -UN-10NOV89

S55,3010,CC,1 -19-17NOV95

REPLACE FUEL CHECK VALVE ASSEMBLY

IMPORTANT: Remove fuel check valve only for replacement purposes, since O-ring seals tightly in bore, removal usually damages check valve assembly.

1. Drain and remove fuel filter (shown removed) as described earlier in this group.

2. Remove filter base fuel inlet line (A). Remove and discard packing.

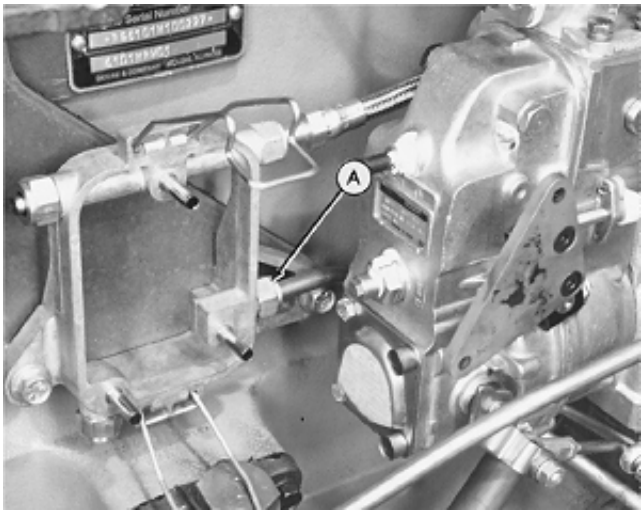
3. Remove check valve and discard.

4. Inspect and clean fuel filter base.

5. Lubricate new check valve assembly with clean diesel fuel and install. The end with O-rings must enter bore in filter base first.

6. Install filter base fuel inlet line using new packing and tighten connection 17—20 N·m (12—15 lb-ft). DO NOT overtighten.

7. Install fuel filter and bleed the fuel system as described in Group 115.



RG5545 -UN-10NOV89

S55,3010,CD,1 -19-17NOV95

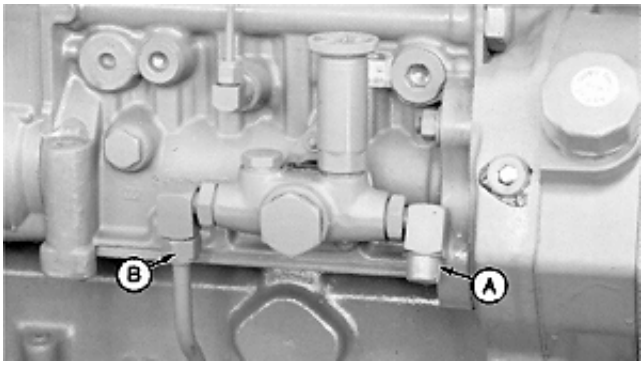
REMOVE FUEL SUPPLY PUMP

Thoroughly clean the exterior of the supply pump. Also clean around the supply pump mounting area on the injection pump housing.

1. Disconnect fuel inlet line (A), shown disconnected, and outlet line (B). Cap all line openings so contaminants do not enter fuel system.

2. Remove three mounting nuts using a 10 mm wrench.

3. Pull fuel supply pump straight out from injection pump housing. Cover supply pump mounting bore so debris cannot enter.



-UN-20DEC88
RG3539

S55,3010,Q -19-20JUN89

TEST FUEL SUPPLY PUMP FOR LEAKS

Fuel delivery pressure should be checked before removing supply pump from injection pump.

1. Connect compressed air line (A) to a pressure gauge (B) and to the supply pump inlet fitting. The air line should have a regulating valve to control pressure.

2. Cap or plug supply pump outlet fitting (C).

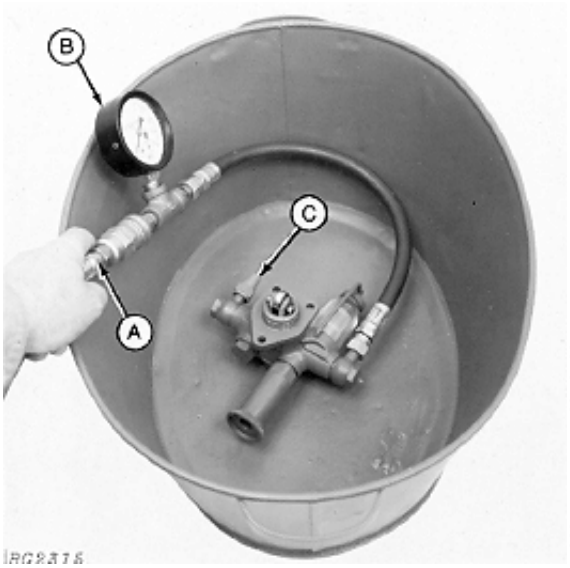
3. Submerge supply pump in a container of clean diesel fuel. Regulate air pressure to 200 kPa (2.0 bar) (29 psi).

4. Move roller tappet in and out by hand. No air bubbles should appear around roller tappet bore.

NOTE: If bubbles appear, it is an indication that either the spindle seal is defective or that the spindle is worn (or possibly both).

IMPORTANT: If enough diesel fuel leaks past the spindle and seal, possible serious damage to the injection pump or engine (or both) could occur.

Any fuel leakage that takes place flows into the injection pump crankcase. Remember that the injection pump and engine both share a common lubricating oil supply.



S55,3010,R,1 -19-13NOV95

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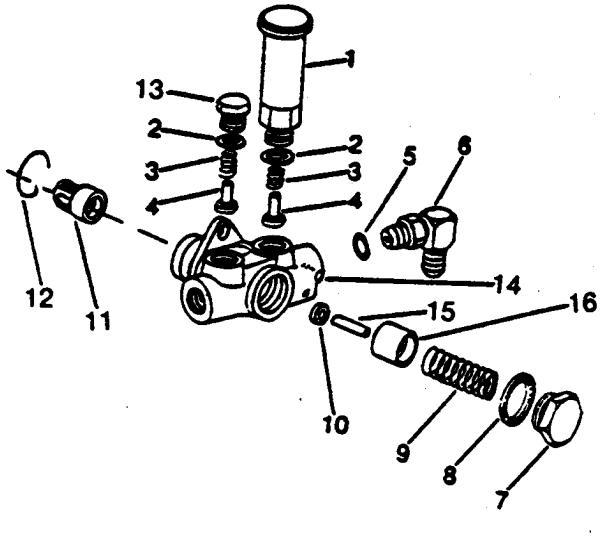
8

DISASSEMBLE FUEL SUPPLY PUMP

1. Remove elbow fitting (6) by loosening locknut and unscrewing elbow fitting from pump housing. Remove and discard O-ring (5).

1—Hand Primer
2—Washer (2 used)
3—Spring (2 used)
4—Valve (2 used)
5—O-Ring (2 used)
6—Elbow Fitting (2 used)
7—Plug
8—Washer
9—Spring
10—O-Ring/Spindle Seal
11—Roller Tappet
12—Snap Ring
13—Plug
14—Pump Housing
15—Pressure Spindle
16—Plunger



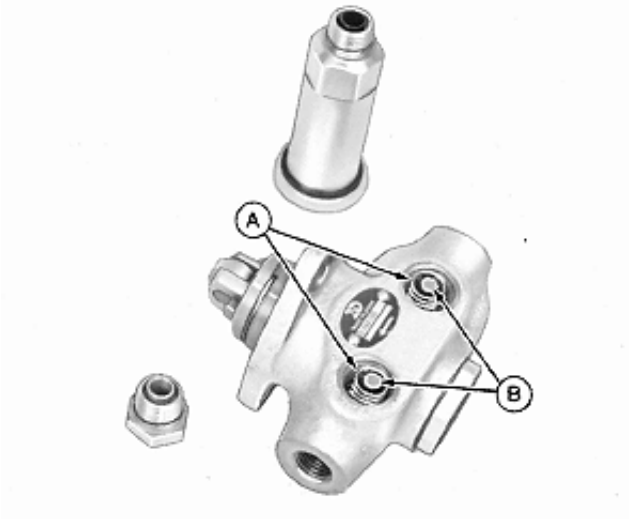
RG5364 -UN-14DEC88

S55,3010,S -19-20JUN89

2. Remove hand primer from housing, shown removed. Discard copper washer.

3. Remove plug from housing, shown removed. Discard copper washer.

4. Remove valves (B) and springs (A).



RG4026 -UN-30NOV88

S55,3010,X -19-25MAR88

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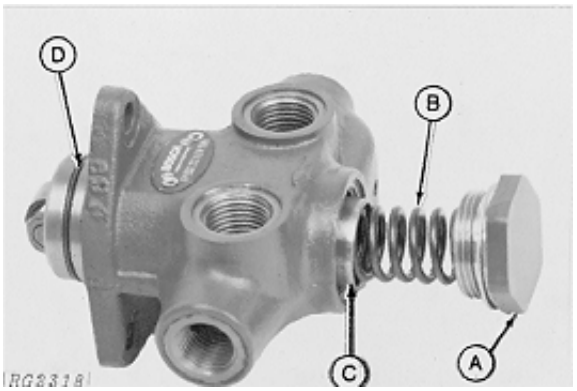
5. Remove plug (A), spring (B) and plunger (C) from pump housing. Discard copper washer.

6. Remove snap ring (D) from outer circumference of pump housing neck.

NOTE: Snap ring has a tang on one end which extends vertically down through a hole in pump housing to retain roller tappet assembly.

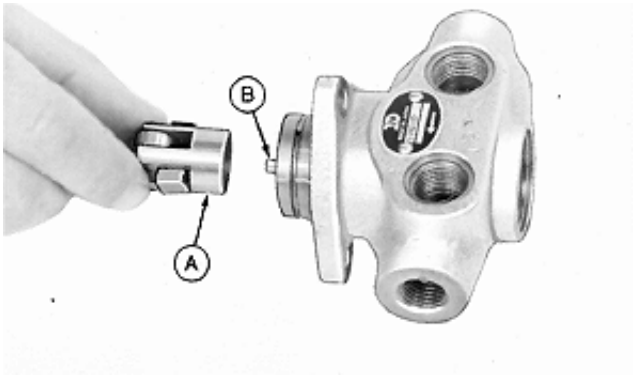
A—Plug
B—Spring
C—Plunger
D—Snap Ring



-UN-20DEC88
RG2318

S55,3010,Y -19-03OCT92

7. Remove roller tappet (A) and spindle (B) from pump housing. Remove and discard O-ring on spindle.

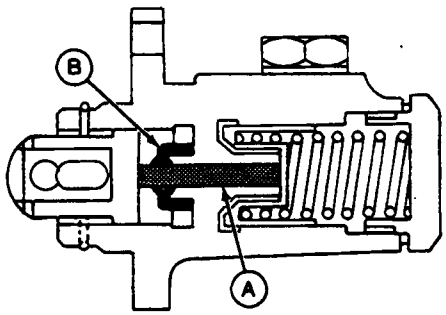


-UN-30NOV88
RG4028

S55,3010,Z -19-03OCT92

NOTE: Spindle/seal O-ring (B) is pressed into pump housing. This seal keeps diesel fuel from leaking past spindle (A) and entering injection pump crankcase.

8. Remove spindle seal from housing using needle nose pliers. Discard seal.



-UN-30NOV88
RG4029

S55,3010,AA -19-03OCT92

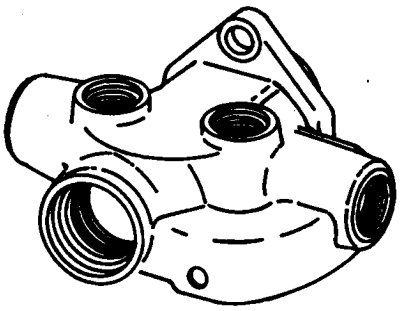
35
10

INSPECT AND REPAIR FUEL SUPPLY PUMP

1. Inspect supply pump housing for cracks and wear. Be sure valve seating areas are not pitted. Replace housing as necessary.

2. Check roller tappet and plunger bore for wear and scoring. Remove any deposits in housing with a suitable solvent. Rinse housing in clean diesel fuel.

3. Check condition of threads for inlet and outlet fittings. Pump elbow fittings have 1/2-20 threads.



RG2320

RG2320 -UN-30NOV88

S55,3010,U -19-13JUL89

4. Inspect roller (A) OD for excessive wear. Be sure roller turns freely on pin (B) and in tappet (C).

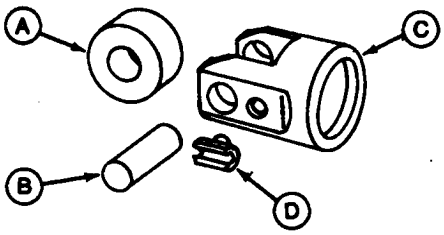
5. Inspect sliding blocks (D). Edges should be square and unpitted. Blocks should slide in and out of tappet easily.

6. Inspect tappet for wear and scoring. Remove any deposits with a suitable solvent.

Be sure land on tappet that contacts pressure spindle is flat and undamaged.

7. Replace parts as required.

NOTE: Tappet assembly is not repairable on Robert Bosch pumps. Replace assembly as required.



RG2321

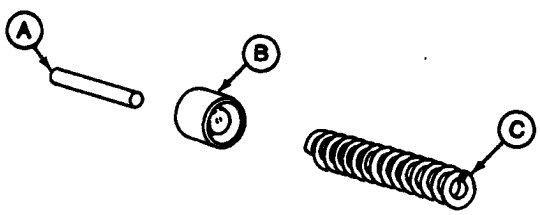
RG2321 -UN-30NOV88

A—Roller
B—Pin
C—Tappet
D—Sliding Block (2 used)

S11,3010,QN -19-20JUL95

8. Inspect pressure spindle (A) and plunger (B) for pits and burrs. If defective, replace supply pump.

9. Inspect spring (C) for cracks and distortion. Replace parts as necessary.



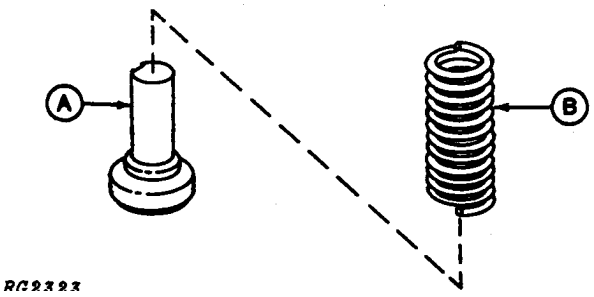
RG2322

RG2322 -UN-30NOV88

S11,3010,QO -19-20JUL95

10. Inspect valves (A), especially valve face, for cracks, pits and wear. Replace as necessary.

11. Spring (B) should not be bent or broken.



S11,3010,QP -19-20JUL95

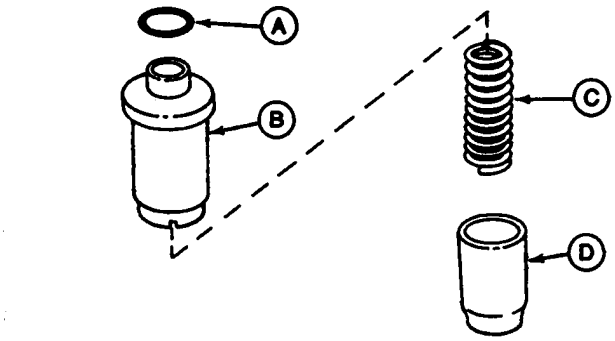
12. Check condition of gasket (A). Replace as necessary.

13. Be sure wire fabric filter (B) is not ripped. Clean filter in fresh diesel fuel.

14. Be sure spring (C) is in good condition.

15. Inspect glass bowl (D) for damage, especially for chips on the upper sealing edge.

A—Gasket
B—Filter
C—Spring
D—Glass Bowl



S11,3010,QQ -19-20JUL95

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12

ASSEMBLE FUEL SUPPLY PUMP

IMPORTANT: Always use new copper gaskets. Dip parts in clean diesel fuel before assembly and hands should be wet with diesel fuel when assembling internal components of fuel supply pump.

1. Install a new O-ring/spindle seal (10) in housing bore. Be sure O-ring is straight in housing bore and not twisted.

2. Insert pressure spindle (15) and plunger (16) in housing (14).

3. Position spring (9) in plunger. Install plug (7) with a new washer (8) over spring. Tighten plug securely.

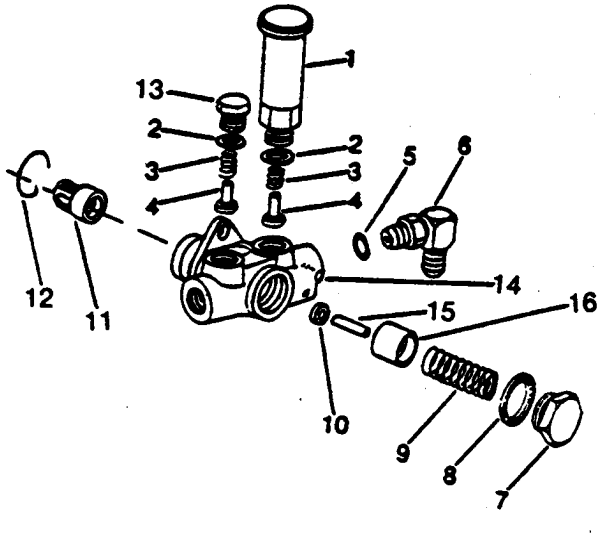
4. Insert tappet assembly (11) in housing and secure with snap ring (12).

5. Position valves (4) with springs (3) in housing.

6. Install plug (13) and hand primer (1) using new washers (2). Tighten plug and hand primer securely.

7. Install elbow fittings (6) with new O-rings (5). Tighten lock nut securely.

Perform leak test described earlier in this group.



RG5364 -UN-14DEC88

1—Hand Primer
2—Washer (2 used)
3—Spring (2 used)
4—Valve (2 used)
5—O-Ring (2 used)
6—Elbow Fitting (2 used)
7—Plug
8—Washer
9—Spring
10—O-Ring/Spindle Seal
11—Roller Tappet
12—Snap Ring
13—Plug
14—Pump Housing
15—Pressure Spindle
16—Plunger

S55,3010,BL -19-20JUN89

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13

INSTALL FUEL SUPPLY PUMP

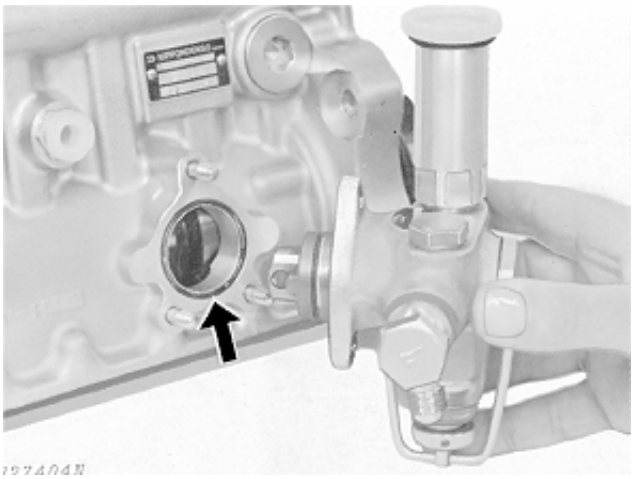
IMPORTANT: Before installing supply pump, test pump to make sure that fuel will not leak around spindle and spindle seal. (See TEST FUEL SUPPLY PUMP FOR LEAKS, earlier in this group.)

1. Put a new O-ring in counterbore of pump housing next to mounting face (arrow).

2. Position pump over mounting studs. Tighten mounting stud nuts 5—7 N·m (4—5 lb-ft).

3. Install fuel inlet and outlet lines when engine is installed in vehicle. Tighten all connections securely.

4. Bleed the fuel system as described in Group 115.



R27404 -UN-29NOV88

S55,3010,AB,1 -19-17NOV95

GENERAL INFORMATION FOR ANEROID (IF EQUIPPED)

NOTE: Aneroids are used on all 6101 Engine applications that are not equipped with electronically controlled governors.

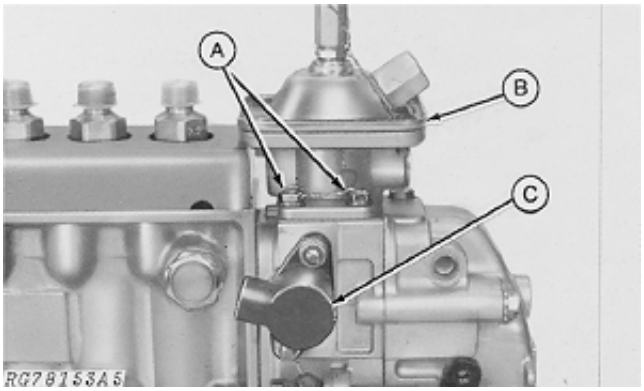
The aneroid (B) is a diaphragm-type control unit that mounts on top of injection pump governor housing. Aneroid mounting screws (A) are sealed to prevent tampering by unauthorized service personnel. Intake manifold pressure is directed to the upper side of the diaphragm chamber to actuate the diaphragm.

A hydraulic aneroid activator located inside activator housing (C), utilizes engine lubricating oil pressure to control aneroid operation.

The purpose of the aneroid is to limit black smoke produced during acceleration, until sufficient manifold pressure is reached, under two conditions:

—When load is moderate to heavy with engine speed from 800 to approximately 1000 rpm.

—When load is light at any engine speed.



RG78153A5 -UN-10NOV89

S55,3030,CG -19-14NOV95

REPAIR ANEROID—MECHANICAL GOVERNORS ONLY

For aneroid repair and adjustment, have an authorized ADS diesel repair station perform the work.

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S55,3010,CH -19-13MAY93

REMOVE HYDRAULIC ANEROID ACTIVATOR—MECHANICAL GOVERNORS ONLY

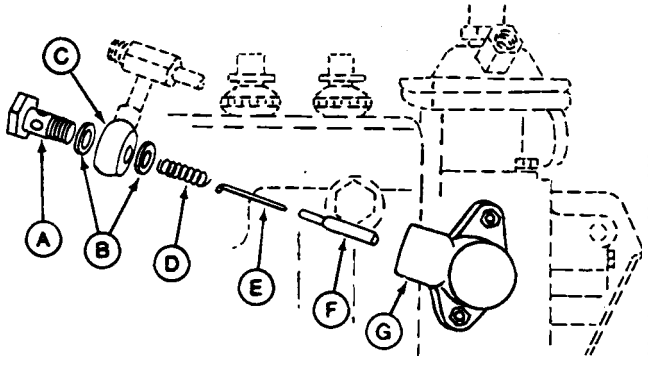
NOTE: The hydraulic aneroid activator is located on the back side of the governor housing next to the cylinder block. Remove the injection pump as described later in this group.

1. Remove special screw (A), copper washers (B) and banjo connector (C).

2. Remove spring (D), restrictor wire (E) and capillary valve (F) from activator housing (G).

3. Remove activator housing from governor housing.

NOTE: Do not bend restrictor wire or other activator parts.



A—Special Screw
B—Copper Washer (2 used)
C—Banjo Connector
D—Spring
E—Restrictor Wire
F—Capillary Valve
G—Activator Housing

S55,3010,CI -19-05APR93

DISASSEMBLE AND CLEAN HYDRAULIC ANEROID ACTIVATOR

1. Remove gasket (G), piston (F) and piston spring (E).

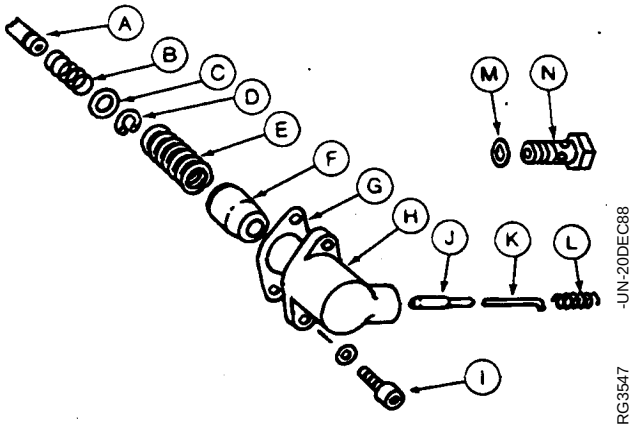
2. Wash all parts in clean solvent and dry with compressed air. Blow out all openings to make sure they are open.

3. Check piston (F) and activator housing (H) for general condition. Piston must move freely in its bore.

4. Inspect piston spring (E) and capillary valve spring (L). Replace if weak or broken.

5. Inspect condition of restrictor wire (K). Wire must not be bent or broken and must fit loosely in capillary valve (J).

6. Check condition of return spring (B), washer (C) and retaining ring (D) on starting fuel control shaft (A). Replace spring if weak or broken. Be sure retaining ring is secure on shaft.



A—Starting Fuel Control Shaft
B—Return Spring
C—Washer
D—Retaining Ring
E—Piston Spring
F—Piston
G—Gasket
H—Activator Housing
I—Mounting Screw (2 used)
J—Capillary Valve
K—Restrictor Wire
L—Capillary Valve Spring
M—Washers
N—Special Screw

S11,3010,DT -19-20JUL95

ASSEMBLE AND INSTALL HYDRAULIC ANEROID ACTIVATOR

NOTE: Refer to previous illustration.

1. Insert piston spring (E) into piston (F). Place these parts in activator housing (H).

2. Using a new gasket (G) mount activator assembly on governor housing. Tighten Allen head mounting screws (I) with washers securely.

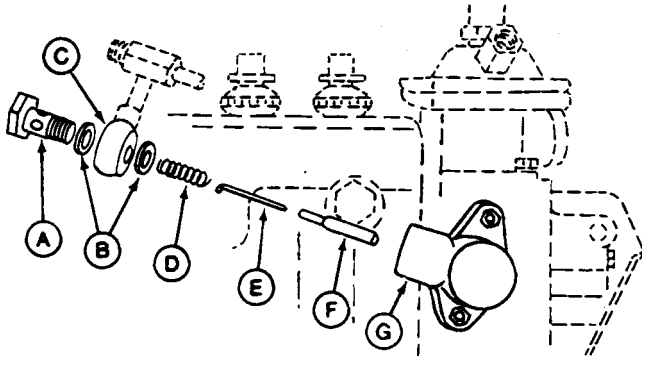
S11,3010,DU -19-20JUL95

3. Assemble capillary valve (F), restrictor wire (E) and spring (D) into activator housing (G).

4. Using two new copper washers (B) install banjo connector (C) and special screw (A).

5. Install injection pump as described later in this group.

6. Connect lube lines to banjo connector.



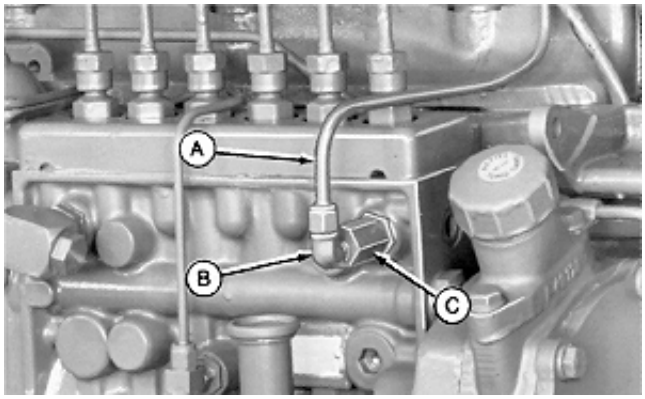
S11,3010,DV -19-17DEC81

SERVICE INJECTION PUMP OVERFLOW VALVE

NOTE: The overflow valve can be serviced with injection pump installed.

1. Remove leak-off line (A) and remove elbow (B).

2. Remove valve assembly (C) from pump.



S11,3010,DW,1 -19-17NOV95

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3. Remove reducer (A) and copper washer (B) from valve body (C).

4. Unscrew spring seat (D); then remove spring (E) and valve (F).

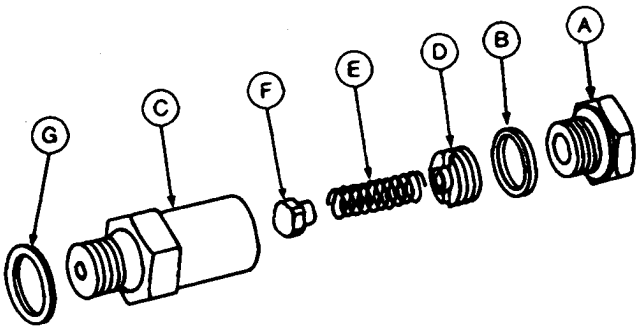
5. Inspect for foreign material imbedded in seat of nylon valve.

6. Check spring to see that it is not weak or broken.

7. Wash all parts in solvent and air dry.

NOTE: There is no adjustment on valve to regulate housing pressure. If suspected that the valve is malfunctioning, replace valve to restore proper operation.

8. Reverse order of removal for reassembly of overflow valve using new copper washers.



RG3549 -UN-20DEC88

A—Reducer
B—Washer
C—Valve Body
D—Spring Seat
E—Spring
F—Valve
G—Washer

S11,3010,DX -19-10AUG94

REMOVE FUEL INJECTION PUMP

IMPORTANT: Never steam clean or pour cold water on an injection pump while the pump is running, or while it is still warm. To do so may cause seizure of pump parts.

1. Clean injection lines and area around the injection pump with cleaning solvent or a steam cleaner to keep debris out of fuel system.

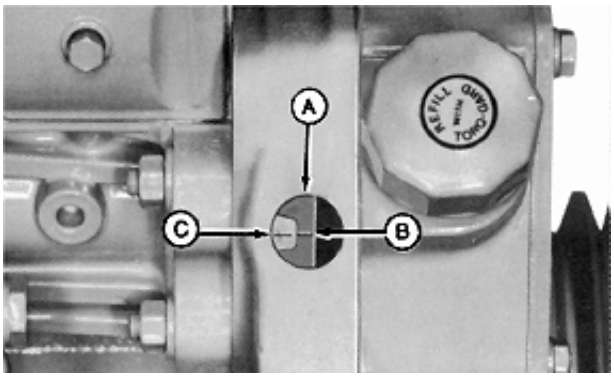
NOTE: Follow the same removal procedure for injection pumps equipped with mechanical governor and electronic governor. Differences will be noted.

S55,3010,AG -19-02JUL91

2. Remove the timing hole plug (A).

3. Using the JDE81-1 and JDE81-4 Engine Rotation Tool Set in flywheel housing, rotate the crankshaft until No. 1 piston is at “TDC” on its compression stroke.

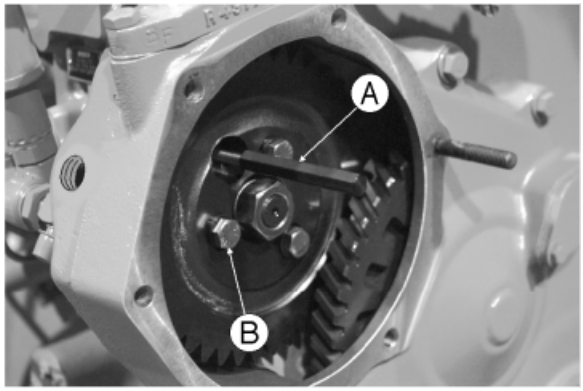
4. The timing marks on the injection pump drive hub (B) and on the timing pointer (C) should be in alignment. At this time the JDE81-4 Timing Pin should enter hole in flywheel.



RG3873 -UN-20OCT88

S11,0408,N -19-20JUL95

IMPORTANT: To assure that accurate injection pump timing is maintained when pump is removed and installed, it is recommended that JDG886 Injection Pump Timing Pin (A) is used prior to removal and installation of injection pump. If injection pump will be serviced at an authorized repair station, remove timing pin prior to shipping for service.



RG7354 -UN-29SEP95

5. Remove fan and fan belts.

6. On 6101HRW01, 02 Engines remove fan drive assembly.

7. Remove injection pump drive gear cover (shown removed), remove and discard all gasket material.

NOTE: It may be necessary to rotate injection pump drive hub slightly to install timing pin.

8. Install JDG886 Timing Pin through hole in injection pump drive gear. Thread timing pin into injection pump hub until it bottoms.

IMPORTANT: Leave injection pump drive gear in housing so that gear train timing is maintained during pump removal and installation.

9. Remove injection pump drive gear cap screws (B) that secure injection pump drive gear to pump hub.

10. Remove fuel filter from filter base.

S55,3010,CJ -19-17NOV95

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19

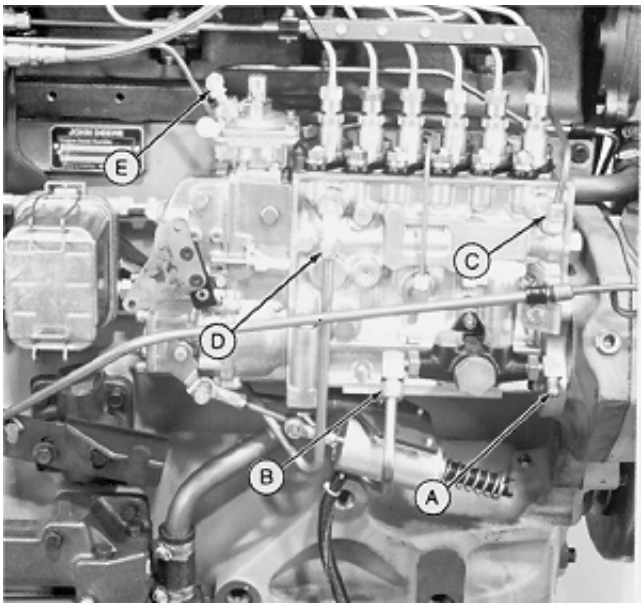
11. On 6106HRW01, 02 Engines, disconnect (and remove if desired) oil dipstick tube assembly. On 6101HRW01 Engines disconnect fuel shut-off solenoid connector.

12. Disconnect fuel inlet (A) and outlet (B) lines from fuel supply pump and fuel leak-off line (C) from injection pump.

13. Disconnect injection pump fuel inlet line (D).

14. Disconnect aneroid line (E).

15. Disconnect lubrication line (not shown) at hydraulic aneroid activator junction located on inboard side of injection pump.



RG5548 -UN-10NOV89

A—Supply Pump Inlet
B—Supply Pump Outlet
C—Leak-Off Line
D—Injection Pump Inlet
E—Aneroid Line

S55,3010,CK -19-17NOV95

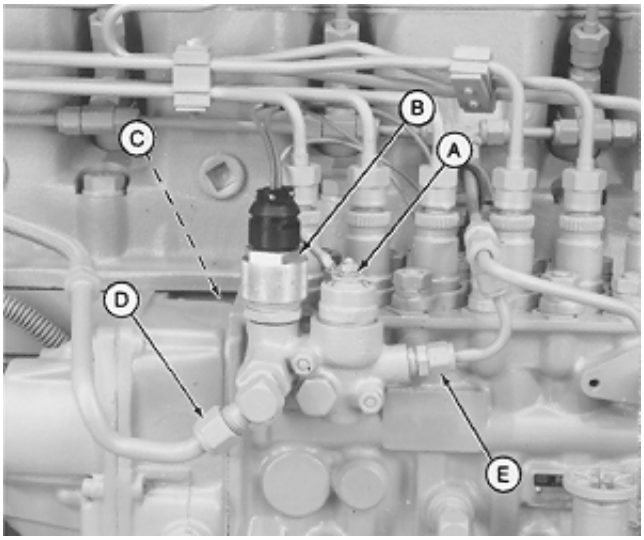
On 6101HRW02 Engines (equipped with electronic governors) follow additional instruction listed below for injection pump removal:

IMPORTANT: Protect connectors on wiring harness while pump is disconnected so debris does not enter connector ends. When the connector is disconnected, be careful not to loose the O-ring located in the cable end connector.

16. Disconnect fuel temperature sensor connector (B) and remove fuel shut-off solenoid wiring lead (A).

17. Disconnect actuator connector (C) at inboard side of governor using the JDG646 Special Crowsfoot Wrench.

18. Disconnect fuel inlet line (D) and leak-off line (E) at fuel shut-off solenoid.



RG5549 -UN-10NOV89

A—Shut-Off Solenoid Leak
B—Fuel Temperature Sensor Connector
C—Actuator Connector
D—Fuel Inlet Line
E—Fuel Leak-off Line

S55,3030,CL -19-17NOV95

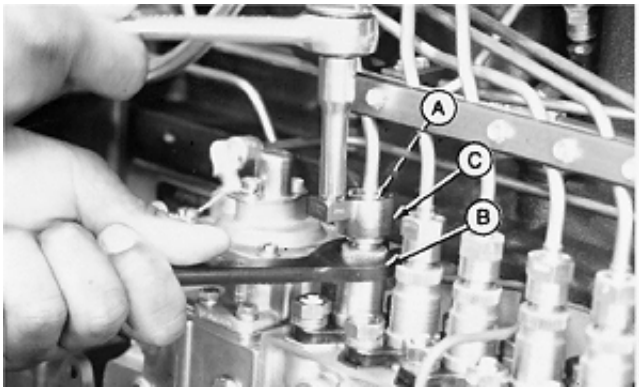
19. To remove fuel injection line nuts (A) use the JDE90 Serrated Wrench (B) with either the JDF22 Crowsfoot Wrench (C) or a standard 3/4 in. Line Wrench (D).

IMPORTANT: The JDE90 Serrated Wrench must be used to keep the delivery valve fittings stationary while loosening the line nuts. If a delivery valve and barrel housing rotates while loosening or tightening a fuel line nut the injection pump delivery will be altered. The pump will have to be recalibrated on a test stand.

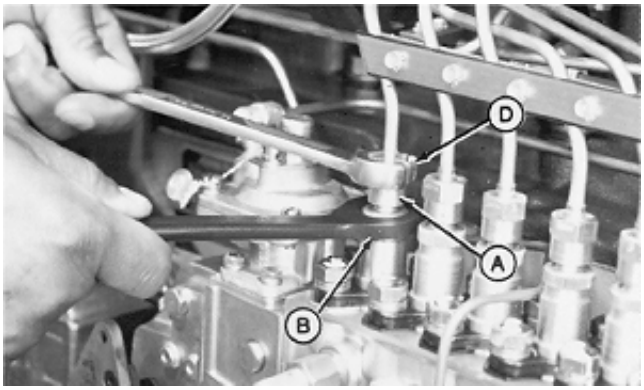
20. Remove four mounting stud nuts which secure injection pump to cylinder block.

21. Carefully remove injection pump from block bore and place it on a clean flat surface.

A—Fuel Injection Line Nuts
B—JDE90 Serrated Wrench
C—JDF22 Crowsfoot Wrench
D—3/4 in. Line Wrench



RG5573 -UN-07JUL89



RG5574 -UN-10NOV89

S55,3010,CM -19-17NOV95

REPAIR FUEL INJECTION PUMP

IMPORTANT: Do not disassemble fuel injection pump further than necessary for installing available service parts, not even for cleaning.

Be sure that injection pump serial number tag is in place and that all identification numbers are legible so that pump is set to the correct specifications for its intended application.

For injection pump repair and testing, have an authorized diesel injection repair station perform the work. Unauthorized repairs made to fuel injection pump will void warranty.

Once injection pump has been returned and installed on engine, run engine on a dynomometer to check engine power levels.

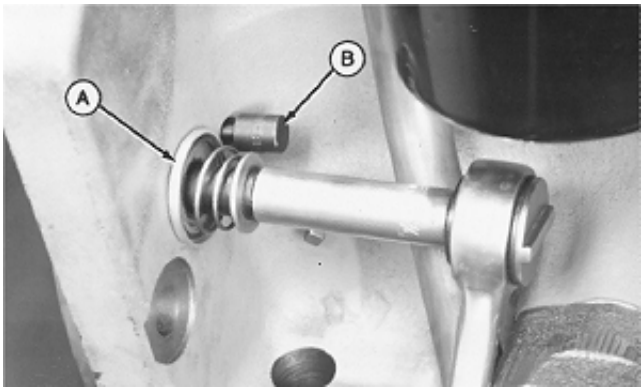
S11,3010,PE -19-17NOV95

INSTALL FUEL INJECTION PUMP

NOTE: When turning flywheel to "TDC", JDE81-4 Timing Pin (B) can engage in flywheel with either No. 1 or No. 6 cylinder on "TDC" compression stroke. When installing fuel injection pump, No. 1 cylinder must be on No. 1 "TDC" compression.

1. If crankshaft was rotated after injection pump was removed, rotate flywheel using JDE81-1 Flywheel Turning Tool (A) until timing pin engages flywheel with No. 1 cylinder at "TDC" compression stroke.

NOTE: When No. 1 cylinder is on "TDC" compression stroke, intake and exhaust valves for No. 1 cylinder will be closed and both rocker arms will be loose.



RG5521 -UN-09JAN90

S55,3010,CN -19-13MAY93

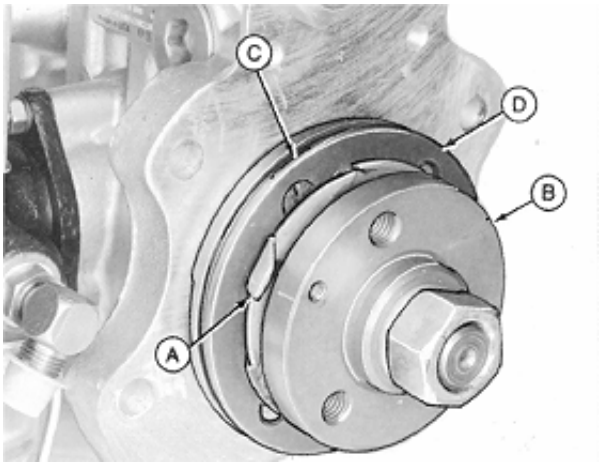
IMPORTANT: Clean drive hub OD and drive gear ID with a degreaser such as trichloroethylene to eliminate seizure of gear on hub.

2. Rotate injection pump drive hub until marks on drive hub (B) and pointer (A) are in alignment. Timing pin should also engage flywheel at this point.

3. Install a new O-ring (C) on bearing plate (D). Lightly lubricate O-ring with clean engine oil to make pump installation easier and prevent O-ring damage.

4. Install injection pump using moderate forward pressure and slight rocking motion to work O-ring into mounting hole. Injection pump flange should seat solid against cylinder block.

5. Install four injection pump-to-cylinder block mounting stud nuts and finger tighten.



RG3673 -UN-20DEC88

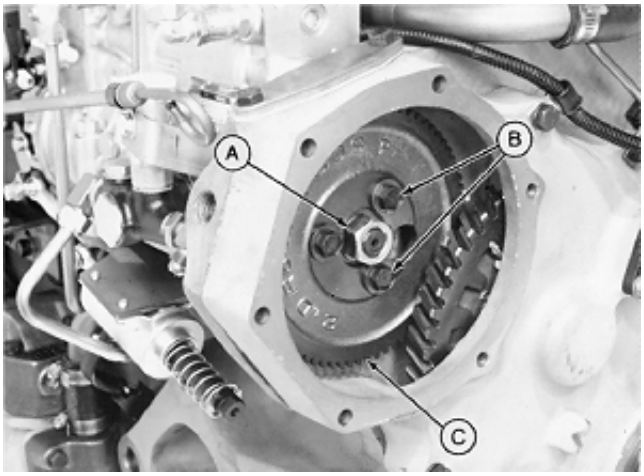
A—Pointer
B—Drive Hub
C—O-Ring
D—Bearing Plate

S55,3010,CO -19-19APR89

6. Place injection pump drive gear (C) in timing gear housing (if previously removed) so part number on gear faces outward.

7. Carefully install drive gear on pump drive hub (A), positioning gear so that cap screws (B) will be in the approximate center of gear slots. Doing so will permit the pump timing to be changed, should the need arise.

8. Install drive hub nut and tighten to 100—110 N·m (74—81 lb-ft).



-UN-05DEC89
RG5547

S55,3010,CP -19-13NOV95

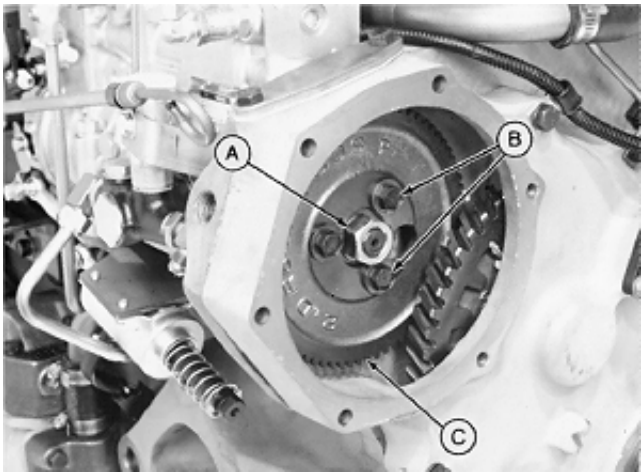
9. Tighten the four injection pump-to-cylinder block mounting stud nuts to 47 N·m (35 lb-ft).

IMPORTANT: The normal backlash of gears is enough to throw the pump timing off by several degrees, resulting in poor engine performance. Therefore, it is very important that pump timing be rechecked after it has been installed. To avoid backlash, always approach the timing mark on pointer by rotating crankshaft in direction of engine rotation.

10. To check alignment of injection pump, remove the JDE81-4 Timing Pin from the flywheel. Rotate the flywheel with JDE81-1 Flywheel Turning Tool 1-1/2 revolutions in direction of normal rotation. Install the timing pin and continue rotating until timing pin engages in timing pin hole. Look into timing window, and if the timing marks ARE NOT in alignment, loosen the pump drive gear (C) cap screws (B). Rotate pump drive hub (A) and bring pump hub timing marks into alignment. Repeat timing check to be sure marks are aligned. Install timing hole plug.

NOTE: Apply LOCTITE 242 Thread Sealant to cap screws before securing cover plate to prevent oil leakage.

11. Install injection pump gear cover with new gasket and tighten cap screws to 47 N·m (35 lb-ft).



RG5547 -UN-05DEC89

S55,3010,CQ -19-17NOV95

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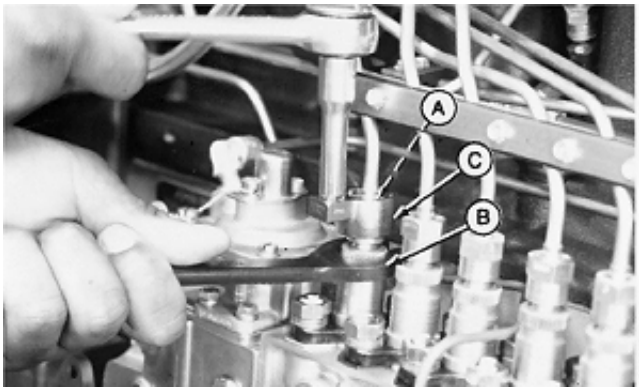
24

NOTE: Remove protective caps and plugs from fuel system components installed during pump removal.

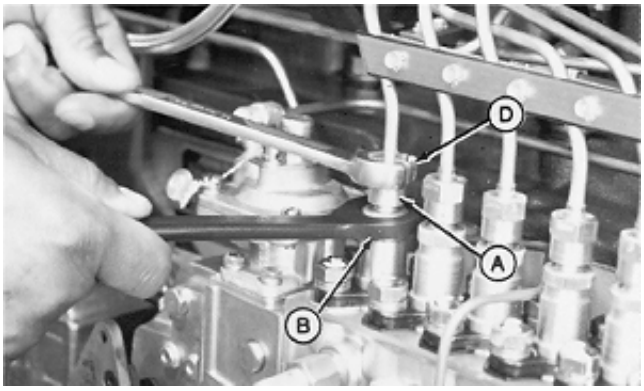
IMPORTANT: The JDE90 Serrated Wrench (B) MUST BE used to keep the delivery valves fittings stationary while tightening fuel line nuts (A). If a delivery valve and barrel housing rotates while tightening a line nut, the injection pump fuel delivery will be altered. The injection pump will then have to be recalibrated on a test stand by an authorized diesel repair station.

12. Connect the fuel delivery line nuts to the injection pump delivery valves and tighten to 27 N·m (20 lb-ft) using JDE90 Serrated Wrench with either the JDF22 Crowsfoot Wrench or a standard 3/4 in. line wrench (D).

A—Fuel Injection Line Nut
B—JDE90 Serrated Wrench
C—JDF22 Crowsfoot Wrench
D—3/4 in. Line Wrench



RG5573 -UN-07JUL89



RG5574 -UN-10NOV89

S55,3010,CR -19-20JUN89

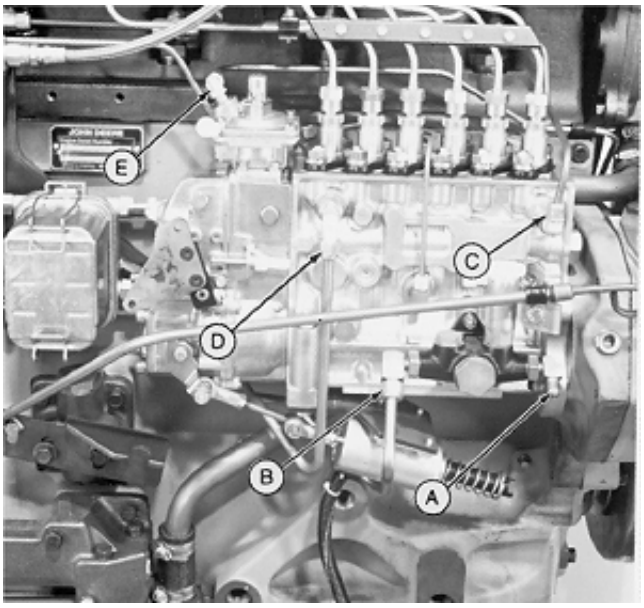
13. Connect aneroid line (E), if equipped.

14. Connect fuel supply pump inlet (A) and outlet lines (B).

15. Connect injection pump inlet line (D) and fuel leak-off line (C).

16. Install fuel filter onto mounting base.

A—Supply Pump Inlet
B—Supply Pump Outlet
C—Leak-Off Line
D—Injection Pump Inlet
E—Aneroid Line



RG5548 -UN-10NOV89

S55,3010,CS -19-20JUN89

On 6101HRW02 Engines equipped with electronic governors:

IMPORTANT: Because of the combination of the aluminum coupling ring and the plastic mating threads, cross-threading of the connectors can damage the connectors. Therefore, care should be used when mating connectors to avoid damaging the threads.

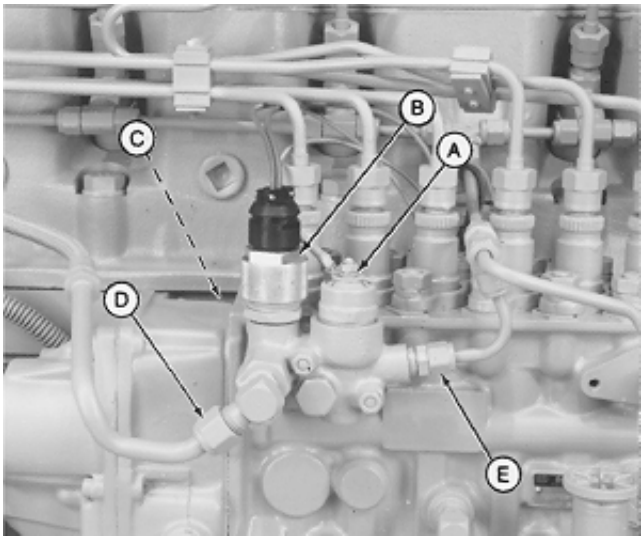
Be careful to tighten the coupling ring to the prescribed torque range to verify the connectors are fully engaged. When the coupling ring engages the sealing O-ring, a false indication of a fully mated connector can be given.

17. Connect fuel shut-off solenoid wiring lead (A) and tighten nut securely. Connect fuel temperature sensor connector (B) and tighten 7—15 N·m (5—11 lb-ft).

18. Connect fuel inlet line (D) and leak-off line (E). Tighten connections securely.

NOTE: Because of the location of the actuator connector (C) accessibility is difficult. A special crowsfoot wrench (JDG646) is required to adequately tighten the coupling ring.

19. Connect the actuator connector and finger tighten. Tighten the connector 10—20 N·m (7—11 lb-ft) using the JDG646 Special Crowsfoot Wrench. DO NOT overtighten.



RG5549 -UN-10NOV89

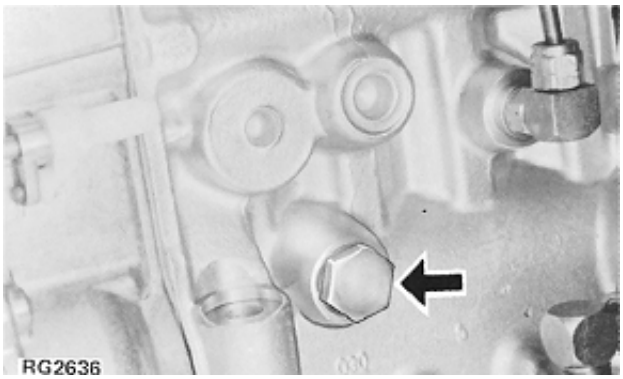
A—Shut-Off Solenoid Lead
B—Fuel Temperature Sensor Connector
C—Actuator Connector
D—Fuel Inlet Line
E—Fuel Leak-Off Line

S55,3010,CT -19-17NOV95

20. Remove oil filler cap (arrow) and add enough clean engine oil until oil comes out oil fill hole. Engine should be level when checking oil level.

21. Bleed the fuel system as outlined in Group 115.

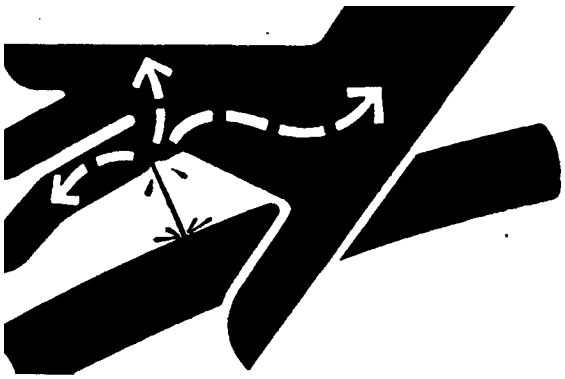
22. Connect throttle levers and adjust engine speeds as required. (See Adjust Engine Speeds in your machined technical manual.)



RG2636 -UN-20DEC88

S55,3010,CU -19-17NOV95

REMOVE FUEL INJECTION NOZZLES



X9811 -UN-23AUG88

CAUTION: Escaping fluid under pressure can penetrate skin causing serious injury. Relieve pressure before disconnecting lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

S55,3010,CV,1 -19-17NOV95

1. Thoroughly clean area around the injection pump and nozzles, including all line connections, using compressed air. Cap or plug all fuel lines as they are disconnected.

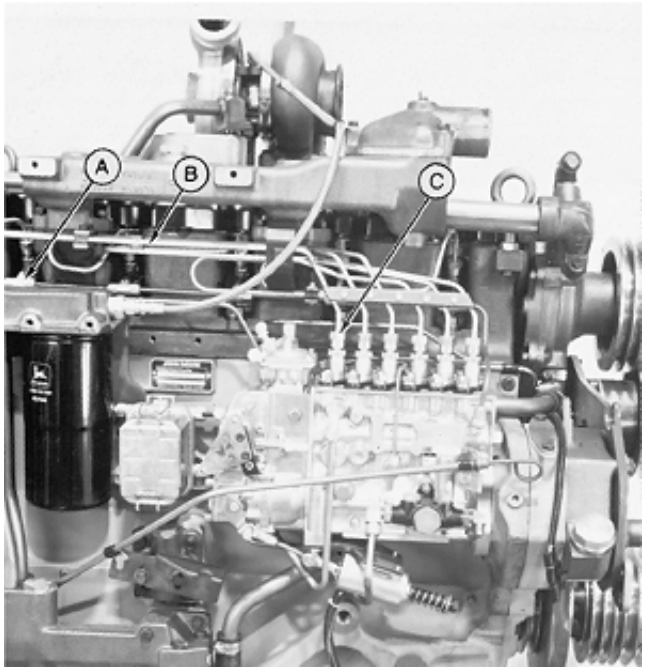
2. Disconnect turbocharger oil inlet line and remove water manifold. (See Group 25.)

3. Disconnect fuel delivery lines (B) at nozzles using the JDF22 Crowsfoot Wrench.

IMPORTANT: The JDE90 Serrated Wrench must be used to keep the fuel delivery valve fittings stationary while loosening the line nuts. If a delivery valve and barrel housing rotates while loosening a fuel line nut the injection pump fuel delivery will be altered. The pump will have to be recalibrated on a test stand.

4. Disconnect fuel delivery line nuts (C) from each delivery valve using the JDE90 Serrated Wrench from either JDF22 Crowsfoot Wrench or a 3/4 in. line wrench. Remove fuel delivery lines as an assembly.

5. Disconnect fuel leak-off line (A) from each injection nozzle leak-off connector. Remove complete leak-off assembly.

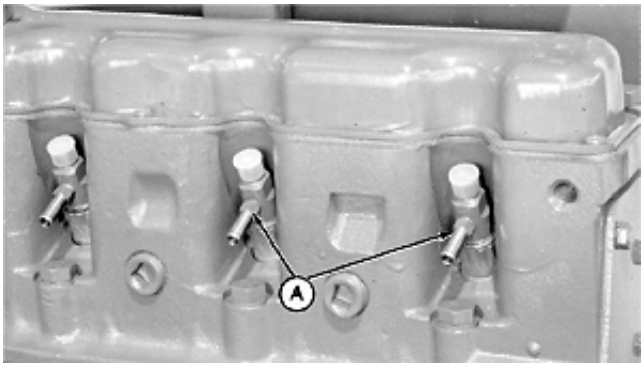


RG5550 -UN-10NOV89

S55,3010,CW -19-17NOV95

6. Remove packing and line nuts from each leak-off connector. Discard packing.

7. Remove leak-off connector (A) with washer from each injection nozzle.

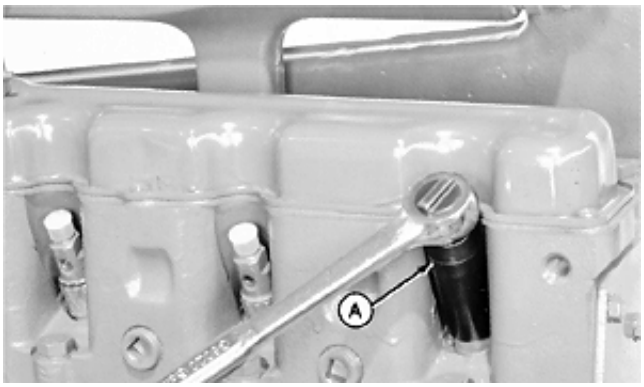


S55,3010,CX,1 -19-17NOV95

NOTE: The socket portion of the JDE92 Nozzle Wrench (A) may be used to remove nozzles from cylinder head.

8. If the JDE92 Nozzle Wrench is not used, use a 24 mm (15/16 in.) deep socket on nozzle gland nut to remove nozzles. The gland nut will act as a jack screw to raise nozzle out of the cylinder head bore.

9. To prevent debris from entering the combustion chamber after nozzles are removed, insert a 12.7 mm (1/2 in.) hardwood dowel in the nozzle bore.



S55,3010,CY,1 -19-17NOV95

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DIAGNOSE INJECTION NOZZLE MALFUNCTION

Problem	Possible Cause	Suggested Remedy
Failed Carbon Stop Seal Washer	Nozzle replaced without using new seal or washer.	Install new seal or washer.
	Carbon stop seal groove not cleaned when new seal was installed.	Clean groove. Install new seal.
Incorrect Opening Pressure	Improper adjustment.	Adjust opening pressure.
	Broken spring.	Replace spring.
Nozzle Will Not Open	Plugged orifices.	Clean.
	Chipped orifices.	Replace nozzle.
	Bottomed lift screw.	Adjust lift screw.
Poor Spray Pattern	Plugged orifices.	Clean.
	Chipped orifices.	Replace nozzle.
	Cracked nozzle tip.	Replace nozzle.
Poor Atomization	Plugged orifice.	Clean.
	Chipped orifice.	Replace nozzle.
	Cracked nozzle tip.	Replace nozzle.
	Valve not free.	See “Inconsistent Chatter”.
Inconsistent Chatter	Spring components misaligned.	Adjust opening pressure.
	Varnish on valve.	Clean guide area.
	Deposits in seat area.	Clean seat.
	Bent valve.	Replace nozzle.
	Distorted body.	Replace nozzle.

S11,3010,NS -19-08APR94

DIAGNOSE INJECTION NOZZLE MALFUNCTION—CONTINUED

Problem	Possible Cause	Suggested Remedy
No Chatter	Spring components misaligned.	Adjust opening pressure.
	Varnish on valve.	Clean guide area.
	Deposits in seat area.	Clean seat.
	Bent valve.	Replace nozzle.
	Valve seat eroded or pitted.	Lap valve to seat. Replace nozzle as necessary.
	Tip seat pitted.	Lap tip to seat. Replace nozzle as necessary.
	Seat interference angle worn.	Replace nozzle.
	Distorted body.	Replace nozzle.
Seat Leakage	Deposits in seat area	Clean seat.
	Valve seat eroded or pitted.	Lap valve to seat. Replace nozzle as necessary.
	Tip seat pitted.	Lap tip to seat. Replace nozzle as necessary.
	Valve not free.	See “Inconsistent Chatter”. See “No Chatter”.
	Distorted body.	Replace nozzle.
	Cracked tip.	Replace nozzle.
High Leak-Off	Wear or Scratched at Guide	Lap valve to guide. Replace nozzle.
Low Leak-Off	Varnish on valve.	Clean guide area.
	Insufficient clearance.	Clean nozzle. Lap valve to guide. Replace nozzle as necessary.

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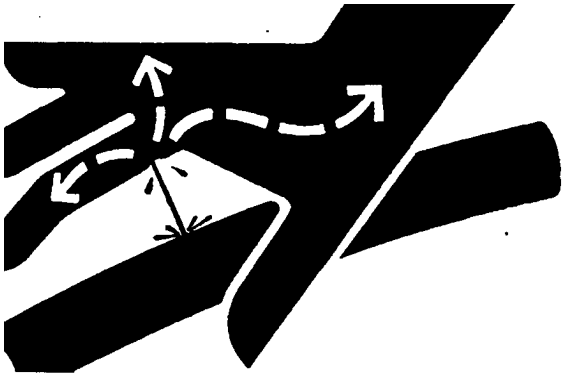
S11,3010,NT -19-13MAY93

TEST FUEL INJECTION NOZZLES

Test the injection nozzle before disassembling to determine its condition. Test for: Opening Pressure, Leakage, Chatter and Spray Pattern. Always use clean filtered fuel when performing tests.



X9811 -UN-23AUG88

CAUTION: The nozzle tip should always be directed away from the operator. Fuel from the spray orifices can penetrate skin and clothing, causing serious personal injury. Enclosing the nozzle in a transparent cover, or glass beaker is recommended.

Before applying pressure to the nozzle tester, be sure that all connections are tight and that the fittings are not damaged. Fuel escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood; rather than your hands, to search for suspected leaks.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

S55,3010,CZ -19-05APR93

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PERFORM OPENING PRESSURE TEST

IMPORTANT: Nozzle tester should be checked periodically for accuracy.

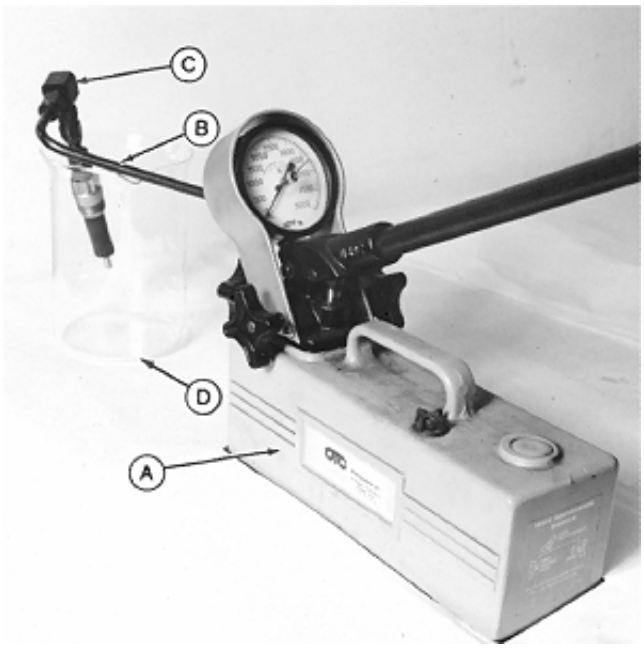
1. Connect KDEL injection nozzle to D01109AA (Y900) Nozzle Tester (A), using 36352 (Y900-2A) Fuel Line (B) and 23623 (Y900-7) and 23693 (Y900-15) Straight Adapters (C). The 208369 (Y900-21) 90° Adapter may also be used.

CAUTION: To avoid personal injuries, place a glass beaker (D) around nozzle during opening pressure test.

2. Pump handle several times to flush out nozzle fittings. Tighten fittings.

3. Expel air from nozzle by operating pump handle several strokes. Then raise pressure until valve opens.

4. Recheck by completely releasing pressure, then gradually building pressure until valve opens.



RG5883 -UN-19AUG91

A—Nozzle Tester
B—Fuel Line
C—Adapter
D—Beaker

S11,3010,PS -19-20JUL95

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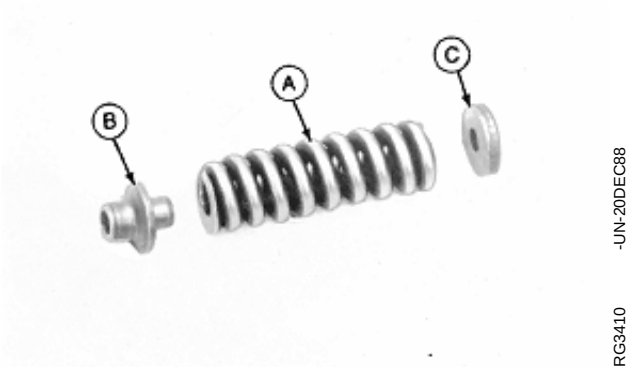
FUEL INJECTION NOZZLE SPECIFICATIONS



-UN-20DEC88

RG3410

A new nozzle or a used nozzle with a new spring (A), shoudl open at approximately the following pressures. A used nozzle that has been rebuilt with a new spring and/or valve should be reset to the same pressures as a new nozzle. New nozzle opening pressures are:

New Nozzle Opening Pressures

6 x 0.285 mm . . . . . 29000—29800 kPa (290—298 bar) (4200—4300 psi)

On nozzles which have been in service, the spring (A) and spring seat (B) will have taken a normal set. In this case, a satisfactory opening pressure should be at least (but not more than the new opening pressure) as follows:

Used Nozzle Minimum Operating Pressures

6 x 0.285 mm . . . . . 26200 kPa (262 bar) (3800 psi)

Shims (C) are available for changing the opening pressure adjustment. Each 0.05 mm (0.002 in.) shim changes the opening pressure approximately 700 kPa (7 bar) (100 psi).

IMPORTANT: Always use John Deere nozzle adjusting shims which are specially hardened. Other shims will not be satisfactory.

If the opening pressure is not correct, disassemble the injection nozzle (as described later in this group) and change shims until nozzle opens at the proper used nozzle pressure given above. The difference in nozzle opening pressure in any one cylinder of the engine should not exceed 350 kPa (3.5 bar) (50 psi).

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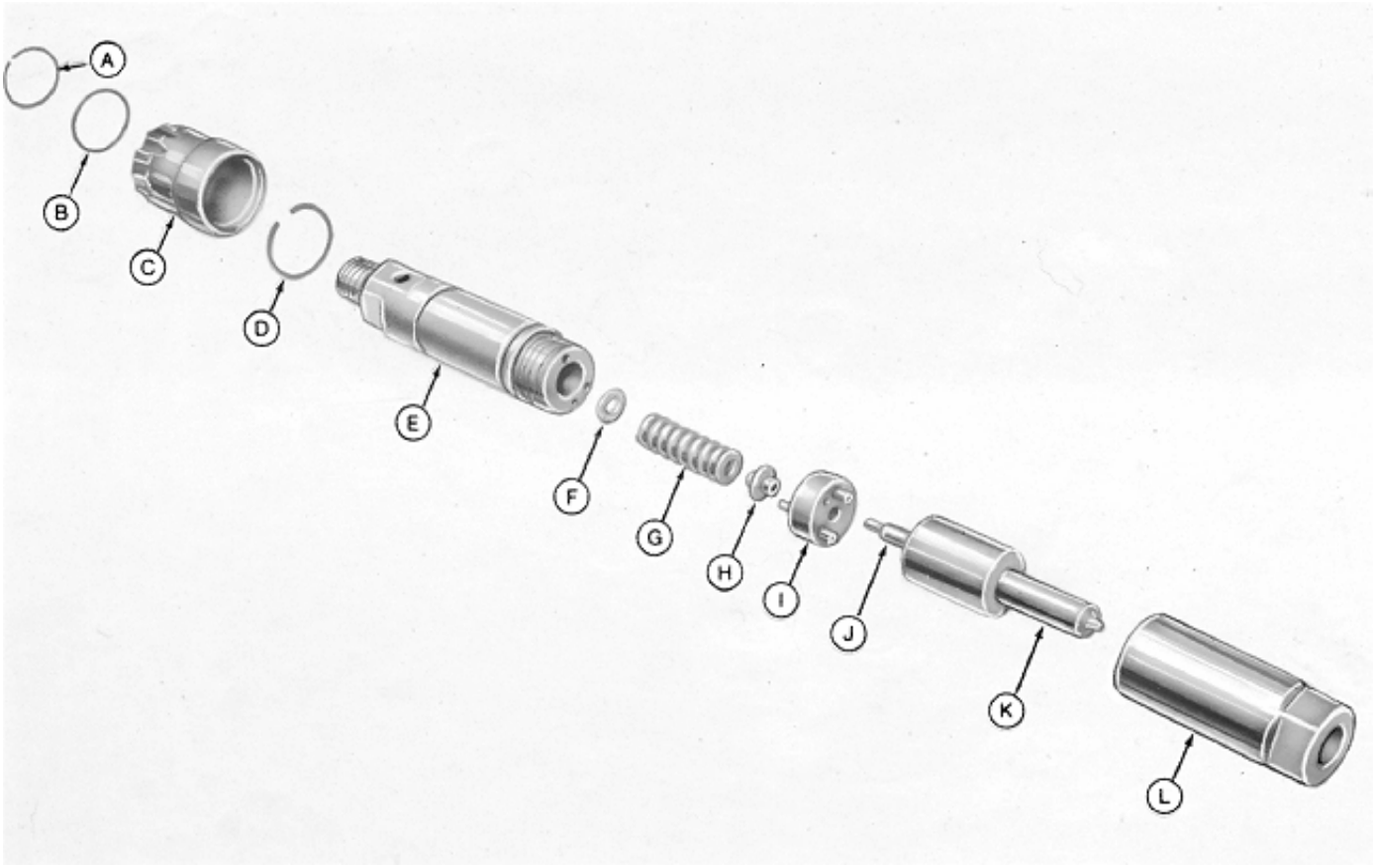
S55,3010,BF -19-13NOV95

PERFORM LEAKAGE TEST



RG2591 -UN-16FEB94

A—Snap Ring (Bosch Only)
B—Gland Nut O-Ring
C—Gland Nut
D—Snap Ring (Bosch Only)
E—Nozzle Holder
F—Shim
G—Nozzle Valve Spring
H—Spring Seat
I—Intermediate Plate
J—Nozzle Valve
K—Nozzle
L—Nozzle Retaining Nut

1. Wipe nozzle dry.

2. Bring pressure up slowly to 1970 kPa (20 bar) (285 psi) below the opening pressure. Watch for an accumulation of fuel from the spray orifice, indicating a bad seat.

If the nozzle drips within 10 seconds, replace nozzle valve (J) and nozzle (K).

3. Check for leakage around nozzle retaining nut (L) thread connection with nozzle holder (E).

Leakage indicates a bad seat either between nozzle and intermediate plate (I) or between nozzle holder and intermediate plate.

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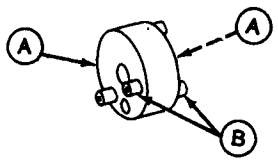
S11,0408,AO -19-13NOV95

RG2248 -UN-20APR89



RG2248

IMPORTANT: Do not lap machined surfaces (A) of intermediate plate in an attempt to stop fuel leakage at these locations. Dowels (spring pins) (B) in plate have to be removed before surfaces can be lapped. Removing these dowels is not recommended as removal is likely to damage them, and replacement dowels are not available as service parts.

If leakage is observed, tighten nozzle retaining nut to a maximum of 88 N·m (65 lb-ft). Replace injection nozzle if leakage continues.

S55,3010,BG -19-05APR93

TEST NOZZLE CHATTER AND SPRAY PATTERN

1. Injection nozzle should chatter very softly, and only when hand lever movement is very rapid (four to six downward movements per second). Failure to chatter may be caused by a binding or bent nozzle valve.

2. Until chattering range is reached, test oil emerges as non-atomized streams. When lever movement is accelerated, sprays should be very broad and finely atomized.

A partially clogged or eroded orifice will usually cause spray to deviate from correct angle. Spray will also be steady rather than finely atomized.

3. Disassemble nozzle for cleaning or reconditioning if it fails to chatter or spray properly.

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S11,0408,AQ -19-20JUL95

DISASSEMBLE FUEL INJECTION NOZZLE

General Nozzle Repair Notes:

NOTE: Disassembly of nozzles is not recommended unless servicing is indicated by nozzle operation and testing.

• Since dirt and water are the worst contaminants in fuel injection system, working area, tools and cleaning materials must be kept spotlessly clean. Whenever possible, work in an isolated, dust-free area.

• Cover workbench with clean paper before disassembly of injection nozzles.

• As parts are disassembled, place them in a pan of clean diesel fuel and leave there until needed. Do not permit parts to strike each other.

• Use a separate pan of clean diesel fuel for washing parts before assembly.

S11,0408,AR -19-08APR94

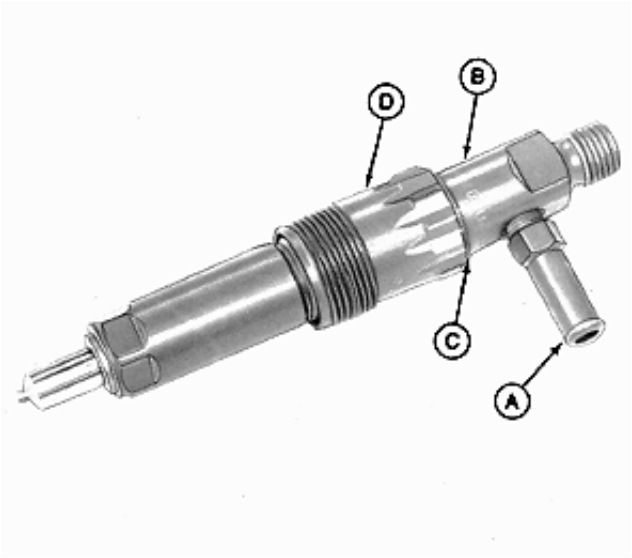
NOTE: The KDEL injection nozzle is a metric unit and only metric tools should be used.

1. Use an 11 mm box or open-end wrench and unscrew leak-off connector (A) (if not removed previously) from nozzle holder (B).

2. Remove O-ring and upper snap ring (C) from nozzle holder.

3. Slip gland nut (D) off nozzle holder.

A—Leak-Off Connector
B—Nozzle Holder
C—O-Ring and Upper Snap Ring
D—Gland Nut



RG3887 -UN-20DEC88

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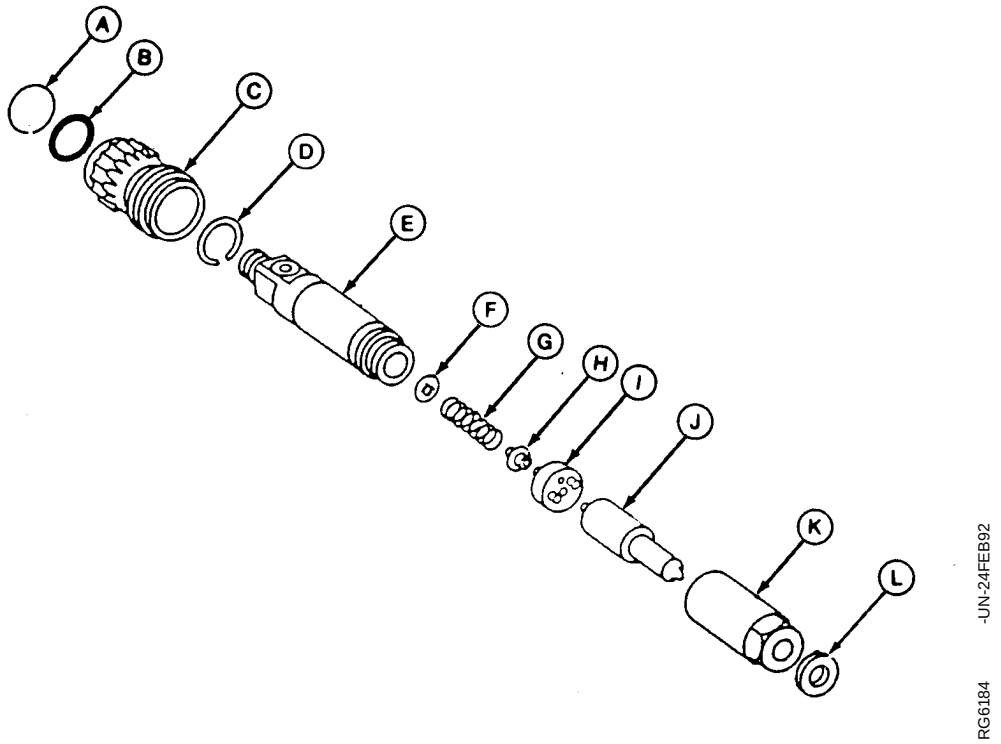
S11,0408,AS -19-08APR94



A—Snap Ring (Bosch only)
B—Gland Nut O-Ring
C—Gland Nut
D—Snap Ring (Bosch only)
E—Nozzle Holder
F—Shim
G—Nozzle Valve Spring
H—Spring Seat
I—Intermediate Plate
J—Nozzle
K—Nozzle Retaining Nut
L—Washer

4. Remove lower snap ring (D).

5. Clamp the two flats of the nozzle holder (fuel inlet end) in a soft-jawed vise and remove nozzle retaining nut (K), using a 12-point 19 mm wrench.

6. Remove nozzle assembly (J and K).

7. Pull off intermediate plate (I).

8. Remove spring seat (H), spring (G), and shims (F).

9. Withdraw nozzle valve from nozzle. If valve is stuck, it may be necessary to soak nozzle assembly in Bendix cleaner, acetone, or other commercial cleaners sold especially for freeing stuck valves.

CAUTION: Use these nozzle cleaning fluids in accordance with manufacturer's instructions.

Do not permit lapped surfaces of valve and nozzle to come in contact with any hard substance. DO NOT touch valve unless your hands are wet with fuel.

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S11,0408,AT -19-20JUL95

CLEAN AND INSPECT FUEL INJECTION NOZZLE ASSEMBLY

IMPORTANT: Never use a steel brush to clean nozzles. Steel brush may damage injection nozzles.

1. Remove anti-corrosive coating from new or reconditioned nozzles by washing them thoroughly with diesel fuel.

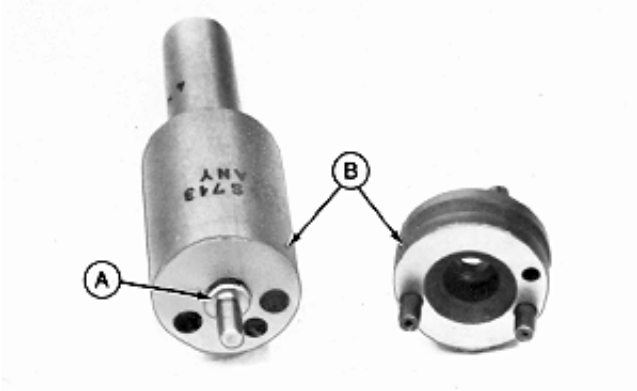
2. Remove carbon from used nozzles and clean by washing them in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush.

3. After removing carbon or lacquer from nozzle exterior, inspect lapped surface for nicks or scratches. Replace if not in good condition.

4. Inspect piston part of nozzle valve (A) to see that it is not scratched or scored. If any of these conditions are present, replace nozzle assembly.

5. Inspect nozzle valve seat, nozzle, and intermediate plate. Contact area of parts (B) must not be scored or pitted. Use inspection magnifier in JDF13 (JDE105) Nozzle Cleaning Kit to aid inspection.

NOTE: A bad nozzle valve seat will cause fuel to drip from nozzle. This condition will usually be noted when making the "Leakage Test".



RG3411 -UN-20DEC88

S11,0408,AU -19-08APR94

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PERFORM NOZZLE SLIDE TEST

NOTE: DO NOT touch lapped surface (D) unless hands are wet with diesel fuel.

1. Dip nozzle valve (A) in clean diesel fuel.

2. Insert valve in nozzle (B).

3. Hold nozzle vertical and pull valve out about one-third of its engaged length.

4. Release valve. Valve should slide down (C) to its seat by its own weight. Always replace a nozzle assembly if the valve does not fall freely to its seat.

A—Nozzle Valve
B—Nozzle
C—Free-Fall Distance
D—Lapped Surface

RG5953 -UN-30AUG91

S11,3010,CZ -19-20JUL95

CLEAN SPRAY ORIFICES

1. Begin with a cleaning wire (D) 0.07—0.10 mm (0.003—0.004 in.) smaller than nominal orifice size of 0.33 mm (0.13 in.) from JDF13 (JDE105) Nozzle Cleaning Kit.

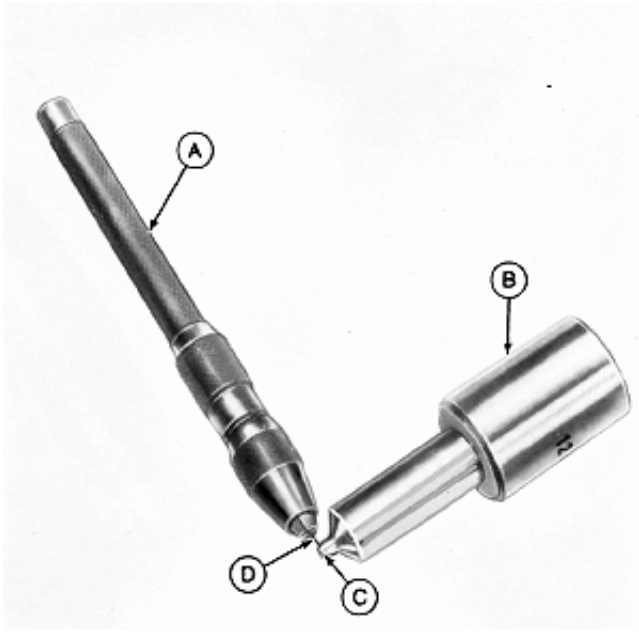
NOTE: Stoning wire to provide a flat surface on one side will help in reaming carbon from clogged hole.

2. Clamp cleaning wire in pin vise (A). Wire should not protrude from vise more than 0.8 mm (0.03 in.).

3. Insert wire into orifice (C) and rotate.

4. For final cleaning, use a cleaning wire 0.03 mm (0.001 in.) smaller than orifice size. Follow previous steps until orifices are clean of any carbon deposits.

A—Pin Vise
B—Nozzle
C—Orifice
D—Cleaning Wire



RG3412 -UN-20DEC88

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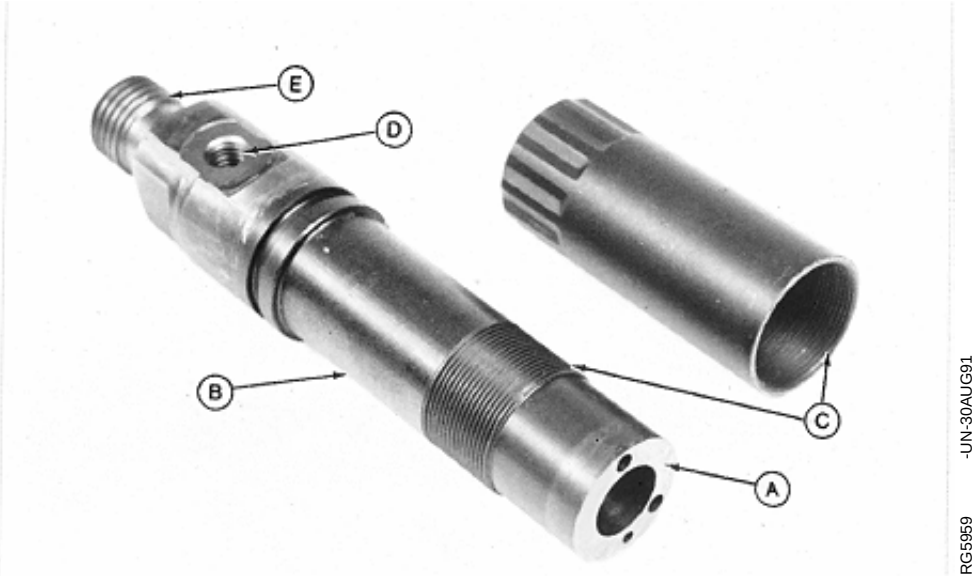
S11,3010,DA -19-20JUL95

INSPECT NOZZLE HOLDER



A—Lapped Surface
B—Nozzle Holder
C—M19 x 1
D—M6 x 1
E—M14 x 1.5

1. Inspect lapped surface (A) on bottom end of nozzle holder (B) for nicks or scratches. Replace holder if not in good condition.

2. Inspect threads M19 x 1 (C), M6 x 1 (D), and M14 x 1.5 (E) on nozzle holder for general condition. Threads that are nicked slightly may be “dressed-up.” Replace holder if threads cannot be restored to a serviceable condition.

Check fuel passages in nozzle holder to make sure they are open. Clean with compressed air.

3. Remove carbon deposits on both inner and outer surfaces of nozzle retaining nut.

4. Inspect retaining nut for cracks caused by overtightening or a damaged lower seating surface. A seat may be restored by rubbing the surface with emery cloth. Any nozzle nut which cannot be reconditioned must be replaced.

S11,3010,DB -19-20JUL95

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5. Examine lapped surfaces on intermediate plate (A) for nicks, scratches, or worn areas which would permit fuel to leak past.

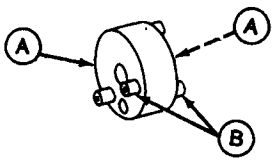
6. Replace intermediate plate if lapped surfaces are worn or damaged.

IMPORTANT: Do not lap machined surfaces of intermediate plate. Dowel pins (B) in plate have to be removed before surfaces can be lapped. Removing these dowels is not recommended as removal is likely to damage them, and replacement dowels are not available as service parts.

7. Inspect spring seat for splitting, cracking, or excessive wear.

Replace seat if any of these conditions are evident.

RG2248 -UN-20APR89



RG2249 -UN-20APR89

RG2249

S11,3010,DC -19-08APR94

8. Examine spring and shims for pitting or excessive wear. Replace as necessary.

NOTE: The edge-type filter is pressed into the nozzle holder and is not removable for service.

9. Clean filter by applying compressed air to nozzle holder fuel passage (A) at nozzle end.

-UN-30AUG91 RG5962

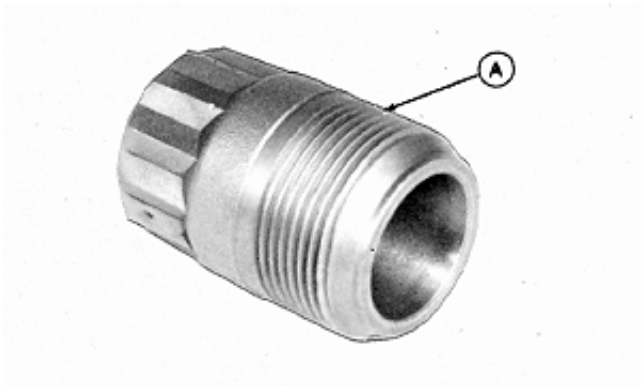
S11,0408,BD -19-20JUL95

INSPECT GLAND NUT

1. Inspect nozzle holder gland nut to insure it is not cracked or split.

2. Inspect the M28 x 1.5 threads (A). Threads which are slightly nicked or damaged may be “dressed up.”

Replace gland nut if unable to restore to a serviceable condition.



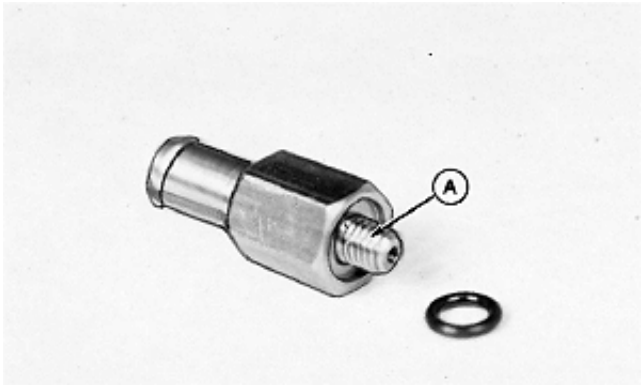
-UN-30AUG91 RG5956

S11,0408,BF -19-20JUL95

3. Check passage in leak-off connector to see that it is open.

4. Blow through connector passage with compressed air.

5. Inspect M6 x 1 threads (A). Replace connector if threads are damaged and can not be restored to a serviceable condition.



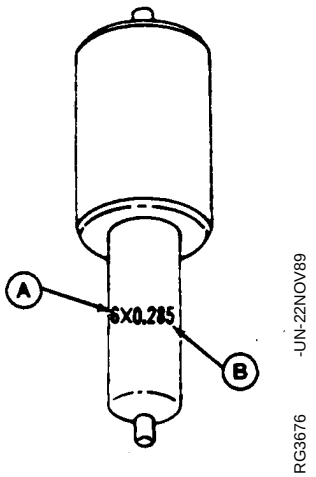
S11,0408,BG -19-20JUL95

ASSEMBLE FUEL INJECTION NOZZLE

IMPORTANT: Be sure to install correct nozzle assembly on nozzle holder. Do not intermix different size nozzle assemblies.

To help determine the right nozzle assembly for each application, note that markings appear on the lower part of the nozzle.

The illustration shows a nozzle marked 6 x 0.285. The number “6” (A) indicates the number of orifices and “0.285” (B) indicates the orifice size in millimeters.



The engine nozzle size relationship is:

Engine	Nozzle Size
6101	6 x 0.285

IMPORTANT: Immerse parts in clean fuel before assembly. Do not dry parts with towels or compressed air. Dust particles might collect and stay on pressure faces of nozzle valve and nozzle holder.

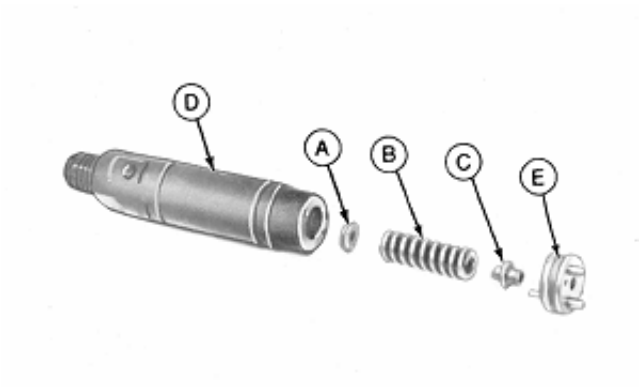
35
42

S55,3010,BI -19-19APR89

1. Place shims (A), spring (B), and spring seat (C) in nozzle holder (D) while still wet with diesel fuel.

NOTE: Make sure intermediate plate (E) is free of any foreign material before reassembling.

A—Shims
B—Spring
C—Spring Seat
D—Nozzle Holder
E—Intermediate Plate



-UN-20DEC88
RG3415

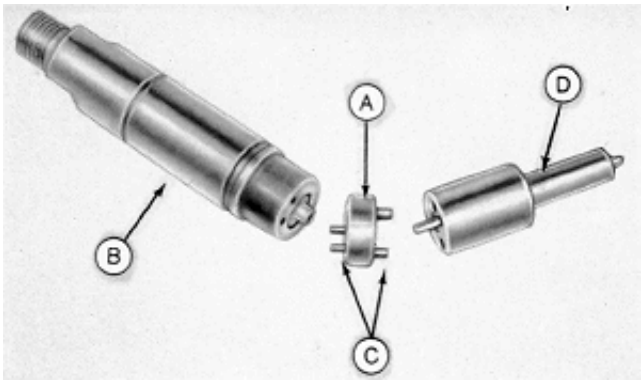
S11,3010,DF -19-20JUL95

NOTE: Make sure intermediate plate (A) is clean before installing.

2. Position intermediate plate (A) on nozzle holder (B). Dowel pins (C) in plate will permit installation only one way.

3. Insert nozzle valve into nozzle (D) while holding parts below diesel fuel level in pan.

A—Intermediate Plate
B—Nozzle Holder
C—Dowel Pins
D—Nozzle and Valve



-UN-29NOV88
RG2254

S11,3010,DG -19-20JUL95

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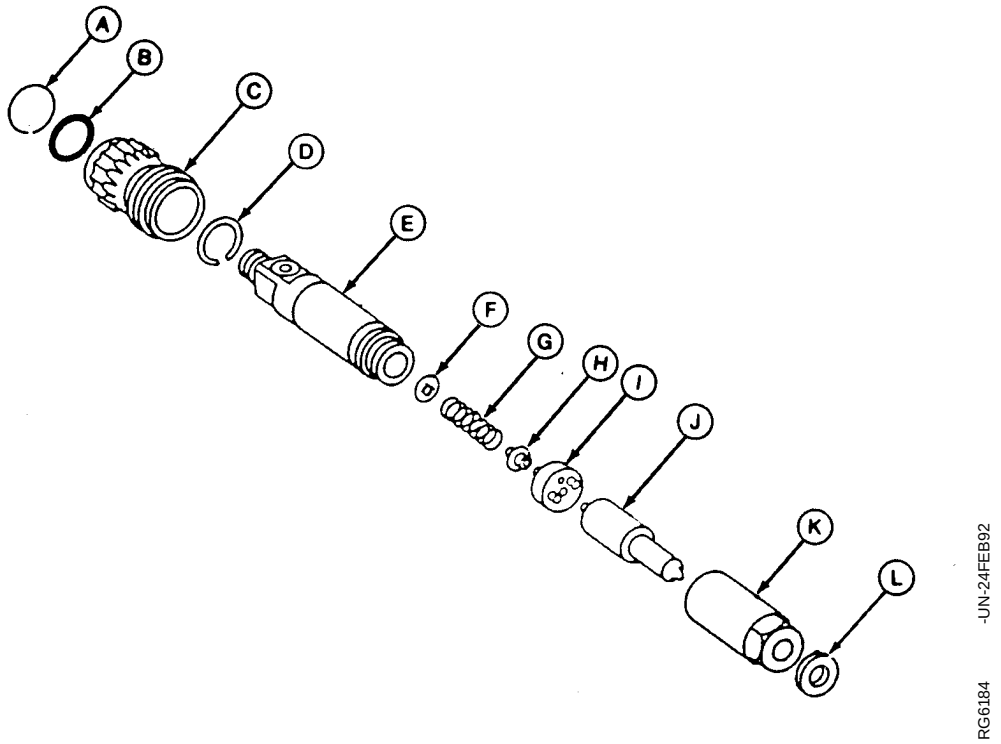
43



A—Snap Ring (upper)
B—Gland Nut O-Ring
C—Gland Nut
D—Snap Ring (Lower)
E—Nozzle Holder
F—Shim
G—Nozzle Valve Spring
H—Spring Seat
I—Intermediate Plate
J—Nozzle
K—Nozzle Retaining Nut
L—Washer

4. Install nozzle assembly on nozzle holder (E) and secure with nozzle retaining nut (K).

5. Clamp nozzle holder in a soft-jawed vise. Tighten nozzle retaining nut to 88 N·m (65 lb-ft).

6. Install lower snap ring (D) on nozzle holder.

7. Coat bore of gland nut (C) liberally with PT569 NEVER-SEEZ compound to prevent gland nut from seizing on holder body.

8. Install upper snap ring (A) on nozzle holder and position O-ring (B) against gland nut.

9. Install leak-off connector on nozzle holder using a new washer.

NOTE: Leak-off connector and washer should be installed on nozzle holder even though they will have to be removed to install injection nozzle in cylinder head. This will prevent misplacement of connector and washer before installation on engine.

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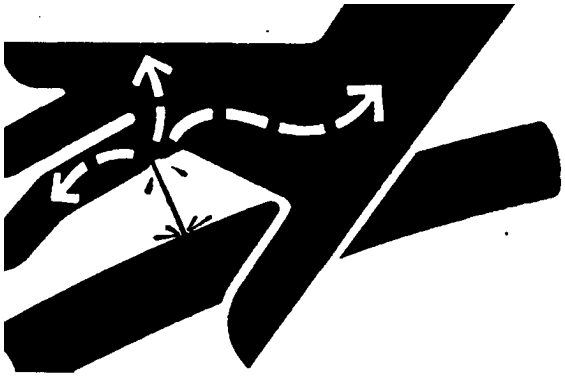
S55,3010,BJ -19-15SEP94

ADJUST FUEL INJECTION NOZZLES



X9811 -UN-23AUG88

CAUTION: Nozzle tip should always be directed away from operator. Fuel from spray orifices can penetrate clothing and skin causing serious personal injury. Enclosing nozzle in a glass beaker is recommended.

Before applying pressure to nozzle tester, be sure all connections are tight, and fittings are not damaged. Fluid escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood, rather than hands, to search for suspected leaks.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

1. Connect nozzle to nozzle tester, as directed earlier in this group.

2. Refer to PERFORM OPENING PRESSURE TEST, earlier in this group, to test opening pressure of nozzle. Adjust as needed.

3. Refer to PERFORM NOZZLE LEAKAGE TEST, earlier in this group, to test for leakage.

4. Refer to PERFORM CHATTER AND SPRAY PATTERN TEST, earlier in this group, to test nozzle overall operation.

S11,3010,OE -19-30SEP94

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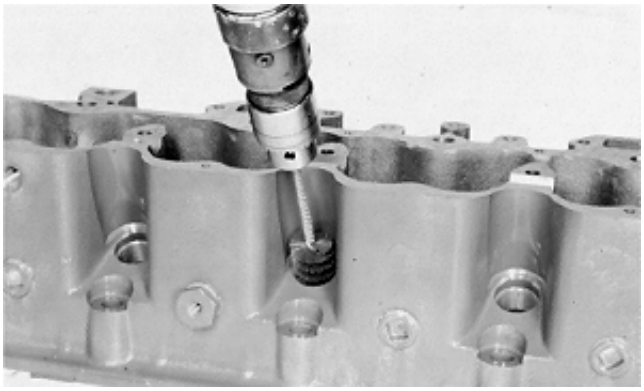
INSPECT AND CLEAN CYLINDER HEAD NOZZLE BORE


RG5251 -UN-14DEC88

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

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

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

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

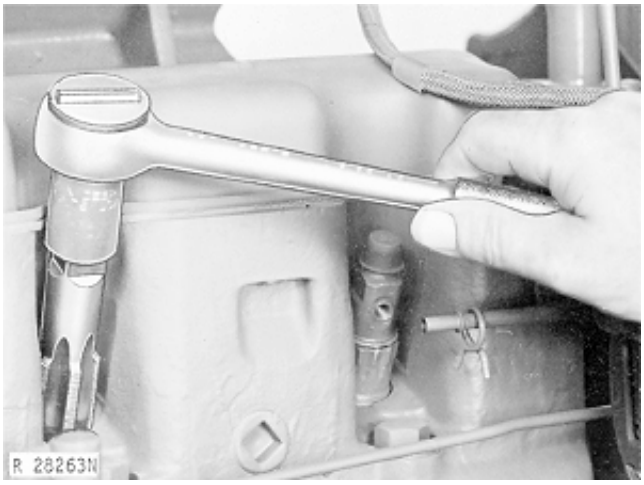
3. Clean threads which have light foreign deposits using an electric drill and D17030BR Nozzle Thread Cleaning Brush. Work brush up and down several times to clean threads.

S11,0408,BL -19-17AUG94

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

5. After cleaning threads, insert a 13 mm (1/2 in.) tapered hardwood dowel to plug nozzle tip bore.

6. Blow out debris from nozzle cavity with compressed air; then remove wood dowel.



R28263N -UN-20DEC88

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46

S11,0408,BM -19-20JUL95

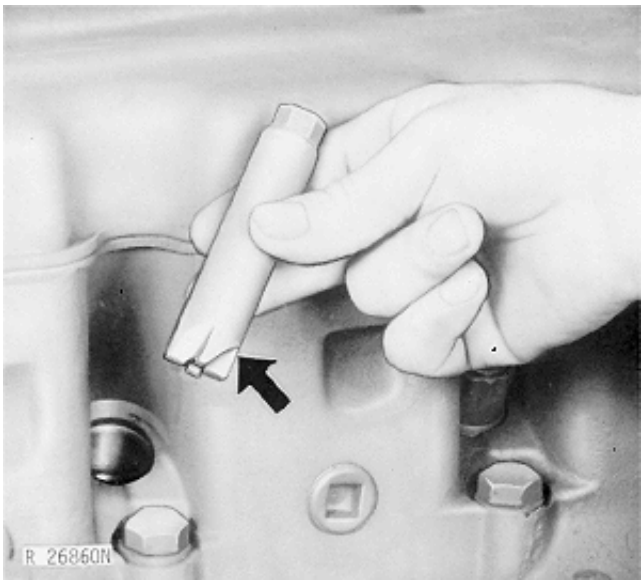
INSPECT AND CLEAN NOZZLE SEATING SURFACE

1. Inspect nozzle seating surface for carbon deposits.

2. If seat is not clean, use JDE99 or JDG609 Nozzle Seat Reamer to remove carbon. Stop using tool when seat comes clean.

3. Insert a 13 mm (1/2 in.) tapered hardwood dowel to plug nozzle tip bore.

4. Blow out debris with compressed air, then remove wood dowel.



R26860N -UN-20DEC88

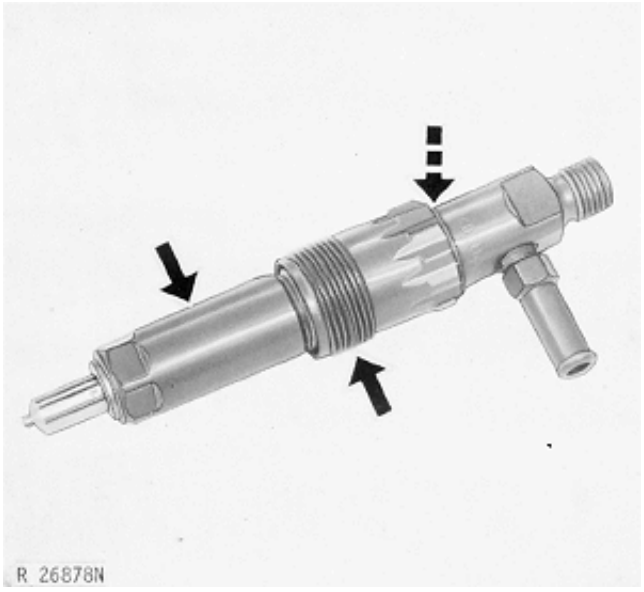
S11,0408,BN -19-08APR94

INSTALL FUEL INJECTION NOZZLES

1. Apply PT569 NEVER-SEEZ Compound to gland nut threads and nozzle barrel (arrows). Be sure that NEVER-SEEZ Compound was also applied to inside bore of gland nut during assembly.

NOTE: Applying NEVER-SEEZ Compound at these locations will help prevent possible seizure of gland nut to holder body.

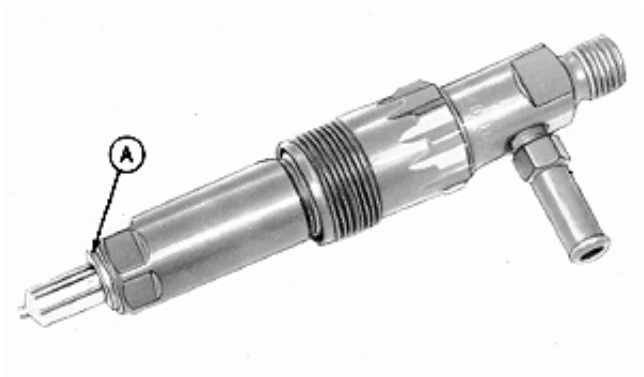
IMPORTANT: Do not intermix injection nozzles of different suppliers or different tip sizes within a single engine.



R26878N -UN-20DEC88

S11,0408,BO -19-10AUG94

2. Install a new R64840 Special Steel Washer (A) on tip end of assembled injection nozzle.



RG3678 -UN-20DEC88

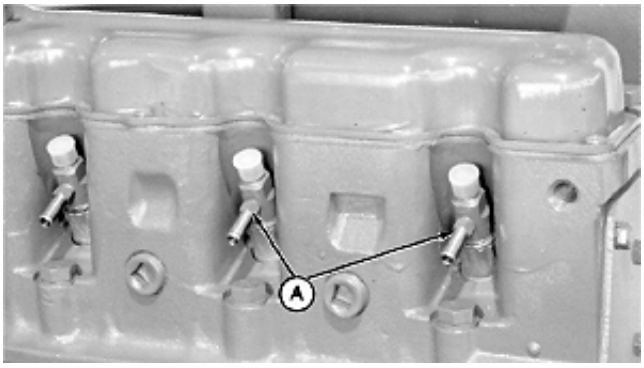
S55,3010,BK -19-19APR89

3. Insert injection nozzle into cylinder head. Turn gland nut by hand to make sure that it is threaded straight in cylinder head.

4. Remove leak-off connectors (A) and washers or O-rings.

5. Use outer socket of JDE92 Nozzle Socket and turn gland nut down to remove most of the looseness.

6. Rotate nozzle holder so hole for leak-off connector threads are facing straight out from cylinder head.



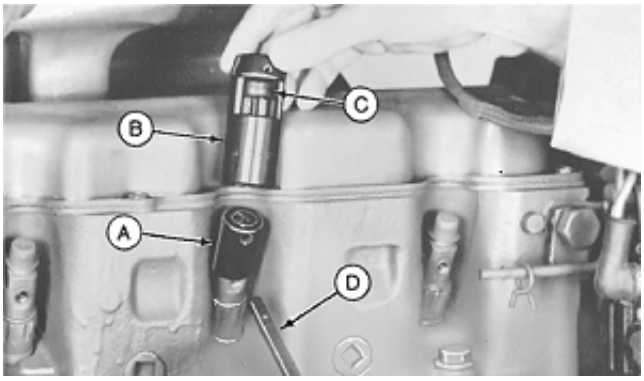
S11,0408,BQ -19-08APR94

7. Position inner socket (A) over nozzle holder and engage with flats at top of nozzle holder.

8. Place outer socket (B) portion of JDE92 Nozzle Socket on gland nut with socket “window” (C) facing outward.

9. Insert handle (D) through window into inner socket. Ball detent in handle will keep it secured to inner socket.

NOTE: Handle simulates position of leak-off connector, which must be square with engine to permit proper installation of leak-off lines.



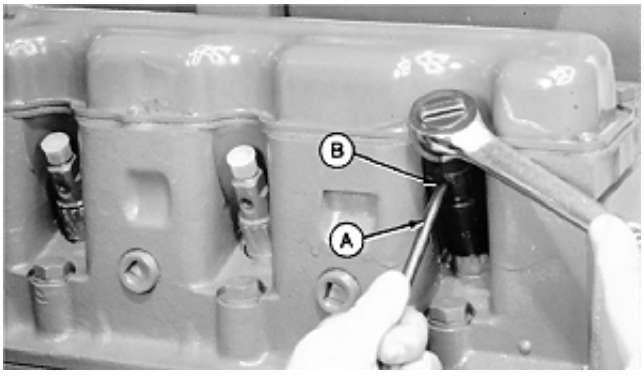
A—Inner Socket
B—Outer Socket
C—Window
D—Handle

S11,0413,X -19-08APR94

10. Tighten injection nozzle gland nut to 75—88 N·m (55—65 lb-ft). Keep handle (A) pointing straight out while tightening.

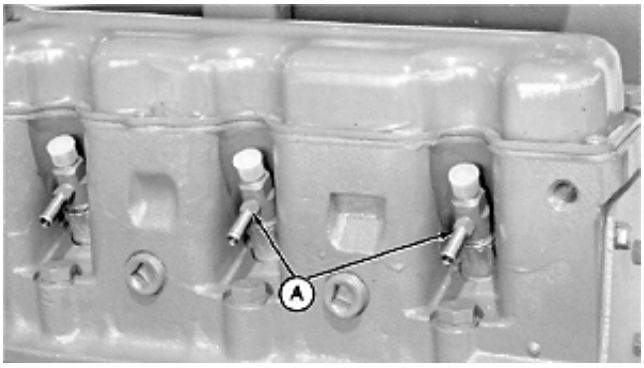
Socket window (B) is cut deep enough to obtain a new “bite” without removing inner socket.

11. Be sure O-ring is positioned against injection nozzle gland nut.



S11,0408,BS,1 -19-17NOV95

12. Install leak-off connectors (A) with washers on injection nozzles. Tighten securely.



S55,3010,AX -19-02DEC87

INSTALL FUEL LEAK-OFF AND FUEL DELIVERY LINE ASSEMBLIES

1. Before installing all-metal, multi-piece leak-off lines, loosen all fittings (A), remove pipes (B) and inspect all packings (C). Discard any packings that are worn or cut.

NOTE: Mark each leak-off pipe before disassembly to assure assembly in correct location.

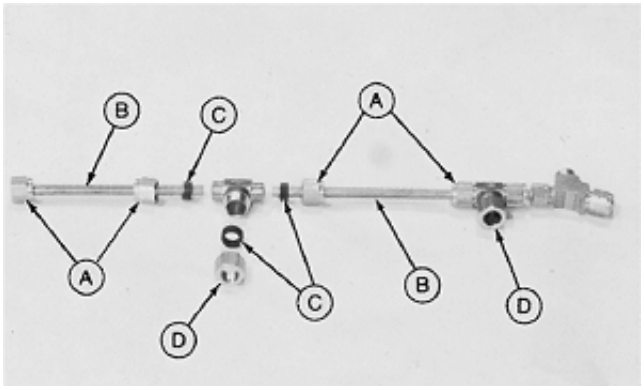
2. Check all pipes and fittings for wear or damage and replace as necessary.

3. Reinstall new packings (if needed), and pipes into tee-fittings. Tighten all connections securely.

4. Install nuts (D) and packing onto leak-off connectors. Install complete assembly over appropriate leak-off line connectors.

5. Tighten all leak-off line connections securely at each injection nozzle.

6. Connect leak-off line at injection pump and tighten securely.



A—Line Nuts
B—Packing
C—Packings
D—Connector Nuts

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S55,3010,BM -19-05APR93

IMPORTANT: JDE90 Serrated Wrench (B) must be used to keep delivery valve fittings stationary while tightening fuel line nuts. If a delivery valve and barrel housing rotates while tightening a fuel line nut, injection pump fuel delivery will be altered. Pump will have to be recalibrated on a test stand.

7. Remove protective caps and plugs from injection lines, nozzles, and delivery valves installed during disassembly. Install and connect injection line assembly at each respective injection nozzle and delivery valve.

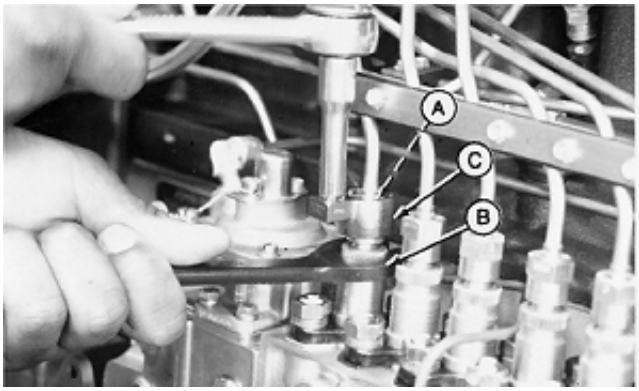
8. Tighten fuel injection line nozzle nuts (A) to 27 N·m (20 lb-ft).

9. Tighten line nuts at delivery valves to 27 N·m (20 lb-ft) using JDF22 Crowsfoot Wrench (C) or a 3/4 in. line wrench (D) along with JDE90 Serrated Wrench.

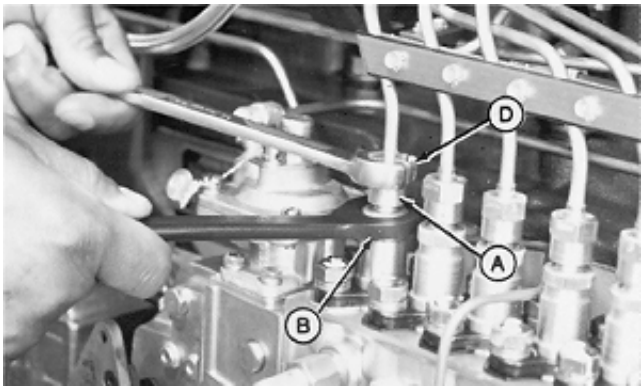
10. Install fuel delivery and fuel leak-off line clamps and tighten connections securely.

11. Bleed fuel system as described in Group 115.

A—Fuel Injection Line Nuts
B—JDE90 Serrated Wrench
C—JDF22 Crowsfoot Wrench
D—3/4 in. Line Wrench



RG5573 -UN-07JUL89



RG5574 -UN-10NOV89

S55,3010,BN,1 -19-17NOV95

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50

EFFECTS OF ALTITUDE AND TEMPERATURE ON ENGINE PERFORMANCE

Altitude, fuel temperature, air temperature, and humidity may affect engine performance. As a general rule, atmospheric changes will usually cause a decrease in engine power by the percentages shown in chart below.

ATMOSPHERIC CHANGE	% POWER DECREASE
Fuel Temperature Rise of 1˚C (1.8˚ F) above 40˚C (104˚F)	0.29
Air Temperature Rise of 5.5˚ C (10˚ F) above 25˚C (77˚F)	0.50
Turbocharged Engines: Altitude Rise of 300 m (1000 ft) above 183 m (600 ft)	0.50*
Relative Humidity Rise of 10% above 0%	0.07

If engine required less fuel for acceptable performance at higher elevation, contact your local authorized fuel injection pump repair station for service.

**Engine may have to be defueled when a substantial percentage of operating time occurs at 2250 m (7500 ft) or higher.*

RG,CTM20,G100,6-19-17NOV95

100
1

PRELIMINARY ENGINE TESTING

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

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

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

3. Perform a dynamometer test and record power output. (See DYNAMOMETER TEST later in this group.) Repeat dynamometer test after tune-up. Compare power output before and after tune-up.

4. Perform compression test (See TEST ENGINE COMPRESSION PRESSURE in Group 105).

S11,22010,BW -19-25JUL95

GENERAL TUNE-UP RECOMMENDATIONS

The following services are recommended each time a tune-up is performed. Disregard those services that do not apply to any particular application.

Operation	Detailed Reference
Check overall engine for fuel, lubricant, and coolant leaks. Repair leaks as necessary.	
Change engine oil and filters.	Operator's Manual
Lubricate PTO clutch internal levers and linkage.	Operator's Manual
Replace fuel filter and water separator, if equipped.	Group 35/Operator's Manual
Clean crankcase ventilation assembly.	This Group/Operator's Manual
Replace air cleaner elements and check air intake system.	This Group/Operator's Manual
Check exhaust system.	This Group
Check and service engine cooling system.	This Group/Operator's Manual
Check and adjust fan and alternator belts. Replace if necessary.	Operator's Manual
Check electrical system.	This Group
Check crankshaft vibration damper.	Group 15/Operator's Manual
Inspect turbocharger and check turbocharger boost pressure.	Group 110
Check fuel injection system: Check engine-to-injection pump timing, clean injection nozzles, and adjust nozzle opening pressure.	Group 35 and 115
Check engine oil pressure. Adjust if necessary.	Group 105
Check engine valve clearance. Adjust if necessary.	Group 05/Operator's Manual
Check engine speeds. Adjust if necessary.	Group 115
Check engine performance on dynamometer.	Group 105

RG,CTM6,G100,2 -19-08APR94

DYNAMOMETER TEST

IMPORTANT: Dynamometers should be periodically checked for accuracy and calibrated as necessary.

NOTE: High elevations may affect engine performance. (See EFFECTS OF ALTITUDE AND TEMPERATURE ON ENGINE PERFORMANCE earlier in this group.)

1. Connect engine to dynamometer using manufacturer's instructions.

2. Operate engine at one-half load until coolant and crankcase oil temperatures are up to normal operating range.

3. Run engine at fast idle, and gradually increase load on engine until speed is reduced to rated speed rpm.

NOTE: Refer to appropriate machine technical manual for average power ratings of specific application. Allow ±5% for minimum and maximum power.

4. Read horsepower on dynamometer and record reading over a period of several minutes after engine stabilizes.

5. Compare readings taken with power rating level for your engine application listed on the following chart.

CTM8,GR105,6 -19-03FEB95

ENGINE BREAK-IN GUIDELINES

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

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

• Pistons, rings, or liners have been replaced.

RG,CTM61,G105,2-19-17NOV95

ENGINE BREAK-IN INSTRUCTIONS

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

IMPORTANT: DO NOT use TORQ-GARD SUPREME PLUS-50™ Engine Oil during break-in period of an engine that has had a major overhaul. TORQ-GARD SUPREME PLUS-50 oil will not allow an overhauled engine to properly wear during the break-in period.

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

1. Fill engine crankcase to proper level with John Deere Break-In Oil during break-in operation. This oil is specifically formulated to enhance break-in of John Deere diesel engines.

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

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

PRELIMINARY ENGINE BREAK-IN AFTER MAJOR OVERHAUL

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

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

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

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

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

As a general rule, makeup oil should not need to be added during 100-hour break-in period. However, if makeup oil is required in the first 100-hour break-in, an additional 100-hour break-in period is required. Use a new change of John Deere Engine Break-In Oil and a new John Deere oil filter.

S55,2505,AL,1 -19-17NOV95

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CHECK CRANKCASE VENTILATION SYSTEM

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

1. Inspect crankcase ventilation system for restrictions; clean as needed.

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

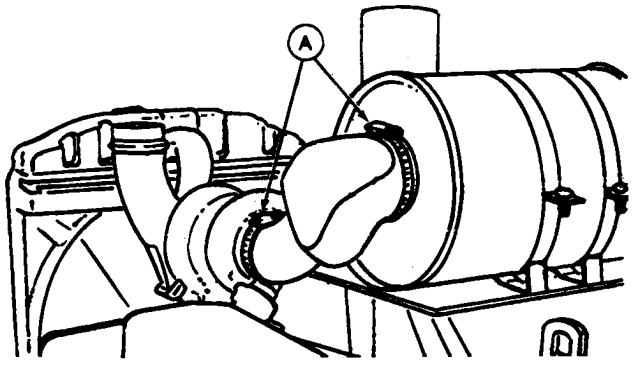
RG,CTM20,G100,1-19-17NOV95

CHECK AIR INTAKE SYSTEM

1. Replace air cleaner primary filter element. Replace secondary element if primary element has holes in it.

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

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



S11,22010,CU -19-08APR94

CHECK EXHAUST SYSTEM

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

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

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

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

S55,22010,C -19-08APR94

CHECK AND SERVICE COOLING SYSTEM

TS281 -UN-23AUG88

RG7343 -UN-23JUN95

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

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

3. Inspect radiator hoses for signs of leakage or rot. Replace hoses as necessary.

CAUTION: Do not drain coolant until it has cooled below operating temperature. Always loosen block drain valve (arrow) slowly to relieve any excess pressure.

4. Drain coolant at drain valve (A), remove thermostats, and flush cooling system. (See REMOVE THERMOSTATS in Group 25.)

5. Test thermostat opening temperature. (See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE in Group 105.)

IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen plug in water manifold to allow air to escape when filling system. Retighten plug when cooling system is full and all air has been expelled.

NOTE: If a coolant conditioner filter is used on engine, do not add additional inhibitors during coolant change; install a new coolant filter element.

6. Fill cooling system with recommended concentration of coolant, clean soft water, and inhibitors. (See HEAVY-DUTY DIESEL ENGINE COOLANT in Group 02.)

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

8. After engine cools, check coolant level.

NOTE: Coolant level should be approximately 19 mm (3/4 in.) below bottom of radiator filler neck.

9. Check system for holding pressure. (See TEST COOLING SYSTEM AND RADIATOR CAP in Group 105.)

10. Check condition of fan belt and replace if cracked, frayed or worn. Check belt tension. (See CHECK AND ADJUST V-BELT TENSION in Group 25.)

100
8

RG,CTM61,G100,2-19-25JUL95

CHECK ELECTRICAL SYSTEM

TS204 -UN-23AUG88

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

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

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

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

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

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

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

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

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

5. If batteries appear to be either undercharged or overcharged, check alternator and charging circuit. Follow diagnosis and testing procedures outlined in CTM77.

6. Check tension of fan belts. (See Engine Operator's Manual.)

7. Check operation of starting motor and gauges.

RG,CTM8,DX123 -19-21SEP95

SPECIAL OR ESSENTIAL TOOLS

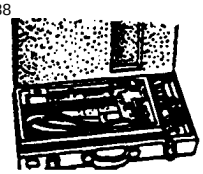
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-20JUL95

RG5161 -UN-23AUG88

Compression Test Set . JT01674 (formerly D14546BA)

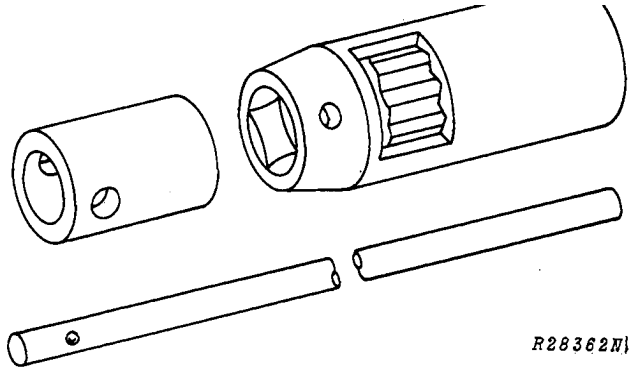
Check engine compression. Use adapter and gauge/hose assembly from set.



S53,JT01674 -19-03OCT94

Nozzle Socket JDE92

Used to remove and install fuel injection nozzles.

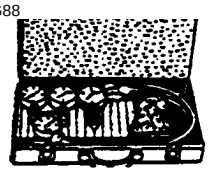


S11,22005,R -19-16AUG94

RG5162 -UN-23AUG88

Universal Pressure Test Kit JT05470

Gauge to check oil and fuel pressure.



S53,JT0547,0 -19-03OCT94

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

Rotate engine flywheel. Use with JDE81-4.

S53,JDE811 -19-06OCT95

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Lock engine at TDC when timing valve train. Use with JDE81-1 or JDE83.

S53,JDE814 -19-06APR90

105
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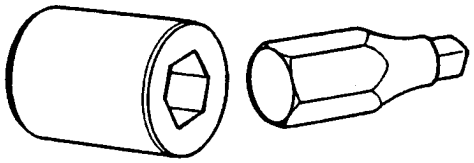
Oil Galley Plug Tool JDG782

Used to remove and install oil galley plug.



RG6612 -UN-29JAN93

RG,JDG782 -19-02APR93

Cooling System Pressure Pump D05104ST

Used to pressure test radiator cap and cooling system.

R26406 -UN-23JAN89

S55,D05104ST -19-03OCT94

ENGINE TEST SPECIFICATIONS

ITEM	SPECIFICATION
Engine Compression Pressure:	
(at 275—325 rpm cranking speed)	2480—2830 kPa (24.8—28.3 bar) (360—410 psi)
Maximum Variation between Cylinders	350 kPa (3.5 bar) (50 psi)
Engine Oil Pressure at 105˚C (220˚F) Sump:	
Minimum No Load at 800 rpm (Slow Idle)	103 kPa (1.03 bar) (15 psi)
Maximum Full Load at 2100 rpm (Rated Speed)	414 kPa (4.14 bar) (60 psi)
Oil Filter Bypass Valve Operating Pressure	210 kPa (2.10 bar) (30 psi)
Maximum Engine Blow-By at Crankcase Vent Tube:	
6101H Engines	17 m^3/h (600 cu ft/h)
6101A Engines	17 m^3/h (600 cu ft/h)
Cooling System and Radiator Pressure Cap	
Leakage Test Pressure	Refer to vehicle technical manual

RG,CTM20,G105,1-19-17NOV95

105
3

GENERAL DESCRIPTION

Model 6101 Engines are vertical stroke, in-line, valve in head, 6-cylinder engines.

Direct fuel injection is provided by an in-line, multi-plunger injection pump and 21 mm injection nozzles mounted in cylinder head. The pump is driven by an intermediate gear in the timing gear train connected to the camshaft gear.

6101 Engines are equipped with a turbocharger. Operated by exhaust gases, the turbocharger compresses intake air from air cleaner and routes it to the combustion chamber.

6101A Engines are turbocharged and in addition have a heat exchanger (called an aftercooler) located in the intake manifold. The aftercooler cools the compressed intake air from the turbocharger before entering the combustion chamber. Engine coolant flowing through the aftercooler is the media used for heat exchange on 6101A Engines. On 6101H Engines (air-to-air aftercooled), the heat exchanger uses no liquid coolant but relies on air flow to cool the charge air.

The camshaft is driven by the crankshaft gear. The camshaft rotates in honed machined bores in cylinder block, (replaceable bushings are used).

Intake and exhaust valves are operated by cam followers, push rods and rocker arm assembly, valve seat inserts and valve rotators are used in cylinder head to increase valve seat life and to prevent valve stem scuffing.

The crankshaft is a one-piece, heat-treated, dynamically balanced, steel forging which rotates in replaceable two-piece main bearings. The rear thrust bearing has a flange on each side to reduce crankshaft deflection and to limit end play during high load operation.

Cylinder liners are of a wet sleeve, flanged, and centrifugally cast design. O-rings are used to seal the connection between cylinder block and liners. Liners are induction hardened and are individually replaceable as a matched piston-liner set only.

Pistons are cast of high grade aluminum alloy and cam ground. The deep combuston chamber design provides maximum combustion efficiency. Two compression rings and one oil control ring are used. The top self-cleaning characteristics that reduces ring groove deposits and eliminates ring sticking. The oil control ring is a cast iron rail type with expander.

The highly polished, hardened piston pins are full-floating and held in position by means of snap rings. Spray jets (piston cooling orifices) in cylinder block direct pressure oil to lubricate piston pins and cool pistons.

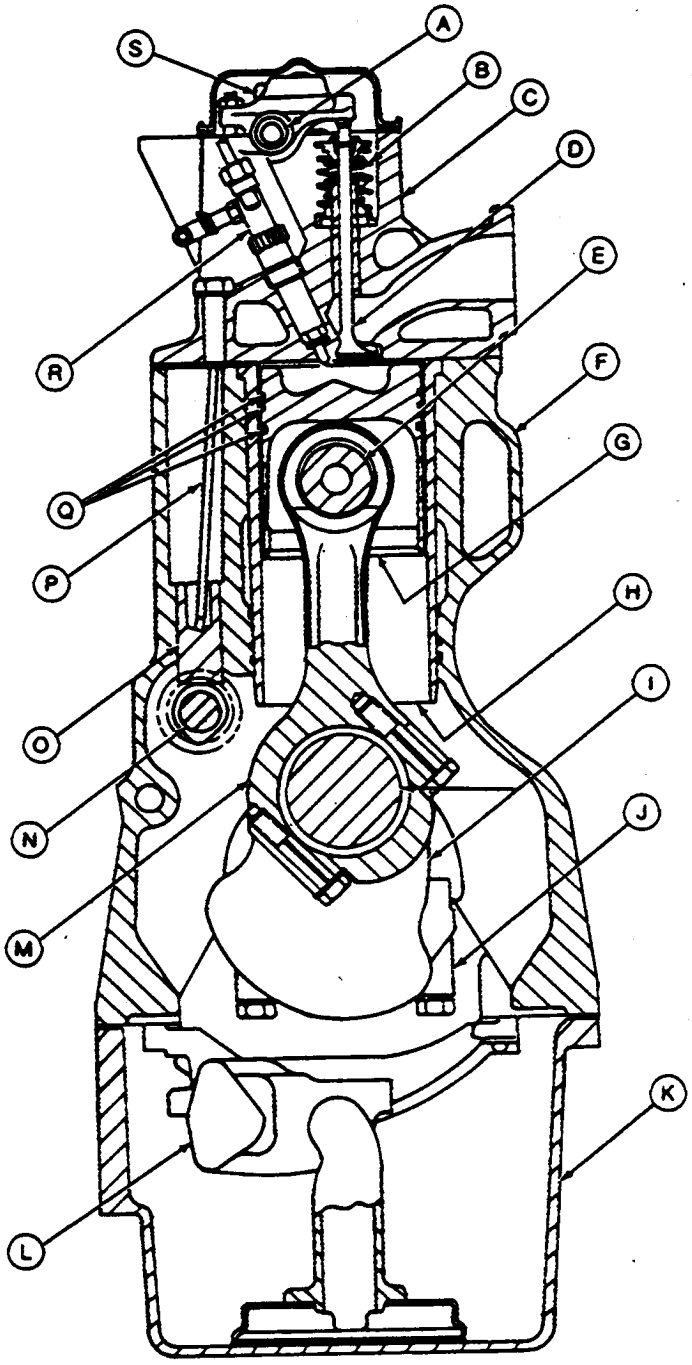
Connecting rods are of forged steel and have replaceable bushing and bearing inserts. They are weight controlled (by matching) on both ends to minimize engine vibration.

The engine lubrication system consists of a crankshaft-driven, positive displacement oil pump, an oil pressure regulating housing containing a pressure regulating valve. The oil filter manifold serves as a mounting base for the full flow and bypass oil filters. Bypass valve housing houses the oil cooler and oil filter bypass valves. An oil pressure relief valve and housing is located in the oil pan as a safety measure in extreme cold conditions.

Oil is pumped from the oil pan, by the oil pump into the oil bypass valve housing, into the oil pressure regulating valve housing and through the oil gallery in the cylinder block. Oil is then distributed, under pressure to each main bearing, piston cooling orifice, camshaft bearings, and cylinder head components.

S55,0000,O -19-14JUN89

ENGINE SECTIONAL VIEW

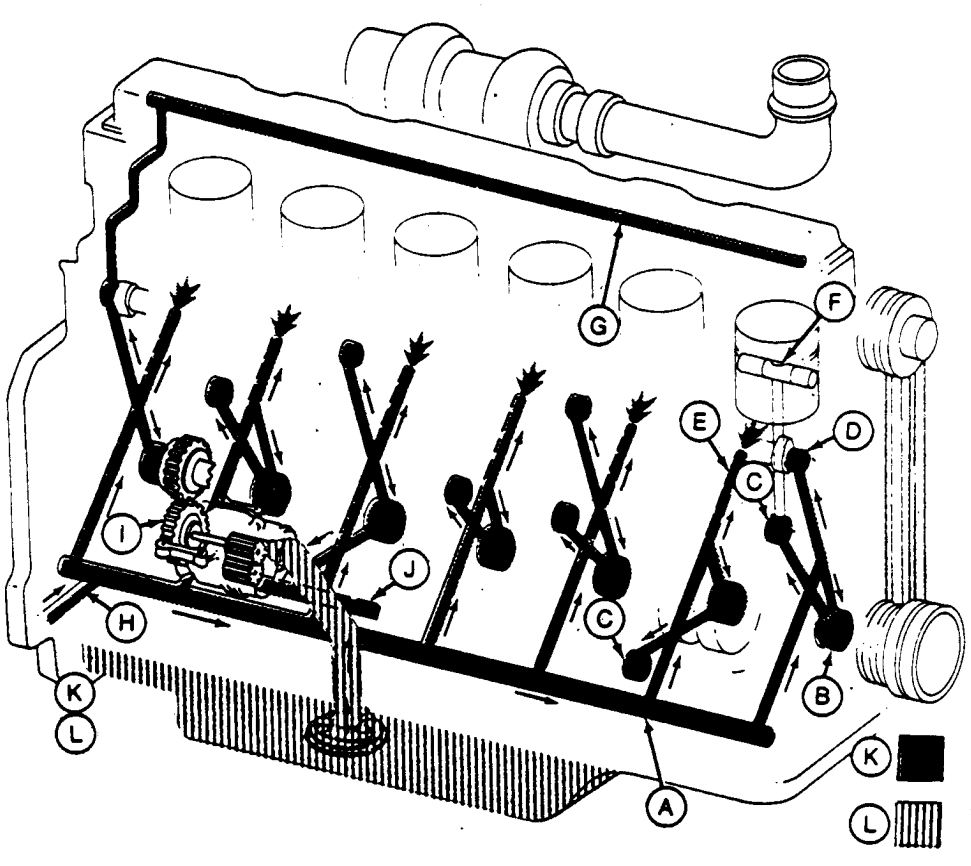


A—Rocker Arm Shaft
B—Valve Spring
C—Cylinder Head
D—Valve
E—Piston Pin
F—Cylinder Block
G—Piston
H—Cylinder Liner
I—Crankshaft
J—Main Bearing
K—Oil Pan
L—Oil Pump
M—Connecting Rod
N—Camshaft
O—Cam Follower
P—Push Rod
Q—Piston Rings
R—Fuel Injection Nozzle
S—Rocker Arm

105
5

S11,2000,FJ -19-06OCT95

HOW THE LUBRICATION SYSTEM WORKS



A—Main Oil Gallery
B—Main Bearings (7 used)
C—Connecting Rod Bearings (6 used)
D—Camshaft Bushings (4 used)
E—Piston Cooling Orifices (6 used)
F—Connecting Rod Pin Bushings (6 used)
G—Rocker Arm Shaft
H—Inlet From Oil Pressure Regulating Valve Housing
I—Engine Oil PUmp
J—Outlet to Oil Pressure Regulating Valve Housing
K—Engine Oil Pressure
L—Oil Pan Oil

Oil is pumped from the oil pan by the oil pump (I) into the oil pressure regulating valve housing. The oil goes through the oil cooler and filter and into the main oil gallery (A) in the cylinder block. Oil is then distributed, under pressure, to each main bearing (B) and piston cooling orifice (B).

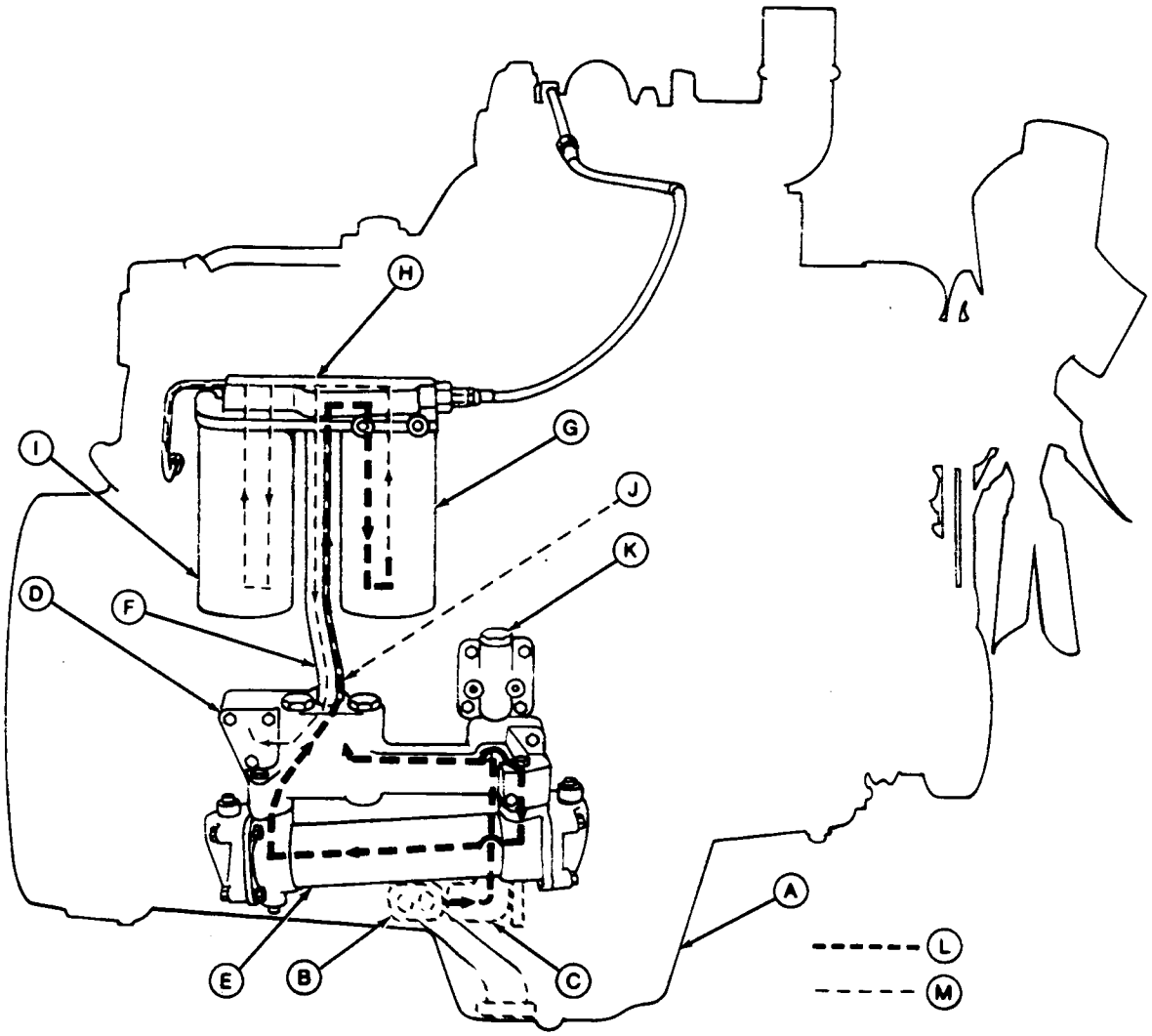
Drilled passages in the crankshaft distribute oil from the main bearing journals to the connecting rod journals to lubricate connecting rod bearings (C).

Numbers 1, 3, 5 and 7 main bearing supports are also drilled to lubricate the four camshaft bushings (D). A drilled passage from the rear camshaft bushing through the cylinder block and cylinder head provides lubrication to the rocker arm shaft.

The piston cooling orifices (E) spray oil to cool pistons and liners and lubricate the connecting rod piston pin bushings through an oil cup in the top of the connecting rod.

S55,2520,S -19-19JUL89

105
6



Item	Description	Primary Function
A	Oil Pan	Reservoir and collecting sump for engine oil.
B	Oil Pump	Flows oil through the lubrication system.
C	Pressure Relief Valve Housing	Discharges oil under extreme cold or high viscosity conditions.
D	Bypass Valve Housing	Bypasses oil in the event of high restriction of oil flow through the oil cooler and full flow oil filter. Directs oil back to the oil gallery and cylinder block.
E	Oil Cooler	Cools engine oil prior to circulation.
F	Outside Vertical Tube	Directs oil to the full flow oil filter.
G	Full Flow Oil Filter	Filter engine oil, removing debris, contaminants, etc.
H	Oil Filter Base	Channels oil between the oil bypass valve housing and filters.
I	Bypass Oil Filter	Provides super filtration of engine oil. Discharges back into oil pan sump.
J	Inside Vertical Tube	Directs clean oil from the filter base to the bypass valve housing.
K	Oil Pressure Regulating Valve	Regulates engine oil pressure within lube system. Returns oil to sump.
L	Unfiltered Oil	Carry debris, contaminants, etc., to oil filters.
M	Clean/Filtered Oil	Lubricate engine internal moving components.

S55,2520,U -19-07JUL89

(Refer to illustration on previous page)

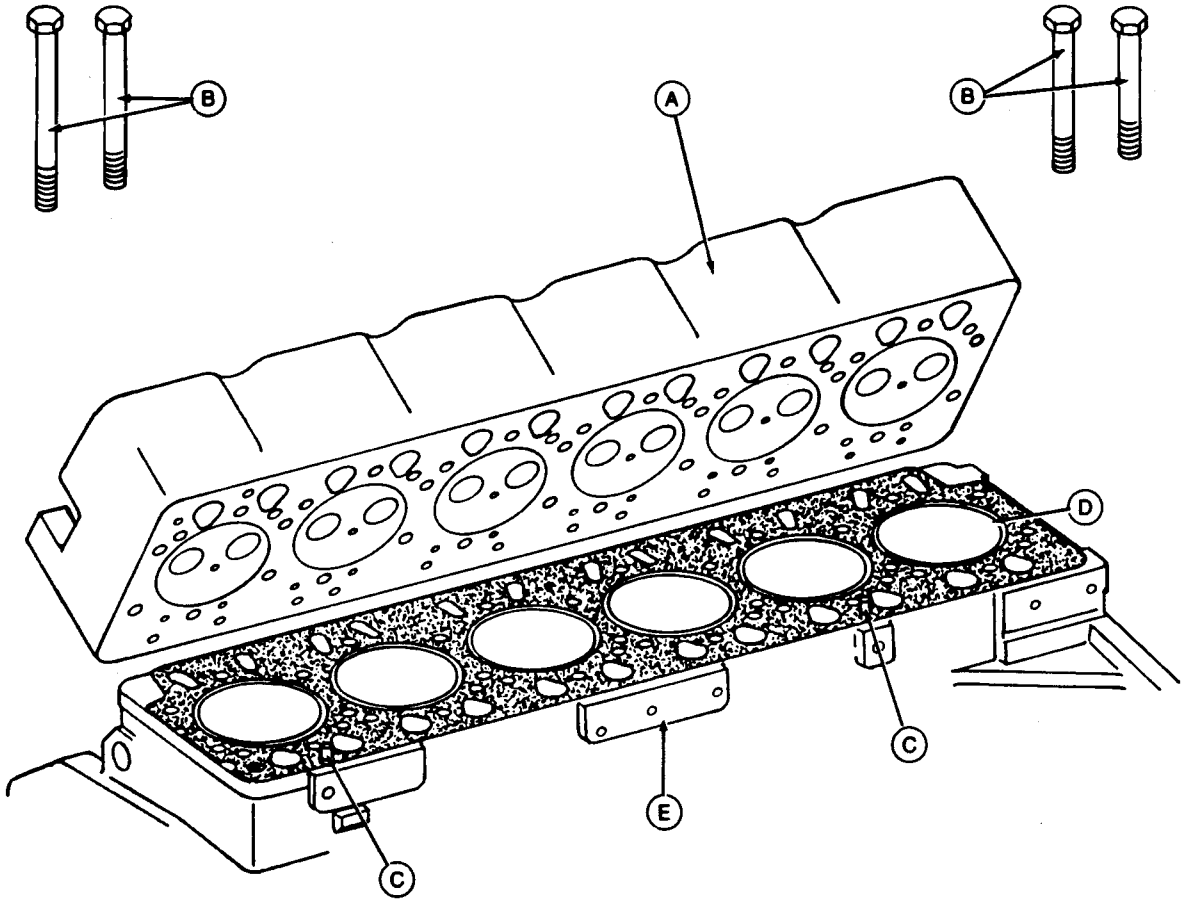
As shown, oil is drawn up from the oil pan (a) through the oil pump (B). After leaving the oil pump, oil flows through the oil pressure relief valve housing (C) which discharges oil back into the sump when excessively high pressure oil (during cold starts) is sensed. The oil proceeds to the bypass valve housing (D) and then through the oil cooler (E). If high restriction is sensed at the bypass valve housing, the oil bypasses the oil cooler and goes directly towards the oil filter. If excessively high restriction is sensed across the primary (full-flow) oil filter (G), oil is diverted directly to the main oil gallery.

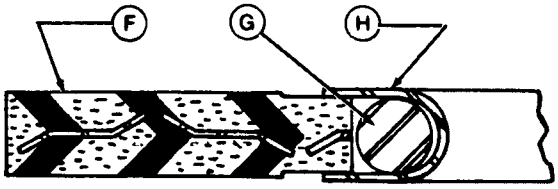
During normal operation, oil from the oil cooler or bypass valve housing goes up the outside vertical tube (F) and enter the full-flow oil filter, migrating from the outside of the filter element to the inside. Once the oil is filtered, it goes through the filter base (H) towards the inside vertical tube (J). A small portion of this already filtered oil is diverted to the bypass filter (I) for super cleaning and then to the oil pan sump. The majority of the filtered flow, however, is directed to the bypass valve housing and then on to the main oil gallery in the cylinder block. Engine oil pressure is sensed along this gallery by the oil pressure regulating valve (K) and excess flow is divierted back to the sump to maintain an acceptable oil pressure operating level.

Clean oil is pressure fed to the main and rod bearing, piston spray jets, camshaft bushings and up to the cylinder head from the oil gallery. Oil in the cylinder head is fed to the rocker arms valve train components.

S55,2520,T -19-13NOV95

HEAD GASKET JOINT CONSTRUCTION AND OPERATION





RG6667 -UN-13MAR93

A—Cylinder Head
B—Cylinder Head Cap Screws
C—Dowel Pins
D—Cylinder Liners
E—Cylinder Block
F—Gasket Body
G—Fire Ring Combustion Seal
H—Stainless Steel Flange

105
9

RG,CTM61,105,15-19-25JUL95

HEAD GASKET JOINT CONSTRUCTION AND OPERATION—CONTINUED

Refer to illustration on previous page.

The head gasket joint consists of:

- Cylinder head gasket (F)
- Cylinder head (A)
- Cylinder block (E)
- Cylinder liners (D)
- Cylinder head cap screws (B)

The head gasket must form an air-tight seal between cylinder liners and cylinder head that can withstand the temperatures and pressures of the combustion process. The gasket must also form a liquid-tight seal between the cylinder head and cylinder block to retain coolant and oil in their respective passages. The gasket is constructed of thin, formed sheets of steel-inserted, non-asbestos material. The surface of gasket is treated to improve liquid sealing and anti-stick characteristics. A fire ring combustion seal (G) is located at each cylinder bore and is held in place by a U-shaped stainless steel flange (H).

The cylinder head and block must be flat to provide an even clamping pressure over the entire surface of gasket, and must have the proper surface finish to keep gasket material from moving in the joint. Dowel pins (C) are used to properly locate head gasket on block.

The cylinder liners must protrude evenly from top of cylinder block the specified amount to provide adequate clamping force on fire ring of each cylinder.

The cap screws must be proper length, made of proper material, and be tightened to proper torque in order to provide an adequate clamp load between other joint components.

Each of the above components contributes to the integrity of the head gasket joint. If any of these components do not conform to specifications, gasket joint may fail resulting in combustion leaks, coolant leaks, or oil leaks.

Operating conditions such as coolant, oil, and combustion temperatures, and combustion pressures can reduce the ability of the head gasket joint to function properly. Failure of head gasket and mating parts may occur when coolant and oil temperatures become excessive, or when abnormally high combustion temperatures and pressures persist.

CTM61,G105,26 -19-13MAY93

DIAGNOSING HEAD GASKET JOINT FAILURES

Head gasket failures generally fall into three categories:

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

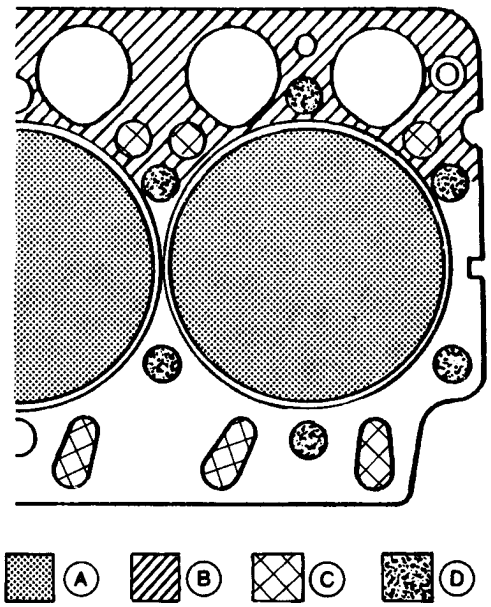
Combustion seal leakage failures occur when combustion gases escape between cylinder head and head gasket combustion flange, or between combustion flange and cylinder liner. Leaking combustion gases may vent to an adjacent cylinder, to a coolant or oil passage, or externally.

Coolant or oil seal leakage failures occur when oil or coolant escapes between cylinder head and gasket body, or between cylinder block and gasket body. The oil or coolant may leak to an adjacent coolant or oil passage, or externally. Since oil and coolant passages are primarily on right hand (camshaft) side of engine, fluid leaks are most likely to occur in that area.

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

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

- Oil or coolant in head gasket seam, or on adjacent surfaces. Especially right rear corner of gasket joint.
- Displacement of gasket from normal position.
- Discoloration or soot from combustion gas leakage.
- Leaking radiator, overflow tank, or hoses.
- Leaking coolant from water pump weep hole.
- Damaged or incorrect radiator, fan, or shroud.
- Obstructed air flow or coolant flow.
- Worn or slipping belts.
- Damaged or incorrect pressure cap.
- Presence of oil in coolant.
- Low coolant levels.
- Improper coolant.
- Unusually high or low oil levels.
- Oil degradation, dilution, or contamination.
- Correctly specified injection pump.
- Indications of fuel or timing adjustments.
- Unburned fuel or coolant in exhaust system.



RG6664 -UN-13MAR93

A—Combustion Sealing Areas
B—Coating Sealing Around Push Rod Holes
C—Coolant Sealing Areas
D—Cylinder Head Cap Screws

105
11

CTM61,G105,16 -19-25JUL95

2. Obtain coolant and oil samples for further analysis.

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

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

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

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

RG,CTM8,G105,11-19-29OCT92

Combustion Seal Leakage

Symptoms:

- Exhaust from head gasket crevice
- Air bubbles in radiator/overflow tank
- Coolant discharge from overflow tube
- Engine overheating
- Power loss
- Engine runs rough
- White exhaust smoke
- Loss of cab heat
- Gasket section dislodged, missing (blown)
- Coolant in cylinder
- Coolant in crankcase oil
- Low coolant level

Possible Causes:

- Insufficient liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Rough/damaged liner flange surface
- Cracked/deformed gasket combustion flange
- Out-of-flat/damaged/rough cylinder head surface
- Missing/mislocated gasket fire ring
- Block cracked in liner support area
- Excessive fuel delivery
- Advanced injection pump timing
- Hydraulic or mechanical disturbance of combustion seal

NOTE: Cracked cylinder head or liners may also allow combustion gas leakage into coolant.

RG,CTM8,G105,12-19-16SEP92

Coolant Seal Leakage

Symptoms:

- Coolant discharge from head gasket crevice
- Coolant in crankcase oil
- Low coolant level
- High oil level
- Coolant discharge from crankcase vent

Possible Causes:

- Excessive liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface
- Out-of-flat/damaged/rough cylinder head surface
- Oil or coolant overheating
- Cracks/creases in gasket body surfaces
- Damage/voids in elastomer beading

NOTE: Cracked cylinder head, liners, liner packings, defective oil cooler or aftercooler may also allow coolant leakage into crankcase.

RG,CTM8,G105,13-19-13MAY93

Oil Seal Leakage

Symptoms:

- Oil discharge from head gasket crevice
- Oil in coolant
- Low crankcase oil level
- Reduced oil to rocker arms (noisy)

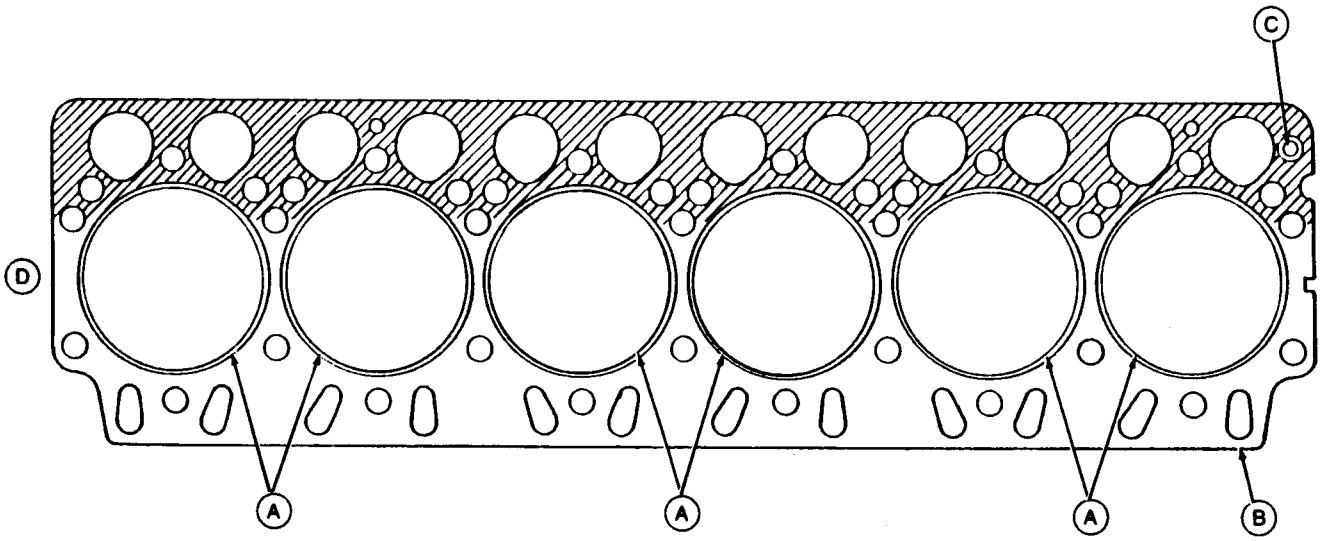
Possible Causes:

- Excessive liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface
- Out-of-flat/damaged/rough cylinder head surface
- Oil or coolant overheating
- Cracks/creases in gasket body surfaces
- Damage/voids in elastomer beading
- Damaged/missing O-ring seal at oil port to rocker arms

NOTE: Defective oil cooler may also allow oil leakage into coolant.

RG,CTM8,G105,14-19-16SEP92

HEAD GASKET INSPECTION AND REPAIR SEQUENCE



RG6663 -UN-13MAR93

A—Combustion Seals (Flanges) **B—Gasket Body** **C—Rocker Arm Oil Port** **D—Front of Engine**

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

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

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

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

4. Remove cylinder head using appropriate lifting devices to prevent handling damage to head gasket. See REMOVE CYLINDER HEAD in Group 05.

5. Observe surfaces of removed head gasket.

Examine combustion seals (A) for the following:
- Flange severed/expanded/cracked/deformed.
- Adjacent body area burned/eroded.
- Fire ring severed/displaced/missing.
- Flange sealing pattern eccentric/contains voids.
- Discoloration of flange and adjacent body areas.
- Flange surfaces rough/abraided/channelled.

Examine gasket body (B) for the following:
- Combustion gas erosion paths or soot deposits originating at combustion seals.
- Extreme discoloration/hardening/embrittlement in localized areas.
- O-ring seal missing/damaged in port area (C).
- Oil or coolant paths from port areas.
- Localized areas of low compression.

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

105
14

CTM61,G105,17 -19-25JUL95

7. Clean block, head, liners, and cap screws. (See Groups 05 and 10.)

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

Cylinder Head (See Group 05.)
- Check surface flatness/finish.
- Inspect for surface damage.
- Check cylinder head thickness, if resurfacing.

Cylinder Block and Liners (assembled and clamped) (See Group 05 or 10.)
- Check liner standout at four places on each liner.
- Check liner standout difference between cylinders.

Cylinder Block (See Group 10.)
- Check surface flatness/finish.
- Inspect for surface damage.
- Check liner counterbore depth (if liner is removed).
- Check top deck to crankshaft centerline dimension.
- Inspect cap screw bosses, must be clean/intact.

Cylinder Liner (See Group 10.)
- Check liner flange flatness/finish.
- Check liner flange thickness (if liner is removed).
- Inspect flange for damage.

Cylinder Head Cap Screws (See Group 05.)
- Inspect for corrosion damage.
- Inspect condition of threads.
- Inspect for straightness.
- Check length.

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

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

CTM42,G105,18 -19-13MAY93

DIAGNOSING ENGINE MALFUNCTIONS

• Will Not Crank:

Electrical System Malfunction
- Weak battery
- Corroded or loose battery connections
- Defective main switch or start safety switch
- Starter solenoid defective
- Starter defective

• Hard to Start or Will Not Start:

Electrical System Malfunction
- Loose or corroded battery connections
- Weak battery
- Excessive resistance in starter circuit

Fuel System Malfunction - See Group 115
- Empty fuel tank
- Improper fuel
- Fuel shut off at tank
- Water, dirt or air in fuel system
- Plugged fuel filter
- Fuel shut-off cable not pushed in
- Dirty or faulty fuel injection nozzles
- Defective fuel injection pump
- Defective fuel supply pump
- Fuel injection pump incorrectly timed

Service Problem
- Too high viscosity crankcase oil

• Engine Runs Irregularly or Stalls Frequently:

Basic Engine Problem
- Coolant temperature too low
- Improper valve clearance
- Cylinder head gasket leaking
- Worn or broken compression rings
- Valves sticking or burned
- Exhaust system restricted
- Engine compression too low
- Engine overheating
- Worn camshaft lobes

Fuel System Malfunction - See Group 115
- Defective fuel injection pump
- Low fuel supply
- Air in fuel
- Vent on fuel tank cap obstructed
- Fuel injection nozzles defective or leaking
- Fuel filter or fuel lines restricted
- Defective fuel supply pump
- Fuel injection pump incorrectly timed

Service Problem
- Improper fuel

• Engine Misfiring:

Service Problem
- Water in fuel
- Mixture of gasoline and diesel fuel

Fuel System Malfunction - See Group 115
- Air in fuel system
- Defective fuel injection nozzles
- Defective fuel injection pump
- Fuel injection nozzles improperly installed
- Leaking fuel injection nozzle seals
- Worn or defective fuel supply pump
- Fuel injection pump incorrectly timed

Basic Engine Problem
- Engine overheated
- Lobes of camshaft worn
- Weak valve springs
- Pre-ignition
- Engine compression too low
- Improper valve clearance
- Burnt, damaged or stuck valves

• Lack of Engine Power:

Service Problem
- Air cleaner restricted or dirty
- Excessive resistance in air intake system
- Improper crankcase oil
- Improper fuel
- Restricted exhaust system

Fuel System Malfunction - See Group 115
- Fuel filter restricted
- Defective fuel supply pump
- Defective fuel injection pump
- Fuel injection pump incorrectly timed
- Faulty injection nozzles
- Plugged fuel tank vent

Basic Engine Problem
- Engine overheated
- Engine clutch slipping
- Defective cylinder head gasket
- Lobes of camshaft worn
- Improper valve clearance
- Improper valve timing
- Burnt, damaged or stuck valves
- Weak valve springs
- Piston rings and cylinder liners excessively worn
- Engine compression too low
- Improper coolant temperature

105
16

S11,22010,BO -19-25JUL95

DIAGNOSING ENGINE MALFUNCTIONS—CONTINUED

• Low Oil Pressure:

Basic Engine Problem
- Stuck or improper regulating valve adjustment
- Excessive main and connecting rod bearing clearance
- Plugged oil pump intake screen
- Faulty bypass oil check valve
- Leakage at internal oil passages
- Faulty oil pump Service Problem
- Low oil level
- Improper viscosity of oil
- Faulty gauge

• High Oil Pressure:

Basic Engine Problem
- Stuck or improperly adjusted regulating valve

• Excessive Fuel Consumption:

Basic Engine Problem
- Low compression

Fuel System Malfunction - See Group 115
- Leaks in fuel system Restricted air cleaners
- Faulty injection pump timing
- Improper valve clearance
- Service problem
- Improper grade of fuel

Fuel System Malfunction - See Group 115
- Excessive fuel delivery
- Faulty injection nozzles
- Restricted air cleaners
- Improper injection pump timing

• Slow Acceleration:

Fuel System Malfunction - See Group 115
- Faulty injection pump
- Faulty injection nozzles

• Detonation:

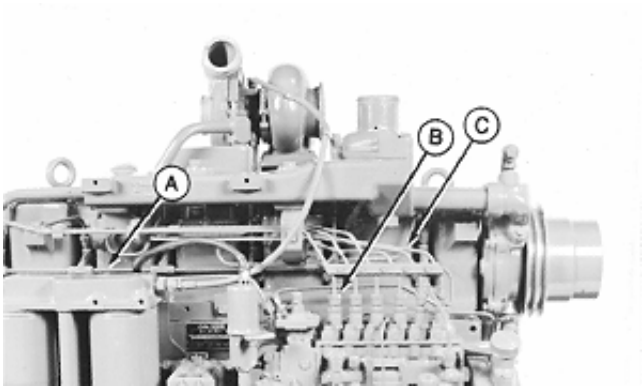
Fuel System Malfunction - See Group 115
- Faulty injection pump
- Faulty injection nozzles
- Improper fuel

• Abnormal Engine Noise:

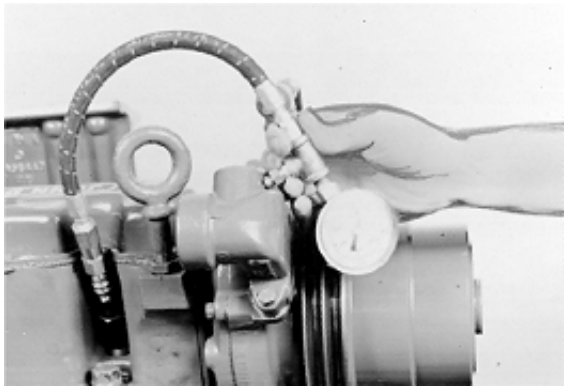
Basic Engine Problem
- Low engine oil level
- Excessive valve clearance
- Worn cam followers
- Bent push rods
- Worn rocker arm shafts
- Worn main or connecting rod bearings
- Foreign material in combustion chamber
- Worn Piston pin bushings and pins
- Scored piston
- Incorrect engine timing
- Excessive crankshaft end play
- Loosen main or connecting rod bearing caps
- Crankshaft oil pump drive gear worn or broken
- Crankshaft vibration damper worn or separated

RG,CTM61,G105,8-19-25JUL95

TEST ENGINE COMPRESSION PRESSURE



RG6179 -UN-24FEB92



RG6210 -UN-14APR93

IMPORTANT: Compression pressures are affected by the cranking speed of the engine. Before beginning test, insure that batteries are fully charged and injection nozzle area is thoroughly cleaned.

1. Start engine and run at rated speed until it warms up to normal operating temperature. From a cold start, operate engine 10—15 minutes.

2. Remove V-belts from engine and remove water manifold.

3. Disconnect fuel delivery lines (C) at injection pump delivery valves (B) and nozzles. Remove delivery lines as an assembly.

4. Disconnect leak-off assembly (A) from nozzles and remove. Remove ALL injection nozzles from cylinder head.

5. Install the JT01675A Nozzle adapter and JT01677 Adapter Nut into injection nozzle bore. Tighten adapter nut to 80 N·m (60 lb-ft).

6. Connect JT01682 Gauge and Hose Assembly to nozzle adapter.

7. Crank engine over at 275—325 rpm cranking speed and record compression readings.

ENGINE COMPRESSION

Engine	Compression Pressure
6101A, 6101H	2480—2830 kPa (24.8—28.3 bar) (360—410 psi)
Maximum variation between cylinders	340 kPa (3.4 bar) (50 psi)

NOTE: Pressure given was taken at 183 m (600 ft) above sea level. A 3.6 percent reduction in gauge pressure will result for each additional 300 m (1000 ft) rise in altitude.

8. If pressure is much lower than shown, remove gauge and apply oil to ring area of piston through injection nozzle bore. Do not use too much oil and do not get oil on valves.

9. Crank engine over and record compression reading again.

If pressure is higher than 2830 kPa (28.3 bar) (410 psi), worn or stuck rings are indicated. Either replace piston rings or install new piston and liner set as needed. (See Group 10.)

If pressure is below 2480 kPa (24.8 bar) (360 psi), it is possible that valves are worn or sticking. Recondition cylinder head as needed. (See Group 05.)

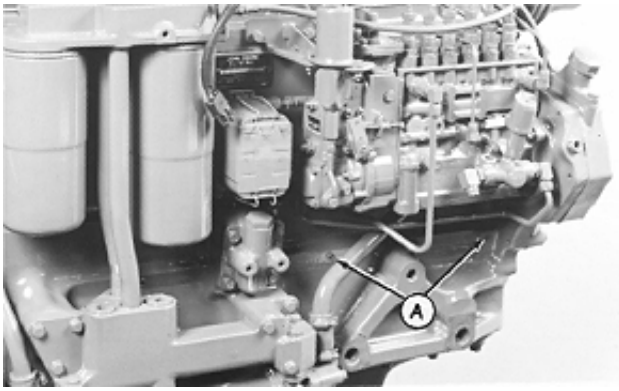
10. Measure compression pressure in all remaining cylinders and compare readings. Recondition cylinders and valves as required.

105
18

RG,CTM20,G105,3-19-17NOV95

CHECK ENGINE OIL PRESSURE

1. Remove one pipe plug (A) from main oil galley using JDG782 Oil Galley Plug Tool.



RG,CTM20,G105,5-19-17NOV95

2. Install No. 2106 (19-HP) Hose (A) with JT05472* Gauge (B) into main oil gallery hole.

IMPORTANT: To achieve an accurate oil pressure reading, warm up engine crankcase oil to 105°C (220°F) or high oil pressure readings will occur.

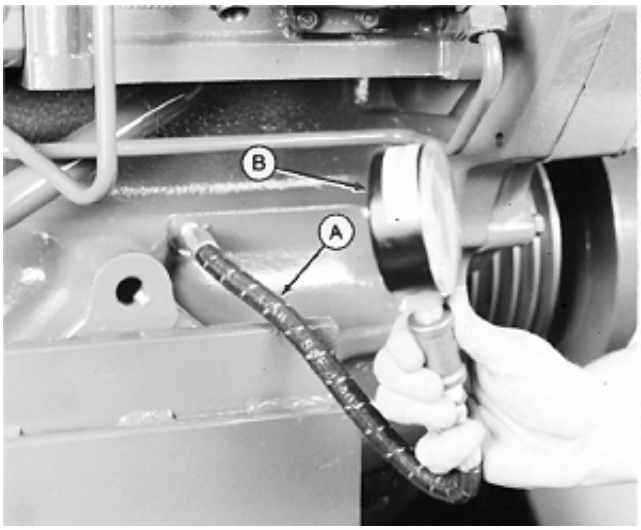
3. Measure oil pressure at slow idle (no load) and rated speed (full load) as specified below.

OIL PRESSURE SPECIFICATIONS

Minimum No Load at 800 rpm (Slow Idle)	103 kPa (1.03 bar) (15 psi)
Maximum Full Load at 2100 rpm (Rated Speed)	414 kPa (4.14 bar) (60 psi)

NOTE: To adjust oil pressure, remove regulating valve spring at filter base and add washers to increase oil pressure and remove washers to decrease oil pressure.

IMPORTANT: Do not use more than a total of five washers.



** Part of JT05470 (D15027NU) Universal Pressure Test Kit*

RG,CTM20,G105,6-19-17NOV95

105
19

MEASURE ENGINE CRANKCASE PRESSURE (BLOW-BY)

1. Place a hose with a standard gas gauge in end of crankcase vent tube.

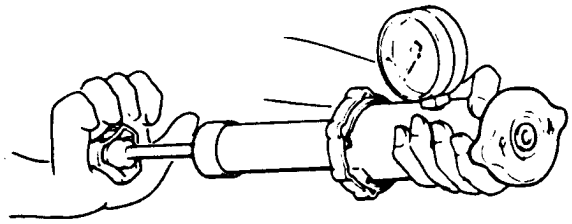
2. Run engine at rated speed and load. Engine should be at operating temperature and run-in (with at least 100 operating hours).

3. Measure blow-by over a period of 5 minutes. Multiply figure obtained by 12 (hourly rate). Maximum engine blow-by is 17m^3/h (600 ft^3/h). See ENGINE TEST SPECIFICATIONS earlier in this group.

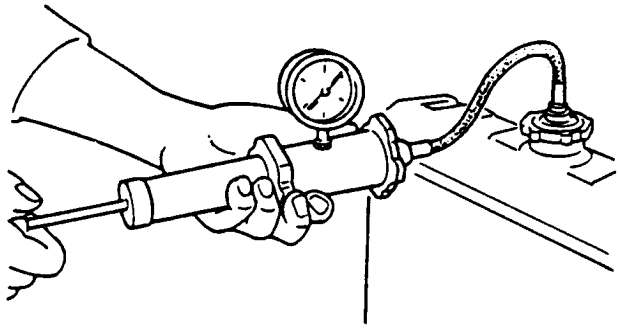
4. If blow-by is lower, there probably is no undue wear between piston rings and liners. If blow-by is higher, there could be excessive wear between piston rings and liners, resulting in loss of engine power. An overhaul of the engine should be considered only after other possible repair options (if any) are evaluated.

CTM8,GR105,16 -19-28SEP95

PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP



RG6557 -UN-20JAN93



RG6558 -UN-20JAN93

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

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

Test Radiator Cap:

1. Remove radiator cap and attach to D05104ST Pressure Pump as shown.

2. Pressurize cap to 50 kPa (0.5 bar) (7 psi)*. Gauge should hold pressure for 10 seconds within the normal range if cap is acceptable.

If gauge does not hold pressure, replace radiator cap.

3. Remove the cap from gauge, turn it 180°, and retest cap. This will verify that the first measurement was accurate.

Test Cooling System:

NOTE: Engine should be warmed up to test overall cooling system.

1. Allow engine to cool, then carefully remove radiator cap.

2. Fill radiator with coolant to the normal operating level.

IMPORTANT: DO NOT apply excessive pressure to cooling system, doing so may damage radiator and hoses.

3. Connect gauge and adapter to radiator filler neck. Pressurize cooling system to 50 kPa (0.5 bar) (7 psi)*, using D05104ST Pressure Pump.

4. With pressure applied, check all cooling system hose connections, radiator, and overall engine for leaks.

If leakage is detected, correct as necessary and pressure test system again.

If no leakage is detected, but the gauge indicated a drop in pressure, coolant may be leaking internally within the system or at the block-to-head gasket. Have your servicing dealer or distributor correct this problem immediately.

**Test pressures recommended are for all Deere OEM cooling systems. On specific vehicle applications, test cooling system and pressure cap according to the recommended pressure for that vehicle.*

RG18293,6 -19-28SEP95

INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE

Visually inspect thermostat for corrosion or damage. Replace as necessary.

• Test thermostat as follows:

CAUTION: DO NOT allow thermostat or thermometer to rest against the side or bottom of container when heating water. Either may rupture if overheated.

1. Remove thermostats. (See REMOVE THERMOSTATS in Group 25.)

2. Suspend thermostat and a thermometer in a container of water.

3. Stir the water as it heats. Observe opening action of thermometer and compare temperatures with specification given in chart below.

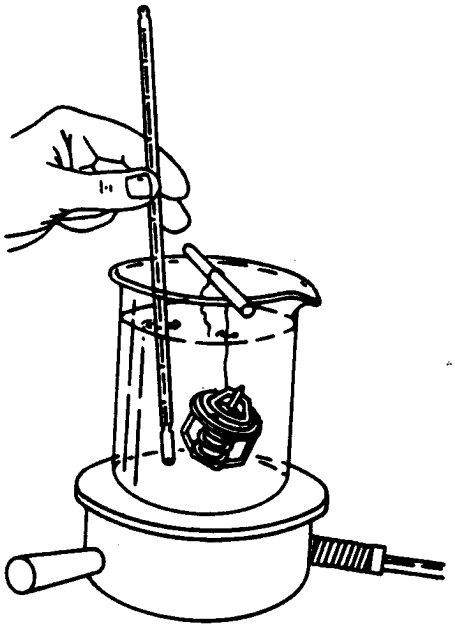
NOTE: Due to varying tolerances of different suppliers, initial opening and full open temperatures may vary slightly from specified temperatures.

THERMOSTAT TEST SPECIFICATIONS

Rating	Initial Opening (Range)	Full Open (Nominal)
71˚C (160˚F)	69—72˚C (156—162˚F)	84˚C (182˚F)
77˚C (170˚F)	74—78˚C (166—172˚F)	89˚C (192˚F)
82˚C (180˚F)	80—84˚C (175—182˚F)	94˚C (202˚F)
89˚C (192˚F)	86—90˚C (187—194˚F)	101˚C (214˚F)
90˚C (195˚F)	89—93˚C (192—199˚F)	103˚C (218˚F)
92˚C (197˚F)	89—93˚C (193—200˚F)	105˚C (221˚F)
96˚C (205˚F)	94—97˚C (201—207˚F)	100˚C (213˚F)
99˚C (210˚F)	96—100˚C (205—212˚F)	111˚C (232˚F)

4. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.

5. If any thermostat is defective on a multiple thermostat engine, replace all thermostats.



RG5971 -UN-17SEP91

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22

CTM42,G105,13 -19-06OCT95

SPECIAL OR ESSENTIAL TOOLS

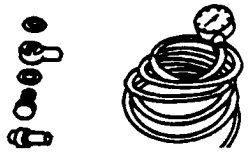
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-20JUL95

RG5163 -UN-23AUG88

Manifold Pressure Tester JDE147

Kit to test intake manifold pressure (turbocharger boost) on turbocharged engines.



S53,JDE147 -19-03OCT94

SERVICE EQUIPMENT AND TOOLS

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

Name	Use
JDG576 Turbocharger Shield	Used to cover inlet on turbine on all turbocharged engines to protect blower when test running the engine with the air filter system disconnected.
D05022ST Water Vacuum Gauge Kit	Used to test air filter.

S55,23005,G -19-14OCT94

AIR INTAKE AND EXHAUST SYSTEM TEST SPECIFICATIONS

NOTE: For machine applications, consult the appropriate machine technical manual.

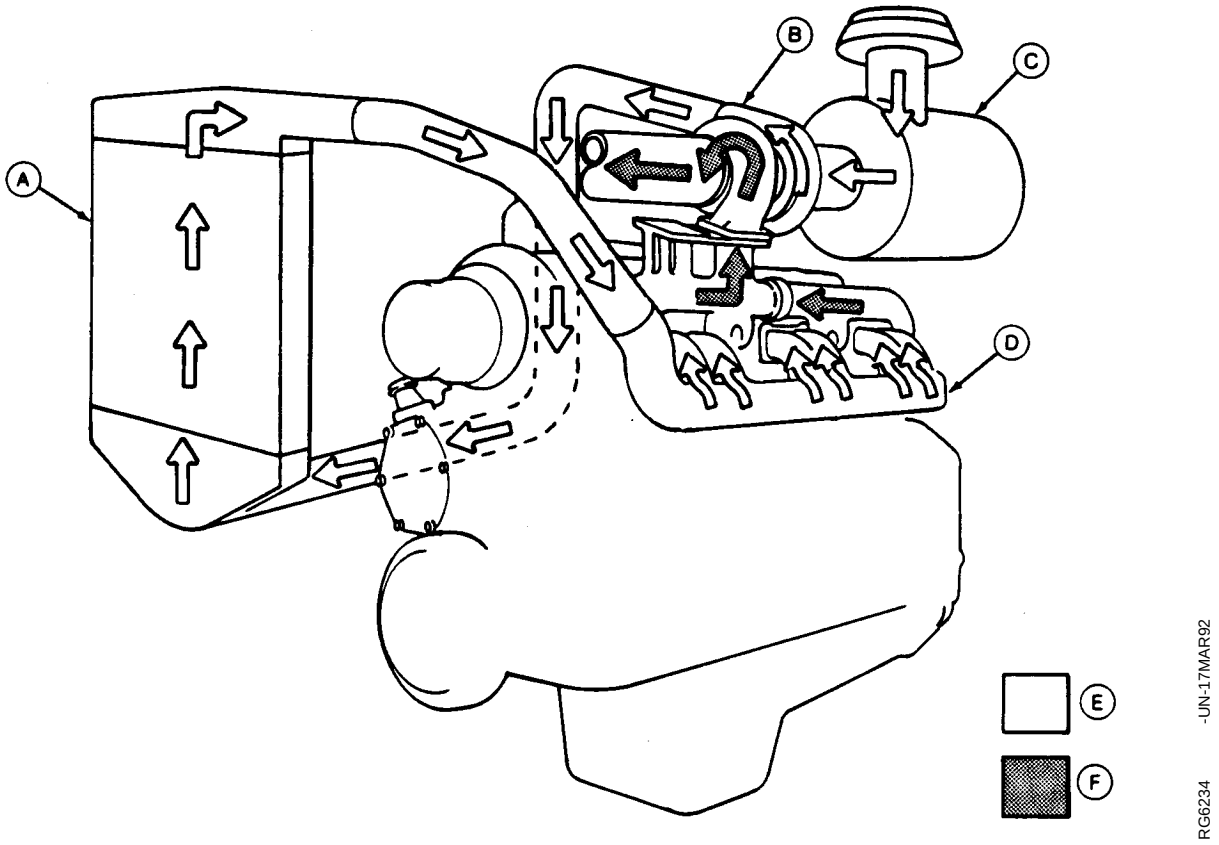
RG,CTM20,G110,7-19-17NOV95

DIAGNOSING AIR INTAKE MALFUNCTIONS

Symptom	Problem	Solution
Engine Starts Hard or Won't Start	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
Erratic Engine Operation	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
Engine Emits Excessive Black Smoke	Air cleaner element restricted	Clean or replace elements (See operator's manual).
	Turbocharger defective	Repair or replace (See Group 30).
	Air leak in manifold	Check hose and pipe connections for tightness; repair as required (See Group 30).
Engine Idles Poorly	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
Engine Does Not Develop Full Power	Air cleaner restricted	Clean or replace elements (See operator's manual).
	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
	Turbocharger defective	Repair or replace (See Group 30).
	Manifold pressure pipe to aneroid loose or broken	Check hose and pipe connections for tightness; repair as required (See Group 30).
Turbocharger "Screams"	Air leak in manifold	Check intake manifold gasket and manifold; repair as required (See Group 30).

S11,23005,AJ -19-25JUL95

HOW THE AIR INTAKE AND EXHAUST SYSTEM WORKS



A—Heat Exchanger
B—Turbocharger
C—Air Cleaner
D—Intake Manifold
E—Outside Air
F—Exhaust

6101H Engine

Engine suction draws dust-laden outside air (E) through an air inlet stack into the air cleaner (C). Air is filtered through dry type primary and secondary (safety) filter elements in the air cleaner canister. Clean air travels through the air intake hose to the turbocharger (B) and intake manifold (D) to the engine.

Exhaust (F), drives the turbocharger to deliver a larger quantity of air to meet the engine requirements than what could be delivered under naturally aspirated (non-turbocharged) conditions.

On 6101H Engines, an air-to-air aftercooler cools the turbocharger compressor discharge air by routing it through a heat exchanger (A) before it enters the engine. The heat exchanger uses no liquid coolant but relies on air flow to cool the charge air.

On 6101A Engines, the aftercooler functions as a heat exchanger. Engine coolant circulates through the aftercooler core and carries heat out of the aftercooler.

RG,CTM61,G110,2-19-13MAY93

AIR CLEANER OPERATION

NOTE: OEM engine air cleaner shown, refer to your machine technical manual for air cleaner operation on your engine application.

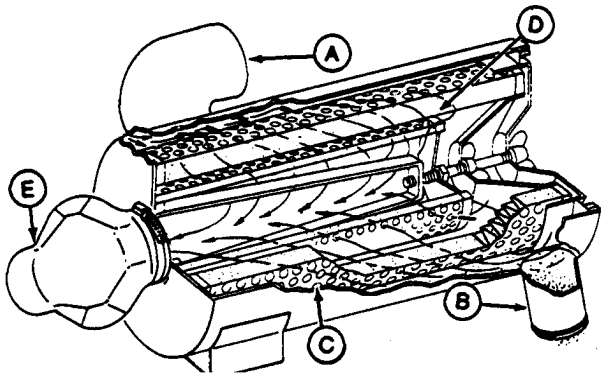
Dust-laden air enters the air cleaner inlet (A) and is forced into a high-speed centrifugal motion.

Most of the dust settles out of the air (before it enters the filter elements) and falls to the bottom of the air cleaner body. It is expelled to the outside of the air cleaner (B) through a rubber valve, which automatically ejects the dust and keeps it from accumulating inside the air cleaner body.

As the intake air is drawn through the primary element (C) and a secondary (safety) element (D), the remaining dust particles are retained in the primary element to permit only clean air to enter the intake manifold.

The safety element retains the dust that would otherwise pass into the engine if the primary element should rupture.

See your operator's manual for recommended service intervals.



R28270 -UN-14DEC88

A—Air Inlet
B—Dust Outlet
C—Primary Element
D—Secondary (Safety) Element
E—Air Outlet

S11,23005,AO,1 -19-20NOV95

DIAGNOSING TURBOCHARGER MALFUNCTIONS

Before replacing the turbocharger, determine what caused the failure of the defective unit, and correct the condition. This will prevent an immediate repeat failure of the replacement unit. Refer to Air Intake and Exhaust System Group 30 for repair information.

• Noise Or Vibration*:

Bearings not lubricated (insufficient oil pressure).
Air leak in engine intake or exhaust manifold.
Improper clearance between turbine wheel and turbine housing.
Broken blades (or other wheel failures).

• Engine Will Not Deliver Rated Power:

Clogged manifold system.
Foreign material lodged in compressor, impeller, or turbine.
Excessive dirt build-up in compressor.
Leak in engine intake or exhaust manifold.
Leak in intake manifold-to-aneroid pipe.
Rotating assembly bearing failure.
Damaged compressor or turbine blades.

• Oil On Compressor Wheel Or In Compressor Housing (Oil Being Pushed or Pulled Through Center Housing):

Excessive crankcase pressure.
Air intake restriction.
Drain tube restriction.

• Oil In Manifold Or Dripping From Housing:

Excessive crankcase pressure.
Air intake restriction.
Drain tube restriction.
Damaged or worn journal bearings.
Unbalanced rotating assembly:
Damage to turbine or compressor wheel or blade.
Dirt or carbon build-up on wheel or blade.
Bearing wear.
Oil starvation or insufficient lubrication.
Shaft seals worn.

• Turbine Wheel Drag:

Carbon build-up behind turbine wheel caused by coked oil or combustion deposits.
Dirt build-up behind compressor wheel caused by air intake leaks.
Bearing seizure or dirty, worn bearings caused by excessive temperatures, unbalanced wheel, dirty oil, oil starvation, or insufficient lubrication.

**Do not confuse the whine heard during run down with noise which indicates a bearing failure.*

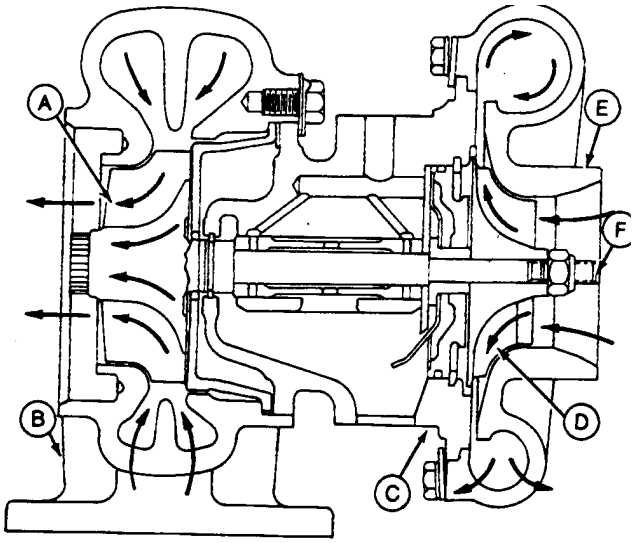
S11,23005,K -19-25JUL95

HOW THE TURBOCHARGER WORKS

Exhaust gases from the engine pass through the turbine housing (B) causing the shaft (F) to rotate before the exhaust gas is discharged to the atmosphere.

The compressor wheel (D), also mounted on shaft (F), rotates in the compressor housing (E). Inlet air is drawn into the housing, where it is compressed and delivered to engine cylinders.

A—Turbine Wheel
B—Turbine Housing
C—Center Housing
D—Compressor Wheel
E—Compresssor Housing
F—Shaft



-UN-14DEC88
R28273

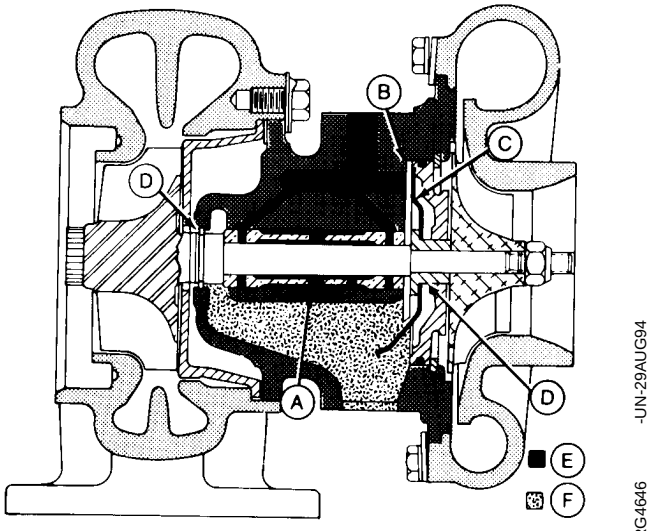
S11,23005,L -19-17MAR92

HOW THE TURBOCHARGER IS LUBRICATED

Engine oil under pressure from the engine lubrication system is pumped through a passage in the bearing housing and directed to the bearing (A), thrust plate (B), and thrust sleeve (C). Oil is sealed from the compressor and turbine by a piston ring (D) at both ends of bearing housing.

The turbocharger contains a single floating bearing. This bearing has clearance between the bearing OD and the housing wall as well as clearance between the bearing ID and the shaft OD. These clearances are lubricated by the oil supply and the bearings are protected by a cushion of oil. Discharge oil drains by gravity from the bearing housing to the engine crankcase.

A—Bearing
B—Thrust Plate
C—Thrust Sleeve
D—Piston Ring
E—Pressure Oil
F—Discharge Oil

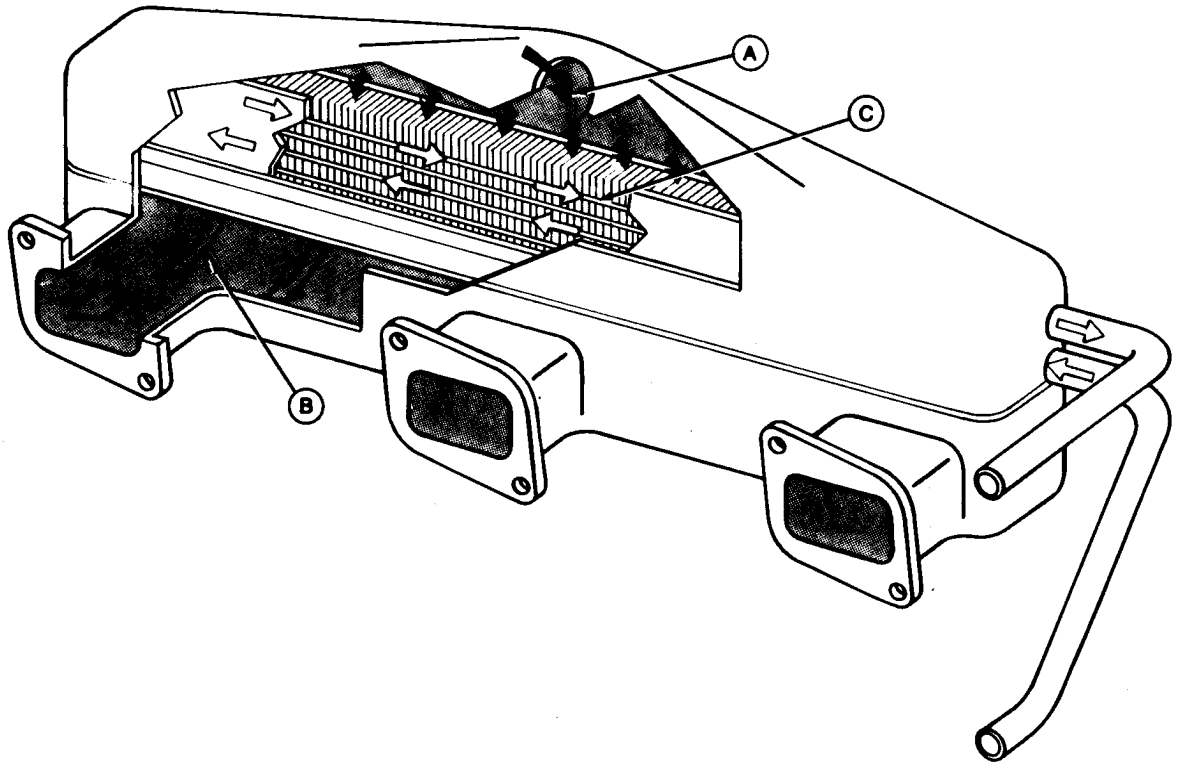


-UN-29AUG94
RG4646

Turbocharger Lubrication

RG,CTM61,G110,5-19-16SEP94

HOW THE AFTERCOOLER WORKS—6101A ENGINES



RG5856 -UN-13AUG91

A—Heated Air **B—Cooled Air** **C—Engine Coolant**

Air entering intake manifold has been compressed (and heated) by turbocharger. As this heated and compressed air (A) enters intake manifold, it flows around aftercooler before going to engine cylinders.

The aftercooler functions as a heat exchanger, lowering intake air (B) temperature as much as 35˚—47˚C (95˚—116˚F). Lowering air temperature makes air more dense, permitting an even greater volume (compared with not having an aftercooler) to be delivered to engine cylinders. This increased volume of air, when combined with a predetermined quantity of additional fuel, enables more power to be produced.

Engine coolant (C) circulates through aftercooler core and carries heat out of aftercooler. Extreme care must be used to insure engine coolant does not leak into intake manifold, resulting in possible damage to engine.

RG,CTM61,G110,6-19-13MAY93

CHECK INTAKE MANIFOLD PRESSURE (TURBOCHARGER BOOST)

NOTE: For each vehicle application, refer to the appropriate machine technical manual for intake manifold pressure specifications.

Intake manifold pressure (turbocharger boost) can be checked at intake manifold and aneroid.

IMPORTANT: Engine speed and load should be stabilized before taking readings on gauge. Be sure that gauge works properly.

Pressure checks are only a guide to determine if there is an engine problem (valve leakage, defective nozzles, etc.). Low readings are not a valid reason for increasing injection pump fuel delivery. Pump adjustment should be within specification as established by an authorized repair station.

• If boost pressure is too high, remove and test fuel injection pump for high fuel delivery.

• If boost pressure is too low, check for the following:

—Restriction in air cleaner.
—Leak in air intake between turbocharger and cylinder head.
—Defective turbocharger.
—Leak in exhaust manifold gasket.
—Leak in fuel control pipe.
—Restricted fuel filter elements.
—Incorrect fast idle adjustment.
—Incorrect injection pump timing.
—Faulty fuel supply pump.
—Low compression pressure.
—Faulty fuel injection nozzles.
—Carbon build-up in turbocharger.
—Turbocharger compressor or turbine wheel rubbing housing.
—Low fuel injection pump delivery.
—Restricted exhaust.

RG,CTM42,110,6 -19-16AUG94

• Check Intake Manifold Pressure (Turbo Boost) at Aneroid:

NOTE: Intake manifold pressure can also be checked at the intake manifold, as described later in this group.

1. Remove aneroid line (A) from aneroid (B).

2. Install a 1/8 in. pipe nipple and “T” fitting (C) into aneroid with pipe adapter (D).

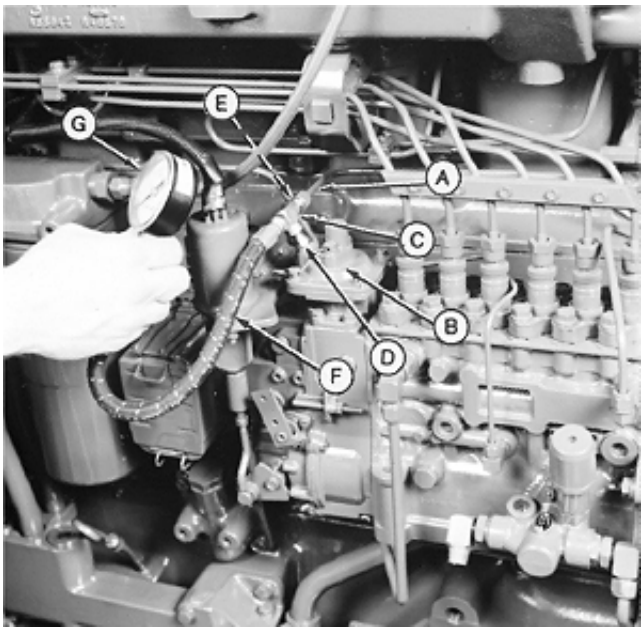
3. Connect aneroid line to “T” fitting.

4. Attach 1/8 in. NPT to 7/16-20 UNC Adapter (E) and JT03017 Hose (F) to JD03092 Pressure Gauge (G).

5. With engine coolant at operating temperature 82—94˚C (180—202˚F), connect to a dynamometer. Operate engine at full load rated speed.

6. Observe pressure readings. If readings are not within the specified range, check for items addressed earlier in this module.

7. Remove test equipment and reinstall aneroid line.



RG6211 -UN-06MAR92

A—Aneroid Line
B—Aneroid
C—T-Fitting
D—Pipe Adapter
E—Adapter
F—JT03017 Hose
G—JT03092 Pressure Gauge

RG,CTM61,G110,3-19-13MAY93

• Check Intake Manifold Pressure (Turbo Boost) at Intake Manifold:

NOTE: Intake manifold pressure can also be checked from aneroid line, as described earlier in this group.

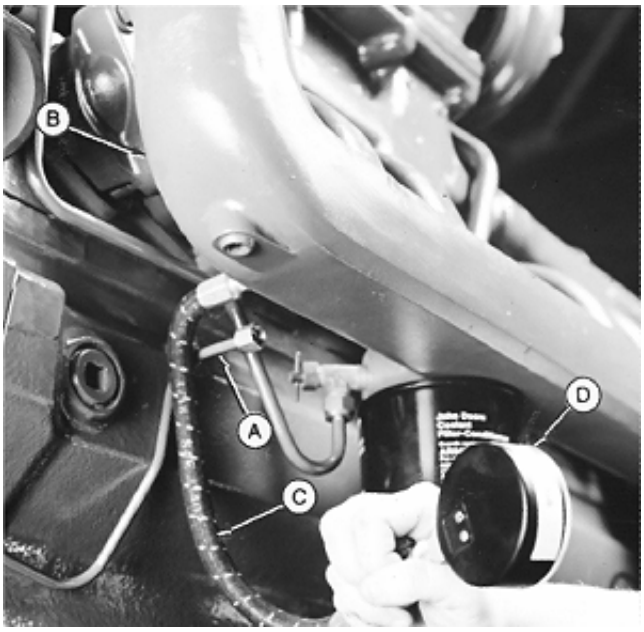
1. Remove aneroid line (A) and plug from intake manifold (B).

2. Install JT03017 Hose (C) with an accurate 0—400 kPa (0-4 bar) (0—60 psi) pressure gauge (D).

3. With engine coolant at operating temperature 82—94˚C (180—202˚F), connect machine to a dynamometer. Operate engine at full load rated speed.

4. Observe pressure reading. If reading is not within the given range, check for items addressed earlier under this major heading.

5. After completing test, remove test equipment and reinstall ether starting aid line, if equipped.



RG6212 -UN-06MAR92

A—Aneroid Line
B—Intake Manifold
C—JT03017 Hose
D—Pressure Gauge

RG,CTM61,G110,4-19-13MAY93

AIR FILTER RESTRICTION INDICATOR SWITCH TEST

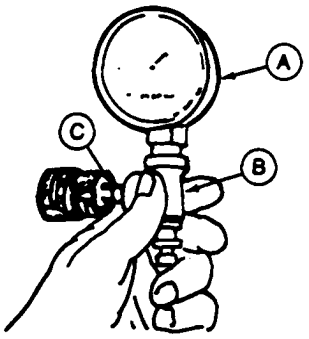
1. Remove air filter restriction indicator switch from air intake piping.

2. Install pipe nipple (C), tee fitting (B), and gauge (A) from D05022ST Water Vacuum Gauge Kit into air filter restriction indicator hole. Install air filter restriction indicator into tee fitting.

3. Start engine and slowly cover the air cleaner inlet with a piece of paper or cardboard.

4. Air restriction indicator must show red at 5.6—6.8 kPa (56—68 mbar) (22.7—27.3 in. water) (1.6—2.0 in. hg) vacuum.

If air restriction indicator shows red at any other value than listed above, install a new indicator.



T6188AQ -UN-09DEC88

RG,CTM6,G110,1 -19-14AUG91

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

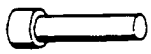
Rotate engine flywheel. Use with JDE81-4.

S53,JDE811 -19-06OCT95

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Lock engine at TDC when timing valve train. Use with JDE81-1 or JDE83.



S53,JDE814 -19-06APR90

SERVICE EQUIPMENT AND TOOLS

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

Name	Use
Pressure Gauge/0—200 kPa (0—2 bar) (0—30 psi), hose, and fittings.	Measure transfer pump pressure. NOTE: Assemble test equipment from JT05470 Universal Pressure Test Kit or any other suitable equipment.

S11,23010,IZ -19-04MAR87

FUEL SYSTEM TEST SPECIFICATIONS

ITEM	SPECIFICATIONS
Fuel Supply Pump Minimum Operating Pressure	200 kPa (2.0 bar) (29.0 psi)
Hydraulic Aneroid Activator Operating Pressure	100 kPa (1.0 bar) (14.5 psi)
Fuel Injection Pump Timing-to-Engine	TDC
Engine Speeds (RPM)	For each machine application, refer to the appropriate machine technical manual for slow idle, fast idle, and rated speed specifications.

RG,CTM20,115,1 -19-17NOV95

FUEL SYSTEM TEST SPECIFICATIONS—CONTINUED

TORQUES

Injection Pump Drive Gear-to-Pump	61 N·m (45 lb-ft)
Injection Pump Drive Gear Cover	68 N·m (50 lb-ft)

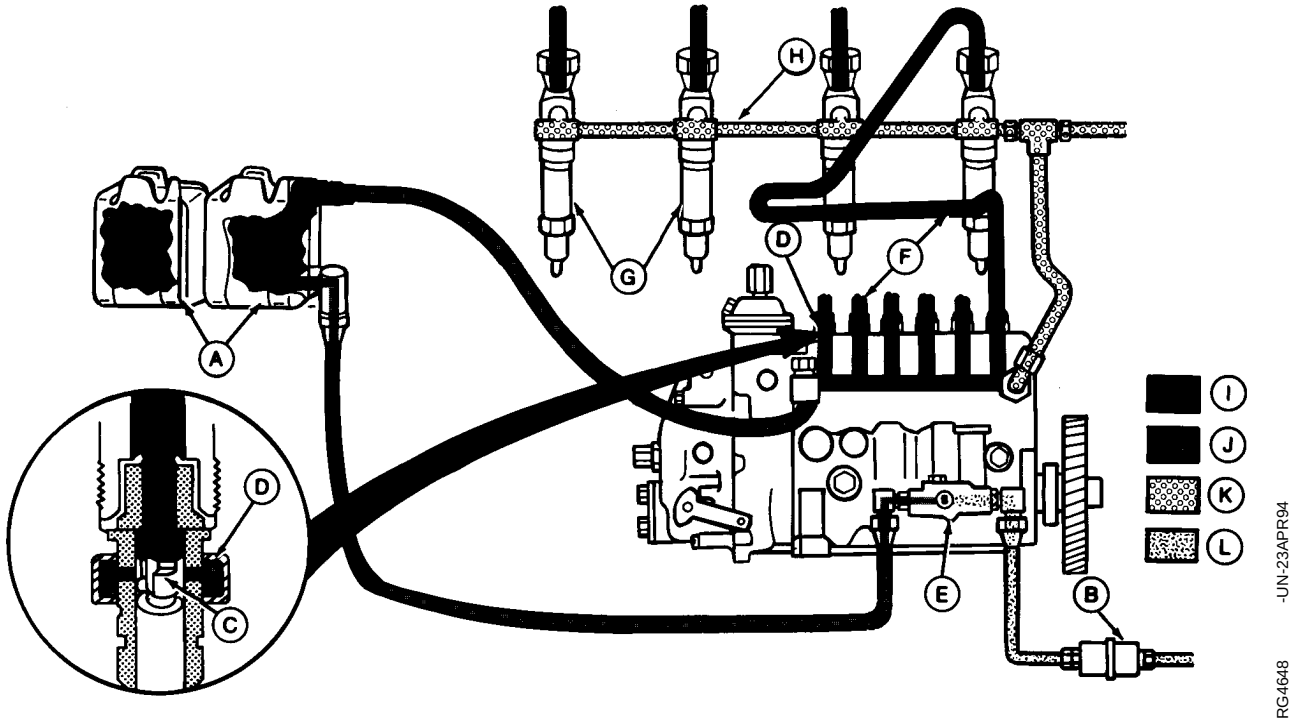
RG,CTM20,115,21-19-17NOV95

FUEL INJECTION PUMP SPECIFICATIONS

Refer to machine technical manual for specifications.

RG,CTM20,115,22-19-17NOV95

FUEL SYSTEM OPERATION



A—Fuel Filters
B—Pre-Filter—Optional
C—Pump Plungers
D—Fuel Gallery
E—Supply Pump
F—Delivery Pipes
G—Nozzles
H—Leak-Off Line
I—Injection Pressure
J—Supply Pump Pressure
K—Fuel Return
L—Gravity Pressure

The supply pump (E) draws fuel from the vented fuel tank through the pre-filter.

The supply pump pressurizes the fuel to 103—340 kPa (1.0—3.4 bar) (15—50 psi) which permits the fuel to flow through the filters (A) to the gallery in the injection pump (D). Supply pump output pressures will vary depending on load and application.

The gallery is kept full by the supply pump. Injection pump plungers (C) further pressurize the fuel to about 69 000 kPa (690 bar) (10 000 psi). Delivery pipes (F) route the fuel to the nozzles (G). The high pressure fuel opens the nozzle valve tip. This atomizes the fuel as it enters the combustion chamber.

There are two sources of excess fuel incorporated into the system. The supply pump supplies more fuel to the pump than is required by the engine, and the nozzle requires excess fuel to lubricate the nozzle valve. A leak-off line (H) returns this excess fuel to the tank from both the pump and nozzles.

S11,23010,IG1 -19-24JUL95

DIAGNOSE FUEL SYSTEM MALFUNCTIONS

Symptom	Problem	Solution
Fuel Not Reaching Injection Nozzles	Fuel filter restricted	Replace fuel filter. (See Group 35.)
	Fuel line restricted	Clean lines as required.
	Fuel too heavy at low temperatures	Use correct grade of fuel.
	Air in system	Correct problem and bleed fuel system (this group).
	Fuel tank valve shut off	Open fuel tank valve.
	Low supply pump pressure	Check fuel lines for restrictions; check pump output pressure (this group).
Engine Starts Hard or Won't Start	Fuel too heavy at low temperature	Use correct grade of fuel. (See Fuels, Group 02.)
	Injection nozzles faulty or sticking	Repair or replace as required. (See Group 35)
	Incorrect timing	Adjust timing (this group).
	Faulty injection pump	Repair or replace.
	Water in fuel	Drain water from filter (or separator if equipped). Install new filter.
	Fuel filter restricted	(See Group 35.)
	Low supply pump pressure	Check pump output pressure. (this group)
	Injection pump return fuel line or fittings restricted	Clean lines as required.
	Low cetane fuel	Use correct grade of fuel. (See Group 02.)

S11,23010,GJ -19-13JUL95

DIAGNOSE FUEL SYSTEM MALFUNCTIONS—CONTINUED

Symptom	Problem	Solution
Engine Starts and Stops	Air in system	Correct problem and bleed fuel system. (See this group.)
	Fuel filter restricted	Replace fuel filter.
	Fuel lines restricted	Clean lines as required.
	Water in fuel	Drain water from filter, (or separator if equipped). Install new filter. (See Group 35.)
	Injection pump return fuel line or fittings restricted	Clean lines as required.
Erratic Engine Operations	Fuel filter restricted	Replace fuel filter. (See Group 35.)
	Fuel too heavy at low temperatures	Use correct grade of fuel. (See Group 02.)
	Injection nozzles faulty or sticking	Repair. (See Group 35.)
	Fuel lines restricted	Clean as required.
	Incorrect timing	Adjust timing (this group).
	Governor faulty	Repair. (See Group 35.)
	Water in fuel	Drain water from filter (or separator, if equipped). Install new filter.
	Injection pump return fuel line or fittings restricted	Clean lines as required.
	Low cetane fuel	Use correct grade of fuel. (See Group 02.)
	Injection nozzle return lines restricted	Clean lines as required.

S11,23010,GK -19-07OCT94

DIAGNOSE FUEL SYSTEM MALFUNCTIONS—CONTINUED

Symptom	Problem	Solution
Engine Emits Excessive Black Smoke	Injection nozzles faulty or sticking	Repair. (See Group 35.)
	Injection pump timing incorrect	Adjust timing (this group).
	Low cetane fuel	Use correct grade of fuel. (See Group 02.)
	Over-fueling	Repair injection pump. (See Group 35.)
Engine Emits Excessive Blue or White Smoke	Cranking speed too slow	Check batteries and electrical system.
	Injection pump timing incorrect	Adjust timing (this group).
	Injection nozzles faulty or sticking	Repair. (See Group 35.)
	Excessive wear in liners and/or piston rings stuck	See Group 10.
	Incorrect cetane fuel for ambient temperature	Use correct grade of fuel. (See Group 02.)
	Engine running too “cold”	Check thermostat. (See Group 25.)
Engine Idles Poorly	Injection nozzles faulty or sticking	Repair. (See Group 35.)
	Incorrect timing	Adjust timing (this group).
	Pump slow idle speed not correctly adjusted	Adjust slow idle speed (this group).
	Fuel lines restricted	Clean as required.
	Water in fuel	Drain water from filter, (or separator if equipped). Install new filter. (See Group 35.)
	Injection pump return lines or fittings restricted	Clean as required.
	Injection nozzle return lines clogged	Clean as required.
	Low cetane fuel	Use correct grade of fuel. (See Group 02.)

S11,23010,GL -19-07OCT94

DIAGNOSE FUEL SYSTEM MALFUNCTIONS—CONTINUED

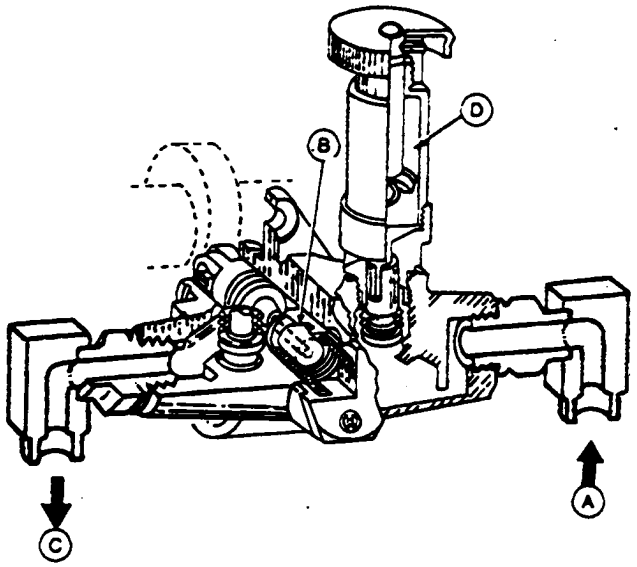
Symptom	Problem	Solution
Engine Does Not Develop Full Power	Low cetane fuel	Use correct grade of fuel. (See Group 02.)
	Incorrect timing	Adjust timing (this group).
	Injection pump or governor faulty	Repair. (See Group 35.)
	Fuel filter clogged	Replace fuel filter. (See Group 35.)
	Injection nozzles faulty or sticking	Repair. (See Group 35.)
	Defective supply pump	Test (this group).
	Injection pump return fuel line or fittings restricted	Clean as required.
	Water or gasoline in diesel fuel	Drain water or replace with clean fuel Install new filters (this group).
	Incorrect fast idle speed	Adjust speed (this group).
	Speed control linkage incorrectly adjusted	Adjust (this group).

S11,23010,GM -19-07OCT94

SUPPLY PUMP OPERATION

The plunger-type Robert Bosch or Nippondenso fuel supply pump is used on all 6101 engines. It is mounted on the side of the injection pump housing and is driven by the injection pump camshaft. Fuel enters the supply pump at (A), is pressurized by the plunger (B), and discharged through outlet (C). The hand primer (D) provides manual pump operation for bleeding the fuel system.

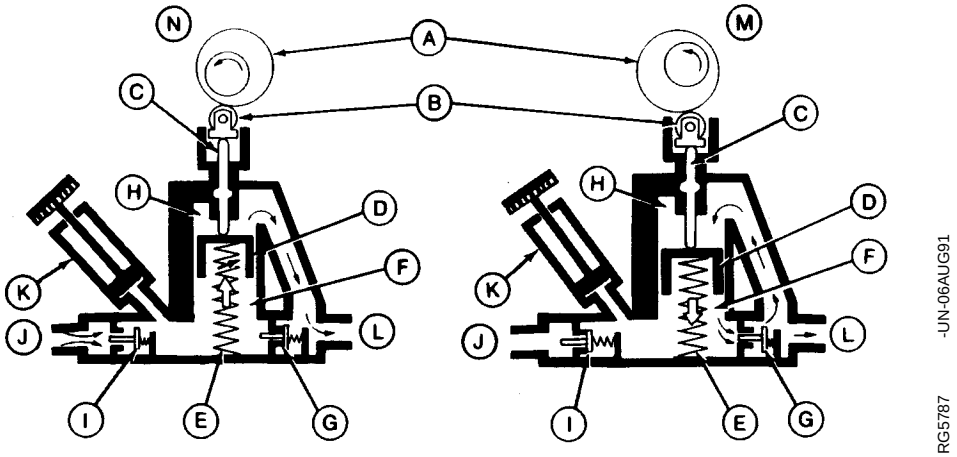
A—Fuel Inlet
B—Plunger
C—Fuel Outlet
D—Hand Primer



RG4451 -UN-14SEP89

S11,23010,IH,1 -19-17NOV95

FUEL SUPPLY PUMP OPERATION—(CONTINUED)



A—Camshaft
B—Roller Tappet
C—Pressure Spindle
D—Plunger
E—Plunger Spring
F—Suction Chamber
G—Pressure Valve
H—Pressure Chamber
I—Suction Valve
J—Fuel Inlet
K—Hand Primer Pump
L—Fuel Outlet
M—Intermediate Stroke Position
N—Suction and Discharge Stroke Position

As the pump camshaft (A) rotates toward the “high cam” intermediate stroke position (M), the roller tappet (B) and pressure spindle (C) cause the plunger (D) to move against and compress the plunger spring (E).

Plunger movement forces the fuel out of the suction chamber (F), through the pressure valve (G), and into the pressure chamber (H). The amount of fuel discharged from the suction chamber is equal to the amount of fuel delivered for each stroke of the plunger. Towards the end of the intermediate stroke, the spring-loaded pressure valve closes again.

As the camshaft rotates toward the “low cam” or suction and discharge position (N), plunger spring pressure causes the plunger, pressure spindle, and roller tappet to follow the camshaft.

Movement of the plunger pushes the fuel from the pressure chamber and delivers it to the fuel filters and injection pump. At the same time, plunger suction pressure is permitting fuel to enter the suction chamber through the suction valve (I). With the suction chamber charged with fuel, the pumping cycle begins again.

Fuel is allowed to flow in around the pressure spindle to lubricate the spindle as it moves back and forth in housing. To prevent the fuel from entering the pump crankcase, a rubber O-ring is positioned in the spindle bore of housing at the roller tappet end.

Pulling upward on the hand primer pump (K) causes the suction valve to open and fuel to flow into the suction chamber. When the hand plunger is pushed downward, the suction valve closes, and fuel is forced out of the pressure valve.

RG,CTM9,115,3 -19-24JUL95

DIAGNOSING MECHANICAL FUEL SUPPLY PUMP MALFUNCTIONS

IMPORTANT: Visually inspect the fuel inlet fitting and pump filter for possible plugging before disassembling to determine cause of malfunction.

Symptom	Problem	Solution
Low Supply Pump Output Pressure or Pump Not Functioning Correctly	Restriction at fuel inlet fitting.	Thoroughly clean fuel tank, lines, filters, and inlet fitting.
	Worn or pitted valves caused by foreign material lodging in valve.	Replace valves as required.
	Missing or broken spring(s).	Replace spring(s).
	Broken spindle.	Replace pump.
	Out of fuel.	Add fuel to fuel tank.
	Fuel shut off at tank.	Open fuel shut off valve.
	Restricted fuel line.	Clean as required.
	Air leak in fuel line between pump and tank.	Repair as required.
	Loose or damaged fuel line connetions.	Repair.
	Worn or damaged valve assemblies.	Repair or replace.
	Broken valve spring(s)	Repair or replace.
Diesel Fuel Leaking Into Injection Pump Crankcase	Worn spindle and/or pump housing.	Replace pump.
	Defective O-ring seal.	Replace O-ring seal.

RG,CTM61,115,32-19-13MAY93

TEST FUEL SUPPLY PUMP FOR LEAKS

Fuel delivery pressure should be checked before removing supply pump from injection pump.

1. Connect compressed air line (A) to a pressure gauge (B) and to the supply pump inlet fitting. The air line should have a regulating valve to control pressure.

2. Cap or plug supply pump outlet fitting (C).

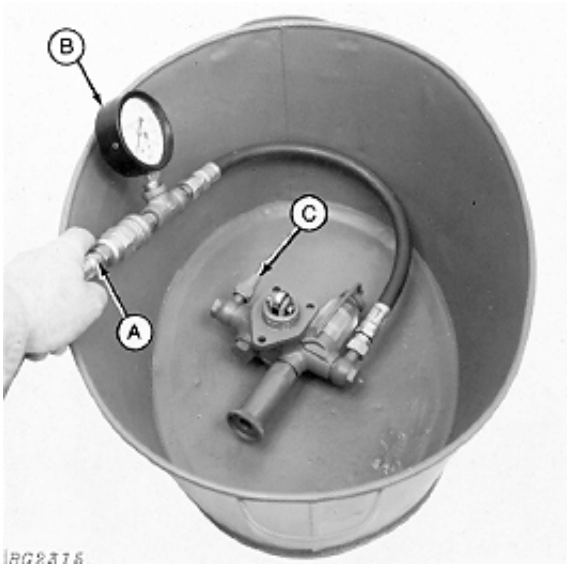
3. Submerge supply pump in a container of clean diesel fuel. Regulate air pressure to 200 kPa (2.0 bar) (29 psi).

4. Move roller tappet in and out by hand. No air bubbles should appear around roller tappet bore.

NOTE: If bubbles appear, it is an indication that either the spindle seal is defective or that the spindle is worn (or possibly both).

IMPORTANT: If enough diesel fuel leaks past the spindle and seal, possible serious damage to the injection pump or engine (or both) could occur.

Any fuel leakage that takes place flows into the injection pump crankcase. Remember that the injection pump and engine both share a common lubricating oil supply.



S55,3010,R,1 -19-13NOV95

CHECK SUPPLY PUMP OPERATION

NOTE: The following procedure can best be performed under moderate air temperature conditions to reduce electrical loads when cranking the engine is required.

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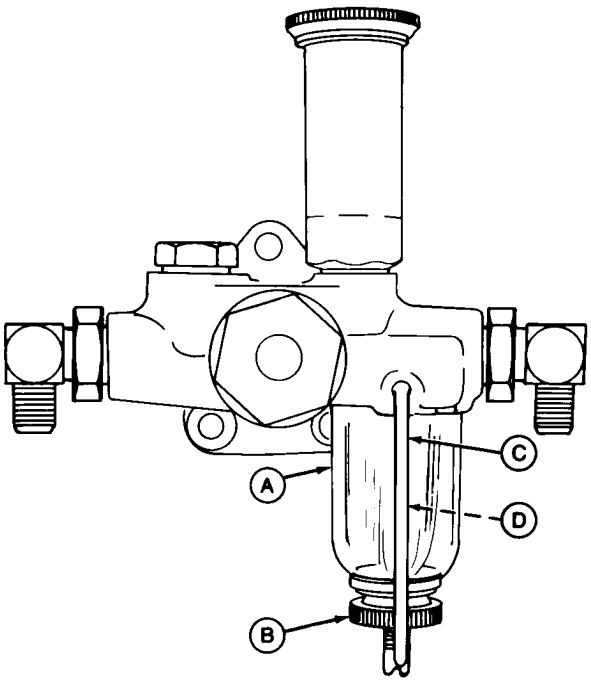
1. Make a preliminary inspection of supply pump. Thoroughly clean area around pump. All connections must be tight and not leaking. On supply pumps with a glass bowl (A) and filter (D), make sure fuel does not leak at bowl gasket. If fuel in glass bowl is contaminated or leaking, loosen clamping nut (B) on wire bail (C) and service the filter.

2. Start engine and bring to operating temperature. Shut-off engine.

NOTE: If fuel leaks around a hand primer (screwed down tight) when engine is running, replace the hand primer.

A—Glass Bowl
B—Nut
C—Wire Bail
D—Filter



RG2825 -UN-03APR89

S11,23010,FH -19-06OCT95

• **Check operation of hand primer:**

1. With engine shut-off, unscrew knob (A) and operate hand primer through several strokes. Moderate to heavy leakage of fuel between plunger and barrel indicates seal is defective. Replace hand primer.

NOTE: Appearance of a slight quantity of fuel around the plunger is normal.

IMPORTANT: Tighten hand primer only when it is completely depressed in barrel, or internal threads can be damaged.

2. Tighten hand primer knob, but do not overtighten. If knob will not tighten (indicating internal thread damage), replace hand primer.

RG3883 -UN-09NOV89

S11,23010,FI -19-24JUL95

• Test operation of suction side of pump:

1. Disconnect suction and discharge lines at pump.

2. Drain all fuel from pump by operating hand primer. Then reconnect suction line to pump.

3. Operate hand primer until fuel flows from pump outlet (discharge). Fuel should flow within 15—25 strokes. If not, the suction line may be obstructed or leaking air; (replace in-line filter when used).

NOTE: When operating hand primer, a moderate resistance should be felt. When only a slight resistance (or no resistance) occurs, replace hand primer or repair pump (valves may be defective).

If fuel does not flow, and if no leak or obstruction is found, pump is defective. Repair or replace pump. (See Group 35.)

• Test operation of discharge side of pump:

1. Suction line must be connected and discharge (pressure) line disconnected.

2. Tighten hand primer (Nippondenso only) and place injection pump fuel shut-off control in “STOP” position to prevent engine from starting.

3. Crank engine with starting motor. Fuel should flow from pump outlet within 10 seconds. If not, the suction line may be obstructed or leaking air; (replace in-line filter when used).

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S11,23010,FJ -19-14FEB95

• Test pump output pressure while cranking engine with starting motor:

1. Connect a 0—400 kPa (0—4 bar) (0—60 psi) pressure gauge to one end of a pressure hose about 250—300 mm (10—12 in.) long. Connect other end of hose to pump outlet. All air must be out of system.

2. Crank engine for 10 seconds with starting motor (approximately 200 engine rpm). Supply pump minimum outlet pressure should be 200 kPa (2.0 bar) (29.0 psi).

IMPORTANT: The starting motor must crank the engine at normal cranking speed. Use booster batteries if necessary.

3. Compare measured output with the minimum pressure specifications.

If pressure is below the minimum specified and if no obstruction or leak is found, repair or replace the supply pump.

RG,CTM20,115,8 -19-17NOV95

SERVICE SUPPLY PUMP

1. To gain access to the valves, remove hand primer and plug from top of supply pump (shown removed).

2. Remove valves (B) and springs (A).

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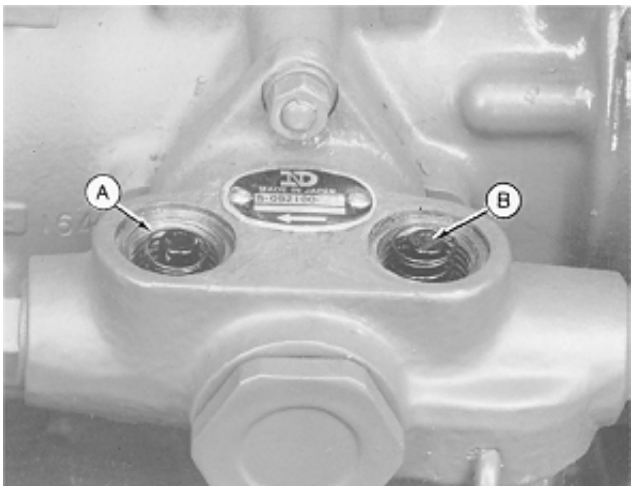
3. Inspect valves and valve seats for foreign material, wear or pitting. Valve springs must not be cracked or broken.

4. Reassemble parts, open tank shut-off valve, and check operation. If pump operation is still not normal, the pump will have to be repaired or replaced. (See Group 35.)



RG78153D1 -UN-14DEC88

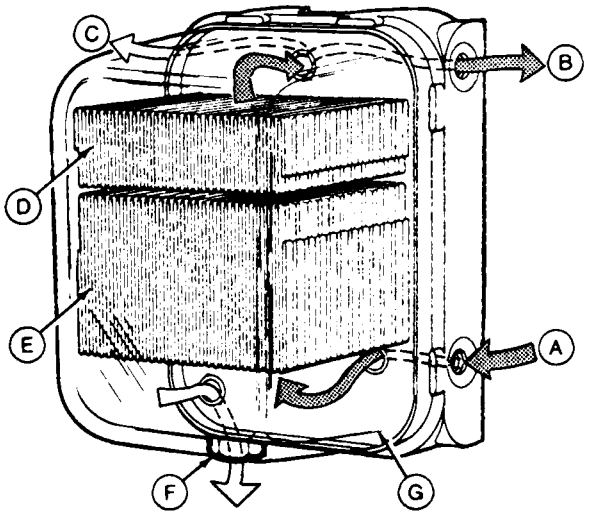
S11,23010,IJ -19-24JUL95

RECTANGULAR FINAL FUEL FILTER OPERATION

Fuel enters the filter at (A) and flows through a first stage filtering media (E) and a second stage filtering media (D) before flowing through outlet (B) to the injection pump. The filtering media is housed in the metal sediment bowl (G) and epoxied to the bowl as one assembly.

Since water and other contaminants may settle to the bottom of the sediment bowl, a drain plug (F) is provided to permit their removal.

An air vent (C) enables air in the fuel system to be expelled to the outside through the filters when bleed plug is removed.

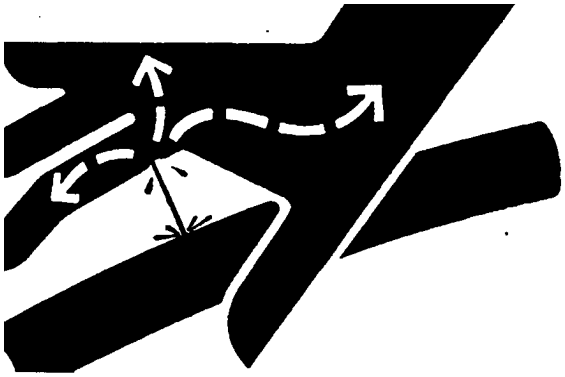


R26812 -UN-28APR89

A—Inlet
B—Outlet
C—Air Vent
D—Second Stage Filtering Media
E—First Stage Filtering Media
F—Drain Plug
G—Sediment Bowl

RG,CTM61,115,24-19-13MAY93

BLEED FUEL SYSTEM



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CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

Whenever the fuel system has been opened up for service (lines disconnected or filters removed), it will be necessary to bleed air from the system.

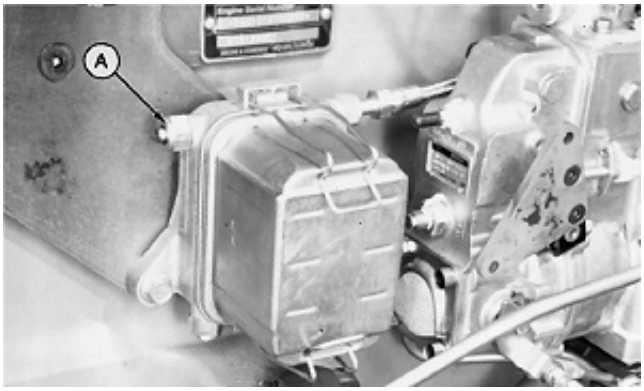
The fuel system may be bled at one of several locations. On some engine applications it may be necessary to consult your operator's manual and choose the location best for your engine/machine application.

S11,0408,AC -19-20JUL95

• At Rectangular Fuel Filter:

1. Loosen bleed plug (A) on filter base.

IMPORTANT: When bleeding the fuel system on engines equipped with electronic governors or electric shut-off solenoids, the key switch must be at the "ON" position.



-UN-10NOV89
RG5546

S55,3010,CE -19-13NOV95

2. Unscrew hand primer (A) on fuel supply pump until it can be pulled by hand.

3. Operate the hand primer until a smooth flow of fuel, free of bubbles, comes out of the filter plug hole.

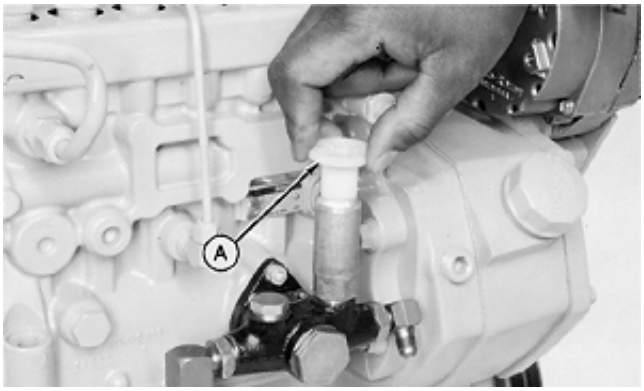
IMPORTANT: Be sure hand primer is all the way down in barrel before tightening to prevent internal thread damage.

4. Simultaneously stroke the hand primmer down and close the port plug. This prevents air from entering the system, tighten plug securely. DO NOT overtighten.

5. Lock hand primer in position.

NOTE: If the engine will not start, it may be necessary to loosen the fuel pipes at the injection nozzles to bleed air from system. Put the hand throttle in slow idle position. Push the engine fuel shut-off control knob all the way in. Turn the engine with the starter until fuel without air flows from the loose fuel pipe connections. Tighten the connections.

6. If the engine still will not start, refer to Fuel System Operation and Tests Group in your machine technical manual.



RG5295 -UN-09DEC88

S55,3010,CF -19-18APR89

- **At Fuel Injection Nozzles**

NOTE: If the engine will not start, it may be necessary to loosen the fuel lines at the injection nozzles to bleed air from system.

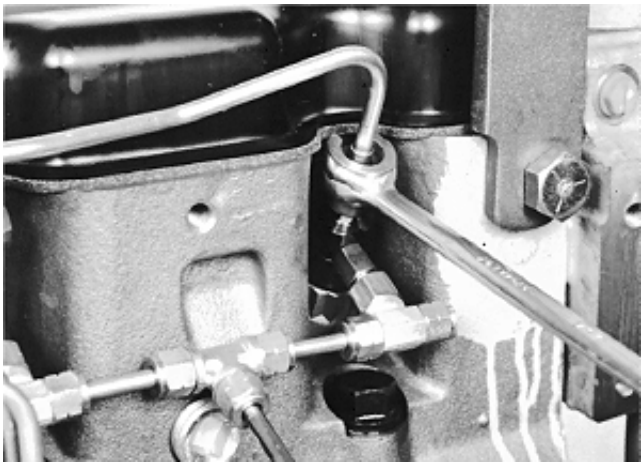
1. Put the hand throttle in fast idle position.

2. Loosen fuel line connection at No.1 injection nozzle.

3. Push the engine fuel shut-off control knob all the way in. Turn the engine with the starter until fuel without air flows from the loose fuel pipe connections.

4. Retighten the connections.

5. Repeat procedure at remaining nozzles (if necessary) until all air has been expelled from fuel system.



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S11,0408,AF -19-10AUG94

FUEL INJECTION PUMP OPERATION

Filtered fuel under pressure by the supply pump fills the injection pump fuel gallery (G). As the camshaft rotates, roller tappets (C) riding on the camshaft (B) lobes operate the plungers (F) to supply high pressure fuel through the delivery valves (H) to the injection nozzles.

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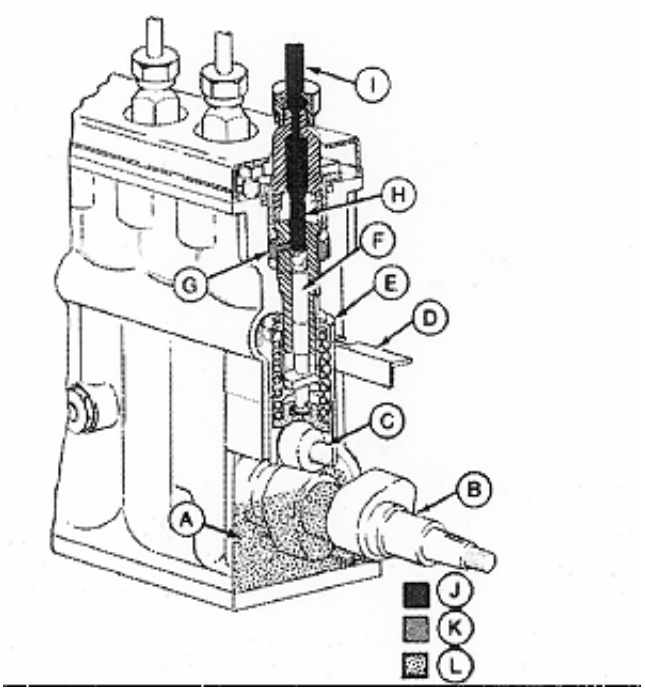
A governor-operated control rack (D) is connected to the control sleeves (E) and plungers to regulate the quantity of fuel delivered to the engine.

Engine lubricating oil is piped to the injection pump crankcase (A) to provide splash lubrication of the working parts. Two drain holes at the front end of the pump determine the level of oil maintained in the crankcase. Excess oil drains out these holes and returns back to the engine through the timing gear housing.



-UN-14DEC88
RG4650

A—Crankcase
B—Camshaft
C—Roller Tappet
D—Control Rack
E—Control Sleeve
F—Plunger
G—Fuel Gallery
H—Delivery Valve
I—Delivery Pipe
J—Injection Pressure
K—Supply Pump Pressure
L—Engine Lubricating Oil

S11,23010,GF,1 -19-20NOV95

DIAGNOSE FUEL INJECTION PUMP MALFUNCTIONS

Symptom	Problem	Solution
Engine Starts Hard or Won't Start	Incorrect fuel shut-off lever position (pump control rack not moving all the way forward)	Adjust shut-off cable as required.
	Defective injection pump	Remove pump from engine and repair (see Group 35)
	Injection pump not correctly timed	Check pump timing
Slow Idle Speed Irregular	Slow idle stop screw improperly adjusted	Recheck stop screw adjustment
	Supplementary idling spring improperly adjusted	Recheck adjustment
	Defective injection pump	Remove pump from engine and repair (See Group 35)
Engine Horsepower Low	Pump not properly timed	Check timing
	Defective injection pump	Remove pump from engine and repair (See Group 35)

S11,23010,FQ,1 -19-20NOV95

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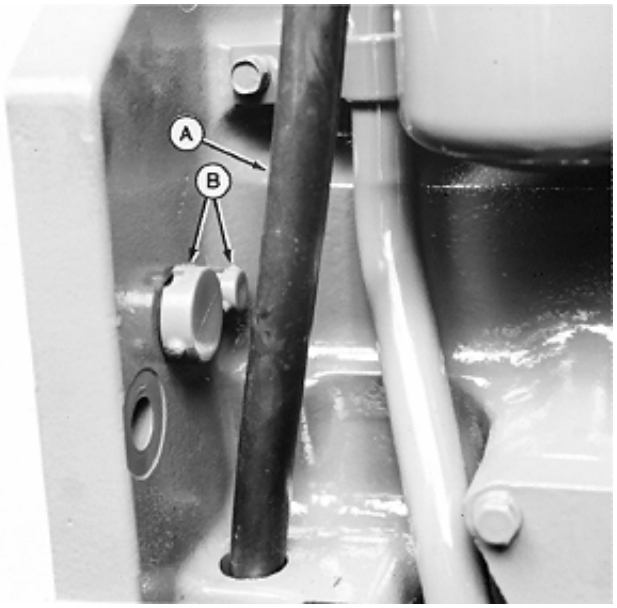
CHECK AND ADJUST INJECTION PUMP TIMING

1. Remove vent tube (A) from in front of plastic plugs (B). Remove two plastic plugs from timing holes.



RG6205 -UN-06MAR92

RG,CTM61,115,11-19-17MAR92

2. Install JDE81-1 Flywheel Rotation Tool (A) and JDE81-4 Timing Pin (B) in their respective timing holes.

3. Position engine at 'TDC' with No. 1 piston on it's compression stroke. (See CHECK AND ADJUST VALVE CLEARANCE in Group 05.)

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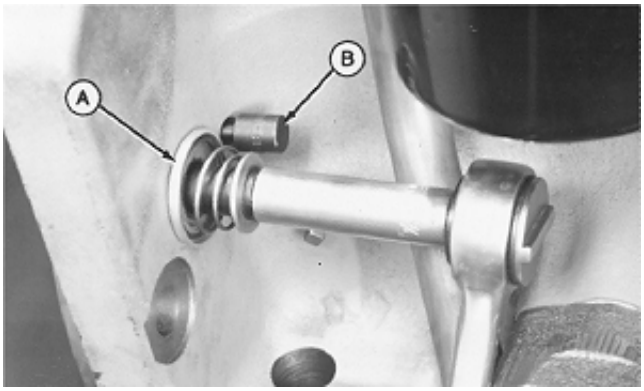
NOTE: The compression stroke can be determined by removing the rocker arm cover and rotating the engine until both valves are closed (rocker arms loose) on No. 1 cylinder.



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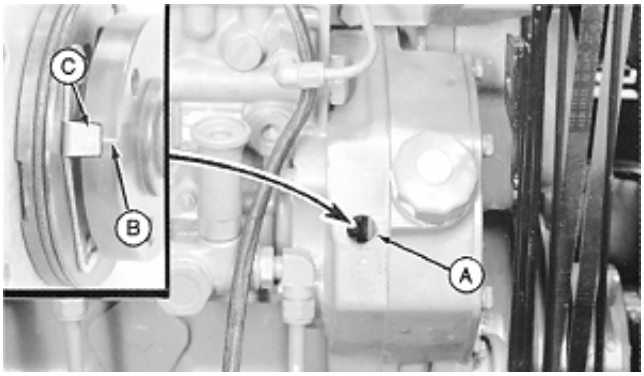
RG5521

RG,CTM61,115,12-19-21APR92

4. Remove the timing hole plug and look into hole (A). As the flywheel is turned, observe when the pump drive hub mark (B) comes in alignment with the pointer mark (C). At this position, the JDE81-4 Timing Pin should enter the hole in flywheel.



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S11,23010,BK -19-18APR94

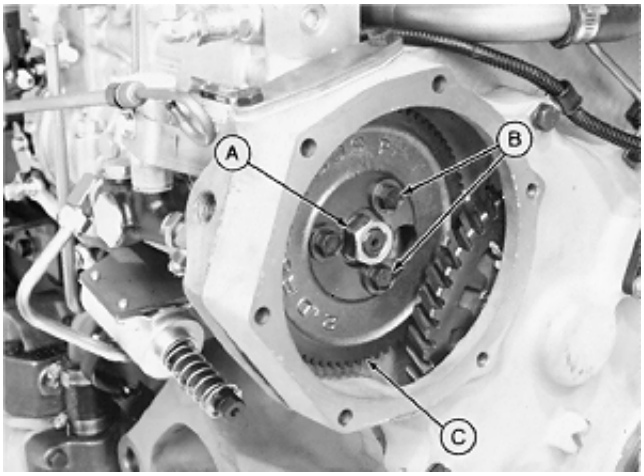
IMPORTANT: The normal backlash of gears is enough to throw the pump timing off by several degrees, resulting in poor engine performance. Therefore, it is very important that pump timing be rechecked after it has been installed. To avoid backlash, always approach the timing mark on pointer by rotating crankshaft in direction of normal engine rotation.

NOTE: Normal engine rotation is counter-clockwise, viewed from flywheel end.

5. If the timing marks are not aligned when timing pin enters hole in flywheel, remove timing pin from the flywheel. Rotate the flywheel 1-1/2 revolutions opposite direction of normal rotation. Replace the timing pin and rotate in direction of normal rotation until timing pin engages hole in flywheel. If timing marks are still not aligned, loosen the pump drive gear (C) cap screws (B). Rotate pump drive hub (A) and bring pump hub timing marks into alignment. Repeat timing check to be sure marks are aligned. Install timing hole plug.

6. Tighten injection pump drive gear-to-pump hub cap screws to 100—110 N·m (74—81 lb-ft).

7. Install injection pump gear cover using a new gasket and tighten cap screws to 47 N·m (35 lb-ft).



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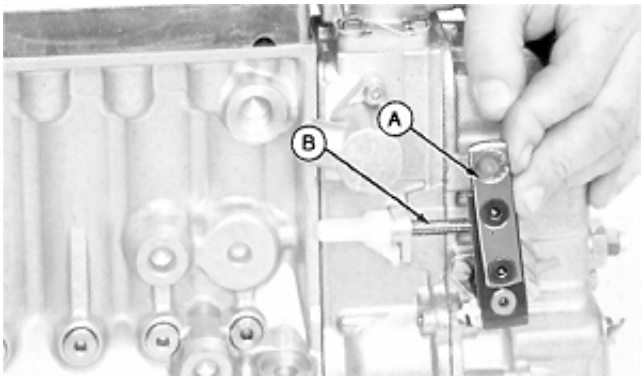
S11,23010,IP,1 -19-17NOV95

CHECK ENGINE FAST IDLE SPEED



IMPORTANT: Injection pump fast idle adjustment should only be done by a authorized diesel repair station or qualified OEM dealer or John Deere Engine Distributor.

115
22

1. With the engine running, move governor control lever (A) against the fast idle stop screw (B).

NOTE: The governor control lever on injection pump may be inboard (next to engine block) or outboard (away from engine block), depending upon engine application.

2. Using a tachometer, check engine fast idle speed to see if it is within specification. Refer to the appropriate machine technical manual for this specification.

If fast idle speed must be adjusted, see your authorized diesel repair station.

S11,23010M,9,1 -19-17NOV95

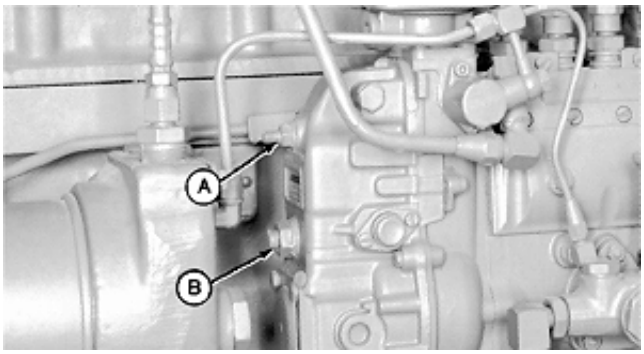
CHECK AND ADJUST SLOW IDLE SPEED

NOTE: Both the slow idle stop screw (A) and the supplementary idling spring (B) may be used to adjust the slow idle speed.

IMPORTANT: Minor adjustment of the slow idle speed may be made with the supplementary idling spring screw. However, it should not be used by itself to change engine speed more than 20 rpm, as overspeeding of the engine may result.

If slow idle stop screw and supplementary idling spring screw are not adjusted according to instruction, engine damage could result because of overspeeding.

CAUTION: ALWAYS STOP ENGINE before making adjustments.



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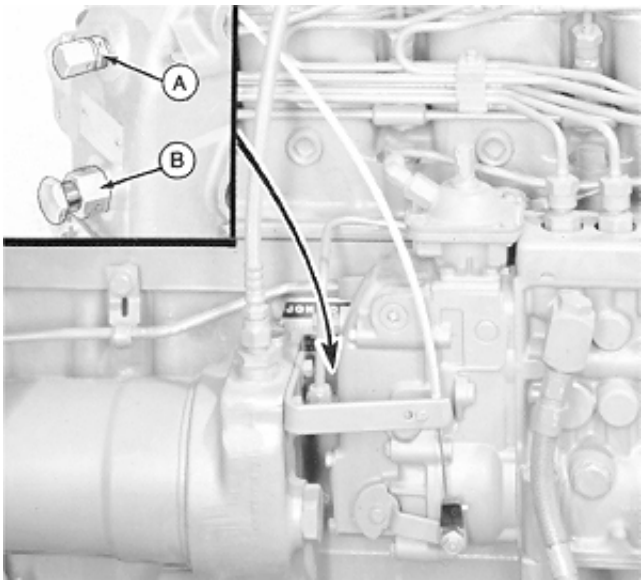

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S11,23010,IS -19-06OCT95

1. With the engine running, pull the governor control lever rearward to the slow idle speed position. Check and adjust slow idle speed to the following specification.

6101 Engines . . . . . 800—850 rpm

S11,23010,IT,1 -19-17NOV95

NOTE: On Nippondenso pumps, first remove slow idle stop screw cover.

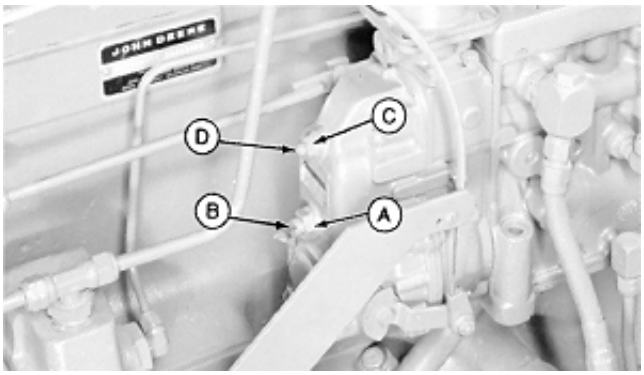
2. Loosen lock nut (A) and back out the bumper spring adjusting screw (B) three turns.

3. Loosen lock nut (C) and adjust slow idle stop screw (D) to obtain an idle speed 50 rpm less than desired slow idle speed setting.

4. Turn the bumper spring adjusting screw in to increase engine speed a maximum of 50 rpm to desired slow idle speed.

For example, to obtain an 800 rpm slow idle speed, use the slow idle stop screw to set speed at approximately 750 rpm. Then increase speed to 800 rpm using the bumper spring screw.

NOTE: Increasing the slow idle speed a slight amount above the specified speed range may help to reduce engine surge (or hunting). If this occurs, use the procedure above, but do not exceed 800 rpm.



RG3609 -UN-14DEC88

Bosch Shown (Nippondenso similar)

A—Lock Nut
B—Bumper Spring Adjusting Screw
C—Lock Nut
D—Slow Idle Stop Screw

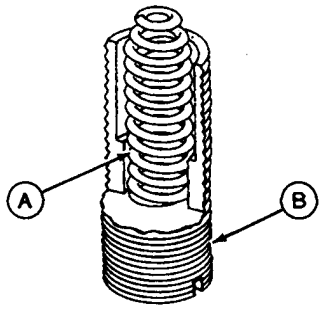
S11,23010,BU -19-10AUG94

5. If engine surging or hunting persists at slow idle, the bumper spring (A) and adjustment screw (B) may need to be replaced with a new one. Remove the pump from the engine and have it repaired by an authorized diesel repair station (ADS shop). See Group 35 for fuel injection pump removal and installation procedures.

6. Check the fast and slow idle speeds again. Readjust slow idle if not correct.

7. Check all adjusting screw lock nuts for tightness but DO NOT overtighten. Install covers (and copper washers) on slow idle stop screw and bumper spring adjusting screw (on Nippondenso Pumps).

8. Connect fuel shut-off cable and speed control rod.



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S11,23010,BW -19-10AUG94

HOW THE ANEROID WORKS—MECHANICAL GOVERNORS ONLY

Intake manifold pressure (created by the turbocharger) enters aneroid at (A). It is directed to upper side of diaphragm chamber (C) and exerts pressure on diaphragm (D).

When the pressure rises to about (100 kPa) (1 bar) 15 psi, or about 1000 engine rpm under moderate to heavy loads, spring pressure (E) is overcome. Diaphragm then moves adjusting shaft screw (F) downward.

Arm (G) has two “legs”. The inner leg bears on the flat surface of adjusting shaft screw (F). The outer leg bears against a block riveted to the control rack (H).

NOTE: Diaphragm adjusting screw (B) regulates the minimum fuel delivery quantity at a specified rpm and zero pressure acting on the diaphragm. The diaphragm spring determines acceleration time (the greater the spring tension, the greater the manifold pressure required to overcome spring tension; hence, a slower acceleration).

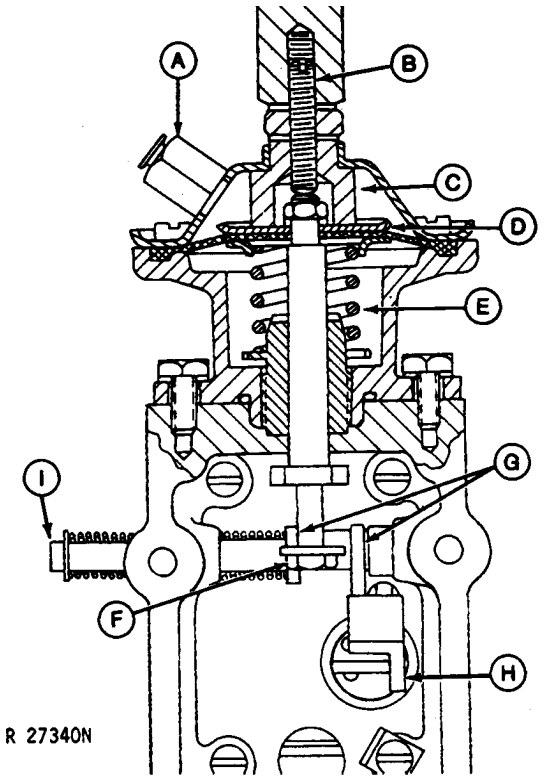
Downward movement of the adjusting shaft causes arm to rotate on starting fuel control shaft (I), permitting control rack to move its normal amount.

If the intake manifold pressure is below 100 kPa (1 bar) (15 psi) because of low engine speed, or is under light load at higher engine speeds, the aneroid spring pressure is greater than the intake manifold pressure. As a result, the control rack travel is limited (therefore, fuel delivery is limited) by the arm and adjusting shaft.

Aneroid control will be in effect until the manifold pressure is high enough to overcome diaphragm spring pressure.

A hydraulic aneroid activator (described in this group) is used to control the lever arm engagement with the control rack by moving the starting fuel control shaft in or out.

During starting, the hydraulic aneroid activator disengages the lever arm from the control rack block to permit the rack to move all the way forward to the starting fuel delivery position.



R27340N -UN-14DEC88

A—Intake Manifold Pressure Opening
B—Adjusting Screw
C—Diaphragm Chamber
D—Diaphragm
E—Spring
F—Adjusting Shaft Screw
G—Arm
H—Control Rack
I—Starting Fuel Shaft

RG,CTM61,115,18-19-13MAY93

DIAGNOSE ANEROID MALFUNCTIONS

Symptom	Problem	Solution
Slow Engine Acceleration	Loose pipe or broken connection at inlet fitting	Repair as required. (See Group 35)
	Aneroid cover cracked around inlet fitting	Repair as required. (See Group 35)
	Defective diaphragm	Repair as required. (See Group 35)
	Aneroid not correctly adjusted	Remove injection pump (See Group 35) and adjust on test stand.
Excessive Smoke When Accelerating Engine	Aneroid not correctly adjusted	Remove injection pump. (See Group 35) and adjust on test stand.

S11,23010,IV -19-24JUL95

Use information contained in the chart above to help diagnose aneroid malfunctions.

See Group 35 for instructions on how to repair and adjust the aneroid.

The aneroid controls fuel delivery when intake manifold pressure is about 100 kPa (1 bar) (15 psi) or less. Therefore, all final adjustments are to be made on the test stand with aneroid mounted on injection pump.

IMPORTANT: Correct aneroid adjustments are essential for satisfactory engine performance. Whenever the aneroid has been disassembled or the adjustments have been altered, the injection pump (including aneroid) must be calibrated on the test stand by an authorized diesel injection repair station before releasing the pump for service.

S11,23010,IV1 -19-09SEP91

HOW THE HYDRAULIC ANEROID ACTIVATOR WORKS—MECHANICAL GOVERNORS ONLY

The hydraulic aneroid activator mounts on the inboard side of the governor housing. It has an internal piston (F) that is operated by engine oil pressure to hydraulically move the starting fuel control shaft inward for aneroid control.

Engine lubricating oil is piped from the oil filter body to operate the activator. This oil is then piped to the injection pump housing to lubricate the internal working parts.

Engine oil upon starting the engine is routed to the aneroid activator housing (I) through a banjo connector (A), special screw (B), and an orifice in the capillary valve (E) to head of piston (F).

Whenever the engine oil pressure is about (60 kPa) (0.6 bar) 9 psi or higher, the piston will overcome resistance of piston spring (G) and move the starting fuel control shaft (H) inward to provide aneroid control.

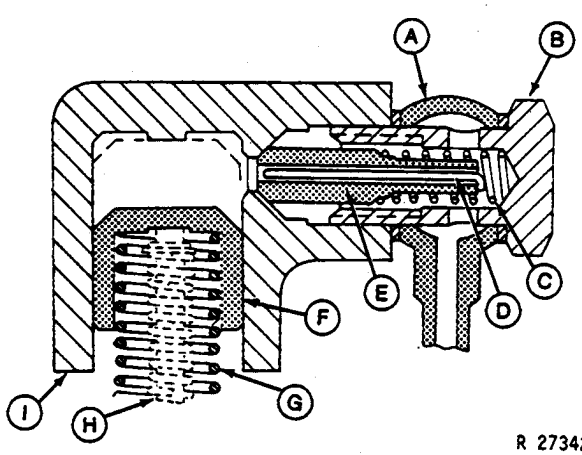
Loss of oil pressure permits a return spring on the starting fuel control shaft to hold the lever arm out of engagement with the control rack. This prevents the aneroid from limiting rack travel.

A restrictor wire (D) is inserted in the capillary valve for two reasons.

(1) To retard engagement of the aneroid when engine is cold.

(2) To help maintain an open passage in the capillary valve (oil pressure action moves the wire enough to prevent orifice from plugging).

The length of time required to achieve aneroid control depends on the ambient air temperature and the viscosity of the engine oil. Warm ambient air temperatures will permit the aneroid to activate in a few seconds. Cold temperatures may delay activation for several minutes.



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R27342N

A—Activator Banjo Connector
B—Special Screw
C—Capillary Valve Spring
D—Restrictor Wire
E—Capillary Valve
F—Piston
G—Piston Spring
H—Starting Fuel Control Shaft
I—Activator Housing

RG,CTM61,115,19-19-13MAY93

The following table gives the approximate ambient temperature-engagement time based on different engine lubricating oil viscosities:

Ambient Temp. °C (°F)	Engine Crankcase Oil	Engagement in Seconds (Approx.)
-1 (30)	SAE 30	86
-18 (1)	10W-20	255
-29 (-20)	5W-20	360

S11,23010,AC -19-16AUG94

DIAGNOSE MALFUNCTIONS—HYDRAULIC ANEROID ACTIVATOR

Symptom	Problem	Solution
Engine Starts Hard	Broken return spring on starting fuel control shaft.	Repair (See Group 35)
	Retaining ring missing from starting fuel control shaft.	Repair (See Group 35)
Excessive Smoke When Accelerating Engine	Restriction in oil supply passages to activator piston.	Disassemble, clean and inspect activator (See Group 35)

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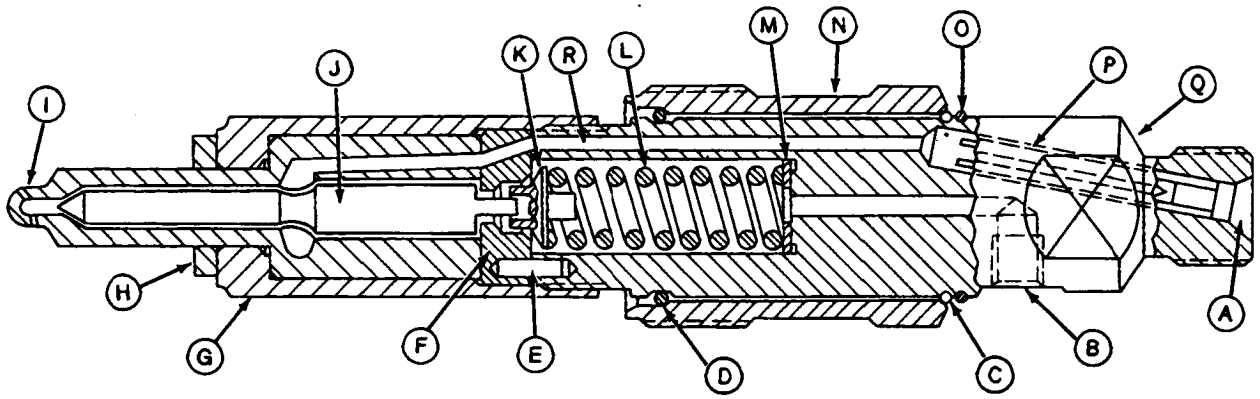
FUEL INJECTION NOZZLES—GENERAL INFORMATION—CONTINUED



A—Fuel Inlet
B—Leak-Off Connection
C—O-Ring
D—Snap Ring
E—Dowel Pin
F—Intermediate Plate
G—Nozzle Retaining Nut
H—Washer
I—Nozzle
J—Valve
K—Spring Seat
L—Spring
M—Shims
N—Gland Nut
O—Snap Ring
P—Edge-Type Filter
Q—Nozzle Holder
R—Fuel Passage

The nozzle valve (J) is held on its seat by a spring (L). Shims (M) are used to regulate the nozzle opening pressure.

The nozzle (I) and valve fit together by precision lapping. These parts are referred to as a nozzle assembly, and are not serviced separately.

Correct alignment of the nozzle assembly with its holder is essential so that the atomized fuel will be sprayed into the combustion chamber at the angle and location intended by design. KDEL holders use an intermediate plate (F) with dowel pins (E) on both sides to insure alignment.

A retaining nut (G) is used to fasten the nozzle assembly to the holder body. The diameter of the holder body is 21 mm, and from this dimension the fuel injection nozzles are known as 21 mm nozzles.

An edge-type filter (P) is placed in the fuel inlet of the nozzle holder. Its purpose is to prevent coarse, foreign particles from damaging the nozzle assembly or plugging the orifices. Finer particles pass through the filter without harm. The filter is not removable.

To provide a seal between the injection nozzle and the engine cylinder head, a steel washer (H) is used at the base of the nozzle retaining nut.

The fuel injection nozzle is fastened to the engine cylinder head by a gland nut (N). The gland nut also functions as a jack screw to raise the injection nozzle out of cylinder head during removal.

S11,23010,AF -19-18APR94

FUEL INJECTION NOZZLE OPERATION

Fuel lines (A) deliver the fuel to injection nozzles. Fuel enters the injection nozzle inlet (B), and passes through the edge-type filter (C). Coarse foreign particles are retained by the filter.

115
30

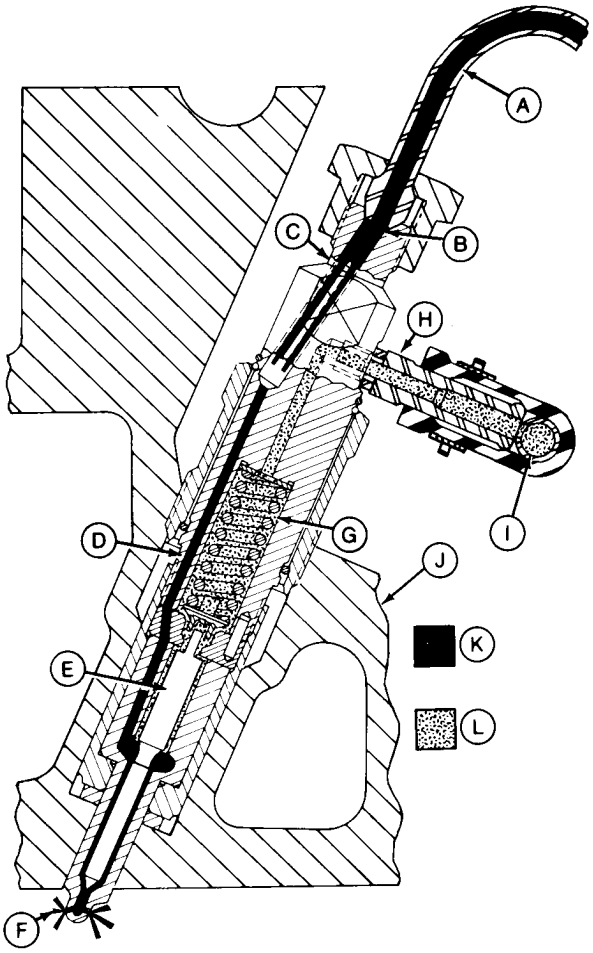
A passage (D) routes fuel through the nozzle holder to the nozzle valve (E). The nozzle valve is lifted instantly off its seat by the high pressure inlet fuel acting on an annulus in the valve.

NOTE: Since the nozzle valve opening pressure is considerably lower than the injection pump output pressure, the inlet fuel pressure easily overcomes the resistance of the nozzle valve spring (G).

When the nozzle valve opens, a definite quantity of fuel (determined by the injection pump output for each plunger stroke) is forced out through orifices (F). The fuel becomes finely atomized as it is sprayed into the combustion chamber at high velocity.

The nozzle assembly is lubricated by a small amount of fuel which seeps between the lapped surfaces of the nozzle and valve which accumulates around the spring (G, refer to previous illustrations).

The leakage fuel is routed out the nozzle holder through a leak-off connector (H) and returned back to the fuel tank by means of a leak-off pipe (I).



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Fuel Flow Through KDEL Injection Nozzle

A—Fuel Delivery Line
B—Fuel Inlet
C—Edge-Type Filter
D—Fuel Passage
E—Nozzle Valve
F—Orifices
G—Nozzle Valve Spring
H—Leak-Off Connector
I—Leak-Off Pipe
J—Engine Cylinder Head
K—High Pressure Fuel
L—Low Pressure (Return) Fuel

S55,23010,P -19-16SEP94

DIAGNOSE MALFUNCTIONS—FUEL INJECTION NOZZLE

Fuel injection nozzles are usually removed from the engine when there is a noticeable loss of power or excessive smoking.

Listed in the following chart are various malfunctions which may occur on the 21 mm nozzles. Only possible defects related to these nozzles are listed. Failures in other components of the fuel injection system are listed under their respective headings in this group.

See Group 35 for repair information.

Symptom	Problem	Solution
Engine Has Low Horsepower	Nozzle orifices plugged	Repair (See Group 35)
	Incorrect nozzle valve opening pressure	Adjust (See Group 35)
	Broken or damaged parts	Repair as required (See Group 35)
	a. Broken nozzle valve spring b. Cracked or split nozzle tip c. Cracked or split nozzle body d. Internal leak	
	Wrong nozzle and valve in holder	Install correct nozzle assembly (See Group 35)
	Nozzle loose in cylinder head	Make sure R84472 Steel Washer is installed on tip end of injection nozzle. Tighten to specified torque (See Group 35)
Engine Emits Too Much Smoke	Nozzle orifices plugged	Repair (See Group 35)
	Broken or damaged parts	Repair as required (See Group 35)
	a. Broken nozzle valve spring b. Cracked or split nozzle tip c. Cracked or split nozzle body d. Internal leak	
	Wrong nozzle and valve in holder	Install nozzle assembly (See Group 35)
	Worn nozzle valve seal	Replace nozzle assembly (See Group 35)

RG,CTM20,115,23-19-17NOV95

TEST FUEL INJECTION NOZZLES (ENGINE RUNNING)

1. Operate engine at intermediate speed with no load.

2. Slowly loosen the fuel pressure line at one of the nozzles until fuel escapes at the connection (fuel not opening nozzle valve).

115
32

NOTE: The injection nozzle before and/or after nozzle being checked could be the faulty nozzle.

• If engine speed changes, the injection nozzle is probably working satisfactory.

• If engine speed does not change, a nozzle is faulty and must be checked and repaired (or replaced).

3. Repeat test for each remaining nozzle assembly.

4. Remove faulty injection nozzles and repair as required. (See Group 35.)

S11,23010,HR -19-24JUL95

FUEL DRAIN BACK TEST PROCEDURE

Fuel draining back through the fuel system may cause hard starting. This procedure will determine if air is entering the system at connections and allowing fuel to siphon back to the fuel tank.

1. Disconnect fuel supply and return lines at fuel tank.

IMPORTANT: Fuel return line MUST extend below fuel level in fuel tank before performing this test. Fill fuel tank if necessary.

2. Drain all fuel from the system, including the fuel transfer pump, fuel injection pump, fuel filters, and water separator (if equipped).

3. Securely plug off the end of the fuel return pipe.

CAUTION: Maximum air pressure should be 100 kPa (1 bar) (15 psi) when performing this test.

4. Using a low pressure air source, pressurize the fuel system at the fuel supply line.

5. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

NOTE: Connections may allow air to enter the system without allowing fuel to leak out.

6. If any leaks are found, take necessary steps to repair.

7. Reconnect supply and return lines and prime system.

8. Start engine and run for approximately 10 minutes.

9. Allow engine to sit overnight and try starting the following morning.

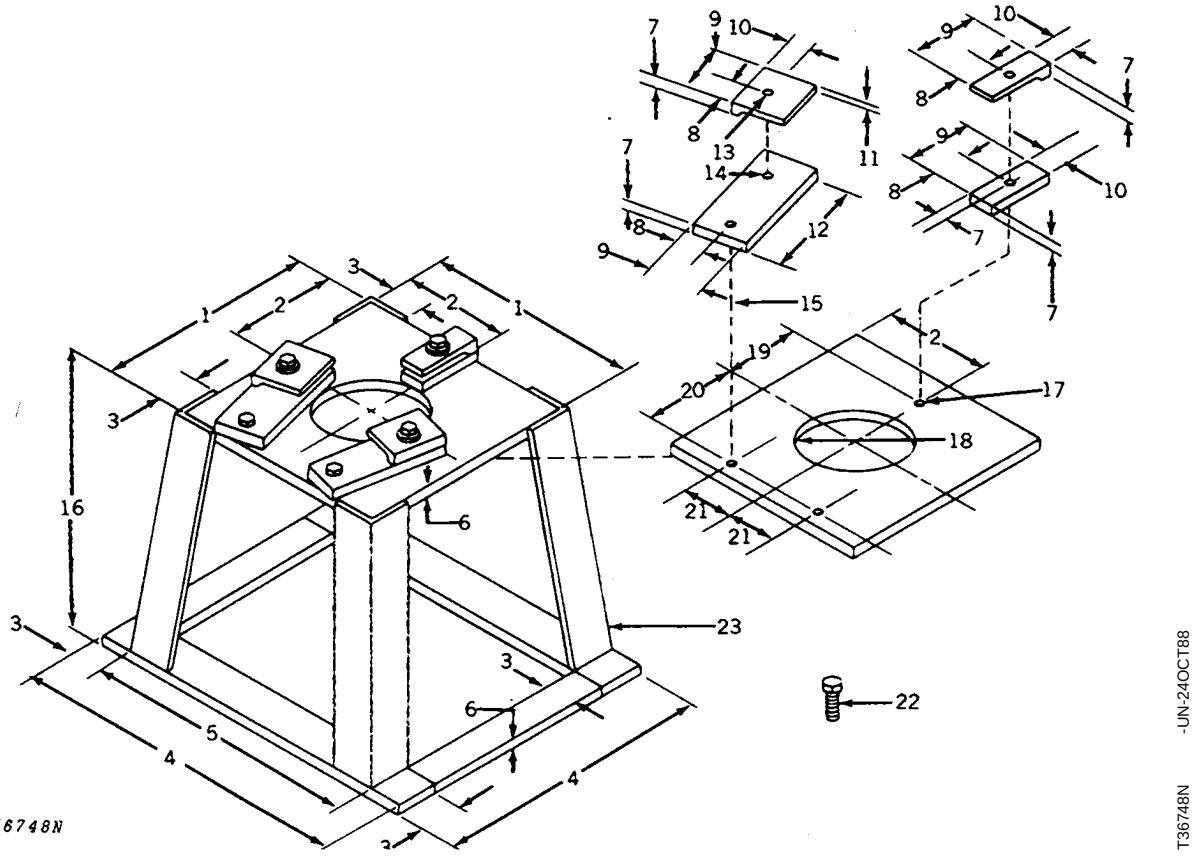
S11,23010,JA -19-24JUL95

HOW TO MAKE TOOLS

These tools can be made in a service shop using common shop tools and locally obtained materials.

S55,DFRG -19-24JUL95

CYLINDER LINER HOLDING FIXTURE



1—254.0 mm (10 in.)
2—127.0 mm (5 in.)
3—38.1 mm (1.5 in.)
4—406.4 mm (16 in.)
5—330.2 mm (13 in.)
6—9.52 mm (0.375 in.)
7—12.7 mm (0.5 in.)
8—31.8 mm (1.25 mm)
9—63.5 mm (2.5 in.)
10—25.4 mm (1 in.)
11—6.35 mm (0.25 in.)
12—152.4 mm (6 in.)
13—0.328 in. Drill Through
14—5/16 in.—18 Tap
15—2 used
16—304.8 mm (12 in.)
17—5/16 in.—18 Tap
18—69.85 mm (2.75 in.) Radius
19—101.6 mm (4 in.)
20—111.25 mm (4.38 in.)
21—60.45 mm (2.38)
22—5/16 in. x 1 in. Cap Screw
23—38.1 mm (1.5 in.) Angle Iron

NOTE: This tool can be made in a service shop using common shop tools and locally obtained materials.

S11,9900,BE -19-24JUL95

Contents

Page

Group 00—Safety

Group 01—General Information
Unified Inch Bolt and Cap Screw Torque Values 01-1
Metric Bolt and Cap Screw Torque Values 01-2
Engine Model Designation 01-3
Engine Nameplate Information 01-4
6101 Engine Application Chart 01-4
Basic 6101 Engine Specifications 01-5

Group 02—Fuels, Lubricants, and Coolant
Diesel Fuel 02-1
Lubricity of Diesel Fuels 02-1
Engine Break-In Oil 02-2
Diesel Engine Oil 02-3
OILSCAN® and COOLSCAN™ 02-4
Alternative and Synthetic Lubricants 02-4
Grease 02-5
Engine Coolant Requirements 02-6
Recommended Engine Coolant 02-8
Engine Coolant Specifications 02-9
Replenishing Supplemental Coolant Additives 02-11
Operating in Tropical Conditions 02-12
Flush and Service Cooling System 02-13
Disposing of Coolant 02-14

Group 03—Engine Mounting
Engine Repair Stand 03-1
Safety Precautions 03-2
Install 500 Series Adapters on Repair Stand 03-2
Engine Lifting Procedure 03-3
Clean Engine 03-4
Mount Engine on Repair Stand 03-5
Disconnect Turbocharger Oil Inlet Line 03-6

Page

Group 04—Engine Rebuild Guide
6101 Engine Disassembly Sequence 04-1
Sealant Application Guidelines 04-2
6101 Engine Assembly Sequence 04-4

Group 05—Cylinder Head and Valves
Special or Essential Tools 05-1
Service Equipment and Tools 05-3
Other Material 05-4
Specifications 05-5
Torques 05-6
Disconnect Turbocharger Oil Inlet Line 05-6
Check and Adjust Valve Clearance 05-7
Measure Valve Lift 05-9
Remove Cylinder Head and Valves 05-10
Check Valve Height in Relation to Cylinder Head 05-13
Disassemble and Inspect Rocker Arm Shaft Assembly 05-13
Assemble Rocker Arm Shaft Assembly 05-15
Make Preliminary Valve Checks 05-16
Remove Valve Assembly 05-17
Inspect Valve Springs 05-18
Inspect Spring Caps, Wear Caps and Valve Rotators 05-18
Clean Valves 05-19
Measure Valves 05-19
Inspect and Clean Cylinder Head 05-20
Check Cylinder Head Combustion Face Flatness 05-21
Measure Cylinder Head Thickness 05-21
Clean Valve Guides 05-22
Measure Valve Guides 05-22
Knurl Valve Guides 05-23
Replace Valve Guides 05-23
Clean and Inspect Valve Seats 05-24
Measure Valve Seats 05-24
Grind Valve Seats 05-25
Replace Valve Seat Inserts 05-26

Continued on next page

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CTM20-19-20NOV95

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Page

Recheck Valve Height in Relation to Cylinder Head 05-27
Install Oversize Valve Seat Inserts 05-28
Clean and Inspect Cylinder Head Nozzle Bore 05-28
Clean and Inspect Nozzle Seating Surface 05-29
Clean and Inspect Push Rods 05-29
Clean and Inspect Cylinder Head Cap Screws 05-30
Inspect Ventilator Assembly 05-30
Inspect and Clean Exhaust Manifold 05-31
Clean and Inspect Top Deck of Cylinder Block 05-31
Measure Cylinder Liner Height 05-32
Install Valve Assembly 05-34
Install Cylinder Head 05-35
Tighten Cylinder Head Cap Screws 05-36
TORQUE-TURN Method for Proper Cylinder Head Torque 05-36
Install Rocker Arm Assembly 05-37
Complete Final Assembly on Injection Pump Side 05-38
Complete Final Assembly on Exhaust Manifold Side 05-38
Perform Engine Break-In 05-40

Group 10—Cylinder Block, Liners, Pistons and Rods

Special or Essential Tools 10-1
Other Material 10-3
Service Equipment and Tools 10-3
Specifications 10-4
Preliminary Liner, Piston, and Rod Checks 10-6
Disconnect Turbocharger Oil Inlet Line 10-7
Remove Pistons and Connecting Rods 10-8
Measure Cylinder Liner Standout (Height Above Block) 10-11
Remove Cylinder Liners 10-12
Remove Piston Rings 10-13
Clean Pistons 10-14
Visually Inspect Pistons 10-14
Clean Cylinder Liners 10-15
Visually Inspect Cylinder Liners 10-16
Check Piston Ring Groove Wear 10-17
Install Piston Pin in Piston 10-18
Measure Piston OD 10-18
Determine Piston-to-Liner Clearance 10-19
Measure Oil Control Ring Groove 10-19
Measure Cylinder Liners 10-20

Page

Deglaze Cylinder Liners 10-21
Inspect and Measure Connecting Rod Bearings 10-22
Inspect Connecting Rod and Cap 10-23
Inspect Piston Pins and Bushings 10-25
Remove Piston Pin Bushing 10-26
Clean and Inspect Piston Pin Bushing Bore 10-27
Install Piston Pin Bushing in Rod 10-28
Complete Disassembly of Cylinder Block (if required) 10-29
Remove and Clean Piston Cooling Orifices 10-29
Inspect and Clean Cylinder Block 10-30
Clean Cylinder Liner O-Ring Bores in Block 10-32
Measure Cylinder Block 10-33
Install Piston Cooling Orifices and Galley Plugs 10-33
Recheck Cylinder Liner Standout (Height Above Block) 10-34
Measure Liner Flange Thickness 10-35
Install Liner Shims—If Required 10-35
Install Cylinder Liner O-Rings and Packings 10-36
Install Cylinder Liners 10-37
Install Pistons and Connecting Rods 10-38
TORQUE-TURN Connecting Rod Cap Screws 10-41
Check Engine Rotation for Excessive Tightness 10-41
Complete Final Assembly 10-42

Group 15—Crankshaft, Main Bearings and Flywheel

Special or Essential Tools 15-1
Shop Equipment and Tools 15-4
Other Material 15-4
Specifications 15-5
Torques 15-6
Crankshaft and Main Bearing Failure Analysis 15-6
Disconnect Turbocharger Oil Inlet Line 15-7
Replace Crankshaft Rear Oil Seal and Wear Sleeve 15-8
Remove Fan Drive Assembly (If Equipped) 15-10
Inspect Vibration Damper 15-11
Remove Damper/Pulley Assembly 15-12

Continued on next page

Page

Remove Crankshaft Front Oil Seal (Timing Gear Cover Installed) 15-13
Remove Crankshaft Front Wear Sleeve (Cover Installed/Removed) 15-15
Install Crankshaft Front Wear Sleeve (Timing Gear Cover Installed) 15-17
Install Crankshaft Front Oil Seal (Timing Gear Cover Installed) 15-18
Remove Timing Gear Cover 15-19
Check Crankshaft End Play 15-20
Check Flywheel Housing Face Runout 15-20
Check Flywheel Face Flatness 15-21
Remove Flywheel and Flywheel Housing . . . 15-21
Inspect and Repair Flywheel 15-22
Replace Flywheel Ring Gear 15-22
Remove Rear Oil Seal Housing 15-23
Remove Rear Oil Seal Housing and Wear Sleeve (Engine Disassembled) 15-23
Remove Crankshaft Main Bearings 15-24
Check Main Bearing Clearance 15-25
Remove Crankshaft 15-26
Inspect Crankshaft 15-27
Measure Assembled ID of Bearings and OD of Crankshaft Journals 15-29
Measure Assembled ID of Main Bearing Caps (Without Bearings) 15-31
Crankshaft Grinding Guidelines 15-32
Crankshaft Grinding Specifications 15-34
Thrust Bearing New Part Specifications 15-34
Replace Crankshaft Gear 15-35
Replace (Crankshaft) Oil Pump Drive Gear 15-36
Inspect Thrust Bearings 15-37
Remove and Clean Piston Cooling Orifices 15-37
Install Main Bearing Inserts in Block 15-38
Install Crankshaft 15-39
Install Oil Pump and Check Drive Gear-to-Crankshaft Clearance 15-40
Install Crankshaft Rear Oil Seal Housing . . . 15-41
Check Oil Seal Housing Runout 15-42
Crankshaft Rear Oil Seal and Wear Sleeve Handling Precautions 15-43
Install Crankshaft Rear Oil Seal and Wear Sleeve Assembly 15-43
Install Crankshaft Front Wear Sleeve 15-45
Install Timing Gear Cover 15-45
Install Crankshaft Front Oil Seal In Timing Gear Cover 15-46
Install Damper Pulley Assembly 15-47
Install Fan Drive Assembly 15-48
Install Flywheel Housign and Flywheel 15-49
Complete Final Assembly 15-49

Group 16—Camshaft and Timing Gear Train
Special or Essential Tools 16-1
Specifications 16-4
Disconnect Turbocharger Oil Inlet Line 16-5
Measure Valve Lift 16-6
Remove Fan Drive Assembly (If Equipped) 16-6
Remove Damper/Pulley Assembly 16-7
Remove Timing Gear Cover 16-9
Remove Front Wear Sleeve (Timing Gear Cover Removed) 16-10
Remove Front Oil Seal (Timing Gear Cover Removed) 16-10
Check Camshaft End Play 16-11
Measure Camshaft Drive Gear-to-Crankshaft Gear Minimum Backlash 16-11
Remove Camshaft 16-12
Remove Camshaft Gear, Spacer, and Thrust Plate 16-13
Measure Thrust Plate and Spacer 16-14
Inspect Camshaft 16-14
Measure Camshaft Journal O.D. and Bushing I.D. 16-15
Measure Camshaft Lobe Lift 16-15
Remove, Inspect, and Measure Camshaft Followers 16-16
Assemble Camshaft 16-17
Service Camshaft Bushings Using JDE6 Camshaft Bushing Replacement Set 16-18
Service Camshaft Bushings Using JDG405 Camshaft Bushing Service Set . . . 16-20
Install Camshaft 16-22
Install Timing Gear Cover 16-24
Install Crankshaft Front Wear Sleeve (Timing Gear Cover Installed) 16-24
Install Crankshaft Front Oil Seal (Timing Gear Cover Installed) 16-25
Complete Final Assembly 16-26

Group 20—Lubrication System
Other Material 20-1
Specifications 20-1
Diagnosing Lubrication System Malfunctions 20-3
Disconnect Turbocharger Oil Inlet Line 20-4

Continued on next page

Page

Drain Engine Oil, Coolant and Remove Oil Pan 20-4
Engine Oil Bypass Valve Housing, Oil Cooler and Oil Filtration System 20-5
Remove Oil Bypass Valve Housing and Oil Cooler Assembly 20-6
Remove and Inspect Oil Cooler Bypass and Oil Filter Bypass Valves 20-7
Assemble Bypass Valve Housing and Oil Cooler Assembly 20-8
Install Oil Bypass Valve Housing and Oil Cooler Assembly 20-9
Remove, Disassemble, Inspect, and Install Oil Pressure Reg. Valve 20-10
Check Crankshaft Gear-to-Oil Pump Drive Gear Backlash 20-12
Engine Oil Pump Assembly 20-13
Remove Engine Oil Pump 20-14
Inspect and Clean Oil Pump 20-15
Check Drive Shaft End Play 20-15
Check Drive Shaft Side Movement 20-16
Check Pumping Gear Backlash 20-16
Inspect Oil Pump Drive Gear 20-16
Adjust Oil Pump Set Screw 20-17
Install Engine Oil Pump 20-17
Install Oil Pan 20-19

Group 25—Cooling System
Special or Essential Tools 25-1
Other Material 25-2
Specifications 25-3
Service Equipment and Tools 25-4
Diagnosing Cooling System Malfunctions 25-4
General Cooling System Information 25-4
Remove and Install Heavy Duty Fan Drive Assembly 25-5
Remove Fan Drive Bearings 25-6
Install Fan Drive Bearings 25-7
Remove Water Pump—6101AT001 Engines 25-8
Remove Water Pump—6101HRW01, 02 Engines 25-9
Water Pump Assembly 25-10
Disassemble Water Pump 25-10
Measure Bearing Bore in Water Pump Housing 25-12
Assemble Water Pump 25-12
Install Water Pump—6101AT001 Engines . . . 25-17
Install Water Pump—6101HRW01, 02 Engines 25-18
Remove Water Manifold 25-19

Page

Inspect and Clean Water Manifold 25-19
Install Water Manifold 25-20
Remove Thermostats 25-20
Install Thermostats 25-21
Remove Coolant Filter Conditioner 25-21
Inspect Coolant Filter Conditioner Components 25-22
Install Coolant Filter Conditioner 25-22
Complete Final Assembly 25-23
Check and Adjust V-Belt Tension 25-24
Remove Coolant Heater—If Equipped 25-25
Install Coolant Heater—If Equipped 25-26

Group 30—Air Intake and Exhaust System
Special or Essential Tools 30-1
Specifications 30-2
Other Material 30-2
Extending Turbocharger Life 30-3
Remove Turbocharger 30-5
Diagnosing Turbocharger Malfunctions 30-7
Turbocharger Seven-Step Inspection 30-10
A—Compressor Housing Inlet and Compressor Wheel 30-10
B—Compressor Housing Outlet 30-11
C—Turbine Housing Inlet 30-11
D—Turbine Housing Outlet and Turbine Wheel 30-11
E—External Center Housing and Joints 30-12
F—Internal Center Housing 30-12
G—Turbo Bench Test 30-13
Perform Radial Bearing Clearance Test (Garret/AiResearch T45) 30-14
Perform Axial End Play Bearing Test (Garret/AiResearch T45) 30-15
Perform Radial Bearing Clearance Test (Schwitzer S3A) 30-16
Perform Axial End Play Bearing Test (Schwitzer S3A) 30-17
Disassemble and Inspect Turbocharger (Garrett/AiResearch T45) 30-18
Replace Center Housing and Rotating Assembly 30-20
Disassemble and Inspect Turbocharger (Schwitzer S3A) 30-21
Replace Center Housing and Rotating Assembly 30-23
Prelube Turbocharger 30-23
Install Turbocharger 30-24

Continued on next page

Page

Remove Aftercooler Assembly and Intake Manifold (6101A Engines) 30-26
Inspect and Repair Aftercooler (6101A Engines) 30-27
Inspect and Repair Intake Manifold (6101A Engines) 30-28
Install Intake Manifold and Aftercooler Assembly (6101A Engines) 30-29
Install Aftercooler Cover (6101A Engines) . . . 30-30
Remove, Inspect, and Install Intake Manifold (6101H Engines) 30-31
Remove, Inspect, and Install Exhaust Manifold Assembly 30-32

Group 35—Fuel System
Special or Essential Tools 35-1
Other Material 35-3
Specifications 35-4
Relieve System Pressure 35-5
Replace Rectangular Final Fuel Filter 35-5
Replace Fuel Check Valve Assembly 35-6
Remove Fuel Supply Pump 35-7
Test Fuel Supply Pump For Leaks 35-8
Disassemble Fuel Supply Pump 35-9
Inspect and Repair Fuel Supply Pump 35-11
Assemble Fuel Supply Pump 35-13
Install Fuel Supply Pump 35-14
General Information For Aneroid (if Equipped) 35-15
Repair Aneroid—Mechanical Governors Only 35-15
Remove Hydraulic Aneroid Activator—Mechanical Governor 35-16
Disassemble and Clean Hydraulic Aneroid Activator 35-16
Assemble and Install Hydraulic Aneroid Activator 35-17
Service Injection Pump Overflow Valve 35-17
Remove Fuel Injection Pump 35-18
Repair Fuel Injection Pump 35-21
Install Fuel Injection Pump 35-22
Remove Fuel Injection Nozzles 35-27
Diagnose Injection Nozzle Malfunction 35-29
Test Fuel Injection Nozzles 35-31
Perform Opening Pressure Test 35-32
Fuel Injection Nozzle Specifications 35-33
Perform Leakage Test 35-34
Test Nozzle Chatter and Spray Pattern 35-35
Disassemble Fuel Injection Nozzle 35-36

Page

Clean and Inspect Fuel Injection Nozzle Assembly 35-38
Perform Nozzle Slide Test 35-39
Clean Spray Orifices 35-39
Inspect Nozzle Holder 35-40
Inspect Gland Nut 35-41
Assemble Fuel Injection Nozzle 35-42
Adjust Fuel Injection Nozzles 35-45
Inspect and Clean Cylinder Head Nozzle Bore 35-46
Inspect and Clean Nozzle Seating Surface 35-47
Install Fuel Injection Nozzles 35-47
Install Fuel Leak-off and Fuel Delivery Line Assemblies 35-49

Group 100—Engine Tune-Up and Break-In
Effects of Altitude and Temperature on Engine Performance 100-1
Preliminary Engine Testing 100-2
General Tune-Up Recommendations 100-3
Dynamometer Test 100-4
Engine Break-In Guidelines 100-4
Engine Break-In Instructions 100-5
Check Crankcase Ventilation System 100-6
Check Air Intake System 100-6
Check Exhaust System 100-7
Check and Service Cooling System 100-8
Check Electrical System 100-9

Group 105—Engine System Operation and Tests
Special or Essential Tools 105-1
Engine Test Specifications 105-3
General Description 105-4
Engine Sectional View 105-5
How the Lubrication System Works 105-6
Head Gasket Joint Construction and Operation 105-9
Diagnosing Head Gasket Joint Failures . . . 105-11
Head Gasket Inspection and Repair Sequence 105-14
Diagnosing Engine Malfunctions 105-16
Test Engine Compression Pressure 105-18
Check Engine Oil Pressure 105-19
Measure Engine Crankcase Pressure (Blow-By) 105-20
Pressure Test Cooling System and Radiator Cap 105-21
Inspect Thermostat and Test Opening Temperature 105-22

Continued on next page

Page

Group 110—Air Intake System Operation and Tests
Special or Essential Tools 110-1
Air Intake and Exhaust System Test Specifications 110-1
Diagnosing Air Intake Malfunctions 110-2
How the Air Intake and Exhaust System Works 110-3
Air Cleaner Operation 110-4
Diagnosing Turbocharger Malfunctions 110-5
How the Turbocharger Works 110-6
How the Turbocharger is Lubricated 110-6
How the Aftercooler Works—6101A 110-7
Check Intake Manifold Pressure (Turbo Boost) 110-8
Air Filter Restriction Indicator Switch Test . . 110-10

Group 115—Fuel System Operation and Tests
Special or Essential Tools 115-1
Service Equipment and Tools 115-1
Fuel System Test Specifications 115-1
Fuel Injection Pump Specifications 115-2
Fuel System Operation 115-3
Diagnose Fuel System Malfunctions 115-4
Supply Pump Operation 115-8
Diagnosing Mechanical Fuel Supply Malfunctions 115-10
Test Fuel Supply Pump for Leaks 115-11
Check Supply Pump Operation 115-12
Service Supply Pump 115-14
Rectangular Final Filter Operation 115-14
Bleed Fuel System 115-15
In-Line Fuel Injection Pump Operation 115-18
Diagnose In-Line Fuel Injection Pump Malfunctions 115-19
Check and Adjust Injection Pump Timing . . 115-19
Check Fast Idle Speed 115-22
Check and Adjust Engine Slow Idle 115-23
How the Aneroid Works—Mechanical Governors Only 115-25
Diagnose Aneroid Malfunction 115-26
How the Hydraulic Aneroid Activator Works 115-27
Diagnose Malfunctions—Hydraulic Aneroid Activator 115-28
Fuel Injection Nozzles—General Information 115-29
Fuel Injection Nozzle Operation 115-30

Page

Diagnose Malfunctions—Fuel Injection Nozzle 115-31
Test Fuel Injection Nozzles (Engine Running) 115-32
Fuel Drain Back Test Procedure 115-32

Group 199—Dealer Fabricated Tools
How to Make Tools 199-1
Cylinder Liner Holding Fixture 199-1

Index

Index

Page

A

Aftercooler
Inspect 30-27
Repair 30-27
Air cleaner
Operation 110-4
Air intake manifold pressure
Aneroid 110-8
Air intake system
Check 100-6
Diagnostics 110-2
General information 110-3
Specifications 110-1
Altitude compensation 100-1
Aneroid
Diagnose malfunctions 115-26
General information 115-25
Repair 35-15
Aneroid activator
Assemble and install 35-17
Diagnosing malfunctions 115-28
Disassemble and clean 35-16
Remove 35-16
Aneroid, hydraulic activator
General information 115-27

B

Bearing caps, main
Measure assembled ID 15-31
Bearing, thrust
Inspect 15-37
Specifications 15-34
Bearings, connecting rod
Inspect and measure 10-22
Bearings, fan drive
Install 25-7
Remove 25-6
Bearings, main
Check clearance 15-25
Failure analysis 15-6
Insall inserts 15-38
Measure assembled ID 15-29
Remove 15-24
Belt tension, check and adjust 25-24
Bleed fuel system 115-15

Page

Block, cylinder
Clean and inspect top check 05-31
Disassembly 10-29
Inspect and clean 10-30
Measure 10-33
Preliminary checks 10-6
Blow-by, crankcase, measure 105-20
Bore, piston pin bushing
Clean and inspect 10-27
Break-In Engine Oil 02-2
Break-in instructions, engine 100-5
Break-in, engine
Guidelines 100-4
Perform 05-40
Bushing, piston pin
Install 10-28
Remove 10-26
Bushings, piston pin
Inspect 10-25

C

Camshaft
Assemble 16-17
Check end play 16-11
Followers, inspect 16-16
Gear, remove 16-13
Install 16-22
Measure and inspect 16-14
Remove 16-12
Thrust plate, remove 16-13
Thrust spacer, remove 16-13
Camshaft and timing gear train
Complete final assembly 16-26
Camshaft spacer
Measure 16-14
Camshaft thrust plate
Measure 16-14
Cap screws
Cylinder head 05-30
Cap screws, cylinder head
Clean and inspect 05-30
Compression pressure, engine
Test 105-18
Connecting rod bearings
Inspect and measure 10-22
Connecting rods
Inspect rod and cap 10-23
Install 10-38
TORQUE-TURN cap screws 10-41

INDX 1

Page

Connecting rods and pistons
Remove 10-8
Coolant
Drain 20-4
Tropical 02-12
Coolant filter conditioner
Inspect 25-22
Coolant heater
Install 25-26
Remove 25-25
Coolant, engine
Additives 02-11
Disposal 02-14
Products 02-8
Requirements 02-6
Specifications 02-9
Cooling orifices
Install 10-33
Remove and clean 10-29
Cooling system
Diagnosing malfunctions 25-4
Flush and service 02-13
Pressure test 105-21
Service 100-8
Cover, timing gear
Install 15-45
Crankcase
Blow-by, measure 105-20
Crankcase ventilation system
Check 100-6
Crankshaft
Failure analysis 15-6
Front oil seal, install 15-18, 16-25
Front oil seal, remove (cover on) 15-13
Front oil seal, remove (cover off) 16-10
Frt oil seal, install (cover off) 15-46
Frt wear sleeve, remove (cover on) 15-15
Frt wear sleeve, remove (cover off) 16-10
Frt wear sleeve,install 15-45
Grinding guidelines 15-32
Grinding specifications 15-34
Inspect 15-27
Install 15-39
Journals, measure OD 15-29
Oil pump to crankshaft clearance 15-40
Rear oil seal handling precautions 15-43
Rear oil seal housing, install 15-41
Rear oil seal housing, remove 15-23
Rear oil seal, install 15-43

Page

Crankshaft—Continued
Rear seal/sleeve, remove (hsg off) 15-23
Rear seal/sleeve, replace (hsg on) 15-8
Remove 15-26
Thrust bearing specifications 15-34
Thrust bearings, inspect 15-37
Crankshaft driven oil pump
Adjust set screw 20-17
Check drive shaft end play 20-15
Check drive shaft side movement 20-16
Check pumping gear backlash 20-16
Inspect and clean 20-15
Inspect drive gear 20-16
Crankshaft gear
Replace 15-35
Crankshaft gear-to oil pump drive gear
Check backlash 20-12
Crankshaft, bearings and flywheel
Complete final assembly 15-49
Failure analysis 15-6
Cyl block, liners, pistons and rods
Preliminary checks 10-6
Cylinder block
Clean and inspect top check 05-31
Disassembly 10-29
Inspect and clean 10-30
Measure 10-33
Preliminary checks 10-6
Cylinder head
Check flatness 05-21
Clean valves 05-19
Gasket construction and operation 105-9
Gasket failure diagnostics 105-11
Gasket, inspect and repair 105-14
Inspect and clean 05-20
Inspect and clean nozzle bore 35-46
Install rocker arm assembly 05-37
Liner, measure height 05-32
Make preliminary valve checks 05-16
Nozzle bores, clean and inspect 05-28
Nozzle seats, clean and inspect 05-29
Oversize valve seats, install 05-28
Push rods, clean and inspect 05-29
Push rods, remove 05-11
Rocker arm assembly, assemble 05-15
Rocker arm assembly, disassemble 05-13
Service equipment and tools 05-3
Valve assembly, install 05-34
Valve caps and rotators, inspect 05-18
Valve guides, clean 05-22

Page

Cylinder head—Continued
Valve guides, measure 05-22
Valve guides, replace 05-23
Valve seat inserts, replace 05-26
Valve seats, clean and inspect 05-24
Valve springs, inspect 05-18
Cylinder head cap screws
Clean and inspect 05-30
Cylinder liners
clean 10-15
Clean O-ring bore 10-32
Deglaze 10-21
Flange thickness, measure 10-35
Holding fixture 199-1
Identification markings 10-10
Inspect 10-16
Install 10-37
Install O-rings and packings 10-36
Measure 10-20
Measure height 05-32
Remove 10-12
Shims, install 10-35
Standout (height), recheck 10-34

D

Diesel Engine Oil 02-3
Diesel fuel 02-1
Diesel fuel, lubricity 02-1
Dynamometer test
Procedure 100-4

E

Electrical system
Check 100-9
Service 100-9
Elevation, compensation guidelines 100-1
Endplay, check
Camshaft 16-11
Engine
Blow-by, measure 105-20
Break-in guidelines 100-4
Break-in instructions 100-5
Check for excessive tightness 10-41
Cleaning 03-4
Diagnostics 105-16
Dynamometer test 100-4
General tune-up recommendations 100-3

Page

Engine—Continued
Preliminary testing 100-2
Repair stand 03-1
Sealant guidelines 04-2
Sectional view 105-5
Engine break-in
Perform 05-40
Engine compression pressure
Test 105-18
Engine coolant
Additives 02-11
Disposal 02-14
Drain 20-4
Products 02-8
Requirements 02-6
Specifications 02-9
Engine oil
Break-In 02-2
Diesel 02-3
Drain 20-4
Engine oil pressure
Check 105-19
Engine speed
Fast idle, check 115-22
Slow idle, check and adjust 115-23
Engine test specifications 105-3
Exhaust manifold
Inspect and clean 05-31
Exhaust system
Check 100-7
General information 110-3
Specifications 110-1

F

Fabricated tools 199-1
Fan drive
Install bearings 25-7
Fan drive assembly
Remove and install 25-5
Fan drive bearings
Install 25-7
Remove 25-6
Fast idle speed, check 115-22
Filter, final fuel
Replace 35-5
Filter, rectangular fuel
Operation 115-14
Flywheel
Check face flatness 15-21
Inspect and repair 15-22

Page

Flywheel—Continued
Install 15-49
Remove 15-21
Ring gear, replace 15-22
Flywheel housing
Check face runout 15-20
Install 15-49
Remove 15-21
Followers, camshaft, inspect 16-16
Front oil seal
Install 15-18, 16-25
Install (timing cover removed) 15-46
Remove (timing cover installed) 15-13
Remove (timing cover removed) 16-10
Front wear sleeve
Install 15-45
Remove (timing cover installed) 15-15
Remove (timing cover removed) 16-10
Fuel check valve
Replace 35-6
Fuel delivery line assembly
Install 35-49
Fuel drain back test 115-32
Fuel filter, final
Replace 35-5
Fuel filter, rectangular
Operation 115-14
Fuel injection nozzle
Operation 115-30
Fuel injection nozzles
Adjustment 35-45
Clean 35-38
Clean spray orifices 35-39
Diagnosis 35-29
Diagnostics 115-31
Disassemble 35-36
Inspect 35-38
Inspect and clean nozzle bore 35-46
Inspect and clean seating surface 35-47
Inspect gland nut 35-41
Inspect nozzle holder 35-40
Install 35-47
Opening pressure test 35-32
Perform slide test 35-39
Remove 35-27
Test 35-31
Test chatter and spray pattern 35-35
Test nozzle leakage 35-34
Test, engine running 115-32

Page

Fuel injection pump
Diagnose malfunctions 115-19
Install 35-22
Operation 115-18
remove 35-18
Repair 35-21
Specifications 115-2
Timing, check and adjust 115-19
Fuel leak-off line assembly
Install 35-49
Fuel overflow valve, service 35-17
Fuel supply pump
Check operation 115-12
Diagnostics 115-10
Operation 115-8
Service 115-14
Fuel system
Bleed 115-15
Diagnose malfunctions 115-4
Fuel drain back test 115-32
Operation 115-3
Specifications 115-1
Fuel, diesel 02-1
Fuel, diesel, lubricity 02-1

G

Galley plugs
Install 10-33
Gear, crankshaft
Replace 15-35
Gear, oil pump drive (crankshaft)
Replace 15-36
Grease
Extreme pressure and multipurpose 02-5
Grinding, crankshaft
Guidelines 15-32
Specifications 15-34
Guides, valve
Knurl 05-23

H

Head, cylinder
Check flatness 05-21
Gasket construction and operation 105-9
Gasket failure diagnostics 105-11
Gasket, inspect and repair 105-14

Page

Head, cylinder—Continued
- Inspect and clean . . . 05-20
- Inspect and clean nozzle bore . . . 35-46
- Install rocker arm assembly . . . 05-37
- Make preliminary valve checks . . . 05-16
- Nozzle bores, clean and inspect . . . 05-28
- Nozzle seats, clean and inspect . . . 05-29
- Push rods, clean and inspect . . . 05-29
- Push rods, remove . . . 05-11
- Rocker arm assembly, assemble . . . 05-15
- Rocker arm assembly, disassemble . . . 05-13
- Service equipment and tools . . . 05-3
- Valve assembly, install . . . 05-34
- Valve caps and rotators, inspect . . . 05-18
- Valve guides, clean . . . 05-22
- Valve guides, measure . . . 05-22
- Valve guides, replace . . . 05-23
- Valve seats, clean and inspect . . . 05-24
- Valve springs, inspect . . . 05-18

Heater, coolant
- Install . . . 25-26
- Remove . . . 25-25

Housing, flywheel
- Check face runout . . . 15-20
- Install . . . 15-49
- Remove . . . 15-21

Housing, rear oil seal
- Check runout . . . 15-42

Hydraulic aneroid activator
- Assemble and install . . . 35-17
- Diagnose malfunctions . . . 115-28
- Disassemble and clean . . . 35-16

I

Idle speed
- Fast, check . . . 115-22
- Slow, check and adjust . . . 115-23

Inch torque values . . . 01-1

Injection nozzle
- Adjustment . . . 35-45
- Operation . . . 115-30

Injection nozzles
- Clean . . . 35-38
- Clean spray orifices . . . 35-39
- Diagnosis . . . 35-29
- Diagnostics . . . 115-31
- Disassemble . . . 35-36
- Inspect . . . 35-38
- Inspect and clean nozzle bore . . . 35-46

Page

Injection nozzles—Continued
- Inspect and clean seating surface . . . 35-47
- Inspect gland nut . . . 35-41
- Inspect nozzle holder . . . 35-40
- Install . . . 35-47
- Opening pressure test . . . 35-32
- Perform slide test . . . 35-39
- Remove . . . 35-27
- Test . . . 35-31
- Test chatter and spray pattern . . . 35-35
- Test nozzle leakage . . . 35-34
- Test, engine running . . . 115-32

Injection pump
- remove . . . 35-18
- Timing, check and adjust . . . 115-19

Injection pump, fuel
- Repair . . . 35-21

Inserts, main bearing, install . . . 15-38

Intake manifold
- Check pressure . . . 110-8

Intake manifold pressure
- Check . . . 110-9, 110-10

Intake system, air
- Check . . . 100-6

J

Journals, crankshaft, measure OD . . . 15-29

L

Leak test, nozzles . . . 35-34

Leak-off line assembly
- Install . . . 35-49

Liners, cylinder
- clean . . . 10-15
- Clean O-ring bore . . . 10-32
- Deglaze . . . 10-21
- Flange thickness, measure . . . 10-35
- Holding fixture . . . 199-1
- Identification markings . . . 10-10
- Inspect . . . 10-16
- Install . . . 10-37
- Install O-rings and packings . . . 10-36
- Measure . . . 10-20
- Remove . . . 10-12
- Shims, install . . . 10-35
- Standout (height), recheck . . . 10-34

Lubricant
- Alternative . . . 02-4
- Synthetic . . . 02-4

Page

Lubrication system
Diagnosing malfunctions 20-3

M

Main bearing caps
Measure assembled ID 15-31
Main bearing inserts, install 15-38
Main bearings
Check clearance 15-25
Failure analysis 15-6
Install inserts 15-38
Measure assembled ID 15-29
Remove 15-24
Make preliminary valve checks 05-16
Manifold pressure, intake
Check 110-10
Manifold, intake
Check pressure 110-8
Manifold, intake pressure
Check 110-9
Metric torque values 01-2

N

Nozzle bores, clean and inspect 05-28
Nozzle seats, clean and inspect 05-29
Nozzle, fuel injection
Operation 115-30
Nozzles, fuel injection
Clean 35-38
Clean spray orifices 35-39
Diagnosis 35-29
Disassemble 35-36
Inspect 35-38
Inspect and clean nozzle bore 35-46
Inspect and clean seating surface 35-47
Inspect gland nut 35-41
Inspect nozzle holder 35-40
Install 35-47
Opening pressure test 35-32
Perform slide test 35-39
Remove 35-27
Test 35-31
Test chatter and spray pattern 35-35
Test nozzle leakage 35-34
Test, engine running 115-32

Page

O

Oil
Drain 20-4
Oil bypass valve housing
Assemble 20-8
Remove 20-6
Oil control ring groove, measure 10-19
Oil cooler assembly
Assemble 20-8
Remove 20-6
Oil cooler bypass valve
Remove and inspect 20-7
Oil filter bypass valve
Remove and inspect 20-7
Oil pan
Install 20-19
Remove 20-4
Oil pressure
Check 105-19
Oil pump
Install 20-17
Remove 20-14
Oil pump assembly 20-13
Oil pump drive gear
Inspect (crankshaft driven) 20-16
Oil pump drive gear (crankshaft)
Replace 15-36
Oil pump drive gear-to-crankshaft gear
Check backlash 20-12
Oil pump, crankshaft driven
Adjust set screw 20-17
Check drive shaft end play 20-15
Check drive shaft side movement 20-16
Check pumping gear backlash 20-16
Inspect and clean 20-15
Inspect drive gear 20-16
Oil seal housing
Check runout 15-42
Install 15-41
Remove 15-23
Oil seal, front
Install 15-18, 16-25
Install (timing cover removed) 15-46
Remove (timing cover installed) 15-13
Remove (timing cover removed) 16-10
Oil seal, rear
Handling precautions 15-43
Install 15-43
Remove (seal housing removed) 15-23
Opening pressure test, nozzles 35-32

Page

Orifices, piston cooling
Remove and clean 10-29, 15-37
Overflow valve, fuel, service 35-17

P

Pan, oil
Install 20-19
Pin bushing in rod
Install 10-28
Pin bushing, piston
Remove 10-26
Piston cooling orifices
Install 10-33
Remove and clean 10-29, 15-37
Piston pin bushing
Install 10-28
Remove 10-26
Piston rings
Check groove wear 10-17
Remove 10-13
Pistons
Bushing bore, clean and inspect 10-27
clean 10-14
Identification markings 10-10
Inspect pins and bushings 10-25
Install 10-38
Measure OD 10-18
Oil control ring groove, measure 10-19
Piston-to-liner clearance 10-19
Rings, remove 10-13
Pistons and connecting rods
Remove 10-8
Plugs, galley
Install 10-33
Pressure, engine compression
Test 105-18
Pressure, engine oil
Check 105-19
Pressure, intake manifold
Check 110-9, 110-10
Pump, fuel injection
Diagnose malfunctions 115-19
Install 35-22
Operation 115-18
Pump, oil
assembly 20-13
Install 20-17
Remove 20-14

Page

Push rods
Clean and inspect 05-29
Remove 05-11

R

Radiator cap
Pressure test 105-21
Rear oil seal
Handling precautions 15-43
Install 15-43
Remove (seal housing removed) 15-23
Replace (seal housing installed) 15-8
Rear oil seal housing
Install 15-41
Remove 15-23
Rear wear sleeve
Install 15-43
Remove (seal housing removed) 15-23
Replace (seal housing installed) 15-8
Relieve system pressure
Nippondenso 35-5
Ring gear, flywheel, replace 15-22
Rings, piston
Check groove wear 10-17
Rocker arm assembly
Assemble 05-15
Install 05-37
Rocker arm shaft assembly
Disassemble and inspect 05-13
Rod bearings
Inspect and measure 10-22
Rods, connecting
Inspect rod and cap 10-23
Install 10-38
TORQUE-TURN cap screws 10-41
Rods, connecting, and pistons
Remove 10-8

S

Seal housing, rear oil
Check runout 15-42
Sealant guidelines 04-2
Shaft, rocker arm assembly
Disassemble and inspect 05-13
Sleeve, front wear
Install (timing cover installed) 15-17, 16-24
Slow idle speed, adjust 115-23

INDX 7

Page

Specifications
Air intake system 110-1
Coolant 02-9
Engine test 105-3
Exhaust system 110-1
Fuel injection pump 115-2
Fuel system 115-1
Intake manifold pressure 110-8
Supply pump, fuel
Check operation 115-12
Diagnostics 115-10
Operation 115-8
Service 115-14
Synthetic Lubricants 02-4
System, crankcase ventilation
Check 100-6

T

Temperature compensation 100-1
Test specifications
Engine 105-3
Thermostats
Inspect and test 105-22
Install 25-21
Remove 25-20
Thrust bearing
Inspect 15-37
Specifications 15-34
Thrust plate, camshaft
Remove 16-13
Thrust spacer, camshaft
Remove 16-13
Timing gear cover
Install 15-45
Remove 15-19, 16-9
Torque values
Inch 01-1
Metric 01-2
TORQUE-TURN procedure
Connecting rod cap screws 10-41
Tune-up
Preliminary engine testing 100-2
Tune-Up Recommendations 100-3
Turbocharger
Axial End Play Bearing Test 30-17
Boost pressure at aneroid 110-8
Diagnostics 30-7, 110-5
Extending life 30-3

Page

Turbocharger—Continued
General information 110-6
How it is lubricated 110-6
Install 30-24
Prelube 30-23
Radial bearing clearance test 30-16
Replace center housing 30-23
Replace rotating assembly 30-23
Seven-step inspection 30-10
Turbocharger boost
Check 110-8

V

V-belt tension, check and adjust 25-24
Valve guides
Knurl 05-23
Valve, cylinder head
Make preliminary checks 05-16
Valve, fuel check
Replace 35-6
Valves
Check and adjust clearance 05-7
Clean 05-19
Clean guides 05-22
Inspect caps and rotators 05-18
Inspect springs 05-18
Install 05-34
Install oversize seat inserts 05-28
Make preliminary checks 05-16
Measure guides 05-22
Replace guides 05-23
Replace seat inserts 05-26
Seats, clean and inspect 05-24
Ventilation system, crankcase
Check 100-6

W

Water pump, heavy-duty
Assemble 25-12
Wear sleeve, front
Install 15-45
Install (timing cover installed) 15-17, 16-24
Remove (timing cover installed) 15-15
Remove (timing cover removed) 16-10
Wear sleeve, rear
Install 15-43
Remove (seal housing removed) 15-23

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