Series 400
6466
Diesel Engines

Deere Power Systems Group
CTM1 (27OCT94)
LITHO IN U.S.A.
ENGLISH

Series 400
6466 Diesel Engines

CTM1 (27OCT94)

Introduction

FOREWORD

This manual is written for an experienced technician. Essential tools required in performing certain service work are identified in this manual and are recommended for use.

Live with safety: Read the safety messages in the introduction of this manual and the cautions presented throughout the text of the manual.

This is the safety-alert symbol. When you see this symbol on the machine or in this manual, be alert to the potential for personal injury.

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

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

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

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

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

DX,CTMIFC -19-22MAY92

Dealer Presentation Sheet

JOHN DEERE DEALERS

IMPORTANT: The changes listed below make your current CTM1 obsolete. Discard CTM-1, dated (2-87) on the front cover. Please copy this page and route through your service department.

• This CTM has been completely revised. Detailed descriptions of the improvements are too numerous to list.

• All safety information has been updated in Group 00. All persons using this manual should read and understand this information.

• Essential and Special Tools listings have been revised and updated throughout the manual.

• Basic engine specifications have been deleted from Group 01. Specifications are covered in detail in their respective groups. All specifications lists have been revised and updated.

• Information on recommended sealants, thread lock compounds, anti-seize compounds, gasket materials and adhesives has been updated. Generic material recommendations have been revised to provide more specific information. Group 04 also contains Sealant Applications Guidelines that provide ordering information for these materials as well as helpful “where used” information.

• Most component identification illustrations and general system descriptions have been moved to Group 105, Engine System Operation and Tests.

• Dealer Fabricated Tools have been removed from the individual groups and consolidated in Group 199.

RG,CTM -19-17AUG94

ABOUT THIS MANUAL

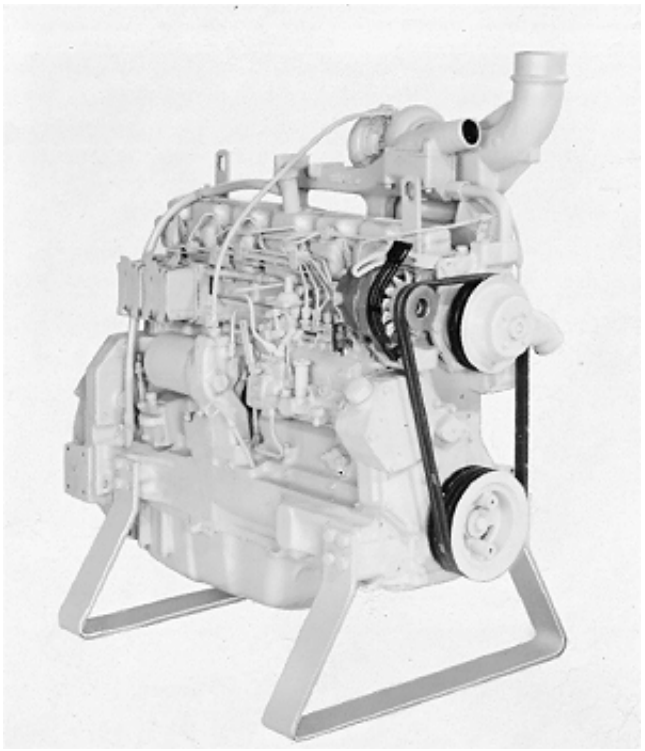
This component technical manual covers the recommended repair procedure for 6466 diesel engines produced in Waterloo, Iowa.

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

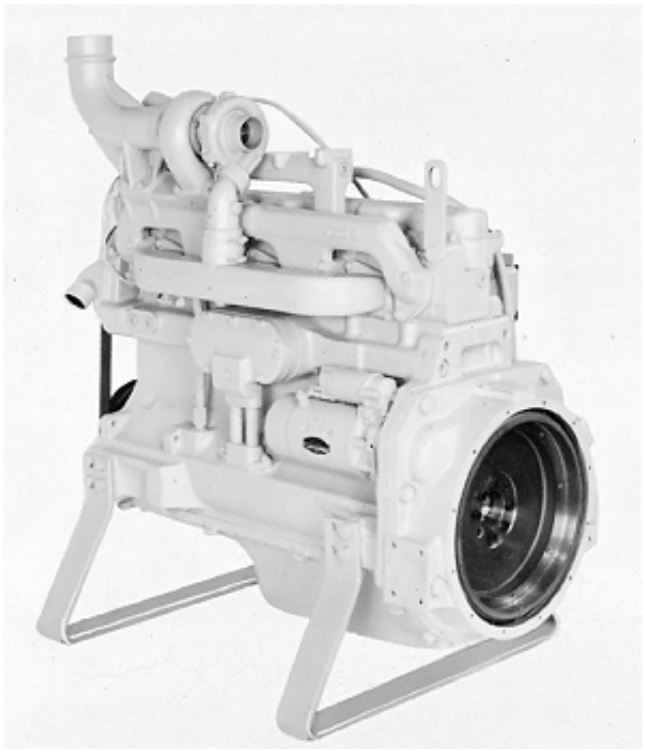
Direction of engine crankshaft rotation in this manual is referenced as counterclockwise, facing the flywheel looking toward the front (fan drive end).

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

Read each module completely before performing any service.



3/4 Right Front View 6466T Engine



3/4 Left Rear View of 6466T Engine

S11,2000,EL -19-08MAR94

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

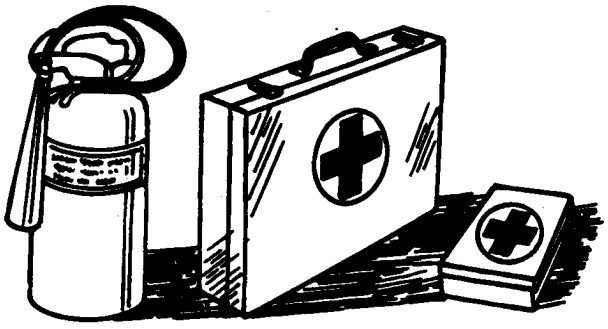
DX,SPARKS -19-03MAR93

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

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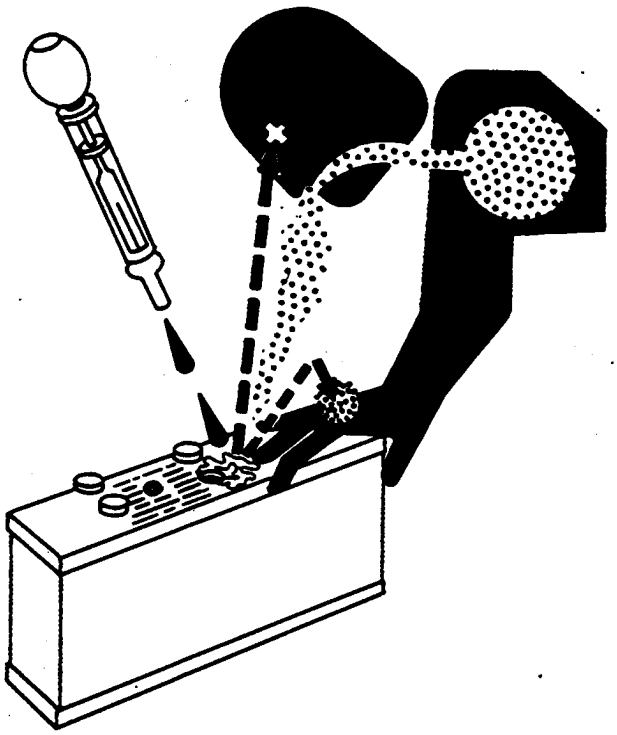
2

Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

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

If you spill acid on yourself:
1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 15—30 minutes. Get medical attention immediately.

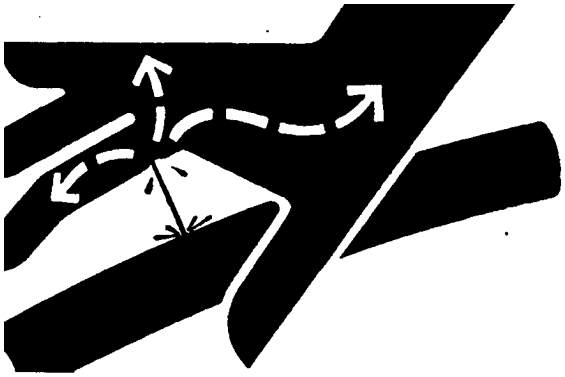
If acid is swallowed:
1. Do not induce vomiting.
2. Drink large amounts of water or milk, but do not exceed 2 L (2 quarts).
3. Get medical attention immediately.



TS203 -UN-23AUG88

DX,POISON -19-21APR93

AVOID HIGH-PRESSURE FLUIDS



X9811 -UN-23AUG88

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

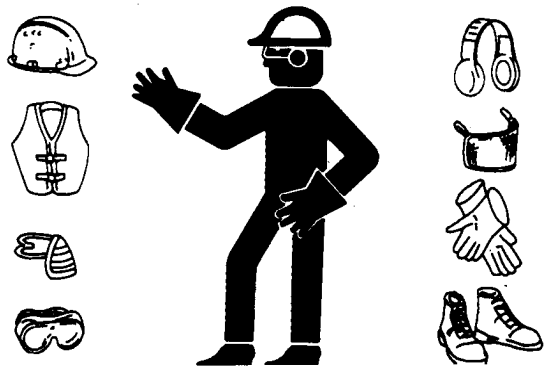
Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

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

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

DX,FLUID -19-03MAR93

WEAR PROTECTIVE CLOTHING



TS206 -UN-23AUG88

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

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

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

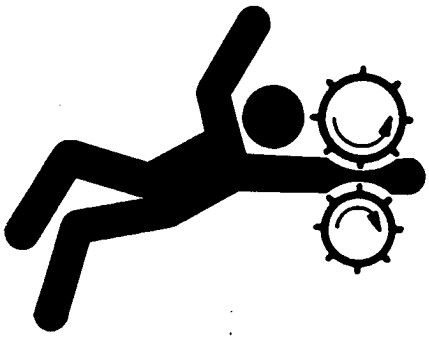
Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.

DX,WEAR -19-10SEP90

SERVICE MACHINES SAFELY

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

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



TS228 -UN-23AUG88

DX,LOOSE -19-04JUN90

WORK IN VENTILATED AREA

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

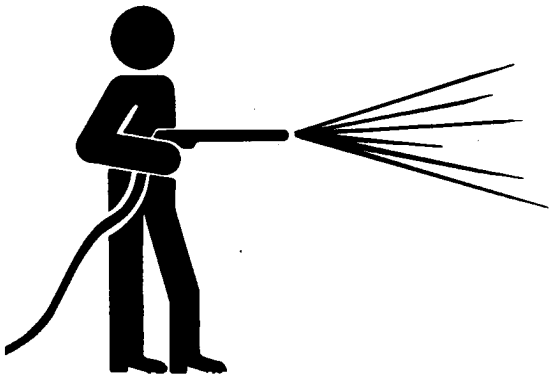
If you do not have an exhaust pipe extension, open the doors and get outside air into the area.

TS220 -UN-23AUG88

DX,AIR -19-04JUN90

WORK IN CLEAN AREA

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



T6642EJ -UN-18OCT88

DX,CLEAN -19-04JUN90

REMOVE PAINT BEFORE WELDING OR HEATING

TS220 -UN-23AUG88

Avoid potentially toxic fumes and dust.

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

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

Remove paint before welding or heating:

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

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

DX,PAINT -19-03MAR93

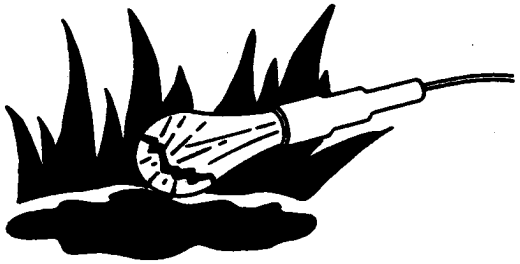
AVOID HEATING NEAR PRESSURIZED FLUID LINES

TS953 -UN-15MAY90

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

DX,TORCH -19-03MAR93

ILLUMINATE WORK AREA SAFELY



TS223 -UN-23AUG88

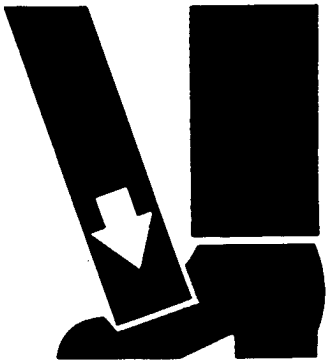
Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

DX,LIGHT -19-04JUN90

USE PROPER LIFTING EQUIPMENT

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

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



TS226 -UN-23AUG88

DX,LIFT -19-04JUN90

PRACTICE SAFE MAINTENANCE

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

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

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

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

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

TS218 -UN-23AUG88

DX,SERV -19-03MAR93

USE PROPER TOOLS

TS779 -UN-08NOV89

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

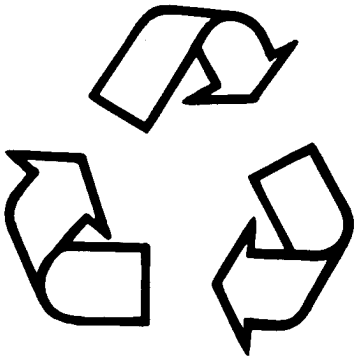
Use power tools only to loosen threaded parts and fasteners.

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

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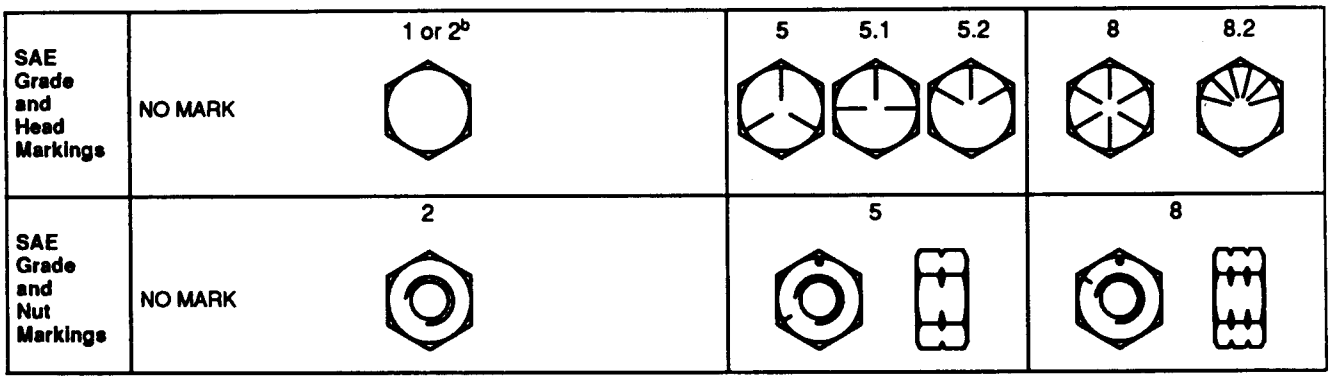
Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

TS231 -19-07OCT88

DX,LIVE -19-25SEP92

UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES



TS1162 -19-04MAR91

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

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

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

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

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

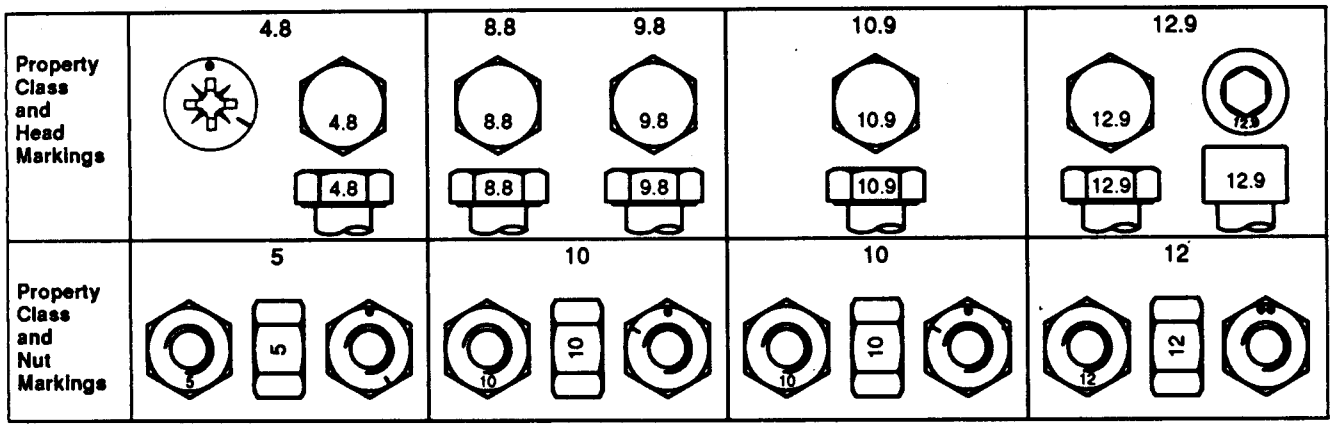
Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

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

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

DX,TORQ1 -19-20JUL94

METRIC BOLT AND CAP SCREW TORQUE VALUES



-19-04MAR91

TS1163

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

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

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

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

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

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

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

DX,TORQ2 -19-20JUL94

ENGINE MODEL DESIGNATION

• 6466 ENGINE

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

6466AF001 ENGINE

6	Number of cylinders
466	Cubic inch displacement
A	Aspiration code
F	User factory code
001	Application code

ASPIRATION CODE

D	Naturally Aspirated
T	Turbocharged
A	Turbocharged and Aftercooled

USER FACTORY CODE	JD FACTORY
CD	Saran, France
CM	Chamberlain, Australia
CZ	Venezuela
DW	Davenport
H	Harvester
J	Argentina
L	Mannheim, Germany
N	Des Moines
P	Mexico
R	Waterloo Tractor Works (Early)
RW	Waterloo Tractor Works (Current)
T	Dubuque
Z	Zweibrucken, Germany

APPLICATION CODE

-00, ,-01, -02
-001,002, etc . . . . . Code for specific application

S11,2000,ES -19-08AUG94

• DETROIT DIESEL ALLISON (DDA) ENGINE MODEL

DDA engine model designation cross-reference with the John Deere engine model. It includes the series, number of cylinders, application type, direction of rotation, aspiration, and application code. For example, the model 6466AF001 engine just previously discussed, becomes DDA model G0679600:

G0679600 MODEL DESIGNATION

G . . . . . Engine series
06 . . . . . Number of cylinders
7 . . . . . Application type
9 . . . . . Direction of rotation
6 . . . . . Aspiration
00 . . . . . Application code

APPLICATION TYPE

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

DIRECTION OF ROTATION

9 . . . . . Right-Hand or clockwise (as viewed from FRONT of engine)
0 . . . . . Left-Hand or counter-clockwise rotation

ASPIRATION

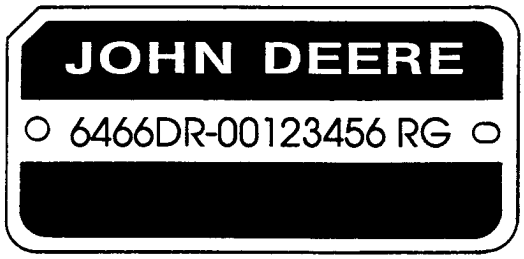
1 . . . . . Naturally aspirated
3 . . . . . Turbocharged
6 . . . . . Turbocharged and aftercooled

APPLICATION CODE

-00, -01, etc. . . . . Code for each specific application

S11,2000,ER -19-08AUG94

ENGINE SERIAL NUMBER PLATE INFORMATION



RG7079 -UN-19JAN94

01
5

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

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

The engine serial number plate on your engine may be one of several styles.

For engine serial numbers (—227600), a one-line serial number plate was used. The serial number on these early plates is a 17-digit number that identifies the engine model designation, user code, and the application code, followed by a 6-digit sequential number and the factory code. The following is an example.

6466DR-01215075RG:

6466 . . . . . Engine Model*
D . . . . . Aspiration Code*
R . . . . . User Factory Code*
-01 . . . . . Application Code*
215075 . . . . . Sequential Serial No.
RG . . . . . Producing Factory (Waterloo)

**See ENGINE MODEL DESIGNATION earlier in this group for more detailed explanations of these codes.*

RG,CTM1,G01,1 -19-08AUG94

For engine serial numbers (227601—), a two-line serial number plate is used.

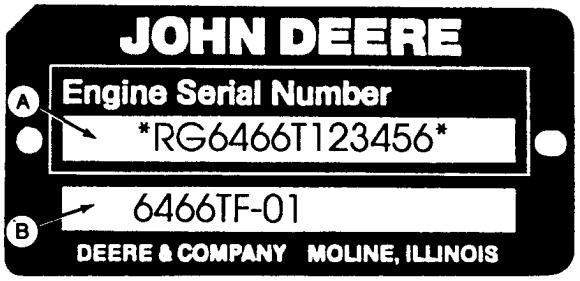
The first line of information (A) is a 13-digit number that identifies the producing factory, engine model designation, and a 6-digit sequential number. The following is an example.

01
6

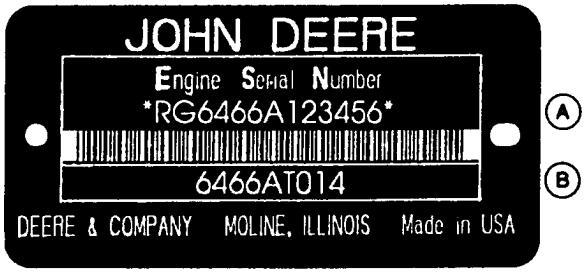
RG6466D215075

RG . . . . . Producing Factory (Waterloo)
6466 . . . . . Engine Model*
D . . . . . Aspiration Code*
215075 . . . . . Sequential Serial No.

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



-UN-19JAN94
RG7080



-UN-19JAN94
RG7083

**See ENGINE MODEL DESIGNATION earlier in this group for more detailed explanations of these codes.*

RG,CTM1,G01,2 -19-08AUG94

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

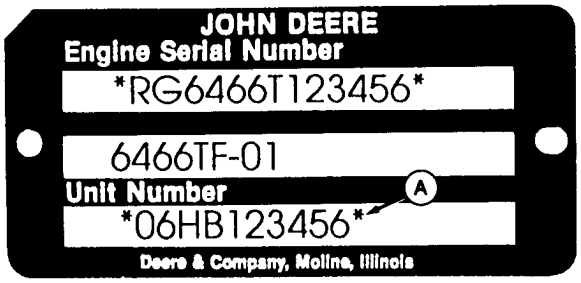
A typical unit number converts the 13-digit engine serial number into one that is 10-digit. It includes the number of cylinders, manufacturing factory location, and the DDA model designation. Example:

JD ENGINE SERIAL NO.	**DDA UNIT NO.**
RG6466T000000	**06HB000000**
	06
RG	H
RG6466T	B**
000000	000000

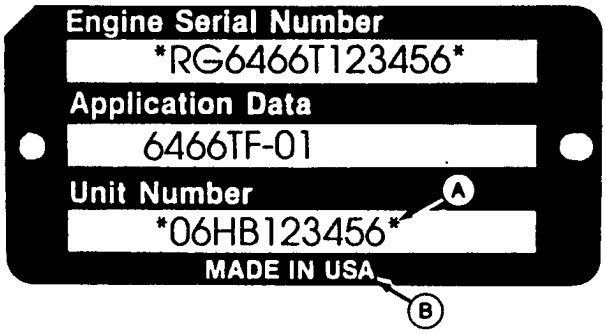
MODEL CODES

JD/DDA Factory Code	**Deere Engine Model**	**DDA Model Code** (4th position of Unit No.)**
RG/H	6466D	A
RG/H	6466T	B
RG/H	6466A	C

NOTE: Some engine serial number plates (B) are used which do not have the John Deere name printed.



DDA Unit Number Plate



Generic Engine Serial Number Plate

S11,2000,EV -19-08AUG94

ENGINE APPLICATION CHART

• John Deere Agricultural Equipment Applications

Machine Model No.	Engine Model
COMBINES	
Harvester Works	
6600	6466DH-01
6602	6466TH-01
6620	6466DH-01, TH-01, 05
6620 SideHill	6466TH-01, 05
6620 Hydro	6466TH-01
6620 Mexico	6466DP-03
6622	6466TH-01, 05
7700	6466DH-02, TH-01, 02
7720	6466TH-01, 02, 03, 05
7720 Hydro	6466TH-04
7720 Mexico	6466TP-03
7722	6466TH-06
8820	6466AH-01, 02
8820 Export	6466AH-03
Zweibrucken (Germany)	
985	6466TZ-01
985 Hydro/4	6466AZ-01
1085	6466TZ-01
1085 Hydro/4	6466AZ-01
1177 Hydro/4	6466AZ004
1188	6466AZ002, 004
1188 Hydro/4	6466AZ003
1188 SII Hydro/4	6466AZ003
COTTON PICKERS	
Des Moines Works	
9940	6466AN-01
9950	6466AN-02
FORAGE HARVESTERS	
Ottumwa Works	
5440	6466AE-01
5720	6466AE-01, 02
5730	6466AE-02
Senoches	
5440E	6466ACA01
5620 France	6466ACA01

S11,2000,CZ -19-08AUG94

ENGINE APPLICATION CHART—CONTINUED

• John Deere Agricultural Equipment Applications—Continued

Machine Model No.	Engine Model
TRACTORS	
Tractor Works	
4050	6466DR-06, 07, 08, 09
4050 Export	6466TRW06
4240	6466DR-01, 02, 03, 04
4250	6466TR-11, 12, 13, 14
4250 Export	6466TR-19, 20
4255	6466TP-05
4440	6466TR-03, 04, 05, 06
4440 Export	6466TR-07, 08
4450	6466TR-15, 16
4450 Export to China	6466TR-17
4450 Export	6466TR-18
4640	6466AR-07, 08
4640 Export	6466AR-09, 10
4650	6466AR-15, 16
4650 Export	6466AR-20, 21
4840	6466AR-04, 05
4840 Export	6466AR-11, 12
4850	6466AR-17
4850 Export	6466AR-18
8430	6466AR-01
8430 Export	6466AR-06
8440	6466AR-01
8440 Export	6466AR-06
8450	6466AR-13, 19
8450 Export	6466AR-14
Mannheim (Germany)	
4240	6466DL-01
4250	6466TL-03, 04
4350	6466TL-09
4440	6466TL-01, 02
Chamberlain (Australia)	
4485	6466TCM01
4685	6466TCM02
Argentina	
4050	6466DJ-02
4730	6466DJ-01
4930	6466TR-10
Mexico	
4235	6466DP-01
4455	6466TP-01
Venezuela	
4240	6466DCZ-01

S11,2000,DC -19-17AUG94

ENGINE APPLICATION CHART—CONTINUED

• John Deere Industrial Equipment Applications

Machine Model No.	Engine Model
COMPACTORS	
646C	6466AT-02
CRAWLERS	
850B	6466AT-10
EXCAVATORS	
690C	6466TT-02
690CR	6466TT-02
790	6466AT-07
790D	6466AT-13
792	6466AT-08
792D	6466AT014
FELLER BUNCHERS	
693B (Harricana)	6466TDW03
693C	6466TT-02
JD743, 743A	6466AT-01
GRADERS, MOTOR	
JD770A, 770A	6466AT-06, TT-07
JD770A—Chamberlain (Australia)	6466ACM01
770AG	6466AT-09
770AH	6466AT-09, 12
770B	6466TT-07, AT-12
770BH	6466AT-12
JD772A, 772A	6466AT-06, TT-07
772AG	6466AT-09
772AH	6466AT-09, 12
772B	6466TT-07
772BH	6466AT-12
HARVESTERS, TREE	
JD743	6466AT-01, TT-01
743A	6466AT-01
LOADERS	
644C	6466TT-05 6466AT-02
644C—Saran (France)	6466ACD01
644D	6466TT-05

S11,2000,DA -19-08AUG94

ENGINE APPLICATION CHART—CONTINUED

• John Deere Industrial Equipment Applications—Continued

Machine Model No.	Engine Model
SCRAPERS	
762A	6466AT-03, 11
762B	6466AT-11
SKIDDERS	
JD740	6466AT-01
JD740A, 740A	6466AT-01

S11,2000,DA1 -19-17AUG94

OEM APPLICATIONS

Machine Model No.	Engine Model
OEM	6466DF, TF, AF
Stationary Engines	6466AR-03 6466DR-05 6466TR-09
Certified On-Highway Engines	6466AF001
Repower Engines	6466AF001

S11,2000,DB -19-08MAR94

DIESEL FUEL

CAUTION: Handle fuel carefully. Do not fill the fuel tank when engine is running. DO NOT smoke while you fill the fuel tank or service the fuel system.

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 meeting U.S. Military Specification VV-F-800E are preferred. Diesel fuels specified to EN 590 or ASTM D975 are also recommended.

In all cases, the fuel should 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 with these properties and meeting an appropriate specification (such as Austrian Standard OENORM C1190-RME) may be used.

IMPORTANT: Low sulfur fuels (less than 0.5% sulfur) may not provide adequate lubricity. If fuel of low or unknown lubricity is used, add John Deere All-Season Fuel Conditioner or equivalent at the specified concentration.

02
1

RG,FUEL1 -19-21OCT94

ENGINE BREAK-IN OIL

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

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

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

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

- API Service Classification CE
- CCMC Specification D4

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

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

DX,ENOIL4 -19-17OCT94

DIESEL ENGINE OIL

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

The following oil is preferred.

• **John Deere PLUS-50®**

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

The following oil is also recommended:

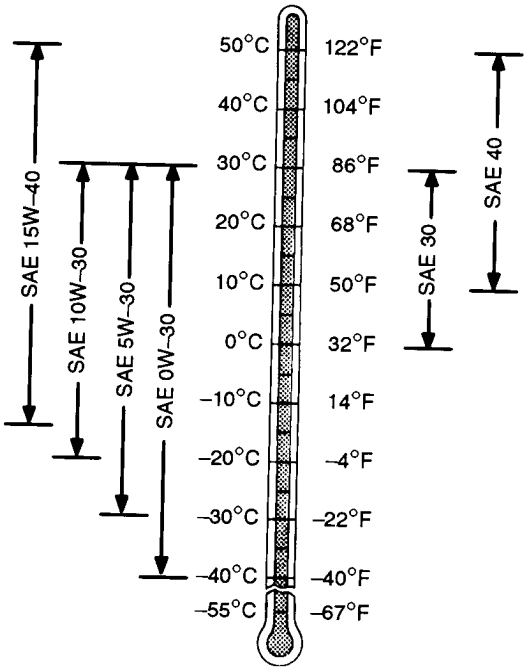
• John Deere TORQ-GARD SUPREME®

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

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

Viscosity grade SAE 15W-40 is preferred.

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



TS1619 -UN-12SEP94

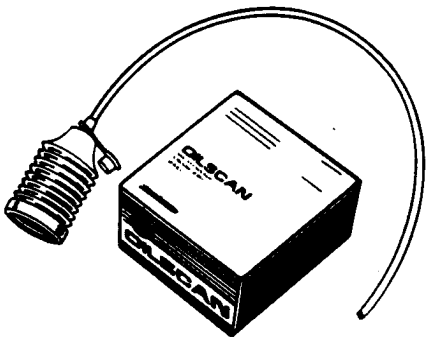
DX,ENOIL -19-16SEP94

OILSCAN® AND COOLSCAN™

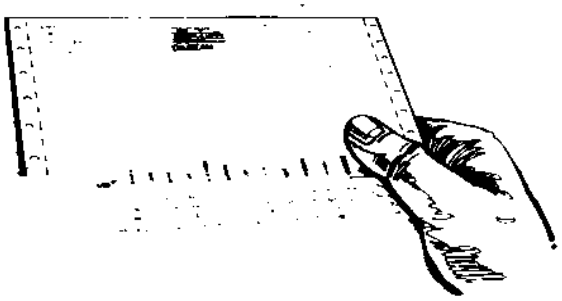
OILSCAN and COOLSCAN are John Deere sampling programs to help you monitor machine performance and identify potential problems before they cause serious damage.

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

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



T6828AB -UN-15JUN89



T6829AB -UN-18OCT88

DX,OILSCAN -19-16APR92

GREASE

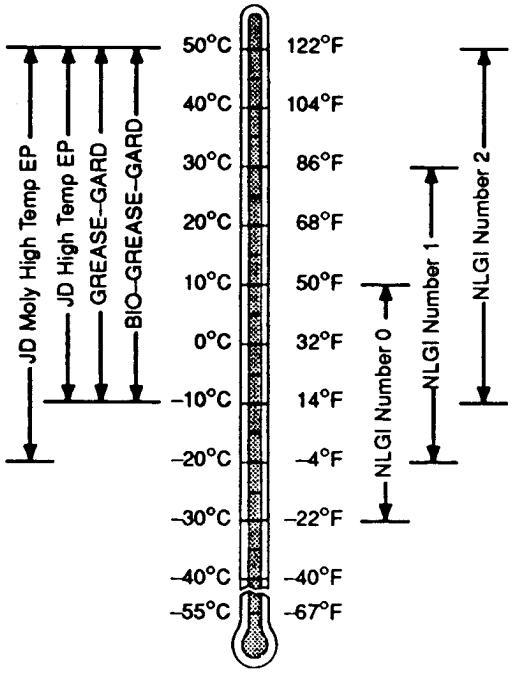
Use grease based on NLGI consistency numbers and the expected air temperature range during the service interval.

The following greases are preferred:

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

Other greases may be used if they meet the following:
- NLGI Performance Classification GC-LB

Arctic greases (such as Military Specification MIL-G-10924F) may be used at temperatures below -30˚C (-22˚F).



TS1417 -UN-31JAN94

DX,GREA1 -19-17OCT94

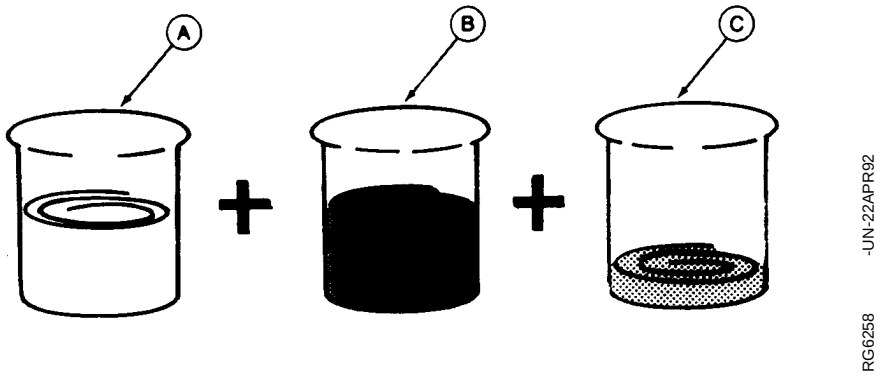
ALTERNATIVE AND SYNTHETIC LUBRICANTS

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

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

DX,ALTER -19-01FEB94

ENGINE COOLANT REQUIREMENTS



A—Quality Water

B—Ethylene Glycol Concentrate (Antifreeze)

C—Supplemental Coolant Additives (SCA's)

Engine Coolant

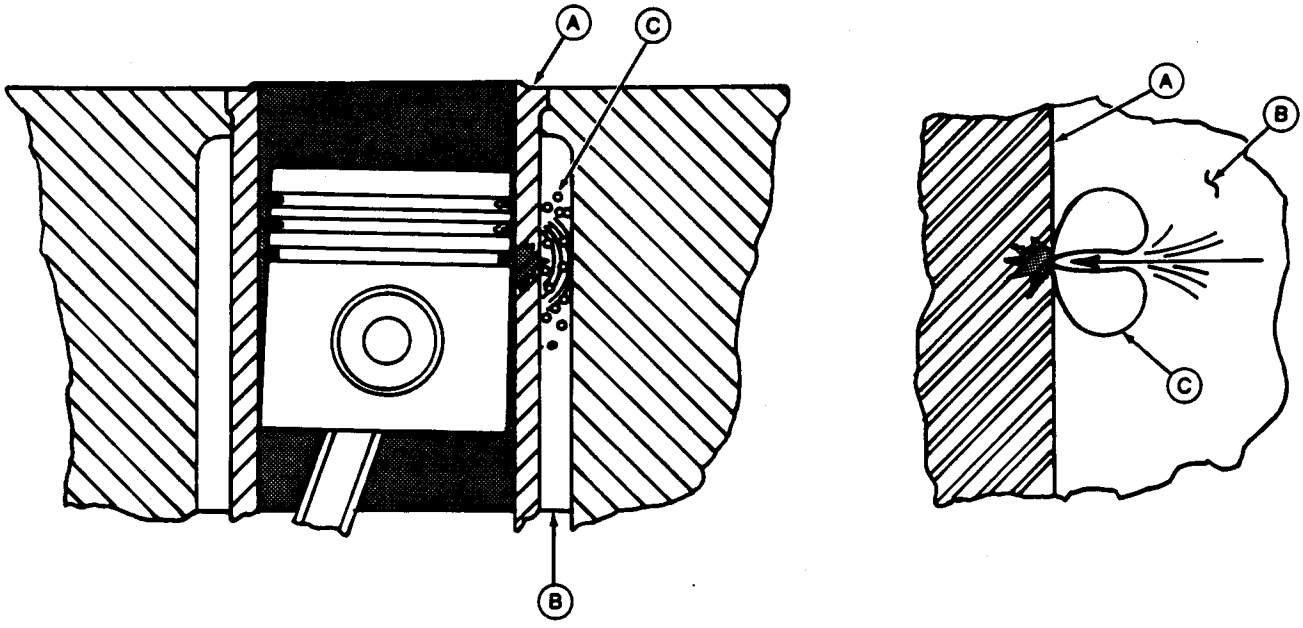
To meet cooling system protection requirements, the coolant MUST consist of a 50/50 mixture of quality water and ethylene glycol concentrate (antifreeze). Supplemental coolant additives (SCA's) must be added to this mixture. Add 3% (by volume) TY16004 or TY16005 Liquid Coolant Conditioner. If an equivalent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

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

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

RG,COOL1 -19-10OCT94

ENGINE COOLANT REQUIREMENTS—CONTINUED



RG6263 -UN-22APR92

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

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

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

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

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

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

RG,COOL1A -19-10OCT94

RECOMMENDED ENGINE COOLANT

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

John Deere Prediluted Antifreeze/Summer Coolant and John Deere Antifreeze/Summer Coolant Concentrate are recommended. John Deere Low Silicate Antifreeze and John Deere COOL-GARD™, where available, may also be used. Supplemental coolant additives MUST be added to John Deere Low Silicate Antifreeze.

• JOHN DEERE PREDILUTED ANTIFREEZE/SUMMER COOLANT

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

John Deere Prediluted Antifreeze/Summer Coolant permits extended service life to 1800 hours or 36 months, with replenishment of supplemental coolant additives every 600 hours or 12 months.

• 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 Antifreeze/Summer Coolant Concentrate has a service life of 1200 hours or 24 months, when recommended cooling system maintenance procedures are followed.

• 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.

John Deere COOL-GARD has a service life of 1200 hours or 24 months, when recommended cooling system maintenance procedures are followed.

RG,COOL2 -19-10OCT94

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, ethylene glycol concentrate (antifreeze) can be used when mixed with quality water and supplemental coolant additives (SCA's), as described below and later in this section. Use an ethylene glycol concentrate meeting ASTM D5345 (prediluted coolant) or ASTM D4985 (coolant concentrate) mixed 50% with quality water.

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8

Water Quality:

Distilled, de-ionized, or soft 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 -19-10OCT94

ENGINE COOLANT SPECIFICATIONS—CONTINUED

TY16004 Liquid Coolant Conditioner

TY16005 Liquid Coolant Conditioner

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: Replenish inhibitors between drain intervals by the addition of a supplemental coolant additive every 600 hours or 12 months of operation.

DO NOT use soluble oil.

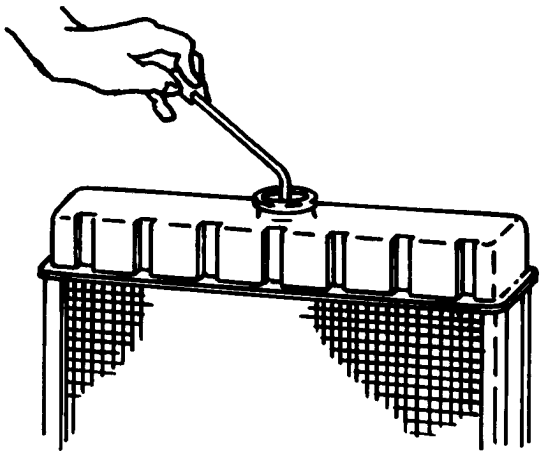
In tropical areas where antifreeze or John Deere COOL-GARD is not available, it is acceptable to use water meeting the quality specifications on the previous page and John Deere Liquid Coolant Conditioner. The recommended concentration of John Deere Liquid Coolant Conditioner must be doubled to 6% (60 mL per Liter of cooling system capacity) by volume when used with water only (no antifreeze).

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.

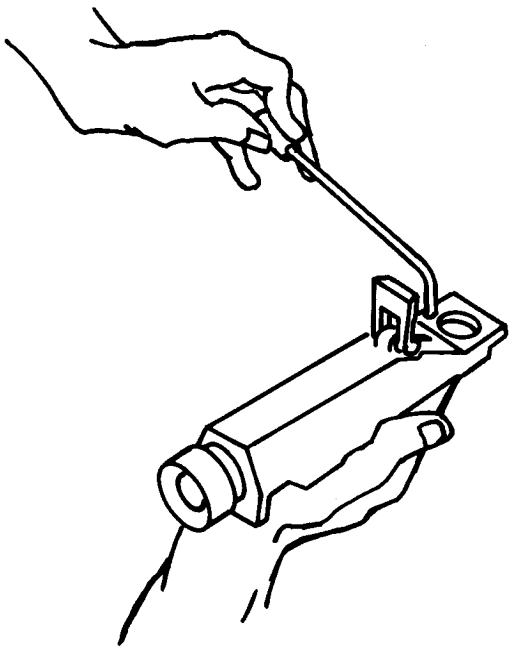
Contact your authorized servicing dealer or engine distributor, if there are further questions.

RG,COOL3A,CTM -19-24OCT94

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.

NOTE: Service intervals listed are a recommended engineering guideline. Refer to your vehicle operator's manual for a specific service interval.

Perform a CoolScan analysis after 600 hours or 12 months of operation. 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 -19-24OCT94

FLUSH AND SERVICE COOLING SYSTEM

TS281 -UN-23AUG88

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

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

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

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

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

Flush cooling system and replace thermostats as described in your operator's manual. Clean cooling system with clean water and TY15979 John Deere Heavy-Duty Cooling System Cleaner or an equivalent cleaner such as FLEETGUARD® RESTORE™. Follow the instructions provided with the cleaner. Refill cooling system with the appropriate coolant solution. See ENGINE COOLANT SPECIFICATIONS, earlier in this group.

IMPORTANT: NEVER overfill the system. A pressurized system needs space for heat expansion without overflowing at the top of the radiator. Coolant level should be at bottom of radiator filler neck.

After adding new coolant solution, run engine until it reaches operating temperature. This mixes the coolant solution uniformly and circulates it through the entire system. After running engine, check coolant level and entire cooling system for leaks.

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

FLEETGUARD® is a registered trademark of Cummins Engine Company.

RESTORE™ is a trademark of FLEETGUARD®.

RG,COOL,REQ8B -19-17AUG94

DISPOSING OF COOLANT

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

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

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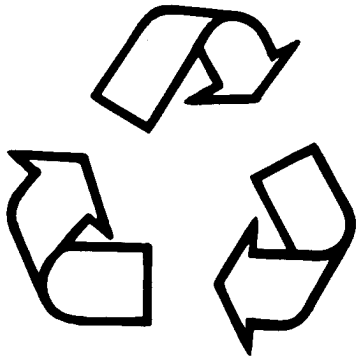
Do not pour waste onto the ground, down a drain, or into any water source.

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

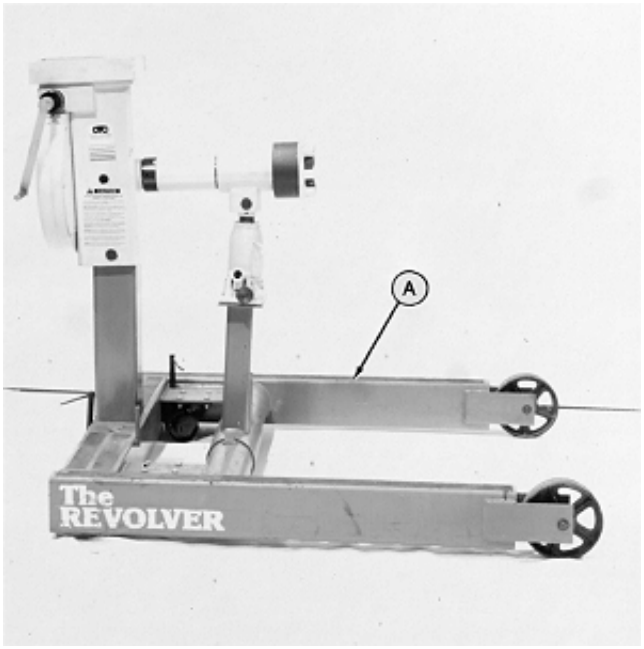


TS1133 -UN-26NOV90

RG,COOL5 -19-01SEP94

ENGINE REPAIR STAND

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



RG4929 -UN-15DEC88

S11,2000,EM -19-08MAR94

SAFETY PRECAUTIONS

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

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

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

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

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

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

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

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

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

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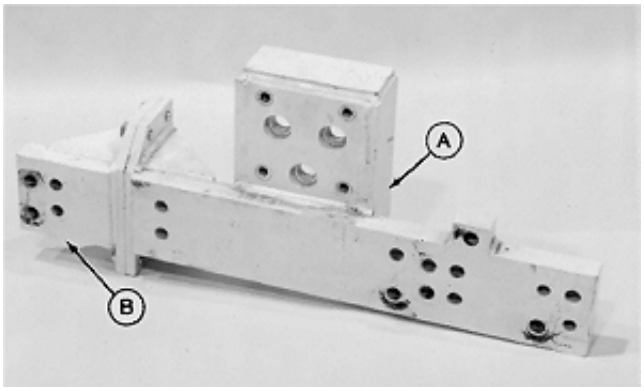
S11,2000,DZ -19-14SEP94

INSTALL 400 SERIES ADAPTERS ON REPAIR STAND

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

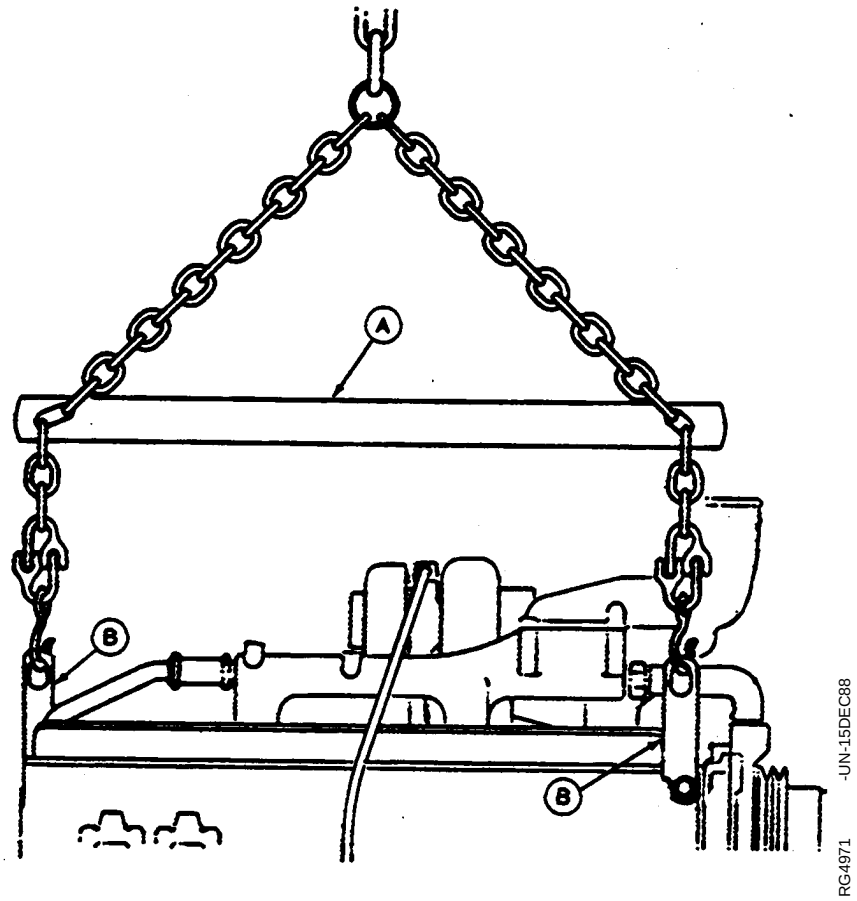
2. Attach the No. 51400 end adapter (B) to the engine adapter, using four 5/8-11 x 2 in. SAE Grade 8 cap screws. Tighten screws to 135 N·m (100 lb-ft).



RG4930 -UN-15DEC88

S11,2000,FB -19-08MAR94

ENGINE LIFTING PROCEDURE



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

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

NOTE: If engine does not have lifting straps, they can be procured through service parts or made-up locally. Use of an engine lifting sling (as shown) is the preferred method for lifting engine. However, if a sling is not on hand, engine can be lifted by chain(s) attached to lifting straps and overhead hoist.

2. Carefully lift engine to desired location.

S11,2000,FC -19-08MAR94

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

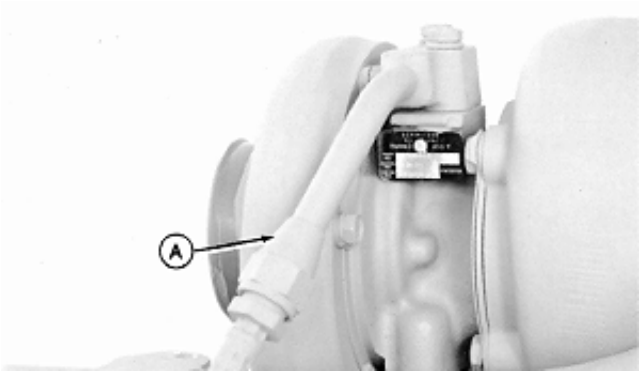
DISCONNECT TURBOCHARGER OIL INLET LINE

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

IMPORTANT: When servicing the 6466T and 6466A Engine on a rollover stand, disconnect turbocharger oil inlet line (A) from oil filter housing and 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.



RG3797 -UN-25SEP89

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

S11,2005,HD -19-08AUG94

MOUNT ENGINE ON REPAIR STAND

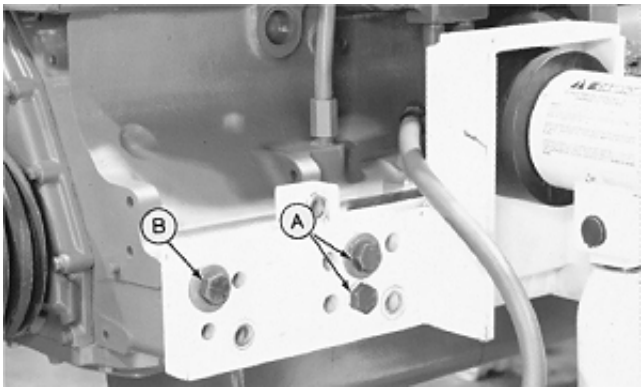
CAUTION: Never remove the overhead lifting equipment until the engine is securely mounted to the stand and all mounting hardware is tightened to specified values. Always release the overhead lifting equipment slowly.

1. Mount the starter side of the engine to the engine adapter with the following cap screws:
   Hole A: (4) 5/8-11 UNC x 2-3/4 in.
   Hole B: (1) 3/4-10 UNC x 2-3/4 in.

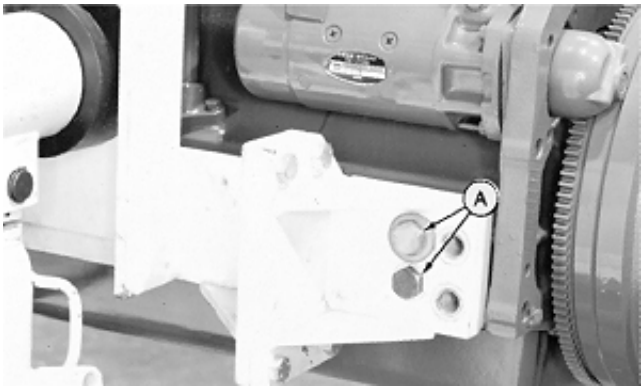
2. Tighten cap screws to 203 N·m (150 lb-ft).

NOTE: On engine blocks manufactured after August 1982, mount to engine stand using (5) 3/4-10 UNC x 2-3/4 in. cap screws. If the new engine blocks will not fit the engine adapter, order Instruction Sheet #104701 from Servicegard to rework the adapter.

3. Carefully remove lifting sling from engine.



RG4945 -UN-15DEC88



RG4946 -UN-15DEC88

S11,2000,FD -19-08AUG94

6466 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 all coolant and engine oil. Check engine oil for metal contaminates.

2. Remove turbocharger oil inlet line (if equipped).

3. Remove breather hose.

4. Remove water manifold/thermostat housing as an assembly.

5. Remove turbocharger exhaust elbow and connector (if equipped).

6. Remove turbocharger (if equipped).

7. Remove rocker arm cover. On engines having an option code label on rocker arm cover, be careful not to damage label.

8. Remove alternator.

9. Remove front crankshaft pulley with damper attached as an assembly.

10. Remove fuel injection lines.

11. On 6466T and 6466A Engines with in-line fuel injection pumps, remove lubrication line.

12. On 6466D Engines with rotary distributor pump, remove supply pump and lines.

13. Remove fuel spill-back or return lines.

14. Remove fuel injection nozzles.

15. Remove water pump (pulley-type).

16. On 6466A Engine, remove aftercooler.

17. On 6466D and 6466T Engines, remove intake and exhaust manifolds.

18. On 6466A Engines remove exhaust manifolds.

19. Remove turbocharger drain-back tube (if equipped).

20. Remove water pump gear cover and gear-type water pump, if applicable.

21. Remove oil pan.

22. Remove oil pump.

23. Remove timing gear cover and front oil seal.

24. Remove fuel filter with filter base and fuel lines.

25. Remove rocker arm shaft assembly.

26. Remove valve wear caps.

27. Remove push rods.

28. Remove cylinder head and gasket. Remove all cylinder head plugs if cylinder head is to be put into a “hot tank”.

29. On SAE 3 flywheel housing, remove flywheel housing then flywheel.

30. On SAE 1 and SAE 2 flywheel housing, remove flywheel then flywheel housing.

31. Remove engine oil filter and filter base as an assembly. Change filter for reassembly.

32. Remove fuel pump drive gear.

33. Remove fuel pump. In-line pumps have bolt-on supply pumps. Remove and replace as an assembly.

34. Remove rear oil seal housing. Remove seal.

35. Roll engine over and remove camshaft.

36. Loosen connecting rod caps. Perform wear checks with PLASTIGAGE™.

37. Rotate engine to vertical position. Remove pistons and connecting rods. Identify for reassembly.

38. Remove cam followers. Identify for reassembly.

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

S11,2000,FF -19-08AUG94

39. Remove main bearing caps.

40. Remove crankshaft and main bearings. Identify for reassembly.

41. Rotate engine, measure cylinder liner standout and remove cylinder liners and their O-ring seals. Mark liners for reassembly in same bore from which removed.

42. Remove piston cooling orifices.

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

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

S11,2000,FG -19-08AUG94

SEALANT APPLICATION GUIDELINES

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

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

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

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

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

—Cap Screws: injection pump access cover, tachometer drive, oil filler inlet, flywheel, water outlet manifold, camshaft thrust plate, and lift straps.

—Oil pressure sending unit

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

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

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

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

• **LOCTITE 518 Flexible Sealant:**

TY6304 50 ml. (1.7 oz) bottle

—Water pump and thermostat cover and water manifold gaskets

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

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

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

—Drain valves: water pump and block

—Injection pump governor cover fitting (fuel return)

—Threaded nipples and elbows in water pump housing

—Temperature sending unit

—Oil pan (drain hose and drain valve)

—Connectors: turbocharger oil supply and drain lines.

—Adapter fitting for turbocharger oil inlet line

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

T43515 50 ml. (1.7 oz) bottle

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

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

TY6299 227 g (8 oz) container

—Timing gear cover-to oil pan

—Flywheel housing-to-oil pan

—Camshaft bore steel cap plug

RG,CTM1,G04,1 -19-17AUG94

SEALANT APPLICATION GUIDELINES—CONTINUED

• **PT569 NEVER-SEEZ®** COMPOUND:

PT569 227 g (8 oz) brush
PT506 453 g (16 oz) spray

—Cap Screws: exhaust manifold turbocharger-to-exhaust manifold, and aftercooler cover-to-intake manifold.

—Gland nut threads and fuel injection nozzle barrel.

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

AR31790 141 g (5 oz) tube

—Rocker arm cover gasket

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TEFLON® is a registered trademark of DuPont Co.

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

RG,CTM1,G04,2 -19-17AUG94

6466 ENGINE ASSEMBLY SEQUENCE

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

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

2. Install clean piston cooling orifices.

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

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

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

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

6. Install engine oil pump assembly.

7. Install crankshaft rear oil seal and wear sleeve.

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

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

10. Align camshaft thrust plate holes and secure plate-to-block. Install camshaft gear cap screw. Check camshaft end play.

11. Install fuel injection pump and drive gear.

12. On 6466D Engines with camshaft-driven fuel supply pump, install fuel supply pump at this time.

13. Install engine oil filter base and oil filter as an assembly, if removed.

14. Install flywheels:
SAE 1 or SAE 2: Housing goes on before flywheel.
SAE 3: Flywheel goes on before housing.

15. Install cylinder head gasket.

NOTE: On 6466D Engines, measure piston protrusion to determine correct heat gasket.

16. Install cylinder head.

17. Install timing gear gasket and cover. Install front wear sleeve and oil seal.

18. Install oil pan.

19. Install push rods.

20. Install rocker shaft assembly.

21. Install starting motor.

22. Install oil cooler assembly.

23. Install exhaust manifold.

24. Install intake manifold.

NOTE: On 6466A Engines, 2-5/16 x 4 in. cap screws located above the oil cooler must be installed with the aftercooler manifold base.

25. Assemble and install aftercooler.

26. Install turbocharger oil return line, if equipped.

27. Install water pump.

28. Adjust all valves.

29. Install turbocharger with elbow and connector, if applicable.

30. Install fuel injection nozzles.

S11,2000,FH -19-08AUG94

31. Install high-pressure fuel lines and spill-back lines.

32. Install front pulley and damper as an assembly.

33. Install alternator.

34. Install fuel filter base, inlet and pump supply lines, and filters.

35. Install water manifold and thermostat housing as an assembly.

36. Install breather hose.

37. Install turbocharger oil inlet line, if equipped.

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

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

S11,2000,FI -19-08AUG94

SPECIAL OR ESSENTIAL TOOLS

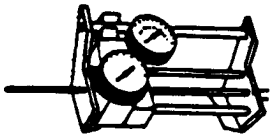
NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-05JUN91

RG5061 -UN-23AUG88

Spring Compression Tester D01168AA

Test valve spring compression.

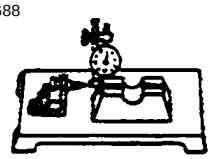


S53,D01168,AA -19-13MAR92

RG5062 -UN-23AUG88

Valve Inspection Center D05058ST

Check valves for out-of round.

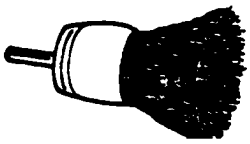


S53,D05058,ST -19-02APR87

RG5063 -UN-23AUG88

End Brush D17024BR

Clean valve seat and bores.

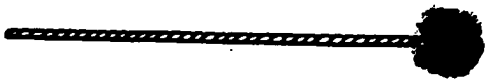


S53,D17024,BR -19-26JAN87

RG5099 -UN-23AUG88

Nozzle Thread Cleaning Brush D17030BR

Used to clean nozzle threads in cylinder head.



S53,D17030,BR -19-16FEB87

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

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

RG6246 -UN-27MAR92

RG,D17526CI -19-29OCT92

RG5065 -UN-23AUG88

Pilot Driver JDE7

Used with JDE66 and JDE67 Valve Seat Step Plates to install intake and exhaust valve seat inserts in cylinder head.

S53,JDE7B -19-08AUG94

RG5072 -UN-23AUG88

Torque Wrench Adapter JDE37A

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

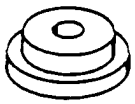
S53,JDE37A -19-07AUG91

RG5066 -UN-23AUG88

Valve Seat Step Plate JDE66

Install intake valve seat inserts on 6466D Engines only.

NOTE: Use with JDE7.



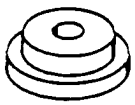
S53,JDE66B -19-08AUG94

RG5066 -UN-23AUG88

Valve Seat Step Plate JDE67

Install exhaust valve seat inserts on 6466D Engines only.

NOTE: Use with JDE7.



RG,JDE67A -19-08AUG94

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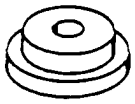
RG5066 -UN-23AUG88

Intake and Exhaust Valve Insert Adapter JDE79

Install intake and exhaust valve seat inserts on 6466T and 6466A Engines only.

NOTE: Use with JDE7.



S53,JDE79A -19-08MAR94

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

Rotate engine flywheel. Use with JDE81-4 Timing Pin.

S53,JDE811B -19-08AUG94

RG5068 -UN-23AUG88

Timing Pin JDE81-4

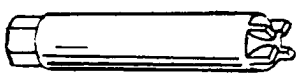
Lock engine at TDC when timing valve train.

S53,JDE814A -19-08AUG94

RG5289 -UN-23AUG88

Nozzle Seat Reamer JDE99

Used to clean carbon from nozzle seats in cylinder head.

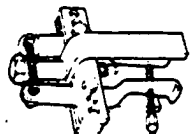


S53,JDE99 -19-08AUG94

RG5071 -UN-23AUG88

Valve Seat Puller JDE41296

Remove valve seats.



S53,JDE,41296 -19-26JAN87

RG5100 -UN-23AUG88

Tap JDF5

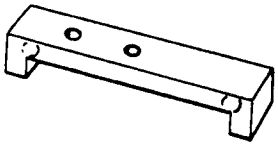
Used to restore nozzle threads in cylinder head.

S53,JDF5 -19-08MAR94

Piston and Liner Height Gauge JDG451

Measure piston and liner heights.

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



RG7029 -UN-30SEP94

RG,JDG451 -19-28SEP94

RG5100 -UN-23AUG88

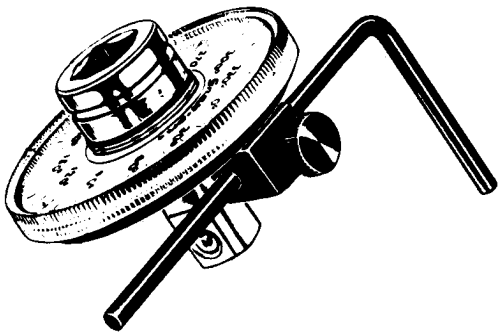
Tap JDG681

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

RG,JDG681 -19-25MAR91

Torque Angle Gauge JT05993

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



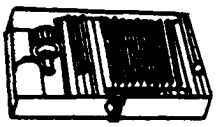
RG5698 -UN-27AUG90

RG,JT05993 -19-22AUG91

RG5064 -UN-23AUG88

Valve Guide Knurler Kit JT05949

Knurl valve guides.



S53,D20002,WI -19-16SEP92

SERVICE EQUIPMENT AND TOOLS

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

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

S55,2505,AH -19-08FEB94

OTHER MATERIAL

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

S11,2505,BW -19-30MAR93

CYLINDER HEAD AND VALVES SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Valve Clearance (Engine Cold): (Rocker Arm-to-Valve Tip)		
Intake Valve	0.41—0.51 mm (0.016—0.020 in.)	---
Exhaust Valve	0.66—0.76 mm (0.026—0.030 in.)	---
Valve Lift at 0.00 mm (in.) Clearance:		
6466D-Intake	11.54—11.70 mm (0.454—0.461 in.)	10.69 mm (0.421 in.)
6466D-Exhaust	11.54—11.70 mm (0.454—0.461 in.)	10.69 mm (0.421 in.)
6466T and 6466A-Intake	11.26—11.44 mm (0.443—0.450 in.)	10.45 mm (0.411 in.)
6466T and 6466A-Exhaust	11.54—11.70 mm (0.454—0.461 in.)	10.69 mm (0.421 in.)
Valve Springs—Compressed Height:		
Valve closed	46.0 mm at 240—276 N (1.81 in. at 54—62 lb force)	---
Valve open	34.5 mm at 591—680 N (1.36 in. at 133—153 lb force)	---
Valve Springs—Free Length	53.8 mm (2.12 in.)	---
Valve Face Angle:		
6466D	44.5°	---
6466T and 6466A	29.5°	---
Valve Head OD:		
6466D-Intake	48.2—48.4 mm (1.90—1.91 in.)	---
6466D-Exhaust	43.4—43.7 mm (1.71—1.72 in.)	---
6466T and 6466A-Intake and Exhaust	43.4—43.7 mm (1.71—1.72 in.)	---
Maximum Permissible Runout of Valve Face	0.05 mm (0.002 in.)	---
Valve Guide ID	9.51—9.54 mm (0.3745—0.3755 in.)	---
Valve Stem OD	9.44—9.46 mm (0.3715—0.3725 in.)	---
Valve Stem-to-Guide Clearance	0.051—0.102 mm (0.002—0.004 in.)	0.15 mm (0.006 in.)
Oversize Valve Available	0.08, 0.38, 0.76 mm (0.003, 0.015, 0.030 in.)	---

S11,2005,HA -19-08AUG94

CYLINDER HEAD AND VALVES SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Valve Seat Angle:		
6466D	45°	---
6466T and 6466A	30°	---
Valve Seat Width	1.83—3.33 mm (0.072—0.131 in.)	---
Valve Seat Concentricity with Guide	0.051 mm (0.0020 in.)	---
Valve Seat Bore:		
6466D Intake	49.44—49.47 mm (1.9465—1.9475 in.)	---
6466D Exhaust	44.67—44.69 mm (1.7585—1.7595 in.)	---
6466T and 6466A Intake and Exhaust	44.67—44.69 mm (1.7585—1.7595 in.)	---
Valve Face Recessed in Head—6466D		
Intake	0.86—1.45 mm (0.034—0.057 in.)	1.60 mm (0.063 in.)
Exhaust	1.19—1.78 mm (0.047—0.070 in.)	1.93 mm (0.076 in.)
Valve Height Above Head		
6466T and 6466A	0.61—0.97 mm (0.024—0.038 in.)	0.46 mm (0.018 in.)
Continuity Tolerance of Valve Seat (Maximum Runout)		0.051 mm (0.0020 in.)
Firing Order	1-5-3-6-2-4	---
Rocker Arm ID	19.06—19.09 mm (0.7505—0.7525 in.)	---
Rocker Arm Shaft OD	19.01—19.05 mm (0.7484—0.7500 in.)	---
Cylinder Head Combustion Face:		
Reconditioning Thickness of Head (Rocker Arm Cover Gasket Rail-to-Combustion face)	155.45—155.71 mm (6.120—6.130 in.)	154.69 mm (6.09 in.)
Surface Finish (AA) (Surface Grind Only)	0.015—0.0028 mm (60—110 micro-in.)	---
Maximum Material Removal for Resurfacing Head	0.762 mm (0.030 in.)	---
Cylinder Head Top Deck Maximum Out-of-Flat (Entire Length or Width)	0.10 mm (0.004 in.)	---
Cylinder Head Top Deck Straightness per Any 305 mm (12 in.) Length	0.025 mm (0.001 in.)	---
Cylinder Liner Height Above Block	0.025—0.127 mm (0.001—0.005 in.)	---
Cylinder Head Gasket Thickness (New):		
RE47366	1.56—1.72 mm (0.061—0.068 in.)	
R66065	1.68—1.80 mm (0.066—0.071 in.)	

S11,2005,HA1 -19-08AUG94

CYLINDER HEAD AND VALVES SPECIFICATIONS—CONTINUED

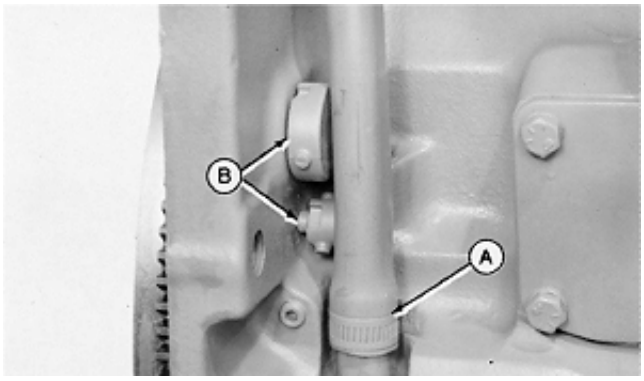
TORQUES

Cylinder Head-to-Cylinder Block:
Refer to CYLINDER HEAD CAP SCREW TIGHTENING PROCEDURES later in this group.

Cylinder Liner Cap Screws (for Checking Liner Standout)	68 N·m (50 lb-ft)
Rocker Arm Shaft Clamps	75 N·m (55 lb-ft)
Rocker Arm Cover-to-Cylinder Head	8 N·m (6 lb-ft) (71 lb-in.)
Intake Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Exhaust Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
6466A Aftercooler Cover	27 N·m (20 lb-ft)
Aftercooler Inlet and Outlet Hose Clamps	4 N·m (3 lb-ft) (35 lb-in.)
6466T and 6466A-Turbocharger Oil Inlet Line	47 N·m (35 lb-ft)
Valve Adjusting Screw Lock Nut	27 N·m (20 lb-ft)
Cylinder Head Front Cover Plate	34 N·m (25 lb-ft)

S11,2005,HB -19-08AUG94

CHECK AND ADJUST VALVE CLEARANCE



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

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

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NOTE: Valve clearance MUST BE checked with engine COLD.

1. Remove rocker arm cover with ventilator tube (A).

2. Remove plastic plugs (B).

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

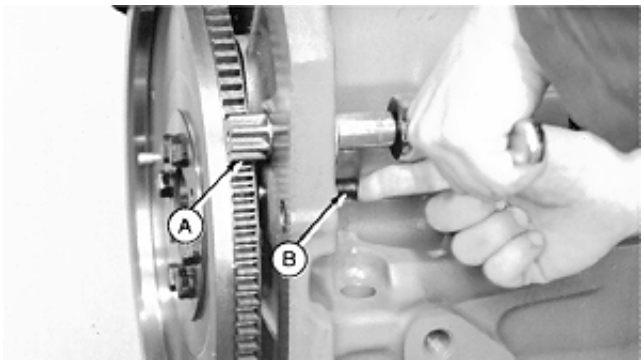
Rocker arms that exhibit excessive valve clearance should be inspected more thoroughly to identify damaged parts.

S11,2005,DO -19-17AUG94

NOTE: On on-highway applications only, flywheel has two timing holes. The injection pump reference timing marks will align at 14˚ BTDC.

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

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



RG3795 -UN-23FEB89

S11,2005,DP -19-08MAR94

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4. Check and adjust (as needed) valve clearance on Nos. 1, 3 and 5 exhaust valves and Nos. 1, 2 and 4 intake valves.

VALVE CLEARANCE SPECIFICATIONS

Intake Valves	0.41—0.51 mm (0.016—0.020 in.)
Exhaust Valves	0.66—0.76 mm (0.026—0.030 in.)

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

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

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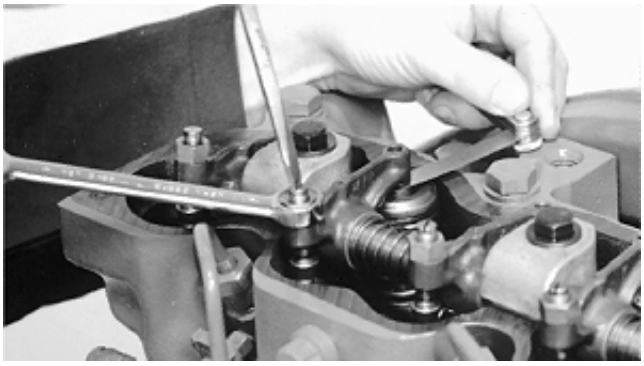
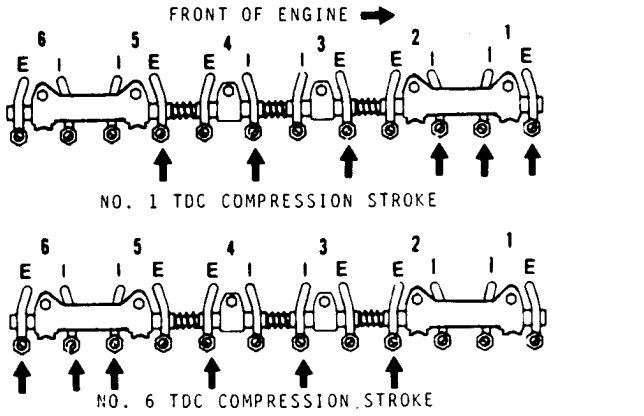
7. Check and adjust (as needed) valve clearance to the same specifications on Nos. 2, 4 and 6 exhaust and Nos. 3, 5 and 6 intake valves. After setting each valve, tighten valve adjusting screw lock nut to 27 N·m (20 lb-ft).

8. Recheck valve clearance on all valves again after lock nut is tightened.

NOTE: The 6466D Engines use six short rocker arm shaft clamps. The adjustment and specifications are the same.



RG3796 -UN-25SEP89



RG4295 -19-21AUG91

S11,2005,DQ -19-08MAR94

CHECK VALVE LIFT

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

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

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

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

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

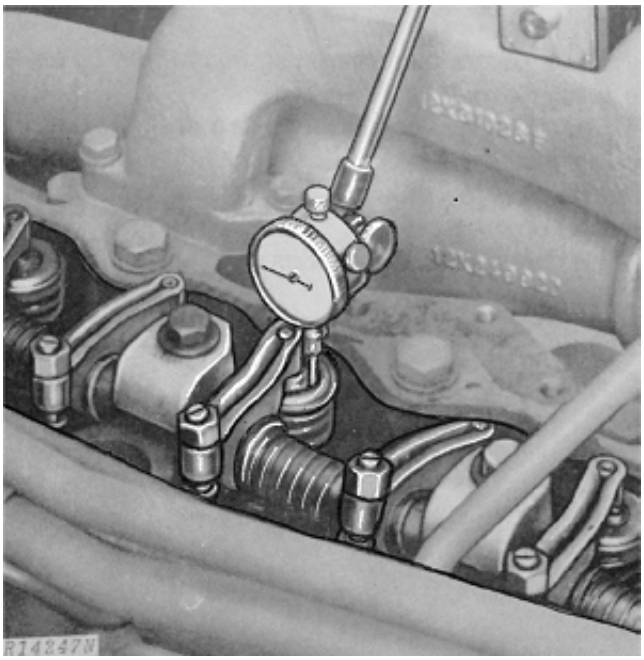
4. Manually turn engine in running direction, using the engine rotation tools previously mentioned for checking valve clearance.

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

VALVE LIFT SPECIFICATIONS AT 0.00 MM (IN.) CLEARANCE

	SPECIFICATION	WEAR LIMIT
6466D:		
Intake	11.54—11.70 mm (0.454—0.461 in.)	10.69 mm (0.421 in.)
Exhaust	11.54—11.70 mm (0.454—0.461 in.)	10.69 mm (0.421 in.)
6466T and 6466A:		
Intake	11.26—11.44 mm (0.443—0.450 in.)	10.45 mm (0.411 in.)
Exhaust	11.54—11.70 mm (0.454—0.461 in.)	10.69 mm (0.421 in.)

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



R14247N -UN-09JAN90

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S11,2005,HC -19-08AUG94

REMOVE CYLINDER HEAD

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

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

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

1. Drain all engine oil and coolant. On 6466T and 6466A Engines, disconnect turbocharger oil inlet line at turbocharger or oil filter housing. (See DISCONNECT TURBOCHARGER OIL INLET LINE in Group 03.)

2. Remove water manifold (A). (See Cooling System, Group 25.)

3. On 6466T and 6466A Engines, remove turbocharger (B). (See Air Intake and Exhaust System, Group 30.)

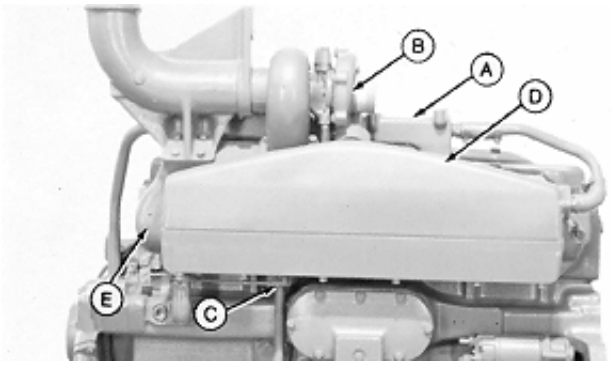
4. On 6466A Engines, remove aftercooler assembly (D). (See Air Intake and Exhaust System, Group 30.)

5. Remove intake manifold assembly and aneroid-to-intake manifold pipe (C). (See Air Intake and Exhaust System, Group 30.)

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

6. Remove exhaust manifold (E).

TS281 -UN-23AUG88



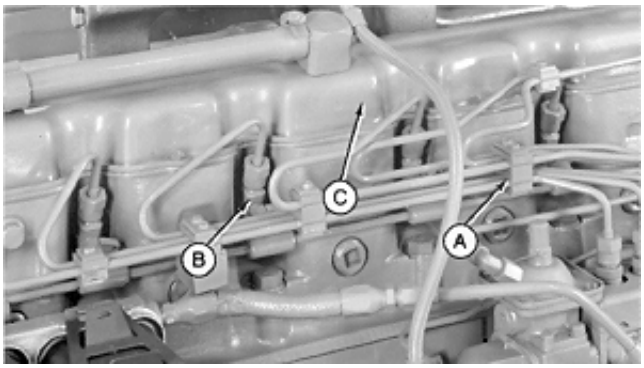
RG3918 -UN-09NOV89

A—Water Manifold
B—Turbocharger
C—Aneroid-to-Intake Manifold Pipe
D—Aftercooler Assembly
E—Exhaust Manifold

S11,2005,HE -19-08AUG94

7. Remove fuel injection lines (A) and nozzles (B). (See REMOVE FUEL INJECTION NOZZLES in Group 35.)

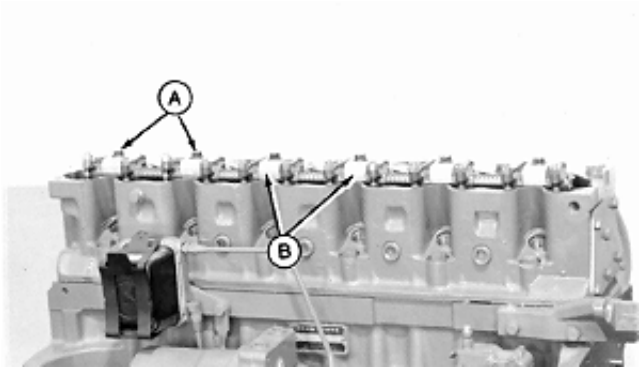
8. Remove rocker arm cover (C) and ventilator outlet hose assembly.



RG3919 -UN-09NOV89

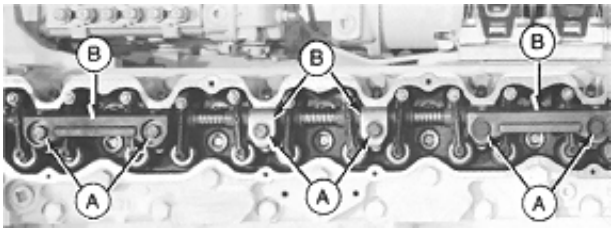
S11,2005,HF -19-08MAR94

9. On 6466D engines, remove six cap screws (A) and remove all six clamps (B). Lift rocker arm assembly up and remove.



S11,2005,HG -19-30OCT86

10. On 6466T and 6466A Engines, remove six cap screws (A) and remove all four clamps (B). Lift rocker arm assembly up and remove.



S11,2005,HH -19-30OCT86

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

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

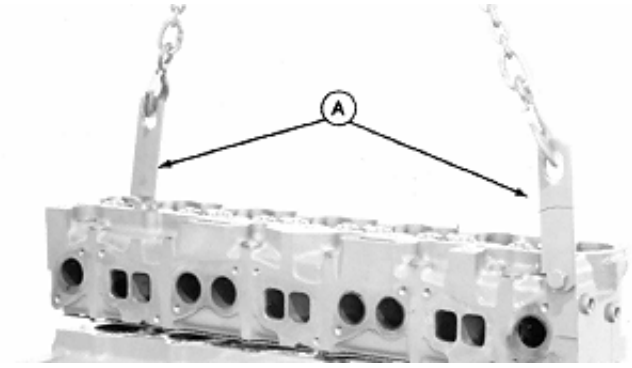
S11,2005,HI -19-08MAR94

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.

12. Remove all 26 cylinder head cap screws.

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

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



-UN-10NOV89
RG3492

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

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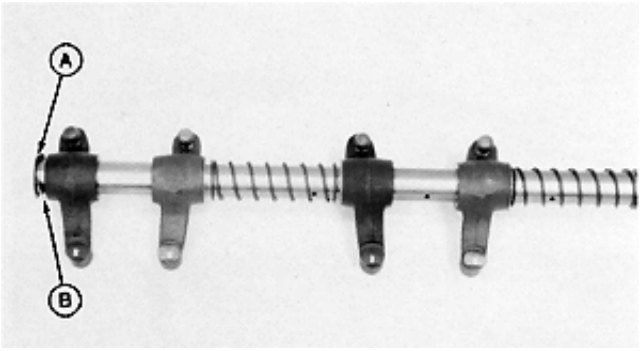
NOTE: Do not rotate crankshaft with cylinder head removed unless all cylinder liners are secured with cap screws and large flat washers.

S11,2005,HJ -19-08AUG94

DISASSEMBLE AND INSPECT ROCKER ARM SHAFT ASSEMBLY

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



-UN-23FEB89
RG3801

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

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

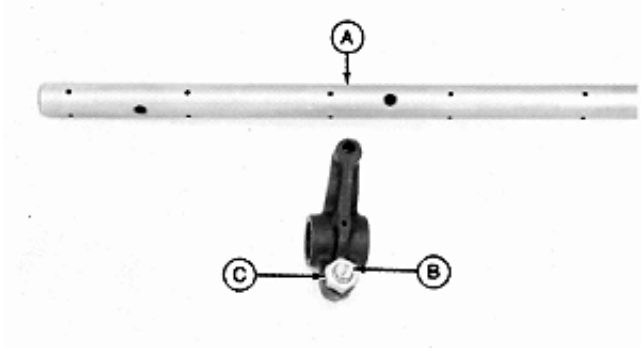
S11,2005,HY1 -19-07AUG91

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

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

ROCKER ARM ASSEMBLY SPECIFICATIONS

Rocker Arm I.D.	19.06—19.09 mm (0.7505—0.7525 in.)
Rocker Arm Shaft O.D.	19.01—19.05 mm (0.7484—0.7500 in.)



RG3802 -UN-23FEB89

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

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

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

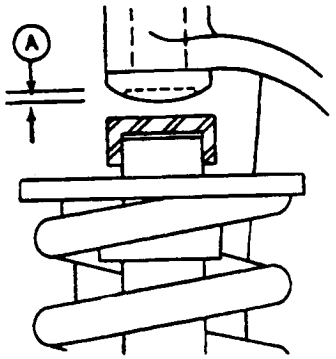
S11,0401,M -19-08MAR94

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

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

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

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



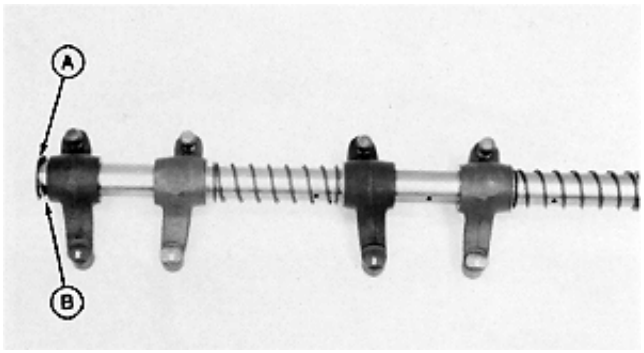
R26131 -UN-09DEC88

S11,0401,N -19-05FEB85

ASSEMBLE ROCKER ARM SHAFT ASSEMBLY

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

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



S11,0401,O -19-08MAR94

MEASURE VALVE HEIGHT OR RECESS

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

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

VALVE HEIGHT OR VALVE RECESS SPECIFICATIONS

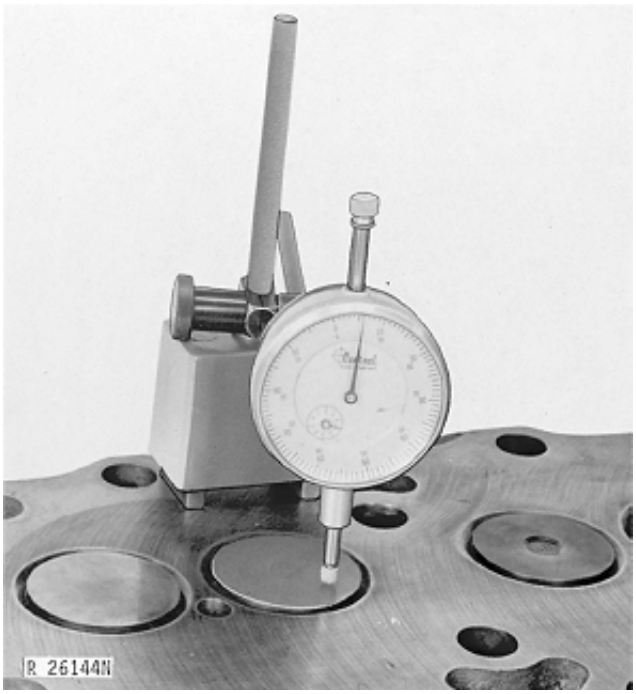
Valve Recessed in Head—6466D:

Intake	0.86—1.45 mm (0.034—0.057 in.)
Maximum Recess	1.60 mm (0.063 in.)
Exhaust	1.19—1.78 mm (0.047—0.070 in.)
Maximum Recess	1.93 mm (0.076 in.)

Valve Height Above Head—6466T and 6466A:

Intake and Exhaust	0.61—0.97 mm (0.024—0.038 in.)
Minimum Height	0.46 mm (0.018 in.)

NOTE: If measurement does not meet specifications, install either new valves, inserts, or both to obtain proper valve height. Existing inserts must be replaced when maximum recess is reached. (See REMOVE AND INSTALL VALVE SEAT INSERTS later in this group.)



S11,2005,LG -19-08AUG94

PRELIMINARY CYLINDER HEAD AND VALVE CHECKS

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

Look for the following conditions:

- **Sticking Valves:**

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

- **Warped, Worn, or Distorted Valve Guides:**

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

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

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

- **Worn or Broken Valve Seats:**

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

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

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

- **Improper Valve Clearance:**

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

- **Excessive Recession:**

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

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

REMOVE VALVE ASSEMBLY

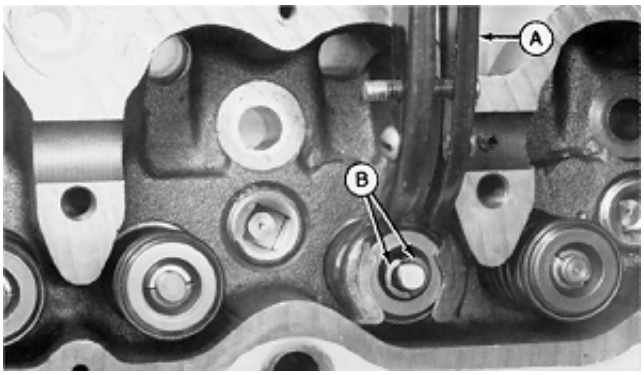
NOTE: Refer to PRELIMINARY CYLINDER HEAD AND VALVE CHECKS earlier in this group.

NOTE: Identify all parts for proper assembly.

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

2. Remove retaining locks (B).

3. Remove valve spring compressor.



RG3803 -UN-23FEB89

S11,0401,Q -19-16AUG94

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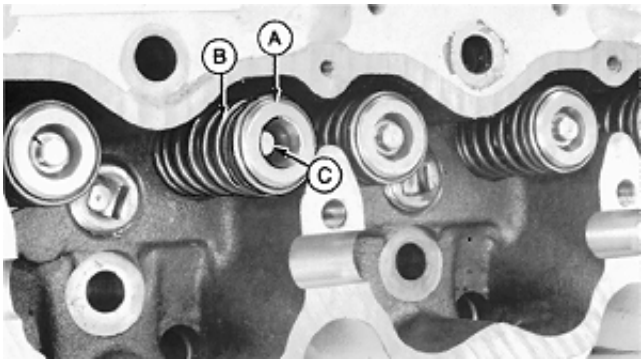
4. Remove valve rotators (A).

5. Remove valve springs (B).

6. Remove valves (C).



RG3804 -UN-23FEB89

S11,0401,R -19-08MAR94

INSPECT AND MEASURE VALVE SPRINGS

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

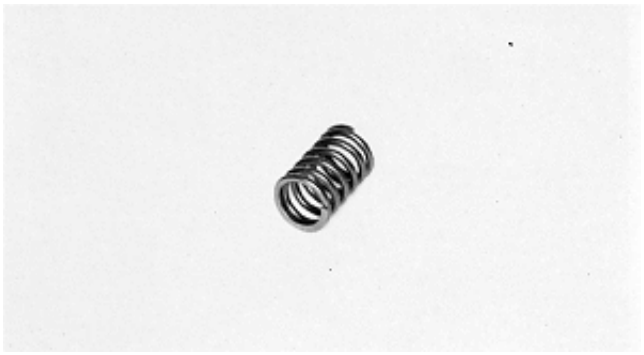
2. Put springs on a flat surface to see that they are square and parallel.

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

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

VALVE SPRING SPECIFICATIONS

Compression	Height
240—276 N (54—62 lb force)	46 mm (1.81 in.)
591—680 N (133—153 lb force)	34.5 mm (1.36 in.)
Valve Springs Free Length	53.8 mm (2.12 in.)


RG2732 -UN-23FEB89

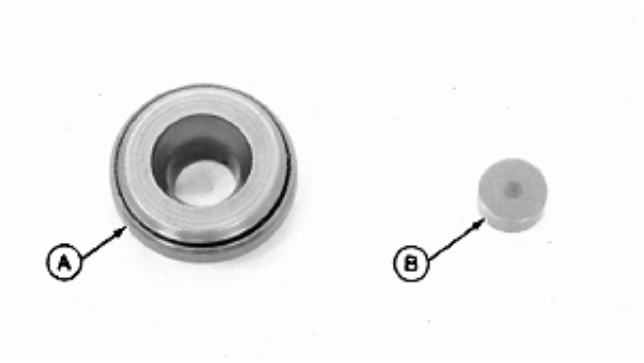

T82054 -UN-08NOV88

S11,0401,S -19-08MAR94

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.



RG3491 -UN-23FEB89

S11,0401,T -19-28OCT92

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.

RG,CTM8,G05,33 -19-08MAR94

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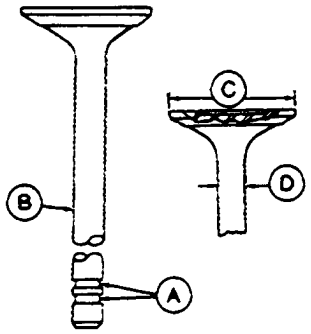
INSPECT AND MEASURE VALVES

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 head OD (C). Compare valve stem OD (D) with guide ID to determine clearance, as outlined later in this group.



RG4974 -UN-06APR89

A—Valve Retainer Lock Grooves
B—Valve Stems
C—Valve Head OD
D—Valve Stem OD

VALVE SPECIFICATIONS

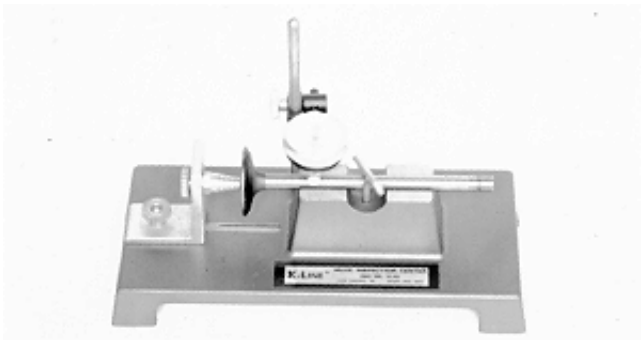
Valve Head OD:	
6466D-Intake	48.2—48.4 mm (1.90—1.91 in.)
6466D-Exhaust	43.4—43.7 mm (1.71—1.72 in.)
6466T and 6466A Intake and Exhaust	43.4—43.7 mm (1.71—1.72 in.)
Valve Stem OD	9.44—9.46 mm (0.3715—0.3725 in.)

S11,2005,IY -19-08AUG94

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

VALVE FACE RUNOUT SPECIFICATION

Maximum Permissible Runout of Valve Face . . . . . 0.05 mm (0.002 in.)



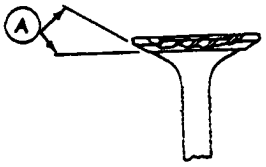
RG4234 -UN-23FEB89

S11,2005,IZA -19-08AUG94

GRIND VALVES

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

If necessary to resurface, grind valve face (A) at the following angle.



RG4975 -UN-06APR89

VALVE FACE ANGLE SPECIFICATIONS

6466D . . . . . 44.5°

6466T and 6466A . . . . . 29.5°

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

S11,2005,JV -19-08MAR94

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.

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

05
22

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

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

RG,CTM8,G05,37 -19-27OCT94

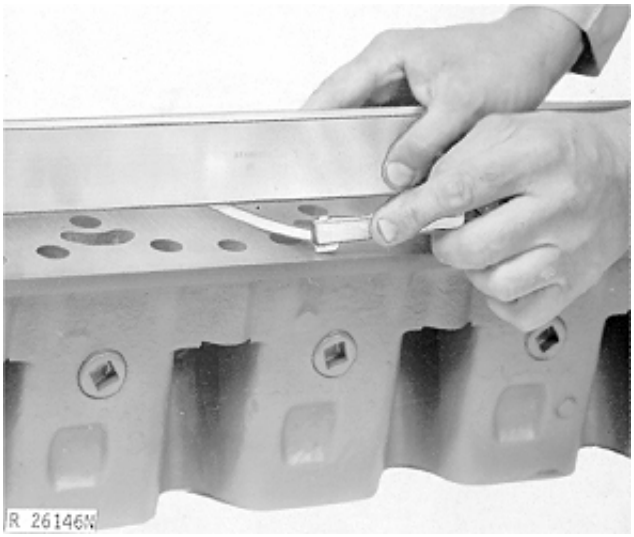
CHECK CYLINDER HEAD COMBUSTION FACE FLATNESS

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

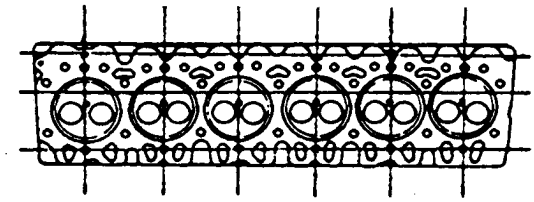
If any measurement exceeds this specification, the cylinder head must be either resurfaced or replaced. (See MEASURE CYLINDER HEAD THICKNESS, later in this group.)

CYLINDER HEAD TOP DECK FLATNESS SPECIFICATION

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



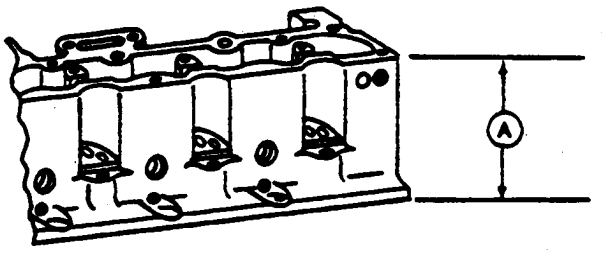
R26146 -UN-09DEC88



RG4629 -UN-06DEC88

S11,2005,KY -19-17AUG94

MEASURE CYLINDER HEAD THICKNESS



-UN-23FEB89

RG4421

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

If cylinder head thickness is less than wear limit, install a new cylinder head.

CYLINDER HEAD SPECIFICATIONS

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

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

05
24

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

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

RG,CTM1,G05,3 -19-08AUG94

CLEAN VALVE GUIDES

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

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

-UN-09FEB90
R26140N

S11,0401,X -19-08MAR94

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25

MEASURE VALVE GUIDES

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

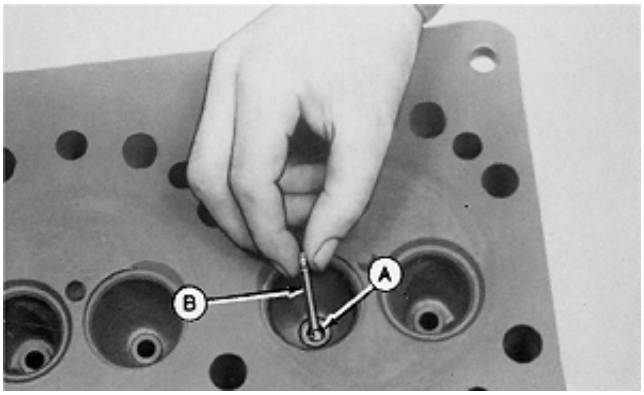
VALVE GUIDE SPECIFICATIONS

I.D. of Guide in a New Head . . . . . 9.51—9.54 mm (0.3745—0.3755 in.)

New Guide-to-Valve
Stem Clearance . . . . . 0.051—0.102 mm (0.002—0.004 in.)

Maximum Allowable Guide-to-Valve
Stem Clearance . . . . . 0.15 mm (0.006 in.)

NOTE: Worn guides may be knurled to return them to specified clearance if valve-to-guide clearance is 0.25 mm (0.010 in.) or less. If clearance exceeds 0.25 mm (0.010 in.), install oversize valves.



-UN-09DEC88
R23984

S11,0401,Y -19-08MAR94

KNURL VALVE GUIDES

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

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

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

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

-UN-09DEC88
R26141

S11,0401,Z -19-08MAR94

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26

CLEAN AND INSPECT VALVE SEATS

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

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

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

-UN-09DEC88
R26142N

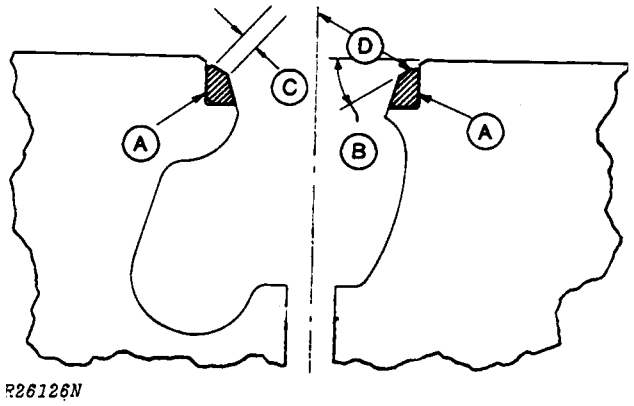
S11,0401,AA -19-28OCT92

MEASURE VALVE SEATS

1. Measure valve seats for proper specifications.

2. Using D11010KW Eccentrimeter, measure valve seat runout.

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



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

VALVE SEAT SPECIFICATIONS

Valve Seat Angle:	
6466D	45°
6466T and 6466A	30°
Valve Seat Width	1.83—3.33 mm (0.072—0.131 in.)
Maximum Valve Seat Runout	0.051 mm (0.0020 in.)

S11,2005,HL -19-08AUG94

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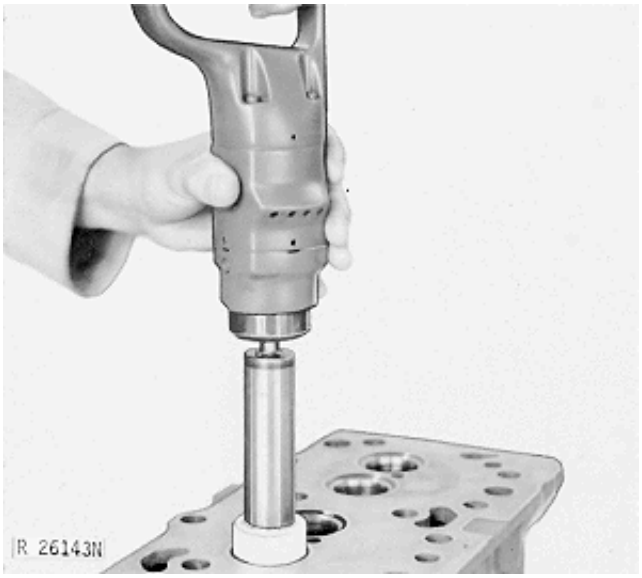
27

GRIND VALVE SEATS



R26143N -UN-09DEC88

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

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

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If valve seats need grinding, do not grind too long. Only a few seconds are required to recondition the average valve seat. Avoid the tendency to grind off too much. Do not use too much pressure. While grinding, support the weight of the dresser to avoid excessive pressure on the stone.

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

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

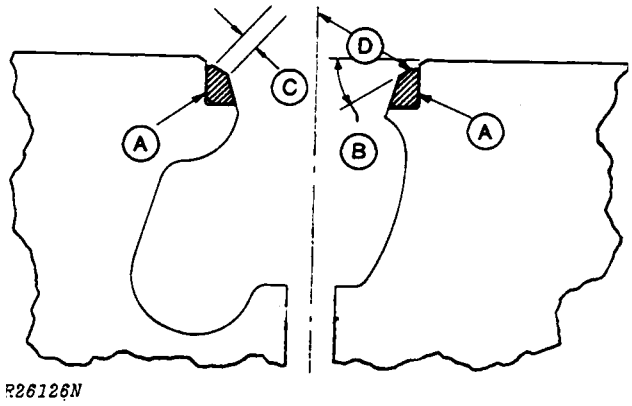
S11,0401,AC -19-08AUG94

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

VALVE SEAT SPECIFICATIONS

Valve Seat Angle:	
6466D	45°
6466T and 6466A	30°
Valve Seat Width	1.83—3.33 mm (0.072—0.131 in.)
Maximum Valve Seat Runout	0.051 mm (0.0020 in.)

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



R26126N -UN-11APR89

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

S11,0401,AC1 -19-08AUG94

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29

REMOVE VALVE SEAT INSERTS

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

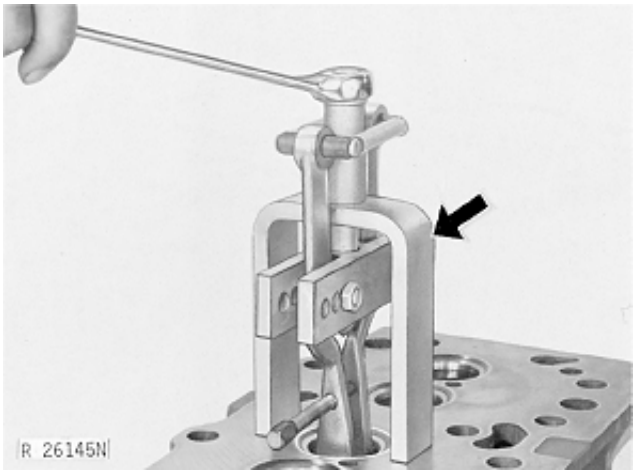
IMPORTANT: Be careful not to damage cylinder head when removing valve seat inserts.

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

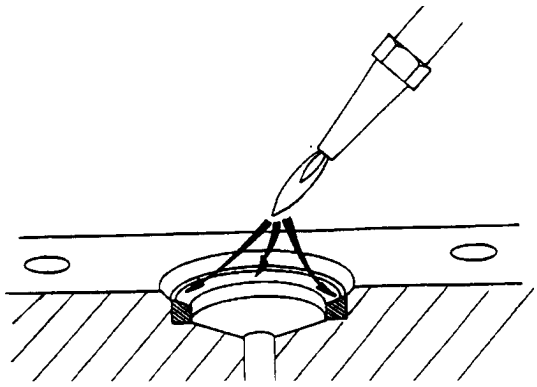
NOTE: On some engines, removal of valve seat inserts with the JDE41296 Puller may not be possible. An alternate removal method is to weld two or three short beads equidistant from each other around the ID of insert (use an arc welder). Allow seat to cool and carefully drive out the hot insert(s) with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

IMPORTANT: Protect entire combustion face and valve throat area from spatter when using an arc welder to remove valve seat inserts.

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



R26145N -UN-09FEB90



RG5605 -UN-17JAN90

S11,0401,AE -19-17AUG94

INSTALL VALVE SEAT INSERTS

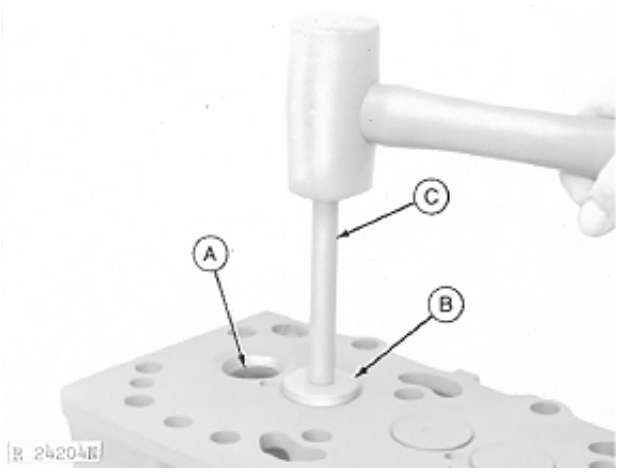
NOTE: On 6466D Engines, use JDE66 Valve Seat Step Plate on intake valve seats and JDE67 Valve Seat Step Plate on exhaust valve seats.

On 6466T and 6466A Engines, use JDE79 Valve Seat Insert Aapter for both intake and exhaust valve seats.

1. Use JDE7 Driver (C) and Valve Seat Step Plate (B) to drive inserts (A) into place.

2. Grind valve seats as required to maintain correct valve recess and valve-to-seat seal.

IMPORTANT: Do not over-grind valve seat. (See GRIND VALVE SEATS, earlier in this group.)



-UN-09FEB90
R24204

S11,0401,AF -19-08AUG94

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30

INSTALL OVERSIZE VALVE SEAT INSERTS

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

1. Remove valve seat inserts with JDE41296 Valve Seat Puller.

2. Machine valve seat bores to the following specifications.

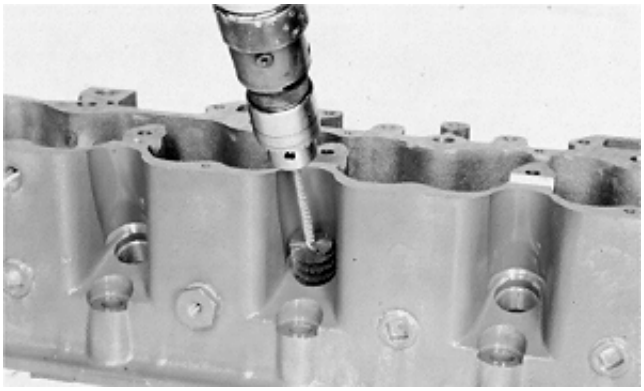
VALVE SEAT BORE SPECIFICATIONS

6466D Intake	49.44—49.47 mm (1.9465—1.9475 in.)
6466D Exhaust	44.67—44.69 mm (1.7585—1.7595 in.)
6466T and 6466A Intake and Exhaust	44.67—44.69 mm (1.7585—1.7595 in.)

3. Replace inserts as previously indicated.

S11,2005,HN -19-17AUG94

INSPECT AND CLEAN CYLINDER HEAD NOZZLE BORE


RG5251 -UN-14DEC88

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

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

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

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

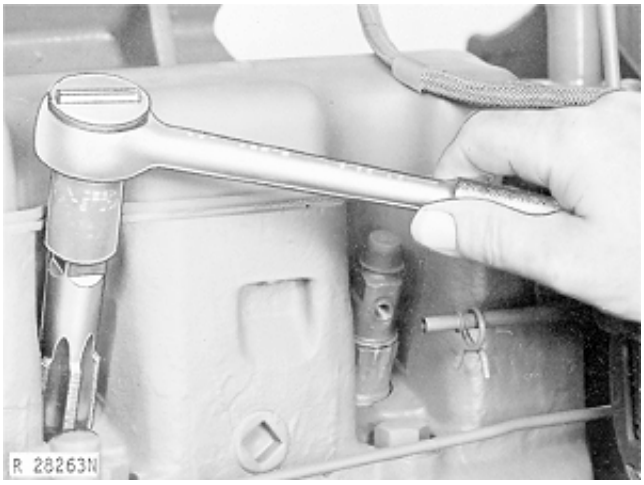
3. Clean threads which have light foreign deposits using an electric drill and D17030BR Nozzle Thread Cleaning Brush. Work brush up and down several times to clean threads.

S11,0408,BL -19-17AUG94

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

5. After cleaning threads, insert a 13 mm (1/2 in.) tapered hardwood dowel to plug nozzle tip bore.

6. Blow out debris from nozzle cavity with compressed air; then remove wood dowel.



R28263N -UN-20DEC88

S11,0408,BM -19-08APR94

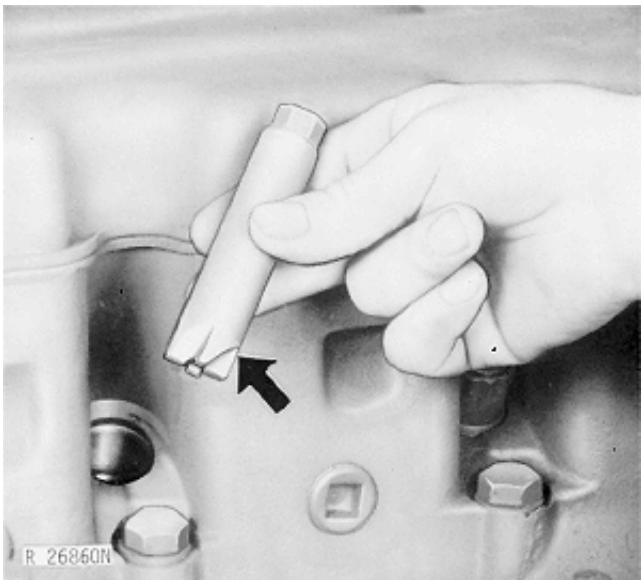
INSPECT AND CLEAN NOZZLE SEATING SURFACE

1. Inspect nozzle seating surface for carbon deposits.

2. If seat is not clean, use JDE99 or JDG609 Nozzle Seat Reamer to remove carbon. Stop using tool when seat comes clean.

3. Insert a 13 mm (1/2 in.) tapered hardwood dowel to plug nozzle tip bore.

4. Blow out debris with compressed air, then remove wood dowel.



R26860N -UN-20DEC88

S11,0408,BN -19-08APR94

05
32

CLEAN AND INSPECT PUSH RODS

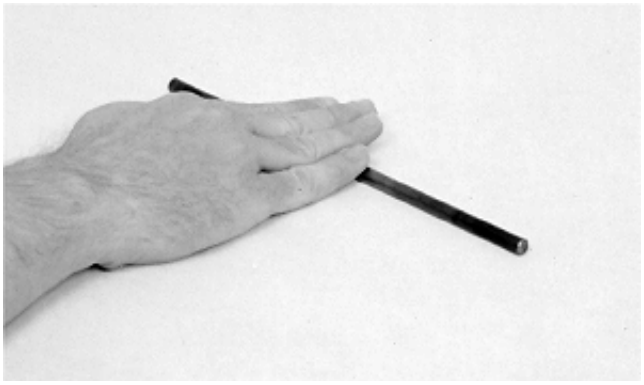
1. Clean push rods with solvent and compressed air.

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

3. Inspect for wear and damage.

4. Replace defective push rods.

IMPORTANT: Early engines were produced with hollow push rods, but only solid push rods are currently available for service. DO NOT intermix hollow and solid push rods within the engine.



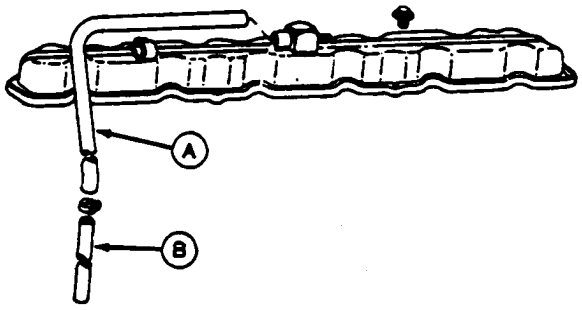
T81233 -UN-01NOV88

RG,CTM1,G5,1 -19-08MAR94

CLEAN AND INSPECT VENTILATOR OUTLET HOSE

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

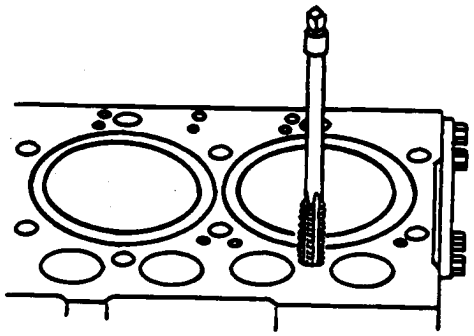
2. Clean ventilator hose and tube (B) if they are restricted.



RG4625 -UN-06DEC88

S11,2005,HO -19-08MAR94

CLEAN AND INSPECT TOP DECK OF CYLINDER BLOCK



RG4718 -UN-13DEC88

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

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

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

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

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

S11,2005,GZ -19-08MAR94

MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

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

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

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

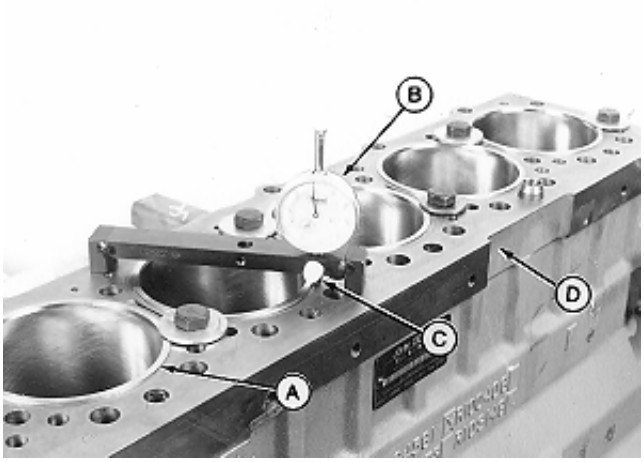
NOTE: Variations in measurement readings may occur within one cylinder and/or between adjacent cylinders.

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

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

CYLINDER LINER HEIGHT SPECIFICATIONS

Cylinder Liner Height Above Block	0.025—0.127 mm (0.001—0.005 in.)



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

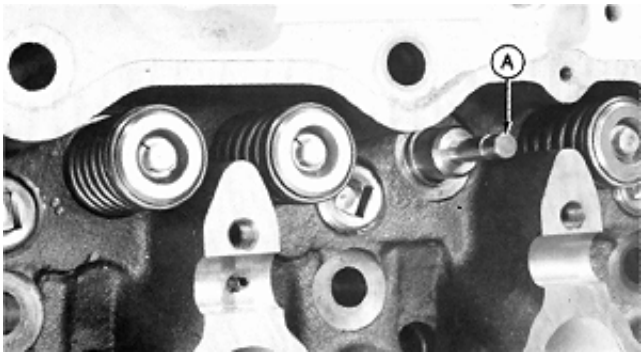
S11,2005,HX1 -19-08AUG94

ASSEMBLE VALVE ASSEMBLY

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

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

NOTE: Valves must move freely and seat properly.

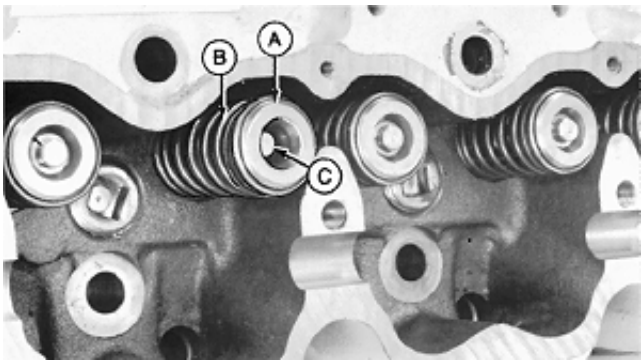


RG,CTM1,G5,2 -19-08MAR94

3. Install valve springs (B) making certain that cylinder head end of spring is located correctly in machined counterbore of head.

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

5. Compress valve springs with JDE138 Valve Spring Compressor.



RG3804 -UN-23FEB89

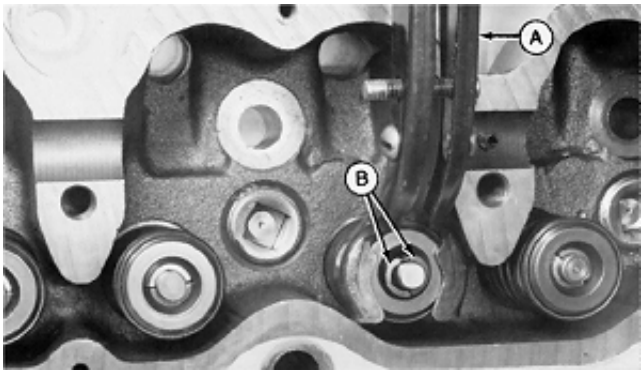
S11,0401,AL -19-08AUG94

6. On 6466D Engines, install valve stem O-ring seals on intake valves.

7. Install retainer locks (B).

8. Release valve spring compressor (A).

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



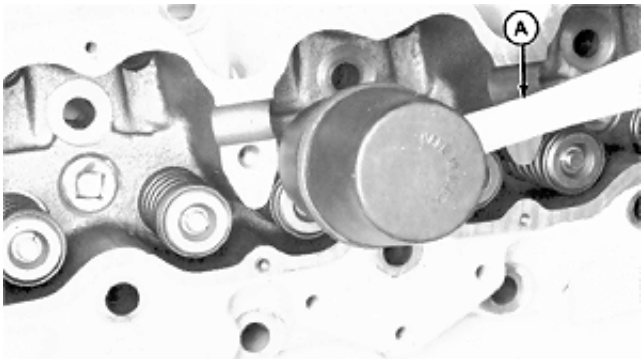
RG3803 -UN-23FEB89

S11,2005,LC -19-08AUG94

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

10. Repeat procedure for all remaining valves.

11. Measure valve recess or height as directed earlier in this group.



RG3807 -UN-23FEB89

S11,2005,LD -19-08MAR94

DETERMINE USE OF CORRECT HEAD GASKET ON 6466D ENGINES

NOTE: Be sure area on block is clean and smooth for dial indicator base.

1. Position indicator tip near rear edge of piston (A).

2. Rotate crankshaft while watching indicator dial. When piston has reached its highest point (TDC) “zero” indicator.

3. CAREFULLY lift indicator point, and rotate indicator and base to position (B).

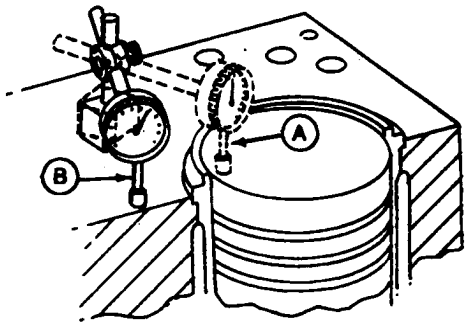
4. Release indicator point and record reading.

If height of any one piston measures more than 0.74 mm (0.0290 in.) above the cylinder block, use R66065 head gasket. If height of all pistons is less than 0.74 mm (0.0290 in.), use RE47336 head gasket.

NOTE: Use RE47336 head gasket on all 6466T and 6466A Engines.

HEAD GASKET THICKNESS (NEW)

RE47336	1.56—1.72 mm (0.061—0.068 in.)
R66065	1.68—1.80 mm (0.066—0.071 in.)



R 31106

-UN-13APR89

R31106

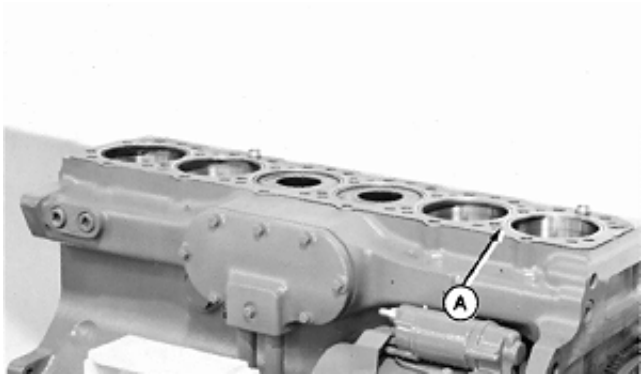
S11,2005,HP -19-08AUG94

INSTALL CYLINDER HEAD

IMPORTANT: ALWAYS thoroughly inspect new 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.

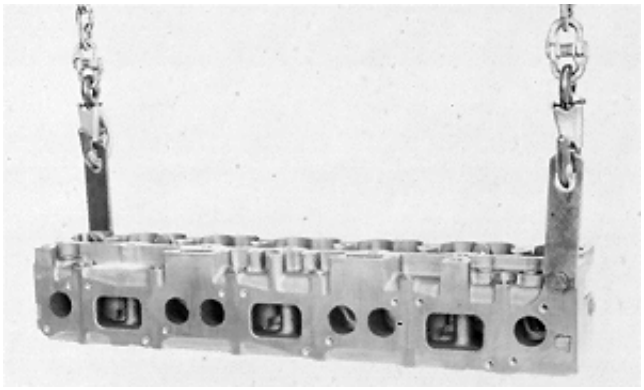
1. Put a new head gasket (A) on top of cylinder block. Do not use sealant on gasket.



RG3808 -UN-23FEB89

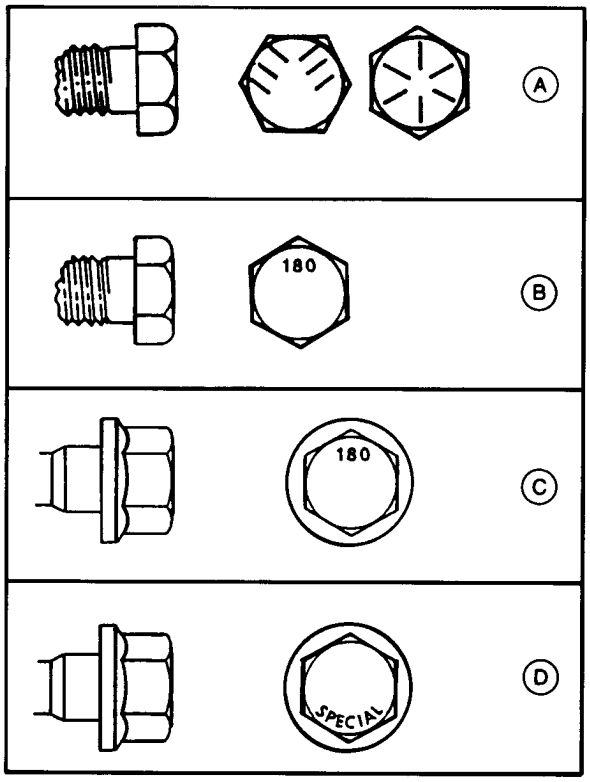
IMPORTANT: If cylinder head is lowered onto cylinder block and you discover that the head is not positioned correctly on locating dowels, remove cylinder head and install a new gasket. DO NOT try to reposition cylinder head on the same gasket again since the fire ring(s) will possibly be damaged.

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


RG5245 -UN-06DEC88

S11,2005,DX -19-05AUG94

CYLINDER HEAD CAP SCREW TYPES



A—SAE Grade 8* **B—ASTM Grade 180*** **C—ASTM Grade 180 Flanged-Head** **D—Flanged-Head marked "SPECIAL"**

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

NOTE: Only flanged-head cap screws are available for service. If necessary to replace one or more (non—flanged-head) cap screws with washers, all 26 cap screws must be replaced. DO NOT intermix flanged-head cap screws and non—flanged-head cap screws within a given engine.

IMPORTANT: Cylinder head cap screw torque specifications and tightening procedures vary depending upon the grade or type of cap screw used and cylinder block casting number. See CYLINDER HEAD CAP SCREW TIGHTENING PROCEDURES, later in this group.

Only cap screws marked "SPECIAL" which are installed in cylinder blocks with casting numbers INCLUDING or AFTER R122724, R122726, R122727, R122728, R122733, R122734, and R122735 can be tightened using the TORQUE-TO-YIELD tightening procedure.

** Use with washers.*

RG,CTM1,G5,6 -19-05AUG94

INSPECT AND CLEAN CYLINDER HEAD CAP SCREWS

IMPORTANT: All cylinder head cap screws can be reused if they pass inspection EXCEPT for the flanged-head cap screws marked "SPECIAL". These cap screws can be used only ONE time and CAN BE USED ONLY on cylinder blocks with casting numbers INCLUDING or AFTER: R122724, R122726, R122727, R122728 R122733, R122734, and R122735.

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

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

S11,2005,HQ -19-05AUG94

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INSTALL CYLINDER HEAD CAP SCREWS

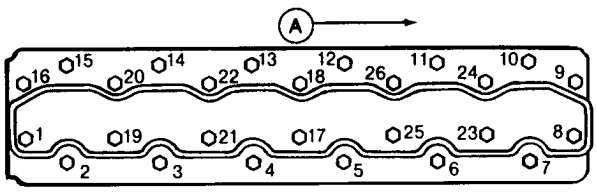
• Effective with all cylinder block casting numbers PRIOR to R87554.

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

1. Dip entire cap screw (and washer, if applicable) in clean SAE30 engine oil. Allow excess oil to drip off.

2. Install correct length cap screws in locations shown and tighten according to proper tightening method, as described later in this group.

Arrow (A) points toward front of engine.



-UN-28FEB94
RG4471

CAP SCREW LENGTH	LOCATION ON CYLINDER HEAD
83 mm (3.3 in.)	2, 3, 4, 5, 6, 7
134 mm (5.3 in.)	19, 21, 17, 25, 23
160 mm (6.3 in.)	1, 15, 14, 13, 12, 11, 10, 8
188 mm (7.4 in.)	16, 20, 22, 18, 26, 24, 9

S11,2005,LX -19-05AUG94

• Effective with cylinder block casting numbers: R87554, R87555, R87556, R87557, R87558, R87559, R87560, R87562, R87563, and R87564.

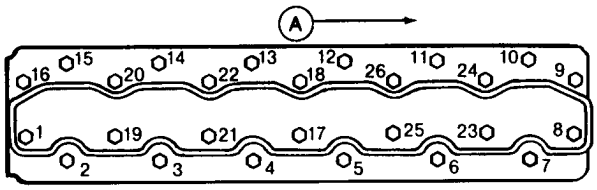
IMPORTANT: DO NOT use multi-viscosity oils to lubricate cap screws.

1. Dip entire cap screw (and washer, if applicable) in clean SAE30 engine oil. Allow excess oil to drip off.

2. Install correct length cap screws in locations shown and tighten according to proper tightening method, as described later in this group.

Arrow (A) points toward front of engine.

CAP SCREW LENGTH	LOCATION ON CYLINDER HEAD
134 mm (5.3 in.)	2, 3, 4, 5, 6, 7, 19, 21, 17, 25, 23
160 mm (6.3 in.)	1, 15, 14, 13, 12, 11, 10, 8
188 mm (7.4 in.)	16, 20, 22, 18, 26, 24, 9



-UN-28FEB94
RG4471

RG,CTM1,G5,11 -19-05AUG94

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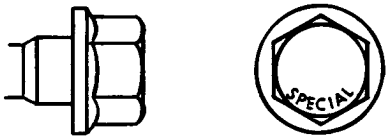
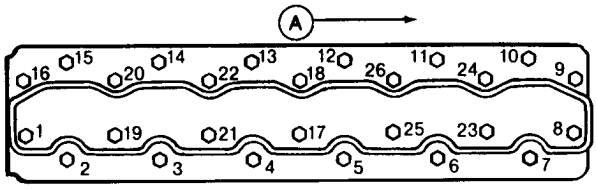
RG7137 -UN-21FEB94





RG4471 -UN-28FEB94

• Effective with cylinder block casting numbers INCLUDING or AFTER: R122724, R122726, R122727, R122728, R122733, R122734, and R122735. Cap screws marked "SPECIAL" may be used in blocks including or after these casting numbers. Use of these cap screws in older blocks could result in cylinder liner or block damage due to increased clamp load.

NOTE: Some early engines with cylinder block casting numbers listed above were built with ASTM Grade 180 flanged-head cap screws. These cap screws may be reused with the TORQUE-TURN tightening procedure or "SPECIAL" cap screws may be used with the TORQUE-TO-YIELD tightening procedure.

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

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

2. Install correct length cap screws marked "SPECIAL" in locations shown and TORQUE-TO-YIELD, as described later in this group.

Arrow (A) points toward front of engine.

CAP SCREW LENGTH	LOCATION ON CYLINDER HEAD
134 mm (5.3 in.)	2, 3, 4, 5, 6, 7, 19, 21, 17, 25, 23
160 mm (6.3 in.)	1, 15, 14, 13, 12, 11, 10, 8
188 mm (7.4 in.)	16, 20, 22, 18, 26, 24, 9

RG,CTM1,G5,12 -19-05AUG94

CYLINDER HEAD CAP SCREW TIGHTENING PROCEDURES

Three different tightening procedures are recommended:

—Specified torque value and retorque
—TORQUE-TURN (Specified torque values plus 90˚ turn)
—TORQUE-TO-YIELD (Specified torque value plus sequence of three separate 90˚ turns)

IMPORTANT: Follow the appropriate tightening procedure when installing cap screws. DO NOT mix grades and types of cap screws on any one engine.

CAP SCREW TYPE	TIGHTENING PROCEDURE	ADDITIONAL INFORMATION
SAE Grade 8 with washers	1st Step: 142 N·m (105 lb-ft) Always tighten cap screw No. 17 first and proceed sequentially through remaining cap screws. 2nd Step: 157 N·m (115 lb-ft) See TIGHTEN CYLINDER HEAD CAP SCREWS (WITH WASHERS)—GRADE 8, later in this group.	After engine break-in, loosen each cap screw 1/4—1/2 turn (begin with cap screw No. 1) and retighten to 178 N·m (130 lb-ft). See RETORQUE AFTER ENGINE BREAK-IN, later in this group.
ASTM Grade 180 with washers	1st Step: 224 N·m (165 lb-ft) Always tighten cap screw No. 17 first and proceed sequentially through remaining cap screws. 2nd Step: 245 N·m (180 lb-ft) See TIGHTEN CYLINDER HEAD CAP SCREWS (WITH WASHERS)—GRADE 180, later in this group.	A minimum of two hours after initial tightening, loosen each cap screw 1/4—1/2 turn (begin with cap screw No. 1) and retighten to 245 N·m (180 lb-ft).
ASTM Grade 180 Flanged-Head	1st Step: 100 N·m (75 lb-ft) Always tighten cap screw No. 17 first and proceed sequentially through remaining cap screws. 2nd Step: 125 N·m (95 lb-ft) 3rd Step: TURN 90˚—100˚ See TORQUE-TURN FLANGED-HEAD CAP SCREWS—GRADE 180, later in this group.	No retorque required.
ASTM Grade 180 Flanged-Head marked “SPECIAL”	1st Step: Tighten cap screw No. 17 to 80 N·m (60 lb-ft). 2nd Step: Tighten cap screws 1—26 to 80 N·m (60 lb-ft). 3rd Step: Turn 90˚ sequentially cap screws 1—26. 4th Step: Turn 90˚ sequentially cap screws 1—26. 5th Step: Turn 90˚ sequentially cap screws 1—26 for a total of 270˚ ±5˚ See TORQUE-TO-YIELD FLANGED-HEAD CAP SCREWS—GRADE 180 MARKED “SPECIAL”, later in this group.	DO NOT retorque. Cap screws can be tightened ONE time only; otherwise, cap screw failure could occur.

RG,CTM1,G5,10 -19-05AUG94

TIGHTEN CYLINDER HEAD CAP SCREWS (WITH WASHERS)—GRADE 8

NOTE: Grade 8 cap screws are determined by head markings (upper illustration).

Arrow (A) points toward front of engine.

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

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

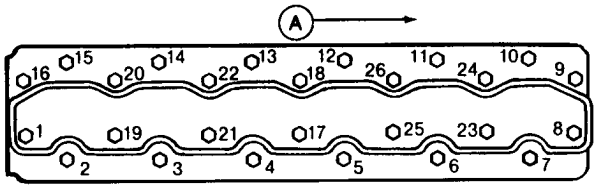
2. Tighten cap screw No. 17 to 142 N·m (105 lb-ft) to prevent the cylinder head from tipping during tightening sequence.

3. Tighten the remaining cap screws to 142 N·m (105 lb-ft), following the numerical sequence shown beginning at No. 1.

4. Retighten in the same numerical sequence to 157 N·m (115 lb-ft) beginning at No. 1.

NOTE: After engine break-in, retighten Grade 8 cylinder head cap screws as described in RETORQUE AFTER ENGINE BREAK-IN later in this group.

RG7134 -UN-21FEB94



RG4471 -UN-28FEB94

S11,2005,HR -19-17AUG94

TIGHTEN CYLINDER HEAD CAP SCREWS (WITH WASHERS)—GRADE 180

NOTE: Grade 180 cap screws are determined by head markings (upper illustration).

Arrow (A) points toward front of engine.

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

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

2. Tighten cap screw No. 17 (lower illustration) to 224 N·m (165 lb-ft) to prevent the cylinder head from tipping during tightening sequence.

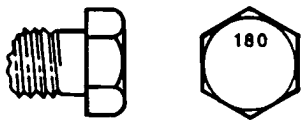
3. Tighten the remaining cap screws to 224 N·m (165 lb-ft), following the numerical sequence shown beginning at No. 1.

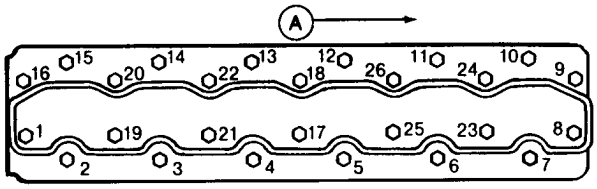
4. Retighten all cap screws in the same numerical sequence to 245 N·m (180 lb-ft) beginning at No. 1.

IMPORTANT: To achieve optimum sealing of the cylinder head gasket, let the engine set for at least two hours after final tightening, then, loosen each cap screw 1/4—1/2 turn and retighten to 245 N·m (180 lb-ft). Begin at cap screw No. 1, (loosen and retighten) and proceed in numerical sequence until all cap screws have been retightened.

NOTE: Retightening of Grade 180 cylinder head cap screws are not required after engine break-in when using the above procedure.

RG7135 -UN-21FEB94



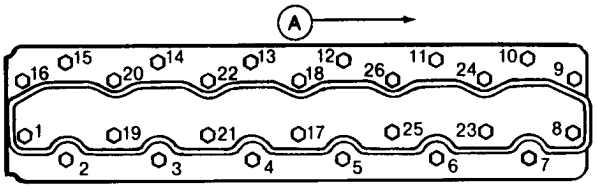


RG4471 -UN-28FEB94

S11,2005,HS -19-17AUG94

TORQUE-TURN FLANGED-HEAD CAP SCREWS—GRADE 180

Arrow (A) points toward front of engine.



RG44471 -UN-28FEB94

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

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

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

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

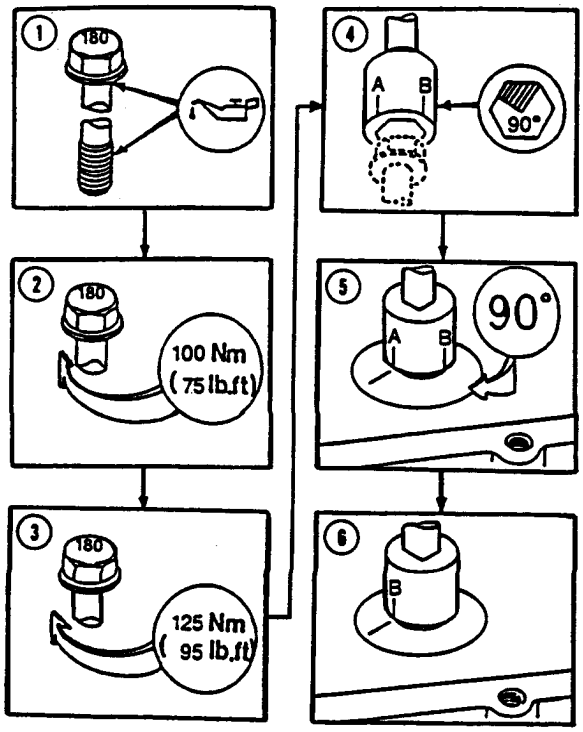
3. Retighten all cap screws to 125 N·m (95 lb-ft) beginning with No. 1.

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

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

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

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

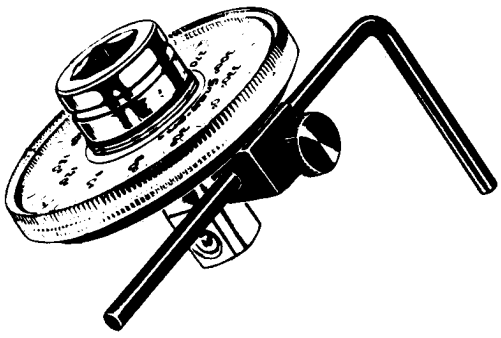


RG7138 -UN-28FEB94

Line Scribe Method

• Using JT05993 Torque Angle Gauge:

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



RG5698 -UN-27AUG90

JT05993 Torque Angle Gauge

RG,CTM1,G5,5 -19-17AUG94

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

Arrow (A) points toward front of engine.

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

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

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

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

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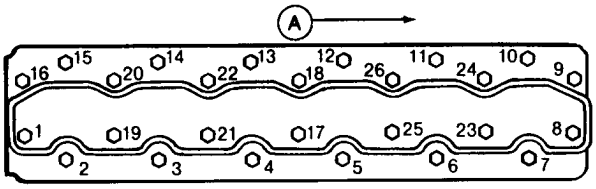
IMPORTANT: If a cap screw is accidentally tightened more than 90° in any one sequence, DO NOT loosen cap screw but make adjustments in the next tightening sequence.

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

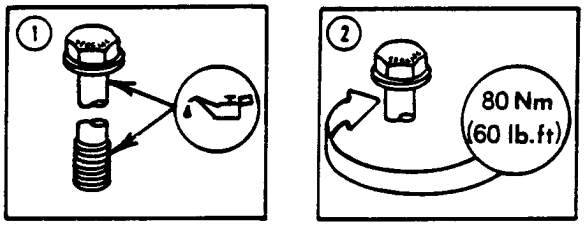
5. Again, sequentially (start at cap screw No. 1 and proceed through cap screw No. 26) turn each cap screw 90°. Line on top of cap screw will now be parallel to crankshaft.

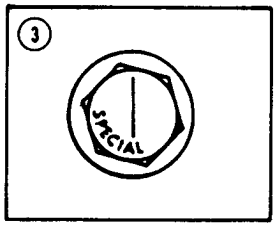
IMPORTANT: Cap screws MUST NOT be tightened more than a total of 270° ±5°.

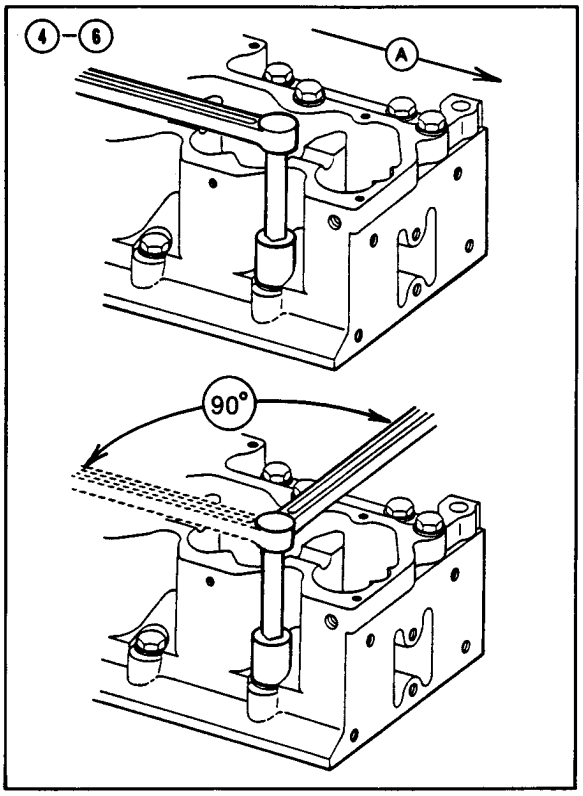
6. Finally, sequentially (start at cap screw No. 1 and proceed through cap screw No. 26) turn each cap screw 90°, SO THAT LINE ON TOP OF CAP SCREW IS AS CLOSE AS POSSIBLE TO BEING PERPENDICULAR TO THE CRANKSHAFT. It is not necessary to obtain the final turn in one swing of the wrench. TOTAL AMOUNT OF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



RG44471 -UN-28FEB94







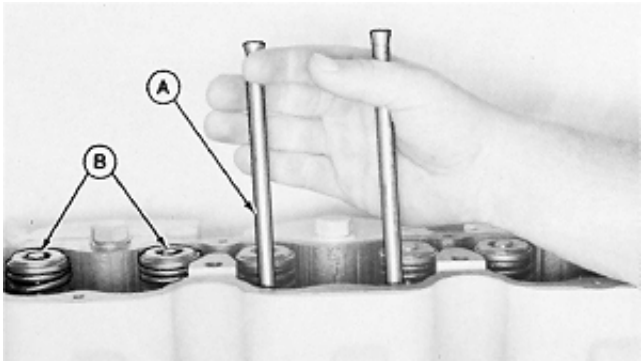
RG7139 -UN-01MAY94

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

INSTALL ROCKER ARM ASSEMBLY

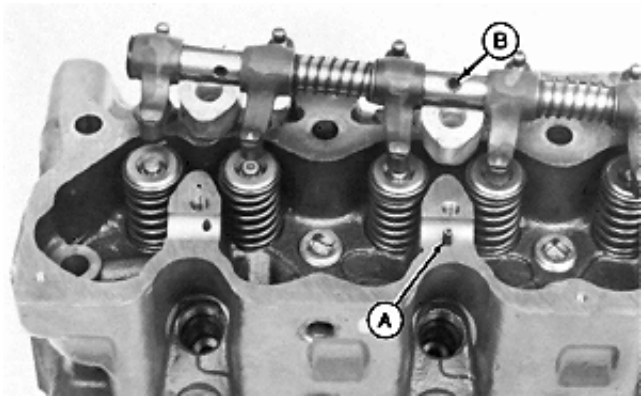
1. Install push rods (A) in holes from which removed.

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



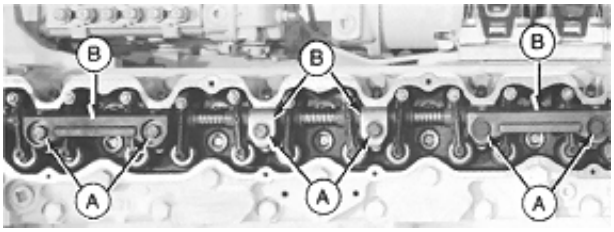
S11,2005,HT -19-12JUL94

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



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

NOTE: 6466D Engines contain 6 short clamps. 6466T and 6466A Engines contain 2 long clamps and 2 short clamps as shown here.



S11,2005,HU -19-08AUG94

COMPLETE FINAL ASSEMBLY ON INJECTION PUMP SIDE

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

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

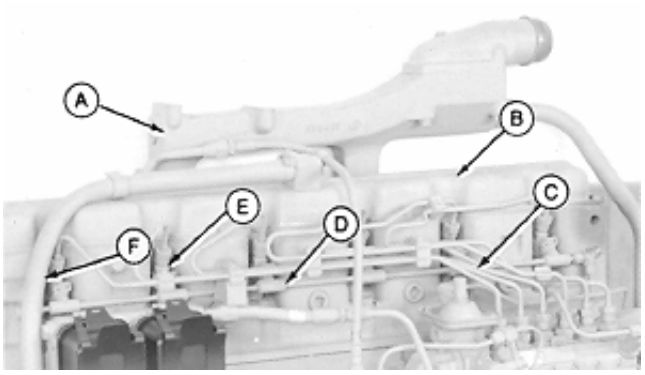
3. Install cover and tighten cap screws to 8 N·m (71 lb-in.).

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

5. Install ventilator outlet hose (F). Tighten all clamps securely.

6. Connect outlet tube to outlet hose and tighten clamp securely.

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



RG3799 -UN-25SEP89

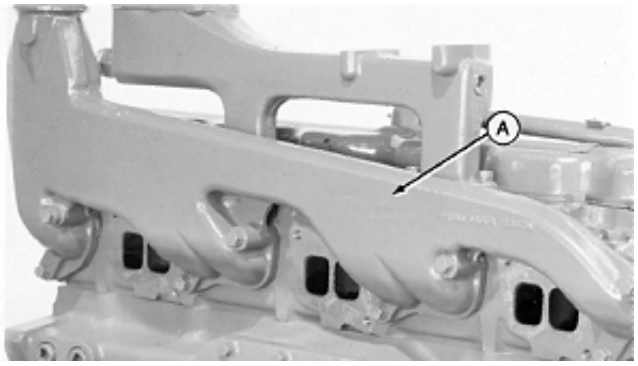
A—Water Manifold
B—Rocker Arm Cover
C—Fuel Injection Lines
D—Leak-Off Lines
E—Fuel Injection Nozzles
F—Ventilator Outlet Hose

S11,2005,DZ -19-08MAR94

COMPLETE FINAL ASSEMBLY ON EXHAUST MANIFOLD SIDE

NOTE: Apply PT569 NEVER-SEEZ Compound or equivalent to all exhaust manifold cap screws.

1. On 6466D Engines, use new gaskets and install exhaust manifold (A). Tighten cap screws to 47 N·m (35 lb-ft).



RG3811 -UN-25SEP89

S11,2005,EA -19-08MAR94

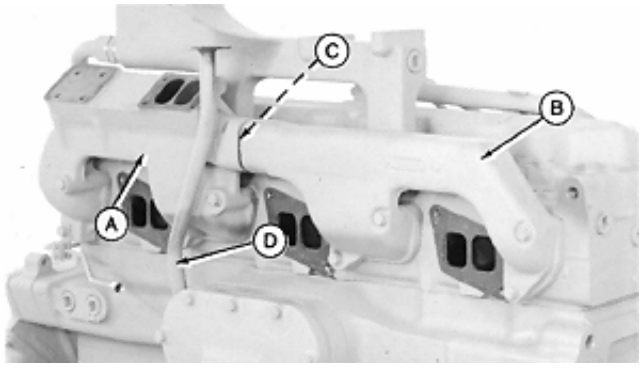
2. On 6466T and 6466A Engines, install front exhaust manifold (A) using new gaskets. Do not tighten cap screws.

3. Install rear exhaust manifold (B) using new gaskets and sealing ring (C).

4. Tighten all cap screws to 47 N·m (35 lb-ft).

5. Install turbocharger oil return pipe (D), using a new O-ring.

A—Front Exhaust Manifold
B—Rear Exhaust Manifold
C—Sealing Ring
D—Turbocharger Oil Return Pipe



-UN-25SEP89
RG3812

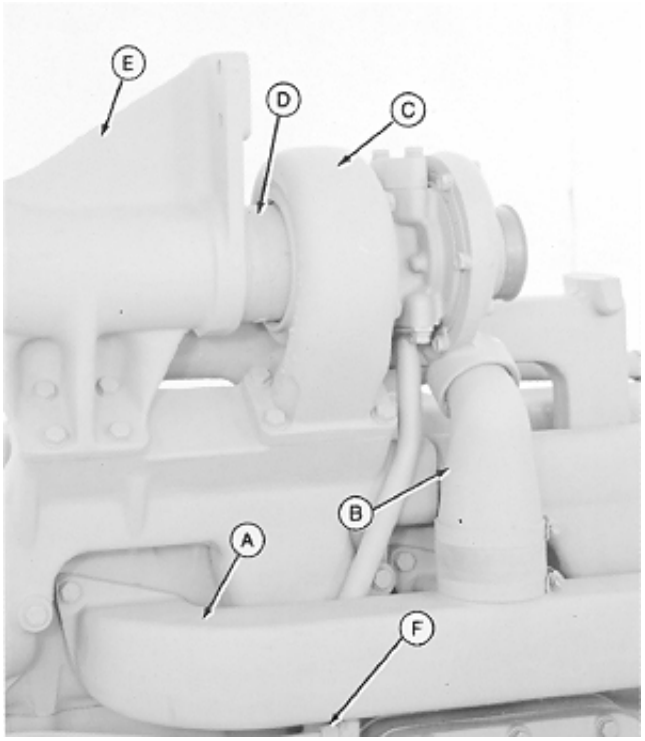
S11,2005,HV -19-17FEB87

6. On 6466T Engines, using new gaskets install intake manifold (A). Tighten cap screws to 47 N·m (35 lb-ft).

7. On 6466T Engines, install intake elbow (B), turbocharger (C), adapter (D), and exhaust elbow (E). (See INSTALL TURBOCHARGER in Group 30.)

8. On 6466T Engines, connect aneroid line (F)-to-intake manifold. Tighten securely.

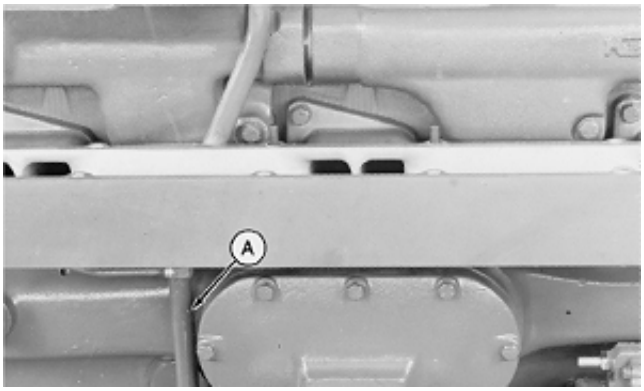
A—Intake Manifold
B—Intake Elbow
C—Turbocharger
D—Adapter
E—Exhaust Elbow
F—Aneroid Line



-UN-25SEP89
RG3813

S11,2005,HW -19-08MAR94

9. On 6466A Engines, install turbocharger oil return pipe (A). Install new O-ring into block fitting.

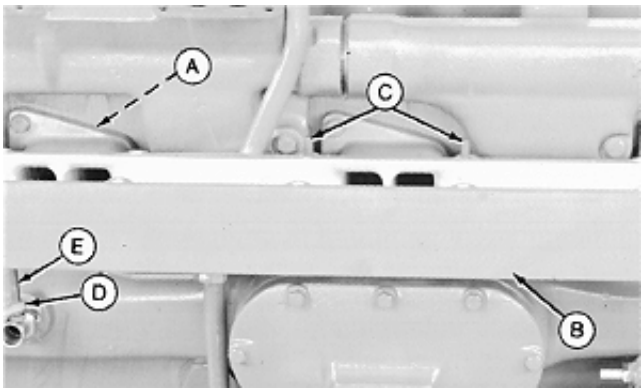


S11,2005,LE -19-30OCT86

NOTE: BEFORE installing intake manifold, install two cap screws (C), adapter (D), cap screw (E), and new O-ring.

10. On 6466A Engines, use new gaskets (A) and install intake manifold (B). Tighten cap screw to 47 N·m (35 lb-ft).

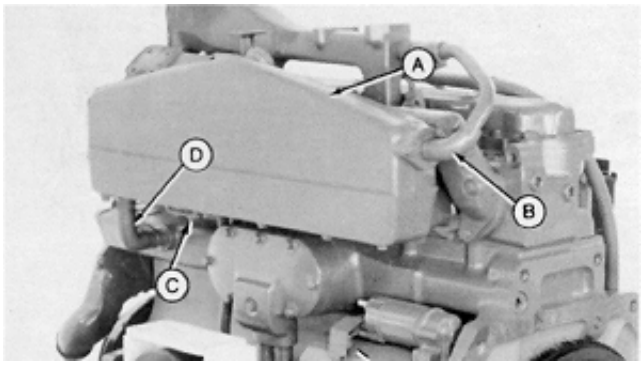
A—Gasket (3 used)
B—Intake Manifold
C—Cap Screws
D—Adapter
E—Cap Screw



S11,2005,LF -19-16MAR87

11. On 6466A Engines, using new gaskets and O-rings, install aftercooler and cover (A). (See INSTALL AFTERCOOLER in Group 30.) Install inlet (B) and outlet (D) hoses. Tighten hose clamps to 4 N·m (3 lb-ft) (35 lb-in.). Install aneroid line (C) and tighten securely.

A—Aftercooler Cover
B—Inlet Hose
C—Aneroid Line
D—Outlet Tube and Hose



S11,2005,HY -19-08AUG94

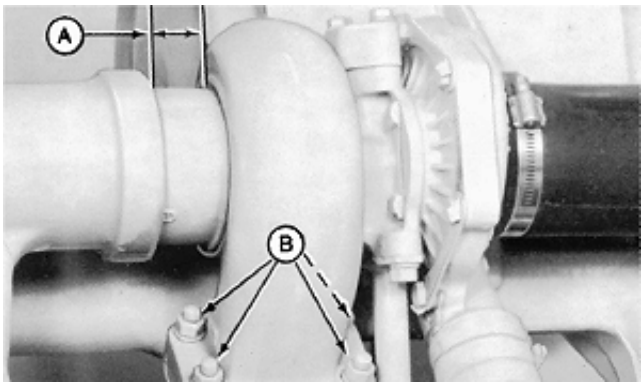
12. On 6466T and 6466A Engines, with turbocharger installed, tighten stud nuts (B) to 47 N·m (35 lb-ft).

NOTE: The exhaust adapter end play (A) minimum is 0.8 mm (0.03 in.).

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

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

15. Perform engine break-in as outlined later in this group.



-UN-25SEP89
RG3669

S11,2005,HZ -19-08AUG94

05
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PERFORM ENGINE BREAK-IN

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

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

NOTE: Dynamometer is the preferred method for engine break-in. If a dynamometer is not available, break-in can be accomplished by matching engine lugging conditions with gear ratio selection.

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

RG,CTM1,G05,8 -19-08AUG94

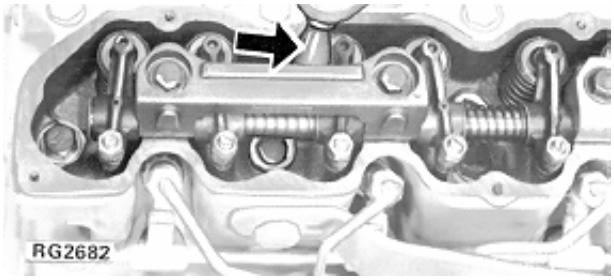
RETORQUE AFTER ENGINE BREAK-IN

RG7134 -UN-21FEB94

• For SAE Grade 8 cylinder head cap screws (with washers) only.

1. After engine break-in remove rocker arm cover, loosen each cap screw 1/4—1/2 turn and retighten to 178 N·m (130 lb-ft). Begin at cap screw No. 1 (loosen and retighten) and proceed in numerical sequence until all cap screws have been retightened.

Final torque . . . . . 178 N·m (130 lb-ft)



-UN-17JUL89

RG2682

NOTE: Use the JDE37A Torque Wrench Adapter (arrow) to properly tighten cylinder head cap screws located under the rocker arm shaft clamps.

2. Install rocker arm cover and tighten cap screws to 2.8 N·m (25 lb-in.).

05
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S11,2005,IA -19-05AUG94

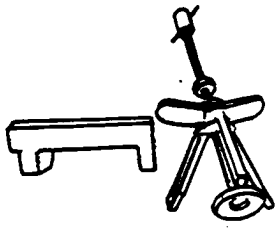
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

Cylinder Liner Puller D01062AA
(or D01073AA)

Remove cylinder liners.



RG5019 -UN-23AUG88

S53,D01062,AA -19-07AUG91

RG5073 -UN-23AUG88

Magnetic Follower Holder Kit D15001NU

Hold cam followers when removing or installing camshaft.

S53,D15001,NU -19-24APR92

RG5074 -UN-23AUG88

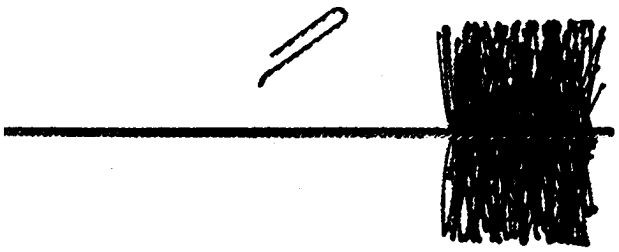
Flexible Cylinder Hone D17005BR

Hone cylinder liners.

S53,D17005,BR -19-07APR88

O-Ring Groove Cleaning Brush D17015BR

Clean cylinder liner O-ring groove in block.



RG5075 -UN-23AUG88

S53,D17015,BR -19-25MAR91

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

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

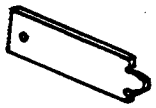
RG6246 -UN-27MAR92

RG,D17526CI -19-29OCT92

RG5076 -UN-23AUG88

Ring Groove Wear Gauge JDE55

Check wear of keystone ring groove on pistons.



S53,JDE55 -19-25MAR91

RG5077 -UN-23AUG88

Piston Ring Expander JDE93

Remove and install piston rings.

S53,JDE93 -19-17FEB87

RG5031 -UN-23AUG88

Piston Ring Compressor JDE96

Compress rings while installing pistons.

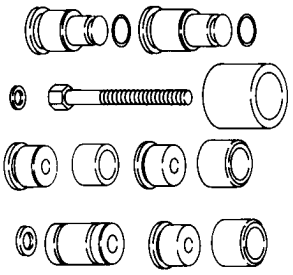
S53,JDE96 -19-25MAR87

Connecting Rod Bushing Service Set JDE98A

Remove and install connecting rod bushings.

Set consists of:

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



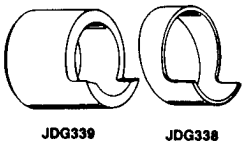
RG5078 -UN-16FEB94

S53,JDE98A -19-16AUG94

RG5079 -UN-25JUN94

Connecting Rod Bushing Service Set JDG337

Use with JDE98A to remove and install 21˚ tapered connecting rod bushings on 6466 Engines.

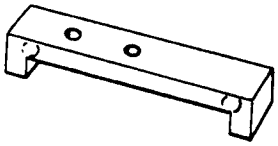


S53,JDG337 -19-08AUG94

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.



-UN-30SEP94
RG7029

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RG,JDG451 -19-28SEP94

RG5100 -UN-23AUG88

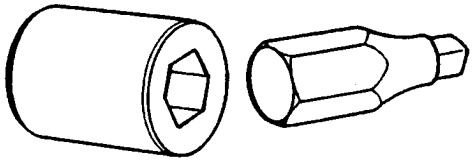
Tap JDG681

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

RG,JDG681 -19-25MAR91

Oil Galley Plug Tool JDG782

Used to remove and install oil galley plug.

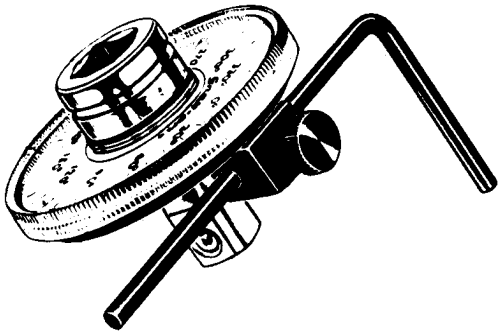


-UN-29JAN93
RG6612

RG,JDG782 -19-02APR93

Torque Angle Gauge JT05993

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



RG5698 -UN-27AUG90

RG,JT05993 -19-22AUG91

SERVICE EQUIPMENT AND TOOLS

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

Name	Use
D05012ST Precision “Bevelled Edge” Straightedge	Check cylinder block flatness
Piston Ring Groove Cleaner	Clean piston ring grooves
Cylinder Bore Ridge Reamer	Remove carbon from liner bore

RG,CTM61,G10,6 -19-04AUG94

10 4

OTHER MATERIAL

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

S11,2010,BS -19-08AUG94

CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Maximum Piston Protrusion Above Block	0.051—0.787 mm (0.0020—0.0309 in.)	---
Cylinder Liner Height Above Block	0.025—0.127 mm (0.001—0.005 in.)	---
Piston Oil Control Ring-to-Groove Clearance	0.061—0.102 mm (0.0024—0.0040 in.)	0.165 mm (0.0065 in.)
Piston Ring End Gap*:		
6466D		
Top Ring	0.43—0.69 mm (0.017—0.027 in.)	---
2nd Ring	0.89—1.14 mm (0.035—0.045 in.)	---
Oil Ring	0.33—0.58 mm (0.013—0.023 in.)	---
6466T and 6466A		
Top Ring	0.43—0.69 mm (0.017—0.027 in.)	---
2nd Ring	0.64—1.02 mm (0.025—0.040 in.)	---
Oil Ring	0.33—0.58 mm (0.013—0.023 in.)	---
Piston OD:		
Top of skirt [77 mm (3.03 in.) from bottom of piston]		
6466D		
Stamped “L”	115.674—115.689 mm (4.5541—4.5547 in.)	---
Stamped “H”	115.689—115.707 mm (4.5547—4.5554 in.)	---
Unstamped	115.674—115.689 mm (4.5541—4.5547 in.)	---
6466T and 6466A		
Stamped “L”	115.631—115.651 mm (4.5525—4.5532 in.)	---
Stamped “H”	115.651—115.669 mm (4.5532—4.5539 in.)	---
Unstamped	115.631—115.651 mm (4.5525—4.5532 in.)	---
Bottom of skirt [2 mm (0.09 in.) from bottom of piston]		
6466D		
Stamped “L”	115.766—115.783 mm (4.5577—4.5584 in.)	---
Stamped “H”	115.783—115.801 mm (4.5584—4.5591 in.)	---
Unstamped	115.766—115.783 mm (4.5577—4.5584 in.)	---
6466T and 6466A		
Stamped “L”	115.760—115.778 mm (4.5575—4.5582 in.)	---
Stamped “H”	115.778—115.796 mm (4.5582—4.5589 in.)	---
Unstamped	115.760—115.778 mm (4.5575—4.5582 in.)	---
Cylinder Liner ID:		
Stamped “LC” or “LL”	115.865—115.895 mm (4.5616—4.5628 in.)	---
Stamped “HH”	115.876—115.905 mm (4.5625—4.5632 in.)	---
Unstamped	115.865—115.895 mm (4.5616—4.5628 in.)	---
Cylinder Liner OD	127.94—128.24 mm (5.037—5.049 in.)	---

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

S11,2010,FB -19-08AUG94

CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Maximum Cylinder Liner Taper in Ring Travel Area		0.051 mm (0.002 in.)
Maximum Cylinder Liner Out-of-Round		0.051 mm (0.002 in.)
Cylinder Liner Thickness	6.05—6.15 mm (0.238—0.242 in.)	---
Cylinder Liner Packing Step Dimension	1.45—1.55 mm (0.057—0.061 in.)	---
Cylinder Liner Flange Thickness	8.175—8.225 mm (0.3218—0.3238 in.)	---
Cylinder Liner Counterbore Depth	8.105—8.155 mm (0.319—0.321 in.)	---
Cylinder Liner Flange OD	135.10—135.16 mm (5.319—5.321 in.)	---
Lower Bore Diameter for Seating Liners	125.133—125.183 mm (4.9265—4.9285 in.)	---
Upper Bore Diameter for Seating Liners	129.155—129.205 mm (5.0848—5.0868 in.)	---
Outer Diameter of Liner at Lower Bore	125.042—125.122 mm (4.9229—4.9260 in.)	---
Outer Diameter of Liner at Upper Bore	129.085—129.135 mm (5.0820—5.0840 in.)	---
Liner-to-Block Clearance at Lower Bore	0.013—0.140 mm (0.0005—0.0055 in.)	---
Liner-to-Block Clearance at Upper Bore	0.026—0.126 mm (0.0010—0.0049)	---
Liner Shim Thickness*	0.05 mm (0.002 in.)	---
Piston-to-Liner Clearance at Bottom of Skirt	0.09—0.14 mm (0.0034—0.0055 in.)	0.15 mm (0.006 in.)
Piston Pin OD:		
6466D	41.267—41.283 mm (1.6247—1.6253 in.)	---
6466T and 6466A	47.597—47.612 mm (1.8739—1.8745 in.)	---
Piston Pin Bore in Piston ID:		
6466D	41.283—41.298 mm (1.6253—1.6259 in.)	---
6466T and 6466A	47.620—47.630 mm (1.8748—1.8752 in.)	---
Centerline of Connecting Rod Piston Pin Bore-to-Crankshaft Rod Journal Bore	222.20—222.30 mm (8.748—8.752 in.)	---

** A maximum of 2 cylinder liner shims per liner can be used on 6466 engines.*

S11,2010,FB1 -19-08AUG94

CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
ID of Installed Service Rod Pin Bushing (Before Boring):		
6466D	41.237—41.262 mm (1.6235—1.6245 in.)	---
6466T and 6466A Engine Serial No. (—227649)	47.554—47.605 mm (1.8722—1.8742 in.)	---
6466T and 6466A Engine Serial No. (227650—)	47.579—47.628 mm (1.8732—1.8751 in.)	---
ID of Installed Service Rod Pin Bushing ID (Bored):		
6466D	41.300—41.326 mm (1.6260—1.6270 in.)	---
6466T and 6466A Engine Serial No. (—227649)	47.630—47.665 mm (1.8752—1.8762 in.)	---
6466T and 6466A Engine Serial No. (227650—)	47.665—47.680 mm (1.8762—1.8772 in.)	---
Piston Pin Bore Diameter Without Bushing	52.354—52.380 mm (2.0612—2.0622 in.)	---
Pin-to-Bushing Oil Clearance:		
Engine Serial No. (—227649)	0.018—0.058 mm (0.0007—0.0023 in.)	0.076 mm (0.003 in.)
Engine Serial No. (227650—)	0.042—0.084 mm (0.0017—0.0033 in.)	0.10 mm (0.004 in.)
Piston Pin Bore-to-Bushing Press Fit Specification:		
6466D	0.038—0.089 mm (0.0015—0.0035 in.)	---
6466T, A		
6° Taper	0.084—0.135 mm (0.0033—0.0053 in.)	---
21° Taper	0.084—0.147 mm (0.0033—0.0058 in.)	---
Connecting Rod Bore ID (Without Bearings)	81.051—81.077 mm (3.191—3.192 in.)	0.04 mm (0.0015 in.)
Connecting Rod Bearing ID (Assembled)	76.210—76.261 mm (3.0004—3.0024 in.)	---
Crankshaft Rod Journal OD	76.149—76.180 mm (2.9980—2.9992 in.)	---
Bearing-to-Journal Clearance	0.030—0.112 mm (0.0012—0.0044 in.)	0.15 mm (0.006 in.)
Connecting Rod Cap End Gap		0.25 mm (0.010 in.)
Connecting Rod Out-of-Round		0.025 mm (0.001 in.)

S11,2010,FC -19-17AUG94

CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Main Bearing Bore ID Without Bearings	92.125—92.151 mm (3.6270—3.6280 in.)	---
Width of Cylinder Block Main Thrust Bearing Cap	37.44—37.54 mm (1.474—1.478 in.)	---
New Camshaft Bore Diameter With Bushing	60.389—60.439 mm (2.3775—2.3795 in.)	---
New Camshaft Bore Diameter Without Bushing	63.487—63.513 mm (2.4995—2.5005 in.)	---
Maximum Runout of Camshaft Bore Diameter	0.038 mm (0.0015 in.)	---
New Camshaft Bushing-to-Journal Clearance	0.05—0.13 mm (0.002—0.005 in.)	---
Maximum Camshaft Bushing-to-Journal Clearance	0.15 mm (0.006 in.)	---
Maximum Cylinder Block Top Deck Out-of-Flat (Entire Length or Width of Cylinder Block)	0.010 mm (0.004 in.)	---
Cylinder Block Top Deck Straightness per Any 305 mm (12 in.) Length	0.025 mm (0.001 in.)	---
Centerline of Main Bearing Bore-to-Top Deck of Cylinder Block	352.35—352.50 mm (13.872—13.878 in.)	---

S11,2010,FC1 -19-08AUG94

CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS—CONTINUED

TORQUES

Connecting Rod Caps:	
Initial (Blind Hole Cap Screws)	27 N·m (20 lb-ft)
Final (All Cap Screws)	75 N·m (55 lb-ft) Plus 90—100° (See TORQUE-TURN Method in this Group)
Piston Cooling Orifices	11 N·m (97 lb-in.)
Tachometer Drive Housing or Cover Plate	47 N·m (35 lb-ft)
Cylinder Liner Cap Screws:	
(for checking liner standout)	68 N·m (50 lb-ft)

RG,CTM1,G10,1 -19-08AUG94

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9

PRELIMINARY LINER, PISTON AND ROD CHECKS

• Scuffed or Scored Pistons:

Insufficient lubrication.
Insufficient cooling.
Improper piston-to-liner clearance.
Coolant leakage in crankcase.
Misaligned or bent connecting rod.
Improperly installed piston.
Low oil level.
Improper operation.
Incorrect connecting rod bearing clearance.
Carbon build-up in ring groove.
Improper break-in.
Worn piston.
Contaminated oil.
Distorted cylinder liner.

• Worn or Broken Compression Rings:

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

• Clogged Oil Control Ring:

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

• Dull Satin Finish and Fine Vertical Scratches on Rings:

Dirt and abrasive in air intake system.

• Stuck Rings:

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

• Cylinder Liner Wear and Distortion:

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

• Warped Cylinder Block:

Insufficient cooling.

• Broken Connecting Rod:

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

• Piston Pin and Snap Ring Failure:

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

• Mottled, Grayish or Pitted Compression Rings:

Internal coolant leaks.

CTM8,GR10,37 -19-17AUG94

REMOVE PISTONS AND CONNECTING RODS

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

CAUTION: DO NOT drain engine coolant until the temperature is below operating temperature.

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

NOTE: If engine is to be completely disassembled, follow 6466 ENGINE DISASSEMBLY SEQUENCE IN Group 04.

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

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

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

-UN-13DEC88
RG3657

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

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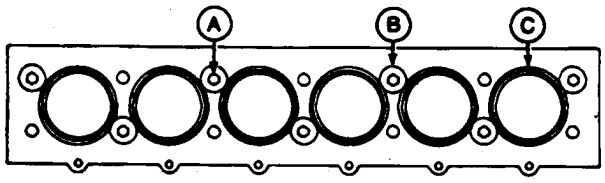
S11,2010,FDA -19-08AUG94

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

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

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



-UN-07DEC88
RG3819

S11,2010,EV -19-07AUG91

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

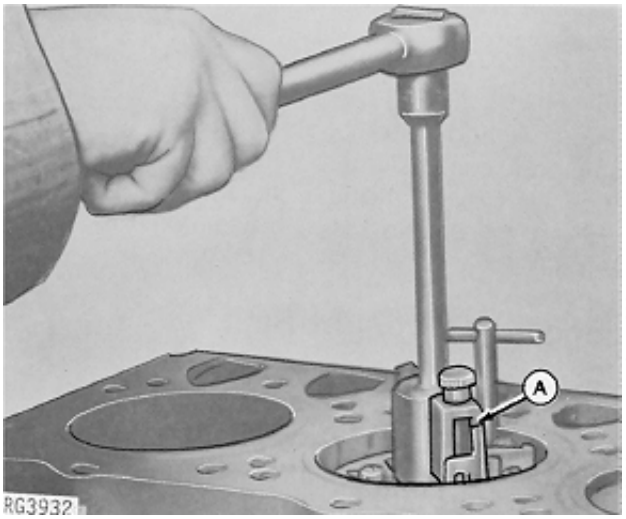
NOTE: Before removing pistons visually inspect condition of cylinder liners with pistons at bottom dead center "BDC". Liners will require replacement if:

—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, on either engine.

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



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S11,2010,FE -19-08MAR94

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

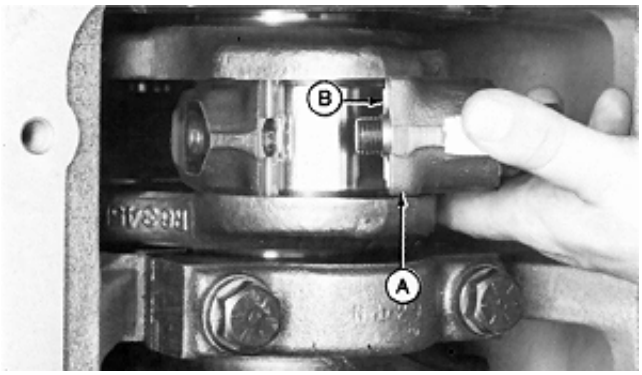
Rod bearing-to-journal oil clearance can be checked with PLASTIGAGE if rod is connected to crankshaft. If rod is out of engine, measure ID of assembled connecting rod bearings and compare with OD of crankshaft journal.

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

IMPORTANT: Using pneumatic wrenches may cause thread damage.

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

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



RG3820 -UN-07DEC88

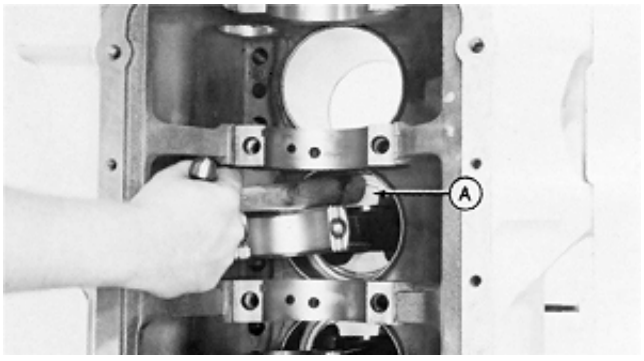
S11,0402,F -19-08AUG94

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

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

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

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



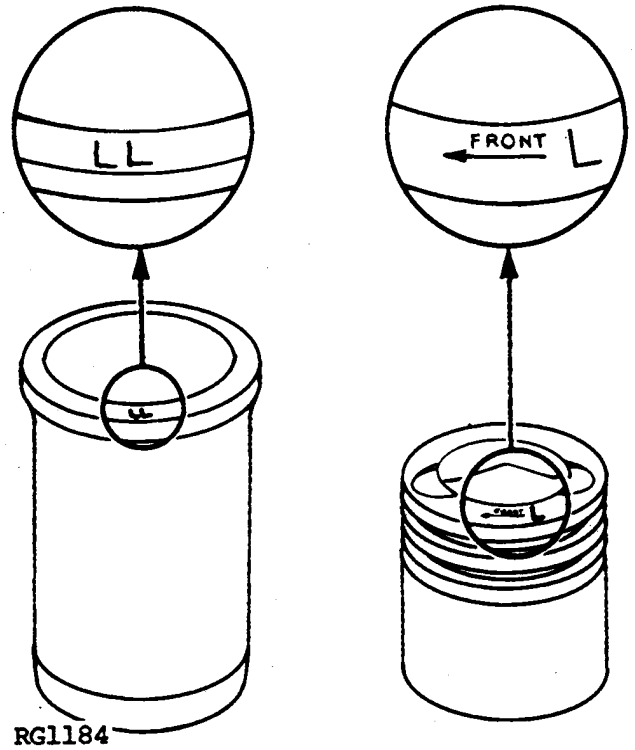
RG3821 -UN-07DEC88

S11,0402,G -19-08MAR94

Pistons stamped with an “L” are matched with liners stamped “LL” or “LC”. Pistons stamped with an “H” are matched with liners stamped “HH”. Unstamped pistons are matched with unstamped liners.

H and L designations refer to piston/liner clearance and not to piston or liner height.

NOTE: It is acceptable to mix unstamped, “H” and “L” piston/liner sets within the same engine as long as the piston-to-liner clearance is within specification for each cylinder.



-UN-20APR89 RG1184

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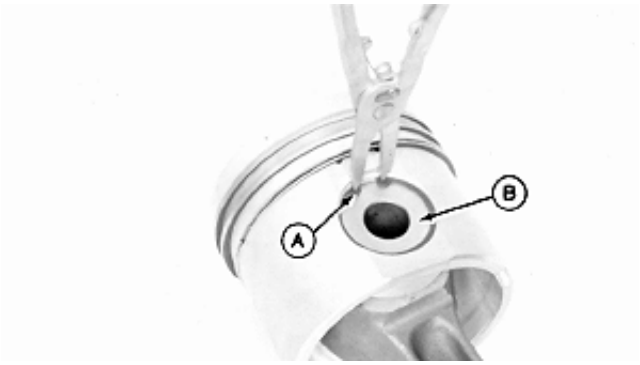
S11,2010,IT -19-08AUG94

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

NOTE: Discard snap rings; DO NOT reuse.



-UN-28JUL89 RG3171

S11,2010,DA1 -19-08MAR94

MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

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

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

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

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

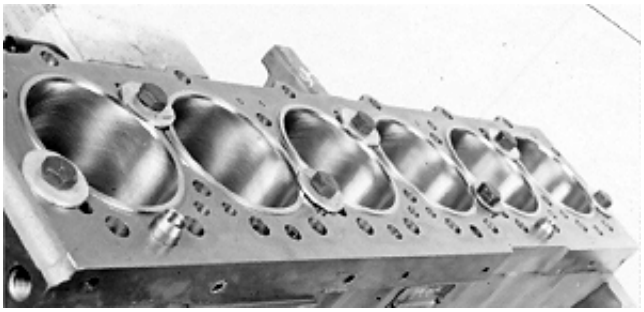
NOTE: Variations in measurement readings may occur within one cylinder and/or between adjacent cylinders.

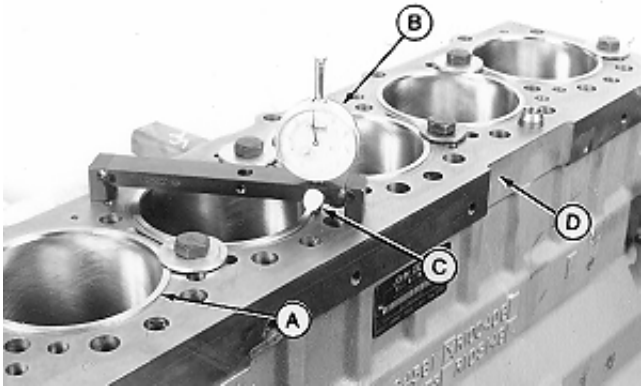
3. Measure each liner in four places, at approximately 1, 5, 7 and 11 O'clock positions as viewed from the rear of the engine (flywheel end). Record all measurements.

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

LINER HEIGHT SPECIFICATIONS

Liner Height Above Block	0.025—0.127 mm (0.001—0.005 in.)





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

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S11,2010,EW -19-08AUG94

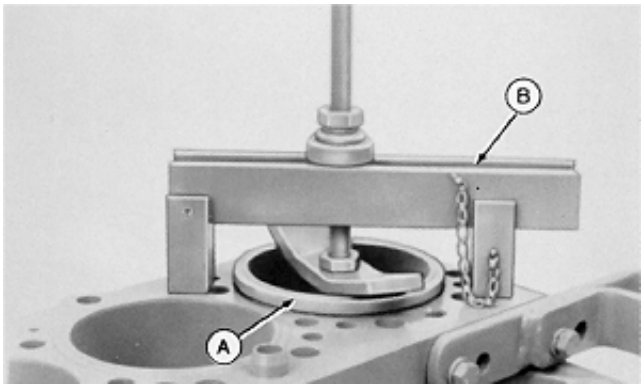
REMOVE CYLINDER LINERS

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

2. Number cylinder liners and pistons. Mark front to assure correct assembly.

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

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



S11,0402,AI -19-08MAR94

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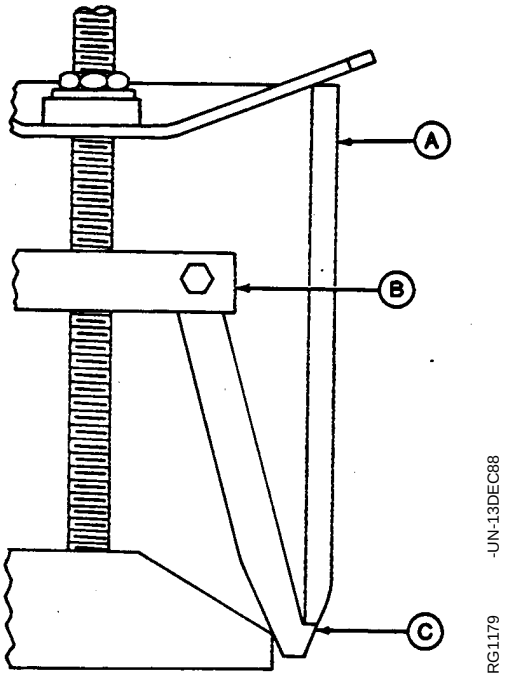
IMPORTANT: When using D01062AA (or D01073AA) Cylinder Liner Puller (B) to remove liners (A), be sure jaw (C) of puller is correctly positioned before attempting to remove liner.

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



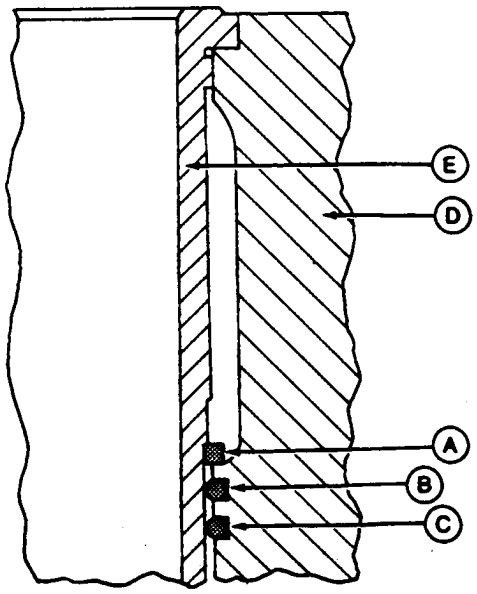
S11,0402,AK -19-02APR93

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

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

NOTE: Early applications used black O-rings (B, and C) only. Current production and service kits will have one black and one red O-ring.

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



RG3825 -UN-13DEC88

S11,0402,AL -19-08AUG94

COMPLETE DISASSEMBLY OF CYLINDER BLOCK (IF REQUIRED)

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If not previously removed, also remove:

1. Crankshaft pulley (Group 15).

2. Oil pressure regulating plug, valve, and spring (Group 20).

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

4. Front plate and lubrication system oil bypass valve (if equipped) (Group 20).

5. Crankshaft and main bearings (Group 15).

6. Piston cooling orifices.

7. Remove water gallery plugs.

8. If necessary to “Hot Tank” the block, also remove oil gallery plugs (or steel balls) and the engine serial number plate.

S11,2010,HZ -19-17FEB87

REMOVE PISTON RINGS

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

R26155 -UN-09FEB90

S11,2010,DC1 -19-08MAR94

CLEAN PISTONS

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

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

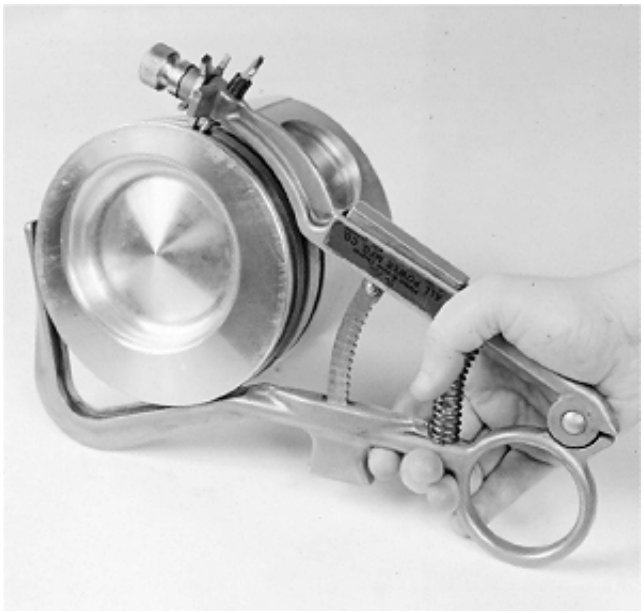
IMPORTANT: When washing pistons, always use a stiff bristle brush—NOT A WIRE BRUSH—to loosen carbon residue.

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 per cent 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.



RG6088 -UN-27JAN92

RG,CTM61,G10,8 -19-02APR93

CLEAN CYLINDER LINERS

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

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

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

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

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

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

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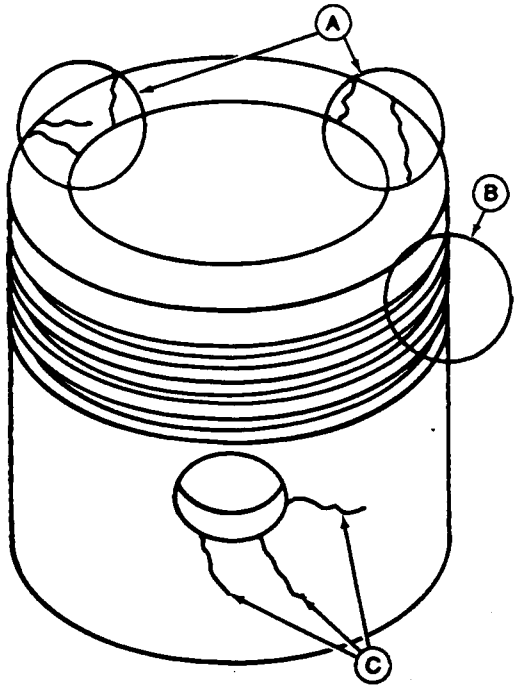
RG,CTM61,G10,9 -19-02APR93

VISUALLY INSPECT PISTONS

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

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

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



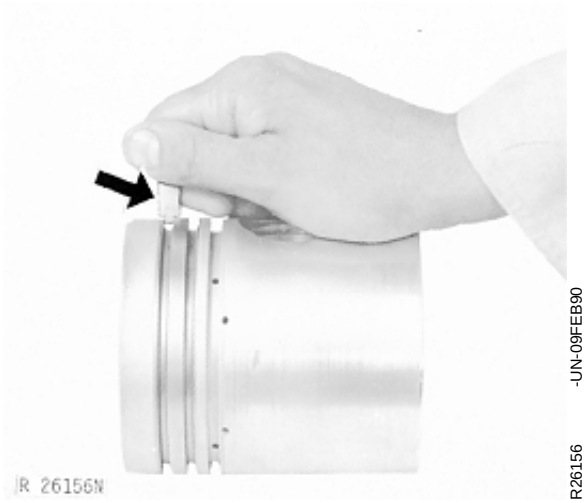
-UN-13DEC88
RG3326

(Defects Exaggerated)

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

CHECK PISTON RING GROOVE WEAR

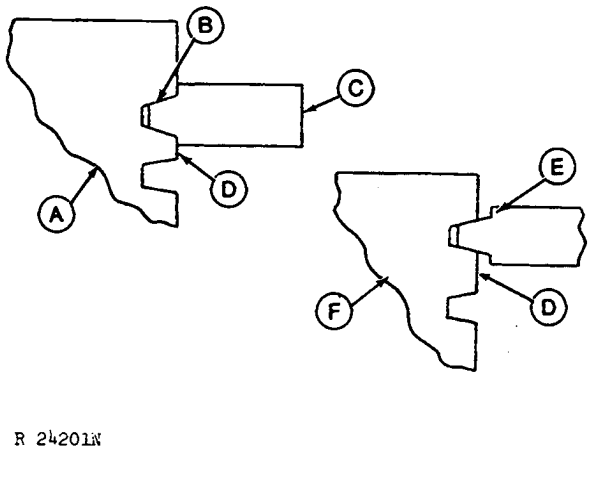
Use JDE55 Ring Groove Wear Gauge (arrow) to check wear of keystone ring grooves. Check each groove at several locations.



S11,2010,DF -19-08MAR94

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

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



S11,2010,DG -19-17FEB87

INSTALL PISTON PIN IN PISTON

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

1. Dip piston pin in clean engine oil.

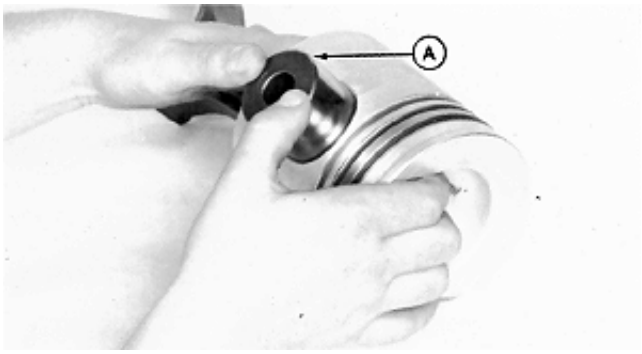
2. Install pin (A) through piston. Pin should pass through piston using only light thumb pressure.

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

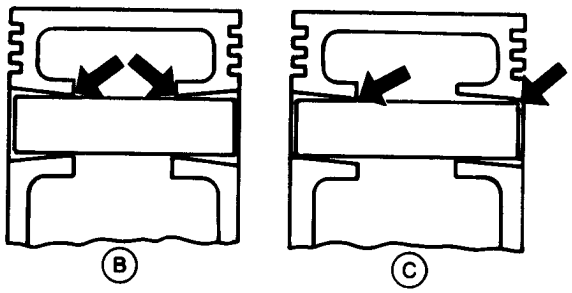
4. Check piston pin and piston bore specifications. If either are not within specification replace pin, piston, and liner.

PISTON PIN/BORE SPECIFICATIONS

Piston Pin OD:	
6466D	41.267—41.283 mm (1.6247—1.6253 in.)
6466T and 6466A	47.597—47.612 mm (1.8739—1.8745 in.)
ID of Piston Pin Bore in Piston:	
6466D	41.283—41.298 mm (1.6253—1.6259 in.)
6466T and 6466A	47.620—47.630 mm (1.8748—1.8752 in.)



RG3747 -UN-13DEC88



RG4984 -UN-26JUL94

A—Piston Pin
B—Tapered Pin Bore
C—Misaligned Pin Bore

S11,2010,FG -19-08AUG94

VISUALLY INSPECT CYLINDER LINERS

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

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

Replace piston and liner if:

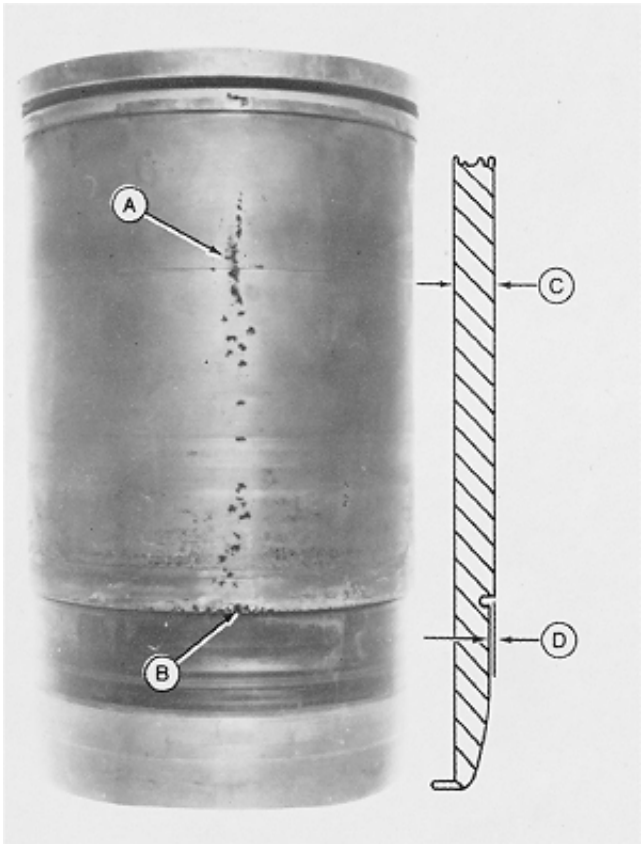
—Depth of any pit is one-half or more of liner thickness (C).

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

CYLINDER LINER SPECIFICATIONS

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

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



RG4643 -UN-13DEC88

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

S11,2010,DI -19-08AUG94

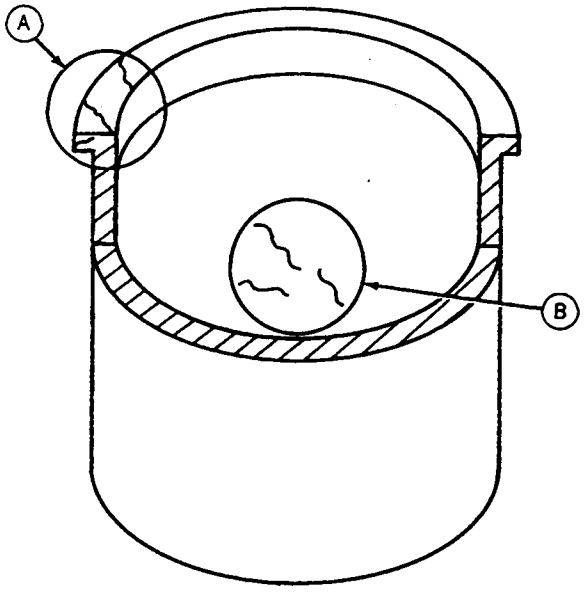
2. Visually examine liner ID. Replace piston and liner if:

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

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

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

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



RG1188 -UN-13DEC88

(Exaggerated defects)

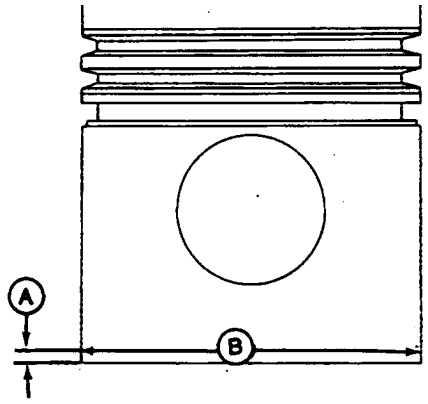
RG,CTM61,G10,14-19-22JUL94

MEASURE PISTON SKIRT OD

1. Measure piston skirt (B) at right angles to piston pin bore at 2 mm (0.09 in.) from bottom of piston (A). Record measurement.

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

Pistons and liners are selectively fitted to maintain specified piston-to-liner clearance. Some pistons are stamped with an “H” or “L” near the “FRONT” designation on top of the piston. “H” and “L” designations refer to piston/liner clearance matching, and not to piston height.



RG1204N -UN-20APR89

RG1204

PISTON SKIRT DIAMETER SPECIFICATIONS

Piston OD:	
Bottom of skirt [2 mm (0.09 in.)] from bottom of piston	
6466D	
Stamped “L”	115.766—115.783 mm (4.5577—4.5584 in.)
Stamped “H”	115.783—115.801 mm (4.5584—4.5591 in.)
Unstamped	115.766—115.783 mm (4.5577—4.5584 in.)
6466T and 6466A	
Stamped “L”	115.760—115.778 mm (4.5575—4.5582 in.)
Stamped “H”	115.778—115.796 mm (4.5582—4.5589 in.)
Unstamped	115.760—115.778 mm (4.5575—4.5582 in.)

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S11,2010,FH -19-08AUG94

DETERMINE PISTON-TO-LINER CLEARANCE

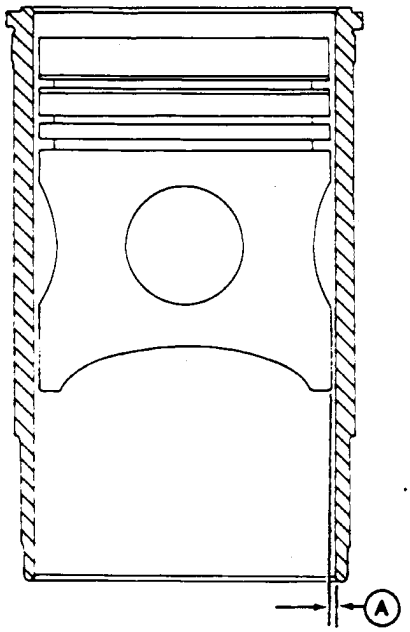
1. Place piston (without rings) in matched liner.

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

PISTON-TO-LINER CLEARANCE SPECIFICATIONS

Piston-to-Liner Clearance . . . . . 0.130—0.152 mm (0.0051—0.0060 in.)

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



RG3655 -UN-22NOV89

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S11,2010,DL -19-08AUG94

MEASURE OIL CONTROL RING GROOVE

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

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

OIL CONTROL RING-TO-GROOVE CLEARANCE SPECIFICATIONS

New Part Clearance . . . . . 0.061—0.102 mm (0.0024—0.0040 in.)

Maximum Serviceable Clearance . . . . . 0.165 mm (0.0065 in.)

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

R26157 -UN-09FEB90

S11,2010,CA -19-08AUG94

MEASURE CYLINDER LINERS

IMPORTANT: ALWAYS measure liners at room temperature.

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

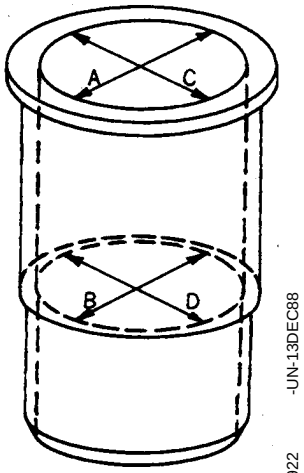
B—Measure bore in same position at bottom end of ring travel.

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

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

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

Compare liner ID with piston OD.



CYLINDER LINER SPECIFICATIONS

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

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

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S11,2010,JQ -19-16AUG94

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.

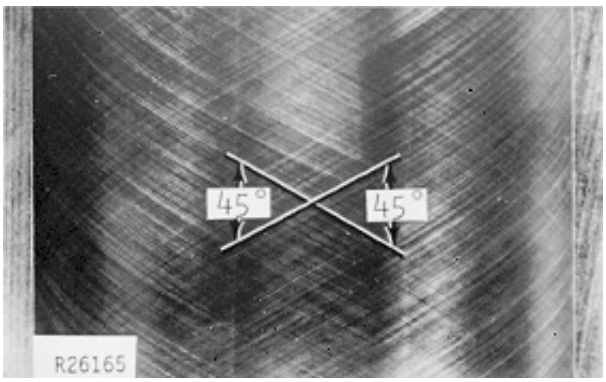
NOTE: Use honing oil along with flex hone when deglazing liners.

R26164 -UN-13DEC88

S11,0402,AS -19-29SEP94

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

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



R26165 -UN-13DEC88

S11,0402,AT -19-12APR93

INSPECT AND MEASURE CONNECTING ROD BEARINGS

Inspect rod bearings for damage or wear.

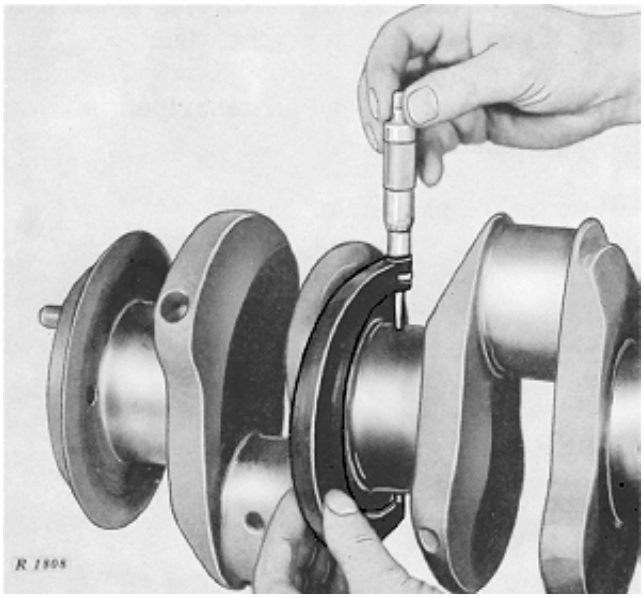
IMPORTANT: Never use new connecting rod cap screws when checking rod bearing I.D. Use new cap screws only for final assembly of connecting rods.

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

S11,0402,AA -19-08MAR94

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

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



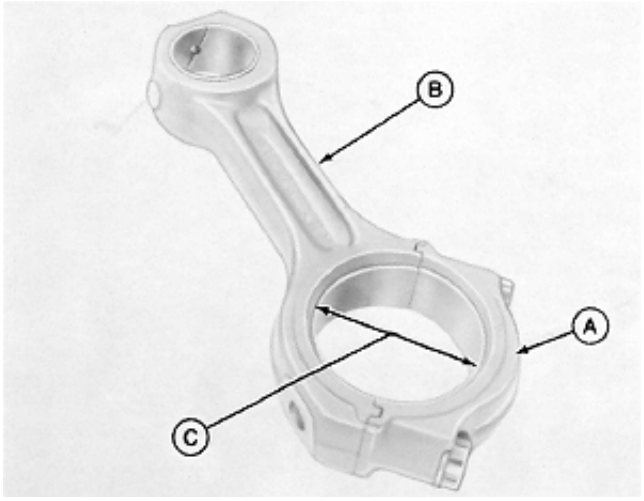
RG1808 -UN-14DEC88

S11,2010,CD -19-08MAR94

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

3. Tighten rod cap-to-rod cap screws. Refer to TORQUE-TURN CONNECTING ROD CAP SCREWS, later in this group.

NOTE: Connecting rods used on later engines do not have the cap screw hole machined all the way through as shown.



RG3823 -UN-13DEC88

S11,0402,AC -19-17AUG94

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

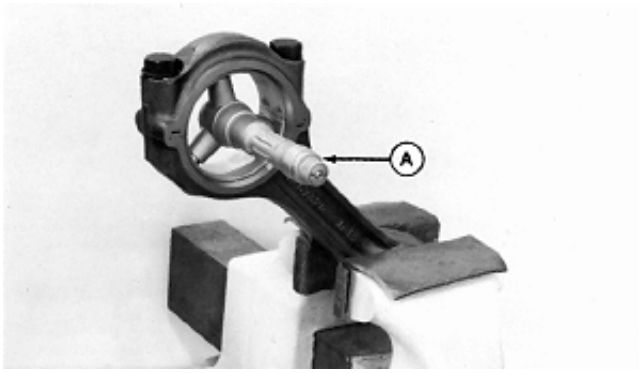
5. Subtract OD of crankshaft journals from ID of rod bearings to obtain oil clearance.

6. Compare measurements with the following specifications.

CONNECTING ROD BEARING AND JOURNAL SPECIFICATIONS

Crankshaft Journal OD	76.149—76.180 mm (2.9980—2.9992 in.)
Assembled Rod Bearing ID	76.210—76.261 mm (3.0004—3.0024 in.)
Oil Clearance (new parts)	0.025—0.102 mm (0.0012—0.0042 in.)
Maximum Serviceable Clearance	0.15 mm (0.0060 in.)

7. Inspect connecting rod bearings for wear or damage. If bearings are worn or are out of specification, replace both connecting rod bearings and rod cap bearing.



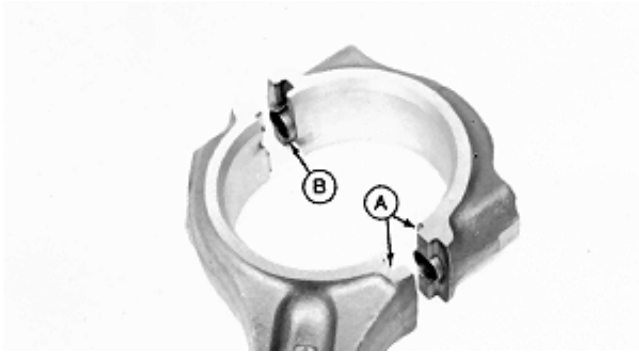
RG3824 -UN-13DEC88

S11,0402,AD -19-08AUG94

INSPECT CONNECTING ROD AND CAP

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

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



RG3749 -UN-13DEC88

S11,0402,AE -19-08MAR94

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

4. Install cap WITHOUT bearing inserts.

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

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

RG4982 -UN-13DEC88

S11,2010,JS -19-17AUG94

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

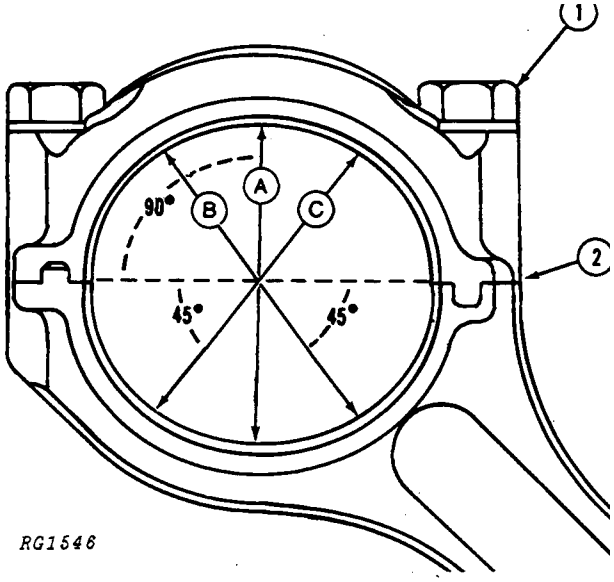
A. At right angle to rod/cap joint.
B. At 45 degrees left of measurement “A”.
C. At 45 degrees right of measurement “A”.

ROD BORE SPECIFICATIONS

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

7. Compare the measurements. If difference between the greatest and least measurement is more than 0.04 mm (0.0015 in.), the rod and cap are out of round. Replace both connecting rod and cap.

8. Remove blind hole cap screw (1). Using a feeler gauge, measure gap at rod/cap joint (2). If gap is greater than 0.25 mm (0.010 in.), the rod and cap are worn and must be replaced.



RG1546 -UN-20APR89

S11,0402,AG -19-08MAR94

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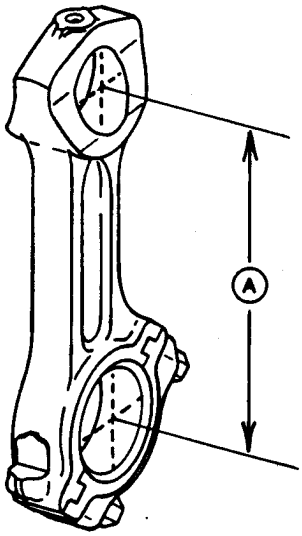
9. Measure rod's piston pin bore-to-crankshaft rod journal bore center-to-center dimension (A) and compare with specification given. If measurement is not within specification, replace rod.

CENTERLINE OF PISTON PIN BORE-TO-CRANKSHAFT BORE

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



RG6455 -UN-22OCT92

RG,CTM1,G10,4 -19-08AUG94

INSPECT PISTON PINS AND BUSHINGS

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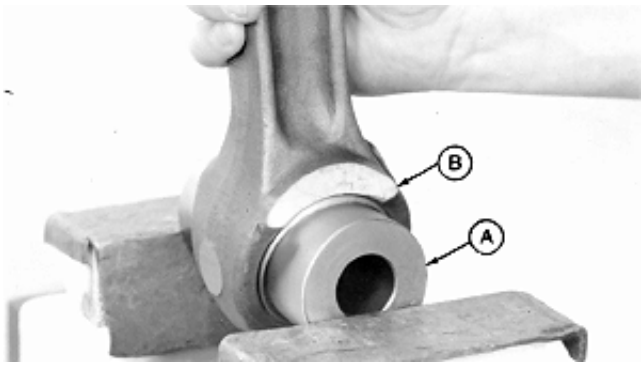
1. Insert piston pin (A) through piston pin bushing and carefully clamp in a soft-jawed vise.

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

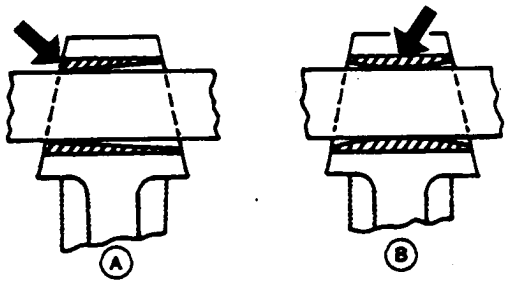
3. Remove piston pin from vise and connecting rod.



RG3172 -UN-13DEC88

S11,2010,DM -19-08MAR94

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



RG4983 -UN-13DEC88

A—Tapered Rod Pin Bushing
B—Bellmouthed Rod Pin Bushing

PISTON PIN BORE SPECIFICATIONS

OD of Piston Pin:	
6466D	41.267—41.283 mm (1.6247—1.6253 in.)
6466T and 6466A	47.597—47.612 mm (1.8739—1.8745 in.)
ID of Pin Bore in Piston:	
6466D	41.283—41.298 mm (1.6253—1.6259 in.)
6466T and 6466A	47.620—47.630 mm (1.8748—1.8752 in.)
ID of Installed Rod Pin Bushing (After Boring):	
6466D	41.300—41.326 mm (1.6260—1.6270 in.)
6466T and 6466A Engine Serial No. (—227649)	47.630—47.665 mm (1.8752—1.8762 in.)
6466T and 6466A Engine Serial No. (227650—)	47.665—47.680 mm (1.8762—1.8772 in.)
Pin-to-Bushing Oil Clearance:	
Engine Serial No. (—227649)	0.018—0.058 mm (0.0007—0.0023 in.)
Maximum Serviceable	0.076 mm (0.003 in.)
Engine Serial No. (227650—)	0.042—0.084 mm (0.0017—0.0033 in.)
Maximum Serviceable	0.10 mm (0.0004 in.)
ID of Installed Service Rod Pin Bushing (Before Boring):	
6466D	41.237—41.262 mm (1.6235—1.6245 in.)
6466T and 6466A Engine Serial No. (—227649)	47.554—47.605 mm (1.8722—1.8742 in.)
6466T and 6466A Engine Serial No. (227650—)	47.579—47.628 mm (1.8732—1.8751 in.)

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S11,2010,FI -19-17AUG94

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

6. Compare pin bushing ID (B) with pin for specified clearance with pin OD.

NOTE: A 21˚ taper connecting rod and bushing was first used on some 6466T and 6466A applications at Engine Serial No. (227650-). All 6466T and 6466A engines prior to Engine Serial No. (—227649) have 6˚ taper rod and bushing.

PISTON PIN BORE SPECIFICATIONS

Piston Pin Bore Diameter	
Without Bushing	52.354—52.380 mm (2.0612—2.0622 in.)

S11,0402,W -19-08AUG94

REMOVE PISTON PIN BUSHINGS—6466D ENGINES

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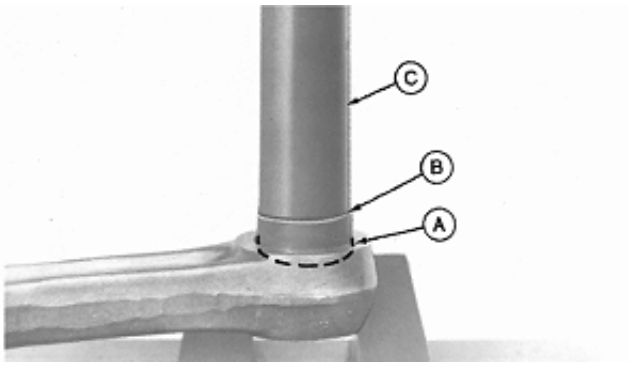
IMPORTANT: Do not use any power tools to remove or install piston pin bushing.

1. If necessary, on 6466D Engines, press out piston pin bushing using No. 27508 Disk (A), No. 27511 Disk (B), and No. 27488 Handle (C). Clean rod thoroughly after removal.

NOTE: Tools are from the No. D01044AA Driver Set.



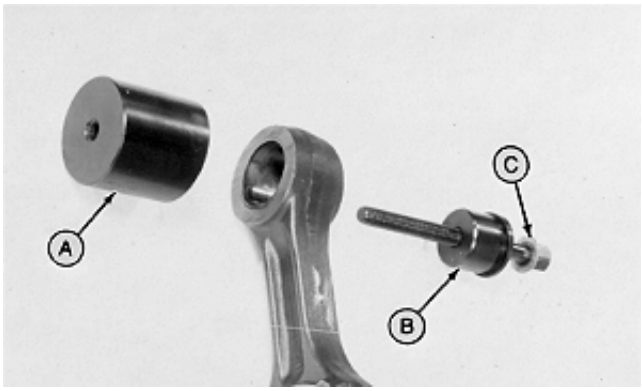
S11,2010,BV -19-08AUG94

REMOVE 6° TAPER BUSHING—6466T AND 6466A ENGINES

1. If necessary, remove 6° taper bushings with JDE98A Connecting Rod Bushing Service Set.

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

A—JDE98-1 Cup
B—JDE98-4 Driver
C—STD36104 Forcing Screw With Washer



RG4925 -UN-19JAN90

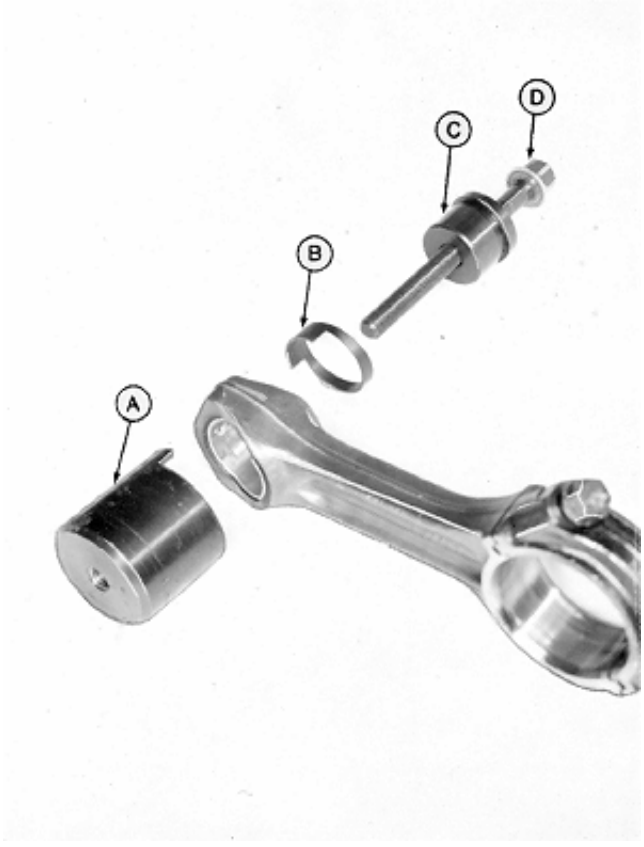
S11,2010,IA -19-08AUG94

REMOVE 21° TAPER BUSHING—6466T AND 6466A ENGINES

1. If necessary, remove 21° taper bushings with JDG337 Service Set.

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

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



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S11,2010,IB -19-08AUG94

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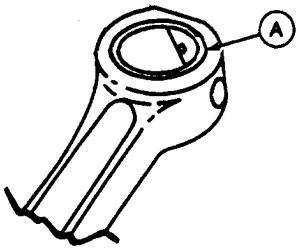
CLEAN AND INSPECT PISTON PIN BUSHING BORE IN CONNECTING ROD



RG4724 -UN-06APR89

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

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

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

CONNECTING ROD PIN BUSHING SPECIFICATIONS

Piston Pin Bore Diameter
Without Bushing . . . . . 52.354—52.380 mm (2.0612—2.0622 in.)

Piston Pin Bore-to-Bushing
Press Fit Specification:
6466D . . . . . 0.038—0.089 mm (0.0015—0.0035 in.)
6466T and 6466A
6° taper . . . . . 0.084—0.135 mm (0.0033—0.0053 in.)
21° taper . . . . . 0.084—0.147 mm (0.0033—0.0058 in.)

ID of Installed Service Rod
Pin Bushing Before Boring:
6466D . . . . . 41.237—41.262 mm (1.6235—1.6245 in.)
6466T and 6466A
Engine Serial No. (—227649) . . . . . 47.554—47.605 mm (1.8722—1.8742 in.)
6466T and 6466A
Engine Serial No. (227650—) . . . . . 47.579—47.628 mm (1.8732—1.8751 in.)

ID of Installed Service Rod
Pin Bushing After Boring:
6466D . . . . . 41.300—41.326 mm (1.6260—1.6270 in.)
6466T and 6466A
Engine Serial No. (—227649) . . . . . 47.630—47.665 mm (1.8752—1.8762 in.)
6466T and 6466A
Engine Serial No. (227650—) . . . . . 47.665—47.680 mm (1.8762—1.8772 in.)

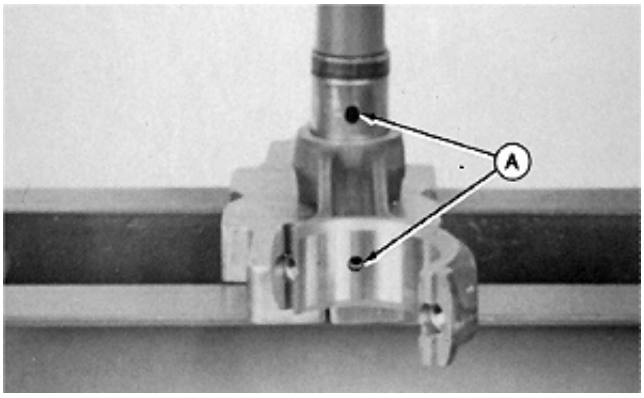
IMPORTANT: If bushing bore diameter is outside of specification or bushing has spun in rod, discard rod and replace with a new one.

S11,2510,AD -19-17AUG94

INSTALL PISTON PIN BUSHING—6466D ENGINES

1. Lubricate connecting rod bore with clean engine oil.

IMPORTANT: On 6466D Engines make sure oil gallery holes (A) in pin bushing and connecting rod are aligned when installing piston pin bushing.



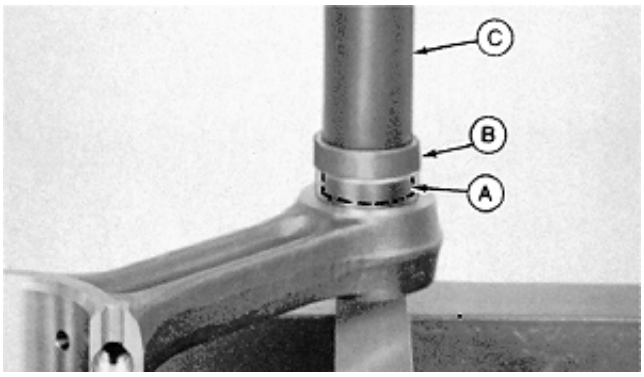
R31123 -UN-12FEB90

S11,2010,BX -19-08MAR94

2. On 6466D Engines, use No. 27508 Disk (A), No. 27513 Disk (B), and No. 27488 Handle (C) to press bushing into connecting rod. Lubricate OD of bushing.

Bore new bushing to 41.30—41.33 mm (1.6260—1.6270 in.)

3. Remove all debris after boring.



R31124 -UN-12FEB90

S11,2010,BY -19-17AUG94

INSTALL 6° TAPER PISTON PIN BUSHING—6466T AND 6466A ENGINES

IMPORTANT: Push bushings in from back side of connecting rod. Burnish bushings after installation.

For installation of 6° taper bushings, use the JDE98A Rod Bushing Service Set.

IMPORTANT: Be sure lubrication holes in bushing and rod are aligned.

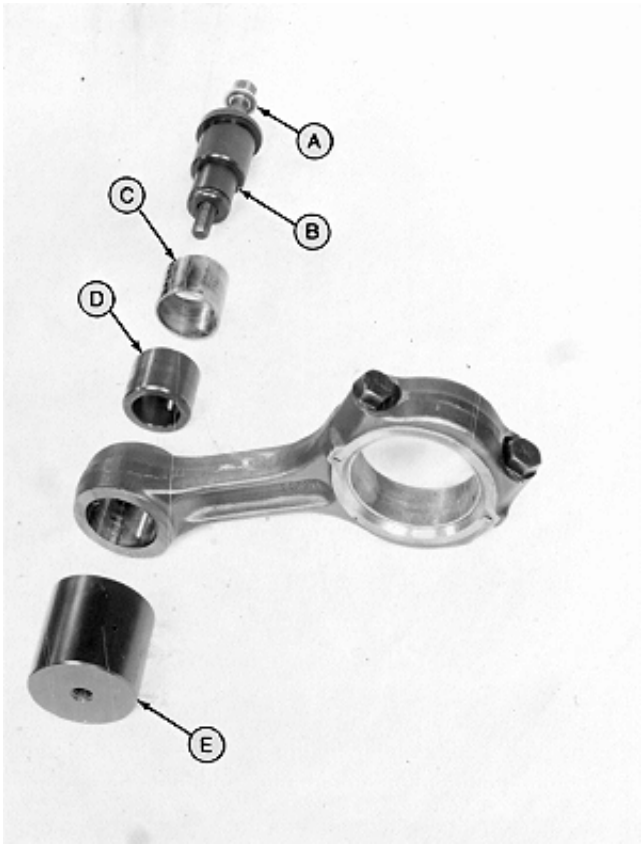
Bore a newly installed bushing to specifications given below. Remove all residue from boring operation.

PISTON PIN BUSHING SPECIFICATIONS

ID of Installed Rod Pin Bushing (Bored):
Engine Serial No. (—227649) . . . . . 47.630—47.665 (1.8752—1.8762 in.)

Engine Serial No. (227650—) . . . . . 47.665—47.680 mm (1.8762—1.8772 in.)

A—STD36104 Forcing Screw With Washer
B—JDE98-2 Driver
C—6° Bushing
D—JDE98-3 Pilot
E—JDE98-1 Cup



RG4926 -UN-19JAN90

S11,2010,ID -19-05AUG94

INSTALL 21° TAPER PISTON PIN BUSHING—6466T AND 6466A ENGINES

IMPORTANT: Push bushings in from back side of connecting rod. Burnish bushings after installation.

Lubricate connecting rod bore with clean engine oil and install 21° taper bushings using JDG337 Connecting Rod Bushing Service Tool Set and JDE98A Rod Bushing Service Set.

IMPORTANT: Be sure lubrication holes in bushing and rod are aligned.

Bore a newly installed bushing to specifications given below. Remove all residue from boring operation.

PISTON PIN BUSHING SPECIFICATIONS

ID of Installed Rod Pin Bushing (Bored):

Engine Serial No. (—227649) . . . . . 47.630—47.665 mm (1.8752—1.8762 in.)

Engine Serial No. (227650—) . . . . . 47.665—47.680 mm (1.8762—1.8772 in.)

RG4986 -UN-13DEC88

A—STD36104 Forcing Screw With Washer
B—JDE98-2 Driver
C—JDG338 Adapter
D—21° Bushing
E—JDE98-3 Pilot
F—JDG339 Cup

S11,2010,IC -19-05AUG94

COMPLETE DISASSEMBLY OF CYLINDER BLOCK (IF REQUIRED)

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

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

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

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

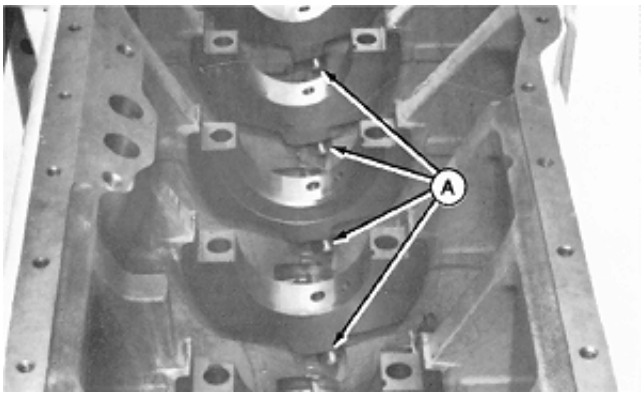
4. Remove timing gear train and camshaft. (Group 16)

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

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

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

REMOVE AND CLEAN PISTON COOLING ORIFICES



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

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

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

3. Install orifices and tighten to 11 N·m (97 lb-in.).

S11,2015,CN -19-07JUL94

INSPECT AND CLEAN CYLINDER BLOCK

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

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

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

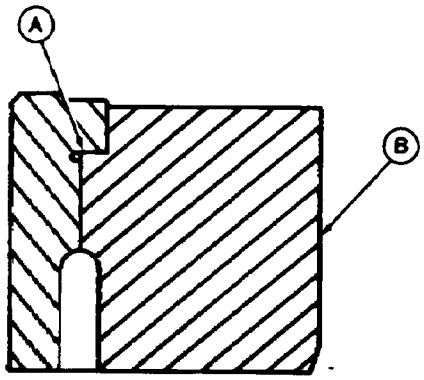
2. Make sure all passages and crevices are cleared of sludge, and grease.

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

S11,2010,EX -19-08MAR94

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

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



RG3329 -UN-13DEC88

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

COUNTERBORE DEPTH AND LINER FLANGE SPECIFICATIONS

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

6. When determined that the cylinder block is serviceable, clean out threads for cylinder head cap screws in top deck of cylinder block. Use JDG681 or an equivalent 9/16-12 UNC-2A tap (C) approximately 88.9 mm (3.5 in.) long. Use compressed air to remove any debris or fluid which may be present in the cap screw hole. Also remove any sealant from cylinder head-to-cylinder block dowel pins and dowel pin holes.

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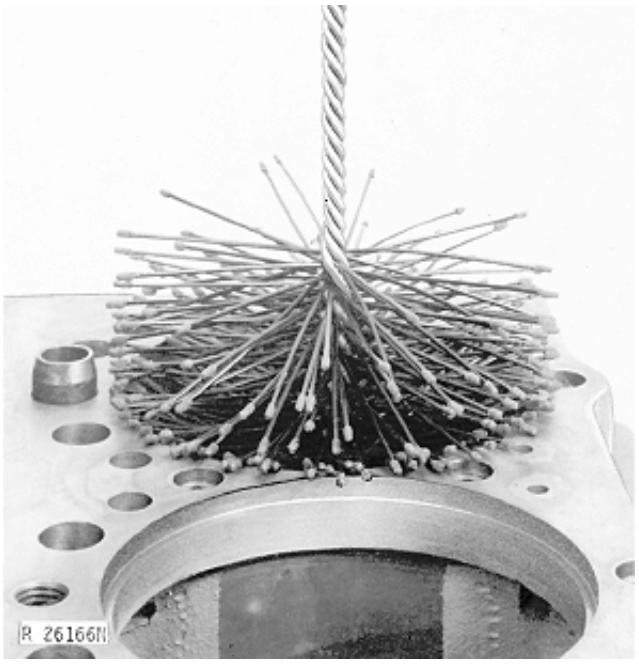
S11,2010,EY -19-08MAR94

CLEAN CYLINDER LINER O-RING BORES IN BLOCK

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

NOTE: Use brush exactly as directed by the manufacturer.



-UN-13DEC88
R26166

S11,0402,AY -19-08AUG94

MEASURE CYLINDER BLOCK

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

CYLINDER BLOCK SPECIFICATIONS

ID of Main Bearing Bore Without Bearings	92.125—92.151 mm (3.6270—3.6280 in.)
Width of Cylinder Block Main Thrust Bearing Cap	37.44—37.54 mm (1.474—1.478 in.)

S11,2010,IF -19-08MAR94

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

If any one camshaft bore is not within specifications, install a new cylinder block.

CAMSHAFT FOLLOWER SPECIFICATIONS

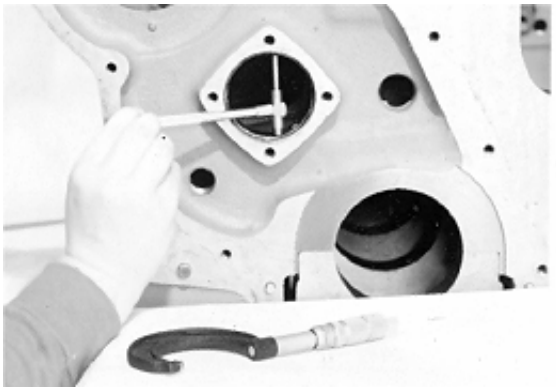
Camshaft Follower Bore ID	17.384—17.440 mm (0.6845—0.6865 in.)
Camshaft Follower OD (New)	17.33—17.35 mm (0.682—0.683 in.)
Maximum Camshaft Follower-to-Bore Clearance	0.114 mm (0.0045 in.)

S11,2010,IG -19-08AUG94

3. Measure camshaft bore diameter. If diameter is more than specified, install a new cylinder block.

CAMSHAFT BUSHING AND BORE SPECIFICATIONS

New Camshaft Bore Diameter Without Bushing	63.487—63.513 mm (2.4995—2.5005 in.)
Maximum Runout of Camshaft Bore Diameter	0.038 mm (0.0015 in.)
New Camshaft Bore Diameter With Bushing	60.389—60.439 mm (2.3775—2.3795 in.)
New Camshaft Bushing-to-Journal Clearance	0.05—0.13 mm (0.002—0.005 in.)
Maximum Camshaft Bushing-to-Journal Clearance	0.15 mm (0.006 in.)



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RG4991

S11,2010,IH -19-08AUG94

4. Measure cylinder block top deck flatness using D05012ST Precision Straightedge. Compare measurements to specifications below. If flatness is not as specified, resurface cylinder block.

CYLINDER BLOCK SPECIFICATIONS

Maximum Top Deck Out-of-Flat
(Entire Length or Width
of Cylinder Block) . . . . . 0.010 mm (0.004 in.)

Cylinder Block Top Deck
Straightness per any 305 mm
(12 in.) Length . . . . . 0.025 mm (0.001 in.)

IMPORTANT: The centerline of the main bearing bore-to-top deck of cylinder block MUST be 352.35—352.50 mm (13.872—13.878 in.). See Group 15, MEASURED ASSEMBLED ID OF MAIN BEARING CAPS.

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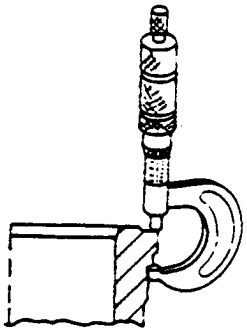
S11,2010,II -19-08AUG94

MEASURE CYLINDER LINER FLANGE THICKNESS

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

LINER FLANGE SPECIFICATIONS

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



RG4727 -UN-13DEC88

S11,2510,AV -19-16AUG94

INSTALL LINER SHIMS—IF REQUIRED

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

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

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

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

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

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

If standout is within specification, proceed to next step.

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

RECHECK CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

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

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

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

RG,CTM1,G10,5 -19-08AUG94

INSTALL CYLINDER LINER O-RINGS AND PACKINGS

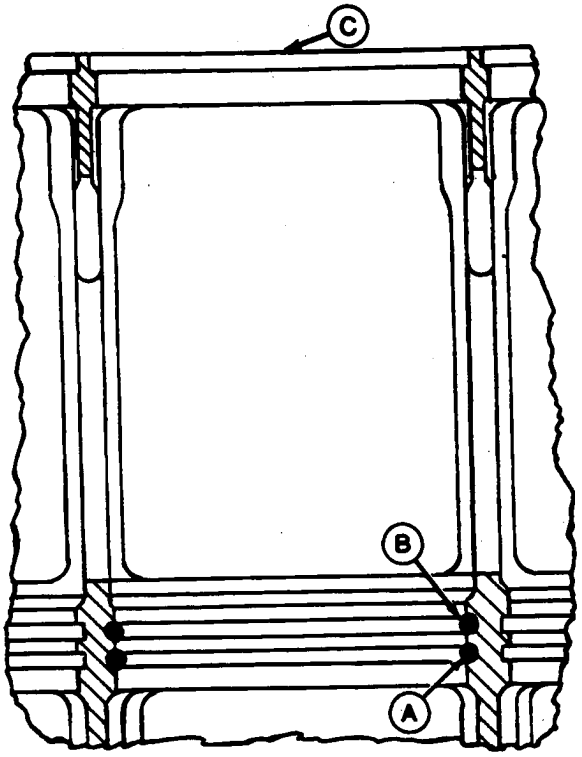
IMPORTANT: DO NOT use oil on cylinder liner packing or O-rings. Oil can cause the red packing to swell, which squeezes liner and could possibly cause a scored piston.

1. Pour AR54749 Soap Lubricant into a suitable container.

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

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

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



RG3826 -UN-13DEC88

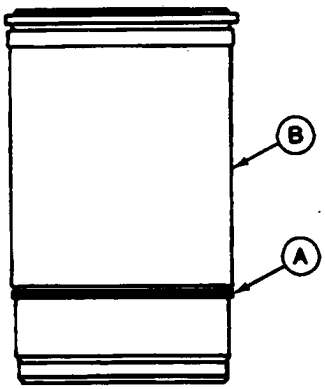
S11,0402,BA -19-16AUG94

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

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

NOTE: Make sure the square packing is not twisted.

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



RG3827 -UN-13DEC88

S11,2010,JT -19-29OCT92

CYLINDER LINER MANUFACTURING DATE CODE EXPLANATION

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

HL90

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

Liner Material Specification

H . . . . . Hardened Bore

Month Liner was Manufactured

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

Year Liner Was Manufactured

90 1990
91 1991
etc.

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

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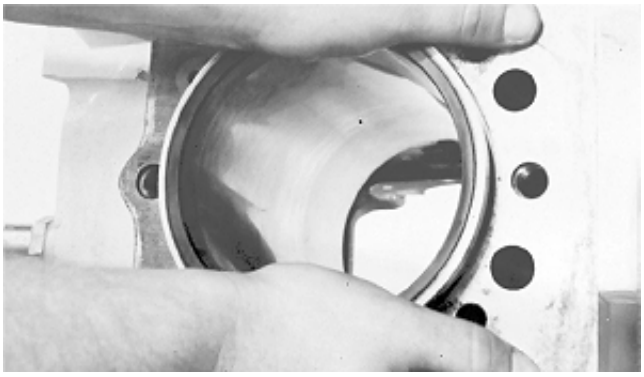
RG,CTM42,G10,11-19-08MAR94

INSTALL CYLINDER LINERS


RG2772 -UN-23FEB89

1. Carefully place the cylinder liner, with packing installed, into same cylinder block bore from which it was removed.

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.

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

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

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

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

S11,0402,BC -19-08MAR94

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

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

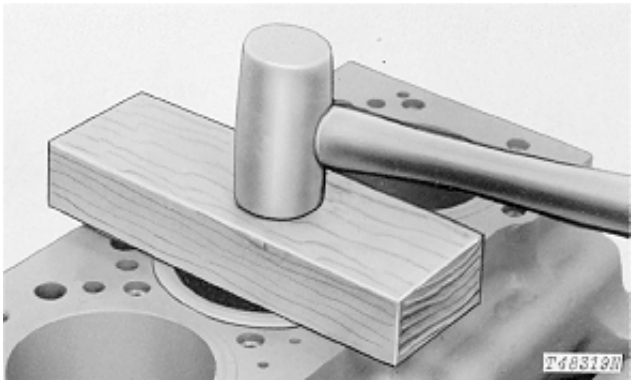
NOTE: Cylinder liner will protrude over top of cylinder block more than normal due to uncompressed packings and O-rings.

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

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

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

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



T48319 -UN-23FEB89

S11,0402,BD -19-08MAR94

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INSTALL PISTONS AND CONNECTING RODS

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

IMPORTANT: If a new piston and liner assembly is to be installed, DO NOT remove piston from liner. Push piston out of liner bottom only far enough to install piston pin.

Engine must have either all 6° piston and rod assemblies or all 21° piston and rod assemblies. Do not intermix.

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

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

2. Install expander ring in bottom ring groove.

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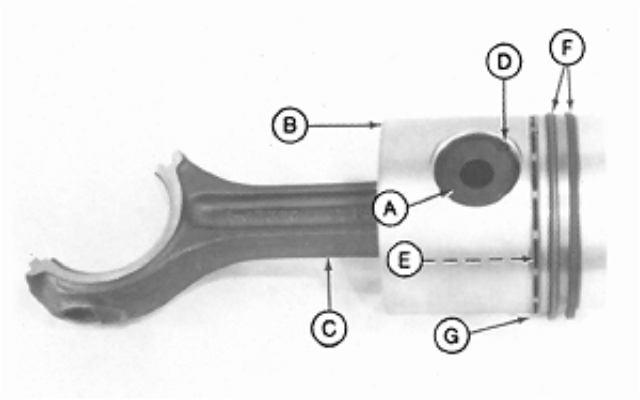
NOTE: "Pip" marks on No. 1 and No. 2 compression rings must face top of piston.

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

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

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



RG3828 -UN-25SEP89

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

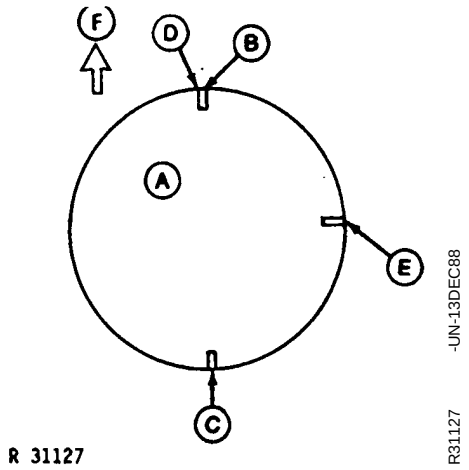
S11,2010,IJ -19-08MAR94

6. Stagger ring gap on pistons as shown.

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

7. Coat pistons, liners and inside of JDE96 Ring Compressor with clean engine oil.

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



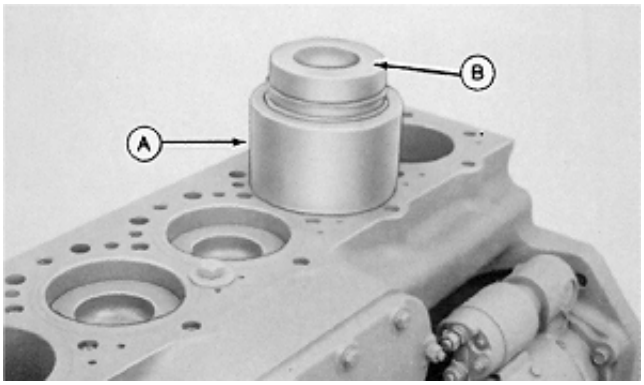
S11,0402,BG -19-08MAR94

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

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

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

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

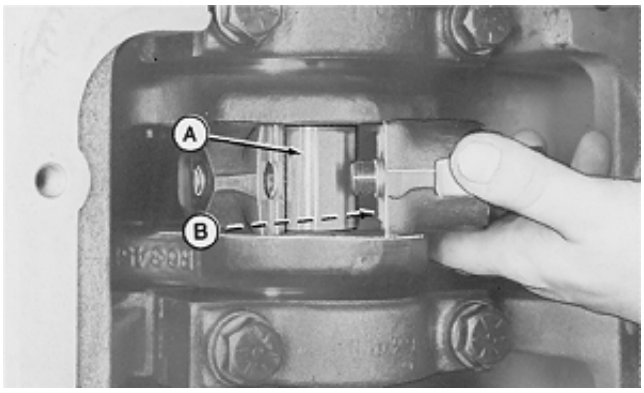


S11,0402,BH -19-08AUG94

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

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

11. Install connecting rod caps.



S11,0402,BI -19-08MAR94

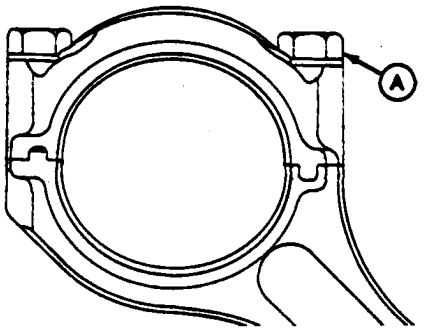
12. Dip new cap screws and washers in clean engine oil. Make sure top of cap screws have oil on them also.

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

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

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

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



RG4375 -UN-13DEC88

S11,0402,BI1 -19-05AUG94

TORQUE-TURN CONNECTING ROD CAP SCREWS

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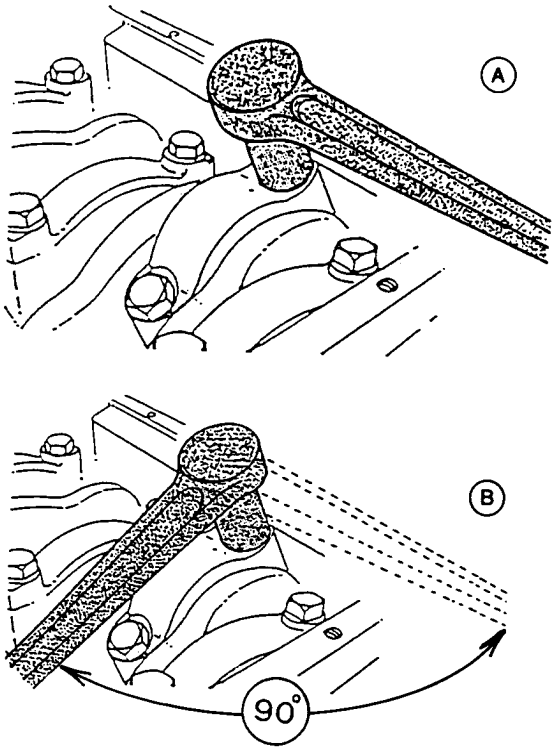
• Using engine axis method to TORQUE-TURN connecting rod cap screws:

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

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

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

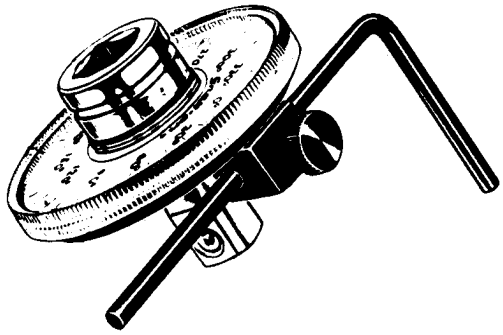


RG7047 -UN-28JUL94

RG,CTM86,G10,41-19-14SEP94

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

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



RG5698 -UN-27AUG90

JT05993 Torque Angle Gauge

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

CHECK ENGINE ROTATION FOR EXCESSIVE TIGHTNESS

1. Rotate crankshaft several revolutions to be sure engine rotates without excessive tightness.

2. Check liners for deep scratches caused by an improperly installed or broken piston ring.

3. Check side clearance of rods. Must have slight side-to-side movement.

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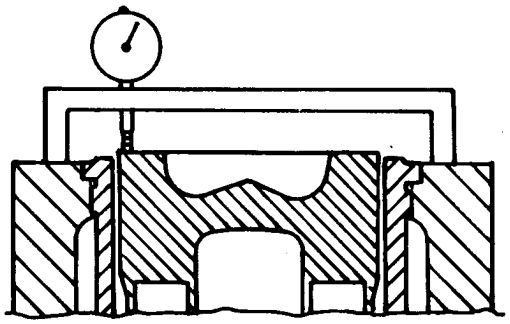
S11,0402,BK -19-08MAR94

MEASURE PISTON PROTRUSION



RG6440 -UN-22SEP92

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

2. Use JDG451 Gauge along with D17526CI (English scale) or D17527CI (Metric scale) Dial Indicator or KJD10123 Gauge to measure piston protrusion. Place gauge on top of cylinder block so dial indicator can be set to “zero” with top of block.

3. Measure piston height at several locations around three pistons. Position gauge across piston. While pressing gauge downward, rotate crankshaft until piston is at “TDC”. Install timing pin in flywheel.

4. Rotate engine one full revolution until timing pin enters flywheel again. Measure piston height at several locations on three remaining pistons and compare with specifications.

NOTE: If using JDG451 Gauge, piston height must be checked at outer most diameter of piston.

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5. Piston protrusion must be within the following specification to prevent piston-to-exhaust valve contact.

PISTON PROTRUSION SPECIFICATION

Maximum Piston Protrusion
Above Block Deck . . . . . 0.051—0.787 mm (0.002—0.031 in.)

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

RG,CTM1,G10,3 -19-08AUG94

COMPLETE FINAL ASSEMBLY

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

1. Install camshaft, valve train, timing gear cover, and tachometer drive assembly, if equipped.

2. Install the oiling system components.

3. Install the cylinder head with new head gasket.

4. Install fuel injection system components.

5. Install the water pump and water piping.

6. Install crankshaft pulley.

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

8. Install the exhaust manifold and intake assembly.

9. Install the starting motor.

10. Fill engine with clean oil and proper coolant.

11. Perform engine break-in. See Group 105.

S11,2010,FL -19-08MAR94

SPECIAL OR ESSENTIAL TOOLS

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

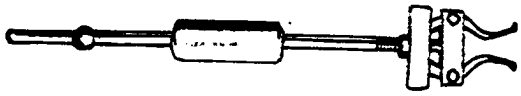
DX,TOOLS -19-05JUN91

RG5081 -UN-15DEC88

Internal Puller D01209AA

Used to remove clutch shaft pilot bushing.

NOTE: Tools from D01061AA Blind Hole Puller Set may also be used.



S11,2515,BH -19-08MAR94

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

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

RG6246 -UN-27MAR92

RG,D17526CI -19-29OCT92

RG5080 -UN-23AUG88

Front Wear Sleeve Installer JDE3

Install front oil seal in timing gear cover.

S53,JDE3A -19-16AUG94

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

Rotate engine flywheel. Use with JDE81-4 Timing Pin.

S53,JDE811B -19-08AUG94

RG5068 -UN-23AUG88

Timing Pin JDE81-4

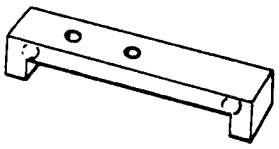
Lock engine at TDC when timing valve train.

S53,JDE814A -19-08AUG94

Piston and Liner Height Gauge JDG451

Measure piston and liner heights.

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



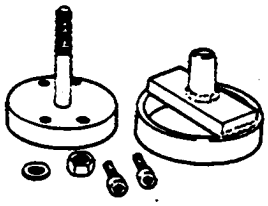
RG7029 -UN-30SEP94

RG,JDG451 -19-28SEP94

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

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

Consists of:
JDG477(85) Pilot
JDG478 Driver



RG5106 -UN-23AUG88

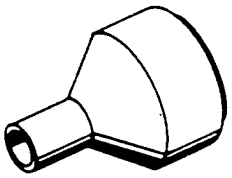
S11,2515,BW -19-03MAY93

15
2

Seal Puller Adapter JDG719

Used with a standard metal screw, JDE38-2 Shank, and JDE38-3 Slide Handle to remove front crankshaft oil seal with timing gear cover installed. Also used to remove rear crankshaft oil seal with seal housing installed.

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



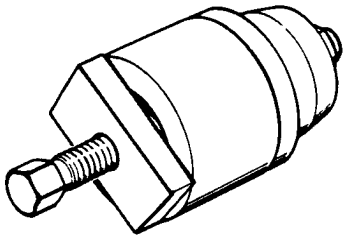
RG6214 -UN-06MAR92

RG,JDG719 -19-29OCT92

Seal Installer JDG720

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

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

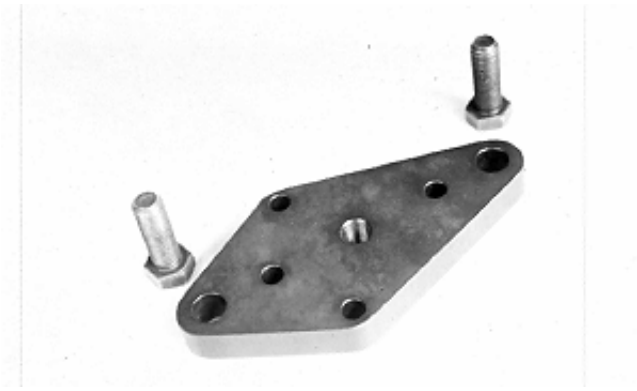


RG6215 -UN-06MAR92

RG,JDG720 -19-01APR93

Hub Puller Kit JDG721

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

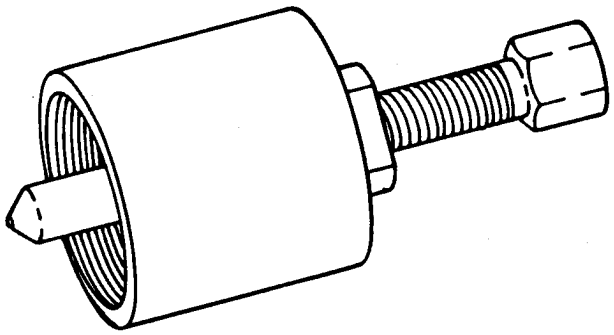


RG5763 -UN-06AUG91

RG,JDG721 -19-03MAY93

Front Wear Sleeve Puller JDG786

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



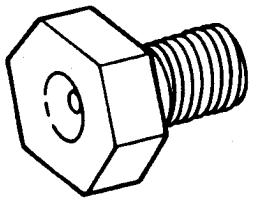
RG6428 -UN-13OCT92

RG,JDG786 -19-29OCT92

15
3

Thread Protector JDG787

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



RG6429 -UN-13OCT92

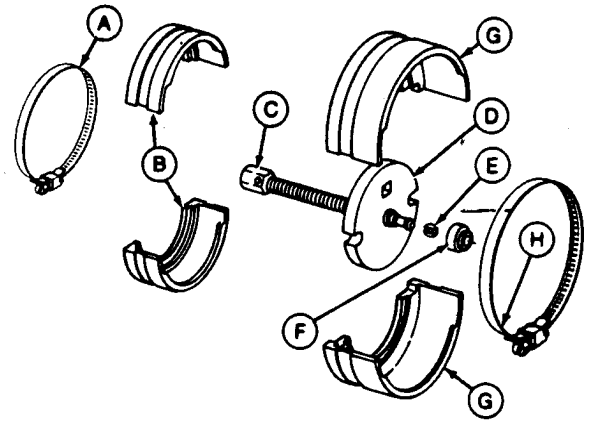
RG,JDG787 -19-03FEB93

Rear Wear Sleeve Puller Kit JDG790

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

Set consists of:

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



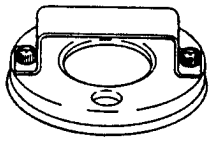
RG6457 -UN-22OCT92

RG,JDG790 -19-03OCT94

RG6590 -UN-18FEB93

Oil Seal Housing Alignment Tool JDG796

Use with oil seal housing casting numbers R115050 and R125027.

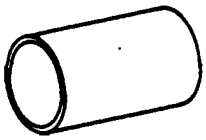


RG,JDG796 -19-08AUG94

RG5108 -UN-23AUG88

Gear Driver JDH7

Install crankshaft drive gear.



S53,JDH7 -19-04AUG94

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
D01048AA 17-1/2-Ton Puller Set	Remove damper pulley and crankshaft gear.
D01045AA Bushing, Bearing and Seal Driver Set	Install front oil seal and clutch shaft pilot bushing.

RG,CTM1,G15,2 -19-08AUG94

OTHER MATERIAL

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

S55,2515,B -19-08AUG94

CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Crankshaft Fillet Radius:		
Pin Journal	3.94—4.44 mm (0.155—0.175 in.)	---
Thrust Journal	3.56—4.06 mm (0.140—0.160 in.)	---
Main Journal	3.94—4.44 mm (0.155—0.175 in.)	---
Crankshaft End Play	0.038—0.380 mm (0.0015—0.0150 in.)	---
Clutch Shaft Pilot Bushing:		
Bushing ID	25.464—25.540 mm (1.0025—1.0055 in.)	---
Shaft OD	25.387—25.413 mm (0.9995—1.0005 in.)	---
Main Bearing Journal OD	85.649—85.674 mm (3.3720—3.3730 in.)	---
Main Bearing ID (Assembled)	85.705—85.755 mm (3.3742—3.3762 in.)	---
Main Bearing-to-Journal Clearance	0.030—0.107 mm (0.0012—0.0042 in.)	---
Connecting Rod Journal OD	76.149—76.175 mm (2.9980—2.9990 in.)	---
Crankshaft Rear Oil Seal-to-Housing		
Maximum Runout	0.15 mm (0.006 in.)	---
Crankshaft Main Bearing Journal Radius	3.30—4.32 mm (0.130—0.170 in.)	---
Journal Taper per 25.4 mm (1.00 in.)		
Length	0.0025 mm (0.0001 in.)	---
Journal Out-of-Round	0.025 mm (0.001 in.)	---
Undersized Bearings Available	0.05, 0.25, 0.51, and 0.76 mm (0.002, 0.010, 0.020, and 0.030 in.)	---
Oversize Thrust Washer Available	0.18 mm (0.007 in.)	---
Main Bearing Cap Bore Specifications:		
ID Without Bearing Inserts	92.125—92.151 mm (3.627—3.628 in.)	---
Maximum Bore Diameter Taper	0.013 mm (0.0005 in.)	---
Maximum Bore Diameter Variation	0.013 mm (0.0005 in.)	---
Maximum Straightness Variation (Any Bore-to-Adjacent Bores)	0.038 mm (0.0015 in.)	
Maximum Straightness Variation (5 Centerbores-to-End Bores)	0.08 mm (0.003 in.)	---
Centerline of Main Bearing Bore-to-Top Deck of Cylinder Block	352.35—352.50 mm (13.872—13.878 in.)	---
Main Bearing Cap Surface Width	36.28—36.78 mm (1.428—1.448 in.)	---

S11,2015,BR -19-08AUG94

CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
No. 5 Main (Thrust) Bearing:		
Surface Width (Thrust Washer Clearance)	37.44—37.54 mm (1.474—1.478 in.)	---
Overall Cap Width	39.16—39.66 mm (1.542—1.561 in.)	---
Base Circle OD for Thrust Washer Clearance*	123.70—125.30 mm (4.87—4.93 in.)	---
Thrust Journal Lap	0.40 Um (16 AA)	
Main and Rod Journal Lap	0.20 Um (8 AA)	
Crankshaft OD for Front Pulley	47.650—47.676 mm (1.875—1.876 in.)	---
Front Pulley ID (Relationship to Mating OD on Crank)	47.594—47.630 mm (1.8738—1.8752 in.)	---
Damper Pulley Radial Runout (Maximum)	1.02 mm (0.040 in.)	
Crankshaft Front Oil Seal Installed Depth Below Front Face of Oil Seal Bore	8.4 mm (0.33 in.)	
Dowel Pin Protrusion From Crankshaft Rear Flange	13.5—14.5 mm (0.53—0.57 in.)	---
Maximum Rear Oil Seal Housing Runout	0.15 mm (0.006 in.)	---
Flywheel Housing Face Runout Maximum Variation	0.20 mm (0.008 in.)	---
Flywheel Face Flatness		
Maximum Variation	0.23 mm (0.009 in.)	---
Maximum Variation per 25 mm (1.0 in.) of travel	0.013 mm (0.0005 in.)	---
Flywheel Bearing Bore Concentricity Maximum Variation	0.127 mm (0.005 in.)	---

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

S11,2015,BR1 -19-08AUG94

CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS—CONTINUED

CRANKSHAFT GRINDING SPECIFICATIONS:

Bearing Size	Crankshaft Main Journal OD	Crankshaft Rod Journal OD
Standard	85.649—85.674 mm (3.3720—3.3730 in.)	76.149—76.175 mm (2.9980—2.9990 in.)
0.05 mm (0.002 in.) Undersize	85.598—85.623 mm (3.3700—3.3710 in.)	76.098—76.124 mm (2.9960—2.9970 in.)
0.25 mm (0.010 in.) Undersize	85.394—85.420 mm (3.3620—3.3630 in.)	75.895—75.920 mm (2.9880—2.9890 in.)
0.51 mm (0.020 in.) Undersize	85.140—85.166 mm (3.3520—3.3530 in.)	75.641—75.667 mm (2.9780—2.9790 in.)
0.76 mm (0.030 in.) Undersize	84.887—84.912 mm (3.3420—3.3430 in.)	75.387—75.413 mm (2.9680—2.9690 in.)

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CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS—CONTINUED

TORQUES

Flywheel Housing-to-Cylinder Block	407 N·m (300 lb-ft)
Flywheel Housing-to-Oil Pan	325 N·m (240 lb-ft)
Damper Assembly-to-Pulley	47 N·m (35 lb-ft)
Damper Pulley-to-Crankshaft	230 N·m (170 lb-ft)
Main Bearing Caps	203 N·m (150 lb-ft)
Rear Crankshaft Oil Seal Housing-to-Cylinder Block*	27 N·m (20 lb-ft)
Flywheel-to-Crankshaft	115 N·m (85 lb-ft)
Piston Cooling Orifices	11 N·m (8 lb-ft) (97 lb-in.)
Timing Gear Cover-to-Cylinder Block**	27 N·m (20 lb-ft)
Magnetic Pickup Cover	12 N·m (9 lb-ft) (106 lb-in.)

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**See INSTALL CRANKSHAFT REAR OIL SEAL HOUSING later in this group for proper cap screw tightening sequence.*

***See INSTALL TIMING GEAR COVER later in this group for proper cap screw tightening sequence.*

RG,CTM1,G15,1 -19-08AUG94

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.

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S11,2015,C -19-29SEP94

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

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

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

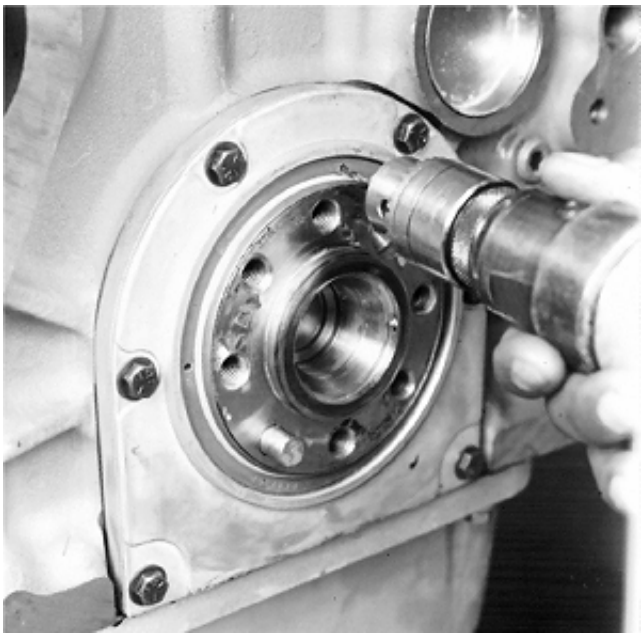
NOTE: If oil seal housing is to be removed, remove seal and wear sleeve after housing is removed. See REMOVE REAR OIL SEAL HOUSING AND WEAR SLEEVE (WITH ENGINE DISASSEMBLED), later in this group.

1. Remove flywheel. See REMOVE FLYWHEEL later in this group.

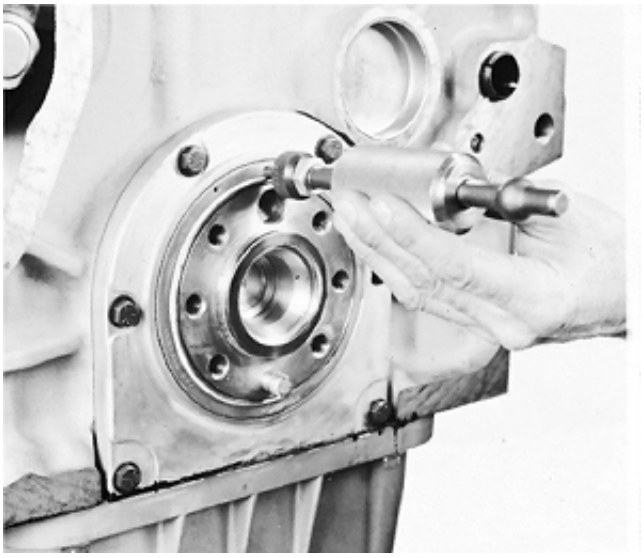
2. Drill two small holes approximately 20˚ apart in bottom of seal casing. Install sheet metal screws in seal casing with JDG22 Seal Remover attached.

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

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



RG5819 -UN-12AUG91



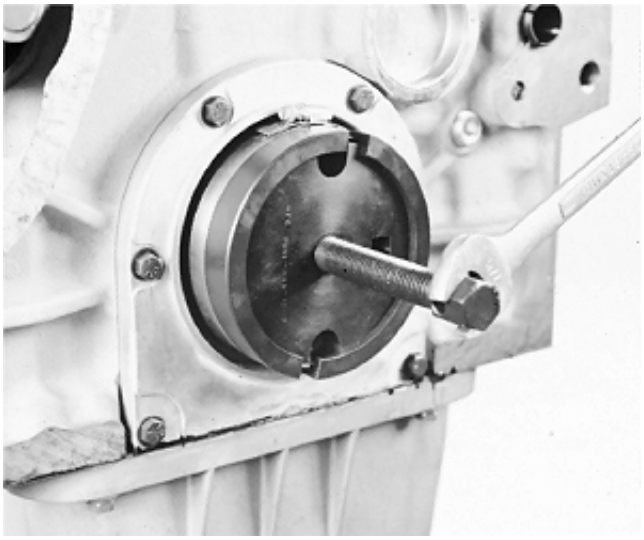
RG6467 -UN-26OCT92

S11,2015,GN -19-08MAR94

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

5. Securely tighten band clamp in groove on OD of jaws.

6. Tighten forcing screw with disc centered in crankshaft flange until wear sleeve is removed from crankshaft.



RG6468 -UN-26OCT92

RG,CTM1,G15,3 -19-08MAR94

Clean OD of crankshaft flange with cleaning solvent, acetone, or any other suitable cleaner that will remove sealant. (Brake Kleen, Ignition Cleaner and Drier are examples of commercially available solvents that will remove sealant from flange.)

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

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

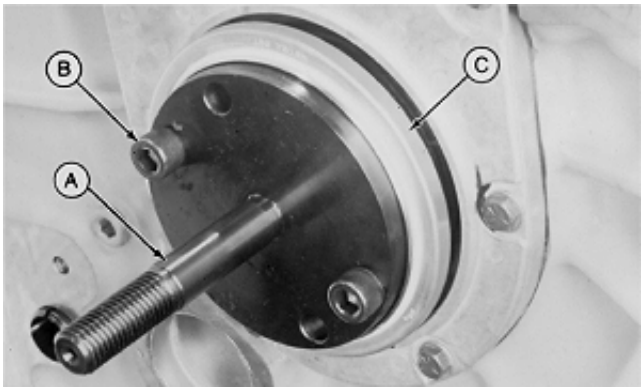
Check oil seal housing runout as explained later in this group.

RG5822 -UN-12AUG91

RG,CTM1,G15,4 -19-08MAR94

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

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



RG4639 -UN-14DEC88

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

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

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

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

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

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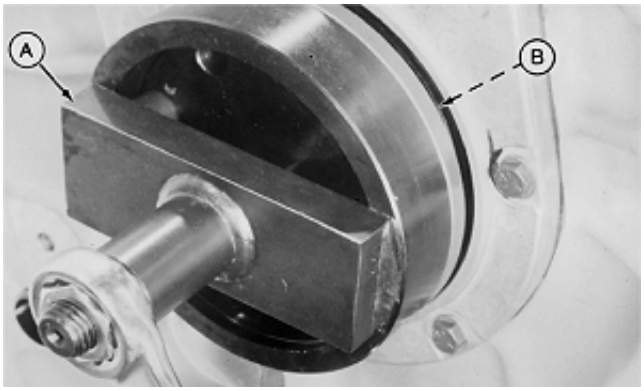
S11,2015,GQ -19-16AUG94

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

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

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



-UN-14DEC88
RG4640

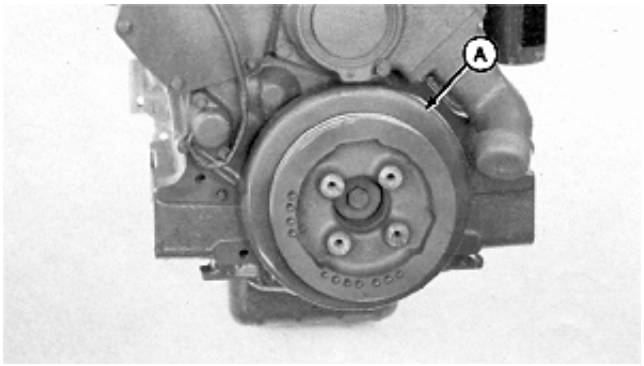
S11,2015,GR -19-11JUN93

INSPECT VIBRATION DAMPER

IMPORTANT: Do not immerse the vibration damper or the damper pulley in cleaning solvent. Damage to the rubber portions of these components may result.

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

The vibration damper assembly is not repairable and MUST be replaced every 5 years or 4500 hours, whichever occurs first. The vibration damper should be replaced any time the crankshaft is replaced or a major engine overhaul has occurred.



-UN-14DEC88
RG3502

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1. Remove fan belts. (Shown removed.)

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

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

S11,2015,DI -19-08AUG94

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

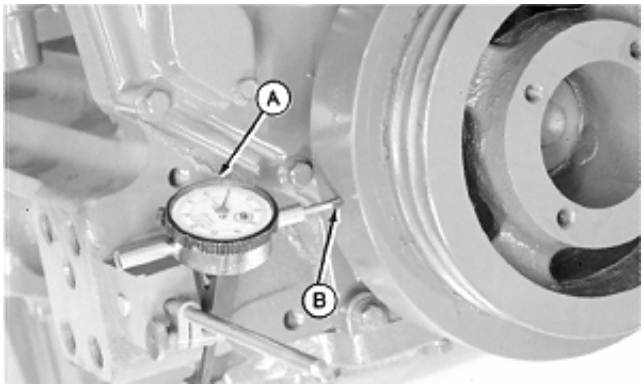
5. Rotate crankshaft using JDE81-1 Flywheel Rotation Tool.

6. Note dial indicator reading.

DAMPER SPECIFICATION

Maximum Radial Runout	1.02 mm (0.040 in.)

If runout exceeds specifications, replace vibration damper.



RG3833 -UN-14DEC88

S11,2015,BJ -19-08MAR94

CHECK CRANKSHAFT END PLAY

1. Completely engage then release the clutch lever.

2. Place a dial indicator on damper face.

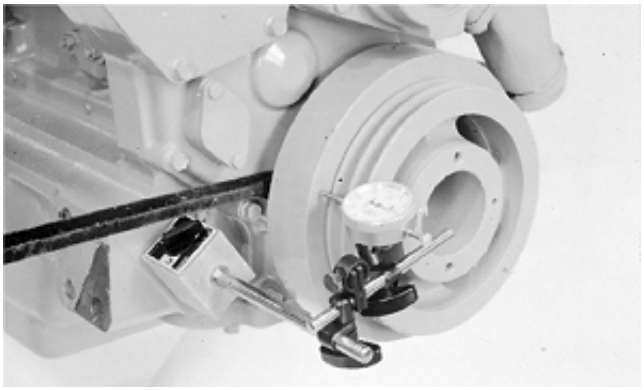
IMPORTANT: Use care not to damage or distort the timing gear cover or bearing inserts when prying. Do not pry on outer interia ring of damper.

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

CRANKSHAFT END PLAY SPECIFICATIONS

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

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



RG7094 -UN-16FEB94

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RG,CTM1,G15,5 -19-08MAR94

REMOVE DAMPER PULLEY

1. Drain oil (if not previously done), remove oil pan and oil pump.

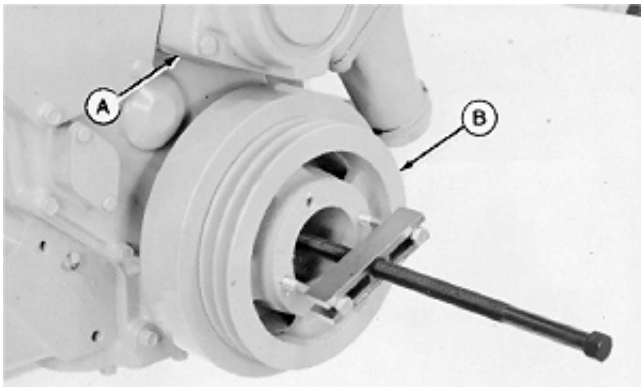
2. For engines equipped with gear drive water pumps, remove water pump (A) if not previously removed. (See Cooling System, Group 25.)

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

IMPORTANT: DO NOT use a jaw-type puller to remove vibration damper. Damage could result to the damper.

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

4. Remove pulley from crankshaft using D01206AA Puller.



RG7095 -UN-16FEB94

S11,2015,DJ -19-08MAR94

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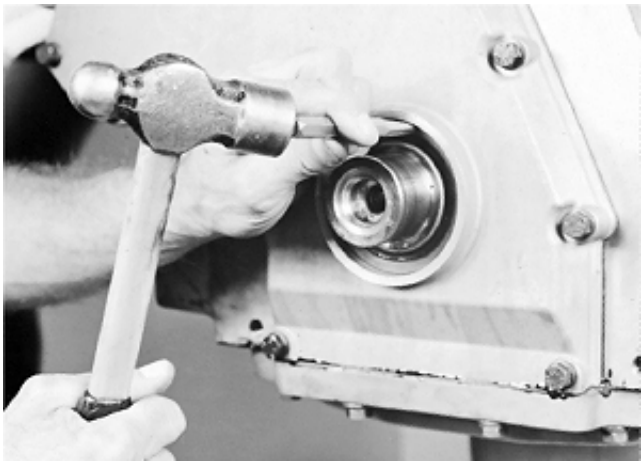
REMOVE FRONT OIL SEAL (WITH TIMING GEAR COVER INSTALLED ON ENGINE)

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

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

1. Check oil seal and wear sleeve for wear, damage, or leakage.

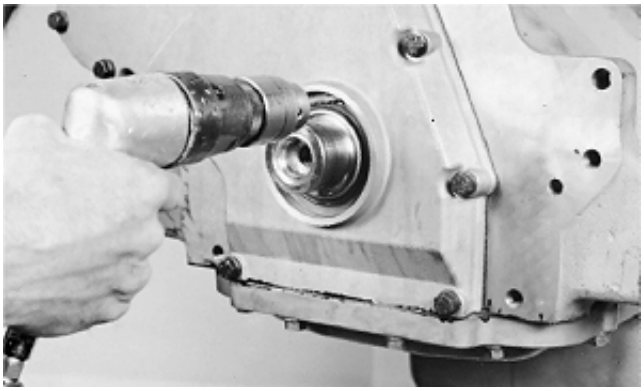
2. Center punch seal casing at 12 O'clock position.



RG6471 -UN-26OCT92

RG,CTM1,G15,6 -19-08AUG94

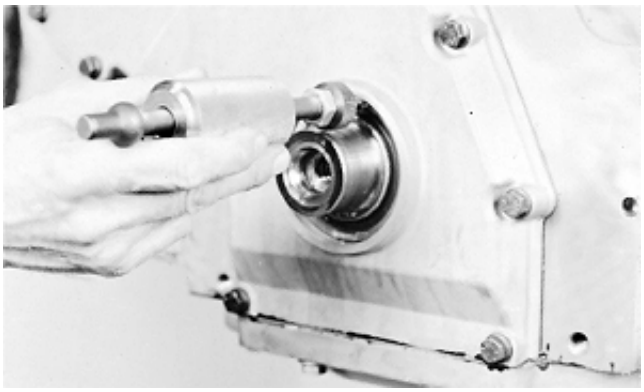
3. Drill 1/8 in. hole in casing.



RG,CTM1,G15,7 -19-28FEB94

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

5. Remove keyway from keyslot of crankshaft.



RG,CTM1,G15,8 -19-08AUG94

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

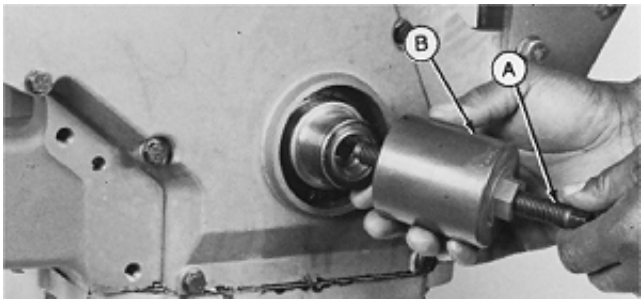
• **To Remove Wear Sleeve Using JDG786:**

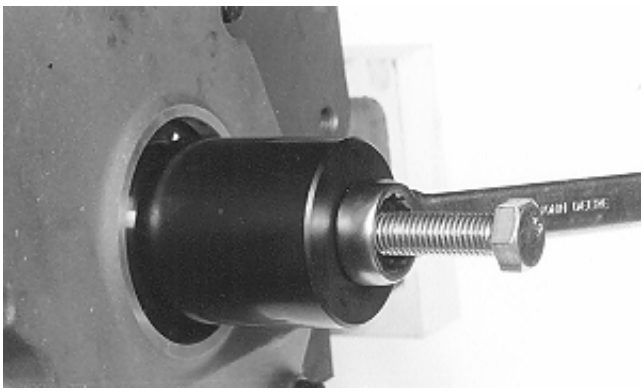
1. Start fully threaded centering screw (A) through hex head end of puller (B) until head of screw is approximately 1/2 in. from hex on puller.

2. Thread centering screw into nose of crankshaft until it bottoms.

3. Tighten puller until it is securely threaded onto wear sleeve.

4. Remove centering screw from nose of crankshaft and puller.





RG,CTM1,G15,9 -19-17AUG94

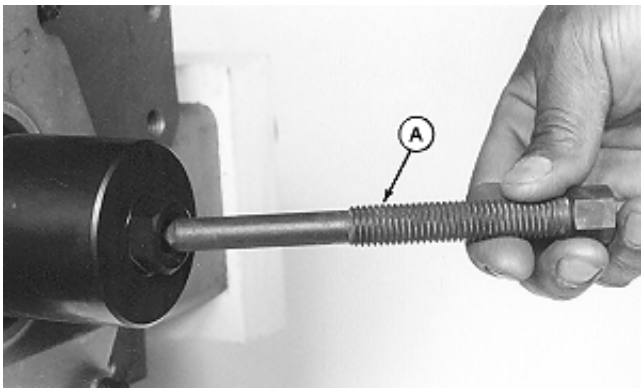
5. Install partially threaded forcing screw (A) into puller and tighten until it bottoms in nose of crankshaft. There is no thread engagement in crankshaft; just with puller.

6. Continue to tighten forcing screw until puller and wear sleeve are free from crankshaft flange.

7. Inspect crankshaft flange for nicks or burrs.

8. Clean up flange with a light file and emery cloth.

9. Measure crankshaft front oil seal bore runout. Maximum allowable runout is 0.254 mm (0.010 in.).



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RG7729

RG,CTM82,G15,19-19-26JUL94

INSTALL FRONT WEAR SLEEVE (WITH TIMING GEAR COVER INSTALLED ON ENGINE)

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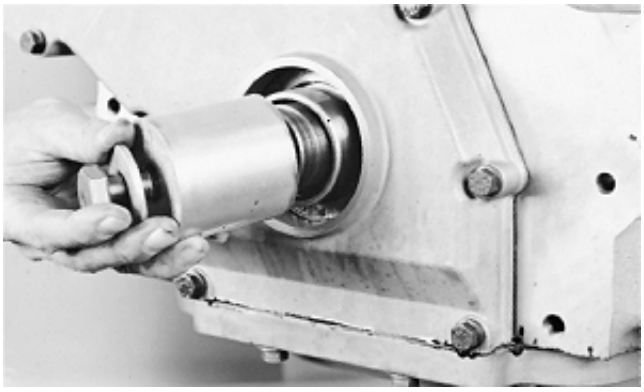
1. Coat ID of new wear sleeve with LOCTITE 609 Retaining Compound.

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

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



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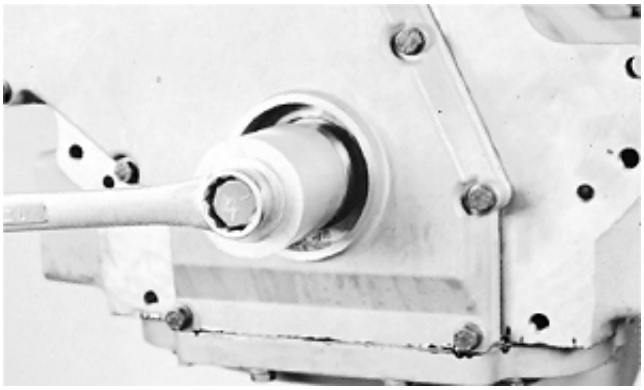

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RG,CTM1,G15,10 -19-08AUG94

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

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

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

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

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

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

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

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

RG6479 -UN-26OCT92

RG6480 -UN-26OCT92

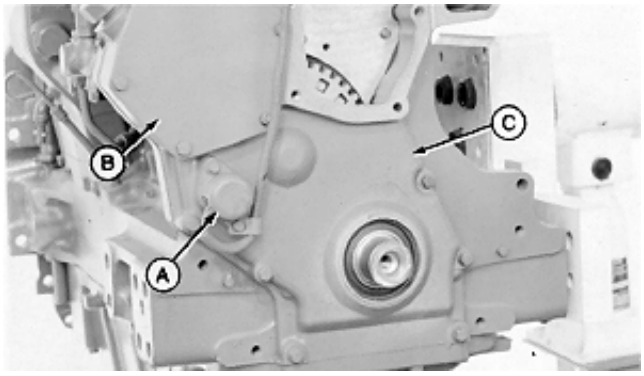
RG,CTM1,G15,11 -19-28FEB94

REMOVE TIMING GEAR COVER

1. Remove magnetic pick-up (A, if equipped) and injection pump drive gear cover (B). Discard gaskets.

2. Remove timing gear cover (C). Discard gasket.

3. Remove oil seal from cover and discard.



RG3927 -UN-14DEC88

S11,2015,DK -19-08MAR94

INSPECT AND MEASURE FLYWHEEL

1. Inspect the clutch contact face for scoring, overheating, or cracks. Replace flywheel if defective.

2. Examine flywheel ring gear for worn or broken teeth. Replace ring gear if defective, as described later in this group.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel or housing face.

3. Measure flywheel housing face run-out, flywheel face flatness, and pilot bearing bore concentricity, as outlined later in this group. Resurface flywheel face or replace as required.

S55,2015,N -19-08MAR94

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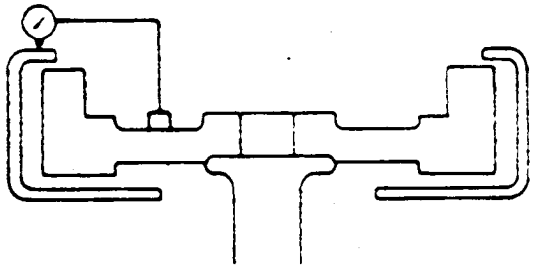
CHECK FLYWHEEL HOUSING FACE RUNOUT

1. Mount dial indicator on flywheel. Set pointer to contact PTO mounting surface on flywheel housing at right angles. Pointer should not contact holes in flywheel housing.



R22212 -UN-14DEC88

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel housing face runout.

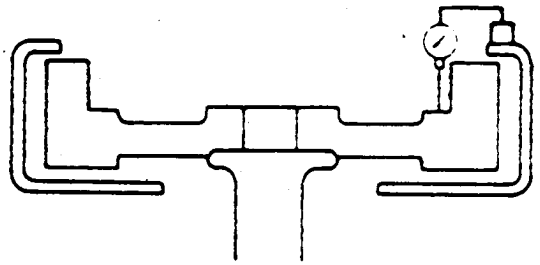
2. Rotate flywheel by turning crankshaft. Read total dial indicator movement.

FLYWHEEL HOUSING FACE RUNOUT SPECIFICATION

Maximum Variation	0.20 mm (0.008 in.)

S55,2015,L -19-29OCT92

CHECK FLYWHEEL FACE FLATNESS


R22213 -UN-14DEC88

1. Mount dial indicator base on flywheel housing. Position pointer to contact driving ring mounting surface. Do not allow pointer to contact driving ring mounting holes.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel face runout.

2. Rotate flywheel by turning crankshaft. Read total dial indicator movement. Resurface flywheel face or replace as required.

FLYWHEEL FACE FLATNESS SPECIFICATION

Maximum Variation	0.23 mm (0.009 in.)
Maximum Variation per 25 mm (1.0 in.) of Travel	0.013 mm (0.0005 in.)

S11,5005,AM -19-02FEB94

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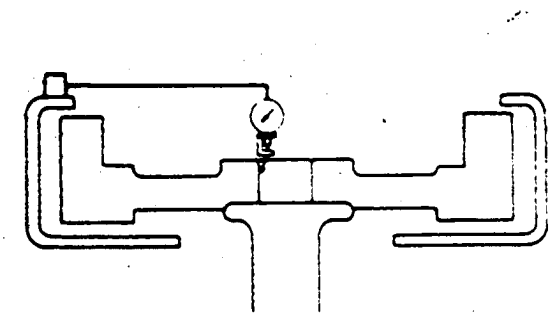
CHECK PILOT BEARING BORE CONCENTRICITY


R22214 -UN-14DEC88

1. Mount dial indicator on flywheel housing face and position pointer to contact ID of pilot bearing bore in flywheel.

2. Rotate flywheel by turning crankshaft. Read total dial indicator movement.

BEARING BORE CONCENTRICITY SPECIFICATION

Maximum Variation	0.127 mm (0.005 in.)

S55,2015,M -19-08MAR94

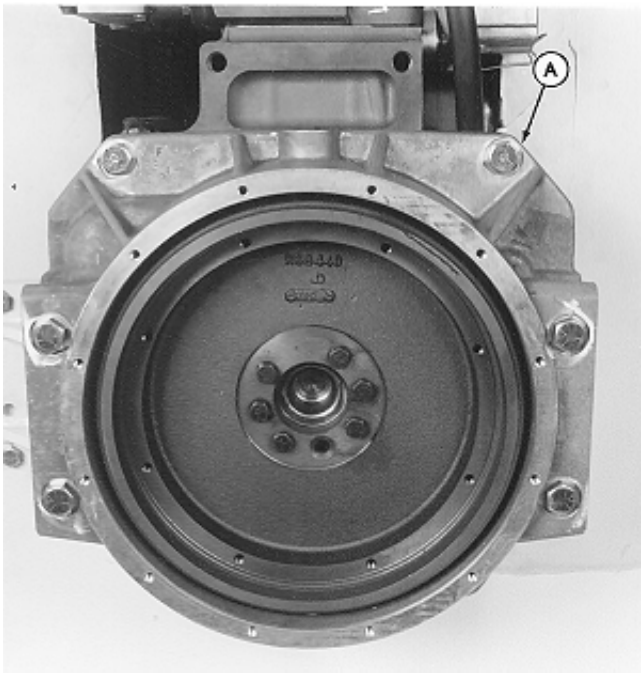
REMOVE SAE 3 FLYWHEEL HOUSING

CAUTION: Flywheel housing (A) is heavy. Plan a proper lifting procedure to avoid personal injury.

1. Remove flywheel housing attaching cap screws.

2. Remove flywheel housing.

3. Inspect mounting holes in flywheel housing for thread damage.



RG7730 -UN-22JUL94

RG,CTM1,G15,14 -19-08AUG94

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REMOVE FLYWHEEL

NOTE: SAE 3 flywheel housing MUST BE removed before flywheel can be removed from engine. (See REMOVE SAE 3 FLYWHEEL HOUSING earlier in this group.)

CAUTION: Flywheel is heavy. Use proper lifting procedures to avoid personal injury.

1. Remove two flywheel attaching cap screws (A), and install two pilot studs in their place.

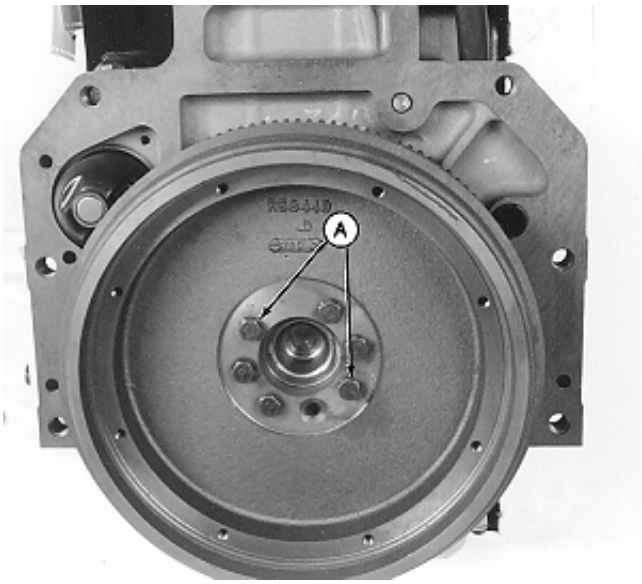
2. Remove remaining cap screws, and carefully pull flywheel from crankshaft.

3. Check condition of dowel pin in crankshaft rear flange. Dowel pin must not be cracked or chipped. Measure protrusion of dowel pin from face of flange. If dowel pin is damaged, or protrusion is not within specifications, replace dowel pin.

NOTE: When replacing dowel pin, crankshaft must be removed to prevent damage to crankshaft thrust bearings.

CRANKSHAFT DOWEL PIN SPECIFICATIONS

Protrusion From Crankshaft
Rear Flange . . . . . 13.5—14.5 mm (0.53—0.57 in.)



RG7731 -UN-22JUL94

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S11,2015,BY -19-08AUG94

REMOVE SAE 1 AND SAE 2 FLYWHEEL HOUSING

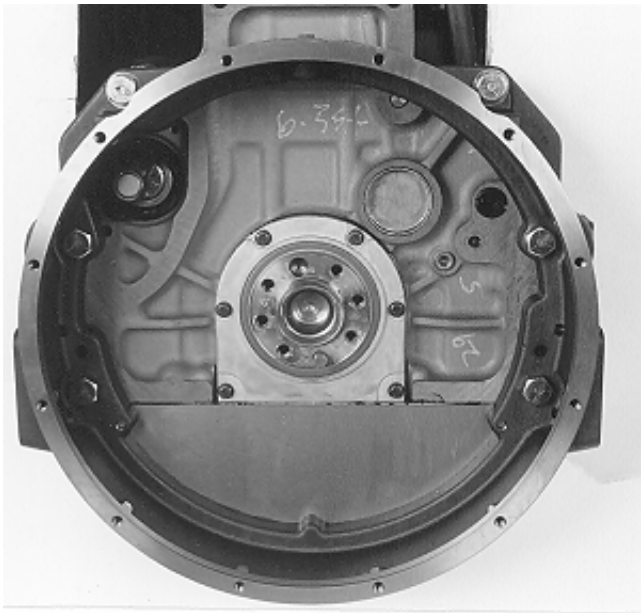
NOTE: The flywheel MUST be removed before removing the SAE 1 or SAE 2 flywheel housing. See REMOVE FLYWHEEL earlier in this group.

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

1. Remove attaching cap screws.

2. Remove flywheel housing.

3. Inspect mounting holes in flywheel housing for thread damage.



RG7732 -UN-22JUL94

RG,CTM1,G15,13 -19-08AUG94

REPLACE FLYWHEEL RING GEAR

CAUTION: Oil fumes or oil can ignite above 193˚C (380˚F). Use a thermometer and do not exceed 182˚C (360˚F). Do not allow a flame or heating element to be in direct contact with the oil. Heat the oil in a well ventilated area. Plan a safe handling procedure to avoid burns.

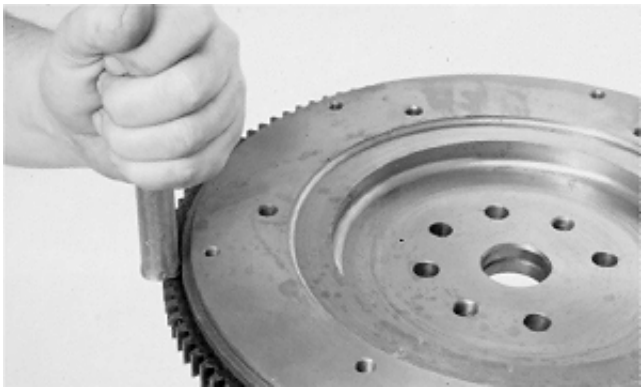
1. If ring gear is damaged, place the flywheel on a solid flat surface.

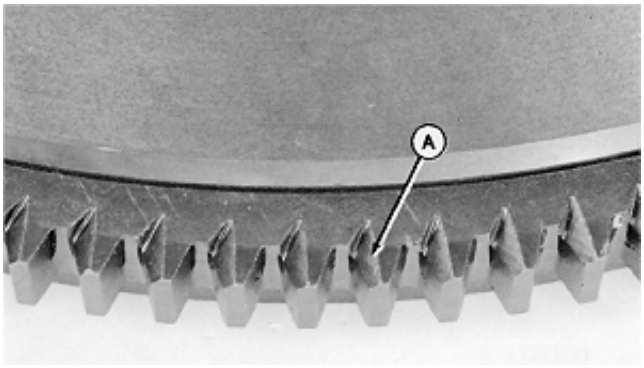
2. Remove ring gear with a brass drift and hammer.

IMPORTANT: If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT. Overheating may destroy original heat treatment of gear. SEE CAUTION.

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

4. Install ring gear against shoulder of flywheel so chamfered side (A) is on engine side of flywheel.





S11,2015,FX -19-16SEP92

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SERVICE CLUTCH SHAFT PILOT BUSHING-QUAD RANGE TRANSMISSIONS

1. Inspect bushing adapter (C), clutch bushing (D) and end of shaft for excessive wear or damage.

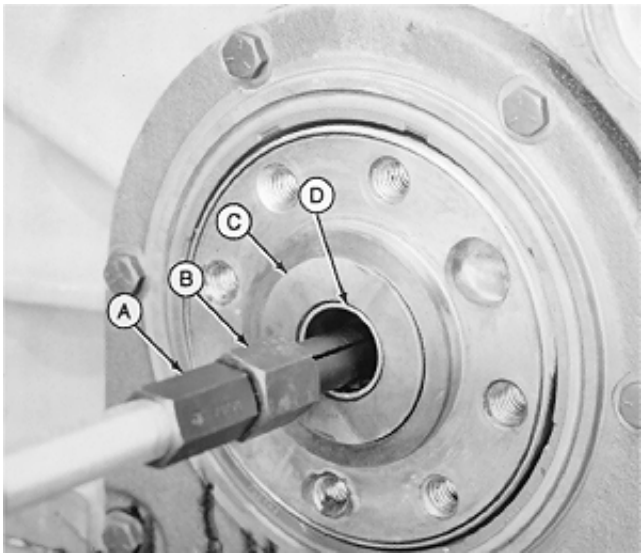
Replace bushing, shaft, and adapter if not within the following specifications.

CLUTCH SHAFT PILOT BUSHING SPECIFICATIONS

Bushing ID	25.585—25.610 mm (1.0073—1.0083 in.)
Shaft OD	25.400—25.426 mm (0.9999—1.0004 in.)

2. Use the JT01731 Collet (B), JT01722 Actuator pin (A), with the slide hammer from the D01061AA Blind Hole Puller Set to remove clutch shaft pilot bushing.

A—JT01722 Actuator Pin
B—JT01731 Collet
C—Adapter
D—Bushing



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RG4338

S11,2015,DW -19-08AUG94

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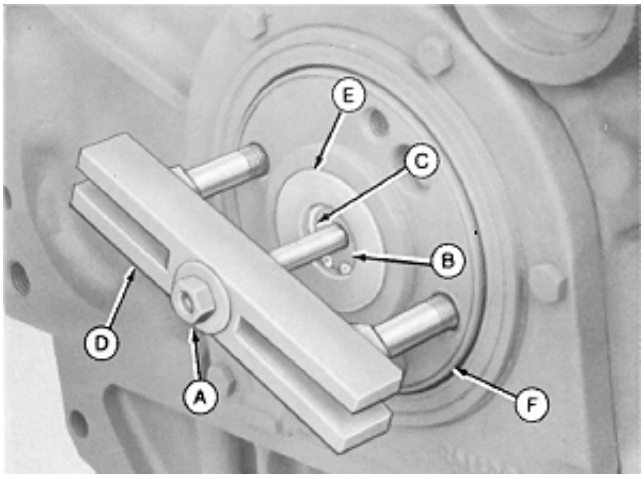
3. To remove adapter (E) place a 9.5 x 127 mm (3/8 x 5-in.) cap screw (A) and R43696 Washer (B) in adapter bushing bore.

4. Install a H214R Snap Ring (C) in adapter bushing bore.

5. Use a D01219AA Cross-Block (D) with two cap screws in the crankshaft flange and pull adapter.

A—Cap Screw
B—Washer
C—Snap Ring
D—Cross-Block
E—Transmission Pump Drive Adapter
F—Crankshaft Flange

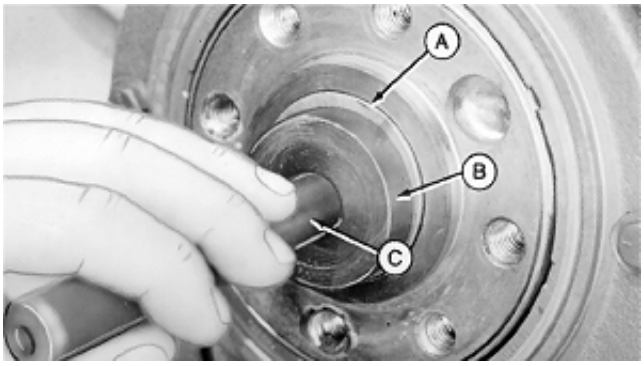


-UN-15DEC88
R25923

S11,2015,CZ -19-08AUG94

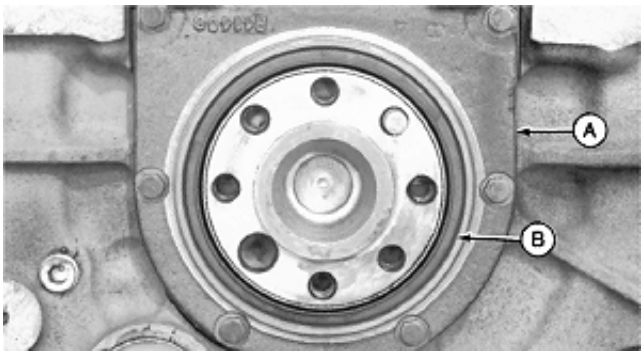
6. Install new adapter/bushing assembly (A) using the 27516 Disk (B) with the 27488 handle (C) from the D01045AA Bushing, Bearing, and Seal Driver Master Set.

Drive adapter until it bottoms in crankshaft bore.



S11,2015,DA -19-08MAR94

REMOVE REAR OIL SEAL HOUSING AND WEAR SLEEVE (WITH ENGINE DISASSEMBLED)



These instructions are for use when the oil seal housing and oil pan will be removed. Refer to REMOVE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE (WITH OIL SEAL HOUSING INSTALLED), earlier in this group, for instructions without the oil seal housing and oil pan being removed.

1. Remove rear oil seal housing (A).

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IMPORTANT: If rear oil seal is replaced, also replace rear wear sleeve. The wear sleeve does not have to be removed to remove crankshaft.

2. Rear oil seal (B) will come off with housing. Use a small punch and hammer to remove oil seal. Discard seal.

RG,CTM42,G15,14-19-16AUG94

IMPORTANT: The preferred method of removing the wear sleeve is with JDG790 Rear Wear Sleeve Puller. When removing wear sleeve with a chisel, DO NOT gouge crankshaft flange. Nicks or burrs should be removed with a medium-grit stone. Polishing cloth (180-grit or finer) may also be used when a stone is not available.

Rear wear sleeve can be removed using one of the following procedures: These procedures may also be followed when crankshaft has been removed from engine.

• Use JDG790 Wear Sleeve Puller to remove wear sleeve from crankshaft flange, as described earlier in this group.

• Use the ball side of a ballpeen hammer and tap wear sleeve across its width in a straight line (to deform and stretch sleeve).

• Score but do not cut the wear sleeve in several places around OD with a blunt chisel.

Remove wear sleeve from crankshaft flange. Clean flange with a light file and emery cloth.

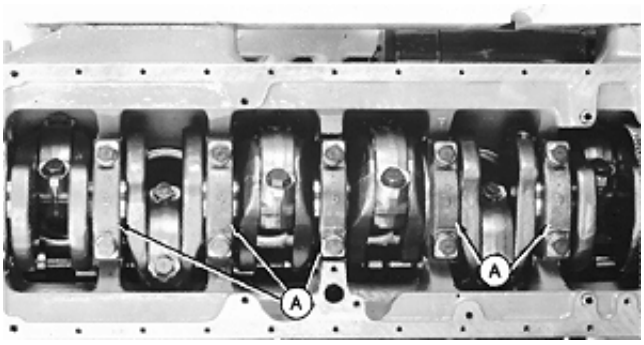
RG,CTM42,G15,54-19-02APR93

REMOVE CRANKSHAFT MAIN BEARINGS

NOTE: A drop in oil pressure, engine knock, or excessive crankshaft end play are indications of main bearing and main thrust bearing washer failures.

IMPORTANT: Before removing main bearing caps (A, five shown), check for proper torque on all main bearings. Also, check each bearing cap to make sure they are numbered for reassembly on the same numbered main bearing bosses. Keep matched bearing inserts with their respective main bearing cap for comparison with crankshaft journal (surface) from which removed.

NOTE: When removing main bearings and caps, leave No. 1 and 7 main bearing caps installed until all connecting rod caps have been removed.



RG3751 -UN-14DEC88

S11,2515,H -19-08MAR94

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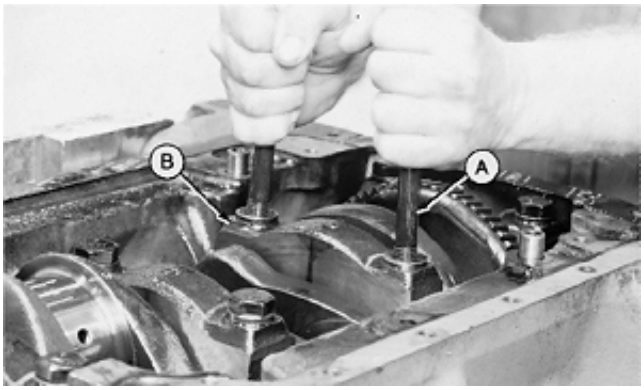
1. Loosen main bearing cap screws and washers.

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

3. Use PLASTIGAGE to measure oil clearance on each main bearing as they are removed. See CHECK MAIN BEARING CLEARANCE later in this group.



RG4469 -UN-14DEC88

S11,2515,AJ -19-08MAR94

CHECK MAIN BEARING CLEARANCE

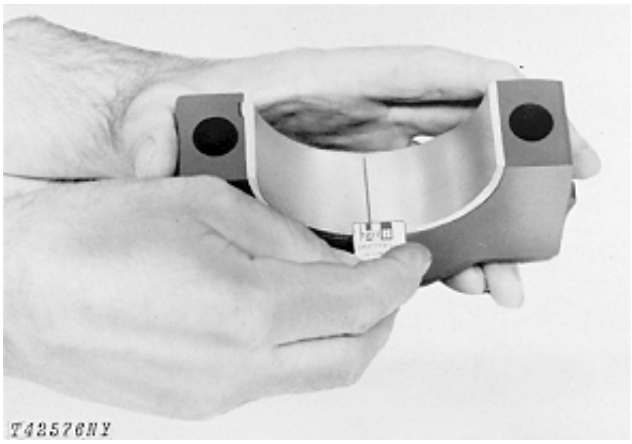
The use of PLASTIGAGE will determine wear but will not determine condition of the bearing or journal surfaces.

1. Put a strip of PLASTIGAGE in the center of the main bearing cap (with insert) about three-fourths of the width of the bearing.

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

3. Install cap and tighten to 203 N·m (150 lb-ft).

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



T42576NY -UN-09NOV88

MAIN BEARING CLEARANCE SPECIFICATIONS

Main Bearing-to-Journal Clearance	0.030—0.107 mm (0.0012—0.0042 in.)

S11,0403,Z -19-08AUG94

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REMOVE CRANKSHAFT

1. Rotate crankshaft using the JDE81-1 Flywheel Rotation Tool until connecting rod caps can be removed easily. You will be able to remove two rod caps at each position.

2. Remove all connecting rod caps (A) with bearings, then remove No. 1 and 7 main bearing caps and bearings. See REMOVE PISTONS AND CONNECTING RODS in Group 10.

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

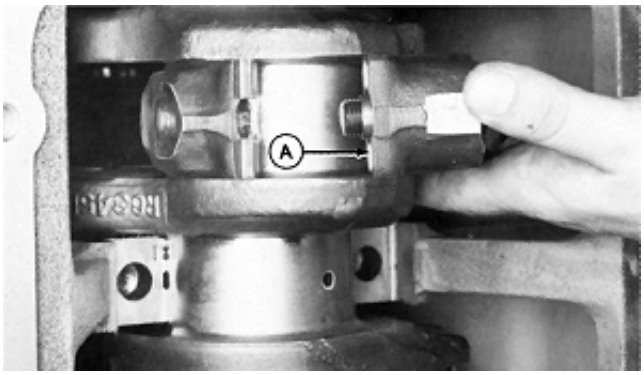
NOTE: Install a screw on each end of crankshaft to aid in lifting crankshaft.

3. Attach a lifting strap to crankshaft.

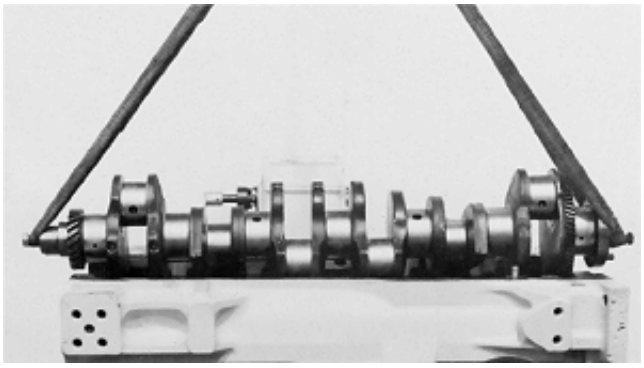
4. Using proper lifting equipment, carefully raise crankshaft out of cylinder block.

5. Clean crankshaft, especially oil passages, using solvent and compressed air.

6. Put crankshaft on clean V-blocks.



RG3840 -UN-14DEC88



RG2794 -UN-23FEB89

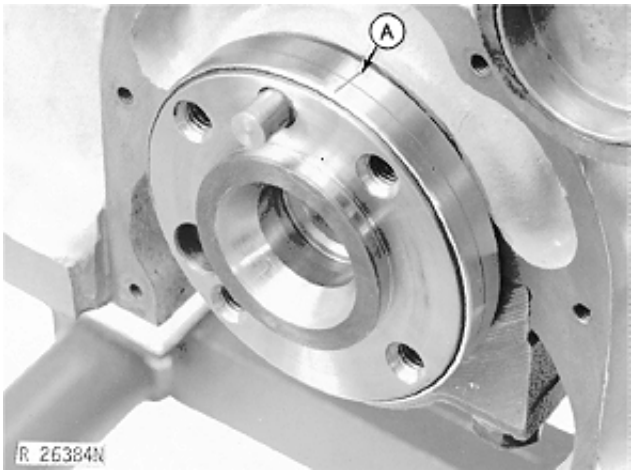
S11,0403,AA -19-08MAR94

If wear sleeve has not been removed from crankshaft, the following procedures may be used. However, removing wear sleeve using JDG790 Wear Sleeve Puller Kit while crankshaft is installed in engine is the preferred method.

• Use JDG790 Wear Sleeve Puller to remove wear sleeve from crankshaft, as described earlier in this group. Position crankshaft rod journals in V-blocks so that crankshaft does not rotate while removing wear sleeve.

• Use the ball side of a ballpeen hammer and tap wear sleeve across its width in a straight line (to deform and stretch sleeve).

• Score (A), but do not cut, the wear sleeve in several places around OD with a blunt chisel.



R26384 -UN-15DEC88

RG,CTM42,G15,55-19-06NOV92

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INSPECT CRANKSHAFT

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

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

2. Inspect crankshaft for any signs of load stress, cracks or scratches on journals. (See INSPECT CRANKSHAFT, later in this group.) Also check each journal for evidence of excessive overheating or discoloration. If either condition exists, replace crankshaft since heat treatment has probably been destroyed.

3. On engines equipped with crankshaft-driven oil pumps, inspect crankshaft gear for cracks, chipped teeth, or excess wear. Replace gear as required. (See REPLACE CRANKSHAFT OIL PUMP DRIVE GEAR, later in this group.)

NOTE: If crankshaft gear requires replacement, inspect oil pump drive gear also. (See Lubrication System, Group 20.)

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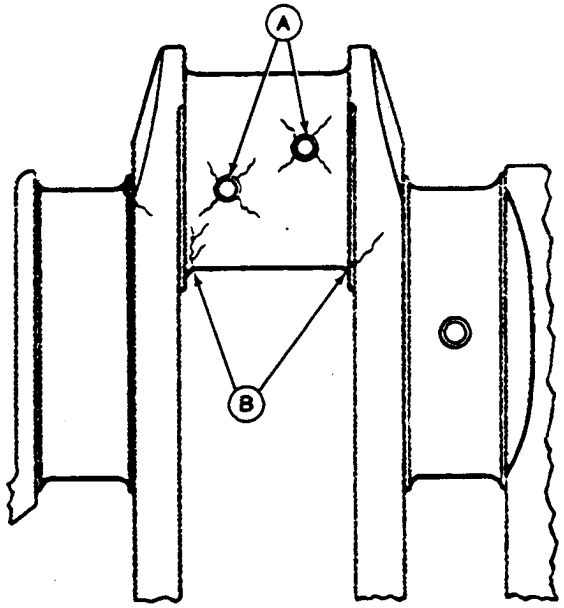
S11,2515,AV -19-08AUG94



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

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

6. Check the crankshaft timing gear and the oil pump drive gear for worn and chipped teeth. Replace the gears as necessary. (See REPLACE CRANKSHAFT OIL PUMP DRIVE GEAR.)

7. Check condition of dowel pin in crankshaft rear flange. Dowel pin must not be cracked or chipped. Measure protrusion of dowel pin from face of flange. If dowel pin is damaged, or protrusion is not within specifications, replace dowel pin.

NOTE: When replacing dowel pin, crankshaft must be removed to prevent damage to crankshaft thrust bearings.

CRANKSHAFT DOWEL PIN SPECIFICATIONS

Dowel Pin Protrusion From Rear Flange	13.5—14.5 mm (0.53—0.57 in.)

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

9. Carefully check the crankshaft for cracks in the area of rod journal oil holes (A) and at journal fillets (B). Replace crankshaft if any cracks are found.

IMPORTANT: When inspecting crankshaft for cracks, a method must be used that is capable of detecting minute cracks that are not visible to the eye such as the Fluorescent Magnetic Particle method. This method magnetizes the crankshaft, employs magnetic particles which are fluorescent and glow under "black light". The crankshaft must be de-magnetized after the test.

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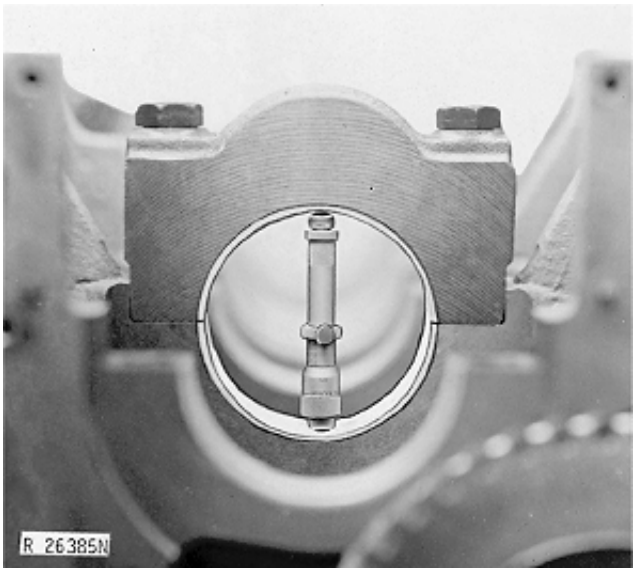
S11,2515,BQ1 -19-08AUG94

MEASURE ID OF ASSEMBLED BEARINGS AND OD OF CRANKSHAFT JOURNALS

1. With crankshaft out of cylinder block, install main bearing inserts and caps (be sure inserts are installed correctly).

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

3. Measure I.D. of all bearings with an inside micrometer.



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MAIN BEARING ID SPECIFICATIONS

With Bearing	85.705—85.755 mm (3.3742—3.3762 in.)
Without Bearing	92.125—92.151 mm (3.627—3.628 in.)

NOTE: Inspect and measure ID of assembled connecting rod bearings. Compare measurements with connecting rod journal OD on crankshaft. (See Group 10.)

S11,0403,AC -19-08MAR94

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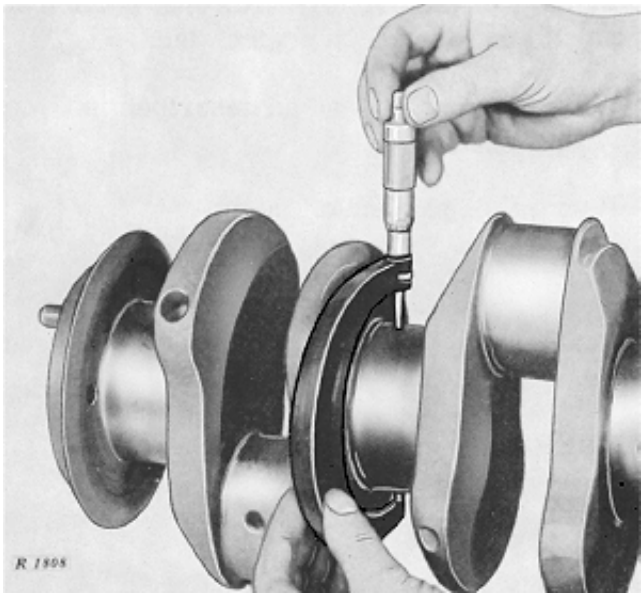
4. Measure OD of all respective crankshaft journals at several points around journal.



RG1808 -UN-14DEC88

CRANKSHAFT SPECIFICATIONS

OD of Main Bearing Journal	85.649—85.674 (3.3720—3.3730 in.)

NOTE: If engine has previously had a major overhaul and undersized bearing inserts were used, above listed ID and OD dimensions may not be the same as those recorded. However, oil clearance should be within specifications. Oil clearance is 0.030—0.107 mm (0.0012—0.0042 in.).

Use crankshaft journal OD measurements to determine if journal is out-of-round or tapered.

CRANKSHAFT WEAR SPECIFICATIONS

Journal Taper Per 25.4 mm (1.0 in.) of Journal Length	0.0025 mm (0.0001 in.)
Journal Out-of-Roundness	0.025 mm (0.0010 in.)

S11,0403,AD -19-17AUG94

MEASURE MAIN BEARING CAP LINE BORE

1. With crankshaft removed from cylinder block, install main bearing caps without bearing inserts.

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

3. Measure ID of all bearing caps with an inside micrometer.

If any main bearing cap assembled ID is not within specification, blank (generic) bearing caps are available and must be line bored to specification. Replace individual bearing caps as needed.

IMPORTANT: Main bearing cap line boring should be done ONLY by experienced personnel on equipment capable of maintaining bore specifications.

MAIN BEARING CAP BORE SPECIFICATIONS

ID Without Bearings (Standard)	92.125—92.151 mm (3.627—3.628 in.)
Maximum Bore Diameter Variation	0.013 mm (0.0005 in.)
Maximum Bore Diameter Taper	0.013 mm (0.0005 in.)
Maximum Straightness Variation (Any Bore-to-Adjacent Bore)	0.038 mm (0.0015 in.)
Maximum Straightness Variation (5 Center Bores-to-End Bores)	0.08 mm (0.003 in.)
Centerline of Bore-to-Top Deck	352.35—352.50 mm (13.872—13.878 in.)

S11,2515,BY -19-16AUG94

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CRANKSHAFT GRINDING GUIDELINES

IMPORTANT: Crankshaft grinding should be done ONLY by experienced personnel on equipment capable of maintaining crankshaft size and finish specifications.

In addition to the standard size main and connecting rod bearings, 0.05, 0.25, 0.51 and 0.76 mm (0.002, 0.010, 0.020 and 0.030 in.) undersize bearings are available. If journals are tapered, out-of-round, scored or damaged, grind the crankshaft and install the proper undersize bearings.

NOTE: The 0.05 mm (0.002 in.) undersize bearings are used normally to compensate for slight un-even wear on crankshafts. Regrinding is usually unnecessary when this size bearing is used.

IMPORTANT: If undersize bearings are used, check bearing clearance after bearing caps have been tightened to specified torque. If undersize bearings are too tight and clearance is not within specifications, the journal and bearing will be wiped clean of all oil. This would result in premature wear of parts.

If the crankshaft is to be reground, use the following recommended procedure:

1. Compare the crankshaft journal measurements taken during inspection and determine the size which the journals are to be reground.

2. If one or more main or connecting rod journals require grinding, then grind all of the main journals or all of the connecting rod journals to the same required size.

3. All journal fillets radii must be free of any sharp grind marks or scratches. The fillet must blend smoothly into the journal and crank cheek. Check the radius with a fillet gage.

IMPORTANT: Care must be taken to avoid localized heating which often produces grinding cracks.

S11,2015,DM -19-16AUG94

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CRANKSHAFT GRINDING GUIDELINES—CONTINUED

4. Cool the crankshaft while grinding by using coolant generously. DO NOT crowd the grinding wheel into the work.

IMPORTANT: Grind crankshaft with journals turning counterclockwise, as viewed from the front end of crankshaft. Lap or polish journals in opposite direction of grinding.

5. Polish or lap the ground surfaces to the specified finish to prevent excessive wear of the journals. (See CRANKSHAFT GRINDING SPECIFICATIONS, later in this group.)

NOTE: Production crankshafts are induction hardened and shotpeened at the factory. Field shotpeening is not recommended due to the equipment required and part geometry.

6. If the thrust surfaces of the crankshaft are worn or grooved excessively, regrind and polish. Maintain the specified radius between each thrust surface and the bearing journal. An oversize thrust washer set containing one standard washer and two 0.18 mm (0.007 in.) oversize washers is available. (See THRUST BEARING NEW PART SPECIFICATIONS, later in this group.)

NOTE: When thrust surfaces are reground and an oversize washer is used, crankshaft end play specification must be maintained to within 0.038—0.380 mm (0.0015—0.0150 in.) (See CHECK CRANKSHAFT END PLAY, earlier in this group.)

7. Stone the edge of all oil holes in the journal surfaces smooth to provide a radius of approximately 1.50 mm (0.060 in.).

8. When finished grinding, inspect the crankshaft for cracks with the Florescent Magnetic Particle method, or similar method.

9. De-magnetize the crankshaft.

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

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S11,2015,HD -19-08MAR94

CRANKSHAFT GRINDING SPECIFICATIONS

ITEM	SPECIFICATION
Engine Stroke	121 mm (4.75 in.)
Main and Rod Journal Surface Finish	Lap 0.20 Um (8 AA)
Thrust Journal Surface Finish	Lap 0.40 Um (16AA)
Rod Journal Fillet Radius	3.94—4.44 mm (0.155—0.175 in.)
Main Journal Fillet Radius	3.94—4.44 mm (0.155—0.175 in.)
Thrust Journal Fillet Radius	3.56—4.06 mm (0.140—0.160 in.)
Thrust Journal Width	44.387—44.487 mm (1.7475—1.7515 in.)

Bearing Size	Crankshaft Main Journal OD	Crankshaft Rod Journal OD
Standard	85.649—85.674 mm (3.3720—3.3730 in.)	76.149—76.175 mm (2.9980—2.9990 in.)
0.05 mm (0.002 in.) Undersize	85.598—85.623 mm (3.3700—3.3710 in.)	76.098—76.124 mm (2.9960—2.9970 in.)
0.25 mm (0.010 in.) Undersize	85.394—85.420 mm (3.3620—3.3630 in.)	75.895—75.920 mm (2.9880—2.9890 in.)
0.51 mm (0.020 in.) Undersize	85.140—85.166 mm (3.3520—3.3530 in.)	75.641—75.667 mm (2.9780—2.9790 in.)
0.76 mm (0.030 in.) Undersize	84.887—84.912 mm (3.3420—3.3430 in.)	75.387—75.413 mm (2.9680—2.9690 in.)

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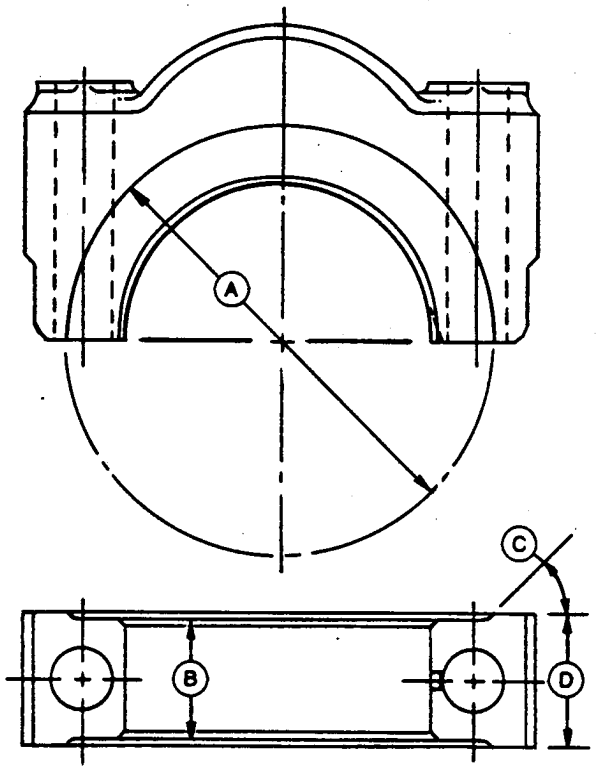
S11,2015,HG -19-17AUG94

THRUST BEARING NEW PART SPECIFICATIONS

IMPORTANT: Install thrust bearing in cylinder block and tighten to specification before regrinding or polishing thrust surfaces to assure that all surface on bearing and on block web are correctly aligned.

THRUST BEARING NEW PART SPECIFICATION

Thrust Washer Clearance Base Circle Diameter	123.70—125.30 mm (4.87—4.93 in.)
Thrust Surface Thickness	37.44—37.54 mm (1.474—1.478 in.)
Relief Angle	45°
Bearing Overall Width	39.16—39.66 mm (1.542—1.561 in.)
Maximum Thrust Surface Runout	0.025 mm (0.0010 in.)



RG5269 -UN-14DEC88

A—Thrust Washer Clearance Base Circle Diameter
B—Thrust Surface Thickness
C—Relief Angle
D—Bearing Overall Width

S55,2015,P -19-16AUG94

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REPLACE (CRANKSHAFT) OIL PUMP DRIVE GEAR

IMPORTANT: Protect all machined surfaces of crankshaft from grinding debris and weld spatter when removing old gear and installing new gear. DO NOT use a cutting torch to remove failed gear.

1. Using a rotary grinding wheel or parting disc, grind weld beads (A) until flush with crankshaft flange.

2. Remove gear (B) by alternately striking gear at each weld location using a brass drift and soft lead mallet.

3. After removal of gear, clean up OD of crankshaft flange and remove any burrs or remaining weld bead to eliminate interference when installing new gear.

CAUTION: Oil fumes or oil can ignite above 193˚C (380˚F). Use a thermometer and do not exceed 182˚C (360˚F). Do not allow a flame or heating element to be in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

4. Heat new gear to 148˚C (300˚F) using either heated oil or oven heat.

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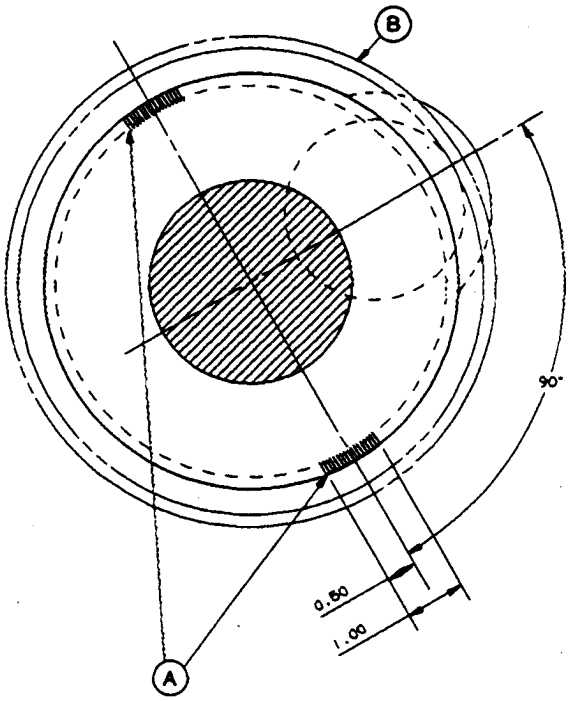
IMPORTANT: DO NOT OVERHEAT GEAR. SEE CAUTION. Overheating may also destroy original heat treatment of gear.

5. Drive gear onto crankshaft flange until flush against shoulder.

NOTE: When driving oil pump drive gear onto crankshaft flange. The beveled edge of gear teeth should face the flywheel end of crankshaft.

6. Weld two 25.4 mm (1 in.) beads according to illustration using 1/8 in. diameter 7018 welding rod. Grind away excess weld to eliminate the possibility of interference with cylinder block.



RG5018 -UN-14DEC88

S11,2515,BG -19-08AUG94

REPLACE CRANKSHAFT DRIVE GEAR

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

1. Install JDG787 Thread Protector in nose of crankshaft.

2. Protect crankshaft wear sleeve surface with masking tape.

3. Remove crankshaft gear using D01212AA* Puller with 630-9 Adapter, or an equivalent puller.

4. Discard gear after removal.

5. Remove Woodruff key from crankshaft keyway.

6. Remove masking tape.

IMPORTANT: Crankshaft gear must be installed on crankshaft before crankshaft is installed in engine, otherwise damage to thrust bearings could occur.

CAUTION: Oil fumes or oil can ignite above 193˚C (380˚F). Use a thermometer and do not exceed 182˚C (360˚F). Do not allow a heating element to be in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

7. Heat crankshaft gear (if removed) to 148˚C (300˚F), using either heated oil or oven heat.

IMPORTANT: If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT. SEE CAUTION. Overheating may also destroy original heat treatment of gear.

NOTE: On crankshafts that have a tabbed Woodruff key, install key with tab facing forward.

8. Install Woodruff key in crankshaft.

9. Place gear on crankshaft flange. Be sure key on crankshaft is properly aligned with keyway in gear.

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

10. Use JDH7 Driver to firmly seat gear against crankshaft flange.

11. Once gear cools, reseat gear using JDH7 Driver.

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**Part of D01048AA 17-1/2 Ton Puller Set.*

RG,CTM1,G15,12 -19-26JUL94

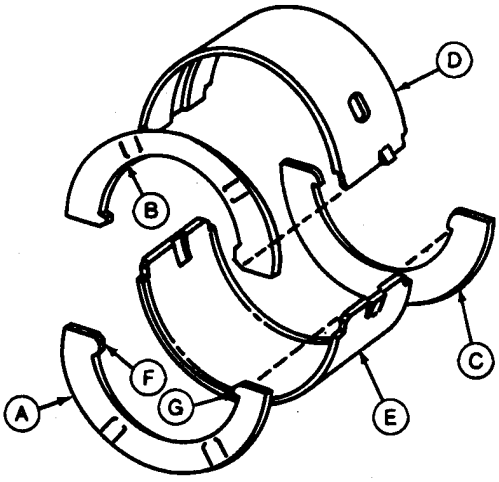
INSPECT THRUST BEARINGS

1. Check thrust surfaces of the thrust bearing and the thrust bearing journal on crankshaft and replace as necessary.

Thrust bearings are available in each of the previously mentioned insert undersizes. An oversize thrust washer set containing one regular size washer and two 0.18 mm (0.007 in.) oversize washers is also available.

NOTE: Thrust bearings must be installed with slots facing crankshaft flange. Two halves (A) and (C) go on cap side, not block.

A—Lower Rear Thrust Washer
B—Upper Rear Thrust Washer
C—Lower Front Thrust Washer
D—Main Bearing Block Thrust Bearing
E—Main Bearing Cap Thrust Bearing
F—Large Tang
G—Small Tang



R24545 -UN-15DEC88

S11,0403,AF -19-08MAR94

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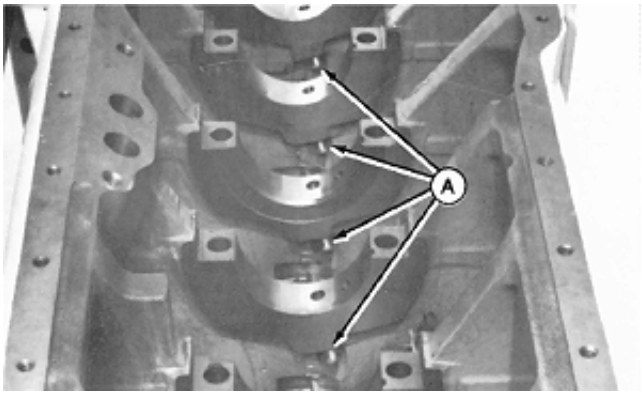
REMOVE AND CLEAN PISTON COOLING ORIFICES

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

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

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

3. Install orifices and tighten to 11 N·m (97 lb-in.).



RG3752 -UN-14DEC88

S11,2015,CN -19-07JUL94

INSTALL MAIN BEARING INSERTS IN BLOCK

IMPORTANT: If new main or thrust bearing inserts or thrust washers are installed, they must be installed as a matched set.

During assembly, apply a liberal coating of clean engine oil to:

—All main bearing webs in block

—Both sides of main bearing inserts, thrust bearing inserts, and thrust washers

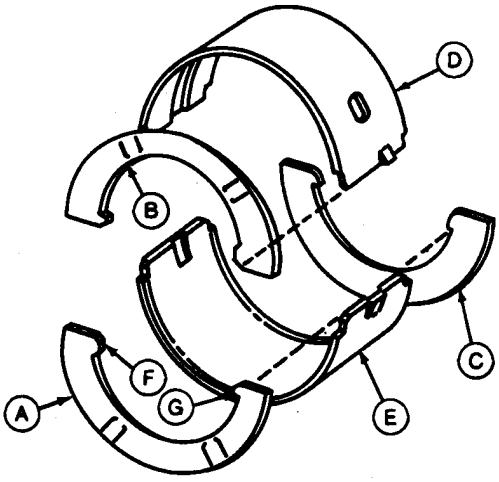
—Entire OD of crankshaft main bearing journal

1. Install six main bearing inserts in block except No. 5 thrust bearing insert. Be sure locating tabs on inserts are properly positioned with slot in block web.

IMPORTANT: Thrust washers (A, C) go on both sides of bearing cap and thrust washer (B) on rear side of block web only with the slots facing the crankshaft.

2. Install No. 5 main thrust bearing insert (D) in block. Install upper thrust washer on bearing insert at rear of block web. Be sure tangs on washer are properly positioned on thrust bearing insert.

3. Check to make sure that oil holes in main bearing web are properly aligned with oil holes in bearing inserts.

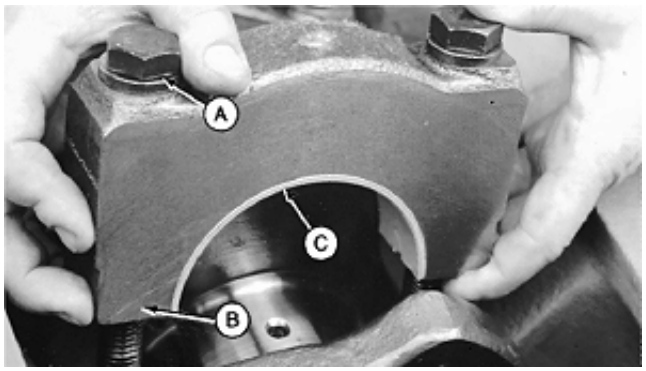


R24545 —UN—15DEC88

A—Lower Rear Thrust Washer
B—Upper Rear Thrust Washer
C—Lower Front Thrust Washer
D—Main Bearing Block Thrust Bearing
E—Main Bearing Cap Thrust Bearing
F—Large Tang
G—Small Tang

S11,0403,AI -19-08MAR94

INSTALL CRANKSHAFT



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

NOTE: If crankshaft is being replaced, vibration damper should be replaced also.

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

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

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44

3. Install each bearing cap (B), bearings (C), and cap screws with washer (A) with the recesses and tabs aligned in matching order. Make sure bearing tabs also match up before tightening cap screws.

NOTE: Make sure main bearing caps are installed on the bearing bosses from which they were removed. The numbers stamped on the caps should be on the same side as the numbers on the block. If there is an arrow on cap, arrow must be on the camshaft side of the block pointing towards the front of the engine. If bearing caps have been rebored, make sure bearing caps have numbers stamped on them.

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

4. Before tightening cap screws on main bearing caps, align upper and lower thrust flanges on main thrust bearings. Using a soft-face hammer, tap crankshaft to the rear and then to the front to line up thrust bearing flanges.

5. Tighten No.'s 1, 2, 3, 4, 6 and 7 main bearing cap screws to 68 N·m (50 lb-ft). Hand-tighten No. 5 main thrust bearing cap screws.

6. Gently pry crankshaft rearward and then forward to align thrust washers on No. 5 main thrust bearing.

NOTE: DO NOT PRY crankshaft on No. 5 main thrust bearing.

7. Tighten No. 5 main thrust bearing cap screws to 68 N·m (50 lb-ft).

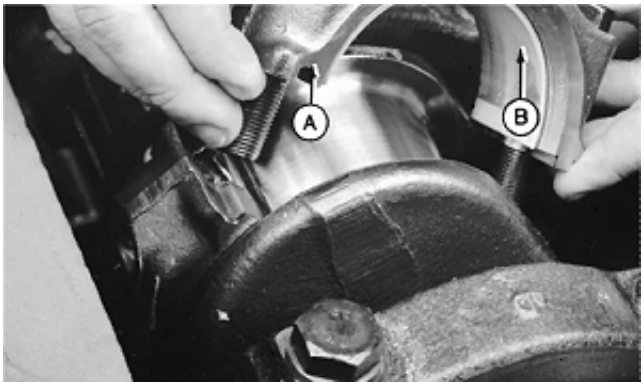
8. Tighten all main bearing cap screws (including No. 5) to 203 N·m (150 lb-ft).

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

S11,2515,O -19-08MAR94

10. Install connecting rod caps (A) with bearings (B). (See INSTALL PISTONS AND CONNECTING RODS in Group 10.)

11. Check crankshaft for 0.038—0.380 mm (0.0015—0.0150 in.) end play.



RG3743 -UN-14DEC88

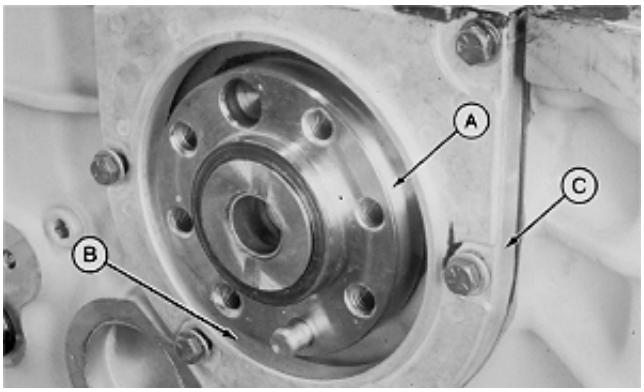
S11,0401,CL -19-08MAR94

INSTALL CRANKSHAFT REAR OIL SEAL HOUSING

These instructions are for when oil seal housing and oil pan have been removed from cylinder block.

1. Make sure the OD of crankshaft flange (A) and ID of seal housing (B) are free from nicks or burrs. Restore damaged surfaces with a fine file or emery cloth. Clean with compressed air.

2. Install oil seal housing (C) on cylinder block using a new gasket. Install all six cap screws with washers, and tighten finger tight.



RG4637 -UN-14DEC88

S11,2015,GS -19-08MAR94

IMPORTANT: Installation tools must be clean to assure proper positioning on crankshaft flange and to hold runout within specification so oil seal does not fail prematurely.

3. On oil seal housing casting no. R78124, use JDG478* Driver (A) over crankshaft flange and into seal housing bore to center oil seal housing. On oil seal housing casting no's. R115050 and R125027, use JDG796 Alignment Tool (C).

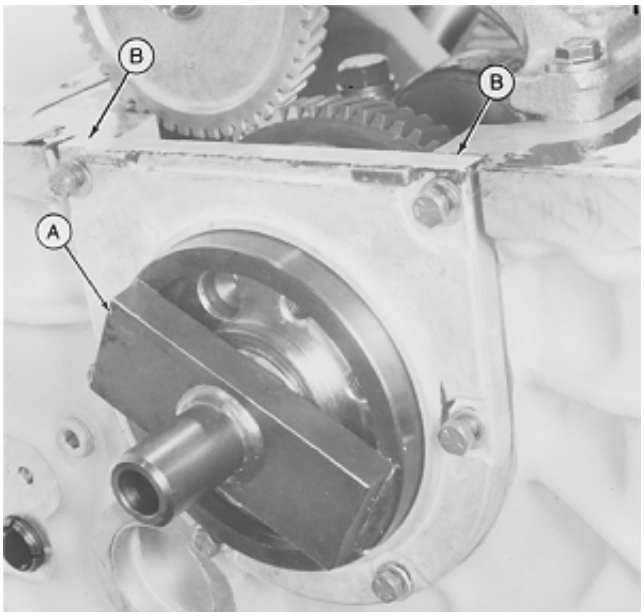
Both tools are designed to center the oil seal housing in relation to crankshaft flange. However, the use of a magnetic base dial indicator is still recommended to measure the seal housing runout. Runout should not exceed 0.15 mm (0.006 in.).

4. Position bottom of oil seal housing flush with cylinder block-to-oil pan mating surface. Tighten oil seal housing cap screws to 27 N·m (20 lb-ft), using sequence shown, beginning with cap screw No. 1.

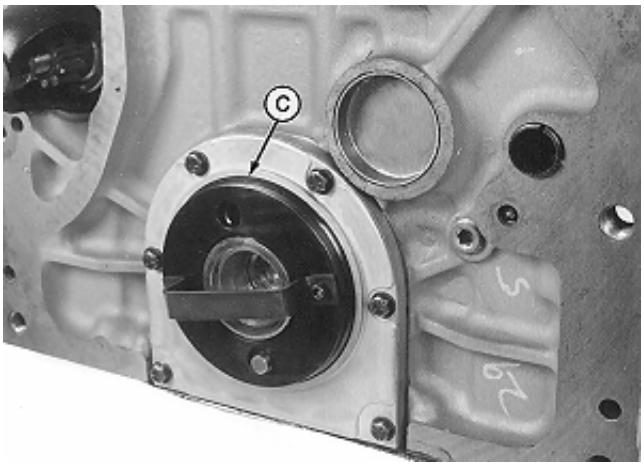
5. Remove tool from end of crankshaft flange.

6. Check oil seal housing runout with a magnetic base dial indicator. See CHECK REAR OIL SEAL HOUSING RUNOUT, later in this group.

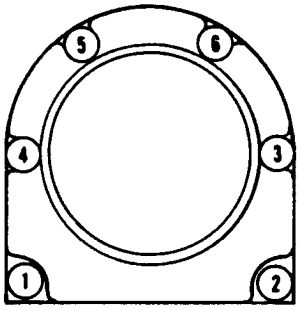
7. Trim off excess gasket material extending below bottom of oil seal housing.



RG4638 -UN-14DEC88



RG7733 -UN-22JUL94



RG6427 -UN-13OCT92

*From JDG476(85) Oil Seal and Wear Sleeve Installer Set.

S11,2015,DQ -19-08AUG94

CHECK REAR OIL SEAL HOUSING RUNOUT

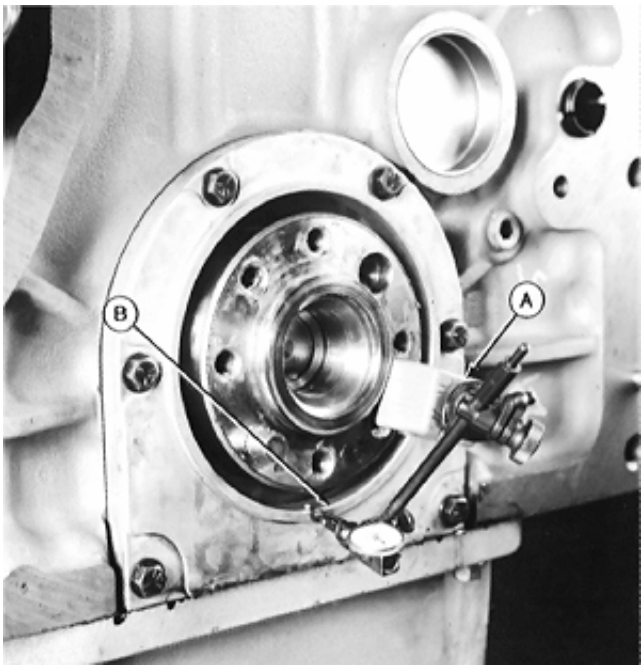
IMPORTANT: On service “shortblock” assemblies, rear oil seal housing runout is preset at the factory. Do not remove housing from block.

1. Position magnetic base dial indicator (A) on end of crankshaft flange as shown. Preset dial indicator tip on ID of oil seal housing bore (B).

2. Zero dial indicator and rotate crankshaft one full revolution, observe full indicator movement. The maximum oil seal housing bore runout is 0.15 mm (0.006 in.).

If runout exceeds specification, loosen cap screws and adjust housing to obtain an acceptable runout while keeping bottom of seal housing flush with oil pan mating surface.

3. Recheck oil seal housing bore runout. If runout still exceeds specification, oil seal housing bore is possibly distorted and should be replaced. See INSTALL CRANKSHAFT REAR OIL SEAL HOUSING, earlier in this group.



RG5751 -UN-05AUG91

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RG,CTM1,G15,15 -19-08MAR94

CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE HANDLING PRECAUTIONS

Use the following precautions for handling seal and wear sleeve:

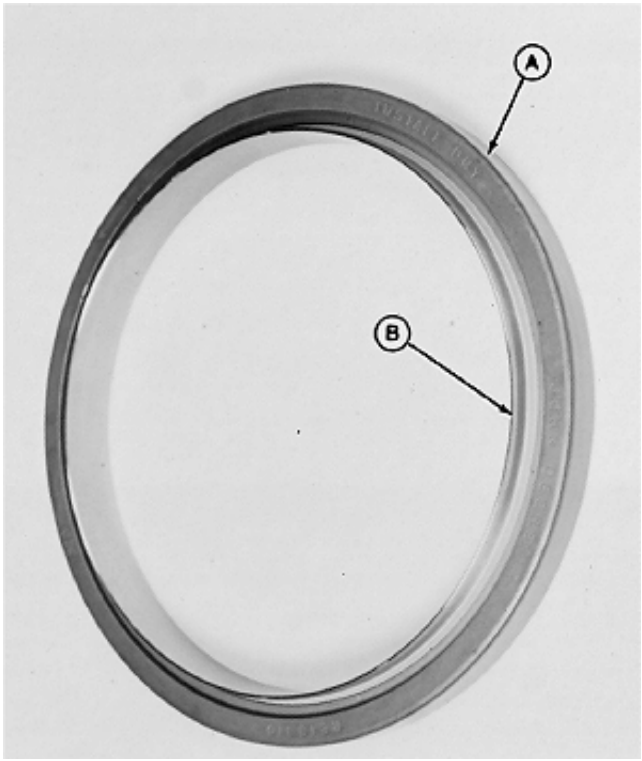
—Seal (A) and wear sleeve (B) are assembled. DO NOT SEPARATE. If parts become separated, discard and replace with a new assembly. Attempts to reassemble will cause the wear sleeve to damage the seal allowing engine oil to leak past seal.

—Always install seal and wear sleeve assembly immediately after removal from plastic bag to avoid possible dirt contamination.

—No lubrication of any kind is to contact seal when installing. Use of a lubricant may result in premature seal failure.

—Install oil seal/wear sleeve assembly with the open side of seal and wear sleeve ID chamfer toward the engine. If seal is reversed, engine oil may be lost because grooves in oil seal lip would be incorrect with respect to direction of crankshaft rotation.

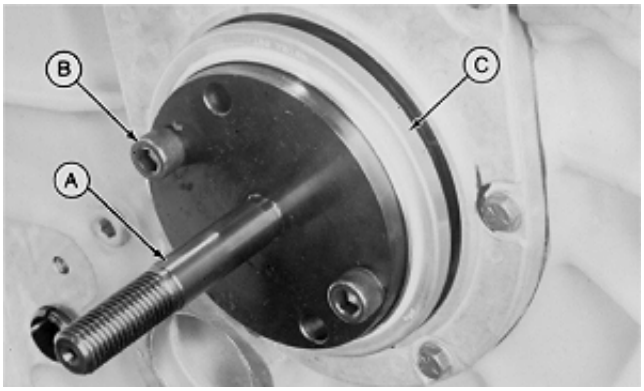
—Oil seal/wear sleeve assembly MUST be installed with the JDG476(85) Crankshaft Rear Oil Seal Installation Tool Set. Tool set consists of JDG477(85) Pilot and JDG478 Driver.



RG5575 -UN-07JUL89

S11,2015,GP -19-08MAR94

INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE ASSEMBLY



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

IMPORTANT: DO NOT allow sealant to get on any part of wear sleeve OD or on oil seal.

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

IMPORTANT: Handle seal and wear sleeve assembly carefully. If assembly becomes separated, discard these parts and install a new assembly.

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

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

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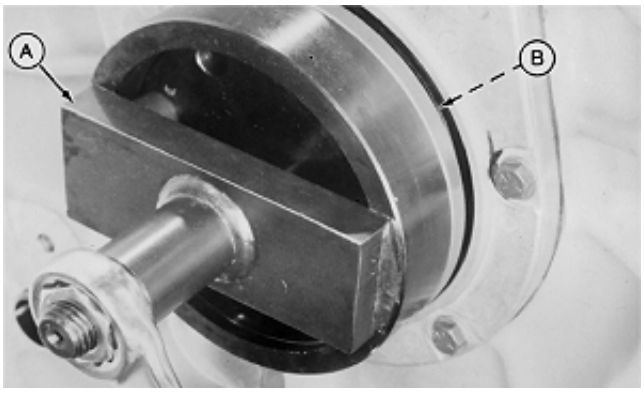
S11,2015,DR -19-08MAR94

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

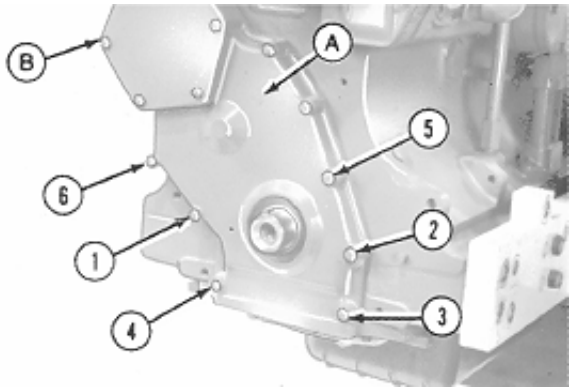
5. Tighten nut to draw JDG478 Installer in until it bottoms on oil seal housing flange (B). When the tool bottoms, seal and wear ring assembly will be correctly positioned.

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



S11,2015,DX -19-08MAR94

INSTALL TIMING GEAR COVER



-UN-26JAN90
RG4377

1. Using new gaskets, install timing gear cover (A) and injection pump gear cover (B). Tighten cap screws in sequence one thru six to 27 N·m (20 lb-ft).

NOTE: Tightening the timing gear cover in proper sequence controls the total runout for the front crankshaft oil seal.

2. Trim gasket flush with oil pan mounting face.

3. Using a new gasket, install magnetic pickup, if equipped, and tighten cap screws to 12 N·m (9 lb-ft).

4. Install gear-driven water pump. (See INSTALL GEAR-DRIVEN WATER PUMP in Group 25.) Finish tightening timing gear cover cap screws to 27 N·m (20 lb-ft).

S11,2005,EH -19-08AUG94

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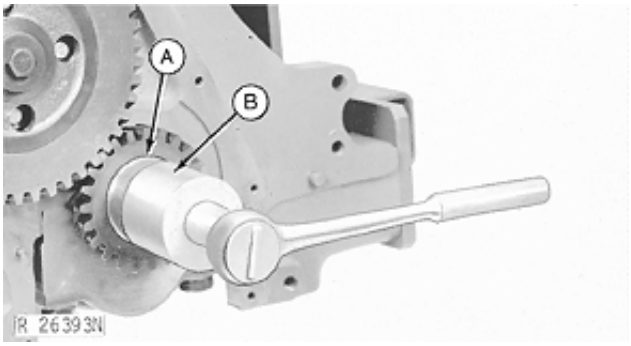
INSTALL FRONT WEAR SLEEVE



-UN-15DEC88
R26393

NOTE: Front wear sleeve can be installed with timing gear cover removed or installed.

1. Coat I.D. of new wear sleeve (if removed) with LOCTITE 609 Retaining Compound or equivalent.

2. Use the JDE3 Front Wear Sleeve Installer (B), large washer, and cap screw threaded in nose of crankshaft to press on wear sleeve (A).

S11,0403,AR -19-08AUG94

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

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

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

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

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

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

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

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

RG6479 -UN-26OCT92

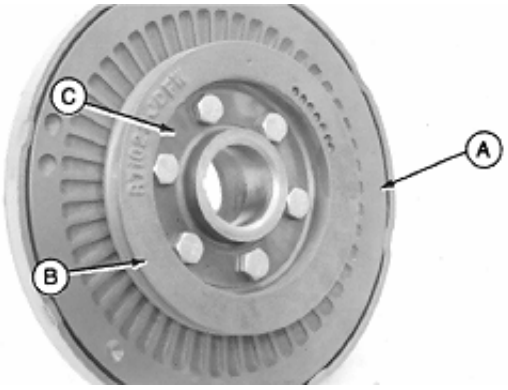
RG6480 -UN-26OCT92

RG,CTM1,G15,16 -19-08MAR94

INSTALL DAMPER PULLEY ASSEMBLY

1. If vibration damper (A) was removed from damper pulley (B), install washer (C) and tighten cap screws to 41 N·m (30 lb-ft).

NOTE: Vibration damper and pulley orientation may vary depending on specific engine application. Be sure damper and pulley are assembled in the same orientation as when removed.



RG3928 -UN-14DEC88

S11,2015,DT -19-16AUG94

2. Make sure crankshaft Woodruff key is in place. Position damper pulley assembly (B) onto crankshaft.

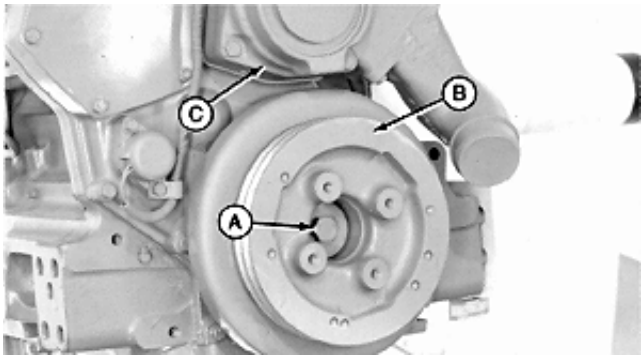
3. Use hardened washer (part of damper assembly) and insert a cap screw that is 25 mm (1 in.) longer than original cap screw (A). Tighten cap screw until cap screw just bottoms out.

4. Remove cap screw and insert original cap screw with same hardened washer.

5. Tighten cap screw to 230 N·m (170 lb-ft).

6. Install water pump (C), if removed. (See INSTALL WATER PUMP in Group 25).

NOTE: It is not necessary to remove water pump for crankshaft removal on belt-driven water pump engines.



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S11,2015,DU -19-08AUG94

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52

INSTALL SAE 1 AND SAE 2 FLYWHEEL HOUSING

On units with SAE 1 and SAE 2 flywheel housings, the flywheel housing is installed BEFORE installing the flywheel. On units with SAE 3 flywheel housings, the housing is installed AFTER installing flywheel.

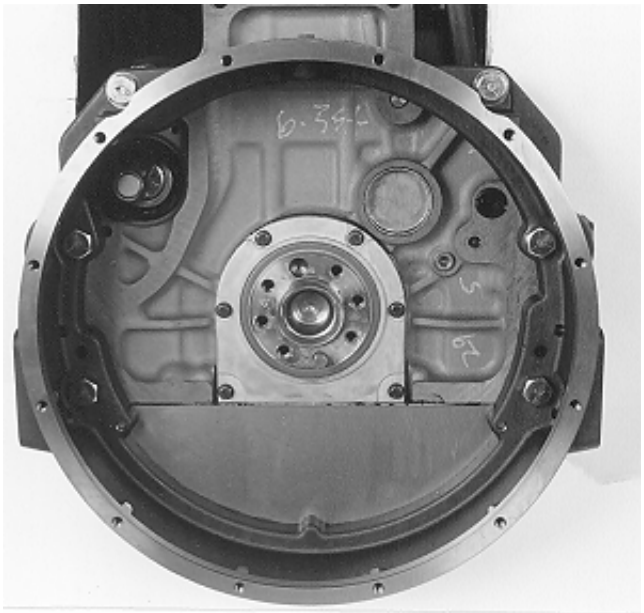
CAUTION: Flywheel housing is heavy. Plan a proper lifting procedures to avoid personal injury.

1. Scrape off all old gasket material. Install a new gasket without sealant between block and flywheel housing, if equipped.

2. Install flywheel housing on cylinder block.

NOTE: ALWAYS use new cap screws when installing flywheel housing.

3. Dip threads of cap screw in engine oil before installing. Install and tighten cap screws to 407 N·m (300 lb-ft).



RG7732 -UN-22JUL94

RG,CTM1,G15,17 -19-08AUG94

INSTALL FLYWHEEL

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

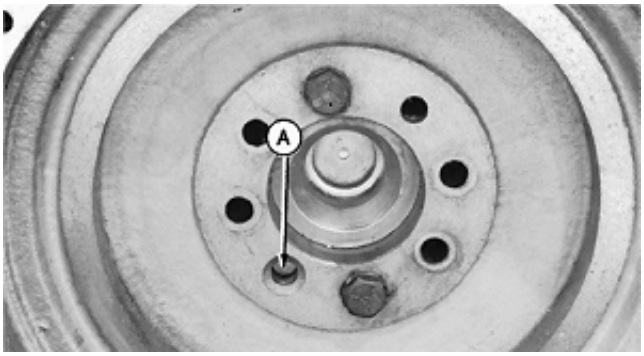
NOTE: Use new cap screws when installing flywheel.

1. Coat threads of flywheel attaching cap screws with LOCTITE 242 Thread Lock and Sealer or its equivalent.

2. Position flywheel over dowel pin (A) and start two cap screws. Do not tighten.

3. Install remaining flywheel attaching cap screws.

4. Tighten flywheel attaching cap screws to 115 N·m (85 lb-ft).



RG4383 -UN-14DEC88

S11,2010,L -19-08MAR94

INSTALL SAE 3 FLYWHEEL HOUSING

On units with SAE 1 and SAE 2 flywheel housings, the flywheel housing is installed BEFORE the flywheel. On units with SAE 3 flywheel housings, the flywheel housing is installed after installing the flywheel.

CAUTION: Flywheel housing (A) is heavy. Plan a proper lifting procedure to avoid personal injury.

1. On engines requiring a gasket between block and flywheel housing, inspect cylinder block and flywheel housing gasket surfaces to see that they are clean. Scrape off all old gasket material. Install a new gasket without sealant between block and flywheel housing.

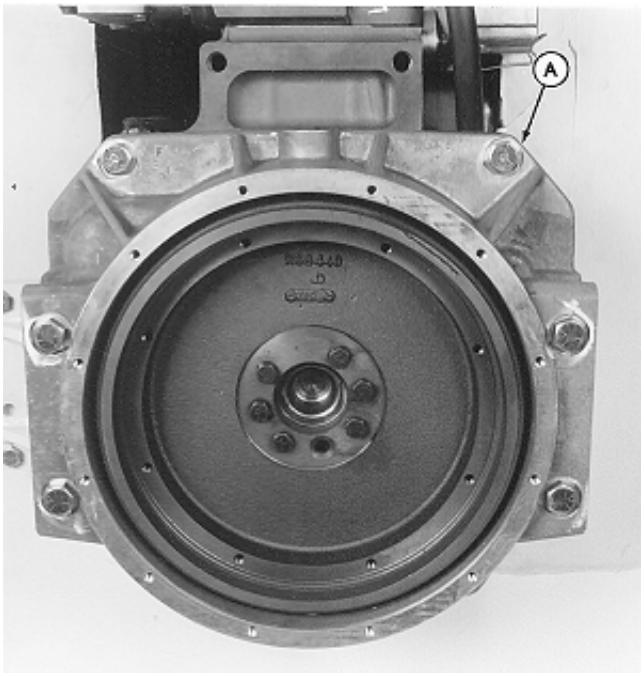
2. Install flywheel housing on cylinder block.

NOTE: Use new cap screws when installing flywheel housing.

3. Dip threads of cap screw in engine oil before installing. Install and tighten cap screws to specifications listed below:

FLYWHEEL HOUSING TORQUE SPECIFICATIONS

Flywheel Housing-to-Cylinder Block	407 N·m (300 lb-ft)
Flywheel Housing-to-Oil Pan	325 N·m (240 lb-ft)



RG7730 -UN-22JUL94

15 53

RG,CTM1,G15,18 -19-08AUG94

COMPLETE FINAL ASSEMBLY

1. Install fan assembly.

2. Install oil pump, oil pan, and clean engine oil. (See Lubrication System, Group 20.)

3. Fill cooling system with proper coolant. (See Fuels, Lubricants, and Coolant Group 02.)

4. Perform engine break-in as instructed in Group 05.

S11,2015,DV -19-17AUG94

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

Slide Hammer D01299AA

Used with JDG405 Camshaft Bushing Service Set and JDG606 Camshaft Bushing Adapter Set to service camshaft bushings.

RG78104H1 -UN-15DEC88

S53,D01299,AAA -19-09SEP91

RG5073 -UN-23AUG88

Magnetic Follower Holder Kit D15001NU

Hold cam followers when removing or installing camshaft.

S53,D15001,NU -19-24APR92

RG5080 -UN-23AUG88

Front Wear Sleeve Installer JDE3

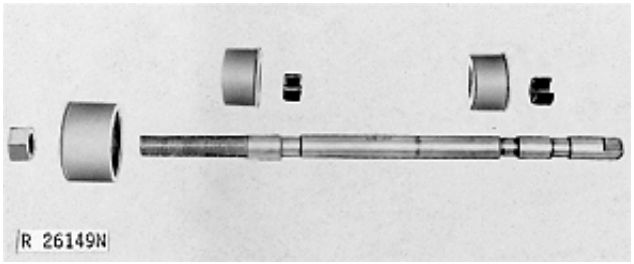
Install front oil seal in timing gear cover.

S53,JDE3A -19-16AUG94

Camshaft Bushing Service Set JDE6

Used with JDG602 Camshaft Bushing Adapter Set to service camshaft bushings.

NOTE: JDG405 Service Set may be used along with JDG606 Adapter Set if JDE6 is not available.



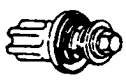
R26149N -UN-23AUG88

S53,JDE6A -19-09SEP91

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

Rotate engine flywheel. Use with JDE81-4 Timing Pin.

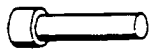


S53,JDE811B -19-08AUG94

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Lock engine at TDC when timing valve train.

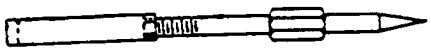


S53,JDE814A -19-08AUG94

RG5009 -UN-06APR89

Camshaft Wear Indicator JDE109

Measure camshaft gear-to-oil pump gear backlash.

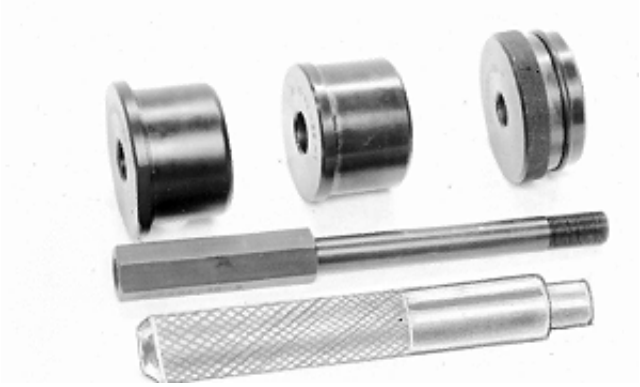


S53,JDE109 -19-10AUG94

Camshaft Bushing Service Set JDG405

Used with JDG606 Camshaft Bushing Adapter Set and D01299AA Slide Hammer to service camshaft bushings.

NOTE: JDE6 Service Set may be used along with JDG602 Adapter Set if JDG405 is not available.



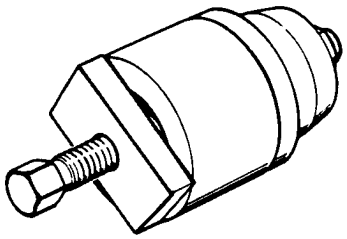
-UN-27JAN92 RG4228

S53,JDG405,A -19-28APR92

Seal Installer JDG720

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

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



-UN-06MAR92 RG6215

RG,JDG720 -19-01APR93

SERVICE EQUIPMENT AND TOOLS

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

Name	Use
D01207AA Puller Kit	Used to remove vibration damper.
D01045AA Bushing, Bearing, and Seal Driver Master Set	Used to install front oil seal in timing gear cover.

RG,CTM42,G16,4 -19-10SEP91

OTHER MATERIAL

Name	Use
High Temperature Grease (TY6333 or TY6347)	Lubricate camshaft lobes and thrust washers before camshaft installation.
PERMATEX AVIATION (Form-A-Gasket No. 3) (TY6299)	Lubricate camshaft bore steel cap plug.
LOCTITE 242 (TY9370/T43512) Thread Lock and Sealer	Coat threads of camshaft thrust plate-to-cylinder block mounting screws and tachometer drive mounting screws.
LOCTITE 592 (TY9374/TY9375) Pipe Sealant with TEFLON	Coat threads of pipe plug in tachometer drive.
LOCTITE 609 (T43515) Retaining Compound	Crankshaft front wear sleeve.

S11,2016,80 -19-17AUG94

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CAMSHAFT AND TIMING GEAR TRAIN SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Camshaft End Play	0.063—0.241 mm (0.0025—0.0095 in.)	0.38 mm (0.0150 in.)
Camshaft Thrust Plate Thickness	4.72—4.80 mm (0.186—0.189 in.)	4.62 mm (0.1820 in.)
Camshaft Journal OD	60.312—60.338 mm (2.3745—2.3755 in.)	---
Camshaft Bushing ID	60.389—60.439 mm (2.3775—2.3795 in.)	---
Camshaft Bushing-to-Journal Clearance	0.051—0.127 mm (0.0020—0.0050 in.)	0.152 mm (0.0060 in.)
Minimum Camshaft Gear-to-Injection Pump Drive Gear Backlash	0.051 mm (0.0020 in.)	---
Camshaft Bushing Bore in Cylinder Block (without bushings)	63.487—63.513 mm (2.4995—2.5005 in.)	---
Maximum Runout of Camshaft Bore Diameter		0.038 mm (0.0015 in.)
Minimum Camshaft Drive Gear-to-Crankshaft Gear Backlash	0.0762 mm (0.003 in.)	---
Camshaft Lobe Lift:		
6466D Intake and Exhaust	7.10—7.20 mm (0.279—0.283 in.)	6.58 mm (0.259 in.)
6466T and 6466A Intake	6.93—7.04 mm (0.273—0.277 in.)	6.43 mm (0.253 in.)
6466T and 6466A Exhaust	7.10—7.20 mm (0.279—0.283 in.)	6.58 mm (0.259 in.)
Camshaft Follower OD	17.33—17.35 mm (0.682—0.683 in.)	---
Camshaft Follower Bore Diameter in Block	17.384—17.440 mm (0.6845—0.6865 in.)	---
Front Camshaft Journal-to-Thrust Plate Clearance	0.115—0.245 mm (0.0045—0.0096 in.)	0.345 mm (0.0136 in.)
Camshaft Gear-to-Oil Pump Gear Backlash*		
Maximum		3.5° or 2.03 mm (0.080 in.)
Minimum		0.5° or 0.25 mm (0.010 in.)
Valve Lift at 0.00 mm (in.) Clearance:		
6466D Intake and Exhaust	11.54—11.70 mm (0.454—0.461 in.)	10.69 mm (0.421 in.)
6466T and 6466A Intake	11.26—11.44 mm (0.443—0.450 in.)	10.45 mm (0.411 in.)
6466T and 6466A Exhaust	11.54—11.70 mm (0.454—0.461 in.)	10.69 mm (0.421 in.)
Maximum Crankshaft Front Oil Seal Bore Runout		0.254 mm (0.010 in.)
Crankshaft Front Oil Seal Installed Depth (Below Front Face of Seal Bore)	8.4 mm (0.33 in.)	---

**Camshaft-driven oil pumps only.*

S11,2016,BK -19-08AUG94

CAMSHAFT AND TIMING GEAR TRAIN SPECIFICATIONS—CONTINUED

TORQUES

Magnetic Pickup Cover	12 N·m (9 lb-ft)
Tachometer Drive Housing or Cover Plate	47 N·m (35 lb-ft)
Rocker Arm Shaft Clamps	75 N·m (55 lb-ft)
Rocker Arm Cover-to-Cylinder Head	8 N·m (71 lb-in.)
Camshaft Thrust Plate	27 N·m (20 lb-ft)
Camshaft Gear:	
D-Grade Cap Screws	115 N·m (85 lb-ft)
G-Grade Cap Screws	163 N·m (120 lb-ft)
Timing Gear Cover-to-Cylinder Block*	27 N·m (20 lb-ft)
Injection Pump Gear Cover	27 N·m (20 lb-ft)

**See INSTALL TIMING GEAR COVER later in this group for proper cap screw tightening sequence.*

RG,CTM1,G16,1 -19-08AUG94

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5

CHECK VALVE LIFT

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

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

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

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

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

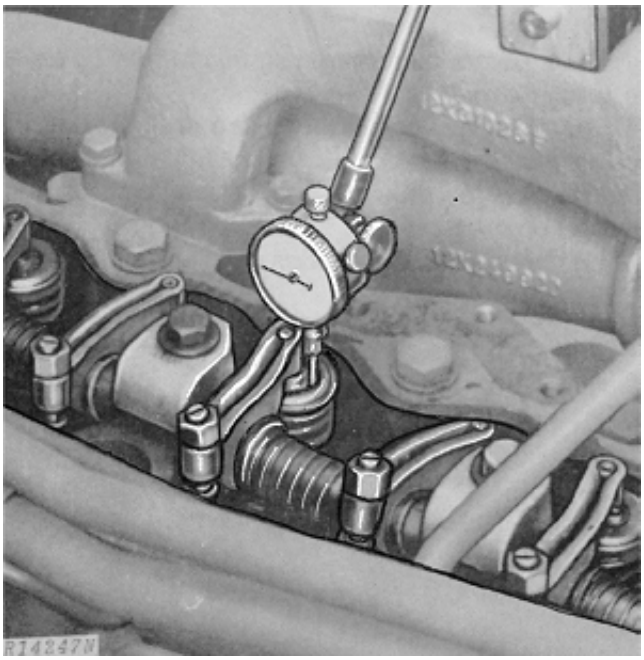
4. Manually turn engine in running direction, using the engine rotation tools previously mentioned for checking valve clearance.

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

VALVE LIFT SPECIFICATIONS AT 0.00 MM (IN.) CLEARANCE

	SPECIFICATION	WEAR LIMIT
6466D:		
Intake	11.54—11.70 mm (0.454—0.461 in.)	10.69 mm (0.421 in.)
Exhaust	11.54—11.70 mm (0.454—0.461 in.)	10.69 mm (0.421 in.)
6466T and 6466A:		
Intake	11.26—11.44 mm (0.443—0.450 in.)	10.45 mm (0.411 in.)
Exhaust	11.54—11.70 mm (0.454—0.461 in.)	10.69 mm (0.421 in.)

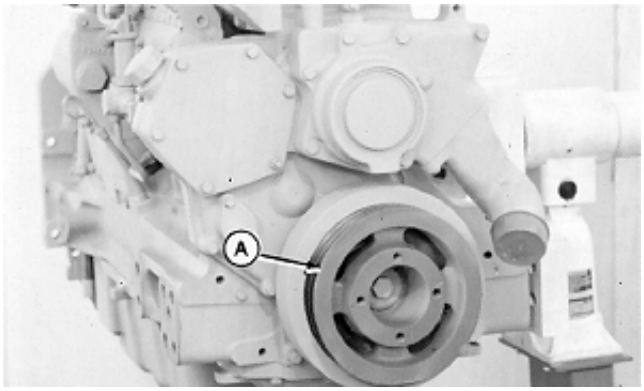
6. Adjust valve clearance to specification after measuring lift. (See CHECK AND ADJUST VALVE CLEARANCE, in Group 05.)



R14247N -UN-09JAN90

S11,2005,HCA -19-08AUG94

REMOVE DAMPER PULLEY AND TIMING GEAR COVER



1. Drain oil from engine crankcase. Disconnect turbocharger oil inlet line at turbocharger or oil filter housing. See DISCONNECT TURBOCHARGER OIL INLET LINE in Group 03.

NOTE: For on-highway applications only, flywheel has two timing holes. Injection pump reference timing marks will align at 14° BTDC.

2. Set engine at "TDC" compression No. 1 cylinder.

3. Remove rocker arm cover, rocker arm assembly, and push rods as instructed earlier in this group. Remove cylinder head, if desired.

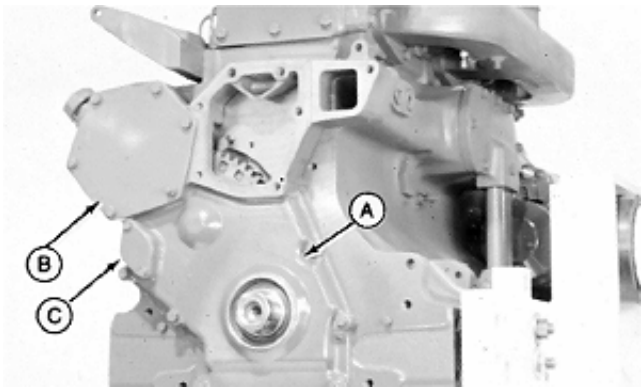
4. Remove water pump (A). (See REMOVE WATER PUMP in Group 25.)

5. Remove vibration damper (B). (See REMOVE VIBRATION DAMPER in Group 15.)

S11,2005,IB -19-08AUG94

6. Remove magnetic pickup (C) if equipped.

7. Remove timing gear cover (A) and injection pump gear cover (B). Discard gaskets.



S11,2005,IC -19-17MAR94

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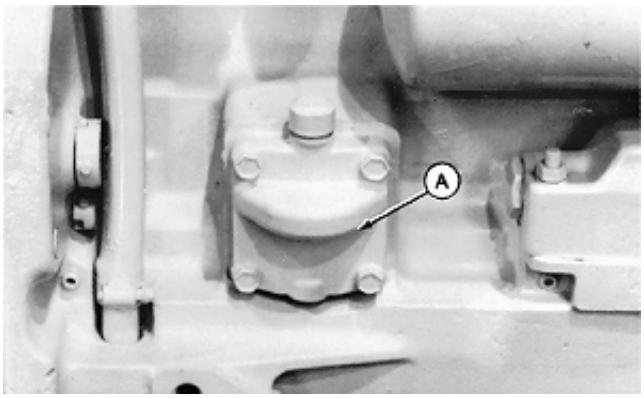
7

REMOVE TACHOMETER DRIVE ASSEMBLY (IF EQUIPPED)



1. Remove cap screws and pull tachometer drive assembly (A) from cylinder block. Discard gasket.

2. Clean all gasket material from cylinder block and housing.

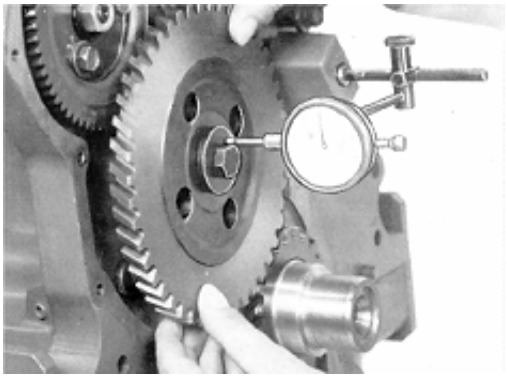
S11,2005,IH -19-17MAR94

CHECK CAMSHAFT END PLAY

1. Install magnetic base dial indicator on front face of cylinder block.

2. Position dial indicator tip on front face of camshaft gear. Set dial indicator to zero.

3. Move camshaft gear back and forth and observe end play reading. Compare with specifications given below.



CAMSHAFT END PLAY SPECIFICATIONS

New Camshaft End Play . . . . . 0.063—0.241 mm (0.0025—0.0095 in.)

Maximum Allowable End Play . . . . . 0.38 mm (0.0150 in.)

If end play is excessive, check thrust plate thickness using a new thrust plate and a feeler gauge after camshaft is removed. If camshaft end play is correct, measure timing gear backlash.

S11,2005,DA -19-17MAR94

MEASURE CAMSHAFT DRIVE GEAR-TO-CRANKSHAFT GEAR BACKLASH

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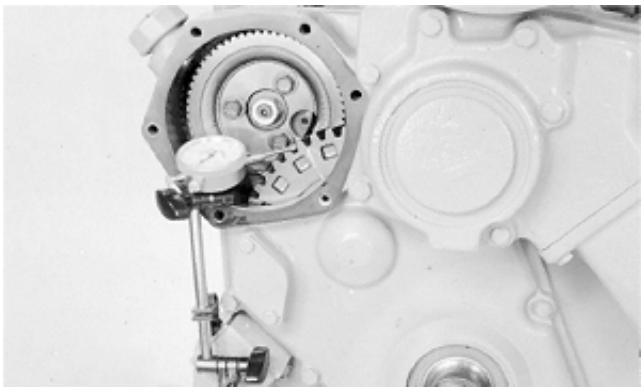
Measure backlash between camshaft drive gear and crankshaft gear in three (3) different positions around the camshaft gear. Use a magnetic base dial indicator with indicator plunger resting on camshaft gear tooth.



CAMSHAFT DRIVE GEAR-TO-CRANKSHAFT-GEAR BACKLASH SPECIFICATIONS

Minimum Camshaft Gear Backlash . . . . . 0.0762 mm (0.003 in.)

If backlash is not correct, install new gears.

S11,2016,BL -19-17MAR94

CHECK CAMSHAFT GEAR-TO-OIL PUMP GEAR BACKLASH— CAMSHAFT-DRIVEN OIL PUMP ENGINES ONLY (BEFORE ENGINE DISASSEMBLY)

NOTE: Before measuring backlash, the engine must be at normal operating temperature.

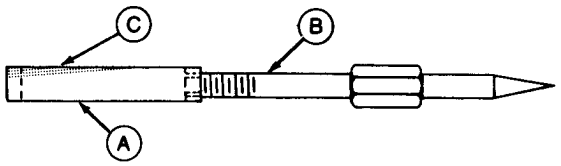
Before removing oil pump, determine if there is adequate backlash between oil pump and camshaft drive gears.

1. Remove tachometer drive housing, located on rear right-hand side of engine block, as described earlier in this group.

2. Screw together pointer (B) and ring (A) from JDE109 Camshaft Wear Indicator.

3. Install ring with pointer on top flange of engine oil pump drive gear. Do not tighten pointer.

NOTE: If interference exists between the cylinder block and the ring, grind some material (C) from ring.



RG7002 -UN-26JUN94

A—Ring
B—Pointer
C—Grind Material as Required

S11,2020,ED1 -19-08AUG94

16
9

4. Install gauge (D) on engine block using the two cap screws (A) provided with tool set.

5. Align the pointer (B) over the center mark on gauge and tighten pointer.

IMPORTANT: The pointer MUST BE tight to achieve an accurate backlash measurement.

6. Place fingers on hex portion of pointer (C) and move the pointer back and forth by hand. DO NOT use excessive force to move the pointer.

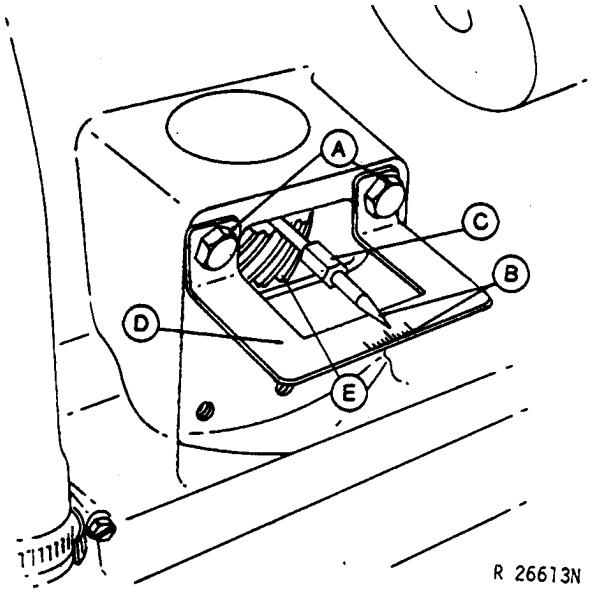
NOTE: Each mark on gauge is equivalent to 1˚ of backlash.

CAMSHAFT GEAR-TO-OIL PUMP DRIVEN GEAR BACKLASH SPECIFICATIONS

Minimum Acceptable Backlash	0.5˚
Maximum Acceptable Backlash	3.5˚

When checking backlash with new camshaft gear and/or oil pump gear, lubricate the camshaft, camshaft gear and oil pump gear with clean SAE30 engine oil.

If backlash is 3.5˚ or more, check camshaft oil pump drive gear and gear on oil pump for a step wear pattern on teeth of gears. Replace parts as necessary. If backlash is less than 0.5˚, or the camshaft does not rotate freely, install a new camshaft.



A—Cap Screws
B—Center Alignment
C—Hex Part of Pointer
D—Gauge
E—Engine Oil Pump Drive Gear

S11,2020,EE -19-10AUG94

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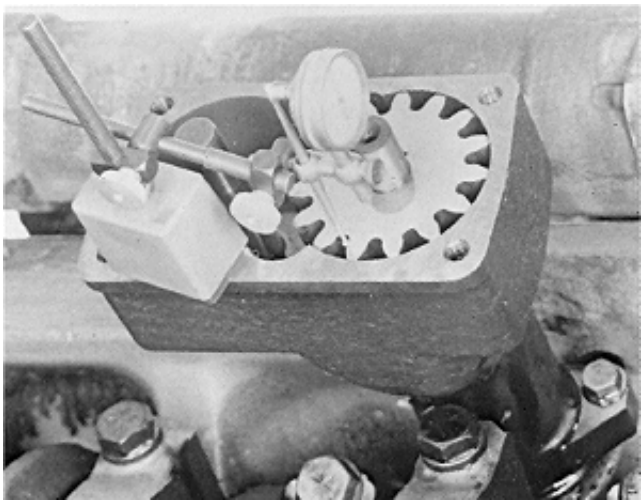
CHECK CAMSHAFT GEAR-TO-OIL PUMP GEAR BACKLASH— CAMSHAFT-DRIVEN OIL PUMP ENGINES ONLY (AFTER ENGINE DISASSEMBLY)


RG4969 -UN-19JAN90

NOTE: This test can be performed only with the engine removed from the vehicle and installed on a repair stand.

1. Turn engine over on engine roll-over stand and remove oil pan. (See DRAIN ENGINE OIL, COOLANT, AND REMOVE OIL PAN in Group 20.)

2. Remove pick-up screen and elbow from oil pump.

3. Remove oil pump cover and remove oil pump idler gear, if desired.

4. Use a magnetic base dial indicator with a ball tip approximately 2.3 mm (0.090 in.) diameter. Place ball tip at root of oil pump driven gear teeth.

5. Rotate gear clockwise by hand and set dial indicator at zero with ball tip of indicator at root of gear teeth.

6. Rotate gear counterclockwise and check dial indicator reading for gear backlash.

CAMSHAFT GEAR-TO-OIL PUMP DRIVEN GEAR BACKLASH SPECIFICATIONS

Maximum Acceptable Backlash	2.03 mm (0.080 in.)
Minimum Acceptable Backlash	0.25 mm (0.010 in.)

When checking backlash with new camshaft gear and/or oil pump gear, lubricate the camshaft, camshaft gear and oil pump gear with clean SAE30 engine oil.

If gear backlash exceeds specification, check oil pump drive gear and camshaft gear for a step wear pattern on teeth of gears. Replace parts as necessary. If backlash is less than 0.25 mm (0.010 in.), or the camshaft does not rotate freely, install a new camshaft.

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11

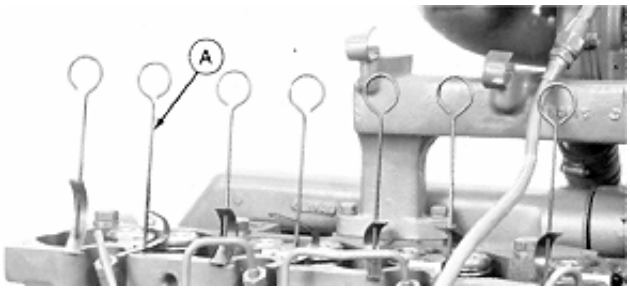
S11,2505,CV1 -19-08AUG94

REMOVE CAMSHAFT

IMPORTANT: Engine Serial No. (—161132), equipped with camshaft-driven oil pump, oil pan and oil pump, must be removed before removing camshaft. (See REMOVE OIL PUMP in Group 20.)

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

2. When removing camshaft with engine on rollover stand, roll engine to a vertical position (horizontal shown) and hold camshaft followers to fall away from the camshaft lobes with D15001NU Magnetic Holding Set (A).



RG3499 -UN-31JUL89

S11,2005,IL -19-08AUG94

3. Remove cap screws (A) from thrust plate.

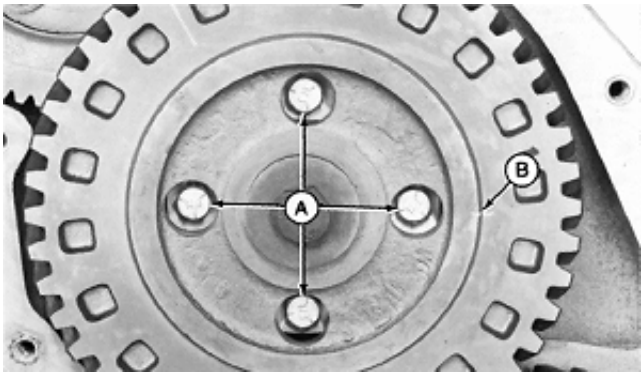
IMPORTANT: Check camshaft gear for slippage between the two parts of the gear. An indexing mark (B) has been placed across the parting line of the two gear parts. If the mark has separated, the gear should be replaced.

4. Examine camshaft gear and injection pump drive gear for worn or damaged gear teeth. Check backlash between gears.

CAMSHAFT GEAR-TO-INJECTION PUMP DRIVE GEAR BACKLASH SPECIFICATION

Minimum Backlash . . . . . 0.051 mm (0.0020 in.)

NOTE: Timing marks on crankshaft and camshaft gear should be aligned and No. 1 cylinder locked at "TDC Compression" stroke when removing camshaft.



RG3817 -UN-25SEP89

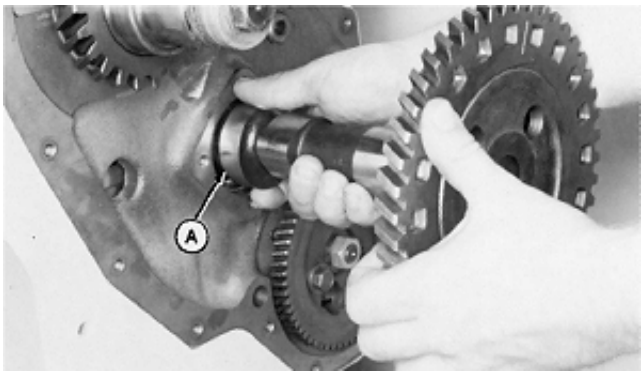

RG5779 -UN-06AUG91

S11,0401,BF -19-08AUG94

IMPORTANT: Be sure to set No. 1 Piston at TDC on compression stroke, using the JDE81-1 and JDE81-4 Engine Rotation Tool Set.

5. Carefully remove camshaft (A) from cylinder block so that camshaft lobes do not drag in bores.

NOTE: Rotate camshaft carefully to aid in removing.



-UN-23FEB89
RG3818

S11,0401,BG1 -19-08AUG94

REMOVE CAMSHAFT GEAR, SPACER, AND THRUST PLATE

NOTE: Camshaft gears are pressed onto the camshaft. Removal of gears from camshaft will require approximately a 10-ton press.

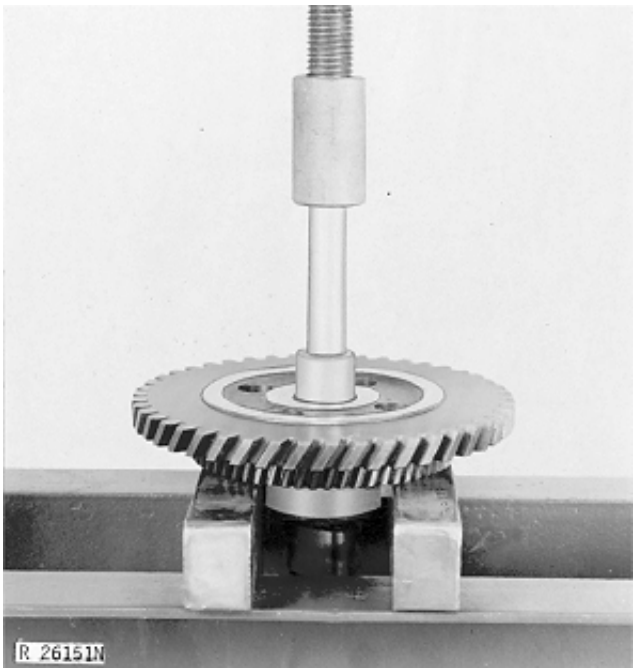
1. Remove cap screw with special washer and support camshaft gear in a press.

IMPORTANT: Prevent camshaft from striking floor when pressing camshaft from gear.

2. Press camshaft out of gear.

3. Remove spacer and thrust plate from camshaft.

4. Clean camshaft and thrust plate in solvent. Dry with compressed air.



-UN-09DEC88
R26151N

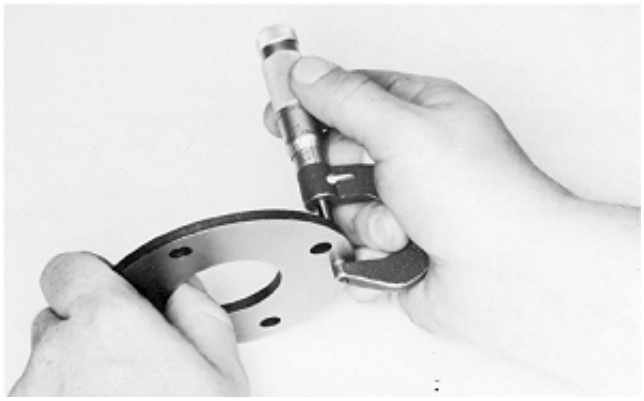
S11,0401,BH -19-17MAR94

MEASURE CAMSHAFT THRUST PLATE THICKNESS

1. After removal of camshaft gear, check thrust plate for proper thickness.

THRUST PLATE SPECIFICATIONS

New Part Thickness	4.72—4.80 mm (0.186—0.189 in.)
Allowable Wear Thickness	4.62 mm (0.182 in.)



-UN-17JUL89
RG2743

S11,0401,BI -19-17MAR94

SERVICE CAMSHAFT BUSHINGS USING JDE6 CAMSHAFT BUSHING SERVICE SET

1. Inspect camshaft journals and bushings for wear or damage. Measure camshaft journals and bushings to determine if proper oil clearance exists. Replace camshaft and/or bushings as necessary.

NOTE: The first two bushings can be reached from the front of the engine. The flywheel and camshaft bore plug (F) must be removed to reach the other two bushings.

2. Remove camshaft bushings (C) using JDE6 Camshaft Bushing Service Set (A, B and E).

CAMSHAFT JOURNAL AND BUSHING NEW PART SPECIFICATIONS

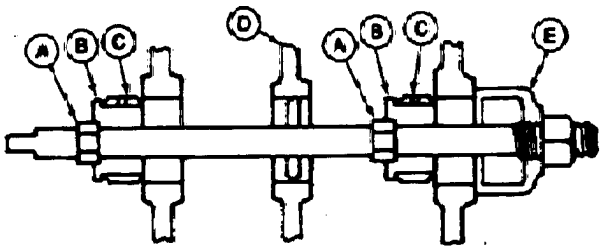
Camshaft Bushing Bore in Block	63.487—63.513 mm (2.4995—2.5005 in.)
Journal OD	60.312—60.338 mm (2.3745—2.3755 in.)
Bushing ID	60.389—60.439 mm (2.3775—2.3795 in.)
Bushing-to-Journal Oil Clearance	0.051—0.127 mm (0.0020—0.0050 in.)
Maximum Clearance	0.152 mm (0.0060 in.)

16
14

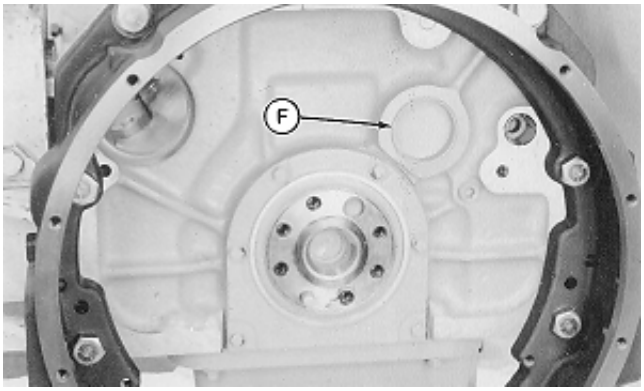
IMPORTANT: Oil holes in bushings and cylinder block must be aligned after installation or oil starvation will occur. The elongated hole in bushing must be toward the top. After installation, use a small mirror with extension to be sure oil holes are aligned properly.

3. Using JDE6 Camshaft Bushing Service Set, reverse the removal procedure to install camshaft bushings.

4. Apply PERMATEX AVIATION (Form-A-Gasket No. 3) to new camshaft bore steel cap plug and install plug in bore. Plug edge must be seated below edge of bore.



RG3320 -UN-06APR89



RG7104 -UN-07JUL94

A—Lock
B—Mandrel
C—Bushing
D—Cylinder Block
E—Cup
F—Camshaft Bore Plug

S11,0401,BJ -19-08AUG94

SERVICE CAMSHAFT BUSHINGS USING JDG405 CAMSHAFT BUSHING SERVICE SET

1. Inspect camshaft journals and bushings for wear or damage. Measure camshaft journals and bushings to determine if proper oil clearance exists. Replace camshaft and/or bushings as necessary.

NOTE: The first two bushings can be reached from the front of the engine. The flywheel and camshaft bore plug (G) must be removed to reach the other two bushings.

2. Remove camshaft bushings (B) using JDG405 Camshaft and Bushing Service Set.

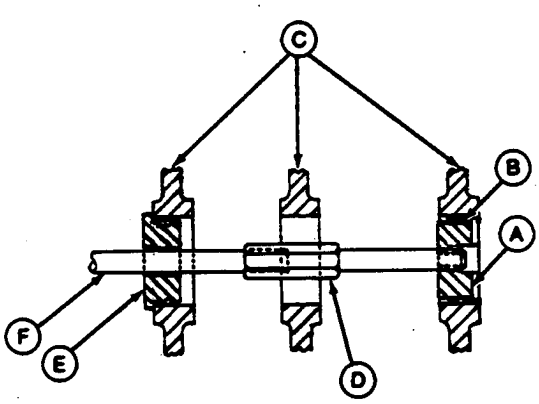
CAMSHAFT JOURNAL AND BUSHING NEW PART SPECIFICATIONS

Camshaft Bushing Bore in Block	63.487—63.513 mm (2.4995—2.5005 in.)
Journal OD	60.312—60.338 mm (2.3745—2.3755 in.)
Bushing ID	60.389—60.439 mm (2.3775—2.3795 in.)
Camshaft Bushing-to-Journal Oil Clearance	0.051—0.127 mm (0.0020—0.0050 in.)
Maximum Clearance	0.152 mm (0.0060 in.)

IMPORTANT: Oil holes in bushings and cylinder block must be aligned after installation or oil starvation will occur. The elongated hole in bushing must be toward the top. After installation, use a small mirror with extension to be sure oil holes are aligned properly.

3. Using JDG405 Camshaft Bushing Service Set, reverse the removal procedure to install the camshaft bushings.

4. Apply PERMATEX AVIATION (Form-A-Gasket No. 3) to new camshaft bore steel cap plug and install plug in bore. Plug edge must be seated below edge of bore.



RG5332 -UN-06DEC88

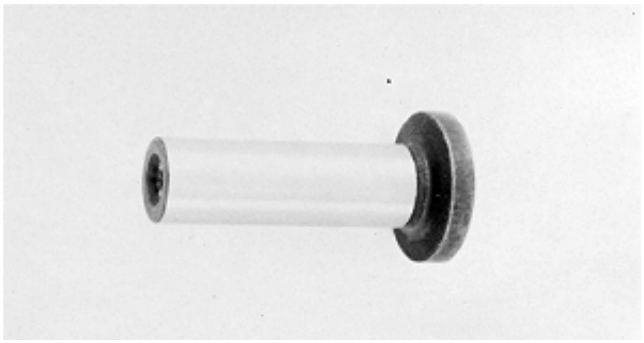
RG5949 -UN-30AUG91

A—Bushing Driver*
B—Camshaft Bushing
C—Cylinder Block Web
D—Slide Hammer Adapter (JDG408)
E—Bushing Pilot (JDG409)
F—Slide Hammer (D01299AA)
G—Camshaft Bore Plug

**For removal use JDG406 Driver; for installation use JDG407 Driver.*

RG,CTM1,G16,2 -19-08AUG94

INSPECT AND MEASURE CAMSHAFT FOLLOWERS


RG2745 -UN-23FEB89

1. Inspect camshaft followers for uneven wear or damage. Also inspect corresponding camshaft lobe for wear or damage. Replace as necessary.

2. Measure follower OD and follower bore ID in cylinder block.

CAMSHAFT FOLLOWER AND BORE SPECIFICATIONS

Camshaft Follower OD	17.33—17.35 mm (0.682—0.683 in.)
Camshaft Follower Bore ID in Block	17.384—17.440 mm (0.6845—0.6865 in.)

Replace camshaft followers that are not within specification. Replace cylinder block if any one camshaft follower bore is not within specification.

S11,0401,BM -19-08AUG94

VISUALLY INSPECT AND MEASURE CAMSHAFT

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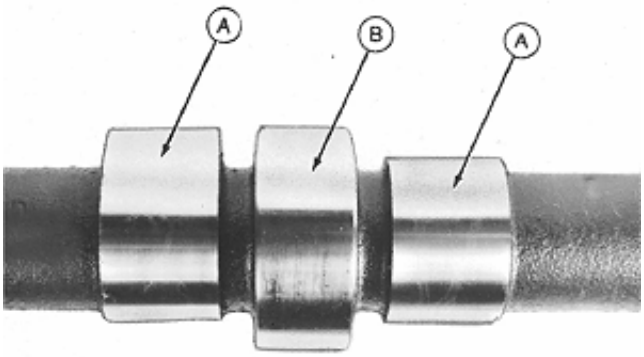


RG3500 -UN-06AUG91

1. Clean camshaft in solvent. Dry with compressed air.

2. Visually inspect camshaft lobes (A) and journals (B) for wear or damage. Replace as necessary. New camshaft followers can be used with old camshaft (if camshaft is serviceable). However, do not reuse old camshaft followers with a new camshaft.

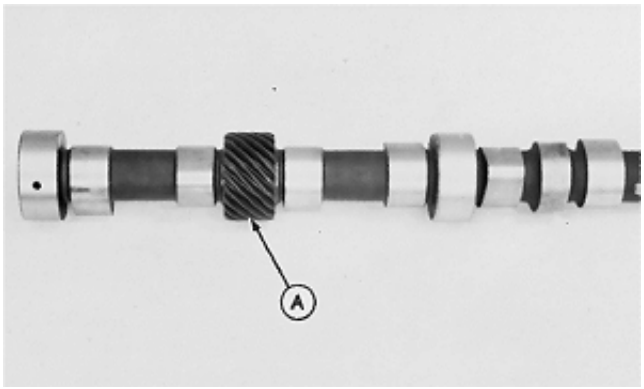
IMPORTANT: Very light score marks may be found, but are acceptable if valve lift is within specification. Pitting or galling dictates replacement. (See CHECK VALVE LIFT, earlier in this group.) It is not always necessary to replace camshaft followers when camshaft is replaced. (See REMOVE, INSPECT, AND MEASURE CAMSHAFT FOLLOWERS, later in this group.)

S11,2005,DB -19-08AUG94

3. If equipped, inspect camshaft oil pump drive gear (A) for wear or damage. Replace camshaft as necessary.

If camshaft is replaced due to a damaged tachometer drive gear, check gear and shaft in tachometer drive housing for damage and replace as necessary.

If camshaft is replaced due to a damaged oil pump drive gear, check gear and shaft on oil pump for damage and replace as necessary.



-UN-19JAN90
RG4628

S11,2005,ID -19-17MAR94

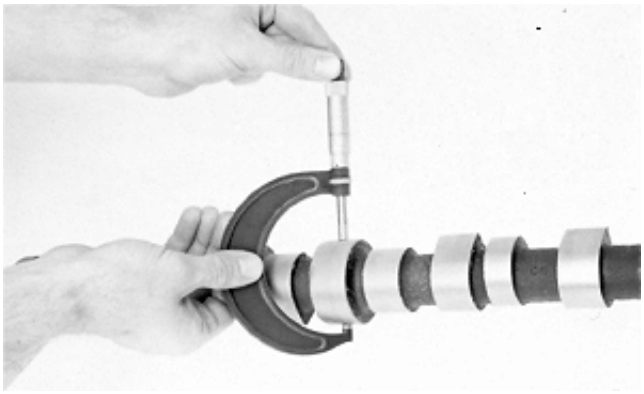
MEASURE CAMSHAFT JOURNAL OD AND BUSHING ID

1. Measure each camshaft journal OD. If camshaft journal OD is not within specification, install a new camshaft.

CAMSHAFT JOURNAL AND BUSHING SPECIFICATIONS

Camshaft Journal Diameter	60.312—60.338 mm (2.3745—2.3755 in.)
Camshaft Bushing ID	60.389—60.439 mm (2.3775—2.3795 in.)
Maximum Camshaft Bushing-to-Journal Oil Clearance	0.051—0.127 mm (0.0020—0.0052 in.)

2. Measure each camshaft bushing ID when installed in cylinder block.



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T81260

S11,2016,BM -19-08AUG94

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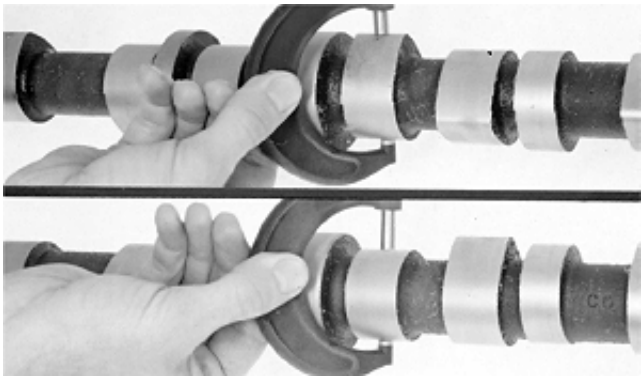
MEASURE CAMSHAFT LOBE LIFT

1. Measure each camshaft lobe at highest point and at narrowest point. Subtract narrowest height from highest height to find camshaft lobe lift.

CAMSHAFT LOBE LIFT NEW PART SPECIFICATIONS

	HEIGHT	WEAR LIMIT
6466D		
Intake	7.10—7.20 mm (0.279—0.283 in.)	6.58 mm (0.259 in.)
Exhaust	7.10—7.20 mm (0.279—0.283 in.)	6.58 mm (0.259 in.)
6466T and 6466A		
Intake	6.93—7.04 mm (0.273—0.277 in.)	6.43 mm (0.253 in.)
Exhaust	7.10—7.20 mm (0.279—0.283 in.)	6.58 mm (0.259 in.)

2. If camshaft lobe lift is not within specifications on any one lobe, install a new camshaft.



S11,2016,BN -19-08AUG94

INSTALL CAMSHAFT GEAR

16
18

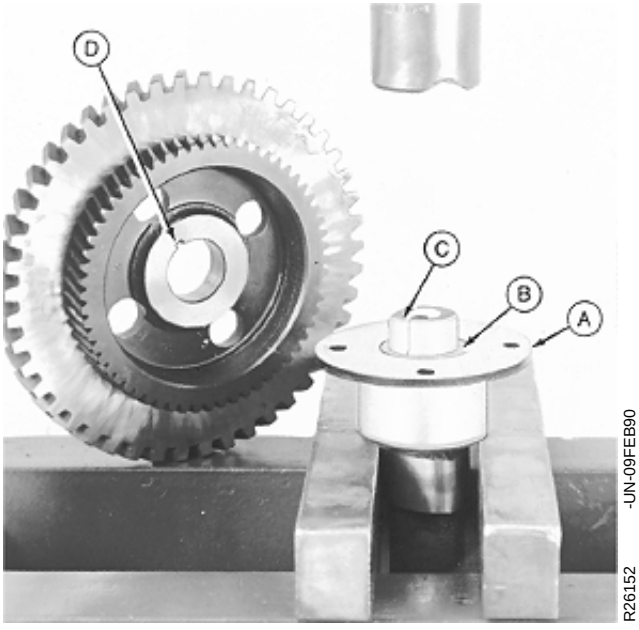
1. Support camshaft under first bearing journal in a hydraulic press.

2. Coat both sides of camshaft thrust plate, around the center hole and oil pump drive gear with TY6333 or TY6347 High Temperature Grease. Install thrust plate (A) and spacer (B).

3. Install Woodruff key (C).

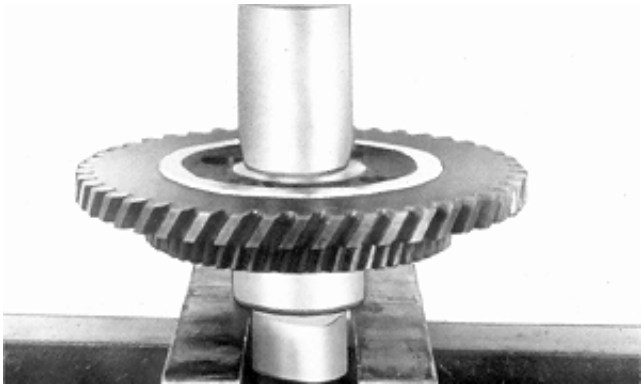
4. Align Woodruff key and keyway (D) and place gear on camshaft with timing mark facing away from camshaft.

A—Thrust Plate
B—Spacer
C—Woodruff Key
D—Keyway



S11,0401,BN -19-17MAR94

5. Press gear on until tight against spacer.



S11,0401,BO -19-13NOV86

SERVICE AND INSPECT TACHOMETER DRIVE (IF EQUIPPED)—ENGINE SERIAL NO. (161133—)

NOTE: Tachometer drive assembly for crankshaft-driven oil pump engine is shown.

1. Remove both snap rings (B) and remove idler gear shaft (C) and idler gear (D).

2. Remove cap (G) and discard gasket (H).

3. Remove hex pipe plug (J); then remove drive shaft (I) with Woodruff key (F) and drive gear (E).

4. Inspect both gears, shaft and housing (K) for wear or damage. Replace as necessary.

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

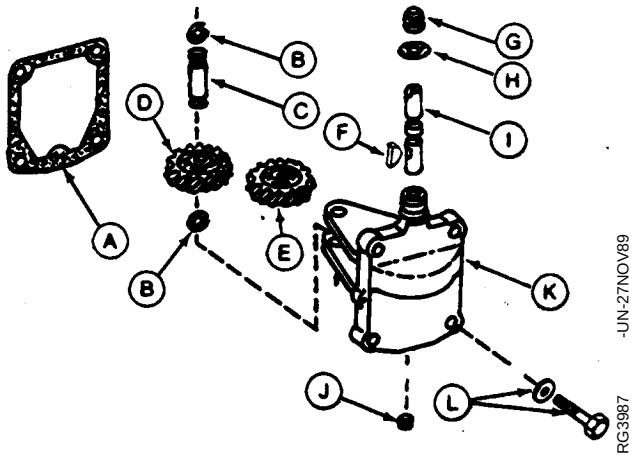
6. Lubricate drive shaft (I) and drive gear (D) with a light coat of engine oil.

7. Install drive shaft whit Woodruff key (F) through housing (K) and drive gear.

8. Lubricate idler gear (D) and shaft (C) with light coat of engine oil and install into housing.

9. Coat hex pipe plug (J) with LOCTITE 592 Pipe Sealant then add a new gasket (H) and cap (G). Tighten hex pipe plug securely.

10. Install snap rings (B) on idler shaft.



A—Gasket
B—Snap Rings
C—Idler Shaft
D—Idler Gear
E—Drive Gear
F—Woodruff Key
G—Cap
H—Gasket
I—Drive Shaft
J—Hex Pipe Plug
K—Tachometer Drive Housing
L—Cap Screw with Washer (4 used)

16
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S11,2005,II -19-17MAR94

SERVICE AND INSPECT TACHOMETER DRIVE (IF EQUIPPED)—ENGINE SERIAL NO. (—161132)

NOTE: Tachometer drive for camshaft-driven oil pump engines is shown.

1. Remove cap (H) and discard gasket (I).

2. Remove hex pipe plug (F), then remove drive shaft (D) with Woodruff key (C) and drive gear (B).

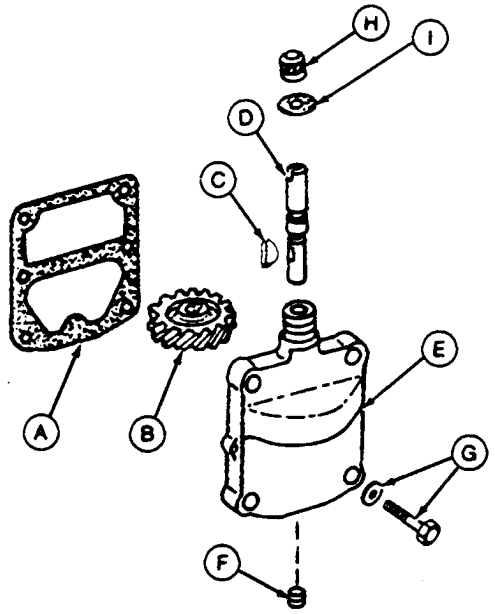
3. Inspect gear, shaft and housing (E) for wear or damage. Replace as necessary.

4. Clean all parts with clean solvent. Dry with compressed air.

5. Lubricate drive shaft and drive gear with a light coat of engine oil.

6. Install drive shaft with Woodruff key through housing and drive gear.

7. Coat hex pipe plug with LOCTITE 592 Pipe Sealant; then add a new gasket and cap. Tighten hex pipe plug securely.



RG4630 -UN-06APR89

A—Gasket
B—Drive Gear
C—Woodruff Key
D—Drive Shaft
E—Tachometer Drive Housing
F—Hex Pipe Plug
G—Cap Screw with Washer (4 used)
H—Cap
I—Gasket

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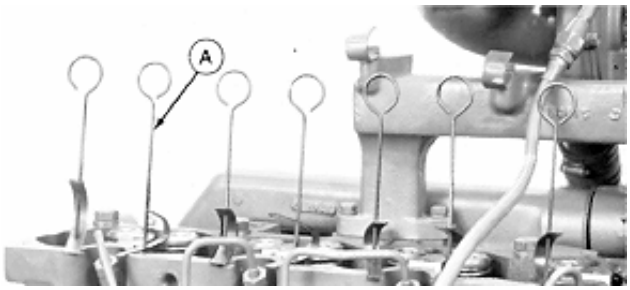
S11,2005,IJ -19-17MAR94

INSTALL CAMSHAFT



IMPORTANT: Set engine at TDC of No. 1 piston's compression stroke before installing camshaft so timing marks on camshaft and crankshaft gears will be aligned.

For on-highway applications, the flywheel has two timing holes. The injection pump reference timing marks will align at 14° BTDC.

1. If camshaft followers were removed with engine on a rollover stand, reinstall followers but do not obstruct camshaft bore. Roll engine to an angle where followers fall away from camshaft bores.

NOTE: If D15001NU Magnetic Follower Holder Kit (A) is used, hold camshaft followers away from camshaft bore until camshaft is installed.

2. Lubricate camshaft lobes with TY6333 or TY6347 High Temperature Grease and lubricate bearings with clean engine oil.

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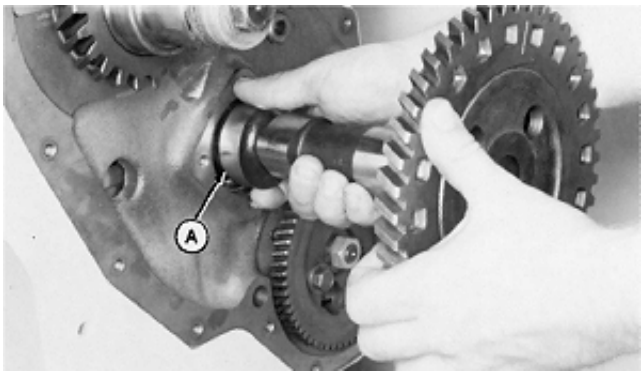
S11,0401,BP -19-08AUG94

3. Carefully install camshaft (A) in cylinder block so that camshaft lobes do not drag in bores. Rotate camshaft during installation to avoid obstruction in any bore.



S11,0401,BQ -19-17MAR94

NOTE: Timing mark (A) is used for manufacturing purposes only.

4. With No. 1 piston on “TDC” compression stroke, align timing marks (C) on camshaft and crankshaft gears.

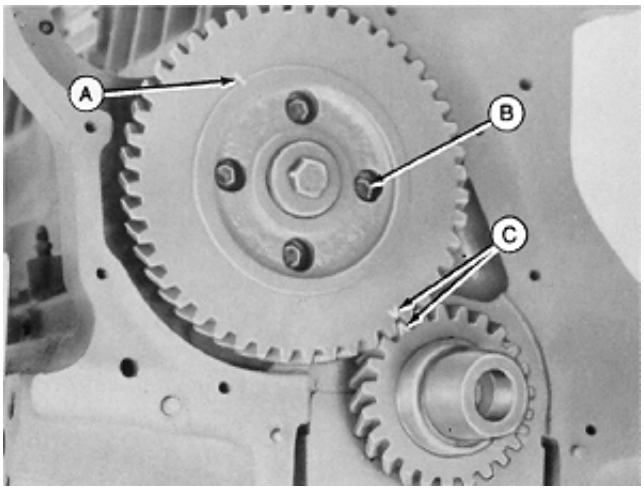
5. Turn camshaft gear to align thrust plate holes with cylinder block holes.

6. Apply LOCTITE 242 Thread Lock and Sealant to cap screws. Tighten thrust plate-to-block cap screws (B) to 27 N·m (20 lb-ft).

7. Install special washer and tighten camshaft gear cap screws as follows:

CAMSHAFT GEAR CAP SCREW TORQUE SPECIFICATIONS

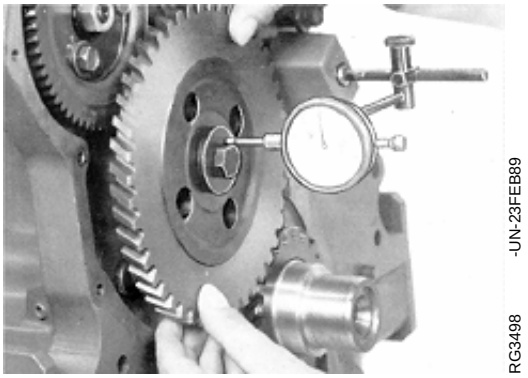
D-Grade Cap Screws . . . . . 115 N·m (85 lb-ft)
G-Grade Cap Screws . . . . . 163 N·m (120 lb-ft)



R24528 -UN-15FEB90

S11,0401,BR -19-08AUG94

8. Check camshaft end play. See CHECK CAMSHAFT END PLAY earlier in this group.


RG3498 -UN-23FEB89

S11,2005,DD -19-17MAR94

INSTALL TIMING GEAR COVER

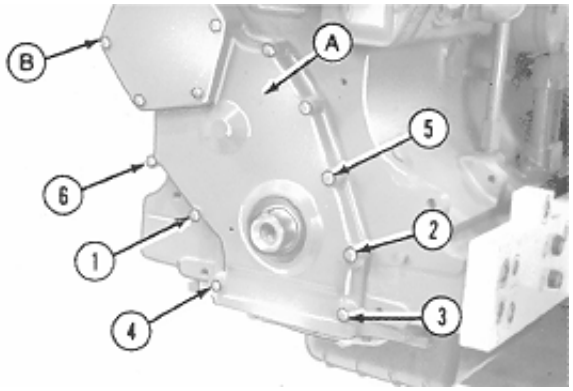
1. Using new gaskets, install timing gear cover (A) and injection pump gear cover (B). Tighten cap screws in sequence one thru six to 27 N·m (20 lb-ft).

NOTE: Tightening the timing gear cover in proper sequence controls the total runout for the front crankshaft oil seal.

2. Trim gasket flush with oil pan mounting face.

3. Using a new gasket, install magnetic pickup, if equipped, and tighten cap screws to 12 N·m (9 lb-ft).

4. Install gear-driven water pump. (See INSTALL GEAR-DRIVEN WATER PUMP in Group 25.) Finish tightening timing gear cover cap screws to 27 N·m (20 lb-ft).



-UN-26JAN90
RG4377

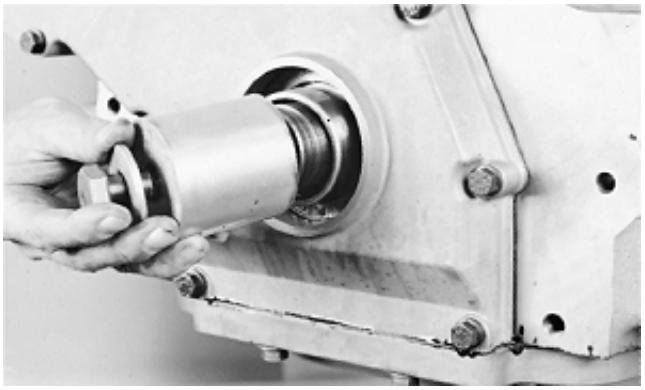
S11,2005,EH -19-08AUG94

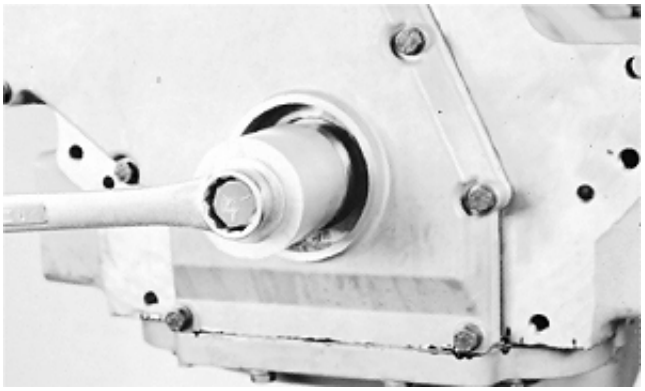
INSTALL FRONT WEAR SLEEVE (WITH TIMING GEAR COVER INSTALLED ON ENGINE)

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

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

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


-UN-26OCT92
RG6476


-UN-26OCT92
RG6477

RG,CTM1,G16,3 -19-08AUG94

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

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

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

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

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

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

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

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

RG6479 -UN-26OCT92

RG6480 -UN-26OCT92

RG,CTM1,G16,4 -19-08AUG94

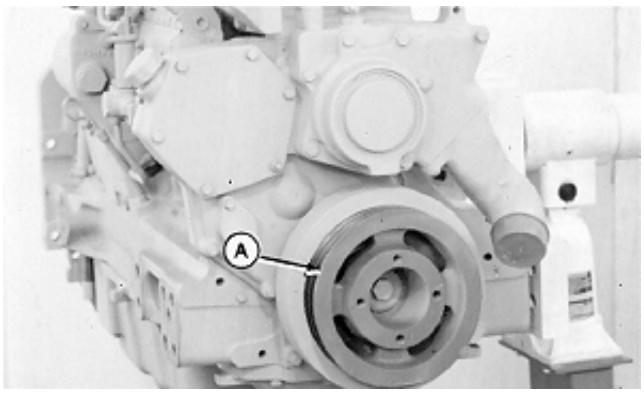
COMPLETE FINAL ASSEMBLY

1. Install vibration damper (A). (See INSTALL DAMPER PULLEY ASSEMBLY in Group 15.)

2. If cylinder head was removed, install as described in Group 05.

3. Install push rods in the holes from which they were removed.

4. Lubricate rocker arm shaft and rocker arm bores with clean engine oil before installing.

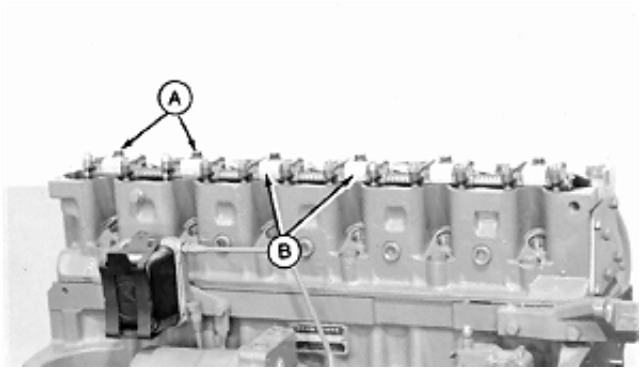


RG3815 -UN-25SEP89

S11,2005,EI -19-08AUG94

5. Install rocker arm shaft assembly as directed in Group 05.

6. Install rocker arm shaft clamps (B) and cap screws (A) as directed in Group 05.



S11,0401,BX -19-17MAR94

7. Adjust valve clearance as directed in Group 05.

8. Install rocker arm cover and tighten cap screws to 8 N·m (71 lb-in.).

9. For engines with camshaft-driven oil pump, install oil pump. (See LUBRICATION SYSTEM, Group 20.)

10. Install oil pan.

11. Install tachometer drive assembly, if equipped. (See INSTALL TACHOMETER DRIVE, later in this group.)

12. Perform engine break-in. (See PERFORM ENGINE BREAK-IN, Group 05.)

16
25

S11,2005,IE -19-08AUG94

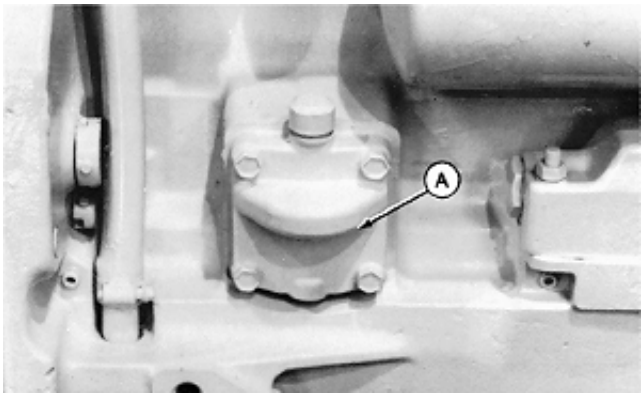
INSTALL TACHOMETER DRIVE

1. Install tachometer drive assembly using new gasket.

NOTE: Make sure that the tachometer idler gear is meshed correctly with drive gear on camshaft or oil pump.

2. Coat all tachometer drive attaching cap screws with LOCTITE 242 Thread Lock and Sealant except for the first three threads.

3. Install all cap screws (A) with washers and tighten to 47 N·m (35 lb-ft).



S11,2005,IK -19-17MAR94

SPECIAL OR ESSENTIAL TOOLS

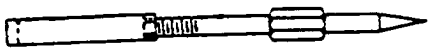
NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-05JUN91

RG5009 -UN-06APR89

Camshaft Wear Indicator JDE109

Measure camshaft gear-to-oil pump gear backlash.



S53,JDE109 -19-10AUG94

OTHER MATERIAL

Name	Use
PERMATEX AVIATION (Form-A-Gasket No. 3) (TY6299)	To seal gasket surfaces on oil pan.
LOCTITE 592 Pipe Sealant with TEFLON® (TY9374/TY9375)	To seal oil pan elbow drain fitting.
High Temperature Grease (TY6343 or TY6347)	To lubricate oil pump components.

RG,CTM1,G20,2 -19-08AUG94

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LUBRICATION SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Engine Oil Pressure @ 800—1900 rpm	103—330 kPa (1.03—3.30 bar) (15—48 psi)	---
Oil Pressure Regulating Valve Spring:		
Compressed Length	48.5 mm @ 133—147 N (1.91 in. @ 30—37 lb-force)	---
Free Length	66.0 mm (2.60 in.)	---
Oil Filter Bypass Valve Spring:		
Compressed Length	35.1 mm @ 80—98 N (1.38 in. @ 18—22 lb-force)	---
Free Length	51.5 mm (2.03 in.)	
Oil Filter Bypass Valve		
Operating Pressure	210 kPa (2.10 bar) (30 psi)	---
Oil Cooler Bypass Valve Spring:		
Compressed Length	35.1 mm @ 80—98 N (1.38 in. @ 18—22 lb-force)	
Free Length	51.5 mm (2.03 in.)	
Oil Pump (Camshaft-Driven):		
Gear Bore Depth in Housing	44.526—44.628 mm (1.7530—1.7570 in.)	---
Driven and Idler Gear Thickness	44.450—44.500 mm (1.7500—1.7520 in.)	---
Driven and Idler Gear OD	85.855—85.880 mm (3.3801—3.3811 in.)	---
Gear Bore ID in Housing	85.954—86.004 mm (3.3840—3.3860 in.)	---
Drive Gear ID	15.799—15.824 mm (0.6220—0.6230 in.)	---
Idler Gear ID	16.078—16.104 mm (0.6330—0.6340 in.)	---
Idler Shaft Bore in Housing ID	15.92—15.95 mm (0.627—0.628 in.)	---
Idler Gear Bushing ID	16.002—16.027 mm (0.6300—0.6310 in.)	---
Idler Shaft OD	15.961—15.977 mm (0.6284—0.6290 in.)	
Drive Shaft OD	15.837—15.862 mm (0.6235—0.6245 in.)	---
Camshaft Gear-to-Oil Pump Drive Gear Backlash:		
Minimum	0.5° or 0.25 mm (0.010 in.)	---
Maximum	3.5° or 2.03 mm (0.080 in.)	---
Oil Pump (Crankshaft-Driven):		
Minimum Drive Gear-to-Crankshaft Gear Backlash		0.08 mm (0.003 in.)
Maximum Drive Shaft End Play		0.15 mm (0.006 in.)
Maximum Drive Shaft Side Movement		0.17 mm (0.007 in.)
Pump Gear Backlash	0.33—2.00 mm (0.013—0.079 in.)	---

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LUBRICATION SYSTEM SPECIFICATIONS—CONTINUED

TORQUES

Oil Cooler Cover-to-Oil Cooler	27 N·m (20 lb-ft)
Oil Cooler-to-Cylinder Block	47 N·m (35 lb-ft)
Oil Filter Housing-to-Cylinder Block	47 N·m (35 lb-ft)
Oil Pump (Camshaft-Driven):	
Cover-to-Housing Cap Screws	47 N·m (35 lb-ft)
Intake-to-Cover Cap Screws	27 N·m (20 lb-ft)
Housing-to-Cylinder Block	34 N·m (25 lb-ft)
Oil Pump (Crankshaft-Driven):	
Drive Gear-to-Drive Shaft Nut	54 N·m (40 lb-ft)
Cover-to-Housing Cap Screws	41 N·m (30 lb-ft)
Gear Shield-to-Housing Cap Screws	
Engine Serial No. (—231629)	27 N·m (20 lb-ft)
Intake Screen-to-Elbow Cap Screws	24 N·m (18 lb-ft)
Housing-to-Cylinder Block	47 N·m (35 lb-ft)
Set Screw-to-Cover	8 N·m (6 lb-ft)
Lock Nut-to-Set Screw	8 N·m (6 lb-ft)
Intake Elbow-to-Pump Cover	41 N·m (30 lb-ft)
Oil Bypass Housing-to-Cylinder Block	75 N·m (55 lb-ft)
Oil Pan:	
11.1 mm (0.43 in.) Rail Thickness	
3/8 in. Cap Screws SAE Grade 5	47 N·m (35 lb-ft)
3/8 in. Cap Screws SAE Grade 8 or 10.9	68 N·m (50 lb-ft)
1/2 in. Cap Screws SAE Grade 5	115 N·m (85 lb-ft)
1/2 in. Cap Screws SAE Grade 8 or 10.9	162 N·m (120 lb-ft)
*20.5 mm (0.81 in.) Rail Thickness	
3/8 in. Cap Screws SAE Grade 5	47 N·m (35 lb-ft)
3/8 in. Cap Screws SAE Grade 8 or 10.9	68 N·m (50 lb-ft)
1/2 in. Cap Screws SAE Grade 5	115 N·m (85 lb-ft)
1/2 in. Cap Screws SAE Grade 8 or 10.9	162 N·m (120 lb-ft)
Oil Pan Drain Plug:	
Aluminum Oil Pan	102 N·m (75 lb-ft)
Cast Iron Oil Pan	47 N·m (35 lb-ft)

**Initially tighten all cap screws to 47 N·m (35 lb-ft), starting at right rear corner of oil pan (facing toward flywheel end) and proceed counterclockwise. Finish tightening cap screws to torque specified above using the same sequence and tighten all 3/8 in. cap screws first.*

S11,2020,EG -19-08AUG94

LUBRICATION SYSTEM—GENERAL INFORMATION

6466 Engines are available with two types of oil pumps; crankshaft-driven oil pump or camshaft-driven oil pump. See HOW THE LUBRICATION SYSTEM WORKS in Group 105 for illustrations showing the two types of oil pumps. Separate removal and repair procedures are provided in this group for each type of oil pump.

RG,CTM1,G20,1 -19-25MAR94

DIAGNOSING LUBRICATION SYSTEM MALFUNCTIONS

- **Low Oil Pressure:**

  Low oil level.
  Clogged cooler or filter.
  Excessive oil temperature.
  Incorrect oil.
  Oil pressure regulating valve failure.
  Excessive main or rod bearing clearance.
  Clogged oil pump screen.
  Excessive clearance between oil pump gears and cover.
  Piston cooling orifice not installed.

- **High Oil Pressure:**

  Improper oil classification.
  Clogged oil lines.
  Oil pressure regulating valve failure.

- **Oil Sludge and Dilution:**

  Improper operation and servicing.
  Coolant leakage into lubrication system.
  Incomplete combustion.
  Excessive oil consumption.
  Defective injection pump (Failed internal O-ring seals)

- **Low Oil Pressure at Slow Idle:**

  Bypass oil check valve failure.

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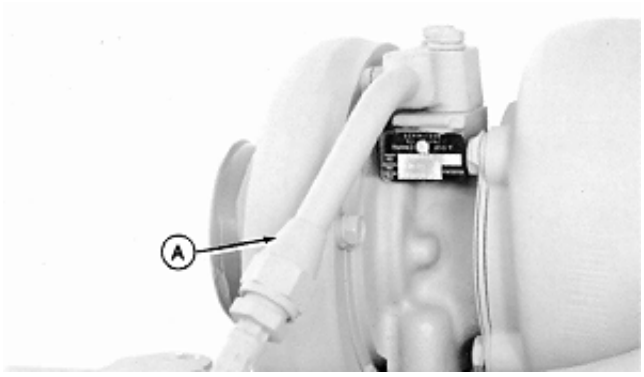
S11,0404,A -19-08AUG94

DRAIN ENGINE OIL, COOLANT, AND REMOVE OIL PAN



IMPORTANT: When servicing the 6466T and 6466A Engines on a rollover stand, disconnect turbocharger oil inlet line (A) from oil filter housing and 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.

1. Drain engine coolant.

2. On 6466T and 6466A Engines, disconnect turbocharger oil inlet line at turbocharger or oil filter housing. See DISCONNECT TURBOCHARGER OIL INLET LINE in Group 03.

3. Remove drain plug from connector on oil pan and drain oil, if not previously done.

4. Remove oil pan and discard gasket.

5. Remove tachometer drive assembly, if equipped. (See Group 16.)

S11,2020,DS -19-08AUG94

REMOVE OIL FILTER AND HOUSING

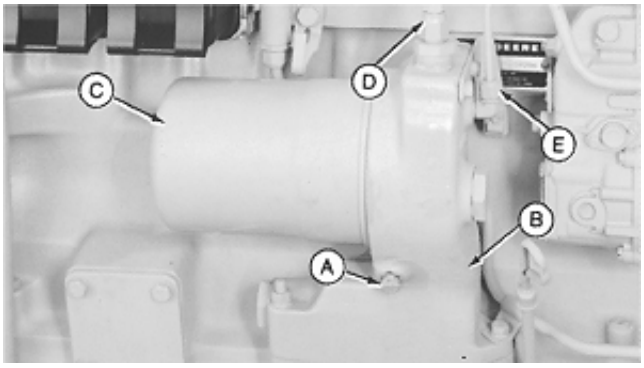
1. Remove plug (A), and drain oil from oil filter housing (B).

2. Turn oil filter (C) counterclockwise, and remove filter.

3. On 6466T and 6466A Engines disconnect turbocharger oil inlet line (D).

4. On 6466T and 6466A Engines disconnect fuel injection pump oil inlet line (E).

5. Remove oil filter housing from cylinder block.



-UN-09NOV89
RG3843

A—Drain Plug
B—Oil Filter Housing
C—Oil Filter
D—Turbocharger Oil Inlet Line
E—Injection Pump Oil Inlet Line

S11,2020,DL -19-25MAR94

INSPECT OIL PRESSURE REGULATING VALVE

1. Remove plug (A), O-ring (B), shims (C), spring (D) and oil pressure regulating valve (E) from housing (F). Discard O-ring.

2. Count shim(s) for reassembly.

3. Inspect valve and valve bore for damage. Replace if necessary.

4. Check spring for proper compression.

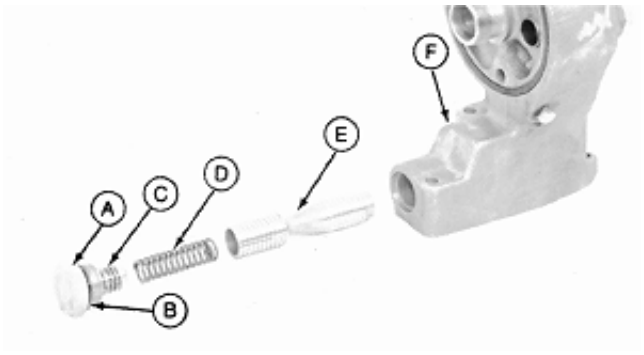
NEW SPRING SPECIFICATION

Working Load at 133—147 N (30—37 lb force)	48.5 mm (1.91 in.)
Spring Free Length	66.0 mm (2.60 in.)

5. Insert valve and spring in housing.

6. Position washer and shim(s) on plug.

7. Install plug using a new O-ring and tighten securely.



-UN-29NOV88
RG3844

A—Plug
B—O-Ring
C—Shim(s)
D—Spring
E—Oil Pressure Regulating Valve
F—Housing

S11,0404,F -19-25MAR94

INSPECT OIL FILTER BYPASS VALVE

1. Remove plug (E) with O-ring (D), spring (C), and valve (B) from housing (A). Discard O-ring.

2. Inspect valve for scoring or damage. Replace if necessary.

3. Check spring for proper compression. Replace if necessary.

NEW SPRING SPECIFICATION

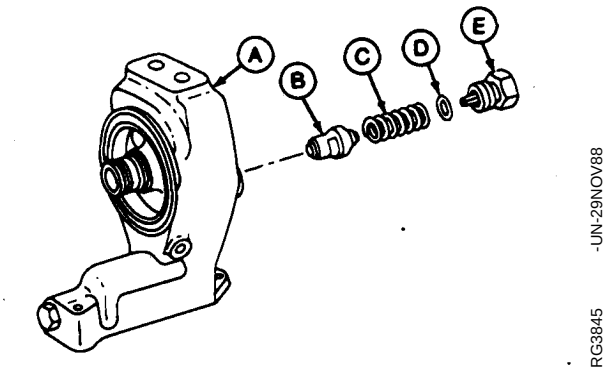
Working Load at 80—98 N (18—22 lb force)	35.1 mm (1.38 in.)
Spring Free Length	51.5 mm (2.03 in.)

4. Insert valve and spring in housing.

5. Install new O-ring on plug.

6. Install plug and tighten securely.

NOTE: Filter bypass valve operating pressure is 210 kPa (2.10 bar) (30 psi).



A—Housing
B—Oil Filter Relief Valve
C—Spring
D—O-Ring
E—Plug

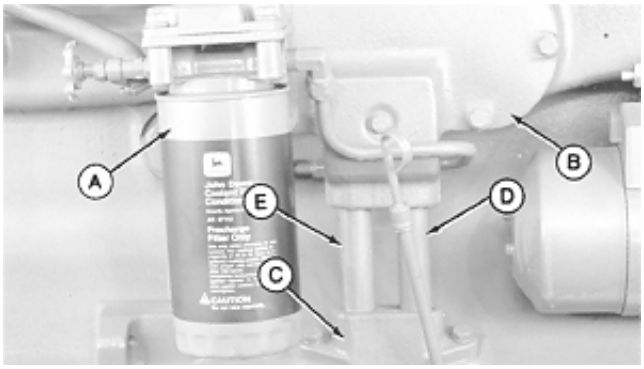
S11,0404,H -19-25MAR94

REMOVE ENGINE OIL COOLER

NOTE: 6466 Engines may be equipped with 8-plate or 12-plate engine oil coolers. Removal, inspection, and installation for both oil coolers are similar; differences will be noted.

1. On engines equipped with coolant filter conditioner (A), remove coolant filter conditioner assembly. (See Cooling System, Group 25.)

2. Remove cover (B) and adapter (C) with inlet tube (D) and outlet tube (E).

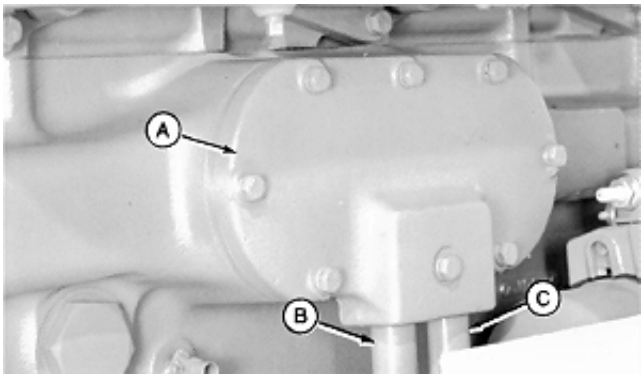


A—Coolant Filter Conditioner
B—Oil Cooler Cover
C—Adapter
D—Inlet Tube
E—Outlet Tube

S11,2020,DM -19-08AUG94

3. On engines not equipped with coolant filter conditioner, remove cover (A) and adapter at bottom of inlet and outlet tubes.

4. Remove cover and adapter with outlet tube (B) and inlet tube (C).



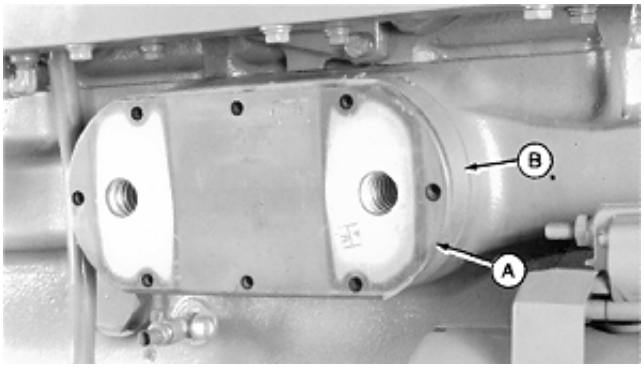
S11,2020,DN -19-25MAR94

5. Remove oil cooler (A) and spacer (B).

NOTE: Spacer is used with 12-plate oil cooler only.

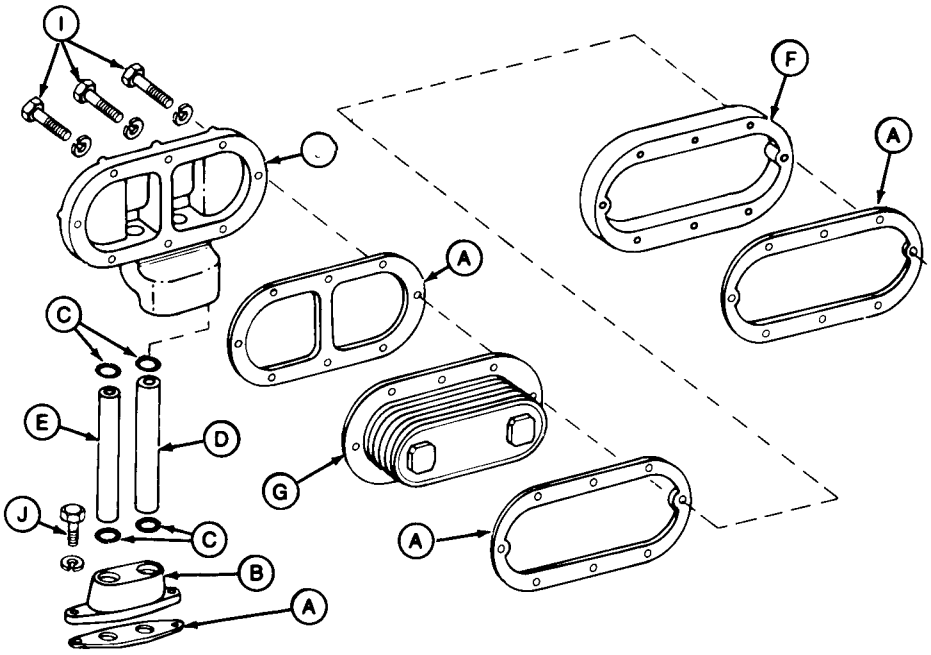
6. Discard gasket. Discard O-rings for tubes.

7. Clean all gasket material from spacer, adapter, cover, and cylinder block.



S11,2020,DO -19-08AUG94

CLEAN, INSPECT AND INSTALL ENGINE OIL COOLER



RG3850 -UN-02AUG94

A—Gasket*
B—Adapter
C—O-Rings
D—Inlet Tube
E—Outlet Tube
F—Spacer (12-plate oil cooler only)
G—Oil Cooler
H—Cover
I—Cap Screws (8 used)
J—Cap Screw (2 used)

1. After oil cooler is removed, scrape off old gasket material.

2. Clean all parts with clean solvent and a brass wire brush. Dry with compressed air.

3. Inspect all parts for serviceability. Replace parts as needed.

NOTE: If mixing of oil and coolant is suspected, pressure test oil cooler in liquid and compressed air. Use 140—170 kPa (1.4—1.7 bar) (20—25 psi) air pressure for testing. Replace oil cooler as necessary.

4. Install new gasket (A) with oil cooler adapter (B). Tighten cap screws (J) to 47 N·m (35 lb-ft).

5. Install new O-rings (C) on inlet and outlet tubes (D and E) and insert into adapter. Make certain O-rings are NOT pinched or rolled during assembly.

6. Install oil cooler spacer (F) if equipped, and new gaskets (A). Place large side towards cylinder block.

7. Install oil cooler (G).

8. Install oil cooler cover (H) with new gasket.

9. Tighten cap screws (I) with washers to 27 N·m (20 lb-ft).

*8-plate oil cooler uses one gasket, 12-plate oil cooler uses two gaskets.

S11,0404,O1 -19-08AUG94

REMOVE OIL COOLER BYPASS HOUSING

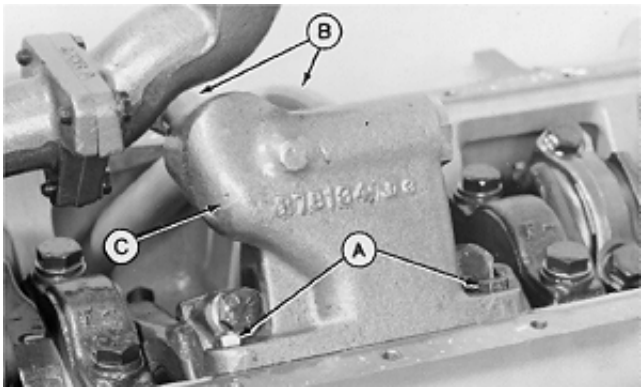
NOTE: Oil cooler bypass housing (shown) began with Engine Serial No. (231772—).

1. Roll engine over on rollover stand until oil pan is in the upright position. Remove oil pan and clean all gasket material from mating surfaces.

2. Remove both housing-to-block cap screws (A).

3. Remove both bypass tubes (B) from housing bores. Discard O-rings.

4. Lift oil cooler bypass housing (C) from cylinder block. Remove all gasket material from housing and block.



-UN-29NOV88
RG4431

S11,2020,DR -19-25MAR94

REMOVE AND INSPECT OIL COOLER BYPASS VALVE

NOTE: Oil cooler bypass valve assembly can be removed without removing bypass housing from cylinder block.

1. Remove plug (A), spring pin (B), O-ring (C), spring (D), and bypass valve (E) from oil cooler bypass housing (F).

2. Check housing for clogged passages and all other parts for scale build-up.

3. Clean all parts with a stiff bristle brush and solvent, if necessary. Dry with compressed air.

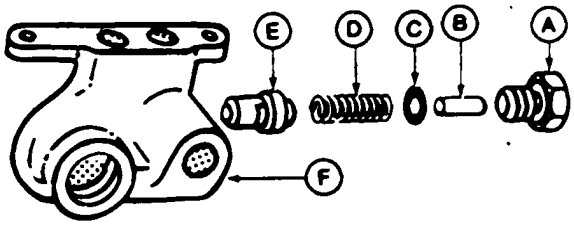
4. Be sure oil cooler bypass housing tubes are clean.

5. Inspect bypass valve for damage. Replace if necessary.

6. Check bypass valve spring for proper specifications. Replace if not within specifications.

NEW SPRING SPECIFICATION

Working Load at 80—98 N (18—22 lb force)	35.1 mm (1.38 in.)
Spring Free Length	51.5 mm (2.03 in.)

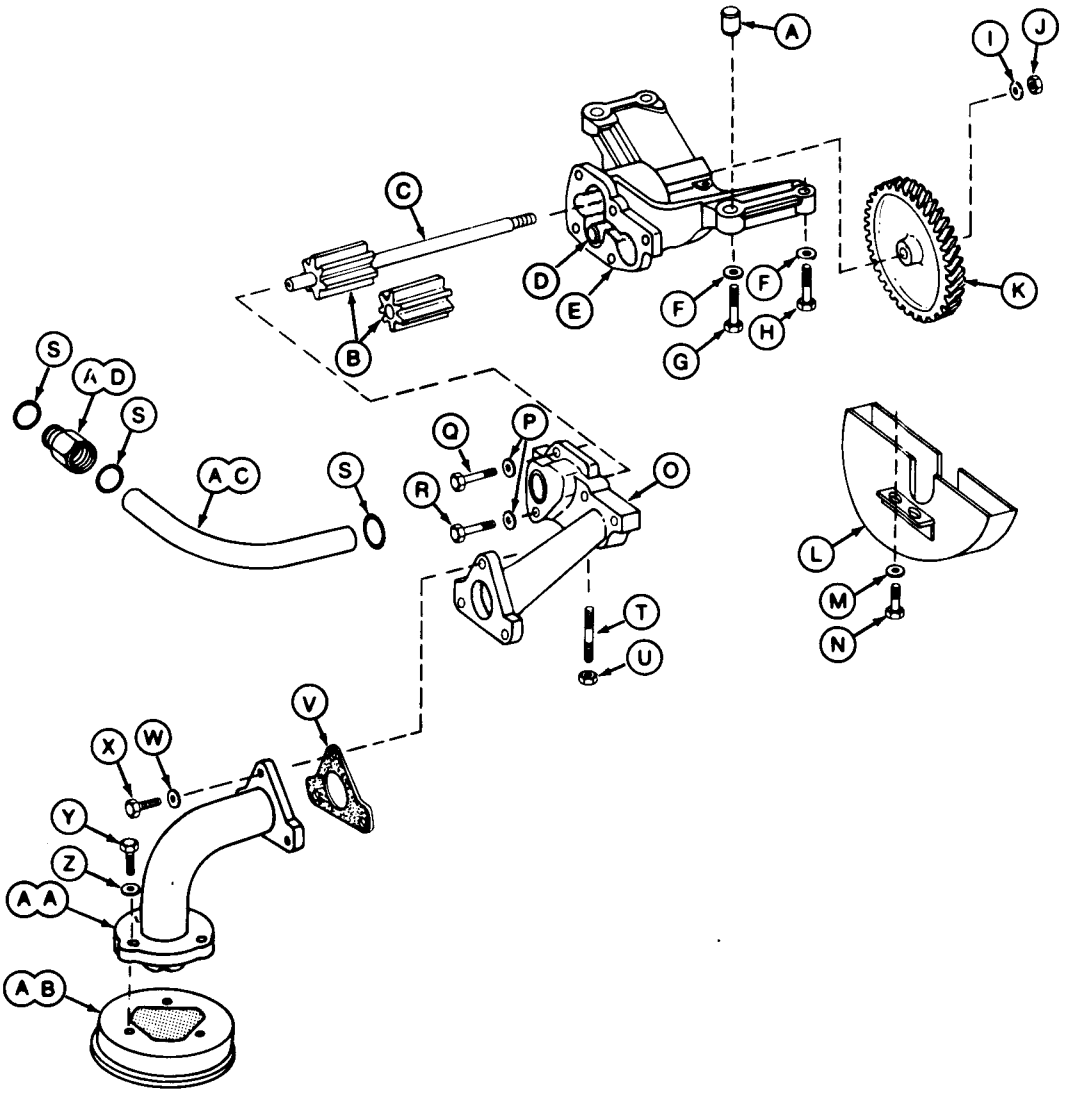


-UN-29NOV88
RG3848

A—Plug
B—Spring Pin
C—O-Ring
D—Spring
E—Bypass Valve
F—Oil Cooler Bypass Valve Housing

RG,CTM6,G20,9 -19-08AUG94

CRANKSHAFT-DRIVEN OIL PUMP ASSEMBLY—DEEP SUMP



RG2611 -UN-03APR89

20 11

A—Hollow Dowel (2 used)
B—Pump Gears
C—Drive Shaft
D—Idler Shaft
E—Pump Housing
F—Washer (4 used)
G—Cap Screw (2 used)
H—Cap Screw (2 used)
I—Special Washer
J—Jam Nut
K—Drive Gear
L—Gear Shield*
M—Lock Washer (2 used)*
N—Cap Screw (2 used)*
O—Pump Housing Cover
P—Washer (5 used)
Q—Cap Screw (3 used)
R—Cap Screw (2 used)
S—O-Ring (3 used)**
T—Set Screw
U—Lock Nut
V—Gasket
W—Washer (3 used)
X—Cap Screw (3 used)
Y—Cap Screw (3 used)
Z—Lock Washer
AA—Elbow***
AB—Screen
AC—Outlet Tube
AD—Gland Nut**

**Used on Engine Serial No. (—231629)*

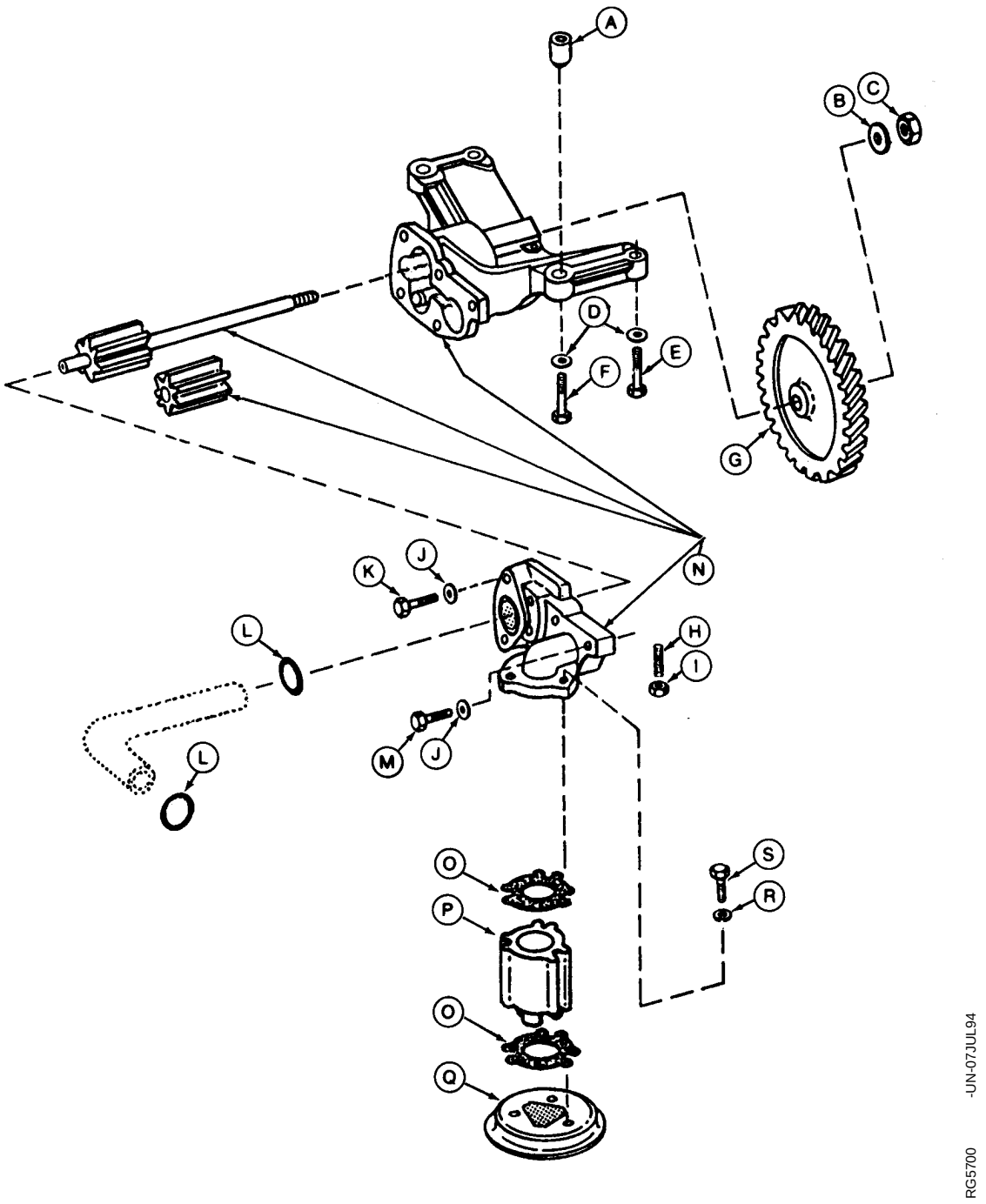
***Two O-rings used on Engine Serial No. (231773—)*

****Used on Engine Serial No. (—231772))*

*****Used on deep sump oil pans application only.*

S11,2020,DT -19-08AUG94

CRANKSHAFT-DRIVEN OIL PUMP ASSEMBLY—STANDARD SUMP



A—Bushing (2 used)
B—Washer
C—Nut
D—Washer (4 used)
E—Cap Screw (2 used)
F—Cap Screw (2 used)
G—Gear
H—Set Screw
I—Nut
J—Washer (5 used)
K—Cap Screw (2 used)
L—O-Ring (2 used)
M—Cap Screw (3 used)
N—Oil Pump Assembly
O—Gasket (2 used)
P—Adapter*
Q—Oil Pump Intake
R—Lock Washer (3 used)
S—Cap Screw (3 used)

**Used to lower the oil pump intake and improve vehicle off-level capability.*

RG,CTM6,G20,3 -19-08AUG94

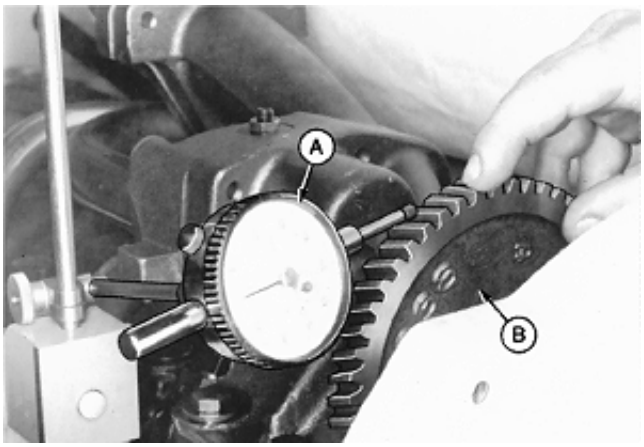
CHECK CRANKSHAFT GEAR-TO-OIL PUMP DRIVE GEAR BACKLASH

Before removing oil pump, determine if there is adequate backlash between oil pump and crankshaft drive gears.

1. Remove gear shield, if equipped. Discard shield if desired.

2. Mount dial indicator (A) and measure backlash between pump drive gear (B) and crankshaft gear.

IMPORTANT: Backlash must be at least 0.08 mm (0.003 in.). If backlash is less than 0.08 mm (0.003 in.), replace the oil pump drive gear.



RG3849 -UN-29NOV88

S11,2020,DH -19-25MAR94

REMOVE CRANKSHAFT-DRIVEN OIL PUMP

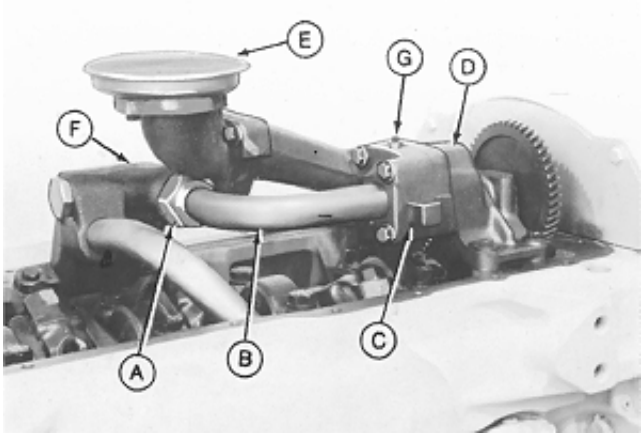
1. On Engine Serial No. (—231772) remove delivery elbow and screen (E) to obtain wrench clearance for loosening gland nut (A).

2. On Engine Serial No. (—231772) unscrew gland nut (A) and remove outlet tube (B). On Engine Serial No. (231773—) loosen cooler bypass housing (F) cap screws. Pull outlet tube (B) from bypass valve housing and pump cover (C).

3. Remove four oil pump housing (D) cap screws.

4. Remove pump with drive gear attached.

IMPORTANT: DO NOT alter adjustment of set screw (G). If adjustment has been altered, see ADJUST OIL PUMP SET SCREW later in this group.



RG4308 -UN-09NOV89

A—Gland Nut
B—Outlet Tube
C—Cover
D—Oil Pump Housing
E—Delivery Elbow and Screen
F—Bypass Valve Housing
G—Set Screw

S11,0404,S -19-08AUG94

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13

INSPECT AND CLEAN CRANKSHAFT-DRIVEN OIL PUMP

1. Visually inspect oil pump for wear or damage.

IMPORTANT: Do not disassemble oil pump for inspection, flushing, or making any wear checks.

2. Flush pump assembly internally with clean solvent to remove oil. Spin pump gears to help remove solvent.

3. Place oil pump on a work bench with pump-to-cylinder block mounting surface facing upward (same as when mounted on engine).

NOTE: Leave pump drive gear installed when making checks.

IMPORTANT: To help insure accurate wear measurements, be sure the oil pump is clean and faces the same way as when mounted on the cylinder block.

S11,0404,T -19-08AUG94

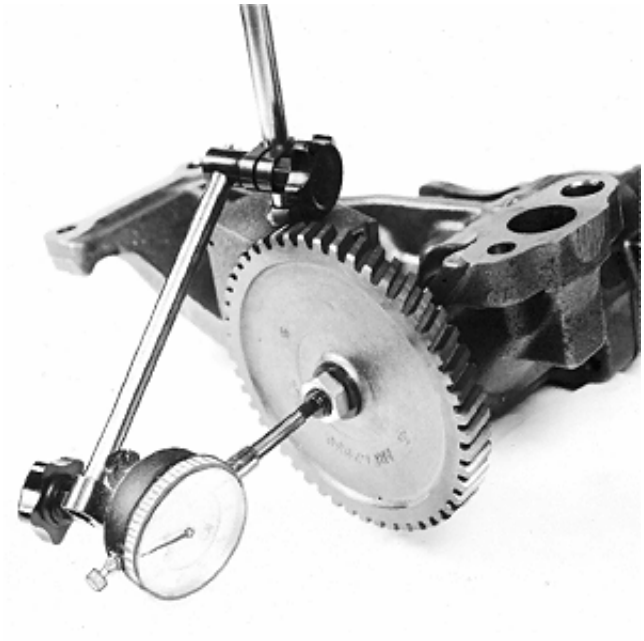
CHECK DRIVE SHAFT END PLAY—CRANKSHAFT-DRIVEN OIL PUMP

1. Mount dial indicator with plunger tip resting against end of pump drive shaft.

2. Move shaft toward and away from indicator.

If end play exceeds 0.15 mm (0.006 in.), there is excessive wear on pump cover and/or wear on end of pump drive gear.

Replace oil pump if end play exceeds 0.15 mm (0.006 in.).



RG5916 -UN-16AUG91

S11,0404,U -19-08AUG94

CHECK DRIVE SHAFT SIDE MOVEMENT—CRANKSHAFT-DRIVEN OIL PUMP

1. Mount dial indicator with plunger tip resting on one of the hex nut flats.

2. Move shaft from side-to-side.

If shaft side movement exceeds 0.17 mm (0.007 in.), there is excessive wear on drive shaft bushing and/or drive shaft.

Replace oil pump if shaft side movement exceeds 0.17 mm (0.007 in.).

RG5917 -UN-16AUG91

S11,0404,V -19-08AUG94

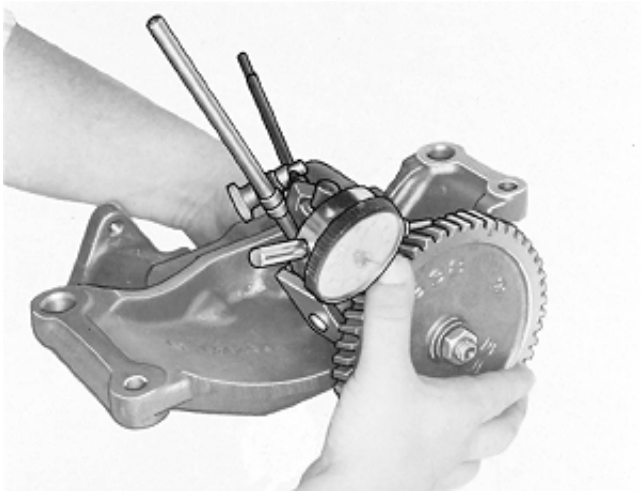
CHECK PUMPING GEAR BACKLASH—CRANKSHAFT-DRIVEN OIL PUMP

1. Mount dial indicator with indicator plunger resting against side of gear tooth.

2. Hold idler gear stationary (by reaching through oil discharge hole) and slowly rotate drive gear back and forth until contact with idler gear is felt.

If backlash is not within 0.33—2.00 mm (0.013—0.079 in.) specification, there is excessive pumping gear wear and/or idler shaft and gear bushing wear. If there is less than 0.33 mm (0.013 in.) backlash, re-clean gears and check backlash again.

3. Replace oil pump if pumping gear backlash exceeds 2.00 mm (0.079 in.).



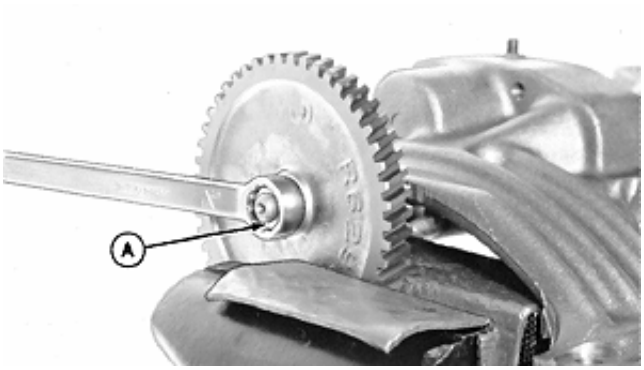
RG3106 -UN-29NOV88

S11,0404,W -19-08AUG94

INSPECT OIL PUMP DRIVE GEAR—CRANKSHAFT-DRIVEN OIL PUMP

NOTE: Oil pump does not need to be removed from engine, when inspecting drive gear.

1. Inspect drive gear teeth for chips, cracks, or wear. Replace as necessary.



S11,0404,X -19-08AUG94

ADJUST OIL PUMP SET SCREW—CRANKSHAFT-DRIVEN OIL PUMP

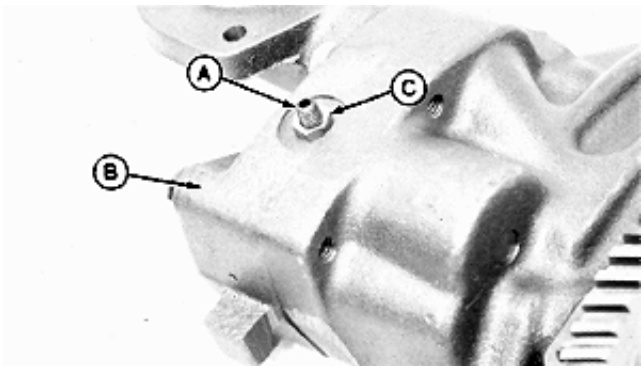
IMPORTANT: Normally the set screw (A) should NOT be adjusted; but if the set screw is altered, the following steps should be followed.

1. Assemble drive gear and idler gear into pump housing.

2. Install oil pump cover (B) and tighten cover-to-housing cap screws to 41 N·m (30 lb-ft).

3. Tighten set screw until it contacts idler shaft.

4. Continue to hold set screw and tighten lock nut (C) to 8 N·m (6 lb-ft). Do not overtighten set screw or lock nut.



S11,2020,BZ -19-17AUG94

INSTALL OIL COOLER BYPASS VALVE AND HOUSING

1. Lubricate and install valve (A), spring (B), new O-ring (C), spring pin (D), and plug (E) into oil cooler bypass housing (F).

2. Tighten plug securely.

3. Install oil cooler bypass housing with new gasket (G) into cylinder block.

4. Install long end of cooler bypass housing-to-block tube (H) with new O-ring (I) into the housing. Install the other end with new O-ring (I) into block.

IMPORTANT: Make sure all O-rings are properly installed in grooves to prevent oil pressure leakage.

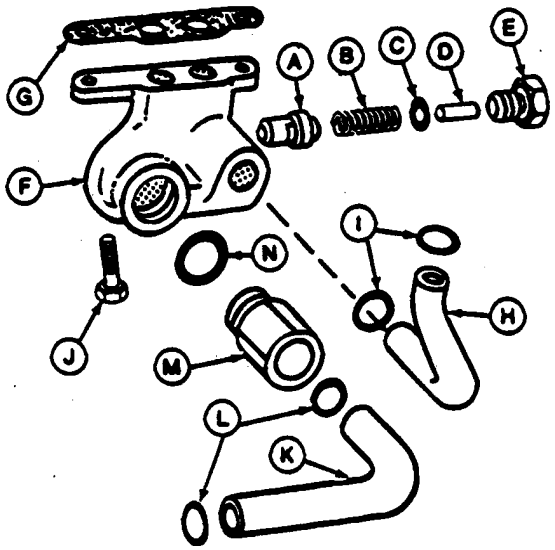
5. Adjust tube and housing with new gasket (G), so that housing is flat against the block mounting pad. Attach cap screws (J) to block, but do not tighten.

6. Engine Serial No. (231773—) install oil pump-to-bypass housing tube (K) with new O-rings (L) into bypass housing and oil pump cover.

7. Engine Serial No. (—231772) install O-rings (L and N) on gland nut (M) and place tube (K) into gland nut. Install one O-ring (L) into oil pump cover.

Align tube and gland nut with bypass housing. Do not tighten.

8. Tighten oil cooler bypass housing cap screws (J) to 75 N·m (55 lb-ft).



RG4309 -UN-27NOV89

A—Valve
B—Spring
C—O-Ring
D—Spring Pin
E—Plug
F—Oil Bypass Housing
G—Gasket
H—Tube
I—O-Ring (2 used)
J—Cap Screw (2 used)
K—Tube
L—O-Ring (2 used)
M—Gland Nut Engine Serial No. (—231772)
N—O-Ring Engine Serial No. (—231772)

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S11,2020,CW -19-08AUG94

INSTALL CRANKSHAFT-DRIVEN OIL PUMP

1. Install pump assembly (A) on cylinder block and tighten cap screws to 47 N·m (35 lb-ft).

NOTE: Make sure oil pump drive gear properly meshes with crankshaft gear.

Replace all O-rings. Lightly lubricate new O-rings with clean engine oil before installing.

2. Insert inlet tube (B) into pump cover. Be careful not to dislodge O-ring.

3. On Engine Serial No. (—231772) start gland nut (C) into bypass valve housing, but do not tighten until bypass valve housing cap screws are tightened (if previously loosened) to 75 N·m (55 lb-ft). Tighten gland nut securely.

4. On Engine Serial No. (231773—) install outlet tube into pump cover.

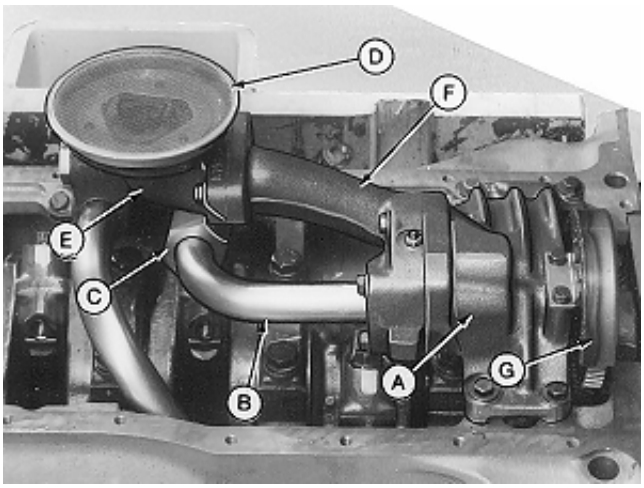
5. Attach intake screen (D) to intake elbow (E) and tighten cap screws to 24 N·m (18 lb-ft).

6. Install elbow with new gasket and intake screen onto pump cover (F) and tighten cap screws to 41 N·m (30 lb-ft).

7. Tighten drive gear nut to 54 N·m (40 lb-ft).

8. On Engine Serial No. (—231629) install gear shield (G), if equipped, and tighten cap screws to 27 N·m (20 lb-ft).

NOTE: The gear shield has been cancelled on later engines, so it may be discarded.

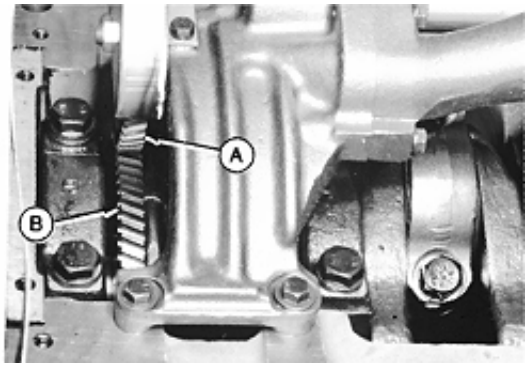


RG4310 -UN-27JUL94

A—Oil Pump
B—Outlet Tube
C—Gland Nut
D—Intake Screen
E—Intake Elbow
F—Cover
G—Gear Shield Engine Serial No. (—231629)

S11,0404,AB -19-08AUG94

IMPORTANT: Push crankshaft rearward (toward flywheel end). Check clearance between oil pump drive gear face and throw of crankshaft. There should be a clearance of at least 0.38 mm (0.0015 in.). If clearance is below specification check thrust bearings for proper placement. Gently pry crankshaft forward and check (after oil pump is installed) the drive gear (A), and crankshaft gear (B) to see that they are properly meshed.



RG3742 -UN-25SEP89

S11,2020,GP -19-18NOV86

CHECK CAMSHAFT GEAR-TO-OIL PUMP GEAR BACKLASH—CAMSHAFT-DRIVEN OIL PUMP ONLY (BEFORE ENGINE DISASSEMBLY)

NOTE: Before measuring backlash, the engine must be at normal operating temperature.

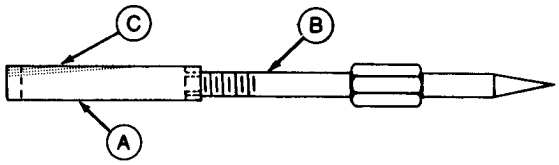
Before removing oil pump, determine if there is adequate backlash between oil pump and camshaft drive gears.

1. Remove tachometer drive housing, located on rear right-hand side of engine block. (See Group 16.)

2. Screw together pointer (B) and ring (A) from JDE109 Camshaft Wear Indicator.

3. Install ring with pointer on top flange of engine oil pump drive gear. Do not tighten pointer.

NOTE: If interference exists between the cylinder block and the ring, grind some material (C) from ring.



RG7002 -UN-26JUN94

A—Ring
B—Pointer
C—Grind Material as Required

S11,2020,ED -19-10AUG94

4. Install gauge (D) on engine block using the two cap screws (A) provided with tool set.

5. Align the pointer (B) over the center mark on gauge and tighten pointer.

IMPORTANT: The pointer MUST BE tight to achieve an accurate backlash measurement.

6. Place fingers on hex portion of pointer (C) and move the pointer back and forth by hand. DO NOT use excessive force to move the pointer.

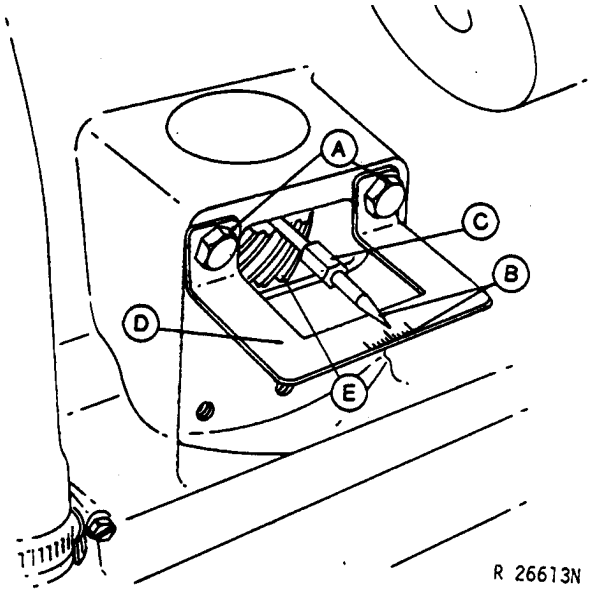
NOTE: Each mark on gauge is equivalent to 1˚ of backlash.

CAMSHAFT GEAR-TO-OIL PUMP DRIVEN GEAR BACKLASH SPECIFICATIONS

Minimum Acceptable Backlash	0.5˚
Maximum Acceptable Backlash	3.5˚

When checking backlash with new camshaft gear and/or oil pump gear, lubricate the camshaft, camshaft gear and oil pump gear with clean SAE30 engine oil.

If backlash is 3.5˚ or more, check camshaft oil pump drive gear and gear on oil pump for a step wear pattern on teeth of gears. Replace parts as necessary. If backlash is less than 0.5˚, or the camshaft does not rotate freely, install a new camshaft.



A—Cap Screws
B—Center Alignment
C—Hex Part of Pointer
D—Gauge
E—Engine Oil Pump Drive Gear

S11,2020,EE -19-10AUG94

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REMOVE AND INSPECT CAMSHAFT-DRIVEN OIL PUMP

1. Loosen gland nut to remove outlet tube from oil pump housing and remove oil pump assembly from cylinder block.

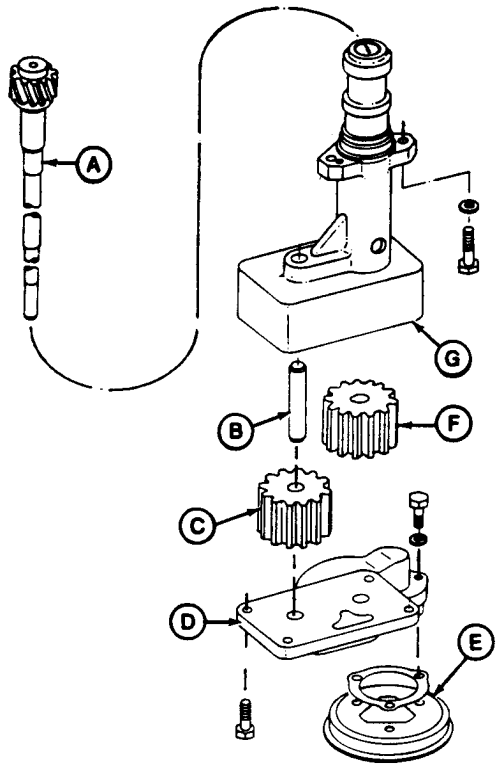
NOTE: If the drive gear on top of the shaft (A) is excessively worn or damaged, check the oil pump drive gear on the camshaft for wear or damage. Replace pump drive gear and camshaft as necessary.

2. Remove intake screen (E) from pump housing cover (D).

3. Examine gears and housing for wear or damage.

4. Check sealing edge of housing for signs of damage that could cause leakage.

IMPORTANT: Worn gears, shafts or housing can reduce pump output and could indicate oil contamination, sludge, or bent/warped shaft.



RG7000 -UN-25JUN94

A—Drive Shaft
B—Idler Shaft
C—Idler Gear
D—Cover
E—Screen
F—Driven Gear
G—Housing

S11,2020,DV -19-08AUG94

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5. Check oil pump assembly with the specifications given below. Replace parts as necessary.

CAMSHAFT-DRIVEN OIL PUMP SPECIFICATIONS

Depth of Gear Bore in Housing	44.526—44.628 mm (1.7530—1.7570 in.)
Gear Thickness	44.450—44.500 mm (1.7500—1.7520 in.)
OD of Gears	85.855—85.880 mm (3.3801—3.3811 in.)
ID of Housing Gear Bore	85.954—86.004 mm (3.3840—3.3860 in.)
ID of Driven Gear	15.799—15.824 mm (0.6220—0.6230 in.)
ID of Idler Gear	16.078—16.104 mm (0.6330—0.6340 in.)
ID of Idler Gear Bushing	16.002—16.027 mm (0.6300—0.6310 in.)
OD of Idler Shaft	15.961—15.977 mm (0.6284—0.6290 in.)
OD of Driven Shaft	15.837—15.862 mm (0.6235—0.6245 in.)
ID of Idler Shaft Bore in Housing	15.92—15.95 mm (0.627—0.628 in.)

If either the idler gear or driven gear must be replaced, replace both gears.

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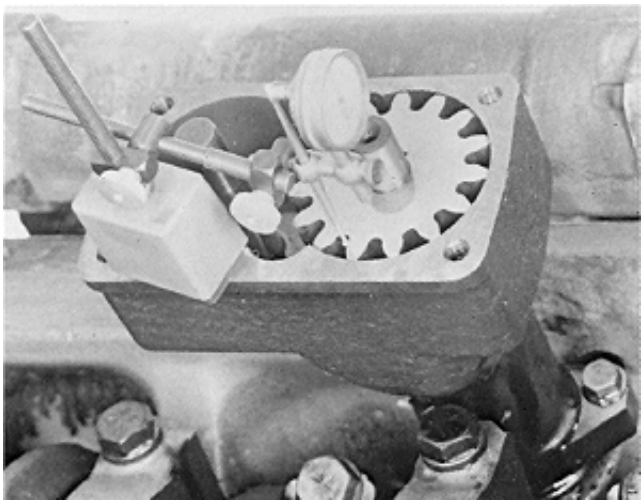
S11,2020,DV1 -19-08AUG94

CHECK CAMSHAFT GEAR-TO-OIL PUMP DRIVE GEAR BACKLASH— CAMSHAFT-DRIVEN OIL PUMP ENGINES ONLY (AFTER ENGINE DISASSEMBLY)


RG4969 -UN-19JAN90

NOTE: This test can be performed only with the engine removed from the vehicle and installed on a repair stand.

1. Turn engine over on engine roll-over stand and remove oil pan. (See DRAIN ENGINE OIL, COOLANT, AND REMOVE OIL PAN earlier in this group.)

2. Remove pick-up screen and elbow from oil pump.

3. Remove oil pump cover and remove oil pump idler gear, if desired.

4. Use a magnetic base dial indicator with a ball tip approximately 2.3 mm (0.090 in.) diameter. Place ball tip at root of oil pump driven gear teeth.

5. Rotate gear clockwise by hand and set dial indicator at zero with ball tip of indicator at root of gear teeth.

6. Rotate gear counterclockwise and check dial indicator reading for gear backlash.

CAMSHAFT GEAR-TO-OIL PUMP DRIVE GEAR BACKLASH SPECIFICATIONS

Maximum Acceptable Backlash	2.03 mm (0.080 in.)
Minimum Acceptable Backlash	0.25 mm (0.010 in.)

When checking backlash with new camshaft gear and/or oil pump gear, lubricate the camshaft, camshaft gear and oil pump gear with clean SAE30 engine oil.

If gear backlash exceeds specification, check oil pump drive gear and camshaft gear for a step wear pattern on teeth of gears. Replace parts as necessary. If backlash is less than 0.25 mm (0.010 in.), or the camshaft does not rotate freely, install a different new camshaft.

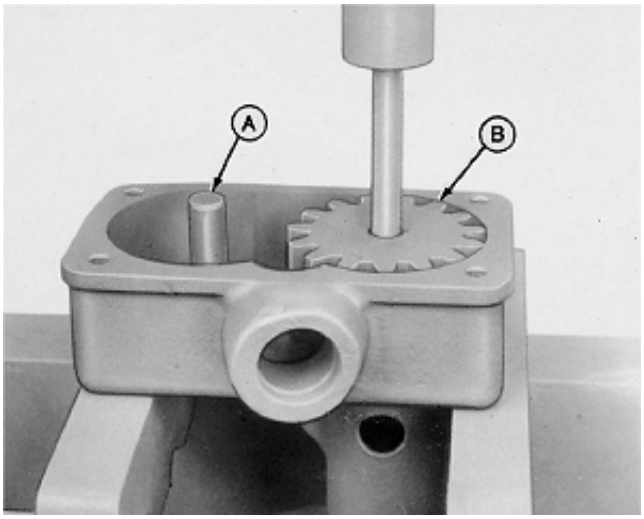
S11,2505,CV -19-08AUG94

REPLACE OIL PUMP GEARS—CAMSHAFT-DRIVEN OIL PUMP

1. Remove idler gear by sliding from idler shaft (A).

2. Press shaft from driven gear (B) and remove.

NOTE: Inspect and clean all parts that will be reused during assembly.



R26129 -UN-09FEB90

S11,2020,DW -19-08AUG94

3. Support pump housing as shown in photo.

4. Use a press adapter (arrow) that has a bore with an I.D. larger than the pump shaft O.D. to install driven gear.

NOTE: Adapter bore must be deeper than 25.9 mm (1.02 in.).

5. Carefully position gear onto shaft.

6. Use a feeler gauge while pressing on gear to obtain a clearance of 0.03—0.18 mm (0.001—0.007 in.) between gear and bottom of housing.

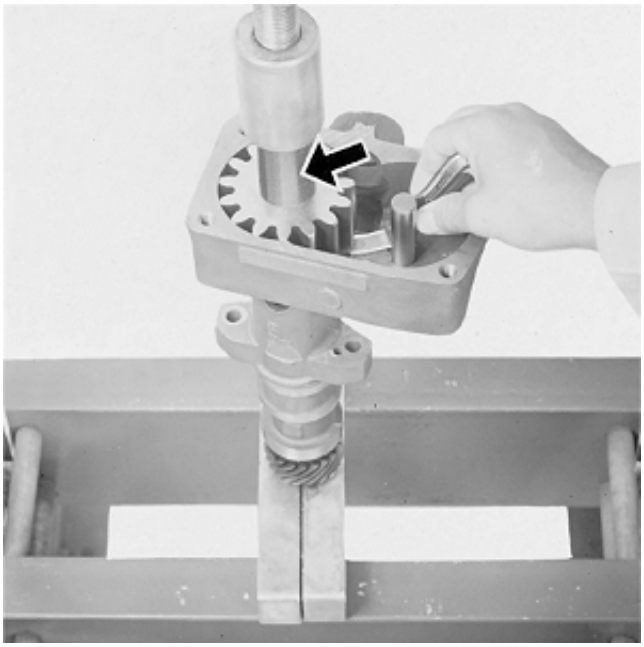
7. Slide idler gear onto shaft.

8. Apply High Temperature Grease (TY6333 or TY6347) to oil pump gears.

9. Install pump cover and tighten cover-to-housing cap screws to 47 N·m (35 lb-ft).

10. Install intake screen and tighten intake-to-cover cap screws to 27 N·m (20 lb-ft).

11. Spin drive gear by hand to make sure both oil pump gears turn freely.



R26395 -UN-09FEB90

S11,2020,DX -19-08AUG94

INSTALL CAMSHAFT-DRIVEN OIL PUMP

1. Install oil pump using new cap screws. Be sure pump drive gear and gear on camshaft mesh.

2. Tighten oil pump-to-block cap screws to 34 N·m (25 lb-ft).

3. Install oil pump-to-bypass housing inlet tube in pump using a new O-ring. Place gland nut with new O-ring on tube.

4. Align inlet tube and gland nut with bypass housing and tighten gland nut.

S11,2020,DY -19-25MAR94

INSTALL OIL PAN WITH 11.1 MM (0.43 IN.) THICK PAN RAIL

Before installing pan, remove old gasket and sealant material from pan and cylinder block mating surfaces. Be sure all gasket surfaces are clean before assembling.

1. Apply a thin layer of PERMATEX AVIATION (Form-A-Gasket No. 3) across entire front and rear gasket rail of block. Install new gasket (A) onto cylinder block and apply a layer of sealant to gasket across front and rear gasket face. On engines equipped with multi-piece gaskets, coat each joint with sealant during assembly.

2. Position oil pan on cylinder block. Guide studs may be used for ease of installation.

3. Insert all cap screws in their appropriate location.

4. Use a straightedge against oil pan and cylinder block (flywheel end) to be sure oil pan is flush with block flange. Trim rear of gasket flush with pan flange.

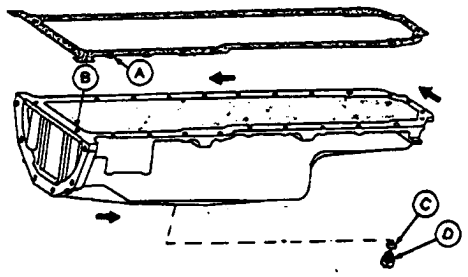
5. Proceeding counterclockwise (bold arrows) from flywheel end (B), tighten all 3/8 in. cap screws and then all 1/2 in. cap screws to the following specifications:

OIL PAN CAP SCREW FINAL TORQUE SPECIFICATIONS

3/8 in. Cap Screws SAE Grade 5	47 N·m (35 lb-ft)
3/8 in. Cap Screws SAE Grade 8 or Grade 10.9	68 N·m (50 lb-ft)
1/2 in. Cap Screws SAE Grade 5	115 N·m (85 lb-ft)
1/2 in. Cap Screws SAE Grade 8 or Grade 10.9	162 N·m (120 lb-ft)

6. Check torque on all 3/8 in. cap screws after final torque of 1/2 in. cap screws.

NOTE: Bottom oil pan drain plug (D) uses either an aluminum washer or rubber O-ring (C) for sealing. Some oil pans may be equipped with an elbow fitting and drain hose in place of drain plug.



RG5010 -UN-29NOV88

A—Oil Pan Gasket
B—Location For First Cap Screw
C—O-Ring or Aluminum Washer
D—Drain Plug

S11,2020,EA -19-08AUG94

7. Apply a light coat of clean engine oil to new rubber O-rings for bottom drain plugs. Install aluminum washers on drain plug so raised center contacts head of plug.

8. Install drain plug and tighten to the following specifications:

OIL PAN DRAIN PLUG TORQUE SPECIFICATIONS

Aluminum Oil Pans	102 N·m (75 lb-ft)
Cast Iron Oil Pans	47 N·m (35 lb-ft)

NOTE: On engines equipped with elbow drain fittings, the threads and sealing surfaces must be free of any oil film to insure an effective seal. Apply a light coat of LOCTITE 592 Pipe Sealant with TEFLON to fitting except for the leading one to three threads. Tighten fitting securely.

S11,2020,EA1 -19-08AUG94

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INSTALL OIL PAN WITH 20.5 MM (0.81 IN.) THICK PAN RAIL

Before installing pan, remove old gasket and sealant material from pan and cylinder block mating surfaces. Be sure all gasket surfaces are clean before assembling.

1. Apply a thin layer of PERMATEX AVIATION (Form-A-Gasket No. 3) across entire front and rear gasket rail of block. Install gasket (A) onto cylinder block and apply a layer of sealant to gasket across front and rear gasket face. On engines equipped with multi-piece gaskets, coat each joint with sealant during assembly.

2. Using R49377 gasket for aluminum pan, or R71918 gasket for cast iron pan, put gasket on cylinder block and install oil pan. Guide studs may be used if desired.

3. Insert all cap screws in their appropriate location.

4. Use a straightedge against oil pan and cylinder block (flywheel end) to be sure oil pan is flush with block flange. Trim rear of gasket flush with pan flange.

5. Proceeding counterclockwise (bold arrows) from flywheel end (B), tighten all cap screws to 47 N·m (35 lb-ft).

6. Repeat sequence by tightening all 3/8 in. cap screws to 68 N·m (50 lb-ft).

7. To complete torquing sequence, proceed counterclockwise and tighten all 1/2 in. Grade 5 cap screws to 115 N·m (85 lb-ft). Tighten all 1/2 in. Grade 8 or 10.9 cap screws to 162 N·m (120 lb-ft).

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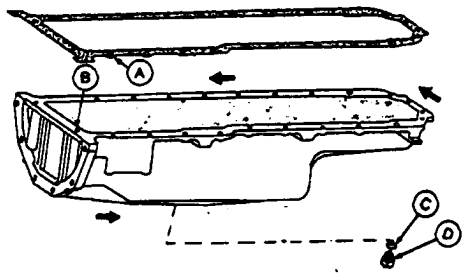
OIL PAN CAP SCREW FINAL TORQUE SPECIFICATIONS

3/8 in. Cap Screws SAE Grade 5	47 N·m (35 lb-ft)
3/8 in. Cap Screws SAE Grade 8 or Grade 10.9	68 N·m (50 lb-ft)
1/2 in. Cap Screws SAE Grade 5	115 N·m (85 lb-ft)
1/2 in. Cap Screws SAE Grade 8 or Grade 10.9	162 N·m (120 lb-ft)

8. Check torque on all 3/8 in. cap screws after final torque of 1/2 in. cap screws.

NOTE: Bottom oil pan drain plug (D) uses either an aluminum washer or rubber O-ring (C) for sealing. Some oil pans may be equipped with an elbow fitting and drain hose in place of drain plug.



RG5010 -UN-29NOV88

A—Oil Pan Gasket
B—Location For First Cap Screw
C—O-Ring or Aluminum Washer
D—Drain Plug

S11,2020,EB -19-08AUG94

9. Apply a light coat of engine oil to new rubber O-rings for bottom drain plug. Install aluminum washer on drain plug so raised center contacts, head of plug.

10. Install drain plug and tighten to the following specifications:

OIL PAN DRAIN PLUG TORQUE SPECIFICATIONS

Aluminum Oil Pans	102 N·m (75 lb-ft)
Cast Iron Oil Pans	47 N·m (35 lb-ft)

NOTE: On engines equipped with elbow drain fittings, the threads and sealing surfaces must be free of any oil film to insure an effective seal. Apply a light coat of LOCTITE 592 Pipe Sealant with TEFLON to fitting except for the leading one to three threads. Tighten fitting securely.

S11,2020,EB1 -19-08AUG94

INSTALL OIL FILTER AND HOUSING

IMPORTANT: If oil filter housing is replaced, turbocharger lube oil line must be connected to out-board threaded hole on top of housing. The in-board threaded hole is a clean-out hole for casting. Connecting turbocharger lube line to the in-board hole will route unfiltered oil to the turbocharger.

1. Remove all gasket residue from cylinder block and filter housing.

2. Install oil filter housing (B) using a new gasket.

3. Tighten hex nuts and cap screw to 47 N·m (35 lb-ft).

4. On 6466T and 6466A Engines, connect turbocharger oil inlet line (D) and injection pump oil inlet line (E).

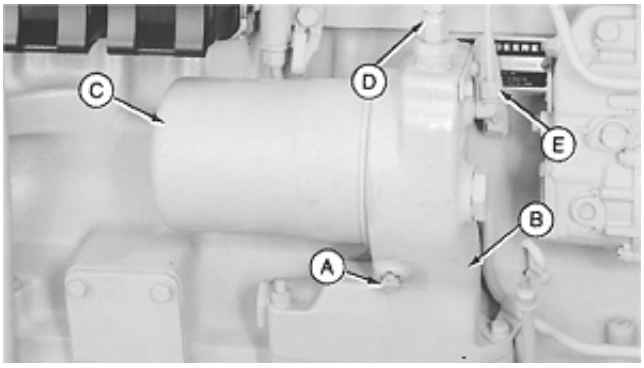
5. Spread a layer of clean engine oil on new filter gasket and install oil filter (C).

6. Tighten new oil filter 1/2—3/4 turn after gasket contacts filter base. DO NOT overtighten.

7. Tighten oil filter drain plug (A).

8. Fill engine with clean engine oil of proper grade and viscosity. (See Group 02).

9. Check for leaks after starting engine.



RG3843 -UN-09NOV89

A—Drain Plug
B—Oil Filter Housing
C—Oil Filter
D—Turbocharger Oil Inlet Line
E—Injection Pump Oil Inlet Line

S11,2020,EC -19-08AUG94

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SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

RG5170 -UN-06APR89

Water Pump Bearing Installing Tool JD262A

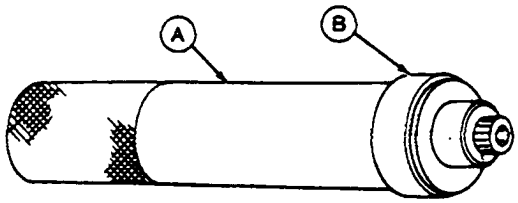
Used to install shaft and bearing assembly on belt-driven water pumps.

S53,JD262A -19-06APR94

A—Drive Handle 27488
B—Seal Driver JDE111

Used to install and properly locate water pump inner seal.

NOTE: JDE132-2 Driver with Handle may be used to install inner seal, if available.



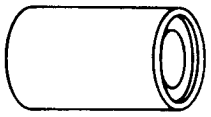
RG5096 -UN-06APR89

S53,JDE111 -19-06APR94

RG5095 -UN-06APR89

Water Pump Shaft and Bearing Driver JDE74

Used to install bearing and shaft assembly into water pump housing.



S53,JDE74 -19-08AUG94

RG5171 -UN-25JUN94

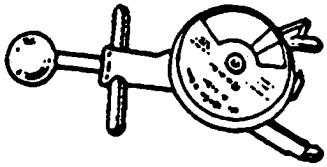
Water Pump Insertion Sleeve JDG249

Used to install water pump bearing and shaft assembly into pump housing. Insertion sleeve prevents inversion of oil seal lip in housing during installation.

S53,JDG249 -19-08AUG94

Belt Tension Gauge JDG529

Used to check and adjust fan belt tension.



RG5082 -UN-23AUG88

S53,JDG529 -19-06APR94

RG5588 -UN-13SEP89

Belt Tension Gauge JDST28

Used with a straightedge to check fan belt tension.

RG,CTM61,G25,26-19-17MAR92

SERVICE EQUIPMENT AND TOOLS

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

Name	Use
D01045AA Bushing, Bearing and Seal Driver Set	Remove and install water pump seals.
D01217AA Bearing Pulling Attachment	Support gear during removal.
D01206AA Gear and Pulley Puller*	Remove gear from water pump shaft.

**Part of D01048AA Puller Set*

RG,CTM1,G25,24 -19-08AUG94

OTHER MATERIAL

Name	Use
LOCTITE 518 (TY6304) Flexible Sealant	Water pump, thermostat cover and water manifold gaskets.
LOCTITE 242 (TY9370) Thread Lock and Sealer	Water outlet manifold-to-cylinder head cap screws. Fan support-to-cylinder head cap screws.
LOCTITE 592 (TY9375) Pipe Sealant with TEFLON®	Water pump and block drain valves, fan drive pipe plug.
High Temperature Grease (TY6333 or TY6347) or PT507 Multi-Purpose Grease	Pack bearings in fan drive and water pump.
PT569 NEVER-SEEZ Compound	Coolant filter conditioner-to-mounting base cap screws.

RG,CTM1,G25,13 -19-08AUG94

COOLING SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Thermostat(s) Opening Temperature	80—84° C (175—182° F)	---
Fan Belt Tension* Using JDG529 Gauge		
New Belts	422—463 N (95—104 lb)	---
Belts in Service (minimum 10 minutes use)	378—423 N (85—95 lb)	---
Fan Belt Tension* Using Tension		
Tester and Straight Edge	19 mm (0.75 in.) with an 89 N (20 lb)	---
	force halfway between pulleys	---
Standard Fixed Position Fan Drive:		
Fan Support ID	25.311—25.337 mm (0.9965—0.9975 in.)	---
Bearing Shaft OD	25.387—25.400 mm (0.9995—1.0000 in.)	---
Pulley ID	47.576—47.612 mm (1.8731—1.8745 in.)	---
Bearing OD	47.612—47.625 mm (1.8745—1.8750 in.)	---
Fixed Position Fan Drive With Front-Mounted Water Manifold:		
Water Manifold ID	25.336—25.362 mm (0.9975—0.9985 in.)	---
Bearing Shaft OD	25.387—25.400 mm (0.9995—1.0000 in.)	---
Pulley ID	47.576—47.612 mm (1.8731—1.8745 in.)	---
Bearing OD	47.612—47.625 mm (1.8745—1.8750 in.)	---
Installed Depth of Bearing Shaft-to-Water Manifold Mounting Surface	28.31—28.57 mm (1.115—1.125 in.)	---
Fixed Position (10° Right) Fan Drive:		
Bearing Housing ID	47.576—47.612 mm (1.8731—1.8745 in.)	---
Fan Hub ID	25.311—25.337 mm (0.9965—0.9975 in.)	---
Bearing OD	47.612—47.625 mm (1.8745—1.8750 in.)	---
Shaft OD	25.387—25.400 mm (0.9995—1.0000 in.)	---
Installed Depth of Fan Hub-to-Bearing Shaft	0.0—1.30 mm (0.051 in.) Below End of Shaft	---
Medium-Duty, Adjustable Fan Drive:		
Bearing Housing ID	47.576—47.612 mm (1.8731—1.8745 in.)	---
Fan Hub ID	25.311—25.337 mm (0.9965—0.9975 in.)	---
Bearing OD	47.612—47.625 mm (1.8745—1.8750 in.)	---
Shaft OD	25.387—25.400 mm (0.9995—1.0000 in.)	---
Shaft	0.0—1.30 mm (0.051 in.) Below End of Shaft	---
Heavy-Duty, Adjustable Fan Drive:		
Bearing Housing ID	71.999—72.025 mm (2.8346—2.8356 in.)	---
Fan Hub ID	30.149—30.175 mm (1.1870—1.1880 in.)	---
Bearing OD	71.987—72.013 mm (2.8341—2.8351 in.)	---
Shaft OD	35.001—35.017 mm (1.3780—1.3786 in.)	---

** On engines with dual belts, check tension on front belt only. Measure tension on longest part of belt between pulleys.*

RG,CTM1,G25,1A -19-08AUG94

COOLING SYSTEM SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Standard-Duty, Belt-Driven Water Pump With Ball Bearings:		
Bearing Bore in Housing, Impeller End	47.000—47.026 mm (1.8503—1.8514 in.)	---
Bearing OD, Impeller End	46.987—47.000 mm (1.8499—1.8504 in.)	---
Bearing ID, Impeller End	19.990—20.010 mm (0.7870—0.7878 in.)	---
Shaft OD for Bearing, Impeller End	20.000—20.016 mm (0.7874—0.7880 in.)	---
Bearing Bore in Housing, Pulley End	71.973—71.999 mm (2.8336—2.8346 in.)	---
Bearing OD, Pulley End	71.987—72.000 mm (2.8341—2.8346 in.)	---
Bearing ID, Impeller End	34.987—35.000 mm (1.3774—1.3780 in.)	---
Shaft OD for Bearing, Pulley End	35.001—35.017 mm (1.3780—1.3786 in.)	---
Pulley ID	25.387—25.413 mm (0.9994—1.0005 in.)	---
Shaft OD for Pulley	25.463—25.489 mm (1.0024—1.0035 in.)	---
Impeller ID	15.854—15.880 mm (0.624—0.625 in.)	---
Shaft OD for Impeller	15.905—15.931 mm (0.626—0.627 in.)	---
Maximum Shaft End Play		0.25 mm (0.010 in.)
Impeller-to-Pump Housing Clearance	0.38—0.89 mm (0.015—0.035 in.)	---
Standard-Duty, Belt-Driven Water Pump With One-Piece Bearing/Shaft:		
Impeller Bore	15.85—15.88 mm (0.624—0.625 in.)	---
Bearing Shaft OD	15.90—15.92 mm (0.626—0.627 in.)	---
Bearing Bore ID in Housing	29.95—29.98 mm (1.1792—1.1802 in.)	---
Bearing OD	29.99—30.00 mm (1.1806—1.1811 in.)	---
Roller Bearing Shaft-to-Housing Interference Press Fit	0.01—0.05 mm (0.0004—0.0019 in.)	---
Impeller-to-Pump Housing Clearance	0.4—0.6 mm (0.015—0.025 in.)	---
Cast Iron Pulley-to-Housing Rear Face Dimension	166.1 mm (6.54 in.)	
Sheet Steel Pulley-to-Housing Rear Face Dimension		
6466AT-05	114 mm (4.49 in.)	---
6466DR-01, 02, 03, 04, 05	114 mm (4.49 in.)	---
6466DF-00, 6466TF-00, 6466AF-00	114 mm (4.49 in.)	---
6466DJ-01	114 mm (4.49 in.)	---
6466DL-01, 02	114 mm (4.49 in.)	---
6466TL-01, 02, 09	114 mm (4.49 in.)	---
6466TDW03	114 mm (4.49 in.)	---
6466TR-03, 04, 05, 06, 07,08, 09, 10	114 mm (4.49 in.)	---
6466DH-01	72 mm (2.83 in.)	---
6466TH-01, 02, 05, 06	72 mm (2.83 in.)	---
6466AH-01, 02, 03	72 mm (2.83 in.)	---
6466AZ-01, 6466AZ002	72 mm (2.83 in.)	---
6466TZ-01	72 mm (2.83 in.)	---

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RG,CTM1,G25,1B -19-08AUG94

COOLING SYSTEM SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Heavy-Duty, Belt-Driven Water Pump:		
Bearing Bore in Housing	72.001—72.027 mm (2.8347—2.8357 in.)	---
Maximum Serviceable		72.047 mm (2.8365 in.)
Bearing OD	71.987—72.000 mm (2.8341—2.8346 in.)	---
Bearing ID	34.987—35.000 mm (1.3774—1.3780 in.)	---
Shaft Bearing Surface OD	35.001—35.017 mm (1.3780—1.3786 in.)	---
Shaft OD—Impeller End	15.905—15.931 mm (0.6262—0.6272 in.)	---
Impeller Bore ID	15.856—15.880 mm (0.6242—0.6252 in.)	---
Shaft OD—Pulley End	30.218—30.234 mm (1.1897—1.1903 in.)	---
Pulley Bore ID	30.149—30.175 mm (1.1870—1.1880 in.)	---
Impeller-to-Pump Housing Clearance	0.0381—0.0889 mm (0.0015—0.0035 in.)	---
Maximum Shaft End Play		0.25 mm (0.010 in.)
Gear-Driven Water Pump:		
Shaft OD—Impeller End	15.90—15.93 mm (0.626—0.627 in.)	---
Shaft OD—Drive Gear End	25.00—25.02 mm (0.984—0.985 in.)	---
Bearing Surface OD, Impeller Side	20.000—20.008 mm (0.7874—0.7877 in.)	---
Impeller Bore ID	15.85—15.88 mm (0.624—0.625 in.)	---
Drive Gear Bore ID	24.92—24.94 mm (0.981—0.982 in.)	---
Drive Gear OD	72.39—72.64 mm (2.850—2.860 in.)	---
Housing ID, Large Bearing	61.96—61.99 mm (2.439—2.440 in.)	---
Large Bearing OD	61.99—62.01 mm (2.440—2.441 in.)	---
Housing ID, Small Bearing	47.00—47.03 mm (1.850—1.852 in.)	---
Small Bearing OD	46.99—47.01 mm (1.850—1.851 in.)	---

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RG,CTM1,G25,1C -19-08AUG94

COOLING SYSTEM SPECIFICATIONS—CONTINUED

TORQUES

Gear-Driven Water Pump:	
Water Pump-to-Cylinder Block	
5/16 in. Cap Screw	27 N·m (20 lb-ft)
3/8 in. Cap Screw	47 N·m (35 lb-ft)
Water Manifold-to-Cylinder Head:	
Top Mount Manifold	47 N·m (35 lb-ft)
Front Mount Manifold	61 N·m (45 lb-ft)
Thermostat Cover-to-Water Manifold	47 N·m (35 lb-ft)
Inlet Elbow-to-Water Pump Housing	30 N·m (22 lb-ft)
Belt-Driven Water Pump:	
Water Pump Cover-to-Housing	27 N·m (20 lb-ft)
Fan-to-Pulley	47 N·m (35 lb-ft)
Water Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Thermostat Cover-to-Water Manifold	47 N·m (35 lb-ft)
Water Pump-to-Cylinder Block	47 N·m (35 lb-ft)
Fan Pulley-to-Hub	47 N·m (35 lb-ft)
Standard Fixed Positon Fan Drive:	
Spacer Hub-to-Support/Pulley	47 N·m (35 lb-ft)
Fan Support-to-Cylinder Head	47 N·m (35 lb-ft)
Fixed Position Fan Drive with Front-Mounted Water Manifold:	
Spacer Hub-to-Support/Pulley	47 N·m (35 lb-ft)
Fixed Position (10° Right) Fan Drive:	
Bearing Housing-to-Support Plate	67 N·m (50 lb-ft)
Medium-Duty, Adjustable Fan Drive:	
Bearing Housing-to-Support Plate	67 N·m (50 lb-ft)
Heavy-Duty, Adjustable Fan Drive:	
Bearing Housing-to-Support Plate	110 N·m (80 lb-ft)
Fan Hub-to-Bearing Shaft	102 N·m (75 lb-ft)

RG,CTM1,G25,2 -19-08AUG94

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COOLING SYSTEM SPECIFICATIONS—CONTINUED

TORQUES—CONTINUED

Coolant Conditioner Filter Mounting Base-to-Cylinder Block	47 N·m (35 lb-ft)
Coolant Conditioner Filter Base-to-Mounting Base	27 N·m (20 lb-ft)
Coolant Heater Flange Nut	68 N·m (50 lb-ft)
Coolant Heater Lock Nut	34 N·m (25 lb-ft)

RG,CTM1,G25,2A -19-08AUG94

DIAGNOSING COOLING SYSTEM MALFUNCTIONS

- **Engine Overheats:**

  Loose or broken fan belt
  Dirty radiator
  Low coolant level
  Low oil level
  Engine overloaded
  Defective head gasket
  Incorrect timing (engine/injection pump)
  Faulty thermostats
  Faulty water pump
  Corroded coolant passages
  Improper grade of fuel
  Excessive fuel delivery

- **Low Coolant Level:**

  Improper maintenance
  Improper operation
  Damaged radiator
  Water pump seal leakage
  Leakage
  Faulty radiator cap

S11,2025,DH -19-17AUG94

FAN DRIVE GENERAL INFORMATION

6466 Engines are available with several types of fan drives: Standard Fixed Position Fan Drive, Fixed Position Fan Drive With Front Mounted Water Manifold, Fixed Position 10° Right Fan Drive, Medium-Duty Adjustable Fan Drive, and Heavy-Duty Adjustable Fan Drive. Separate removal and repair procedures are available for each type of fan drive.

RG,CTM1,G25,3 -19-08AUG94

REPLACE BEARINGS IN STANDARD FIXED POSITION FAN DRIVE

To Disassemble Fan Drive:

1. Remove fan and fan belts.

2. Remove four cap screws (F) securing fan support (C) to cylinder head.

3. For engines equipped with spacer hub (D), remove cap screws (E) securing spacer hub to pulley.

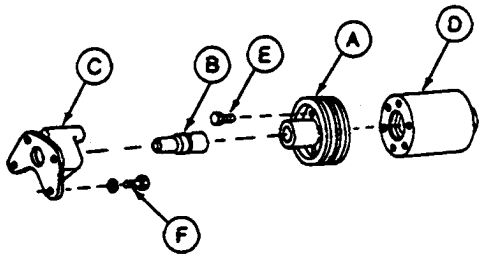
4. Support fan support and press bearing shaft (B) with attached pulley out of fan support. Do not let bearing and pulley fall to the floor.

5. Support pulley (A) and press bearing shaft out of pulley. Discard old bearing shaft.

6. Thoroughly clean and inspect fan support and pulley. Measure parts and compare with specifications given below. Replace parts that are damaged or not within specification.

STANDARD FIXED POSITION FAN DRIVE SPECIFICATIONS

Fan Support ID	25.311—25.337 mm (0.9965—0.9975 in.)
Bearing Shaft OD	25.387—25.400 mm (0.9995—1.0000 in.)
Pulley ID	47.576—47.612 mm (1.8731—1.8745 in.)
Bearing OD	47.612—47.625 mm (1.8745—1.8750 in.)



RG5094 -UN-06APR89

A—Pulley
B—Bearing Shaft
C—Fan Support
D—Spacer Hub
E—Cap Screws
F—Cap Screws With Lock Washers

S11,2025,GQ -19-08AUG94

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To Assemble Fan Drive:

1. Support pulley (A) firm and flat with bearing bore up in a vertical position.

2. Apply a thin coat of clean engine oil to outside of bearing shell.

3. Using a driver that bears on outer shell of bearing, press bearing shaft (B) into pulley until bearing bottoms with end of bearing shaft extending through pulley.

NOTE: The working surface of the bearing driver must be free of nicks, gouges, and visible foreign material.

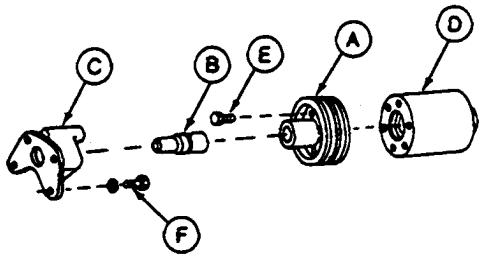
4. Rotate the pulley with shaft and support the assembly on the bearing shaft end.

5. Press pulley/bearing shaft assembly into fan support (C) until end of shaft is 28.31—28.57 mm (1.11—1.12 in.) from fan support mounting face.

6. Install fan support assembly to cylinder head. Coat first three threads of cap screws with LOCTITE 242 Thread Sealer and tighten cap screws with lock washers (F) to 47 N·m (35 lb-ft).

7. For engines equipped with a spacer hub (D), install spacer hub to support/pulley assembly and tighten cap screws (E) to 47 N·m (35 lb-ft).

8. Install fan and fan belts. See CHECK AND ADJUST V-BELT TENSION later in this group.



RG5094 -UN-06APR89

A—Pulley
B—Bearing Shaft
C—Fan Support
D—Spacer Hub
E—Cap Screws
F—Cap Screws With Lock Washers

S11,2025,GQ1 -19-08AUG94

REPLACE BEARINGS IN FIXED POSITION FAN DRIVE WITH FRONT-MOUNTED WATER MANIFOLD

To Disassemble Fan Drive:

1. Remove fan and fan belts.

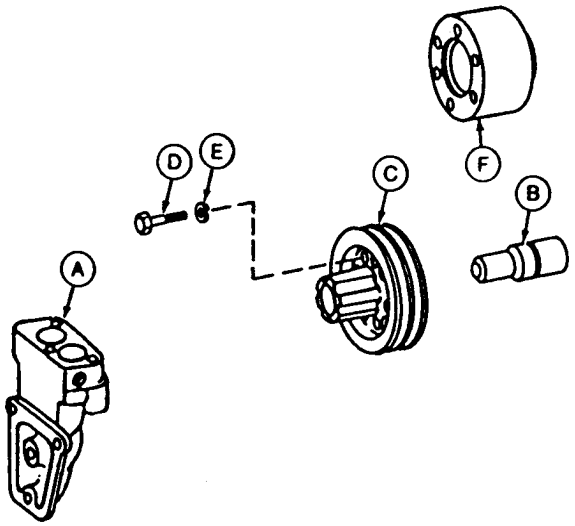
2. Remove front-mounted water manifold (A) from cylinder head as described later in this group.

3. For engines equipped with a spacer hub (F), remove cap screws (D) securing spacer hub to pulley.

4. Support water manifold and press bearing shaft (B) with attached pulley (C) out of water manifold. Do not let bearing shaft and pulley fall to the floor.

5. Support pulley and press bearing shaft out of pulley. Discard old bearing shaft.

6. Thoroughly clean and inspect water manifold and pulley. Measure parts and compare with specifications given below. Replace parts that are damaged or not within specification.



RG7092 -UN-16FEB94

A—Water Manifold
B—Bearing Shaft
C—Pulley
D—Cap Screw
E—Washer
F—Spacer Hub

WATER MANIFOLD-MOUNTED FIXED FAN DRIVE SPECIFICATIONS

Water Manifold ID	25.336—25.362 mm (0.9975—0.9985 in.)
Bearing Shaft OD	25.387—25.400 mm (0.9995—1.0000 in.)
Pulley ID	47.576—47.612 mm (1.8731—1.8745 in.)
Bearing OD	47.612—47.625 mm (1.8745—1.8750 in.)

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RG,CTM1,G25,10 -19-08AUG94

To Assemble Fan Drive:

1. Support pulley (C) firm and flat with bearing bore up in a vertical position.

2. Apply a thin coat of clean engine oil to outside of bearing shell.

3. Using a driver that bears on outer shell of bearing, press bearing shaft (B) into pulley until bearing bottoms with end of bearing shaft extending through pulley.

NOTE: The working surface of the bearing driver must be free of nicks, gouges, and visible foreign material.

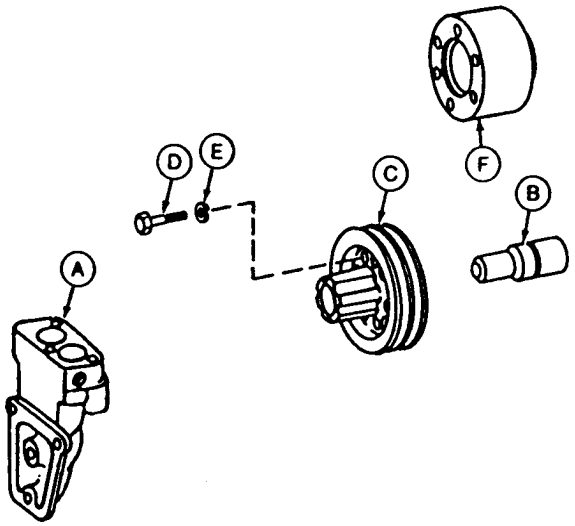
4. Rotate the pulley with shaft and support the assembly on the bearing shaft end.

5. Press pulley/bearing shaft assembly into water manifold (A) until end of shaft is 28.31—28.57 mm (1.115—1.125 in.) from water manifold mounting surface.

6. For engines equipped with a spacer hub (F), install spacer hub to support/pulley assembly and tighten cap screws (D) with washer (E) to 47 N·m (35 lb-ft).

7. Install water manifold as described later in this group.

8. Install fan and fan belts. See CHECK AND ADJUST V-BELT TENSION later in this group.



RG7092 -UN-16FEB94

A—Water Manifold
B—Bearing Shaft
C—Pulley
D—Cap Screw
E—Washer
F—Spacer Hub

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RG,CTM1,G25,10A-19-08AUG94

REPLACE BEARINGS IN FIXED POSITION (10° RIGHT) FAN DRIVE ASSEMBLY

To Disassemble Fan Drive:

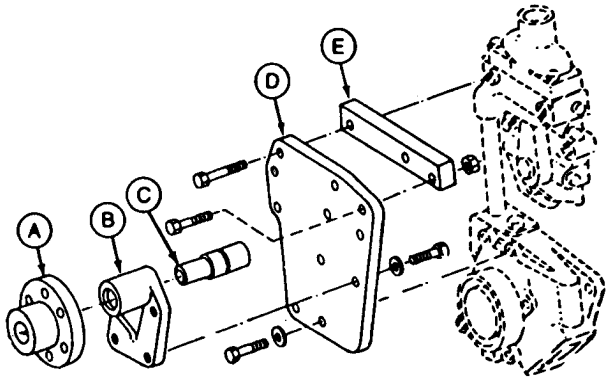
1. Remove fan and fan belts.

2. Remove four cap screws securing bearing housing (B) to support plate (D). Remove fan drive assembly from support plate.

3. Support fan hub (A) and press bearing shaft (C) out of hub. Do not let bearing and housing fall to floor.

4. Support bearing housing and press bearing shaft out of housing. Discard old bearing shaft.

5. Thoroughly clean and inspect bearing housing and fan hub. Measure parts and compare with specifications given below. Replace parts that are damaged or not within specification.



RG7090 -UN-16FEB94

A—Fan/Pulley Hub
B—Bearing Housing
C—Bearing Shaft
D—Support Plate
E—Support Spacer

FIXED POSITION (10°RIGHT) FAN DRIVE SPECIFICATIONS

Bearing Housing ID	47.576—47.612 mm (1.8731—1.8745 in.)
Fan Hub ID	25.311—25.337 mm (0.9965—0.9975 in.)
Bearing OD	47.612—47.625 mm (1.8745—1.8750 in.)
Shaft OD	25.387—25.400 mm (0.9995—1.0000 in.)

To Assemble Fan Drive:

1. Support bearing housing flat and firm with bearing bore in the up position.

2. Apply clean engine oil to OD of bearing and press bearing into housing, using a driver that bears on outer bearing shell only, until bearing bottoms in housing. Long end of shaft should extend through housing.

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3. Support the bearing shaft flat and firm on housing end of shaft.

4. Install fan hub onto bearing shaft until hub is flush-to-1.30 mm (0.051 in.) below end of bearing shaft using a driver which bears on machined surface of hub only.

5. Rotate hub by hand to assure bearing spins freely.

6. Install bearing housing on support plate and tighten cap screws to 67 N·m (50 lb-ft).

7. Install fan and fan belts. See CHECK AND ADJUST V-BELT TENSION later in this group.

RG,CTM1,G25,11 -19-08AUG94

REPLACE BEARINGS IN MEDIUM-DUTY, ADJUSTABLE FAN DRIVE ASSEMBLY

To Disassemble Fan Drive:

1. Remove fan and fan belts.

2. Remove four cap screws securing bearing housing (B) to support plate (D). Remove fan drive assembly from engine.

3. Support fan hub (A) and press bearing shaft (C) out of hub. Do not let bearing and housing (B) fall to floor.

4. Support bearing housing and press bearing shaft out of housing. Discard old bearing shaft.

5. Thoroughly clean and inspect bearing housing and fan hub. Measure parts and compare with specifications given below. Replace parts that are damaged or not within specification.

MEDIUM-DUTY, ADJUSTABLE FAN DRIVE SPECIFICATIONS

Bearing Housing ID	47.576—47.612 mm (1.8731—1.8745 in.)
Fan Hub ID	25.311—25.337 mm (0.9965—0.9975 in.)
Bearing OD	47.612—47.625 mm (1.8745—1.8750 in.)
Shaft OD	25.387—25.400 mm (0.9995—1.0000 in.)

To Assemble Fan Drive:

1. Support bearing housing flat and firm with bearing bore in the up position.

2. Apply clean engine oil to OD of bearing and press bearing into housing, using a driver that bears on outer bearing shell only, until bearing bottoms in housing. Long end of shaft should extend through housing.

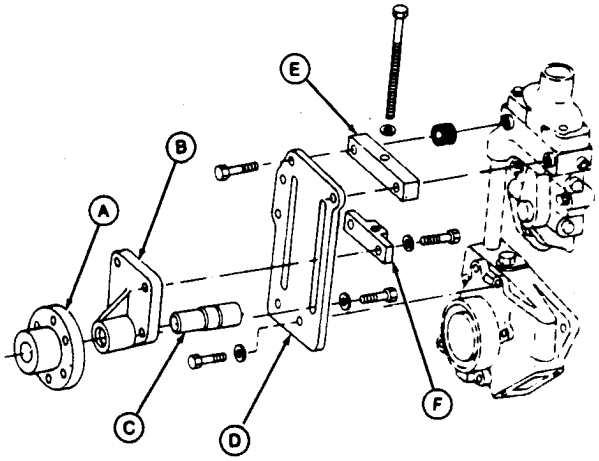
3. Support the bearing shaft flat and firm on housing end of shaft.

4. Install fan hub onto bearing shaft until hub is flush-to-1.30 mm (0.051 in.) below end of bearing shaft using a driver which bears on machined surface of hub only.

5. Rotate hub by hand to assure bearing spins freely.

6. Install bearing housing on support plate. Center fan drive in fan shroud and tighten cap screws to 67 N·m (50 lb-ft).

7. Install fan and fan belts. See CHECK AND ADJUST V-BELT TENSION later in this group.



RG5741 -UN-05AUG91

A—Fan/Pulley Hub
B—Bearing Housing
C—Bearing Shaft
D—Support Plate
E—Support Spacer
F—Adjuster

RG,CTM1,G25,17 -19-08AUG94

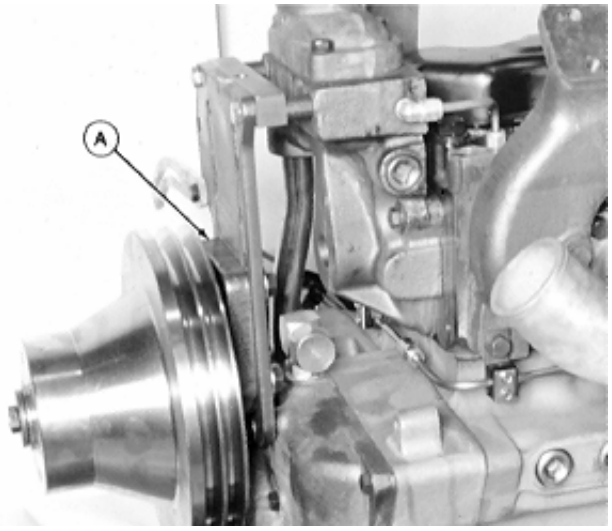
REMOVE AND INSTALL HEAVY-DUTY, ADJUSTABLE FAN DRIVE ASSEMBLY

1. Remove fan belts and fan, shown removed.

2. Remove four cap screws securing bearing housing (A) to support plate and remove fan drive assembly from engine.

3. Reverse removal steps and install fan drive assembly. Center fan drive in fan shroud and tighten mounting cap screws to 110 N·m (80 lb-ft).

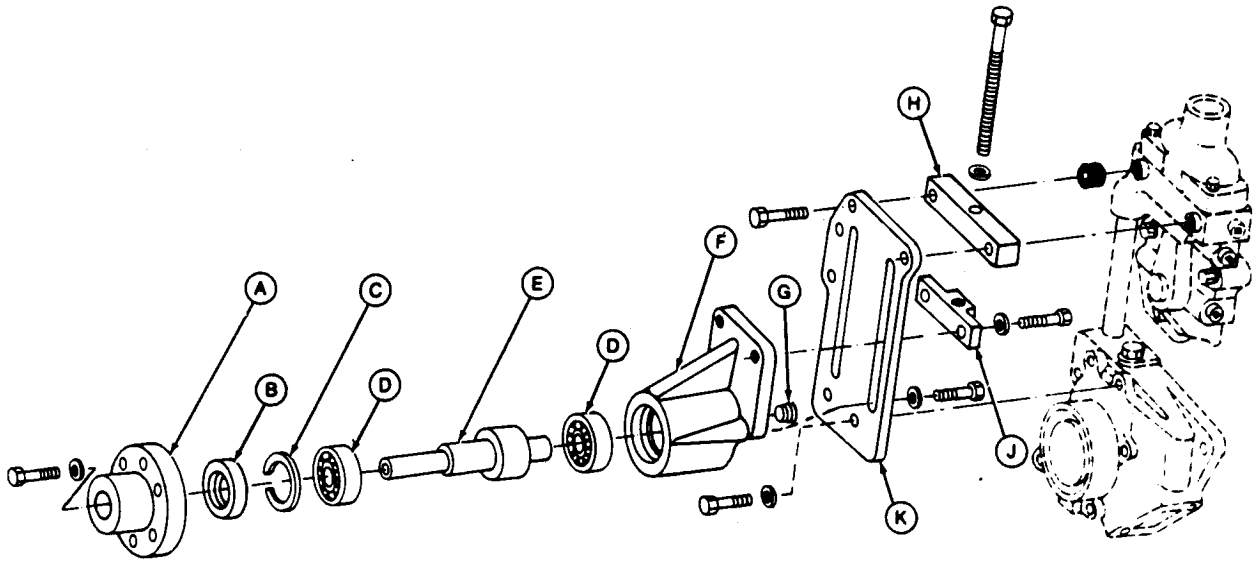
4. Install fan and fan belts. See CHECK AND ADJUST V-BELT TENSION later in this group.



RG5744 -UN-05AUG91

RG,CTM6,G25,3 -19-08AUG94

REPLACE BEARINGS IN HEAVY-DUTY, ADJUSTABLE FAN DRIVE ASSEMBLY



RG5742 -UN-05AUG91

A—Fan Hub
B—Grease Seal
C—Snap Ring
D—Ball Bearing (2 used)
E—Shaft
F—Bearing Housing
G—Pipe Plug
H—Support Spacer
J—Adjuster
K—Support Plate

Heavy-Duty, Adjustable Fan Drive

RG,CTM6,G25,4 -19-08AUG94

(Refer to illustration on previous page)

To Disassemble Fan Drive:

1. Remove fan drive assembly as detailed earlier in this group.

2. Clamp fan hub (A) in a soft-jawed vise. Support fan hub (so it does not fall to floor), and remove cap screw securing hub to shaft (E).

3. Remove pipe plug (G), grease seal (B) and snap ring (C). Discard seal and snap ring.

4. Remove shaft with bearings (D) by lightly tapping with a rubber mallet or brass hammer.

5. Remove bearings from shaft using a press and discard bearings.

6. Thoroughly clean and inspect shaft and bearing housing (F) for cracks or any other damage. Measure parts and compare with specifications given below.

HEAVY-DUTY, ADJUSTABLE FAN DRIVE SPECIFICATIONS

Bearing Housing ID	71.999—72.025 mm (2.8346—2.8356 in.)
Shaft OD	35.001—35.017 mm (1.3780—1.3786 in.)
Bearing OD	71.987—72.013 mm (2.8341—2.8351 in.)
Fan Hub ID	30.149—30.175 mm (1.1870—1.1880 in.)

Replace parts that are damaged or not within specification.

To Assemble Fan Drive:

1. Pack inner and outer bearings with High Temperature Grease (TY6333 or TY6347). Apply clean engine oil to bearing ID and shaft OD.

2. Support end of shaft and install bearings onto end against shoulder by pressing on bearing inner race only.

3. Support bearing housing on a firm flat surface with bearing bore in the upward position.

4. Install bearing and shaft assembly into housing, small end of shaft should extend through housing.

NOTE: Several thickness of snap rings are available through service parts, use the correct thickness to obtain correct end play. Refer to your engine parts catalog or microfiche.

5. Determine proper snap ring to use to obtain 0.10 mm (0.004 in.) end play.

6. Install proper snap ring in housing groove. Visually inspect snap ring installation for proper seating in housing groove.

7. Apply a thin coat of clean engine oil to OD of seal casing and rubber seal lips. Install seal in housing bore until metal casing is flush-to-0.50 mm (0.020 in.) below housing face.

8. While supporting shaft through pipe plug hole in bearing housing, apply clean engine oil to ID of fan hub. Install hub onto shaft until it bottoms on shoulder.

9. Install washer and cap screw. Tighten cap screw to 102 N·m (75 lb-ft).

10. Apply LOCTITE 592 Pipe Sealant with TEFLON® to threads of pipe plug, install plug in bearing housing and tighten securely.

11. Install fan drive assembly onto support plate as detailed earlier in this group.

12. Install fan and fan belts. Install fan and fan belts. See CHECK AND ADJUST V-BELT TENSION later in this group.

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RG,CTM1,G25,12 -19-08AUG94

WATER PUMP GENERAL INFORMATION

Early 6466 Engines were equipped with three basic belt-driven water pumps: a standard-duty water pump with ball bearings, a standard-duty water pump with a one-piece shaft and roller bearing, and a heavy-duty water pump with a separate bearing pressed on each end of the shaft. Later 6466 Engines were equipped with a (crankshaft) gear-driven water pump.

Removal and installation of standard-duty and heavy-duty belt-driven water pumps are the same, but repair procedures differ. Use the appropriate repair procedure for the water pump supplied on your engine.

S11,2025,GB -19-08AUG94

CHECK WATER PUMP LEAKAGE CAUSES

Cracked housing.
Scratched, damaged, or worn water pump seal.
Cracked, loose or damaged ceramic insert.
Loose or defective cupped rubber insert.
Defective water pump shaft.

Leakage at the drain hole in the pump housing usually indicates a leaking water pump seal. Replace with new seal, cupped rubber insert, and ceramic insert.

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16

S11,0405,L -19-06APR94

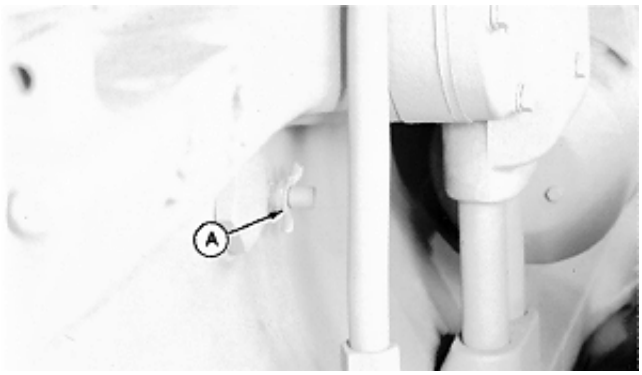
PRELIMINARY DISASSEMBLY FOR WATER PUMP REMOVAL

1. Remove fan assembly if not previously done. On belt-driven water pump engines with bolt-on pulley, remove pulley.

2. Remove alternator.

CAUTION: Do not drain engine coolant until the coolant temperature is below operating temperature. Loosen drain cock (A) slowly to relieve any excess pressure.

3. Drain all coolant.



RG3851 -UN-14DEC88

S11,2025,DI -19-06APR94

GEAR-DRIVEN WATER PUMP—APPLICATION CHART

Engine Model

6466ACM01	6466AR-18	6466AT-14	6466TH001	6466TR-16	6466TT-06
6466ACZ01	6466AR-19	6466AT014	6466TL-03	6466TR-17	6466TT-07
6466AF	6466AR-20	6466DR-06	6466TL-04	6466TR-18	6466TT-08
6466AF001	6466AR-21	6466DR-07	6466TL-05	6466TR-19	6466TT008
6466AN-02	6466AT-06	6466DR-08	6466TL-06	6466TR-20	
6466AR-13	6466AT-07	6466DR-09	6466TR-11	6466TRW04	
6466AR-14	6466AT-09	6466HH001	6466TR-12	6466TT-02	
6466AT-10	6466AR-15	6466TCZ01	6466TR-13	6466TT-03	
6466AT-12	6466AR-16	6466TCZ02	6466TR-14	6466TT-04	
6466AR-17	6466AT-13	6466TF	6466TR-15	6466TT-05	

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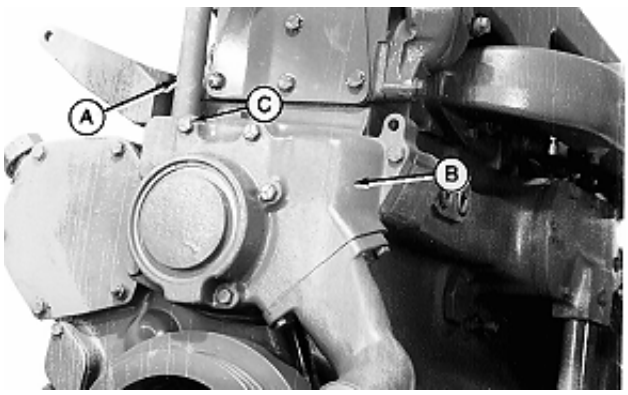
RG,CTM1,G25,4 -19-08AUG94

REMOVE GEAR-DRIVEN WATER PUMP

NOTE: Three-thermostat water manifold does not have a gland nut, pipe is held in place with a cap screw (C).

1. Disconnect gland nut at water manifold and remove bypass pipe (A) from water pump housing.

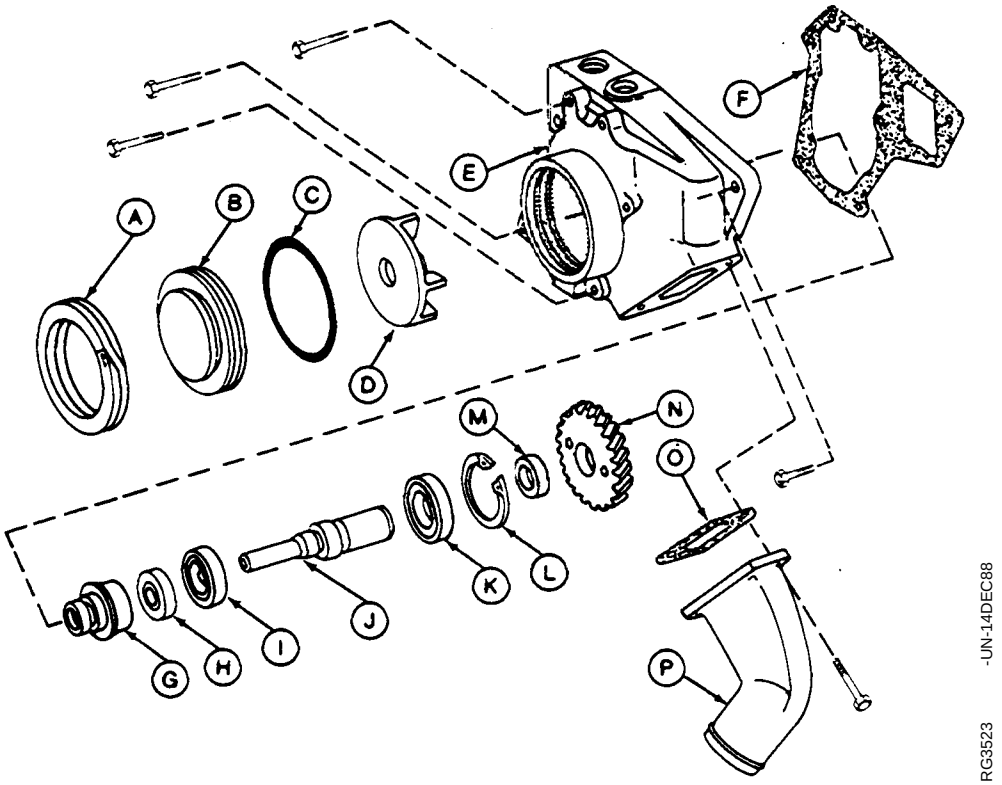
2. Remove mounting cap screws and lift water pump (B) from cylinder block.



RG3852 -UN-20APR94

S11,2025,DJ -19-08AUG94

DISASSEMBLE GEAR-DRIVEN WATER PUMP



A—Retaining Ring
B—Cover
C—O-Ring
D—Impeller
E—Housing
F—Gasket
G—Seal (Water Pump)
H—Seal (Oil)
I—Bearing (Front)
J—Shaft
K—Bearing (Rear)
L—Retaining Ring
M—Spacer
N—Drive Gear
O—Gasket
P—Inlet Elbow

6466 Gear-Driven Water Pump

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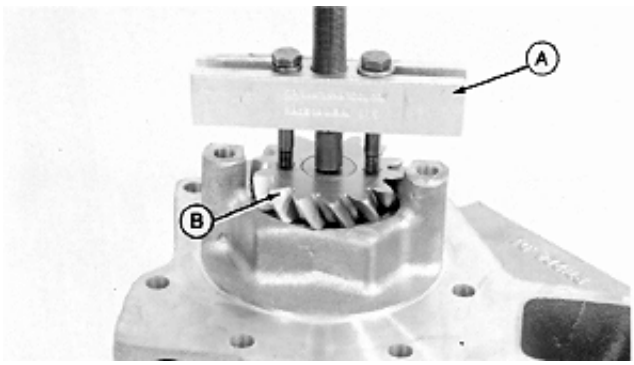
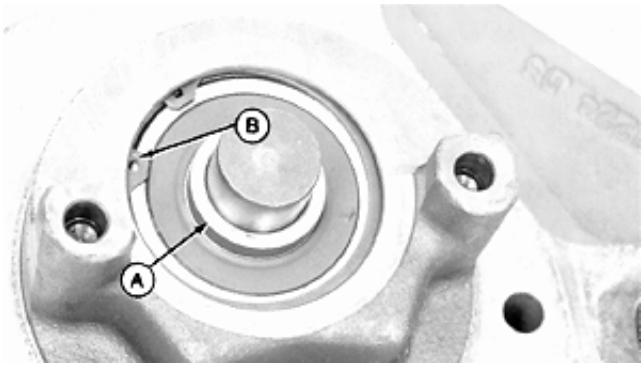
S11,2025,DK -19-06APR94

1. Remove water pump drive gear (B) using the D01206AA Gear Puller (A) with two 3/8—16 in. cap screws and flat washers.



S11,2025,BI -19-06APR94

2. Remove spacer (A) and retaining ring (B).

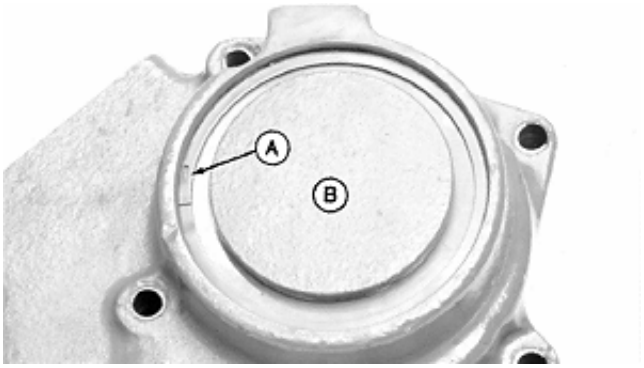


S11,2025,BJ -19-17JUN91

3. Remove retaining ring (A).

4. Pry water pump cover (B) from housing using two screwdrivers.

5. Discard O-ring on water pump cover.

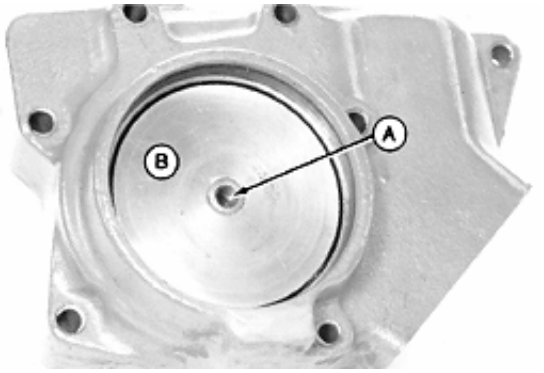


S11,2025,BK -19-09APR85

6. Install an Allen-head screw into water pump shaft (A).

7. Use a press and press on screw only.

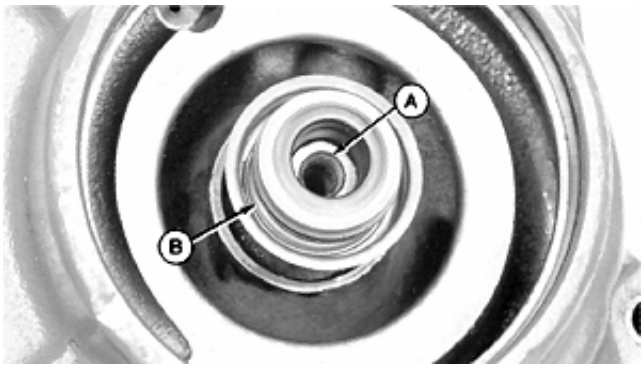
8. Remove impeller (B).



S11,2025,BL -19-09APR85

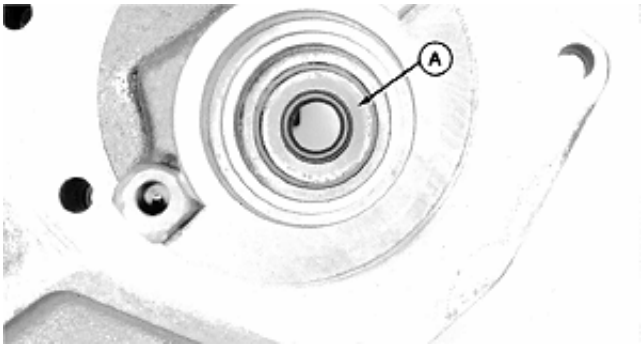
9. Press shaft (A) and bearing assembly from water pump housing.

10. Drive seal (B) from housing using a small driver. Discard seal.



S11,2025,BM -19-09APR85

11. Remove and discard grease seal (A).



S11,2025,BN -19-18JUN91

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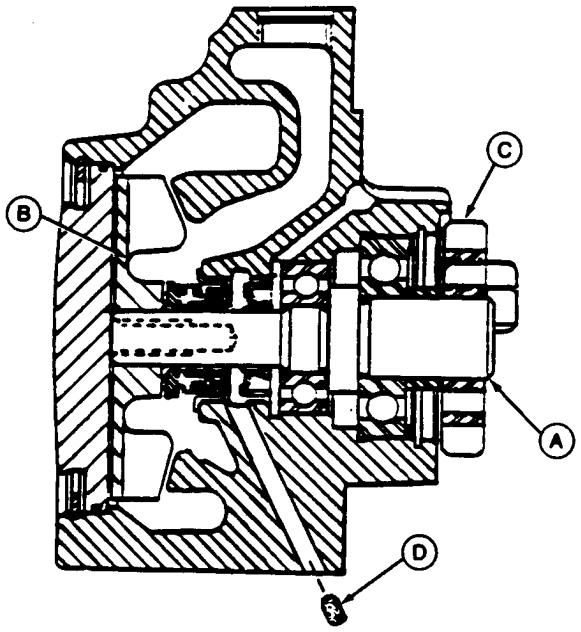
INSPECT GEAR-DRIVEN WATER PUMP PARTS

1. Visually inspect and measure shaft OD (A) at both ends, impeller bore ID (B), and drive gear bore (C). Replace parts if worn, damaged, or not within specifications.

GEAR-DRIVEN WATER PUMP SPECIFICATIONS

Shaft OD Impeller End	15.90—15.93 mm (0.626—0.627 in.)
Shaft OD Drive Gear End	25.00—25.02 mm (0.984—0.985 in.)
Bearing Surface OD Impeller Side	20.000—20.008 mm (0.7874—0.7877 in.)
Impeller Bore ID	15.85—15.88 mm (0.624—0.625 in.)
Drive Gear Bore ID	24.92—24.94 mm (0.981—0.982 in.)
Drive Gear OD	72.39—72.64 mm (2.85—2.86 in.)
Housing ID, Large Bearing	61.96—61.99 mm (2.439—2.440 in.)
Large Bearing OD	61.99—62.01 mm (2.440—2.441 in.)
Housing ID, Small Bearing	47.00—47.03 mm (1.850—1.852 in.)
Small Bearing OD	46.99—47.01 mm (1.850—1.851 in.)



RG5702 -UN-07JAN91

A—Shaft
B—Impeller
C—Drive Gear
D—Weep Hole Filter

2. When replacing bearings or shaft, support bearings and press on shaft only to disassemble.

3. Install new bearings onto shaft using a tubular driver. Drive on INNER bearing race only.

4. Effective with Engine Serial No. (348589—), remove and discard foam weep hole filter (D).

5. Inspect water pump housing for debris, cracks, or damage. Be sure the “weep hole” in the housing is cleaned while pump is disassembled. Replace housing as necessary.

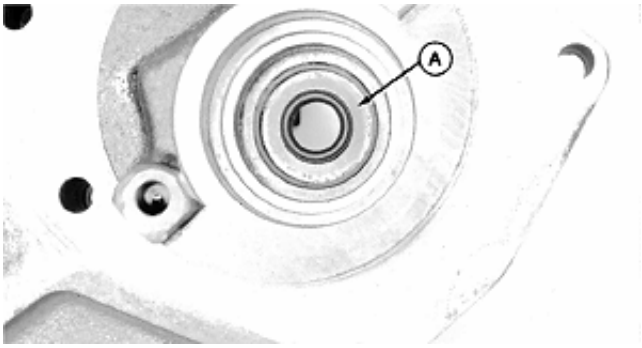
NOTE: Make sure all gasket material is removed from pump.

6. Clean all reusable parts, except bearings, with clean solvent, and dry with compressed air.

S11,2025,DL -19-08AUG94

ASSEMBLE GEAR-DRIVEN WATER PUMP

1. Install new oil seal (A) from rear side of housing with spring loaded lip toward drive gear end of housing using a suitable driver.

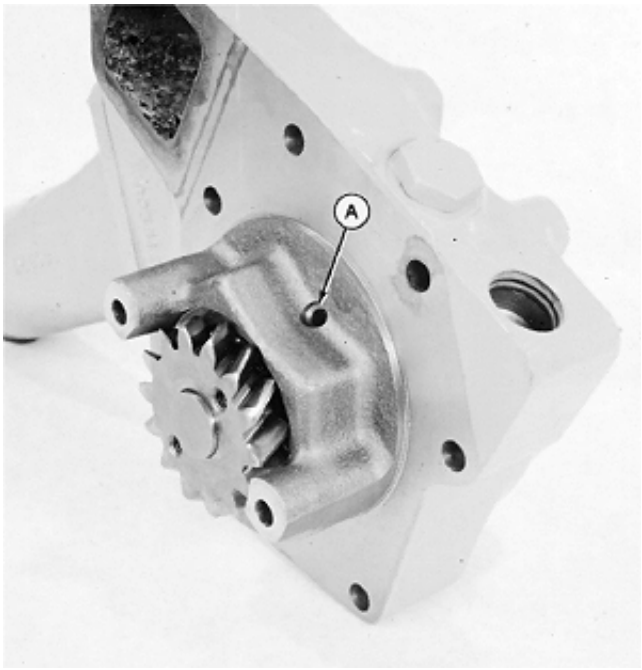


RG3518 -UN-14DEC88

RG,CTM1,G25,16 -19-08AUG94

NOTE: Water pumps prior to Engine Serial No. (309262—) have sealed bearings in the pump. Water pumps after Engine Serial No. (—309263) use non-sealed ball bearings, and have an oil feed hole (A) in the water pump housing to lubricate the ball bearings with engine oil.

Water pumps without the oil feed hole must use sealed bearings. Water pumps with an oil feed hole must use non-sealed ball bearings. Do not mix sealed and non-sealed bearings within the water pump.



RG7100 -UN-08MAR94

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RG,CTM1,G25,5 -19-08AUG94

2. Install new bearings onto shaft against shoulder using a driver which bears on inner race only.

3. Apply a light coat of clean engine oil on O.D. of JDG249 Water Pump Insertion Sleeve (A). Install tool over shaft.

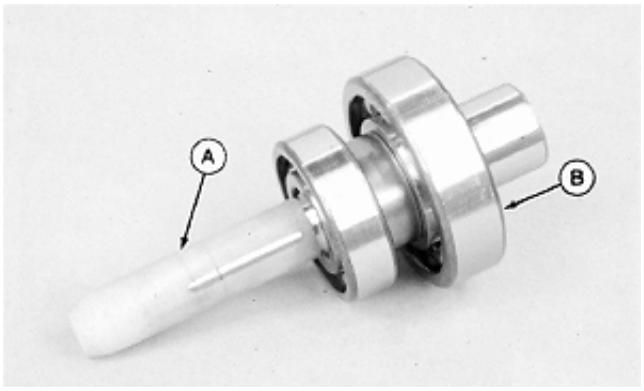
4. Pack grease seal cavity between sealing lips and within cup with a generous amount of PT507 Multi-Purpose Grease or High Temperature Grease (TY6333 or TY6347).

5. Install shaft bearing assembly into water pump housing with the JDG249 Water Pump Insertion Sleeve.

6. Gently drive shaft bearing assembly into housing bore using a driver that bears on outer race of large bearing (B).

7. Remove JDG249 Sleeve from end of shaft after shaft bearing assembly is firmly seated in housing bore.

NOTE: The JDG249 Sleeve is used to relieve any excess pressure build up when installing shaft/bearing assembly, and to keep oil seal lips from rolling.

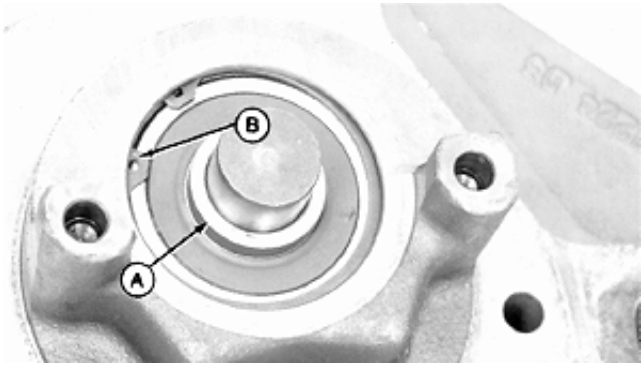


-UN-16FEB94
RG7097

RG,CTM1,G25,25 -19-08AUG94

8. Install retaining ring (B) in groove in housing with flat side of ring facing bearing.

9. Install gear spacer (A) over shaft.



-UN-14DEC88
RG3514

RG,CTM1,G25,26 -19-08AUG94

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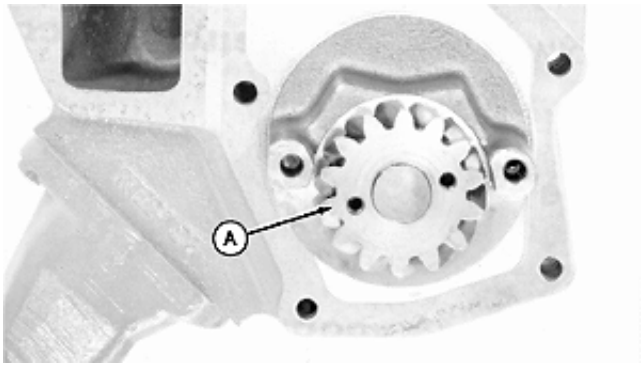
10. Support opposite end of shaft and press drive gear (A) onto shaft against spacer.

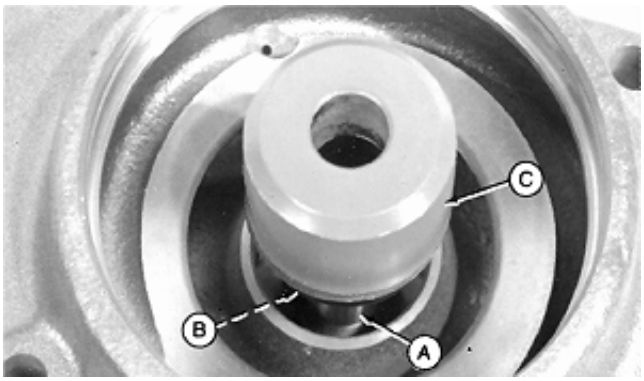
11. Rotate gear by hand to be sure assembly turns freely. Disassemble and correct problem if resistance is felt.



-UN-14DEC88
RG3513

RG,CTM1,G25,27 -19-08AUG94

12. Turn pump housing over and position water pump seal (B) onto shaft (A). Install seal into housing using the R78350 Driver (C) included in seal kit.

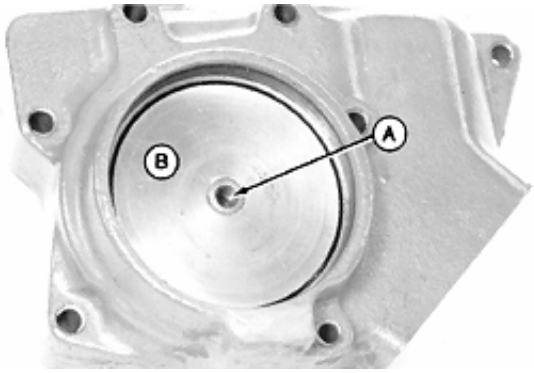


-UN-14DEC88
RG3933

RG,CTM1,G25,28 -19-08AUG94

13. Support shaft (A) and press impeller (B) in place. Press impeller until flush-to-0.130 mm (0.0051 in.) below end of shaft (A).

14. Turn shaft to be sure impeller does not rub against housing.



-UN-14DEC88
RG3516

RG,CTM1,G25,29 -19-08AUG94

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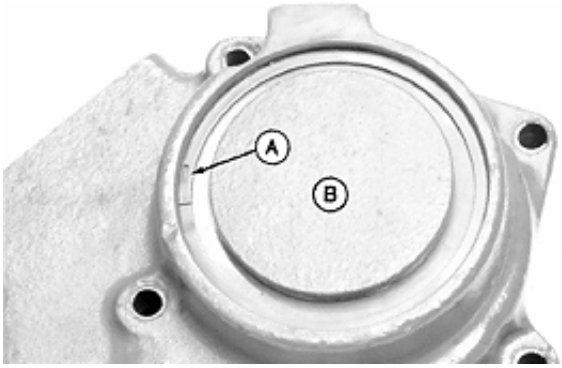
15. Lubricate new O-ring with liquid soap and install on cover. Press cover (B) into housing.

16. Install retaining ring (A). Be sure ring is fully seated in retaining groove.

17. Effective with Engine Serial No. (348589—), install a new foam filter in weep hole of water pump housing.

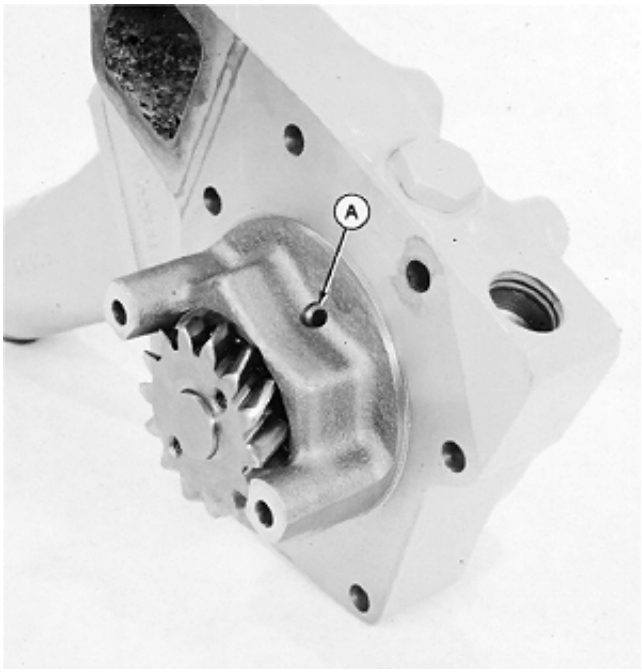
18. Install inlet elbow onto housing using a new gasket. Tighten cap screws to 30 N·m (22 lb-ft).



RG3515 -UN-14DEC88

RG,CTM1,G25,30 -19-08AUG94

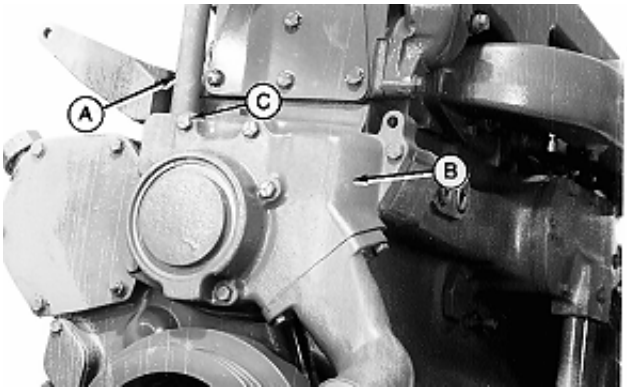
If non-sealed ball bearings have been installed, pre-lube water pump bearings by squirting clean engine oil into water pump oil feed hole (A) until oil runs out of bearing behind gear.



RG7100 -UN-08MAR94

RG,CTM1,G25,6 -19-06APR94

INSTALL GEAR-DRIVEN WATER PUMP



RG3852 -UN-20APR94

1. Using LOCTITE 518 Flexible Sealant, position a new gasket onto timing gear cover. Install water pump (B), making sure pump drive gear is properly positioned.

IMPORTANT: Apply LOCTITE 242 Thread Lock and Sealer to cap screw (C) during assembly to avoid leaks.

2. Install and tighten all 3/8 in. cap screws to 47 N·m (35 lb-ft) and all 5/16 in. cap screws to 27 N·m (20 lb-ft).

NOTE: Lubricate O-ring with grease to ease installation of bypass pipe (A).

3. Install bypass pipe, using a new O-ring in water pump housing and tighten gland nut securely.

S11,2025,DN -19-08AUG94

STANDARD DUTY BELT-DRIVEN WATER PUMP WITH BALL BEARINGS—APPLICATION CHART

Engine Model

6466ACD01
6466AT-01
6466AT-02
6466TCF01
6466TT-01

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26

S11,2025,GC -19-06APR94

REMOVE STANDARD DUTY BELT-DRIVEN WATER PUMP WITH BALL BEARINGS

CAUTION: Do not drain engine coolant until the coolant temperature is below operating temperature. Then loosen drain valve slowly to relieve any excess pressure.

1. Drain engine coolant from cylinder block and radiator.

2. Remove fan blade from pulley and set it down in the fan shroud.

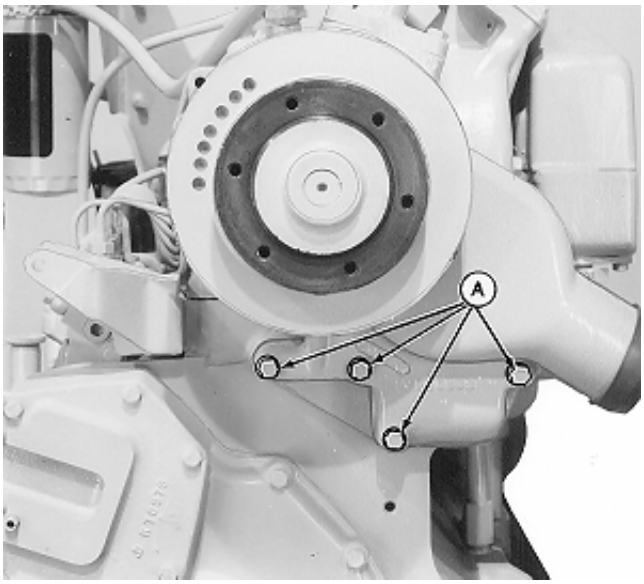
3. Remove alternator and alternator belt.

4. Loosen fan belt tightener center bolt and adjusting screw far enough to remove fan belts.

CAUTION: Water pump is heavy. Plan proper handling procedure to avoid personal injuries.

5. Remove four cap screws (A) attaching water pump to cylinder block.

6. Remove water pump.

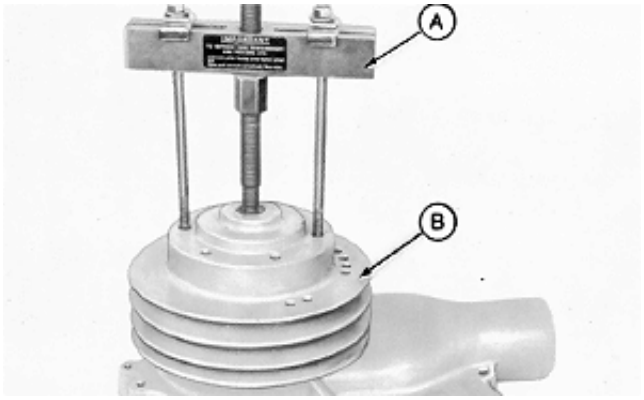


RG2802 -UN-12AUG94

S11,2025,GDA -19-08AUG94

DISASSEMBLE STANDARD DUTY BELT-DRIVEN WATER PUMP WITH BALL BEARINGS

1. Use D01206AA Puller (A) to remove fan pulley (B) from water pump shaft.



RG4001 -UN-09NOV89

S11,0405,C -19-08AUG94

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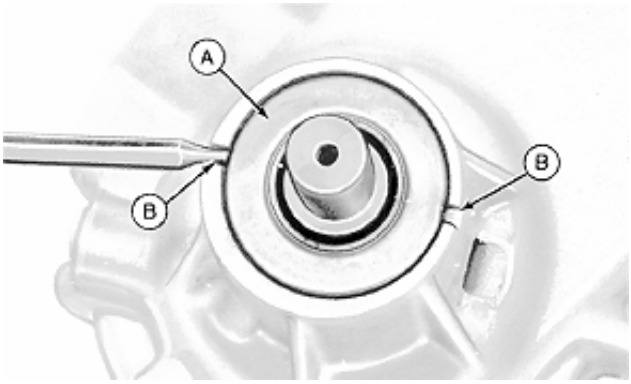
27

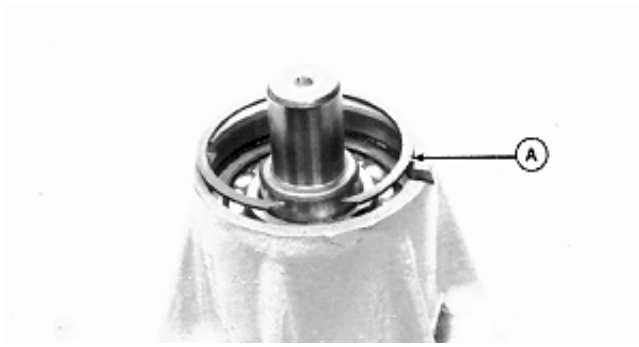
2. Drive outer seal (A) from housing using a center punch and notches (B) provided in housing.



S11,0405,D -19-10MAY82

3. Remove snap ring (A).

4. Remove the cover plate and gasket.

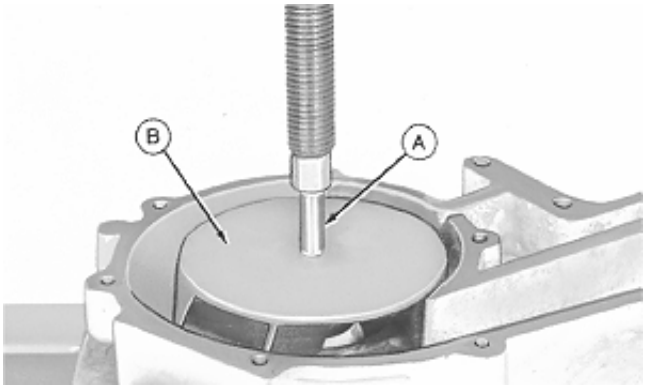


S11,0405,E -19-10MAY82

5. Select a drive (A) slightly smaller than the I.D. of the impeller (B).

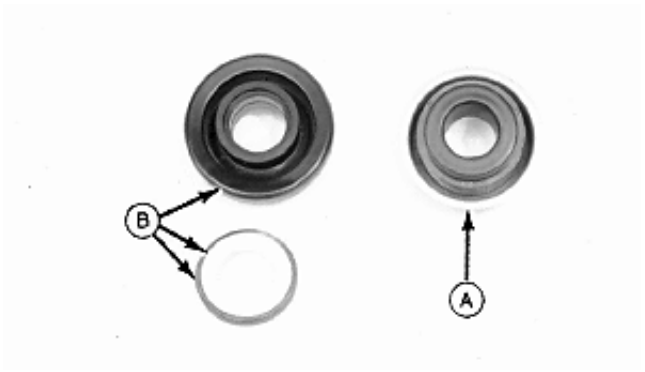
6. Support pump housing from pulley side and press water pump shaft, inner bearing, and outer bearing down through pump housing.

7. Remove the impeller.



S11,0405,F -19-10MAY82

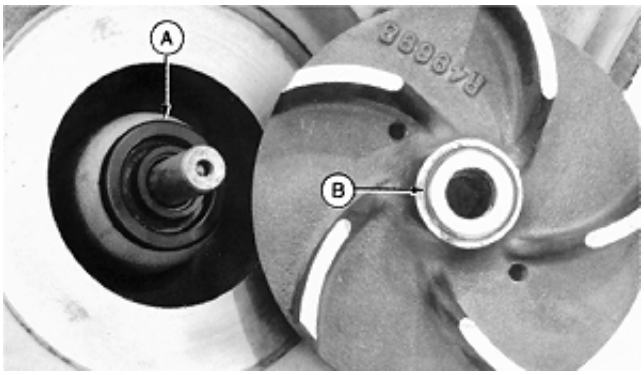
NOTE: A one-piece seal (A) went into production beginning with Engine Serial No. (147234—). The three-piece seal (B) was used prior to Engine Serial No. (—147234) and is replaced by the one-piece seal.



S11,0417,R -19-06APR94

8. On pumps with three-piece seal, remove water pump seal (A) from shaft. Remove bearings and shaft from pump housing.

9. Use an O-ring pick or other suitable tool to remove ceramic insert (B) from impeller.

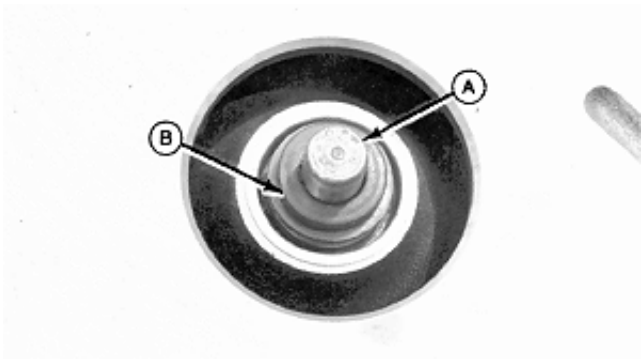


S11,0405,G -19-10MAY82

On pumps with one-piece seal, use a press to remove shaft (A) and bearing assembly. Press until assembly is clear from water pump housing.

NOTE: Press only on end of shaft and not on water pump seal (B).

Remove seal.

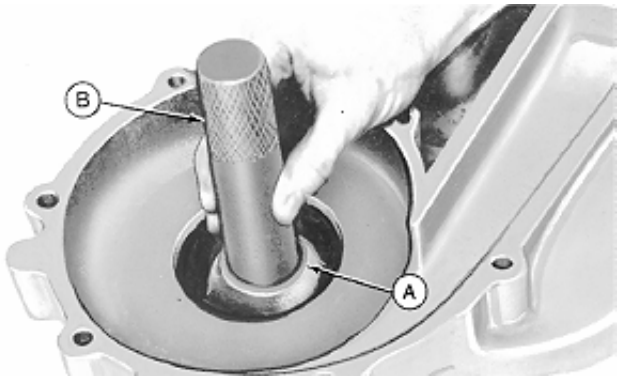


S11,0417,S -19-08AUG94

10. Use 27495, 27505 Drivers (A) and 27488 Handle (B) to drive the inner seal out of its bore.

NOTE: If the inner bearing remained in the housing during shaft removal, it will be removed with the inner seal.

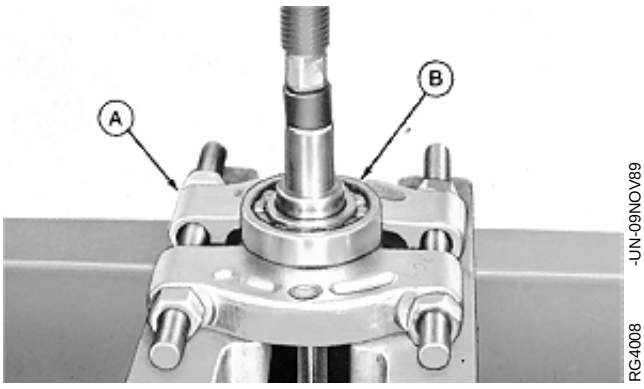
11. Scrape gasket material from pump housing and cover plate.



S11,0405,H -19-10MAY82

12. Use D01217AA Bearing Puller (A) or other suitable tool to support inner race of OUTER bearing (B).

13. Press shaft out of bearing.



S11,0405,I -19-08AUG94

14. Use D01217AA Bearing Puller (A) or other suitable tool to support inner race of the INNER bearing (B).

15. Press shaft out of bearing.

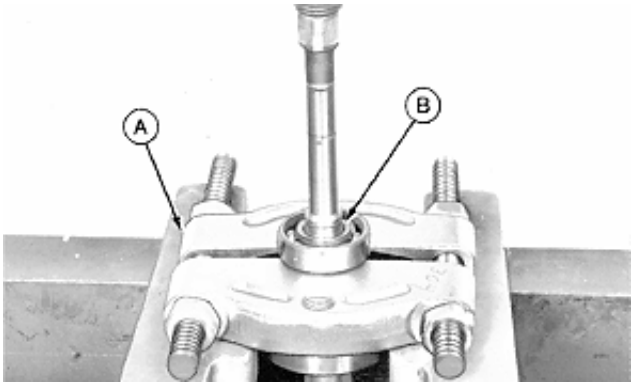
16. Inspect all water pump parts for wear or damage.

17. Inspect housing for damage behind the impeller. Replace if metal has been scraped away by impeller.

18. Clean all water pump parts of sludge and sediment using clean solvent. Dry with compressed air.

19. Inspect both inner and outer bearings and replace as necessary.

20. Replace parts if worn, damaged, or not within specifications.



RG4009 -UN-09NOV89

STANDARD-DUTY, BELT-DRIVEN WATER PUMP WITH BALL BEARINGS SPECIFICATIONS

Bearing Bore in Housing, Impeller End	47.000—47.026 mm (1.8503—1.8514 in.)
Bearing OD, Impeller End	46.987—47.000 mm (1.8499—1.8504 in.)
Bearing ID, Impeller End	19.990—20.010 mm (0.7870—0.7878 in.)
Shaft OD for Bearing, Impeller End	20.000—20.016 mm (0.7874—0.7880 in.)
Bearing Bore in Housing, Pulley End	71.973—71.999 mm (2.8336—2.8346 in.)
Bearing OD, Pulley End	71.987—72.000 mm (2.8341—2.8346 in.)
Bearing ID, Impeller End	34.987—35.000 mm (1.3774—1.3780 in.)
Shaft OD for Bearing, Pulley End	35.001—35.017 mm (1.3780—1.3786 in.)
Pulley ID	25.387—25.413 mm (0.9994—1.0005 in.)
Shaft OD for Pulley	25.463—25.489 mm (1.0024—1.0035 in.)
Impeller ID	15.854—15.880 mm (0.624—0.625 in.)
Shaft OD for Impeller	15.905—15.931 mm (0.626—0.627 in.)

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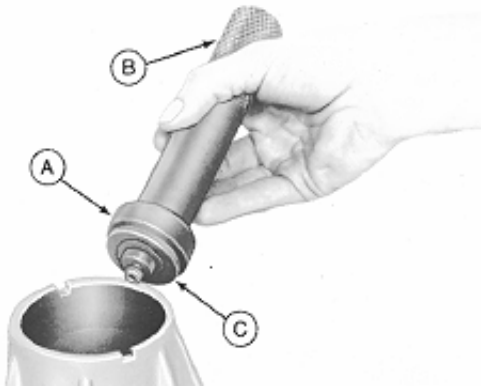
S11,0405,J -19-08AUG94

ASSEMBLE STANDARD-DUTY, BELT-DRIVEN WATER PUMP WITH BALL BEARINGS

1. Insert JDE111 Seal Driver (A) and 27488 Handle (B) in inner seal (C) with open face of seal toward driver.

2. Drive seal into housing from fan pulley end until driver bottoms.

3. Pack inner and outer bearings with High Temperature Grease (TY6333 or TY6347).



-UN-09NOV89
RG4010

S11,0405,M -19-08AUG94

4. Use tubular drivers against the inner races and press the inner bearing (A) and outer bearing (B) onto the shaft until they bottom against their respective shoulders.

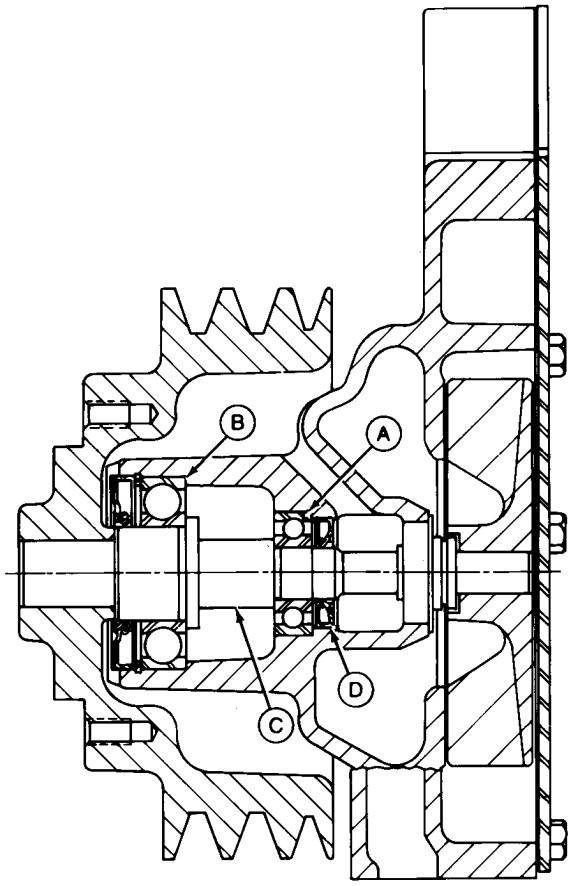
5. Pack the area around the shaft between the bearings with High Temperature Grease (TY6333 or TY6347), or an equivalent.

IMPORTANT: Never use excessive force if bearings must be driven into place by applying pressure through the balls. To do so may damage bearings and cause premature failure.

6. Position shaft (C) and bearing assembly over pulley end of housing. Lower into place. Use care not to hit inner seal (D).

The bearings should slip into place in the housing with little resistance. A very light tap with a soft face hammer on the fan pulley end may be necessary if resistance is felt.

A—Inner Bearing
B—Outer Bearing
C—Shaft
D—Inner Seal

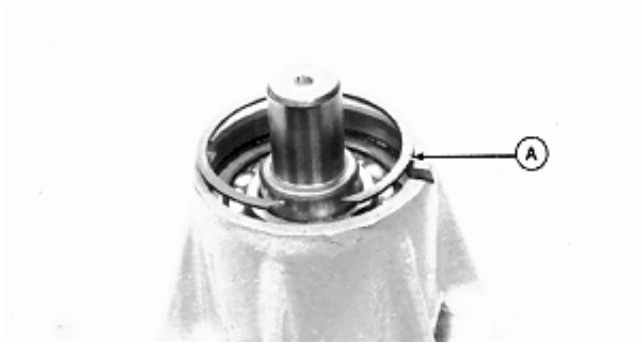


-UN-25APR94
RG4011

S11,0405,N -19-08AUG94

7. Install thinnest snap ring (A) out of five which are available in the snap ring groove in end of housing.

The following thickness of snap rings are available:
1.57 mm (0.062 in.)
1.70 mm (0.067 in.)
1.96 mm (0.077 in.)
2.21 mm (0.087 in.)
2.46 mm (0.097 in.)



RG4003 -UN-09NOV89

S11,0405,P -19-06APR94

8. Check shaft end play with a dial indicator.

9. Choose the snap ring which will allow a maximum shaft end play of 0.25 mm (0.010 in.). Remove the snap ring and install the correct one.


RG4012 -UN-09NOV89

S11,0405,Q -19-02JUN82

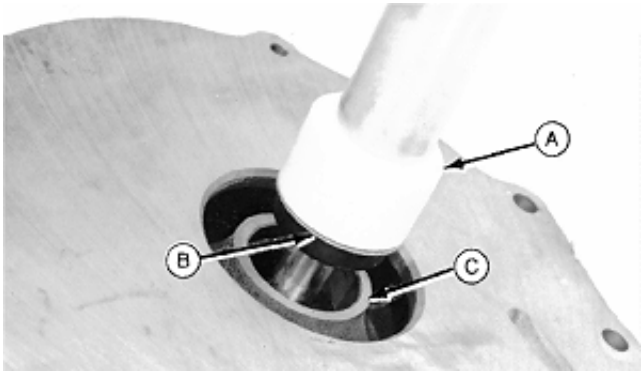
10. Install outer seal (A) (with open side of seal toward bearings) in pump housing until it bottoms.

RG4013 -UN-09NOV89

S11,0405,R -19-02JUN82

IMPORTANT: Use R74005 Driver (A) that is included with AR101549 Water Pump Seal Kit to drive seal to proper depth.

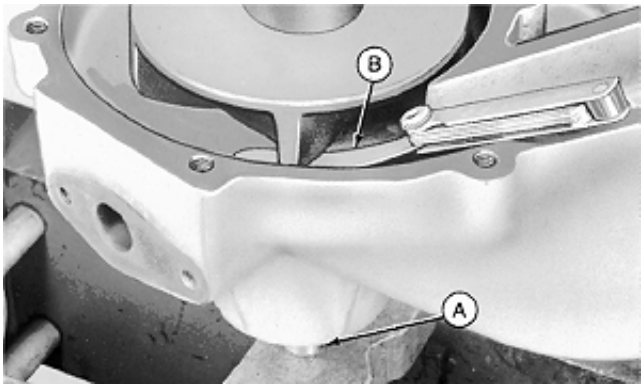
11. Place seal (B) onto shaft with R74005 Driver over seal. Drive seal until it bottoms on water pump housing.



RG2953 -UN-14JUL89

S11,0417,T -19-06APR94

12. Support pump assembly on pulley end of shaft (A) and press impeller onto bearing shaft (vanes toward housing) until impeller vanes have 0.38—0.89 mm (0.015—0.035 in.) clearance (B) with pump housing.



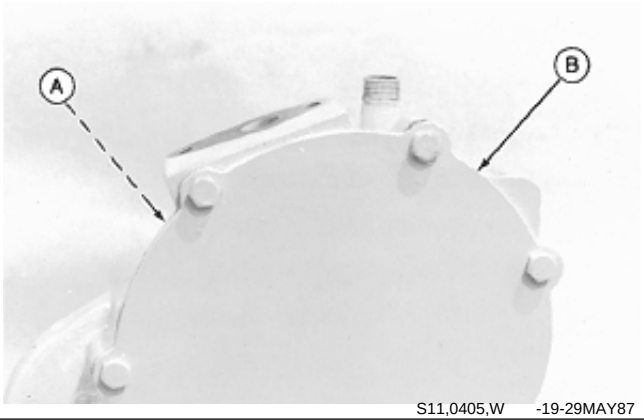
S11,0405,U -19-06APR94

13. Use a drift which is smaller than the impeller end of the water pump shaft and press shaft into fan pulley until shaft bottoms on pulley.

14. Check pulley-to-rear face measurement.

S11,0405,V -19-02JUN82

15. Use a new gasket (A) and install cover plate (B) on water pump housing. Tighten cap screws to 47 N·m (35 lb-ft).



S11,0405,W -19-29MAY87

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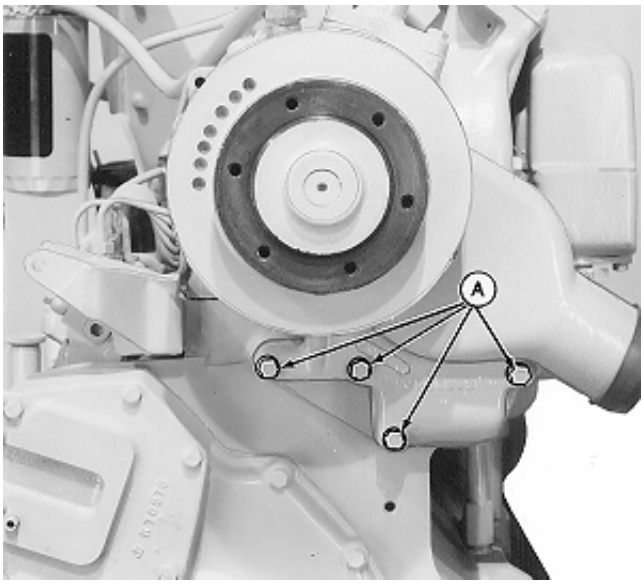
33

INSTALL STANDARD DUTY BELT-DRIVEN WATER PUMP WITH BALL BEARINGS AND COMPLETE FINAL ASSEMBLY

1. Use a hoist or two people to position water pump with spacer plate and new gaskets on the cylinder block.

2. Tighten water pump attaching screws (A) to 47 N·m (35 lb-ft).

3. Install alternator, alternator belt, and adjust belt tension.



S11,0405,XA -19-08AUG94

4. Install fan belts and adjust tension.

5. Install fan blade.

6. Install water bypass elbow and tube.

7. Install lower radiator hose.

8. Install alternator regulator connector and alternator lead wire.

9. Fill cooling system to proper level with proper coolant.

10. Connect battery negative (-) cables to batteries.

11. Run engine and inspect water pump assembly for leaks.

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S11,0405,X1 -19-02DEC86

STANDARD DUTY BELT-DRIVEN WATER PUMP WITH ONE-PIECE BEARING/SHAFT—APPLICATION CHART

6466ACA01	6466AR-12	6466DL-02	6466TLE01
6466AE-01	6466AR-15	6466DR-01	6466TP-01
6466AE-02	6466ARE01	6466DR-02	6466TP-04
6466AF	6466AT-05	6466DR-03	6466TR-01
6466AH-01	6466AT-06	6466DR-04	6466TR-02
6466AH-02	6466AT-07	6466DR-05	6466TR-03
6466AH-03	6466AT-08	6466TCM01	6466TR-04
6466AN-01	6466AT-09	6466TCM02	6466TR-05
6466AR-01	6466AZ-01	6466TDW03	6466TR-06
6466AR-03	6466AZ002	6466TF	6466TR-07
6466AR-04	6466AZ003	6466TH-01	6466TR-08
6466AR-05	6466AZ004	6466TH-02	6466TR-09
6466AR-06	6466DCV01	6466TH-05	6466TR-10
6466AR-07	6466DCZ01	6466TH-06	6466TR-11
6466AR-08	6466DF	6466TL-01	6466TR-13
6466AR-09	6466DH-01	6466TL-02	6466TR-15
6466AR-10	6466DJ-01	6466TL-09	6466TT-02
6466AR-11	6466DL-01	6466TL-10	6466TZ-01

S11,2025,GE -19-08AUG94

REMOVE STANDARD DUTY BELT-DRIVEN WATER PUMP WITH ONE-PIECE BEARING/SHAFT

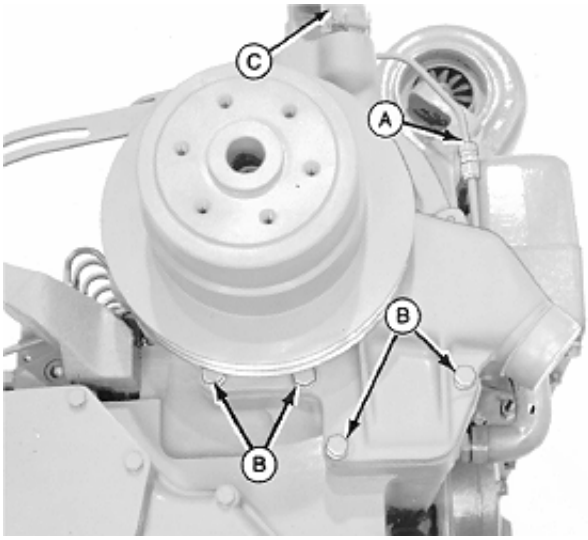
1. Remove aneroid-to-intake manifold line (A), if equipped.

2. Remove coolant bypass hose (C), and inlet hose. Also remove coolant conditioner hoses, if equipped.

CAUTION: Water pump is heavy. Use proper lifting procedures to avoid personal injury.

3. Remove four water pump-to-cylinder block cap screws (B).

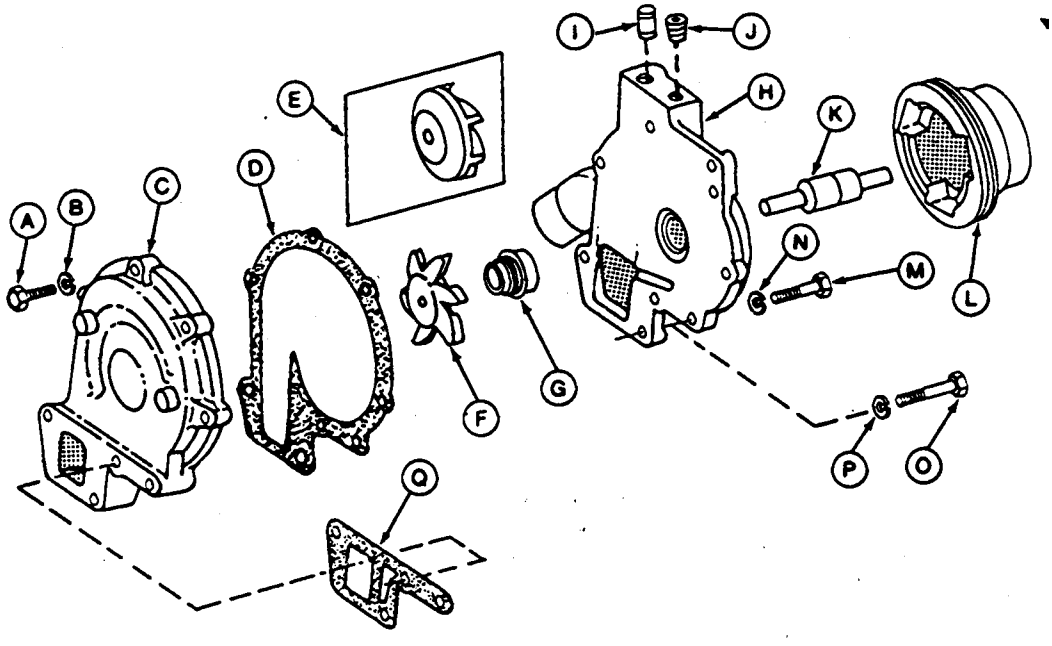
4. Lift water pump from cylinder block and place on a clean flat surface. Remove all gasket material from water pump and cylinder block.



RG4380 -UN-26JAN90

S11,2025,DO -19-06APR94

DISASSEMBLE, STANDARD-DUTY, BELT-DRIVEN WATER PUMP WITH ONE-PIECE BEARING/SHAFT



A—Cap Screw (4 used)
B—Lock Washer (4 used)
C—Cover
D—Gasket
E—Impeller*
F—Impeller**
G—Water Pump Seal
H—Housing
I—Nipple
J—Pipe Plug
K—Shaft/Bearing
L—Pulley
M—Cap Screw (2 used)
N—Lock Washer (2 used)
O—Cap Screw (2 used)
P—Lock Washer (2 used)
Q—Gasket

6466 Belt-Driven Water Pump

NOTE: Cast iron pulley assembly shown, sheet steel pulley assembly similar. Sheet steel pulley bolts to hub which is pressed onto pump shaft. Cast iron pulley presses directly onto pump shaft.

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36

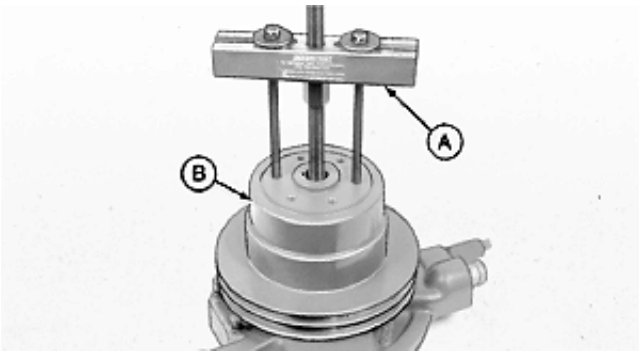
**Used on Engine Serial No. (—211131)*

***Used on Engine Serial No. (211132—)*

S11,2025,DP -19-08AUG94

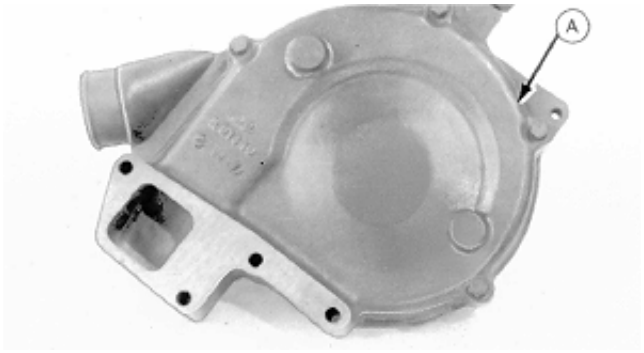
1. On engines equipped with pressed-on cast iron fan pulleys, use D01206AA Puller (A) to remove fan pulley (B) from water pump shaft.

NOTE: An air wrench may be used to aid removing fan pulley.



S11,2025,DQ -19-08AUG94

2. Remove water pump cover (A).

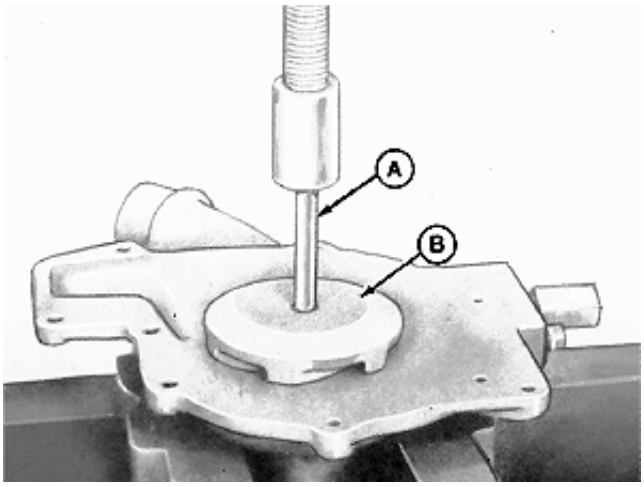


S11,2030,C -19-13DEC82

3. Push shaft/bearing from impeller (B) using a press and driver (A). Support housing adjacent to bearing bore or housing may break.

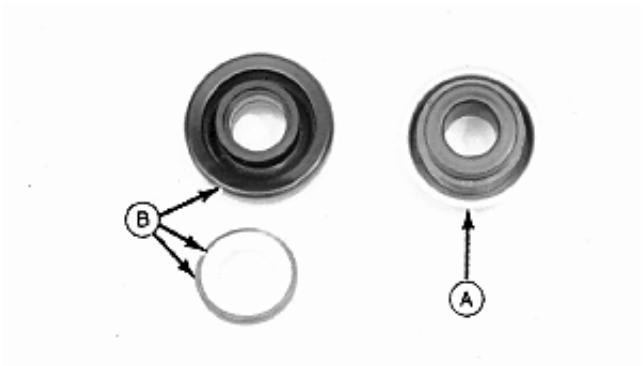
4. Remove impeller.

NOTE: A new impeller went into production with Engine Serial No. (211132—). Use a new impeller if bearing assembly is replaced. DO NOT use new impeller with early bearing assembly.



S11,2030,X -19-06APR94

NOTE: Belt-driven 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.



S11,2025,DR -19-14MAR85

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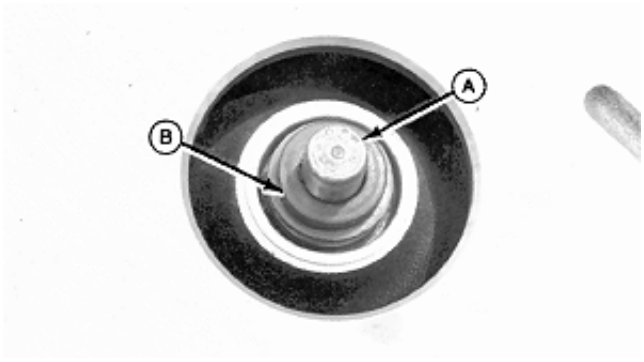
37

5. Use a press to remove shaft and bearing assembly (A) and press until assembly is clear from water pump housing.

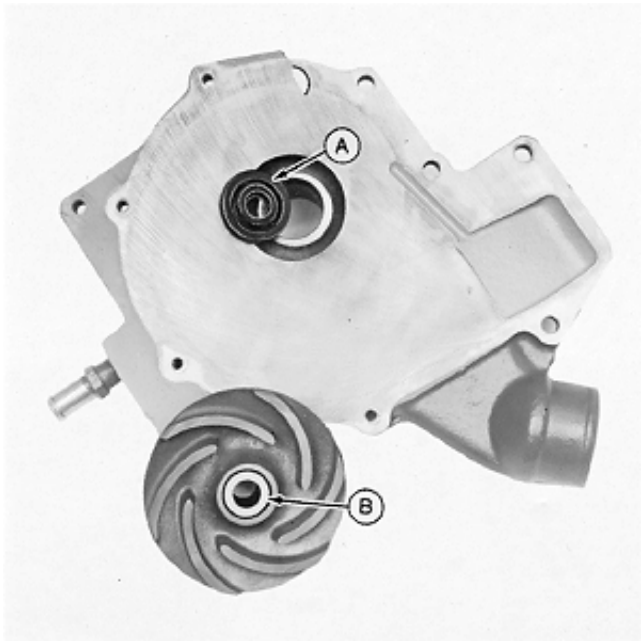
NOTE: Press only on diameter of shaft and not on water pump seal (B).



S11,2030,E -19-09APR85

6. On pumps with a three-piece seal, remove ceramic insert (B) and rubber cup from impeller. Remove seal (A) from pump housing. Discard seal.

7. On pumps with a one-piece seal, remove seal from housing or from bearing shaft as found. Discard seal.



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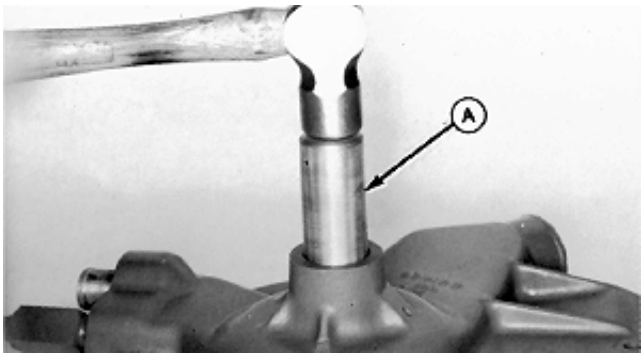
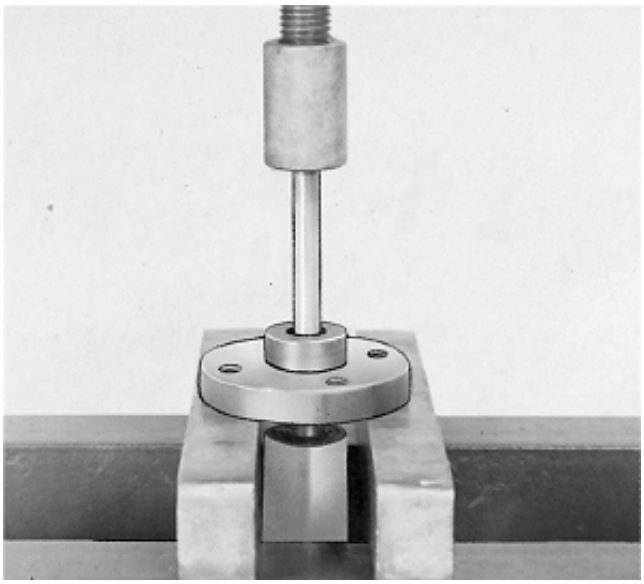
S11,2025,DS -19-07MAY85

8. Drive seal from housing using a driver (A) with approximately the same O.D. as the seal to drive seal. Discard seal.



S11,2025,DT -19-27FEB87

9. If bearing shaft or hub is to be replaced, press bearing shaft from hub.



-UN-09FEB90
R26398

S11,2025,DU -19-07MAY85

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39

INSPECT AND CLEAN STANDARD-DUTY, BELT-DRIVEN WATER PUMP WITH ONE-PIECE BEARING/SHAFT

1. Inspect shaft and bearing assembly for warpage or damage. Replace as necessary.

2. Inspect water pump housing and cover for debris, cracks or damage. Replace as necessary.

3. Inspect impeller for debris or cracks. Replace as necessary.

4. Measure impeller bore and bearing shaft O.D.

STANDARD-DUTY, BELT-DRIVEN WATER PUMP WITH ONE-PIECE BEARING/SHAFT SPECIFICATIONS

Impeller Bore	15.85—15.88 mm (0.624—0.625 in.)
Bearing Shaft OD	15.90—15.92 mm (0.626—0.627 in.)
Bearing Bore ID in Housing	29.95—29.98 mm (1.1792—1.1802 in.)
Bearing OD	29.99—30.00 mm (1.1806—1.1811 in.)
Roller Bearing/Shaft-to-Housing Interference Press Fit	0.01—0.05 mm (0.0004—0.0019 in.)

Replace impeller and bearing shaft if either are not within specifications.

5. Clean all parts with clean solvent and dry with compressed air.

NOTE: Make sure all gasket material is removed from water pump housing and cover.

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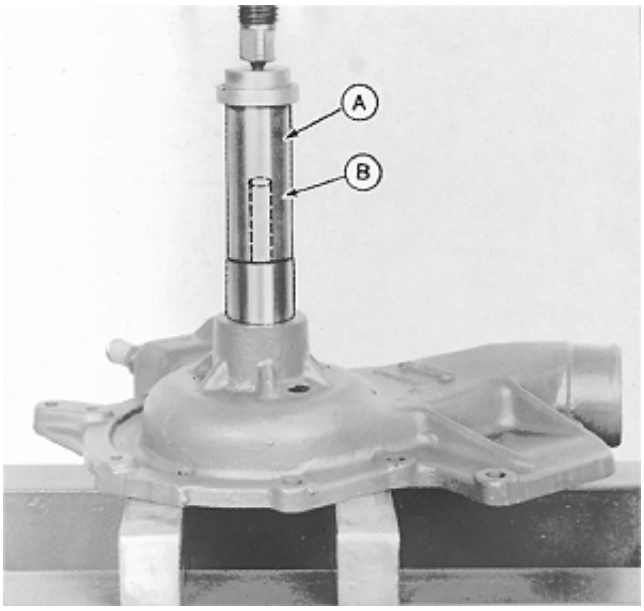
S11,2025,DV -19-08AUG94

ASSEMBLE STANDARD DUTY BELT-DRIVEN WATER PUMP WITH ONE-PIECE BEARING/SHAFT

1. Coat shaft bearing assembly with a light coat of clean SAE 10W engine oil.

2. Put the JD262A Installation Tool (A) over shaft bearing assembly (B). Press bearing into housing until flush with housing edge.

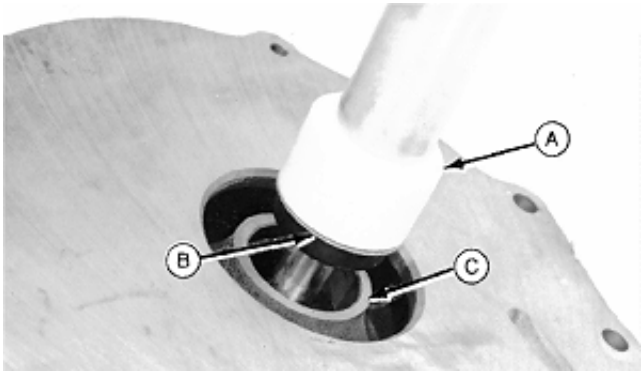


-UN-09FEB90
R26399

S11,2025,DW -19-06APR94

IMPORTANT: On water pumps using a one-piece seal, use R74005 Driver (A) that is included with AR101549 Water Pump Seal Kit to drive seal to proper depth. Seal has a press fit with both the shaft and pump housing.

3. Place seal (B) onto shaft with R74005 Driver over seal. Drive seal until it bottoms on water pump housing (C).



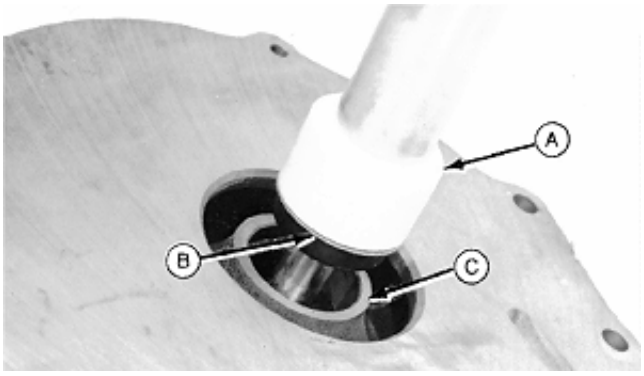
-UN-14JUL89
RG2953

S11,2025,DX -19-09APR85

4. For water pumps using a three-piece seal, drive seal (B) onto shaft with a driver (A) until it bottoms on water pump housing (C).

NOTE: To prevent contamination of the ceramic insert, do not handle the insert with bare hands. Install ceramic insert into rubber cup with the polished side out. (The back side of insert has a groove for identification).

5. Apply a light coat of engine oil to impeller bore. Install the rubber cup and ceramic insert into impeller by placing cup and insert at an angle and pressing in by hand. Wipe ceramic insert clean after assembly into impeller.

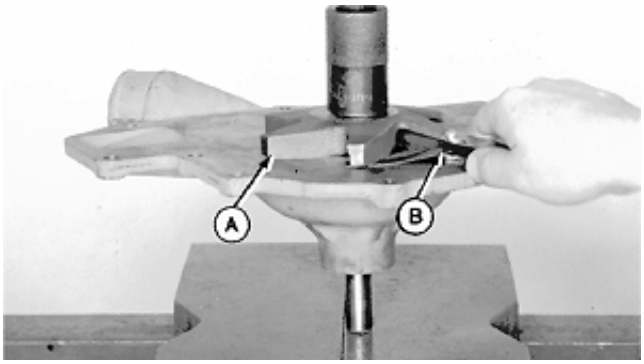


-UN-14JUL89
RG2953

S11,2025,DY -19-15MAR85

6. Support pump shaft and press impeller (A) in place. Press until there is 0.4—0.6 mm (0.015—0.025 in.) clearance between machined surface of housing and impeller. Check clearance with a feeler gauge (B).

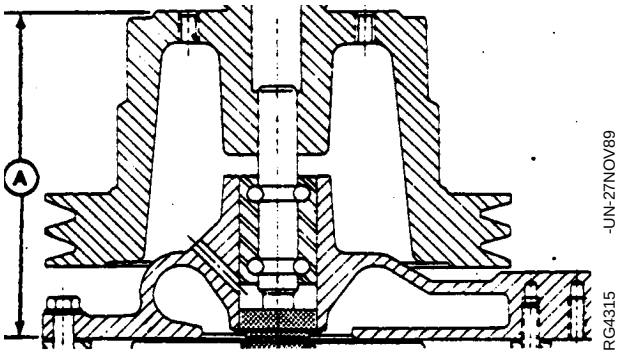
7. Remove from press and turn shaft with impeller to be sure impeller does not drag on housing.



S11,2025,DZ -19-06APR94

IMPORTANT: Support bearing shaft through impeller bore to maintain 0.4—0.6 mm (0.015—0.025 in.) clearance between impeller and pump housing. Recheck clearance after pressing on hub or pulley.

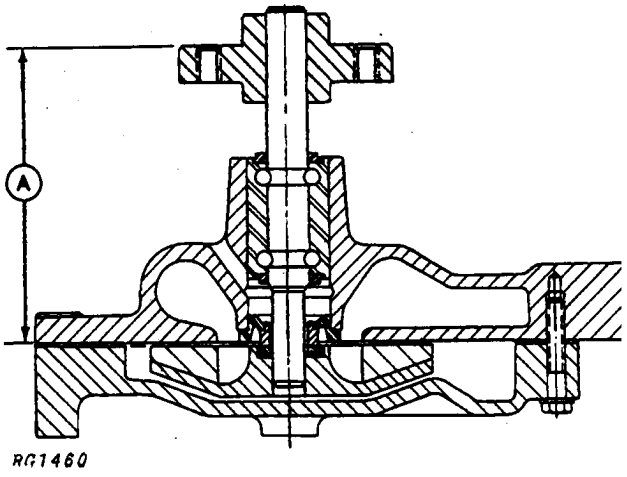
8. For water pumps equipped with cast in pulley, press on pulley until pulley-to-rear face measurement (A) is 166.1 mm (6.54 in.).



S11,2025,EA -19-06APR94

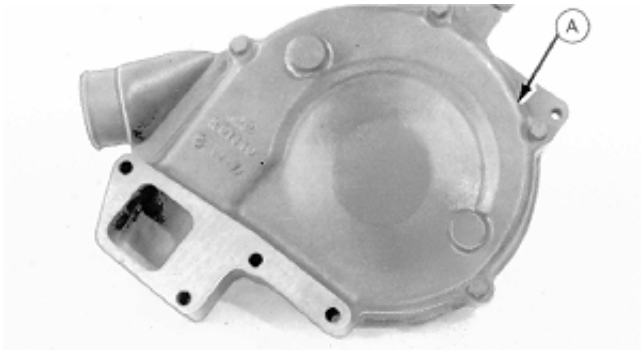
9. For water pumps equipped with a sheet steel pulley and hub, press on hub until the hub-to-rear face measurement (A) is obtained according to the chart below.

ENGINE MODEL NO.	HUB-TO-REAR FACE MEASUREMENT
6466AT-05	114 mm (4.49 in.)
6466DR-01, 02, 03, 04, 05	114 mm (4.49 in.)
6466DF-00, 6466TF-00, 6466AF-00	114 mm (4.49 in.)
6466DJ-01	114 mm (4.49 in.)
6466DL-01, 02	114 mm (4.49 in.)
6466TL-01, 02, 09	114 mm (4.49 in.)
6466TDW03	114 mm (4.49 in.)
6466TR-03, 04, 05, 06, 07,08, 09, 10	114 mm (4.49 in.)
6466DH-01	72 mm (2.83 in.)
6466TH-01, 02, 05, 06	72 mm (2.83 in.)
6466AH-01, 02, 03	72 mm (2.83 in.)
6466AZ-01, 6466AZ002	72 mm (2.83 in.)
6466TZ-01	72 mm (2.83 in.)



S11,2025,EB -19-17AUG94

10. Use a new gasket and install cover (A) on housing. Tighten cap screws to 27 N·m (20 lb-ft).



RG4313 -UN-09NOV89

S11,2025,EC -19-08AUG94

INSTALL STANDARD-DUTY, BELT-DRIVEN WATER PUMP WITH ONE-PIECE BEARING/SHAFT

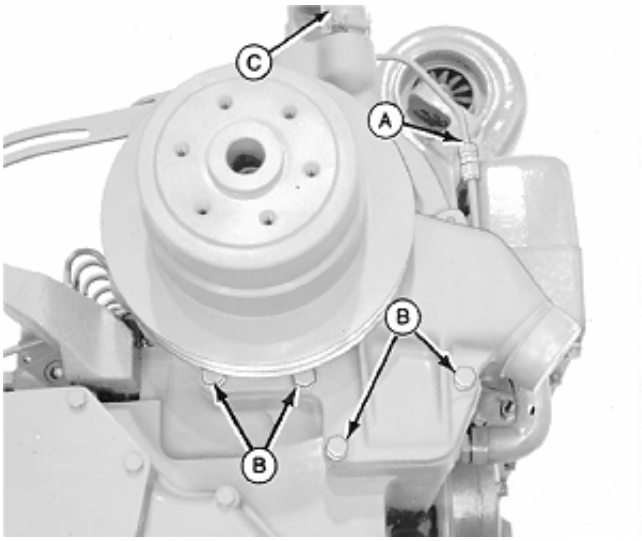
1. Using a hoist or two persons, position water pump with new gasket onto cylinder block.

2. Install water pump attaching screws (B). Tighten 5/16 in. cap screws to 27 N·m (20 lb-ft) and 3/8 in. cap screws to 47 N·m (35 lb-ft).

3. Install aneroid-to-intake manifold line (A), if equipped, under the two line clamps at the top rear side of the water pump. Also install coolant conditioner hoses, if equipped.

4. Install water bypass hose (C).

5. Install fan on pulley or fan and pulley on hub. Tighten cap screws to 47 N·m (35 lb-ft).



RG4380 -UN-26JAN90

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43

S11,2025,ED -19-08AUG94

HEAVY-DUTY, BELT-DRIVEN WATER PUMP—APPLICATION CHART

Engine Model

6466AT-02
6466AT-03
6466AT-11
6466TCF01
6466TT-01

S11,2025,GF -19-08AUG94

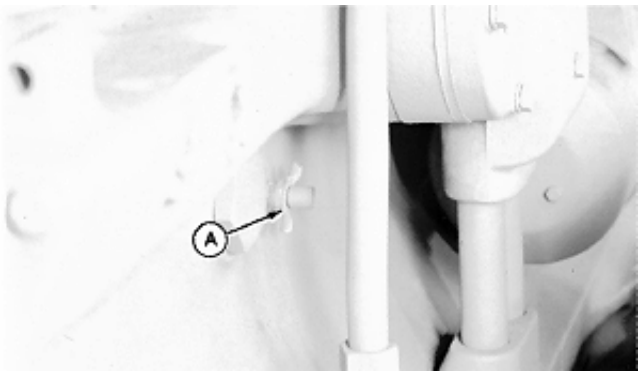
REMOVE HEAVY-DUTY, BELT-DRIVEN WATER PUMP

CAUTION: Do not drain engine coolant until the temperature is below operating temperature. Then loosen drain valve (A) slowly to relieve any pressure.

1. Drain coolant from cylinder block if not previously done.

2. Disconnect all items attaching water pump to engine.

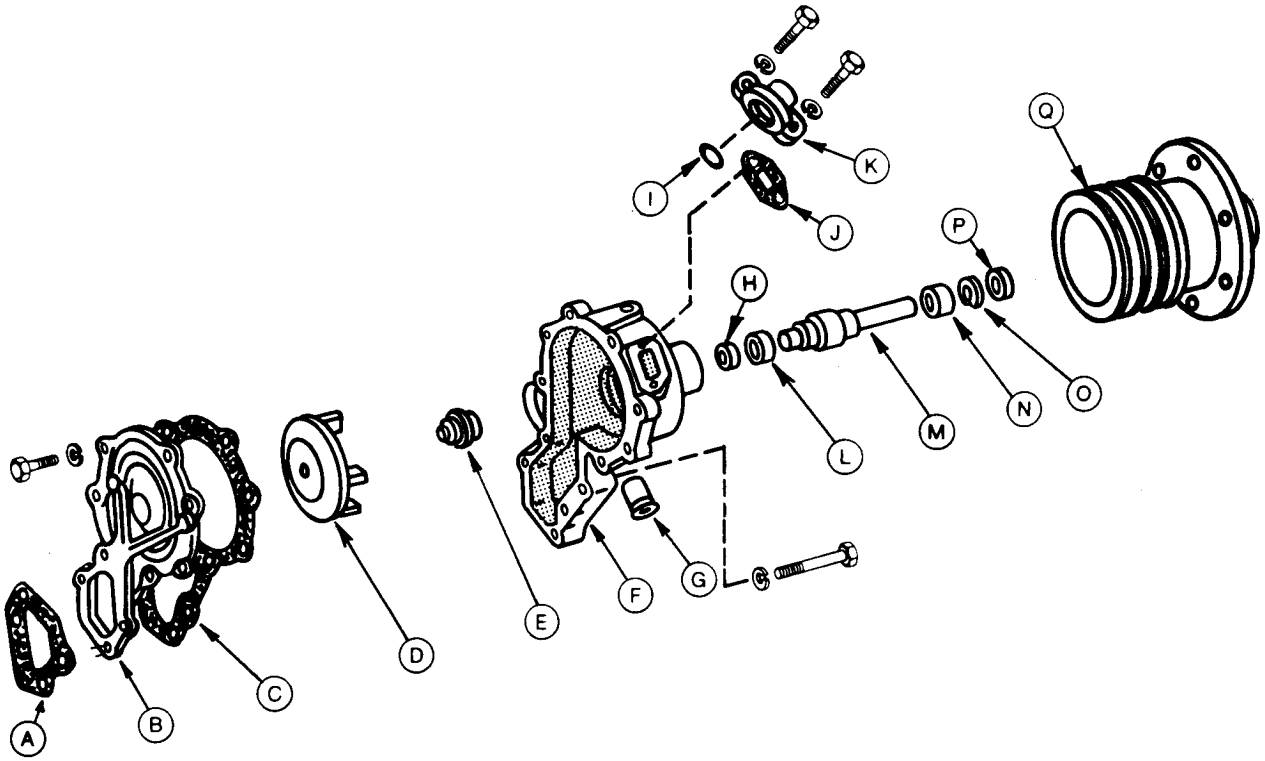
3. Remove water pump.



RG3851 -UN-14DEC88

S11,2025,GG -19-08AUG94

DISASSEMBLE HEAVY-DUTY, BELT-DRIVEN WATER PUMP

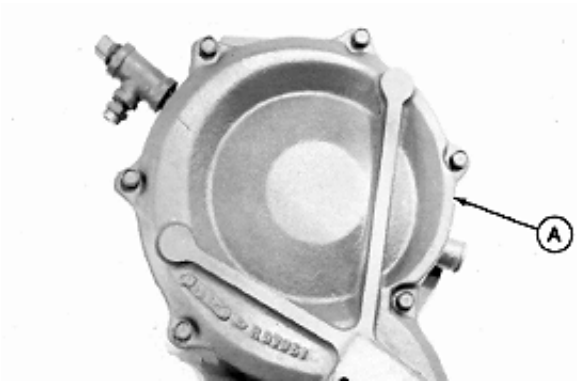


A—Gasket
B—Cover
C—Gasket
D—Impeller
E—Seal
F—Housing
G—Tube
H—Seal
I—O-Ring
J—Gasket
K—Elbow
L—Ball Bearing
M—Shaft
N—Ball Bearing
O—Snap Ring
P—Seal
Q—Pulley

25
45

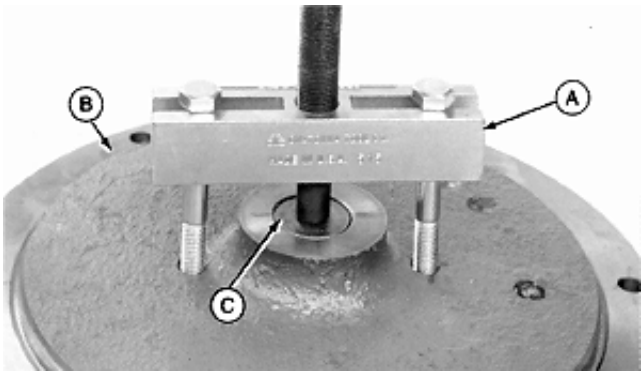
S11,2525,BH -19-08AUG94

1. Remove six cap screws and remove cover (A).
Scrape all gasket material from cover and housing face.



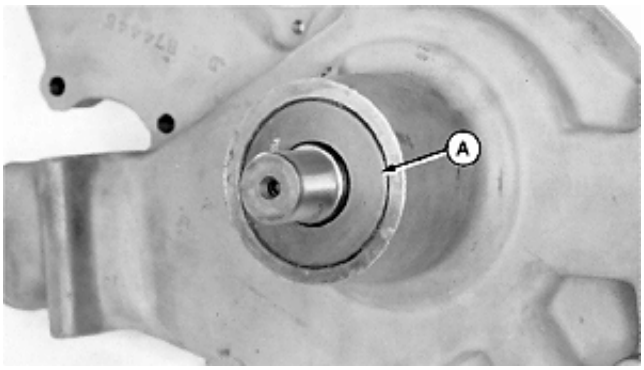
S11,2525,BI -19-11APR94

2. Remove pulley (B) from shaft (C) with the D01206AA Puller (A).



S11,2525,BJ -19-06APR94

3. Use a small sharp punch and punch a hole through outer seal (A). Pry outer grease seal from housing. Discard seal.

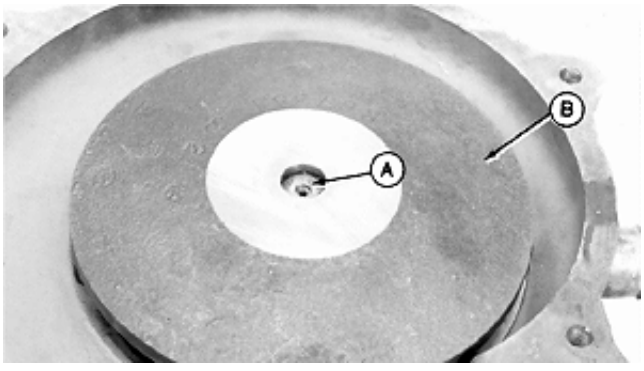


RG,CTM1,G25,19 -19-06APR94

4. Remove snap ring (A).

RG,CTM1,G25,20 -19-06APR94

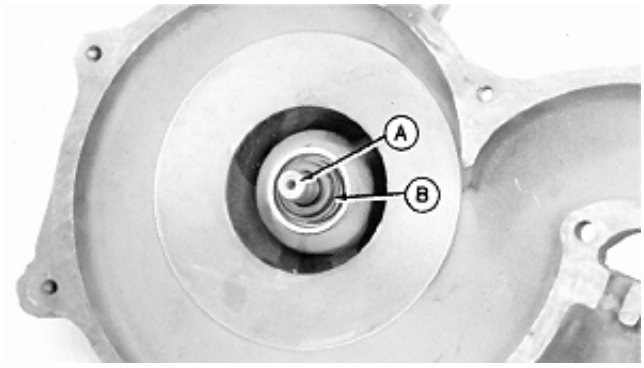
5. Use a press and press shaft (A) through impeller (B). Press on shaft only. Remove impeller.



RG,CTM1,G25,18 -19-17AUG94

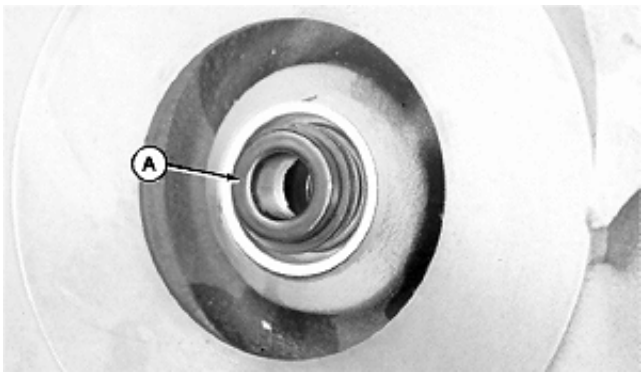
6. Use a press to remove shaft and bearing assembly (A). Press until bearing and shaft assembly are clear from pump housing.

NOTE: Press only on diameter of shaft and not on water pump seal (B).



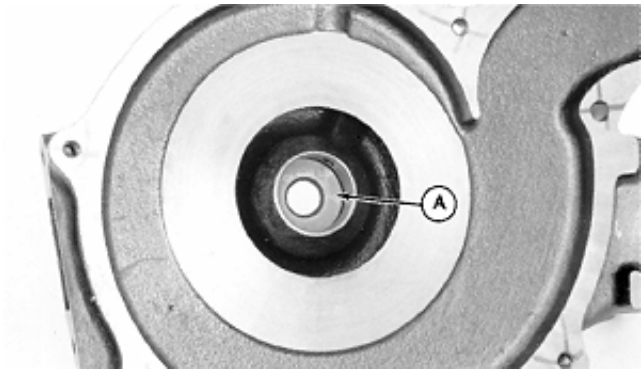
RG,CTM1,G25,21 -19-06APR94

7. Use a small punch to drive unitized seal (A) from housing. Discard seal.



RG,CTM1,G25,22 -19-06APR94

8. Use a driver with approximately the same O.D. as the O.D. of the inner grease seal (A) and drive seal from housing. Discard seal.

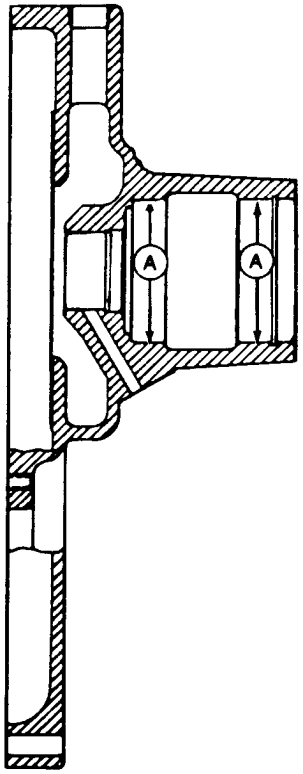


RG,CTM1,G25,23 -19-06APR94

MEASURE BEARING BORE IN HEAVY-DUTY, BELT-DRIVEN WATER PUMP HOUSING

NOTE: Thoroughly clean housing bores before measuring to achieve an accurate measurement.

1. Measure bearing bore in pump housing at both bearing locations (A) using a telescoping gauge or dial bore gauge. Take the average of three readings at each bearing location.



RG5055 -UN-31MAR92

HEAVY-DUTY, BELT-DRIVEN WATER PUMP HOUSING SPECIFICATIONS

Bearing Bore in Housing	72.001—72.027 mm (2.8347—2.8357 in.)
Maximum Serviceable	72.047 mm (2.8365 in.)
Bearing OD	71.987—72.000 mm (2.8341—2.8346 in.)
Bearing ID	34.987—35.000 mm (1.3774—1.3780 in.)
Shaft Bearing Surface OD	35.001—35.017 mm (1.3780—1.3786 in.)
Shaft OD Impeller End	15.905—15.931 mm (0.6262—0.6272 in.)
Impeller Bore ID	15.856—15.880 mm (0.6242—0.6252 in.)
Pulley-to-Shaft Interference Press Fit	0.0381—0.0889 mm (0.0015—0.0035 in.)
Shaft OD Pulley End	30.218—30.234 mm (1.1897—1.1903 in.)
Pulley Bore ID	30.149—30.175 mm (1.1870—1.1880 in.)
Maximum Shaft End Play	0.25 mm (0.010 in.)

If pump housing bearing bore is not within maximum service specification, install a new water pump assembly.

NOTE: New water pump will be supplied without pump housing cover and fan pulley. These parts must be reused from existing water pump.

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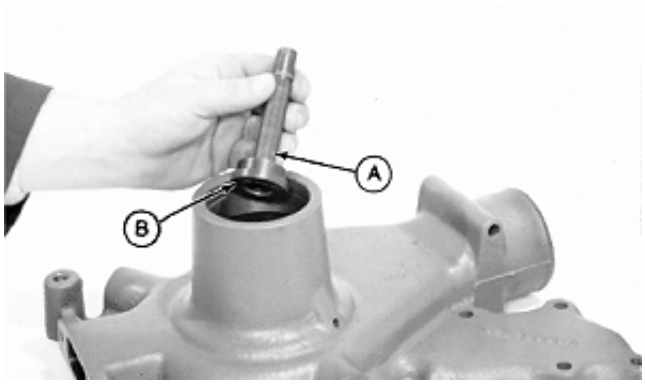
S11,2525,BK -19-08AUG94

ASSEMBLE HEAVY-DUTY, BELT-DRIVEN WATER PUMP

1. Use the JDE132-2 Driver (A) to install inner grease seal (B) into housing bore until seal bottoms against shoulder.



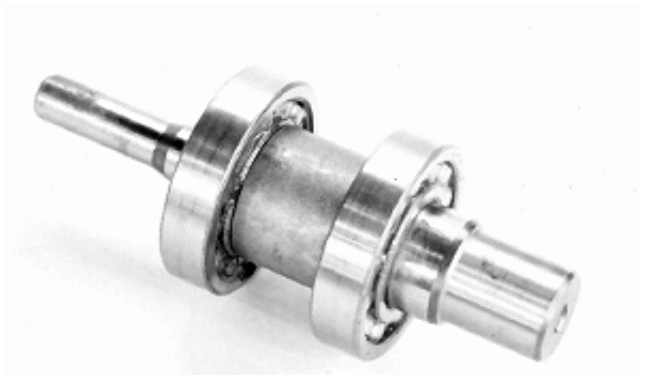
S11,2525,BL -19-08AUG94

2. Pack bearings with 28.5 g (1 oz) of High Temperature Grease (TY6333 or TY6347). Install bearings onto shaft with a press and driver which bears on inner bearing race only.

3. Fill the cavity between bearings about half full with grease around the entire OD of bearing shaft before installing into housing.

4. Install shaft and bearing assembly into water pump housing using JDE74 Driver and lightly tap with a hard rubber mallet until inner bearing bottoms in housing bore.

IMPORTANT: The bearing shaft assembly should slip into housing with little resistance. DO NOT use excessive force to install assembly.



S11,2525,BM -19-08AUG94

5. Install 1.96 mm (0.077 in.) thick green snap ring (A) in housing groove with sharp edge of snap ring facing up.

S11,2525,BN -19-17MAR92

25
49

6. Use a magnetic base dial indicator and measure shaft end play. The maximum end play allowed is 0.25 mm (0.010 in.).

7. Install the correct thickness of snap ring which will achieve the proper end play.

Snap Ring Thickness

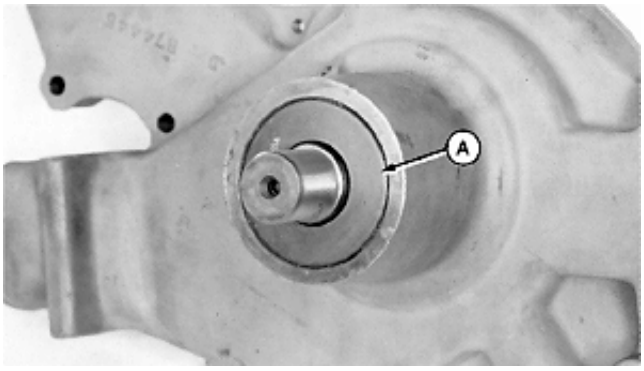
1.57 mm (0.062 in.)
1.70 mm (0.067 in.)
1.96 mm (0.077 in.)
2.21 mm (0.087 in.)
2.46 mm (0.097 in.)

-UN-17JUL89
RG2656

S11,2525,BO -19-06APR94

IMPORTANT: Generously lubricate ID of seal lip and fill the entire seal casing with grease prior to installing seal onto shaft. As seal is being installed over shoulder of pump shaft, rotate seal to prevent damage to lip.

8. Install outer grease seal (A) onto housing with spring loaded lip facing bearings. Tap lightly with small hammer until seal is flush with housing face.

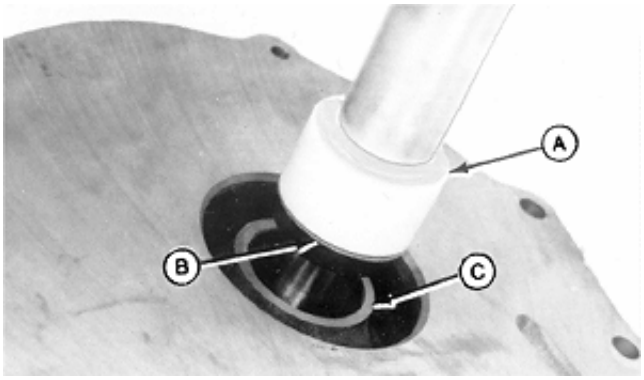


-UN-31JUL89
RG3560

S11,2525,AO -19-17MAR92

IMPORTANT: Use R78350 Driver (A), that is included with water pump seal kit and repair kit to drive seal to proper depth.

9. Support pump assembly on front pulley shaft. Place a new seal (B) onto impeller shaft. Position R74005 Driver on seal and drive seal until it bottoms on water pump housing lip (C).

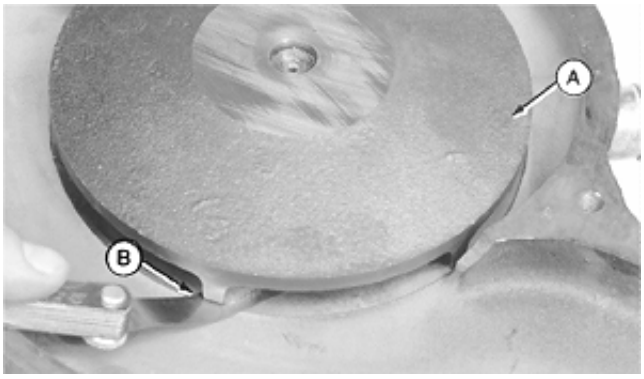


-UN-14DEC88
RG3568

S11,2525,BP -19-06APR94

10. Support pulley end of shaft and press impeller (A) onto shaft until there is 0.0381—0.0889 mm (0.0015—0.0035 in.) clearance (B) between machined surface of housing and impeller.

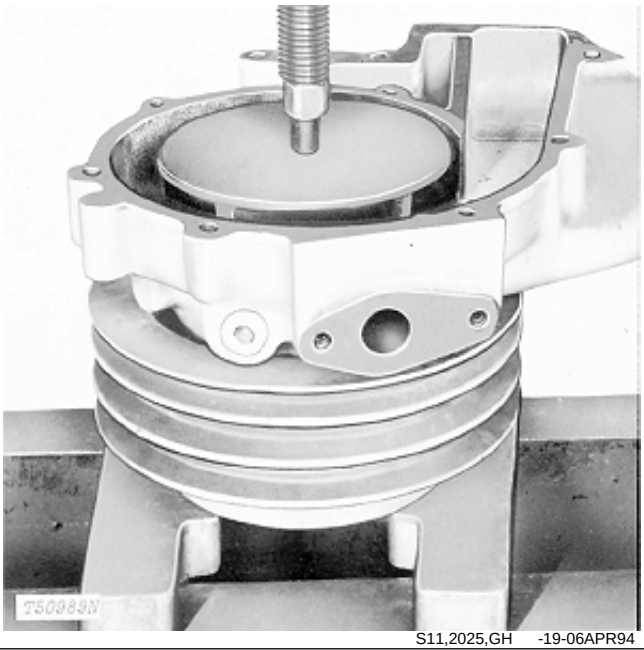
IMPORTANT: Pump seal should NOT touch impeller.



RG3569 -UN-31JUL89

S11,2525,BQ -19-09FEB87

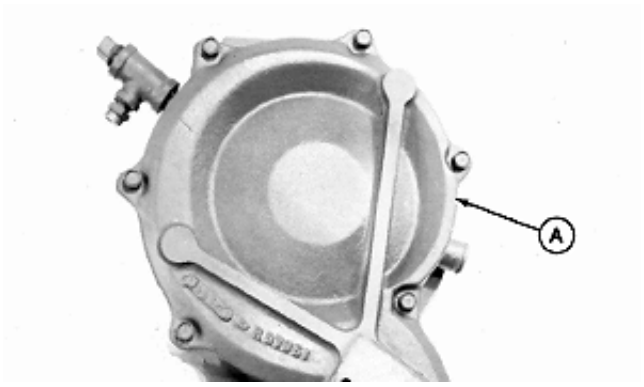
11. Support bearing shaft assembly through impeller bore. Using a drift which is smaller than the impeller end of the water pump shaft, press shaft into fan pulley until shaft bottoms on pulley Install washer and cap screw to secure fan pulley on pump shaft. Tighten cap screw to 115 N·m (85 lb-ft).



T50989N -UN-28JUL89

S11,2025,GH -19-06APR94

12. Using a new gasket, install pump housing cover (A). Tighten cap screws to 27 N·m (20 lb-ft).



RG3571 -UN-31JUL89

S11,2525,BS -19-21OCT86

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51

INSTALL HEAVY-DUTY, BELT-DRIVEN WATER PUMP

1. Using a hoist or an assistant, mount water pump with new gasket onto engine.

2. Tighten four mounting cap screws to 47 N·m (35 lb-ft).

3. Connect hoses and tighten hose clamps securely.

4. Install alternator, alternator belt, and adjust belt tension.

5. Install fan belts and adjust tension.

6. Install fan blade.

7. Connect elbows and lines. Tighten connections securely.

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 water manifold to allow air to escape when filling system. Retighten fitting or plug when all the air has been expelled.

8. Start engine and check the entire cooling system for leaks.

S11,2025,GI -19-08AUG94

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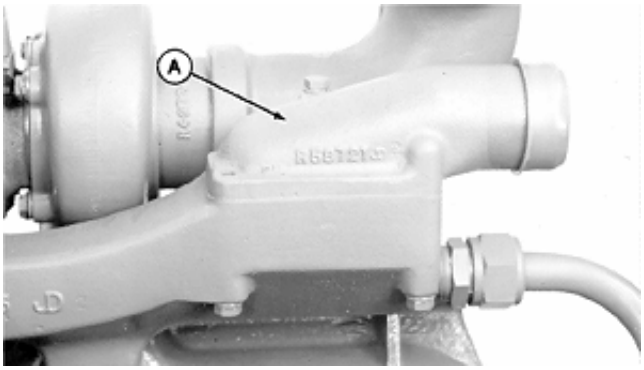
REMOVE AND TEST THERMOSTATS

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

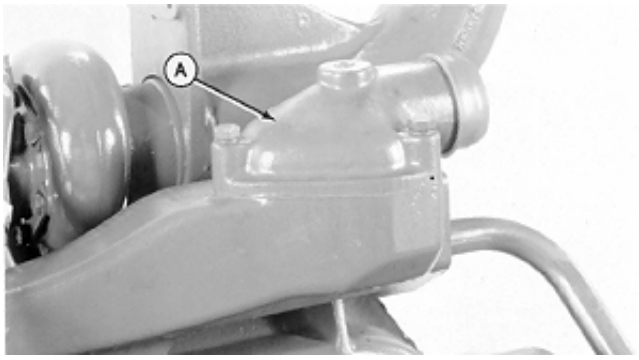
NOTE: 6466 Engines have either a two-thermostat or three-thermostat arrangement.

1. Visually inspect area around water manifold for leaks. Partially drain coolant from system.

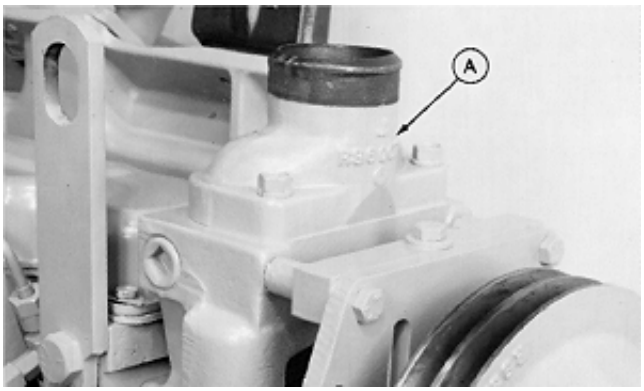
2. Remove thermostat cover (A).



RG3521 -UN-31JUL89



RG3934 -UN-14DEC88



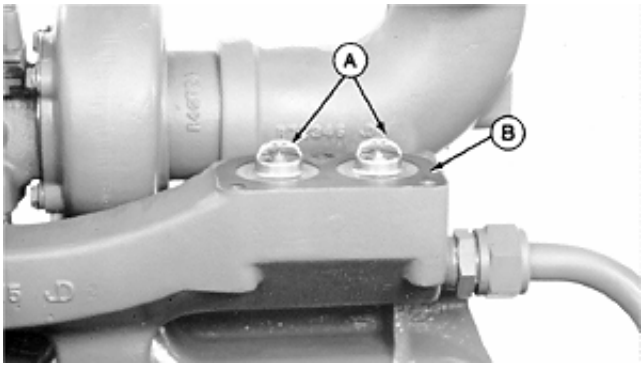
RG5279 -UN-14DEC88

S11,2025,EE -19-08AUG94

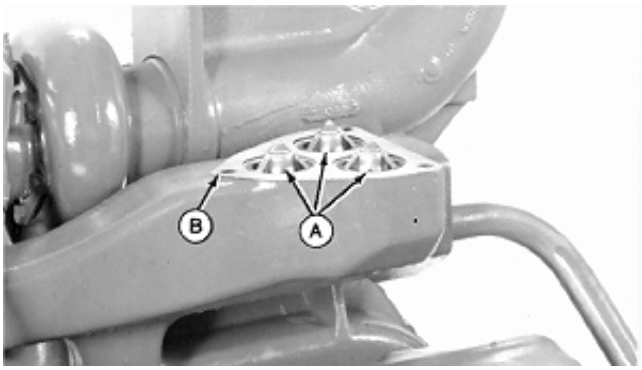
3. Remove thermostats (A). Discard gasket (B).

4. Inspect thermostats for debris or damage. Test each thermostat using an approved thermostat tester. See INSPECT THERMOSTAT AND TEST THERMOSTAT OPENING TEMPERATURE in Group 105. Thermostats should start to open at 80—84˚C (175—182˚F).

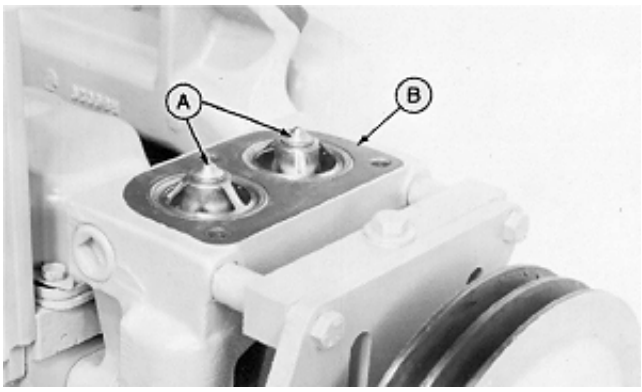
If any thermostat fails to open within this range, replace all thermostats.



RG3522 -UN-31JUL89



RG3935 -UN-14DEC88



RG5280 -UN-09DEC88

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S11,2025,EF -19-08AUG94

INSTALL THERMOSTATS

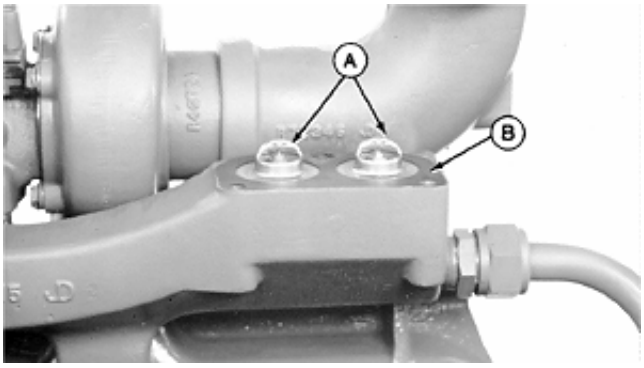
1. Apply LOCTITE 518 Flexible Sealant or equivalent on water manifold-to-thermostat cover mating surface.

NOTE: Install thermostats (A) in slot in housing first, then install gasket (B) after thermostat is properly seated in housing.

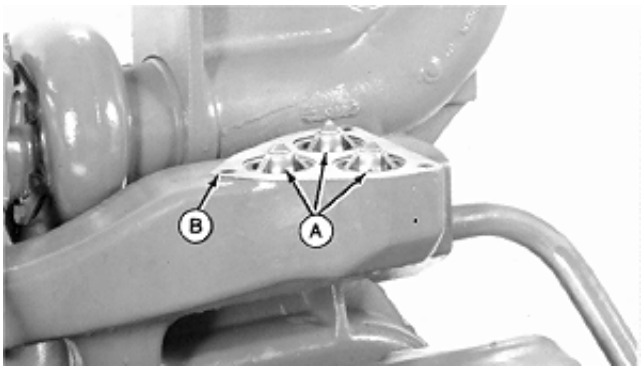
2. Install thermostats and a new gasket.

3. Install cover and tighten cap screws to 47 N·m (35 lb-ft).

IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen temperature sending unit fitting at rear of cylinder head, bleed plug or petcock at top front of cylinder head, or plug in thermostat housing to allow air to escape when filling system. Retighten fitting or plug when all the air has been expelled.



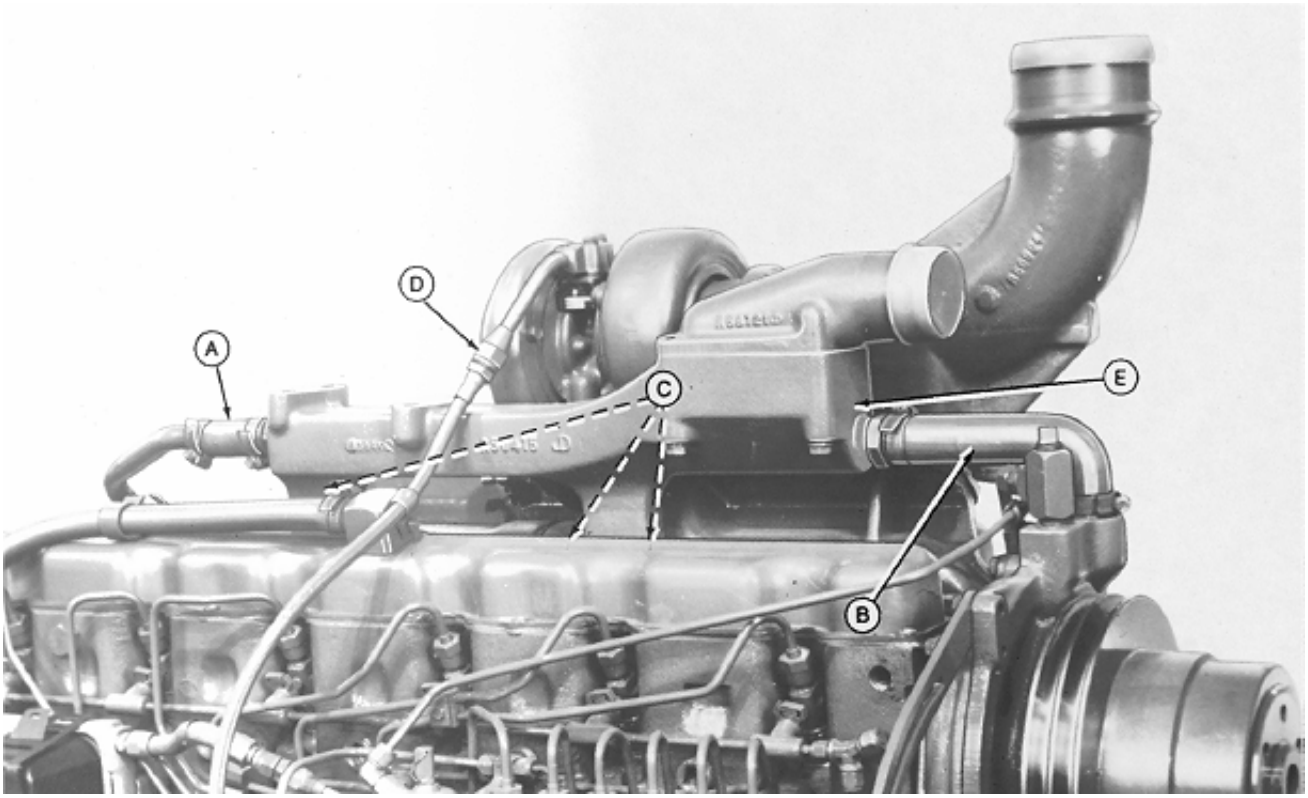
-UN-31JUL89
RG3522



-UN-14DEC88
RG3935

S11,2025,EH -19-08AUG94

REMOVE TOP MOUNTED WATER MANIFOLD/THERMOSTAT HOUSING



A—Aftercooler-to-Water Manifold Tube (6466A Engines Only)
B—Bypass Hose/Tube
C—Cap Screws (4 used)
D—Turbocharger Oil Inlet Line (6466T and 6466A Engines Only)
E—Water Manifold

6466A Engine Shown

1. On 6466A Engines, remove aftercooler-to-water manifold tube (A).

2. Disconnect bypass hose/tube (B) from water manifold (E).

NOTE: On 6466T and 6466A Engines, water manifold can be removed without disconnecting the turbocharger oil inlet line (D).

3. Remove four water manifold attaching cap screws (C). Carefully remove water manifold from cylinder head.

S11,2025,EI -19-06APR94

INSPECT AND CLEAN WATER MANIFOLD

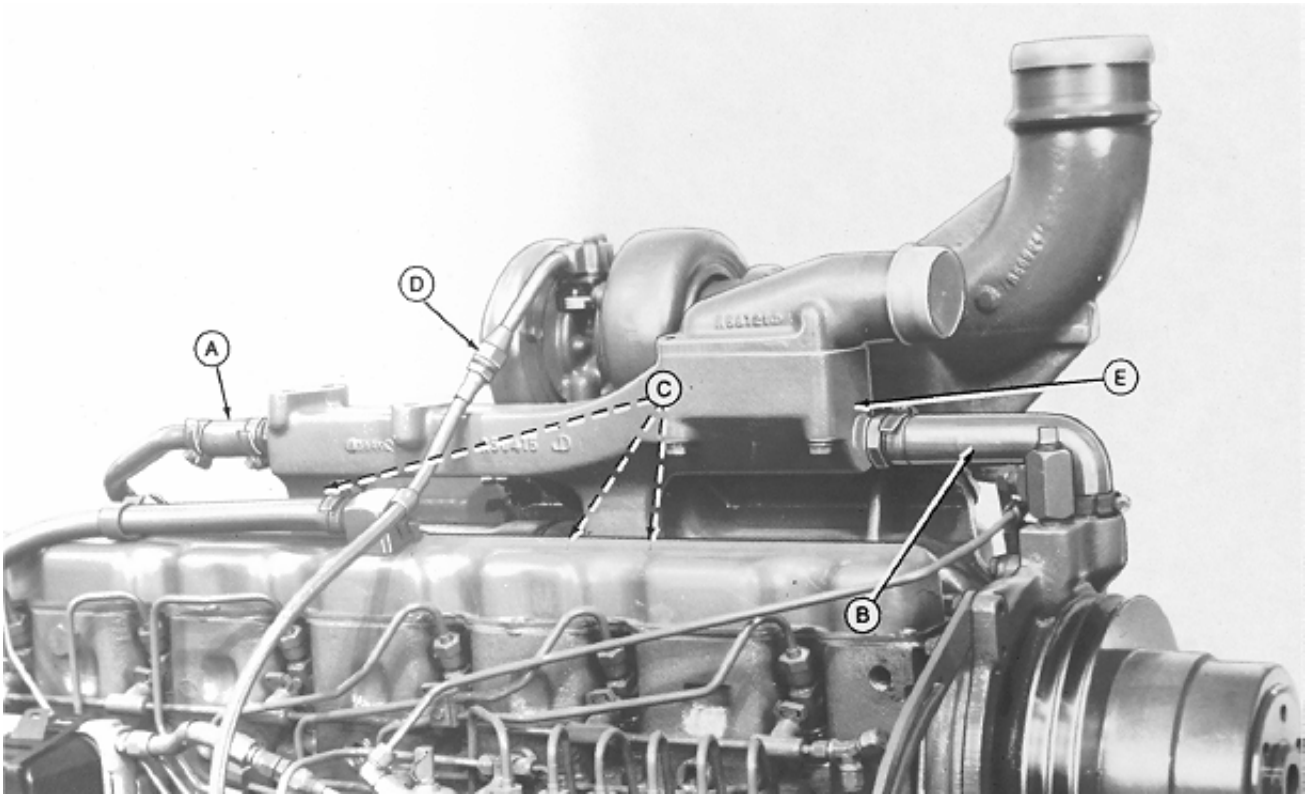
1. Remove all gasket material from manifold and cylinder head.

2. Inspect water manifold for debris and damage. Replace as necessary.

3. Clean water manifold with solvent and dry with compressed air.

S11,2030,Q -19-06APR94

INSTALL TOP MOUNTED WATER MANIFOLD/THERMOSTAT HOUSING



A—Aftercooler-to-Water Manifold Tube (6466A Engines Only)
B—Bypass Hose/Tube
C—Cap Screws (4 used)
D—Turbocharger Oil Inlet Line (6466T and 6466A Engines Only)
E—Water Manifold

6466A Engine Shown

NOTE: Make sure all old gasket material is removed from water manifold-to-cylinder head mounting surfaces before installation.

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1. Apply LOCTITE 518 Flexible Sealant to water manifold-to-cylinder head mounting surfaces.

NOTE: On 6466T and 6466A Engines, water manifold (E) must be installed under turbocharger oil inlet line (D) if line was not disconnected during removal.

2. Using new gaskets, carefully install water manifold. Tighten cap screws (C) to 47 N·m (35 lb-ft).

3. Install bypass hose/tube (B). Tighten all connections securely.

4. On 6466A engines, install water manifold-to-aftercooler tube (A). Tighten all connections securely.

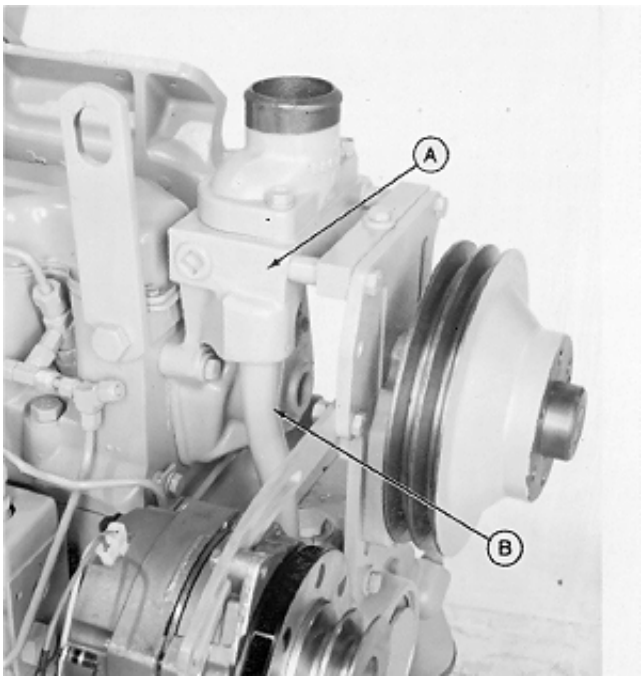
S11,2025,EJ -19-08AUG94

REMOVE FRONT MOUNTED WATER MANIFOLD/THERMOSTAT HOUSING

1. Loosen three water manifold-to-cylinder head cap screws and remove water manifold assembly (A).

NOTE: Pull water manifold straight ahead (toward) front of engine approximately 6.35 mm (0.25 in.) to disengage from locator (spring) pin, then lift straight up to disengage from bypass pipe (B).

2. Remove bypass pipe. Remove and discard O-rings from slots in water manifold and water pump housing bores.



RG5281 -UN-14DEC88

RG,CTM1,G25,7 -19-08AUG94

INSPECT AND CLEAN WATER MANIFOLD

1. Remove all gasket material from manifold and cylinder head.

2. Inspect water manifold for debris and damage. Replace as necessary.

3. Clean water manifold with solvent and dry with compressed air.

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59

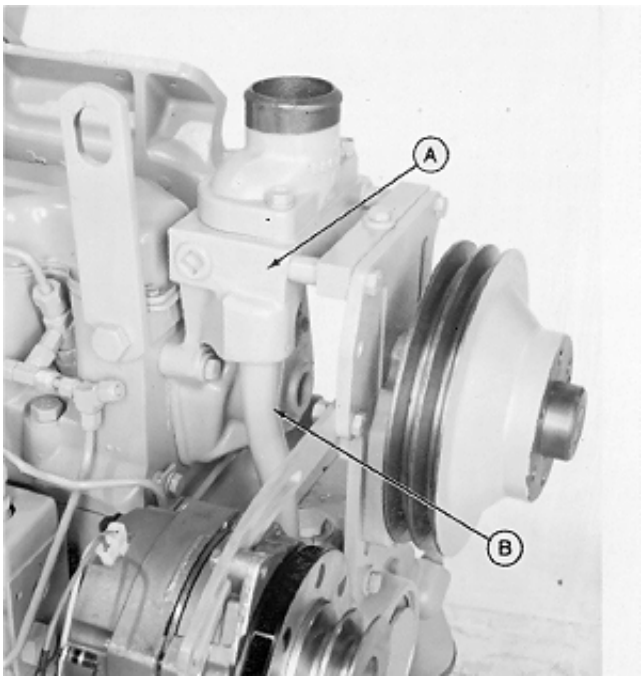
S11,2030,Q -19-06APR94

INSTALL FRONT MOUNTED WATER MANIFOLD/THERMOSTAT HOUSING

1. Install a new O-ring into water manifold and water pump housing bores. Lubricate ID of O-rings with grease to ease bypass pipe installation. Install bypass pipe (B) into bore of water manifold (A), be careful not to cut O-ring.

2. Using LOCTITE 518 Flexible Sealant and a new gasket, install water manifold assembly. Be sure water manifold is properly positioned on spring pin (in front face of cylinder head) and that bypass pipe is fully seated in water manifold and water pump housing bores.

3. Apply LOCTITE 242 Thread Sealer to water manifold-to-cylinder head cap screw threads 360 degrees (except for the leading one to three threads). Tighten water manifold cap screws to 61 N·m (45 lb-ft).



-UN-14DEC88
RG5281

RG,CTM1,G25,8 -19-08AUG94

REMOVE COOLANT FILTER CONDITIONER ASSEMBLY—IF EQUIPPED

CAUTION: Do not remove coolant filter conditioner until the coolant temperature is below operating temperature. Loosen drain valve slowly to relieve any excess pressure. Put all coolant in a clean container, and cover to prevent entry of contaminants.

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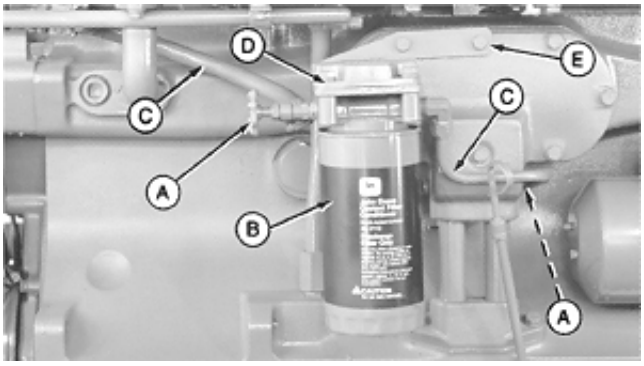
1. Close shut-off valves (A).

2. Remove and discard coolant filter element (B).

3. Remove attaching hardware and remove both inlet and outlet lines (C).

4. Remove cap screws and washers and remove filter base (D).

5. Remove mounting base (E).



-UN-31JUL89
RG3525

A—Shut-Off Valve (2 used)
B—Coolant Filter Element
C—Lines
D—Filter Base
E—Mounting Base

S11,2025,EK -19-08AUG94

INSPECT COOLANT FILTER CONDITIONER COMPONENTS—IF EQUIPPED

1. Inspect all lines for cracks or pin holes. Replace as necessary.

2. Inspect filter base and shut-off valves for debris and damage. Replace as necessary.

3. Clean all coolant filter conditioner component parts using liquid household soap and water. Rinse thoroughly.

4. Dry with compressed air.

S11,2025,EL -19-08AUG94

INSTALL COOLANT FILTER CONDITIONER ASSEMBLY—IF EQUIPPED

NOTE: Apply LOCTITE 592 Pipe Sealant with TEFLON® to all threads on adapters elbows and shut-off valves before installing.

1. Install mounting base (A). Tighten cap screws to 47 N·m (35 lb-ft).

2. Apply PT569 NEVER-SEEZ Compound to filter base cap screws and install filter base (B). Tighten cap screws to 27 N·m (20 lb-ft).

3. Install shut-off valve and inlet line (C). Tighten securely.

4. Install shut-off valve and outlet line (D). Tighten securely.

5. Lubricate gasket on new coolant conditioner filter element (E) with a thin layer of clean engine oil and install on filter base.

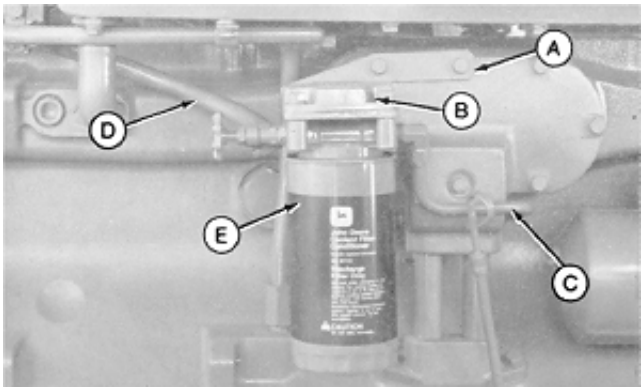
6. Tighten filter until gasket contacts filter base, then tighten additional 1/2 to 3/4 turn. DO NOT overtighten.

IMPORTANT: DO NOT use John Deere Summer Coolant Conditioner or any antifreeze containing a stop-leak additive. These products may clog the coolant filter.

DO NOT use Dowtherm 209 antifreeze. This antifreeze is not compatible with coolant filter chemical. Damage can occur to rubber seals on cylinder liners which are in contact with coolant.

25 62 7. Fill cooling system with correct coolant to proper level. (See 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.



RG3526 -UN-31JUL89

A—Mounting Base
B—Filter Base
C—Inlet Line
D—Outlet Line
E—Filter Element

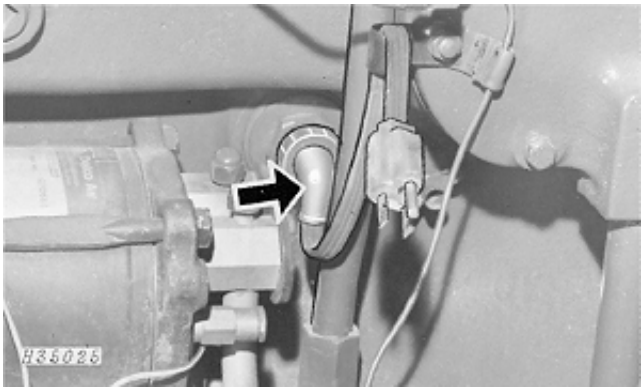
S11,2025,EM -19-08AUG94

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 (arrow) out of block.



S11,2025,GJ -19-06APR94

INSTALL COOLANT HEATER—IF EQUIPPED

CAUTION: To avoid shock or hazardous operation, always use a three-wire heavy-duty electrical cord equipped with three-wire connectors. If a two-to-three contact adapter is used at the wall receptacle, always connect green wire to a good ground. Keep electrical connectors clean to prevent arcing.

Only plug coolant heater into electrical power if heating element is immersed in coolant. Sheath could burst and result in personal injury.

NOTE: The heater element (A) cannot be repaired. If defective, replace with a new one.

1. Lubricate O-ring (B) with clean engine oil and install onto groove of flange nut (D). Install gasket (C) onto heater element and install element into flange nut.

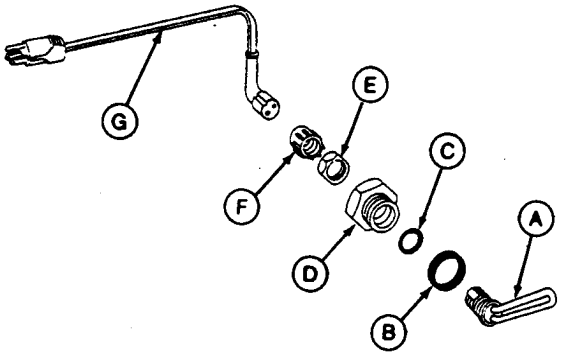
2. Install lock nut (E) onto threads of heater element finger tight only.

3. Install assembly into threaded heater hole in block. While holding heater element in the upward, vertical position, tighten flange nut to 68 N·m (50 lb-ft) making sure O-ring seals against block.

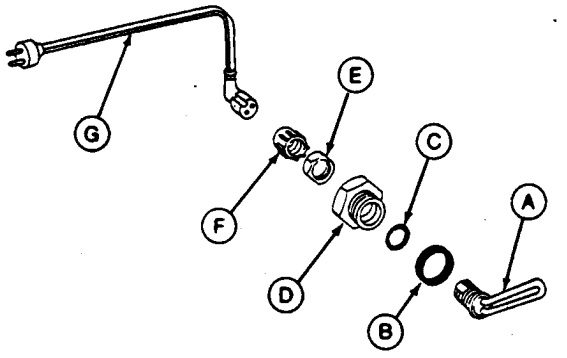
IMPORTANT: HEATER element must remain in the upright vertical position after installation and must not touch internal walls of the block.

4. Hold assembly so that flats on threaded end of heater element are vertical. Tighten lock nut to 34 N·m (25 lb-ft).

5. Install wiring lead (G) or dust cap (F) when wiring lead is not being used.



110 Volt



220 Volt

A—Heater Element
B—O-Ring
C—Gasket
D—Flange Nut Adapter
E—Lock Nut
F—Cap
G—Wiring Lead

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S55,2025,N -19-08AUG94

CHECK AND ADJUST V-BELT TENSION

1. Check belt tension and replace belts as required. If adjustment is necessary, use JDG529 Belt Tension Gauge (A) or JDST28 Belt Tension Gauge with straightedge. Follow manufacturer's instructions.

IMPORTANT: Do not check tension or adjust belts when hot.

NOTE: Measure tension on long part of front belt. Replace both belts if either of the pair is to be replaced. The belts must be replaced as a matched set to obtain satisfactory service life.

2. Loosen alternator mounting bolts.

IMPORTANT: DO NOT pry against alternator rear frame as this may damage the alternator housing.

3. Apply outward force to the front frame of the alternator until belt tension is correct.

4. Tighten alternator mounting cap screws securely.

After installing a new belt, run engine for about 10 minutes. Stop engine and check belt tension. If tension is not within new belt specifications, wait 10 minutes, loosen belt and adjust to used belt specifications.

• JDG529 Gauge Method:

V-BELT TENSION SPECIFICATIONS

	New Belt	Used Belt*
2-Belt System (Tension front belt only)	422—463 N (95—104 lb)	378—423 N (85—95 lb)

• JDST28 Belt Tension Gauge/Straightedge Method:

On new and used standard V-belts, an 89 N (20 lb-force) halfway between the pulleys should deflect the belt 19 mm (3/4 in.).

**Belts are considered used after 10 minutes of operation.*

RG,CTM61,G25,28-19-08AUG94

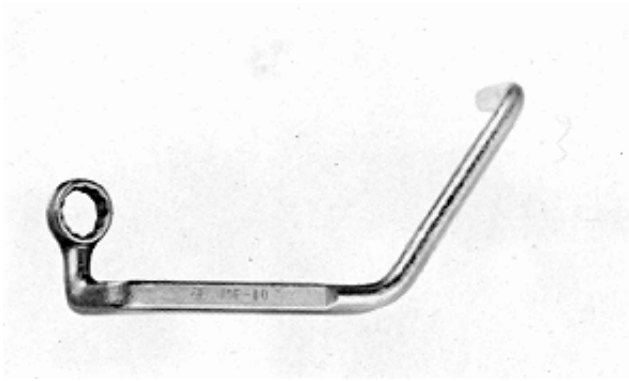
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

Starter Wrench JDE80

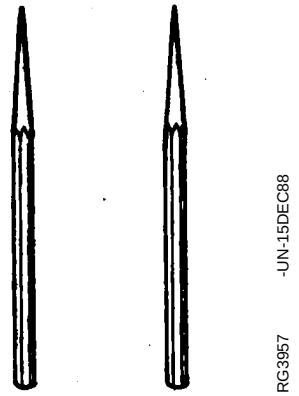
Use with JDG626 and standard 9/16 12-point, 3/8 in. drive socket to remove and install rear cap screw on turbocharger drain tube.



RG,CTM42,G30,32-19-10SEP91

Retaining Ring Point Set JDF29

Used with the JDG24 Snap Ring Plier Kit to remove and install snap rings.

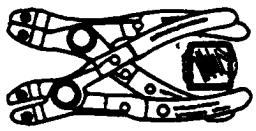


S53,JDF29 -19-06APR94

RG5172 -UN-23AUG88

Snap Ring Plier Kit JDG24

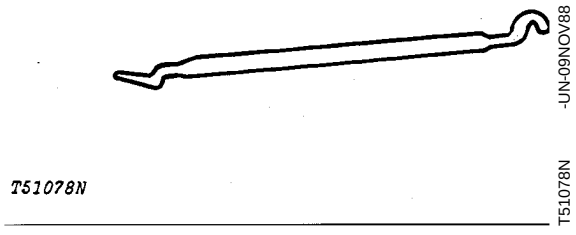
Used with JDF29 Retaining Ring Point Set to remove and install snap rings.



S53,JDG24 -19-06APR94

O-Ring Seal Tool Set JDG127

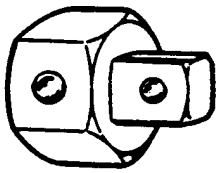
Used as an aid to install turbine shaft piston rings.



S53,JDG127 -19-06APR94

Special Socket Adapter JDG626

Use with JDE80 and standard 9/16 12-point, 3/8 in. drive socket to remove and install rear cap screw on turbocharger drain tube.

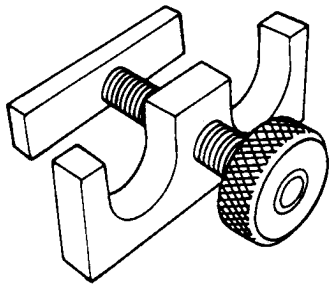


RG5367 -UN-14DEC88

S53,JDG626 -19-09SEP91

Sealing Ring Compression Tool JDG683

Used to compress aftercooler sealing ring for cover-to-intake manifold alignment during assembly.



RG5571 -UN-04JUL89

RG,JDG683 -19-09SEP91

OTHER MATERIAL

Name	Use
PT569 NEVER-SEEZ Compound	Exhaust manifold cap screws, turbocharger-to-exhaust manifold cap screws, and aftercooler cover-to-intake manifold cap screws.
LOCTITE 592 (TY9374/TY9375) Pipe Sealant with TEFLON	Turbocharger oil supply and drain lines.

RG,CTM42,G30,1 -19-29OCT92

AIR INTAKE AND EXHAUST SYSTEM SPECIFICATIONS

ITEM	SPECIFICATION	WEAR LIMIT
Turbocharger-Schwitzer		
Total Indicator Reading Limits:		
Maximum Radial Bearing Clearance		0.53 mm (0.021 in.)
Maximum Axial Bearing End Play		0.05—0.13 mm (0.002—0.005 in.)
Piston Ring Groove Width	1.63—1.65 mm (0.064—0.065 in.)	---
Thrust Bearing Thickness	2.72—2.74 mm (0.107—0.108 in.)	---
Thrust Sleeve Length	13.13—13.18 mm (0.517 —0.519 in.)	---
Thrust Sleeve Piston Ring Gap	0.05—0.18 mm (0.002—0.007 in.)	---
Shaft Diameter at:		
Bearing	11.176—11.184 mm (0.4400—0.4403 in.)	---
Compressor Wheel	7.932—7.938 mm (0.3123—0.3125 in.)	---
Bearing Housing Bore	19.050—19.063 mm (0.7500—0.7505 in.)	---
Bearing Length	61.60—61.62 mm (2.425—2.426 in.)	---
Shaft Bearing Area Length	64.41—64.44 mm (2.536—2.537 in.)	---
Shaft Concentricity		
Maximum Runout		0.0154 mm (0.0006 in.)
Turbine Wheel-to-Back Plate Clearance	0.43—1.24 mm (0.017—0.049 in.)	---
Exhaust Adapter End Play	1.588 mm (0.0625 in.)	---

RG,CTM1,G30,1 -19-08AUG94

AIR INTAKE AND EXHAUST SYSTEM SPECIFICATIONS—CONTINUED

ITEM	SPECIFICATION	WEAR LIMIT
Turbocharger-Garrett/AiResearch:		
Total Indicator Reading Limits:		
Maximum Radial Bearing Clearance		0.076—0.152 mm (0.003—0.006 in.)
Maximum Axial Bearing End Play		0.025—0.102 mm (0.001—0.004 in.)
Thrust Washer:		
Washer Groove Width	4.445 mm (0.1752 in.)	---
Ring Groove Width	1.67 mm (0.067 in.)	---
Compressor Wheel Bore ID	6.360 mm (0.2504 in.)	---
Back Plate Seal Bore ID	12.73 mm (0.501 in.)	---
Shaft and Wheel Assembly:		
Journal OD	10.150 mm (0.3994 in.)	---
Seal Hub OD	17.297 mm (0.6809 in.)	---
Ring Groove Width	1.867 mm (0.0735 in.)	---
Center Housing:		
Bearing Bore ID	15.819 mm (0.6228 in.)	---
Seal Bore ID	17.856 mm (0.7029 in.)	---
Exhaust Adapter End Play	1.586 mm (0.0625 in.)	---

S11,3005,JB -19-08AUG94

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AIR INTAKE AND EXHAUST SYSTEM SPECIFICATIONS—CONTINUED

TORQUES

Turbocharger—Schwitzer:

Compressor Wheel Lock Nut	18 N·m (156 lb-in.)
Lock Plate Screws (Compressor and Turbine)	7 N·m (60 lb-in.)
Turbocharger-to-Exhaust Manifold	47 N·m (35 lb-ft)
Turbine Housing-to-Bearing Housing	17 N·m (13 lb-ft) (144 lb-in.)
Compressor Housing-to-Bearing Housing	7 N·m (5 lb-ft) (60 lb-in.)
Turbocharger Oil Return Line	47 N·m (35 lb-ft)
Turbocharger Oil Inlet Adapter	34 N·m (25 lb-ft)

Turbocharger—Garrett/AiResearch:

Backplate-to-Center Housing	8.5—10.2 N·m (75—90 lb-in.)
Compressor Wheel Nut	2.0—2.3 N·m (18—20 lb-in.) (continue to tighten lock nut through an angle of 90°)
Compressor Housing-to-Backplate	12.4—14.7 N·m (110—130 lb-in.)
Turbine Housing-to-Center Housing	11.3—14.7 N·m (100—130 lb-in.)
Turbocharger-to-Exhaust Manifold	47 N·m (35 lb-ft)
Turbocharger Oil Return Line	41 N·m (30 lb-ft)
Turbocharger Oil Inlet Line	47 N·m (35 lb-ft)
Turbocharger Coupling Clamp	11 N·m (100 lb-in.)
Exhaust Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Exhaust Elbow-to-Exhaust Manifold	47 N·m (35 lb-ft)
Intake Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Intake Manifold-to-Aftercooler Cover	34 N·m (25 lb-ft)
Aftercooler Inlet and Outlet Hose Clamps	4 N·m (35 lb-in.)
Aftercooler End Adapter	27 N·m (20 lb-ft)

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S11,3005,LS -19-08AUG94

EXTENDING TURBOCHARGER LIFE

Turbochargers are designed to last the life of the engine, but, because they operate at such high speeds (100,000 rpm or more); a moment's carelessness can cause them to fail in seconds.

The major causes of turbocharger failures are attributed to:

- **Lack of lube oil (quick starts and hot shutdowns)**
- **Oil contamination**
- **Ingestion of foreign objects**
- **Restricted oil drainage**
- **Low oil level**
- **Operation on excessive side slopes**
- **Abnormally high exhaust temperatures**

S55,3005,E -19-06APR94

- **Lack of Lube Oil**

Oil not only lubricates the turbocharger's spinning shaft and bearings, it also carries away heat. When oil flow stops or is reduced, heat is immediately transferred from the hot turbine wheel to the bearings, which are also heating up because of the increased friction due to the lack of oil. This combination causes the turbocharger shaft temperature to increase rapidly.

If oil flow does not increase and the process continues, bearings will fail. Once the bearings fail (which can happen in just seconds) seals, shaft, turbine and compressor wheels can also be damaged.

The principle causes of turbocharger bearing lubrication problems are low oil pressure, a bent, plugged or undersized oil lube supply line, plugged or restricted oil galleries in the turbocharger, or improper machine start-up and shutdown procedure.

Oil levels and pressure should always be closely monitored and all worn hoses and lines should be replaced. The turbocharger oil supply line should be checked frequently to make sure it is not kinked or bent and it should always be replaced with a line of equal size, length and strength.

The easiest way to damage a turbocharger is through improper start-up and shutdown procedures. Always idle the engine for at least 30 seconds (no load) after start-up and before shutdown. Warming the engine up before applying a load allows oil pressure to build up and lines to fill with oil.

Idling the engine before shutdown allows the engine and turbocharger to cool. "Hot" shutdowns can cause the turbocharger to fail because after high-speed operation the turbocharger will continue to rotate long after the engine has been shut off and oil pressure has dropped to zero. This will cause heat to build up and possible bearing damage. It can also cause carbon and varnish deposits to form.

S55,3005,F -19-04JUN93

• Oil Contamination

A second cause of turbocharger failures is contaminated oil. It can be caused by a worn or damaged oil filter or not changing the lube oil at recommended intervals. Expecting the oil filter to remove dirt, sand, metal chips, etc. from the oil before they reach the engine or turbocharger can be a costly mistake because contaminated oil may completely bypass the engine oil filter if the oil filter or oil cooler is clogged, if the filter element is improperly installed, or if the oil is thick during cold weather.

Four good ways of avoiding oil contamination are:

— Always inspect the engine thoroughly during major overhaul. Look especially for any sludge or debris left in lube oil galleries.

— Change lube oil at recommended intervals. Analysis of oil samples at filter change periods can help identify potentially harmful contaminants in the oil.

— Clean the area around the oil fill cap before adding oil.

— Use a clean container when adding oil.

S11,3005,MK -19-04JUN93

• Ingestion of Foreign Objects

The third cause of turbocharger damage is the ingestion of foreign objects. Foreign objects or particles can be ingested and cause damage to the turbocharger on both compressor and turbine sides. This is easy to avoid.

On the compressor side, foreign objects usually take the form of dust, sand, or shreds of air cleaner element that enter through improperly installed air cleaner elements. Leaky air inlet piping (loose clamps or torn rubber joints) or torn pleats in dry-type air cleaner elements also create problems.

The result is erosion of compressor blades that can cause the delicately balanced wheel to wobble.

IMPORTANT: Whenever an internal engine failure (valve, valve seat, piston) occurs, a thorough inspection of the turbocharger MUST BE performed before returning engine to service.

S11,3005,ML -19-04JUN93

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• Restricted Oil Drainage

A fourth cause of turbocharger damage is restricted lube oil drainage. The lubricating oil carries away heat generated by friction of the bearings and from the hot exhaust gases. If drainage back to the sump is impeded, the bearings will overheat with damage that will ultimately lead to failure.

There are two primary reasons for restricted drainage. A blocked drain tube, due to either damage or a buildup of sludged oil or high crankcase pressure which can be due to restricted crankcase breather or excessive engine blowby.

Periodically check both the turbocharger oil drain tube and engine breather tube for damage or restriction. Correction of these conditions leads to longer turbocharger life.

RG,CTM8,G30,R1 -19-04JUN93

- **Abnormally High Exhaust Temperatures**

A fifth cause of turbocharger damage is abnormally high exhaust temperatures. Elevated exhaust temperatures cause coking of oil which can lead to bearing failure. Extreme over-temperature operation can case wheel burst.

There are two basic causes of over-temperature. The first is restricted air flow and the second is overpowering the engine. In either case the engine has more fuel than available air for proper combustion, this overfueled condition leads to elevated exhaust temperatures.

Causes of restricted air flow can include damaged inlet piping, clogged air filters, excessive exhaust restriction, or operation at extreme altitudes. Overpowering generally is due to improper fuel delivery or injection timing. If overtemperature operation has been identified, an inspection of the air inlet and exhaust systems should be performed. Also, check the fuel delivery and timing.

RG,CTM8,G30,R2 -19-19AUG92

REMOVE TURBOCHARGER—6466T AND 6466A ENGINES (GARRETT/AIRESEARCH, SCHWITZER, AND HOLSET)

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

NOTE: 6466T and 6466A Engines will have Schwitzer, Garrett/AiResearch, or Holset turbochargers. Removal and installation procedures are the same for all turbochargers, but repair of Garrett/AiResearch and Schwitzer differ. Refer to the proper repair group when repairing the turbocharger. Repair parts are not available for the Holset turbocharger. If turbocharger is defective a replacement turbocharger must be purchased.

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.)

S11,3005,JH -19-08AUG94

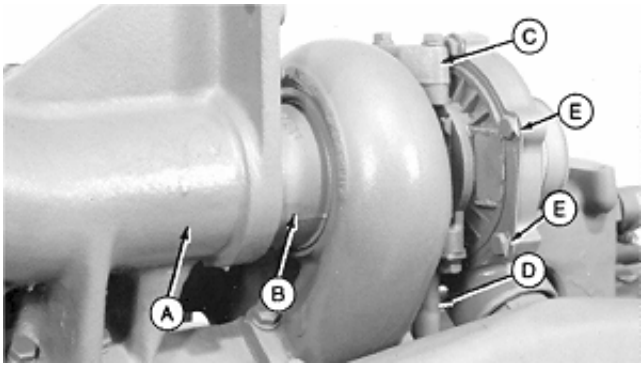
1. Remove exhaust elbow (A) and adapter (B).

NOTE: Do not let adapter push against turbine wheel during removal.

2. Disconnect oil inlet line (C). Loosen oil return tube cap screws using JDG626 Special Socket Adapter with JDE80 Starter Wrench and standard 9/16 12-point, 3/8 in. drive socket and remove oil return tube (D). Discard gaskets.

NOTE: Scribe location marks on compressor housing and backplate. The location marks will insure correct alignment when turbocharger is installed.

3. Straighten ears on lockplates (E) and loosen compressor cover-to-backplate cap screws.



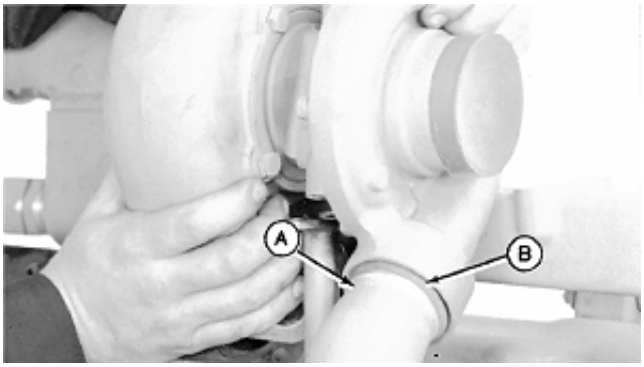
A—Exhaust Elbow
B—Adapter
C—Oil Inlet Line
D—Oil Return Tube
E—Lock Plates

S11,3005,FA -19-08AUG94

4. Lift turbocharger off exhaust manifold. Disengage turbocharger from intake manifold coupling (A). Discard O-ring (B).

5. Cap or plug all openings (exhaust and intake manifold related), and place turbocharger on a clean flat table for inspection.

6. Perform turbocharger seven-step inspection, as described later, if failure mode has not been determined.



S11,3005,EP -19-06APR94

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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

Oil and/or Dirt in Housing	Restricted air intake system.	Inspect and clean air cleaner.
	Prolonged periods of low RPM engine idling.	Check with operator to confirm conditions. (See Operators manual.)
	Defective oil seal ring.	Repair as required. (This group.)
	Restricted oil drain line.	Inspect and clear oil drain line as required.

TURBINE HOUSING INLET DEFECTS

Oil in Housing	Internal engine failure.	Inspect and repair engine as required.
	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 -19-16AUG94

Compressor Housing Inlet and Compressor Wheel

1. Check compressor inlet and compressor wheel (A) for foreign object damage.

NOTE: Foreign object damage may be extensive or minor. In either case, the source of the foreign object must be found and corrected to eliminate further damages.

2. Mark findings on your checklist and continue the inspection.

RG4523 -UN-20DEC88

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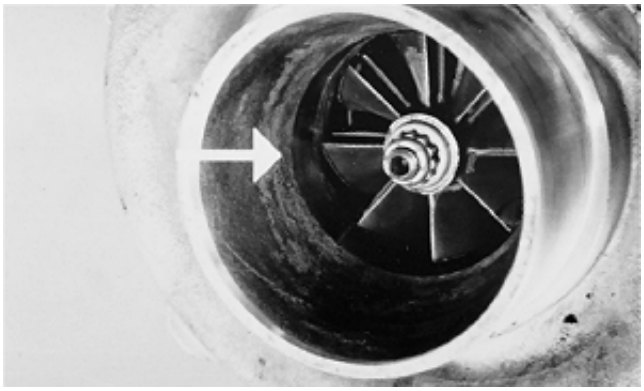
S11,3005,IG -19-07AUG92

NOTE: You will need a good light source for this check.

3. Check compressor inlet for wheel rub on the housing (arrow). Look very closely for any score marks on the housing itself and check the tips of the compressor wheel blades for damage.

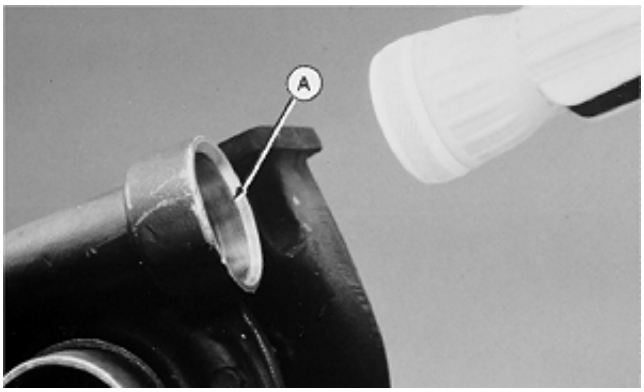


S11,3005,IH -19-07AUG92

Compressor Housing Outlet

1. Check compressor housing outlet (A). The outlet should be clean and free of dirt or oil.

2. Mark it on your checklist if dirt or oil is found and continue the inspection.

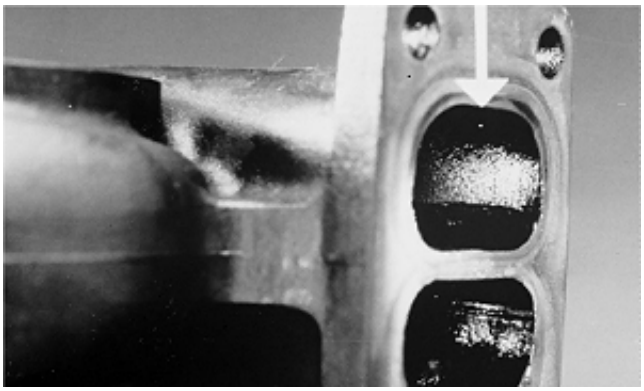


S11,3005,II -19-07AUG92

Turbine Housing Inlet

1. Check the turbine housing inlet ports (arrow) for oil in housing, excessive carbon deposit or erosion of center walls.

NOTE: If the inlet is wet with oil, or has excessive carbon deposits, an engine problem is likely. Center wall erosion (cracking or missing pieces), indicate excessive exhaust temperature.



S11,3005,IJ -19-11SEP92

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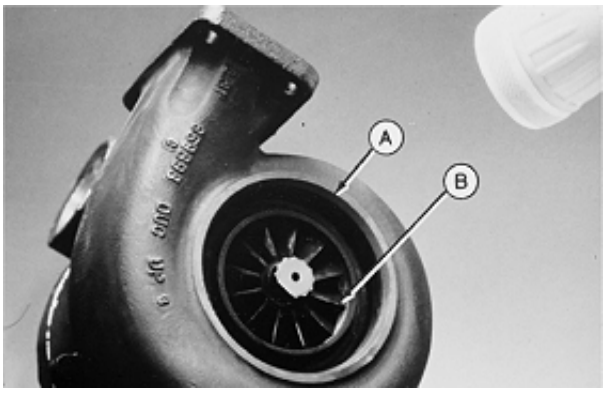
Turbine Housing Outlet and Turbine Wheel

1. Use a flashlight to look up inside the turbine housing outlet (A) and check blades (B) for foreign object damage.



S11,3005,IK -19-11SEP92

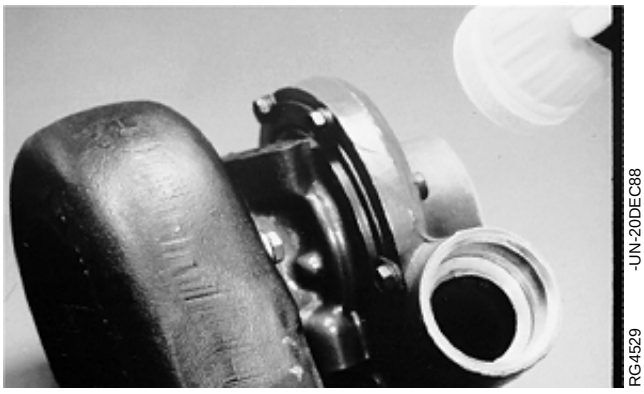
2. Inspect the wheel blades and housing for evidence of wheel rub (arrow). Wheel rub can bend the tips of the blades with the housing showing wear or damage.

S11,3005,IL -19-11SEP92

External Center Housing and Joints

1. Visually check the outside of the center housing, all connections to the compressor, and turbine housing for oil.

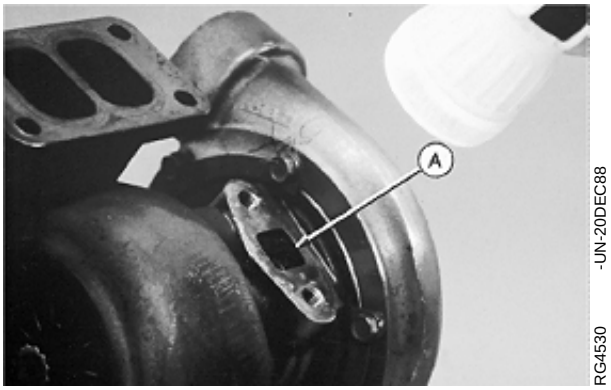
NOTE: If oil is present, make sure it is not coming from a leak at the oil supply or return line.



S11,3005,IM -19-07AUG92

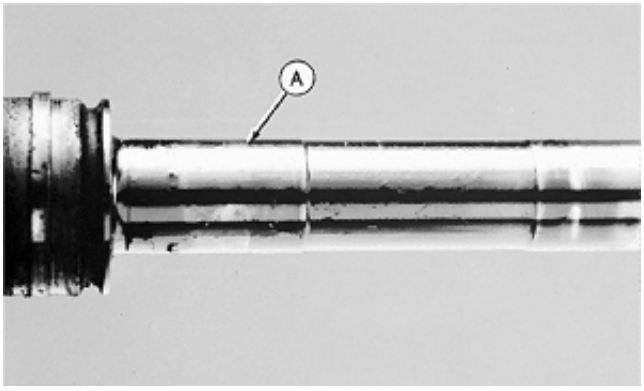
Internal Center Housing

1. Using a flashlight, look through the oil return hole (A), to check the condition of the shaft and/or bearings. There should not be excess carbon deposits on the shaft or in the housing.



S11,3005,IN -19-07AUG92

2. Excessive “blueing” or “coking” of oil along the complete length of the shaft (A) indicates a possible lack of lubrication caused by an engine failure, or improper operation, such as hot shutdowns.

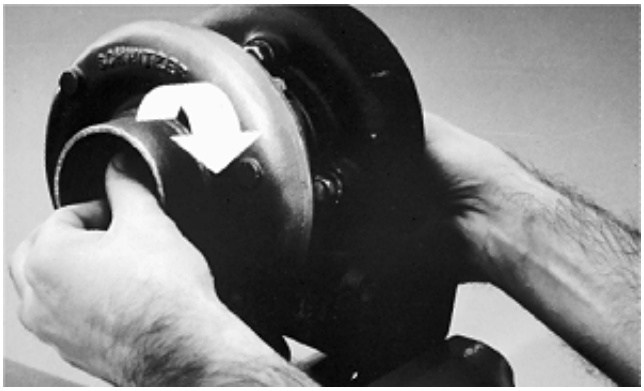


S11,3005,IO -19-07AUG92

Turbocharger Bench Test

1. Mount the turbocharger in a vise.

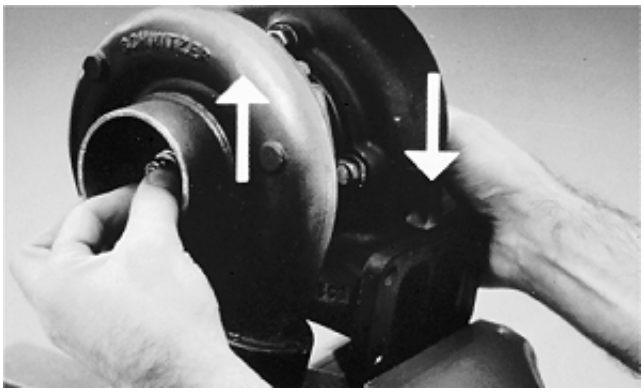
2. Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely, however, there may be a slight amount of drag.



S11,3005,IP -19-29APR93

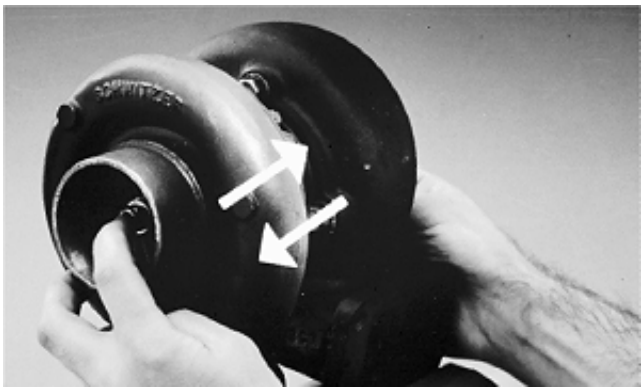
3. Next, pull up on the compressor end of the shaft and press down on the turbine end while rotating shaft. Neither the compressor wheel nor the turbine wheel should contact the housing at any point.

NOTE: There will be some "play" because the bearings inside the center housing are free floating.



S11,3005,IQ -19-07AUG92

4. Next, check shaft endplay by moving the shaft back and forth while rotating. There will be some endplay but not to the extent that the wheels contact the housings.



S11,3005,IR -19-07AUG92

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NOTE: These diagnostic procedures will allow you to determine the condition of the turbocharger. If the turbocharger has failed, analysis of your inspection notes should direct you to the specific areas of the engine to correct the problems causing the turbocharger failure (See TURBOCHARGER FAILURE ANALYSIS, outlined earlier in this group). It is not unusual to find that a turbocharger has not failed. If your turbocharger passes all the inspections, the problem lies somewhere else.

IMPORTANT: Before you finalize your conclusion that the turbocharger has not failed, it is strongly recommended that the following procedures of checking radial bearing clearance and axial bearing endplay with a dial indicator be performed. These procedures are not required if a failure mode has already been identified.

S11,3005,IS -19-14OCT94

PERFORM AXIAL BEARING END PLAY TEST—SCHWITZER

This test will give an indication of the condition of the thrust bearing within the center housing and rotating assembly.

1. Mount magnetic base dial indicator (arrow) so indicator tip rests on flat surface on turbine end of shaft. Preload indicator tip and zero dial on indicator.

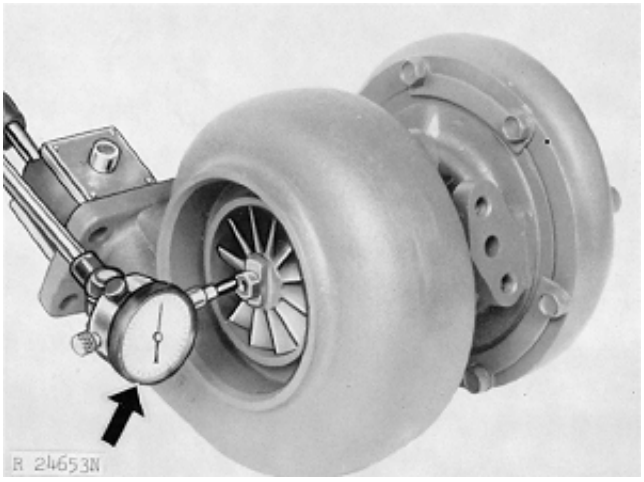
2. Move shaft axially back and forth by hand.

3. Observe and record total dial indicator movement.

TURBOCHARGER SHAFT AXIAL END PLAY SPECIFICATION

Schwitzer	0.05—0.13 mm (0.002—0.005 in.)

If bearing end play is not within specifications, the rotating assembly must be repaired or replaced. (See DISASSEMBLE SCHWITZER TURBOCHARGER, later in this group.)



R24653N -UN-20DEC88

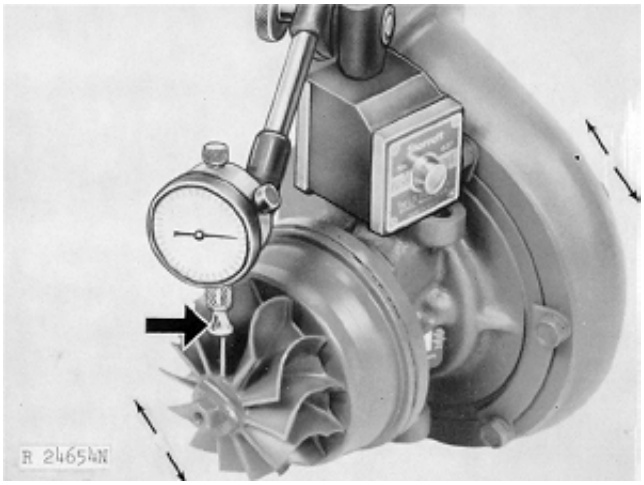
S11,3005,JJ -19-08AUG94

PERFORM RADIAL BEARING CLEARANCE TEST (SCHWITZER)

This test will give an indication of the condition of radial bearings within the center housing and rotating assembly.

NOTE: Radial Bearing clearance check can be done with or without compressor housing attached.

1. Position a dial indicator [plunger-type with 25 mm (1.0 in.) travel] and check the radial shaft movement by moving shaft up and down.



R24654N -UN-20DEC88

SCHWITZER TURBOCHARGER
RADIAL BEARING CLEARANCE SPECIFICATION

Maximum Clearance	0.53 mm (0.021 in.)

If radial bearing clearance is not within specifications, the rotating assembly must be repaired or replaced. (See DISASSEMBLE SCHWITZER TURBOCHARGER, later in this group.)

RG,CTM1,G30,9 -19-08AUG94

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PERFORM RADIAL BEARING CLEARANCE TEST—GARRETT/AIRESEARCH

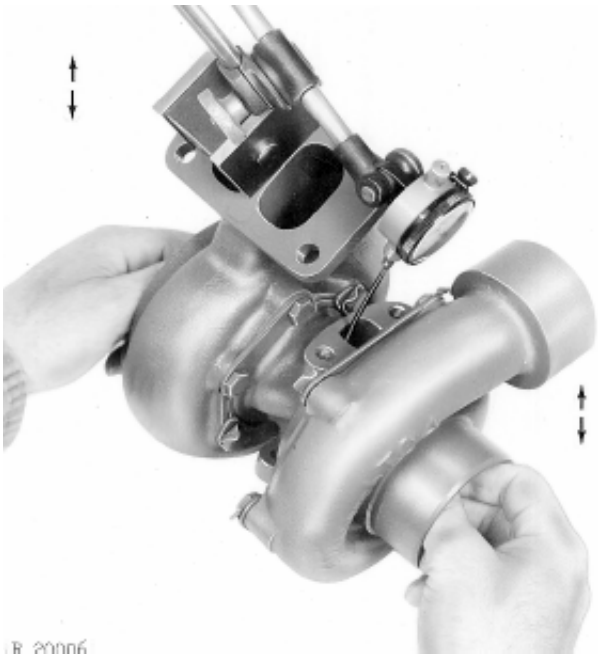
This test will give an indication of the condition of radial bearings within the center housing and rotating assembly.

1. Fasten a magnetic base (plunger-type) dial indicator to the turbocharger mounting base. Assemble an extension adapter and indicator extension rod onto dial indicator.

2. Position indicator tip (through center housing oil return) on center of shaft. Preload indicator tip and zero dial on indicator.

3. Grasp rotating shaft at both ends and move the shaft toward the indicator then away from the indicator (arrows). Use care to move the shaft in the same direction as the dial indicator tip travels and apply equal pressure at both ends of the shaft.

4. Observe and record the total dial indicator movement.



R20006 -UN-20DEC88

GARRETT/AIRSEARCH TURBOCHARGER RADIAL BEARING CLEARANCE SPECIFICATION

Maximum Clearance . . . . . 0.076—0.152 mm (0.003—0.006 in.)

If total indicator reading is not within specification, the rotating assembly must be repaired or replaced. (See DISASSEMBLE GARRETT/AIRESEARCH TURBOCHARGER, later in this group.)

S11,3005,JX -19-08AUG94

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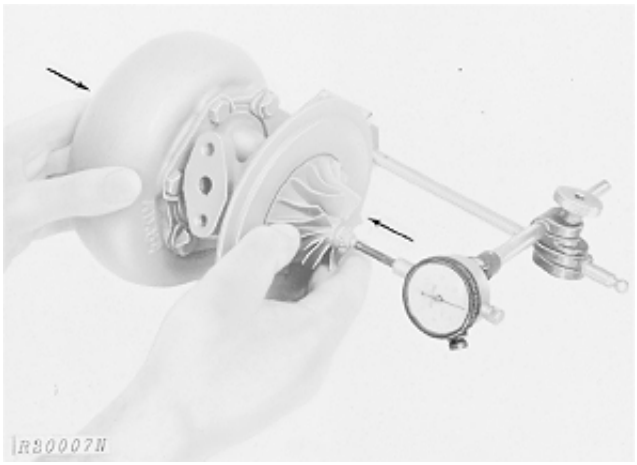
PERFORM AXIAL BEARING END PLAY TEST—(GARRETT/AIRESEARCH)



R20007N -UN-20DEC88

This test will give an indication of the condition of the thrust bearing within the center housing and rotating assembly.

1. Mount magnetic base dial indicator (arrow) so indicator tip rests on flat surface on turbine end of shaft. Preload indicator tip and zero dial on indicator.

2. Move shaft axially back and forth by hand.

3. Observe and record total dial indicator movement.

TURBOCHARGER SHAFT AXIAL END PLAY SPECIFICATION

Maximum Clearance . . . . . 0.025—0.102 mm (0.001—0.004 in.)

If bearing end play is not within specifications, the rotating assembly must be repaired or replaced. (See DISASSEMBLE GARRETT/AIRESEARCH TURBOCHARGER, later in this group.)

NOTE: This test can also be made with compressor housing installed.

S11,3005,JY -19-08AUG94

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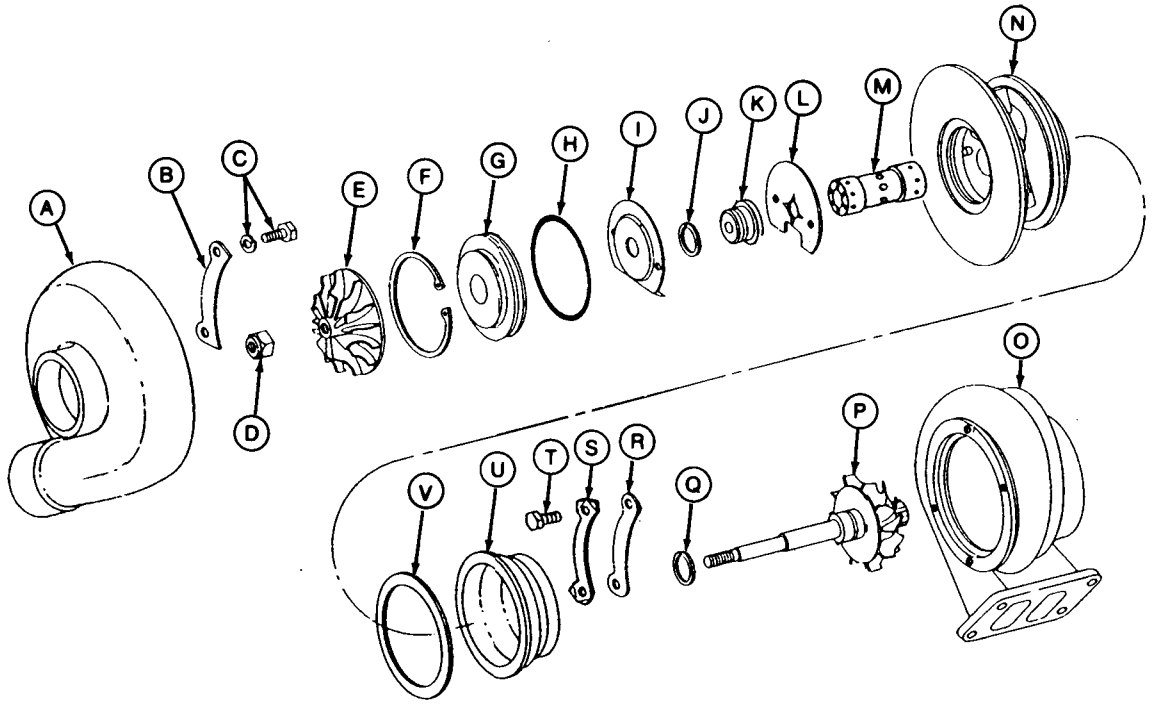
DISASSEMBLE SCHWITZER TURBOCHARGER



RG7087 -UN-16FEB94

A—Compressor Cover
B—Clamp Plate
C—Screw with Lock Washer (8 used)
D—Lock Nut
E—Compressor Wheel
F—Snap Ring
G—Compressor Insert
H—O-Ring
I—Oil Deflector
J—Piston Ring
K—Thrust Sleeve
L—Thrust Plate
M—Bearing
N—Bearing Housing
O—Turbine Housing
P—Turbine Wheel With Shaft
Q—Piston Ring (Copper Plated)
R—Clamp Plate
S—Lock Plate
T—Cap Screw
U—Back Plate
V—Gasket

Schwitzer Turbocharger

Cap or plug all openings (including exhaust and intake ports) and clean exterior of turbocharger with a pressure spray of cleaning solvent. Dry turbocharger with compressed air.

IMPORTANT: When cleaning turbocharger do not spray directly into compressor cover or turbine housing. Spinning rotor with high pressure spray may cause bearing damage.

Put turbocharger on a clean flat surface.

As each part is removed, place it in a clean protective container.

1. Remove turbine housing (O) and compressor cover (A).

2. Scribe locating marks on compressor cover, bearing housing (N), and on turbine housing for proper indexing during assembly.

3. Remove cap screws (C) and clamp plates (B) from compressor cover. Remove cover.

4. Bend lock tabs back and remove cap screw (T) from clamp plate (R) and lock plate (S). Gently tap turbine housing with a soft hammer if necessary to remove. Be careful not to damage turbine housing or turbine wheel.

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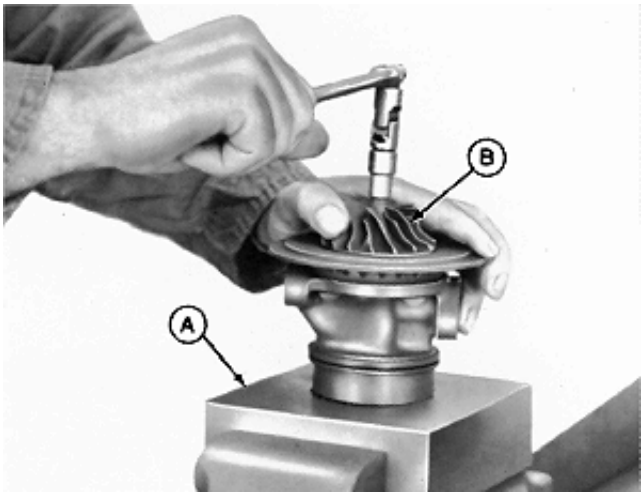
S11,3005,JK -19-08AUG94

5. Mount either a 11/16-in., 12-point box end wrench in a vise, or special holding fixture (A). (See Group 199, Dealer Fabricated Tools.)

6. Remove compressor wheel lock nut. Use a double universal socket to avoid bending shaft.

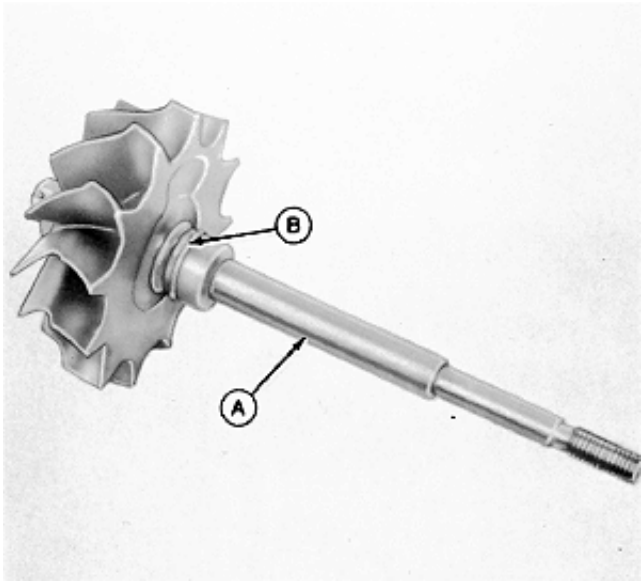
7. Remove compressor wheel (B) from shaft.



S11,3005,H -19-06APR94

8. Remove turbine wheel and shaft assembly (A) from bearing housing. Discard lock nut.

9. Remove and discard piston ring (B) from shaft.



S11,3005,I -19-19APR82

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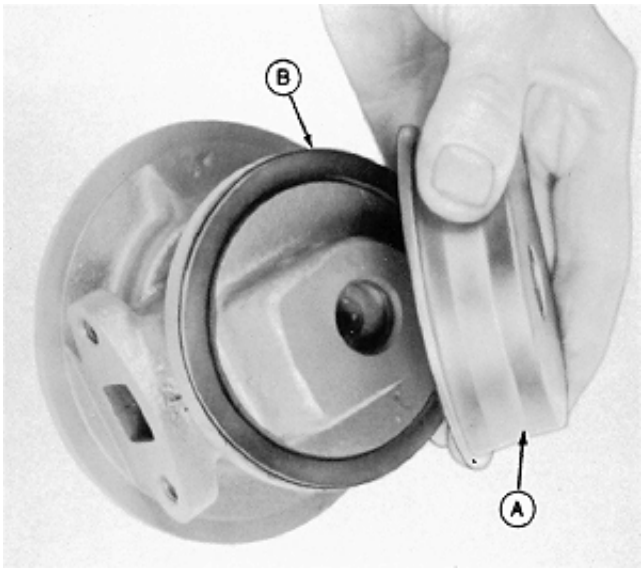
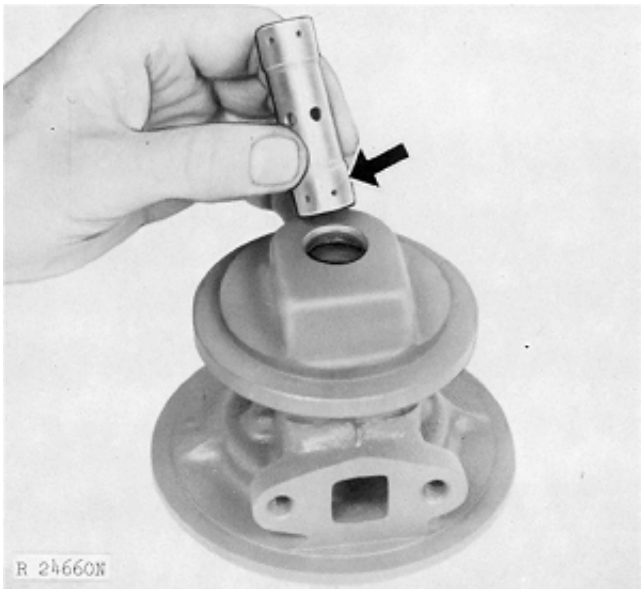
10. Lift off back plate (A). Remove and discard gasket (B).



R28369 -UN-20DEC88

S11,3005,J -19-19APR82

11. Remove bearing (arrow) from bearing housing.



R24660N -UN-20DEC88

S11,3005,K -19-16MAR81

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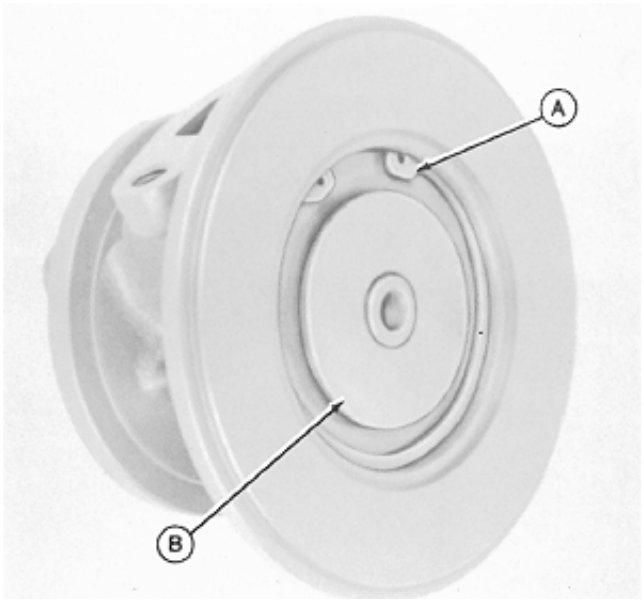
23

12. Put bearing housing assembly on a clean flat surface with compressor side up.

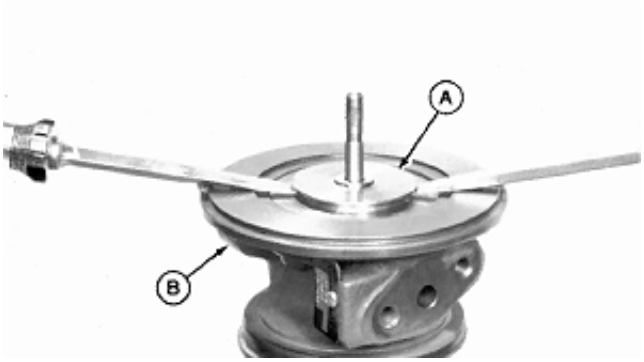
CAUTION: To prevent personal injury or loss of snap ring, place a shop towel over snap ring while it is being compressed.

13. Remove large snap ring (A), which retains compressor insert (B).



S11,3005,L -19-08AUG94

14. Gently lift compressor insert (A) from bearing housing (B), using two screwdrivers.



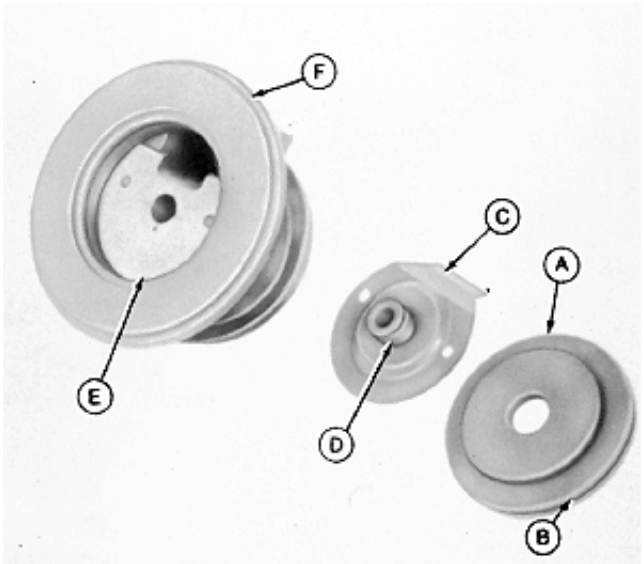
S11,3005,M -19-18APR85

NOTE: Remove and discard O-ring (B).

15. Lift out oil deflector (C), thrust sleeve (D), and thrust plate (E) from bearing housing (F).

16. Remove and discard piston ring from thrust sleeve.

A—Compressor Insert
B—O-Ring
C—Oil Deflector
D—Thrust Sleeve
E—Thrust Plate
F—Bearing Housing



S11,3005,N -19-19APR82

CLEAN TURBOCHARGER PARTS

Before cleaning, inspect all parts carefully for signs of burning, rubbing or other damage which might not be evident after cleaning.

1. Use a commercially approved solvent only. A caustic solution will damage certain parts and should not be used. Soak parts in solvent until all deposits have been loosened.

2. Use a plastic scraper or bristle-type brush - BUT NOT A WIRE BRUSH - on aluminum parts. A glass bead dry blast may also be used, but be sure air pressure does not exceed 280 kPa (2.8 bar) (40 psi).

Clean all drilled passages with a compressed air jet.

Make certain surfaces adjacent to wheels on stationary housings are free of deposits, clean and smooth.

S11,3005,O -19-08AUG94

INSPECT AND REPAIR SCHWITZER TURBOCHARGER PARTS

NOTE: Use the following chart to determine whether or not to replace parts.

NEW PART SPECIFICATION CHART

Item	Specification
Piston Ring Grooves Width	1.63—1.65 mm (0.064—0.065 in.)
Thrust Bearing Thickness	2.72—2.74 mm (0.107—0.108 in.)
Thrust Sleeve Length	13.13—13.18 mm (0.517—0.519 in.)
Thrust Sleeve Piston Ring Gap	0.05—0.18 mm (0.002—0.007 in.)
Shaft Diameter:	
Bearing Journal Section	11.176—11.184 mm (0.4400—0.4403 in.)
Compressor Wheel Section	7.932—7.938 mm (0.3123—0.3125 in.)
Bearing Housing Bore	19.050—19.063 mm (0.7500—0.7505 in.)
Bearing Length	61.60—61.62 mm (2.425—2.426 in.)
Shaft Bearing Area Length	64.41—64.44 mm (2.536—2.537 in.)
Shaft Concentricity Maximum Runout	0.0154 mm (0.0006 in.)
Turbine Wheel-to-Backplate Clearance	0.43—01.24 mm (0.017—0.049 in.)
Exhaust Adapter End Play	1.588 mm (0.0625 in.)

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1. Inspect bearing journals for excessive scratches and wear. Minor scratches may be tolerated.

NOTE: The shaft bearing journal may be polished lightly to remove minor defects.

To do so, mount small diameter shaft section in a lathe chuck, being careful not to mar the shaft. Operate the lather at 300—600 rpm and polish the shaft using 400 grit abrasive paper and clean lubricating oil.

S11,3005,P -19-08AUG94

2. Inspect piston ring groove wall on turbine wheel and shaft assembly for scoring. Minor scratches are acceptable.

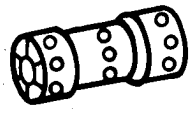
3. Inspect compressor wheel and turbine wheel. Replace wheels if they are bent, cracked or have damaged blades.

IMPORTANT: Do not attempt to straighten blades.

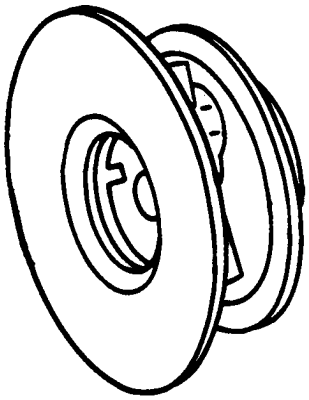
S11,3005,Q -19-16MAR88

RG2939 -UN-20APR94

4. Install a new bearing any time turbocharger is disassembled.



5. Inspect bearing housing. Replace if bearing or piston ring bores are excessively scratched or worn.



RG2940 -UN-20DEC88

6. Inspect thrust plate. Replace if faces are worn excessively, unevenly, or are severely scratched and otherwise damaged. Replace if doing a major rebuild.

7. Inspect piston ring groove and thrust faces on thrust sleeve. Replace if damaged or severely scratched.

Replace all O-rings. Do not attempt to reuse.

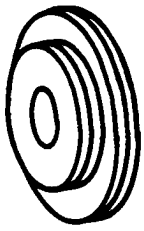
RG2941 -UN-20DEC88

RG2942 -UN-20APR94

8. Inspect compressor insert bore insert for piston ring wear. To check bore for wear, install a new thrust sleeve piston ring in bore of compressor insert where piston ring had made contact.

9. Visually inspect bore for full circle contact. Measure ring gap with a feeler gauge. Gap should be 0.05—0.18 mm (0.002—0.007 in.).

Replace insert ring if ring does not make good contact with insert or if the ring gap is not within the specified limits.



RG2943 -UN-20DEC88

S11,3005,EN -19-08AUG94

ASSEMBLE SCHWITZER TURBOCHARGER

NOTE: Be sure to recheck each part prior to assembly to insure cleanliness. As parts are assembled, cover openings to prevent entry of dirt or other foreign material.

IMPORTANT: If any particle falls into the turbocharger during assembly, remove the particle immediately, even though extensive disassembly may be required.

S11,3005,JL -19-08AUG94

When rebuilding the turbocharger, always replace the following parts. The key letters refer to the exploded view of the turbocharger shown in DISASSEMBLE SCHWITZER TURBOCHARGER earlier in this group.

Description	Key Letter
Lock Nut	(D)
O-Ring	(H)
Piston Ring	(J)
Thrust Plate	(L)
Bearing	(M)
Piston Ring	(Q)
Gasket	(V)

S11,3005,X -19-08AUG94

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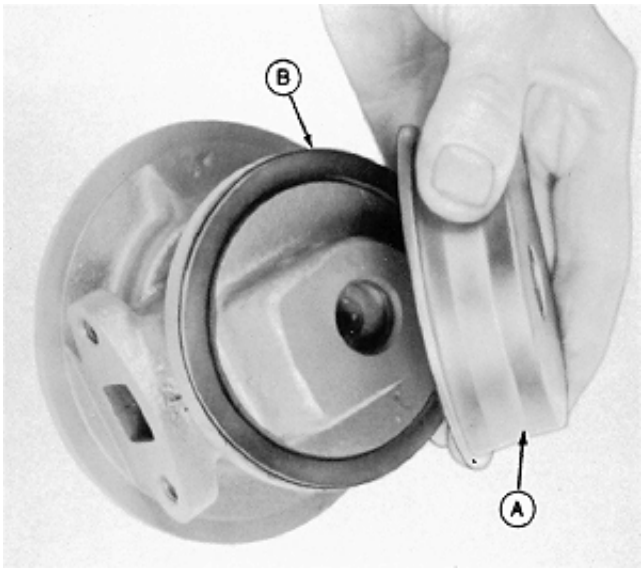
1. Place new gasket (B) on bearing housing.

2. Install back plate (A) on gasket.

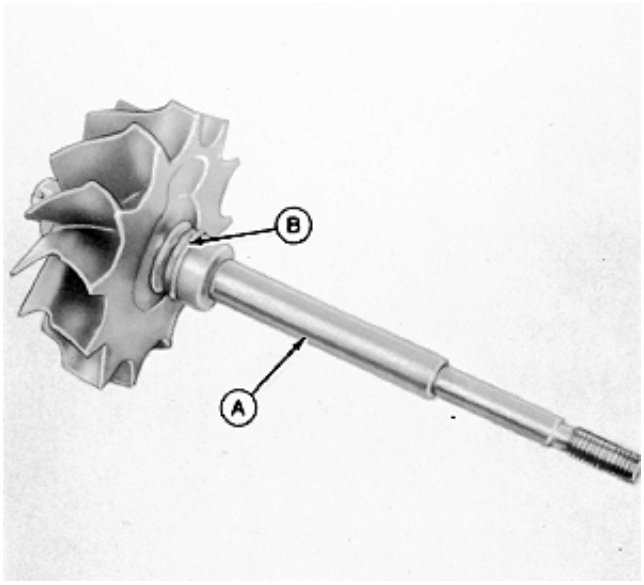


S11,3005,JM -19-27MAR85

3. Install new piston ring (B) in groove on turbine wheel and shaft assembly (A). Be careful not to overexpand the ring.

4. Lubricate piston ring with light weight clean oil and install turbine wheel with shaft in bearing housing. Use care when seating piston ring to prevent damage to piston ring and bore.

NOTE: Place shaft and wheel assembly with bearing housing into compressor cover to aid with assembly.



S11,3005,JN -19-27MAR85

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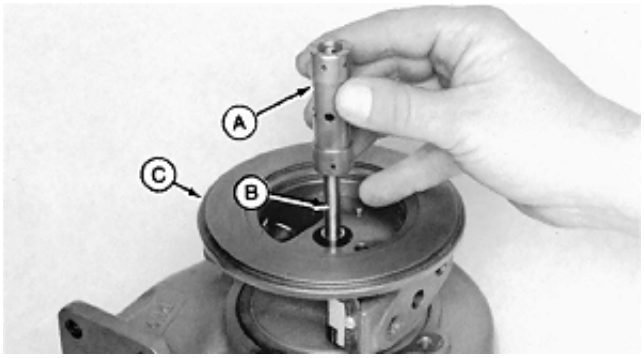
NOTE: Place bearing housing assembly into turbine housing to make assembly easier.

5. Lubricate I.D. and O.D. of bearing (A) with clean engine oil.

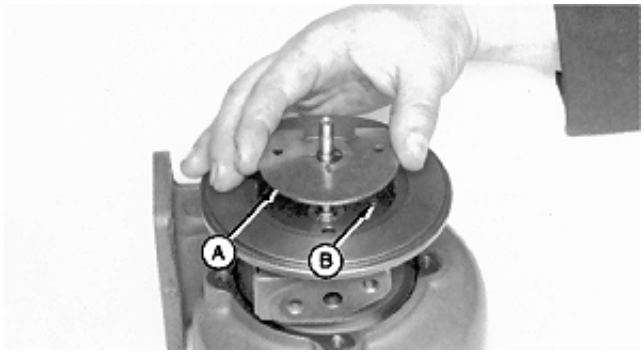
6. Place bearing on shaft (B) (from compressor end) and push down into position inside bearing housing (C).



S11,3005,JO -19-27MAR85

7. Lubricate thrust faces on each side of thrust plate (A) with clean engine oil.

8. Install thrust plate with bronze face up on shaft. Align hole with dowels (B) in bearing housing.



S11,3005,JP -19-27MAR85

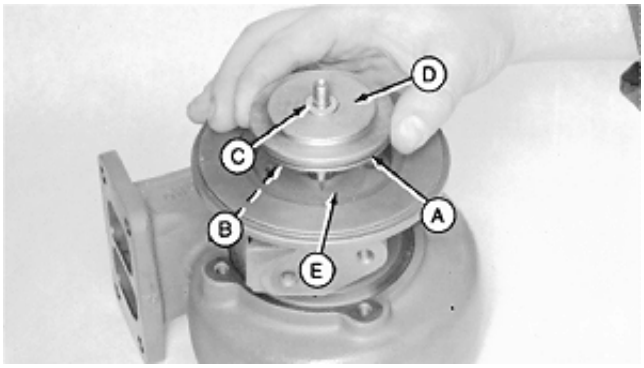
9. Lubricate O-ring (A) with clean engine oil and install on compressor insert.

10. Place oil deflector (B) with thrust sleeve (C) and compressor insert (D) over shaft and onto thrust plate (E).

NOTE: Align oil deflector hole with dowel pin.

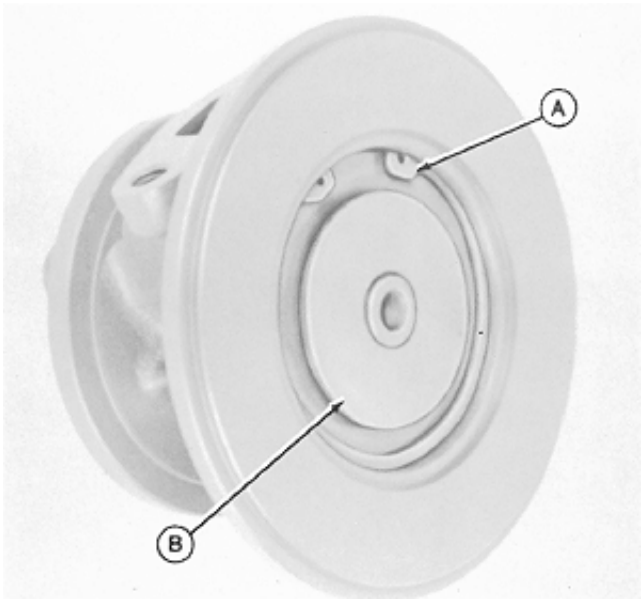
IMPORTANT: DO NOT press on thrust sleeve, damage to the piston ring could occur.

A—O-Ring
B—Oil Deflector
C—Thrust Sleeve
D—Compressor Insert
E—Thrust Plate



S11,3005,JQ -19-27MAR85

11. Install snap ring (A) beveled side facing outward. Be sure that snap ring is completely engaged in its groove and compressor insert (B) is properly seated.



S11,3005,JR -19-27MAR85

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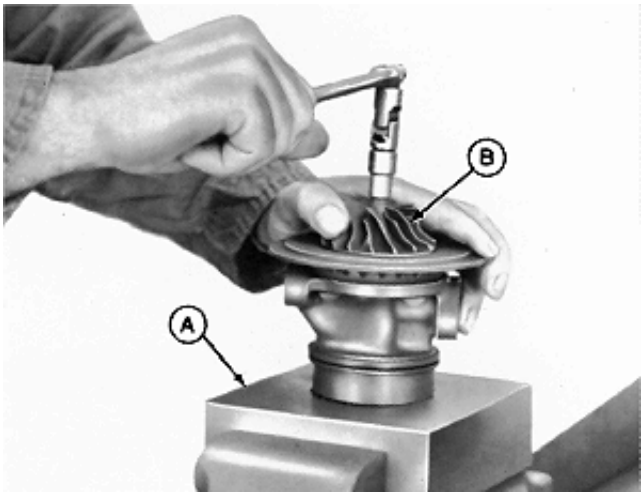
12. Slip compressor wheel (B) over shaft until wheel bottoms against thrust sleeve.

13. If not using the holding fixture, mount a 11/16-in., 12-point box end wrench in a vise.

14. Put turbine wheel end of turbocharger either in fixture (A) or box end wrench.

15. Coat threads and back face of lock nut with PT569 NEVER-SEEZ Compound.

16. Install lock nut and tighten to 18 N·m (156 lb-in.).



RG3856 -UN-20DEC88

S11,3005,JS -19-08AUG94

CHECK TURBINE WHEEL-TO-BACK PLATE CLEARANCE (SCHWITZER)

1. Put compressor housing (A) on bench with wheel cavity facing upward.

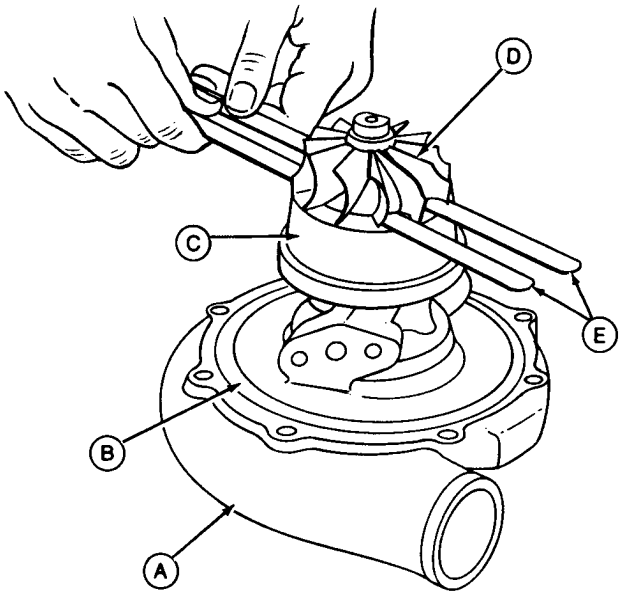
2. Lubricate outer diameter of bearing housing (B) which pilots into compressor housing with a light clean oil.

3. Insert bearing housing assembly into compressor housing.

4. Use two equal stacks of feeler gauges (E) one stack on each side of shaft.

5. Check clearance between turbine wheel (D) and back plate (C). Clearance should be 0.43—1.24 mm (0.017—0.049 in.).

If clearance is not within specifications, check for burrs, dirt particles, or incorrectly assembled parts.



RG7003 -UN-25JUN94

A—Compressor Housing
B—Bearing Housing
C—Backplate
D—Turbine Wheel
E—Feeler Gauges

S11,3005,AJ -19-08AUG94

CHECK RADIAL BEARING CLEARANCE (SCHWITZER)

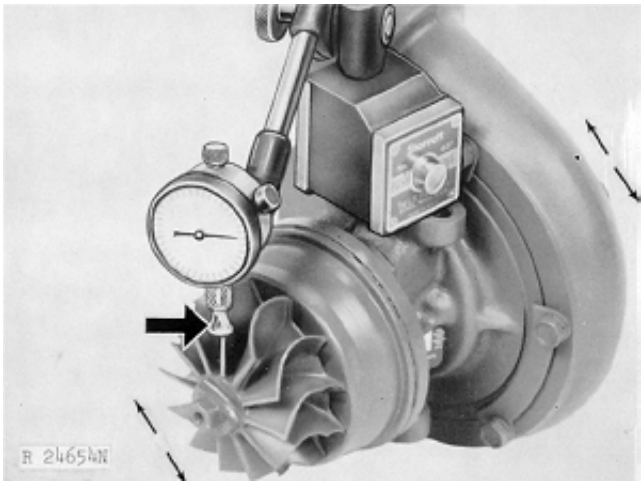
NOTE: Radial Bearing clearance check can be done with or without compressor housing attached.

1. Position a dial indicator [plunger-type with 25 mm (1.0 in.) travel] and check the radial shaft movement by moving shaft up and down.

SCHWITZER TURBOCHARGER
RADIAL BEARING CLEARANCE SPECIFICATION

Maximum Clearance . . . . . 0.53 mm (0.021 in.)

If radial bearing clearance is not within specifications, check for burrs, dirt particles, or incorrectly assembled parts.



R24654N -UN-20DEC88

S11,3005,AG -19-08AUG94

CHECK AXIAL END PLAY (SCHWITZER)

NOTE: Axial end play can be checked with or without compressor housing or turbine housing.

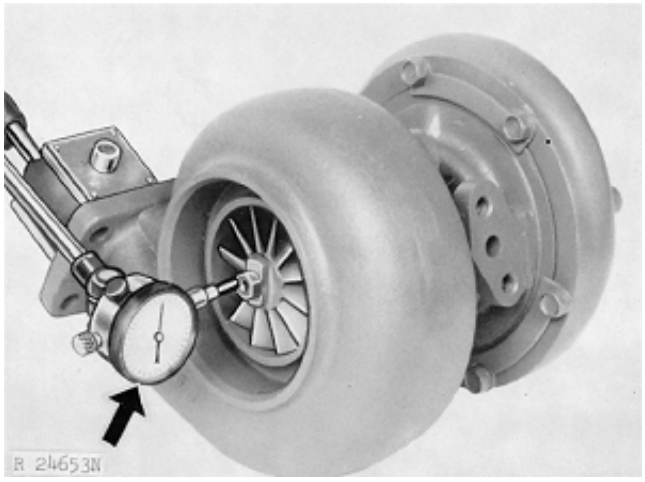
1. Mount a dial indicator on bearing housing with indicator stem tip resting on end of shaft.

2. Move shaft axially back and forth.

SCHWITZER TURBOCHARGER
AXIAL END PLAY SPECIFICATION

Axial End Play . . . . . 0.05—0.13 mm (0.002—0.005 in.)

If end play is not within specifications, check for burrs, dirt particles, or incorrectly assembled parts.



R24653N -UN-20DEC88

S11,3005,AI -19-08AUG94

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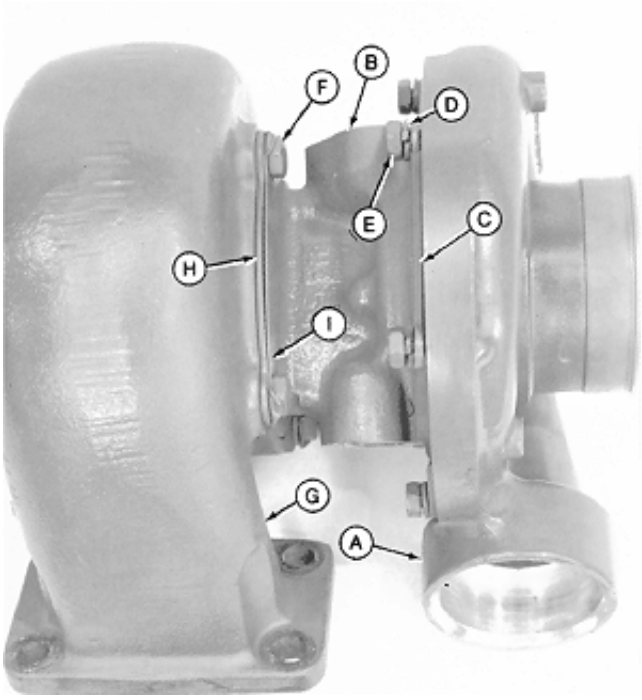
INSTALL COMPRESSOR COVER AND TURBINE HOUSING (SCHWITZER)

1. Install compressor cover (A) to bearing housing (B), clamp plates (C), lock washers (D), and cap screws (E). Leave cap screws loose until turbocharger is installed on engine.

2. Apply a coat of PT569 NEVER-SEEZ Compound to the threads of four cap screws (F) before installing.

3. Install turbine housing (G) to bearing housing clamp plates (H), lock plates (I) and cap screws. Leave cap screws slightly loose until turbocharger is installed on engine.

A—Compressor Cover
B—Bearing Housing
C—Clamp Plate (4 used)
D—Lock Washer (8 used)
E—Cap Screw (8 used)
F—Cap Screw (4 used)
G—Turbine Housing
H—Clamp Plates (2 used)
I—Lock Plate (2 used)

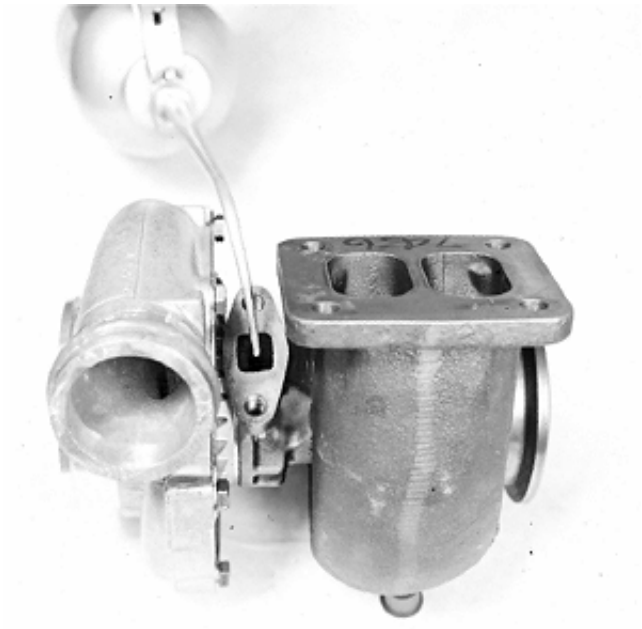


RG3861 -UN-09NOV89

S11,3005,AK -19-08AUG94

PRELUBE TURBOCHARGER (SCHWITZER OR HOLSET)

Just prior to mounting the turbocharger, prime the turbocharger lubrication system. Fill the center housing with new engine oil through the oil inlet port. Turn the rotating assembly by hand to lubricate the bearings.



RG5858 -UN-13AUG91

RG,CTM1,G30,3 -19-08AUG94

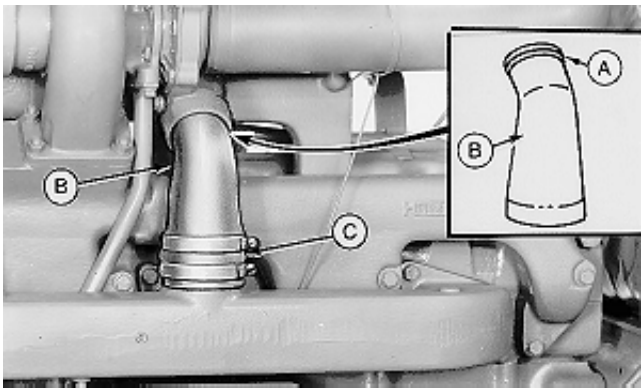
INSTALL TURBOCHARGER (SCHWITZER OR HOLSET)

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 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.

1. On 6466T Engines coat new O-ring (A) with liquid soap and install on coupling (B).

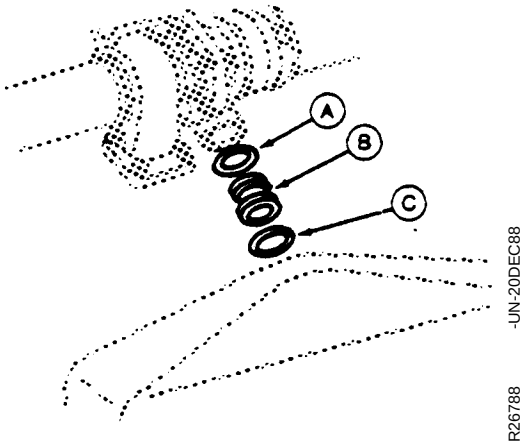
2. Slip hose (C) with hose clamp on intake manifold. Tighten hose clamps securely.



6466T Engine

S11,3005,JT -19-08AUG94

3. On 6466A Engines, coat O-rings (A and C) with grease and install on coupling (B).

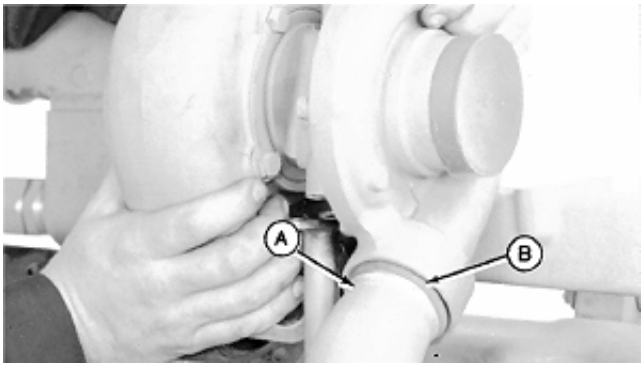


6466A Engine

S11,3005,JU -19-28MAR85

4. Put a new gasket on exhaust manifold (not illustrated).

5. Mount turbocharger on exhaust manifold. Position compressor housing to properly align coupling (A) with new O-ring (B) to intake manifold. Use alignment marks (made prior to removal) as a guide.



S11,3005,JV -19-31MAR85

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6. Apply PT569 NEVER-SEEZ Compound to all turbocharger mounting cap screws. Tighten turbocharger-to-exhaust manifold mounting cap screws (C) to 47 N·m (35 lb-ft).

7. Using a new gasket, connect the lubricating oil inlet adapter (A) to the turbocharger. Tighten cap screws to 34 N·m (25 lb-ft). Using a new gasket, connect the oil return line (B) to the turbocharger. Tighten cap screws to 47 N·m (35 lb-ft).

8. Apply PT569 NEVER-SEEZ Compound and tighten turbine housing-to-bearing housing cap screws to 17 N·m (144 lb-in.). Bend ears on lock plates.

9. Apply PT569 NEVER-SEEZ Compound and tighten compressor housing-to-bearing housing cap screws (D) to 7 N·m (60 lb-in.). Tighten hose clamps on coupling securely.

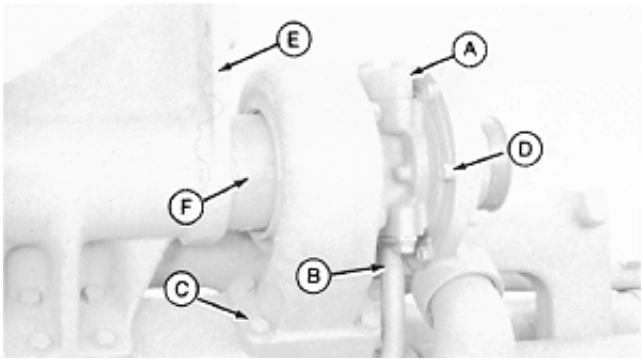
10. Install exhaust adapter (F) and exhaust elbow (E). Tighten cap screws to 47 N·m (35 lb-ft). Make sure adapter turns freely.

IMPORTANT: Make sure that the installation does not apply force on the turbine housing. The exhaust adapter must have 1.59 mm (1/16 in.) minimum end play and must rotate freely. 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.

11. Inspect the air cleaner-to-turbocharger hoses to see that they are in good condition. If they are not, replace with new one. Install air intake hose and tighten hose clamps securely.

IMPORTANT: Before starting an engine with a new or repaired turbocharger, hold the engine shut-off knob out and crank the engine with the starter until the engine oil pressure indicator shows pressure. DO NOT crank engine longer than 30 seconds at a time to avoid damage to starting motor.

12. Start and run engine at slow idle while checking oil inlet and air piping connections for leaks.

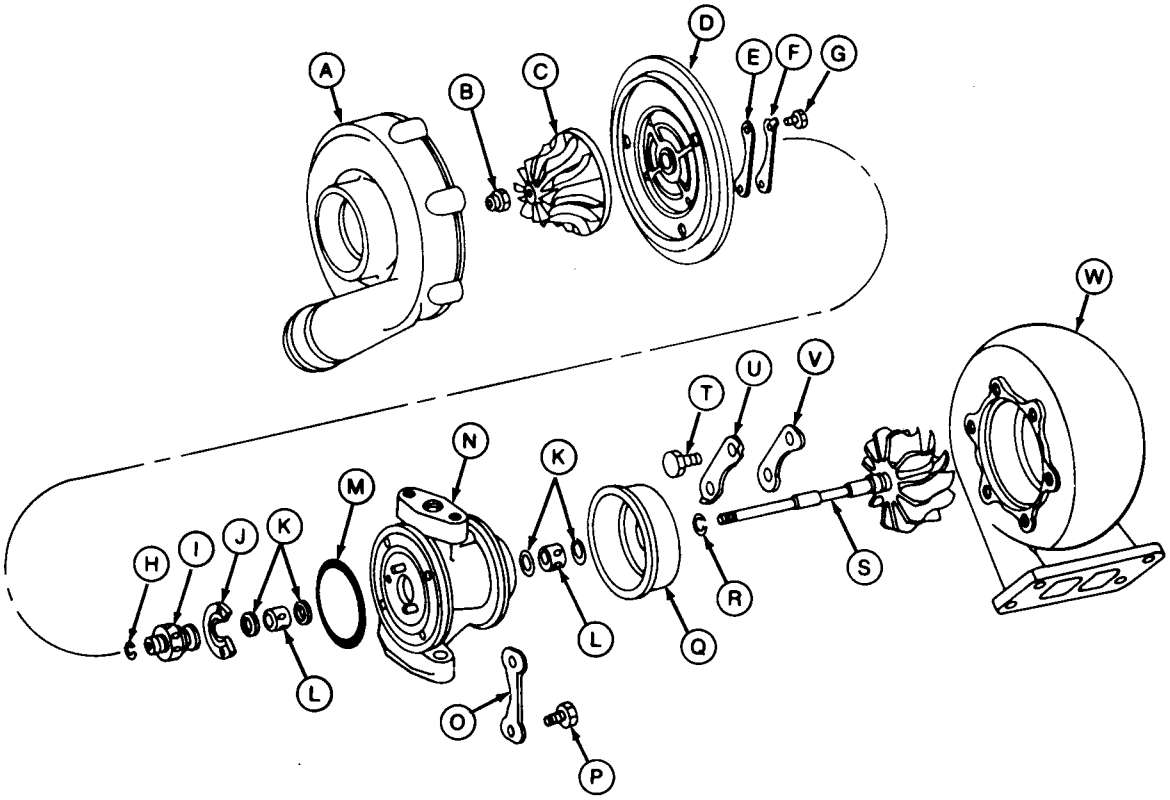


RG3854 -UN-09NOV89

A—Oil Inlet Adapter
B—Oil Return Line
C—Cap Screw (4 used)
D—Cap Screw (6 used)
E—Exhaust Elbow
F—Exhaust Adapter

S11,3005,JW -19-08AUG94

DISASSEMBLE GARRETT/AIRESEARCH TURBOCHARGER



RG7088 -UN-16FEB94

A—Compressor Housing
B—Lock Nut
C—Impeller
D—Backplate Assembly
E—Clamp (3 used)
F—Lock Plate (3 used)
G—Cap Screw (6 used)
H—Piston Ring
I—Thrust Collar
J—Thrust Bearing
K—Retaining Ring (4 used)
L—Bearing (2 used)
M—O-Ring
N—Center Assembly Housing
O—Lock Plate (2 used)
P—Cap Screw (4 used)
Q—Wheel Shroud
R—Piston Ring
S—Turbine Wheel With Shaft
T—Special Bolt (6 used)
U—Lock Plate (3 used)
V—Clamp (3 used)
W—Turbine Housing

S11,3005,JZ -19-08AUG94

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Cap or plug all openings (including exhaust and intake ports) and clean exterior of turbocharger with a pressure spray of cleaning solvent. Dry turbocharger with compressed air.

IMPORTANT: When cleaning turbocharger do not spray directly into compressor cover or turbine housing. Spinning rotor with high pressure spray may cause bearing damage.

Put turbocharger on a clean flat surface.

S11,3005,AW -19-06APR94

Clean the exterior with a pressure spray of cleaning solvent before disassembly. As a part is removed, place it in a clean protective container.

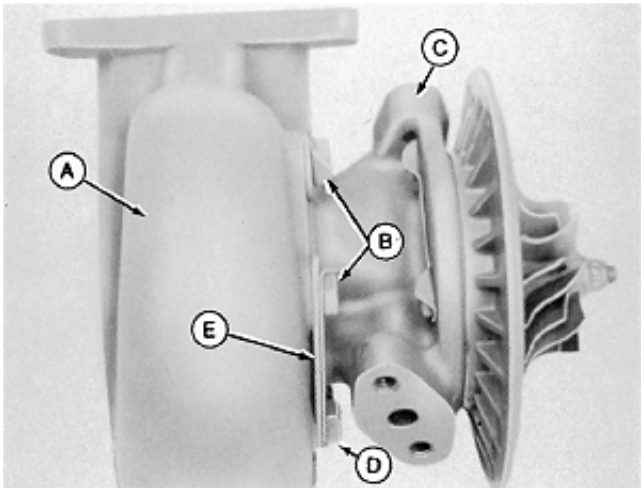
NOTE: Garrett/AiResearch Turbochargers are serviced only as a complete rebuilt assembly OR with new center housing and rotating shaft assemblies. In some engine applications, the center housing and/or compressor housing may need to be reorientated before installation. Unit parts are available for the Garrett/AiResearch T04B Turbocharger. Garrett/AiResearch TA25 Turbochargers are ready to install without any change.

1. Put a location mark on the turbine housing (A) and the center housing (C) to assist proper indexing of housing when turbocharger is assemble.

2. Straighten lock plates (B) if they were not straightened previously.

3. Remove cap screws (D), lock plates, and clamps (E).

4. Gently tap turbine housing with a soft hammer if force is needed to remove. Be careful not to damage turbine wheel.



R26752 -UN-20DEC88

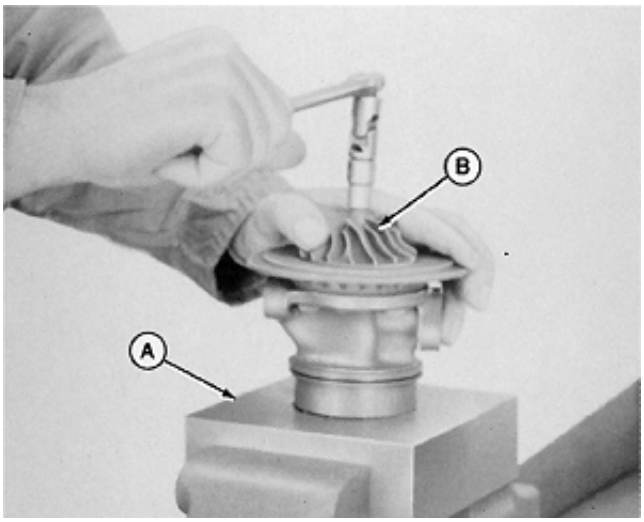
A—Turbine Housing
B—Lock Plate (3 used)
C—Center Housing
D—Cap Screw (6 used)
E—Clamp (3 used)

S11,0407,G -19-08AUG94

5. Mount a suitable holding fixture (A) (see Dealer Fabricated Tools in Group 199) in a vise, and insert turbine wheel into the fixture.

6. Remove the compressor wheel (B) retaining nut, using a double universal socket to avoid possibly bending of the shaft.

7. Remove the compressor wheel from the shaft.

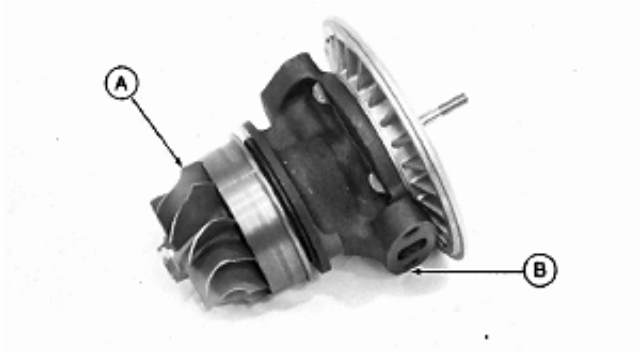


R28364 -UN-20DEC88

S11,0407,H -19-06APR94

8. Remove the turbine wheel and shaft assembly (A) from the center housing (B).

Keep shaft centered with bearings until it is clear of housing.

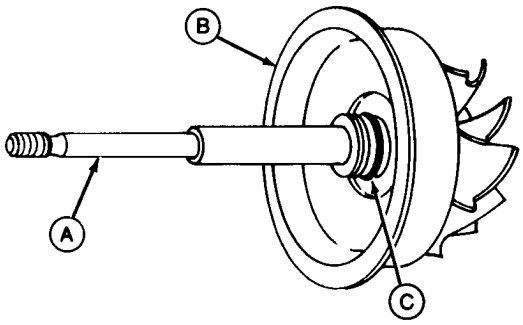


RG3939 -UN-20DEC88

S11,0407,I -19-29APR82

9. Remove piston ring (C) from shaft and wheel assembly (A).

10. Remove wheel shroud (B).



RG6998 -UN-25JUN94

S11,0407,J -19-08AUG94

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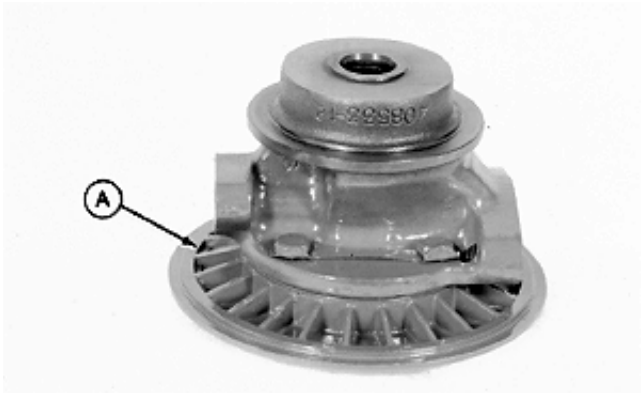
11. Remove backplate-to-center housing cap screws and lock plates. Remove backplate (A).



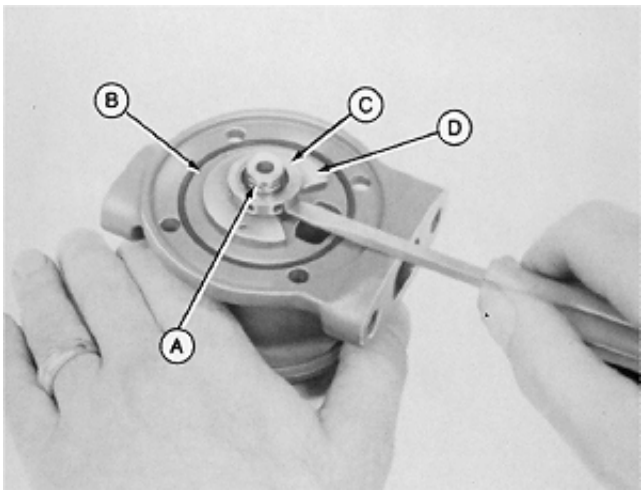
S11,3005,FC -19-28APR82

12. Remove piston ring (A).

13. Remove thrust collar (C) and thrust bearing (D).

14. Remove and discard O-ring (B) from housing.

A—Piston Ring
B—O-Ring
C—Thrust Collar
D—Thrust Bearing

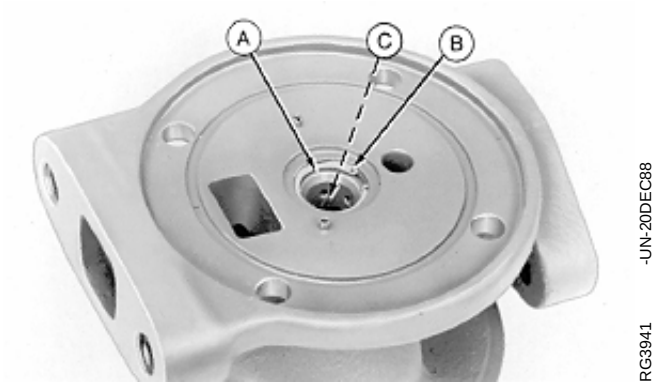


S11,0407,K -19-13JUN83

15. Use the JDG24 Snap Ring Plier Kit with the JDF29 Retaining Ring Point Set to remove retaining rings (B, two used).

16. Remove both bearings (A, one illustrated.)

17. Remove inner snap rings (C, two used).



S11,3005,FD -19-08AUG94

CLEAN TURBOCHARGER PARTS

Before cleaning, inspect all parts carefully for signs of burning, rubbing or other damage which might not be evident after cleaning.

1. Use a commercially approved solvent only. A caustic solution will damage certain parts and should not be used. Soak parts in solvent until all deposits have been loosened.

2. Use a plastic scraper or bristle-type brush - BUT NOT A WIRE BRUSH - on aluminum parts. A glass bead dry blast may also be used, but be sure air pressure does not exceed 280 kPa (2.8 bar) (40 psi).

Clean all drilled passages with a compressed air jet.

Make certain surfaces adjacent to wheels on stationary housings are free of deposits, clean and smooth.

S11,3005,O -19-08AUG94

INSPECT AND REPAIR TURBOCHARGER PARTS (GARRETT/AIRESEARCH)

1. Burnish or polish out minor surface damage. Use a silicone carbide abrasive cloth for aluminum parts. Use crocus abrasive cloth for steel parts.

Replace any part that fails to meet the requirements given in the inspection procedure.

2. Replace the following parts: O-rings, lock plates, piston rings, and retaining rings.

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NOTE: Replace bearings, thrust washers, or cap screws if they show any signs of nicks, scores, shellac, deposits, or embedded foreign material.

S11,0407,M -19-08AUG94

GARRETT/AIRESEARCH TURBOCHARGER INSPECTION WEAR TOLERANCE CHART

ITEM	MAXIMUM WEAR PERMITTED	INSPECTION NOTES
Center Housing:		
Bearing Bore ID	15.819 mm (0.6228 in.)	Bore surfaces must be free of scores. Scrape carbonized oil from internal surfaces if present.
Seal Bore ID	17.856 mm (0.7029 in.)	
Shaft and Wheel Assembly:		
Journal OD	10.150 mm (0.3994 in.)	Journal surfaces must not be scored. Polish surfaces with crocus cloth.
Seal Hub OD	17.297 mm (0.6809 in.)	
Ring Groove Width	1.867 mm (0.0735 in.)	Ring groove shoulders must be free of step wear.
Turbine Wheel Blades		Slight erosion permissible. Blade tips must not be feather-edged or torn. Minimum tip thickness is 0.635 mm (0.025 in.).
Back Plate:		Thrust surface must be clean and smooth.
Seal Bore ID	12.73 mm (0.501 in.)	
Thrust Collar:		Thrust faces must be smooth.
Bearing Groove Width	4.445 mm (0.1752 in.)	
Ring Groove Width	1.67 mm (0.067 in.)	Ring groove shoulders must be free of step wear.
Thrust Bearing		Replace any time unit is disassembled.
Journal Bearings		Replace any time unit is disassembled.
Compressor Wheel:		Replace if any evidence of rubbing, erosion or nicks is noted.
Bore ID	6.360 mm (0.2504 in.)	
Compressor Housing		Replace if heavily damaged by wheel rub. Clean-up of light rub is permissible.
Turbine Housing		Replace if discharge opening is warped out-of-round, shows erosion, cracked, scaled, or heavy wheel rub.
Turbine Wheel Shroud		Replace if warped, eroded, or heavily rubbed.

S11,0407,N -19-17AUG94

ASSEMBLE GARRETT/AIRESEARCH TURBOCHARGER

NOTE: Be sure to recheck each part prior to assembly to insure cleanliness. As parts are assembled, cover openings to prevent entry of dirt or other foreign material.

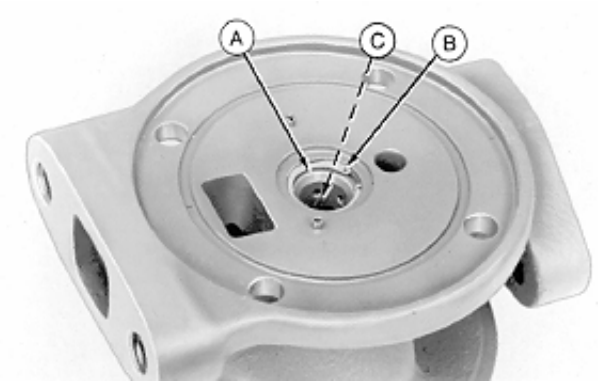
IMPORTANT: If any particle falls into the turbocharger during assembly, remove the particle immediately, even though extensive disassembly may be required.

S11,3005,KA -19-08AUG94

1. Install inner bearing retaining rings (C, two used) in center housing with rounded shoulder toward the bearing using the JDG24 Snap Ring Plier Kit with JDF29 Retaining Ring Point Set.

2. Lubricate bearings (A) with clean engine oil and install.

3. Install outer snap rings (B, two used).



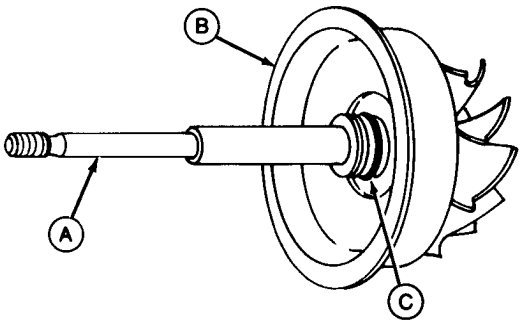
-UN-20DEC88
RG3941

S11,3005,KB -19-08AUG94

4. Install piston ring (C) in groove on shaft (A).

5. Put wheel shroud (B) in position on shaft. Insert assembly through bearings.

Do not use force to compress piston ring into place. A gentle rocking and pushing action will allow the piston ring to seat and the shaft to bottom. Use JDG127 O-Ring Seal Tool Set or a thin dental pick to aid in compressing the ring, if difficulty is encountered. Do not force piston ring since it can be easily broken.



-UN-25JUN94
RG6998

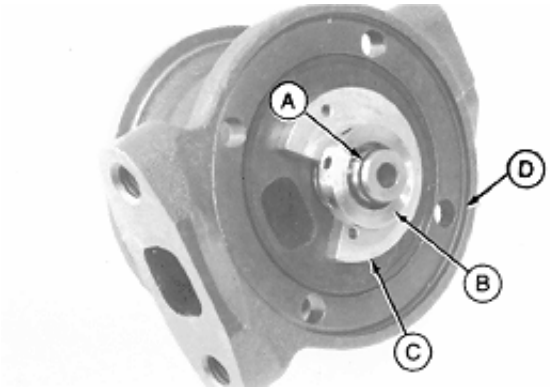
S11,3005,KC -19-08AUG94

6. Install piston ring (A) in groove on thrust collar (B).

7. Put thrust bearing (C) on thrust collar and engage unit over pins on center housing. Chamfered face of thrust bearing must face against the center housing.

8. Install new O-ring (D) in groove in center housing.

A—Piston Ring
B—Thrust Collar
C—Thrust Bearing
D—Rubber O-Ring

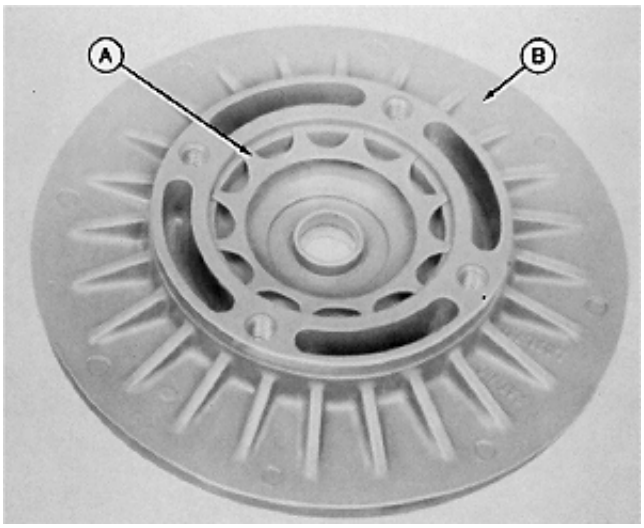


-UN-20DEC88
RG3942

S11,3005,KD -19-31MAR87

9. Check thrust spring (A) to make sure it is positioned in backplate (B).

IMPORTANT: Backplate and spring are sold only as an assembly. The installed depth of the spring is a controlled dimension. Therefore, do not remove or replace the spring by itself. Cleaning can be done without removing the spring.

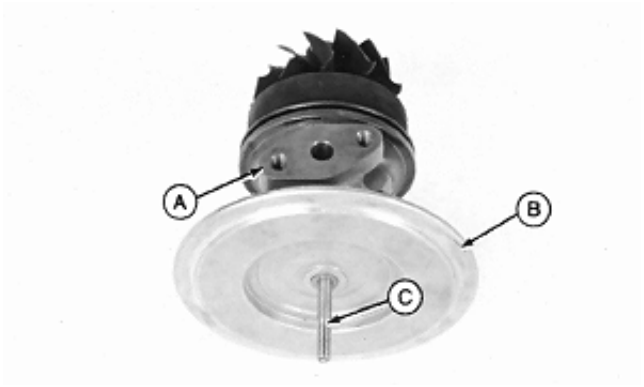


-UN-20DEC88
R26757

S11,3005,KE -19-28MAR85

10. Align mounting holes of center housing (A) and install backplate (B) over shaft (C) and thrust collar.

Use care not to break piston ring when engaging seal in backplate bore. Backplate is easily installed if open end of piston ring is engaged in backplate bore first.



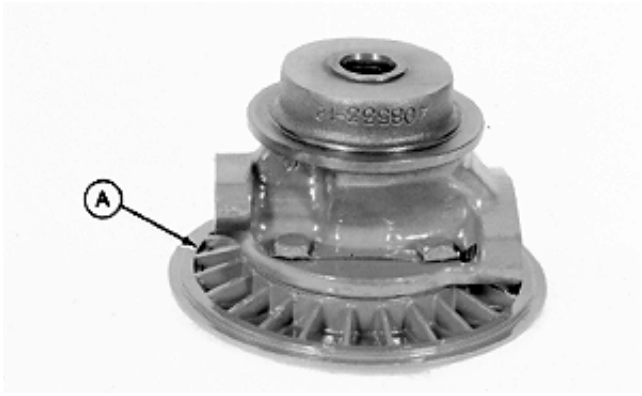
-UN-20DEC88
RG3943

S11,3005,KF -19-28MAR85

11. Install backplate (A)-to-center housing cap screws, and lock plates.

12. Tighten cap screws to 8.5—10.2 N·m (75—90 lb-in.).

13. Bend ears of lock plates against head of cap screws.



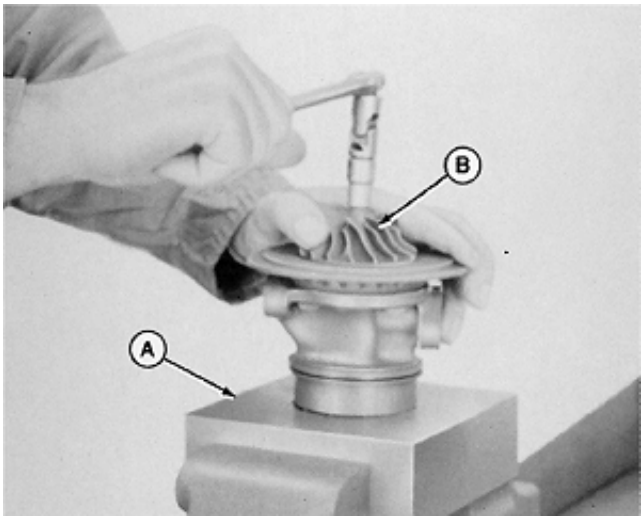
S11,3005,KG -19-28MAR85

14. Mount holding fixture (A) in a vise. If desired a box end wrench may be clamped in the vise and used in place of the holding fixture.

15. Put turbine wheel end of turbocharger in fixture and install compressor wheel (B) on shaft.

16. Use a double universal socket and tighten lock nut to 2.0—2.3 N·m (18—20 lb-in.).

17. Continue to tighten lock nut through an angle of 90˚. This is sufficient to stretch the shaft 0.140—0.165 mm (0.0055—0.0065 in.) for proper lock nut installation.



S11,3005,KH -19-08AUG94

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18. Check clearance between wheel shroud and turbine wheel (not shown). These parts must not contact each other.

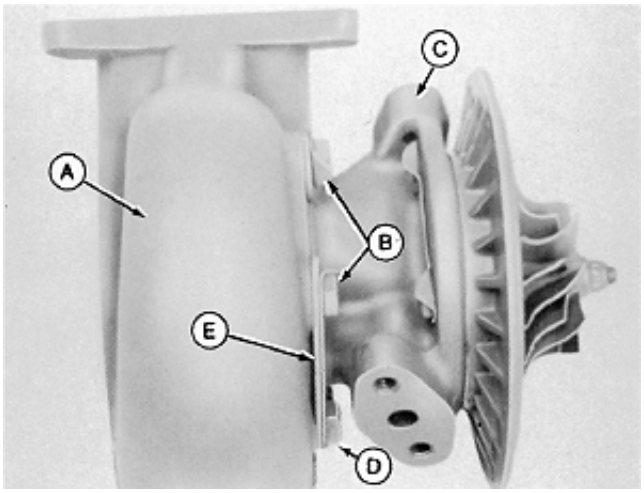
19. Mount turbine housing (A) to center housing (C) by aligning scribe marks made prior to disassembly.

20. Coat screw threads with PT569 NEVER-SEEZ Compound.

21. Install clamps (E), lock plates (B), and cap screws (D).

22. Tighten cap screws to 11.3—14.7 N·m (100—130 lb-in.).

23. Bend ears of lock plates against head of cap screws.



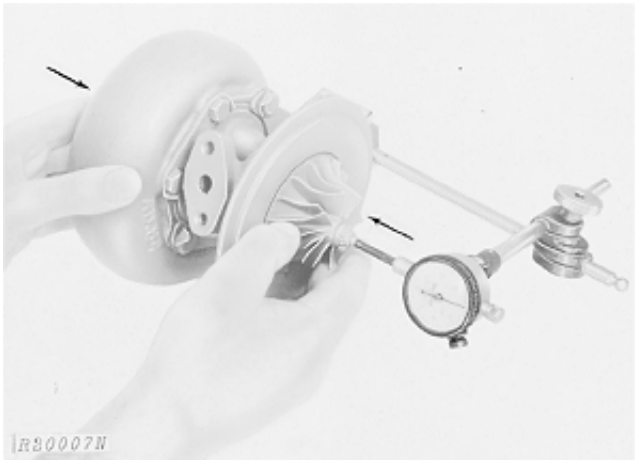
R26752 -UN-20DEC88

A—Turbine Housing
B—Lock Plate (3 used)
C—Center Housing
D—Cap Screw (6 used)
E—Clamp (3 used)

S11,3005,KI -19-08AUG94

24. Check axial end play as described earlier in this group.

25. If end play is not within 0.025—0.102 mm (0.001—0.004 in.), recheck parts and installation to determine the cause.



R20007N -UN-20DEC88

S11,3005,KJ -19-08AUG94

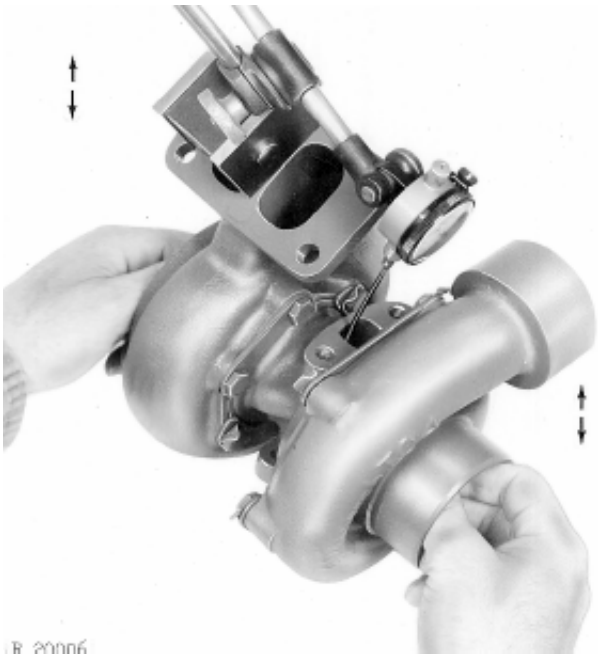
NOTE: Compressor housing (shown installed), need not be installed check radial bearing movement.

26. Check radial bearing clearance as described earlier in this group.

27. If radial bearing clearance is not within 0.076—0.152 mm (0.003—0.006 in.), recheck parts and installation to determine the cause.

28. Check for clearance between wheel shroud and turbine wheel.

29. After assembly, push rotating assembly as far as possible from turbine end and check for binding. Repeat check, pushing from the compressor end.



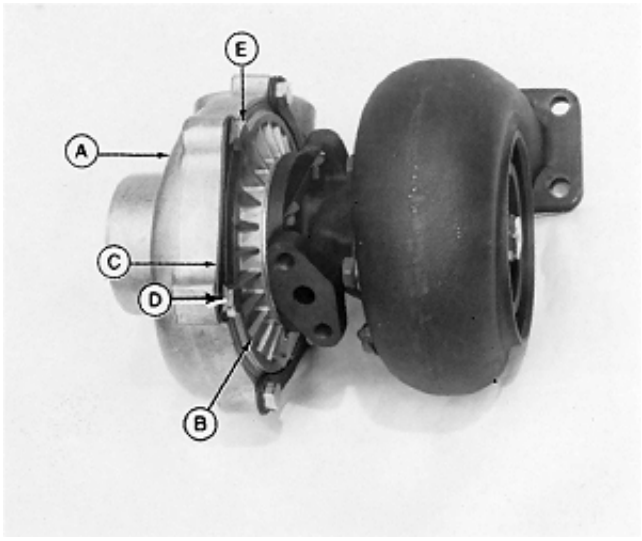
R20006 -UN-20DEC88

S11,3005,KK -19-08AUG94

30. Position compressor housing (A) on backplate (B). Be sure location marks (scribed during disassembly) on compressor housing and backplate are aligned.

31. Install clamps (C), lock plates (D), and cap screws (E). Leave cap screws slightly loose until turbocharger is mounted on engine.

A—Compressor Housing
B—Backplate
C—Clamp
D—Lock Plate
E—Cap Screw (6 used)



RG3945 -UN-20DEC88

S11,3005,KL -19-28MAR85

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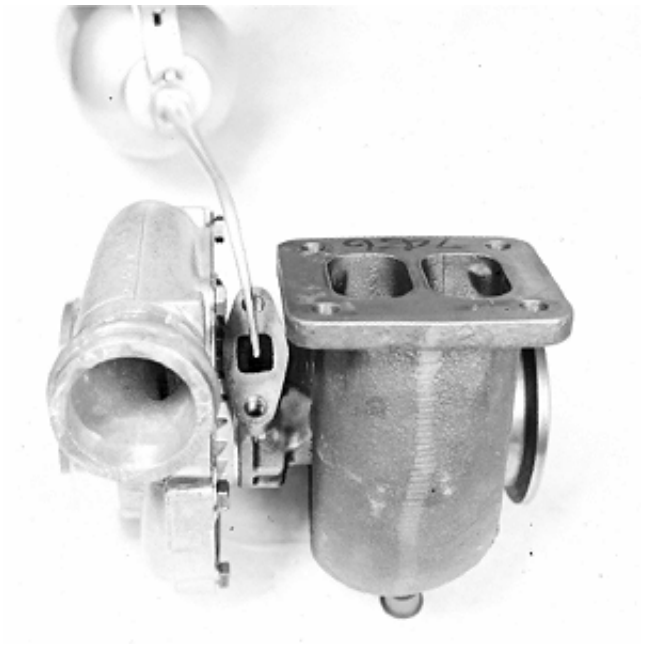
PRELUBE TURBOCHARGER (GARRETT/AIRESEARCH)

IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

Fill oil return (drain) port with clean engine oil and spin rotating assembly by hand to properly lubricate bearings.

If turbocharger is to be stored for an extended period of time, lubricate internally and install protective covers on all openings.



RG5858 -UN-13AUG91

RG,CTM1,G30,4 -19-08AUG94

INSTALL TURBOCHARGER (GARRETT/AIRESEARCH)

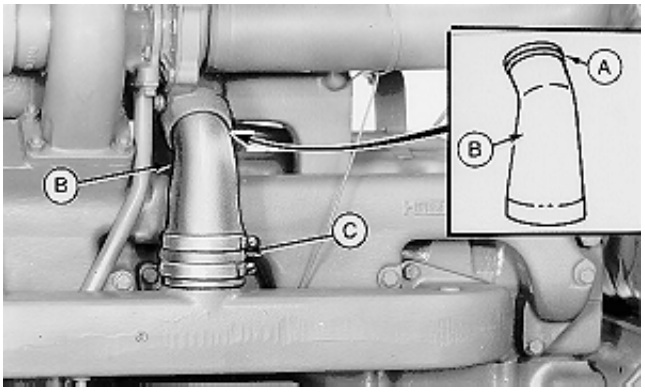
IMPORTANT: If turbocharger failed because of foreign material entering the air intake system, be sure to examine the system and clean as required to prevent a repeat failure.

Just prior to mounting turbocharger, prime the turbocharger lubrication system. Fill the center housing with new engine oil through the oil drain hole. Turn the rotating assembly by hand to lubricate the bearings.

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.

1. On 6466T Engines, coat new O-ring (A) with liquid soap and install on coupling (B).

2. Slip hose (C) with hose clamps on intake manifold. Tighten hose clamps securely.



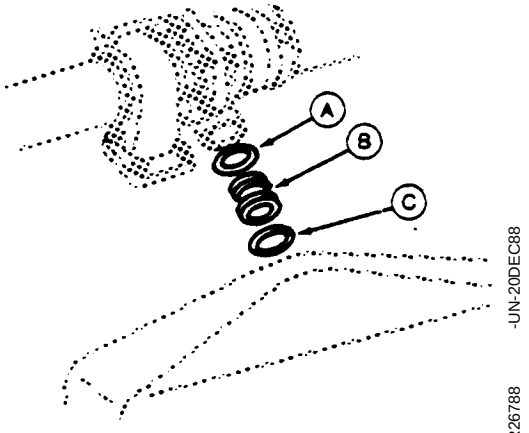
R28249N -UN-25JUN94

6466T Engine

S11,3005,KM -19-08AUG94

3. On 6466A Engines, coat O-rings (A and C) with grease and install on coupling (B).

4. Put a new gasket on exhaust manifold (not illustrated.)



6466A Engine

S11,3005,KR -19-31MAR87

5. Mount turbocharger on engine. Position compressor housing to properly align with coupling connection to intake manifold. Use alignment scribe marks (made prior to removal) as a guide.

6. Tighten mounting cap screws to 47 N·m (35 lb-ft).

7. Use new gaskets, install oil inlet line (C) and oil return line (D). Tighten cap screws to 47 N·m (35 lb-ft).

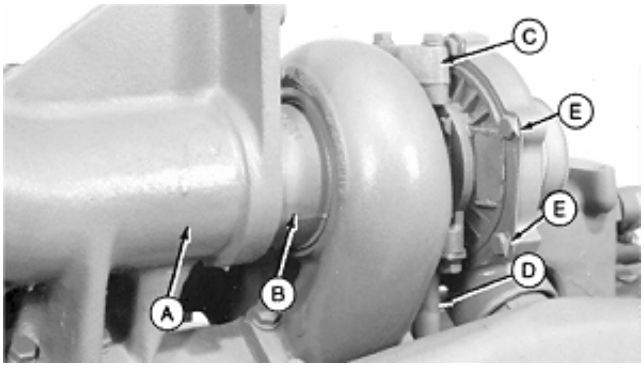
8. Tighten compressor housing-to-backplate cap screws to 12.4—14.7 N·m (110—130 lb-in.). Bend lock plate (E) ears against cap screws.

9. Install turbocharger adapter (B) and exhaust elbow (A). Tighten exhaust elbow-to-exhaust manifold cap screws to 47 N·m (35 lb-ft).

IMPORTANT: Make sure that the installation does not apply force on the turbine housing. The exhaust adapter must have 1.59 mm (1/16 in.) minimum end play and must rotate freely. 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.

10. Inspect the air cleaner-to-turbocharger hoses to see that they are in good condition. If they are not, replace with new one. Install air intake hose and tighten hose clamps securely.

When starting engine with a new or repaired turbocharger, hold the engine shut-off knob out and crank the engine with the starter until the engine oil pressure indicator shows pressure. Start and run engine at slow idle while checking oil inlet and air passage connections for leaks.



A—Exhaust Elbow
B—Turbocharger Adapter
C—Oil Inlet Line
D—Oil Return Line
E—Lock Plates

S11,3005,KN -19-08AUG94

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REMOVE AND INSPECT INTAKE MANIFOLD (6466D AND 6466T ENGINES)

IMPORTANT: All intake manifold connections at the turbocharger (6466T Engines) and engine cylinder head must be tight to prevent loss of power resulting from lower manifold pressure. On 6466D engines, leaking joints allow dirt entry.

Intake manifold hose and cap screw connections should be inspected periodically for tightness.

Whenever a tune-up has been performed on the engine, or whenever it is suspected that the horsepower output might be low, the intake manifold pressure (turbocharger boost) should be checked. [See CHECK INTAKE MANIFOLD PRESSURE (TURBOCHARGER BOOST) in Group 110.]

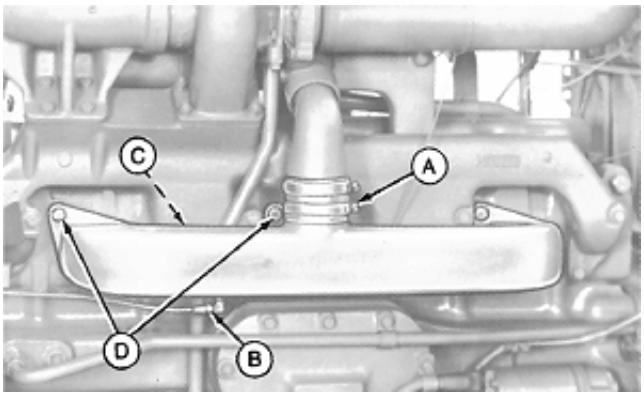
1. On 6466T Engines loosen hose clamps (A) on lower air intake hose.

2. Disconnect aneroid line (B), if equipped.

3. Disconnect either starting aid pipe (C) from manifold, if equipped.

4. Remove six mounting cap screws (D) and lift off intake manifold.

5. Discard all gaskets.



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RG3862

A—Hose Clamps (2 used)
B—Aneroid Line
C—Ether Starting Aid Pipe
D—Cap Screws (6 used)

S11,3005,KO -19-08AUG94

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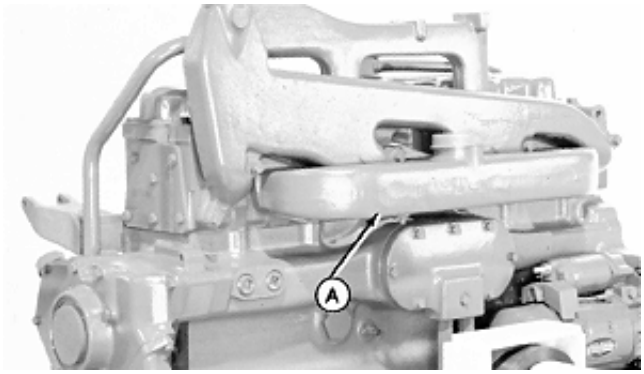
6. On 6466D Engines remove cap screws and lift off intake manifold (A). Discard all gaskets.



-UN-09NOV89
RG3863

S11,3005,EU -19-19APR82

7. Inspect the intake manifold for serviceability; replace if cracked or otherwise damaged.

8. Inspect the machined mating surfaces of cylinder head and intake manifold. Clean, as required, by using a scraper and/or wire brush, and compressed air.

S11,3005,EV -19-06APR94

INSTALL INTAKE MANIFOLD (6466D AND 6466T ENGINES)

1. On both 6466D and 6466T Engines use new gaskets and install intake manifold.

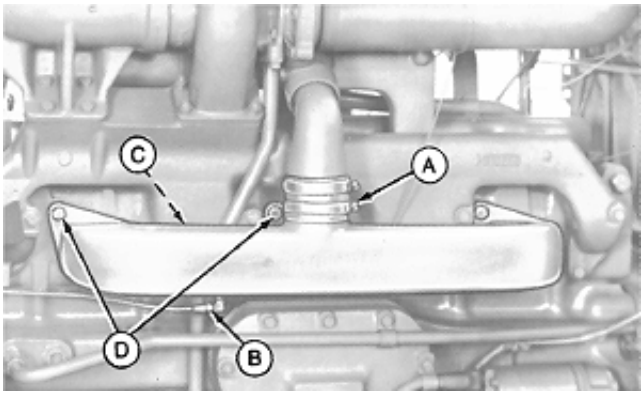
NOTE: Some gaskets may have a sealing bead. Install gasket with bead towards the cylinder head.

2. Apply PT569 NEVER-SEEZ Compound to intake manifold cap screws (D) and tighten cap screws to 47 N·m (35 lb-ft).

3. On 6466T Engines be sure lower intake hose clamps (A) are properly positioned. Tighten hose clamps securely.

4. On 6466T Engines install either starting aid line (C), if equipped, and aneroid line (B). Tighten all connections securely.

5. Check intake manifold pressure. [See CHECK INTAKE MANIFOLD PRESSURE (TURBOCHARGER BOOST) in Group 110.]



-UN-09NOV89
RG3862

A—Hose Clamps (2 used)
B—Aneroid Line
C—Ether Starting Aid Line
D—Cap Screws (6 used)

S11,3005,KP -19-08AUG94

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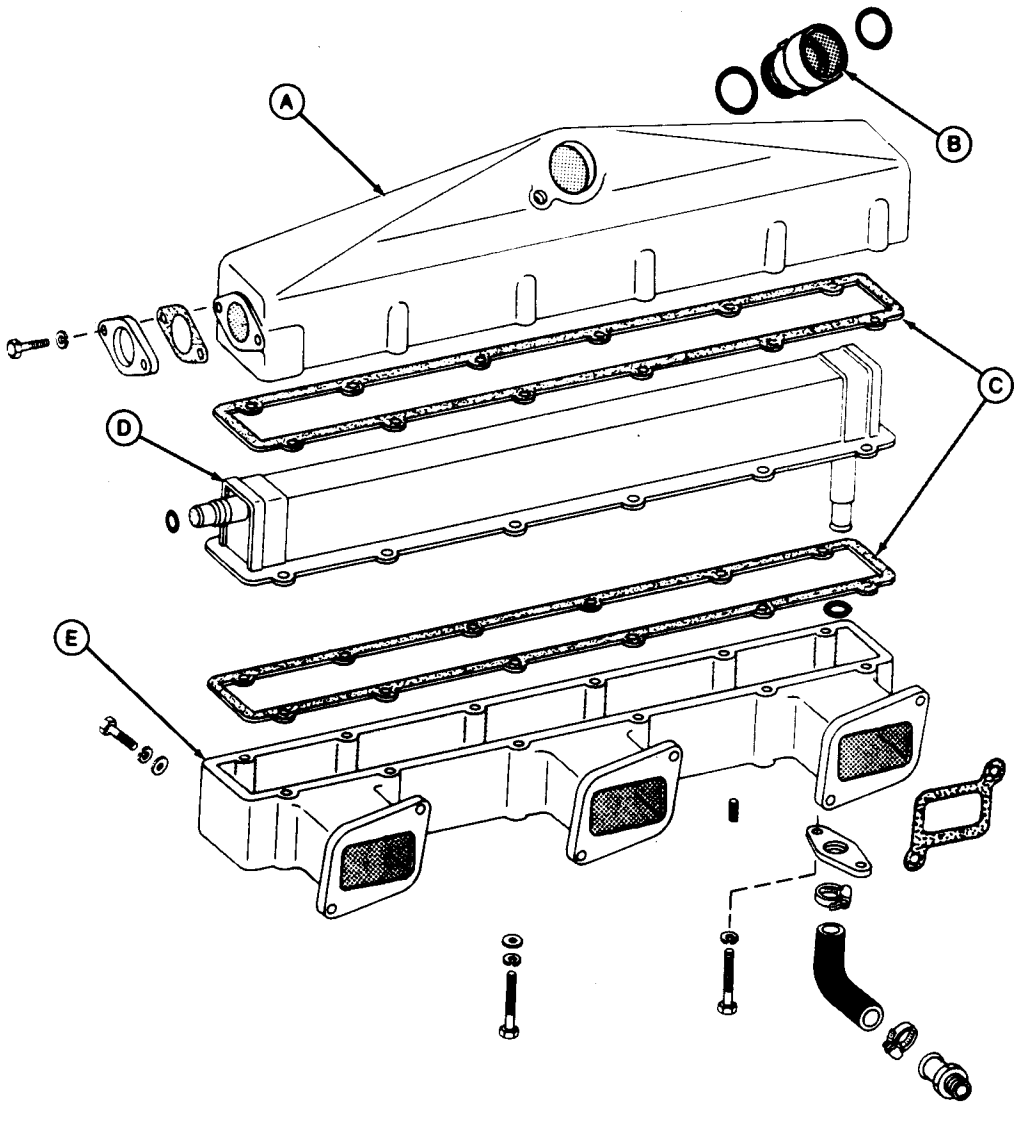
53

SINGLE-PASS AFTERCOOLER ASSEMBLY—6466A ENGINES



A—Aftercooler Cover
B—Coupling
C—Gasket (2 used)
D—Aftercooler
E—Intake Manifold

Single-Pass Aftercooler Assembly

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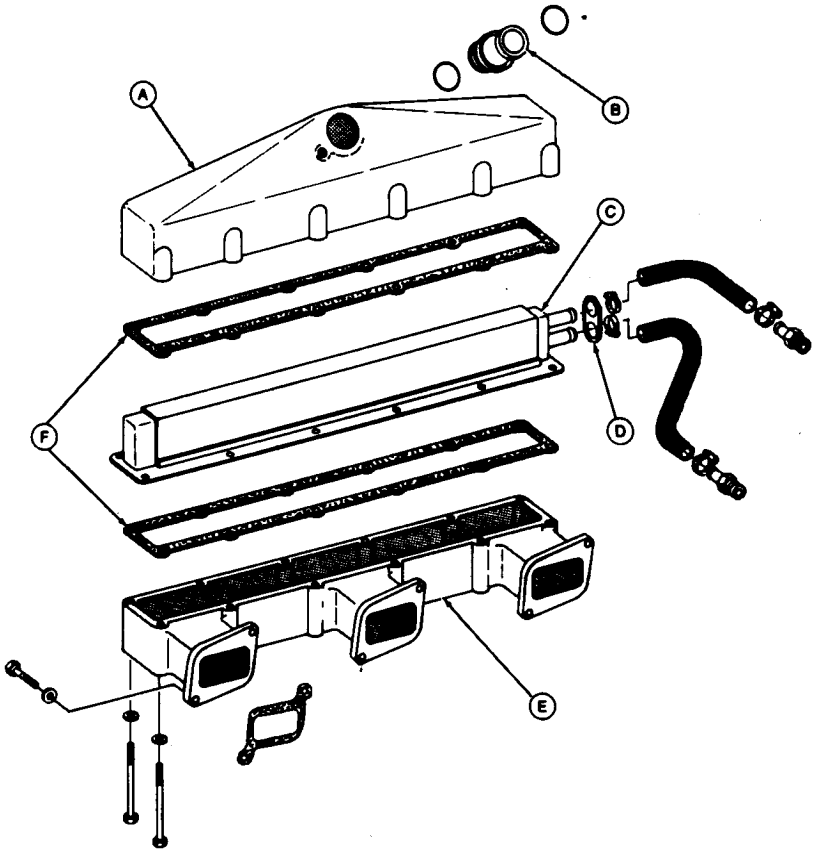
RG,CTM1,G30,7 -19-08AUG94

TWO-PASS AFTERCOOLER ASSEMBLY—6466A ENGINES



A—Aftercooler Cover
B—Coupling
C—Aftercooler
D—Seal Ring
E—Intake Manifold
F—Gaskets (2 used)

Two-Pass Aftercooler Assembly

RG,CTM1,G30,8 -19-08AUG94

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REMOVE AFTERCOOLER AND INTAKE MANIFOLD (6466A ENGINES)

Removal of the single-pass aftercooler and two-pass aftercooler are similar, differences will be noted.

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 turbocharger as described earlier in this group.

3. Loosen clamps on inlet and outlet hoses. Remove hoses from aftercooler.

4. Remove front and rear adapter plates (A).

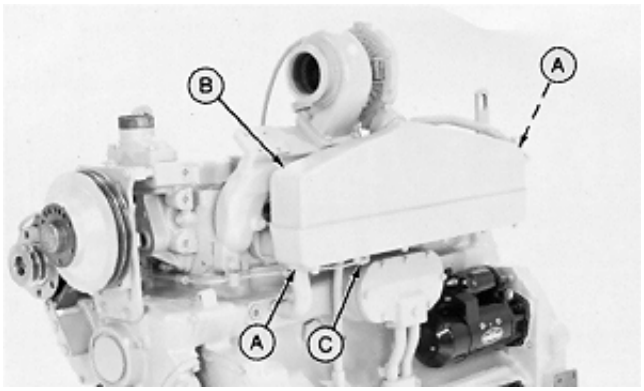
5. Remove aneroid-to-intake manifold connector (C), if equipped.

6. Remove all intake manifold cover (B) cap screws.

7. Carefully lift aftercooler with cover from intake manifold. Place cover on a clean flat surface.

8. Remove aftercooler from cover. Remove and discard gaskets and O-rings or seal ring.

9. Remove all intake manifold-to-cylinder head cap screws and remove intake manifold. Remove and discard all manifold gaskets.



Single-pass aftercooler shown

RG,CTM1,G30,5 -19-08AUG94

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56

INSPECT AND REPAIR AFTERCOOLER (6466A ENGINES)

1. Inspect aftercooler for overall condition. The fins should be reasonably straight and cross straps should be free of cracks.

2. Inspect aftercooler inlet and outlet hoses. Replace either tube if cracked or damaged.

3. Test the aftercooler for leaks by plugging either (A or B).

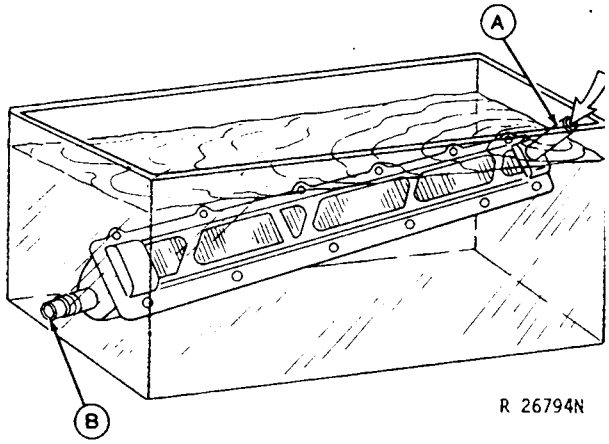
4. Apply compressed air to the other opening while unit is submerged under water. Use 140—170 kPa (1.4—1.7 bar) (20—25 psi) air pressure for testing.

IMPORTANT: Coolant leakage from the aftercooler may cause severe engine damage.

A minor leak that is accessible may be repaired. However, if the condition of the core is questionable, replace aftercooler.

5. Inspect air intake cover for cracks or damage. Replace as necessary.

6. Clean cover with clean solvent and dry with compressed air.



Single-Pass Aftercooler Shown

S11,3005,KS -19-06APR94

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57

INSPECT AND REPAIR INTAKE MANIFOLD AND AIR INTAKE COVER (6466A ENGINES)

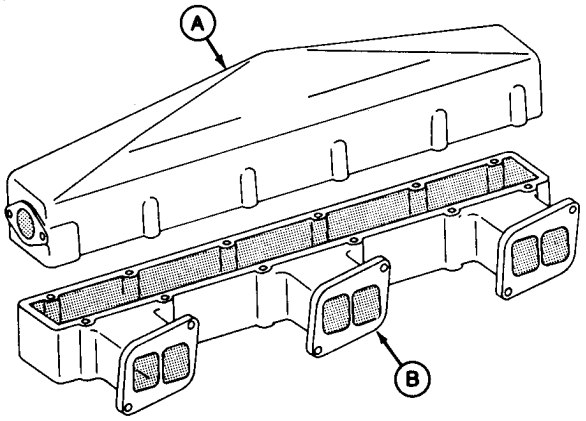
1. Check air intake cover (A) for cracks or damage. Replace as necessary.

2. Check intake manifold (B) for damage. Inspect machined mounting surfaces for burrs or other defects which might prevent gaskets from sealing properly. Repair as required.

3. Thoroughly steam clean interior of intake manifold and covers.

IMPORTANT: Do not use a hot tank to clean aluminum parts as damage and severe deterioration can occur.

4. Scrape all gasket material from cylinder head and intake manifold mounting surfaces.



RG7085 -UN-16FEB94

S11,3005,KT -19-08AUG94

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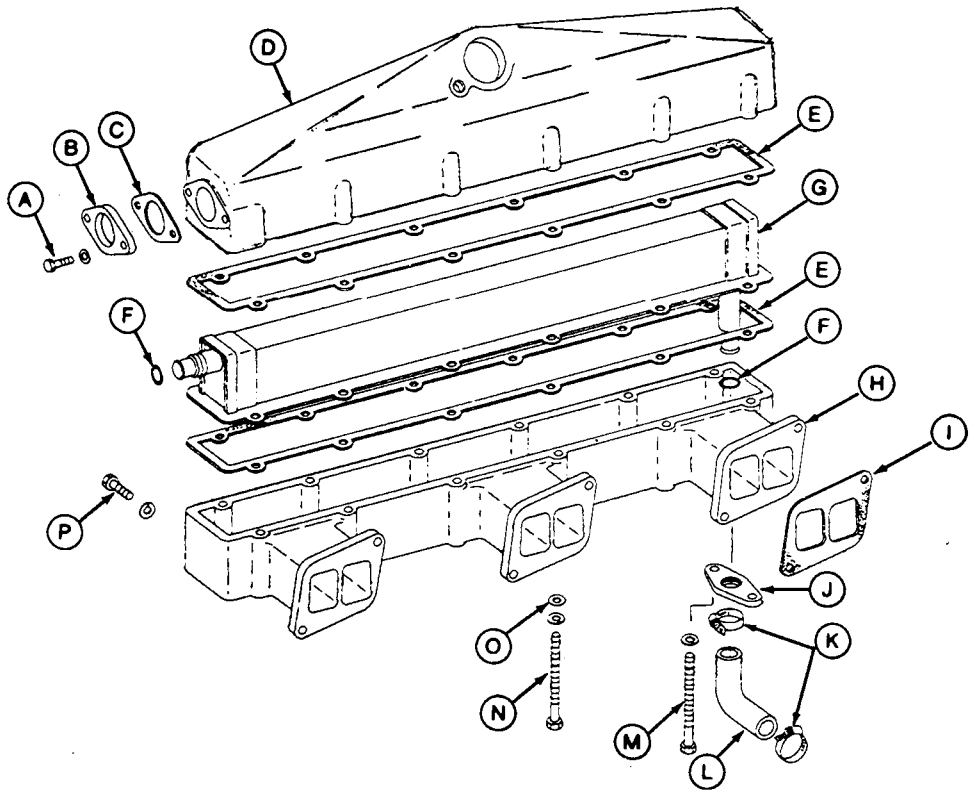
58

INSTALL INTAKE MANIFOLD AND SINGLE-PASS AFTERCOOLER (6466A ENGINES)



A—Cap Screw
B—Rear Adapter Plate
C—Gasket (2 used)
D—Cover
E—Gasket
F—O-Ring
G—Aftercooler
H—Intake Manifold
I—Gasket
J—Front Adapter Plate
K—Hose Clamp (2 used)
L—Inlet Hose
M—Cap Screw (2 used)
N—Cap Screw (10 used)
O—Flat Washer (10 used)
P—Cap Screw (6 used)

Aftercooler and Intake Manifold Assembly

NOTE: Three inside row cap screws over the oil cooler must be installed into the manifold before the manifold is installed on the engine.

Install O-ring (F) in bore of front adapter plate (J). Place adapter plate (with O-ring bore toward manifold) on manifold and insert cap screw (M) with lock washer through adapter plate and into manifold.

Also install cap screws (N) with lock washers and flat washers (O) in third and fourth inside holes (over the oil cooler). Secure the three cap screws temporarily until the manifold is installed.

Apply PT569 NEVER-SEEZ Compound or equivalent to all aftercooler cover-to-intake manifold cap screws before assembly.

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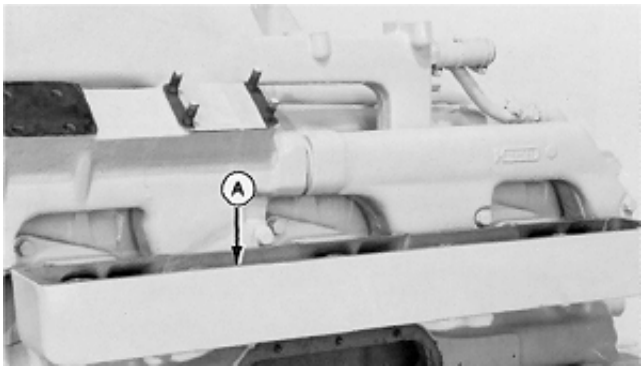
S11,3005,CB -19-08AUG94

IMPORTANT: Debris left in intake manifold (A) can cause engine damage. Make sure that inside of manifold is clean before assembly.

Install cap screws with washers in third and fourth inside holes (from front of engine) in intake manifold (directly over oil cooler) BEFORE installing manifold onto cylinder head and secure cap screws until manifold is installed. Cap screws can not be installed after manifold is installed.



RG3948 -UN-20DEC88

NOTE: Gaskets may have a sealant bead. Install gasket with bead toward the cylinder head.

1. Install intake manifold on cylinder head using new gaskets.

2. Tighten intake manifold-to-cylinder head cap screws to 47 N·m (35 lb-ft).

S11,0407,AK -19-08AUG94

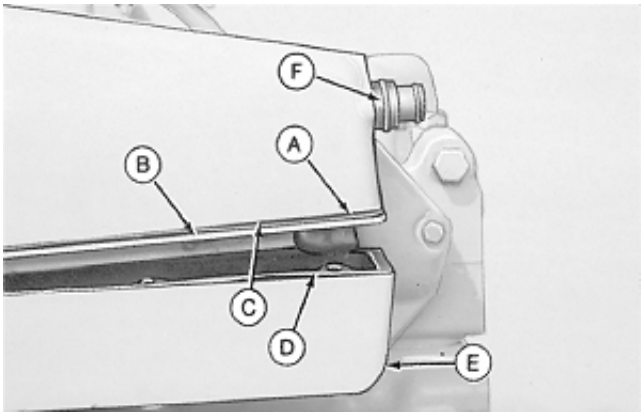
NOTE: Guide studs may be used to align gaskets, aftercooler, and cover during assembly.

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

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A—Upper Gasket
B—Aftercooler
C—Aftercooler Cover
D—Lower Gasket
E—Intake Manifold
F—O-Ring (2 used)

S11,0407,AL -19-08AUG94

7. Align cover and gaskets to permit installation of all cap screws with lock washers and flat washers. Make sure that front adapter plate and O-ring are correctly installed.

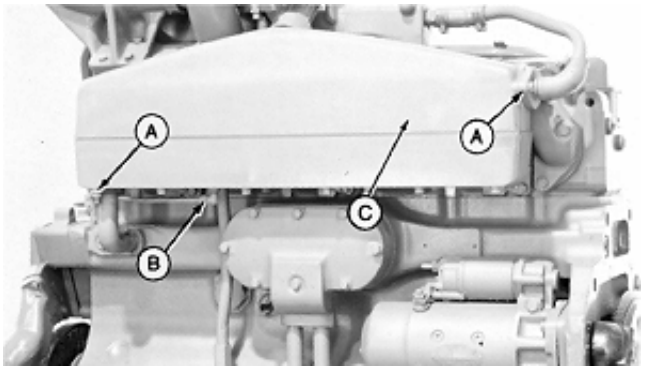
IMPORTANT: All intake manifold and aftercooler connections must be tight to prevent damage from dusting. Dirt is extremely abrasive and can rapidly wear internal engine parts.

8. Apply PT569 NEVER-SEEZ Compound to all intake manifold-to-aftercooler cover (C) cap screws and tighten to 34 N·m (25 lb-ft).

9. Install inlet and outlet hoses. Tighten hose clamps to 4 N·m (35 lb-in.). Install adapter plates (A). Tighten to 27 N·m (20 lb-ft).

10. Install aneroid-to-intake manifold line (B) if equipped. Tighten securely.

11. Install turbocharger as described earlier in this group.



RG3946 -UN-09NOV89

A—Adapter Plates
B—Aneroid-to-Intake Line
C—Intake Manifold Cover

S11,3005,FJ -19-08AUG94

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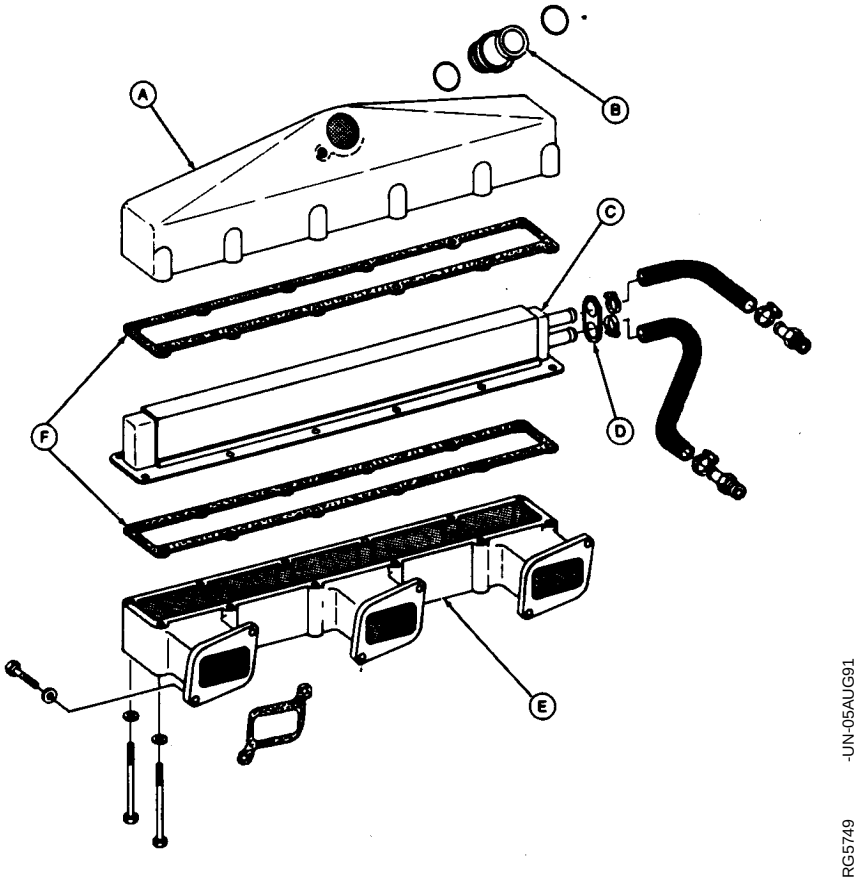
61

INSTALL INTAKE MANIFOLD AND TWO-PASS AFTERCOOLER (6466A ENGINES)



A—Cover
B—Intake Coupling
C—Aftercooler
D—Sealing Ring
E—Intake Manifold
F—Gasket (2 used)

Two-Pass Aftercooler Assembly

IMPORTANT: Make sure that the inside of intake manifold (E) is clean before assembly.

Install cap screws with washers in third and fourth inside holes (from front of engine) of intake manifold (directly over oil cooler) BEFORE installing manifold onto cylinder head and secure cap screws until manifold is installed. Cap screws can not be installed after manifold is installed.

1. Install intake manifold onto cylinder head using new gaskets.

2. Apply PT569 NEVER-SEEZ Compound to all intake manifold cap screws. Install cap screws and tighten to 47 N·m (35 lb-ft).

3. Using new gaskets (F) and sealing ring (D), install aftercooler into intake manifold.

IMPORTANT: Make sure sealing ring is properly positioned in intake manifold and not crimped.

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62

RG,CTM1,G30,6 -19-08AUG94

4. Position cover (A) over aftercooler assembly. Install JDG683 Sealing Ring Compression Tool (B) onto aftercooler tubes (C) with crossbar across slot as shown.

Tool is designed to pull on aftercooler tubes while pushing on cover to compress sealing gasket (as tool is tightened).

5. Tighten tool until mounting holes in cover, aftercooler, gaskets and intake manifold are all aligned.

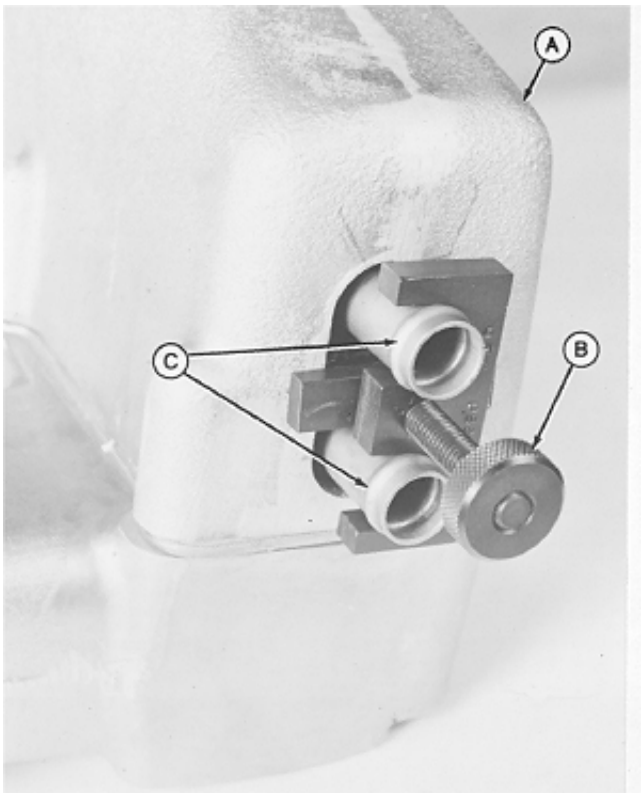
6. Apply PT569 NEVER-SEEZ Compound to all intake manifold-to-cover cap screws and tighten to 34 N·m (25 lb-ft).

7. Install coolant inlet and outlet hoses. Tighten connections to 4 N·m (35 lb-in.).

8. Install aneroid-to-intake manifold line.

IMPORTANT: All intake manifold and aftercooler must be tight to prevent severe engine damage from dusting. Dirt is extremely abrasive and can rapidly wear internal engine parts.

9. Install turbocharger as detailed earlier in this group.



RG5570 -UN-09JAN90

RG,CTM6,G30,12 -19-08AUG94

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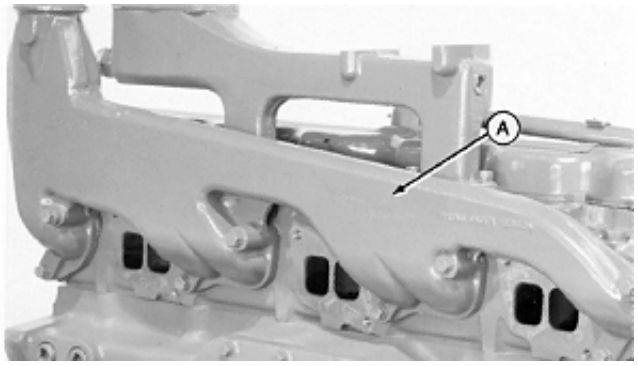
63

REMOVE, INSPECT, AND INSTALL EXHAUST MANIFOLD



1. Remove turbocharger and intake manifold as described earlier in this group.

2. Remove cap screws and lift off exhaust manifold.

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

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

5. Inspect entire exhaust manifold for cracks or damage. Inspect machined mounting surfaces for burrs or other defects which might prevent gaskets from sealing properly. Replace parts as necessary.

NOTE: Apply PT569 NEVER-SEEZ Compound to all exhaust manifold cap screws.

6. On 6466D Engines use new gaskets and install exhaust manifold (A). Tighten cap screws to 47 N·m (35 lb-ft).

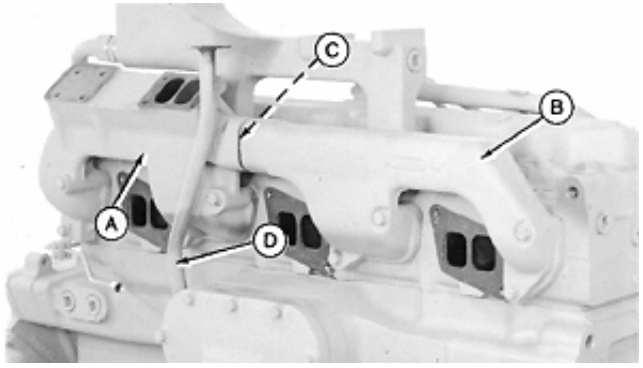
S11,3005,MM -19-06APR94

7. On 6466T and 6466A Engines install front exhaust manifold (A) using new gaskets. Do not tighten cap screws.

8. Install rear exhaust manifold (B) using new gaskets and sealing ring (C).

9. Tighten all cap screws to 47 N·m (35 lb-ft).

10. Install turbocharger oil return line (D), using a new O-ring.



A—Front Exhaust Manifold
B—Rear Exhaust Manifold
C—Sealing Ring
D—Turbocharger Oil Return Line

S11,3005,MN -19-08AUG94

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

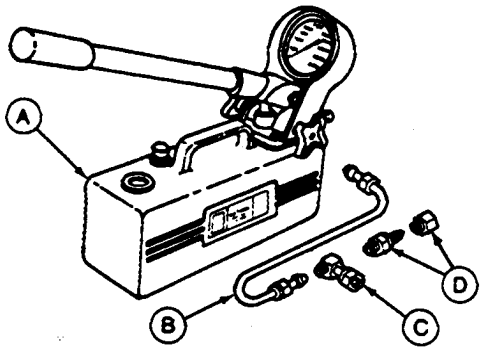
A—Fuel Injection Nozzle Tester . . . D01109AA (Y900)

B—Fuel Line Assembly Y900-2A*

C—Adapter Nut Y900-21**

D—Straight Adapters . . . . . Y900-7* and Y900-15*

Used to test operational performance and opening pressure of nozzles.



RG4954 -UN-14DEC88

*Included in D01110AA (Y910A) Adapter Set.

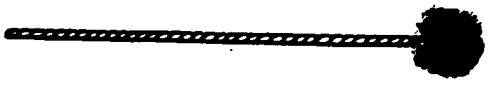
**May be used instead of Y900-7 and Y900-15.

S11,3010,OX -19-09SEP91

RG5099 -UN-23AUG88

Nozzle Thread Cleaning Brush D17030BR

Used to clean nozzle threads in cylinder head.



S53,D17030,BR -19-16FEB87

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

Rotate engine flywheel. Use with JDE81-4 Timing Pin.

S53,JDE811B -19-08AUG94

RG5068 -UN-23AUG88

Timing Pin JDE81-4

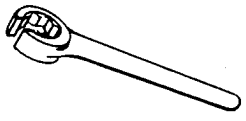
Lock engine at TDC when timing valve train.

S53,JDE814A -19-08AUG94

RG5290 -UN-15OCT92

Serrated Wrench JDE90

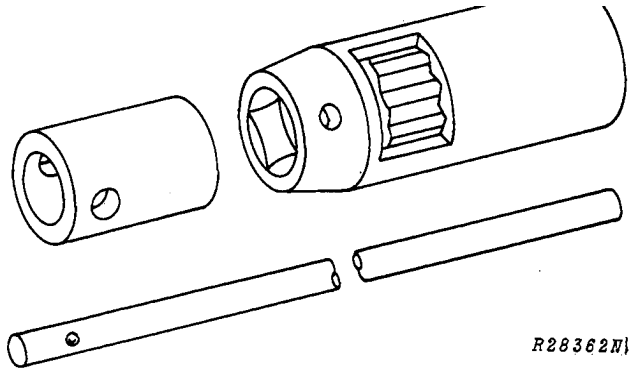
Use to hold injection pump fuel outlet fittings on Bosch “P” pump from turning when loosening and tightening fuel pipe connections.



S54,JDE90 -19-29OCT92

Nozzle Socket JDE92

Used to remove and install 21 mm injection nozzles.

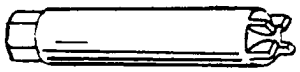


S11,3010,OU -19-16AUG94

RG5289 -UN-23AUG88

Nozzle Seat Reamer JDE99

Used to clean carbon from nozzle seats in cylinder head.

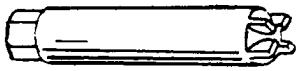


S53,JDE99 -19-08AUG94

RG5289 -UN-23AUG88

Nozzle Seat Reamer JDG609

Used to clean carbon from nozzle seats in cylinder head.



S53,JDG609 -19-02DEC87

RG5100 -UN-23AUG88

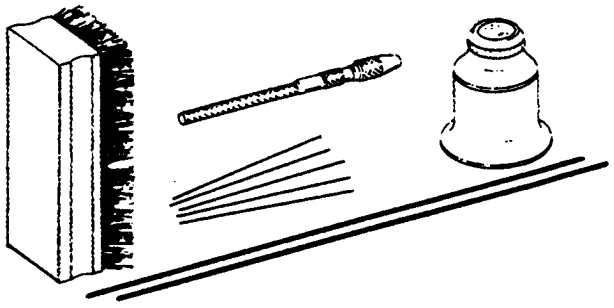
Tap JDF5

Used to restore nozzle threads in cylinder head.

S53,JDF5 -19-08MAR94

Nozzle Cleaning Kit JDF13 (JDE105)

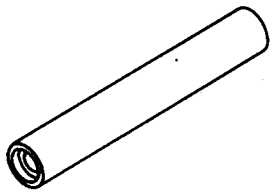
Used to clean injection nozzles.



S11,3010,OW -19-09SEP91

Driver JDF15

Used to install spindle seals in fuel supply pumps.



RG2017 -UN-30NOV88

S55,3010,BA -19-25JUL91

RG5154 -UN-23AUG88

3/4 in. Special Crowsfoot Wrench JDF22

Tighten injection lines at pump and nozzles.

S53,JDF22 -19-10JUL89

RG5287 -UN-23AUG88

Special Socket JDF33

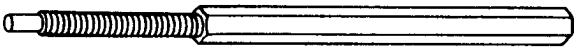
Used to loosen and tighten fast idle stop screw on Nippondenso injection pumps when adjusting engine speeds.

S53,JDF33 -19-02DEC87

RG7212 -UN-23JUL94

Injection Pump Timing Pin JDG886

Used to set in-line fuel injection pump timing prior to removal of pump.



RG,JDG886 -19-10AUG94

OTHER MATERIAL

Name	Use
AR54749 Soap Lubricant	Injection pump mounting flange O-ring.
PT569 NEVER-SEEZ Compound	Gland nut threads and fuel injection nozzle barrel.
LOCTITE 242 (TY9370/T43512) Thread Lock and Sealer	Injection pump timing hole plug.
LOCTITE 592 (TY9374/TY9375) Pipe Sealant with TEFLON	Fuel filter drain plug and bleed plug.

RG,CTM42,G35,76-19-15SEP94

DIESEL FUEL SYSTEM SPECIFICATIONS

ITEM	SPECIFICATIONS
Engine Speeds:	
OEM Applications	See Groups 01 and 105 in this CTM
All Other Machine Applications	See Applicable Machine TM
Injection Pump Timing-To-Engine:	
6466AF001	14° BTDC
All Other Applications	TDC
Hydraulic Aneroid Activator Operating Pressure:	
(6466T and 6466A)	48—75 kPa (0.5—0.8 bar) (7—11 psi)
Overflow Valve Regulating Pressure	Approximately 100 kPa (1 bar) (14.5 psi)
Fuel Injection Nozzles—21 mm:	
New Nozzle Opening Pressure (by nozzle tip size)	
4 x 0.275 mm	25 500 kPa (255 bar) (3700 psi)
4 x 0.28 mm	25 900 kPa (259 bar) (3750 psi)
4 x 0.30 mm	26 200 kPa (262 bar) (3800 psi)
4 x 0.33 mm	27 900 kPa (279 bar) (4050 psi)
4 x 0.345 mm	27 900 kPa (279 bar) (4050 psi)
4 x 0.35 mm	27 900 kPa (279 bar) (4050 psi)
4 x 0.36 mm	29 400 kPa (294 bar) (4250 psi)
4 x 0.40 mm	27 900 kPa (279 bar) (4050 psi)
5 x 0.28 mm	25 990 kPa (260 bar) (3769 psi)
6 x 0.285 mm	29 400 kPa (294 bar) (4250 psi)
Used Nozzle Opening Pressure (by nozzle tip size)	
4 x 0.275 mm	24 800 kPa (248 bar) (3600 psi)
4 x 0.28 mm	24 800 kPa (248 bar) (3600 psi)
4 x 0.30 mm	24 800 kPa (248 bar) (3600 psi)
4 x 0.33 mm	26 200 kPa (262 bar) (3800 psi)
4 x 0.345 mm	26 200 kPa (262 bar) (3800 psi)
4 x 0.35 mm	26 200 kPa (262 bar) (3800 psi)
4 x 0.36 mm	26 200 kPa (262 bar) (3800 psi)
4 x 0.40 mm	26 200 kPa (262 bar) (3800 psi)
5 x 0.28 mm	23 390 kPa (234 bar) (3392 psi)
6 x 0.285 mm	26 200 kPa (262 bar) (3800 psi)

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S11,3010,KB -19-10AUG94

DIESEL FUEL SYSTEM SPECIFICATIONS—CONTINUED

TORQUES

Injection Pump Access Cover	27 N·m (20 lb-ft)
Injection Pump-to-Cylinder Block	47 N·m (35 lb-ft)
Injection Pump Drive Gear-to-Pump Hub	47 N·m (35 lb-ft)
Fuel Pipe Connectors	27 N·m (20 lb-ft)
Injection Nozzle Gland Nut-to-Cylinder Head	75—88 N·m (55—65 lb-ft)
Injection Nozzle Retaining Nut	60—79 N·m (44—58 lb-ft)
Fuel Supply Pump Mounting Stud Nut	5—7 N·m (4—5 lb-ft) (45—60 lb-in.)
Fuel Leak-off Connector	Tighten securely
Fuel Pipe-to-Filter Base (Single Filter)	17 N·m (12 lb-ft)
Fuel Filter Base-to-Cylinder Block:	
Single Filter System	44 N·m (32 lb-ft)
Dual Filter System	44 N·m (32 lb-ft)
Hydraulic Aneroid Activator Valve Screw-to-Housing	14 N·m (10 lb-ft) (122 lb-in.)
Hollow Screw for Banjo Fittings on Fuel Supply Pump	41 N·m (30 lb-ft)

RG,CTM1,G35,1 -19-10AUG94

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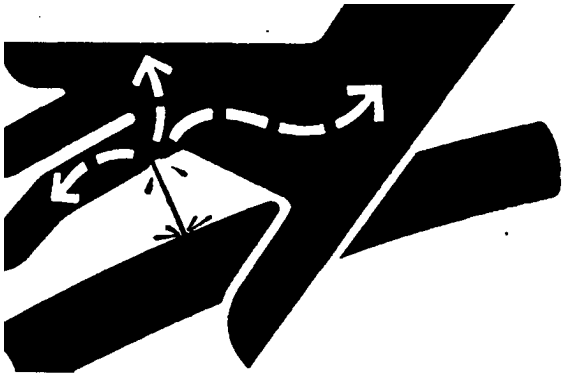
RELIEVE FUEL SYSTEM PRESSURE



X9811 -UN-23AUG88

CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin, causing serious injury. Before disconnecting lines, be sure to relieve pressure. Before applying pressure to the system, be sure ALL connections are tight and lines, pipes and hoses are not damaged. Keep hands and body away from pinholes and 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,CTM1,G35,2 -19-08APR94

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REPLACE FUEL FILTER(S)—6466T AND 6466A ENGINES SERIAL NO. (—346035) AND ALL 6466D

NOTE: Refer to operator's manual for proper servicing and (hourly) replacement intervals.

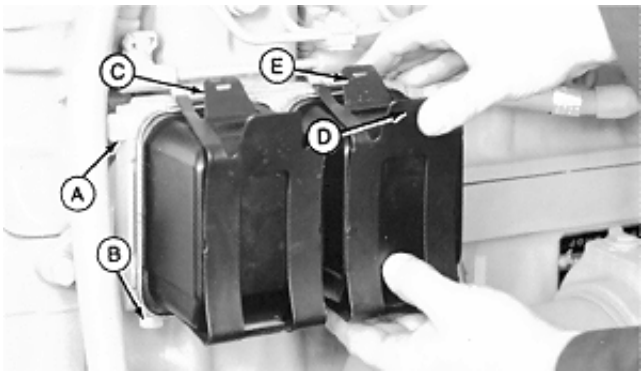
1. Close fuel shut-off valve at bottom of fuel tank (not illustrated).

2. Loosen bleed plug (A) and remove drain plugs (B). Drain fuel from filters.

NOTE: Keep a small container under drain plugs to catch draining fuel.

3. Release the retaining spring (C) and pull fuel filter off fuel filter body.

NOTE: The spring may be released by pressing inward on the outside finger tab (D) until the top hook of the spring can be disengaged. Disengage the top hook by pulling upward on the inside finger tab (E).



RG3866 -UN-20DEC88

A—Bleed Plug
B—Drain Plugs (2 used)
C—Retaining Spring
D—Outside Finger Tab
E—Inside Finger Tab

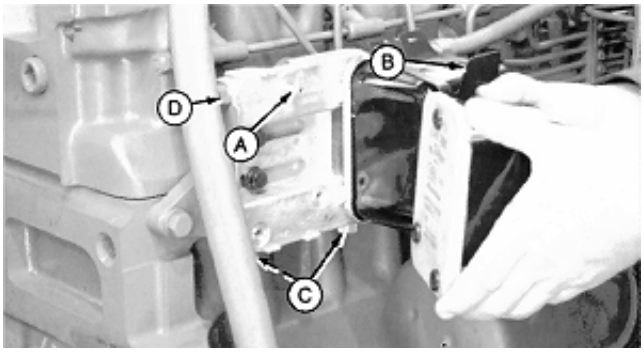
S11,3010,KE -19-10AUG94

NOTE: Engines with metal fuel filters will not have spring pins (A) on filter body. Engines with glass fuel filters will have spring pins.

4. Hook bottom end of retaining spring on new filter element first (B); then hook the top end.

5. Using LOCTITE 592 Pipe Sealant with TEFLON®, install drain plugs (C) and bleed plug (D). Tighten securely.

6. Open fuel shut-off valve and bleed filters as described in Group 115.



RG3869 -UN-09NOV89

A—Spring Pin
B—Retaining Spring
C—Drain Plug (2 Used)
D—Bleed Plug

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S11,3010,KH -19-10AUG94

REPLACE FUEL FILTER—6466T AND 6466A ENGINES SERIAL NO. (346036—)

NOTE: Refer to operator's manual for proper servicing and hourly replacement intervals.

1. Close the fuel shut-off valve at bottom of fuel tank (not illustrated).

2. Loosen bleed plug (A) and remove drain plug (B). Drain fuel from filter.

NOTE: Keep a small container under drain plug to catch draining fuel.

3. With fuel filter firm against base, lift up on top retaining spring and pull down on bottom retaining spring. Pull fuel filter off guide pins of fuel filter base and discard.

RG7098 -UN-16FEB94

A—Bleed Plug
B—Drain Plug

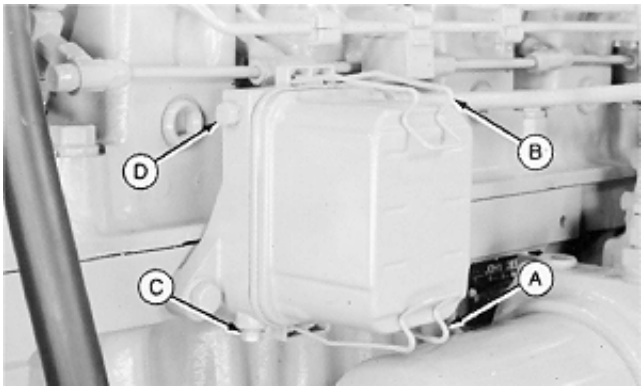
RG,CTM1,G35,3 -19-10AUG94

4. Install fuel filter onto guide pins on fuel filter base. Hold filter firmly against base.

5. Secure bottom retaining spring (A) first, then secure top retaining spring (B).

6. Using LOCTITE 592 Pipe Sealant with TEFLON®, install drain plug (C), shown installed. Tighten bleed plug (D) and drain plug securely. Do not overtighten.

7. Open fuel shut-off valve and bleed fuel system. (See BLEED THE FUEL SYSTEM, in Group 115.)



RG7099 -UN-16FEB94

A—Retaining Spring (Bottom)
B—Retaining Spring (Top)
C—Drain Plug
D—Bleed Plug

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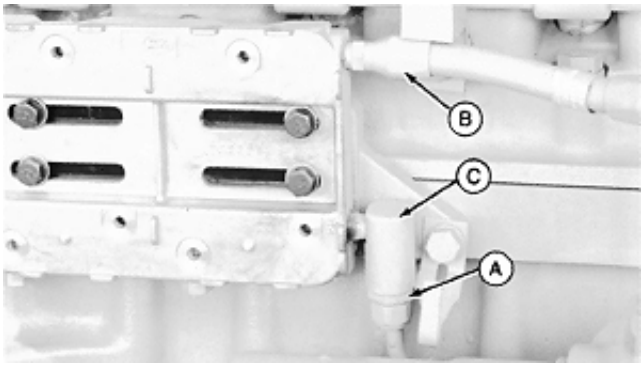
RG,CTM1,G35,4 -19-10AUG94

REMOVE AND INSPECT FUEL CHECK VALVE ASSEMBLY—6466T AND 6466A ENGINES SERIAL NO. (—346035)



-UN-09NOV89
RG3867

1. Remove fuel filters as described earlier in this group.

2. Disconnect fuel inlet pipe and unscrew connector (A). Check valve will fall out of housing when connector is removed.

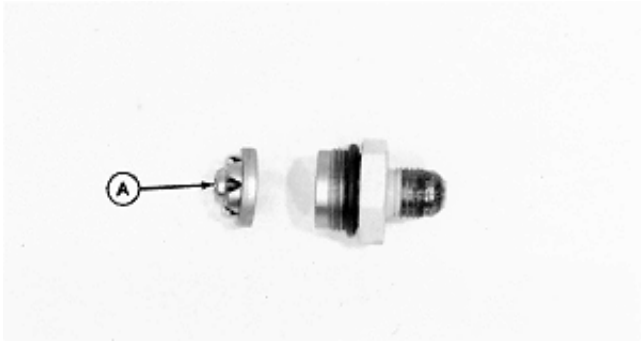
3. Remove injection pump inlet line (B).

NOTE: Early application shown, current application similar.

4. Remove fuel filter body with check valve body (C).

5. Unscrew check valve body from fuel filter body. Clean check valve body with compressed air. Inspect check valve body for damage. Replace if necessary.

S11,3010,KF -19-10AUG94



-UN-20OCT88
RG3868

6. Inspect check valve (A) for foreign material which could keep valve open.

7. Remove foreign material from valve using compressed air.

NOTE: The check valve cannot be repaired. Replace if damaged.

S11,3010,KG -19-26APR85

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INSTALL FUEL CHECK VALVE ASSEMBLY—6466T AND 6466A ENGINES SERIAL NO. (—346035)

NOTE: Early application shown, current application similar.

1. Apply LOCTITE 592 Pipe Sealant with TEFLON® to pipe nipple threads (E).

2. Attach valve body (D) to filter body and tighten securely.

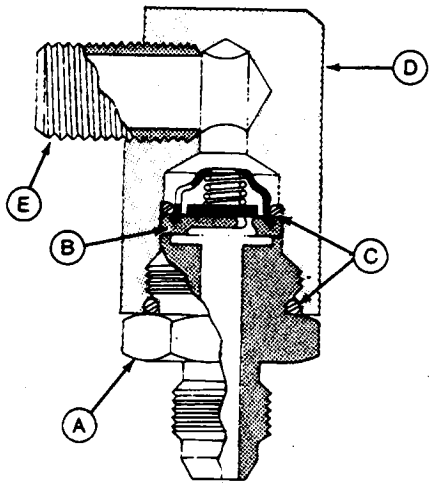
3. Install fuel filter body and attaching hardware to fuel filter support securely (not illustrated).

4. Position new O-rings (C) on check valve (B) and connector (A).

5. Install check valve and connector in valve body securely.

6. Connect the fuel pipe. Tighten securely.

7. Install fuel filters as described earlier in this group.



R 26811N

R26811 -UN-01JUN89

A—Connector
B—Check Valve
C—O-Rings
D—Valve Body
E—Pipe Nipple Threads

S11,3010,KI -19-10AUG94

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10

REPLACE FUEL CHECK VALVE ASSEMBLY—6466T AND 6466A ENGINES SERIAL NO. (346036—)

IMPORTANT: Remove fuel check valve only for replacement purposes, since O-ring seals tightly in bore, removal usually damages check valve assembly.

1. Drain and remove fuel filter (A) as described earlier in this group.

2. Remove fuel filter inlet line (B), (shown removed).

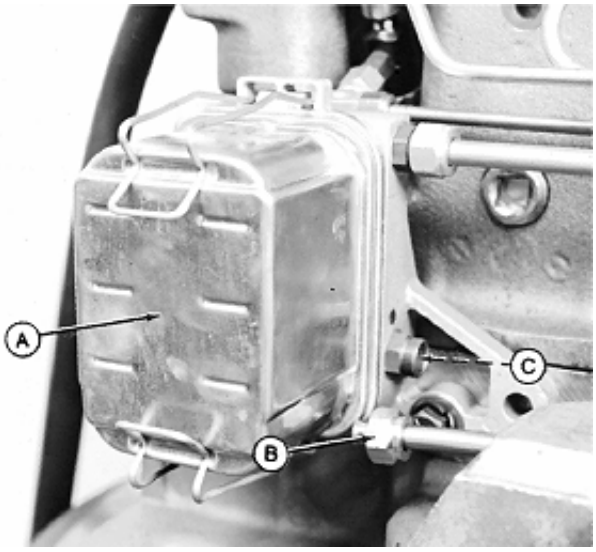
3. Remove check valve (C) from fuel filter base.

4. Inspect and clean fuel filter base.

5. Lubricate new check valve assembly with clean diesel fuel and install.

6. Install fuel inlet line and tighten connection 17 N·m (12 lb-ft). DO NOT overtighten.

7. Install fuel filter and bleed fuel system. (See BLEED THE FUEL SYSTEM, in Group 115.)



-UN-19AUG91
RG5868

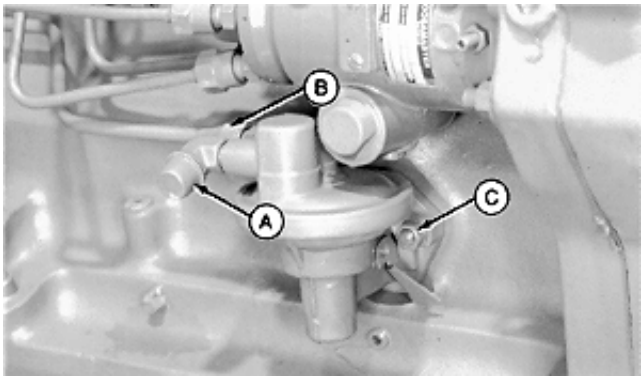
RG,CTM1,G35,5 -19-10AUG94

REMOVE FUEL SUPPLY PUMP—6466D ENGINES

NOTE: This fuel supply pump is not designed to be repaired. If pump is defective, install a new one.

1. Remove inlet (A, shown removed) and outlet (B) connections from supply pump.

2. Remove two mounting nuts (C) and pull supply pump straight out from injection pump housing.



-UN-09NOV89
RG3864

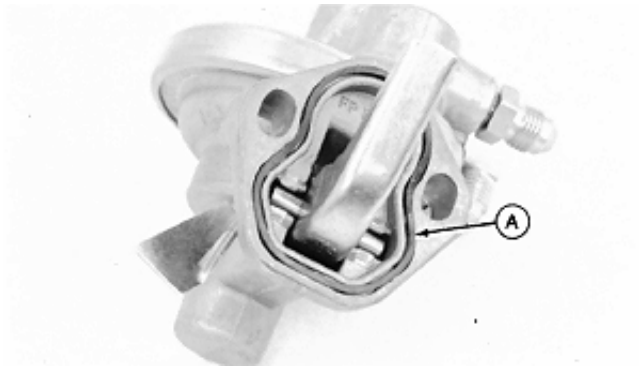
S11,3010,QB -19-08APR94

INSTALL FUEL SUPPLY PUMP—6466D ENGINES

1. Install a new packing seal (A) on fuel supply pump.

NOTE: Be sure supply pump mounting pad on engine block is clean and debris free.

2. Install supply pump on mounting studs. Be sure packing seal is properly positioned.

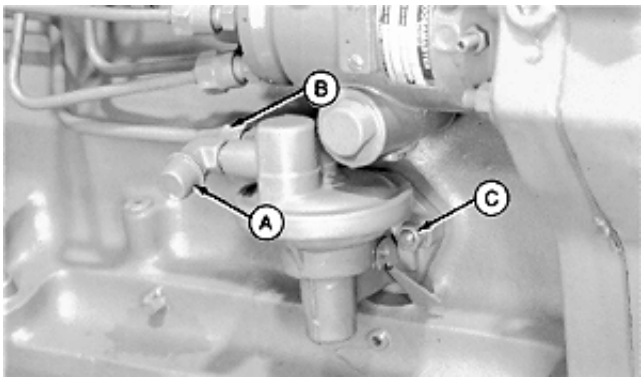


S11,3010,QC -19-08APR94

3. Install both mounting nuts (C) and tighten to 5—7 N·m (4—5 lb-ft).

4. Connect fuel outlet line (B) and inlet line (A) when engine is installed in vehicle. Tighten all connections securely.

5. Bleed the fuel system. (See BLEED FUEL SYSTEM in Group 115.)



S11,3010,QD -19-08APR94

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12

IDENTIFICATION OF FUEL SUPPLY PUMPS—6466T AND 6466A ENGINES

On 6466T and 6466A Engines, the fuel supply pumps mount to the fuel injection pump. A tappet on the fuel supply pump is actuated by a rotating cam in the injection pump. The tappet on the supply pump may be either a roller-type tappet or a flat plunger-type tappet. The type of tappet can be determined visually, when the fuel supply pump is removed, or by the “size of injection pump” indicator in the pump model number. Fuel supply pumps with roller tappets may be used only on P-Series injection pumps. Plunger tappet pumps may be used only on A-Series injection pumps. See IDENTIFICATION OF FUEL INJECTION PUMPS—6466T AND 6466A ENGINES, later in this group.

RG2170 -UN-23APR94

Fuel Supply Pump ID Number

FUEL SUPPLY PUMP IDENTIFICATION NUMBER

(A)—FP/KE22AD290

-FP	Fuel Supply Pump
/K	Single-Acting Plunger Pump
E	Pump Driven by Eccentric Cam
22	Diameter of Plunger in mm
A	Size of Injection Pump Used
D	Pump Version
000	Manufacturer’s Design Number

RG,CTM1,G35,14 -19-18AUG94

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REMOVE FUEL SUPPLY PUMP—6466T AND 6466A ENGINES

NOTE: To diagnose fuel supply pump malfunctions or test for leaks, refer to Group 115.

Thoroughly clean the exterior of the supply pump. Also clean around the supply pump mounting area on the injection pump housing.

NOTE: On engines not equipped with an in-line pre-filter, the fuel supply pump will have a filter housing assembly (C). Use the same removal and installation procedure for both applications.

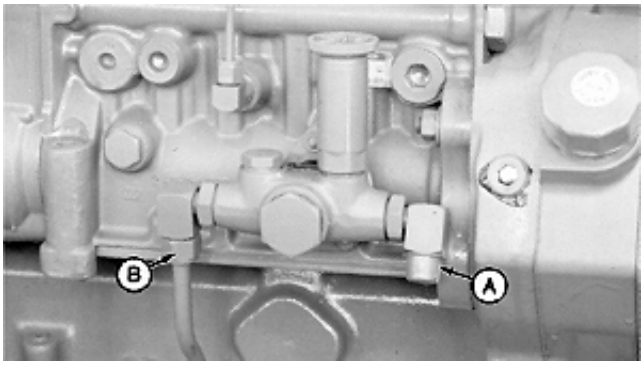
1. Disconnect fuel inlet line (A), shown disconnected, and outlet line (B). Cap all line openings so contaminants do not enter fuel system.

2. Remove three mounting nuts using a 10 mm wrench.

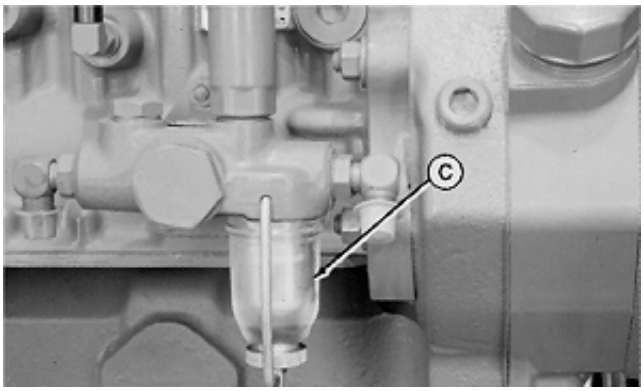
3. Pull fuel supply pump straight out from injection pump housing.

NOTE: When fuel supply pump is removed, note type of tappet used on injection pump side of fuel supply pump. Some fuel supply pumps have a roller tappet and some pumps have a flat plunger-style tappet. Separate disassembly, inspection and assembly procedures are provided later in this group for each type of fuel supply pump.

Also refer to IDENTIFICATION OF FUEL INJECTION AND FUEL SUPPLY PUMPS earlier in this group.



RG3539 -UN-20DEC88



RG4634 -UN-19JAN90

S11,3010,KJ -19-10AUG94

TEST FUEL SUPPLY PUMP FOR LEAKS—6466T AND 6466A ENGINES

Fuel delivery pressure should be checked before removing supply pump from injection pump. If a test stand is available, output performance may be checked with the injection pump mounted on stand. See CHECK FUEL SUPPLY PUMP OPERATION—6466T AND 6466A ENGINES in Group 115.

1. Connect compressed air line (A) to a pressure gauge (B) and to the supply pump inlet fitting. The air line should have a regulating valve to control pressure.

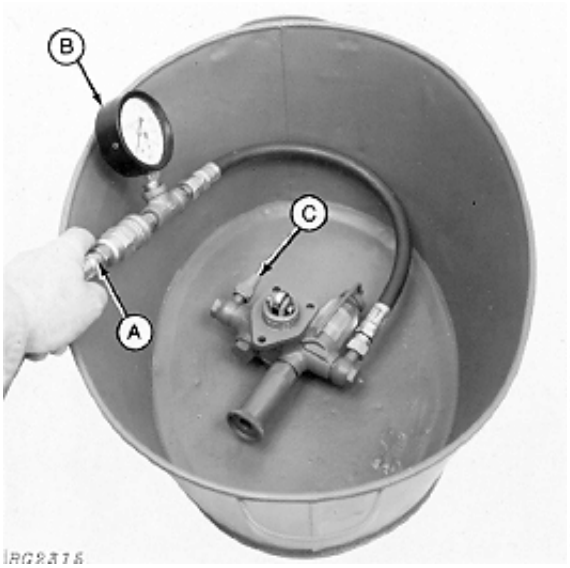
2. Cap or plug supply pump outlet fitting (C).

3. Submerge supply pump in a container of clean diesel fuel. Regulate air pressure to 200 kPa (2.0 bar) (29 psi).

4. Move roller tappet or plunger tappet in and out by hand. No air bubbles should appear around roller tappet bore.

NOTE: If bubbles appear, it is an indication that either the spindle seal is defective or that the spindle is worn (or possibly both).

IMPORTANT: Serious injection pump or engine damage could occur, if enough diesel fuel leaks past spindle and seal. Fuel leakage past spindle dilutes engine oil.



S11,3010,QF -19-10AUG94

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DISASSEMBLE FUEL SUPPLY PUMP WITH ROLLER TAPPET—6466T AND 6466A ENGINES

NOTE: Engines which have a final filter at fuel filter base will NOT have a glass or metal filter housing (R) and filter (T) on fuel supply pump.

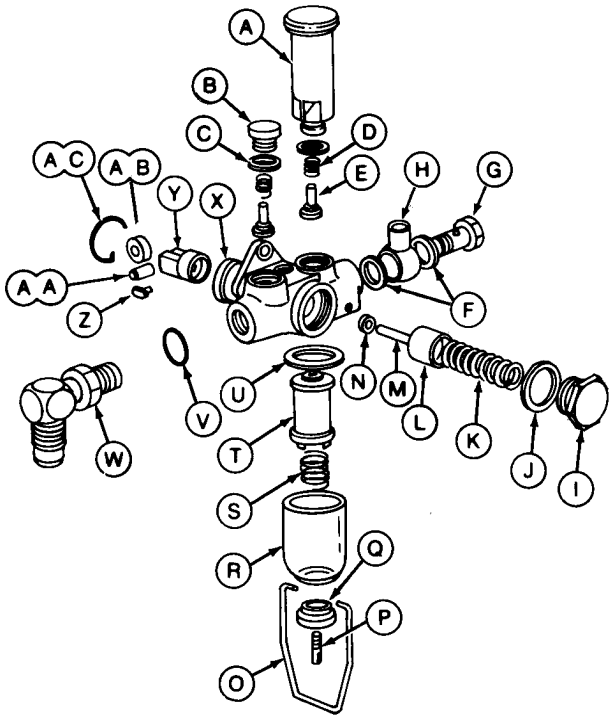
1. If pump has a filter housing, loosen clamp nut (Q) as far as possible. Push filter housing up to compress spring (S), swing clip (O) aside and remove filter housing with spring and filter. Remove and discard gasket (U). Remove clip, stud bolt (P), and clamp nut.
2. On supply pumps with banjo fittings (H), remove hollow screw (G) and banjo fitting. Remove and discard gaskets (F).
3. On supply pumps with elbow fittings (W), loosen lock nut and unscrew elbow fitting from pump housing (X). Remove and discard O-ring (V).
4. Remove hand primer (A) from pump housing. Discard gasket (C).
5. Remove plug (B), gasket, valves (E) and springs (D).

NOTE: It may be necessary to push on pressure spindle (M) or roller tappet (Y) to remove plunger (L).

6. Remove plug (I), spring (K) and plunger from pump housing. Remove and discard gasket (J).
7. Remove snap ring (AC) from outer circumference of pump housing neck.

NOTE: Snap ring has a tang on one end which extends vertically down through a hole in pump housing to retain the roller tappet assembly.

8. Remove roller tappet and pressure spindle from pump housing. Remove sliding blocks (Z), pin (AA), and roller (AB) from roller tappet.
9. On Bosch pumps, remove O-ring (N) from pressure spindle or pump housing. On Nippondenso pumps, spindle seal (N) is pressed into pump housing. Remove spindle seal with needle nose pliers and discard seal.



RG2325 -UN-20APR89

A—Hand Primer
B—Plug
C—Gasket (2 used)
D—Spring (2 used)
E—Valve (2 used)
F—Gasket (2 used)*
G—Hollow Screw*
H—Banjo Fitting*
I—Plug
J—Gasket
K—Spring
L—Plunger
M—Pressure Spindle
N—Seal or O-Ring***
O—Clip
P—Stud Bolt
Q—Clamp Nut
R—Filter Housing
S—Spring
T—Filter
U—Gasket
V—O-Ring**
W—Elbow with Lock Nut**
X—Pump Housing
Y—Roller Tappet
Z—Sliding Blocks
AA—Pin
AB—Roller
AC—Snap Ring

** Used only on pumps with banjo fittings.*

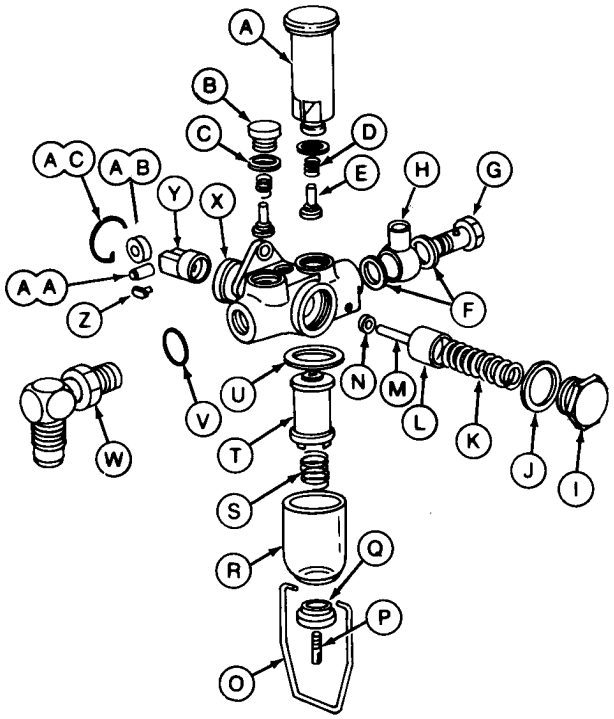
*** Used only on pumps with elbow fittings.*

**** On Nippondenso pumps, item (N) is a seal; on Bosch pumps, item (N) is an O-ring.*

RG,CTM1,G35,7 -19-10AUG94

INSPECT AND REPAIR FUEL SUPPLY PUMP WITH ROLLER TAPPET—6466T AND 6466A ENGINES

1. Inspect pump housing (X) for cracks or wear. Be sure valve seating areas are not pitted. Replace housing as necessary.
2. Check roller tappet bore and plunger bore for wear and scoring. Remove any deposits in housing with a suitable solvent. Rinse housing in clean diesel fuel.
3. Check condition of threads for inlet and outlet fittings. Pumps with banjo fittings (H) have M14 x 1.5 threads. Pumps with elbow fittings (W) have 1/2-20 threads.
4. Inspect OD of roller (AB) for excessive wear. Be sure roller turns freely on pin (AA) and in tappet (Y).
5. Inspect sliding blocks (Z). Edges should be square and unpitted. Blocks should slide easily in tappet.
6. Inspect tappet for wear and scoring. Remove any deposits with a suitable solvent. Be sure land on tappet that contacts pressure spindle (M) is flat and undamaged.
7. Inspect pressure spindle and plunger (L) for pitting and burrs. Replace parts as necessary. Inspect spring (K) for cracks or distortion. Replace parts as necessary.
8. Inspect valves (E), especially valve face, for cracks, pits and wear. Replace as necessary. Spring (D) must not be damaged.
9. Be sure wire fabric filter (T) is not ripped. Clean filter in clean diesel fuel. Spring (S) must not be damaged.
10. Inspect filter housing (R) for damage, especially for chips on upper sealing edge.
11. Inspect threads and wrench flats of plug (B), hollow screw (G), banjo fitting (H), plug (I), stud bolt (P), clamp nut (Q), and elbow (W) for damage. Replace damaged parts as necessary.
12. Inspect clip (O) and snap ring (AC) for damage or distortion. Replace as necessary.



RG2325 -UN-20APR89

A—Hand Primer
B—Plug
C—Gasket (2 used)
D—Spring (2 used)
E—Valve (2 used)
F—Gasket (2 used)*
G—Hollow Screw*
H—Banjo Fitting*
I—Plug
J—Gasket
K—Spring
L—Plunger
M—Pressure Spindle
N—Seal or O-Ring***
O—Clip
P—Stud Bolt
Q—Clamp Nut
R—Filter Housing
S—Spring
T—Filter
U—Gasket
V—O-Ring**
W—Elbow with Lock Nut**
X—Pump Housing
Y—Roller Tappet
Z—Sliding Blocks
AA—Pin
AB—Roller
AC—Snap Ring

** Used only on pumps with banjo fittings.*

*** Used only on pumps with elbow fittings.*

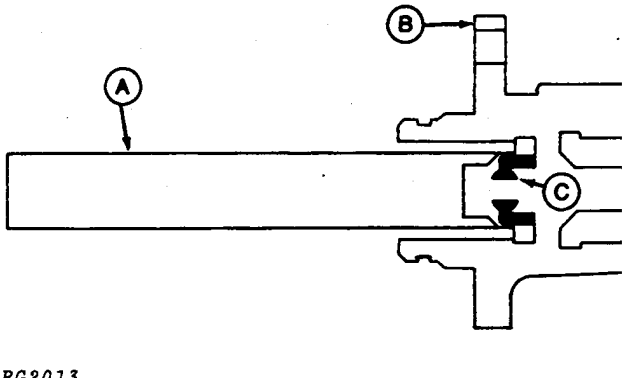
**** On Nippondenso pumps, item (N) is a seal; on Bosch pumps, item (N) is an O-ring.*

RG,CTM1,G35,8A -19-10AUG94

ASSEMBLE FUEL SUPPLY PUMP WITH ROLLER TAPPET—6466T AND 6466A ENGINES

IMPORTANT: Always use new copper gaskets. Dip parts in clean diesel fuel before assembly. Hands should be wet with clean diesel fuel when assembling internal components of fuel supply pump.

1. On Nippondenso pumps, install a new spindle seal (C) into pump housing (B) using JDF15 Driver (A). Be sure seal is started straight in housing bore and drive until driver contacts housing.



RG,CTM1,G35,9 -19-10AUG94

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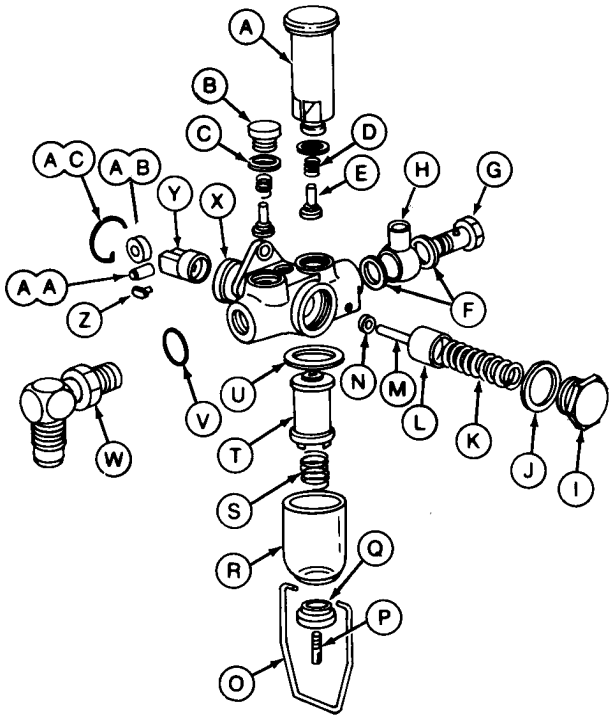
2. On Bosch pumps, install a new O-ring (N) in pump housing (X) bore. Insert pressure spindle (M) and plunger (L) in pump housing.
3. Position spring (K) in plunger. Install plug (I) with a new gasket (J) over spring. Tighten plug securely.
4. Assemble sliding blocks (Z), roller (AB), and pin (AA) to roller tappet (Y). Insert assembled tappet in housing and secure with snap ring (AC).
5. Position valves (E) with springs (D) in pump housing.
6. Install plug (B) and hand primer (A) using new gaskets (C). Tighten plug and hand primer securely.
7. On pumps with filter housing (R) and filter (T), install clip (O) with stud bolt (P) and clamp nut (Q) on pump housing.
8. Position a new gasket (U) on pump housing. Insert spring (S) and filter in filter housing and install on pump. Tighten clamp nut securely.
9. On pumps with banjo fittings (H), install fittings using new gaskets (F). Tighten hollow screw (G) to 41 N·m (30 lb-ft).
10. On pumps with elbow fittings (W), install fittings with new O-rings (V). Tighten lock nut securely.
11. Perform leak test. (See TEST FUEL SUPPLY PUMP FOR LEAKS—6466T AND 6466A ENGINES earlier in this group.)



RG2325 -UN-20APR89

A—Hand Primer
B—Plug
C—Gasket (2 used)
D—Spring (2 used)
E—Valve (2 used)
F—Gasket (2 used)*
G—Hollow Screw*
H—Banjo Fitting*
I—Plug
J—Gasket
K—Spring
L—Plunger
M—Pressure Spindle
N—Seal or O-Ring***
O—Clip
P—Stud Bolt
Q—Clamp Nut
R—Filter Housing
S—Spring
T—Filter
U—Gasket
V—O-Ring**
W—Elbow with Lock Nut**
X—Pump Housing
Y—Roller Tappet
Z—Sliding Blocks
AA—Pin
AB—Roller
AC—Snap Ring

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** Used only on pumps with banjo fittings.*

*** Used only on pumps with elbow fittings.*

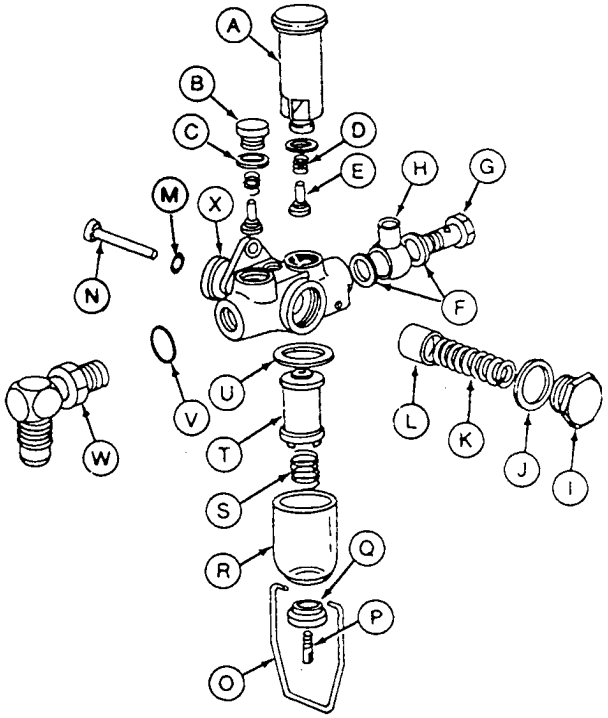
**** On Nippondenso pumps, item (N) is a seal; on Bosch pumps, item (N) is an O-ring.*

RG,CTM1,G35,15 -19-10AUG94

DISASSEMBLE FUEL SUPPLY PUMP WITH PLUNGER TAPPET—6466T AND 6466A ENGINES

NOTE: Engines which have a final filter at fuel filter base will NOT have a glass or metal filter housing (R) and filter (T) on fuel supply pump.

1. If pump has a filter housing, loosen clamp nut (Q) as far as possible. Push filter housing up to compress spring (S), swing clip (O) aside and remove filter housing with filter and spring. Remove and discard gasket (U). Remove clip, stud bolt (P) and clamp nut.
2. On supply pumps with banjo fittings (H), remove hollow screw (G) and banjo fitting. Remove and discard gaskets (F).
3. On supply pumps with elbow fittings (W), loosen lock nut and unscrew elbow fitting from pump housing (X). Remove and discard O-ring (V).
4. Remove hand primer (A) from pump housing. Discard gasket (C).
5. Remove plug (B), gasket, valves (E) and springs (D).
6. Remove plug (I), spring (K) and plunger (L) from pump housing. Remove and discard gasket (J).
7. Remove pressure spindle (N) from pump housing. Remove and discard O-ring (M) on spindle.



RG7102 -UN-08MAR94

A—Hand Primer
B—Plug
C—Gasket (2 used)
D—Spring (2 used)
E—Valve (2 used)
F—Gasket (2 used)*
G—Hollow Screw*
H—Banjo Fitting*
I—Plug
J—Gasket
K—Spring
L—Plunger
M—O-Ring
N—Pressure Spindle
O—Clip
P—Stud Bolt
Q—Clamp Nut
R—Filter Housing
S—Spring
T—Filter
U—Gasket
V—O-Ring**
W—Elbow with Lock Nut**
X—Pump Housing

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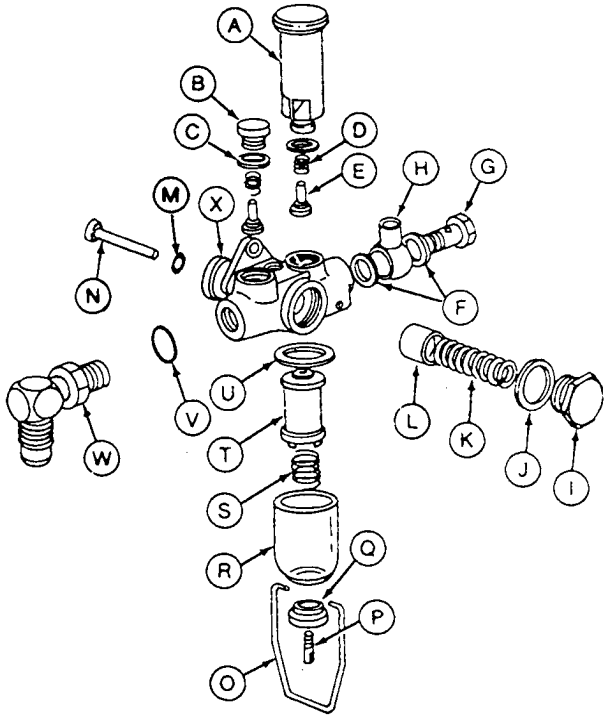
** Used only on pumps with banjo fittings.*

*** Used only on pumps with elbow fittings*

RG,CTM1,G35,11 -19-10AUG94

INSPECT AND REPAIR FUEL SUPPLY PUMP WITH PLUNGER TAPPET—6466T AND 6466A ENGINES

1. Inspect pump housing (X) for cracks or wear. Be sure valve seating areas are not pitted. Replace housing as necessary.
2. Check plunger tappet bore and plunger bore for wear and scoring. Remove any deposits in housing with a suitable solvent. Rinse housing in clean diesel fuel.
3. Check condition of threads for inlet and outlet fittings. Pumps with banjo fittings (H) have M14 x 1.5 threads. Pumps with elbow fittings (W) have 1/2-20 threads.
4. Inspect pressure spindle (N) and plunger (L) for pitting and burrs. Inspect spring (K) for cracks or distortion. Replace parts as necessary.
5. Inspect valves (E), especially valve face, for cracks, pits and wear. Replace as necessary. Spring (D) must not be bent, cracked or broken.
6. Be sure wire fabric filter (T) is not ripped. Clean filter in clean diesel fuel. Spring (S) must not be bent, cracked or broken.
7. Inspect filter housing (R) for damage, especially for chips on upper sealing edge.
8. Inspect threads and wrench flats of plug (B), hollow screw (G), banjo fitting (H), plug (I), stud bolt (P), clamp nut (Q), and elbow (W) for damage. Replace damaged parts as necessary.
9. Inspect clip (O) for damage or distortion. Replace as necessary.



RG7102 -UN-08MAR94

A—Hand Primer
B—Plug
C—Gasket (2 used)
D—Spring (2 used)
E—Valve (2 used)
F—Gasket (2 used)*
G—Hollow Screw*
H—Banjo Fitting*
I—Plug
J—Gasket
K—Spring
L—Plunger
M—O-Ring
N—Pressure Spindle
O—Clip
P—Stud Bolt
Q—Clamp Nut
R—Filter Housing
S—Spring
T—Filter
U—Gasket
V—O-Ring**
W—Elbow with Lock Nut**
X—Pump Housing

** Used only on pumps with banjo fittings.*

*** Used only on pumps with elbow fittings*

RG,CTM1,G35,12 -19-10AUG94

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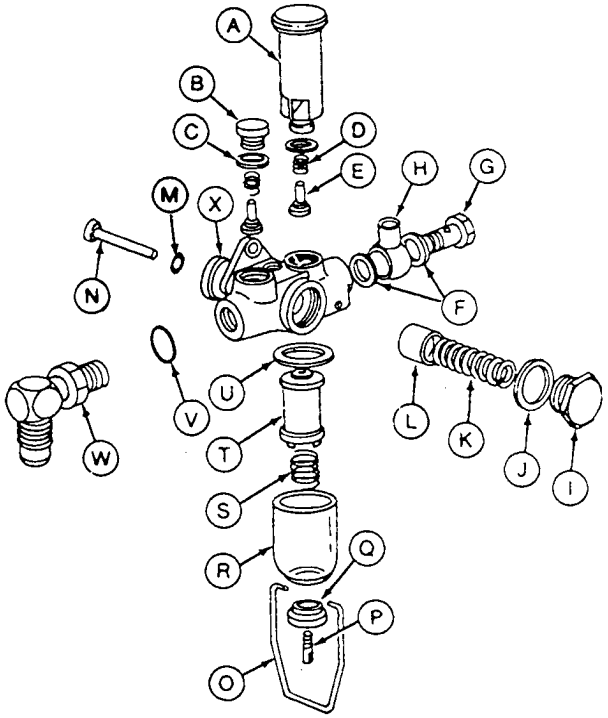
ASSEMBLE FUEL SUPPLY PUMP WITH PLUNGER TAPPET—6466T AND 6466A ENGINES

IMPORTANT: Always use new copper gaskets. Dip parts in clean diesel fuel before assembly. Hands should be wet with clean diesel fuel when assembling internal components of fuel supply pump.

1. Install a new O-ring (M) on pressure spindle (N) and install pressure spindle in pump housing (X). Install plunger (L) in opposite side of pump housing.
2. Position spring (K) in plunger. Install plug (I) with a new gasket (J) over spring. Tighten plug securely.
3. Position valves (E) with springs (D) in housing.
4. Install plug (B), and hand primer (A) using new gaskets (C). Tighten plug and hand primer securely.
5. On pumps with filter housing (R) and filter (T), install clip (O) with stud bolt (P) and clamp nut (Q) on housing.
6. Position a new gasket (U) on housing. Insert spring (S) and filter in filter housing and install on pump housing. Tighten clamp nut securely.
7. On pumps with banjo fittings (H), install fittings using new gaskets (F). Tighten hollow screw (G) to 41 N·m (30 lb-ft).
8. On pumps with elbow fittings (W), install fittings with new O-rings (V). Tighten lock nut securely.
9. Perform leak test. (See TEST FUEL SUPPLY PUMP FOR LEAKS—6466T AND 6466A ENGINES earlier in this group.)



RG7102 -UN-08MAR94

A—Hand Primer
B—Plug
C—Gasket (2 used)
D—Spring (2 used)
E—Valve (2 used)
F—Gasket (2 used)*
G—Hollow Screw*
H—Banjo Fitting*
I—Plug
J—Gasket
K—Spring
L—Plunger
M—O-Ring
N—Pressure Spindle
O—Clip
P—Stud Bolt
Q—Clamp Nut
R—Filter Housing
S—Spring
T—Filter
U—Gasket
V—O-Ring**
W—Elbow with Lock Nut**
X—Pump Housing

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** Used only on pumps with banjo fittings*

*** Used only on pumps with elbow fittings*

RG,CTM1,G35,13 -19-10AUG94

INSTALL FUEL SUPPLY PUMP—6466T AND 6466A ENGINES

IMPORTANT: Before installing supply pump, test pump to make sure that fuel will not leak around spindle and spindle seal. (See TEST FUEL SUPPLY PUMP FOR LEAKS—6466T AND 6466A ENGINES, earlier in this group.)

NOTE: The fuel supply pump must be properly matched with the fuel injection pump. See IDENTIFICATION OF FUEL INJECTION AND FUEL SUPPLY PUMPS—6466T AND 6466A ENGINES earlier in this group.

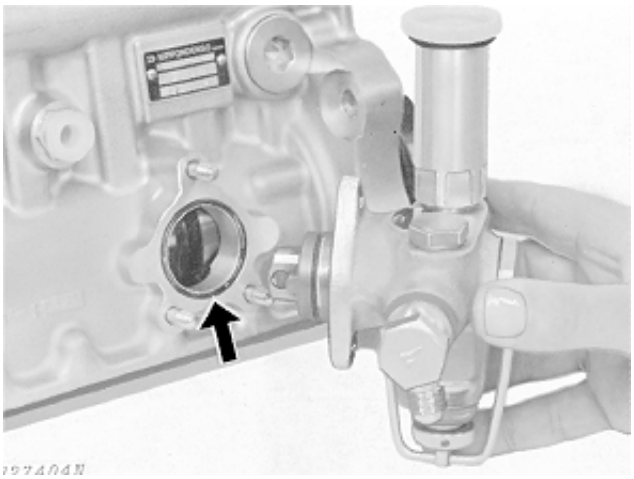
1. On Nippondenso pumps, put a new O-ring in counterbore of injection pump housing next to fuel supply pump mounting face (arrow).

On Bosch pumps, install a new gasket on supply pump mounting face.

2. Position pump over mounting studs. Tighten mounting stud nuts 5—7 N·m (4—5 lb-ft) (45—60 lb-in.).

3. Install fuel inlet and outlet lines when engine is installed in vehicle. Tighten all connections securely.

4. Bleed the fuel system as described in Group 115.



R27404 -UN-29NOV88

S11,3010,QT -19-10AUG94

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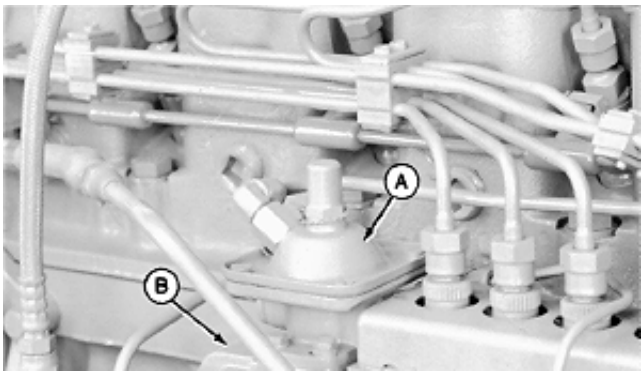
GENERAL INFORMATION FOR ANEROID—IF EQUIPPED



The purpose of the aneroid is to limit black smoke produced during acceleration until sufficient manifold pressure is reached under two conditions:

—When load is moderate to heavy with engine speed from 800 to approximately 1000 rpm.

—When load is light at any engine speed.

The aneroid controls fuel delivery when intake manifold pressure is about 70 kPa (0.70 bar) (10 psi) or less. Therefore, all final adjustments are to be made on the test stand with aneroid mounted on injection pump.

NOTE: Aneroids are used only on certain applications of 6466T and 6466A engines. 6466D engines do not have aneroids.

The aneroid (A) is a diaphragm-type control unit that mounts on top of the injection pump governor housing (B).

Aneroid mounting screws are sealed to prevent tampering by unauthorized service personnel. Intake manifold pressure is directed to the upper side of the diaphragm chamber to actuate the diaphragm.

A hydraulic aneroid activator located inside activator housing, utilizes engine oil pressure to control aneroid operation.

S11,3010,KM -19-10AUG94

REPAIR ANEROID

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24

For aneroid repair and adjustment, have an authorized ADS diesel repair station perform the work.

RG,CTM1,G35,6 -19-08APR94

REMOVE HYDRAULIC ANEROID ACTIVATOR—IF EQUIPPED (6466T AND 6466A ENGINES)

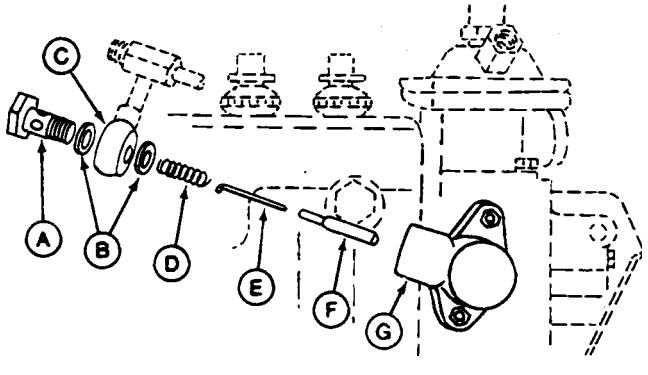
NOTE: The hydraulic aneroid activator is located on back side of governor housing next to cylinder block.

1. Remove injection pump as described later in this group.

2. Remove special screw (A), copper washers (B) and banjo connector (C). Discard copper washers.

3. Remove spring (D), restricter wire (E) and capillary valve (F) from activator housing (G). Remove activator housing.

NOTE: Do not bend restricter wire or other activator parts.



A—Special Screw
B—Copper Washer (2 used)
C—Banjo Connector
D—Spring
E—Restricter Wire
F—Capillary Valve
G—Activator Housing

S11,3010,KN -19-10AUG94

DISASSEMBLE AND CLEAN HYDRAULIC ANEROID ACTIVATOR PARTS

1. Remove gasket (G), piston (F) and piston spring (E).

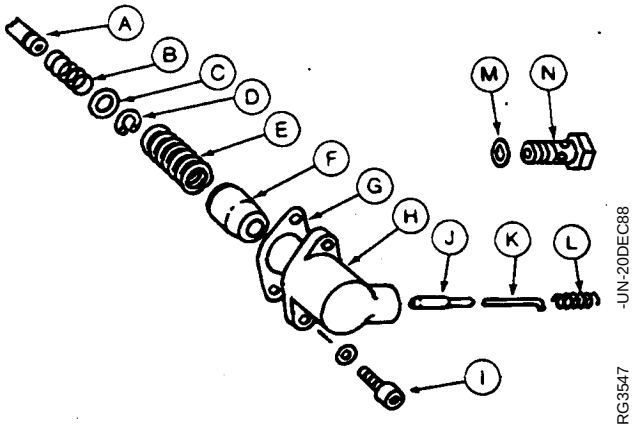
2. Wash all parts in clean solvent and dry with compressed air. Blow out all openings to make sure they are open.

3. Check piston (F) and activator housing (H) for general condition. Piston must move freely in its bore.

4. Inspect piston spring (E) and capillary valve spring (L). Replace if weak or broken.

5. Inspect condition of restricter wire (K). Wire must not be bent or broken and must fit loosely in capillary valve (J).

6. Check condition of return spring (B), washer (C) and retaining ring (D) on starting fuel control shaft (A). Replace spring if weak or broken. Be sure retaining ring is secure on shaft.



A—Starting Fuel Control Shaft
B—Return Spring
C—Washer
D—Retaining Ring
E—Piston Spring
F—Piston
G—Gasket
H—Activator Housing
I—Mounting Screw (2 used)
J—Capillary Valve
K—Restricter Wire
L—Capillary Valve Spring
M—Washers
N—Special Screw

RG,CTM42,G35,71-19-16AUG94

ASSEMBLE AND INSTALL HYDRAULIC ANEROID ACTIVATOR

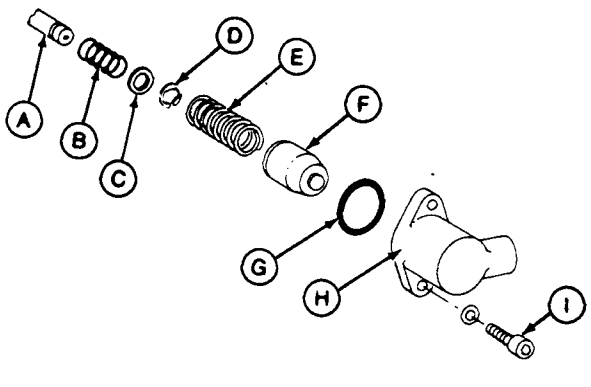
1. Install return spring (B), washer (C) and retaining ring (D) on control shaft (A).

NOTE: Be sure the starting fuel control shaft is held all the way out by the return spring.

2. Clean mounting surfaces on governor and activator housing (H) so new O-ring (G) will seal properly.

3. Insert piston (F) and piston spring (E) into activator housing.

4. Install activator housing with O-ring and tighten Allen mounting screws (I) with washer securely.



RG3406 -UN-06APR89

A—Starting Fuel Control Shaft
B—Return Spring
C—Washer
D—Retaining Ring
E—Piston Spring
F—Piston
G—O-Ring
H—Activator Housing
I—Mounting Screws

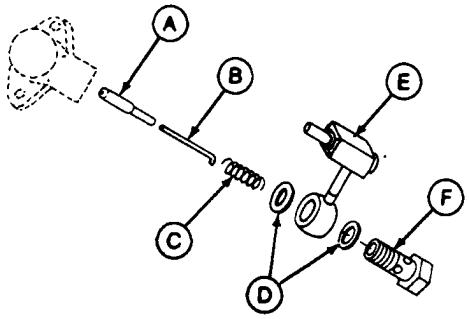
S11,3010,BC -19-10AUG94

5. Insert restricter wire (B) in orifice of capillary valve (A) and position in activator housing.

6. Slip spring (C) over capillary valve.

7. Install lubrication pipe banjo connector (E), washers (D), and secure with special screw (F). Tighten screw to 14 N·m (10 lb-ft) (122 lb-in.).

A—Capillary Valve
B—Restricter Wire
C—Spring
D—Copper Washers
E—Banjo Connector
F—Special Screw



RG3407 -UN-06APR89

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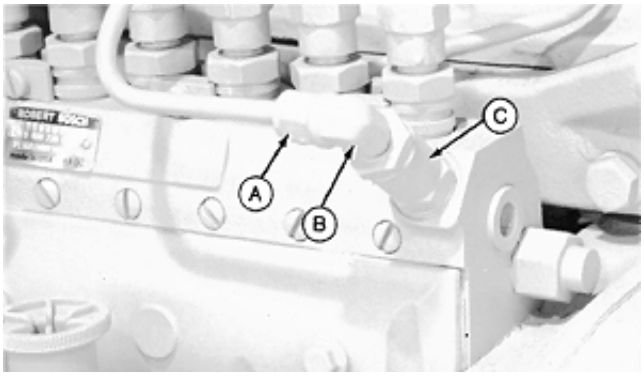
S11,3010,BD -19-10AUG94

SERVICE INJECTION PUMP OVERFLOW VALVE—6466T AND 6466A ENGINES

NOTE: Overflow valve can be serviced with injection pump installed.

1. Remove leak-off line (A) and elbow (B).

2. Remove overflow valve assembly (C) from injection pump.



RG3872 -UN-09NOV89

S11,3010,KO -19-08APR94

3. Remove reducer (A) and copper washer (B) from valve body (C).

4. Unscrew spring seat (D); then remove spring (E) and valve (F).

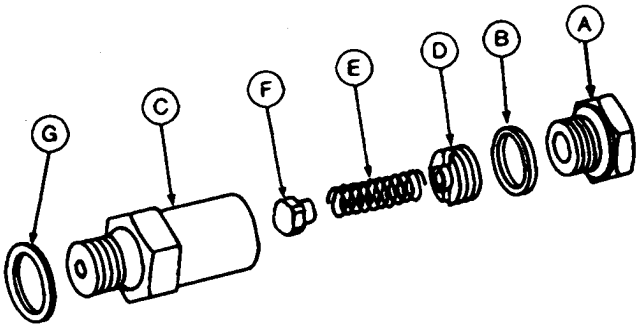
5. Inspect for foreign material imbedded in seat of nylon valve.

6. Check spring to see that it is not weak or broken.

7. Wash all parts in solvent and air dry.

NOTE: There is no adjustment on valve to regulate housing pressure. If suspected that the valve is malfunctioning, replace valve to restore proper operation.

8. Reverse order of removal for reassembly of overflow valve using new copper washers.



RG3549 -UN-20DEC88

A—Reducer
B—Washer
C—Valve Body
D—Spring Seat
E—Spring
F—Valve
G—Washer

S11,3010,DX -19-10AUG94

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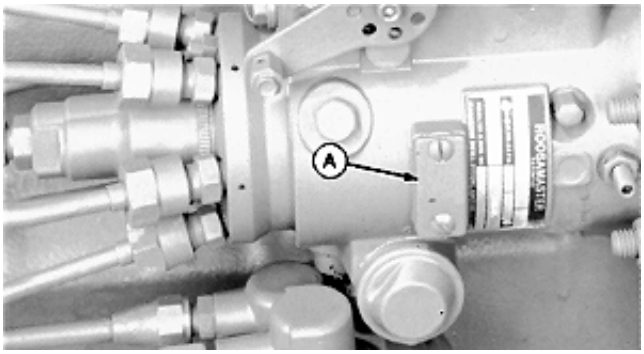
REMOVE ROTARY FUEL INJECTION PUMP—6466D ENGINES



RG3874 -UN-09NOV89

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

1. Thoroughly clean area around the injection pump and nozzles, including all line connections, using compressed air.

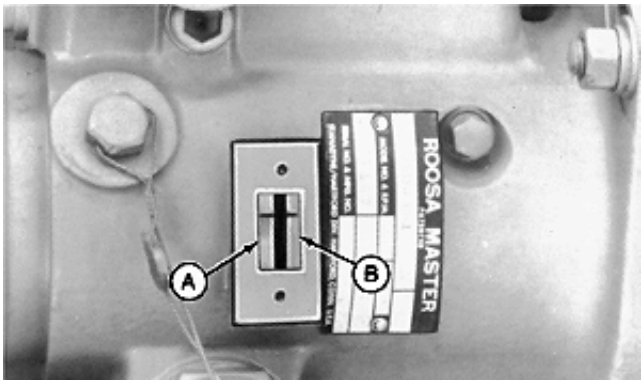
NOTE: Cap or plug all fuel lines as they are disconnected to prevent dirt and debris from entering fuel system. Debris in fuel system can plug injectors and cause engine damage.

2. Rotate the crankshaft (in normal running direction) until No. 1 piston is at “TDC” on its compression stroke using the JDE81-1 Engine Rotation Tool. At this point, JDE81-4 Timing Pin should enter hole in flywheel.

3. Remove the timing window cover (A).

S11,0408,M -19-10AUG94

4. Rotate engine until timing mark on governor weight retainer (B) is in line with timing mark on camshaft ring (A).



RG3875 -UN-09NOV89

S11,3010,EZ -19-10AUG94

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5. Remove injection pump gear cover (shown removed) and remove injection pump drive gear cap screws (A).

IMPORTANT: Plug or cap all fuel lines, oil lines and hoses as they are disconnected.

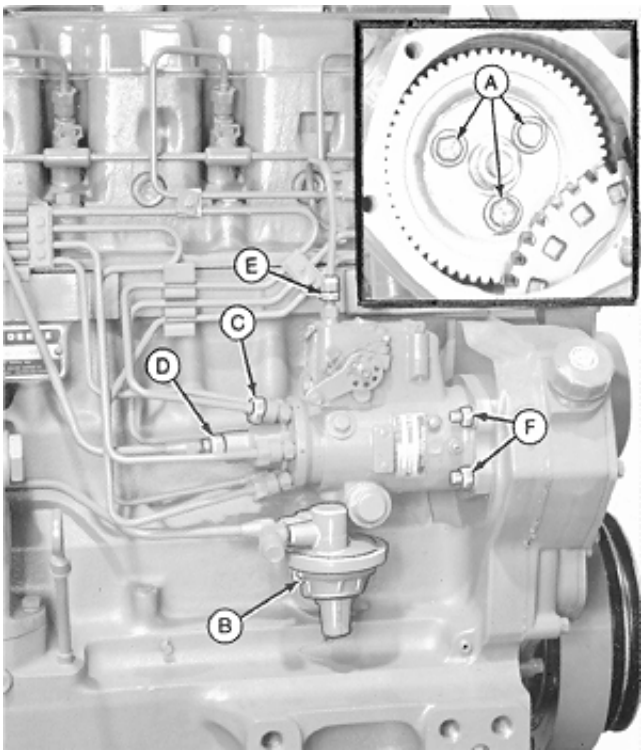
6. Remove fuel supply pump (B) as described earlier.

7. Remove injection lines (C) and injection pump fuel inlet (D) using the JDF22 Line Wrench.

8. Disconnect fuel leak-off line (E), speed control rod cable and fuel shut off cable (shown removed).

9. Remove three mounting nuts (F) and carefully remove injection pump. Place on a clean flat surface.

A—Drive Gear Hub Cap Screws (3 used)
B—Fuel Supply Pump
C—Injection Lines
D—Fuel Inlet Line
E—Fuel Leak-Off Line
F—Mounting Nut (3 used)



RG3876 -UN-09NOV89

S11,3010,FA -19-10AUG94

REPAIR ROTARY FUEL INJECTION PUMP

IMPORTANT: Do not disassemble fuel injection pump further than necessary for installing available service parts, not even for cleaning.

Be sure that injection pump serial number tag is in place and that all identification numbers are legible so that pump is set to the correct specifications for its intended application.

For injection pump repair and testing, have an authorized diesel injection repair station perform the work. Unauthorized repairs made to fuel injection pump will void warranty.

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S11,3010,PE -19-10AUG94

INSTALL ROTARY FUEL INJECTION PUMP—6466D ENGINES

NOTE: When turning the flywheel to TDC, the JDE81-4 Timing Pin can engage in the flywheel with either No. 1 or No. 6 cylinder on TDC compression stroke. When installing the fuel injection pump, No. 1 cylinder must be on TDC compression.

1. If the engine was rotated after the injection pump was removed, rotate the flywheel using the engine rotation tools, until the timing pin engages in the flywheel as described above.

NOTE: When No. 1 cylinder is on TDC compression stroke, the intake and exhaust valves for No. 1 cylinder will be closed and both rocker arms will be loose.

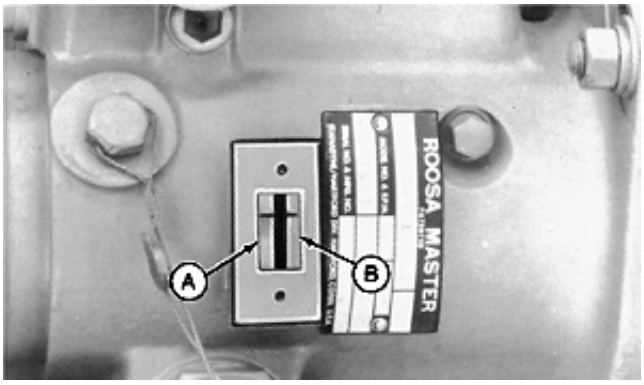
S11,3010,QU -19-10AUG94

2. Rotate pump drive shaft and align the timing mark on the governor weight retainer (B) with timing mark on camshaft ring (A).

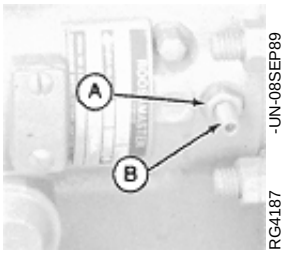
3. Loosen lock nut (A, lower illustration). Turn drive shaft locking screw (B) until drive shaft is locked with timing marks in line. Tighten lock nut.

4. Install injection pump so top edge of pump flange is parallel to edge of mating flange on cylinder block. Tighten mounting nuts to 47 N·m (35 lb-ft). Install timing hole cover and tighten securely.

IMPORTANT: Loosen locknut and turn drive shaft locking screw OUT a minimum of two full turns to be sure the drive shaft is free. Tighten lock nut securely.



RG3875 -UN-09NOV89



RG4187 -UN-08SEP89

RG,CTM1,G35,16 -19-10AUG94

5. Place injection pump drive gear in timing gear housing (if previously removed) with chamfered side of gear toward injection pump. Chamfer is at outer edge of bore for easier installation of gear to pump drive hub.

6. Carefully install drive gear on pump drive hub, positioning gear so mounting cap screws are approximately centered in mounting slots. This will allow for minor adjustment of pump housing if necessary.

7. Install drive gear-to-pump hub cap screws and tighten securely.

RG,CTM1,G35,17 -19-10AUG94

IMPORTANT: The normal backlash of gears is enough to throw the pump timing off by several degrees, resulting in poor engine performance. Therefore, it is very important that pump timing be rechecked after pump has been installed. To avoid backlash, always approach timing mark on pointer by rotating crankshaft in direction of normal engine rotation.

NOTE: Normal engine rotation is counter-clockwise, viewed from flywheel end.

8. To check alignment of injection pump, remove the JDE81-4 Timing Pin from the flywheel. Rotate the flywheel 1-1/2 revolutions opposite direction of normal rotation. Replace timing pin and rotate flywheel in direction of normal rotation until timing pin engages in timing pin hole. If the marks ARE NOT in alignment, loosen the pump drive gear cap screws. Rotate pump drive hub and bring pump hub timing marks into alignment. Repeat timing check to be sure marks are aligned. Install timing hole plug using LOCTITE 242 Thread Lock and Sealer.

9. Tighten drive gear-to-pump hub cap screws to 47 N·m (35 lb-ft).

RG,CTM1,G35,18 -19-10AUG94

10. Remove protective caps and plugs that were installed on fuel system components during injection pump removal.

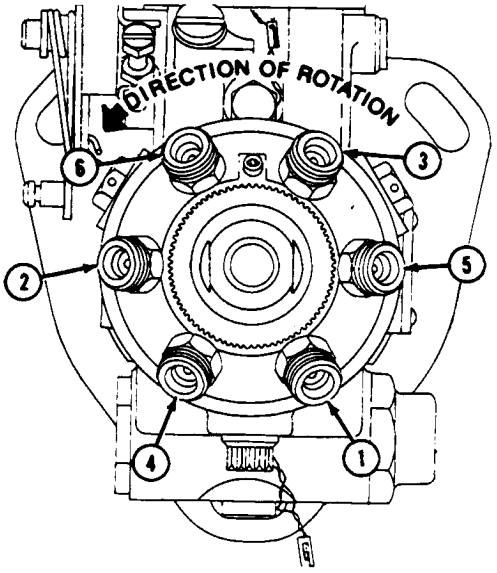
11. Connect injection pump-to-nozzle lines. Connect No. 1 outlet first and continue around pump head in counterclockwise direction, attaching lines in order of engine firing (1-5-3-6-2-4). Tighten line connectors to 27 N·m (20 lb-ft).

12. Install fuel supply pump as directed earlier in this group.

NOTE: Fill pump crankcase with the recommended amount of clean engine oil before starting engine.

13. Use a new gasket and install pump gear cover. Tighten cap screws to 27 N·m (20 lb-ft).

14. Bleed the fuel system as required. (See BLEED THE FUEL SYSTEM in Group 115.)



RG3880 -19-05DEC89

RG,CTM1,G35,19 -19-10AUG94

IDENTIFICATION OF FUEL INJECTION PUMPS—6466T AND 6466A ENGINES

The fuel injection pumps on 6466T and 6466A engines are either A-Series or P-Series pumps. The type of pump is determined by the “size of pump” indicator in the model number on the pump identification plate.

FUEL INJECTION PUMP IDENTIFICATION NUMBERS

(A)—922 14019

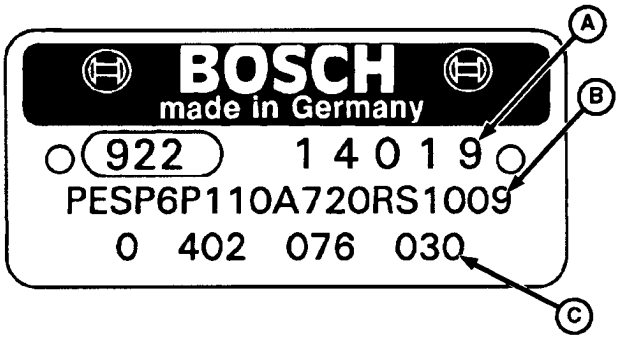
-000 00000 . . . . . Pump Serial Number

(B)—PESP6P110A720RS1009

-PESP . . . . . Injection Pump With Housing Flange
6 . . . . . Number of Plungers
P . . . . . Size of Pump
110 . . . . . Plunger Diameter in mm (110 is 11 mm)
A . . . . . Alphabetical Letter Designating Design Change
000 . . . . . Three Numbers Denoting an Assembly
R . . . . . Right-Hand Rotation (Viewed From Drive End)
S . . . . . Production Pump
0000 . . . . . Pump Identification Number

(C)—0 402 076 030

-0 000 000 000 . . . . . Bosch Part Number



RG2432 -UN-25APR94

Fuel Injection Pump ID Numbers

RG,CTM1,G35,14A-19-18AUG94

REMOVE IN-LINE FUEL INJECTION PUMP—6466T AND 6466A ENGINES

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

1. Thoroughly clean area around the injection pump and nozzles, including all line connections, using compressed air.

NOTE: Cap or plug all fuel lines as they are disconnected to prevent dirt and debris from entering fuel system. Debris in fuel system can plug injectors and cause engine damage.

RG,CTM1,G35,20 -19-10AUG94

2. Remove the timing hole plug (A, shown removed).

3. Rotate the crankshaft (in normal running direction) until No. 1 piston is at “TDC” on its compression stroke using the JDE81-1 Engine Rotation Tool. At this point, JDE81-4 Timing Pin should enter hole in flywheel.

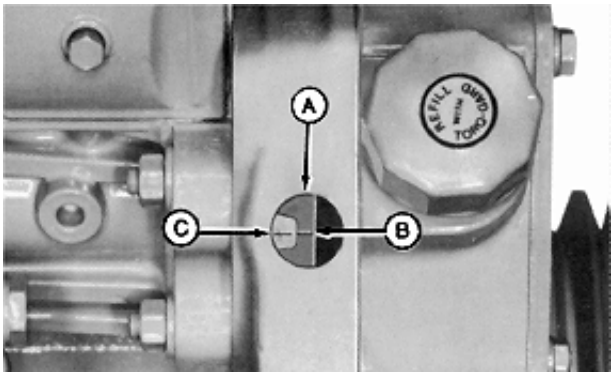
NOTE: On 6466AF001 Engines only, the injection pump is timed at 14° BTDC of No. 1 piston compression stroke. All other applications are timed at TDC.

4. The timing marks on the injection pump drive hub (B) and on the timing pointer (C) should be in alignment.

NOTE: Some injection pumps used on 6466 Engines have four cap screws attaching drive gear-to-injection pump drive hub. Some applications have three cap screws.

5. Remove injection pump gear cover.

IMPORTANT: Plug or cap all fuel lines, oil lines and hoses as they are disconnected.



RG,CTM1,G35,21 -19-10AUG94

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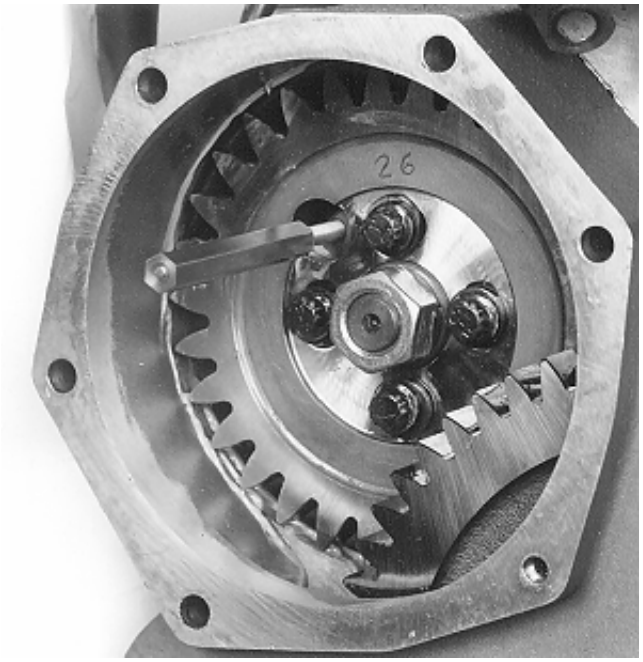
NOTE: In some situations JDG886 Injection Pump Timing Pin cannot be installed.

6. Install JDG886 Injection Pump Timing Pin through injection pump drive gear into injection pump hub until it bottoms. In some instances it may be necessary to rotate the pump drive hub slightly to get the pin installed.

7. Remove injection pump drive gear cap screws.



RG7213 -UN-26JUL94

RG,CTM1,G35,22 -19-18AUG94

8. Disconnect oil inlet line (A), fuel inlet line (B), fuel supply pump lines (C) and leak-off line (D).

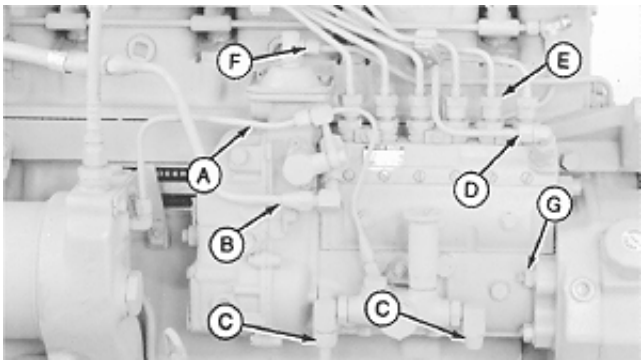
IMPORTANT: On "P" size injection pumps, the JDE90 Wrench (Bosch) and the 22 mm Open End Wrench (Nippondenso) must be used to keep the delivery valve fittings stationary while loosening the line nuts. If a delivery valve and barrel housing rotates while loosening or tightening a fuel line nut the injection pump delivery will be altered. The pump will have to be recalibrated on a test stand.

9. To remove fuel injection line nuts on Bosch P110 injection pumps, use the JDE90 Wrench with the JDF22 Crowfoot Wrench or a 3/4 in. line wrench. On Nippondenso P110 injection pumps, use a 22 mm open end wrench with either the JDF22 Crowfoot Wrench or equivalent crowfoot wrench. On A3000 injection pumps use either the JDF22 Crowfoot Wrench or an equivalent crowfoot wrench.

10. Disconnect aneroid line (F).

NOTE: On 6466A Engines equipped with Nippondenso or Robert Bosch "P" size pumps the oil filter housing must be removed before removing injection pump. (See REMOVE OIL FILTER HOUSING in Group 20.)

11. Remove four mounting nuts (G) and carefully remove injection pump. Place pump on a clean flat surface.



RG3877 -UN-09NOV89

A—Oil Inlet Line
B—Fuel Inlet Line
C—Fuel Supply Pump Line
D—Leak-Off Line
E—Injection Lines
F—Aneroid Line
G—Mounting Nut (4 used)

S11,3010,KQ -19-10AUG94

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REPAIR IN-LINE FUEL INJECTION PUMP

IMPORTANT: Do not disassemble fuel injection pump further than necessary for installing available service parts, not even for cleaning.

Be sure that injection pump serial number tag is in place and that all identification numbers are legible so that pump is set to the correct specifications for its intended use.

NOTE: Remove JDG886 Injection Pump Timing Pin when sending an injection pump out for repair.

For injection pump repair and testing, have an authorized diesel injection repair station perform the work. Unauthorized repairs made to the injection pump will void warranty.

RG,CTM1,G35,23 -19-10AUG94

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INSTALL IN-LINE FUEL INJECTION PUMP—6466T AND 6466A ENGINES

IMPORTANT: The fuel injection pump and governor MUST be prelubed prior to installation on the engine.

On 6466AF001 Engines ONLY, injection pump is timed at 14° BTDC of No. 1 piston compression stroke. The hole provided in flywheel for pump timing goes all the way through. A second timing pin hole will be found in flywheel. This hole does not go all the way through. When utilized, this second hole assures engine timing at TDC as required for adjusting valves.

NOTE: When turning the flywheel to TDC, the JDE81-4 Timing Pin can engage in the flywheel with either No. 1 or No. 6 cylinder on TDC compression stroke. When installing the fuel injection pump, No. 1 cylinder must be on TDC compression except for 6466AF001 Engines timed at 14° BTDC for on-highway applications.

1. If the engine was rotated after the injection pump was removed, rotate the flywheel using the engine rotation tools, until the timing pin engages in the flywheel as described above.

NOTE: When No. 1 cylinder is on TDC compression stroke, the intake and exhaust valves for No. 1 cylinder will be closed and both rocker arms will be loose.

RG,CTM1,G35,24 -19-10AUG94

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By using JDG886 Injection Pump Timing Pin, the timing marks on drive hub (B) and pointer (A) should be aligned. In situations where JDG886 Injection Pump Timing Pin cannot be installed, rotate injection pump drive hub until marks on drive hub and pointer are in alignment.

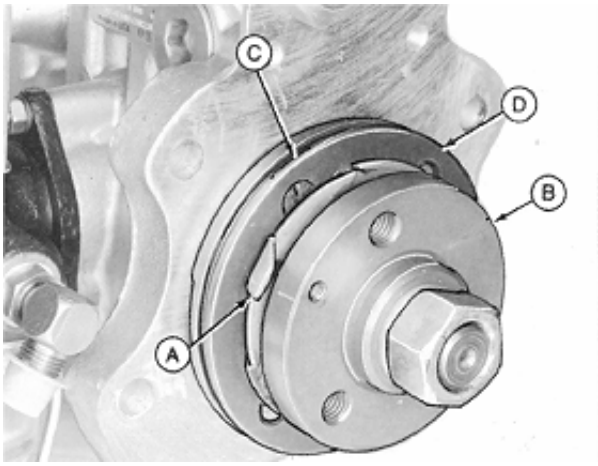
2. Install a new O-ring (C) on bearing plate (D). Lightly lubricate O-ring with AR54749 Soap Lubricant to aid in pump installation and prevent O-ring damage.

NOTE: If injection pump drive gear has been removed, put gear in timing gear housing with chamfered side of gear toward injection pump. Chamfer is at outer edge of bore for easier installation of gear to pump hub.

3. Install injection pump using moderate forward pressure and slight rocking motion to work O-ring into mounting hole.

Injection pump flange should seat solid against cylinder block and drive hub nut should be positioned in ID of drive gear.

4. Install mounting nuts and tighten to 47 N·m (35 lb-ft).



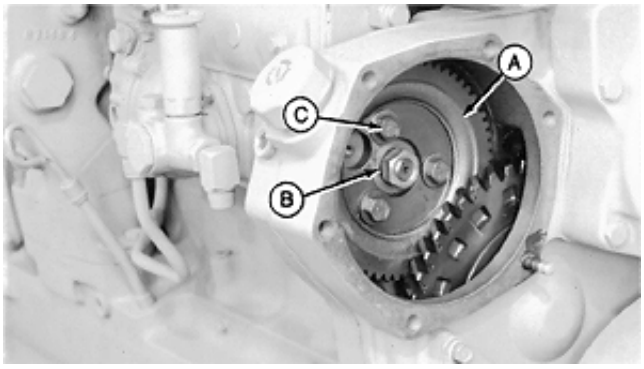
RG3673 -UN-20DEC88

A—Pointer
B—Drive Hub
C—O-Ring
D—Bearing Plate

S11,3010,KS -19-18AUG94

5. Carefully install drive gear (A) on pump drive hub (B), positioning gear so mounting cap screws (C) are approximately centered in mounting slots. This will allow for minor adjustment of pump housing if necessary.

6. Install drive gear-to-pump hub cap screws and tighten snugly.



RG3879 -UN-20DEC88

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RG,CTM1,G35,25 -19-10AUG94

IMPORTANT: The normal backlash of gears is enough to throw the pump timing off by several degrees, resulting in poor engine performance. Therefore, it is very important that pump timing be rechecked after pump has been installed. To avoid backlash, always approach timing mark on pointer by rotating crankshaft in direction of normal engine rotation.

NOTE: Normal engine rotation is counter-clockwise, viewed from flywheel end.

7. Remove JDG886 Injection Pump Timing Pin. Injection pump hub timing marks should be aligned.

In some instances, JDG886 Injection Pump Timing Pin cannot be installed. To check alignment of injection pump in these situations, remove JDE81-4 Timing Pin from flywheel. Rotate flywheel 1-1/2 revolutions in opposite direction of normal rotation. Replace timing pin and rotate flywheel in direction of normal rotation until timing pin engages in timing pin hole. If marks ARE NOT in alignment, loosen pump drive gear cap screws. Rotate pump drive hub and bring pump hub timing marks into alignment. Repeat timing check to be sure marks are aligned.

8. Install timing hole plug using LOCTITE 242 Thread Lock and Sealer.

9. Tighten drive gear-to-pump hub cap screws to 47 N·m (35 lb-ft).

RG,CTM1,G35,26 -19-18AUG94

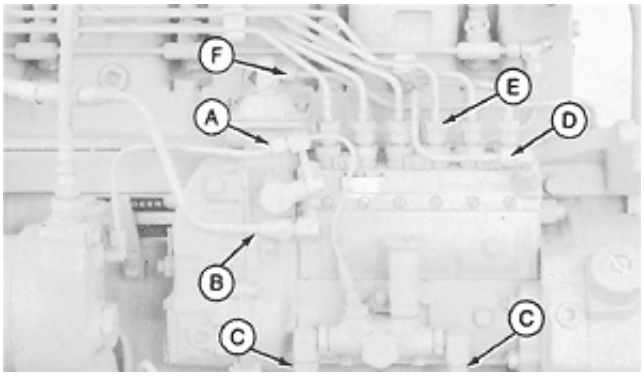
10. Remove protective caps and plugs that were installed on fuel system components during injection pump removal.

11. Install fuel supply pump as directed earlier in this group.

RG,CTM1,G35,27 -19-10AUG94

12. Connect lubrication line (A) fuel inlet line (B), fuel supply pump lines (C), leak-off line (D) and aneroid line (F), if so equipped. Tighten all connections securely.

A—Lubrication Line
B—Fuel Inlet Line
C—Fuel Supply Pump Lines
D—Leak-Off Line
E—Injection Lines
F—Aneroid Line



-UN-09NOV89
RG3881

S11,3010,KT -19-10AUG94

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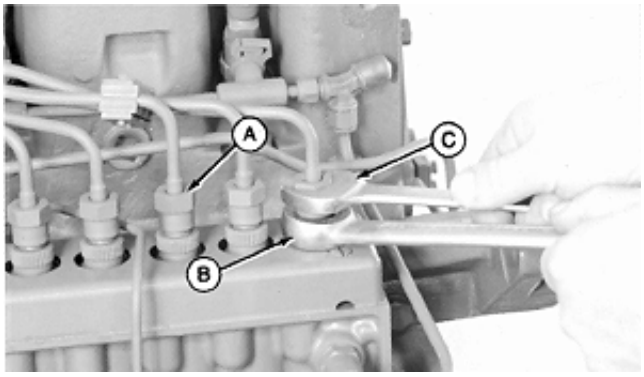
IMPORTANT: On "P" size injection pumps, the JDE90 Wrench (Bosch) and the 22 mm Open End Wrench (Nippondenso) must be used to keep the delivery valve fittings stationary while loosening the line nuts. If a delivery valve and barrel housing rotates while loosening or tightening a fuel line nut the injection pump delivery will be altered. The pump will have to be recalibrated on a test stand.

13. To install fuel injection line nuts (A) on Bosch P110 injection pumps, use the JDE90 Wrench (B) with the JDF22 Crowfoot Wrench or a 3/4 in. line wrench (C). On Nippondenso P110 injection pumps use a 22 mm open end wrench with either the JDF22 Crowfoot Wrench or equivalent crowfoot wrench. On A3000 injection pumps use either the JDF22 Crowfoot Wrench or an equivalent crowfoot wrench. Tighten lines to 27 N·m (20 lb-ft).

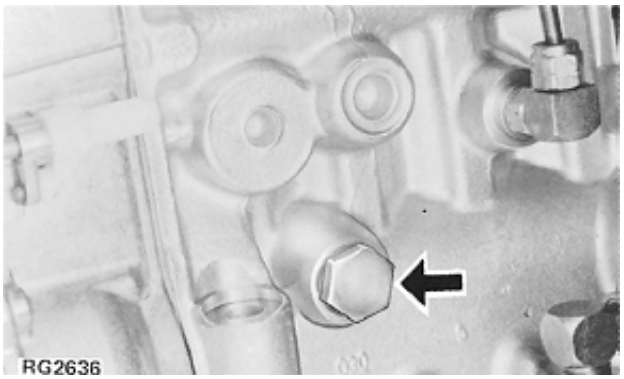


RG3954 -UN-09NOV89

14. Use a new gasket and install pump gear cover. Tighten cap screws to 27 N·m (20 lb-ft).

NOTE: On 6466A Engines with "P" size injection pumps, install oil filter housing assembly at this time. (See Lubrication System, Group 20.)

IMPORTANT: Oil fill locations may vary by injection pump applications. Familiarize yourself with the location on your engine before adding oil to pump.



RG2636 -UN-20DEC88

15. Remove oil filler plug (arrow) and add enough clean engine oil until oil comes out fill hole. Engine should be level when checking oil level.

16. Bleed the fuel system as required. (See BLEED THE FUEL SYSTEM in Group 115.)

17. Adjust engine speed. (See OPERATION AND TESTS section in your Machine Technical Manual).(For 6466TF and 6466AF Engines, see Group 115.)

NOTE: JDF33 Socket is required to loosen fast idle stop screw on Nippondenso injection pumps.

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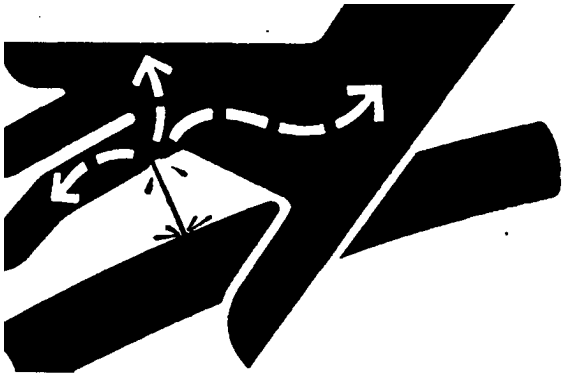
RG,CTM1,G35,28 -19-10AUG94

REMOVE FUEL INJECTION NOZZLES



X9811 -UN-23AUG88

CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin, causing serious injury. Before disconnecting lines, be sure to relieve pressure. Before applying pressure to the system, be sure ALL connections are tight and lines, pipes and hoses are not damaged. Keep hands and body away from pinholes and 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.

NOTE: Follow the same removal procedure for all 6466 Engine applications.

S11,3010,FR -19-08APR94

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• **General Nozzle Service Precautions:**

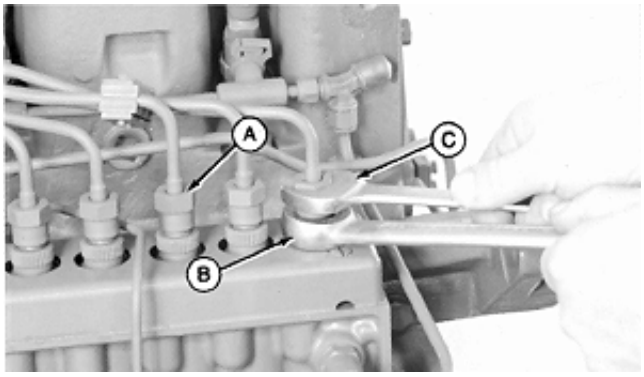
1. Thoroughly clean area around the injection pump and nozzles, including all line connections, using compressed air.

2. Cap or plug all fuel lines as they are disconnected to prevent dirt and debris from entering fuel system. Debris in fuel system can plug injectors and cause engine damage.

3. Disconnect injection lines from injection pump using JDF22 Crowfoot Wrench.

IMPORTANT: On “P” size injection pumps, the JDE90 Wrench (Bosch) and the 22 mm Open End Wrench (Nippondenso) must be used to keep the delivery valve fittings stationary while loosening the line nuts. If a delivery valve and barrel housing rotates while loosening or tightening a fuel line nut the injection pump delivery will be altered. The pump will have to be recalibrated on a test stand.

4. To remove fuel injection line nuts (A) on Bosch P110 injection pumps use the JDE90 Wrench (B) with the JDF22 Crowfoot Wrench or a 3/4 in. line wrench (C). On Nippondenso P110 injection pumps use a 22 mm open end wrench with either the JDF22 Crowfoot Wrench or equivalent crowfoot wrench. On A3000 injection pumps use either the JDF22 Crowfoot Wrench or an equivalent crowfoot wrench.



RG3954 -UN-09NOV89

S11,3010,KY -19-10AUG94

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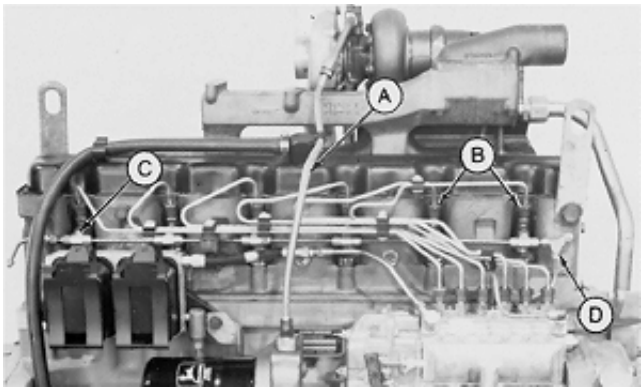
5. On 6466T and 6466A Engines, disconnect turbocharger oil inlet line (A).

6. Remove fuel delivery line connections (B) at injection nozzles. Remove fuel delivery lines as an assembly.

NOTE: Effective with Engine Serial No. (286642—), all metal leak-off lines are being used in production.

7. Remove leak-off line-to-injection nozzle connections (C) and leak-off line-to-injection pump connection (D). Remove complete leak-off assembly.



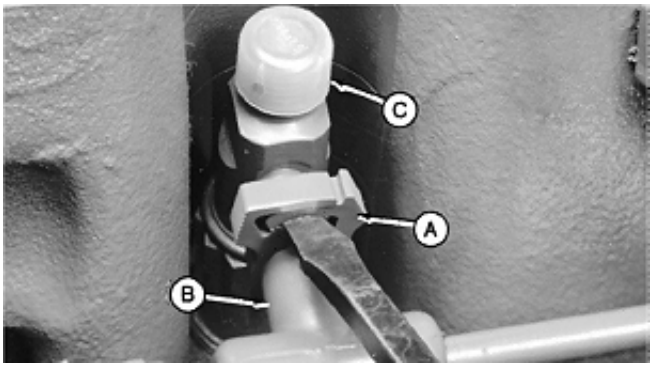
RG4635 -UN-14DEC88

A—Turbocharger Oil Inlet Line
B—Fuel Delivery Line Connection
C—Leak-Off Line-to-Injection Nozzle Connection
D—Leak-Off Line-to-Injection Pump Connection

S11,3010,KZ -19-10AUG94

8. On engines not equipped with all metal leak-off lines, use a screwdriver or other suitable tool and pry leak-off clamp (A) apart from leak-off line (B). Remove complete leak-off assembly.

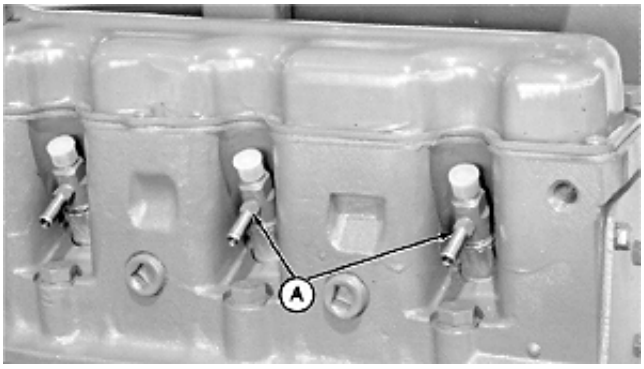
9. Cap or plug all fuel injection nozzles (C).



RG3885 -UN-09NOV89

S11,3010,LA -19-08APR94

10. Remove leak-off connectors (A) and washers or O-rings.



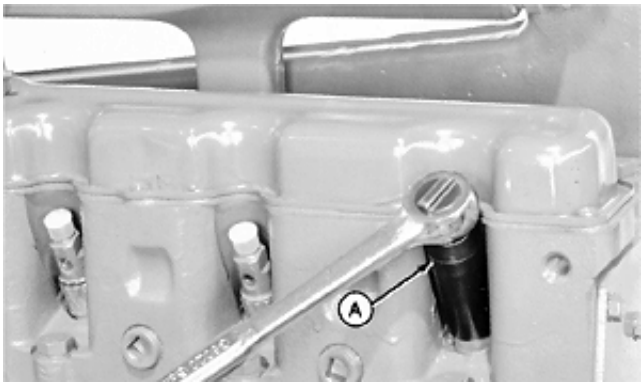
RG3552 -UN-20DEC88

S11,3010,LB -19-08APR94

NOTE: The socket portion of the JDE92 Wrench (A) may be used to remove nozzles from head.

11. If the JDE92 Wrench is not used, use a 24 mm (15/16 in.) deep socket on gland nut to remove nozzle. The gland nut will act as a jack screw to raise nozzle out of the cylinder head bore.

12. To prevent debris from entering the combustion chamber after nozzle has been removed, install a 12.7 mm (1/2 in.) hardwood dowel in the nozzle bore.



-UN-20DEC88
RG3886

S11,3010,LC -19-08APR94

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

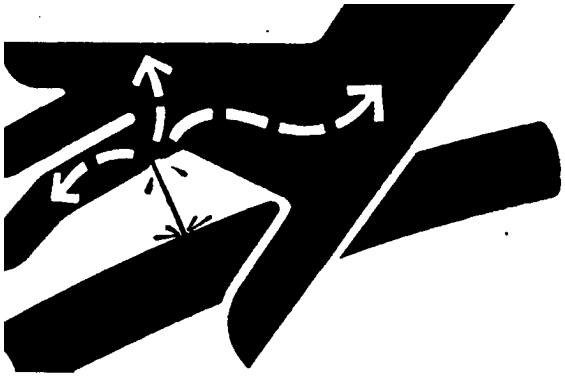
Problem	Possible Cause	Suggested Remedy
No Chatter	Spring components misaligned.	Adjust opening pressure.
	Varnish on valve.	Clean guide area.
	Deposits in seat area.	Clean seat.
	Bent valve.	Replace nozzle.
	Valve seat eroded or pitted.	Lap valve to seat. Replace nozzle as necessary.
	Tip seat pitted.	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 FUEL INJECTION NOZZLES

Before disassembling, test injection nozzles with clean filtered fuel to determine its condition.

Test for:
—Opening Pressure
—Leakage
—Chatter
—Spray Pattern



X9811 -UN-23AUG88

CAUTION: Nozzle tip should always be directed away from operator. Fuel from spray orifices can penetrate skin and clothing, causing serious personal injury. Enclosing nozzle in a transparent cover, or glass beaker is recommended.

Before applying pressure to nozzle tester, be sure all connections are tight and fittings are not damaged. Fuel escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood; rather than your hands, to search for suspected leaks.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

S11,0408,AL -19-08APR94

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TEST NOZZLE OPENING PRESSURE

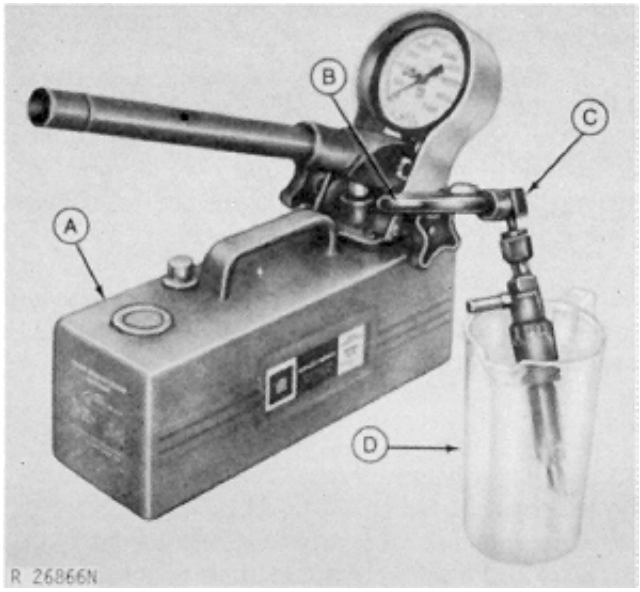
1. Connect KDEL injection nozzle to No. Y-900 Nozzle Tester (A), using No. Y-900-2 Fuel Line (B) and Y-900-7 and Y-900-15 Straight Adapters (C). The Y-900-11 90° Adapter may also be used. Place a glass beaker (D) around nozzle.

2. Pump handle several times to flush out nozzle fittings. Tighten fittings.

3. Expel air from nozzle by operating pump handle several strokes. Then raise pressure until valve opens.

4. Recheck by completely releasing pressure, then gradually building pressure until valve opens.

IMPORTANT: Nozzle tester should be checked periodically for accuracy.



-UN-20DEC88
R26866

A—Nozzle Tester
B—Fuel Line
C—Adapter
D—Beaker

S11,0408,AM -19-08APR94

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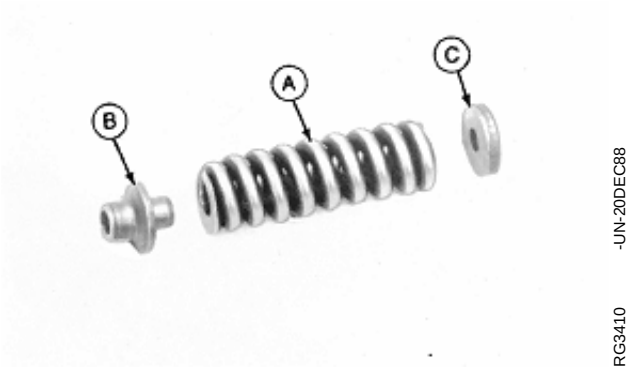
INJECTION NOZZLE SPECIFICATIONS



RG3410 -UN-20DEC88

A new nozzle, or a used nozzle with a new spring (A), should open at approximately the following pressures. A used nozzle that has been rebuilt with a new spring and/or valve should be reset to the same pressures as a new nozzle. New nozzle opening pressures are:

NEW NOZZLE OPENING PRESSURES—BY NOZZLE TIP SIZE**

4 x 0.275 mm	25 500 kPa (255 bar) (3700 psi)
4 x 0.28 mm	25 900 kPa (259 bar) (3750 psi)
4 x 0.30 mm	26 200 kPa (262 bar) (3800 psi)
4 x 0.33 mm	27 900 kPa (279 bar) (4050 psi)
4 x 0.345 mm	27 900 kPa (279 bar) (4050 psi)
4 x 0.35 mm	27 900 kPa (279 bar) (4050 psi)
4 x 0.36 mm	29 400 kPa (294 bar) (4250 psi)
4 x 0.40 mm	27 900 kPa (279 bar) (4050 psi)
5 x 0.28 mm	25 990 kPa (260 bar) (3769 psi)
6 x 0.285 mm	29 400 kPa (294 bar) (4250 psi)

On nozzles which have been in service, spring and spring seat (B) will have taken a normal set. In this case opening pressure is satisfactory if it meets or exceeds used nozzle minimum opening pressure given below, but does not exceed new opening pressure given above. Used nozzle minimum opening pressures are:

USED NOZZLE OPENING PRESSURE—BY NOZZLE TIP SIZE**

4 x 0.275 mm	24 800 kPa (248 bar) (3600 psi)
4 x 0.28 mm	24 800 kPa (248 bar) (3600 psi)
4 x 0.30 mm	24 800 kPa (248 bar) (3600 psi)
4 x 0.33 mm	26 200 kPa (262 bar) (3800 psi)
4 x 0.345 mm	26 200 kPa (262 bar) (3800 psi)
4 x 0.35 mm	26 200 kPa (262 bar) (3800 psi)
4 x 0.36 mm	26 200 kPa (262 bar) (3800 psi)
4 x 0.40 mm	26 200 kPa (262 bar) (3800 psi)
5 x 0.28 mm	23 390 kPa (234 bar) (3392 psi)
6 x 0.285 mm	26 200 kPa (262 bar) (3800 psi)

Shims (C) of different thickness are available for changing the opening pressure adjustment. Each 0.05 mm (0.002 in.) of shim thickness changes opening pressure approximately 700 kPa (7 bar) (100 psi).

IMPORTANT: Always use John Deere nozzle adjusting shims which are specially hardened. Other shims will not be satisfactory.

If nozzle opening pressure is not correct, disassemble injection nozzles, described later in this group, and change shims until nozzles open at the proper new nozzle pressure given above. The difference in nozzle opening pressures between cylinders in an engine should not exceed 350 kPa (3.5 bar) (50 psi).

*** See ASSEMBLE FUEL INJECTION NOZZLE, later in this group, for nozzle tip size identification.*

S11,3010,LD -19-10AUG94

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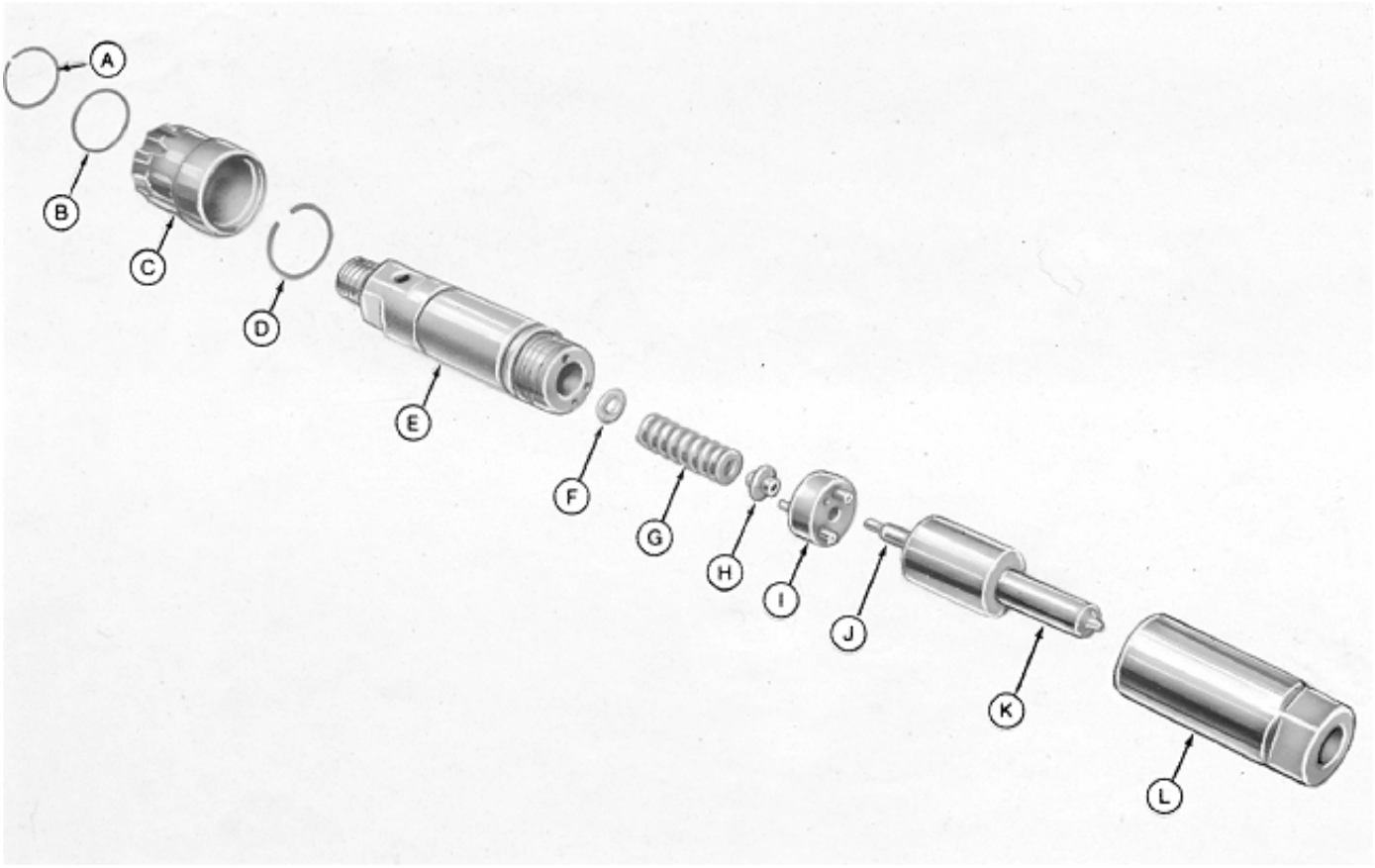
TEST NOZZLE LEAKAGE



A—Snap Ring (Upper)
B—Gland Nut O-Ring
C—Gland Nut
D—Snap Ring (Lower)
E—Nozzle Holder
F—Shim
G—Nozzle Valve Spring
H—Spring Seat
I—Intermediate Plate
J—Nozzle Valve
K—Nozzle
L—Nozzle Retaining Nut

1. Wipe nozzle dry.

2. Bring pressure up slowly to 1 970 kPa (20 bar) (285 psi) below the opening pressure. Watch for an accumulation of fuel from the spray orifice, indicating a bad seat.

If the nozzle drips within 10 seconds, replace nozzle valve (J) and Nozzle (K).

3. Check for leakage around nozzle retaining nut (L) thread connection with nozzle holder (E).

Leakage indicates a bad seat either between nozzle and intermediate plate (I) or between nozzle holder and intermediate plate.

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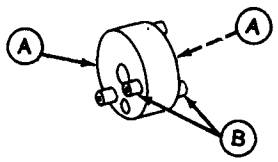
S11,0408,AO -19-10AUG94

RG2248 -UN-20APR89



RG2248

IMPORTANT: Do not lap the machined surfaces (A) of the intermediate plate in an attempt to stop fuel leakage at these locations. Dowels (spring pins) (B) in plate have to be removed before surfaces can be lapped. Removing dowels is not recommended as removal is likely to damage them, and replacement dowels are not available as service parts.

If leakage is observed, tighten nozzle retaining nut to a maximum of 79 N·m (58 lb-ft). Replace injection nozzle if leakage continues.

S11,0408,AP -19-08APR94

TEST NOZZLE CHATTER AND SPRAY PATTERN

1. Injection nozzle should chatter very softly, and only when hand lever movement is very rapid (four to six downward movements per second). Failure to chatter may be caused by a binding or bent nozzle valve.

2. Until chattering range is reached, test oil emerges as non-atomized streams. When lever movement is accelerated, sprays should be very broad and finely atomized.

A partially clogged or eroded orifice will usually cause spray to deviate from correct angle. Spray will also be steady rather than finely atomized.

3. Disassemble nozzle for cleaning or reconditioning if it fails to chatter or spray properly.

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S11,0408,AQ -19-08APR94

DISASSEMBLE FUEL INJECTION NOZZLE

General Nozzle Repair Notes:

NOTE: Disassembly of nozzles is not recommended unless servicing is indicated by nozzle operation and testing.

• Since dirt and water are the worst contaminants in fuel injection system, working area, tools and cleaning materials must be kept spotlessly clean. Whenever possible, work in an isolated, dust-free area.

• Cover workbench with clean paper before disassembly of injection nozzles.

• As parts are disassembled, place them in a pan of clean diesel fuel and leave there until needed. Do not permit parts to strike each other.

• Use a separate pan of clean diesel fuel for washing parts before assembly.

S11,0408,AR -19-08APR94

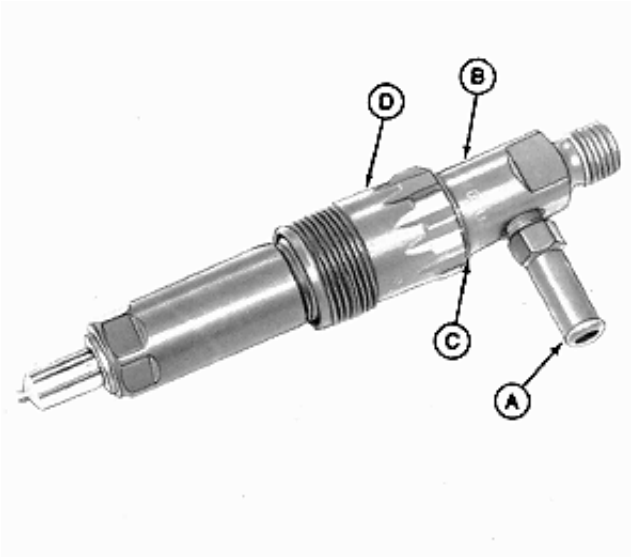
NOTE: The KDEL injection nozzle is a metric unit and only metric tools should be used.

1. Use an 11 mm box or open-end wrench and unscrew leak-off connector (A) (if not removed previously) from nozzle holder (B).

2. Remove O-ring and upper snap ring (C) from nozzle holder.

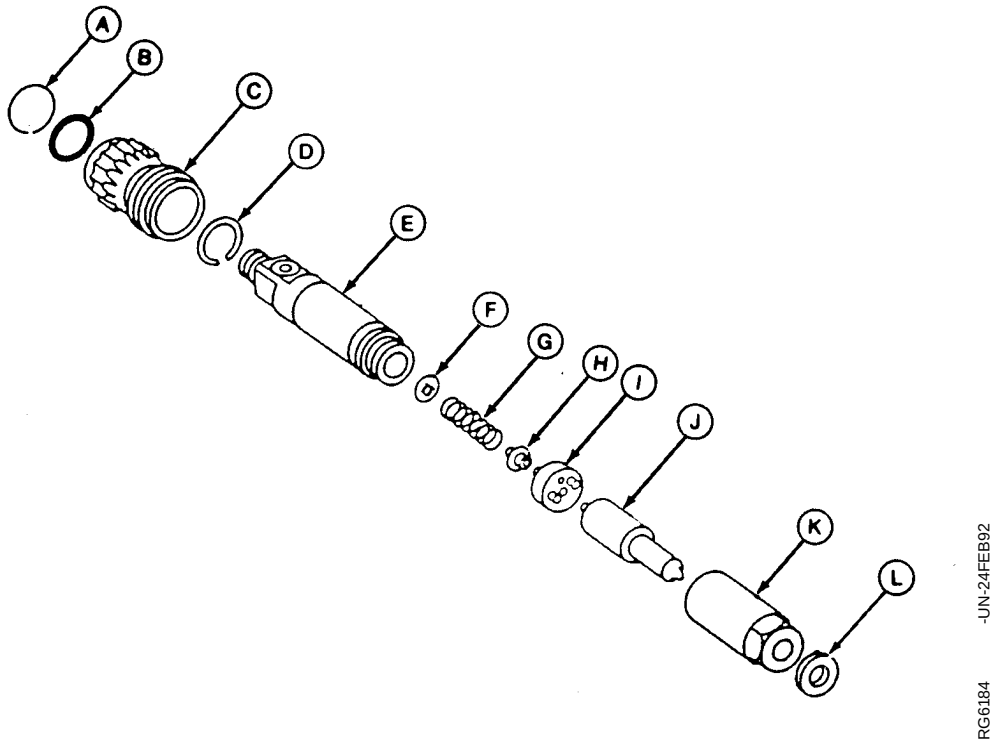
3. Slip gland nut (D) off nozzle holder.

A—Leak-Off Connector
B—Nozzle Holder
C—O-Ring and Upper Snap Ring
D—Gland Nut



RG3887 -UN-20DEC88

S11,0408,AS -19-08APR94



A—Snap Ring (Upper)
B—Gland Nut O-Ring
C—Gland Nut
D—Snap Ring (Lower)
E—Nozzle Holder
F—Shim
G—Nozzle Valve Spring
H—Spring Seat
I—Intermediate Plate
J—Nozzle
K—Nozzle Retaining Nut
L—Washer

4. Remove lower snap ring (D).

5. Clamp the two flats of the nozzle holder (fuel inlet end) in a soft-jawed vise and remove nozzle retaining nut (K), using a 12-point 19 mm wrench.

6. Remove nozzle assembly (J and K).

7. Pull off intermediate plate (I).

8. Remove spring seat (H), spring (G), and shims (F).

9. Withdraw nozzle valve from nozzle. If valve is stuck, it may be necessary to soak nozzle assembly in Bendix cleaner, acetone, or other commercial cleaners sold especially for freeing stuck valves.

CAUTION: Use these nozzle cleaning fluids in accordance with manufacturer's instructions.

Do not permit lapped surfaces of valve and nozzle to come in contact with any hard substance. DO NOT touch valve unless your hands are wet with fuel.

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S11,0408,AT -19-08APR94

CLEAN AND INSPECT FUEL INJECTION NOZZLE ASSEMBLY

IMPORTANT: Never use a steel brush to clean nozzles. Steel brush may damage injection nozzles.

1. Remove anti-corrosive coating from new or reconditioned nozzles by washing them thoroughly with diesel fuel.

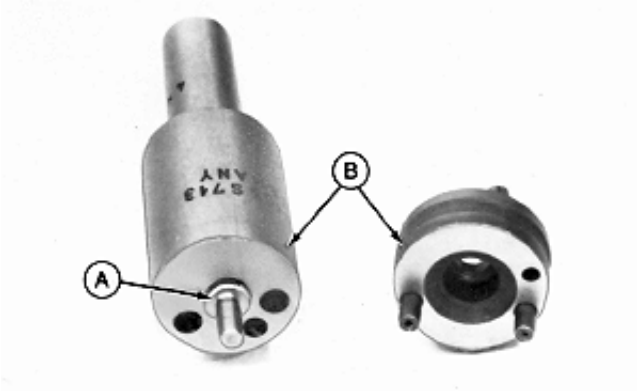
2. Remove carbon from used nozzles and clean by washing them in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush.

3. After removing carbon or lacquer from nozzle exterior, inspect lapped surface for nicks or scratches. Replace if not in good condition.

4. Inspect piston part of nozzle valve (A) to see that it is not scratched or scored. If any of these conditions are present, replace nozzle assembly.

5. Inspect nozzle valve seat, nozzle, and intermediate plate. Contact area of parts (B) must not be scored or pitted. Use inspection magnifier in JDF13 (JDE105) Nozzle Cleaning Kit to aid inspection.

NOTE: A bad nozzle valve seat will cause fuel to drip from nozzle. This condition will usually be noted when making the "Leakage Test".



RG3411 -UN-20DEC88

S11,0408,AU -19-08APR94

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PERFORM NOZZLE SLIDE TEST

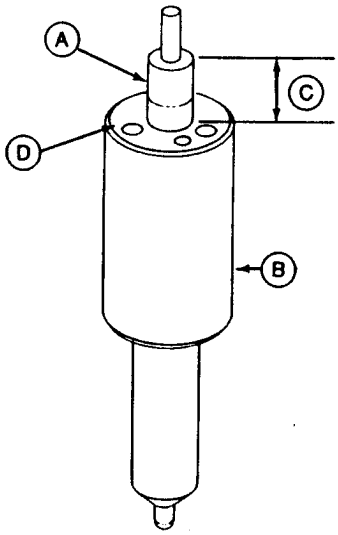
NOTE: DO NOT touch lapped surface (D) unless hands are wet with diesel fuel.

1. Dip nozzle valve (A) in clean diesel fuel.

2. Insert valve in nozzle (B).

3. Hold nozzle vertical and pull valve out about one-third of its engaged length.

4. Release valve. Valve should slide down (C) to its seat by its own weight. Always replace a nozzle assembly if the valve does not fall freely to its seat.



RG2233 -UN-12APR93

A—Nozzle Valve
B—Nozzle
C—Free-Fall Distance
D—Lapped Surface

S11,3010,CZ -19-08APR94

CLEAN SPRAY ORIFICES

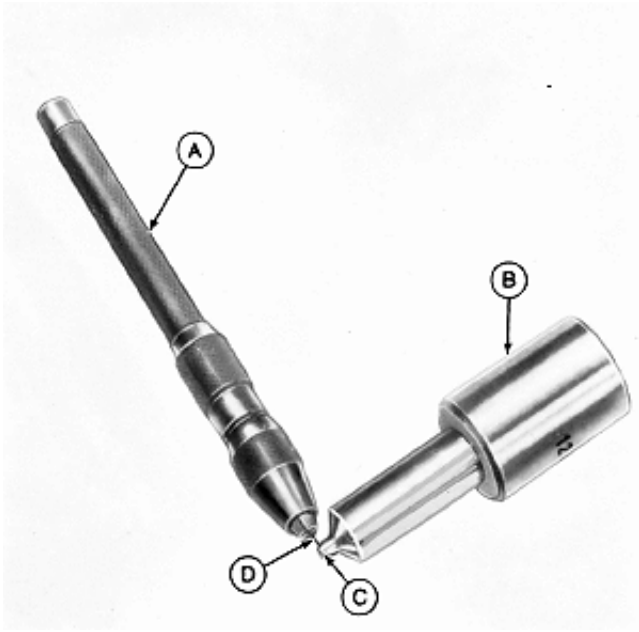
1. Begin with cleaning wire (D) 0.07—0.10 mm (0.003—0.004 in.) smaller than nominal orifice size of 0.33 mm (0.13 in.) from JDF13 (JDE105) Nozzle Cleaning Kit.

NOTE: Stoning wire to provide a flat surface on one side will help in reaming carbon from clogged hole.

2. Clamp cleaning wire in pin vise (A). Wire should not protrude from vise more than 0.8 mm (1/32 in.).

3. Insert wire into orifice (C) and rotate.

4. For final cleaning, use cleaning wire 0.03 mm (0.001 in.) smaller than orifice size. Follow previous steps until orifices are clean of any carbon deposits.



RG3412 -UN-20DEC88

A—Pin Vise
B—Nozzle
C—Orifice
D—Cleaning Wire

S11,3010,DA -19-08APR94

INSPECT NOZZLE HOLDER

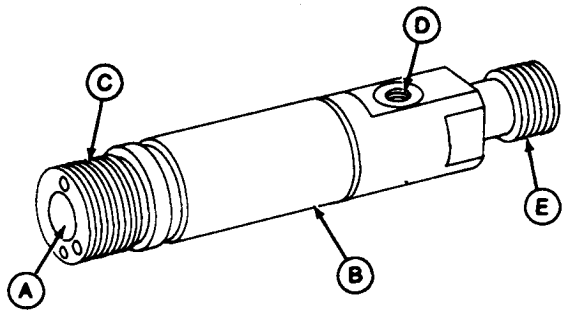
1. Inspect lapped surface (A) on bottom end of nozzle holder (B) for nicks or scratches. Replace holder if not in good condition.

2. Inspect threads M19 x 1 (C), M6 x 1 (D), and M14 x 1.5 (E) on nozzle holder for general condition. Threads that are nicked slightly may be “dressed-up.” Replace holder if threads cannot be restored to a serviceable condition.

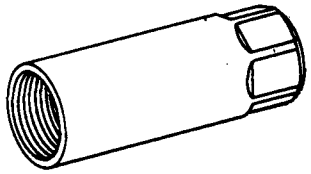
Check fuel passages in nozzle holder to make sure they are open. Clean with compressed air.

3. Remove carbon deposits on both inner and outer surfaces of nozzle retaining nut.

4. Inspect retaining nut for cracks caused by overtightening or a damaged lower seating surface. A seat may be restored by rubbing the surface with emery cloth. Any nozzle nut which cannot be reconditioned, must be replaced.



RG3413 -UN-20DEC88



RG2247 -UN-20DEC88

RG2247

A—Lapped Surface
B—Nozzle Holder
C—M19 x 1
D—M6 x 1
E—M14 x 1.5

S11,3010,DB -19-08APR94

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5. Examine lapped surfaces on intermediate plate (A) for nicks, scratches, or worn areas which would permit fuel to leak past.

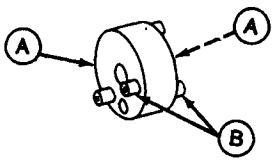
6. Replace intermediate plate if lapped surfaces are worn or damaged.

IMPORTANT: Do not lap machined surfaces of intermediate plate. Dowel pins (B) in plate have to be removed before surfaces can be lapped. Removing these dowels is not recommended as removal is likely to damage them, and replacement dowels are not available as service parts.

7. Inspect spring seat for splitting, cracking, or excessive wear.

Replace seat if any of these conditions are evident.

RG2248 -UN-20APR89



RG2248

RG2249 -UN-20APR89

RG2249

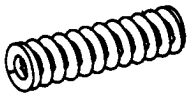
S11,3010,DC -19-08APR94

8. Examine spring and shims for pitting or excessive wear. Replace as necessary.

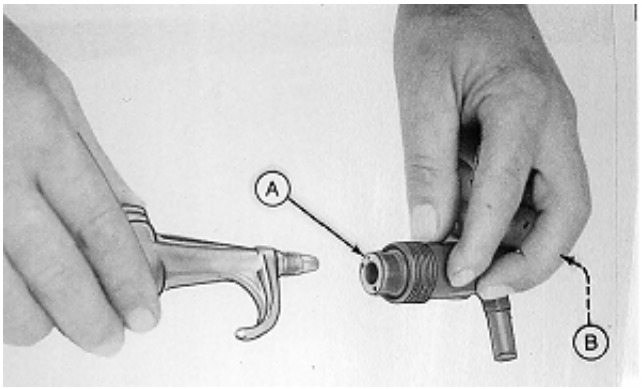
NOTE: The edge-type filter is pressed into the nozzle holder (B) and is not removable for service.

9. Clean filter by applying compressed air to nozzle holder fuel passage (A) at nozzle end.

RG2250 -UN-20APR89



RG2250



RG2251 -UN-28JUL94

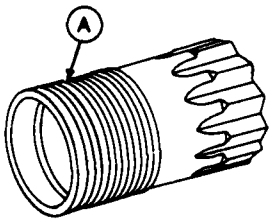
S11,0408,BD -19-08APR94

INSPECT GLAND NUT

1. Inspect nozzle holder gland nut for general condition, be sure that it is not cracked or split.

2. Inspect the M28 x 1.5 threads (A) for general condition. Threads which are slightly nicked or damaged may be “dressed up.”

Replace gland nut if unable to restore to a serviceable condition.



RG3414 -UN-20DEC88

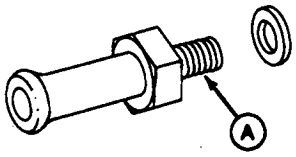
S11,0408,BF -19-08APR94

RG3888 -UN-20DEC88

3. Check passage in leak-off connector to see that it is open.

4. Blow through connector passage with compressed air.

5. Inspect M6 x 1 threads (A) for general condition. Replace connector if threads are damaged and can not be restored to a serviceable condition.



S11,0408,BG -19-05APR93

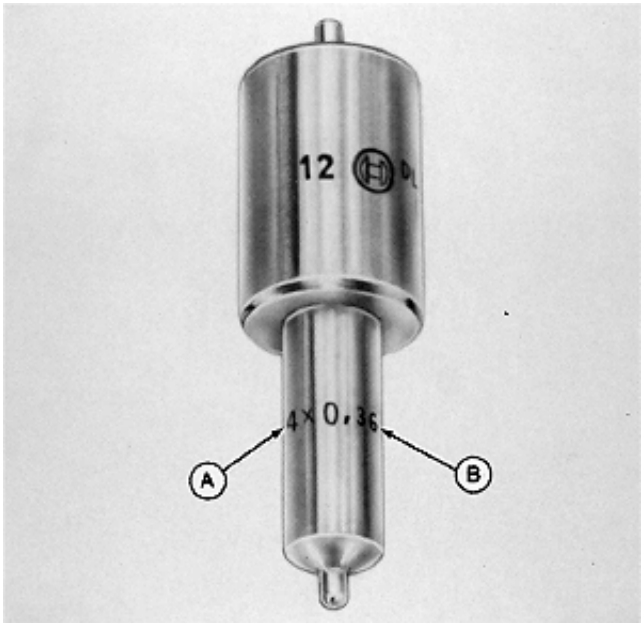
ASSEMBLE FUEL INJECTION NOZZLE

IMPORTANT: Be sure to install correct nozzle assembly on nozzle holder. Do not intermix different size nozzle assemblies, or nozzles from different suppliers.

To help determine correct nozzle assembly for each application, note markings on lower part of nozzle.

The illustration shows a nozzle marked 4 x 0.36. The number “4” (A) indicates the number of orifices and “0.36” (B) indicates the orifice size in millimeters.

IMPORTANT: Immerse parts in clean fuel before assembly. DO NOT dry parts with towels or compressed air. Dust particles might collect and stay on pressure faces of nozzle valve and nozzle holder.



R28734 -UN-20DEC88

S11,3010,LE -19-10AUG94

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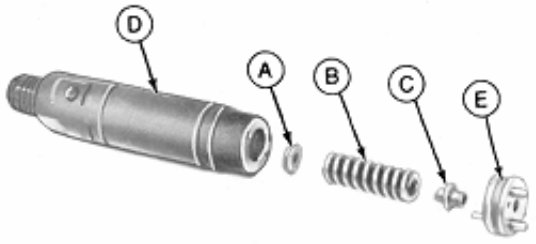
60

1. Place shims (A), spring (B), and spring seat (C) in nozzle holder (D) while still wet with diesel fuel.

NOTE: Make sure intermediate plate (E) is free of any foreign material before reassembling.

A—Shims
B—Spring
C—Spring Seat
D—Nozzle Holder
E—Intermediate Plate



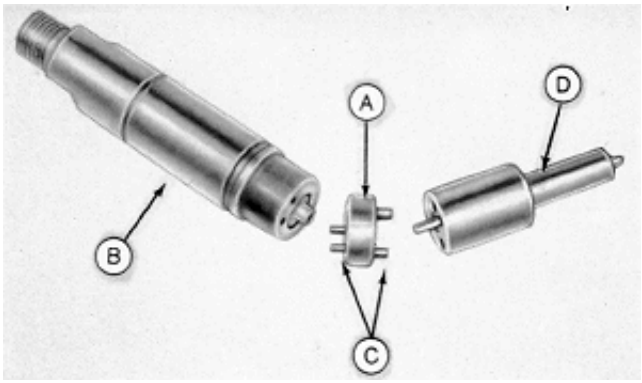
-UN-20DEC88
RG3415

S11,3010,DF -19-19JUL82

2. Position intermediate plate (A) on nozzle holder (B). Dowel pins (C) in plate will permit installation only one way.

3. Insert nozzle valve into nozzle (D) while holding parts below diesel fuel level in pan.

A—Intermediate Plate
B—Nozzle Holder
C—Dowel Pins
D—Nozzle and Valve



-UN-29NOV88
RG2254

S11,3010,DG -19-08APR94

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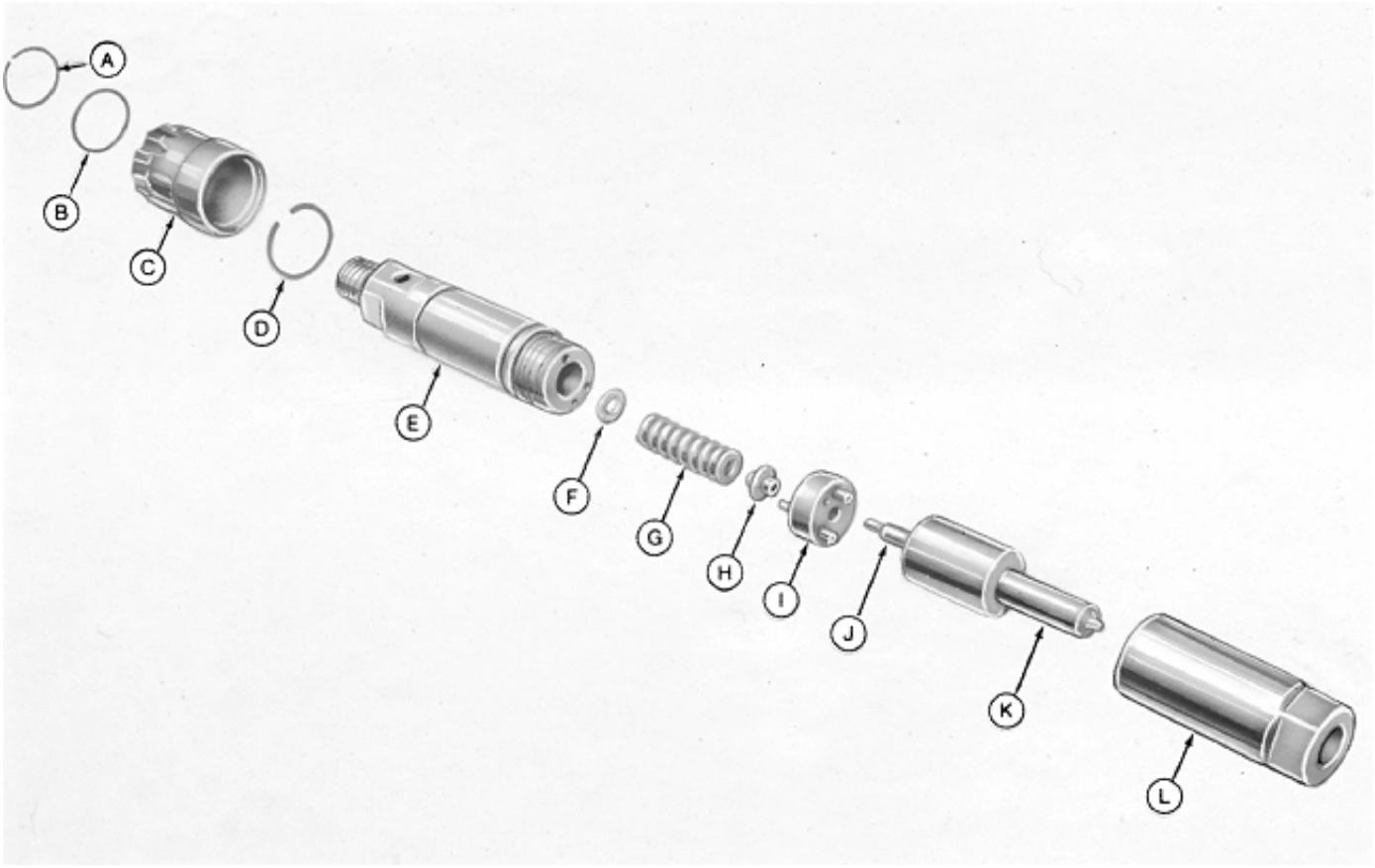

RG2591 -UN-16FEB94

A—Snap Ring (Upper)
B—Gland Nut O-Ring
C—Gland Nut
D—Snap Ring (Lower)
E—Nozzle Holder
F—Shim
G—Nozzle Valve Spring
H—Spring Seat
I—Intermediate Plate
J—Nozzle Valve
K—Nozzle
L—Nozzle Retaining Nut

4. Install nozzle assembly on nozzle holder (E) and secure with nozzle retaining nut (L).

5. Clamp nozzle holder in a soft-jawed vise. Tighten nozzle retaining nut (L) 60—79 N·m (44—58 lb-ft).

6. Install lower snap ring (D) on nozzle holder.

7. Coat bore of gland nut (C) liberally with PT569 NEVER-SEEZ compound to prevent gland nut from seizing on holder body.

8. Install upper snap ring (A) on nozzle holder and position O-ring (B) against gland nut.

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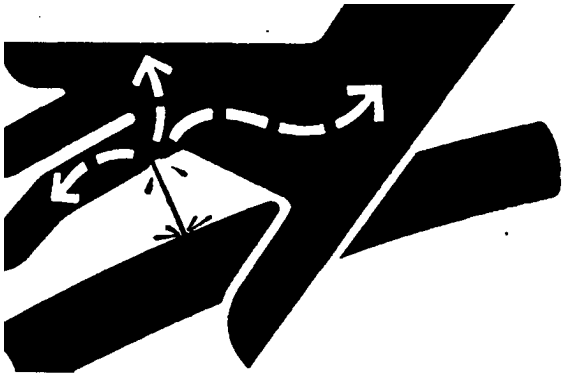
NOTE: For engines up to Engine Serial No. (—312216), a washer is used between leak-off connector and nozzle holder. For engines beginning with Engine Serial No. (312217—), an O-ring is used in place of the washer.

9. Install leak-off connector on nozzle holder (E), using a new washer or O-ring.

NOTE: Leak-off connector and washer or O-ring should be installed on nozzle holder even though they will have to be removed to install injection nozzle in cylinder head. This will prevent misplacement of connector and washer or O-ring before installation on engine.

S11,0408,BK -19-10AUG94

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 injured by escaping fluid, 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.

1. Connect nozzle to nozzle tester, as directed earlier in this group.

2. Refer to TEST OPENING PRESSURE, earlier in this group, to test opening pressure of nozzle. Adjust as needed.

3. Refer to TEST NOZZLE LEAKAGE, earlier in this group, to test for leakage.

4. Refer to TEST CHATTER AND SPRAY PATTERN, earlier in this group, to test nozzle overall operation.

RG,CTM1,G35,10 -19-08APR94

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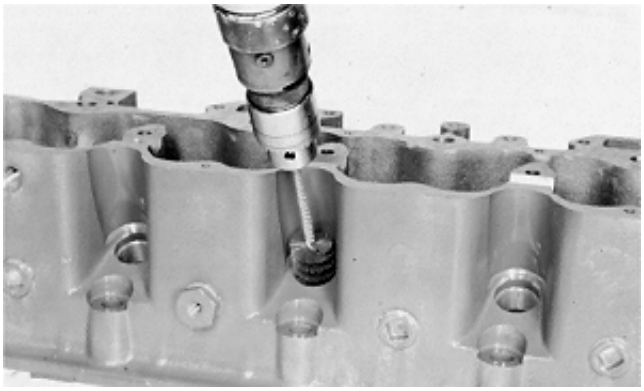
63

INSPECT AND CLEAN CYLINDER HEAD NOZZLE BORE


RG5251 -UN-14DEC88

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

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

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

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

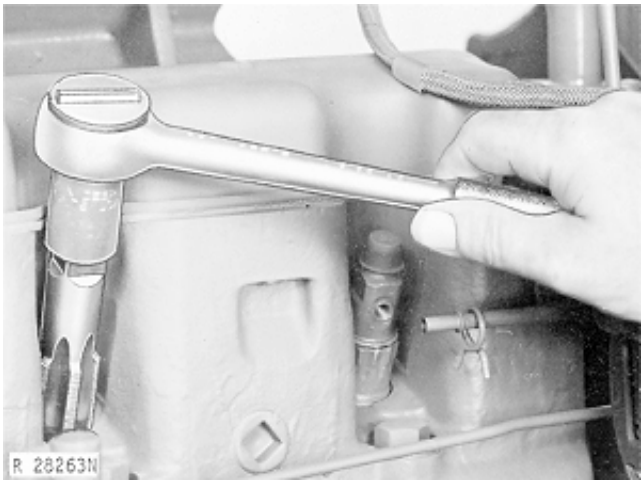
3. Clean threads which have light foreign deposits using an electric drill and D17030BR Nozzle Thread Cleaning Brush. Work brush up and down several times to clean threads.

S11,0408,BL -19-17AUG94

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

5. After cleaning threads, insert a 13 mm (1/2 in.) tapered hardwood dowel to plug nozzle tip bore.

6. Blow out debris from nozzle cavity with compressed air; then remove wood dowel.



R28263N -UN-20DEC88

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S11,0408,BM -19-08APR94

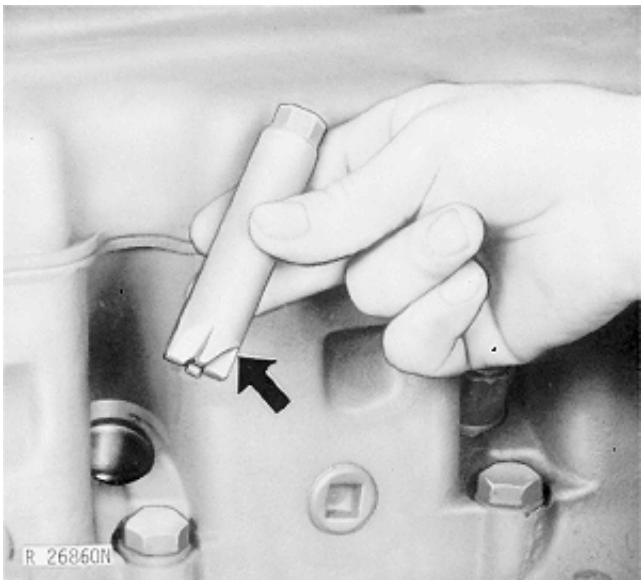
INSPECT AND CLEAN NOZZLE SEATING SURFACE

1. Inspect nozzle seating surface for carbon deposits.

2. If seat is not clean, use JDE99 or JDG609 Nozzle Seat Reamer to remove carbon. Stop using tool when seat comes clean.

3. Insert a 13 mm (1/2 in.) tapered hardwood dowel to plug nozzle tip bore.

4. Blow out debris with compressed air, then remove wood dowel.



R26860N -UN-20DEC88

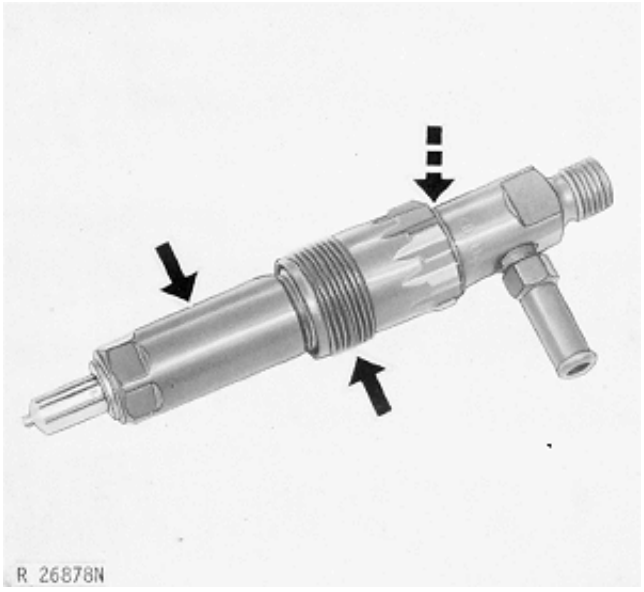
S11,0408,BN -19-08APR94

INSTALL FUEL INJECTION NOZZLES

1. Apply PT569 NEVER-SEEZ Compound to gland nut threads and nozzle barrel (arrows). Be sure that NEVER-SEEZ Compound was also applied to inside bore of gland nut during assembly.

NOTE: Applying NEVER-SEEZ Compound at these locations will help prevent possible seizure of gland nut to holder body.

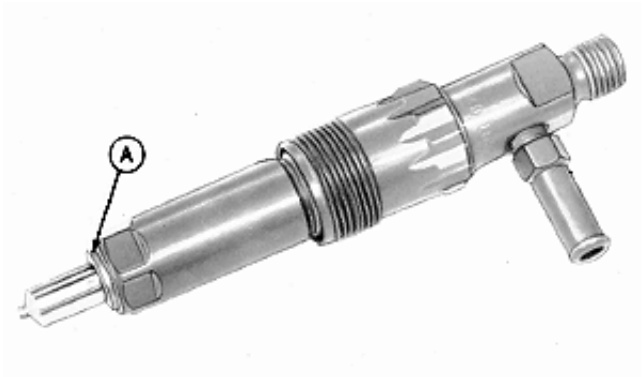
IMPORTANT: Do not intermix injection nozzles of different suppliers or different tip sizes within a single engine.



R26878N -UN-20DEC88

S11,0408,BO -19-10AUG94

2. Install a new R64840 Special Steel Washer (A) on tip end of assembled injection nozzle.



RG3678 -UN-20DEC88

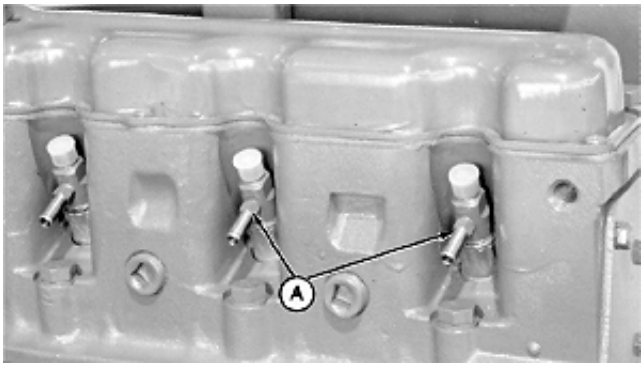
S11,0413,V -19-08APR94

3. Insert injection nozzle into cylinder head. Turn gland nut by hand to make sure that it is threaded straight in cylinder head.

4. Remove leak-off connectors (A) and washers or O-rings.

5. Use outer socket of JDE92 Nozzle Socket and turn gland nut down to remove most of the looseness.

6. Rotate nozzle holder so hole for leak-off connector threads are facing straight out from cylinder head.



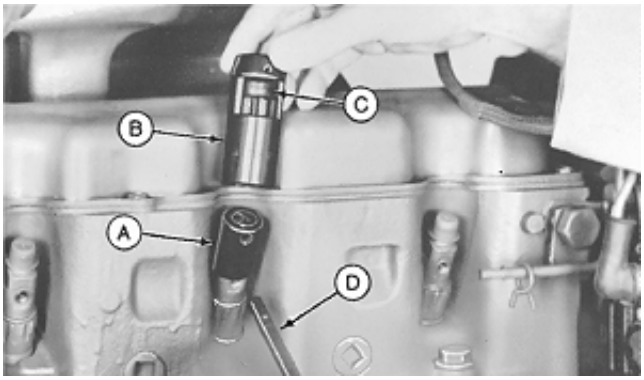
S11,0408,BQ -19-08APR94

7. Position inner socket (A) over nozzle holder and engage with flats at top of nozzle holder.

8. Place outer socket (B) portion of JDE92 Nozzle Socket on gland nut with socket “window” (C) facing outward.

9. Insert handle (D) through window into inner socket. Ball detent in handle will keep it secured to inner socket.

NOTE: Handle simulates position of leak-off connector, which must be square with engine to permit proper installation of leak-off lines.



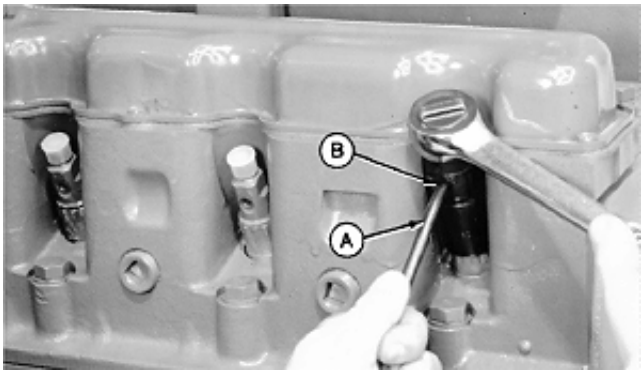
A—Inner Socket
B—Outer Socket
C—Window
D—Handle

S11,0413,X -19-08APR94

10. Tighten injection nozzle gland nut to 75—88 N·m (55—65 lb-ft). Keep handle (A) pointing straight out while tightening.

Socket window (B) is cut deep enough to obtain a new “bite” without removing inner socket.

11. Be sure O-ring is positioned against injection nozzle gland nut.

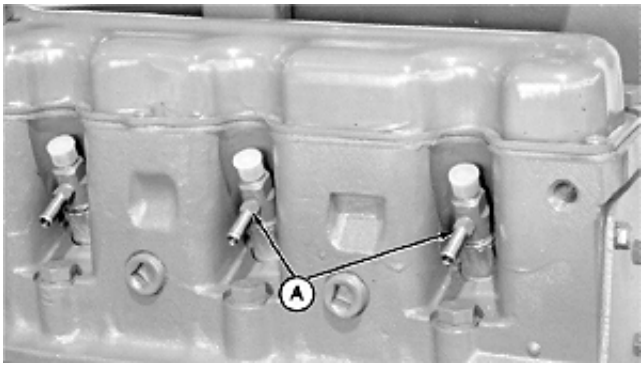


S11,0408,BS -19-08APR94

NOTE: Engines up to Engine Serial No. (—312216) use washers between leak-off connectors and nozzle holders. Engines beginning with Engine Serial No. (312217—) use O-rings in place of the washers.

12. Install leak-off connectors (A) with washer or O-rings on injection nozzles. Tighten securely.

NOTE: Early leak-off connectors shown, current connectors are similar.

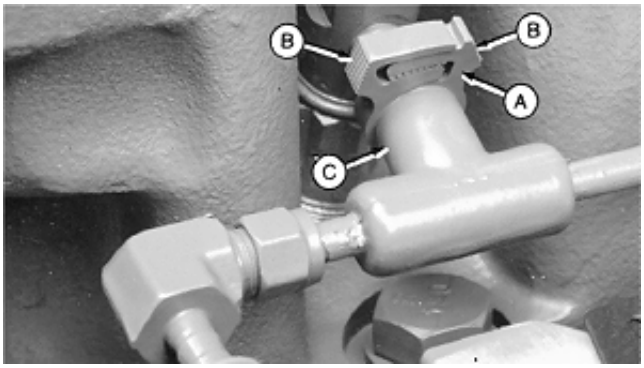


S11,0408,BT -19-10AUG94

13. Install fuel leak-off line clamp (A) over rubber leak-off line (C). Snug line tight against nozzle.

14. Using either fingers or pliers, press leak-off line clamps at both sides (B) together until there is one tooth left, or the clamp is tight around leak-off line.

NOTE: Be sure leak-off line clamps are tight and not loose.



S11,3010,AP -19-20APR82

15. For engines equipped with all-metal, multi-piece leak-off lines, loosen all fittings (A), remove pipes (B) and inspect all packings (C). Discard any packings that are worn or cut.

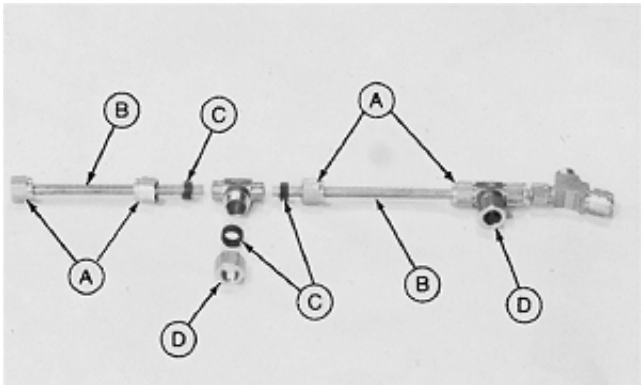
NOTE: Mark each leak-off pipe before disassembly to assure assembly in correct location.

16. Check all pipes and fittings for wear or damage and replace as necessary.

17. Reinstall new packings (if needed), and pipes into tee-fittings. Tighten all connections securely.

18. Install nuts (D) and packings onto leak-off connectors. Install complete assembly over appropriate leak-off line connectors.

19. Tighten all leak-off line connections securely at each injection nozzle.



A—Fittings
B—Pipes
C—Packings
D—Nuts

S11,3010,JZ -19-10AUG94

COMPLETE FINAL ASSEMBLY

IMPORTANT: On “P” size injection pumps, the JDE90 Wrench (Robert Bosch) and the 22 mm Open End Wrench (Nippondenso) must be used to keep the delivery valve fittings stationary while loosening the line nuts. If a delivery valve and barrel housing rotates while loosening or tightening a fuel line nut the injection pump delivery will be altered. The pump will have to be recalibrated on a test stand.

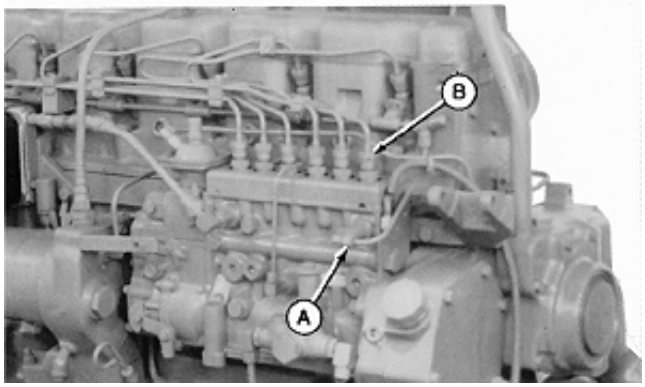
1. Install fuel delivery lines as described earlier in this group. Tighten fuel pipe-to-filter base (single filter) to 17 N·m (12 lb-ft).

2. Install fuel leak-off line at injection pump. Tighten all connections securely.

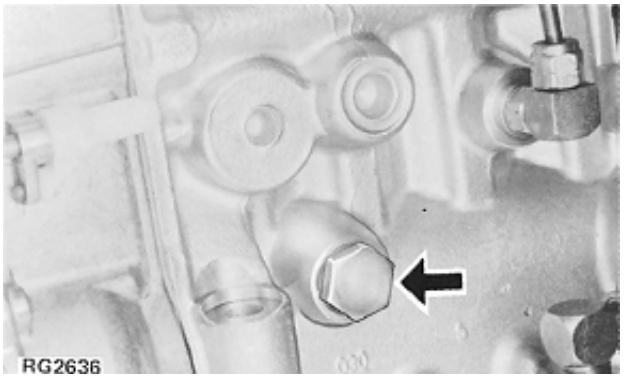
3. Check oil level in injection pump crankcase. Add clean engine oil until it comes out oil fill hole (arrow). Engine should be level when checking oil level.

4. Bleed the fuel system. See BLEED THE FUEL SYSTEM in Group 115.

5. Perform engine break-in if major repair was done to fuel system. (See Group 115.)



RG3956 -UN-09NOV89



RG2636 -UN-20DEC88

S11,3010,GE -19-10AUG94

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EFFECTS OF ALTITUDE AND TEMPERATURE ON ENGINE PERFORMANCE

Altitude, fuel temperature, air temperature, and humidity may affect engine performance. As a general rule, atmospheric changes will usually cause a decrease in engine power by the percentages shown in chart below.

ATMOSPHERIC CHANGE	% POWER DECREASE
Fuel Temperature Rise of 1˚C (1.8˚ F) above 40˚C (104˚F)	0.29
Air Temperature Rise of 5.5˚ C (10˚ F) above 25˚C (77˚F)	0.50
Naturally Aspirated Engines: Altitude Rise of 300 m (1000 ft) above 183 m (600 ft)	3.00**
Turbocharged Engines: Altitude Rise of 300 m (1000 ft) above 183 m (600 ft)	0.50*
Relative Humidity Rise of 10% above 0%	0.07

If engine required less fuel for acceptable performance at higher elevation, contact your local authorized fuel injection pump repair station for service.

**Engine may have to be defueled when a substantial percentage of operating time occurs at 2250 m (7500 ft) or higher.*

***Engine may have to be defueled when a substantial percentage of operating time occurs at 1500 m (5000 ft) or higher.*

RG,CTM42,G100,6-19-30SEP94

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1

PRELIMINARY ENGINE TESTING

Before tuning-up an engine, determine if a tune-up will restore operating efficiency. If in doubt, the following preliminary tests will help determine if the engine can be tuned-up. Choose from the following procedures only those necessary to restore the unit.

1. After engine has stopped for several hours, loosen crankcase drain plug and watch for any water to seep out. A few drops could be due to condensation, but any more than this would indicate problems which require engine repairs rather than just a tune-up.

2. With engine stopped, inspect engine coolant for oil film. With engine running, inspect coolant for air bubbles. Either condition would indicate problems which require engine repairs rather than just a tune-up.

3. Perform a dynamometer test and record power output. See DYNAMOMETER TEST later in this group. Repeat dynamometer test after tune-up. Compare power output before and after tune-up.

4. Perform compression test (See Group 105).

S11,22010,BW -19-08APR94

GENERAL TUNE-UP RECOMMENDATIONS

The following services are recommended each time a tune-up is performed. Disregard those services that do not apply to any particular application.

Operation	Detailed Reference
Check overall engine for fuel, lubricant, and coolant leaks. Repair leaks as necessary.	
Change engine oil and filters.	Operator's Manual
Lubricate PTO clutch internal levers and linkage.	Operator's Manual
Replace fuel filter.	Group 35 and/or Operator's Manual
Clean crankcase ventilation assembly.	This Group and/or Operator's Manual
Replace air cleaner elements and check air intake system.	This Group and/or Operator's Manual
Check exhaust system.	This Group
Check and service engine cooling system.	This Group and/or Operator's Manual
Check and adjust fan and alternator belts. Replace if necessary.	Operator's Manual
Check electrical system.	This Group
Check crankshaft vibration damper.	Group 15 and/or Operator's Manual
Inspect turbocharger and check turbocharger boost pressure.	Group 110
Check fuel injection system: Check engine-to-injection pump timing, clean injection nozzles, and adjust nozzle opening pressure.	Group 35 and 115
Check engine oil pressure. Adjust if necessary.	Group 105
Check engine valve clearance. Adjust if necessary.	Group 05 and/or Operator's Manual
Check engine speeds. Adjust if necessary.	Group 115
Check engine performance on dynamometer.	Group 105

RG,CTM1,G100,1 -19-10AUG94

DYNAMOMETER TEST

NOTE: High elevations, ambient temperature and humidity 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.

3. Run engine at fast idle.

4. Gradually increase load on engine until speed is reduced to rated speed rpm.

5. Read horsepower on dynamometer.

6. Compare readings taken with power rating level for your engine application listed on the following chart.

RG,CTM61,105,16-19-10AUG94

DYNAMOMETER TEST SPECIFICATIONS

NOTE: Specifications given below apply to OEM applications only. For machine applications, consult the appropriate machine technical manual.

Engine Model	Option Code	Original Injection Pump (Part No.)	Replaced By Injection Pump (Part No.)	Governor Regulation	Slow Idle RPM	Fast Idle RPM	Rated Speed RPM	Power Rating* kW (BHP)
6466DF	1602	AR85568	RE10316	Std.	800	2400	2200	130 (174)
	1603	AR85570	RE10317	3-5%	800	1890	1800	85 (114)
	1602	RE10316		Std.	800	2400	2200	99 (133)
	1603	RE10317		3-5%	800	1890	1800	87 (117)
6466TF	1601	AR88906		Std.	800	2400	2200	112 (150)
	1604	AR88907		3-5%	800	2268	2160	113 (151)
	1601	AR94027	RE28034	Std.	800	2400	2200	130 (174)
	1604	AR94028	RE28033	3-5%	800	1890	1800	120 (161)
	1657, 1658	RE10076	RE23746	Std.	850	2400	2200	120 (161)
	1657, 1658	RE15997	RE23746	Std.	850	2400	2200	120 (161)
	1601, 1626	RE18161	RE28034	Std.	800	2400	2200	130 (174)
	1604, 1610	RE18163	RE28033	3-5%	800	1890	1800	120 (161)
	1657, 1658	RE23753	RE23746	Std.	850	2400	2200	120 (161)
	1657, 1658	RE23746		Std.	850	2400	2200	120 (161)
	1657, 1658	RE23926	RE23746	Std.	850	2400	2200	120 (161)
	1604, 1610	RE28033		3-5%	800	1890	1800	120 (161)
	1601, 1626	RE28034		Std.	800	2400	2200	130 (174)
6466AF	1606	AR92838	RE25013	Std.	800	2300	2100	165 (221)
	1608	AR88919		3-5%	800	1890	1800	157 (210)
	1610	AR94482	RE25014	3-5%	800	1890	1800	180 (241)
	1606, 1625, 1626, 1640	RE18155	RE25013	Std.	800	2300	2100	165 (221)
	1610	RE18157	RE25014	3-5%	800	1890	1800	180 (241)
	1629	RE25013		3-5%	800	2205	2100	165 (221)
	1610	RE25014		3-5%	800	1890	1800	180 (241)
	1610	RE25019	RE25014	3-5%	800	1890	1800	180 (241)
	1606, 1625, 1626, 1629, 1640	RE25018	RE25013	Std.	800	2300	2100	165 (221)
	1661, 1663	RE23478		Std.	850	2400	2200	157 (210)
6466AF001	1630	RE26315		Std.	650	2425	2200	160 (215)
	1631	RE23616		Std.	650	2425	2200	180 (241)

** Average power rating shown. Allow ± 5% for maximum and minimum power.*

S11,22010,BM -19-18AUG94

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ENGINE BREAK-IN GUIDELINES

Engine break-in should be performed when the following repair have been made:

• Main bearings, rod bearings, crankshaft, or any combination of these parts have been replaced.

• Pistons, rings, or liners have been replaced.

• Rear crankshaft oil seal and wear sleeve have been replaced. (Primary objective is to see if oil seal still leaks).

• Cylinder head has been removed. Check and reset valve clearance.

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

RG,CTM61,G105,2-19-29SEP94

PERFORM ENGINE BREAK-IN

Use a dynamometer to perform the following break-in procedure. If necessary, engine break-in can be performed without a dynamometer if under controlled operating conditions.

IMPORTANT: DO NOT use TORQ-GARD SUPREME PLUS-50™ engine oil during the first 100 hours of operation on 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.

Fill engine crankcase with JOHN DEERE BREAK-IN OIL to proper level for use during the break-in operation.

IMPORTANT: During break-in, periodically check engine oil pressure and coolant temperature. Also check for signs of fuel, oil, or coolant leaks.

ENGINE BREAK-IN AFTER MAJOR OVERHAUL

Time	Load	Engine Speed*
5 Minutes	No Load	850 rpm
5 Minutes	No Load	1500—2000 rpm
5 Minutes	1/4 Load	1900—2100 rpm
10 Minutes	1/2 Load	1900—2100 rpm
10 Minutes	1/2—3/4 Load	1900—2100 rpm
10 Minutes	3/4—Full Load	Rated Speed

Check and readjust valve clearance as necessary. Cylinder head retorque is not required. (See Group 05, Cylinder Head and Valves.)

During the first 100 hours of operation, avoid over-loads, excessive idling, and no-load operation. Do NOT use foot throttle.

After 100 hours maximum, drain crankcase oil and change oil filter. Fill crankcase with oil of proper viscosity and service classification. See ENGINE OIL in Group 02, Fuels, Lubricants, and Coolant.

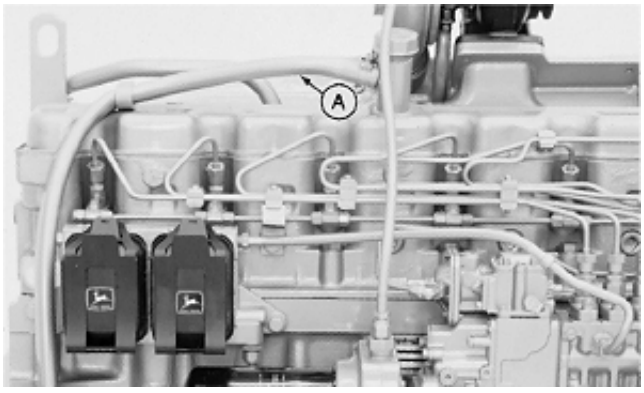
** Engine speeds listed are for engines equipped with a mechanical governor (8—10% regulation). For gen set engines, run at rated speed.*

S11,22010,BN -19-18AUG94

CHECK CRANKCASE VENTILATION SYSTEM

1. Inspect crankcase ventilation system for restrictions. Lack of ventilation causes sludge to form in engine crankcase. This can lead to clogging of oil passages, filters, and screens, resulting in serious engine damage.

2. Clean crankcase vent tube or hose (A) with solvent and compressed air if it is restricted. Install and tighten hose clamps securely.



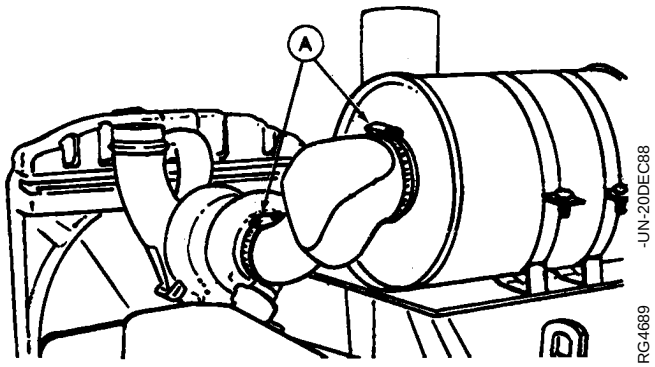
S11,22010,CT -19-08APR94

CHECK AIR INTAKE SYSTEM

1. Replace air cleaner primary filter element. Replace secondary element if primary element has holes in it.

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

3. Check hose clamps (A) for tightness. Replace clamps that cannot be properly tightened. This will help prevent dust from entering the air intake system which could cause serious engine damage.



S11,22010,CU -19-08APR94

CHECK EXHAUST SYSTEM

1. Inspect exhaust system for leaks or restrictions. Check manifold for cracks. Repair or replace as necessary.

2. Check that turbocharger-to-exhaust elbow adapter clamps are securely tightened and do not leak.

3. Check exhaust stack for evidence of oil leakage past valve stem seals.

Oil in exhaust stack may be caused by excessive valve stem-to-guide clearance or excessive light load engine idling.

S55,22010,C -19-08APR94

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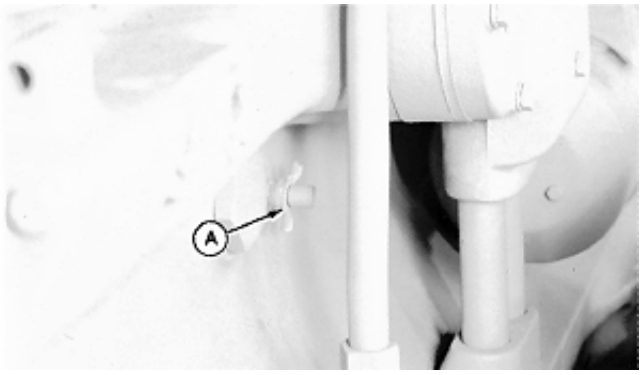
CHECK AND SERVICE COOLING SYSTEM

TS281 -UN-23AUG88



RG3851 -UN-14DEC88

1. Visually inspect entire cooling system and all components for leaks or damage. Repair or replace as necessary.

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

3. Inspect radiator hoses for signs of leakage or rot. Replace hoses as necessary.

CAUTION: Do not drain coolant until it has cooled below operating temperature. Always loosen block drain valve (arrow) slowly to relieve any excess pressure.

4. Drain coolant, remove thermostats, and flush cooling system. See FLUSHING AND SERVICING COOLING SYSTEM in Group 02.

5. Test thermostat opening temperature. Replace defective thermostats as needed. See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE in Group 105.

IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen plug in water manifold to allow air to escape when filling system. Retighten plug when cooling system is full and all air has been expelled.

6. Fill cooling system with recommended concentration of coolant, clean soft water, and inhibitors. (See RECOMMENDED ENGINE COOLANT in Group 02.)

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

8. After engine cools, check coolant level.

NOTE: Coolant level should be at bottom of radiator filler neck.

9. Check system for holding pressure. See PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP in Group 105.

S11,22010,CW -19-18AUG94

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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 (-) battery clamp first and replace it last.

1. Clean batteries, and cables with a damp cloth. If corrosion is present, remove it and wash the terminals with a solution of ammonia or baking soda in water. Then flush area with clean water.

2. Coat battery terminals and connectors with petroleum jelly mixed with baking soda to retard corrosion.

3. Test batteries. If batteries are not near full charge, try to find out why.

4. On low-maintenance batteries, check level of electrolyte in each cell of each battery. Level should be to bottom of filler neck. If water is needed, use clean, mineral-free water.

If water must be added to batteries more often than every 250 hours, alternator may be overcharging.

NOTE: Water cannot be added to maintenance-free batteries.

5. If batteries appear to be either undercharged or overcharged, check alternator and charging circuit.

6. Check tension of fan belts. See operator's manual.

7. Check operation of starting motor and gauges.

S11,22010,CZ -19-16SEP94

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SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

Cooling System Pressure Pump D05104ST

Used to pressure test radiator cap and cooling system.

R26406N -UN-29NOV88

S55,22005,C -19-17SEP91

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

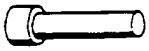
Rotate engine flywheel. Use with JDE81-4 Timing Pin.

S53,JDE811B -19-08AUG94

RG5068 -UN-23AUG88

Timing Pin JDE81-4

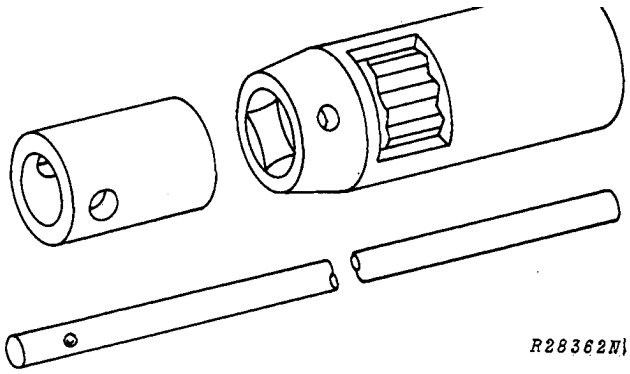
Lock engine at TDC when timing valve train.



S53,JDE814A -19-08AUG94

Nozzle Socket JDE92

Used to remove and install fuel injection nozzles.



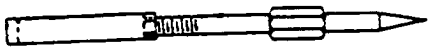
R28362N -UN-20DEC88

S11,22005,R -19-16AUG94

RG5009 -UN-06APR89

Camshaft Wear Indicator JDE109

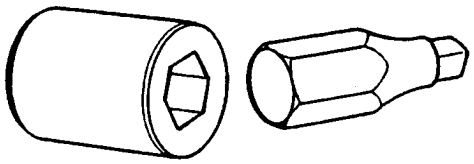
Measure camshaft gear-to-oil pump gear backlash.



S53,JDE109 -19-10AUG94

Oil Galley Plug Tool JDG782

Used to remove and install oil galley plug.



RG6612 -UN-29JAN93

RG,JDG782 -19-02APR93

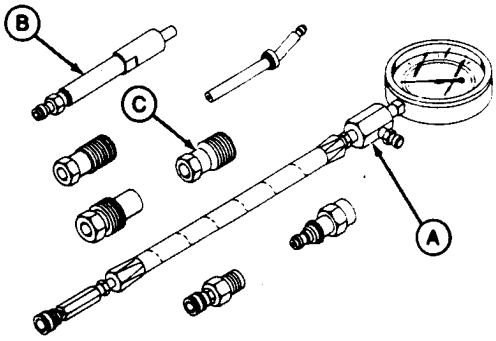
Compression Test Kit JT01674 (D14546BA)

A—Gauge and Hose Assembly JT01682 (D14547BA)

B—Nozzle Adapter JT01675A (D14557BA)

C—Adapter Nut JT01677

Used to test each cylinder's compression pressure.



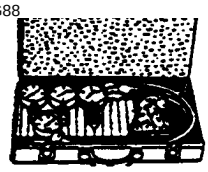
RG5784 -UN-09AUG91

RG,JT01674 -19-17SEP91

RG5162 -UN-23AUG88

Universal Pressure Test Kit JT05470 (D15027NU)

Used for testing engine oil pressure.



S55,22005,B -19-17SEP91

ENGINE TEST SPECIFICATIONS

ITEM	SPECIFICATION
Engine Compression Pressure:	
(at 200—250 rpm cranking speed)	
6466D	3 000—3 410 kPa (30.0—34.1 bar) (435—495 psi)
6466T Engine Serial No. (—253372)	2 280—2 550 kPa (22.8—25.5 bar) (330—370 psi)
Engine Serial No. (253373—)	2 690—3 100 kPa (26.9—31.0 bar) (390—450 psi)
6466A Engine Serial No. (—233592)	2 280—2 550 kPa (22.8—25.5 bar) (330—370 psi)
Engine Serial No. (233593—)	2 450—2 860 kPa (24.5—28.6 bar) (355—415 psi)
Maximum Variation between Cylinders	340 kPa (3.4 bar) (50 psi)
Engine Oil Pressure at 105°C (220°F) Sump:	
Minimum No Load at 800 rpm (Slow Idle)	103 kPa (1.03 bar) (15 psi)
Maximum Full Load at 1800—2200 rpm (Rated Speed)	330 kPa (3.30 bar) (48 psi)
Oil Filter Bypass Valve Operating Pressure	210 kPa (2.10 bar) (30 psi)
Maximum Engine Blow-By at Crankcase Vent Tube	14 m^3/h (494 cu ft/h)
Cooling System and Radiator Pressure Cap	
Leakage Test Pressure	50 kPa (0.5 bar) (7 psi)*
Camshaft Gear-to-Oil Pump Gear Backlash:	
Minimum	0.5°
Maximum	3.5°

** Test pressures listed 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.*

S11,22010,BL -19-18AUG94

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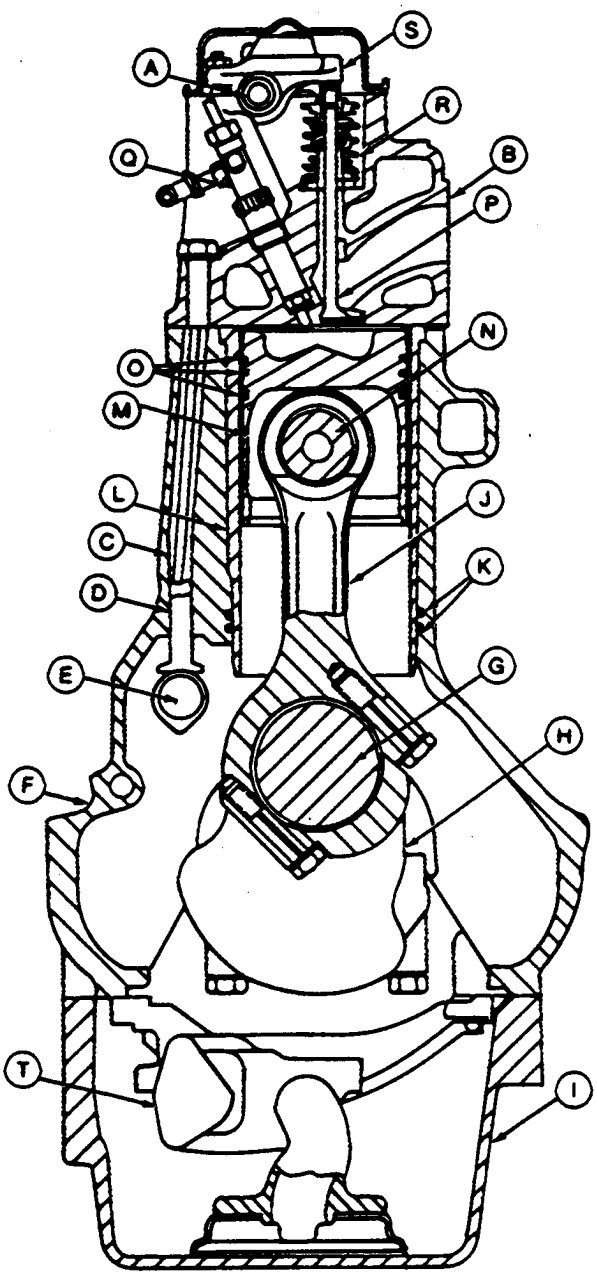
ENGINE—SECTIONAL VIEW

A—Rocker Arm Shaft
B—Cylinder Head
C—Push Rod
D—Camshaft Follower
E—Camshaft
F—Cylinder Block
G—Crankshaft
H—Crankshaft Counterweight
I—Oil Pan
J—Connecting Rod
K—Liner Packing Rings
L—Cylinder Liner
M—Piston
N—Piston Pin
O—Piston Rings
P—Valve
Q—Fuel Injection Nozzle
R—Valve spring
S—Rocker Arm
T—Oil Pump



S11,2000,FA -19-10AUG94

GENERAL ENGINE DESCRIPTION

All 6466 Engines are vertical stroke, in-line, valve in head, 6-cycle diesel engines.

On 6466D Engines, direct fuel injection is provided by a distributor-type fuel injection pump and 21 mm injection nozzles mounted in cylinder head. The pump is driven by an intermediate gear in the timing gear train meshing with the crankshaft gear. 6466T and 6466A Engines have in-line injection pumps.

The pump has an engine-driven camshaft which rotates at one-half engine speed. Roller cam followers, riding on the camshaft lobes, operate the plungers to supply high-pressure fuel through the delivery valves to the injection nozzles. A governor-operated control rack is connected to the control sleeves and plungers to regulate the quantity of fuel delivered to the engine.

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 made of special alloy iron. The cam lobes are individually flame hardened to provide excellent wear characteristics. Spherically ground followers riding on tapered cam lobes help insure positive follower rotation.

Intake and exhaust valves are operated by cam followers, push rods and rocker arm assembly. Cylinder heads have replaceable inserts and valves, and have positive rotators for both intake and exhaust valves.

The crankshaft is a one-piece, heat treated, dynamically balanced steel forging which operates in replaceable two-piece main bearings. The rear thrust bearing has a flange on each side to support crankshaft deflection and to limit end play during high load operation.

Cylinder liners are a wet sleeve, flanged, and centrifugally cast design. O-rings are used to seal the connection between cylinder block and liners. Liners are induction hardened and individually replaceable.

Pistons are constructed of high-grade cast aluminum alloy and cam ground. A double Ni-Resist ring carrier is cast integrally in the piston (both compression rings on 6466T and A Engines and top ring of 6466D Engines) to greatly improve the life of the ring groove(s). A deep combustion chamber design provides maximum combustion efficiency. Pistons have a three ring combination. The top two rings are compression rings and lower ring is an oil control ring.

The highly polished, hardened piston pins are fully-floating and held in position by means of snap rings. Spray jets (piston cooling orifices) in cylinder block direct pressure oil to lubricate piston pins and cool pistons.

Connecting rods are of forged steel and have replaceable bushing and bearing inserts. They are weight controlled (by machining) on both ends to minimize engine vibration.

Lubricating oil is supplied to the engine by either a camshaft- or crankshaft-driven oil pump. 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.

S11,2000,EZ -19-10AUG94

HOW THE LUBRICATION SYSTEM WORKS

Refer to illustrations on following two pages.

The engine lubrication system consists of gear-driven, (camshaft or crankshaft), positive displacement pump, oil cooler, oil filter, cooler bypass valve, oil pressure regulating valve and filter bypass valve.

Oil is pumped from the oil pan by the engine oil pump through the engine oil cooler (A), around the oil cooler bypass valve (B), and into the engine oil filter (C).

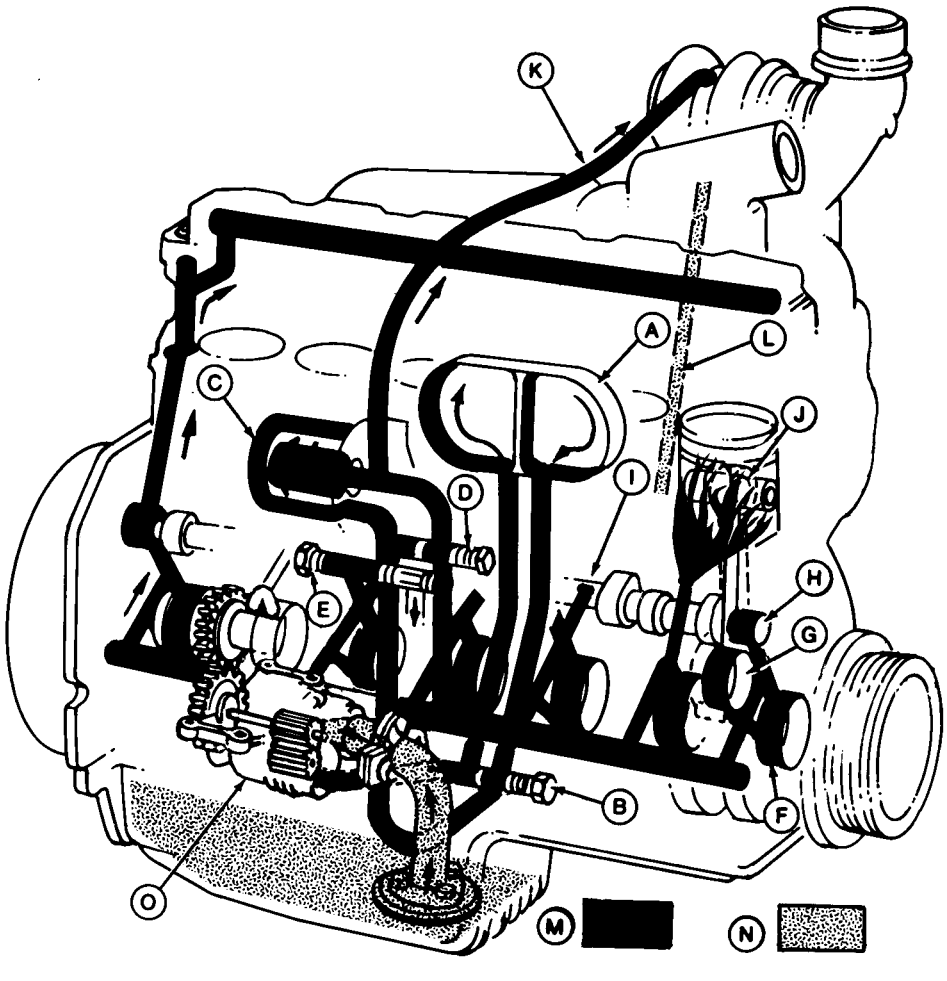
On 6466T and 6466A engines oil is directed to the top of the oil filter housing and through the oil inlet line (K) to lubricate the turbocharger. Oil is then returned through the turbocharger oil return tube (L) and back to the oil pan as unpressed oil. Passing through the filter, the oil continues around the filter bypass valve (D) and in front of the engine oil pressure regulating valve (E) into the engine oil gallery in the cylinder block. Oil is then distributed, under pressure, to each main bearing (F) and piston cooling orifice (I).

Oil from the piston cooling orifices lubricates the piston pin and bushing (J) through a hole in the top of the connecting rod in T and A Engines. The 6466D piston pin and bushing is pressure lubricated through hole in connecting rod from the crankshaft.

During cold weather starting or if the oil cooler is plugged, the oil cooler bypass valve senses pressure on the inlet side of the oil cooler and opens, allowing oil to flow directly to the full-flow oil filter and cylinder block.

RG,CTM1,G105,1 -19-10AUG94

CRANKSHAFT-DRIVEN OIL PUMP



A—Engine Oil Cooler
B—Oil Cooler Bypass Valve
C—Oil Filter
D—Filter Bypass Valve
E—Oil Pressure Regulating Valve
F—Main Bearings
G—Connecting Rod Bearings
H—Camshaft Bushings
I—Piston Cooling Orifices
J—Piston Pin and Bushings
K—Turbocharger Oil Inlet Line-6466T and 6466A Engines
L—Turbocharger Oil Return Tube-6466T and 6466A Engines
M—Engine Oil Pressure
N—Oil Pan Oil
O—Crankshaft-Driven Oil Pump

S11,2020,DP -19-10AUG94

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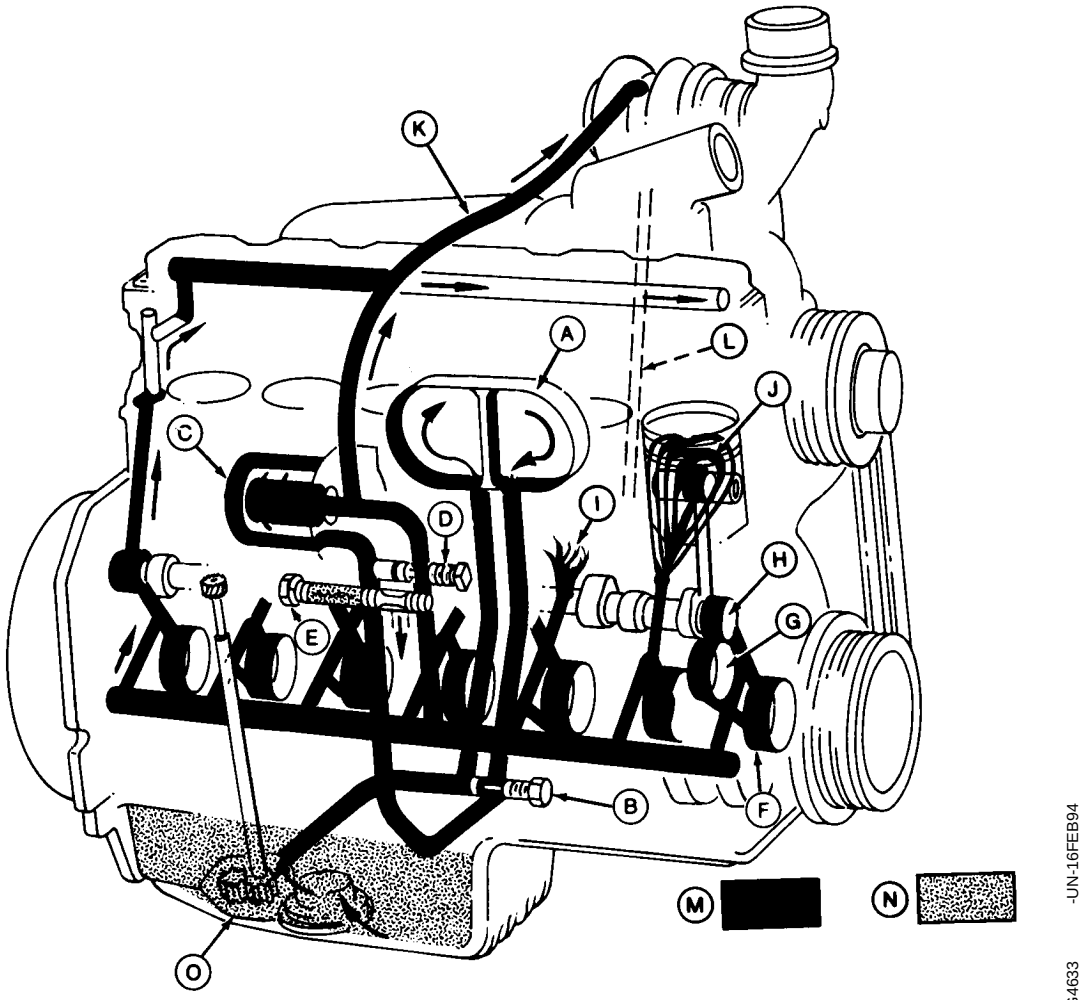
CAMSHAFT-DRIVEN OIL PUMP



A—Engine Oil Cooler
B—Oil Cooler Bypass Valve
C—Oil Filter
D—Filter Bypass Valve
E—Oil Pressure Regulating Valve
F—Main Bearings
G—Connecting Rod Bearings
H—Camshaft Bushings
I—Piston Cooling Orifices
J—Piston Pin and Bushing
K—Turbocharger Oil Inlet Line-6466T and 6466A Engines
L—Turbocharger Oil Return Tube-6466T and 6466A Engines
M—Engine Oil Pressure
N—Oil Pan Oil
O—Camshaft-Driven Oil Pump

S11,2020,DQ -19-10AUG94

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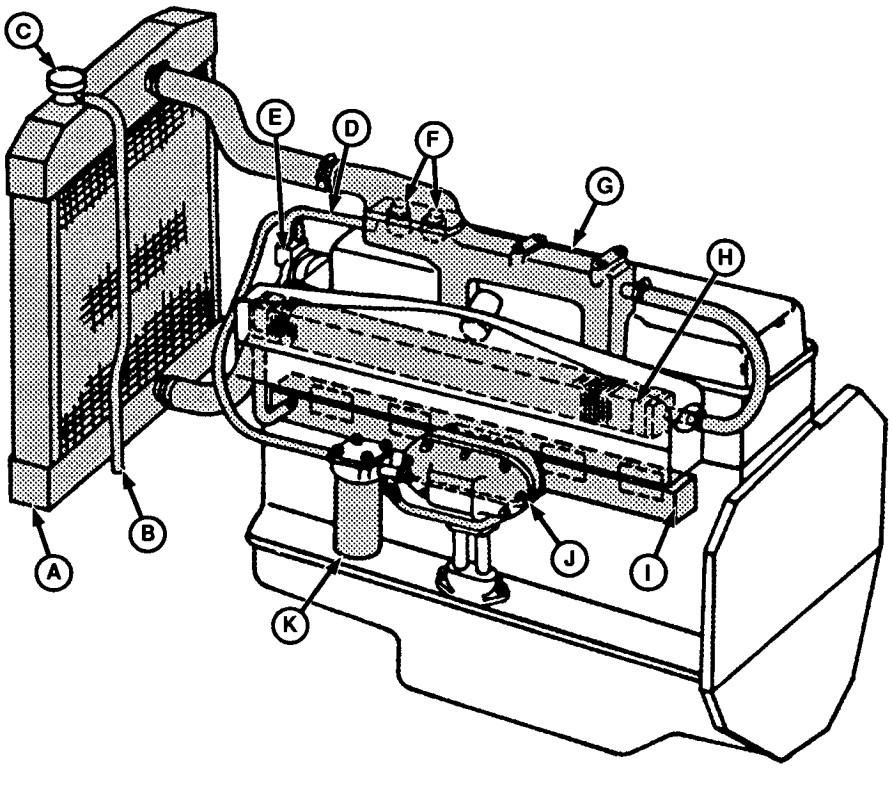
HOW THE COOLING SYSTEM WORKS



A—Radiator
B—Water Hose
C—Radiator Cap (15 psi) (1.03 bar)
D—Coolant Bypass Pipe
E—Water Pump
F—Thermostats
G—Water Manifold
H—Aftercooler (“A” Engines)
I—Main Cooling Gallery
J—Engine Oil Cooler
K—Coolant Conditioner Filter

NOTE: Gear-driven water pump is shown; belt-driven system is similar.

The pressurized cooling system consists of a conventional type radiator (A), water pump (E), thermostats (F) and water manifold (G).

The pump draws coolant from the bottom of the radiator and discharges it into the main coolant gallery (I) on the left-hand side of the engine. Coolant from the gallery circulates through the block to cool block and cylinder liners, then flows into the cylinder head. From the cylinder head, the coolant passes into the water manifold (G) and thermostat housing.

If the thermostats are closed (as during warm-up periods), coolant is directed back to the pump through the bypass pipe (D) to be recirculated. This provides a faster and more uniform warm-up.

If the thermostats are open (engine at normal operating temperature), coolant flows back through the thermostats to the top of the radiator.

On 6466A Engines, coolant is also taken from the main gallery into the aftercooler (H) to cool intake air. It circulates through the aftercooler and out to the water manifold.

The engine oil cooler (J), located in the main gallery, receives its cooling capacity from the coolant flow around it.

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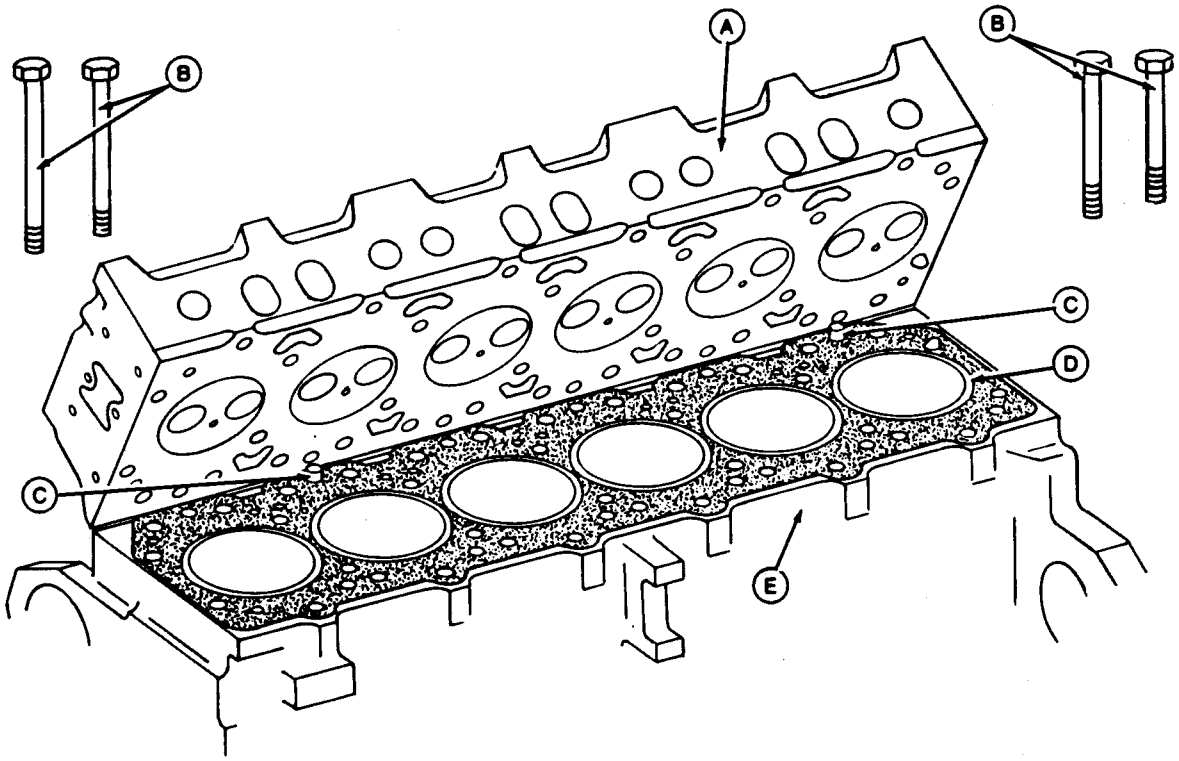
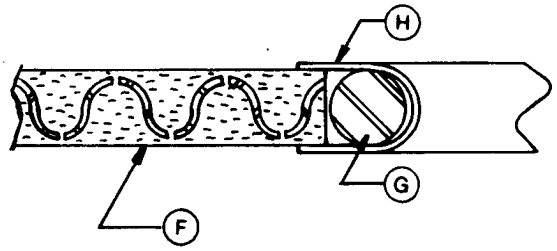
S11,2025,GN -19-10AUG94

HEAD GASKET JOINT CONSTRUCTION AND OPERATION



RG6447 -UN-13OCT92



RG6430 -UN-17SEP92

A—Cylinder Head
B—Cylinder Head Cap Screws
C—Dowel Pins
D—Cylinder Liners
E—Cylinder Block
F—Gasket Body
G—Fire Ring Combustion Seal
H—Stainless Steel Flange

The head gasket joint consists of:

- Cylinder head gasket
- Cylinder head (A)
- Cylinder block (E)
- Cylinder liners (C)
- Cylinder head cap screws (B)

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CTM42,G105,15 -19-08APR94

Refer to illustration on previous page.

The head gasket must form an air-tight seal between cylinder liners and cylinder head that can withstand the temperatures and pressures of the combustion process. The gasket must also form a liquid-tight seal between the cylinder head and cylinder block to retain coolant and oil in their respective passages. The gasket is constructed of thin, formed sheets of steel-inserted, non-asbestos material (F). The surface of gasket is treated to improve liquid sealing and anti-stick characteristics. A fire ring combustion seal (G) is located at each cylinder bore and is held in place by a U-shaped stainless steel flange (H).

The cylinder head and block must be flat to provide an even clamping pressure over the entire surface of gasket, and must have the proper surface finish to keep gasket material from moving in the joint. Dowels (D) are used to properly locate head gasket on block.

The cylinder liners must protrude evenly from top of cylinder block the specified amount to provide adequate clamping force on fire ring of each cylinder.

The cap screws must be proper length, made of proper material, and be tightened to proper torque in order to provide an adequate clamp load between other joint components.

Each of the above components contributes to the integrity of the head gasket joint. If any of these components do not conform to specifications, gasket joint may fail resulting in combustion leaks, coolant leaks, or oil leaks.

Operating conditions such as coolant, oil, and combustion temperatures, and combustion pressures can reduce the ability of the head gasket joint to function properly. Failure of head gasket and mating parts may occur when coolant and oil temperatures become excessive, or when abnormally high combustion temperatures and pressures persist.

CTM42,G105,26 -19-29OCT92

DIAGNOSING HEAD GASKET JOINT FAILURES

Head gasket failures generally fall into three categories:

- Combustion seal leakage.
- Coolant seal leakage.
- Oil seal leakage.

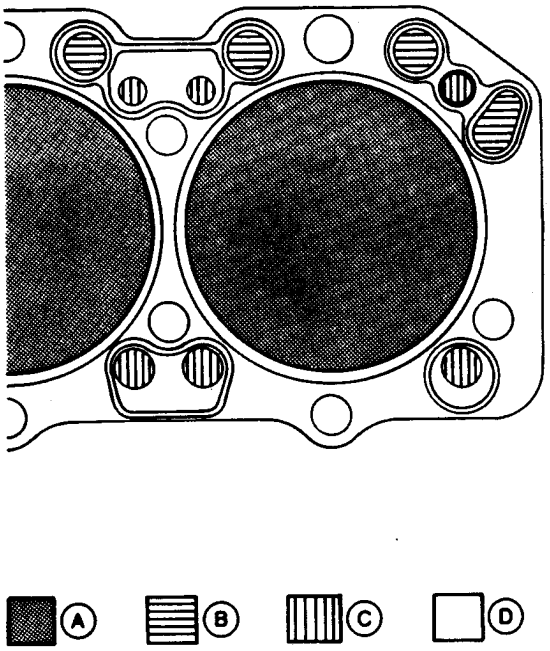
Combustion seal leakage failures occur when combustion gases escape between cylinder head and head gasket combustion flange, or between combustion flange and cylinder liner. Leaking combustion gases may vent to an adjacent cylinder, to a coolant or oil passage, or externally.

Coolant or oil seal leakage failures occur when oil or coolant escapes between cylinder head and gasket body, or between cylinder block and gasket body. The oil or coolant may leak to an adjacent coolant or oil passage, or externally. Since oil and coolant passages are primarily on right hand (camshaft) side of engine, fluid leaks are most likely to occur in that area.

Follow these diagnostic procedures when a head gasket joint failure occurs, or is suspected.

1. Before starting or disassembling engine, conduct a visual inspection of machine, and note any of the following:

- Oil or coolant in head gasket seam, or on adjacent surfaces. Especially right rear corner of gasket joint.
- Displacement of gasket from normal position.
- Discoloration or soot from combustion gas leakage.
- Leaking radiator, overflow tank, or hoses.
- Leaking coolant from water pump weep hole.
- Damaged or incorrect radiator, fan, or shroud.
- Obstructed air flow or coolant flow.
- Worn or slipping belts.
- Damaged or incorrect pressure cap.
- Presence of oil in coolant.
- Low coolant levels.
- Improper coolant.
- Unusually high or low oil levels.
- Oil degradation, dilution, or contamination.
- Correctly specified injection pump.
- Indications of fuel or timing adjustments.
- Unburned fuel or coolant in exhaust system.



RG6449 -UN-13OCT92

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

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CTM42,G105,16 -19-08APR94

2. Obtain coolant and oil samples for further analysis.

3. Start and warm up engine if it can be safely operated. Examine all potential leakage areas again as outlined previously. Using appropriate test and measurement equipment, check for the following:

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

4. Shut engine down. Recheck crankcase, radiator, and overflow tank for any significant differences in fluid levels, viscosity, or appearance.

5. Compare your observations from above steps with the following diagnostic charts. If diagnostic evaluations and observations provide conclusive evidence of combustion gas, coolant, or oil leakage from head gasket joint, the cylinder head must be removed for inspection and repair of gasket joint components.

RG,CTM8,G105,11-19-29OCT92

Combustion Seal Leakage

Symptoms:

- Exhaust from head gasket crevice
- Air bubbles in radiator/overflow tank
- Coolant discharge from overflow tube
- Engine overheating
- Power loss
- Engine runs rough
- White exhaust smoke
- Loss of cab heat
- Gasket section dislodged, missing (blown)
- Coolant in cylinder
- Coolant in crankcase oil
- Low coolant level

Possible Causes:

- Insufficient liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Rough/damaged liner flange surface
- Cracked/deformed gasket combustion flange
- Out-of-flat/damaged/rough cylinder head surface
- Missing/mislocated gasket fire ring
- Block cracked in liner support area
- Excessive fuel delivery
- Advanced injection pump timing
- Hydraulic or mechanical disturbance of combustion seal

NOTE: Cracked cylinder head or liners may also allow combustion gas leakage into coolant.

RG,CTM8,G105,12-19-16SEP92

Coolant Seal Leakage

Symptoms:

- Coolant discharge from head gasket crevice
- Coolant in crankcase oil
- Low coolant level
- High oil level
- Coolant discharge from crankcase vent

Possible Causes:

- Excessive liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface
- Out-of-flat/damaged/rough cylinder head surface
- Oil or coolant overheating
- Cracks/creases in gasket body surfaces
- Damage/voids in elastomer beading

NOTE: Cracked cylinder head, liners, liner packings, defective oil cooler or aftercooler may also allow coolant leakage into crankcase.

RG,CTM8,G105,13-19-13MAY93

Oil Seal Leakage

Symptoms:

- Oil discharge from head gasket crevice
- Oil in coolant
- Low crankcase oil level
- Reduced oil to rocker arms (noisy)

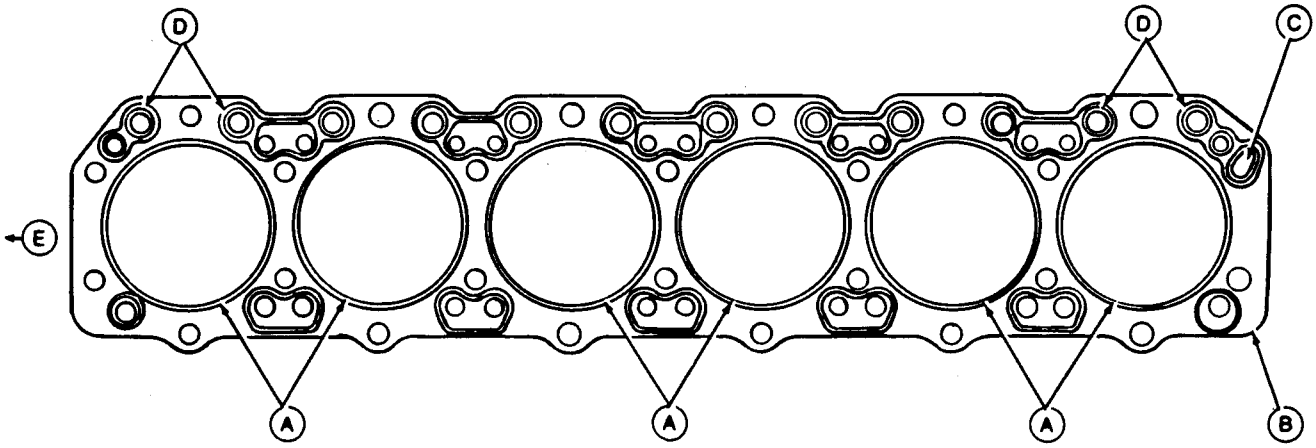
Possible Causes:

- Excessive liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface
- Out-of-flat/damaged/rough cylinder head surface
- Oil or coolant overheating
- Cracks/creases in gasket body surfaces
- Damage/voids in elastomer beading
- Damaged/missing O-ring seal at oil port to rocker arms

NOTE: Defective oil cooler may also allow oil leakage into coolant.

RG,CTM8,G105,14-19-16SEP92

HEAD GASKET INSPECTION AND REPAIR SEQUENCE



RG6448 -UN-13OCT92

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.

105
15

CTM42,G105,17 -19-08APR94

7. Clean block, head, liners, and cap screws. (See Groups 05 and 10.)

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

Cylinder Head (See Group 05.)
- Check surface flatness/finish.
- Inspect for surface damage.
- Check cylinder head thickness, if resurfacing.

Cylinder Block and Liners (assembled and clamped) (See Group 05 or 10.)
- Check liner standout at four places on each liner.
- Check liner standout difference between cylinders.

Cylinder Block (See Group 10.)
- Check surface flatness/finish.
- Inspect for surface damage.
- Check liner counterbore depth (if liner is removed).
- Check top deck to crankshaft centerline dimension.
- Inspect cap screw bosses, must be clean/intact.

Cylinder Liner (See Group 10.)
- Check liner flange flatness/finish.
- Check liner flange thickness (if liner is removed).
- Inspect flange for damage.

Cylinder Head Cap Screws (See Group 05.)
- Inspect for corrosion damage.
- Inspect condition of threads.
- Inspect for straightness.
- Check length.

9. When inspections and measurements have been completed, determine most probable causes of joint failure. Make all necessary repairs to joint components, cooling system, and fuel injection system.

10. Reassemble the engine according to procedures and specifications in the repair groups of this manual.

CTM42,G105,18 -19-13MAY93

DIAGNOSING ENGINE MALFUNCTIONS

• Will Not Crank:

Electrical System Malfunction
- Weak battery
- Corroded or loose battery connections
- Defective main switch or start safety switch
- Starter solenoid defective
- Starter defective

• Hard to Start or Will Not Start:

Electrical System Malfunction
- Loose or corroded battery connections
- Weak battery
- Excessive resistance in starter circuit

Fuel System Malfunction - See Group 115
- Empty fuel tank
- Improper fuel
- Fuel shut off at tank
- Water, dirt or air in fuel system
- Plugged fuel filter
- Fuel shut-off cable not pushed in
- Dirty or faulty fuel injection nozzles
- Defective fuel injection pump
- Defective fuel supply pump
- Fuel injection pump incorrectly timed

Service Problem
- Too high viscosity crankcase oil

• Engine Runs Irregularly or Stalls Frequently:

Basic Engine Problem
- Coolant temperature too low
- Improper valve clearance
- Cylinder head gasket leaking
- Worn or broken compression rings
- Valves sticking or burned
- Exhaust system restricted
- Engine compression too low
- Engine overheating
- Worn camshaft lobes

Fuel System Malfunction - See Group 115
- Defective fuel injection pump
- Low fuel supply
- Air in fuel
- Vent on fuel tank cap obstructed
- Fuel injection nozzles defective or leaking
- Fuel filter or fuel lines restricted
- Defective fuel supply pump
- Fuel injection pump incorrectly timed

Service Problem
- Improper fuel

• Engine Misfiring:

Service Problem
- Water in fuel
- Mixture of gasoline and diesel fuel

Fuel System Malfunction - See Group 115
- Air in fuel system
- Defective fuel injection nozzles
- Defective fuel injection pump
- Fuel injection nozzles improperly installed
- Leaking fuel injection nozzle seals
- Worn or defective fuel supply pump
- Fuel injection pump incorrectly timed

Basic Engine Problem
- Engine overheated
- Lobes of camshaft worn
- Weak valve springs
- Pre-ignition
- Engine compression too low
- Improper valve clearance
- Burnt, damaged or stuck valves

• Lack of Engine Power:

Service Problem
- Air cleaner restricted or dirty
- Excessive resistance in air intake system
- Improper crankcase oil
- Improper fuel
- Restricted exhaust system

Fuel System Malfunction - See Group 115
- Fuel filter restricted
- Defective fuel supply pump
- Defective fuel injection pump
- Fuel injection pump incorrectly timed
- Faulty injection nozzles
- Plugged fuel tank vent

Basic Engine Problem
- Engine overheated
- Engine clutch slipping
- Defective cylinder head gasket
- Lobes of camshaft worn
- Improper valve clearance
- Improper valve timing
- Burnt, damaged or stuck valves
- Weak valve springs
- Piston rings and cylinder liners excessively worn
- Engine compression too low
- Improper coolant temperature

S11,22010,BO -19-18AUG94

DIAGNOSING ENGINE MALFUNCTIONS—CONTINUED

• Low Oil Pressure:

Basic Engine Problem
- Stuck or improper regulating valve adjustment
- Excessive main and connecting rod bearing clearance
- Plugged oil pump intake screen
- Faulty bypass oil check valve
- Leakage at internal oil passages
- Faulty oil pump

Service Problem
- Low oil level
- Improper viscosity of oil
- Faulty gauge

• High Oil Pressure:

Basic Engine Problem
- Stuck or improperly adjusted regulating valve

• Excessive Fuel Consumption:

Basic Engine Problem
- Low compression

Fuel System Malfunction - See Group 115
- Leaks in fuel system
- Restricted air cleaners
- Faulty injection pump timing
- Improper valve clearance
- Service problem
- Improper grade of fuel

Fuel System Malfunction - See Group 115
- Excessive fuel delivery
- Faulty injection nozzles
- Restricted air cleaners
- Improper injection pump timing

• Slow Acceleration:

Fuel System Malfunction - See Group 115
- Faulty injection pump
- Faulty injection nozzles

• Detonation:

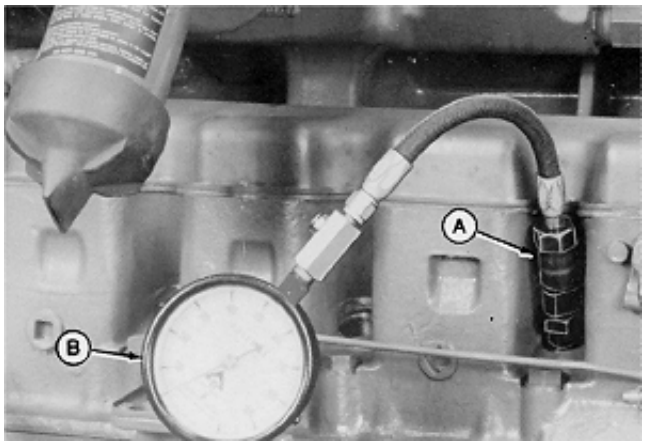
Fuel System Malfunction - See Group 115
- Faulty injection pump
- Faulty injection nozzles
- Improper fuel

• Abnormal Engine Noise:

Basic Engine Problem
- Low engine oil level
- Excessive valve clearance
- Worn cam followers
- Bent push rods
- Worn rocker arm shafts
- Worn main or connecting rod bearings
- Foreign material in combustion chamber
- Worn Piston pin bushings and pins
- Scored piston
- Incorrect engine timing
- Excessive crankshaft end play
- Loosen main or connecting rod bearing caps
- Crankshaft oil pump drive gear worn or broken
- Crankshaft vibration damper worn or separated

RG,CTM61,G105,8-19-18AUG94

TEST ENGINE COMPRESSION PRESSURE



IMPORTANT: Compression pressures are affected by the cranking speed of the engine. Before beginning test, insure that batteries are fully charged and injection nozzle area is thoroughly cleaned.

1. Start engine and run at rated speed until it warms up to normal operating temperature. From a cold start, operate engine 10—15 minutes at slow idle.

2. Remove V-belts from engine.

3. Remove injection lines, leak-off lines, and injection nozzles. (See REMOVE INJECTION NOZZLES in Group 35).

4. Install the JT01675A Nozzle Adapter (A) with the JT01682 Gauge (B) and hose assembly into injection nozzle bore.

5. Pull fuel shut-off knob all the way out, if equipped, and close fuel shut-off valve.

6. Crank engine over and record compression readings at 200—250 rpm cranking speed.

7. If pressure is much lower than shown, remove gauge and apply oil to ring area of piston through nozzle bore. Do not use too much oil or get oil on the valves.

ENGINE COMPRESSION SPECIFICATIONS

Engine	Compression Pressure
6466D	3 000—3 410 kPa (30.0—34.1 bar) (435—495 psi)
6466T Serial No. (—253372)	2 280—2 550 kPa (22.8—25.5 bar) (330—370 psi)
Serial No. (253373—)	2 690—3 100 kPa (26.9—31.0 bar) (390—450 psi)
6466A Serial No. (—233592)	2 280—2 550 kPa (22.8—25.5 bar) (330—370 psi)
Serial No. (233593—)	2 450—2 860 kPa (24.5—28.6 bar) (355—415 psi)
Maximum Variation Between Cylinders	340 kPa (3.4 bar) (50 psi)

NOTE: Pressure given was taken at 183 m (600 ft) above sea level. A 3.6 percent reduction in gauge pressure will result for each additional 300 m (1000 ft) of altitude.

8. Crank engine over and record compression reading again. If pressure is higher than 2 790 kPa (27.9 bar) (405 psi), worn or stuck rings are indicated. Replace piston rings or install new piston and liner set. (See Group 10.)

If pressure is below 2 380 kPa (23.8 bar) (345 psi) it is possible that valves are worn or sticking. Recondition cylinder head as needed. (See Group 05.)

9. Measure compression pressure in all remaining cylinders and compare readings. Recondition cylinders and valves as required. (See Group 05.)

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S11,22010,BQ -19-10AUG94

CHECK CAMSHAFT GEAR-TO-OIL PUMP GEAR BACKLASH—CAMSHAFT-DRIVEN OIL PUMP ONLY (BEFORE ENGINE DISASSEMBLY)

NOTE: Before measuring backlash, the engine must be at normal operating temperature.

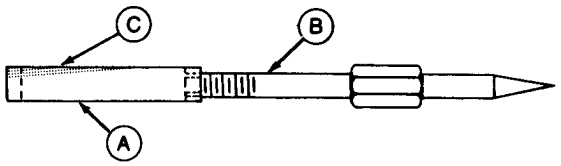
Before removing oil pump, determine if there is adequate backlash between oil pump and camshaft drive gears.

1. Remove tachometer drive housing, located on rear right-hand side of engine block. (See Group 16.)

2. Screw together pointer (B) and ring (A) from JDE109 Camshaft Wear Indicator.

3. Install ring with pointer on top flange of engine oil pump drive gear. Do not tighten pointer.

NOTE: If interference exists between the cylinder block and the ring, grind some material (C) from ring.



RG7002 -UN-26JUN94

A—Ring
B—Pointer
C—Grind Material as Required

S11,2020,ED -19-10AUG94

4. Install gauge (D) on engine block using the two cap screws (A) provided with tool set.

5. Align the pointer (B) over the center mark on gauge and tighten pointer.

IMPORTANT: The pointer MUST BE tight to achieve an accurate backlash measurement.

6. Place fingers on hex portion of pointer (C) and move the pointer back and forth by hand. DO NOT use excessive force to move the pointer.

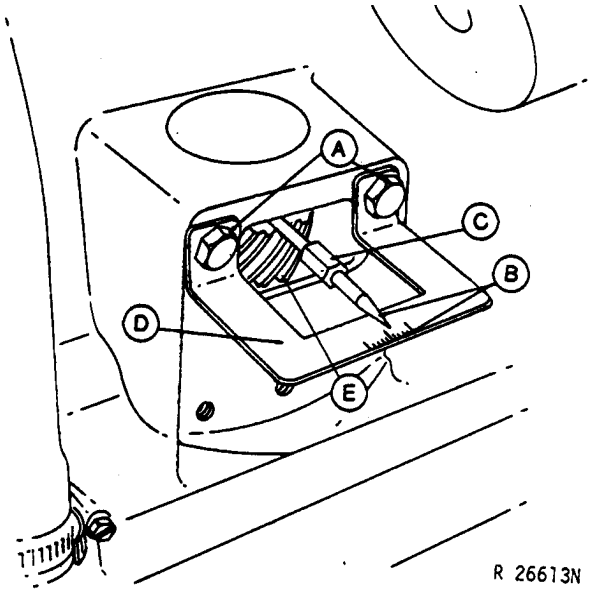
NOTE: Each mark on gauge is equivalent to 1˚ of backlash.

CAMSHAFT GEAR-TO-OIL PUMP DRIVEN GEAR BACKLASH SPECIFICATIONS

Minimum Acceptable Backlash	0.5˚
Maximum Acceptable Backlash	3.5˚

When checking backlash with new camshaft gear and/or oil pump gear, lubricate the camshaft, camshaft gear and oil pump gear with clean SAE30 engine oil.

If backlash is 3.5˚ or more, check camshaft oil pump drive gear and gear on oil pump for a step wear pattern on teeth of gears. Replace parts as necessary. If backlash is less than 0.5˚, or the camshaft does not rotate freely, install a new camshaft.

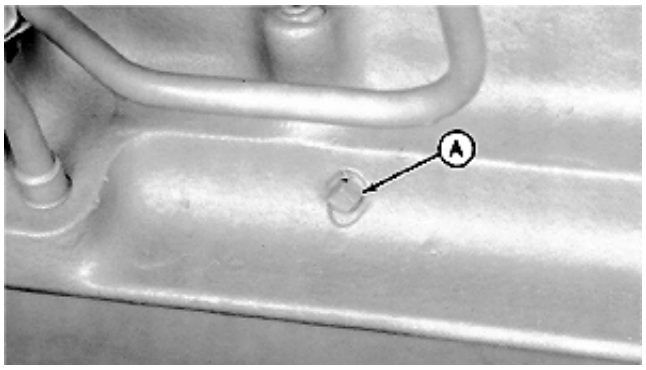


A—Cap Screws
B—Center Alignment
C—Hex Part of Pointer
D—Gauge
E—Engine Oil Pump Drive Gear

S11,2020,EE -19-10AUG94

CHECK ENGINE OIL PRESSURE

1. Remove pipe plug (A) from main oil gallery using JDG782 Oil Galley Plug Tool.



S11,22010,AM -19-08APR94

105
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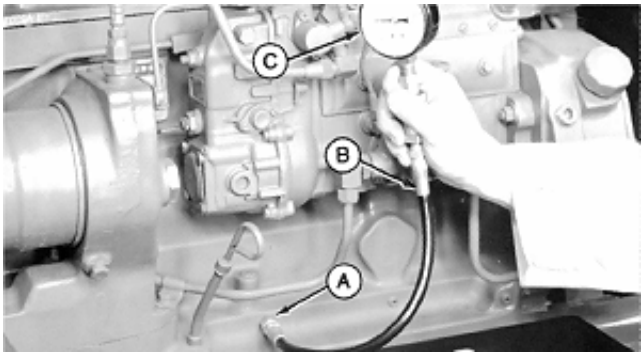
2. Install No. 0070 (D1) Fitting (A), No. 2106 (19-HP) Hose (B), and JT05472* Gauge (C).

IMPORTANT: To achieve an accurate oil pressure reading, warm up engine to 105˚C (220˚F).

3. Measure oil pressure.



RG4125 -UN-30NOV88

ENGINE OIL PRESSURE SPECIFICATIONS

Minimum No Load at 800 rpm
(Slow Idle) . . . . . 103 kPa (1.03 bar) (15 psi)

Maximum Full Load at 1800—2200 rpm
(Rated Speed) . . . . . 330 kPa (3.30 bar) (47 psi)

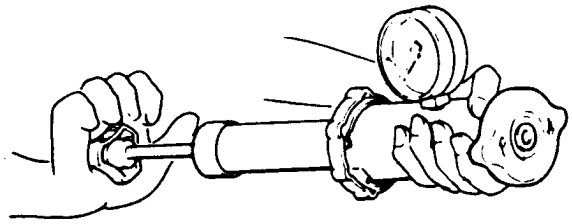
NOTE: To adjust oil pressure, remove regulating valve spring at filter base and add washers to increase oil pressure. Subtract washers to decrease oil pressure.

Do not use more than a total of five washers.

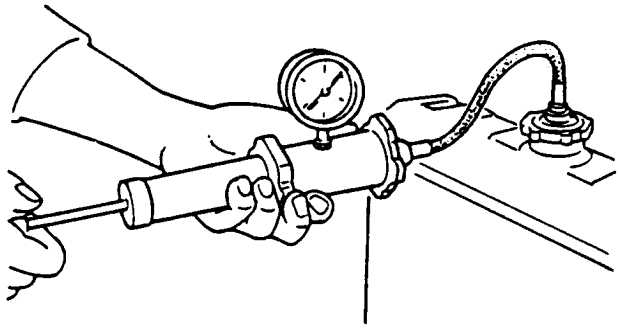
** Part of JT05470 (D15027NU) Universal Pressure Test Kit*

S11,22010,AN -19-18AUG94

PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP



RG6557 -UN-20JAN93



RG6558 -UN-20JAN93

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

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

Test Radiator Cap:

1. Remove radiator cap and attach to D05104ST Tester as shown.

2. Pressurize cap to 50 kPa (0.5 bar) (7 psi)*. Gauge should hold pressure for 10 seconds within the normal range if cap is acceptable.

If gauge does not hold pressure, replace radiator cap.

3. Remove the cap from gauge, turn it 180˚, and retest cap. This will verify that the first measurement was accurate.

Test Cooling System:

NOTE: Engine should be warmed up to test overall cooling system.

1. Allow engine to cool, then carefully remove radiator cap.

2. Fill radiator with coolant to the normal operating level.

IMPORTANT: DO NOT apply excessive pressure to cooling system, doing so may damage radiator and hoses.

3. Connect gauge and adapter to radiator filler neck. Pressurize cooling system to 50 kPa (0.5 bar) (7 psi)*.

4. With pressure applied, check all cooling system hose connections, radiator, and overall engine for leaks.

If leakage is detected, correct as necessary and pressure test system again.

If no leakage is detected, but the gauge indicated a drop in pressure, coolant may be leaking internally within the system or at the block-to-head gasket. Have your servicing dealer or distributor correct this problem immediately.

**Test pressures recommended are for all Deere OEM cooling systems. On specific vehicle applications, test cooling system and pressure cap according to the recommended pressure for that vehicle.*

RG18293,6 -19-14OCT94

INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE

Visually inspect thermostat for corrosion or damage. Replace as necessary.

• Test thermostat as follows:

CAUTION: DO NOT allow thermostat or thermometer to rest against the side or bottom of container when heating water. Either may rupture if overheated.

1. Suspend thermostat and a thermometer in a container of water.

2. Stir the water as it heats. Observe opening action of thermometer and compare temperatures with specification given in chart below.

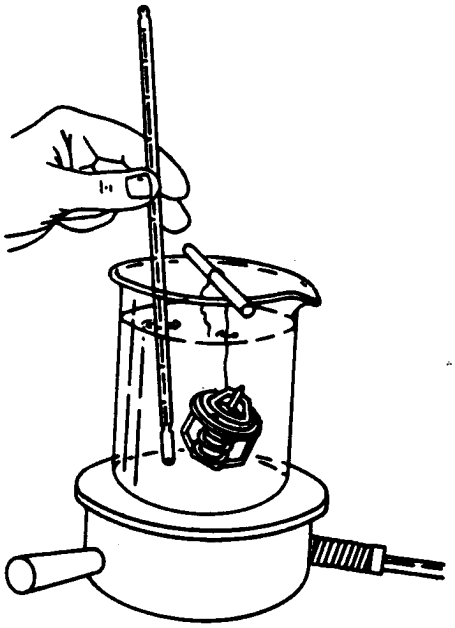
NOTE: Due to varying tolerances of different suppliers, initial opening and full open temperatures may vary slightly from specified temperatures.

THERMOSTAT TEST SPECIFICATIONS

Rating	Initial Opening (Range)	Full Open (Nominal)
71˚C (160˚F)	69—72˚C (156—162˚F)	84˚C (182˚F)
77˚C (170˚F)	74—78˚C (166—172˚F)	89˚C (192˚F)
82˚C (180˚F)	80—84˚C (175—182˚F)	94˚C (202˚F)
89˚C (192˚F)	86—90˚C (187—194˚F)	101˚C (214˚F)
90˚C (195˚F)	89—93˚C (192—199˚F)	103˚C (218˚F)
92˚C (197˚F)	89—93˚C (193—200˚F)	105˚C (221˚F)
96˚C (205˚F)	94—97˚C (201—207˚F)	100˚C (213˚F)
99˚C (210˚F)	96—100˚C (205—212˚F)	111˚C (232˚F)

3. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.

4. If any thermostat is defective on a multiple thermostat engine, replace all thermostats.



RG5971 -UN-17SEP91

CTM42,G105,13 -19-13MAY93

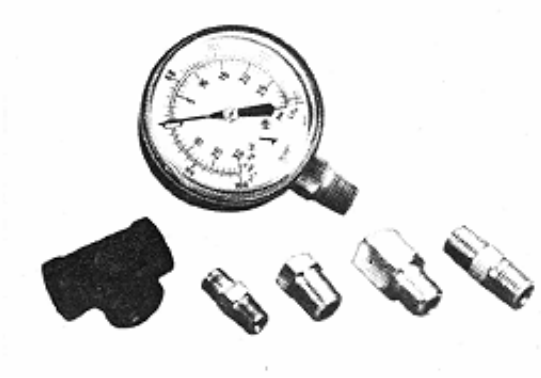
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

Water Vacuum Gauge Set D05022ST

Test air intake restriction indicator switch.



RG5921 -UN-16AUG91

RG,D05022ST -19-18SEP91

A—JT03092 Gauge *

B—JT03017 Hose and Connector *

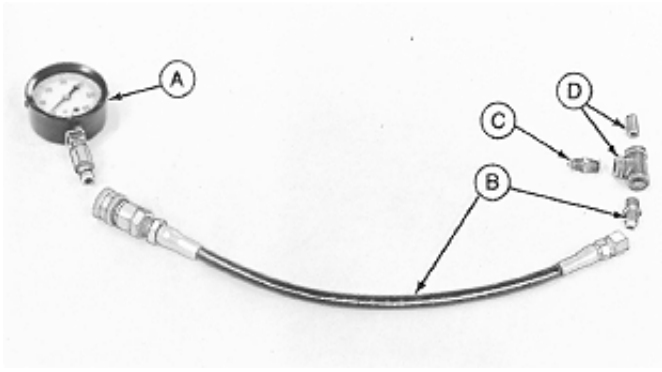
C—Connector

1/8 in. Pipe Nipple	**Used with above hose and gauge to check intake manifold pressure at aneroid.**
1/4 in.—1/8 in. Pipe Reducer	
1/8 NPT-7/16-20 UNC Adapter	

D—"T" Fitting

D—JT03104 Fitting*	**Used with above hose and gauge to check intake manifold pressure at aftercooler on 6466A Engines.**

*** Part of JT05412 Hydraulic Test Kit**



R28266 -UN-15DEC88

S11,23005,BA -19-14APR94

AIR INTAKE AND EXHAUST SYSTEM TEST SPECIFICATIONS

NOTE: Specifications given below apply to OEM engines only. For machine applications, consult the appropriate machine technical manual.

ITEM	SPECIFICATION
Intake Manifold Pressure (Turbocharger Boost) at Engine Rated Speed and Rated Full Load Power:	
6466TF	80—110 kPa (0.8—1.1 bar) (11—16 psi)
6466AF	135—165 kPa (1.4—1.7 bar) (20—24 psi)

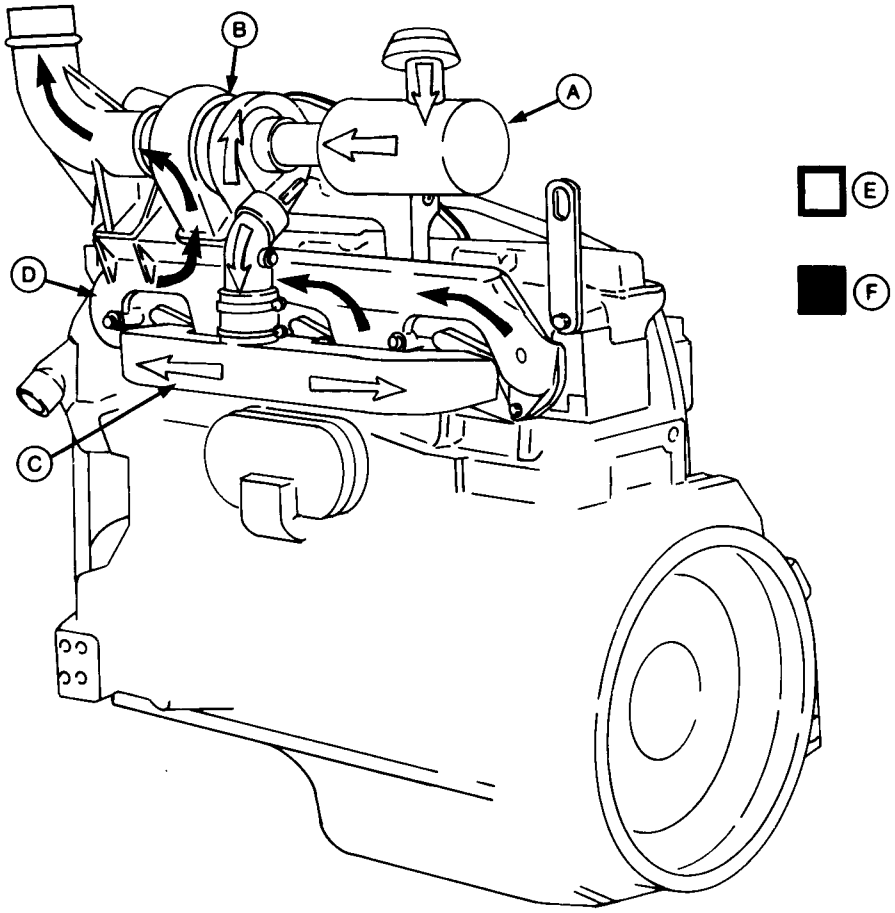
S11,23005,AI -19-18AUG94

DIAGNOSING AIR INTAKE MALFUNCTIONS

Symptom	Problem	Solution
Engine Starts Hard or Won't Start	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
Erratic Engine Operation	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
Engine Emits Excessive Black Smoke	Air cleaner element restricted	Clean or replace elements (See operator's manual).
	Turbocharger defective	Repair or replace (See Group 30).
	Air leak in manifold	Check hose and pipe connections for tightness; repair as required (See Group 30).
Engine Idles Poorly	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
Engine Does Not Develop Full Power	Air cleaner restricted	Clean or replace elements (See operator's manual).
	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
	Turbocharger defective	Repair or replace (See Group 30).
	Manifold pressure pipe to aneroid loose or broken	Check hose and pipe connections for tightness; repair as required (See Group 30).
Turbocharger "Screams"	Air leak in manifold	Check intake manifold gasket and manifold; repair as required (See Group 30).

S11,23005,AJ -19-16SEP92

HOW THE AIR INTAKE AND EXHAUST SYSTEM WORKS



RG7089 -UN-16FEB94

A—Air Cleaner
B—Turbocharger
C—Intake Manifold
D—Exhaust Manifold
E—Intake Air
F—Exhaust Air

Engine vacuum draws outside air into the air cleaner (A). The air is filtered through the primary and secondary (safety) filter elements in the air cleaner.

On 6466T engines the turbocharger (B) compresses the air and sends it to the intake manifold (C) which distributes the intake air (E) to each cylinder. Exhaust air (F) from the cylinders passes through the exhaust manifold (D) and drives the turbocharger before exiting through the muffler and exhaust stack.

On 6466A engines, an aftercooler is installed between the turbocharger and intake manifold. The aftercooler cools the intake air before it reaches the cylinders.

6466D engines are naturally-aspirated. Engine vacuum created by the cylinders draws the intake air through the air cleaner and intake manifold without the aid of a turbocharger or aftercooler.

RG,CTM1,G110,1 -19-10AUG94

AIR CLEANER OPERATION

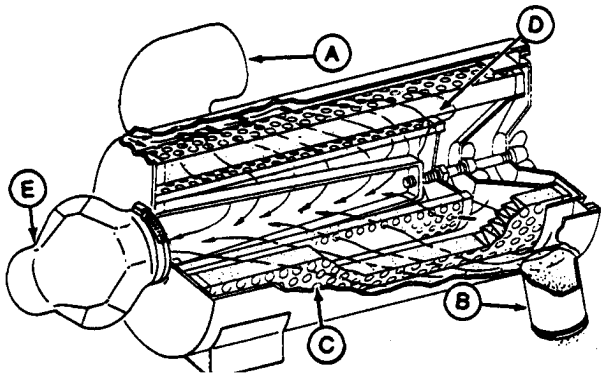
Dust-laden air enters the air cleaner inlet (A) and is forced into a high-speed centrifugal motion.

Most of the dust settles out of the air (before it enters the filter elements) and falls to the bottom of the air cleaner body. It is expelled to the outside of the air cleaner (B) through a rubber valve, which automatically ejects the dust and keeps it from accumulating inside the air cleaner body.

As the intake air is drawn through the primary element (C) and a secondary (safety) element (D), the remaining dust particles are retained in the primary element to permit only clean air to enter the intake manifold.

The safety element retains the dust that would otherwise pass into the engine if the primary element should rupture.

See your operator's manual for recommended service intervals.



R28270 -UN-14DEC88

A—Air Inlet
B—Dust Outlet
C—Primary Element
D—Secondary (Safety) Element
E—Air Outlet

S11,23005,AO -19-04FEB93

DIAGNOSING TURBOCHARGER MALFUNCTIONS

Before replacing the turbocharger, determine what caused the failure of the defective unit, and correct the condition. This will prevent an immediate repeat failure of the replacement unit. Refer to Air Intake and Exhaust System Group 30 for repair information.

• Noise Or Vibration*:

Bearings not lubricated (insufficient oil pressure).
Air leak in engine intake or exhaust manifold.
Improper clearance between turbine wheel and turbine housing.
Broken blades (or other wheel failures).

• Engine Will Not Deliver Rated Power:

Clogged manifold system.
Foreign material lodged in compressor, impeller, or turbine.
Excessive dirt build-up in compressor.
Leak in engine intake or exhaust manifold.
Leak in intake manifold-to-aneroid pipe.
Rotating assembly bearing failure.
Damaged compressor or turbine blades.

• Oil On Compressor Wheel Or In Compressor Housing (Oil Being Pushed or Pulled Through Center Housing):

Excessive crankcase pressure.
Air intake restriction.
Drain tube restriction.

• Oil In Manifold Or Dripping From Housing:

Excessive crankcase pressure.
Air intake restriction.
Drain tube restriction.
Damaged or worn journal bearings.
Unbalance of rotating assembly:
Damage to turbine or compressor wheel or blade.
Dirt or carbon build-up on wheel or blade.
Bearing wear.
Oil starvation or insufficient lubrication.
Shaft seals worn.

• Turbine Wheel Drag:

Carbon build-up behind turbine wheel caused by coked oil or combustion deposits.
Dirt build-up behind compressor wheel caused by air intake leaks.
Bearing seizure or dirty, worn bearings caused by excessive temperatures, unbalanced wheel, dirty oil, oil starvation, or insufficient lubrication.

**Do not confuse the whine heard during run down with noise which indicates a bearing failure.*

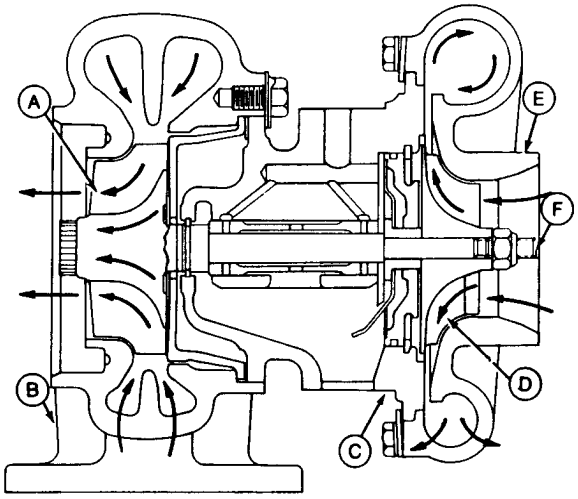
S11,23005,K -19-18AUG94

HOW THE TURBOCHARGER WORKS—6466T AND 6466A ENGINES

Exhaust gases from the engine pass through the turbine housing (B) causing the shaft (F) to rotate before the exhaust gas is discharged to the atmosphere.

The compressor wheel (D), also mounted on shaft (F), rotates in the compressor housing (E). Inlet air is drawn into the housing, where it is compressed and delivered to engine cylinders.

A—Turbine Wheel
B—Turbine Housing
C—Center Housing
D—Compressor Wheel
E—Compressor Housing
F—Shaft



RG6999 -UN-25JUN94

*Schwitzer Air Flow**

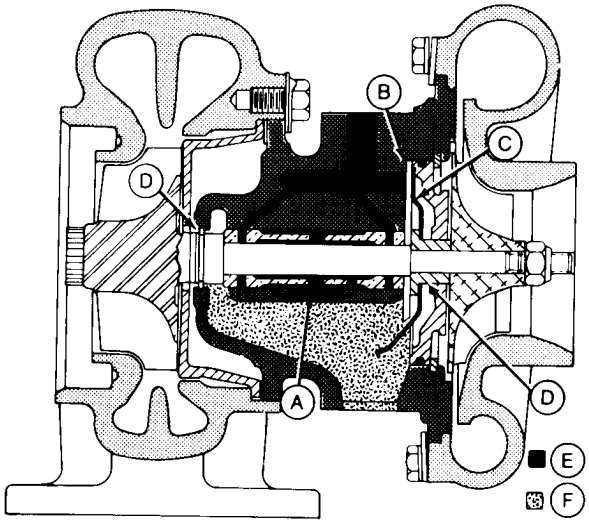
**Garrett/AiResearch air flow similar.*

S11,3005,JD -19-10AUG94

HOW THE TURBOCHARGER IS LUBRICATED

Engine oil under pressure from the engine lubrication system is pumped through a passage in the bearing housing and directed to the bearings (A), thrust plate (B), and thrust sleeve (C). Oil is sealed from the compressor and turbine by a piston ring (D) at both ends of the bearing housing.

The Garrett/AiResearch turbocharger contains two floating bearings and the Schwitzer turbocharger contains a single floating bearing. These bearings have clearance between the bearing OD and the housing bore as well as clearance between the bearing ID and the shaft OD. These clearances are lubricated by the oil supply (E) and the bearings are protected by a cushion of oil. Discharge oil (F) drains by gravity from the bearing housing to the engine crankcase.



RG4646 -UN-29AUG94

Schwitzer Turbocharger Lubrication

A—Bearing(s)
B—Thrust Plate
C—Thrust Sleeve
D—Piston Ring
E—Pressure Oil
F—Discharge Oil

S11,3005,JE -19-16AUG94

HOW THE AFTERCOOLER WORKS—6466A ENGINES

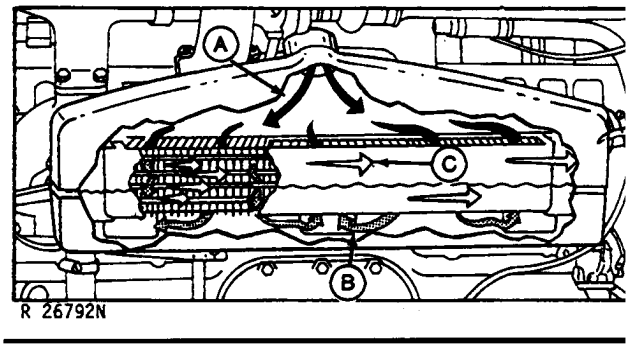
110
8

6466A Engines produced prior to Engine Serial Number (—345908) were equipped with a single-pass aftercooler (upper illustration). Engines produced since that serial number are equipped with a dual-pass aftercooler (lower illustration).

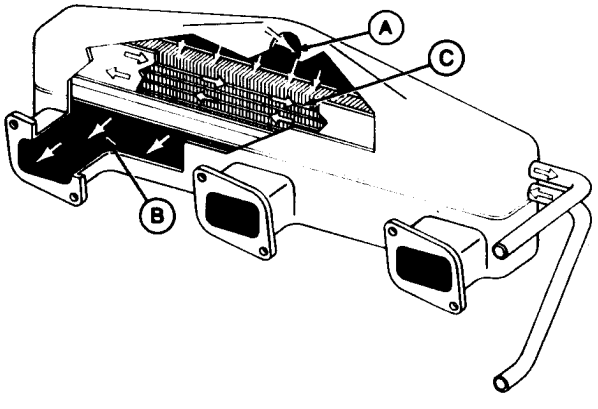
Air entering the intake manifold has been compressed (and heated) by the turbocharger. As this heated, compressed air (A) enters the intake manifold, it flows around the aftercooler before entering the engine cylinders.

The aftercooler functions as a heat exchanger, lowering the intake air (B) temperatures as much as 27—32˚C (80—90˚F) on single-pass aftercoolers and as much as 35—47˚C (95—116˚F) on dual-pass aftercoolers. 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, produces more power.

Engine coolant (C) circulating through the aftercooler core is the media used for heat exchange. Extreme care must be exercised to insure that the engine coolant does not leak into the intake manifold, resulting in possible damage to the engine.



Single-Pass Aftercooler



Dual-Pass Aftercooler

A—Heated Air
B—Cooled Air
C—Engine Coolant

S11,3005,KQ -19-14APR94

CHECK INTAKE MANIFOLD PRESSURE (TURBOCHARGER BOOST)

NOTE: For each vehicle application, refer to the appropriate machine technical manual for intake manifold pressure specifications.

Intake manifold pressure (turbocharger boost) can be checked at intake manifold and aneroid.

IMPORTANT: Engine speed and load should be stabilized before taking readings on gauge. Be sure that gauge works properly.

Pressure checks are only a guide to determine if there is an engine problem (valve leakage, defective nozzles, etc.). Low readings are not a valid reason for increasing injection pump fuel delivery. Pump adjustment should be within specification as established by an authorized repair station.

• If boost pressure is too high, remove and test fuel injection pump for high fuel delivery.

• If boost pressure is too low, check for the following:

—Restriction in air cleaner.
—Leak in air intake between turbocharger and cylinder head.
—Defective turbocharger.
—Leak in exhaust manifold gasket.
—Leak in fuel control pipe.
—Restricted fuel filter elements.
—Incorrect fast idle adjustment.
—Incorrect injection pump timing.
—Faulty fuel supply pump.
—Low compression pressure.
—Faulty fuel injection nozzles.
—Carbon build-up in turbocharger.
—Turbocharger compressor or turbine wheel rubbing housing.
—Low fuel injection pump delivery.
—Restricted exhaust.

RG,CTM1,G110,6 -19-10AUG94

• **At Aneroid (If Equipped):**

1. Remove aneroid line (A) from aneroid (B).

2. Install a 1/8 in. pipe nipple and “T” fitting (C) into aneroid with a 1/4 in.-to-1/8 in. pipe reducer (D).

3. Connect aneroid line to “T” fitting.

4. Attach 1/8 in. NPT-to-7/16-20 UNC Adapter (E) and JT03017 Hose (F) to JD03092 Pressure Gauge (G).

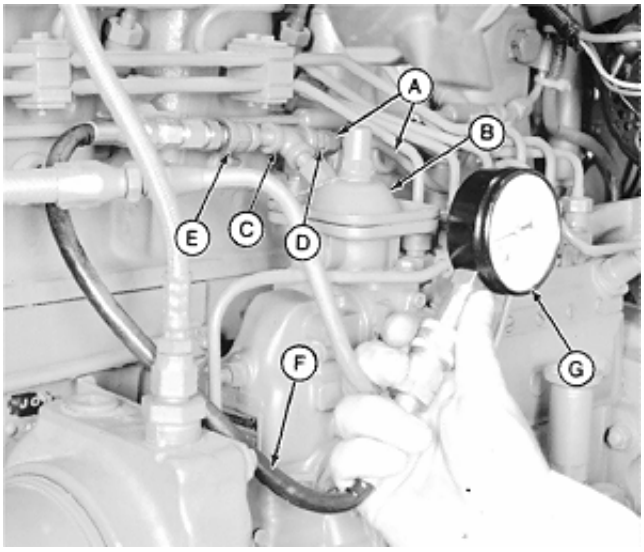
5. With engine at operating temperature, connect to a dynamometer. Operate engine at full load speed. Refer to DYNAMOMETER TEST SPECIFICATIONS in Group 100 for appropriate full load speed.

6. Observe pressure readings and compare to specifiations below. If the reading is not within the given range, check possible malfunctions as given in this group.

7. Remove test equipment and reinstall aneroid line.

INTAKE MANIFOLD PRESSURE SPECIFICATONS (TURBOCHARGER BOOST)

6466TF	80—110 kPa (0.8—1.1 bar) (11—16 psi)
6466AF	135—165 kPa (1.4—1.7 bar) (20—24 psi)



6466T Shown - 6466A Similar

A—Aneroid Line
B—Aneroid
C—T-Fitting
D—1/4-to-1/8 in. Pipe Reducer
E—Adapter
F—JT03017 Hose
G—JD03092 Pressure Gauge

S11,23005,AK -19-18AUG94

• **At Intake Manifold:**

NOTE: Intake manifold pressure can also be checked from the ether starting aid line, if equipped, as described later in this group.

1. On 6466A engines, remove plug or ether starting aid line (A) (if equipped) with nozzle adapter from aftercooler cover. On 6466T engines, remove plug or ether starting aid line and nozzle adapter from intake manifold.

2. Install JT03104 Fitting (B) into aftercooler cover or intake manifold.

3. Install JT03017 Hose (C) with JT03092 Pressure Gauge (D).

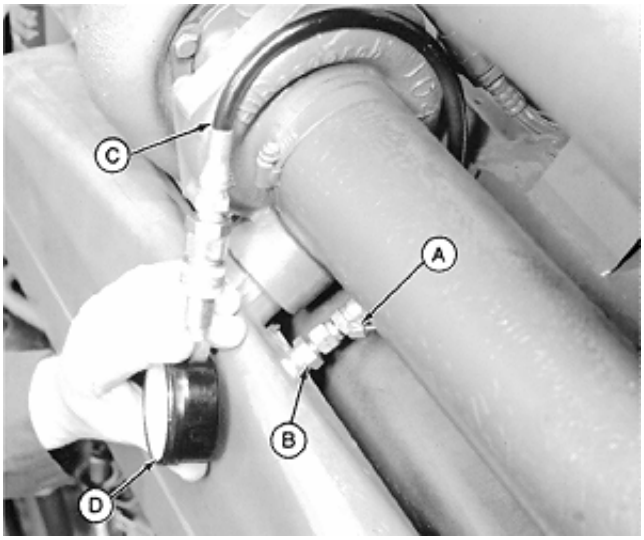
4. With engine at operating temperature, connect to a dynamometer. Operate engine at full load speed. Refer to DYNAMOMETER TEST SPECIFICATIONS in Group 100 for appropriate full load speed.

INTAKE MANIFOLD PRESSURE SPECIFICATONS (TURBOCHARGER BOOST)

6466TF	80—110 kPa (0.8—1.1 bar) (11—16 psi)
6466AF	135—165 kPa (1.4—1.7 bar) (20—24 psi)

5. Observe pressure readings and compare to specifications above. If the reading is not within the given range, check possible malfunctions as given in this group.

6. After completing test, remove test equipment and reinstall plug or ether starting aid line with nozzle adapter.



RG4130 -UN-14DEC88

6466A Shown

A—Ether Starting Aid Nozzle Adapter
B—JT03104 Fitting
C—JT03017 Hose
D—JT03092 Pressure Gauge

S11,23005,AL -19-18AUG94

CHECK INTAKE MANIFOLD PRESSURE (TURBOCHARGER BOOST) FROM ETHER STARTING AID LINE—6466T AND 6466A ENGINES

1. If equipped with ether starting aid, remove elbow connector (A) and install into ether line (B).

2. Connect 1/8 in. NPT-to-7/16-20 UNC Adapter (C) and JT03017 Hose (D) to JT03092 Pressure Gauge (E) .

3. With engine at operating temperature, connect to a dynamometer. Operate engine at rated full load speed. Refer to DYNAMOMETER TEST SPECIFICATIONS in Group 100 for appropriate full load speed.

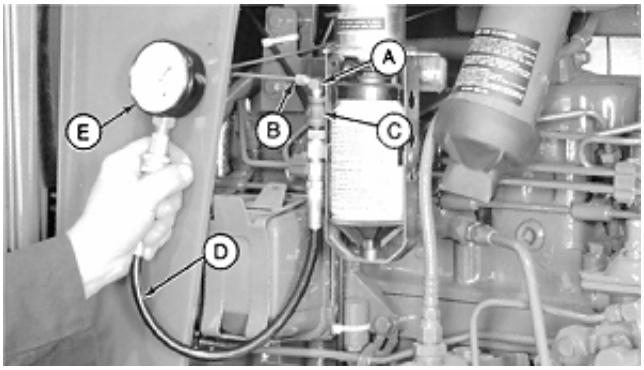
INTAKE MANIFOLD PRESSURE SPECIFICATONS (TURBOCHARGER BOOST)

6466TF . . . . . 80—110 kPa (0.8—1.1 bar) (11—16 psi)

6466AF . . . . . 135—165 kPa (1.4—1.7 bar) (20—24 psi)

4. Observe pressure readings and compare to specifications listed above. If the reading is not within the given range, check possible malfunctions as given in this group.

5. Remove test equipment and reinstall ether starting aid line.



RG4146 -UN-08SEP89

A—Elbow Connector
B—Ether Starting Aid Line
C—Adapter
D—JT03017 Hose
E—JT03092 Pressure Gauge

S11,23005,AN -19-18AUG94

AIR FILTER RESTRICTION INDICATOR SWITCH TEST

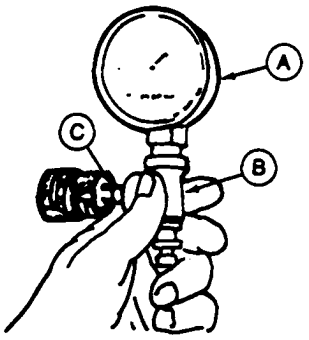
1. Remove air filter restriction indicator switch from air intake piping.

2. Install pipe nipple (C), tee fitting (B), and gauge (A) from D05022ST Water Vacuum Gauge Kit into air filter restriction indicator hole. Install air filter restriction indicator into tee fitting.

3. Start engine and slowly cover the air cleaner inlet with a piece of paper or cardboard.

4. Air restriction indicator must show red at 5.6—6.8 kPa (56—68 mbar) (22.7—27.3 in. water) (1.6—2.0 in. hg) vacuum.

If air restriction indicator shows red at any other value than listed above, install a new indicator.



T6188AQ -UN-09DEC88

RG,CTM6,G110,1 -19-14AUG91

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

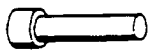
Rotate engine flywheel. Use with JDE81-4 Timing Pin.

S53,JDE811B -19-08AUG94

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Lock engine at TDC when timing valve train.



S53,JDE814A -19-08AUG94

SERVICE EQUIPMENT AND TOOLS

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

Name	Use
Pressure Gauge/0—200 kPa (0—2 bar) (0—30 psi), hose, and fittings.	Measure transfer pump pressure. NOTE: Assemble test equipment from JT05470 Universal Pressure Test Kit or any other suitable equipment.

S11,23010,IZ -19-04MAR87

FUEL SYSTEM TEST SPECIFICATIONS

ITEM	SPECIFICATIONS
Fuel Supply Pump Output Pressure:	
6466D Engines (diaphragm type)	25—30 kPa (0.25—0.30 bar) (3.5—4.5 psi)
6466T and 6466A Engines (plunger type)	
Standard pressure (with filter bowl)	100 kPa (1.0 bar) (14.5 psi) minimum
High pressure (without filter bowl)	200 kPa (2.0 bar) (29.0 psi) minimum
Aneroid Activator Operating Pressure	48—75 kPa (0.5—0.8 bar) (7—11 psi)
Fuel Injection Pump Timing-to-Engine:	
6466AF001 Engine	14° BTDC
All Other Applications	TDC
Engine Speeds (RPM)	For each machine application, refer to the appropriate machine technical manual for slow idle, fast idle, and rated speed specifications. For OEM applications, see FUEL INJECTION PUMP SPECIFICATIONS, later in this group.

TORQUES

Injection Pump Drive Gear-to-Pump Hub	47 N·m (35 lb-ft)

S11,23010,FB -19-10AUG94

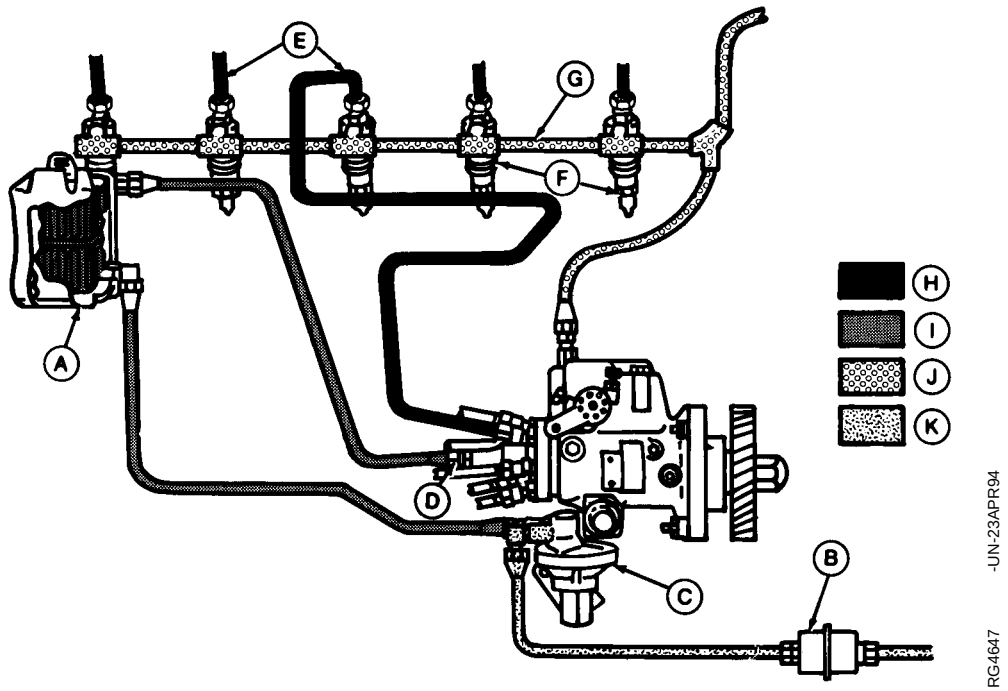
FUEL INJECTION PUMP SPECIFICATIONS

Engine Model	Option Code	Original Injection Pump (Part No.)	Replaced By Injection Pump (Part No.)	Governor Regulation	Slow Idle RPM	Fast Idle RPM	Rated Speed RPM	Power Rating* kW (BHP)
6466DF	1602	AR85568	RE10316	Std.	800	2400	2200	130 (174)
	1603	AR85570	RE10317	3-5%	800	1890	1800	85 (114)
	1602	RE10316		Std.	800	2400	2200	99 (133)
	1603	RE10317		3-5%	800	1890	1800	87 (117)
6466TF	1601	AR88906		Std.	800	2400	2200	112 (150)
	1604	AR88907		3-5%	800	2268	2160	113 (151)
	1601	AR94027	RE28034	Std.	800	2400	2200	130 (174)
	1604	AR94028	RE28033	3-5%	800	1890	1800	120 (161)
	1657, 1658	RE10076	RE23746	Std.	850	2400	2200	120 (161)
	1657, 1658	RE15997	RE23746	Std.	850	2400	2200	120 (161)
	1601, 1626	RE18161	RE28034	Std.	800	2400	2200	130 (174)
	1604, 1610	RE18163	RE28033	3-5%	800	1890	1800	120 (161)
	1657, 1658	RE23753	RE23746	Std.	850	2400	2200	120 (161)
	1657, 1658	RE23746		Std.	850	2400	2200	120 (161)
	1657, 1658	RE23926	RE23746	Std.	850	2400	2200	120 (161)
	1604, 1610	RE28033		3-5%	800	1890	1800	120 (161)
	1601, 1626	RE28034		Std.	800	2400	2200	130 (174)
6466AF	1606	AR92838	RE25013	Std.	800	2300	2100	165 (221)
	1608	AR88919		3-5%	800	1890	1800	157 (210)
	1610	AR94482	RE25014	3-5%	800	1890	1800	180 (241)
	1606, 1625, 1626, 1640	RE18155	RE25013	Std.	800	2300	2100	165 (221)
	1610	RE18157	RE25014	3-5%	800	1890	1800	180 (241)
	1629	RE25013		3-5%	800	2205	2100	165 (221)
	1610	RE25014		3-5%	800	1890	1800	180 (241)
	1610	RE25019	RE25014	3-5%	800	1890	1800	180 (241)
	1606, 1625, 1626, 1629, 1640	RE25018	RE25013	Std.	800	2300	2100	165 (221)
	1661, 1663	RE23478		Std.	850	2400	2200	157 (210)
6466AF001	1630	RE26315		Std.	650	2425	2200	160 (215)
	1631	RE23616		Std.	650	2425	2200	180 (241)

** Average power rating shown. Allow ± 5% for maximum and minimum power.*

RG,CTM1,G115,2 -19-18AUG94

FUEL SYSTEM OPERATION—6466D ENGINES



A—Fuel Filter
B—Pre-Filter-Optional
C—Supply Pump
D—Transfer Pump
E—Delivery Lines
F—Nozzles
G—Leak-Off Line
H—Injection Pressure
I—Supply Pump Pressure
J—Fuel Return
K—Gravity Pressure

The supply pump (C) draws fuel from the tank and pressurizes it to 25—30 kPa (0.25—0.30 bar) (3.5—4.5 psi) at idle speed. This pressure permits the fuel to flow through the pre-filter (B), fuel filter (A) and charge the transfer pump (D) of the injection pump.

With the transfer pump charged with fuel by the fuel transfer pump, the injection pump plungers pressurize the fuel to about 41 370 kPa (413 bar) (6000 psi). Delivery lines (E) are used to route this high pressure fuel to the fuel injection nozzles (F).

Fuel entering the injection nozzle at 41 370 kPa (413 bar) (6000 psi) easily overcomes the pressure required to open the nozzle valve. When the nozzle valve opens, fuel is forced out through the orifices in the nozzle tip and atomizes as it enters the combustion chamber.

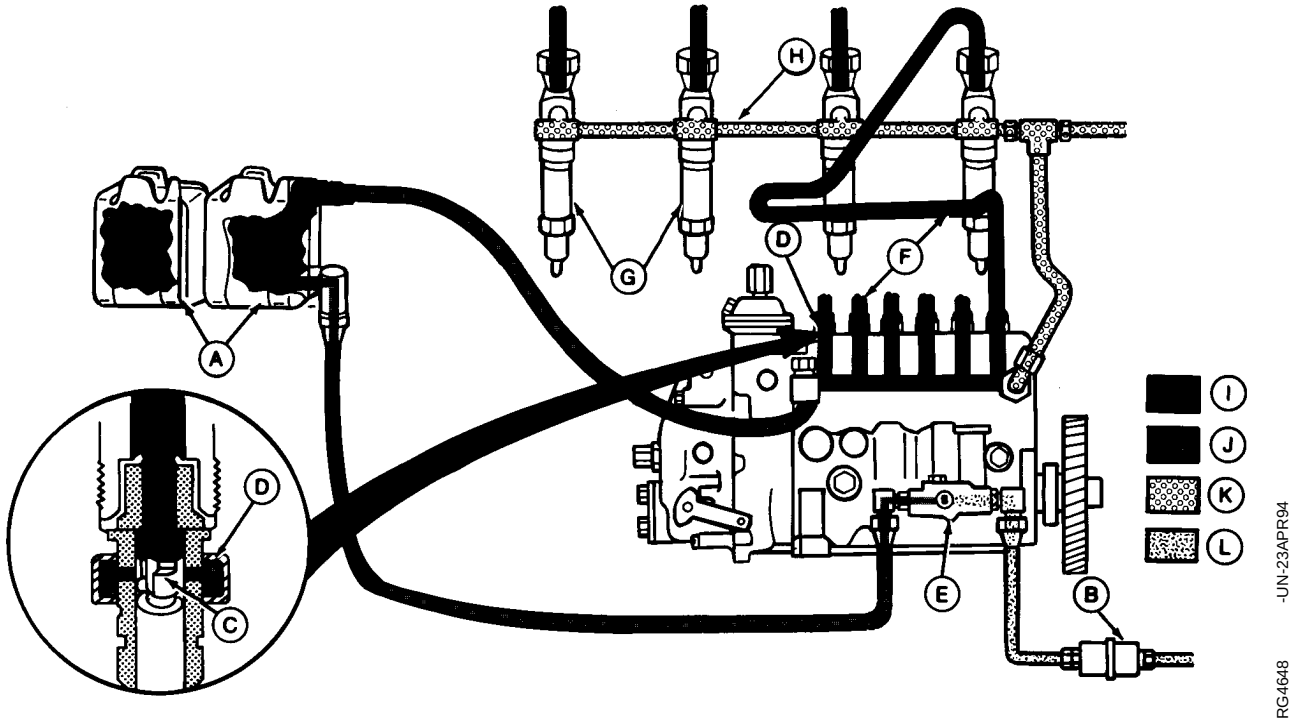
Incorporated into the fuel system is a means of returning excess (or unused) fuel back to the fuel tank. Excess fuel comes from two sources:

- Injection Pump—A quantity of fuel greater than that required by the engine is supplied to the fuel injection pump.
- 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 either end of the nozzle leak-off line (G). Fuel from both sources is then returned to the tank by a return line connected to the leak-off line.

S11,3010,KC -19-10AUG94

FUEL SYSTEM OPERATION—6466T AND 6466A ENGINES



A—Fuel Filters
B—Pre-Filter-Optional
C—Pump Plungers
D—Fuel Gallery
E—Supply Pump
F—Delivery Lines
G—Nozzles
H—Leak-Off Line
I—Injection Pressure
J—Supply Sump Pressure
K—Fuel Return
L—Gravity Pressure

The supply pump (E) draws fuel from the vented fuel tank through the pre-filter.

The supply pump pressurizes the fuel to 103—340 kPa (1.0—3.4 bar) (15—50 psi) which permits the fuel to flow through the filters (A) to the gallery (D) in the injection pump. Supply pump output pressures will vary depending on load and application.

The gallery is kept full by the supply pump. Injection pump plungers (C) further pressurize the fuel to about 69 000 kPa (690 bar) (10 000 psi). Delivery lines (F) route the fuel to the nozzles (G). The high pressure fuel opens the nozzle valve and forces fuel out the small orifices in the nozzle tip. This atomizes the fuel as it enters the combustion chamber.

There are two sources of excess fuel incorporated into the system. The supply pump supplies more fuel to the pump than is required by the engine, and the nozzle requires excess fuel to lubricate the nozzle valve. A leak-off line (H) returns this excess fuel to the tank from both the pump and nozzles.

S11,3010,KD -19-10AUG94

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
	Supply pump filter (if used) restricted	Service (See Group 35)
	Fuel too heavy at low temperatures	Use correct grade of fuel (See Group 02)
	Air in system	Correct problem and bleed fuel system (this group)
	Fuel tank valve shut off	Open fuel tank valve
	Low supply pump pressure	Check fuel lines for restrictions; check pump output pressure (this group)
Engine Starts Hard or Won't Start	Fuel too heavy at low temperature	Use correct grade of fuel (See Group 02)
	Injection nozzles faulty or sticking	Repair or replace as required (See Group 35)
	Incorrect timing	Adjust timing (this group)
	Faulty injection pump	Repair or replace
	Water in fuel	Drain water from fuel. Install new filter (See Group 35)
	Fuel filter restricted	Replace fuel filters (See Group 35)
	Supply pump filter (if used) restricted	Service (See Group 35)
	Low supply pump pressure	Check pump output pressure. (See this group)
	Injection pump return fuel line or fittings restricted	Clean lines as required
	Low cetane fuel	Use correct grade of fuel (See Group 02)
	Broken starting fuel control shaft spring	Repair (See Group 35)

Continued on next page

Symptom	Problem	Solution
	Injection pump drive gear teeth worn or broken	Check timing gear backlash and check for failed crankshaft vibration damper.
Engine Starts and Stops	Air in system	Correct problem and bleed fuel system (See this group)
	Fuel filter restricted	Replace fuel filter (See Group 35)
	Supply pump filter (if used) restricted	Service (See Group 35)
	Fuel lines restricted	Clean lines as required
	Water in fuel	Drain water from fuel. 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)
	Supply pump filter (if used) restricted	Service (Group 35)
	Fuel too heavy at low temperatures	Use correct grade of fuel (See Group 02)
	Injection nozzles faulty or sticking	Repair (See Group 35)
	Fuel lines restricted	Clean as required
	Incorrect timing	Adjust timing (this group)
	Governor faulty	Repair (See Group 35)
	Water in fuel	Drain water from fuel. Install new filter (See Group 35)
	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.

Continued on next page

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 and adjust (See Group 35)
	Aneroid defective	Repair and adjust (See Group 35)
Engine Emits Excessive Blue or White Smoke	Cranking speed too low	Check batteries and electrical system
	Injection pump timing incorrect	Adjust timing (this group)
	Injection nozzles faulty or sticking	Repair (See Group 35)
	Excessive wear in liners and/or piston rings stuck	Refer to 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. Install new filters (See Group 35)
	Injection pump return lines or fittings restricted	Clean as required
	Injection nozzle return lines clogged	Clean as required
	Low cetane fuel	Use correct grade of fuel (See Group 02)
Engine Does Not Develop Full Power	Low cetane fuel	Use correct grade of fuel (See Group 02)

Continued on next page

Symptom	Problem	Solution
	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)
	Injection pump return fuel line or fittings restricted	Clean as required
	Water in fuel (or gasoline in fuel)	Drain water or replace with clean fuel. Install new filters (this Group)
	Incorrect fast idle speed	Adjust speed (this Group)
	Manifold pressure pipe to aneroid loose or broken	Repair as required
	Fuel shut-off cable improperly adjusted	Adjust

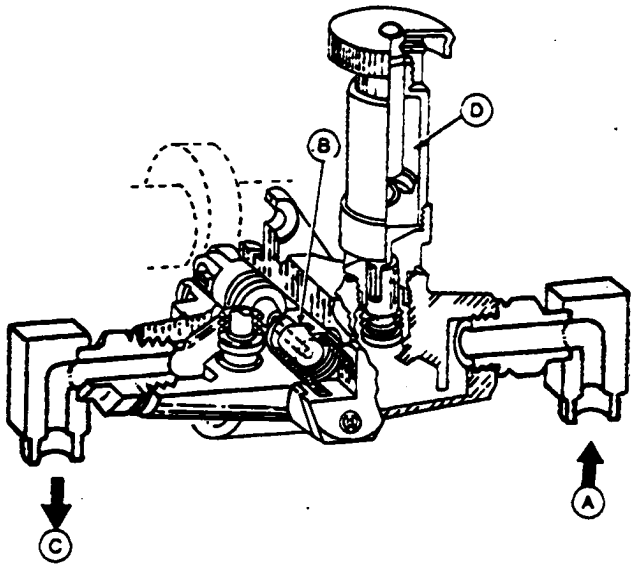
S11,23010,FCA1 -19-10AUG94

FUEL SUPPLY PUMP OPERATION—6466T AND 6466A ENGINES

NOTE: 6466D Engines use a diaphragm-type fuel supply pump which is operated by an eccentric lobe on the engine camshaft. This pump is not serviceable.

The plunger-type Bosch or Nippondenso fuel supply pump is used on all 6466T and 6466A engines. It is mounted on the side of the injection pump housing and is driven by the injection pump camshaft. Fuel enters the supply pump at (A), is pressurized by the plunger (B), and discharged through outlet (C). The hand primer (D) provides manual pump operation for bleeding the fuel system.

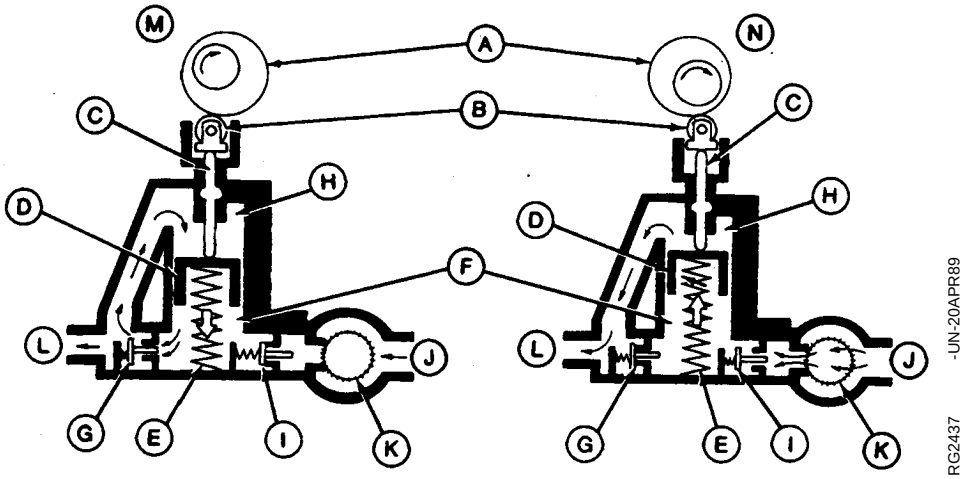
A—Fuel Inlet
B—Plunger
C—Fuel Outlet
D—Hand Primer



RG4451 -UN-14SEP89

S11,23010,FG -19-18AUG94

FUEL SUPPLY PUMP OPERATION—6466T AND 6466A ENGINES—CONTINUED



A—Camshaft
B—Roller Tappet
C—Pressure Spindle
D—Plunger
E—Plunger Spring
F—Suction Chamber
G—Pressure Valve
H—Pressure Chamber
I—Suction Valve
J—Fuel Inlet
K—Filter
L—Fuel Outlet
M—Intermediate Stroke Position
N—Suction and Discharge Stroke Position

As the pump camshaft (A) rotates toward the “high cam” intermediate stroke position, the roller tappet (B) and pressure spindle (C) cause the plunger (D) to move against and compress the plunger spring (E).

Plunger movement forces the fuel out of the suction chamber (F), through the pressure valve (G), and into the pressure chamber (H). The amount of fuel discharged from the suction chamber is equal to the amount of fuel delivered for each stroke of the plunger. Towards the end of the intermediate stroke, the spring-loaded pressure valve closes again.

As the camshaft rotates toward the “low cam” or suction and discharge position (N), plunger spring pressure causes the plunger, pressure spindle, and roller tappet to follow the camshaft.

Movement of the plunger pushes the fuel from the pressure chamber, and delivers it to the fuel filters and injection pump. At the same time, plunger suction pressure is permitting fuel to enter the suction chamber through the suction valve (I). With the suction chamber charged with fuel, the pumping cycle begins again.

Fuel is allowed to work its way around the pressure spindle to lubricate the spindle as it moves back and forth in housing. To prevent the fuel from entering the pump crankcase, a rubber O-ring is positioned in the spindle bore of housing at the roller tappet end.

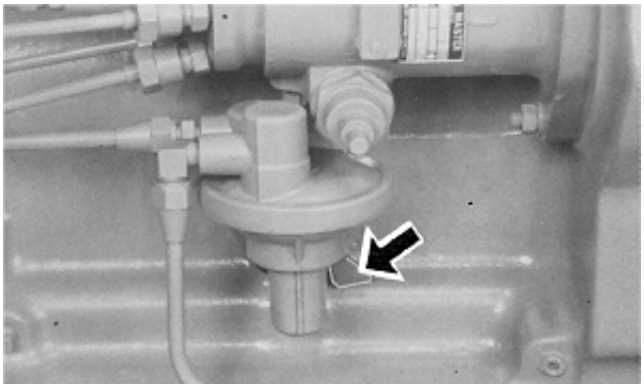
Unscrewing the knurled knob and pulling upward causes the suction valve to open and fuel to flow into the suction chamber. When the hand plunger is pushed downward, the suction valve closes, and fuel is forced out of the pressure valve.

Each stroke of the hand primer delivers approximately 6 cm^3 (0.336 cu in.) of fuel.

S11,23010,F -19-10AUG94

FUEL SUPPLY PUMP OPERATION—6466D ENGINES

The diaphragm fuel supply pump used on all 6466D Engines is operated by an eccentric lobe on the engine camshaft. This supply pump is not serviceable, if damaged, replace with a new pump.



S11,23010,HX -19-10AUG94

DIAGNOSE FUEL SUPPLY PUMP MALFUNCTIONS

Symptom	Problem	Solution
Low Supply Pump Pressure or Pump Not Functioning Correctly	Out of fuel	Add fuel to fuel tank.
	Fuel shut off at tank	Open fuel shut-off valve.
	Restricted fuel line	Clean as required.
	Air leak in fuel line between pump and tank	Repair as required.
	Loose or damaged fuel line connections	Repair.
	Hand primer left in upward position	On 6466T and 6466A Engines, bleed fuel system, gently push hand primer down and tighten securely. On 6466D Engines, push hand primer back (toward engine) as far as it will go.
	Punctured or leaking diaphragm (6466D)	Replace pump. (See Group 35)
	Worn or damaged valve assemblies (6466T and 6466A)	Repair or replace. (See Group 35)
	Broken valve spring(s) (6466T and 6466A)	Repair or replace. (See Group 35)
	Wear or damage to hand primer linkage (6466D)	Replace pump. (See Group 35)

S11,23010,HY -19-10AUG94

TEST FUEL SUPPLY PUMP FOR LEAKS—6466T AND 6466A ENGINES

Fuel delivery pressure should be checked before removing supply pump from injection pump. (See CHECK FUEL SUPPLY PUMP OPERATION, later in this group.)

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1. Connect compressed air line (A) to a pressure gauge (B) and to supply pump inlet fitting. Air line should have a regulating valve to control pressure.

2. Cap or plug supply pump outlet fitting (C).

3. Submerge supply pump in a container of clean diesel fuel. Regulate air pressure to 200 kPa (2.0 bar) (29 psi).

4. Move roller tappet (Nippondenso pumps) or plunger tappet (Bosch pumps) in and out by hand. No air bubbles should appear around roller tappet or spindle bore.

NOTE: If bubbles appear, it is an indication that either the O-ring seal is defective or spindle or tappet is worn (or possibly both).

IMPORTANT: Serious injection pump or engine damage could occur if excessive diesel fuel leaks past spindle and seal. Fuel leakage past spindle dilutes engine oil.

RG5894 -UN-19AUG91

RG,CTM1,G115,3 -19-10AUG94

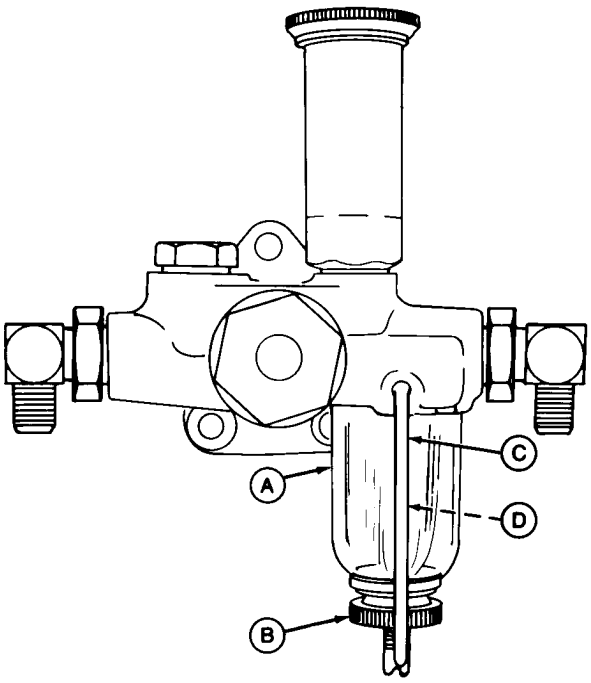
CHECK FUEL SUPPLY PUMP OPERATION—6466T AND 6466A ENGINES

NOTE: The following procedure can best be performed under moderate air temperature conditions to reduce electrical loads when cranking the engine is required.

1. Make a preliminary inspection of supply pump. Thoroughly clean area around pump. All connections must be tight and not leaking. On supply pumps with a filter housing (A) and filter (D), make sure fuel does not leak at bowl gasket. If fuel in filter housing is contaminated or is leaking out, loosen clamp nut (B) on clip (C) and service the filter.

2. Start engine and bring to operating temperature. Shut-off engine.

NOTE: If fuel leaks around a hand primer that is screwed down tight when engine is running, replace the hand primer.



RG2825 -UN-03APR89

A—Filter Housing
B—Clamp Nut
C—Clip
D—Filter

S11,23010,HZ -19-10AUG94

- **Check operation of hand primer:**

3. With engine shut-off, unscrew knob (A) and operate hand primer through several strokes. Moderate to heavy leakage of fuel between plunger and barrel indicates seal is defective. Replace hand primer.

NOTE: Appearance of a slight quantity of fuel around the plunger is normal.

4. Tighten hand primer knob, but do not overtighten. If knob will not tighten (indicating internal thread damage), replace hand primer.

RG3883 -UN-09NOV89

S11,23010,FI -19-18APR94

• **Test operation of suction side of pump:**

5. Disconnect suction and discharge lines at pump.

6. Drain all fuel from pump by operating hand primer. Then reconnect suction line to pump.

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7. Operate hand primer until fuel flows from pump outlet (discharge). Fuel should flow within 15—25 strokes. If not, the suction line may be obstructed or leaking air; (replace in-line filter when used).

NOTE: When operating hand primer, a moderate resistance should be felt. When only a slight resistance (or no resistance) occurs, replace hand primer or repair pump (valves may be defective).

If fuel does not flow, and if no leak or obstruction is found, pump is defective. Repair or replace pump. (See Group 35.)

• **Test operation of discharge side of pump:**

8. Suction line must be connected and discharge (pressure) line disconnected.

9. Tighten hand primer (Nippondenso only) and place injection pump fuel shut-off control in “STOP” position to prevent engine from starting.

10. Crank engine with starting motor. Fuel should flow from pump outlet within 10 seconds. If not, the suction line may be obstructed or leaking air; (replace in-line filter when used).

S11,23010,FJ -19-18AUG94

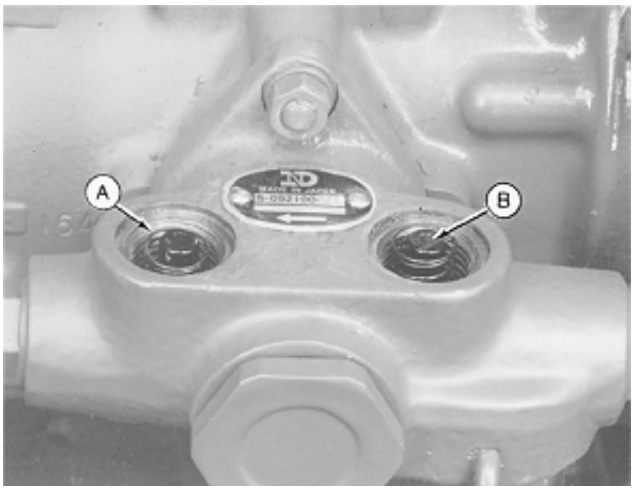
SERVICE FUEL SUPPLY PUMP—6466T AND 6466A ENGINES

1. To gain access to the valves, remove hand primer and plug from top of supply pump (shown removed).

2. Remove valves (B) and springs (A).

3. Inspect valves and valve seats for foreign material, wear or pitting. Valve springs must not be cracked or broken.

4. Reassemble parts, open take shut-off valve, and check operation. If the pump operation is still not normal, the pump should be repaired or replaced. (See Group 35.)



RG78153D1 -UN-14DEC88

S11,23010,IA -19-18APR94

CHECK FUEL SUPPLY PUMP OPERATION—6466D ENGINES

1. Make a preliminary inspection of supply pump. Thoroughly clean area around pump. All connection must be tight and not leaking.

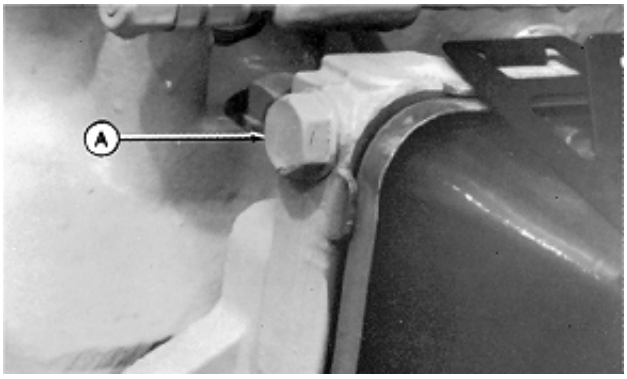
2. Remove bleed plug (A) from fuel filter base and install hose and test adapters from JT05470 Universal Pressure Test Kit along with pressure gauge.

3. Start engine and check supply pump pressure according to specification.

DIAPHRAGM-TYPE SUPPLY PUMP SPECIFICATIONS

Normal Operating Pressure	25—30 kPa (0.25—0.30 bar) (3.5—4.5 psi)
Minimum Operation Pressure	15—30 kPa (0.15—0.30 bar) (2—4 psi)

Fuel pump should maintain positive minimum pressure of 15—30 kPa (0.15—0.30 bar) (2—4 psi). If pressure is low, replace filter element and recheck pressure.



S11,23010,IB -19-10AUG94

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 solenoid wire disconnected) so engine will not start, turn engine over several times with staring motor.

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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.

4. If little or no fuel flows, check the following:

—Loose or damaged connections
—Restricted fuel lines
—Air leak in fuel line between transfer pump and fuel tank

NOTE: If the problem is not caused by one of these conditions, the supply pump is probably defective. Replace the supply pump with a new one since there is no repair for this pump.

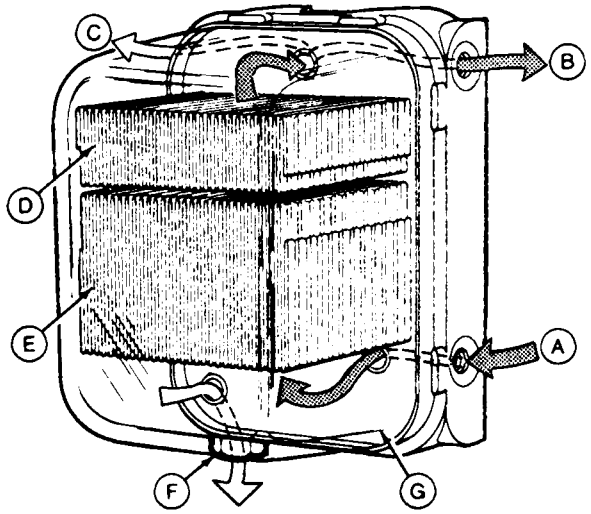
S11,23010,IC -19-10AUG94

FUEL FILTER OPERATION

Fuel enters the filter at (A) and flows through a first stage filtering media (E) and a second stage filtering media (D) before flowing through outlet (B) to the injection pump. The filtering media is housed in the metal sediment bowl (G) and epoxied to the bowl as one assembly.

Since water and other contaminants may settle to the bottom of the sediment bowl, a drain plug (F) is provided to permit their removal.

An air vent (C) enables air in the fuel system to be expelled to the outside through the filters when bleed plug (A, refer to next illustration) is removed.

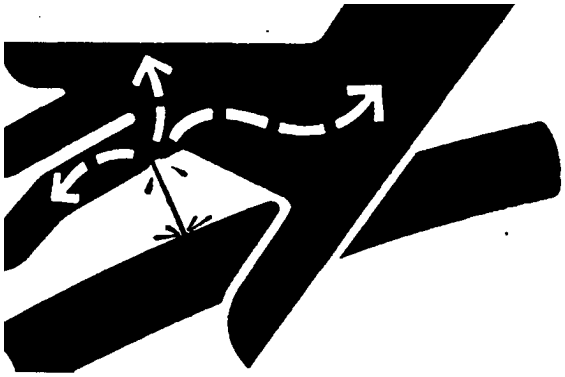


R26812 -UN-28APR89

A—Inlet
B—Outlet
C—Air Vent
D—Second Stage Filtering Media
E—First Stage Filtering Media
F—Drain Plug
G—Sediment Bowl

S11,23010,I -19-18APR94

BLEED THE FUEL SYSTEM



X9811 -UN-23AUG88

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

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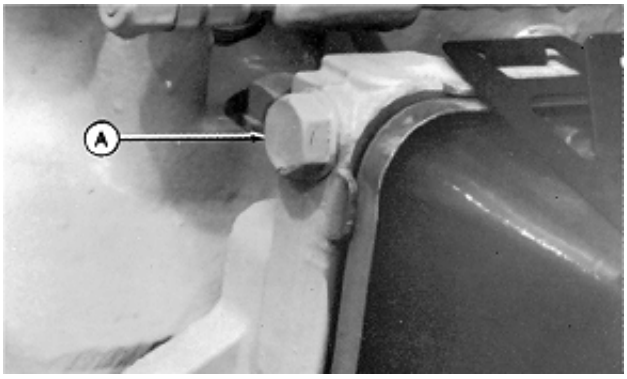
Whenever the fuel system has been opened up for service (lines disconnected or filters removed), it will be necessary to bleed air from the system.

The fuel system may be bled at one of several locations. On some engine applications it may be necessary to consult your operator's manual and choose the location best for your engine/machine application.

S11,0408,AC -19-18APR94

- **At Fuel Filter**

1. Loosen bleed plug (A).



RG3400 -UN-20DEC88

3OU,230010,BX5 -19-18APR94

2. On 6466T and 6466A Engines, unscrew hand primer knurled knob (A) on fuel supply pump. Loosen knob until it can be pulled up by hand.

3. Operate the hand primer until fuel comes out of the bleed plug.

4. Tighten bleed plug securely, continue operating hand primer until a slight pressure is felt. The pressure indicates that the fuel has filled the gallery in the injection pump.

5. Gently push hand primer down and tighten securely.

RG3883 -UN-09NOV89

S11,23010,CJ -19-10AUG94

- **At Fuel Injection Nozzles**

NOTE: If the engine will not start, it may be necessary to loosen the fuel lines at the injection nozzles to bleed air from system.

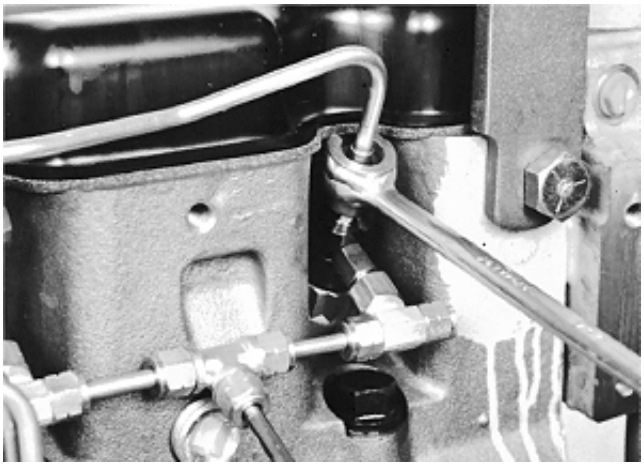
1. Put the hand throttle in fast idle position.

2. Loosen fuel line connection at No.1 injection nozzle.

3. Push the engine fuel shut-off control knob all the way in. Turn the engine with the starter until fuel without air flows from the loose fuel pipe connections.

4. Retighten the connections.

5. Repeat procedure at remaining nozzles (if necessary) until all air has been expelled from fuel system.



RG6484 -UN-26OCT92

S11,0408,AF -19-10AUG94

FUEL INJECTION PUMP GENERAL INFORMATION

The fuel injection pumps used on 6466T and 6466A Engines are a multiple-plunger, in-line type equipped with a mechanical flyweight governor and aneroid control. An engine-driven gear on the pump camshaft drives the pump at one-half engine speed. 6466T and 6466A Engines use either a Bosch or Nippondenso fuel injection pump.

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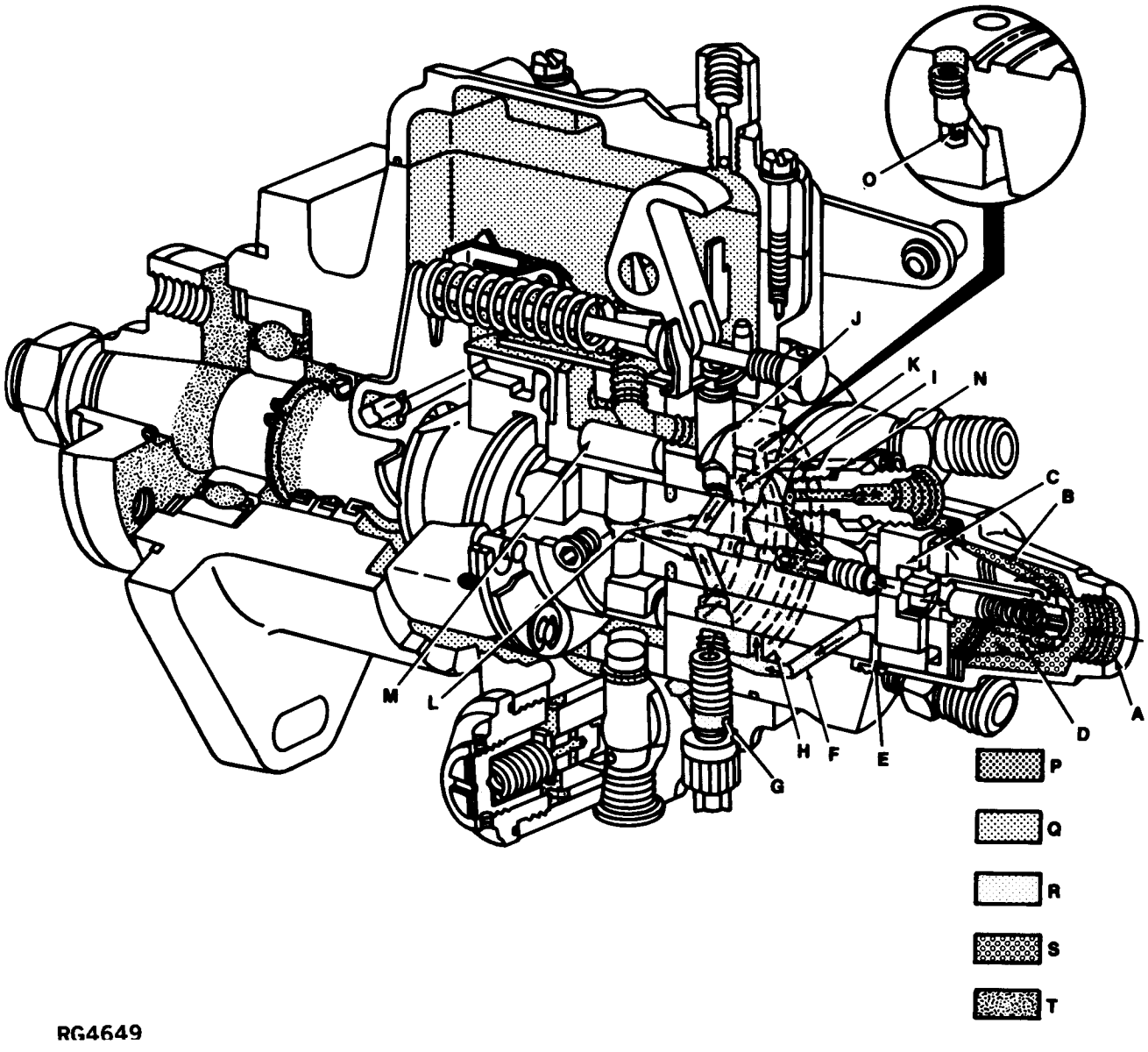
The 6466D Engine uses a Stanadyne rotary-type injection pump.

S11,23010,FN -19-10AUG94

FUEL INJECTION PUMP OPERATION—6466D ENGINES



A—Supply Pump Inlet	F—Passage	K—Charging Ring	P—Inlet Pressure
B—Inlet Screen	G—Advance Circuit	L—Inlet Passages	Q—Supply Pump Pressure
C—Supply Pump	H—Charging Circuit	M—Rollers	R—Housing Pressure
D—Regulator Assembly	I—Annulus	N—Vent Passage	S—Discharge Pressure
E—Rotor Retainers	J—Metering Valve	O—Vent Wire	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.

S11,23010,GE -19-10AUG94

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.

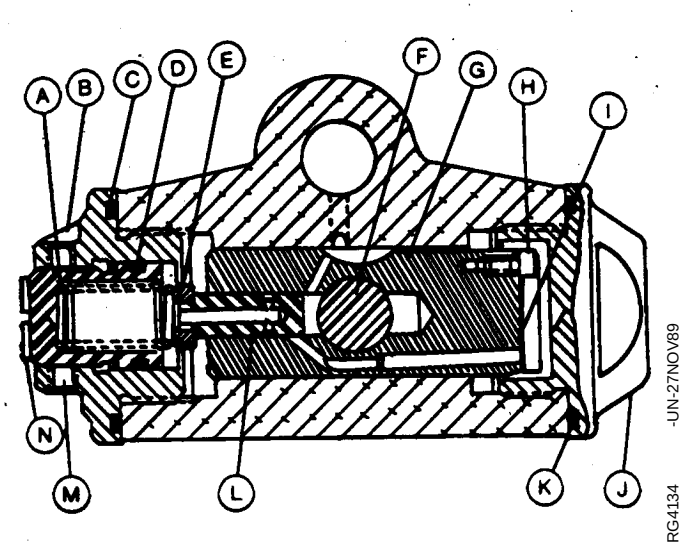
As the rotor revolves, the two inlet passages (L) register with the charging ports in the hydraulic head, allowing fuel to flow into the pumping cylinders. With further rotation, the inlet passages move out of registry, and the discharge port of the rotor registers with one of the head outlets. While 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

HOW THE SPEED ADVANCE WORKS—6466D ENGINES ONLY



A—Pilot Valve Spring
B—End Plug
C—O-Ring
D—O-Ring
E—Pilot Valve Spring Seat
F—Cam Advance Pin
G—Advance Piston
H—Check Valve Screw
I—Check Valve
J—Plug
K—O-Ring
L—Pilot Valve
M—Trimmer Lock Screw
N—Advance Trimmer Screw

The purpose of the automatic speed advance is to insure optimum combustion for maximum power at higher engine speeds. This is done by advancing or retarding the start of fuel delivery in response to changes in engine speed.

As engine speed increases, the movement of the cam ring also increases to a maximum of 9 degrees. As engine speed decreases, the cam ring is forced to return to a retarded position.

Movement of the cam ring is accomplished hydraulically, using fuel under pressure from the transfer pump. Fuel is directed to an advance piston (G) which rotates the cam ring against the direction of rotor rotation. Counteracting piston movement is a spring (A), that is preloaded by and adjusting screw (N), called a “trimmer” screw.

S11,23010,CG -19-10AUG94

DIAGNOSE MALFUNCTIONS—FUEL INJECTION PUMP—6466D ENGINES

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. (See Group 35)
	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. (See Group 35)
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. (See Group 35)

S11,23010,ID -19-10AUG94

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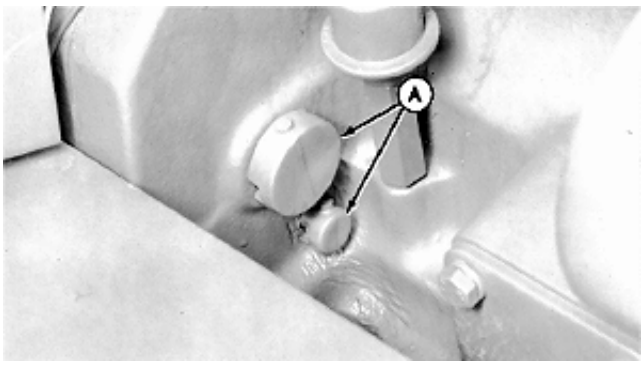
CHECK FUEL INJECTION PUMP TIMING—6466D ENGINES

1. Remove vent tube and plastic plugs (A).

2. Install the JDE81-1 Flywheel Rotation Tool.



S11,23010,CQ -19-10AUG94

IMPORTANT: ALWAYS ROTATE engine in direction of normal rotation when adjusting pump timing. DO NOT ROTATE pump backwards. Cam ring movement CAN OCCUR towards an advance position causing engine to be retarded in static timing.

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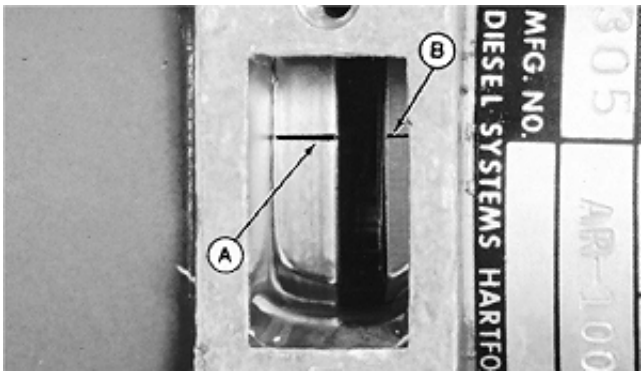
3. Remove timing hole cover and rotate engine until timing mark on governor weight retainer (B) is in line with timing mark on cam ring (A). If injection pump timing requires adjustment, have an authorized diesel repair station, servicing dealer, or engine distributor make the adjustment.



S11,23010,CS -19-18APR94

CHECK FAST IDLE SPEED—6466D ENGINES

NOTE: Make sure engine has reached its normal operating temperature before recording engine speed.

1. Move pump shut-off lever all the way forward against its stop in “RUN” position.

2. Read and record engine speed using a tachometer. Compare readings with specifications. See FUEL INJECTION PUMP SPECIFICATIONS earlier in this group.

IMPORTANT: If fast idle is not within specification, have an authorized diesel repair station, servicing dealer, or engine distributor adjust as necessary.

S11,23010,FS -19-10AUG94

CHECK AND ADJUST SLOW IDLE SPEED—6466D ENGINES

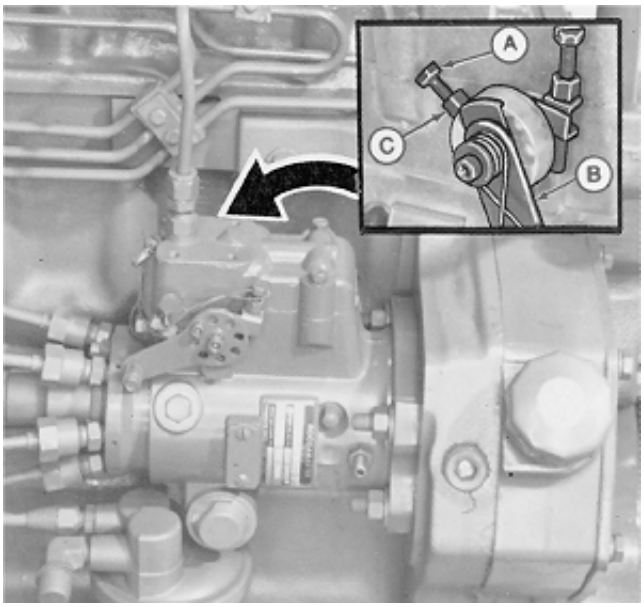
NOTE: Be sure engine has reached its normal operating temperature before recording engine speed.

1. With engine running, move throttle lever (A) rearward so slow idle screw (B) is against its stop.

2. Check slow idle speed (regular governor); the correct setting is 800 rpm.

3. If slow idler speed is not within specification range, loosen lock nut (C) and turn slow idle screw to adjust.

4. When slow idle is set correctly, tighten lock nut securely but DO NOT overtighten.



RG4143 -UN-21SEP89

S11,23010,GD -19-10AUG94

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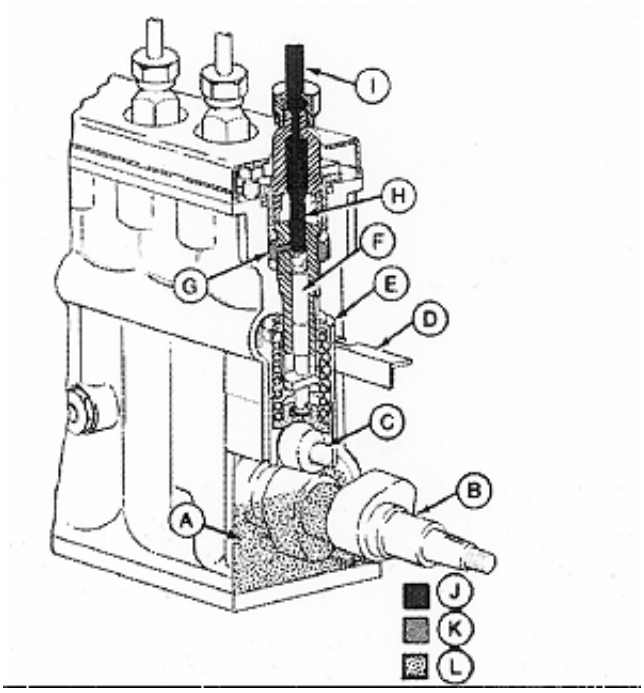
FUEL INJECTION PUMP OPERATION—6466T AND 6466A ENGINES

Filtered fuel under pressure by the supply pump fills the injection pump fuel gallery (G). As the camshaft rotates, roller tappets (C) riding on the camshaft (B) lobes operate the plungers (F) to supply high pressure fuel through the delivery valves (H) to the injection nozzles.

A governor-operated control rack (D) is connected to the control sleeves (E) and plungers to regulate the quantity of fuel delivered to the engine.

Engine lubricating oil is piped to the injection pump crankcase (A) to provide splash lubrication of the working parts. Two drain holes at the front end of the pump determine the level of oil maintained in the crankcase. Excess oil drains out these holes and returns back to the engine through the timing gear housing.

A—Crankcase
B—Camshaft
C—Roller Tappet
D—Control Rack
E—Control Sleeve
F—Plunger
G—Fuel Gallery
H—Delivery Valve
I—Delivery Line
J—Injection Pressure
K—Supply Pump Pressure
L—Engine Lubricating Oil



RG4650 -UN-14DEC88

RG,CTM1,G115,5 -19-10AUG94

IDENTIFICATION OF FUEL INJECTION PUMPS—6466T AND 6466A ENGINES

The fuel injection pumps on 6466T and 6466A engines are either A-Series or P-Series pumps. The type of pump is determined by the “size of pump” indicator in the model number on the pump identification plate.

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FUEL INJECTION PUMP IDENTIFICATION NUMBERS

(A)—922 14019

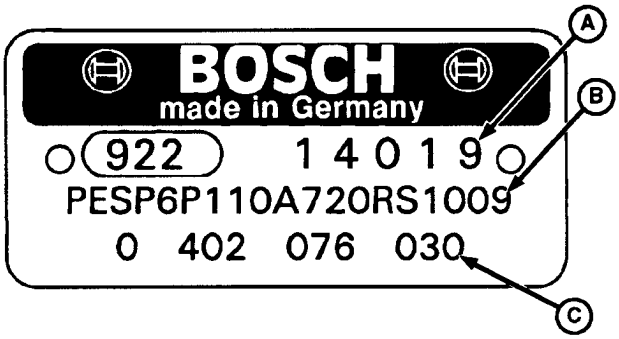
-000 00000 . . . . . Pump Serial Number

(B)—PESP6P110A720RS1009

-PESP . . . . . Injection Pump With Housing Flange
6 . . . . . Number of Plungers
P . . . . . Size of Pump
110 . . . . . Plunger Diameter in mm (110 is 11 mm)
A . . . . . Alphabetical Letter Designating Design Change
000 . . . . . Three Numbers Denoting an Assembly
R . . . . . Right-Hand Rotation (Viewed From Drive End)
S . . . . . Production Pump
0000 . . . . . Pump Identification Number

(C)—0 402 076 030

-0 000 000 000 . . . . . Bosch Part Number



RG2432 -UN-25APR94

Fuel Injection Pump ID Numbers

RG,CTM1,G35,14A-19-18AUG94

DIAGNOSE FUEL INJECTION PUMP MALFUNCTIONS—6466T AND 6466A ENGINES

Symptom	Problem	Solution
Engine Starts Hard or Won't Start	Incorrect fuel shut-off lever position (pump control rack not moving all the way forward)	Adjust shut-off cable as required.
	Defective injection pump	Remove pump from engine and repair (see Group 35)
	Injection pump not correctly timed	Check pump timing
Slow Idle Speed Irregular	Slow idle stop screw improperly adjusted	Recheck stop screw adjustment
	Supplementary idling spring improperly adjusted	Recheck adjustment
	Defective injection pump	Remove pump from engine and repair (See Group 35)
Engine Horsepower Low	Pump not properly timed	Check timing
	Defective injection pump	Remove pump from engine and repair (See Group 35)

RG,CTM1,G115,4 -19-10AUG94

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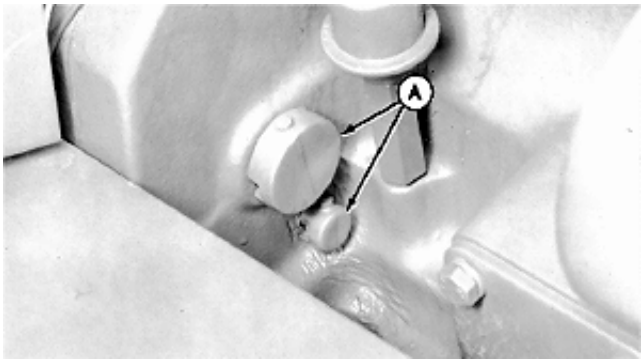
CHECK AND ADJUST FUEL INJECTION PUMP TIMING—6466T AND 6466A ENGINES

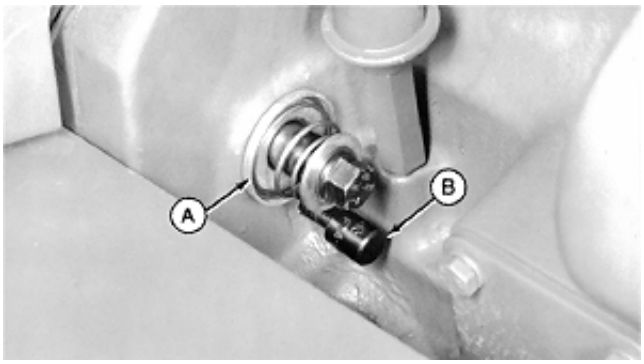
1. Remove vent tube and plastic plugs (A).



RG4119 -UN-23FEB89

S11,23010,CX -19-10AUG94

2. Install JDE81-1 Flywheel Turning Tool (A) and JDE81-4 Timing Pin (B).



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RG4120

IMPORTANT: On 6466AF001 Engines, rotate engine (in normal direction of rotation) until No. 1 piston is coming up on its compression stroke. Continue rotating until JDE81-4 Timing Pin enters first hole in flywheel. This hole goes all the way through flywheel and provides injection pump timing at 14° BTDC.

NOTE: A second timing pin hole in flywheel will be found. This hole does not go all the way through. When utilized, it locks engine timing at TDC required for adjusting the valves.

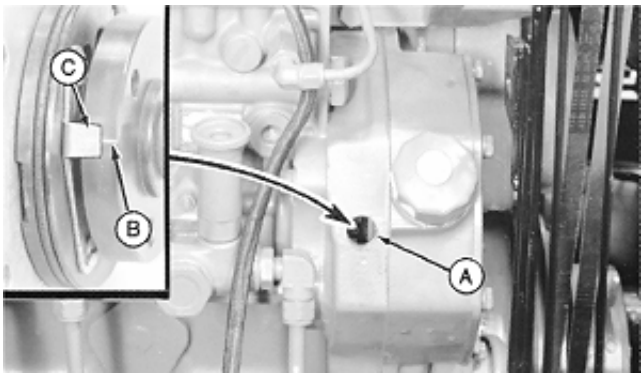
Some 6466AF001 Engines have been modified to TDC timing and have industrial flywheels which have TDC timing pin hole only. These engines may be identified by looking at injection pump serial number tag. Timing procedures for these engines is the same as all other 6466T and 6466A Engines.

3. On all other 6466T and 6466A Engines, position engine at No.1 TDC with No. 1 piston on the compression stroke.

NOTE: The compression stroke can be determined by removing the rocker arm cover and turning the engine until both valves are closed (rocker arms loose) on No. 1 cylinder.

RG,CTM1,G115,6 -19-10AUG94

4. Remove the timing hole plug and look into hole (A). As the flywheel is turned, observe when the pump drive hub mark (B) comes in alignment with the pointer mark (C). At this position, the JDE81-4 Timing Pin should enter the hole in flywheel.



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RG3599

S11,23010,BK -19-18APR94

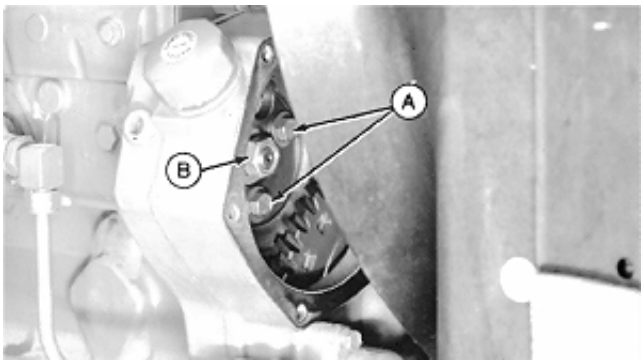
5. If the marks are not in line when timing pin enters hole, loosen the pump gear cap screw (A), and bring marks into alignment by moving pump drive hub (B).

IMPORTANT: The normal backlash of gears is enough to throw the pump timing off by several degrees, resulting in poor engine performance. To avoid backlash, always approach the timing mark on pointer by turning flywheel in direction of normal rotation.

Tighten drive gear cap screws and pump mounting stud nuts to 47 N·m (35 lb-ft).

6. Rotate the flywheel 1-1/2 revolutions in direction of normal rotation. Continue to turn the flywheel until the timing pin drops in flywheel hole for TDC (14° BTDC on 6466AF001 Engines). Recheck alignment of marks, repeating above procedure, if necessary, until marks are aligned.

7. Install gear cover plate and timing hole plug.



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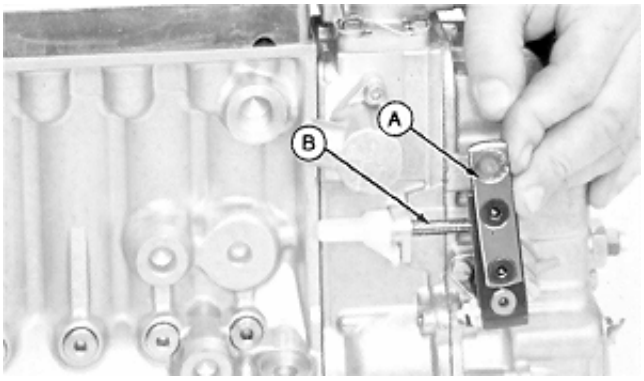
S11,23010,DM -19-18APR94

CHECK FAST IDLE SPEED—6466T AND 6466A ENGINES



1. Remove speed control rod. With the engine running, move governor control lever (A) against the fast idle stop screw (B).

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NOTE: The governor control lever on injection pump may be inboard (next to engine block) or outboard (away from engine block), depending upon engine application.

2. Using a tachometer, check fast idle speed to see if it is within specification.

NOTE: For each application, refer to the appropriate machine technical manual for fast idle speed specifications.

IMPORTANT: If fast idle speed must be adjusted, see your authorized diesel repair station.

NOTE: For some applications, such as generator sets, special equipment may be required for fast idle adjustment in conjunction with droop adjustment. See your OEM dealer or John Deere Engine Distributor.

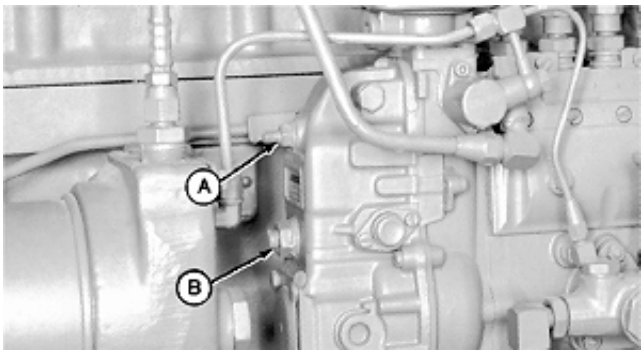
S11,23010,FU -19-10AUG94

CHECK AND ADJUST SLOW IDLE SPEED—6466T AND 6466A ENGINES

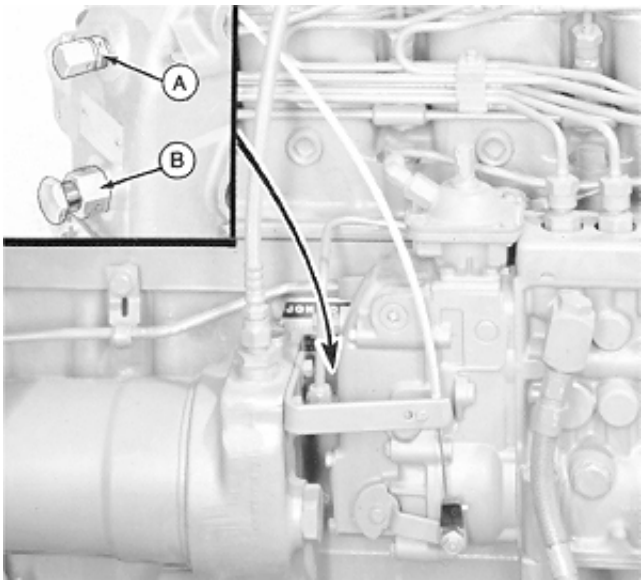
NOTE: Both the slow idle stop screw (A) and the bumper spring screw (B) may be used to adjust the slow idle speed.

IMPORTANT: Minor adjustment of the slow idle speed may be made with the bumper spring screw. However, it should not be used by itself to change engine speed more that 50 rpm, as overspeeding of the engine may result.

If slow idle stop screw and bumper spring screw are not adjusted according to instruction, engine damage could result because of overspeeding.



(Bosch Pump Shown)



(Nippondenso Pump Shown)

S11,23010,FW -19-18AUG94

CAUTION: ALWAYS STOP ENGINE before making adjustments.

1. With the engine running, pull the governor control lever rearward to the slow idle speed position. Check and adjust slow idle speed to the following specifications.

SLOW IDLE SPECIFICATIONS

6466TF and 6466AF Engines	800 rpm
6466AF001 (On-Highway)	650 rpm

NOTE: Refer to the appropriate machine technical manual for slow idle speed specifications pertaining to applications other than those using 6466TF and 6466AF Engines.

S11,23010,FX -19-10AUG94

NOTE: On Nippondenso pumps, first remove slow idle stop screw cover.

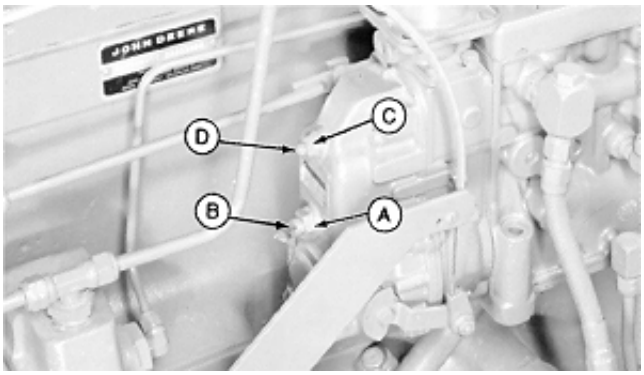
2. Loosen lock nut (A) and back out the bumper spring adjusting screw (B) three turns.

3. Loosen lock nut (C) and adjust slow idle stop screw (D) to obtain an idle speed 50 rpm less than desired slow idle speed setting.

4. Turn the bumper spring adjusting screw in to increase engine speed a maximum of 50 rpm to desired slow idle speed.

For example, to obtain an 800 rpm slow idle speed, use the slow idle stop screw to set speed at approximately 750 rpm. Then increase speed to 800 rpm using the bumper spring screw.

NOTE: Increasing the slow idle speed a slight amount above the specified speed range may help to reduce engine surge (or hunting). If this occurs, use the procedure above, but do not exceed 800 rpm.



RG3609 -UN-14DEC88

Bosch Shown (Nippondenso similar)

A—Lock Nut
B—Bumper Spring Adjusting Screw
C—Lock Nut
D—Slow Idle Stop Screw

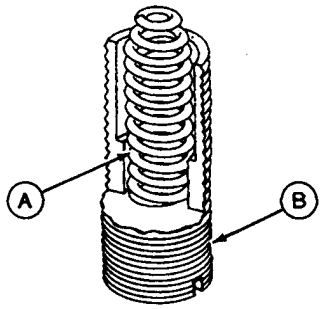
S11,23010,BU -19-10AUG94

5. If engine surging or hunting persists at slow idle, the bumper spring (A) and adjustment screw (B) may need to be replaced with a new one. Remove the pump from the engine and have it repaired by an authorized diesel repair station (ADS shop). See Group 35 for fuel injection pump removal and installation procedures.

6. Check the fast and slow idle speeds again. Readjust slow idle if not correct.

7. Check all adjusting screw lock nuts for tightness but DO NOT overtighten. Install covers (and copper washers) on slow idle stop screw and bumper spring adjusting screw (on Nippondenso Pumps).

8. Connect fuel shut-off cable and speed control rod.



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S11,23010,BW -19-10AUG94

HOW THE ANEROID WORKS—6466T AND 6466A ENGINES

Intake manifold pressure (created by the turbocharger) enters aneroid at (A). It is directed to upper side of diaphragm chamber (C) and exerts pressure on diaphragm (D).

When the pressure rises to about 100 kPa (1 bar) (15 psi), or about 1000 engine rpm under moderate to heavy loads, spring pressure (E) is overcome. Diaphragm then moves adjusting shaft screw (F) downward.

Arm (G) has two “legs”. The inner leg bears on the flat surface of adjusting shaft screw (F). The outer leg bears against a block riveted to the control rack (H).

NOTE: Diaphragm adjusting screw (B) regulates the minimum fuel delivery quantity at a specified rpm and zero pressure acting on the diaphragm. The diaphragm spring determines acceleration time (the greater the spring tension, the greater the manifold pressure required to overcome spring tension; hence, a slower acceleration).

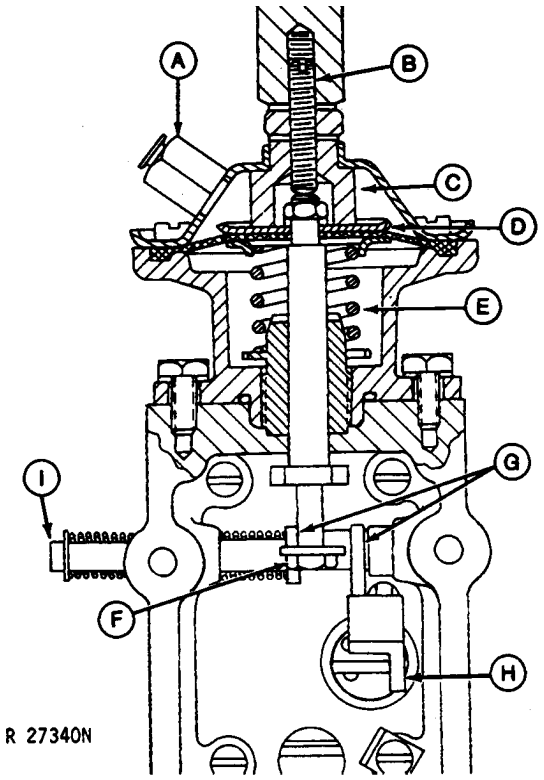
Downward movement of the adjusting shaft causes arm to rotate on starting fuel control shaft (I), permitting control rack to move its normal amount.

If the intake manifold pressure is below 100 kPa (1 bar) (15 psi) because of low engine speed, or is under light load at higher engine speeds, the aneroid spring pressure is greater than the intake manifold pressure. As a result, the control rack travel is limited (therefore, fuel delivery is limited) by the arm and adjusting shaft.

Aneroid control will be in effect until the manifold pressure is high enough to overcome diaphragm spring pressure.

A hydraulic aneroid activator, described in this group, is used to control the lever arm engagement with the control rack by moving the starting fuel control shaft in or out.

During starting, the hydraulic aneroid activator disengages the lever arm from the control rack block to permit the rack to move all the way forward to the starting fuel delivery position.



R27340N -UN-14DEC88

A—Intake Manifold Pressure Opening
B—Adjusting Screw
C—Diaphragm Chamber
D—Diaphragm
E—Spring
F—Adjusting Shaft Screw
G—Arm
H—Control Rack
I—Starting Fuel Shaft

S11,23010,Y -19-10AUG94

DIAGNOSE ANEROID MALFUNCTION

Symptom	Problem	Solution
Slow Engine Acceleration	Loose pipe or broken connection at inlet fitting	Repair as required. (See Group 35)
	Aneroid cover cracked around inlet fitting	Repair as required. (See Group 35)
	Defective diaphragm	Repair as required. (See Group 35)
	Aneroid not correctly adjusted	Remove injection pump (See Group 35) and adjust on test stand.
Excessive Smoke When Accelerating Engine	Aneroid not correctly adjusted	Remove injection pump. (See Group 35) and adjust on test stand.

S11,23010,IV -19-17MAR92

Use information contained in the chart above to help diagnose aneroid malfunctions.

See Group 35 for instructions on how to repair and adjust the aneroid.

The aneroid controls fuel delivery when intake manifold pressure is about 100 kPa (1 bar) (15 psi) or less. Therefore, all final adjustments are to be made on the test stand with aneroid mounted on injection pump.

IMPORTANT: Correct aneroid adjustments are essential for satisfactory engine performance. Whenever the aneroid has been disassembled or the adjustments have been altered, the injection pump (including aneroid) must be calibrated on the test stand by an authorized diesel injection repair station before releasing the pump for service.

S11,23010,IV1 -19-09SEP91

HOW THE HYDRAULIC ANEROID ACTIVATOR WORKS—6466T AND 6466A ENGINES

The hydraulic aneroid activator mounts either on the inboard or outboard side of the governor housing. It has an internal piston (F) that is operated by engine oil pressure to hydraulically move the starting fuel control shaft inward for aneroid control.

Engine lubricating oil is piped from the oil filter body to operate the activator. This oil is then piped to the injection pump housing to lubricate the internal working parts.

Upon starting the engine, engine oil is routed to the aneroid activator housing (I) through a banjo connector (A), special screw (B), and an orifice in the capillary valve (E) to head of piston (F).

Whenever the engine oil pressure is approximately 60 kPa (0.6 bar) (9 psi) or higher, the piston will overcome resistance of piston spring (G) and move the starting fuel control shaft (H) inward to provide aneroid control.

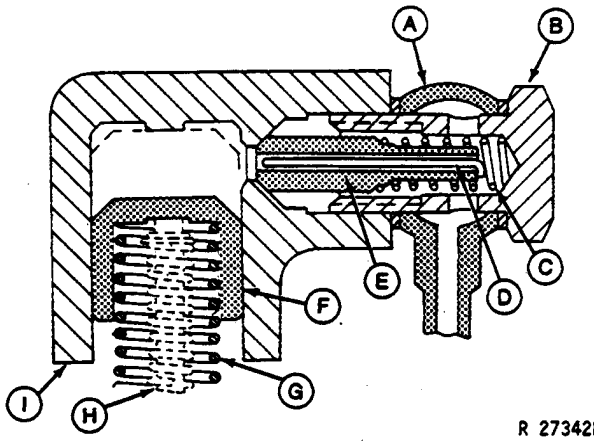
Loss of oil pressure permits a return spring on the starting fuel control shaft to hold the lever arm out of engagement with the control rack. This prevents the aneroid from limiting rack travel.

A restricter wire (D) is inserted in the capillary valve for two reasons:

(1) To retard engagement of the aneroid when engine is cold.

(2) To help maintain an open passage in the capillary valve (oil pressure action moves the wire enough to prevent orifice from plugging).

The length of time required to achieve aneroid control depends on the ambient air temperature and the viscosity of the engine oil. Warm ambient air temperatures will permit the aneroid to activate in a few seconds. Cold temperatures may delay activation for several minutes.



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R27342

A—Activator Banjo Connector
B—Special Screw
C—Capillary Valve Spring
D—Restricter Wire
E—Capillary Valve
F—Piston
G—Piston Spring
H—Starting Fuel Control Shaft
I—Activator Housing

S11,23010,DG -19-10AUG94

The following table gives the approximate ambient temperature-engagement time based on different engine lubricating oil viscosities:

Ambient Temp. °C (°F)	Engine Crankcase Oil	Engagement in Seconds (Approx.)
-1 (30)	SAE 30	86
-18 (1)	10W-20	255
-29 (-20)	5W-20	360

S11,23010,AC -19-16AUG94

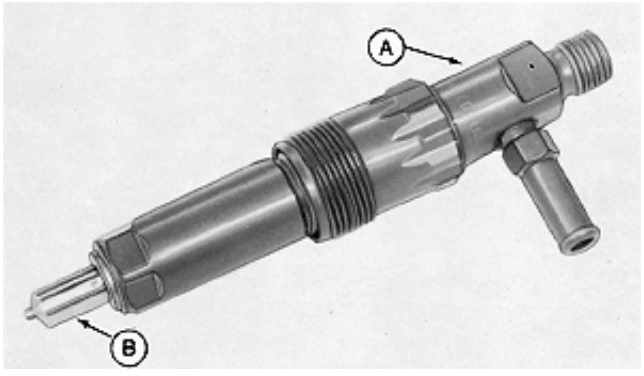
DIAGNOSE MALFUNCTIONS—HYDRAULIC ANEROID ACTIVATOR

Symptom	Problem	Solution
Engine Starts Hard	Broken return spring on starting fuel control shaft.	Repair (See Group 35)
	Retaining ring missing from starting fuel control shaft.	Repair (See Group 35)
Excessive Smoke When Accelerating Engine	Check for restriction in oil supply passages to activator piston.	Disassemble activator (See Group 35)

S11,23010,IW -19-28OCT92

FUEL INJECTION NOZZLES—GENERAL INFORMATION

The KDEL 21 mm injection nozzle consists of the nozzle holder (A) and the DLLA nozzle assembly (B).



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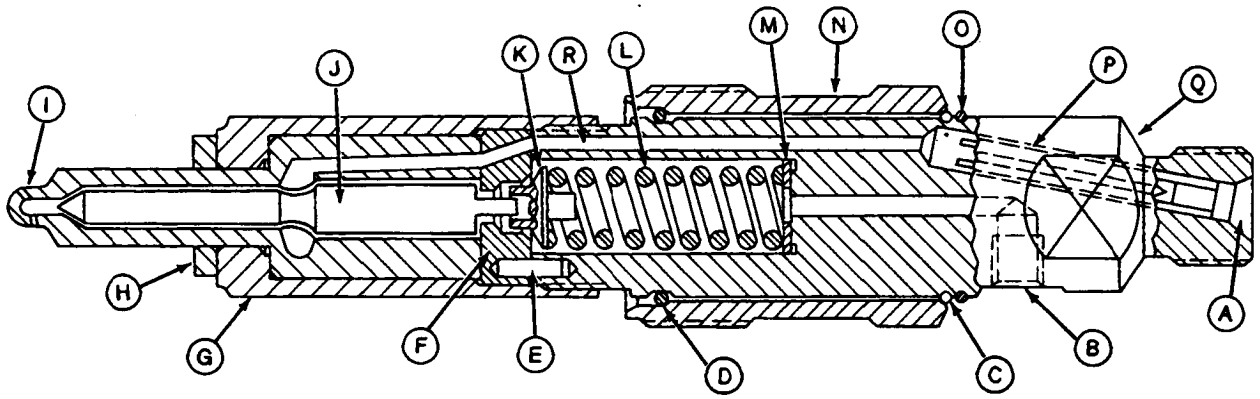
S11,23010,AE -19-18APR94

FUEL INJECTION NOZZLES—GENERAL INFORMATION—CONTINUED



A—Fuel Inlet
B—Leak-Off Connection
C—O-Ring
D—Snap Ring
E—Dowel Pin
F—Intermediate Plate
G—Nozzle Retaining Nut
H—Washer
I—Nozzle
J—Valve
K—Spring Seat
L—Spring
M—Shims
N—Gland Nut
O—Snap Ring
P—Edge-Type Filter
Q—Nozzle Holder
R—Fuel Passage

The nozzle valve (J) is held on its seat by a spring (L). Shims (M) are used to regulate the nozzle opening pressure.

The nozzle (I) and valve fit together by precision lapping. These parts are referred to as a nozzle assembly, and are not serviced separately.

Correct alignment of the nozzle assembly with its holder is essential so that the atomized fuel will be sprayed into the combustion chamber at the angle and location intended by design. KDEL holders use an intermediate plate (F) with dowel pins (E) on both sides to insure alignment.

A retaining nut (G) is used to fasten the nozzle assembly to the holder body. The diameter of the holder body is 21 mm, and from this dimension the fuel injection nozzles are known as 21 mm nozzles.

An edge-type filter (P) is placed in the fuel inlet of the nozzle holder. Its purpose is to prevent coarse, foreign particles from damaging the nozzle assembly or plugging the orifices. Finer particles pass through the filter without harm. The filter is not removable.

To provide a seal between the injection nozzle and the engine cylinder head, a steel washer (H) is used at the base of the nozzle retaining nut.

The fuel injection nozzle is fastened to the engine cylinder head by a gland nut (N). The gland nut also functions as a jack screw to raise the injection nozzle out of cylinder head during removal.

S11,23010,AF -19-18APR94

FUEL INJECTION NOZZLE OPERATION

The fuel is pressurized to approximately 41 400 kPa (414 bar) (6000 psi) on distributor-type pumps, 51 700 kPa (517 bar) (7500 psi) on A-Series pumps, and 69 000 kPa (690 bar) (10 000 psi) on P-Series pumps.

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Fuel lines (A) deliver the fuel to injection nozzles. Fuel enters the injection nozzle inlet (B), and passes through the edge-type filter (C). Coarse foreign particles are retained by the filter.

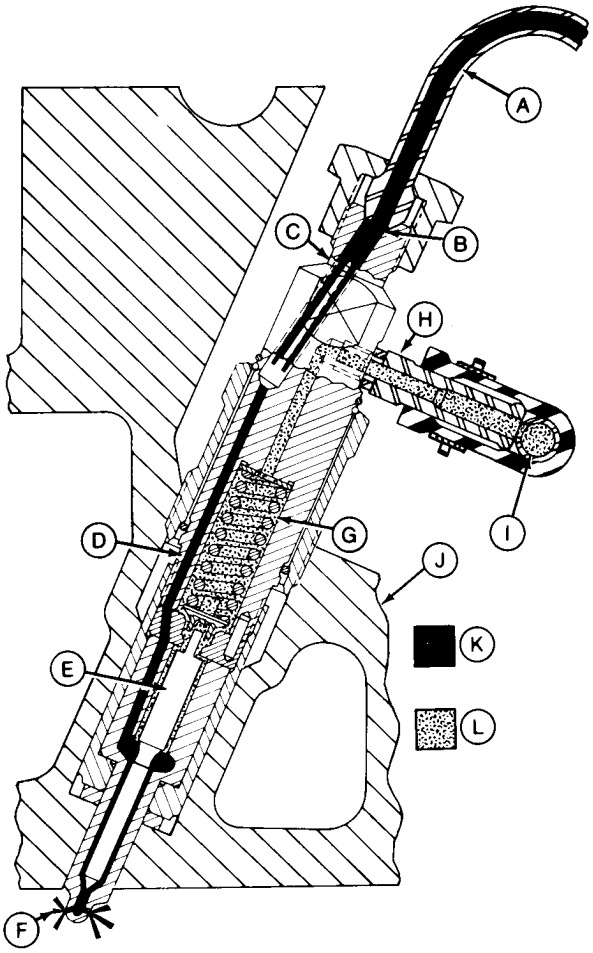
A passage (D) routes fuel through the nozzle holder to the nozzle valve (E). The nozzle valve is lifted instantly off its seat by the high pressure inlet fuel acting on an annulus in the valve.

NOTE: Since the nozzle valve opening pressure is considerably lower than the injection pump output pressure, the inlet fuel pressure easily overcomes the resistance of the nozzle valve spring (G).

When the nozzle valve opens, a definite quantity of fuel (determined by the injection pump output for each plunger stroke) is forced out through orifices (F). The fuel becomes finely atomized as it is sprayed into the combustion chamber at high velocity.

The nozzle assembly is lubricated by a small amount of fuel which seeps between the lapped surfaces of the nozzle and valve which accumulates around the spring (G, refer to previous illustrations).

The leakage fuel is routed out the nozzle holder through a leak-off connector (H) and returned back to the fuel tank by means of a leak-off line (I).



RG4651 -UN-29AUG94

Fuel Flow Through KDEL Injection

A—Fuel Delivery Line
B—Fuel Inlet
C—Edge-Type Filter
D—Fuel Passage
E—Nozzle Valve
F—Orifices
G—Nozzle Valve Spring
H—Leak-Off Connector
I—Leak-Off Line
J—Engine Cylinder Head
K—High Pressure Fuel
L—Low Pressure Return Fuel

S11,23010,GB -19-10AUG94

DIAGNOSE MALFUNCTIONS—FUEL INJECTION NOZZLE

Fuel injection nozzles are usually removed from the engine when there is a noticeable loss of power or excessive smoking.

Listed in the following chart are various malfunctions which may occur on the 21 mm nozzles. Only possible defects related to these nozzles are listed.

Failures in other components of the fuel injection system are listed under their respective headings in this group.

See Group 35 for repair information.

Symptom	Problem	Solution
Engine Has Low Horsepower	Nozzle orifices plugged	Repair (See Group 35)
	Incorrect nozzle valve opening pressure	Adjust (See Group 35)
	Broken or damaged parts	Repair as required (See Group 35)
	a. Broken nozzle valve spring b. Cracked or split nozzle tip c. Cracked or split nozzle body d. Internal leak	
	Wrong nozzle and valve in holder	Install correct nozzle assembly (See Group 35)
	Nozzle loose in cylinder head	Make sure R64840 Steel Washer is installed on tip end of injection nozzle. Tighten to specified torque (See Group 35)
Engine Emits Too Much Smoke	Nozzle orifices plugged	Repair (See Group 35.)
	Broken or damaged parts	Repair as required (See Group 35)
	a. Broken nozzle valve spring b. Cracked or split nozzle tip c. Cracked or split nozzle body d. Internal leak	
	Wrong nozzle and valve in holder	Install nozzle assembly (See Group 35)
	Worn nozzle valve seal	Replace nozzle assembly (See Group 35)

S11,23010,GC -19-18APR94

TEST FUEL INJECTION NOZZLES (ENGINE RUNNING)

1. Operate engine at intermediate speed and no load.

2. Slowly loosen the fuel pressure line at one of the nozzles until fuel escapes at the connection (fuel not opening nozzle valve).

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NOTE: The injection nozzle before and/or after nozzle being checked could be the faulty nozzle.

• If engine speed changes, the injection nozzle is probably working satisfactory.

• If engine speed does not change, a nozzle is faulty and must be checked and repaired (or replaced).

3. Repeat test for each remaining nozzle assembly.

4. Remove faulty injection nozzles and repair as required. See Group 35.

S11,23010,HR -19-18APR94

FUEL DRAIN BACK TEST PROCEDURE

Fuel draining back through the fuel system may cause hard starting. This procedure will determine if air is entering the system at connections and allowing fuel to siphon back to the fuel tank.

1. Disconnect fuel supply line and fuel return line at fuel tank.

IMPORTANT: Fuel return line MUST extend below fuel level in fuel tank before performing this test. Fill fuel tank if necessary.

2. Drain all fuel from the system, including the fuel transfer pump, fuel injection pump, fuel filters, and water separator (if equipped).

3. Securely plug off the end of the fuel return pipe.

4. Using a low pressure air source, pressurize the fuel system at the fuel supply line.

CAUTION: Maximum air pressure should be 100 kPa (1 bar) (15 psi) when performing this test.

5. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

NOTE: Connections may allow air to enter the system without allowing fuel to leak out.

6. If any leaks are found, take necessary steps to repair.

7. Reconnect supply and return lines and prime system.

8. Start engine and run for approximately 10 minutes.

9. Allow engine to sit overnight and try starting the following morning.

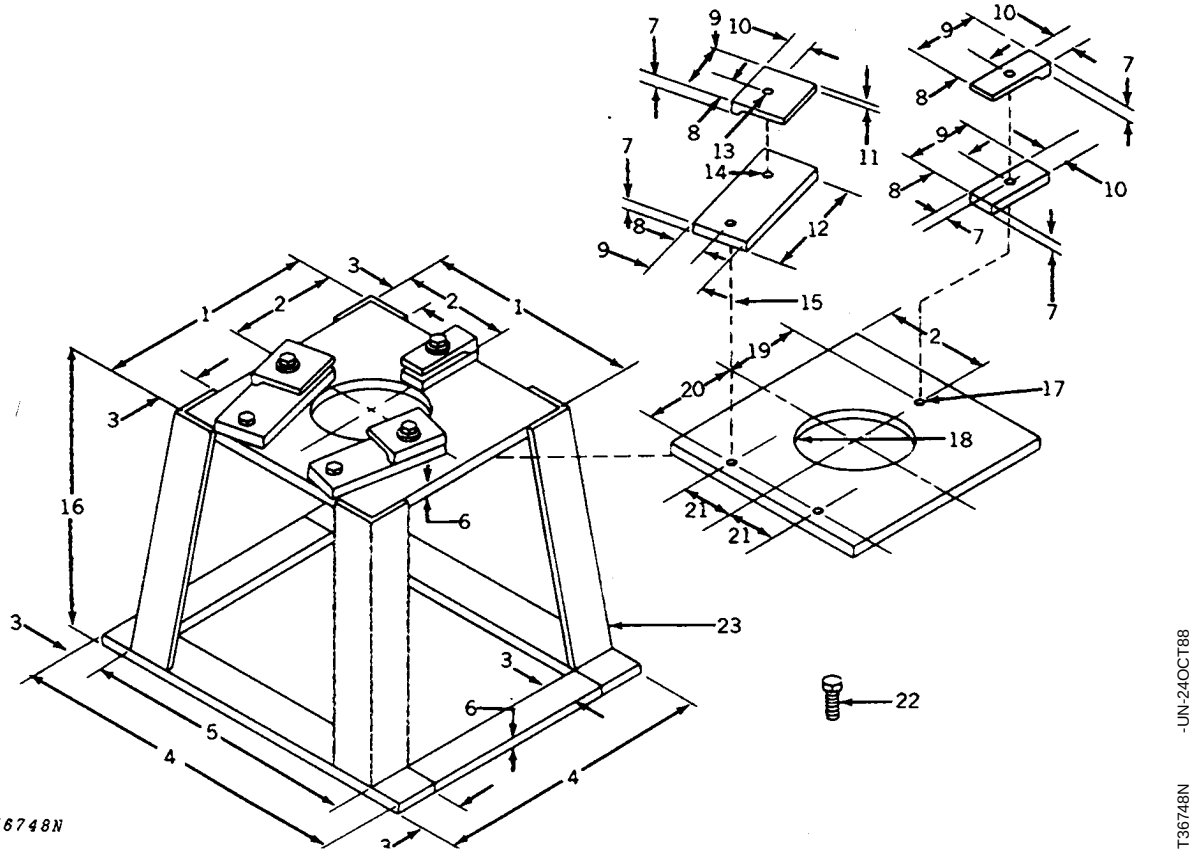
S11,23010,JA -19-28OCT92

HOW TO MAKE TOOLS

These tools can be made in a service shop using common shop tools and locally obtained materials.

S55,DFRG -19-01DEC89

DFRG3—CYLINDER LINER HOLDING FIXTURE

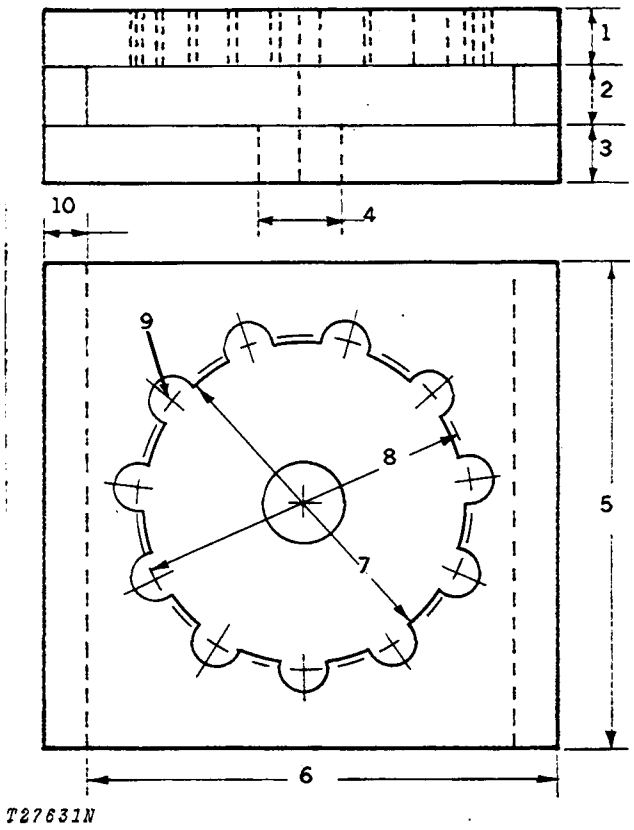


1—254.0 mm (10 in.)
2—127.0 mm (5 in.)
3—38.1 mm (1.5 in.)
4—405.4 mm (16 in.)
5—330.2 mm (13 in.)
6—9.52 mm (0.38 in.)
7—12.7 mm (0.5 in.)
8—31.8 mm (1.25 in.)
9—63.5 mm (2.5 in.)
10—25.4 mm (1 in.)
11—6.35 mm (0.25 in.)
12—152.4 mm (6 in.)
13—0.328 in. Drill Through
14—5/16 in.—18 Tap
15—2 used
16—304.8 mm (12 in.)
17—5/16 in—18 Tap
18—69.85 mm (2.75 in.) Radius
19—101.6 mm (4 in.)
20—111.25 mm (4.38 in.)
21—60.45 mm (2.38 in.)
22—5/16 in. x 1 in. Cap Screw
23—38.1 mm (1.5 in.) Angle Iron

S55,DFRG3 -19-23FEB87

TURBINE WHEEL HOLDING FIXTURE

1—19.1 mm (3/4 in.)
2—19.1 mm (3/4 in.)
3—19.1 mm (3/4 in.)
4—Bore to Clear Wheel Hub
5—165.1 mm (6-1/2 in.)
6—165.1 mm (6-1/2 in.)
7—63.5 mm (2-1/2 in.) Schwitzer;
73.0 mm (2-7/8 in.) Garrett/AiResearch
8—69.9 mm (2-3/4 in.) Schwitzer;
79.3 mm (3-1/8 in.) Garrett/AiResearch
9—9.5 mm (3/8 in.) Diameter, 11 Places Equally Spaced
10—25.4 mm (1 in.) Material: Hardware or Aluminum



S11,3005,MO -19-10AUG94

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