Series 400 6076 Diesel Engines Serial Number (500000-)

JOHN DEERE

COMPONENT TECHNICAL MANUAL

Series 400 6076 Diesel Engines Serial Number (500000-)

CTM42 (24MAR95) English

Deere Power Systems Group

CTM42 (24MAR95)

LITHO IN U.S.A.
ENGLISH

DCT

CTM42 24MAR95

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

JOHN DEERE ENGINE OWNER:

Don’t wait until you need warranty or other service to meet your local John Deere Engine Distributor or Service Dealer.

Learn who he is and where he is. At your first convenience, go meet him. He’ll want to get to know you and to learn what your needs might be.

UTILISATEURS DE MOTEURS JOHN DEERE:

N’attendez pas d’être obligé d’avoir recours a votre Concessionnaire ou Point de Service le plus proche pour vous adresser a lui.

Renseignez-vous des que possible pour l’identifier et le localiser. A la premiere occasion, prenez contact avec lui et faites-vous connaître. Il sera lui aussi heureux de faire votre connaissance et de savoir que vous pourrez compter sur lui le moment venu.

AN DEN BESITZER DES JOHN DEERE MOTORS:

Warten Sie nicht auf einen evt. Reparaturfall um den nächstgelegenen John Deere Händler kennen zu lernen.

Machen Sie sich bei ihm bekannt und nutzen Sie sein “Service Angebot”.

PROPRIETARIO DEL MOTORE JOHN DEERE:

Non aspetti fino a quando ha bisogno della garanzia o di un altro tipo di assistenza per incontrarsi con il Suo Concessionario che fornisce l’assistenza tecnica.

Impari a conoscere chi è e dove si trova. Alla Sua prima occasione cerchi d’incontrarlo. Egli desidera farsi conoscere e conoscere le Sue necessità.

PROPIETARIO DE EQUIPO JOHN DEERE:

No espere hasta necesitar servicio de garantía o de otro tipo para conocer a su Distribuidor de Motores John Deere o al Concesionario de Servicio.

Entérese de quién es, y dónde está situado. Cuando tenga un momento, vaya a visitarlo. A él le gustará conocerlo, y saber cuáles podrían ser sus necesidades.

JOHN DEERE MOTORÄGARE:

Vänta inte med att besöka Din John Deere återförsäljare till dess att Du behöver service eller garanti reparation.

Bekanta Dig med var han är och vem han är. Tag första tillfälle att besöka honom. Han vill också träffa Dig för att få veta vad Du behöver och hur han kan hjälpa Dig.

Dealer Presentation Sheet

JOHN DEERE DEALERS

IMPORTANT: The changes listed below make your current CTM obsolete. Discard CTM42, dated 02 NOV 92. Please copy this page and route through your service department.

• Engine application charts updated to include the latest product models. See ENGINE APPLICATION CHART in Group 01.

• Engine coolant information revised. See ENGINE COOLANT RECOMMENDATIONS in Group 02.

• Recommendation to use ONLY JDG23 Lifting Sling and Deere provided lifting straps for lifting engines. Also recommend the use of SAE Grade 8 or higher grade cap screws and Loctite 242 when installing engine lifting straps added to Group 03.

• New “TORQUE-TO-YIELD” instructions for tightening cylinder head cap screws marked “SPECIAL” added to Group 05.

• Valve lift specifications revised in Group 05 and Group 16.

• Piston ring end gap specifications for new pistons have been added to Group 10.

• A revised (longer) JDG681A Tap for cleaning deeper tapped cylinder head cap screw holes in block added to Group 10.

• Use of JDG796 Alignment Tool for installing crankshaft rear oil seal housing added to Group 15.

• Detailed instructions for inspection of the vibration damper and the crankshaft dowel pin added to Group 15.

• Timing gear cover and rear oil seal housing replacement procedures for 6076HRW33, 34, and 35 Engines (equipped with structural front frame/oil sump), with engine installed in vehicle added to Group 15.

• Camshaft lobe lift specifications and valve lift specifications revised in Group 16.

• Recommendation against disassembly of the engine oil pump added to Group 20.

• Instructions for installation of structural front frame/oil sump on engines used in 8000 series tractors added to Group 20.

• Information and specifications for fan drive assembly with press-fit fan spacer added to Group 25.

• Torque specifications for turbocharger oil inlet line added to Group 30.

• Information to help identify A-Series and P-Series fuel injection pumps and fuel supply pumps added to Group 35.

• Instructions for disassembly and assembly of the fuel check valve deleted from Group 35. The check valve has been replaced by a non-serviceable assembly.

• In Group 100 — Engine Tune-Up and Break-In, the paragraph titled ALTITUDE COMPENSATION GUIDELINE changed to EFFECTS OF TEMPERATURE AND ALTITUDE ON ENGINE PERFORMANCE.

• In Group 105, the recommended temperatures and engine speeds for checking engine oil pressure revised. The procedure to pressure test the cooling system and radiator cap also revised.

• Dynamic timing procedure using TIME TRAC® timing kit to accurately check and adjust (rotary) injection pump-to-engine timing added to Group 115.

• Instructions and specifications for check and adjustment of the fuel shut-off solenoid added to Group 115.

• Instructions for changing 6076 generator set engines with mechanical governor from rated speed of 1800 RPM (60 Hz) to 1500 RPM (50 Hz) added to Group 115.

RG,CTM42,DPS -19-21MAR95

ABOUT THIS MANUAL

This component technical manual covers the recommended repair procedure for 6076, 7.6 L (466 cu. in.) diesel engines produced in Waterloo, Iowa beginning with Engine Serial No. (500000—).

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

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

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

Read each module completely before performing any service.

RG,CTM42,G0,1 -19-14FEB95

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

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INDX

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HANDLE FLUIDS SAFELY—AVOID FIRES

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

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

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

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

TS227 -UN-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

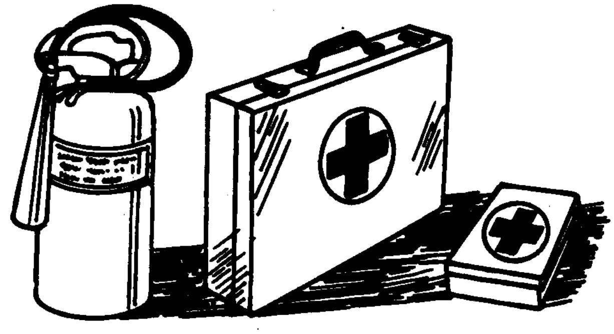
DX,SPARKS -19-03MAR93

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

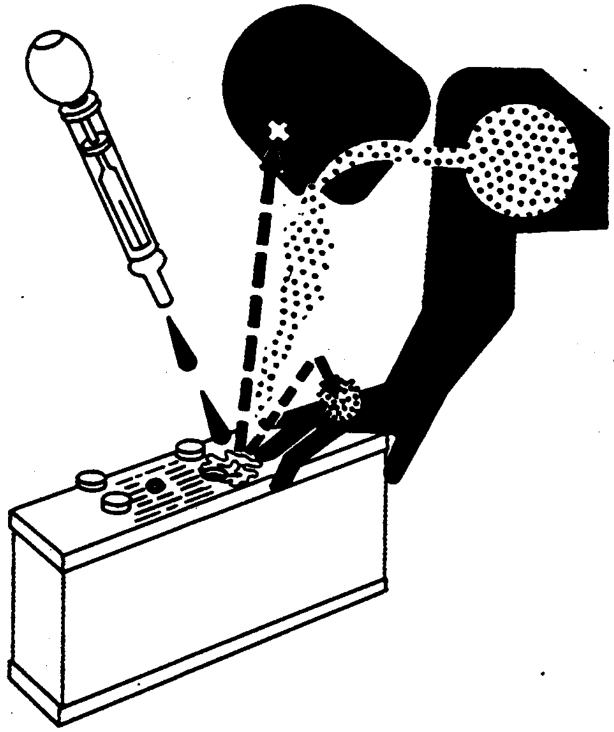
PREVENT ACID BURNS

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.

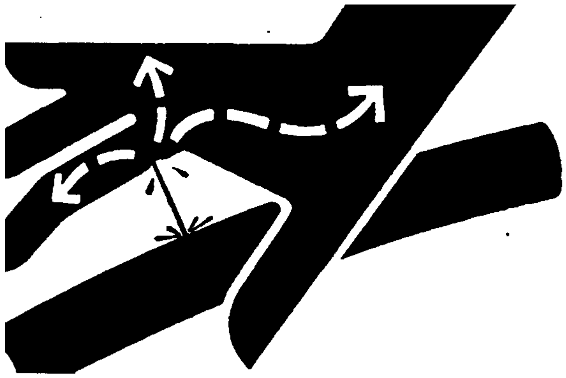
If acid is swallowed:
1. Do not induce vomiting.
2. Drink large amounts of water or milk, but do not exceed 2 L (2 quarts).
3. Get medical attention immediately.



TS203 -UN-23AUG88

DX,POISON -19-21APR93

AVOID HIGH-PRESSURE FLUIDS



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

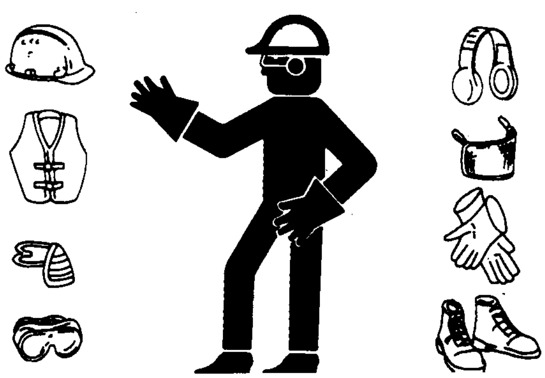
Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

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



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.

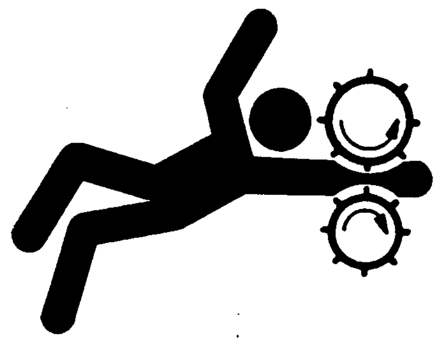
Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.

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.



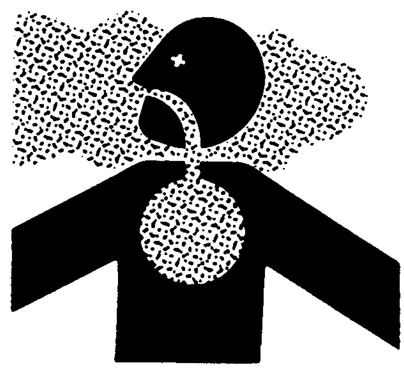
TS228 -UN-23AUG88

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.

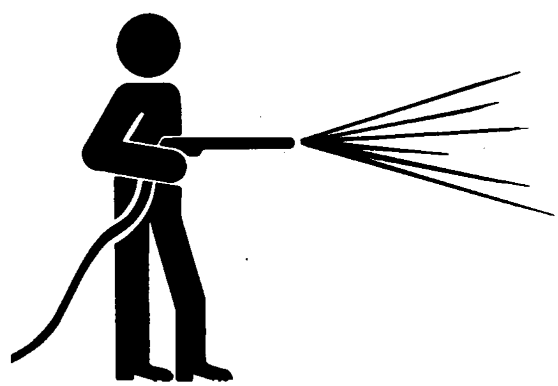


TS220 -UN-23AUG88

DX,AIR -19-04JUN90

WORK IN CLEAN AREA

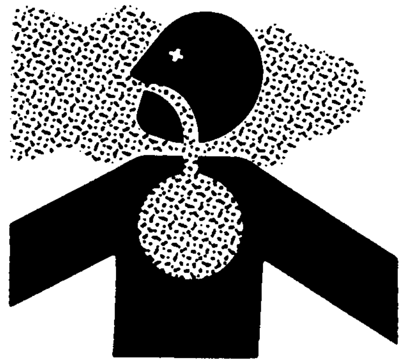
Before starting a job:
- Clean work area and machine.
- Make sure you have all necessary tools to do your job.
- Have the right parts on hand.
- Read all instructions thoroughly; do not attempt shortcuts.



T6642EJ -UN-18OCT88

DX,CLEAN -19-04JUN90

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

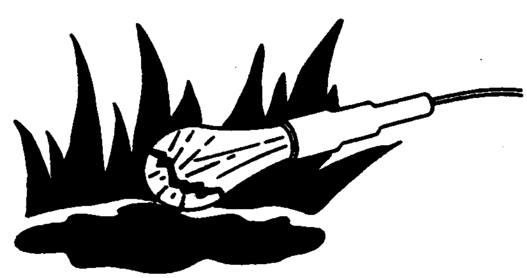
AVOID HEATING NEAR PRESSURIZED FLUID LINES

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

ILLUMINATE WORK AREA SAFELY



TS223 -UN-23AUG88

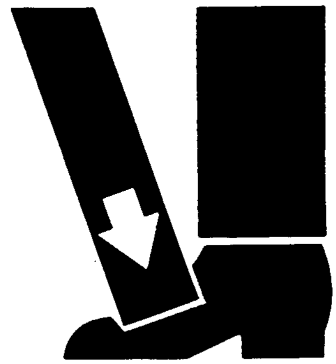
Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

DX,LIGHT -19-04JUN90

USE PROPER LIFTING EQUIPMENT

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

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



TS226 -UN-23AUG88

DX,LIFT -19-04JUN90

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

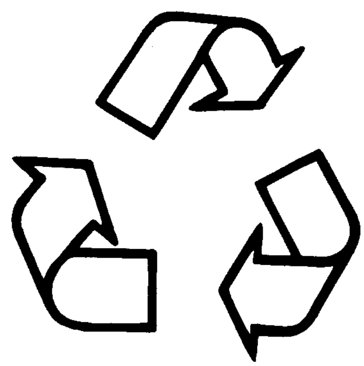
Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries.

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

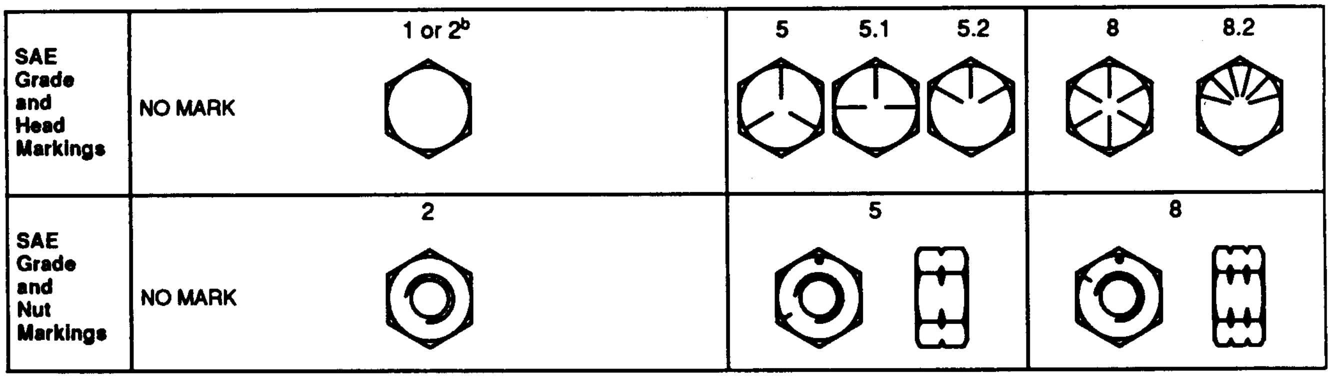
LIVE WITH SAFETY

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.

[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.*

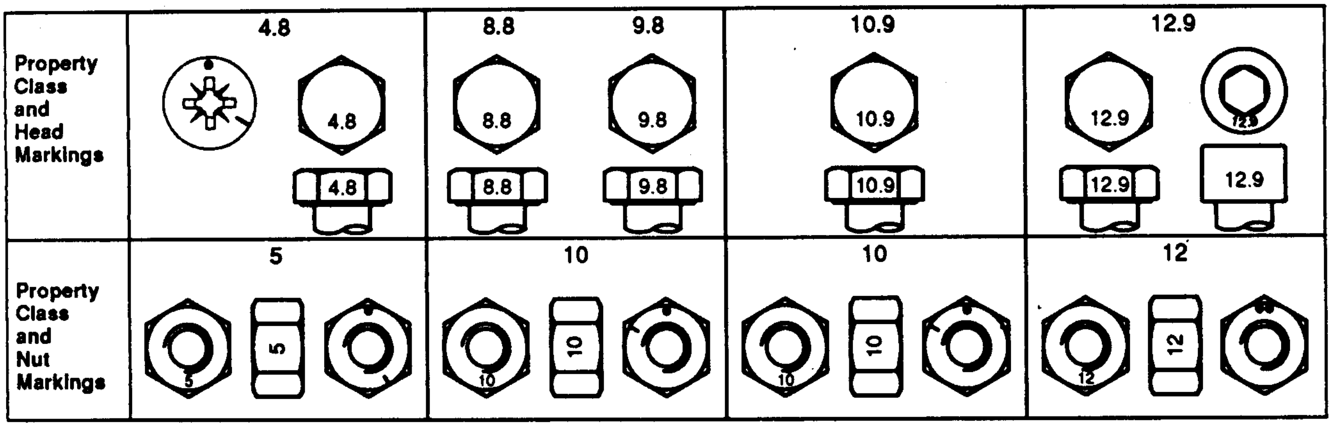
Fasteners should be replaced with the same or higher grade. If higher grade fasteners are used, these should only be tightened to the strength of the original.

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.

DX,TORQ1 -19-20JUL94

METRIC BOLT AND CAP SCREW TORQUE VALUES



TS1163 -19-04MAR91

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.

[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.

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.

DX,TORQ2 -19-20JUL94

ENGINE MODEL DESIGNATION

JOHN DEERE ENGINE MODEL—6076

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

6076HH030 Engine

6	Number of cylinders
076	Liter displacement
H	Aspiration code
H	End user code
030	Application code

Aspiration Code

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

End User Code

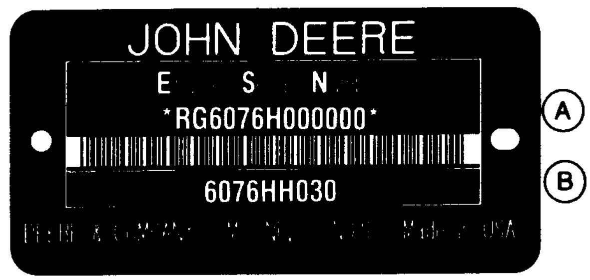
DW	Davenport
F	OEM
H	Harvester
N	Des Moines
RW	Tractor
T	Dubuque
Z	Zweibrucken

Application Code

30, 31, etc.

RG,CTM42,G1,1 -19-14FEB95

ENGINE SERIAL NUMBER PLATE INFORMATION



RG5804 -UN-12AUG91

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

- **Engine Serial Number (A)**

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

RG6076H000000

RG . . . . Factory code producing engine
6076H . . . . Engine Model Designation
000000 . . . . . Sequential Number

Factory Code Producing Engine

RG . . . . Waterloo Engine Works

Engine Model Designation

6076H . . . . . . Definition explained previously. (See ENGINE MODEL DESIGNATION.)

Sequential Number

000000 . . . . . 6-digit sequential number.

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

- **Engine Application Data (B)**

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

RG,CTM42,G1,2 -19-14FEB95

ENGINE APPLICATION CHART

John Deere Agricultural Equipment Applications

Machine Model No.	Engine Model
COMBINES—HARVESTER WORKS	
CTS Rice Combine*	6076HH030
2056	6076AZ031
2058	6076AZ030
2064	6076AZ030
2066	6076HZ031
9500*	6076HH031, 6076HH032
9600*	6076HH030, 6076HH031
COMBINES—ZWEIBRUCKEN	
2056 Hillmaster	6076AZ031
2058 Hillmaster	6076AZ030
2064 Hillmaster	6076AZ030
2066 Hillmaster	6076HZ031
FORAGE HARVESTERS—ZWEIBRUCKEN	
6610	6076HZ030
COTTON PICKER—DES MOINES	
9960**	6076AN030
9965	6067AN031
TRACTORS—WATERLOO	
7700	6076TRW31
7800	6076TRW30
8100	6076HRW33
8200	6076HRW34
8300	6076HRW35
8560 4-Wheel Drive***	6076HRW30
8570 4-Wheel Drive	6076HRW32

** Beginning with combine serial number (645000—)*

*** Above P.I.N. 4001*

**** Beginning with tractor serial number (5000—)*

RG,CTM42,G1,3 -19-16AUG94

01
5

ENGINE APPLICATION CHART—CONTINUED

John Deere Industrial Equipment Applications

Machine Model No.	Engine Model
LOADERS—DUBUQUE	
644G	6076ADW30
644GH	6076ADW32
644G Dual Power	6076ADW33
MOTOR GRADERS—DUBUQUE	
770B	6076TDW30
770BH	6076ADW31
772BH	6076ADW31
EXCAVATORS—DUBUQUE	
892E	6076AT030
BULLDOZERS—DUBUQUE	
850C	6076AT032

RG,CTM42,G1,3B -19-16AUG94

OEM APPLICATIONS

Machine Model No.	Engine Model
Marine	6076AFM030
OEM Repower	6076AF030 6076HF030 6076TF030

RG,CTM42,G1,3A -19-16AUG94

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 -19-22FEB95

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 -19-22FEB95

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:

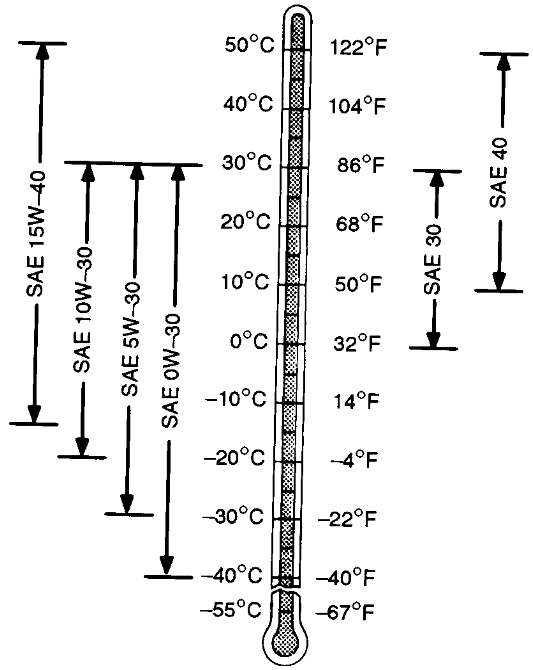
- John Deere TORQ-GARD SUPREME®

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

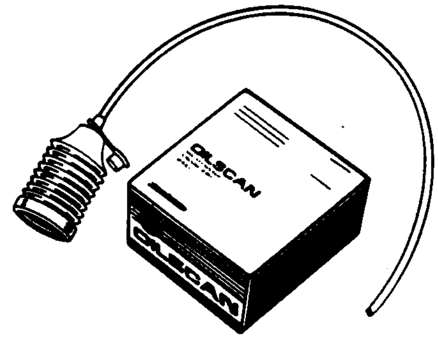
DX,ENOIL -19-16SEP94

OILSCAN® AND COOLSCAN™

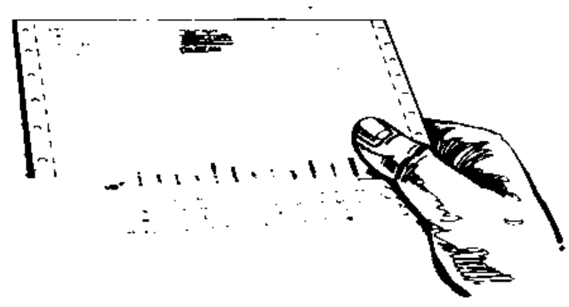
OILSCAN and COOLSCAN are John Deere sampling programs to help you monitor machine performance and identify potential problems before they cause serious damage.

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

GREASE

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

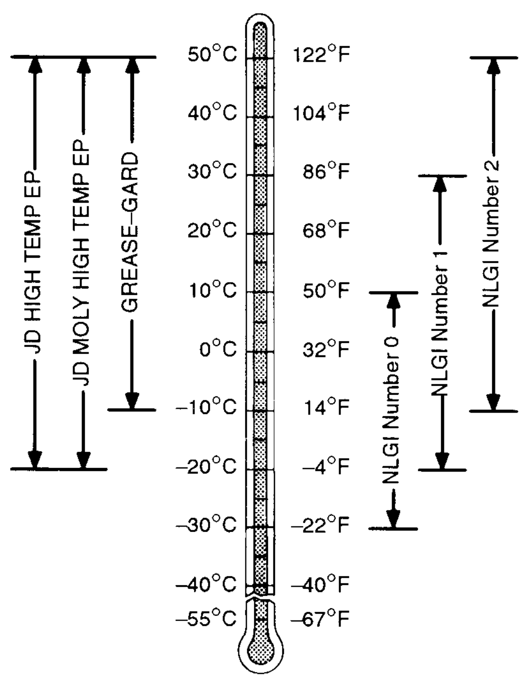
The following greases are preferred:

- 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.



TS1622 -UN-02NOV94

DX,GREA1 -19-02NOV94

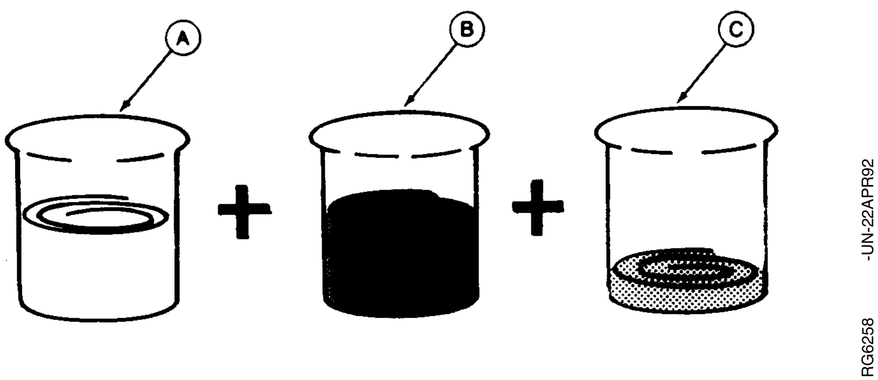
ALTERNATIVE AND SYNTHETIC LUBRICANTS

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

ENGINE COOLANT REQUIREMENTS



A—Quality Water
B—Ethylene Glycol Concentrate (Antifreeze)
C—Supplemental Coolant Additives (SCA's)

Engine Coolant

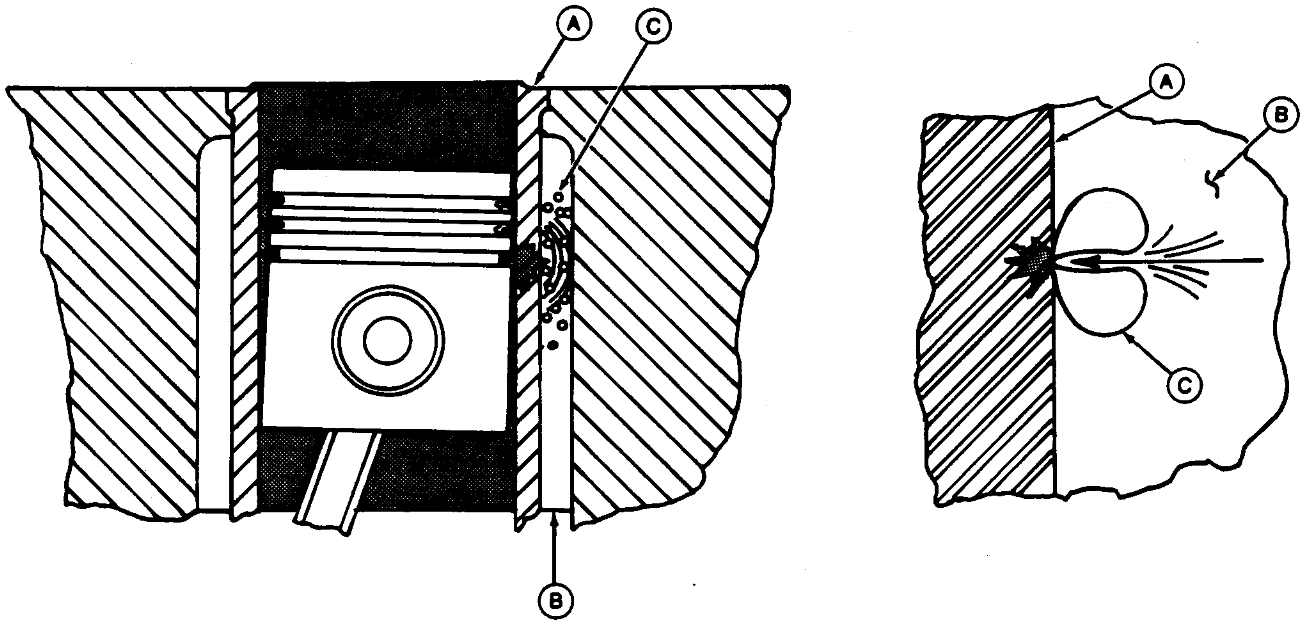
To meet cooling system protection requirements, the coolant MUST consist of a 50/50 mixture of quality water and ethylene glycol concentrate (antifreeze). Supplemental coolant additives (SCA's) must be added to this mixture. Add 3% (by volume) TY16004 or TY16005 Liquid Coolant Conditioner. If an equivalent product is used, always follow the supplier's recommendations printed on the container. See ENGINE COOLANT SPECIFICATIONS, later in this section, 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 -19-10OCT94

ENGINE COOLANT REQUIREMENTS—CONTINUED



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 -19-10OCT94

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 Prediluted Antifreeze/Summer Coolant permits extended service life.

• 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 -19-23FEB95

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 -19-23FEB95

ENGINE COOLANT SPECIFICATIONS—CONTINUED

RG7298 -UN-13FEB95

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.

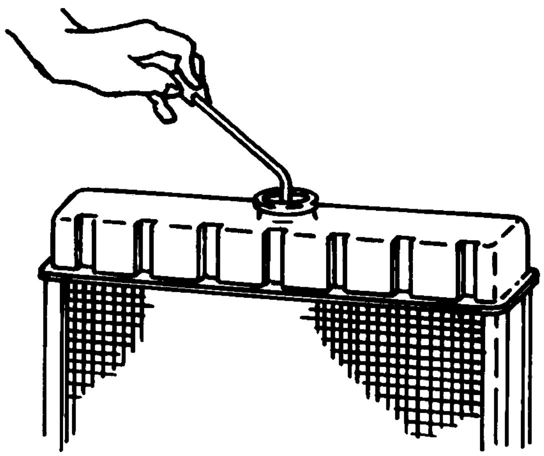
DO NOT use soluble oil.

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.

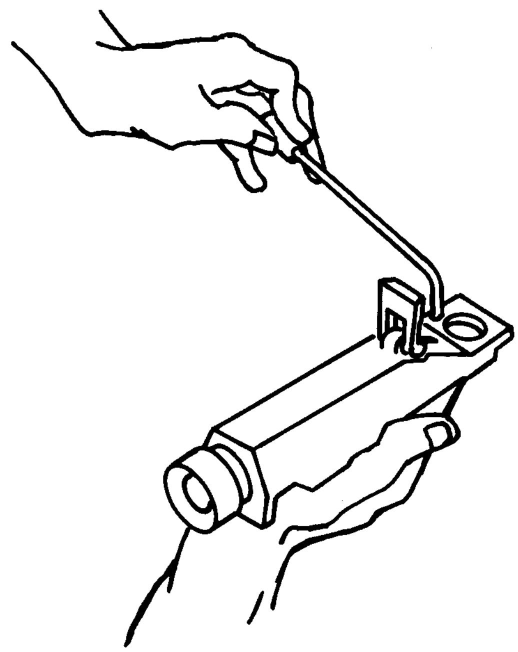
Contact your authorized servicing dealer or engine distributor, if there are further questions.

RG,COOL3A,CTM -19-23FEB95

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



RG6261 -UN-22APR92



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 -19-23FEB95

OPERATING IN TROPICAL CONDITIONS

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

Only when no glycol base engine coolant (antifreeze) is available, use distilled, deionized, or demineralized water meeting the quality specifications on the previous page. Add to the water an initial charge of supplemental coolant additives, such as John Deere Liquid Coolant Conditioner or equivalent. The recommended concentration of John Deere Liquid Coolant Conditioner must be doubled to 6% (60 mL per Liter of cooling system capacity) by volume when used with water only (no antifreeze). Double other manufacturer's recommended concentration.

IMPORTANT: Never use water as the engine coolant without an initial charge of supplemental coolant additives. Using water alone will cause severe corrosion and pitting damage to vital engine parts. Drain system and refill cooling system as specified in your vehicle operator's manual.

RG,COOL6,CTM -19-23FEB95

FLUSH AND SERVICE COOLING SYSTEM


TS281 -UN-23AUG88

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

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

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

The ethylene glycol base (antifreeze) can become depleted of 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

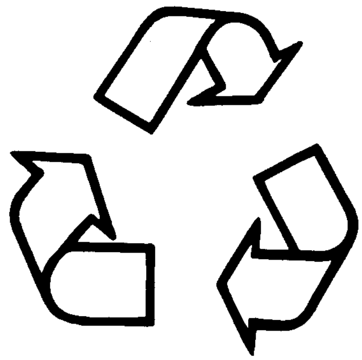
DISPOSING OF COOLANT

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.

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.

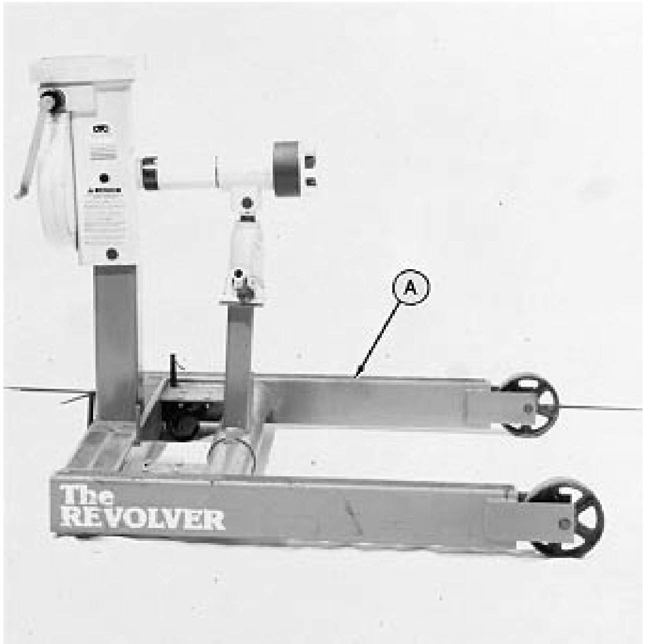


TS1133 -UN-26NOV90

RG,COOL5 -19-01SEP94

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 170 N·m (125 lb-ft).

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

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

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

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

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

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

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

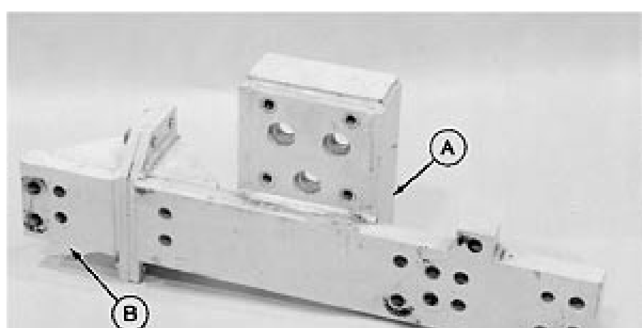
LOCTITE® is a registered trademark of Loctite Corporation.

S11,2000,DZ -19-21MAR95

INSTALL 400 SERIES ADAPTERS ON REPAIR STAND

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

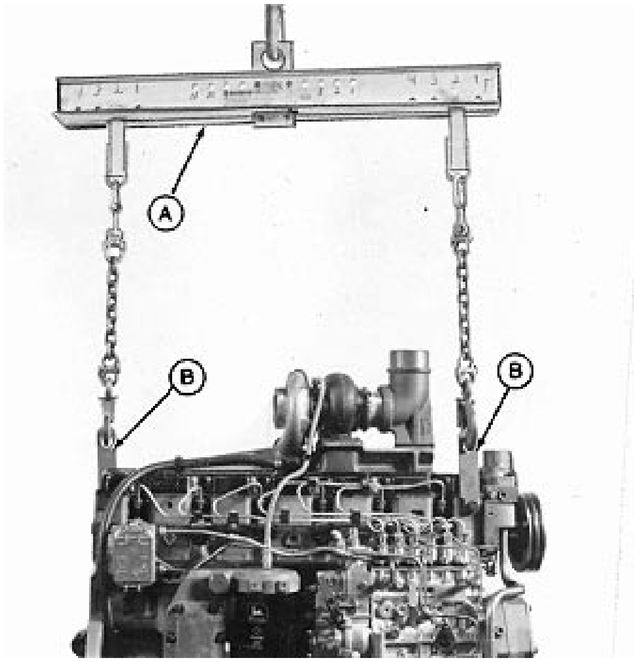
2. Attach the No. 51400 end adapter (B) to the engine adapter, using four 5/8-11 x 2 in. SAE Grade 8 cap screws. Tighten screws to 135 N·m (100 lb-ft).



RG4930 -UN-15DEC88

S11,2000,FB -19-08MAR94

ENGINE LIFTING PROCEDURE



RG5788 -UN-09AUG91

CAUTION: Use of JDG23 Engine Lifting Sling (A) is the ONLY APPROVED method for lifting engine. Use extreme caution when lifting and NEVER permit any part of the body to be positioned under an engine being lifted or suspended.

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

IMPORTANT: Ensure that engine lifting straps are secured to engine with SAE Grade 8 (or higher) cap screws. Apply LOCTITE 242 Thread Lock and Sealer and tighten cap screws to 170 N·m (125 lb-ft).

NOTE: If engine does not have lifting straps, they can be procured through service parts network. USE ONLY lifting straps supplied by DEERE.

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

RG,CTM42,G3,1 -19-23MAR95

CLEAN ENGINE

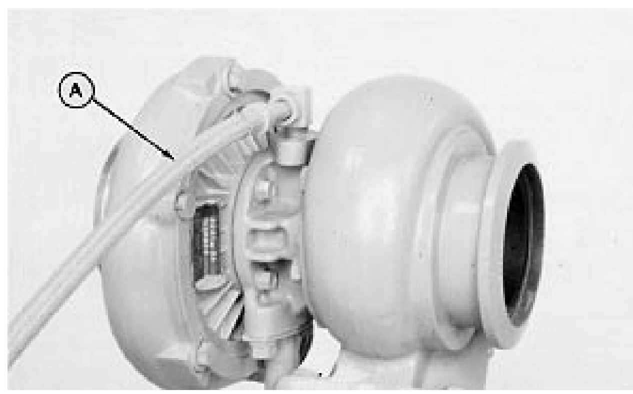
1. Cap or plug all openings on engine. If electrical components (starter, alternator, etc.) are not removed prior to cleaning, cover with plastic and tape securely to prevent moisture from entering.

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

DISCONNECT TURBOCHARGER OIL INLET LINE



RG5323 -UN-06DEC88

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

IMPORTANT: When servicing 6076 Engines on a rollover stand, disconnect turbocharger oil inlet line (A) from oil conditioning housing or turbocharger before rolling engine over. Failure to do so may cause a hydraulic lock upon starting engine. Hydraulic lock may cause possible engine failure.

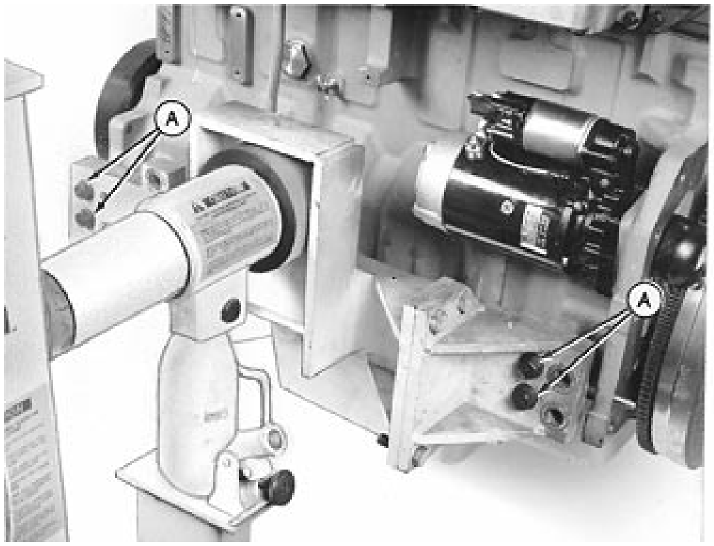
Hydraulic lock occurs when trapped oil in the oil filter housing drains through the turbocharger, the exhaust and intake manifolds, and then into the cylinder head.

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

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

RG,CTM42,G03,3 -19-24SEP91

MOUNT ENGINE ON REPAIR STAND



RG5965 -UN-05SEP91

NOTE: If starting motor is to be removed from engine, remove before mounting engine onto repair stand.

CAUTION: Never remove the overhead lifting equipment from the equipment until the engine is securely mounted to the stand and all mounting hardware is tightened to specified values. Always release the overhead lifting equipment slowly.

1. Mount the starter side of the engine to the engine adapter with four 5/8-11UNC Flanged-head, SAE Grade 8 or higher grade cap screws (A).

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

3. Carefully remove lift sling from engine.

RG,CTM42,G3,2 -19-21MAR95

6076 ENGINE DISASSEMBLY SEQUENCE

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

NOTE: Remove starting motor before mounting engine into repair stand.

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

2. Remove turbocharger oil inlet line.

3. Remove breather hose.

4. Remove fan pulley and water manifold assembly.

5. Remove turbocharger exhaust elbow and connector. Remove turbocharger.

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

6. Remove rocker arm cover.

7. Remove rocker arm assembly and push rods. Identify parts for re-assembly.

8. Remove alternator and mounting brackets.

9. Remove front crankshaft pulley and damper assembly.

10. Remove fuel injection lines and injection nozzles.

11. Remove water pump.

12. Remove engine oil filter and oil conditioning housing.

13. Remove injection pump gear cover and remove injection pump. Remove fuel filter and mounting base.

14. On 6076A Engines, remove aftercooler cover and aftercooler assembly.

15. Remove exhaust manifold and air intake manifold.

16. Remove turbocharger oil return line.

17. Remove cylinder head with valve assembly. Remove head gasket.

18. On SAE No. 3 flywheel housings, remove flywheel then remove flywheel housing.

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

20. Roll engine over and remove oil pan and engine oil pump assembly.

21. Remove front timing gear cover.

22. Rotate engine to vertical position. Remove pistons and connecting rods. Identify for re-assembly. Perform wear checks with PLASTIGAGE™.

NOTE: Perform wear check on main bearing surfaces with PLASTIGAGE, when removing main bearing caps.

23. Remove main bearing caps. Remove crankshaft and main bearings. Identify for re-assembly.

24. Remove camshaft and cam followers. Identify for re-assembly.

25. Rotate engine and remove liners and their O-ring seals. Mark liners for reassembly in same bore from which removed.

26. Remove piston cooling orifices.

27. Remove cylinder block plugs and engine serial number plate, if block is to be put in a “hot tank”.

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

PLASTIGAGE™ is a trademark of the Perfect Circle Division of Dana Corp.

RG,CTM42,G4,1 -19-24SEP91

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.

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

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

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

—Cap Screws: injection pump access cover, tachometer drive, oil filler inlet, flywheel, water outlet manifold, engine lifting straps.

—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.

—Oil filter adapter.

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

• **LOCTITE 515 Flexible Sealant:**

TY6304 50 ml. (1.7 oz) bottle

—Water pump and water manifold gaskets

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

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

—Pipe plugs: cylinder block (water manifold), thermostat housing, air intake manifold, tachometer drive, water pump, fan drive, fuel filter drain and bleed.

—Drain valves: water pump and block

—Injection pump governor cover fitting (fuel return)

—Threaded nipples and elbows in water pump housing

—Temperature sending unit

—Oil pan (drain hose and drain valve)

—Connectors: turbocharger oil supply and drain lines.

—Adapter fitting for turbocharger oil inlet line

• **LOCTITE 609 Retaining Compound (green):**

T43515 50 ml. (1.7 oz) bottle

—Crankshaft rear oil seal/wear sleeve, crankshaft front wear sleeve

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

TY6299 227 g (8 oz) container

—Timing gear cover-to oil pan

—Flywheel housing-to-oil pan

—Camshaft bore steel cap plug

RG,CTM42,G4,2 -19-17MAR95

SEALANT APPLICATION GUIDELINES—CONTINUED

• **PT569 NEVER-SEEZ®** COMPOUND:

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

—Cap Screws: exhaust manifold, turbocharger-to-exhaust manifold.

—Gland nut threads and fuel injection nozzle barrel.

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

AR31790 118 ml (4 oz)

—Rocker arm cover gasket

• **FEL-PRO®** C-670 Molybdenum Disulfide Paste

—Camshaft nose (gear installation)

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

TEFLON® is a registered trademark of DuPont Co.

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

FEL-PRO® is a registered trademark of FEL-PRO.

RG,CTM42,G4,5 -19-16AUG94

6076 ENGINE ASSEMBLY SEQUENCE

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

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

2. Install clean piston cooling orifices.

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

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

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

5. If installing new piston/liner kits, assemble the respective connecting rods.

6. Install engine oil pump assembly.

7. Install crankshaft rear oil seal housing, oil seal, and wear sleeve.

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

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

10. Install fuel injection pump and drive gear.

11. Install engine oil conditioning assembly, if removed.

12. Install flywheels:

    SAE 1 or SAE 2: Flywheel goes on before housing.

    SAE 3: Housing goes on before flywheel.

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

14. Install rocker arm cover. Install breather hose.

15. Install exhaust manifold and water manifold.

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

17. Install air intake manifold.

18. Install aftercooler assembly on 6076A Engines.

19. Install turbocharger with elbow and oil lines.

20. Install water pump.

21. Install injection nozzles and line assembly.

22. Install front pulley and damper as an assembly.

23. Install alternator. Install fan pulley assembly.

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

25. Fill engine with clean oil and the proper coolant. Install dipstick.

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

RG,CTM42,G4,3 -19-14FEB95

SPECIAL OR ESSENTIAL TOOLS

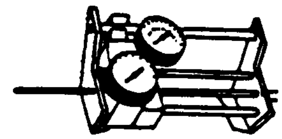
NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-05JUN91

RG5061 -UN-23AUG88

Spring Compression Tester D01168AA

Test valve spring compression.

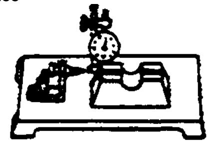


S53,D01168,AA -19-13MAR92

RG5062 -UN-23AUG88

Valve Inspection Center D05058ST

Check valves for out-of round.

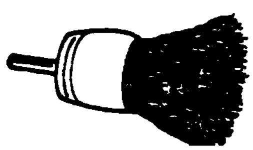


S53,D05058,ST -19-02APR87

RG5063 -UN-23AUG88

End Brush D17024BR

Clean valve seat and bores.



S53,D17024,BR -19-26JAN87

RG5099 -UN-23AUG88

Nozzle Thread Cleaning Brush D17030BR

Used to clean nozzle threads in cylinder head.

S53,D17030,BR -19-16FEB87

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.

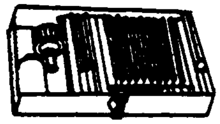
RG6246 -UN-27MAR92

RG,D17526CI -19-29OCT92

RG5064 -UN-23AUG88

Valve Guide Knurler Kit JT05949

Knurl valve guides.



S53,D20002,WI -19-16SEP92

RG5065 -UN-23AUG88

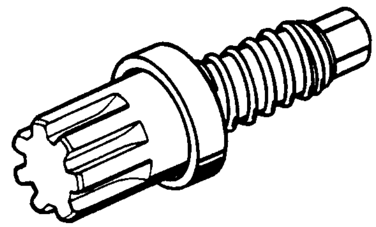
Valve Seat Pilot Driver JDE7

Install replacement valve seat inserts. Use with JDG605.

S53,JDE7A -19-04FEB93

Flywheel Turning Tool JDG820

Used to rotate engine to check damper radial runout and time engine. JDE81-1 may be used also if JDG820 is not available.



RG7056 -UN-10AUG94

RG,JDG820 -19-14FEB95

RG5068 -UN-23AUG88

Timing Pin JDE81-4

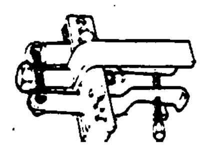
Lock engine at TDC when timing valve train, adjusting valve clearance, and installing fuel injection pump. Use with JDG820 and JDE81-1 Flywheel Turning Tools.

RG,JDE814,86 -19-14FEB95

RG5071 -UN-23AUG88

Valve Seat Puller JDE41296

Remove valve seats.

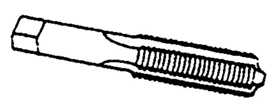


S53,JDE,41296 -19-26JAN87

RG5100 -UN-23AUG88

Tap JDF5

Used to restore nozzle threads in cylinder head.

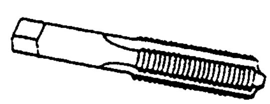


S53,JDF5 -19-08MAR94

RG5100 -UN-23AUG88

Tap JDG681A

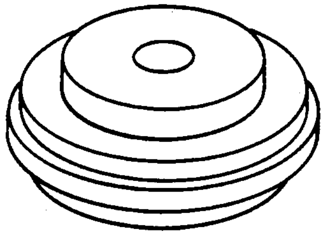
Used to restore threaded holes in cylinder block for cylinder head cap screws.



RG,JDG681A -19-17MAR95

Valve Seat Installer JDG605

Install intake and exhaust valve seat inserts. Use with JDE7.



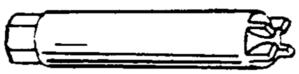
RG5240 -UN-23AUG88

S53,JDG605 -19-25MAR91

RG5289 -UN-23AUG88

Nozzle Seat Reamer JDG609

Used to clean carbon from nozzle seats in cylinder head.



S53,JDG609 -19-02DEC87

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 -19-08FEB94

OTHER MATERIAL

Name	Use
AR44402 Valve Stem Lubricant	Lubricate valve stems.
PT569 NEVER-SEEZ Compound	Exhaust manifold and cylinder head front plate cap screws.
AR31790 SCOTCH-GRIP Plastic Adhesive	Rocker arm cover gasket.

S11,2505,BW -19-30MAR93

CYLINDER HEAD AND VALVES SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Valve Lift at 0.00 mm (in.) Clearance		
Intake	13.53—13.71 mm (0.533—0.540 in.)	12.65 mm (0.498 in.)
Exhaust	14.52—14.70 mm (0.572—0.579 in.)	13.64 mm (0.537 in.)
Valve Clearance With Engine Cold (Rocker Arm-to-Valve Tip):		
Intake	0.331—0.431 mm (0.013—0.017 in.)	——
Exhaust	0.457—0.559 mm (0.018—0.022 in.)	——
Valve Spring Compressed Height:		
Valve Closed-Intake	52.5 mm @ 345—399 N (2.07 in. @ 78—90 lb-force)	——
Exhaust	54.5 mm @ 284—338 N (2.15 in. @ 64—76 lb-force)	——
Valve Open-Intake	38.1 mm @ 810—880 N (1.50 in. @ 182—198 lb-force)	——
Exhaust	38.5 mm @ 797—867 N (1.52 in. @ 179—195 lb-force)	——
Valve Head OD:		
Intake	50.87—51.13 mm (2.003—2.013 in.)	——
Exhaust	46.87—47.13 mm (1.845—1.856 in.)	——
Valve Stem OD:		
Exhaust	9.44—9.46 mm (0.3717—0.3724 in.)	——
Intake	9.46—9.49 mm (0.3724—0.3736 in.)	——
Oversize Valve (Stem) Available	0.08, 0.38, 0.76 mm (0.003, 0.015, 0.030 in.)	——
Valve Guide ID	9.51—9.54 mm (0.3745—0.3755 in.)	——
Valve Stem-to-Guide Clearance:		
Exhaust	0.051—0.102 mm (0.002—0.004 in.)	——
Intake	0.025—0.076 mm (0.001—0.003 in.)	——
Valve Face Angle	29.25° ±0.25°	——
Valve Seat Angle	30° ±0.50°	——
Valve Seat Width:		
Exhaust	2.0—3.8 mm (0.79—0.150 in.)	——
Intake	1.4—3.8 mm (0.055—0.150 in.)	——
Valve Seat Concentricity with Guide	0.051 mm (0.0020 in.)	——
Valve Recess in Cylinder Head:		
Intake	3.35—3.86 mm (0.132—0.152 in.)	4.62 mm (0.182 in.)
Exhaust	1.19—1.70 mm (0.047—0.067 in.)	2.46 mm (0.097 in.)
Maximum Valve Seat Runout	0.051 mm (0.0020 in.)	——
Maximum Valve Face Runout	0.051 mm (0.0020 in.)	——

RG,CTM42,G5,1 -19-14FEB95

CYLINDER HEAD AND VALVES SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Cylinder Firing Order	1-5-3-6-2-4	——
Rocker Arm ID	19.07—19.10 mm (0.7507—0.7520 in.)	——
Rocker Arm Shaft OD	19.01—19.05 mm (0.7484—0.7500 in.)	——
Cylinder Liner Height Above Block	0.050—0.127 mm (0.002—0.005 in.)	——
Cylinder Head Reconditioning:		
Thickness of Head (Rocker Arm Cover Gasket Rail-to-Combustion Face)	155.45—155.71 mm (6.120—6.130 in.)	——
Minimum Acceptable Thickness	154.69 mm (6.09 in.)	——
Maximum Acceptable Head Out-of-Flat (Entire Length or Width)	0.102 mm (0.0040 in.)	——
Combustion Face Surface Finish (Surface Grind Only)	60—110AA	——
Maximum Wave Depth	0.008 mm (0.0003 in.)	——
Maximum Material Removal for Resurfacing Head	0.762 mm (0.0300 in.)	——

RG,CTM42,G5,2 -19-14FEB95

CYLINDER HEAD AND VALVES SPECIFICATIONS—CONTINUED

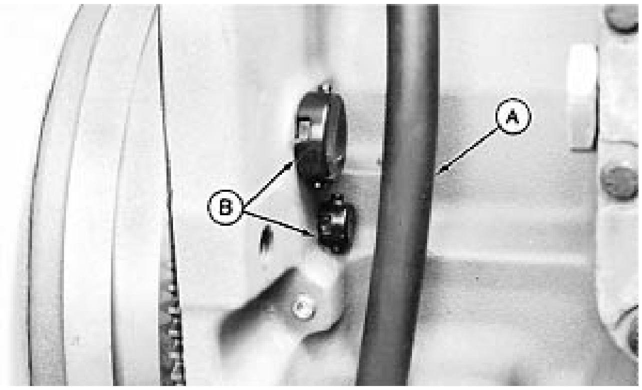
TORQUES

Cylinder Head-to-Cylinder Block:
Refer to TORQUE-TURN FLANGED-HEAD CAP SCREWS—GRADE 180 and TORQUE-TO-YIELD FLANGED-HEAD CAP SCREWS—GRADE 180 MARKED “SPECIAL”, later in this group.

Rocker Arm Shaft Clamps	75 N·m (55 lb-ft)
Rocker Arm Cover-to-Cylinder Head	8 N·m (6 lb-ft) (72 lb-in.)
Intake Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Exhaust Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Valve Adjusting Screw Locknut	27 N·m (20 lb-ft)

RG,CTM42,G5,33A-19-14FEB95

CHECK AND ADJUST VALVE CLEARANCE



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

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

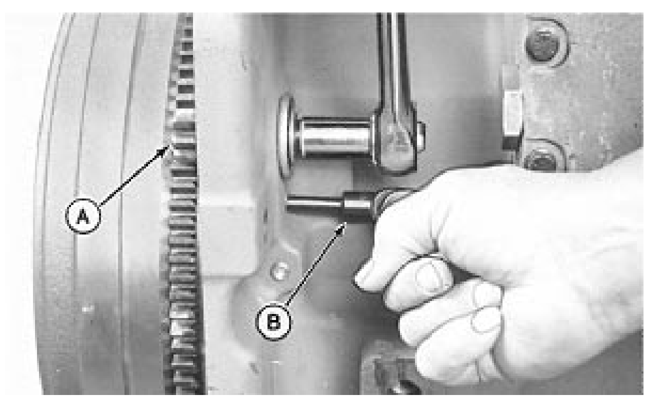
NOTE: Valve clearance should be checked with engine cold.

1. Remove rocker arm cover and ventilator hose (A).

2. Remove plastic plugs (B).

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.

RG,CTM42,G5,5 -19-03MAY93

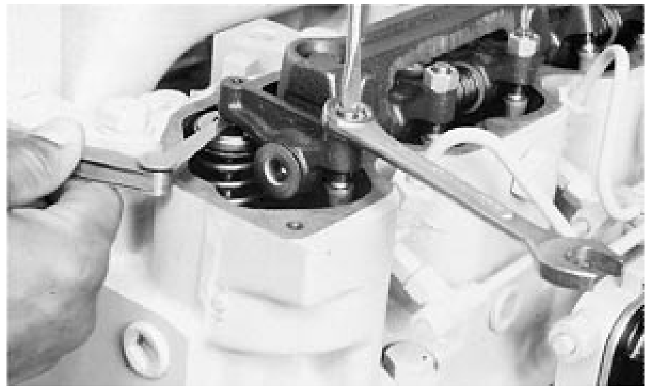


3. Rotate engine with the JDE81-1 or JDG820 Flywheel Turning Tool (A) until JDE81-4 Timing Pin (B) engages timing hole in flywheel.

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.”

RG,CTM42,G5,26 -19-14FEB95

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.

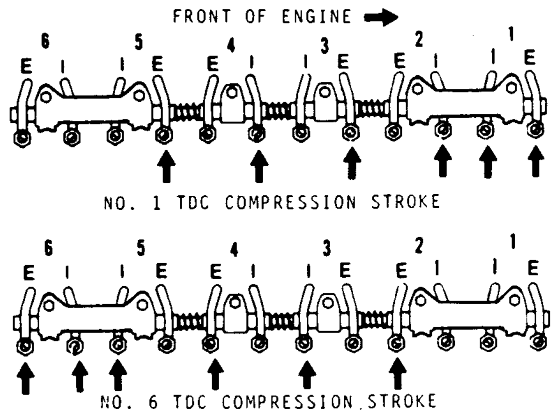


RG5241 -UN-06DEC88

VALVE CLEARANCE SPECIFICATIONS

Intake Valves	0.331-0.431 mm (0.013-0.017 in.)
Exhaust Valves	0.457-0.559 mm (0.018-0.022 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.



RG4295 -19-21AUG91

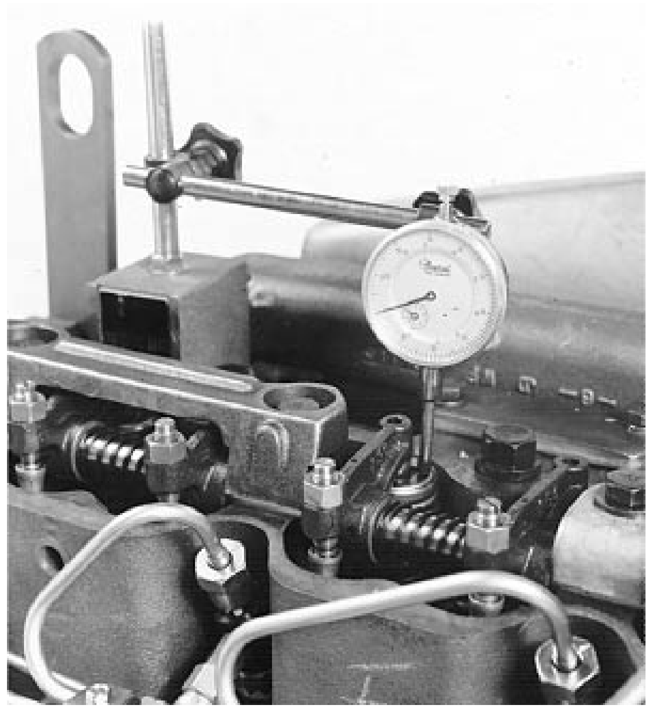
6. Rotate flywheel 360˚ until No. 6 piston is at “TDC” of its compression stroke. Rocker arms for No. 6 piston should be loose.

7. Check and adjust (as needed) valve clearance to the same specifications on Nos. 2, 4 and 6 exhaust 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.

S11,2005,NB -19-14FEB95

CHECK VALVE LIFT



RG5789 -UN-09AUG91

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

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

1. Remove turbocharger oil inlet line clamp and rocker arm cover. Loosen locknut on rocker arm. Set valve clearance at 0.00 mm (in.). Tighten locknut.

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

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

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

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

VALVE LIFT SPECIFICATION AT 0.00 MM (IN.) CLEARANCE

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

6. Adjust valve clearance to specification after measuring lift. (See CHECK AND ADJUST VALVE CLEARANCE, earlier in this group.)

7. Repeat procedure on all remaining valves.

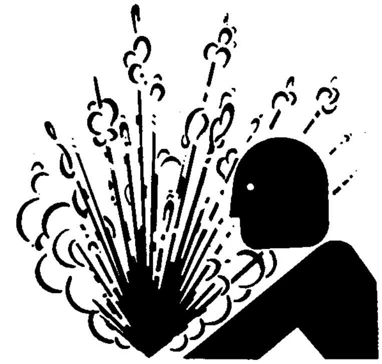
RG,CTM42,G5,4 -19-14FEB95

REMOVE CYLINDER HEAD

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

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

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



TS281 -UN-23AUG88

Remove rocker arm cover, if not previously done.

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

2. Remove water manifold (A) and all coolant piping. (See Cooling System, Group 25.)

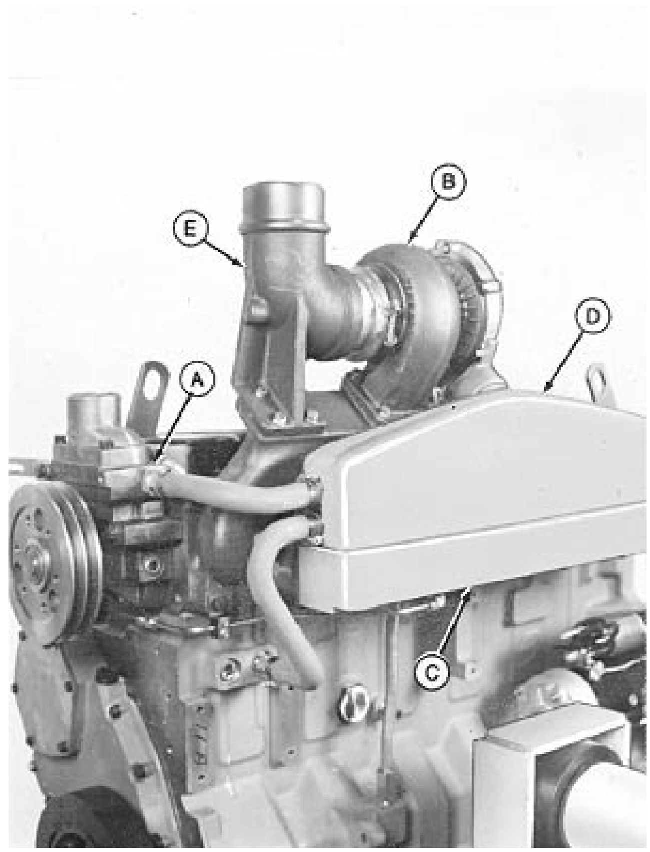
3. Remove turbocharger (B) and exhaust elbow (E). (See Air Intake and Exhaust System, Group 30.)

4. On 6076A Engines, remove aftercooler assembly (D).

NOTE: Remove exhaust manifold before removing intake manifold on 6076HRW33, 34, and 35 engines.

5. Remove air intake manifold (C). (Group 30.)

6. Remove exhaust manifold. (Group 30.)



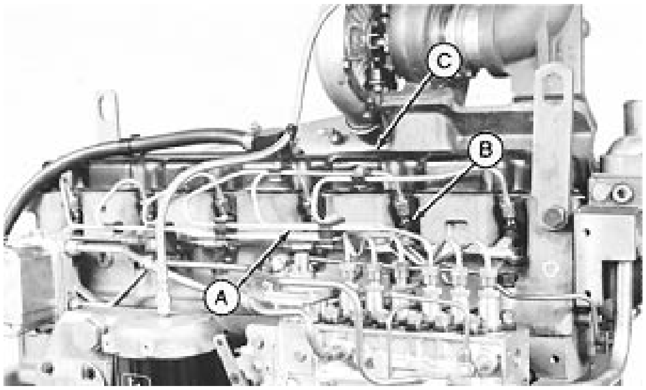
RG5792 -UN-09AUG91

A—Water Manifold
B—Turbocharger
C—Intake Manifold
D—Aftercooler Assembly
E—Exhaust Elbow

RG,CTM42,G5,6 -19-17MAR95

7. Remove fuel injection lines (A) and nozzles (B). (See Fuel System, Group 35.)

8. Remove rocker arm cover (C) and ventilator outlet hose assembly.

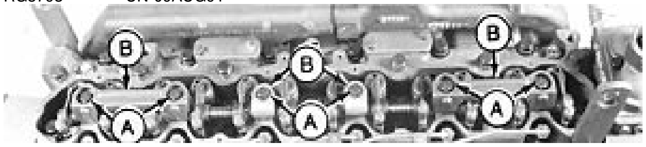


RG5887 -UN-13AUG91

RG,CTM42,G5,7 -19-22AUG91

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

RG5793 -UN-09AUG91



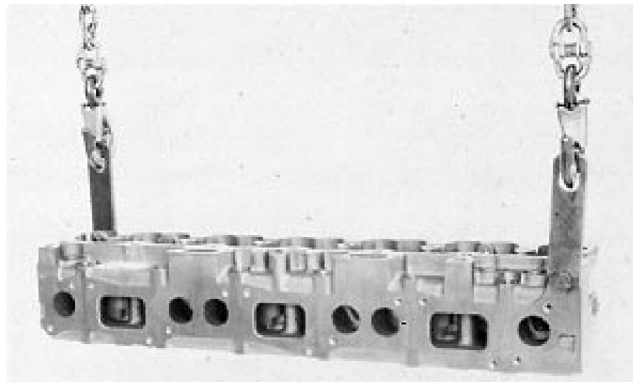
10. Remove all 12 push rods and identify for reassembly.

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

RG5794 -UN-09AUG91

RG,CTM42,G5,8 -19-28OCT92

11. Remove all 26 cylinder head cap screws.



RG5245 -UN-06DEC88

NOTE: If cylinder head gasket failed, check and record each cylinder head cap screw torque before removing. Make a reference mark (in-line) on socket and cylinder head surface. Loosen cap screw at least 1/2 turn. Retighten cap screw (using torque wrench) until reference marks align, and record torque.

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.

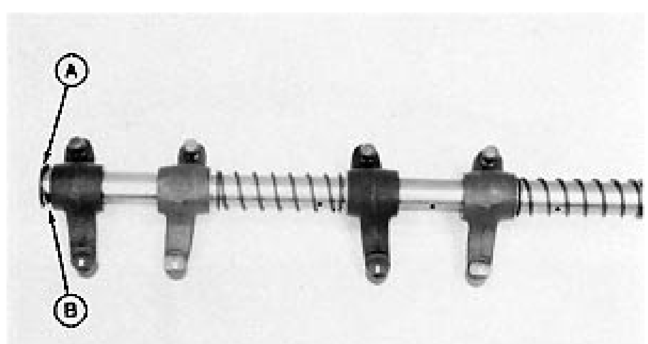
05
12

12. Remove cylinder head 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 later in this group.

S11,2005,MT -19-16AUG94

DISASSEMBLE AND INSPECT ROCKER ARM SHAFT ASSEMBLY



RG3801 -UN-23FEB89

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

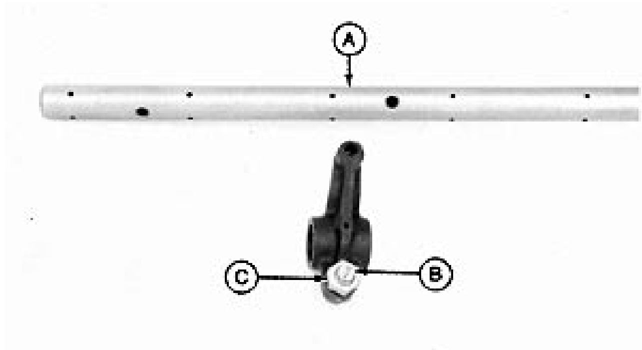
1. Remove plugs (A) and washers (B) from ends of rocker arm shaft.

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.

S11,2005,HY1 -19-07AUG91

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

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



ROCKER ARM ASSEMBLY SPECIFICATIONS

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

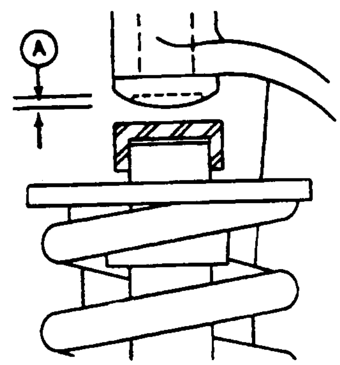
4. Check rocker arm adjusting nut (C) and screw (B) for damage. Visually inspect rocker arm for hairline cracks. Replace if necessary.

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

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

S11,2005,MB -19-28OCT92

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.

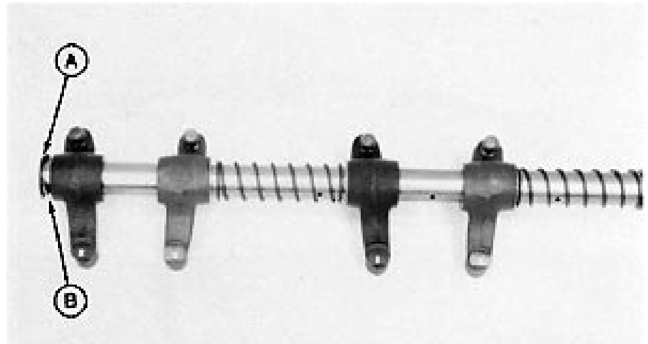
8. Roll rocker arm shaft and push rods on a flat surface to check for bends or distortion. Replace parts as necessary.

S11,0401,N -19-05FEB85

ASSEMBLE ROCKER ARM SHAFT ASSEMBLY

1. Assemble parts on rocker arm shaft opposite removal procedure.

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



RG3801 -UN-23FEB89

S11,0401,O -19-08MAR94

MEASURE VALVE RECESS

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

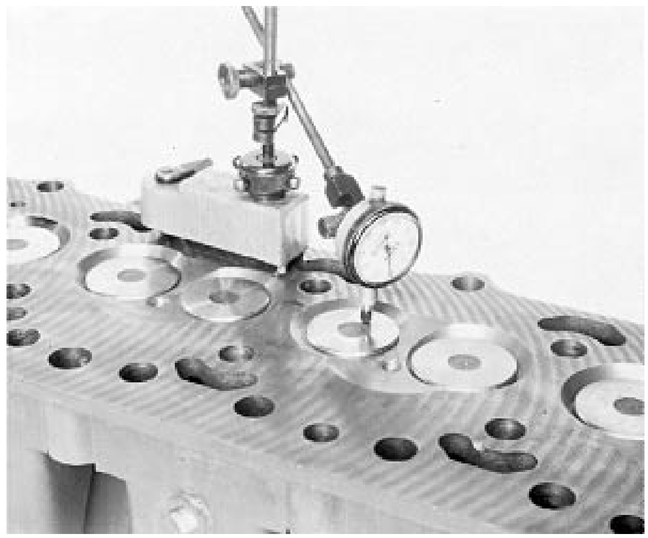
05
14

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

VALVE RECESS SPECIFICATIONS

Valve Recess Below Cylinder Head:	
Exhaust	1.19—1.70 mm (0.047—0.067 in.)
—Maximum Recess	2.46 mm (0.097 in.)
Intake	3.35—3.86 mm (0.132—0.152 in.)
—Maximum Recess	4.62 mm (0.182 in.)

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



RG5250 -UN-06DEC88

RG,CTM42,G5,10 -19-28OCT92

PRELIMINARY CYLINDER HEAD AND VALVE CHECKS

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

Look for the following conditions:

- **Sticking Valves:**

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

- **Distorted Cylinder Head and Gasket Leakage:**

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

- **Worn or Broken Valve Seats:**

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

- **Burned, Pitted, Worn, or Broken Valves:**

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

- **Improper Valve Clearance:**

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

- **Excessive Recession:**

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

RG,CTM8,G05,28 -19-08MAR94

REMOVE VALVE ASSEMBLY

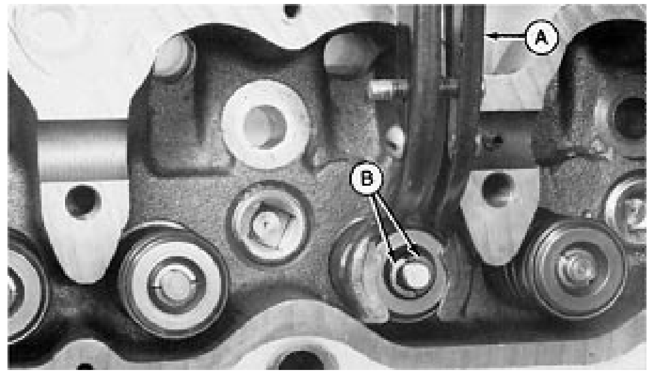
NOTE: Refer to PRELIMINARY CYLINDER HEAD AND VALVE CHECKS earlier in this group.

NOTE: Identify all parts for proper assembly in same location as removed.

1. Compress JDE138 Valve Spring Compressor (A) over valve.

2. Remove retaining locks (B).

3. Remove valve spring compressor.



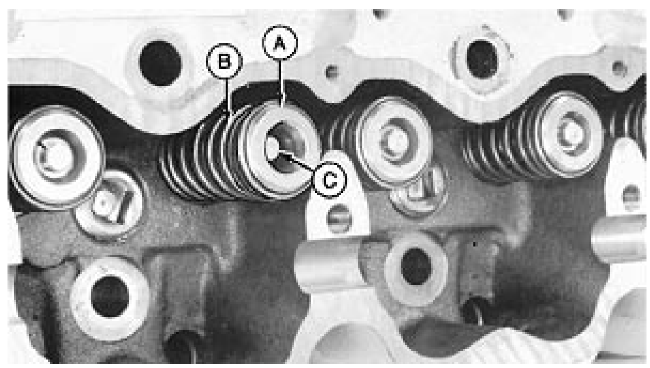
RG3803 -UN-23FEB89

S11,0401,Q -19-14FEB95

4. Remove valve rotators (A) and valve springs (B).

5. Remove exhaust valve stem shields.

6. Remove valves (C) from cylinder head.



RG3804 -UN-23FEB89

RG,CTM42,G5,27 -19-28OCT92

INSPECT AND MEASURE VALVE SPRINGS

RG2732 -UN-23FEB89

T82054 -UN-08NOV88

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

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

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

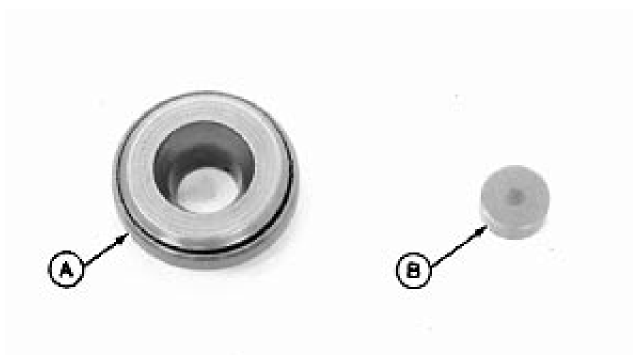
NOTE: Free spring length of 65 mm (2.56 in.) springs differ slightly, but compressed height must be the same.

VALVE SPRING SPECIFICATIONS

Spring Load	Height
Intake:	
Open: 810—880 N (182—198 lb-force)	38.1 mm (1.50 in.)
Closed: 345—399 N (78—90 lb-force)	52.5 mm (2.07 in.)
Exhaust:	
Open: 797—867 N (179—195 lb-force)	38.5 mm (1.52 in.)
Closed: 284—338 N (64—76 lb-force)	54.5 mm (2.15 in.)

RG,CTM42,G5,11 -19-06SEP94

INSPECT VALVE ROTATORS AND WEAR CAPS



RG3491 -UN-23FEB89

1. Insure that valve rotators (A), if equipped, will turn freely. Replace if defective.

2. Replace valve wear caps (B) if pitted or worn.

3. Inspect valve retainer locks for excessive wear. Replace as needed.

S11,0401,T -19-14FEB95

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.

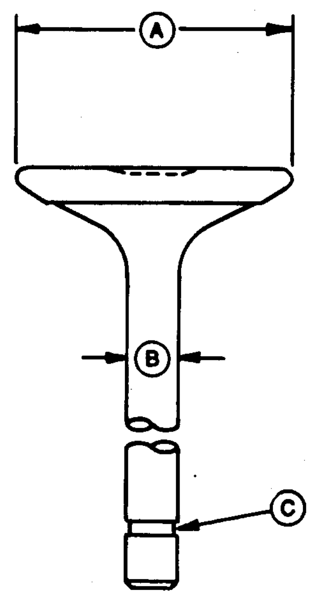
S11,0401,U -19-13MAR92

INSPECT AND MEASURE VALVES

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

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

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



RG5795 -UN-12AUG91

VALVE HEAD AND STEM SPECIFICATIONS

A—Valve Head OD:
- Exhaust . . . . 46.87—47.13 mm (1.845—1.856 in.)
- Intake . . . . 50.87—51.13 mm (2.003—2.013 in.)

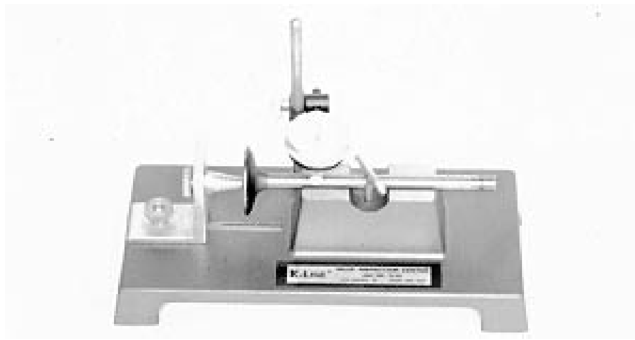
B—Valve Stem OD:
- Exhaust . . . . 9.44—9.46 mm (0.3717—0.3724 in.)
- Intake . . . . 9.46—9.49 mm (0.3724—0.3736 in.)

RG,CTM42,G5,12 -19-03MAY93

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

VALVE FACE RUNOUT SPECIFICATION

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



RG4234 -UN-23FEB89

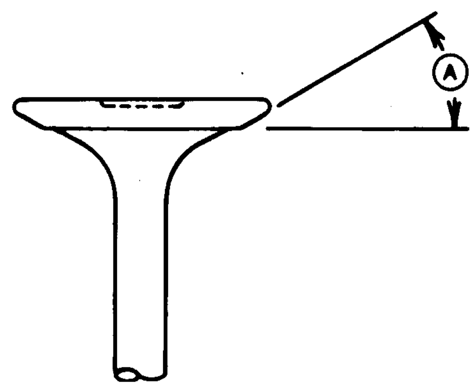
S11,2005,IZ -19-14FEB95

GRIND (REFACE) VALVES

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

If necessary to reface valve, grind valve face to an angle of 29.25° ± 0.25° (A).

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



RG5247 -UN-12AUG91

S11,2005,MG -19-20JUL94

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.

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

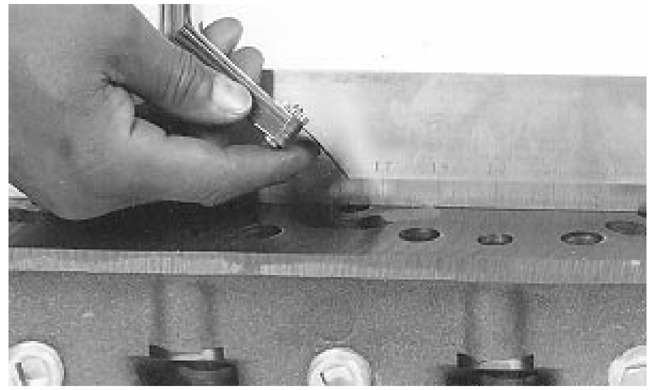
CHECK CYLINDER HEAD COMBUSTION FACE FLATNESS

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

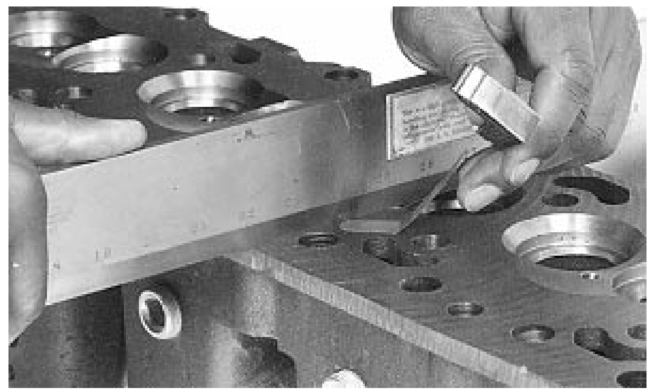
If any measurement exceeds this specification, the cylinder head must be either resurfaced or replaced. (See MEASURE CYLINDER HEAD THICKNESS, later in this group.)

CYLINDER HEAD TOP DECK FLATNESS SPECIFICATION

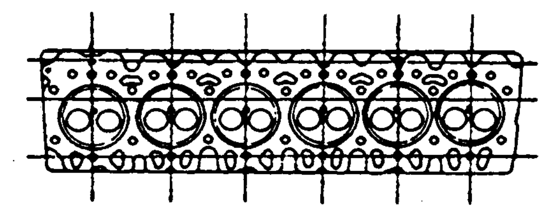
Maximum Out-of-Flat
(Over Entire Length or Width) . . . . 0.102 mm (0.0040 in.)
Straightness per any 305 mm
(12 in.) Length . . . . 0.025 mm (0.001 in.)



RG7231 -UN-07SEP94



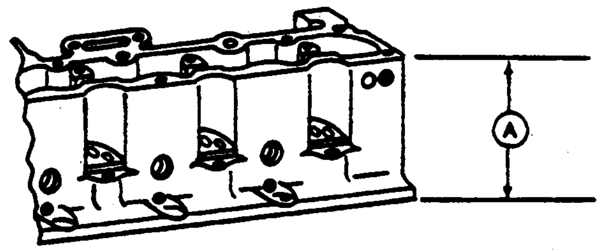
RG7232 -UN-07SEP94



RG4629 -UN-06DEC88

S11,2005,KY -19-14FEB95

MEASURE CYLINDER HEAD THICKNESS



RG4421 -UN-23FEB89

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

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

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

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

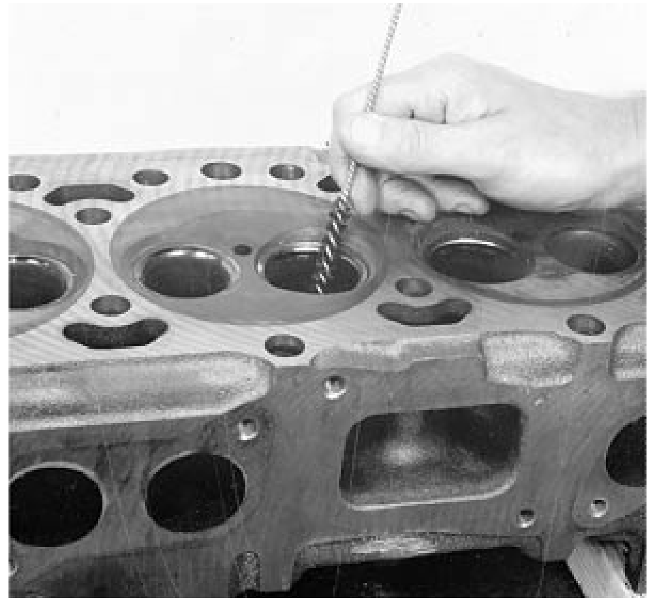
Check valve recess after grinding. (See MEASURE VALVE RECESS, earlier in this group.) Valve seat or valve face may be ground to bring this characteristic within specification.

CYLINDER HEAD SPECIFICATIONS

Thickness	155.45—155.71 mm (6.120—6.130 in.)
Wear Limit	154.69 mm (6.09 in.)
Combustion Face Surface Finish (AA)	0.015—0.0028 mm (60—110 micro-in.)
Maximum Wave Depth	0.008 mm (0.0003 in.)

S11,2005,KZ -19-14SEP94

CLEAN VALVE GUIDES

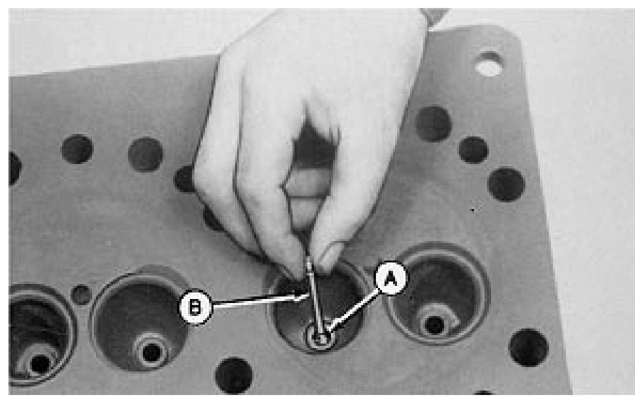

RG5346 -UN-06DEC88

1. Use a D17011BR Valve Guide Cleaning 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.

S11,2005,MY -19-28OCT92

MEASURE VALVE GUIDES



R23984 -UN-09DEC88

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

VALVE GUIDE SPECIFICATIONS

I.D. Guide in a New Head	9.51—9.54 mm (0.3745—0.3755 in.)
New Guide-to-Valve Stem Clearance:	
Exhaust	0.051—0.102 mm (0.002—0.004 in.)
Intake	0.025—0.076 mm (0.001—0.003 in.)

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

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

S11,2005,MH -19-03MAY93

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

R26141 -UN-09DEC88

S11,0401,Z -19-08MAR94

CLEAN AND INSPECT VALVE SEATS

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

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

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

R26142N -UN-09DEC88

S11,0401,AA -19-28OCT92

MEASURE VALVE SEATS

1. Measure valve seats for proper specifications listed below.

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

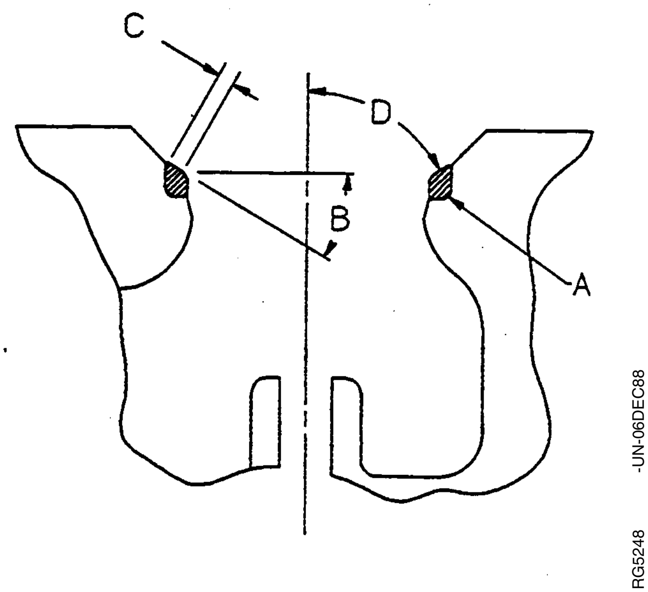
3. If valve seat is not within specification, recondition valve seat by grinding or replace valve seat inserts (A) if reconditioning is not possible. (See GRIND VALVE SEATS or INSTALL VALVE SEAT INSERTS, later in this group.)

VALVE SEAT SPECIFICATIONS

Valve Seat Angle (B) . . . . 30° ±0.50°

Valve Seat Width (C):
—Exhaust . . . . 2.0—3.8 mm (0.079—0.150 in.)
—Intake . . . . 1.4—3.8 mm (0.055—0.150 in.)

Maximum Valve Seat Runout . . . . 0.051 mm (0.0020 in.)



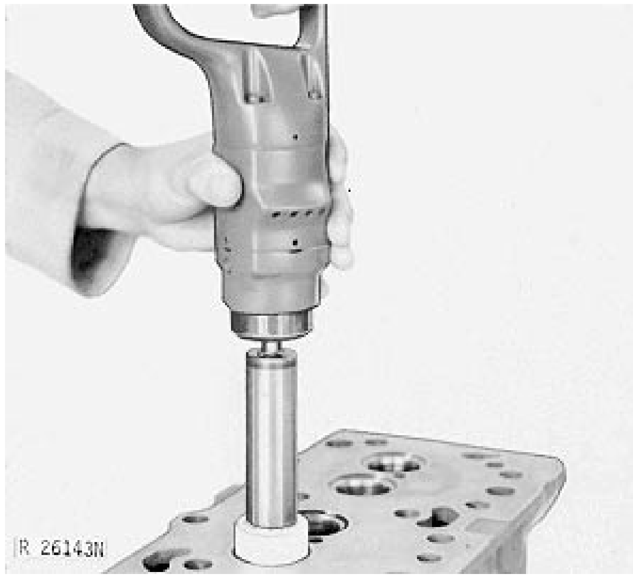
A—Valve Seat Insert
B—Valve Seat Angle
C—Valve Seat Width
D—Valve Seat Runout

S11,2005,MI -19-16SEP94

GRIND VALVE SEATS

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

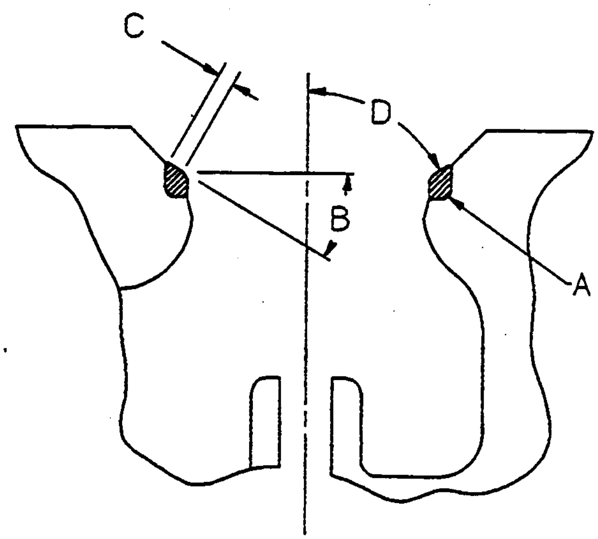
Using JT05893 Heavy-Duty Seat Grinder Set, grind valve seats to obtain correct valve recess in cylinder head. (See MEASURE VALVE RECESS earlier in this group.) Be sure valve guide bores are clean before grinding valve seats. (See CLEAN VALVE GUIDES earlier in this group.)



R26143N -UN-09DEC88

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

05
25



RG5248 -UN-06DEC88

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

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

2. ALWAYS measure valve seat runout after grinding using D11010KW Eccentrimeter.

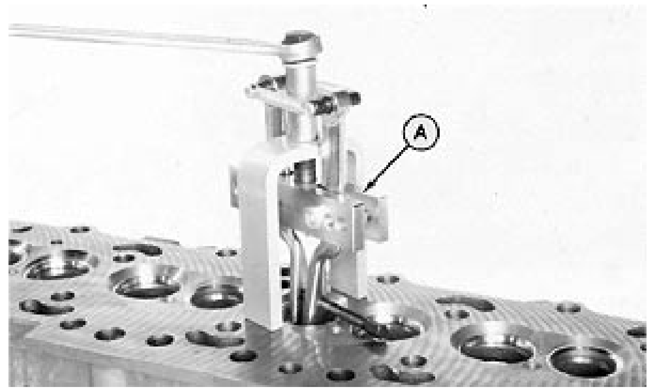
VALVE SEAT SPECIFICATIONS

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

IMPORTANT: Blend or radius all sharp edges after grinding valve seats. Always check valve recess in cylinder head after grinding as described later.

S11,2005,MJ -19-28OCT92

REMOVE VALVE SEAT INSERTS AND MEASURE BORES IN CYLINDER HEAD



RG5306 -UN-06DEC88

In some cases the inside diameter of the valve seat bore may become damaged or oversized 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 (if necessary) with JDE41296 Valve Seat Puller (A). Adjusting screw on puller may need to be retightened during removal of inserts.

NOTE: On some engines, removal of 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) equidistant from each other around the face of insert. Allow seat to cool and carefully pry out the insert(s) with a screwdriver.

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

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

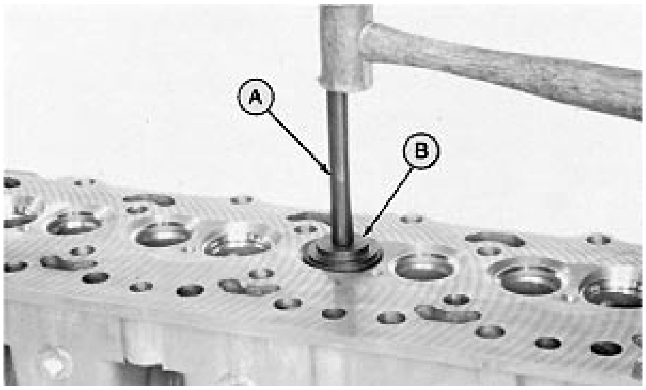
S11,2005,ML -19-28OCT92

INSTALL VALVE SEAT INSERTS

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

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

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



RG5249 -UN-06DEC88

S11,2005,MM -19-28OCT92

05
27

INSPECT AND CLEAN CYLINDER HEAD NOZZLE BORE

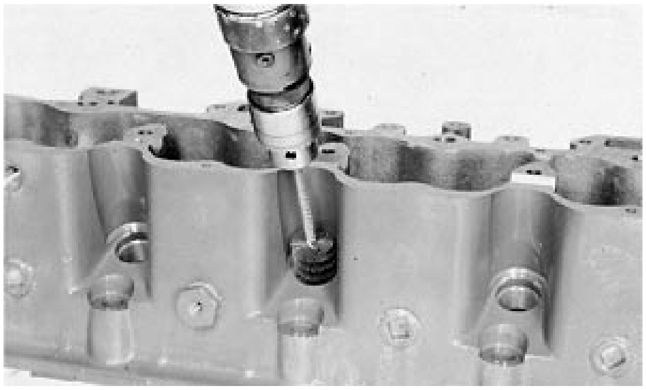
1. Inspect condition of threads for gland nut. Threads are metric (M28 x 1.5).

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.

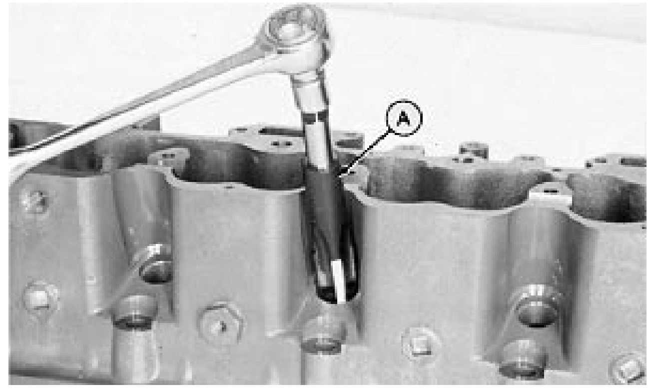
3. Clean threads which have light foreign deposits using a drill and the D17030BR Thread Cleaning Brush. Work brush up and down several times to clean threads.



RG5251 -UN-14DEC88

RG,CTM42,G5,14 -19-08FEB94

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.

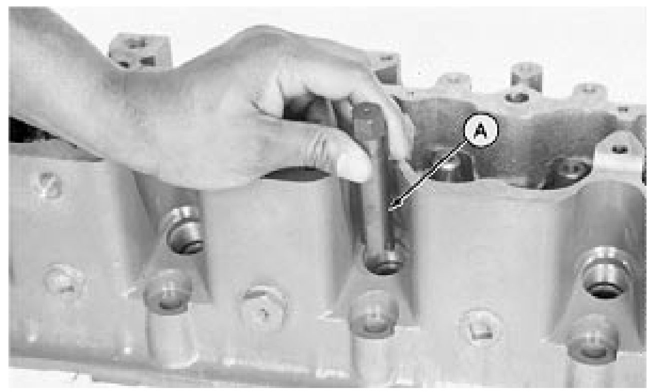


RG5252 -UN-06DEC88

RG,CTM42,G5,15 -19-22AUG91

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

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



RG5253 -UN-06DEC88

S11,2005,NU -19-23AUG91

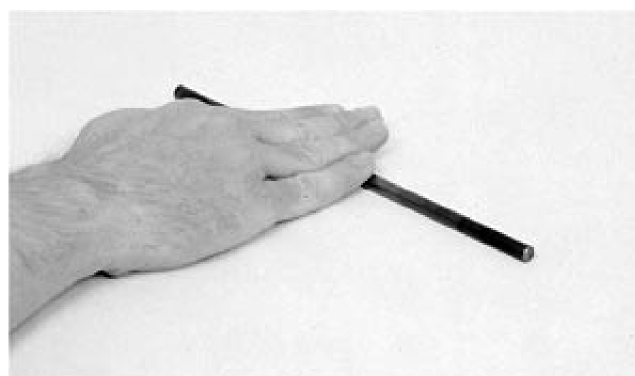
CLEAN AND INSPECT PUSH RODS

1. Clean push rods with solvent and compressed air.

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

3. Inspect contact ends for wear and damage.

4. Replace defective push rods.



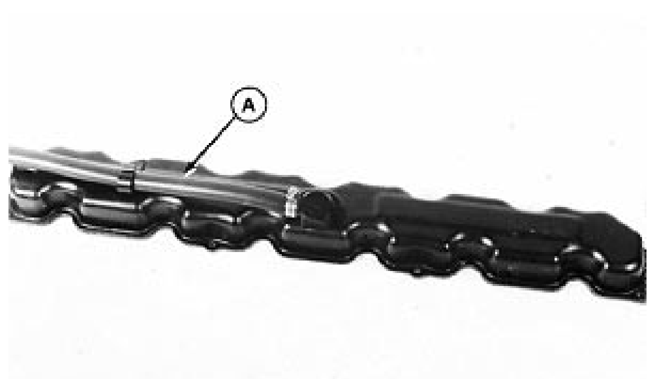
T81233 -UN-01NOV88

S11,2005,JN -19-24APR92

INSPECT AND CLEAN VENTILATOR OUTLET HOSE

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

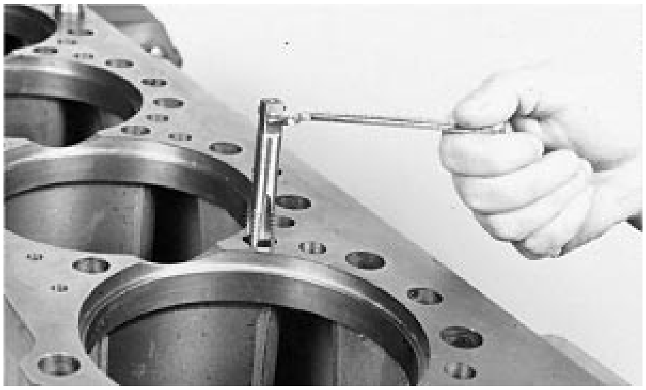
2. Clean ventilator hose if restricted.



RG5797 -UN-12AUG91

RG,CTM42,G5,9 -19-28OCT92

CLEAN AND INSPECT TOP DECK OF CYLINDER BLOCK



RG5796 -UN-12AUG91

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

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

3. Remove cylinder head locating dowels.

4. Clean all cylinder head mounting cap screw holes using JDG681A or an equivalent 9/16-12 UNC-2A tap about 114.3 mm (4.5 in.) long. Use compressed air to remove debris and any fluids which may be present in the cap screw holes.

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

6. Install new cylinder head locating dowel pins in cylinder block.

RG,CTM42,G5,17 -19-17MAR95

MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

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

NOTE: Liners having obvious defects must be replaced.

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

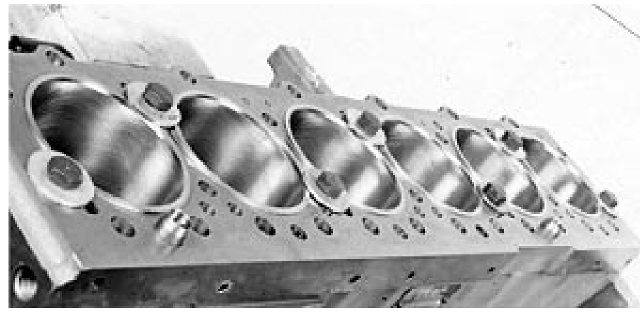
NOTE: Variations in measurement readings may occur within one cylinder and/or between adjacent cylinders.

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

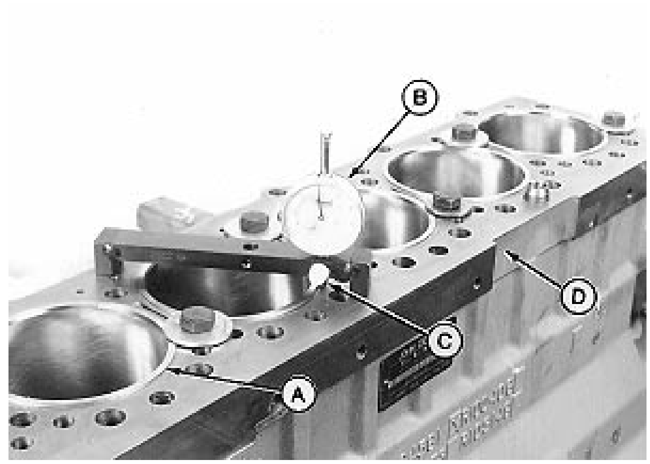
4. Remove any liner that does not meet standout specification at any location and install liner shims or replace piston/liner sets as necessary, as outlined in Group 10. See INSTALL LINER SHIMS—IF REQUIRED.

LINER HEIGHT SPECIFICATIONS

Liner Height Above Block	0.050—0.127 mm (0.002—0.005 in.)



RG5829 -UN-12AUG91



RG5813 -UN-08MAR94

A—Cylinder Liner
B—Dial Indicator
C—Liner Height
D—Cylinder Block

RG,CTM42,G5,31 -19-16AUG94

05
30

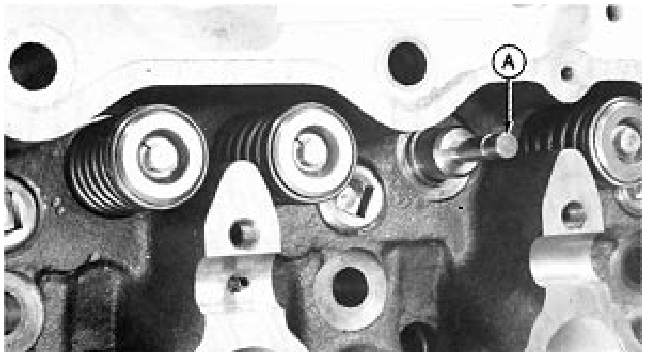
ASSEMBLE VALVE ASSEMBLY

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

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

2. Install reconditioned or new valves (A) in head. If valves are reused, install in same location from which removed.

NOTE: Valves must move freely and seat properly.



RG3806 -UN-23FEB89

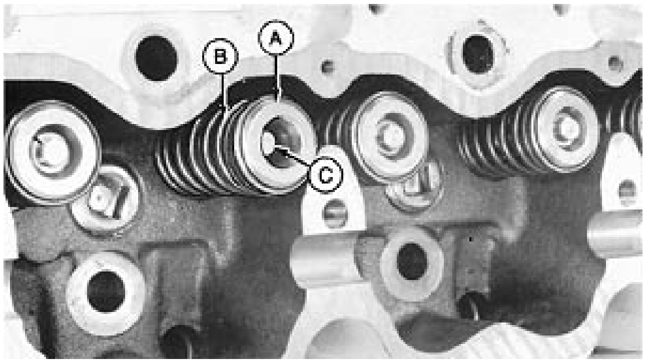
S11,0401,AK -19-28OCT92

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

3. Position valve springs (B). End of spring must be in machined counterbore of head. Do not mix valve springs. See INSPECT AND MEASURE VALVE SPRINGS, earlier in this group.

4. Install valve rotators (A) on springs and valves (C).

5. Install valve stem shields on exhaust valve stems.

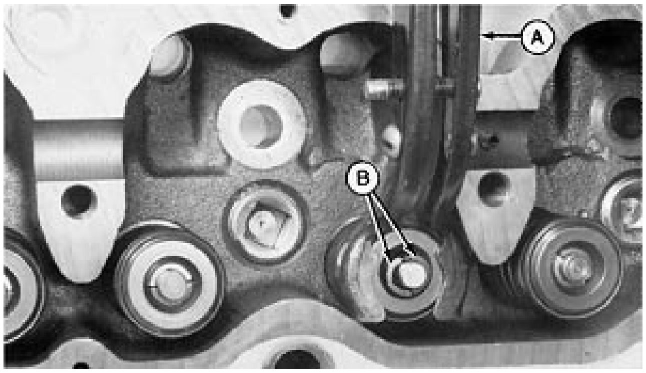


RG3804 -UN-23FEB89

RG,CTM42,G5,28 -19-28OCT92

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

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



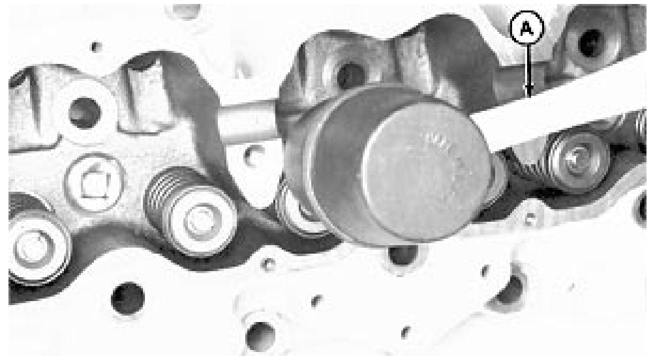
RG3803 -UN-23FEB89

RG,CTM42,G5,29 -19-28OCT92

7. Strike end of each valve with a soft mallet (A) three or four times to insure proper seating of the retainer locks.

Repeat procedure for all remaining valves. Remember valve stem seals are installed onto exhaust valve stems only.

8. Measure valve recess as directed earlier in this group.



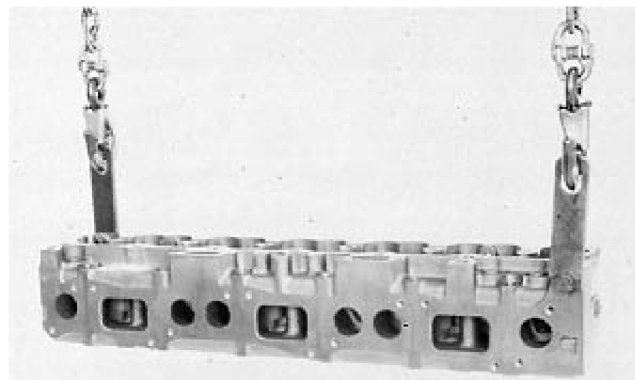
RG3807 -UN-23FEB89

RG,CTM42,G5,30 -19-28OCT92

INSTALL CYLINDER HEAD

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

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



RG5245 -UN-06DEC88

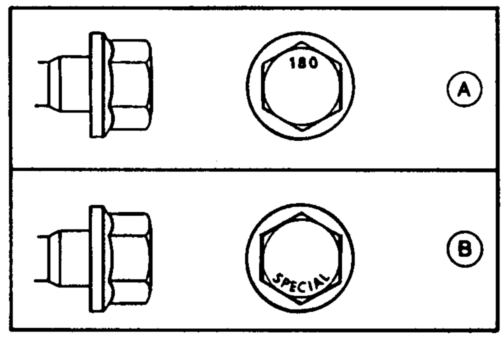
1. Put a new head gasket on cylinder block. Do not use sealant on gasket; install dry.

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

2. Lower cylinder head everly to correct position on block using appropriate lifting equipment. Make sure that head is positioned correctly over dowels.

RG,CTM42,G5,40 -19-14FEB95

CYLINDER HEAD CAP SCREW TYPES



RG7226 -UN-22JUL94

A—ASTM Grade 180 Flanged-Head
B—Flanged-Head Marked "SPECIAL"

One of the two cylinder head cap screws shown will be found on the engine, depending upon when the engine was built.

IMPORTANT: Cylinder head cap screw torque specifications and tightening procedures vary depending upon the grade or type of cap screw used, and the cylinder block casting number.

Cylinder block casting numbers R116070, R119995, R119996, R119997, R119998 and R119999 use Grade 180 flanged-head cylinder head cap screws. These cap screws must be tightened using the "Torque-Turn" method. See TIGHTEN FLANGED-HEAD CYLINDER HEAD CAP SCREWS later in this group.

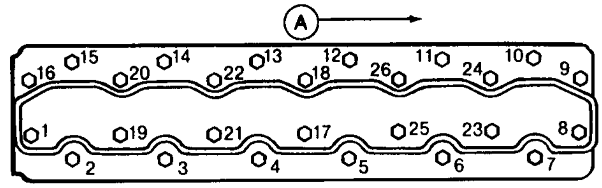
For cylinder blocks with casting numbers R122736, R122737, R122738, R122739, R122740 and R122741, the early engines were built with Grade 180 flanged-head cylinder head cap screws, and later engines are built with cylinder head cap screws marked "SPECIAL". For service of these engines, either type of cylinder head cap screw can be used, although use of "SPECIAL" cylinder head cap screws is recommended.

Grade 180 flanged-head cylinder head cap screws must be tightened using the "TORQUE-TURN" method. See TIGHTEN FLANGED-HEAD CYLINDER HEAD CAP SCREWS — GRADE 180, later in this group.

Cylinder head cap screws marked "SPECIAL" must be tightened using the "TORQUE-TO-YIELD" method. See TORQUE-TO-YIELD FLANGED-HEAD CAP SCREWS—GRADE 180 MARKED "SPECIAL" later in this group.

IMPORTANT: DO NOT re-use cylinder head cap screws marked "SPECIAL", they may be used only one time.

CLEAN, INSPECT AND INSTALL CYLINDER HEAD CAP SCREWS



RG4471 -UN-28FEB94

IMPORTANT: All SAE Grade 180 flanged-head cap screws can be reused if they pass inspection EXCEPT for the flanged-head cap screws marked "SPECIAL". These cap screws can be used only one time and only on cylinder blocks with casting numbers R116070, R119995, R119996, R119997, R119998, and R119999.

1. Clean entire length of cap screws (if reusing) to remove rust and scale using a wire brush and solvent. Dry cap screws with compressed air.

2. Inspect cap screws for corrosion damage and condition of threads. ANY CAP SCREW WITH CORROSION OR OTHER IMPERFECTIONS MUST BE REPLACED.

IMPORTANT: DO NOT use multi-viscosity oils tolubricate cap screws. Only SAE30 engine oil may be used.

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

Arrow (A) points toward front of engine.

4. Install cap screws in proper location.

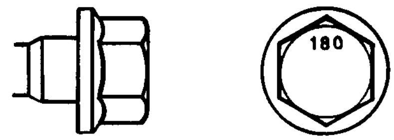
Use the following cap screws in location as shown:

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

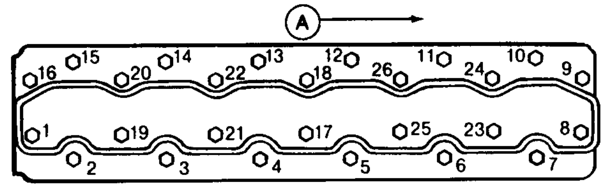
RG,CTM42,G5,42 -19-17MAR95

TORQUE-TURN FLANGED-HEAD CAP SCREWS—GRADE 180

RG7136 -UN-21FEB94



Arrow (A) points toward front of engine.



RG4471 -UN-28FEB94

• Using line scribe method to TORQUE-TURN cylinder head cap screws:

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

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

2. Tighten cap screw No. 17 to 100 N·m (75 lb-ft) first. Tighten all remaining cap screws to 100 N·m (75 lb-ft), beginning with No. 1 and proceed sequentially.

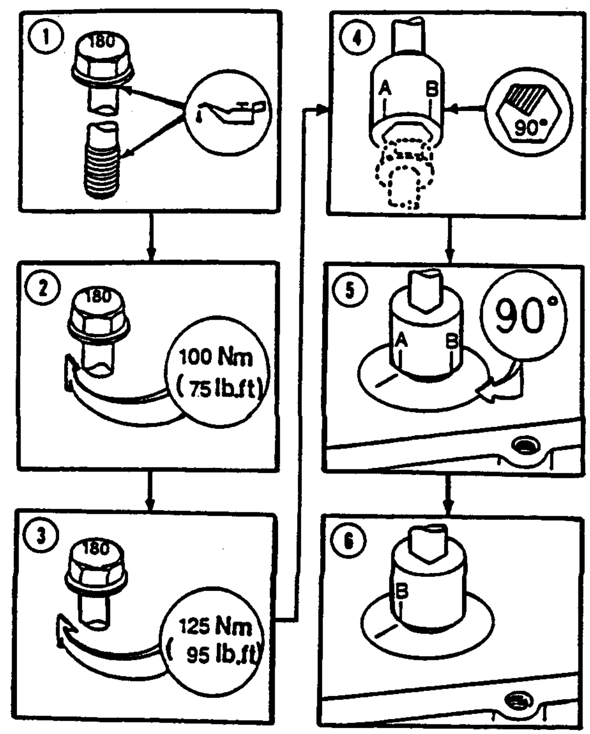
3. Retighten all cap screws to 125 N·m (95 lb-ft) beginning with No. 1.

4. Make 90˚ reference marks (A,B) on socket.

5. Install socket on cap screw No. 1 and make a reference mark on cylinder head that aligns with reference mark (A) on socket.

6. Turn cap screw 90˚—100˚ until reference mark on cylinder head aligns with reference mark (B) on socket.

7. Repeat Steps 5 and 6 on all remaining cap screws.



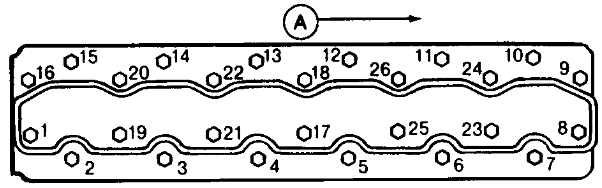
RG7138 -UN-28FEB94

• Using JT05993 Torque Angle Gauge:

After lubricating and tightening cylinder head cap screws (in proper sequence) according to steps 1, 2, and 3 listed above, follow directions provided with gauge and TORQUE-TURN each cap screw 90˚—100˚, beginning with cap screw No. 1 and sequentially proceed thru to No. 26.

RG,CTM42,G5,36 -19-14FEB95

TORQUE-TO-YIELD FLANGED-HEAD CAP SCREWS—GRADE 180 MARKED “SPECIAL”



RG4471 -UN-28FEB94

Arrow (A) points toward front of engine.

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

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

2. Tighten cap screw No. 17 to 80 N·m (60 lb-ft). Sequentially (start at cap screw No. 1 and proceed through cap screw No. 26) tighten all cap screws to 80 N·m (60 lb-ft).

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

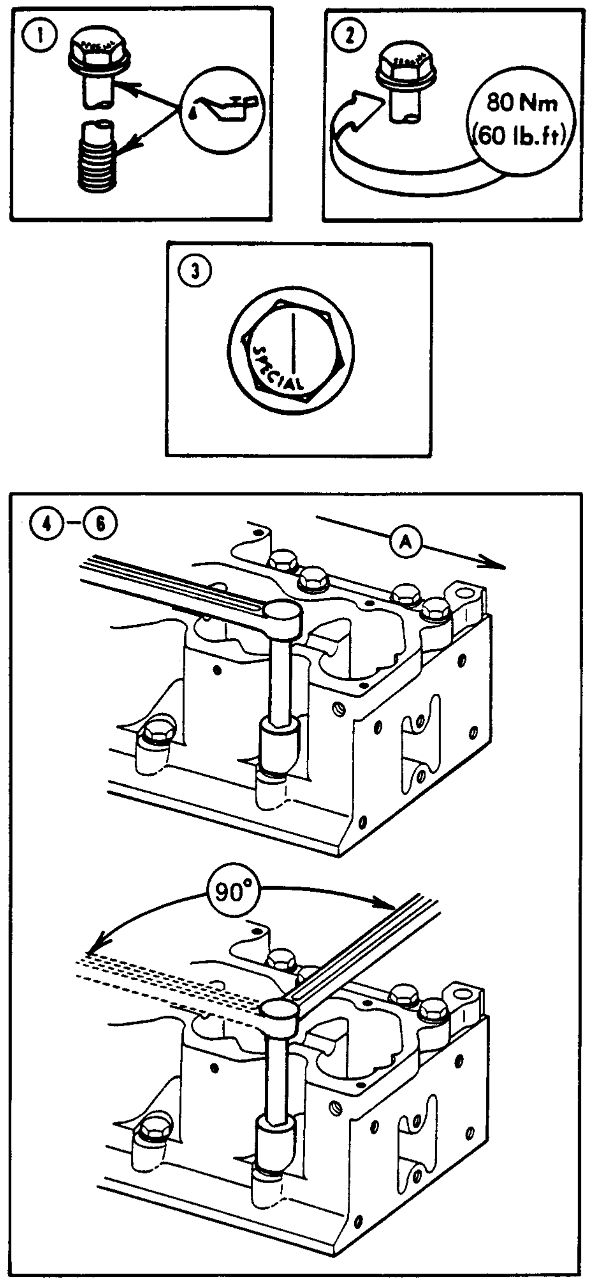
IMPORTANT: If a cap screw is accidentally tightened more than 90° in any one sequence, DO NOT loosen cap screw but make adjustments in the next tightening sequence.

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

5. Again, sequentially (start at cap screw No. 1 and proceed through cap screw No. 26) turn each cap screw 90°. Line on top of cap screw will now be parallel to crankshaft.

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

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



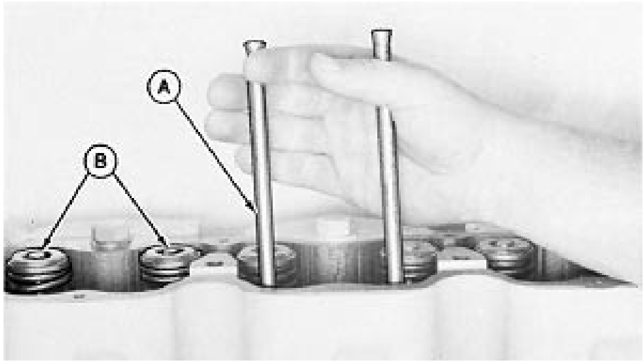
RG7139 -UN-01MAY94

RG,CTM1,G5,4 -19-09AUG94

INSTALL ROCKER ARM ASSEMBLY

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

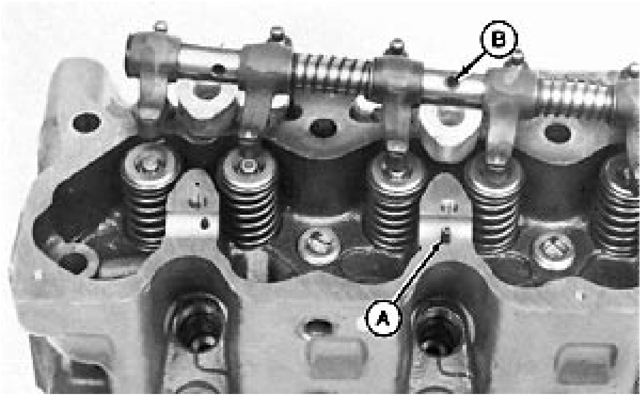
2. Install wear caps (B) on valves, making certain caps rotate freely.



RG3809 -UN-23FEB89

S11,2005,HT -19-12JUL94

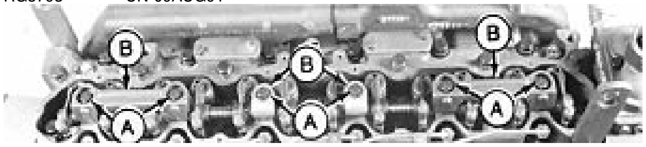
3. Make sure spring pin (A) engages with hole (B) in shaft.



RG3810 -UN-23FEB89

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

RG5793 -UN-09AUG91



RG,CTM42,G5,20 -19-07AUG91

COMPLETE FINAL ASSEMBLY OF INJECTION PUMP SIDE

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

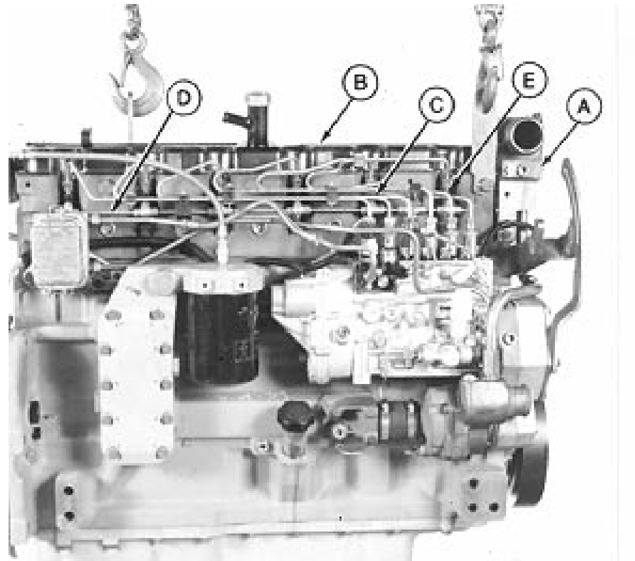
2. Apply AR31790 SCOTCH-GRIP Adhesive or equivalent to new gasket, and seal gasket to rocker arm cover (B). Be sure to follow the manufacturer's directions on the package for correct application procedures and curing times.

3. Install cover and tighten cap screws to 8 N·m (6 lb-ft) (72 lb-in.).

4. Install fuel injection nozzles (E), leak-off lines (D) and fuel injection lines (C). (See INSTALL FUEL INJECTION NOZZLES in Group 35.)

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

6. Install water manifold (A). (See INSTALL WATER MANIFOLD in Group 25.)



RG5798 -UN-12AUG91

A—Water Manifold
B—Rocker Arm Cover
C—Fuel Injection Lines
D—Leak-off Lines
E—Fuel Injection Nozzles

RG,CTM42,G5,21 -19-28OCT92

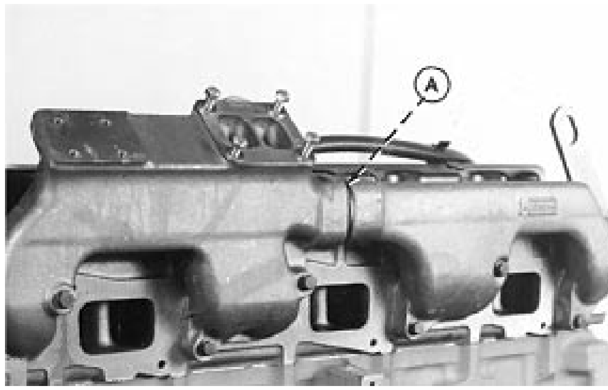
COMPLETE FINAL ASSEMBLY ON EXHAUST MANIFOLD SIDE

NOTE: Apply PT569 NEVER-SEEZ Compound or equivalent to all exhaust manifold cap screws, except 6076 HRW 33, 34, and 35 engines. Also, intake manifold is installed before exhaust manifold on these engines.

1. Install front exhaust manifold using new gaskets. Do not tighten cap screws until sealing ring (A) and rear exhaust manifold is installed.

RG5799 -UN-12AUG91

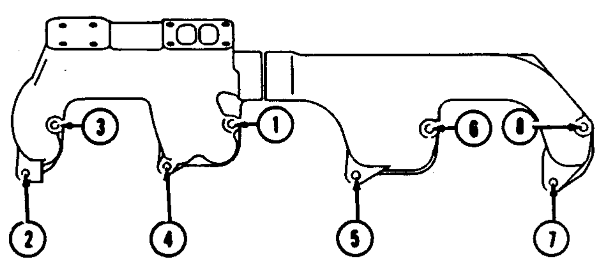
2. Install rear exhaust manifold using new gaskets and sealing ring.



RG5800 -UN-12AUG91

3. Tighten cap screws in sequence shown in bottom illustration to 47 N·m (35 lb-ft).

4. Install turbocharger oil return pipe, using a new O-ring.



RG6338 -UN-03AUG92

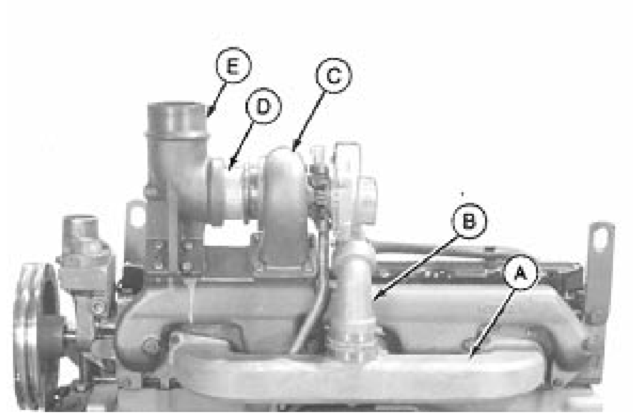
RG,CTM42,G5,22 -19-14FEB95

5. On 6076T and 6076H Engines, using new gaskets install intake manifold (A). Tighten cap screws to 47 N·m (35 lb-ft).

6. On 6076T Engines, install intake coupling (B). Do not tighten clamps.

7. On 6076T and 6076H Engines, install turbocharger (C), adapter (D), and exhaust elbow (E). (See INSTALL TURBOCHARGER in Group 30.)

8. Position intake adapter with turbocharger and intake manifold and tighten clamps securely.

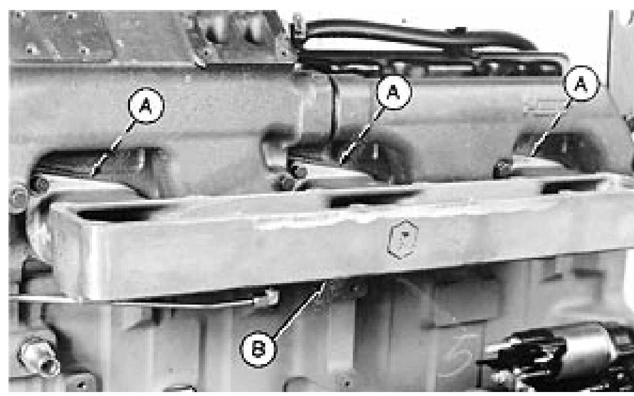


RG5801 -UN-12AUG91

A—Intake Manifold
B—Intake Coupling
C—Turbocharger
D—Turbocharger Adapter
E—Exhaust Elbow

RG,CTM42,G5,23 -19-16AUG94

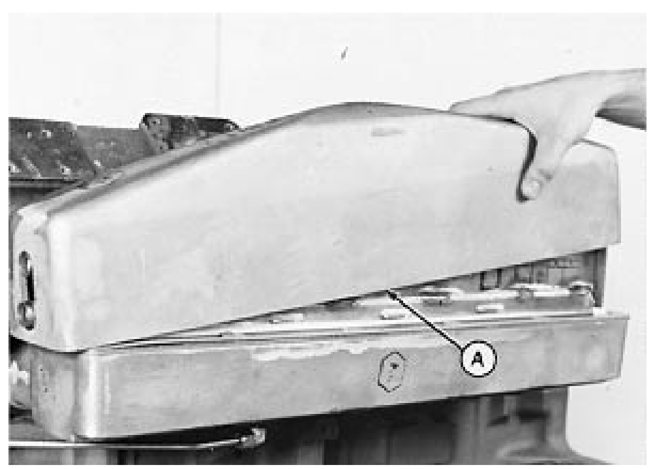
9. On 6076A Engines, use new gaskets (A) and install intake manifold (B). Tighten cap screws to 47 N·m (35 lb-ft).



RG5802 -UN-13AUG91

RG,CTM42,G5,24 -19-22AUG91

10. On 6076A Engines, using new gaskets and O-rings, install aftercooler and cover (A). (See INSTALL INTAKE MANIFOLD AND AFTERCOOLER in Group 30.)



RG5803 -UN-13AUG91

RG,CTM42,G5,25 -19-06SEP91

11. Install water inlet (A) and water outlet (C) hoses. Tighten hose clamps securely.

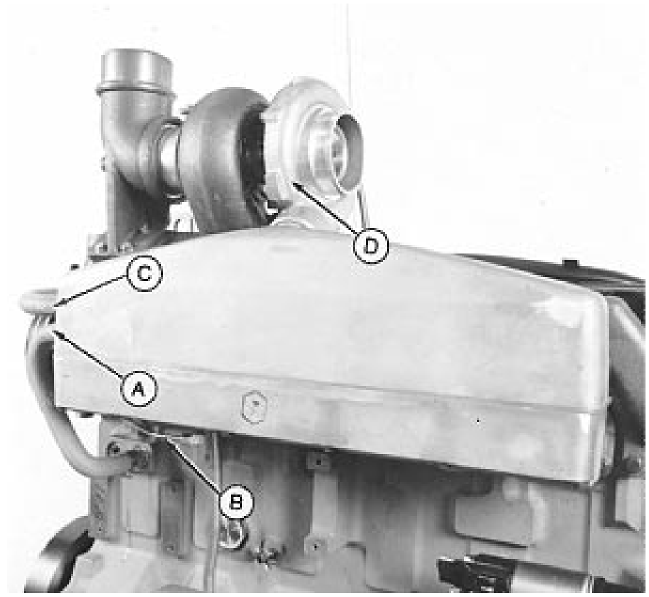
12. Install aneroid line (B), if equipped, and tighten securely.

13. Install turbocharger (D) with couplings. Tighten cap screws to 47 N·m (35 lb-ft). (See INSTALL TURBOCHARGER in Group 30.)

14. If engine oil was drained from crankcase, install new oil filter and fill with clean oil of correct grade and viscosity. (See DIESEL ENGINE OIL in Group 02.)

15. Fill cooling system with clean coolant. (See ENGINE COOLANT SPECIFICATIONS in Group 02.)

16. Perform engine break-in as outlined later in this group. (See PERFORM ENGINE BREAK-IN.)



A—Water Inlet Hose
B—Aneroid Line
C—Water Outlet Tube and Hose
D—Turbocharger

RG,CTM42,G5,32 -19-28OCT92

PERFORM ENGINE BREAK-IN

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

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

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

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

4. Install rocker arm cover gasket and cover. Tighten rocker arm cover cap screws to 8 N·m (6 lb-ft) (72 lb-in.). (See COMPLETE FINAL ASSEMBLY OF INJECTION PUMP SIDE OF ENGINE, earlier in this group.)

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

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

RG,CTM6,G05,5 -19-14SEP94

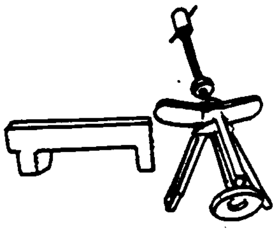
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

Cylinder Liner Puller . . . . D01062AA (or D01073AA)

Remove cylinder liners.



RG5019 -UN-23AUG88

S53,D01062,AA -19-07AUG91

RG5074 -UN-23AUG88

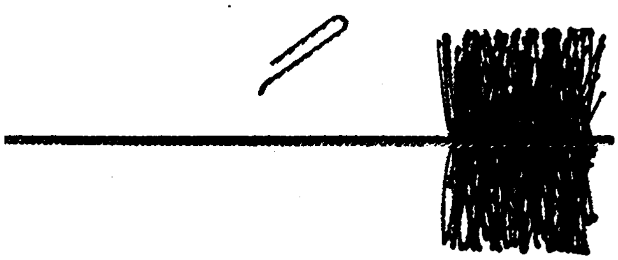
Flexible Cylinder Hone D17005BR

Hone cylinder liners.

S53,D17005,BR -19-07APR88

O-Ring Groove Cleaning Brush D17015BR

Clean cylinder liner O-ring groove in block.



RG5075 -UN-23AUG88

S53,D17015,BR -19-25MAR91

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.

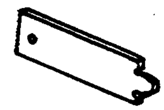
RG6246 -UN-27MAR92

RG,D17526CI -19-29OCT92

RG5076 -UN-23AUG88

Ring Groove Wear Gauge JDE55

Check wear of keystone ring groove on pistons.

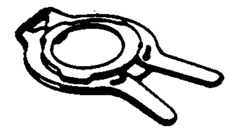


S53,JDE55 -19-25MAR91

RG5077 -UN-23AUG88

Piston Ring Expander JDE93

Remove and install piston rings.

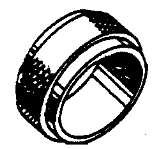


S53,JDE93 -19-17FEB87

RG5031 -UN-23AUG88

Piston Ring Compressor JDE96

Compress rings while installing pistons.

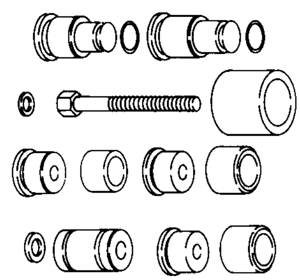


S53,JDE96 -19-25MAR87

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



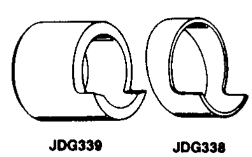
RG5078 -UN-16FEB94

S53,JDE98A -19-16AUG94

RG5079 -UN-25JUN94

Connecting Rod Bushing Service Set JDG337

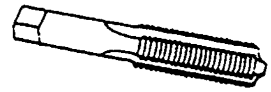
Use with JDE98A Bushing Service Set to remove and install connecting rod bushings.



S53,JDG337,A -19-29JUL94

RG5100 -UN-23AUG88

Tap JDG681A

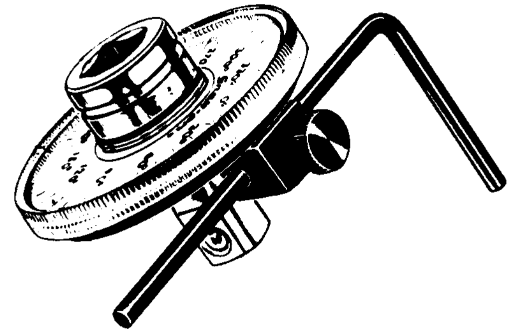


Used to restore threaded holes in cylinder block for cylinder head cap screws.

RG,JDG681A -19-17MAR95

Torque Angle Gauge JT05993

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



RG5698 -UN-27AUG90

RG,JT05993 -19-22AUG91

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
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,CTM61,G10,6 -19-04AUG94

OTHER MATERIAL

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

S11,2010,BS -19-08AUG94

CYLINDER BLOCK, LINERS, PISTONS, AND RODS SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Cylinder Liner Height Above Block	0.050—0.127 mm (0.002—0.005 in.)	——
Maximum Piston Protrusion Above Block	0.051—0.787 mm (0.002—0.031 in.)	——
Piston Oil Control Ring-to-Groove Clearance	0.064—0.102 mm (0.0025—0.0040 in.)	0.165 mm (0.0065 in.)
Piston Compression Ring End Gap:		
Pistons Stamped RE50868		
No. 1	0.43—0.69 mm (0.017—0.027 in.)	——
No. 2	0.63—0.89 mm (0.025—0.035 in.)	——
Pistons Stamped RE57512		
No. 1	0.43—0.69 mm 0.017—0.027 in.)	——
No. 2	1.27—1.52 mm (0.050—0.060 in.)	——
Piston OD: —19.1 mm (0.75 in.) from Bottom of Skirt Engine Serial No.	115.771—115.789 mm (4.5579—4.5586 in.)	——
Piston-to-Liner Clearance at Bottom of Skirt: Engine Serial No.	0.076—0.124 mm (0.0030—0.0049 in.)	0.152 mm (0.0060 in.)
Cylinder Liner ID	115.865—115.895 mm (4.5616—4.5628 in.)	——
OD	127.94—128.24 mm (5.037—5.049 in.)	——
Cylinder Liner Thickness	6.05—6.15 mm (0.238—0.242 in.)	——
Cylinder Liner Packing Step Dimension	1.45—1.55 mm (0.057—0.061 in.)	——
Cylinder Liner Maximum Taper	0.051 mm (0.0020 in.)	——

RG,CTM42,G10,25-19-17MAR95

CYLINDER BLOCK, LINERS, PISTONS, AND RODS SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Cylinder Liner Maximum Out-of-Round	0.051 mm (0.0020 in.)	——
Cylinder Liner Counterbore Depth	8.105—8.155 mm (0.319—0.321 in.)	——
Cylinder Liner Flange Thickness	8.175—8.225 mm (0.322—0.324 in.)	——
Cylinder Liner Flange OD	135.105—135.130 mm (5.319—5.321 in.)	——
Outer Diameter of Liner:		
at Upper Bore	129.085—129.135 mm (5.082—5.084 in.)	——
at Lower Bore	125.042—125.122 mm (4.923—4.926 in.)	——
Upper Bore Diameter in Block For Seating Liners	129.155—129.205 mm (5.085—5.087 in.)	——
Lower Bore Diameter in Block for Seating Liners	125.133—125.183 mm (4.9265—4.9285 in.)	——
Liner-to-Block Clearance:		
at Upper Bore	0.026—0.126 mm (0.001—0.005 in.)	——
at Lower Bore	0.012—0.140 mm (0.0005—0.0055 in.)	——
Liner Shim Thickness	0.05 mm (0.002 in.)	——
Piston Pin OD	47.597—47.613 mm (1.8739—1.8745 in.)	——
Piston Pin Bore ID in Piston	47.620—47.630 mm (1.8748—1.8752 in.)	——
Rod Pin Bushing ID (Before Honing)	47.579—47.628 mm 1.8732—1.8751 in.)	——
Rod Pin Bushing ID (After Honing)	47.655—47.681 mm (1.8762—1.8772 in.)	——
Rod Pin Bore Diameter Without Bushing	52.354—52.380 mm (2.0612—2.0622 in.)	——

RG,CTM42,G10,29-19-16AUG94

CYLINDER BLOCK, LINERS, PISTONS, AND RODS SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Rod Pin-to-Bushing Oil Clearance	0.042—0.084 mm (0.0017—0.0033 in.)	0.102 mm (0.0040 in.)
Rod-to-Pin Bushing Press Fit Specification	0.084—0.147 mm (0.0033—0.0058 in.)	——
Connecting Rod Bore Without Bearings	81.051—81.077 mm (3.191—3.192 in.)	——
Connecting Rod Bearing Assembled ID	76.21—76.26 mm (3.0004—3.0024 in.)	——
Crankshaft Rod Journal OD	76.15—76.18 mm (2.9980—2.9992 in.)	——
Bearing-to-Journal Clearance	0.030—0.110 mm (0.0012—0.0044 in.)	——
Maximum Connecting Rod/Cap Gap	0.254 mm (0.0100 in.)	——
Maximum Connecting Rod Out-of-Round	0.025 mm (0.0010 in.)	——
Centerline of Main Bearing Bore-to-Top Deck of Cylinder Block	352.35—352.50 mm (13.872—13.878 in.)	——
Camshaft Bushing Bore in Block	69.987—70.013 mm (2.7554—2.7564 in.)	——
Maximum Runout of Camshaft Bushing Bore in Block	0.038 mm (0.0015 in.)	——
New Camshaft Bushing-to-Journal Clearance	0.063—0.115 mm (0.0025—0.0045 in.)	——
Camshaft Bushing ID	67.076—67.102 mm (2.6408—2.6418 in.)	——
Cylinder Block Top Deck:		
Maximum Out-of-Flat Over Entire Length or Width	0.10 mm (0.004 in.)	——
Straightness per Any 305 mm (12 in.) Length	0.025 mm (0.001 in.)	——
Centerline of Rod Pin Bore-to-Centerline of Crankshaft Journal Bore	222.20—222.30 mm (8.748—8.752 in.)	——

RG,CTM42,G10,20-19-14FEB95

CYLINDER BLOCK, LINERS, PISTONS, AND RODS SPECIFICATIONS—CONTINUED

TORQUES

Connecting Rod Cap Screws:
- Initial * . . . . 27 N·m (20 lb-ft)
- Final (All Cap Screws) . . . . 75 N·m (55 lb-ft) Plus 90—100°

Piston Cooling Orifices into Cylinder Block . . . . 9.6—12.4 N·m (85—110 lb-in.)

Cylinder Liner Cap Screws
(for Checking Liner Standout) . . . . 68 N·m (50 lb-ft)

** See INSTALL PISTONS AND CONNECTING RODS, later in this group, before tightening cap screws.*

RG,CTM42,G10,39-19-16AUG94

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.

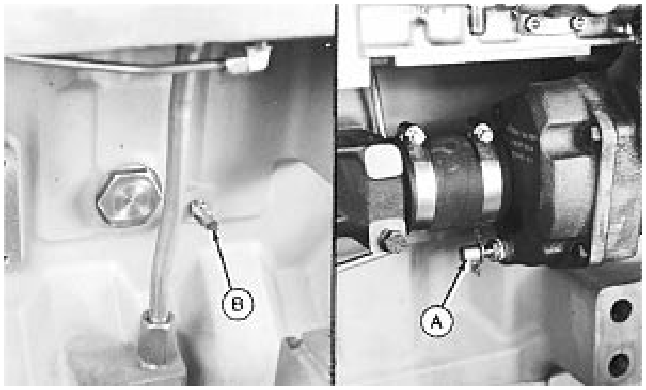
• Mottled, Grayish or Pitted Compression Rings:

Internal coolant leaks.

CTM8,GR10,37 -19-17AUG94

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.



RG5836 -UN-28AUG91

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

IMPORTANT: Both water pump drain valve and block drain valve must be opened to completely drain both sides of the engine.

1. Drain all coolant and engine oil.

RG,CTM42,G10,19-19-29OCT92

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.)

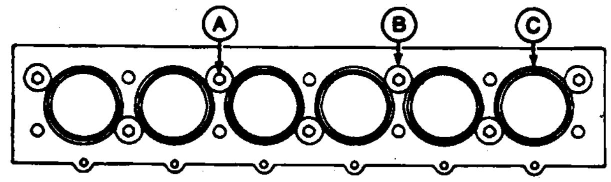
3. Remove oil pan and oil pump. (See REMOVE ENGINE OIL PUMP in Group 20.)

RG3657 -UN-13DEC88

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

RG,CTM42,G10,30-19-14FEB95

4. 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).



-UN-07DEC88

RG3819

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).See MEASURE LINER STANDOUT (HEIGNT ABOVE BLOCK), later in this group.

As the cylinder liner wears, a ridge is formed at the top of piston ring travel zone. If this ridge gets too high, pistons and rings can be damaged when they are removed. Remove any ridge from liner bores with a scraper or ridge reamer before removing pistons.

5. Before removing pistons, visually inspect condition of cylinder liners with pistons at bottom dead center “BDC”. Liners will require replacement if:

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

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

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

RG,CTM42,G10,41-19-14FEB95

NOTE: Connecting rod bearing-to-journal oil clearance should be measured before removing piston/rod assembly.

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

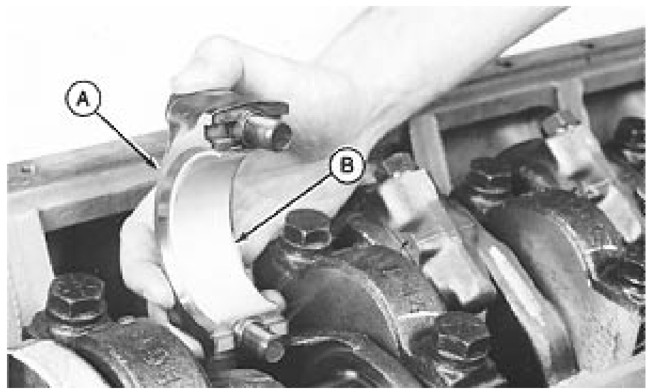
NOTE: Use PLASTIGAGE as directed by the manufacturer. Remember, the use of PLASTIGAGE will determine bearing journal clearance, but will not indicate the condition of either surface.

IMPORTANT: DO NOT use pneumatic wrench to tighten connecting rod cap screws. Using pneumatic wrenches may cause thread damage.

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

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

RG5807 -UN-12AUG91



RG5806 -UN-12AUG91

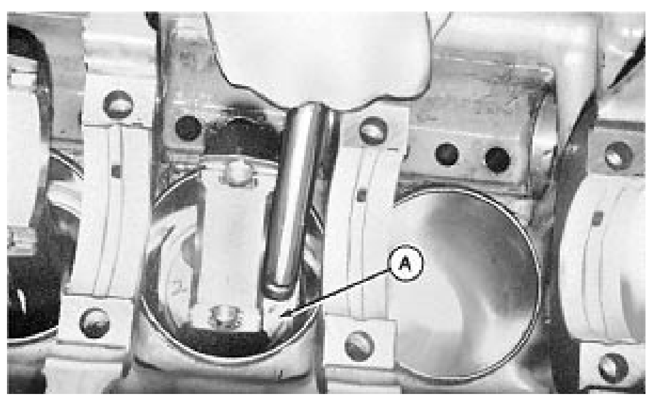
RG,CTM42,G10,2 -19-14FEB95

8. 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.

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

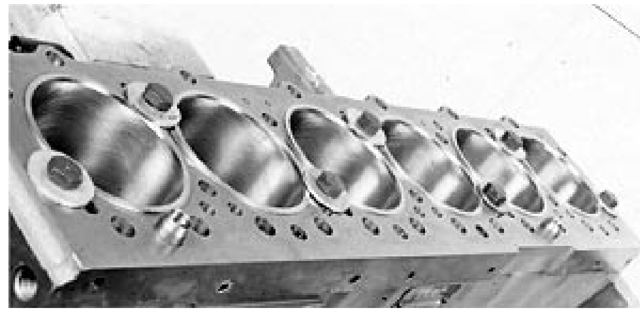
Pistons and liners are selectively fitted to maintain piston-to-liner clearance. Always keep matched pistons and liners together as a set and each set MUST BE installed in the same cylinder as removed.



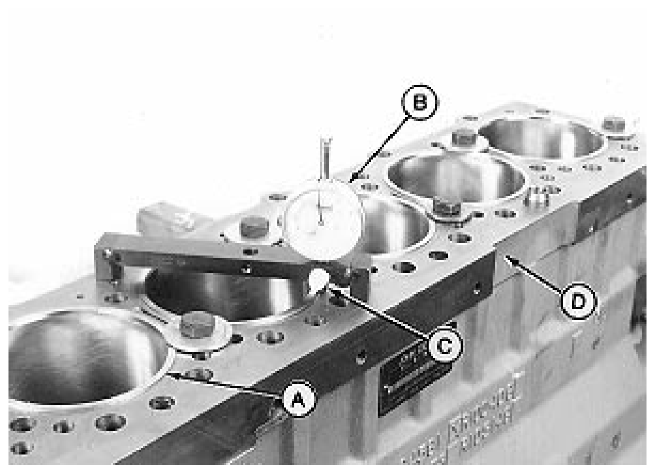
RG5808 -UN-12AUG91

RG,CTM42,G10,3 -19-29OCT92

MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)



RG5829 -UN-12AUG91



RG5813 -UN-08MAR94

A—Cylinder Liner
B—Dial Indicator
C—Liner Height
D—Cylinder Block

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

NOTE: Liners having obvious defects must be replaced as a matched piston and liner set.

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

2. Use JDG451 Gauge along with D17526CI (English, in.) or D17527CI (Metric, mm) Dial Indicator (B) or KJD10123 Gauge to measure the height (C) of bolted down liners (A) that are not obviously defective before removal from block (D). Cap screws must be tightened to 68 N·m (50 lb-ft) to achieve an accurate reading.

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

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

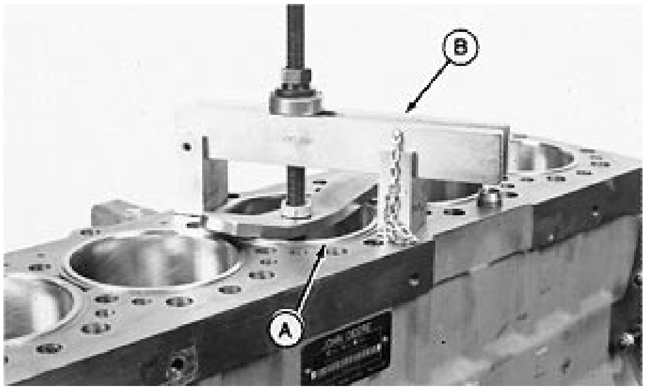
4. Remove any liner that does not meet standout specification at any location and measure liner flange thickness, as explained later in this group. Use liner shims or replace piston/liner sets as necessary.

LINER HEIGHT SPECIFICATIONS

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

RG,CTM42,G10,21-19-14FEB95

REMOVE CYLINDER LINERS



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

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

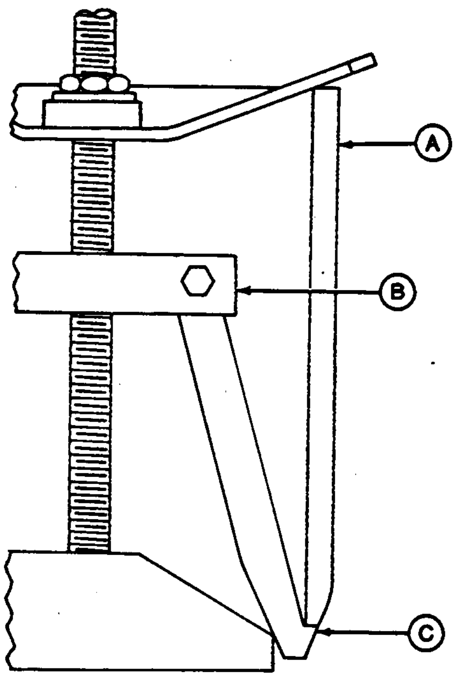
IMPORTANT: Keep matched pistons and liners together. Liners must be reinstalled in same cylinder bore.

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

RG,CTM42,G10,4 -19-12APR93

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.

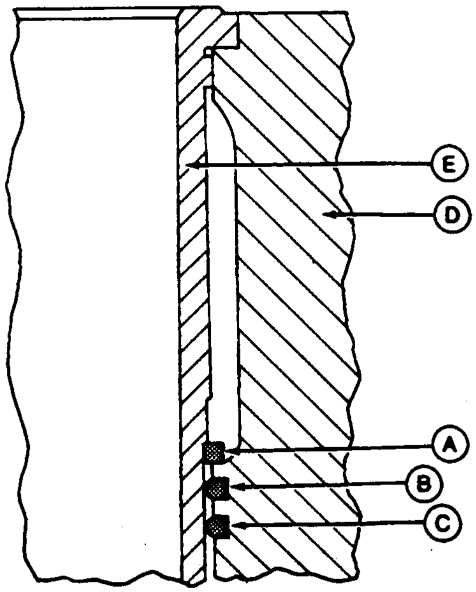


S11,0402,AK -19-02APR93

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—Liner



RG3825 -UN-13DEC88

RG,CTM42,G10,5 -19-07AUG91

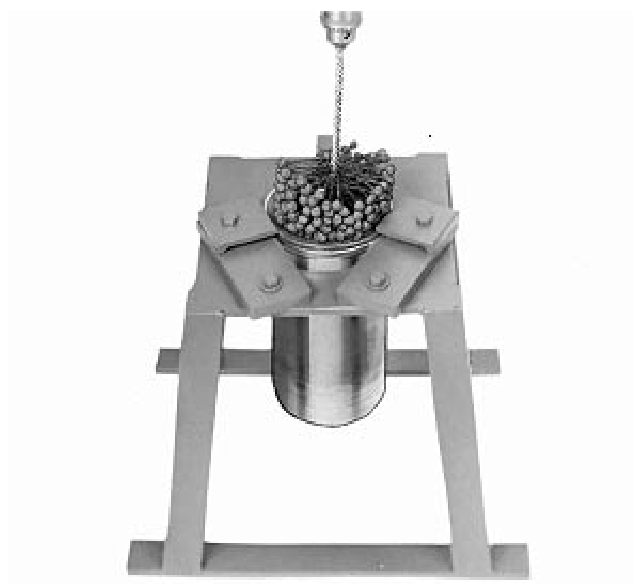
DEGLAZE CYLINDER LINERS

10
14

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

2. Use D17004BR Flexible Cylinder Hone to deglaze cylinder liner.

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

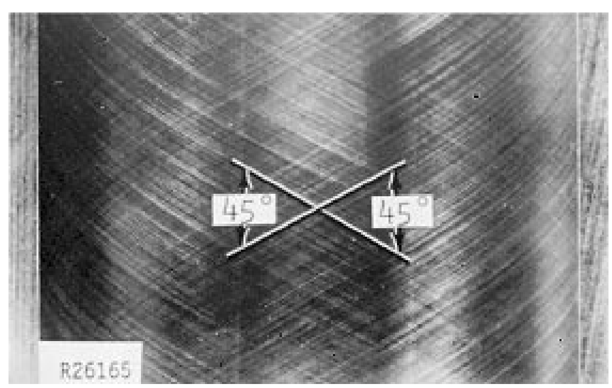


R26164 -UN-13DEC88

S11,0402,AS -19-08FEB95

3. Use D17005BR Hone according to instructions supplied with tool to obtain a 45° cross-hatch pattern.

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



R26165 -UN-13DEC88

S11,0402,AT -19-12APR93

CLEAN CYLINDER LINERS

1. Use a stiff bristle brush to remove all debris, rust, and scale from O.D. of liners, under liner flange, and in O-ring packing areas. Make certain there are no nicks or burrs in areas where packings will seat.

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

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

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

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

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

RG,CTM61,G10,9 -19-02APR93

DISASSEMBLE PISTON/ROD ASSEMBLY AND CLEAN PISTON

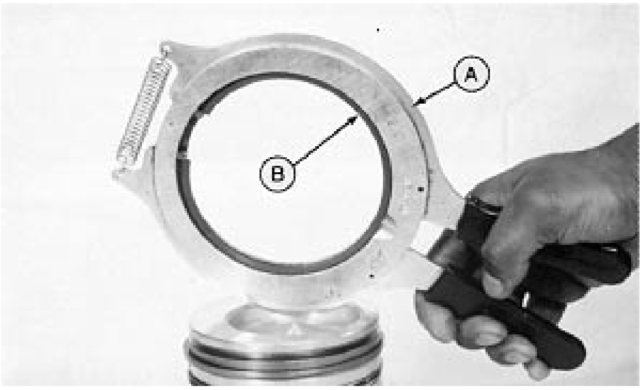
1. Remove piston snap rings. Remove piston pin and connecting rod from piston.

NOTE: Discard snap rings, DO NOT reuse.

RG5228 -UN-13DEC88

RG,CTM86,G10,11-19-14FEB95

2. Remove piston rings (B) using the JDE93 Piston Ring Expander (A). Discard rings.



RG5229 -UN-13DEC88

RG,CTM86,G10,12-19-14FEB95

3. Clean piston ring grooves using a piston ring groove cleaning tool.


RG6088 -UN-27JAN92

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. DO NOT bead blast ring groove areas.

4. Clean pistons by any of the following methods:

• Immersion-Solvent "D-Part"
• Hydra-Jet Rinse Gun
• Hot water with liquid detergent soap.

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

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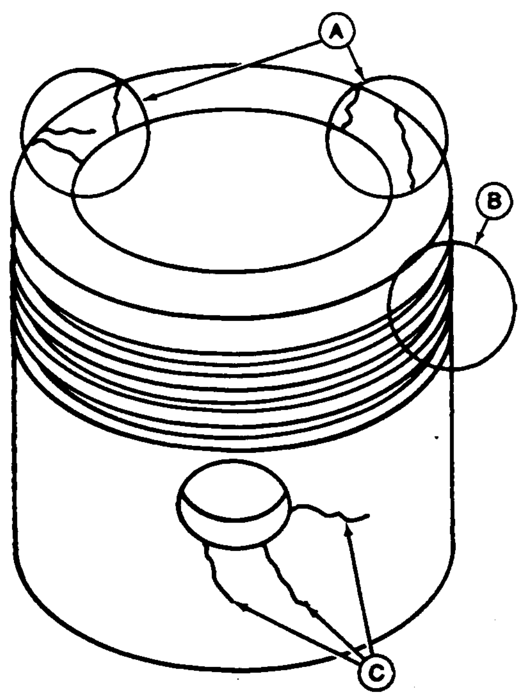
RG,CTM86,G10,13-19-14FEB95

VISUALLY INSPECT PISTONS



RG3326 -UN-13DEC88

1. Carefully inspect clean pistons under magnification. Check for:

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

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

(Defects Exaggerated)

RG,CTM61,G10,10-19-29OCT92

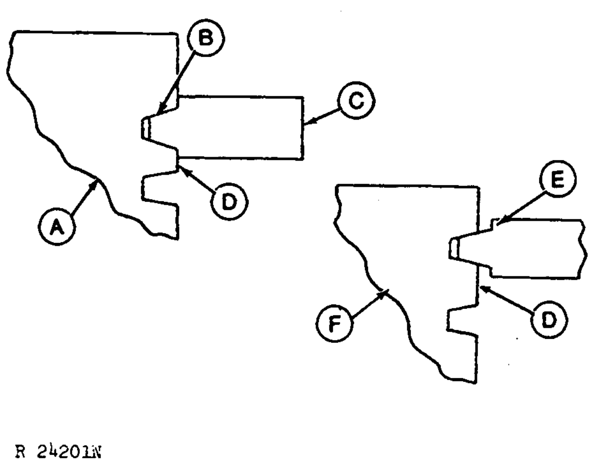
CHECK PISTON COMPRESSION RING GROOVE WEAR

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

RG,CTM42,G10,32-19-14FEB95

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

MEASURE OIL CONTROL RING GROOVE

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

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

OIL CONTROL RING-TO-GROOVE CLEARANCE SPECIFICATIONS

New Part Clearance	0.064—0.102 mm (0.0025—0.0040 in.)
Maximum Serviceable Clearance	0.165 mm (0.0065 in.)

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

S11,2010,JF -19-29OCT92

INSTALL PISTON PIN IN PISTON PIN BORE

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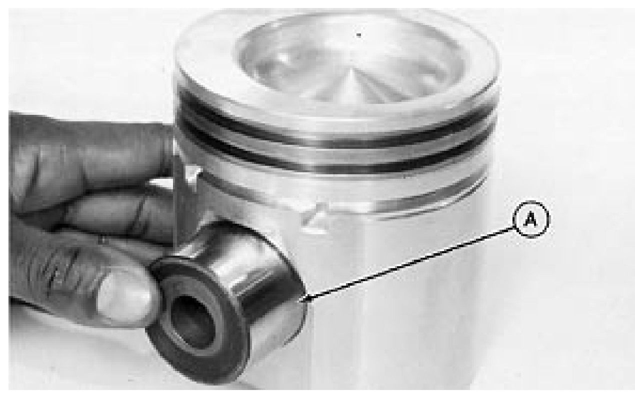
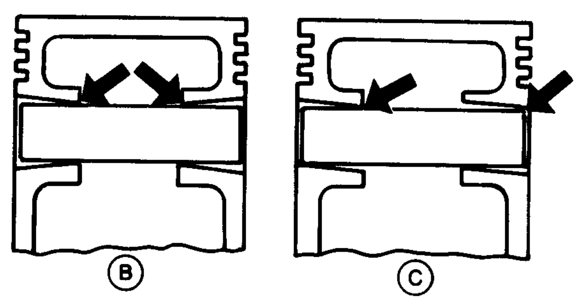


NOTE: Piston pin must be in good condition and not worn beyond specification given below.

1. Dip piston pin in clean engine oil.

2. Install pin (A) through piston.

Pin should pass through piston using only light thumb pressure. 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).



3. 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	47.60—47.61 mm (1.8739—1.8745 in.)
Piston Pin Bore ID	47.62—47.63 mm (1.8748—1.8752 in.)

RG,CTM42,G10,33-19-14FEB95

VISUALLY INSPECT CYLINDER LINERS

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

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

Replace piston and liner if:

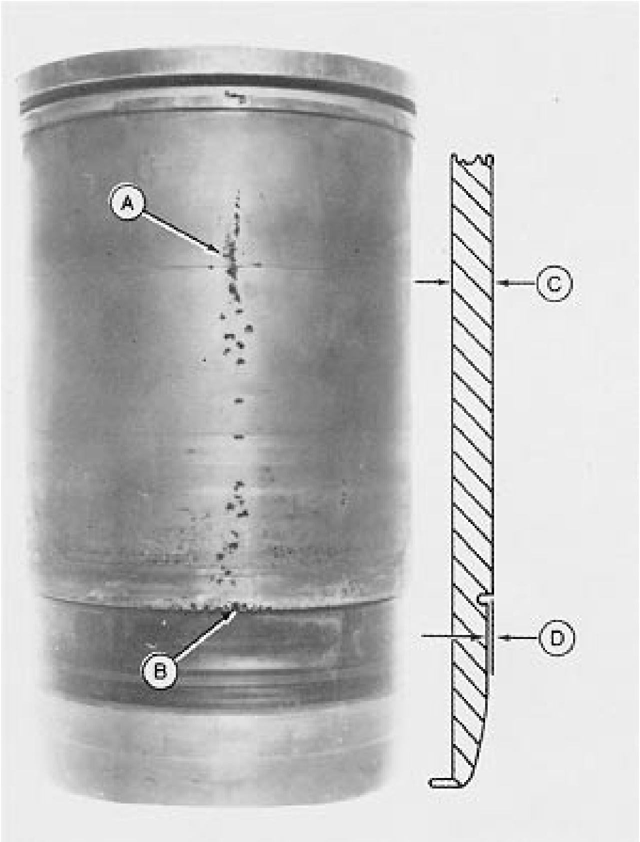
—Pitting depth is one-half liner thickness (C) or more.

—Erosion depth is one-half packing step (D) or more.

CYLINDER LINER SPECIFICATIONS

Cylinder Liner Thickness	6.05—6.15 mm (0.238—0.242 in.)
Packing Step Dimension	1.45—1.55 mm (0.057—0.061 in.)

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



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

RG,CTM42,G10,34-19-22JUL94

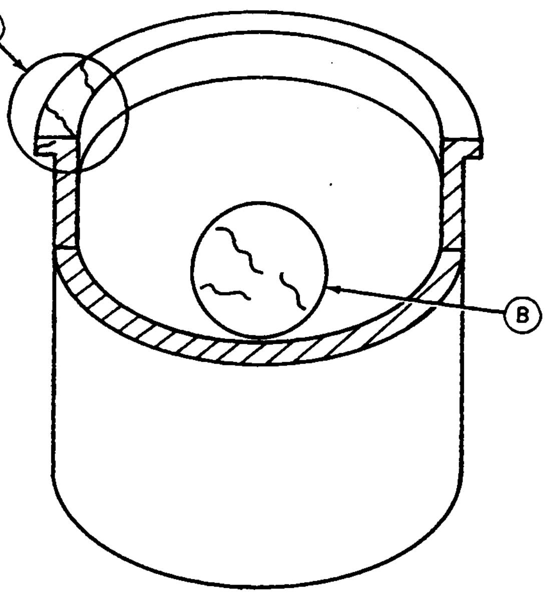
2. Visually examine liner ID. Replace piston and liner if:

— 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,G10,14-19-22JUL94

CYLINDER LINER MANUFACTURING DATE CODE EXPLANATION

RG5944 -UN-30AUG91

A manufacturing four-digit date code will appear on the liner. The following is an example of this four-digit date code:

HL90

H	Liner Material Type
L	Month Liner was Manufactured
90	Year Liner was Manufactured

Liner Material Specification

H	Hardened Bore

Month Liner was Manufactured

A	January
B	February
C	March
D	April
E	May
F	June
G	July
H	August
I	September
J	October
K	November
L	December

Year Liner Was Manufactured

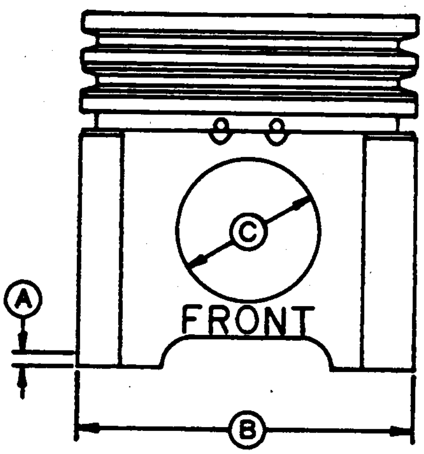
90	1990
91	1991

etc.

When installing new liners, the liner manufacturing date code should be toward the front of the engine. This will help with future repairs in knowing whether the liners have been moved or not during a previous repair.

RG,CTM42,G10,11-19-08MAR94

MEASURE PISTON SKIRT OD



RG5232 -UN-13DEC88

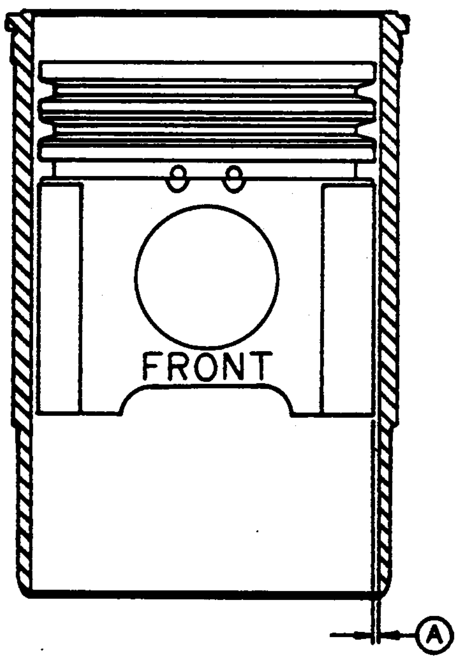
1. Measure piston skirt diameter (B) at right angles to piston pin bore (C) 19.1 mm (0.75 in.) from the bottom of the piston (A).

2. Measure cylinder liner as directed later in this group and compare with piston measurement.

PISTON SKIRT DIAMETER SPECIFICATION

Piston OD: 19.1 mm (0.75 in.) from Bottom of Skirt	115.771—115.789 mm (4.5579—4.5586 in.)

RG,CTM42,G10,35-19-17MAR95



RG5233 -UN-13DEC88

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

4. Compare liner ID measurement with piston skirt OD measurement to determine piston-to-liner clearance (A). Piston-to-liner clearance specifications are:

PISTON-TO-LINER CLEARANCE

New Part	0.076—0.124 mm (0.0030—0.0049 in.)
Maximum Wear Tolerance	0.152 mm (0.0060 in.)

Replace piston and liner as a matched set if clearance exceeds limit.

NOTE: Pistons and liners require replacement if liner taper or out-of-roundness (top-to-bottom in ring travel area) is more than 0.051 mm (0.0020 in). See MEASURE CYLINDER LINERS, later in this group.

RG,CTM42,G10,36-19-17MAR95

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MEASURE CYLINDER LINER ID

IMPORTANT: ALWAYS measure liners at room temperature.

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

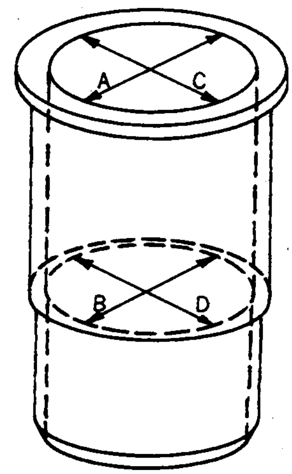
B—Measure bore in same position at bottom end of ring travel.

C—Measure bore at right angle to piston pin 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.

Compare liner ID with piston OD.



R25922 -UN-13DEC88

CYLINDER LINER SPECIFICATIONS

Maximum Wear or Taper in Ring Travel Area	0.051 mm (0.002 in)
Maximum Liner Out-of-Round	0.051 mm (0.002 in.)
Maximum Piston-to-Liner Clearance	0.15 mm (0.006 in.)

NOTE: Replace piston and liner (as a set) if they exceed wear specifications given.

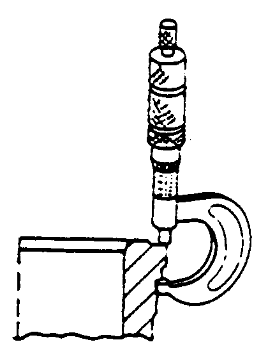
S11,2010,JQ -19-14FEB95

MEASURE CYLINDER 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 SPECIFICATIONS

Flange Thickness	8.175—8.225 mm (0.322—0.324 in.)



RG4727 -UN-13DEC88

S11,2510,AV -19-16AUG94

INSPECT AND MEASURE CONNECTING ROD BEARINGS

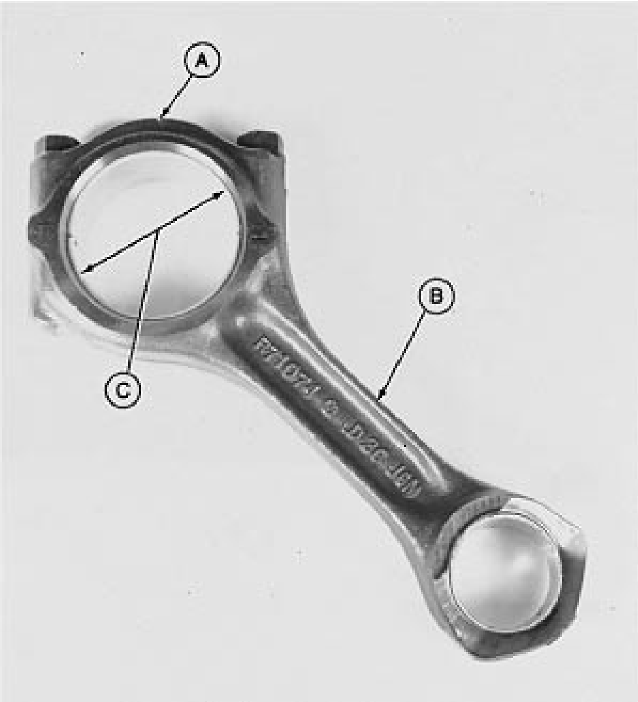
IMPORTANT: Never use new connecting rod cap screws when checking rod bearing ID. Use new cap screws only for final assembly of connecting rods.

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, described later in this group.)



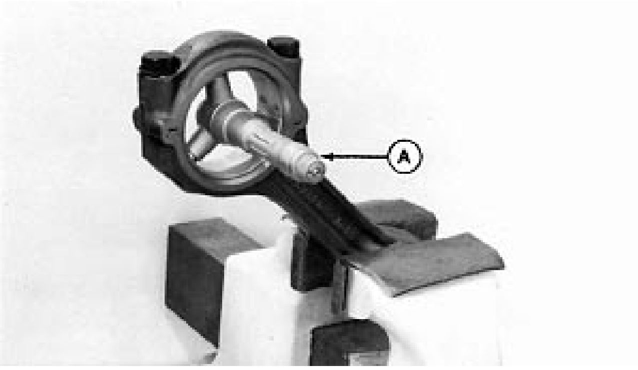
RG5705 -UN-01APR91

RG,CTM42,G10,40-19-29OCT92

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

5. Subtract OD of crankshaft journals from ID of rod bearings to obtain oil clearance.

6. Compare measurements with the following specifications.



RG3824 -UN-13DEC88

CONNECTING ROD BEARING AND JOURNAL SPECIFICATIONS

Crankshaft Journal OD	76.150—76.180 mm (2.9980—2.9992 in.)
Assembled Rod Bearing ID	76.210—76.260 mm (3.0005—3.0025 in.)
Oil Clearance (new parts)	0.030—0.110 mm (0.0012—0.0044 in.)
Wear Limit	0.152 mm (0.0060 in.)

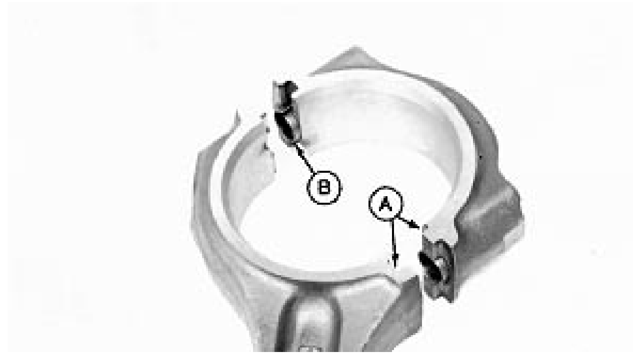
7. Inspect connecting rod bearings for wear or damage. If bearings are worn or not within specification, replace both connecting rod bearing and rod pin bearing.

S11,2010,JR -19-14FEB95

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 -19-08MAR94

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.

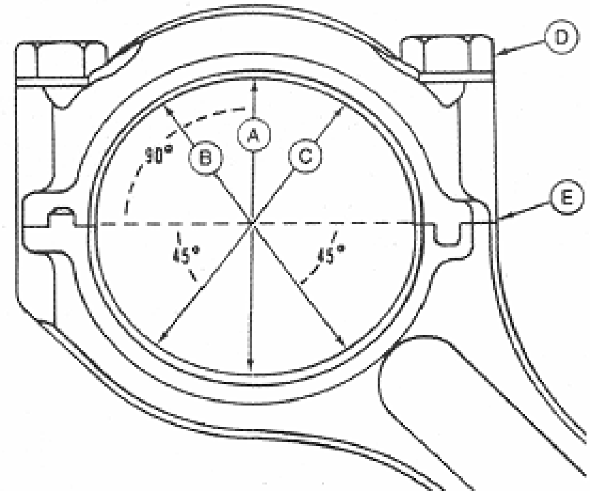
6. Tighten cap screws to 75 N·m (55 lb-ft), then tighten each cap screw an additional 90°—100°. (See TORQUE-TURN CONNECTING ROD CAP SCREWS, later in this group.)

RG4982 -UN-13DEC88

S11,2010,JS -19-14FEB95

6. 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˚ left of measurement “A”.
C. At 45˚ right of measurement “A”.



RG6661 -UN-11MAR93

ROD BORE SPECIFICATIONS

Rod Bore ID . . . . 81.051—81.077 mm (3.191—3.192 in.)

7. Compare the measurements. If difference between the greatest and least measurement is more than 0.04 mm (0.0016 in.), the rod and cap are out-of-round. Replace both connecting rod and cap.

8. Remove cap screw (D). Using a feeler gauge, measure gap at rod/cap joint (E). If gap is excessive, mating surfaces of rod and cap are worn and must be replaced.

ROD CAP SPECIFICATION

Maximum End Gap . . . . 0.25 mm (0.010 in.)

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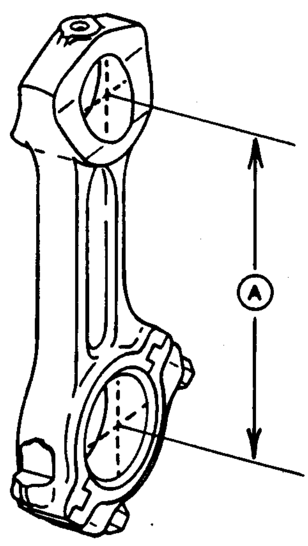
S11,2010,JU -19-12APR93

9. Measure connecting rod pin bore-to-crankshaft bore center-to-center dimension (A) and compare with specification given. If measurement is not within specification, replace rod.



RG6455 -UN-22OCT92

CENTERLINE OF PISTON BORE-TO-CRANKSHAFT BORE

New part . . . . 222.20—222.30 mm (8.748—8.752 in.)

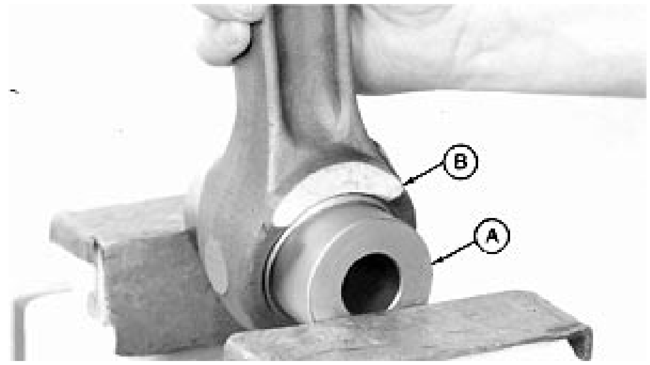
RG,CTM42,G10,37-19-16AUG94

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 vise and connecting rod.

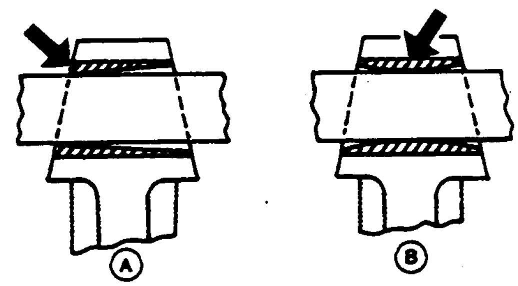


RG3172 -UN-13DEC88

S11,2010,DM -19-08MAR94

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. Measure ID of rod pin bushing and OD of piston pin. Compare measurements with specifications given below:



RG4983 -UN-13DEC88

PISTON PIN BORE SPECIFICATIONS

OD of Piston Pin	47.597—47.613 mm (1.8739—1.8745 in.)
ID of Pin Bore in Piston	47.620—47.630 mm (1.8748—1.8752 in.)
ID of Installed Rod Pin Bushing (After Boring)	47.655—47.681 mm (1.8762—1.8772 in.)
Rod Pin-to-Bushing Oil Clearance	0.042—0.084 mm (0.0017—0.0033 in.)
Maximum Serviceable	0.102 mm (0.0040 in.)

6. If necessary, remove and replace piston pin bushing. See REMOVE PISTON PIN BUSHING, CLEAN AND INSPECT PIN BORE, later in this group.

S11,2010,JG -19-14SEP94

REMOVE PISTON PIN BUSHING

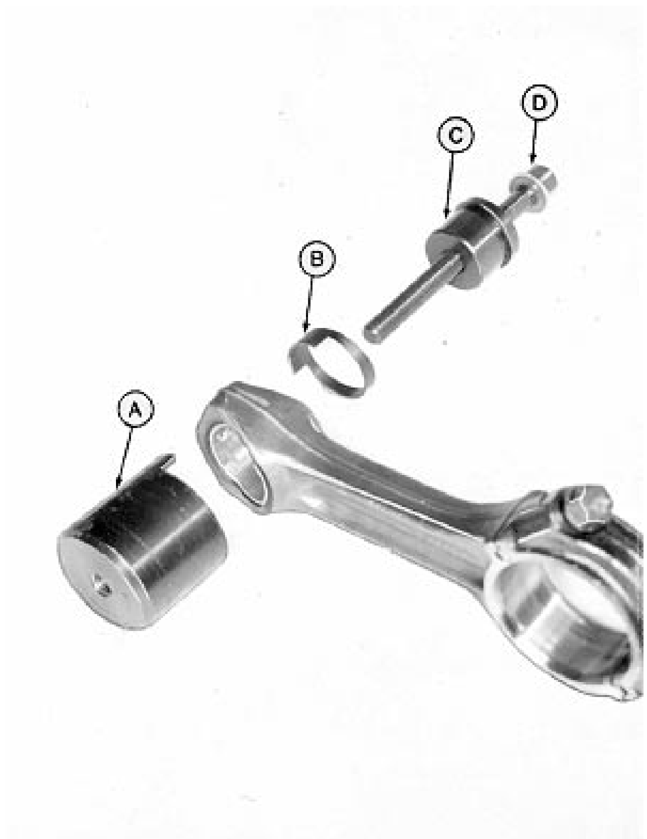
IMPORTANT: Do not use any power tool to remove or install piston pin bushing.

1. If necessary, remove pin bushing with the JDG337 Connecting Rod Bushing Service Set.

Use the following tools from the service set:

A—JDG339 Cup
B—JDG338 Adapter
C—JDE98-4 Driver
D—STD36104 Forcing Screw with Washer

IMPORTANT: Use care to properly align the JDE98-4 Driver with bushing so that the connecting rod bushing bore is not damaged.



RG4985 -UN-13DEC88

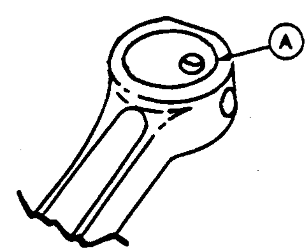
S11,2010,J1 -19-12APR93

CLEAN AND INSPECT CONNECTING ROD PIN BORE

1. Clean rod bushing bore using a medium grit emery cloth, as burrs will distort bushing. Install bushing on opposite side of 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 pin bore in three places approximately 45° apart. Compare the measurements with the specifications given below:



RG5227 -UN-13DEC88

CONNECTING ROD PIN BORE SPECIFICATIONS
(Bushing Removed)

ID of Rod Pin Bore . . . . 52.354—52.380 mm (2.0612—2.0622 in.)

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

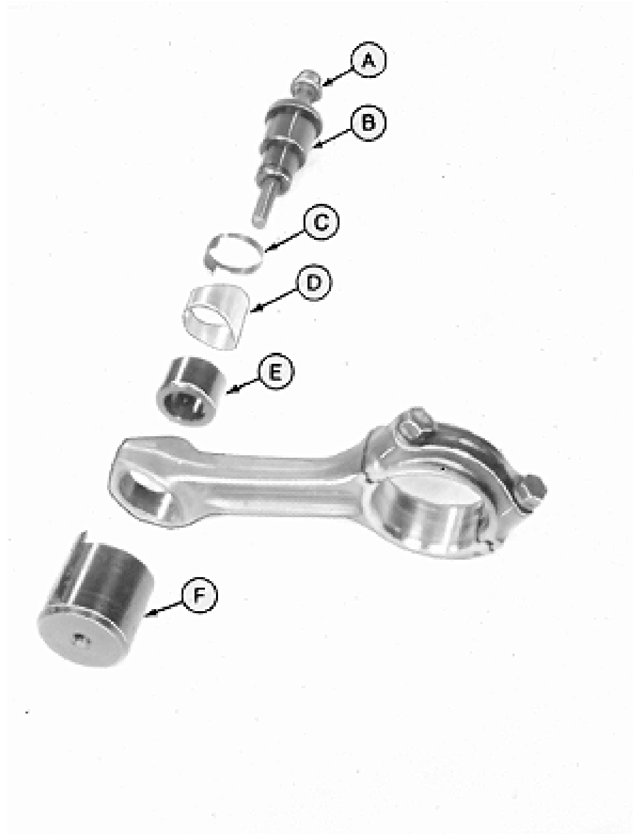
S11,2010,JJ -19-12APR93

INSTALL PISTON PIN BUSHING IN ROD

1. Lubricate rod bushing bore and bushing with clean engine oil. Install bushing using the JDG337 and JDE98A Connecting Rod Bushing Service Sets.

Use the following tools from the above sets and assemble in sequence as shown:

A—STD36104 Forcing Screw With Washer
B—JDE98A Driver
C—JDG338 Adapter
D—Service Bushing
E—JDE98-3 Pilot
F—JDE339 Cup



RG4986 -UN-13DEC88

IMPORTANT: Be sure oil hole in service bushing and connecting rod are properly aligned.

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

2. Precision bore and hone bushing to the specified dimensions.

CONNECTING ROD PIN BORE AND BUSHING SPECIFICATIONS

Rod Pin Bore-to-Bushing Press Fit Specification	0.084—0.147 mm (0.0033—0.0058 in.)
ID of Installed Service Rod Pin Bushing (Before Honing)	47.579—7.628 mm (1.8732—1.8751 in.)
ID of Installed Rod Pin Bushing (After Honing)	47.655—47.681 mm (1.8762—1.8772 in.)
Bearing Bore-to-Pin Bushing Bore (Center-to-Center) Length	222.20—222.30 mm (8.748—8.752 in.)

3. Check piston pin-to-rod pin bushing clearance. See INSPECT PISTON PINS AND BUSHINGS, earlier in this group. Replace piston pin as required.

S11,2010,JK -19-16AUG94

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) Remove starting motor.

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

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

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

6. If necessary to “Hot Tank” the block, remove oil gallery plugs, water gallery plugs, piston cooling orifices and the engine serial number plate. (See REMOVE AND CLEAN PISTON COOLING ORIFICES, later in this group.)

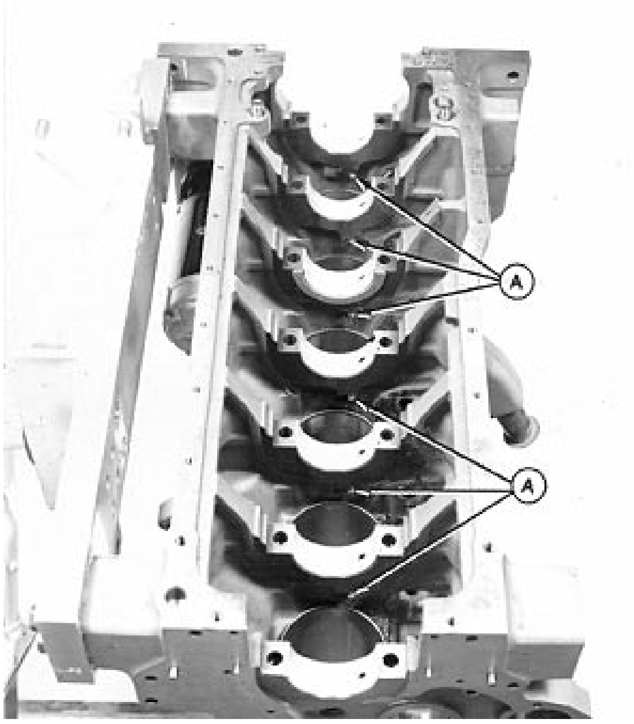
RG,CTM42,G10,6 -19-22JUL94

REMOVE AND CLEAN PISTON COOLING ORIFICES

1. Remove all six 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.



RG5811 -UN-12AUG91

RG,CTM42,G10,7 -19-29OCT92

INSPECT AND CLEAN CYLINDER BLOCK

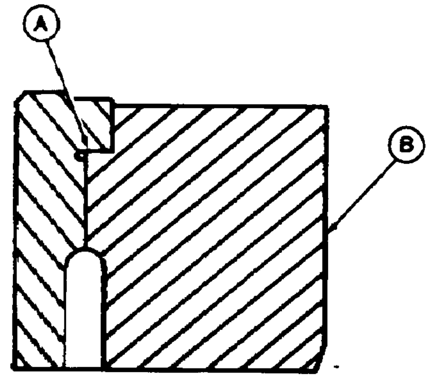
NOTE: All components (including piston cooling orifices), water gallery plugs and oil gallery plugs must be removed from the cylinder block for inspection and cleaning. Refer to the proper group for removal of all external and internal mounted components.

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.

RG,CTM42,G10,38-19-29OCT92

2. 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.



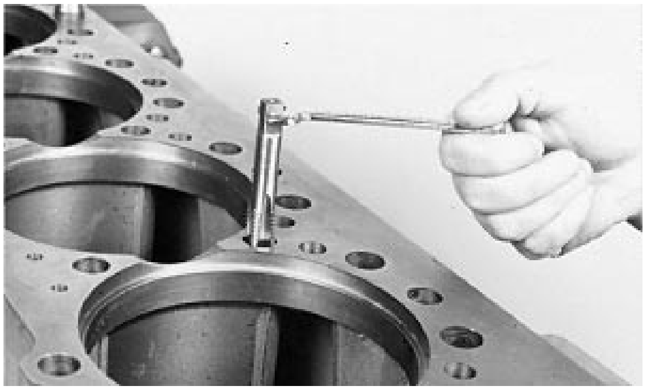
RG3329 -UN-13DEC88

NOTE: DO NOT file liner support flange excessively. Excess filing can damage liner support flange and allow an improper liner fitting. Thoroughly clean all filings from cylinder block (B).

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

COUNTERBORE DEPTH AND LINER FLANGE SPECIFICATIONS

Cylinder Liner Counterbore Depth	8.105—8.155 mm (0.319—0.321 in.)
Liner Flange Thickness	8.175—8.225 mm (0.322—0.324 in.)



RG5796 -UN-12AUG91

4. When determined that the cylinder block is serviceable, remove cylinder head locating dowels. Clean out all threaded holes for cylinder head cap screws in top deck of cylinder block. Use JDG681A Tap or an equivalent 9/16-12 UNC-2A tap approximately 114.3 mm (4.5 in.) long. Use compressed air to remove any debris or fluid which may be present in the cap screw hole.

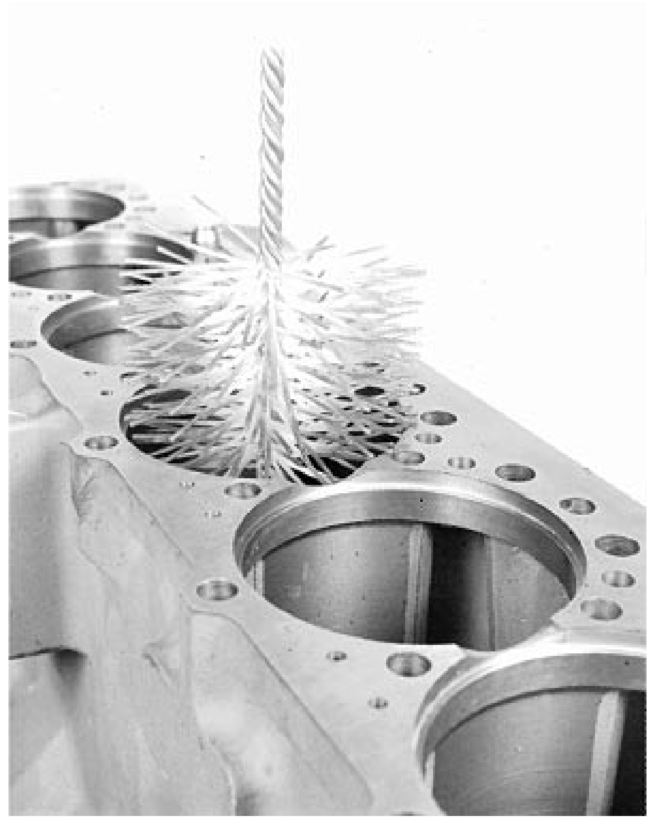
5. Install new locating dowel pins in cylinder block.

RG,CTM42,G10,8 -19-17MAR95

CLEAN CYLINDER LINER O-RING BORE

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.



RG5812 -UN-12AUG91

RG,CTM42,G10,9 -19-12APR93

MEASURE CYLINDER BLOCK

1. Assemble and measure main and thrust bearing bores. Compare measurements with specifications given below:

MAIN AND THRUST BEARING SPECIFICATIONS

Main and Thrust Bearing Bore ID Without Bearing	92.125—92.151 mm (3.627—3.628 in.)
Main Bearing Surface Width	36.28—36.78 mm (1.428—1.448 in.)
Thrust Bearing (No. 5 Main) Surface Width	37.44—37.54 mm (1.474—1.478 in.)
Overall Thrust Bearing Cap Width	39.16—39.66 mm (1.542—1.561 in.)

If any main or thrust bearing cap assembled ID is not within specification, blank (generic) bearing caps are available and must be lined bored to specification. (See Group 15-Crankshaft, Main Bearings, and Flywheel.)

S11,2010,JH -19-29OCT92

2. Measure cam follower bore diameter at all bore locations. Record measurements by bore location.

CAMSHAFT FOLLOWER AND BORE SPECIFICATIONS

Cam Follower Bore ID . . . . 17.384—17.440 mm (0.6845—0.6865 in.)

Cam Follower OD . . . . 17.33—17.35 mm (0.682—0.683 in.)

Maximum Cam Follower-to-Bore Clearance . . . . 0.114 mm (0.0045 in.)

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

S11,2010,JV -19-12APR93

3. Measure camshaft bore diameter at all locations and record readings. Compare measurements with specifications given in chart below:


RG5830 -UN-12AUG91

CAMSHAFT BUSHING AND BORE SPECIFICATION

Camshaft Bushing Installed ID . . . . 67.076—67.102 mm (2.6408—2.6418 in.)

Camshaft Bushing Bore in Block . . . . 69.987—70.013 mm (2.7554—2.7564 in.)

Maximum Runout of Camshaft Bushing Bore in Block . . . . 0.038 mm (0.0015 in.)

New Camshaft Bushing-to-Journal Clearance . . . . 0.063—0.115 mm (0.0025—0.0045 in.)

If camshaft bushing bore diameter in block is more than specified, install a new cylinder block.

RG,CTM42,G10,22-19-14FEB95

4. Measure cylinder block top deck flatness using D05012ST Precision Straightedge and feeler gauge. Resurface as required.

CYLINDER BLOCK TOP DECK SPECIFICATIONS

Maximum Out-of-Flat (Over Entire Length or Width) . . . . 0.10 mm (0.004 in.)

Straightness per Any 305 mm (12 in.) Length . . . . 0.025 mm (0.001 in.)

Minimum Main Bearing Bore Centerline-to-Top Deck Distance . . . . 352.35 mm (13.872 in.)

IMPORTANT: The centerline of the main bearing bore-to-top deck of cylinder block MUST be 352.35—352.50 mm (13.872—13.878 in.). If not, replace cylinder block.

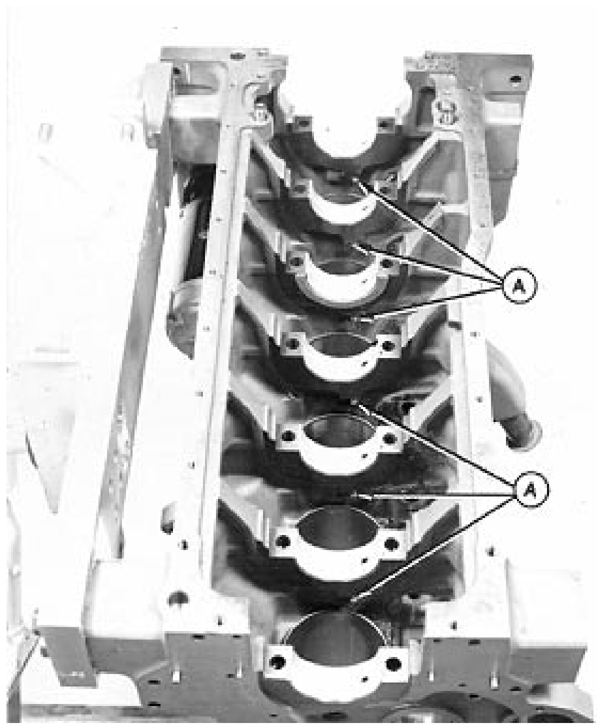
S11,2010,JW -19-16AUG94

INSTALL PISTON COOLING ORIFICES AND GALLERY 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 piston cooling orifices (A) and tighten to 11 N·m (97 lb-in.).

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



RG5811 -UN-12AUG91

RG,CTM42,G10,10-19-29OCT92

RECHECK CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

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

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

1. Install liners without O-ring. Secure with cap screws and washers and measure liner standout. See MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK), earlier in this group.

Liner shims may be used to bring to bring standout within specification. (See INSTALL LINER SHIMS—IF REQUIRED, later in this group.)

RG,CTM42,G10,23-19-22JUL94

INSTALL LINER SHIMS—IF REQUIRED

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

The liner shim is 0.05 mm (0.002 in.) thick. A maximum of two liner shims may be used per cylinder, as required. Shims have tangs in the I.D. to help hold them in place against bottom of liner flange during liner installation.

1. Make sure counterbore in block is clean and free of burrs. Install liner(s), and shim(s), in block bore without O-rings. Secure liners with cap screws and washers as done previously. Tighten cap screws to 68 N·m (50 lb-ft).

Liner standout MUST NOT exceed 0.102 mm (0.004 in.) after shim installation.

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

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

If standout is within specification, proceed to next step.

RG,CTM6,G10,2 -19-08MAR94

INSTALL CYLINDER LINER O-RINGS AND PACKINGS

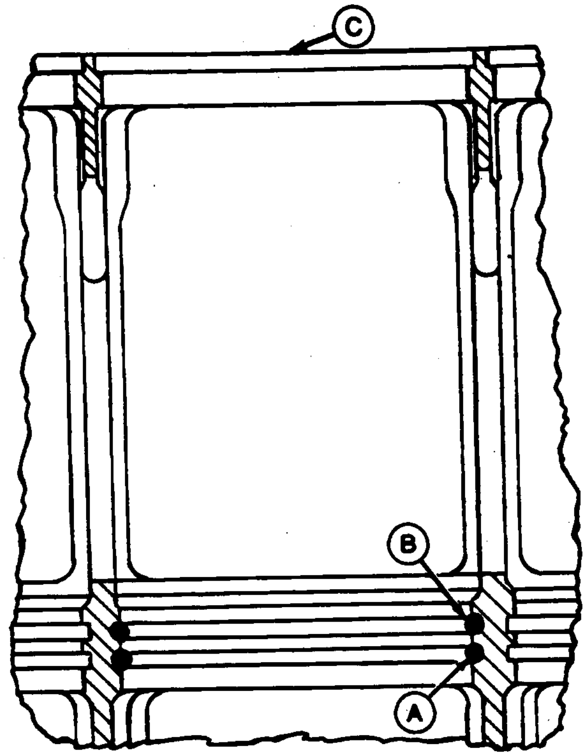
IMPORTANT: DO NOT use oil on cylinder liner packing or O-rings. Oil can cause the red packing to swell, which squeezes liner and could possibly cause a scored piston.

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

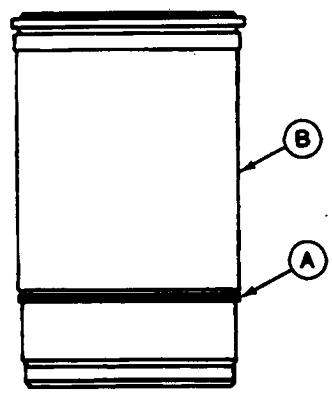
S11,0402,BA -19-16AUG94

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

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

NOTE: Make sure the square packing is not twisted.

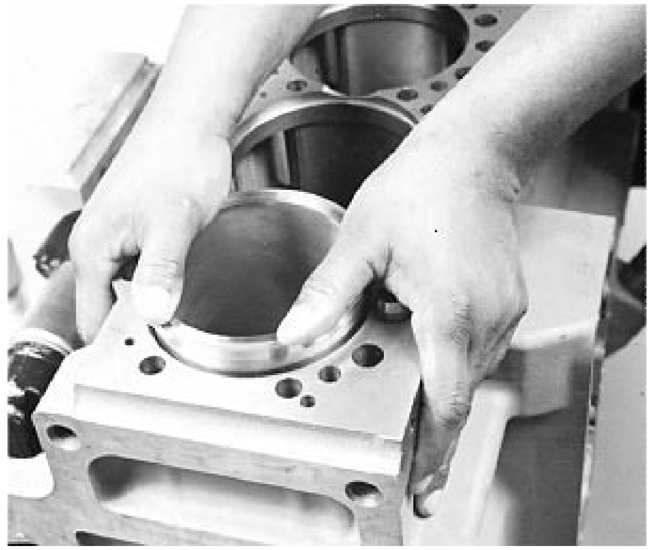
7. Coat the liner packings sealing area of the cylinder liner and cylinder block O-rings with liquid soap.



RG3827 -UN-13DEC88

S11,2010,JT -19-29OCT92

INSTALL CYLINDER LINERS


RG5814 -UN-12AUG91

IMPORTANT: Install cylinder liners into same cylinder block bore as removed.

DO NOT scuff liner packing across upper counterbore.

Pitted or eroded liners that meet reuse guidelines should be rotated 90° from their removed position. See VISUALLY INSPECT CYLINDER LINERS, earlier in this group for reuse guidelines.

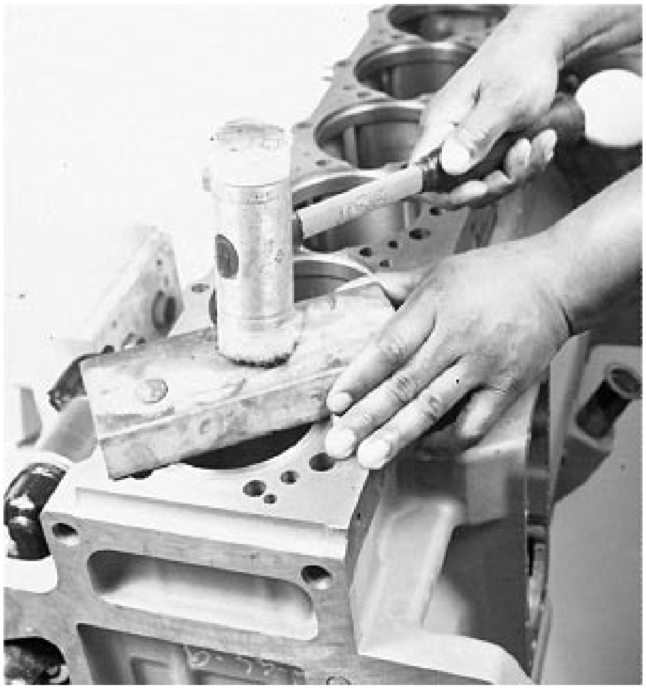
1. Install liner and packing in block bore with mark toward front of engine, unless liner OD is pitted or eroded.

If liner OD is pitted or eroded, but still within acceptable service limits, rotate liner 90° from it's removed position. Pitted sections of the liner should be facing the front or rear of engine.

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

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

RG,CTM42,G10,12-19-12APR93



RG5815 -UN-12AUG91

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

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

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

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

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

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

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

RG,CTM42,G10,13-19-14FEB95

INSTALL PISTONS AND CONNECTING RODS

IMPORTANT: Pistons must be installed on same connecting rod from which they were removed.

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. Use the JDE93 Ring Expander to install piston rings (F) and oil control ring with expander ring (E).

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

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

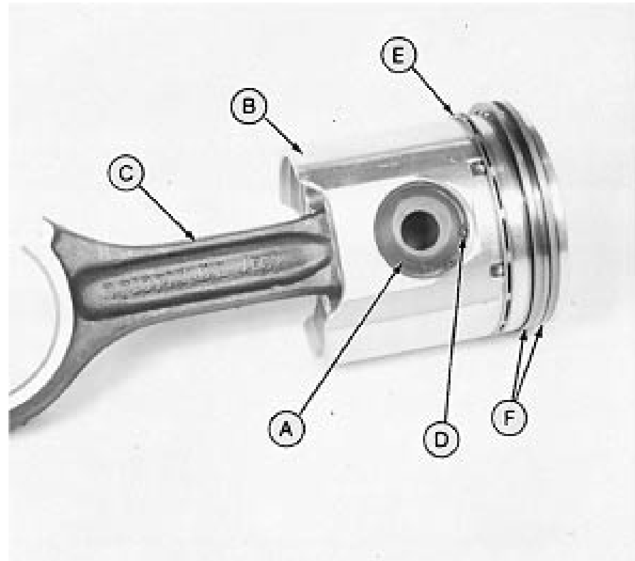
2. Lubricate piston pin (A) and bushing with clean engine oil.

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

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

PISTON COMPRESSION RING END GAP SPECIFICATIONS

Pistons Stamped RE50868:	
No. 1	0.43—0.69 mm (0.017—0.027 in.)
No. 2	0.63—0.89 mm (0.025—0.035 in.)
Pistons Stamped RE57512:	
No. 1	0.43—0.69 mm (0.017—0.027 in.)
No. 2	1.27—1.52 mm (0.050—0.060 in.)



RG5239 -UN-13DEC88

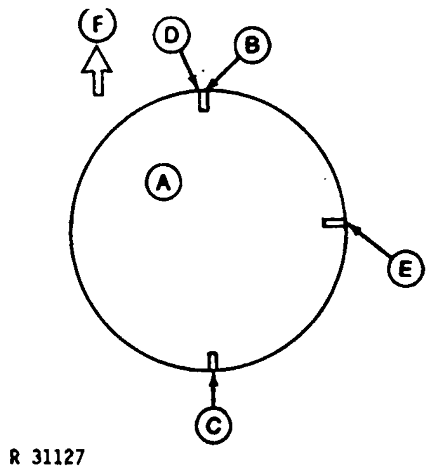
A—Piston Pin
B—Piston
C—Connecting Rod
D—Snap Rings (2 used)
E—Oil Control Ring with Expander Ring
F—Piston Rings

S11,2010,JO -19-16AUG94

5. Stagger ring gap on pistons as shown.

NOTE: If crankshaft was removed, see INSTALL CRANKSHAFT in Group 15.

6. Coat pistons, liners and ID of JDE96 Piston Ring Compressor with clean engine oil.



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

S11,2010,JW1 -19-07AUG91

7. Carefully place ring compressor with piston and rod over liner.

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

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

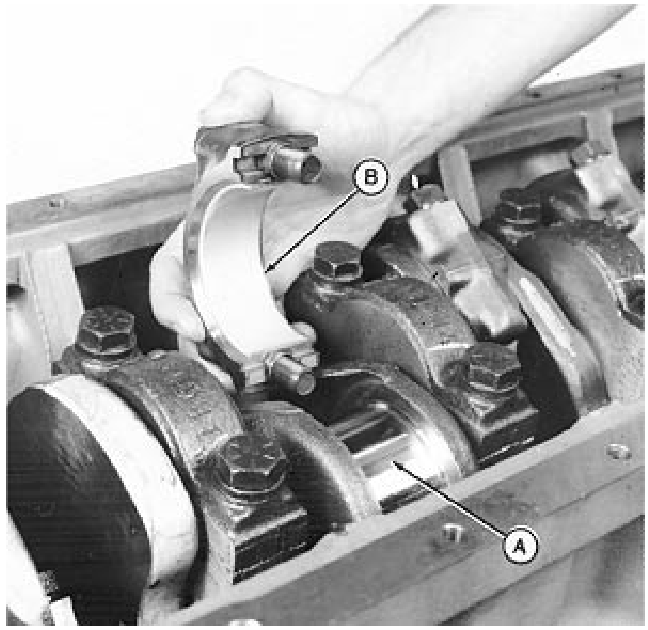
8. With piston centered in ring compressor and rings staggered correctly, push piston into liner.

RG,CTM42,G10,14-19-02NOV92

9. 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 asssembly.

10. Install connecting rod caps.



RG5817 -UN-12AUG91

RG,CTM42,G10,15-19-12APR93

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

IMPORTANT: Using pneumatic wrenches to install cap screws may cause damage to the threads.

12. Initially tighten cap screw (A) to 27 N·m (20 lb-ft) before tightening the other cap screw.

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

14. Finally TORQUE-TURN all cap screws 90—100˚. (See USE TORQUE-TURN METHOD FOR PROPER TORQUE, described next in this group.)

RG5818 -UN-12AUG91

RG,CTM42,G10,16-19-29OCT92

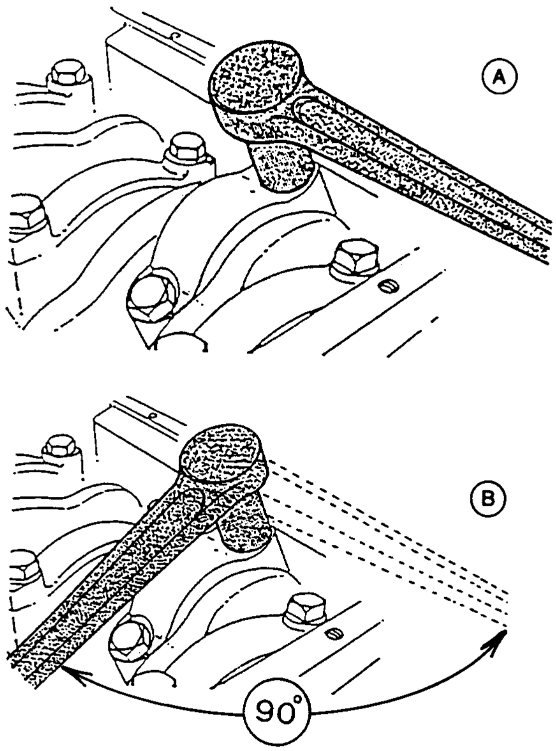
TORQUE-TURN CONNECTING ROD CAP SCREWS

• Using engine axis 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.

2. Position handle of wrench parallel to centerline of engine crankshaft axis (A).

3. Tighten 1/4 turn (90—100˚) clockwise until handle of wrench is perpendicular to centerline of engine crankshaft axis (B) as shown.

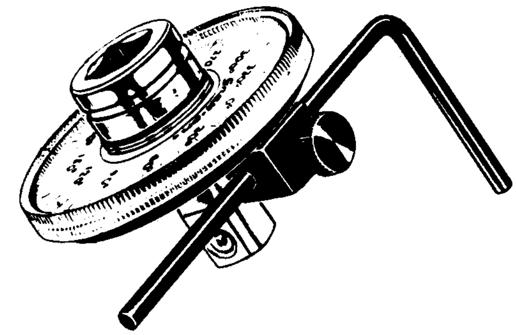


RG7047 -UN-28JUL94

RG,CTM86,G10,41-19-14FEB95

• 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

RG5698 -UN-27AUG90

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

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 -19-08MAR94

COMPLETE FINAL ASSEMBLY

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

1. Install camshaft and timing gear cover. (Group 16)

2. Install oiling system components. (Group 20)

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

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

5. Install water bypass pipe. (Group 25)

6. Install crankshaft pulley. (Group 15)

7. Install alternator, fan, and fan belts. (Machine Technical Manual)

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

9. Install starting motor, if removed.

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

11. Perform engine break-in. (Group 05)

RG,CTM42,G10,17-19-14FEB95

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

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.

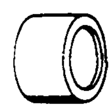
RG6246 -UN-27MAR92

RG,D17526CI -19-29OCT92

RG5080 -UN-23AUG88

Front Wear Sleeve Installer JDE3

Install front oil seal in timing gear cover.

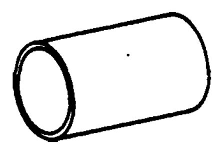


S53,JDE3A -19-16AUG94

RG5108 -UN-23AUG88

Gear Driver JDH7

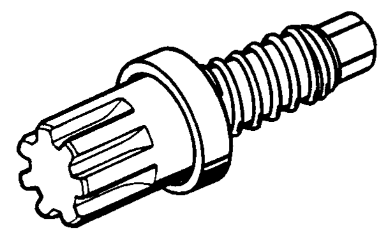
Install crankshaft drive gear.



S53,JDH7 -19-04AUG94

Flywheel Turning Tool JDG820

Used to rotate engine to check damper radial runout and time engine. JDE81-1 may be used also if JDG820 is not available.



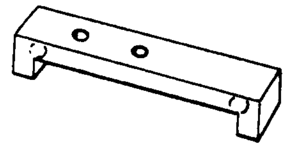
RG7056 -UN-10AUG94

RG,JDG820 -19-14FEB95

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.



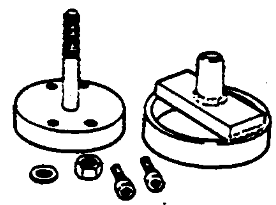
RG7029 -UN-30SEP94

RG,JDG451 -19-28SEP94

Seal and Wear Sleeve Installer . . . . JDG476(85)

Used to simultaneously install the new teflon unitized oil seal and wear sleeve on the rear crankshaft flange. Use with JDG796 Alignment Tool to install rear oil seal housing eliminating need for dial indicator to measure runout.

Consists of:
JDG477(85) Pilot
JDG478 Driver



RG5106 -UN-23AUG88

S11,2515,BW -19-03MAY93

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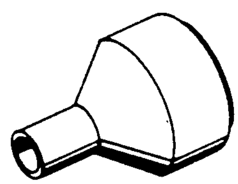
2

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



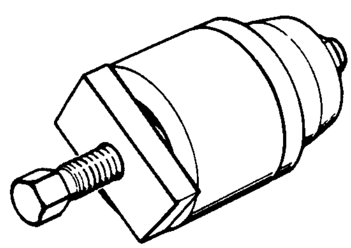
RG6214 -UN-06MAR92

RG,JDG719 -19-29OCT92

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 Installer JDG720-3
4—Ring (500 Series Engines) JDG720-4

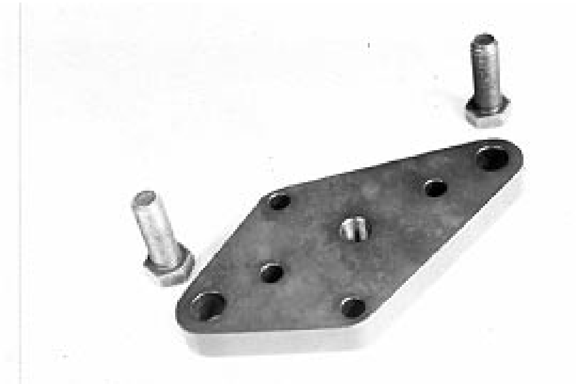


RG6215 -UN-06MAR92

RG,JDG720 -19-01APR93

Hub Puller Kit JDG721

Used with JDG787 Thread Protector to remove vibration damper pulley assembly on some engine applications.

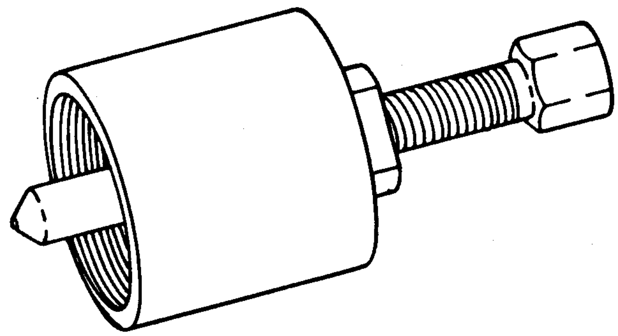


RG5763 -UN-06AUG91

RG,JDG721 -19-03MAY93

Front Wear Sleeve Puller JDG786

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

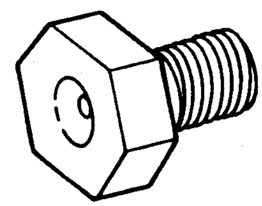


RG6428 -UN-13OCT92

RG,JDG786 -19-29OCT92

Thread Protector JDG787

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



RG6429 -UN-13OCT92

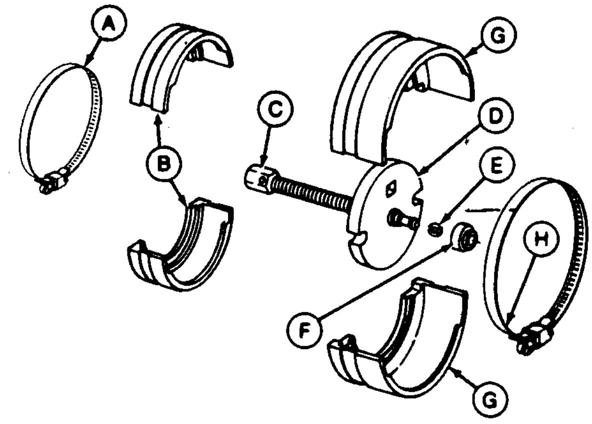
RG,JDG787 -19-03FEB93

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



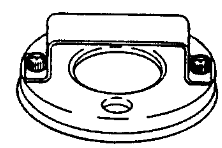
RG6457 -UN-22OCT92

RG,JDG790 -19-03OCT94

RG6590 -UN-18FEB93

Oil Seal Housing Alignment Tool JDG796

Use with oil seal housing casting numbers R115050 and R125027.



RG,JDG796 -19-08AUG94

15
4

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
D01251AA Puller*	Used to remove crankshaft gear.

**Name*Part of D01047AA 17-1/2 and 30-Ton Puller Set*

RG,CTM42,G15,32-19-11JUN93

OTHER MATERIAL

Name	Use
LOCTITE 242 (TY9370) Thread Lock and Sealer	Coat threads of flywheel mounting cap screws.
LOCTITE 515 (TY6304) Flexible Sealant (General Purpose)	Coat trimmed flywheel housing-to-cylinder block gasket.
LOCTITE 609 (TY15969) Retaining Compound	Coat OD of crankshaft flange for installation of rear oil seal/wear sleeve.
PLASTIGAGE	Check main bearing-to-crankshaft journal oil clearance during engine disassembly.
Brake Kleen or Ignition Cleaner and Drier	Remove sealant from crankshaft flange.

S11,2015,EE -19-11OCT94

CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Crankshaft Fillet Radius:		
Pin Journal	3.94—4.44 mm (0.156—0.175 in.)	——
Thrust Journal	3.56—4.06 mm (0.140—0.160 in.)	——
Main Journal	3.94—4.44 mm (0.156—0.175 in.)	——
Engine Stroke	121 mm (4.75 in.)	
Crankshaft End Play	0.038—0.380 mm (0.0015—0.0150 in.)	——
Main Bearing Journal OD	85.65—85.67 mm (3.372—3.373 in.)	——
Main Bearing Assembled ID	85.705—85.755 mm (3.3742—3.3762 in.)	——
Main Bearing-to-Journal Clearance	0.030—0.108 mm (0.0012—0.0042 in.)	——
Connecting Rod Journal OD	76.15—76.18 mm (2.9980—2.9990 in.)	——
Crankshaft Rear Oil Seal-to-Housing Maximum Runout	0.152 mm (0.0060 in.)	——
Journal Taper per 25.4 mm (1.00 in.) Length	0.0025 mm (0.0001 in.)	——
Journal Out-of-Roundness	0.025 mm (0.0010 in.)	——
Undersized Bearings Available	0.05, 0.25, 0.51 and 0.76 mm (0.002, 0.010, 0.020, and 0.030 in.)	——
Oversize Thrust Washer Available	0.18 mm (0.007 in.)	——
Main Bearing Cap Bore Specifications:		
ID without Bearing Inserts	92.125—92.151 mm (3.6270—3.6280 in.)	——
Maximum Bore Diameter Taper	0.008 mm (0.0003 in.)	——
Maximum Bore Diameter Variation	0.013 mm (0.0005 in.)	——
Maximum Straightness Variation (Any Bore-to-Adjacent Bores)	0.038 mm (0.0015 in.)	——
Maximum Straightness Variation (5 Center Bores-to-End Bores)	0.076 mm (0.0030 in.)	——
Centerline of Bore-to-Top Deck of Block	352.35—352.50 mm (13.872—13.878 in.)	——
Main Bearing Cap Surface Width	36.28—36.78 mm (1.428—1.448 in.)	——

RG,CTM42,G15,37-19-14FEB95

CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
No. 5 Main (Thrust) Bearing:		
Surface Width		
(Thrust Washer Clearance)	37.44—37.54 mm (1.474—1.478 in.)	——
Overall Cap Width	39.16—39.66 mm (1.542—1.561 in.)	——
Base Circle OD for Thrust Washer Clearance*	123.70—125.30 mm (4.87—4.93 in.)	——
Crankshaft OD for Front Pulley	47.650—47.676 mm (1.8785—1.876 in.)	——
Front Pulley ID	47.594—47.630 mm (1.8738—1.8752 in.)	——
Damper Pulley		
Radial Runout (Maximum)	1.02 mm (0.040 in.)	——
Front Oil Seal Housing		
Install Below Front of Timing Gear Cover (Maximum)	8.4 mm (0.33 in.)	——
Oil Pump Drive Gear-to-Crankshaft Clearance	0.38 mm (0.015 in.)	——
Maximum Rear Oil Seal Housing Runout	0.15 mm (0.006 in.)	——
Flywheel Housing Face Runout		
Maximum Variation	0.20 mm (0.008 in.)	——
Flywheel Face Flatness		
Maximum Variation	0.23 mm (0.009 in.)	——
Maximum Variation per 25 mm (1.0 in.) of travel	0.013 mm (0.0005 in.)	——
Flywheel Bearing Bore Concentricity		
Maximum Variation	0.127 mm (0.005 in.)	——

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

RG,CTM42,G15,1 -19-14FEB95

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CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS—CONTINUED

TORQUES

Flywheel Housing-to-Cylinder Block	407 N·m (300 lb-ft)
Damper Pulley-to-Crankshaft	230 N·m (170 lb-ft)
Main Bearing Caps	203 N·m (150 lb-ft)
Rear Crankshaft Oil Seal Housing	27 N·m (20 lb-ft)
Flywheel-to-Crankshaft	115 N·m (85 lb-ft)
Piston Cooling Orifices	11 N·m (8 lb-ft)
Damper Assembly-to-Pulley	41 N·m (30 lb-ft)
Injection Pump Gear Cover-to-Timing Gear Cover	27 N·m (20 lb-ft)
Timing Gear Cover-to-Cylinder Block*	27 N·m (20 lb-ft)
Hub Drive-to-Flywheel	115 N·m (85 lb-ft)
Magnetic Pickup-to-Timing Gear Cover	14 N·m (10 lb-ft)

** See INSTALL TIMING GEAR COVER—NON-AUXILIARY DRIVE ENGINES, later in this group, for proper cap screw tightening sequence.*

RG,CTM42,G15,47-19-24MAR95

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.

S11,2015,C -19-29SEP94

REMOVE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE (WITH OIL SEAL HOUSING INSTALLED)

Using JDG719 Seal Puller Adapter along with JDE38-2 Shank and JDE38-3 Slide Handle is the preferred method for removing the crankshaft rear oil seal. If JDG719, JDE38-2, and JDE38-3 are not available, JDG22 Seal Remover can be used to remove the seal. Follow same procedure for both pullers.

IMPORTANT: If rear oil seal is replaced, also replace rear wear sleeve (as a matched set).

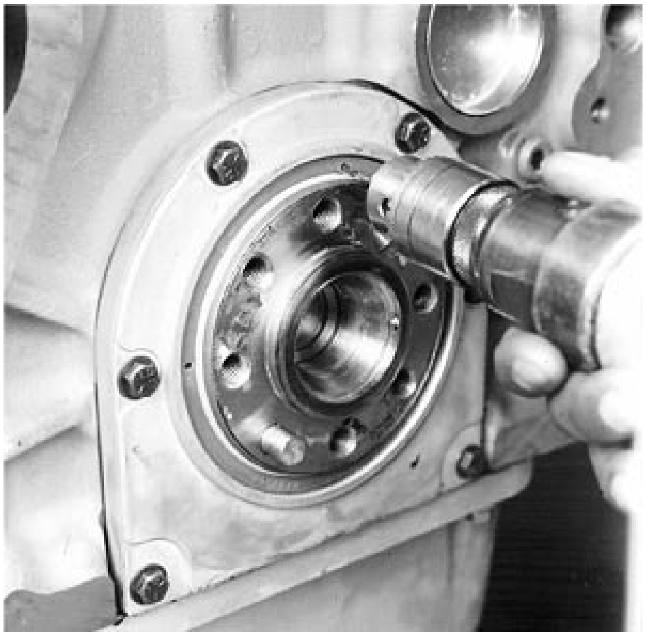
NOTE: If oil seal housing is to be removed, remove seal and wear sleeve after housing is removed. See REMOVE REAR OIL SEAL HOUSING AND WEAR SLEEVE (WITH ENGINE DISASSEMBLED), later in this group.

1. Remove rear drive hub (if equipped) and flywheel. See REMOVE FLYWHEEL later in this group.

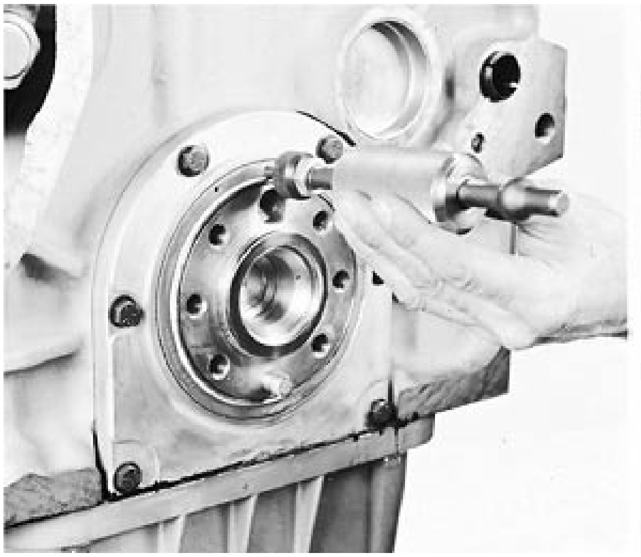
2. Drill two small holes approximately 20° apart in bottom of seal casing. Install sheet metal screws in seal casing with JDG22 Seal Remover attached.

NOTE: It may be necessary to drill a small hole in seal at one or two other locations to aid in removal.

3. Cock seal at 6 O'clock position (180° opposite drilled hole) using a small punch and carefully pull seal from housing.



RG5819 -UN-12AUG91



RG6467 -UN-26OCT92

RG,CTM42,G15,2 -19-03MAY93

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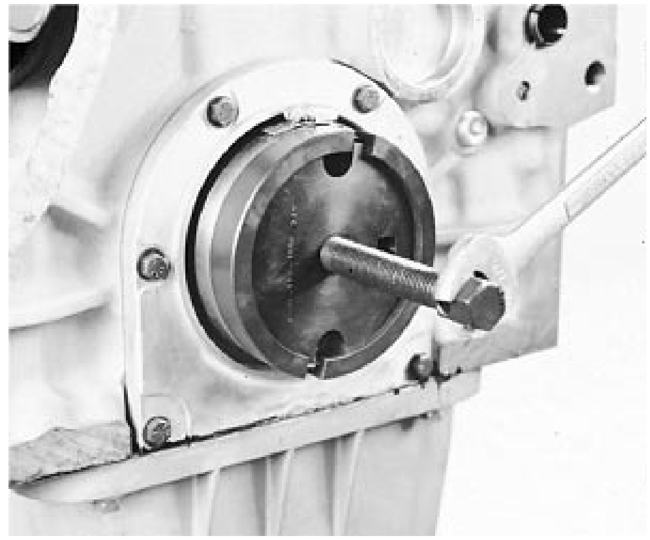
4. Assemble JDG790 Rear Wear Sleeve Puller and position onto crankshaft flange with wear sleeve seated in jaws.

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.



RG6468 -UN-26OCT92

RG,CTM42,G15,50-19-29OCT92

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.)

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

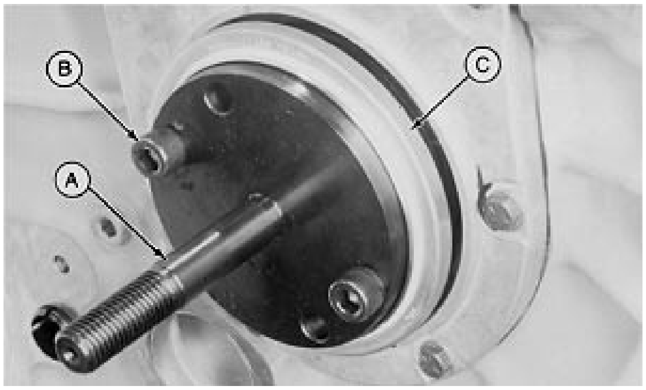
Finish cleaning by wiping flange with a clean rag. Any small nicks should be removed with 180-grit or finer polishing cloth.

Check oil seal housing runout as explained later in this group.

RG5822 -UN-12AUG91

RG,CTM42,G15,4 -19-29OCT92

INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE (WITHOUT ENGINE DISASSEMBLY)



RG4639 -UN-14DEC88

NOTE: These instructions are for use when the oil seal housing and oil pan would not be removed. Refer to INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE (WITH ENGINE DISASSEMBLED), later in this group, for instructions with oil seal housing and oil pan removed.

1. Apply a light coating of LOCTITE 609 Retaining Compound, or equivalent, completely around the leading edge of crankshaft flange. Wipe away any sealant that may have gotten on ID of seal housing bore.

2. Install JDG477 (85) Pilot (A) on end of crankshaft using the Allen head cap screws (B) supplied with tool set. Tighten cap screws securely.

IMPORTANT: Handle seal and wear sleeve assembly carefully. If assembly becomes separated, discard these parts and install a new assembly. (See CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE HANDLING PRECAUTIONS, later in this group.)

3. Carefully start oil seal/wear sleeve assembly (C) over JDG477 (85) Pilot and crankshaft flange with open side of seal toward engine.

IMPORTANT: When installing the JDG478 Driver on JDG477 (85) Pilot and crankshaft flange to position oil seal/wear sleeve assembly, locate crossbar of installer at right angle (90°) to Allen head cap screws. This allows the crossbar to bottom on pilot, not head of cap screws, assuring correct installation.

S11,2015,GQ -19-16AUG94

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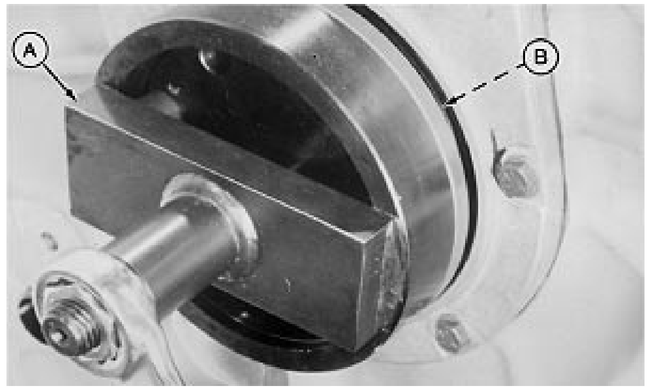
4. Position JDG478 Driver (A) so that hole in the cross plate goes over threaded stud of pilot. Install washer and nut on stud.

5. Tighten nut to draw JDG478 Driver in until crossbar bottoms on JDG477(85) Pilot. When the tool bottoms, seal and wear ring assembly (B) will be correctly positioned.

6. Remove JDG476(85) Tool Set from engine.



RG4640 -UN-14DEC88

S11,2015,GR -19-11JUN93

INSPECT VIBRATION DAMPER

IMPORTANT: Do not immerse the vibration damper or the damper pulley in cleaning solvent. Doing so may damage the rubber portions of these components.

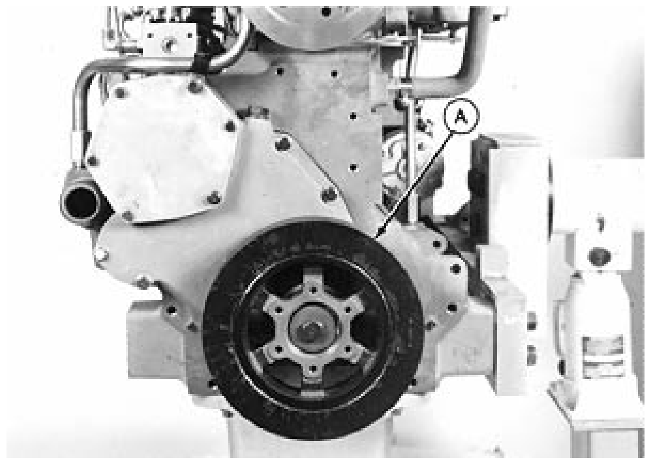
Never apply thrust on outer ring of damper. Damper is sensitive to impact damage, such as being dropped or struck with a hammer.

The damper assembly is not repairable and should be replaced every 5 years or 4500 hours, whichever occurs first, or whenever crankshaft is replaced.

1. Remove fan belts (shown removed).

2. Inspect damper for torn or split rubber protruding from damper, ring shift toward front or back of damper, or slippage of the ring (reference chisel marks). Replace damper if any defects are found.

3. Grasp vibration damper (A) with both hands and attempt to turn it in both directions. If rotation is felt, damper is defective and should be replaced.



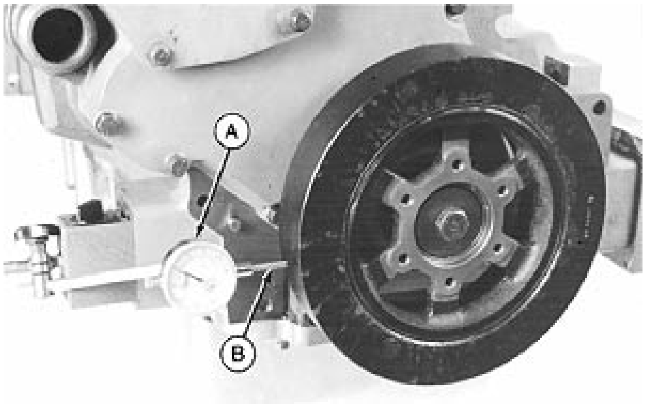
RG5823 -UN-05SEP91

RG,CTM42,G15,5 -19-16AUG94

4. Check vibration damper radial runout by positioning a dial indicator (A) so probe (B) contacts damper O.D.

5. Rotate crankshaft using JDE81-1 Flywheel Turning Tool.

6. Note dial indicator reading.



RG5824 -UN-12AUG91

DAMPER RADIAL RUNOUT SPECIFICATION

Maximum . . . . 1.02 mm (0.040 in.)

If runout exceeds specifications, replace vibration damper.

RG,CTM42,G15,6 -19-16AUG94

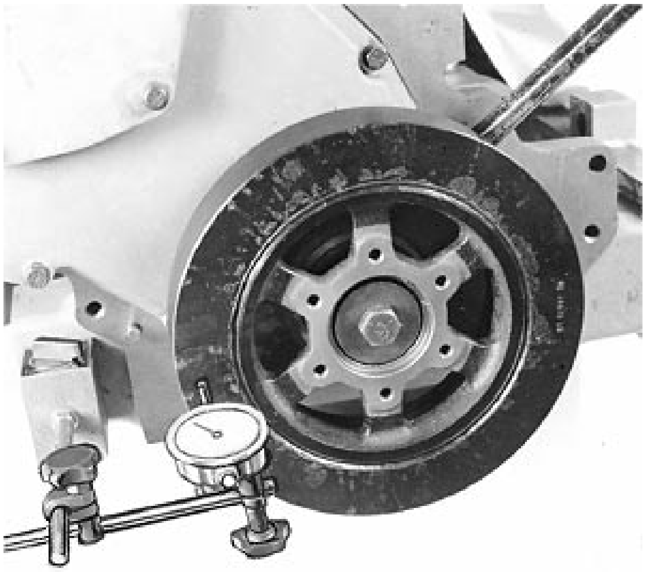
CHECK CRANKSHAFT END PLAY

1. Completely engage then release the clutch lever.

2. Place a dial indicator on damper face.

IMPORTANT: Use care not to damage or distort the timing gear cover or bearing inserts when prying. Do not pry on outer interia ring of damper.

3. Pry with flat bar between the damper pulley and timing gear cover.



RG5934 -UN-28AUG91

CRANKSHAFT END PLAY SPECIFICATIONS

End Play . . . . 0.038—0.380 mm (0.0015—0.0150 in.)

NOTE: New thrust bearings will usually restore proper end play.

RG,CTM42,G105,8-19-29OCT92

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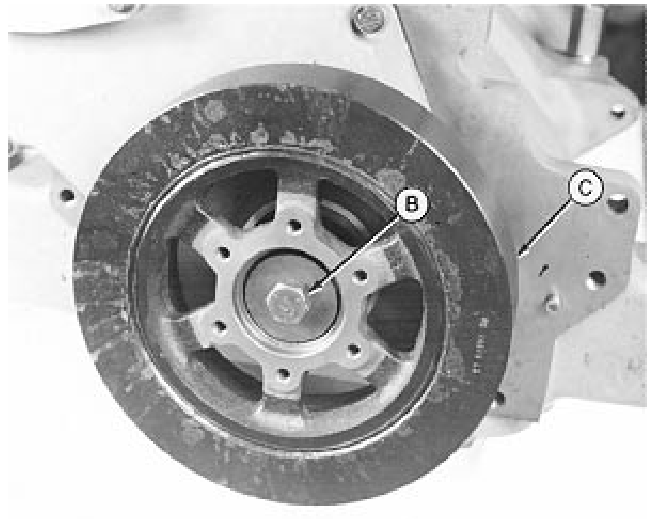
REMOVE DAMPER PULLEY

1. Drain oil (if not previously done), and remove oil pan. Remove oil pump if crankshaft is to be removed.

2. Remove cap screw (B) and washer on damper pulley (A).



RG5827 -UN-12AUG91

RG,CTM42,G15,7 -19-29OCT92

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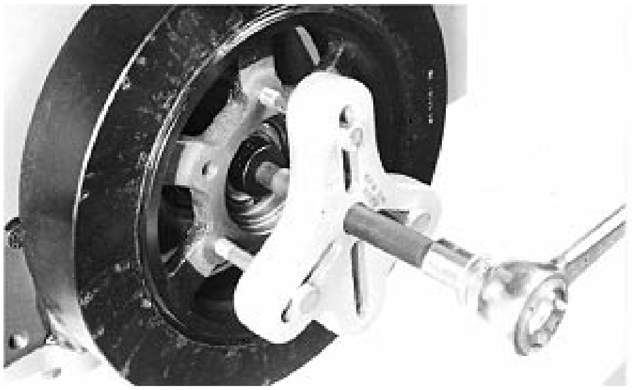
IMPORTANT: DO NOT use a jaw-type puller to remove vibration damper. Damage could result to the damper. Never apply thrust on outer ring of damper. Do not drop or hammer on damper.

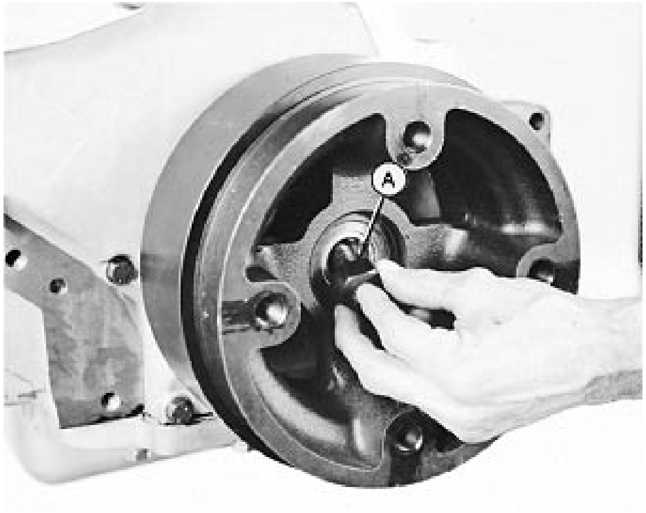
NOTE: On some applications, it may be necessary to remove the pulley from the damper before pulling damper from crankshaft flange.

3. Remove pulley and damper from crankshaft using D01207AA(OTC518) Puller Set (upper photo).

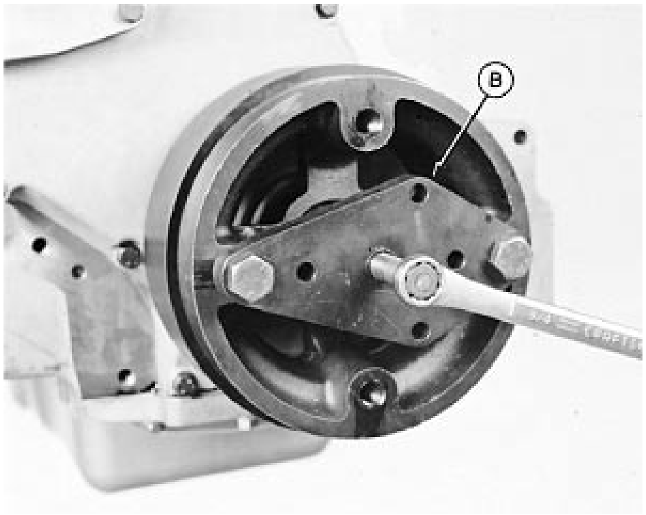
On certain applications, it may be necessary to use JDG721 Hub Puller (B) and JDG787 Thread Protector (A) (lower photos) to remove damper pulley.



RG5765 -UN-06AUG91



RG6469 -UN-26OCT92



RG6470 -UN-26OCT92

RG,CTM42,G15,33-19-16AUG94

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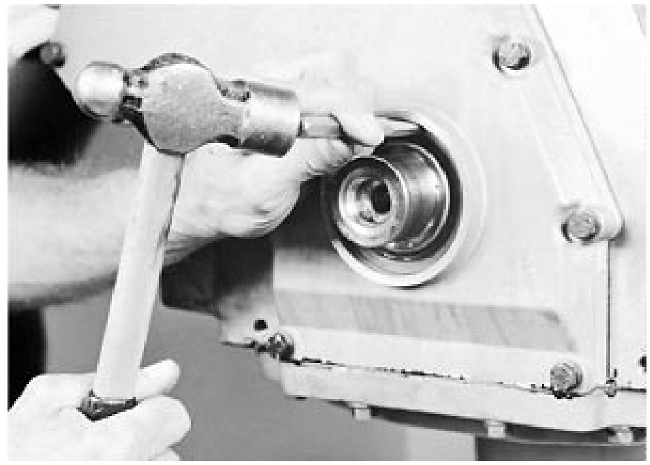
REMOVE CRANKSHAFT FRONT OIL SEAL (WITH TIMING GEAR COVER INSTALLED ON ENGINE)



RG6471 -UN-26OCT92

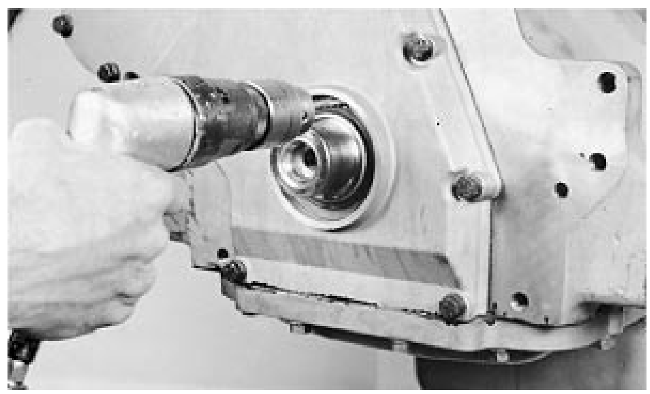
IMPORTANT: Whenever front oil seal is replaced, the wear sleeve must also be replaced.

NOTE: If timing gear cover is going to be removed from engine, remove front seal 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.

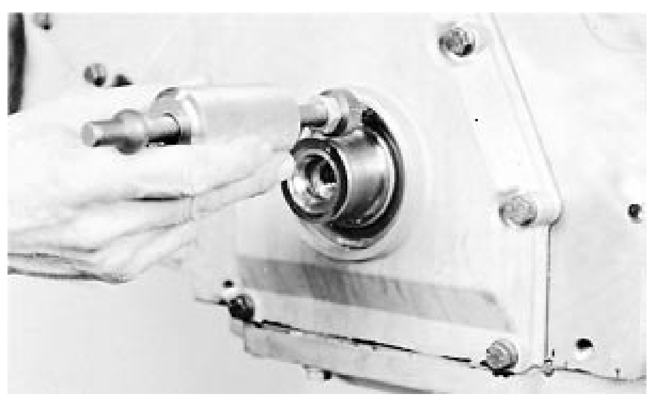
RG,CTM42,G15,38-19-03MAY93



RG6472 -UN-26OCT92

3. Drill 1/8 in. hole in casing.

RG,CTM42,G15,39-19-29OCT92



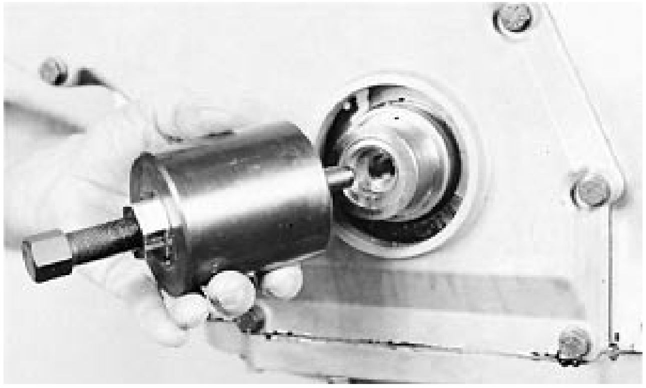
RG6473 -UN-26OCT92

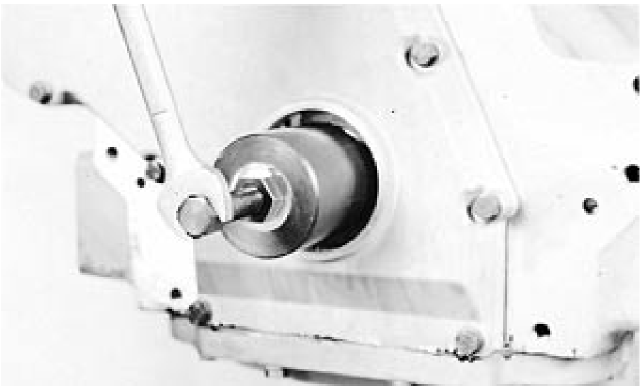
4. Using JDG719 Seal Puller along with JDE38-2 Shank, JDE38-3 Hammer, and metal screw; remove seal.

5. Remove keyway from keyslot of crankshaft.

RG,CTM42,G15,40-19-29OCT92

REMOVE CRANKSHAFT FRONT WEAR SLEEVE (WITH TIMING GEAR COVER INSTALLED OR REMOVED)


RG6474 -UN-26OCT92


RG6475 -UN-26OCT92

1. Position JDG786 Front Wear Sleeve Puller on crankshaft nose.

2. Center puller on wear sleeve and thread onto sleeve approximately two full turns.

3. Tighten forcing screw until wear sleeve is removed from crankshaft flange.

NOTE: To remove wear sleeve from tool, place tool in vise and cut two slots adjacent from each other in wear sleeve using hack saw or parting wheel. Put file or similar flat object in slots and turn wear sleeve out of tool.

4. Clean crankshaft flange using Brake Kleen or Ignition Cleaner and Drier.

RG,CTM42,G15,41-19-03MAY93

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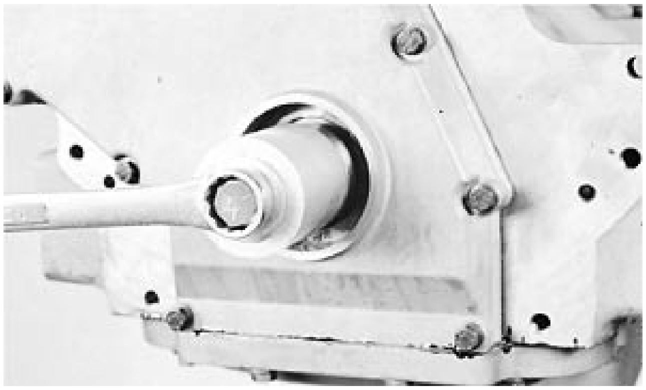
INSTALL CRANKSHAFT FRONT WEAR SLEEVE


RG6476 -UN-26OCT92


RG6477 -UN-26OCT92

NOTE: Wear sleeve can also be installed with timing gear cover removed, but seal must be installed with timing gear cover installed.

1. Coat ID of new wear sleeve with LOCTITE 609 Retaining Compound.

2. Using JDG467 Driver from JDE3 Installer along with washer and 5/8-11 UNC x 3 in. cap screw that secures damper pulley assembly to crankshaft. Tighten cap screw until driver bottoms.

3. Remove installation tools and clean any sealant from OD of wear sleeve or ID of seal bore.

RG,CTM42,G15,42-19-11JUN93

INSTALL CRANKSHAFT FRONT OIL SEAL (WITH TIMING GEAR COVER INSTALLED ON ENGINE)

RG6479 -UN-26OCT92

RG6480 -UN-26OCT92

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

1. Place JDG720-2 Seal Protector (A) on nose of crankshaft. Lubricate ID of front oil seal lips with clean engine oil. Slide seal with spring side of seal facing engine onto seal protector. Be careful not to roll oil seal lips.

2. Place JDG720-3 Seal Installer onto seal protector against seal. Do not use spacer ring provided with tool set.

3. With nut and washer installed onto JDG720-1 Forcing Screw, thread forcing screw into nose of crankshaft until it bottoms.

4. Tighten nut against crossplate of installer until installer bottoms onto front face of timing gear cover.

5. Remove installation tools. Verify seal is installed square in bore and that seal lips are not rolled on wear sleeve.

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Oil seal should be 8.4 mm (0.33 in.) below front lip of seal bore.

RG,CTM42,G15,43-19-03MAY93

REPLACE TIMING GEAR COVER (6076HRW33, 34, AND 35 ENGINES) —ENGINE INSTALLED IN VEHICLE

6076HRW33, 34, and 35 Engines used in 8100, 8200, and 8300 Tractors are equipped with front frame/oil sump, refer to TM1575 (8100, 8200, 8300, and 8400 Tractors—Repair) for access to front frame/oil sump-to-engine block cap screws.

To Remove Timing Gear Cover:

1. Remove viscous fan drive, drive housing, and coupler. (Refer to TM1575.)

2. Remove crankshaft vibration damper as detailed earlier in this group.

3. Disconnect water piping and remove water pump cover with water bypass tube. Remove and discard gaskets.

4. Back out all front frame/oil sump-to-engine block cap screws 9.5 mm (0.38 in.)

5. Disconnect engine speed sensor connector from sensor.

6. Remove injection pump drive gear cover.

7. Slowly lift engine block assembly approximately 6.4 mm (0.25 in.) using safety approved lifting equipment.

IMPORTANT: The timing gear cover must not be “dragged” horizontally while in contact with front frame/oil sump gasket. Doing so may damage gasket sealing bead.

8. Remove remaining cap screws and carefully remove timing gear cover. Remove and discard timing gear cover gasket.

9. Remove front oil seal from timing gear cover and discard seal.

10. Remove front wear sleeve from crankshaft flange and discard sleeve.

To Install Timing Gear Cover:

1. Thoroughly clean all timing gear cover gasket surfaces and front oil seal bore.

NOTE: Front wear sleeve can be installed with timing gear cover removed or installed.

2. Install a new front wear sleeve on crankshaft flange (See INSTALL FRONT WEAR SLEEVE, later in this group).

3. Install timing gear cover (See INSTALL TIMING GEAR COVER, later in this group).

4. Install Front oil seal (See INSTALL CRANKSHAFT FRONT OIL SEAL WITH TIMING GEAR COVER INSTALLED ON ENGINE, later in this group).

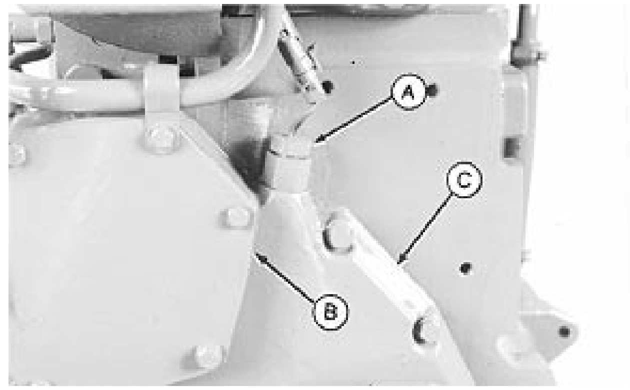
5. Install vibration damper (See INSTALL VIBRATION DAMPER, later in this group).

6. Tighten front frame/oil sump cap screws as detailed in Group 20, Lubrication System of this manual (See TIGHTEN CAP SCREWS ON FRONT FRAME/OIL SUMP) or TM1575.

7. Complete final assembly as outlined in TM1575.

RG,CTM42,G15,49-19-21MAR95

REMOVE TIMING GEAR COVER



RG5828 -UN-12AUG91

1. Remove magnetic pick-up (A, if equipped) and injection pump drive gear cover (B). Discard gasket.

2. Remove timing gear cover (C). Discard gasket.

3. Remove oil seal from cover and discard.

RG,CTM42,G15,44-19-29OCT92

INSPECT AND MEASURE FLYWHEEL

1. Inspect the clutch contact face for scoring, overheating, or cracks. Replace flywheel if defective.

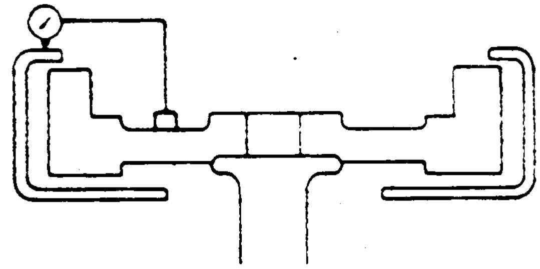
2. Examine flywheel ring gear for worn or broken teeth. Replace ring gear if defective, as described later in this group.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel or housing face.

3. Measure flywheel housing face run-out, flywheel face flatness, and pilot bearing bore concentricity, as outlined later in this group. Resurface flywheel face or replace as required.

S55,2015,N -19-08MAR94

CHECK FLYWHEEL HOUSING FACE RUNOUT



1. Mount dial indicator on flywheel. Set pointer to contact PTO mounting surface on flywheel housing at right angles. Pointer should not contact holes in flywheel housing.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel housing face runout.

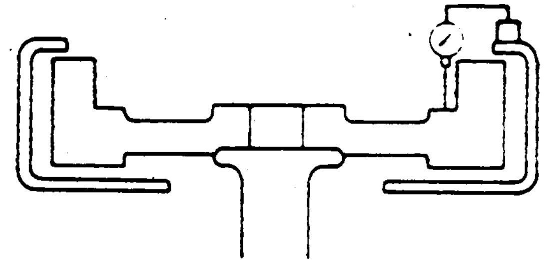
2. Rotate flywheel by turning crankshaft. Read total dial indicator movement.

FLYWHEEL HOUSING FACE RUNOUT SPECIFICATION

Maximum Variation	0.20 mm (0.008 in.)

S55,2015,L -19-29OCT92

CHECK FLYWHEEL FACE FLATNESS



1. Mount dial indicator base on flywheel housing. Position pointer to contact driving ring mounting surface. Do not allow pointer to contact driving ring mounting holes.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel face runout.

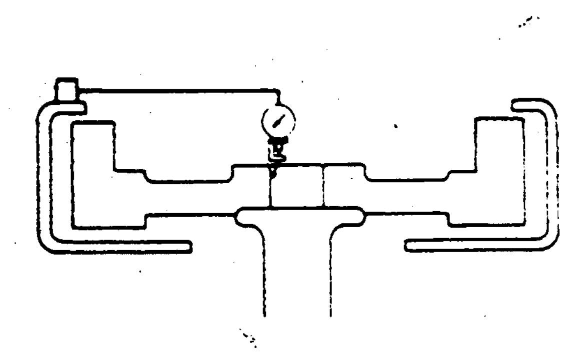
2. Rotate flywheel by turning crankshaft. Read total dial indicator movement. Resurface flywheel face or replace as required.

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

CHECK PILOT BEARING BORE CONCENTRICITY


R22214 -UN-14DEC88

1. Mount dial indicator on flywheel housing face and position pointer to contact ID of pilot bearing bore in flywheel.

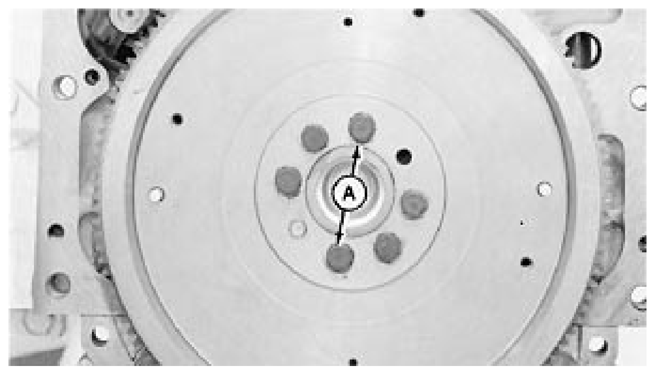
2. Rotate flywheel by turning crankshaft. Read total dial indicator movement.

BEARING BORE CONCENTRICITY SPECIFICATION

Maximum Variation	0.127 mm (0.005 in.)

S55,2015,M -19-08MAR94

REMOVE FLYWHEEL



RG3836 -UN-14DEC88

NOTE: SAE 1 and SAE 2 flywheel housings MUST BE removed before flywheel can be removed from engine. See REMOVE SAE 1 AND SAE 2 FLYWHEEL HOUSING, later in this group.

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

1. Remove two flywheel attaching cap screws (A), and install two pilot studs in their place.

2. Remove remaining cap screws, remove drive hub (if equipped), and carefully pull flywheel from crankshaft.

4. Check condition of dowel pin in crankshaft rear flange. Dowel pin must not be cracked or chipped. Measure protrusion of dowel pin from face of flange. If dowel pin is damaged, or protrusion is not within specifications, replace dowel pin.

NOTE: When replacing dowel pin, crankshaft must be removed to prevent damage to crankshaft thrust bearings.

CRANKSHAFT DOWEL PIN SPECIFICATIONS

Protrusion From Crankshaft Rear Flange	13.5—14.5 mm (0.53—0.57 in)

RG,CTM42,G15,52-19-16AUG94

REMOVE SAE 1 AND SAE 2 FLYWHEEL HOUSING

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

1. Remove attaching cap screws.

2. Remove flywheel housing.

3. Inspect mounting holes in flywheel housing for thread damage.

S11,2015,GK -19-29OCT92

REMOVE SAE 3 FLYWHEEL HOUSING

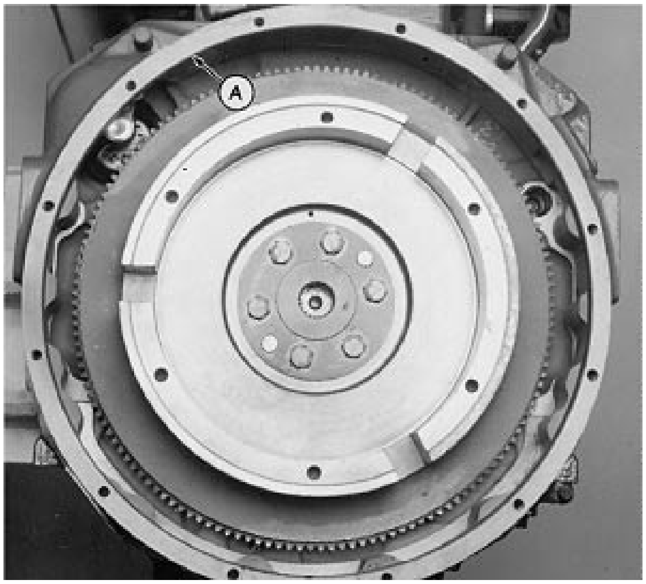
NOTE: The flywheel MUST be removed before removing the SAE 3 flywheel housing. See REMOVE FLYWHEEL earlier in this group.

CAUTION: Flywheel housing (A) is heavy. Plan a proper lifting procedure to avoid personal injury.

1. Remove flywheel housing attaching cap screws.

2. Remove flywheel housing.

3. Inspect mounting holes in flywheel housing for thread damage.



RG5005 -UN-14DEC88

S11,2015,GO -19-29OCT92

REPLACE FLYWHEEL RING GEAR

CAUTION: Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer and do not exceed 182°C (360°F). Do not allow a flame or heating element to be in direct contact with the oil. Heat the oil in a well ventilated area. Plan a safe handling procedure to avoid burns.

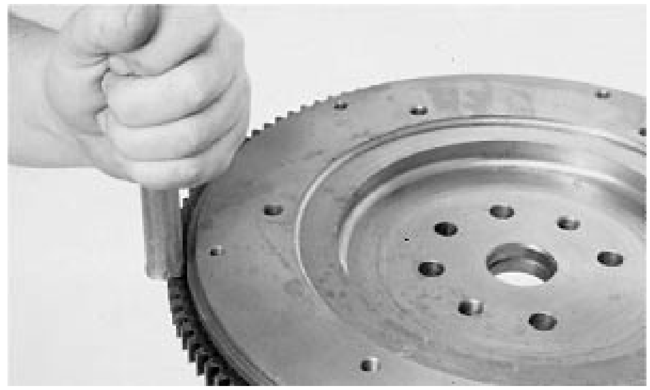
1. If ring gear is damaged, place the flywheel on a solid flat surface.

2. Remove ring gear with a brass drift and hammer.

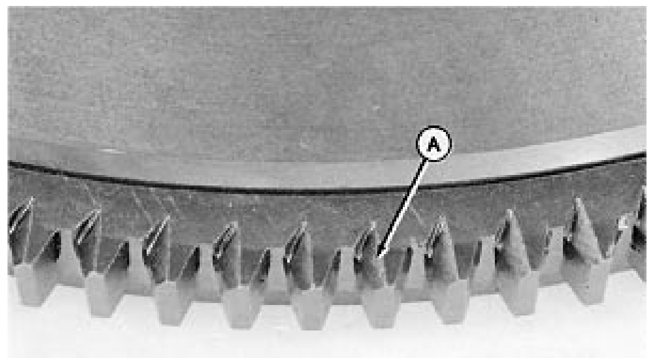
IMPORTANT: If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT. Overheating may destroy original heat treatment of gear. SEE CAUTION.

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

4. Install ring gear against shoulder of flywheel so chamfered side (A) is on engine side of flywheel.



T90596 -UN-14OCT88



RG3838 -UN-14OCT88

S11,2015,FX -19-16SEP92

REPLACE REAR OIL SEAL HOUSING (6076HRW33, 34, AND 35 ENGINES)—ENGINE INSTALLED IN VEHICLE

6076HRW33, 34, and 35 Engines used in 8100, 8200, and 8300 tractors are equipped with front frame/oil sump, refer to TM1575 (8100, 8200, 8300, and 8400 Tractors—Repair) for access to front frame/oil sump-to-engine block cap screws.

IMPORTANT: Remove rear oil seal housing (A) for replacement purposes only, it is not necessary to remove seal housing for rear seal and wear sleeve replacement.

To Remove Rear Oil Seal Housing:

NOTE: Refer to TM1575 for access to rear crankshaft seal housing area.

1. Remove flywheel cover.

2. Remove transmission input shaft coupler bolts and pry coupler rearward.

NOTE: Use a set screw to separate damper from flywheel, if necesssary.

3. Remove torsional damper from flywheel.

4. Remove flywheel from right side of tractor.

5. Back out all front frame/oil sump-to-engine block cap screws 9.5 mm (0.38 in.)

6. Slowly lift engine block assembly approximately 6.4 mm (0.25 in.) using safety approved lifting equipment.

IMPORTANT: The rear oil seal housing must not be “dragged” horizontally while in contact with front frame/oil sump gasket. Doing so may damage gasket sealing bead.

7. Remove rear oil seal housing (A).

8. Remove rear wear sleeve from crankshaft flange with JDG790 Wear Sleeve Puller Kit as detailed earlier in this group. Clean flange with emery cloth.

To Install Rear Oil Seal Housing:

1. Install rear oil seal housing and check runout. (See INSTALL CRANKSHAFT REAR OIL SEAL HOUSING and CHECK OIL SEAL HOUSING RUNOUT, later in this group.)

2. Carefully lower engine onto locating dowels of front frame/oil sump.

3. Tighten front frame/oil sump cap screws as detailed in Group 20, Lubrication System of this manual (See TIGHTEN CAP SCREWS ON FRONT FRAME/OIL SUMP) or TM1575.

4. Install a new rear oil seal and wear sleeve assembly. (See INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE, WITHOUT ENGINE DISASSEMBLY, earlier in this group.)

5. Install flywheel. (See INSTALL FLYWHEEL, later in this group.)

6. Install torsional damper onto flywheel. (See TM1575.)

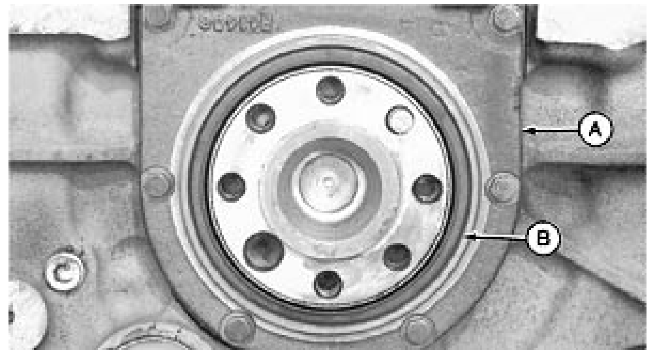
7. Pull transmission input shaft coupler forward, install cap screws and tighten to specified torque. (See TM1575.)

8. Install flywheel cover. (See TM1575.)

9. Start engine and chack for leaks.

RG,CTM42,G15,48-19-21MAR95

REMOVE REAR OIL SEAL HOUSING AND WEAR SLEEVE (WITH ENGINE DISASSEMBLED)



These instructions are for use when the oil seal housing and oil pan will be removed. Refer to REMOVE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE (WITH OIL SEAL HOUSING INSTALLED), earlier in this group, for instructions without the oil seal housing and oil pan being removed.

1. Remove rear oil seal housing (A).

IMPORTANT: If rear oil seal is replaced, also replace rear wear sleeve. The wear sleeve does not have to be removed to remove crankshaft.

2. Rear oil seal (B) will come off with housing. Use a small punch and hammer to remove oil seal. Discard seal.

RG,CTM42,G15,14-19-16AUG94

IMPORTANT: The preferred method of removing the wear sleeve is with JDG790 Rear Wear Sleeve Puller. When removing wear sleeve with a chisel, DO NOT gouge crankshaft flange. 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.

Rear wear sleeve can be removed using one of the following procedures: These procedures may also be followed when crankshaft has been removed from engine.

• Use JDG790 Wear Sleeve Puller to remove wear sleeve from crankshaft flange, as described earlier in this group.

• Use the ball side of a ballpeen hammer and tap wear sleeve across its width in a straight line (to deform and stretch sleeve).

• Score but do not cut the wear sleeve in several places around OD with a blunt chisel.

Remove wear sleeve from crankshaft flange. Clean flange with a light file and emery cloth.

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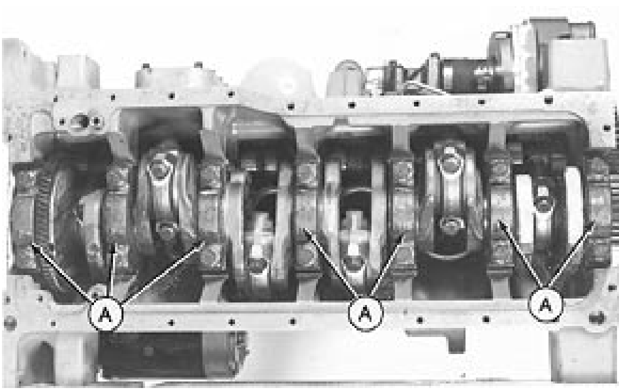
RG,CTM42,G15,54-19-02APR93

REMOVE CRANKSHAFT MAIN BEARINGS



RG5832 -UN-12AUG91

IMPORTANT: Before removing main bearing caps (A), check for proper torque on all main bearings. Also, check each bearing cap to make sure they are numbered for reassembly on the same numbered main bearing bosses. Keep matched bearing inserts with their respective main bearing cap for comparison with crankshaft journal (surface) from which removed.

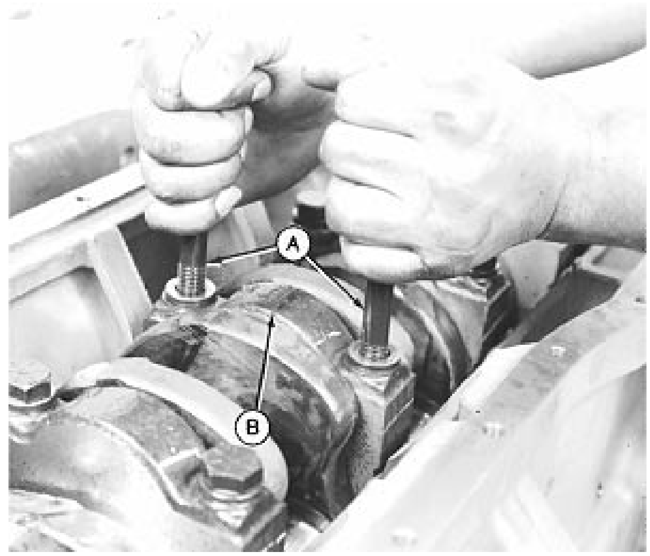
NOTE: When removing main bearings and caps, leave No. 1 and 7 main bearing caps installed until all of the connecting rod caps have been removed.

RG,CTM42,G15,16-19-29OCT92

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 OIL CLEARANCE later in this group.



RG5833 -UN-12AUG91

RG,CTM42,G15,17-19-14SEP94

CHECK MAIN BEARING CLEARANCE

The use of PLASTIGAGE will determine wear but will not determine condition of the bearing or journal surfaces.

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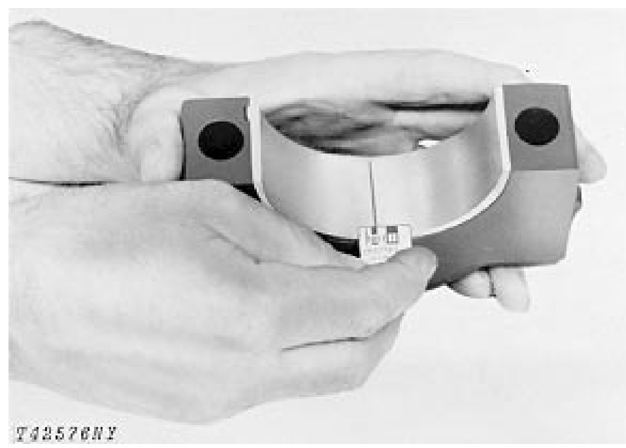
1. Put a strip of PLASTIGAGE in the center of the main bearing cap (with insert) about three-fourths of the width of the bearing.

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

3. Install cap and tighten to 203 N·m (150 lb-ft).

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



T42576NY -UN-09NOV88

MAIN BEARING CLEARANCE SPECIFICATIONS

Main Bearing-to-Journal Clearance . . . . 0.030—0.107 mm (0.0012—0.0042 in.)

S11,0403,Z -19-08AUG94

REMOVE CRANKSHAFT

1. Rotate crankshaft using JDE81-1 Flywheel Turning 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 (B), 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. Using proper lifting equipment, carefully raise crankshaft out of cylinder block.

4. Clean crankshaft, especially oil passages, using solvent and compressed air.

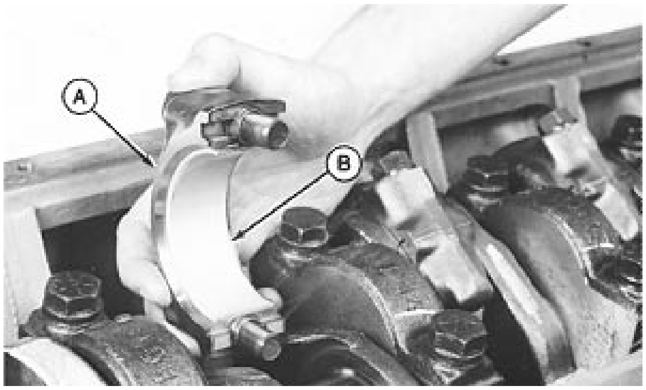
5. Put crankshaft on clean V-blocks.

If wear sleeve has not been removed from crankshaft, the following procedures may be used. However, removing wear sleeve using JDG790 Wear Sleeve Puller Kit while crankshaft is installed in engine is the preferred method.

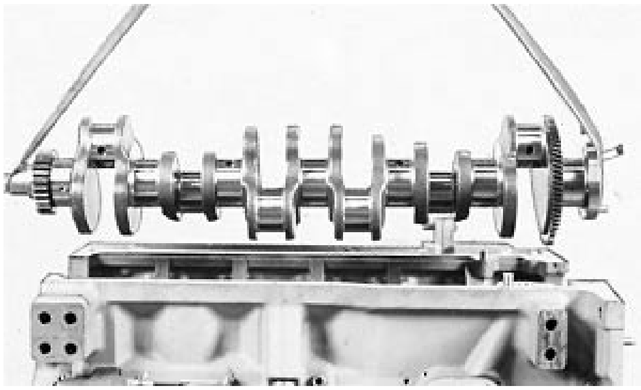
• Use JDG790 Wear Sleeve Puller to remove wear sleeve from crankshaft, as described earlier in this group. Position crankshaft rod journals in V-blocks so that crankshaft does not rotate while removing wear sleeve.

• Use the ball side of a ball peen hammer and tap wear sleeve across its width in a straight line (to deform and stretch sleeve).

• Score (A), but do not cut, the wear sleeve in several places around OD with a blunt chisel.



RG5806 -UN-12AUG91


RG5834 -UN-12AUG91

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RG,CTM42,G15,18-19-16AUG94

INSPECT CRANKSHAFT

NOTE: If the 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.) The vibration damper should be replaced whenever the crankshaft is replaced.

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 FRONT CRANKSHAFT GEAR and REPLACE CRANKSHAFT OIL PUMP DRIVE GEAR, later in this group.)

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

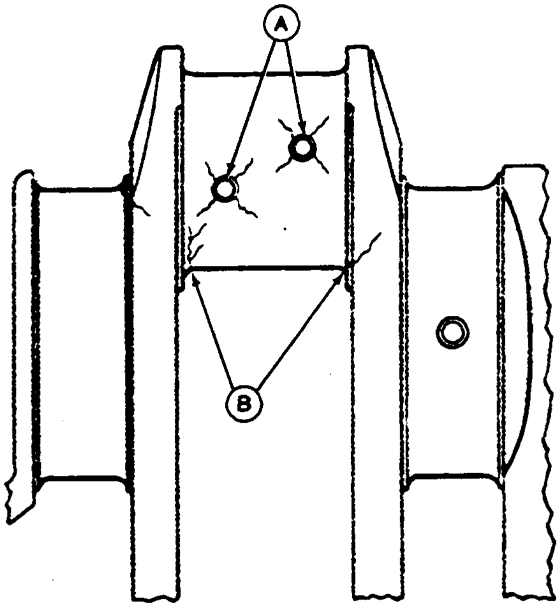
5. Carefully inspect the rear hub of the crankshaft in the area of the wear sleeve contact surface for evidence of a rough or grooved condition. Any imperfections in this area will result in oil leakage. Slight ridges may be cleaned up with emery cloth and crocus cloth.

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

RG,CTM42,G15,93-19-16AUG94

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 method such as the Fluorescent Magnetic Particle method. This method magnetizes the crank, employs magnetic particles which are fluorescent and glow under "black light". The crankshaft must be de-magnetized after the test.



RG5093 -UN-15DEC88

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.

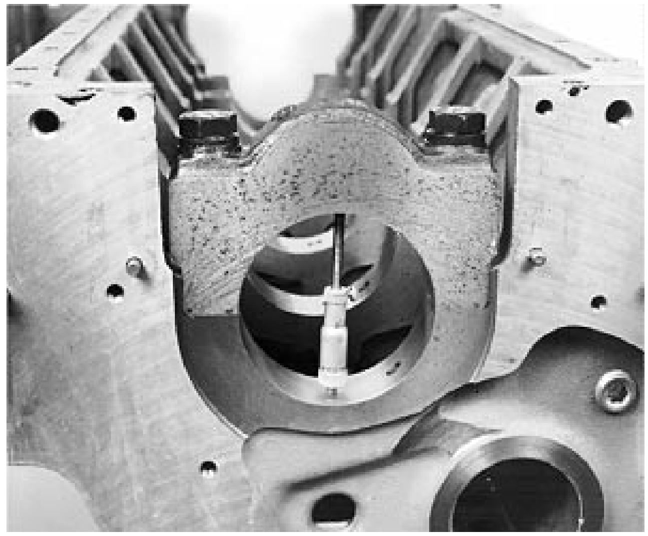
NOTE: If replacing dowel pin, crankshaft must be removed to prevent damage to crankshaft thrust bearings.

CRANKSHAFT DOWEL PIN SPECIFICATIONS

Dowel Pin Protrusion From
Rear Flange . . . . 13.5—14.5 mm (0.53—0.57 in.)

RG,CTM42,G15,94-19-16AUG94

MEASURE ASSEMBLED ID OF BEARINGS AND OD OF CRANKSHAFT JOURNALS



RG5835 -UN-12AUG91

1. With crankshaft removed from engine, install main bearing inserts and caps (be sure inserts are installed correctly).

2. Tighten main bearing cap screws to 203 N·m (150 lb-ft).

3. Measure I.D. of all bearings with an inside micrometer.

MAIN BEARING ID SPECIFICATIONS

With Bearing	85.705—85.755 mm (3.3742—3.3762 in.)
Without Bearing	92.125—92.151 mm (3.627—3.628 in.)

NOTE: Inspect and measure assembled ID of connecting rod bearings. Compare measurements with connecting rod journal OD on crankshaft. (See Group 10.)

RG,CTM42,G15,34-19-16AUG94

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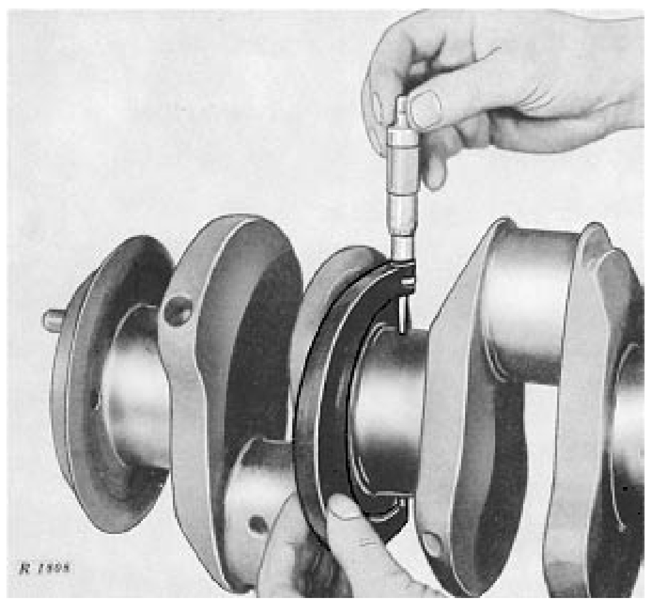


RG1808 -UN-14DEC88

4. Measure OD of all respective crankshaft journals at several points around journal.

CRANKSHAFT SPECIFICATIONS

OD of Main Bearing Journal	85.649—85.674 (3.3720—3.3730 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 0.030—0.107 mm (0.0012—0.0042 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.)

S11,0403,AD -19-17AUG94

MAIN BEARING CAP LINE BORE SPECIFICATION

1. With crankshaft removed from cylinder block, install main bearing caps without bearing inserts.

2. Tighten main bearing cap screws to 203 N·m (150 lb-ft).

3. Measure ID of all bearing caps, at several locations, with an inside micrometer.

If any main bearing cap assembled ID is not within specification, blank (generic) bearing caps are available and must be line bored to specification. Replace individual bearing caps as needed.

IMPORTANT: Main bearing cap line boring should be done ONLY by experienced personnel on equipment capable of maintaining bore specifications.

MAIN BEARING CAP BORE SPECIFICATIONS

ID Without Bearings (Standard)	92.125—92.151 mm (3.627—3.628 in.)
Maximum Bore Diameter Variation	0.013 mm (0.0005 in.)
Maximum Bore Diameter Taper	0.013 mm (0.0005 in.)
Maximum Straightness Variation (Any Bore-to-Adjacent Bore)	0.038 mm (0.0015 in.)
Maximum Straightness Variation (5 Center Bores-to-End Bores)	0.08 mm (0.003 in.)
Centerline of Bore-to-Top Deck	352.35—352.50 mm (13.872—13.878 in.)

S11,2515,BY -19-21MAR95

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 -19-16AUG94

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 counterclockwise, 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. (See CRANKSHAFT GRINDING SPECIFICATIONS, later in this group.)

NOTE: Production crankshafts are induction hardened and shotpeened at the factory. Field shotpeening is not recommended due to the equipment required and part geometry.

6. If the thrust surfaces of the crankshaft are worn or grooved excessively, regrind and polish. Maintain the specified radius between each thrust surface and the bearing journal. An oversize thrust washer set containing one standard washer and two 0.18 mm (0.007 in.) oversize washers is available. (See THRUST BEARING NEW PART SPECIFICATIONS, later in this group.)

NOTE: When thrust surfaces are reground and an oversize washer is used, crankshaft end play specification must be maintained to within 0.038—0.380 mm (0.0015—0.0150 in.) (See CHECK CRANKSHAFT END PLAY, earlier in this group.)

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.

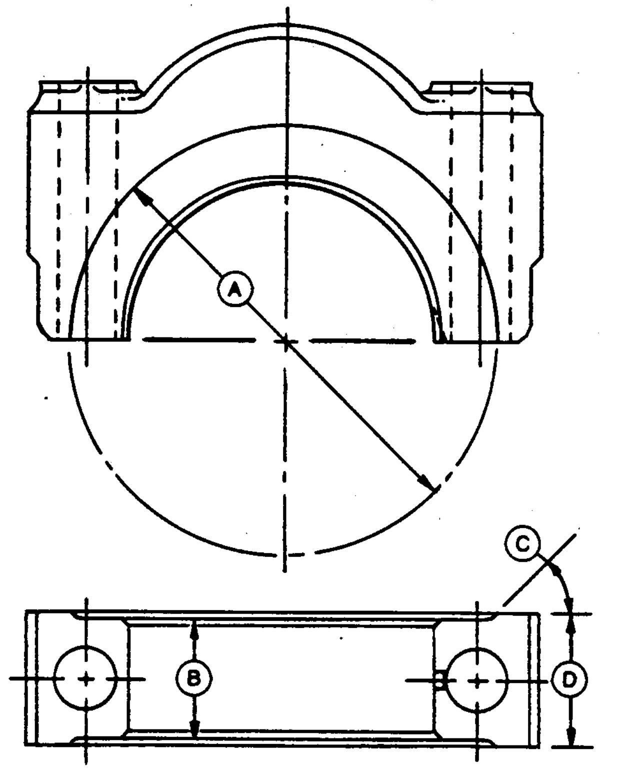
9. De-magnetize the crankshaft.

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

S11,2015,HD -19-08MAR94

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 surface on bearing and on block web are correctly aligned.



THRUST BEARING NEW PART SPECIFICATION

Thrust Washer Clearance Base Circle Diameter	123.70—125.30 mm (4.87—4.93 in.)
Thrust Surface Thickness	37.44—37.54 mm (1.474—1.478 in.)
Relief Angle	45°
Bearing Overall Width	39.16—39.66 mm (1.542—1.561 in.)
Maximum Thrust Surface Runout	0.025 mm (0.0010 in.)

A—Thrust Washer Clearance Base Circle Diameter
B—Thrust Surface Thickness
C—Relief Angle
D—Bearing Overall Width

S55,2015,P -19-16AUG94

CRANKSHAFT GRINDING SPECIFICATIONS

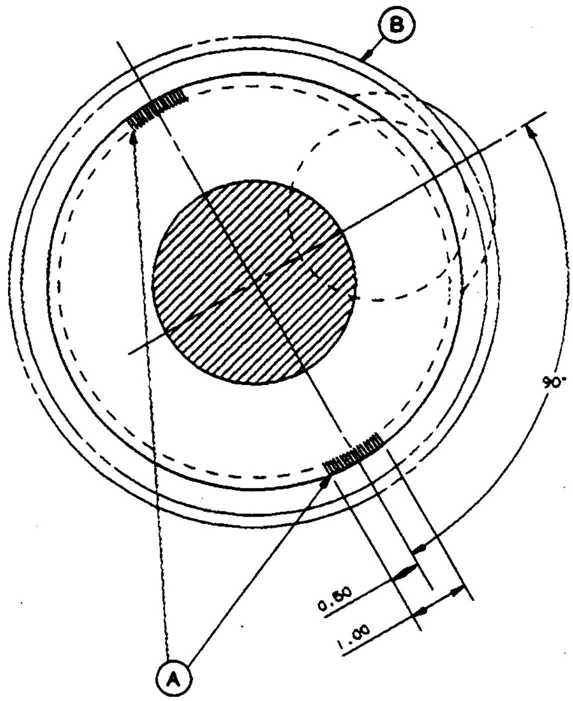
ITEM	SPECIFICATION
Engine Stroke	121 mm (4.75 in.)
Main and Rod Journal Surface Finish	Lap 0.20 Um (8 AA)
Thrust Journal Surface Finish	Lap 0.40 Um (16AA)
Rod Journal Fillet Radius	3.94—4.44 mm (0.155—0.175 in.)
Main Journal Fillet Radius	3.94—4.44 mm (0.155—0.175 in.)
Thrust Journal Fillet Radius	3.56—4.06 mm (0.140—0.160 in.)
Thrust Journal Width	44.387—44.487 mm (1.7475—1.7515 in.)

Bearing Size	Crankshaft Main Journal OD	Crankshaft Rod Journal OD
Standard	85.649—85.674 mm (3.3720—3.3730 in.)	76.149—76.175 mm (2.9980—2.9990 in.)
0.05 mm (0.002 in.) Undersize	85.598—85.623 mm (3.3700—3.3710 in.)	76.098—76.124 mm (2.9960—2.9970 in.)
0.25 mm (0.010 in.) Undersize	85.394—85.420 mm (3.3620—3.3630 in.)	75.895—75.920 mm (2.9880—2.9890 in.)
0.51 mm (0.020 in.) Undersize	85.140—85.166 mm (3.3520—3.3530 in.)	75.641—75.667 mm (2.9780—2.9790 in.)
0.76 mm (0.030 in.) Undersize	84.887—84.912 mm (3.3420—3.3430 in.)	75.387—75.413 mm (2.9680—2.9690 in.)

S11,2015,HG -19-17AUG94

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.



RG5018 -UN-14DEC88

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.

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.

S11,2515,BG -19-08AUG94

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.

**Part of D01047AA 17-1/2 and 30-Ton Puller Set.*

RG,CTM61,G15,27-19-30APR93

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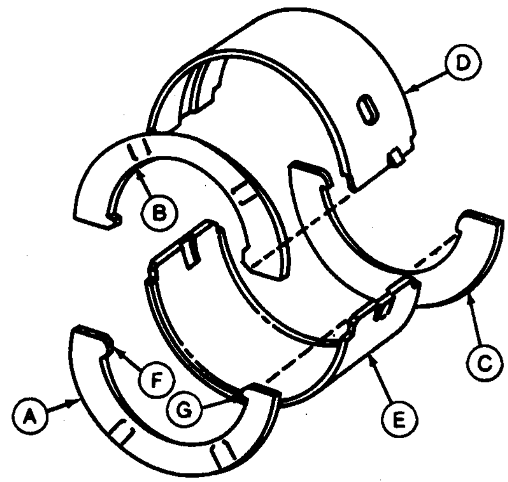
39

INSPECT THRUST BEARINGS



1. Check thrust surfaces of the thrust bearing and the thrust bearing journal on crankshaft and replace as necessary.

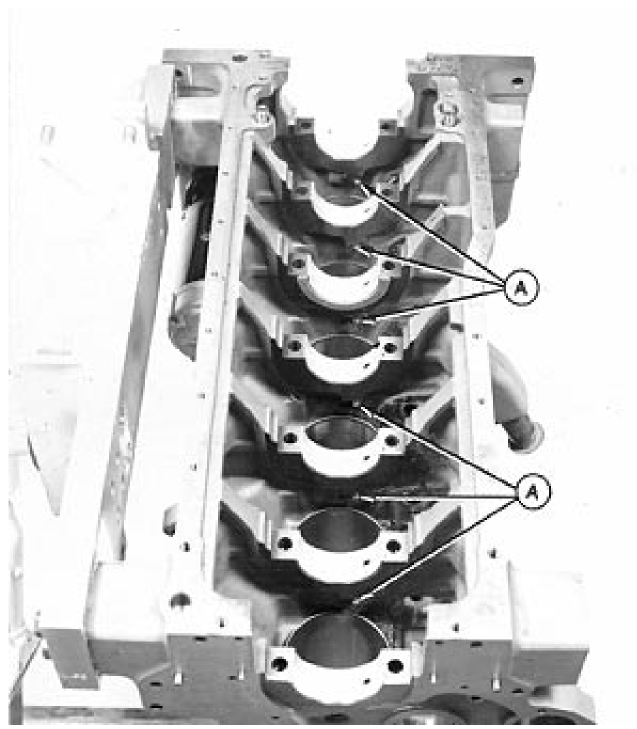
Thrust bearings are available in each of the previously mentioned insert undersizes. An oversize thrust washer set containing one regular size washer and two 0.18 mm (0.007 in.) oversize washers is also available.

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

S11,0403,AF -19-08MAR94

REMOVE AND CLEAN PISTON COOLING ORIFICES



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

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

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

3. Install orifices and tighten to 11 N·m (8 lb-ft) (96 lb-in.).

RG,CTM42,G15,20-19-29OCT92

INSTALL MAIN BEARINGS AND CRANKSHAFT

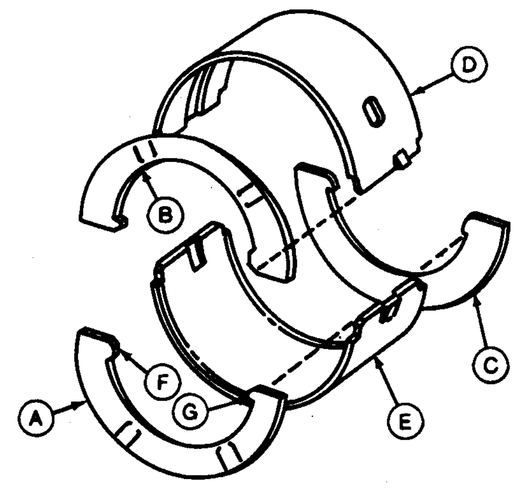
IMPORTANT: If new main or thrust bearing inserts or thrust washers are installed, they must be installed as a matched set.

During assembly, apply a liberal coating of clean engine oil to:

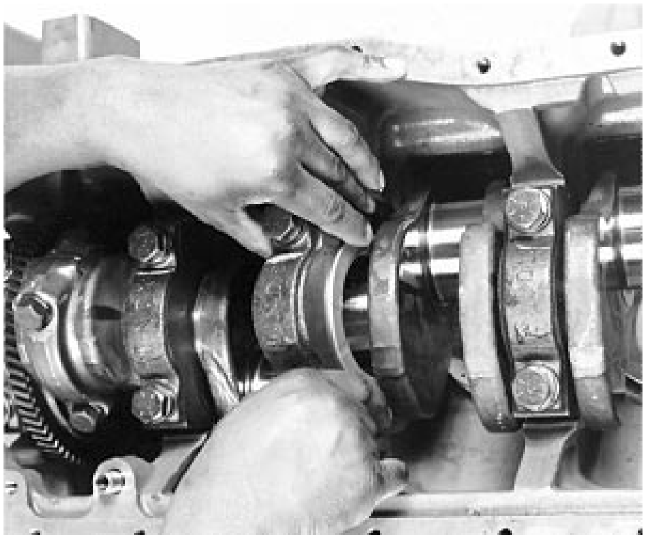
—All main bearing webs in block

—Both sides of main bearing inserts, thrust bearing inserts, and thrust washers

—Entire OD of crankshaft main bearing journal



No. 5 Main Thrust Bearing Assembly



1. Install six main bearing inserts in block except No. 5 thrust bearing insert. Be sure locating tabs on inserts are properly positioned with slot in block web.

IMPORTANT: Thrust washers (A,C) go on both sides of bearing cap and thrust washer (B) on rear side of block web only with the slots facing the crankshaft.

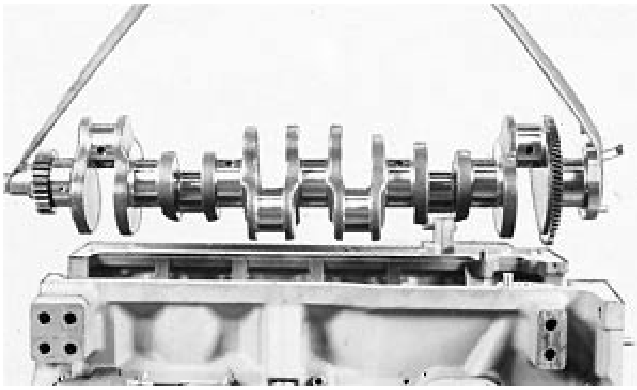
2. Install No. 5 main thrust bearing insert (D) in block. Install upper thrust washer on bearing insert at rear of block web. Be sure tangs on washer are properly positioned on thrust bearing insert.

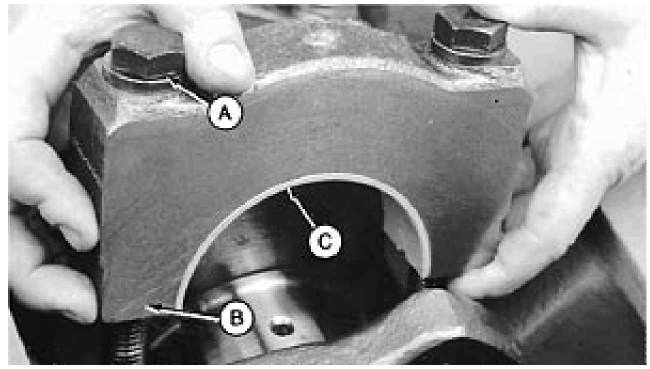
3. Check to make sure that oil holes in main bearing web are properly aligned with oil holes in bearing inserts.

A—Lower Rear Thrust Washer
B—Upper Rear Thrust Washer
C—Lower Front Thrust Washer
D—Main Bearing Block Thrust Bearing
E—Main Bearing Cap Thrust Bearing
F—Large Tang
G—Small Tang

RG,CTM42,G15,21-19-14SEP94

INSTALL CRANKSHAFT





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

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

2. 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 be on the camshaft side of the block pointing towards the front of the engine. If bearing caps have been rebored, make sure bearing caps have numbers stamped on them.

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

4. Before tightening cap screws on main bearing caps, align upper and lower thrust flanges on main thrust bearings. Using a soft-face hammer, tap crankshaft to the rear and then to the front to line up thrust bearing flanges.

5. Tighten No.'s 1, 2, 3, 4, 6 and 7 main bearing cap screws to 68 N·m (50 lb-ft). Hand-tighten No. 5 main thrust bearing cap screws.

6. Gently pry crankshaft rearward and then forward to align thrust washers on No. 5 main thrust bearing.

NOTE: DO NOT PRY crankshaft on No. 5 main thrust bearing.

7. Tighten No. 5 main thrust bearing cap screws to 68 N·m (50 lb-ft).

8. Tighten all main bearing cap screws (including No. 5) to 203 N·m (150 lb-ft).

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

10. Install connecting rod bearings and connecting rods caps. See INSTALL PISTONS AND CONNECTING RODS in Group 10.

11. Check crankshaft for 0.038—0.380 mm (0.0015—0.0150 in.) end play.

12. Install oil pump and check drive gear-to-crankshaft clearance. See INSTALL ENGINE OIL PUMP in Group 20.

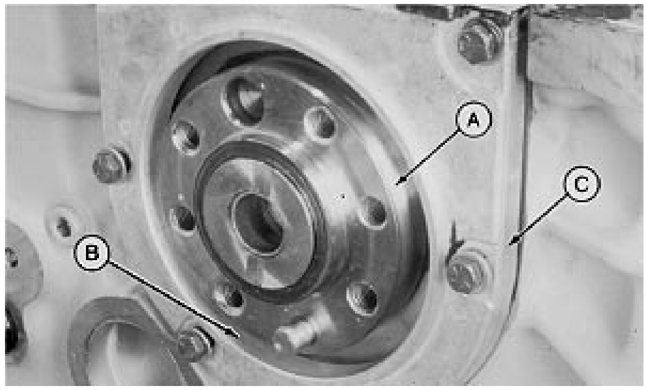
RG,CTM42,G15,22-19-03MAY93

INSTALL CRANKSHAFT REAR OIL SEAL HOUSING

These instructions are for when oil seal housing and oil pan have been removed from cylinder block.

1. Make sure the OD of crankshaft flange (A) and ID of seal housing (B) are free from nicks or burrs. Restore damage surfaces with a fine file or emery cloth. Clean with compressed air.

2. Install oil seal housing (C) on cylinder block using a new gasket. Install all six cap screws with washers, and tighten finger tight.



RG4637 -UN-14DEC88

RG,CTM42,G15,24-19-29OCT92

IMPORTANT: Installation tools must be clean to assure proper positioning on crankshaft flange and to hold runout within specification so oil seal does not fail prematurely.

NOTE: For oil seal housings stamped R78124, use JDG748 Driver. For oil seal housings stamped R115050, use JDG796 Alignment Tool.*

3. Slip the proper tool (A) over crankshaft flange and into seal housing bore to center oil seal housing.

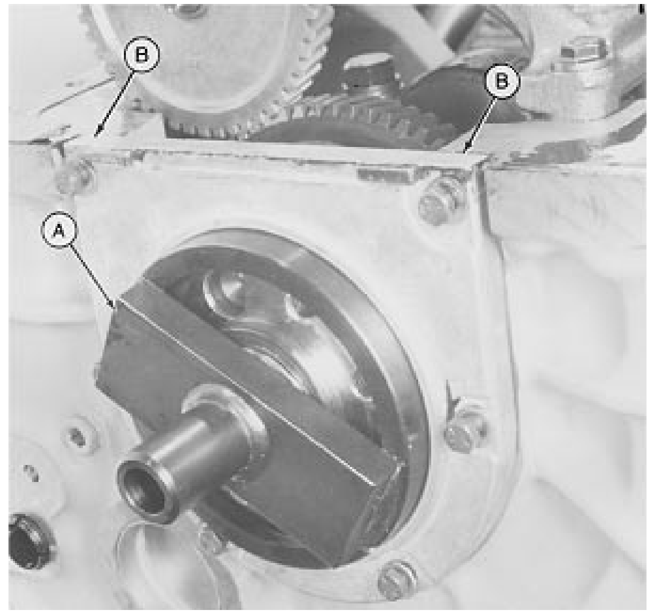
The driver is designed to center the oil seal housing in relation to crankshaft flange. However, the use of a magnetic base dial indicator is still recommended to measure the seal housing runout. Runout should not exceed 0.15 mm (0.006 in.).

4. Position bottom of oil seal housing flush (B) with cylinder block-to-oil pan mating surface. Tighten seal housing cap screws to 27 N·m (20 lb-ft), using sequence shown in bottom illustration, beginning with cap screw No. 1.

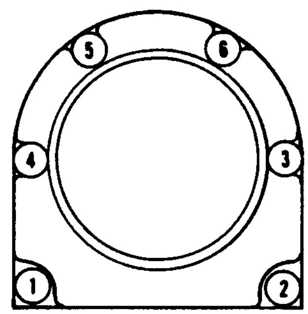
5. Remove driver from end of crankshaft flange.

6. Check oil seal housing runout with a magnetic base dial indicator. See CHECK OIL SEAL HOUSING RUNOUT, later in this group.

7. Trim off excess gasket material extending below bottom of oil seal housing.



RG4638 -UN-14DEC88



RG6427 -UN-13OCT92

*From JDG476(85) Oil Seal and Wear Sleeve Installer Set.

RG,CTM42,G15,25-19-16AUG94

CHECK OIL SEAL HOUSING RUNOUT

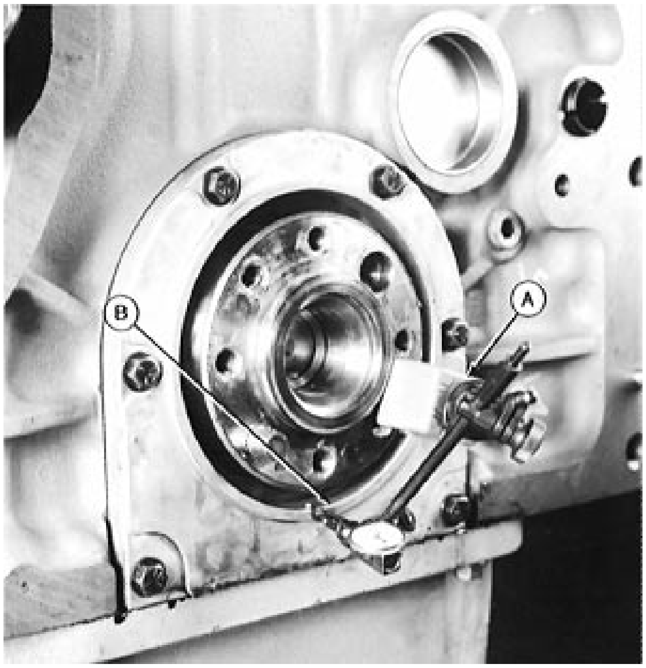
IMPORTANT: On service "short block" assemblies, rear oil seal housing runout is preset at the factory. Do not remove housing from block.

1. Position magnetic base dial indicator (A) on end of crankshaft flange as shown. Preset dial indicator tip on 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 bore runout is 0.15 mm (0.006 in.).

If runout exceeds specification, loosen cap screws and adjust housing to obtain an acceptable runout while keeping bottom of seal housing flush with oil pan mating surface.

3. Recheck oil seal housing bore runout. If runout still exceeds specification, oil seal housing bore is possibly distorted and should be replaced. See INSTALL CRANKSHAFT REAR OIL SEAL HOUSING, earlier in this group.



RG5751 -UN-05AUG91

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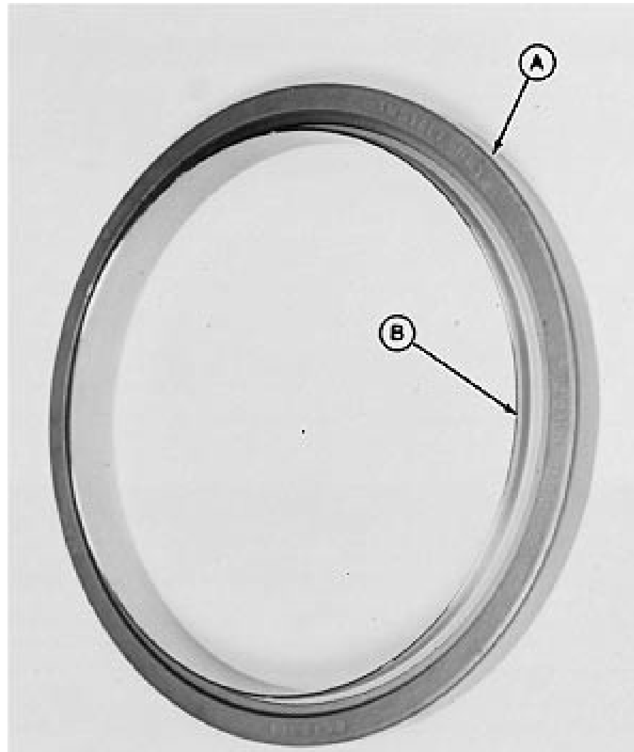
S11,2515,AK -19-16AUG94

CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE HANDLING PRECAUTIONS



RG5575 -UN-07JUL89

Use the following precautions for handling seal and wear sleeve:

—Seal (A) and wear sleeve (B) are assembled. DO NOT SEPARATE. If parts become separated, discard and replace with a new assembly. Attempts to reassemble will cause the wear sleeve to damage the seal allowing engine oil to leak past seal.

—Always install seal and wear sleeve assembly immediately after removal from plastic bag to avoid possible dirt contamination.

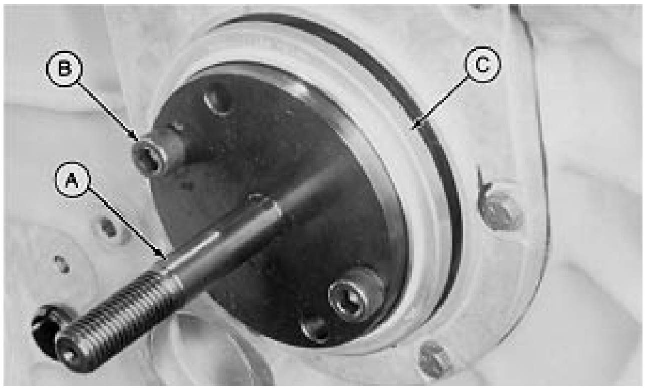
—No lubrication of any kind is to contact seal when installing. Use of a lubricant may result in premature seal failure.

—Install oil seal/wear sleeve assembly with the open side of seal and wear sleeve 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 JDG476(85) Crankshaft Rear Oil Seal Installation Tool Set. Tool set consists of JDG477(85) Pilot and JDG478 Driver.

S11,2015,GP -19-08MAR94

INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE ASSEMBLY



1. Apply a light coating of LOCTITE 609 Retaining Compound, or equivalent, completely around the leading edge of crankshaft flange. Wipe away any sealant that may have gotten on seal housing bore.

IMPORTANT: DO NOT allow sealant to get on any part of wear sleeve OD or on oil seal.

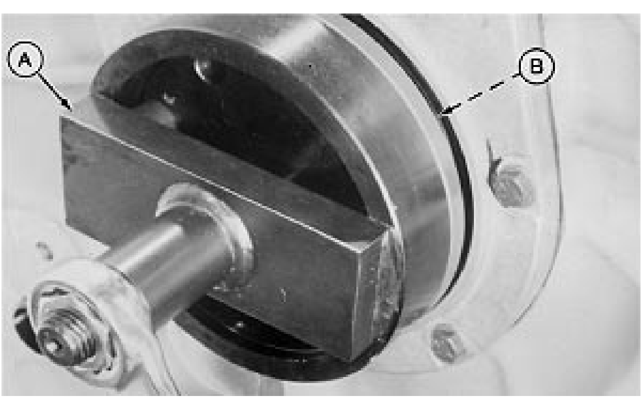
2. Install JDG477(85) Pilot (A) on end of crankshaft using the Allen head cap screws (B) supplied with tool set. Tighten cap screws securely.

IMPORTANT: Handle seal and wear sleeve assembly carefully. If assembly becomes separated, discard these parts and install a new assembly.

3. Carefully start oil seal/wear sleeve assembly (C) over JDG477(85) Pilot and crankshaft flange with open side of seal toward engine.

IMPORTANT: When installing the JDG478 Driver on JDG477(85) Pilot and crankshaft flange to position oil seal/wear sleeve assembly, locate crossbar of installer at right angle (90°) to Allen head cap screws. This allows the crossbar to bottom on pilot, not head of cap screws, assuring correct installation.

RG,CTM42,G15,26-19-29OCT92



4. Position JDG478 Driver (A) so that hole in the cross plate goes over threaded stud of pilot. Install washer and nut on stud.

5. Tighten nut to draw JDG478 Driver in until crossbar bottoms on JDG477(85) Pilot. When the tool bottoms, seal and wear ring assembly (B) will be correctly positioned.

6. Remove JDG476(85) Tool Set from engine.

RG,CTM42,G15,27-19-11JUN93

INSTALL TIMING GEAR COVER

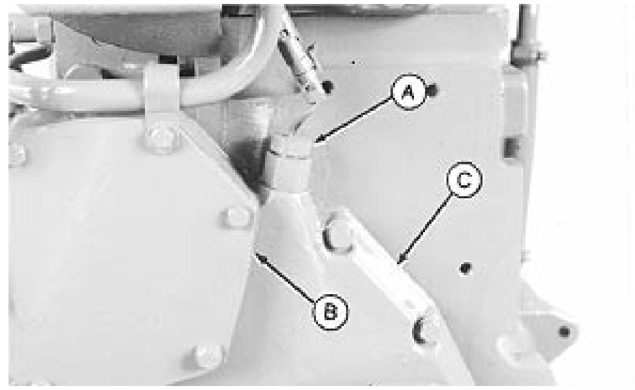
IMPORTANT: Tightening the timing gear cover cap screws in numerical sequence controls the total runout of the front crankshaft oil seal.

1. Install a new gasket on the engine block. Lightly grease the gasket to hold it in place. Install timing gear cover (C). Tighten cap screws in sequence one through nine (as shown) to 27 N·m (20 lb-ft).

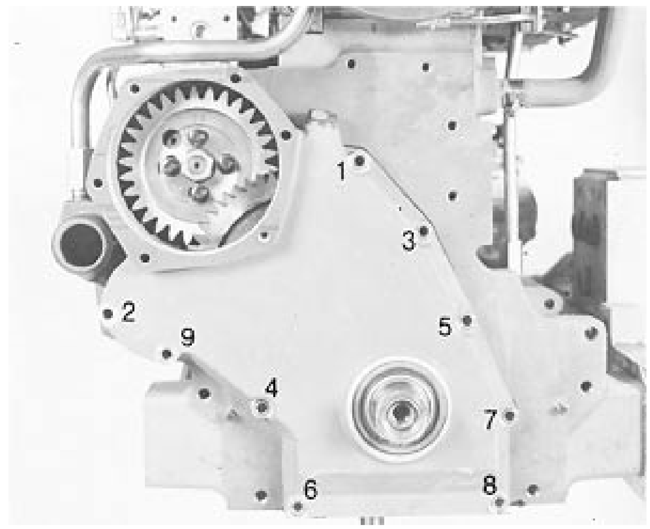
2. Trim timing gear cover gasket flush with oil pan gasket rail.

3. Lightly grease and install a new injection pump drive gear cover gasket on timing gear cover. Install cover (B). Tighten cap screws to 27 N·m (20 lb-ft).

4. Using a new O-ring, install magnetic pickup (A, if equipped) in timing gear cover and tighten to 14 N·m (10 lb-ft).



RG5828 -UN-12AUG91



RG5783 -UN-13OCT92

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48

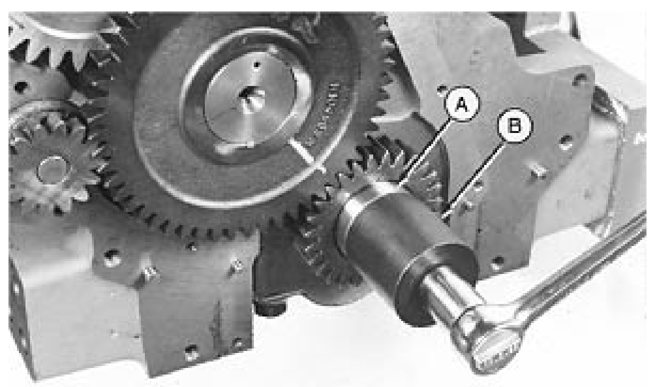
RG,CTM42,G15,30-19-24MAR95

INSTALL FRONT WEAR SLEEVE

NOTE: Front wear sleeve can be installed with timing gear cover removed or installed.

1. Coat I.D. of new wear sleeve (if removed) with LOCTITE 609 Retaining Compound or equivalent.

2. Use the JDE3 Driver (B), large washer, and cap screw threaded in nose of crankshaft to press on wear sleeve (A).



RG5879 -UN-13AUG91

RG,CTM42,G15,29-19-29OCT92

INSTALL CRANKSHAFT FRONT OIL SEAL (WITH TIMING GEAR COVER INSTALLED ON ENGINE)

RG6479 -UN-26OCT92

RG6480 -UN-26OCT92

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

1. Place JDG720-2 Seal Protector (A) on nose of crankshaft. Lubricate ID of front oil seal lips with clean engine oil. Slide seal with spring side of seal facing engine onto seal protector. Be careful not to roll oil seal lips.

2. Place JDG720-3 Seal Installer onto seal protector against seal. Do not use spacer ring provided with tool set.

3. With nut and washer installed onto JDG720-1 Forcing Screw, thread forcing screw into nose of crankshaft until it bottoms.

4. Tighten nut against crossplate of installer until installer bottoms onto front face of timing gear cover.

5. Remove installation tools. Verify seal is installed square in bore and that seal lips are not rolled on wear sleeve.

Oil seal should be 8.4 mm (0.33 in.) below front lip of seal bore.

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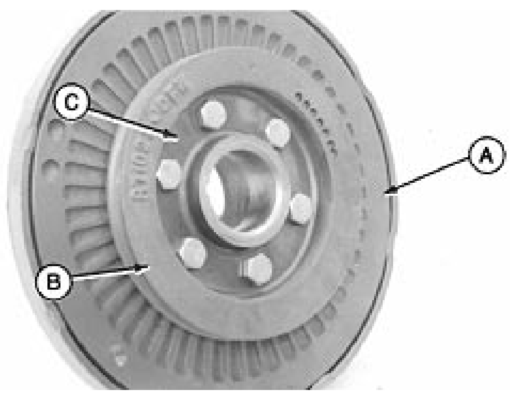
49

RG,CTM42,G15,43-19-03MAY93

INSTALL DAMPER PULLEY ASSEMBLY



RG3928 -UN-14DEC88

1. If vibration damper (A) was removed from damper pulley (B), install washer (C) and tighten cap screws to 41 N·m (30 lb-ft).

NOTE: Vibration damper and pulley orientation may vary depending on specific engine application. Be sure damper and pulley are assembled in the same orientation as when removed.

S11,2015,DT -19-16AUG94

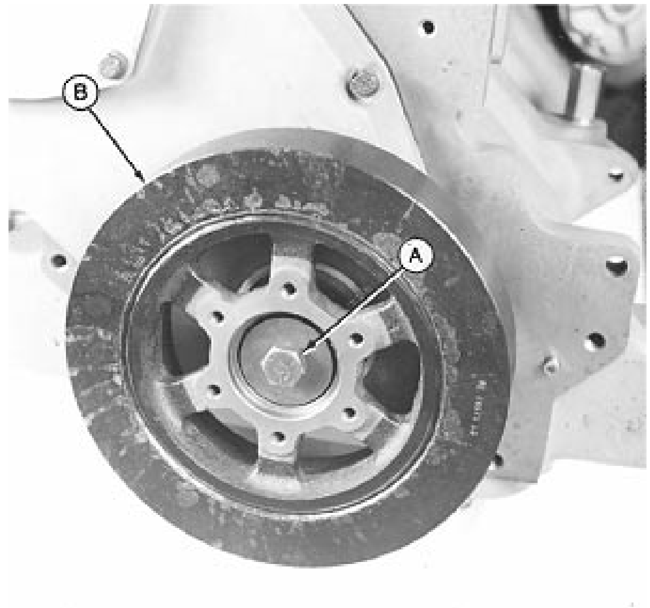
2. Make sure crankshaft Woodruff key is in place, with tab facing forward. Position damper pulley assembly (B) onto crankshaft.

3. Use hardened washer (part of damper assembly) and insert a cap screw that is 25 mm (1 in.) longer than original cap screw (A). Tighten cap screw until it just bottoms out.

4. Remove cap screw and insert original cap screw with same hardened washer.

5. Tighten cap screw to 230 N·m (170 lb-ft).

6. Install water bypass pipe.



RG5882 -UN-13AUG91

RG,CTM42,G15,31-19-16AUG94

INSTALL SAE 3 FLYWHEEL HOUSING

On SAE 1 and SAE 2 flywheel housings, the flywheel housing is installed AFTER the flywheel.

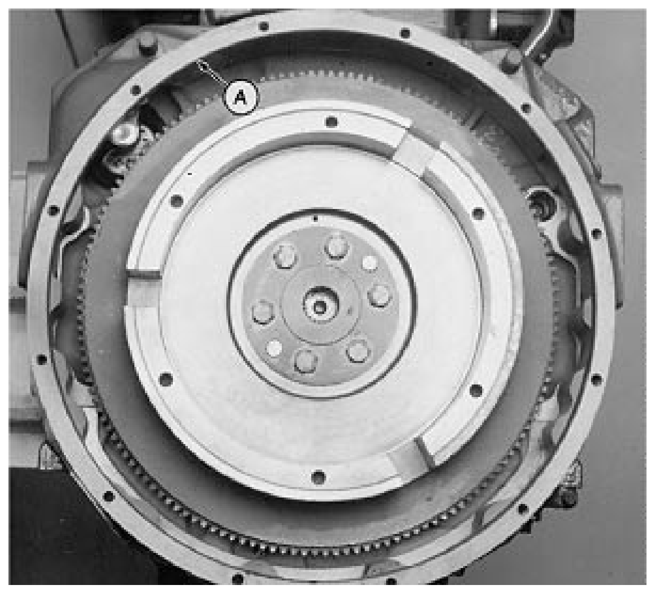
CAUTION: Flywheel housing (A) is heavy. Plan a proper lifting procedure to avoid personal injury.

1. On engines requiring a gasket between block and flywheel housing, inspect cylinder block and flywheel housing gasket surfaces to see that they are clean. Scrape off all old gasket material. Install a new gasket without sealant between block and flywheel housing.

2. Install flywheel housing on cylinder block.

NOTE: Use new cap screws when installing flywheel housing.

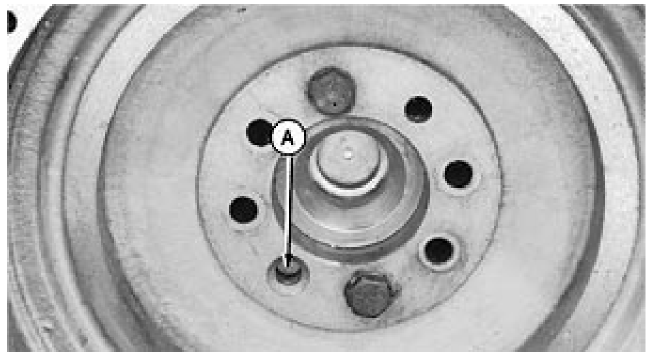
3. Dip threads of cap screw in engine oil before installing. Install and tighten cap screws to 407 N·m (300 lb-ft).



RG5005 -UN-14DEC88

S11,2015,GL -19-29OCT92

INSTALL FLYWHEEL



RG4383 -UN-14DEC88

Two guide studs may be used to aid in flywheel installation.

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

NOTE: ALWAYS use new cap screws when installing flywheel. Flywheel must be clean and free of oil before installing.

1. Coat threads of flywheel attaching cap screws with LOCTITE 242 or its equivalent.

2. Position flywheel over dowel pin (A) and install drive hub (if equipped). Start four cap screws. Remove guide studs and install remaining cap screws.

3. Install remaining flywheel attaching cap screws.

4. Tighten flywheel attaching cap screws to 115 N·m (85 lb-ft).

S11,2020,L -19-29OCT92

INSTALL SAE 1 AND SAE 2 FLYWHEEL HOUSING

On SAE 3 flywheel housings, the housing MUST be installed BEFORE installing flywheel.

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

1. Scrape off all old gasket material. Install a new gasket without sealant between block and flywheel housing, if equipped.

2. Install flywheel housing on cylinder block.

NOTE: ALWAYS use new cap screws when installing flywheel housing.

3. Dip threads of cap screw in engine oil before installing. Install and tighten cap screws to 407 N·m (300 lb-ft).

S11,2015,GT -19-29OCT92

COMPLETE FINAL ASSEMBLY

1. Install fan assembly.

2. Install oil pan and fill with clean engine oil.

3. Fill cooling system with proper coolant after engine installation and perform engine break-in. (See PERFORM ENGINE BREAK-IN in Group 05.)

S55,2015,Y -19-29OCT92

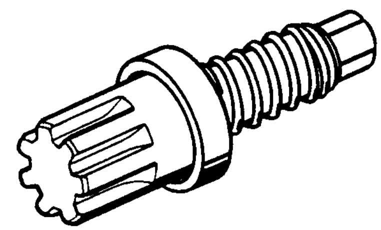
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

Flywheel Turning Tool JDG820

Used to rotate engine to check damper radial runout and time engine. JDE81-1 may be used also if JDG820 is not available.



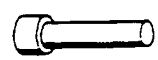
RG7056 -UN-10AUG94

RG,JDG820 -19-14FEB95

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Lock engine at TDC when timing valve train, adjusting valve clearance, and installing fuel injection pump. Use with JDG820 and JDE81-1 Flywheel Turning Tools.



RG,JDE814,86 -19-14FEB95

RG5073 -UN-23AUG88

Magnetic Follower Holder Kit D15001NU

Hold cam followers when removing or installing camshaft.

S53,D15001,NU -19-24APR92

Slide Hammer D01299AA

Used with JDG405 Camshaft Bushing Service Set and JDG606 Camshaft Bushing Adapter Set to service camshaft bushings.

RG78104H1 -UN-15DEC88

S53,D01299,AAA -19-09SEP91

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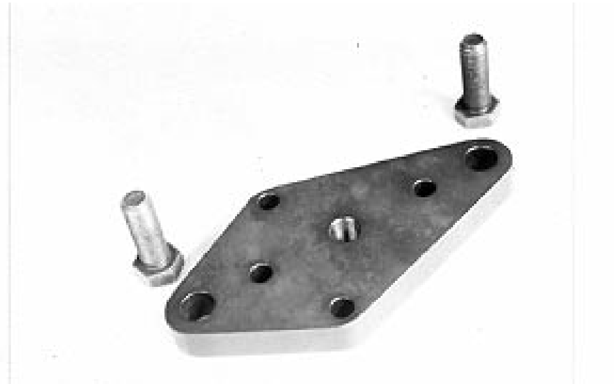
Hub Puller Kit JDG721

Used with JDG787 Thread Protector to remove vibration damper pulley assembly on some engine applications.


RG5763 -UN-06AUG91

RG,JDG721 -19-03MAY93

Camshaft Bushing Service Set JDG405

Used with JDG606 Camshaft Bushing Adapter Set and D01299AA Slide Hammer to service camshaft bushings.

NOTE: JDE6 Service Set may be used along with JDG602 Adapter Set if JDG405 is not available.

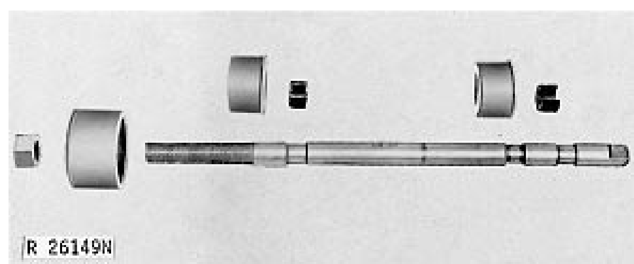

RG4228 -UN-27JAN92

S53,JDG405,A -19-28APR92

Camshaft Bushing Service Set JDE6

Used with JDG602 Camshaft Bushing Adapter Set to service camshaft bushings.

NOTE: JDG405 Service Set may be used along with JDG606 Adapter Set if JDE6 is not available.

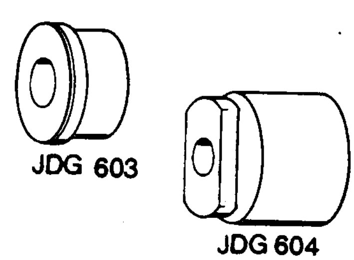


R26149N -UN-23AUG88

S53,JDE6A -19-09SEP91

Camshaft Bushing Adapter Set JDG602

Used with JDE6 Camshaft Bushing Service Set to service camshaft bushings. JDG602 consists of JDG603 Driver and JDG604 Receiver Cup.

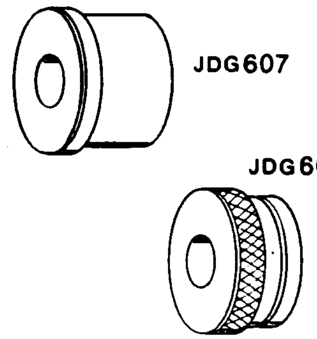


RG5336 -UN-23AUG88

S53,JDG602 -19-09SEP91

Camshaft Bushing Adapter Set JDG606

Used with JDG405 Camshaft Bushing Service Set and D01299AA Slide Hammer to service camshaft bushings. JDG606 consists of JDG607 Driver and JDG608 Pilot.



RG5337 -UN-28AUG91

S53,JDG606 -19-09SEP91

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
D01207AA Puller Kit	Used to remove vibration damper.
D01045AA Bushing, Bearing, and Seal Driver Master Set	Used to install front oil seal in timing gear cover.

RG,CTM42,G16,4 -19-10SEP91

OTHER MATERIAL

Name	Use
High Temperature Grease (TY6333 OR TY6347)	Lubricate camshaft lobes and thrust washers before camshaft installation.
FEL-PRO® C-670 Molybdenum Disulfide Paste	Lubricate camshaft nose to provide lubrication to aid in camshaft gear installation.
PERMATEX AVIATION (Form-A-Gasket No.3) (TY6299)	Lubricate camshaft bore steel cap plug.

RG,CTM42,G16,1 -19-29OCT92

CAMSHAFT AND TIMING GEAR TRAIN SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Camshaft End Play	0.0130—0.5000 mm (0.0005—0.0200 in.)	0.65 mm (0.026 in.)
Camshaft Thrust Washer Thickness	2.24—2.34 mm (0.088—0.092 in.)	——
Camshaft Journal OD	66.987—67.013 mm (2.6373—2.6383 in.)	——
Camshaft Bushing ID	67.076—67.102 mm (2.6408—2.6418 in.)	——
Camshaft Bushing-to-Journal Clearance	0.063—0.115 mm (0.0025—0.0045 in.)	——
Camshaft Gear-to-Injection Pump Drive Gear Backlash	0.051 mm (0.0020 in.) minimum	——
Camshaft Bushing Bore in Block (without bushings)	69.987—70.013 mm (2.7554—2.7564 in.)	——
Maximum Runout of Camshaft Bore	0.038 mm (0.0015 in.)	——
Maximum Runout of Camshaft Gear Thrust Surfaces	0.10 mm (0.004 in.)	——
Camshaft Drive Gear-to-Crankshaft Gear Backlash	0.076 mm (0.0030 in.) minimum	——
Camshaft Lobe Lift:		
Intake	7.69—7.07 mm (0.303—0.307 in.)	7.19 mm (0.283 in.)
Exhaust	8.25—8.35 mm (0.325—0.329 in.)	7.75 mm (0.305 in.)
Cam Follower OD	17.33—17.35 mm (0.682—0.683 in.)	——
Cam Follower Bore Diameter in Block	17.384—17.440 mm (0.6845—0.6865 in.)	——
Valve Lift at 0.00 mm (in.) Clearance:		
Intake	13.53—13.71 mm (0.533—0.540 in.)	12.65 mm (0.498 in.)
Exhaust	14.52—14.70 mm (0.572—0.579 in.)	13.64 mm (0.537 in.)
Crankshaft Front Oil Seal Bore Runout	0.254 mm (0.010 in.) maximum	——
Crankshaft Front Oil Seal Installed Depth (below front face of cover)	8.4 mm (0.33 in.)	——

RG,CTM42,G16,2 -19-16AUG94

CAMSHAFT AND TIMING GEAR TRAIN SPECIFICATIONS—CONTINUED

TORQUES

Rocker Arm Shaft Clamps . . . . 75 N·m (55 lb-ft)

Rocker Arm Cover-to-Cylinder Head . . . . 8 N·m (6 lb-ft) (72 lb-in.)

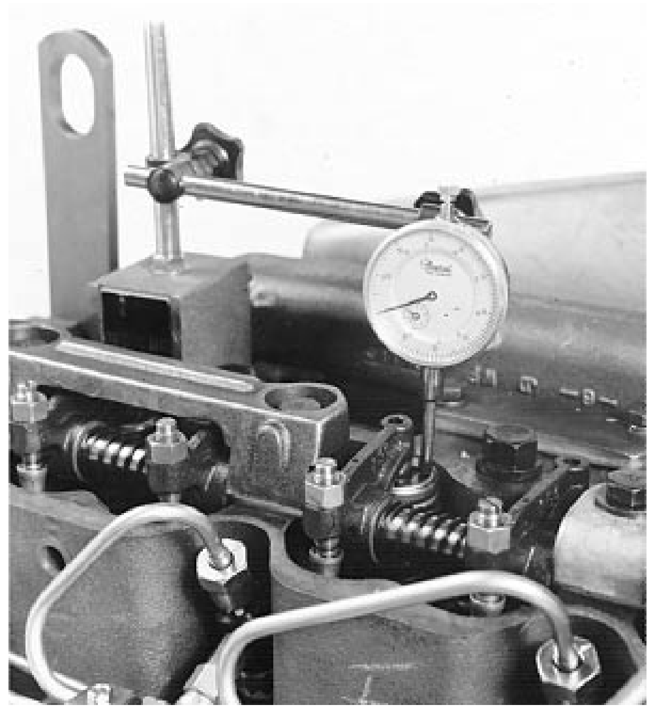
Timing Gear Cover-to-Cylinder Block . . . . 27 N·m (20 lb-ft)

Injection Pump Gear Cover . . . . 27 N·m (20 lb-ft)

Magnetic Pickup-to-Timing Gear Cover . . . . 14 N·m (10 lb-ft)

RG,CTM42,G16,3 -19-24MAR95

CHECK VALVE LIFT


RG5789 -UN-09AUG91

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

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

1. Remove turbocharger oil inlet line clamp and rocker arm cover. Loosen locknut on rocker arm. Set valve clearance at 0.00 mm (in.). Tighten locknut.

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

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

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

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

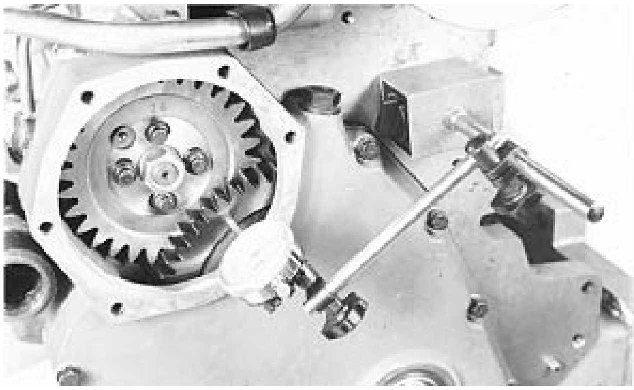
VALVE LIFT SPECIFICATION AT 0.00 MM (IN.) CLEARANCE

Intake	13.53—13.71 mm (0.533—0.540 in.)
Wear Tolerance	12.65 mm (0.498 in.)
Exhaust	14.52—14.70 mm (0.572—0.579 in.)
Wear Tolerance	13.65 mm (0.537 in.)

6. Follow same procedure for all remaining valves and adjust valve clearance to specification. (See CHECK AND ADJUST VALVE CLEARANCE in Group 05.)

RG,CTM42,G16,5 -19-16AUG94

CHECK CAMSHAFT END PLAY


RG5769 -UN-06AUG91

NOTE: Camshaft end play must be measured before removing timing gear cover, as thrust washer in back side of timing gear cover limits camshaft end play.

1. Remove injection pump drive gear cover (shown removed).

2. Install magnetic base dial indicator on front face of cylinder block.

3. Position dial indicator tip on front face of camshaft gear, as shown. Set dial indicator to zero.

4. Move camshaft gear back and forth and observe end play reading. Compare reading with specification given below.

CAMSHAFT END PLAY SPECIFICATIONS

Camshaft End Play (NEW)	0.013—0.500 mm (0.0005—0.0200 in.)
Maximum Allowable End Play	0.65 mm (0.0260 in.)

If end play is excessive, remove timing gear cover and camshaft and measure thickness of thrust washers.

16
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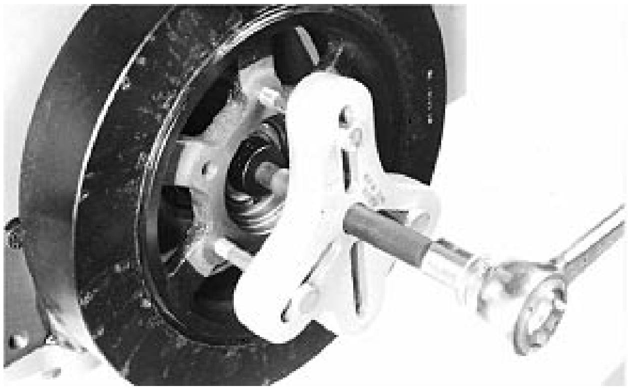
RG,CTM42,G16,12-19-29OCT92

REMOVE DAMPER PULLEY AND TIMING GEAR COVER


RG5765 -UN-06AUG91

1. Drain oil (if not previously done), and remove oil pan. Remove oil pump if crankshaft is to be removed.

2. Remove cap screw and washer on damper pulley.

IMPORTANT: DO NOT use a jaw-type puller to remove vibration damper. Damage could result to the damper. Never apply thrust on outer ring of damper. Do not drop damper or strike with a hammer.

3. Remove pulley and damper from crankshaft using D01207AA Puller Set.

RG,CTM42,G16,8 -19-29OCT92

4. Remove magnetic pick-up (A, if equipped) and injection pump drive gear cover (B).

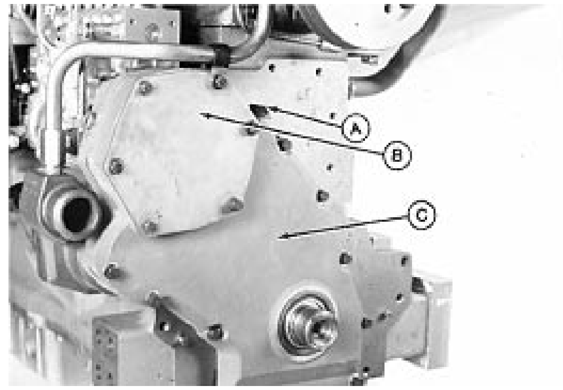
5. Check camshaft end play. (See CHECK CAMSHAFT ENDPLAY earlier in this group.)

IMPORTANT: Whenever timing gear cover is removed, ALWAYS install a new front oil seal.

6. Remove timing gear cover (C).

7. Remove front oil seal from timing gear cover. Install a new seal after timing gear cover is installed. See INSTALL FRONT OIL SEAL (WITH TIMING GEAR COVER INSTALLED ON ENGINE) in Group 15.

8. Remove front crankshaft wear sleeve.



RG5766 -UN-06AUG91

RG,CTM42,G16,9 -19-16AUG94

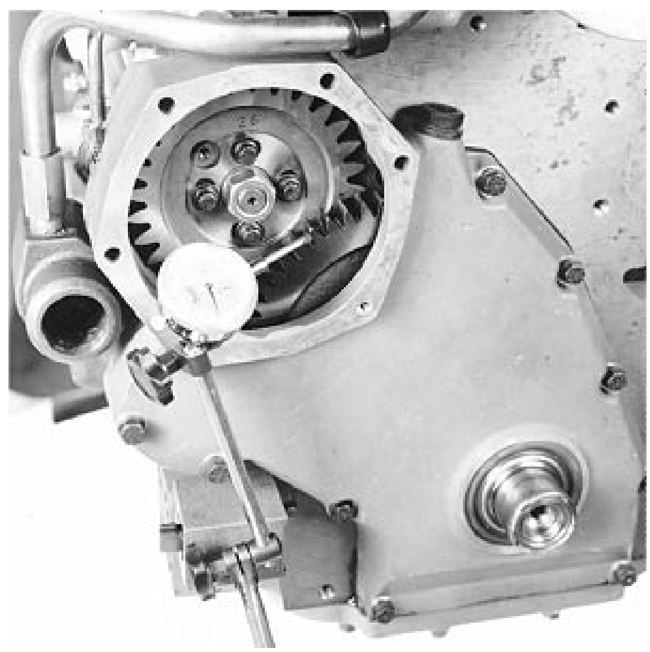
MEASURE CAMSHAFT DRIVE GEAR-TO-CRANKSHAFT GEAR BACKLASH

Measure backlash between camshaft drive gear and crankshaft gear in three (3) different positions around the camshaft gear. Use a magnetic base dial indicator with indicator plunger resting on camshaft gear tooth.

CAMSHAFT DRIVE GEAR-TO-CRANKSHAFT GEAR BACKLASH SPECIFICATION

Camshaft Gear Backlash . . . . 0.076 mm (0.003 in.) min.

Replace gears if backlash is not within specification.

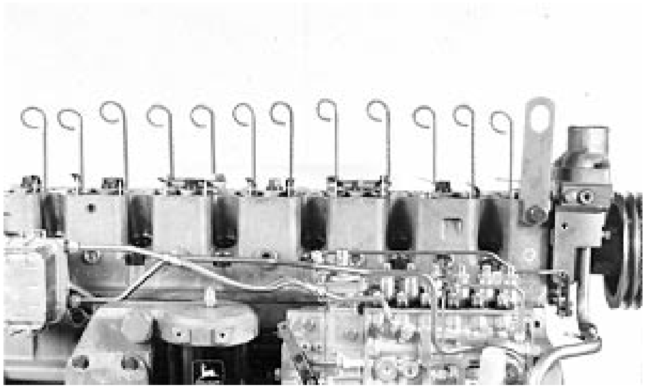


RG5770 -UN-06AUG91

RG,CTM42,G16,13-19-29OCT92

REMOVE CAMSHAFT

NOTE: It is not necessary to remove cylinder head from engine for camshaft removal. If push rods are bent or show excessive scuffing, it may be necessary to remove cylinder head for inspection of block, head, cam lobes and cam followers.


RG5764 -UN-06AUG91

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

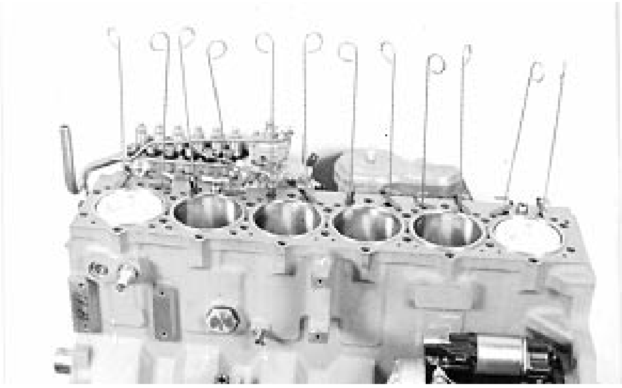
2. Disconnect turbocharger oil inlet line at turbocharger or oil conditioning housing.

3. Set engine at No. 1 cylinder's "TDC-Compression" stroke with JDE81-4 Timing Pin. (See Group 05, Cylinder Head and Valves.)

4. Remove rocker arm cover, rocker arm assembly and push rods. Remove cylinder head, if desired. (See Group 05, Cylinder Head and Valves.)

RG,CTM42,G16,32-19-29OCT92

5. When removing camshaft with engine on rollover stand, roll engine to a vertical position (horizontal shown) and hold cam followers away from camshaft lobes with D15001NU Magnetic Holding Set.

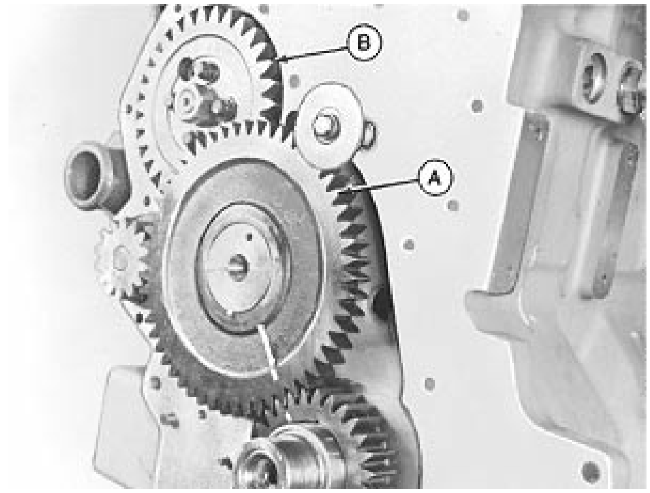

RG5778 -UN-06AUG91

RG,CTM42,G16,33-19-29OCT92

16
9

6. Examine camshaft gear (A) and injection pump drive gear (B) for worn or damaged gear teeth. Gears should have a minimum backlash of 0.051 mm (0.0020 in.).

NOTE: Timing marks on crankshaft and camshaft gear should be aligned and No. 1 cylinder locked at "TDC Compression" stroke when removing camshaft.



RG5771 -UN-06AUG91

RG,CTM42,G16,15-19-29OCT92

7. Carefully remove camshaft (B) from cylinder block so that camshaft lobes do not drag in bores.

NOTE: Rotate camshaft carefully to aid in removing.

8. Remove thrust washer (A) from behind cam gears.

9. Remove cam followers.

RG5772 -UN-06AUG91

RG,CTM42,G16,16-19-29OCT92

REMOVE CAMSHAFT GEARS

NOTE: Camshaft gears are pressed onto the camshaft. Removal of gears from camshaft will require approximately a 10-ton press.

IMPORTANT: Prevent camshaft from striking floor when pushing camshaft nose out of gear. Camshaft may be damaged if it is allowed to fall to the floor.

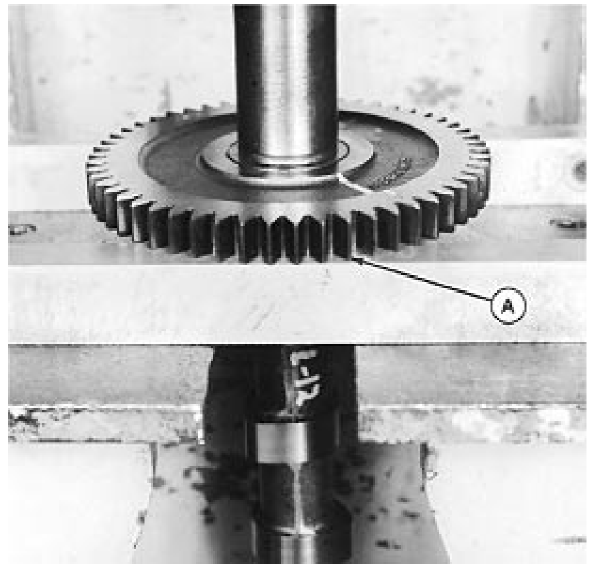
1. Support outer camshaft gear (A) in a press.

2. Remove outer gear from camshaft.

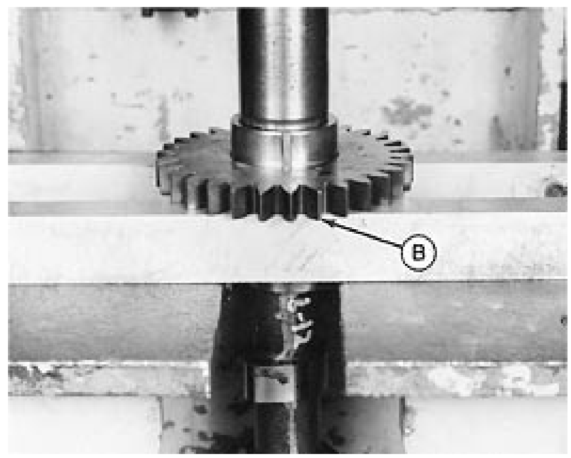
3. Support inner camshaft gear (B) in a press.

4. Remove inner gear from camshaft.

5. Clean camshaft and gears in solvent. Dry with compressed air.



RG5773 -UN-06AUG91



RG5774 -UN-06AUG91

RG,CTM42,G16,17-19-29OCT92

MEASURE THRUST WASHER THICKNESS

1. After removal of camshaft, check the two thrust washers individually for proper thickness.

THRUST WASHER THICKNESS SPECIFICATIONS

Thrust Washer Thickness . . . . 2.24—2.34 mm (0.088—0.092 in.)

2. Replace washers if worn or damaged.

RG5775 -UN-06AUG91

RG,CTM42,G16,18-19-29OCT92

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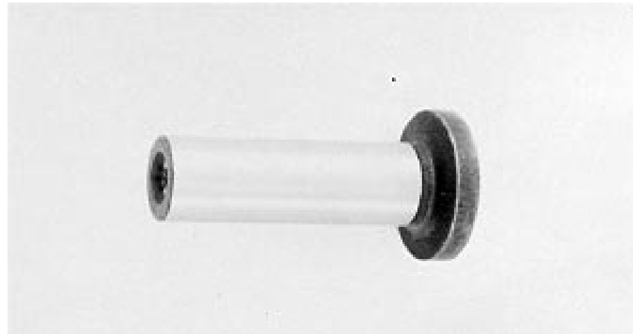
11

INSPECT AND MEASURE CAMSHAFT FOLLOWERS


RG2745 -UN-23FEB89

1. Inspect camshaft followers for uneven wear or damage. Also inspect corresponding camshaft lobe for wear or damage. Replace as necessary.

2. Measure follower OD and follower bore ID in cylinder block.

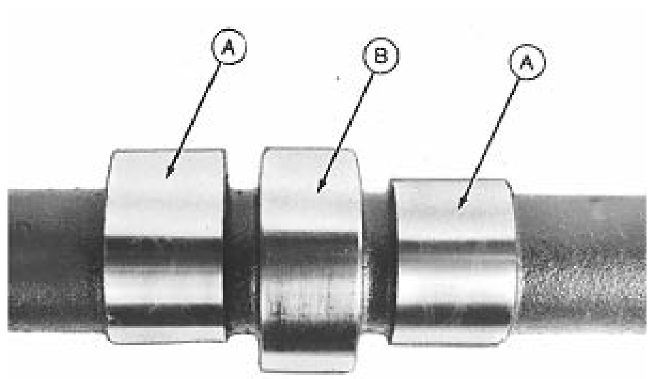
CAMSHAFT FOLLOWER AND BORE SPECIFICATIONS

Camshaft Follower OD	17.33—17.35 mm (0.682—0.683 in.)
Camshaft Follower Bore ID in Block	17.384—17.440 mm (0.6845—0.6865 in.)

Replace cam followers that are not within specification. Replace cylinder block if any one cam follower bore is not within specification.

RG,CTM42,G16,19-19-15SEP94

VISUALLY INSPECT CAMSHAFT



RG3500 -UN-06AUG91

16
12

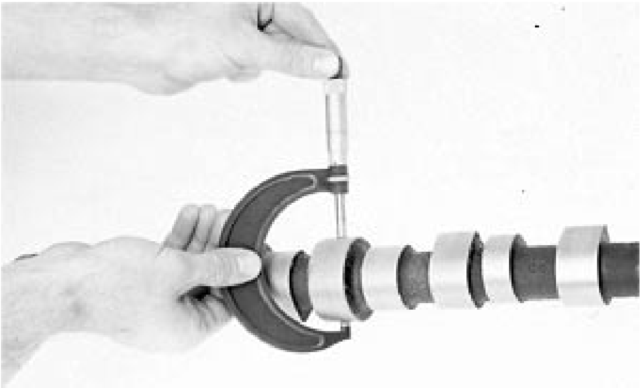
1. Clean camshaft in solvent. Dry with compressed air.

2. Visually inspect camshaft lobes (A) and journals (B) for wear or damage. Replace as necessary. New camshaft followers can be used with old camshaft (if camshaft is serviceable). DO NOT reuse old cam followers with a new camshaft.

NOTE: Very light score marks may be found, but are acceptable if valve lift is within specification. Pitting or galling dictates replacement. (See CHECK VALVE LIFT earlier in this group.)

RG,CTM42,G16,20-19-29OCT92

MEASURE CAMSHAFT JOURNAL OD AND BUSHING ID


T81260 -UN-07NOV88

1. Measure each camshaft journal OD. If camshaft journal OD is not within specification, install a new camshaft.

2. Measure each camshaft bushing ID when installed in cylinder block.

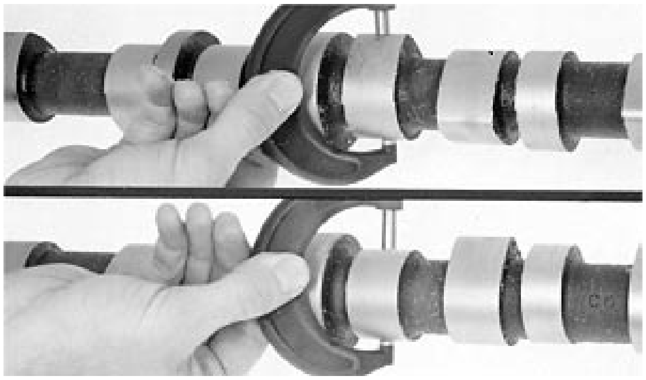
Compare measurements with specs given below. Replace camshaft and bushings as needed.

CAMSHAFT JOURNAL AND BUSHING SPECIFICATIONS

Camshaft Journal Diameter (NEW)	66.987—67.013 mm (2.6373—2.6383 in.)
Camshaft Bushing ID (NEW)	67.076—67.102 mm (2.6408—2.6418 in.)

RG,CTM42,G16,21-19-15SEP94

MEASURE CAMSHAFT LOBE LIFT


T81262 -UN-01NOV88

1. Measure each camshaft lobe at its highest point and at its narrowest point. Subtract narrowest dimension from highest dimension to find camshaft lobe lift.

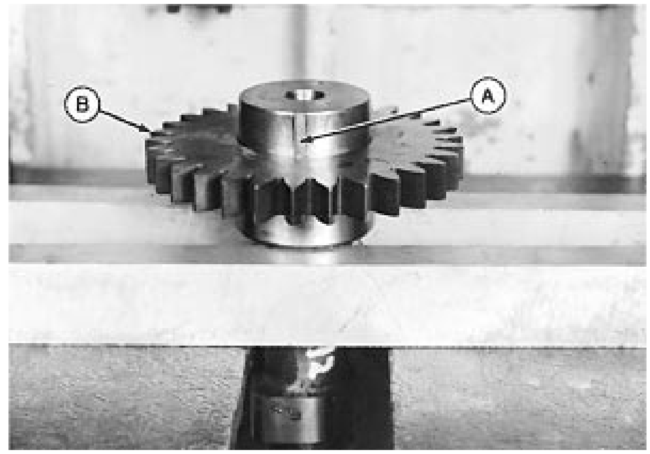
If camshaft lobe lift is not within the wear specification on any one lobe, install a new camshaft.

CAM LOBE LIFT NEW PART SPECIFICATION

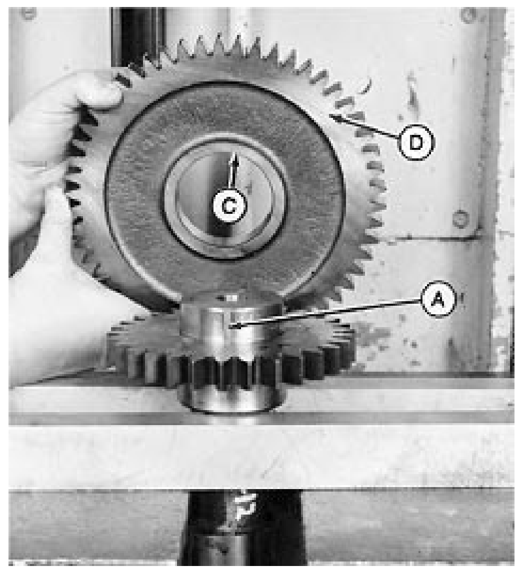
Intake Lobe Lift	7.69—7.79 mm (0.303—0.307 in.)
Wear Limit	7.19 mm (0.283 in.)
Exhaust Lobe Lift	8.25—8.35 mm (0.325—0.329 in.)
Wear Limit	7.75 mm (0.305 in.)

RG,CTM42,G16,22-19-16AUG94

INSTALL CAMSHAFT GEARS



RG5776 -UN-06AUG91



RG5777 -UN-17SEP91

1. Support camshaft under first bearing journal in a hydraulic press.

2. Install Woodruff key (A). Lubricate camshaft nose with FEL-PRO® C-670 Molybdenum Disulfide Paste.

3. Set inner gear (B) on camshaft with thrust washer surface to the inside (toward the camshaft). Align Woodruff key and keyway

4. Install gear onto nose of camshaft. Push inner gear on until tight against the camshaft bearing journal.

5. Set outer gear on camshaft with timing mark upward (away from the camshaft). Align Woodruff key and keyway (C) of outer gear (D).

6. Push outer gear onto camshaft nose until tight against inner gear.

A—Woodruff Key
B—Inner Gear
C—Keyway
D—Outer Gear

RG,CTM42,G16,23-19-29OCT92

7. Support each end of the camshaft on centers. Use a dial indicator with plunger resting on the thrust surface of the camshaft gears.

8. Check the runout of the inner and outer gear thrust surfaces.

CAMSHAFT GEAR THRUST SURFACE RUNOUT SPECIFICATIONS

Camshaft Gear Thrust Surface Runout . . . . 0.10 mm (0.004 in.)

RG,CTM42,G16,24-19-23SEP91

SERVICE CAMSHAFT BUSHINGS USING JDG602 ADAPTER SET

1. Inspect camshaft journals and bushings for wear or damage. Measure cam journals and bushings to determine if proper oil clearance exists. Replace camshaft and/or bushings as necessary.

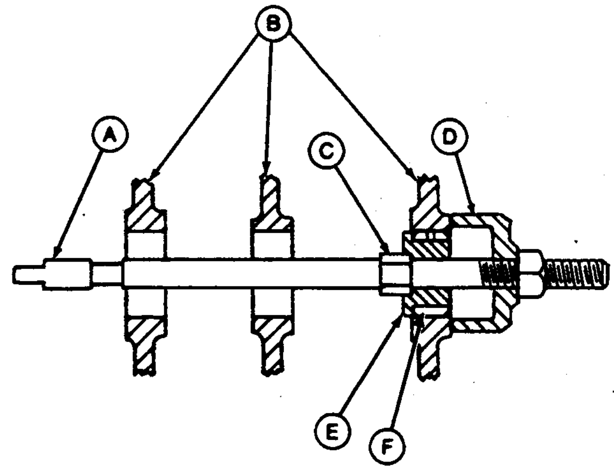
CAMSHAFT JOURNAL AND BUSHING NEW PART SPECIFICATION

Camshaft Bushing Bore in Block	69.987—70.013 mm (2.7554—2.7564 in.)
Journal OD	66.987—67.013 mm (2.6373—2.6383 in.)
Bushing ID	67.076—67.102 mm (2.6408—2.6418 in.)
Oil Clearance	0.063—0.115 mm (0.0025—0.0045 in.)

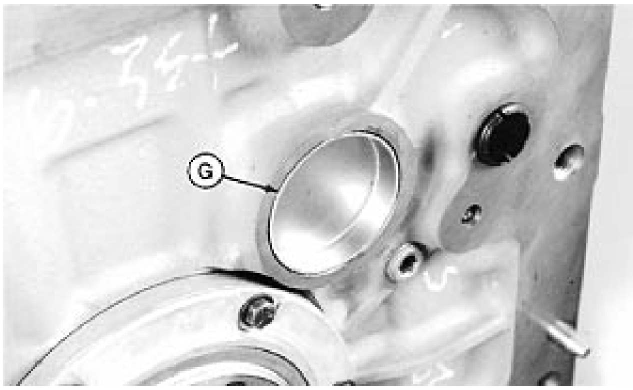
NOTE: The front two bushings can be reached from the front of the engine. The flywheel and rear camshaft bore plug (G) must be removed to reach the other two bushings.

2. Remove camshaft bushings (F) using JDG603 Bushing Driver (E) and JDG604 Receiver Cup (D) along with the components shown from JDE6 Camshaft Bushing Replacement Set (A and C).

3. Tighten nut on end of bushing screw until bushing is pulled out of camshaft bushing bore. Inspect and measure camshaft bushing bore in block (B). Follow same procedure for remaining bushings to be replaced.



RG5272 -UN-06DEC88



RG5949 -UN-30AUG91

16
15

A—Bushing Screw (JDE6-1)
B—Cylinder Block Web
C—Lock Bushing (No. 25916)
D—Receiver Cup (JDG604)
E—Bushing Driver (JDG603)
F—Camshaft Bushing
G—Camshaft Bore Plug

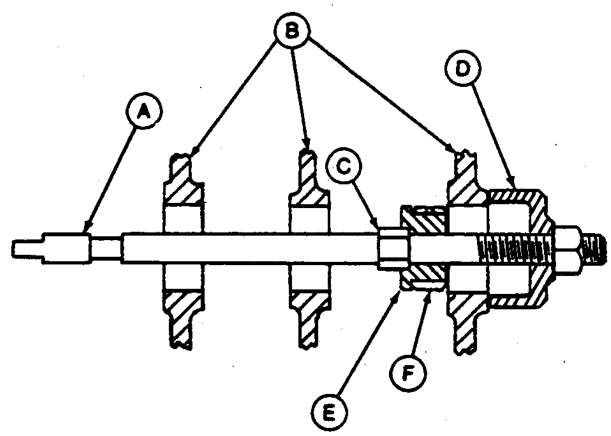
RG,CTM42,G16,30-19-15SEP94

IMPORTANT: Oil holes in bushings and cylinder block must be aligned after installation or oil starvation will occur. The elongated hole in bushing must be toward the top. After installation, use a small mirror with extension to be sure oil holes are properly aligned.

4. Slide a new camshaft bushing (F) onto JDG603 Bushing Driver (E). Assemble driver and JDG604 Receiver Cup (D) along with components shown from JDE6 Camshaft Bushing Replacement Set (A and C).

5. Be sure bushing is started square in bore and oil holes are aligned with holes in block. Tighten nut to pull bushing in until it is properly positioned in bore.

6. Check bushing-to-cylinder block oil hole alignment using a small mirror with extension.

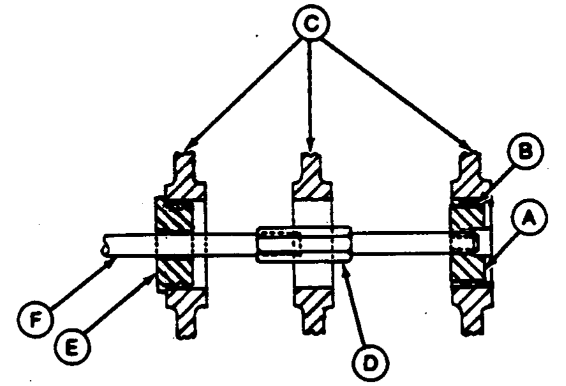


RG5273 -UN-06DEC88

A—Bushing Screw (JDE6-1)
B—Cylinder Block Web
C—Lock Bushing (No. 25916)
D—Receiver Cup (JDG604)
E—Bushing Driver (JDG603)
F—Camshaft Bushing

S55,2016,N -19-23SEP91

SERVICE CAMSHAFT BUSHINGS USING JDG606 ADAPTER SET



RG5332 -UN-06DEC88

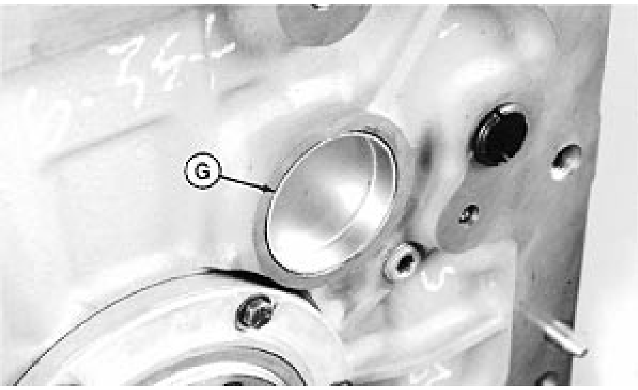
1. Inspect camshaft journals and bushings for wear or damage. Measure cam journals and bushings to determine if proper oil clearance exists. Replace camshaft and/or bushings as necessary.

CAMSHAFT JOURNAL AND BUSHING NEW PART SPECIFICATIONS

Camshaft Bushing Bore in Block	69.987—70.013 mm (2.7554—2.7564 in.)
Journal OD	66.987—67.013 mm (2.6373—2.6383 in.)
Bushing ID	67.076—67.102 mm (2.6408—2.6418 in.)
Oil Clearance	0.063—0.115 mm (0.0025—0.0045 in.)

NOTE: The front two bushings can be reached from the front of the engine. The flywheel and rear camshaft bore plug (G) must be removed to reach the other two bushings.

Lubricate O-ring on JDG608 Bushing Pilot with clean engine oil before installing in cylinder block web (C).



RG5949 -UN-30AUG91

2. Remove camshaft bushing (B) using JDG607 Bushing Driver (A), JDG408 Slide Hammer Adapter (D) (from JDG405 Camshaft Bushing Service Set), JDG608 Bushing Pilot (E), and D01299AA Slide Hammer (F).

A—Bushing Driver (JDG607)
B—Camshaft Bushing
C—Cylinder Block Web
D—Slide Hammer Adapter (JDG408)
E—Bushing Pilot (JDG608)
F—Slide Hammer (D01299AA)
G—Camshaft Bore Plug

NOTE: End bushing at front and rear of cylinder block may be removed with just JDG607 Bushing Driver and D01299AA Slide Hammer.

3. Inspect and measure each camshaft bushing bore in block as bushings are removed.

RG,CTM42,G16,31-19-15SEP94

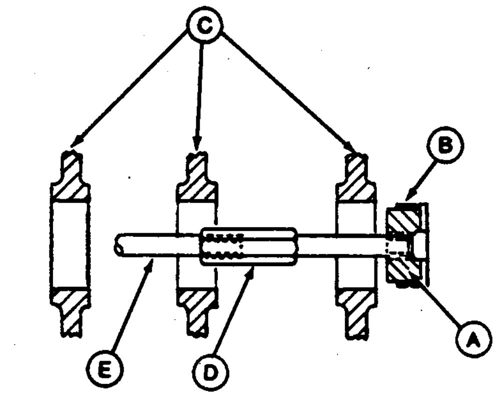
IMPORTANT: Oil holes in bushings and cylinder block must be aligned after installation. The elongated hole in bushing must be toward top. After installation, use a small mirror with extension to be sure oil holes are properly aligned.

4. Slide a new camshaft bushing (B) onto JDG607 Bushing Driver (A). With JDG608 Bushing Pilot installed in outside cylinder block web (C), assemble D01299AA Slide Hammer (E) and JDG408 Slide Hammer Adapter (D) with bushing driver as shown.

5. Be sure bushing is started square in bore and oil holes are aligned with holes in block. Pull bushing into bore with slide hammer until properly positioned.

6. Check bushing-to-cylinder block alignment using a small mirror with extension.

7. Apply PERMATEX AVIATION (Form-A-Gasket No. 3) to new camshaft bore steel cap plug and install plug in bore. Plug edge must be seated below edge of bore.



RG5333 -UN-06DEC88

A—Bushing Driver (JDG607)
B—Camshaft Bushing
C—Cylinder Block Web
D—Slide Hammer Adapter (JDG408)
E—Slide Hammer (D01299AA)

S55,2016,P -19-29OCT92

INSTALL CAMSHAFT

16
18

IMPORTANT: Set engine at TDC of No. 1 piston's compression stroke before installing camshaft so timing marks on camshaft and crankshaft gears will be aligned.

1. If camshaft followers were removed with engine on a rollover stand, reinstall followers but do not obstruct camshaft bore. Roll engine to an angle where followers fall away from camshaft bores.

NOTE: If D15001NU Magnetic Holding Tool Set is used, hold camshaft followers away from camshaft bore until camshaft is installed.

2. Lubricate thrust washer (A) with TY6333 or TY6347 High Temperature Grease and install on camshaft behind inner gear.

3. Lubricate camshaft lobes with TY6333 or TY6347 High Temperature Grease and bearing journals with clean engine oil.

RG5780 -UN-06AUG91

RG,CTM42,G16,25-19-29OCT92

4. 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.

RG5781 -UN-06AUG91

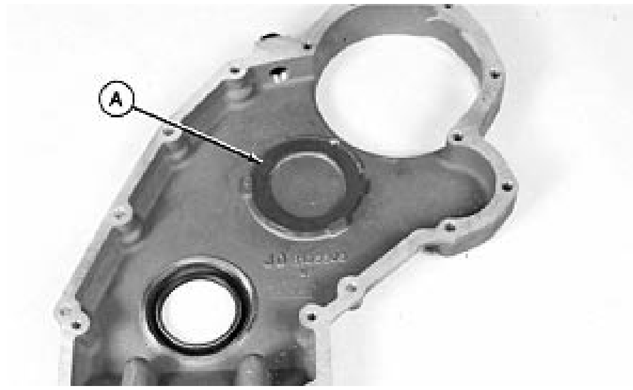
RG,CTM42,G16,26-19-10SEP91

5. With No. 1 piston on “TDC” compression, align timing marks on camshaft and crankshaft gears. Check injection pump timing.

RG5779 -UN-06AUG91

RG,CTM42,G16,27-19-10SEP91

INSTALL THRUST WASHER AND TIMING GEAR COVER



RG5782 -UN-06AUG91

1. Lubricate thrust washer (A) with TY6333 or TY6347 High Temperature Grease and install in timing gear cover.

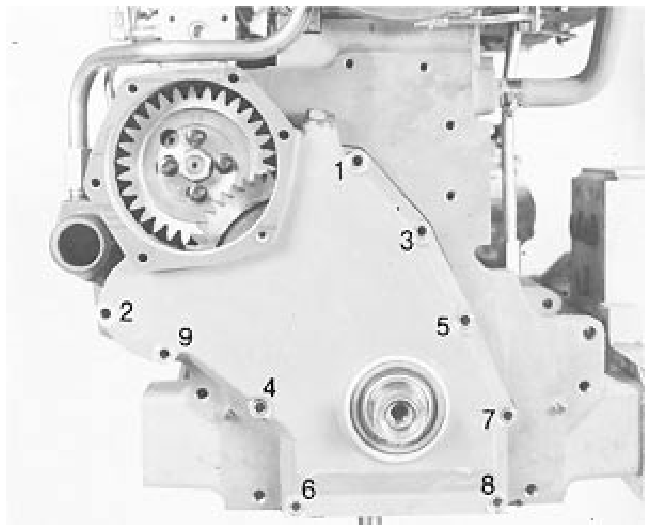
2. Install a new gasket on the engine block. Apply a light film of grease to the gasket to hold it in place.

NOTE: Tightening the timing gear cover cap screws in proper sequence controls the total runout for the front crankshaft oil seal.

3. Install timing gear cover. Tighten cap screws in sequence one through nine (as shown) to 27 N·m (20 lb-ft).

4. Trim timing gear cover gasket flush with oil pan gasket rail.

5. Check camshaft endplay. (See CHECK CAMSHAFT END PLAY earlier in this group.)



RG5783 -UN-13OCT92

RG,CTM42,G16,28-19-29OCT92

INSTALL CRANKSHAFT FRONT OIL SEAL (WITH TIMING GEAR COVER INSTALLED ON ENGINE)

RG6479 -UN-26OCT92

RG6480 -UN-26OCT92

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

1. Place JDG720-2 Seal Protector (A) on nose of crankshaft. Lubricate ID of front oil seal lips with clean engine oil. Slide seal with spring side of seal facing engine onto seal protector. Be careful not to roll oil seal lips.

2. Place JDG720-3 Seal Installer onto seal protector against seal. Do not use spacer ring provided with tool set.

3. With nut and washer installed onto JDG720-1 Forcing Screw, thread forcing screw into nose of crankshaft until it bottoms.

4. Tighten nut against crossplate of installer until installer bottoms onto front face of timing gear cover.

5. Remove installation tools. Verify seal is installed square in bore and that seal lips are not rolled on wear sleeve.

Oil seal should be 8.4 mm (0.33 in.) below front lip of seal bore.

16
21

RG,CTM42,G15,43-19-03MAY93

COMPLETE FINAL ASSEMBLY

1. Install the magnetic pickup assembly in timing gear cover (if equipped). Tighten to 14 N·m (10 lb-ft).

2. Install injection pump drive gear cover and gasket. Tighten the six cap screws to 27 N·m (20 lb-ft).

3. Install vibration damper and pulley assembly. (See Group 15, Crankshaft, Main Bearings and Flywheel.)

4. Install cylinder head, valve train, and rocker arm assembly. (See Group 05, Cylinder Head and Valves.)

5. Install oil pan and new gasket. (See Group 20, Lubrication System.) Fill engine with clean engine oil.

6. Perform engine break-in as required. (See PERFORM ENGINE BREAK-IN, Group 05.)

RG,CTM42,G16,29-19-24MAR95

OTHER MATERIAL

Name	Use
PERMATEX AVIATION (Form-A-Gasket No. 3) (TY6299)	To seal gasket surfaces on oil pan.
LOCTITE 242 Thread Lock and Sealer (TY9370 or T43512)	Oil filter adapter threads
LOCTITE 592 Pipe Sealant with TEFLON (TY9374/TY9375)	To seal oil pan elbow drain fitting.
High Temperature Grease (TY6343 or TY6347)	To lubricate oil pump components.

RG,CTM42,G20,1 -19-16AUG94

LUBRICATION SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION
Oil Filter Bypass Valve Operating Pressure	210 kPa (2.1 bar) (30 psi)
Oil Pressure Regulating Valve Spring:	
Compressed Length	43.0 mm @ 66—74 N (1.69 in. @ 15—17 lb-force)
Free Length	85.0 mm (3.35 in.)
Oil Filter Bypass Valve Spring:	
Compressed Length	30.0 mm @ 64—78 N (1.18 in. @ 14—18 lb-force)
Free Length	44.0 mm (1.73 in.)
Oil Cooler Bypass Valve Spring:	
Compressed Length	30.0 mm @ 64—78 N (1.18 in. @ 14—18 lb-force)
Free Length	44.0 mm (1.73 in.)
Oil Pump:	
Crankshaft Gear-to-Oil Pump Drive Gear Minimum Backlash	0.08 mm (0.003 in.)
Pump Gear Backlash	0.33—2.00 mm (0.013—0.079 in.)
Oil Pump Drive Gear-to-Crankshaft Throw Minimum Clearance	0.38 mm (0.015 in.)
Maximum Drive Shaft End Play	0.15 mm (0.006 in.)
Maximum Drive Shaft Side Movement	0.17 mm (0.0065 in.)

RG,CTM42,G20,2 -19-07JUN93

LUBRICATION SYSTEM SPECIFICATIONS—CONTINUED

TORQUES

Oil Conditioning Housing-to-Cylinder Block: *	
Step 1	20 N·m (15 lb-ft)
Step 2	37 N·m (27 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)
Intake Tube-to-Cover	41 N·m (30 lb-ft)
Pump Housing-to-Cylinder Block	47 N·m (35 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 Drain Plug:	
Aluminum Pans	102 N·m (75 lb-ft)
Cast Iron Pans	47 N·m (35 Lb-ft)

** Refer to INSTALL OIL FILTER AND OIL CONDITIONING HOUSING, later in this group, for proper cap screw tightening sequence.*

*** 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.*

RG,CTM42,G20,32-19-16AUG94

DRAIN ENGINE OIL AND REMOVE OIL PAN

1. Drain engine coolant.

2. Disconnect turbocharger oil inlet line at turbocharger or oil conditioning housing. (See DISCONNECT TURBOCHARGER OIL INLET LINE, in Group 03.)

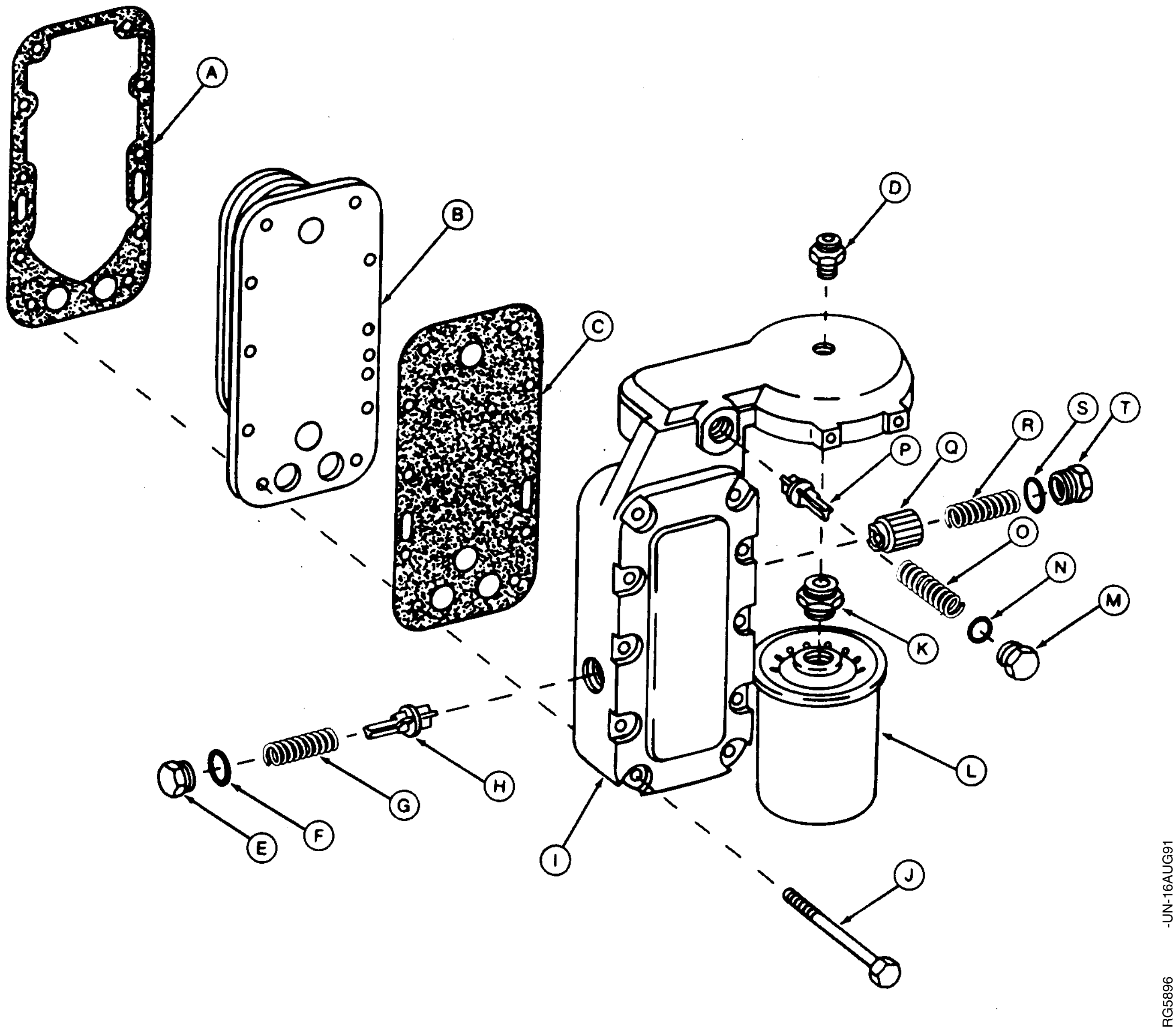
3. Drain engine oil.

4. Remove oil level sight gauge (if equipped).

5. Remove oil pan and discard gasket.

S11,0404,C -19-04JUN93

OIL FILTER AND OIL CONDITIONING HOUSING ASSEMBLY



A—Gasket
B—Oil Cooler
C—Gasket
D—Fitting
E—Plug
F—O-Ring
G—Spring
H—Oil Cooler Bypass Valve
I—Oil Conditioning Housing
J—Cap Screw (10 Used)
K—Adapter
L—Oil Filter
M—Plug
N—O-Ring
O—Spring
P—Oil FIlter Bypass Valve
Q—Oil Pressure Regulating Valve
R—Spring
S—O-Ring
T—Plug

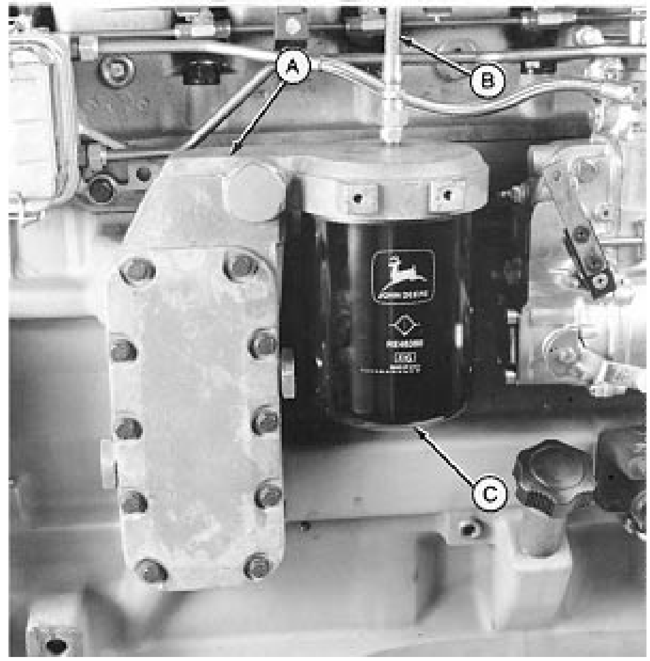
RG,CTM42,G20,5 -19-09OCT92

REMOVE OIL FILTER AND OIL CONDITIONING HOUSING

1. Disconnect turbocharger oil inlet line (B) from oil conditioning housing (A).

2. Turn oil filter (C) counterclockwise and remove filter from housing.

3. Remove cap screws securing oil conditioning housing to cylinder block and remove housing.



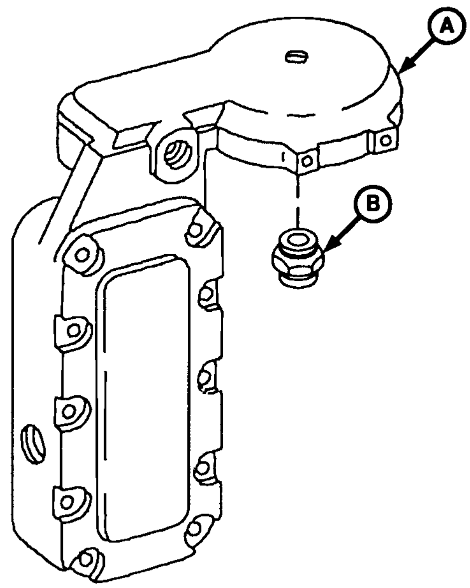
RG5897 -UN-16AUG91

RG,CTM42,G20,6 -19-09OCT92

INSPECT AND REPLACE OIL FILTER ADAPTER

1. Inspect threads on oil filter adapter (B) for damage. Remove adapter from housing (A) if necessary.

2. Coat adapter-to-oil conditioner housing threads with LOCTITE 242 Thread Lock and Sealer before installing adapter in housing.



RG7214 -UN-07JUL94

RG,CTM42,G20,41-19-16AUG94

REMOVE, INSPECT, AND INSTALL OIL PRESSURE REGULATING VALVE, OIL FILTER BYPASS VALVE, AND OIL COOLER BYPASS VALVE

See OIL FILTER AND OIL CONDITIONING HOUSING ASSEMBLY, earlier in this group, for illustration of valves.

- **Oil Pressure Regulating Valve**

1. Remove plug (T), O-ring (S), spring (R), oil pressure regulating valve (Q) from housing (I). Discard O-ring.

2. Inspect valve and valve bore for damage. Replace if necessary.

3. Check spring for proper compression.

NEW PRESSURE REGULATING VALVE SPRING SPECIFICATION

Working Load at 66—74 N (15—17 lb force) . . . . . 43.0 mm (1.69 in.)

Spring Free Length . . . . . 85.0 mm (3.35 in.)

4. Dip all parts in clean engine oil, insert valve and spring in housing.

5. Install plug using a new O-ring and tighten securely.

- **Oil Filter Bypass Valve**

1. Remove plug (M) with O-ring (N), spring (O), and oil filter bypass valve (P) from oil conditioning housing (I). Discard O-ring.

2. Inspect valve and housing bore for scoring or damage. Replace if necessary.

3. Check spring for proper compression. Replace if necessary.

NEW OIL FILTER BYPASS VALVE SPRING SPECIFICATION

Working Load at 64—78 N (14—18 lb force) . . . . . 30.0 mm (1.18 in.)

Spring Free Length . . . . . 44.0 mm (1.73 in.)

4. Dip all parts in clean engine oil, insert valve and spring in housing.

5. Install new O-ring on plug. Install plug and tighten securely.

NOTE: Filter bypass valve operating pressure is 210 kPa (2.10 bar) (30 psi).

- **Oil Cooler Bypass Valve**

1. Remove plug (E), O-ring (F), spring (G), and oil cooler bypass valve (H) from oil conditioning housing (I). Discard O-ring.

2. Check housing for clogged passages and all other parts for scale build-up.

3. Clean all parts with a stiff bristle brush and solvent, if necessary. Dry with compressed air.

4. Inspect bypass valve for damage. Replace if necessary.

5. Check bypass valve spring for proper specifications. Replace if not within specifications.

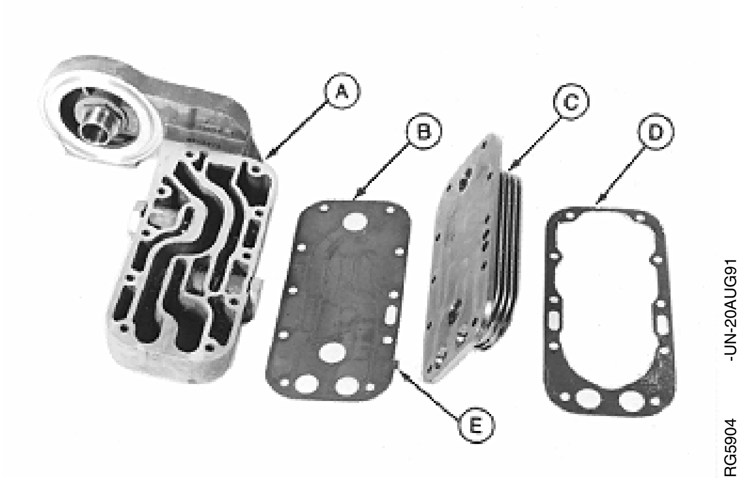
NEW OIL COOLER BYPASS VALVE SPRING SPECIFICATION

Working Load at 64—78 N (14-18 lb force) . . . . . 30.0 mm (1.18 in.)

Spring Free Length . . . . . 44.0 mm (1.73 in.)

RG,CTM42,G20,29-19-12APR93

INSTALL OIL FILTER AND OIL CONDITIONING HOUSING



A—Oil Conditioning Housing **C—Oil Cooler** **D—Gasket** **E—Tab**
B—Gasket

1. Remove all gasket material from cylinder block and oil conditioning housing (A).

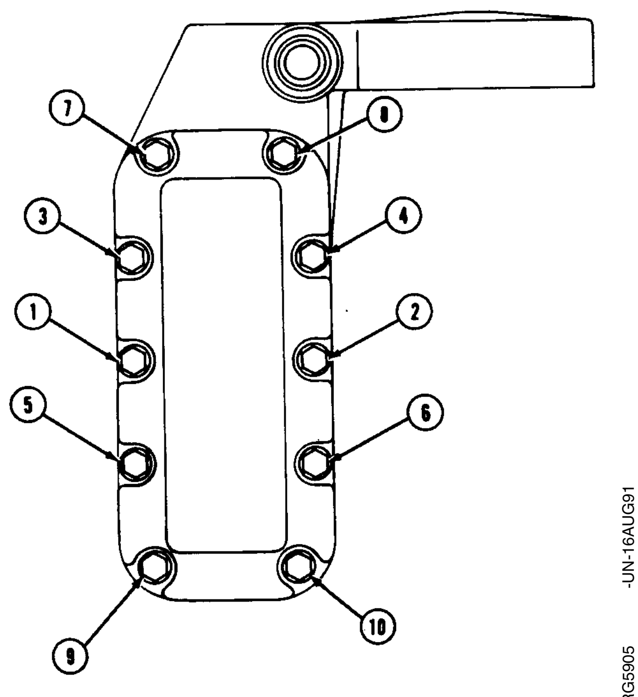
2. Install gasket (D), engine oil cooler (C), gasket (B), and oil conditioning housing onto cylinder block using 5/16 x 3 in. studs. Tab (E) on gasket with silicone bead should be downward and to the right.

RG,CTM42,G20,9 -19-09OCT92

3. Tighten cap screws to 20 N·m (15 lb-ft) following sequence shown in diagram.

4. Retighten cap screws to 37 N·m (27 lb-ft) following same sequence.

NOTE: It may be helpful to put an ink mark on each cap screw after tightening each time to assure all cap screws have been tightened.



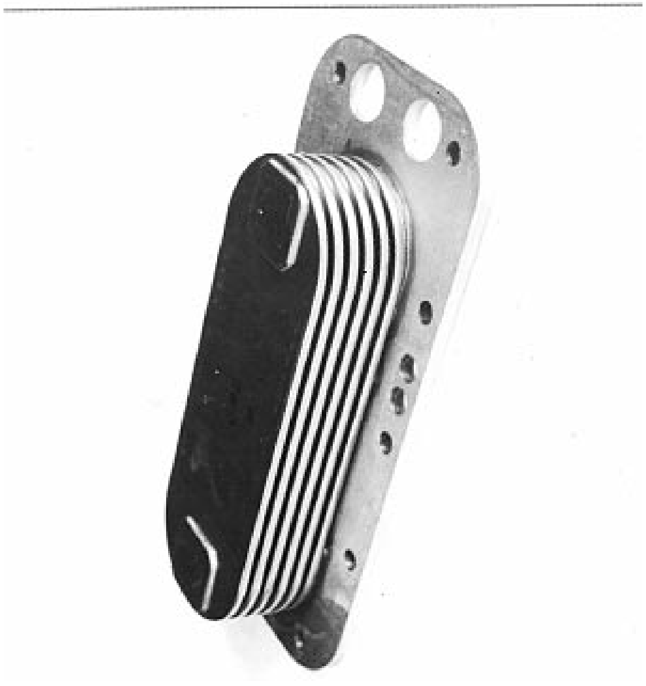
RG,CTM42,G20,10-19-09OCT92

REMOVE ENGINE OIL COOLER

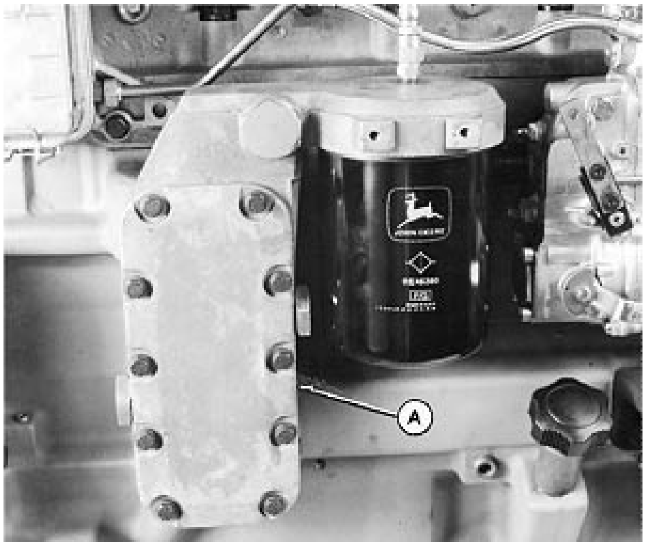
6076 Engines are equipped with a 6-plate engine oil cooler.

1. Remove cover (A).

2. Remove oil cooler.

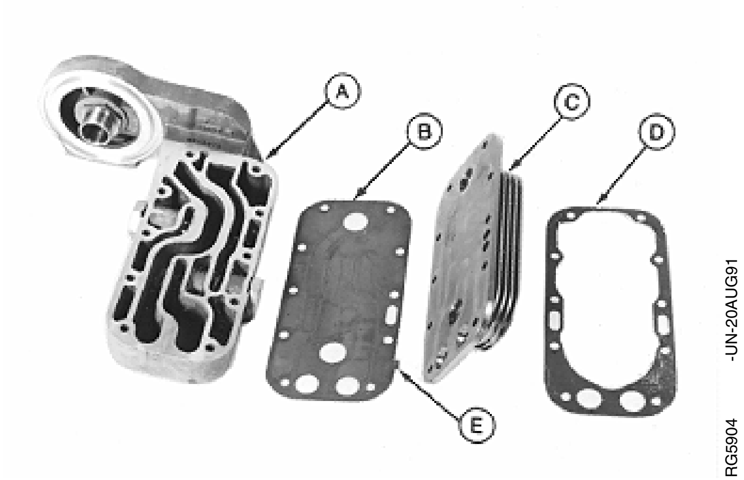


6-plate oil cooler



RG,CTM42,G20,25-19-09OCT92

CLEAN, INSPECT, AND INSTALL ENGINE OIL COOLER



A—Oil Conditioning Housing B—Gasket C—Oil Cooler D—Gasket

1. Once oil cooler is removed, scrape off all old gasket material from cooler and block.

2. Clean all parts with clean solvent and a brass wire brush. Dry with compressed air.

3. Inspect all parts for serviceability. Replace parts as necessary.

NOTE: If mixing of oil and coolant is suspected, pressure test oil cooler in liquid 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. Using new gaskets install oil cooler/oil conditioning housing. See INSTALL OIL FILTER AND OIL CONDITIONING HOUSING, earlier in this group.

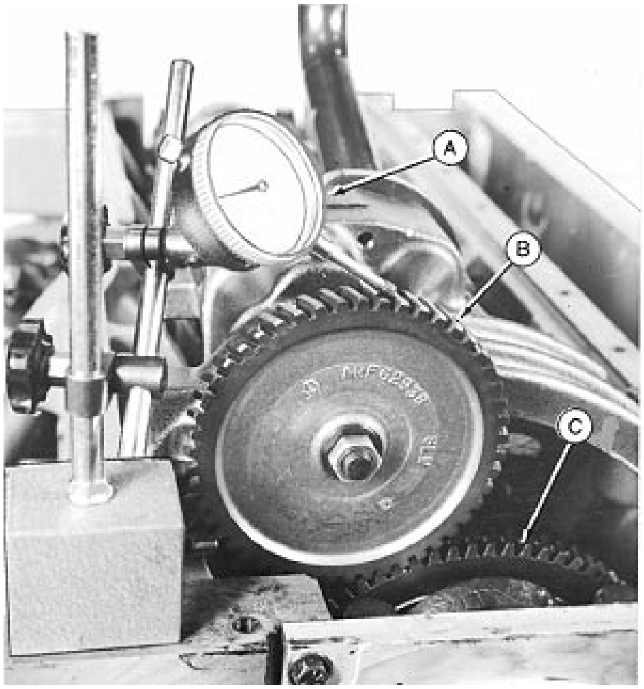
RG,CTM42,G20,12-19-09OCT92

CHECK CRANKSHAFT GEAR-TO-OIL PUMP DRIVE GEAR BACKLASH

Before removing oil pump, determine if there is adequate backlash between oil pump and crankshaft drive gears.

1. Mount dial indicator (A) and measure backlash between pump drive gear (B) and crankshaft gear (C).

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.



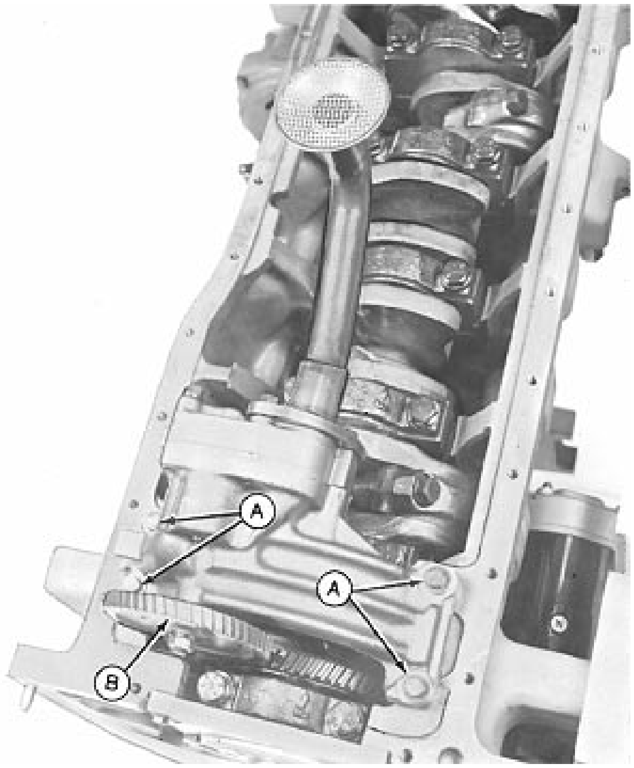
RG5914 -UN-16AUG91

RG,CTM42,G20,16-19-09OCT92

REMOVE ENGINE OIL PUMP

1. Remove four oil pump housing cap screws (A).

2. Remove oil pump assembly with drive gear (B) attached.



RG5915 -UN-16AUG91

RG,CTM42,G20,17-19-09OCT92

INSPECT AND CLEAN OIL PUMP

1. Visually inspect oil pump for wear or damage.

IMPORTANT: DO NOT disassemble engine oil pump for flushing, inspection, or performing wear checks. Individual components of oil pump are not available through sevice parts, Replace pump as a complete assembly.

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.

RG,CTM42,G20,18-19-15SEP94

CHECK DRIVE SHAFT END PLAY

1. Mount dial indicator with indicator plunger resting against end of pump drive shaft.

2. Move shaft toward and away from indicator.

If end play exceeds 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 if end play exceeds 0.15 mm (0.006 in.).

RG5916 -UN-16AUG91

RG,CTM42,G20,19-19-09OCT92

CHECK DRIVE SHAFT SIDE MOVEMENT

1. Mount dial indicator with indicator plunger resting on one of the hex nut flats.

2. Move shaft from side-to-side.

If shaft side movement exceeds 0.17 mm (0.0065 in.), there is excessive wear on drive shaft bushing and/or drive shaft.

Replace oil pump if shaft side movement exceeds 0.17 mm (0.0065 in.).

RG5917 -UN-16AUG91

RG,CTM42,G20,20-19-09OCT92

CHECK PUMPING GEAR BACKLASH


RG5918 -UN-16AUG91

1. Mount dial indicator with indicator plunger resting against side of gear tooth.

2. Hold idler gear stationary. Slowly rotate drive gear back and forth until contact with idler gear is felt.

If backlash is not within 0.33—2.00 mm (0.013—0.079 in.) specification, 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.).

RG,CTM42,G20,21-19-16AUG94

INSPECT OIL PUMP DRIVE GEAR


RG6435 -UN-13OCT92

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. Replace as necessary.

RG,CTM42,G20,31-19-09OCT92

INSTALL ENGINE OIL PUMP

1. 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 TY6333 or TY6347 High Temperature Grease.

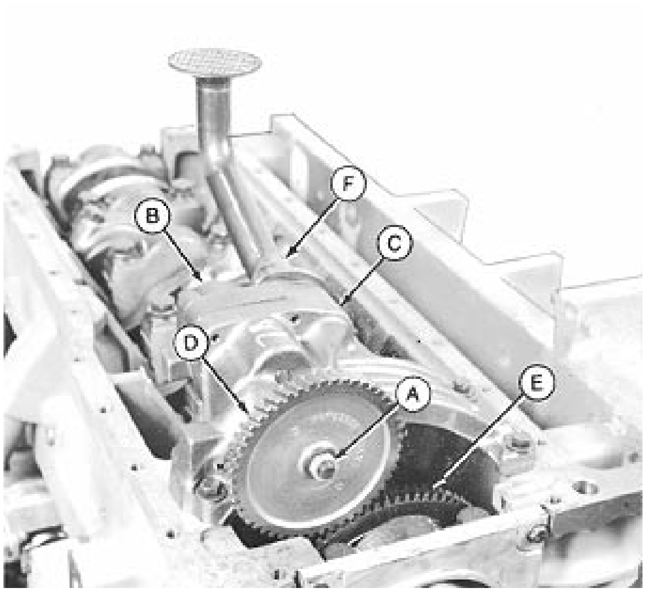
2. Tighten oil pump drive gear-to-drive shaft nut (A) to 54 N·m (40 lb-ft). Install oil pump cover (B)-to-oil pump housing (C).

3. Using a new gasket, install oil pump intake (F)-to-oil pump cover and tighten cap screws to 41 N·m (30 lb-ft).

NOTE: Oil pump gears must turn freely after installation of oil pump cover and intake.

4. Install oil pump assembly over hollow dowel pin in cylinder block. Tighten oil pump housing-to-cylinder block cap screws to 47 N·m (35 lb-ft).

NOTE: Make sure oil pump drive gear (D) meshes properly with crankshaft gear (E).

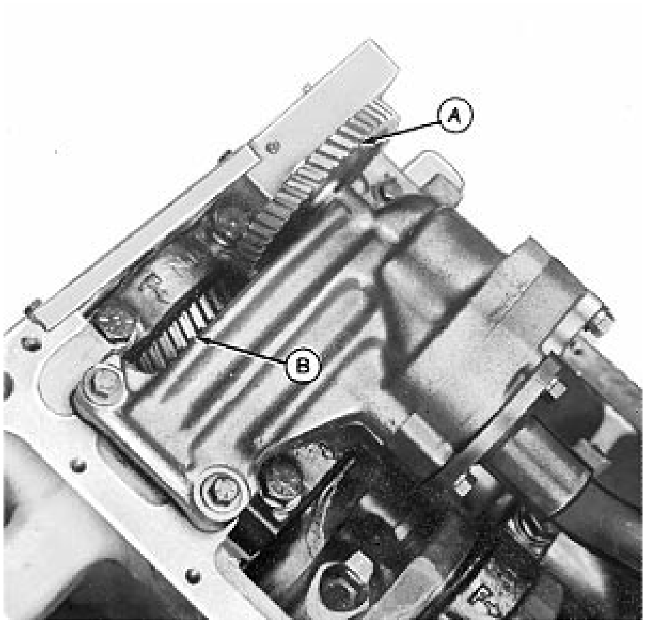


RG5922 -UN-16AUG91

A—Shaft Nut
B—Oil Pump Cover
C—Oil Pump Housing
D—Oil Pump Drive Gear
E—Crankshaft Gear
F—Oil Pump Intake

RG,CTM42,G20,23-19-16AUG94

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 bearings 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.



RG5923 -UN-20AUG91

RG,CTM42,G20,24-19-22AUG91

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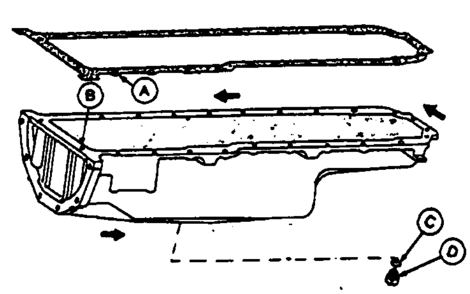
INSTALL OIL PAN



RG5010 -UN-29NOV88

Before installing oil pan, remove old gasket and sealant material from pan and cylinder block mating surfaces. Guide studs may be used if desired.

1. Apply a thin layer of PERMATEX AVIATION (Form-A-Gasket No. 3) across entire front and rear gasket rail of block. Install gasket (A) onto cylinder block and apply a layer of sealant to gasket across front and rear gasket face. On engines equipped with multi-piece gaskets, also apply sealant to mating joints. Install oil pan.

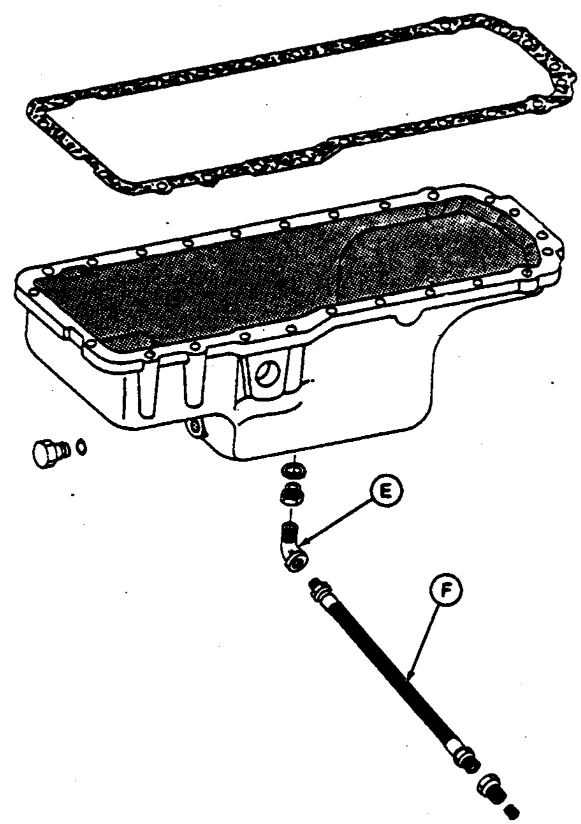
2. Insert all 3/8 in. and 1/2 in. cap screws in their appropriate locations.

3. Use a straightedge against oil pan and cylinder block (flywheel end) to be sure oil pan is flush with block flange.

4. Proceeding counterclockwise (bold arrows) from flywheel end (B), tighten all cap screws to 47 N·m (35 lb-ft).

5. Repeat sequence by tightening all 3/8 in. cap screws to 68 N·m (50 lb-ft).

6. Complete sequence by tightening counterclockwise all 1/2 in. cap screws to 156 N·m (115 lb-ft). Check torque on all 3/8 in. cap screws after final torque of 1/2 in. cap screws. Trim gasket flush with rear of pan flange.



RG5267 -UN-29NOV88

20
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7. Bottom oil pan drain plug (D) uses either an aluminum washer or rubber O-ring (C) for sealing. Apply a light coat of engine oil to new rubber O-rings for bottom drain plug. Install aluminum washer on drain plug so raised center contacts head of plug.

Some engine oil pans may be equipped with an elbow fitting (E) and drain hose (F).

8. Install drain plug and tighten to specifications listed below. Fill engine crankcase with correct engine oil.

OIL PAN DRAIN PLUG TORQUE SPECIFICATIONS

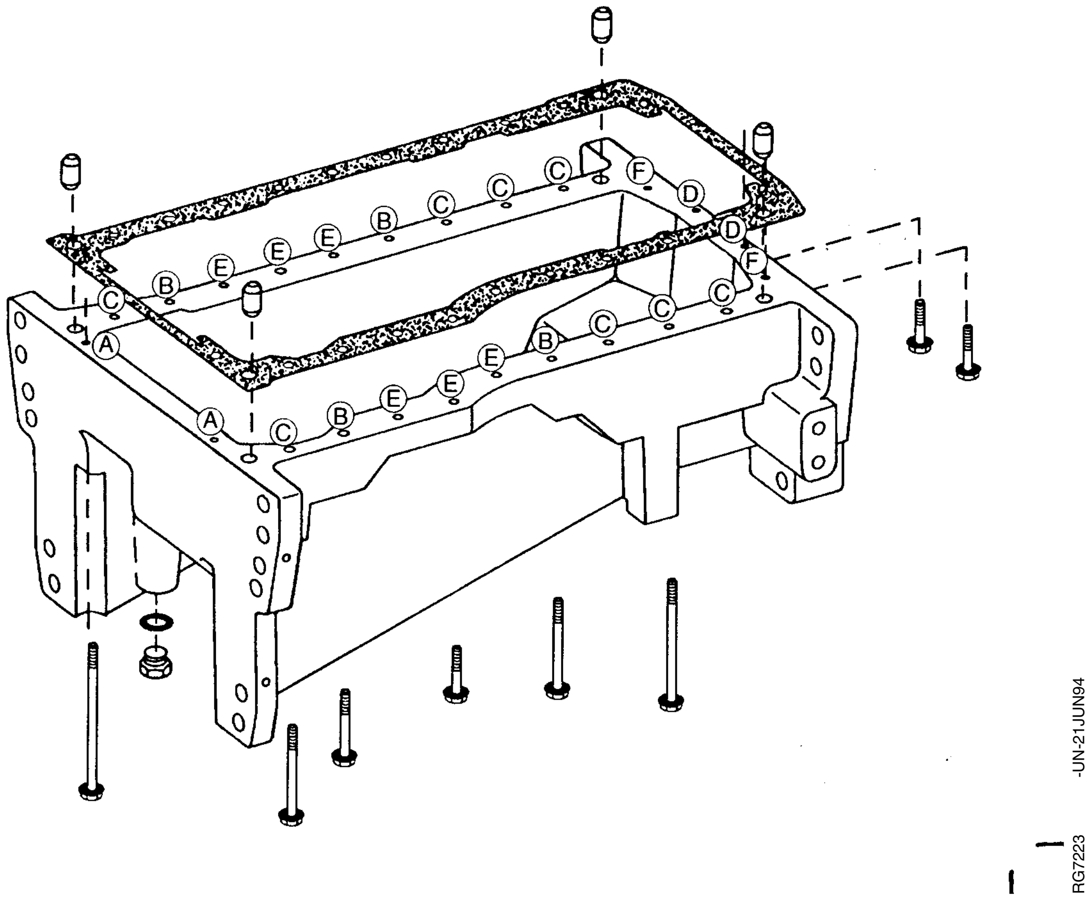
Aluminum Oil Pans	102 N·m (75 lb-ft)
Cast Iron Oil Pans	47 N·m (35 lb-ft)

NOTE: On engine equipped with elbow fittings and drain hose, the threads and sealing surfaces must be free of any oil film to insure an effective seal. Apply a light coat of LOCTITE 592 to fittings except for the leading one to three threads. Tighten fittings securely.

A—Oil Pan Gasket
B—Location For First Cap Screw
C—O-Ring or Aluminum Washer
D—Drain Plug
E—Elbow Fitting
F—Drain Hose

S55,2020,O -19-16AUG94

TIGHTEN CAP SCREWS ON FRONT FRAME/OIL SUMP



A—0.375 x 7.625 in. (2 used)
B—0.500 x 4.000 in. (4 used)
C—0.500 x 6.000 in. (8 used)
D—0.375 x 2.500 in. (2 used)
E—0.500 x 2.500 in. (6 used)
F—0.375 x 1.875 in. (2 used)

1. Be sure dowel pins are in place.

IMPORTANT: DO NOT apply gasket sealant to gasket, front frame/oil sump, trimmed edges of timing gear cover gasket, oil seal housing gasket, or cylinder block mating surfaces. Before installing engine, be sure mating surfaces of engine and front frame/oil sump are clean.

2. Install front frame/oil sump-to-cylinder block gasket.

3. Carefully lower engine onto front frame/oil sump.

4. Install all 3/8 in. and 1/2 in. cap screws in their appropriate locations.

5. Tighten all 1/2 in. cap screws to 133 N·m (98 lb-ft). Tighten all 3/8 in. cap screws to 58 N·m (43 lb-ft).

6. Re-tighten all 3/8 in. cap screws to 58 N·m (43 lb-ft). Re-tighten all 1/2 in. cap screws to 133 N·m (98 lb-ft).

7. Apply clean engine oil to new O-ring for bottom drain plug and install drain plug.

RG,CTM42,G20,33-19-17MAR95

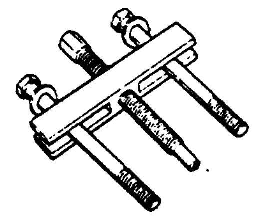
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

Push Puller D01206AA

Used to remove water pump impeller from water pump and to remove fan pulley from shaft pressed into water manifold. Also used with D01217AA to remove water pump drive gear from water pump.

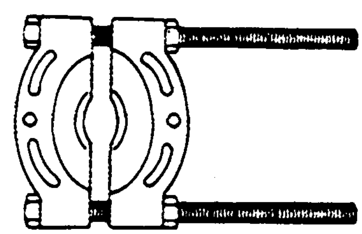


RG5097 -UN-23AUG88

RG,CTM42,G25,33-19-10SEP91

Bearing Puller* D01217AA

Used with D01206AA to remove water pump drive gear from water pump.



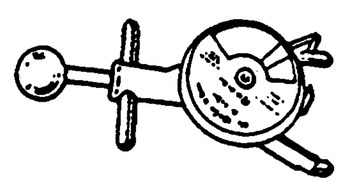
RG4981 -UN-06APR89

** Part of D01212AA Step Plate Adapter Set*

RG,CTM42,G25,34-19-10SEP91

Belt Tension Gauge JDG529

Used to check and adjust fan belt tension.



RG5082 -UN-23AUG88

S53,JDG529 -19-06APR94

RG5588 -UN-13SEP89

Belt Tension Gauge JDST28

Used with a straightedge to check fan belt tension.

RG,CTM61,G25,26-19-17MAR92

25
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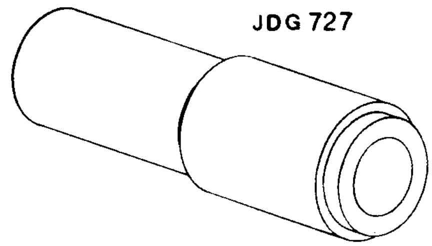
Bearing Driver JDG727

Used to remove and install water pump bearing assembly in water pump housing. Installs new bearing to the correct depth.



RG5963 -UN-03SEP91

RG,CTM42,G25,35-19-10SEP91

OTHER MATERIAL

Name	Use
LOCTITE 518 (TY6304) Flexible Sealant	Water pump, thermostat cover and water manifold gaskets.
LOCTITE 242 (TY9370) Thread Lock and Sealer	Water outlet manifold-to-cylinder head cap screws.
LOCTITE 592 (TY9375) Pipe Sealant with TEFLON	Water pump and block drain valves.
High Temperature Grease (TY6333 or TY6347)	Pack bearings in fan drive.

RG,CTM42,G25,7 -19-16AUG94

COOLING SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION
Water Pump:	
Impeller Bore ID	15.849—15.875 mm (0.624—0.625 in.)
Shaft OD Impeller End	15.905—15.917 mm (0.626—0.627 in.)
Bearing Bore in Water Pump Housing (NEW)	38.041—38.067 mm (1.498—1.499 in.)
Maximum Allowable Pump Bearing Bore	38.067 mm (1.499 in)
Bearing OD	38.087—38.100 mm (1.499—1.500 in.)
Drive Gear Bore ID	18.90—18.92 mm (0.744—0.745 in.)
Shaft OD Drive Gear End	18.948—18.960 mm (0.746—0.747 in.)
Water Pump Seal Installed Height	10.16—10.42 mm (0.400—0.410 in.)
Impeller Installed Depth Below Gasket Surface	2.75—3.50 mm (0.108—0.138 in.)
Bearing Installed Depth Below Pump Housing Nose	6.75—7.00 mm (0.266—0.276 in.)
Thermostat Opening Temperature:	
82°C (180°F) Thermostat(s)	80—84°C (175—182°F)
89°C (192°F) Thermostat(s)	87—91°C (188—195°F)
Heavy Duty Adjustable Fan Drive*:	
Bearing Bore ID in Housing	71.999—72.025 mm (2.8346—2.8356 in.)
Shaft OD for Bearings	35.001—35.017 mm (1.3780—1.3786 in.)
Bearing OD	71.987—72.013 mm (2.8341—2.8351 in.)
Bearing ID	34.987—35.013 mm (1.3774—1.3785 in.)
Maximum Shaft End Play	0.50 mm (0.020 in.)
Standard Duty Adjustable Fan Drive*:	
Bearing Bore ID in Housing	47.576—47.612 mm (1.8731—1.8745 in.)
Bearing OD (Housing End)	47.612—47.625 mm (1.8745—1.8750 in.)
Shaft OD (Pulley End)	25.387—25.400 mm (0.9995—1.0000 in.)
Fan Pulley Bore ID	25.336—25.362 mm (0.9975—0.9985 in.)
Bearing/Shaft Installed Dim. From Pulley Front Face	Flush to 1.30 mm (0.05 in.) Below
Water Manifold Mounted, Fixed Fan Drive*:	
Shaft Installed Dimension From Manifold Mounting Face-to-End of Shaft	33.31—33.57 mm (1.311—1.322 in.)
Fan Pulley Bore ID	47.576—47.612 mm (1.8731—1.8745 in.)
Bearing OD (Pulley End)	47.612—47.625 mm (1.8745—1.8750 in.)
Shaft OD (Manifold End)	25.387—25.400 mm (0.9995—1.0000 in.)
Manifold Bore ID	25.336—25.362 mm (0.9975—0.9985 in.)
Injection Pump Drive Gear Cover Mounted, Fan Pulley:	
Bearing OD (Pulley End)	47.612—47.625 mm (1.8745—1.8750 in.)
Bearing OD (Drive Gear Cover End)	25.387—25.400 mm (0.9995—1.0000 in.)
Fan Pulley Bore ID	47.576—47.612 mm (1.8731—1.8745 in.)
Drive Gear Cover ID	25.336—25.362 mm (0.9975—0.9985 in.)
Shaft Installed Dimension Injection Pump Drive Gear Cover Mounting Face-to-End of Shaft	3.43—3.69 mm (0.135—0.145 in.)

** Specifications apply only to fan drives supplied by John Deere Factory. Refer to manufacturers specifications for other fan drives.*

RG,CTM42,G25,1 -19-17MAR95

COOLING SYSTEM SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION
Standard V-Belt Tension Using JDG529 Gauge:	
Single Belt System:	
New Belts	578—622 N (130—140 lb)
Belts in Service (minimum 10-minutes use)	378—423 N (85—95 lb)
Dual Belt System*:	
New Belts	422—463 N (95—104 lb)
Belts in Service (minimum 10-minutes use)	378—423 N (85—95 lb)
Poly V-Belt Tension Using JT05975 Gauge:	
New Belts	890—1068 N (200—240 lb)
Belt in Service (minimum 10-minutes use)	800—979 N (180—220 lb)
Fan Belt Tension Using JDST28 Tension Gauge and Straight Edge: (force applied halfway between pulleys)	
Standard V-Belts (new and used)	19 mm (3/4 in.) with 89 N (20 lb) force
Poly V-Belts (new and used)	13 mm (1/2 in.) with 130 N (30 lb) force

** On engines with dual belts, check tension on front belt only. Measure tension on long part of belt.*

RG,CTM42,G25,41-19-29OCT92

COOLING SYSTEM SPECIFICATIONS—CONTINUED

TORQUES

Water Pump-to-Cylinder Block Cap Screw	27 N·m (20 lb-ft)
Water Manifold-to-Cylinder Head—Cast Iron	61 N·m (45 lb-ft)
—Aluminum	20 N·m (15 lb-ft)
Thermostat Cover-to-Water Manifold—Cast Iron	47 N·m (35 lb-ft)
—Aluminum	20 N·m (15 lb-ft)
Water Pump Cover-to-Water Pump Housing	30 N·m (22 lb-ft)
Water Pump Drain Valve-to-Water Pump Cover	27 N·m (20 lb-ft)
Water Inlet Manifold Elbow-to-Cylinder Block	30 N·m (22 lb-ft)
Fan-to-Fan Hub or Pulley*	40 N·m (30 lb-ft)
Fan Drive Assembly-to-Support Plate (Heavy Duty Adjustable Fan Drive)	80 N·m (60 lb-ft)
Fan Spacer and Pulley-to-Hub	47 N·m (35 lb-ft)
Fan Pulley Mounted Injection Pump Drive Gear Cover	27 N·m (20 lb-ft)

** Applies only to fans provided by the John Deere factory. See equipment manufacturers recommendations for torque specifications on OEM supplied fans.*

RG,CTM42,G25,2 -19-17MAR95

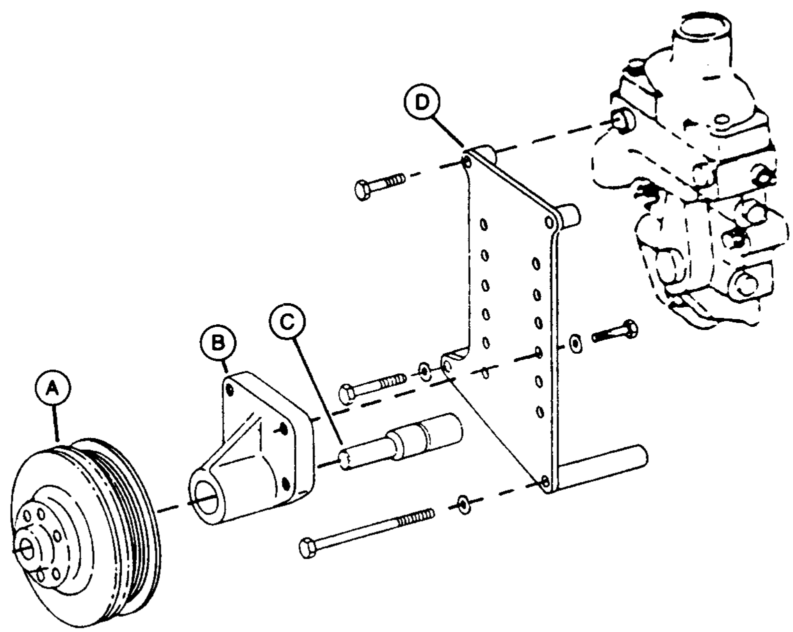
SERVICE EQUIPMENT AND TOOLS

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	Remove and install seals.
D01217AA Bearing Pulling Attachment	Support gear during removal.
D01206AA Gear and Pulley Puller	Remove gear from water pump shaft.

RG,CTM42,G25,38-19-06APR94

REPLACE BEARINGS IN STANDARD DUTY, ADJUSTABLE FAN DRIVE ASSEMBLY



A—Fan Hub/Pulley B—Bearing Housing C—Bearing/Shaft D—Support Plate

- **To Disassemble Fan Drive:**

1. Remove V-belt and remove support plate (D) with fan drive assembly.

2. Remove fan drive assembly from support plate.

3. Support back side of fan hub/pulley (A), and press bearing/shaft (C) out of hub bore.

4. Support back side of bearing housing (B) and press bearing/shaft out of housing. Discard bearing.

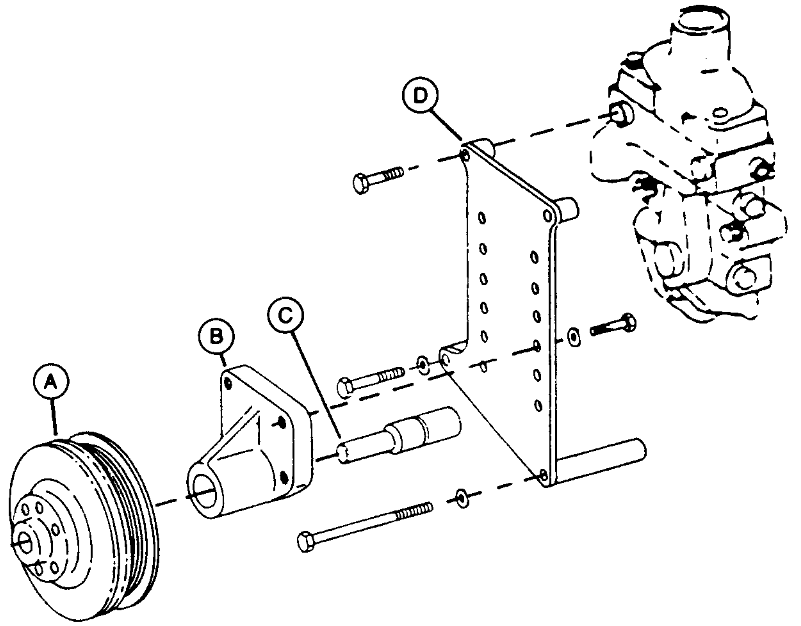
5. Thoroughly clean and inspect fan hub/pulley and bearing housing for cracks or any other damage. Measure parts and compare with specifications given later.

STANDARD DUTY, ADJUSTABLE FAN DRIVE SPECIFICATIONS

Housing ID	47.576—47.612 mm (1.8731—1.8745 in.)
Bearing OD	47.612—47.625 mm (1.8745—1.8750 in.)
Shaft OD	25.387—25.400 mm (0.9954—1.0000 in.)
Pulley ID	25.336—25.362 mm (0.9975—0.9985 in.)
Shaft Installed Dimension From Pulley Front Face	Flush to 1.30 mm (0.05 in.) Below

Replace parts that are cracked or not within specification.

RG,CTM42,G25,44-19-21MAR95



A—Fan Hub/Pulley B—Bearing Housing C—Bearing/Shaft D—Support Plate

To Assemble Fan Drive:

1. Support front nose of bearing housing (B) with ID open so bearing/shaft (B) can pass through opening when installed.

2. Press on outer shell of bearing and install bearing into housing until bearing bottoms. Shaft end of bearing will protrude from hoousing.

3. Support inner portion of bearing and press fan hub/pulley (A) omto shaft until shaft is flush to 1.30 mm (0.05 in.) below front face of pulley.

4. Spin pulley by hand to assure assembly turns freely and bearing was not damaged during assembly.

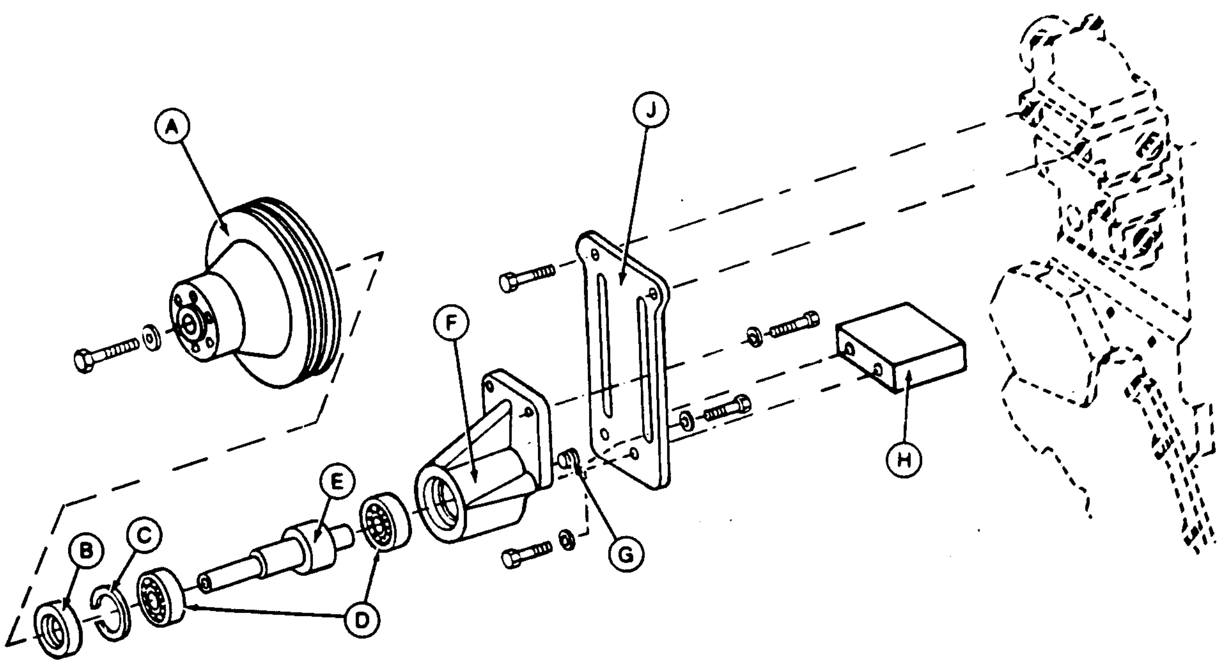
5. Install fan drive housing assembly onto support plate (D). Tighten four cap screws with washers to 80 N·m (60 lb-ft).

6. Install support plate onto engine. Tighten 5/16-in. cap screws to 27 N·m (20 lb-ft) and 3/8-in. cap screws to 47 N·m (35 lb-ft).

7. Install V-belts and position onto belt tensioner.

RG,CTM42,G25,45-19-21MAR95

REPLACE BEARINGS IN HEAVY DUTY, ADJUSTABLE FAN DRIVE ASSEMBLY



A—Fan Hub/Pulley
B—Grease Seal
C—Snap Ring
D—Ball Bearing (2 used)
E—Shaft
F—Bearing Housing
G—Pipe Plug
H—Support Spacer
J—Support Plate

- **To Disassemble Fan Drive:**

1. Remove V-belts and remove fan. Remove fan drive assembly from engine.

2. Clamp fan hub/pulley (A) in a soft-jawed vise. Support fan hub (so it does not fall to floor), and remove cap screw securing hub to shaft (E). Remove fan hub.

3. Remove pipe plug (G), grease seal (B), and snap ring (C). Discard seal and snap ring.

4. Remove shaft with bearings (D) by lightly tapping with a rubber mallet or brass hammer.

5. Remove bearings from shaft using a press and discard bearings.

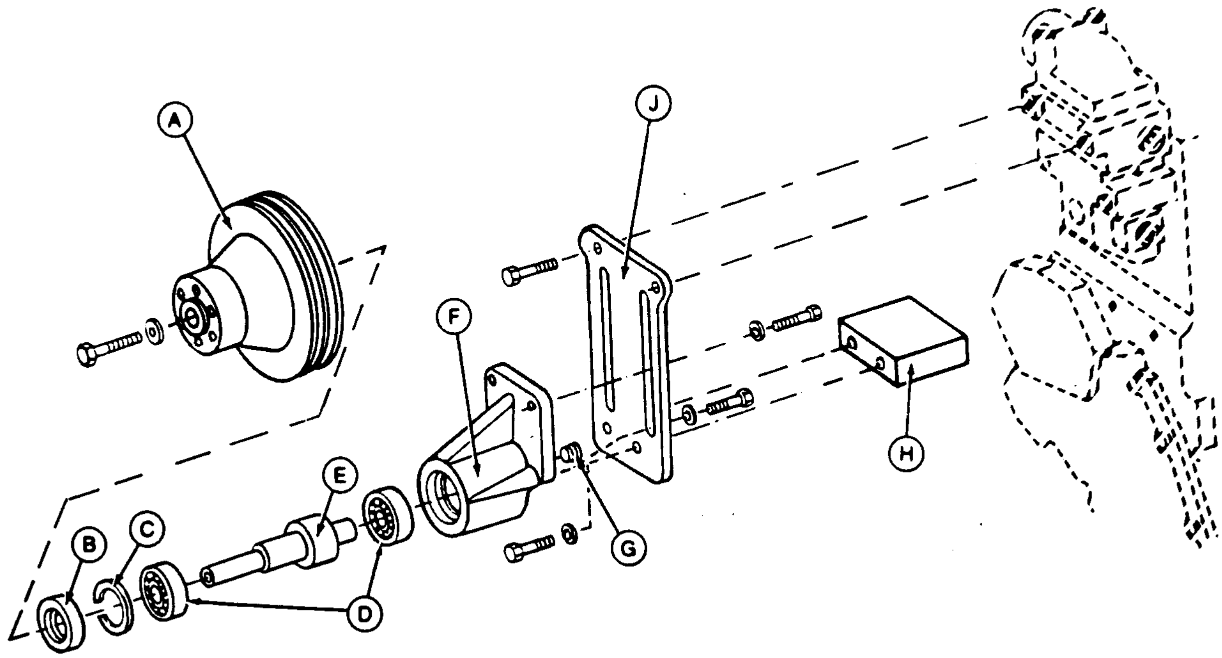
6. Thoroughly clean and inspect shaft and bearing housing (F) for cracks or any other damage. Measure parts and compare with specifications given below.

HEAVY DUTY, ADJUSTABLE 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.)

Replace parts that are cracked or not within specification.

RG,CTM42,G25,9 -19-24MAR95



A—Fan Hub/Pulley
B—Grease Seal
C—Snap Ring
D—Ball Bearing (2 used)
E—Shaft
F—Bearing Housing
G—Pipe Plug
H—Support Spacer
J—Support Plate

• **To Assemble Fan Drive:**

1. Pack inner and outer bearings (D) with TY6333 or TY6347 High Temperature Grease. Apply clean engine oil to bearing ID and shaft OD.

2. Support end of shaft (E) and install bearings against shoulder. Apply force to bearing inner race only.

3. Support bearing housing (F) on a firm flat surface with bearing bore in the upward position.

4. Install bearing and shaft assembly into housing. Small end of shaft should extend through housing.

5. Determine proper snap ring (C) thickness needed to obtain 0.10 mm (0.004 in.) end play.

6. Install snap ring in housing groove. Visually inspect snap ring installation for proper seating in housing groove.

7. Apply a thin coat of clean engine oil to OD of seal casing (B) and to seal lips. Install seal 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 hub/pulley (A). 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 washer and cap screw. Tighten cap screw to 80 N·m (60 lb-ft).

10. Apply LOCTITE 592 Pipe Sealant to threads of pipe plug (G). Install and tighten plug in bearing housing.

11. Install fan drive assembly onto support plate (J).

12. Install support plate assembly onto engine and tighten 5/16-in mounting cap screws to 27 N·m (20 lb-ft) and all 3/8-in. cap screws to 47 N·m (35 lb-ft).

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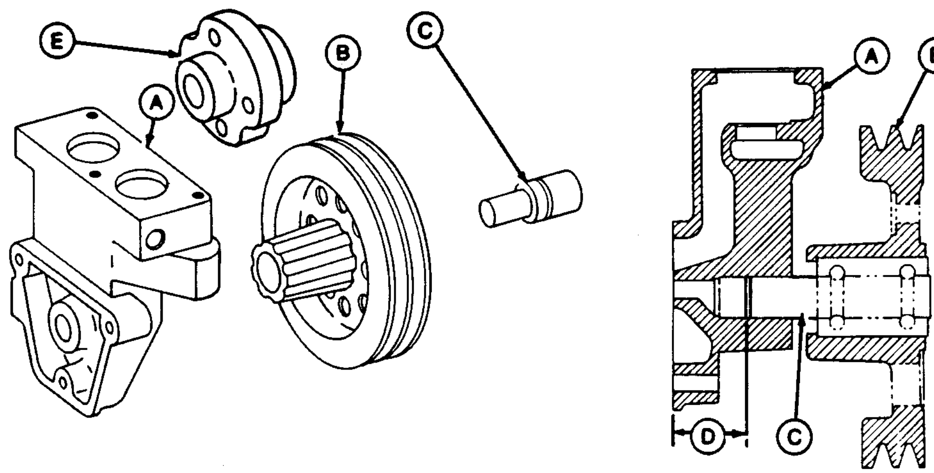
RG,CTM42,G25,3 -19-17MAR95

REPLACE BEARINGS IN WATER MANIFOLD MOUNTED, FIXED FAN DRIVE ASSEMBLY



RG6437 -UN-13OCT92

A—Water Manifold
B—Fan Pulley
C—Bearing
D—Bearing Shaft Installed Dimension
E—Hub*

• To Disassemble Fan Drive:

1. Remove three water manifold-to-cylinder head cap screws. Remove water manifold (A) and fan pulley (B) assembly from cylinder head and lift to dislodge water bypass pipe from manifold.

2. Support front face of water manifold and use a press to push bearing (C) and pulley out of manifold.

3. Support front face of fan pulley and push bearing out of pulley, and fan spacer (if equipped). Discard bearing.

4. Thoroughly inspect water manifold and pulley for cracks or damage. Measure parts and compare readings with specifications given below. Replace parts as necessary.

IMPORTANT: Support fan pulley on a flat, firm surface and press on bearing outer race to prevent damage to the bearing.

5. Install new bearing into pulley until outer race bottoms in bore of pulley. End of shaft will extend through bearing stop.

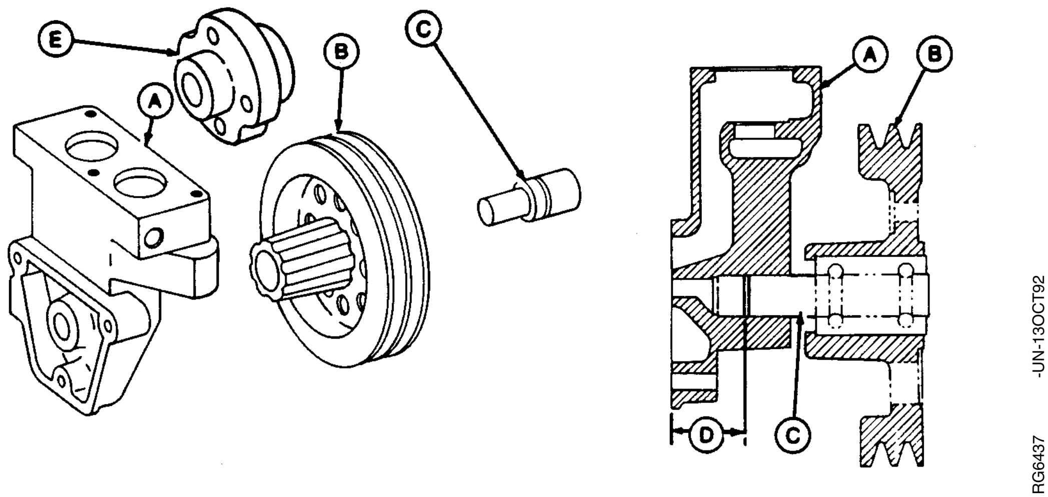
WATER MANIFOLD MOUNTED, FIXED FAN DRIVE SPECIFICATIONS

Shaft OD	25.387—25.400 mm (0.9995—1.0000 in.)
Bearing OD	47.612—47.625 mm (1.8745—1.8750 in.)
Pulley ID, Bearing End	47.576—47.612 mm (1.8731—1.8745 in.)
Pulley ID, Fan Spacer End**	49.485—49.518 mm (1.9482—1.9495 in.)
Fan Spacer OD**	49.457—49.483 mm (1.9471—1.9481 in.)
Manifold ID	25.336—25.362 mm (0.9975—0.9985 in.)
Shaft Installed Dimension from Manifold Mounting Face-to-End of Shaft	33.31—33.47 mm (1.311—1.318 in.)

**In some applications, bearing is pressed into hub (E). The fan spacer and pulley are then bolted to hub. In some applications, the fan spacer is press-fit into the pulley. Dimension (D) is the same for all applications.*

***Units with press-fit fan spacer only.*

RG,CTM42,G25,10-19-14FEB95



A—Water Manifold
B—Fan Pulley
C—Bearing
D—Bearing Shaft Installed Dimension
E—Hub*

- **To Assemble Fan Drive:**

IMPORTANT: Support water manifold on machined surface and press on inner shaft to prevent damage to bearing.

1. On units with a press-fit fan spacer, press spacer into pulley flush to 0.5 mm (0.020 in.) below front face of pulley.

2. Press bearing shaft (C) into water manifold (A). End of shaft should be 33.31—33.47 mm (1.311—1.318 in.) (D) from manifold mounting surface. Hold water manifold firmly and turn fan pulley by hand to assure bearings rotate freely.

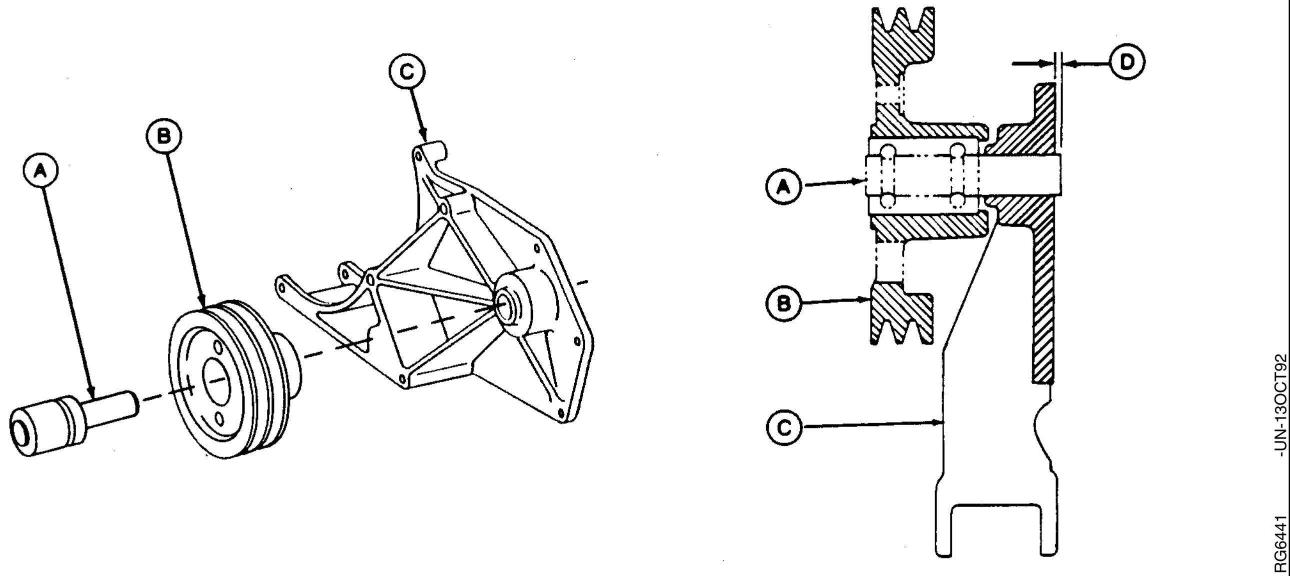
3. Install a new gasket and O-rings. Insert water bypass pipe in manifold and install assembly onto locating pin in front face of cylinder head. Tighten cap screws to 60 N·m 45 (lb-ft).

4. Install fan and V-belts. Refer to appropriate operator's manual for proper belt tensioning.

**In some applications, bearing is pressed into hub (E). The fan spacer and pulley are then bolted to hub. In some applications, the fan spacer is press-fitinto the pulley. Dimension (D) is the same for all applications.*

RG,CTM42,G25,48-19-22MAR95

REPLACE BEARING IN INJECTION PUMP DRIVE GEAR COVER MOUNTED, FAN DRIVE



A—Bearing
B—Fan Pulley
C—Injection Pump Drive Gear Cover
D—Bearing Shaft Installed Dimension

• To Disassemble Fan Drive:

1. Remove injection pump drive gear cover (C) and fan pulley assembly from timing gear cover.

2. Support front face of injection pump gear cover and press bearing (A) and pulley (B) out of cover.

3. Support front face of fan pulley and push bearing out of pulley. Discard bearing.

4. Thoroughly inspect cover and pulley for cracks or damage. Measure parts and compare readings with specifications given below. Replace parts as necessary.

INJECTION PUMP DRIVE GEAR COVER MOUNTED FIXED FAN PULLEY SPECIFICATIONS

Bearing OD (Pulley End)	47.612—47.625 mm (1.8745—1.8750 in.)
Bearing OD (Cover End)	25.387—25.400 mm (0.9995—1.0000 in.)
Fan Pulley Bore ID	47.576—47.612 mm (1.8731—1.8745 in.)
Drive Gear Cover ID	25.336—25.362 mm (0.9975—0.9985 in.)

• To Assemble Fan Drive:

IMPORTANT: Support fan pulley on a flat, firm surface and press on bearing outer race to prevent damage to the bearing.

1. Install new bearing into pulley against stop.

IMPORTANT: Support injection pump drive gear cover on machined mounted surface and press on inner shaft to prevent damage to bearing.

2. Press bearing into cover. End of shaft should be 3.43—3.69 mm (0.135—0.145 in.) from cover mounting surface (D).

3. Hold cover firmly and turn fan pulley by hand to assure bearings rotate freely.

4. Using new gasket, install cover onto timing gear cover. Tighten cap screws to 27 N·m (20 lb-ft).

5. Install fan and V-belts. Refer to the appropriate operator's manual for proper belt tensioning.

RG,CTM42,G25,40-19-14FEB95

INSPECT AND CHECK BELT TENSIONER SPRING TENSION

NOTE: The pulleys and the spring tensioner are not serviceable. If spring tension is not within specification, replace tensioner assembly.

1. Release tension on belt using a long-handle 1/2 in. drive tool (A). Remove belt from the alternator pulley.

2. Release the tension on the tension arm and remove drive tool.

3. Put a mark (B) on swing arm of tensioner as shown.

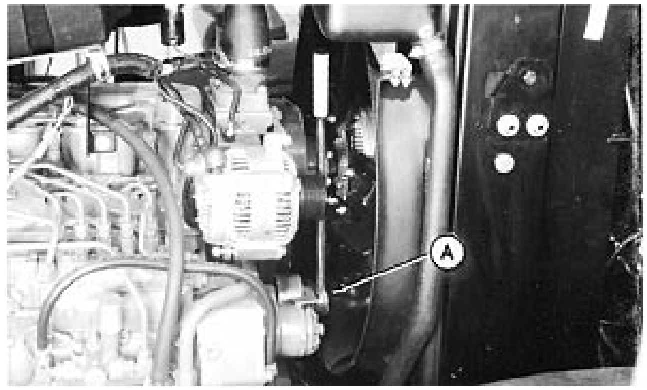
4. Measure 21 mm (13/16 in.) from (B) and put a mark (C) on the mounting bracket.

5. Rotate the arm using a torque wrench (positioned as shown) until mark (B) and (C) are aligned.

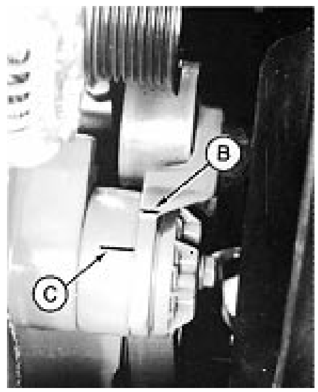
6. Note the torque wrench measurement and compare with specification below. Replace tensioner assembly as required.

SPRING TENSION

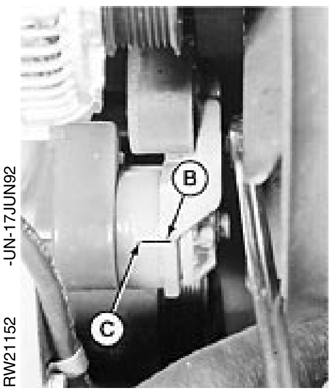
Specification . . . . 24—28 N·m (17—21 lb-ft)



RW21151 -UN-17JUN92



RW21152 -UN-17JUN92

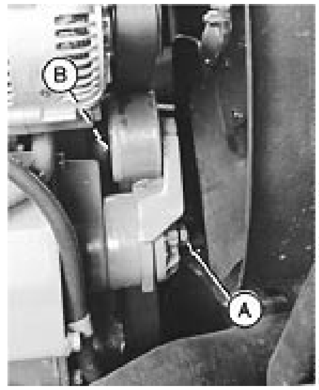


RW21153 -UN-17JUN92

A—1/2 in. Drive Tool
B—Tension Arm Mark
C—Mounting Bracket Mark

RG,CTM42,G25,46-19-17MAR95

REPLACE BELT TENSIONER ASSEMBLY



RW21154 -UN-17JUN92

1. Release tension on pulley (B) and remove belt, (shown removed).

2. Remove cap screw (A) and remove the tensioner assembly.

NOTE: Locator pin in tensioner base fits in hole in injection pump drive gear cover to assure proper positioning.

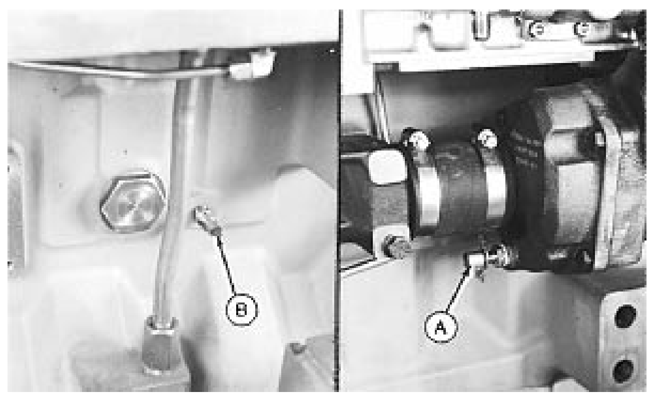
3. Install tensioner and tighten cap screw to 50 N·m (37 lb-ft).

4. Check spring tension on newly installed tensioner. (See INSPECT AND CHECK BELT TENSIONER SPRING TENSION earlier in this group.)

5. Install belt and position onto tensioner.

RG,CTM42,G25,47-19-17MAR95

REMOVE WATER PUMP



RG5836 -UN-28AUG91

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Wait until engine is cool enough to touch with bare hands before draining coolant. Slowly loosen radiator cap to first stop to relieve pressure.

IMPORTANT: Both water pump drain valve and block drain valve must be opened to completely drain both sides of the engine.

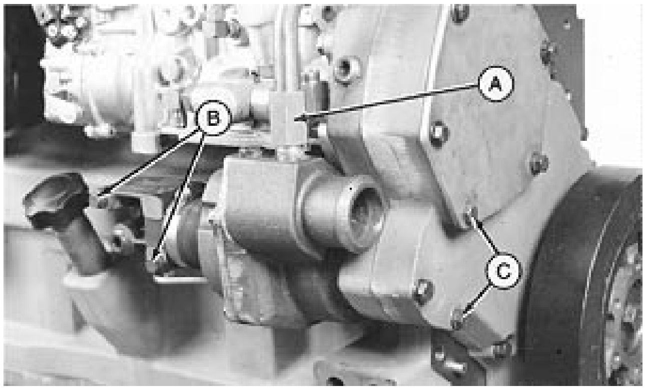
1. Open both water pump drain valve (A) and block drain valve (B) and drain coolant from engine.

RG,CTM42,G25,11-19-14FEB95

2. Remove fitting (A) and water bypass tube.

3. Remove water inlet manifold elbow cap screws (B) and water pump mounting cap screws (C).

NOTE: Oil dipstick may have to be removed to provide clearance for water pump removal. Rotate water pump inlet downward and lift inlet manifold elbow up between block and dipstick tube while sliding water pump to the rear. Some applications may be different.

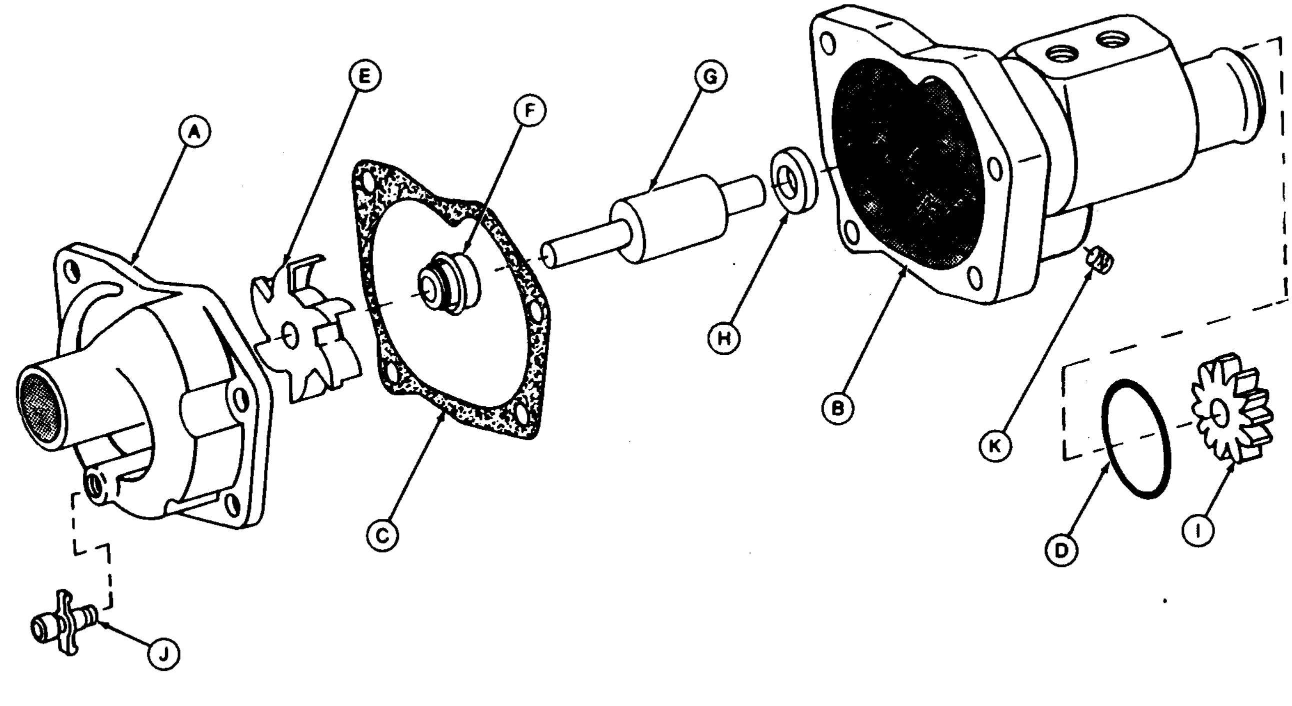


RG5837 -UN-13AUG91

4. Slide water pump nose out of cylinder block flange bore. Remove O-ring.

RG,CTM42,G25,12-19-29OCT92

DISASSEMBLE ENGINE WATER PUMP



RG5847 -UN-13AUG91

A—Cover
B—Housing
C—Gasket
D—O-Ring
E—Impeller
F—Seal (Water Pump)
G—Bearing
H—Seal (Oil)
I—Drive Gear
J—Drain Valve
K—Weep Hole Filters (2 used)

RG,CTM42,G25,13-19-23FEB93

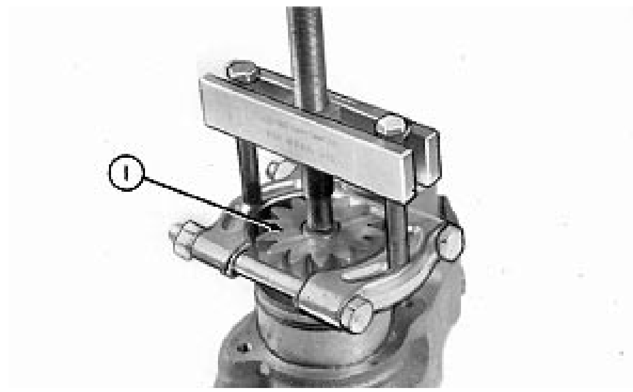
1. Remove four cap screws and remove cover (A) from housing (B).

2. Remove and discard gasket. Scrape all gasket material from cover and housing face.

RG5851 -UN-13AUG91

RG,CTM42,G25,14-19-12SEP91

3. Remove the water pump gear (I) by supporting the back side of the gear with D01217AA Bearing Puller and using D01206AA Puller to pull the gear off of the bearing shaft.



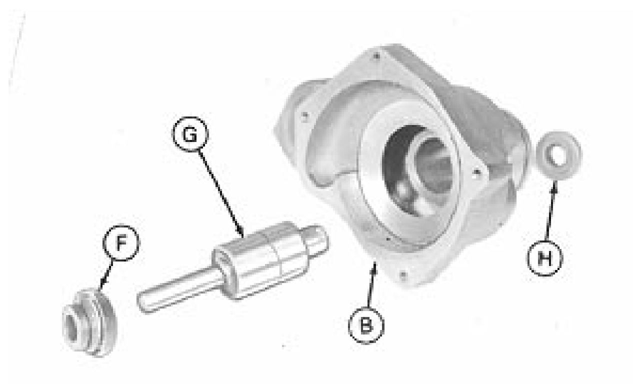
RG5840 -UN-13AUG91

RG,CTM42,G25,16-19-12SEP91

4. Roll oil seal lip (H) using a punch and hammer. Using needle nose pliers, remove and discard oil seal.

5. Using a press, remove bearing (G), water pump seal (F), and impeller (not shown). Support pump housing (B) on gasket surface so that impeller will clear the supports and press on the outer race of the bearing from the gear end with JDG727 Bearing Driver. Discard bearing, seal, and impeller.

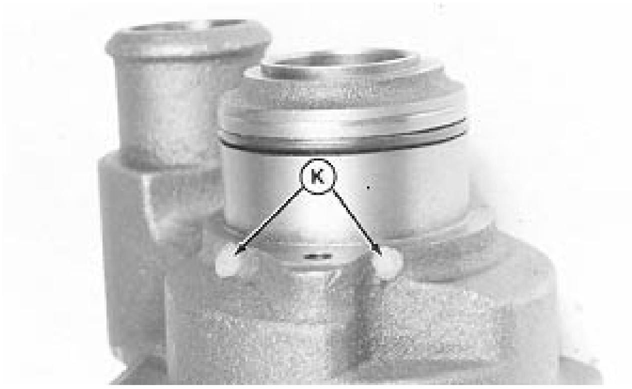
NOTE: It is not recommended that bearing and impeller be reused once they have been removed from the water pump. A new bearing, water pump seal, and impeller are provided in water pump overhaul kit.



RG5841 -UN-13AUG91

RG,CTM42,G25,17-19-29OCT92

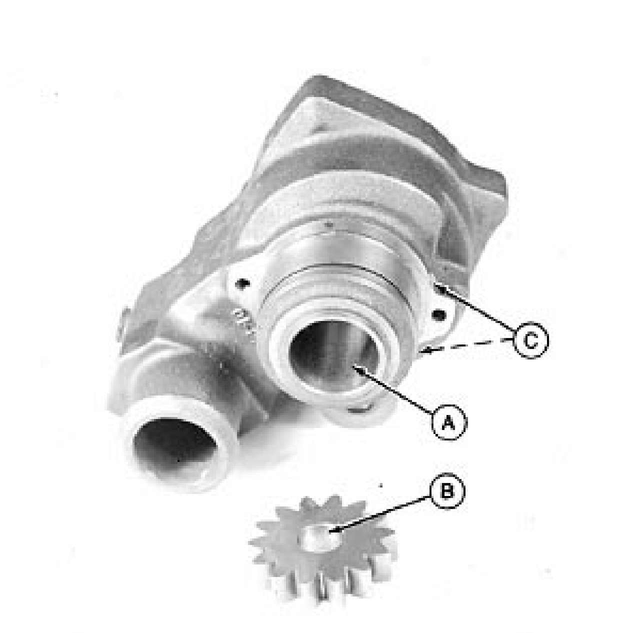
6. Remove and discard foam weep hole filters (K).



RG5842 -UN-13AUG91

RG,CTM42,G25,36-19-12SEP91

INSPECT WATER PUMP PARTS



1. Measure water pump housing bore ID (A) and drive gear ID (B). Replace parts if worn, damaged, cracked, or not within specifications.

WATER PUMP SPECIFICATIONS

Impeller Bore ID	15.849—15.875 mm (0.624—0.625 in.)
Shaft OD Impeller End	15.905—15.917 mm (0.626—0.627 in.)
Bearing Bore in Water Pump Housing (NEW)	38.041—38.067 mm (1.498—1.499 in.)
Maximum Allowable Pump Bearing Bore	38.067 mm (1.499 in.)
Bearing OD	38.087—38.100 mm (1.499—1.500 in.)
Drive Gear Bore ID	18.90—18.92 mm (0.744—0.745 in.)
Shaft OD Drive Gear End	18.948—18.960 mm (0.746—0.747 in.)
Water Pump Seal Installed Height	10.16—10.42 mm (0.400—0.410 in.)
Impeller Installed Depth Below Gasket Surface	2.75—3.50 mm (0.108—0.138 in.)
Bearing Installed Depth Below Pump Housing Nose	6.75—7.00 mm (0.266—0.276 in.)

2. Clean gear and housing with clean solvent and dry with compressed air.

3. Inspect water pump housing for debris, cracks, or damage. Be sure the “weep holes” in the housing are cleaned and foam filters (C) are removed from weep holes while pump is disassembled.

NOTE: Make sure all gasket material is removed from pump.

RG,CTM42,G25,18-19-29OCT92

ASSEMBLE ENGINE WATER PUMP

IMPORTANT: When installing water pump bearing into housing, press only on outer bearing race. Do NOT press on bearing shaft as this will damage the bearing.

1. Support pump housing on gasket surface. Using JDG727 Bearing Driver, press a new bearing into drive gear end of pump housing until outer race is 6.75—7.00 mm (0.266—0.276 in.) below nose of housing. Press only on outer race. Bearing driver will bottom against nose of housing, leaving bearing at correct depth.

2. Apply a light film of clean engine oil to the drive gear end of shaft and to the oil seal lip. Install the new oil seal with spring loaded lip facing outward toward gear end of bearing shaft. Seal should be installed flush with housing nose.

RG5844 -UN-13AUG91

RG5845 -UN-13AUG91

RG,CTM42,G25,19-19-23FEB93

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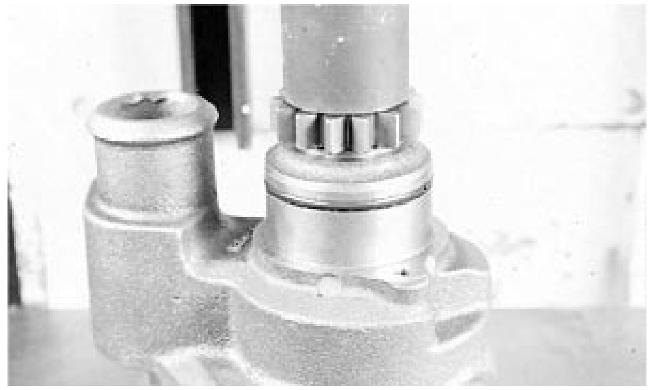
IMPORTANT: When installing drive gear, support impeller end of shaft so pressing load is transmitted through the shaft. Bearing damage will result if load is transmitted through the outer bearing race.

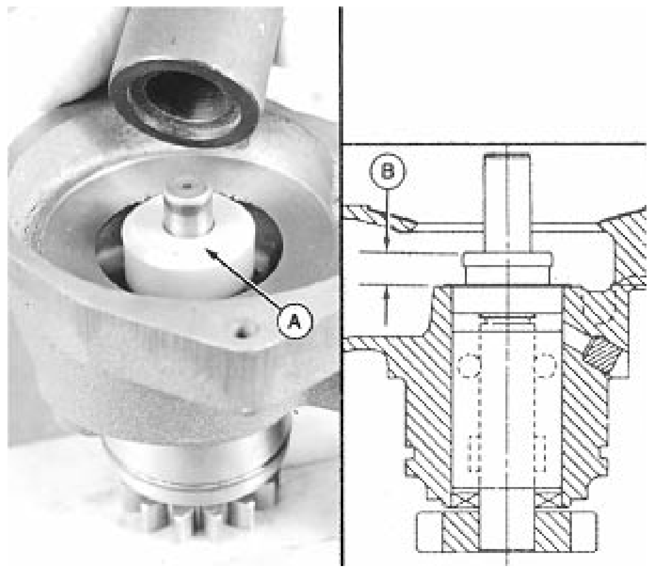
3. Support water pump on impeller end of bearing shaft. Press drive gear onto shaft until gear is flush with end of shaft.



RG5846 -UN-13AUG91

IMPORTANT: When installing water pump seal, support drive gear end of shaft so pressing load is transmitted through the shaft.

4. Support water pump on gear end of bearing shaft and use R113749 Seal Driver (A) (supplied with water pump overhaul kit) and JDG727 Water Pump Bearing Driver to install a new water pump seal. Seal height (B) should be 10.16—10.42 mm (0.400—0.410 in.) when properly installed. R113749 Seal Driver will install seal to proper height.



RG5848 -UN-13AUG91

RG,CTM42,G25,37-19-04FEB93

IMPORTANT: When installing impeller, support drive gear end of shaft so pressing load is transmitted through the shaft. Bearing damage will result if load is transmitted through the outer bearing race.

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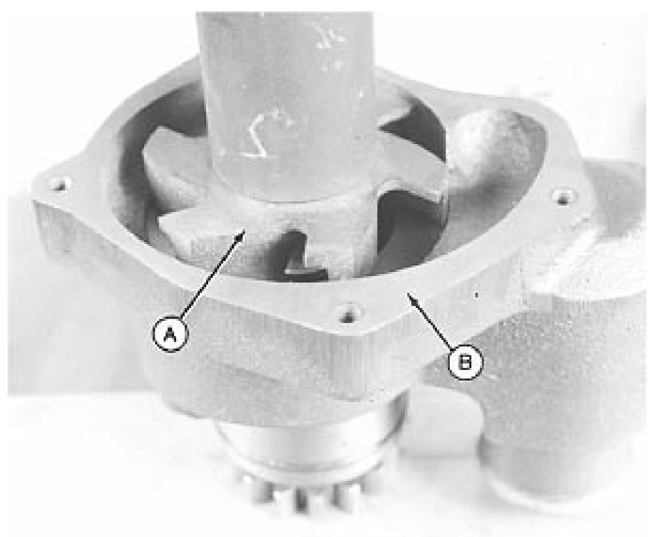
5. Support water pump on gear end of bearing shaft and press new impeller (A) onto shaft until impeller face is 2.97—3.23 mm (0.117—0.127 in.) below gasket surface (B). Use straightedge and dial caliper from bottom of straightedge to impeller to measure depth specification. Pump impeller must rotate freely. Disassemble and correct problem if interference is felt.



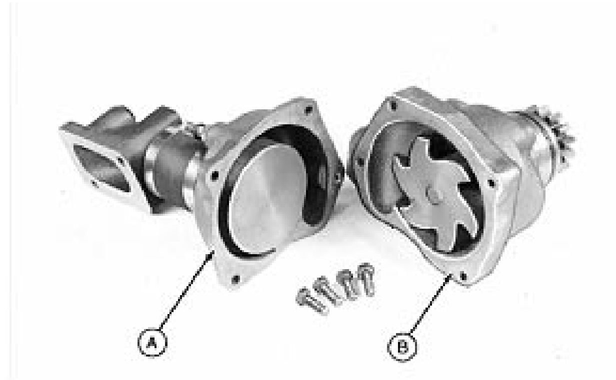
RG5849 -UN-15OCT92

RG,CTM42,G25,20-19-29OCT92

6. Apply a coat of LOCTITE 518 Flexible Sealant to the gasket surfaces (A and B). Install a new gasket and pump cover. Tighten the four cover cap screws to 30 N·m (22 lb-ft).

7. If drain valve is removed, apply LOCTITE 592 Pipe Sealant to threads and tighten drain valve to 27 N·m (20 lb-ft).

8. Install new weep hole filters and a new O-ring on the pump housing pilot.



RG5851 -UN-13AUG91

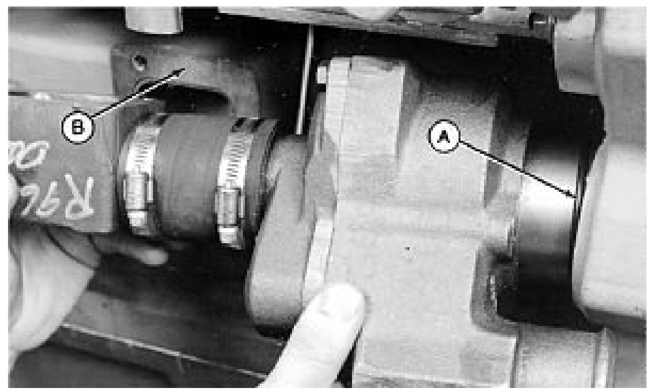
RG,CTM42,G25,21-19-16AUG94

INSTALL ENGINE WATER PUMP

1. Apply a light coat of engine oil to water pump housing O-ring (A). Install pump into pilot bore in block making sure that pump drive gear properly meshes with camshaft gear.

2. Install two water pump mounting cap screws and tighten to 27 N·m (20 lb-ft).

3. Install a new gasket (B) between water inlet manifold elbow and cylinder block. Install two 5/16 in. inlet manifold elbow cap screws and tighten to 27 N·m (20 lb-ft).



RG5850 -UN-13AUG91

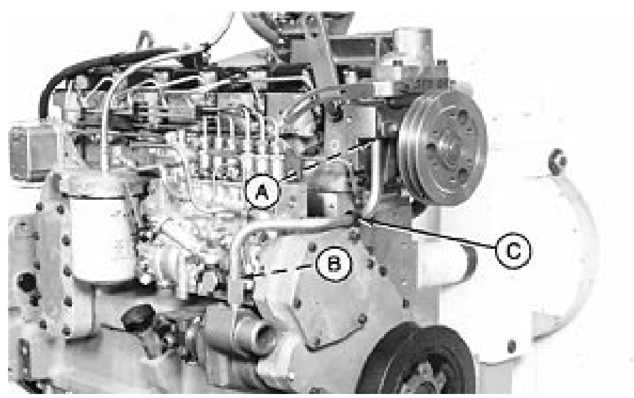
RG,CTM42,G25,22-19-16AUG94

4. Install new O-ring (A) into bore of water outlet manifold. Lubricate O-ring with engine oil and install bypass pipe into water outlet manifold.

5. Install new O-ring (B) in water bypass fitting. Lubricate O-ring with engine oil and install fitting onto pump end of bypass pipe.

6. Apply LOCTITE 592 Pipe Sealant with TEFLON to fitting threads and screw fitting into water pump housing. Tighten securely.

7. Install clamp (C) with “J” of clamp toward rear of engine on inside-upper injection pump drive gear cover cap screw.

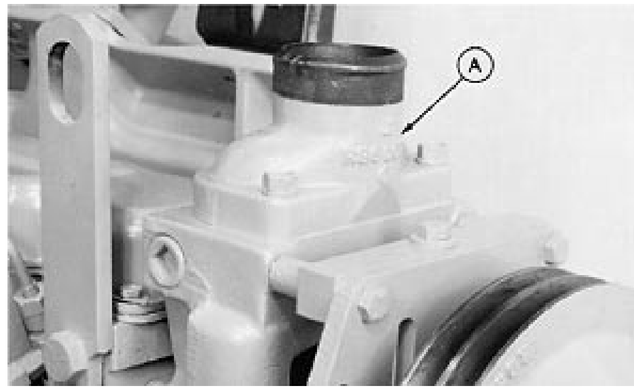


RG5853 -UN-13AUG91

RG,CTM42,G25,23-19-16AUG94

REMOVE AND TEST THERMOSTATS

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain cock slowly to relieve pressure.

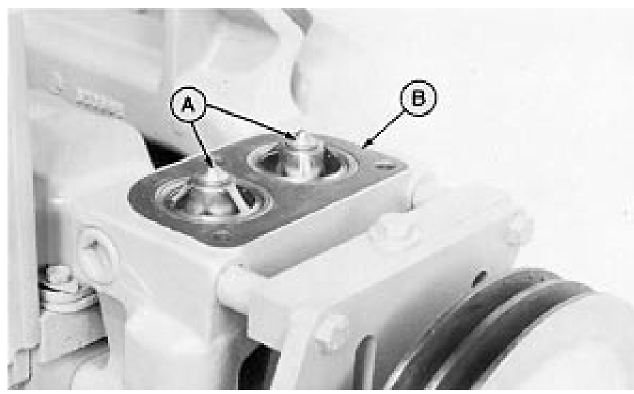


RG5279 -UN-14DEC88

1. Visually inspect the area around the water manifold for leaks. Partially drain coolant from the cooling system.

2. Remove thermostat cover (A).

RG,CTM42,G25,24-19-29OCT92



RG5280 -UN-09DEC88

3. Remove thermostats (A). Discard gasket (B).

4. Inspect thermostats for debris or damage, and test each thermostat using an approved thermostat testing procedure. See INSPECT THERMOSTAT AND TEST THERMOSTAT OPENING TEMPERATURE in Group 105 for thermostat testing procedure. Thermostats should start to open within the range specified.

THERMOSTAT OPENING TEMPERATURE SPECIFICATIONS

82°C (180°F) Thermostat(s)	80—84°C (175—182°F)
89°C (192°F) Thermostat(s)	87—91°C (188—195°F)

If either thermostat fails to open within this range, replace both thermostats.

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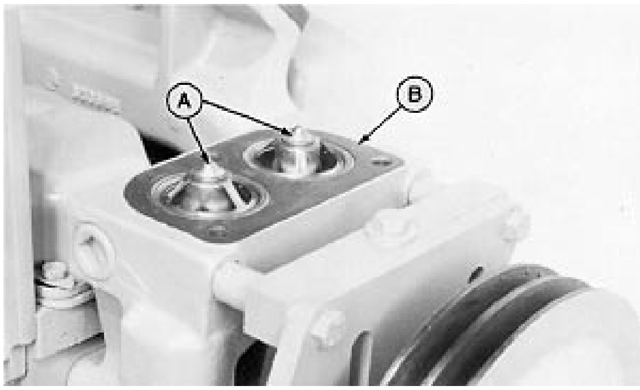
RG,CTM42,G25,43-19-29OCT92

INSTALL THERMOSTATS



1. Apply LOCTITE 518 Flexible Sealant to water manifold-to-thermostat cover mating surface.

NOTE: Install thermostats in slot in housing first, then install gasket after thermostat is properly seated in housing.

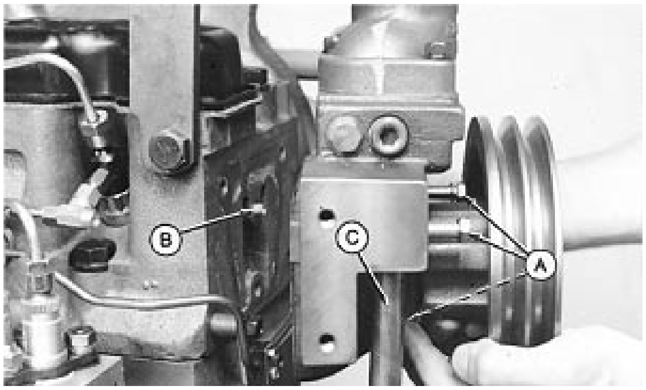
2. Install thermostats (A) and a new gasket (B).

3. Install cover and tighten cap screws to 47 N·m (35 lb-ft)—Cast Iron housing, 20 N·m (15 lb-ft)—Aluminum housing.

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

RG,CTM42,G25,25-19-14FEB95

REMOVE WATER MANIFOLD



1. Remove air bleed line from cylinder head-to-thermostat housing (if equipped) and aftercooler hose from water manifold-to-aftercooler (if equipped).

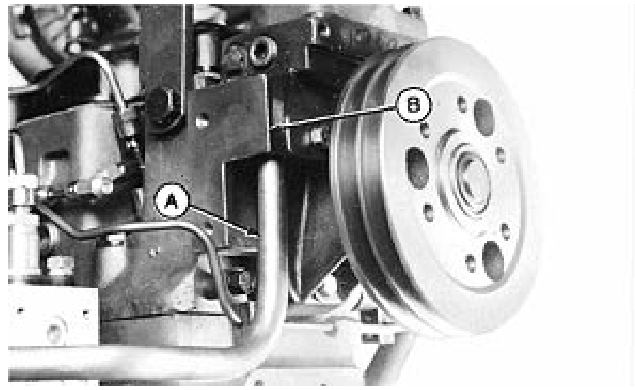
2. Remove three water manifold-to-cylinder head cap screws (A) and remove water manifold assembly.

NOTE: Pull water manifold straight ahead (toward front of engine) approximately 6.35 mm (0.25 in.) to disengage from locator (spring) pin (B), then lift straight up to disengage from bypass pipe (C).

3. Remove bypass pipe. Remove and discard O-rings from bore of water manifold and from water pump fitting.

RG,CTM42,G25,26-19-29OCT92

INSTALL WATER MANIFOLD



RG5855 -UN-13AUG91

1. Install a new O-ring into water manifold and water pump fitting bores. Lubricate O-rings with grease to ease bypass pipe installation. Install bypass pipe (A) into bore of water manifold (B), be careful not to cut O-ring.

2. Using LOCTITE 518 Flexible Sealant and a new gasket, install water manifold assembly. Be sure water manifold is properly positioned on spring pin (in front face of cylinder head) and that bypass pipe is fully seated in water manifold and water pump fitting bores.

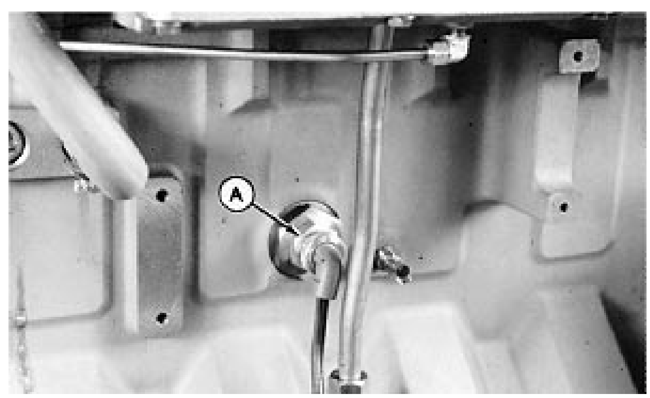
3. Apply LOCTITE 242 Thread Sealer to water manifold-to-cylinder head cap screw threads 360 degrees (except for the leading one to three threads). Tighten water manifold cap screws to 61 N·m (45 lb-ft)—Cast Iron housing, 20 N·m (15 lb-ft)—Aluminum housing..

4. Install bypass pipe “J” clamp to inside-upper injection pump gear cover cap screw and tighten to 27 N·m (20 lb-ft).

5. If equipped, install aftercooler hose to water manifold, and bleed line from cylinder head-to-thermostat housing.

RG,CTM42,G25,28-19-14FEB95

REMOVE COOLANT HEATER—IF EQUIPPED



RG5948 -UN-30AUG91

1. Unplug heater (A) from electrical power source.

2. Drain cooling system.

3. Remove electrical cord, loosen nut, and pull heater element out of block.

RG,CTM42,G25,29-19-29OCT92

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.

TS210 -UN-23AUG88

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.

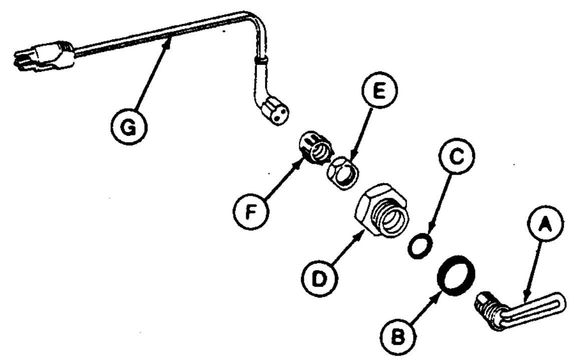
2. Install nut (E) onto threads of heater element finger tight only.

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.



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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COMPLETE FINAL ASSEMBLY

NOTE: Consult your engine operator's manual or see Group 02 of this CTM for coolant recommendations in your area.

1. Fill cooling system to proper level with the proper coolant.

2. Start engine and run for several minutes to check for leaks in the cooling system.

3. After fan belts cool, check belt tension as detailed in your operator's manual.

RG,CTM42,G25,31-19-15SEP94

FAN BELT TENSION SPECIFICATIONS

- **JDG529 Gauge Method (Standard V-belts) JT05975 Gauge Method (Poly V-belts):**

FAN BELT TENSION SPECIFICATIONS (Using JDG529 or JT05975 Tension Gauge Method)

	New Belt	Belt in Service*
Standard V-Belts:		
Single Belt System	578—623 N (130—140 lb)	378—423 N (85—95 lb)
2-Belt System (Tension Front Belt Only)	423—463 N (95—104 lb)	378—423 N (85—95 lb)
Poly V-Belts:		
Single Belt System	890—1068 N (200—240 lb)	801—979 N (180—220 lb)

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- **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.).

—On new and used poly V-belts, a 130 N (30 lb) force halfway between the pulleys should deflect the belt 13 mm (1/2 in.).

**Belts are considered used after 10 minutes of operation.*

RG,CTM42,G25,39-19-01SEP94

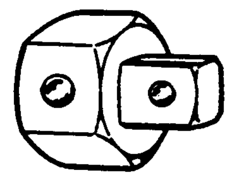
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

Special Socket Adapter JDG626

Use with JDE80 and standard 9/16 12-point, 3/8 in. drive socket to remove and install rear cap screw on turbocharger drain tube.

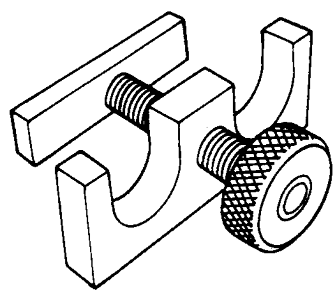


RG5367 -UN-14DEC88

S53,JDG626 -19-09SEP91

Sealing Ring Compression Tool JDG683

Used to compress aftercooler sealing ring for cover-to-intake manifold alignment during assembly.

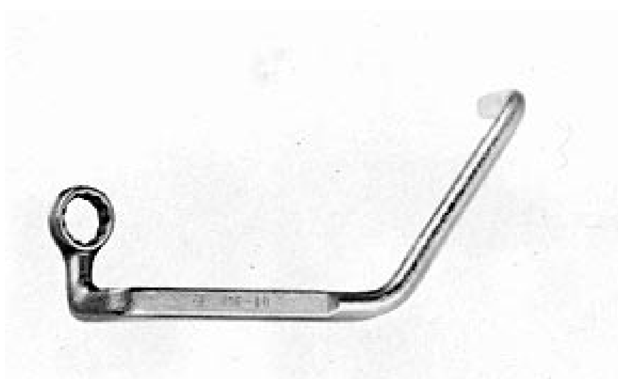


RG5571 -UN-04JUL89

RG,JDG683 -19-09SEP91

Starter Wrench JDE80

Use with JDG626 and standard 9/16 12-point, 3/8 in. drive socket to remove and install rear cap screw on turbocharger drain tube.



R26547 -UN-09FEB90

RG,CTM42,G30,32-19-10SEP91

OTHER MATERIAL

Name	Use
PT569 NEVER-SEEZ Compound	Exhaust manifold cap screws, turbocharger-to-exhaust manifold cap screws, and aftercooler cover-to-intake manifold cap screws.
LOCTITE 592 (TY9374/TY9375) Pipe Sealant with TEFLON	Turbocharger oil supply and drain lines.

RG,CTM42,G30,1 -19-29OCT92

AIR INTAKE AND EXHAUST SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION
Total Indicator Reading Limits (AiResearch):	
Radial Bearing Clearance	0.08—0.15 mm (0.003—0.006 in.)
Bearing End Play	0.03—0.10 mm (0.001—0.004 in.)
Total Indicator Reading Limits (Schwitzer):	
Radial Bearing Clearance	0.13—0.18 mm (0.005—0.007 in.)
Bearing End Play	0.05—0.13 mm (0.002—0.005 in.)
Exhaust Adapter End Play	1.59 mm (0.0625 in.)

RG,CTM42,G30,2 -19-29OCT92

AIR INTAKE AND EXHAUST SYSTEM SPECIFICATIONS—CONTINUED

TORQUES

Compressor Housing-to-Backplate (AiResearch)	15.3—18.7 N·m (135—165 lb-in.)
Turbine Housing-to-Center Housing (AiResearch)	15.8—19.2 N·m (140—170 lb-in.)
Compressor Housing-to-Backplate (Schwitzer)	7—8 N·m (60—70 lb-in.)
Turbine Housing-to-Center Housing (Schwitzer)	15—16 N·m (135—145 lb-in.)
Turbocharger-to-Exhaust Manifold	24 N·m (18 lb-ft)
Turbocharger Oil Inlet Line	26—34 N·m (19—25 lb-ft)
Turbocharger Coupling Clamp	11 N·m (100 lb-in.)
Exhaust Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Intake Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Exhaust Elbow-to-Exhaust Manifold	24 N·m (18 lb-ft)
Exhaust Adapter V-Band Clamp	20 N·m (15 lb-ft)
Intake Manifold-to-Aftercooler Cover (6076A Only)	34 N·m (25 lb-ft)
Aftercooler Inlet and Outlet Hose Clamps	4 N·m (35 lb-in.)
Intake Manifold-to-Intake Hose Clamps	9—13 N·m (12—17 lb-ft) (146—203 lb-in.)

RG,CTM42,G30,56-19-14FEB95

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 -19-04JUN93

• **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 -19-04JUN93

• **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

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

Thoroughly clean exterior of turbocharger and surrounding area to prevent entry of dirt into the air intake system during removal.

IMPORTANT: When cleaning turbocharger, do not spray directly into compressor cover or turbine housing. If turbocharger inspection is required, do not clean exterior prior to removal. Doing so may wash away evidence of a potential failure mode. (See TURBOCHARGER SEVEN STEP INSPECTION, later in this group.)

NOTE: Your 6076 Engine is equipped with either AiResearch/Garrett, Holset, or Schwitzer turbochargers. Removal and installation procedures are the same for all turbochargers, but repair of AiResearch/Garrett and Schwitzer differ. Refer to the proper repair section when repairing turbocharger. Repair parts are not available for Holset turbochargers; if defective, install a replacement.

RG,CTM42,G30,11-19-29OCT92

NOTE: 6076A shown, 6076T and H similar.

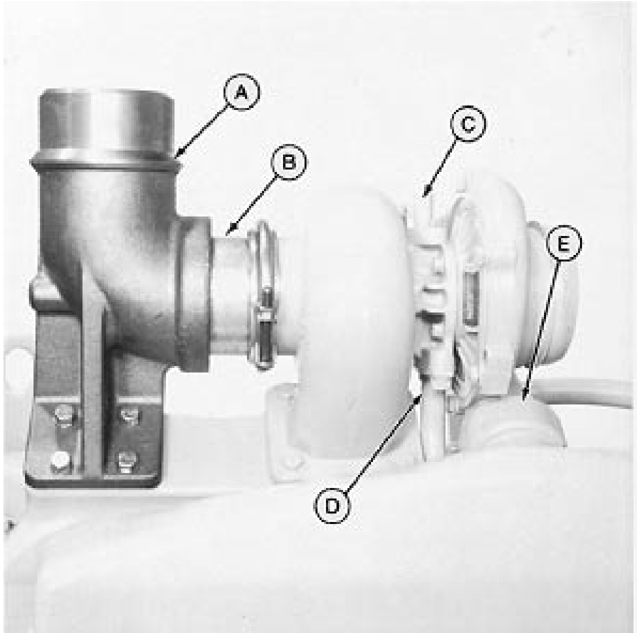
1. Remove exhaust elbow (A). Remove clamp and exhaust adapter (B).

2. Disconnect oil inlet line (C). Loosen oil return tube cap screws using JDG626 Special Socket Adapter with JDE80 and standard 9/16 12-point, 3/8 in. drive socket and remove oil return tube (D). Discard gasket.

3. Remove four turbocharger mounting cap screws with washers and lift turbocharger from exhaust manifold. Disengage turbocharger from intake manifold coupling (E). Discard turbocharger-to-coupling O-ring.

4. Cap or plug all openings (exhaust and intake manifold related) and place turbocharger on a clean flat table for inspection.

5. Perform turbocharger seven-step inspection, as described later, if failure mode has not been determined.



A—Exhaust Elbow
B—Exhaust Adapter
C—Oil Inlet Line
D—Oil Return Tube
E—Intake Manifold Coupling

RG,CTM42,G30,12-19-29OCT92

TURBOCHARGER FAILURE ANALYSIS

The following is a guide for diagnosing the cause of turbocharger failures after removal from the engine.

COMPRESSOR HOUSING INLET DEFECTS

Problem	Possible Cause	Suggested Remedy
Foreign Object Damage	Objects left in intake system.	Disassemble and inspect intake system for foreign objects (this group).
		Inspect engine for internal damage.
	Leaking and/or defective intake system.	Inspect air intake system connections including air filter; repair as required (this group).
		Inspect air intake related engine components.
Compressor Wheel Rub	Bearing failure.	Determine if engine and/or operator contributed to lack of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in progress. Correct as required.
	Manufacturing defects.	Correct as required.

COMPRESSOR HOUSING OUTLET DEFECTS

Problem	Possible Cause	Suggested Remedy
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

Problem	Possible Cause	Suggested Remedy
Oil in Housing	Internal engine failure.	Inspect and repair engine as required.
	Oil leaking from compressor housing seal.	Verify that oil is in compressor housing and refer to “Compressor Housing Outlet Defects” as listed earlier in this chart.
Center Wall Deteriorated	Excessive operating temperature.	Check for restricted air intake.
		Check engine for overfueling.
		Check injection pump timing.

RG,CTM8,G30,R3 -19-11SEP92

TURBINE HOUSING OUTLET DEFECTS

Problem	Possible Cause	Suggested Remedy
Turbine Wheel Rub	Bearing failure.	Determine if engine and/or operator contributed to lack of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in progress. Correct as required.
	Manufacturing defect.	Correct as required (this group).
Foreign Object Damage	Internal engine failure.	Inspect and repair engine as required.
	Objects left in intake system.	Disassemble and inspect air intake system, (this group).
	Leaking air intake system.	Correct as required, (this group).
Oil and/or Excessive Carbon	Internal engine failure.	Verified by oil in turbine housing. Correct as required.
	Turbine seal failure.	Inspect for excessive heat from overfueling and/or restricted air intake.
	Prolonged periods of low RPM engine idling.	Verify with operator to run engine under load or a higher RPM. (Operator’s Manual.) joints.
	Restricted oil drain line.	Inspect and clear oil drain line as required.

EXTERNAL CENTER HOUSING AND JOINT DEFECTS

Problem	Possible Cause	Suggested Remedy
Leaks from Casting	Defective casting.	Replace turbocharger, (this group).
	Defective gasket.	Verify that leaks are not occurring at gasket joints.
Leaks from Joints	Loose attaching screws.	Tighten to specifications in CTM, (this group).
	Defective gasket.	Inspect and repair as required.

INTERNAL CENTER HOUSING DEFECTS

Problem	Possible Cause	Suggested Remedy
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.

S11,3005,JG -19-28SEP94

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.

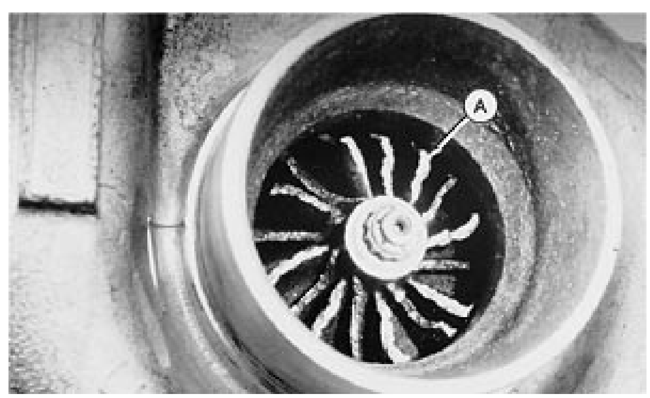
S11,3005,IF -19-16AUG94

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.

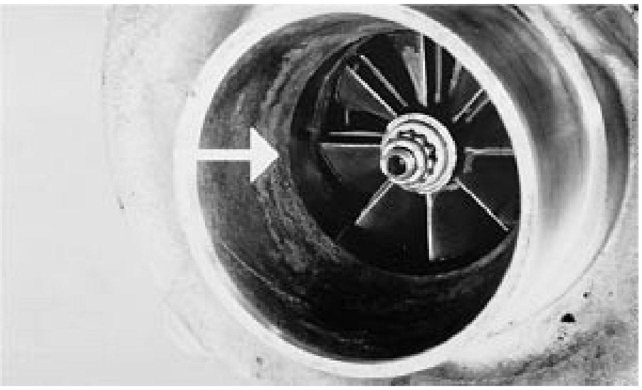


RG4523 -UN-20DEC88

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.



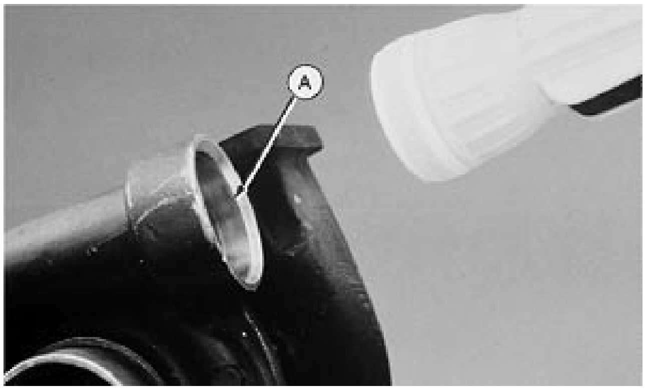
RG4524 -UN-20DEC88

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.



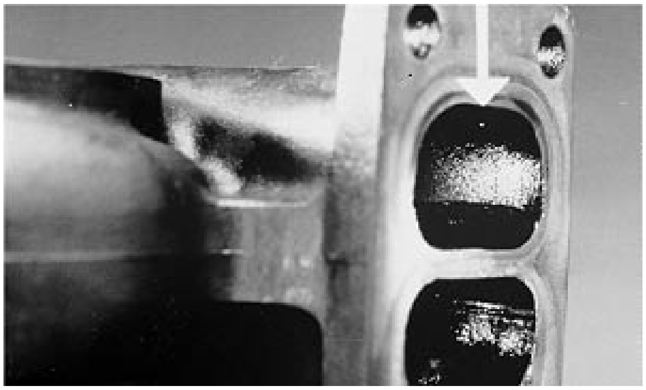
RG4525 -UN-20DEC88

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.

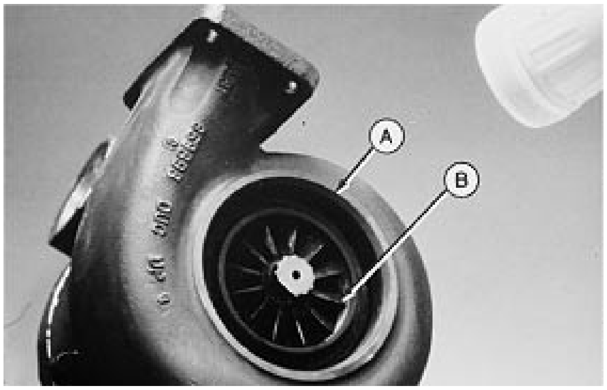


RG4526 -UN-20DEC88

S11,3005,IJ -19-11SEP92

Turbine Housing Outlet and Turbine Wheel

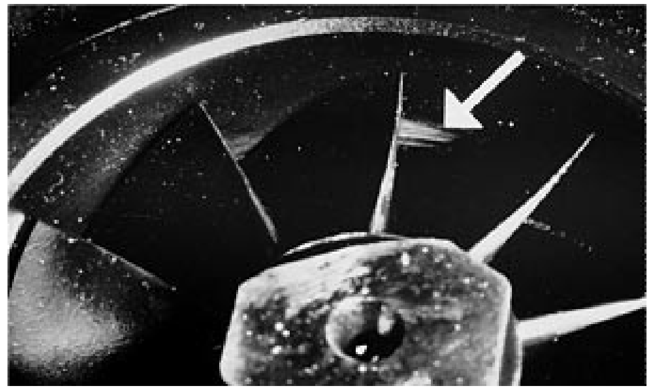
1. Use a flashlight to look up inside the turbine housing outlet (A) and check blades (B) for foreign object damage.



RG4527 -UN-20DEC88

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.



RG4528 -UN-20DEC88

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.

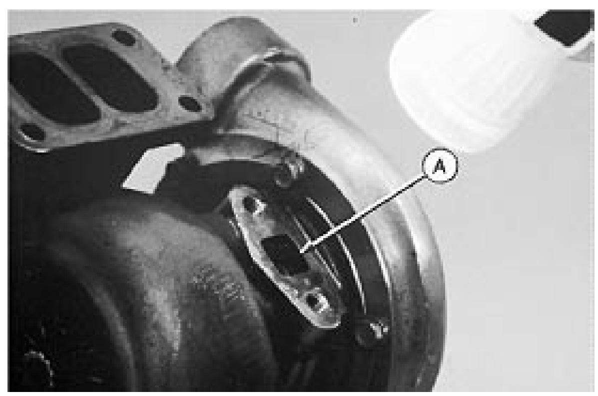
NOTE: If oil is present, make sure it is not coming from a leak at the oil supply or return line.

RG4529 -UN-20DEC88

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.



RG4530 -UN-20DEC88

S11,3005,IN -19-07AUG92

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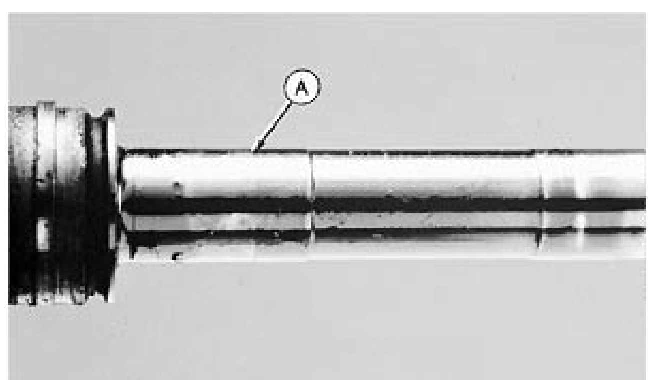
2. Excessive "blueing" or "coking" of oil along the complete length of the shaft (A) indicates a possible lack of lubrication caused by an engine failure, or improper operation, such as hot shutdowns.



RG4531 -UN-20DEC88

S11,3005,IO -19-07AUG92

Turbocharger Bench Test

1. Mount the turbocharger in a vise.

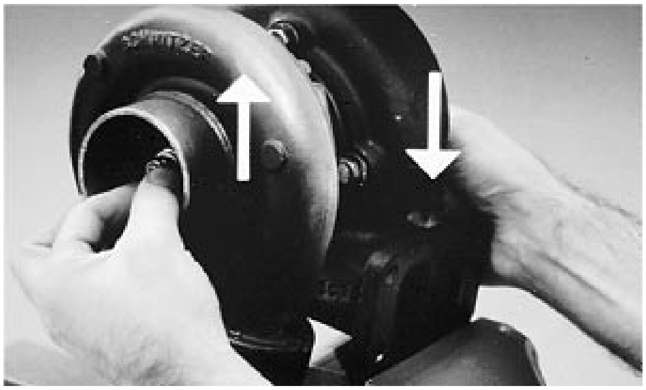
2. Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely, however, there may be a slight amount of drag.

RG4532 -UN-20DEC88

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.



RG4533 -UN-20DEC88

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.

RG4534 -UN-20DEC88

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

This test will give an indication of the condition of radial bearings within the center housing and rotating assembly.

1. Fasten a magnetic base (plunger-type) dial indicator to the turbocharger mounting base. Assemble an extension adapter and indicator extension rod onto dial indicator.

2. Position indicator tip (through center housing oil return) on center of shaft. Preload indicator tip and zero dial on indicator.

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 movement.

TURBOCHARGER SHAFT RADIAL MOVEMENT SPECIFICATION

Garrett/AiResearch . . . . 0.08—0.15 mm (0.003—0.006 in.)

Schwitzer . . . . 0.13—0.18 mm (0.005—0.007 in.)

If total indiactor reading is not within specification, replace center housing and rotating assembly. (See REPLACE CENTER HOUSING AND ROTATING ASSEMBLY, later in this group.)

RG,CTM42,G30,29-19-29OCT92

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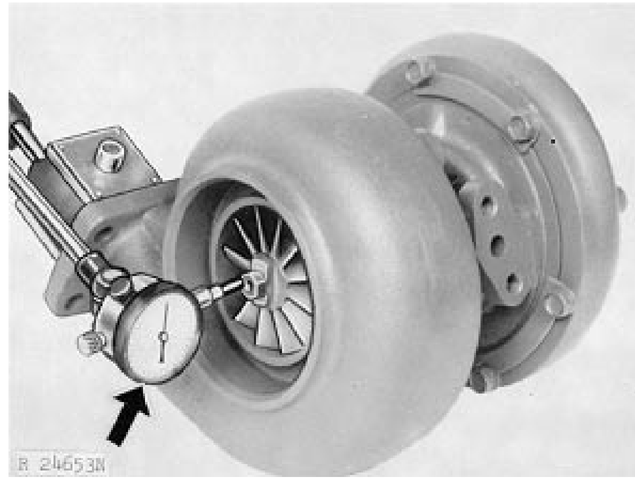
PERFORM AXIAL BEARING END PLAY TEST



R24653N -UN-20DEC88

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 (arrow) so indicator tip rests on flat surface on turbine end of shaft. Preload indicator tip and zero dial on indicator.

2. Move shaft axially back and forth by hand.

3. Observe and record total dial indicator movement.

TURBOCHARGER SHAFT AXIAL END PLAY SPECIFICATION

Garrett/AiResearch	0.03—0.10 mm (0.001—0.004 in.)
Schwitzer	0.05—0.13 mm (0.002—0.005 in.)

If bearing end play is not within specifications, replace center housing and rotating assembly, as outlined later in this group.

RG,CTM42,G30,28-19-29OCT92

REPAIR TURBOCHARGER

AiResearch/Garrett and Schwitzer turbochargers used on the engines covered in this manual are available through service parts as a complete remanufactured assembly or as a new center housing and rotating assembly only. When a new center housing and rotating assembly are being installed, thoroughly inspect and reuse turbine and compressor housings from existing turbocharger. New mounting hardware MUST be used.

IMPORTANT: Repairing a turbocharger center housing and rotating assembly requires specialized tooling and highly trained personnel and thus it is not recommended that the turbocharger be disassembled completely.

CTM8,GR30,7 -19-13JAN95

DISASSEMBLE TURBOCHARGER

A—Compressor Housing
B—Clamp Plates
C—Center Housing Assembly
D—Clamp Plates
E—Turbine Housing

Cap or plug all openings (including exhaust and intake ports) and clean exterior of turbocharger with a pressure spray of cleaning solvent. Dry turbocharger with compressed air.

IMPORTANT: When cleaning turbocharger do not spray directly into compressor cover or turbine housing. Spinning rotor with high pressure spray may cause bearing damage.

Put turbocharger on a clean flat surface.

1. Scribe a location mark on the turbine housing (E), center housing (C), and compressor housing (A) to assist proper indexing of housings when turbocharger is assembled.

NOTE: Some turbochargers may not have lock plates on compressor or turbine housing cap screws.

2. If equipped, straighten ears on lock plates.

3. Remove compressor housing cap screws, lock plates (if equipped), and clamps (B).

4. Remove compressor housing. Gently tap compressor housing with a soft hammer, if necessary, to remove. Be careful not to damage compressor housing or compressor wheel.

5. Remove turbine housing cap screws, lock plates (if equipped), and clamps (D).

6. Remove turbine housing. Gently tap turbine housing with a soft hammer, if necessary, to remove. Be careful not to damage turbine housing or turbine wheel.

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RG,CTM42,G30,30-19-16AUG94

CLEAN AND INSPECT TURBINE AND COMPRESSOR HOUSINGS

1. Thoroughly clean compressor housing (A) and turbine housing (C) using a commercially approved solvent only. Caustic solutions may damage housings. Dry housings with compressed air after cleaning. After a part is cleaned, place it on a clean flat surface and inspect as outlined below.

• **Inspect turbine housing for:**

—Wheel rub damage within the contour area that cannot be polished out with 60-grit silicon carbide abrasive cloth.

—Nicks, dents or warpage that could prevent proper sealing between the turbine housing and center housing.

—Corroded or stripped threaded mounting holes.

• **Inspect compressor housing for:**

—Wheel rub damage within the contour area that cannot be polished out with 80-grit silicon carbide abrasive cloth.

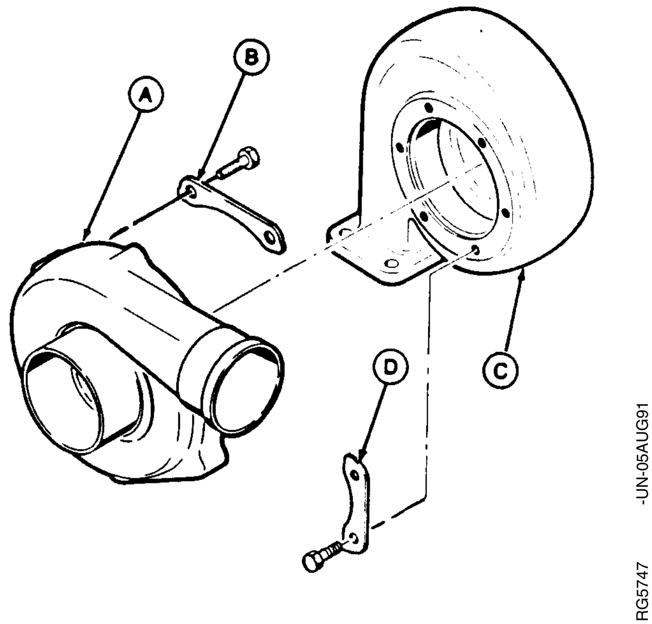
—Nicks, dents, or warpage that could prevent proper sealing between the compressor housing and center housing.

—Corroded or stripped threaded mounting holes.

NOTE: Use new mounting cap screws when turbocharger is reassembled.

2. Clean all threads in housings with a tap.

3. Replace either housing if any of the above defects are found.



A—Compressor Housing
B—Compressor Clamp
C—Turbine Housing
D—Turbine Clamp

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RG,CTM42,G30,31-19-15SEP94

REPLACE CENTER HOUSING ASSEMBLY AND ASSEMBLE TURBOCHARGER

NOTE: Center housing and rotating assembly is serviced as a complete assembly; individual internal parts are not available.

1. Carefully transfer the scribed marks from the original center housing (C) to the replacement assembly, if necessary. Use the same procedure for the turbine housing (E) and compressor housing (A), if they are also being replaced.

2. Lay turbine housing on it’s side and install center housing assembly (C) into turbine housing (E). Align scribed reference marks (scribed during disassembly) on turbine housing and center housing.

3. Apply a coat of PT569 NEVER-SEEZ Compound to cap screws. Install clamps (D), lock plates (if equipped), and cap screws. Tighten cap screws to specification. Bend lock plates up against head of cap screws.

A—Compressor Housing
B—Clamp Plates
C—Center Housing Assembly
D—Clamp Plates
E—Turbine Housing

TURBOCHARGER CAP SCREW TORQUE SPECIFICATIONS

Garrett/AiResearch	
Turbine Housing-to-Center Housing	15.8—19.2 N·m (140—170 lb-in.)
Compressor Housing-to-Backplate	15.3—18.7 N·m (135—165 lb-in.)
Schwitzer	
Turbine Housing-to-Center Housing	7—8 N·m (60—70 lb-in.)
Compressor Housing-to-Backplate	7—8 N·m (60—70 lb—in.)

4. Position compressor housing (A) onto center housing assembly (C). Align scribed reference marks (scribed during disassembly) on compressor housing and center housing.

5. Apply a coat of PT569 NEVER-SEEZ Compound to cap screws. Install clamps (B), lock plates (if equipped), and cap screws. Tighten cap screws to specification.

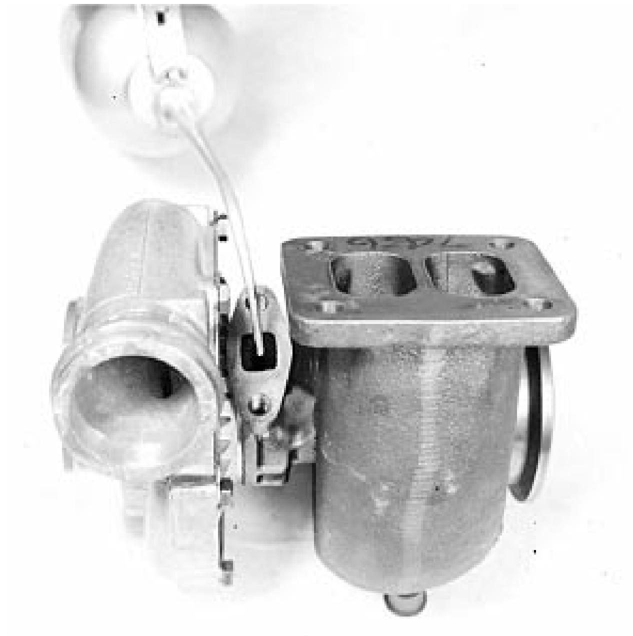
IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

6. After assembly, spin rotating assembly by hand to check for binding and wheel rub. If either condition exists, disassemble turbocharger and determine the cause.

7. Prelube turbocharger bearings with clean engine oil before putting turbocharger into service.

RG,CTM42,G30,33-19-29OCT92

PRELUBE TURBOCHARGER



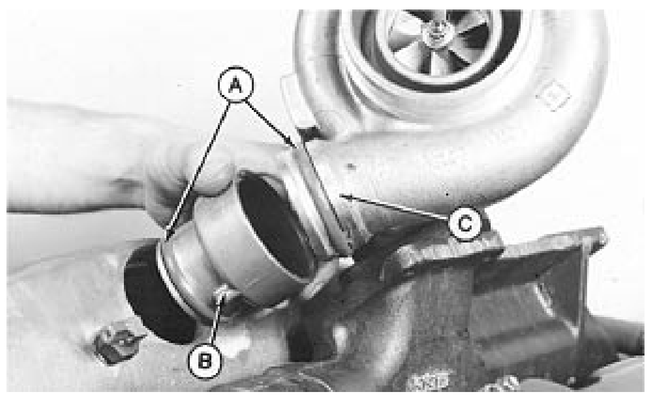
IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

Fill oil return (drain) port with clean engine oil and spin rotating assembly by hand to properly lubricate bearings.

If turbocharger is to be stored for an extended period of time, lubricate internally and install protective covers on all openings.

RG,CTM42,G30,34-19-29OCT92

INSTALL TURBOCHARGER



6076A shown, 6076T similar

IMPORTANT: If turbocharger failed because of foreign material entering the air intake system, be sure to examine the system and clean as required to prevent a repeat failure.

If not previously done, prime turbocharger lubrication system prior to mounting turbocharger on engine. Fill center housing with new engine oil through oil drain hole (as shown). Turn rotating assembly by hand to lubricate bearings.

1. Apply a coat of grease to O-rings (A) and install on compressor housing outlet (C) and coupling (B).

2. Put a new gasket on turbocharger-to-exhaust manifold mounting surface (not shown).

RG,CTM42,G30,35-19-29OCT92

NOTE: Coat coupling O-rings with liquid soap or grease as an aid during assembly.

Install turbocharger oil drain tube on engine before mounting turbocharger.

Guide studs may be used to position exhaust gasket during turbocharger installation.

3. Mount turbocharger on engine, making sure coupling (E) is properly seated over compressor housing and in intake manifold.

4. Apply PT569 NEVER-SEEZ Compound to all turbocharger mounting cap screws. Install cap screws and tighten to 24 N·m (18 lb-ft). On 6076T engines, tighten hose clamps on intake manifold and coupling hose to 9—13 N·m (12—17 lb-ft) (146—203 lb-in.).

NOTE: Remove all caps or plugs from turbocharger openings.

5. Using a new gasket, install oil drain tube (D). Tighten cap screws securely using JDG626 Special Socket Adapter with JDE80 and standard 9/16, 12-point, 3/8 in. drive socket. Connect oil inlet line (C) and tighten to 26—34 N·m 19—25 lb-ft).

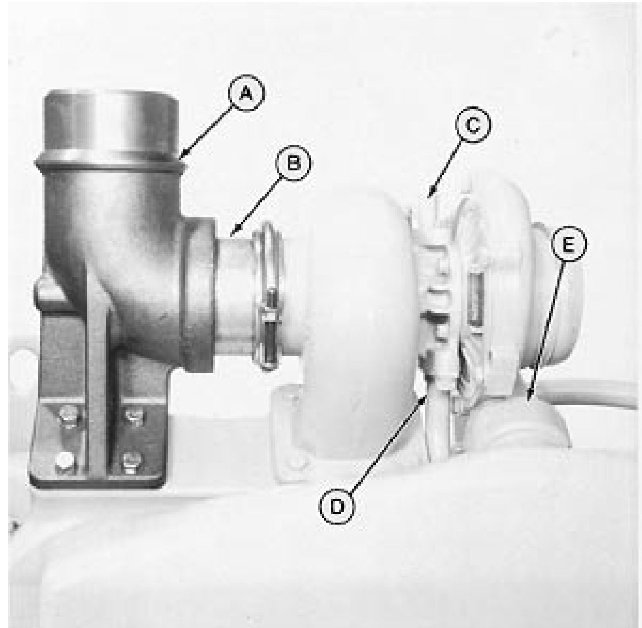
6. Install exhaust adapter (B) to turbine housing outlet with V-band clamp. Tighten clamp to 20 N·m (15 lb-ft).

7. Install exhaust elbow (A). Apply PT569 NEVER-SEEZ Compound to mounting cap screws and tighten to 24 N·m (18 lb-ft).

8. 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. DO NOT crank engine longer than 30 seconds at a time to avoid damage to starting motor.

9. Start and run engine at low idle while checking oil inlet and air piping connections for leaks.



A—Exhaust Elbow
B—Exhaust Adapter
C—Oil Inlet Line
D—Oil Drain Tube
E—Coupling

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RG,CTM42,G30,39-19-24MAR95

REMOVE, INSPECT, AND INSTALL INTAKE MANIFOLD (6076T AND 6076H ENGINES)

IMPORTANT: All intake manifold connections at the turbocharger and engine cylinder head must be tight to prevent loss of power resulting from lower manifold pressure.

Intake manifold hose and cap screw connections should be inspected periodically for tightness.

Whenever a tune-up has been performed on the engine, or whenever it is suspected that the horsepower output might be low, the intake manifold pressure (turbocharger boost should be checked. (See Group 110.)

NOTE: On 6076 HRW 33, 34, and 35 Engines, the exhaust manifold must be removed before removing intake manifold.

1. On 6076T engines, loosen hose clamps (A) on lower air intake hose.

2. On 6076H engines, remove connections from compressor outlet and intake manifold.

3. Disconnect aneroid line, if equipped.

4. Disconnect ether starting aid pipe from manifold, if equipped.

5. Remove six manifold mounting cap screws and intake manifold.

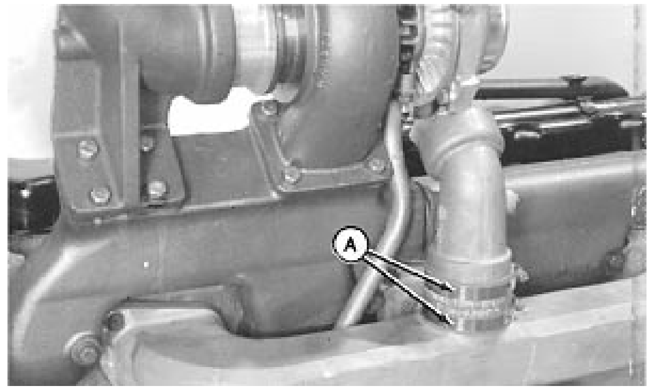
6. Inspect the intake manifold for serviceability. Replace if it is cracked or otherwise damaged.

7. Inspect the machined mating surfaces of cylinder head and intake manifold. Clean, as required, by using a scraper and/or wire brush, and compressed air.

8. To install intake manifold, reverse removal procedures and use new gaskets.

9. Make sure air intake hose is in good condition. Tighten hose clamps to 9—13 N·m (12—17 lb-ft) (146—203 lb-in.).

10. Tighten intake manifold attaching cap screws to 47 N·m (35 lb-ft).



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RG,CTM42,G30,40-19-14FEB95

REMOVE VERTICALLY-MOUNTED AFTERCOOLER AND INTAKE MANIFOLD (6076A ENGINES)

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Wait until engine coolant is cool enough to touch with bare hands before draining. Slowly loosen radiator cap to first stop to relieve pressure.

NOTE: On some applications, aftercooler may be mounted horizontally on engine. Specifications are the same regardless of how aftercooler is mounted.

1. Open water pump and block drain valves to completely drain engine coolant.

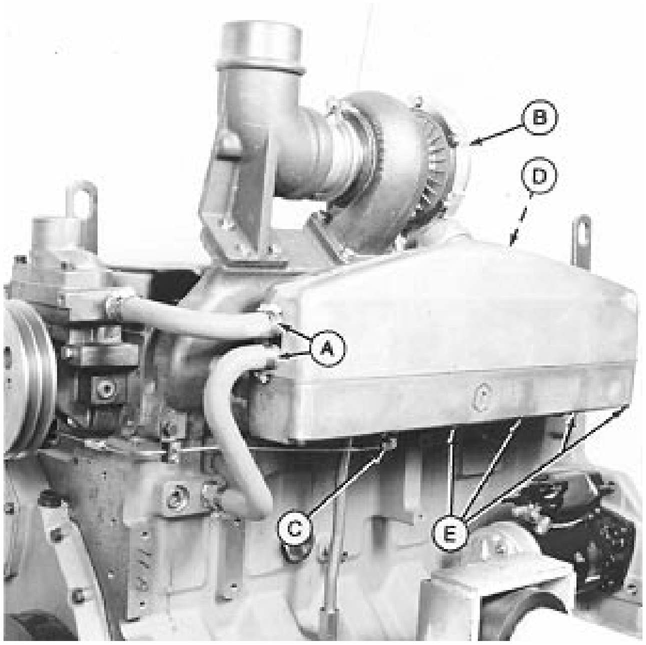
2. Thoroughly clean exterior of turbocharger (B), intake manifold and adjacent areas to prevent entry of dirt into the engine when parts are removed.

3. Remove turbocharger as described earlier in this group.

4. Loosen clamps (A) on inlet and outlet hoses. Remove coolant hoses from aftercooler.

5. Remove aneroid-to-intake manifold connector (C) and ether starting aid pipe (D), if equipped.

6. Remove air intake cover cap screws (E).



RG5861 -UN-13AUG91

A—Clamps
B—Turbocharger
C—Aneroid-to-Intake Manifold Connector
D—Ether Starting Aid Pipe
E—Air Intake Cover Cap Screws

RG,CTM42,G30,44-19-29OCT92

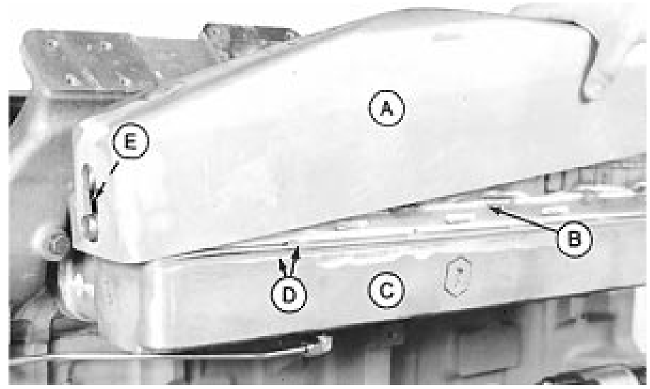
30
23

7. Carefully lift air intake cover (A) from intake manifold (C).

8. Remove aftercooler (B).

9. Remove and discard gaskets (D).

10. Inspect aftercooler end seal (E) and replace as needed.



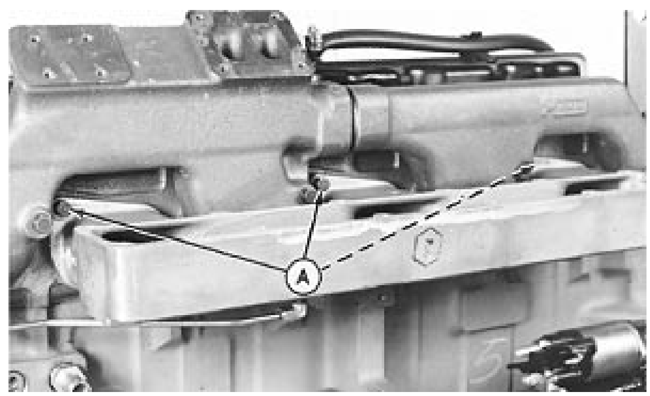
RG5862 -UN-13AUG91

A—Air Intake Cover
B—Aftercooler
C—Intake Manifold
D—Gaskets
E—Aftercooler End Seal

RG,CTM42,G30,45-19-23SEP91

11. Remove the six intake manifold-to-cylinder head cap screws (A) and remove intake manifold. Remove and discard all manifold gaskets.

12. Inspect and repair aftercooler. See INSPECT AND REPAIR AFTERCOOLER (6076A ENGINES), later in this group.



RG5863 -UN-13AUG91

RG,CTM42,G30,46-19-29OCT92

REMOVE AND DISASSEMBLE HORIZONTALLY-MOUNTED AFTERCOOLER ASSEMBLY (6076A ENGINES)

NOTE: On some applications, aftercooler may be mounted vertically on engine. Specifications are the same regardless of how aftercooler is mounted.

1. Completely drain engine coolant from aftercooler.

2. Disconnect turbocharger oil inlet (A) and return (B) lines.

3. Remove four turbocharger-to-exhaust manifold cap screws.

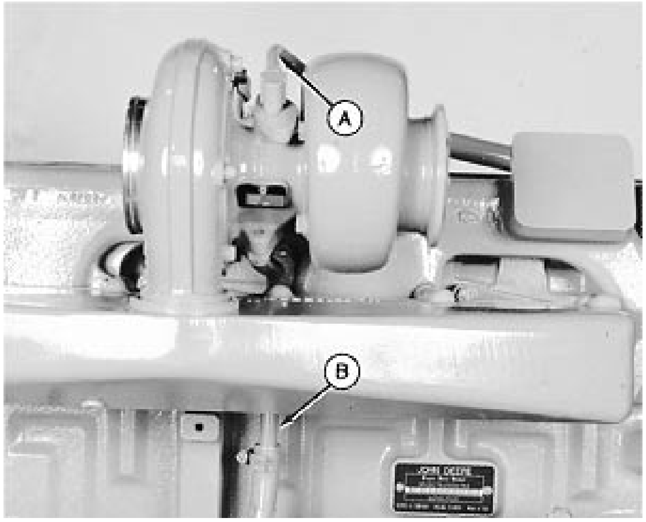
4. Remove coolant inlet and outlet hoses (C) from aftercooler.

5. Remove top three intake manifold cap screws. Install guide studs at the three locations. Remove remaining cap screws.

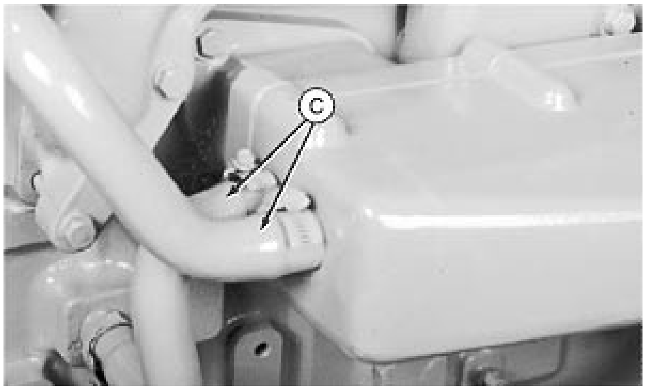
6. Remove intake manifold and aftercooler as an assembly.

7. Remove and discard intake manifold gaskets.

8. Remove turbocharger from aftercooler cover.



RG6486 -UN-26OCT92



RG6487 -UN-26OCT92

RG,CTM42,G30,55-19-29OCT92

9. Install JDG683 Sealing Ring Compression Tool (A) onto aftercooler coolant tubes with cross bar across slot.

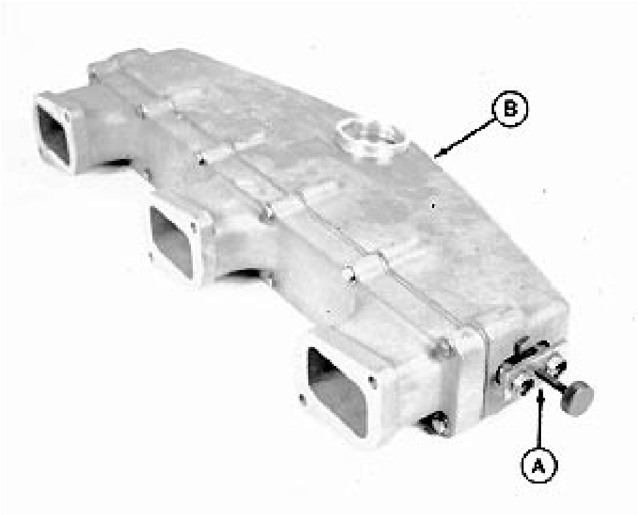
10. Remove intake manifold cover (B).

11. Remove JDG683 tool.

12. Remove aftercooler core from intake manifold.

13. Inspect aftercooler end seal and replace as needed.

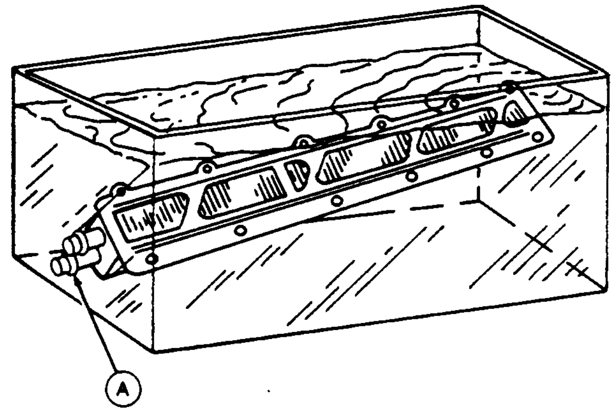
14. Inspect and repair aftercooler. See INSPECT AND REPAIR AFTERCOOLER (6076A ENGINES), as described earlier in this group.



RG6488 -UN-26OCT92

RG,CTM42,G30,59-19-29OCT92

INSPECT AND REPAIR AFTERCOOLER (6076A ENGINES)



1. Inspect aftercooler for overall condition. The fins should be reasonably straight, and cross straps should be free of cracks.

2. Inspect aftercooler inlet and outlet hoses. Replace either hose if cracked or damaged.

3. Test the aftercooler for leaks by plugging one of the tubes (A).

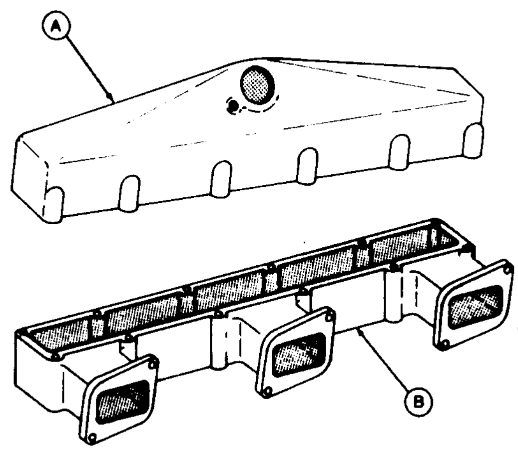
4. Apply compressed air to the other tube while unit is submerged under water. Use 140—170 kPa (1.4—1.7 bar) (20—25 psi) air pressure for testing.

IMPORTANT: Coolant leakage from the aftercooler may cause severe engine damage.

A minor leak that is accessible may be repaired. However, if the condition of the core is questionable, replace the aftercooler.

RG,CTM42,G30,47-19-29OCT92

INSPECT AND REPAIR INTAKE MANIFOLD AND AIR INTAKE COVER (6076A ENGINES)



1. Inspect air intake cover (A) for cracks or damage. Replace as necessary.

2. Check intake manifold (B) for damage. Inspect machined mounting surfaces for burrs or other defects which might prevent gaskets from sealing properly. Repair as required.

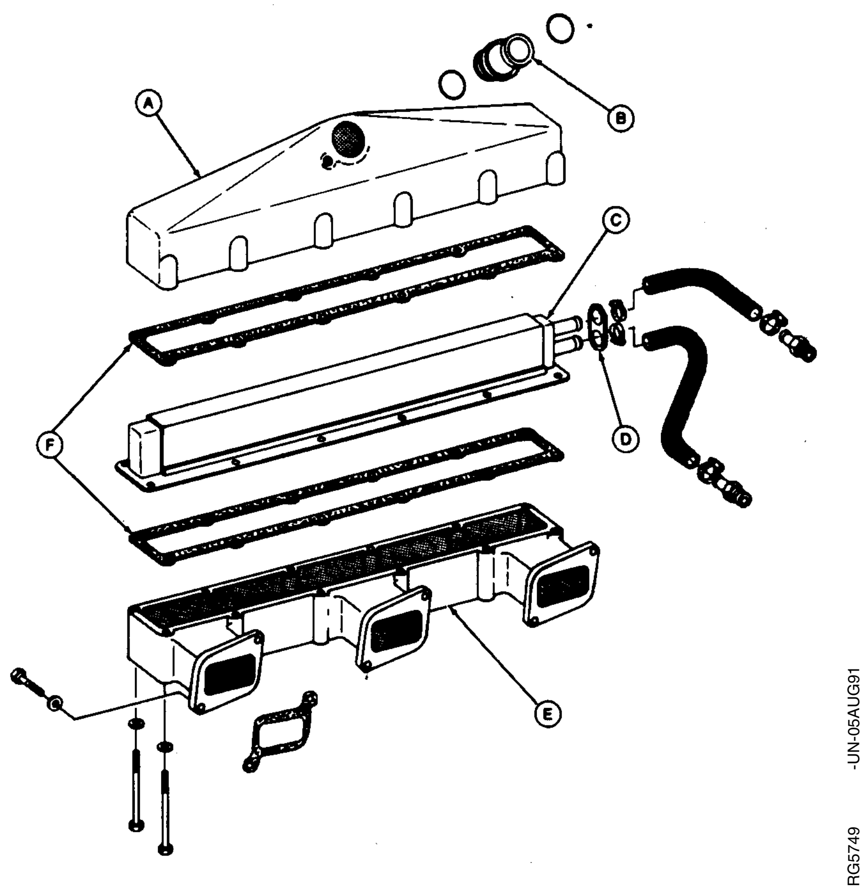
3. Thoroughly steam clean interior of intake manifold and covers.

IMPORTANT: Do not use a hot tank to clean aluminum parts as damage and severe deterioration can occur.

4. Scrape all gasket material from cylinder head and intake manifold mounting surfaces.

RG,CTM42,G30,48-19-29OCT92

INSTALL INTAKE MANIFOLD AND VERTICALLY-MOUNTED AFTERCOOLER (6076A ENGINES)



A—Air Intake Cover
B—Intake Coupling
C—Aftercooler
D—End Seal
E—Intake Manifold
F—Gasket (2 used)

6076A Engine—Two-Pass Aftercooler

Apply PT569 NEVER-SEEZ Compound to all aftercooler cover-to-intake manifold cap screws before assembly.

RG,CTM42,G30,49-19-29OCT92

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IMPORTANT: Debris left in intake manifold can cause engine damage. Make sure that the inside of manifold is clean before assembly.

1. Install the intake manifold on cylinder head using new gaskets.

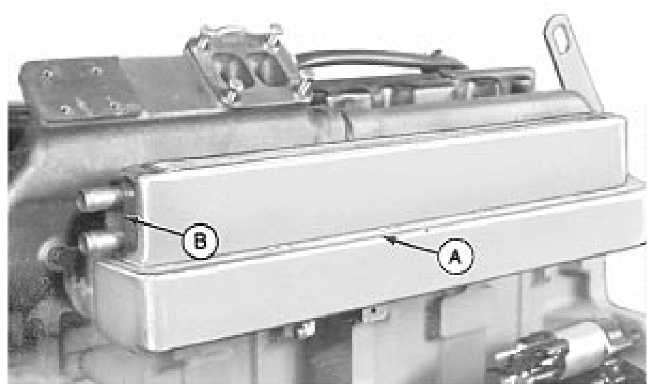
2. Tighten the six cap screws (A) to 47 N·m (35 lb-ft).

RG,CTM42,G30,50-19-23SEP91

3. Install a new gasket (A) on top of intake manifold.

4. Install aftercooler end seal (B) on inlet and outlet tubes.

5. Install aftercooler on top of intake manifold. Put a new gasket on top of aftercooler. Carefully align cap screw holes in aftercooler, intake manifold, and gaskets.



RG5864 -UN-13AUG91

RG,CTM42,G30,51-19-29OCT92

6. Install air intake cover (A) over aftercooler so inlet and outlet tubes are protruding through hole in cover.

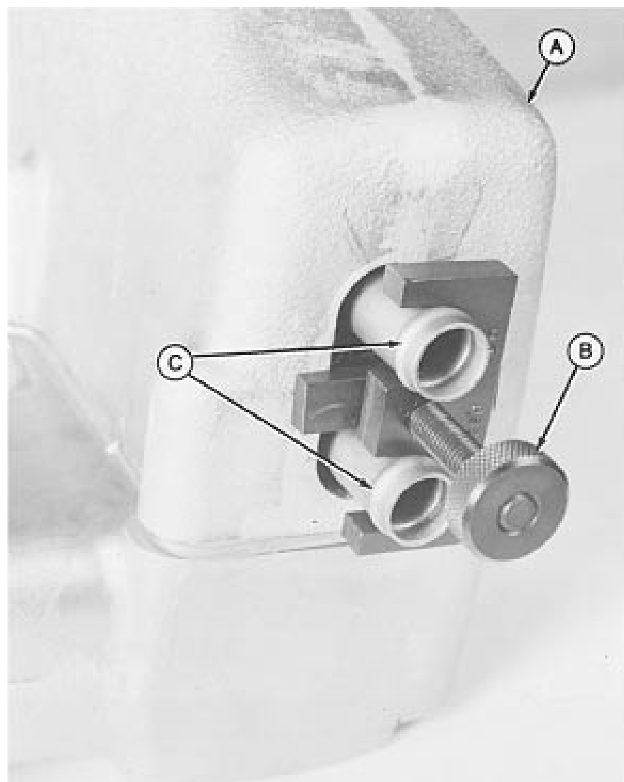
IMPORTANT: Improperly seated or crimped end seal can result in loss of power and possible engine damage. Make sure end seal is properly seated.

7. Install JDG683 Sealing Ring Compression Tool (B) onto aftercooler coolant tubes (C) with crossbar across slot as shown.

8. Tighten tool until air intake cover cap screw holes are aligned with holes in gaskets, aftercooler, and intake manifold.

IMPORTANT: All intake manifold and aftercooler connections at the turbocharger and engine cylinder head must be tight to prevent loss of power resulting from lower manifold pressure, and possible engine damage.

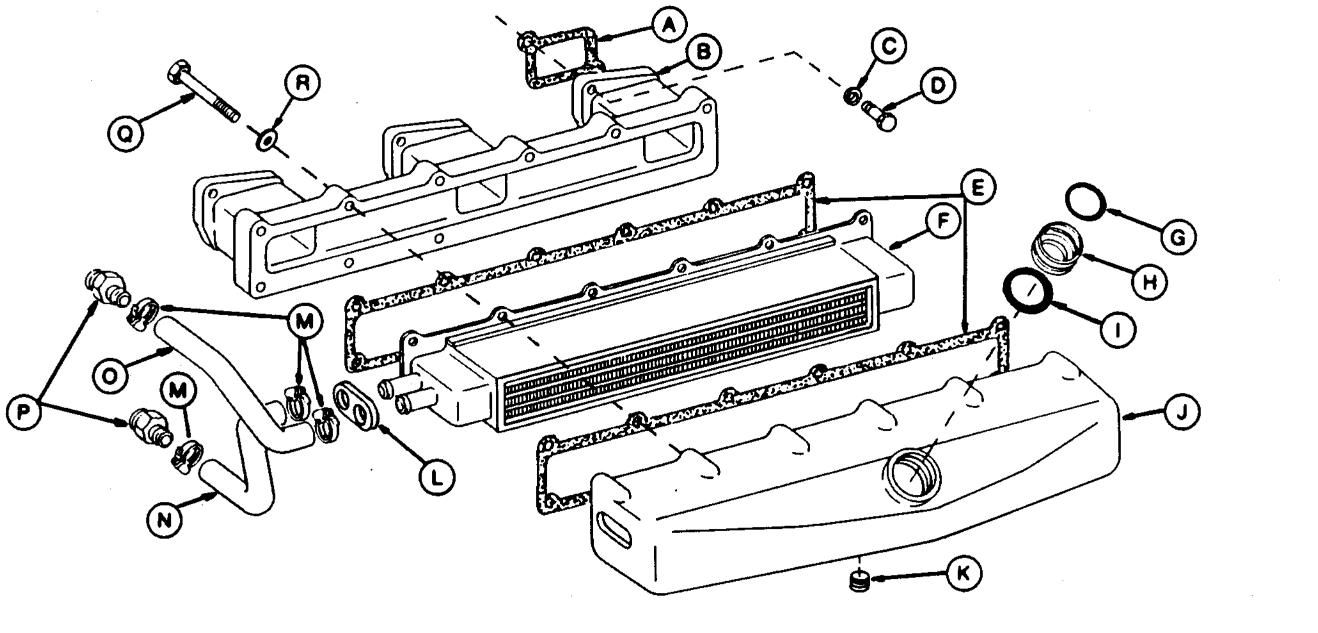
9. Apply PT569 NEVER-SEEZ to all intake manifold-to-aftercooler cover cap screws. Install cap screws and tighten to 34 N·m (25 lb-ft). Remove seal compression tool.



RG5570 -UN-09JAN90

RG,CTM42,G30,52-19-14FEB95

ASSEMBLE AND INSTALL HORIZONTALLY-MOUNTED AFTERCOOLER ASSEMBLY (6076A ENGINES)



A—Gasket (3 Used)
B—Intake Manifold
C—Washer (6 Used)
D—Cap Screw (6 Used)
E—Gasket (2 Used)
F—Aftercooler Core
G—O-Ring
H—Intake Coupler
I—O-Ring
J—Aftercooler Cover
K—Pipe Plug
L—End Seal
M—Clamps (4 Used)
N—Hose
O—Hose
P—Nipple (2 Used)
Q—Cap Screw (12 Used)
R—Washer (12 Used)

IMPORTANT: Improperly seated or crimped aftercooler end seal can result in loss of power and possible engine damage. Make sure end seal is properly seated.

1. Install aftercooler end seal on coolant tubes.

IMPORTANT: Debris left in intake manifold can cause engine damage. Make sure that inside of manifold is clean before assembly.

2. Position aftercooler core into intake manifold using new gaskets.

3. Install JDG683 Sealing Ring Compression Tool onto aftercooler coolant tubes with cross bar across slot.

4. Tighten tool until intake manifold cover cap screw holes are aligned with holes in gaskets, aftercooler, and intake manifold. Use guide studs as needed to hold alignment.

5. Apply PT569 NEVER-SEEZ Compound to all aftercooler cover-to-intake cap screws. Tighten cap screws to 34 N·m (25 lb-ft). Remove seal compression tool.

6. Apply multi-purpose grease to turbocharger compressor O-ring and install turbocharger onto aftercooler cover.

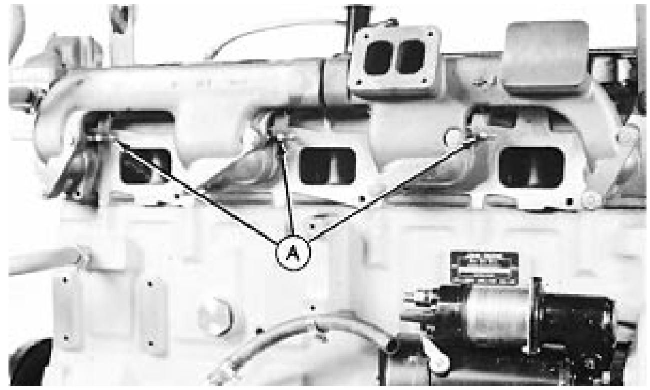
7. Install three guide studs (A) in locations shown.

IMPORTANT: All intake manifold connections must be tight to prevent loss of power resulting from lower manifold pressure, and possible engine damage.

8. Using new gaskets, install aftercooler assembly to cylinder head. Tighten cap screws to 47 N·m (35 lb-ft).

9. Connect coolant inlet and outlet hoses to aftercooler and tighten clamps.

10. Connect turbocharger oil inlet and return lines.



RG6490 -UN-26OCT92

RG,CTM42,G30,58-19-29OCT92

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REMOVE, INSPECT, AND INSTALL EXHAUST MANIFOLD

NOTE: On 6076 HRW 33, 34, and 35 Engines, exhaust manifold can be removed without removing intake manifold.

1. Remove turbocharger, air intake and manifold assembly as described earlier in this group.

2. Remove turbocharger oil return pipe (D).

3. Remove cap screws and lift off front exhaust manifold (A) and rear exhaust manifold (B).

4. Remove and discard front-to-rear exhaust manifold sealing ring (C).

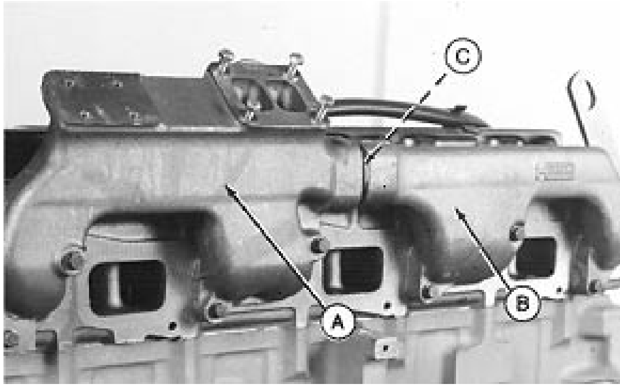
5. Remove all residue and gasket material from gasket surfaces.

6. Thoroughly clean passages in exhaust manifolds and exhaust elbow.

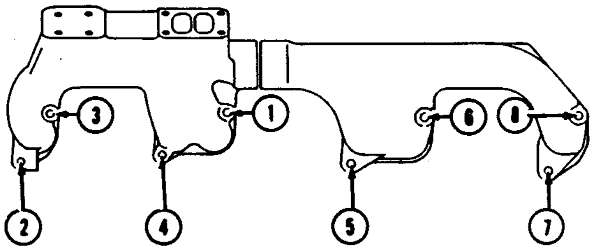
7. Inspect each exhaust manifold for cracks or damage. Inspect machined mounting surfaces for burrs or other defects which might prevent gaskets from sealing properly. Replace parts as necessary.

8. To install exhaust manifold, reverse removal procedure and use new gaskets.

9. Coat exhaust manifold cap screws with PT569 NEVER-SEEZ Compound and tighten to 47 N·m (35 lb-ft) in sequence as shown.



RG5865 -UN-13AUG91



RG6338 -UN-03AUG92

A—Front Exhaust Manifold
B—Rear Exhaust Manifold
C—Sealing Ring
D—Turbocharger Oil Return Pipe

RG,CTM42,G30,53-19-14FEB95

SPECIAL OR ESSENTIAL TOOLS

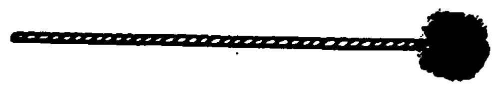
NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-05JUN91

RG5099 -UN-23AUG88

Nozzle Thread Cleaning Brush D17030BR

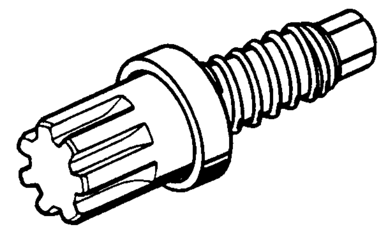
Used to clean nozzle threads in cylinder head.



S53,D17030,BR -19-16FEB87

Flywheel Turning Tool JDG820

Used to rotate engine to check damper radial runout and time engine. JDE81-1 may be used also if JDG820 is not available.



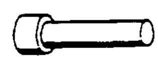
RG7056 -UN-10AUG94

RG,JDG820 -19-14FEB95

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Lock engine at TDC when timing valve train, adjusting valve clearance, and installing fuel injection pump. Use with JDG820 and JDE81-1 Flywheel Turning Tools.

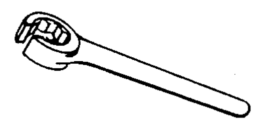


RG,JDE814,86 -19-14FEB95

RG5290 -UN-15OCT92

Serrated Wrench JDE90

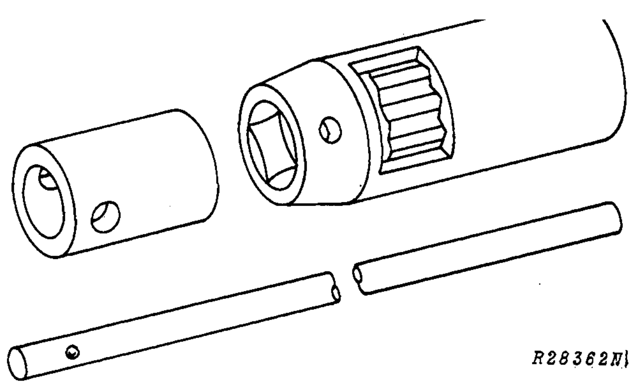
Use to hold injection pump fuel outlet fittings on Bosch “P” pump from turning when loosening and tightening fuel pipe connections.



S54,JDE90 -19-29OCT92

Nozzle Socket JDE92

Used to remove and install 21 mm injection nozzles.



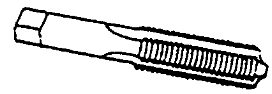
R28362N -UN-20DEC88

S11,3010,OU -19-16AUG94

RG5100 -UN-23AUG88

Tap JDF5

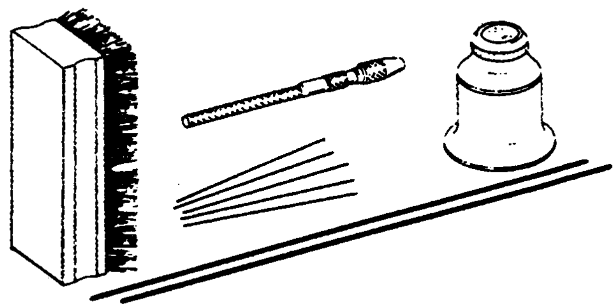
Used to restore nozzle threads in cylinder head.



S53,JDF5 -19-08MAR94

Nozzle Cleaning Kit JDF13 (JDE105)

Used to clean injection nozzles.

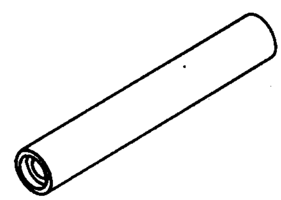


RG4953 -UN-14DEC88

S11,3010,OW -19-09SEP91

Driver JDF15

Used to install spindle seals in fuel supply pumps.



RG2017

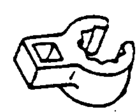
RG2017 -UN-30NOV88

S55,3010,BA -19-25JUL91

RG5288 -UN-23AUG88

Crowsfoot Wrench JDF22

Use to loosen and tighten fuel pipes at injection nozzles and at injection pump.



S53,JDF22,1 -19-02DEC87

RG5287 -UN-23AUG88

Special Socket JDF33

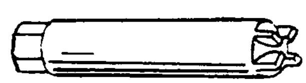
Used to loosen and tighten fast idle stop screw on Nippondenso injection pumps when adjusting engine speeds.

S53,JDF33 -19-02DEC87

RG5289 -UN-23AUG88

Nozzle Seat Reamer JDG609

Used to clean carbon from nozzle seats in cylinder head.

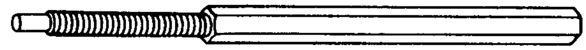


S53,JDG609 -19-02DEC87

RG7212 -UN-23JUL94

Injection Pump Timing Pin JDG886

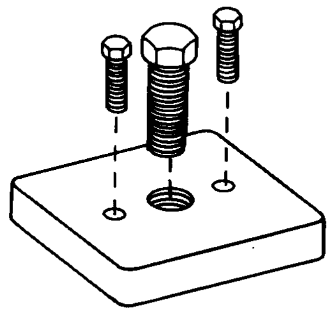
Used to set in-line fuel injection pump timing prior to removal of pump.



RG,JDG886 -19-10AUG94

Injection Pump Drive Gear Puller JDG670A

Remove drive gear from tapered shaft on Stanadyne DB4 fuel injection pumps.



RG6032 -UN-13JAN92

RG,JDG670A,400 -19-02OCT92

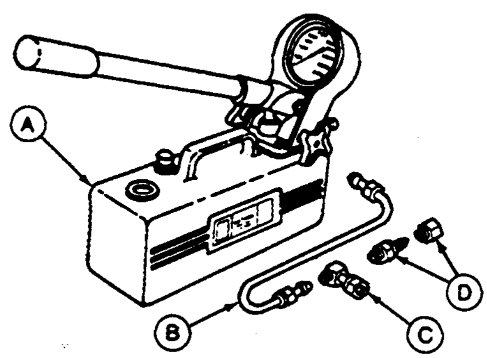
A—Fuel Injection Nozzle Tester . . . D01109AA (Y900)

B—Fuel Line Assembly Y900-2A*

C—Adapter Nut Y900-21**

D—Straight Adapters . . . . Y900-7* and Y900-15*

Used to test operational performance and opening pressure of nozzles.



RG4954 -UN-14DEC88

Included in D01110AA (Y910A) Adapter Set.

***May be used instead of Y900-7 and Y900-15.*

S11,3010,OX -19-09SEP91

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OTHER MATERIAL

Name	Use
AR54749 Soap Lubricant	Injection pump mounting flange O-ring.
PT569 NEVER-SEEZ Compound	Gland nut threads and fuel injection nozzle barrel.
LOCTITE 242 (TY9370/T43512) Thread Lock and Sealer	Injection pump timing hole plug.
LOCTITE 592 (TY9374/TY9375) Pipe Sealant with TEFLON	Fuel filter drain plug and bleed plug.

RG,CTM42,G35,76-19-15SEP94

DIESEL FUEL SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION
Engine Operating Speeds	See Applicable Machine TM
Injection Pump Timing to Engine	TDC
Hydraulic Aneroid Activator Operating Pressure (If Equipped)	100 kPa (1.0 bar) (14.5 psi)
Overflow Valve Opening Pressure	130—180 kPa (1.3—1.8 bar) (19—26 psi)
Fuel Injection Nozzles	21 mm
New Nozzle Opening Pressure (for tip sizes) 7 x 0.22 mm, 7 x 0.23 mm, 7 x 0.255 mm	29 000—30 200 kPa (290—302 bar) (4200—4370 psi)
Used Nozzle Minimum Opening Pressure (for tip sizes) 7 x 0.22 mm, 7 x 0.23 mm, 7 x 0.255 mm	26 200 kPa (262 bar) (3800 psi)
Injection Pump Static Timing: In-Line Pumps (Robert Bosch/Nippondenso)	Lock No. 1 cylinder at TDC compression stroke. Align mark on injection pump drive hub with pointer mark. Install pump, recheck alignment of marks.
Rotary Pumps (Stanadyne)	Lock No. 1 cylinder at TDC compression stroke. Align marks on injection pump mounting flange with factory (dynamic) timing mark on cylinder block.

RG,CTM42,G35,1 -19-16AUG94

DIESEL FUEL SYSTEM SPECIFICATIONS—CONTINUED

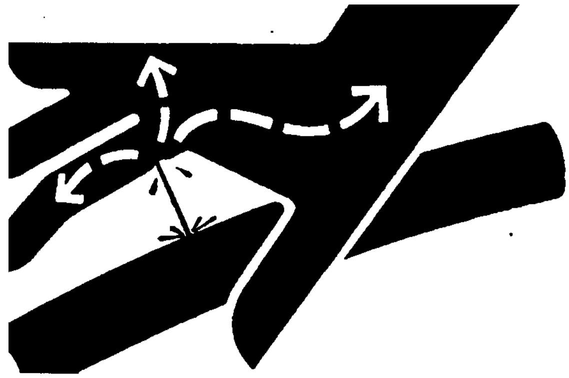
TORQUES

Injection Pump-to-Cylinder Block Stud Nuts	47 N·m (35 lb-ft)
Injection Pump Drive Gear-to-Pump Hub Cap Screws:	
A-Series Injection Pumps*	47 N·m (35 lb-ft)
P-Series Injection Pumps*	61 N·m (45 lb-ft)
Injection Pump Drive Gear-to-Tapered Shaft Hex Nut:	
Stanadyne DB4 Injection Pumps	142 N·m (105 lb-ft)
Injection Line Connectors	27 N·m (20 lb-ft)
Nozzle Gland Nut-to-Cylinder Head	88 N·m (65 lb-ft)
Nozzle Retaining Nut	60—79 N·m (44—68 lb-ft)
Supply Pump Mounting Stud Nuts	5—7 N·m (4—5 lb-ft)(45—60 lb-in.)
Leak-off Connectors	17 N·m (13 lb-ft)(150 lb-in.) Max.
Fuel Filter Base-to-Cylinder Block	34—54 N·m (25—40 lb-ft)
Fuel Pipe Connections at Filter Base	17 N·m (13 lb-ft)(150 lb-in.) Max.
Injection Pump Drive Gear Cover Cap Screws	27 N·m (20 lb-ft)
Fuel Shutoff Solenoid Bracket-to-Oil Filter Housing Cap Screws	23 N·m (17 lb-ft)
Fuel Shutoff Solenoid-to-Bracket Hex Nuts	7 N·m (5 lb-ft)(60 lb-in.)

*Refer to IDENTIFICATION OF IN-LINE INJECTION PUMPS later in this group.

RG,CTM42,G35,98-19-17MAR95

RELIEVE FUEL SYSTEM PRESSURE



X9811 -UN-23AUG88

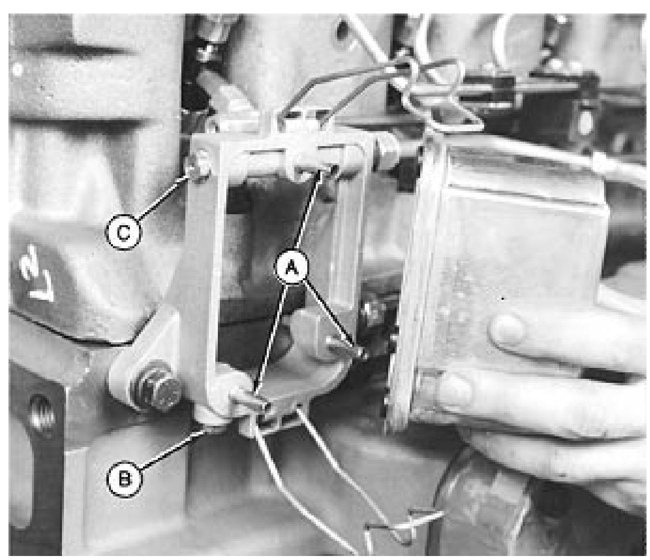
CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin, causing serious injury. Before disconnecting lines, be sure to relieve pressure. Before applying pressure to the system, be sure ALL connections are tight and lines, pipes and hoses are not damaged. Keep hands and body away from pinholes and and nozzles which eject fluid under pressure. 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. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

Any time the fuel system has been opened up for service (lines disconnected or filters removed), it will be necessary to bleed air from the system. (See BLEED FUEL SYSTEM in Group 115.)

RG,CTM8,G35,6 -19-29SEP94

REPLACE RECTANGULAR FUEL FILTER ELEMENT



RG5866 -UN-19AUG91

NOTE: Refer to your operator's manual for proper servicing and replacement (hourly) intervals.

1. Close fuel shut-off valve at bottom of fuel tank (not illustrated).

2. Loosen bleed plug (C) and remove drain plug (B). Drain fuel from filter.

3. With fuel filter firmly against base, lift up on top retaining spring and pull down on bottom retaining spring. Pull fuel filter off guide pins (A) of fuel filter base and discard.

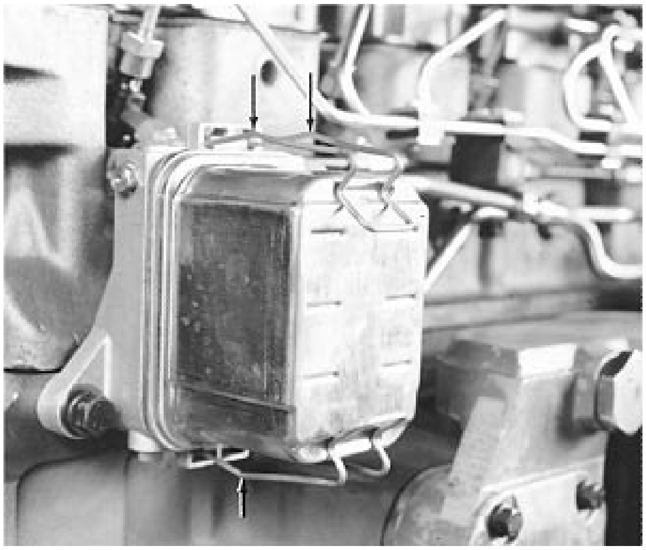
RG,CTM42,G35,2 -19-03OCT92

4. Install fuel filter onto guide pins on fuel filter base. Hold filter firmly against base.

5. Secure bottom retaining spring first, then secure top retaining spring.

6. Install drain plug, shown installed. Tighten bleed plug and drain plug securely. Do not overtighten.

7. Open fuel shut-off valve and bleed fuel system. (See BLEED THE FUEL SYSTEM, in Group 115.)



RG5867 -UN-19AUG91

RG,CTM42,G35,3 -19-03OCT92

REPLACE FUEL CHECK VALVE

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 (A) as described earlier in this group.

2. Remove fuel filter inlet line (B), (shown removed).

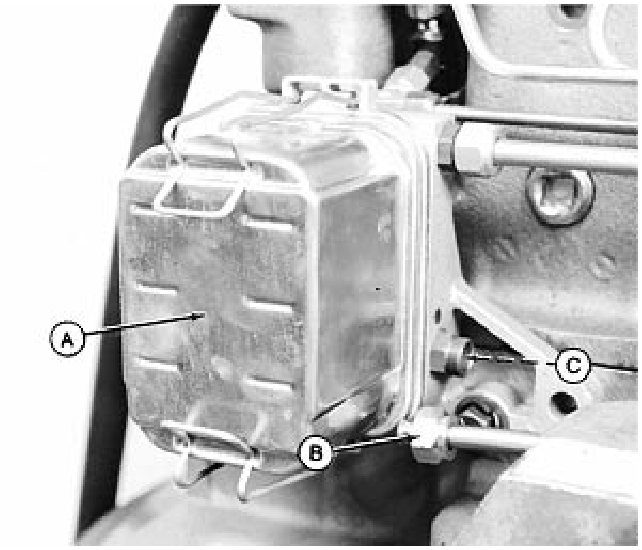
3. Inspect and clean fuel filter base as described later in this group.

4. Remove check valve adapter housing (C) from fuel filter base, and discard.

5. Install new check valve assembly and tighten securely.

6. Install fuel inlet line and tighten connection 17 N·m (13 lb-ft)(150 in-lb) maximum. DO NOT overtighten.

7. Install fuel filter and bleed fuel system. (See BLEED THE FUEL SYSTEM, in Group 115.)



RG5868 -UN-19AUG91

RG,CTM42,G35,4 -19-17MAR95

REPLACE ROUND FUEL FILTER ELEMENT

1. Thoroughly clean exterior of filter element (C) and base (A). Also clean around filter mounting area on block.

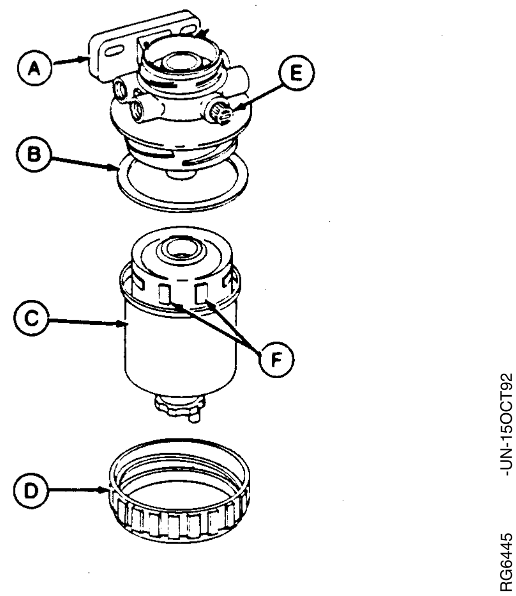
2. Rotate retaining ring (D) counterclockwise (left) 1/4 turn. Lifting ring as it is rotated helps to get it past retaining detent. Ring should now drop down and release filter from base.

NOTE: Notice indexing keys (F) on filter element. These keys insure proper alignment of filter element to filter base.

3. Index filter element until longer, vertical keys are oriented away from engine. Insert filter element into base securely. It may be necessary to rotate filter slightly to left or right for correct alignment.

4. Install retaining ring to filter base, making certain dust seal (B) is in place on filter base. Tighten retaining ring until it locks into detent position.

5. Loosen bleed screw (E) and bleed fuel system. (See BLEED THE FUEL SYSTEM, in Group 115.)



A—Filter Element Base
B—Dust Seal
C—Filter Element
D—Retaining Ring
E—Bleed Screw
F—Indexing Keys

RG,CTM42,G35,91-19-28OCT92

IDENTIFICATION OF MECHANICAL FUEL SUPPLY PUMPS

RG2170 -UN-23APR94

NOTE: 6076TRW31 engines are epuipped with Stanadyne DB4 rotary-style injection pump which uses an electric fuel supply pump, all other 6076 engines are equipped with an in-line injection pump (Bosch or Nippondenso) and mechanical supply pump.

Mechanical fuel supply pumps mount onto the side of the in-line injection pump. A tappet on the supply pump is activated by the injection pump rotating cam during engine revolution. The tappet on the supply pump may be either a roller-type tappet (Nippondenso) or a flat plunger-type tappet (Bosch). The type of tappet can be determined visually, when the fuel supply pump is removed, or by the “size of injection pump” indicator in the pump model number.

FUEL SUPPLY PUMP IDENTIFICATION NUMBER

FP/KE22AD290

FP	Fuel Supply Pump
/K	Single-Acting Plunger Pump
E	Pump Driven by Eccentric Cam
22	Diameter of Plunger in mm
A	Size of Injection Pump Used
D	Pump Version
290	Manufacturer’s Design Number

RG,CTM42,G35,92-19-17MAR95

REMOVE MECHANICAL FUEL SUPPLY PUMP

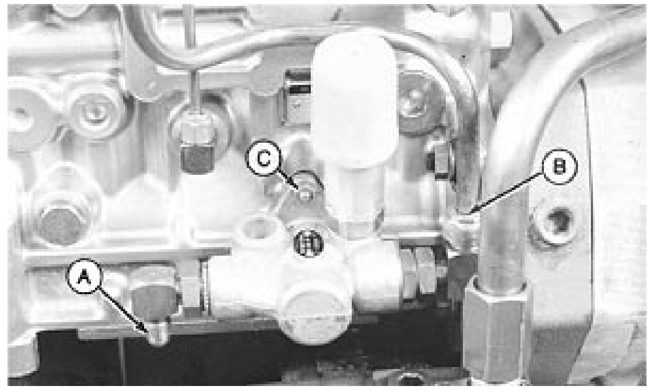
NOTE: To diagnose mechanical fuel supply pump malfunctions or test for leaks, refer to Group 115.

Thoroughly clean exterior of supply pump. Also clean around supply pump mounting area on 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 (C).

3. Pull fuel supply pump straight out from injection pump housing. Cover supply pump mounting bore so debris cannot enter injection pump.



RG5893 -UN-19AUG91

RG,CTM42,G35,8 -19-03OCT92

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TEST MECHANICAL FUEL SUPPLY PUMP FOR LEAKS

RG5894 -UN-19AUG91

Fuel delivery pressure should be checked before removing supply pump from injection pump. (See CHECK MECHANICAL FUEL SUPPLY PUMP OPERATION, in Group 115.)

1. Connect compressed air line (A) to a pressure gauge (B) and to supply pump inlet fitting. 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 (Nippondenso pumps) or spindle (Bosch pumps) in and out by hand. No air bubbles should appear around roller tappet or spindle bore.

NOTE: If bubbles appear, it is an indication that either the O-ring seal is defective or spindle or tappet is worn (or possibly both).

IMPORTANT: Serious injection pump or engine damage could occur, if enough diesel fuel leaks past spindle and seal. Fuel leakage past spindle dilutes engine oil.

RG,CTM42,G35,9 -19-28OCT92

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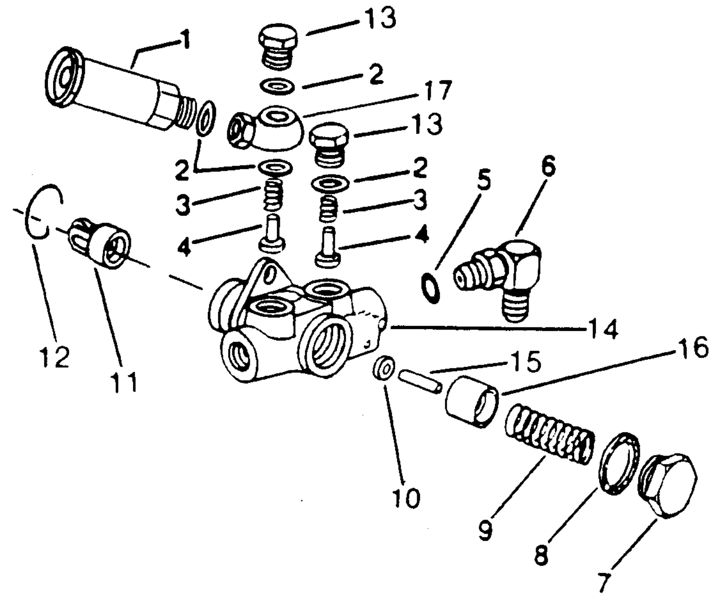
DISASSEMBLE MECHANICAL (ROLLER TAPPET) FUEL SUPPLY PUMP—NIPPONDENSO



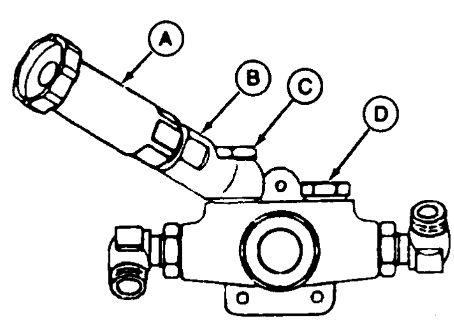
1—Hand Primer
2—Washer (4 used)
3—Spring (2 used)
4—Valve
5—O-Ring (2 used)
6—Elbow Fitting (2 used)
7—Plug
8—Washer
9—Spring
10—O-Ring/Spindle Seal
11—Roller Tappet Assembly
12—Snap Ring
13—Plug
14—Pump Housing
15—Pressure Spindle
16—Plunger
17—Banjo fitting

1. Remove elbow fitting (6) by loosening locknut and unscrewing elbow fitting from pump housing. Remove and discard O-ring (5).

RG,CTM42,G35,10-19-14FEB95

2. Remove hand primer (A), banjo fitting (B), and plug (C) from housing. Discard copper washer.

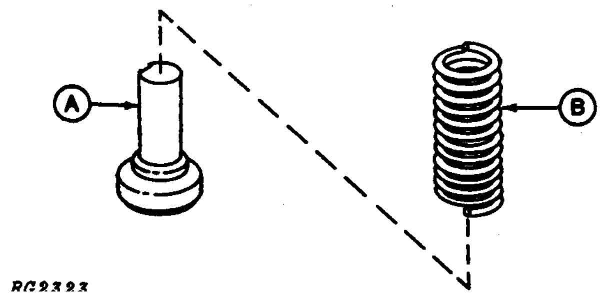
3. Remove plug (D) from housing. Discard copper washers.



A—Hand Primer
B—Banjo Fitting
C—Plug
D—Plug

RG,CTM42,G35,61-19-02NOV92

4. Remove valves (A) and springs (B).



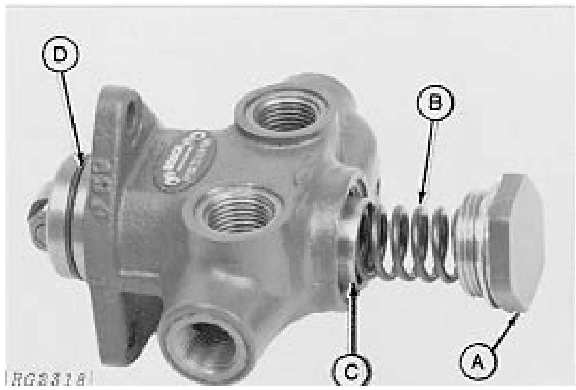
RG,CTM42,G35,62-19-10SEP91

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.

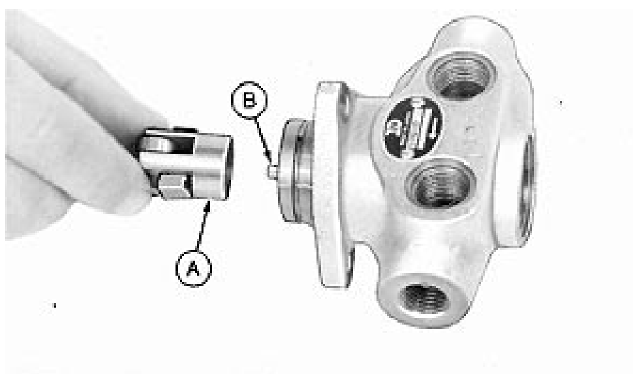
NOTE: Snap ring has a tang on one end which extends vertically down through a hole in pump housing to retain roller tappet assembly.

A—Plug
B—Spring
C—Plunger
D—Snap Ring



S55,3010,Y -19-03OCT92

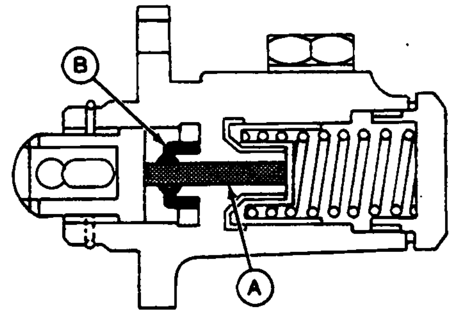
7. Remove roller tappet (A) and spindle (B) from pump housing. Remove and discard O-ring on spindle.



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.



RG4029 -UN-30NOV88

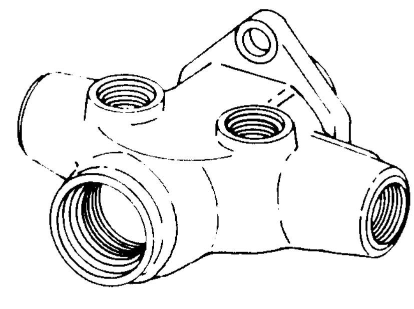
S55,3010,AA -19-03OCT92

INSPECT AND REPAIR MECHANICAL (ROLLER TAPPET) FUEL SUPPLY PUMP COMPONENTS—NIPPONDENSO

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.



RG5902 -UN-19AUG91

RG,CTM42,G35,11-19-14FEB95

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.

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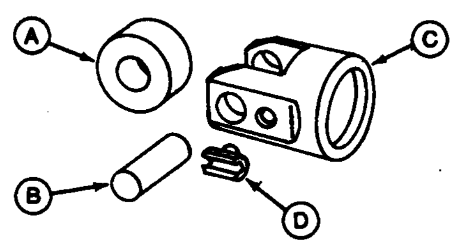
Be sure land on tappet that contacts pressure spindle is flat and undamaged.



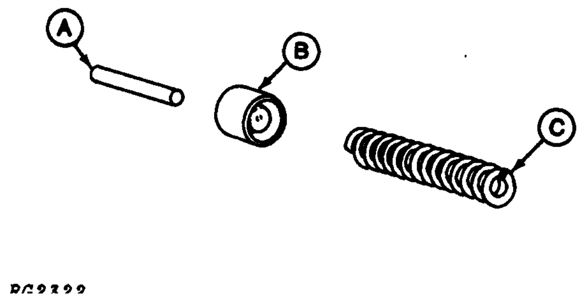
RG2321 -UN-30NOV88

A—Roller
B—Pin
C—Tappet
D—Sliding Block (2 used)

S11,3010,QN -19-24NOV86

7. Inspect pressure spindle (A) and plunger (B) for pits and burrs. Replace parts as necessary.

8. Inspect spring (C) for cracks and distortion. Replace parts as necessary.

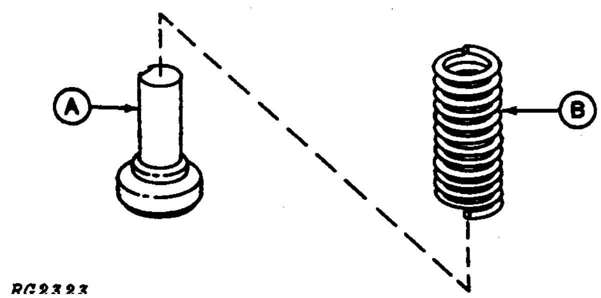


RG2322 -UN-30NOV88

S11,32010,QO -19-24NOV86

9. Inspect valves (A), especially valve face, for cracks, pits and wear. Replace as necessary.

10. Spring (B) should not be bent or broken.



RG2323 -UN-30NOV88

S11,3010,QP -19-24NOV86

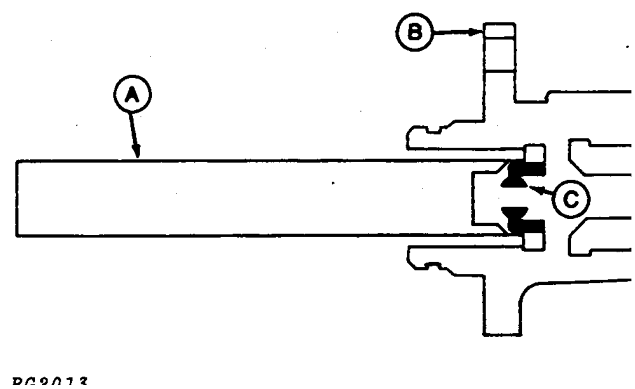
ASSEMBLE MECHANICAL (ROLLER TAPPET) FUEL SUPPLY PUMP—NIPPONDENSO

IMPORTANT: Always use new copper gaskets. Dip parts in clean diesel fuel before assembly. Hands should be wet with diesel fuel when assembling internal components of fuel supply pump.

1. Install new spindle seal (C) into pump housing (B) using JDF15 Driver (A). Be sure seal is started straight in housing bore and drive until driver contacts housing.

2. To assemble supply pump, reverse disassembly procedure using new O-rings.

Perform leak test described in Group 115.



RG2013 -UN-30NOV88

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RG,CTM42,G35,12-19-14FEB95

DISASSEMBLE MECHANICAL (FLAT PLUNGER) FUEL SUPPLY PUMP—ROBERT BOSCH

1. Remove inlet elbow fitting (A) and outlet elbow fitting (B) by loosening locknut and unscrewing fittings from pump housing. Remove and discard O-rings.

2. Remove hand primer (C) from housing. Remove and discard copper washer (D).

A—Inlet Elbow Fitting
B—Outlet Elbow Fitting
C—Hand Primer Pump
D—Copper Washer

RG5909 -UN-19AUG91

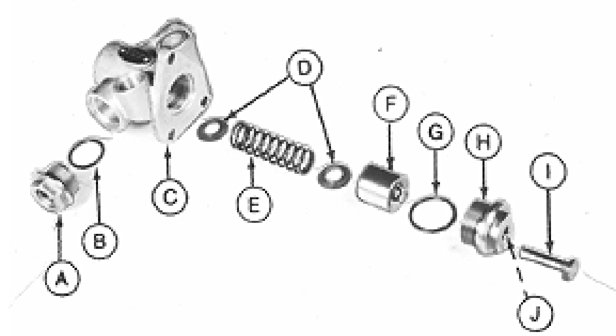
RG,CTM42,G35,63-19-14FEB95

3. Remove fuel pump outlet valve fitting (A) from pump housing (C). Remove and discard O-ring (B).

4. Remove spindle (I) and spindle guide plug (H) by unscrewing guide plug from pump housing. Remove and discard O-rings (J and G).

5. Remove plunger (F), spring wear plates (D), and spring (E).

A—Outlet Valve Fitting
B—O-Ring
C—Supply Pump Housing
D—Spring Wear Plates
E—Spring
F—Plunger Assembly
G—O-Ring
H—Spindle Guide Plug
I—Spindle
J—O-Ring

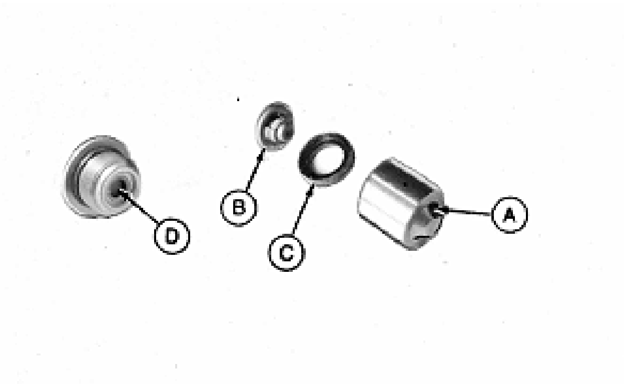


RG5912 -UN-28AUG91

RG,CTM42,G35,64-19-28OCT92

6. Push inlet valve (B) and seal (C) out of plunger (A) by poking rounded end of a small pin through closed end of plunger.

NOTE: The outlet valve is located in outlet valve fitting (D) and is not removable from fitting.



A—Plunger
B—Inlet Valve Seal
C—Inlet Valve
D—Outlet Valve and Fitting

RG,CTM42,G35,65-19-03OCT92

INSPECT AND REPAIR MECHANICAL (FLAT PLUNGER) FUEL SUPPLY PUMP—ROBERT BOSCH

1. Inspect supply pump housing (C) for cracks and wear. Be sure plunger bore is not worn or scored. Check condition of threads for inlet and outlet fittings, hand primer pump, and spindle guide plug (H).

2. Inspect spindle (I) for wear, scoring on OD, and burrs. Check lands that contact plunger and fuel pump cam lobe to be sure they are flat and undamaged. Remove any deposits with a suitable solvent.

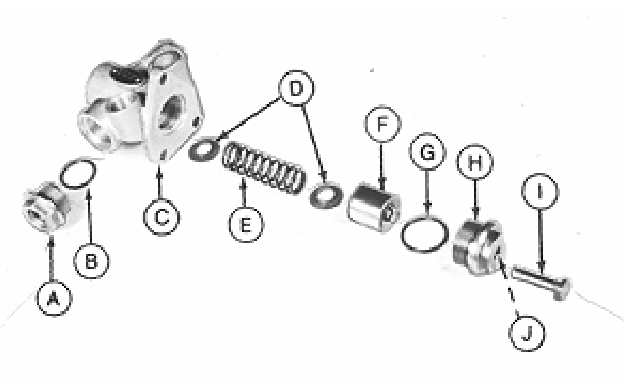
3. Inspect plunger (F) for burrs and pits. Remove any deposits with a suitable solvent.

4. Inspect spring (E) and wear plates (D) for cracks, distortion, and wear.

5. Inspect inlet valve and seal (not shown) for wear, cracks, and broken or missing spring.

6. Inspect outlet valve and fitting (A) for wear, cracks, broken or missing spring, or damaged threads.

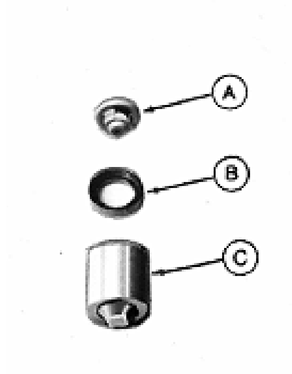
If any of the above parts are damaged, worn, or defective, replace as necessary.



A—Outlet Valve Fitting
B—O-Ring
C—Supply Pump Housing
D—Spring Wear Plates
E—Spring
F—Plunger Assembly
G—O-Ring
H—Spindle Guide Plug
I—Spindle
J—O-Ring

RG,CTM42,G35,66-19-14FEB95

ASSEMBLE MECHANICAL (FLAT PLUNGER) FUEL SUPPLY PUMP—ROBERT BOSCH



RG5946 -UN-28AUG91

IMPORTANT: Always use new copper gaskets and O-rings. Dip parts in clean diesel fuel before assembly. Hands should be wet with diesel fuel when assembling internal components of fuel supply pump.

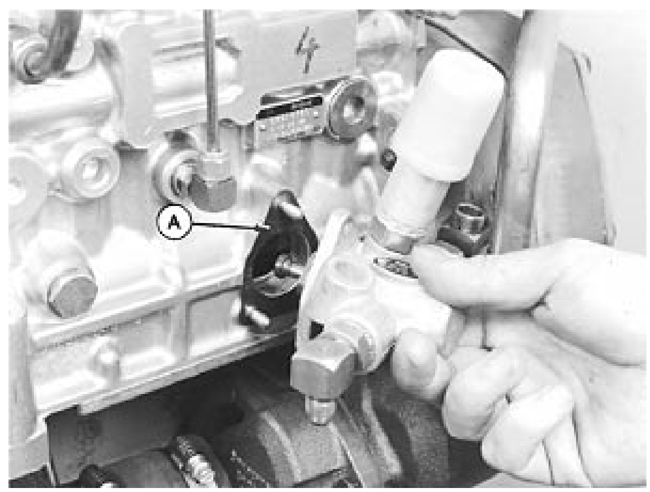
1. Assemble seal (B) into plunger (C) so flat side of seal is against closed end of plunger. Install inlet valve (A) into plunger so spring side of valve protrudes through center of seal and faces toward closed end of plunger.

2. To assemble supply pump, reverse disassembly procedure using new O-rings and copper washer.

Perform leak test described in Group 115.

RG,CTM42,G35,67-19-14FEB95

INSTALL MECHANICAL FUEL SUPPLY PUMP



RG5906 -UN-19AUG91

Bosch pump shown

IMPORTANT: Before installing supply pump, test pump to make sure fuel will not leak around spindle and spindle seal. (See TEST MECHANICAL FUEL SUPPLY PUMP FOR LEAKS, in Group 115.)

1. On Nippondenso (roller tappet) pumps, put a new O-ring in counterbore of injection pump housing next to fuel supply pump mounting face.

On Robert Bosch pumps, install a new gasket on supply pump mounting face (A).

2. Position pump over mounting studs. Tighten mounting stud nuts 5—7 N·m (4—5 lb-ft) (45—60 lb-in.).

3. Install fuel inlet and outlet lines when engine is installed in vehicle. Tighten all connections securely.

4. Bleed fuel system. (See BLEED THE FUEL SYSTEM, in Group 115.)

RG,CTM42,G35,14-19-14FEB95

REMOVE AND INSTALL ELECTRIC FUEL SUPPLY PUMP—6076TRW31 ENGINES

NOTE: Refer to Group 115 for operation and test of electric fuel supply pump.

1. Thoroughly clean exterior of supply pump and mounting area on block.

2. Disconnect fuel inlet line (A) and outlet line (B). Cap all line openings.

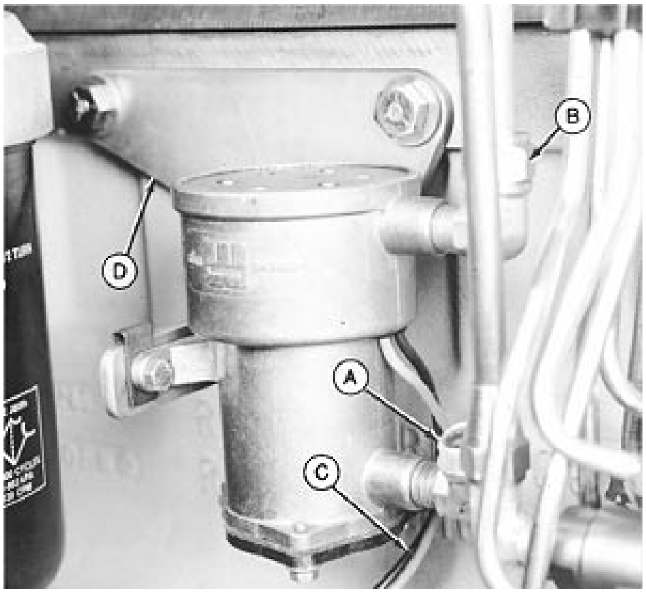
3. Disconnect wiring harness (C) at connector.

4. Remove mounting bracket (D).

5. Remove pump from mounting bracket.

6. To install pump, reverse disassembly procedure. Tighten mounting bracket cap screws to 8.5 N·m (6 lb-ft) (75 lb-in.).

7. Check for leaks during engine operation.



RG6460 -UN-26OCT92

A—Fuel Inlet Line
B—Fuel Outlet Line
C—Wiring Harness
D—Mounting Bracket

RG,CTM42,G35,81-19-17MAR95

CLEAN OR REPLACE ELECTRIC FUEL SUPPLY PUMP FILTER SCREEN—6076TRW31 ENGINES

Electric supply pump filter screen element (B) should be cleaned frequently under normal engine operating conditions. If output flow or pressure is below specifications, it may be result of a partially obstructed filter screen. Refer to operator's manual for recommended hourly maintenance interval.

1. Remove cap screws from cover plate (D). Remove cover and gasket (C) from pump (A).

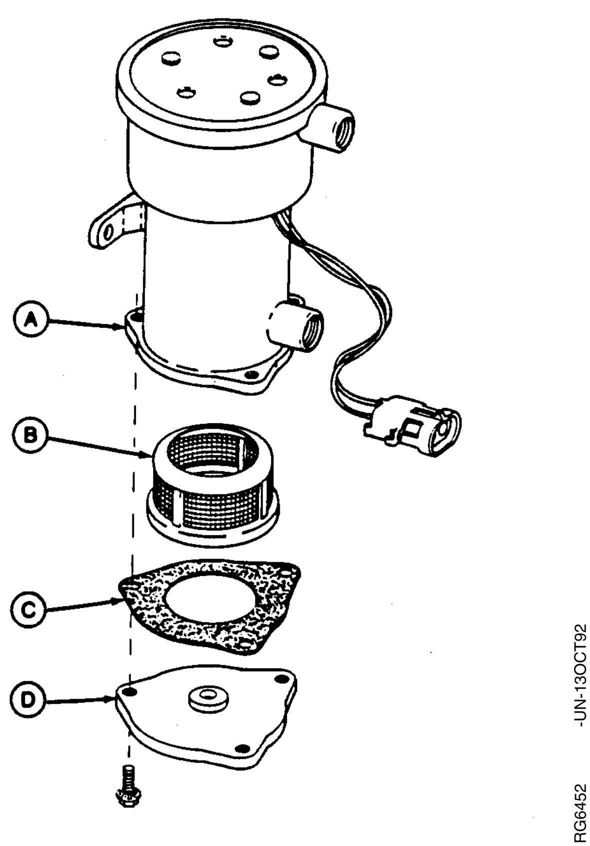
2. With clean hands, remove filter screen from pump.

IMPORTANT: Do not clean or touch screen or inside of pump with cotton cloth. The smallest piece of lint may cause fuel system contamination.

3. Using compressed air, clean by blowing air through filter from inside to outside. If screen is damaged, either by holes or sealing surfaces, it must be replaced.

4. Install screen with flange end of screen against filter plate gasket.

5. Install cover plate.



A—Electric Fuel Supply Pump
B—Filter Screen Element
C—Gasket
D—Cover Plate

RG,CTM42,G35,82-19-17MAR95

REPAIR ANEROID—IF EQUIPPED

For aneroid repair and adjustment, have an authorized diesel repair station perform the work.

The aneroid controls fuel delivery when intake manifold pressure is about 100 kPa (1.00 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 aneroid has been disassembled or adjustments have been altered, injection pump (including aneroid) must be calibrated on test stand before releasing pump for service.

S11,3010,PG -19-14FEB95

REMOVE HYDRAULIC ANEROID ACTIVATOR—IF EQUIPPED

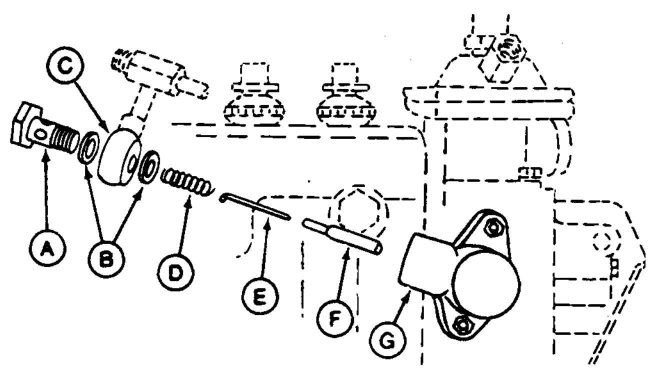
NOTE: The hydraulic aneroid activator is located on back side of governor housing next to cylinder block.

1. Remove injection pump as described later in this group.

2. Remove special screw (A), copper washers (B) and banjo connector (C). Discard copper washers.

3. Remove spring (D), restricter wire (E) and capillary valve (F) from activator housing (G). Remove activator housing.

NOTE: Do not bend restricter wire or other activator parts.



A—Special Screw
B—Copper Washer (2 used)
C—Banjo Connector
D—Spring
E—Restricter Wire
F—Capillary Valve
G—Activator Housing

RG,CTM42,G35,70-19-14FEB95

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21

DISASSEMBLE AND CLEAN HYDRAULIC ANEROID ACTIVATOR PARTS—IF EQUIPPED

1. Remove gasket (G), piston (F) and piston spring (E).

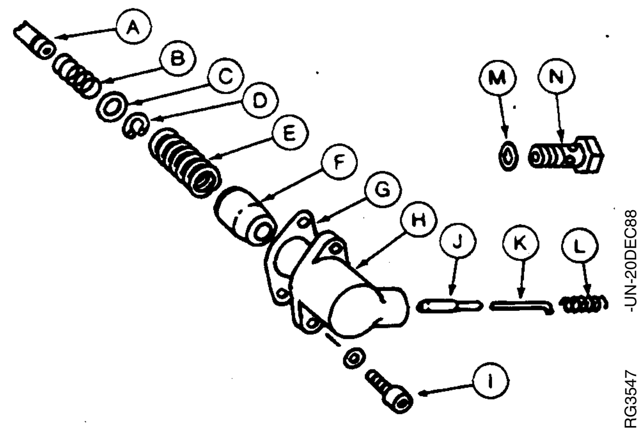
2. Wash all parts in clean solvent and dry with compressed air. Blow out all openings to make sure they are open.

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 restricter 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—Restricter Wire
L—Capillary Valve Spring
M—Washers
N—Special Screw

RG,CTM42,G35,71-19-14FEB95

ASSEMBLE AND INSTALL HYDRAULIC ANEROID ACTIVATOR—IF EQUIPPED

NOTE: Refer to previous illustration.

1. To assemble and install activator, reverse disassembly procedure using new gaskets.

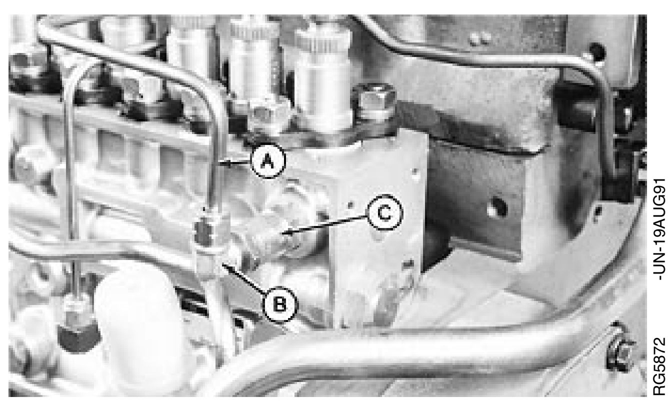
RG,CTM42,G35,83-19-14FEB95

SERVICE INJECTION PUMP OVERFLOW VALVE

NOTE: 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.



RG,CTM42,G35,16-19-28OCT92

3. Remove reducer (A) and copper washer (B) from valve body (C). Discard copper washer.

4. Unscrew spring seat (D); then remove spring (E) and valve (F).

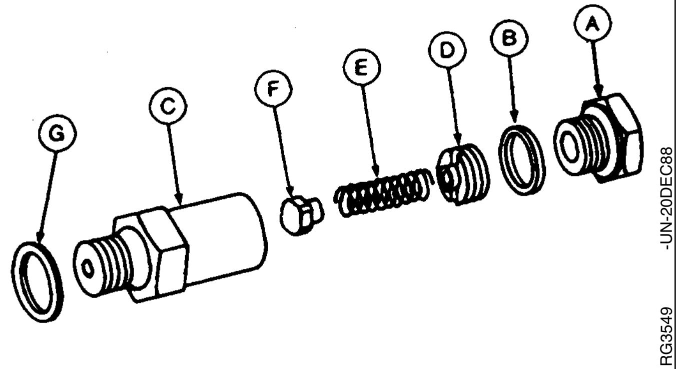
5. Inspect for foreign material imbedded in seat of nylon valve.

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 valve is malfunctioning replace valve to restore proper operation.

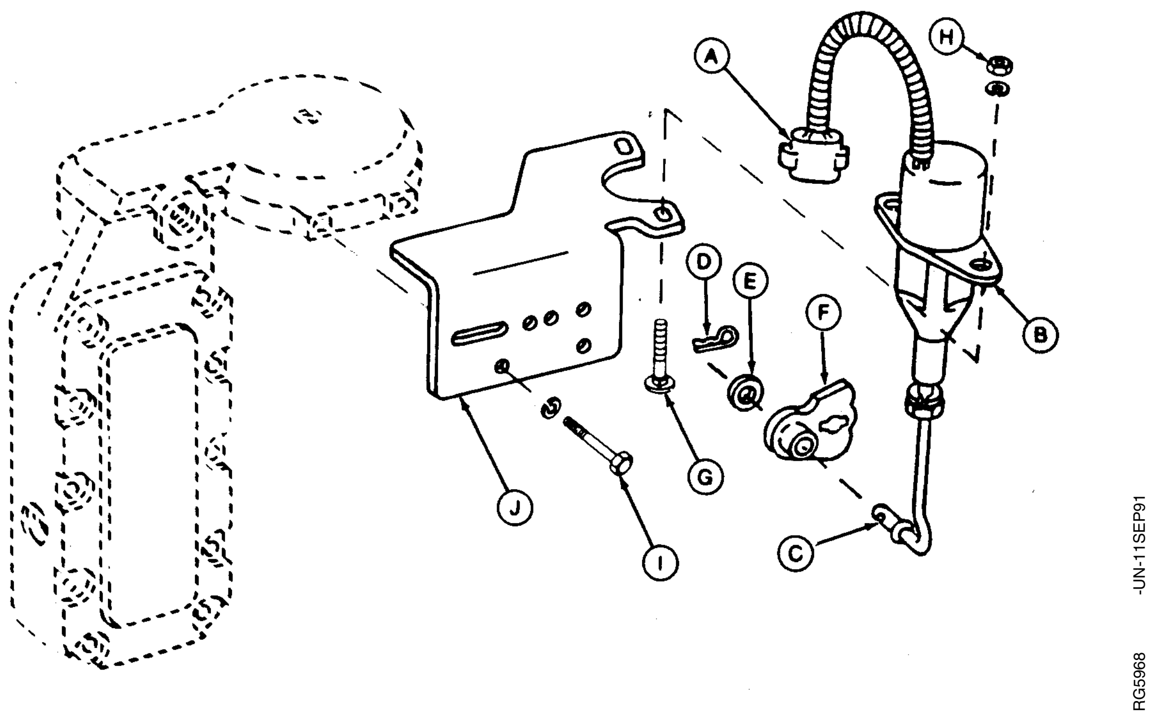
8. Reverse order of removal for reassembly of overflow valve. Install new copper washers.



A—Reducer
B—Washer
C—Valve Body
D—Spring Seat
E—Spring
F—Valve
G—Washer

RG,CTM42,G35,72-19-03OCT92

REMOVE AND INSTALL FUEL SHUTOFF SOLENOID



A—Wiring Connector
B—Fuel Shutoff Solenoid
C—Solenoid Shaft
D—Cotter Pin
E—Washer
F—Fuel Shutoff Lever
G—Lock Washer and Screws
H—Hex Nuts
I—Cap Screws
J—Solenoid Mounting Bracket

1. Disconnect electrical wiring connector (A) in solenoid lead.

2. Remove cotter pin (D), washer (E), and pull solenoid shaft (C) out of fuel shutoff lever (F).

3. Remove fuel shutoff solenoid (B) from solenoid mounting bracket (J) by removing hex nuts (H), lock washers, and machine screws (G).

4. If solenoid mounting bracket is to be removed, remove cap screws (I) and lock washers that fasten the bracket to oil filter housing.

IMPORTANT: Fuel shutoff solenoid linkage should move freely back and forth. On “A” pumps if linkage is binding, check pump for proper alignment. (See INSTALL IN-LINE “A” AND “P” FUEL INJECTION PUMPS, later in this group.)

NOTE: Electric fuel shutoff solenoids are factory adjusted to a specified length and should not require additional adjustment. See machine technical manual for fuel shutoff solenoid diagnostics.

5. To install fuel shutoff solenoid, reverse removal procedure. Tighten cap screws (I) to 23 N·m (17 lb-ft) and hex nuts (H) to 7 N·m (5 lb-ft).

RG,CTM42,G35,77-19-16AUG94

IDENTIFICATION OF IN-LINE FUEL INJECTION PUMPS

The in-line fuel injection pumps used on 6076 engines are either A-Series or P-Series pumps. The type of pump is easily determined by the "Size of Pump" indicator in the model number on the pump identification plate.

FUEL INJECTION PUMP IDENTIFICATION NUMBERS

A—922 14019

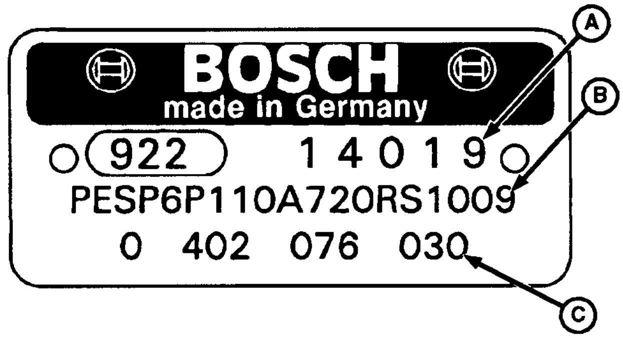
000 00000 . . . . Pump Serial Number

B—PESP6P110A720RS1009

PESP . . . . Injection Pump With Housing Flange
6 . . . . Number of Plungers
P . . . . Size of Pump
110 . . . . Plunger Diameter in mm (110 is 11 mm)
A . . . . Letter Designating Design Change
000 . . . . Three Numbers Denoting an Assembly
R . . . . Right-Hand Rotation (Viewed From Drive End)
S . . . . Production Pump
0000 . . . . Pump Identification Number

C—0 402 076 030

0 000 000 000 . . . . Bosch Part Number



Fuel Pump Identification Plate

RG,CTM42,G35,99-19-14FEB95

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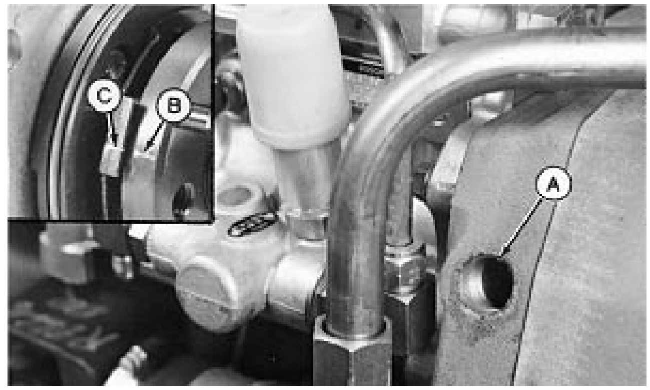
REMOVE IN-LINE FUEL INJECTION PUMP



IMPORTANT: Never steam clean or pour cold water on an injection pump while 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.

NOTE: Follow same removal procedure for injection pumps equipped with mechanical governor and electronic governor. Differences will be noted.

2. Remove timing hole plug (A, shown removed).

3. Rotate engine flywheel (in normal running direction) until No. 1 piston is at “TDC” of its compression stroke. At this point, JDE81-4 Timing Pin should enter hole in flywheel.

4. Timing marks on injection pump drive hub (B) and timing pointer (C) should be in alignment.

RG,CTM42,G35,73-19-28OCT92

NOTE: Remove alternator at this time if not previously removed.

5. Remove injection pump drive gear cover (shown removed), remove and discard all gasket material.

NOTE: In some situations JDG886 Injection Pump Timing Pin cannot be installed.

6. Install JDG886 Injection Pump Timing Pin through injection pump drive gear into injection pump hub until it bottoms. In some instances it may be necessary to rotate the pump drive hub slightly to get the pin installed.

7. Remove injection pump drive gear cap screws.

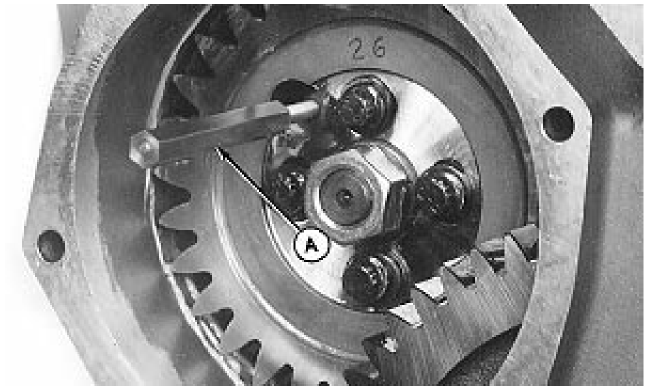
8. Disconnect injection pump lube line (B) from cylinder block fitting. Remove oil filter (C).

9. On standard governor pumps, remove fuel shutoff solenoid (not shown) from oil filter housing. (See REMOVE AND INSTALL FUEL SHUTOFF SOLENOID, earlier in this group.)

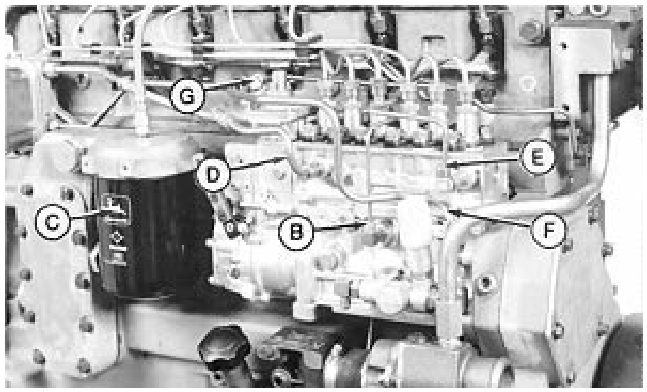
10. Remove fuel inlet line (D). Remove fuel leak-off line (E).

11. Disconnect fuel supply pump lines (F). Photo shows only one line.

12. Disconnect aneroid line (G), if equipped.



RG7283 -UN-07FEB95

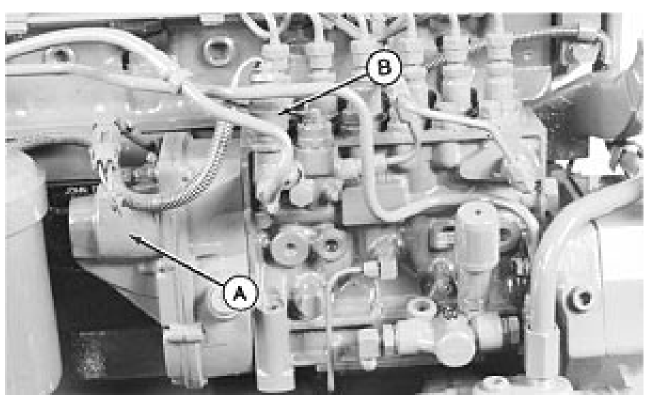


RG5875 -UN-19AUG91

A—JDG886 Injection Pump Timing Pin
B—Injection Pump Lube Line
C—Oil Filter
D—Fuel Inlet Line
E—Leak-Off Line
F—Fuel Supply Pump Lines
G—Aneroid Line

RG,CTM42,G35,18-19-14FEB95

NOTE: For injection pumps equipped with electronic governors (A), disconnect wiring harness at governor and shut-off solenoid (B). Protect connectors on wiring harness while pump is disconnected so debris does not enter connector ends.



RG5876 -UN-19AUG91

RG,CTM42,G35,19-19-10SEP91

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27

13. Remove fuel injection line nuts (A).

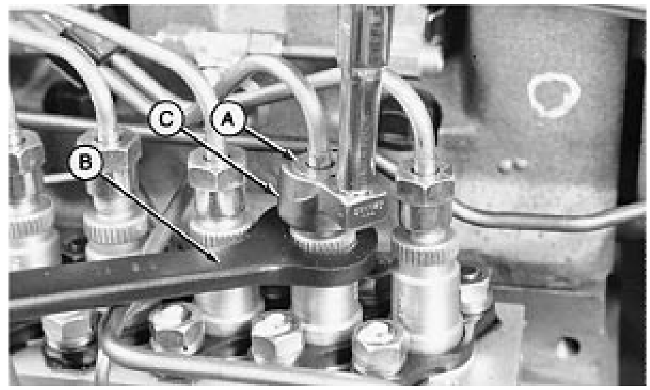
On Robert Bosch “P” injection pumps use JDE90 Serrated Wrench (B) with either JDF22 Crowsfoot Wrench (C) or a standard 3/4 in. Line Wrench (D).

On Nippondenso “P” injection pumps, use a 22 mm Open End Wrench with either the 3/4 in. line wrench or Crowsfoot Wrench mentioned above.

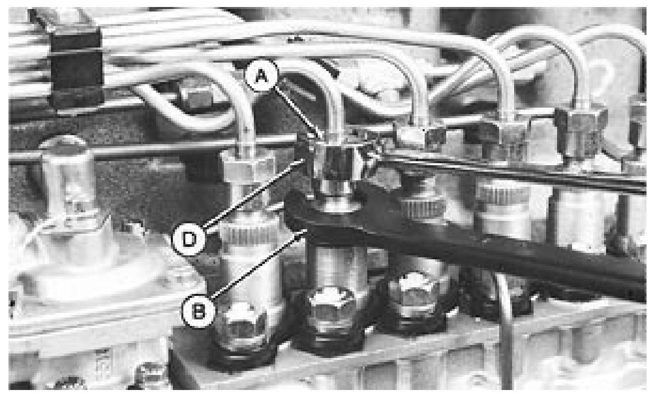
IMPORTANT: JDE-90 Serrated Wrench (Robert Bosch) and 22 mm Open End Wrench (Nippondenso) must be used to keep delivery valve fittings stationary while loosening line nuts. If a delivery valve and barrel housing rotates while loosening or tightening a fuel line nut, injection pump delivery will be altered. The pump will have to be recalibrated on a test stand.

14. Remove four mounting stud nuts which secure injection pump to cylinder block.

15. Carefully remove injection pump and place it on a clean flat surface.



RG5877 -UN-19AUG91

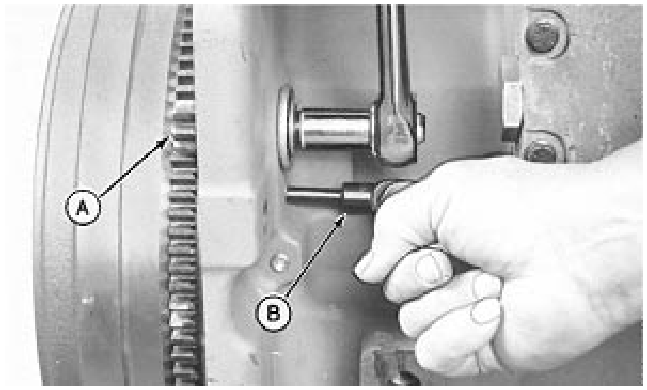


RG5878 -UN-19AUG91

A—Fuel Injection Line Nuts
B—JDE-90 Serrated Wrench
C—JDF-22 Crowsfoot Wrench
D—3/4 in. Line Wrench

RG,CTM42,G35,20-19-14FEB95

INSTALL IN-LINE FUEL INJECTION PUMP



RG5791 -UN-09AUG91

1. If engine was rotated after injection pump was removed, rotate flywheel until timing pin enters flywheel at No. 1 cylinder's "TDC" compression stroke.

NOTE: When No. 1 cylinder is at "TDC" compression stroke, intake and exhaust valves for No. 1 cylinder will be closed and both rocker arms will be loose.

2. On standard governor pumps, install fuel shutoff solenoid. (See REMOVE AND INSTALL FUEL SHUTOFF SOLENOID, earlier in this group.)

RG,CTM42,G35,47-19-28OCT92

3. Rotate injection pump drive hub until marks on drive hub (B) and pointer (A) are aligned.

NOTE: It may be necessary to rotate pump hub slightly to allow JDG886 Timing Pin (E) to enter bearing plate.

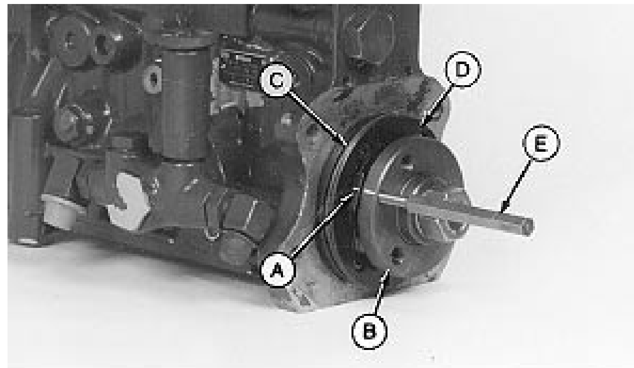
4. Thread JDG886 Timing Pin into drive hub as shown, and tighten until it bottoms against bearing plate (D).

5. Install a new O-ring (C) on bearing plate. Lightly lubricate O-ring with AR54749 Soap Lubricant to aid in pump installation and prevent O-ring damage.

IMPORTANT: "A" Series injection pumps must be installed straight (upright) on the engine to assure correct alignment of fuel shutoff solenoid linkage. Misaligned linkage will bind and not allow shutoff solenoid to operate properly, if pump is incorrectly installed. Pump is correctly aligned if linkage can be moved freely back and forth.

6. Install injection pump using moderate forward pressure and slight rocking motion to work O-ring into mounting bore. Injection pump flange should seat solidly against cylinder block.

7. Install mounting stud nuts and tighten to 47 N·m (35 lb-ft).

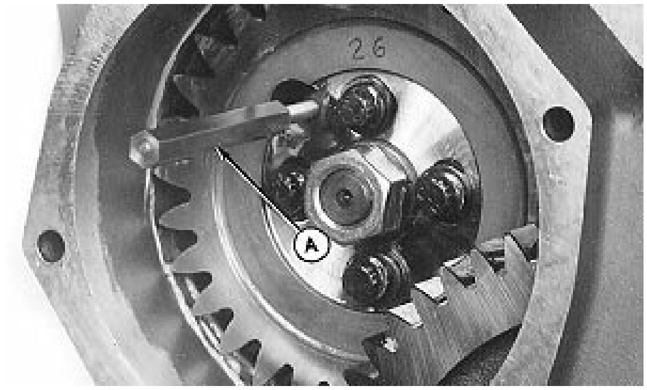


RG7741 -UN-07SEP94

A—Pointer
B—Drive Hub
C—O-Ring
D—Bearing Plate
E—JDG886 Timing Pin

RG,CTM42,G35,74-19-14FEB95

8. Place injection pump drive gear in timing gear housing (if previously removed) with chamfered side of gear toward injection pump. Chamfer is at outer edge of bore for easier installation of gear to pump drive hub.



RG7283 -UN-07FEB95

9. Carefully install drive gear on pump drive hub, position gear so mounting cap screws are approximately centered in mounting slots. This will allow for minor adjustment of pump timing, should the need arise.

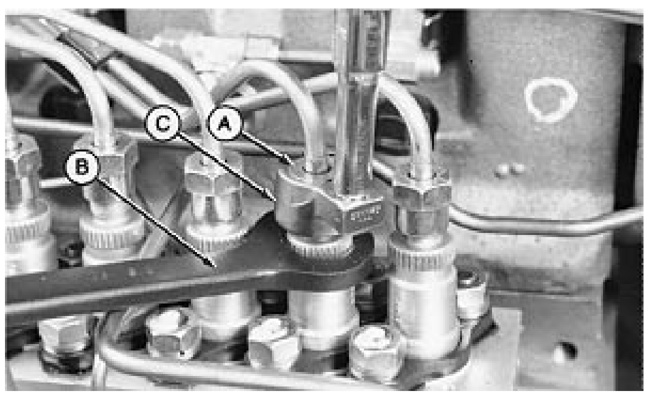
10. Install drive gear-to-pump hub cap screws (C) and tighten to:
—47 N·m (35 lb-ft) on "A" pumps
—61 N·m (45 lb-ft) on "P" pumps

11. Remove JDG886 Timing Pin (A) from injection pump hub. Install timing hole plug using LOCTITE 242 (TY9370) Thread Lock and Sealant, tighten plug securely.

12. Install injection pump drive gear cover using a new gasket, tighten cap screws to 27 N·m (20 lb-ft).

RG,CTM42,G35,21-19-14FEB95

NOTE: Remove protective caps and plugs that were installed on fuel system components during injection pump removal.



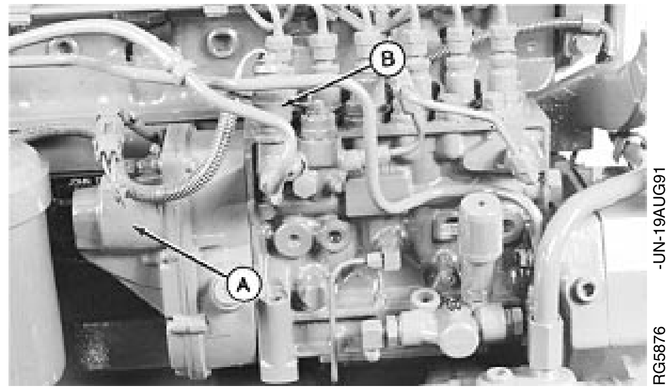
RG5877 -UN-19AUG91

13. Connect fuel delivery lines using JDE90 Serrated Wrench (B) and JDF22 Crowsfoot Wrench (C). Tighten line nuts (A) to 27 N·m (20 lb-ft).

IMPORTANT: DO NOT move delivery valve fittings while tightening line nuts. If delivery valve and barrel housing rotates while tightening a fuel line nut, injection pump fuel delivery will be altered. The injection pump will have to be recalibrated on a test stand by an authorized diesel repair station.

RG,CTM42,G35,23-19-03OCT92

14. On injection pumps equipped with electronic governors (A), connect wiring harness at governor and shut-off solenoid (B). Tighten connections securely.



RG,CTM42,G35,24-19-02OCT92

15. Connect aneroid line (G), if equipped.

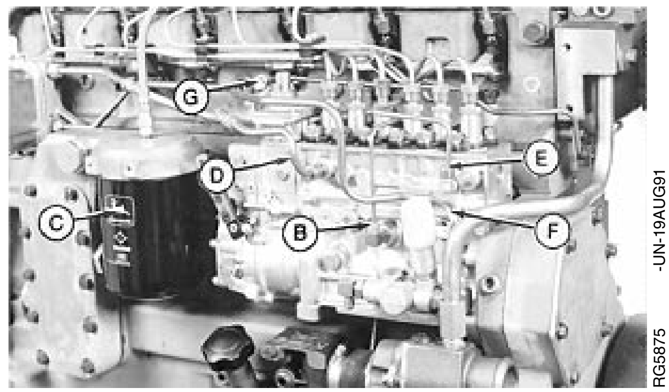
16. Connect fuel supply pump lines (F).

17. Connect fuel inlet line (D) and leak-off line (E).

18. Install oil filter (C).

19. Connect injection pump oil line (B) to cylinder block fitting.

20. Tighten all connections securely.



B—Injection Pump Oil Line
C—Oil Filter
D—Fuel Inlet Line
E—Fuel Leak-Off Line
F—Supply Pump Lines
G—Aneroid Line

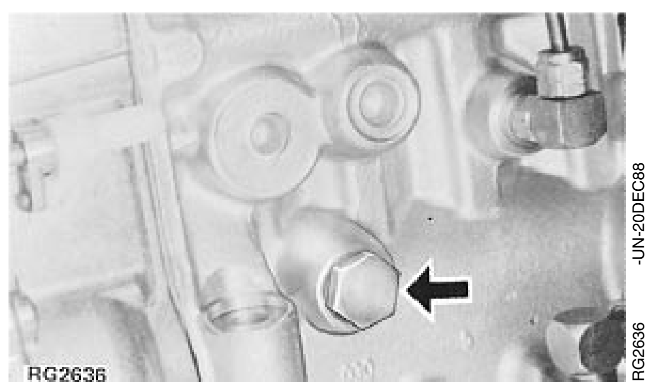
RG,CTM42,G35,25-19-24MAR95

IMPORTANT: Oil fill locations may vary by injection pump applications. Familiarize yourself with the location on your engine before adding oil to pump.

21. Remove oil fill plug (arrow) and add enough clean engine oil until oil comes out fill hole. Engine should be level when checking oil level.

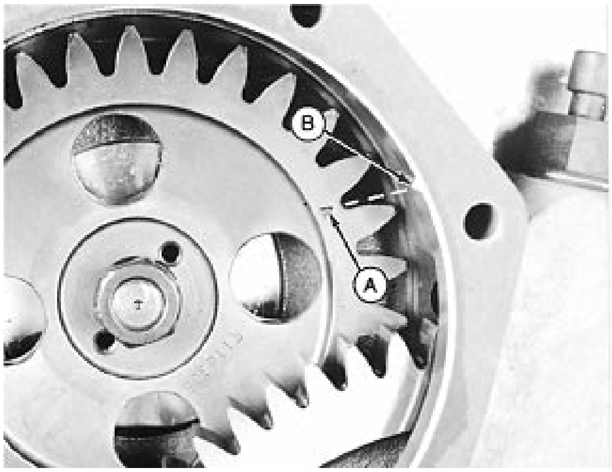
22. Bleed fuel system. (See BLEED THE FUEL SYSTEM, in Group 115.)

23. Connect throttle levers and adjust engine speeds as required. (See ADJUST ENGINE SPEEDS, in Group 115.)



RG,CTM42,G35,80-19-03OCT92

REMOVE ROTARY FUEL INJECTION PUMP—STANADYNE DB4



RG6456 -UN-22OCT92

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

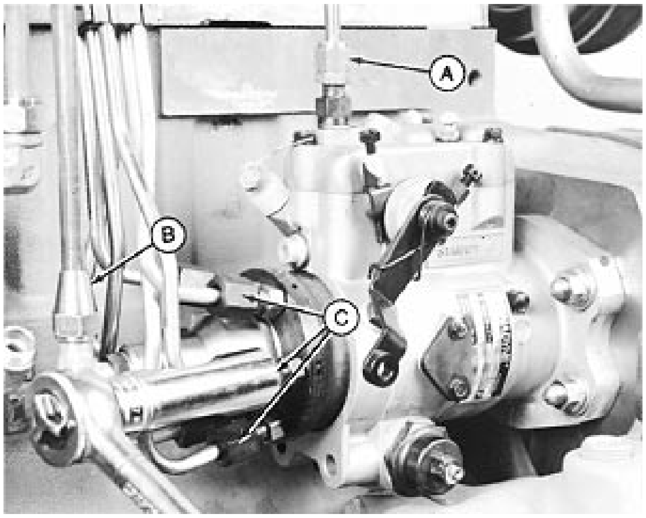
1. Clean injection lines and area around injection pump with cleaning solvent or a steam cleaner to keep debris out of fuel system.

2. Remove injection pump timing gear cover (shown removed).

3. Rotate engine flywheel (in normal running direction) until No. 1 piston is at “TDC” of its compression stroke, and JDE81-4 Timing Pin enters hole in flywheel. “V” marks on injection pump drive gear (A) and drive gear access opening (B) MUST align.

If marks do not align, remove timing pin and rotate engine one full revolution until timing pin enters hole in flywheel again. “V” timing marks should now align.

RG,CTM42,G35,84-19-28OCT92



RG6461 -UN-26OCT92

4. Disconnect shut-off cable and speed control rod.

5. Disconnect fuel leak-off line (A).

6. Disconnect fuel supply line (B).

7. Disconnect fuel delivery (pressure) lines (C), using a suitable 17 mm deep-well crowsfoot socket.

RG,CTM42,G35,85-19-28OCT92

8. Remove hex nut (A) and washer securing pump drive gear to pump shaft. Be careful not to drop nut or washer inside engine.

9. Attach JDG670A Injection Pump Drive Gear Puller (B) to injection pump gear and shaft.

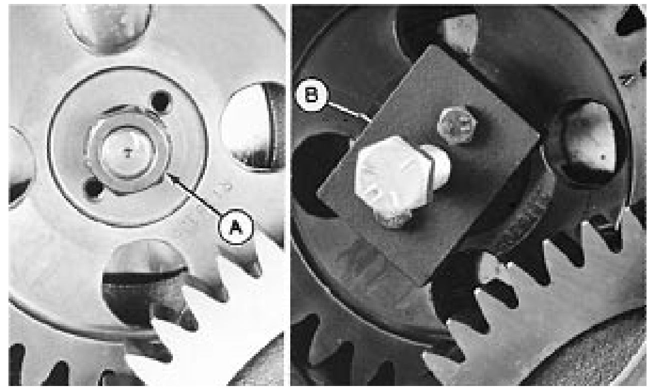
10. Loosen three pump mounting nuts several turns to permit separation of pump shaft and drive gear.

IMPORTANT: Pump may fall to floor if mounting nuts are removed from threaded studs prior to shaft/gear separation.

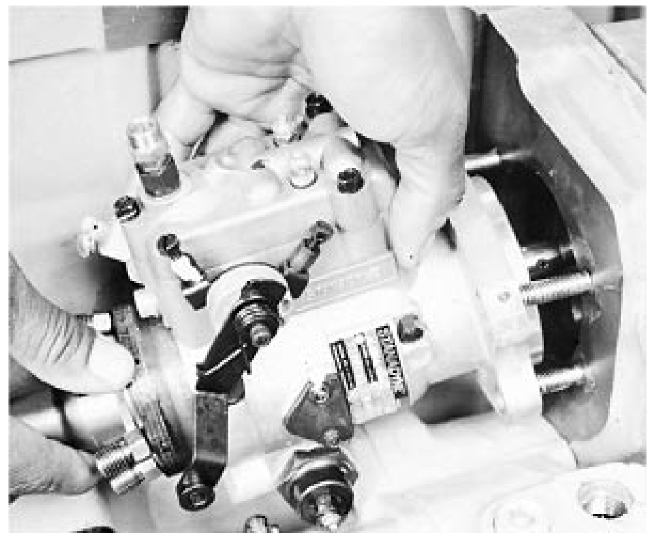
11. Tighten large hex head cap screw clockwise until pump shaft is loosened from tapered bore of drive gear.

12. Remove three mounting hex nuts and withdraw pump from mounting studs.

13. Remove JDG670A Gear Puller from drive gear. Plug or cap all openings on pump.



RG6462 -UN-26OCT92



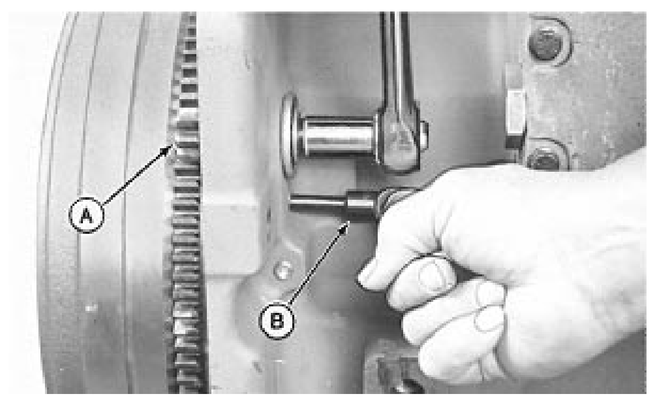
RG6463 -UN-26OCT92

RG,CTM42,G35,86-19-28OCT92

INSTALL ROTARY FUEL INJECTION PUMP—STANADYNE DB4

1. If engine was rotated after injection pump was removed, rotate flywheel until timing pin enters flywheel at No. 1 cylinder's "TDC" compression stroke.

NOTE: When No. 1 cylinder is at "TDC" compression stroke, intake and exhaust valves for No. 1 cylinder will be closed and both rocker arms will be loose. Insure that gear backlash is taken out of system by smoothly rotating flywheel until timing pin engages.



RG5791 -UN-09AUG91

RG,CTM42,G35,87-19-28OCT92

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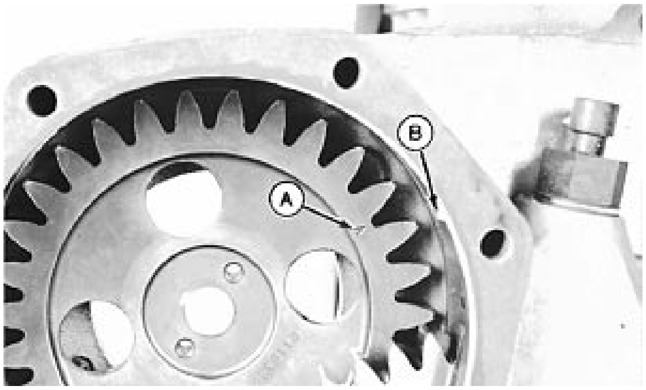
2. Position injection pump drive gear in timing gear cover so “V” mark (A) on gear aligns with “V” mark (B) on drive gear access opening.

3. Lubricate injection pump mounting flange O-ring with AR54749 Soap Lubricant before installing pump on engine.



RG6464 -UN-26OCT92

RG,CTM42,G35,88-19-16AUG94

Make sure index pin is installed in pump shaft. Replace pump drive shaft and/or pin as necessary.

IMPORTANT: DO NOT drop shaft nut or washer into timing gear area while installing injection pump.

4. Install injection pump onto cylinder block mounting studs until pump flange is square to cylinder block. Retain shaft in gear with nut and washer. Install stud nuts with washers and finger tighten.

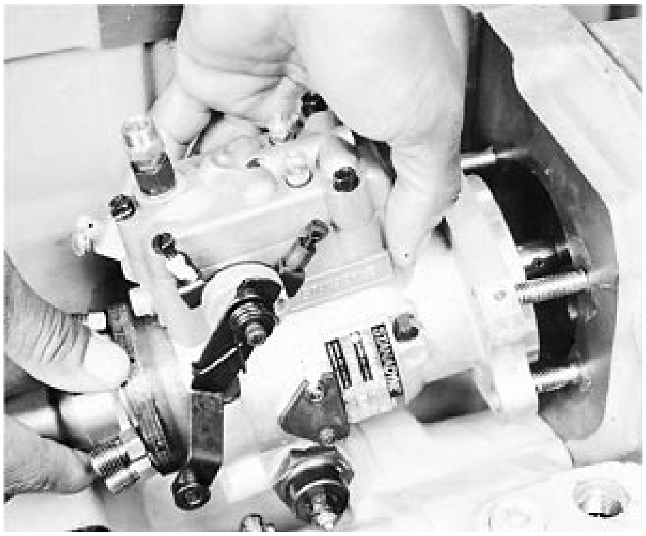
• **Injection Pump Timing:**

NOTE: DO NOT use window on side of injection pump to time DB4 pumps; there are no internal timing marks.

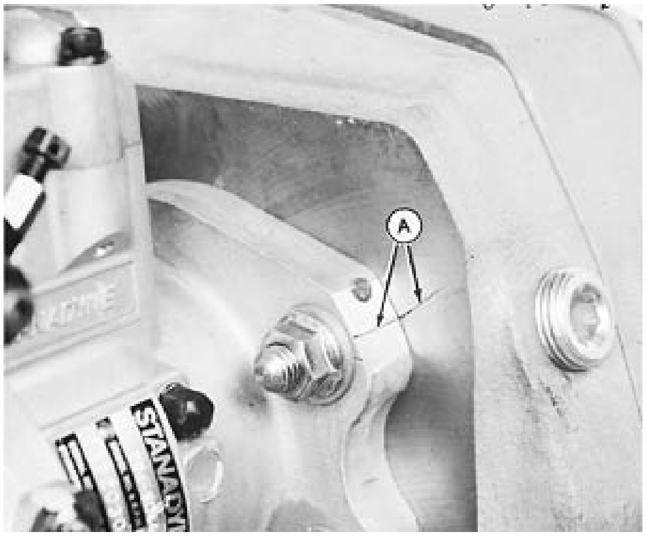
5. Index injection pump so timing marks (A) on pump flange and cylinder block face align.

6. Tighten injection pump mounting nuts to 47 N·m (35 lb-ft).

7. Tighten injection pump drive gear-to-shaft nut to 142 N·m (105 lb-ft).



RG6463 -UN-26OCT92



RG6465 -UN-26OCT92

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RG,CTM42,G35,89-19-16AUG94

8. Connect injection pump pressure lines (D). Beginning with outlet (A) and continue around pump head in counterclockwise direction, attaching lines in engine firing order.

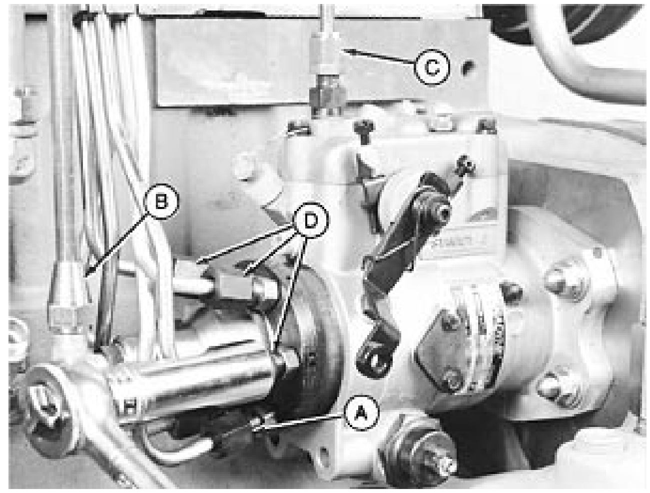
9. Tighten pressure lines at pump to 27 N·m (20 lb-ft), using a suitable 17 mm wrench.

IMPORTANT: When tightening fuel pressure lines at fuel injection pump, be sure not to turn fuel injection pump fittings. Turning fittings may cause internal pump damage.

10. Connect fuel supply line (B), leak-off line (C), shut-off cable and speed control rod.

11. Bleed air from fuel system as outlined in Group 115.

12. Remove timing pin from cylinder block. Tighten injection lines to injection nozzles to 27 N·m (20 lb-ft). Hold injection nozzle holders during tightening.



RG6466 -UN-26OCT92

A—Outlet Connection to No. 1 Cylinder
B—Fuel Supply Line
C—Fuel Leak-off Line
D—Fuel Pressure Lines

RG,CTM42,G35,90-19-14FEB95

REMOVE FUEL INJECTION NOZZLES

General Nozzle Service Precautions:

1. Thoroughly clean area around injection pump and nozzles, including all line connections, using compressed air.

2. Cap or plug all fuel lines as they are disconnected to prevent dirt and debris from entering fuel system. Debris in fuel system can plug injectors and cause engine damage.

- **On In-Line Injection Pumps:**

3. Disconnect injection lines from injection pump using JDF22 Crowsfoot Wrench.

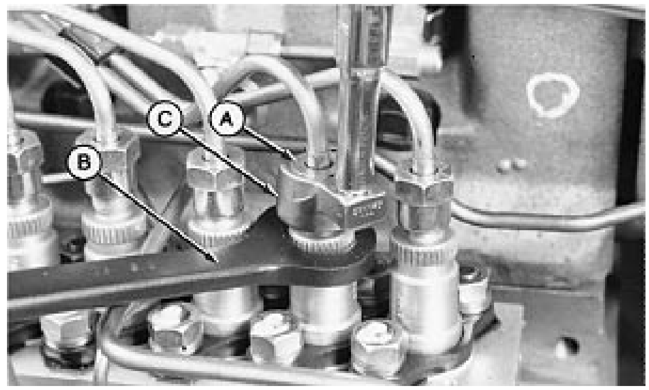
IMPORTANT: On "P" injection pumps, JDE90 Serrated Wrench (Robert Bosch) (B) and 22 mm Open End Wrench (Nippondenso) must be used to keep delivery valve fittings stationary while loosening line nuts. If a delivery valve and barrel housing rotates while loosening or tightening a fuel line nut, injection pump delivery will be altered. Pump must be recalibrated on a test stand.

4. Remove fuel injection line nuts (A).

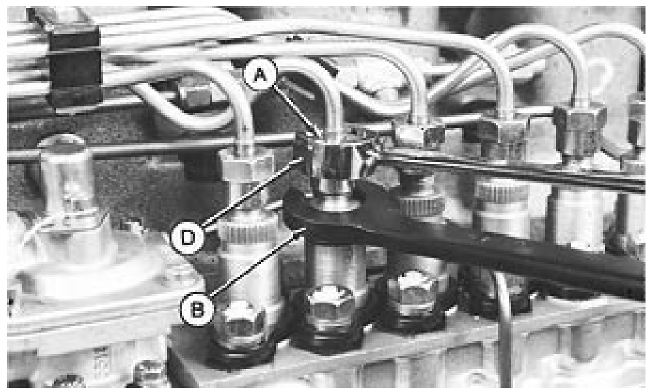
On Robert Bosch "P" injection pumps use JDE90 Serrated Wrench with either JDF22 Crowsfoot Wrench (C) or a standard 3/4 in. Line Wrench (D).

On Nippondenso "P" injection pumps, use a 22 mm Open End Wrench with either JDF22 Crowsfoot Wrench or equivalent crowsfoot wrench mentioned above.

On "A" injection pumps, use either JDF22 Crowsfoot Wrench or an equivalent crowsfoot wrench.



RG5877 -UN-19AUG91



RG5878 -UN-19AUG91

A—Fuel Injection Line Nuts
B—JDE90 Serrated Wrench
C—JDF22 Crowsfoot Wrench
D—3/4 in. Line Wrench

35
37

RG,CTM42,G35,96-19-28OCT92

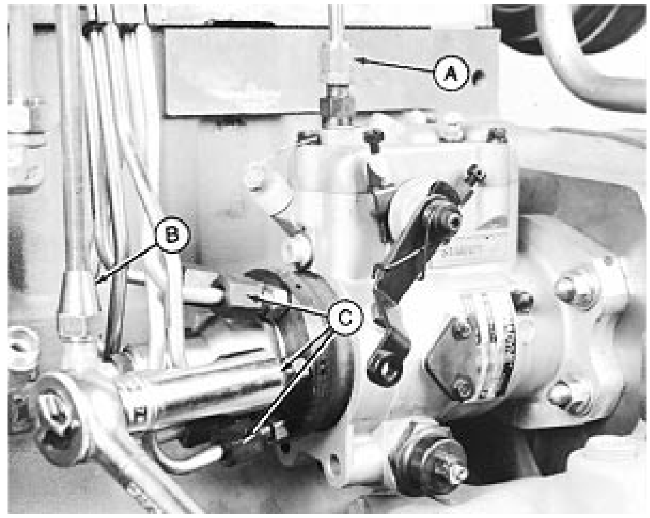
• **On Rotary Pumps:**

5. Disconnect shut-off cable and speed control rod.

6. Disconnect fuel leak-off line (A) and fuel supply line (B).

7. Using a suitable 17 mm deep-well crowsfoot socket, disconnect fuel delivery (pressure) lines (C).

A—Fuel Leak-off Lines
B—Fuel Supply Line
C—Fuel Pressure Lines



RG6461 -UN-26OCT92

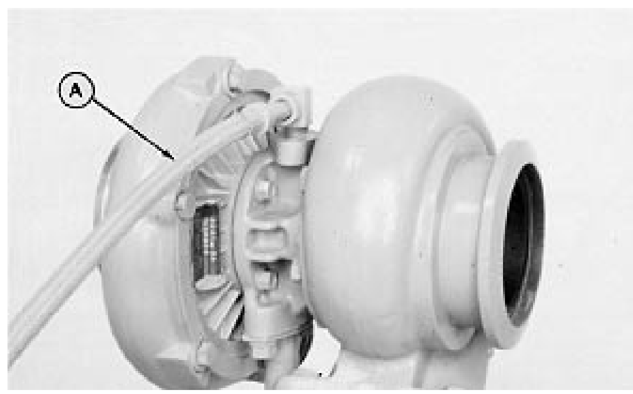
RG,CTM42,G35,97-19-28OCT92

• **On In-Line and Rotary Pumps:**

8. Disconnect turbocharger oil line (A) at turbocharger.

9. Remove fuel delivery lines from injection nozzles. Lift injection line assembly from engine.

10. Disconnect fuel leak-off line from injection nozzle leak-off connectors. Remove complete leak-off assembly.

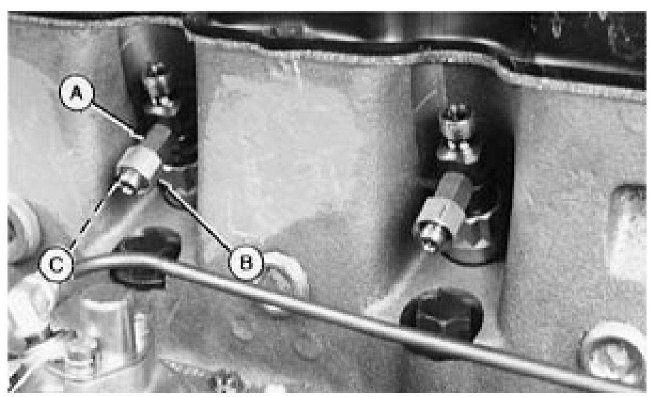


RG5323 -UN-06DEC88

RG,CTM42,G35,49-19-28OCT92

11. Remove packing (C) and line nuts (B) from each leak-off connector. Discard packing.

12. Remove leak-off connector (A) with O-ring from each injection nozzle.



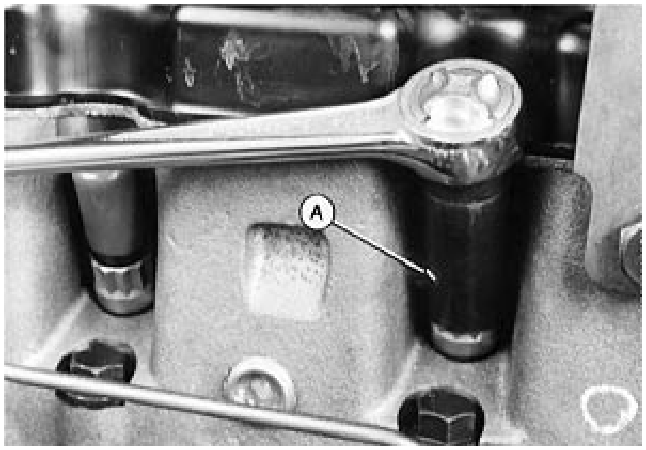
RG5756 -UN-05AUG91

RG,CTM42,G35,27-19-02OCT92

NOTE: The socket portion of JDE92 Nozzle Wrench (A) may be used to remove nozzles from cylinder head.

13. If JDE92 Nozzle Wrench is not used, use a 24 mm (15/16 in.) deep socket on nozzle gland nut to remove nozzles. Gland nut will act as a jack screw to raise nozzle out of cylinder head bore. Remove hardened steel washer from injection nozzle bore if it does not come out with nozzle.

14. To prevent debris from entering combustion chamber after nozzles are removed, insert a 12.7 mm (1/2 in.) hardwood dowel in nozzle bore.



RG5757 -UN-05AUG91

RG,CTM42,G35,28-19-03OCT92

DIAGNOSE INJECTION NOZZLE MALFUNCTION

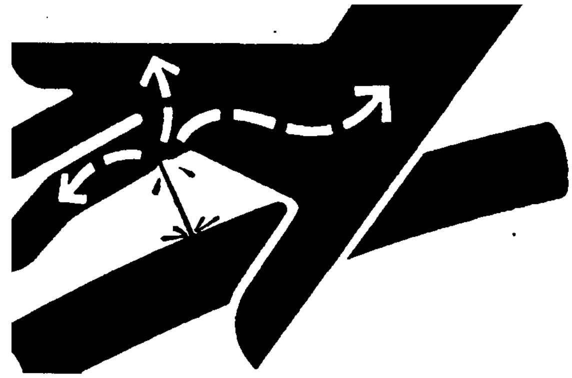
Problem	Possible Cause	Suggested Remedy
Failed Carbon Stop Seal Washer	Nozzle replaced without using new seal or washer.	Install new seal or washer.
	Carbon stop seal groove not cleaned when new seal was installed.	Clean groove. Install new seal.
Incorrect Opening Pressure	Improper adjustment.	Adjust 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.

TEST FUEL INJECTION NOZZLES



X9811 -UN-23AUG88

Before disassembling, test injection nozzles with clean filtered fuel to determine its condition.

Test for:
—Opening Pressure
—Leakage
—Chatter
—Spray Pattern

CAUTION: Nozzle tip should always be directed away from operator. Fuel from spray orifices can penetrate skin and clothing, causing serious personal injury. Enclosing nozzle in a transparent cover, or glass beaker is recommended.

Before applying pressure to nozzle tester, be sure all connections are tight and 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.

S11,0408,AL -19-08APR94

PERFORM OPENING PRESSURE TEST

1. Connect injection nozzle to D01109AA Nozzle Tester (Y900) (A), using No. Y900-2A Fuel Line (B) and Y900-7 and Y900-15 Straight Adapters (C). Y900-21 90˚ Adapter may also be used. Place a glass beaker (D) around nozzle.

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.

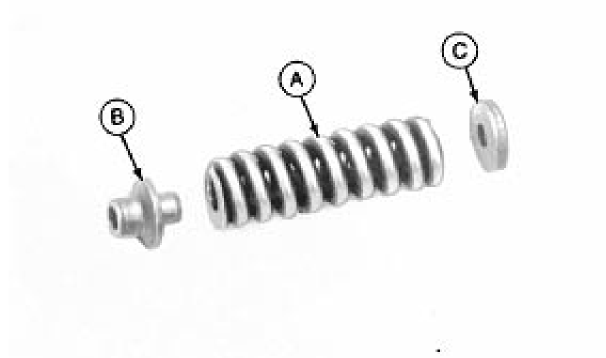
4. Recheck by completely releasing pressure, then gradually building pressure until valve opens.

IMPORTANT: Nozzle tester should be checked periodically for accuracy.

A—Nozzle Tester
B—Fuel Line
C—Adapter
D—Beaker

RG,CTM42,G35,30-19-03OCT92

INJECTION NOZZLE SPECIFICATIONS



RG3410 -UN-20DEC88

A new nozzle or a used nozzle with a new spring (A), should open at approximately the following pressures. A used nozzle that has been rebuilt with a new spring and/or valve should be reset to same pressures as a new nozzle. New nozzle opening pressures are:

New Nozzle Opening Pressures (by nozzle tip size)**

7 x 0.22 mm, 7 x 0.23 mm,
7 x 0.255 mm . . . . 29 000—30 200 kPa (290—302 bar) (4200—4370 psi)

On nozzles which have been in service, spring (A) and spring seat (B) will have taken a normal set. In this case, opening pressure is satisfactory if it meets or exceeds used nozzle minimum opening pressure given below, but does not exceed new opening pressure given above. Used nozzle minimum opening pressures are:

Used Nozzle Minimum Opening Pressures (by nozzle tip size)**

7 x 0.22 mm, 7 x 0.23 mm,
7 x 0.255 mm . . . . 26 200 kPa (262 bar) (3800 psi)

Shims (C) of different thickness are available for changing opening pressure adjustment. Each 0.05 mm (0.002 in.) of shim thickness changes opening pressure approximately 700 kPa (7 bar) (100 psi).

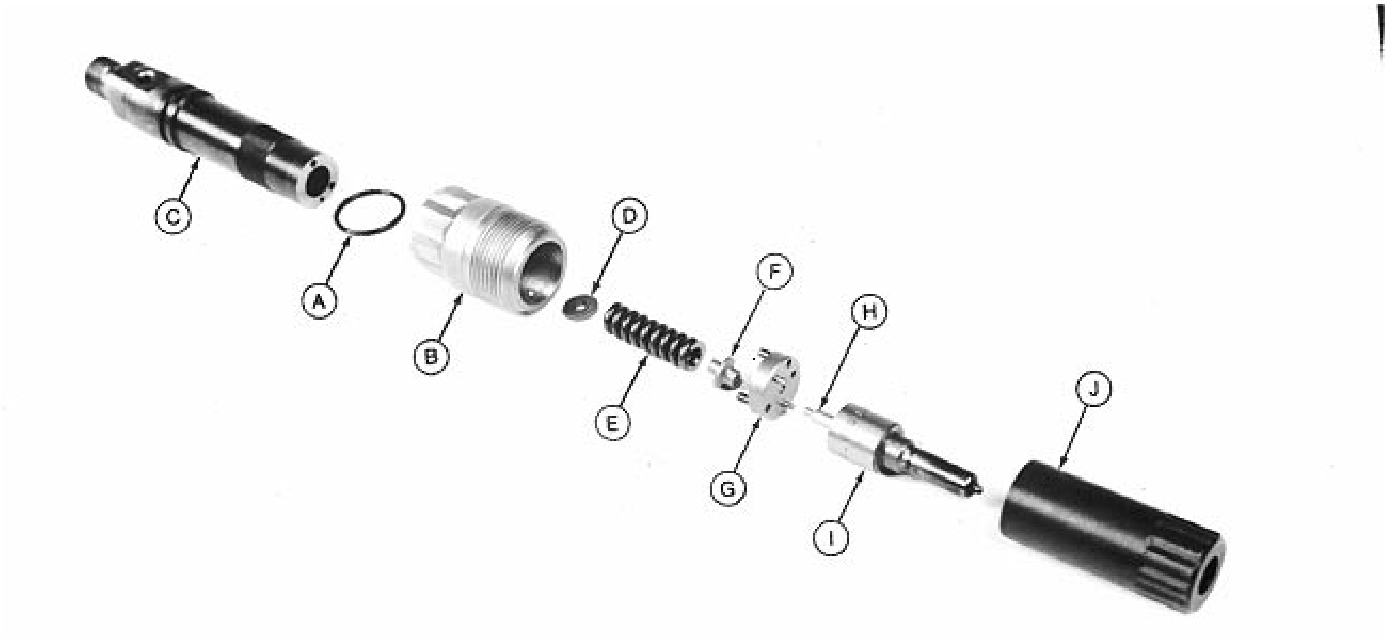
IMPORTANT: ALWAYS use John Deere nozzle adjusting shims which are specially hardened. Other shims will not be satisfactory.

If nozzle opening pressures are not correct, disassemble injection nozzles (as described in this group) and change shims until nozzles open at proper new nozzle pressure given above. The difference in nozzle opening pressures between cylinders in an engine should not exceed 350 kPa (3.5 bar) (50 psi).

***See ASSEMBLE FUEL INJECTION NOZZLE later in this group for nozzle tip size identification.*

RG,CTM42,G35,31-19-14FEB95

PERFORM NOZZLE LEAKAGE TEST



A—Gland Nut O-Ring
B—Gland Nut
C—Nozzle Holder
D—Shim
E—Nozzle Valve Spring
F—Spring Seat
G—Intermediate Plate
H—Nozzle Valve
I—Nozzle
J—Nozzle Retaining Nut

Nippondenso Nozzle (Bosch Similar)

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 spray orifice, indicating a bad seat.

If nozzle drips within 10 seconds, replace nozzle valve (H) and nozzle (I).

3. Check for leakage around nozzle retaining nut (J) thread connection with nozzle holder (C).

Leakage indicates a bad seat either between nozzle and intermediate plate (G) or between nozzle holder and intermediate plate.

RG,CTM42,G35,32-19-03OCT92

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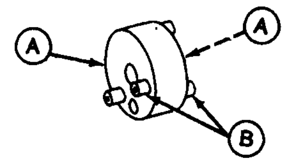
45

RG2248 -UN-20APR89



RG2248

IMPORTANT: Do not lap the machined surfaces (A) of the 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 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 79 N·m (58 lb-ft). Replace injection nozzle if leakage continues.

S11,0408,AP -19-08APR94

PERFORM CHATTER AND SPRAY PATTERN TEST

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, the 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 the 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.

35
46

RG,CTM42,G35,33-19-03OCT92

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

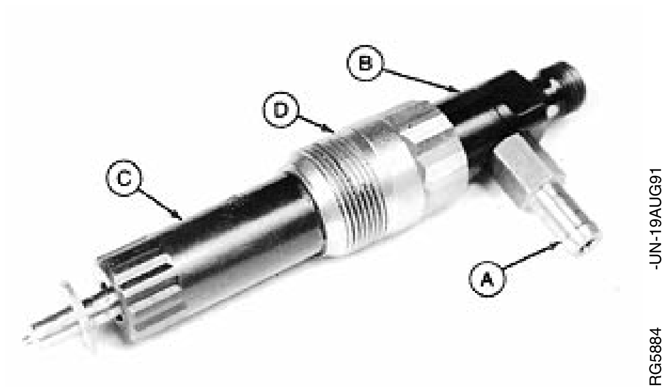
NOTE: Bosch KDEL and Nippondenso KDAL injection nozzles are metric units. Only metric tools should be used.

1. Use a 11 mm box or open-end wrench and unscrew leak-off connector (A) (if not removed previously) out of nozzle holder (B).

2. Clamp flats of nozzle holder in a soft jawed vise. Remove nozzle retaining nut (C) from nozzle holder using a 12-point 19mm wrench.

3. Slip gland nut (D) off nozzle holder.

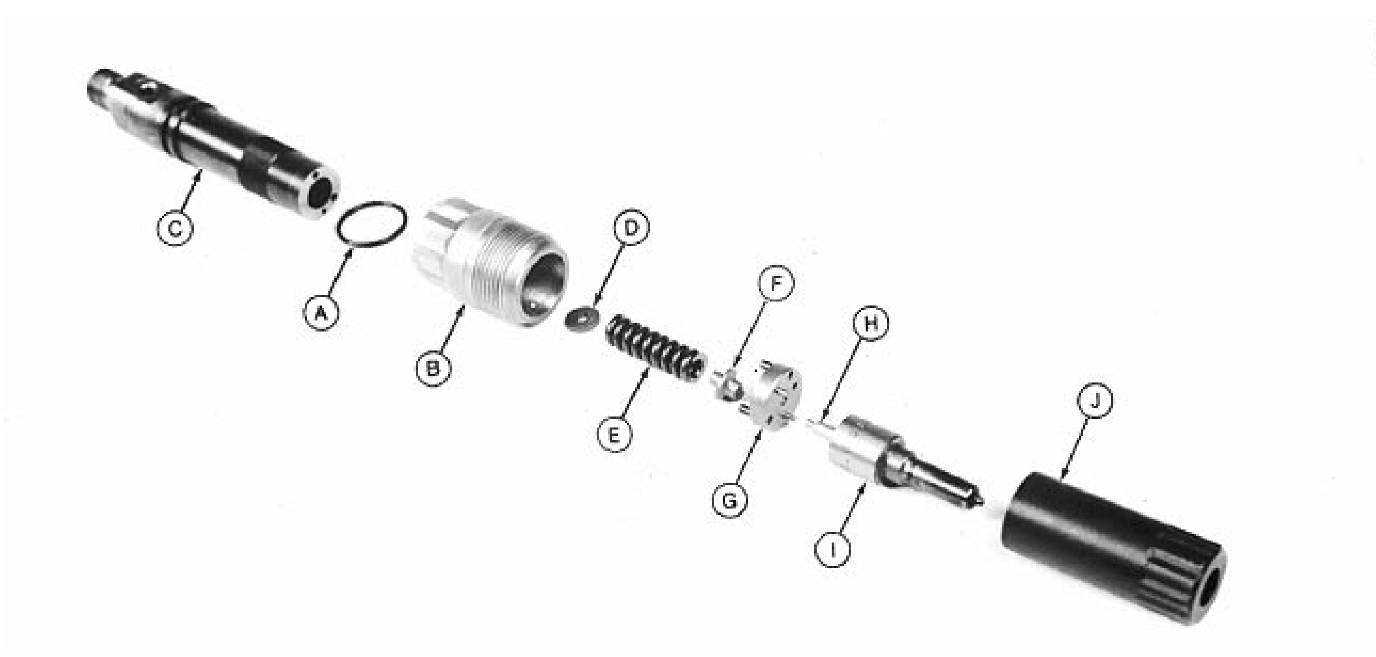
NOTE: Bosch nozzles have a snap ring and O-ring at top of gland nut that must be removed before gland nut can be removed. After removing gland nut, lower snap ring can be removed.



A—Leak-Off Connector
B—Nozzle Holder
C—Nozzle Retaining Nut
D—Gland Nut

35
47

RG,CTM42,G35,50-19-03OCT92



A—Gland Nut O-Ring
B—Gland Nut
C—Nozzle Holder
D—Shim
E—Nozzle Valve Spring
F—Spring Seat
G—Intermediate Plate
H—Nozzle Valve
I—Nozzle
J—Nozzle Retaining Nut

4. Remove nozzle assembly (H and I).

5. Pull off intermediate plate (G).

6. Remove spring seat (F), spring (E), and shims (D).

7. Remove gland nut O-ring (A).

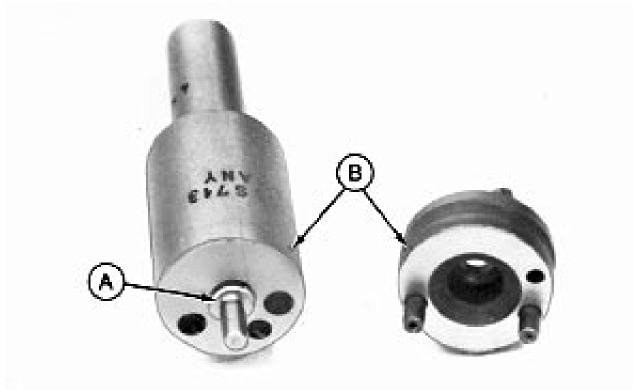
8. Withdraw nozzle valve (H) from nozzle (I). If valve is stuck, it may be necessary to soak nozzle assembly in Bendix cleaner, acetone, or other commercial cleaners sold especially for freeing stuck valves.

CAUTION: Use 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.

RG,CTM42,G35,51-19-03OCT92

CLEAN AND INSPECT FUEL INJECTION NOZZLE ASSEMBLY



RG3411 -UN-20DEC88

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".

S11,0408,AU -19-08APR94

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49

PERFORM NOZZLE SLIDE TEST

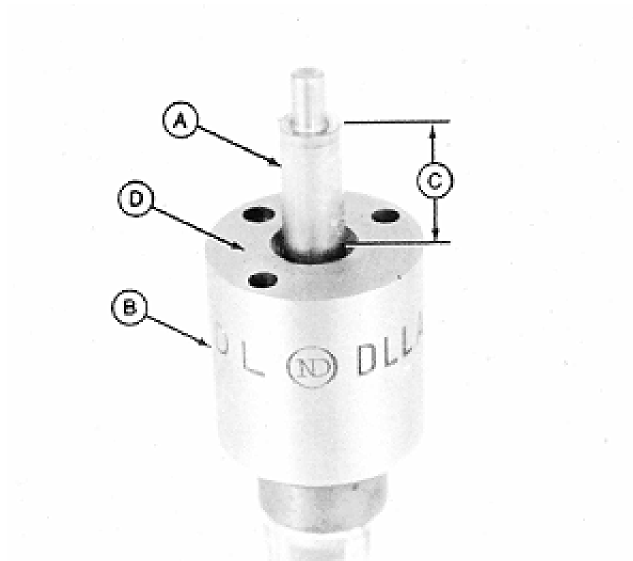
NOTE: DO NOT touch lapped surface (D) unless hands are wet with diesel fuel.

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 valve does not fall freely to its seat.



A—Nozzle Valve
B—Nozzle
C—Free-Fall Distance
D—Lapped Surface

RG,CTM42,G35,53-19-03OCT92

CLEAN SPRAY ORIFICES

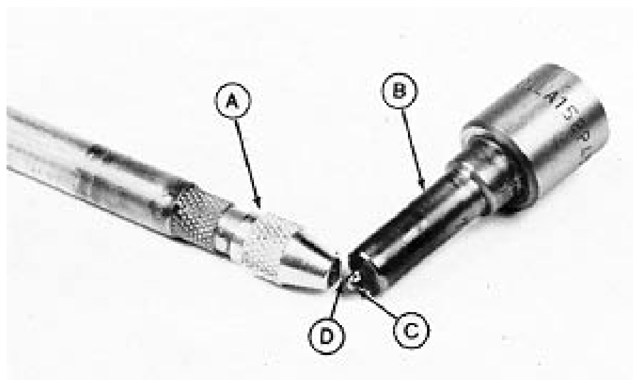
1. Begin with cleaning wire (D) 0.07—0.10 mm (0.003—0.004 in.) from JDF13 (JDE105) Nozzle Cleaning Kit.

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 (1/32 in.).

3. Insert wire into orifice (C) and rotate.

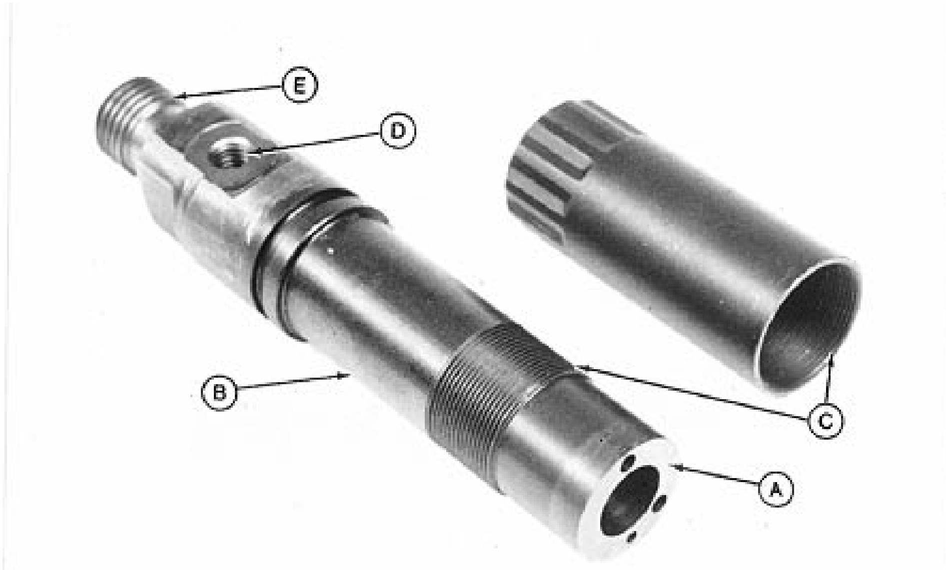
4. For final cleaning, use cleaning wire 0.03 mm (0.001 in.) smaller than orifice size. Follow previous steps until orifices are clean of any carbon deposits.



A—Pin Vise
B—Nozzle
C—Orifice
D—Cleaning Wire

RG,CTM42,G35,54-19-05APR93

INSPECT NOZZLE HOLDER



RG5959 -UN-30AUG91

A—Lapped Surface
B—Nozzle Holder
C—M19 x 0.75
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 0.75 (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.

3. Check fuel passages in nozzle holder to make sure they are open. Clean with compressed air.

4. Remove carbon deposits on both inner and outer surfaces of nozzle retaining nut.

5. 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.

RG,CTM42,G35,55-19-03OCT92

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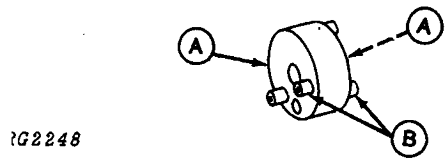
RG2248 -UN-20APR89



RG2249 -UN-20APR89

6. Examine lapped surfaces on intermediate plate (A) for nicks, scratches, or worn areas which would permit fuel to leak past.

7. 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 dowels is not recommended as removal is likely to damage them. Replacement dowels are not available as service parts.

8. Inspect spring seat for splitting, cracking, or excessive wear.

Replace seat if any of these conditions are evident.

RG,CTM42,G35,75-19-03OCT92

35
52

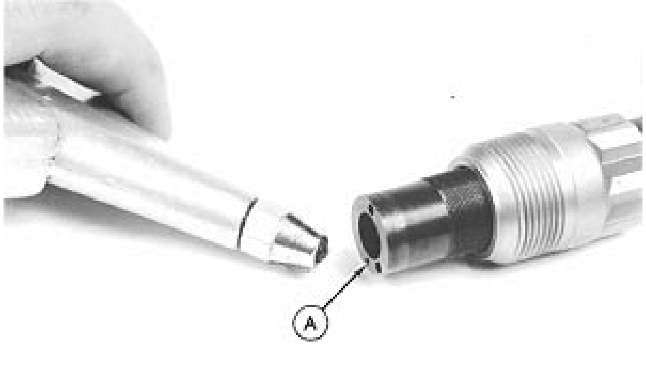
9. Examine spring and shims for pitting or excessive wear.

Replace as necessary.

NOTE: The edge-type filter is pressed into nozzle holder and is not removable for service.

10. Clean filter by applying compressed air to nozzle holder fuel passage (A) at nozzle end.

RG5955 -UN-30AUG91



RG5962 -UN-30AUG91

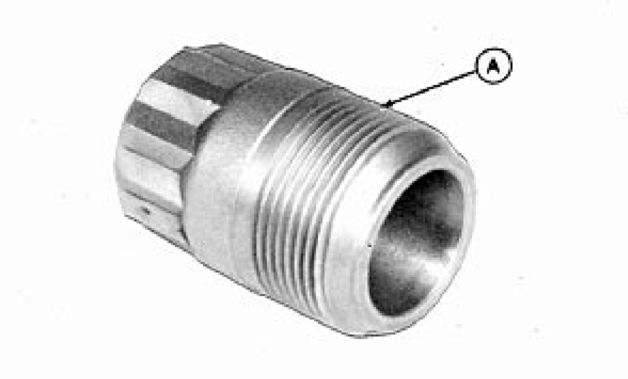
RG,CTM42,G35,56-19-03OCT92

INSPECT GLAND NUT

1. Inspect nozzle holder gland nut for general condition, be sure that it is not cracked or split.

2. Inspect M28 x 1.5 threads (A) for general condition. Threads which are slightly nicked or damaged may be “dressed up.”

Replace gland nut if unable to restore to a serviceable condition.



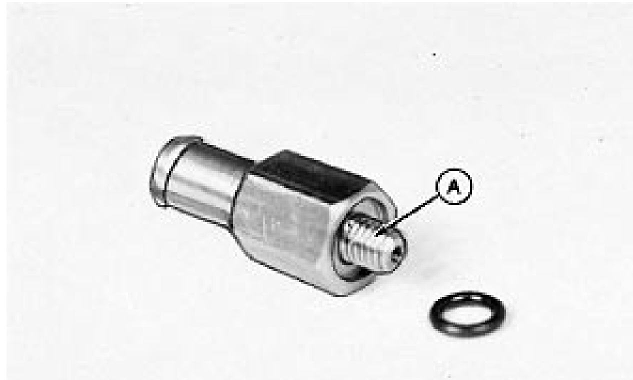
RG5956 -UN-30AUG91

RG,CTM42,G35,57-19-05APR93

3. Check passage in leak-off connector to see that it is open.

4. Blow through connector passage with compressed air.

5. Inspect the M6 x 1 threads (A) for general condition. Replace connector if threads are damaged and cannot be restored to a serviceable condition.



RG5886 -UN-19AUG91

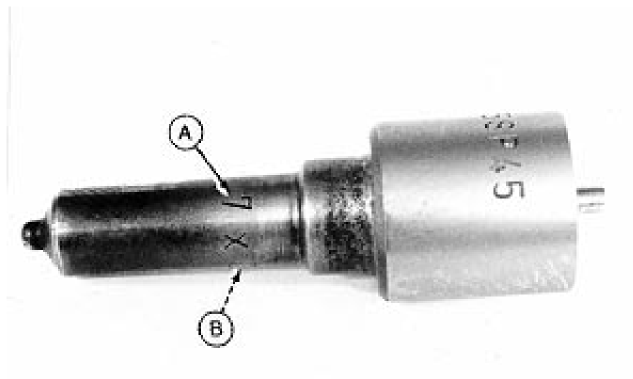
RG,CTM42,G35,34-19-03OCT92

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 correct nozzle assembly for each application, note markings on lower part of nozzle.

The illustration shows a nozzle marked 7 x 0.255. The number “7” (A) indicates the number of orifices and “0.255” (B) indicates the size of each orifice in millimeters.



RG5958 -UN-30AUG91

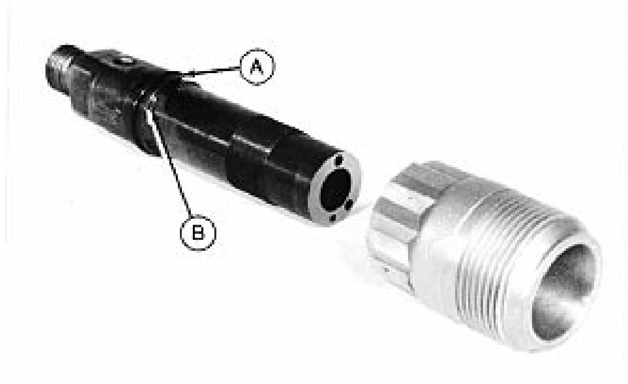
IMPORTANT: Immerse parts in clean fuel before assembly. DO NOT dry parts with towels or compressed air. Dust particles might collect and stay on pressure faces of nozzle valve and nozzle holder.

RG,CTM42,G35,35-19-03OCT92

1. Install a new O-ring (A) on nozzle holder.

2. Apply PT569 NEVER-SEEZ compound liberally to inside bore of gland nut to prevent gland nut from seizing on holder body. Slide gland nut over nozzle holder until it bottoms against shoulder (B).

NOTE: Bosch nozzles have a snap ring toward bottom end that gland nut bottoms against, and an O-ring and snap ring at top end of gland nut to keep it captive. Gland nut is installed from top of nozzle holder on Bosch nozzles.



RG5960 -UN-30AUG91

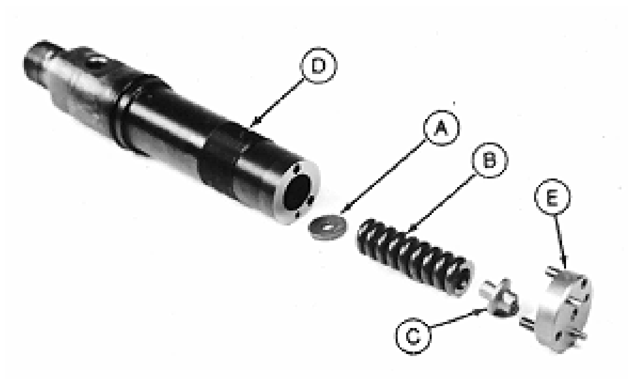
Nippondenso Shown (Bosch Similar)

RG,CTM42,G35,58-19-03OCT92

3. 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



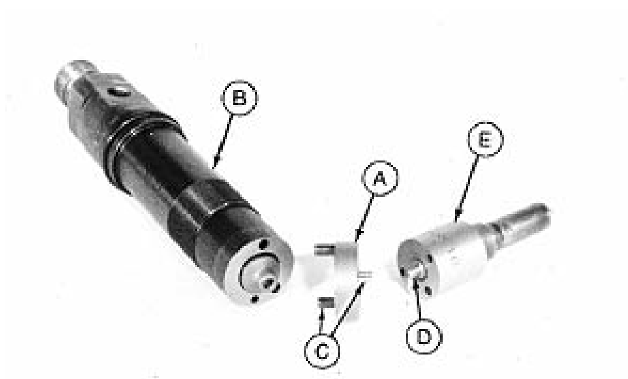
RG5957 -UN-30AUG91

RG,CTM42,G35,59-19-12SEP91

4. Position intermediate plate (A) on nozzle holder (B). Dowel pins (C) in plate will permit installation only one way.

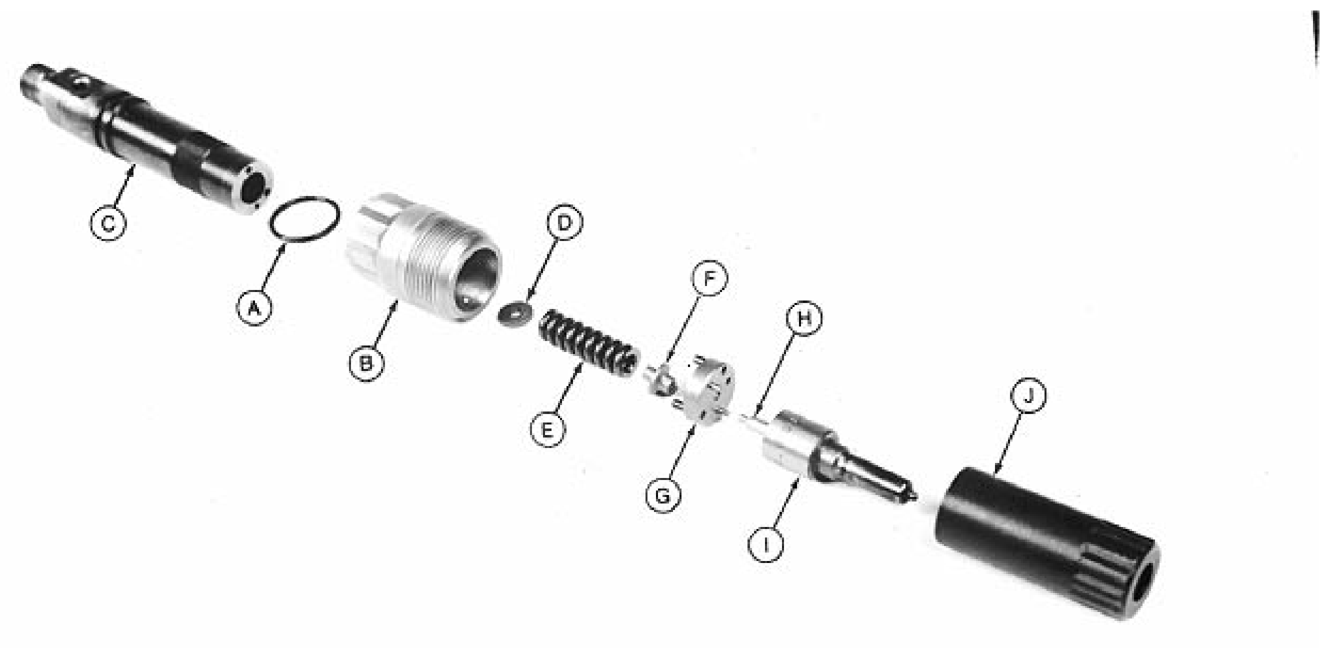
5. Insert nozzle valve (D) into nozzle (E) while holding parts below diesel fuel level in pan.

A—Intermediate Plate
B—Nozzle Holder
C—Dowel Pins
D—Nozzle valve
E—Nozzle



RG5961 -UN-30AUG91

RG,CTM42,G35,36-19-03OCT92



A—Gland Nut O-Ring	**D—Shim**	**G—Intermediate Plate**	**I—Nozzle**
B—Gland Nut	**E—Nozzle Valve Spring**	**H—Nozzle Valve**	**J—Nozzle Retaining Nut**
C—Nozzle Holder	**F—Spring Seat**		

Nippondenso Nozzle (Bosch Similar)

6. Install nozzle assembly on nozzle holder (C) and secure with nozzle retaining nut (J).

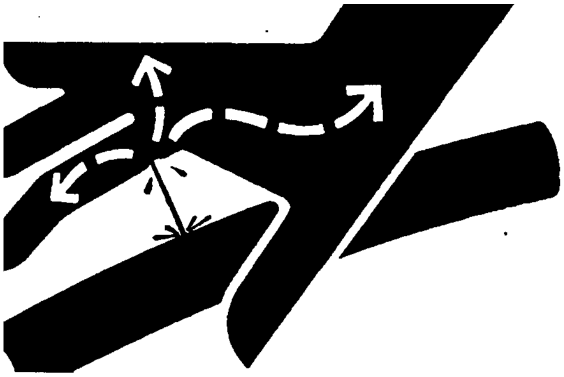
7. Clamp nozzle holder in a soft-jawed vise. Tighten nozzle retaining nut (12) to 60—79 N·m (44—58 lb-ft).

8. Install leak-off connector on nozzle holder (C), using a new O-ring.

NOTE: Leak-off connector and O-ring 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 O-ring before installation on engine.

RG,CTM42,G35,60-19-03OCT92

ADJUST FUEL INJECTION NOZZLES



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.

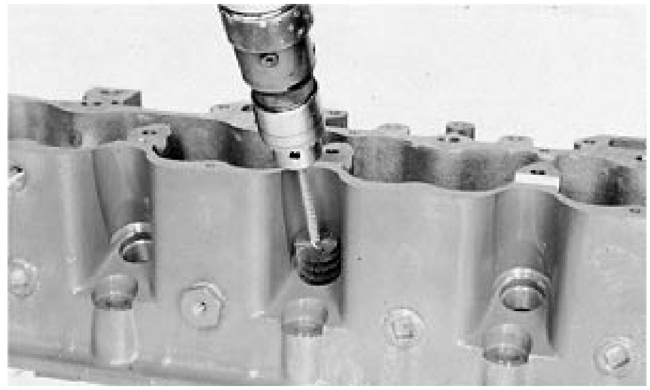
2. Refer to PERFORM OPENING PRESSURE TEST, earlier in this group, to test opening pressure of nozzle. Adjust as needed.

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

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).

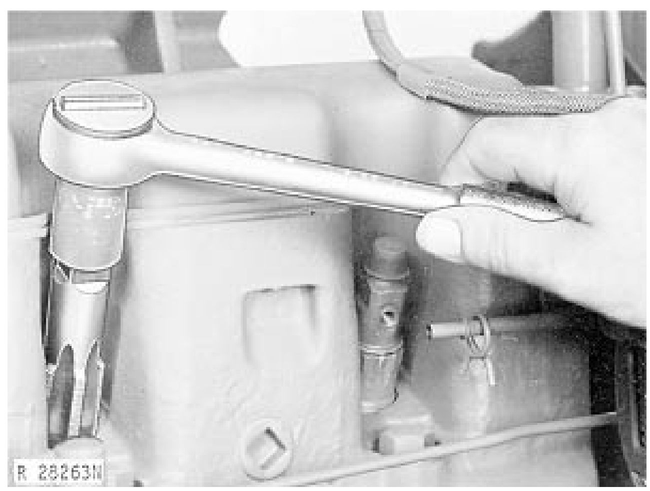
2. Inspect condition of nozzle seating surface in cylinder head.

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 Thread Cleaning Brush. Work brush up and down several times to clean threads.

S55,3010,AU -19-03OCT92



R28263N -UN-20DEC88

4. Clean threads with heavy foreign deposits or clean up damaged threads by 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.

RG,CTM42,G35,37-19-03OCT92

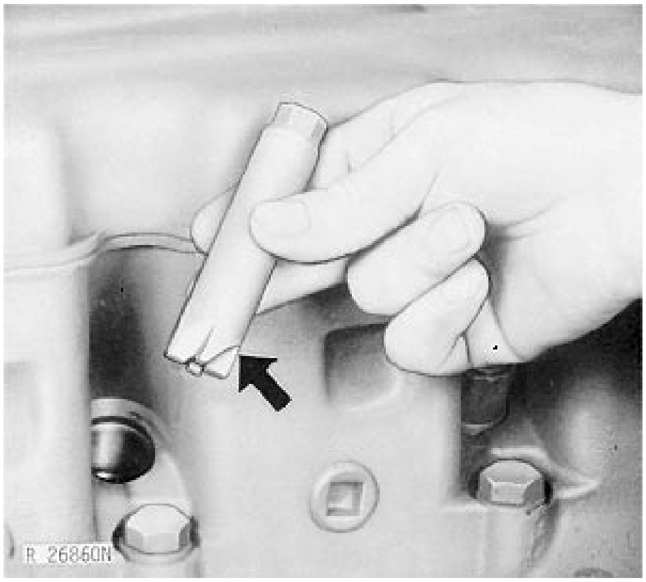
INSPECT AND CLEAN NOZZLE SEATING SURFACE

1. Inspect nozzle seating surface for carbon deposits.

2. If seat is not clean, use the 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 the nozzle tip bore.

4. Blow out debris from nozzle cavity with compressed air; then remove wood dowel.



R26860N -UN-20DEC88

RG,CTM42,G35,38-19-02OCT92

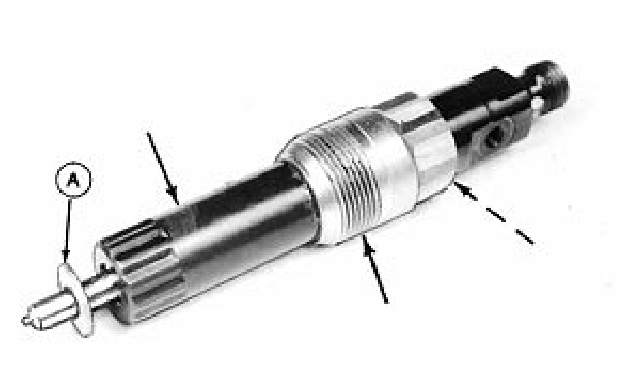
INSTALL FUEL INJECTION NOZZLES

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.

2. Install a new R84472 Special Steel Washer (A) on tip end of assembled injection nozzle.

IMPORTANT: Do not intermix injection nozzles of different suppliers or different tip sizes within a single engine.



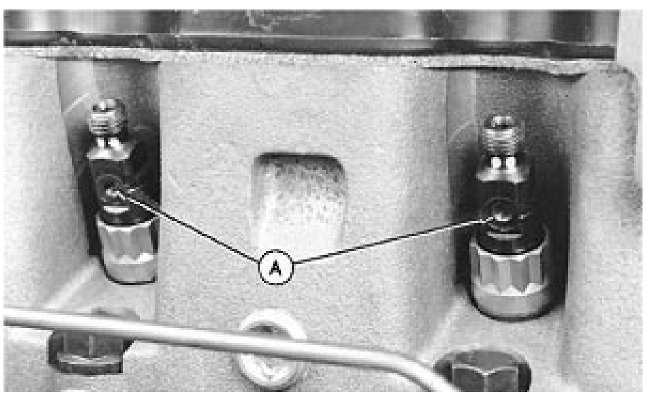
RG5888 -UN-19AUG91

RG,CTM42,G35,39-19-03OCT92

3. Insert injection nozzle into cylinder head. Turn gland nut by hand to make sure it is threaded straight in cylinder head.

4. Use outer socket of JDE92 Nozzle Socket and turn gland nut down to remove most of the looseness.

5. Rotate nozzle holder so hole for leak-off connector threads (A) are facing straight out from cylinder head.



RG5889 -UN-19AUG91

RG,CTM42,G35,41-19-15SEP94

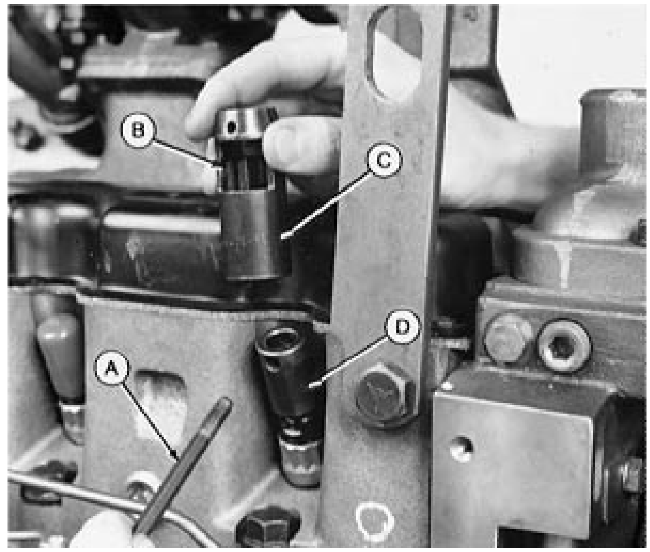
35
59

6. Position inner socket (D) over nozzle holder and engage with flats at top of nozzle holder.

7. Place outer socket (C) portion of JDE92 Nozzle Socket on gland nut with socket “window” (B) facing outward.

8. Insert handle (A) 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.



RG5758 -UN-05AUG91

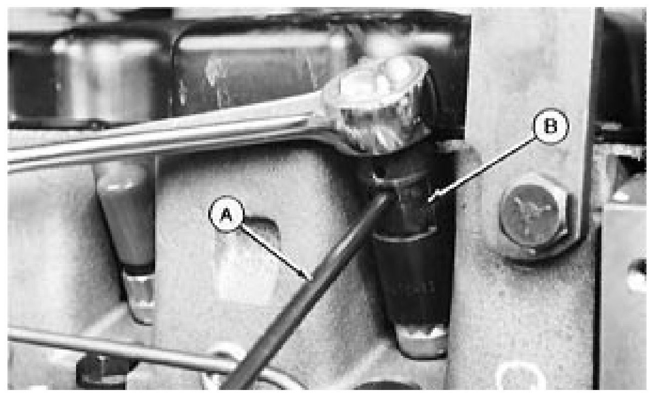
A—Handle
B—Window
C—Outer Socket
D—Inner Socket

RG,CTM42,G35,42-19-15SEP94

9. Tighten injection nozzle gland nut to 88 N·m (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.

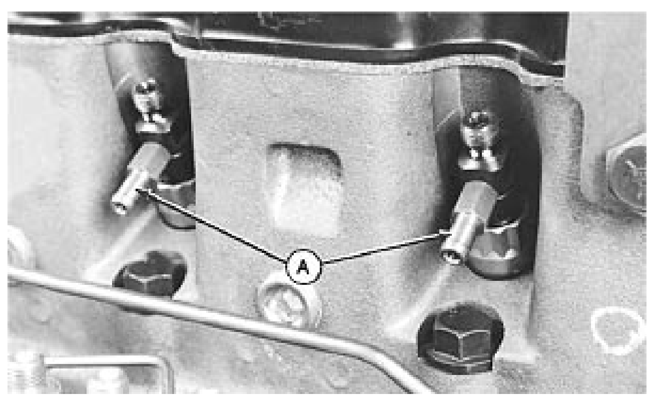
10. Be sure O-ring is positioned against injection nozzle gland nut.



RG5759 -UN-05AUG91

RG,CTM42,G35,43-19-03OCT92

11. Install leak-off connectors (A) with O-rings on injection nozzles. Tighten securely.



RG5890 -UN-19AUG91

RG,CTM42,G35,44-19-10SEP91

12. Loosen all leak-off line fittings (A), remove pipes (B), and inspect packings (C). Discard packings that are worn or cut.

NOTE: Mark each leak-off pipe before disassembly to assure assembly in correct location.

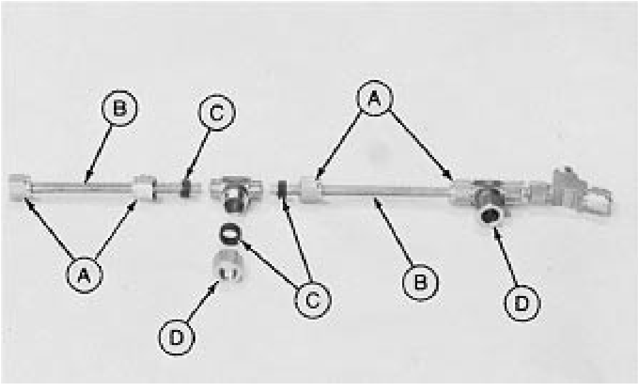
13. Check all pipes and fittings for wear or damage and replace as necessary.

14. Reinstall new packings (if needed), and pipes into tee-fittings. Tighten all connections securely.

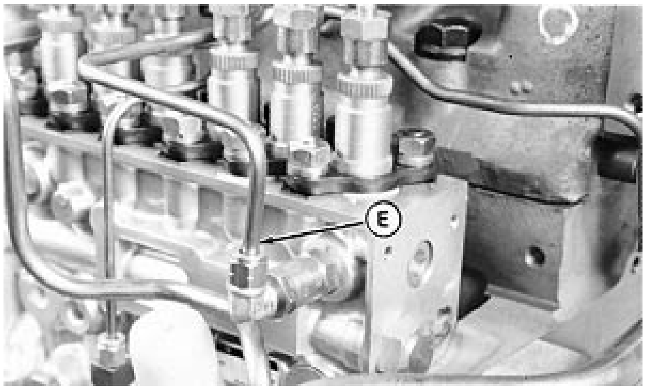
15. Install nuts (D) and packings onto leak-off connectors. Install complete assembly over appropriate leak-off line connectors.

16. Tighten all leak-off line connections securely at each injection nozzle.

17. Connect leak-off line at injection pump (E) and tighten securely.



RG5091 -UN-14DEC88



RG5880 -UN-19AUG91

A—Fittings
B—Pipes
C—Packings
D—Nuts
E—Pump Leak-off Line

RG,CTM42,G35,45-19-28OCT92

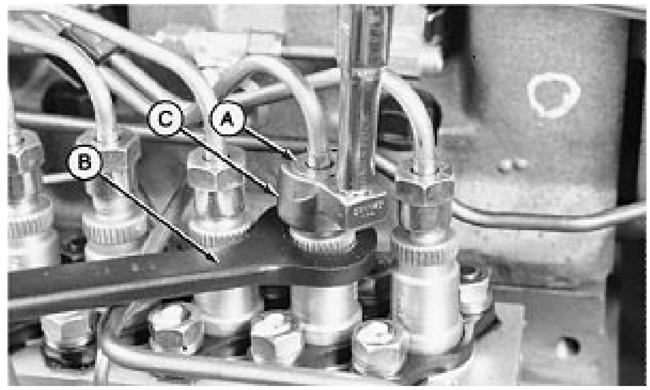
IMPORTANT: Use JDE90 Serrated Wrench (B) on Robert Bosch "P" injection pumps, or a 22 mm open end wrench on Nippondenso "P" and all "A" pumps, to keep delivery valve fittings stationary while tightening fuel line nuts. If a delivery valve and barrel housing rotates while tightening a fuel line nut, injection pump fuel delivery will be altered, and pump will have to be recalibrated on a test stand.

18. Remove protective caps and plugs, that were installed during disassembly, from injection lines, nozzles and delivery valves. Install and connect injection line assembly at each respective injection nozzle and delivery valve.

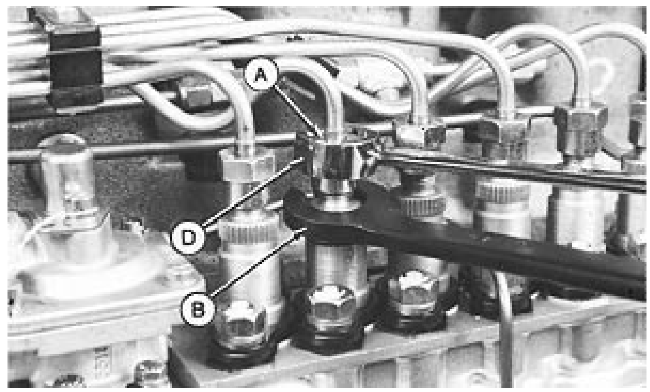
19. Tighten fuel injection line nozzle nuts (A) to 27 N·m (20 lb-ft).

20. 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 (B) (Robert Bosch "P" Pumps) or a 22 mm open end wrench (all other pumps).

21. Bleed the fuel system. (See BLEED THE FUEL SYSTEM, in Group 115.)



RG5877 -UN-19AUG91



RG5878 -UN-19AUG91

A—Fuel Injection Line Nuts
B—JDE90 Serrated Wrench
C—JDF22 Crowsfoot Wrench
D—3/4 in. Line Wrench

RG,CTM42,G35,46-19-03OCT92

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EFFECTS OF ALTITUDE AND TEMPERATURE ON ENGINE PERFORMANCE

Altitude, fuel temperature, air temperature, and humidity may affect engine performance. As a general rule, atmospheric changes will usually cause a decrease in engine power by the percentages shown in chart below.

ATMOSPHERIC CHANGE	% POWER DECREASE
Fuel Temperature Rise of 1˚C (1.8˚ F) above 40˚C (104˚F)	0.29
Air Temperature Rise of 5.5˚ C (10˚ F) above 25˚C (77˚F)	0.50
Naturally Aspirated Engines: Altitude Rise of 300 m (1000 ft) above 183 m (600 ft)	3.00**
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.*

***Engine may have to be defueled when a substantial percentage of operating time occurs at 1500 m (5000 ft) or higher.*

RG,CTM42,G100,6-19-30SEP94

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 Group 105).

S11,22010,BW -19-08APR94

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

NOTE: High elevations may affect engine performance. See EFFECT 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.

3. Run engine at fast idle.

4. Gradually increase load on engine until speed is reduced to rated speed rpm.

NOTE: Refer to the appropriate machine technical manual for average power ratings of specific applications, allow ±5% for minimum and maximum power.

5. Read horsepower on dynamometer and record reading.

6. Compare readings taken with power rating level for your engine application.

RG,CTM86,G100,2-19-16SEP94

ENGINE BREAK-IN GUIDELINES

Engine break-in should be performed when the following repair have been made:

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

• Pistons, rings, or liners have been replaced.

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

• Cylinder head has been removed. Check and reset valve clearance.

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

RG,CTM61,G105,2-19-29SEP94

PERFORM ENGINE BREAK-IN

Use a dynamometer to perform the following break-in procedure. If necessary, 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 a new engine or engine that has had a major overhaul. TORQ-GARD SUPREME PLUS-50 oil will not allow a new or overhauled engine to properly wear during this break-in period.

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

Fill engine crankcase with John Deere Break-In oil to proper level for use during the break-in operation. This oil is specifically formulated to enhanced break-in of John Deere diesel engines. Add John Deere Break-In oil as needed to maintain the specified oil level during break-in period.

ENGINE BREAK-IN AFTER MAJOR OVERHAUL

Time	Load	Engine Speed
5 Minutes	No Load	850 rpm
5 Minutes	No Load	1500—2000 rpm
5 Minutes	1/4 Load	1900—2100 rpm
10 Minutes	1/2 Load	1900—2100 rpm
10 Minutes	1/2—3/4 Load	1900—2100 rpm
10 Minutes	3/4—Full Load	Rated Speed

Check and readjust valve clearance as necessary. Cylinder head retorque is not required. (See Group 05, Cylinder Head and Valves.)

Sufficiently load engine during the first 100 hours of operation, but, avoid over-loads, excessive idling, and extended no-load operation.

A second 100-hour service interval with John Deere Engine Break-In Oil may be required if the engine is operated under light loads during the first 100-hour break-in period.

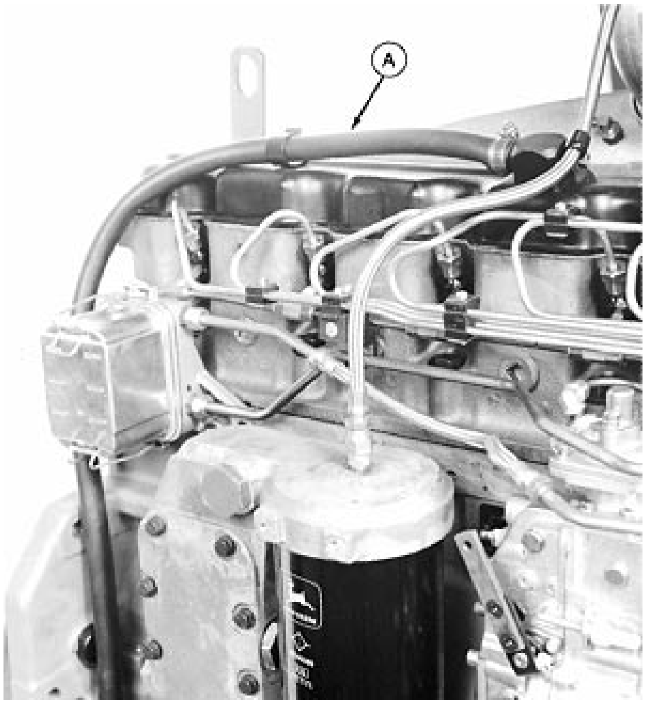
After 100 hours maximum, drain break-in oil and change oil filter. Fill crankcase with John Deere TORQ-GARD SUPREME PLUS-50™ or other heavy-duty diesel engine oil within the same service classification as recommended in this manual. See DIESEL ENGINE OIL in Group 02, Fuels, Lubricants, and Coolant.

RG,CTM86,G100,5-19-26OCT94

CHECK CRANKCASE VENTILATION SYSTEM

1. Inspect crankcase ventilation system for restrictions. 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.

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



RG5930 -UN-20AUG91

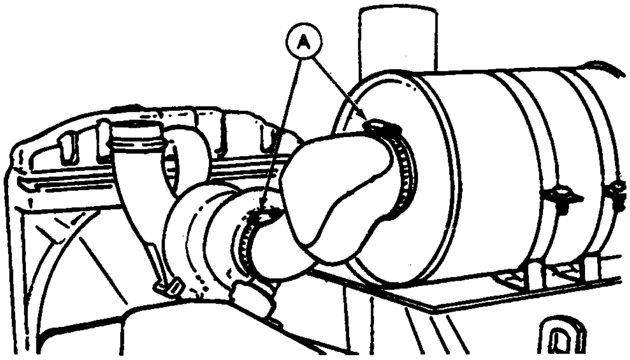
RG,CTM42,G100,1-19-29OCT92

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.



RG4689 -UN-20DEC88

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

RG5964 -UN-05SEP91

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

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

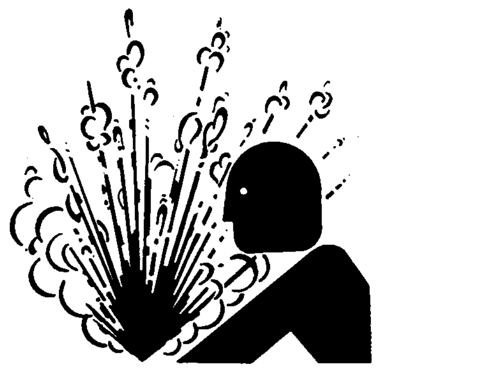
3. Remove the foam filters from weep holes (A) located in the bottom of water pump housing. Inspect the weep holes for any restrictions.

4. Insert a heavy gauge wire deep into weep holes to make sure holes are open.

5. Install new foam filters flush with pump housing in each weep hole, if pump assembly passes inspection.

RG,CTM42,G100,2-19-29OCT92

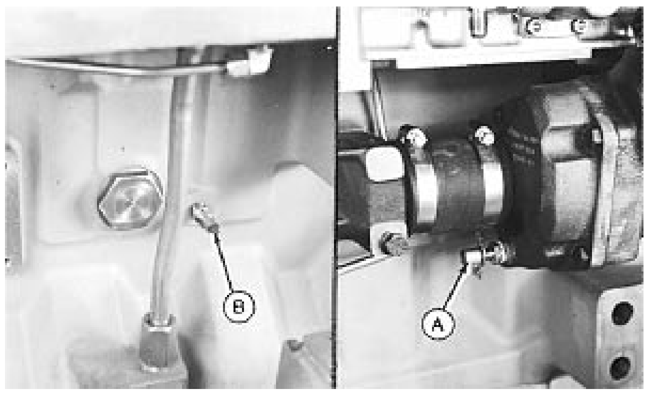
CAUTION: Do not drain coolant until the coolant temperature is below operating temperature. Always loosen water pump drain valve (A) and block drain valve (B) slowly to relieve any excess pressure.



TS281 -UN-23AUG88

IMPORTANT: Both water pump drain valve and block drain valve must be opened to completely drain both sides of the engine.

6. Remove and check thermostats. See REMOVE AND TEST THERMOSTATS in Group 25.



RG5836 -UN-28AUG91

7. Drain and flush cooling system. See FLUSHING AND SERVICING COOLING SYSTEM in Group 02.

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

8. Fill cooling system with coolant. Follow recommendations in Group 02.

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

10. After engine cools, check coolant level.

NOTE: Coolant level should be approximately 19 mm (3/4 in.) below bottom of radiator filler neck.

11. Check system for holding pressure. See PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP in Group 105.

RG,CTM42,G100,3-19-29OCT92

CHECK ELECTRICAL SYSTEM

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

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

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

TS204 -UN-23AUG88

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

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

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

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

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

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

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

6. Check tension of fan belts. See operator's manual.

7. Check operation of starting motor and gauges.

S11,22010,CZ -19-16SEP94

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

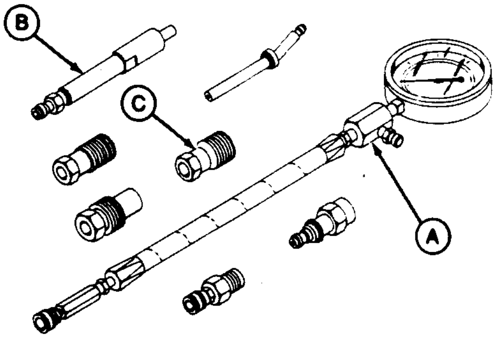
Compression Test Kit JT01674 (D14546BA)

A—Gauge and Hose Assembly JT01682 (D14547BA)

B—Nozzle Adapter JT01675A (D14557BA)

C—Adapter Nut JT01677

Used to test each cylinder's compression pressure.

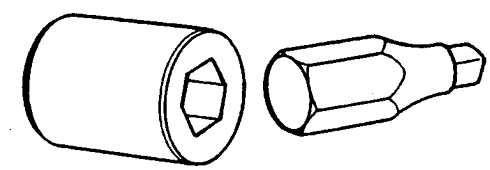


RG5784 -UN-09AUG91

RG,JT01674 -19-17SEP91

Oil Galley Plug Tool JDG782

Used to remove and install oil galley plug.

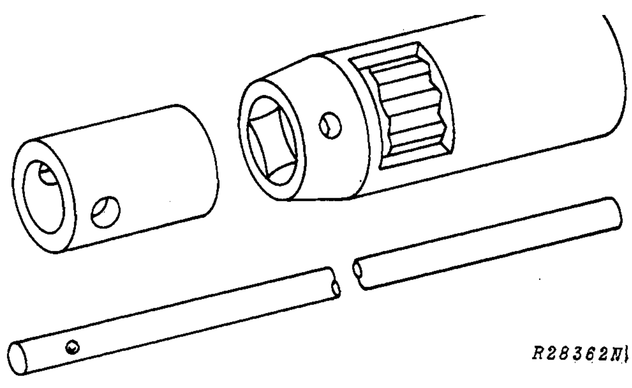


RG6612 -UN-29JAN93

RG,JDG782 -19-02APR93

Nozzle Socket JDE92

Used to remove and install fuel injection nozzles.



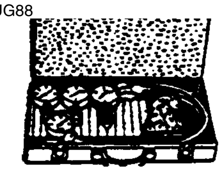
R28362N -UN-20DEC88

S11,22005,R -19-16AUG94

Universal Pressure Test Kit JT05470 (D15027NU)

Used for testing engine oil pressure.

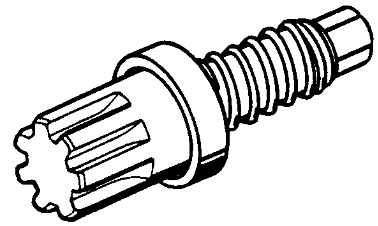
RG5162 -UN-23AUG88



S55,22005,B -19-17SEP91

Flywheel Turning Tool JDG820

Used to rotate engine to check damper radial runout and time engine. JDE81-1 may be used also if JDG820 is not available.



RG7056 -UN-10AUG94

RG,JDG820 -19-14FEB95

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Lock engine at TDC when timing valve train.

S53,JDE814A -19-08AUG94

Cooling System Pressure Pump D05104ST

Used to pressure test radiator cap and cooling system.

R26406N -UN-29NOV88

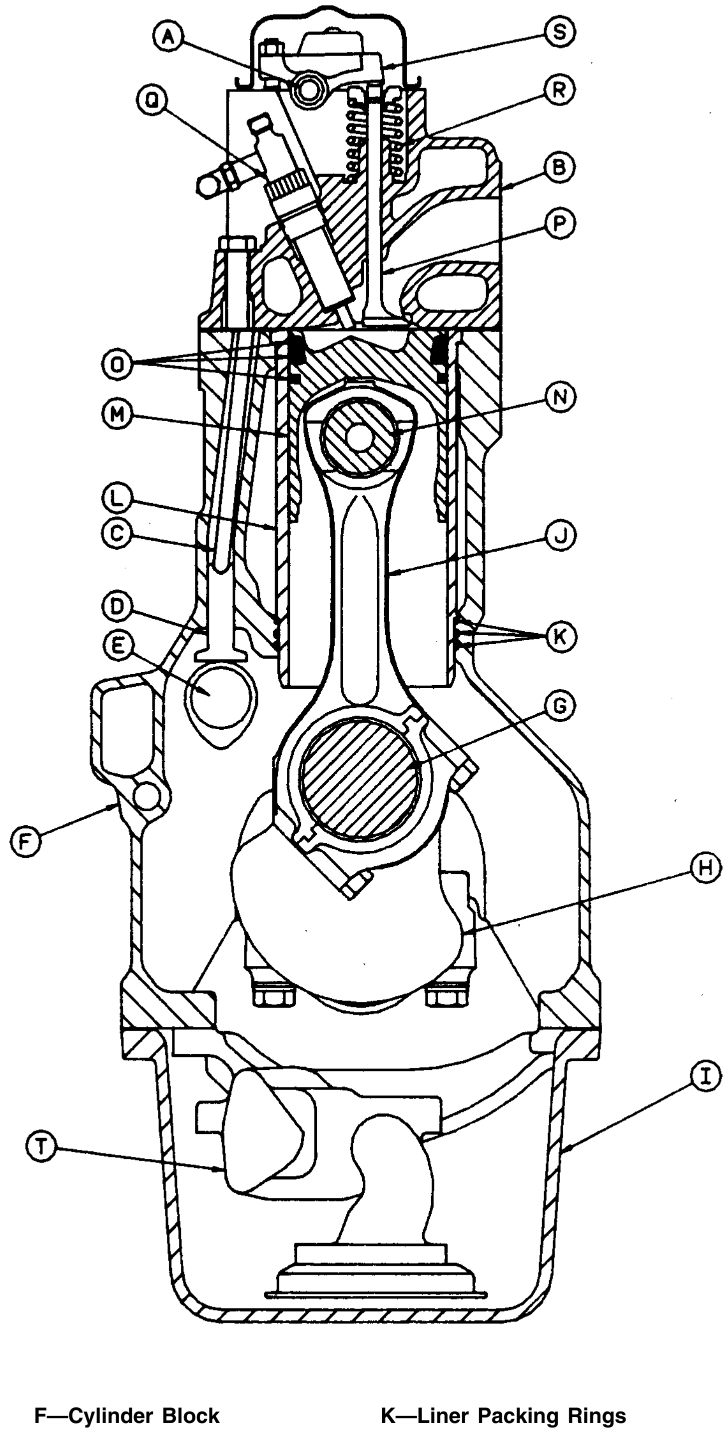
S55,22005,C -19-17SEP91

ENGINE TEST SPECIFICATIONS

ITEM	SPECIFICATION
Compression Pressure:	
(at 275—325 RPM cranking speed)	2380—2790 kPa (23.8—27.9 bar) (345—405 psi)
Maximum Variation between cylinders	340 kPa (3.4 bar) (50 psi)
Oil Pressure at 115˚C (240˚F):	
Minimum No Load at 850 rpm (Slow Idle)	138 kPa (1.4 bar) (20 psi)
Maximum Full Load at 1800—2200 rpm Rated Speed)	400 kPa (4.0 bar) (58 psi)
Cooling System Leakage Test Pressure	50 kPa (0.5 bar) (7 psi)

RG,CTM42,G105,1-19-16AUG94

ENGINE—SECTIONAL VIEW



A—Rocker Arm Shaft	**F—Cylinder Block**	**K—Liner Packing Rings**	**P—Valve**
B—Cylinder Head	**G—Crankshaft**	**L—Cylinder Liner**	**Q—Fuel Injection Nozzle**
C—Push Rod	**H—Crankshaft Counterweight**	**M—Piston**	**R—Valve spring**
D—Cam Follower	**I—Oil Pan**	**N—Piston Pin**	**S—Rocker Arm**
E—Camshaft	**J—Connecting Rod**	**O—Piston Rings**	**T—Oil Pump**

RG,CTM42,G1,6 -19-20AUG91

GENERAL ENGINE DESCRIPTION

All 6076 Engines are vertical stroke, in-line, valve-in-head, 6-cylinder diesel engines. The cylinder firing order is 1-5-3-6-2-4.

On 6076 Engines, direct fuel injection is provided by an in-line injection pump and 21 mm injection nozzles mounted in cylinder head. The pump is driven by an intermediate gear in the timing gear train meshing with the camshaft gear.

The pump has an engine-driven camshaft which rotates at one-half engine speed. Roller cam followers, riding on the camshaft lobes, operate the plungers to supply high-pressure fuel through the delivery valves to the injection nozzles. A governor-operated control rack is connected to the control sleeves and plungers to regulate the quantity of fuel delivered to the engine.

All engines are turbocharged. Operated by exhaust gases, the turbocharger compresses intake air from air cleaner and routes it to each cylinder's combustion chamber.

An air-to-air aftercooler cools the turbocharger compressor discharge air by routing it through a heat exchanger (usually mounted in front of radiator) before it enters the intake manifold. The heat exchanger uses no liquid coolant, but relies on air flow to cool the charge air.

The camshaft and followers are made of chilled iron. The cam lobes are individually flame hardened to provide excellent wear characteristics. Spherically ground followers riding on tapered cam lobes help insure positive follower rotation.

Intake and exhaust valves are operated by cam followers, push rods, and rocker arm assembly. Cylinder heads have replaceable inserts and valves, and have positive rotators for both intake and exhaust valves.

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.

Pistons are constructed of high-grade cast aluminum alloy and are cam ground. A double Ni-Resist ring carrier is cast integrally in the piston to greatly improve the life of the two ring grooves. A deep combustion chamber design provides maximum combustion efficiency. Pistons have a three ring combination. The top two rings are compression rings and the lower ring is an oil control ring.

The highly polished, hardened piston pins are fully-floating and held in position by means of snap rings. Spray jets (piston cooling orifices) in cylinder block direct pressure oil to lubricate piston pins and cool pistons.

Connecting rods are of forged steel and have replaceable bushing and bearing inserts. They are weight controlled (by machining) on both ends to minimize engine vibration.

The engine is supplied with lubricating oil by a spur gear pump driven off the rear of the crankshaft. Oil is conditioned in a housing located on the right side of the engine. Oil temperature is limited by an oil cooler and filtered by a full flow oil filter. Individual cooler and filter bypass valves protect the system and ensure engine lubrication during times of high restriction; such as cold starts. Oil pressure is controlled by a pressure regulating valve located before the gallery.

RG,CTM42,G1,5 -19-29OCT92

HOW THE LUBRICATION SYSTEM WORKS

NOTE: Refer to illustration on following page. A separate illustration of the oil conditioning housing assembly is found later in this group.

The engine lubrication system consists of a gear-driven (crankshaft), positive displacement pump (O), oil cooler (A), oil filter (C), cooler bypass valve (B), filter bypass valve (D), and oil pressure regulating valve (E).

Oil is drawn up from the oil pan through the oil pump. After it leaves the oil pump, oil flows to the oil cooler through a machined passage in the cylinder block. The oil conditioning housing (V) contains the oil cooler bypass valve, oil filter bypass valve, oil pressure regulating valve, and the engine oil filter. Oil then proceeds through the oil cooler where it exchanges heat with the coolant.

If high restriction is sensed, such as during a cold start, oil bypasses the oil cooler through the cooler bypass valve and goes directly to the oil filter. If excessively high restriction is sensed at the filter, oil is diverted directly to the regulating valve. After flowing past the regulating valve; pressurized, cooled clean oil is supplied to the main oil gallery. Oil is then distributed, under pressure, to each main bearing (F) and piston cooling orifice (I). Oil from the piston cooling orifices lubricates the piston pin and bushing (J) through a hole in the top of the connecting rod. The regulating valve permits excess oil to be diverted back to the oil pan.

From the main oil gallery, cooled clean oil is pressure fed to the main and rod bearings (G), piston cooling orifices, and camshaft bushings (H). Oil from the front camshaft bushing is fed through a drilled hole in the camshaft nose and lubricates the camshaft thrust washer and splash lubes the front gears. The injection pump is pressure lubed off of the main gallery.

Oil from the rear camshaft bushing is fed through a drilling in the cylinder block and cylinder head and up to the rocker arm shaft. Oil from the shaft is distributed to the rocker arms. Oil from the rocker arms lubricates the other valve train components and camshaft followers.

Clean oil from the oil filter goes to the turbocharger oil inlet line (K) and is returned through the turbocharger oil return tube (L). Oil completes the circuit by returning to the oil pan.

CTM42,G105,20 -19-29OCT92

HOW THE LUBRICATION SYSTEM WORKS—CONTINUED

RGC6421 -UN-

A—Engine Oil Cooler
B—Oil Cooler Bypass Valve
C—Oil Filter
D—Filter Bypass Valve
E—Oil Pressure Regulating Valve
F—Main Bearings
G—Connecting Rod Bearings
H—Camshaft Bushings
I—Piston Cooling Orifices
J—Piston Pin and Bushing
K—Turbocharger Oil Inlet Line
L—Turbocharger Oil Return Tube*
M—High Pressure Engine Oil
N—Low Pressure Engine Oil
O—Engine Oil Pump
P—From Oil Cooler*
Q—To Oil Cooler*
R—From Oil Pump*
S—To Main Oil Gallery*
T—To Oil Pan*
U—To Turbocharger*
V—Oil Conditioning Housing*

Not shown on this artwork, refer to artwork later in this group.

CTM42,G105,21 -19-29OCT92

HOW THE LUBRICATION SYSTEM WORKS—CONTINUED

A—Engine Oil Cooler*
B—Oil Cooler Bypass Valve
C—Oil Filter
D—Filter Bypass Valve
E—Oil Pressure Regulating Valve
F—Main Bearings*
G—Connecting Rod Bearings*
H—Camshaft Bushings*
I—Piston Cooling Orifices*
J—Piston Pin and Bushing*
K—Turbocharger Oil Inlet Line*
L—Turbocharger Oil Return Tube*
M—High Pressure Engine Oil
N—Low Pressure Engine Oil
O—Engine Oil Pump*
P—From Oil Cooler
Q—To Oil Cooler
R—From Oil Pump
S—To Main Oil Gallery
T—To Oil Pan
U—To Turbocharger
V—Oil Conditioning Housing

**Not shown on artwork on following page. Refer to artwork earlier in this group.*

CTM42,G105,22 -19-29OCT92

HOW THE LUBRICATION SYSTEM WORKS—CONTINUED

RGC6422 -UN-

Oil Conditioning Assembly

CTM42,G105,23 -19-30APR93

HOW THE COOLING SYSTEM WORKS

Refer to illustration on the following page.

The pressurized cooling system consists of a conventional radiator (A), water pump (C), thermostats (H), and water outlet manifold (G).

The pump draws low temperature coolant from the bottom of the radiator and discharges it through the water inlet manifold elbow (D), into the main coolant gallery (E) on the right-hand side of the engine. Coolant from the main coolant gallery flows into the lower end of the engine oil cooler cavity (F), circulates around the oil cooler plates to cool the engine oil, and then flows out the upper end of the oil cooler cavity and into the cylinder block coolant jacket.

Coolant enters the coolant jacket near the rear of the engine, and flows around the cylinder liners progressing upward toward the cylinder head and forward from No. 6 cylinder toward No. 1 cylinder. As the coolant circulates around the cylinder liners, it carries excess heat away from the liners.

The coolant then flows through the block deck passages and cylinder head gasket into the cylinder head. Coolant passages in the block deck, cylinder head gasket, and cylinder head are sized to provide even coolant flow in all parts of the cylinder head. Upon entering the cylinder head, the coolant circulates through cavities around intake and exhaust ports, injector bores, valve guides and valve seats to keep all parts of the head at acceptable temperature levels.

The coolant flows toward the front end of the cylinder head where it passes through the outlet cavity and into the water outlet manifold (G) and thermostat housing.

If the coolant temperature in the thermostat housing is below the thermostat opening temperature, thermostats will remain closed (as during warm-up periods), causing coolant to be directed back through the bypass pipe (B) and into the water pump inlet to be recirculated through the engine. This provides a faster and more uniform warm-up.

If the coolant temperature in the thermostat housing is above the thermostat opening temperature, thermostats will be open (engine is at normal operating temperature) and coolant will flow through the thermostats into the thermostat cover and on to the radiator top tank to be cooled.

On 6076A engines, coolant is taken from the upper left cylinder block and routed into the aftercooler (I) where it circulates through the aftercooler core and back out to the thermostat housing. Coolant circulating through the aftercooler absorbs heat from the pressurized intake air and carries the heat back to the engine cooling system to be dissipated through the radiator.

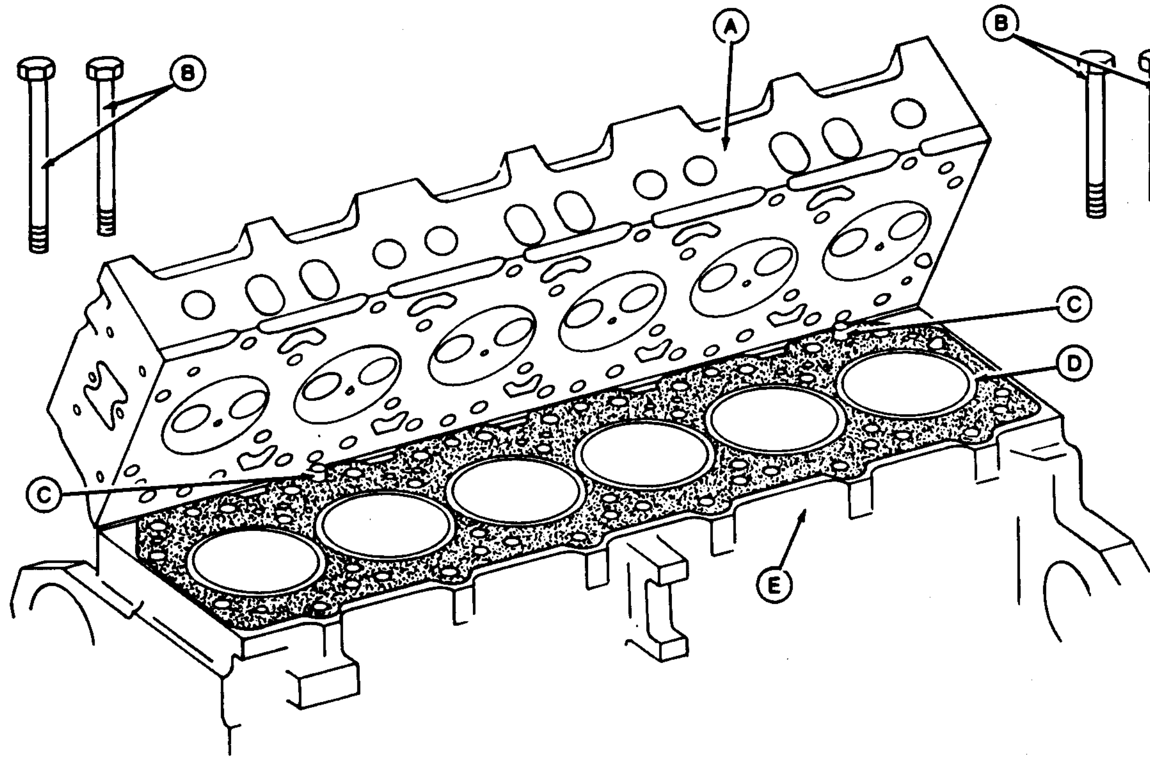
Two locations are provided for draining the coolant out of the engine. The block drain valve (J) is located in the center of the left-hand side of the cylinder block, and is used to drain the left side of the engine. The water pump drain valve (K) is located on the bottom rear of the water pump, and is used to drain the right side of the engine (water pump, oil cooler, main coolant gallery).

CTM42,G105,24 -19-29OCT92

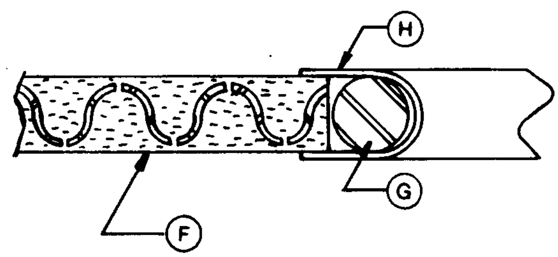
HOW THE COOLING SYSTEM WORKS—CONTINUED

A—Radiator
B—Coolant Bypass Pipe
C—Water Pump
D—Water Inlet Manifold Elbow
E—Main Coolant Gallery
F—Engine Oil Cooler
G—Water Outlet Manifold
H—Thermostats (2 used)
I—Aftercooler ('A' Engines)
J—Block Drain Valve
K—Water Pump Drain Valve
L—Low Temperature Engine Coolant
M—High Temperature Engine Coolant

HEAD GASKET JOINT CONSTRUCTION AND OPERATION



RG6447 -UN-13OCT92



RG6430 -UN-17SEP92

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

The head gasket joint consists of:

- Cylinder head gasket
- Cylinder head (A)
- Cylinder block (E)
- Cylinder liners (C)
- Cylinder head cap screws (B)

Refer to illustration on previous page.

The head gasket must form an air-tight seal between cylinder liners and cylinder head that can withstand the temperatures and pressures of the combustion process. The gasket must also form a liquid-tight seal between the cylinder head and cylinder block to retain coolant and oil in their respective passages. The gasket is constructed of thin, formed sheets of steel-inserted, non-asbestos material (F). The surface of gasket is treated to improve liquid sealing and anti-stick characteristics. A fire ring combustion seal (G) is located at each cylinder bore and is held in place by a U-shaped stainless steel flange (H).

The cylinder head and block must be flat to provide an even clamping pressure over the entire surface of gasket, and must have the proper surface finish to keep gasket material from moving in the joint. Dowels (D) are used to properly locate head gasket on block.

The cylinder liners must protrude evenly from top of cylinder block the specified amount to provide adequate clamping force on fire ring of each cylinder.

The cap screws must be proper length, made of proper material, and be tightened to proper torque in order to provide an adequate clamp 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.

CTM42,G105,26 -19-29OCT92

DIAGNOSING HEAD GASKET JOINT FAILURES

Head gasket failures generally fall into three categories:

• Combustion seal leakage.
• Coolant seal leakage.
• Oil seal leakage.

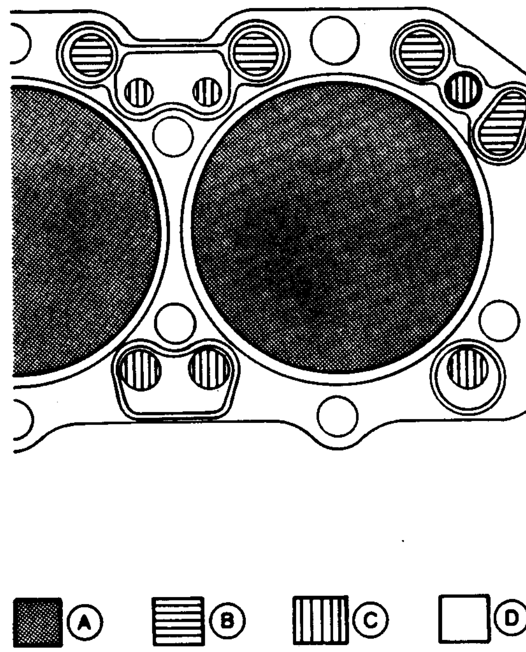
Combustion seal leakage failures occur when combustion gases escape between cylinder head and head gasket combustion flange, or between combustion flange and cylinder liner. Leaking combustion gases may vent to an adjacent cylinder, to a coolant or oil passage, or externally.

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.



RG6449 -UN-13OCT92

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

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14

CTM42,G105,16 -19-08APR94

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)

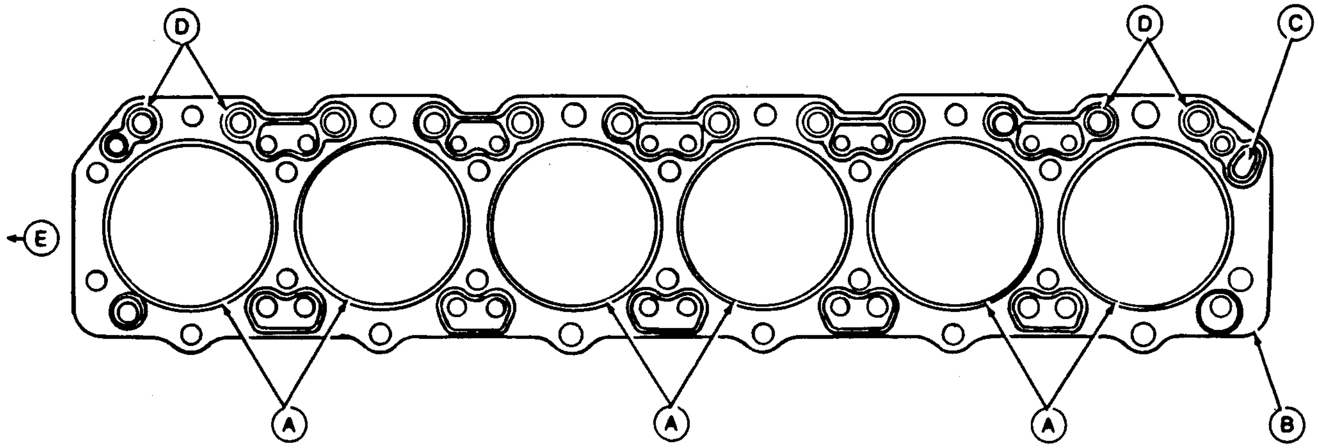
Possible Causes:

- 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



A—Combustion Seals (Flanges)
B—Gasket Body
C—Rocker Arm Oil Port
D—Elastomer Beading Strips
E—Front of Engine

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

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

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

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

4. Remove cylinder head using appropriate lifting devices to prevent handling damage to head gasket. See REMOVE CYLINDER HEAD 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).
- Elastomer missing/damaged in port areas (D).
- Oil or coolant paths from port areas.
- Localized areas of low compression.

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

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CTM42,G105,17 -19-08APR94

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

S11,22010,BO -19-18AUG94

DIAGNOSING ENGINE MALFUNCTIONS—CONTINUED

• Engine Overheats

Service Problem
- Lack of coolant in cooling system
- Radiator core and/or side screens dirty
- Cooling system limed up
- Engine overloaded
- Too low crankcase oil level
- Improper fuel

Basic Engine Problem
- Loose or defective fan belt
- Defective thermostat(s)
- Damaged cylinder head gasket
- Defective water pump
- Defective radiator cap

Fuel System Malfunction - See Group 115
- Fuel injection pump delivers too much fuel
- Fuel injection pump incorrectly timed

• Excessive Oil Consumption

Basic Engine Problem
- Oil control rings worn or broken
- Scored cylinder liners or pistons
- Excessive resistance in air intake system
- Oil flow through oil passages restricted
- Worn valve guides or stems
- Excessive oil pressure
- Piston ring grooves excessively worn
- Piston rings sticking in ring grooves
- Insufficient piston ring tension
- Piston ring gaps not staggered
- Excessive main or connecting rod bearing clearance
- Front and/or rear crankshaft oil seal faulty
- Glazed cylinder liners (insufficient load during engine break-in)

Service Problem
- Too low viscosity crankcase oil
- Crankcase oil level too high
- External oil leaks

• Low Oil Pressure

Service Problem
- Low crankcase oil level
- Improper crankcase oil
- Defective oil pressure warning switch or engine oil pressure indicator light

Basic Engine Problem
- Leakage at internal oil passages
- Defective oil pump
- Excessive main and connecting rod bearing clearance
- Improper regulating valve adjustment
- Piston cooling orifice missing
- Plugged oil pump intake screen

• High Oil Pressure

Basic Engine Problem
- Oil pressure regulating valve bushing loose (wanders)
- Improperly operating regulating valve
- Stuck or damaged filter bypass valve

• Excessive Fuel Consumption

Service Problem
- Improper grade of fuel
- Engine overloaded
- Air cleaner restricted or dirty

Basic Engine Problem
- Compression too low

Fuel System Malfunction - See Group 115
- Leaks in fuel system
- Fuel injection nozzles dirty or faulty
- Fuel injection pump defective (delivers too much fuel)
- Fuel injection pump incorrectly timed
- Improper valve clearance

• Black or Grey Exhaust Smoke

Service Problem
- Excess fuel
- Engine overloaded
- Air cleaner restricted or dirty
- Defective muffler (causing back-pressure)

Fuel System Malfunction - See Group 115
- Fuel injection nozzles dirty or faulty
- Incorrect engine timing

DIAGNOSING ENGINE MALFUNCTIONS—CONTINUED

- **White Exhaust Smoke**

Basic Engine Problem
  Engine compression too low
  Defective thermostat(s) (does not close)
Fuel System Malfunction - See Group 115
  Defective fuel injection nozzles
  Fuel injection pump incorrectly timed
Service Problem
  Improper fuel

- **Coolant in Crankcase**

Basic Engine Problem
  Cylinder head gasket defective
  Cylinder head or block cracked
  Cylinder liner seals leaking

- **Abnormal Engine Noise**

Basic Engine Problem
  Low engine oil level
  Worn main or connecting rod bearings
  Excessive crankshaft end play
  Loose main and connecting rod bearing caps
  Foreign material in combustion chamber
  Worn piston pin bushings and pins
  Scored pistons
  Worn main or connecting rod bearings
  Worn timing gears
  Incorrect engine timing
  Excessive valve clearance
  Worn cam followers
  Bent push rods
  Worn camshaft
  Worn rocker arm shaft
  Insufficient engine lubrication
  Worn turbocharger bearings
  Crankshaft oil pump drive gear worn or broken
  Crankshaft vibration damper worn or separated
Fuel System Malfunction - See Group 115
  Fuel injection pump incorrectly timed

- **Detonation or Pre-Ignition**

Basic Engine Problem
  Oil picked up by intake air stream (intake manifold)
Fuel System Malfunction - See Group 115
  Dirty or faulty fuel injection nozzles
  Incorrect fuel injection pump timing
  Fuel injection nozzle tip holes enlarged
  Fuel injection nozzle tips broken
  Carbon build-up in compression chamber
  Faulty injection pump
Service Problem
  Improper fuel

- **Water Pump Leaking**

Seal ring or pump shaft worn

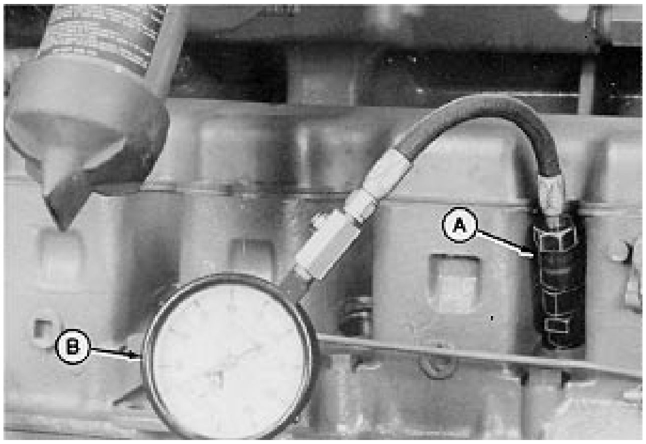
- **Coolant Temperature Below Normal**

Defective thermostat(s)
Coolant temperature gauge defective

- **Engine Vibrating**

Fan blades bent or broken
Water pump shaft worn

TEST ENGINE COMPRESSION PRESSURE



-UN-27OCT88

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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 at slow idle.)

2. Remove injection lines, leak-off lines, and injection nozzles. See Group 35.

3. Install the JT01675A Nozzle adapter and JT01677 Adapter Nut (A) into injection nozzle bore. Tighten adapter nut to 80 N·m (60 lb-ft).

4. Connect JT01682 Gauge and Hose Assembly (B) to nozzle adapter.

5. Pull fuel shut-off knob all the way out, if equipped, and close fuel shut-off valve.

6. Crank engine over at 275—325 rpm cranking speed and record compression readings.

ENGINE COMPRESSION

Engine	Compression Pressure
6076	2380—2790 kPa (23.8—27.9 bar) (345—405 psi)

NOTE: Pressure given was taken at 300 m (1000 ft) above sea level. A 3.6 percent reduction in gauge pressure will result for each additional 300 m (1000 ft) of altitude.

All cylinder pressures should be approximately alike. There should be less than 340 kPa (3.4 bar) (50 psi) difference between cylinder pressures.

7. 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.

8. Crank engine over and record compression reading again.

If pressure is higher than 2790 kPa (27.9 bar) (405 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 2380 kPa (23.8 bar) (345 psi), it is possible that valves are worn or sticking. Recondition cylinder head as needed. See Group 05.

9. Measure compression pressure in all remaining cylinders and compare readings. Recondition power cylinders and valves as required.

S55,22005,I -19-14FEB95

CHECK ENGINE OIL PRESSURE

NOTE: JDG782 Oil Galley Plug Tool must be used to remove galley plugs on current engine.

1. Remove pipe plug (A) from main oil gallery and install No. 0070 (D1) Fitting (A), No. 2106 (19-HP) Hose (B), and JT05472* Gauge (C).

IMPORTANT: To achieve an accurate oil pressure reading, warm up engine to 115°C (240°F).

2. Measure engine oil pressure.

OIL PRESSURE SPECIFICATIONS

Minimum No Load at 850 rpm
(Slow Idle) . . . . 138 kPa (1.4 bar) (20 psi)

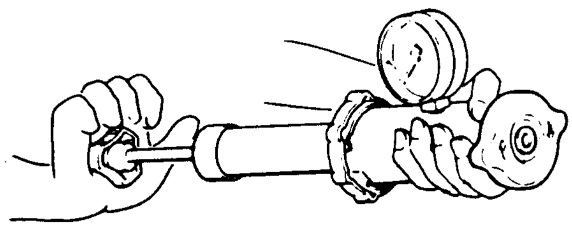
Maximum Full Load at 1800—2200 rpm
(Rated Speed) . . . . 400 kPa (4.0 bar) (58 psi)

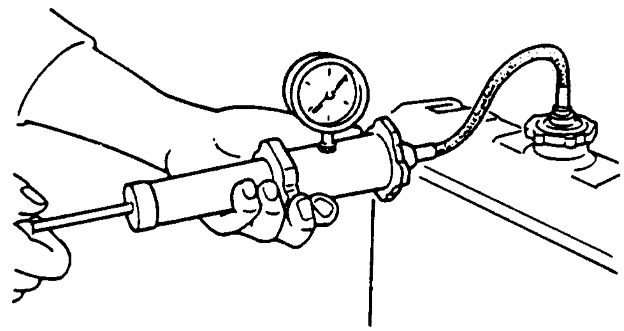
NOTE: The regulating valve is designed so that adjustment of oil pressure should not be required.

** Part of JT05470 (D15027NU) Universal Pressure Test Kit*

RG,CTM42,105,9A-19-14FEB95

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 Tester 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)*.

4. With pressure applied, check all cooling system hose connections, radiator, and overall engine for leaks.

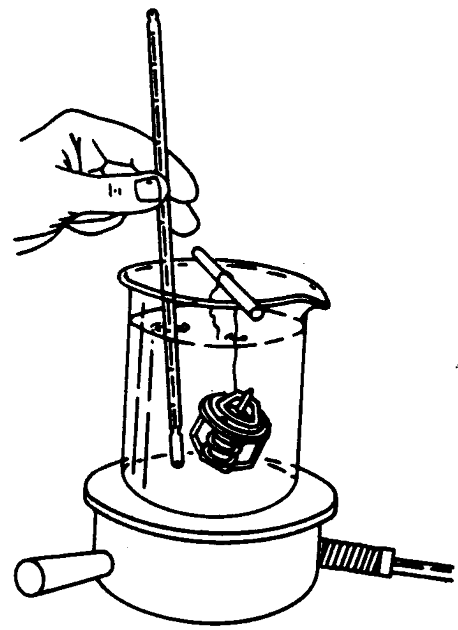
If leakage is detected, correct as necessary and pressure test system again.

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 -19-14OCT94

INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE


RG5971 -UN-17SEP91

Visually inspect thermostat for corrosion or damage. Replace as necessary.

• Test thermostat as follows:

CAUTION: DO NOT allow thermostat or thermometer to rest against the side or bottom of container when heating water. Either may rupture if overheated.

1. Suspend thermostat and a thermometer in a container of water.

2. Stir the water as it heats. Observe opening action of 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)

3. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.

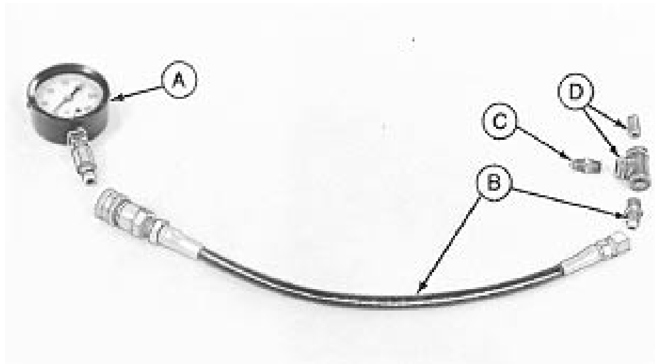
4. If any thermostat is defective on a multiple thermostat engine, replace all thermostats.

CTM42,G105,13 -19-13MAY93

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91



R28266 -UN-15DEC88

A—JT03092 Gauge *

B—JT03017 Hose and Connector *

C—Connector

1/8 in. Pipe Nipple 1/4 in.—1/8 in. Pipe Reducer 1/8 NPT-7/16-20 UNC Adapter	**Used with above hose and gauge to check intake manifold pressure at aneroid.**

D—"T" Fitting

D—JT03104 Fitting*	**Used with above hose and gauge to check intake manifold pressure at aftercooler on 6076A Engines.**

*** Part of JT05412 Universal Pressure Test Kit**

S55,23005,A -19-16SEP94

AIR INTAKE AND EXHAUST SYSTEM TEST SPECIFICATIONS

Engine Application	Fuel Injection Pump Part No.	Air Intake Manifold Pressure (Turbo-Boost) kPa	(bar)	(psi)
6076ADW30	RE55529	104—122	1.0—1.2	15—18
6076ADW31(a)	RE47396	100—116	1.0—1.1	15—17
6076ADW31(b)	RE47396	119—139	1.2—1.4	17—20
6076ADW32	RE55711	111—125	1.1—1.3	16—18
6076AF030	RE47395	119—133	1.2—1.3	17—19
6076AF030	RE47396	156—176	1.6—1.8	23—26
6076AF030	RE48642	161—179	1.6—1.8	23—26
6076AF030	RE48643	168—192	1.7—1.9	24—28
6076AF030	RE50748	158—174	1.6—1.7	23—25
6076AF030	RE55292	179—201	1.8—2.0	26—29
6076AN030	RE47394	156—176	1.6—1.8	23—26
6076AN031	RE50748	158—174	1.6—1.7	23—25
6076AT030	RE46898	152—172	1.5—1.7	22—25
6076AZ030	RE47398	170—188	1.7—1.9	25—27
6076AZ031	RE52038	120—136	1.2—1.4	17—20
6076HF030	RE47396	164—182	1.6—1.8	24—26
6076HF030	RE47410	169—187	1.7—1.9	25—27
6076HH030(a)	RE47396	145—151	1.4—1.5	21—22
6076HH030(b)	RE47396	146—150	1.4—1.5	21—22
6076HH031(a)	RE44518	118—130	1.2—1.3	17—19
6076HH031(b)	RE44518	118—130	1.2—1.3	17—19
6076HH032(a)	RE47396	145—151	1.4—1.5	21—22
6076HH032(b)	RE47396	146—150	1.4—1.5	21—22
6076HRW32	RE47396	158—162	1.5—1.6	22—23
6076HZ030	RE47549	140—156	1.4—1.6	20—23
6076HZ031	RE47399	170—188	1.7—1.9	25—27
6076TDW30	RE54248	95—113	1.0—1.1	14—16
6076TF030	RE48640	115—127	1.2—1.3	17—18
6076TF030	RE48641	131—149	1.3—1.5	19—22
6076TRW30	RE41833	95—113	1.0—1.1	14—16
6076TRW31	RE41233	130—154	1.3—1.5	19—22

RG,CTM42,G110,1-19-17MAR95

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 -19-16SEP92

HOW THE AIR INTAKE AND EXHAUST SYSTEM WORKS

Engine suction draws dust-laden outside air through an air inlet stack into the air cleaner. Air is filtered through dry type primary and secondary (safety) filter elements in the air cleaner canister. Clean air travels through the air intake hose to the turbocharger and intake manifold to the engine.

Exhaust, as it is expelled out the exhaust elbow, drives the turbocharger to deliver a larger quantity of air to meet the engine requirements than what could be delivered under naturally aspirated (non-turbocharged) conditions.

On 6076A Engines, intake air, which has been compressed (and heated) by the turbocharger, flows around the aftercooler and lowers the air temperature as much as 27—32°C (80—90°F) before entering the engine cylinders. Lowering the air temperature makes the air more dense and permits an even greater volume of air to be delivered to engine cylinders for combustion.

On 6076H Engines, an air-to-air aftercooler cools the turbocharger compressor discharge air by routing it through a heat exchanger before it enters the engine. The heat exchanger uses no liquid coolant but relies on air flow to cool the charge air.

This increased volume of air, when combined with a predetermined quantity of additional fuel, enables more power to be produced.

RG,CTM42,110,3 -19-29OCT92

AIR CLEANER OPERATION

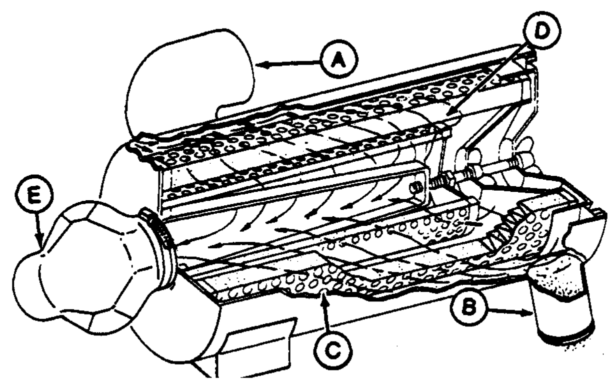
Dust-laden air enters the air cleaner inlet (A) and is forced into a high-speed centrifugal motion.

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.

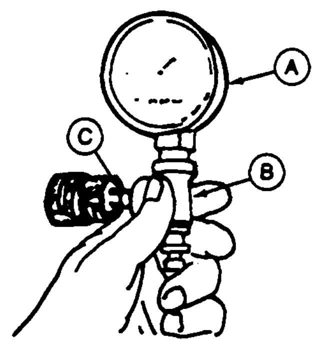


R28270 -UN-14DEC88

A—Air Inlet
B—Dust Outlet
C—Primary Element
D—Secondary (Safety) Element
E—Air Outlet

S11,23005,AO -19-04FEB93

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.

RG,CTM6,G110,1 -19-14AUG91

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.
  Unbalance of 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 -19-18AUG94

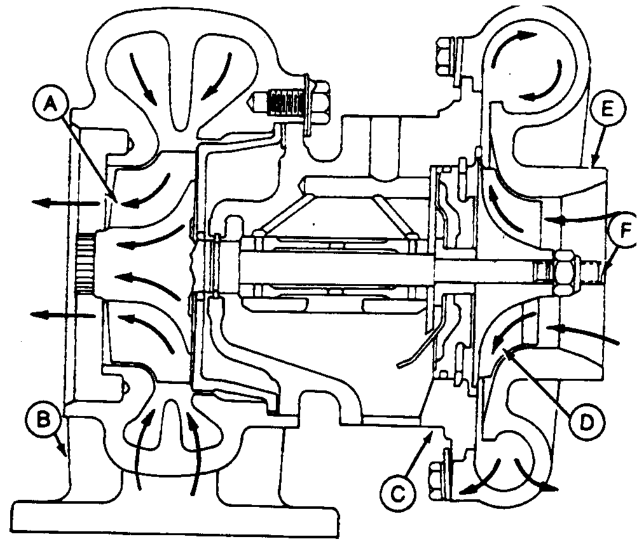
HOW THE TURBOCHARGER WORKS

The turbocharger, which is baically an air pump that is driven by exhaust gases, allows the engine to produce added power without increasing displacement. Turbochargers are specially matched for the power ratio requirements of each specific application.

Exhaust gases from the engine pass through the turbine housing (B) causing the turbine wheel (A) to rotate before the exhaust gas is discharged to the atmosphere. The turbine wheels mounted on a shaft (F) to drive the compressor wheel (D) which is also mounted on the shaft.

As the compressor wheel rotates in the compressor housing (E), an increased volume of (compressed) inlet air is drawn into the housing and delivered to the intake manifold (through an aftercooler or heat exchanger, if so equipped).

All rotating components of the turbocharger are lubricated within the center housing (C).



R28273 -UN-14DEC88

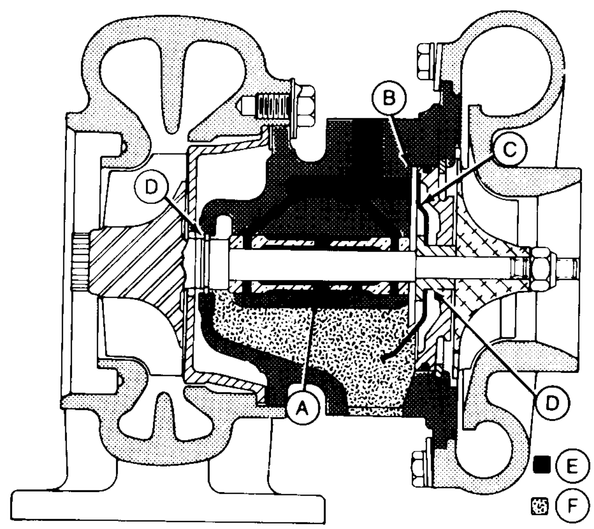
A—Turbine Wheel
B—Turbine Housing
C—Center Housing
D—Compressor Wheel
E—Compresssor Housing
F—Shaft

RG,CTM86,G110,3-19-16SEP94

HOW THE TURBOCHARGER IS LUBRICATED

Engine oil under pressure from the engine lubrication system is pumped through a passage in the bearing housing and directed to the bearings (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 the bearing housing.

The Garrett/AiResearch turbocharger contains two floating bearings and the Schwitzer turbocharger contains a single floating bearing. These bearings have clearance between the bearing OD and the housing bore as well as clearance between the bearing ID and the shaft OD. These clearances are lubricated by the oil supply (E) and the bearings are protected by a cushion of oil. Discharge oil (F) drains by gravity from the bearing housing to the engine crankcase.



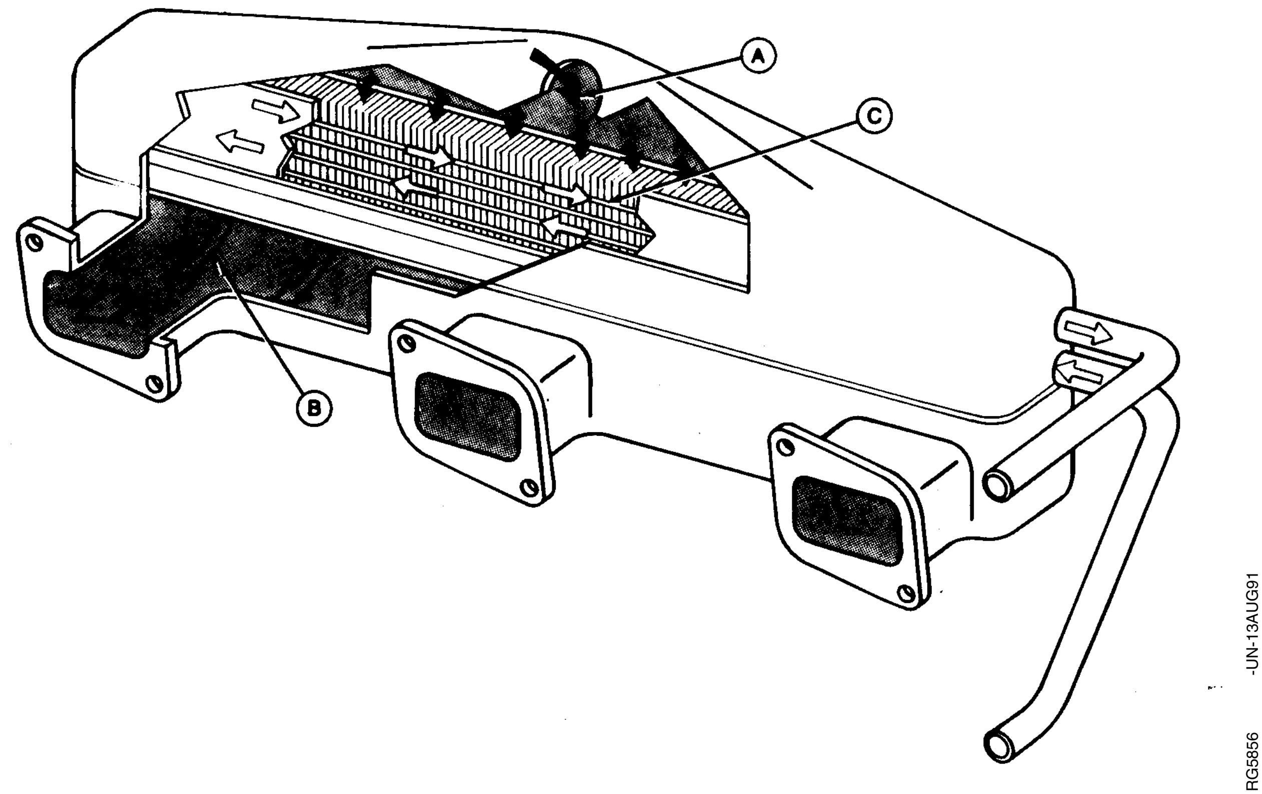
RG4646 -UN-29AUG94

Schwitzer Turbocharger Lubrication

A—Bearing(s)
B—Thrust Plate
C—Thrust Sleeve
D—Piston Ring
E—Pressure Oil
F—Discharge Oil

S11,3005,JE -19-16AUG94

HOW THE AFTERCOOLER WORKS—6076A ENGINES



A—Heated Air **B—Cooled Air** **C—Engine Coolant**

NOTE: On some applications, aftercooler may be mounted horizontally on engine. Specifications are the same regardless of how aftercooler is mounted.

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,CTM42,G30,43-19-29OCT92

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

- **At Aneroid (If Equipped):**

1. Remove aneroid line (A) from aneroid (B).

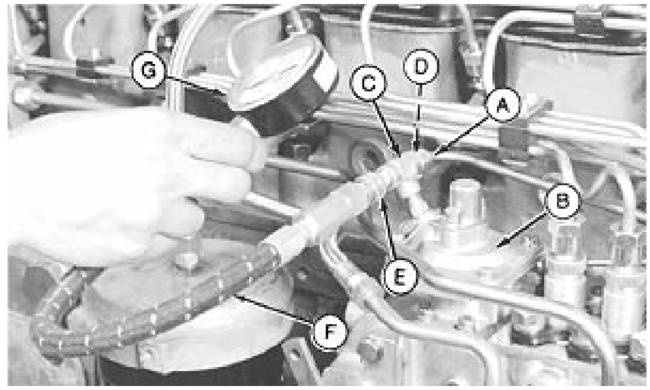
2. Install a 1/8-in. pipe nipple and “T” fitting (C) into aneroid with a 1/4-in. to 1/8-in. pipe reducer (D).

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 at operating temperature, connect to a dynamometer. Operate engine at rated full load speed. Observe pressure readings.

6. Remove test equipment and reinstall aneroid line.



RG5920 -UN-19AUG91

A—Aneroid Line
B—Aneroid
C—T-Fitting
D—1/4—1/8 in. Pipe Reducer
E—Adapter
F—JT03017 Hose
G—JT03092 Pressure Gauge

RG,CTM42,G110,8-19-29OCT92

- **At Intake Manifold:**

6076A engine shown, use same procedure for 6076T and 6076H.

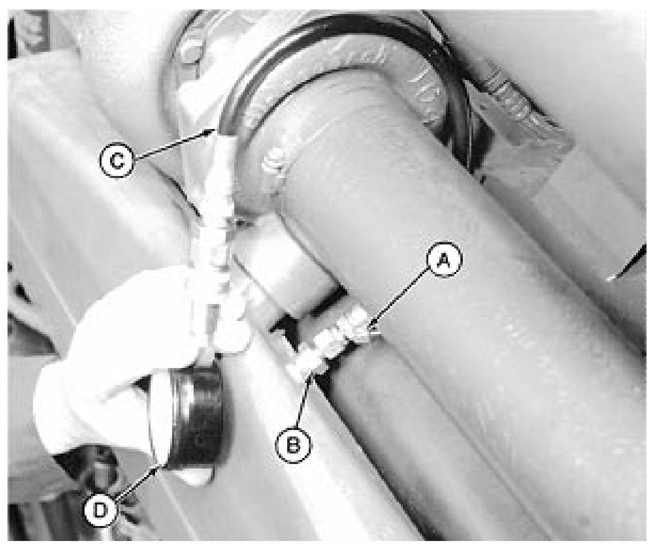
1. Remove ether aid starting line (A), if equipped, nozzle adapter and plug from intake manifold cover.

2. Install JT03104 Fitting (B) into cover.

3. Install a JT03017 Hose (C) with an accurate 0—400 kPa (0—4 bar) (0—60 psi) pressure gauge (D).

4. With engine at operating temperature, connect machine to a dynamometer. Operate engine at rated full load speed. Observe pressure reading.

5. Remove test equipment and reinstall ether starting aid line.



RG4130 -UN-14DEC88

A—Ether Starting Aid
B—JT03104 Fitting
C—JD03017 Hose
D—JT03092 Pressure Gauge

RG,CTM42,110,7 -19-29OCT92

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

TIME TRAC® Kit .. JT07158
(FKM10429)

Used to perform the dynamic timing of engines.

- JT07158 Kit consists of the following:
  26932 Meter
  Magnetic Pickup
  Transducer Cable
  28037 SOI Clamp Assembly
  28062 Instruction Booklet
  Specification Sheet
  JT07155 9/16 in. SOI Sensor
  29361 Single Carton
  29361 6-Pack Carton
  JDE81-4 Timing Pin
  JDG793 Magnetic Pickup Adapter
  26924 Carry Case

- FKM10429 Kit consists of the following:
  FKM10429-1 Meter
  FKM10429-2 Timing Light
  FKM10429-3 Transducer Cable
  FKM10429-4 Sensor Clamp
  FKM10429-5 6 mm Clamp-on Transducer
  FKM10429-6 Sensor
  FKM10429-7 Carrying Case
  FKM10429-8 Instruction Manual

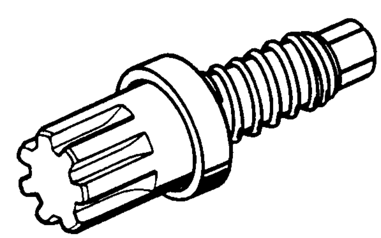
RG7246 -UN-09FEB95

TIME TRAC® is a registered trademark of Stanadyne Automotive Corp.

RG,JT07158 -19-18FEB95

Flywheel Turning Tool JDG820

Used to rotate engine to check damper radial runout and time engine. JDE81-1 may be used also if JDG820 is not available.



RG7056 -UN-10AUG94

RG,JDG820 -19-14FEB95

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Lock engine at TDC when timing valve train.

S53,JDE814A -19-08AUG94

115
2

FUEL SYSTEM TEST SPECIFICATIONS

ITEM	SPECIFICATIONS
Mechanical Fuel Supply Pump Minimum Output Pressure	200 kPa (2.0 bar) (29.0 psi)
Hydraulic Aneroid Activator Operating Pressure (If Equipped)	48—75 kPa (0.5—0.8 bar) (7—11 psi)
Fuel Injection Pump Timing-to-Engine	TDC
Engine Speeds (RPM)*	

TORQUES

In-Line Injection Pump Drive Gear-to-Pump Hub:	
A Pumps	47 N·m (35 lb-ft)
P Pumps	61 N·m (45 lb-ft)
Rotary Injection Pump Gear-to-Pump Hub	130 N·m (95 lb-ft)
Rotary Injection Pump-to-Cylinder Block Stud Nuts	27 N·m (20 lb-ft)
Injection Pump Drive Gear Cover	27 N·m (20 lb-ft)

** For each application, refer to the appropriate machine technical manual for slow idle, fast idle, and rated speed specifications.*

RG,CTM42,115,1 -19-12JUL94

CHECK AND ADJUST ROTARY FUEL INJECTION PUMP DYNAMIC TIMING USING JT07158 TIME TRAC KIT

The JT07158 Time Trac Kit electronically indicates start of injection with respect to piston top dead center (TDC), and allows accurate setting of injection pump timing to provide optimum power, smoke, and exhaust emissions.

Timing engines with this timing kit improves consistency between engines and helps to control cylinder firing pressures which can be a factor in head gasket failures as well as improve overall engine efficiencies.

RG,CTM42,115,46-19-14FEB95

• **Install JT07158 Time Trac Kit:**

IMPORTANT: All transducers and sensors must be installed at nozzle end of No. 1 fuel injection line. If access to No. 1 line is restricted, sensor can be installed on No. 6 injection line.

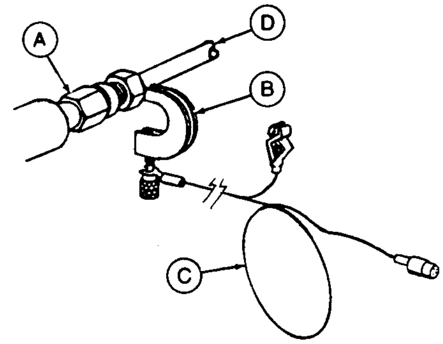
Remove all paint from injection line where clamp-on transducer will be installed and be sure this location is thoroughly clean.

1. On engines with optional JT07155 In-Line SOI Sensor (A) installed between injection nozzle and fuel delivery line, install JT07173 SOI Clamp Assembly (B) onto clean sensor and tighten securely.

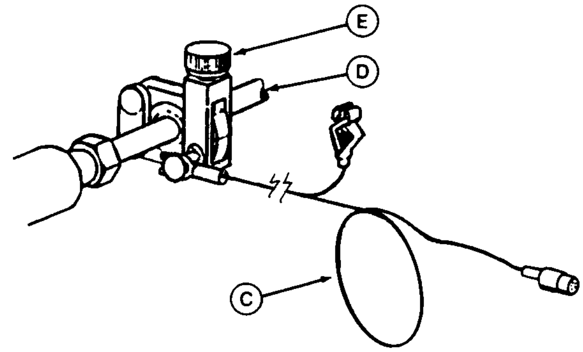
2. On engines without optional JT07155 In-Line Sensor, install JT07177 6 mm (green) Clamp-on Transducer (E) onto clean, paint-free injection line and tighten securely.

3. Assemble red lead of JT07172 Transducer Cable (C) onto in-line sensor or transducer, however equipped.

4. Attach spring clip to a solid ground. Plug connector into JT07170 meter port marked SR.



RG7285 -UN-06FEB95



RG7286 -UN-13FEB95

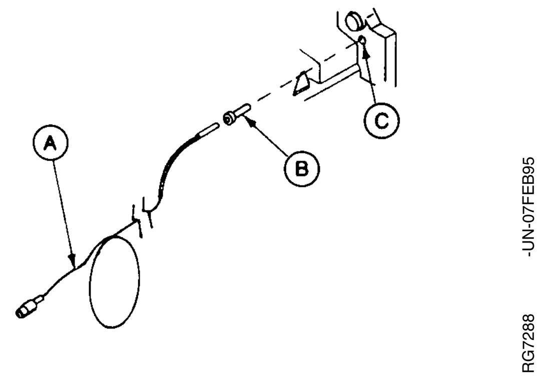
A—JT07155 In-Line SOI Sensor
B—JT07173 SOI Clamp Assembly
C—JT07172 Transducer Cable
D—Fuel Injection (Delivery) Line
E—JT07177 6 mm (Green) Clamp-on Transducer

RG,CTM42,115,50-19-17MAR95

5. Use JDE81-4 Timing Pin in flywheel timing hole (C) to ensure engine is NOT stopped at TDC. Magnetic pick-up probe will enter TDC timing hole in flywheel and be damaged when engine is started. An air gap of 0.64 mm (0.025 in.) is recommended between tip of probe and flywheel face.

6. Install JDG821 Magnetic Pick-up Adapter (B) into flywheel housing. Lightly tap adapter to lock into position. Insert probe of magnetic pick-up (A) into adapter until it contacts the flywheel. Pull probe back out to provide 0.64 mm (0.025 in.) air gap.

7. Plug magnetic pick-up adapter connector into JT07170 meter port marked MP.



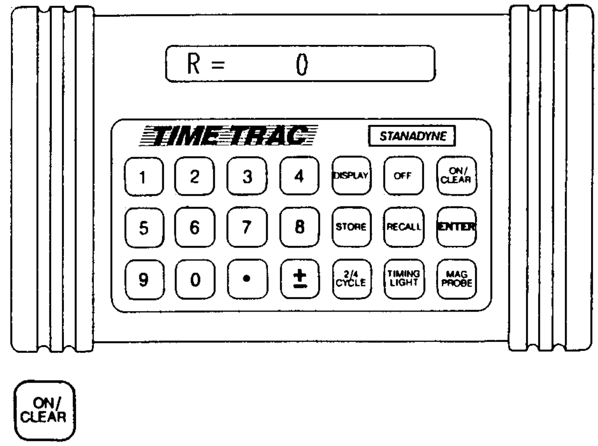
A—Magnetic Pick-up
B—JDG821 Magnetic Pick-up Adapter
C—Flywheel Timing Hole

RG,CTM42,115,47-19-17MAR95

• Check Injection Pump Rated Load Dynamic Timing:

1. Engine OFF. Push ON/CLEAR button.

Display shows: R=0

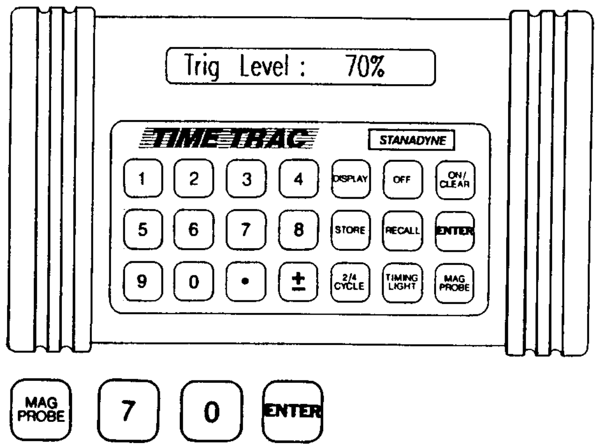


RG7031 -UN-27SEP94

2. Push MAG PROBE button.

Display shows: Trig Level: 30%

3. Change to 70% and push ENTER.



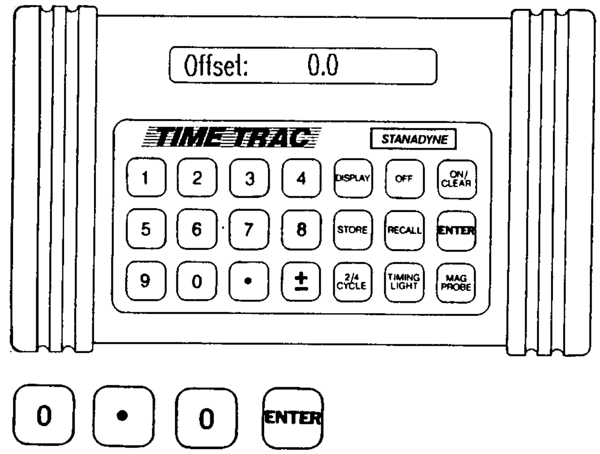
RG7032 -UN-27SEP94

RG,CTM8,G115,23-19-02FEB95

115
5

Display shows: Offset: 20.0°

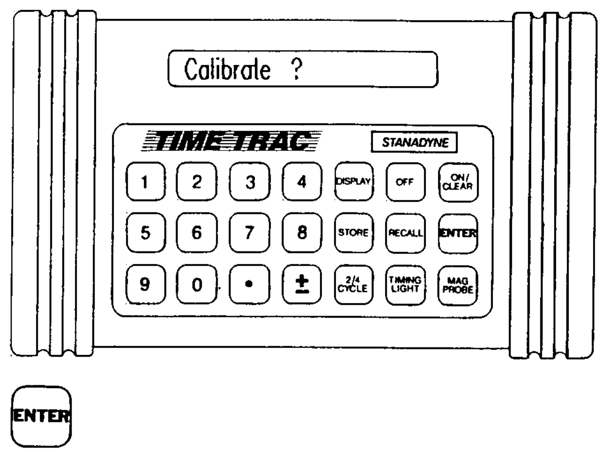
4. Change to offset 0° and push ENTER.



RG7033 -UN-27SEP94

Display shows: Calibrate?

5. Start engine and push ENTER.



RG7129 -UN-06OCT94

RG,CTM8,G115,24-19-02FEB95

6. Run engine at 1300 rpm. Push ENTER.

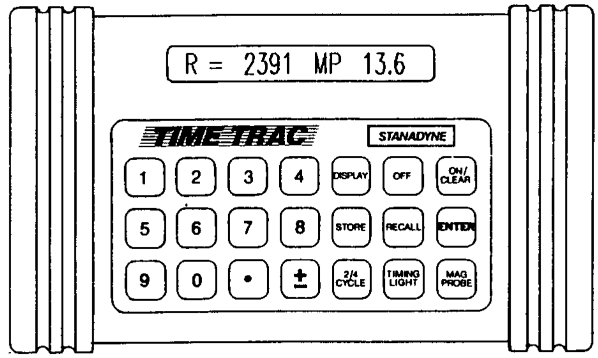
Display shows: Calibrating then Engine RPM and timing.

NOTE: If display shows NO PROBE, the magnetic pick-up probe has not been installed properly [air gap exceeds 0.64 mm (0.025 in.)] or there is debris on the back of the flywheel. Check for proper air gap or to clean the back side of the flywheel, insert a soft wooden dowel into the engine timing pin hole with the engine running at low idle speed to clean the debris from flywheel.

7. Warm engine to normal operating temperature, check slow and fast idle rpm. See FUEL INJECTION PUMP SPECIFICATIONS earlier in this group. Adjust speeds as necessary.

RG,CTM8,G115,25-19-02FEB95

IMPORTANT: Many machines have hydraulic pumps that have adequate flow to load engine well below rated load rpm. Some equipment may need to be driven in high gear or pull a load to bring engine speed to rated load rpm.



RG7037 -UN-27SEP94

8. Run engine at wide open throttle (WOT) and load engine down gradually to rated speed rpm.

NOTE: A negative timing value indicates the clamp-on sensor signal is not adequate. Check sensor and lines for cleanliness and proper installation.

9. Record engine speed (rpm) and timing degrees.

IMPORTANT: Stop engine prior to making timing adjustments. Injection pump can seize if adjustment is made with engine running.

10. Stop engine.

If dynamic timing reading is more than 8 degrees retarded with pump flange and front plate timing marks at original location as shipped from factory, this may indicate the pump advance is not functioning. Check the following:

• Change fuel filter(s)
• Check transfer pump for positive fuel pressure to injection pump
• Check camshaft movement on injection pumps with rectangular timing window.
• Check pump drive shaft-to-gear key or pin to ensure key or pin has not sheared.
• If none of the above checks are conclusive, remove pump and have necessary repairs made at an authorized diesel repair station.

RG,CTM8,G115,26-19-02FEB95

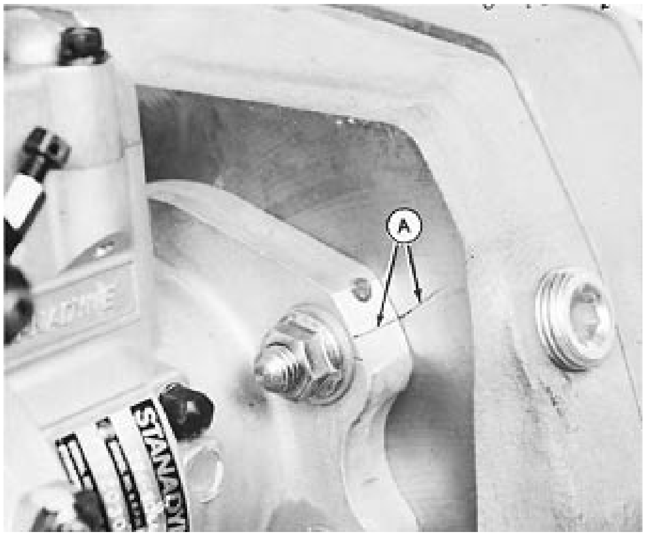
- **Adjust Injection Pump Dynamic Timing:**

1. Loosen injection pump mounting flange nuts and adjust pump timing.

To advance pump timing, rotate top of pump clockwise view from rear (flywheel end) of engine. To retard timing, rotate top of pump counterclockwise. Pump flange movement of 1.524 mm (0.060 in.) is equivalent to 2 degrees of engine timing.

2. Tighten injection pump mounting flange nuts to 47 N·m (35 lb-ft). Start engine and check injection pump dynamic timing again. Adjust timing as needed.

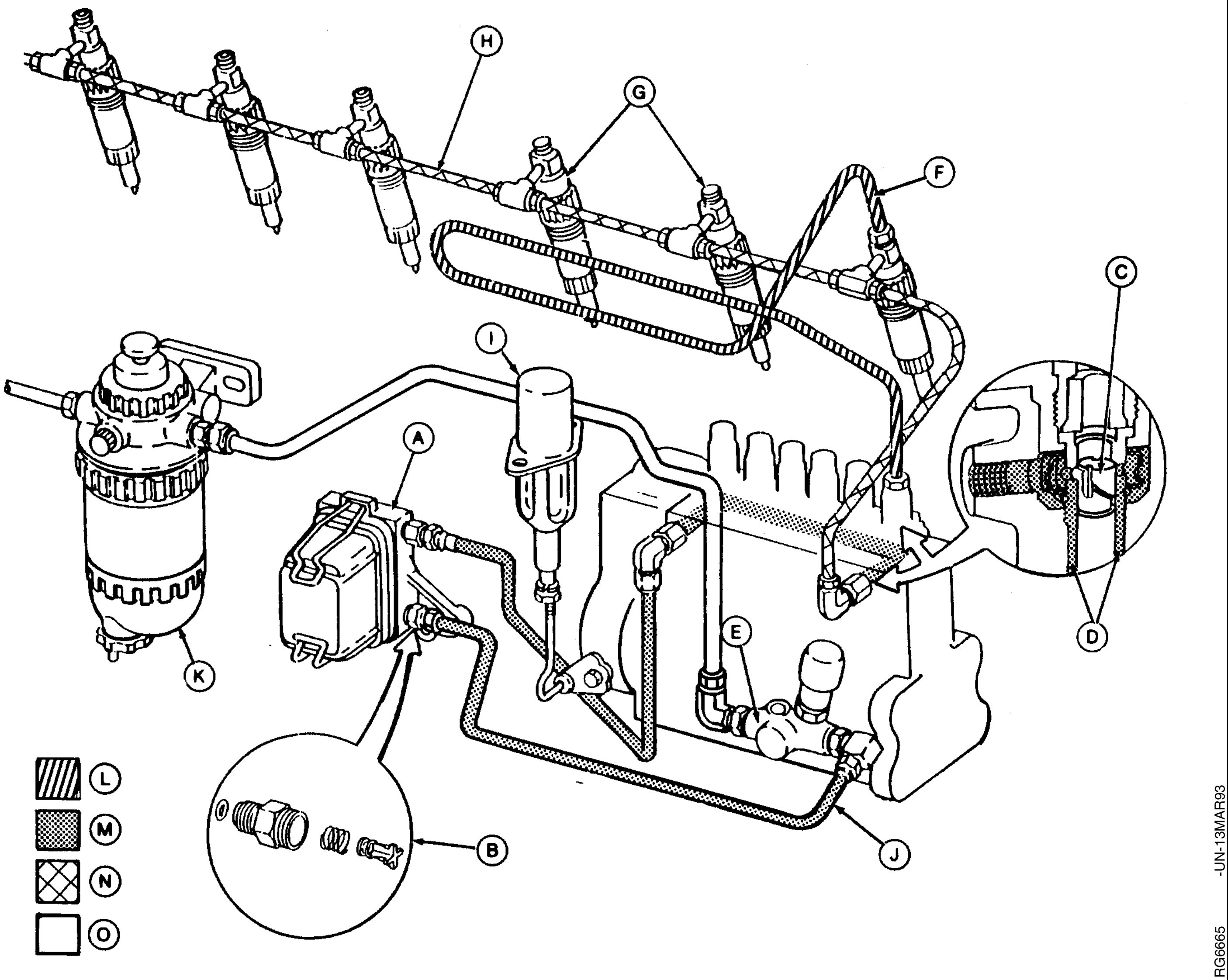
3. Grind away original timing mark and stamp new timing mark onto injection pump flange so timing mark (A) aligns after all final adjustments have been made and satisfactory engine performance is achieved.



RG6465 -UN-26OCT92

RG,CTM42,115,48-19-14FEB95

FUEL SYSTEM OPERATION—IN-LINE FUEL INJECTION PUMP



A—Fuel Filter
B—Check Valve Assembly
C—Pump Plungers
D—Fuel Galley
E—Supply Pump
F—Injection Pressure Lines
G—Nozzles
H—Leak-Off Line
I—Fuel Shut-off Solenoid
J—Supply Pump Outlet
K—Round Primary Filter/Water Separator
L—Injection Pressure
M—Supply Pump Pressure
N—Fuel Return
O—Gravity Pressure

The supply pump (E) draws fuel from the vented fuel tank through the primary filter (K).

The supply pump pressurizes the fuel so that it flows through the filter (A) to the injection pump galley (D). Supply pump output pressure will vary depending on load and application.

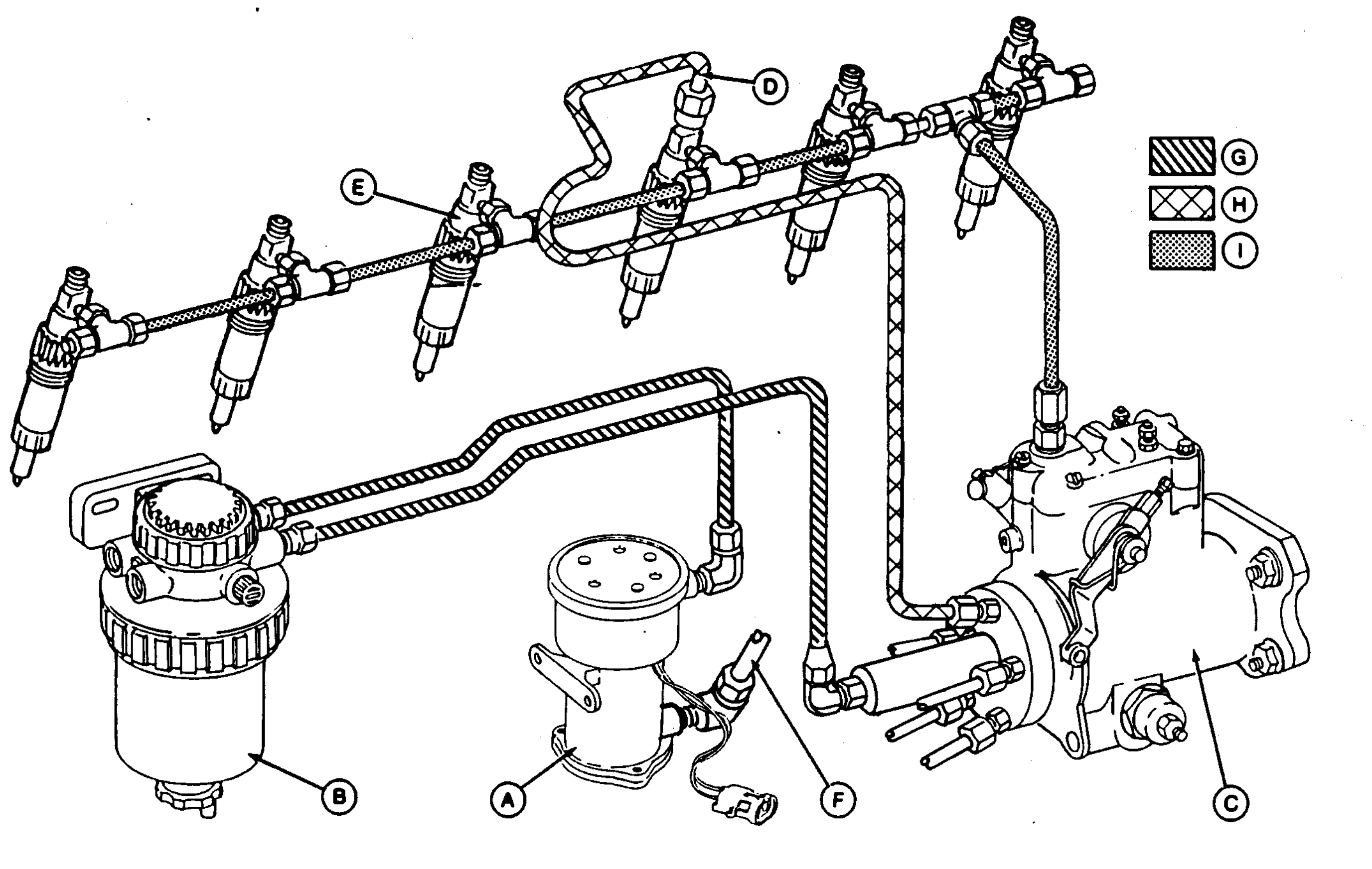
The galley is kept full by the supply pump. Injection pump plungers (C) further pressurize the fuel. Injection pressure lines (F) route the fuel to the nozzles (G).

The high pressure fuel opens the nozzle valve and forces fuel out the small orifices in the nozzle 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.

RG,CTM42,115,3 -19-07APR93

FUEL SYSTEM OPERATION—ROTARY FUEL INJECTION PUMP



A—Electric Fuel Supply Pump
B—Fuel Filter
C—Fuel Injection Pump
D—Injection Pressure Lines
E—Fuel Injection Nozzles
F—Fuel Inlet Line
G—Fuel Supply Pump Pressure
H—Fuel Injection Pump Pressure
I—Fuel Return (Leak-off) Line Pressure

The electric fuel supply pump (A) draws fuel from the tank and pressurizes it. This pressure permits the fuel to flow through the filter (B) and charge the transfer pump of the injection pump (C).

With the fuel injection pump charged with fuel by the fuel supply pump, the injection pump plungers pressurize the fuel to approximately 50 000 kPa (500 bar) (7255 psi). Injection pressure lines (D) are used to route this high pressure fuel to the fuel injection nozzles (E).

Fuel enters the injection nozzle at a pressure which easily overcomes the pressure required to open the nozzle valve. When the nozzle valve opens, fuel is forced out through the orifices in the nozzle tip and atomizes as it enters the combustion chamber.

Incorporated into the fuel system is a means of returning excess (or unused) fuel back to the fuel tank. Excess fuel comes from two sources:

1. Fuel Injection Pump: A quantity of fuel greater than that required by the engine is supplies to the fuel injection pump.

2. Fuel Injection Nozzles: A small amount of fuel seeps past the nozzle valve for lubrication purposes.

To get the excess fuel back to the tank, a return line from the injection pump is connected to the middle of the nozzle leak-off line. Fuel from both sources is then returned to the tank by a return pipe connected to the front end of the leak-off pipe.

RG,CTM42,115,33-19-28OCT92

DIAGNOSE FUEL SYSTEM MALFUNCTIONS

NOTE: The following diagnostics apply to either standard mechanical in-line or rotary fuel pumps, or electronic governor type fuel pumps. See CTM11 for additional electronic pump diagnostics.

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 (See Group 02)
	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 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 fuel (or separator if equipped). Install new filter (See Group 35)
	Fuel filter restricted	Replace fuel filters (See Group 35)
	Low supply pump pressure	Check pump output pressure. (See 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)
	Broken starting fuel control shaft spring	Repair (See Group 35)

Continued on next page

Symptom	Problem	Solution
	Injection pump drive gear teeth worn or broken	Check timing gear backlash and check for failed crankshaft vibration damper.
Engine Starts and Stops	Air in system	Correct problem and bleed fuel system (See this group)
	Fuel filter restricted	Replace fuel filter (See Group 35)
	Fuel lines restricted	Clean lines as required
	Water in fuel	Drain water from fuel, (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 fuel (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
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)

Continued on next page

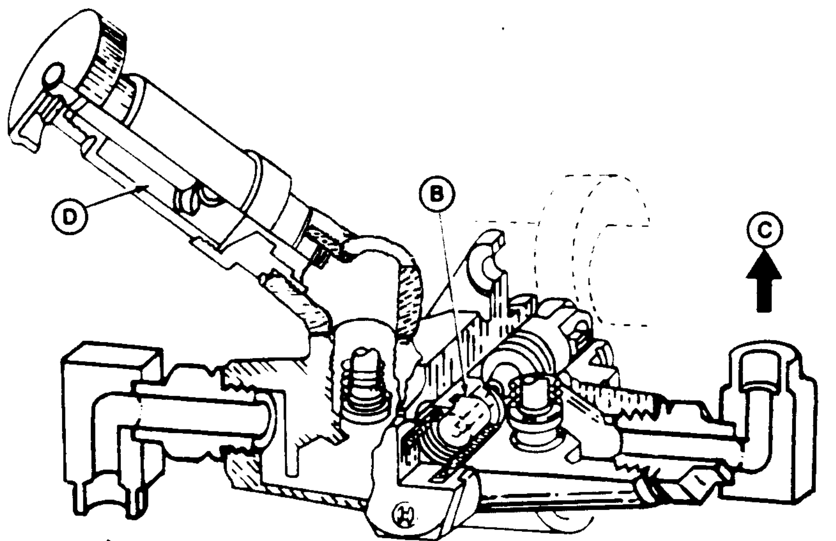
Symptom	Problem	Solution
	Over-fueling	Repair and adjust (See Group 35)
	Aneroid defective	Repair and adjust (See Group 35)
Engine Emits Excessive Blue or White Smoke	Cranking speed too low	Check batteries and electrical system
	Injection pump timing incorrect	Adjust timing (this group)
	Injection nozzles 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 filters (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)
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)

Continued on next page

Symptom	Problem	Solution
	Injection nozzles faulty or sticking	Repair (See Group 35)
	Injection pump return fuel line or fittings restricted	Clean as required
Engine Does Not Develop Full Power	Water in fuel (or gasoline in fuel)	Drain water or replace with clean fuel Install new filters (this Group)
	Incorrect fast idle speed	Adjust speed (this Group)
	Manifold pressure pipe to aneroid loose or broken	Repair as required
	Fuel shut-off cable improperly adjusted	Adjust

RG,CTM42,115,2 -19-28OCT92

MECHANICAL FUEL SUPPLY PUMP OPERATION



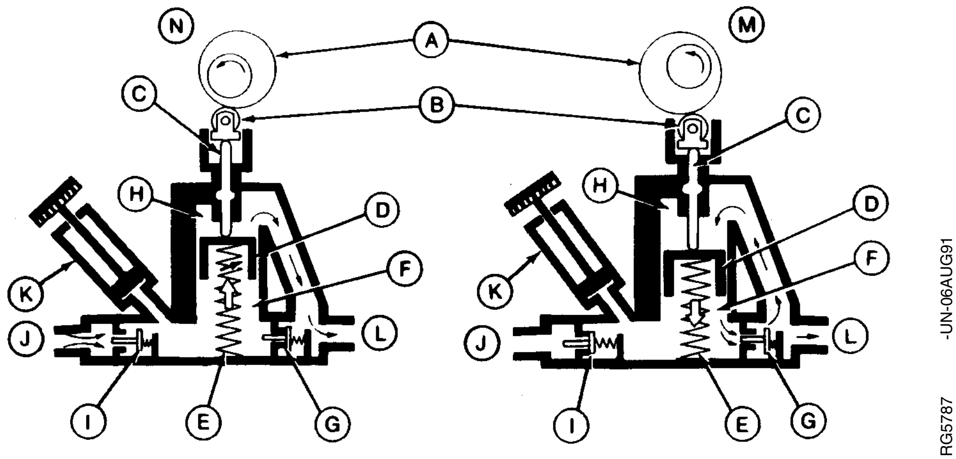
A—Fuel Inlet **B—Plunger** **C—Fuel Outlet** **D—Hand Primer**

Nippondenso pump shown

The plunger-type Robert Bosch or Nippondenso fuel supply pump is used on 6076 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.

RG,CTM42,115,4 -19-28OCT92

MECHANICAL 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.

Unscrewing the knurled knob on the hand primer pump (K) and pulling upward 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,CTM42,115,5 -19-28OCT92

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.
	Hand primer not screwed down tight, allowing dirt to enter hand primer plunger chamber (Nippondenso pumps only).	Advise customer to tighten hand primer after use.
	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.
	Hand primer left in upward position (Nippondenso pump only)	Bleed fuel system, gently push hand primer down and tighten securely.
	Worn or damaged valve assemblies/	Repair or replace.
	Broken valve spring(s)	Repair or replace.

RG,CTM42,G35,48-19-28OCT92

DIAGNOSE MECHANICAL FUEL SUPPLY PUMP MALFUNCTION—CONTINUED

Symptom	Problem	Solution
Diesel Fuel Leaking Into Injection Pump Crankcase	Worn spindle and/or pump housing.	Replace pump.
	Defective O-ring seal.	Replace O-ring seal.
Supply Pump Will Not Pump on P-Size Pump	Supply pump from A-Series Injection pump may have been installed.	Install correct supply pump on injection pump.
Supply Pump Mounting Flange Breaks When Mounted on A-Size Pump and Operated	Supply pump from P-Series Injection pump may have been installed.	Install correct supply pump on injection pump.

RG,CTM42,115,21-19-28OCT92

TEST MECHANICAL FUEL SUPPLY PUMP FOR LEAKS

RG5894 -UN-19AUG91

Fuel delivery pressure should be checked before removing supply pump from injection pump. (See CHECK MECHANICAL FUEL SUPPLY PUMP OPERATION, in Group 115.)

1. Connect compressed air line (A) to a pressure gauge (B) and to supply pump inlet fitting. 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).

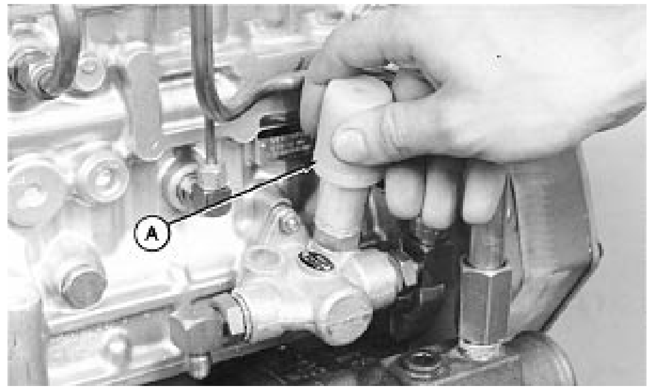
4. Move roller tappet (Nippondenso pumps) or spindle (Bosch pumps) in and out by hand. No air bubbles should appear around roller tappet or spindle bore.

NOTE: If bubbles appear, it is an indication that either the O-ring seal is defective or spindle or tappet is worn (or possibly both).

IMPORTANT: Serious injection pump or engine damage could occur, if enough diesel fuel leaks past spindle and seal. Fuel leakage past spindle dilutes engine oil.

RG,CTM42,G35,9 -19-28OCT92

CHECK MECHANCIAL FUEL SUPPLY PUMP OPERATION



RG5903 -UN-19AUG91

NOTE: The following test procedures can best be performed under moderate air temperature conditions to reduce electrical loads when cranking the engine is required.

- **Test fuel supply pump and hand primer for leaks:**

1. Make a preliminary inspection of supply pump. Thoroughly clean area around pump. All connections must be tight and not leaking.

2. Start engine and bring to operating temperature. Shut-off engine.

NOTE: If fuel leaks around a Nippondenso hand primer that is screwed down tight when engine is running, replace the hand primer.

Robert Bosch hand primers (A) are spring loaded to remain in the fully extended position. If fuel leaks around a Bosch hand primer while seated in the extended position, replace the hand primer.

3. Check operation of hand primer. With engine shut-off, unscrew knob (Nippondenso only) 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: On Nippondenso pumps, be sure hand primer is seated all the way down in barrel before tightening to prevent internal thread damage.

4. On Nippondenso pumps only, tighten hand primer knob, but do not overtighten. If knob will not tighten (indicating internal thread damage), replace hand primer.

RG,CTM42,115,6 -19-17MAR95

• 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).

115
21

S11,23010,FJ -19-14FEB95

• Test pump output pressure while cranking engine:

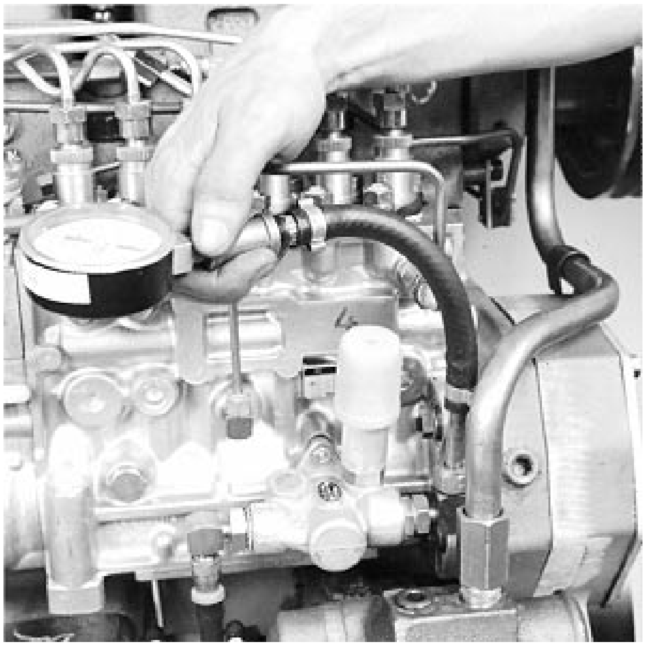
1. Connect a 0—400 kPa (0—4 bar) (0—60 psi) pressure gauge to one end of a pressure hose about 250—300 mm (10—12 in.) long. Connect other end of hose to pump outlet. All air must be out of system.

IMPORTANT: The starting motor must crank the engine at normal cranking speed. Use booster batteries if necessary.

2. Crank engine for 10 seconds with starting motor (approximately 300 engine rpm). Supply pump minimum outlet pressure should be 200 kPa (2.0 bar) (29.0 psi).

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 pump.



RG5927 -UN-19AUG91

RG,CTM42,115,7 -19-17MAR95

SERVICE MECHANICAL FUEL SUPPLY PUMP

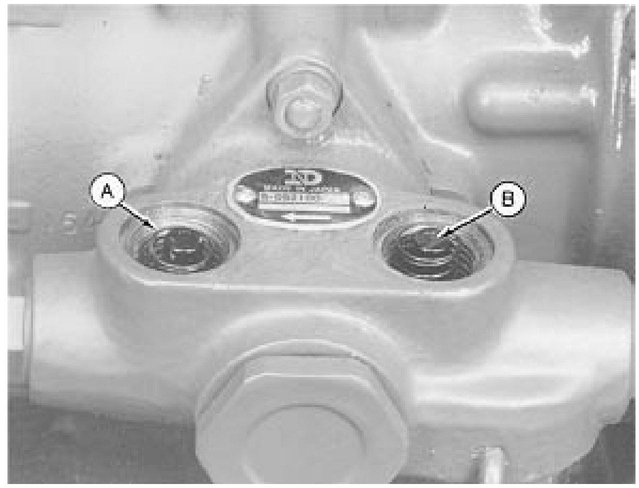
NOTE: Gaining access to the valves on Robert Bosch supply pump requires removal and disassembly of the supply pump, (See Group 35).

1. To gain access to the valves on Nippondenso supply pump, remove hand primer, banjo fitting, and plug from top of supply pump (shown removed).

2. Remove valves (B) and springs (A).

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 the pump operation is still not normal, the pump will have to be repaired or replaced. (See Group 35.)

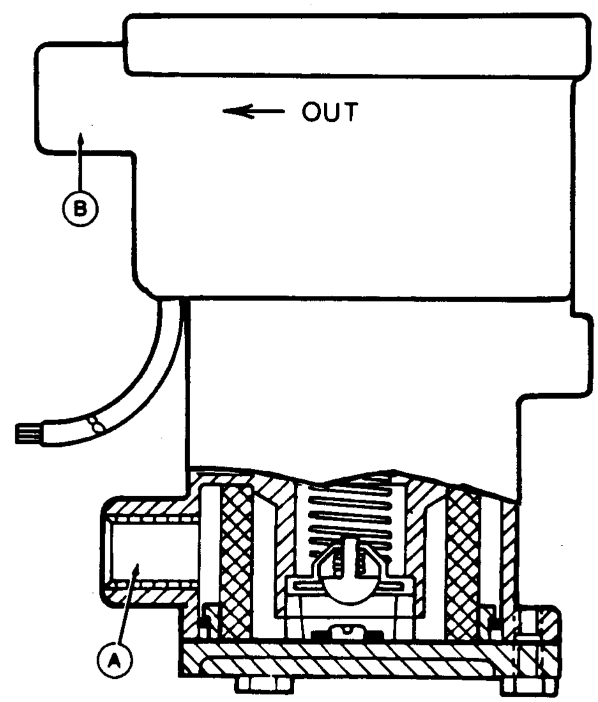


RG78153D1 -UN-14DEC88

Nippondenso pump

RG,CTM42,115,8 -19-28OCT92

ELECTRIC FUEL SUPPLY PUMP OPERATION



RG6450 -UN-15OCT92

A—Fuel Inlet **B—Fuel Outlet**

The electric supply pump is used on 6076 Engines equipped with the rotary fuel injection pump.

As the coil is energized, the plunger is forced down. When the coil de-energizes, a spring forces the plunger back up creating a vacuum. The vacuum draws fuel in through the inlet valve and fills the plunger area. This fuel is then forced out the top of the pump on the subsequent stroke. Maximum pressure delivered by this pump is 69 kPa (0.7 bar) (10 psi) at 2.8 A.

Operation of the pump can be determined by listening for a “clicking” sound when the key is “ON”. A sharp clicking is an indication that there is no fuel getting to the pump. Fuel flowing through the pump muffles the clicking sound. If no clicking sound is heard, check wiring harness for 12 v. If pumps clicks once then quits, there is most likely an electrical problem in the pump and the pump will have to be replaced, as it is not repairable.

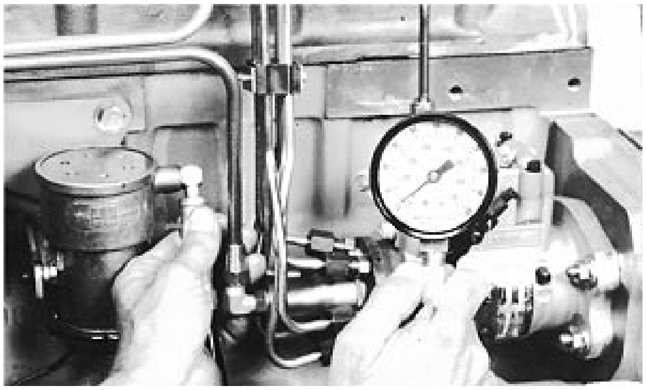
RG,CTM42,115,24-19-28OCT92

DIAGNOSE ELECTRIC FUEL SUPPLY PUMP MALFUNCTION

Symptom	Problem	Solution
Low Supply Pump Pressure or Pump Not Functioning Correctly	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 connections	Repair.

RG,CTM42,115,25-19-28OCT92

TEST ELECTRIC FUEL SUPPLY PUMP FOR OUTPUT PRESSURE AND FLOW


RG6481 -UN-26OCT92

- **Output Pressure Test:**

1. Bleed fuel system. See BLEED FUEL SYSTEM later in this group.

2. Put key in “ON” position.

3. Connect pressure gauge to one end of pressure hose. Connect other end of hose to pump outlet.

4. Measure output pressure.

ELECTRIC FUEL SUPPLY PUMP OUTPUT PRESSURE

Normal . . . . 62—69 kPa (0.62—0.69 bar) 9—10 psi

If output pressure is low, it may be the result of a partially obstructed supply pump filter screen. See CLEAN OR REPLACE ELECTRIC FUEL SUPPLY FILTER SCREEN in Group 35.

- **Flow Test:**

A clean fuel supply and a 12v power supply is needed for this test.

1. Disconnect fuel inlet line from supply line.

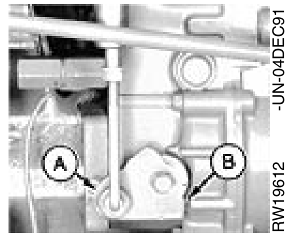
2. Connect pressure hose to pump inlet. Submerge the other end of hose in clean fuel.

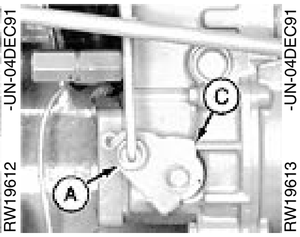
3. With key in “ON” position, supply pumps should pump 3 qts. of fuel in 1 minute or 45 gallons per hour.

If pump does not meet these specifications, see DIAGNOSING ELECTRIC SUPPLY PUMP MALFUNCTIONS earlier in this group.

RG,CTM42,115,26-19-02NOV92

FUEL SHUT-OFF SOLENOID OPERATIONAL CHECK





1. Observe fuel shut-off lever (A) when key switch is turned from “OFF” to “START” (engine running at slow idle) and then released to “ON” position.

2. Fuel shut-off lever should move from “NO FUEL” position (B) to “RUN” position (C) when starting motor begins to crank. The lever should remain at the “RUN” position after key switch is released to “ON” position.

If fuel shut-off lever returns to “NO FUEL” position with key switch at “ON” position, check for:

—Loss of battery voltage to fuel shutoff winding. Check voltage and wiring connection to solenoid.

—Binding of fuel shut-off lever, solenoid rod or linkage does not allow solenoid to lock in position. Repair or replace linkage.

—Torn or leaking rubber boot allowing dirt or moisture to enter at spring end of solenoid rod.

—Improperly adjusted fuel shut-off solenoid linkage. See FUEL SHUT-OFF SOLENOID LINKAGE ADJUSTMENT, later in this group.

3. Start engine and run at slow idle. Turn key switch to “OFF” position.

4. Fuel shut-off lever should move to “NO FUEL” position and engine should stop.

If the solenoid stops just short of the “NO FUEL” position, slight adjustment of the linkage is required. See FUEL SHUT-OFF SOLENOID LINKAGE ADJUSTMENT, later in this group.

If engine continues to run with key switch at “OFF” position, unplug shut-off solenoid 3-way connector.

—If solenoid moves lever to “NO FUEL” position, problem is in the electrical circuit.

—If solenoid does not shut off fuel to engine, check linkage for binding or excessive tightness. Replacement service kit is available with a swivel rod which is less sensitive to misalignment and binding.

RG,CTM61,115,29-19-13MAY93

FUEL SHUT-OFF SOLENOID RESISTANCE TEST

1. Disconnect shut-off solenoid 3-way WEATHER PACK™ connector.

2. Measure “PULL” coil resistance between black lead wire “C” and white lead wire “B”.

3. Measure “HOLD” coil resistance between black lead wire “C” and red lead wire “A”.

Replace solenoid if resistance is not within specification given below.

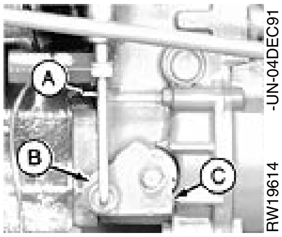
PULL AND HOLD COIL RESISTANCE SPECIFICATIONS

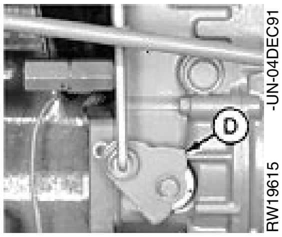
Solenoid Part Number	Pull Coil Resistance (Ohms)	Hold Coil Resistance (Ohms)
12-Volt System:		
RE53507, RE55415	0.187—0.281	10.04—12.27
RE53559	0.140—0.210	6.63—8.11
24-Volt System:		
RE54747, RE55416	0.735—0.899	37.22—45.49
RE53560	0.560—0.684	24.35—29.76

WEATHER PACK is a trademark of Packard Electric.

RG,CTM42,115,45-19-16AUG94

FUEL SHUT-OFF SOLENOID LINKAGE ADJUSTMENT





A—Link
B—Lever
C—Stop
D—Stop

Shut-off solenoid linkage is factory adjusted and usually will not require additional field adjustment. ALWAYS check linkage and lever for alignment and binding before making adjustments.

1. Thoroughly lubricate all linkage and lever pivot points.

2. If necessary, adjust linkage (A) so that lever (B) contacts stop (C) with key switch “OFF” and engine not running.

3. Start engine and run at slow idle. Lever should contact stop (D) or nearly contact when the lever is being pushed up.

RG,CTM61,115,30-19-13MAY93

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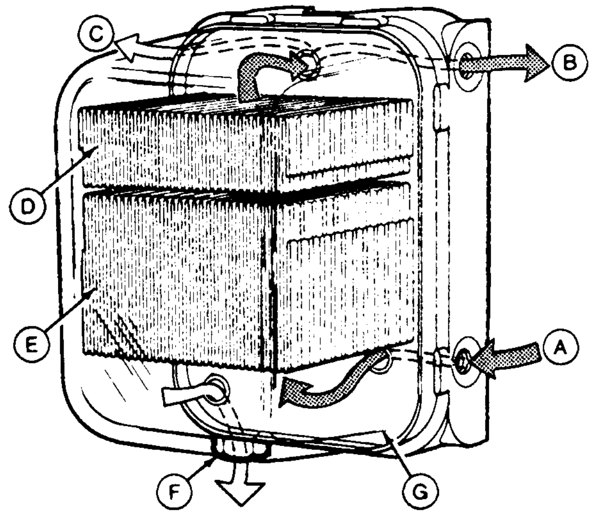
RECTANGULAR FUEL FILTER OPERATION

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

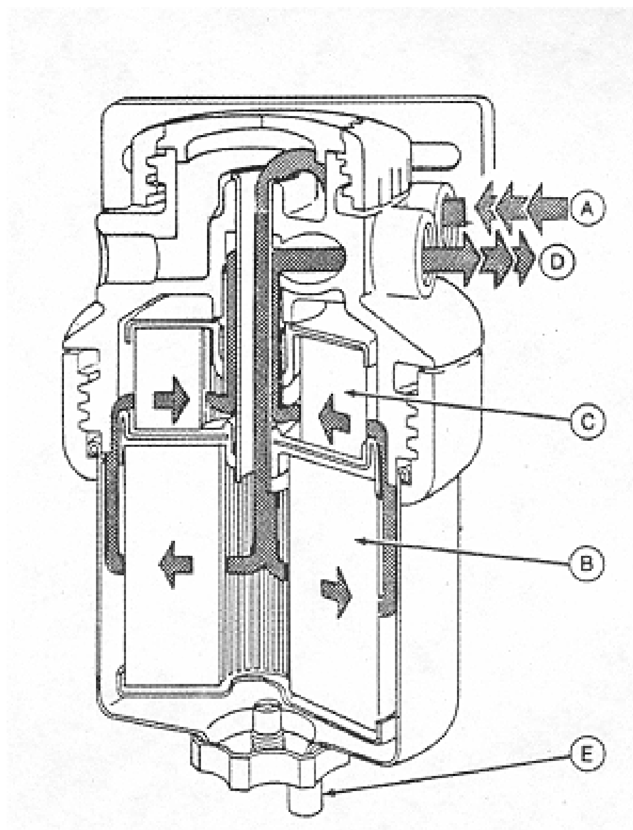
RG,CTM42,115,27-19-28OCT92

ROUND (FINAL) FUEL FILTER OPERATION

Fuel enters the filter at the inlet (A), then flows through a primary filter (B) and a secondary filter (C) before exiting filter through outlet (D) to the fuel injection pump. The filter elements are housed in a sediment bowl attached to the base with a threaded (detent) ring.

Since water and contaminants settle at the bottom of the sediment bowl, a drain plug (E) is provided.

Air in the system can be expelled through the air vent when bleed screw is loosened.

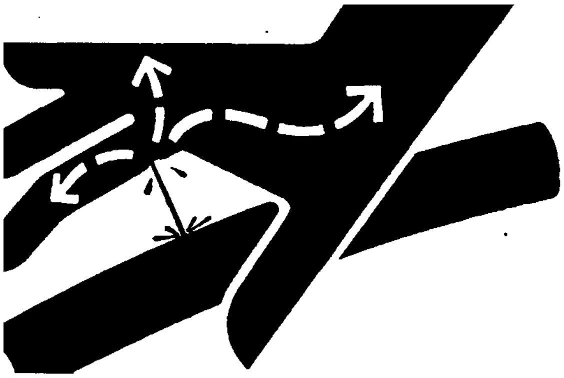


RG6444 -UN-13OCT92

A—Fuel Inlet
B—Primary Filter
C—Secondary Filter
D—Fuel Outlet
E—Drain Plug

RG,CTM42,115,28-19-28OCT92

BLEED THE FUEL SYSTEM


X9811 -UN-23AUG88

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.

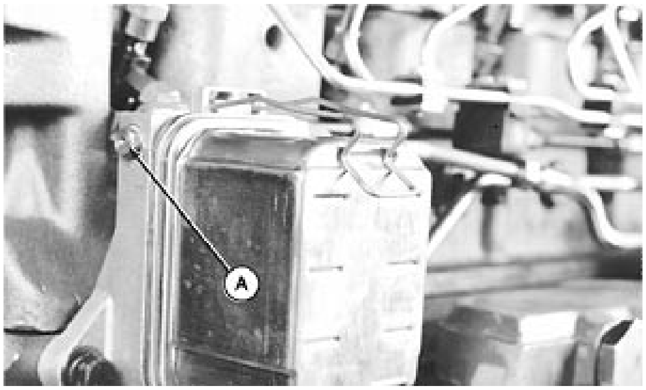
If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

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 -19-18APR94

A. At Rectangular Fuel Filter:



RG5870 -UN-19AUG91

1. Loosen bleed plug (A) on fuel filter base.

NOTE: When bleeding the fuel system on engines equipped with electronic governors, the key switch must be at the 'ON' position so the fuel shutoff valve will be open to allow fuel flow.

RG,CTM42,G35,6 -19-02OCT92

2. Unscrew hand primer on fuel supply pump until it can be pulled by hand (Nippondenso pumps only).

NOTE: Robert Bosch supply pumps use a hand primer that is spring loaded and remains fully extended during normal engine operation.

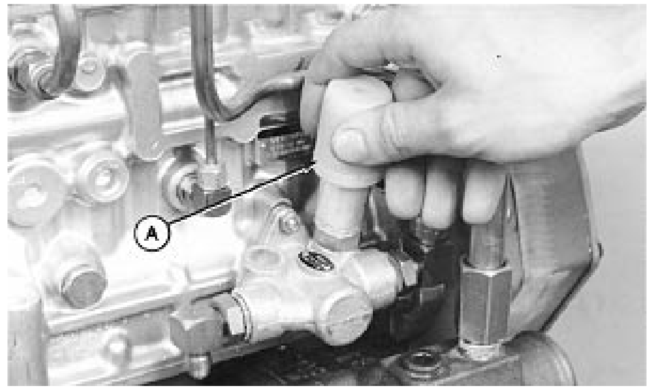
3. Operate the hand primer (A) on fuel supply pump until a smooth flow of fuel, free of bubbles, comes out of the filter plug hole.

IMPORTANT: On Nippondenso pumps, be sure hand primer is all the way down in barrel before tightening to prevent internal thread damage.

4. Simultaneously stroke the hand primer down and close the filter port plug. This prevents air from entering the system. Tighten plug securely. DO NOT overtighten.

5. Lock hand primer in position (Nippondenso pumps only).

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.



RG5903 -UN-19AUG91

Bosch Pump Shown

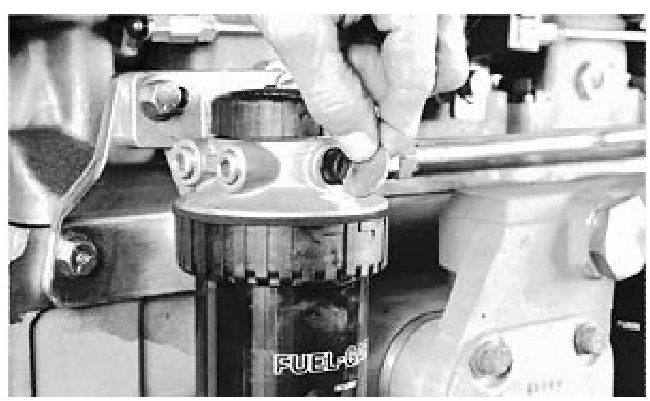
RG,CTM42,115,9 -19-28OCT92

B. At Round Fuel Filter:

NOTE: This procedure is for engine applications with electric fuel supply pumps.

1. Open air bleed vent screw two full turns by hand.

2. Turn key switch “ON” until a noticeable amount of fuel and air comes out of vent opening. Close vent screw when fuel starts to flow.



RG6482 -UN-26OCT92

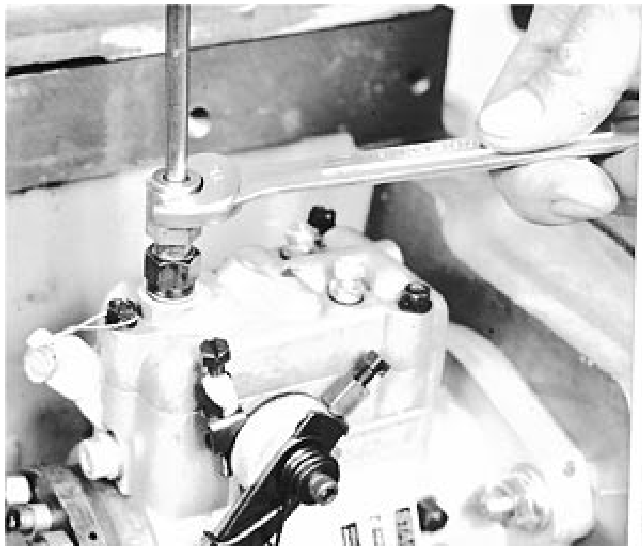
RG,CTM42,G35,93-19-02NOV92

C. At Fuel Injection Pump:

NOTE: This procedure is for engine applications with electric fuel supply pumps.

1. Loosen fuel return line at fuel injection pump.

2. Turn key switch “ON”. As soon as fuel flow is free from air bubbles, tighten fuel return line.



RG6483 -UN-26OCT92

RG,CTM42,G35,94-19-02NOV92

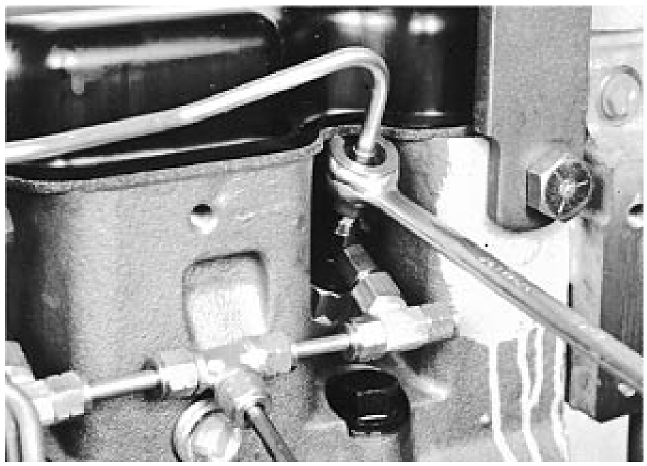
D. At Fuel Injection Nozzles:

1. Place throttle lever in fast idle position.

2. Using two open-end wrenches, loosen fuel line connection at No. 1 injection nozzle.

3. Crank engine with starting motor (but do not start engine), until fuel free from bubbles flows out of loosened connection. Retighten connection.

4. Repeat procedure for remaining injection nozzles (if necessary) until all air has been removed from fuel system.



RG6484 -UN-26OCT92

RG,CTM42,G35,95-19-28OCT92

DIAGNOSE IN-LINE 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)

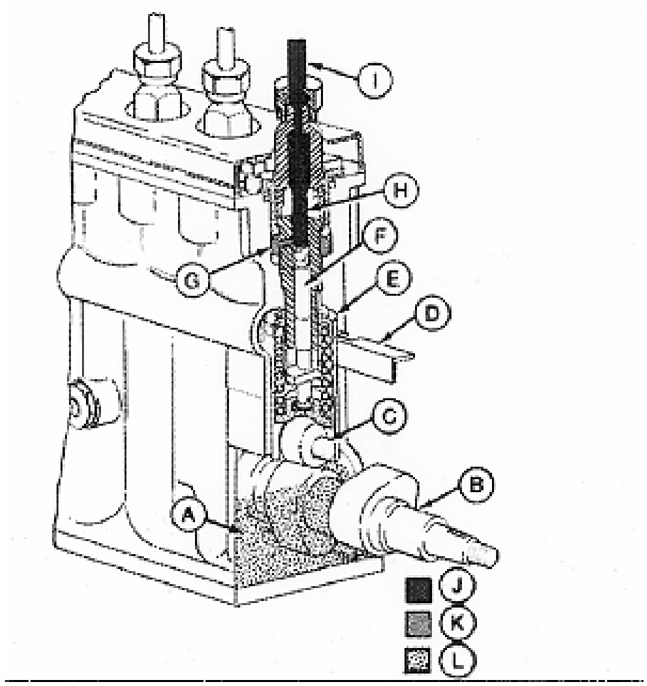
RG,CTM42,115,51-19-17MAR95

IN-LINE 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.

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.

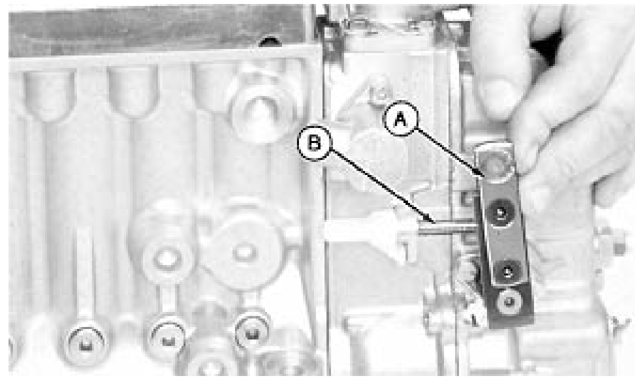


RG4650 -UN-14DEC88

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,GF1 -19-14FEB95

CHECK FAST IDLE SPEED—IN-LINE FUEL INJECTION PUMP



RG3600 -UN-14DEC88

1. Remove speed control rod. With the engine running, move governor control lever (A) against the fast idle stop screw (B).

115
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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 fast idle speed to see if it is within specification.

NOTE: For each application, refer to the appropriate machine technical manual for fast idle speed specifications.

If fast idle speed must be adjusted, see your authorized diesel repair station.

NOTE: For some applications such as generator sets, special equipment may be required for fast idle adjustment in conjunction with droop adjustment. See your OEM dealer or John Deere Engine Distributor.

RG,CTM42,115,14-19-28OCT92

CHECK AND ADJUST SLOW IDLE SPEED—IN-LINE FUEL INJECTION PUMP

NOTE: Both the slow idle stop screw (A) and the bumper spring screw (B) may be used to adjust the slow idle speed.

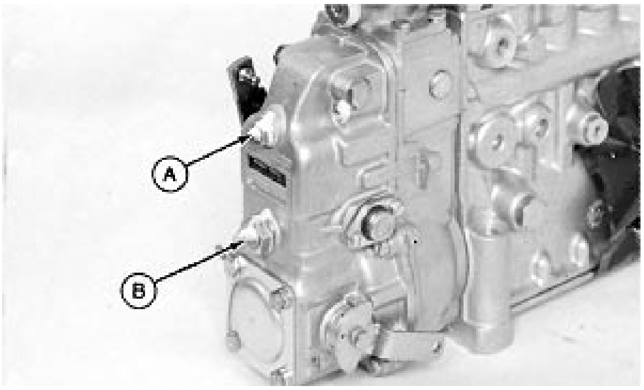
IMPORTANT: Minor adjustment of the slow idle speed may be made with the bumper spring screw. However, it should not be used by itself to change engine speed more than 50 rpm, as overspeeding of the engine may result.

If slow idle stop screw and bumper spring screw are not adjusted according to instruction, engine damage could result because of overspeeding.

CAUTION: ALWAYS STOP ENGINE before making adjustments.

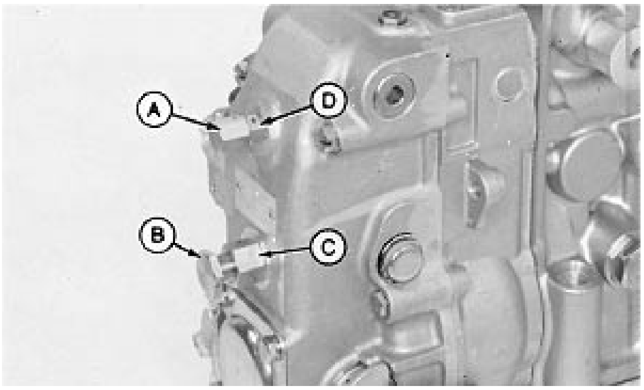
1. With the engine running, pull the governor control lever rearward to the slow idle speed position. Check and adjust slow idle speed to specification.

NOTE: For each application, refer to the appropriate machine technical manual for slow idle speed specifications.



RG5942 -UN-23AUG91

(Robert Bosch)



RG5943 -UN-23AUG91

(Nippondenso)

A—Slow Idle Stop Screw
B—Bumper Spring Screw
C—Lock Nut
D—Lock Nut

RG,CTM42,115,34-19-16AUG94

NOTE: On Nippondenso first remove slow idle stop screw cover.

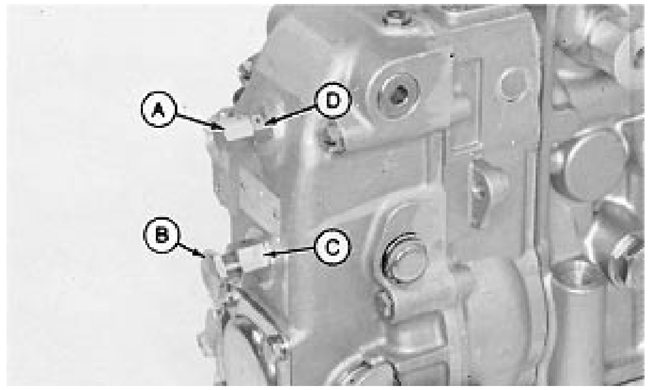
2. Loosen lock nut (C) and back out the bumper spring adjusting screw (B) three turns.

3. Loosen lock nut (D) and adjust slow idle stop screw (A) to obtain an idle speed 50 rpm less that the 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 850 rpm slow idle speed, use the slow idle stop screw to set speed at approximately 800 rpm. Then increase speed to 850 rpm using the bumper spring adjusting 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 given above; but do not exceed 850 rpm.



Robert Bosch (Nippondenso similar)

A—Slow Idle Stop Screw
B—Bumper Spring Adjusting Screw
C—Lock Nut
D—Lock Nut

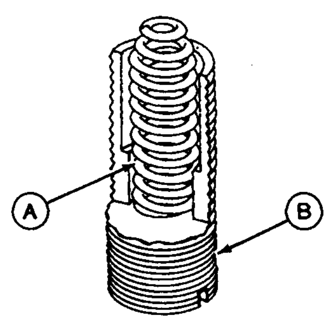
RG,CTM42,115,35-19-16AUG94

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.

6. Again check the fast and slow idle speeds. Readjust, slow idle speed if not correct.

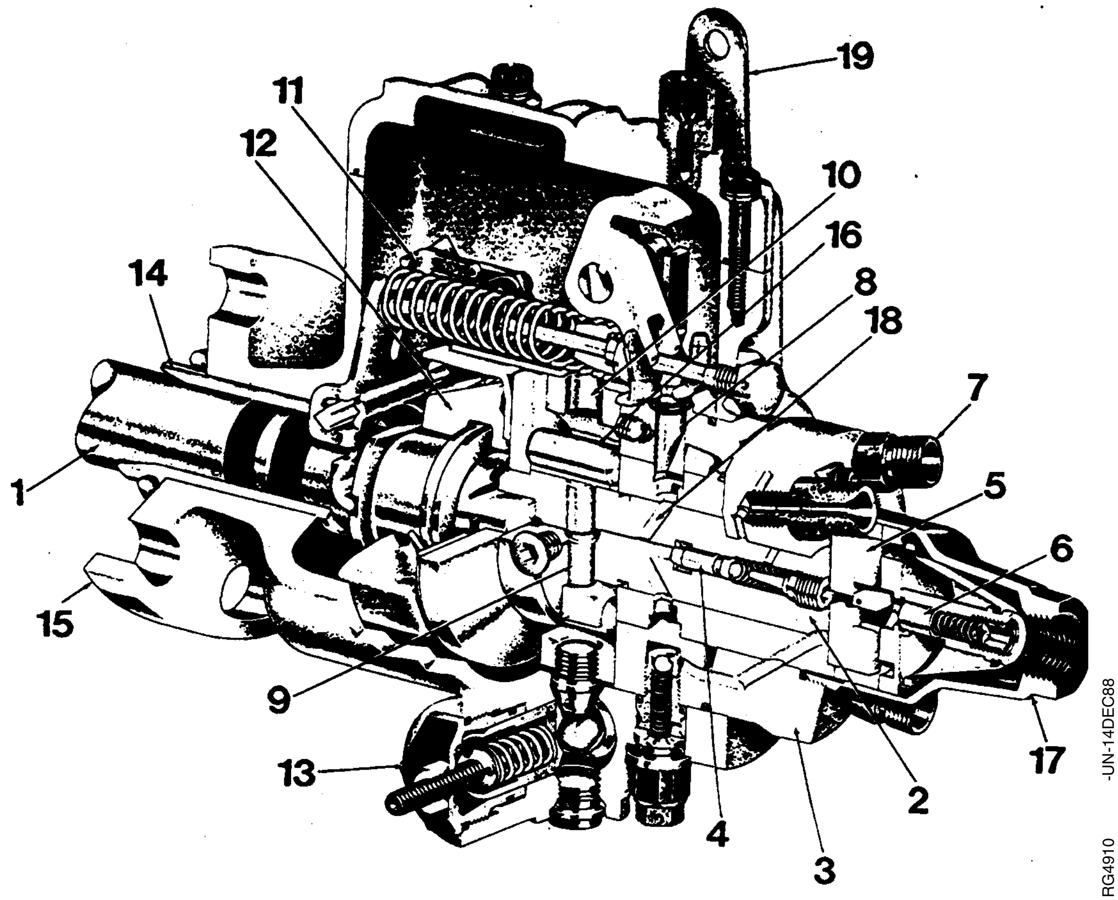
7. Check all adjusting screw lock nuts for tightness. Install covers (and copper washers) on slow idle stop screw and idling spring adjusting screw (on Nippondenso Pumps).

8. Connect fuel shut-off cable and speed control rod.



RG,CTM42,115,36-19-16AUG94

ROTARY FUEL INJECTION PUMP OPERATION—STANADYNE DB4



1—Drive Shaft
2—Distributor Rotor
3—Hydraulic Head
4—Delivery Valve
5—Supply Pump
6—Pressure Regulator
7—Discharge Fitting
8—Metering Valve
9—Pumping Plungers
10—Internal Cam Ring
11—Governor
12—Governor Weights
13—Advance
14—Drive Shaft Bushing
15—Housing
16—Rollers
17—Supply Pump Inlet
18—Charging Ports
19—Throttle Lever

The main rotating components are the drive shaft (1), distributor rotor (2), supply pump (5), and the governor (11).

The drive shaft engages the distributor rotor in hydraulic head (3). The drive end of rotor incorporates two pumping plungers (9).

The plungers are actuated toward each other simultaneously by an internal cam ring (10) through rollers (16) and shoes which are carried in slots at drive end of the rotor. The number of cam lobes normally equal the number of engine cylinders.

The supply pump at rear of rotor is a positive displacement vane-type pump enclosed in the end cap. The end cap also houses supply pump inlet (17), fuel strainer and pressure regulator (6). Supply pump pressure is automatically compensated for viscosity effects due to temperature changes and fuel grade variations.

The distributor rotor incorporates two charging ports (18) and a single axial bore (passage) with one discharge port to serve all head outlets (7) to the injection lines. The rotor rotates in bore of hydraulic head. Metering valve (8) bore, charging ports and discharge fittings are located in the head.

RG,CTM42,115,29-19-28OCT92

(Refer to illustration on previous page).

This pump contains its own mechanical governor. The centrifugal force of the weights (12) in their retainer is transmitted through a sleeve to a governor arm and through a positive linkage to the metering valve. The metering valve can be closed to shut off fuel through a solid linkage by an independently operated shut-off lever.

The automatic speed advance (13), advances or retards (hydraulically) the beginning of fuel delivery from the pump. The advance responds to changes in speed only, or to a combination of speed and load changes.

Fuel is drawn from the supply tank through filters into the pump inlet through the inlet filter screen by the vane type fuel transfer pump. Some fuel is bypassed through the pressure regulator assembly to the suction side.

Fuel under transfer pump pressure flows through the center of the transfer pump rotor, past the rotor retainer into a circular groove on the rotor. It then flows through a connecting passage in the head to the automatic advance and up through a radial passage and then through a connecting passage to the metering valve. The radial position of the metering valve, controlled by the governor, regulates flow of the fuel into the radial charging passages which incorporates the head charging ports.

As the rotor revolves, the two rotor inlet passages register with the charging ports in the hydraulic head, allowing fuel to flow into the pumping chamber. With further rotation, the inlet passages move out of registry and the discharge port of the rotor registers with one of the head outlets. While the discharge port is opened, the rollers contact the cam lobes forcing the plungers together. Fuel trapped between the plungers is then pressurized and delivered by the nozzle to the combustion chamber.

Self-lubrication is an inherent feature of the pump's design. As fuel at transfer pump pressure reaches the charging ports, slots on the rotor shank allow fuel and any entrapped air to flow into the pump housing cavity.

Additionally, an air vent passage in the hydraulic head connects the outlet side of the transfer pump with the pump housing. This allows air and some fuel to be bled back to the fuel tank via the return line. The fuel thus bypassed fills the housing, lubricates the internal components, cools and carries off any small air bubbles. The pump operates with the housing completely full of fuel; there are no dead air spaces anywhere within the pump.

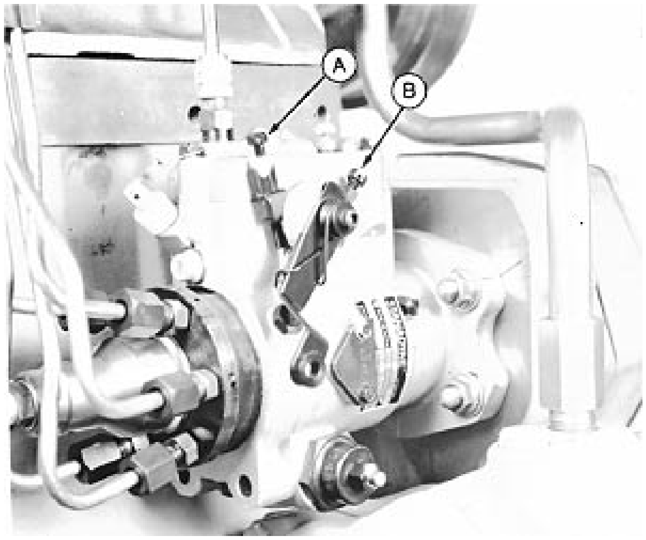
RG,CTM8,G115,3 -19-06FEB95

DIAGNOSE ROTARY FUEL INJECTION PUMP MALFUNCTIONS

Symptom	Problem	Solution
Engine Starts Hard or Won't Start	Shut-off solenoid not functioning properly; or wiring lead loose or broken	Repair.
	Injection pump not correctly timed	Check pump timing (refer to this group).
	Defective injection pump	Remove pump from engine and repair.
	Automatic advance faulty or not operating	Adjust or repair.
Slow Idle Speed Irregular	Nozzle faulty or sticking	Repair (See Group 35).
	Automatic advance faulty or not operating	Inspect and adjust or repair.
	Injection pump not properly timed	Check pump timing (refer to this group).
	Defective injection pump	Remove pump and repair.
Engine Horsepower Low	Pump not properly timed	Check timing (refer to this group).
	Insufficient throttle arm travel	Inspect and adjust.
	Automatic advance faulty or not operating	Adjust or repair.
	Nozzle faulty or sticking	Repair (See Group 35)
	Defective injection pump	Remove pump and repair.

RG,CTM42,115,30-19-28OCT92

CHECK AND ADJUST ENGINE SPEEDS ON ROTARY PUMP—STANADYNE DB4



RG6485 -UN-26OCT92

A—Fast Idle Adjusting Screw **B—Slow Idle Adjusting Screw**

NOTE: Before adjusting engine speed, make sure engine has reached its normal operating temperature.

• Check Slow and Fast Idle Speeds:

1. Start engine and run at 50% load and rated speed until engine reaches normal operating temperature.

2. Stop engine and disconnect speed control rod or cable from injection pump throttle lever.

3. Start engine and run at slow idle and no-load until engine stabilizes. Move injection pump throttle lever to slow idle position against adjusting screw stop.

4. Measure engine speed using a tachometer. Compare reading with specification.

Adjust slow idle speed if necessary as detailed below.

5. Move throttle lever to the fast idle position against adjusting screw stop.

6. Read and record engine speed using a tachometer. Compare readings with specifications.

IMPORTANT: If fast idle is not within specification, have an authorized diesel repair station, servicing dealer, or engine distributor adjust as necessary.

• Adjust Slow Idle Speed:

1. Hold pump throttle lever against slow idle stop.

2. Loosen slow idle adjusting screw lock nut. Turn adjusting screw clockwise to increase speed and counterclockwise to decrease speed.

RG,CTM42,115,32-19-14FEB95

HOW THE ANEROID WORKS (IF EQUIPPED)—IN-LINE INJECTION PUMPS

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).

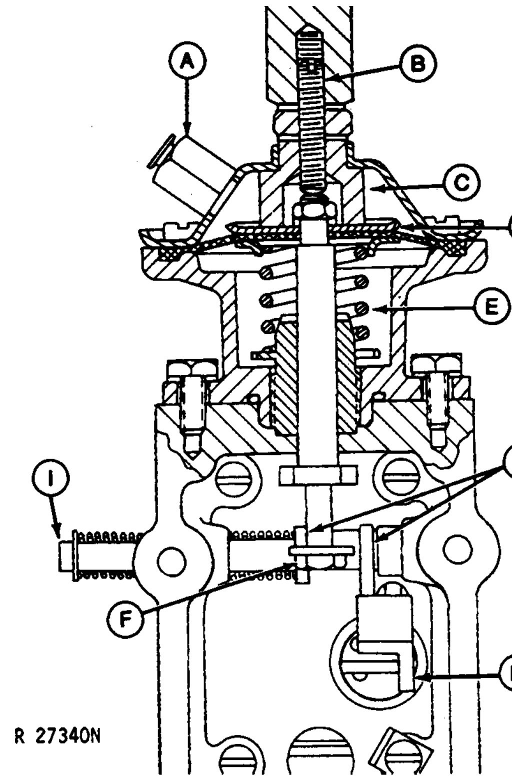
Downward movement of the adjusting shaft causes arm to rotate on starting fuel control shaft (I), permitting control rack to move its normal amount.

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

S11,23010,IU -19-14FEB95

DIAGNOSE ANEROID MALFUNCTION

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 -19-17MAR92

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 (IF EQUIPPED)

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.

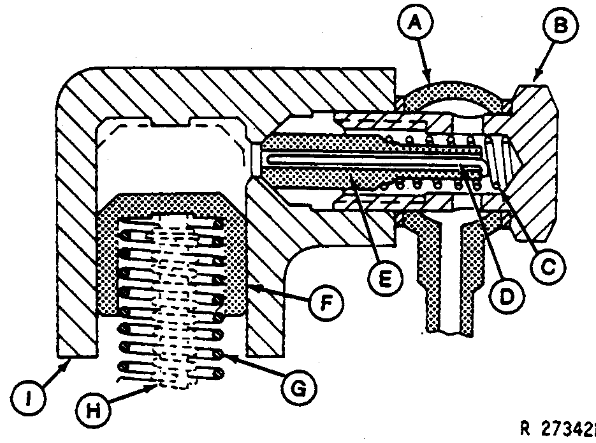
Loss of oil pressure permits a return spring on the starting fuel control shaft to hold the lever arm out of engagement with the control rack. This prevents the aneroid from limiting rack travel.

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.



R27342N -UN-14DEC88

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

S11,23010,AB -19-28OCT92

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

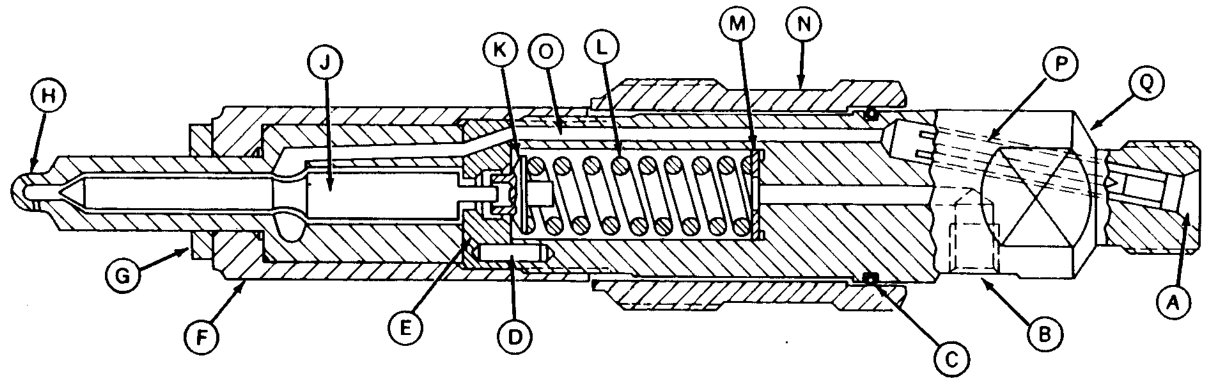
S11,23010,AC -19-16AUG94

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	Check for restriction in oil supply passages to activator piston.	Disassemble activator (See Group 35)

S11,23010,IW -19-28OCT92

FUEL INJECTION NOZZLES—GENERAL INFORMATION



A—Fuel Inlet	**E—Intermediate Plate**	**J—Valve**	**N—Gland Nut**
B—Leak-Off Connection	**F—Nozzle Retaining Nut**	**K—Spring Seat**	**O—Fuel Passage**
C—O-Ring	**G—Washer**	**L—Spring**	**P—Edge-Type Filter**
D—Dowel Pin	**H—Nozzle**	**M—Shims**	**Q—Nozzle Holder**

Nippondenso Shown (Bosch Similar)

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 (H) 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 and KDAL holders use an intermediate plate (E) with dowel pins (D) on both sides to insure alignment.

A retaining nut (F) 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 (G) 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.

RG,CTM42,115,22-19-28OCT92

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.

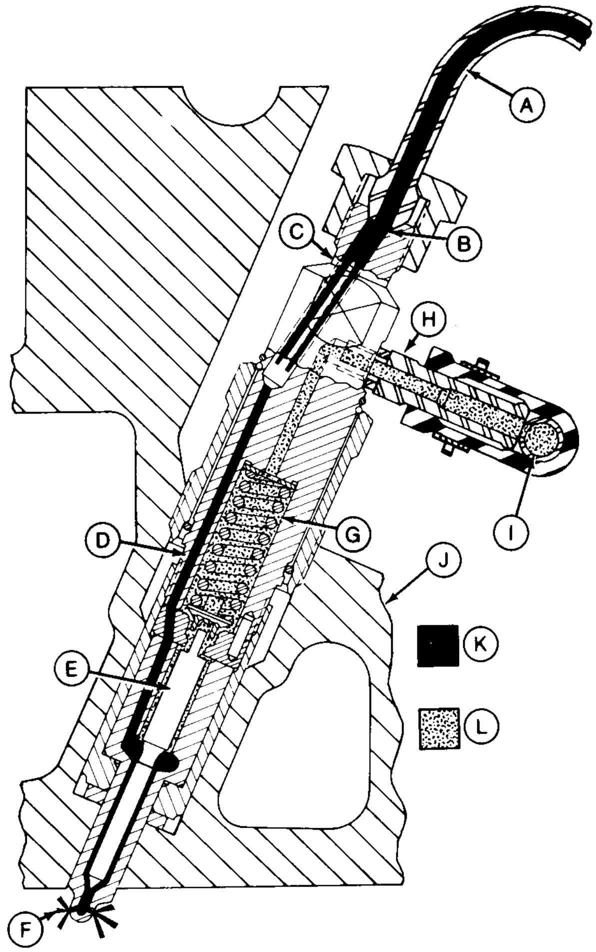
A passage (D) routes fuel through the nozzle holder to the nozzle valve (E). The nozzle valve is lifted instantly off its seat by the high pressure inlet fuel acting on an annulus in the valve.

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).



RG4651 -UN-29AUG94

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 Diesel Fuel System)
	Broken or damaged parts	Repair as required (See Group 35) Diesel Fuel System
	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 Diesel Fuel System)
	Worn nozzle valve seal	Replace nozzle assembly (See Group 35 Diesel Fuel System)

RG,CTM42,115,23-19-28OCT92

TEST FUEL INJECTION NOZZLES (ENGINE RUNNING)

1. Operate engine at intermediate speed and 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).

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 -19-18APR94

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 line and fuel return line 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.

4. Using a low pressure air source, pressurize the fuel system at the fuel supply line.

CAUTION: Maximum air pressure should be 100 kPa (1 bar) (15 psi) when performing this test.

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.

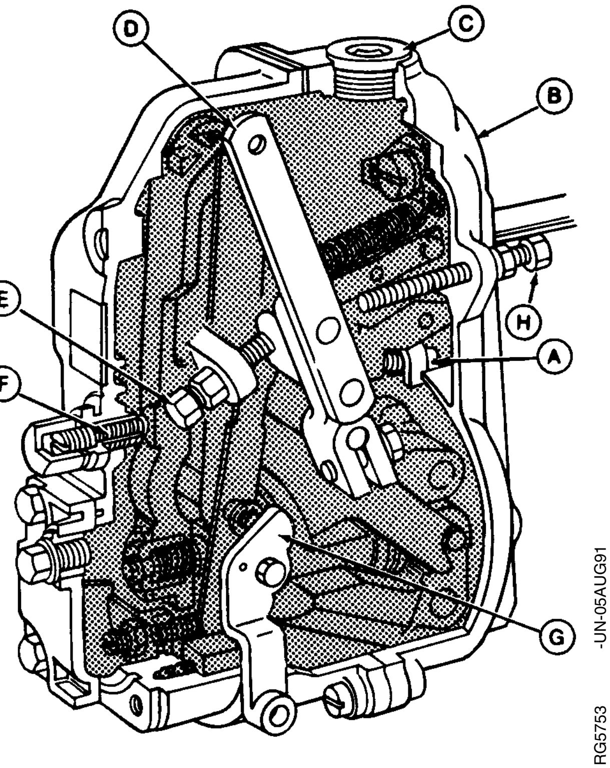
7. Reconnect supply and return lines and prime system.

8. Start engine and run for approximately 10 minutes.

9. Allow engine to sit overnight and try starting the following morning.

S11,23010,JA -19-28OCT92

INSTRUCTIONS FOR CHANGING 6076 GEN SET ENGINE RATED SPEED FROM 1800 RPM (60 HZ) TO 1500 RPM (50 HZ)—MECHANICAL GOVERNOR



A—Droop Adjusting Screw
B—Governor Housing
C—Droop Adjusting Screw Access Plug
D—Throttle Lever
E—Slow Idle (Adjusting) Screw
F—Idle (Bumper) Spring
G—Mechanical Shutoff Lever
H—Fast Idle (Stop) Screw

This instruction covers step-by-step adjustment procedures for changing 6076 Gen Set Engine rated speed from 1800 RPM (60 Hz) to 1500 RPM (50 Hz) while maintaining the desired speed regulation.

IMPORTANT: Only qualified technicians should attempt the adjustments covered in this instruction. If qualifications are in doubt, have your nearest ADS repair shop perform these adjustments.

To assure specified power and governing during engine operation, the throttle lever must be fixed against the fast idle (stop) screw (H).

To assure specified governing, the fast idle screw and bumper spring screw (F) must be readjusted any time the droop screw (A) is adjusted.

If an electric shutoff solenoid is connected to the shutoff lever (G) by rigid linkage, it must be adjusted to provide a gap of 0.0762 mm (0.003 in.), (one paper thickness) between the lever and stop. Too much gap will limit rack travel, no gap will bind the lever shaft. If flexible linkage is used, it should be adjusted for no gap.

RG,GENSET4,1 -19-11FEB93

CHANGE ENGINE RATED SPEED FROM 1800 RPM TO 1500 RPM AND ADJUST DROOP

1. Start engine and apply 50% load at rated speed until it reaches operating temperature. Remove cap nuts from adjusting screws before making adjustments.

2. When the engine has reached normal operating temperature, adjust fast idle (stop) screw (A) clockwise (CW) to 1500 rpm (50 Hz) with 100 % (full) load.

3. Remove load and back out the idle (bumper) spring screw (E), while observing the corresponding drop in engine rpm's until engine quits losing speed.

4. Screw in idle (bumper) spring screw until engine speed increases 5—10 rpm.

5. Check for specified no-load (frequency). If governor regulation is within 5—7% range, proceed to Step 8.

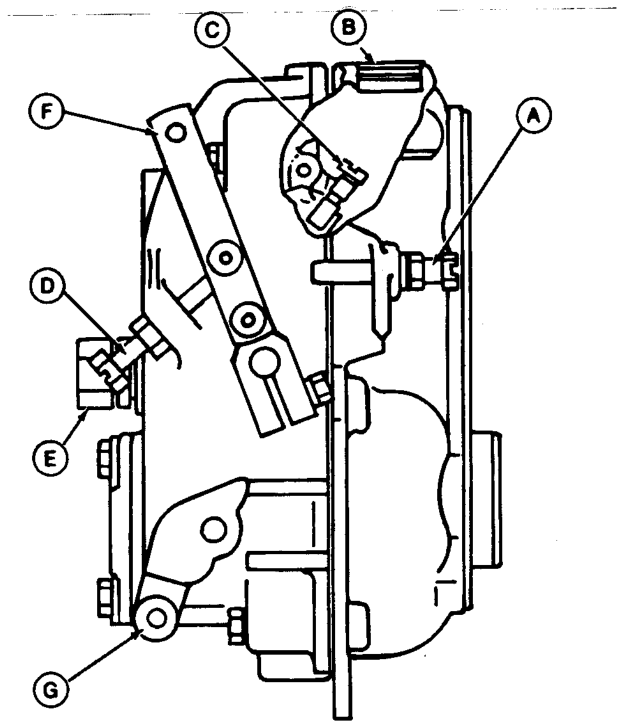
NOTE: A noticable click will occur at each 1/4 turn of droop adjusting screw. One click CW will increase no-load speed approximately 10 rpm, counter-clockwise (CCW) will reduce speed by 10 rpm. Maximum 24 clicks out, minimum 4 clicks out with final setting.

6. If governor regulation is above 7% or below 5%, stop engine and remove droop adjusting screw access plug (B, shown removed) from top of governor housing.

a. Back out slow idle (adjusting) screw (D) and and bumper screw. Pull back on throttle lever (F, toward rear of governor housing) by hand until the droop adjusting screw (C) inside housing can be adjusted through the access plug hole.
b. Screw the droop screw in (CW), counting the turns until screw bottoms out. Then, return screw to original setting.
c. Screw in the droop screw (CW) no more than 1/2 turn (two clicks) at a time to reduce governor droop. CCW no more than two clicks at a time to increase governor droop (to reduce governor sensitivity).
d. Replace access plug in top of governor housing. Start engine, apply full (100%) load, and readjust high idle adjusting screw until 1500 rpm (50 Hz) is obtained at the specified power.
e. Screw in idle (bumper) spring until engine speed increases 5—10 rpm.

7. Repeat Steps 6 (a—d) until governor regulation is within the 5—7% range.

Replace all cap nuts onto adjusting screws and tighten lock nuts securely.



RG5752 -UN-05AUG91

A—Fast Idle (Stop) Screw
B—Droop Adjusting Screw Access Plug Location
C—Droop Adjusting Screw
D—Slow Idle (Adjusting) Screw
E—Idle (Bumper) Spring
F—Throttle Lever
G—Mechanical Shutoff Lever

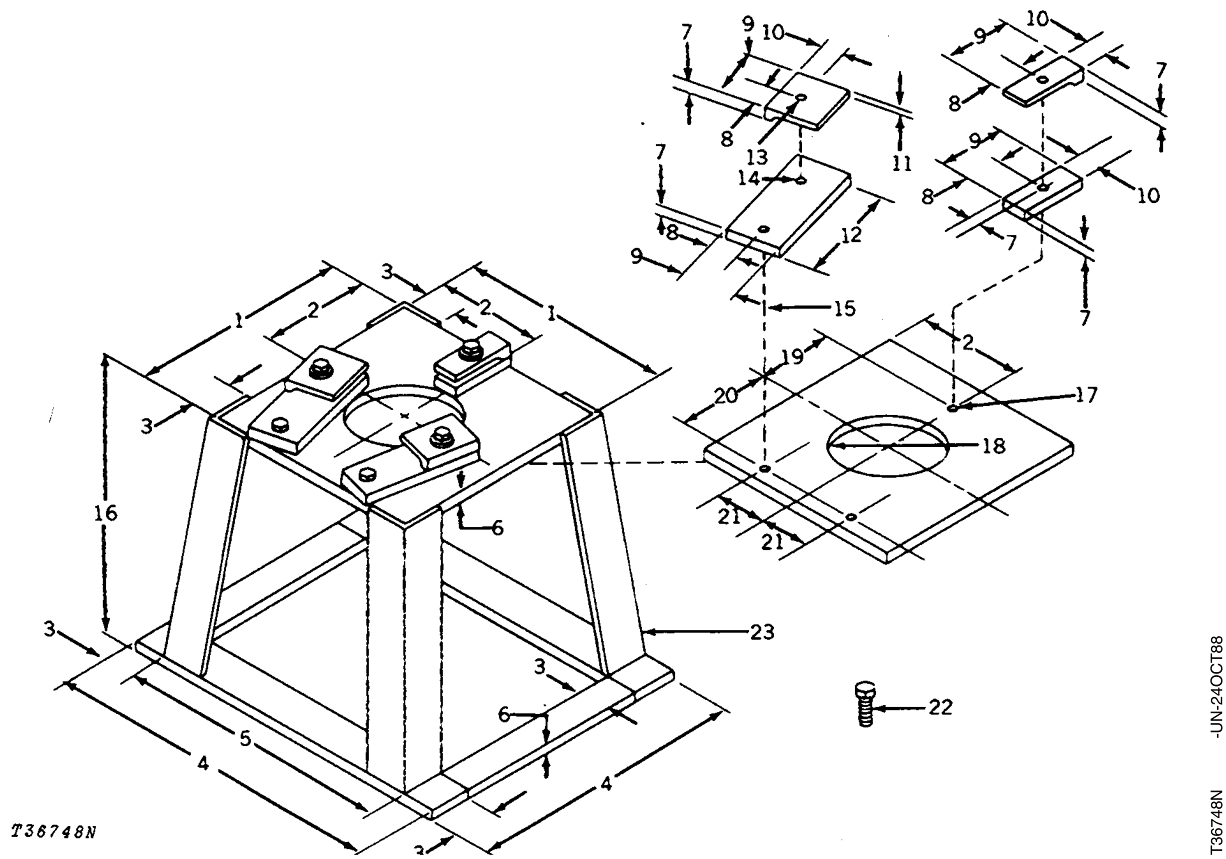
RG,GENSET4,3 -19-11FEB93

HOW TO MAKE TOOLS

These tools can be made in a service shop using common shop tools and locally obtained materials.

S55,DFRG -19-01DEC89

DFRG3—CYLINDER LINER HOLDING FIXTURE



1—254.0 mm (10 in.)
2—127.0 mm (5 in.)
3—38.1 mm (1.5 in.)
4—405.4 mm (16 in.)
5—330.2 mm (13 in.)
6—9.52 mm (0.38 in.)
7—12.7 mm (0.5 in.)
8—31.8 mm (1.25 in.)
9—63.5 mm (2.5 in.)
10—25.4 mm (1 in.)
11—6.35 mm (0.25 in.)
12—152.4 mm (6 in.)
13—0.328 in. Drill Through
14—5/16 in.—18 Tap
15—2 used
16—304.8 mm (12 in.)
17—5/16 in—18 Tap
18—69.85 mm (2.75 in.) Radius
19—101.6 mm (4 in.)
20—111.25 mm (4.38 in.)
21—60.45 mm (2.38 in.)
22—5/16 in. x 1 in. Cap Screw
23—38.1 mm (1.5 in.) Angle Iron

S55,DFRG3 -19-23FEB87

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