Series 300
3179, 4239, 6359, 4276, and 6414
Diesel Engines

Deere Power Systems Group

CTM4 (28OCT95)

LITHO IN U.S.A.
ENGLISH

Series 300
3179, 4239, 6359, 4276, and 6414 Diesel Engines

CTM4 (28OCT95)

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 DEALERS

IMPORTANT: The changes listed below make your current CTM obsolete. Discard CTM4, dated 24 Jan 90. Please copy this page and route through your service department.

• Specifications listed at the beginning of each group have been updated.

• Engine model designation and application charts have been updated to include the latest product models. (Group 01.)

• Engine break-in oil information has been added. Engine coolant requirements and specifications have been revised. (Group 02.)

• Methods for properly lifting of engines have been revised and added. (Group 03.)

• Valve clearance checking and adjustment procedure revised to show that these procedures MUST BE done with engine COLD. Cylinder head removal, inspection, and installation procedures have been revised. (Group 05.)

• Main thrust bearing, compression ring, piston pin length and crankshaft rod journal specifications have been added. Tools required for piston and rod assembly have been updated. Procedures for measuring piston skirt, piston pin bore and piston-to-liner clearance have been revised. (Group 10.)

• Specifications for six-piece thrust bearing and main bearing cap screw torque for Dubuque and Saran-built engines have been added. (Group 15.)

• Crankshaft gear removal and installation procedures, crankshaft grinding guidelines and specifications chart have been revised. (Group 15.)

• Procedures for installing upper idler shaft for Saran engines requiring a special washer has been added. (Group 16.)

• Procedures for both aluminum and composite material timing gear covers have been added. (Group 16.)

• Description of standard-flow and high-flow oil coolers have been added. (Group 20.)

• Procedures for identifying and installing the oil bypass valve, which reflect a new design configuration have been added. (Group 20.)

• Water pump procedures have been revised to reflect a unitized (one-piece) water seal. (Group 25.)

• Checking Water Pump Cap Screw Protrusion procedure has been added for Saran 4-and 6-cylinder OEM engines. (Group 25.)

• Removal and installation procedures for the aftercooler have been added. (Group 30.)

• Turbocharger radial bearing clearance and axial bearing endplay procedures have been revised. (Group 30.)

• Engine break-in procedures have been revised. (Group 100.)

• Removal and installation procedures for the fuel shut-off solenoid have been added. Procedures for the removal, repair, and installation of the fuel injection pumps have been revised. (Group 35.)

• Fuel injection pump specifications chart has been updated to include dynamic timing values for all engine models. Procedures for dynamic timing using TIME TRAC® Kit has been added. Check and Adjust Engine Speed procedure for Lucas CAV and Stanadyne pumps have been added. (Group 115.)

TIME TRAC® is a registered trademark of Stanadyne Automotive Corp.

RG,CTM4,DW815 -19-01NOV95

ABOUT THIS MANUAL

This Component Technical Manual (CTM4) covers the recommended repair procedures for the following engines:

• All 179 cu. in. (2.9 L), 239 cu. in. (3.9 L), and 359 cu. in. (5.9 L) produced in Saran, France having Engine Serial No. (CD394145—).

• All 239 cu. in. (3.9 L) and 359 cu. in. (5.9 L) produced in Dubuque, Iowa having Engine Serial No. (T0100001—300000).

• All 276 cu. in. (4.5 L) and 414 cu. in. (6.8 L) produced in Dubuque, Iowa having Engine Serial No. (T0100001—300000). These engines have serial number plates with raised letters and numbers, and were manufactured November 1983 or later.

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

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

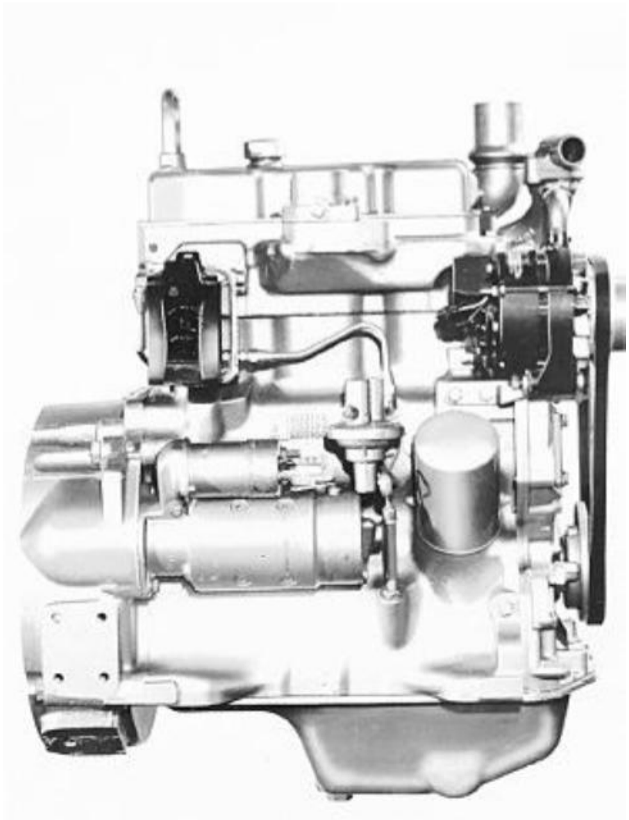
Direction of engine crankshaft rotation in this manual is referenced from facing the flywheel looking toward water pump. Front of engine is water pump end. NORMAL CRANKSHAFT ROTATION IS COUNTERCLOCKWISE.

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

Read each module completely before performing service to check for differences in procedure or specifications. Follow only the procedures that apply to the engine model number you are working on. If only one procedure is given, that procedure applies to all 300 Series Diesel Engines in this manual.

S11,2000,DF -19-28SEP95

3179D ENGINE IDENTIFICATION

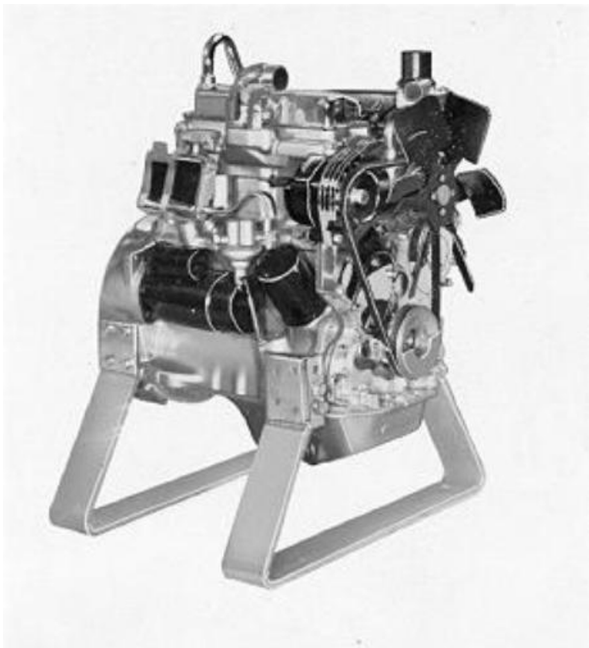


RG4872 -UN-19JAN90

3179D Engine

RG,CTM4,DW610 -19-01NOV95

4276D ENGINE IDENTIFICATION



RG4873 -UN-19JAN90

4276D Engine

RG,CTM4,DW611 -19-28SEP95

6359A ENGINE IDENTIFICATION


RG4875 -UN-19JAN90

6359A Engine

RG,CTM4,DW612 -19-28SEP95

6359T ENGINE IDENTIFICATION


RG4874 -UN-19JAN90

6359T Engine

RG,CTM4,DW613 -19-28SEP95

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

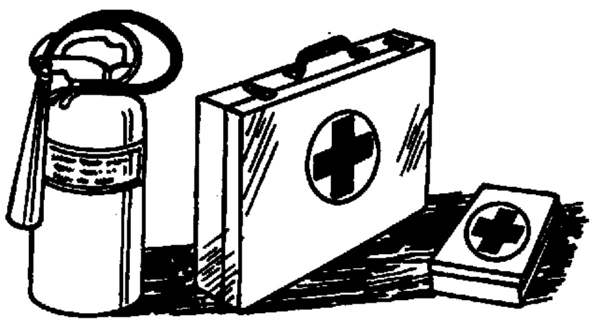
DX,SPARKS -19-03MAR93

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

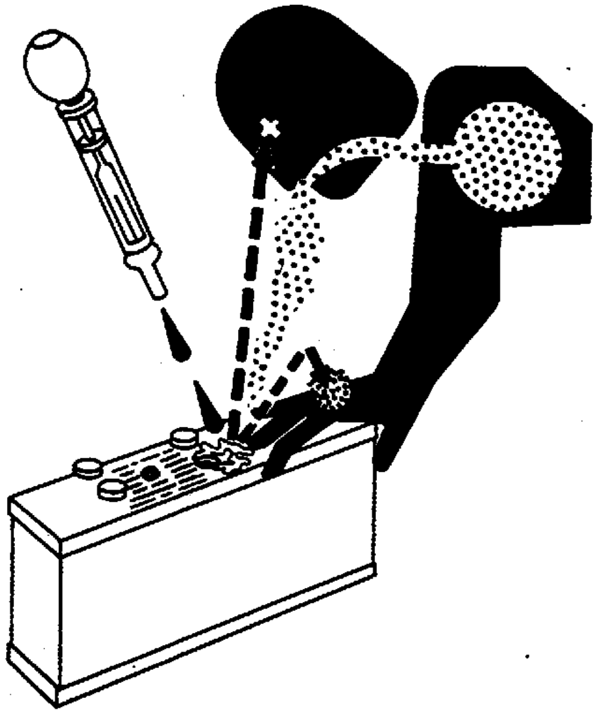
PREVENT ACID BURNS

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.

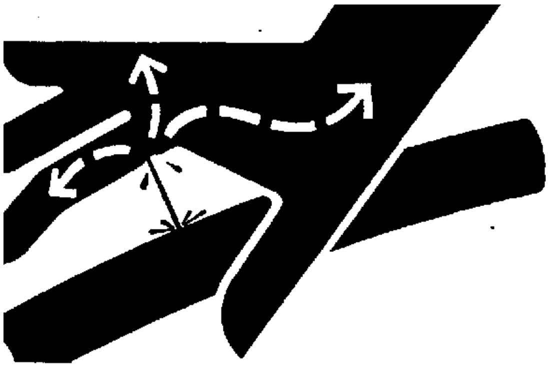
If acid is swallowed:
1. Do not induce vomiting.
2. Drink large amounts of water or milk, but do not exceed 2 L (2 quarts).
3. Get medical attention immediately.



TS203 -UN-23AUG88

DX,POISON -19-21APR93

AVOID HIGH-PRESSURE FLUIDS



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

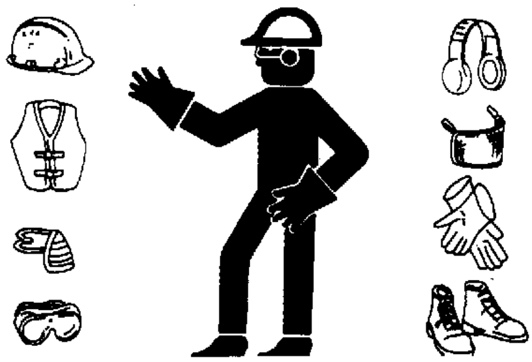
Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

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

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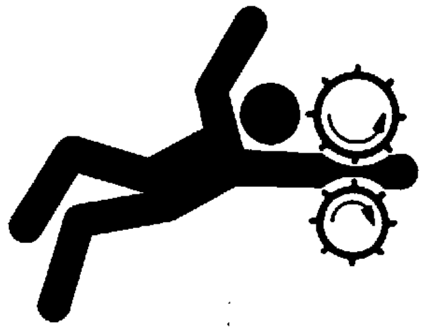
SERVICE MACHINES SAFELY

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

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



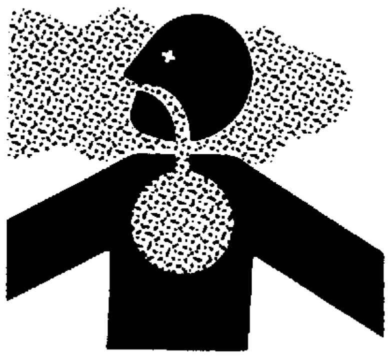
TS228 -UN-23AUG88

DX,LOOSE -19-04JUN90

WORK IN VENTILATED AREA

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

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



TS220 -UN-23AUG88

DX,AIR -19-04JUN90

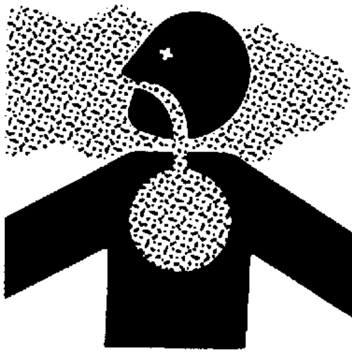
ILLUMINATE WORK AREA SAFELY

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

TS223 -UN-23AUG88

DX,LIGHT -19-04JUN90

REMOVE PAINT BEFORE WELDING OR HEATING



TS220 -UN-23AUG88

Avoid potentially toxic fumes and dust.

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

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

Remove paint before welding or heating:

• If you sand or grind paint, avoid breathing the dust. Wear an approved respirator.

• If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.

DX,PAINT -19-03MAR93

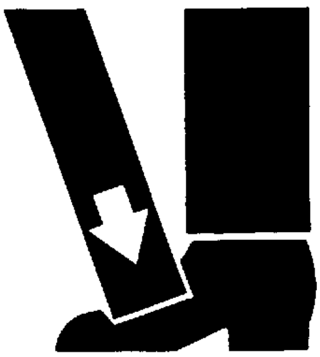
AVOID HEATING NEAR PRESSURIZED FLUID LINES

TS953 -UN-15MAY90

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

DX,TORCH -19-03MAR93

USE PROPER LIFTING EQUIPMENT



TS226 -UN-23AUG88

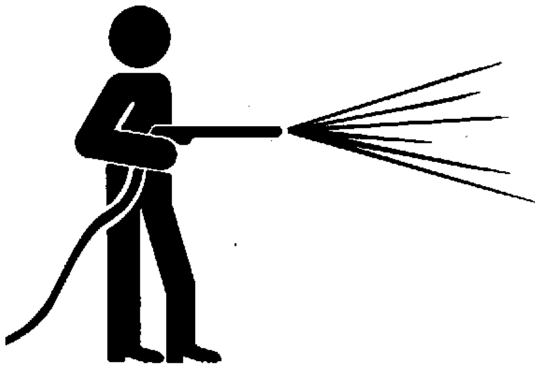
Lifting heavy components incorrectly can cause severe injury or machine damage.

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

DX,LIFT -19-04JUN90

WORK IN CLEAN AREA

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



T6642EJ -UN-18OCT88

DX,CLEAN -19-04JUN90

PRACTICE SAFE MAINTENANCE

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

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

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

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

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

TS218 -UN-23AUG88

DX,SERV -19-03MAR93

USE PROPER TOOLS

TS779 -UN-08NOV89

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

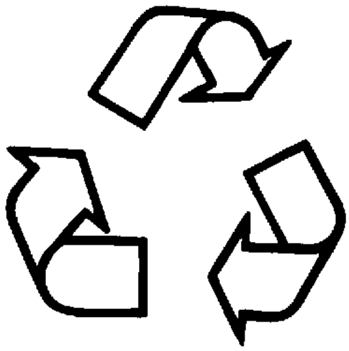
Use power tools only to loosen threaded parts and fasteners.

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.

DX,REPAIR -19-04JUN90

DISPOSE OF WASTE PROPERLY



TS1133 -UN-26NOV90

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

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

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

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

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

DX,DRAIN -19-03MAR93

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

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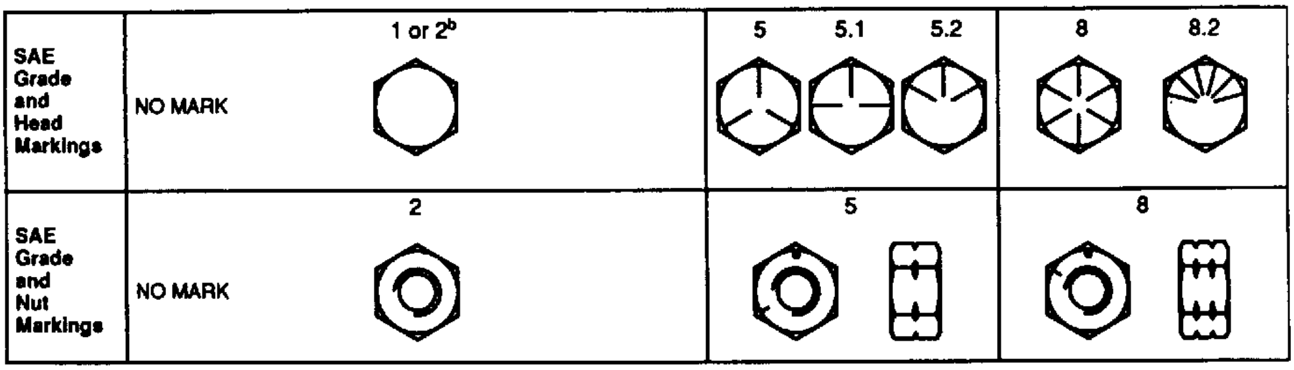
UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES



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.*

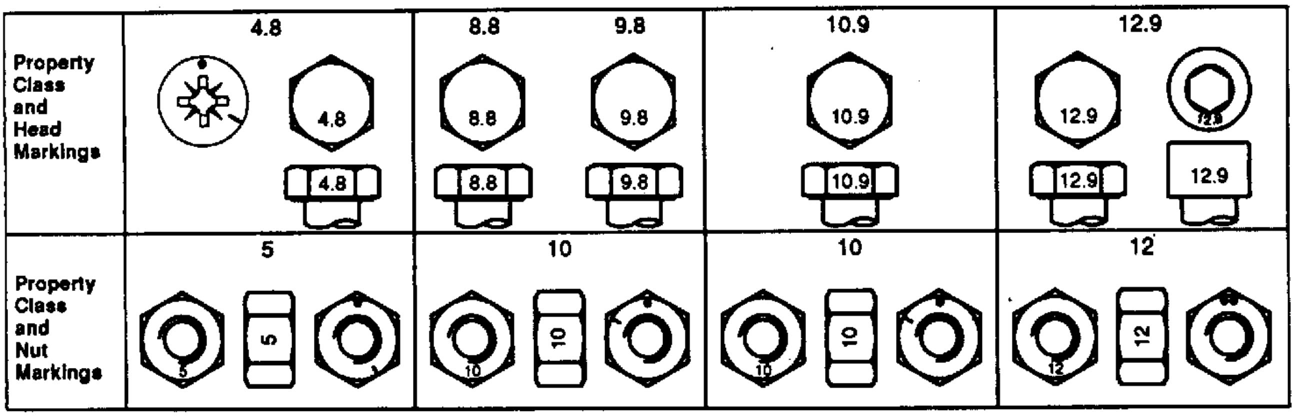
Fasteners should be replaced with the same or higher grade. If higher grade fasteners are used, these should only be tightened to the strength of the original.

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

1. John Deere Engine Model—3179, 4239, 4276, 6359, and 6414 Engines.

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

4239TF001 Engine

4	Number of cylinders
239	Cubic inch displacement
T	Aspiration code
F0	User factory code* (one or two digits)
01	Application code

*Factories with a one position factory code were formerly designated with a hyphen (-) in the second position (4239TF-01). Later engines are designated with a zero (0) in the second position of the factory code (4239TF001).

Aspiration Code

D	Naturally aspirated
T	Turbocharged
A	Turbocharged and air-to-coolant aftercooled

User Factory Code

J0	Argentina
DW	Davenport (Iowa)
N0	Des Moines (Iowa)
T0	Dubuque (Iowa)
H0	Harvester (Moline, Illinois)
CE	Iberica (Spain)
L0	Mannheim (Germany)
P0	Mexico
F0	OEM
E0	Ottumwa (Iowa)
CD	Saran (France)
R or RW	Waterloo Tractor Works
W0	Welland (Canada)
Z0	Zweibrucken (Germany)

Application Code

00, 01, 02, etc.	Code for specific application

S11,2000,DH -19-22SEP95

2. Detroit Diesel Allison (DDA) Engine Models.

DDA engine model designations cross-reference from John Deere engine models. They include the series, number of cylinders, application type, direction of rotation, aspiration, and application code. Thus, the model 4239TF001 engine discussed on the previous page, becomes DDA model F0439300. For example:

F0439300 Model Designation

F	Engine series
04	Number of cylinders
3	Application type
9	Direction of rotation
3	Aspiration
00	Application code

Application Type

2	Marine
3	Industrial
4	Power Base
5	Generator Set
8	Special

Direction of Rotation

9	Right-Hand (as viewed from FRONT of engine)
0	Left-Hand rotation

Aspiration

1	Naturally aspirated
3	Turbocharged
6	Turbocharged and aftercooled

Application Code

00, 01, 02 etc	Code for each specific application

S11,2000,DI -19-22JUN95

ENGINE SERIAL NUMBER PLATE INFORMATION

IMPORTANT: The engine serial number can be easily destroyed. Before “hot tank” cleaning the block, remove the plate or record the information elsewhere.

• 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:

CD6359T000000

CD	Factory producing engine
6359T	Engine model designation
000000	Sequential serial number

Factory Codes

T0	Dubuque, Iowa
CD	Saran, France

Engine Model Designation

6359T	Definition explained previously. (See “Engine Model Designation“.)

Sequential Number*

000000	6-digit sequential serial number

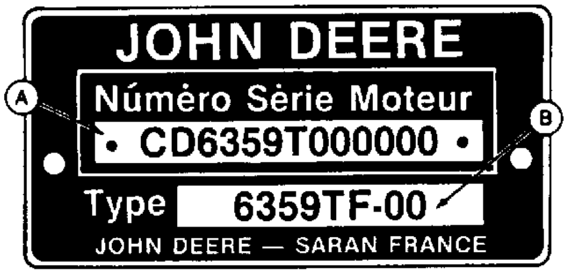
*Numbering sequence differs between factories.

• Engine Application Data (B and C)

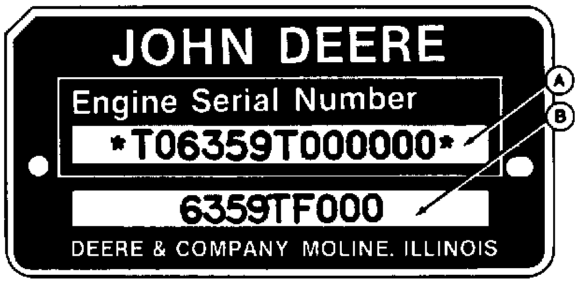
The second line of information on the nameplate identifies the engine/machine or OEM relationship. See ENGINE APPLICATION CHART later in this group.

• Coefficient of Absorption (D)—Saran built engines only

The third line of information on some Saran serial number plates contains the coefficient of absorption value for smoke emissions.



RG4730 -UN-24JAN90



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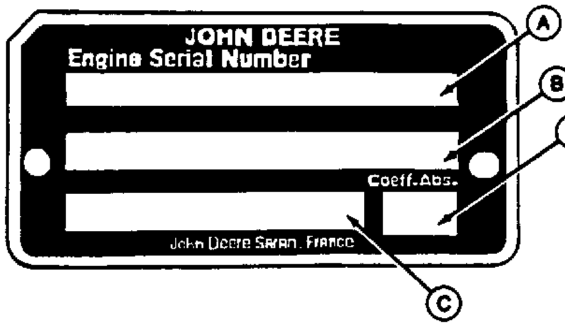


RG5610 -UN-09JAN90

A—Engine Serial Number
B—Engine Application Data
C—Engine Application Data
D—Coefficient of Absorption

S11,2000,DJ -19-25SEP95

• Unit Number (A)

Engines marketed by Detroit Diesel Allison (DDA) have a third line of information on the serial number plate. The unit number is the DDA application serial number and must be utilized for DDA service and customer reference purposes.

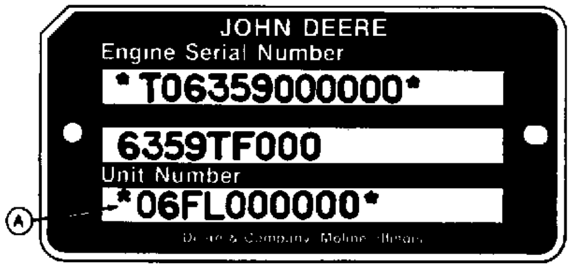
A typical unit number converts the 13-digit engine serial number into one that is 10-digit. It includes the number of cylinders, manufacturing factory location, and the DDA model designation. Example:

JD Engine Serial No.	DDA Unit No.
T06359T000000	**06FL000000**
6	06
T0	F
T06359T	L**
000000	000000

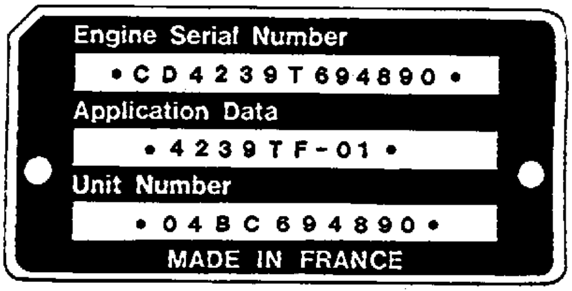
Model Codes

JD/DDA Factory Code	Deere Engine Type	DDA Model Code** (4th position of Unit No.)
CD/B	CD3179D	A
	CD4239D	B
	CD4239T	C
	CD4239A	F
	CD6359D	D
	CD6359T	E
	CD6359A	G
T0/F	T04239D	H
	T04239T	J
	T04276D	C
	T04276T	D
	T06359D	K
	T06359T	L
	T06414D	F
	T06414T	G

NOTE: Some serial number plates (with three lines) were used which do not reference the name John Deere.



RG4734 -UN-09OCT89



RG4917 -UN-15DEC88

S11,2000,DL -19-22SEP95

ENGINE APPLICATION CHART*

• John Deere Agricultural Equipment

Machine Model No.	Engine Model	Engine Serial No.
COMBINES		
Harvester Works		
4420	CD6359DH-01	
9400	T06359TH001**	
9400	T06359AH001	
Zweibrucken (Germany)		
4425	CD6359DZ004	
4435	CD6359DZ004	
COTTON PICKER/STRIPPER		
Des Moines Works		
484	CD6359DN-01	
7440	CD6359DN-01	
7445	CD6359TN002	
	CD6359TN-02	
	T06359TN002	
9900	CD6359DN-01	
9900HRA	CD6359TN-01	
9910	CD6359DN-01	
9920	CD6359DN-01	
9930	CD6359TN002	
	CD6359TN-02	
	T06359TN002	
HI-CYCLE™ SPRAYER		
Des Moines Works		
6000	4239DN-03	

** Applies to Saran-built engines Serial No. (394145CD-) and all 106.5 mm (4.19 in.) bore Dubuque-built engines Serial No. (100001T—).*

***These engines are now equipped with aftercoolers per a field modification program.*

S11,2000,DO -19-22SEP95

ENGINE APPLICATION CHART—CONTINUED

• John Deere Agricultural Equipment—Continued

Machine Model No.	Engine Model	Engine Serial No.
TRACTORS		
Argentina		
2730	4239DJ-02	
3330	4239DJ-01	
Dubuque Works		
2630	4276DR-01	
2640 CS	4276DR-01	
2640 CS	4276DR-04	
Iberica (Spain)		
1630	3179DCE01	
	4239DCE02	
3130	6359DCE01	
3140	6359DCE01	
Mannheim (Germany)		
1630	3179DL-01	
2130	4239DL-01	
2140	CD4239TL02	
2150	3179DL-11	(—CD571078)
2150	3179DL-01	(CD571079—)
2155 CS	3179DL001	
2155 TSS	3179DL017	
2255	3179DL-01	(—CD581072)
2255	3179DL-12	(CD581073—)
2350	4239DL-07	
2355 CS	CD4239DL007	
2355 TSS	4239DL010	
2355N CS	3179TL003	
2355N TSS	CD3179TL002	
2550	4239DL-08	
2555 CS	4239DL008	
2555 TSS	CD4239TL006	
2750	4239TL-04	
2750	4239TL-05	
2755 CS	CD4239TL005	
2755 TSS	4239TL009	
2855N	4239TL008	
2940	6359DL-03US	
2950	6359DL-04	
2955 TSS	CD6359DL009	
3055	CD6359DL011	(931422—)
3140 C	6359TL-02	
3150	6359DL-07	
3155 TSS	CD6359DL010	
3255	CD6359TL007	

S11,2000,DP -19-22SEP95

ENGINE APPLICATION CHART—CONTINUED

• John Deere Agricultural Equipment—Continued

Machine Model No.	Engine Model	Engine Serial No.
Mexico		
2535P	4239DP-02	
2735	4239DP-01	
Waterloo (Tractor)		
3055	6359DL011	
4050	CD6359TR001	
WINDROWERS		
Ottumwa Works		
2360	CD4239DE002	
2360	CD4239DW-01	
2360	CD4239DW001	
3430	CD4239DE-01	
3430	CD4239DE001	
3430	T04239DE001	
3830	CD4239TE-01	
3830	CD4239TE001	
3830	T04239TE001	

JOHN DEERE INDUSTRIAL EQUIPMENT

Machine Model No.	Engine Model	Engine Serial No.
BACKHOE-LOADERS		
210C	T04239DT002	
210C Series I	T04239DT006	
310C	T04239DT003	
	T04239TT004*	
410C	T04276DT003	
	T04276TT005*	
415B	CD4239DCD03	
510B	T04276DT003	
	T04276TT005*	
510C	T04276TT010	
515B	CD4239TCD02	
610B	T04276TT010	
610C	T04276TT014	
710B	T06359TT001	
710C	T06359TT002	

Turbocharged for altitude compensation

S11,2000,DT434 -19-22SEP95

ENGINE APPLICATION CHART—CONTINUED

• John Deere Industrial Equipment—Continued

Machine Model No.	Engine Model	Engine Serial No.
CRAWLERS		
350D	CD3179DT001	
355D	CD3179DT001	
400G	T04239DT005	
450E	T04276DT005	
	T04276TT011*	
450 ELT	T04276DT006	
	T04276TT013*	
450G	T04276TT015	
455E	T04276TT011	
455G	T04276TT015	
550	T04276TT001	
550A	T04276TT006	
550B	T04276TT006	
550G	T04276TT016	
555	T04276TT001	
555A	T04276TT006	
555B	T04276TT006	
555G	T04276TT017	
650G	T04276TT017	
655A	T06414TT007	
655B	T06414TT009	
JD750	T06414TT004	
	T06414TT007	
750A	T06414TT007	
750B	T06414TT009	
JD755	T06414TT004	
755A	T06414TT006	
755B	T06414TT010	
755B MIL	T06414TT016	

**Turbocharged for altitude compensation*

S55,2000,NA -19-22SEP95

ENGINE APPLICATION CHART—CONTINUED

• John Deere Industrial Equipment—Continued

Machine Model No.	Engine Model	Engine Serial No.
EXCAVATORS		
JD34	CD4239DCD01	
JD44	CD4239DCD02	
JD45	CD4239DCD02	
JD54	CD6359DCD01	
JD55	CD6359DCD01	
JD65	CD6359TCD02	
70	T04239DT004	
70D	T04239DT004	
290D	T04239DT007	
490	CD4239TT003	
490D	T04276DT008	
495D	T04276TT021	
590D	T04276TT021	
595	T04276TT012	
595D	T04276TT021	
690D	T06414TDW14	
LOADERS, 4 WHEEL DRIVE		
344E	T04276DT010	
JD444	CD6359DCD02	
444D	T06359DDW01	
	T06359TDW01*	
444E	T04276TT018	
JD544B	CD6359TCD01	
	T06414TT002	
544C	T06414TT-05	
	CD6359TCD03	
544D	T06414TDW11	
544DH	T06414TDW12	
544E	T06359TDW04	
544EH	T06359TDW05	
624E	T06414TDW15	
624EH	T06414TDW16	

*Turbocharged for altitude compensation

S55,2000,NB -19-01NOV95

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ENGINE APPLICATION CHART—CONTINUED

• John Deere Industrial Equipment—Continued

Machine Model No.	Engine Model	Engine Serial No.
MOTOR GRADERS		
570B	T06359DDW02	
	T06359TDW02*	
JD670	T06414TT003	
670A	T06414TT003	
	T06414TDW03	
670B	T06414TDW03	
672A	T06414TT003	
	T06414TDW03	
672B	T06414TDW13	
SKIDDERS		
340D	T04276DT004	
	T04276DDW04	
440C	T04276TT002	
440D	T04276TT007	
	T04276TDW07	
448D	T04276TT007	
	T04276TDW07	
540B	T04276TT004	
540D	T04276TT008	
	T04276TDW08	
548D	T04276TT008	
	T04276TDW08	
640	T06414TT001	
640D	T06414TT008	
	T06414TDW08	
648D	T06414TT008	
	T06414TDW08	
FELLER BUNCHERS		
643	T06414TT015	
693D	T06414TDW14	
FORK LIFT		
482C	T04239DT002	

**Turbocharged for altitude compensation*

S55,2000,MT -19-22SEP95

ENGINE APPLICATION CHART—CONTINUED

• OEM

3179DF	3179TF	4239DF	4239TF	4239AF
4276DF	4276TF	6359DF	6359TF	6359AF
6414DF	6414TF			

S11,2000,DS -19-22SEP95

DIESEL FUEL

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

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

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

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

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

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

- **Sulfur Content**

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

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

RG,FUEL1 -19-06OCT95

LUBRICITY OF DIESEL FUELS

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

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

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

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

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

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

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

RG,FUEL5 -19-06OCT95

ENGINE BREAK-IN OIL

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

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

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

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

• API Service Classification CE
• CCMC Specification D4

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

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

DX,ENOIL4 -19-17OCT94

DIESEL ENGINE OIL

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

The following oil is preferred.

- **John Deere PLUS-50®**

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

The following oil is also recommended:

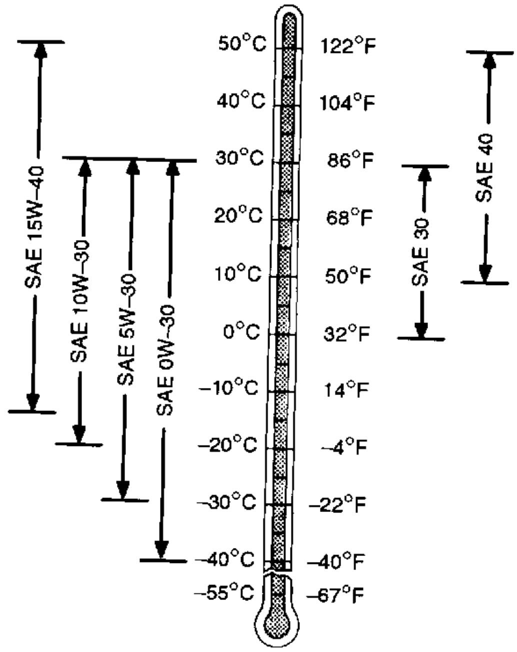
- John Deere TORQ-GARD SUPREME®

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

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

Viscosity grade SAE 15W-40 is preferred.

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



TS1619 -UN-12SEP94

DX,ENOIL -19-16SEP94

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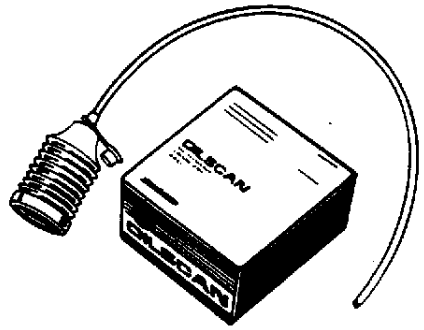
3

OILSCAN® AND COOLSCAN™

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

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

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



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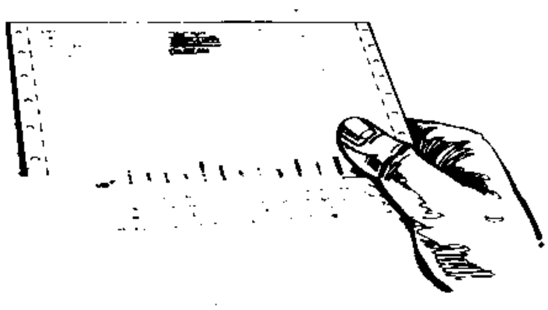


T6829AB -UN-18OCT88

DX,OILSCAN -19-16APR92

ALTERNATIVE AND SYNTHETIC LUBRICANTS

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

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

DX,ALTER -19-01FEB94

GREASE

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

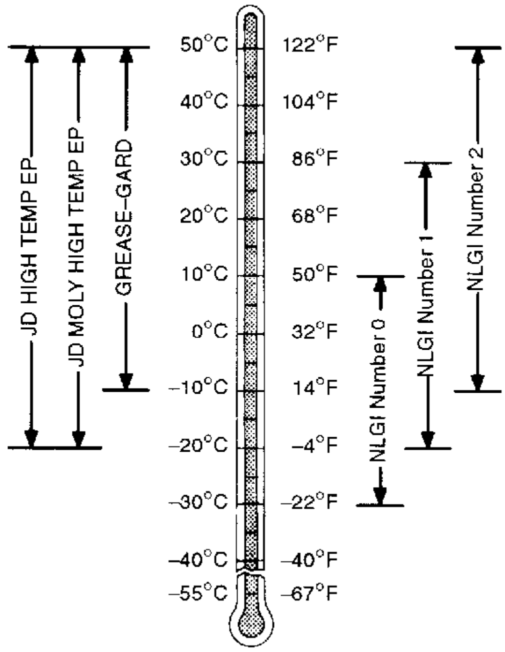
The following greases are preferred:

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

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

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

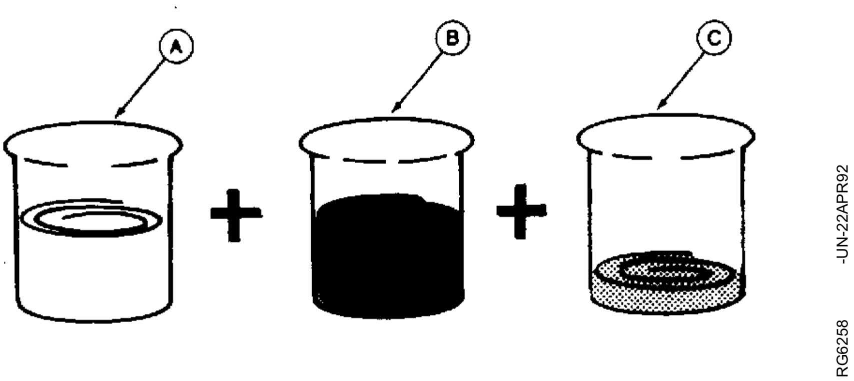
Greases meeting Military Specification MIL-G-10924F may be used as arctic grease.



TS1622 -UN-02NOV94

DX,GREA1 -19-02NOV94

ENGINE COOLANT REQUIREMENTS



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

Engine Coolant

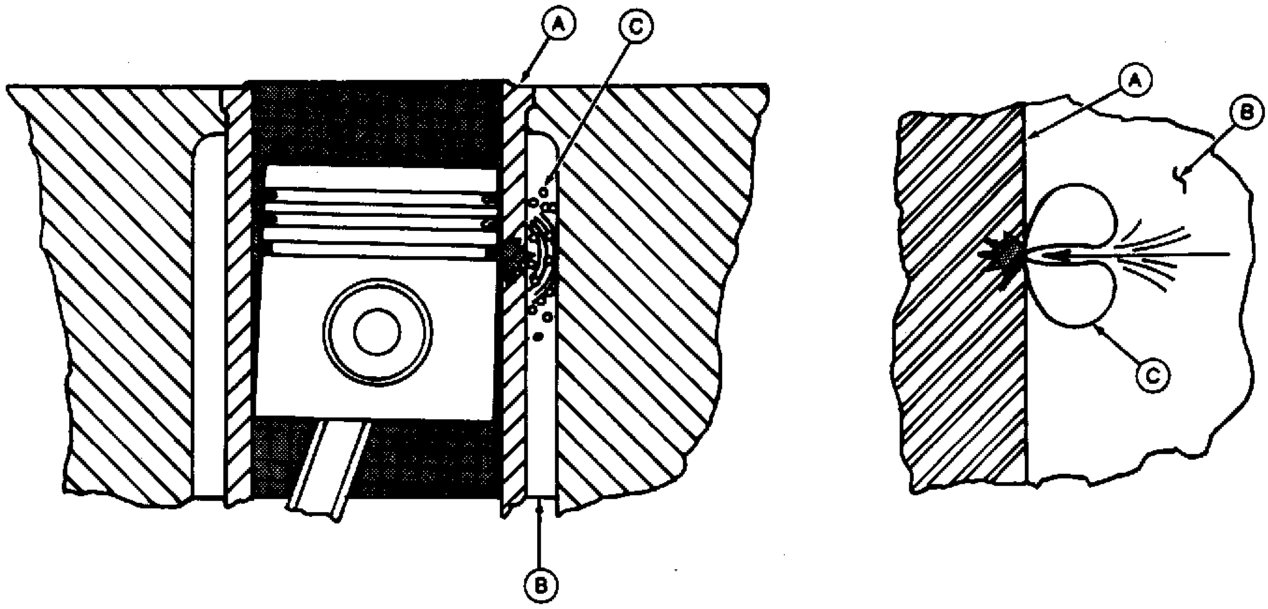
To meet cooling system protection requirements, the coolant MUST consist of a 50/50 mixture of quality water and ethylene glycol concentrate (antifreeze). Supplemental coolant additives (SCA's) must be added to this mixture. Add 3% (by volume) TY16004 or TY16005 Liquid Coolant Conditioner. If an equivalent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

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

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

RG,COOL1 -19-01NOV95

ENGINE COOLANT REQUIREMENTS—CONTINUED



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

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

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

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

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

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

RG,COOL1A -19-06OCT95

RECOMMENDED ENGINE COOLANT

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

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

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

• JOHN DEERE PREDILUTED ANTIFREEZE/SUMMER COOLANT

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

• JOHN DEERE ANTIFREEZE/SUMMER COOLANT CONCENTRATE

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

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

• JOHN DEERE COOL-GARD™

In certain geographical areas, John Deere COOL-GARD is marketed for use in the engine cooling system. This product contains all the necessary ingredients that make up the proper coolant solution: chemically pure water, ethylene glycol (low silicate antifreeze), and supplemental coolant additives (SCA's). It is ready to add to cooling system as is; no mixing or supplemental coolant additives required. Contact your John Deere Parts Network for local availability.

RG,COOL2,CTM -19-06OCT95

ENGINE COOLANT SPECIFICATIONS

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

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

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

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

Water Quality:

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

Water Quality Specifications

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

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

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

Ethylene Glycol Concentrate (Antifreeze):

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

RG,COOL3 -19-06OCT95

ENGINE COOLANT SPECIFICATIONS—CONTINUED

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.

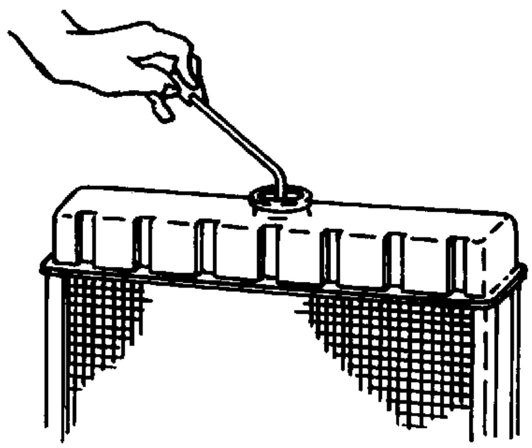
DO NOT use soluble oil.

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.

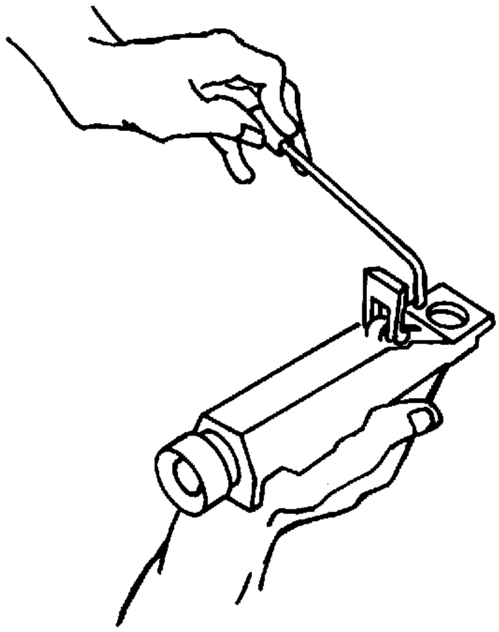
Contact your authorized servicing dealer or engine distributor, if there are further questions.

RG,COOL3A,CTM -19-06OCT95

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 -19-06OCT95

OPERATING IN TROPICAL CONDITIONS

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

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

RG,COOL6,CTM -19-01NOV95

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.

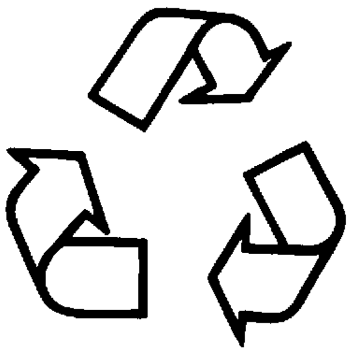
Contact your authorized servicing dealer or engine distributor, if there are further questions.

FLEETGUARD® is a registered trademark of Cummins Engine Company.

RESTORE™ is a trademark of FLEETGUARD®.

RG,COOL,REQ8B -19-17AUG94

DISPOSING OF COOLANT



TS1133 -UN-26NOV90

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

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

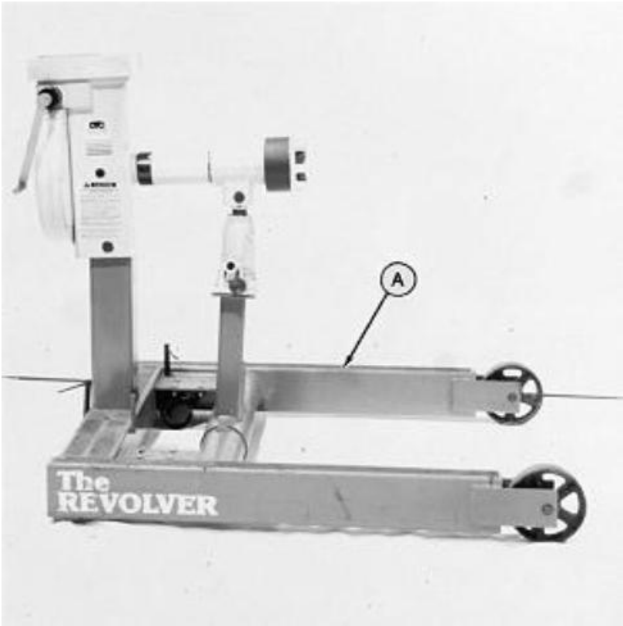
Do not pour waste onto the ground, down a drain, or into any water source.

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

RG,COOL5 -19-06OCT95

ENGINE REPAIR STAND

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



RG4929 -UN-15DEC88

S11,2000,EM -19-08MAR94

SAFETY PRECAUTIONS

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

• To maintain shear strength specifications, alloy steel SAE Grade 8 or higher cap screws must be used to mount adapters and engine to repair stand. Use LOCTITE 242 Thread Lock and Sealer on cap screws when installing lifting straps on engine. Tighten cap screws to 245 N·m (180 lb-ft).

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

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

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

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

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

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

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

LOCTITE® is a registered trademark of Loctite Corporation.

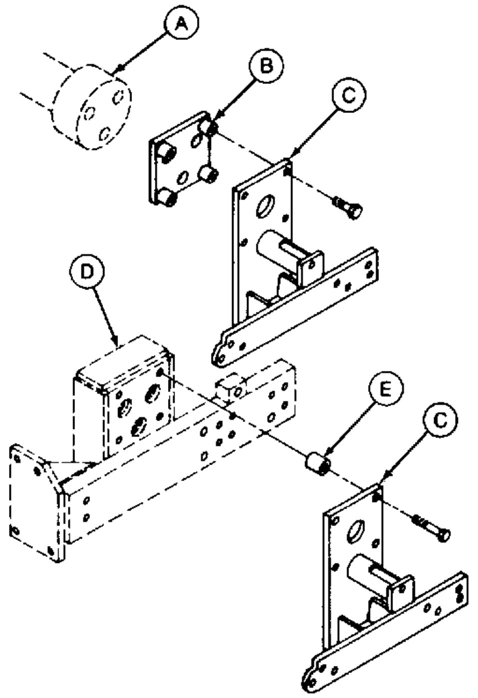
S11,2000,DZ -19-06OCT95

INSTALL 300 SERIES ADAPTERS ON REPAIR STAND

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

2. Attach D05225ST Engine Adapter (C) to the special adapter, using four 5/8-11 x 2 in. SAE Grade 8 cap screws. Tighten screws to 135 N·m (100 lb-ft).

NOTE: The D05225ST Engine Adapter can be attached directly to the No. 60581 Engine Adapter (D) which is required for mounting 400 Series Engines. Use four No. 204897 Spacers (E) and four 5/8-11 x 3-1/4 in. SAE Grade 8 cap screws. Tighten screws to 135 N·m (100 lb-ft).

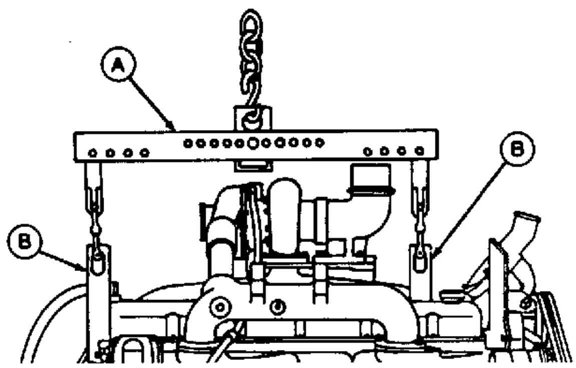


RG4737 -UN-08FEB95

A—Hub
B—D05226ST Special Adapter
C—D05225ST Engine Adapter
D—No. 60581 Adapter
E—No. 204897 Spacer (4 used)

S11,2000,EA -19-22JUN95

ENGINE LIFTING PROCEDURE



RG4738 -UN-18MAY90

CAUTION: Use extreme caution when lifting and NEVER permit any part of the body to be positioned under a load being lifted or suspended.

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

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

NOTE: If engine does not have lifting straps, they can be procured through service parts. Use of an engine lifting sling is the only approved method for lifting the engine.

2. Carefully lift engine to desired location.

S11,2000,EB -19-01NOV95

03
3

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

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

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

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

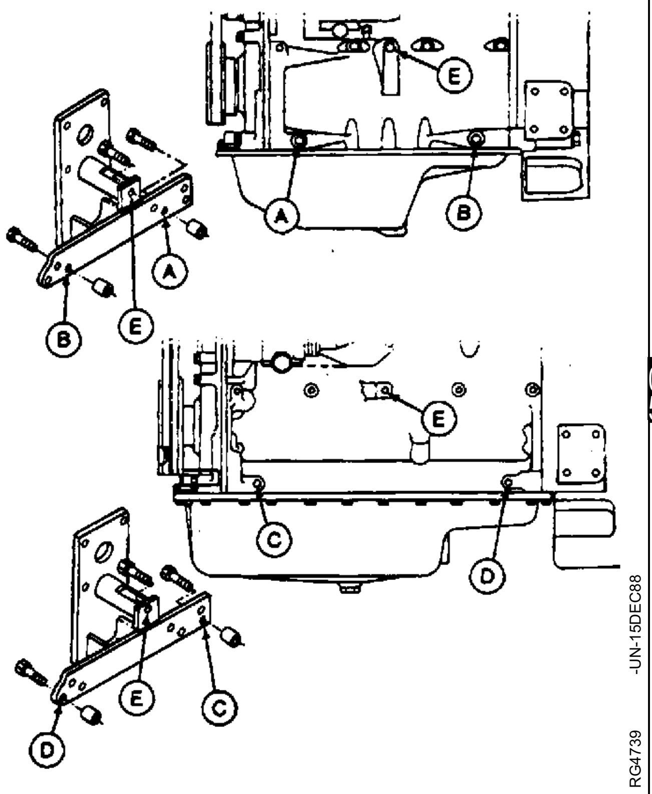
After starting the engine, the trapped oil in the manifold and head is released into the cylinder(s) filling them with oil causing hydraulic lock and possible engine failure.

2. Disconnect turbocharger oil inlet line.

S53,2000,MS -19-30JUN95

MOUNT ENGINE ON REPAIR STAND

CAUTION: NEVER remove the overhead lifting 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.



On engines equipped with a low-profile turbocharger, remove turbocharger before attaching engine to repair stand.

• 3179 Engines

Use No. 202557 Spacer at hole (A) and No. 202558 Spacer at hole (B). Mount engine-to-adapter using the cap screws listed below at the hole locations as shown:

Hole A—9/16-12 x 4-1/4 in.
Hole B—9/16-12 x 4-1/2 in.
Hole E—9/16-12 x 1-1/2 in.

• 4239 and 4276 Engines

Use No. 202557 Spacer at hole (C) and No. 202558 Spacer at hole (D). Mount engine-to-adapter using the cap screws listed below at the hole locations as shown:

Hole C—9/16-12 x 4-1/2 in.
Hole D—9/16-12 x 4-1/2 in.
Hole E—9/16-12 x 1-1/2 in.

• 6359 and 6414 Engines

Use No. 202555 Spacer both at hole (C) and hole (D). Mount engine-to-adapter using the cap screws listed below at the hole locations as shown:

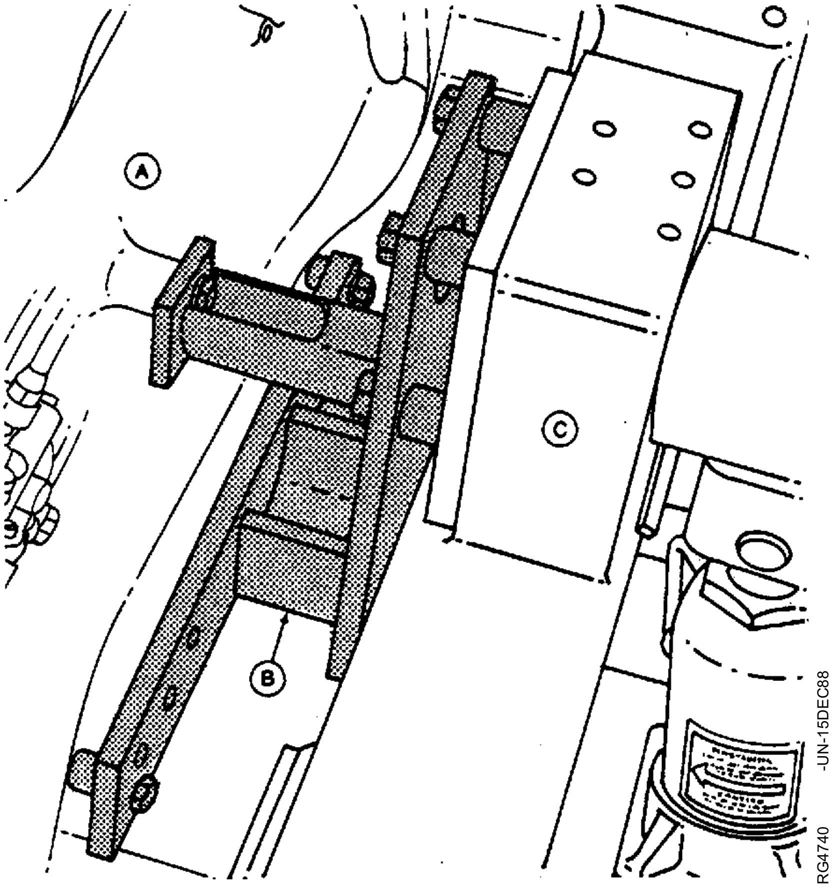
Hole C—9/16-12 x 2 in.
Hole D—9/16-12 x 2 in.
Hole E—9/12-12 x 1 1/2 in.

NOTE: Spacers are furnished with the D05225ST Engine Adapter. If spacers have been lost, make from pipe to following sizes:

Spacer No.	Size
202555	25 mm OD x 17 mm lg. (1 in. OD x 0.66 in. lg.)
202557	25 mm OD x 73 mm lg. (1 in. OD x 2.87 in. lg.)
202558	25 mm OD x 79 mm lg. (1 in. OD x 3.12 in. lg.)

S11,2000,ED -19-22JUL95

ENGINE MOUNTED ON REPAIR STAND



A—Engine **B—Engine Mounting Adapter** **C—Repair Stand**

S11,2000,EJ -19-22SEP95

ENGINE DISASSEMBLY SEQUENCE

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

1. Drain coolant and oil. Check engine oil for metal contaminates. (Groups 20 and 25.) Perform OILSCAN and COOLSCAN analysis.

2. Remove fan belts, fan, and alternator. (Group 25.)

3. Remove turbocharger (if equipped) and exhaust manifold. (Group 30.)

4. Remove rocker arm cover and vent tube. If Option Code label is located on rocker arm cover, be careful not to damage label. (Group 05.)

5. Remove water manifold or thermostat housing. (Group 25.)

6. Remove oil cooler piping and water pump. (Groups 20 and 25.)

7. Remove dipstick, oil filter, oil cooler, and adapter housing (if equipped). Discard standard-flow oil cooler if oil is contaminated. (Group 20.)

8. Remove oil pressure regulating valve assembly. (Group 20.)

9. Remove fuel filter, fuel supply pump, and fuel line. (Group 35.)

10. Remove injection lines, injection pump, and injection nozzles. (Group 35.)

11. Remove starting motor.

12. Remove rocker arm assembly and push rods. Keep rods in order. (Group 05.) Check for bent push rods and condition of wear pad contact surfaces on rockers.

13. Remove cylinder head. Check piston protrusion. Verify piston height selection. (Groups 05 and 10.)

14. Remove cam followers. Keep followers in order. (Group 05 and 16.)

15. Remove flywheel and flywheel housing. (Group 15.)

16. Remove oil pan. (Group 20.)

17. Remove crankshaft pulley. (Group 15.)

18. Remove timing gear cover. (Group 16.)

19. Remove oil pump drive gear, outlet tube, and pump body. (Group 20.)

20. Remove oil deflector, timing gears, and camshaft. Perform wear checks. (Group 16.)

21. Remove balancer shafts. (Group 16.)

22. Remove engine front plate. (Group 16.)

23. Remove oil by-pass valve (3179, 4239, 6359 Engines). (Group 20.)

24. Stamp cylinder number on connecting rod. Remove pistons and rods. Perform wear checks with PLASTIGAGE®. (Group 10.)

25. Remove crankshaft and main bearings. Perform wear checks with PLASTIGAGE. (Group 15.)

26. Remove cylinder liners and mark each one with cylinder number. (Group 10.)

27. Remove piston cooling orifices. (Groups 10 and 15.)

28. Remove balancer shaft bushings (if equipped). (Group 16.)

29. Remove cylinder block plugs and serial number plate when block is to be put in a “hot tank”. (Group 10.)

30. Clean upper and lower liner bores with nylon brush. (Group 10.)

31. Measure cylinder block. (Groups 10, 15, and 16.)

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S11,2000,DT -19-29SEP95

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.

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

TY9370 6 mL tube/T43512 50 mL tube

—Plugs and fittings—fuel filter base, fuel transfer pump, intake manifold, cylinder block (oil galley), 4276 and 6414 oil filter base housing

—Cap Screws—injection pump access cover, electronic tachometer cover, oil filler inlet, flywheel, fuel transfer pump, oil cooler housing-to-cylinder block (open holes only).

—Oil pressure sending unit

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

TY9371 6 mL tube/T43513 50 mL bottle

—Studs—water pump-to-cylinder block, injection pump-to-front plate, exhaust manifold-to-turbocharger.

—Mechanical tachometer drive gear

—Oil filter nipple

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

T43514 50 mL bottle

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

—O-ring adapter for oil pump outlet tube

—Nipples and elbows which are pressed into place, water pump housing, and oil cooler cover.

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

TY6304 50 mL bottle

—Flywheel housing-to-cylinder block

—Oil pan gasket surfaces and dipstick nipple threads

—Thermostat cover gaskets

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

TY9374 6 mL tube/TY9375 50 mL tube

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

—Dipstick tube threads

—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—Turbo line, turbo drain, and water return-to-cylinder block (4276 and 6414 engines).

—Adapter fitting and plug for turbo lube on dual oil filter base

LOCTITE® is a registered trademark of Loctite Corporation.

TEFLON® is a registered trademark of DuPont Corporation.

S55,2000,NE -19-01NOV95

SEALANT APPLICATION GUIDELINES—CONTINUED

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

  TY15696 50 mL bottle

—Rear oil seal (wear ring-to-crankshaft only)

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

  TY15934 8 oz tube

—Front plate/timing gear cover-to oil pan

—Flywheel housing-to-oil pan

- **JDT364 NEVER-SEEZ®** COMPOUND

—Cap Screws—Exhaust manifold, turbine housing-to-center housing, intake manifold-to-aftercooler cover.

- **JDT350 PERMATEX (Form-A-Gasket No. 2)**

—Water pump and thermostat cover gaskets

- **PT569 NEVER-SEEZ®** Compound:

  PT569 227g brush/PT506 453g spray

—Intake manifold and aftercooler cap screws

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

RG,CTM4,DW614 -19-22JUL95

ENGINE ASSEMBLY SEQUENCE

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

1. Install all plugs (and serial number plates) in cylinder block that were removed to service block. (See Groups 10 and 15.)

2. Install clean piston cooling orifices and new balancer shaft bushings. (See Group 10.)

3. Install cylinder liners without O-rings and measure stand-out. Install liners with O-rings. (See Group 10.)

4. Install crankshaft and main bearings. PLASTIGAGE™ bearings. (See Group 15.)

5. Install flywheel housing, rear oil seal and flywheel. (See Group 15.)

6. Install pistons and rods. Measure piston protrusion for proper piston selection (3179, 4239, 6359 Engines). PLASTIGAGE bearings. (See Group 10.)

7. Install lube oil system by-pass valve (3179, 4239, 6359 Engines).

8. Install front plate. (See Group 16.)

9. Install balancer shafts. Check end play. (See Group 16.)

10. Install oil outlet tube, O-ring in block, and oil pump (no timing required.) (See Group 20.)

11. Install injection pump on front plate. (See Group 35.)

12. Time all gears to TDC, No. 1 cylinder on compression stroke. (See Group 16.)

13. Install camshaft, timing gears, and oil deflector. (See Group 16.)

14. Install timing gear cover (with new front seal). (See Group 16.)

15. Install oil pan. (See Group 20.)

16. Install oil pressure regulating valve (if equipped). (See Group 20.)

17. Install cam follower in the same sequence as removed. (See Group 16.)

18. Install cylinder head gasket, cylinder head, push rods, and rocker arm assembly. (See Group 05.)

19. Install starting motor.

20. Install injection nozzles (with new seals) and injection lines. (See Group 35.)

21. Install fuel filter, fuel supply pump, and fuel lines. (See Group 35.)

22. Install engine oil cooler, new oil filter, and dipstick. (Never clean or reuse a contaminated standard-flow oil cooler on 3179, 4239, 6359 Engines. Install a new one.) (See Group 20.)

23. Install water manifold/thermostat housing with thermostats. (See Group 30.)

24. Install exhaust manifold and turbocharger. Prelube the turbocharger. (See Group 30.)

25. Install water pump and hoses. (See Group 30.)

26. Install crankshaft pulley or vibration damper/pulley. (See Group 15.)

27. Install alternator, fan belts, and fan. (See Group 25.)

28. Adjust valves and install rocker arm cover. (See Group 05.)

29. Install vent tube.

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

31. Perform engine break-in and perform normal standard performance checks. (See Group 105.)

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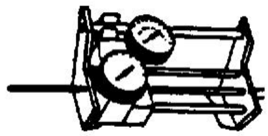
S11,2000,DU -19-29SEP95

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

RG5061 -UN-23AUG88



Spring Compression Tester D01168AA

Test valve spring compression.

S53,D01168,AA -19-13MAR92

Dial Indicator . . . . (English, in.) D17526CI
or (Metric, mm) D17527CI

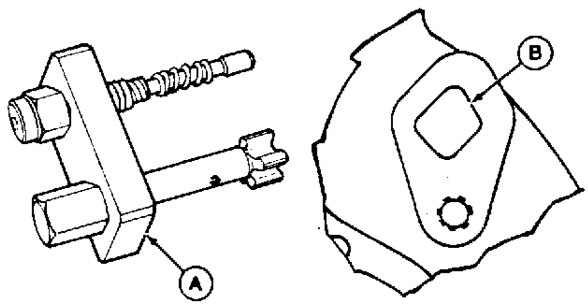
Use with JDG451 to measure valve recess and cylinder liner height-to-cylinder block top deck.

RG6246 -UN-27MAR92

RG,D17526CI -19-29OCT92

Flywheel Turning Tool (A) JD281A

Used on engines with 142 tooth flywheel ring gear and a diamond shaped tool guide bore (B) in flywheel housing. Tool has it’s own spring loaded timing pin which threads into flywheel housing.



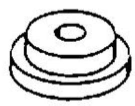
RG6252 -UN-22JUL92

RG,JD281A -19-17JUL92

RG5066 -UN-23AUG88

Intake Valve Insert Installing Adapter JD287

Used with JDE7 Pilot to install intake valve inserts.



S53,JD287 -19-04MAR87

RG5085 -UN-23AUG88

Torque Wrench Adapter JD307

Use with standard torque wrench to tighten head bolts under rocker arm assembly.

S53,JD307 -19-04MAR87

RG5065 -UN-23AUG88

Pilot Driver JDE7

Install intake or exhaust valve seat inserts. Use with JDE72 or JDE73.

S53,JDE7 -19-31MAY95

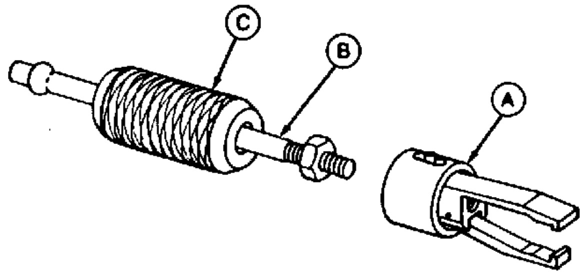
Injection Nozzle Puller JDE38B

Remove Stanadyne 9.5 mm injection nozzles.

NOTE: If JDE38A Nozzle Puller is available, order JDG716 Adapter and use with slide handle from JDE38A.

JDG716 Adapter can be used with slide handle from JDE38 or JDE38A to remove 9.5 mm injection nozzles without removing the rocker arm cover.

NOTE: JDG716-1 Repair Kit is available if leg of JDG716 Adapter is damaged.



RG6436 -UN-17SEP92

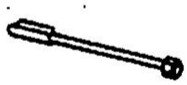
A—JDG716 Adapter
B—JDE38-2 Shank
C—JDE38-3 Hammer

RG,JDE38B -19-08MAR95

RG5084 -UN-23AUG88

Nozzle Bore Cleaning Tool JDE39

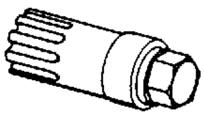
Clean injection nozzle bore in cylinder head.



S53,JDE39 -19-10JUL89

Flywheel Turning Tool JDE83

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



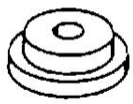
RG6251 -UN-22JUL92

RG,JDE83 -19-17JUL92

RG5066 -UN-23AUG88

Exhaust Valve Insert Installing Adapter JDE86

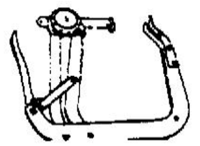
Used with JDE7 Pilot to install exhaust valve inserts.



S53,JDE86 -19-04MAR87

RG5070 -UN-23AUG88

Valve Spring Compressor JDE138

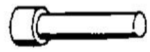


Used to compress valve spring when removing and installing valves.

S53,JDE138 -19-04MAR87

RG5068 -UN-23AUG88

Timing Pin JDE81-4

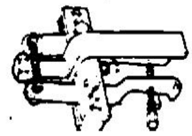


Lock engine at TDC when installing injection pump or timing valve train. Use with JDG820, JDE81-1, or JDE83 Flywheel Turning Tool.

RG,JDE814 -19-03JAN95

RG5071 -UN-23AUG88

Valve Seat Puller JDE41296

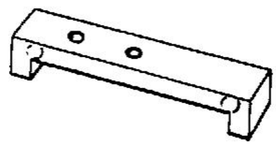


Remove valve seats.

S53,JDE,41296 -19-26JAN87

05
3

Piston and Liner Height Gauge JDG451



RG7029 -UN-30SEP94

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.

RG,JDG451 -19-28SEP94

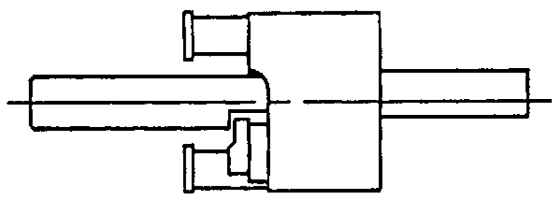
RG5100 -UN-23AUG88

Tap JDG680

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

RG,JDG680 -19-02APR90

Valve Guide Cutting Tool JDG714



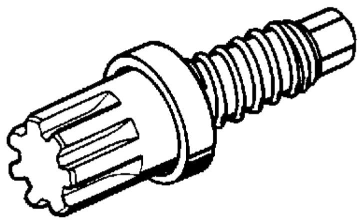
RG7307 -UN-05JUL95

Used to machine exhaust valve towers to install valve stem seals.

RG,JDG714 -19-09OCT95

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.



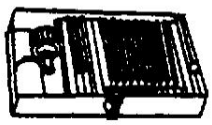
RG7056 -UN-10AUG94

RG,CTM8,DW570 -19-22SEP95

RG5064 -UN-23AUG88

Valve Guide Knurler Kit JT05949

Knurl valve guides.



S53,D20002,WI -19-16SEP92

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 head flatness
Plastic Brush	Clean valve guides
D11010KW Eccentrimeter	Measure valve seat runout
JT05893 Heavy Duty Seat Grinder Set	Grind valve seats
D17024BR End Brush	Remove carbon on valve seats
JDG714 Valve Guide Cutting Tool	Machine exhaust valve towers
JT05993 Torque Angle Gauge	Tighten flanged-head cylinder head cap screws

RG,CTM8,G05,1 -19-22SEP95

CYLINDER HEAD AND VALVES SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Thickness of New Cylinder Head	104.87—105.13 mm (4.129—4.139 in.)	——
Minimum Acceptable Thickness of Cylinder Head	104.24 mm (4.104 in.)	——
Maximum Material Removal for Resurfacing Head	0.76 mm (0.03 in.)	——
Maximum Acceptable Head Out-of-Flat (Entire Length/Width)	0.102 mm (0.004 in.)	——
Combustion Face Surface Finish (Surface Grind Only) (AA)	0.0008—0.0032 mm (31—125 micro-in.)	—— ——
Maximum Wave Depth	0.012 mm (0.0005 in.)	——
Valve Stem OD (standard)	9.43—9.46 mm (0.371—0.372 in.)	——
Valve Guide ID	9.51—9.53 mm (0.374—0.375 in.)	0.025 mm (0.001 in.)
Valve Stem-to-Guide Clearance	0.05—0.10 mm (0.002—0.004 in.)	0.15 mm (0.006 in.)
Valve Stem Oversize, Stem Diameter larger than standard by	0.08 mm (0.003 in.) 0.381 mm (0.015 in.) 0.76 mm (0.030 in.)	——

RG,CTM4,DT435 -19-01NOV95

CYLINDER HEAD AND VALVES SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Valve Seat Angle on Naturally Aspirated Engines (Intake and Exhaust)	45°	——
Valve Seat Angle on Turbocharged Engines:		
Intake Valve	30°	——
Exhaust Valve		
All (except 4276TT-08, 4276TT012, 4276TT018, 4276TT021, 6414TT-04, -06, -07, -09, 009, -10, 6414TT010, TCP03, DTW14, TDW14)	45°	——
4276TT-08, 4276TT012, 4276TT018, 4276TT021, 6414TT-04, -06, -07, -09, 009, -10, 010, 6414TCP03, DTW14, TDW14	30°	——
Valve Face Angle on Naturally Aspirated Engines (Intake and Exhaust)	43.5°	——
Valve Face Angle on Turbocharged Engines:		
Intake Valve	29.5°	——
Exhaust Valve		
All (except 4276TT-08, 4276TT012, 4276TT018, 4276TT021, 6414TT-04, -06, -07, -09, 009, -10, 6414TT010, TCP03, DTW14, TDW14)	43.5°	——
4276TT-08, 4276TT012, 4276TT018, 4276TT021, 6414TT-04, -06, -07, -09, 009, -10, 010, 6414TCP03, DTW14, TDW14	29.5°	——
Maximum Valve Seat Runout		0.05 mm (0.002 in.)

S11,2005,IP -19-01NOV95

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CYLINDER HEAD AND VALVES SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Valve Recess in Cylinder Head:		
Intake Valve	0.58—1.19 mm (0.023—0.047 in.)	1.63 mm (0.064 in.)
Exhaust Valve	0.97—1.83 mm (0.038—0.072 in.)	2.26 mm (0.089 in.)
Valve Seat Width		
Intake and Exhaust Valve	1.50—2.00 mm (0.06—0.08 in.)	——
Valve Head OD:		
Intake Valve on Naturally Aspirated Engines	44.88—45.13 mm (1.767—1.777 in.)	——
Intake Valve on Turbocharged Engines	46.13—46.38 mm (1.816—1.821 in.)	——
Exhaust Valve on Naturally Aspirated and Turbocharged Engines	39.88—40.13 mm (1.570—1.580 in.)	——
Cylinder Firing Order:		
3-Cylinder Engines	1-2-3	——
4-Cylinder Engines	1-3-4-2	
6-Cylinder Engines	1-5-3-6-2-4	
Valve Clearance (Engine Cold) (Rocker Arm-to-Valve Tip):		
Intake Valve	0.35 mm (0.014 in.)	——
Exhaust Valve	0.45 mm (0.018 in.)	
Valve Lift at 0.00 mm (in.) Clearance		
Intake Valve:		
3179 (—CD666423) 4239 (—CD656456) (—T0133254) 4276 (—T0133254) 6359 (—CD656605) (—T0134868) 6414 (—T0134868)	11.28—12.12 mm (0.444—0.477 in.)	10.85 mm (0.427 in.)

S11,2005,IQ -19-25SEP95

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CYLINDER HEAD AND VALVES SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Valve Lift at 0.00 mm (in.) Clearance		
Intake Valve—continued:		
3179 (CD666424—)		
4239 (CD656457—) (T0133255—)		
4276 (T0133255—)		
6359 (CD656606—) (T0134869—)		
6414 (T0134869—)	11.56—12.37 mm (0.455—0.487 in.)	11.13 mm (0.438 in.)
Exhaust Valve:		
All Dubuque and Saran Engines	11.28—12.12 mm (0.444—0.477 in.)	10.85 mm (0.427 in.)
Rocker Arm Shaft OD	19.99—20.02 mm (0.787—0.788 in.)	0.05 mm (0.002 in.)
Rocker Arm Shaft Support ID	20.17 mm (0.794 in.)	——
Rocker Arm Bore ID	20.07—20.12 mm (0.790—0.792 in.)	0.05 mm (0.002 in.)
Rocker Arm Shaft Spring		
Spring Tension at a Length of 46 mm (1.81 in.)	18—27 N (4—6 lb)	——
Valve Spring Free Length*	54.0 mm (2.125 in.)	——
Valve Spring Compressed Height:		
Valve Closed	46 mm @ 240—280 N (1.81 in. @ 54—62 lb-force)	—— ——
Valve Open	34.5 mm @ 590—680 N (1.36 in. @ 133—153 lb-force)	—— ——
Liner Height Above Block	0.01—0.10 mm (0.0004—0.004 in.)	—— ——
Maximum Permissible Height Difference at Nearest Point of Two Adjacent Liners	0.06 mm (0.002 in.)	—— ——

*Face length of springs may vary slightly between springs.

RG,CTM4,DW615 -19-01NOV95

CYLINDER HEAD AND VALVES SPECIFICATIONS—CONTINUED

TORQUES

Rocker Arm Adjusting Set Screw	10 N·m (7 lb-ft)
Rocker Arm Shaft Clamp	47 N·m (35 lb-ft)
Cylinder Head Cap Screws	
108 mm (4.25 in.) Screw Length:	
Step 1	47 N·m (35 lb-ft)
Step 2	90 N·m (65 lb-ft)
Step 3	130 N·m (95 lb-ft)
Step 4	Retorque after break-in
114 mm (4.50 in.) Screw Length:	
Step 1	47 N·m (35 lb-ft)
Step 2	120 N·m (88 lb-ft)
Step 3	150 N·m (110 lb-ft)
Step 4	Retorque after break-in
112 mm (4.41 in.) Flanged-Head Screw Length:	
Step 1	100 N·m (75 lb-ft)
Step 2	150 N·m (110 lb-ft)
Step 3	Wait 5 minutes and verify 150 N·m (110 lb-ft)
Step 4	Tighten additional 50°—70°
Fuel Injection Nozzles-to-Cylinder Head	27 N·m (20 lb-ft)
Intake Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Exhaust Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Rocker Arm Cover-to-Cylinder Head —with rubber/metal gasket or composite material rocker arm cover	11 N·m (8 lb-ft) (96 lb-in.)

RG,CTM4,DY082 -19-25SEP95

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OTHER MATERIAL

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

RG,CTM4,DW797 -19-22SEP95

CHECK AND ADJUST VALVE CLEARANCE

Insufficient valve clearance forces valves out of time. Valves open too early and close too late. Hot combustion gases rush past valves, causing the valves to overheat. Overheating lengthens valve stems preventing proper valve seating. Valves seat so briefly or poorly that normal heat transfer to the valve seat and cooling system does not have time to take place, resulting in burned valves, and low power.

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

NOTE: Valve clearance MUST be checked with engine cold.

1. Remove rocker arm cover with ventilator tube.

2. Remove plastic plugs in engine timing holes.

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.

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

S11,2005,IR -19-22SEP95

3. Rotate engine flywheel in running direction (clockwise viewed from water pump) with the appropriate flywheel turning tool until JDE81-4 Timing Pin engages timing hole in flywheel. Some engines are equipped with flywheel housings which do not allow use of an engine rotation tool.

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

T81224 -UN-07NOV88

VALVE CLEARANCE SPECIFICATIONS

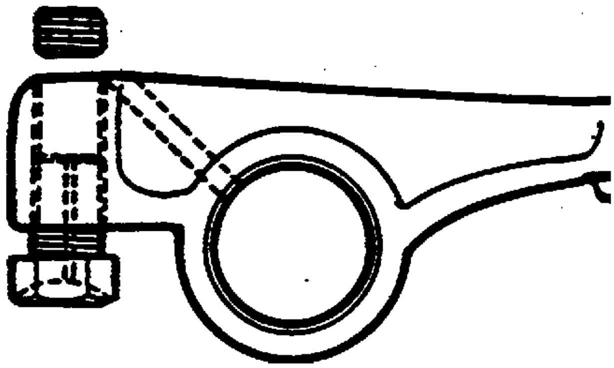
Intake Valve . . . . 0.35 mm (0.014 in.)

Exhaust Valve . . . . 0.45 mm (0.018 in.)

S55,2005,E -19-22SEP95

If valve clearance is not within specification, tighten set screw to 10 N·m (7 lb-ft.) after adjustment is made. Make sure set screw does not restrict lube oil passages in rocker arm. All other applications are designed with a slight screw thread interference, therefore, set screws are not required.

Refer to the appropriate procedure for your engine application and adjust valve clearance, as directed in the following modules.



RG5102 -UN-06DEC88

S55,2005,F -19-24JUL95

• **3-Cylinder Engine:**

NOTE: Firing order is 1-2-3.

Set No. 1 piston at TDC compression stroke (B) and install timing pin in flywheel.

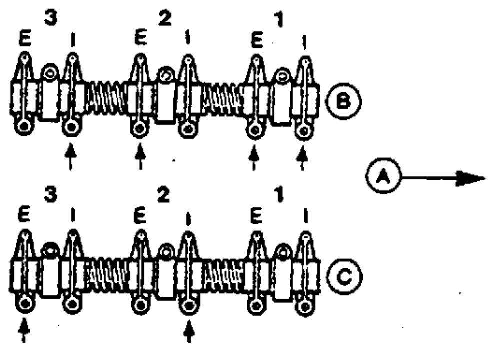
Adjust valve clearance on No. 1 and 2 exhaust valves and No. 1 and 3 intake valves.

Turn crankshaft 360° until No. 3 piston is at TDC compression stroke (C) and reinsert timing pin.

Adjust valve clearance on No. 3 exhaust valve and No. 2 intake valves.

VALVE CLEARANCE (ROCKER ARM-TO-VALVE TIP) SPECIFICATION

Intake Valve	0.35 mm (0.014 in.)
Exhaust Valve	0.45 mm (0.018 in.)



RG4775 -UN-06DEC88

A—Front of Engine
B—No. 1 Piston at TDC Compression Stroke
C—No. 3 Piston at TDC Compression Stroke
E—Exhaust Valve
I—Intake Valve

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S11,2005,KN -19-22JUN95

• **4-Cylinder Engine:**

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

Set No. 1 piston at TDC compression stroke (B) and install timing pin in flywheel.

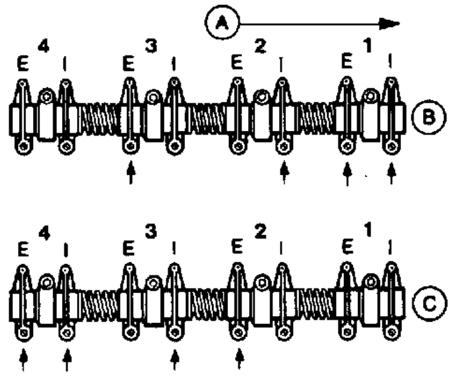
Adjust valve clearance on No. 1 and 3 exhaust valves and No. 1 and 2 intake valves.

Turn crankshaft 360° so that No. 4 piston is at TDC compression stroke (C) and reinsert timing pin.

Adjust valve clearance on No. 2 and 4 exhaust valves and No. 3 and 4 intake valves.

VALVE CLEARANCE (ROCKER ARM-TO-VALVE TIP) SPECIFICATION

Intake Valve	0.35 mm (0.014 in.)
Exhaust Valve	0.45 mm (0.018 in.)



RG4776 -UN-22SEP92

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

S11,2005,KO -19-24JUL95

- **6-Cylinder Engine:**

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

Set No. 1 piston at TDC compression stroke (B) and install timing pin in flywheel.

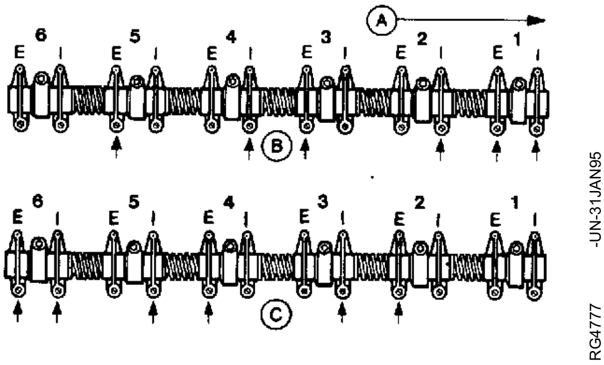
Adjust valve clearance on No. 1, 3 and 5 exhaust valves and No. 1, 2 and 4 intake valves.

Turn crankshaft 360° so that No. 6 piston is at TDC compression stroke (C) and insert timing pin.

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

VALVE CLEARANCE (ROCKER ARM-TO-VALVE TIP) SPECIFICATION

Intake Valve	0.35 mm (0.014 in.)
Exhaust Valve	0.45 mm (0.018 in.)



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

S11,2005,KP -19-24JUL95

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MEASURE VALVE LIFT


T81227 -UN-01NOV88

Measuring valve lift can give an indication of excess wear on cam lobes, followers, and/or push rods.

IMPORTANT: For a more accurate measurement, it is recommended that valve lift be measured at 0.00 mm (in.) rocker arm-to-wear cap/valve tip clearance.

1. Remove rocker arm cover, if not previously removed.

2. Set No. 1 piston at TDC and install JDE81-4 Timing Pin in flywheel.

3. Set rocker arm-to-wear cap/valve tip clearance to 0.00 mm (in.) for:

- No. 1 and 2 exhaust and No. 1 and 3 intake valves on 3-cylinder engines.
- No. 1 and 3 exhaust and No. 1 and 2 intake valves on 4-cylinder engines.
- No. 1, 3, and 5 exhaust and No. 1, 2, and 4 intake valves on 6-cylinder engines.

Refer to illustration under CHECK AND ADJUST VALVE CLEARANCE earlier in this group for engine valve locations.

4. Place dial indicator tip on top of valve spring cap or rotator. Preload indicator tip and set dial at 0.00 mm (in.).

5. Remove timing pin from flywheel and manually turn engine in running direction one full revolution (360˚) in running direction, using appropriate flywheel turning tool.

RG,CTM4,DY104 -19-30JUN95

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

VALVE LIFT SPECIFICATION
[At 0.00 mm (in.) Valve Clearance]

Intake Valves:	
3179 (—CD666423)	
4239 (—CD656456) (—T0133254)	
4276 (—T0133254)	
6359 (—CD656605) (—T0134868)	
6414 (—T0134868)	11.28—12.12 mm (0.444—0.477 in.)
Wear Limit	10.85 mm (0.427 in.)
3179 (CD666424—)	
4239 (CD656457—) (T0133255—)	
4276 (T0133255—)	
6359 (CD656606—) (T0134869—)	
6414 (T0134869—)	11.56—12.37 mm (0.455—0.487 in.)
Wear Limit	11.13 mm (0.438 in.)
Exhaust Valves:	
All Dubuque and Saran Engines	11.28—12.12 mm (0.444—0.477 in.)
Wear Limit	10.85 mm (0.427 in.)

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

If valve lift is within specification, adjust valves to specified clearance. See CHECK AND ADJUST VALVE CLEARANCE in Group 05.

If valve lift is not within specification, remove and inspect entire valve train and camshaft.

8. Rotate engine one full revolution (360°). Lock engine at:

• TDC No. 1 exhaust stroke for 3-cylinder engines.
• TDC No. 4 compression stroke for 4-cylinder engines.
• TDC No. 6 compression stroke for 6-cylinder engines.

9. Set rocker arm-to-wear cap/valve tip clearance to 0.00 mm (in.) for:

• No. 3 exhaust and No. 2 intakes valves on 3-cylinder engines.
• No. 2 and 4 exhaust and No. 3 and 4 intake valves on 4-cylinder engines.
• No. 2, 4, and 6 exhaust and No. 3, 5, and 6 intake valves on 6-cylinder engines.

10. Repeat step 7.

S11,2005,IS -19-21SEP95

REMOVE CYLINDER HEAD

TS281 -UN-23AUG88

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 temperature is below operating temperature. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

1. Drain engine coolant and oil. On turbocharged engines, disconnect turbocharger oil inlet line. See DISCONNECT TURBOCHARGER OIL INLET LINE in Group 03.

NOTE: On engines equipped with a low-profile turbocharger, remove turbocharger before attaching engine to repair stand.

2. Remove turbocharger and exhaust manifold as an assembly. (See Air Intake and Exhaust System, Group 30.)

3. Remove air intake. (See Air Intake and Exhaust System, Group 30.)

4. Remove water manifold/thermostat housing. (See Cooling System, Group 25.)

5. Remove fuel filter. (See Fuel System, Group 35.)

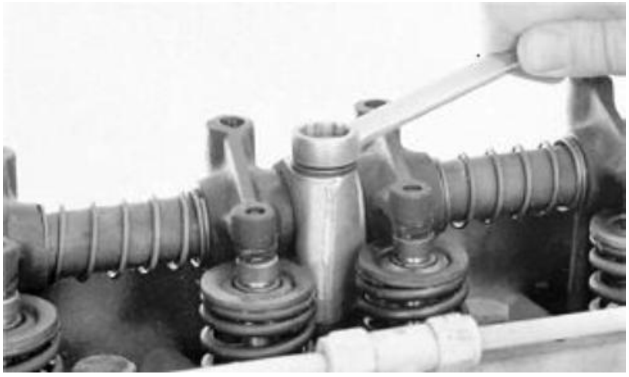
6. Remove injection nozzles and lines. (See Fuel System, Group 35.)

S11,2005,IT -19-22JUN95

7. Remove rocker arm cover.

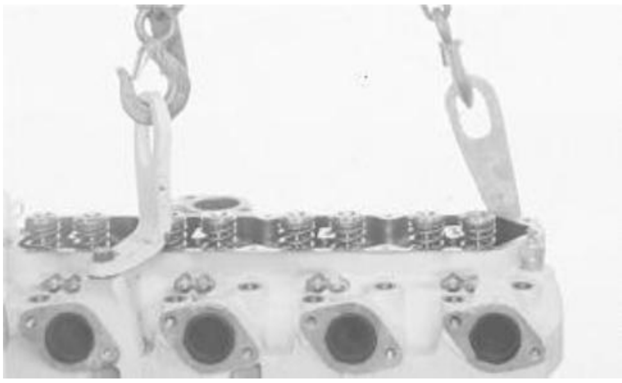
8. Remove rocker arm assembly.

NOTE: Remove wear caps from valve stems.



T81230 -UN-01NOV88

S11,2005,IU -19-11APR86


T91222 -UN-28OCT88

9. Remove all push rods and identify for reassembly. Clean and inspect push rods, as explained later in this group.

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 a torque wrench) until reference marks align and record torque.

10. Remove all cylinder head cap screws.

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

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

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

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

NOTE: Do not rotate crankshaft with cylinder head removed unless all cylinder liners are secured with cap screws and large flat washers. (See MEASURE CYLINDER LINER STANDOUT [Height Above Block] later in this group.)

RG,CTM4,DY083 -19-09OCT95

DISASSEMBLE AND INSPECT ROCKER ARM SHAFT ASSEMBLY

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 and bowed washers from rocker arm shaft.

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

S11,2005,JK -19-03JUL86

3. Check rocker arm shaft spring tension.

Spring tension at 46 mm (1.81 in.)
compressed height . . . . 18—27 N (4—6 lb)

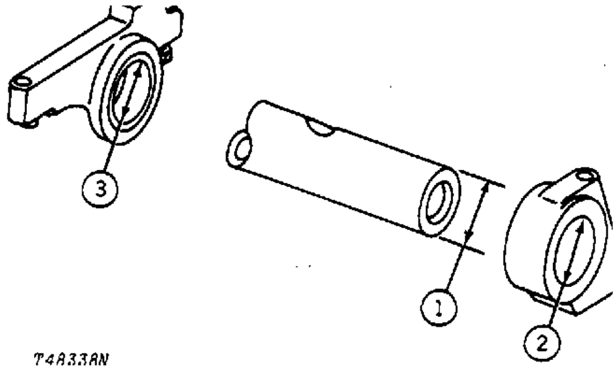
NOTE: If the rocker arm has been damaged by a valve failure, replace it together with the corresponding push rod, valve rotator (if equipped), valve wear cap and keepers.

S11,2005,JL -19-03JUL86

4. Inspect rocker arm shaft for severe scratching, scoring, or excessive wear at points of rocker arm contact.

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

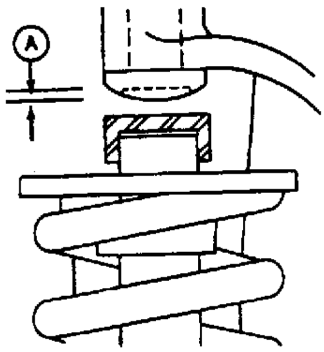
5. Roll rocker arm shaft and push rods on a flat surface to check for bends or distortion. Replace parts as necessary.



T48338N -UN-24FEB89

ROCKER ARM ASSEMBLY SPECIFICATIONS

Rocker Arm Shaft O.D. (New) (1)	19.99—20.02 mm (0.787—0.788 in.)
Wear Limit	0.05 mm (0.002 in.)
Rocker Arm Shaft Support I.D. (Maximum) (2)	20.17 mm (0.794 in.)
Rocker Arm I.D. (Maximum) (3)	20.07—20.12 mm (0.790—0.792 in.)
Wear Limit	0.05 mm (0.002 in.)



R26131 -UN-09DEC88

6. Check rocker arm adjusting screw for damage. Visually inspect rocker arm for hairline cracks. Replace if necessary.

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

7. Check for cups or concave wear (A) on ends of rocker arms where they contact wear caps. If wear exists, replace rocker arm.

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

9. Assemble parts on rocker arm shaft opposite removal procedure, as outlined next in this group.

S11,2005,JM -19-01NOV95

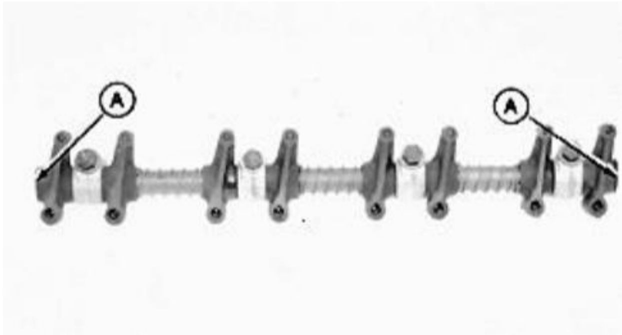
ASSEMBLE ROCKER ARMS ON SHAFT

1. Lubricate O.D. of shaft, bores of rocker arms, and rocker arm supports with clean engine oil.

IMPORTANT: Make sure during assembly that the main oil supply bore on the rocker arm shaft faces toward the flywheel end.

2. Slide spring, rocker arms, and rocker arm support on shaft. Assemble in the same relationship they were in before disassembly.

3. Install bowed washers (A) and end plugs on shaft. End plugs must be firmly seated against end of shaft.



T88682 -UN-28OCT88

S11,2005,KJ -19-22JUN95

05
21

CLEAN AND INSPECT PUSH RODS

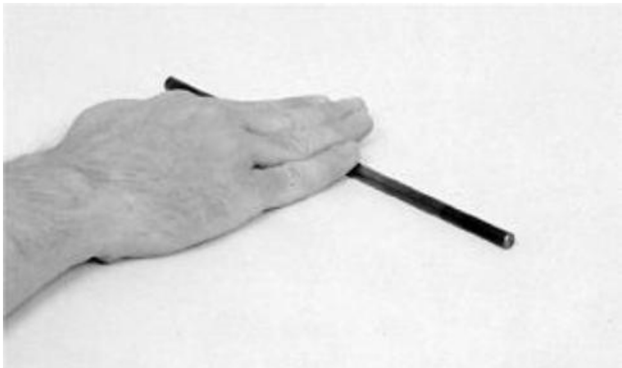
1. Clean push rods with solvent and compressed air.

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

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

3. Inspect contact ends for wear and damage.

4. Replace defective push rods.



T81233 -UN-01NOV88

S11,2005,JN -19-01NOV95

MAKE PRELIMINARY VALVE CHECKS

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

• Sticking Valves:

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

• Warped, Worn Or Distorted Valve Guides:

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

• Distorted Cylinder Head And Cylinder Head Gasket Leakage:

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

• Worn Or Broken Valve Seats:

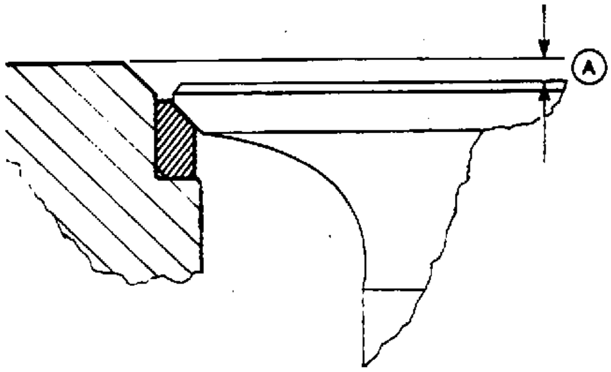
Misaligned valves.
Distorted cylinder head.
Carbon deposits on seats due to incomplete combustion.
Valve spring tension too weak.
Excessive heat.
Improper valve clearance.
Improper valve timing.

• Burned, Pitted, Worn Or Broken Valves:

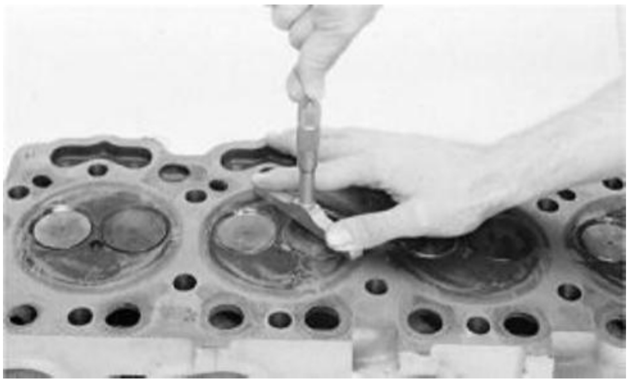
Worn or distorted valve seats.
Worn valve guides.
Insufficient cooling.
Cocked or broken valve springs.
Improper engine operation.
Improper valve train timing.
Faulty valve rotators.
Warped or distorted valve stems.
“Stretched” valves due to excessive spring tension.
Warped cylinder head.
Bent push rods.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

S11,0401,B -19-22JUN95

CHECK VALVE RECESS IN CYLINDER HEAD



RG4756 -UN-06DEC88



T81869 -UN-07NOV88

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

VALVE RECESS SPECIFICATIONS

Intake Valve	0.58—1.19 mm (0.023—0.047 in.)
Wear Limit	1.63 mm (0.064 in.)
Exhaust Valve	0.97—1.83 mm (0.038—0.072 in.)
Wear Limit	2.26 mm (0.089 in.)

NOTE: If measurement does not meet specifications, install either new valves or inserts, or both to obtain proper valve recess. (See REMOVE VALVE SEAT INSERTS later in this group.)

S11,2005,JE -19-22SEP95

REMOVE VALVE ASSEMBLY

T81870 -UN-07NOV88

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

1. Using JDE138 Valve Spring Compressor, compress valve springs far enough to remove keepers.

2. Release spring tension and remove valve spring cap or rotator and valve spring.

3. Remove valves from cylinder head.

NOTE: Identify all parts for correct reassembly. Use a valve board or other suitable means of keeping valves in order.

S11,2005,JG -19-22JUN95

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INSPECT AND MEASURE VALVE SPRINGS

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

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

VALVE SPRING SPECIFICATIONS

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

RG2732 -UN-23FEB89

T82054 -UN-08NOV88

Free length of springs may vary slightly between springs.

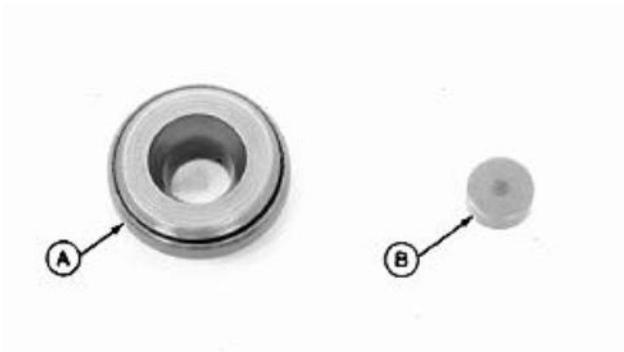
RG,CTM8,G05,31 -19-08FEB95

INSPECT VALVE ROTATORS AND WEAR CAPS

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.



RG3491 -UN-23FEB89

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.

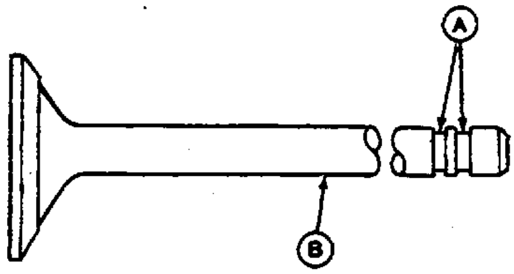
S11,0401,U -19-13MAR92

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 grooves (A) on valve stem for damage. Also, inspect stems (B) for signs of scuffing, which may indicate insufficient valve guide-to-valve stem clearance. Replace if defects are evident.

3. Measure valve stem OD. Record measurements and compare with valve guide ID.



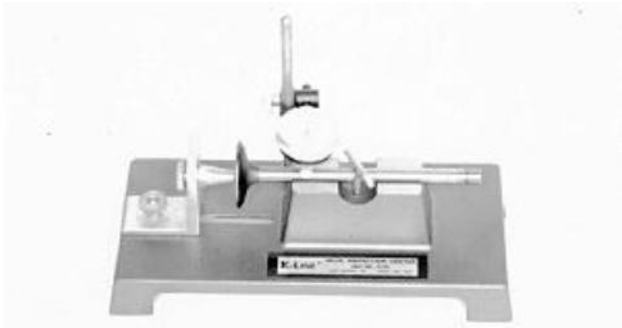
RG4754 -UN-06DEC88

VALVE STEM OD SPECIFICATIONS

Valve Stem OD (all valves) . . . . 9.43—9.46 mm
0.371—0.372 in.)

S11,2005,JP -19-30JUN95

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


RG4234 -UN-23FEB89

VALVE FACE RUNOUT SPECIFICATIONS

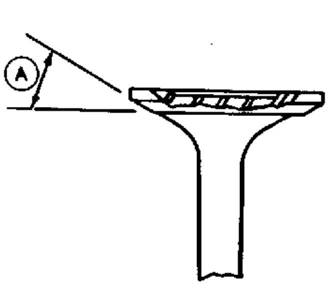
Maximum permissible
runout of valve face . . . . 0.05 mm (0.002 in.)

*No longer available from SERVICEGARD.

S11,2005,JQ -19-22SEP95

GRIND VALVES

1. Valves determined to be serviceable should be refaced to specified angle (A).



RG4755 -UN-19NOV89

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. Break all sharp edges after grinding.

VALVE FACE ANGLES

	Intake Valve	Exhaust Valve
"D" Engines	43.5°	*43.5°
"T" and "A" Engines	29.5°	*43.5°

** Except 4276TT-08, 4276TT012, 4276TT018, 4276TT021, 6414TT-04, 6414TT-06, 6414TT-07, 6414TT-09, 6414TT009, 6414TT-10, 6414TT010, 6414TCP03, 6414DTW14, and 6414TDW14 Engines which have a valve face angle of 29.5°.*

S11,2005,JR -19-24JUL95

INSPECT AND CLEAN CYLINDER HEAD

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

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

3. If front plate is present on cylinder head, remove prior to dipping head in chemical hot tank.

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

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

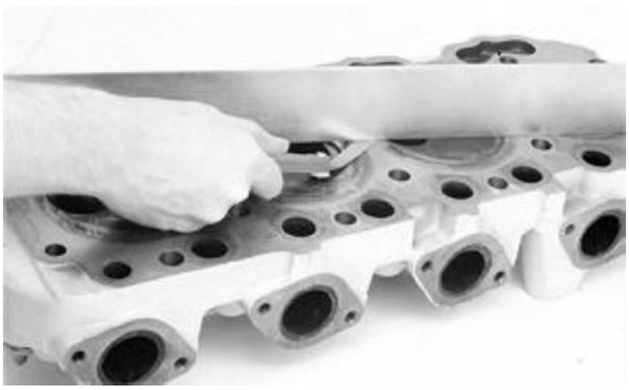
5. Dry with compressed air and blow out all passages.

RG,CTM8,G05,37 -19-14JUN95

CHECK CYLINDER HEAD FLATNESS

Check cylinder head for flatness using D05012ST Precision Straightedge and feeler gauge. Check lengthwise, crosswise, and diagonally in several places. The out-of-flat measurement must not exceed 0.102 mm (0.004 in.) for the entire length or width.

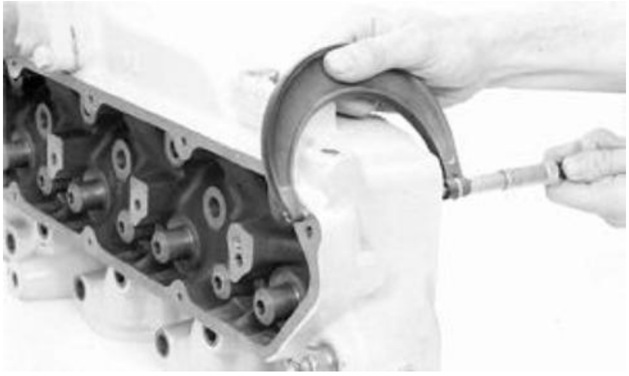
If any measurement exceeds this specification, the cylinder head must be either reconditioned or replaced. (See MEASURE CYLINDER HEAD THICKNESS later in this group.)



T81872 -UN-07NOV88

S11,2005,JI -19-30JUN95

MEASURE CYLINDER HEAD THICKNESS



T81873 -UN-07NOV88

If cylinder head thickness is less than the minimum allowable thickness, install a new cylinder head.

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

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

Determine if head has been resurfaced previously by measuring distance from valve cover gasket rail-to-combustion face.

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

CYLINDER HEAD RESURFACING SPECIFICATIONS

New Cylinder Head Thickness	104.87—105.13 mm (4.129—4.139 in.)
Minimum Acceptable Thickness	104.24 mm (4.104 in.)
Combustion Face Surface Finish (Surface Grind Only) (AA)	0.0008—0.0032 mm (31—125 micro-in.)
Maximum Wave Depth	0.012 mm (0.0005 in.)

S11,2005,JJ -19-01NOV95

CLEAN INJECTION NOZZLE BORES

RG6317 -UN-03AUG92

1. Clean carbon deposits from nozzle bores with JDE39 Nozzle Bore Cleaning Tool. Blow debris from bore with compressed air.

RG,CTM8,G05,38 -19-27DEC94

CLEAN VALVE GUIDES

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

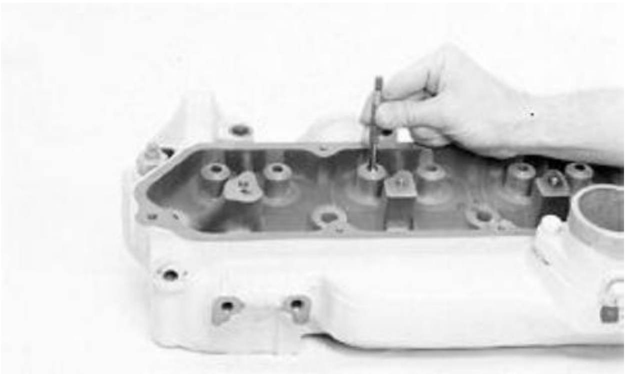
NOTE: A few drops of light oil or kerosene will help to fully clean the guide.

T81874 -UN-01NOV88

S11,2005,JS -19-03JUL86

MEASURE VALVE GUIDES

1. Using a telescopic gauge, measure valve guides for wear.



T81875 -UN-07NOV88

VALVE GUIDE SPECIFICATIONS

I.D. of Valve Guide Bore
in a New Cylinder Head . . . . 9.51—9.53 mm (0.374—0.375 in.)
Wear Limit . . . . 0.025 mm (0.001 in.)

New Guide-to-Valve
Stem Clearance . . . . 0.05—0.10 mm (0.002—0.004 in.)
Maximum Permissible Clearance . . . . 0.15 mm (0.006 in.)

If valve guide oil clearance is more than maximum allowable, but not more than 0.20 mm (0.008 in.), valve guides can be knurled.

If valve guide oil clearance is over 0.20 mm (0.008 in.), intake and exhaust valves with oversize stems are available. Valve guides can be knurled and then reamed to fit oversize valve stems.

NOTE: Oversize valve stems are available for service in 0.08 mm (0.003 in.), 0.38 mm (0.015 in.) or 0.76 mm (0.030 in.) sizes.

S11,2005,JT -19-01NOV95

KNURL VALVE GUIDES


T81876 -UN-01NOV88

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

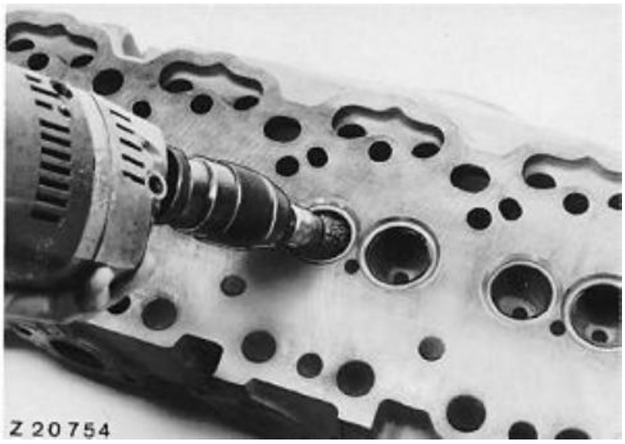
1. Use JT05949 Valve Guide Knurler Kit to knurl valve guides.

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.

S55,2005,G -19-30JUN95

CLEAN AND INSPECT VALVE SEATS



Z20754 -UN-25MAY89

1. Use an electric hand drill with D17024BR End Brush to remove all carbon on valve seats.

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

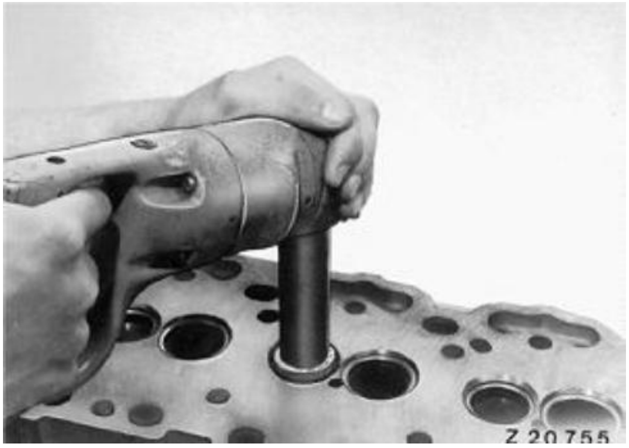
3. Check entire combustion face for rust, scoring, pitting, or cracks.

NOTE: Replaceable valve seat inserts are used on both the intake and exhaust valve ports for the 6414D and all "T" and "A" applications.

On 3179D, 4239D, 4276D, and 6359D production engines, valve seat inserts are used on exhaust ports only. However, since intake inserts (30°) are used on turbocharged engines and are available through service parts, these inserts can be installed in a 3179D, 4239D, 4276D, or 6359D cylinder head intake port after the head has been machined to receive the insert. The 30° intake insert must be reground to 45° after installation in cylinder head.

S55,2005,H -19-12MAY89

GRIND VALVE SEATS



-UN-25MAY89 Z20755

IMPORTANT: Grind valve seats to obtain correct valve recess. (See CHECK VALVE RECESS IN CYLINDER HEAD earlier in this group.) Be sure valve guide bores are clean before grinding valve seats. (See CLEAN VALVE GUIDES earlier in this group.)

ALWAYS keep work area clean when grinding valve seats. Use JT05893 Heavy Duty Seat Grinder Set to grind valve seats.

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

2. Do not use too much pressure. While grinding, support the weight of the driver to avoid excessive pressure on the stone. Grind valve seats at the following angles:

VALVE SEAT ANGLES

Engine	**Intake Valve Seat**	**Exhaust Valve Seat***
3179D	45˚	45˚
3179T	30˚	45˚
4239D	45˚	45˚
4239T,A	30˚	45˚
4276D	45˚	45˚
4276T	30˚	45˚
6414D	30˚	45˚
6414T	30˚	45˚
6359D	45˚	45˚
6359T	30˚	45˚
6359A	30˚	45˚

** Except 4276TT-08, 4276TT012, 4276TT018, 4276TT021, 6414TT-04, 6414TT-06, 6414TT-07, 6414TT-09, 6414TT009, 6414TT-10, 6414TT010, 6414TCP03, 6414DTW14, and 6414TDW14 Engines which have a valve seat angle of 30.0˚.*

S11,2005,KD -19-24JUL95

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3. Check the valve seat width and contact pattern between the seat and valve with blueing. Seat width should be within specification. Maintain valve seat width. Use a vernier caliper or scale to measure seat width. Clean seat area 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.

VALVE SEAT WIDTH SPECIFICATIONS

Engine	Intake Valve Seat Width	Exhaust Valve Seat Width
3179D,T	1.5 mm (0.06 in.)	1.5 mm (0.06 in.)
4239D	1.5 mm (0.06 in.)	1.5 mm (0.06 in.)
4239T,A	2.0 mm (0.08 in.)	1.5 mm (0.06 in.)
4276D,T	2.0 mm (0.08 in.)	1.5 mm (0.06 in.)
6414D,T	2.0 mm (0.08 in.)	1.5 mm (0.06 in.)
6359D,A	1.5 mm (0.06 in.)	1.5 mm (0.06 in.)
6359T	2.0 mm (0.08 in.)	1.5 mm (0.06 in.)

4. Use a new or refaced valve and blueing to check contact between valve seat and face. If valve does not seat properly, use D11010KW Eccentrimeter to check valve seat runout. Replace valves and inserts as necessary.

5. Use a new or refaced valve to check valve recess in cylinder head after grinding. (See CHECK VALVE RECESS IN CYLINDER HEAD earlier in this group.)

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

S55,2005,L -19-30JUN95

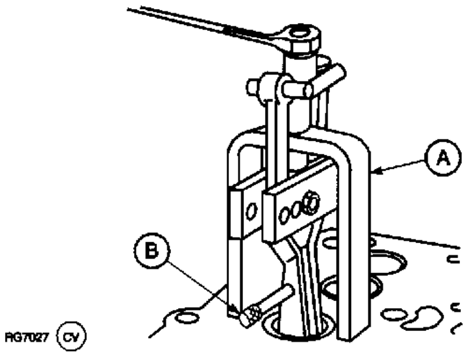
REMOVE VALVE SEAT INSERTS

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

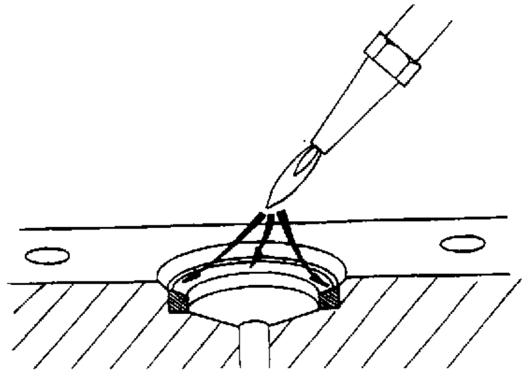
1. Remove valve seat (if necessary) with the JDE41296 Valve Seat Puller (A). Adjusting screw (B) on puller may have to be retightened during removal of inserts.

NOTE: On some engines, removal of valve seat inserts with the JDE41296 Puller may not be possible. Also, on Saran engines (CD823655—), valve seat inserts are made of sintered (powdered) metal. To remove these inserts, carefully heat insert with an oxy-acetylene torch at four opposite points until it becomes red hot. Allow seat to cool. Use a screwdriver or similar tool and carefully pry insert from bore.

2. After removal of inserts, thoroughly clean area around valve seat bore and inspect for damage or cracks. Replace cylinder head as necessary; oversize valve seat inserts are not available.



RG7027 -UN-30SEP94



RG5605 -UN-17JAN90

S11,2005,KA -19-22SEP95

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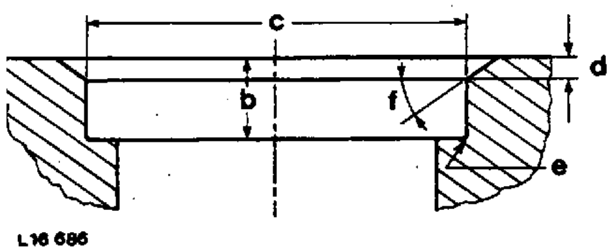
MEASURE VALVE SEAT BORE IN CYLINDER HEAD



L16686 -UN-23FEB89

Intake valve seat inserts are available for "D" engines. Depending on the application, "D" engines may be equipped with no valve seat inserts, or inserts in the exhaust. These cylinder heads must be machined to accept intake valve seats. The replacement inserts are from turbocharged engines and ground at 30 degrees. The exhaust valve seat on "D" engines must be reground to 45 degrees after installation.

1. Compare dimensions of bore with valve seat insert. Insert must have a press fit.

NOTE: Replacement valve seat inserts have a 0.05 mm (0.002 in.) larger O.D. than original production inserts. (Saran-built engines only.)

2. If bore dimensions are not within specification (or head has to be bored to accept a new insert when one was not previously used), machine head to the following specifications.

Exhaust Valve Insert Bore Specifications:

B	9.08—9.20 mm (0.357—0.362 in.)
C	41.57—41.59 mm (1.636—1.637 in.)
D	2.31—2.57 mm (0.091—0.101 in.)
E	Radius 0.5 mm (0.019 in.)
F	35°

Intake Valve Insert Bore Specifications:

B	8.32—8.44 mm (0.327—0.332 in.)
C	47.16—47.18 mm (1.856—1.857 in.)
D	2.69—2.95 mm (0.106—0.116 in.)
E	Radius 0.5 mm (0.019 in.)

Valve Seat Insert O.D. Specifications (Production Parts/Dubuque and Saran; Service Parts/Dubuque):

Intake	47.180—47.206 mm (1.8575—1.8585 in.)
Exhaust	41.579—41.599 mm (1.638—1.639 in.)

Valve Seat Insert O.D. Specifications (Service Parts/Saran):

Intake	47.230—47.256 mm (1.8595—1.8605 in.)
Exhaust	41.643—41.669 mm (1.6359—1.6405 in.)

S11,2005,KB -19-24JUL95

INSTALL VALVE SEAT INSERTS


T88930 -UN-07NOV88

1. Use JDE7 Pilot Driver and JDE86 Exhaust Valve Seat Insert Driver and JD287 Intake Valve Seat Insert Driver, install inserts in cylinder head.

IMPORTANT: Regrind replacement valve seat inserts according to specifications.

2. Install new or refaced valves and check valve recess. (See CHECK VALVE RECESS IN CYLINDER HEAD earlier in this group.)

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

S11,2005,KC -19-25SEP95

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INSTALL VALVES


T81870 -UN-07NOV88

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

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

2. Insert valves in head (must go in same location from which removed).

3. Position valve springs. End of spring must be in machined counterbore of head.

4. If exhaust valve tower seals are used, see INSTALL VALVE STEM TOWER SEALS later in this group.

5. Install spring caps or rotators.

6. Compress valve springs using JDE138 Valve Spring Compressor.

7. Install valve stem O-ring seals, if used. See INSTALL VALVE STEM O-RING SEALS later in this group.

8. Install keepers on valve and release spring tension.

9. After having installed the valves, strike end of each valve three or four times with a soft mallet (non-metallic) to insure proper positioning of the keepers.

RG,CTM4,DT436 -19-22SEP95

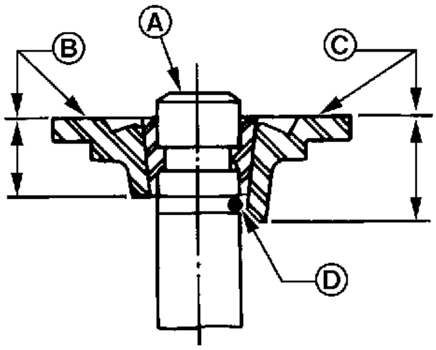
VALVE STEM SEALS—GENERAL INFORMATION

Later production engines were equipped with valves that had an additional groove on valve stem. An O-ring is installed in lower groove to control oil filtration between valve stem and guide. See INSTALL VALVE STEM O-RING SEALS later in this group.

R110524 Valve Tower Seal was adopted for use on EXHAUST valves, as a more effective means of controlling oil filtration especially during light load operation. These seals are retained to the valve tower and allow a controlled amount of leakage to flow down the valve stem. Valve tower seals may be used in lieu of original O-ring seals on exhaust valves to provide improved oil control, however, valve towers must be machined to accept these seals. These seals can be used on standard and 0.08 mm (0.003 in.) oversize exhaust valves. See INSTALL VALVE STEM TOWER SEALS later in this group.

RG,CTM4,GR05,1 -19-22SEP95

INSTALL VALVE STEM O-RING SEALS

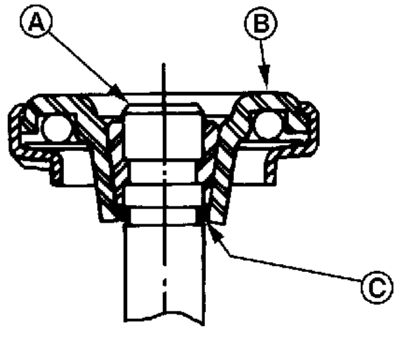


• Naturally Aspirated Engines

Naturally aspirated engines may be equipped with either a standard valve spring cap (B) or a long valve spring cap (C). If O-ring seal (D) is used, a long valve spring cap MUST BE USED. Long spring caps may be used without O-rings also.

A—Valve Stem
B—Standard Valve Spring Cap—9.8—10.8 mm (0.39—0.42 in.)
C—Long Valve Spring Cap—12—13 mm (0.47—0.51 in.)
D—O-Ring Seal

S55,2005,K -19-22SEP95



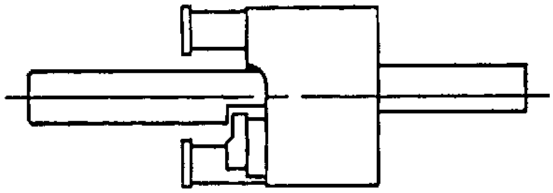
• Turbocharged Engines

Turbocharged engines are equipped with a standard valve spring rotator (B) regardless if your engine has O-ring seals (C) or not.

A—Valve Stem
B—Valve Spring Rotator
C—O-Ring Seal

RG,CTM4,DW798 -19-01NOV95

INSTALL VALVE STEM TOWER SEALS

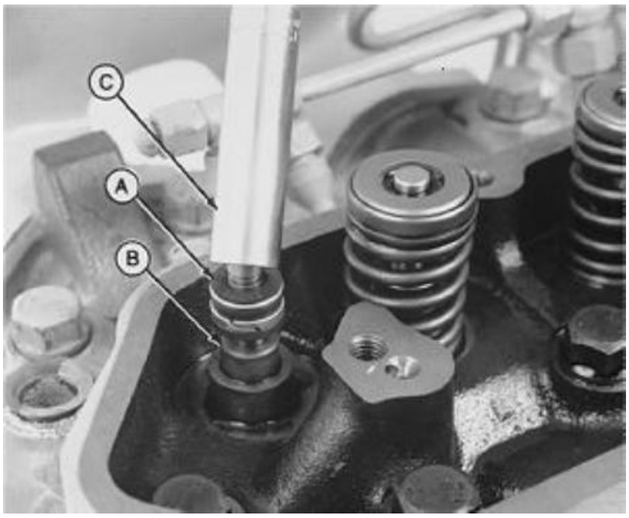


To install the new R110524 Seal, the exhaust valve towers on the cylinder head have to be machined using JDG714 Valve Guide Cutting Tool.

IMPORTANT: Follow instructions supplied with the tool for correct machining of the valve tower. The tool is used in conjunction with a 1/2 in. drill motor. (Tool speed should not exceed 450 rpm.) It is important to use firm down pressure on the tool to prevent bouncing of the tool when cutting and to stop cutting just after the top of the valve tower has been machined. Continued cutting of the valve tower will reduce valve guide length and may cause excessive valve-to-guide wear.

RG,CTM4,GR05,2 -19-22SEP95

IMPORTANT: Cutter performs best at approximately 450 rpm drill speed. Cutting oil may be used to extend tool life, if desired.



RG5716 -UN-11APR91

1. Using the JDG714 Valve Guide Cutting Tool and heavy-duty 1/2 in. or 3/4 in. drill, machine all EXHAUST valve towers until proper depth is reached. Tool guide will bottom on tip of valve stem and drill will speed-up. Stop cutting when tool speeds up.

NOTE: Cylinder head can be sent to a qualified machine shop for machining valve towers, if desired.

2. Thoroughly clean cylinder head and remove all shavings. Dry head with compressed air.

3. To install valve tower seals, lightly coat ID of valve stem seal (A) with clean engine oil and install exhaust valve stem until seal contacts valve tower (B).

4. Using an 11/16 in. deep-well socket (C) and one valve rotator (not shown) carefully press seal onto tower until it is firmly seated. Check lower ring on seal to be sure it is properly positioned in groove around bottom of seal. Use a small screwdriver to reposition ring if necessary.

RG,CTM4,GR05,4 -19-31MAR95

INSPECT AND CLEAN VENTILATOR OUTLET HOSE

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

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

S55,2005, I -19-15MAY89

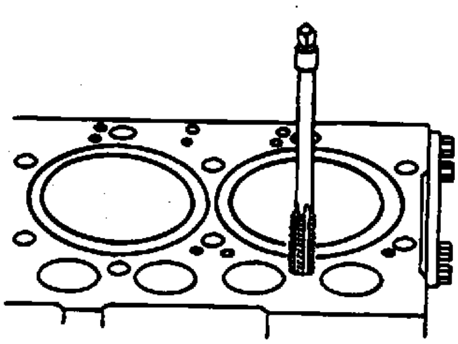
INSPECT AND CLEAN EXHAUST MANIFOLD

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

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

RG,CTM8,G05,54 -19-16SEP92

CLEAN AND INSPECT TOP DECK OF CYLINDER BLOCK


RG4718 -UN-13DEC88


T90973 -UN-28OCT88

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

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

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

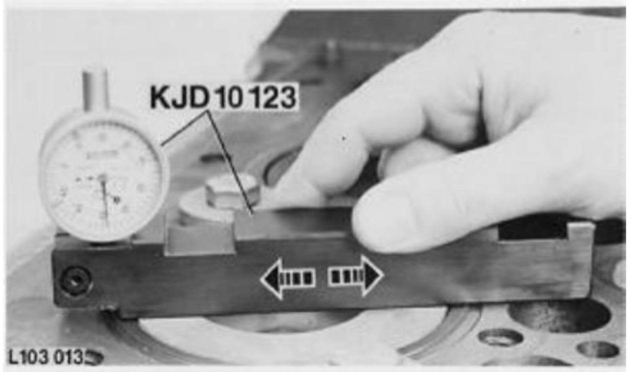
IMPORTANT: All debris must be cleaned from the camshaft followers before assembling the engine.

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

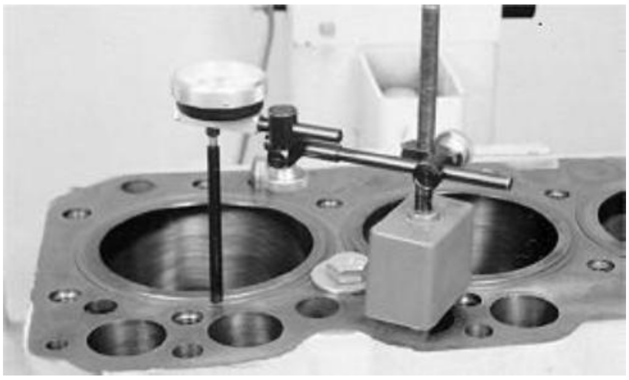
5. Inspect top deck for flatness and serviceability. (See Group 10.)

RG,CTM8,G05,55 -19-16SEP92

MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)



L103013 -UN-09DEC88



T81644 -UN-01NOV88

1. Secure liners as shown 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).

NOTE: Liners having obvious defects must be replaced.

2. Using JDG451 Gauge (or KJD10123 Gauge, illustrated), or a D17527CI Dial Indicator, measure liner height.

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

LINER HEIGHT SPECIFICATIONS

Liner Height Above Block	0.01—0.10 mm (0.0004—0.004 in.)
Maximum Permissible Height Difference at Nearest Point of Two Adjacent Liners	0.06 mm (0.002 in.)

NOTE: If liner height is less than minimum specified, ONE LINER SHIM ONLY may be installed under liner flange. Two sizes of shims are available: 0.05 mm (0.002 in.) and 0.10 mm (0.004 in.).

S11,2005,JC -19-30JUN95

CLEAN AND INSPECT CYLINDER HEAD CAP SCREWS

1. Clean entire length of cap screws. Use a wire brush and solvent to remove rust and scale. Dry cap screws with compressed air.

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

RG,CTM4,DW623 -19-11AUG95

INSTALL CYLINDER HEAD

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

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

NOTE: Verify that all camshaft followers are installed in their respective bore prior to installing cylinder head.

1. Place the correct new cylinder head gasket on cylinder block. Do not use sealant; install dry.

A cylinder head gasket with a fire ring diameter of 120 mm (4.724 in.) can be used with previous liner having a fire ring diameter of 119 mm (4.685 in.) and with new liner having a fire ring diameter of 120 mm (4.724 in.). However, the cylinder head gasket with a fire ring diameter of 119 mm (4.685 in.) can not be used with 120 mm (4.724 in.) liners. Check to make sure that head gasket fire rings do not interfere with liner fire dam step (upper most portion on top of liner).

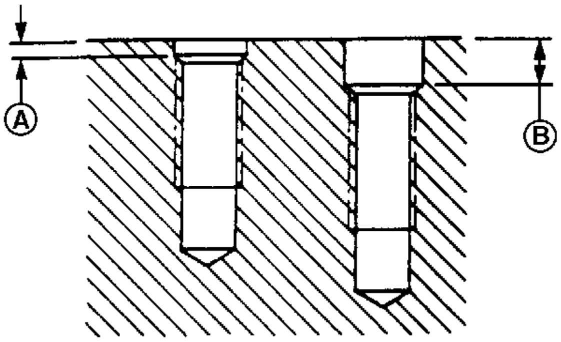
Only 120 mm (4.724 in.) diameter cylinder head gaskets may be used on the following engines:

Saran—
- 3179 Engine Serial No. (CD665598—)
- 4239 Engine Serial No. (CD679662—)
- 6359 Engine Serial No. (CD664757—)

Dubuque—
- 4239, Engine Serial No. (T0100001—)
- 6359, Engine Serial No. (T0100001—)
- 4276, Engine Serial No. (T0137128—)
- 6414, Engine Serial No. (T0137165—)

RG,CTM4,DY086 -19-11AUG95

INSTALL CYLINDER HEAD CAP SCREWS



IMPORTANT: Currently, ONLY flanged-head cap screws are used in production and provided for service. Flanged-head cap screws do not require washers and provide for a tighter joint between the head and block. If your engine is not equipped with flanged-head cap screws, replace ALL cap screws. Do not intermix flanged-head and non—flanged-head cap screws within a given engine.

Early production cylinder blocks were machined to a 3.0 mm (0.118 in.) counterbore depth (A). Later cylinder blocks are machined to a 9.5 mm (0.370 in.) counterbore depth (B).

—Engines with 3.0 mm (0.118 in.) counterbore depths, the cylinder head cap screws MUST BE tightened using the conventional method. DO NOT TORQUE-TURN.

—Engines with 9.5 mm (0.370 in.) counterbore depths, the cylinder head cap screws MUST BE tightened using the TORQUE-TURN method.

IMPORTANT: Measure the counterbore depth in the block to determine the correct torquing procedure to follow when tightening cylinder head cap screws.

RG,CTM4,DY087 -19-11AUG95

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

1. Dip entire cap screw in clean SAE30 engine oil. Remove excess oil from screw.

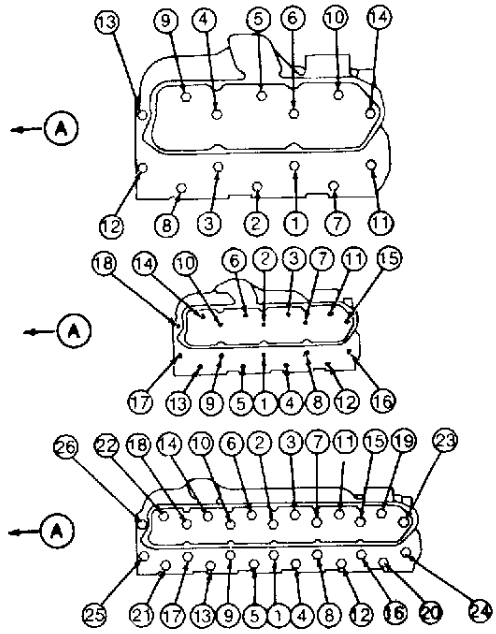
2. Arrow (A) points toward front of engine. Install two guide studs in cylinder block (for piloting cylinder head) at locating holes shown.

Engine	Locating Holes
3179	11 and 12
4239/4276	16 and 17
6359/6414	24 and 25

IMPORTANT: Without guide studs, the viton O-ring seal bonded in new cylinder head gaskets (at rocker arm lube oil passage) could become damaged if the cylinder head requires repositioning on engine block to align cap screw holes.

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

4. Install flanged-head cylinder head cap screws in all open holes. Remove guide studs and install cap screws in their place.



RG7252 -UN-11JUL95

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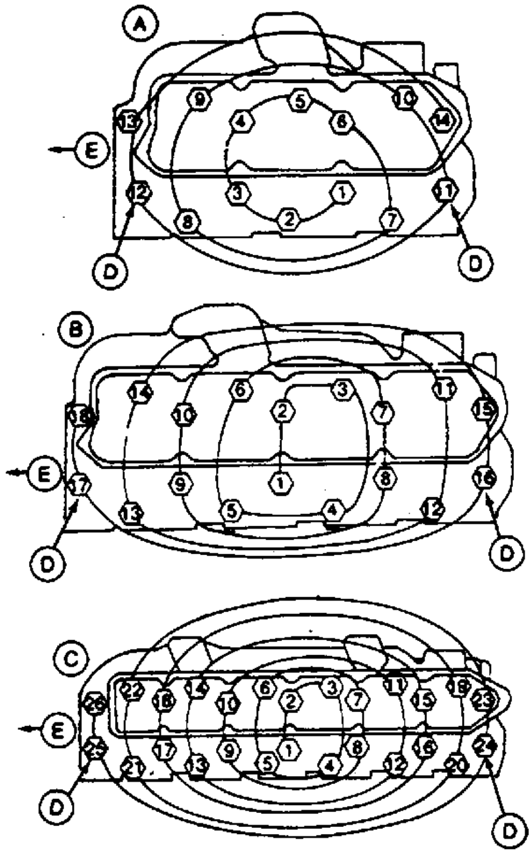
RG,CTM4,DY088 -19-11AUG95

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

COUNTERBORE DEPTH IN CYLINDER BLOCK	TORQUE PROCEDURE
3.0 mm (0.118 in.)	1st step—47 N·m (35 lb-ft) 2nd step—120 N·m (88 lb-ft) 3rd step—150 N·m (110 lb-ft) 4th step—Retorque after break-in. (See PERFORM ENGINE BREAK-IN later in this group.)
9.5 mm (0.370 in.)	1st step—100 N·m (75 lb-ft) 2nd step—150 N·m (110 lb-ft) 3rd step—Wait 5 minutes. Verify 150 N·m (110 lb-ft). 4th step—Turn each bolt an additional 60° ±10°. Retorque not required. (See TORQUE-TURN METHOD FOR PROPER TORQUE next in this group.)

A—3-Cylinder Engine
B—4-Cylinder Engine
C—6-Cylinder Engine
D—Locating Holes
E—Arrow Toward Front of Engine



RG4773 -UN-06DEC88

RG,CTM4,DY089 -19-11AUG95

TORQUE-TURN METHOD FOR PROPER TORQUE

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

Line scribe method:

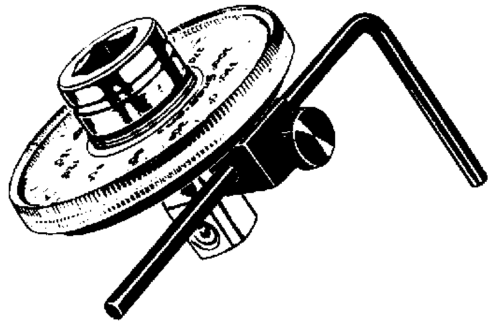
Step A—Make two marks on socket 1/6 turn (60°±10°) apart.

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

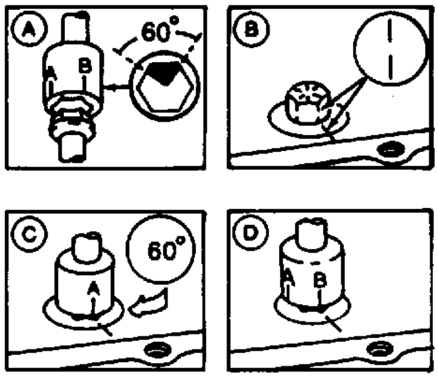
Step C—Place socket on cap screw so first mark aligns with mark on cylinder head.

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

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



JT05993 Torque Angle Gauge



RG,CTM8,G05,60 -19-08FEB95

INSTALL ROCKER ARM ASSEMBLY

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

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

S11,2005,KK -19-30JUN95

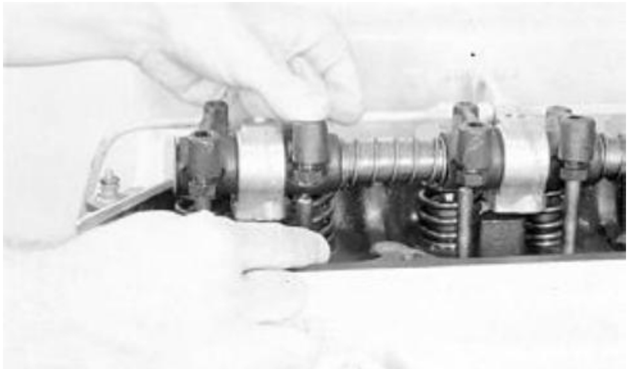
3. Position rocker arm assembly on engine.

IMPORTANT: Make sure that oil supply hole of rocker arm shaft is on the flywheel end and facing downward when rocker shaft is installed.

4. Lubricate all rocker arms with engine oil and make sure they move freely.

5. Tighten attaching cap screws to 47 N·m (35 lb-ft).

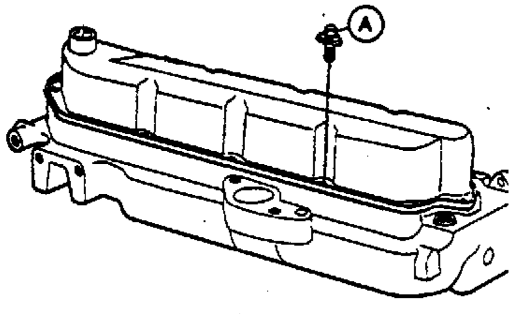
6. Adjust valve clearance. (See CHECK AND ADJUST VALVE CLEARANCE earlier in this group.)



T81240 -UN-01NOV88

S11,2005,KL -19-30JUN95

INSTALL ROCKER ARM COVER



Two types of rocker arm covers are used:

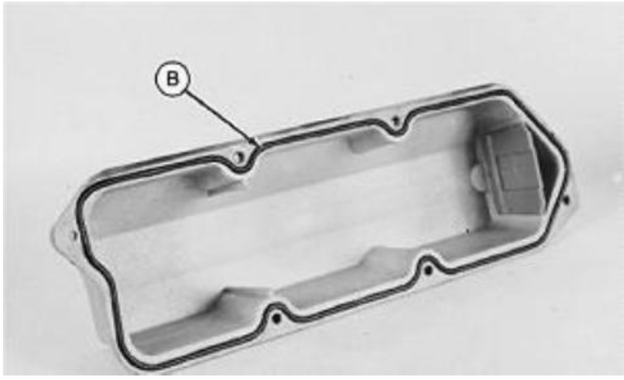
• Sheet Metal Cover

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

NOTE: The old gasket can be reused if not damaged.

2. Install rocker arm cover.

3. Tighten rocker arm cap screws (A) to 11 N·m (8 lb-ft) (96 lb-in.). (Cover has to be removed after engine break-in to readjust valves and retighten cylinder head cap screws.)



• Composite Material Cover

1. Install rocker arm cover with built-in seal ring (B). Do not use sealant on seal ring.

2. Install all cap screws finger tight.

3. Tighten all cap screws to 11 N·m (8 lb-ft) (96 lb-in.), starting at the center and alternate sides until reaching the ends.

The sealing ring is reusable if not damaged. If the sealing ring leaks, the following procedure should be used to install a new sealing ring:

—Carefully remove the old sealing ring from rocker arm cover. Do not use any cutting tool that could damage the cover.

—Clean the groove with acetone. Follow the manufacturer's directions on label. Dry with compressed air.

—Lubricate sealing ring with grease to avoid misalignment. Install in groove.

—Cut sealing ring slightly longer than necessary. Place the two ends of sealing ring end-to-end. Press the sealing ring into the groove all the way around the cover to ensure proper assembly. Tighten cap screws to specification listed above.

RG,CTM4,DY090 -19-22SEP95

COMPLETE FINAL ASSEMBLY

1. Install injection nozzles and injection lines. (See Group 35 - Fuel System.)

2. Install exhaust manifold. (See Group 30 - Air Intake and Exhaust System.)

3. Install fuel filter. (See Group 35 - Fuel System.)

4. Install water manifold or thermostat housing. (See Group 25 - Cooling System.)

5. Install air intake on non-turbocharged engines or turbocharger. (See Group 30 - Air Intake and Exhaust System.)

6. If engine oil was drained from crankcase, refill with new oil of correct grade and viscosity. Also install a new oil filter. (See Group 02 - Fuels, Lubricants, and Coolant.)

7. Fill cooling system with clean coolant. (See Group 02 - Fuels, Lubricants, and Coolant.)

S11,2005,LK -19-20FEB87

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. (See DYNAMOMETER TEST SPECIFICATIONS in Group 105.)

NOTE: Dynamometer is the preferred load control but loading can be improvised by matching engine lugging conditions with gear ratio selection.

Use JD307 Torque Wrench Adapter to loosen each cylinder head cap screw in correct sequence, and retighten to correct torque, as described in INSTALL CYLINDER HEAD earlier in this group.

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

Install rocker arm cover with gasket. Tighten cover cap screws to the following specifications:

Rubber/Metal Gasket . . . . 11 N·m (8 lb-ft) (96 lb-in.)

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

RG,CTM4,DY084 -19-22SEP95

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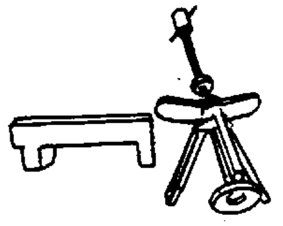
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

Cylinder Liner Puller . . . . D01062AA, or D01073AA, or KCD10001

Used to remove and install cylinder liners.



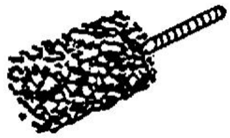
RG5019 -UN-23AUG88

S53,D01073,AA -19-03APR90

RG5074 -UN-23AUG88

Flexible Cylinder Hone D17004BR

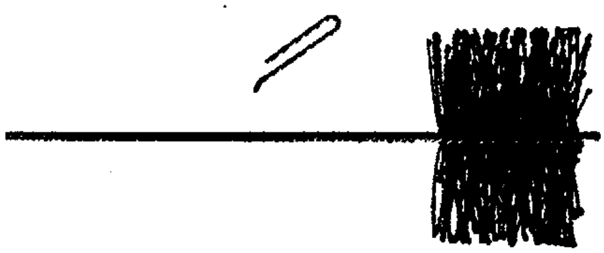
Hone cylinder liners.



S53,D17004,BR -19-03APR90

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.

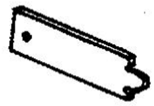
RG6246 -UN-27MAR92

RG,D17526CI -19-29OCT92

RG5076 -UN-23AUG88

Ring Groove Wear Gauge JDE62

Check wear of keystone ring groove on pistons.



S53,JDE62 -19-03APR90

RG5031 -UN-23AUG88

Piston Ring Compressor JDE84

Compress rings while installing pistons.

S53,JDE84 -19-03APR90

RG6244 -UN-23MAR92

Piston Ring Expanders . . . . . . A—JDE85, B—JDE135

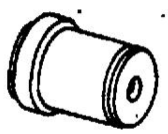
Remove and install piston rings.

S53,JDE85 -19-29SEP94

RG5107 -UN-23AUG88

Piston Pin Bushing Remover and
Installer . . . . JDE88 (Small Pin)
JD286 (Large Pin)

Replace piston pin bushing in connecting rods with straight pin-end.

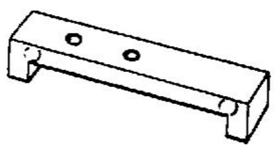


S53,JDE88 -19-14FEB92

Piston and Liner Height Gauge JDG451

Measure piston and liner heights.

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



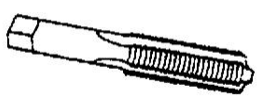
RG7029 -UN-30SEP94

RG,JDG451 -19-28SEP94

RG5100 -UN-23AUG88

Tap JDG680

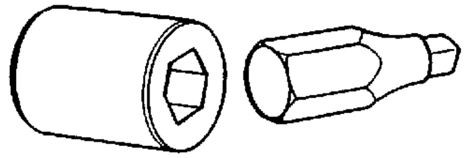
Used to restore threaded holes in cylinder block for cylinder head cap screws.



RG,JDG680 -19-02APR90

Oil Galley Plug Tool JDG782

Used to remove and install oil galley plug.



-UN-29JAN93

RG6612

RG,JDG782 -19-02APR93

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,CTM8,GR10,65-19-11OCT94

OTHER MATERIAL

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

PLASTIGAGE is a trademark of the TRW Company.

S11,2010,BS -19-16JUN95

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CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Centerline of Main Bearing Bore-to-Top Deck of Cylinder Block:		
3179, 4239, 6359 Engines	302.006—302.082 mm (11.8899—11.8929 in.)	301.981 mm (11.8889 in.)
4276, 6414 Engines	337.896—337.972 mm (13.3029—13.3059 in.)	337.871 mm (13.3019 in.)
Maximum Acceptable Top Deck Out-of-Flat:		
For Entire Length or Width		0.08 mm (0.003 in.)
For Every 150 mm (5.90 in.) Length or Width		0.025 mm (0.001 in.)
Top Deck Surface Finish:		
Surface Grind Only (AA)	0.0008—0.0032 mm (31—125 micro-in.)	——
Maximum Wave Depth		0.012 mm (0.0005 in.)
Maximum Crankshaft Rod Journal Out-of-Roundness		0.005 mm (0.0002 in.)
Camshaft Follower Bore ID	31.70—31.75 mm (1.248—1.250 in.)	——
Camshaft Follower OD	31.61—31.64 mm (1.245—1.246 in)	——
Camshaft Follower-to-Bore Clearance	0.06—0.13 mm (0.002—0.005 in.)	——
Camshaft Bore Diameter	55.986—56.012 mm (2.2042—2.2052 in.)	0.05 mm (0.002 in.)
Camshaft Journal Clearance (New)	0.08—0.13 mm (0.003—0.005 in.)	——
Maximum Clearance		0.15 mm (0.006 in.)
Balancer Shaft Bushing Bore in Cylinder Block:		
Standard Bushings*	41.262—41.288 mm (1.6245—1.6255 in.)	——
Oversize Bushings**	43.237—43.263 mm (1.7015—1.7025 in.)	——
Chamfer	20°—25° x 1.50 mm (0.060 in.)	——
Main Bearing Bore in Cylinder Block	84.455—84.480 mm (3.3249—3.3259 in.)	——
Main Thrust Bearing Width in Cylinder Block	33.62—33.72 mm (1.324—1.328 in.)	——
Crankshaft Rod Journal OD:		
3179, 4239, 6359 Engines	69.799—69.825 mm (2.7479—2.7490 in.)	——
4276, 6414 Engines	77.800—77.826 mm (3.0628—3.0640 in.)	——
Lower Liner	115.75—115.80 mm (4.557—4.559 in.)	——
Liner Flange ID in Block	126.33—126.35 mm (4.973—4.974 in.)	——
Upper Block Bore For Seating Liner	120.70—120.75 mm (4.752—4.754 in.)	——

4239 and 4276 (4-cylinder) Engines only.

***4239 Engines with one-piece balancer shafts only.*

S11,2010,FP -19-01NOV95

CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
OD of Liner at Upper Bore	120.61—120.69 mm (4.748—4.751 in.)	——
OD of Liner at Lower Bore:		
Dubuque Engines	115.697—115.733 mm (4.555—4.556 in.)	——
Saran Engines	115.698—115.748 mm (4.555—4.557 in.)	——
Clearance Between Liner and Cylinder Block at Lower Bore:		
All Dubuque Engines	0.035—0.100 mm (0.001—0.004 in.)	——
Saran Eng. Ser. No. (—CD707729)	0.035—0.100 mm (0.001—0.004 in.)	——
Saran Eng. Ser. No. (CD707730—)	0.035—0.075 mm (0.001—0.003 in.)	——
Clearance Between Liner and Cylinder Block at Upper Bore Dubuque and Saran		
Engines (—CD707729)	0.10—0.14 mm (0.004—0.005 in.)	——
Saran Engines (CD707730—)	0.075 mm (0.003 in.)	——
Cylinder Liner ID	106.48—106.52 mm (4.192—4.194 in.)	——
Maximum Permissible Wear		0.10 mm (0.004 in.)
Maximum Permissible Taper		0.05 mm (0.002 in.)
Maximum Permissible Out-of-Round		0.05 mm (0.002 in.)
Liner Flange OD	125.82—125.98 mm (4.954—4.960 in.)	——
Liner Flange Thickness	6.022—6.058 mm (0.2371—0.2385 in.)	——
Liner Counterbore Depth In Block	5.95—5.99 mm (0.234—0.236 in.)	——
Liner Height Above Block	0.010—0.100 mm (0.0004—0.0039 in.)	——
Maximum Permissible Height Difference at Nearest Point of Two Adjacent Liners or Within a Single Liner		0.05 mm (0.002 in.)
Thickness of Liner Shim CD15466	0.05 mm (0.002 in.)	——
Thickness of Liner Shim R65833	0.10 mm (0.004 in.)	——
Minimum Dimension of Proper Compression of Liner Packing	0.13 mm (0.005 in.)	——
Desired Cylinder Liner Wall Finish (crosshatch pattern)	0.0006—0.0011 mm (25—45 micro-in.)	——
Piston OD at 19 mm (0.74 in.) From Bottom of Skirt and Measured 90° to Piston Pin:		
All Naturally Aspirated Engines and All Dubuque Engines	106.38—106.40 mm (4.188—4.189 in.)	——
Turbocharged Saran Engines:		
Serial No. (—CD599999)	106.32—106.34 mm (4.186—4.187 in.)	——
Serial No. (CD600000—)	106.38—106.40 mm (4.188—4.189 in.)	——

S11,2010,FP1 -19-01NOV95

CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Piston Pin Bore ID*:		
Small Pin	34.933—34.943 mm (1.3753—1.3757 in.)	——
Large Pin	41.285—41.295 mm (1.6254—1.6258 in.)	——
Piston Protrusion Above Block (maximum)		0.33 mm (0.013 in.)
Clearance Between Piston and Cylinder Liner, Measured at Bottom of Skirt:		
All Naturally Aspirated Engines		0.08—0.14 mm (0.003—0.005 in.)
All Turbocharged Engines—		
Saran Engine Serial No. (—CD599999)		0.14—0.20 mm (0.005—0.008 in.)
Saran Engine Serial No. (CD600000—) and All Dubuque-Built		0.08—0.15 mm (0.003—0.006 in.)
Maximum Permissible Wear Between Second Piston Ring and Ring Groove		0.20 mm (0.008 in.)
Piston Ring End Gap:		
No. 1 Compression Ring	0.33—0.58 mm (0.013—0.023 in.)	——
No. 2 Compression Ring (Dubuque Engines)	0.33—0.58 mm (0.013—0.023 in.)	——
No. 2 Compression Ring (Saran Engines)**	0.75—1.00 mm (0.030—0.039 in.)	——
No. 3 Oil Control Ring	0.33—0.58 mm (0.013—0.023 in.)	——
Piston Pin OD:		
Small Pin	34.920—34.930 mm (1.3748—1.3752 in.)	34.907 mm (1.3743 in.)
Large Pin	41.270—41.280 mm (1.6248—1.6252 in.)	41.257 mm (1.6243 in.)
Rod Pin Bushing ID:		
Small Pin	34.950—34.976 mm (1.3760—1.3770 in.)	35.026 mm (1.3790 in.)
Large Pin	41.300—41.326 mm (1.6260—1.6270 in.)	41.376 mm (1.6290 in.)
Pin-to-Bushing Oil Clearance	0.020—0.056 mm (0.0007—0.0022 in.)	0.102 mm (0.0040 in.)
Connecting Rod Bearing (assembled) ID:		
3179, 4239, 6359 Engines	69.850—69.901 mm (2.7499—2.7520 in.)	——
4276, 6414 Engines	77.876—77.927 mm (3.0659—3.0679 in.)	——
Connecting Rod Bearing-to-Journal Clearance	0.025—0.102 mm (0.0012—0.0040 in.)	0.152 mm (0.0060 in.)
Connecting Rod Bore for Bearing:		
3179, 4239, 6359 Engines	73.660—73.686 mm (2.9000—2.9010 in.)	——
4276, 6414 Engines	82.677—82.703 mm (3.2550—3.2560 in.)	——
Maximum Permissible Bore Out-of-Round		0.038 mm (0.0015 in.)

**Some piston pin bores are elliptical, the width being 0.038 mm (0.0015 in.) wider than specification given.*

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

RG,CTM4,DW625 -19-01NOV95

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CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Undersize Connecting Rod Bearings		
Available	0.25 and 0.51 mm (0.01 and 0.02 in.)	——
Connecting Rod Bore-to-Pin Bushing Bore (Center-to-Center) Distance:		
3179, 4239, 6359 Engines	180.95—181.05 mm (7.124—7.128 in.)	——
4276, 6414 Engines	202.95—203.05 mm (7.990—7.994 in.)	——
Piston Pin Length	84.05—84.45 mm (3.309—3.325 in.)	——
Connecting Rod Pin Bore ID (without bushing):		
Small Pin	38.087—38.113 mm (1.4995—1.5005 in.)	——
Large Pin	46.025—46.051 mm (1.8120—1.8130 in.)	——

S11,2010,FP2 -19-25SEP95

CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS—CONTINUED

TORQUES

Piston Cooling Orifices Into Cylinder Block	10.5 N·m (7.7 lb-ft) (93 lb-in.)
Cylinder Liner Cap Screws (For Checking Liner Standout)	68 N·m (50 lb-ft)
Connecting Rod Cap Screws	
3179, 4239, 6359 Engines:	
R74194, 54 mm (2.13 in.), phosphate coated	75 N·m (55 lb-ft)
R80033, 59 mm (2.32 in.), black	75 N·m (55 lb-ft)
4276, 6414 Engines:	
R74195, 63.5 mm (2.50 in.), phosphate coated	130 N·m (95 lb-ft)

RG,CTM4,DW626 -19-22SEP95

REMOVE PISTONS AND CONNECTING RODS

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

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

1. Drain coolant and engine oil.

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

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

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

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

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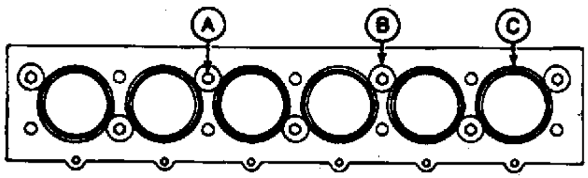
RG,CTM8,GR10,62-19-29JUN95

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



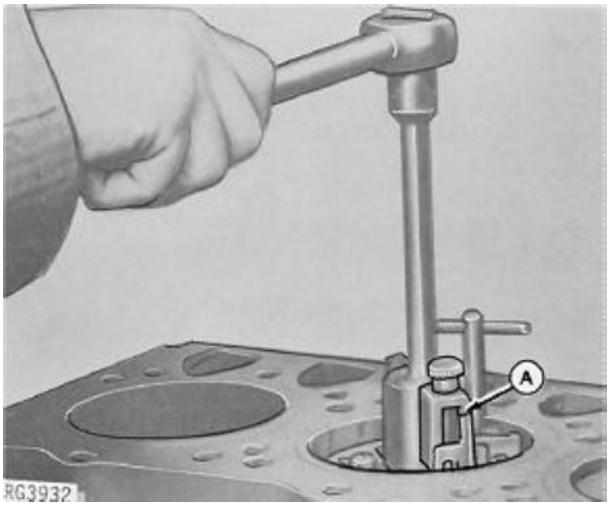
RG3819 -UN-07DEC88

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

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

CTM8,GR10,4 -19-27DEC94

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



RG3932 -UN-07DEC88

S11,2010,FV -19-07JUL92

7. Remove oil pan. (See Group 20.)

8. Remove oil pump and outlet tube. (See Group 20.)

9. Mark rods, pistons, and caps to ensure correct assembly in same location.

NOTE: Connecting rod bearing oil clearance should be measured before removing piston/rod assembly. Be sure to check connecting rod cap screws for proper torque.

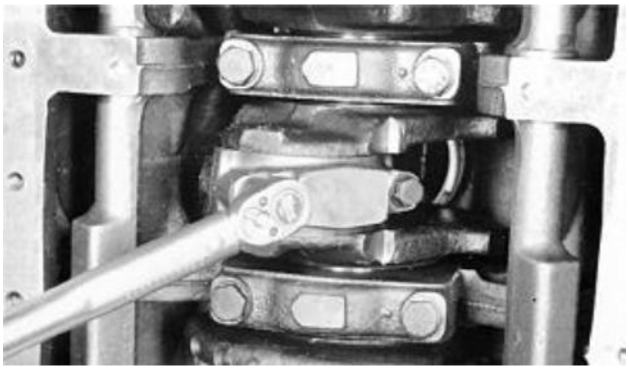
10. Measure rod bearing-to-journal oil clearance with PLASTIGAGE before removing piston and rod assembly. (See INSPECT AND MEASURE CONNECTING ROD BEARINGS later in this group.)

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

IMPORTANT: Keep inserts with their respective rods and caps.

NOTE: Saran Engines having Serial No. (CD724056—CD733430) did not have the engine cylinder number stamped on the connecting rods or caps. On these engines, stamp the correct number before removing to assure correct reassembly.

11. Remove all rod caps with bearings.



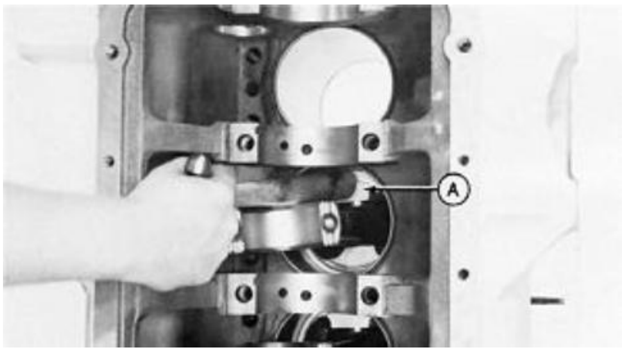
T81615 -UN-07NOV88

S11,2010,FW -19-22SEP95

12. Gently tap piston through top of cylinder block from the bottom.

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

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



RG3821 -UN-07DEC88

S11,2010,FY -19-05JUN92

REMOVE CYLINDER LINERS

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

1. Using D17526CI (or D17527CI) Dial Indicator and JDG451 Gauge (or KJD10123 Gauge), measure 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.

CYLINDER LINER HEIGHT SPECIFICATIONS

Liner height
above block . . . . 0.010—0.100 mm (0.0004—0.0039 in.)

Maximum permissible difference between
readings within one cylinder or
between adjacent cylinders . . . . 0.05 mm (0.002 in.)

NOTE: If liner height is less than minimum specified, ONE LINER SHIM ONLY may be installed on bottom of liner flange. Two sizes of shims are available:

—Part No. CD15466 - 0.05 mm (0.002 in.) thick
—Part No. R65833 - 0.10 mm (0.004 in.) thick

S11,2010,FZ -19-22SEP95

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

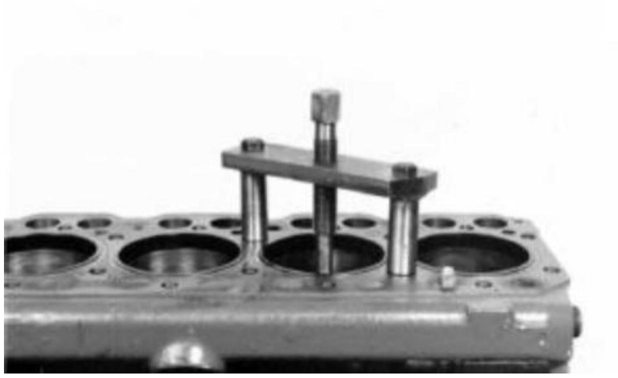
3. Number cylinder liners and pistons. Stamp front of liner to assure correct assembly. Do not stamp liner flange; stamp on fire dam only.

IMPORTANT: Each cylinder liner must be reinstalled in cylinder bore from which it was removed. ALWAYS keep matched pistons and liners together.

S11,2010,GA -19-29JUN95

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

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

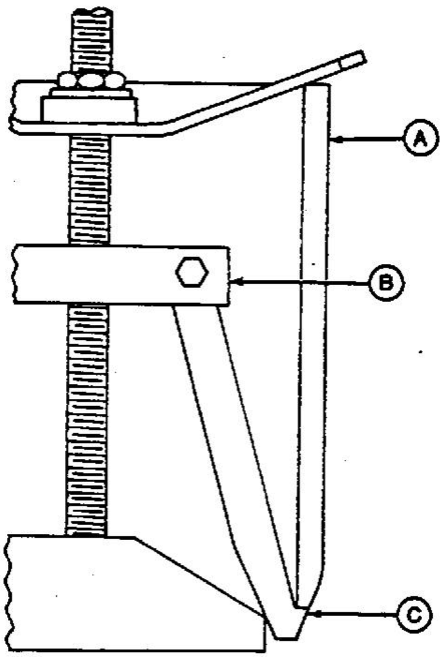


CD6372 -UN-23FEB89

S11,2010,GB -19-03APR90

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.

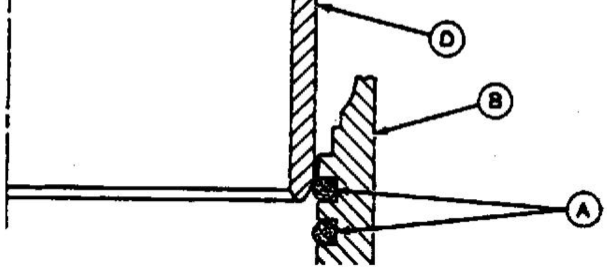


RG1179 -UN-13DEC88

S11,0402,AK -19-22SEP95

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

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



RG4745 -UN-13DEC88

S11,2010 GC -19-03APR90

COMPLETE DISASSEMBLY OF CYLINDER BLOCK (IF REQUIRED)

If not previously removed, also remove:

1. Crankshaft pulley (Group 15).

2. Oil pressure regulating plug, valve, and spring on 3179, 4239, and 6359 Engines (Group 16).

3. Timing gear cover, timing gears, and camshaft (Group 16).

4. Balancer shafts and balancer shaft bushings (4-cylinder engines, if equipped) (Group 16).

5. Front plate and lubrication system oil bypass valve (if equipped) (Group 16).

6. Crankshaft and main bearings (Group 15).

7. Piston cooling orifices.

8. Remove water gallery plugs.

9. If necessary to “Hot Tank” the block, also remove screw-in type oil gallery plugs and the engine serial number plate.

S11,2010,GD -19-24APR89

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

DISASSEMBLE PISTON AND ROD ASSEMBLY

IMPORTANT: DO NOT REUSE piston rings.

1. Remove and discard snap rings.

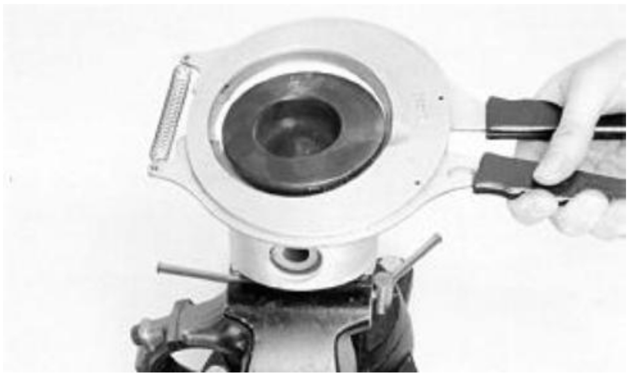
2. Separate piston and rod. Keep these parts in place with their respective cylinder liner.

NOTE: Discard piston rings and connecting rod bearings. DO NOT REUSE.

T81603 -UN-01NOV88

S11,2010,GE -19-29JUN95

3. Remove piston rings using the JDE85, JDE135 or KJD10140 Piston Ring Expander (A). DISCARD RINGS.



T81600 -UN-07NOV88

S11,2010,GG -19-05MAR90

CLEAN PISTONS

CAUTION: Always follow manufacturer's instructions, and safety steps exactly.

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

IMPORTANT: When washing pistons, always use a stiff bristle brush — NOT A WIRE BRUSH — to loosen carbon residue.

DO NOT bead blast ring groove areas.

2. Clean pistons by any of the following methods:

• Immersion-Solvent "D-Part".
• Hydra-Jet Rinse Gun.
• glass bead blasting machine.
• hot water with liquid detergent soap.

If cleaning with hot water and liquid detergent, soak pistons in a 50 percent solution of liquid household detergent and hot water for 30 to 60 minutes. Use a stiff bristle brush to loosen carbon residue. Dry with compressed air.

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16

CTM8,GR10,31 -19-27DEC94

VISUALLY INSPECT PISTONS

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

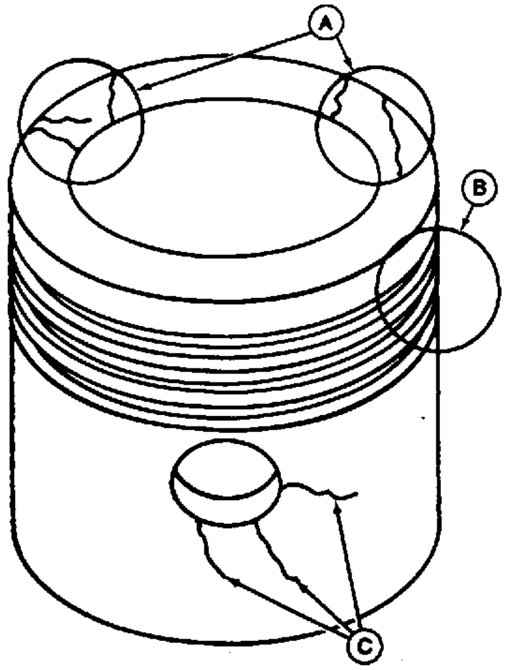
2. Look for fine cracks in piston head (A).

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

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

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

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

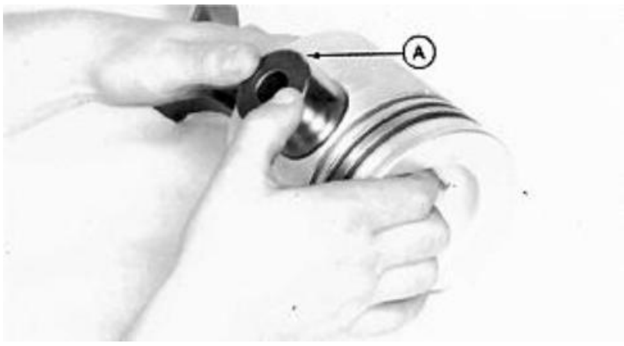


RG3326 -UN-13DEC88

(Imperfections exaggerated)

RG,CTM4,DY101 -19-13JUL95

INSTALL PISTON PIN

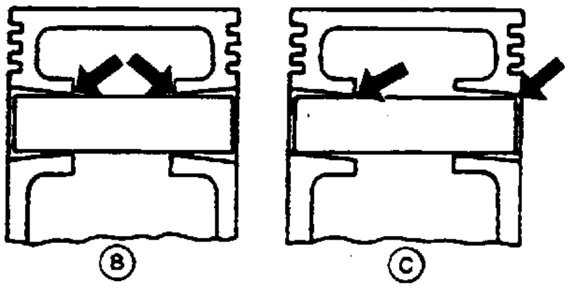


NOTE: Piston pin must be in good condition and not worn beyond specification given below.

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 and/or piston/liner set.

PIN OD/PIN BORE SPECIFICATIONS

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Piston Pin OD:	
Small pin	34.920—34.930 mm (1.3748—1.3752 in.)
Wear Tolerance	34.907 mm (1.3743in.)
Large pin	41.270—41.280 mm (1.6248—1.6252 in.)
Wear Tolerance	41.257 mm (1.6243 in.)
Piston Bore (For Pin):	
Small pin	34.933—34.943 mm (1.3753—1.3757 in.)
Large pin	41.285—41.295 mm (1.6254—1.6258 in.)

NOTE: Some piston pin bores are elliptical, the width being 0.038 mm (0.0015 in.) larger than the bore specifications.

S11,2010,GJ -19-01NOV95

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 abrasives from liner walls.

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

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

4. Swab out liner as often as necessary with clean SAE 10W oil. Clean liner until a clean, white rag shows no discoloration.

CTM8,GR10,32 -19-16SEP92

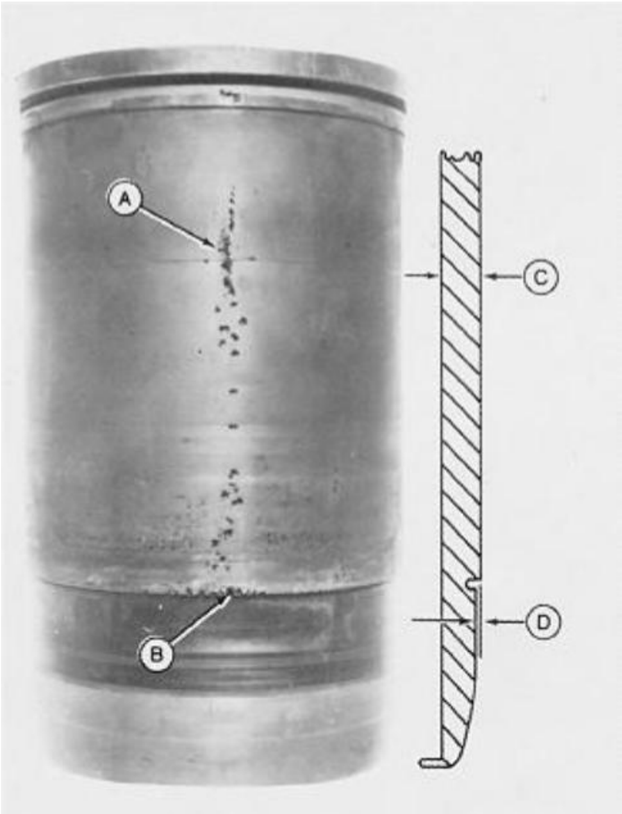
VISUALLY INSPECT CYLINDER LINERS

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

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

• Depth of any pit is one-half or more of liner thickness (C).

• Depth of erosion is one-half or more of the packing step (D).



RG4643 -UN-13DEC88

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

CTM8,GR10,34 -19-09FEB95

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

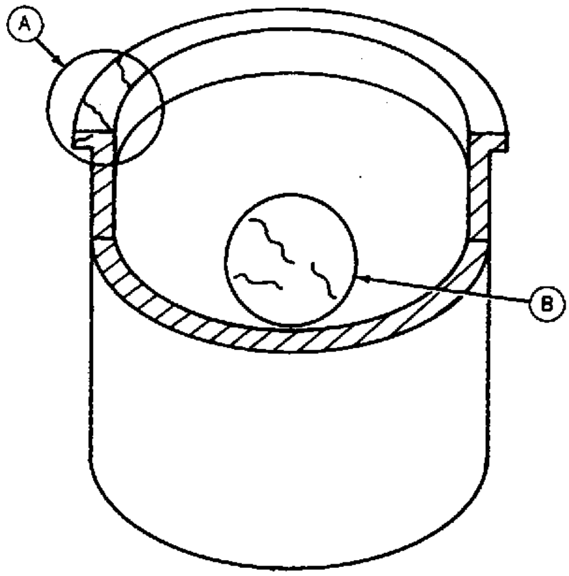
• The crosshatch honing pattern is not visible immediately below the top ring turn-around area for turbocharged engines.

• The hone pattern is not visible all the way around the liner in over 75 percent of the ring travel area for naturally aspirated engines.

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

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

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



RG1188 -UN-13DEC88

(Imperfections exaggerated)

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CTM8,GR10,35 -19-13JUL95

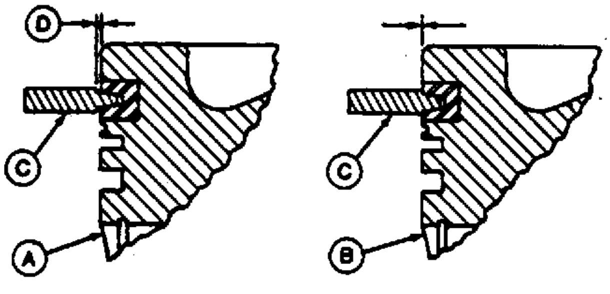
CHECK PISTON RING GROOVE WEAR

1. Use the JDE62 Ring Groove Wear Gauge (C) to check wear of keystone ring groove (top groove). Gauge shoulders should not contact ring land. Clearance (D) between shoulders of tool and ring land indicate ring groove is good.

If ring groove is worn, replace piston and liner as a matched set. If ring groove is good, proceed to next step.

A—Piston With Good Keystone Ring Groove
B—Piston With Worn Keystone Ring Groove
C—JDE62 Gauge
D—Tool Shoulder-to-Ring Land Clearance

RG5624 -UN-28MAR90



RG4746 -UN-13DEC88

CTM8,GR10,23 -19-29SEP94

2. Check second and third ring grooves using a new piston ring and a feeler gauge.

Replace piston if clearance exceeds specification.


RG5625 -UN-28MAR90

PISTON RING-TO-GROOVE SPECIFICATIONS

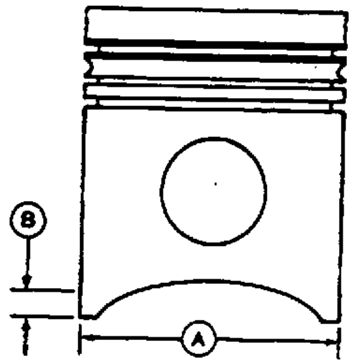
Maximum piston ring-to-groove clearance with new piston ring (second and third ring grooves) . . . . 0.20 mm (0.008 in.)

CTM8,GR10,21 -19-22SEP95

MEASURE PISTON SKIRT

1. Measure piston skirt (A) 90° to piston pin bore and 19 mm (0.74 in.) from bottom of piston (B). Record measurement.

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



RG4748 -UN-13DEC88

PISTON SKIRT DIAMETER SPECIFICATIONS

Bottom of skirt 19 mm (0.74 in.) from bottom of piston:
All Naturally Aspirated Engines and
All Dubuque Engines . . . . 106.38—106.40 mm (4.188—4.189 in.)

Turbocharged Saran Engines:
Serial No. (—CD599999) . . . . 106.32—106.34 mm (4.186—4.187 in.)
Serial No. (CD600000—) . . . . 106.38—106.40 mm (4.188—4.189 in.)

S11,2010,GM -19-01NOV95

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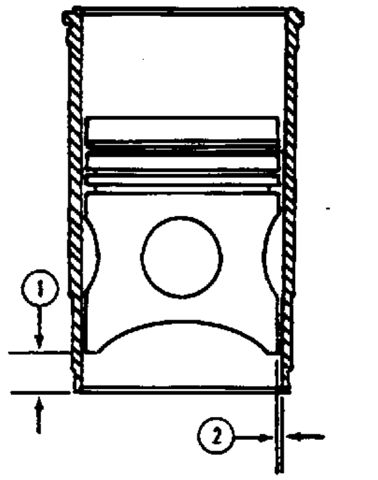
DETERMINE PISTON-TO-LINER CLEARANCE

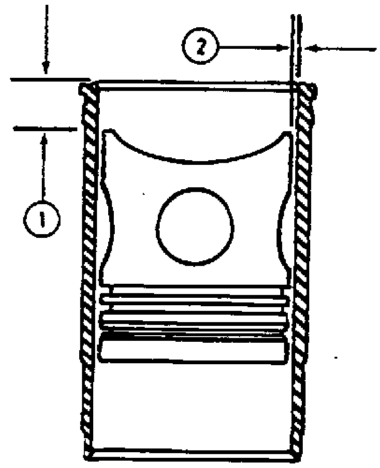
1. Put piston (without rings) in matched liner with piston “front” and liner “front”* aligned. Move piston down until bottom edge of piston skirt is 25.4 mm (1.00 in.) (1) above bottom of liner. Use a feeler gauge to measure distance (2) between piston skirt and liner 90° to piston pin bore. Record the measured distance and compare with specifications given.



T71624 -UN-25OCT88

2. Turn piston 90° in liner. Measure clearance between piston skirt and liner 90° to pin bore. Record the clearance.

3. Put piston upside down in liner with piston “front” and liner “front” aligned. Move piston so bottom edge of piston skirt is 25.4 mm (1.00 in.) (1) below top of liner. Measure clearance (2) between piston skirt and liner at 90° to pin bore. Record clearance.



T71625 -UN-25OCT88

4. Turn piston 90° in liner. Measure clearance between piston skirt and liner 90° to pin bore. Record the clearance.

5. The difference between clearances in steps 1 and 2 is the amount liner is out-of-round at bottom of the liner.

6. The difference between clearance in steps 3 and 4 is the amount liner is out-of-round at top of the liner.

7. The difference between clearances in steps 1 and 3 is the amount liner is tapered.

PISTON-TO-LINER CLEARANCE
(Measured at bottom of piston skirt)

All Naturally Aspirated Engines	0.08—0.14 mm (0.003—0.005 in.)
Turbocharged Engines:	
Saran Engine Serial No. (—CD599999)	0.14—0.20 mm (0.005—0.008 in.)
Saran Engine Serial No. (CD600000—) and All Dubuque-Built	0.08—0.15 mm (0.003—0.006 in.)

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

As marked during liner removal from engine.

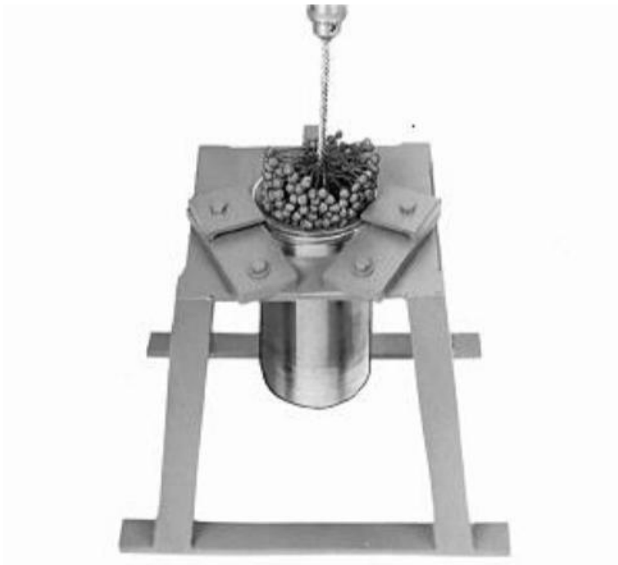
S11,2010,GN -19-01NOV95

DEGLAZE CYLINDER LINERS

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.

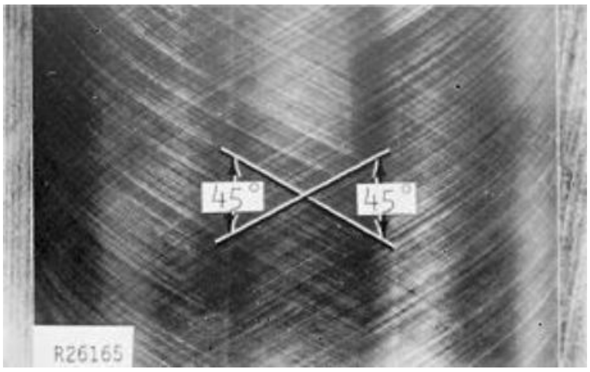


R26164 -UN-13DEC88

S11,0402,AS -19-08FEB95

3. Use D17004BR Hone according to instructions supplied with tool to obtain a 45˚ cross-hatch pattern.

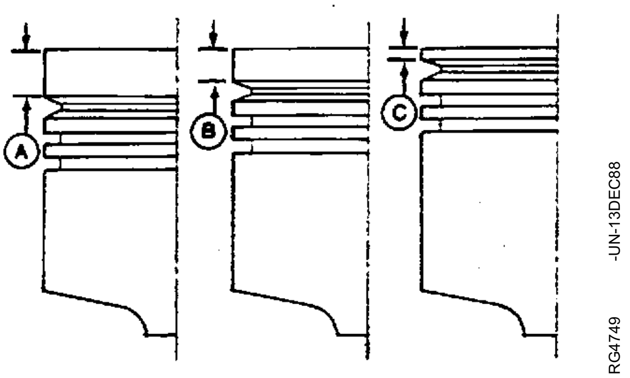
Thoroughly clean liners after deglazing. See CLEAN CYLINDER LINERS earlier in this group.



R26165 -UN-13DEC88

RG,CTM8,GR10,43-19-29SEP94

REPLACE PISTON AND LINER SETS



IMPORTANT: ALWAYS install a new (matched set) liner when replacing a piston.

Two types of piston (marked "B" or "H" on top or bottom face) may be installed in 300 Series Engines (See DETERMINE PISTON TYPE later in this group). These two piston types also exist in three different styles (determined by the top ring set position relative to top face of piston) as outlined below.

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1. Determine style of original pistons. Measure distance from top of piston to top of keystone ring groove.

Key	Piston Style	Dimension	Engine
A*	Low Ring	18 mm (0.709 in.)	All
B**	Intermediate Ring	13 mm (0.512 in.)	All
C***	High Ring	4 mm (0.158 in.)	All

IMPORTANT: Do not stamp top of high ring piston. Piston may be damaged.

PISTON STYLE REPLACEMENT GUIDE

Original Style	One Piston & Liner	Piston & Liner Set (All Cyls.)
Low Ring (A)	Intermediate Ring B	High Ring (C)
Intermediate Ring (B)	Intermediate Ring (B)	High Ring (C)
High Ring (C)	High Ring (C)	High Ring (C)

** Used on Saran-built engines, Serial No. (—CD571869).*

*** Used on Saran-built engines, Serial No. (CD571870—).*

**** Used on some Saran-built engines, Serial No. (CD684803—) and on Dubuque-built engines, Serial No. (T0100001—).*

NOTE: Effective with Serial No. (CD803105—), only style "C" (High Ring) pistons are used on production 3179 Engines.

Use only "B" style (Intermediate Ring) pistons on 4239A and 6359A Engines.

IMPORTANT: Never stamp (punch marks or numerical marks) a style "C" (High Ring) piston on the top. Doing so could upset the Ni-Resist insert. Stamp only on the flat piston pin weight boss on bottom of piston. See next module.

Only one of a different style piston may be replaced by a style "C" (high ring) piston within a given engine. If more than one piston requires replacement, install an entire set of style C" (high ring) pistons and liners.

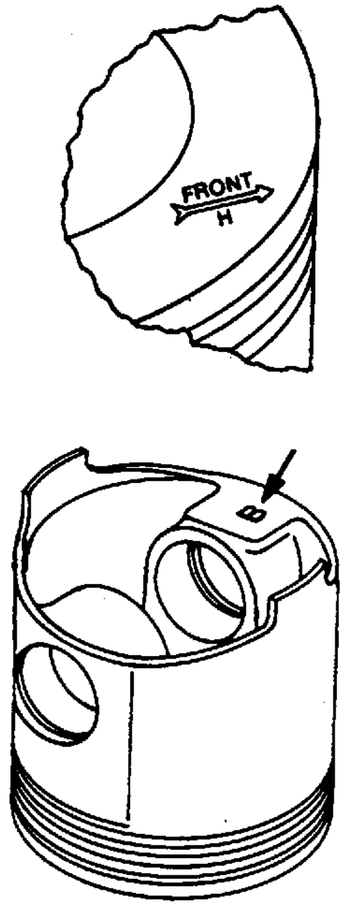
S11,2010,GP -19-22SEP95

DETERMINE PISTON TYPE

NOTE: Two different types of pistons marked "B" or "H" can be selectively installed on 3179D, 4239D and T, and 6359D and T engines for a better dead space control inside the cylinder. The "H" piston is 0.13 mm (0.0059 in.) higher than the "B" piston as measured from the piston pin centerline to the top of piston.

In production, Dubuque-built engines have only the "B" piston, while Saran-built engines may have both "B" and "H" types. High-ring pistons have "B" or "H" stamped on a piston pin boss at bottom of piston (stamped side of piston is "front"). All other pistons are stamped on top.

Use only "B" style (Intermediate Ring) pistons on 4239A and 6359A Engines.



RG4750 -UN-13DEC88

IMPORTANT: If cylinder block does not require replacement, replace pistons with the same type (either "B" or "H") originally used.

If cylinder block, connecting rod, or crankshaft are to be replaced, determine the type of piston required.

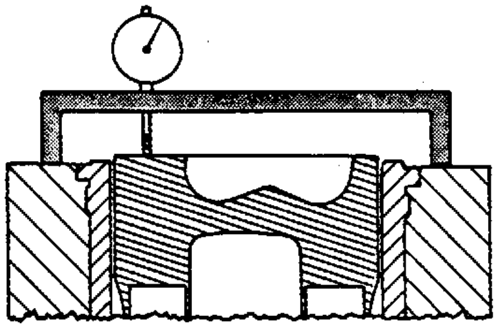
NOTE: To determine piston type, the crankshaft and cylinder liners must be installed in cylinder block. In addition "B" pistons must be assembled to a serviceable connecting rod (complete with bearings). Secure liners with cap screws as described earlier in this group.

Install a "B" type piston (without rings) and its connecting rod. Secure with rod, cap and screws.

NOTE: Press down on top of piston to remove oil clearances before measuring piston height.

S11,2010,GQ -19-22SEP95

MEASURE PISTON PROTRUSION

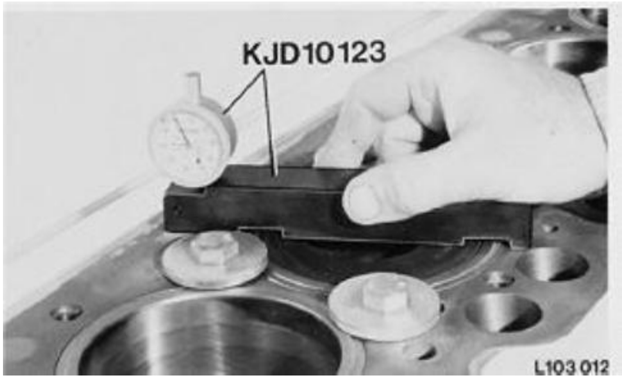

RG5222 -UN-13DEC88

Use JDG451 or KJD10123 Gauge (or use a magnetic base dial indicator) to measure piston protrusion.

1. Press down on top of piston to remove oil clearances before measuring piston protrusion.

IMPORTANT: Maximum protrusion must never exceed 0.33 mm (0.013 in.) to prevent piston-to-exhaust valve contact.

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



L103012 -UN-15NOV88

JDG451 GAUGE:

• Mount a dial indicator in gauge. Place gauge on top of cylinder block in such a manner that the dial indicator can be set at “zero” with top of block.

• Position gauge across piston with outer ends on block so dial indicator plunger can contact top of piston. Press down on top of gauge and rotate crankshaft until piston is at TDC.

• If piston protrusion equals or exceeds 0.18 mm (0.007 in.) above surface of cylinder block, install a “B” type piston.

• If protrusion is less than 0.18 mm (0.007 in.), install an “H” type piston.

KJD10123 GAUGE:

• Place gauge (with flat side up) on cylinder block so dial indicator point rests on block surface.

• While pressing gauge downward, turn crankshaft until piston is at TDC. When piston lightly touches gauge, use “B” type piston. When piston does not contact gauge, use “H” type piston.

S11,2010,GR -19-13JUL95

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.

Inspect rod bearings for damage or wear.

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

• Connecting Rod and Crankshaft Removed From Engine

1. Measure crankshaft rod journal OD at several points.

2. Assemble connecting rod, cap, and bearings with old cap screws.

3. Tighten cap screws to:

—75 N·m (55 lb-ft) on 3179, 4239, and 6359 Engines

—130 N·m (95 lb-ft) on 4276 and 6414 Engines

S11,2010,FX -19-29JUN95

4. Using an inside micrometer, measure assembled ID of rod bearing.

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

6. Compare measurements with the following specifications. Replace bearings if out of specification.

T81598 -UN-07NOV88

CONNECTING ROD JOURNAL AND BEARING SPECIFICATIONS

	3179/4239/6359	4276/6414
Crankshaft Journal OD	69.799—69.825 mm (2.7479—2.7490 in.)	77.800—77.826 mm (3.0628—3.0640 in.)
Assembled Rod Bearing ID	69.850—69.901 (2.7499—2.7520 in.)	77.876—77.927 mm (3.0659—3.0679 in.)
Oil Clearance (new parts)	0.025—0.102 mm (0.0012—0.0040 in.)	0.025—0.102 mm (0.0012—0.0040 in.)
Wear Limit	0.152 mm (0.0060 in.)	0.152 mm (0.0060 in.)

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• Rod and Crankshaft Assembled in Engine

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

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

1. Remove rod cap. Place a piece of PLASTIGAGE in center of bearing. Tighten cap screws to:

—75 N·m (55 lb-ft) on 3179, 4239, and 6359 Engines

—130 N·m (95 lb-ft) on 4276 and 6414 Engines

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

S11,2010,GU -19-22SEP95

INSPECT ROD AND CAP

1. Inspect rod and cap for wear or damage, such as chips or cracks in the joint area.

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

S11,2010,GV -19-29JUN95

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

IMPORTANT: NEVER USE NEW connecting rod cap screws when checking rod bore ID. Use new cap screws only for final engine assembly.

4. Install cap WITHOUT bearing inserts.

5. Tighten cap screws to:

—75 N·m (55 lb-ft) on 3179, 4239, and 6359 Engines

—130 N·m (95 lb-ft) on 4276 and 6414 Engines

S11,2010,GW -19-08MAY89

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 degrees left of measurement step “A”.

C. At 45 degrees right of measurement step “A”.

ROD BORE SPECIFICATIONS (WITHOUT BEARING INSERTS)

	3179/4239/6359	4276/6414
Rod Bore ID	73.660—73.686 mm (2.9000—2.9010 in.)	82.677—82.703 mm (3.2550—3.2560 in.)

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

T81599 -UN-07NOV88

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S11,2010,GX -19-22SEP95

INSPECT PISTON PINS AND BUSHINGS

1. Inspect piston pin for general overall condition. Replace pin if it shows signs of fretting.

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

2. Measure pin OD. Replace if not within specifications.

PISTON PIN SPECIFICATIONS

Small Pin OD . . . . 34.920—34.930 mm (1.3748—1.3752 in.)

Wear Limit . . . . 34.907 mm (1.3743 in.)

Large Pin OD . . . . 41.270—41.280 mm (1.6248—1.6252 in.)

Wear Limit . . . . 41.257 mm (1.6243 in.)

Pin Length . . . . 84.05—84.45 mm (3.309—3.325 in.)

T81604 -UN-07NOV88

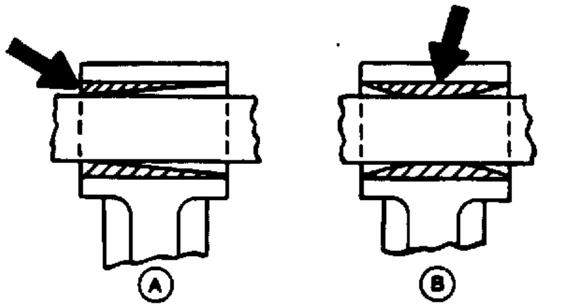
S11,2010,GY -19-22SEP95

3. Inspect piston pin bushing for damage or excessive wear. Lubrication hole must be open.

4. Compare pin bushing ID with pin OD for specified oil clearance.

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

T81605 -UN-07NOV88



RG5595 -UN-01NOV89

PISTON PIN BUSHING ID SPECIFICATIONS

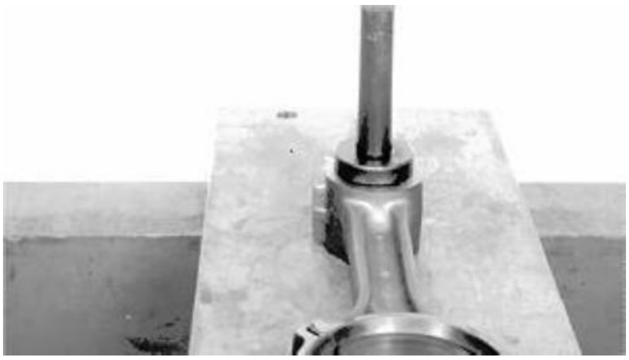
ID of New Piston Pin Bushing (Installed):

Small Pin	34.950—34.976 mm (1.3760—1.3770 in.)
Wear Limit	35.026 mm (1.3790 in.)
Large Pin	41.300—41.326 mm (1.6260—1.6270 in.)
Wear Limit	41.376 mm (1.6290 in.)
Pin-to-Bushing Clearance	0.020—0.056 mm (0.0007—0.0022 in.)
Wear Limit	0.102 mm (0.0040 in.)

S11,2010,GZ -19-22SEP95

REMOVE PISTON PIN BUSHING

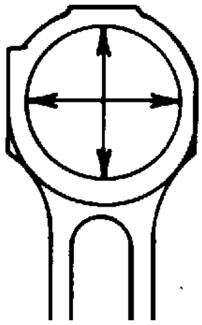
Push bushing out of connecting rod using JD286 Driver (for large pin) or JDE88 Driver (for small pin).



T88802 -UN-07NOV88

S11,2010,HA -19-29JUN95

CLEAN AND INSPECT CONNECTING ROD PIN BORE



RG6273 -UN-03AUG92

1. Clean bore of rod with medium grit emery cloth.

2. Inspect for cracks or other damage. Make sure that lube oil hole in top of rod is open.

3. Measure bore diameter in two places, 90° apart. Replace rod if not within specification.

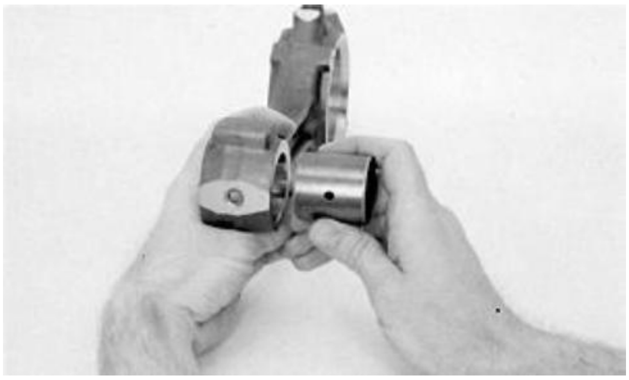
IMPORTANT: If bushing has spun in rod, replace rod.

CONNECTING ROD PIN BORE SPECIFICATION
(With Bushing Removed)

Small Pin	38.087—38.113 mm (1.4995—1.5005 in.)
Large Pin	46.025—46.051 mm (1.8120—1.8130 in.)

S11,2010,HB -19-22SEP95

INSTALL PISTON PIN BUSHING IN CONNECTING ROD



T81608 -UN-01NOV88

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IMPORTANT: Make sure that lubrication oil hole in bushing is aligned with bore in connecting rod.

1. Press a new bushing into rod using JD286 Driver (large pin) or JDE88 Driver (small pin).

2. If necessary, bore bushing to obtain a clearance with piston pin of 0.020—0.056 mm (0.0007—0.0022 in.).

S11,2010,HC -19-22SEP95

INSPECT AND CLEAN CYLINDER BLOCK

1. Remove all components (including piston cooling orifices, soft plugs and oil gallery plugs) before inspecting and cleaning cylinder block.

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

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

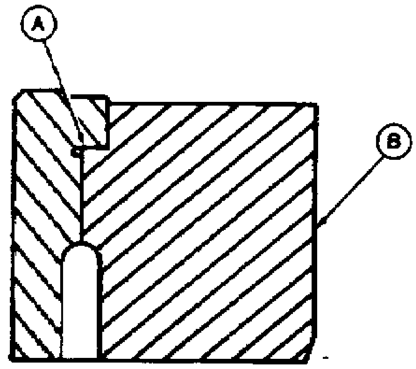
3. All passages and crevices must be clear of sludge, and grease.

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

S11,2010,HD -19-29JUN95

5. 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.

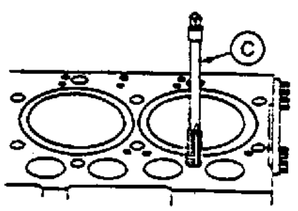
NOTE: DO NOT file liner support flange excessively. Excess filing can damage liner support flange and allow an improper liner fit. Thoroughly clean all filings from cylinder block (B).



RG3329 -UN-13DEC88

6. 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 block if there is evidence of physical damage.

7. If cylinder block is serviceable, clean cylinder head cap screw threads in block using JDG680 Tap (C) or equivalent 1/2-13 UNC-2A x 76 mm (3.00 in.) long tap. Remove debris or fluid from tapped holes with compressed air.



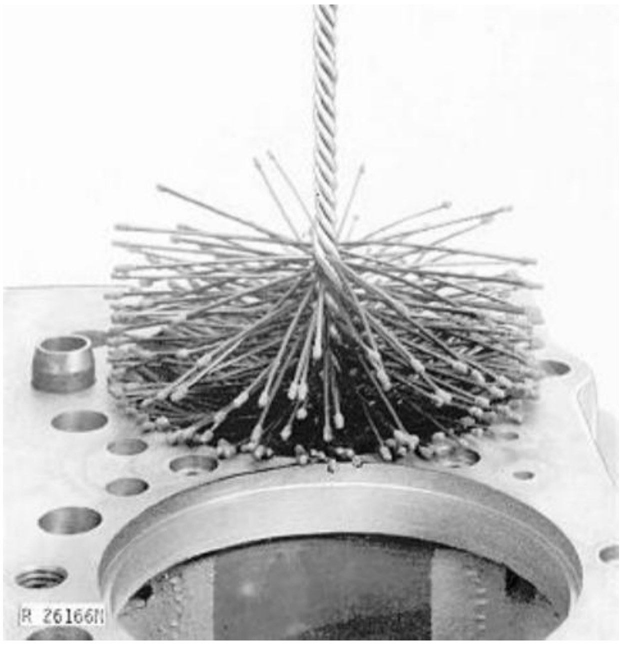
RG4725 -UN-13DEC88

S11,2010,IR -19-22SEP95

CLEAN CYLINDER LINER O-RING BORE

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

NOTE: Use brush exactly as directed by the manufacturer.



R26166 -UN-13DEC88

RG,CTM8,GR10,63-19-29SEP94

MEASURE CYLINDER BLOCK MAIN BEARING BORE

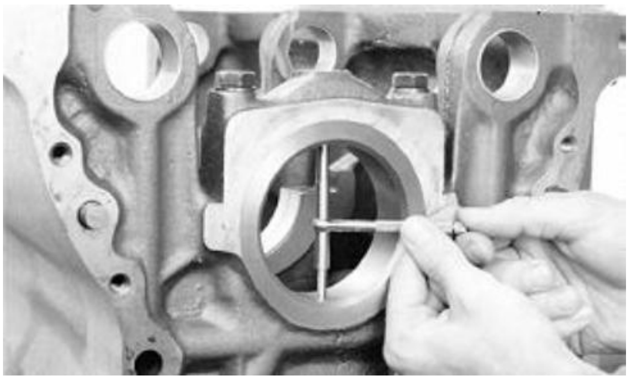
Measure main bearing bore diameter and cylinder block main thrust bearing width.

CYLINDER BLOCK MAIN BEARING SPECIFICATIONS

Main Bearing Bore Diameter	84.455—84.480 mm (3.3249—3.3259 in.)
Main Thrust Bearing Width	33.62—33.72 mm (1.324—1.328 in.)

If bearing caps are damaged, or bore is not within specification, replace caps and line bore to specifications.

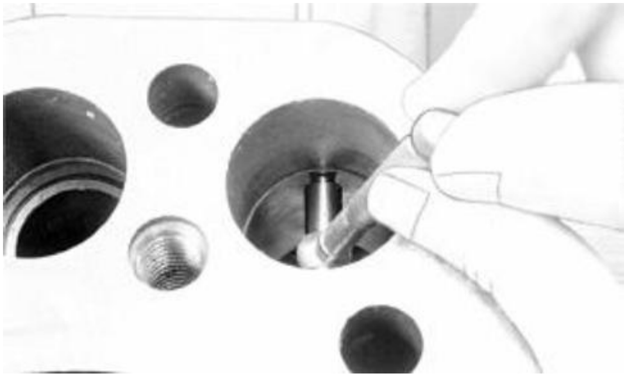
NOTE: Replacement bearing caps are supplied with bearing bore unfinished. (See MEASURE ASSEMBLED ID OF BEARING CAPS in Group 15.)



T81655 -UN-01NOV88

S11,2010,HE -19-01NOV95

MEASURE CAMSHAFT FOLLOWER BORE



T81656 -UN-01NOV88

Measure camshaft follower bore diameter.

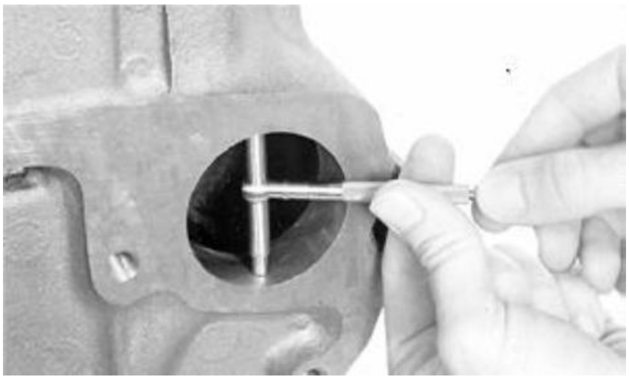
CAMSHAFT FOLLOWER BORE SPECIFICATIONS

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

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

RG,CTM8,GR10,51-19-29JUN95

MEASURE CAMSHAFT BEARING BORE



T81657 -UN-01NOV88

Measure camshaft bore diameter.

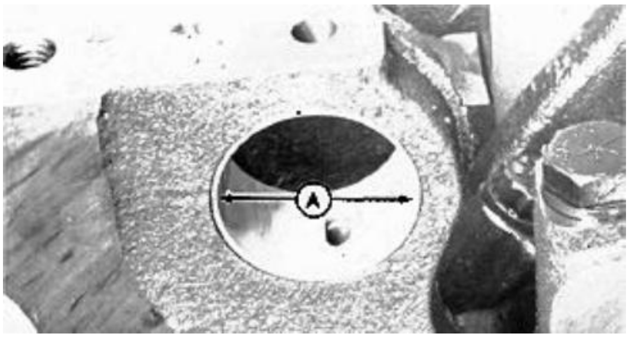
CAMSHAFT BEARING BORE SPECIFICATIONS

Camshaft Bore Diameter (new)	55.986—56.012 mm (2.2042—2.2052 in.)
Camshaft Journal Clearance (new) (Camshaft Bore ID Minus Camshaft Journal OD)	0.08—0.13 mm (0.003—0.005 in.)
Maximum Clearance	0.15 mm (0.006 in.)

If bearing bore diameter is more than specified, install a new cylinder block.

S11,2010,HG -19-01NOV95

MEASURE BALANCER SHAFT BORE—4-CYLINDER ENGINES



T88841 -UN-09NOV88

Both Dubuque and Saran-built 4-cylinder engines are available with or without balancer shafts from the factory. Cylinder blocks for engines ordered without balancer shafts are machined as follows:

—Dubuque built 4-cylinder engines without balancer shafts will have the balancer shaft bores and oil feed passages machined in the block. The bushings (A), however, will be installed so the oil holes do not align with oil feed passages to block off oil flow.

—Saran-built 4-cylinder engines without balancer shafts will not have the balancer shaft bushing bores nor oil feed passages machined in the cylinder block.

1. Measure balancer shaft bushing bore diameters in cylinder block (4-cylinder engines only). New bore diameter is 41.262—41.288 mm (1.6245—1.6255 in.).

If diameter is more than specified, install a new cylinder block, except for 4239 Engines with one-piece balancer shafts, which has oversize balancer shaft bushings available. (See INSTALL OVERSIZE BALANCER SHAFT BUSHINGS in Group 16.)

IMPORTANT: The use of oversize balancer shaft bushings on 4276 engines and 4239 engines with bolt-on weights are not recommended due to the rotating mass of bolt-on weights compared to thickness of balancer shaft web.

S11,2010,IS -19-01NOV95

MEASURE CYLINDER BLOCK TOP DECK FLATNESS


T81658 -UN-07NOV88

1. Measure cylinder block top deck flatness using D05012ST Precision Straightedge. If flatness is not as specified, resurface cylinder block.

CYLINDER BLOCK TOP DECK SPECIFICATIONS

Maximum Acceptable Out-of-Flat:
Entire Length or Width (used) . . . . 0.08 mm (0.003 in.)
Any 150 mm (5.90 in.) Length . . . . 0.025 mm (0.001 in.)

Top Deck Surface Finish:
Surface Grind Only (AA) . . . . 0.0008—0.0032 mm (31—125 micro-in.)
Maximum Wave Depth . . . . 0.012 mm (0.0005 in.)

Main Bearing Bore Centerline-to-Cylinder Block Top Deck Distance (minimum):
3179, 4239, 6359 Engines . . . . 301.98 mm (11.889 in.)
4276, 6414 Engines . . . . 337.87 mm (13.302 in.)

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

If cylinder block top deck is resurfaced, also measure depth of liner counterbores.

S11,2010,HH -19-09OCT95

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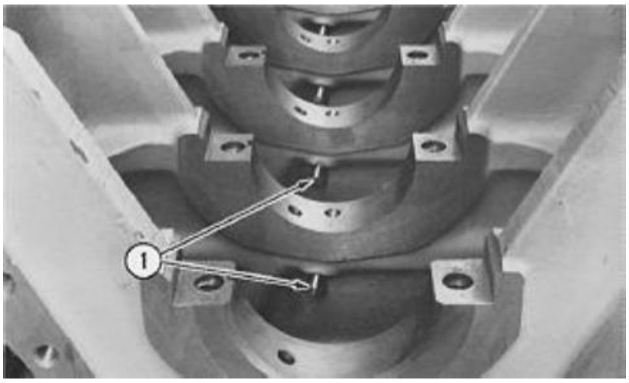
INSPECT PISTON COOLING ORIFICES

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

IMPORTANT: A piston cooling orifice failure could cause damage to piston, piston pin, pin bushing, and liner. If a piston cooling orifice is left out, low oil pressure will result.

2. Install and tighten orifices to 10.5 N·m (7.7 lb-ft) (93 lb-in.).



CD5782 -UN-23FEB89

RG,CTM4,DT439 -19-22SEP95

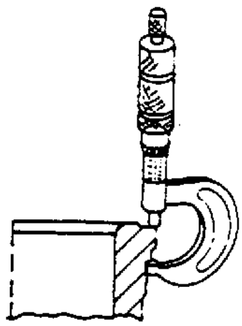
MEASURE LINER FLANGE THICKNESS AND BLOCK COUNTERBORE DEPTH

1. Measure cylinder liner flange thickness at several locations and compare to specifications listed below. If liner flange is not within specification, a shim may be installed under each liner flange. See RECHECK CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK) later in this group.

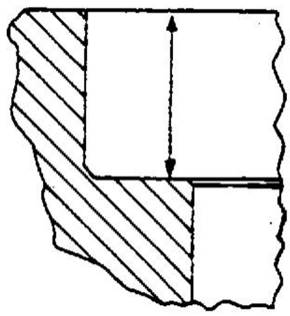
2. Measure cylinder block counterbore depth and compare to specifications listed below. If depth is not within specification, install a new block.

SPECIFICATIONS

Flange Thickness	6.022—6.058 mm (0.2371—0.2385 in.)
Cylinder Block Counterbore Depth	5.95—5.99 mm (0.234—0.236 in.)



RG4727 -UN-13DEC88

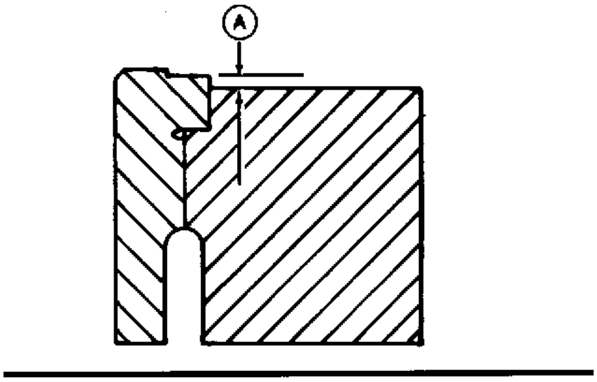


RG4726 -UN-13DEC88

RG,CTM4,DW799 -19-09OCT95

RECHECK CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

CD6371 -UN-23FEB89



RG6439 -UN-22SEP92

1. Entire liner bore in cylinder block must be clean.

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

NOTE: On Saran Engines, Serial No. (CD707730—), new cylinder liner OD was increased by 0.02 mm (0.0008 in.) and block pilot bore ID was reduced slightly. The maximum clearance is now 0.075 mm (0.003 in.), whereas before it was 0.10 mm (0.004 in.).

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

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

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

LINER HEIGHT SPECIFICATIONS

Liner Height Above Block	0.010—0.100 mm (0.0004—0.0039 in.)
Maximum Permissible Height Difference at Nearest Point of Two Adjacent Liners, or Within a Single Liner	0.05 mm (0.002 in.)

S11,2010,HJ -19-22SEP95

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

IMPORTANT: ONLY ONE SHIM MAY BE INSTALLED UNDER EACH LINER FLANGE. If liner requires more than one shim, install a new liner or cylinder block.

NOTE: Before installing shims, inspect block for possible internal cracking causing low liner. See INSPECT AND CLEAN CYLINDER BLOCK earlier in this group.

If liner height is below specification, install one liner shim on bottom of liner flange. Two sizes of shims are available:

—0.05 mm (0.002 in.) - Part No. CD15466

—0.10 mm (0.004 in.) - Part No. R65833

RG,CTM4,DT456 -19-22SEP95

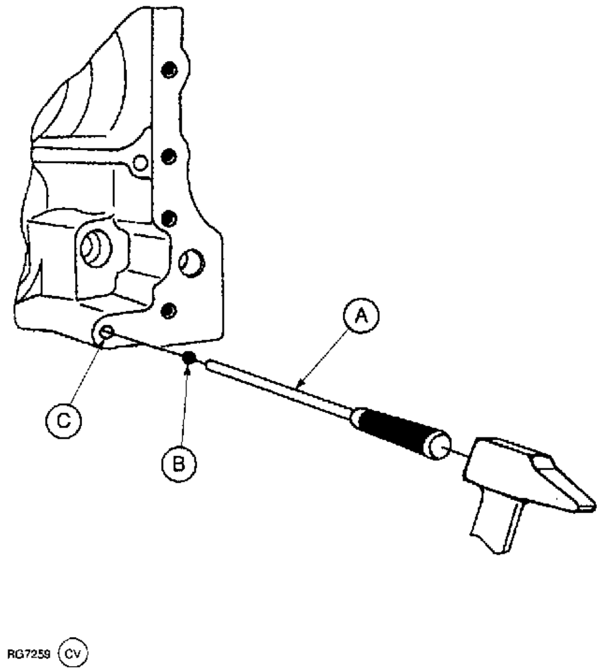
INSTALL STEEL BALL IN OIL PASSAGE OF SERVICE CYLINDER BLOCK

NOTE: On Saran-built 3- and 6-cylinder engines, when using a service cylinder block, install a steel ball (provided with cylinder block) in oil passage to prevent engine seizure. On Dubuque-built engines, the steel ball is already installed in block.

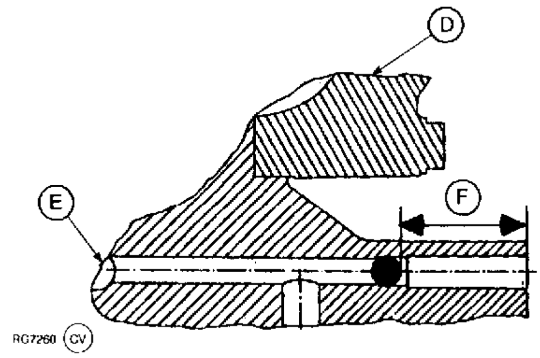
1. Install steel ball (B) in oil passage (C).

2. Using a driver (A), push steel ball into the main oil gallery (E). The distance between oil pan rail and top of ball is approximately 54 mm (2.16 in.) (F).

A—Driver
B—Steel Ball
C—Oil Passage
D—Main Bearing Cap
E—Main Oil Gallery
F—54.0 mm (2.16 in.)



RG7259 -UN-20JUL95



RG7260 -UN-20JUL95

RG,CTM4,DW719 -19-22SEP95

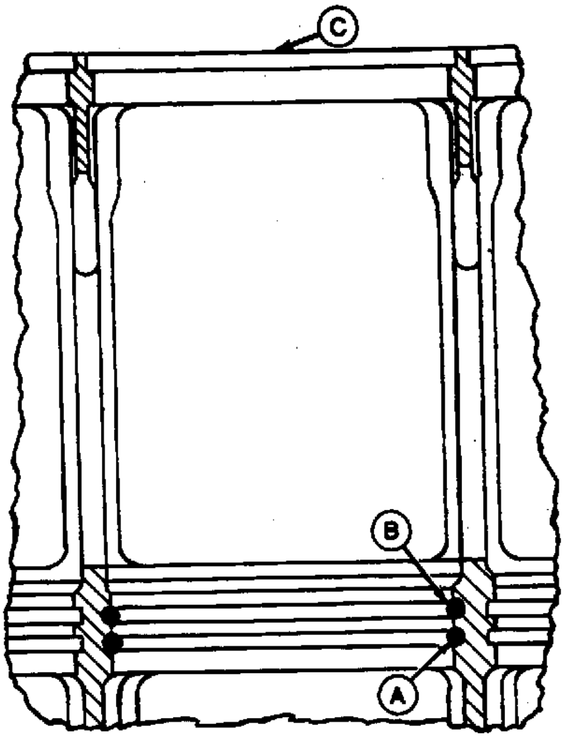
INSTALL CYLINDER LINER O-RINGS AND PACKINGS

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

1. Dip O-rings in AR54749 Soap Lubricant.

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

3. Install the red (or white) O-ring (B) in the upper O-ring groove in the cylinder block.



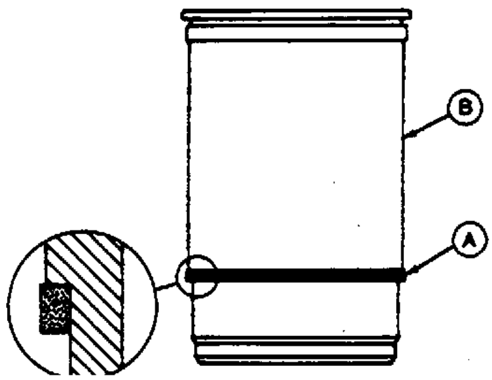
RG3826 -UN-13DEC88

S11,2010,HK -19-29JUN95

4. Turn cylinder liner (B) upside-down. Dip square packing (A) in soap and install over outside of liner.

5. Slide packing down firmly against shoulder on liner. Make sure packing is not twisted.

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



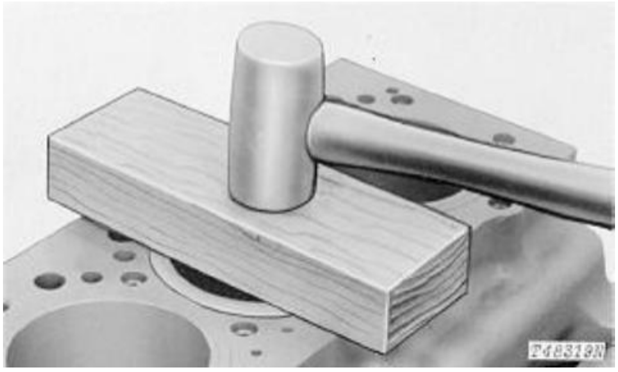
RG4752 -UN-13DEC88

S11,2010,HL -19-16SEP92

INSTALL CYLINDER LINER

IMPORTANT: Do not scuff the liner packing across the upper counterbore.

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



T48319 -UN-23FEB89

CD6373 -UN-23FEB89

1. Install liner 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. Seat liners with wood block and hammer. KCD10001 Puller may also be used to seat liners.

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

IMPORTANT: If you suspect a packing may have sheared or displaced during liner installation, remove and examine the liner and packing assembly. If no damage is found, check packings for proper position, resoap packings, and reinstall liner assembly.

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

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

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

RG,CTM8,GR10,53-19-06OCT94

ASSEMBLE PISTON AND CONNECTING ROD

IMPORTANT: If a new piston and liner assembly is to be installed, DO NOT remove piston from liner. Push piston out of liner bottom only far enough to install piston pin.

1. Lubricate piston pin and bushing with clean engine oil.

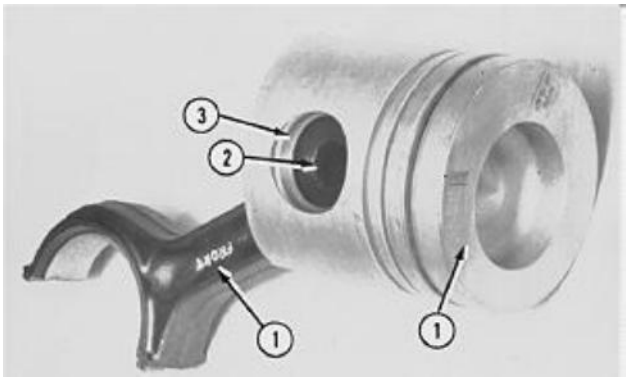
RG,CTM8,GR10,54-19-16SEP92

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

2. Assemble pistons and connecting rods, making sure the word “FRONT” (1) or arrow on top of the piston and side of connecting rod are on same side.

IMPORTANT: If “FRONT” or arrow is not visible on top of piston, install piston on rod so that offset in combustion bowl of piston is opposite camshaft side of engine.

3. Insert piston pin into piston pin bore (2). Install NEW piston pin retaining rings (3) with sharp edge of ring facing away from piston pin. Make sure retaining rings are seated in grooves of piston pin bore.



T79442 -UN-25OCT88

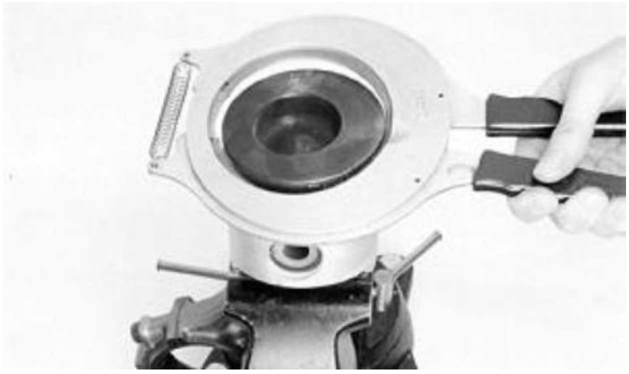
S11,2010,GT -19-22SEP95

INSTALL PISTON RINGS

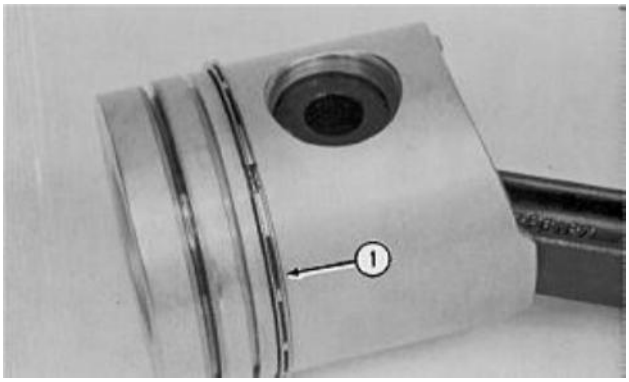
1. When installing new piston rings, use JDE85 or JDE135 (or KJD10140) Piston Ring Expander. Install oil ring expander in bottom ring groove. Position end gap toward either end of piston pin.

2. Install oil control ring (1) in bottom ring groove over ring expander. Install with end gap on opposite side of piston from ring expander gap.

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



T81600 -UN-07NOV88



T79443 -UN-09DEC88

S11,2010,HO -19-22SEP95

NOTE: On later production piston rings, a dye stain has been added to top side of rectangular and keystone compression ring for added identification. Some piston rings are marked with a yellow dye mark on their outside diameter. To determine the top of these rings, the dye mark must be on the left side of the ring gap when the gap is facing you.

3. Rectangular compression ring is marked (1) to identify top side of ring. Install rectangular compression ring in center ring groove with mark toward top of piston.

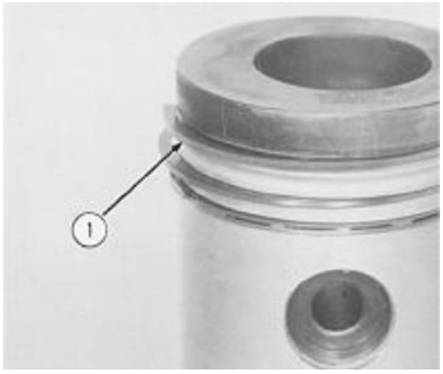
4. Position gap in rectangular compression ring on opposite side of piston from oil control ring gap.

T79444 -UN-09DEC88

S11,2010,HP -19-22SEP95

5. Keystone compression ring has a mark (1) to identify top side of ring. Install keystone compression ring in top ring groove with mark toward top of piston.

6. Position gap in Keystone compression ring on opposite side of piston from rectangular compression ring gap.



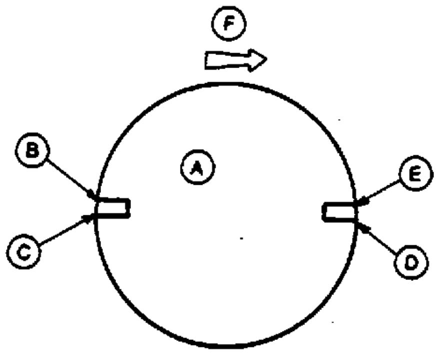
T79445 -UN-25OCT88

S11,2010,HQ -19-29JUN95

7. Stagger ring gaps on pistons as shown.

8. Coat pistons, liners and inside of JDE84 Ring Compressor with clean engine oil.

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



CD5781 -UN-23FEB89

S11,2010,HR -19-29JUN95

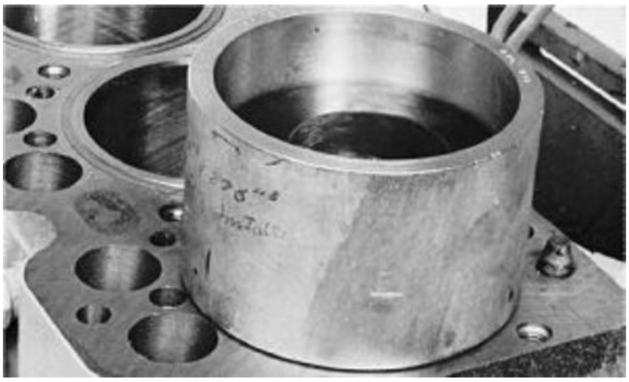
INSTALL PISTON AND CONNECTING ROD ASSEMBLY

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

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

NOTE: Be sure the word "front" on side of rod and the arrow on top of piston faces toward the front of the engine. If arrows are not visible on top of pistons, offset in combustion bowl must be opposite camshaft side of engine when installed. The long side of the connecting rod should face camshaft side of engine.

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

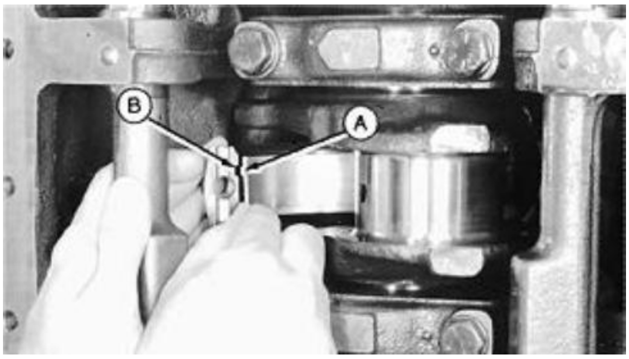


T79446 -UN-09DEC88

S11,2010,HS -19-29JUN95

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

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



T88805 -UN-07NOV88

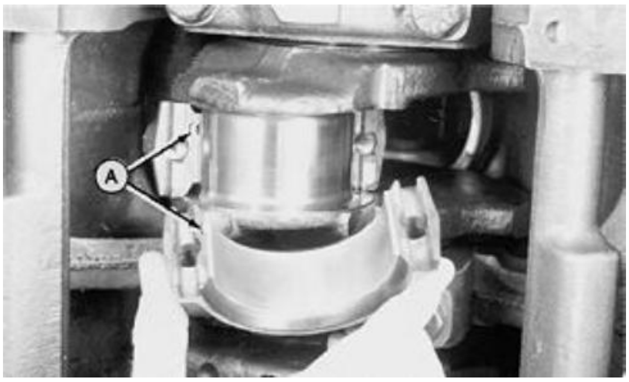
K01,0403,46 -19-29JUN95

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

T88806 -UN-07NOV88

K01,0403,47 -19-29JUN95

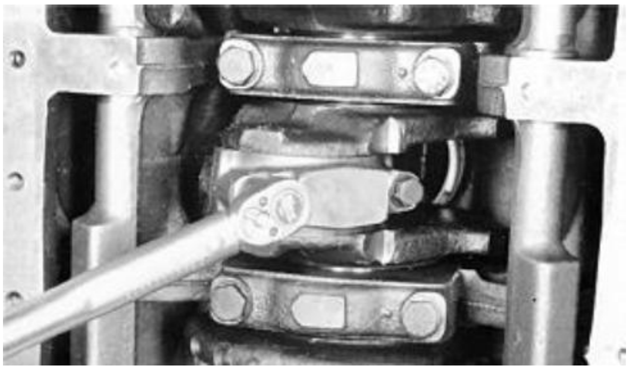
6. Apply clean engine oil to bearing insert. Install cap on connecting rod with tangs (A) to same side.



T88807 -UN-06DEC88

K01,0403,48 -19-29JUN95

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



T81615 -UN-07NOV88

On 3179, 4239, and 6359 Engines, two rod cap screws are available for service. They are not interchangeable:

—Connecting rod cap equipped with two protruding spot facings, use R80033 cap screws.

—Connecting rod cap equipped with two embedded spot facings, use R74194 (phosphate coated) cap screws.

7. Dip NEW connecting rod cap screws in clean oil and install. Tighten cap screws alternately to following torques:

- 3179, 4239, and 6359 Engines:
  - —R74194, length- 54 mm (2.13 in.)— 75 N·m (55 lb-ft)
  - —R80033, length- 59 mm (2.32 in.)— 75 N·m (55 lb-ft)
- 4276, 6414 Engines:
  - —R74195, length- 63.5 mm (2.5 in.)— 130 N·m (95 lb-ft)

S11,2010,HU -19-29JUN95

CHECK ENGINE ROTATION FOR EXCESSIVE TIGHTNESS

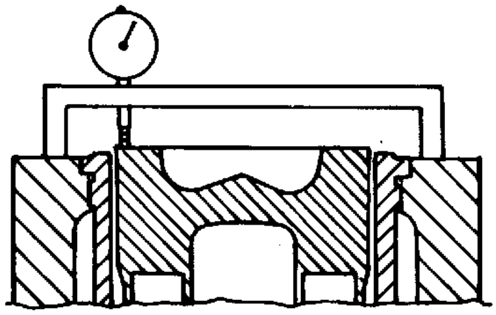
1. Rotate crankshaft several revolutions to be sure engine rotates without excessive tightness.

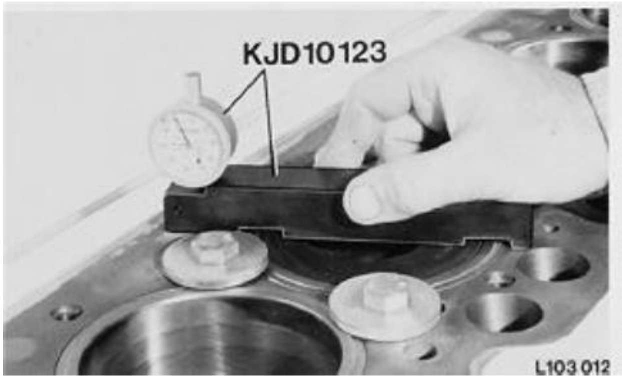
2. Check liners for deep scratches caused by an improperly installed or broken piston ring.

3. Check side clearance of rods. Must have slight side-to-side movement.

S11,0402,BK -19-16JUN95

MEASURE PISTON PROTRUSION


RG6440 -UN-22SEP92



L103012 -UN-15NOV88

1. Press down on top of piston to remove oil clearances before measuring piston protrusion.

2. Use JDG451 or KJD10123 Gauge (or use a magnetic base dial indicator) to measure piston protrusion. Place gauge on top of cylinder block so dial indicator can be set to “zero” with top of block.

3. Position gauge across piston. While pressing gauge downward, rotate crankshaft until piston is at TDC. Measure piston height at several positions around the piston. If using JDG451 Gauge, piston height must be checked at outer most diameter of piston.

4. Piston protrusion must not exceed the following specification to prevent piston-to-exhaust valve contact.

PISTON PROTRUSION SPECIFICATIONS

Maximum Piston Protrusion
(above block deck) . . . . 0.33 mm (0.013 in.)

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

RG,CTM4,DW645 -19-22SEP95

COMPLETE FINAL ASSEMBLY

1. Install oil pump outlet tube O-ring in cylinder block. Install oil pump and outlet tube. (See Group 20.)

2. Install oil pan. (See Group 20.)

3. Install cam followers. (See Group 16.)

4. Install cylinder head with new gasket. (See Group 05.)

5. Fill engine with clean oil and proper coolant.

6. Perform engine break-in. (See Group 05.)

S11,2010,HV -19-05MAR90

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

Dial Indicator . . . . (English, in.) D17526CI
or (Metric, mm) D17527CI

Use with JDG451 to measure vibration damper and flywheel housing face runout, crankshaft end play, and flywheel face flatness.

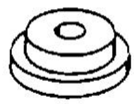
RG6246 -UN-27MAR92

RG,D17526CI,1 -19-22JUL95

RG5066 -UN-23AUG88

Seal Driver JD250

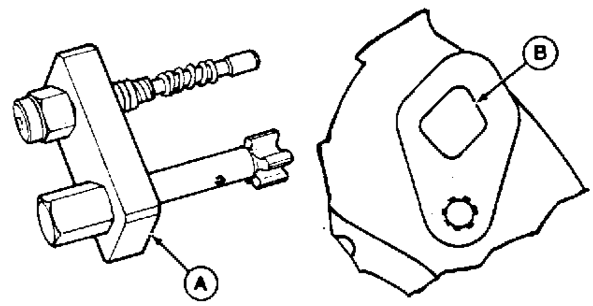
Install front oil seal in timing gear cover. Use with JDG537 Driver Handle.



JD250 -19-03APR90

Flywheel Turning Tool (A) JD281A

Used on engines with 142 tooth flywheel ring gear and a diamond shaped tool guide bore (B) in flywheel housing. Tool has it's own spring loaded timing pin which threads into flywheel housing.



RG6252 -UN-22JUL92

RG,JD281A -19-17JUL92

RG5068 -UN-23AUG88

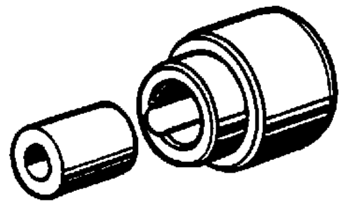
Timing Pin JDE81-4

Lock engine at TDC when installing injection pump or timing valve train. Use with JDG820, JDE81-1, or JDE83 Flywheel Turning Tool.

RG,JDE814 -19-03JAN95

Front Crankshaft Oil Seal Installer KJD10164

Install front crankshaft oil seal with timing gear cover installed on the engine. MUST BE used on composite material timing gear covers.

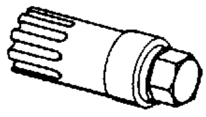


RG6304 -UN-03AUG92

RG,KJD10164 -19-27AUG92

Flywheel Turning Tool JDE83

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



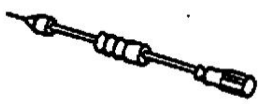
RG6251 -UN-22JUL92

RG,JDE83 -19-17JUL92

RG5109 -UN-23AUG88

Seal Remover JDG22

Remove crankshaft rear oil seal without removing flywheel housing.

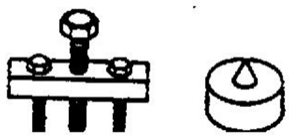


JDG22 -19-27DEC94

RG5112 -UN-06APR89

Vibration Damper Puller Set JDG410

Remove vibration damper and pulley.

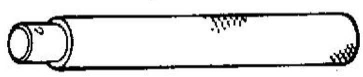


JDG410 -19-09APR92

RG5560 -UN-01NOV89

Driver Handle . . . . JDG537 (OTC No. 815)

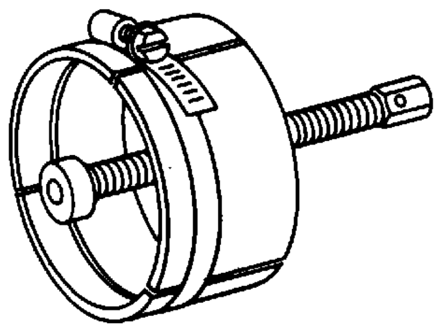
Install front crankshaft oil seal in timing gear cover. Use with JD250 Driver.



JDG537 -19-03APR90

Rear Wear Sleeve Puller JDG645

Remove wear sleeve from rear crankshaft flange.



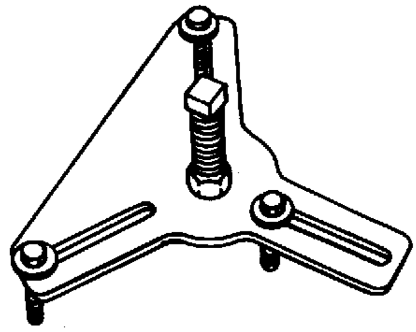
RG5561 -UN-01NOV89

JDG645 -19-29SEP94

Seal and Wear Sleeve Remover JDG698

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

This tool will also remove the non-unitized (two-piece) oil seal. However, JDG645 Rear Crankshaft Wear Sleeve Puller must be used to remove wear sleeve.



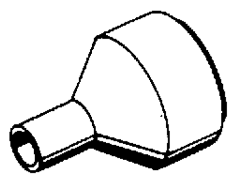
RG5631 -UN-12APR90

JDG698 -19-06OCT94

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



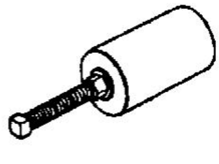
RG6214 -UN-06MAR92

RG,JDG719 -19-29OCT92

Crankshaft Gear Installer JDG794

Used to install crankshaft gear either prior to, or after, installing crankshaft into engine.

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

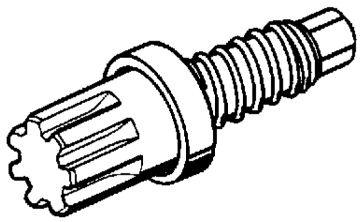


RG7030 -UN-30SEP94

RG,JDG794 -19-27DEC94

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.



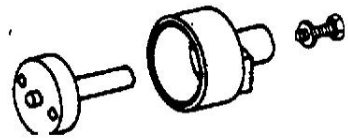
RG7056 -UN-10AUG94

RG,CTM8,DW570 -19-22SEP95

RG5110 -UN-23AUG88

Rear Seal and Wear Sleeve Installer Set JT30040

Install crankshaft rear oil seal and wear sleeve assembly.



JT30040 -19-29SEP94

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
D01047AA 17-1/2 and 30-Ton Puller Set	Remove crankshaft gear from crankshaft.
JT05993 Torque Angle Gauge	Tighten flywheel flanged-head cap screws.

RG,CTM4,DY113 -19-22SEP95

CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Maximum Vibration Damper Radial Run-Out		1.50 mm (0.060 in.)
Maximum Vibration Damper Wobble (outer ring)		1.50 mm (0.060 in.)
Maximum Vibration Damper Wobble (inner ring machine with front PTO only)		0.5 mm (0.02 in.)
Crankshaft End Play (thrust bearing clearance):		
Engine With Two-piece Thrust Bearing	0.05—0.25 mm (0.002—0.010 in.)	0.50 mm (0.020 in.)
Engine With Six-piece Thrust Bearing*:		
Saran Engine Serial No. (—560945CD)	0.025—0.430 mm (0.001—0.017 in.)	0.60 mm (0.024 in.)
Saran Engine Serial No. (560946CD—) and All Dubuque-Built	0.025—0.35 mm (0.001—0.014 in.)	0.50 mm (0.020 in.)
Main Bearing Journal OD (Std)	79.324—79.350 mm (3.1229—3.1240 in.)	——
Main Bearing Assembled ID (Std)	79.375—79.426 mm (3.1249—3.1270 in.)	——
Main Bearing-to-Journal Clearance	0.025—0.102 mm (0.0009—0.0040 in.)	——
Thrust Bearing Journal Width (Std)	38.952—39.028 mm (1.5335—1.5365 in.)	——
Thrust Bearing Overall Width (Std)	38.811—38.862 mm (1.5279—1.5299 in.)	——
Thrust Bearing Surface Width	33.62—33.72 mm (1.324—1.328 in.)	——
Thrust Bearing-to-Journal Oil (Side) Clearance	0.10—0.20 mm (0.004—0.008 in.)	0.38 mm (0.015 in.)
Maximum Main or Rod Journal Taper	0.010 mm (0.0004 in.)	——
Maximum Main or Rod Journal Out-of-Roundness	0.005 mm (0.0002 in.)	——
Undersized Bearing Available	0.25 and 0.51 mm (0.010 and 0.020 in.)	——
Oversize Thrust Washer Available	0.18 mm (0.007 in.)	——
Main Bearing Bore Specifications:		
ID Without Bearing Inserts	84.455—84.480 mm (3.3249—3.3259 in.)	——
Bore Centerline-to-top Deck of Block:		
3179, 4239, 6359 Engines	302.006—302.082 mm (11.8899—11.8929 in.)	301.981 mm (11.8889 in.)
4276, 6414 Engines	337.896—337.972 mm (13.3029—13.3059 in.)	337.871 mm (13.3019 in.)

*Service thrust bearing kits are now six-piece sets.

S11,2015,ED -19-01NOV95

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CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Rod Bearing Journal OD (Std.):		
3179, 4239, 6359 Engines	69.799—69.825 mm	——
	(2.7479—2.7490 in.)	——
4276, 6414 Engines	77.800—77.826 mm	——
	(3.0628—3.0640 in.)	——
Crankshaft Fillet Radii (for grinding purposes):		
Main and Thrust Journals (all engines)	3.7—4.0 mm (0.146—0.156 in.)	——
Rod Journals:		
3179, 4239, 6359 Engines	4.2—4.4 mm (0.165—0.175 in.)	——
4276, 6414 Engines	3.7—4.0 mm (0.146—0.156 in.)	
Crankshaft Grinding Surface Finish:*		
Main and Connecting Rod Journals	Lap 0.20 um (8 AA)	——
Thrust Journal	Lap 0.40 um (16 AA)	——
Crankshaft OD for Front Pulley	38.00—38.02 mm (1.496—1.497 in.)	——
Flywheel Housing Run-Out (ID)		0.152 mm (0.006 in.)
Flywheel Housing Face Run-Out:		
12 O'clock position		0.30 mm (0.012 in.)
3 and 9 O'clock positions		0.25 mm (0.010 in.)
Flywheel 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.)

** Grind clockwise (viewed from flywheel end); lap counterclockwise.*

RG,CTM4,DW647 -19-01NOV95

CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS—CONTINUED

CRANKSHAFT GRINDING SPECIFICATIONS

BEARING SIZE	CRANKSHAFT MAIN JOURNAL OD	CRANKSHAFT ROD JOURNAL OD 3179, 4239, 6359	CRANKSHAFT ROD JOURNAL OD 4276, 6414
Standard	79.34—79.36 mm (3.123—3.124 in.)	69.80—69.83 mm (2.748—2.749 in.)	77.80—77.83 mm (3.063—3.064 in.)
0.25 mm (0.010 in.) Undersize	79.07—79.09 mm (3.113—3.114 in.)	69.54—69.57 mm (2.738—2.739 in.)	77.55—77.57 mm (3.053—3.054 in.)
0.51 mm (0.020 in.) Undersize*	78.82—78.84 mm (3.103—3.104 in.)	69.29—69.32 mm (2.728—2.729 in.)	77.29—77.32 mm (3.043—3.044 in.)

** Not available for undercut and rolled fillets.*

RG,CTM4,DW817 -19-01NOV95

CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS—CONTINUED

TORQUES

Pulley/Damper-to-Crankshaft (without front PTO or auxiliary drive) . . . . 183 N·m (135 lb-ft)

Collet-to-Crankshaft (with front PTO or auxiliary drive) . . . . 150 N·m (110 lb-ft)

Pulley/Damper-to-Collet (with front PTO) . . . . 35 N·m (25 lb-ft)

Main Bearing Caps:
All Dubuque-Built Engines and Saran-Built Engines
Serial No. (—CD979057) . . . . 115 N·m (85 lb-ft)
Saran-Built Engines Serial No. (CD979058—) . . . . 135 N·m (100 lb-ft)

Flywheel-to-Crankshaft:
Hexagon-head cap screws . . . . 163 N·m (120 lb-ft)
R74444 Flanged-head cap screws . . . . 55 N·m (40 lb-ft)
Plus TORQUE-TURN an additional 1/6 turn (60°)

Flywheel Housing-to-Cylinder Block:
3/8 in. Cap Screws (all applications-8 used)
Initial . . . . 30 N·m (22 lb-ft)
Final . . . . 47 N·m (35 lb-ft)
5/8 in. Cap Screws (SAE 2, 3, 4 housings-4 used) . . . . 230 N·m (170 lb-ft)

6359TR001 Flywheel Housing-to-Cylinder Block:
3/4 x 2-1/2 in. (upper left) . . . . 450 N·m (330 lb-ft)
3/4 x 3-1/2 in. (upper right) . . . . 570 N·m (420 lb-ft)
5/8 x 2-1/4 in. (lower, 2 used) . . . . 325 N·m (240 lb-ft)

Piston Cooling Orifices . . . . 10.5 N·m (7.7 lb-ft) (93 lb-in.)

RG,CTM4,DW648 -19-22SEP95

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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 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:**

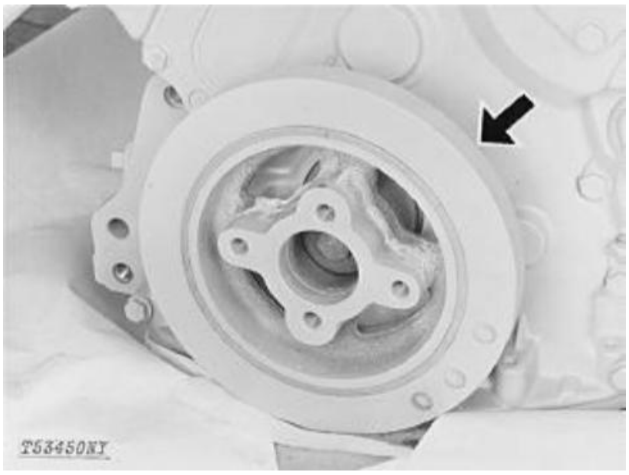
Improper installation.
Dirt between bearing and crankshaft journal.
Low oil pressure.
Oil pump failure.

• **Cracked, Chipped or Broken Bearings:**

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

S11,2015,C -19-29SEP94

INSPECT VIBRATION DAMPER (6-CYLINDER ENGINE)



T53450NY -UN-23FEB89

IMPORTANT: Do not immerse the vibration damper in cleaning solvent or any petroleum product. Rubber portion of damper may be damaged.

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

The damper assembly is not repairable. Replace damper every 5 years or 4500 hours, whichever occurs first.

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

S11,2015,EF -19-29SEP94

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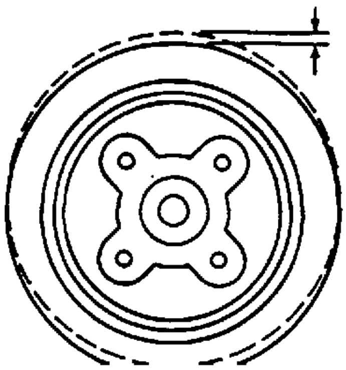


RG4779 -UN-14DEC88

2. Check vibration damper radial runout by positioning a dial indicator so probe contacts damper OD.

3. With engine at operating temperature, rotate crankshaft using engine rotation tool.

4. Note dial indicator reading. If runout exceeds specifications given below, replace vibration damper.

DAMPER RADIAL RUNOUT SPECIFICATION

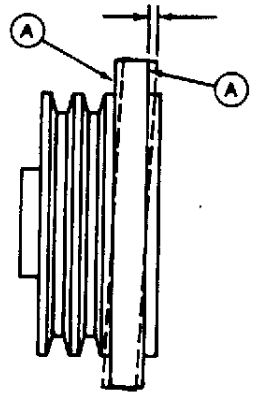
Maximum Damper Radial Runout . . . . 1.50 mm (0.060 in.)

S11,2015,EG -19-27DEC94

5. Check vibration damper wobble using a dial indicator.

Measure wobble at the outer edges of damper face (A).

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



RG5679 -UN-30MAY90

DAMPER PULLEY WOBBLE SPECIFICATION

Outer Ring (Maximum)	1.50 mm (0.060 in.)
Vibration Damper or Pulley: Maximum Wobble	0.5 mm (0.02 in.)

S11,2015,EH -19-22JUL95

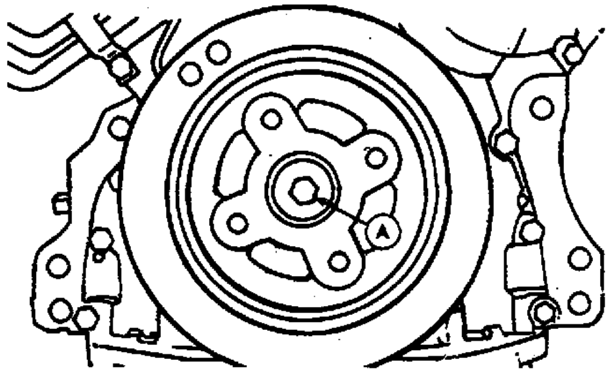
REMOVE PULLEY OR VIBRATION DAMPER PULLEY

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

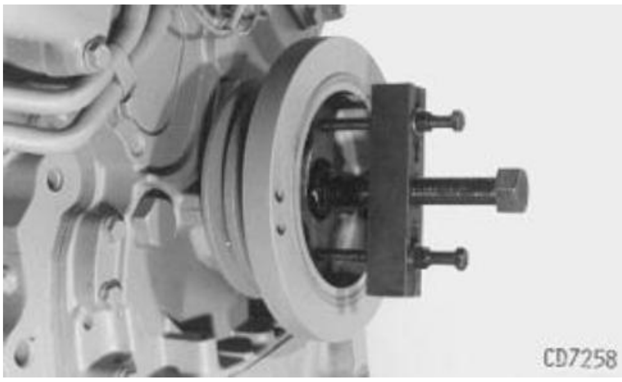
1. Remove pulley or damper pulley cap screw (A).

NOTE: The V-belt pulley used on engines without a vibration damper attaches to engine same as damper pulley shown.

2. Using JDG410 Puller or other suitable puller, remove damper pulley from crankshaft.



RG5113 -UN-14DEC88



CD7258 -UN-23MAY95

S11,2015,EI -19-22JUN95

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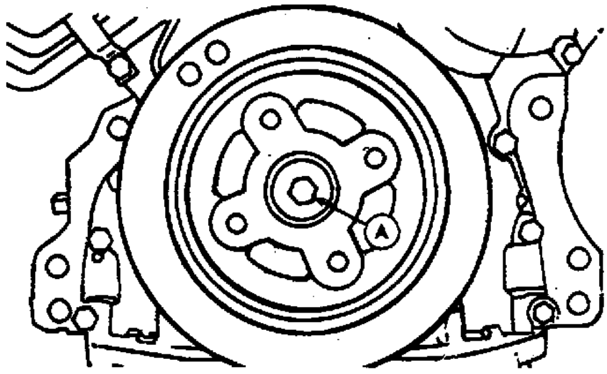
INSTALL PULLEY OR VIBRATION DAMPER PULLEY



RG5113 -UN-14DEC88

1. Position damper pulley on crankshaft. Handle vibration damper with care to avoid impact damage.

IMPORTANT: Damper pulley-to-crankshaft cap screw must be SAE Grade 8 or higher. If a lower grade cap screw was previously used on your engine, replace it with an appropriate SAE Grade 8 or higher cap screw and tighten to specified torque.

2. Apply LOCTITE 242 (TY9370) Thread Lock and Sealer to cap screw threads. Install cap screw and 12 mm (0.47 in.) thick washer (with flat side toward crankshaft), and tighten to 183 N·m (135 lb-ft).

NOTE: Some engines are equipped with a 10 mm (0.39 in.) thick washer, but cap screw torque remains 183 N·m (135 lb-ft).

S11,2015,EJ -19-22JUN95

CHECKING VIBRATION DAMPER OR PULLEY (ENGINE WITH FRONT PTO)

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

1. Prior to disassembly, check the following specifications:

SPECIFICATIONS

Vibration damper only:
Maximum radial run-out (A) . . . . 1.50 mm (0.060 in.)
Maximum wobble (B) . . . . 1.50 mm (0.060 in.)

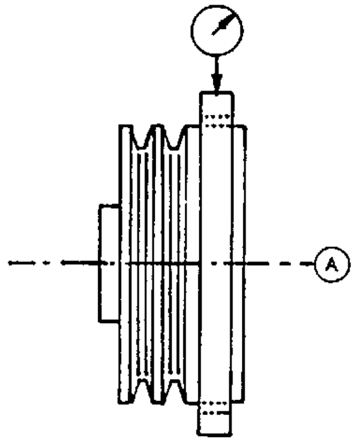
Vibration damper pulley:
Maximum wobble (C) . . . . 0.5 mm (0.02 in.)

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

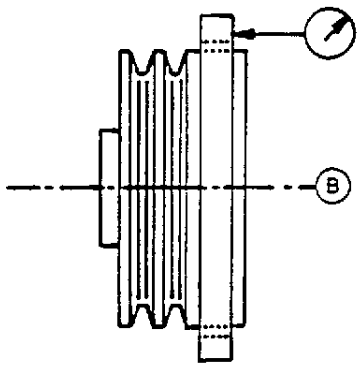
3. Grasp damper and attempt to turn in both directions (clockwise and counterclockwise). If rotation is felt, replace damper.

4. If wobble (C) exceeds specifications, it indicates improper mating of tapered surfaces due to uneven tightening of collet cap screws or damage to one or both the tapered surfaces.

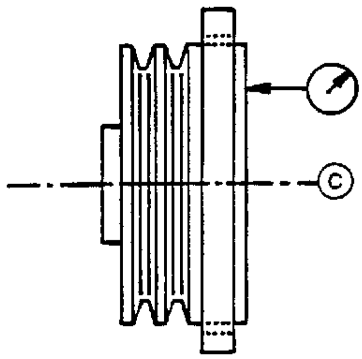
IMPORTANT: Replace damper after 4500 hours or every five years, whichever occurs first.



RG7123 -UN-06OCT94



RG7124 -UN-06OCT94



RG7125 -UN-06OCT94

RG,CTM8,DX160 -19-25SEP95

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REMOVING VIBRATION DAMPER OR PULLEY (ENGINE WITH FRONT PTO)

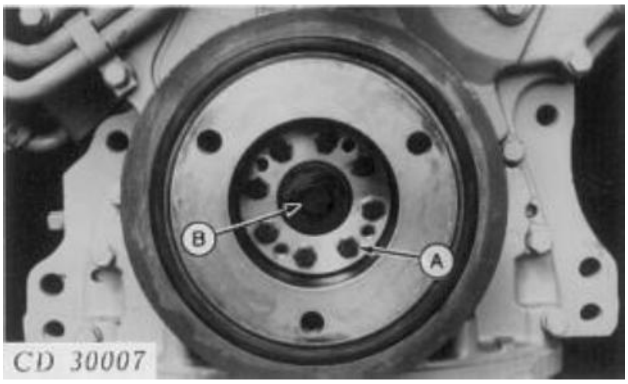
1. Remove cap screws (A) attaching damper or pulley to collet.

2. Using a wooden block and a hammer, tap on inner damper ring or pulley until it loosens from conical seat of collet.

IMPORTANT: Never tap or apply thrust to outer ring of damper.

3. Remove collet attaching cap screw (B).

4. Remove collet and damper or pulley.



CD30007 -UN-05OCT94

CD30008 -UN-05OCT94

RG,CTM8,DX344 -19-08FEB95

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INSTALL VIBRATION DAMPER OR PULLEY (ENGINE WITH FRONT PTO)

1. Lightly oil tapered surfaces of collet and damper.

NOTE: When replacing damper, always use new cap screws.

2. Position collet in damper or pulley. Install new cap screws (A) 180° apart to keep collet with damper or pulley.

NOTE: Apply LOCTITE 609 (TY15969) Retaining Compound to screw threads to eliminate oil leakage.

3. Install collet-damper assembly on crankshaft with washer and cap screw (B).

4. **On 3179 Engines only,** put cylinder No. 1 at 'TDC' and rotate pulley-collet assembly so that external groove mark (C) on pulley aligns with the timing gear cover 'TDC' reference mark (D).

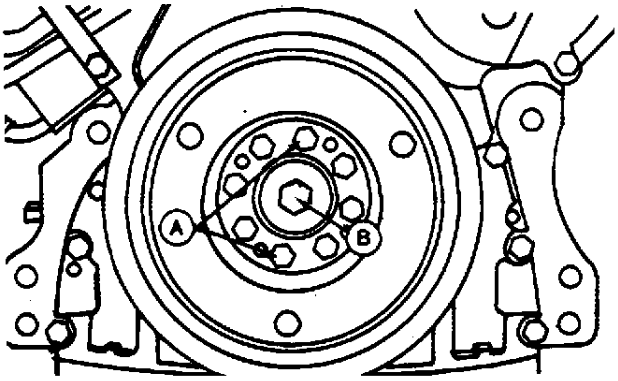
5. Tighten collet-to-crankshaft cap screw to 150 N·m (110 lb-ft).

6. Alternately and evenly tighten the two collet cap screws to a final torque of 35 N·m (25 lb-ft).

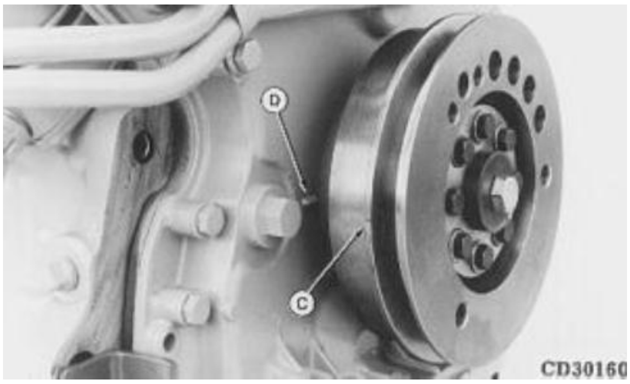
7. Install the remaining new six collet cap screws. Again alternately and evenly tighten two cap screws 90° from the first two cap screws to 35 N·m (25 lb-ft). Tighten the remaining cap screws to 35 N·m (25 lb-ft). Always tighten collet cap screws in pairs opposite each other.

8. Repeat the collet cap screw tightening sequence until all the cap screws have been tightened to the specified torque of 35 N·m (25 lb-ft).

9. Check damper/pulley wobble to ensure that tapered surfaces are mated correctly.



RG5116 -UN-14DEC88



CD30160 -UN-05OCT94

A—Cap Screws
B—Collet Retaining Cap Screw with Washer
C—External Groove Mark on Pulley
D—(TDC) Reference Mark on Timing Gear Cover

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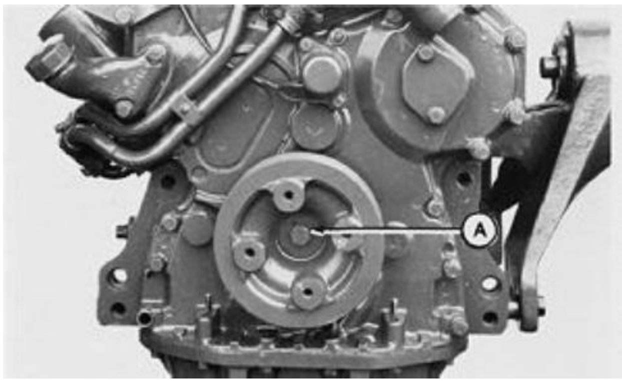
S11,2015,EL -19-22SEP95

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



CD7373 -UN-23FEB89

NOTE: If timing gear cover is to be removed, remove seal after cover is removed.

• **To Remove Front Oil Seal:**

1. Remove V-belts.

NOTE: DO NOT use a jaw-type puller to remove vibration damper. Damage could result to the damper.

2. Remove cap screw (A) and washer. Remove vibration damper/pulley or pulley from crankshaft using JDG410 Puller or equivalent puller, as previously instructed in this group.

3. Remove Woodruff key from key slot of crankshaft.

4. Center punch seal casing at 12 O'clock position and drill 1/8 in. hole in casing.

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

NOTE: The shoulder on pulley serves as a wear ring on crankshaft gear-driven auxiliary drive engines.

6. On non-auxiliary drive (crankshaft gear-driven) engines, remove wear ring from crankshaft flange. Remove O-ring from crankshaft after wear ring is removed.

IMPORTANT: If wear ring can not be removed with timing gear cover installed, remove timing gear cover and remove wear ring. Wear ring MUST BE replaced whenever oil seal is replaced.

7. Thoroughly clean crankshaft flange and seal housing bore to assure oil seal will seal properly after installation.

S11,2015,EM -19-22JUN95

• **To Install Front Oil Seal:**

IMPORTANT: Wear ring must be installed after the oil seal to avoid rolling seal lips.

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

IMPORTANT: To assure proper sealing, the OD of the crankshaft and ID of the wear ring MUST BE cleaned with trichloroethylene or equivalent and dry prior to installing seal.

NOTE: Timing gear cover shown removed in upper photo for illustration purposes only.

2. If an O-ring (A) is used, lightly lubricate a new O-ring with engine oil and install O-ring inboard, positioned next to oil deflector.

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

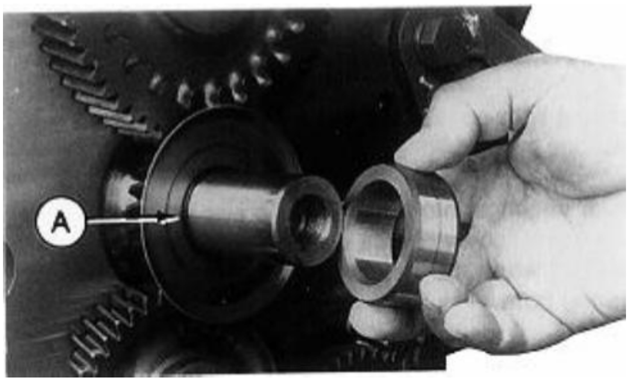
NOTE: KJD10164 Seal Driver Set contains a spacer (D) for use on engine equipped with short nose crankshafts.

4. Slide driver (B) on nose of crankshaft against seal. Install forcing screw with washer (C).

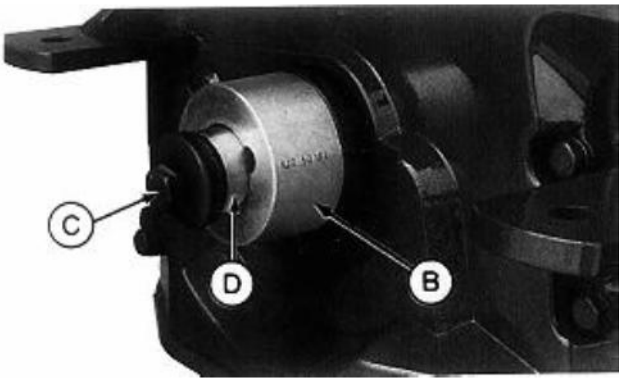
5. Tighten screw until driver bottoms in seal bore of timing gear cover.

6. On non-crankshaft gear-driven auxiliary drive engines, lightly lubricate new wear ring with clean engine oil and install on crankshaft against O-ring. Be sure seal lips are properly positioned on wear ring.

7. Install Woodruff key in key slot of crankshaft. Seat key all the way in slot.



RG7302 -UN-20FEB95



RG7303 -UN-20FEB95

A—O-Ring
B—Driver*
C—Forcing Screw with Washer*
D—Spacer*

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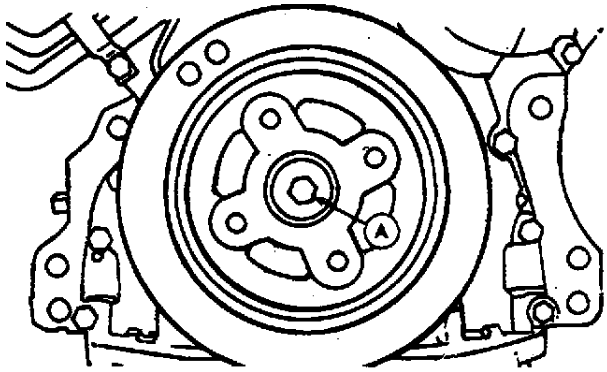
**Part of KJD10164 Front Crankshaft Seal Driver*

S11,2015,EM,2 -19-22SEP95

8. Lightly coat pulley hub with clean engine oil.

9. Install pulley or damper/pulley on crankshaft. Apply LOCTITE 242 (TY9370) Thread Lock and Sealer to threads of 1/2 x 1-3/4 in. cap screw. Place a 12 mm (0.47 in.) thick washer (A) on cap screw and install. Tighten cap screw to 183 N·m (135 lb-ft).



RG5113 -UN-14DEC88

S11,2015,EM,3 -19-22SEP95

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CHECK CRANKSHAFT END PLAY

It is recommended that crankshaft end play be measured prior to removing crankshaft to determine condition of thrust bearings.

1. Position dial indicator on face of flywheel or on front crankshaft nose.

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

2. Using a pry bar, push crankshaft as far to rear of engine as possible.

3. Zero the dial indicator.

4. Gently pry the crankshaft as far forward as possible. Note indicator reading. If end play is not within specifications, install new thrust bearing.

T88331 -UN-14OCT88

CRANKSHAFT END PLAY SPECIFICATIONS

New Parts:
Two-Piece Thrust Bearing . . . . 0.05—0.25 mm (0.002—0.010 in.)
Wear Limit . . . . 0.50 mm (0.020 in.)

Six-Piece Thrust Bearing
Engine Serial No. (—CD560945) . . . . 0.025—0.430 mm (0.001—0.017 in.)
Wear Limit . . . . 0.60 mm (0.024 in.)

Engine Serial No. (CD560946—)
and All Dubuque-Built . . . . 0.025—0.35 mm (0.001—0.014 in.)
Wear Limit . . . . 0.50 mm (0.020 in.)

NOTE: New thrust bearings will usually restore proper end play. If end play is not within specification on two-piece flanged thrust bearings, install a six-piece thrust bearing set with oversized thrust washers.

IMPORTANT: Service thrust bearing kits are now supplied with a six-piece thrust bearing assembly. It is acceptable to use a six-piece bearing where five-piece bearing was previously used. Follow installation instructions provided with kit.

S11,2015,EZ -19-01NOV95

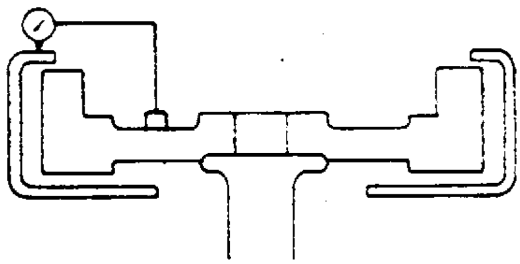
INSPECT FLYWHEEL

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.

RG,CTM8,GR15,43-19-22JUL92

CHECK FLYWHEEL HOUSING FACE RUNOUT



R22212 -UN-14DEC88

1. Mount dial indicator on flywheel. Set pointer to contact PTO mounting surface on flywheel housing at right angles. Pointer should not contact holes in flywheel housing.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel housing face runout.

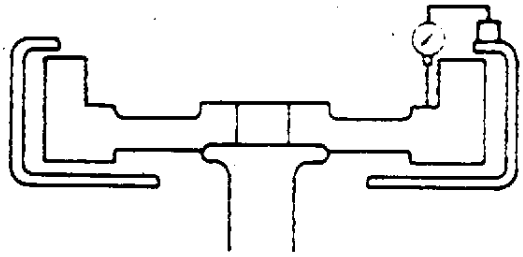
2. Rotate flywheel by turning crankshaft. Read total indicator movement.

FLYWHEEL HOUSING FACE RUNOUT SPECIFICATION

12 O'clock position	0.30 mm (0.012 in.)
3 and 9 O'clock positions	0.25 mm (0.010 in.)

RG,CTM8,GR15,44-19-28DEC94

CHECK FLYWHEEL FACE FLATNESS



R22213 -UN-14DEC88

1. Mount dial indicator base on flywheel housing. Position pointer to contact driving ring mounting surface. Do not allow pointer to contact driving ring mounting holes.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel face runout.

2. Rotate flywheel by turning crankshaft. Read total 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.)

RG,CTM8,GR15,45-19-22JUL92

REMOVE FLYWHEEL

T90586 -UN-07NOV88

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

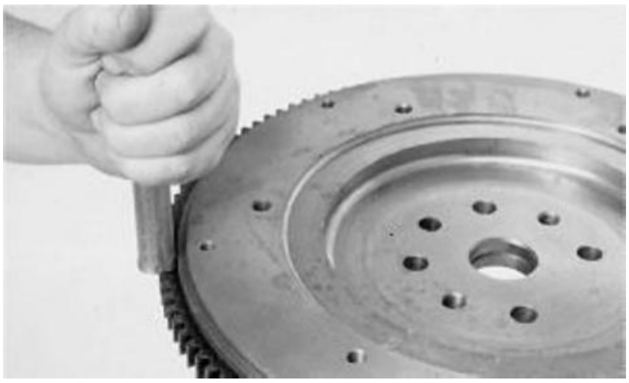
CAUTION: Flywheel is heavy. Plan a proper lifting procedures to avoid personal injury.

2. Remove flywheel.

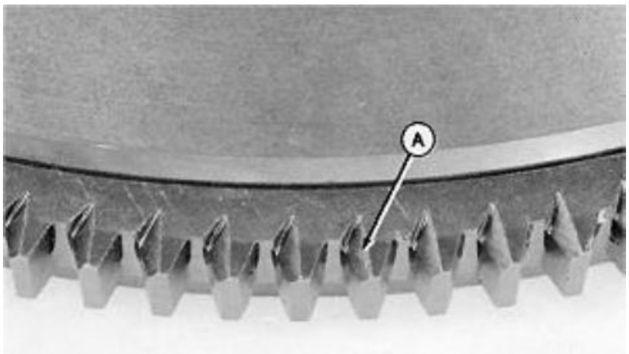
RG,CTM4,DY092 -19-22JUN95

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.



T90596 -UN-14OCT88



RG3838 -UN-14OCT88

1. Place the flywheel on a solid flat surface.

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

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

IMPORTANT: If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT. SEE CAUTION. Overheating may also destroy original heat treatment of gear.

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

5. Install ring gear against shoulder of flywheel.

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RG,CTM4,DY103 -19-30JUN95

INSTALL FLYWHEEL

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

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

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

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

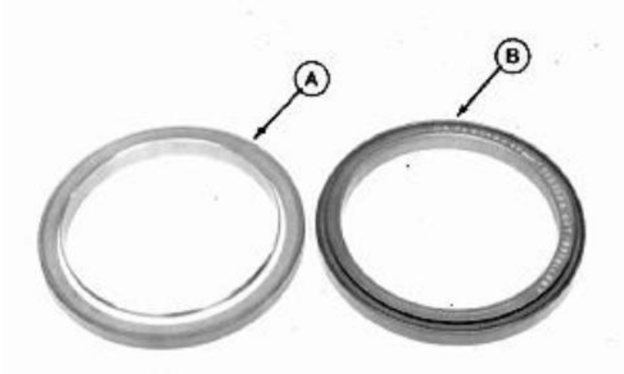
2. Apply LOCTITE 242 (TY9370) to threads of all flywheel mounting cap screws. Start cap screws in crankshaft. Do not tighten until guide studs are removed and all cap screws started.

3. Tighten hexagon head cap screws with washers to 163 N·m (120 lb-ft).

When R74444 flanged-head high strength cap screws are used, tighten to 55 N·m (40 lb-ft) PLUS an additional 1/6 turn (60 degrees).

S11,2015,FY -19-22JUN95

CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE GENERAL INFORMATION



RG5634 -UN-02APR90

Two types of oil seal and wear sleeve assemblies are used:

• A two-piece oil seal and wear sleeve assembly (A) that can easily be separated by hand.

• A unitized (non-separable) oil seal and wear sleeve assembly (B).

Removal of the two oil seal and wear sleeve types are different; refer to the appropriate procedure when servicing rear crankshaft oil seal and wear sleeve assembly.

The unitized (non-separable) oil seal assembly is the only type that is currently available through service parts.

CTM8,GR15,18 -19-16FEB95

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24

REMOVE TWO-PIECE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE (WITHOUT REMOVING FLYWHEEL HOUSING)

These instructions are for use when flywheel housing would not otherwise be removed from cylinder block. If flywheel housing is to be removed, remove seal and wear ring after housing is removed.

Remove flywheel as outlined earlier in this group.

CTM8,GR15,19 -19-29SEP94

• JDG698 Seal and Wear Sleeve Remover

RG5636 -UN-02APR90

RG5635 -UN-02APR90

1. Remove flywheel as outlined earlier in this group.

2. Adjust forcing screw on JDG698 Seal and Wear Sleeve Remover and position screw so it centers tool on crankshaft flange.

3. Using the slots in JDG698 tool as a template, mark three locations on oil seal casing where sheet metal screws will be installed.

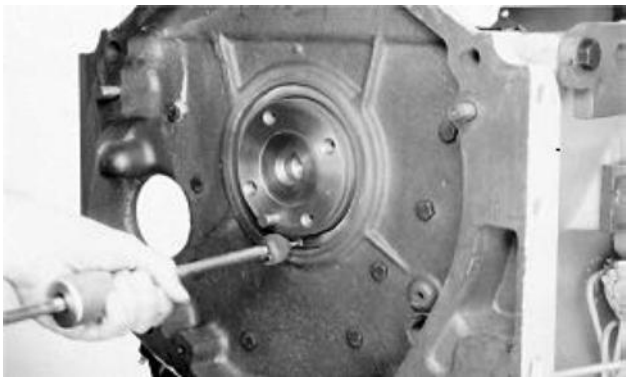
4. Drill a hole through oil seal casing at the three locations marked.

5. Install three sheet metal screws into slots of removal tool and thread screws into drilled holes. Evenly tighten screws until plate is flush with rear face of crankshaft.

6. Tighten forcing screw in center of tool until the plate pulls evenly against the three sheet metal screws. Tighten forcing screw until oil seal is free from housing bore. Discard seal.

CTM8,GR15,20 -19-28DEC94

• JDG22 Seal Remover



T81200 -UN-07NOV88

Using JDG698 Seal and Wear Sleeve Remover is the preferred method for removing the rear crankshaft oil seal. If JDG698 tool is not available, JDG22 Seal Remover can be used to remove the seal.

1. Remove flywheel as outlined earlier in this group.

2. Drill a small hole through seal casing at three locations (equally spaced).

3. Use JDG22 Seal Remover and a sheet metal screw to pull seal from housing bore. Discard seal.

CTM8,GR15,21 -19-28DEC94

• JDG645 Rear Wear Sleeve Puller

IMPORTANT: 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.

1. Adjust forcing screw on JDG645 Rear Wear Sleeve Puller and position screw with disc so it centers tool on crankshaft flange.

2. Assemble tool so puller pulls against inner edge of wear sleeve. Tighten band clamp until wear sleeve is secured within tool ID.

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

RG5637 -UN-02APR90

CTM8,GR15,22 -19-29SEP94

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4. Clean OD of crankshaft flange with cleaning solvent, trichloroethylene, acetone, or any other suitable cleaner that will remove sealant.

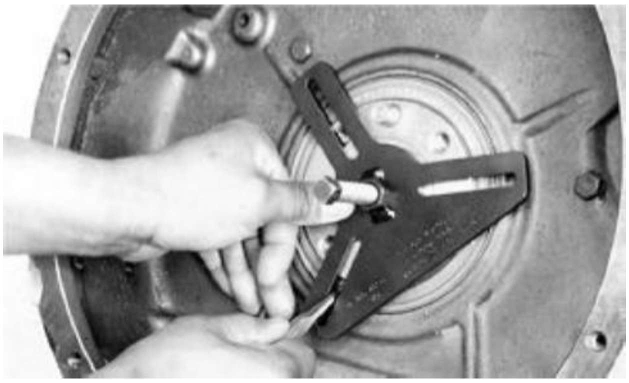
5. Look for nicks or burrs on wear ring surface and bore in flywheel housing. If necessary, use polishing cloth to remove nicks or burrs.

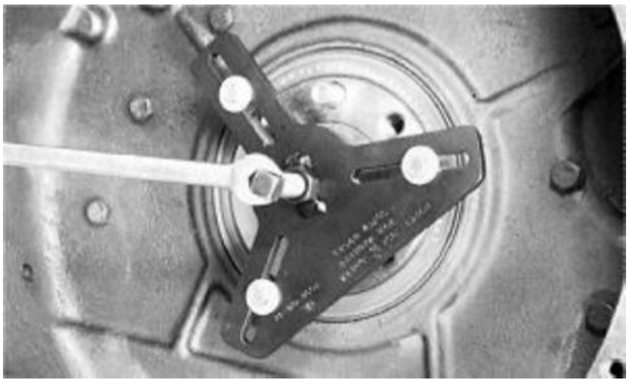
Finish cleaning by wiping flange with a clean rag.

T81202 -UN-01NOV88

CTM8,GR15,13 -19-22JUL92

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


RG5638 -UN-02APR90


RG5639 -UN-02APR90

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

1. Remove flywheel.

2. Adjust forcing screw on JDG698 Seal and Wear Sleeve Remover and position screw so it centers tool on crankshaft flange.

3. Use the slots in JDG698 Remover as a template, mark three locations on seal casing where screws should be installed for removal purposes. Remove tool from crankshaft flange.

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

4. Drill a 3/16 in. hole through wear sleeve lip and seal casing at the three marked locations.

5. Position JDG698 Remover on end of crankshaft.

6. Install three 2-1/2 in. (approximate) sheet metal screws with washers into slots of removal tool and thread screws into holes in seal casing. Evenly tighten screws until plate is flush with rear face of crankshaft.

7. Tighten forcing screw (plate should pull evenly against the three screws) until seal and wear sleeve assembly is removed from engine.

CTM8,GR15,23 -19-11OCT94


T81202 -UN-01NOV88

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

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

Finish cleaning by wiping flange with a clean rag.

CTM8,GR15,24 -19-22JUL92

INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE


RG5640 -UN-02APR90

Unitized Oil Seal And Wear Sleeve

The unitized (non-separable) oil seal and wear sleeve assembly is the only type that is available through service parts.

IMPORTANT: No lubrication of any kind is to contact seal when installing. Use of a lubricant may result in premature seal failure.

Install seal and wear sleeve assembly immediately after removal from plastic bag to avoid possible dirt contamination.

1. Clean OD of crankshaft flange and ID of wear sleeve with trichloroethylene or equivalent just prior to application of sealant. Make sure that OD of crankshaft flange and ID of seal housing bore are free from nicks or burrs.

2. Apply a light coating of LOCTITE 609 (TY15969) Retaining Compound completely around the leading edge of crankshaft flange. Wipe away sealant that may have gotten on flywheel housing seal bore.

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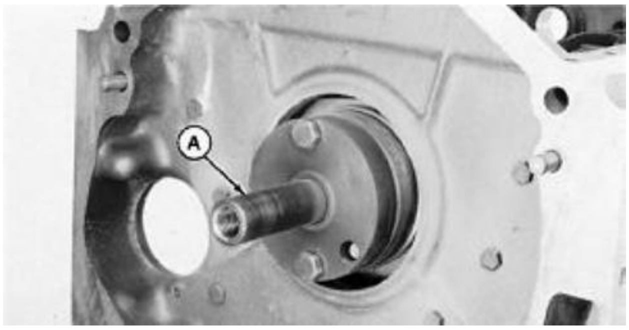
CTM8,GR15,14 -19-28DEC94

3. Install pilot (A) from the JT30040 (formerly JDE140) or KCD10002 Seal and Wear Sleeve Installer Set on end of crankshaft using two hex-head cap screws. Tighten both cap screws securely. Make sure tool contacts face of crankshaft.



T88559 -UN-14OCT88

RG,CTM8,GR15,29-19-28DEC94

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

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

T81204 -UN-01NOV88

CTM8,GR15,16 -19-28DEC94

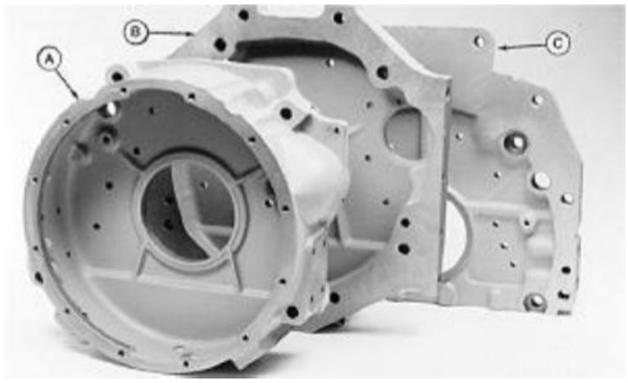
5. Attach driver and thrust washer to the guide plate with cap screw. Tighten the cap screw until driver bottoms on pilot.

6. Remove seal driver and pilot plate.

T81205 -UN-07NOV88

RG,CTM8,GR15,30-19-09APR92

REMOVE FLYWHEEL HOUSING



RG4919 -UN-14DEC88

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

2. Remove starting motor.

3. If a unitized rear oil seal is used, it MUST BE removed before removing flywheel housing. (See REMOVE UNITIZED (NON-SEPARABLE) CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE earlier in this group.)

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

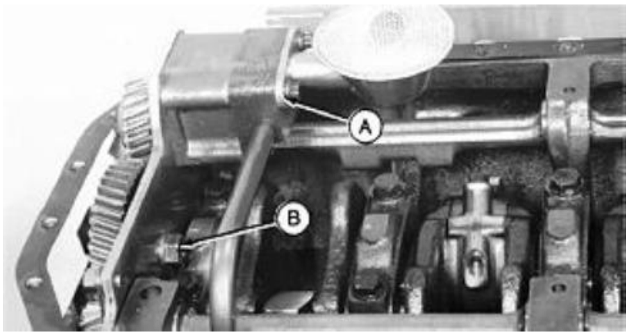
4. Remove flywheel housing-to-cylinder block cap screws and flywheel housing-to-oil pan cap screws. Remove flywheel housing from block.

NOTE: Some flywheel housings are assembled to cylinder block by using four 5/8 in. and eight 3/8 in. cap screws; some use eight 3/8 in. cap screws only; and the rest use two 5/8 in., two 3/4 in. and eight 3/8 in. cap screws.

Illustration shows three different types of flywheel housings used:
—SAE 2, 3, and 4 housings (A).
—Standard flat housings (B) used primarily on utility tractors.
—Special flat housings (C) used primarily on Row-Crop tractors.

RG,CTM8,DW682 -19-30JUN95

REMOVE CRANKSHAFT MAIN BEARINGS



T88551 -UN-07NOV88

1. Drain oil from engine crankcase.

2. Remove oil pan. (See Group 20.)

3. Remove oil pump (A) and idler shaft cap screw (B).

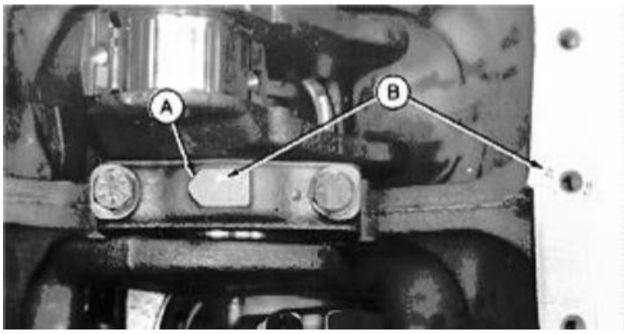
RG,CTM8,GR15,46-19-29SEP94

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

4. Check main bearing caps for arrows (A, cast in main bearing cap) and numbers (B) stamped on cap and oil pan rail. Arrow points toward camshaft side of engine and away from number stamped on pan rail.

If there are no numbers, stamp corresponding numbers on cap and oil pan rail to assure correct placement of bearing caps during reassembly.

5. Remove main bearing caps. Visually inspect condition of bearing inserts as bearing caps are removed. Keep caps and inserts together and in correct order.



T88558 -UN-14OCT88

CTM8,GR15,25 -19-27AUG92

CHECK MAIN BEARING CLEARANCE

1. Place a strip of PLASTIGAGE in the center of the main bearing cap about three-fourths of the width of the bearing.

2. Use clean engine oil on PLASTIGAGE to prevent smearing.

3. Install cap and tighten cap screws to specified torque.

MAIN BEARING CAP SCREW TORQUE SPECIFICATIONS

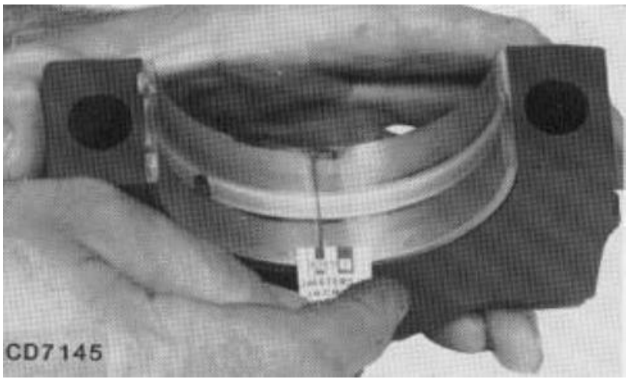
All Dubuque- and Saran-Built Engines
(Serial No. —CD979057) . . . . 115 N·m (85 lb-ft)
Saran-Built Engines
(Serial No. CD979058—) . . . . 135 N·m (100 lb-ft)

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

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

MAIN BEARING CLEARANCE SPECIFICATIONS

Main Bearing-to-Journal Clearance . . . . 0.025—0.102 mm (0.0009—0.0040 in.)



CD7145 -UN-23MAY95

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S11,2015,FD -19-22SEP95

REMOVE AND INSTALL CRANKSHAFT GEAR (CRANKSHAFT INSTALLED IN ENGINE)

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

• To Remove Crankshaft Gear:

1. Lock engine at No. 1 “TDC” compression.

2. Remove timing gear cover (shown removed).

3. Remove oil pump gear (A).

4. Remove upper idler gear (B) and lower idler gear (C).

5. Remove lower idler gear shaft (D).

NOTE: On 4-cylinder engines it is not necessary to remove balancer shafts, if equipped.

6. Install No. 1123 Pulling Attachment (E) onto crankshaft gear.

7. Using a disc (F) to protect threads in nose of crankshaft, install D01200AA Push Puller (G) and No. 1123 (D01218AA) Pulling Attachment. Remove crankshaft gear.

• To Install Crankshaft Gear:

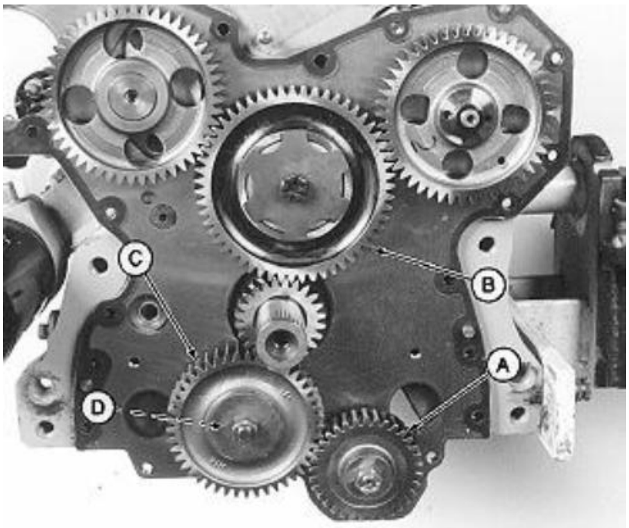
CAUTION: Oil fumes or oil can ignite above 193˚C (380˚F). Use a thermometer and do not exceed 182˚C (360˚F). Do not allow a heating element to be in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

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

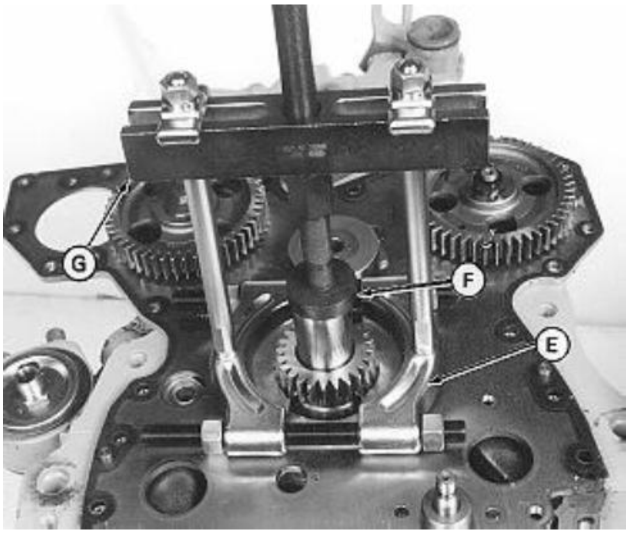
1. Heat crankshaft gear to 148˚C (300˚F) using either heated oil or oven heat.

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.

2. Place gear on crankshaft flange. Be sure Woodruff key on crankshaft is properly aligned with keyway in gear.



RG7237 -UN-10OCT94



RG7238 -UN-10OCT94

A—Oil Pump Gear
B—Upper Idler Gear
C—Lower Idler Gear
D—Lower Idler Shaft
E—No. 1123 Pulling Attachment
F—Disc
G—D01200AA Push Puller

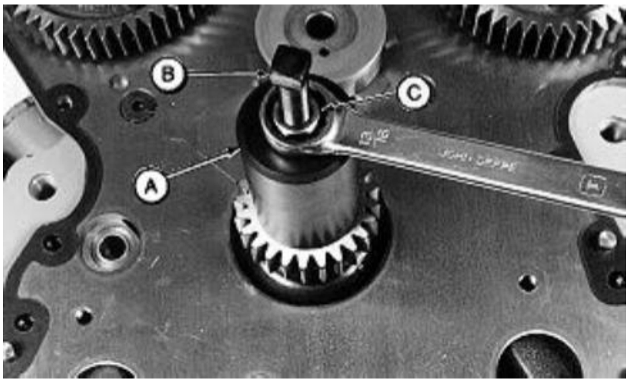
RG,CTM8,DX174 -19-22SEP95

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

3. Use JDG794 Crankshaft Gear Installer (A) to install gear. Tighten cap screw (B) in crankshaft nose until cap screw bottoms.

4. Turn nut (C) clockwise until gear firmly seats against crankshaft flange. Allow gear to cool before removing JDG794 Installer.

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



RG7245 -UN-09FEB95

RG,CTM8,DY033 -19-08FEB95

REMOVE CRANKSHAFT

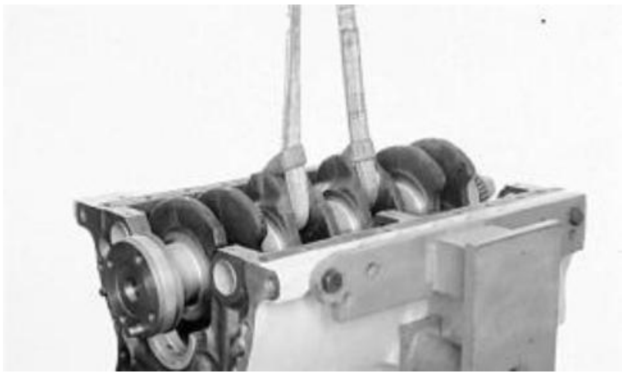
CAUTION: Crankshaft is very heavy. Plan a proper handling procedure to avoid injury.

1. Attach a lifting sling to crankshaft. Using proper lifting equipment, carefully raise crankshaft out of cylinder block.

2. Place crankshaft on a clean flat surface and support journals with V-blocks.

3. If main bearings are to be replaced, remove inserts from cylinder block. Otherwise, leave bearing inserts in block until assembled ID has been measured.

4. Remove Woodruff key from front end of crankshaft. On all 6-cylinder engines and all engines with long nose crankshafts, remove wear sleeve, O-ring (if used) and oil deflector.



T81184 -UN-01NOV88

RG,CTM8,DY093 -19-22SEP95

REMOVE CRANKSHAFT REAR WEAR SLEEVE (CRANKSHAFT REMOVED FROM ENGINE)

T81193 -UN-01NOV88

This procedure applies only to the two-piece (separable) oil seal and wear sleeve assemblies. Unitized (non-separable) oil seal/wear sleeve must be removed before flywheel housing can be removed.

IMPORTANT: The preferred method of removing the wear sleeve on two-piece assemblies is with JDG645 Puller, when removing the 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.

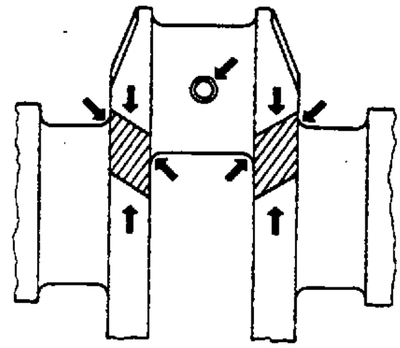
Remove crankshaft rear wear sleeve by using one of the following procedures:

- Use JDG645 Puller and pull wear ring from crankshaft flange, as described earlier in this group.
- 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 (but do not cut) the wear ring in several places around OD with a blunt chisel, as shown in photo.

Remove wear ring from crankshaft flange when loose.

CTM8,GR15,17 -19-28DEC94

INSPECT CRANKSHAFT



CD7147 -UN-23FEB89

NOTE: A crankshaft inspection must be made if the crankshaft damper was found to be damaged or defective.

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

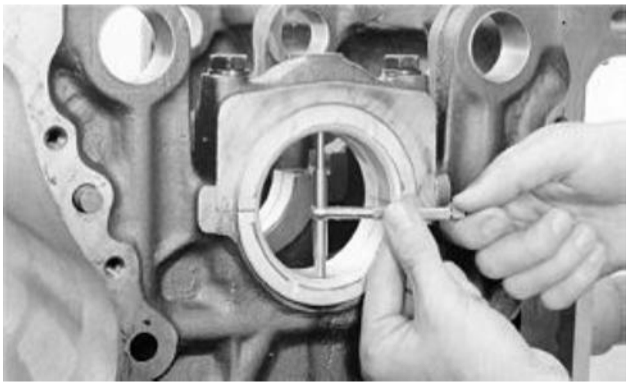
IMPORTANT: Small cracks may not be visible to the eye. Use a method (such as the Fluorescent Magnetic Particle Method) that is capable of detecting small cracks. The crankshaft must be de-magnetized after the test.

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

3. Check each journal for evidence of excessive overheating or discoloration. Replace crankshaft if either condition exists.

RG,CTM8,GR15,32-19-04SEP92

MEASURE ASSEMBLED ID OF BEARINGS AND OD OF CRANKSHAFT JOURNAL



1. With crankshaft removed from engine, assemble main bearing caps with bearing inserts.

2. Tighten main bearing cap screws to specified torque.

MAIN BEARING CAP SCREW TORQUE SPECIFICATIONS

Dubuque- and Saran-Built Engines: (Serial No. —CD979057)	115 N·m (85 lb-ft)
Saran-Built Engines: (Serial No. CD979058—)	135 N·m (100 lb-ft)

3. Measure and record main bearing assembled ID at several points.

4. Measure and record crankshaft main journal OD at several points around each journal.

5. Compare measurements with specifications given below.

MAIN BEARING AND CRANKSHAFT JOURNAL SPECIFICATIONS

Main Bearing ID (standard)	79.375—79.426 mm (3.1249—3.1270 in.)
Crankshaft Journal OD (standard)	79.324—79.350 mm (3.1229—3.1240 in.)
Main Bearing-to-Journal Oil Clearance	0.025—0.102 mm (0.0009—0.0040 in.)
Maximum Main or Rod Journal Taper	0.010 mm (0.0004 in.)
Maximum Main or Rod Journal Out-of-Roundness	0.005 mm (0.0002 in.)

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

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

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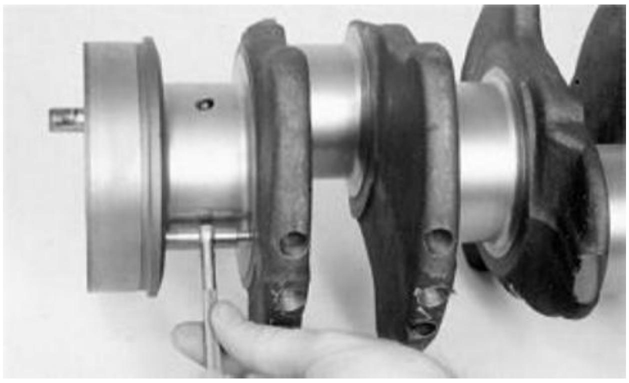
RG,CTM4,DW649 -19-22SEP95

MEASURE MAIN THRUST JOURNAL WIDTH AND THRUST BEARING WIDTH


T81187 -UN-09NOV88

1. Measure and record crankshaft main thrust journal width.

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

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

NOTE: Assemble thrust washers onto bearing half prior to measuring five/six-piece thrust bearings.

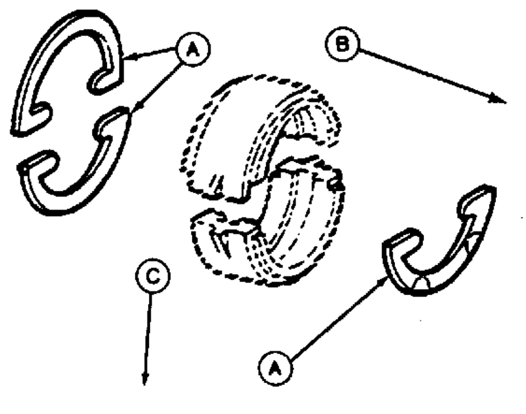

T81188 -UN-09NOV88

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

NOTE: Oversize thrust washer sets have thrust washers (A) that are 0.18 mm (0.007 in.) wider.

MAIN THRUST JOURNAL AND THRUST BEARING SPECIFICATIONS

Thrust Bearing Journal Width (new)	38.952—39.028 mm (1.5335—1.5365 in.)
Thrust Bearing Width (standard)	38.811—38.862 mm (1.5279—1.5299 in.)
Thrust Bearing-to-Journal Oil (Side) Clearance	0.10—0.20 mm (0.004—0.008 in.)
Wear Limit	0.38 mm (0.015 in.)



RG5584 -UN-03AUG92

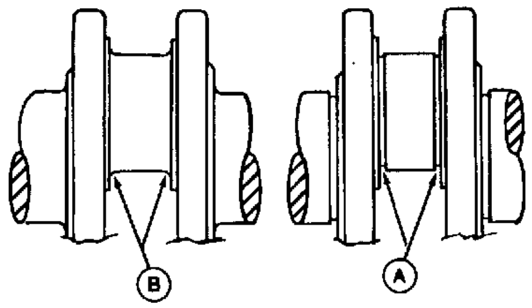
A—Thrust Washers
B—Arrow Toward Front of Engine
C—Arrow Toward Oil Pan

RG,CTM4,DW800 -19-01NOV95

CRANKSHAFT GRINDING GUIDELINES

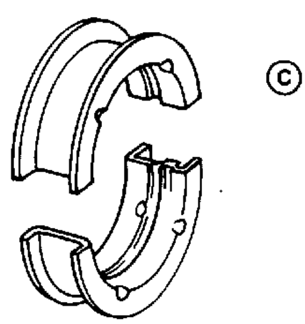
IMPORTANT: Crankshaft grinding should be done ONLY by experienced personnel on equipment capable of maintaining crankshaft size and finish specifications.

Service crankshafts for 3179, 4239, 4276, 6359, and 6414 Engines are undercut and rolled ductile iron or steel. Undercut and rolled fillets (A) have taken the place of ground (tangential) fillets (B). These crankshafts also have micro-finished journal surfaces.



RG6349 -UN-03AUG92

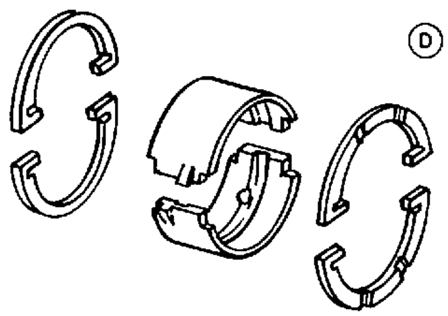
IMPORTANT: If undersize bearings are installed, recheck bearing-to-journal clearance. If oil clearance is not within specifications, premature wear of bearings and journals will result.



RG6279 -UN-03AUG92

In addition to the standard size main and connecting rod bearings, 0.25 and 0.51 mm (0.010 and 0.020 in.) undersize bearings are available.

IMPORTANT: Service thrust bearing kits are now supplied with a six-piece thrust bearing assembly (D). It is acceptable to use a six-piece bearing where five-piece was previously used. Follow installation instructions provided with kit.



RG7300 -UN-17FEB95

To maintain the correct end play, the six-piece main thrust bearing (with individual thrust washers)* can be used to replace the two-piece (flanged) main thrust bearing (C) if desired. (See INSTALL MAIN AND THRUST BEARING INSERTS IN BLOCK later in this group for correct installation of five-piece thrust bearings.)

A—Undercut and Rolled Fillet
B—Ground (Tangential) Fillet
C—Two-Piece Rear Thrust Bearing Insert
D—Six-Piece Rear Thrust Bearing Assembly

**Six-piece thrust bearings will not fit early production engines with 110 mm (4.33 in.) diameter undercut on main bearing web in block and on thrust bearing cap. Web undercut must be 113.8 mm (4.48 in.) diameter in order to accept five/six-piece thrust bearings. Six-piece thrust bearings are effective on Saran-built engines beginning with Serial No. 968611CD.*

RG,CTM4,DW654 -19-22SEP95

CRANKSHAFT GRINDING GUIDELINES—CONTINUED

If the crankshaft is to be ground, use the following recommended guidelines:

1. Determine the size to which the journals are to be reground according to the measures taken during inspections.

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. Grind clockwise (as viewed from nose of crankshaft).

IMPORTANT: On tangential fillet crankshafts, 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. The radius may be checked with a fillet gauge.

On undercut and rolled crankshafts, DO NOT grind within this undercut area when undersize bearings are used.

3. Care must be taken to avoid localized heating which often produces grinding cracks. Use coolant generously to cool the crankshaft while grinding. Do not crowd the grinding wheel into the work.

4. Polish or lap (clockwise) the ground surfaces to the specified finish except for cast iron crankshafts. The reground journals will be subject to excessive wear unless polished smooth.

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

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

6. Stone the edge of all oil holes in the journal surfaces smooth to provide a radius of approximately 1.50 mm (0.060 in.).

7. After grinding has been completed, inspect the crankshaft by the fluorescent magnetic particle method, or other similar method to determine if cracks have originated due to the grinding operation.

8. De-magnetize the crankshaft after inspection.

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

CTM8,GR15,47 -19-28DEC94

CRANKSHAFT GRINDING SPECIFICATIONS

Bearing Size	Crankshaft Main Journal OD	Crankshaft Rod Journal OD 3179, 4239, 6359	Crankshaft Rod Journal OD 4276, 6414
Standard	79.34—79.36 mm (3.123—3.124 in.)	69.80—69.83 mm (2.748—2.749 in.)	77.80—77.83 mm (3.063—3.064 in.)
0.25 mm (0.010 in.) Undersize	79.07—79.09 mm (3.113—3.114 in.)	69.54—69.57 mm (2.738—2.739 in.)	77.55—77.57 mm (3.053—3.054 in.)
0.51 mm (0.020 in.) Undersize*	78.82—78.84 mm (3.103—3.104 in.)	69.29—69.32 mm (2.728—2.729 in.)	77.29—77.32 mm (3.043—3.044 in.)

Main and Connecting Rod Journal Surface Finish (all engines) . . . . Lap 0.20 um (8 AA)

Thrust (Main) Journal Surface Finish (all engines) . . . . Lap 0.40 um (16 AA)

Thrust Bearing Journal Width . . . . 38.952—39.028 mm (1.5335—1.5365 in.)

Connecting Rod Journal Fillet Radius**
3179, 4239, 6359 Engines . . . . 4.2—4.4 mm (0.165—0.175 in.)

4276, 6414 Engines . . . . 3.7—4.0 mm (0.146—0.156 in.)

Main Journal Fillet Radius** . . . . 3.7—4.0 mm (0.146—0.156 in.)

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40
Thrust Journal Fillet Radius** . . . . 3.7—4.0 mm (0.146—0.156 in.)

Direction of crankshaft rotation (viewed from flywheel end):
Grinding . . . . clockwise
Lapping . . . . counterclockwise

Engine Stroke:
3179, 4239, 6359 Engines . . . . 110 mm (4.33 in.)
4276, 6414 Engines . . . . 127 mm (5.00 in.)

Not available for undercut and rolled fillets.

***Tangential fillet radii crankshafts only.*

RG,CTM4,DY094 -19-01NOV95

MEASURE ASSEMBLED ID OF MAIN BEARING CAPS

1. Remove bearing inserts from caps and cylinder block. Keep inserts in correct order if they are to be reused.

2. Clean and inspect caps for damage. Small burrs or nicks on flat surfaces may be removed with a file. Use a medium-grit polishing cloth to dress up curved bearing surfaces.

RG,CTM4,DY095 -19-25JUL95

3. Install bearing caps (without bearings) in cylinder block. Tighten cap screws to specified torque.

MAIN BEARING CAP SCREW TORQUE SPECIFICATIONS

All Dubuque-Built and Saran-Built Engines
(Serial No. —CD979057) . . . . 115 N·m (85 lb-ft)

Saran-Built Engines
(Serial No. CD979058—) . . . . 135 N·m (100 lb-ft)

4. Measure ID of bearing cap bores.

MAIN BEARING CAP BORE SPECIFICATIONS

Main Bearing Bore Without
Bearings . . . . 84.455—84.480 mm (3.3249—3.3259 in.)

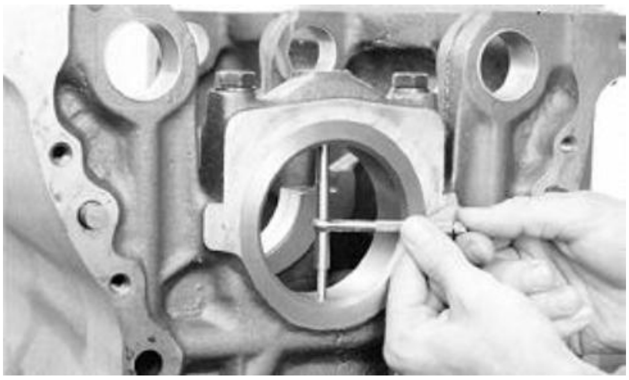
Main Bearing Bore Centerline-to-Top
Deck Distance (Minimum):
3179, 4239, 6359 Engines . . . . 301.981 mm (11.8889 in.)
4276 and 6414 Engines . . . . 337.871 mm (13.3019 in.)

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

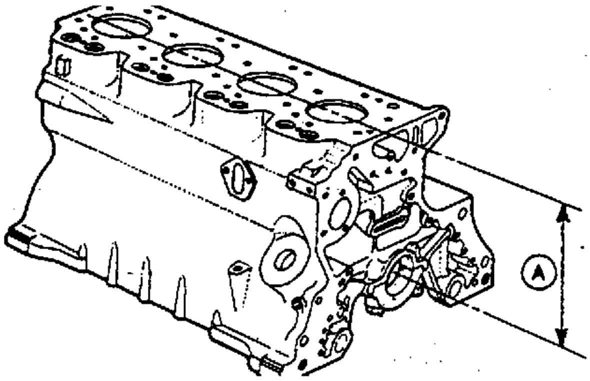
NOTE: Replacement bearing caps are supplied with unfinished bearing bore.

IMPORTANT: When cylinder block is line bored, the dimension (A) from centerline of main bearing bore to cylinder block top deck will be changed. Piston may contact cylinder head if this dimension is less than specified above.

Main bearing cap line boring should be done ONLY by experienced personnel on equipment capable of maintaining the bore specifications. After machining (3179, 4239, and 6359 Engines), the proper piston height selection (B or H) is required. (See Group 10.)



T81655 -UN-01NOV88



RG4788 -UN-14DEC88

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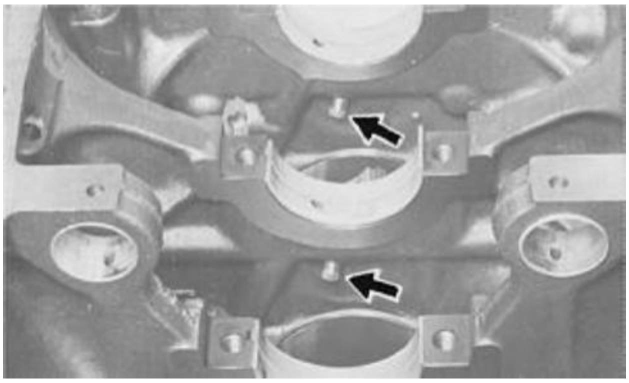
RG,CTM4,DT444 -19-01NOV95

INSPECT PISTON COOLING ORIFICES

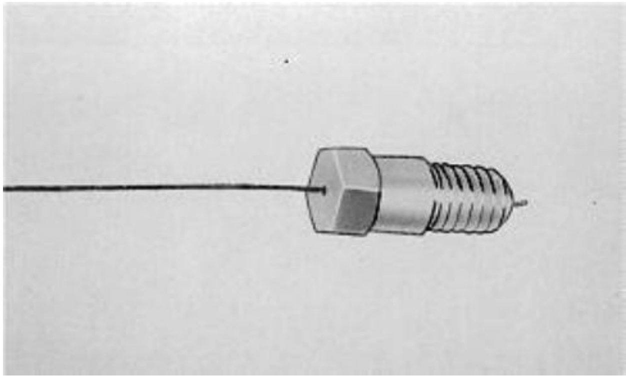
1. Inspect and clean each cooling orifice to make sure it is not plugged or damaged.

Install orifices in block and tighten to 10.5 N·m (7.7 lb-ft) (93 lb-in.).

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



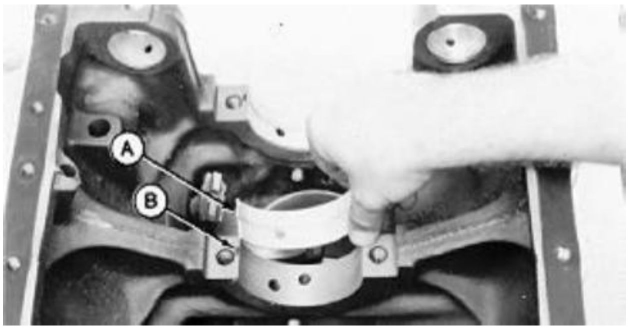
RG4943 -UN-14DEC88



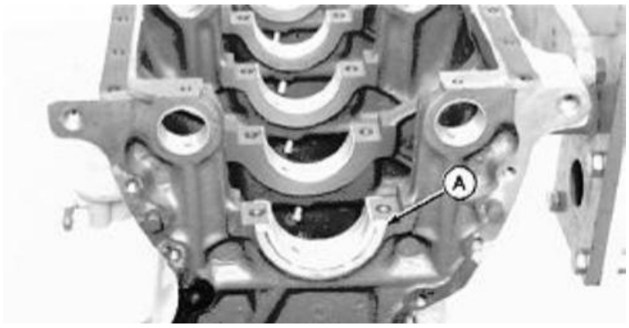
T88830 -UN-22OCT88

RG,CTM8,DX137 -19-29SEP94

INSTALL MAIN AND THRUST BEARING INSERTS IN BLOCK



T88555 -UN-14OCT88



T88556 -UN-14OCT88

IMPORTANT: Service thrust bearing kits are now supplied with a six-piece thrust bearing assembly. It is acceptable to use a six-piece bearing where five-piece was previously used. Follow installation instructions provided with the kit.

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

IMPORTANT: If new thrust bearing inserts or thrust washers are installed, they must be installed as a set.

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

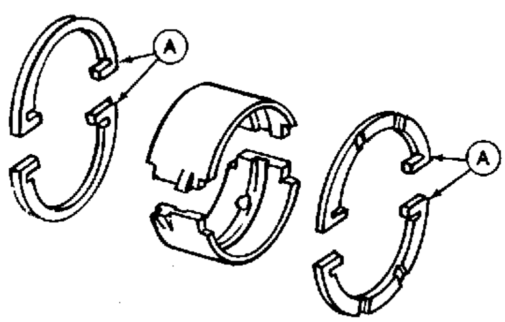
IMPORTANT: If a six-piece main thrust is being used, oil grooves on thrust washer must face crankshaft thrust surface (away from the block web).

NOTE: Some engines may have been built with two thrust washers in the block and one on cap. However, for service ALWAYS reassemble engine with two thrust washers in the block and two on the cap.

3. Apply a liberal coating of clean engine oil to bearing surfaces and crankshaft journals.

RG,CTM8,GR15,36-19-22SEP95

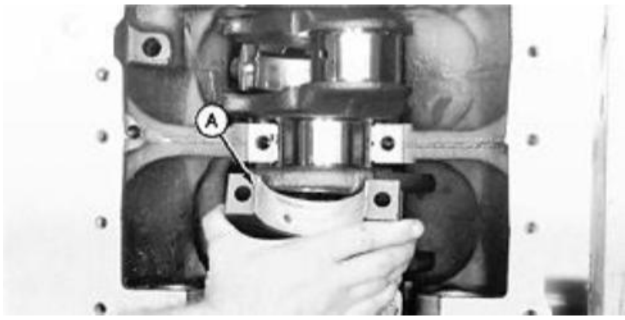
4. Install two thrust washers in the block and two on bearing cap. The oil grooves (A) must face toward crankshaft thrust surfaces.



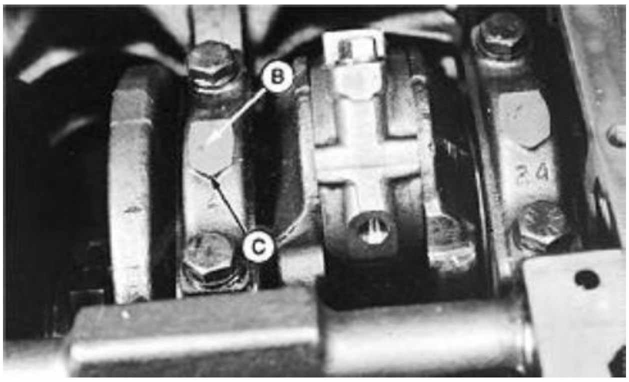
RG7126 -UN-17FEB95

RG,CTM8,DY030 -19-28DEC94

INSTALL CRANKSHAFT



T88557 -UN-14OCT88



RG6351 -UN-03AUG92

1. Using proper lifting equipment, lower crankshaft onto main bearings.

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

NOTE: Saran produced engines will have the arrow cast into the cap next to machined surface where cap number is stamped.

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

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

IMPORTANT: If a six-piece main thrust bearing is being used, install a thrust washer on BOTH SIDES of the main thrust bearing cap. Oil grooves on thrust washers must face crankshaft thrust surface (away from the bearing cap).

RG,CTM8,DX129 -19-28DEC94

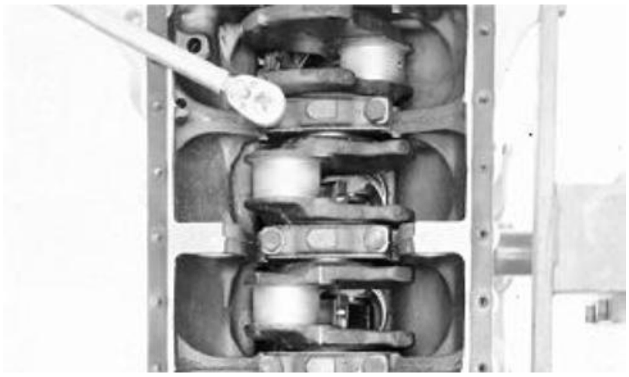
IMPORTANT: Do not use pneumatic wrench to install main bearing cap screws, as damage may occur to the threads.

5. Tighten all main bearing cap screws to specifications except rear main (thrust) bearing cap screws. Tighten rear main (thrust) bearing cap screw finger tight.

6. Before tightening rear main (thrust) bearing cap screws, align upper and lower thrust bearings. Carefully force crankshaft and main thrust bearing cap to rear using a pry bar between crankshaft throw and block web. Then force crankshaft to front to line up thrust bearing surfaces.

7. Tighten rear main (thrust) cap screws to specifications.

8. Turn crankshaft by hand. If it does not turn easily, disassemble main bearing caps and determine the cause.



T81198 -UN-09NOV88

MAIN BEARING CAP SPECIFICATIONS

All Dubuque-Built and Saran-Built Engines
Serial No. (—CD979057) . . . . 115 N·m (85 lb-ft)

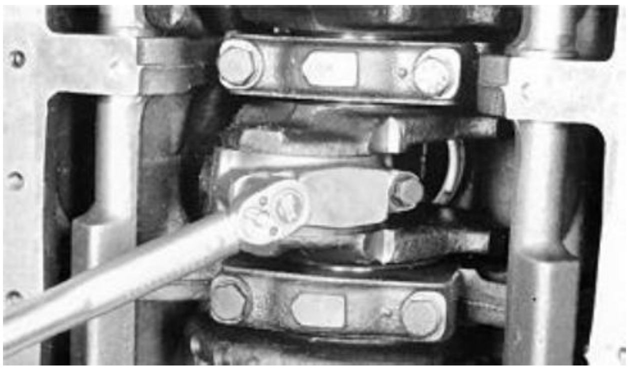
Saran-Built Engines
Serial No. (CD979058—) . . . . 135 N·m (100 lb-ft)

RG,CTM4,DY096 -19-25SEP95

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

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

10. Check crankshaft for specified end play. (See CHECK CRANKSHAFT END PLAY earlier in this group.)



T81615 -UN-07NOV88

RG,CTM4,DY097 -19-26JUN95

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INSTALL FLYWHEEL HOUSING

1. Drive old crankshaft rear oil seal out of flywheel housing (if not previously removed).

2. Make sure that wear ring was removed from crankshaft flange. (See CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE GENERAL INFORMATION earlier in this group.)

T81199 -UN-07NOV88

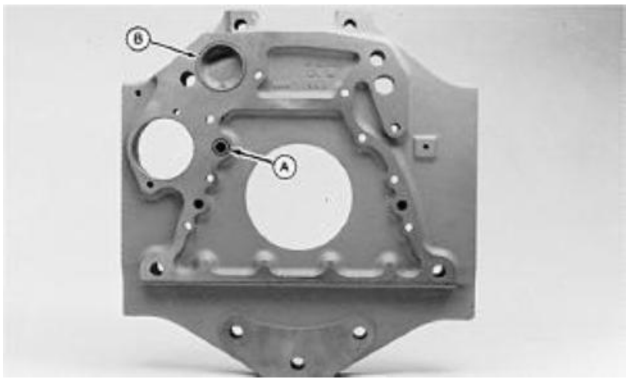
RG,CTM8,GR15,40-19-22SEP95

3. Inspect and clean cylinder block and flywheel housing gasket surfaces.

4. Replace flywheel housing O-rings (A and B), if equipped.

5. Install a new flywheel housing gasket without sealant. Trim gasket flush with bottom of cylinder block and coat trimmed edge with LOCTITE 515 (TY6304) General Purpose Flexible Sealant.

NOTE: Some engine overhaul gasket sets may contain two gaskets: one with a silicone bead, and one without silicone bead. Use gasket without silicone bead on applications having O-rings in flywheel housing. Use gasket with silicone bead on all others.



RG4785 -UN-14DEC88

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S11,2015,FV -19-22SEP95

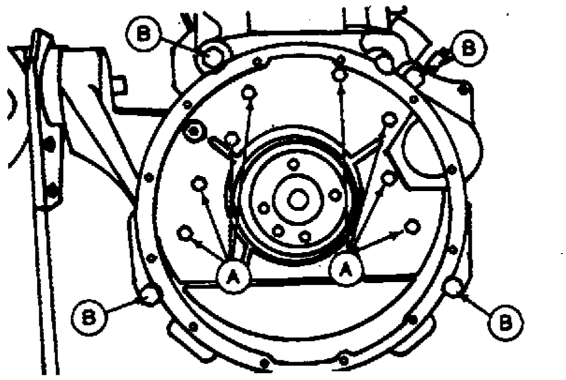
6. Install flywheel housing on cylinder block.

IMPORTANT: Cap screw torques vary with size of cap screw and type of flywheel housing. Dip threads of cap screw in clean engine oil before installing.

• SAE 2, 3, and 4 Housings (illustrated):

— Install eight 3/8 in. cap screws (A) and tighten initially to 30 N·m (22 lb-ft); followed by a final torque of 47 N·m (35 lb-ft).

— Install four 5/8 in. cap screws (B) and tighten to 230 N·m (170 lb-ft).



RG5117 -UN-14DEC88

S11,2015,FW -19-22JUL92

• Standard Flat Flywheel Housing (not illustrated):

— Install eight 3/8 in. cap screws and tighten initially to 30 N·m (22 lb-ft); followed by final value of 47 N·m (35 lb-ft).

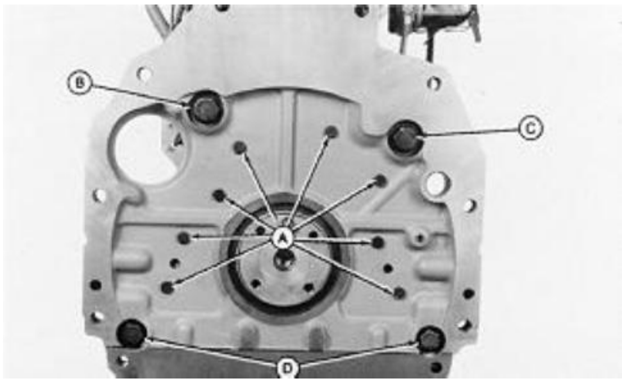
• Special Flat Flywheel Housing (illustrated):

— Install eight 3/8 in. cap screws (A) and tighten initially to 30 N·m (22 lb-ft) followed by final value of 47 N·m (35 lb-ft).

— Install 3/4 x 2-1/2 in. cap screw (B) and tighten to 450 N·m (330 lb-ft).

— Install 3/4 x 3-1/2 in. cap screw (C) and tighten to 570 N·m (420 lb-ft).

— Install two 5/8 x 2-1/4 in. cap screws (D) and tighten to 325 N·m (240 lb-ft).



RG4920 -UN-14DEC88

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

FLYWHEEL HOUSING RUN-OUT SPECIFICATIONS

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

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

CTM8,GR15,26 -19-22SEP95

COMPLETE FINAL ASSEMBLY

Always use new gaskets and o-rings during final engine assembly. Clean all engine components as necessary prior to assembly.

1. Install lube oil system by-pass valve assembly (3179, 4239, 6359 Engines). (Group 20).

2. Install front plate, timing gear train, camshaft, and balancer shafts (if equipped). (Group 16).

3. Install oil pump assembly. (Group 20).

4. Install oil deflector. (Group 16).

5. Install timing gear cover gasket, cover, oil pressure regulating valve assembly (3179, 4239, 6359 Engines), and front oil seal. (Groups 15 and 16).

6. Install oil pan. (Group 20).

7. Install crankshaft pulley or vibration damper. (Group 15).

8. Install cam followers, push rods, rocker arm assembly. (Groups 05 and 16).

9. Install fuel supply pump and injection pump. (Group 35).

10. Install starting motor.

11. Adjust valve clearance. (Group 05).

12. Install and adjust fan belts. (Group 25).

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

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

S11,2015,FZ -19-23JUN95

SPECIAL OR ESSENTIAL TOOLS

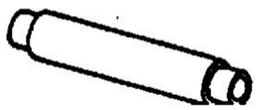
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-20JUL95

RG5120 -UN-23AUG88

Balancer Shaft Bushing Driver JD249

Replace balancer shaft bushings.

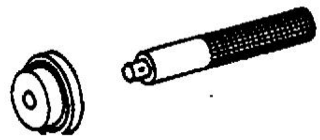


S53,JD249 -19-04APR90

RG5111 -UN-23AUG88

Idler Gear Bushing Driver JD252
Handle . . . . JDG537(OTC815)

Install idler gear bushings in idler gear, on engines with helical gears.

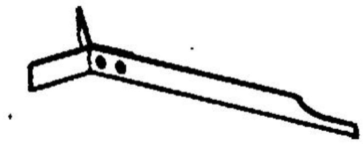


RG,JD252,CTM8 -19-19OCT92

RG5118 -UN-23AUG88

Gear Timing Tool JD254

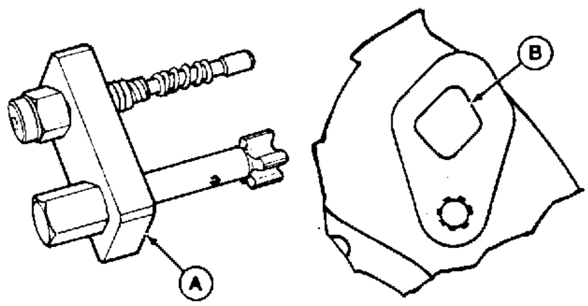
Time camshaft gear, injection pump gear, and balancer shafts.



S53,JD254 -19-04APR90

Flywheel Turning Tool (A) JD281A

Used on engines with 142 tooth flywheel ring gear and a diamond shaped tool guide bore (B) in flywheel housing. Tool has it's own spring loaded timing pin which threads into flywheel housing.



RG6252 -UN-22JUL92

RG,JD281A -19-17JUL92

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Lock engine at TDC when installing injection pump or timing valve train. Use with JDG820, JDE81-1, or JDE83 Flywheel Turning Tool.

RG,JDE814 -19-03JAN95

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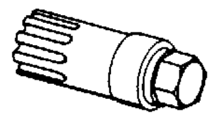
Flywheel Turning Tool JDE83

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



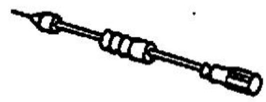
RG6251 -UN-22JUL92

RG,JDE83 -19-17JUL92

RG5109 -UN-23AUG88

Seal Remover JDG22

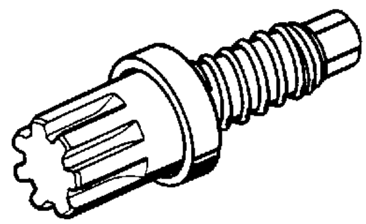
Remove crankshaft rear oil seal without removing flywheel housing.



JDG22 -19-27DEC94

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.

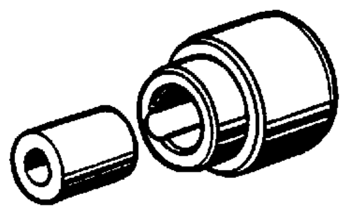


RG7056 -UN-10AUG94

RG,CTM8,DW570 -19-22SEP95

Front Crankshaft Oil Seal Installer KJD10164

Install front crankshaft oil seal with timing gear cover installed on the engine. MUST BE used on composite material timing gear covers.



RG6304 -UN-03AUG92

RG,KJD10164 -19-27AUG92

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
D15001NU Magnetic Follower Holder Kit	Hold cam followers when removing and installing camshaft.
JD247 Balancer Shaft Holding Tool	Hold balancer shaft while pressing gear on shaft.

S55,2000,MR -19-04APR90

OTHER MATERIALS

Name	Use
LOCTITE 242 (TY9370) Thread Lock and Sealer	Front plate studs and set screws, tachometer gear screw, gaskets, and front crankshaft oil seal (OD).
LOCTITE 515 (TY6304) Flexible Sealant (General Purpose)	Front plate gasket, oil filler neck gasket, and timing gear cover gasket.
TY6333 or TY6347 High Temperature Grease	Coat cam followers, camshaft lobes, journals, and bushings during installation. Coat idler gear, bushing, and shaft during installation. Coat internal splines of auxiliary output gear.

RG,CTM8,DX136 -19-06OCT94

CAMSHAFT, BALANCER SHAFTS, AND TIMING GEAR TRAIN SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Camshaft Journal OD	55.872—55.898 mm (2.1997—2.2007 in.)	——
Camshaft Bore Diameter in Cylinder Block	55.986—56.012 mm (2.2042—2.2052 in.)	——
Maximum Runout		0.05 mm (0.002 in.)
Camshaft Bore-to-Journal Clearance	0.08—0.13 mm (0.003—0.005 in.)	0.15 mm (0.006 in.)
Camshaft End Play	0.08—0.23 mm (0.003—0.009 in.)	0.38 mm (0.015 in.)
Camshaft Thrust Plate Thickness	3.96—4.01 mm (0.156—0.158 in.)	3.83 mm (0.151 in.)
Cam Follower OD	31.61—31.64 mm (1.245—1.246 in.)	——
Cam Follower Bore Diameter in Cylinder Block	31.70—31.75 mm (1.248—1.250 in.)	——
Camshaft Follower-to-Bore Clearance	0.06—0.13 mm (0.002—0.005 in.)	——

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S55,2005,BH -19-01NOV95

CAMSHAFT, BALANCER SHAFTS, AND TIMING GEAR TRAIN SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Valve Lift at 0.00 mm (in.) Clearance		
Intake Valve:		
3179 (—CD666423)		
4239 (—CD656456)		
4239 (—T0133254)		
4276 (—T0133254)		
6359 (—CD656605)		
6359 (—T0134868)		
6414 (—T0134868)	11.28—12.12 mm (0.444—0.477 in.)	10.85 mm (0.427 in.)
3179 (CD666424—)		
4239 (CD656457—)		
4239 (T0133255—)		
4276 (T0133255—)		
6359 (CD656606—)		
6359 (T0134869—)		
6414 (T0134869—)	11.56—12.37 mm (0.455—0.487 in.)	11.13 mm (0.438 in.)
Exhaust Valve:		
All Dubuque and Saran Engines	11.28—12.12 mm (0.444—0.477 in.)	10.85 mm (0.427 in.)
Camshaft Lobe Height		
Intake Lobe:		
3179 (—CD666423)		
4239 (—CD656456)		
4239 (—T0133254)		
4276 (—T0133254)		
6359 (—CD656605)		
6359 (—T0134868)		
6414 (—T0134868)	6.76—7.26 mm (0.266—0.286 in.)	6.50 mm (0.256 in.)
3179 (CD666424—)		
4239 (CD656457—)		
4239 (T0133255—)		
4276 (T0133255—)		
6359 (CD656606—)		
6359 (T0134869—)		
6414 (T0134869—)	6.93—7.42 mm (0.273—0.292 in.)	6.68 mm (0.263 in.)
Exhaust Lobe:		
All Dubuque and Saran Engines	6.76—7.26 mm (0.266—0.286 in.)	6.50 mm (0.256 in.)

S11,2016,A -19-26JUN95

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CAMSHAFT, BALANCER SHAFTS, AND TIMING GEAR TRAIN SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Balancer Shaft Bearing Journal Diameter	38.137—38.163 mm (1.5014—1.5024 in.)	——
Balancer Shaft Bushing ID (installed):		
Standard	38.177—38.237 mm (1.5030—1.5054 in.)	——
Oversized (4239 Engines)	38.194—38.220 mm (1.5035—1.5045 in.)	——
Bushing-to-Journal Clearance	0.024—0.102 mm (0.001—0.004 in.)	0.15 mm (0.006 in.)
Cylinder Block Bore Diameter for Balancer Shaft Bushing (Standard)	41.262—41.288 mm (1.6245—1.6255 in.)	——
Cylinder Block Bore Diameter for Balancer Shaft Bushing (Oversize)	43.237—43.263 mm (1.7015—1.7025 in.)	——
Balancer Shaft Thrust Plate Thickness	2.97—3.02 mm (0.117—0.119 in.)	——
Thrust Plate-to-Gear Clearance	0.05—0.26 mm (0.002—0.010 in.)	——
Balancer Shaft End Play	0.05—0.26 mm (0.002—0.010 in.)	0.38 mm (0.015 in.)
Timing Gear Backlash Between:		
Upper Idler Gear and Crankshaft Gear	0.07—0.30 mm (0.003—0.012 in.)	0.40 mm (0.016 in.)
Upper Idler Gear and Camshaft Gear	0.07—0.35 mm (0.003—0.014 in.)	0.51 mm (0.020 in.)
Upper Idler Gear and Injection Pump Gear	0.07—0.35 mm (0.003—0.014 in.)	0.51 mm (0.020 in.)
Lower Idler Gear and Crankshaft Gear	0.07—0.35 mm (0.003—0.014 in.)	0.51 mm (0.020 in.)
Lower Idler Gear and Balancer Shaft Gear	0.05—0.40 mm (0.002—0.016 in.)	0.51 mm (0.020 in.)
Lower Idler Gear and Oil Pump Gear	0.04—0.36 mm (0.0016—0.015 in.)	0.40 mm (0.016 in.)
Oil Pump Gear and Balancer Shaft Gear	0.05—0.36 mm (0.002—0.015 in.)	0.51 mm (0.020 in.)
Lower Idler Gear Shaft OD	44.43—44.46 mm (1.751—1.753 in.)	44.40 mm (1.748 in.)
Lower Idler Gear Bushing ID	44.48—44.53 mm (1.751—1.753 in.)	44.56 mm (1.754 in.)
End Play of Idler Gear	0.14—0.29 mm (0.006—0.012 in.)	0.40 mm (0.016 in.)

S55D,3005,BO -19-01NOV95

CAMSHAFT, BALANCER SHAFTS, AND TIMING GEAR TRAIN SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Hub Width of Idler Gear	21.98—22.03 mm (0.865—0.867 in.)	21.93 mm (0.863 in.)
Hub Width of Idler Shaft	22.17—22.27 mm (0.873—0.877 in.)	——
Spring Pins Protrude from Shaft:		
On Lower Idler Gear:	5.0—7.0 mm (0.20—0.28 in.)	——
On Upper Idler Gear:	3.5—4.5 mm (0.14—0.18 in.)	——
Oil Clearance:		
Upper and Lower Idler Gear Bushing-to-Shaft	0.02—0.10 mm (0.001—0.004 in.)	0.15 mm (0.006 in.)

RG,CTM4,DW801 -19-25SEP95

CAMSHAFT, BALANCER SHAFTS, AND TIMING GEAR TRAIN SPECIFICATIONS—CONTINUED

TORQUES

Camshaft Thrust Plate-to-Cylinder Block . . . . 47 N·m (35 lb-ft)

Balancer Shaft Thrust Plate-to-Cylinder Block . . . . 47 N·m (35 lb-ft)

Weight-to-Balancer Shaft, Special Nut . . . . 60 N·m (45 lb-ft)

Front Plate-to-Cylinder Block, Special Screws . . . . 34 N·m (25 lb-ft)

Oil Pump Drive Gear on Oil Pump Shaft, Hex. Nut (Staked) . . . . 54 N·m (40 lb-ft)

Upper Idler Gear Cap Screw:
All Dubuque Engines and Saran Engine Serial No. (—CD868856) . . . . 100 N·m (75 lb-ft)
Saran Engine Serial No. (CD868857—) . . . . 110 N·m (81 lb-ft)

Lower Idler Gear:
Cap Screw on Eng. Ser. No. (—CD775574), (—T0225854), (T0300001—303310) . . . 130 N·m (95 lb-ft)
Cap Screw on Eng. Ser. No. (CD868857—) . . . . 110 N·m (81 lb-ft)
Hex Nut on Eng. Ser. No. (CD775575—CD868856), (T0225855—300000), (T0303311—) 100 N·m (75 lb-ft)

Timing Gear Cover-to-Cylinder Block and Front Plate . . . . 47 N·m (35 lb-ft)

Auxiliary Gear Cover-to-Cylinder Block and Front Plate . . . . 47 N·m (35 lb-ft)

Fuel Injection Pump Gear:
Roto Diesel/Lucas CAV (three screw hub) . . . . 35 N·m (25 lb-ft)
Roto Diesel/Lucas CAV (solid drive shaft) . . . . 85 N·m (63 lb-ft)
Stanadyne (Models JDB and DB2) . . . . 60 N·m (45 lb-ft)
Stanadyne (Model DM4) . . . . 195 N·m (145 lb-ft)

Balancer Shaft Thrust Plate . . . . 47 N·m (35 lb-ft)

Alternator Mounting Bracket . . . . 47 N·m (35 lb-ft)

S11,2016,B -19-01NOV95

CAMSHAFT, BALANCER SHAFTS, AND TIMING GEAR TRAIN SPECIFICATIONS—CONTINUED

TORQUES—CONTINUED

Oil Filler Neck:	
Aluminum Neck	47 N·m (35 lb-ft)
Composite Material Neck	30 N·m (22 lb-ft)
Injection Pump Drive Gear Cover Plate	24 N·m (18 lb-ft)
Injection Pump Drive Gear Threaded Cap	30 N·m (22 lb-ft)
Screw-in Tachometer Drive Gear	20 N·m (15 lb-ft)
Aluminum Timing Gear Cover:	
Cover-to-Front Plate Cap Screws	47 N·m (35 lb-ft)
Cover-to-Oil Pan Cap Screws	37 N·m (27 lb-ft)
Magnetic Pick-up	14 N·m (10 lb-ft)
Oil Pressure Regulating Valve Plug	30 N·m (22 lb-ft)
Composite Timing Gear Cover:	
Magnetic Pick-up	14 N·m (10 lb ft)
Plug-to-Access Injection Pump Drive Gear Nut	30 N·m (22 lb-ft)
Cover-to-Oil Pan Cap Screws	30 N·m (22 lb-ft)
Cover-to-Front Plate Cap Screws	47 N·m (35 lb-ft)
Oil Pressure Regulating Valve Plug	30 N·m (22 lb-ft)
Pulley or Damper-to-Crankshaft:	
Engines without Auxiliary Drive	150 N·m (110 lb-ft)
Engines with Auxiliary Drive	183 N·m (135 lb-ft)
Rocker Arm Cover-to-Cylinder Head	10 N·m (84 lb-in.)
Oil Pan-to-Cylinder Block:	
Sheet Metal Pan	47 N·m (35 lb-ft)
Aluminum Pan	47 N·m (35 lb-ft)
Cast Iron Pan*	47 N·m (35 lb-ft)

**SAE 8 C/S 68 N·m (50 lb-ft)*

RG,CTM4,DY106 -19-01NOV95

AUXILIARY GEAR DRIVE SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Drive Ratio (Output Gear-to-Crankshaft Gear)	0.97:1	—
Crankshaft OD for Collet	38.000—38.002 mm (1.49606—1.49614 in.)	—
Collet ID	38.013—38.063 mm (1.496—1.498 in.)	—
Drive Gear (Crankshaft, 34-tooth) ID at Front Face	46.192 mm (1.818 in)	—
Idler Gear (49-tooth) ID	39.936—39.962 mm (1.572—1.573 in.)	—
Idler Shaft OD for Gear	39.987—40.013 mm (1.574—1.575 in.)	—
Idler Shaft OD for Bearings	34.970—34.986 mm (1.376—1.377 in.)	—
Output Gear (35-tooth) OD for Bearings	34.970—34.986 mm (1.376—1.377 in.)	—
Machined Bore in Gear Covers: for Idler Shaft Bearing	79.92—79.96 mm (3.146—3.148 in.)	—
for Output Shaft Bearing	71.93—71.97 mm (2.832—2.833 in.)	—
Idler Shaft Bearing: OD	79.987—80.000 mm (3.149—3.150 in.)	—
ID	34.987—35.000 mm (1.377—1.378 in.)	—
Output Shaft Bearing: OD	71.987—72.000 mm (2.834—2.835 in.)	—
ID	34.987—35.000 mm (1.377—1.378 in.)	—
Dowel Pin Protrusion Front Face of Timing Gear Cover	11.0—12.0 mm (0.43—0.47 in.)	—
Set Screws in Unused Threaded Holes	0.0—1.0 mm below (0.000—0.004 in. below)	—

S11,2016,BT -19-21SEP95

MEASURE VALVE LIFT

T81227 -UN-01NOV88

Measuring valve lift can give an indication of excess wear on cam lobes, followers, and/or push rods.

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

1. Remove rocker arm cover.

2. Lock No. 1 piston at TDC compression stroke. See CHECK AND ADJUST VALVE CLEARANCE in Group 05 for engine valve locations.

3. Set rocker arm-to-wear cap/valve tip clearance to 0.00 mm (in.) for:

• No. 1 and 2 exhaust and No. 1 and 3 intake valves on 3-cylinder engines.

• No. 1 and 3 exhaust and No. 1 and 2 intake valves on 4-cylinder engines.

• No. 1, 3, and 5 exhaust and No. 1, 2, and 4 intake valves on 6-cylinder engines.

4. Place dial indicator tip on top of valve spring cap or rotator. Preload indicator tip and set dial at 0.00 mm (in.).

5. Remove timing pin from flywheel and manually rotate engine one full revolution (360˚) in running direction.

S55,2005,BL -19-21SEP95

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

VALVE LIFT SPECIFICATION
[At 0.00 mm (in.) Valve Clearance]

Intake Valves:
3179 (—CD666423)
4239 (—CD656456) (—T0133254)
4276 (—T0133254)
6359 (—CD656605) (—T0134868)
6414 (—T0134868) . . . . 11.28—12.12 mm (0.444—0.477 in.)
Wear Limit . . . . 10.85 mm (0.427 in.)
3179 (CD666424—   )
4239 (CD656457—   ) (T0133255—   )
4276 (T0133255—   )
6359 (CD656606—   ) (T0134869—   )
6414 (T0134869—   ) . . . . 11.56—12.37 mm (0.455—0.487 in.)
Wear Limit . . . . 11.13 mm (0.438 in.)
Exhaust Valves:
All Dubuque and Saran Engines . . . . 11.28—12.12 mm (0.444—0.477 in.)
Wear Limit . . . . 10.85 mm (0.427 in.)

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

If valve lift is within specification, adjust valves to specified clearance. See CHECK AND ADJUST VALVE CLEARANCE in Group 05.

If valve lift is not within specification, remove and inspect entire valve train and camshaft.

8. Rotate engine one full revolution (360°). Lock engine at:

- TDC No. 1 exhaust stroke for 3-cylinder engines.
- TDC No. 4 compression stroke for 4-cylinder engines.
- TDC No. 6 compression stroke for 6-cylinder engines.

9. Set rocker arm-to-wear cap/valve tip clearance to 0.00 mm (in.) for:

- No. 3 exhaust and No. 2 intakes valves on 3-cylinder engines.
- No. 2 and 4 exhaust and No. 3 and 4 intake valves on 4-cylinder engines.
- No. 2, 4, and 6 exhaust and No. 3, 5, and 6 intake valves on 6-cylinder engines.

10. Repeat step 7.

S11,2005,IS -19-21SEP95

REMOVE TIMING GEAR COVER

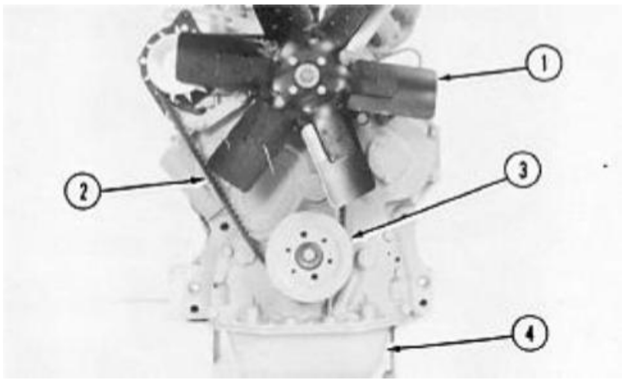
1. Drain oil from engine crankcase.

2. Remove fan (1), fan belt (2), and water pump. (See Group 25 - Cooling System.)

3. Remove alternator and alternator mounting bracket.

4. Remove crankshaft pulley or damper/pulley (3). (See Group 15 - Crankshaft, Main Bearings, and Flywheel.)

5. Remove oil pan (4). (See Group 20 - Lubrication System.)



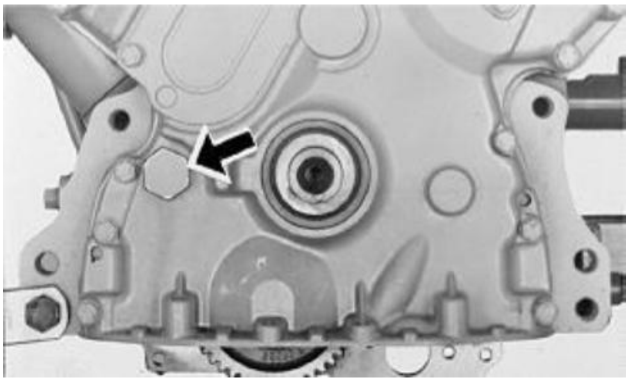
T79150 -UN-07NOV88

1—Fan
2—Fan Belt
3—Crankshaft Pulley or Damper/Pulley
4—Oil Pan

S11,2016,D -19-21SEP95

6. Unscrew the oil pressure regulating valve plug and remove spring and valve (3179, 4239, and 6359 Engines).

7. Remove timing gear cover-to-cylinder block cap screws. Remove cover.



T70248 -UN-24FEB89

S11,2016,E -19-13JUL95

8. Remove oil deflector from crankshaft. On 6-cylinder engines, first remove wear sleeve and then remove oil deflector.

NOTE: Some 6-cylinder engines also use an O-ring with the wear sleeve.

RG4923 -UN-06DEC88

S11,2016,F -19-26JUN95

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REMOVE AUXILIARY DRIVE GEARS (ENGINES WITH AUXILIARY GEAR DRIVE OPTION)

1. Remove auxiliary drive gear cover (A) with bearings.

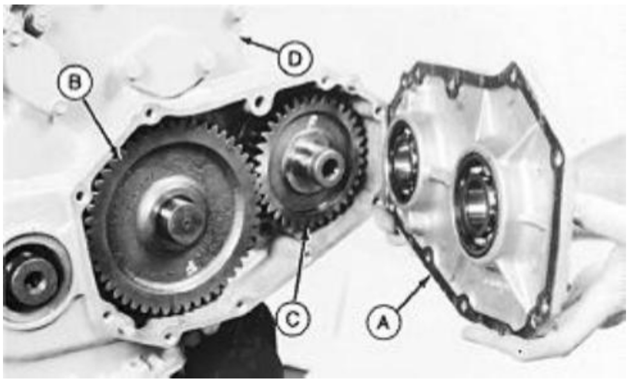
2. Remove auxiliary idler (B) and output drive (C) gears.

3. Remove timing gear cover (D) nuts and cap screws. Remove crankshaft (drive) gear (E) and collet.

4. Replace worn or damaged bearings.

5. Clean covers and inspect for cracks or damage.

A—Auxiliary Drive Gear Cover
B—Auxiliary Idler Gear
C—Output Drive Gear
D—Timing Gear Cover
E—Crankshaft (Drive) Gear



RG6315 -UN-03AUG92

RG6316 -UN-03AUG92

CTM8,GR16,24 -19-03JAN95

MEASURE CAMSHAFT END PLAY

1. Measure camshaft end play.

CAMSHAFT END PLAY SPECIFICATIONS

Camshaft End Play	0.08—0.23 mm (0.003—0.009 in.)
Wear Limit	0.38 mm (0.015 in.)

NOTE: If end play is excessive, check thrust plate thickness with camshaft removed. (See MEASURE CAMSHAFT THRUST PLATE CLEARANCE later in this group).

T90982 -UN-07NOV88

S11,2016,G -19-01NOV95

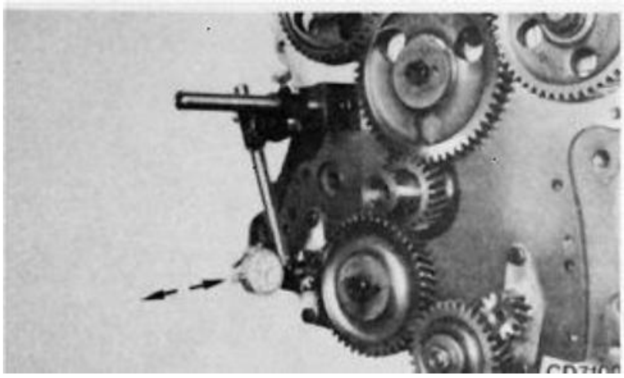
MEASURE BALANCER SHAFT END PLAY—4-CYLINDER ENGINES

1. Measure balancer shaft end play.

BALANCER SHAFT END PLAY SPECIFICATIONS

Balancer Shaft End Play	0.05—0.26 mm (0.002—0.010 in.)
Wear Limit	0.38 mm (0.015 in.)

NOTE: If balancer shaft end play exceeds specifications, check thrust plate thickness. (See INSPECT BALANCER SHAFT GEARS AND THRUST PLATES later in this group.)



CD7109 -UN-09DEC88

S11,2016,H -19-26JUN95

MEASURE TIMING GEAR BACKLASH

Measure backlash between gears.

TIMING GEAR BACKLASH SPECIFICATIONS

Camshaft-to-Upper Idler (A)	0.07—0.35 mm (0.003—0.014 in.)
Wear Limit	0.51 mm (0.020 in.)
Injection Pump-to-Upper Idler (B)	0.07—0.35 mm (0.003—0.014 in.)
Wear Limit	0.51 mm (0.020 in.)
Upper Idler-to-Crankshaft (C)	0.07—0.30 mm (0.003—0.012 in.)
Wear Limit	0.40 mm (0.016 in.)
Crankshaft-to-Lower Idler (D)	0.07—0.35 mm (0.003—0.014 in.)
Wear Limit	0.51 mm (0.020 in.)
*Balancer Shaft-to-Oil Pump (E)	0.05—0.36 mm (0.002—0.015 in.)
Wear Limit	0.51 mm (0.020 in.)
Oil Pump-to-Lower Idler (F)	0.04—0.36 mm (0.0016—0.015 in.)
Wear Limit	0.40 mm (0.016 in.)
*Lower Idler-to-Balancer Shaft (G)	0.05—0.40 mm (0.002—0.016 in.)
Wear Limit	0.51 mm (0.020 in.)

16
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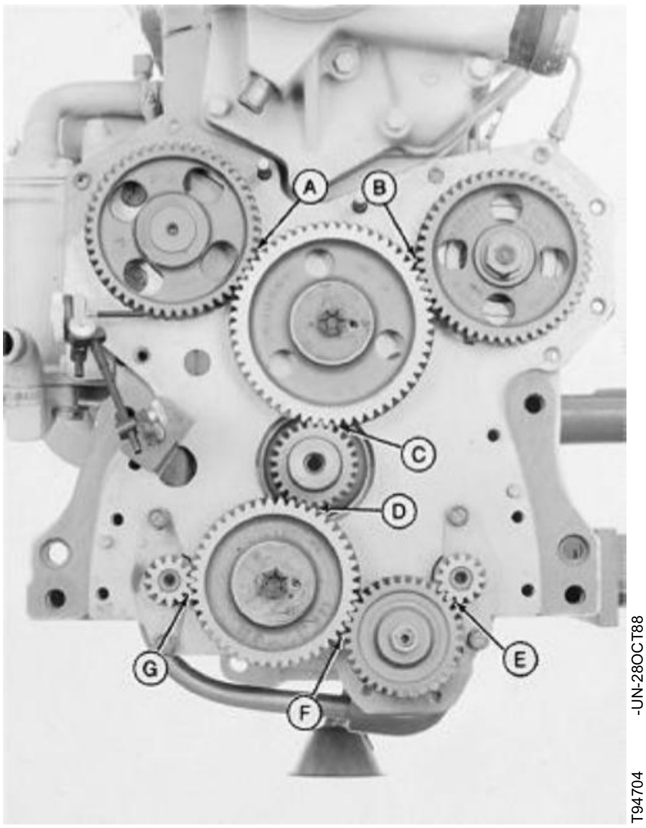
If backlash is not within specification, install new gears.



A—Camshaft Gear-to-Upper Idler Gear
B—Injection Pump Gear-to-Upper Idler Gear
C—Upper Idler Gear-to-Crankshaft Gear
D—Crankshaft Gear-to-Lower Idler Gear
E—Balancer Shaft Gear-to-Oil Pump Gear*
F—Oil Pump Gear-to-Lower Idler Gear
G—Lower Idler Gear-to-Balancer Shaft Gear*

** 4-cylinder engine only*

S11,2016,I -19-21SEP95

MEASURE IDLER GEAR END PLAY


T81269 -UN-09NOV88

Check end play of upper and lower idler gears.

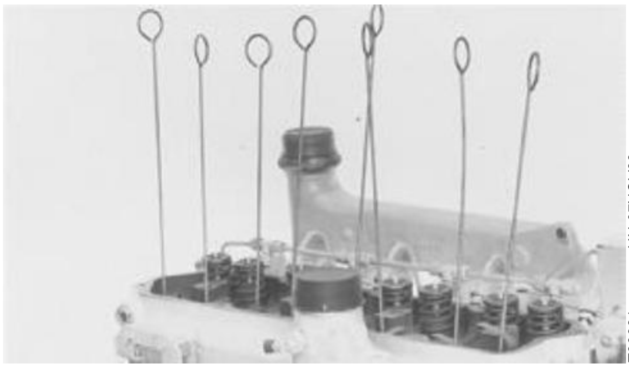
IDLER GEAR END PLAY SPECIFICATIONS

Idler Gear End Play	0.14—0.29 mm (0.006—0.012 in.)
Wear Limit	0.40 mm (0.016 in.)

If idler gear end play does not meet specifications, check idler gear, idler shaft, and thrust washer for wear. See MEASURE IDLER GEAR BUSHING AND SHAFT later in this group.

S11,2016,J -19-21SEP95

REMOVE CAMSHAFT


T90981 -UN-07NOV88

NOTE: If camshaft lobes show excessive wear, then remove cylinder head so camshaft followers can be removed for inspection. (See REMOVE CYLINDER HEAD in Group 05.)

1. Measure valve lift. (See MEASURE VALVE LIFT earlier in this group).

2. Remove rocker arm assembly and push rods. (See Group 05.)

3. Remove timing gear cover. (See REMOVE TIMING GEAR COVER earlier in this group.)

4. Remove camshaft activated fuel supply pump, if equipped.

RG,CTM8,GR16,38-19-03JAN95

5. Turn crankshaft until cap screws (A) can be removed.

6. Turn engine front side up and hold camshaft followers away from camshaft lobes with D15001NU Magnetic Follower Holder Kit.

T90983 -UN-09NOV88

RG,CTM8,GR16,39-19-21SEP95

IMPORTANT: DO NOT allow camshaft lobes to drag on camshaft bushing or honed camshaft bore surfaces.

7. Pull camshaft straight up, out of cylinder block. Remove thrust plate.

T81258 -UN-01NOV88

RG,CTM8,GR16,40-19-19OCT92

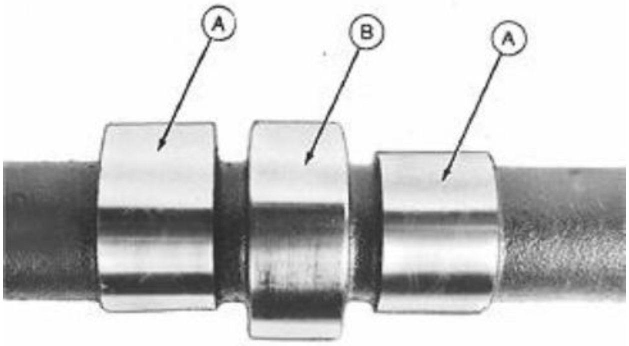
VISUALLY INSPECT CAMSHAFT

1. Clean camshaft in solvent. Dry with compressed air.

2. Inspect camshaft lobes (A) and journals (B) for wear or damage. Replace as necessary. New camshaft followers can be used with old camshaft. DO NOT use old camshaft followers with a new camshaft. (See Group 05 for camshaft follower replacement.)

NOTE: Very light score marks are acceptable if valve lift is within specification. If pitting or galling exists, replace camshaft. (See MEASURE VALVE LIFT earlier in this group.)

3. Inspect tachometer drive for wear. Replace as necessary. (See REPLACE TACHOMETER DRIVE GEAR later in this group.)



RG3500 -UN-06AUG91

RG,CTM8,GR16,41-19-11OCT94

MEASURE CAMSHAFT THRUST PLATE CLEARANCE

1. Clean camshaft thrust plate and check clearance using a feeler gauge. Replace parts as necessary.

CAMSHAFT THRUST PLATE CLEARANCE

Camshaft Thrust Plate Clearance . . . . 0.08—0.23 mm (0.003—0.009 in.)
Wear Limit . . . . 0.38 mm (0.015 in.)

NOTE: Thrust plate clearance determines camshaft end play.

T81261 -UN-01NOV88

RG,CTM8,GR16,42-19-16SEP92

INSPECT AND MEASURE CAMSHAFT BEARING BORE ID AND JOURNAL OD

1. Measure camshaft journals. If a camshaft journal is damaged or does not meet specification, install a new camshaft.

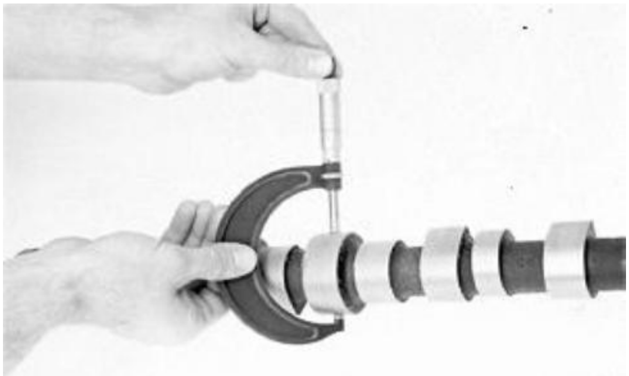
2. Measure camshaft bore ID in cylinder block. If camshaft bore is damaged or is not within specification, install a new cylinder block or short block assembly.

CAMSHAFT BEARING BORE AND JOURNAL SPECIFICATIONS

Camshaft Journal OD . . . . 55.872—55.898 mm (2.1997—2.2007 in.)

Camshaft Bore ID in Cylinder Block . . . . 55.986—56.012 mm (2.2042—2.2052 in.)

Camshaft Journal Clearance (new)
(Camshaft Bore ID Minus Camshaft Journal OD) . . . . 0.08—0.13 mm (0.003—0.005 in.)
Maximum Clearance . . . . 0.15 mm (0.006 in.)



T81260 -UN-07NOV88

RG,CTM4,DY099 -19-01NOV95

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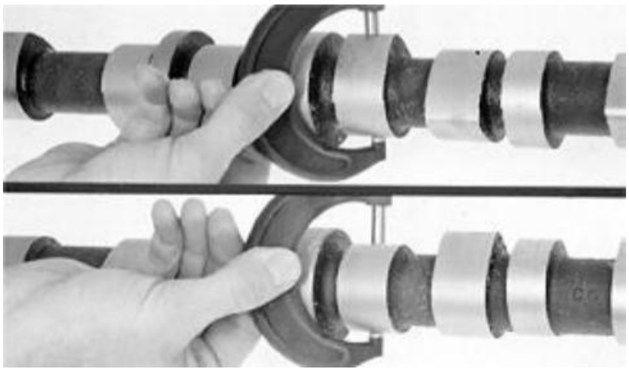
MEASURE CAMSHAFT LOBE HEIGHT

1. Measure each camshaft lobe at highest point and at narrowest point. The difference between these dimensions is camshaft lobe height. If height is not correct on any lobe, install a new camshaft.



T81262 -UN-01NOV88

CAMSHAFT LOBE HEIGHT SPECIFICATIONS

Intake Lobe:

3179 (—CD666423)
4239 (—CD656456)
(—T0133254)
4276 (—T0133254)
6359 (—CD656605)
(—T0134868)
6414 (—T0134868)

New Part . . . . 6.76—7.26 mm (0.266—0.286 in.)

Wear Limit . . . . 6.50 mm (0.256 in.)

3179 (CD666424—)
4239 (CD656457—)
(T0133255—)
4276 (T0133255—)
6359 (CD656606—)
(T0134869—)
6414 (T0134869—)

New Part . . . . 6.93—7.42 mm (0.273—0.292 in.)

Wear Limit . . . . 6.68 mm (0.263 in.)

Exhaust Lobe:

All Dubuque and Saran Engines

New Part . . . . 6.76—7.26 mm (0.266—0.286 in.)

Wear Limit . . . . 6.50 mm (0.256 in.)

S11,2016,R -19-21SEP95

REMOVE AND INSTALL CAMSHAFT GEAR

IMPORTANT: Camshaft must be replaced if dropped or damaged, do not allow camshaft to strike floor when removing gear.

1. Press camshaft out of gear.

2. Inspect cam journals for nicks and scratches. Replace camshaft if damage is found.

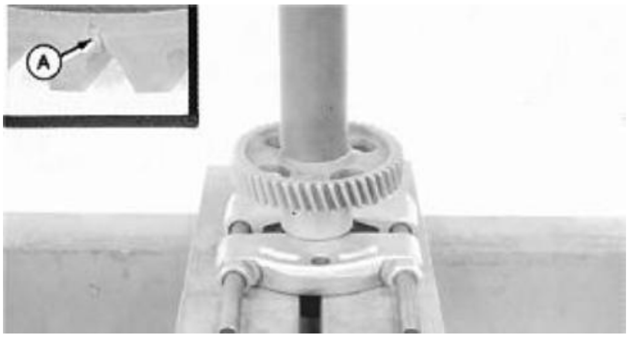
T88696 -UN-28OCT88

RG,CTM8,GR16,44-19-19OCT92

3. Apply TY6333 High-Temperature Grease to camshaft nose and gear ID to ease installation.

4. Install Woodruff key in camshaft nose.

5. Install gear with timing mark (A) away from camshaft (towards front timing gear cover). Press gear onto camshaft with a tubular driver until gear bottoms against camshaft shoulder.



T88697 -UN-28OCT88

RG,CTM8,GR16,45-19-25SEP95

INSPECT CAMSHAFT FOLLOWERS

NOTE: Cylinder head must be removed before camshaft followers can be removed from engine. (See Group 05.)

1. Inspect followers for uneven wear or damage. Also inspect corresponding camshaft lobe for wear or damage. Replace as necessary.

2. Measure follower OD and follower bore ID in cylinder block.

RG6324 -UN-03AUG92

CAMSHAFT FOLLOWER AND BORE SPECIFICATIONS

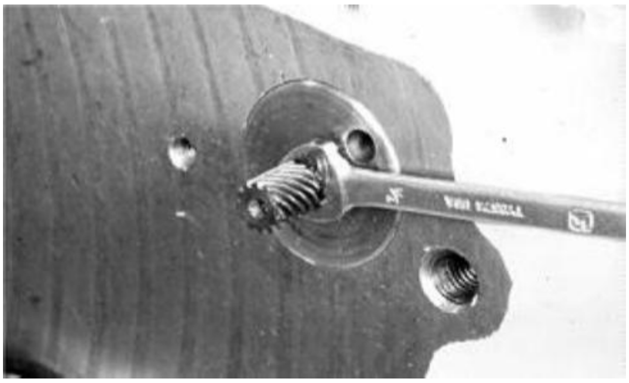
Camshaft Follower OD	31.61—31.64 mm (1.245—1.246 in.)
Camshaft Follower Bore ID in Block	31.70—31.75 mm (1.248—1.250 in.)

Replace cam followers that are not within specification.

Replace cylinder block if any one cam follower bore is not within specification.

RG,CTM8,GR16,46-19-16SEP92

REPLACE TACHOMETER DRIVE GEAR



RG5641 -UN-02APR90

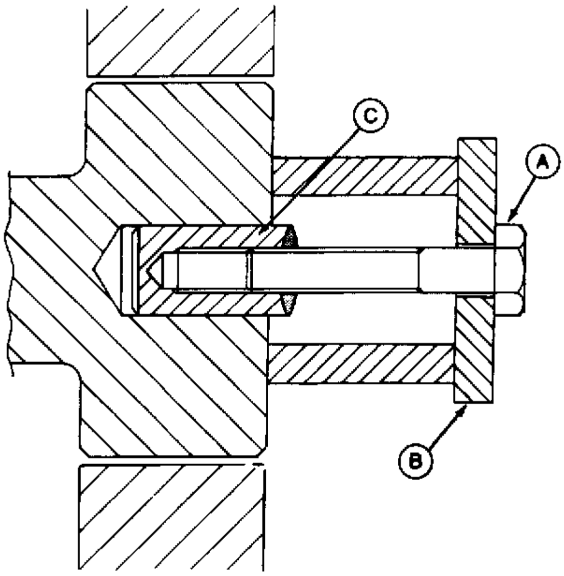
NOTE: If the camshaft is not removed from the engine, the flywheel and flywheel housing must be removed before the tachometer drive gear can be replaced.

• Screw-In Type Tachometer Drive Gear:

1. Remove failed tachometer drive gear.

2. Apply LOCTITE 242 (TY9370) Thread Lock and Sealer to threads of new tachometer drive gear and tighten to 20 N·m (15 lb-ft).

• Press-In Type Tachometer Drive Gear (Saran Engines Only):



RG5579 -UN-09OCT89

IMPORTANT: The tachometer drive gear is tightly pressed into the camshaft. Follow removal and installation procedures carefully. Failure to do so will result in a broken or damaged gear and in most cases will require camshaft replacement.

1. Break off or saw off gear so shaft stub can be drilled.

2. If camshaft is not removed from engine, protect vital areas such as rear camshaft bore, crankshaft bearings, crankcase, etc. from metal shavings.

3. Drill and tap a hole 6.0 mm (0.250 in.) diameter and 12.7 mm (0.050 in.) deep in the center of the gear shaft.

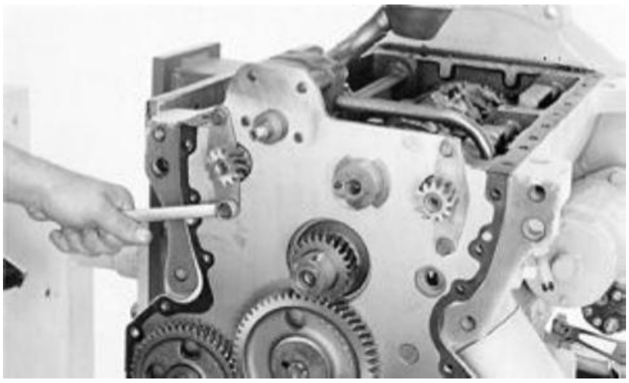
4. Using an appropriate cap screw (A) and spacer (B) (or several washers), engage the cap screw until it bottoms or until stub (C) comes out. If cap screw bottoms, add more washers until shaft stub is free from camshaft bore.

IMPORTANT: When installing tachometer drive gear, support front end of camshaft so that front thrust plate is not damaged.

5. Install tachometer drive gear. Press only on shaft portion of gear.

CTM8,GR16,26 -19-03JAN95

REMOVE BALANCER SHAFTS—IF EQUIPPED (4-CYLINDER ENGINES)

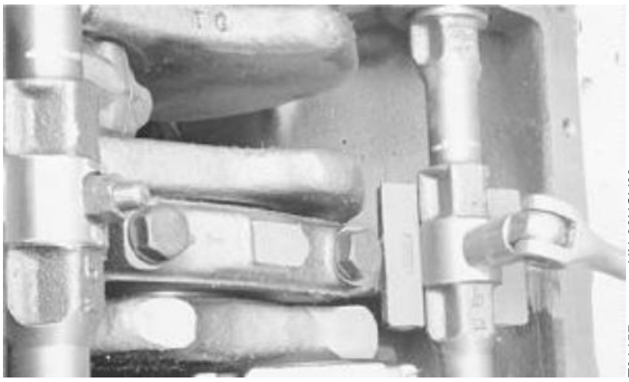

T82116 -UN-09NOV88

Both Dubuque-built and Saran-built 4-cylinder engines are available without balancer shafts. Dubuque-built 4-cylinder engines without balancer shafts will have the balancer shaft bores machined in the cylinder block. However, the bushings will be installed so the oil holes do not align in the block. Saran-built 4-cylinder engines without balancer shafts will not have the balancer shaft oil holes drilled in block.

1. Remove lower idler gear and oil pump gear.

2. Remove cap screws from balancer shaft thrust plate.

CTM8,GR16,27 -19-12JAN95


T91157 -UN-09NOV88

IMPORTANT: Identify left and right balancer shafts for correct reassembly. Journals are lapped for one direction of rotation. Interchanging shaft locations could cause premature wear of shafts and bushings.

3. Remove balancer shaft weights (if equipped). Discard cap screws and nuts.

4. Remove balancer shafts.

RG,CTM8,GR16,48-19-04SEP92

INSPECT AND MEASURE BALANCER SHAFT BUSHINGS AND JOURNALS

RG6330 -UN-03AUG92

1. Inspect, measure and record bushing ID (A).

BALANCER SHAFT BUSHING AND JOURNAL SPECIFICATIONS

New Balancer Shaft Bushing ID	38.177—38.237 mm (1.5030—1.5054 in.)
Balancer Shaft Journal OD	38.137—38.163 mm (1.5014—1.5024 in.)
Journal-to-Bushing Oil Clearance	0.024—0.102 mm (0.001—0.004 in.)
Maximum Allowable Oil Clearance	0.15 mm (0.006 in.)

2. Measure balancer shaft journal OD. Difference between journal OD and bushing ID is oil clearance.

If oil clearance is not within specification, install new bushings and, if necessary, new balancer shaft.

T81899 -UN-09NOV88

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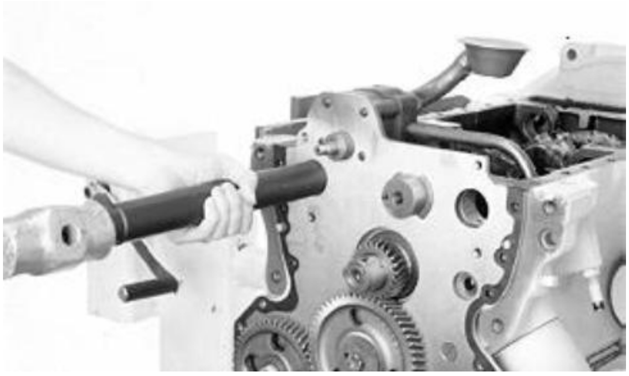
CTM8,GR16,7 -19-26JUN95

REMOVE AND INSTALL BALANCER SHAFT BUSHINGS IN BLOCK (4-CYLINDER, IF EQUIPPED)



T81898 -UN-07NOV88

Both Dubuque-built and Saran-built 4-cylinder engines are available without balancer shafts. Dubuque-built 4-cylinder engines without balancer shafts will have the balancer shaft bores machined in the cylinder block. However, the bushings will be installed so the oil holes do not align in the block. Saran-built 4-cylinder engines without balancer shafts will not have the balancer shaft bores machined in the cylinder block.

1. Remove bushings from cylinder block with JD249 Balancer Shaft Bushing Driver. To remove the rear (third) bushing, the flywheel housing has to be removed. (See REMOVE FLYWHEEL HOUSING in Group 15.)

2. Install new bushings into cylinder block with JD249 Balancer Shaft Bushing Driver.

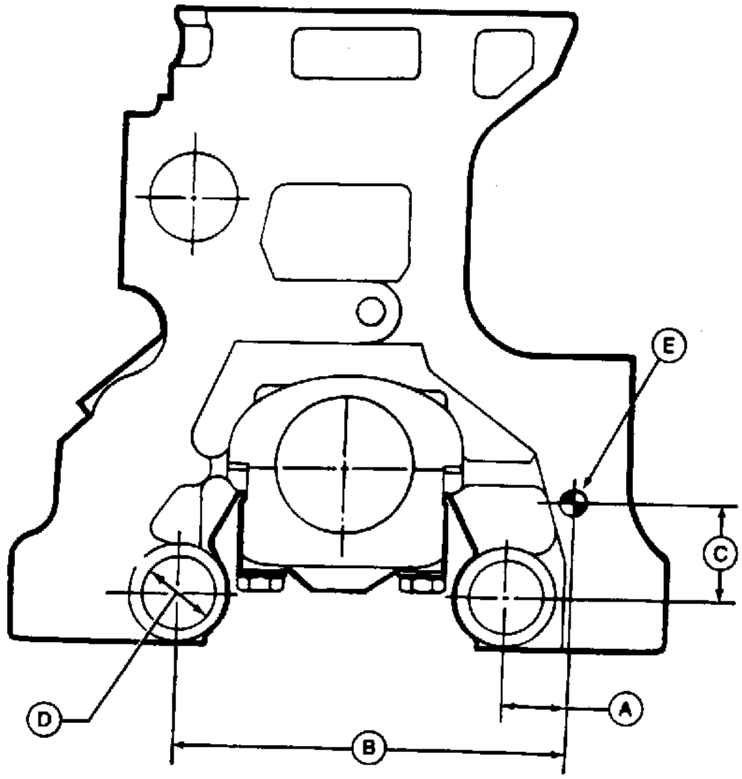
NOTE: Cylinder block must be line bored if oversize bushings are to be installed. See INSTALL OVERSIZE BALANCER SHAFT BUSHINGS IN CYLINDER BLOCK later in this group.

IMPORTANT: Make sure oil holes in bushing and block are aligned for proper bushing and journal lubrication.

3. Insert balancer shaft to check for bushing-to-shaft clearance. If shaft can be rotated by hand with a slight-to-moderate drag, adequate bushing-to-balancer shaft clearance exists. It is not necessary to hone bushings to obtain specified oil clearance. Excessive clearance can result in shaft seizure.

S11,2016,Y -19-26JUN95

INSTALL OVERSIZE BALANCER SHAFT BUSHINGS IN CYLINDER BLOCK —4239 ENGINES



IMPORTANT: Do not use oversize balancer shaft bushings in 4276 Engines with bolt-on weight balancer shafts. Oversize bushings should only be used with one-piece balancer shafts.

1. Remove standard bushings and check for cracked or broken block bosses.

2. Line bore cylinder block as specified.

IMPORTANT: Reference all line boring dimensions from front left dowel pin (E).

BALANCER SHAFT BUSHING LINE BORING SPECIFICATIONS

A	41.985—42.035 mm (1.653—1.655 in.)
B	257.985—258.035 mm (10.157—10.159 in.)
C	64.986—65.036 mm (2.558—2.560 in.)
D	43.237—43.263 mm (1.7015—1.7025 in.)

3. Make a chamfer 20—25° by 1.5 mm (0.060 in.) toward front of engine for front and middle bores and toward rear for rear bore to make bushing installation easier.

4. Install new bushings. See REMOVE AND INSTALL BALANCER SHAFT BUSHINGS IN BLOCK earlier in this group.

S55,2016,Y -19-26JUN95

INSPECT BALANCER SHAFT GEARS AND THRUST PLATES

-UN-20FEB95

RG4742

1. Inspect for broken, cracked or excessively worn gears. Check thrust plate for scoring or other excessive wear.

—Thrust plates on Option Code 4501 (60 percent balance-4239T) and Code 4502 (full balance-4239D) have a slotted hole (A) to permit removal and installation without removing the gear. For Code 4502 (on full balance-4239T and 4276 Engines), the gear must first be removed since the thrust plate hole (B) is not slotted.

—Saran built 4239 production engines beginning with Engine Serial No. (CD716485—) no longer use the slotted thrust plate for both naturally aspirated and turbocharged engines. A new plate without the slotted hole replaces both the slotted and non-slotted types previously used. Gear removal is required.

BALANCER SHAFT THRUST PLATE SPECIFICATIONS

Thrust Plate Thickness (new) . . . . 2.97—3.02 mm (0.117—0.119 in.)

S11,2016,Z -19-21SEP95

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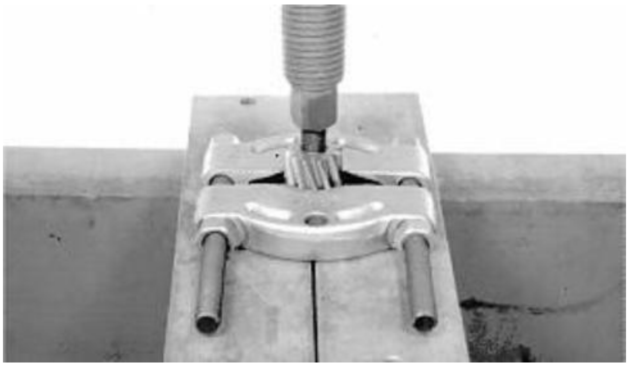
REMOVE AND INSTALL BALANCER SHAFT GEARS



T88842 -UN-07NOV88

IMPORTANT: DO NOT intermix gears and shafts. Balancer shafts must be installed in the location from which removed. Reversing shaft locations could result in excessive bushing and shaft wear. If in doubt about proper shaft locations, replace the balancer shaft and bushings.

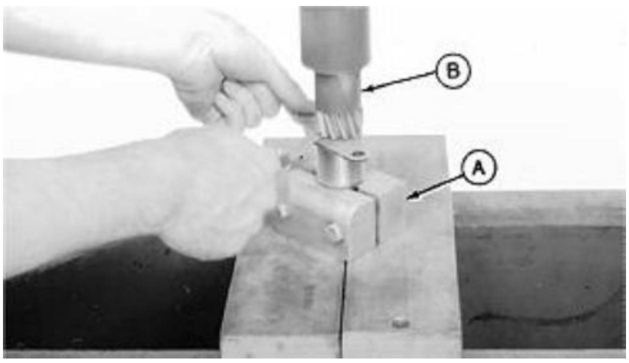
NOTE: Balancer shaft kits provided for service are delivered without gear. These shafts are finish-lapped in different directions, therefore it is important to note the letter stamped at the rear of the shafts:

- *“R” for right-hand side shaft*
- *“L” for left-hand side shaft*

1. Support back side of gear in a press and push on balancer shaft to remove gear.

2. Inspect Woodruff key, gear, and thrust plate for cracks and wear. Replace if necessary.

S11,2016,AA -19-21SEP95



T88840 -UN-07NOV88

3. Position balancer shaft in JD247 Balancer Shaft Holding Tool (A).

4. Install thrust plate and gear on balancer shaft. Be sure timing mark is on front face of gear.

5. Press gear onto shaft with a tube-type driver (B) until proper clearance between thrust plate and gear is obtained.

BALANCER SHAFT ASSEMBLY SPECIFICATIONS

Thrust Plate-to-Gear Clearance . . . . 0.05—0.26 mm (0.002—0.010 in.)

S11,2016,AB -19-29SEP94

REMOVE BALANCER SHAFT

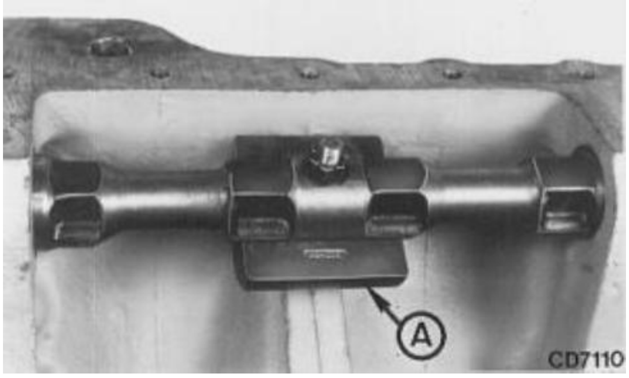
IMPORTANT: During removal, identify left and right balancer shafts to ensure correct reassembly. Journals are lapped for one direction of rotation. Interchanging shaft locations could therefore cause premature wear on shafts and bushings.

1. Remove lower idler gear and oil pump gear.

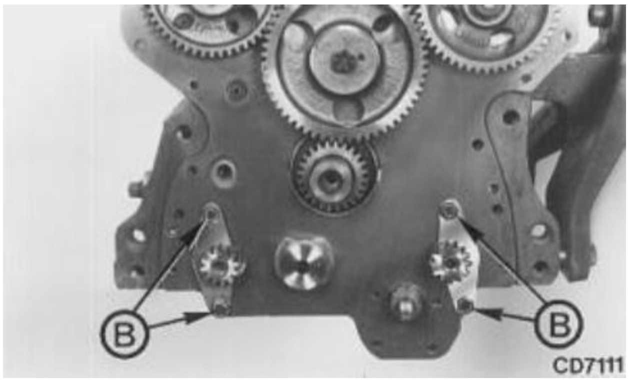
2. Remove balancer shaft weights (A), if equipped.

3. Loosen cap screws (B) and pull balancer shafts out of cylinder block.

NOTE: Take care when removing balancer shafts that neither shaft journals nor bushings in cylinder block are damaged.



CD7110 -UN-02NOV94



CD7111 -UN-02NOV94

RG,CTM4,DY111 -19-21SEP95

REMOVE CYLINDER BLOCK FRONT PLATE

Before the front plate can be removed, the following components must first be removed:

— Timing gear cover.

— Camshaft and gear (A)

— Injection pump drive gear (B)

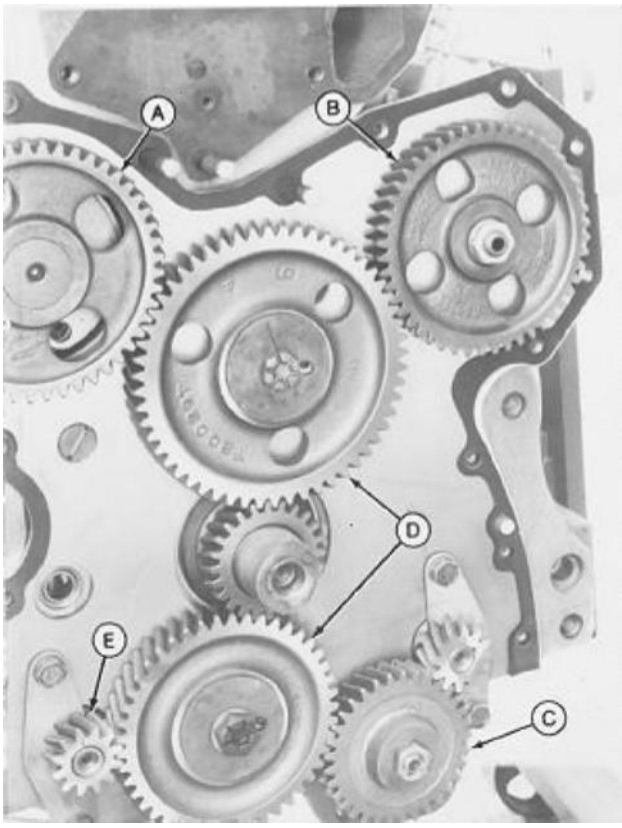
— Injection pump (See Group 35.)

— Oil pump drive gear (C)

— Oil pump (See Group 20.)

— Idler gears (D)

— Balancer shafts (E)



T90985 -UN-09NOV88

S11,2016,AC -19-26JUN95

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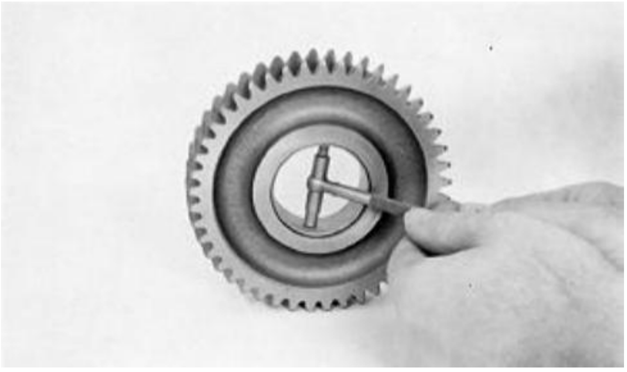
1. Remove five countersunk, flat-head screws and remove front plate.

S11,2016,AD -19-22JUL92

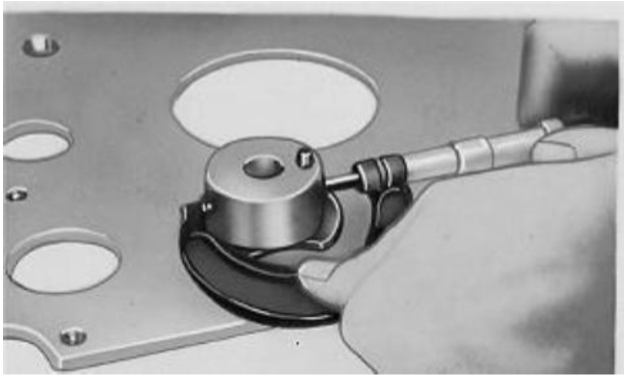
2. On 3179, 4239, and 6359 Engines, remove oil by-pass valve and spring (if equipped).

S11,2016,AE -19-23FEB87

MEASURE IDLER GEAR BUSHING AND SHAFT



T81273 -UN-09NOV88



T81347 -UN-09NOV88

1. Measure idler gear bushing ID and shaft OD to determine oil clearance.

If oil clearance exceeds specification, replace worn parts.

IDLER GEAR SPECIFICATIONS

	New Part	Wear Limit
Idler Bushing I.D.	44.48—44.53 mm (1.751—1.753 in.)	44.56 mm (1.754 in.)
Idler Shaft O.D.	44.43—44.46 mm (1.751—1.753 in.)	44.40 mm (1.748 in.)
Bushing-to-Shaft Oil Clearance	0.02—0.10 mm (0.001—0.004 in.)	0.15 mm (0.006 in.)
Gear Hub Width	21.98—22.03 mm (0.865—0.867 in.)	21.93 mm (0.863 in.)
Shaft Hub Width	22.17—22.27 mm (0.873—0.877 in.)	——
End Play	0.14—0.29 mm (0.006—0.012 in.)	0.40 mm (0.016 in.)

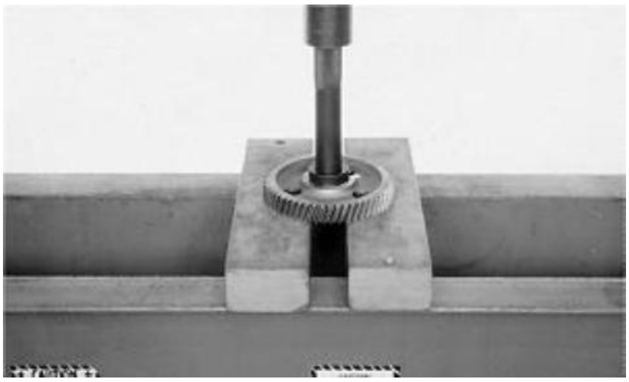
2. If idler gear end play measured earlier in this group was out of specification, remove idler shaft and thrust washer from front plate. (See REMOVE LOWER AND UPPER IDLER SHAFTS later in this group.)

3. Check thrust washer for wear.

4. Measure idler gear hub width and shaft width. Replace worn parts that are out of specification.

S11,2016,AF -19-26JUN95

REMOVE AND INSTALL IDLER GEAR BUSHINGS



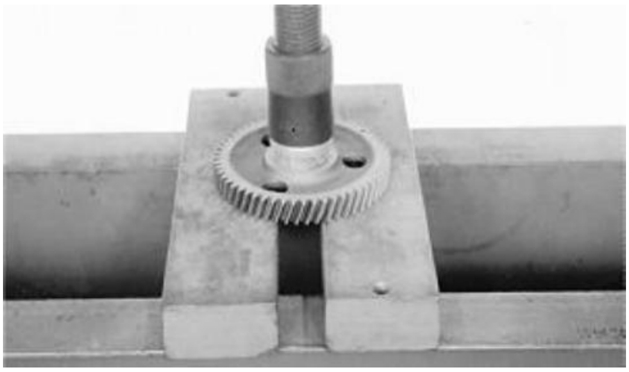
T88701 -UN-09NOV88

1. Press worn idler gear bushings out of gears.

S11,2016,AG -19-26JUN95

IMPORTANT: Bushing failure will result if upper and lower bushings are interchanged. Lower idler gear bushings are splash lubricated and have a spiral oil groove; upper idler gear bushings are pressure lubricated and DO NOT have oil grooves.

2. Coat ID and OD of idler gear bushing and ID of gear with TY6333 High-Temperature Grease. Install bushing into idler gear using JD252 Driver and JDG537 (OTC815) Handle.



T88702 -UN-28OCT88

RG,CTM8,GR16,63-19-25SEP95

REMOVE LOWER AND UPPER IDLER SHAFTS

Two types of lower idler shafts are used:

• Threaded Idler Shaft

Engine Serial Nos.: (—CD775574), (CD868857—), (—T0225854), and (T0300001—303310)

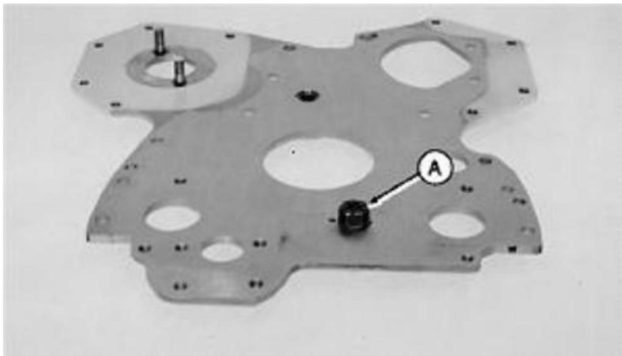
1. To remove lower idler shaft, remove cap screw (A) from cylinder block side of front plate. Remove shaft and thrust washer.

• Non-Threaded Idler Shaft)

Engine Serial Nos.: (CD775575—CD868856), (T0225855—300000), and (T0303311—)

2. To remove lower idler shaft, remove lock nut from gear side and hex head cap screw with washer from cylinder block side of front plate. Remove idler gear, shaft, and thrust washer.

NOTE: On engines (CD775575—CD779287), the hex head cap screw is located on the gear side. When replacing these screws, install them with the screw head on the pump side for all engine applications.



T88676 -UN-09NOV88

S11,2016,AI -19-01NOV95

3. Remove upper idler shaft and thrust washer by driving or pressing on shaft from block side of front plate.

T88704 -UN-09NOV88

S11,2016,AJ -19-26JUN95

CLEAN AND INSPECT FRONT PLATE

1. Clean front plate and inspect for damage.

S11,2016,AK -19-26JUN95

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33

REPLACE ENGINE FRONT PLATE

Two new replacement front plates are available through service parts: One plate is used for all Roto Diesel/Lucas-CAV and Stanadyne (JDB, and DB2 with ISO drive) injection pumps. A second plate is used for Stanadyne DM4 injection pumps.

New replacement front plates do not have a timing mark for the fuel injection pump. A new timing mark must be established at reassembly.

1. Install bushing (D) in bore (C) using a suitable driver when replacing front plate on engines equipped with a 46 mm (1.81 in.) pilot bore diameter pump. On pumps with a 50 mm (1.97 in.) pilot bore diameter, bushing is not required.

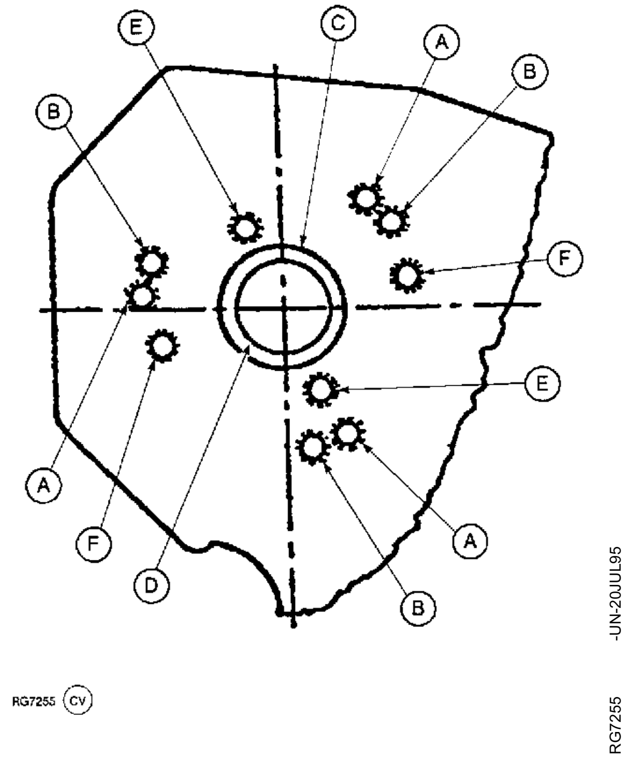
NOTE: Apply LOCTITE 242 (TY9370) Thread Lock and Sealer to studs and set screw plugs before installing in front plate.

2. Install mounting studs in appropriate location on front plate for your pump application.

3. Install set screw plugs in ALL threaded holes not used for mounting studs.

4. Accurately transfer injection pump timing mark from original front plate onto replacement plate as outlined later in this group. See TRANSFER FUEL INJECTION PUMP TIMING MARK ONTO REPLACEMENT FRONT PLATE.

5. Install front plate. (See INSTALL ENGINE FRONT PLATE later in this group.)



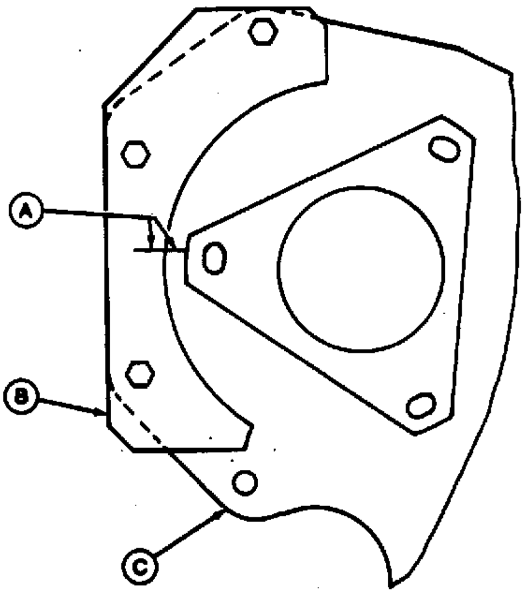
Viewed From Pump Side of Plate

A—Threaded Stud Holes (All Engines Except Roto Diesel/Lucas CAV 4-Cylinder and Stanadyne JDB)
B—Threaded Stud Holes (Roto Diesel/Lucas CAV 4-Cylinder)
C—50 mm (1.97 in.) Injection Pump Pilot Bore
D—46 mm (1.81 in.) Bushing ID for Stanadyne JDB Pump
E—Threaded Stud Holes (Stanadyne JDB)
F—*Threaded Stud Holes (Stanadyne Model “C” Pumps)

**Not used on any engine applications covered in this manual.*

S11,2016,AL -19-21SEP95

TRANSFER FUEL INJECTION PUMP TIMING MARK ONTO REPLACEMENT FRONT PLATE



Front Plate (Viewed From Pump Side)

IMPORTANT: Replacement front plates do not have an injection pump timing mark. It is extremely important that the timing be accurately transferred from original front plate to the replacement plate in the exact location for correct injection pump timing.

1. Position DFRG2 Aluminum Template (B) onto original front plate (C) as shown. (See Group 199, Dealer Fabricated Tools for manufacturing detail.) Install and tighten three 3/8-16 cap screws securely.

2. Transfer injection pump timing mark (A) from previous front plate onto template using a fine tip marker and straightedge. Remove template from front plate being replaced.

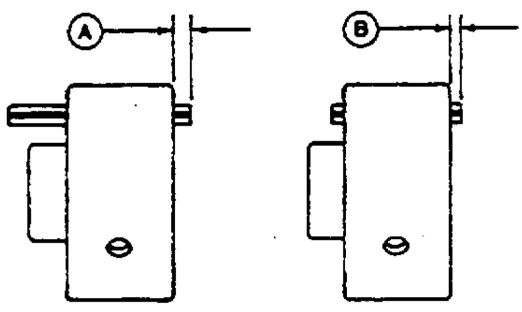
3. Attach template (with timing mark) to new replacement front plate and tighten cap screws securely.

4. Transfer timing mark from the template to the new front plate using a scribe. Scribe deep enough so mark becomes a permanent reference.

5. Remove template from front plate and refer to Group 16 for front plate installation procedure.

RG,CTM8,G35,33 -19-29SEP94

INSTALL IDLER SHAFT SPRING PINS



Install spring pin in shaft with end of pin protruding:

IDLER SHAFT SPRING PIN PROTRUSION SPECIFICATIONS

Lower Idler Shaft (A)	5.0—7.0 mm (0.20—0.28 in.)
Upper Idler Shaft (B)	3.5—4.5 mm (0.14—0.18 in.)

S11,2016,AM -19-21SEP95

INSTALL UPPER IDLER SHAFT IN FRONT PLATE

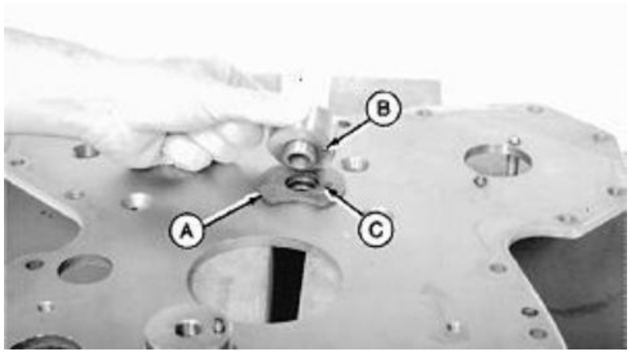
IMPORTANT: Oil holes in idler shaft must be properly indexed to provide adequate lubrication to idler gear bushing.

1. Install thrust washer (A) and upper idler shaft into front plate so oil hole is located at 12 O'clock position (toward top of plate).

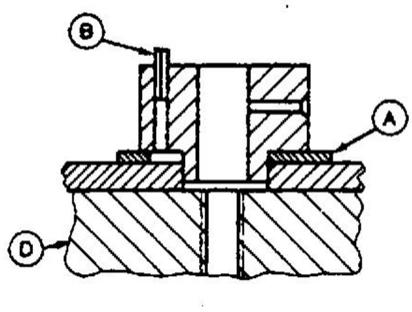
NOTE: Shaft is secured to front plate when the idler gear cap screw is threaded into cylinder block (D).

2. Press shaft into front plate until thrust washer is fully seated. Spring pin (B, if equipped) must be located in thrust washer notch (C).

3. On Saran Engines (868857CD—) containing the special washer, tighten idler gear cap screw to 110 N·m (81 lb-ft)*. All other engines tighten upper idler gear cap screw to 100 N·m (75 lb-ft).



T88706 -UN-28OCT88



RG4790 -UN-06DEC88

A—Thrust Washer
B—Spring Pin*
C—Thrust Washer Notch
D—Cylinder Block

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**On Saran Engines (868857CD—) a special washer is used and eliminates the need for the spring pin as it is no longer necessary to orientate the washer.*

S11,2016,AN -19-01NOV95

INSTALL LOWER IDLER SHAFT IN FRONT PLATE

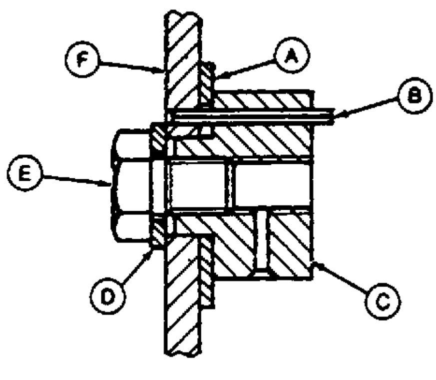
Two types of lower idler shafts are used:

- **Threaded Idler Shaft**

Engine Serial Nos.: (—CD775574), (—T0225854), and (T0300001—303310)

1. Install thrust washer (A) on lower idler shaft (C) and drive shaft in until thrust washer is fully seated on front plate (F).

2. Install washer (D) and cap screw (E). Tighten to 130 N·m (95 lb-ft).



RG4928 -UN-06DEC88

A—Thrust Washer
B—Spring Pin
C—Lower Idler Shaft/Hub
D—Washer
E—Cap Screws
F—Front Plate

S11,2016,AO -19-01NOV95

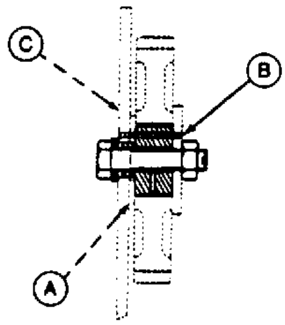
• **Non-Threaded Idler Shaft:**

Engine Serial Nos.: (CD775575—CD868856), (T02025855—300000), and (T0303311—)

IMPORTANT: ALWAYS replace hex head screw and lock nut whenever removed.

NOTE: Shaft is secured to front plate, when the idler gear bolt and nut are tightened.

On Saran Engines (868857CD—) a special washer is used and eliminates the need for the spring pin as it is no longer necessary to orientate the washer. Tighten idler gear bolt and nut to 110 N·m (81 lb-ft).



RG5592 -UN-09OCT89

1. Install thrust washer (A) and lower idler shaft with spring pin (B).

2. Drive shaft into plate (C) until thrust washer is fully seated.

3. Tighten lower idler gear bolt and nut to 100 N·m (75 lb-ft).

S55,2016,X -19-01NOV95

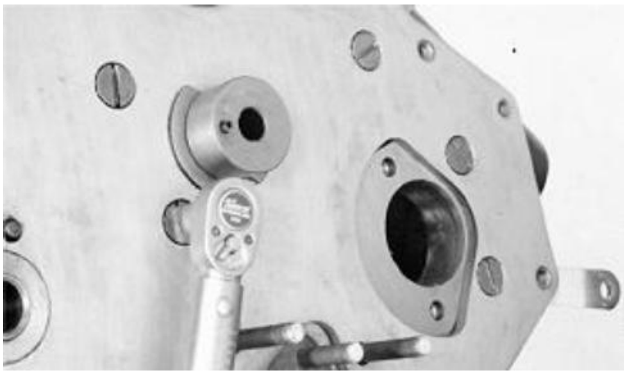
INSTALL ENGINE FRONT PLATE

T87436 -UN-09NOV88

IMPORTANT: A new (shorter) oil bypass valve and spring has been adopted. If this new (shorter) valve and spring are installed in the old (deeper bore) cylinder block, the valve will remain open and unfiltered oil will flow through the engine. If the old (longer) valve and spring are installed in a new (shallower bore) cylinder block, the bypass valve will not open to allow oil to flow. (See MEASURE OIL BYPASS VALVE LENGTH AND CYLINDER BLOCK BORE in Group 20.)

1. On 3179, 4239, and 6359 Engines, install oil by-pass valve and spring (if equipped).

RG,CTM4,DT457 -19-21SEP95



T81348 -UN-09NOV88

2. Apply LOCTITE 515 (TY6304) Flexible Sealant to cylinder block side of new gasket.

3. Install gasket and front plate.

4. Inspect external-tooth (star) washers. Replace as necessary. Install washers on screws and tighten screws to 34 N·m (25 lb-ft).

IMPORTANT: Do not cut off protruding edge of gasket until timing gear cover has been installed and all cap screws tightened.

S11,2016,AQ -19-12JAN95

INSTALL AND TIME BALANCER SHAFTS—IF EQUIPPED (4-CYLINDER ENGINES)

1. Using engine rotation tool and timing pin, lock No. 1 piston at TDC compression stroke.

T90969 -UN-10NOV88

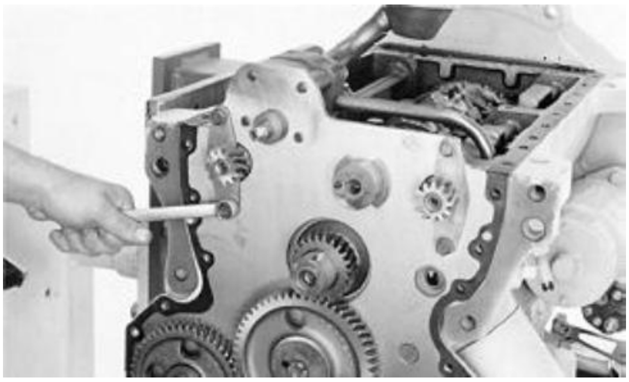
S11,2016,AR -19-26JUN95

2. Apply a liberal amount of clean engine oil to bushings in cylinder block and to balancer shaft journals.

3. Install balancer shafts and thrust plates. Tighten thrust plate cap screws to 47 N·m (35 lb-ft).

IMPORTANT: Balancer shaft kits for service are delivered without gear. These shafts are finish-lapped in different directions, therefore it is important to note the letter stamped at the rear of the shafts:

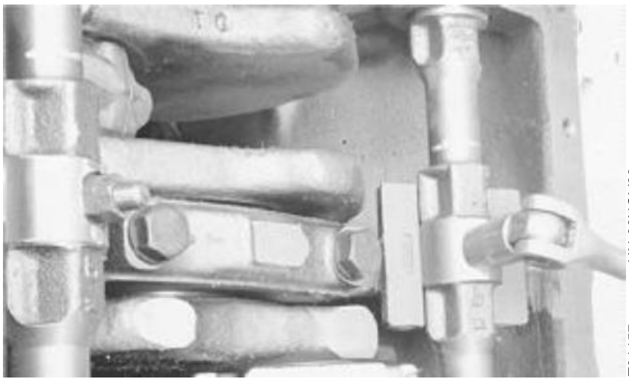
- **"R" for right side**
- **"L" for left side**



T82116 -UN-09NOV88

4. If equipped, install balancer shaft weights. Use new cap screws and nuts each time weights are installed. Tighten nuts to 60 N·m (45 lb-ft).

NOTE: On Saran-built 4239 Engines, Serial No. (CD688524—), the special cap screw formerly used is replaced by a hex head cap screw.



T91157 -UN-09NOV88

S55,2016,W -19-21SEP95

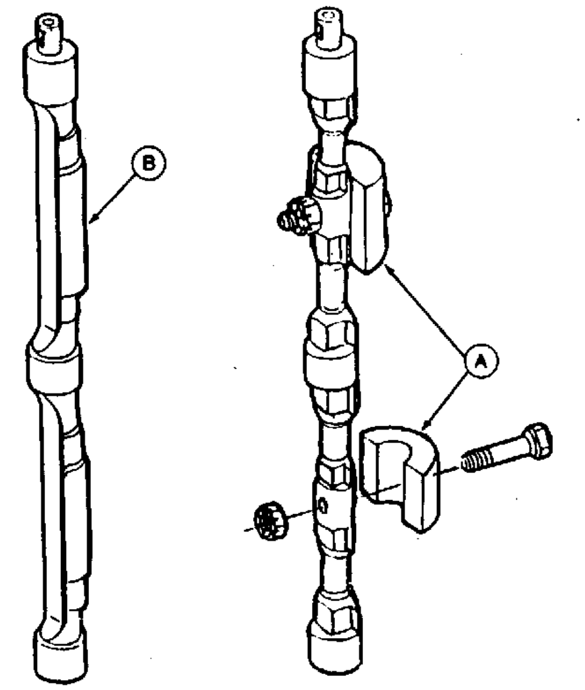
NOTE: On some engines, bolt-on weights (A) are available in two lengths: 64.5 mm (2.539 in.) or 52.0 mm (2.047 in.). Saran-built 4239 Engines, Serial No. (CD746397—) have a one-piece balancer shaft (B).

IMPORTANT: Make sure that weights have the same length on any one engine. Do not intermix old and new balancer shaft designs in the same engine.

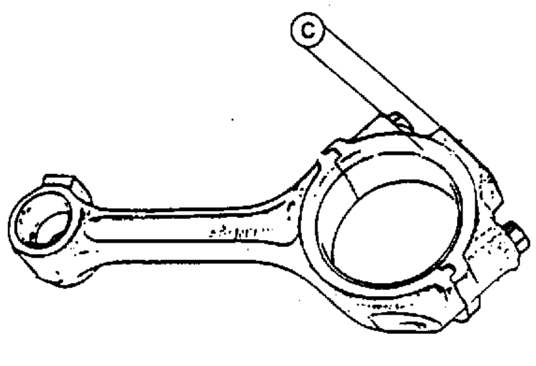
5. When installing a new balancer shaft on an engine originally equipped with the old design parts, there may be contact between the connecting rod weight pad boss and the left-hand balancer shaft. The maximum allowable weight pad boss measurement (C) must not exceed 19 mm (0.75 in.).

IMPORTANT: Under no circumstances should material be removed from the connecting rod weight pad boss or balancer shaft to allow free rotation.

If interference occurs, connecting rod must be replaced.



RG5593 -UN-09OCT89



RG5594 -UN-09OCT89

S11,2016,AS -19-23FEB87

6. Turn right (camshaft side) balancer shaft so timing mark (A) is under JD254 Gear Timing Tool. Timing mark on balancer shaft gear must point to centerline of crankshaft when correctly timed.

T88710 -UN-07NOV88

S11,2016,AT -19-21SEP95

7. Apply TY6333 High-Temperature Grease to idler gear bushing ID and shaft OD. Install lower idler gear without turning balancer shaft.

Spring pin (A) must enter hole in washer (B) when it is installed.

• **On threaded idler shaft:**

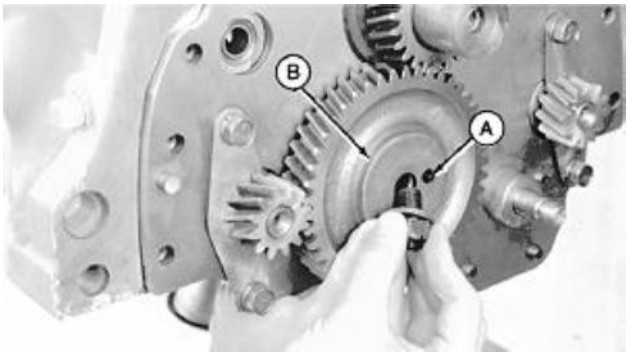
Engine Serial Nos.: (—CD775574), (—T0225854), and (T0300001—303310)

8. Install cap screw and washer. Tighten to 130 N·m (95 lb-ft).

• **On non-threaded idler shaft:**

Engine Serial Nos.: (CD775575—CD868856), (T0225855—300000), and (T0303311—)

9. Install new bolt with washer from oil pump side and new nut on front plate gear side. Secure nut with thread lock sealant and tighten to 100 N·m (75 lb-ft).



T88711 -UN-28OCT88

S11,2016,AU -19-01NOV95

10. Turn left (injection pump side) balancer shaft so timing mark (A) is under JD254 Gear Timing Tool.

11. Install oil pump and oil pump gear. Tighten hex nut (to retain gear) 54 N·m (40 lb-ft). Stake nut to shaft in three places using a punch and hammer. (See INSTALL STANDARD CAPACITY OIL PUMP in Group 20.)

12. Recheck gear timing for both balancer shafts.

T88712 -UN-09NOV88

S11,2016,AV -19-21SEP95

INSTALL AND TIME CAMSHAFT AND FUEL INJECTION PUMP

1. Lock engine with No. 1 piston at TDC compression stroke.

2. Install fuel injection pump on front plate.

3. Install fuel injection pump drive gear and new retaining nut. Time injection pump to engine. (See Group 35 for injection pump timing.)

4. Tighten injection pump-to-front plate hex nuts to 25 N·m (19 lb-ft). Tighten injection pump drive gear cap screw to:

DRIVE GEAR RETAINING NUT TORQUE SPECIFICATIONS

Roto Diesel/Lucas CAV (three screw hub)	30—35 N·m (22—25 lb-ft)
Roto Diesel/Lucas CAV (solid drive shaft)	85 N·m (63 lb-ft)
Stanadyne (Model DB4)	195 N·m (145 lb-ft)
Stanadyne (Model DB2):	
with 8 mm (0.315 in.) thick retaining nut (chrome finish)	60 N·m (45 lb-ft)
with 10 mm (0.393 in.) thick retaining nut (black finish)	195 N·m (145 lb-ft)
Stanadyne (Model JDB)	60 N·m (45 lb-ft)
Stanadyne (Model DM4)	195 N·m (145 lb-ft)

5. Lubricate camshaft bearing journals, lobes, and followers with TY6333 High Temperature Grease.

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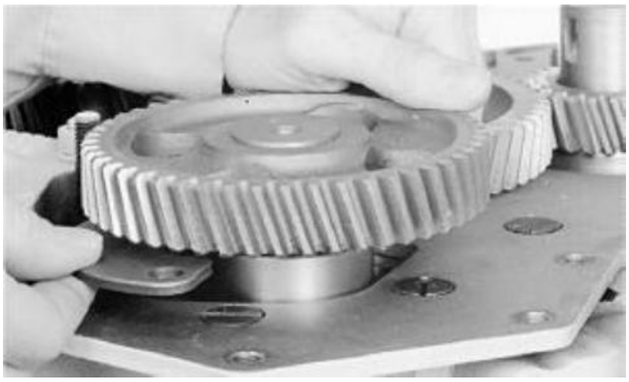
S11,2016,AW -19-01NOV95

IMPORTANT: DO NOT allow camshaft lobes to drag on camshaft bore or bushing surfaces while installing camshaft. Bearing surfaces may become scratched or scored. Rotate camshaft during installation to avoid obstruction in any bore.



T94700 -UN-28OCT88

6. Install camshaft and thrust plate in cylinder block.

7. Install thrust plate cap screws and tighten to 47 N·m (35 lb-ft).

S11,2016,AX -19-26JUN95

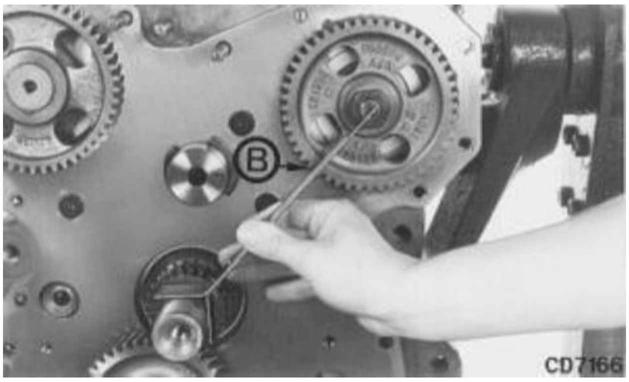
8. With JD254 Gear Timing Tool resting on nose of crankshaft and center of camshaft (as shown), turn camshaft until timing mark (A) aligns with timing tool.

9. Check injection pump gear timing with JD254 Gear Timing Tool resting on nose of crankshaft and center of injection pump shaft. Timing mark (B), with “3”, “4”, or “6” beside it, must align with timing tool (as shown).

IMPORTANT: Use the timing mark corresponding to the number of cylinders the engine has that is being timed.

NOTE: On 6-cylinder engines equipped with a Stanadyne Model DB2 or DB4 Injection Pump, use “6A” timing mark.

T88698 -UN-28OCT88



CD7166 -UN-03NOV94

RG,CTM8,DW650 -19-01NOV95

NOTE: If gear is equipped with cogs (A) for magnetic speed sensor, it must be installed with cogs facing away from the cylinder block and toward the gear cover. If installed incorrectly, no speed signal will be produced.

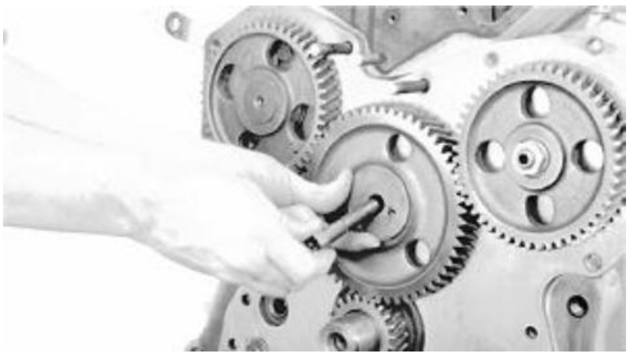
10. Lubricate upper idler gear bushing ID and shaft OD with TY6333 High-Temperature Grease. Install upper idler gear without turning camshaft gear or injection pump gear.

NOTE: On Saran Engines (868857CD—) containing the special washer, tighten idler gear cap screw to 110 N·m (81 lb-ft).

11. Install washer so hole and spring pin align. Install cap screw. Tighten cap screw to 100 N·m (75 lb-ft).

12. Recheck gear timing to make sure it is correct.

RG6333 -UN-03AUG92



T88700 -UN-09NOV88

S11,2016,BA -19-25SEP95

CLEAN AND INSPECT TIMING GEAR COVER

1. Drive crankshaft front oil seal out of cover.

2. Remove material and sealant from cylinder block and timing gear cover. If necessary, remove oil filler neck and gasket and injection pump drive gear nut cover plate and gasket.

CAUTION: Do not spin ball bearings when drying with compressed air.

3. If engine is equipped with the Auxiliary Gear Drive Option, remove ball bearings from timing gear cover and auxiliary cover. Clean bearings in solvent and dry with compressed air. Replace bearings that are not serviceable. (See INSTALL BALL BEARINGS AND DOWELS later in this group.)

4. Clean cover in solvent and dry with compressed air.

5. Inspect cover for cracks or damage. Make sure that seal bore is clean and not nicked.

6. Install oil filler elbow or cover plate using a new gasket.

7. Install injection pump drive gear cover plate using a new gasket.

S11,2016,BB -19-21SEP95

INSTALL BALL BEARINGS AND DOWELS (ENGINES WITH CRANKSHAFT-DRIVEN AUXILIARY GEAR DRIVE OPTION)

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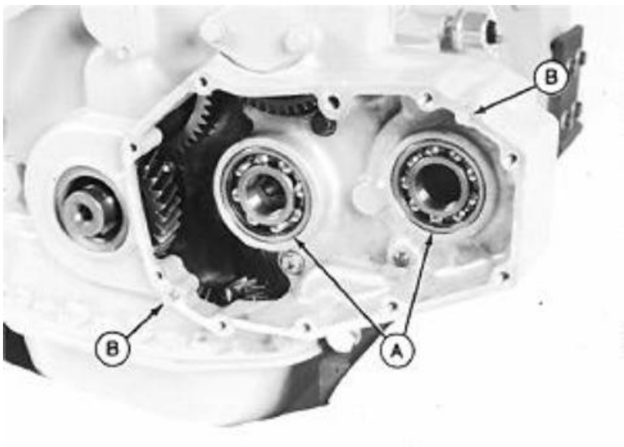


RG6337 -UN-03AUG92

1. Lubricate OD of ball bearings (A) with clean engine oil.

2. Press bearings into timing gear cover and front auxiliary drive gear cover. Press only on outer bearing race; stop pressing when bearing is tight against shoulder of bearing bore.

3. If dowel pins (B) were removed from the timing gear cover, install replacement pins so top of dowels are 11—12 mm (0.430—0.470 in.) above surface of cover.

RG,CTM8,GR16,57-19-12JAN95

INSTALL DRIVE GEAR (ENGINES WITH CRANKSHAFT-DRIVEN AUXILIARY GEAR DRIVE OPTION)

RG6339 -UN-03AUG92

1. Lubricate OD and ID of collet (A) with engine oil. Slide collet onto nose of crankshaft with large end toward drive gear (B).

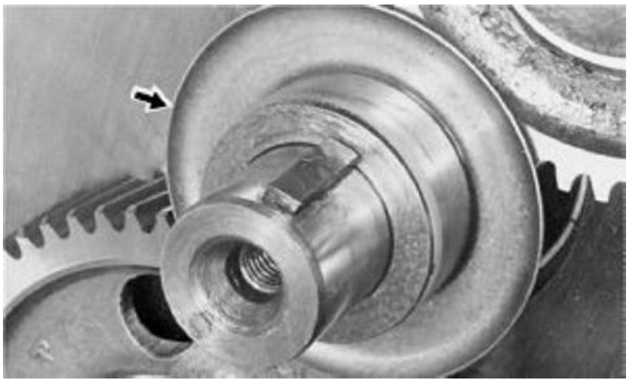
2. Install O-ring on crankshaft and position against front edge of collet.

3. Lubricate ID of auxiliary drive gear (C) with engine oil and place on collet.

Gear is pressed onto collet when crankshaft pulley or damper is installed and tightened to specification. (See COMPLETE FINAL ASSEMBLY, later in this group.)

RG,CTM8,GR16,53-19-16FEB95

INSTALL TIMING GEAR COVER



RG4923 -UN-06DEC88

1. Make sure gasket surfaces on cover and front plate are clean.

2. Install oil filler neck or cover plate using a new gasket. If a composite oil filler neck is to be used on an aluminum timing gear cover, apply LOCTITE 515 (TY6304) Flexible Sealant (General Purpose) to new gasket. Tighten screws to:

• Aluminum neck: 47 N·m (35 lb-ft)
• Composite material neck: 30 N·m (22 lb-ft)

3. Install injection pump drive gear cover plate using a new gasket. Tighten screws to 24 N·m (18 lb-ft).

If a threaded cap is used instead of a cover plate, tighten cap to 30 N·m (22 lb-ft).

NOTE: Oil deflector is not used on engines with crankshaft gear-driven auxiliary drive option.

4. Install oil deflector (bold arrow) on crankshaft so concave side faces away from crankshaft gear.

IMPORTANT: Do not install wear ring or Woodruff Key until oil seal has been installed in timing gear cover.

5. On engines without crankshaft gear-driven auxiliary drive, install O-ring on crankshaft nose against oil deflector.

RG,CTM4,DW651 -19-09OCT95

RG6340 -UN-03AUG92

• Aluminum Timing Gear Cover:

6. Apply a light coating of LOCTITE 515 (TY6304) Flexible Sealant (General Purpose) to block side of a new gasket. Position gasket on front plate.

7. Install timing gear cover on engine and apply the following torques:

TORQUE SPECIFICATIONS

Timing Gear Cover-to-Front Plate	47 N·m (35 lb-ft)
Oil Pan-to-Timing Gear Cover	37 N·m (27 lb-ft)
Magnetic Pick-up	14 N·m (10 lb-ft)
Oil Pressure Regulating Valve Plug	30 N·m (22 lb-ft)

8. Install alternator mounting bracket, cap screws, nuts, and washers. Tighten screws to 47 N·m (35 lb-ft).

9. On engines equipped with crankshaft gear-driven auxiliary drive, be sure to install the cap screws (A) and washers securing the timing gear cover to front plate and engine block. These screws are located behind the auxiliary idler gear.

RG,CTM4,DW652 -19-01NOV95

16
47

• Composite Material Timing Gear Cover:

1. The sealing ring is reusable. When replacement is needed, proceed as follows:

— Remove previous sealing ring from cover (do not use any cutting tool to avoid cover damage).
— Clean groove with acetone (follow recommended precautions and safe operating practices) then dry with compressed air.

CAUTION: Do not use any other industrial solvent which might not be compatible with composite material.

— Install the new sealing ring starting at one edge of the cover. Place the thicker area of the sealing ring toward the cover.
— If properly installed, the sealing ring may protrude up to 30 mm (1.18 in.) at the other edge (A). If NOT, restart procedure.
— Cut away excess sealing ring.

2. Apply a bead of LOCTITE 515 Flexible Sealant on bottom face (B) which is in contact with oil pan.

NOTE: A tube of LOCTITE 515 Flexible Sealant is provided with overhaul gasket set. This tube is also available under part number TY6304.

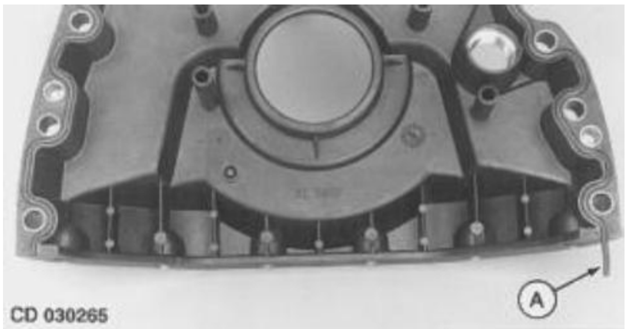
3. Coat the oil pan gasket top face with engine oil where the timing gear cover will be installed.

4. Install cover and tighten cap screws to specifications given using the sequence shown:

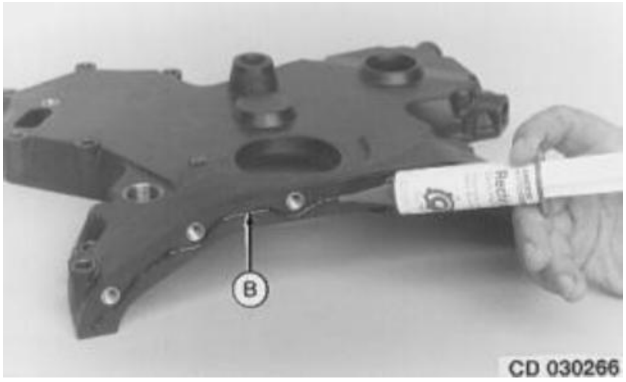
TORQUE SPECIFICATIONS

Magnetic Pick-up (C)	14 N·m (10 lb-ft)
Plug-to-Access Injection Pump Drive Gear Nut (D)	30 N·m (22 lb-ft)
Oil Pan-to-Timing Gear Cover, Cap Screws (18—23)	30 N·m (22 lb-ft)
Timing Gear Cover-to-Front Plate, Cap Screws (1—17)	47 N·m (35 lb-ft)
Oil Pressure Regulating Valve Plug (E)	30 N·m (22 lb-ft)

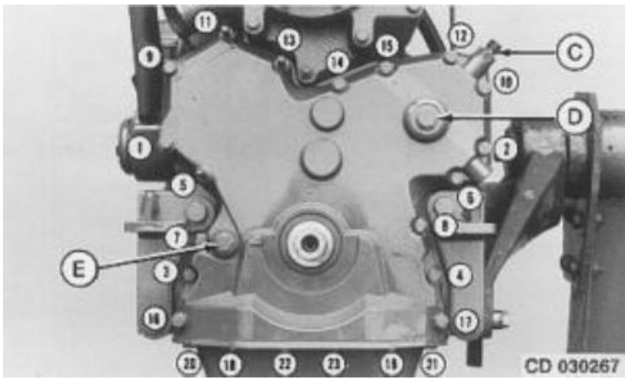
5. Install alternator mounting bracket, cap screws, nuts, and washers. Tighten cap screws to 47 N·m (35 lb-ft).



CD30265 -UN-05OCT94



CD30266 -UN-05OCT94



CD30267 -UN-05OCT94

A—Timing Gear Cover Outer Edge
B—Timing Gear Cover Bottom Face
C—Magnetic Pick-up
D—Plug-to-Access Injection Pump Drive Gear Nut
E—Oil Pressure Regulating Valve Plug

RG,CTM8,DY032 -19-21SEP95

INSTALL CRANKSHAFT FRONT OIL SEAL

RG6341 -UN-03AUG92

Seal case is coated with dry sealant, DO NOT apply additional sealant.

1. With timing gear cover installed and wear ring removed from crankshaft nose, use KJD10164 Seal Installer to install front oil seal in timing gear cover until seal bottoms in seal bore.

NOTE: On auxiliary drive engine there is no wear ring; the oil seal rides on the machine surface of the pulley.

2. Apply a light coating of engine oil on wear ring and install on crankshaft nose with O-ring groove facing toward oil deflector. Install Woodruff Key in crankshaft nose.

RG,CTM8,GR16,56-19-12JAN95

16
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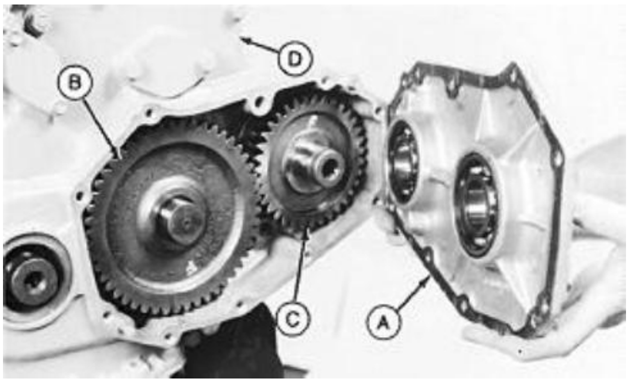
INSTALL IDLER GEAR AND OUTPUT GEAR (ENGINES WITH AUXILIARY GEAR DRIVE OPTION)

RG6316 -UN-03AUG92



RG6315 -UN-03AUG92

1. Lubricate auxiliary drive shafts with engine oil.

2. Place idler gear (B) in timing gear cover (D) so that shaft enters bore of bearing and gear meshes with auxiliary drive gear (E).

3. Install output gear (C) so small 9-tooth spline faces front of engine and large 13-tooth spline faces rear of engine. Apply high temperature grease to internal splines.

4. Place a new gasket over dowels on timing gear cover. Install the front auxiliary gear cover (A) on timing gear cover. When both shafts have entered their respective bearings, align cover with dowel pins and push in place against timing gear cover.

5. Tighten cap screws to 47 N·m (35 lb-ft).

6. Install front and/or rear output shaft cover plates (if used) using a new gasket.

A—Front Auxiliary Gear Cover
B—Idler Gear
C—Output Gear
D—Timing Gear Cover
E—Auxiliary Drive Gear

RG,CTM8,GR16,55-19-16FEB95

COMPLETE FINAL ASSEMBLY

1. If a new front plate-to-engine block gasket was installed, trim off protruding portion and apply LOCTITE 515 (TY6304) Flexible Sealant.

2. Install oil pan. (See Group 20.)

3. Install pulley or damper on crankshaft. (See Group 15).

4. Install oil pressure regulating valve assembly. (See Group 20.)

5. Install fuel transfer pump. (See Group 35.)

6. Remove cam follower lifting tools (if used for camshaft removal).

7. Install push rods and rocker arm assembly. (See Group 05.)

8. Install alternator, fan belts, and fan. (See Group 25.)

9. Fill engine crankcase with clean oil having correct viscosity and grade specifications. (See Group 02.)

10. Adjust valve clearance. (See Group 05.)

11. Install rocker arm cover and new gasket. (See Group 05.)

12. Perform engine break-in as outlined in Group 05.

** Some engines may be equipped with a 10 mm (0.39 in.) thick washer. Torque value does not change.*

S11,2016,BF -19-21SEP95

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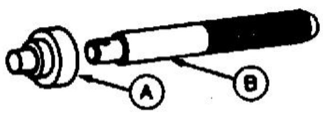
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

RG5183 -UN-13SEP89



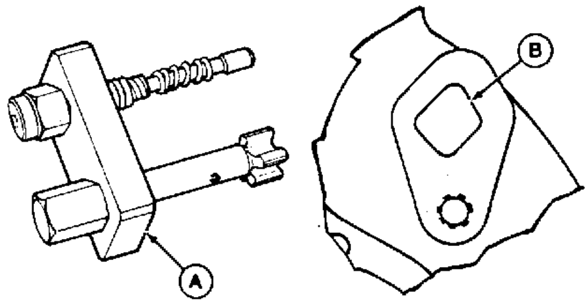
Bushing Driver (A) JD248A
Handle (B) . . . . JDG536(OTC813)

Install oil pressure relief valve bushing.

S53,JD248,A -19-04APR90

Flywheel Turning Tool (A) JD281A

Used on engines with 142 tooth flywheel ring gear and a diamond shaped tool guide bore (B) in flywheel housing. Tool has it’s own spring loaded timing pin which threads into flywheel housing.



RG6252 -UN-22JUL92

RG,JD281A -19-17JUL92

RG5068 -UN-23AUG88

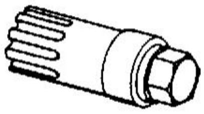
Timing Pin JDE81-4

Lock engine at TDC when installing injection pump or timing valve train. Use with JDG820, JDE81-1, or JDE83 Flywheel Turning Tool.

RG,JDE814 -19-03JAN95

Flywheel Turning Tool JDE83

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

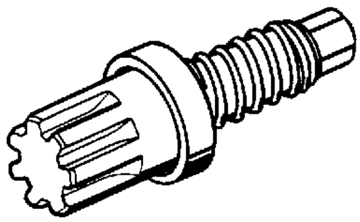


RG6251 -UN-22JUL92

RG,JDE83 -19-17JUL92

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,CTM8,DW570 -19-22SEP95

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
D01061AA Blind Hole Puller Set (3179, 4239, and 6359 Engines)	Remove oil pressure regulating valve seat.
D01048AA 17-1/2 Ton Puller Set D01209AA Pilot Bearing Puller D01226AA Long Jaws	Remove oil filter adapter from cylinder block.

RG,CTM4,DW803 -19-21SEP95

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2

OTHER MATERIAL

Name	Use
PERMATEX AVIATION (Form-A-Gasket No. 3) (TY15934) (OR) LOCTITE 515 Flexible Sealant (General Purpose) (TY6304)	To seal oil pan gasket surfaces and dipstick tube threads.
LOCTITE 592 Pipe Sealant with TEFLON (TY9374)	To seal oil pan elbow drain fitting.

S11,2020,EI -19-21SEP95

LUBRICATION SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Oil Pump (Standard Capacity):		
Drive shaft bore in pump housing	16.059—16.083 mm (0.6322—0.6332 in.)	16.163 mm (0.06362 in.)
Diameter of idler shaft journal	12.319—12.329 mm (0.4850—0.4854 in.)	12.306 mm (0.4845 in.)
Diameter of drive shaft journal	16.022—16.032 mm (0.6308—0.6312 in.)	15.997 mm (0.6298 in.)
Gear-to-pump housing radial clearance	0.10—0.16 mm (0.004—0.006 in.)	0.20 mm (0.008 in.)
Thickness of gears	41.156—41.206 mm (1.6203—1.6223 in.)	41.106 mm (1.6183 in.)
Gears-to-pump cover axial clearance	0.031—0.157 mm (0.0012—0.0062 in.)	0.22 mm (0.0085 in.)
Oil Pump (High Capacity):		
Drive shaft bore in pump cover	16.058—16.084 mm (0.6322—0.6332 in.)	16.16 mm (0.636 in.)
Drive shaft bore in pump housing	12.281—12.307 mm (0.4835—0.4845 in.)	12.323 mm (0.4850 in.)
Diameter of drive shaft		
Front journal	16.022—16.032 mm (0.6308—0.6312 in.)	15.997 mm (0.6298 in.)
Rear journal	12.256—12.266 mm (0.4825—0.4829 in.)	12.231 mm (0.4815 in.)
Diameter of idler shaft journal	12.319—12.329 mm (0.4850—0.4854 in.)	12.306 mm (0.4845 in.)
Thickness of gears	50.975—51.025 mm (2.007—2.009 in.)	50.925 mm (2.005 in.)
Gear-to-pump housing radial clearance	0.08—0.18 mm (0.003—0.007 in.)	0.23 mm (0.009 in.)
Gears-to-pump cover axial clearance	0.042—0.168 mm (0.0016—0.0066 in.)	0.22 mm (0.0085 in.)

S11,2020,EJ -19-01NOV95

LUBRICATION SYSTEM SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Spring for Oil Pressure Regulating Valve (3179, 4239, 6359):		
Free length of spring (approx.)	120 mm (4.72 in.)	——
Spring tension at a length of 42.5 mm (1.68 in.)	60—75 N	——
	(13.5—16.5 lb-force)	——
Spring for Oil Pressure Regulating Valve (4276 and 6414):		
Free length of spring (approx.)	59 mm (2.32 in.)	——
Spring tension at a length of 34 mm (1.34 in.)	92—112 N	——
	(21—25 lb-force)	——
By-Pass Valve Spring (3179, 4239, 6359):		
Free length of spring		
Saran (S.N. —968590) and All Dubuque Engines	59 mm (2.32 in.)	——
Saran (S.N. 968591—)* and Dubuque Service Short Blocks	51 mm (2.00 in.)	——
Spring tension at a length of 34 mm (1.34 in.)	92—112 N	——
	(21—25 lb-force)	——
Minimum oil pressure at 850 rpm and engine oil temperature at 93˚C (200˚F):		
3-cylinder engines	140 kPa (1.4 bar) (20 psi)	——
4 and 6-cylinder engines	100 kPa (1 bar) (14 psi)	——

** In some cases, engines prior to serial number break may have the shorter valve and spring installed.*

S55,2020,T -19-01NOV95

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LUBRICATION SYSTEM SPECIFICATIONS—CONTINUED

TORQUES

Oil Pump Assembly-to-Cylinder Block Front Plate . . . . 47 N·m (35 lb-ft)

Oil Pump Pickup Tube-to-Oil Pump . . . . 47 N·m (35 lb-ft)

Drive Gear on Oil Pump Shaft:
4-Cylinder Engines . . . . 75 N·m (55 lb-ft)
On All Other Engines . . . . 75 N·m (55 lb-ft) (Staked)

Oil Pan-to-Cylinder Block:
SAE 5 - 3 dashes* . . . . 47 N·m (35 lb-ft)
SAE 8 - 6 dashes* . . . . 68 N·m (50 lb-ft)

Oil Pan-to-Aluminum Timing Gear Cover . . . . 37 N·m (27 lb-ft)

Oil Pan-to-Composite Material Timing Gear Cover . . . . 30 N·m (22 lb-ft)

Oil Pan-to-Flywheel Housing:
SAE 5 - 3 dashes* . . . . 47 N·m (35 lb-ft)
SAE 8 - 6 dashes* . . . . 68 N·m (50 lb-ft)

Oil Pan Drain Plug:
Cylindrical Plug . . . . 68 N·m (50 lb-ft)
Conical Plug . . . . 55 N·m (40 lb-ft)

Oil Pressure Regulating Valve Plug in Timing Gear Cover . . . . 95 N·m (70 lb-ft)

Oil Cooler Adapter in Cylinder Block (3179, 4239, 6359) . . . . 37 N·m (27 lb-ft)

Oil Cooler Lines Banjo Bolts (6359) . . . . 100 N·m (74 lb-ft)

Oil Cooler Housing-to-Cylinder Block (4276 and 6414) . . . . 47 N·m (35 lb-ft)

Oil Filter Housing-to-Oil Cooler Housing (4276 and 6414) . . . . 37 N·m (27 lb-ft)

Oil Cooler Covers-to-Oil Cooler Housing (4276 and 6414) . . . . 37 N·m (27 lb-ft)

Oil Filter Adapter-to-Oil Filter Housing (4276 and 6414) . . . . 47 N·m (35 lb-ft)

** Refer to UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES in Group 01 for cap screw identification markings.*

RG,CTM4,DY109 -19-01NOV95

ENGINE CRANKCASE OIL FILL QUANTITIES

Listed below are crankcase oil fill quantities with filter change for all 300 Series engine applications.

Fill crankcase with quantity of oil shown for your engine application and adjust dipstick tube height until the dipstick reads full.

• JOHN DEERE AGRICULTURAL APPLICATIONS

Machine Model No.	Engine Model	Engine Serial No.	Crankcase Oil Fill Quantity with Filter Change
COMBINES			
Harvester			
4420	CD6359DH-01		11.5 L (12.0 qt)
9400	T06359TH001		17.0 L (18.0 qt)
Zweibrucken			
4425	CD6359DZ004		11.5 L (12.0 qt)
4435	CD6359DZ004		11.5 L (12.0 qt)
COTTON PICKER/STRIPPER			
Des Moines			
484	CD6359DN-01		11.5 L (12.0 qt)
7440	CD6359DN-01		11.5 L (12.0 qt)
7445	CD6359TN002		14.0 L (15.0 qt)
	CD6359TN-02		14.0 L (15.0 qt)
	T06359TN002		14.0 L (15.0 qt)
9900	CD6359DN-01		11.5 L (12.0 qt)
9900HRA	CD6359TN-01		14.0 L (15.0 qt)
9910	CD6359DN-01		11.5 L (12.0 qt)
9920	CD6359DN-01		11.5 L (12.0 qt)
9930	CD6359TN002		14.0 L (15.0 qt)
	CD6359TN-02		14.0 L (15.0 qt)
	T06359TN002		14.0 L (15.0 qt)
HI-CYCLE™ SPRAYER			
Des Moines			
6000	T04239DN003		8.5 L (9.0 qt)

S55,2020,Q -19-21SEP95

ENGINE CRANKCASE OIL FILL QUANTITIES—CONTINUED

• JOHN DEERE AGRICULTURAL APPLICATIONS—CONTINUED

Machine Model No.	Engine Model	Engine Serial No.	Crankcase Oil Fill Quantity with Filter Change
TRACTORS			
Argentina			
2730	4239DJ-02		8.5 L (9.0 qt)
3330	4239DJ-01		8.5 L (9.0 qt)
Dubuque			
2630	4276DR-01		8.5 L (9.0 qt)
2640 CS	4276DR-01		8.5 L (9.0 qt)
2640 CS	4276DR-04		8.5 L (9.0 qt)
Iberica			
1630	3179DCE01		7.0 L (7.5 qt)
	4239DCE02		7.0 L (7.5 qt)
3130	6359DCE01		11.5 L (12.0 qt)
3140	6359DCE01		11.5 L (12.0 qt)
Mannheim			
1630	3179DL-01		7.0 L (7.5 qt)
2130	4239DL-01		7.0 L (7.5 qt)
2140 TSS	CD4239TL02		8.5 L (9.0 qt)
2150	3179DL-11	(—CD571078)	7.0 L (7.5 qt)
2150	3179DL-01	(CD571079—)	7.0 L (7.5 qt)
2155 CS	3179DL001		6.0 L (6.5 qt)
2155 TSS	3179DL017		6.0 L (6.5 qt)
2255	3179DL-01	(—CD581072)	7.0 L (7.5 qt)
2255	3179DL-12	(CD581073—)	7.0 L (7.5 qt)
2350	4239DL-07		8.5 L (9.0 qt)
2355 CS	CD4239DL007		10.0 L (10.5 qt)
2355 TSS	4239DL010		6.0 L (6.5 qt)
2355N CS	3179TL003		6.0 L (6.5 qt)
2355N TSS	CD3179TL002		6.0 L (6.5 qt)
2550	4239DL-08		8.5 L (9.0 qt)
2555 CS	4239DL008		10.0 L (10.5 qt)
2555 TSS	CD4239TL006		10.0 L (10.5 qt)
2750	4239TL-04		8.5 L (9.0 qt)
2750	4239TL-05		8.5 L (9.0 qt)
2755 CS	CD4239TL005		10.0 L (10.5 qt)
2755 TSS	4239TL009		10.0 L (10.5 qt)
2855N	4239TL008		10.0 L (10.5 qt)
2940	6359DL-03US		11.5 L (12.0 qt)
2950	6359DL-04		11.5 L (12.0 qt)
2955 TSS	CD6359DL009		11.5 L (12.0 qt)
3140 C	6359TL-02		11.5 L (12.0 qt)
3150	6359DL-07		11.5 L (12.0 qt)
3155 TSS	CD6359DL010		11.5 L (12.0 qt)

S55,2020,S -19-06OCT89

ENGINE CRANKCASE OIL FILL QUANTITIES—CONTINUED

• JOHN DEERE AGRICULTURAL APPLICATIONS—CONTINUED

Machine Model No.	Engine Model	Engine Serial No.	Crankcase Oil Fill Quantity with Filter Change
TRACTORS (CONTINUED)			
Mexico			
2535P	4239DP-02		8.5 L (9.0 qt)
2735	4239DP-01		8.5 L (9.0 qt)
Waterloo (Tractor)			
4050	6359TR001		17.0 L (18.0 qt)
WINDROWERS			
Ottumwa			
2360	CD4239DW-01		7.5 L (8.0 qt)
	CD4239DW001		7.5 L (8.0 qt)
3430	CD4239DE-01		8.5 L (9.0 qt)
	CD4239DE001		8.5 L (9.0 qt)
	T04239DE001		8.5 L (9.0 qt)
3830	CD4239TE-01		8.5 L (9.0 qt)
	CD4239TE001		8.5 L (9.0 qt)
	T04239TE001		8.5 L (9.0 qt)

• JOHN DEERE INDUSTRIAL APPLICATIONS

Machine Model No.	Engine Model	Engine Serial No.	Crankcase Oil Fill Quantity with Filter Change
BACKHOE-LOADERS			
210C	T04239DT002		8.5 L (9.0 qt)
210C Series I	T04239DT006		8.5 L (9.0 qt)
310C	T04239DT003		8.5 L (9.0 qt)
	T04239TT004*		8.5 L (9.0 qt)
410C	T04276DT003		8.5 L (9.0 qt)
	T04276TT005		8.5 L (9.0 qt)
415C	CD4239DCD03		8.5 L (9.0 qt)
510B	T04276DT003		8.5 L (9.0 qt)
	T04276TT005*		8.5 L (9.0 qt)
510C	T04276TT010		8.5 L (9.0 qt)
515B	CD4239TCD02		8.5 L (9.0 qt)
610B	T04276TT010		8.5 L (9.0 qt)
610C	T04276TT014		8.5 L (9.0 qt)
710B	T06359TT001		19.0 L (20.0 qt)
710C	T06359TT002		19.0 L (20.0 qt)

*Turbo for altitude compensation

S55,2000,ND -19-10OCT89

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ENGINE CRANKCASE OIL FILL QUANTITIES—CONTINUED

• JOHN DEERE INDUSTRIAL APPLICATIONS—CONTINUED

Machine Model No.	Engine Model	Engine Serial No.	Crankcase Oil Fill Quantity with Filter Change
CRAWLERS			
350D	CD3179DT001		8.5 L (9.0 qt)
355D	CD3179DT001		8.5 L (9.0 qt)
400G	T04239DT005		8.5 L (9.0 qt)
450E	T04276DT005		8.5 L (9.0 qt)
	T04276TT011*		8.5 L (9.0 qt)
450 ELT	T04276DT006		8.5 L (9.0 qt)
	T04276TT013*		8.5 L (9.0 qt)
450G	T04276TT015		8.5 L (9.0 qt)
455E	T04276TT011		8.5 L (9.0 qt)
455G	T04276TT015		8.5 L (9.0 qt)
550	T04276TT001		14.0 L (15.0 qt)
550A	T04276TT006		14.0 L (15.0 qt)
550B	T04276TT006		14.0 L (15.0 qt)
550G	T04276TT016		12.5 L (13.0 qt)
555	T04276TT001		14.0 L (15.0 qt)
555A	T04276TT006		14.0 L (15.0 qt)
555B	T04276TT006		14.0 L (15.0 qt)
555G	T04276TT017		12.5 L (13.0 qt)
650G	T04276TT017		12.5 L (13.0 qt)
655A	T06414TT007		19.0 L (20.0 qt)
655B	T06414TT009		19.0 L (20.0 qt)
JD750	T06414TT004		19.0 L (20.0 qt)
	T06414TT007		19.0 L (20.0 qt)
750A	T06414TT007		19.0 L (20.0 qt)
750B	T06414TT009		19.0 L (20.0 qt)
JD755	T06414TT004		19.0 L (20.0 qt)
755A	T06414TT006		19.0 L (20.0 qt)
755B	T06414TT010		19.0 L (20.0 qt)
755B MIL	T06414TT016		19.0 L (20.0 qt)

*Turbo for altitude compensation

S55,2000,NA1 -19-28SEP89

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ENGINE CRANKCASE OIL FILL QUANTITIES—CONTINUED

• JOHN DEERE INDUSTRIAL APPLICATIONS—CONTINUED

Machine Model No.	Engine Model	Engine Serial No.	Crankcase Oil Fill Quantity with Filter Change
EXCAVATORS			
JD34	CD4239DCD01		14.0 L (15.0 qt)
JD44	CD4239DCD02		14.0 L (15.0 qt)
JD45	CD4239DCD02		14.0 L (15.0 qt)
JD54	CD6359DCD01		17.0 L (18.0 qt)
JD55	CD6359DCD01		17.0 L (18.0 qt)
JD65	CD6359TCD02		17.0 L (18.0 qt)
70	T04239DT004		8.5 L (9.0 qt)
70D	T04239DT004		8.5 L (9.0 qt)
290D	T04239DT007		8.5 L (9.0 qt)
490	T04239TT003		14.0 L (15 qt)
490D	T04276DT008		8.5 L (9.0 qt)
495D	T04276TT021		12.5 L (13.0 qt)
590D	T04276TT021		12.5 L (13.0 qt)
595	T04276TT012		12.5 L (13.0 qt)
595D	T04276TT021		12.5 L (13.0 qt)
690D	T06414DTW14		19.0 L (20.0 qt)
LOADERS—4 WHEEL DRIVE			
344E	T04276TT010		12.5 L (13.0 qt)
JD444	CD6359DCD02		11.5 L (12.0 qt)
444D	T06359DDW01		11.5 L (12.0 qt)
	T06359TDW01*		11.5 L (12.0 qt)
444E	T04276TT018		12.5 L (13.0 qt)
JD544B	CD6359TCD01		19.0 L (20.0 qt)
	T06414TT002		19.0 L (20.0 qt)
544C	T06414TT-05		19.0 L (20.0 qt)
	CD6359TCD03		19.0 L (20.0 qt)
544D	T06414TDW11		19.0 L (20.0 qt)
544DH	T06414TDW12		19.0 L (20.0 qt)
544E	T06359TDW04		19.0 L (20.0 qt)
544EH	T06359TDW05		19.0 L (20.0 qt)
624E	T06414TDW15		19.0 L (20.0 qt)
624EH	T06414TDW16		19.0 L (20.0 qt)

*Turbo for altitude compensation

S55,2000,NB1 -19-01NOV95

ENGINE CRANKCASE OIL FILL QUANTITIES—CONTINUED

• JOHN DEERE INDUSTRIAL APPLICATIONS—CONTINUED

Machine Model No.	Engine Model	Engine Serial No.	Crankcase Oil Fill Quantity with Filter Change
MOTOR GRADERS			
570B	T06359DDW02		11.5 L (12.0 qt)
	T06359TDW02*		11.5 L (12.0 qt)
JD670	T06414TT003		19.0 L (20.0 qt)
670A	T06414TT003		19.0 L (20.0 qt)
	T06414TDW03		19.0 L (20.0 qt)
670B	T06414TDW03		19.0 L (20.0 qt)
672A	T06414TT003		19.0 L (20.0 qt)
	T06414TDW03		19.0 L (20.0 qt)
672B	T06414TDW13		19.0 L (20.0 qt)
SKIDDERS			
340D	T04276DT004		14.0 L (15.0 qt)
	T04276DDW04		14.0 L (15.0 qt)
440C	T04276TT002		14.0 L (15.0 qt)
440D	T04276TT007		14.0 L (15.0 qt)
	T04276TDW07		14.0 L (15.0 qt)
448D	T04276TT007		14.0 L (15.0 qt)
	T04276TDW07		14.0 L (15.0 qt)
540B	T04276TT004		14.0 L (15.0 qt)
540D	T04276TT008		14.0 L (15.0 qt)
	T04276TDW08		14.0 L (15.0 qt)
548D	T04276TT008		14.0 L (15.0 qt)
	T04276TDW08		14.0 L (15.0 qt)
640	T06414TT001		19.0 L (20.0 qt)
640D	T06414TT008		19.0 L (20.0 qt)
	T06414TDW08		19.0 L (20.0 qt)
648D	T06414TT008		19.0 L (20.0 qt)
	T06414TDW08		19.0 L (20.0 qt)
FELLER BUNCHER			
643	T06414TT015		19.0 L (20.0 qt)
693D	T06414TDW14		19.0 L (20.0 qt)
FORK LIFT			
482C	T04239DT002		8.5 L (9.0 qt)

*Turbo for altitude compensation

S55,2000,MT1 -19-26JUL89

ENGINE CRANKCASE OIL FILL QUANTITIES—CONTINUED

• OEM APPLICATIONS

Engine Model	Option Code	Oil Pan Part No.*	Crankcase Oil Fill Quantity with Filter Change
CD3179DF	1901	AT18180	6.0 L (6.5 qt)
	1903	AT18180	6.0 L (6.5 qt)
	1904	R53469	6.0 L (6.5 qt)
CD3179TF	1904	R53469	8.0 L (8.5 qt)
	1906	R91851	8.0 L (8.5 qt)
CD4239DF	1902	AR66726	8.5 L (9.0 qt)
	1903	AR66726	8.5 L (9.0 qt)
	1924	AR66726	8.5 L (9.0 qt)
	1932	R91163	8.5 L (9.0 qt)
T04239DF	1901	AR66726	8.5 L (9.0 qt)
	1902	AR66726	8.5 L (9.0 qt)
	1903	AR66726	8.5 L (9.0 qt)
	1904	T20163	8.5 L (9.0 qt)
	1910	R109904	8.5 L (9.0 qt)
CD4239TF	1904	R59355	12.5 L (13.0 qt)
	1908	R82426	13.5 L (14.5 qt)
	1932	R91163	11.5 L (12.0 qt)
T04239TF	1901	R105383	13.0 L (14.0 qt)
	1903	AR66726	8.5 L (9.0 qt)
	1908	R82426	12.5 L (13.0 qt)
	1910	R109904	8.5 L (9.0 qt)
CD4239AF	1908	R82426	13.5 L (14.5 qt)
CD6359DF	1905	R91455	17.0 L (18.0 qt)
	1909	R80541	15.0 L (16.0 qt)
T06359DF	1905	R91455	17.0 L (18.0 qt)
	1905	R56406	17.0 L (18.0 qt)
	1905	R106045	17.0 L (18.0 qt)
	1916	R86923	17.0 L (18.0 qt)
	1918	T23220	11.5 L (12.0 qt)
	1935	R56406	17.0 L (18.0 qt)
	1935	R91455	17.0 L (18.0 qt)
	1935	R106045	17.0 L (18.0 qt)
CD6359TF	1905	R91455	17.0 L (18.0 qt)
	1909	R80541	15.0 L (16.0 qt)
	1935	R91455	17.0 L (18.0 qt)

**On aluminum and cast iron oil pans, the part number is embossed on the oil pan. On sheet metal oil pans, the part number listed is the part number listed in the parts catalog.*

S55,2000,MZ -19-01NOV95

ENGINE CRANKCASE OIL FILL QUANTITIES—CONTINUED

• OEM APPLICATIONS—CONTINUED

Engine Model	Option Code	Oil Pan Part No.*	Crankcase Oil Fill Quantity with Filter Change
T06359TF	1905	R91455	17.0 L (18.0 qt)
	1916	R86923	17.0 L (18.0 qt)
	1935	R91455	17.0 L (18.0 qt)
	1935	R56406	17.0 L (18.0 qt)
	1935	R106045	17.0 L (18.0 qt)
CD6359AF	1905	R91455	17.0 L (18.0 qt)
T04276DF	1901	AR66726	8.5 L (9.0 qt)
	1902	AR66726	8.5 L (9.0 qt)
	1903	AR66726	8.5 L (9.0 qt)
	1904	R59355	12.5 L (13.0 qt)
	1908	R82426	12.5 L (13.0 qt)
	1908	R105383	12.5 L (13.0 qt)
T04276TF	1904	R59355	12.5 L (13.0 qt)
	1907	R82426	12.5 L (13.0 qt)
	1908	R82426	12.5 L (13.0 qt)
	1914	R82426	12.5 L (13.0 qt)
T06414DF	1905	R91455	18.0 L (19.0 qt)
	1905	R56406	18.0 L (19.0 qt)
	1905	R106045	18.0 L (19.0 qt)
	1916	R86923	19.0 L (20.0 qt)
T06414TF	1905	R91455	19.0 L (20.0 qt)
	1905	R106045	19.0 L (20.0 qt)
	1909	R91455	19.0 L (20.0 qt)
	1909	R106045	19.0 L (20.0 qt)
	1935	R91455	19.0 L (20.0 qt)
	1935	R106045	19.0 L (20.0 qt)

**On aluminum and cast iron oil pans, the part number is embossed on the oil pan. On sheet metal oil pans, the part number listed is the part number listed in the parts catalog.*

S55,2020,R -19-01NOV95

IDENTIFY OIL COOLER TYPE—3179, 4239, 6359 ENGINES

Two types of oil coolers are used:

- **Standard-Flow Oil Cooler (A, B, C)**

Standard-flow coolers are positioned between the oil filter and cylinder block. The standard-flow oil cooler may be of the 4-plate (A), 8-plate (B), or 10-plate (C) type.

NOTE: On Saran Engines (794194CD—) the 4 and 8 plate oil coolers have been replaced by a 6 plate cooler. On Saran Engines (795107CD—) the 10 plate oil cooler has been replaced by an 8 plate cooler.

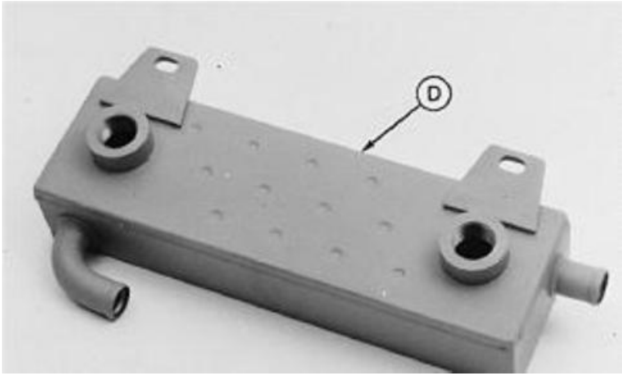
- **High-Flow Oil Cooler (D)**

High-flow coolers are attached to the cylinder head or block. High-flow oil coolers have 7 plates.

NOTE: High-flow oil coolers are used on some 6359T and all 6359A Engines.

RG4798 -UN-29NOV88

Standard-Flow Oil Cooler



RG4927 -UN-29NOV88

High-Flow Oil Cooler

S11,2020,FR -19-21SEP95

REMOVE, INSPECT, AND INSTALL STANDARD-FLOW OIL COOLER (3179, 4239, 6359 ENGINES)

Inspect coolant hoses. Replace if cracked or damaged.

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1. Drain coolant. A drain plug is located on side of oil cooler base.

2. Remove oil filter.

3. Disconnect coolant hoses.

4. Remove adapter (A) to remove oil cooler.

5. Inspect coolant passage through cooler for a restriction caused by scale or sludge. Use compressed air and blow through passage to make sure it is open. If engine lubricating oil was contaminated with metallic particles, discard oil cooler (puncture to prevent accidental reuse) and install a new one.

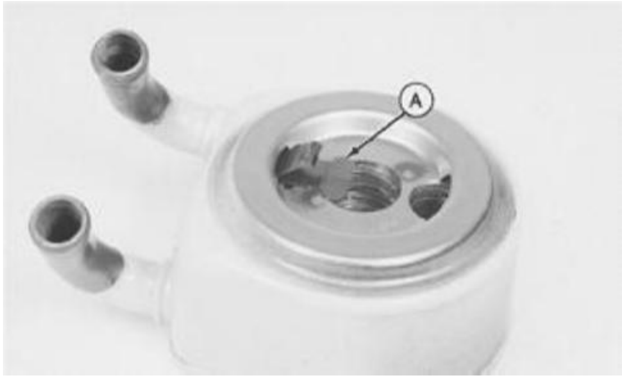
T91327 -UN-09NOV88

S11,2020,EL -19-21SEP95

6. Remove oil cooler relief valve (A) and inspect for damage. Replace if necessary.

7. Install relief valve.

8. Install hoses and hose clamps on oil cooler pipes.



T91328 -UN-25OCT88

S11,2020,EM -19-21SEP95

9. Install oil cooler using a new packing. Tighten oil cooler adapter to 37 N·m (27 lb-ft). Tighten hose clamps.

10. Install a new oil filter.

11. Fill cooling system.

T91329 -UN-09NOV88

S11,2020,EN -19-21SEP95

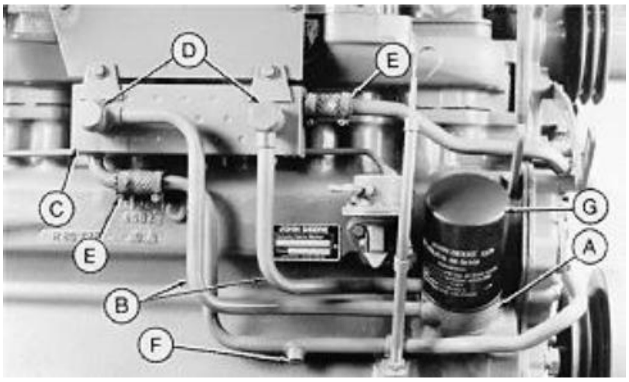
REMOVE AND INSTALL HIGH-FLOW OIL COOLER (6359 ENGINES)

Inspect coolant hoses. Replace if cracked or damaged.

1. Remove drain plug (F) and drain coolant from base (A).

2. Disconnect oil lines (B) from oil cooler (C), and remove two banjo bolts (D).

3. Remove oil cooler from its support.



RG4799 -UN-29NOV88

A—Base
B—Oil Lines
C—Oil Cooler
D—Banjo Bolts
E—Coolant Connections
F—Coolant Drain Plug
G—Oil Filter

S11,2020,FS -19-14JUL95

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15

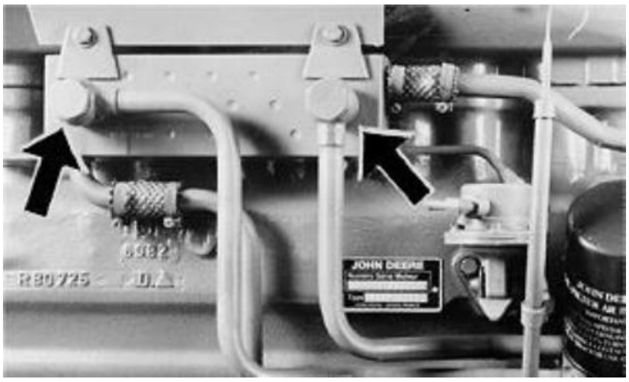
NOTE: Inspect coolant passage through cooler for a restriction caused by scale or sludge. Use compressed air and blow through passage to make sure it is open.

4. Inspect oil cooler for general condition. Replace if not in good condition. Puncture old cooler (to prevent accidental reuse) and discard if replacing with a new one.

S11,2020,FT -19-14JUL95

5. Attach oil cooler to support and connect coolant lines.

6. Connect oil lines to cooler with banjo bolts and new copper washers. Tighten bolts to 100 N·m (74 lb-ft).



RG4800 -UN-29NOV88

S11,2020,FU -19-11APR86

REMOVE DISTRIBUTOR BASE—HIGH-FLOW OIL COOLER (6359)

1. Remove oil filter, and disconnect oil lines (A).

2. Remove adapter (B) and lift out of distributor base (C). Discard packing.

RG4801 -UN-29NOV88

S11,2020,FV -19-22JUL95

INSPECT AND REPAIR DISTRIBUTOR BASE—HIGH-FLOW OIL COOLER (6359)

1. Remove oil cooler relief valve (A) and inspect for damage. Replace if necessary. Reinstall in base.

2. To replace adapter, remove from base and press in a new one. Install adapter so that threaded end faces outward (away from base).

RG4802 -UN-29NOV88

S11,2020,FW -19-14JUL95

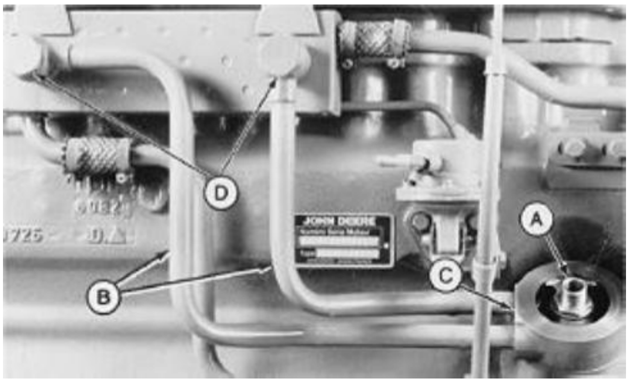
INSTALL DISTRIBUTOR BASE—HIGH-FLOW OIL COOLER (6359)

1. Install a new packing between cylinder block and base.

2. Attach distributor base to cylinder block with the adapter (A). Tighten adapter to 37 N·m (27 lb-ft).

3. Press oil lines (B) into distributor base (C) using new O-rings. Connect oil lines to cooler with banjo bolts (D) using new copper washers. Tighten to 100 N·m (74 lb-ft).

4. Install a new filter and fill cooling system.



RG4803 -UN-29NOV88

A—Adapter
B—Oil Lines
C—Distributor Base
D—Banjo Bolts

S11,2020,FX -19-21SEP95

REMOVE OIL COOLER (4276, 6414 ENGINES)

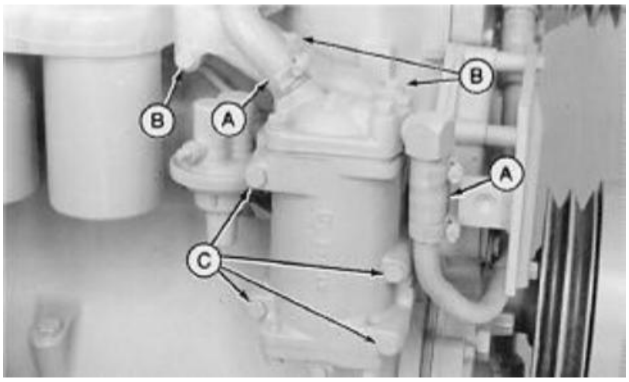
Inspect coolant hoses. Replace if cracked or damaged.

1. Drain coolant from the radiator.

2. Disconnect the coolant lines (A).

3. Remove cap screws (B) to remove filter base.

4. Remove cap screws (C) to remove oil cooler.



T6078AA -UN-25OCT88

S11,2020,GR -19-21SEP95

REPAIR OIL COOLER (4276, 6414 ENGINES)

1. Remove covers from both ends.

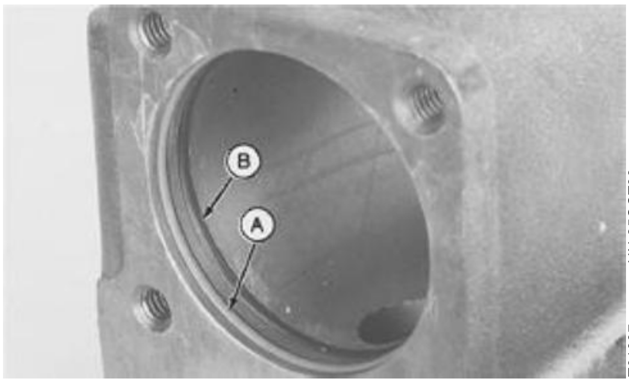
2. Remove oil cooler from housing.

NOTE: Oil cooler bypass valve is not a service item. If damaged, order oil cooler housing assembly. (See REMOVE AND INSTALL OIL COOLER/FILTER BYPASS VALVE later in this group.)

T91332 -UN-25OCT88

S11,2020,GS -19-14JUL95

INSTALL OIL COOLER (4276, 6414 ENGINES)



T91337 -UN-25OCT88

1. Install a new red O-ring in the lower groove (A) and black O-ring (B) in the upper groove. O-rings must be installed in the proper grooves.

2. Install oil cooler element in housing.

3. Install covers with new gaskets. Tighten cap screws to 37 N·m (27 lb-ft).

4. Before installing oil cooler housing, clean gasket material from cylinder block, filter base and oil cooler housing.

5. Check that O-ring is installed on pressurizing regulating valve in block.

6. Install new gaskets.

7. Install the oil cooler housing and filter base. Tighten cap screw for oil cooler first then the filter base. Tighten oil cooler housing cap screws to 47 N·m (35 lb-ft). Tighten oil filter base cap screw to 37 N·m (27 lb-ft).

8. Connect the lines. Fill radiator with proper coolant. (See Group 02.)

S11,2020,GT -19-21SEP95

REMOVE AND INSPECT OIL BYPASS VALVE (3179, 4239, 6359 ENGINES)


T87436 -UN-09NOV88

*NOTE: Oil bypass valve used on: Saran built—
3179 engines, Engine Serial No. (CD465253—)
4239D engines, Engine Serial No. (CD460067—)
4239T engines, Engine Serial No. (CD464488—)
6359 engines, Engine Serial No. (CD465213—)
Dubuque built—all 4239 and 6359 Engines*

1. Remove timing gear cover and front plate as described in Group 16.

2. Remove oil bypass valve and spring.

IMPORTANT: A new (shorter) oil bypass valve and spring has been adopted for Saran Engine Serial No. (968591—)* and Dubuque service short blocks. If this new (shorter) valve and spring are installed in the old (deeper bore) cylinder block, the valve will remain open and unfiltered oil will flow through the engine. If the old (longer) valve and spring are installed in a new (shallower bore) cylinder block, the bypass valve will not open to allow oil to flow. (See MEASURE OIL BYPASS VALVE LENGTH AND CYLINDER BLOCK BORE later in this group.)

3. Inspect valve and spring for damage. Replace parts if necessary.

** In some cases, engines prior to serial number break may have the shorter valve and spring installed.*

RG,CTM4,DW804 -19-01NOV95

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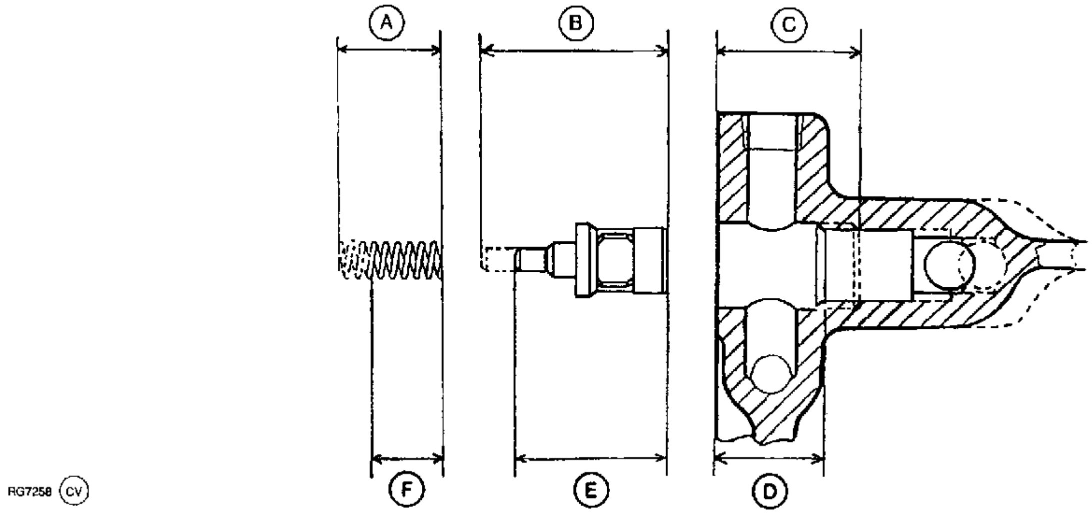
19

MEASURE OIL BYPASS VALVE LENGTH AND CYLINDER BLOCK BORE



RG7258 -UN-19SEP95

A—59.0 mm (2.32 in.) Previous Spring Length
B—49.5 mm (1.95 in.) Previous Valve Length
C—41.5 mm (1.63 in.) Previous Bore Depth
D—33.07 mm (1.30 in.) New Bore Depth
E—41.0 mm (1.61 in.) New Valve Length
F—51.0 mm (2.00 in.) New Spring Length

IMPORTANT: When replacing parts, be sure to measure valve length or cylinder block bore depth to determine which parts should be installed.

1. Measure cylinder block bore depth (C or D).

2. Measure the oil bypass valve length (B or E).

3. Compare dimension to those listed above and install the correct oil bypass valve and spring.

RG,CTM4,DW717 -19-09OCT95

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INSTALL OIL BYPASS VALVE (3179, 4239, 6359 ENGINES)

1. Install oil bypass valve and spring in cylinder block.

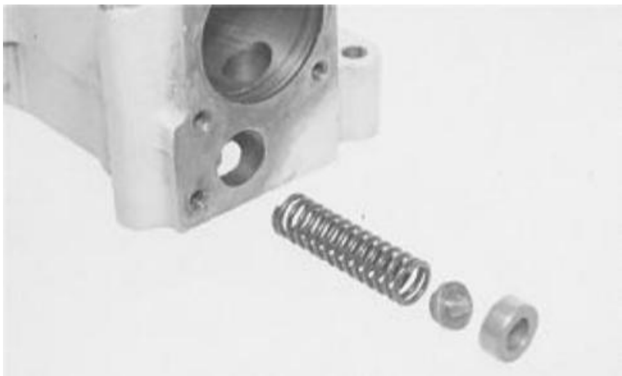
2. Install front plate and timing gear cover as described earlier in Group 16.

RG,CTM4,DW805 -19-21SEP95

REMOVE AND INSTALL OIL COOLER/FILTER BYPASS VALVE (4276, 6414 ENGINES)

The oil cooler/filter bypass valve assembly is located in a bottom bore of oil cooler housing. The spring and valve are retained in housing by the pressed-in seat.

NOTE: Since the spring, valve and seat are not easily removed and seldom require replacement, these parts are not provided for service. The cooler housing provided for service includes the valve assembly.



T91330 -UN-25OCT88

S11,2020,GU -19-14JUL95

REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT (3179, 4239, 6359 ENGINES)

1. Remove oil pressure regulating valve plug.

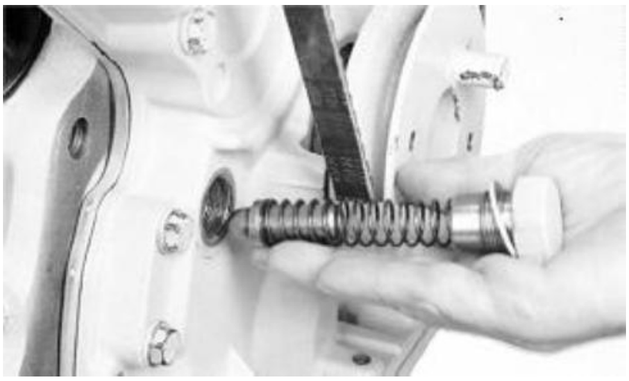
T88877 -UN-09NOV88

S11,2020,HB -19-14JUL95

2. Remove oil pressure regulating valve and spring. Check valve cone for excessive wear and damaged sealing face.

PRESSURE REGULATING VALVE SPRING SPECIFICATIONS

Spring Free Length	120 mm (4.72 in.)
Spring Tension at 42.5 mm (1.68 in.)	60—75 N (13.5—16.5 lb-force)

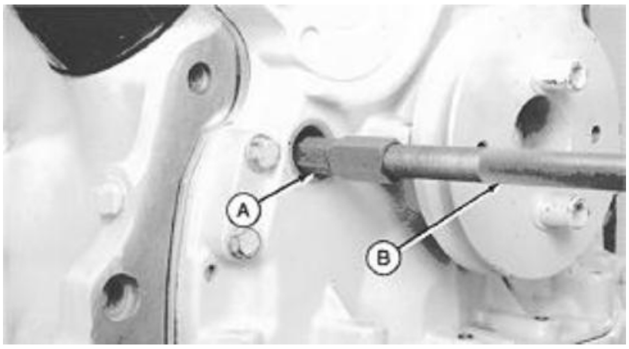


T81788 -UN-09NOV88

T49,0407,16 -19-18FEB95

20
21

3. Pull valve seat out of cylinder block with JT01727 Collet (A) and JT01718 slide hammer (B) from D01061AA Blind-Hole Puller Set, or equivalent.



T88878 -UN-25OCT88

T49,0407,17 -19-16SEP92

IMPORTANT: DO NOT drive against raised inner rim of valve seat so that valve seat bore is not damaged.

4. Drive valve seat into cylinder block with JD248A Oil Pressure Relief Valve Bushing Driver and JDG536 (OTC813) Handle until the seat bottoms.

T88879 -UN-25OCT88

T49,0407,18 -19-21SEP95

5. Install valve, spring, washer, and plug in timing gear cover. Tighten plug to 95 N·m (70 lb-ft).

T88873 -UN-09NOV88

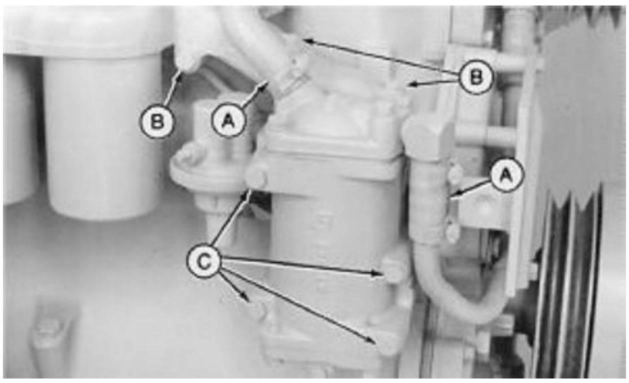
S11,2020,HC -19-04APR90

REMOVE, INSPECT, AND INSTALL OIL PRESSURE REGULATING VALVE (4276, 6414 ENGINES)

1. Disconnect lines (A).

2. Remove cap screws (B) to remove filter assembly.

3. Remove cap screws (C) to remove oil cooler.



T6078AA -UN-25OCT88

S11,2020,GV -19-14JUL95

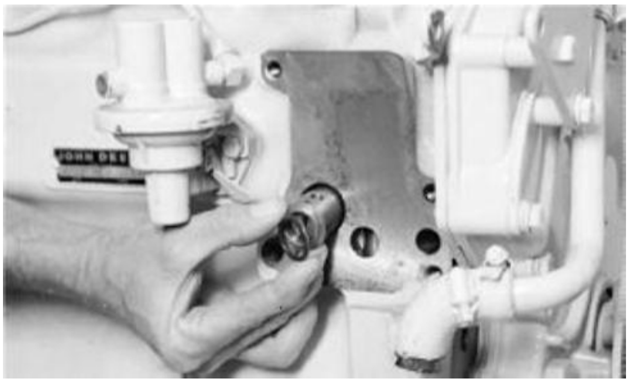
4. Remove pressure regulating valve.

IMPORTANT: The hole in the valve must align with the hole in the block.

5. After repair, install new O-ring on valve and install into block.

6. Install new gaskets. Install the oil cooler and filter assembly. Tighten oil cooler housing cap screws to 47 N·m (35 lb-ft). Tighten oil filter housing cap screws to 37 N·m (27 lb-ft).

7. Connect lines to oil cooler.



T94572 -UN-25OCT88

S11,29020,GW -19-12JUN90

REPAIR OIL PRESSURE REGULATING VALVE (4276, 6414 ENGINES)

1. Remove spring pin to remove valve and spring.

T91271 -UN-25OCT88

S11,2020,GX -19-14JUL95

2. Check valve spring using spring compression tester.

PRESSURE REGULATING VALVE SPECIFICATIONS

Spring Free Length	59 mm (2.32 in.)
Spring Tension at 34 mm (1.34 in.)	92—112 N (21—25 lb-force)

3. Inspect valve and housing bore for damage. Valve must slide freely in bore.

T91264 -UN-25OCT88

S11,2020,GY -19-21SEP95

4. Install spring and valve. Compress spring and install punch.

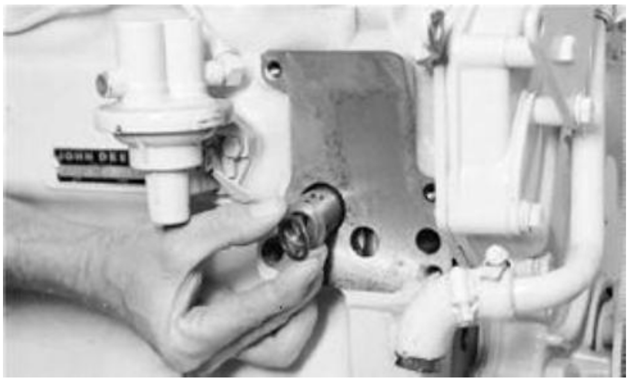
5. Install spring pin and remove punch.

T91272 -UN-25OCT88

S11,2020,GZ -19-04APR90

6. Install valve into hole in cylinder block, and install a new O-ring.

7. Install new gaskets. Install the oil cooler and filter assembly. (See REMOVE AND INSTALL OIL COOLER 4276, 6414 ENGINES earlier in this group.)



T94572 -UN-25OCT88

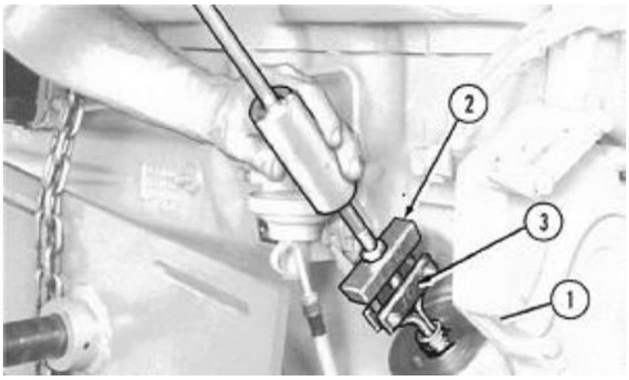
RG,CTM8,DX428 -19-21SEP95

REMOVE OIL FILTER ADAPTER (3179, 4239, 6359 ENGINES)

1. Remove engine oil cooler.

2. Inspect oil filter adapter (1) for damage. If it is damaged remove it.

3. Pull oil filter adapter out of cylinder block with D01209AA Pilot Bearing Puller (2) and D01226AA Long Jaws (3) from D01048AA 17-1/2 Ton Puller Set, or equivalent.

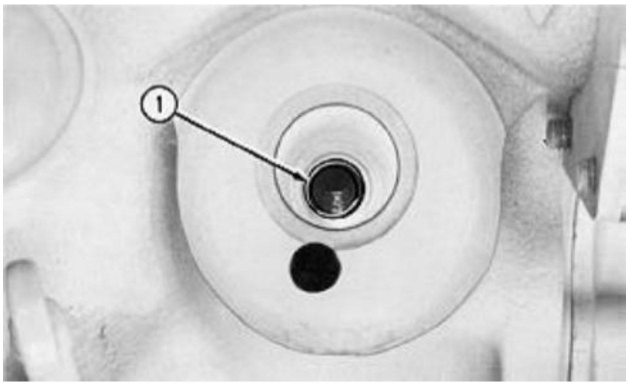


T79806 -UN-09DEC88

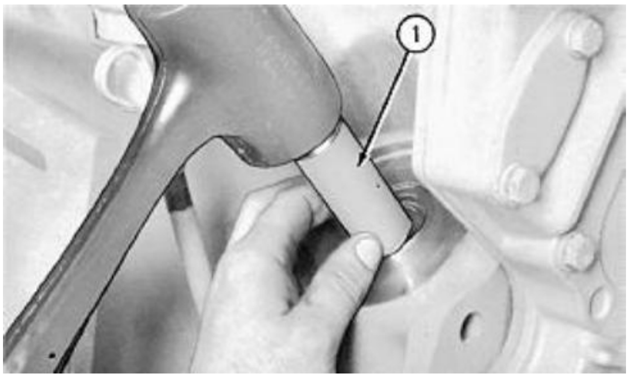
S11,2020,HD -19-21SEP95

INSTALL OIL FILTER ADAPTER (3179, 4239, 6359 ENGINES)

1. Put the oil filter adapter over its bore in the cylinder block. Turn the oil filter adapter so the oil hole (1) is as low as possible.



S11,2020,HE -19-21SEP95



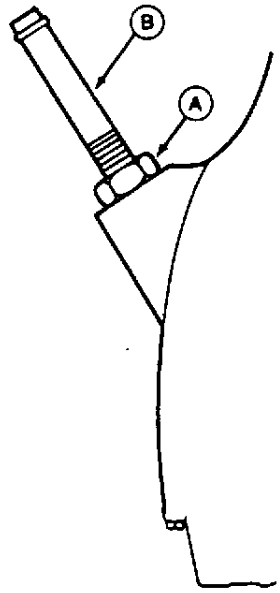
2. Using a tubular driver (1), push the oil filter adapter into the cylinder block until it is flush with the cylinder block.

3. Install oil cooler, if equipped, as described earlier in this group.

4. Install oil filter.

K01,0407,62 -19-21SEP95

REMOVE, INSTALL, AND ADJUST DIPSTICK TUBE



RG5599 -UN-14NOV89

1. Loosen lock nut (A) and screw dipstick tube (B) out of cylinder block.

2. Replace dipstick tube if damaged.

3. With lock nut installed on dipstick tube, apply LOCTITE 515 (TY6304) Flexible Sealant to threads of dipstick tube. Screw tube into block until tube is at correct height. Tighten lock nut.

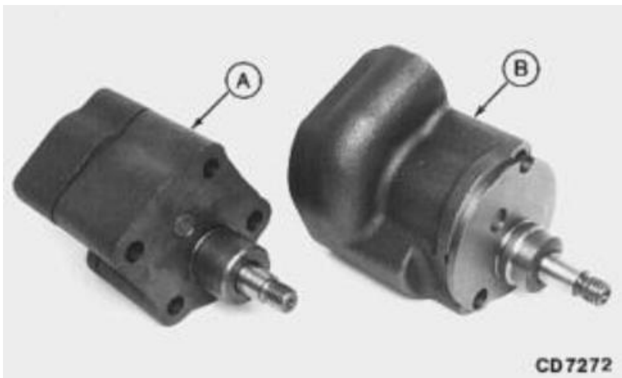
4. Check dipstick calibration. Adjust tube height as required.

The preferred method for adjusting dipstick tube is to:

• Run engine to circulate oil.
• Drain crankcase and replace filter.
• Allow engine to cool, then fill crankcase with the correct amount of new engine oil. (See ENGINE CRANKCASE OIL FILL QUANTITIES earlier in this group.)
• Adjust tube to have oil level at full mark on dipstick.

RG,CTM4,DY110 -19-21SEP95

GENERAL OIL PUMP INFORMATION



CD7272 -UN-23MAY95

Two types of oil pumps are used:

• All 3179 and most 4239 and 6359 Engines will be equipped with standard capacity pump (A). However, a limited number of 4239 and 6359 Saran-built engines may have the high capacity pump (B).

• All 4276 and 6414 Engines are equipped with the high capacity pump.

A—Capacity 0.88 L/S (14 GPM)
B—Capacity 1.01 L/S (16 GPM)

S11,2020,EQ -19-21SEP95

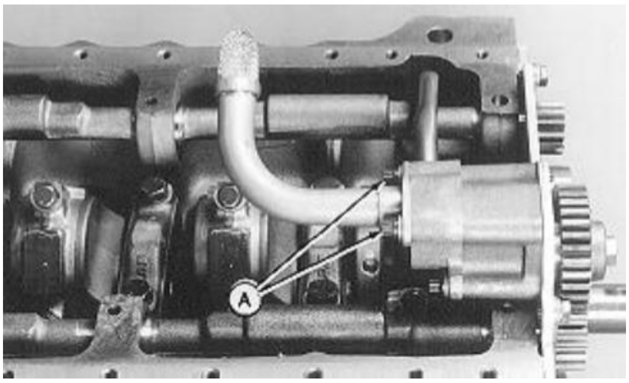
REPLACE OIL PUMP PICK-UP TUBE ASSEMBLY

1. Remove oil pan.

2. Loosen cap screws (A) and remove oil pump pick-up tube assembly.

3. Install new assembly with new O-ring and tighten cap screws to 47 N·m (35 lb-ft).

4. Reinstall oil pan.



RG7299 -UN-17FEB95

Standard Capacity Oil Pump Shown

RG,CTM8,DX167 -19-18FEB95

REMOVE STANDARD CAPACITY OIL PUMP

1. Drain oil and disconnect turbocharger oil inlet line at the turbocharger.

2. Remove oil pan. Remove gasket from oil pan and pan rail.

NOTE: To aid reassembly of 4-cylinder engines with balancer shafts, lock the crankshaft with No. 1 piston at TDC compression stroke.

3. Remove nut and pull gear from pump shaft.

If a suitable puller is not available, loosen nut several turns and apply force between the front plate and gear on two sides of gear with small pry bars. Strike the nut on end of shaft with a lead hammer while applying force to gear until gear is free of tapered shaft.

T81790 -UN-09NOV88

CTM8,GR20,31 -19-16SEP92

4. Remove the oil pump-to-front plate cap screws.

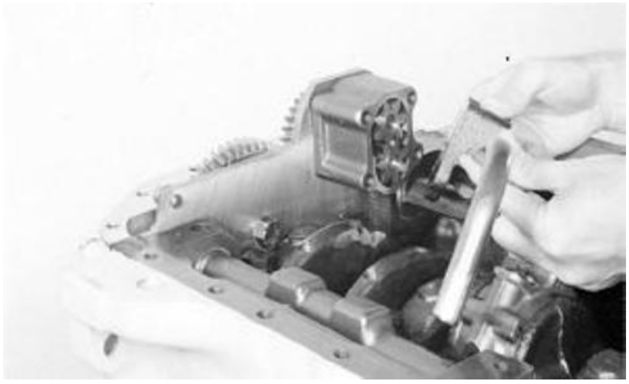
T81956 -UN-31OCT88

S11,2020,ES -19-21SEP95

5. Remove cover and outlet tube.

6. Remove housing assembly and drive gear from front plate.

7. Remove O-ring from tube bore in block.



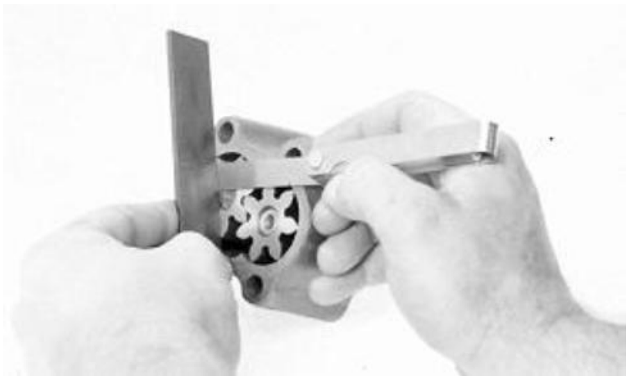
T81957 -UN-31OCT88

S11,2020,ET -19-25JUN92

INSPECT AND MEASURE CLEARANCES (STANDARD CAPACITY OIL PUMP)

Inspect oil pump components for excessive wear. Replace parts or oil pump assembly, as necessary.

1. Check gear-to-pump cover axial clearance.



T81779 -UN-09NOV88

AXIAL CLEARANCE SPECIFICATIONS

Thickness of gears	41.156—41.206 mm (1.6203—1.6223 in.)
Wear Limit	41.106 mm (1.6183 in.)
Axial clearance	0.031—0.157 mm (0.0012—0.0062 in.)
Wear Limit	0.22 mm (0.0085 in.)

RG,CTM8,GR20,45-19-16SEP92

2. Check gear-to-pump housing radial clearance.

RADIAL CLEARANCE SPECIFICATIONS

Radial Clearance	0.10—0.16 mm (0.004—0.006 in.)
Wear Limit	0.20 mm (0.008 in.)

T81780 -UN-09NOV88

RG,CTM8,GR20,46-19-25JUN92

3. Check housing bore ID and pump shaft OD.

PUMP DRIVE SHAFT OD AND BORE ID SPECIFICATIONS

Bore ID (in housing)	16.059—16.083 mm (0.6322—0.6332 in.)
Wear Limit	16.163 mm (0.6362 in.)
Drive Shaft OD	16.022—16.032 mm (0.6308—0.6312 in.)
Wear Limit	15.997 mm (0.6298 in.)
Idler Shaft OD	12.319—12.329 mm (0.4850—0.4854 in.)
Wear Limit	12.306 mm (0.4845 in.)

T81953 -UN-09NOV88

T81781 -UN-09NOV88

RG,CTM8,GR20,47-19-25JUN92

COMPLETE STANDARD CAPACITY OIL PUMP DISASSEMBLY

1. Remove outlet tube from cover.

2. Remove and discard O-ring.

T81791 -UN-01NOV88

S11,2020,EX -19-14JUL95

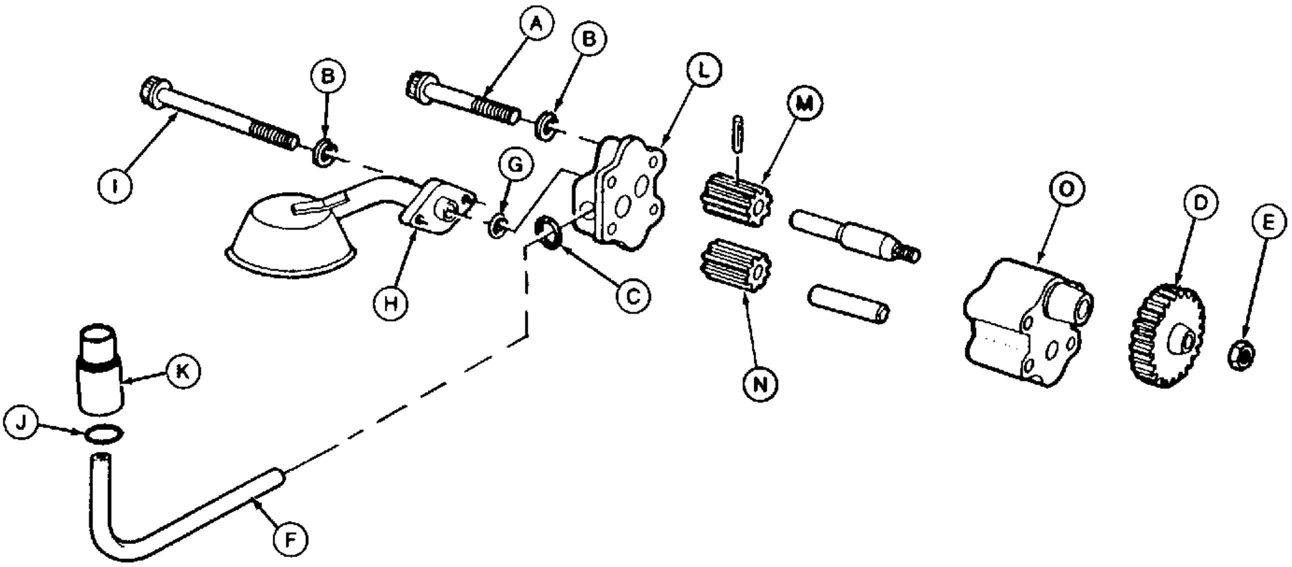
3. Remove O-ring (A) from pick-up tube.

4. Clean all oil pump parts in solvent. Use compressed air to dry parts.

5. Inspect pick-up tube. Check flange-to-tube weld for cracks. If cracks or other defects are found, replace pick-up tube. See REPLACE OIL PUMP PICK-UP TUBE ASSEMBLY, earlier in this group.

S11,2020,EY -19-18FEB95

ASSEMBLE STANDARD CAPACITY OIL PUMP



A—Cap Screw (4 used)
B—Washer (6 used)
C—O-Ring
D—Gear
E—Nut
F—Outlet Tube
G—O-Ring
H—Intake Pick-up Tube
I—Cap Screw (2 used)
J—O-Ring
K—Inlet Tube
L—Cover
M—Drive Gear
N—Idler Gear
O—Pump Housing

IMPORTANT: Lubricate gears and shaft with clean engine oil before assembling.

1. Install new O-ring (C) in cover (L).

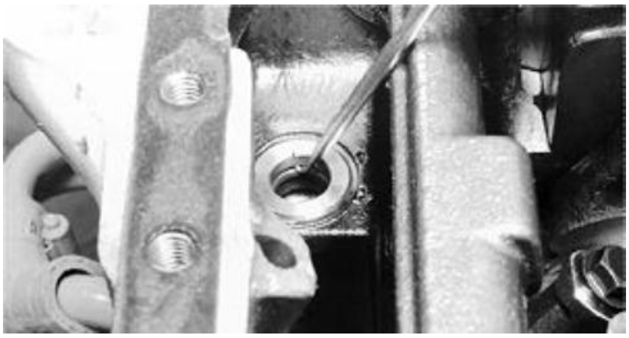
2. Install new O-ring (G) in oil intake pick-up tube (H).

3. Put idler gear (N) and drive gear (M) in pump housing (O). Gears must turn freely.

4. Install outlet tube (F) in cover.

RG,CTM4,DW807 -19-21SEP95

INSTALL STANDARD CAPACITY OIL PUMP


T88931 -UN-09NOV88

NOTE: This procedure is for installing the oil pump with timing gear cover installed. If timing gear cover is removed from the engine, refer to INSTALL AND TIMING BALANCER SHAFT in Group 16 for 4-cylinder engines only.

1. On 4-cylinder engines with balancer shafts, lock No. 1 piston at TDC compression stroke.

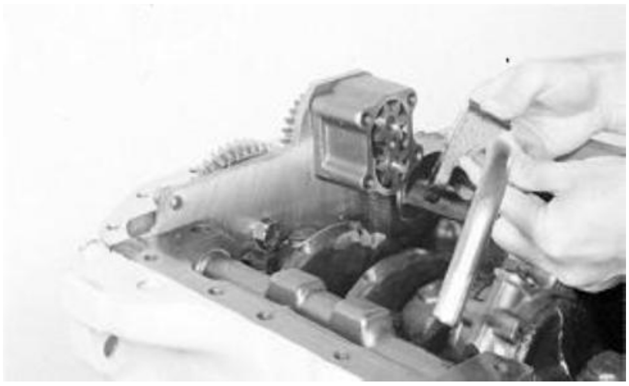
2. Install a new O-ring in groove of cylinder block (for outlet tube).

NOTE: The cylinder block O-ring is used on all Dubuque-built engines. On Saran-built engines, the O-ring is used on the following:

4239D and T Serial No. (CD574190—)
6359D, T, and A Serial No. (CD571540—)

3. Install a new O-ring on oil intake pickup tube.

S11,2020,FA -19-21SEP95


T81957 -UN-31OCT88

IMPORTANT: On 4-cylinder engines, the key slot in the balancer shafts must be at the 12 O'clock position (timing marks on both balancer shaft gears facing inboard toward crankshaft centerline), when No. 1 piston is at TDC compression stroke.

4. Install oil pump drive gear so it meshes with balancer shaft gear and idler gear WITHOUT altering the timing position of the balancer shaft.

5. While holding drive gear in place, install housing on front plate.

6. Install pump cover with outlet tube and pick-up tube.

RG,CTM4,DT458 -19-01NOV95

7. Install pump-to-front plate cap screws and tighten to 47 N·m (35 lb-ft).

8. Rotate oil pump shaft by hand to be sure it turns easily.

T82027 -UN-09NOV88

RG,CTM4,DT459 -19-21SEP95

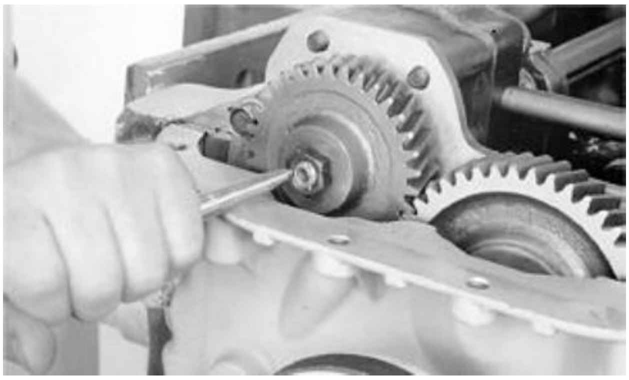
• On 4-cylinder engines:

9. Install oil pump drive gear making sure that it meshes with left balancer shaft gear and lower idler gear WITHOUT altering the timing position of the balancer shaft gear. Tighten hex nut to 75 N·m (55 lb-ft).

• On all other engines:

10. Install oil pump gear and nut. Tighten nut to 75 N·m (55 lb-ft).

11. Stake nut to shaft by applying three center punch marks near ID of nut.



T81782 -UN-09NOV88

RG,CTM4,DT460 -19-21SEP95

REMOVE HIGH CAPACITY OIL PUMP

NOTE: This pump is used on some Saran and Dubuque-built 4239 and 6359 Engines. Also used on all 4276 and 6414 Engines.

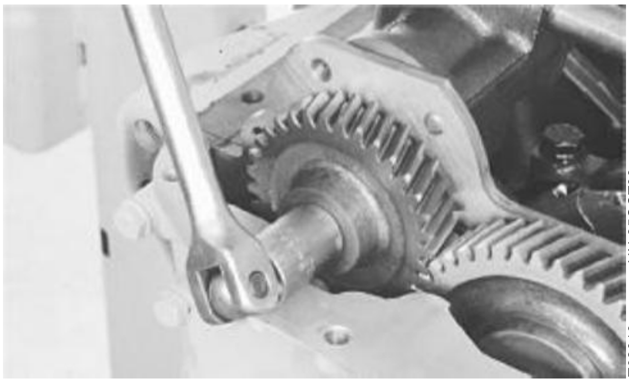
1. Drain oil and disconnect turbocharger oil inlet line at the turbocharger.

2. Remove oil pan. Remove gasket from oil pan and oil pan rail.

NOTE: To aid reassembly of 4-cylinder engines with balancer shafts, lock the crankshaft with No. 1 piston at TDC compression stroke.

3. Remove nut and pull gear from oil pump drive shaft.

If a suitable puller is not available, loosen nut several turns and apply force between the front plate and gear on two sides of gear with small pry bars. Strike the nut on end of shaft with a lead hammer while applying force to gear until gear is free of tapered shaft.



T92913 -UN-25OCT88

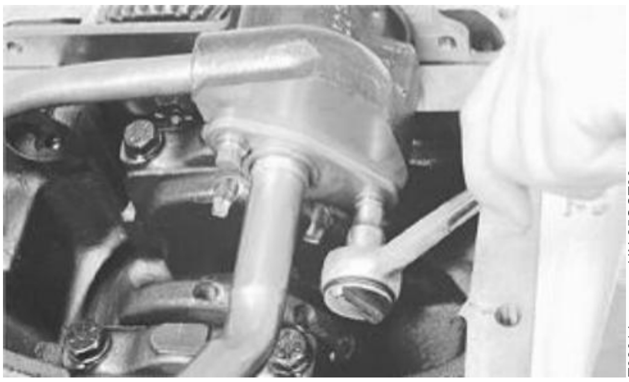
S11,2020,FE -19-21SEP95

4. Remove two oil pump-to-front plate cap screws. Lift pickup tube off oil pump.

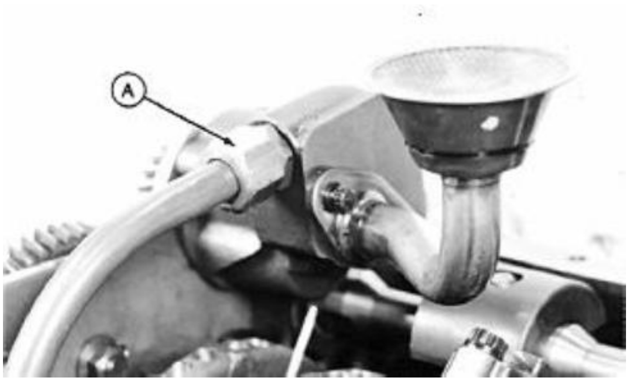
5. Lift oil pump, with outlet tube, off engine.

6. Pull outlet tube out of pump housing.

NOTE: On late Dubuque-built engines equipped with the increased capacity oil pump, the oil pump outlet tube is retained in the oil pump by a gland nut (A). The gland nut was effective at approximately Engine Serial No. (T0122431—). This change can be made to earlier engines, if desired.



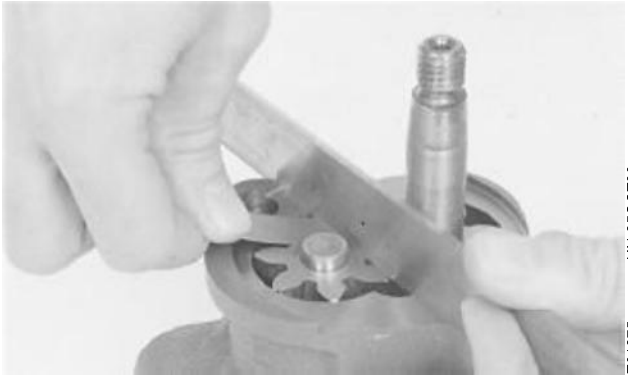
T92914 -UN-25OCT88



RG6362 -UN-17AUG92

S11,2020,FF -19-21SEP95

INSPECT AND MEASURE CLEARANCES (HIGH CAPACITY OIL PUMP)


T91275 -UN-25OCT88

Inspect oil pump components for excessive wear. Replace parts or oil pump assembly, as necessary.

1. Check gear-to-pump cover axial clearance.

AXIAL CLEARANCE SPECIFICATIONS

Thickness of Gears	50.975—51.025 mm (2.007—2.009 in.)
Wear Limit	50.925 mm (2.005 in.)
Axial Clearance	0.042—0.168 mm (0.0016—0.0066 in.)
Wear Limit	0.22 mm (0.0085 in.)

RG,CTM8,GR20,53-19-16SEP92


T91276 -UN-25OCT88

2. Check gear-to-pump housing radial clearance.

RADIAL CLEARANCE SPECIFICATIONS

Radial Clearance	0.08—0.18 mm (0.003—0.007 in.)
Wear Limit	0.23 mm (0.009 in.)

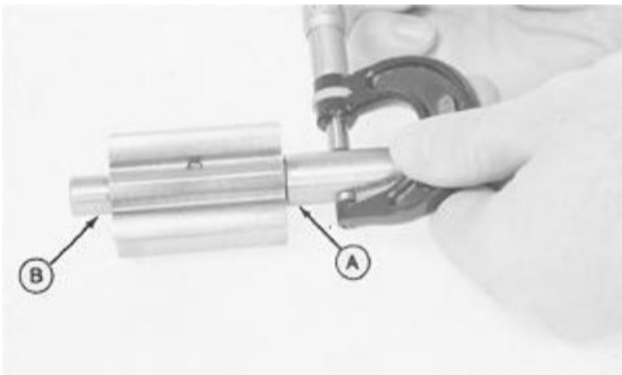
RG,CTM8,GR20,54-19-25JUN92

3. Check housing and cover bore ID and shaft OD.

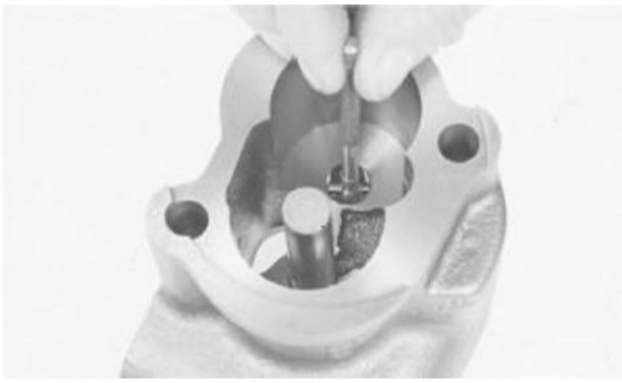
PUMP SHAFT OD AND BORE ID SPECIFICATIONS

Drive Shaft Bore (in pump cover)	16.058—16.084 mm (0.6322—0.6332 in.)
Wear Limit	16.16 mm (0.636 in.)
Drive Shaft OD (A)	16.022—16.032 mm (0.6308—0.6312 in.)
Wear Limit	15.997 mm (0.6298 in.)
Drive Shaft Bore (in pump housing)	12.281—12.307 mm (0.4835—0.4845 in.)
Wear Limit	12.323 mm (0.4850 in.)
Drive Shaft OD (B)	12.256—12.266 mm (0.4825—0.4829 in.)
Wear Limit	12.231 mm (0.4815 in.)
Idler Shaft OD	12.319—12.329 mm (0.4850—0.4854 in.)
Wear Limit	12.306 mm (0.4845 in.)

T91266 -UN-25OCT88



T91265 -UN-25OCT88



T91267 -UN-25OCT88

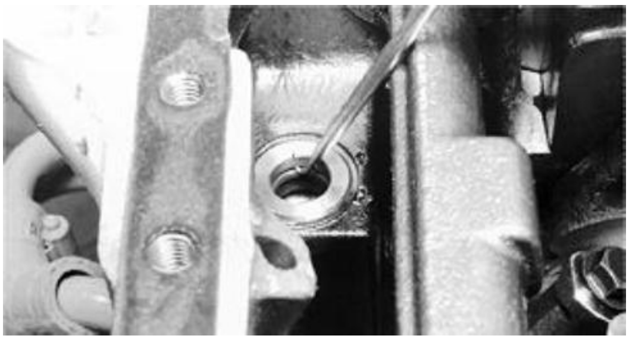
RG,CTM8,GR20,55-19-28SEP94

COMPLETE HIGH CAPACITY OIL PUMP DISASSEMBLY

1. Remove O-ring from pump housing and cylinder block (for outlet tube).

2. Remove O-ring from oil pick-up tube.

3. Clean oil pump parts in solvent. Dry with compressed air.



T88931 -UN-09NOV88

RG,CTM8,GR20,56-19-18FEB95

ASSEMBLE HIGH CAPACITY OIL PUMP

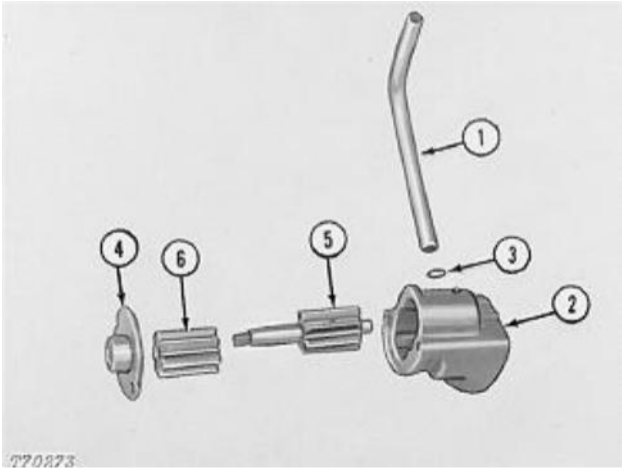
IMPORTANT: Lubricate gears and shaft with clean engine oil before assembling.

1. Install new O-ring (3) in pump housing (2); or new packing in flex fitting (as equipped).

2. Put idler gear (6) and drive gear (5) in pump housing.

3. Install outlet tube (1) in pump housing.

4. Put cover (4) on pump housing.



T70273 -UN-10FEB89

1—Outlet Tube
2—Oil Pump Housing
3—O-Ring
4—Cover
5—Drive Gear
6—Idler Gear

CTM8,GR20,27 -19-18FEB95

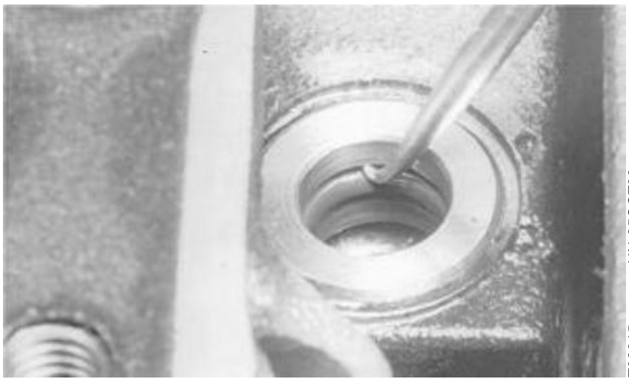
INSTALL HIGH CAPACITY OIL PUMP

NOTE: This procedure is for installing the oil pump with timing gear cover installed. If timing gear cover is removed from engine, refer to INSTALL AND TIME BALANCER SHAFTS in Group 16 (for 4-cylinder engines only).

1. On 4-cylinder engines with balancer shafts, lock No. 1 piston at TDC compression stroke.

2. Install a new O-ring in cylinder block (for outlet tube).

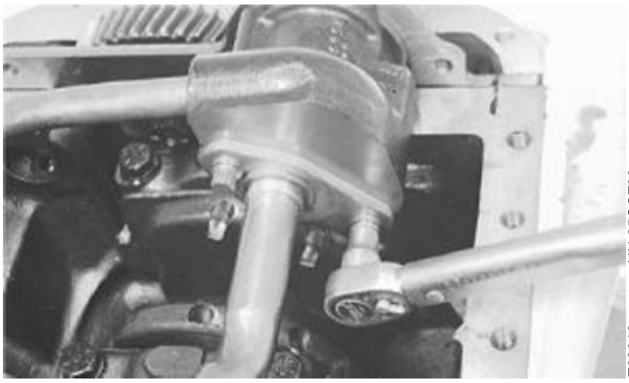
3. Install a new O-ring on oil pick-up tube.



T92915 -UN-25OCT88

RG,CTM8,GR20,57-19-18FEB95

IMPORTANT: On 4-cylinder engines, the key slot in the balancer shafts must be at the 12 o'clock position (timing marks on both shaft gears facing inboard toward crankshaft centerline) and locked with No. 1 piston at TDC compression stroke.

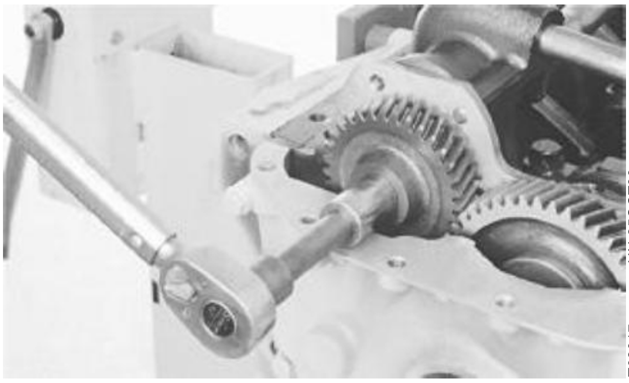


T92916 -UN-25OCT88

4. Install oil pump drive gear so it meshes with balancer shaft gear and idler gear WITHOUT altering the timing position of the balancer shaft gear.

5. While holding drive gear in place, mount oil pump.

6. Rotate oil pump shaft by hand to be sure it turns easily.



T92917 -UN-25OCT88

Right and left is referenced as viewed from flywheel end of engine.

• On 4-cylinder engines:

7. Install oil pump drive gear making sure that it meshes with left balancer shaft gear and lower idler gear WITHOUT altering the timing position of the balancer shaft gear. Tighten hex nut to 75 N·m (55 lb-ft).

• On all other engines:

8. Install pump drive gear and tighten hex nut to 75 N·m (55 lb-ft).

9. Stake nut to shaft by applying three center punch marks near ID of nut.

10. Tighten gland nut on pump outlet tube securely if equipped.

S11,2020,FM -19-21SEP95

INSTALL OIL PAN

1. Apply Permatex Aviation (Form-a-Gasket No. 3) or LOCTITE 515 Flexible Sealant on oil pan rail where flywheel housing, front plate, and timing gear cover attach to cylinder block.

2. Select and install correct gasket for oil pan being used.

• Cork gasket—Use on sheet metal oil pan. Apply a bead of non-hardening sealant to both sides of gasket. Retorque oil pan cap screws after engine break-in.

• All other gaskets—Use on aluminum oil pans. Install dry (no sealant).

3. Install oil pan and tighten cap screws to value shown in table in the sequences shown. “A” points toward front of engine.

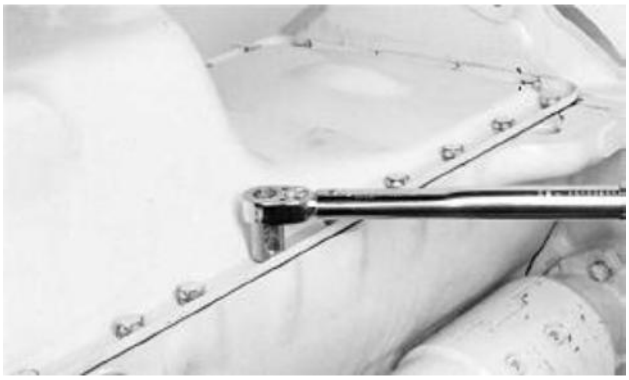
IMPORTANT: Do not overtighten the oil pan-to-timing gear cover cap screws.

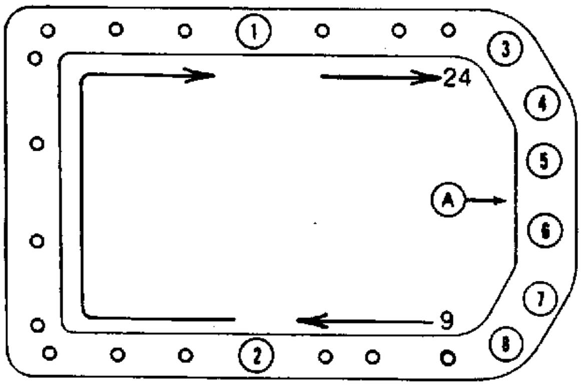
OIL PAN TORQUE SPECIFICATIONS

Oil Pan-to-Block:	
SAE 5 - 3 dashes*	47 N·m (35 lb-ft)
SAE 8 - 6 dashes*	68 N·m (50 lb-ft)
Oil Pan-to Flywheel Housing:	
SAE 5 - 3 dashes*	47 N·m (35 lb-ft)
SAE 8 - 6 dashes*	68 N·m (50 lb-ft)
Aluminum or Sheet Metal Oil Pan-to-Timing Gear Cover:	
Aluminum Timing Gear Cover	37 N·m (27 lb-ft)
Composite Timing Gear Cover	30 N·m (22 lb-ft)

NOTE: Current production aluminum oil pans use flanged head cap screws. Earlier aluminum oil pans use cap screws with washers.

** Refer to UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES in Group 01 for cap screw identification markings.*


T82059 -UN-09NOV88



RG6424 -UN-31AUG92

3-Cylinder Engine

S11,2020,FN -19-01NOV95

20
38

4. Install aluminum or copper washer on drain plug with raised center against plug. Install plug in oil pan. Tighten drain plug to specification.

T81958 -UN-31OCT88

OIL PAN DRAIN PLUG TORQUE SPECIFICATIONS

Cylindrical Plug	68 N·m (50 lb-ft)
Conical Plug	55 N·m (40 lb-ft)

If equipped with elbow drain fittings, the threads and sealing surfaces must be free of oil film to insure an effective seal. Apply LOCTITE 592 (TY9374) Pipe Sealant to fitting except for the leading one to three threads. Install and tighten fitting.

5. Fill engine crankcase with correct grade and viscosity engine oil. (See FUELS, LUBRICANTS AND COOLANT in Group 02.)

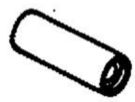
RG,CTM8,GR20,58-19-18FEB95

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

RG5132 -UN-23AUG88



Bearing Driver (4239T, 4276T, 6359D, T and A) JDE74
Bearing Driver (3179D, 4239D, 4276D) JD262A

Install water pump bearing.

S53,JDE74B -19-06MAR87

RG5109 -UN-23AUG88

Seal Remover JDG22

Remove oil seals.

S53,JDG22 -19-05APR90

RG5134 -UN-23AUG88

Belt Tension Gauge
Standard V-belts JDG529
Poly V-belts JT05975

Adjust fan belt tension.

S53,JDG529,B -19-19MAY92

RG5588 -UN-13SEP89

Belt Tension Gauge JDST28

Used with a straightedge to check fan belt tension (standard and poly V-belts).

S53,JDST28 -19-18FEB95

SERVICE EQUIPMENT AND TOOLS

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

Name	Use
D01045AA—Bushing, Bearing, and Seal Driver Set	Remove inner seal in water pump housing (heavy-duty pump).
D01047AA—17-1/2 and 30-Ton Puller Set	Remove pulley from water pump shaft.
D01200AA—10-Ton Push-Puller	Remove impeller from water pump shaft.

RG,CTM4,DT523 -19-21SEP95

OTHER MATERIAL

Name	Use
LOCTITE 515 (TY6304) Flexible Sealant (General Purpose)	Thermostat cover gaskets
PT507 Multi-Purpose Grease	Thermostat housing O-rings
TY6341 High Temperature Grease	Pack heavy-duty pump bearings

RG,CTM8,GR25,32-19-05OCT94

COOLING SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Low Flow Water Pump (Standard-Duty):		
Distance from pump housing gasket surface-to-impeller	0—0.25 mm (0—0.01 in.)	——
Impeller Bore	15.85—15.88 mm (0.6242—0.6252 in.)	——
Bearing Shaft OD:		
Impeller End	15.90—15.92 mm (0.6260—0.6267 in.)	——
Pulley End	18.95—18.96 mm (0.7460—0.7465 in.)	——
Pulley/Hub Bore (cast iron pulley)	18.91—18.93 mm (0.7445—0.7455 in.)	——
High Flow Water Pump (Heavy-Duty):		
Pump Shaft End Play, maximum	0.25 mm (0.01 in.)	——
Clearance between pump housing gasket surface-to-impeller		
All engines except 6359TF002 with option codes 2007 and 2302, 6414TT006, 6414TT007, 6414TT009, 6414TT010	0.0—0.38 mm (0.0—0.015 in.)	——
Clearance between pump housing and impeller—6359TF002 with option codes 2007 and 2302, 6414TT006, 6414TT007, 6414TT009, 6414TT010	0.39—0.89 mm (0.015—0.035 in.)	——
Impeller Bore		
All engines	15.85—15.88 mm (0.6242—0.6252 in.)	
Pump Shaft OD (All engines except 6359TF002 with option codes 2007 and 2302)		
Impeller End	15.90—15.92 mm (0.6260—0.6267 in.)	——
Pulley End	30.22—30.23 mm (1.1897—1.1903 in.)	——
Pump Shaft OD (6359TF002 with option codes 2007 and 2302)		
Impeller End	15.90—15.92 mm (0.6260—0.6272 in.)	——
Pulley End	28.991—29.009 mm (1.141—1.142 in.)	——
Pulley Bore (cast iron pulley)		
All engines except 6359TF002 with option codes 2007 and 2302	30.13—30.19 mm (1.1864—1.1886 in.)	——
6359TF002 Engines with option codes 2007 and 2302	28.91—28.93 mm (1.138—1.139 in.)	——
Thermostats, open at:		
All engines except 6359DH-01 and 6359TF002 with option codes 2007 and 2302	82°C (180°F)	——
6359DH-01	90°C (195°F)	——
6359TF002 with option codes 2007 and 2302	94°C (202°F)	——

S11,2025,EV -19-01NOV95

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COOLING SYSTEM SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Deaeration method	Across thermostats in housing. Air must be bled from system when refilled with coolant. See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE in Group 105.	
Fan Belt Tension (Standard V-belts)*		
Using JDG529 Gauge		
Single belt (new)	578—622 N (130—140 lb-force)	——
Single belt (used)**	378—423 N (85—94 lb-force)	——
Dual belt (new)	423—467 N (95—104 lb-force)	——
Dual belt (used)**	378—423 N (85—94 lb-force)	——
Using JDST28 Gauge and straightedge	19 mm (3/4 in.) deflection with an 89 N (20 lb-force) halfway between pulleys	——
Fan Belt Tension (Poly-V-belt—8 ribs)		
Using JT05975 Gauge		
Single belt (new)	890—1068 N (200—240 lb-force)	——
Single belt (used)**	800—979 N (180—220 lb-force)	——
Using JDST28 Gauge and straightedge	13 mm (1/2 in.) deflection with a 130 N (30 lb-force) halfway between pulleys	——

**Check front belt tension only on engines with dual belts. Measure tension on long part of belt.*

***Belts are considered used after 10 minutes of operation.*

S11,2025,GO -19-25SEP95

COOLING SYSTEM SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION
Pulley or Hub-to-Rear Face of Water Pump Housing Dimension:	
• Dubuque-Built Engines	
Backhoe-Loaders	
4239DT003 and 4239TT004 Engines	162.5 mm (6.40 in.)
4276DT003, 4276TT-05, 4276DT010, and 4276TT014 Engines	pulley against shoulder
6359TT001 Engines	pulley against shoulder
Crawlers	
4276DT006, 4276TT013 Engines	flush with shaft
4276TT006 Engines	191 mm (7.52 in.)
4276DT005 , 4276TT011 Engines	flush with shaft
6414TT006 Engines	pulley against shoulder
6414TT007 Engines	pulley against shoulder
6414TT009 Engines	pulley against shoulder
6414TT010 Engines	pulley against shoulder
Excavators	
4239DT004 Engines	pulley against shoulder
4276TT012 Engines	pulley against shoulder
6414TDW14 Engines	170.5 mm (6.71 in.)
Loaders, 4-Wheel Drive	
6359DDW01 and 6359TDW01 Engines	pulley against shoulder
6414TT005 and 6414TDW11 Engines	pulley against shoulder
Loader-Backhoes	
4239DT002 Engines	flush with shaft
Motor Graders	
6414TT003 Engines	180 mm (7.09 in.)
6414TDW13 Engines	180 mm (7.09 in.)
Skidders	
4276DT004 Engines	162.5 mm (6.40 in.)
4276TT004 Engines	162.5 mm (6.40 in.)
4276TDW04 Engines	162.5 mm (6.40 in.)
4276TDW07 Engines	162.5 mm (6.40 in.)
4276TDW08 Engines	162.5 mm (6.40 in.)
6414TT001 Engines	162.5 mm (6.40 in.)
6414TDW08 Engines	162.5 mm (6.40 in.)
Tractors	
4276DR004 Engines	flush with shaft

S11,2025,FU -19-01NOV95

COOLING SYSTEM SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION
Pulley or Hub-to-Rear Face of Water Pump Housing Dimension:	
• Dubuque-Built Engines (continued)	
Dubuque-Built Engines For OEM	
4239DF Engines	138.9 mm (5.47 in.)
4239TF Engines	162.5 mm (6.40 in.)
4276DF Engines	flush with shaft
4276TF Engines	162.5 mm (6.40 in.)
6359DF Engines	162.5 mm (6.40 in.)
6359TF002 Engines with option codes 2007 and 2302	105.7 mm (4.16 in.)
6359TF Engines	162.5 mm (6.40 in.)
6414DF Engines	162.5 mm (6.40 in.)
6414TF Engines	162.5 mm (6.40 in.)

RG,CTM4,DY112 -19-01NOV95

COOLING SYSTEM SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION
Pulley or Pulley Hub-to-Rear Face of Water Pump Housing Dimension:	
• Saran-Built Engines	
Mannheim Tractors for Venezuela:	
4239DL006 4239TL006-007 engines	154.4 mm (6.08 in.)
6359DL009 6359TL009 engines	150.5 mm (5.93 in.)
Mannheim Tractors for North America:	
3179DL01-11-12 3179DL001-17 engines (up to Serial No. 743472)	138 mm (5.43 in.)
3179DL001-17 engines (from Serial No. 743473)	136 mm (5.35 in.)
3179TL002-003 4239DL007-008-010 4239TL005-006-008-009 engines	154.5 mm (6.08 in.)
4239DL07-08 4239TL04-05 6359DL04-07 engines	159.5 mm (6.28 in.)
6359DL009 engines (up to Serial No. 742794)	167 mm (6.57 in.)
6359DL009 engines (from Serial No. 742795)	150.5 mm (5.93 in.)
6359DL010 engines	150.5 mm (5.93 in.)
Waterloo Tractors:	
6359TR001 engines	167.5 mm (6.59 in.)
Zweibrucken Combines for North America:	
6359DZ004 engines	180.5 mm (7.1 in.)
Harvester Works Combines:	
6359DH01 engines	146.5 mm (5.76 in.)
Des Moines Cotton Strippers/Pickers:	
6359DN01 and TN002 engines	181.5 mm (7.14 in.)
Ottumwa Windrowers:	
4239DE01 engines	153.5 mm (6.04 in.)
4239TE01 engines	159.5 mm (6.28 in.)
Welland Windrowers:	
4239DW01 engines	139 mm (5.47 in.)
Dubuque Crawlers/Excavators:	
3179DT001 engines	139 mm (5.47 in.)
4239TT03 engines	214 mm (8.42 in.)

S11,2025,GS -19-01NOV95

COOLING SYSTEM SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION
Pulley or Pulley Hub-to-Rear Face of Water Pump Housing Dimension:	
• Saran-Built Engines (continued)	
Saran-Built Engines for OEM*	
3179DF Engines with option codes:	
2004, 2005, 2011, 2018, 2019	140 mm (5.51 in.)
2014	137 mm (5.39 in.)
2032	165 mm (6.50 in.)
3179TF Engines with option codes:	
2004, 2005, 2011, 2018	140 mm (5.51 in.)
2014	137 mm (5.39 in.)
2032	165 mm (6.50 in.)
4239DF Engines with option codes:	
2004, 2005	140 mm (5.51 in.)
2021, 2022	163.5 mm (6.44 in.)
2033	165 mm (6.50 in.)
4239TF Engines with option codes:	
2004, 2021, 2022	163.5 mm (6.44 in.)
2005, 2026	140 mm (5.51 in.)
2023	188.5 mm (7.42 in.)
4239AF Engines with option codes:	
2004	163.5 mm (6.44 in.)
2023	188.5 mm (7.42 in.)
6359DF Engines with option codes:	
2004, 2008	163.5 mm (6.44 in.)
2023	188.5 mm (7.42 in.)
2033	165 mm (6.50 in.)
6359DF Engines with option codes:	
2004	162.5 mm (6.40 in.)
2007	105.7 mm (4.16 in.)
2023	187.5 mm (7.38 in.)
6359TF Engines with option codes:	
2004, 2008	163.5 mm (6.44 in.)
2023	188.5 mm (7.42 in.)
2033	165 mm (6.50 in.)
6359TF Engines with option codes:	
2004 (S.N. —795106)	191.0 mm (7.52 in.)
2004 and 2008	162.5 mm (6.40 in.)
2023	187.5 mm (7.38 in.)
6359AF Engines with option codes:	
2004	163.5 mm (6.44 in.)
2023	188.5 mm (7.42 in.)
2033	165 mm (6.50 in.)

**Dimensions listed are for 6 mm thick cover plate. If a 7 mm thick cover plate is used, remove 1 mm to the listed dimension.*

RG,CTM4,DY114 -19-01NOV95

COOLING SYSTEM SPECIFICATIONS—CONTINUED

TORQUES

Water Pump-to-Cylinder Block:
- SAE Grade 5 Cap Screw . . . . . 47 N·m (35 lb-ft)
- SAE Grade 8 Cap Screw . . . . . 54 N·m (40 lb-ft)
- Retaining Nut with Fine Thread . . . . . 40 N·m (30 lb-ft)

Cover-to-Water Pump Housing . . . . . 47 N·m (35 lb-ft)

Sheet Metal Pulley and Fan-to-Pulley Hub . . . . . 27 N·m (20 lb-ft)

Fan-to-Cast Iron Pulley:
- 5/16 in. . . . . . 27 N·m (20 lb-ft)
- 3/8 in. . . . . . 47 N·m (35 lb-ft)

Thermostat Cover-to-Thermostat Housing . . . . . 30 N·m (22 lb-ft)

Thermostat Housing-to-Cylinder Head:
- All engines, except 6359DH-01 . . . . . 47 N·m (35 lb-ft)
- 6359DH-01 . . . . . 130 N·m (90 lb-ft)

Pulley-to-Shaft Cap Screw . . . . . 115 N·m (85 lb-ft)

Engine Coolant Heater Retaining Nut . . . . . 34 N·m (25 lb-ft)

RG,CTM4,DY107 -19-21SEP95

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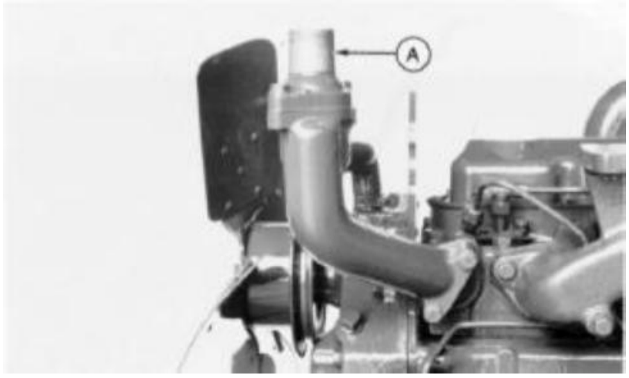
REMOVE, TEST, AND INSTALL THERMOSTATS

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

1. Visually inspect area around water manifold for leaks. Partially drain coolant from system.

2. Remove thermostat cover (A). Different styles of thermostat housings may be found, depending on application.



CD7369 -UN-23FEB89

3. Remove thermostat(s).

NOTE: Engines may be equipped with either one or two thermostats.

T90486 -UN-25OCT88

4. Test in hot water for correct opening and closing temperatures. (See COOLING SYSTEM SPECIFICATIONS earlier in this group.)

NOTE: Deaeration is accomplished by a jiggle wire or groove in the thermostat flange area.

T90487 -UN-25OCT88

5. Remove gasket material from gasket surfaces. Clean and inspect housing for cracks or damage.

6. Install thermostat(s) and thermostat cover using a new gasket. Tighten cover cap screws to 30 N·m (22 lb-ft).

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

S11,2025,EY -19-21SEP95

REMOVE AND INSTALL THERMOSTAT HOUSING/WATER MANIFOLD

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until the coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

TS281 -UN-23AUG88

1. Drain coolant.

2. Disconnect hoses.

3. Remove housing-to-cylinder head cap screws.

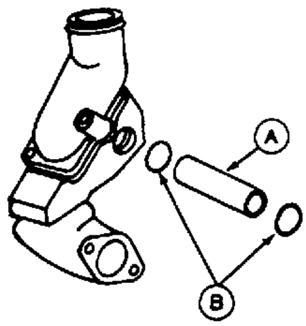
4. Remove housing (A) from cylinder head.

RG5643 -UN-02APR90

S11,2025,EZ -19-21SEP95

5. Remove housing-to-water pump tube (A), Option Code 2102. Remove O-rings (B) from housing and water pump.

6. Remove thermostat cover and thermostat(s).



RG4792 -UN-14DEC88

S11,2025,FA -19-13JUL95

7. Clean gasket surfaces.

8. Apply a light coating of multi-purpose grease to new O-rings, Option Code 2102, and install a thermostat housing and water pump. Insert tube in housing.

9. Install housing with new gasket onto cylinder head. (Make sure tube correctly enters water pump.)

THERMOSTAT HOUSING-TO-CYLINDER HEAD TORQUE SPECIFICATIONS

All engines except 6359DH-01	47 N·m (35 lb-ft)
6359DH-01 only	130 N·m (90 lb-ft)

10. Install thermostat(s) and thermostat cover using a new gasket. Tighten cover cap screws to 30 N·m (22 lb-ft).

11. Connect hoses.

12. Fill cooling system and check for leaks.

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

S11,2025,FB -19-21SEP95

GENERAL WATER PUMP INFORMATION

300 Series engines are equipped with one of the following belt-driven water pumps.

• Low Flow:

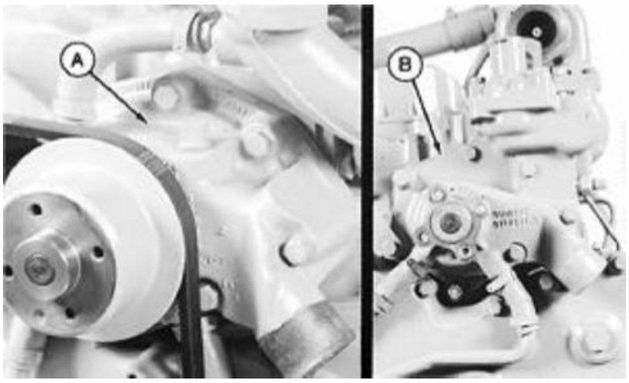
Low flow water pumps use a one-piece bearing and shaft assembly with a pressed-on pulley or hub. The pump housing will be similar to (A) or (B).

• Standard-Duty High Flow:

Standard-duty high flow water pumps (C) use a one-piece bearing and shaft assembly with a pressed-on pulley or hub. Standard-duty pumps use the same impeller and are similar in appearance to heavy-duty high flow water pumps.

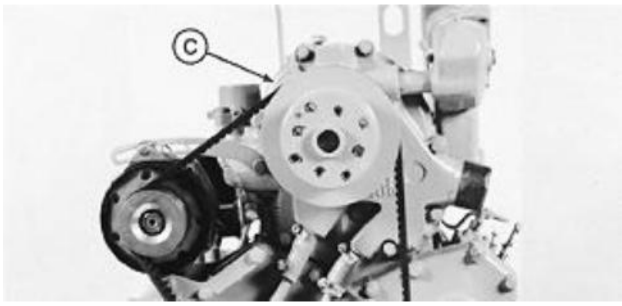
• Heavy-Duty High Flow:

Heavy-duty high flow water pumps (D) use a separate shaft with two heavy-duty ball bearings pressed on the shaft. The pulley is retained by a cap screw (E) threaded into the end of the pump shaft. Most heavy-duty high flow water pumps use the same impeller and are similar in appearance to standard-duty high flow water pumps.



RG6365 -UN-17AUG92

Low Flow Pumps



RG6366 -UN-17AUG92

Standard-Duty High Flow Pumps

RG6367 -UN-17AUG92

Heavy-Duty High Flow Pumps

RG,CTM4,DW684 -19-13JUL95

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13

Water pumps are available in four mounting positions. These positions which reference from the centerline of crankshaft to the centerline of water pump shaft are as follows:

Position	Distance (Centerline of Crankshaft-to-Centerline of Water Pump Shaft)
Low	290 mm (11.4 in.)
Medium	338 mm (13.3 in.)
High	404 mm (15.9 in.)
Special Applications*	444.5 mm (17.5 in.)

*Engines equipped with option codes 2007 and 2302.

RG,CTM4,DW685 -19-13JUL95

REMOVE LOW FLOW (STANDARD DUTY) WATER PUMP

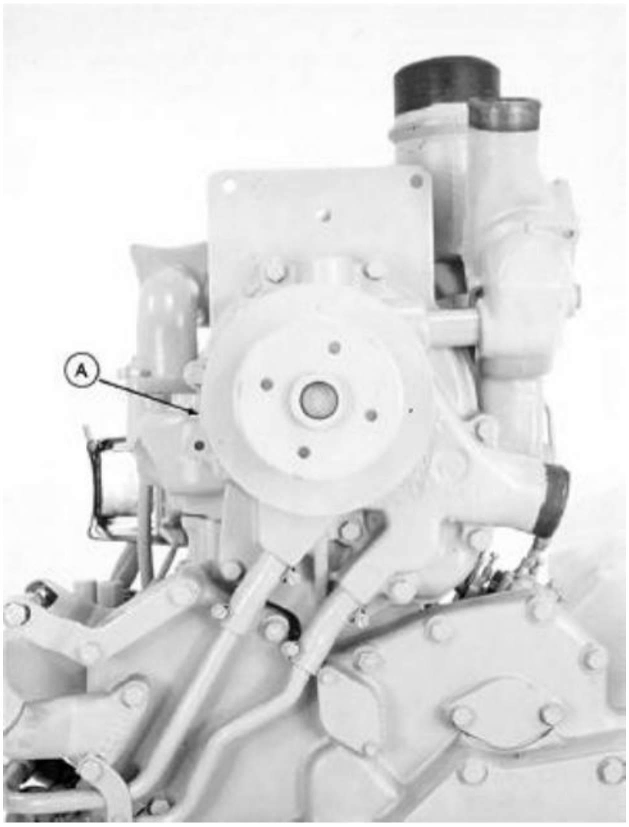
CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until the coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

1. Drain coolant.

2. Remove fan and fan belt(s). If a sheet metal pulley is used, remove from pump.

3. Remove inlet and outlet hoses from water pump.

4. Remove water pump (A).



RG5644 -UN-02APR90

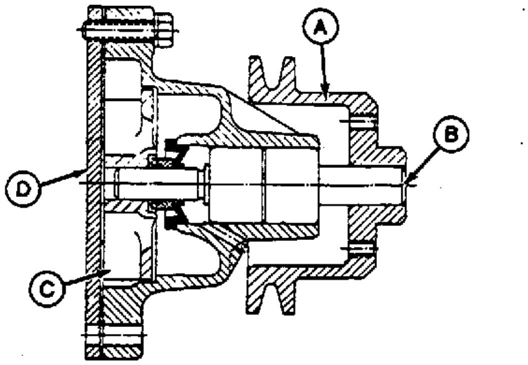
S11,2025,FC -19-21SEP95

DISASSEMBLE LOW FLOW (STANDARD DUTY) WATER PUMP

1. Remove rear cover of water pump (D) and discard gasket.

2. Using a suitable puller, remove water pump pulley (A) (or pulley hub) from bearing shaft (B).

A—Pulley
B—Bearing Shaft
C—Impeller
D—Rear Cover



CD7358 -UN-23FEB89

CD7357 -UN-23FEB89

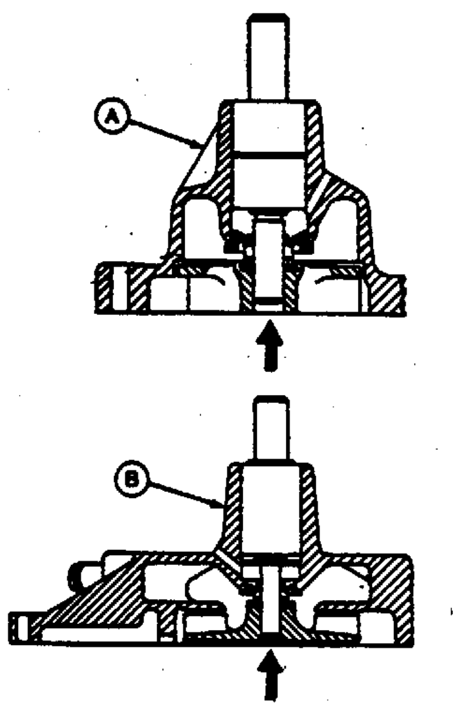
S11,2025,FD -19-13JUL95

IMPORTANT: Before removing impeller, first determine how impeller and bearing shaft have to be removed. Pressing bearing shaft out of housing in the wrong direction may result in a broken pump housing.

Some standard pumps (A) have an impeller without tapped holes. Remove the bearing shaft from both the impeller and housing simultaneously by pressing on impeller end of bearing shaft, as shown by bold arrow.

Other standard pumps (B) have an impeller with two tapped holes to permit removal with a puller. With impeller removed, press on shaft is made from impeller end as shown by bold arrow. Note that bearing shaft must be removed toward pulley end. A flange in bearing bore prevents removal in opposite direction.

Current production Saran engines have a composite material impeller with brass hub. After each removal, the impeller must be replaced.



RG5223 -UN-14DEC88

S11,2025,FE -19-13JUL95

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On water pumps having impellers without tapped holes:

3. Support water pump on pulley end of housing using a 13 mm (0.5 in.) O.D. driver and simultaneously remove impeller from shaft and bearing shaft assembly from pump housing.

4. Using a suitable driver, remove seal from pump housing.

S11,2025,FF -19-13JUL95

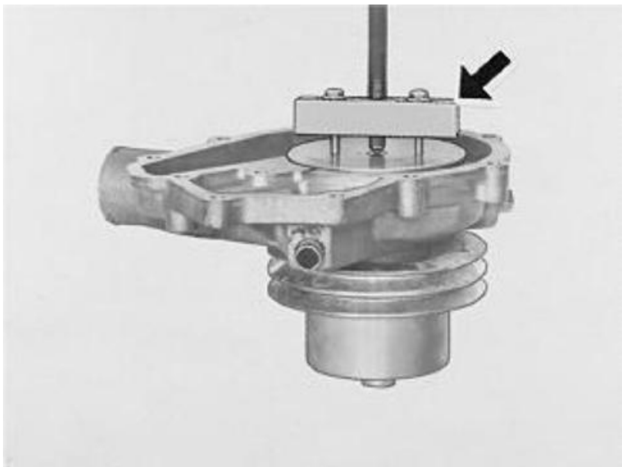
On water pumps having an impeller with two tapped holes:

5. Remove impeller using D01200AA Puller (or other suitable puller).

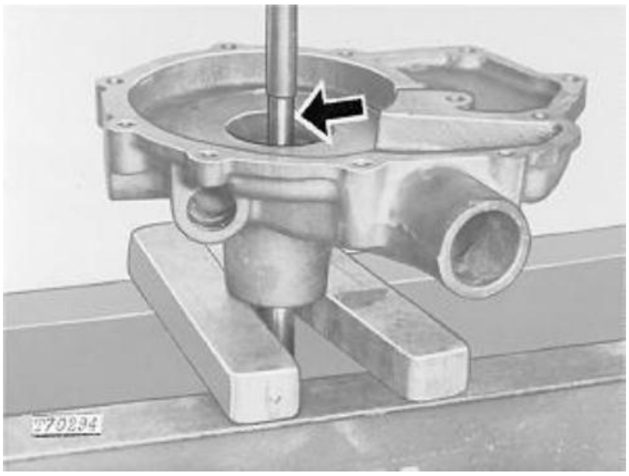
IMPORTANT: Do not attempt to push shaft from pulley end. A flange in the bearing bore prevents bearing passage through housing.

6. Support water pump on pulley end of housing. Select a 13 mm (0.5 in.) diameter x 76 mm (3.0 in.) driver. Push against impeller end of bearing shaft to push bearing out of housing.

7. Using a suitable driver, remove seal from pump housing.



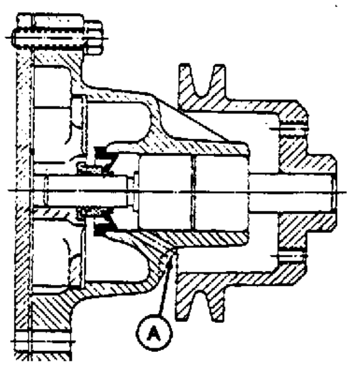
T70293 -UN-23FEB89



T70294 -UN-23FEB89

S11,2025,FV -19-13JUL95

INSPECT AND CLEAN LOW FLOW (STANDARD DUTY) WATER PUMP PARTS



CD7359 -UN-23FEB89

NOTE: If coolant leaked from hole (A) during operation, it is an indication that the seal needs replacing.

1. Inspect shaft and bearing assembly for wear or damage. Replace as necessary.

2. Inspect water pump housing and cover for wear, debris, cracks, or damage. Replace as necessary.

3. Inspect impeller for wear, debris, or cracks. Replace as necessary.

4. Measure impeller bore and bearing shaft OD.

WATER PUMP SPECIFICATIONS

Impeller Bore	15.85—15.88 mm (0.6242—0.6252 in.)
Bearing Shaft OD:	
Impeller End	15.90—15.92 mm (0.6262—0.6267 in.)
Pulley/Hub Bore (Cast iron pulley)	18.95—18.96 mm (0.7460—0.7465 in.)
Pulley Bore	18.91—18.93 mm (0.7445—0.7455 in.)

Replace impeller if not within specifications or if impeller is made of composite material. Always replace bearing shaft assembly when it has been removed from pump.

5. Clean parts with clean solvent and dry with compressed air.

6. Clean out weep hole.

NOTE: Make sure all gasket material is removed from water pump housing and cover.

S11,2025,FG -19-21SEP95

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ASSEMBLE LOW FLOW (STANDARD DUTY) WATER PUMP

CD7360 -UN-23FEB89

1. Place pump housing with impeller side down on a press.

NOTE: Bearing shaft is installed from pulley end of pump housing for both types of pumps.

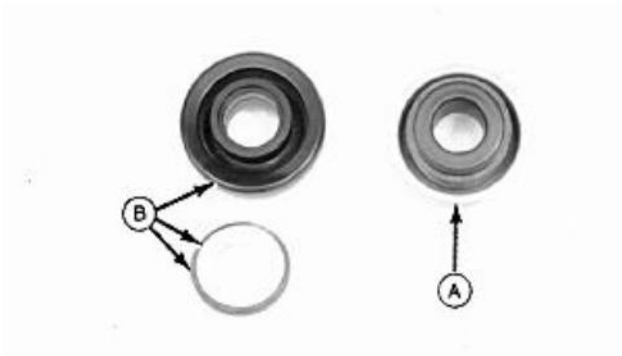
2. Place a large flat washer with hole large enough to go over pulley end of new bearing shaft. Check washer to make sure it does not contact protruding-type bearing seals. (Washer will act as a stop on pump housing when pressing bearing shaft.)

IMPORTANT: Do not push against end of bearing shaft. Push against outer race only.

3. Press bearing shaft into pump housing with driver until washer bottoms.

3179D, 4239D, and 4276D Engines—Use JD262A Driver
4239T, 4276T, 6359D, T, and A—Use JDE74 Driver

S11,2025,FH -19-13JUL95



RG2952 -UN-14DEC88

4. Install water pump seal.

NOTE: Water pumps have either a one-piece seal [(A), seal with insert and cup all in one piece] or a three-piece seal [(B), seal, ceramic insert, and rubber cup]. The one-piece seal has a press fit with both the bearing shaft and pump housing. On three-piece seals, the seal presses into pump housing while rubber cup and ceramic insert slips into recess of impeller bore. Only the unitized (one-piece) seal is provided for service.

IMPORTANT: Use installation tool that is included in seal kit to drive seal into pump housing. This tool installs seal to correct height. Shaft and seal must be free of grease and debris. Do not use sealant on any portion of unitized seal.

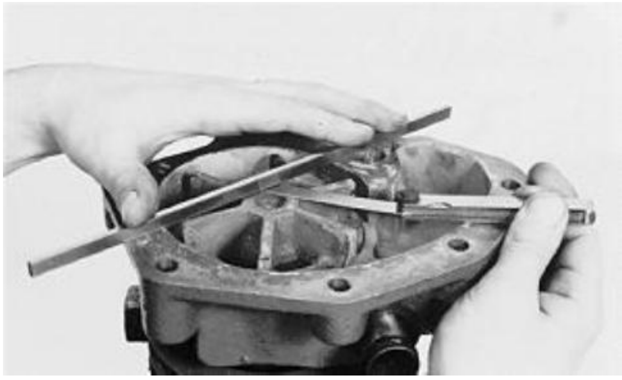
Support water pump on nose of housing or on shaft. Using special tool included in seal kit, install water pump seal over shaft until seal bottoms on shoulder of housing.

S11,2025,FI -19-13JUL95

5. Place pump housing under a press and support on pulley end of shaft.

6. Using JD262A Bearing Driver, press impeller onto pump shaft until flush with pump housing face within a given tolerance of +0.00 mm (0.000 in.) and -0.25 mm (0.010 in.).

CD7361 -UN-23FEB89



CD7355 -UN-23FEB89

S11,2025,FJ -19-21SEP95

7. Install water pump pulley or pulley hub.

Place water pump under a press so that the thrust when pressing on the fan belt pulley or pulley hub is received only by the pump shaft face (impeller end).

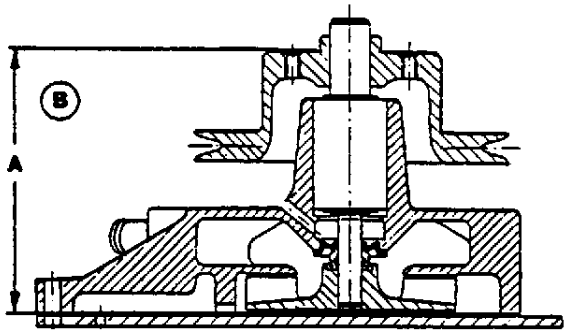
Place pulley or hub on pump and press until specified dimension “A” is obtained. (See COOLING SYSTEM SPECIFICATIONS earlier in this group.)

On water pumps equipped with a pulley hub, install sheet metal V-belt pulley and tighten attaching cap screws to 27 N·m (20 lb-ft).

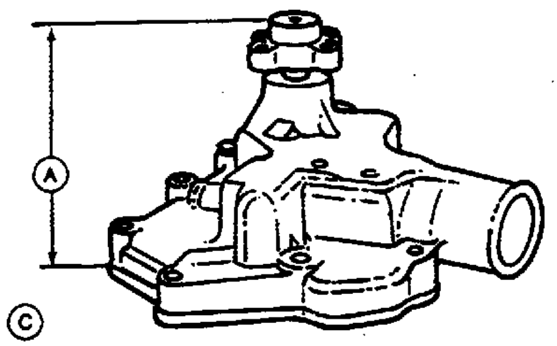
8. Turn pulley by hand to make sure shaft turns freely.

A—Distance Between Pump Housing Sealing Face and Pulley or Hub
B—Water Pump With Cast Iron Pulley
C—Water Pump With Sheet Metal Pulley

CD7363 -UN-23FEB89



RG5596 -UN-01NOV89

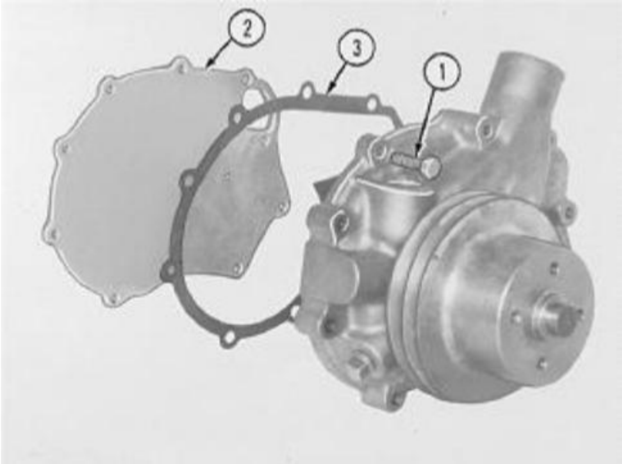


RG5135 -UN-14DEC88

S11,2025,FK -19-13JUL95

9. Install cover plate (2), using a new gasket (3). (Also install alternator adjusting strap.) Tighten cap screws (1) to 47 N·m (35 lb-ft).

10. Rotate pulley by hand. If impeller drags on cover plate, remove cover and recheck impeller position on shaft.



T70288 -UN-23FEB89

S11,2025,FL -19-13JUL95

INSTALL LOW FLOW (STANDARD DUTY) WATER PUMP

1. Place a new gasket between pump cover and cylinder block. Tighten cap screws (A) to 47 N·m (35 lb-ft).

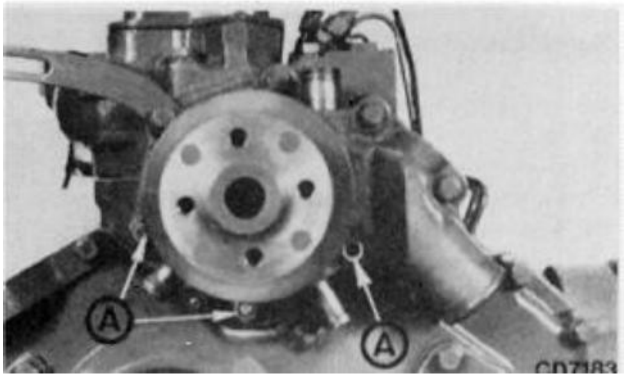
2. Install thermostat housing (if removed.).

3. Connect hoses and tighten hose clamps securely.

4. Install alternator (if removed) and fan belt(s). Adjust tension. (See COOLING SYSTEM SPECIFICATIONS at the beginning of this group.)

5. Fill cooling system with proper coolant. (See Group 02 - Fuels, Lubricants, and Coolant).

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



CD7183 -UN-23FEB89

S11,2025,FM -19-13JUL95

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REMOVE HIGH FLOW (HEAVY-DUTY) WATER PUMP

NOTE: 6359TF002 Engines with option codes 2007 and 2302 use a different style heavy-duty pump than other engine applications with the heavy-duty pump. Basic repair information which follows applies to all applications with the heavy-duty pump. When required, differences are noted.

CAUTION: Do not drain coolant until the coolant temperature is below operating temperature. Always loosen the cooling system filler cap, radiator cap, or drain valve slowly to relieve any excess pressure.

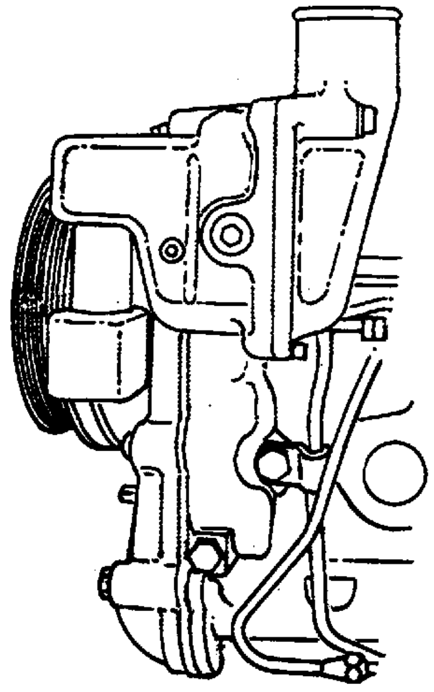
1. Drain coolant.

2. Remove fan and fan belts.

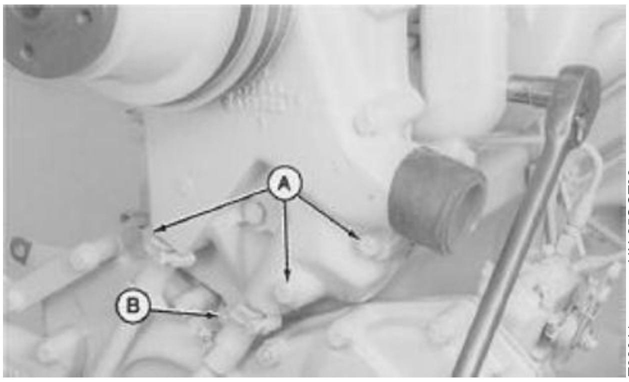
3. Remove thermostat housing.

4. Disconnect after pump hoses.

5. Remove three cap screws (A) and hex nut (B), and lift off water pump.



RG5089 -UN-14DEC88



T92941 -UN-25OCT88

S11,2025,FN -19-21SEP95

DISASSEMBLE HIGH FLOW (HEAVY-DUTY) WATER PUMP

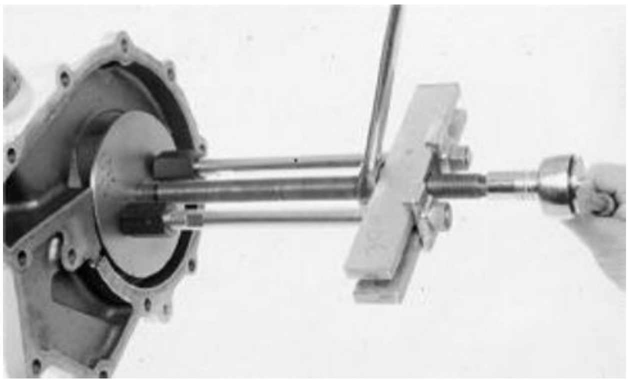
1. Remove cap screws to remove cover.

T90458 -UN-25OCT88

S11,2025,FO -19-13JUL95

2. Using a suitable puller, remove impeller from shaft.

NOTE: Current production Saran engines have a composite material impeller with brass hub. After each removal, the impeller must be replaced.



T5820BV -UN-25OCT88

T49,0417,90 -19-21SEP95

3. Remove cap screw and washer. (Not used on 6359TF002 Engines with option codes 2007 and 2302.)

4. Using a suitable puller, remove pulley from pump shaft.

T5820BY -UN-25OCT88

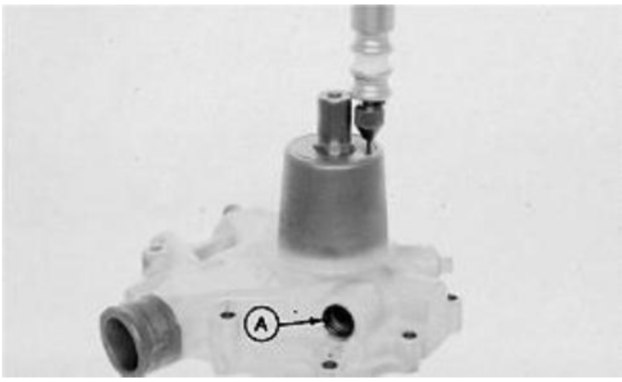
S11,2025,GT -19-13JUL95

5. Using JDG22 Seal Remover, remove oil seal.

6. Remove ceramic insert and rubber cup from impeller, if equipped.

7. Remove O-ring (A).

NOTE: Oil seal and O-ring are not used on 6359TF002 Engines with option codes 2007 and 2302.



T5823AC -UN-25OCT88

S11,20925,GU -19-21SEP95

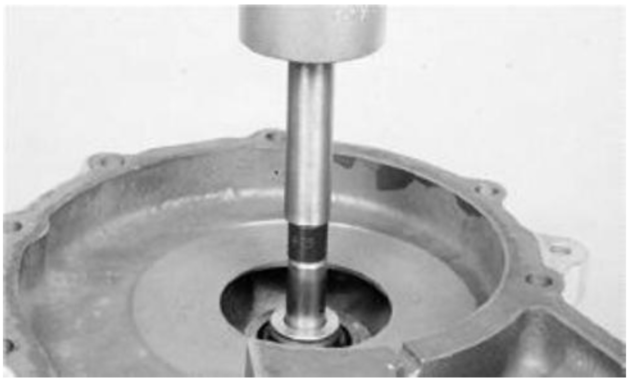
8. Remove bearing retaining ring.

T5823AE -UN-25OCT88

T49,0417,93 -19-13JUL95

IMPORTANT: Do not attempt to push shaft from pulley end. Removal in the wrong direction may result in a broken housing.

9. Remove shaft using a press and a suitable shaft protector.



T5823AB -UN-25OCT88

T49,0417,94 -19-13JUL95

10. Remove water pump seal using a punch. Be careful not to damage housing.

T5824AA -UN-25OCT88

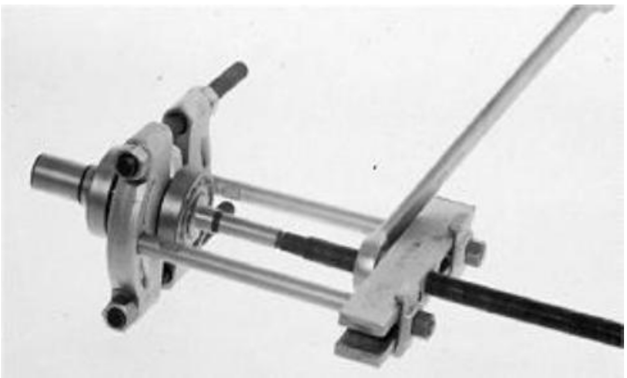
T49,0417,95 -19-05APR90

11. Remove inner seal using 18 and 38 mm disks from D01045AA Bushing, Bearing, and Seal Driver Set. (Seal not used on 6059DF001, TF001, and TF004 Engines with option codes 2007, 2302, and 2419.)

T5823AA -UN-25OCT88

S11,2025,GV -19-05APR90

12. Remove bearings from shaft using a suitable bearing puller.


T90466 -UN-25OCT88

S11,2025,FQ -19-13JUL95

INSPECT AND CLEAN HIGH FLOW (HEAVY-DUTY) WATER PUMP PARTS

NOTE: If coolant leaked from hole during operation, it is an indication that seal needs replacing.

1. Inspect shaft and bearings for wear or damage. Clean non-sealed bearings and determine if they are reusable. Sealed bearings are used on 6359TF002 engines with option codes 2007 and 2302 and cannot be cleaned. Replace as necessary.

2. Inspect water pump housing and cover for wear, debris, cracks, or damage. Replace as necessary.

3. Inspect impeller for wear, debris, or cracks. Replace as necessary.

4. Measure impeller bore and pump shaft OD.

WATER PUMP SPECIFICATIONS
(All Engines Except 6359TF002 with option codes 2007 and 2302)

Impeller Bore	15.85—15.88 mm (0.6242—0.6252 in.)
Pump Shaft OD:	
Impeller End	15.90—15.92 mm (0.6262—0.6267 in.)
Pulley End	30.22—30.23 mm (1.1897—1.1903 in.)
Pulley Bore	30.13—30.19 mm (1.1864—1.1886 in.)

WATER PUMP SPECIFICATIONS
(6359TF002 Engines with option codes 2007 and 2302)

Impeller Bore	15.85—15.88 mm (0.6242—0.6252 in.)
Pump Shaft OD:	
Impeller End	15.90—15.92 mm (0.6260—0.6267 in.)
Pulley End	28.991—29.009 mm (1.141—1.142 in.)
Pulley Bore	28.91—28.93 mm (1.138—1.139 in.)

Replace impeller and shaft if either are not within specifications. Composite material impellers must be replaced after each removal.

5. Clean all parts with clean solvent and dry with compressed air. Clean out weep hole.

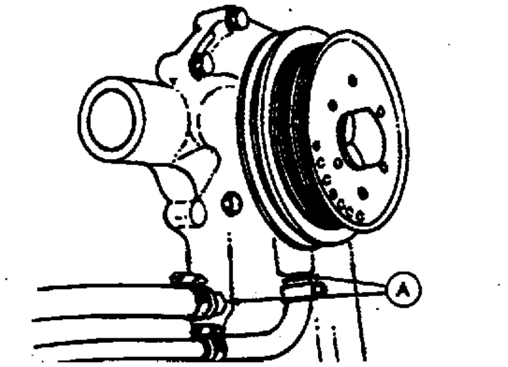
NOTE: Make sure all gasket material is removed from water pump housing and cover.

S11,2025,FP -19-01NOV95

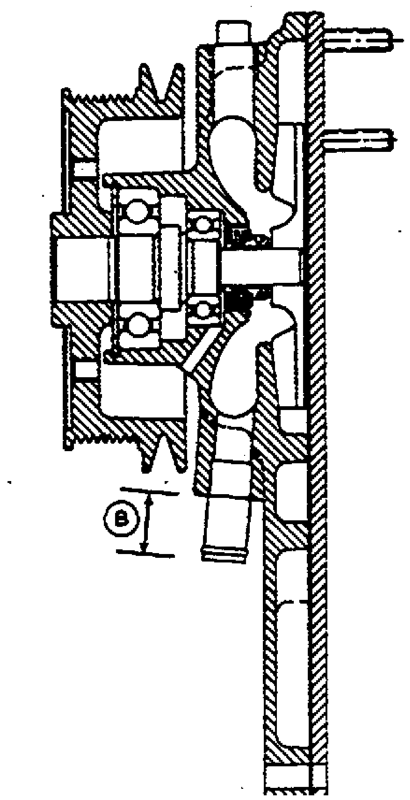
ASSEMBLE HIGH FLOW (HEAVY-DUTY) WATER PUMP

NOTE: If necessary to replace nipples (A) on 6359TF002 Engines with option codes 2007 and 2302, apply a light coating of sealant around OD of nipple for a distance of 10 mm (0.4 in.) from housing end. Using a suitable driver and disks from D01045AA Bushing, Bearing, and Seal Driver Set, install both nipples so that there is 29 mm (1.14 in.) length (B) available for attaching hoses.

Use this sectional view of Water Pump (6359TF002 Engine with option codes 2007 and 2302) as a guide when assembling pump along with instructions for all high flow (heavy-duty) pumps which follow.



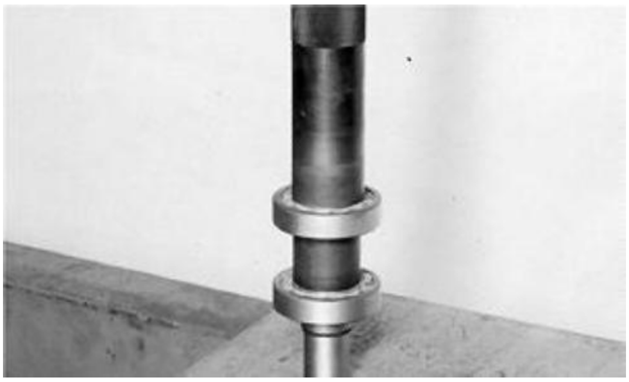
RG5087 -UN-14DEC88



RG5088 -UN-14DEC88

S11,2025,GW -19-13JUL95

1. Press new bearings on shaft using a tubular driver that contacts the inner bearing race only.



T90467 -UN-25OCT88

S11,2025,FR -19-05APR90

2. Install inner seal with metal side down using 18 mm and 41 mm disk from D01045AA Bushing, Bearing, and Seal Driver Set. (Seal not used on 6359TF002 Engines with option codes 2007 and 2302.)

T5823AD -UN-25OCT88

S11,2025,GX -19-06MAR87

3. Pack bearings and area between bearings in TY6341 High Temperature Grease (all high flow [heavy-duty] pumps except for 6359TF002 Engines with option codes 2007 and 2302).

4. Install shaft with bearings and snap ring. On water pump for 6359TF002 Engines with option codes 2007 and 2302, install snap ring with OD chamfer facing outward.

T90478 -UN-25OCT88

S11,2025,GY -19-13JUL95

5. Measure shaft end play. Shaft end play must be 0.25 mm (0.010 in.) maximum.

NOTE: If end play is greater than specification, install an oversize snap ring. Snap rings are available in 0.3, 0.5, and 0.8 mm (0.010, 0.020, and 0.030 in.) oversizes.

T5824AB -UN-25OCT88

T49,0417,J3 -19-13JUL95

6. Use a seal driver of approximately 50 mm (2.0 in.) ID and 72 mm (2.8 in.) OD to install outer seal against snap ring. (Not used on 6359TF002 Engines with option codes 2007 and 2302.)

NOTE: To install outer oil seal, use a metal tube or suitable driver with an ID of 50 mm (2.0 in.) and OD of 72 mm (2.8 in.).

RG6388 -UN-17AUG92

S11,2025,GZ -19-21SEP95

7. Support pulley end of shaft and housing using a piece of pipe with a minimum ID of 2-3/4 in. and a maximum ID of 3 in.

8. Install water pump seal.

NOTE: Water pumps have either a unitized (one-piece) water seal (A), or a three-piece water seal (B). Only the unitized (one-piece) water (coolant) seal is provided for service.

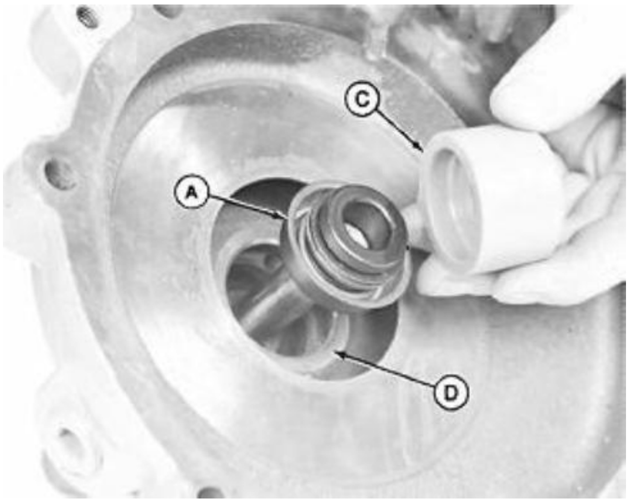
- **Unitized (one-piece) water seal:**

IMPORTANT: Use Installation Tool (C), that is included in seal kit, to drive seal into water pump housing. This tool will install seal to correct height.

Shaft and seal must be free of grease and debris. Do not use sealant on any portion of unitized seal.

Using installation tool included in seal kit, install water pump seal over shaft until seal bottoms on shoulder (D) of housing.

RG6389 -UN-21AUG92



RG6390 -UN-17AUG92

A—One-Piece Water Seal
B—Three-Piece Water Seal
C—Installation Tool
D—Water Pump Housing Shoulder

RG,CTM8,GR25,22-19-18FEB95

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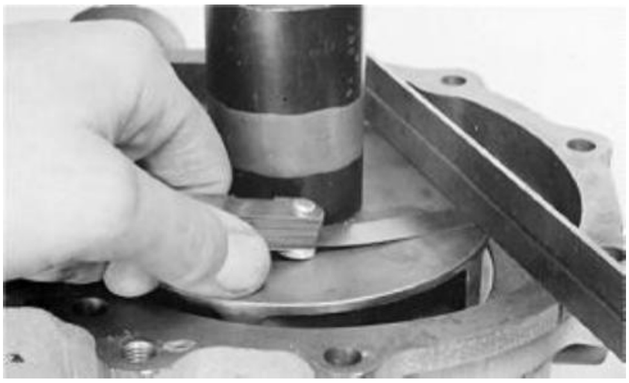
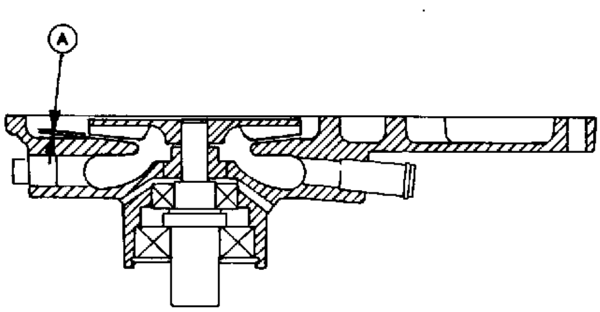
9. Using JD262A Bearing Driver, install impeller 0.38 mm (0.015 in.) below surface of housing on all engines except 6359TF002 with option codes 2007 and 2302, 6414TT006, 6414TT007, 6414TT009 and 6414TT010. On these five engines, install impeller to obtain 0.39—0.89 mm (0.015—0.035 in.) clearance between inner side of impeller and housing (A).



T5827AC -UN-25OCT88



RG6281 -UN-17AUG92

S11,2025,HA -19-21SEP95

IMPORTANT: Water pump must be supported on impeller end of shaft when installing pulley or hub. Bearings will be damaged if not supported on shaft face only.

10. Place pump housing under a press and support on impeller end of shaft.

11. Install water pump pulley to the specified pulley-to-housing rear face dimension. (See SPECIFICATIONS at the beginning of this group for the correct dimension.)

12. Turn pulley by hand to make sure shaft turns freely.

13. Install washer and cap screw (A) in pulley end of shaft. Tighten to 115 N·m (85 lb-ft).

T5827AA -UN-25OCT88

RG6412 -UN-21AUG92

S11,2025,HC -19-22JUL95

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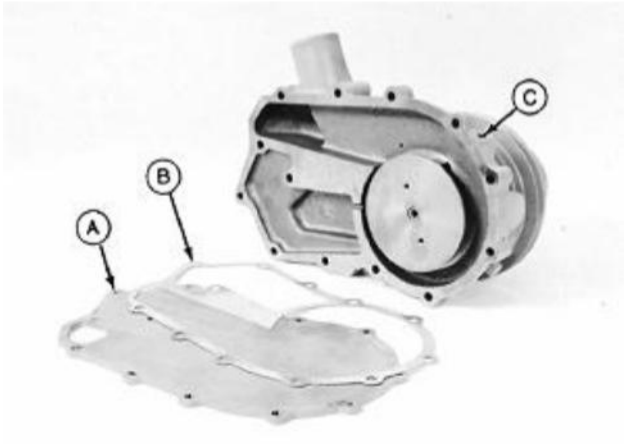
14. Install a new gasket (B) and housing cover (A). Install cap screws and tighten to 47 N·m (35 lb-ft).

15. Install new O-ring in port (C, where used).



RG6413 -UN-21AUG92

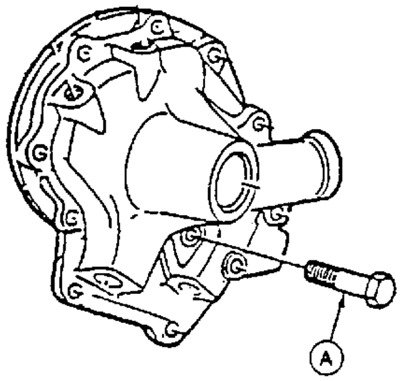
RG,CTM8,GR25,25-19-18AUG92

CHECKING WATER PUMP CAP SCREW PROTRUSION

NOTE: On Saran OEM Engines:

- *4239AF and 4238TF with option code 2004 or 2023*
- *6359DF and 6359TF with option code 2004, 2008 or 2023*

Cap screw (A) when used with service water pump, may interfere with cylinder block. As a result, coolant will leak from service water pump.



RG7263 -UN-10DEC94

RG,CTM8,DX393 -19-13JUL95

To increase the depth of the cap screw in the water pump cover (A), the counterbore height on the water pump housing has been reduced from 32 mm (1.26 in.) (B) to 30.5 mm (1.20 in.) (C). This reduced counterbore height may cause the water pump cap screw to protrude beyond the water pump cover.

To assure proper installation of the service water pump, it is necessary to perform the following procedures:

1. Measure previous dimension (B) of water pump being replaced.

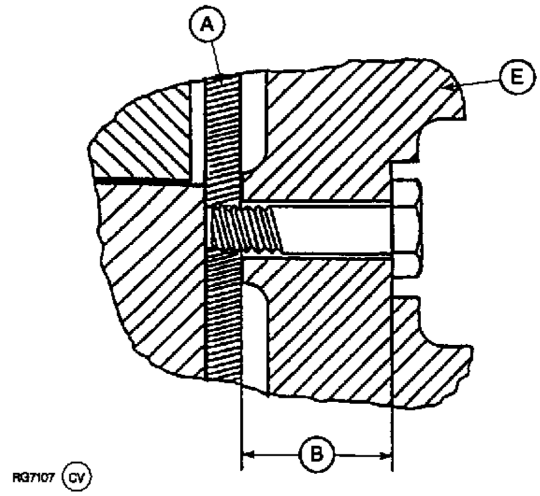
2. Measure new dimension (C) of service water pump.

If previous dimension (B) is 32 mm (1.26 in.) and new dimension (C) is 30.5 mm (1.20 in.), it will be necessary to machine the cylinder block (G) to avoid any contact with the cap screw.

If previous dimension (B) and new dimension (C) are 30.5 mm, make sure a recess (D) exists on cylinder block.

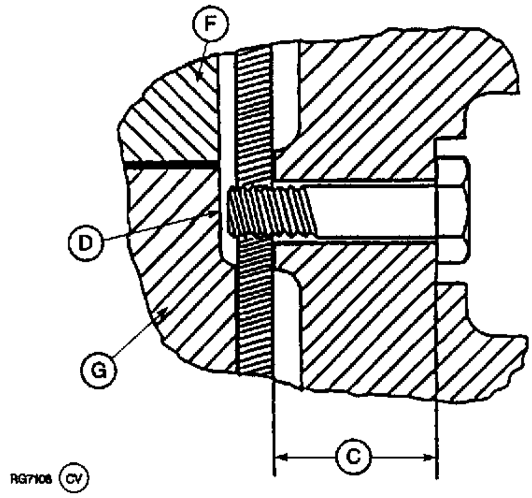
NOTE: The length of cap screw is 38 mm (1.50 in.). Cap screw is to be used without a washer.

A—Water Pump Cover
B—Previous Dimension [32 mm (1.26 in.)]
C—New Dimension [30.5 mm (1.20 in.)]
D—Recess
E—Water Pump
F—Cylinder Head
G—Cylinder Block
H—14 mm (0.55 in.)
I—90 mm (3.50 in.)
J—4 mm (0.15 in.)
K—25 mm (1.0 in.)



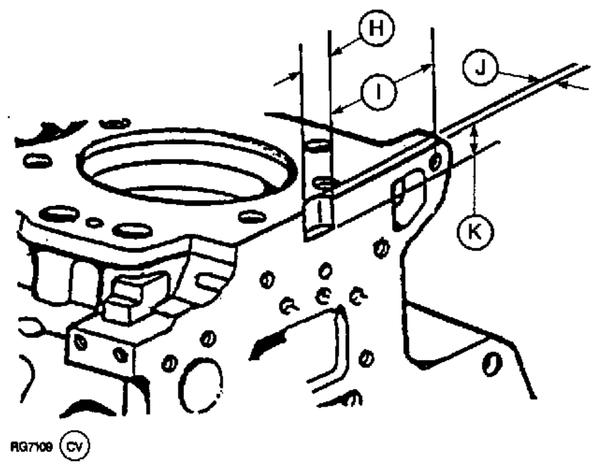
RG7107 -UN-30SEP94

Previous



RG7108 -UN-10OCT94

New



RG7109 -UN-10OCT94

RG,CTM8,DX121 -19-08FEB95

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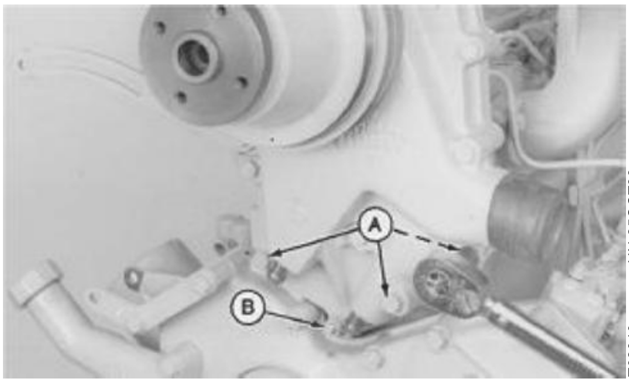
INSTALL HIGH FLOW (HEAVY-DUTY) WATER PUMP



1. Clean gasket surfaces. Install a new gasket and water pump. Tighten cap screw (A) and nut (B) to the following specification.

WATER PUMP-TO-CYLINDER BLOCK TORQUE SPECIFICATIONS

SAE Grade 5 Cap Screw	47 N·m (35 lb-ft)
SAE Grade 8 Cap Screw	54 N·m (40 lb-ft)
Retaining Nut with Fine Thread	40 N·m (30 lb-ft)

2. Install a new gasket and thermostat housing. (See ASSEMBLE AND INSTALL THERMOSTAT HOUSING earlier in this group.)

3. Connect oil cooler tubes.

4. Install alternator (if removed) and fan belt(s). Adjust belt tension. (See COOLING SYSTEM SPECIFICATIONS at the beginning of this group.)

5. Fill cooling system with proper coolant. (See Group 02 - Fuels, Lubricants, and Coolant.)

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

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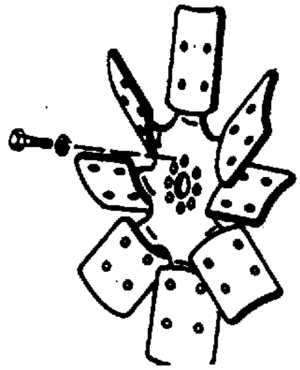
S11,2025,FS -19-21SEP95

INSPECT AND INSTALL FAN BLADE ASSEMBLY



RG4797 -UN-14DEC88

1. Inspect fan blades for bent or damaged condition. Bent blades reduce cooling system efficiency and throw the fan out of balance. Replace fan if blades are bent or damaged.

NOTE: Engines may be equipped with either suction-type fan or a blower-type fan, depending on application.

2. Install fan on pulley or pulley hub. Tighten cap screws (with lock washers) to specification.

FAN-TO-PULLEY HUB CAP SCREW TORQUE SPECIFICATION

5/16 in. Cap Screw	27 N·m (20 lb-ft)
3/8 in. Cap Screw	47 N·m (35 lb-ft)

S11,2025,FT -19-13JUL95

REMOVE COOLANT HEATER—IF EQUIPPED

1. Unplug heater from electrical power source.

2. Drain cooling system.

3. Remove electrical cord, loosen nut, and pull heater element out of block.

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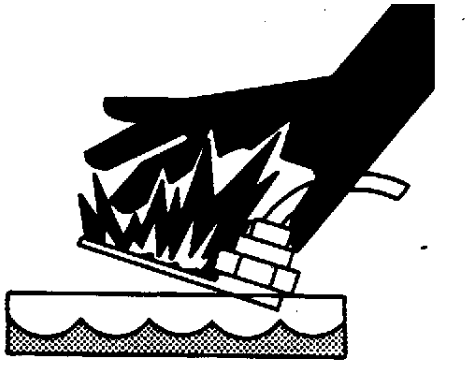
CTM8,GR25,21 -19-16SEP92

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 (G) cannot be repaired. If defective, replace it.

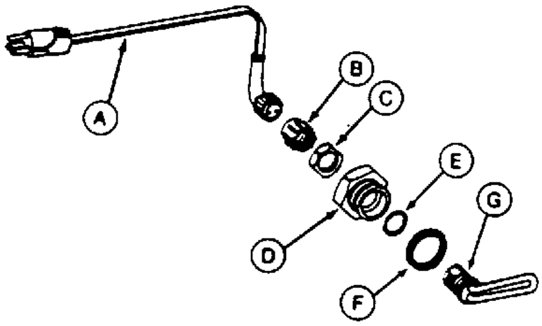
1. Assemble coolant heater (110 volt or 220 volt) as shown in illustration.

2. Place heater element in block so flats on the threaded part of the element are vertical. The element must not touch the internal walls of the block.

NOTE: If heater has been ordered as an attachment only, it will include a dust cover (B). The cover is used to protect the electrical connectors when cord assembly (A) has been removed.

3. Tighten retaining nut (C) to 34 N·m (25 lb-ft).

4. Install cord.



RG5619 -UN-10MAR90

A—Cord
B—Dust Cap
C—Retaining Nut
D—Adapter
E—Gasket
F—O-Ring
G—Heater Element

CTM8,GR25,22 -19-13JAN95

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OTHER MATERIAL

Number	Name	Use
PT569	NEVER-SEEZ Compound	Turbine housing-to-center housing cap screws and exhaust manifold-to-cylinder head cap screws.

CTM8,GR30,10 -19-31AUG92

AIR INTAKE AND EXHAUST SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION
Intake Manifold Pressure (Turbocharger Boost) (see Group 110)	
Exhaust Adapter, Minimum End Play	0.8—1.6 mm (0.03—0.06 in.)
KKK Turbocharger:	
Radial Bearing Clearance, Maximum	0.42 mm (0.016 in.)
Rotating Assembly Axial Bearing End Play, Maximum	0.16 mm (0.006 in.)
AiResearch/Garrett T04B, TA31, TA34 Turbochargers:	
Radial Bearing Clearance (Maximum)	0.08—0.18 mm (0.003—0.007 in.)
Axial Bearing End Play (Maximum)	0.025—0.102 mm (0.001—0.004 in.)
AiResearch/Garrett TA25 Turbocharger:	
Radial Bearing Clearance (Maximum)	0.06—0.13 mm (0.0024—0.0051 in.)
Axial Bearing End Play (Maximum)	0.025—0.09 mm (0.001—0.0035 in.)

S11,3005,IW -19-01NOV95

AIR INTAKE AND EXHAUST SYSTEM SPECIFICATIONS—CONTINUED

TORQUES	SPECIFICATION
Intake Manifold-to-Intake Manifold Cover	27 N·m (20 lb-ft)
Intake Manifold-to-Cylinder Head	
Aftercooled (“A” Engines)	35 N·m (26 lb-ft)
Non-Aftercooled (“D” and “T” Engines)	47 N·m (35 lb-ft)
Air Inlet Elbow-to-Intake Manifold (Low Profile Turbochargers only)	47 N·m (35 lb-ft)
Exhaust Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Aftercooler Adapter Plate-to-Aftercooler	27 N·m (20 lb-ft)
Turbocharger Adapter Plate-to-Manifold	27 N·m (20 lb-ft)
Aftercooler-to-Intake Manifold	27 N·m (20 lb-ft)
Aftercooler Bracket-to-Cylinder Head	47 N·m (35 lb-ft)
Turbocharger and Exhaust Elbow-to-Exhaust Manifold:	
3-Cylinder Engines	23 N·m (17 lb-ft)
4-Cylinder and 6-Cylinder Engines	47 N·m (35 lb-ft)
Oil Inlet Line-to-Turbocharger	27 N·m (20 lb-ft)
Oil Return Line-to-Turbocharger	27 N·m (20 lb-ft)
Compressor Housing-to-Center Housing:	
Initial Torque	10 N·m (7 lb-ft)
Final Torque:	
3-Cylinder Engines	27 N·m (20 lb-ft)
4-Cylinder and 6-Cylinder Engines	17 N·m (13 lb-ft)
Turbine Housing-to-Center Housing:	
Initial Torque	10 N·m (7 lb-ft)
Final Torque:	
3-Cylinder Engines	26 N·m (19 lb-ft)
4-Cylinder and 6-Cylinder Engines	17 N·m (13 lb-ft)
V-Band Clamp TA25 Turbochargers on 3179 Engines	7 N·m (5 lb-ft)
Oil Cooler Bracket	35 N·m (26 lb-ft)

S11,3005,IX -19-01NOV95

EXTENDING TURBOCHARGER LIFE

Turbochargers are designed to last the life of the engine, but, because they operate at such high speeds (100,000 rpm or more); a moment's carelessness can cause them to fail in seconds.

The major causes of turbocharger failures are attributed to:

- **Lack of lube oil (quick starts and hot shutdowns)**
- **Oil contamination**
- **Ingestion of foreign objects**
- **Restricted oil drainage**
- **Low oil level**
- **Operation on excessive side slopes**
- **Abnormally high exhaust temperatures**

S55,3005,E -19-06APR94

- **Lack of Lube Oil**

Oil not only lubricates the turbocharger's spinning shaft and bearings, it also carries away heat. When oil flow stops or is reduced, heat is immediately transferred from the hot turbine wheel to the bearings, which are also heating up because of the increased friction due to the lack of oil. This combination causes the turbocharger shaft temperature to increase rapidly.

If oil flow does not increase and the process continues, bearings will fail. Once the bearings fail (which can happen in just seconds) seals, shaft, turbine and compressor wheels can also be damaged.

The principle causes of turbocharger bearing lubrication problems are low oil pressure, a bent, plugged or undersized oil lube supply line, plugged or restricted oil galleries in the turbocharger, or improper machine start-up and shutdown procedure.

Oil levels and pressure should always be closely monitored and all worn hoses and lines should be replaced. The turbocharger oil supply line should be checked frequently to make sure it is not kinked or bent and it should always be replaced with a line of equal size, length and strength.

The easiest way to damage a turbocharger is through improper start-up and shutdown procedures. Always idle the engine for at least 30 seconds (no load) after start-up and before shutdown. Warming the engine up before applying a load allows oil pressure to build up and lines to fill with oil.

Idling the engine before shutdown allows the engine and turbocharger to cool. "Hot" shutdowns can cause the turbocharger to fail because after high-speed operation the turbocharger will continue to rotate long after the engine has been shut off and oil pressure has dropped to zero. This will cause heat to build up and possible bearing damage. It can also cause carbon and varnish deposits to form.

S55,3005,F -19-04JUN93

• **Oil Contamination**

A second cause of turbocharger failures is contaminated oil. It can be caused by a worn or damaged oil filter or not changing the lube oil at recommended intervals. Expecting the oil filter to remove dirt, sand, metal chips, etc. from the oil before they reach the engine or turbocharger can be a costly mistake because contaminated oil may completely bypass the engine oil filter if the oil filter or oil cooler is clogged, if the filter element is improperly installed, or if the oil is thick during cold weather.

Four good ways of avoiding oil contamination are:

— Always inspect the engine thoroughly during major overhaul. Look especially for any sludge or debris left in lube oil galleries.
— Change lube oil at recommended intervals. Analysis of oil samples at filter change periods can help identify potentially harmful contaminants in the oil.
— Clean the area around the oil fill cap before adding oil.
— Use a clean container when adding oil.

S11,3005,MK -19-04JUN93

• **Ingestion of Foreign Objects**

The third cause of turbocharger damage is the ingestion of foreign objects. Foreign objects or particles can be ingested and cause damage to the turbocharger on both compressor and turbine sides. This is easy to avoid.

On the compressor side, foreign objects usually take the form of dust, sand, or shreds of air cleaner element that enter through improperly installed air cleaner elements. Leaky air inlet piping (loose clamps or torn rubber joints) or torn pleats in dry-type air cleaner elements also create problems.

The result is erosion of compressor blades that can cause the delicately balanced wheel to wobble.

IMPORTANT: Whenever an internal engine failure (valve, valve seat, piston) occurs, a thorough inspection of the turbocharger MUST BE performed before returning engine to service.

S11,3005,ML -19-07JUL95

• **Restricted Oil Drainage**

A fourth cause of turbocharger damage is restricted lube oil drainage. The lubricating oil carries away heat generated by friction of the bearings and from the hot exhaust gases. If drainage back to the sump is impeded, the bearings will overheat with damage that will ultimately lead to failure.

There are two primary reasons for restricted drainage. A blocked drain tube, due to either damage or a buildup of sludged oil, or high crankcase pressure, which can be due to restricted crankcase breather or excessive engine blowby.

Periodically check both the turbocharger oil drain tube and engine breather tube for damage or restriction. Correction of these conditions leads to longer turbocharger life.

RG,CTM8,G30,R1 -19-07JUL95

• **Abnormally High Exhaust Temperatures**

A fifth cause of turbocharger damage is abnormally high exhaust temperatures. Elevated exhaust temperatures cause coking of oil which can lead to bearing failure. Extreme over-temperature operation can case wheel burst.

There are two basic causes of over-temperature. The first is restricted air flow and the second is overpowering the engine. In either case the engine has more fuel than available air for proper combustion, this overfueled condition leads to elevated exhaust temperatures.

Causes of restricted air flow can include damaged inlet piping, clogged air filters, excessive exhaust restriction, or operation at extreme altitudes. Overpowering generally is due to improper fuel delivery or injection timing. If overtemperature operation has been identified, an inspection of the air inlet and exhaust systems should be performed. Also, check the fuel delivery and timing.

RG,CTM8,G30,R2 -19-19AUG92

REMOVE TURBOCHARGER—4239T AND 6359T & A ENGINES (AIRESEARCH/GARRETT AND K.K.K.*)

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

NOTE: Turbocharged engines will have either K.K.K. or AiResearch turbochargers. Removal and installation procedures are the same for both turbochargers, but, repair of two brands differ. Refer to the proper repair group when repairing the turbocharger.*

Thoroughly clean exterior of turbocharger and surrounding area to prevent entry of dirt into the air intake system during removal.

IMPORTANT: When cleaning turbocharger, do not spray directly into compressor cover or turbine housing. If turbocharger inspection is required, do not clean exterior prior to removal. Doing so may wash away evidence of a potential failure mode. See TURBOCHARGER SEVEN STEP INSPECTION later in this group.)

Kuhnle, Kopp, and Kausch

S11,3005,IY -19-29JUN95

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NOTE: On all engines except 6359TF002 with option codes 2007 and 2302, remove air intake hose, exhaust elbow and adapter from turbocharger. On 6359TF002 Engines with option codes 2007 and 2302, disconnect air intake hose and exhaust from turbocharger.

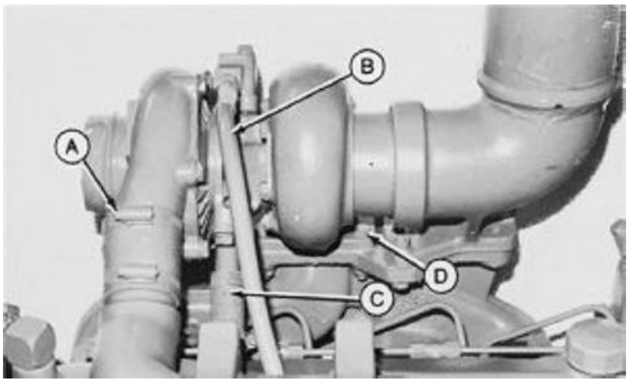
1. Loosen hose clamps (A).

2. Disconnect oil inlet (B) and oil return line (C) from turbocharger.

3. Remove cap screws (D) and remove turbocharger.

4. Place turbocharger on a clean flat surface. Cap or plug all air intake and exhaust openings.

5. Perform turbocharger seven-step inspection as described later, if failure mode has not yet been determined. See TURBOCHARGER SEVEN-STEP INSPECTION in this group.



A—Clamp (2 used)
B—Oil Inlet Line
C—Oil Return Line
D—Cap Screw (4 used)

S11,3005,IZ -19-22SEP95

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

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

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 -19-07JUL95

Compressor Housing Inlet and Compressor Wheel

1. Check compressor inlet and compressor wheel (A) for foreign object damage.

NOTE: Foreign object damage may be extensive or minor. In either case, the source of the foreign object must be found and corrected to eliminate further damages.

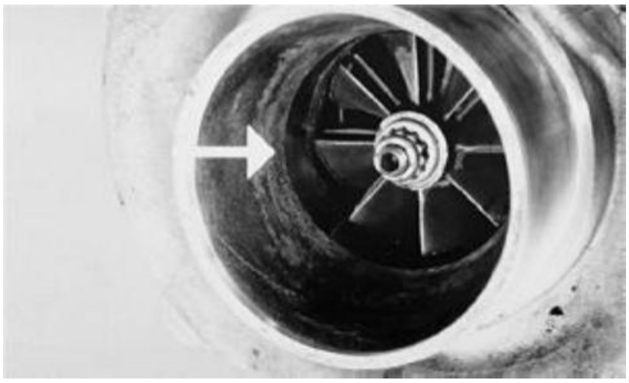
2. Mark findings on your checklist and continue the inspection.

RG4523 -UN-20DEC88

S11,3005,IG -19-07AUG92

NOTE: You will need a good light source for this check.

3. Check compressor inlet for wheel rub on the housing (arrow). Look very closely for any score marks on the housing itself and check the tips of the compressor wheel blades for damage.



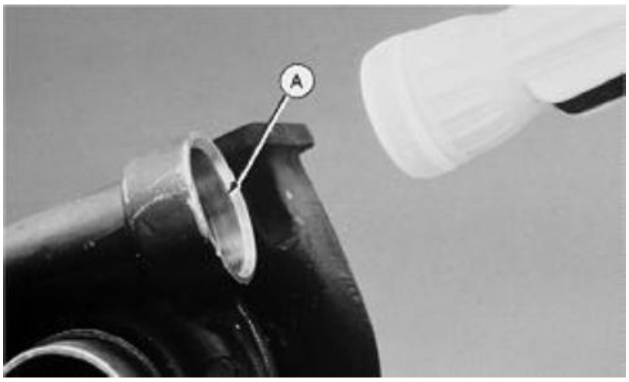
RG4524 -UN-20DEC88

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.



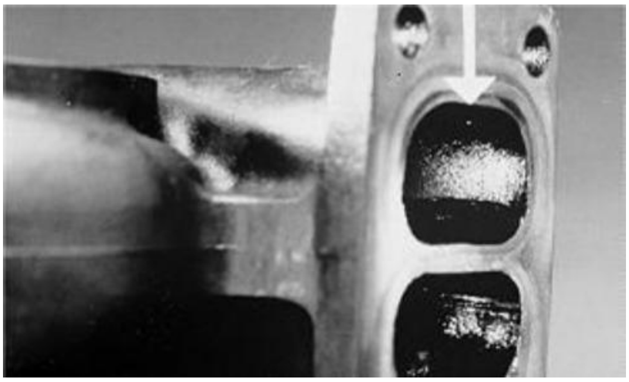
RG4525 -UN-20DEC88

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

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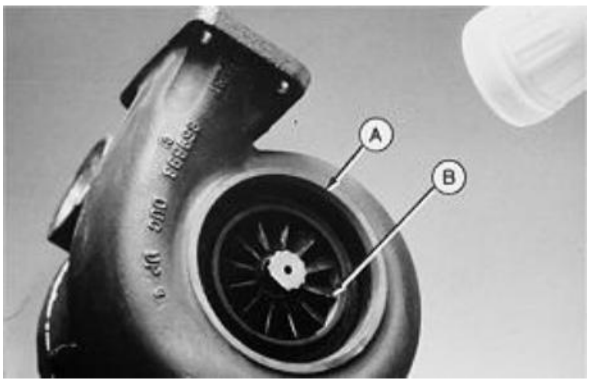
Turbine Housing Outlet and Turbine Wheel

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.

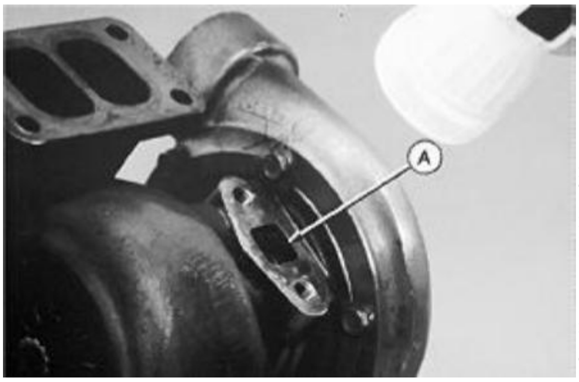
NOTE: If oil is present, make sure it is not coming from a leak at the oil supply or return line.

RG4529 -UN-20DEC88

S11,3005,IM -19-07AUG92

Internal Center Housing

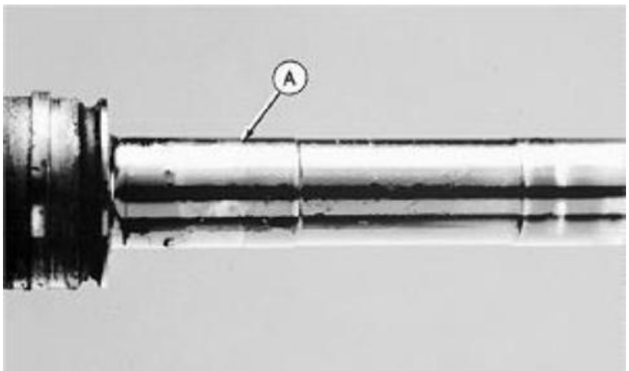
1. Using a flashlight, look through the oil return hole (A), to check the condition of the shaft and/or bearings. There should not be excess carbon deposits on the shaft or in the housing.



RG4530 -UN-20DEC88

S11,3005,IN -19-07AUG92

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

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Turbocharger Bench Test

1. Mount the turbocharger in a vise.

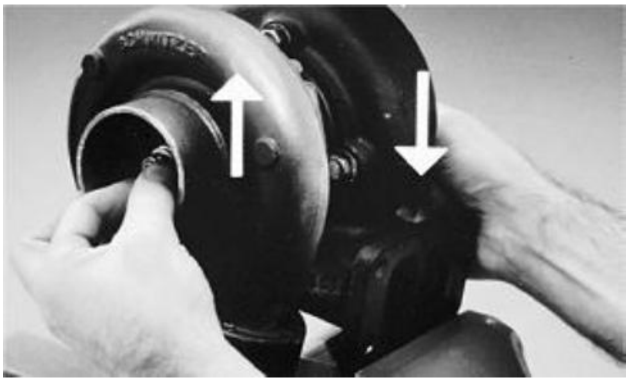
2. Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely, however, there may be a slight amount of drag.

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.

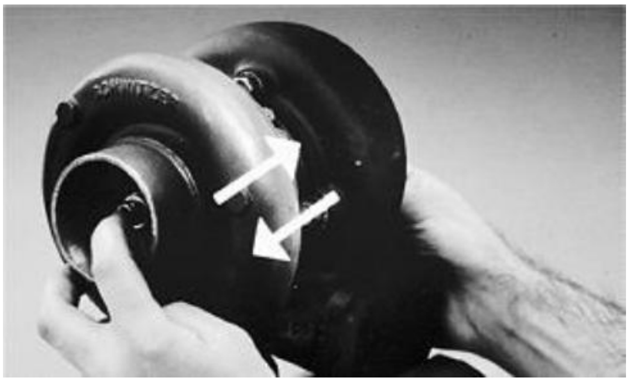
NOTE: There will be some "play" because the bearings inside the center housing are free floating.



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

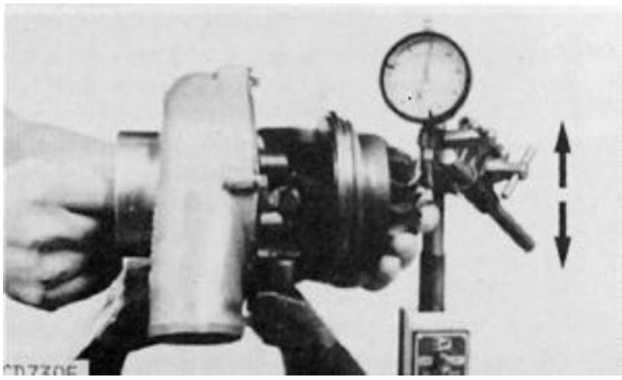
S11,3005,IR -19-07AUG92

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—K.K.K.



CD7305 -UN-23FEB89

This test will give an indication of the condition of the radial bearings within the center housing and rotating assembly.

1. Remove turbine housing and secure turbocharger in a vise.

2. Using a dial indicator with indicator rod against hex. nut, measure radial movement.

3. Applying equal pressure to both ends of the shaft at the same time, the range of travel should not exceed: 0.42 mm (0.016 in.). If movement is not within specifications, replace center housing and rotating assembly.

S11,3005,KV -19-11JUL95

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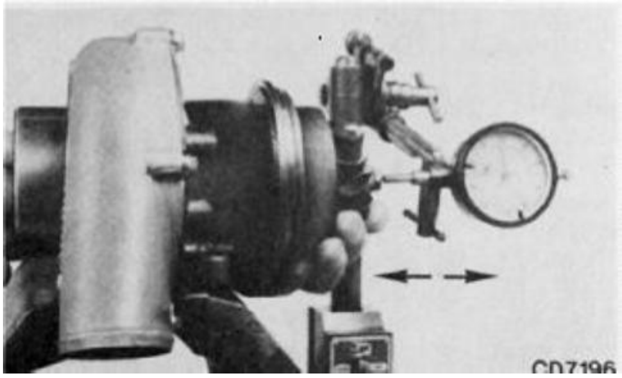
PERFORM AXIAL BEARING END PLAY BEARING TEST—K.K.K.

Perform this test to determine thrust bearing wear.

1. Using a dial indicator with indicator rod against shaft, measure axial end play.

2. Move the shaft axially back and forth by hand. Axial end play should not exceed: 0.16 mm (0.006 in.).

If total indicator reading is not within specification, the rotating assembly must be replaced.



CD7196 -UN-23FEB89

S11,3005,KW -19-29JUN95

PERFORM RADIAL BEARING CLEARANCE TEST—AIRESEARCH/GARRETT

This test will give an indication of the condition of the radial bearings within the center housing and rotating assembly.

1. Position dial indicator with extension adapter onto center housing so that tip rests on shaft extending through oil return cavity.

2. Grasp rotating shaft at both ends and move the shaft toward the indicator then away from the indicator (arrows).

3. Observe and record total indicator reading.

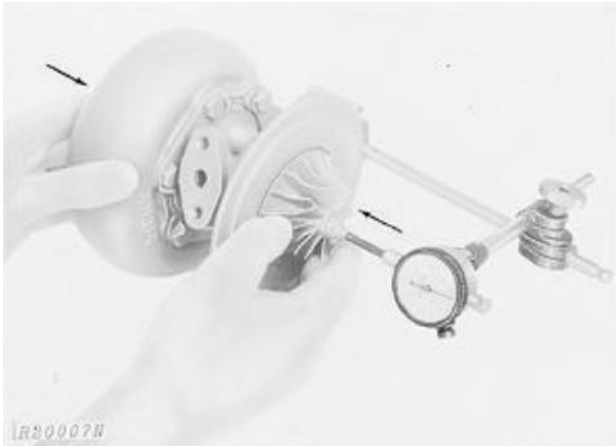
The bearing clearance specification is 0.06—0.13 mm (0.0024—0.0051 in.) for TA25 Turbochargers used on 3179 Engines and 0.08—0.18 mm (0.003—0.007 in.) for turbochargers used on all other engine applications.

If total indicator reading is not within specification, replace center housing and rotating assembly. (See REPLACE CENTER HOUSING AND ROTATING ASSEMBLY for your model of turbocharger, later in this group.)

R20006 -UN-20DEC88

S11,3005,KZ -19-29JUN95

PERFORM AXIAL BEARING END PLAY TEST—AIRESEARCH/GARRETT



R20007N -UN-20DEC88

This test will give an indication of the condition of the axial bearing within the center housing and rotating assembly.

1. Mount magnetic base dial indicator so that indicator tip rests on end of shaft. Preload indicator tip and zero dial on indicator.

2. Move shaft axially back and forth by hand.

3. Observe and record total dial indicator reading.

The bearing end play specification is 0.025—0.09 mm (0.001—0.0035 in.) for TA25 Turbochargers used on 3179 engines and 0.025—0.102 mm (0.001—0.004 in.) for turbochargers used on all other engine applications.

If bearing end play is not within specification, replace center housing and rotating assembly. (See REPLACE CENTER HOUSING AND ROTATING ASSEMBLY for your model of turbocharger, later in this group.)

S11,3005,LA -19-29JUN95

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15

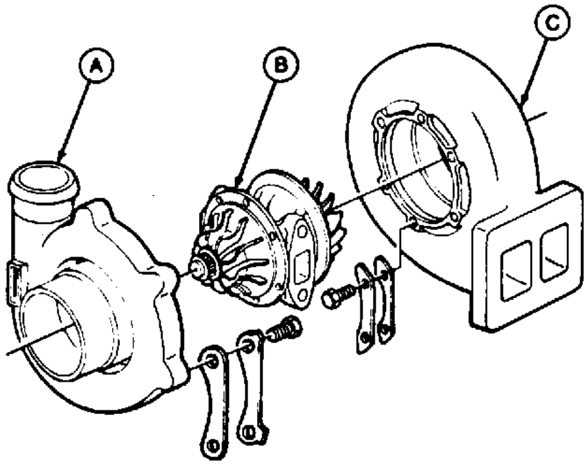
REPAIR TURBOCHARGER

AiResearch/Garrett and K.K.K. 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.

RG,CTM4,DX430 -19-22SEP95

DISASSEMBLE AND INSPECT TURBOCHARGER



RG5667 -UN-12APR90

1. Scribe locating marks on turbine housing (C) and compressor housing (A) in reference to any location (eg. oil inlet or return) on center housing and rotating assembly (B). These reference marks are essential for proper indexing during reassembly.

2. Remove compressor housing and turbine housing cap screws with lock plates and clamps.

If necessary, gently tap turbine housing and compressor housing with a soft hammer and carefully remove turbine housing from center housing.

3. Thoroughly clean compressor and turbine housings using a commercially approved solvent only. A caustic solution may damage housings. Dry housings with compressed air. 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 silicone carbide abrasive cloth.

—Nicks, dents, or warpage that could prevent proper sealing between the turbine housing and center housing.

• **Inspect compressor housing for:**

—Wheel rub damage within the contour area that cannot be polished out with 80-grit silicone carbide abrasive cloth.

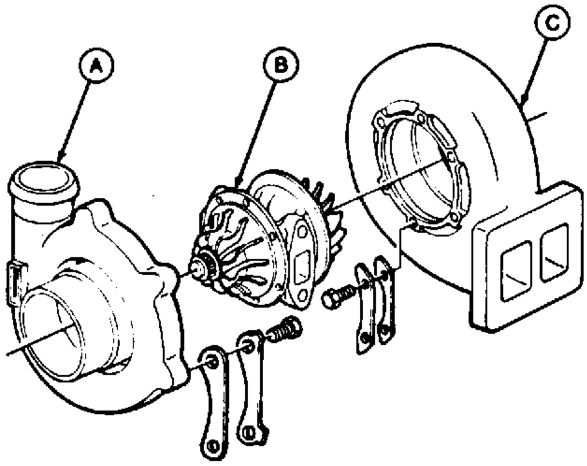
—Nicks, dents, or warpage that could prevent proper sealing between the compressor housing and center housing.

—Corroded or stripped center housing mounting holes.

4. Replace either housing if any one of the above defects are found.

CTM8,GR30,8 -19-17FEB95

REPLACE CENTER HOUSING AND ROTATING ASSEMBLY



RG5667 -UN-12APR90

1. Carefully transfer scribed marks from original center housing to replacement assembly, if necessary. Use same procedure for compressor and turbine housings, if replaced.

2. Attach compressor housing (A) to center housing and rotating assembly (B) with cap screws, lock plates, and clamps. Tighten cap screws to specification.

COMPRESSOR HOUSING-TO-CENTER HOUSING CAP SCREW TORQUE SPECIFICATIONS

Initial Torque	10 N·m (7 lb-ft)
Final Torque:	
3-Cylinder Engines	27 N·m (20 lb-ft)
4-Cylinder and 6-Cylinder Engines	17 N·m (13 lb-ft)

3. Attach turbine housing (C) to center housing and rotating assembly. Coat threads of cap screws with PT569 NEVER-SEEZ. Install cap screws, lock plates, and clamps. Tighten cap screws to specification.

TURBINE HOUSING-TO-CENTER HOUSING TORQUE SPECIFICATION

Initial Torque	10 N·m (7 lb-ft)
Final Torque:	
TA25 Turbochargers on 3179 Engines	26 N·m (19 lb-ft)
All Other Engines	17 N·m (13 lb-ft)
V-Band Clamp TA25 Turbochargers on 3179 Engines	7 N·m (5 lb-ft)

4. After assembly, check the center housing and rotating assembly for binding and wheel rub. If either condition exists, disassemble turbocharger and correct the cause.

5. Bend ears of lock plates against heads of cap screws.

RG,CTM4,DX395 -19-01NOV95

PRELUBE TURBOCHARGER

IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearing can occur.

Fill oil inlet or drain port with clean oil and turn rotating assembly (by hand) to properly lubricate bearings. If turbocharger is to be stored, lubricate internally and install protective covers on all openings.

RG6303 -UN-22JUL92

RG,CTM8,G30,R4 -19-11SEP92

INSTALL K.K.K. AND AIRESEARCH/GARRETT TURBOCHARGER

IMPORTANT: If turbocharger failed because of foreign material entering the air intake system, be sure to examine the system and clean as required to prevent a repeat failure.

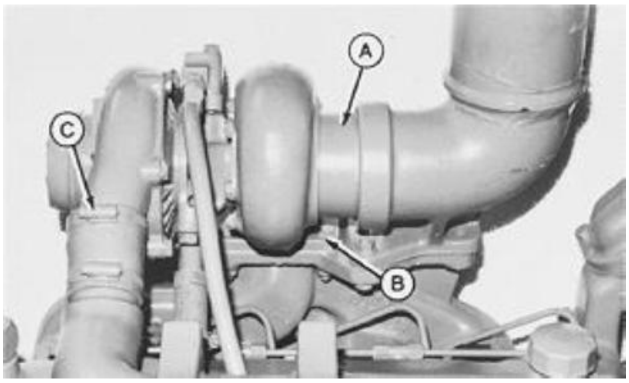
Inspect the rubber hose at the end of the turbocharger oil return line for damage or cracks. Replace as necessary. Since the greatest amount of suction occurs between the air cleaner and turbocharger, it is essential that the hose connections are tight to prevent entry of dirt into the engine.

If not done previously, prime the turbocharger lubrication system prior to mounting turbocharger on the engine. Fill the center housing with new engine oil through the oil drain hole. Turn the rotating assembly by hand to lubricate the bearings.

Inspect the air cleaner-to-turbocharger hose to see that it is in good condition. Replace hose if it is hard, cracked or shows any signs of deterioration.

S11,3005,LB -19-29JUN95

NOTE: Remove all caps or plugs from turbocharger openings.



1. Attach turbocharger to exhaust manifold, tightening cap screws (B) to specification.

TURBOCHARGER-TO-EXHAUST MANIFOLD TORQUE SPECIFICATION

3-Cylinder Engine	23 N·m (17 lb-ft)
4-Cylinder and 6-Cylinder Engines	47 N·m (35 lb-ft)

NOTE: Guide studs may be used to position exhaust gasket during turbocharger installation.

2. Using new gaskets, connect lubrication oil inlet manifold and oil return pipe to turbocharger. Tighten cap screws to 27 N·m (20 lb-ft).

3. Rotate compressor housing to align with air inlet hose (C). Tighten compressor housing-to-center housing cap screws (E) to specification given below.

COMPRESSOR HOUSING-TO-CENTER HOUSING TORQUE SPECIFICATION

Initial Torque	10 N·m (7 lb-ft)
Final Torque:	
3-Cylinder Engines	27 N·m (20 lb-ft)
4-Cylinder and 6-Cylinder Engines	17 N·m (13 lb-ft)

NOTE: Coat turbine housing-to-center housing cap screws with PT569 NEVER-SEEZ Compound before installation.

4. Tighten turbine housing-to-center housing cap screws to specifications. Bend lock tabs against heads of cap screws.

TURBINE HOUSING-TO-CENTER HOUSING TORQUE SPECIFICATION

Initial Torque	10 N·m (7 lb-ft)
Final Torque:	
3-Cylinder Engines	26 N·m (19 lb-ft)
4-Cylinder and 6-Cylinder Engines	17 N·m (13 lb-ft)

Install exhaust adapter and exhaust elbow (A) on all engines except 6359TF002 Engines with option codes 2007 and 2302. The exhaust adapter must have a minimum end play of 0.8—1.6 mm (0.03—0.06 in.).

On 6359TF002 Engines with option codes 2007 and 2302, connect air intake hose and exhaust pipe to turbocharger.

S11,3005,LC -19-01NOV95

TURBOCHARGER BREAK-IN

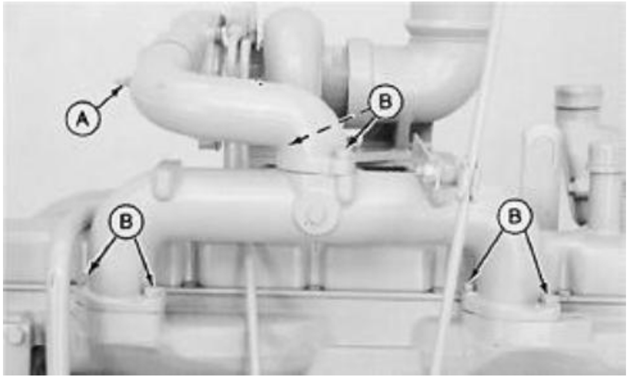
IMPORTANT: A new or repaired turbocharger does not have an adequate oil supply for immediated start-up of engine. Perform the steps below to prevent damage to turbocharger bearings.

1. Either push the throttle lever to the "STOP" position, hold the engine shut-off knob out, or disconnect electrical wire from injetion pump.

2. Crank engine over with starting until oil pressure gauge needle registers within the "GREEN" zone of pressure gauge. DO NOT crank engine longer than 30 seconds at a time to avoid damage to starting motor.

CTM8,GR30,16A -19-15SEP92

REMOVE, INSPECT, AND INSTALL INTAKE MANIFOLD (“D” AND “T” ENGINES)



T6077AM -UN-24FEB89

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 and kept tight.

Whenever a tune-up has been performed on a turbocharged engine, or whenever it is suspected that the horsepower output might be low, the intake manifold pressure (turbo boost) should be checked. (See CHECK INTAKE MANIFOLD PRESSURE [TURBO-BOOST] in Group 110.)

1. Loosen hose clamps (A) and remove hose from inlet elbow.

2. Remove cap screws (B) attaching air inlet elbow (if used) and intake manifold.

3. Inspect the intake manifold for serviceability. Replace, if it is cracked or otherwise damaged.

4. Inspect the machined mating surfaces of cylinder head and intake manifold. Clean as required using a scraper, wire brush, and compressed air.

5. To install intake manifold, reverse removal procedures and use new gaskets.

6. Make sure air intake hose is in good condition. Tighten hose clamps securely.

7. Coat intake manifold attaching cap screws with PT569 NEVER-SEEZ Compound and tighten to 47 N·m (35 lb-ft).

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S11,3005,LE -19-22SEP95

REMOVE CROSS-OVER TUBE ASSEMBLY—IF EQUIPPED

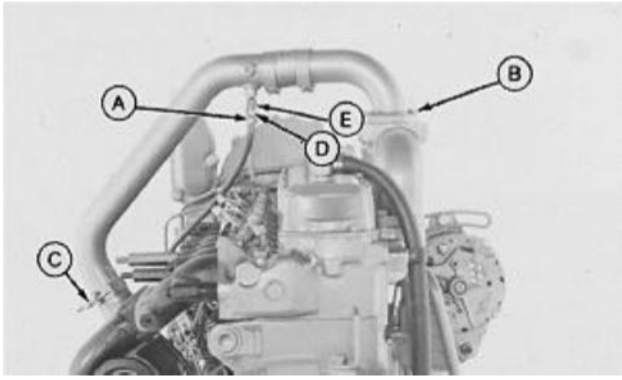
1. Disconnect hose (A) at connector fitting.

2. Remove air inlet elbow-to-intake manifold cap screws (B).

3. Loosen hose clamps (C) at turbocharger end of cross-over tube.

4. Remove cross-over tube assembly. Remove inlet elbow, hoses, and clamps from tube.

5. Remove connector (D) and filter vent plug (E) from cross-over tube.



RG5147 -UN-20DEC88

A—Hose
B—Cap Screws
C—Hose Clamps
D—Connector
E—Filter Vent Plug

S11,3005,HE -19-29JUN95

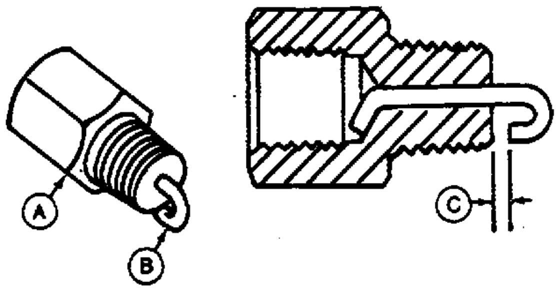
INSPECT AND REPAIR CROSS-OVER TUBE ASSEMBLY—IF EQUIPPED

1. Inspect filter vent plug (A). Make sure that orifice is clean and wire (B) moves freely. Orifice diameter is 1.68—1.70 mm (0.066—0.067 in.); wire diameter 0.63—0.76 mm (0.025—0.030 in.). Linear movement of wire should be 0.76—1.52 mm (0.030—0.060 in.). Bend wire, if necessary, to obtain specified dimension (C).

2. Inspect hose connector to be certain that opening is not restricted.

3. Inspect all hoses and clamps for good overall condition. Replace as required.

NOTE: If hose requires replacement, replace with one meeting. Specification SAE 30R2 Type 1. This type of hose is made to withstand high under hood temperatures.



RG5148 -UN-20DEC88

S11,3005,HF -19-29JUN95

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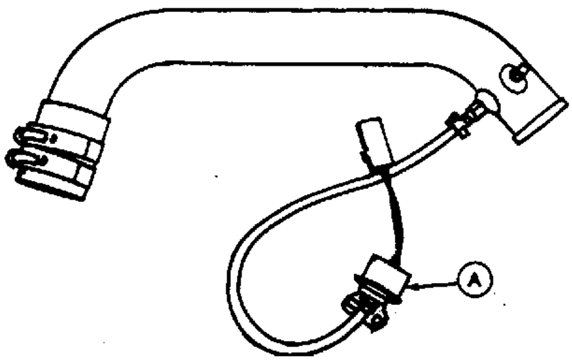
23

4. Inspect pressure switch assembly (A). Switch is normally closed, but opens on increasing pressure above 15—22 kPa (2—3 psi). Check condition of wiring and connector. Make sure connector terminals are clean. Repair or replace as required.

5. Inspect cross-over tube and air inlet elbow for general condition. Recondition or replace if required.



RG5149 -UN-20DEC88

S11,3005,HG -19-05MAR90

INSTALL CROSS-OVER TUBE ASSEMBLY—IF EQUIPPED

1. Apply a light coating of sealant to make threads on vent plug and install plug in cross-over tube.

2. Install hose connector in filter plug and install hose/pressure switch assembly on connector.

3. Install air inlet elbow (use a new elbow-to-manifold gasket) and cross-over tube assembly on engine. Tighten hose clamps securely. Tighten air inlet elbow cap screws 47 N·m (35 lb-ft).

4. Connect pressure switch wiring.

S11,3005,HH -19-29JUN95

REMOVE AFTERCOOLER AND INTAKE MANIFOLD (6359A)

CAUTION: Do not drain engine coolant until the coolant temperature is below operating temperature. Next, open drain valve slowly to relieve any excess pressure.

1. Thoroughly clean exterior of turbocharger, intake manifold and adjacent areas to prevent entry of dirt into the engine when parts are removed.

2. Remove fuel filter and base (A).

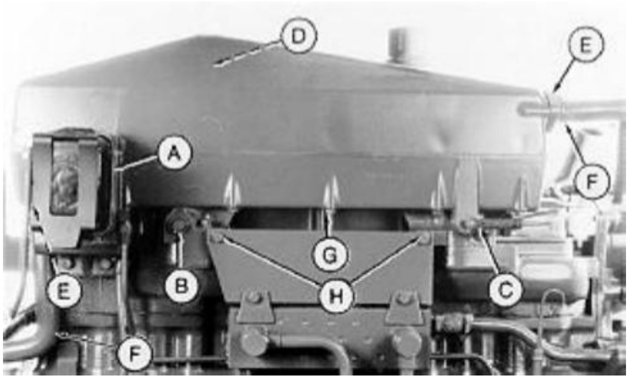
3. Remove oil cooler bracket attaching cap screws (H).

4. Disconnect thermostat line (B) and injection pump aneroid control line (C).

5. Remove turbocharger adapter plate (D) cap screws at rear of intake manifold.

6. Disconnect aftercooler front and rear adapter plates (E). Then remove clamps and hoses (F).

7. Remove intake manifold-to-cover cap screws (G) with washers.



RG4813 -UN-23AUG89

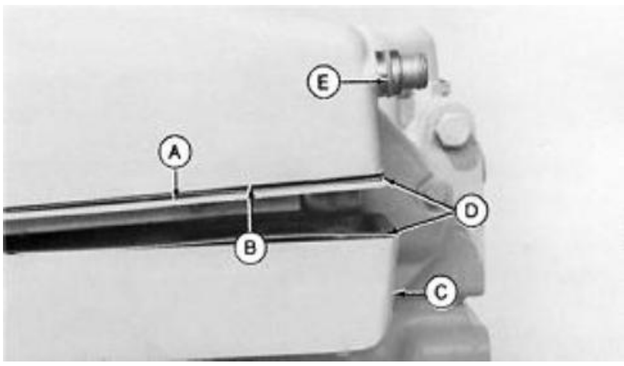
A—Fuel Filter
B—Thermostat Line
C—Aneroid Control Line
D—Turbocharger Adapter Plate
E—Aftercooler Adapter Plates
F—Hoses
G—Intake Manifold-to-Intake Manifold Cover Cap Screws
H—Oil Cooler Bracket Cap Screws

S11,3005,LH -19-22SEP95

8. Carefully lift aftercooler (A) with intake manifold cover (B) from intake manifold (C).

9. Remove and discard gaskets (D) and O-rings (E).

10. Remove all intake manifold-to-cylinder head cap screws and remove intake manifold.

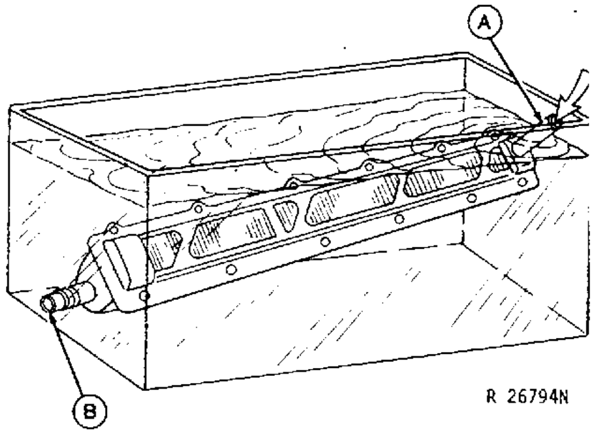


RG3947 -UN-20DEC88

A—Aftercooler
B—Intake Manifold Cover
C—Intake Manifold
D—Gaskets
E—O-Ring (2 used)

RG,CTM4,DW802 -19-22SEP95

INSPECT AND REPAIR AFTERCOOLER (6359A)



R26794N -UN-20DEC88

1. Inspect aftercooler for overall condition. The fins should be reasonably straight.

2. Inspect aftercooler inlet and outlet hoses. Replace either tube if cracked or damaged.

3. Test aftercooler for leaks by plugging either (A or B).

4. Apply compressed air to the other opening while aftercooler is submerged under water. Use 140—170 kPa (1.4—1.7 bar) (20—25 psi) air pressure for testing.

A minor leak that is accessible may be repaired. However, if the condition of the core is questionable, replace aftercooler.

IMPORTANT: Coolant leakage from the aftercooler may cause severe engine damage.

5. Inspect intake manifold cover for cracks or damage. Replace as necessary.

6. Clean cover with clean solvent and dry with compressed air.

S11,3005,LI -19-29JUN95

INSPECT AND REPAIR INTAKE MANIFOLD (6359A)

1. Check intake manifold for damage.

2. Inspect machined mounting surfaces for burrs or other defects which might prevent gaskets from sealing properly. Repair as required.

3. Scrape all old gasket material from parts.

4. Thoroughly steam clean interior of intake manifold.

IMPORTANT: Do not use a hot tank to clean aluminum parts. Severe damage and deterioration of these parts may occur.

S11,3005,LJ -19-29JUN95

INSTALL INTAKE MANIFOLD AND AFTERCOOLER (6359A)

NOTE: Insert manifold-to-cover cap screws into manifold (screws on engine side of manifold) before installing intake manifold on engine.

1. Using new gaskets install intake manifold.

2. Coat cap screws with PT569 NEVER-SEEZ Compound or equivalent. Tighten cap screws to 35 N·m (26 lb-ft).

S11,3005,LK -19-29JUN95

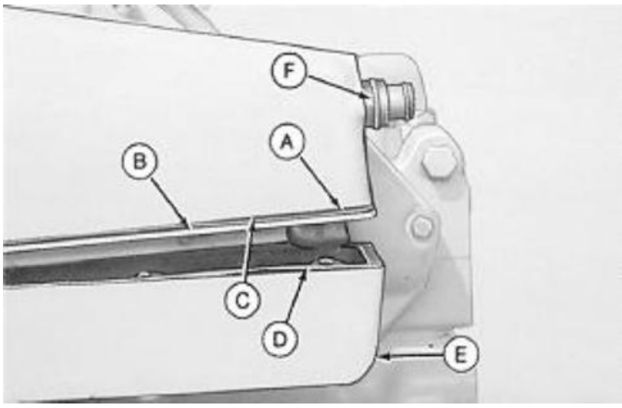
NOTE: Guide studs may be used to align gaskets, aftercooler, and cover during assembly.

3. Position a new upper gasket (A) on top of aftercooler (B).

4. Install a new O-ring (F) on aftercooler inlet and outlet tubes. Install aftercooler into aftercooler cover (C).

5. Put a new lower gasket (D) on intake manifold (E).

6. Position cover and aftercooler on intake manifold.



RG3949 -UN-20DEC88

A—Upper Gasket
B—Aftercooler
C—Aftercooler Cover
D—Lower Gasket
E—Intake Manifold
F—O-Ring (2 used)

S11,0407,AL -19-08AUG94

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27

7. Align aftercooler adapter plates (E) and turbocharger adapter plate (D). Tighten cap screws to 27 N·m (20 lb-ft).

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.

8. Coat all intake manifold-to-intake manifold cover cap screws (G) with PT569 NEVER-SEEZ Compound and tighten to 27 N·m (20 lb-ft).

9. Connect hoses (F) and tighten clamps securely.

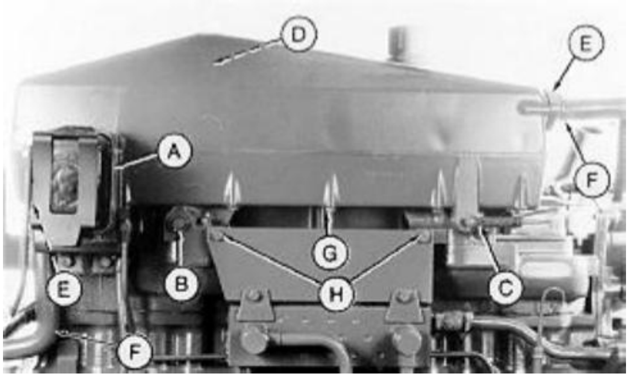
10. Connect thermostat line (B) and aneroid control line (C). Tighten connections securely.

11. Install oil cooler bracket and tighten cap screws (H) to 35 N·m (26 lb-ft).

12. Install fuel filter and base (A).

13. Fill cooling system with the proper clean coolant. (See Group 02 - Fuels, Lubricants, and Coolant.)

14. Start engine and inspect complete intake manifold assembly for leaks.



RG4813 -UN-23AUG89

A—Fuel Filter
B—Thermostat Line
C—Aneroid Control Line
D—Turbocharger Adapter Plate
E—Aftercooler Adapter Plates
F—Hoses
G—Intake Manifold-to-Intake Manifold Cover Cap Screws
H—Oil Cooler Bracket-to-Cylinder Head Cap Screws

S11,3005,LL -19-22SEP95

REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD

1. Remove turbocharger (B), (if equipped), remove exhaust elbow (A), or exhaust pipe, and exhaust manifold (C).

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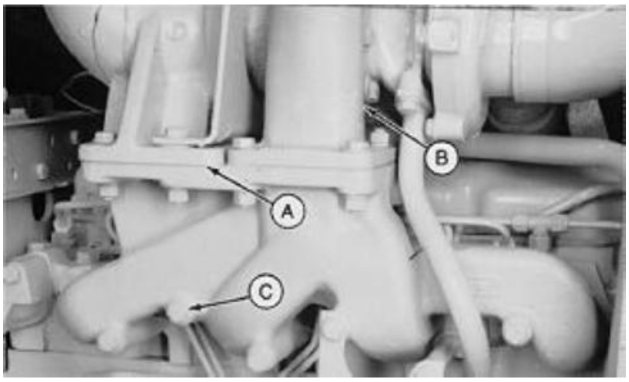
28

2. Reverse removal procedure to install exhaust manifold.

NOTE: When using gaskets with one steel-backed side, the non-steel backed side must face toward the cylinder head.

3. Tighten cap screws to 47 N·m (35 lb-ft).



T6021AD2 -UN-24FEB89

S11,3005,LM -19-22SEP95

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

RG5153 -UN-23AUG88

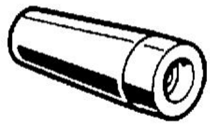
Injection Pump Drive Shaft Seal Installer JD256

Used to install pump shaft seal on Stanadyne DB2 injection pumps with non-retained drive shafts.

RG,JD256 -19-29SEP94

Nozzle Carbon Stop Seal Installer JD258

Used to install carbon stop seal in injection nozzle groove.

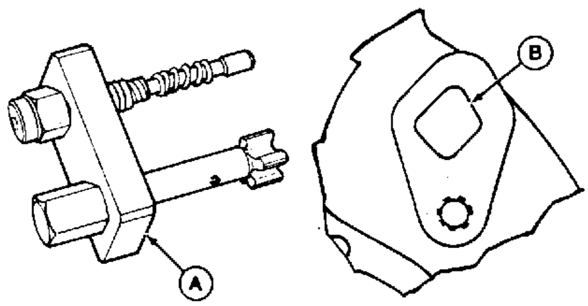


RG6254 -UN-22JUL92

RG,JD258 -19-17JUL92

Flywheel Turning Tool (A) JD281A

Used on engines with 142 tooth flywheel ring gear and a diamond shaped tool guide bore (B) in flywheel housing. Tool has it's own spring loaded timing pin which threads into flywheel housing.



RG6252 -UN-22JUL92

RG,JD281A -19-17JUL92

RG5152 -UN-23AUG88

Injection Pump Shaft Removal Tool JD303

Used to remove injection pump drive shaft from drive gear on Stanadyne DB2 injection pumps with non-retained drive shafts.

RG,JD303 -19-29SEP94

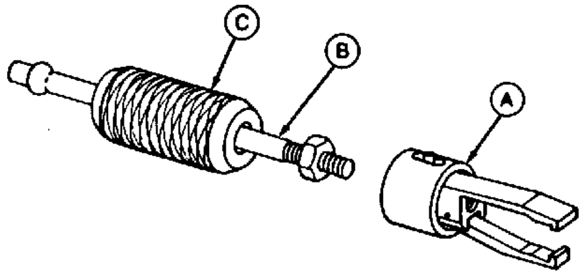
Injection Nozzle Puller JDE38B

Remove Stanadyne 9.5 mm injection nozzles.

NOTE: If JDE38A Nozzle Puller is available, order JDG716 Adapter and use with slide handle from JDE38A.

JDG716 Adapter can be used with slide handle from JDE38 or JDE38A to remove 9.5 mm injection nozzles without removing the rocker arm cover.

NOTE: JDG716-1 Repair Kit is available if leg of JDG716 Adapter is damaged.



RG6436 -UN-17SEP92

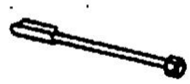
A—JDG716 Adapter
B—JDE38-2 Shank
C—JDE38-3 Hammer

RG,JDE38B -19-08MAR95

RG5084 -UN-23AUG88

Nozzle Bore Cleaning Tool JDE39

Clean injection nozzle bore in cylinder head.



S53,JDE39 -19-10JUL89

RG5068 -UN-23AUG88

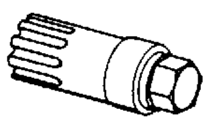
Timing Pin JDE81-4

Lock engine at TDC when installing injection pump or timing valve train. Use with JDG820, JDE81-1, or JDE83 Flywheel Turning Tool.

RG,JDE814 -19-03JAN95

Flywheel Turning Tool JDE83

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



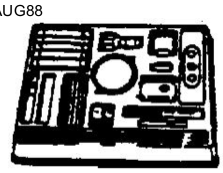
RG6251 -UN-22JUL92

RG,JDE83 -19-17JUL92

RG5224 -UN-23AUG88

Injection Nozzle Cleaning Kit JDF13 (JDE105)

Clean 9.5 mm injection nozzles.



RG,JDF13 -19-17JUL92

RG5151 -UN-23AUG88

Roto Diesel/Lucas CAV Injection Pump
Removal Tool . . . . JDG535 or KJD10108

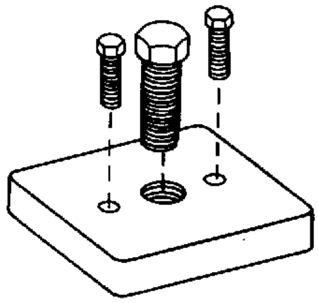
Used to remove injection pump gear from tapered shaft on Roto Diesel/Lucas CAV and Stanadyne DB2 (with retained drive shaft).

NOTE: If gear on Stanadyne DB2 (with retained drive shaft) has two holes, JDG670A may be used.

S53,JDG275 -19-29JUN95

Injection Pump Drive Gear Puller JDG670A

Remove drive gear* from tapered shaft on Stanadyne DB2 (with retained drive shafts) and DB4 fuel injection pumps. Also used to remove drive gear on Lucas CAV injection pumps.



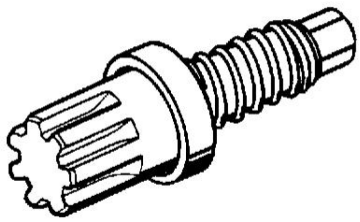
RG6032 -UN-13JAN92

**If drive gear does not have two holes, JDG535 or KJD10108 will have to be used to remove gear.*

JDG670A,DX396 -19-21SEP95

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,CTM8,DW570 -19-22SEP95

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
Bosch Bench Mounted Nozzle Tester (JT25510); or, OTC Portable Nozzle Tester (D01109AA)	Check nozzle opening pressure
Fuel Injection Nozzle Tester Adapter Set (D01110AA)	Check nozzle opening pressure.

RG,CTM8,G35,1 -19-17JUL92

OTHER MATERIAL

Number	Name	Use
LOCTITE 242 (TY9370)	Thread Sealant	Fuel line fittings and supply pump mounting cap screws, between fuel pump and cylinder block gasket, and timing hole cover cap screws.
LOCTITE 595* (TY15130)	Superflex Sealant (Form-In-Place Gasket)	Use on injection pump cover and pump timing gear cover ONLY when a traditional gasket is not available through service parts.
ROS16489	Lapping Compound	Use on nozzle valve for cleaning in the guide area ONLY.

**Use DD14928 Sealing Compound Kit when servicing an engine within the European Market/Service Area. Follow manufacturer's directions on package when using and storing sealant.*

RG,CTM8,G35,2 -19-11SEP92

FUEL SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION
ENGINE SPEEDS:	
Machine application	See applicable machine TM
OEM applications	See Groups 01 and/or 105 of this CTM
FUEL INJECTION PUMP DYNAMIC (TIME TRAC®)	
All Models	See Group 115
FUEL INJECTION PUMP-TO-STATIC TIMING:	
ROTO DIESEL/LUCAS CAV Fuel Injection Pump	
(Saran-built engines only)	Align marks on pump flange and engine front plate after setting engine to following specified degree position:
Tractor Engines:	
3179 Engines	13° before TDC
4239D Engines	13° before TDC
4239T Engines Serial No. (—CD539999)	13° before TDC
4239T Engines Serial No. (CD540000—CD685789)	17° before TDC
4239T Engines Serial No. (CD685790—)	19° before TDC
6359DL-01, DL-02; and 6359TL-02, TL-03 Engines	13° before TDC
6359DL-04, DL-06 Engines	15° before TDC
Combine Engines:	
4239D Engines	13° before TDC
4239T Engines Serial No. (—CD539999)	13° before TDC
4239T Engines Serial No. (CD540000—CD685789)	17° before TDC
4239T Engines Serial No. (CD685790—)	19° before TDC
6359 Engines	13° before TDC
Windrower Engines (4239)	13° before TDC
Loader Backhoe Engines (4239)	13° before TDC
Saran OEM Engines:	
Regular Governor—3179DF, 4239DF, 6359DF	13° before TDC
3—5 percent Governor—4239DF, 6359DF	15° before TDC
STANADYNE Injection Pump (Saran and Dubuque-built engines):	
All engines with JDB and DM4 pumps	Lock No. 1 Cylinder at TDC Compression Stroke; Align marks on pump cam ring and governor weight retainer.
All Saran engines with DB2 pumps	Lock No. 1 Cylinder at TDC Compression Stroke; Align marks on pump flange and engine front plate.
All Dubuque engines with DB2 pumps	Lock No. 1 Cylinder at TDC Compression Stroke; Align marks on pump cam ring and governor weight retainer.

TIME TRAC® is a registered trademark of Stanadyne Automotive Corp.

S11,3010,LH -19-21SEP95

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FUEL SYSTEM SPECIFICATIONS—CONTINUED

ITEM	NATURALLY ASPIRATED ENGINES (EXCEPT 4276D & 6414D)	TURBOCHARGED ENGINES AND 4276D, 6414D ENGINES
Fuel Injection Nozzles		
—Number of nozzle tip orifices	4	4
Diameter of nozzle tip orifice	0.28 mm (0.011 in.)	0.30 mm (0.012 in.)
Opening pressure of a new or reconditioned nozzle with new internal parts:		
—For Setting	22 100—22 600 kPa (221—226 bar) (3200—3280 psi)	25 500—26 100 kPa (255—261 bar) (3700—3780 psi)
—For Checking (min.)	21 800 (218 bar) (3160 psi)	25 200 (252 bar) (3660 psi)
Minimum acceptable opening pressure of a used nozzle being checked (min.)	19 850 kPa (198 bar; 2880 psi)	22 950 kPa (230 bar; 3330 psi)
Maximum opening pressure difference between cylinders	700 kPa (7 bar; 100 psi)	700 kPa (7 bar; 100 psi)
Nozzle valve/seat tightness condition at pressure test of 2800—3500 kPa (28—35 bar) (400—500 psi) below opening pressure	Nozzle tip still dry after 5 seconds. (A slight dampness is permissible on used nozzles)	Nozzle tip still dry after 5 seconds. (A slight dampness is permissible on used nozzles)
Return leakage at pressure test of 10 300 kPa (103 bar) (1500 psi) . . .	3—10 drops/30 seconds	3—10 drops/30 seconds
Valve lift (based on zero lift)	1/2 turn counterclockwise	3/4 turn counterclockwise
Fuel Supply Pump:		
Vacuum/Pressure Test	28—41 kPa (0.28—0.41 bar) (4—6 psi)	28—41 kPa (0.28—0.41 bar) (4—6 psi)
Aneroid Pressure Test:		
Lever Lift-Off	76—102 mm Hg (3—4 in. Hg) 10—14 kPa (1.5—2.0 psi)	76—102 mm Hg (3—4 in. Hg) 10—14 kPa (1.5—2.0 psi)
Lever at Full Travel	330—380 mm Hg (13—15 in. Hg) 44—51 kPa (6.4—7.4 psi)	330—380 mm Hg (13—15 in. Hg) 44—51 kPa (6.4—7.4 psi)

S11,3010,LI -19-01NOV95

FUEL SYSTEM SPECIFICATIONS—CONTINUED

TORQUES

Fuel Injection Pumps:
Pump drive gear-to-pump shaft, hex. nut:
Roto Diesel/Lucas CAV (three screw hub) . . . . 30—35 N·m (22—25 lb-ft)
Roto Diesel/Lucas CAV (solid drive shaft) . . . . 85 N·m (63 lb-ft)
Stanadyne (Model DB4) . . . . 195 N·m (145 lb-ft)
Stanadyne (Model DB2):
With 8 mm (0.315 in.) thick retaining nut
(chrome finish) . . . . 60 N·m (45 lb-ft)
With 10 mm (0.393 in.) thick retaining nut
(black finish) . . . . 195 N·m (145 lb-ft)
Stanadyne (Model JDB) . . . . 60 N·m (45 lb-ft)
Stanadyne (Model DM4) . . . . 195 N·m (145 lb-ft)
Injection pump-to-front plate hex-nuts . . . . 27 N·m (20 lb-ft)

Drive gear nut cover plate cap screws . . . . 47 N·m (35 lb-ft)

Fuel lines-to-injection pump and nozzles:
Roto Diesel/Lucas CAV:
With Banjo Fittings . . . . 34 N·m (25 lb-ft)
With Axial Outlet Fittings . . . . 34 N·m (25 lb-ft)
Stanadyne (Model JDB) . . . . 34 N·m (25 lb-ft)
Stanadyne (Models DB2, DB4 and DM4) . . . . 34 N·m (25 lb-ft)

Fuel supply line-to-injection pump . . . . 30 N·m (22 lb-ft)

Fuel return line-to-injection pump . . . . 16 N·m (12 lb-ft)

Pump drive gear access cover . . . . 24 N·m (18 lb-ft)

Injection pump inspection cover plate:
Roto Diesel/Lucas CAV (all models) . . . . 3.5 N·m (2.5 lb-ft) (30 lb-in.)

Drive gear access plate:
Stanadyne (all models) . . . . 2 N·m (1.5 lb-ft) (18 lb-in.)

Shut-off solenoid valve:
Roto Diesel/Lucas CAV (all models) . . . . 15—20 N·m (11—15 lb-ft)

Adjusting screw lock nut for slow and
fast idle speeds . . . . 5 N·m (3.5 lb-ft) (42 lb-in.)

Aneroid bracket-to-injection pump cover . . . . 5 N·m (3.5 lb-ft) (42 lb-in.)

S11,3010,LJ -19-01NOV95

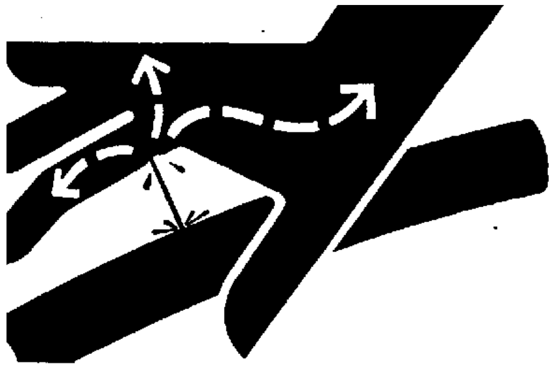
FUEL SYSTEM SPECIFICATIONS—CONTINUED

TORQUES—CONTINUED

Fuel injection nozzles:	
Pressure adjusting screw lock nut	10 N·m (7 lb-ft)
Lock nut of lift adjusting screw	5 N·m (3.5 lb-ft) (42 lb-in.)
Fuel injection nozzle-to-cylinder head	27 N·m (20 lb-ft)
Fuel leak-off hex. nut	5 N·m (3.5 lb-ft) (42 lb-in.)
Fuel supply pump-to-cylinder block	30 N·m (22 lb-ft)
Fuel filter base mounting bracket-to-cylinder head	34—54 N·m (25—40 lb-ft)
Fuel filter mounting base-to-bracket	34 N·m (25 lb-ft)

RG,CTM4,DT440 -19-01NOV95

RELIEVE FUEL SYSTEM PRESSURE



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 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 -19-20JUL95

REPLACE FUEL FILTER

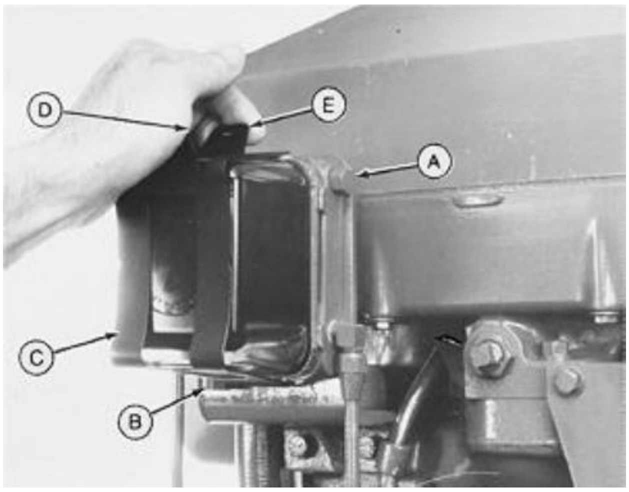
NOTE: Refer to your operator's manual for proper servicing and replacement (hourly) intervals.

1. Close the fuel shut-off valve at bottom of fuel tank.

2. Loosen bleed plug (A). Remove drain plug (B) to drain fuel from filter.

3. Push inward on finger tab (D) and disengage top hook by pulling upward on finger tab (E).

4. Release the top hook of retaining spring (C) and remove spring from filter base. Pull fuel filter off fuel filter body.



RG4888 -UN-14DEC88

A—Bleed Plug
B—Drain Plug
C—Retaining Spring
D—Tab D
E—Tab E

S11,3010,RF -19-21SEP95

Before installing a new filter element, inspect the filter element-to-mounting plate contact locations (broken lines) for cleanliness. This location MUST BE completely void of any dirt or other contaminants. Carefully clean as required.

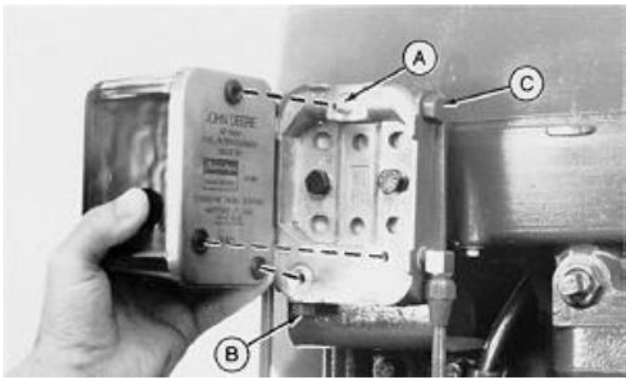
IMPORTANT: Any dirt lodged in the spring pin groove or at the end of the spring pin (A) by cleaning efforts will be washed into the fuel injection system. This may result in severe damage to the fuel injection pump or nozzles.

5. Place filter on filter body with upper seal over spring pin (A) on filter body.

6. Hook bottom end of retaining spring first; then hook the top end.

7. Install drain plug (B) and tighten securely.

8. Open fuel shut-off valve and bleed filters. (See BLEED FUEL SYSTEM in Group 115.)



RG4889 -UN-14DEC88

A—Spring Pin
B—Drain Plug
C—Bleed Plug

S11,3010,RG -19-29JUN95

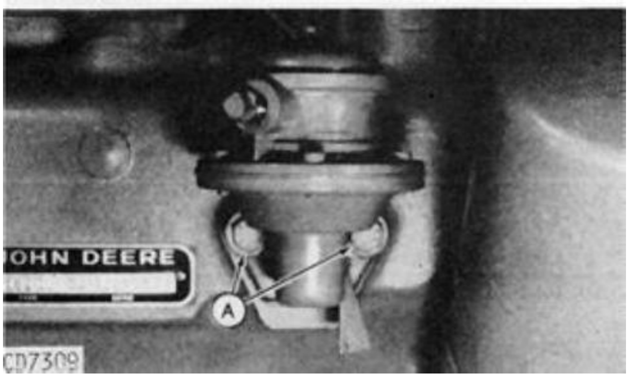
REMOVE FUEL SUPPLY PUMP

IMPORTANT: A backup wrench must always be used when disconnecting fittings or fuel lines from supply pump to avoid damage to fittings.

1. Disconnect fuel lines and cap connections on fuel supply pump and fuel lines to keep debris out of fuel system.

2. Remove cap screws (A) and remove fuel supply pump assembly from cylinder block.

3. Cover opening on cylinder block to prevent dirt from entering the engine.



CD7309 -UN-23FEB89

S11,3010,LL -19-29JUN95

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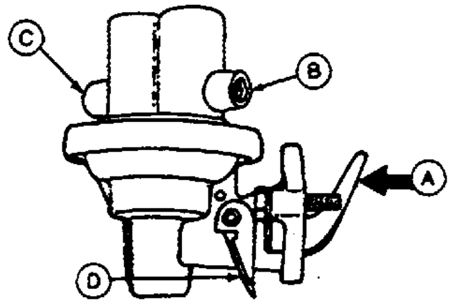
BENCH TEST FUEL SUPPLY PUMP



A—Lever
B—Inlet Side of Pump
C—Outlet Side of Pump
D—Primer Lever

The following bench tests can be performed on a supply pump when it is suspected to be defective. See MEASURE FUEL SUPPLY PUMP PRESSURE—IF EQUIPPED in Group 115.

After completing the Vacuum/Pressure Test and Leakage Test, listed below, either repair or replace pump if it is defective. AC, Sofabex, and Corona pumps have repair kits available. Airtex pumps cannot be repaired.

A. Vacuum/Pressure Test:

NOTE: This test will give a good indication of condition of both the inlet and outlet valves, as well as the diaphragm. The numerical values obtained on both the vacuum and pressure sides are not important; rather it is the needle movement that is important (very slow for a good pump; very fast or not at all for a defective pump).

1. Remove inlet and outlet fittings.

2. Install vacuum/pressure gauge to inlet side of pump (B).

3. Move primer lever (D) all the way upward. Release lever and at the same time observe gauge:

• The gauge needle should read the same value, and then very slowly go back to “0”. This indicates that the inlet valve and diaphragm are in good condition. Proceed to next step.

• If the gauge needle does not move at all, or the needle moves rapidly to “0”, the pump is defective and must be repaired or replaced.

4. Remove vacuum/pressure gauge and install onto outlet side of pump (C).

5. Move priming lever all the way to upward position. Release lever and at same time observe gauge:

• The gauge needle should initially read 28—41 kPa (0.28—0.41 bar) (4—6 psi), then return to “0” very slowly. This indicates that the outlet valve and diaphragm are in good condition. Supply pump is operating properly and should be reinstalled on engine.

• If the gauge needle initially reads the same value as above and then returns immediately back to “0”, the pump is defective and must be repaired or replaced.

S11,3010,OP -19-21SEP95

B. Leakage Test:

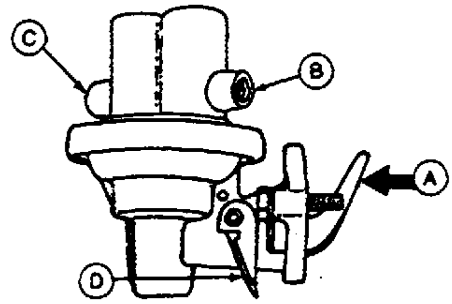
The leakage test should be performed on a supply pump suspected of leaking fuel externally or internally, into the engine crankcase.

1. Install an air line on inlet side of pump (B) and apply 140 kPa (1.4 bar) (20 psi) pressure.

2. Hold finger over outlet side of pump (C) or install a plug. Submerge pump into a container of clean diesel fuel.

• If air bubbles (indicating leakage) occur around banded (Airtex) or screwed connection (AC, Sofabex, or Corona) holding the two halves of pump together, repair or replace pump if leakage is observed.

• If the diaphragm is bad, there will be leakage through vent holes (if equipped) and around the rocker arm. Repair or replace pump as necessary.



A—Lever
B—Inlet Side of Pump
C—Outlet Side of Pump
D—Primer Lever

S11,3010,OS -19-29JUN95

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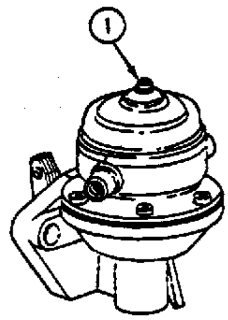
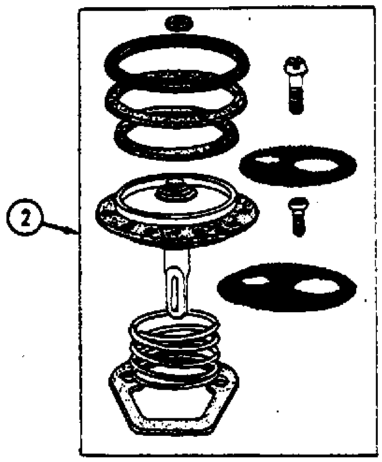
REPAIR "SOFABEX" AND "AC" FUEL SUPPLY PUMPS





CD5788 -UN-11JUL89

1. Remove screw (1) and fuel supply pump cover.

2. Check all parts for serviceability and replace, when necessary.

NOTE: A general repair kit (2) common to both supply pump models is available.

3. Assemble fuel supply pump:

• Make sure that diaphragm is engaged in rocker arm.

• Before installing pump cover, position diaphragm so that it is level by moving rocker arm.

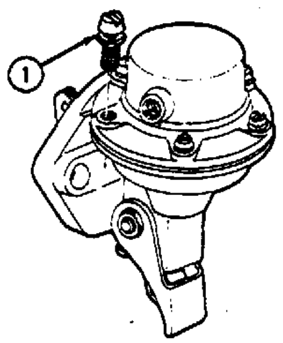
• Holding lever in this position, install pump cover and turn screws in until they just contact the washers.

• Operate the lever several times and then release with a snap to make sure that the diaphragm will not be overstretched when in use.

• Alternately tighten cover screws crosswise.

S11,3010,LM -19-12OCT95

REPAIR "CORONA" FUEL SUPPLY PUMP



CD5789 -UN-23FEB89

1. Remove pump cover attaching screws (1).

2. Mark pump cover and pump body for easier reassembly.

S11,3010,LN -19-12OCT95

3. Press diaphragm on flange side and disconnect it.

CD5790 -UN-23FEB89

K01,0421,04 -19-28MAR83

4. Carefully remove valve plate with filter out of pump cover.

5. Inspect all parts for serviceability. Replace parts as necessary.

CD5791 -UN-23FEB89

K01,0421,05 -19-18JUL89

To Assemble Fuel Supply Pump:

NOTE: A repair kit consisting of parts 1 to 5 is available.

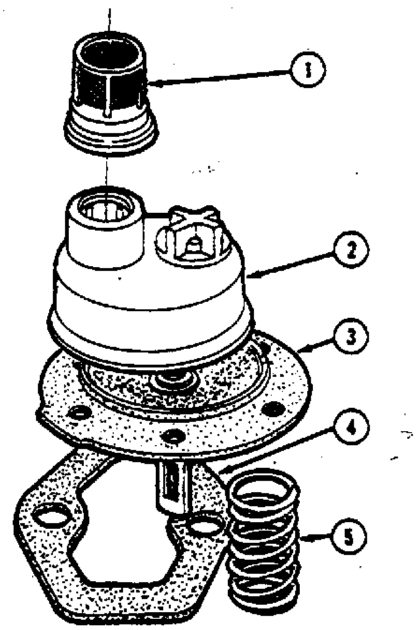
1. Make sure that diaphragm is engaged in rocker arm.

2. Before installing the pump cover, position diaphragm so that it is level by moving rocker arm. Hold lever in this position during assembly.

3. Install pump cover and cover screws. Finger tighten screws so that they just contact the washers.

4. Operate rocker arm several times, then release with a "SNAP" to make sure that diaphragm will not be overstretched when in use.

5. Alternately tighten cover screws crosswise.

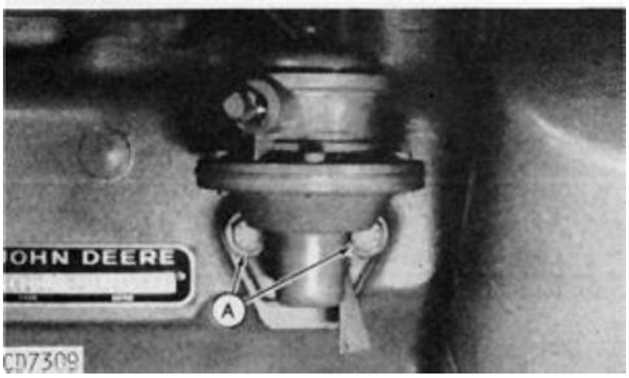


CD5792 -UN-23FEB89

1—Filter
2—Valve Plate
3—Diaphragm
4—Gasket
5—Spring

K01,0421,06 -19-14JUL95

INSTALL FUEL SUPPLY PUMP



CD7309 -UN-23FEB89

IMPORTANT: Apply LOCTITE 242 Thread Lock and Sealer (TY9370) to cap screw threads and fuel line fittings when reinstalling supply pump. DO NOT allow sealant to get into fuel system.

1. Install the fuel supply pump to cylinder block using a new gasket. Tighten cap screws (A) to 30 N·m (22 lb-ft).

IMPORTANT: ALWAYS use a backup wrench when installing fittings and/or fuel lines onto supply pump to avoid damage to fittings.

2. Remove plugs and connect fuel lines. Tighten securely.

3. Bleed fuel system. (See BLEED THE FUEL SYSTEM in Group 115.)

S11,3010,LR -19-21SEP95

FUEL INJECTION PUMP TIMING

Fuel injection pumps on John Deere Diesel Engines are timed one of two ways at the factory:

—By Static Timing, which is accomplished by the alignment of internal pump timing marks (cam ring-to-governor weight retainer) and/or the alignment of injection pump flange-to-front plate timing marks.

—By Dynamic Timing, which involves a sensor installed within the No. 1 fuel line and connected to a pulse-activated timing meter to determine precisely at what point injection occurs. Another form of dynamic timing employs the use of a timing light along with a fixed reference mark on engine block and a timing mark on crankshaft damper or pulley which aligns with fixed reference mark when light flashes.

Both types of timing are covered in this manual. Dynamic timing the engine is the preferred method. However, on some applications, dynamic timing values are not available and the engine must be static timed.

S55,3010,BR -19-28SEP95

FUEL INJECTION PUMP—GENERAL INFORMATION

Engine will be equipped with one of the following pumps:

—Stanadyne DM4, JDB, DB2, DB4 or

—Roto Diesel/Lucas CAV

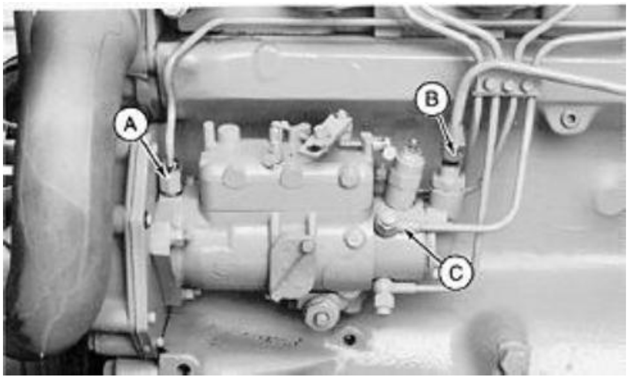
On JDB and some DB2 fuel injection pumps, the pump drive shaft is a non-retained drive shaft. The shaft stays in the engine.

On DB4, some DB2's, DM4 and Roto Diesel/Lucas CAV pumps, the pump has a retained drive shaft. The shaft stays with the pump. DB2 pumps with retained drive shafts are identified with a label on the pump mounting flange that reads "TOOL REQUIRED FOR REMOVAL—SEE OPERATOR'S MANUAL."

Refer to the appropriate service procedures in this group.

RG,CTM4,DX397 -19-21SEP95

REMOVE ROTO DIESEL/LUCAS CAV FUEL INJECTION PUMP



CD6375 -UN-11JUL89

IMPORTANT: NEVER steam clean or pour cold water on a fuel injection pump while it is running or while the pump is warm. Doing so may cause seizure of internal rotating pump parts.

1. Clean the fuel injection pump, lines and area around the pump with cleaning solvent or a steam cleaner.

2. Disconnect shut-off cable and speed control linkage, if equipped. Disconnect electrical connection to shut-off solenoid or throttle positioning solenoid, if equipped. Tag electrical wires for correct reassembly.

3. Disconnect fuel return line (A) and fuel supply line (B).

NOTE: On early injection pumps the injection lines (with banjo fittings, shown) are secured to the pump with hex fitting assemblies called pressurizing valves. Current injection pumps have pressurizing valves installed in the pump head with axial outlet fittings for easier assembly and improved joint sealing.

IMPORTANT: On current injection pumps with axial outlet fittings, use a back-up wrench when removing fuel lines to prevent possible leaks upon reassembly.

4. Disconnect fuel injection lines (C).

5. Cap or plug all open connections on pump and fuel lines. Do not use fibrous material.

S11,3010,LS -19-14JUL95

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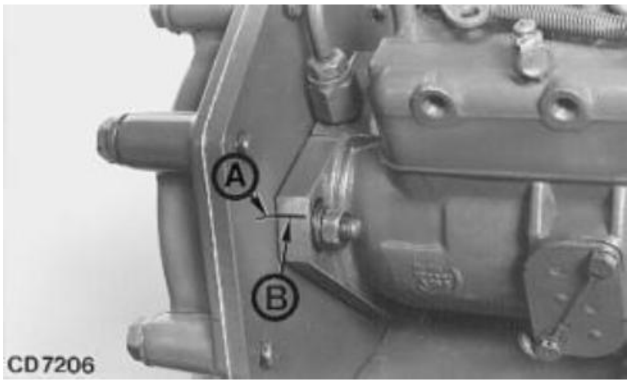
IMPORTANT: Check to make sure that timing marks are scribed on engine front plate (A) and injection pump flange (B). Exact alignment of these timing marks will assure correct injection pump-to-valve train timing when pump is reinstalled on engine.

If timing mark is not clearly visible on front plate, scribe a visible reference mark as accurately as possible in-line with mark on pump flange.



CD7206 -UN-23MAY95

S11,3010,LS1 -19-29JUN95

6. Remove injection pump drive gear cover (shown removed).

• On Pumps With Three Cap Screws On Drive Hub:

Remove the three cap screws which secure fuel injection pump drive gear to pump shaft.

Remove the three hex nuts securing pump to engine front plate and lift out fuel injection pump.

• On Pumps With Solid Drive Shaft:

Remove drive gear retaining nut (A) and washer from end of pump shaft. Be careful not to let washer fall inside timing gear cover.

T95246 -UN-01NOV88

RG,CTM4,DX398 -19-21SEP95

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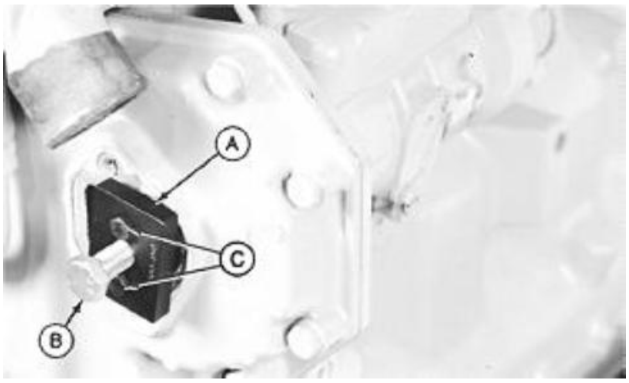


RG6294 -UN-22JUL92

Using JDG670A Drive Gear Puller:

1. If injection pump drive gear has two holes, JDG670A Drive Gear Puller (A) may be attached to drive gear as shown. Follow instructions provided with tool set.

NOTE: Replace 6 mm, Grade 12.9 cap screws (C) as needed.

2. Evenly tighten the two 6 mm, Grade 12.9 cap screws (threaded in drive gear) and snugly tighten center forcing screw (B) against end of pump shaft.

IMPORTANT: On engines equipped with crankshaft gear-driven auxiliary drive options, DO NOT remove puller from gear after pump shaft is free from gear. The drive gear will move inside timing gear cover and may become disengaged from camshaft gear causing the gear to be one or more teeth out of time.

Once gear is free from shaft, remove center forcing screw from puller and tighten the two 6 mm screws into gear on puller until gear is pulled against timing gear cover. Leave puller attached until injection pump is reinstalled on engine.

3. Tighten center forcing screw until pump drive gear is free from tapered shaft. Remove JDG670A Puller and screws from drive gear.

4. Remove injection pump mounting studs. Remove injection pump from mounting studs.

RG,CTM4,DT441 -19-21SEP95

Using JDG535 (or KJD10108) Injection Pump Removal Tool:

1. Attach JDG535 (or KJD10108) Injection Pump Removal Tool to timing gear cover. Loosen the three nuts (attaching fuel injection pump to engine front plate) several turns to permit shaft separation from drive gear.

NOTE: If the three pump-to-front plate nuts are removed before pump shaft is loosened from gear, pump will fall to the floor when unassisted.

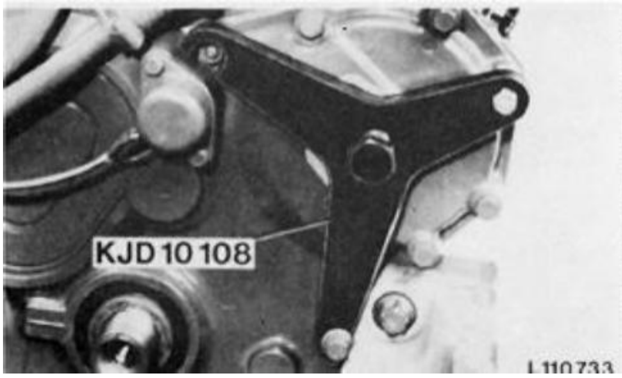
2. Turn cap screw of special tool clockwise until pump shaft is loosened from conical seat of drive gear.

3. If pump shaft cannot be removed from conical seat of drive gear, then use a brass drift and strike engine front plate several blows as shown.

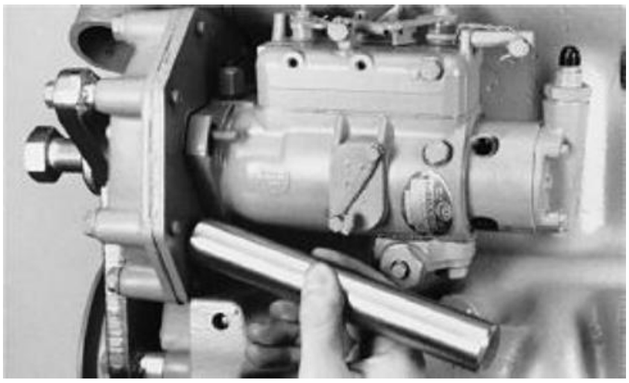
4. Remove mounting nuts and withdraw the injection pump backward from the three studs. Place pump on a clean flat surface.

NOTE: When removing fuel injection pump be careful not to lose pump shaft Woodruff Key.

5. Remove JDG535 (or KJD10108) Injection Pump Removal Tool from timing gear cover. Remove injection pump.



L110733 -UN-20DEC88



RG4821 -UN-14DEC88

RG,CTM4,DX399 -19-25SEP95

REPAIR ROTO DIESEL/LUCAS CAV FUEL INJECTION PUMP

IMPORTANT: DO NOT disassemble the Roto Diesel/Lucas CAV fuel injection pump further than necessary for installing available service parts, not even for cleaning.

1. Have an authorized ADS Diesel Repair Station perform all injection pump testing, adjustments and repairs.

S11,3010,LW -19-29JUN95

INSTALL ROTO DIESEL/LUCAS CAV FUEL INJECTION PUMP

Roto Diesel/Lucas CAV Injection Pumps used on Saran-built 3179 Engines only, are timed at beginning of injection (13—19° before top dead center). Time the pump by aligning mark on pump flange with mark on front plate.

IMPORTANT: If the injection pump drive gear was removed from engine, it must be timed when reinstalled. (See INSTALL AND TIME CAMSHAFT AND FUEL INJECTION PUMP in Group 16.)

• On Pumps With Three Cap Screws On Drive Hub:

1. Put a new gasket on pump housing and position pump drive hub into drive gear. Make sure that dowel pin in gear fits into slot in pump drive hub.

2. Secure gear onto pump hub with cap screws and tighten to 30—35 N·m (22—25 lb-ft).

• On Pumps With Solid Drive Shaft:

NOTE: Make sure that Woodruff key is properly installed in pump drive shaft. Key MUST fit tightly in keyway.

3. Guide pump drive shaft into bore of drive gear. Tighten drive gear hex nut (A) to 85 N·m (63 lb-ft).

S11,3010,LX -19-21SEP95

Injection pump internal timing marks must be in same position as when pump was removed.

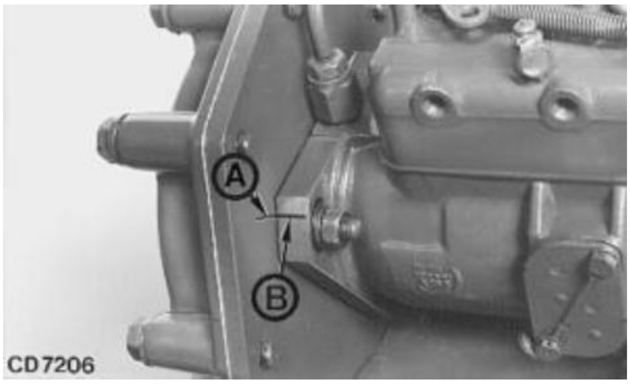
• On Both Pump Types:

4. Install hex nuts and washers on the three studs, but do not tighten at this time.

NOTE: If the front plate was replaced, no timing mark will be found on the new plate. (See REPLACE ENGINE FRONT PLATE and TRANSFER INJECTION PUMP TIMING MARK ONTO REPLACEMENT FRONT PLATE later in this group.) A mark must be scribed on plate based on engine and injection pump timing. If timing mark can not be transferred from original front plate, see TIMING ROTO DIESEL/LUCAS CAV INJECTION PUMP WHEN NEW SERVICE FRONT PLATE HAS BEEN INSTALLED later in this group.

5. Pivot pump housing first away from cylinder block as far as slots will allow. Then pivot it back again, but only far enough to align timing mark on the pump flange (B) exactly with timing mark on the cylinder block front plate (A).

6. Tighten the three hex nuts securing the pump to the front plate to 27 N·m (20 lb-ft).



CD7206 -UN-23MAY95

S11,3010,LY -19-21SEP95

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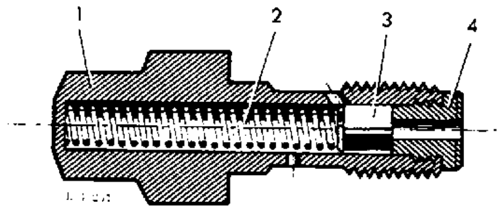
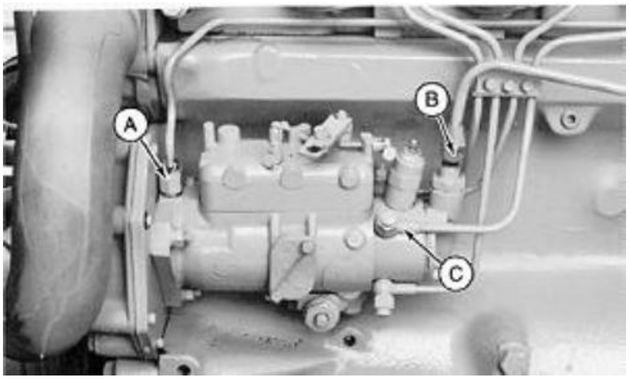
NOTE: On early injection pumps pressurizing valves are only available as an assembly. DO NOT try to disassemble or repair valves, ALWAYS replace if condition is questionable.

Current injection pumps have pressurizing valves with axial outlet fittings installed in the pump head as an assembly. DO NOT service pressurizing valves, have the pump serviced as an assembly by an authorized diesel repair station.





1—Valve Body
2—Valve Spring
3—Valve Piston
4—Valve Seat

7. On early injection pumps with banjo fittings, inspect pressurizing valves and replace if they are not functioning properly.

NOTE: Outlets on the fuel injection pump head to which the pressure lines connect are identified by letters stamped on pump head.

For 3-cylinder engine, U, Y and W are used in relation to cylinders 1, 2 and 3.

For the 4-cylinder engine, V, U, X and W are used in relation to cylinders 1, 3, 4 and 2.

For 6-cylinder engine, V, U, Z, Y, X and W are used in relation to cylinders 1, 5, 3, 6, 2 and 4.

8. On early injection pumps with banjo connections, connect fuel injection lines (C) to the pump. Use new sealing washers (one on each side of banjo) and install pressurizing valves. Tighten valves to 34 N·m (25 lb-ft).

9. On current injection pumps with axial outlet fittings, connect fuel injection lines to fittings. Hold fittings stationary with a back-up wrench and tighten line connection to 34 N·m (25 lb-ft).

10. Connect fuel return line (A) and fuel supply line (B) to pump.

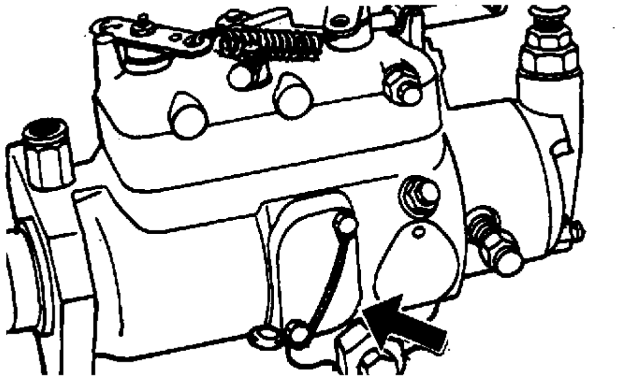
11. Connect shut-off cable (or wiring lead) and speed control rod to pump, however equipped.

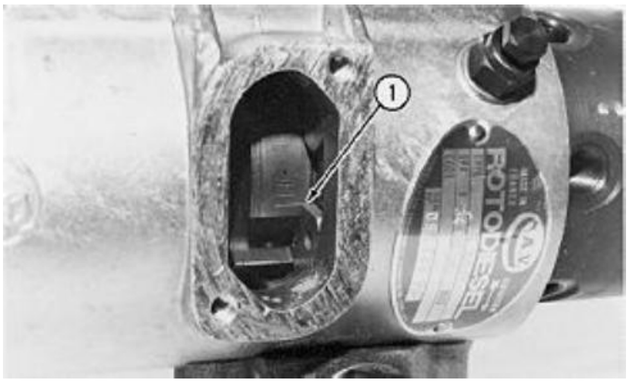
12. Install injection pump drive gear nut cover plate using a new gasket on timing gear cover. Tighten cap screws to 47 N·m (35 lb-ft).

13. Bleed the fuel system as outlined earlier in Group 115.

S11,3010,LZ -19-29JUN95

TIMING ROTO DIESEL/LUCAS CAV INJECTION PUMP WHEN NEW SERVICE FRONT PLATE HAS BEEN INSTALLED


RG4822 -UN-14DEC88



CD5531 -UN-11JUL89

A new front plate (obtained through service parts) does not have a timing mark. However, a new injection pump will have the timing mark scribed on pump flange.

Roto Diesel/Lucas CAV injection pump timing is established for beginning of injection—not TDC. Use the following procedure only when injection pump timing mark cannot be transferred from original front plate or when you suspect that the original timing mark was incorrect.

IMPORTANT: To check pump internal timing, the sealing wire and inspection cover plate (bold arrow) must be removed from side of pump. If the injection pump is under warranty, contact an authorized Roto Diesel/Lucas CAV repair station about how to get the pump timed.

1. Check pump internal timing (beginning of injection), using following procedure:

• With injection pump removed from engine, connect a nozzle tester to “U” outlet on pump head for 3-cylinder engines and “V” outlet on 4 and 6-cylinder engines.

• Remove inspection cover plate from side of pump housing.

• Pump handle on nozzle tester to obtain approximately 3000 kPa (30 bar) (430 psi) pressure.

• Rotate pump shaft in direction of normal rotation until resistance is felt. In this position the straight edge of the snap ring (1) that can be seen through the inspection hole should be in line with the scribed mark adjacent to letter:

—“F” on 3-cylinder engines.
—“A” (or “C” on some applications) on 4-cylinder engines.
—“H” on 6-cylinder engines.

If mark and edge of snap ring are not aligned, see your authorized Roto Diesel/Lucas CAV repair station for service.

• Disconnect nozzle tester.

S11,3010,MA -19-29JUN95

2. Time Engine For Beginning Of Injection:


RG4823 -UN-14DEC88

• Rotate engine until No. 1 piston is at TDC of compression stroke.

• Remove No. 1 injection nozzle.

• Insert a 6466 engine valve into injection nozzle bore of cylinder head until valve contacts top of piston.

• Attach a dial indicator so that the indicator tip rests on valve head. Set dial indicator at 0.00 mm (in.).

• Rotate crankshaft opposite of running direction (clockwise, viewed from flywheel end) to bring valve 6.0 mm (0.20 in.) BTDC. This is necessary to eliminate timing gear backlash as crankshaft is rotated in running direction (next step).

• Slowly rotate crankshaft in normal running direction (counterclockwise, viewed from flywheel end) until dial indicator needle registers the specified piston stroke dimension——No. 1 piston at beginning of injection. Beginning of injection in degrees BTDC is equal to the following piston stroke movement:

13°—1.83 mm (0.072 in.) piston stroke
15°—2.43 mm (0.095 in.) piston stroke
17°—3.12 mm (0.123 in.) piston stroke
19°—3.88 mm (0.153 in.) piston stroke

NOTE: Engine timing (beginning of injection) varies with model and application. (See FUEL INJECTION PUMP SPECIFICATIONS at the beginning of this group.)

S11,3010,MC -19-28SEP95

3. With both the engine and injection pump timed (Steps 1 and 2), install pump on engine. (See INSTALL ROTO DIESEL/LUCAS CAV FUEL INJECTION PUMP earlier in this group.) Leave nuts loose at this time.

4. Pivot pump toward cylinder block as far as slots will allow. Then, slowly pivot pump away from block until snap ring is aligned with correct letter-designated scribe mark (inside pump) for the specific engine model and application.

5. Tighten pump-to-front plate hex nuts to 27 N·m (20 lb-ft).

6. Scribe a mark on front plate in alignment with mark on pump housing flange.

7. Install inspection cover plate on injection pump using a new gasket. Tighten cap screws to 3.5 N·m (2.5 lb-ft) (30 lb-in.).

NOTE: If pump is under warranty and approval (by the authorized repair station) was given to remove the original sealing wire, a new sealing wire must be installed. Contact your authorized Roto Diesel/Lucas CAV repair station for instructions.

8. Remove dial indicator and valve from No. 1 injection nozzle bore. Install injection nozzle in cylinder head.

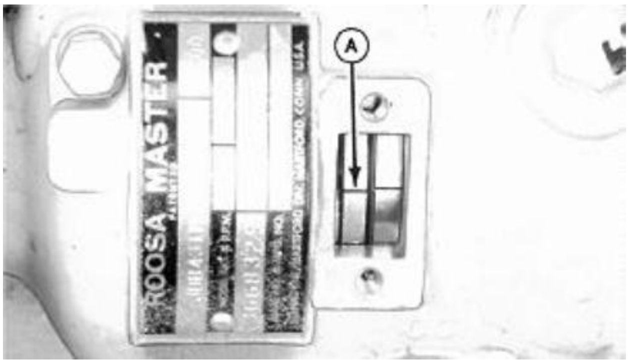
9. Complete installation of pump following instructions previously given.

10. Bleed air from system and check all connections for leaks. (See BLEED FUEL SYSTEM in Group 115.)

11. Start engine, run for several minutes and check entire fuel system for leaks.

RG,CTM4,DY102 -19-01NOV95

REMOVE STANADYNE INJECTION PUMP—MODEL JDB AND DB2 WITH NON-RETAINED DRIVE SHAFT



T87483 -UN-09NOV88

IMPORTANT: Never steam clean or pour cold water on a fuel injection pump while the pump is running or while it is warm. Doing so may cause seizure to internal rotating pump parts.

1. Clean the fuel injection pump, lines and area around the pump with cleaning solvent or a steam cleaner.

2. Use appropriate flywheel turning tool to rotate crankshaft to position No. 1 piston at TDC on compression stroke. On JDB and early DB2 pumps, the timing marks on governor weight retainer and cam ring must align (A). At this position, timing pin should enter hole in flywheel to lock engine at TDC.

On later DB2 pumps, if timing mark is not clearly visible on front plate, scribe a visible reference timing mark as accurately as possible in-line with mark on pump flange. Use this mark for timing pump when reinstalled on engine.

NOTE: The injection pump can be removed without engine being at No. 1 TDC. However, setting engine at No.1 "TDC" aids pump installation if the pump position is not changed.

S11,3010,MF -19-29JUN95

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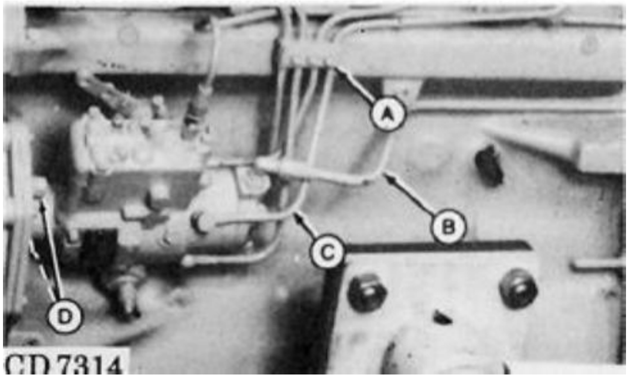


CD7314 -UN-23FEB89

3. Disconnect speed control rod.

4. Disconnect fuel return line and fuel supply line (B).

5. Disconnect fuel injection lines (C) and clamp (A).

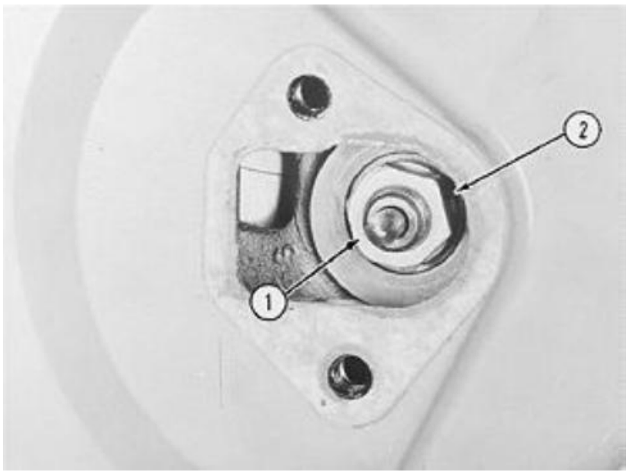
6. Plug all open connections on pump and fuel lines. Do not use fibrous material.

7. Remove pump mounting nuts (D). Pull pump away from mounting plate in a straight line. Injection pump drive gear and shaft will stay in the engine.

A—Clamp
B—Fuel Supply Line
C—Fuel Injection Line
D—Pump Mounting Nuts

S11,3010,MG -19-21SEP95

REMOVE STANADYNE MODEL JDB AND DB2 INJECTION PUMP WITH NON-RETAINED DRIVE SHAFT FROM ENGINE



T53575 -UN-23FEB89

Some authorized Stanadyne repair stations require the drive shaft to accompany the injection pump when pump is serviced. Otherwise, it is not necessary to remove the drive shaft, unless shaft is broken, worn, or damaged.

1. Remove injection pump as described earlier in this group.

2. Remove injection pump gear cover plate from timing gear cover (shown removed).

3. Remove thrust pin (1) and thrust spring.

4. Remove nut (2) and washer from drive shaft.

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S11,3010,MH -19-29JUN95

5. Install JD303 Injection Pump Shaft Removal Tool on timing gear cover. Evenly tighten attaching screws securely.

IMPORTANT: DO NOT overtighten center cap screw, damage may occur to timing gear cover.

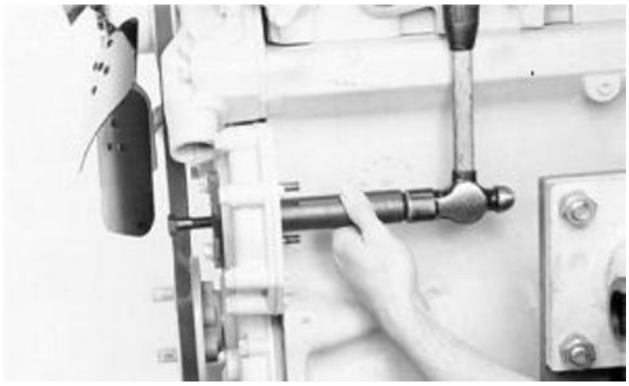
6. Turn center cap screw clockwise against injection pump drive shaft until drive gear is held firmly against the front plate.

T81889 -UN-01NOV88

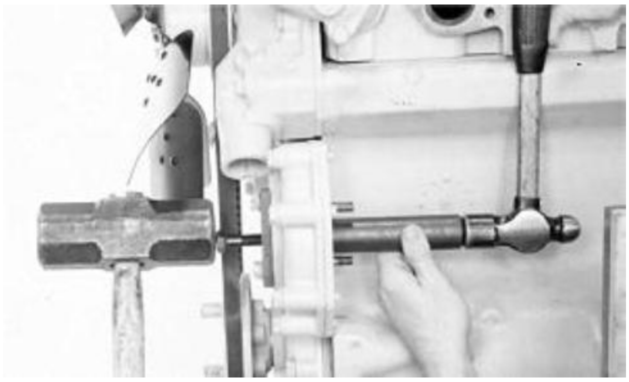
S11,3010,MI -19-29JUN95

7. Using a suitable tubular-type driver (one that will go over shaft and against drive gear) and a hammer, drive gear off shaft. Be careful not to lose Woodruff key in pump shaft.

NOTE: Pump shaft is tapered. It may be necessary to have an assistant hold a heavy hammer against the head of JD303 Shaft Removal Tool's center forcing screw while striking the gear. If shaft still does not come loose from gear, it may be necessary to remove the timing gear cover (Group 16) and press shaft out of gear.



T81894 -UN-01NOV88



T81895 -UN-01NOV88

S11,3010,MJ -19-29JUN95

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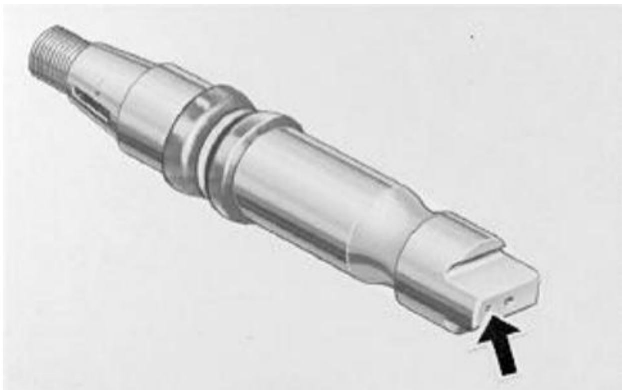
REPAIR STANADYNE MODEL JDB AND DB2 FUEL INJECTION PUMP WITH NON-RETAINED DRIVE SHAFT

IMPORTANT: Do not disassemble the fuel injection pump any further than necessary to install available service parts—not even for cleaning.

For injection pump repair and testing, have an authorized diesel injection repair station perform the work.

S11,3010,MK -19-29JUN95

INSTALL NON-RETAINED DRIVE SHAFT IN STANADYNE MODEL JDB AND DB2 INJECTION PUMP (IF REMOVED FROM ENGINE)

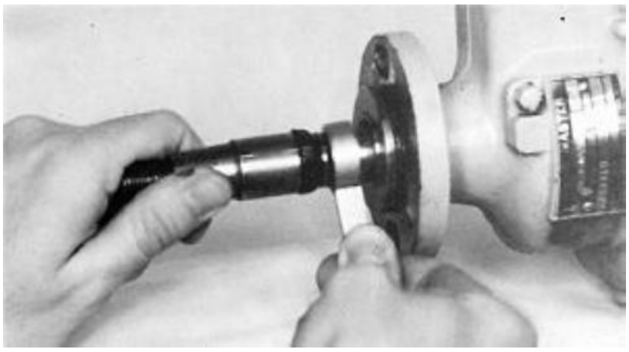


T71440 -UN-23FEB89

1. Apply a light coating of clean engine oil or grease to new seals for pump drive shaft. Install seals on shaft.

2. Before installing the drive shaft, find the small drilled hole off-center on the drive shaft tang. There is a similar drilled hole in the distributor rotor in the injection pump. The shaft must be installed in the injection pump so the two drilled holes are aligned.

S11,3010,ML -19-29JUN95



T82265 -UN-31OCT88

IMPORTANT: Do not invert drive shaft seal lips. If resistance is felt, stop and inspect position of seal. If seal has been forced back, replace seal.

3. Compress seal with JD256 Injection Pump Drive Shaft Seal Installing Tool as the shaft is installed.

S11,3010,MM -19-29JUN95

INSTALL STANADYNE MODEL JDB AND DB2 INJECTION PUMP WITH NON-RETAINED DRIVE SHAFT

Time Stanadyne JDB and early DB2 injection pumps by locking No. 1 cylinder at TDC Compression stroke, and align timing mark on pump cam ring with mark on governor weight retainer. Current DB2 injection pumps are timed by locking No. 1 cylinder at TDC of its compression stroke and align timing marks on pump mounting flange with reference mark on front plate. ALWAYS check for reference timing marks on pump mounting flange and front plate first. If no marks are found, pump should be timed by referencing internal marks.

IMPORTANT: If the injection pump drive gear was removed from engine, it must be timed when reinstalled. (See INSTALL AND TIME CAMSHAFT AND FUEL INJECTION PUMP in Group 16.)

1. Make sure that No. 1 piston is at TDC on compression stroke.

2. If drive shaft was not removed from drive gear, install a new shaft seal and lubricate seal with a light coating of engine oil or grease.

3. If drive shaft was removed from drive gear, make sure Woodruff key is installed in pump shaft and that it is not loose in shaft keyway.

Replace pump drive shaft and/or Woodruff Key as necessary.

NOTE: Install a new O-ring (lubricate with engine oil) on front face of pump.

S11,3010,MN -19-21SEP95

4. Turn injection pump rotor until timing marks (A) are aligned.

5. Install pump onto engine front plate.

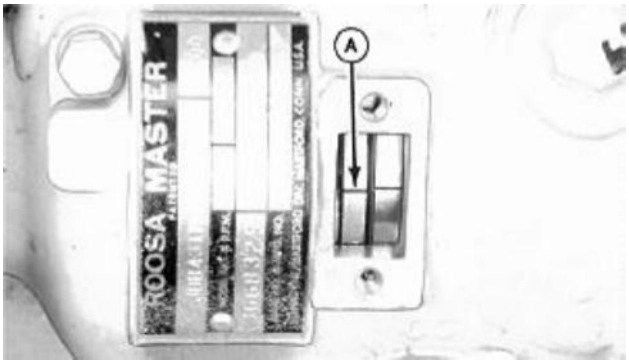
• On pumps where drive shaft has remained in drive gear:

6. Lubricate two new shaft seals with a light coating of clean engine oil or grease and install.

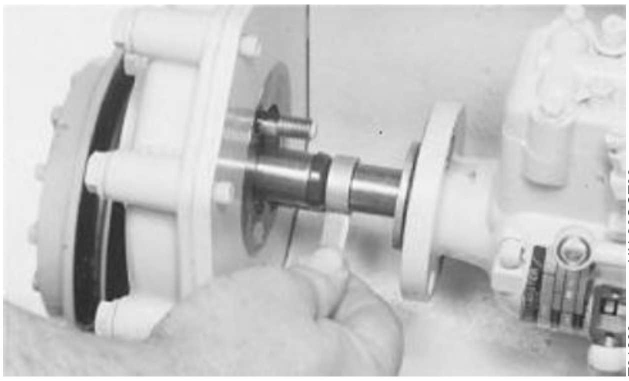
NOTE: Lubricate a new O-ring with clean engine oil and install on front face of injection pump mounting flange.

IMPORTANT: Do not invert drive shaft seal lips. If resistance is felt, stop and inspect position of seals. If either seal has been forced back, install a new seal.

7. Compress seals with JD256 Shaft Seal Installation Tool and install pump over shaft and position hub onto mounting studs.



T87483 -UN-09NOV88



T91283 -UN-20OCT88

S11,3010,MO -19-21SEP95

• On pumps where drive shaft is installed in pump:

Make sure Woodruff key is installed in pump shaft and that it is not loose in keyway. Replace pump drive shaft and/or keyway as necessary.

IMPORTANT: Do not drop Woodruff key, shaft nut, or washer into timing gear cover while installing injection pump. Retain shaft in gear with nut and washer.

8. Lubricate a new O-ring with clean engine oil. Install O-ring onto front face of pump mounting flange. Slide injection pump onto mounting studs while inserting pump shaft and key into drive gear keyway.

9. Install three hex nuts onto pump mounting studs and tighten finger-tight only at this time.

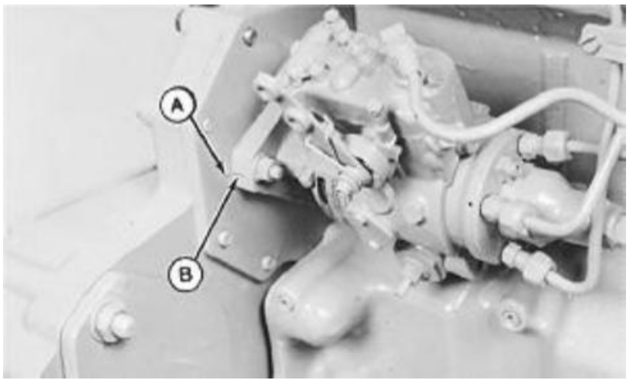
10. Tighten drive gear-to-shaft hex nut (A) to 60 N·m (45 lb-ft). Install drive gear access plate using a new gasket, apply LOCTITE 242 to cap screw threads and tighten to 2 N·m (1.5 lb-ft) (18 lb-in.).

T95246 -UN-01NOV88

RG,CTM4,DX400 -19-01NOV95

11. Align timing mark on the pump flange (B) exactly with timing mark on the cylinder block front plate (A).

12. Install and tighten three hex nuts securing the pump to the front plate to 27 N·m (20 lb-ft).



RG6278 -UN-22JUL92

RG,CTM4,DX401 -19-21SEP95

13. Connect injection pump pressure lines. Beginning with outlet (B) and continue around the pump head in counterclockwise direction, attaching lines in same order as engine firing (1-5-3-6-2-4 on 6-cylinder engines and 1-3-4-2 on 4-cylinder engines).

14. Tighten fuel delivery (pressure) lines at pump to 34 N·m (25 lb-ft), using a suitable 17 mm deep-well socket.

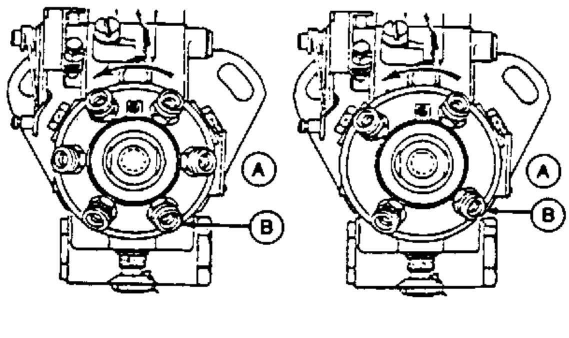
IMPORTANT: ALWAYS use a backup wrench when loosening or tightening fuel delivery lines at fuel injection pump, so that the pump discharge fittings are not altered. This prevents possible internal pump damage.

15. Connect fuel supply line and fuel return line.

16. Connect fuel shut-off cable and speed control linkage, if equipped. Install and securely tighten electrical connections to shut-off solenoid and throttle positioning solenoid, if equipped.

17. Install timing hole cover plate on pump, using a new gasket. Apply LOCTITE 242 to cap screw threads and tighten to 2 N·m (18 lb-in.).

18. Bleed air from fuel system as outlined in Group 115. Start engine, run for several minutes and check entire fuel system for leaks.



6-Cylinder *4-Cylinder*

RG5565 -UN-12APR90

A—Engine Block Side
B—Outlet Connection to No. 1 Connection

RG,CTM4,DX402 -19-09OCT95

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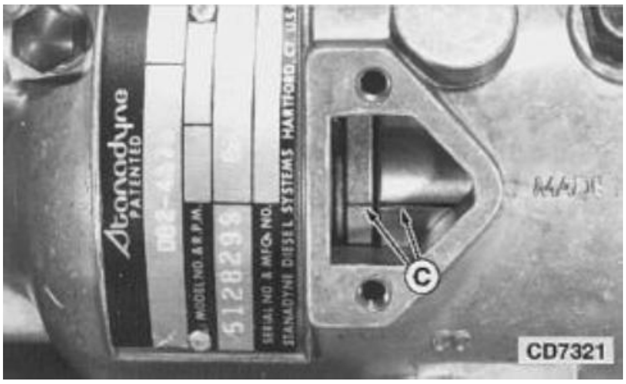
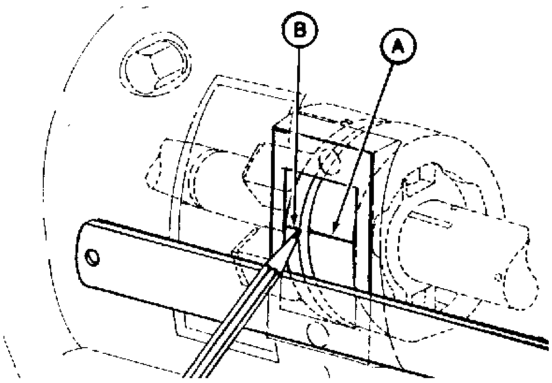
33

REMOVE STANADYNE MODEL DB2 (WITH RETAINED DRIVE SHAFT) AND DB4 INJECTION PUMP



CD7321 -UN-23MAY95



RG4824 -UN-11JUL95

Stanadyne DB2 injection pumps will have either a non-retained drive shaft (shaft stays in engine when pump is removed) or a retained drive shaft (shaft stays in the pump when pump is removed from engine). All Stanadyne DB4 injection pumps have retained drive shafts.

IMPORTANT: Never steam clean or pour cold water on a fuel injection pump while the pump is running or while it is warm. Doing so may cause seizure of internal rotating pump parts.

1. Clean the fuel injection pump, lines and area around the pump with cleaning solvent or a steam cleaner.

NOTE: The injection pump can be removed without engine being at No. 1 TDC. However, setting the engine at No. 1 TDC aids installation if the pump position is not changed.

2. Use appropriate flywheel turning tool to rotate crankshaft to position No. 1 piston at TDC on compression stroke.

If the engine front plate is not being replaced, proceed to Step 4.

3. If the engine front plate is to be replaced, remove timing hole cover plate from side of pump housing.

Check timing marks (C). If there is a mark on cam ring (rear mark) and governor weight retainer (front mark) proceed with disassembly.

If there is no mark on the weight retainer, scribe a mark on weight retainer (B) directly in line with mark on cam ring (A).

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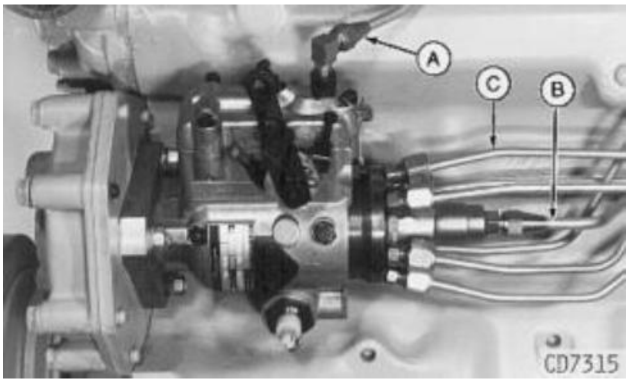
S11,3010,MQ -19-21SEP95

4. Disconnect shut-off cable and speed control rod.

5. Disconnect fuel return line (A).

6. Disconnect fuel supply line (B).

7. Disconnect fuel pressure lines (C), using a suitable 17 mm deep-well crowsfoot socket.



CD7315 -UN-23MAY95

S11,3010,MS -19-21SEP95

8. Remove cover plate from timing gear cover (shown removed).

9. Remove hex nut and washer securing pump drive gear to pump shaft (A). Be careful not to drop nut and washer inside engine.

JDG535 or KJD10108 Injection Pump Removal Tool should be used to remove injection pump drive gear from tapered shaft on early Stanadyne DB2 (with retained drive shaft) pumps. DB2 pumps have 2 holes in drive gear and JDG670A should be used.

JDG670A Injection Pump Drive Gear Puller should be used for all DB4 pumps.

• Using JDG535 or KJD10108 Injection Pump Removal Tool:

10. Attach special tool JDG535 or KJD10108 to timing gear cover.

11. Loosen the three hex nuts (securing pump to engine front plate) several turns to permit shaft/gear separation. If nuts are removed prior to separation, pump will fall to floor when unassisted.

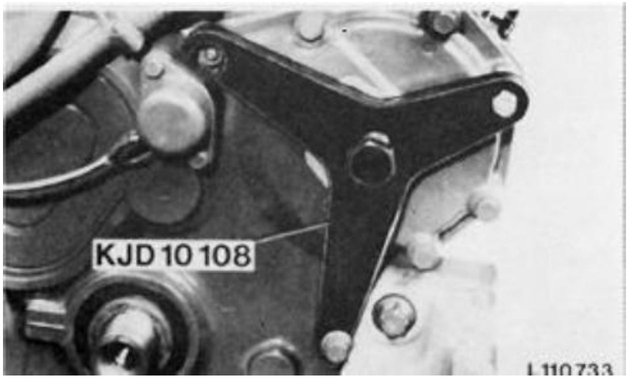
12. Turn cap screw of special tool clockwise until pump shaft is loosened from tapered bore of drive gear.

NOTE: If pump shaft cannot be removed from tapered bore of drive gear, strike engine front plate several blows with a brass drift and hammer.

13. Remove nuts and withdraw pump from the three mounting studs. Be careful not to lose the Woodruff key in pump shaft.

14. Remove special tool JDG535 or KJD10108. Plug or cap all openings in pump.

T95246 -UN-01NOV88



L110733 -UN-20DEC88

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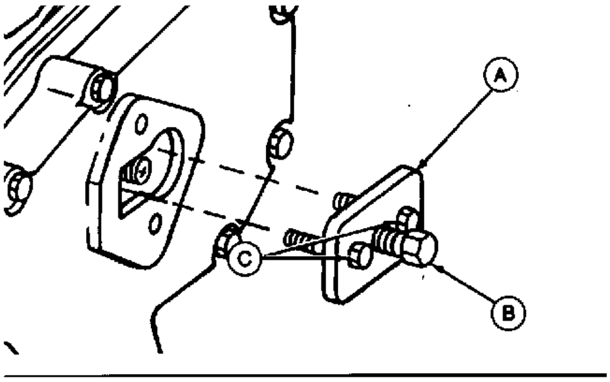
S11,3010,MT -19-21SEP95

• Using JDG670A Injection Pump Drive Gear Puller:



1. Attach JDG670A Drive Gear Puller (A) to injection pump drive gear as shown.

NOTE: Replace 6 mm Grade 12.9 cap screws (C) as needed.

2. Evenly tighten the two 6 mm, Grade 12.9 screws (threaded in drive gear) and snugly tighten center forcing screw (B) against end of pump shaft.

IMPORTANT: On engines equipped with crankshaft gear-driven auxiliary drive options, DO NOT remove puller from gear after pump shaft is free from gear. The drive gear will move inside timing gear cover and may become disengaged from camshaft gear causing the gear to be one or more teeth out of time.

Once gear is free from shaft, remove center forcing screw from puller and tighten the two 6 mm screws into gear on puller until gear is pulled against timing gear cover. Leave puller attached until injection pump is reinstalled on engine.

3. Tighten center forcing screw until pump drive gear is free from tapered shaft. Remove JDG670A Puller and screws from drive gear.

RG,CTM4,DT442 -19-14JUL95

INSPECT INJECTION PUMP DRIVE GEAR I.D. AND SHAFT O.D.

IMPORTANT: Use a good light source to thoroughly inspect gear I.D. and shaft O.D.

1. Inspect injection pump drive gear I.D. full 360° for metal transfer as a result of slippage on shaft.

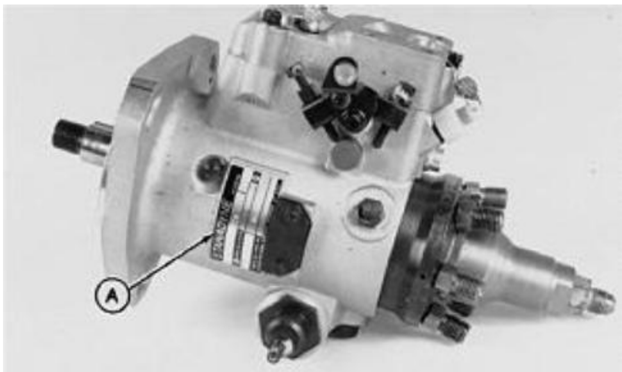
2. Inspect injection pump drive shaft O.D. full 360° for presence of metal transfer from gear slippage. Also, check to see if index pin in shaft is not damaged, indicating gear slippage.

If there is clear evidence of metal transfer on pump shaft O.D., in drive gear I.D., or if index pin in pump shaft is damaged, injection pump and drive gear MUST BE replaced.

IMPORTANT: When replacing injection pump drive gear or installing a new pump, the tapered surfaces of the pump drive shaft O.D. and drive gear I.D. MUST BE cleaned to remove protective coatings and oily residue. Use a suitable cleaner that does not leave a residue. Mating surfaces MUST BE ASSEMBLED DRY and LUBRICANTS MUST NOT BE USED.

RG,CTM8,G35,R14-19-21AUG92

REPAIR STANADYNE FUEL INJECTION PUMP



RG5724 -UN-12APR91

IMPORTANT: Do not disassemble the fuel injection pump further than necessary for installing available repair parts—not even for cleaning.

Be sure that injection pump serial number tag (A) is in place and that all identification numbers are legible so that pump is set to the correct specification for its intended application.

For injection pump repair and testing, have an authorized ADS diesel injection repair station perform the work. Unauthorized repairs made to fuel injection pumps will void warranty.

RG,CTM8,G35,25 -19-29SEP94

INSTALL STANADYNE MODEL DB2 (WITH RETAINED DRIVE SHAFT) AND DB4 INJECTION PUMP

Installation of DB4 Injection Pump is similar to DB2, except where noted.

Injection pump mounting flange timing mark and front plate timing mark presence and alignment MUST BE verified before removing pumps from engine. When pump is reinstalled on engine, time pump by aligning these two (external) marks. DO NOT reference internal timing marks (on pump cam ring and governor weight retainer) for accurate pump timing.

IMPORTANT: If the injection pump drive gear was removed from engine, it must be timed when reinstalled. (See INSTALL AND TIME CAMSHAFT AND FUEL INJECTION PUMP in Group 16.)

NOTE: When engine front plate was replaced, see REPLACE ENGINE FRONT PLATE AND TRANSFER FUEL INJECTION PUMP TIMING ONTO REPLACEMENT FRONT PLATE later in this group. No timing mark will be found on the new plate, a mark must be established and scribed.

Make sure that Woodruff key is in place in pump shaft and that it fits tight in keyway.

1. Rotate engine crankshaft using engine rotation tool and timing pin so that No. 1 piston is at TDC on compression stroke (if not done previously).

2. Using a new gasket (if required), slide pump onto mounting studs.

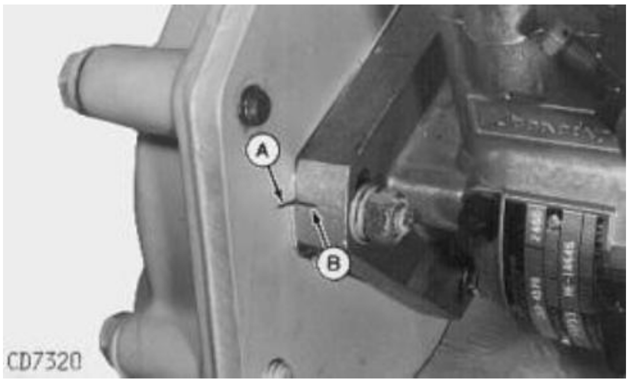
3. Screw the three hex nuts onto studs and tighten finger-tight only at this stage.

4. Tighten drive gear hex nut to 60 N·m (45 lb-ft). Install drive gear access plate using a new gasket. Apply LOCTITE 242 to cap screw threads and tighten to 2 N·m (18 lb-in.).

S11,3010,MW -19-01NOV95

On current pumps that are static timed:

5. First, pivot pump housing away from cylinder block as far as slots will allow. Then, pivot it back again, but only far enough to align timing mark on the pump flange (B) exactly with timing mark on the cylinder block front plate (A).



CD7320 -UN-23MAY95

IMPORTANT: If a new engine front plate was installed, remove timing hole cover on side of pump. With engine at No.1 TDC compression stroke, align the two marks (cam ring and governor weight retainer). Then, scribe mark (A) directly in line with mark (B) on pump, if not previously done.

6. Tighten the three hex nuts securing the pump to the front plate to 27 N·m (20 lb-ft).

S11,3010,MY -19-29JUN95

7. Connect injection pump pressure lines (D). Beginning with outlet (B) and continue around the pump head in counterclockwise direction, attaching lines in same order as engine firing (1-5-3-6-2-4 on 6-cylinder engines and 1-3-4-2 on 4-cylinder engines).

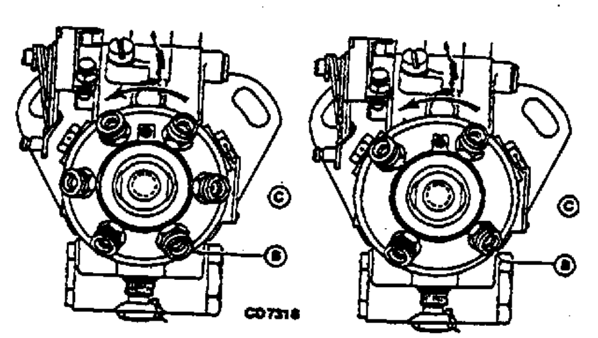
8. Tighten fuel delivery (pressure) lines at pump to 34 N·m (25 lb-ft) using a suitable 17 mm deep-well socket.

IMPORTANT: ALWAYS use a backup wrench when loosening or tightening fuel delivery lines at fuel injection pump, so that the pump discharge fittings are not altered. This prevents possible internal pump damage.

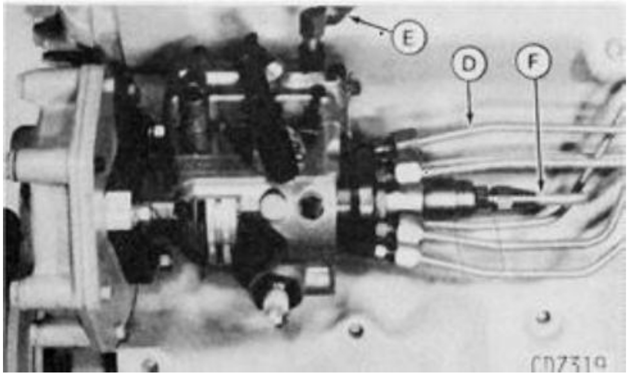
9. Connect fuel supply line (F), return line (E), shut-off cable and speed control rod.

10. Install timing hole cover plate on DB2 pump, using a new gasket. Apply LOCTITE 242 to cap screw threads and tighten to 2 N·m (18 lb-in.).

11. Bleed air from fuel system as outlined in Group 115. Start engine, run for several minutes and check entire fuel system for leaks.



CD7318 -UN-23FEB89



CD7319 -UN-23FEB89

B—Outlet Connection to No. 1 Cylinder
C—Engine Block Side
D—Fuel Pressure Lines
E—Fuel Return Line
F—Fuel Supply Line

S11,3010,MZ -19-01NOV95

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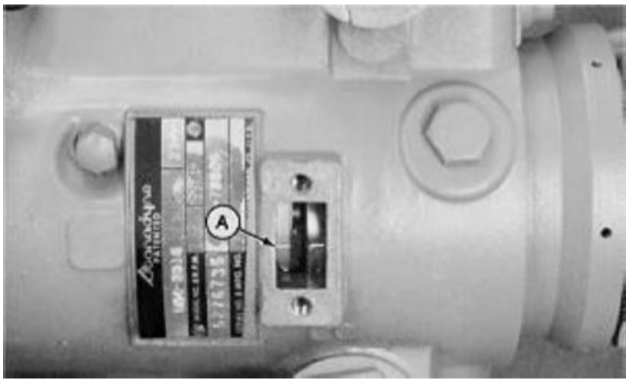
REMOVE STANADYNE MODEL DM4 FUEL INJECTION PUMP



T6077AK -UN-28OCT88

Stanadyne injection pumps are internally timed by aligning governor weight retainer with cam ring.

IMPORTANT: Never steam clean or pour cold water on a fuel injection pump while the pump is running or while it is warm. Doing so may cause seizure of internal rotating pump parts.

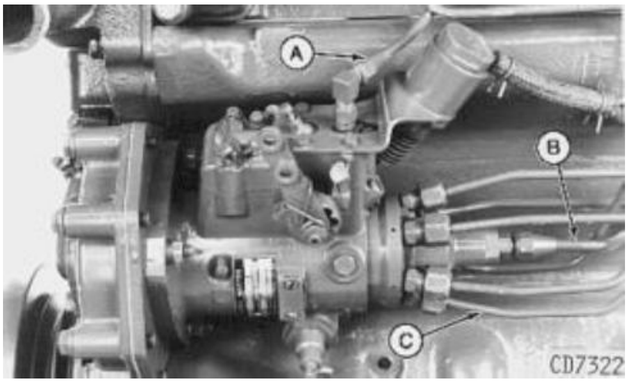
1. Clean the fuel injection pump, lines and area around the pump with cleaning solvent or a steam cleaner.

2. Use appropriate flywheel turning tool to rotate flywheel until engine is positioned at 'TDC' of No. 1 cylinder's compression stroke. Install JDE81-4 Timing Pin into hole in flywheel to lock engine at this position.

3. Remove timing hole cover (shown removed) from side of injection pump. Timing marks (A) will be aligned when engine is at No. 1 'TDC'.

If timing marks are not aligned, remove timing pin from flywheel and rotate engine one full revolution until timing pin once again enters hole in flywheel. Marks should now be aligned and engine should be locked at No.1 'TDC'.

RG,CTM8,G35,R18-19-18FEB95



CD7322 -UN-23MAY95

4. Disconnect shut-off cable and speed control linkage, if equipped. Disconnect electrical connection to shut-off solenoid or throttle positioning solenoid if equipped. Tag electrical wires for correct reassembly.

IMPORTANT: ALWAYS use a backup wrench when loosening or tightening fuel lines at injection pump so that discharge fittings are not altered to prevent possible internal pump damage.

5. Disconnect fuel supply line (B) and fuel return line (A).

6. Disconnect all fuel delivery lines (C) from fuel injection pump outlet fittings.

RG,CTM8,G35,R19-19-24JUL95

7. Remove injection pump drive gear cover plate from timing gear cover, (shown removed).

8. Remove hex nut (A) and washer securing injection pump drive gear to pump drive shaft.

NOTE: Be careful pump shaft key does not fall into timing gear cover when pump is removed from engine.

9. Remove three mounting stud nuts and washers and remove remove injection pump from engine. Place pump on a clean flat table.

T95246 -UN-01NOV88

RG,CTM8,G35,R20-19-18AUG92

REPAIR STANADYNE FUEL INJECTION PUMP

IMPORTANT: Do not disassemble the fuel injection pump further than necessary for installing available repair parts—not even for cleaning.

Be sure that injection pump serial number tag (A) is in place and that all identification numbers are legible so that pump is set to the correct specification for its intended application.

For injection pump repair and testing, have an authorized ADS diesel injection repair station perform the work. Unauthorized repairs made to fuel injection pumps will void warranty.

RG5724 -UN-12APR91

RG,CTM8,G35,25 -19-29SEP94

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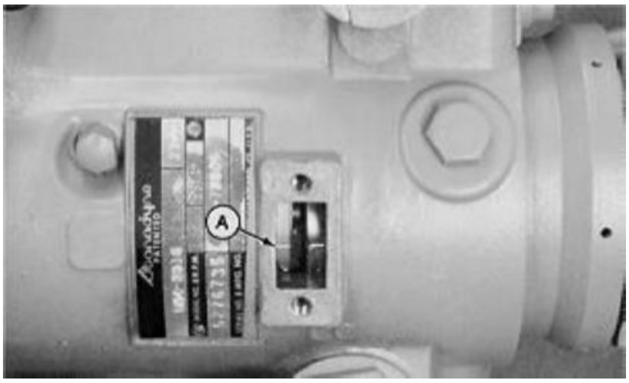
INSTALL STANADYNE MODEL DM4 FUEL INJECTION PUMP



T6077AK -UN-28OCT88

1. Make sure that engine is locked at 'TDC' of No. 1 cylinder's compression stroke.

2. Remove timing hole cover from side of injection pump, (shown removed). Rotate pump drive shaft and align timing mark (A) on governor weight retainer hub with timing mark on cam ring.

3. Check pump mounting flange packing for damage. Replace packing as necessary. Lubricate packing with clean engine oil an instsall in groove on front face of pump mounting flange.

4. Install injection pump onto mounting studs so that shaft key aligns with keyway in pump drive gear. Install washers and nuts onto mounting studs. Tighten nuts finger tight.

RG,CTM8,G35,R21-19-16SEP92

T95246 -UN-01NOV88

5. Install washer and nut (A) onto end of injection pump shaft. Tighten nut to 195 N·m (145 lb-ft).

6. Install injection pump drive gear cover using a new gasket. Apply LOCTITE 242 to cap screw threads and tighten to 2 N·m (18 lb-in.).

7. Rotate injection pump away from block (counterclockwise, as viewed from flywheel end) as far as it will go. Now rotate pump in opposite direction until timing marks on governor weight retainer and cam ring are aligned. Tighten mounting stud nuts to 27 N·m (20 lb-ft).

RG,CTM8,G35,R22-19-01NOV95

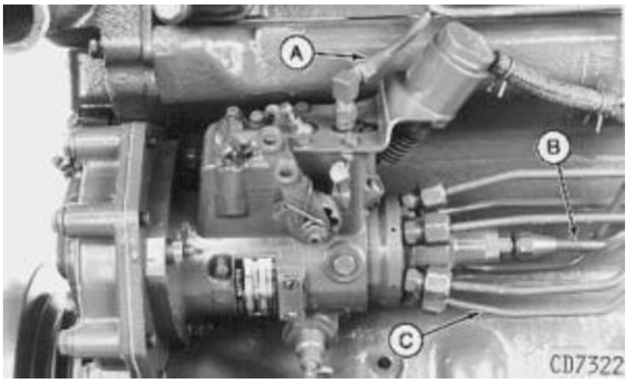
IMPORTANT: ALWAYS use a backup wrench when tightening fuel lines at injection pump so that fuel discharge fittings are altered to prevent possible internal pump damage.

8. Connect all fuel delivery (pressure) lines (C) at injection pump discharge fittings and tighten to 34 N·m (25 lb-ft).

9. Connect and securely tighten fuel supply line (B) and fuel return line (A).

10. Connect wiring to throttle positioning solenoid or fuel shut-off solenoid, if equipped.

11. Bleed the fuel system as detailed in Group 115. Start engine, run for several minutes, and check entire fuel system for leaks.



CD7322 -UN-23MAY95

RG,CTM8,G35,R23-19-24JUL95

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REPLACE ENGINE FRONT PLATE

Refer to Group 16 for front plate removal procedure. Consult your parts catalog for correct replacement front plate to use for your engine.

Two new replacement front plates are available through service parts:

• One plate is used for all Roto Diesel/Lucas CAV and Stanadyne (JDB and DB2 with ISO drive) and DB4 injection pumps.

• A second plate is used for Stanadyne DM4 injection pumps.

IMPORTANT: Replacement front plates do not have a reference timing mark for the fuel injection pump. A new timing mark must be transferred from existing front plate during reassembly.

1. Install bushing (D) in bore (C) using a suitable driver when replacing front plate on engines equipped with a 46 mm (1.81 in.) pilot bore diameter pump. On pumps with a 50 mm (1.97 in.) pilot bore diameter, bushing is not required.

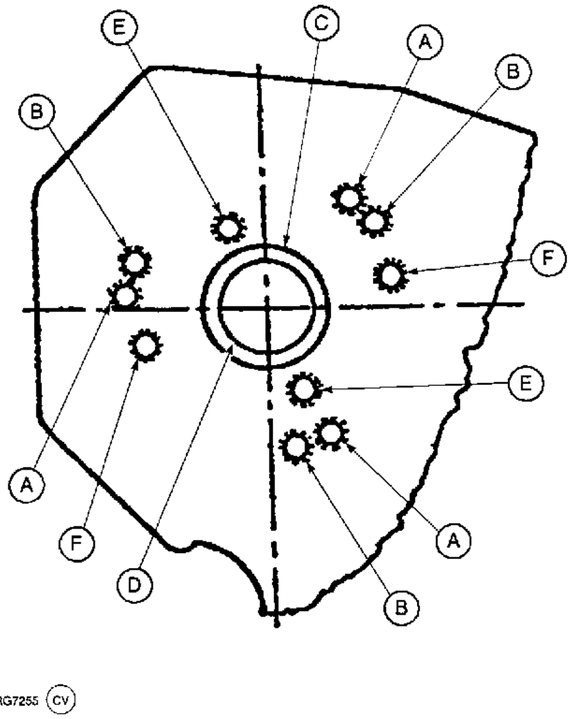
NOTE: Apply LOCTITE 242 (TY9370) to threads of studs and set screw plugs before installing in front plate.

2. Install mounting studs in appropriate location on front plate for your pump application.

3. Install set screw plugs in ALL threaded holes not used for mounting studs.

4. Accurately transfer injection pump timing mark from original front plate onto replacement plate as outlined next in this group.

5. Refer to Group 16 for front plate installation procedure.



-UN-20JUL95 RG7255

Viewed From Pump Side of Plate

A—Threaded Stud Holes (All engines except Roto Diesel 4-cylinder and Stanadyne JDB)
B—Threaded Stud Holes (Roto Diesel 4-cylinder)
C—50 mm (1.97 in.) Injection Pump Pilot Bore
D—46 mm (1.81 in.) Bushing I.D. for Stanadyne JDB Pump
E—Threaded Stud Holes (Stanadyne JDB)
F—*Threaded Stud Holes (Stanadyne Model “C” Pumps)

**Not used on any engine applications covered in this manual.*

S55,3010,BP -19-14JUL95

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TRANSFER FUEL INJECTION PUMP TIMING MARK ONTO REPLACEMENT FRONT PLATE

IMPORTANT: Replacement front plates do not have an injection pump timing mark. It is extremely important that the timing be accurately transferred from original front plate to the replacement plate in the exact location for correct injection pump timing.

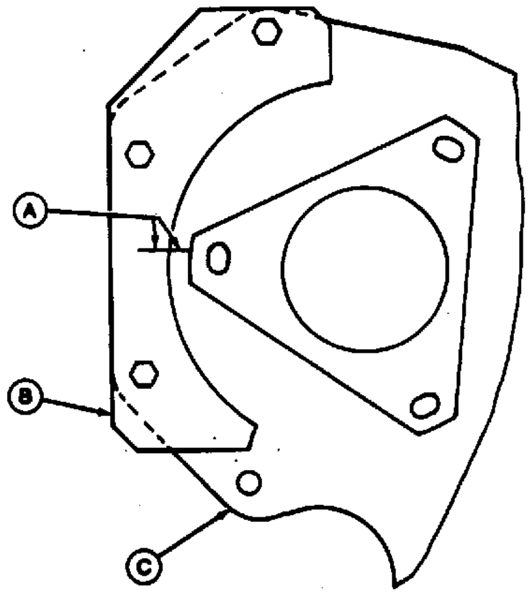
1. Position DFRG2 Aluminum Template (B) onto original front plate (C) as shown. (See Group 199, Dealer Fabricated Tools for manufacturing detail.) Install and tighten three 3/8-16 cap screws securely.

2. Transfer injection pump timing mark (A) from previous front plate onto template using a fine tip marker and straightedge. Remove template from front plate being replaced.

3. Attach template (with timing mark) to new replacement front plate and tighten cap screws securely.

4. Transfer timing mark from the template to the new front plate using a scribe. Scribe deep enough so mark becomes a permanent reference.

5. Remove template from front plate and refer to Group 16 for front plate installation procedure.



RG5590 -UN-01NOV89

Front Plate (Viewed From Pump Side)

RG,CTM8,G35,33 -19-29SEP94

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ANEROID REPLACEMENT

NOTE: It is not necessary to remove fuel injection pump when replacing an aneroid.

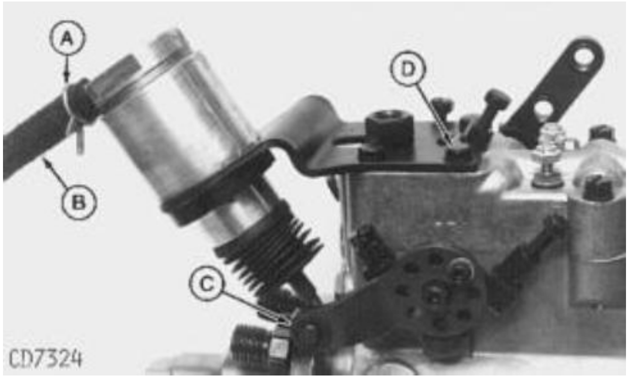
1. Remove clamp (A) and hose (B). Remove retaining ring (C) and attaching screws (D).

2. Remove aneroid and bracket assembly from pump.

3. Prepare and adjust new aneroid. (See ANEROID ADJUSTMENT in this group.)

4. Attach operating rod to pump lever with retaining ring and fasten bracket to injection pump cover with screws. Tighten screws to 5 N·m (3.5 lb-ft) (42 lb-in.).

5. Connect hose to aneroid inlet with clamp.



CD7324 -UN-23MAY95

A—Clamp
B—Hose
C—Retaining Ring
D—Cap Screw

RG,CTM8,DY022 -19-01NOV95

ANEROID FIELD ADJUSTMENT

1. On an inoperative aneroid, screw in operating rod and count the number of turns until it bottoms.

2. Take the new aneroid, screw in operating rod until it bottoms then back off by the same number of turns as were needed for the previous aneroid.

3. Install adjusted aneroid on injection pump.

RG,CTM8,G35,50 -19-29SEP94

ANEROID WORKSHOP ADJUSTMENT

1. Install a new aneroid on the injection pump.

2. Connect a regulated air pressure source to aneroid inlet and use a mercury manometer in preference to a gauge, as operating pressures are very low.

3. Note the pressure at which shut-off lever lifts off forward screw and the pressure required to obtain full travel until rear screw bottoms.

ANEROID PRESSURE SPECIFICATIONS

Lever lift-off	76—102 mm Hg (3—4 in. Hg) 10—14 kPa (1.5—2.0 psi)
Lever at full travel	330—380 mm Hg (13—15 in. Hg) 44—51 kPa (6.4—7.4 psi)

NOTE: Lift-off pressure can be checked by inserting a shim of 0.05 mm (0.002 in.) thickness between lever and front screw; the shim will slip out as soon as the lever starts to move.

4. If lever travel requires more pressure than specified, lengthen the operating rod; if less pressure is required, shorten operating rod.

5. Once aneroid is set, repeat test to check adjustment.

6. Install injection pump on engine.

IMPORTANT: During aneroid adjustment, do not touch the forward/rear screw, as these devices have been adjusted on the test stand.

RG,CTM8,G35,51 -19-21SEP95

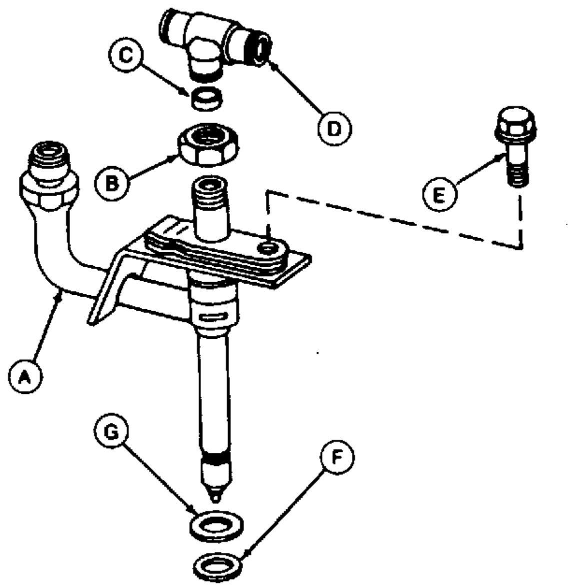
REMOVE FUEL INJECTION NOZZLES

General Nozzle Service Precautions:

• Before removal, thoroughly remove all dirt from the cylinder head around fuel injection nozzles. Clean with compressed air to prevent dirt from entering the cylinders. Plug the bore in the cylinder head after each nozzle has been removed. Cap fuel line openings as soon as they are disconnected.

• Immediately fit protective caps over the nozzle tips and the line connections to avoid getting debris in fuel system and handling damage.

• Do not bend the fuel delivery lines, as this may affect their durability. When loosening the fuel pressure lines, hold male union of nozzle line stationary with a backup wrench.



RG6266 -UN-22JUL92

A—Nozzle Assembly
B—Tube Nut
C—Packing
D—Leak-off T-fitting
E—Cap Screw
F—Carbon Stop Seal
G—Upper Sealing Washer

RG,CTM8,G35,34 -19-16SEP92

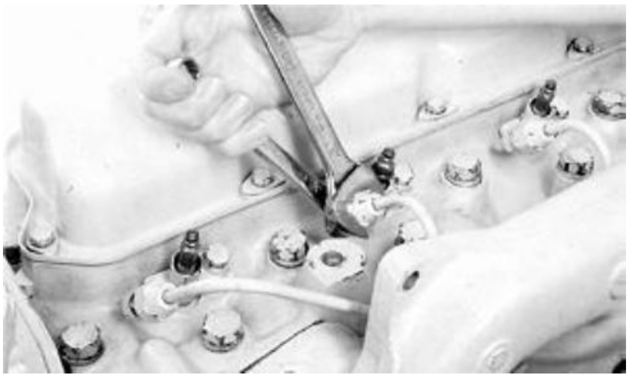
NOTE: When all fuel injection nozzles have to be removed, disconnect leak-off line assembly at fuel tank, at injection pump, and at each nozzle T-fitting. Lift off complete leak-off line as an assembly. For individual nozzle removal, remove only the section of leak-off line necessary for nozzle removal.

1. Loosen tube nuts at each assembly to remove leak-off lines and T-fittings as an assembly.

T82098 -UN-09NOV88

S11,3010,NI -19-29JUN95

2. Disconnect fuel injection line from nozzle using a backup wrench on nozzle connection as shown.



T82097 -UN-31OCT88

T49,0413,24 -19-29JUN95

35
50

3. Remove cap screw, clamp, and spacer securing nozzle in cylinder head nozzle bore.

T82099 -UN-31OCT88

T49,0413,25 -19-29JUN95

4. Pull injection nozzle out of cylinder head using JDE38B Injection Nozzle Puller Set or JDG716 Adapter and slide handle from JDE38 or JDE38A Puller Set.

IMPORTANT: Do not use screwdrivers or similar tools for this as they might damage the injection nozzle beyond repair.

T82100 -UN-09NOV88

S11,3010,NJ -19-29JUN95

CLEAN FUEL INJECTION NOZZLE BORE

IMPORTANT: Always turn tool clockwise through bore to prevent tool from dulling.

CAUTION: Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection including eye protection.

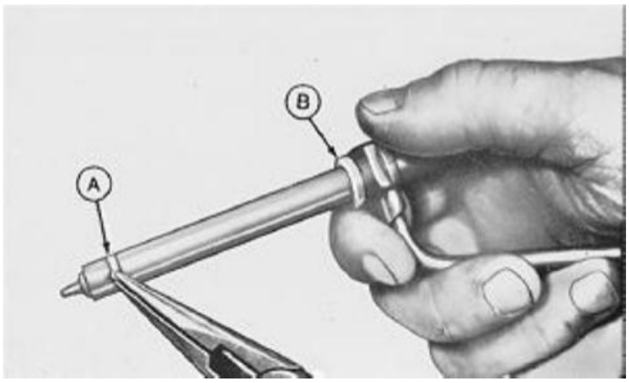
1. Clean injection nozzle bore using JDE39 Nozzle Bore Cleaning Tool. Blow debris from bore using compressed air, and plug the bore to prevent entry of foreign material.

T82101 -UN-01NOV88

S11,3010,NK -19-21SEP95

CLEAN INJECTION NOZZLES

1. Remove carbon stop seal (A) and upper sealing washer (B), using a needle-nose pliers. Discard seal and washer.



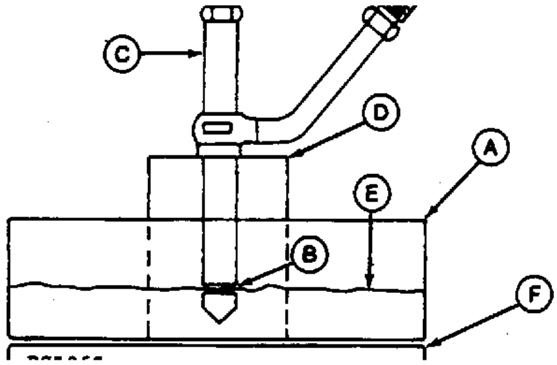
RG1254 -UN-20DEC88

S11,3010,NL -19-29JUN95

2. Place nozzles (so carbon stop seal groove is just covered) in a commercial nozzle cleaning solvent or clean diesel fuel. Follow manufacturer's directions provided with solvent.

IMPORTANT: Do not scrape or disturb the teflon coating on the nozzle body above the carbon stop seal groove. This coating will become discolored during normal operation, but this is not harmful. Do not use a motor-driven brush to clean up nozzle body.

3. After soaking, clean nozzle tip with ROS16488 Brass Wire Brush. Never use a steel wire brush or scraper.



RG1953 -UN-20DEC88

A—Container
B—Carbon Stop Seal Groove
C—Nozzle
D—Rack
E—Cleaning Solution
F—Heating Unit

S11,3010,NM -19-29JUN95

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.

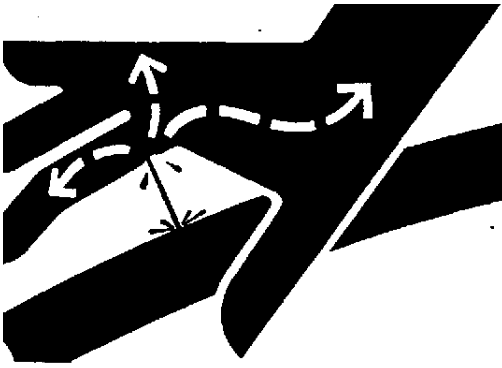
S11,3010,NS -19-08APR94

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.

S11,3010,NT -19-13MAY93

TEST INJECTION NOZZLES



X9811 -UN-23AUG88

CAUTION: The nozzle tip should always be directed away from the operator. Fuel from the spray orifices can penetrate clothing and skin causing serious personal injury. Enclosing the nozzle in a clear glass beaker is recommended.

Before applying pressure to the nozzle tester, be sure that all connections are tight, and that the fittings are not damaged. Fluid escaping from a very small hole can be almost invisible. To search for suspected leaks, use a piece of cardboard or wood, rather than hands.

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 injection nozzle to nozzle tester. When using the Bosch tester (JT25510), use the KJD10109 Fuel Line and connect line to tester and nozzle.

2. Use Y900-3, Y900-5 Adapters (C) and Y900-2 Fuel Line (B) from D01110AA Adapter Set to connect nozzles to D01109AA Nozzle Tester.

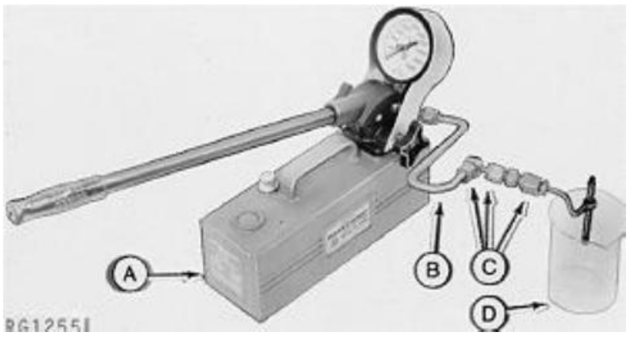
3. Position tip of nozzle below top of beaker (D) and back out 30° from vertical. This is necessary to contain all spray in beaker, as nozzle spray pattern is at an angle to the nozzle centerline. Leave connections slightly loose.

NOTE: Rapid operation of pump handle will result in inaccurate cracking pressure readings and cause undue wear on gauge.

4. Pump handle several strokes to flush air from lines and to determine the pumping rate required for proper fuel atomization. Tighten all connections securely after all air has been expelled from nozzle and line.

IMPORTANT: Make sure that nozzle tester is in good condition and that gauge works properly. Service nozzle tester as recommended in the operating instructions provided with tester.

D40048 -UN-11JUL89



RG1255 -UN-20DEC88

A—Nozzle Tester
B—Fuel Line
C—Adapters
D—Beaker

S11,3010,NN -19-21SEP95

• Opening Pressure Test

NOTE: Actual nozzle opening pressure is less important than equal opening pressure of all nozzles. For maximum variation between nozzles see FUEL SYSTEM SPECIFICATIONS, at beginning of this group.

1. Actuate the nozzle tester rapidly several times to allow the valve to seat rapidly.

2. Open gauge valve, actuate the tester and raise the pressure to a point where the gauge needle falls rapidly. This is the nozzle opening pressure, and should be as specified for a new or used nozzle.

IMPORTANT: If any of the nozzle opening pressures are not within specified range, reset pressure and valve lift BEFORE checking chatter and spray pattern. Otherwise, these characteristics may be affected. (See ADJUST FUEL INJECTION NOZZLES later in this group.)

S11,3010,NP -19-21SEP95

• Chatter Test

1. Close gauge shut-off valve and operate nozzle tester at a pumping rate that will cause the nozzle to chatter. Nozzle should chatter softly, and spray pattern should be broad and finely atomized.

NOTE: Until the chattering range is reached, fuel will emerge in non-atomized streams.

If nozzle fails to chatter, the nozzle valve may be bent or tight in it’s guide due to accumulated laquer deposits. Disassemble nozzle and correct as detailed later in this group.

2. Using the pumping rate for proper atomization, operate tester for ten strokes. The nozzle must atomize on at least eight of the ten strokes without consecutive misses.

If the nozzle fails to meet this requirement, repeat procedure. Nozzles which do not meet the requirement after second test should be considered unacceptable and should be either repaired or replaced.

S11,3010,NQ -19-20AUG92

• Spray Pattern Test

1. Close gauge shut-off valve and operate nozzle tester at a pumping rate that will cause the nozzle to chatter.

NOTE: Partially clogged, chipped, or eroded orifices will cause the spray to deviate from the correct angle. Spray will be streaky, rather than finely atomized.

2. Observe spray pattern and check for plugged orifices.

If nozzle fails to chatter or spray properly, disassemble, clean and recondition as outlined later in this group.

S11,3010,NQ1 -19-11SEP92

• **Leakage Test**

1. Check nozzle for fuel leakage past valve seat by positioning nozzle on nozzle tester with nozzle tip down.

2. Operate pump handle rapidly to firmly seat valve. Wipe the nozzle tip dry with a clean, lint-free cloth.

3. Slowly raise pressure at nozzle to about 2800—3500 kPa (28—35 bar) (400—500 psi) under specified opening pressure and hold at that pressure. Watch for an accumulation of fuel around the nozzle tip orifices.

If fuel drips from nozzle within 5 seconds, nozzle must be lapped.

S11,3010,NR -19-11SEP92

• **Valve Stem and Guide Wear Test**

1. Position nozzle with tip slightly above the horizontal plane.

CAUTION: Completely enclose spray zone in a glass beaker to avoid possible personal injury from spray.

2. Slowly raise pressure to 10 300 kPa (103 bar) (1500 psi) on test gauge.

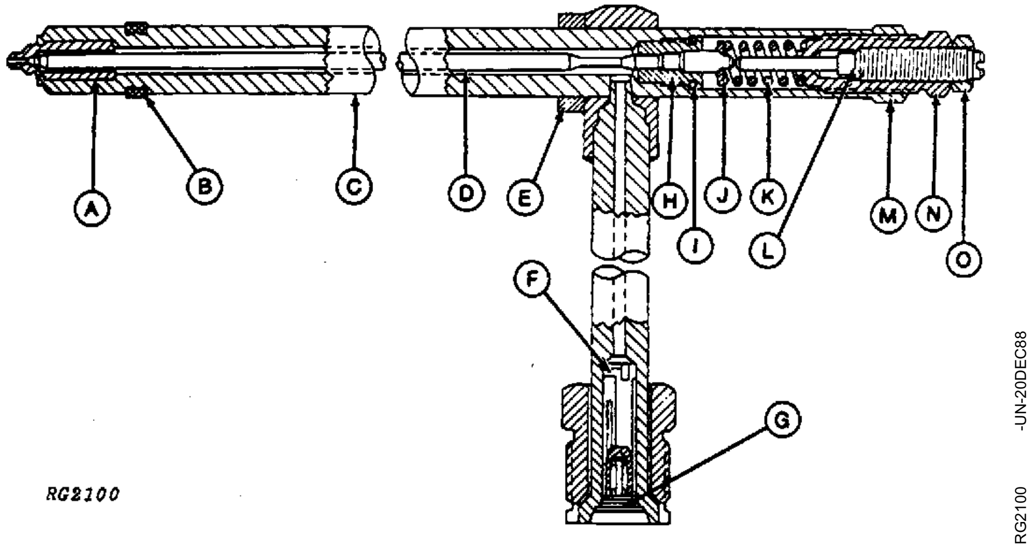
NOTE: Leakage rate based on use of No. 2 diesel fuel or an equivalent viscosity of test oil at 18°—24°C (65°—75°F) ambient temperature.

3. Look for leakage from the return end of nozzle. After one drop, leakage should be 3—10 drops in 30 seconds.

If nozzle leakage is not within specified range, nozzle must be reconditioned as outlined later in this group.

S11,3010,NR1 -19-21SEP95

DISASSEMBLE INJECTION NOZZLES



A—Nozzle Tip
B—Carbon Stop Seal
C—Nozzle Body
D—Nozzle Valve
E—Upper Sealing Washer
F—Edge-Type Filter
G—Fuel Inlet
H—Upper Guide
I—Upper Seal
J—Spring Seat
K—Spring
L—Lift Adjusting Screw
M—Lock Nut
N—Pressure Adjusting Screw
O—Lock Nut

S11,3010,NU -19-29JUN95

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 the fuel injection system, the working area, tools and cleaning materials must be kept spotlessly clean. Whenever possible, work in an isolated, dust-free area.

• Cover the work bench with clean paper before beginning disassembly of injection nozzles.

• As parts are disassembled, place then in a pan of clean diesel fuel and leave there until needed. Do not permit these parts to strike each other.

• Use a separate pan of clean fuel for washing parts before assembly.

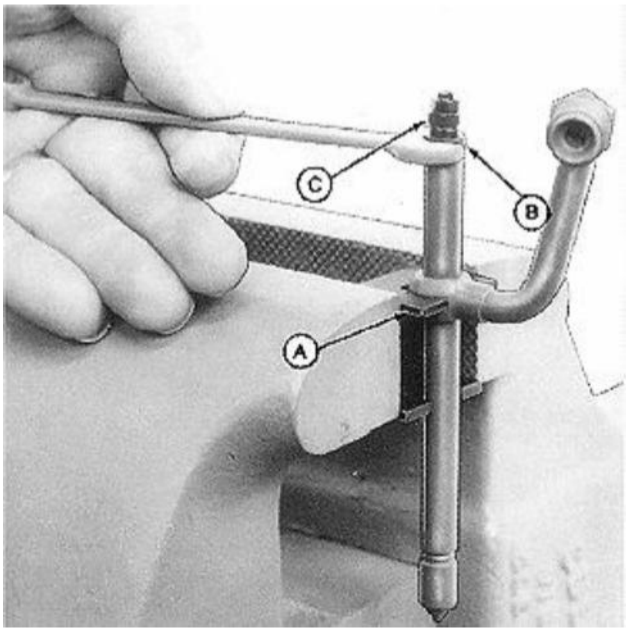
S11,3010,NV -19-12JUN90

1. Place nozzle in ROS17787 Holding Fixture (A) and secure fixture in a vise.

2. Loosen pressure adjusting screw lock nut (B).

3. Back out pressure adjusting screw (C) and lift assembly.

4. Invert nozzle and allow pressure adjusting spring seat and adjusting assembly to fall into your hand. Do not bend stem during removal.

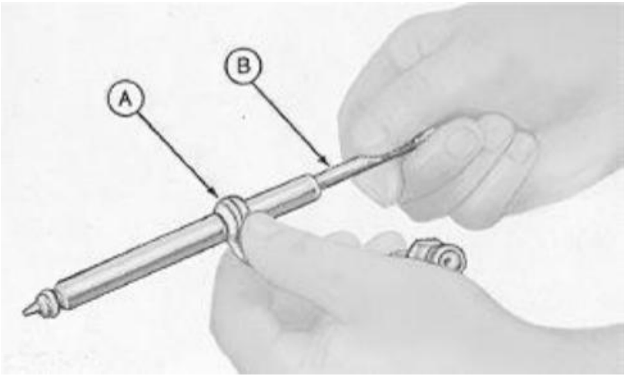


RG1918 -UN-07NOV94

RG,CTM8,DX122 -19-18JAN95

5. If valve does not slide freely from body (A), use No. 1681 Retractor (B) to remove valve.

6. Remove locating clamps and spacer from nozzle body.



RG2092 -UN-20DEC88

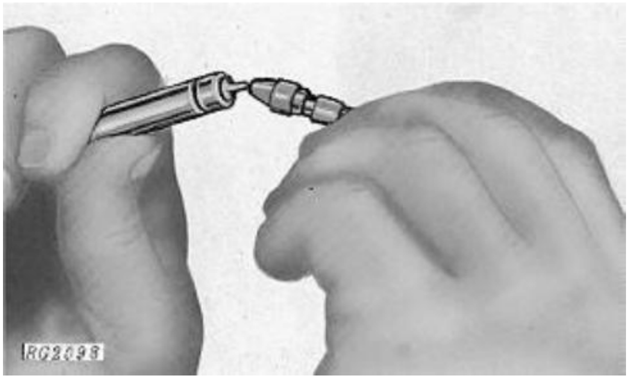
RG,CTM8,DX177 -19-07OCT94

INSPECT AND CLEAN NOZZLE BODY

NOTE: Unless otherwise indicated, all tools required for nozzle cleaning can be found in the ROS16494 Nozzle Cleaning Kit.

Clean carbon stop seal groove and nozzle tip with ROS16488 Brass Wire Brush.

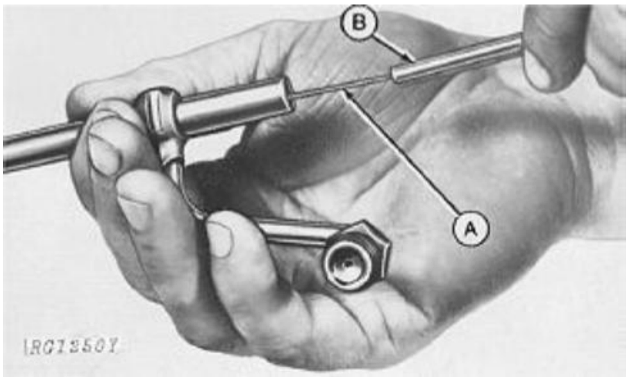
Inspect tip for cracks and spray orifices for chipping and erosion using ROS16487 Inspection Magnifier.



RG2098 -UN-20DEC88

S11,3010,NX -19-29JUN95

To clean carbon from nozzle orifices:



1. Begin with a cleaning wire 0.07—0.10 mm (0.003—0.004 in.) smaller than the nominal orifice size given in specifications.

NOTE: Stoning the wire to provide a flat surface on one side will help in reaming carbon from a clogged hole.

2. Clamp the wire in ROS16483 Pin Vise. Wire should not protrude from the vise more than 0.8 mm (1/32 in.).

3. Insert wire in orifice and rotate.

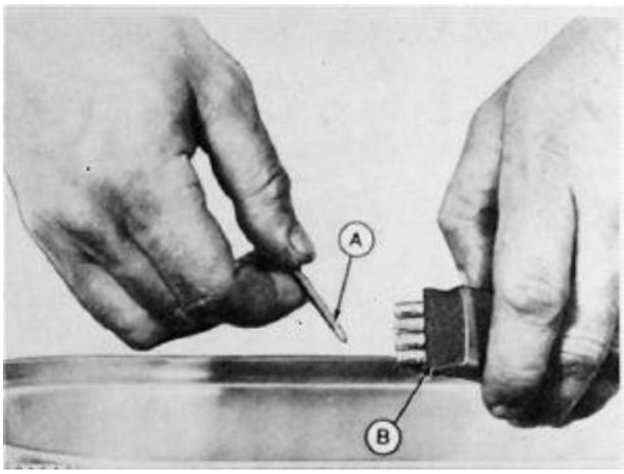
4. Use ROS17712 Scraper to clean deposits from valve seating area.

5. Grasp ROS16476 Sac Hole Drill (A) with No. 16481 Valve Retractor (B).

6. For final cleaning, use a cleaning wire 0.03 mm (0.001 in.) smaller than the nominal orifice size and repeat Steps 2 and 3.

S11,3010,NY -19-18JAN95

INSPECT AND CLEAN VALVE AND VALVE SEAT



IMPORTANT: NEVER use a steel wire brush on nozzle parts.

Use ROS16488 Brass Wire Brush (B) to remove deposits from seating area on tip of nozzle valve (A). Use a ROS16544 Felt Pad to remove varnish deposits.

Inspect guide area of valve scratches which could cause sticking. This area will generally be polished on one side during operation. Visible vertical marks are normal.

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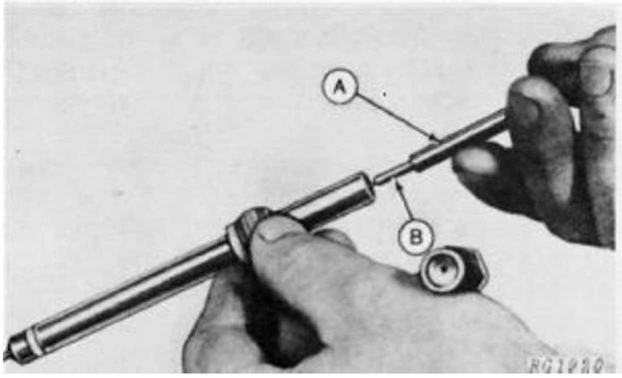
S11,3010,NZ -19-29JUN95



RG1920 -UN-20DEC88

• Inconsistent Chatter Or No Chatter

A nozzle which during test had spotty chatter or showed definite signs of sticking accompanied by low return leakage, may be corrected by polishing the valve guide area as follows:

1. Place a small amount of ROS16489 Lapping Compound on the valve in guide area only. DO NOT use any other compound for this purpose.

2. Slide valve into body.

3. Grip top of the valve with No. 16481 Retractor (A) and rotate valve (B) in the guide by turning retractor. The amount of lapping required can be accomplished in 10—20 turns by hand. The valve should be raised and lowered in the guide every 3—4 revolutions and direction of rotation changed for best results.

IMPORTANT: Never attempt to rotate the valve in a motor driven chuck for this purpose.

4. Wash nozzle body and valve thoroughly in clean fuel before reassembly.

S11,3010,OA -19-19JUN90

• Seat Leakage

Seat leakage may be caused by dirt, carbon or fuel deposits in valve area. Inspect valve seat and clean as follows:

1. Apply a small amount of ROS16489 Lapping Compound to valve tip and insert valve in nozzle body.

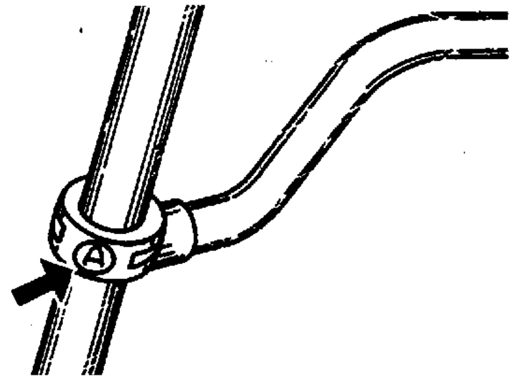
2. Gripping valve with No. 16481 Retractor, rotate valve 3 to 5 turns to clean up seat.

3. Wash valve and nozzle body thoroughly in clean fuel.

• Valve Coding

All nozzles are marked on the banjo inlet fitting with a code letter. This letter is used in manufacturing to mate a sized valve to a sized nozzle body. Up to 10 different sized valves and nozzle bodies may be found, with markings ranging from “A” through “T”.

RG1251



RG1251 -UN-20DEC88

S11,3010,OB -19-19JUN90

INSPECT VALVE ADJUSTING MECHANISM

NOTE: Inspection steps refer to first illustration under DISASSEMBLE INJECTION NOZZLES earlier in this group.

1. Inspect lift adjusting screw (L). Replace if bent or otherwise damaged.

2. Inspect pressure adjusting screw (N). Replace if worn or damaged.

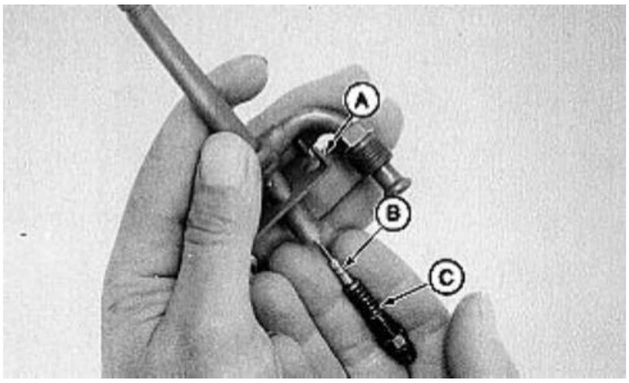
3. Inspect pressure adjusting spring (K). Replace if broken or distorted.

4. Inspect spring seat (J) for wear. Replace as necessary.

5. Replace nozzle clamp if bent.

S11,3010,OC -19-29JUN95

ASSEMBLE INJECTION NOZZLES



RG7249 -UN-11JUL95

1. Position nozzle locating clamp (A) over upper nozzle body with flanges pointing downward.

IMPORTANT: Hands must be clean and kept wet with fuel when assembling nozzles.

2. Dip valve (B) in clean fuel and insert into nozzle body.

3. Thread lift adjusting screw into pressure adjusting screw until top just enters screw.

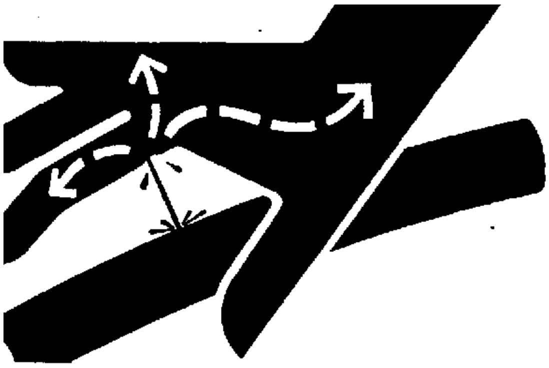
4. Invert adjusting screw assembly and assemble spring seat and spring to adjusting screw.

5. Tilt body, DO NOT allow valve to fall out, and install spring adjusting screw to body. Be careful not to dislodge spring (C) or seat during initial assembly.

6. Turn pressure adjusting screw down as far as possible by hand; usually about ten full turns. Adjust nozzle as detailed later in this group.

S11,3010,OD -19-21SEP95

ADJUST FUEL INJECTION NOZZLES



X9811 -UN-23AUG88

CAUTION: Nozzle tip should always be directed away from operator. Fuel from spray orifices can penetrate clothing and skin causing serious personal injury. Enclosing nozzle in a glass beaker is recommended.

Before applying pressure to nozzle tester, be sure all connections are tight, and fittings are not damaged. Fluid escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood, rather than hands, to search for suspected leaks.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

1. Connect nozzle to nozzle tester. See TEST INJECTION NOZZLES earlier in this group.

RG,CTM8,DY047 -19-21SEP95

• Adjust Nozzle Opening Pressure

Close pressure gauge valve and flush nozzle by operating pump rapidly.

Raise pressure on pump until nozzle opens (gauge drops sharply).

Refer to nozzle opening pressure specification, given in Fuel System Specifications at beginning of this group.

If opening pressure is incorrect:

1. Remove nozzle from tester and install in ROS17787 Holding Fixture (A).

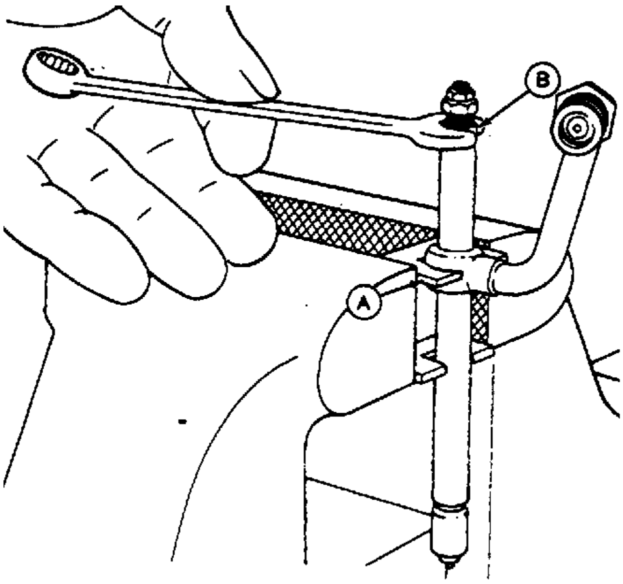
2. Loosen pressure adjusting screw lock nut (B).

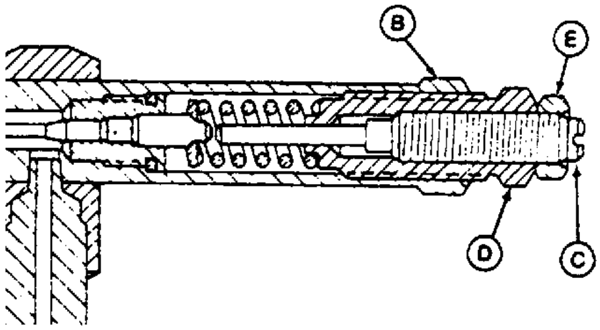
3. Reconnect nozzle to tester with tip pointing downward.

4. Back out lift adjusting screw (C) far enough (two or three turns) to prevent bottoming when pressure adjusting screw (D) is turned.

5. Turn pressure adjusting screw in (clockwise) to increase opening pressure, or out (counterclockwise) to decrease opening pressure.

NOTE: It is desirable to set opening pressure to the high limit of specification. If required, repeat procedure to obtain proper result.



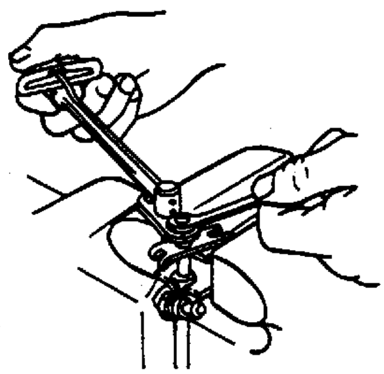


RG4825 -UN-14DEC88

A—ROS17787 Holding Fixture
B—Pressure Adjusting Screw Locknut
C—Lift Adjusting Screw
D—Pressure Adjusting Screw
E—Lift Adjusting Screw Locknut

S11,3010,OF -19-19JUN90

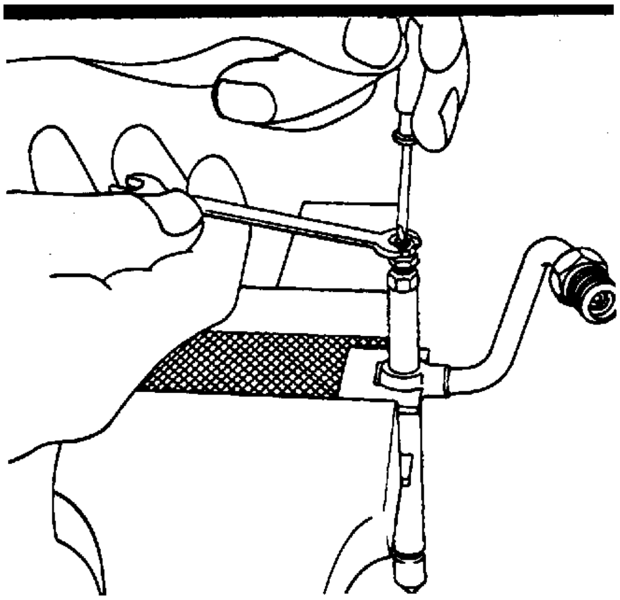
6. Remove nozzle from tester and secure in holding fixture. While holding pressure adjusting screw, tighten pressure adjusting screw lock nut to 10 N·m (7 lb-ft) using the ROS18958 (English size) or No. 24374 (metric size) Torque Wrench Adapter.



RG4826 -UN-14DEC88

S11,3010,OG -19-12MAY86

• Adjust Nozzle Valve Lift


RG4827 -UN-14DEC88

1. Reconnect nozzle to tester. While pumping fuel through nozzle, hold pressure adjusting screw and slowly turn lift adjusting screw in (clockwise) until valve ceases to open.

IMPORTANT: DO NOT manually bottom the valve with excessive force as bending of the valve may result.

2. Check for valve bottoming by raising pressure to 1380—3450 kPa (14—34 bar) (200—500 psi) above nozzle opening pressure.

Although some fuel may collect at nozzle tip, a rapid dribble should not occur.

3. Remove nozzle from tester and install in holding fixture.

4. Carefully turn lift adjusting screw out specified amount. A tolerance of 1/8 turn is permissible. (See FUEL SYSTEM SPECIFICATIONS earlier in this group.)

S11,3010,ON -19-07OCT94

Hold pressure adjusting screw stationary while tightening lock nut. Use ROS18958 Torque Wrench Adapter on English-type lock nuts; No. 24374 on metric-type lock nuts.

5. Tighten pressure adjusting screw lock nut to 5 N·m (3.5 lb-ft) (42 lb-in.).

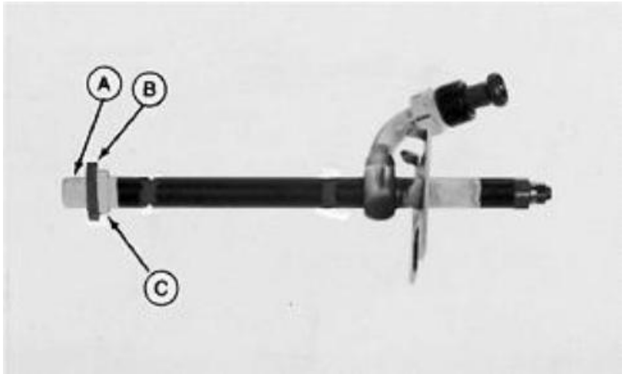
6. Recheck nozzle opening pressure.

If nozzle chatter is incorrect after servicing, valve parts may be misaligned. To correct, screw pressure adjusting screw through its range of adjustment several times and reset valve lift. Recheck nozzle for chatter.

7. Clean nozzle with ROS16488 Brass Wire Brush.

S11,3010,OH -19-01NOV95

INSTALL SEALS ON INJECTION NOZZLE



T94608 -UN-01NOV88

IMPORTANT: Each time an injection nozzle is removed from the cylinder head, replace carbon stop seal (C) with a new one.

1. Position JD258 (ROS16477) Pilot Tool (A) over nozzle tip.

2. Position a new carbon stop seal on pilot tool. Use a new seal washer (B) to help slide the carbon seal into place until it seats in it's groove on nozzle body.

3. Continue to slide upper sealing washer onto nozzle body until it seats against inlet fitting.

NOTE: If nozzle is not going to be installed at this time, install a No. 16189 Nozzle Protector Cap over nozzle tip. Plug all other openings in nozzle to prevent contamination.

S11,3010,OI -19-29JUN95

INSTALL INJECTION NOZZLES

NOTE: If nozzle bore in cylinder head must be cleaned, use JDE39 Nozzle Bore Cleaning Tool. (See CLEAN FUEL INJECTION NOZZLE BORE earlier in this group.)

IMPORTANT: Before installing injection nozzles, make sure nozzles are clean and free from oil or grease.

1. Remove plug (if installed previously) from nozzle bore in cylinder head and blow out bore with compressed air.

NOTE: Make sure that the sealing surface of the cylinder head (on which the seal washer will be resting) is smooth and free of damage or dirt. This could prevent proper sealing. Dirt and roughness could also cause distortion to nozzle when the attaching screw is tightened, making the valve stick.

S11,3010,OJ -19-21SEP95

2. Install nozzle in cylinder head using a slight twisting motion as nozzle is seated in bore.

NOTE: Illustration shows relationship of parts required for installation.

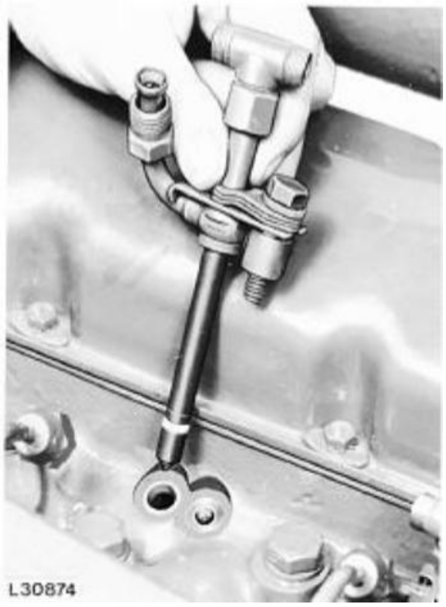
3. Install spacer, clamp and cap screw. Do not tighten cap screw at this stage.

4. Connect fuel pressure line to nozzle. Leave connection slightly loose until air is bled from system.

5. Tighten nozzle hold-down cap screws to 27 N·m (20 lb-ft).

6. Install leak-off line assembly.

7. Bleed air from loose injection line connection. Tighten connection using two wrenches to 34 N·m (25 lb-ft). (See BLEED THE FUEL SYSTEM in Group 115.)



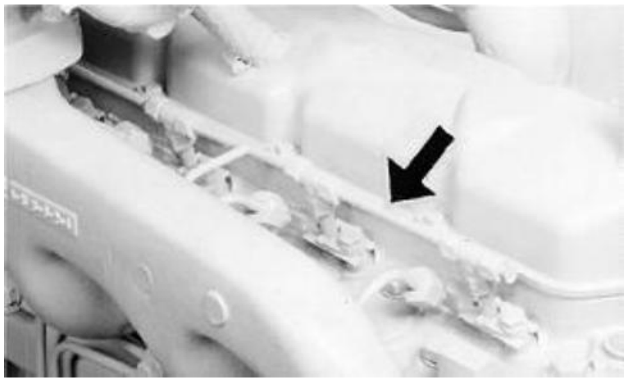
L30874 -UN-20DEC88

T82102 -UN-31OCT88

S11,3010,OK -19-29JUN95

REPAIR LEAK-OFF LINE ASSEMBLY

NOTE: When all fuel injection nozzles have to be removed, disconnect leak-off line at fuel tank return line and at fuel injection pump T-fittings only. Loosen nut on each fuel injection nozzle and lift off complete leak-off line as an assembly.



RG4828 -UN-14DEC88

S11,3010,OO -19-29JUN95

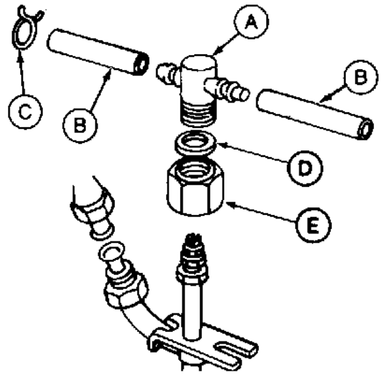
• Early Leak-off Line Assemblies

Early leak-off line assemblies consist of a T-fitting (A) with barbed openings for connecting hoses (B). Some line fittings require a hose clamp. (C).

A rubber packing (D) in packing nut (E) seals connection at the nozzle.

Inspect hoses for splitting, cracking, or deterioration. Make sure that all connections are not restricted.

Replace parts as required using a new rubber packing (D) at each nozzle. Do not overtighten packing nuts.



RG4829 -UN-11JUL95

A—T-Fitting
B—Hose
C—Hose Clamp
D—Rubber Packing
E—Packing Nut

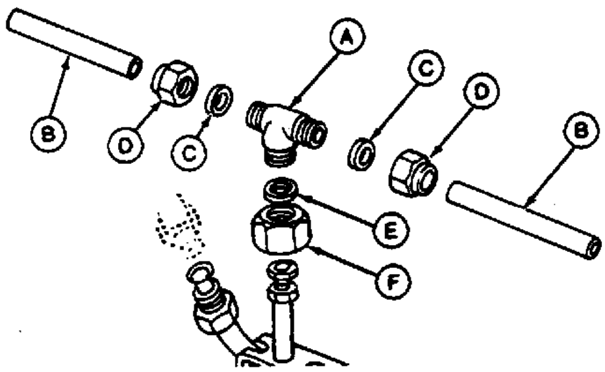
S11,3010,OL -19-21SEP95

• Current Leak-off Line Assemblies

Current production leak-off line assemblies consist of a T-fitting (A) with metal lines (B). Line connections are sealed with a rubber packing (C) and packing nut (D). A rubber packing (E) in packing nut (F) seals connection at the nozzle.

Inspect parts for general overall condition. Make sure that all connections are open.

Replace parts as required. Install new rubber packings at each connection. Do not overtighten packing nuts.



RG4830 -UN-14DEC88

A—T-Fitting
B—Fuel Line
C—Rubber Packing
D—Packing Nut
E—Rubber Packing
F—Packing Nut

S11,3010,OM -19-21SEP95

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

RG5085 -UN-23AUG88

Torque Wrench Adapter JD307

Use with standard torque wrench to tighten head bolts under rocker arm assembly.

S53,JD307 -19-04MAR87

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 TURBOCHARGED AND AFTERCOOLED ENGINES	% POWER DECREASE NATURALLY ASPIRATED ENGINES
Fuel Temperature Rise of 1˚C (1.8˚ F) above 40˚C (104˚F)	0.19	0.17
Air Temperature Rise of 5.5˚ C (10˚ F) above 25˚C (77˚F)	0.50	1.50
Altitude Rise of 300 m (1000 ft) above 183 m (600 ft)	0.50*	3.00**
Relative Humidity Rise of 10% above 0%	0.07	0.10

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,CTM4,DW680 -19-21SEP95

PRELIMINARY ENGINE TESTING

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

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

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

3. Perform a dynamometer test and record power output. (See DYNAMOMETER TEST later in this group.) Repeat dynamometer test after tune-up. Compare power output before and after tune-up.

4. Perform compression test (See TEST ENGINE COMPRESSION PRESSURE in Group 105).

S11,22010,BW -19-25JUL95

GENERAL TUNE-UP RECOMMENDATIONS

1. 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
Change oil and filter.	Operator's Manual
Lubricate PTO clutch internal levers and linkage.	Operator's Manual
Replace fuel filter.	Group 35/Operator's Manual
Clean crankcase vent tube.	Group 05/Operator's Manual
Check air intake system. Replace air cleaner elements.	This Group/Operator's Manual
Check exhaust system.	This Group
Check and service engine cooling system.	This Group/Operator's Manual
Check and adjust fan and alternator belts.	Group 25/Operator's Manual
Check electrical system.	This Group
Check crankshaft vibration damper (6-cylinder).	Group 15/Operator's Manual
Inspect turbocharger and check turbocharger boost pressure.	Group 110
Check fuel injection system: Check engine/injection pump timing: check and adjust speed advance; clean injection nozzles, and adjust opening pressure.	Group 35 and 115
Check engine oil pressure. Adjust if necessary.	Group 105
Check engine valve clearance. Adjust if necessary.	Group 05
Check engine speeds. Adjust if necessary.	Group 115
Check engine performance on dynamometer.	This Group

RG,CTM8,G100,1 -19-05OCT94

DYNAMOMETER TEST

IMPORTANT: Dynamometers should be periodically checked for accuracy and calibrated as necessary.

NOTE: High elevations may affect engine performance. (See EFFECTS OF ALTITUDE AND TEMPERATURE ON ENGINE PERFORMANCE earlier in this group.)

1. Connect engine to dynamometer using manufacturer's instructions.

2. Operate engine at one-half load until coolant and crankcase oil temperatures are up to normal operating range.

3. Run engine at fast idle, and gradually increase load on engine until speed is reduced to rated speed rpm.

NOTE: Refer to appropriate machine technical manual for average power ratings of specific application. Allow ±5% for minimum and maximum power.

4. Read horsepower on dynamometer and record reading over a period of several minutes after engine stabilizes.

5. Compare readings taken with power rating level for your engine application listed on the following chart.

CTM8,GR105,6 -19-03FEB95

DYNAMOMETER TEST SPECIFICATIONS—SARAN BUILT ENGINES

Engine Model	Injection Pump Option Code	Original Injection Pump (Part No.)	Replaced By Injection Pump (Part No.)	Governor Regulation	Rated Speed (rpm)	Fast Idle (rpm)	Power Ratings* kW (BHP)
3179DF	1602	RE12266	RE37918	STD.	2500	2700	43 (58)
3179DF	1603	RE12267	RE37920	3—5%	1800	1900	34 (46)
3179DF	1620	RE21695**	——	STD.	2500	2700	43 (58)
3179DF	1623	RE21695**	——	STD.	2500	2700	43 (58)
3179DF	1641	RE29907	RE37919	3—5%	1500	1600	30 (40)
3179DF	1643	RE30107	——	3—5%	1800	1900	34 (46)
3179DF	1644	RE37885	——	3—5%	1800	1900	34 (46)
3179DF	1648	RE37884	——	3—5%	1500	1600	31 (41)
3179DF	1650	RE37886	——	STD.	2500	2700	43 (58)
3179TF	1602	RE30230	——	STD.	2500	2700	58 (78)
3179TF	1603	RE30230	——	STD.	2500	2700	58 (78)
3179TF	1632	RE31834	——	STD.	2500	2700	58 (78)
4239DF	1602	AR80230	——	STD.	2500	2700	55 (74)
4239DF	1602	RE15699	——	STD.	2500	2700	56 (75)
4239DF	1602	RE21504	——	STD.	2500	2700	58 (78)
4239DF	1602	RE37927	——	STD.	2500	2700	56 (75)
4239DF	1603	AR80233	——	3—5%	1800	1900	46 (62
4239DF	1603	RE15697	——	3—5%	1800	1900	49 (66)
4239DF	1603	RE37929	——	3—5%	1800	1900	49 (66)
4239DF	1617	RE30543	RE37965	STD.	2200	2400	53 (71)
4239DF	1623	RE21504	——	STD.	2500	2700	58 (78)
4239DF	1641	RE29470	——	3—5%	1500	1600	40 (54)
4239DF	1641	RE37928	——	3—5%	1500	1600	40 (54)
4239DF	1645	RE29470	——	3—5%	1500	1600	40 (54)
4239DF	1646	RE37927	——	3—5%	1800	1900	49 (66)
4239TF	1602	RE16150	——	STD.	2500	2700	70 (94)
4239TF	1602	RE21503	RE26858	STD.	2500	2700	79 (106)
4239TF	1602	RE26858	——	STD.	2500	2700	79 (106)
4239TF	1603	AR99951	RE21515	3—5%	1800	1900	67 (90)
4239TF	1603	RE21515	——	3—5%	1800	1900	67 (90)
4239TF	1623	RE26858	——	STD.	2500	2700	79 (106)
4239TF	1635	RE29471	——	3—5%	1500	1600	54 (72)
4239TF	1636	RE21515	——	3—5%	1800	1900	67 (90)
4239TF	1641	RE29471	——	3—5%	1500	1600	54 (72)
4239AF	1602	RE29200	——	STD.	2500	2700	87 (117)
4239AF	1606	RE29200	——	STD.	2500	2700	87 (117)

** Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset depending upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at factory.*

*** Can be used with JP5/JP8/Jet "A" Fuel*

S11,22010,DJ -19-26JUN95

DYNAMOMETER TEST SPECIFICATIONS—SARAN BUILT ENGINES—CONTINUED

Engine Model	Injection Pump Option Code	Original Injection Pump (Part No.)	Replaced By Injection Pump (Part No.)	Governor Regulation	Rated Speed (rpm)	Fast Idle (rpm)	Power Ratings* kW (BHP)
6359DF	1602	AR80603	——	STD.	2500	2700	86 (115)
6359DF	1602	RE15700	RE37935	STD.	2500	2700	87 (117)
6359DF	1603	AR80604	——	3—5.	1800	1900	69 (92)
6359DF	1603	RE15698	RE37933	3—5%	1800	1900	72 (96)
6359DF	1623	RE15700	RE37935	STD.	2500	2700	87 (117)
6359DF	1636	RE15698	RE37933	3—5%	1800	1900	72 (96)
6359DF	1638	RE29908	RE37934	3—5%	1500	1600	60 (80)
6359DF	1641	RE29908	RE37934	3—5%	1500	1600	60 (80)
6359TF	1602	RE19914	——	STD.	2500	2700	122 (163)
6359TF	1603	RE19981	——	3—5%	1800	1900	105 (141)
6359TF	1605	AR89482	——	STD.	2200	2400	97 (130)
6359TF	1623	RE19914	——	STD.	2500	2700	122 (163)
6359TF	1632	RE19981	——	3—5%	1800	1900	105 (141)
6359TF	1636	RE29472	——	3—5%	1500	1600	87 (117)
6359TF	1641	RE29472	——	3—5%	1500	1600	87 (117)
6359AF	1602	RE24924	——	STD.	2500	2700	131 (176)
6359AF	1608	RE24924	——	STD.	2500	2700	131 (176)
6359AF	1609	RE24925	——	3—5%	1800	1900	112 (151)
6359AF	1611	RE24925	——	3—5%	1800	1800	112 (151)
6359AF	1641	RE29473	——	3—5%	1500	1600	96 (128)
6359AF	1650	RE29473	——	3—5%	1500	1600	96 (128)

** Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset depending upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at factory.*

S55,22010,DP -19-11JUL95

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DYNAMOMETER TEST SPECIFICATIONS—DUBUQUE BUILT ENGINES

Engine Model	Injection Pump Option Code	Original Injection Pump (Part No.)	Replaced By Injection Pump (Part No.)	Governor Regulation	Rated Speed (rpm)	Fast Idle (rpm)	Power Ratings* kW (BHP)
4239DF	1602	RE20510	——	STD.	2500	2700	59 (79)
4239DF	1603	RE20511	——	3—5%	1800	1900	49 (66)
4239DF	1604	RE20211	——	STD.	2500	2700	52 (70)
4239DF	1624	RE28451	——	3—5%	1800	1900	49 (66)
4239TF	1602	RE27450	——	STD.	2500	2700	81 (109)
4239TF	1603	RE27451	——	3—5%	1800	1900	69 (93)
4239TF	1619	RE24765	——	STD.	2500	2700	81 (109)
4239TF	1624	RE38018	——	3—5%	1800	1900	69 (93)
4276DF	1602	AR70530	——	STD.	2500	2700	61 (82)
4276DF	1602	AR78647	——	STD.	2500	2700	61 (82)
4276DF	1602	RE20994	——	STD.	2500	2700	61 (82)
4276DF	1603	AR70530	——	3—5%	1800	1900	53 (71)
4276DF	1603	AR79212	——	3—5%	1800	1900	53 (71)
4276DF	1603	RE20996	——	3—5%	1800	1900	53 (71)
4276DF	1613	RE22592	——	STD.	2300	2500	61 (82)
4276DF	1621	RE28454	——	STD.	2500	2700	61 (82)
4276DF	1624	RE28455	——	3—5%	1800	1900	53 (71)
4276TF	1602	AR71421	RE16265	STD.	2200	2400	73 (98)
4276TF	1602	RE16265	——	STD.	2200	2400	73 (98)
4276TF	1603	AR76503	AR90716	3—5%	1800	2000	78 (105)
4276TF	1603	RE18938	——	3—5%	1800	2000	78 (105)
4276TF	1605	AR90716	——	STD.	2200	2400	73 (98)
4276TF	1609	RE18937	——	3—5%	1800	1900	78 (105)
4276TF	1623	RE28808	——	STD.	2200	2400	73 (98)
4276TF	1624	RE28809	——	3—5%	1800	1900	78 (105)

** Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset depending upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at factory.*

S55,22010,K -19-21SEP95

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DYNAMOMETER TEST SPECIFICATIONS—DUBUQUE BUILT ENGINES—CONTINUED

Engine Model	Injection Pump Option Code	Original Injection Pump (Part No.)	Replaced By Injection Pump (Part No.)	Governor Regulation	Rated Speed (rpm)	Fast Idle (rpm)	Power Ratings* kW (BHP)
6359DF	1602	RE24182	——	STD.	2500	2700	90 (121)
6359DF	1603	RE24184	——	3—5%	1800	1900	74 (99)
6359DF	1619	RE24182	——	STD.	2500	2700	90 (121)
6359DF	1624	RE24182	——	3—5%	1800	1900	74 (99)
6359TF	1602	RE25699	——	STD.	2500	2700	122 (163)
6359TF	1603	RE38764	——	3—5%	1800	1900	105 (141)
6359TF	1621	RE25699	——	STD.	2500	2700	122 (163)
6359TF	1624	RE38764	——	3—5%	1800	1900	105 (141)
6414DF	1602	AR66395	AR104000	STD.	2200	2400	88 (118)
6414DF	1602	AR70778	——	STD.	2200	2400	88 (118)
6414DF	1602	AR104000	——	STD.	2200	2400	88 (118)
6414DF	1603	AR70551	——	3—5%	1800	1900	79 (106)
6414DF	1609	RE18940	——	3—5%	1800	1900	79 (106)
6414DF	1619	RE28464	——	STD.	2200	2400	88 (118)
6414DF	1624	RE28463	——	3—5%	1800	1900	79 (106)
6414TF	1602	AR70778	——	STD.	2200	2400	109 (146)
6414TF	1602	AR104000	——	STD.	2200	2400	109 (146)
6414TF	1603	AR70551	——	3—5%	1800	1900	119 (160)
6414TF	1609	RE18940	——	3—5%	1800	1900	119 (160)
6414TF	1619	RE28464	——	STD.	2200	2400	109 (146)
6414TF	1624	RE28465	——	3—5%	1800	1900	119 (160)

** Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset depending upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at factory.*

RG,CTM4,DT437 -19-21SEP95

ENGINE BREAK-IN GUIDELINES

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

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

• Pistons, rings, or liners have been replaced.

• 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,G105,2-19-25JUL95

PERFORM ENGINE BREAK-IN

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

IMPORTANT: DO NOT use 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.

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

1. Fill engine crankcase to proper level with John Deere Break-In Oil during break-in operation. This oil is specifically formulated to enhance break-in of John Deere diesel engines.

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

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

PRELIMINARY ENGINE BREAK-IN AFTER MAJOR OVERHAUL

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

NOTE: To retighten cylinder head cap screws, use JD307 Torque Wrench Adapter. This special tool permits tightening of screws under rocker arm shaft without having to remove rocker arm and shaft assembly.

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

4. Loosen, then retighten cylinder head cap screws (if required) as specified in Group 05, Cylinder Head and Valves.

5. Check and readjust valve clearance as necessary. (See Group 05.)

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

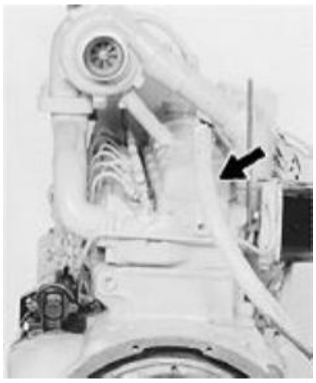
If the engine has significant operating time at idle, constant speeds, and/or light load usage, an additional 100 hour break-in period is recommended using a new change of John Deere Engine Break-In Oil and new John Deere oil filter.

As a general rule, makeup oil should not need to be added during 100-hour break-in period. However, if makeup oil is required in the first 100-hour break-in, an additional 100-hour break-in period is required. Use a new change of John Deere Engine Break-In Oil and new John Deere oil filter.

**Speeds given are for all engine applications except gen sets which will run at a constant full load rated speed (1500 rpm or 1800 rpm). Follow recommended load and time given in chart; speeds will vary on gen set engines.*

RG,CTM4,DT438 -19-01NOV95

CHECK CRANKCASE VENTILATION SYSTEM



RG4833 -UN-30NOV88

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 or hose with solvent and compressed air if restricted. Install and tighten hose clamps securely.

S11,22010,BX -19-26JUN95

CHECK AIR INTAKE SYSTEM

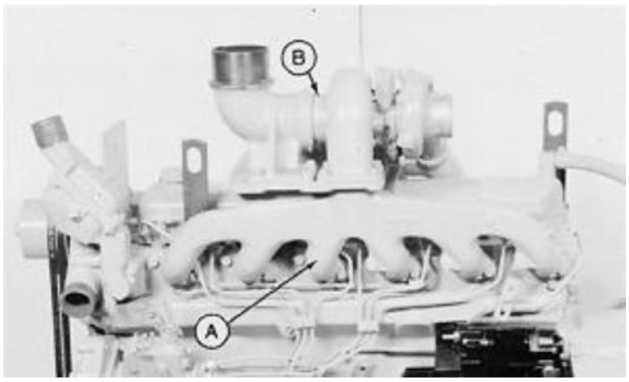
1. Replace air cleaner primary filter element. Replace secondary element if primary element has holes in it.

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

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

S11,22010,BY -19-26JUN95

CHECK EXHAUST SYSTEM



RG4834 -UN-30NOV88

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

2. On turbocharged engines, check exhaust adapter (B) to make sure it has end play and rotates freely. Correct as necessary.

S11,22010,BZ -19-26JUN95

CHECK AND SERVICE COOLING SYSTEM

TS281 -UN-23AUG88

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

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

3. Inspect radiator hoses for signs of leakage or rot. Replace hoses as necessary.

CAUTION: Do not drain coolant until it has cooled below operating temperature. Always loosen block drain valve slowly to relieve any excess pressure.

4. Remove and check thermostats. (See REMOVE, TEST, AND INSTALL THERMOSTATS in Group 25.)

5. 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 or plug in thermostat housing to allow air to escape when filling system. Retighten fitting or plug when all the air has been expelled.

6. Fill cooling system with recommended concentration of coolant, clean soft water, and inhibitors. (See ENGINE COOLANT RECOMMENDATIONS/SPECIFICATIONS in Group 02.)

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

8. After engine cools, check coolant level.

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

9. Check system for holding pressure. (See PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP in Group 105.)

RG,CTM8,DX126 -19-21SEP95

CHECK ELECTRICAL SYSTEM

TS204 -UN-23AUG88

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

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

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

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

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

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

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

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

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

5. If batteries appear to be either undercharged or overcharged, check alternator and charging circuit. Follow diagnosis and testing procedures outlined in CTM77.

6. Check tension of fan belts. (See Engine Operator's Manual.)

7. Check operation of starting motor and gauges.

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

Cooling System Pressure Pump D05104ST

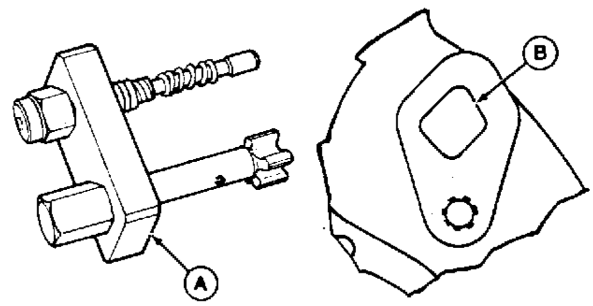
Used to pressure test radiator cap and cooling system.

R26406 -UN-23JAN89

S55,D05104ST -19-03OCT94

Flywheel Turning Tool (A) JD281A

Used on engines with 142 tooth flywheel ring gear and a diamond shaped tool guide bore (B) in flywheel housing. Tool has it’s own spring loaded timing pin which threads into flywheel housing.

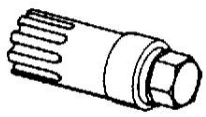


RG6252 -UN-22JUL92

RG,JD281A -19-17JUL92

Flywheel Turning Tool JDE83

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



RG6251 -UN-22JUL92

RG,JDE83 -19-17JUL92

RG5068 -UN-23AUG88

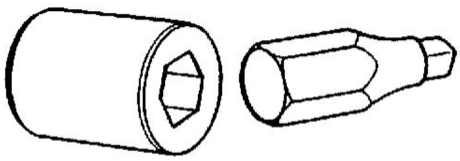
Timing Pin JDE81-4

Lock engine at TDC when installing injection pump or timing valve train. Use with JDG820, JDE81-1, or JDE83 Flywheel Turning Tool.

RG,JDE814 -19-03JAN95

Oil Galley Plug Tool JDG782

Used to remove and install oil galley plug.

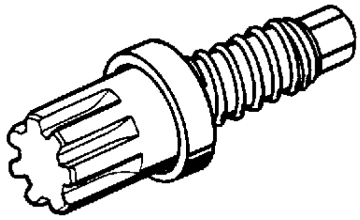


RG6612 -UN-29JAN93

RG,JDG782 -19-02APR93

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.



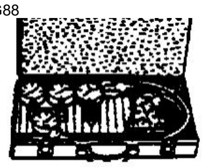
RG7056 -UN-10AUG94

RG,CTM8,DW570 -19-22SEP95

RG5162 -UN-23AUG88

Universal Pressure Test Kit JT05470

Gauge to check oil and fuel pressure.

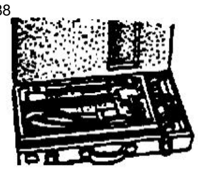


S53,JT0547,0 -19-03OCT94

RG5161 -UN-23AUG88

Compression Test Set . JT01674 (formerly D14546BA)

Check engine compression. Use adapter and gauge/hose assembly from set.



S53,JT01674 -19-03OCT94

ENGINE TEST SPECIFICATIONS

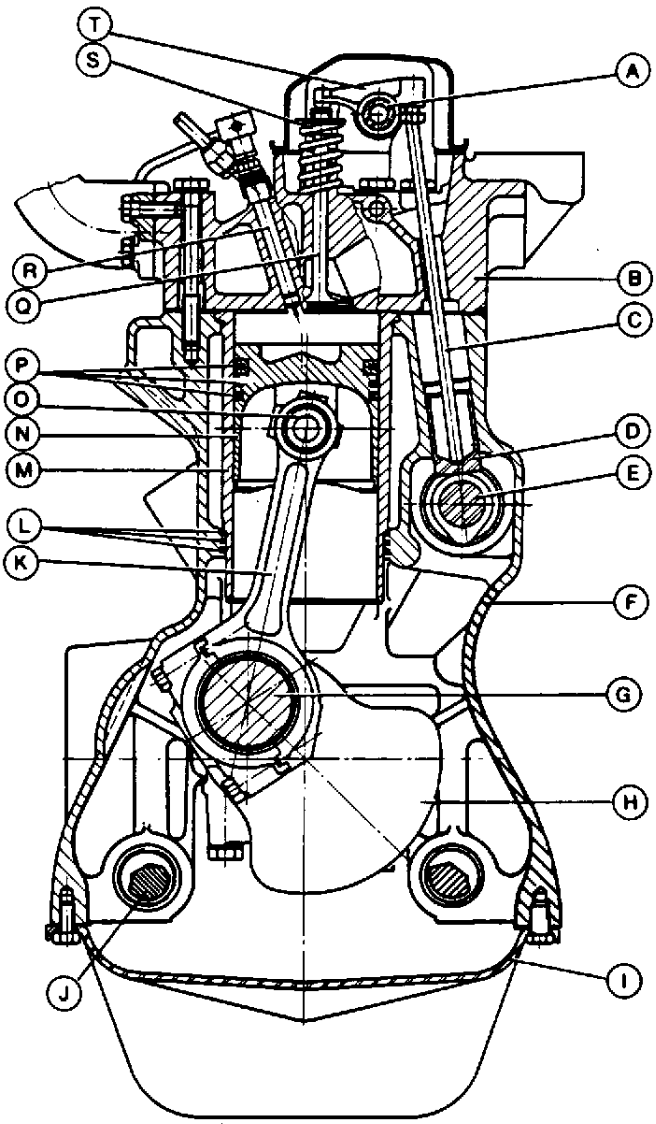
ITEM	SPECIFICATION	WEAR LIMIT
Engine Compression Pressure at 150—200 rpm Cranking Speed:		
Minimum	2400 kPa (24 bar) (350 psi)	——
Maximum Difference between Cylinders	350 kPa (3.5 bar) (50 psi)	——
Engine Oil Pressure at 93°C (200°F) Sump Temperature:		
Minimum at 850 rpm (4- and 6-cylinder)	100 kPa (1.0 bar) (15 psi)	——
Minimum at 850 rpm (3-cylinder)	140 kPa (1.4 bar) (20 psi)	——
Maximum at rated speed*	280—410 kPa (2.8—4.1 bar) (40—60 psi)	——
Engine Blow-By at Crankcase Vent Tube:		
3- and 4-Cylinder “D” Engines	4.0 m^3/h (141 cu ft/h)	——
6-Cylinder “D” Engines	6.0 m^3/h (225 cu ft/h)	——
3- and 4-Cylinder “T” and “A” Engines	6.0 m^3/h (225 cu ft/h)	——
6-Cylinder “T” and “A” Engines	8.0 m^3/h (282 cu ft/h)	——
Cooling System Leakage Test Pressure**	50 kPa (0.5 bar) (7 psi)	——

**Gauge fluctuations and tolerance extremes can result in readings up to 586 kPa (5.86 bar) 85 psi.*

***Test pressures recommended for all Deere OEM cooling systems. On specific vehicle applications, test cooling system and pressure cap according to the recommended pressure for that vehicle.*

CTM8,GR105,5 -19-01NOV95

ENGINE—SECTIONAL VIEW



RG7248 -UN-11JUL95

A—Rocker Arm Shaft	**F—Cylinder Block**	**K—Connecting Rod**	**P—Piston Rings**
B—Cylinder Head	**G—Crankshaft**	**L—Liner Packing Rings**	**Q—Valve**
C—Push Rod	**H—Crankshaft Counterweight**	**M—Cylinder Liner**	**R—Fuel Injection Nozzle**
D—Cam Follower	**I—Oil Pan**	**N—Piston**	**S—Valve Spring**
E—Camshaft	**J—Balancer Shafts**	**O—Piston Pin**	**T—Rocker Arm**

S11,2000,EH -19-11JUL95

GENERAL ENGINE DESCRIPTION

Model 3179, 4239, 4276, 6359, and 6414 engines are vertical-in-line, valve in head, 4-cycle (stroke) diesel engines.

Direct fuel injection is provided by a distributor-type fuel injection pump and 9.5 mm injection nozzles mounted in cylinder head. The pump is driven by an intermediate gear in the timing gear train meshing with the crankshaft gear.

Some engines are equipped with a turbocharger. Operated by exhaust gases, the turbocharger compresses intake air from air cleaner and routes it to the combustion chamber.

Aftercooled engines are turbocharged, and in addition, have a heat exchanger (called an aftercooler) located in the intake manifold. The aftercooler cools the compressed (and heated) intake air from the turbocharger before entering the combustion chamber. Engine coolant flowing through the aftercooler is the media used for heat exchange.

The camshaft is driven by an intermediate gear in the timing gear train which meshes with the crankshaft gear. Camshaft rotates in honed machined bores in cylinder block; no bushings are used. The camshaft lobes determine the time and rate of opening of each valve and actuates the fuel transfer pump.

Intake and exhaust valves are operated by cam followers, push rods and rocker arm assembly. Valve seat inserts in cylinder head are used for intake and exhaust valves on turbocharged engine. Naturally aspirated engines have inserts for intake valves only.

The crankshaft is a one-piece, heat treated, steel forging which operates in replaceable two-piece main bearings.

Two different types of crankshaft main thrust bearing inserts are used to control end-play, depending on the producing factory. Normally a two-piece thrust bearing insert is used on Dubuque engines. A five-piece bearing insert normally is installed on Saran engines. The five-piece bearing has high thrust load capability.

The five-piece thrust bearings must be installed as a set. They may also be retro-fitted to Dubuque engines at service repair if so desired. Should a crankshaft be found to have developed excessive end play, an oversized thrust bearing plate set is available through service parts. Thrust bearing side plates are available in either standard size or 0.007 in. oversize.

Cylinder liners are “wet” (surrounded by coolant) and are individually replaceable. O-rings are used to seal the connection between cylinder block and liners.

Pistons are constructed of cast aluminum alloy and cam ground. The piston crown has a cut-out swivel cup with a truncated cone in the center. Two compression rings and one oil control ring are used. The top compression ring is a keystone type ring. All piston rings are located above the piston pin.

The 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.

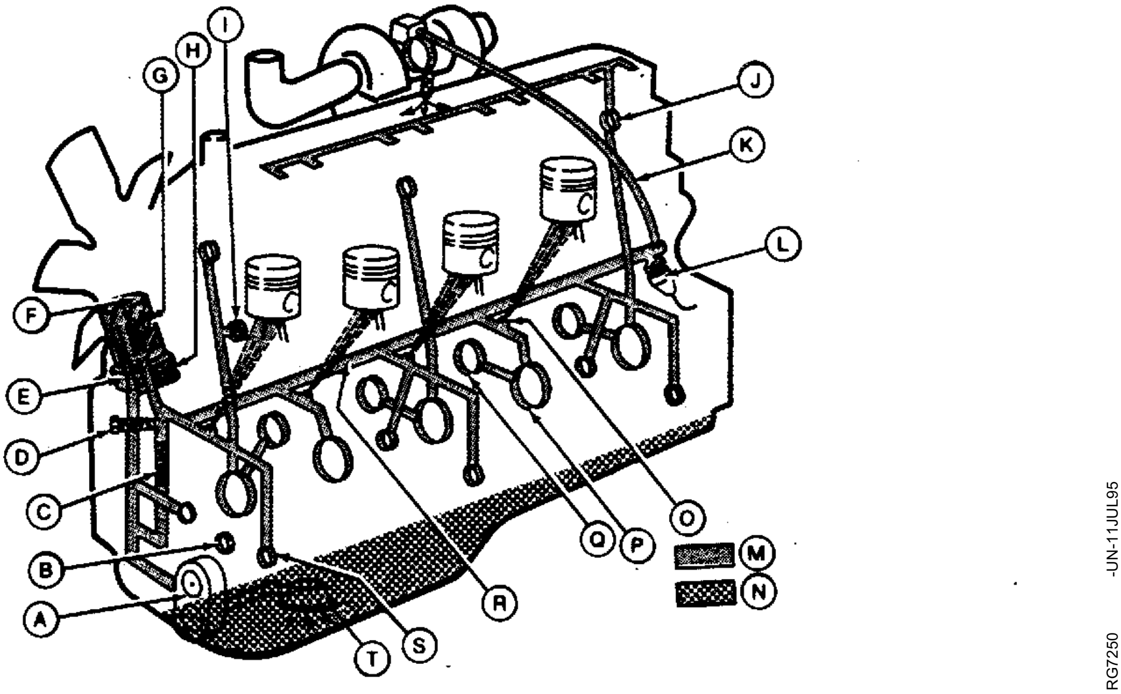
Connecting rods are of forged steel and have replaceable bushing and bearing inserts.

The engine is supplied with lubricating oil by a gear pump driven by the crankshaft. The lubricating oil passes through a full-flow oil filter in the main oil gallery of cylinder block. To ensure engine lubrication, the oil filter is provided with a by-pass valve which opens when the filter element is restricted. On most engines, engine oil is cooled by means of an oil cooler mounted externally on the cylinder block. Engine oil passes through the oil cooler before flowing to the oil filter. A by-pass valve located between oil pump and main gallery relieves any pressure build-up in this area.

Balancer shafts are used on some four-cylinder engines to reduce vibration. The two shafts operate on bushings in cylinder block and are counter-rotating at twice the engine speed.

The engine has a pressurized cooling system, consisting of radiator, water pump, multi-blade fan and one or two thermostats.

HOW THE LUBRICATION SYSTEM WORKS (4239 ENGINE WITH TURBOCHARGER SHOWN)



A—Oil Pump
B—Lower Idler Gear Bushing
C—Oil Bypass Valve
D—Oil Pressure Regulating Valve
E—Oil Cooler
F—Oil Filter
G—Oil Filter Relief Valve
H—Oil Cooler Bypass Valve
I—Upper Idler Gear Bushing
J—Camshaft Bearings
K—Lubricating Oil Line-to-Turbocharger (when equipped)
L—Oil Pressure Warning Switch
M—Engine Lubricating Oil
N—Pressure-Free Oil
O—Spray Jet (4 used)
P—Main Bearings
Q—Connecting Rod Bearings
R—Main Oil Gallery
S—Balancer Shaft Bushings (4 cylinder)
T—Suction Screen

The pressure lubrication system consists of an oil pump (A), filter strainer in the suction pipe, full flow oil filter (F), oil cooler (E), oil pressure regulating valve (D), oil bypass valve (C) and an electrical oil pressure warning switch (L) in the flywheel housing.

The pump draws lubrication oil from the crankcase through a strainer and a suction line. The oil is then pumped through an oil line to the oil cooler (E), oil filter (F) and through the main oil gallery (R) of the cylinder block.

From the oil gallery, oil is forwarded under pressure to the main bearings (P) and spray jets (O) to cool the pistons. Drilled cross-passages in the crankshaft distribute oil from the main bearings to connecting rod bearings (Q).

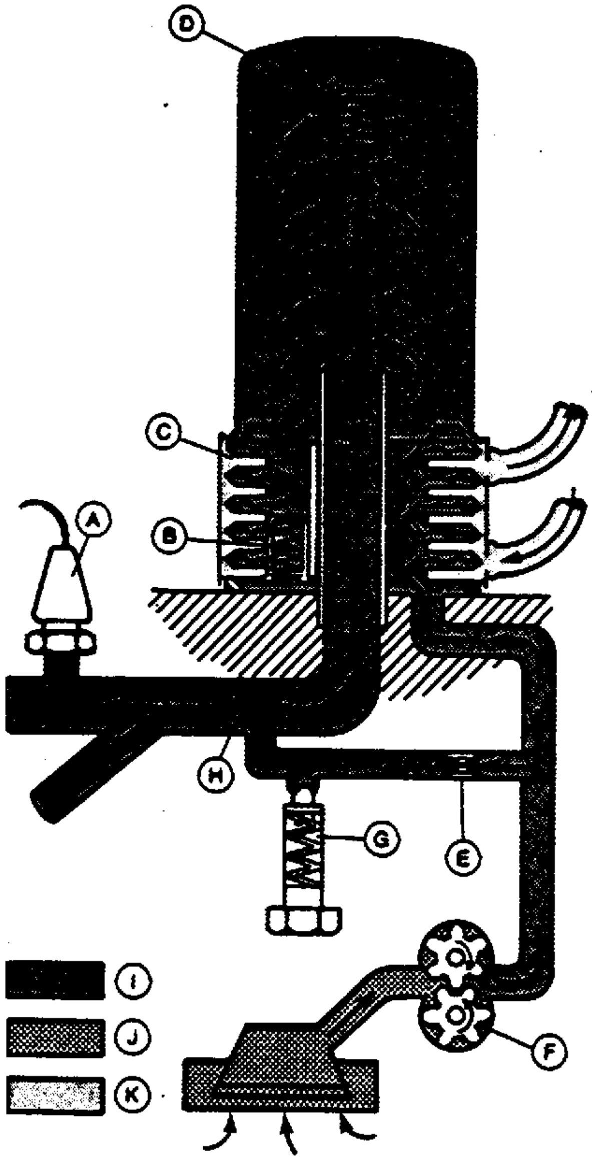
Lube oil holes in Nos. 1, 3, and 5 main bearing oil grooves are provided to direct oil to the camshaft bearings (J).

A drilled passage from the rear camshaft bearing through the cylinder block and cylinder head supplies lubricating oil to the rocker arm shaft.

Oil passages direct from the main oil gallery provide lubricating oil to balancer shaft bushings (S) and the shaft of the turbocharger. The front right-hand balancer shaft bushing is lubricated direct from the oil pump.

S11,22010,CD -19-28SEP95

HOW THE LUBRICATION SYSTEM WORKS—CONTINUED



RG5165 -UN-30NOV88

An externally non-adjustable pressure regulating valve is located at the front cylinder block in the oil gallery (H). It controls the oil pressure and provides constant pressure in the main gallery and in the complete lubrication system.

The valve consists of a valve cone held against a seat by a spring and plug. If oil pressure exceeds spring pressure, the valve cone is raised from the seat, permitting oil to by pass to the crankcase and maintain constant pressure.

An oil by-pass valve* (E) is located in the cylinder block behind the front plate and near the oil pressure regulating valve on later 3179, 4239, and 6359 Engines. On 4276 and 6414 Engines the valve is located in the bottom side of oil cooler. Should the difference between the pressures in the main oil gallery and oil pump become excessive, this valve would open and let oil by-pass the filter and oil cooler to reach the main gallery faster. This valve has a permanent setting which cannot be changed.

The oil filter is mounted on the right-hand side of the engine. It is a full-flow type with a spin-on type replacement element. If the filter clogs, a by-pass valve (D) in the element opens to keep a full flow of the oil to vital engine parts.

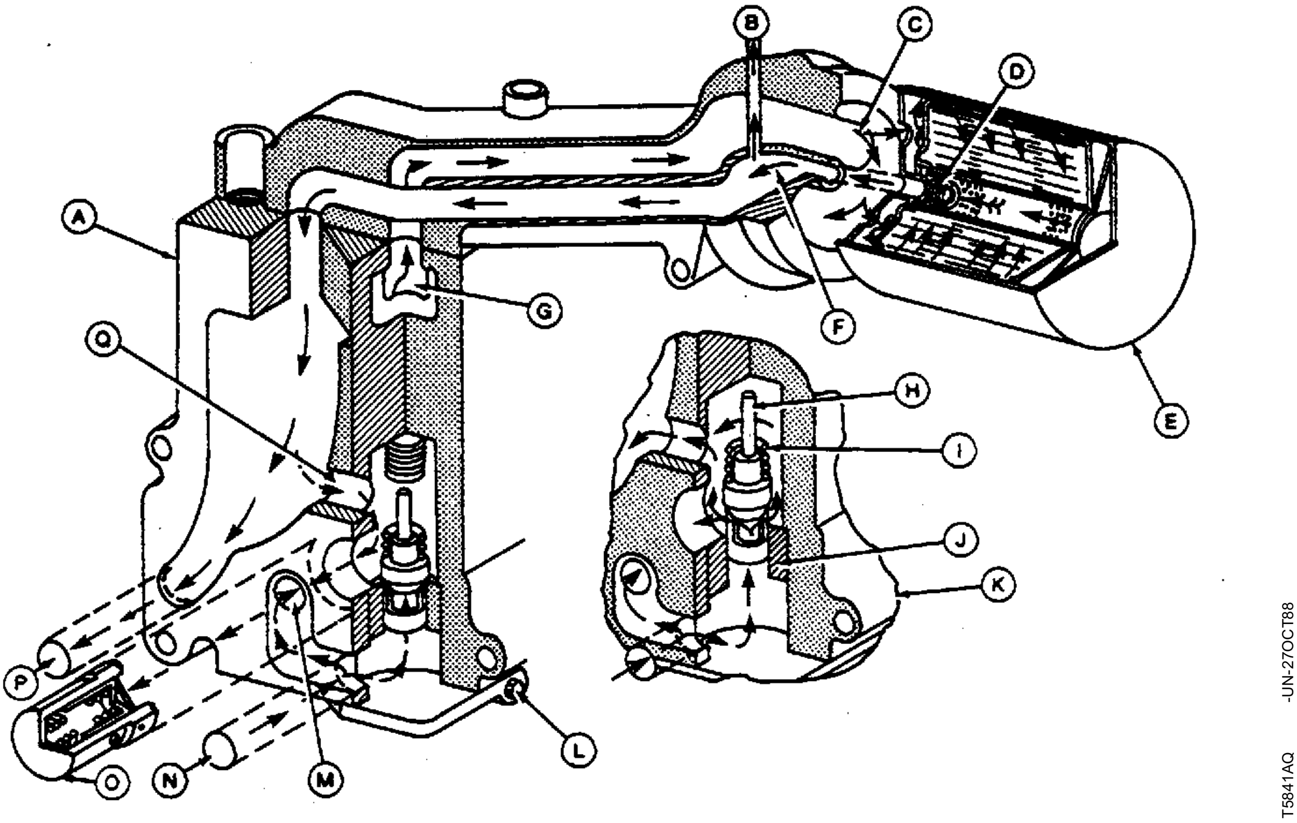
NOTE: Illustration shows the standard-flow oil cooler (C). Some engines are equipped with a cooler having a different appearance, but having the same function.

A—Oil Pressure Warning Switch
B—Oil Cooler By-Pass Valve
C—Oil Cooler
D—Oil Filter Relief Valve
E—By-Pass Valve
F—Oil Pump
G—Oil Pressure Regulating Valve
H—Main Oil Gallery
I—Lubricating Oil
J—Pressure-Free Oil
K—Coolant from Cooling System

**On 3179 Engines Serial No. (CD465253—), 4239D Engines Serial No. (CD460067—), 4239T Engines Serial No. (CD464488—), 6359 Engines Serial No. (CD465213—), All Dubuque-built engines.*

RG,CTM4,DW808 -19-29SEP95

OIL COOLER OPERATION—4276 AND 6414 ENGINES



A—Oil Cooler Housing
B—Lube Oil-to-Turbocharger
C—Filter Inlet Oil
D—Filter Bypass Spring
E—Filter
F—Outlet Oil (Clean)
G—From Oil Cooler
H—Oil Cooler Bypass Valve
I—Spring
J—Seat
K—Oil Cooler Bypass Operation
L—Oil Cooler Coolant Drain
M—To Oil Cooler
N—From Oil Pump
O—Oil Pressure Regulating Valve
P—To Oil Gallery
Q—To Regulating Valve

• Normal Operation

Oil from the oil pump enters gallery (M). This gallery also routes this oil to the base of the oil cooler bypass valve (H). During normal operation the bypass valve (H) is held on its seat (J) by spring (I) and all oil is routed through the oil cooler. The oil cooler operates the same as a radiator. Oil passes through tubes which transfer heat to the engine coolant.

Cooled oil is routed from oil cooler (G) to the filter inlet (C) of the oil filter (E). After the oil passes through the filter, clean oil is routed to the turbocharger (B) for lube, to the oil gallery (P), to regulating valve passage (Q), and to oil pressure regulating valve (O).

• Bypass Operation

When the engine is started in cold weather, oil flows from the pump and enters gallery (M). However, due to the higher viscosity (thickness) of the cold oil, all the oil from the oil pump cannot flow through the tubes in the oil cooler and through the filter. When the pressure difference between the main oil gallery (P) and oil cooler inlet (M) is higher than 370 kPa (54 psi), the oil cooler bypass valve (H) moves up off its seat (J). This allows oil to enter the engine oil gallery (P) and turbocharger inlet (B) and bypasses the filter and cooler. As soon as the pressure difference decreases, the bypass valve closes and the oil is routed through the oil cooler and filter to the oil gallery.

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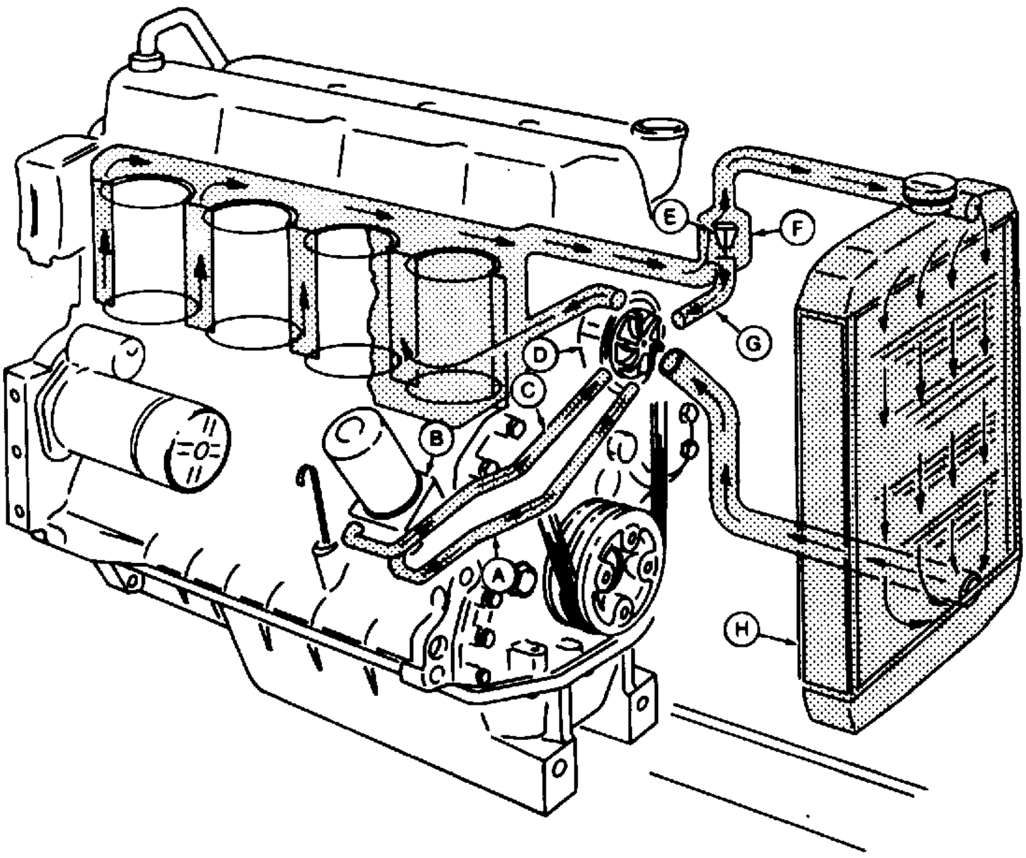
HOW THE COOLING SYSTEM WORKS—ENGINES WITH STANDARD-FLOW OIL COOLER



A—Coolant Flow to Oil Cooler
B—Oil Cooler
C—Return Flow to Water Pump
D—Water Pump
E—Thermostat
F—Thermostat Housing
G—Coolant Bypass
H—Radiator

The pressure cooling system includes the radiator, water pump multi-blade fan and the thermostat.

During the warm-up period, thermostat (E) remains closed and coolant is directed through bypass (G) to suction side of water pump (D). The coolant then circulates through the cylinder block and water pump only to provide a uniform and fast warm-up period.

Once the engine has reached operating temperature, the thermostat opens and coolant is pumped from the bottom of radiator via the bottom hose into the cylinder block. Here it circulates through the block and around the cylinder liners. From the block, coolant is then directed through the cylinder head and into thermostat housing (F). With the thermostat open, coolant passes through the housing into the top of radiator (H) where it is circulated to dissipate heat.

NOTE: Oil cooler (B) illustrated is the standard-flow type. If engine is equipped with a high-flow cooler, two additional lines (for coolant) lead to the oil cooler. (See ENGINES WITH HIGH-FLOW OIL COOLER, next module.)

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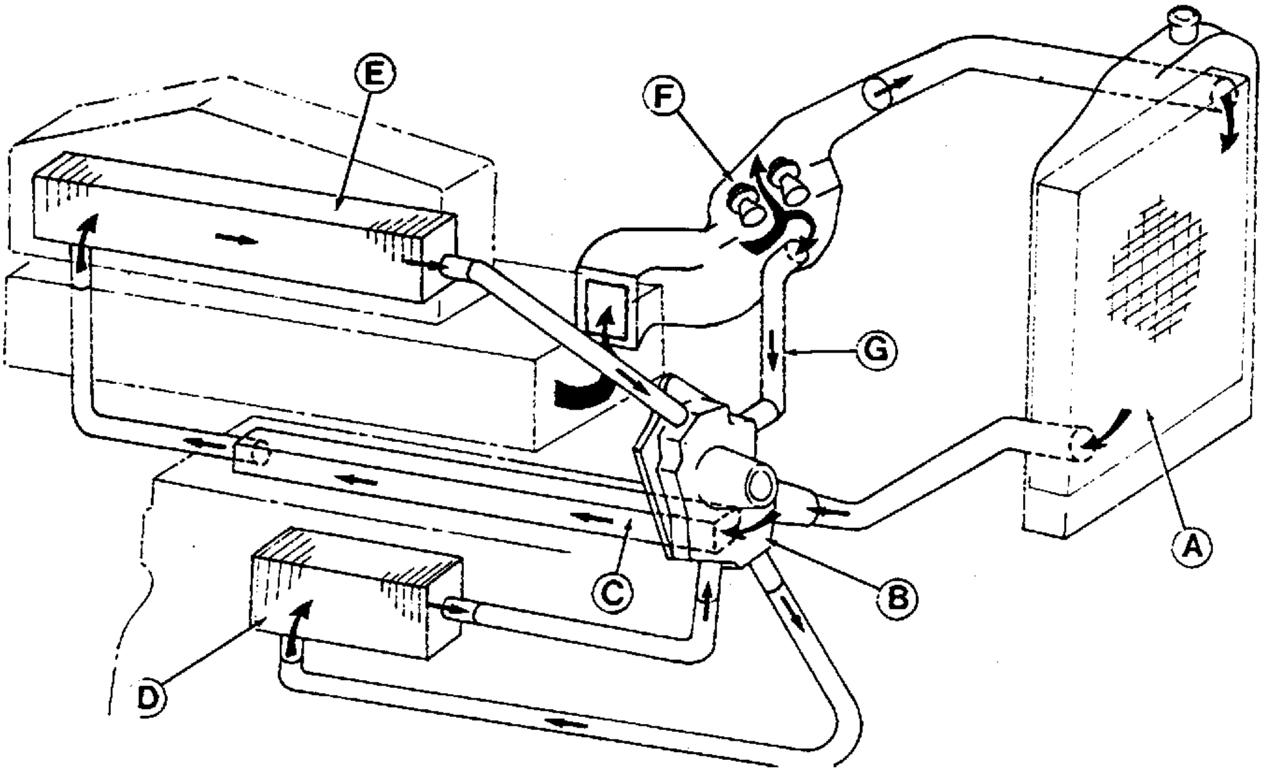
S11,22010,CF -19-28SEP95

HOW THE COOLING SYSTEM WORKS—ENGINES WITH HIGH-FLOW OIL COOLER



A—Radiator
B—Water Pump
C—Cylinder Block Main Cooling Gallery
D—High-Flow Oil Cooler
E—Aftercooler
F—Thermostats
G—Bypass Pipe

The pressure cooling system consists of a conventional-type radiator (A), water pump (B) and thermostats (F).

The pump draws coolant from bottom of radiator and discharges it into coolant inlet manifold (C). Coolant from the manifold circulates through the block to cool block and cylinder liners before flowing into cylinder head. From the cylinder head, coolant passes into the thermostat housing.

If thermostats are closed (as during warm-up periods), coolant is directed back to the pump through the bypass pipe (G) to be recirculated. This provides a faster and more uniform warm-up.

If thermostats are open, (engine at normal operating temperature) coolant flows back through the thermostats to the top of radiator.

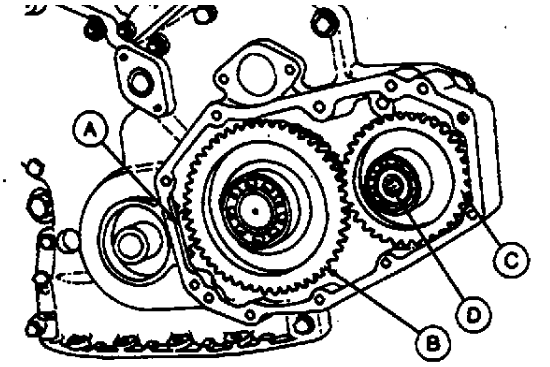
The engine high flow oil cooler (D) receives coolant from water pump and circulates it through the block.

On “A” Engines, coolant is taken from rear end of inlet manifold in block and circulated through the aftercooler (E) to cool intake air. From the aftercooler, coolant returns back to the water pump.

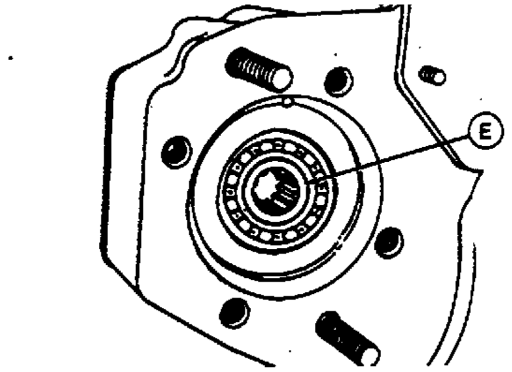
HOW THE CRANKSHAFT GEAR-DRIVEN AUXILIARY DRIVE WORKS

A drive gear (A) on the engine crankshaft transmits power through an idler gear (B) to the auxiliary (output) drive gear (C) for driving engine accessories. The output shaft at front (D) is equipped with a 5/8—9 tooth SAE type "A" spline and 2-bolt mounting. Output shaft at rear (E) is equipped with a 7/8—13 tooth SAE type "B" spline which can have either a 2-bolt or 4-bolt mounting.

A—Drive Gear
B—Idler Gear
C—Auxiliary (Output) Drive Gear
D—Output Shaft (at front)
E—Output Shaft (at rear)



RG5173 -UN-30NOV88



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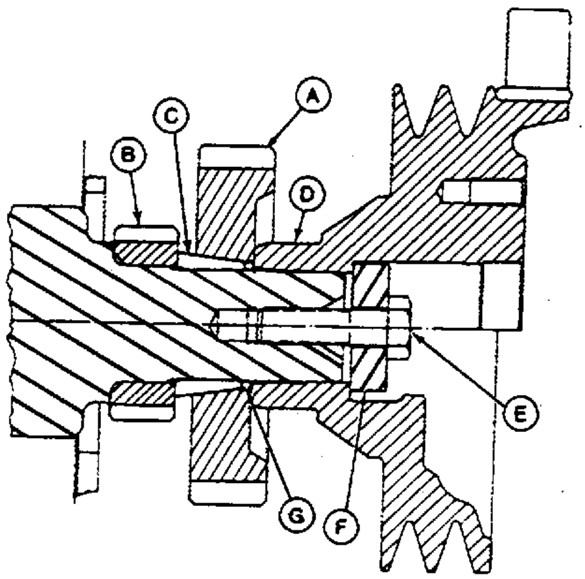
The auxiliary drive gear (A) is positioned in front of the regular crankshaft gear (B) and mounts on a tapered collet (C). When damper pulley (D) and cap screw (E) are installed, the auxiliary drive gear is forced onto the collet causing the collet to clamp onto the crankshaft nose. This allows power to be transmitted through the collet and drive gear. One O-ring (G) is used to prevent external seepage of engine oil.

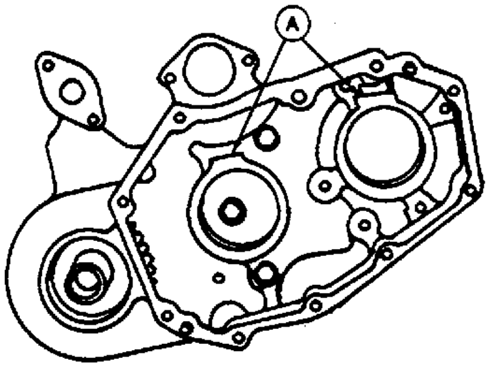
A—Auxiliary Crankshaft Drive Gear
B—Regular Crankshaft Gear
C—Tapered Collet
D—Pulley
E—Cap Screw
F—Washer
G—O-Ring



RG5175 -UN-30NOV88

CTM8,GR105,18 -19-18FEB95

The idler and output gears are supported by ball bearings. Gears and bearings are splash lubricated. Splash oil collecting on top of bearing bosses (A) is directed down through a hole in each boss to lubricate the bearings.



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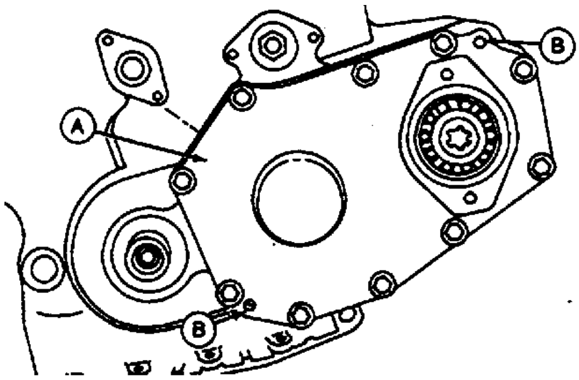
The auxiliary gear cover (A) supports the outer bearing race for the idler and output gear assemblies. Two dowel pins (B) are used to properly align auxiliary gear cover to timing gear cover.



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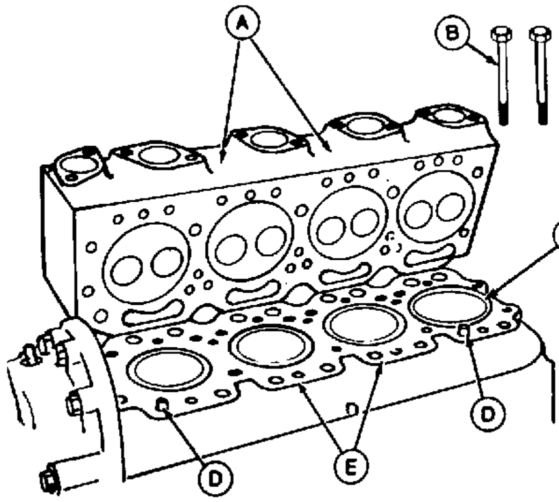
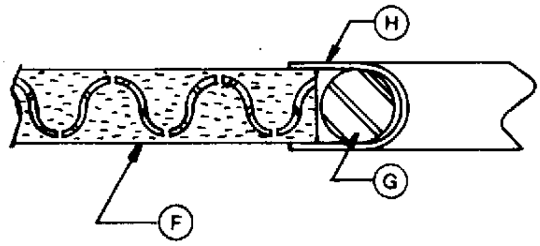
HEAD GASKET JOINT CONSTRUCTION AND OPERATION

The head gasket joint consists of the following components:

• Cylinder head gasket
• Cylinder head (A)
• Cylinder block (E)
• Cylinder liners (C)
• Cylinder head cap screws (B)



The head gasket must form an air-tight seal between cylinder liners and cylinder head that can withstand the temperatures and pressures of the combustion process. The gasket must also form a liquid-tight seal between the cylinder head and cylinder block to retain coolant and oil in their respective passages. The gasket is constructed of thin, formed sheets of steel-inserted, non-asbestos material (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).



A—Cylinder Head
B—Cylinder Head Cap Screws
C—Cylinder Liners
D—Dowel Pins
E—Cylinder Block
F—Gasket Body
G—Fire Ring Combustion Seal
H—Stainless Steel Flange

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.

DIAGNOSING HEAD GASKET JOINT FAILURES

NOTE: DB1119 'CYLINDER HEAD GASKET FAILURES' for 400 Series engines can be used as a guide for diagnosing head gasket failures on 300 Series engines. Use 300 Series specifications from this manual (CTM4).

Head gasket failures generally fall into three categories:

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

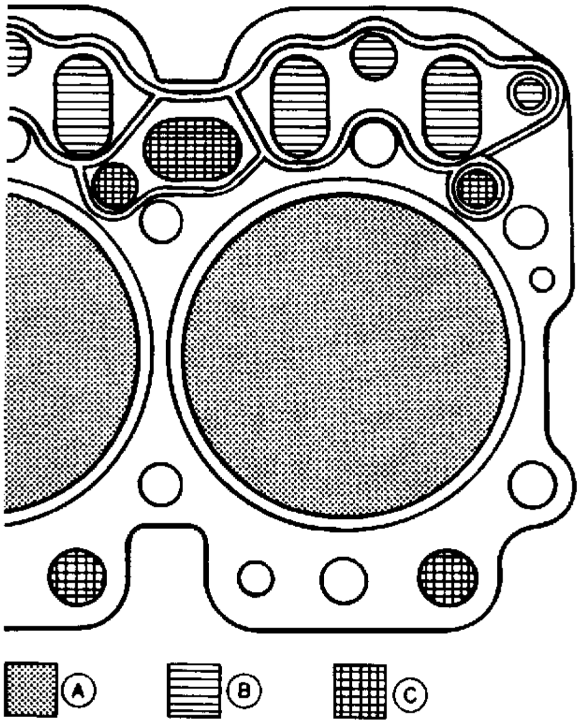
Combustion seal failures occur when combustion gases escape between cylinder head and head gasket combustion flange, or between combustion flange and cylinder liner. Leaking combustion gases may vent to an adjacent cylinder, to a coolant or oil passage, or externally.

Coolant or oil seal failures occur when oil or coolant escapes between cylinder head and gasket body, or between cylinder block and gasket body. The oil or coolant may leak to an adjacent coolant or oil passage, or externally. Since oil and coolant passages are primarily on right hand (camshaft) side of engine, fluid leaks are most likely to occur in that area.

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

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

- Oil or coolant in head gasket seam, or on adjacent surfaces. Especially right rear corner of gasket joint.
- Displacement of gasket from normal position.
- Discoloration or soot from combustion gas leakage.
- Leaking radiator, overflow tank, or hoses.
- Leaking coolant from 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.



RG6432 -UN-17SEP92

A—Combustion Sealing Areas
B—Oil Sealing Areas
C—Coolant Sealing Areas

RG,CTM4,DW809 -19-28SEP95

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)

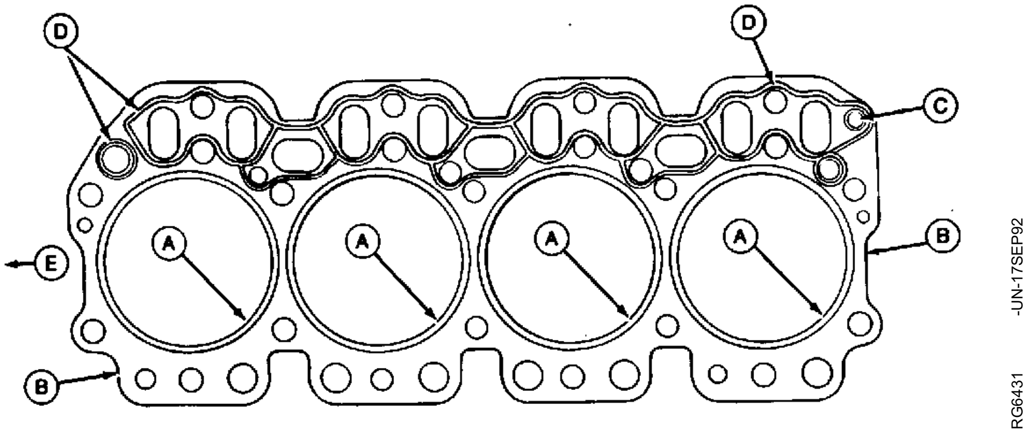
Possible Causes:

- 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.

7. Clean block, head, liners, and cap screws. (See Groups 05 and 10.)

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

Cylinder Head (See Group 05.)
- Check surface flatness/finish.
- Inspect for surface damage.
- Check cylinder head thickness, if resurfacing.

Cylinder Block and Liners (assembled and clamped) (See Group 05 or 10.)
- Check liner standout at four places on each liner.
- Check liner standout difference between cylinders.

Cylinder Block (See Group 10.)
- Check surface flatness/finish.
- Inspect for surface damage.
- Check liner counterbore depth (if liner is removed).
- Check top deck to crankshaft centerline dimension.
- Inspect cap screw bosses, must be clean/intact.

Cylinder Liner (See Group 10.)
- Check liner flange flatness/finish.
- Check liner flange thickness (if liner is removed).
- Inspect flange for damage.

Cylinder Head Cap Screws (See Group 05.)
- Inspect for corrosion damage.
- Inspect condition of threads.
- Inspect for straightness.
- Check length.

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

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

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
- Water, dirt or air in fuel system
- Plugged fuel filter
- Stuck shut-off control
- Dirty or faulty fuel injection nozzles
- Defective fuel injection pump
- Defective fuel transfer 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
- Fuel injection nozzles defective or leaking
- Fuel filter or fuel lines restricted
- Defective fuel transfer pump
- Fuel injection pump incorrectly timed

• **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 transfer 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

Fuel System Malfunction - See Group 115
- Fuel filter restricted
- Defective fuel transfer pump
- Defective fuel injection pump
- Fuel injection pump incorrectly timed

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

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

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

• **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
- 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

• **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 times

• **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
- Worn main or connecting rod bearings
- Excessive crankshaft end play
- Loose main bearing caps
- Foreign material in combustion chamber
- Worn connecting rod bushings and piston pins
- Scored pistons
- Worn timing gears
- Excessive valve clearance
- Worn cam followers
- Bent push rods
- Worn camshaft
- Worn rocker arm shaft
- Insufficient engine lubrication
- Worn turbocharger bearings

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

• **Water Pump Leaking**

Seal ring or pump shaft worn

• **Coolant Temperature Below Normal**

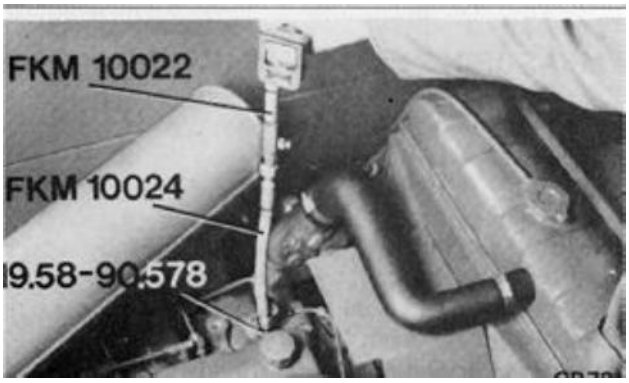
Defective thermostat(s)
Coolant temperature gauge defective

• **Engine Vibrating**

Fan blades bent or broken
Water pump shaft worn
Balancer shaft/gear broke (4-cyl.)

CTM8,GR105,12 -19-19JUN90

TEST ENGINE COMPRESSION PRESSURE



CD7215 -UN-10FEB89

IMPORTANT: Before beginning test, insure that batteries are fully charged and injection nozzle area is thoroughly cleaned.

1. Run engine to bring up to normal operating temperature. (From a cold start, operate engine 10—15 minutes at slow idle.)

2. Remove fuel injection nozzles. (See Group 35 - Fuel System.)

3. Install No. JT01679** with O-ring (or D14550BA* Adapter) in injection nozzle bore. Use JT02017 Holding Clamp** to hold JT01679 Adapter in position. Install hold down screw in clamp and tighten screw to 37 N·m (27 lb-ft). Attach JT01682** Test Gauge (or D14547BA*) to adapter.

4. Push throttle lever to “STOP” position. Turn crankshaft for 10—15 seconds with starting motor (minimum cranking speed—150 rpm cold/200 rpm hot).

5. Compare readings from all cylinders.

Compression pressure must be 2400 kPa (24 bar) (350 psi) minimum. The difference between the highest and lowest cylinder must be less than 350 kPa (3.5 bar) (50 psi).

NOTE: Pressure given was taken at 183 m (600 ft) above sea level. A 3.6 percent reduction in gauge pressure will result for each additional 300 m (1000 ft) rise in altitude.

6. 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. Do not get oil on the valves.

**Part of D14546BA Compression Test Set*

***Part of JT01674 Compression Test Set*

S11,22010,CO -19-28SEP95

7. Test compression again.

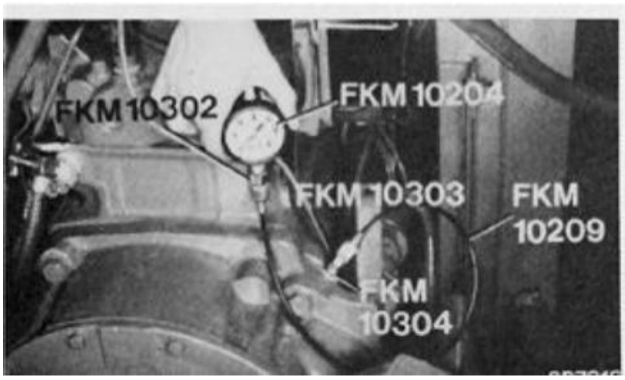
If pressure is high, worn, or stuck rings are indicated, replace piston rings or install new piston and liner set as needed. (See Group 10.)

If pressure is low, valves could be worn or sticking. Recondition cylinder head as required. (See Group 05.)

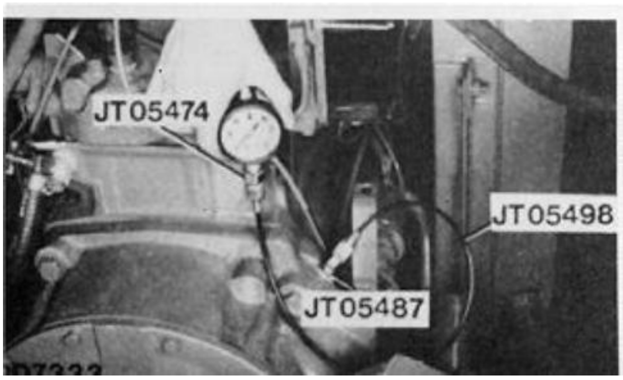
8. Measure compression pressure in all remaining cylinders and compare readings. Recondition cylinders and valves as required.

RG,CTM8,DY031 -19-14OCT94

CHECK ENGINE OIL PRESSURE



CD7216 -UN-10FEB89



CD7333 -UN-10FEB89

1. Attach pressure gauge.

IMPORTANT: To achieve an accurate oil pressure, warm up engine crankcase oil to reach 93°C (200°F) or high oil pressure readings will occur.

2. At 850 rpm engine speed and 93°C (200°F) operating temperature, gauge should show a minimum pressure of 100 kPa (1 bar) (14 psi) on 4 and 6-cylinder engines and 140 kPa (1.4 bar) (20 psi) on 3-cylinder engines.

3. At rated speed (1800—2500 rpm) and 93°C (200°F) operating temperature, gauge should show a pressure of 280—410 kPa (2.8—4.1 bar) (40—60 psi) on all 3, 4, and 6-cylinder engines.

S11,22010,CP -19-28SEP95

MEASURE ENGINE CRANKCASE PRESSURE (BLOW-BY)

1. Place a hose with a standard gas gauge in end of crankcase vent tube.

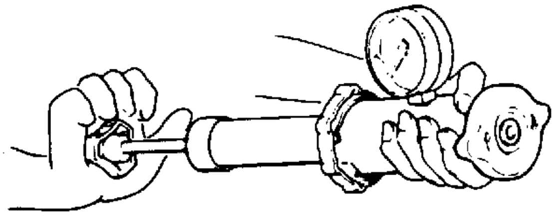
2. Run engine at rated speed and load. Engine should be at operating temperature and run-in (with at least 100 operating hours).

3. Measure blow-by over a period of 5 minutes. Multiply figure obtained by 12 (hourly rate). Maximum engine blow-by is 17m^3/h (600 ft^3/h). See ENGINE TEST SPECIFICATIONS earlier in this group.

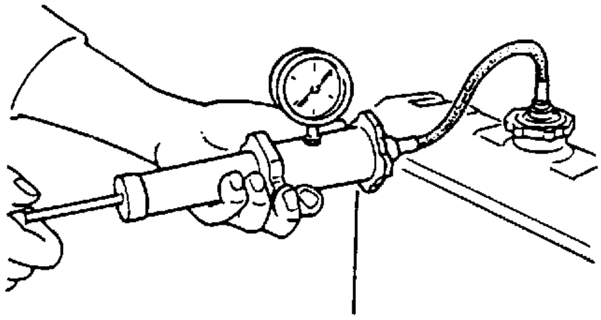
4. If blow-by is lower, there probably is no undue wear between piston rings and liners. If blow-by is higher, there could be excessive wear between piston rings and liners, resulting in loss of engine power. An overhaul of the engine should be considered only after other possible repair options (if any) are evaluated.

CTM8,GR105,16 -19-28SEP95

PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP



RG6557 -UN-20JAN93



RG6558 -UN-20JAN93

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

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

Test Radiator Cap:

1. Remove radiator cap and attach to D05104ST Pressure Pump as shown.

2. Pressurize cap to 50 kPa (0.5 bar) (7 psi)*. Gauge should hold pressure for 10 seconds within the normal range if cap is acceptable.

If gauge does not hold pressure, replace radiator cap.

3. Remove the cap from gauge, turn it 180°, and retest cap. This will verify that the first measurement was accurate.

Test Cooling System:

NOTE: Engine should be warmed up to test overall cooling system.

1. Allow engine to cool, then carefully remove radiator cap.

2. Fill radiator with coolant to the normal operating level.

IMPORTANT: DO NOT apply excessive pressure to cooling system, doing so may damage radiator and hoses.

3. Connect gauge and adapter to radiator filler neck. Pressurize cooling system to 50 kPa (0.5 bar) (7 psi)*, using D05104ST Pressure Pump.

4. With pressure applied, check all cooling system hose connections, radiator, and overall engine for leaks.

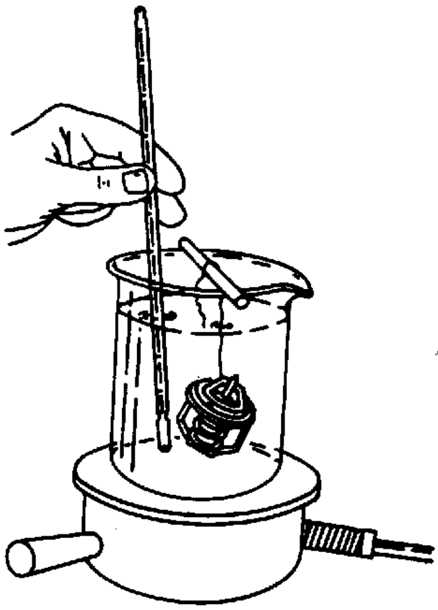
If leakage is detected, correct as necessary and pressure test system again.

If no leakage is detected, but the gauge indicated a drop in pressure, coolant may be leaking internally within the system or at the block-to-head gasket. Have your servicing dealer or distributor correct this problem immediately.

**Test pressures recommended are for all Deere OEM cooling systems. On specific vehicle applications, test cooling system and pressure cap according to the recommended pressure for that vehicle.*

RG18293,6 -19-28SEP95

INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE


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. Remove thermostats. (See REMOVE, TEST, AND INSTALL THERMOSTATS in Group 25.)

2. Suspend thermostat and a thermometer in a container of water.

3. Stir the water as it heats. Observe opening action of thermometer and compare temperatures with specification given in chart below.

NOTE: Due to varying tolerances of different suppliers, initial opening and full open temperatures may vary slightly from specified temperatures.

THERMOSTAT TEST SPECIFICATIONS

Rating	Initial Opening (Range)	Full Open (Nominal)
71°C (160°F)	69—72°C (156—162°F)	84°C (182°F)
77°C (170°F)	74—78°C (166—172°F)	89°C (192°F)
82°C (180°F)	80—84°C (175—182°F)	94°C (202°F)
89°C (192°F)	86—90°C (187—194°F)	101°C (214°F)
90°C (195°F)	89—93°C (192—199°F)	103°C (218°F)
92°C (197°F)	89—93°C (193—200°F)	105°C (221°F)
96°C (205°F)	94—97°C (201—207°F)	100°C (213°F)
99°C (210°F)	96—100°C (205—212°F)	111°C (232°F)

4. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.

5. If any thermostat is defective on a multiple thermostat engine, replace all thermostats.

RG,CTM4,DW810 -19-28SEP95

SPECIAL OR ESSENTIAL TOOLS

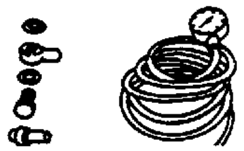
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-20JUL95

Manifold Pressure Tester JDE147

Kit to test intake manifold pressure (turbocharger boost) on turbocharged engines.

RG5163 -UN-23AUG88



S53,JDE147 -19-03OCT94

SERVICE EQUIPMENT AND TOOLS

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

Name	Use
JDG576 Turbocharger Shield	Used to cover inlet on turbine on all turbocharged engines to protect blower when test running the engine with the air filter system disconnected.
D05022ST Water Vacuum Gauge Kit	Used to test air filter.

S55,23005,G -19-14OCT94

AIR INTAKE AND EXHAUST SYSTEM TEST SPECIFICATIONS

NOTE: The specifications given below apply to OEM engines only. As a general rule, minimum boost pressure should be 60 kPa (0.60 bar) (9 psi). For machine applications, consult the appropriate machine technical manual.

ITEM	SPECIFICATION
Intake Manifold Pressure (Turbo Boost)	
At engine rated speed and rated full load power:	
3179TF Engines	
Standard Governor (2500 rpm)	103—131 kPa (1.03—1.31 bar) (15—19 psi)
3—5% Governor (1800 rpm)	62—76 kPa (0.62—0.76 bar) (9—11 psi)
3—5% Governor (1500 rpm)	60—69 kPa (0.60—0.69 bar) (9—10 psi)
4239TF Engines	
Standard Governor (2500 rpm)	103—131 kPa (1.03—1.31 bar) (15—19 psi)
3—5% Governor (1800 rpm)	62—76 kPa (0.62—0.76 bar) (9—11 psi)
3—5 % Governor (1500 rpm)	60—69 kPa (0.60—0.69 bar) (9—10 psi)
4239AF Engines	
Standard Governor (2500 rpm)	87—110 kPa (0.87—1.10 bar) (13—16 psi)
3—5% Governor (1800 rpm)	52—64 kPa (0.52—0.64 bar) (8—9 psi)
3—5% Governor (1500 rpm)	51—58 kPa (0.51—0.58 bar) (7—8 psi)
4276TF Engines	
Standard Governor (2200 rpm)	103—131 kPa (1.03—1.31 bar) (15—19 psi)
3—5% Governor (1800 rpm)	70—80 kPa (0.70—0.80 bar) (10—12 psi)
3—5% Governor (1500 rpm)	50—60 kPa (0.50—0.60 bar) (7—9 psi)
6359TF Engines	
Standard Governor (2500 rpm)	90—117 kPa (0.90—1.17 bar) (13—17 psi)
3—5% Governor (1800 rpm)	62—76 kPa (0.62—0.76 bar) (9—11 psi)
3—5% Governor (1500 rpm)	48—62 kPa (0.48—0.62 bar) (7—9 psi)
6359AF Engines	
Standard Governor (2500 rpm)	76—103 kPa (0.76—1.03 bar) (11—15 psi)
3—5% Governor (1800 rpm)	69—97 kPa (0.69—0.97 bar) (10—14 psi)
3—5% Governor (1500 rpm)	62—76 kPa (0.62—0.76 bar) (9—11 psi)
6414TF Engines	
Standard Governor (2200 rpm)	70—98 kPa (0.70—0.98 bar) (10—14 psi)
3—5% Governor (1800 rpm)	55—65 kPa (0.55—0.65 bar) (8—9 psi)
3—5% Governor (1500 rpm)	40—50 kPa (0.40—0.50 bar) (6—7 psi)

S11,23005,AQ -19-01NOV95

DIAGNOSING AIR INTAKE MALFUNCTIONS

Symptom	Problem	Solution
Engine Starts Hard or Won't Start	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
Erratic Engine Operation	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
Engine Emits Excessive Black Smoke	Air cleaner element restricted	Clean or replace elements (See operator's manual).
	Turbocharger defective	Repair or replace (See Group 30).
	Air leak in manifold	Check hose and pipe connections for tightness; repair as required (See Group 30).
Engine Idles Poorly	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
Engine Does Not Develop Full Power	Air cleaner restricted	Clean or replace elements (See operator's manual).
	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
	Turbocharger defective	Repair or replace (See Group 30).
	Manifold pressure pipe to aneroid loose or broken	Check hose and pipe connections for tightness; repair as required (See Group 30).
Turbocharger "Screams"	Air leak in manifold	Check intake manifold gasket and manifold; repair as required (See Group 30).

S11,23005,AJ -19-25JUL95

HOW THE AIR INTAKE AND EXHAUST SYSTEM WORKS

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 if equipped and intake manifold to the engine.

Exhaust 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 engines equipped with an aftercooler, the aftercooler functions as a heat exchanger. Air compressed and heated by the turbocharger flows around the aftercooler fins before entering the engine. The aftercooler lowers the temperature of the air. Lowering the air temperature makes the air denser, and when combined with a pre-determined quantity of fuel, enables more power to be produced. Engine coolant circulating through the aftercooler core is the medium used for the heat exchanger.

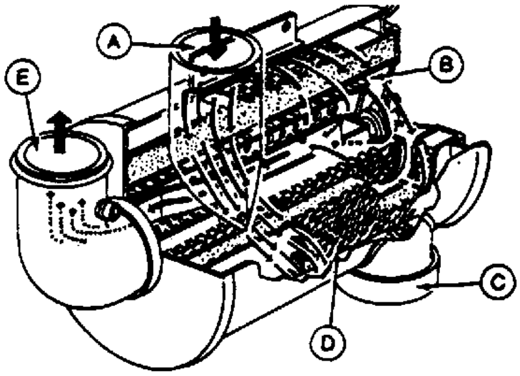
RG,CTM4,DW681 -19-28SEP95

AIR CLEANER OPERATION

Under suction generated by the engine, unfiltered air flows through air inlet tube (A) and is forced into a high-speed centrifugal motion by tilted fins in the element. By this circulating action most of the dust and dirt particles are separated from the air and collected in the dust unloading valve (C).

The remaining dirt is removed as the air flows through the primary element (D) and the secondary (safety) filter (B) before being drawn into the engine.

The secondary (safety) filter (B) ensures that should primary element (D) fail, no unfiltered air is drawn into the engine.



E25999 -UN-20SEP88

A—Air Inlet Tube
B—Secondary (Safety) Element
C—Dust Unloading Valve
D—Primary Element
E—Air Outlet

S11,23005,AU -19-14JUL95

DIAGNOSING TURBOCHARGER MALFUNCTIONS

Before replacing the turbocharger, determine what caused the failure of the defective unit, and correct the condition. This will prevent an immediate repeat failure of the replacement unit. Refer to Air Intake and Exhaust System Group 30 for repair information.

• Noise Or Vibration*:

Bearings not lubricated (insufficient oil pressure).
Air leak in engine intake or exhaust manifold.
Improper clearance between turbine wheel and turbine housing.
Broken blades (or other wheel failures).

• Engine Will Not Deliver Rated Power:

Clogged manifold system.
Foreign material lodged in compressor, impeller, or turbine.
Excessive dirt build-up in compressor.
Leak in engine intake or exhaust manifold.
Leak in intake manifold-to-aneroid pipe.
Rotating assembly bearing failure.
Damaged compressor or turbine blades.

• Oil On Compressor Wheel Or In Compressor Housing (Oil Being Pushed or Pulled Through Center Housing):

Excessive crankcase pressure.
Air intake restriction.
Drain tube restriction.

• Oil In Manifold Or Dripping From Housing:

Excessive crankcase pressure.
Air intake restriction.
Drain tube restriction.
Damaged or worn journal bearings.
Unbalanced rotating assembly:
  Damage to turbine or compressor wheel or blade.
  Dirt or carbon build-up on wheel or blade.
  Bearing wear.
    Oil starvation or insufficient lubrication.
Shaft seals worn.

• Turbine Wheel Drag:

Carbon build-up behind turbine wheel caused by coked oil or combustion deposits.
Dirt build-up behind compressor wheel caused by air intake leaks.
Bearing seizure or dirty, worn bearings caused by excessive temperatures, unbalanced wheel, dirty oil, oil starvation, or insufficient lubrication.

**Do not confuse the whine heard during run down with noise which indicates a bearing failure.*

S11,23005,K -19-25JUL95

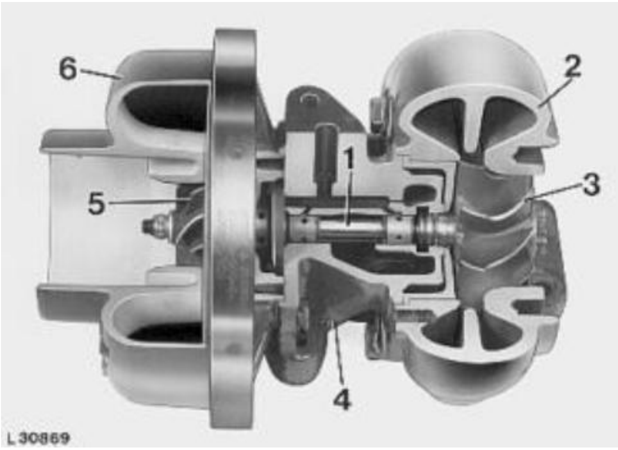
HOW THE TURBOCHARGER IS LUBRICATED

Engine oil under pressure from the engine lubrication system is pumped through a passage in the bearing housing and directed to the bearings, thrust plate, and thrust sleeve. Oil is sealed from the compressor and turbine by a piston ring at both ends of the bearing housing.

Garrett/AiResearch and K.K.K. Turbochargers contain two floating bearings. These bearings have clearance between the bearing OD and the housing bore as well as clearance between the bearing ID and the shaft OD. These clearances are lubricated by the oil supply and the bearings are protected by a cushion of oil. Discharge oil drains by gravity from the bearing housing to the engine crankcase.

RG,CTM4,DW811 -19-29SEP95

TURBOCHARGER OPERATION



L30869 -UN-23MAY95

The turbine wheel (3) is driven by the hot engine exhaust gases. These gases flowing through the turbine housing (2) act on the turbine wheel causing shaft (1) to turn.

Compressor wheel (5) brings in filtered air and discharges the compressed air into the intake manifold where it is then delivered to engine cylinders.

Engine oil under pressure from the engine lubrication system is forced through passages in center housing (4) to bearings.

1—Shaft
2—Turbine Housing
3—Turbine Wheel
4—Center Housing
5—Compressor Wheel
6—Compressor Housing

S11,23005,AR -19-25JUL95

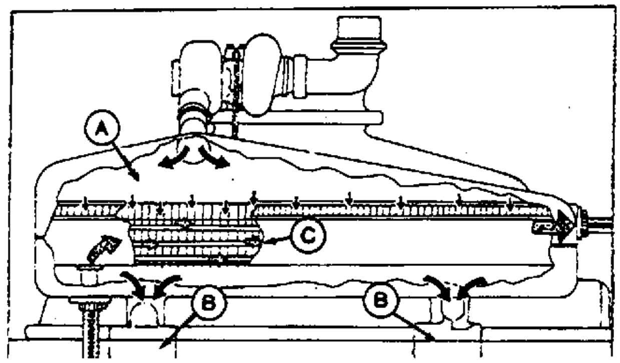
HOW THE AFTERCOOLER WORKS

6359A Engine shown; 4239A Engine similar.

Air entering the intake manifold has been compressed (and heated) by the turbocharger. As this heated, compressed air (A) enters the intake manifold, it flows around the aftercooler before going to the engine cylinders.

The aftercooler functions as a heat exchanger, lowering the intake air (B) temperature as much as 27°—32°C (80°—90°F). Lowering the air temperature makes the air more dense, permitting an even greater volume (compared with not having an aftercooler) to be delivered to the 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) circulating through the aftercooler core is the media used for heat exchange. Extreme care must be used to insure that the engine coolant does not leak into the intake manifold, resulting in possible damage to the engine.



RG4871 -UN-14DEC88

A—Heated Air
B—Cooled Air
C—Engine Coolant

S11,23005,AS -19-14JUL95

CHECK INTAKE MANIFOLD PRESSURE (TURBO BOOST)

T6022AA -UN-09FEB89

NOTE: See AIR INTAKE AND EXHAUST SYSTEM TEST SPECIFICATIONS at the beginning of this group for all OEM (TF) engine specifications. Refer to the appropriate machine technical manual for specific machine applications.

1. Remove plug from intake manifold and install the appropriate fitting from JDE147 Kit. Connect gauge and test line to fitting.

2. Before checking boost pressure, warm up engine to allow the lubricating oil to reach 93˚C (200˚F).

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 pump repair station.

3. Observe pressure reading on gauge. Reading should be at least 60 kPa (0.6 bar) (9 psi) when engine is developing rated power at full load rated speed.

S11,23005,AT -19-28SEP95

• If boost pressure it too high, remove and test fuel injection pump for high fuel delivery.

• If boost pressure is too low, check for the following:

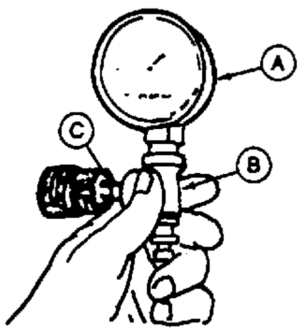
Restricted air filter elements.
Restricted fuel filter elements.
Incorrect fast idle adjustment.
Incorrect injection pump timing.
Exhaust manifold leaks.
Intake manifold leaks.
Faulty fuel transfer pump.
Low compression pressure.
Faulty fuel injection nozzles.
Carbon build-up in turbocharger.
Turbocharger compressor or turbine wheel rubbing housing.
Low fuel injection pump fuel delivery.
Restricted exhaust.

4. After completing test, remove test gauge and test fitting.

5. Install nozzle adapter and plug. Tighten securely.

RG,CTM4,DT524 -19-22JUL95

AIR FILTER RESTRICTION INDICATOR SWITCH TEST



T6188AQ -UN-09DEC88

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

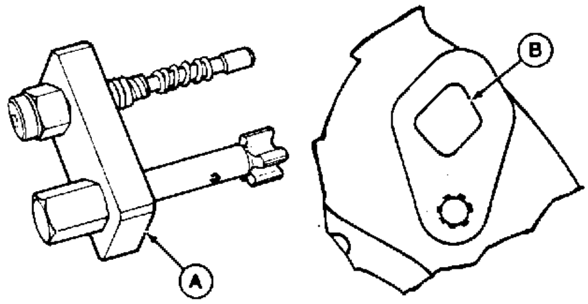
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

Flywheel Turning Tool (A) JD281A

Used on engines with 142 tooth flywheel ring gear and a diamond shaped tool guide bore (B) in flywheel housing. Tool has it's own spring loaded timing pin which threads into flywheel housing.



RG6252 -UN-22JUL92

RG,JD281A -19-17JUL92

RG5068 -UN-23AUG88

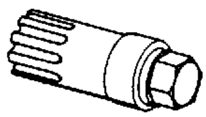
Timing Pin JDE81-4

Lock engine at TDC when installing injection pump or timing valve train. Use with JDG820, JDE81-1, or JDE83 Flywheel Turning Tool.

RG,JDE814 -19-03JAN95

Flywheel Turning Tool JDE83

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

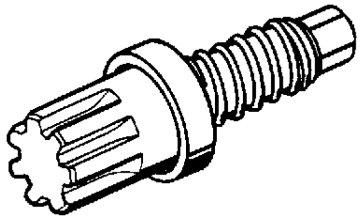


RG6251 -UN-22JUL92

RG,JDE83 -19-17JUL92

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,CTM8,DW570 -19-22SEP95

TIME TRAC® Kit .. JT07158

(FKM10429)

-UN-09FEB95

RG7246

Used to perform the dynamic timing of engines.

- JT07158 Kit consists of the following:
  JT07170 Meter
  JT07171 - Magnetic Pickup 15’
  JT07172 - Transducer Cable 15’
  JT07173 - SOI Clamp Assembly (28037)
  JT07174 - Instruction Booklet (28062)
  JT07175 - John Deere Spec Sheet
  JDE81-4 - Magnetic Pickup Adapter
  JDG821 - Magnetic Pickup Adapter
  JDG793 - Magnetic Pickup Adapter
  JT07176 - Carry Case
  JT07177 - 6 mm Clamp
  JT07178 - 1/4“ Clamp-on Sensor (Black)

- Optional In-Line Sensor:
  JT07175 - 9/16“ SOI Sensor

- 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

TIME TRAC® is a registered trademark of Stanadyne Automotive Corp.

RG,CTM4,DY116 -19-09OCT95

SERVICE EQUIPMENT AND TOOLS

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

Name	Use
Pressure Gauge/0—200 kPa (0—2 bar) (0—30 psi), hose, and fittings.	Measure transfer pump pressure. NOTE: Assemble test equipment from JT05470 Universal Pressure Test Kit or any other suitable equipment.

S11,23010,IZ -19-04MAR87

FUEL SYSTEM TEST SPECIFICATIONS

ITEM	SPECIFICATION
Fuel Supply Pump Operating Pressure:	
Fuel static pressure	25—30 kPa (0.25—0.30 bar) (3.5—4.5 psi)
Min. static pressure at 850 rpm engine speed	15 kPa (0.15 bar) (2.0 psi)
Min. flow at 2400 rpm engine speed	1.5 L/min (0.42 gpm)
Engine Speeds (rpm)	For each machine application refer to the appropriate technical manual for slow idle, fast idle, and rated speed specifications. For OEM applications, see FUEL INJECTION PUMP SPECIFICATIONS later in this group.

RG,CTM8,G115,10-19-01NOV95

FUEL SYSTEM TEST SPECIFICATIONS—CONTINUED

TORQUES

Injection pump idle screw lock nuts	5 N·m (3.5 lb-ft) (42 lb-in.)
Fuel return line-to-pump	16 N·m (12 lb-ft)
Injection supply line-to-pump	30 N·m (22 lb-ft)
Injection lines-to-nozzles	34 N·m (25 lb-ft)
Injection pump-to-front plate mounting stud nuts	27 N·m (20 lb-ft)
Injection pump timing hole cover screws:	
Roto Diesel/Lucas CAV (all models)	3.5 N·m (2.5 lb-ft) (30 lb-in.)
Stanadyne (all models)	2 N·m (1.5 (lb-ft) (18 lb-in.)

RG,CTM8,DX403 -19-01NOV95

SARAN FUEL INJECTION PUMP SPECIFICATIONS*

Injection pump timing specifications are provided for OEM applications. For industrial applications, refer to SP458 Specifications Handbook. For agricultural applications, refer to DB1216 Specifications Handbook.

Engine Model	Injection Pump Option Code	Original Injection Pump (Part No.)	Replaced By Injection Pump (Part No.)	Slow Idle (rpm)	Rated Speed (rpm)	Fast Idle (rpm)	Dynamic Timing (DBTDC)
3179DF	1602	RE12266	RE37918	800—850	2500	2710	15
3179DF	1602	RE37918	RE41937	800—850	2500	2710	15
3179DF	1602	RE41937	——	800—850	2500	2710	17
3179DF	1603	RE12267	RE37920	800—850	1800	1880	15
3179DF	1603	RE37920	RE39877	800—850	1800	1880	15
3179DF	1603	RE39877	——	800—850	1800	1880	15
3179DF	1604	RE41937	——	800—850	2500	2710	15
3179DF	1620	RE21695**	——	800—850	2500	2710	15
3179DF	1623	RE21695**	RE31769	800—850	2500	2710	15
3179DF	1623	RE31769	——	800—850	2500	2710	15
3179DF	1641	RE29907	RE37919	800—850	1500	1565	15
3179DF	1641	RE37919	RE41940	800—850	1500	1565	15
3179DF	1641	RE41940	——	800—850	1500	1565	13
3179DF	1643	RE30107	——	800—850	1800	1880	15
3179DF	1644	RE37885	RE41939	800—850	1800	1880	15
3179DF	1644	RE41939	——	800—850	1800	1880	15
3179DF	1648	RE37884	RE41941	800—850	1500	1565	15
3179DF	1648	RE41941	RE64242	800—850	1500	1565	13
3179DF	1648	RE64242	——	800—850	1500	1565	13
3179DF	1650	RE37886	RE41938	800—850	2500	2710	15
3179DF	1650	RE41938	——	800—850	2500	2710	17
3179DF	1651	RE39877	——	800—850	1800	1880	15
3179DF	1664	RE41937	——	1700	2500	2710	17
3179TF	1602	RE30230	RE48528	800—850	2500	2710	13
3179TF	1602	RE48528	——	800—850	2500	2710	13
3179TF	1632	RE31762	RE48529	800—850	2500	2710	13
3179TF	1632	RE48529	——	800—850	2500	2710	13

**Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset depending upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.*

***Can be used with JP5/JP8 Jet "A" fuel.*

S11,23010,HT -19-01NOV95

SARAN FUEL INJECTION PUMP SPECIFICATIONS—CONTINUED*

Engine Model	Injection Pump Option Code	Original Injection Pump (Part No.)	Replaced By Injection Pump (Part No.)	Slow Idle (rpm)	Rated Speed (rpm)	Fast Idle (rpm)	Dynamic Timing (DBTDC)
4239DF	1602	AR80230	RE15699	800—850	2500	2710	15
4239DF	1602	RE15699	RE21504	800—850	2500	2710	15
4239DF	1602	RE21504	RE37927	800—850	2500	2710	15
4239DF	1602	RE37927	RE42348	800—850	2500	2710	15
4239DF	1602	RE42348	RE49360	800—850	2500	2710	15
4239DF	1602	RE49360	——	800—850	2500	2710	15
4239DF	1603	AR80233	RE15697	800—850	1800	1880	15
4239DF	1603	RE15697	RE37929	800—850	1800	1880	15
4239DF	1603	RE37929	RE42351	800—850	1800	1880	15
4239DF	1603	RE42351	RE47134	800—850	1800	1880	15
4239DF	1603	RE47134	——	800—850	1800	1880	15
4239DF	1617	RE30543	RE37965	800—850	2200	2390	15
4239DF	1617	RE37965	——	800—850	2200	2390	15
4239DF	1623	RE21504	RE37927	800—850	2500	2710	15
4239DF	1623	RE37927	RE42349	800—850	2500	2710	15
4239DF	1623	RE42349	——	800—850	2500	2710	15
4239DF	1641	RE29470	RE37928	800—850	1500	1565	15
4239DF	1641	RE37928	RE42353	800—850	1500	1565	15
4239DF	1641	RE42353	——	800—850	1500	1565	15
4239DF	1645	RE29470	RE37928	800—850	1500	1565	15
4239DF	1645	RE37928	RE42354	800—850	1500	1565	15
4239DF	1645	RE42354	——	800—850	1500	1565	15
4239DF	1646	RE15697	RE37929	800—850	1800	1880	15
4239DF	1646	RE37929	RE42352	800—850	1800	1880	15
4239DF	1646	RE42352	RE47176	800—850	1800	1880	15
4239DF	1646	RE47176	——	800—850	1800	1880	15
4239TF	1602	AR80325	AR87186	800—850	2500	2710	13
4239TF	1602	AR87186	RE16150	800—850	2500	2710	13
4239TF	1602	RE16150	RE21503	800—850	2500	2710	13
4239TF	1602	RE21503	RE26858	800—850	2500	2710	13
4239TF	1602	RE26858	——	800—850	2500	2710	13
4239TF	1603	AR80326	AR99951	800—850	1800	1880	15
4239TF	1603	AR99951	RE21515	800—850	1800	1880	15

**Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset depending upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.*

S11,23010,HT1 -19-09OCT95

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SARAN FUEL INJECTION PUMP SPECIFICATIONS—CONTINUED*

Engine Model	Injection Pump Option Code	Original Injection Pump (Part No.)	Replaced By Injection Pump (Part No.)	Slow Idle (rpm)	Rated Speed (rpm)	Fast Idle (rpm)	Dynamic Timing (DBTDC)
4239TF	1603	RE21515	——	800—850	1800	1880	15
4239TF	1604	RE38862	——	800—850	2100	2200	13
4239TF	1623	RE26858	——	800—850	2500	2710	13
4239TF	1635	RE31759	——	800—850	1500	1565	17
4239TF	1636	RE31766	——	800—850	1800	1880	15
4239TF	1641	RE29471	——	800—850	1500	1565	17
4239TF	1643	RE45356	——	800—850	2500	2710	13
4239TF	1650	RE38946	——	800—850	2500	2710	13
4239TF	1651	RE38947	——	800—850	2500	2710	13
4239AF	1602	RE29200	——	800—850	2500	2710	11
4239AF	1606	RE31770	——	800—850	2500	2710	11
6359DF	1602	AR80603	RE15700	800—850	2500	2710	15
6359DF	1602	RE15700	RE37935	800—850	2500	2710	15
6359DF	1603	AR80604	RE15698	800—850	1800	1880	15
6359DF	1603	RE15698	RE37933	800—850	1800	1880	15
6359DF	1623	RE15700	RE37935	800—850	2500	2710	15
6359DF	1636	RE15698	RE37933	800—850	1800	1880	15
6359DF	1638	RE29908	RE37934	800—850	1500	1565	15
6359DF	1641	RE29908	RE37934	800—850	1500	1565	15
6359TF	1602	RE19914	——	800—850	2500	2710	15
6359TF	1603	RE19981	——	800—850	1800	1880	15
6359TF	1604	RE38864	——	800—850	2100	2200	15
6359TF	1605	AR89482	——	800—850	2200	2390	15
6359TF	1611	RE37937	——	800—850	2500	2710	15
6359TF	1623	RE19914	——	800—850	2500	2710	15
6359TF	1632	RE31768	——	800—850	1800	1880	15
6359TF	1636	RE31760	——	800—850	1500	1565	17
6359TF	1641	RE29472	——	800—850	1500	1565	17
6359AF	1602	RE24924	——	800—850	2500	2710	11
6359AF	1608	RE31763	——	800—850	2500	2710	11
6359AF	1609	RE24925	——	800—850	1800	1885	11
6359AF	1611	RE31764	——	800—850	1800	1885	11
6359AF	1641	RE29473	——	800—850	1500	1565	12
6359AF	1643	RE45360	——	800—850	2500	2710	11
6359AF	1650	RE31761	——	800—850	1500	1565	12
6359AF	1661	RE42745	——	800—850	2100	2200	12

**Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset depending upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.*

RG,CTM4,DY115 -19-09OCT95

DUBUQUE FUEL INJECTION PUMP SPECIFICATIONS*

Injection pump timing specifications are provided for OEM applications. For industrial applications, refer to SP458 Specifications Handbook. For agricultural applications, refer to DB1216 Specifications Handbook.

Engine Model	Injection Pump Option Code	Original Injection Pump (Part No.)	Replaced By Injection Pump (Part No.)	Slow Idle (rpm)	Rated Speed (rpm)	Fast Idle (rpm)	Dynamic Timing (DBTDC)
4239DF	1602	RE20510	——	800—850	2500	2700	15
4239DF	1603	RE20511	——	800—850	1800	1900	15
4239DF	1604	RE20211	——	800—850	2500	2700	15
4239DF	1619	RE28450	——	800—850	2500	2700	13
4239DF	1624	RE28451	——	800—850	1800	1900	15
4239TF	1602	RE27450	——	800—850	2500	2700	13
4239TF	1603	RE27451	——	800—850	1800	1900	15
4239TF	1603	RE24766	——	800—850	1800	1870	13
4239TF	1619	RE24765	——	800—850	2500	2700	13
4239TF	1619	RE28452	——	800—850	2500	2700	13
4239TF	1624	RE28453	——	800—850	1800	1870	13
4239TF	1624	RE38018	——	800—850	1800	1900	15
4276DF	1602	AR70530	——	800—850	2500	2700	13
4276DF	1602	AR78647	——	800—850	2500	2700	13
4276DF	1602	RE20994	——	800—850	2500	2700	13
4276DF	1603	AR70530	——	800—850	1800	1900	13
4276DF	1603	AR79212	——	800—850	1800	1900	13
4276DF	1603	RE20996	——	800—850	1800	1900	13
4276DF	1613	RE22592	——	800—850	2300	2500	13
4276DF	1621	RE28454	——	800—850	2500	2700	13
4276DF	1624	RE28455	——	800—850	1800	1900	13
4276TF	1602	AR71421	RE16265	800—850	2200	2400	13
4276TF	1602	RE16265	——	800—850	2200	2400	13
4276TF	1603	AR76503	AR90716	800—850	1800	2000	13
4276TF	1603	RE18938	——	800—850	1800	1870	13
4276TF	1605	AR90716	——	800—850	2200	2400	13
4276TF	1609	RE18937	——	800—850	1800	1900	13
4276TF	1623	RE28808	——	800—850	2200	2400	13
4276TF	1623	RE28456	——	800—850	2200	2400	13
4276TF	1624	RE28457	——	800—850	1800	1870	13
4276TF	1624	RE28809	——	800—850	1800	1900	13

Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset depending upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.

S55,23010,Q -19-29SEP95

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DUBUQUE FUEL INJECTION PUMP SPECIFICATIONS*—CONTINUED

Engine Model	Injection Pump Option Code	Original Injection Pump (Part No.)	Replaced By Injection Pump (Part No.)	Slow Idle (rpm)	Rated Speed (rpm)	Fast Idle (rpm)	Dynamic Timing (DBTDC)
6359DF	1602	RE24182	——	800—850	2500	2700	15
6359DF	1603	RE24184	——	800—850	1800	1900	15
6359DF	1619	RE24182	——	800—850	2500	2700	15
6359DF	1619	RE28458	——	800—850	2500	2700	13
6359DF	1624	RE24182	——	800—850	1800	1900	15
6359DF	1624	RE28459	——	800—850	1800	1870	13
6359TF	1602	RE25699	——	800—850	2500	2700	15
6359TF	1603	RE25700	——	800—850	1800	1870	13
6359TF	1603	RE38764	——	800—850	1800	1900	15
6359TF	1621	RE25699	——	800—850	2500	2700	15
6359TF	1621	RE28460	——	800—850	2500	2700	13
6359TF	1624	RE28461	——	800—850	1800	1870	13
6359TF	1624	RE38764	——	800—850	1800	1900	15
6414DF	1602	AR66395	AR104000	800—850	2200	2400	13
6414DF	1602	AR70778	——	800—850	2200	2400	13
6414DF	1602	AR104000	——	800—850	2200	2400	13
6414DF	1603	AR70551	——	800—850	1800	1870	13
6414DF	1609	RE18940	——	800—850	1800	1900	13
6414DF	1619	RE28462	——	800—850	2200	2400	13
6414DF	1624	RE28463	——	800—850	1800	1900	13
6414TF	1602	AR70778	——	800—850	2200	2400	13
6414TF	1602	AR104000	——	800—850	2200	2400	13
6414TF	1603	AR70551	——	800—850	1800	1900	13
6414TF	1609	RE18940	——	800—850	1800	1870	13
6414TF	1619	RE28464	——	800—850	2200	2400	13
6414TF	1624	RE28465	——	800—850	1800	1900	13
6414TT	1611	RE29446	——	800—850	2100	2300	13
6414TT	1617	RE32295	——	800—850	2100	2300	13
6414TT	1623	RE21157	——	800—850	2100	2300	13

Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset depending upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.

S11,23010,HT2 -19-09OCT95

FUEL INJECTION PUMP TIMING

Fuel injection pumps on John Deere Diesel Engines are timed one of two ways at the factory:

—By Static Timing, which is accomplished by the alignment of internal pump timing marks (cam ring-to-governor weight retainer) and/or the alignment of injection pump flange-to-front plate timing marks.

—By Dynamic Timing, which involves a sensor installed within the No. 1 fuel line and connected to a pulse-activated timing meter to determine precisely at what point injection occurs. Another form of dynamic timing employs the use of a timing light along with a fixed reference mark on engine block and a timing mark on crankshaft damper or pulley which aligns with fixed reference mark when light flashes.

Both types of timing are covered in this manual. Dynamic timing the engine is the preferred method. However, on some applications, dynamic timing values are not available and the engine must be static timed.

S55,3010,BR -19-28SEP95

CHECK AND ADJUST 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,CTM8,G115,20-19-02FEB95

• **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. 4 injection line (4-cylinder engines) and No. 6 injection line (6-cylinder engines). Sensor MUST BE installed on No. 1 injection line of all 3-cylinder engines.

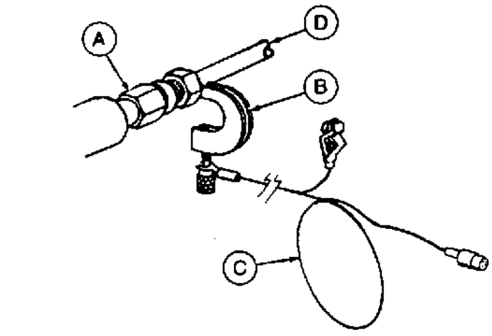
Remove all paint from injection line where clamp-on transducer will be installed and be sure this location is thoroughly clean.

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.

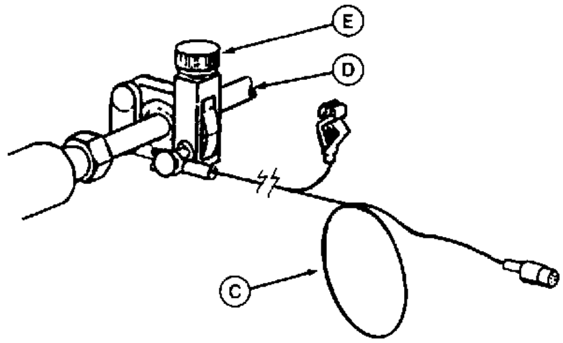
2. On engines without optional JT07155 In-Line Sensor, install JT07177 6 mm (green) Clamp-on Transducer (E) onto clean, paint-free injection line and tighten securely.

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

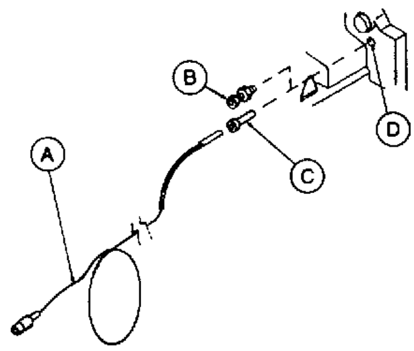
RG,CTM8,G115,21-19-02FEB95

5. Use JDE81-4 Timing Pin in flywheel timing hole (D) 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 JDG793 Magnetic Pick-up Adapter (B) into flywheel housings with tapped hole until it bottoms. Insert probe of magnetic pickup (A) into adapter until it contacts flywheel. Back out hex head of adapter two flats and tighten lock nut; this will provide recommended air gap.

7. Install JDG821 Magnetic Pick-up Adapter (C) into flywheel housings without tapped hole. Lightly tap adapter to lock into position. Insert probe into adapter until it contacts the flywheel. Pull probe back out to provide 0.64 mm (0.025 in.) gap.

8. Plug magnetic pick-up adapter connector into JT07170 meter port marked MP.



RG7287 -UN-06FEB95

A—Magnetic Pick-up
B—JDG793 Magnetic Pick-up Adapter
C—JDG821 Magnetic Pick-up Adapter
D—Flywheel Timing Hole

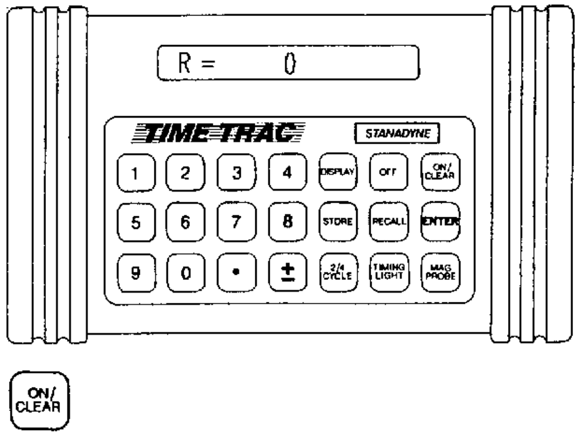
RG,CTM8,G115,22-19-02FEB95

115
11

• **Check Injection Pump Rated Load Dynamic Timing:**

1. Engine OFF. Push ON/CLEAR button.

Display shows: R=0

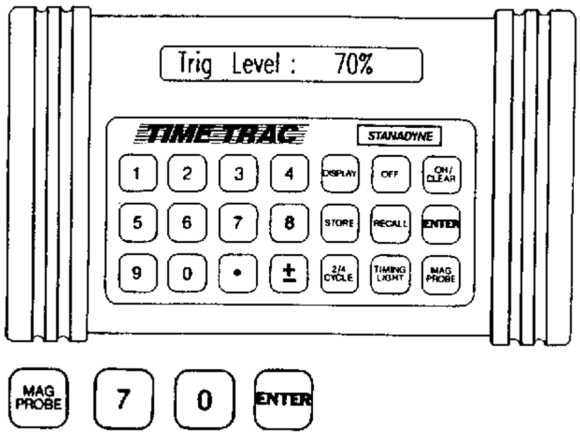


RG7031 -UN-27SEP94

2. Push MAG PROBE button.

Display shows: Trig Level: 30%

3. Change to 70% and push ENTER.

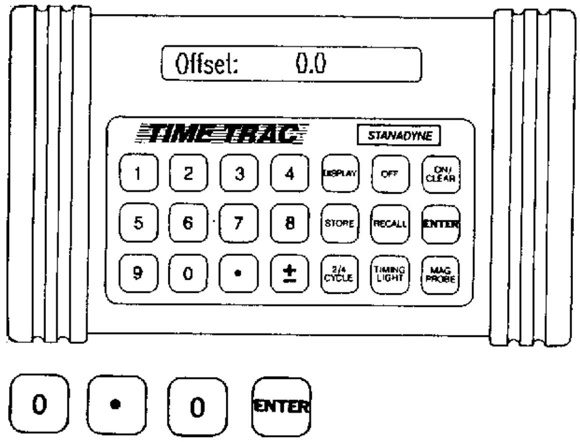


RG7032 -UN-27SEP94

RG,CTM8,G115,23-19-02FEB95

Display shows: Offset: 20.0°

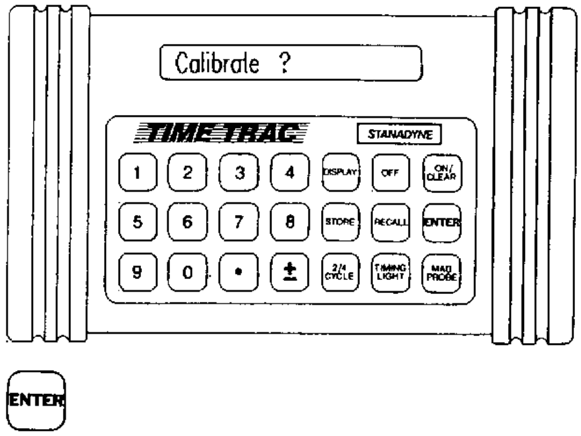
4. Change to offset 0° and push ENTER.



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.

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.

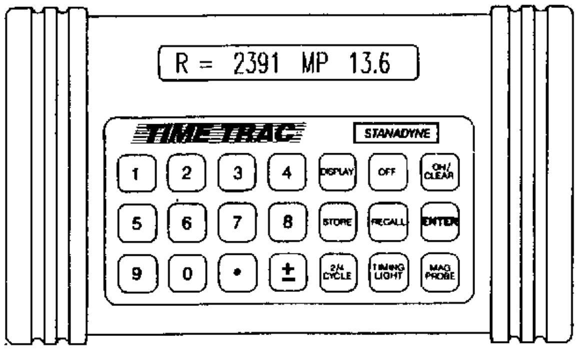
9. Record engine speed (rpm) and timing degrees.

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.



RG7037 -UN-27SEP94

115
15

RG,CTM8,G115,26-19-02FEB95

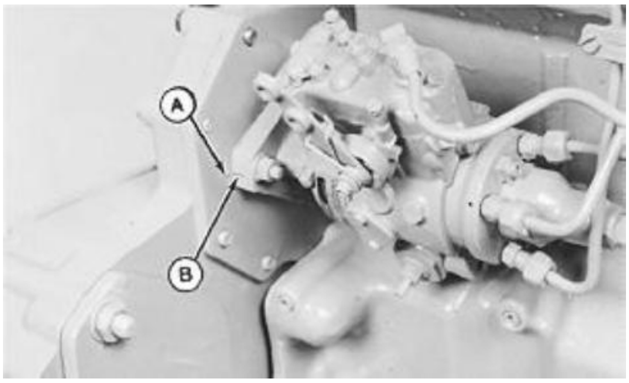
• **Adjust Injection Pump Dynamic Timing:**

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 27 N·m (20 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 (B) onto injection pump flange to align with timing mark (A) on front plate after all final adjustments have been made and satisfactory engine performance is achieved.



RG6278 -UN-22JUL92

RG,CTM8,G115,27-19-28SEP95

CHECK ROTO DIESEL/LUCAS CAV INJECTION PUMP STATIC TIMING

Roto Diesel/Lucas CAV injection pump static timing is established for beginning of injection—not TDC.

IMPORTANT: To check pump internal timing, the sealing wire and inspection cover plate must be removed from side of pump. If the injection pump is under warranty, contact an authorized Roto Diesel/Lucas CAV repair station about how to get the pump timed.

1. Check Pump Internal Timing (Beginning of Injection):

• With injection pump removed from engine, connect a nozzle tester to “U” outlet on pump head for 3-cylinder engines and “V” outlet on 4 and 6-cylinder engines.

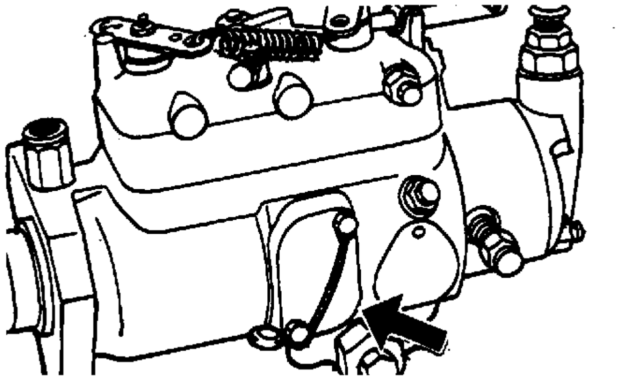
• Remove inspection cover plate from side of pump housing.

• Pump handle on nozzle tester to obtain approximately 3000 kPa (30 bar) (430 psi) pressure.

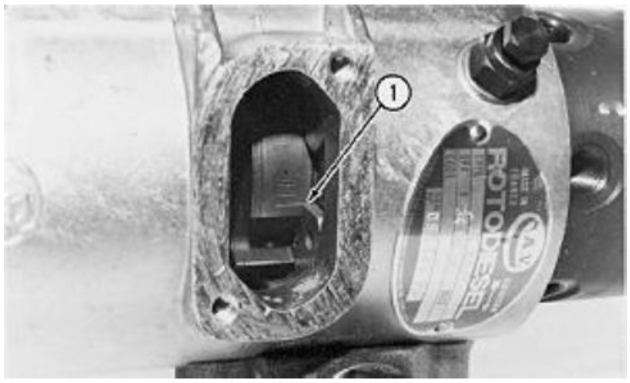
• Rotate pump shaft in direction of normal rotation until resistance is felt. In this position the straight edge of the snap ring (1) that can be seen through the inspection hole should be in line with the scribed mark adjacent to letter “F” on 3-cylinder, “A” (or “C” on some applications) on 4-cylinder and “H” on 6-cylinder engines.

If mark and edge of snap ring are not aligned, see your authorized Roto Diesel/Lucas CAV repair station for service.

• Disconnect nozzle tester.



RG4822 -UN-14DEC88



CD5531 -UN-11JUL89

S11,23010,MB -19-13JUL95

2. Time Engine For Beginning Of Injection:

• Rotate engine until No. 1 piston is at TDC of compression stroke.

• Remove No. 1 injection nozzle.

• Insert a 6466 engine valve into injection nozzle bore of cylinder head until valve contacts top of piston.

• Attach a dial indicator so that the indicator tip rests on valve head. Set dial indicator at 0.00 mm (in.).

• Rotate crankshaft opposite of running direction (clockwise, viewed from flywheel end) to bring valve 6.0 mm (0.20 in.) BTDC. This is necessary to eliminate timing gear backlash as crankshaft is rotated in running direction (next step).

• Slowly rotate crankshaft in normal running direction (counterclockwise, viewed from flywheel end) until dial indicator needle registers the specified piston stroke dimension——No. 1 piston at beginning of injection. Beginning of injection in degrees BTDC is equal to the following piston stroke movement:

13°—1.83 mm (0.072 in.) piston stroke
15°—2.43 mm (0.095 in.) piston stroke
17°—3.12 mm (0.123 in.) piston stroke
19°—3.88 mm (0.153 in.) piston stroke

NOTE: Engine timing (beginning of injection) varies with model and application. (See FUEL INJECTION PUMP SPECIFICATIONS at the beginning of this group.)

S11,3010,MC -19-28SEP95

3. Install pump on engine. Tighten pump-to-front plate hex nuts finger tight.

4. Pivot pump toward cylinder block as far as slots will allow. Then, slowly pivot pump away from block until snap ring is aligned with correct letter-designated scribe mark (inside pump) for the specific engine model and application.

5. Tighten pump to front plate mounting nuts 27 N·m (20 lb-ft).

6. Install inspection cover plate on injection pump using a new gasket. Tighten cap screws 3.5 N·m (2.5 lb-ft).

NOTE: If pump is under warranty and approval (by the authorized repair station) was given to remove the original sealing wire, a new sealing wire must be installed. Contact your authorized Roto Diesel/Lucas CAV repair station for instructions.

7. Remove dial indicator and valve from No. 1 injection nozzle hole. Install injection nozzle in cylinder head.

8. Bleed air from system and check for leaks. (See BLEED FUEL SYSTEM later in this group.)

NOTE: If speed advance on Roto Diesel/Lucas CAV pump is suspected to be faulty, pump must be removed and taken to an authorized repair station for repair.

S11,23010,GZ -19-28SEP95

CHECK STANADYNE DB2 PUMP STATIC TIMING

1. Check alignment of mark on pump flange with mark on front plate.

NOTE: If a timing mark does not exist on the front plate, follow timing procedure for JDB Pump.

2. If marks are aligned, proceed to CHECK AND ADJUST ENGINE SPEEDS ON STANADYNE PUMP later in this group.

3. If marks are not aligned, disconnect fuel lines to pump and loosen the pump-to-front plate mounting nuts.

4. Pivot pump housing first away from cylinder block as far as slots will allow. Then pivot it back again, but only far enough to align timing mark on the pump flange exactly with timing mark on the cylinder block front plate.

5. Tighten the three mounting nuts securing the pump to the front plate to 27 N·m (20 lb-ft).

S11,23010,HA -19-28SEP95

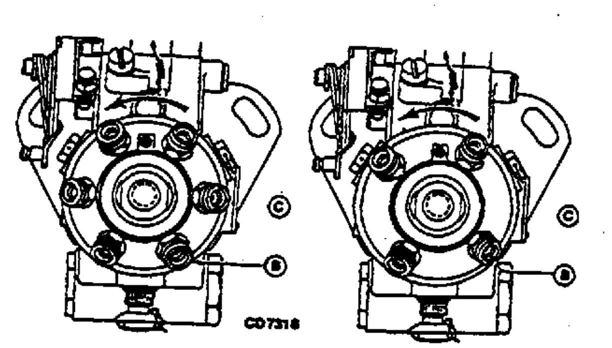
6. Connect injection pump pressure lines (D). Start with outlet (B) and continue around the pump head in counterclockwise direction, attaching lines in same order as engine firing (1-5-3-6-2-4 on 6-cylinder engines and 1-3-4-2 on 4-cylinder engines).

7. Tighten fuel pressure lines at pump to 30 N·m (22 lb-ft) using a suitable 17 mm deep-well socket.

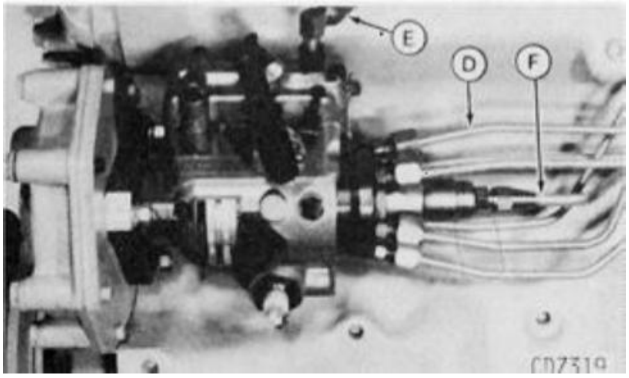
IMPORTANT: Always use a backup wrench when loosening or tightening fuel lines at injection pump so that discharge fittings are not altered to prevent possible internal pump damage.

8. Connect fuel supply line (F), return line (E), shut-off cable, and speed control rod.

9. Proceed to CHECK AND ADJUST ENGINE SPEEDS ON STANADYNE PUMP later in this group.



CD7318 -UN-23FEB89



CD7319 -UN-23FEB89

B—Outlet Connection to No. 1 Cylinder
C—Engine Block Side
D—Fuel Pressure Lines
E—Fuel Return Line
F—Fuel Supply Line

S11,23010,HB -19-28SEP95

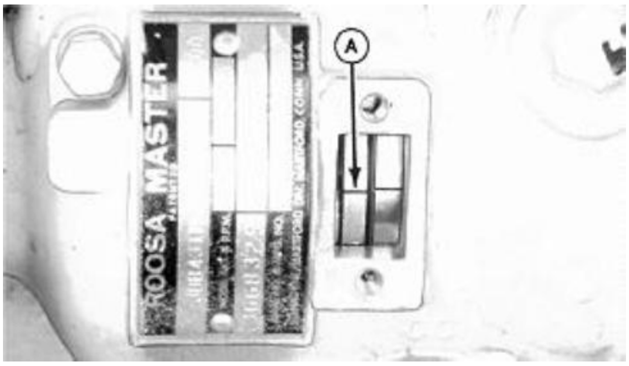
CHECK STANADYNE JDB INJECTION PUMP STATIC TIMING

1. Clean area around timing hole cover plate on side of pump, and remove cover plate.

2. Use appropriate flywheel turning tool to rotate crankshaft until No. 1 piston is at TDC on compression stroke.

3. Check alignment of governor weight retainer and cam ring timing marks (A).

4. If marks are in alignment, proceed to CHECK AND ADJUST ENGINE SPEEDS ON STANADYNE PUMP later in this group.



T87483 -UN-09NOV88

S11,23010,HC -19-13JUL95

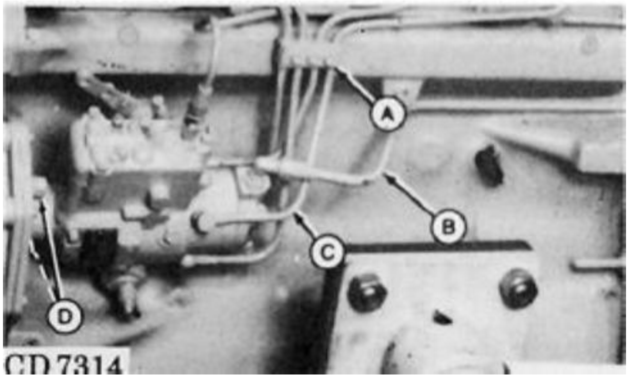
5. If marks are not aligned, remove clamp (A) disconnect fuel lines (B and C) from pump and loosen the pump mounting nuts (D).

6. Rotate pump counterclockwise (viewed from flywheel end) and then in opposite direction until timing marks on cam ring and governor weight retainer are aligned.

7. Tighten pump mounting nuts (D) to 27 N·m (20 lb-ft).

8. Connect fuel injection lines (C), fuel return line, fuel supply line (B), and speed control rod. Install line clamp (A).

9. Proceed to CHECK AND ADJUST ENGINE SPEEDS ON STANADYNE PUMP later in this group.



CD7314 -UN-23FEB89

A—Clamp
B—Fuel Line
C—Fuel Line
D—Nut (3 used)

S11,23010,HD -19-01NOV95

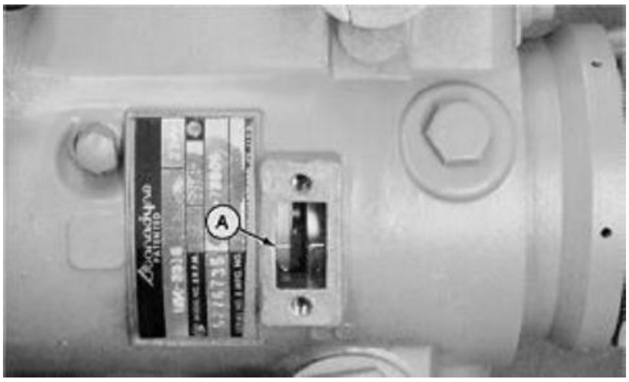
CHECK STANADYNE DM4 INJECTION PUMP STATIC TIMING

1. Clean area around timing hole cover plate on side of pump, and remove cover plate.

2. Use appropriate flywheel turning tool to rotate crankshaft until No. 1 piston is at TDC of compression stroke.

3. Check alignment of governor weight retainer and cam ring timing marks (A).

4. If marks are in alignment, proceed to CHECK AND ADJUST ENGINE SPEEDS ON STANADYNE PUMP later in this group.



T6077AK -UN-28OCT88

S11,23010,HE -19-17JUL95

5. If marks are not aligned, disconnect fuel lines (B, C, and D) and loosen the pump-to-front plate mounting nuts (A).

6. Rotate pump counterclockwise (viewed from flywheel end) and then in opposite direction until timing marks on cam ring and governor weight retainer are aligned.

7. Tighten pump mounting nuts to 27 N·m (20 lb-ft).

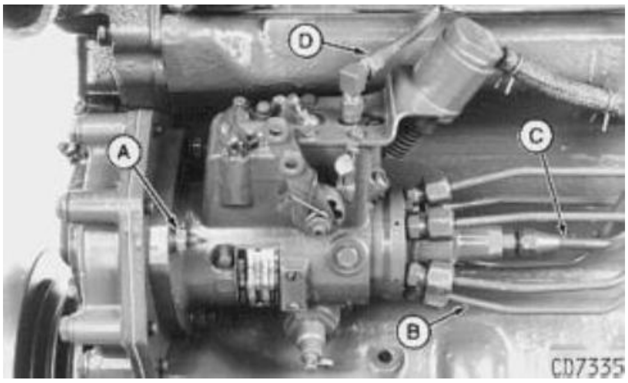
8. Connect injection pump pressure lines. Start with No. 1 outlet line and continue around pump head in counterclockwise direction, attaching lines in same order as engine firing (1-5-3-6-2-4 on 6-cylinder engines and 1-3-4-2 on 4-cylinder engines).

IMPORTANT: Always use a backup wrench when loosening or tightening fuel delivery lines at fuel injection pump, so that pump discharge fittings are not altered. This prevents possible internal pump damage.

9. Tighten fuel pressure lines at pump to 30 N·m (22 lb-ft) using a suitable 17 mm deep-well socket.

10. Connect fuel supply line (C), return line (D), and speed control rod.

11. Proceed to CHECK AND ADJUST ENGINE SPEEDS ON STANADYNE PUMP later in this group.



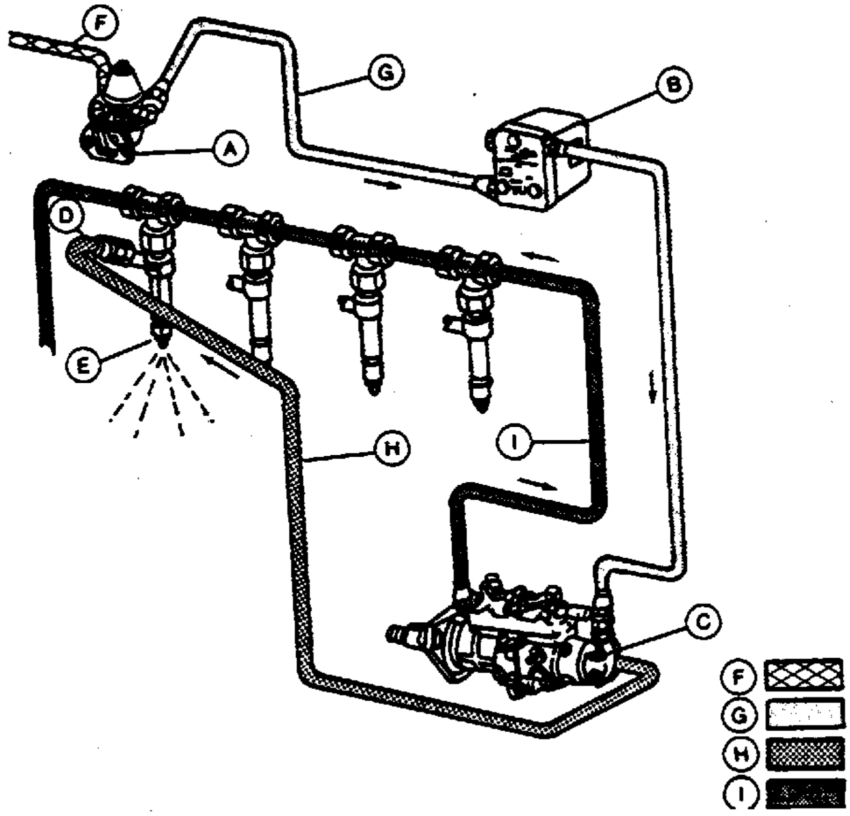
-UN-23MAY95

CD7335

A—Pump Mounting Nuts
B—Fuel Pressure Lines
C—Fuel Supply Line
D—Fuel Return Line

S11,23010,HF -19-28SEP95

FUEL SYSTEM OPERATION



RG5166 -UN-14DEC88

A—Fuel Supply (Transfer) Pump
B—Round Primary Fuel Filter/Water Separator
C—Round Final Fuel Filter
D—Rectangular Fuel Filter
E—Fuel Injection Nozzles
F—Fuel Injection Pump
G—Supply Pump Pressure Fuel
H—Injection Pressure Fuel
I—Fuel Return (Leak-off)

The 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 (F).

NOTE: Some vehicle applications equipped with 3029 engines may utilize a fuel supply pump. Fuel is supplied by injection pump pressure.

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). Delivery (pressure) lines 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 (I) 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 supplied 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.

S11,23010,GI -19-13JUL95

DIAGNOSE FUEL SYSTEM MALFUNCTIONS

Symptom	Problem	Solution
Fuel Not Reaching Injection Nozzles	Fuel filter restricted	Replace fuel filter. (See Group 35.)
	Fuel line restricted	Clean lines as required.
	Fuel too heavy at low temperatures	Use correct grade of fuel.
	Air in system	Correct problem and bleed fuel system (this group).
	Fuel tank valve shut off	Open fuel tank valve.
	Low supply pump pressure	Check fuel lines for restrictions; check pump output pressure (this group).
Engine Starts Hard or Won't Start	Fuel too heavy at low temperature	Use correct grade of fuel. (See Fuels, Group 02.)
	Injection nozzles faulty or sticking	Repair or replace as required. (See Group 35)
	Incorrect timing	Adjust timing (this group).
	Faulty injection pump	Repair or replace.
	Water in fuel	Drain water from filter (or separator if equipped). Install new filter.
	Fuel filter restricted	(See Group 35.)
	Low supply pump pressure	Check pump output pressure. (this group)
	Injection pump return fuel line or fittings restricted	Clean lines as required.
	Low cetane fuel	Use correct grade of fuel. (See Group 02.)

S11,23010,GJ -19-13JUL95

DIAGNOSE FUEL SYSTEM MALFUNCTIONS—CONTINUED

Symptom	Problem	Solution
Engine Starts and Stops	Air in system	Correct problem and bleed fuel system. (See this group.)
	Fuel filter restricted	Replace fuel filter.
	Fuel lines restricted	Clean lines as required.
	Water in fuel	Drain water from filter, (or separator if equipped). Install new filter. (See Group 35.)
	Injection pump return fuel line or fittings restricted	Clean lines as required.
Erratic Engine Operations	Fuel filter restricted	Replace fuel filter. (See Group 35.)
	Fuel too heavy at low temperatures	Use correct grade of fuel. (See Group 02.)
	Injection nozzles faulty or sticking	Repair. (See Group 35.)
	Fuel lines restricted	Clean as required.
	Incorrect timing	Adjust timing (this group).
	Governor faulty	Repair. (See Group 35.)
	Water in fuel	Drain water from filter (or separator, if equipped). Install new filter.
	Injection pump return fuel line or fittings restricted	Clean lines as required.
	Low cetane fuel	Use correct grade of fuel. (See Group 02.)
	Injection nozzle return lines restricted	Clean lines as required.

S11,23010,GK -19-07OCT94

DIAGNOSE FUEL SYSTEM MALFUNCTIONS—CONTINUED

Symptom	Problem	Solution
Engine Emits Excessive Black Smoke	Injection nozzles faulty or sticking	Repair. (See Group 35.)
	Injection pump timing incorrect	Adjust timing (this group).
	Low cetane fuel	Use correct grade of fuel. (See Group 02.)
	Over-fueling	Repair injection pump. (See Group 35.)
Engine Emits Excessive Blue or White Smoke	Cranking speed too slow	Check batteries and electrical system.
	Injection pump timing incorrect	Adjust timing (this group).
	Injection nozzles faulty or sticking	Repair. (See Group 35.)
	Excessive wear in liners and/or piston rings stuck	See Group 10.
	Incorrect cetane fuel for ambient temperature	Use correct grade of fuel. (See Group 02.)
	Engine running too “cold”	Check thermostat. (See Group 25.)
Engine Idles Poorly	Injection nozzles faulty or sticking	Repair. (See Group 35.)
	Incorrect timing	Adjust timing (this group).
	Pump slow idle speed not correctly adjusted	Adjust slow idle speed (this group).
	Fuel lines restricted	Clean as required.
	Water in fuel	Drain water from filter, (or separator if equipped). Install new filter. (See Group 35.)
	Injection pump return lines or fittings restricted	Clean as required.
	Injection nozzle return lines clogged	Clean as required.
	Low cetane fuel	Use correct grade of fuel. (See Group 02.)

S11,23010,GL -19-07OCT94

DIAGNOSE FUEL SYSTEM MALFUNCTIONS—CONTINUED

Symptom	Problem	Solution
Engine Does Not Develop Full Power	Low cetane fuel	Use correct grade of fuel. (See Group 02.)
	Incorrect timing	Adjust timing (this group).
	Injection pump or governor faulty	Repair. (See Group 35.)
	Fuel filter clogged	Replace fuel filter. (See Group 35.)
	Injection nozzles faulty or sticking	Repair. (See Group 35.)
	Defective supply pump	Test (this group).
	Injection pump return fuel line or fittings restricted	Clean as required.
	Water or gasoline in diesel fuel	Drain water or replace with clean fuel Install new filters (this group).
	Incorrect fast idle speed	Adjust speed (this group).
	Speed control linkage incorrectly adjusted	Adjust (this group).

S11,23010,GM -19-07OCT94

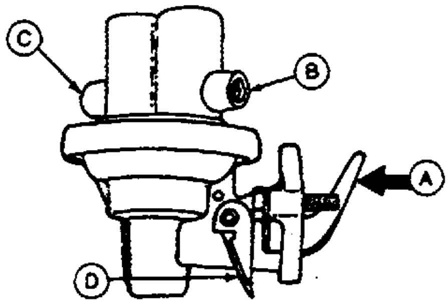
FUEL SUPPLY PUMP OPERATION—IF EQUIPPED

NOTE: Some vehicle applications which use the 3179 engine may not utilize the fuel supply pump. Fuel is supplied by injection pump pressure.

An eccentric lobe on the engine camshaft operates the lever (A) on supply pump to pressurize fuel system.

Fuel flows from the fuel tank at gravity pressure to the inlet side (B) of the diaphragm-type pump. This pump increases the fuel pressure to 25—30 kPa (0.25—0.30 bar) (3.5—4.5 psi) at slow idle speed and forces fuel through the outlet side (C) to the filter and fuel injection pump. Minimum output pressure--15 kPa (0.15 bar) (2 psi).

A hand primer lever (D) is provided for manually forcing fuel through the system to bleed fuel filter, etc.



RG5167 -UN-14DEC88

A—Lever
B—Inlet Side
C—Outlet Side
D—Hand Primer Lever

RG,CTM4,DX404 -19-28SEP95

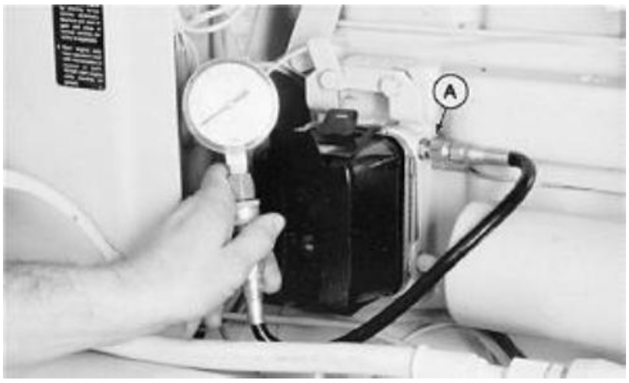
115
30

DIAGNOSE SUPPLY PUMP MALFUNCTION

Symptom	Problem	Solution
Low Supply Pump Pressure or Pump Not Functioning Correctly	Out of fuel	Add fuel to tank.
	Fuel shut off at tank	Open 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.
	Hand primer lever left in upward position	Move lever toward engine block as far as it will go.
	Punctured or leaking diaphragm	Repair or replace. (See Group 35)
	Worn or damaged valve assemblies	Repair or replace. (See Group 35)
	Broken valve spring(s)	Repair or replace. (See Group 35)
	Foreign material under diaphragm (from vent holes)	Repair or replace. (See Group 35)
	Wear or damage to hand primer linkage	Replace pump. (See Group 35)

S11,23010,GO -19-13JUL95

MEASURE FUEL SUPPLY PUMP PRESSURE—IF EQUIPPED



T6006AL -UN-25OCT88

NOTE: Some vehicle applications which use the 3179 engine may not utilize the fuel supply pump. Fuel is supplied by injection pump pressure.

FUEL SUPPLY PUMP OPERATING PRESSURE SPECIFICATIONS

Fuel Supply Pump Operating Pressure:
Normal . . . . 25—30 kPa (0.25—0.30 bar) (3.5—4.5 psi)
Minimum . . . . 15 kPa (0.15 bar) (2 psi)

1. Remove plug on fuel filter base.

2. Install test equipment as shown.

3. Start engine. Fuel pump should maintain positive minimum pressure of 15—30 kPa (0.15—0.3 bar) (2—4 psi). If pressure is low, replace filter element and recheck pressure.

RG,CTM4,DX405 -19-28SEP95

If pressure is still low, perform the following:

1. Disconnect pump-to-filter fuel line at the filter.

2. With throttle set at no-fuel position (or injection pump shut-off solenoid wire disconnected) so engine will not start, turn engine over several times with staring motor.

3. If fuel spurts from the line, the pump is operating properly.

NOTE: Look for a possible restriction in filter/filter base. Make sure pressure gauge/hose assembly is not at fault.

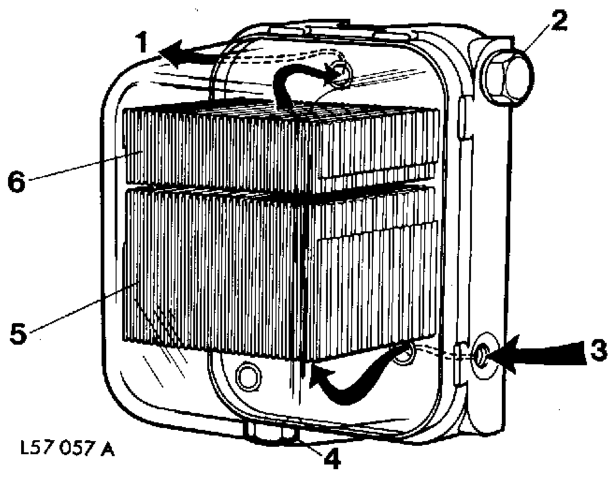
S11,23010,GQ -19-06FEB95

RECTANGULAR FINAL FUEL FILTER OPERATION

Fuel enters the filter at inlet (3) and flows through a first stage filtering media (5) then through a second stage filtering media (6) before flowing through outlet (1) to the fuel injection pump. The filtering media is housed in a metal sediment bowl and is glued to the bowl as an assembly.

Since water and other contaminants may settle at the bottom of the sediment bowl, a drain plug (4) is provided to permit removal of these contaminants.

An air vent/bleed plug (2) enables air in the system to be expelled to the outside through the filters when the bleed plug is loosened.

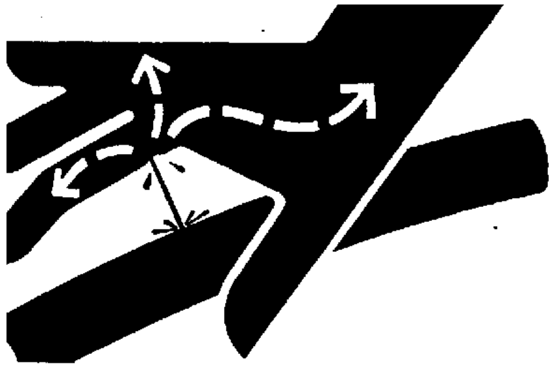


L57057A -UN-23MAY95

1—Fuel Outlet
2—Bleed Plug
3—Fuel Inlet
4—Drain Plug
5—First Stage Filter
6—Second Stage Filter

S11,23010,GS -19-13JUL95

BLEED THE FUEL SYSTEM


X9811 -UN-23AUG88

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid hazards 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 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.

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.

RG,CTM8,G35,9 -19-03OCT94

T95989 -UN-20OCT88

T79458 -UN-01NOV88

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 application.

1. At Fuel Filter:

— Loosen air bleed screw (A).

— Operate primer lever of fuel supply pump until fuel flow is free from air bubbles. Tighten bleed screw.

If engine will not start, proceed to next step.

2. At Fuel Injection Pump:

• Stanadyne And Roosa-Master Injection Pumps:

— Loosen fuel supply line at fuel injection pump.

— Operate primer lever of fuel supply pump until fuel flow is free from air bubbles. Tighten fuel supply line.

If engine will not start, proceed to next step.

• Roto-Diesel And Lucas-CAV Injection Pumps:

— Loosen bleed screw on pump cover.

— Operate primer lever of fuel transfer pump until fuel flows. Tighten bleed screw securely.

IMPORTANT: NEVER loosen the screw securing the hydraulic head to the pump housing, otherwise pump internal damage may occur.

If the engine still will not start after the above bleeding procedures, continue with the following steps.

3. At Fuel Injection Nozzles:

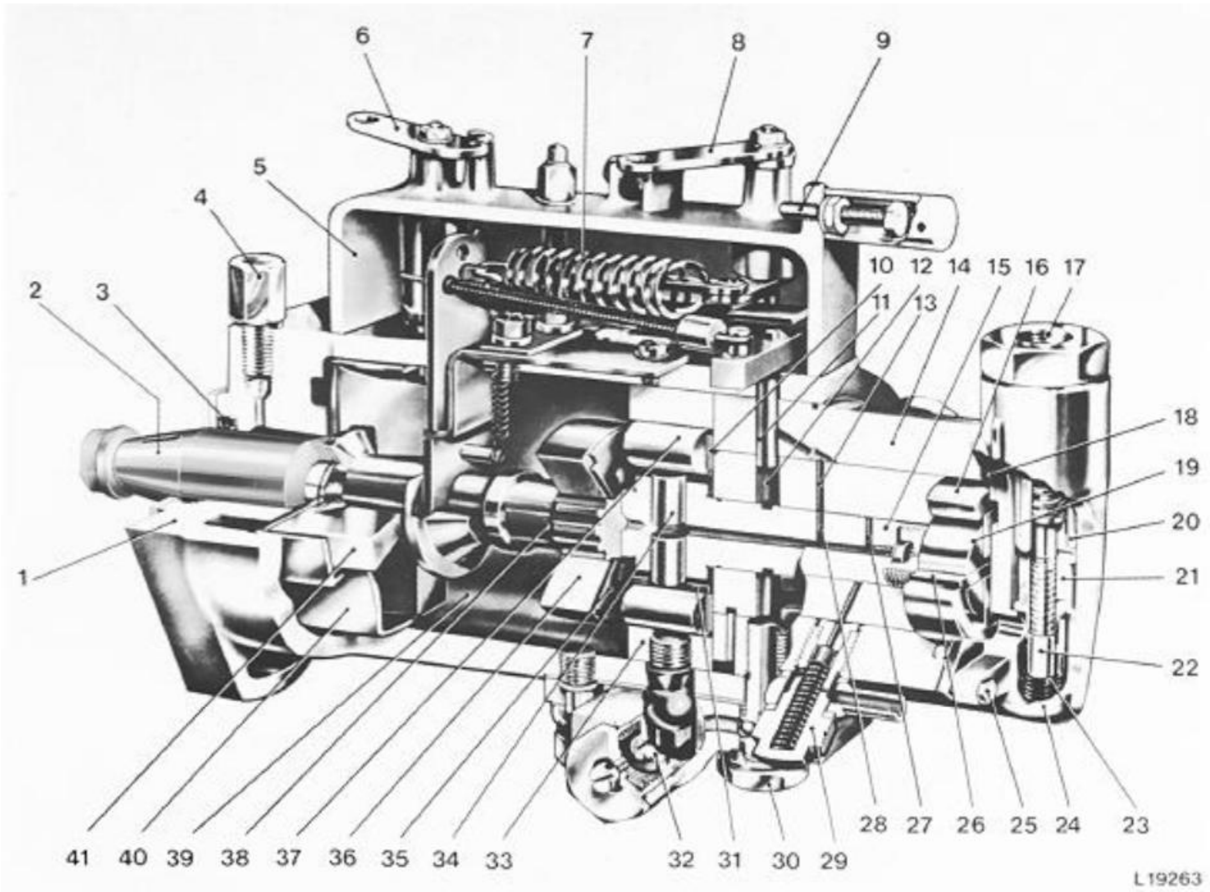
— Place throttle lever in fast idle position.

— Using two open-end wrenches, loosen fuel line on at least three injection nozzles.

— Turn engine over with starting motor, but do not start engine, until fuel free from bubbles flows out of loosened connections. Tighten connections to 34 N·m (25 lb-ft).

RG,CTM4,DX406 -19-28SEP95

ROTO DIESEL/LUCAS CAV FUEL INJECTION PUMP OPERATION



- 1—Pump Housing
- 2—Drive Shaft
- 3—Seal Ring
- 4—Leak-Off Adapter
- 5—Governor Housing
- 6—Shut-Off Lever
- 7—Governor Spring
- 8—Speed Control Lever
- 9—Fast Idle Adjusting Screw
- 10—Rear Adjusting Plate
- 11—Metering Valve
- 12—Metering Valve Chamber
- 13—Metering Channel
- 14—Pump Head
- 15—Pump and Distributor Rotor
- 16—Eccentric Sleeve of Sleeve Pump
- 17—Fuel Inlet
- 18—Seal
- 19—Rotor of Transfer Pump
- 20—Filter
- 21—Pressure Regulating Valve Sleeve
- 22—Pressure Regulating Valve Piston
- 23—Bleed Spring
- 24—End Plate
- 25—Cap Screw
- 26—Rotor Blades of Transfer Pump
- 27—Distributor Channel
- 28—Radial Bore (one per cylinder)
- 29—Pressurizing Valve (one per cylinder)
- 30—Hollow Screw
- 31—Race
- 32—Automatic Hydraulic Speed Advance
- 33—Cam Ring
- 34—Plunger
- 35—Front Adjusting Plate
- 36—Drive Plate
- 37—Cam Roller
- 38—Pump Shaft
- 39—Internal Chamber of Pump Housing
- 40—Governor Cage
- 41—Flyweights

S11,23010,GT -19-13JUL95

(Refer to illustration on previous page.)

The Roto Diesel/Lucas CAV fuel injection pump is a horizontally installed distributor pump with mechanical governor and automatic hydraulic speed advance (32). The moving parts of the pump are simultaneously lubricated and cooled by the diesel fuel flowing through the pump. No lubricant is required.

The diesel fuel for injection is fed to the cylinders, regardless of the number, by a single unit. The pump and distributor rotor (15) is fitted with two opposed plungers (34) controlled by a cam ring (33).

On the other end of the rotor, opposite the two pump plungers, there is a transfer pump (19) which delivers the fuel, drawn from the fuel filter, through the metering valve (11) into the inlet bore (13) in the pump head (14), at a pressure which varies with engine speed.

• FILLING PROCESS:
As rotor (15) rotates, the inlet bore (13) in pump head aligns with inlet bore (28) in the rotor. Fuel coming from the transfer pump reaches the pump plunger chamber through bore, regulated by the metering valve and forces the two plungers apart.

• PUMPING AND DELIVERY PROCESS:
During further rotation of the distributor rotor, inlet bore in the pump head is closed and distributor channel (27) in the rotor eventually aligns with one of the outlet bores in the pump head. Meanwhile the two pump plungers have reached the cam so that they move towards each other. The trapped, metered fuel is forced, under high pressure, through channel in the rotor and outlet opening in the pump head. Then, through pressurizing valve (29) and connected pressure line, to the fuel injection nozzle and into the appropriate cylinder.

A pressurizing valve is located at each outlet in the pump head where the pressure line leading to the fuel injection nozzle is connected. After injection, the pressure valve closes again, and with its small relief piston, sucks a quantity of fuel from the pressure line.

The resulting relief in the pressure line causes a quick and firm shutting of the nozzle valve. This prevents fuel from leaking into the combustion chamber.

The quantity of fuel which is needed at any given moment for each cylinder and combustion cycle is regulated by a metering valve. The metering valve is controlled by the speed control rod and control lever (8), and by the governor inside the governor housing (5).

In the engine “OFF” position, the metering valve completely cuts the supply of fuel from transfer pump to the rotor.

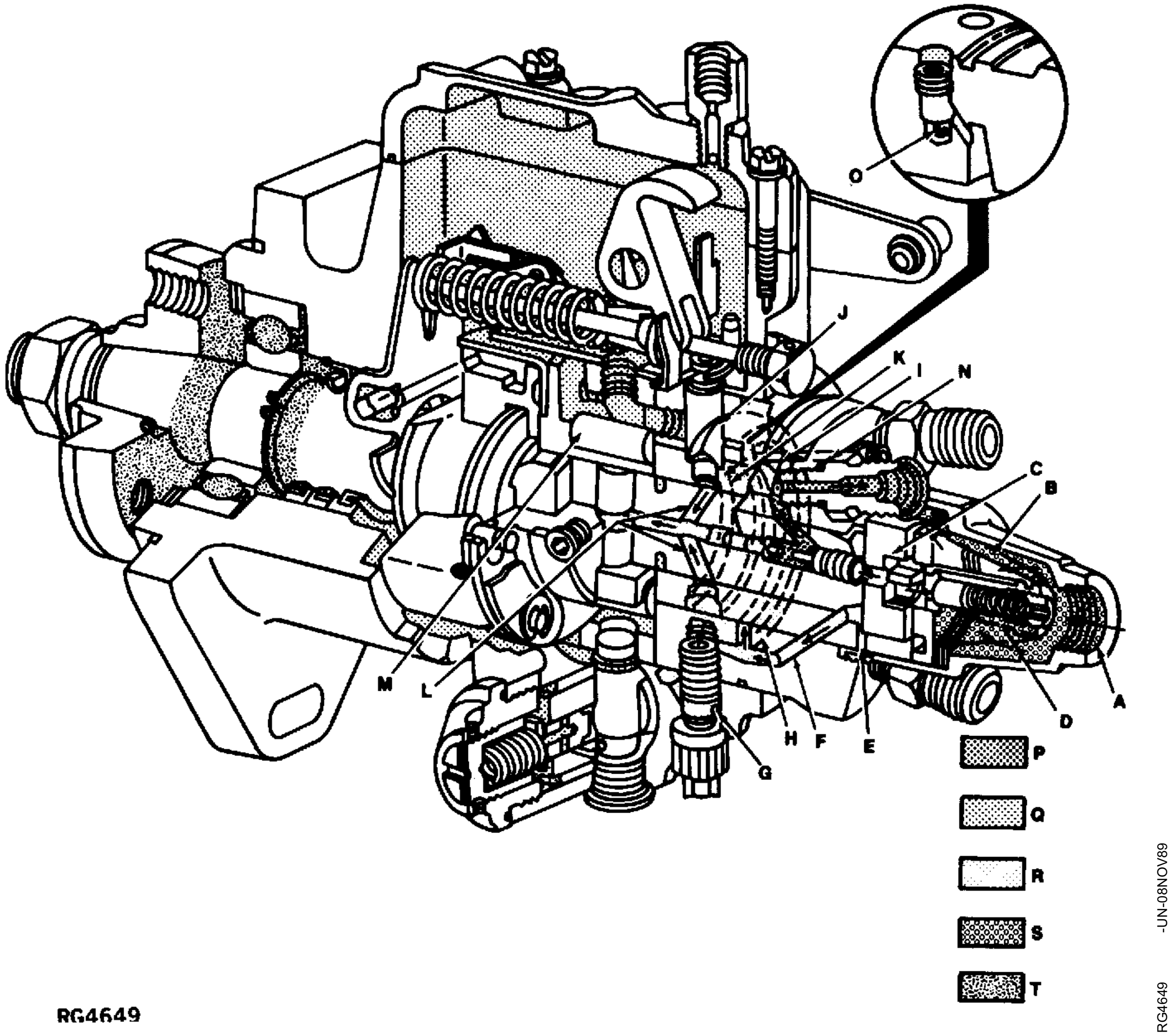
At idling speed or under load, the transfer pump feeds more fuel to the metering valve than is needed for injection. The excessive fuel flows through the pressure regulating valve back to the suction side of the transfer pump. A very small amount of this surplus fuel escapes through the top of the governor housing.

To obtain the best possible performance over the entire speed range, the fuel injection pump is fitted with an automatic, hydraulically operated speed advance (32). It is pre-set at the factory.

The speed advance adjusts timing of the fuel injection pump in relation to engine speed and load.

S11,23010,GU -19-04MAR87

STANADYNE DM4 FUEL INJECTION PUMP OPERATION



A—Supply Pump Inlet
B—Inlet Screen
C—Supply Pump
D—Regulator Assembly
E—Rotor Retainers
F—Passage
G—Advance Circuit
H—Charging Circuit
I—Annulus
J—Metering Valve
K—Charging Ring
L—Inlet Passages
M—Rollers
N—Vent Passage
O—Vent Wire
P—Inlet Pressure
Q—Supply Pump Pressure
R—Housing Pressure
S—Discharge Pressure
T—Lubrication Oil Pressure

Fuel is delivered to the supply pump inlet (A) where it passes through the inlet screen (B), and enters the vane-type pump (C). Since the supply pump displacement greatly exceeds the injection requirements, a large percentage of fuel is by-passed through the regulator assembly (D) to the suction side.

This positive displacement pump causes the fuel flow to increase with speed, and, because of the regulating piston, the pump pressure also increases with speed.

RG,CTM4,DW813 -19-28SEP95

Refer to illustration on previous page.

Fuel at supply pump pressure (Q) flows past the rotor retainers (E) into an annulus on the rotor. It then flows through a connecting passage (F) in the head to the advance (G) and charging circuit (H). The fuel flows around the annulus (I) through a connecting passage to the metering valve (J). The radial position of the metering valve (controlled by the governor) regulates the flow of fuel into the charging ring (K) which incorporates the charging ports.

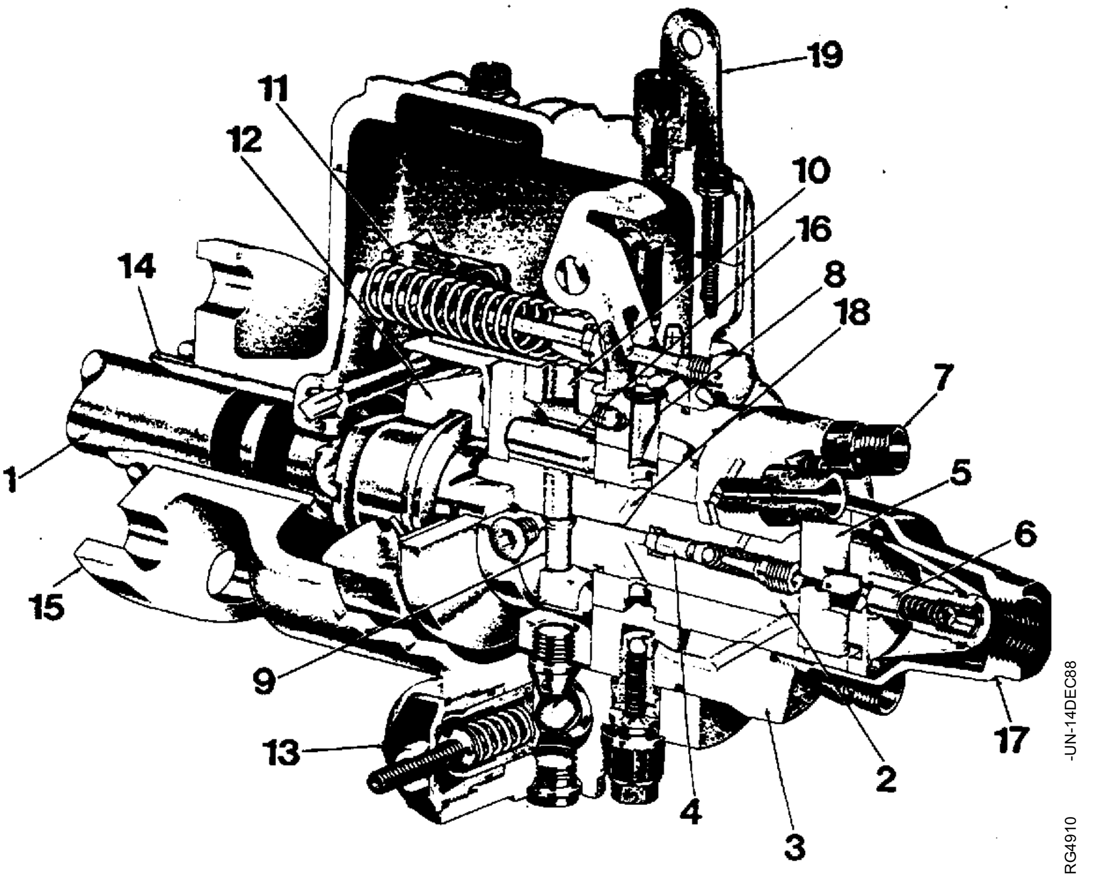
As the rotor revolves, the two inlet passages (L) register with the charging ports in the hydraulic head, allowing fuel to flow into the pumping cylinders. With further rotation, the inlet passages move out of registry, and the discharge port of the rotor registers with one of the head outlets. While the discharge port is opened, the rollers (M) contact the camshaft lobes, forcing the plungers together. Fuel trapped between the plungers is then delivered to the injection nozzle.

With the exception of the drive shaft bearing, lubrication of the working parts of the pump is achieved by utilizing by-passed fuel from the supply pump before it is returned to the fuel tank. The drive shaft bearing is lubricated by engine oil from the timing gear housing.

As fuel leaves the supply pump, it is directed through a passageway leading to an annulus in the hydraulic head. Connected to this passage way is a vent passage (N) located behind the metering valve bore. This vent passage contains a vent wire (O) to prevent excessive return fuel flow and high pressure loss. A short passage connects the vent passage with the governor linkage compartment. Should air enter the supply pump, it immediately passes to the vent passage. Air and small quantity of fuel then flow from the housing to the fuel tank by way of the return pipe.

S11,23010,CM -19-10AUG94

STANADYNE DB2/DB4 FUEL INJECTION PUMP OPERATION



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

DB2 Pump Shown, DB4 Pump Similar

The main rotating components are the drive shaft (1), distributor rotor (2), supply pump (5) and governor (11).

The drive shaft engages the distributor rotor in hydraulic head (3). The drive end of rotor incorporates the supply pump.

The plungers (9) 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.

S11,23010,GV -19-28SEP95

(Refer to illustration on previous page.)

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 changes due to temperature and fuel grade variations.

The distributor rotor incorporates two charging ports (18) and a single bore (passage) with one discharge port (4) 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.

This pump contains its own mechanical governor (11). 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.

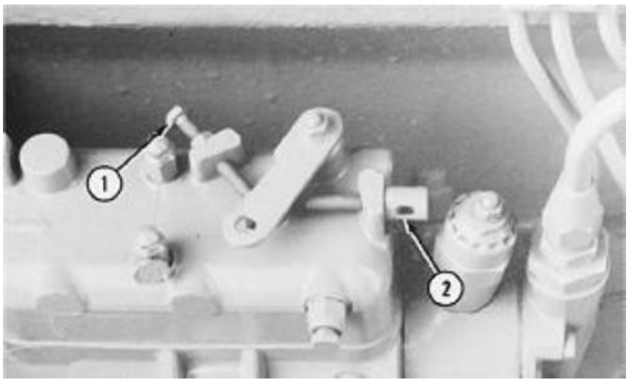
S11,23010,GW -19-07AUG86

DIAGNOSE 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.

S11,23010,GX -19-13JUL95

CHECK AND ADJUST ENGINE SPEEDS ON LUCAS CAV PUMP



T88011 -UN-17OCT89

NOTE: Before checking and 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 from fuel injection pump throttle lever.

NOTE: Refer to FUEL INJECTION PUMP SPECIFICATIONS, earlier in this group, for slow and fast idle speeds.

3. Start engine and move injection pump lever to slow idle position against slow idle adjusting screw (1). Using a tachometer, read and record engine speed. Compare reading with specifications. Adjust slow idle as necessary as detailed below.

4. Move injection pump lever to fast idle position against fast idle adjusting screw (2). Using a tachometer, read and record engine speed. Compare reading 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. Move pump throttle lever to slow idle position against slow idle adjusting screw (1). See specifications for specified engine speeds.

2. Loosen slow idle screw lock nut. Turn adjusting screw clockwise to increase speed and counterclockwise to decrease engine speed.

S11,23010,HM -19-13JUL95

ADJUST VARIABLE SPEED ON GENERATOR SET ENGINES (LUCAS CAV PUMPS ONLY)

See your authorized Lucas CAV Repair Station for speed droop adjustment. This service requires that an internal pump adjustment be made.

RG,CTM4,DX407 -19-13JUL95

CHECK AND ADJUST ENGINE SPEEDS ON STANADYNE PUMP

NOTE: Before checking and 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 remove control rod pin (B, if used). Disconnect speed control rod (or control cable) from fuel injection pump throttle lever.

NOTE: Refer to FUEL INJECTION PUMP SPECIFICATIONS, earlier in this group, for slow and fast idle speeds.

3. Start engine and move injection pump lever to slow idle position against slow idle adjusting screw (A or D). Using a tachometer, read and record engine speed. Compare reading with specifications. Adjust as necessary as detailed below.

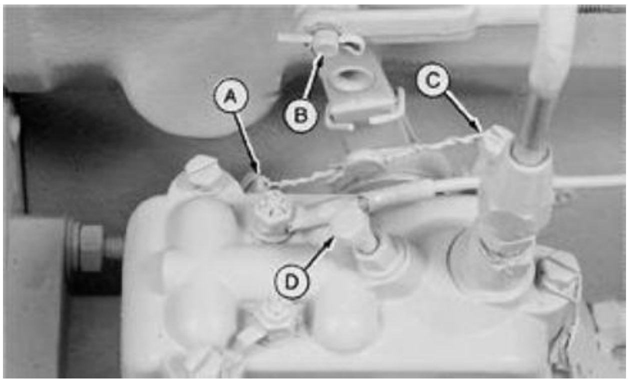
4. Move injection pump lever to fast idle position against fast idle adjusting screw (C). Using a tachometer, read and record engine speed. Compare reading with specifications.

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. Move pump throttle lever in slow idle position against slow idle adjusting screw (A or D). See specifications for specified engine speeds.

2. Loosen slow idle screw lock. Turn adjusting screw clockwise to increase speed and counterclockwise to decrease engine speed.



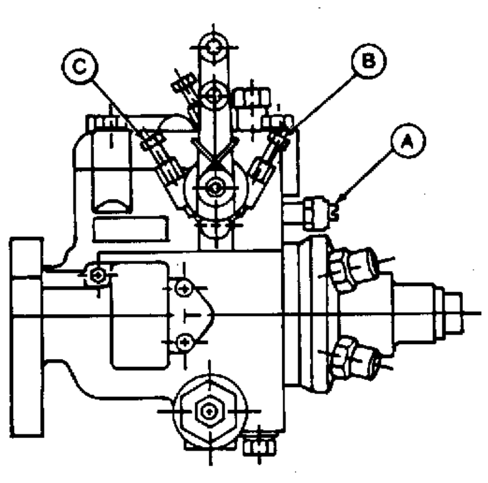
A—Slow Idle Adjusting Screw*
B—Control Rod Pin
C—Fast Idle Adjusting Screw
D—Slow Idle Adjusting Screw*

**Slow idle adjusting screw location varies by injection pump application. Will either be at location A or D.*

S11,23010,HN -19-13JUL95

ADJUST VARIABLE SPEED ON GENERATOR SET ENGINES—STANADYNE INJECTION PUMPS ONLY

An external speed droop adjusting cap (A) at the rear of the injection pump housing provides precise control of governor sensitivity by decreasing or increasing the effective length (and thereby the rate) of the governor control spring. Fine adjustments can be made while the engine is operating.



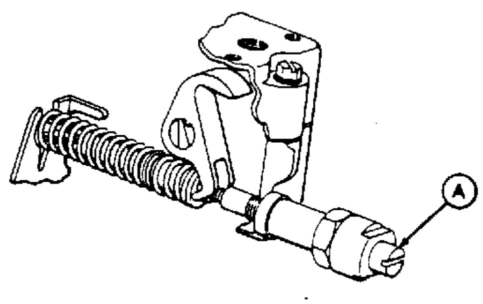
RG5754 -UN-05AUG91

1. Start engine and run at rated speed with 50% load applied until it reaches normal operating temperature.

NOTE: If serious surging occurs during the warm-up period, turn the speed droop adjusting cap clockwise until surging stops.

2. When engine has warmed to normal operating temperature, position throttle lever (D or E) to attain full load rated speed (e.g., 1500, 1800 RPM) and apply 100% (full) load.

Adjust the throttle if necessary to obtain satisfactory full load performance.

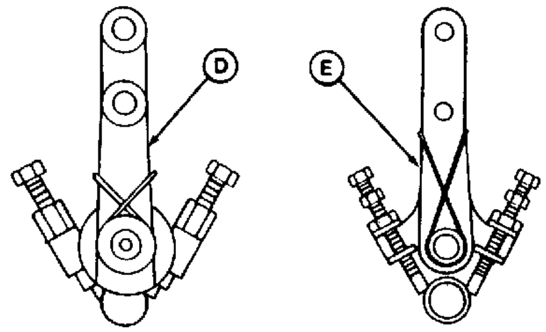


RG6395 -UN-17AUG92

NOTE: Whenever speed droop adjustments are made, throttle position adjustments will also be necessary.

3. Remove load and check for specified no-load speed or frequency.

If incorrect, adjust speed droop adjusting cap slightly (clockwise for increased droop or counterclockwise for less droop).



RG6397 -UN-21AUG92

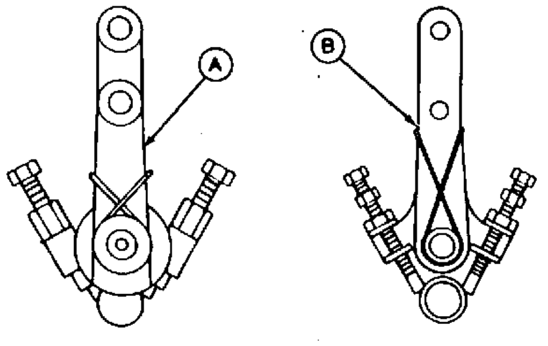
If surging exists upon removing the load, turn the adjusting cap clockwise to eliminate.

4. Recheck full load and no-load performance and readjust as necessary.

A—Speed Droop Adjusting Cap
B—Fast Idle Screw
C—Slow Idle Screw
D—Early Throttle Lever
E—Current Throttle Lever

S11,OMLM,DM -19-17OCT95

CHANGING GEN SET ENGINE RATED SPEED FROM 1800 RPM TO 1500 RPM—STANADYNE INJECTION PUMPS ONLY



A—Early Throttle Lever
B—Current Throttle Lever

This instruction covers step-by-step adjustment procedures for changing gen set engine rated speed from 1800 RPM (60 Hz) to 1500 RPM (50 Hz) while maintaining a 3—5% governor 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.

Before proceeding with the adjustment covered in this instruction, verify that maximum power is correct for the unit which is being modified.

To assure specified power and governing during engine operation on pumps with early type throttle levers (A), the throttle lever must be fixed against the fast idle screw stop by means of an external linkage or spring. If linkage is used, adjust so that the upper throttle lever is pushed 1/8“ to 1/4” out of alignment with the lower lever. On pumps with current type throttle levers (B), you can adjust and lock the fast idle using the injection pump fast and slow idle adjusting screws.

To assure specified governing, the fast idle speed must be readjusted any time the droop adjusting cap is adjusted.

RG,CTM4,DW814 -19-09OCT95

1. Start engine and apply 50% load at rated speed until it reaches normal operating temperature.

NOTE: If serious surging occurs during the warm-up period, turn in the speed droop adjusting cap (A) clockwise (CW, as viewed from rear of pump) until surging stops.

IMPORTANT: DO NOT back out slow idle screw (C) more than is necessary or internal pump damage may result.

2. When engine has warmed to normal operating temperature, load engine at 100% (full) load and adjust fast idle adjusting screw (B) CW until engine speed is 1500 RPM (50 Hz). Slow idle screw may need to be backed out slightly to obtain this speed setting.

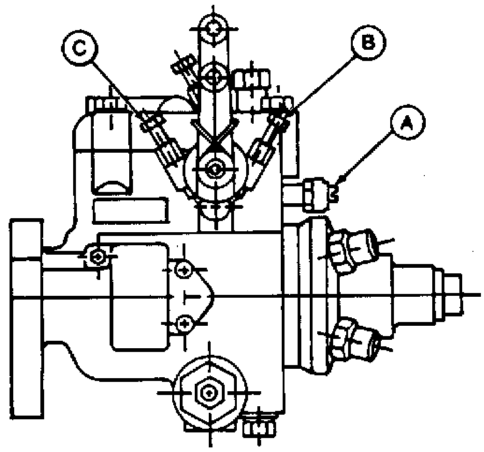
3. Remove load and check for specified no-load speed (frequency). If governor regulation is within 3—5% range, proceed to Step 6.

4. If governor regulation is above the 5% range, back out droop adjusting cap one full turn counterclockwise (CCW, as viewed from rear of pump). If engine surges when load is removed, turn the speed droop adjusting cap CW to eliminate surging.

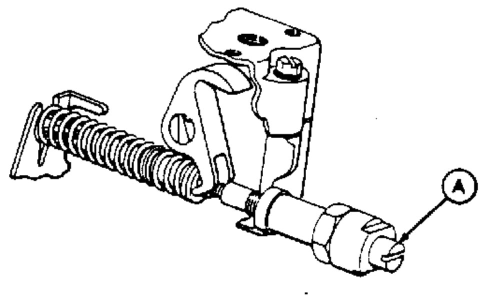
5. Readjust high idle adjusting screw until 1500 rpm (50 Hz) is obtained at specified power.

Repeat steps 4—5 until governor regulation is within the 3—5 % range.

6. Tighten fast and slow idle screw lock nuts, remove load, and stop engine.



RG5754 -UN-05AUG91



RG6395 -UN-17AUG92

A—Droop Adjusting Cap
B—Fast Idle Screw
C—Slow Idle Screw

RG,GENSET3,2 -19-19AUG92

FUEL INJECTION NOZZLES—GENERAL INFORMATION AND OPERATION

The injection nozzles are located in the engine cylinder head and are of the spring and valve type, hydraulically operated by the fuel delivered from the injection pump.

A locating clamp (Q) positions the nozzle assembly in the cylinder head. The nozzle is sealed at the top end by a seal washer (E). A carbon stop seal (B), located on the lower end of the nozzle body, prevents carbon from collecting around the nozzle in the cylinder head.

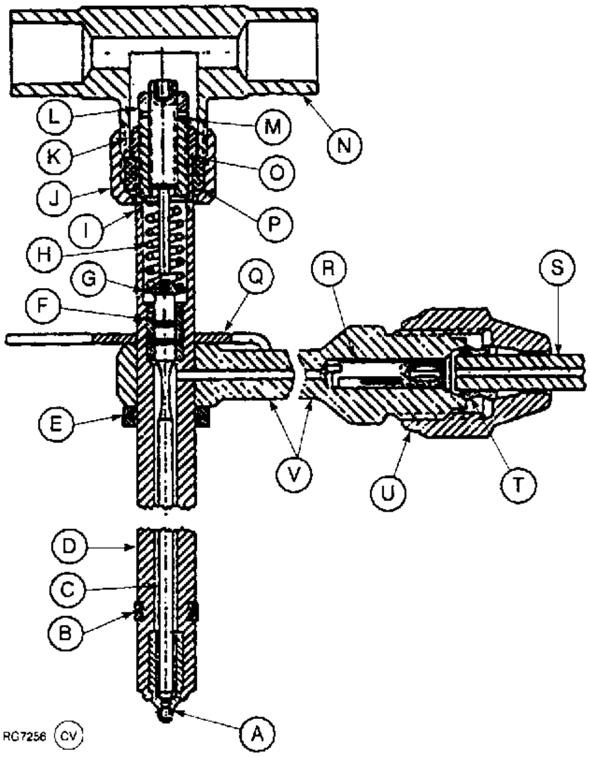
Enclosed in the nozzle body (D) are the valve (C), valve spring (H), and spring seat (G). The nozzle operating pressure is controlled by the pressure adjusting screw (O) in the upper end of the nozzle body. Valve lift is adjusted by the lift adjusting screw (M) located in the pressure adjusting screw. The nozzle tip (A) is pressed into the nozzle body and cannot be separated.

A leak-off line tee (N) is attached to the upper end of the injection nozzle, secured by a grommet (P) and hex nut (J).

Metered fuel, under high pressure, is delivered by the injection pump through the nozzle inlet on the valve body into the area surrounding the valve. When fuel pressure reaches nozzle opening pressure, the valve is forced from its seat against the pressure of the spring, permitting a measured amount of fuel to enter the combustion chamber through four small holes in the nozzle tip.

After fuel has been injected, the spring closes the valve. In actual operation, the valve opens and closes very rapidly, providing a distinct chatter.

A small amount of fuel leaks past the valve into the spring area. This provides lubrication for the nozzle working parts. This excess fuel is then removed from the nozzle at the top by means of a leak-off line routed to the fuel source.



RG7256 -UN-20JUL95

A—Spray Tip
B—Carbon Stop Seal
C—Nozzle Valve
D—Nozzle Body
E—Seal Washer
F—Nozzle Valve Guide
G—Spring Seat
H—Adjustable Pressure Spring
I—Spacer Washer
J—Hex Nut
K—Lock Nut
L—Lock Nut
M—Lift Adjusting Screw
N—Leak-Off Tee
O—Pressure Adjusting Screw
P—Grommet
Q—Locating Clamp
R—Filter Screen
S—Fuel Pressure Line
T—Nipple
U—Line Nut
V—Connection for Injection Line

S11,23010,HP -19-28SEP95

DIAGNOSE MALFUNCTION—FUEL INJECTION NOZZLE

Fuel injection nozzles are usually removed and tested or replaced when there is a noticeable loss of power or excessive smoking.

Listed in the following chart are various malfunctions which may occur on the 9.5 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.

Refer to 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, worn or damaged parts: —Broken nozzle valve spring —Cracked or split nozzle tip —Cracked or split nozzle body —Internal leak	Repair as required. (See Group 35.)
	Wrong nozzle assembly installed	Install correct nozzle assembly. (See Group 35.)
	Nozzle loose in cylinder head	Make sure nozzle assembly is correctly installed. Tighten clamp cap screw to specified torque. (See Group 35.)
Engine Emits Too Much Smoke	Nozzle orifices plugged	Repair. (See Group 35.)
	Broken, worn or damaged parts: —Broken nozzle valve spring —Cracked or split nozzle tip —Cracked or split nozzle body —Internal leak	Repair as required. (See Group 35.)
	Wrong nozzle assembly installed	Install correct nozzle assembly. (See Group 35.)

S11,23010,HQ -19-13JUL95

TEST FUEL INJECTION NOZZLES (ENGINE RUNNING)

1. Operate engine at intermediate speed with no load.

2. Slowly loosen the fuel pressure line at one of the nozzles until fuel escapes at the connection (fuel not opening nozzle valve).

NOTE: The injection nozzle before and/or after nozzle being checked could be the faulty nozzle.

• If engine speed changes, the injection nozzle is probably working satisfactory.

• If engine speed does not change, a nozzle is faulty and must be checked and repaired (or replaced).

3. Repeat test for each remaining nozzle assembly.

4. Remove faulty injection nozzles and repair as required. (See Group 35.)

S11,23010,HR -19-24JUL95

FUEL DRAIN BACK TEST PROCEDURE

Fuel draining back through the fuel system may cause hard starting. This procedure will determine if air is entering the system at connections and allowing fuel to siphon back to the fuel tank.

1. Disconnect fuel supply and return lines at fuel tank.

IMPORTANT: Fuel return line MUST extend below fuel level in fuel tank before performing this test. Fill fuel tank if necessary.

2. Drain all fuel from the system, including the fuel transfer pump, fuel injection pump, fuel filters, and water separator (if equipped).

3. Securely plug off the end of the fuel return pipe.

CAUTION: Maximum air pressure should be 100 kPa (1 bar) (15 psi) when performing this test.

4. Using a low pressure air source, pressurize the fuel system at the fuel supply line.

5. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

NOTE: Connections may allow air to enter the system without allowing fuel to leak out.

6. If any leaks are found, take necessary steps to repair.

7. Reconnect supply and return lines and prime system.

8. Start engine and run for approximately 10 minutes.

9. Allow engine to sit overnight and try starting the following morning.

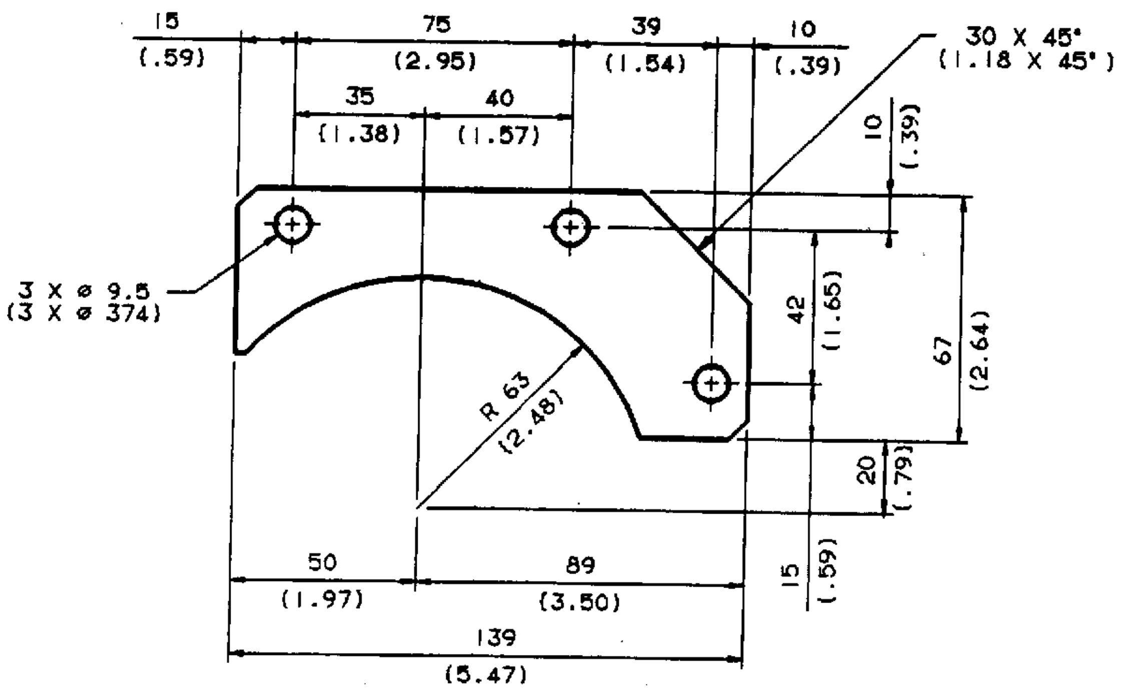
S11,23010,JA -19-24JUL95

HOW TO MAKE TOOLS

These tools can be made in a service shop using common shop tools and locally obtained materials.

S55,DFRG -19-24JUL95

DFRG2—INJECTION PUMP FRONT PLATE TIMING MARK TRANSFER TOOL

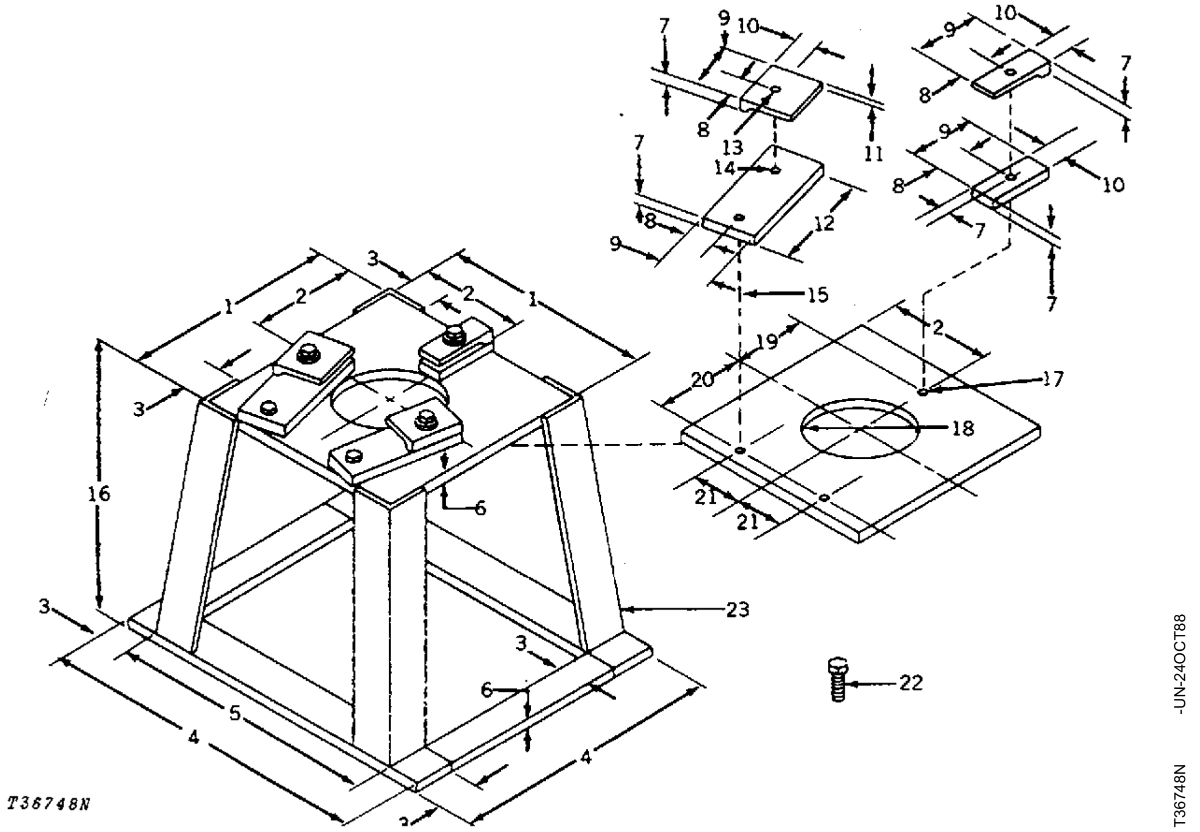


RG5589 -UN-09OCT89

Material—Aluminum

S55,DFRG2 -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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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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