

Series 500 6619 Diesel Engines



JOHN DEERE

COMPONENT TECHNICAL MANUAL

Series 500 6619 Diesel
Engines

CTM9 (25JAN96) English

Deere Power Systems Group
CTM9 (25JAN96)

LITHO IN U.S.A.
ENGLISH



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.

JOHN DEERE DEALERS

IMPORTANT: The changes listed below make your current CTM9 obsolete. Discard CTM9, dated (2-87). Please copy this page and route through your service department.

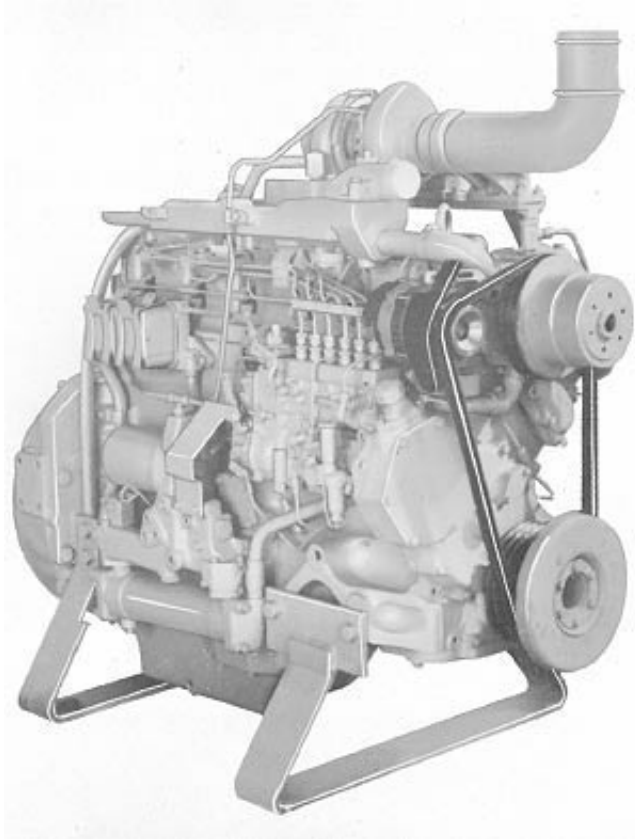
- All safety information has been updated in Group 00. All persons using this manual should read and understand this information.
- Essential and Special Tools listings have been updated throughout the manual.
- Specifications listed at the beginning of each group have been updated.
- Basic engine specifications have been deleted from Group 01. Specifications are covered in detail in their respective groups. All specifications lists have been updated.
- Engine break-in oil information has been added. Engine coolant requirements and recommendations have been updated. (Group 02.)
- Methods for properly lifting of engines have been updated. (Group 03.)
- Information on recommended sealants, thread lock compounds, anti-seize compounds, gasket materials and adhesives has been updated. Generic material recommendations have been updated to provide more specific information. Also, Sealant Applications Guidelines that provide ordering information for these materials as well as helpful "where used" information. (Group 04.)
- Valve clearance checking and adjustment procedure updated to show that these procedures **MUST BE** done with engine **COLD**. Cylinder head removal, inspection, and installation procedures have been updated. (Group 05.)
- Cylinder head cap screw and tightening information have been updated. (Group 05.)
- Crankshaft gear removal and installation procedures, crankshaft grinding guidelines and specifications chart have been updated. (Group 15.)
- Procedures for the removal, repair and installation of the fuel injection pumps have been updated. (Group 35.)
- Engine break-in procedures have been updated. (Group 100.)
- 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.

ABOUT THIS MANUAL

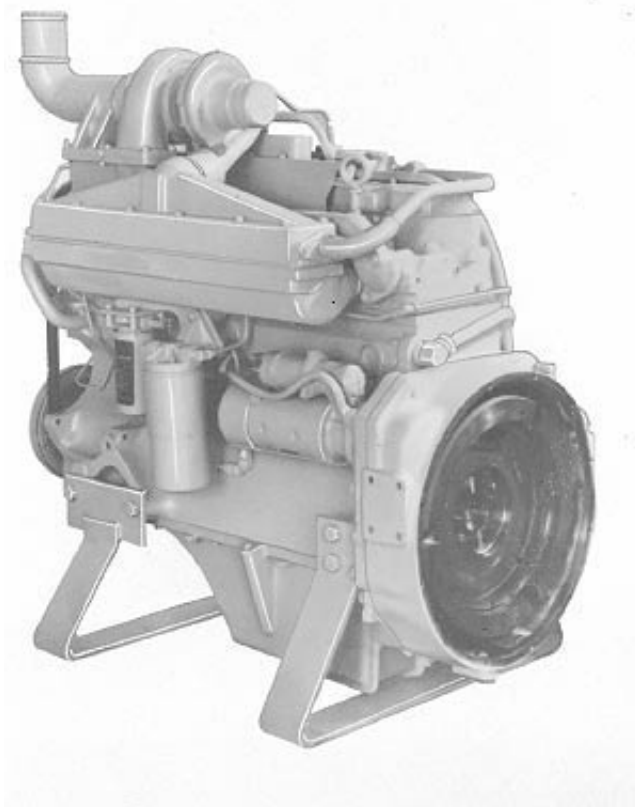
This component Technical Manual (CTM-9) covers the recommended repair procedure for all 10.1 L (619 cu. in.) Engines produced in Waterloo, Iowa. Before beginning repair of an engine, clean engine and mount in a safety approved repair stand. (See Group 03.)

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

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



RG5207 -UN-19JAN90



RG5208 -UN-19JAN90

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

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HANDLE FLUIDS SAFELY—AVOID FIRES

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

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

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

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



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TS227

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).



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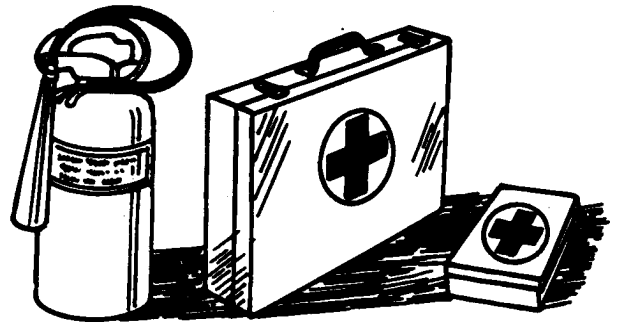
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TS204

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.



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TS291

PREVENT ACID BURNS

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

Avoid the hazard by:

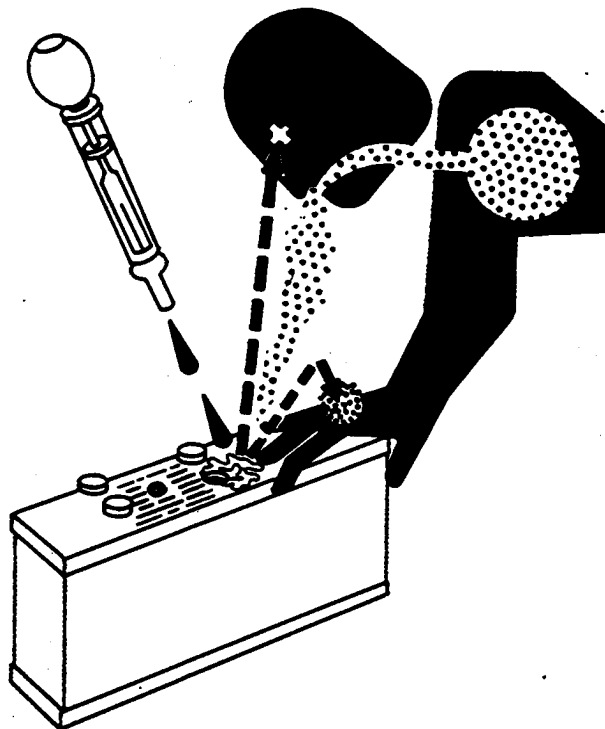
1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Use proper jump start procedure.

If you spill acid on yourself:

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

If acid is swallowed:

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



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DX,POISON -19-21APR93

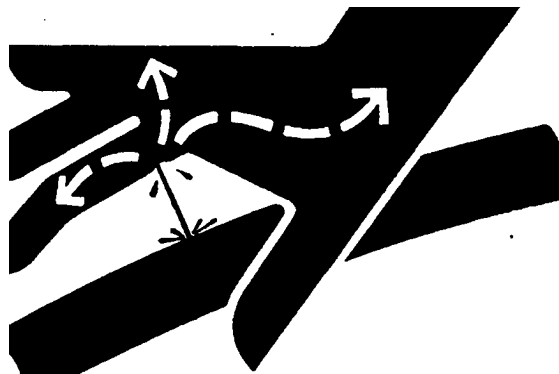
AVOID HIGH-PRESSURE FLUIDS

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

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

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

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



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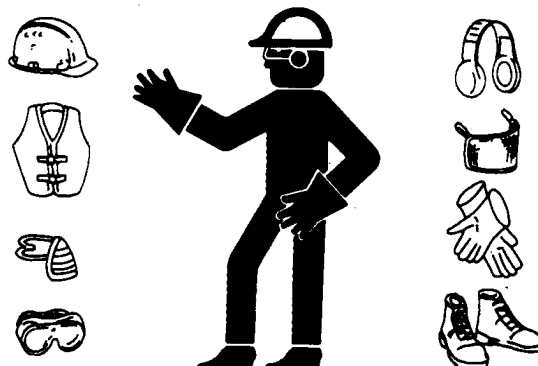
WEAR PROTECTIVE CLOTHING

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

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

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

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



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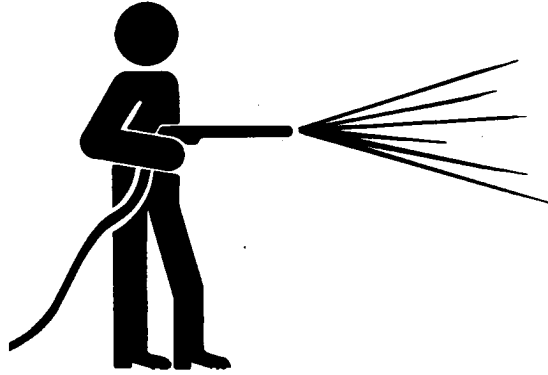
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TS206

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.



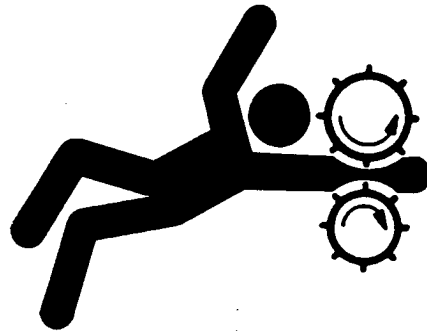
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SERVICE MACHINES SAFELY

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

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



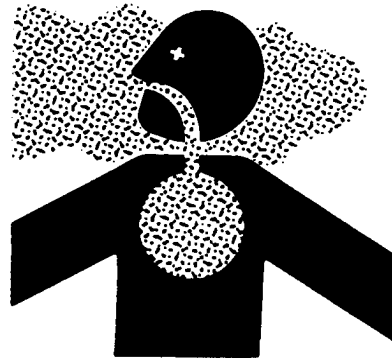
DX,LOOSE -19-04JUN90

TS228 -UN-23AUG88

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.



DX,AIR -19-04JUN90

TS220 -UN-23AUG88

ILLUMINATE WORK AREA SAFELY

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



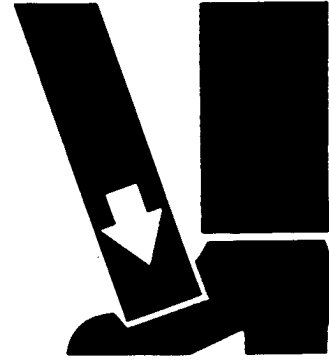
DX,LIGHT -19-04JUN90

TS223 -UN-23AUG88

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.



DX,LIFT -19-04JUN90

5100
-UN-23AUG88
TS226

AVOID HEATING NEAR PRESSURIZED FLUID LINES

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



DX,TORCH -19-03MAR93

-UN-15MAY90
TS953

REMOVE PAINT BEFORE WELDING OR HEATING

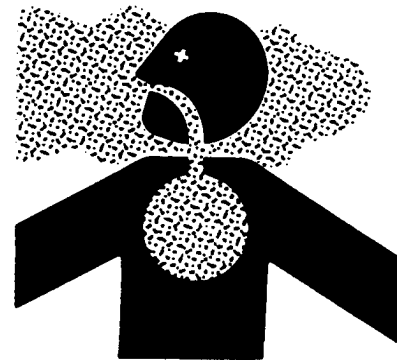
Avoid potentially toxic fumes and dust.

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

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

Remove paint before welding or heating:

- If you sand or grind paint, avoid breathing the dust. Wear an approved respirator.
- If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.



DX,PAINT -19-03MAR93

-UN-23AUG88
TS220

USE PROPER TOOLS

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

Use power tools only to loosen threaded parts and fasteners.

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

Use only service parts meeting John Deere specifications.



TS779 -UN-08NOV89

DX,REPAIR -19-04JUN90

DISPOSE OF WASTE PROPERLY

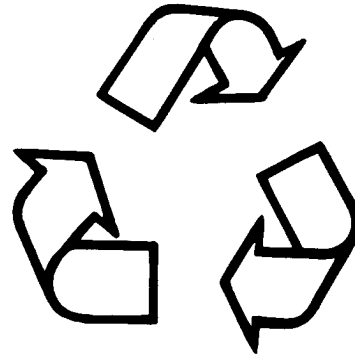
Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries.

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

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

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

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



TS1133 -UN-26NOV90

DX,DRAIN -19-03MAR93

LIVE WITH SAFETY

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



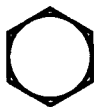
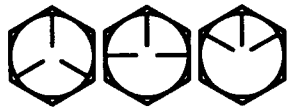
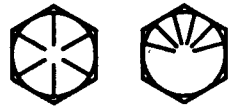





DX,LIVE

-19-25SEP92

TS231 -19-07OCT88

00
7

UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES

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

01
-19-04MARG1
TS1162

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.

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.

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

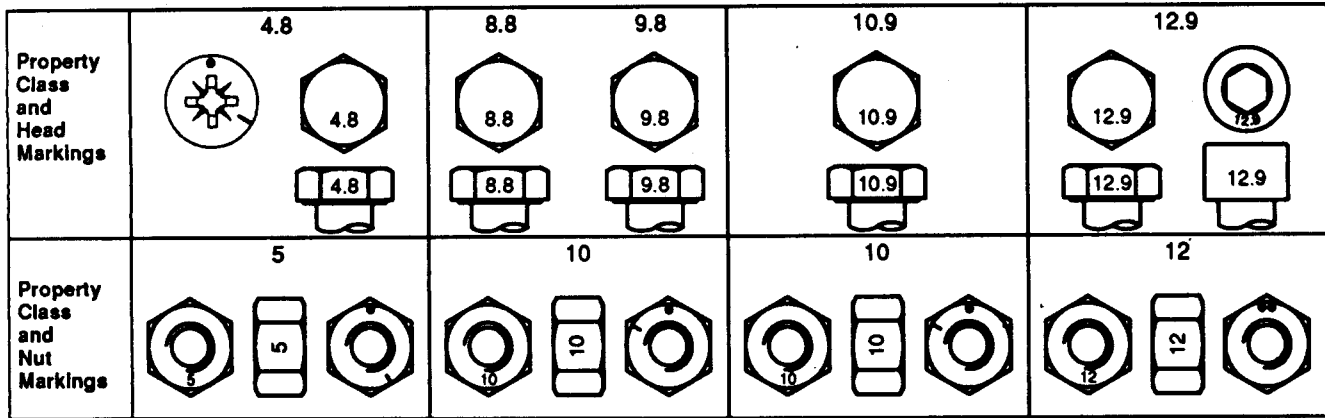
Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

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.

METRIC BOLT AND CAP SCREW TORQUE VALUES



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

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

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

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

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

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

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

ENGINE MODEL DESIGNATION

1. JOHN DEERE ENGINE MODEL - 6619 ENGINE

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

6619AF-00 ENGINE

6 Number of cylinders
619 Cu. in. displacement
A Aspiration code
F User factory code
-00 Application

ASPIRATION CODE

T Turbocharged
A Turbocharged and aftercooled

JD FACTORY/OEM USER FACTORY CODE

T Dubuque
E Ottumwa
R Tractor
F OEM

APPLICATION CODE

-00, -01 Code for specific application

S11,0000,AF -19-25JAN96

2. 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 6619AF001 engine just previously discussed, becomes DDA model H0639600:

H0639600 Model Designation

H	.....	Engine series
06	.....	Number of cylinders
3	.....	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 counterclockwise rotation

Aspiration

3	.....	Turbocharged
6	.....	Turbocharged and aftercooled

Application Code

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

S11,0000,AG -19-27MAY87

01
4

ENGINE SERIAL NUMBER PLATE INFORMATION

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

1. ENGINE SERIAL NUMBER

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

RG6619A000000

RG Factory code producing engine
 6619A Engine model designation
 000000 Sequential number

Factory Code Producing Engine

RG Waterloo

Engine Model Designation

6619A Definition explained previously
 (See Engine Model Designation)

Sequential Number

000000 6-digit sequential number

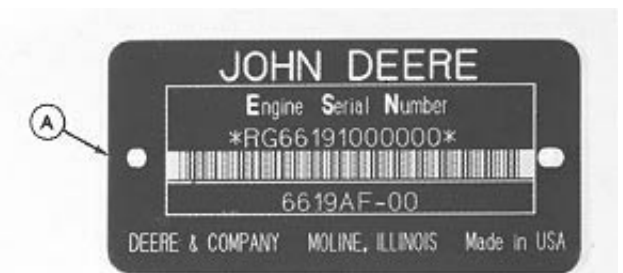
2. ENGINE APPLICATION DATA

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

NOTE: Current (later) engines will have a bar coded serial number plate (A, lower illustration) with the same information as detailed above.



John Deere Embossed Nameplate



John Deere Bar Coded Nameplate

-UN-19JAN90
5101
RG4934

-UN-25OCT91
RG5978

RG,0000,AH -19-25JAN96

3. Unit Number

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

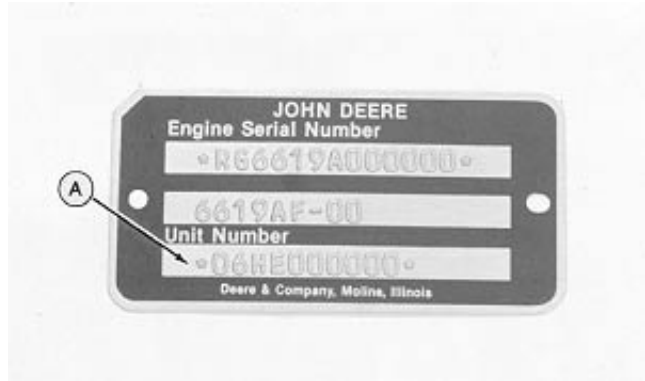
A typical unit number converts the 13-digit engine serial number into one that is 10-digits. It includes the number of cylinders, manufacturing factory location, and DDA model designation.

Example:

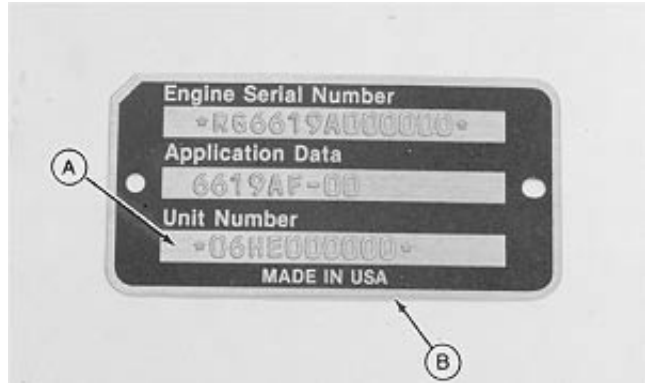
JD Engine Serial No.	DDA Unit No.
RG6619A000000	06HE000000
6	06
RG	H
RG6619A	**E
000000	000000

JD/DDA	Model Codes	
	Deere Engine Model	DDA Model Code ** (4th position of Unit No.)
RG/H	6619T	D
RG/H	6619A	E

NOTE: Some nameplates (B) are used which do not have the John Deere name printed.



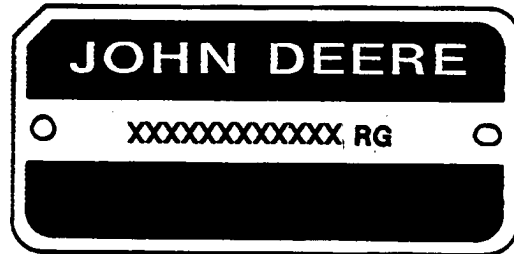
DDA Unit Number Plate



Generic Engine Nameplate

RG.0000,AJ -19-19MAY95

NOTE: Prior to Engine Serial No. (-047325), a one line engine name plate was used on production engines.



S11,0000,AT -19-27MAY87

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-UN-19JAN90

RG4935

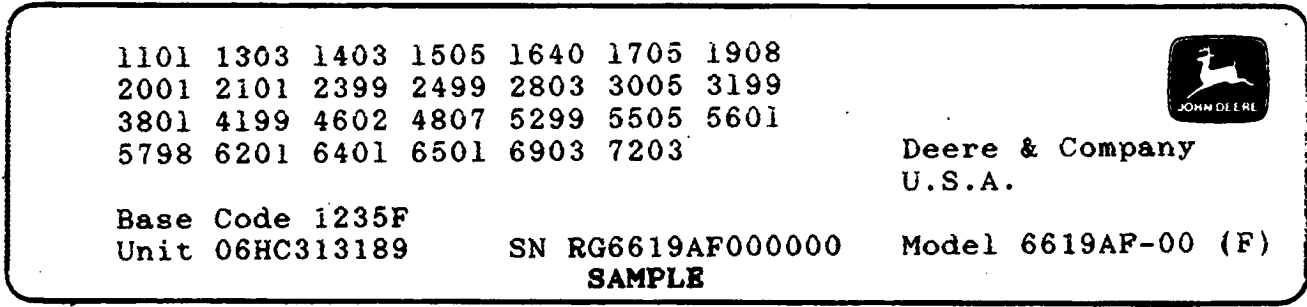
-UN-19JAN90

RG4936

-UN-06APR89

RG5059

OPTION CODE LABEL



An option code label is affixed to the rocker arm cover on all OEM engines. (Label is not installed on engines for John Deere machines.)

The label identifies only the factory-installed options on each engine. Distributor/Dealer installed kits would not be shown.

A four-digit number is used to identify a particular option. For example, Code 1403 indicates that the engine is equipped with an SAE No. 3 flywheel housing.

Always provide option code information when ordering repair parts. A listing of option codes is given in the Operator's Manual.

S11,000,AK1 -19-26MAR87

ENGINE APPLICATION CHART

John Deere Agricultural Equipment Applications

Machine Model No.	Engine Model
Forage Harvesters	
5460	6619AE-01
5720	6619AE-02
5820	6619AE-02, 03
5830	6619AE-03
Tractors	
8630	6619AR-01, 10
8630 Export	6619AR-06, 13
8640	6619AR-08
8640 Export	6619AR-09
8650	6619AR-11, 14
8650 Export	6619AR-12

S11,000,AL -19-27MAY87

General Information/Engine Application Chart

John Deere Industrial Equipment Applications

Machine Model No.	Engine Model
Crawlers	
JD850, 850	6619TT-02
JD855, 855	6619AT-02
Excavator	
JD890,890	6619AT-03
890A	6619AT-05
992D	6619AT-07
Scraper	
JD762, 762	6619TT-01
JD860B	6619AT-01
JD862, 862	6619AT-04
862B	6619AT-04

RG,0000,AM -19-31JAN96

OEM Applications

Machine Model No.	Engine Model
OEM	6619AF-00
Repower	6619TF-01
Stationary Engines	6619AR-04

S11,0000,AN -19-27MAY87

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8

DIESEL FUEL

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

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

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

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

- **Cetane Number 40 minimum.** Cetane number greater than 50 is preferred, especially for temperatures below -20° C (-4° F) or elevations above 1500 m (5000 ft).
- **Cold Filter Plugging Point (CFPP)** below the expected low temperature OR **Cloud Point** at least 5° C (9° F) below the expected low temperature.

- **Sulfur Content**

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

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

RG,FUEL1 -19-25JAN96

LUBRICITY OF DIESEL FUELS

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

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

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

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

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

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

If fuel of low or unknown lubricity is used, add John Deere PREMIUM DIESEL FUEL CONDITIONER or equivalent at the specified concentration. John Deere Premium Diesel Fuel Conditioner is available in winter and summer formulas. Consult your John Deere engine distributor or servicing dealer for more information.

RG,FUEL5 -19-25JAN96

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:

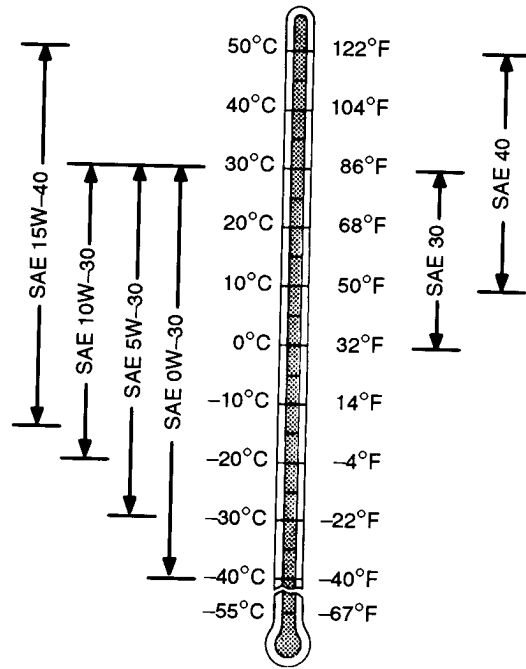
- **John Deere TORQ-GARD SUPREME®**

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%.



-UN-12SEP94

TS1619

DX,ENOIL -19-16SEP94

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.

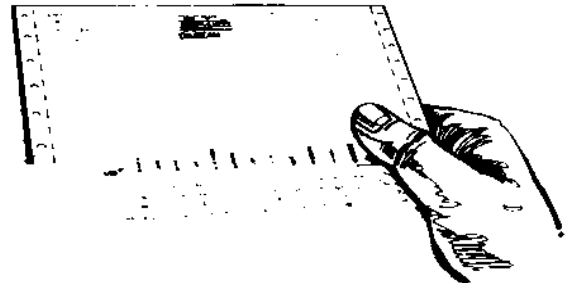
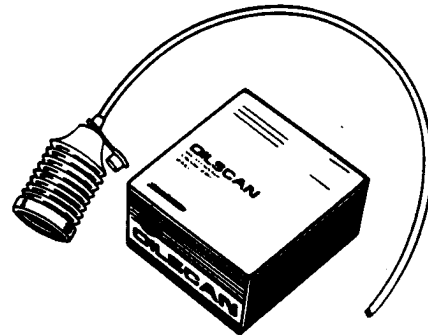
DX,ENOIL4 -19-17OCT94

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.



DX,OILSCAN -19-16APR92

02
3

T6828AB -UN-15JUN89

T6829AB -UN-18OCT88

GREASE

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

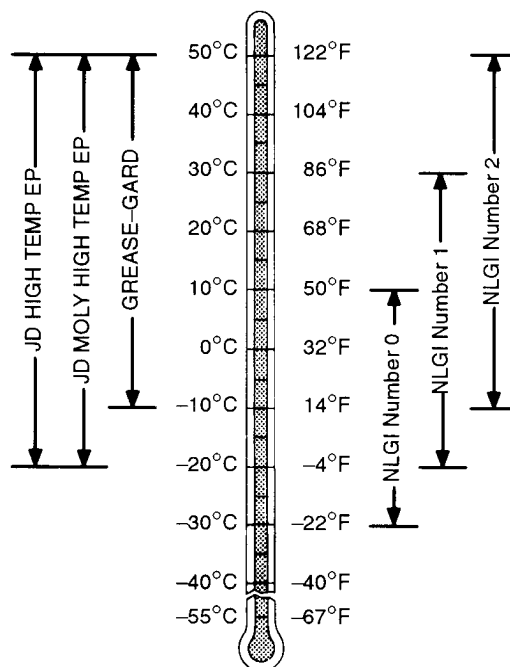
The following greases are preferred:

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

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

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

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

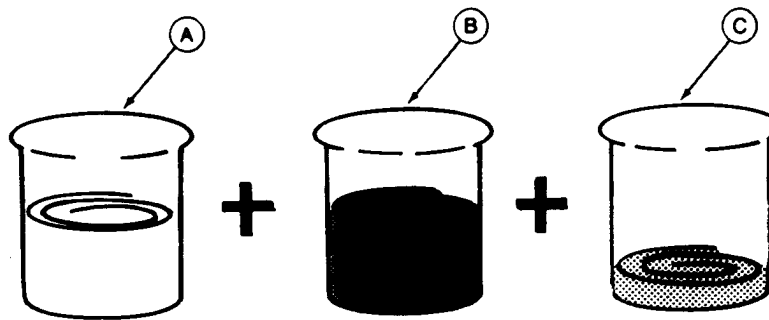


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DX,GREA1 -19-02NOV94

TS1622 -UN-02NOV94

ENGINE COOLANT REQUIREMENTS



A—Quality Water

B—Ethylene Glycol Concentrate
(Antifreeze)

C—Supplemental Coolant Additives
(SCA's)

Engine Coolant

RG6258 -UN-22APR92

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.

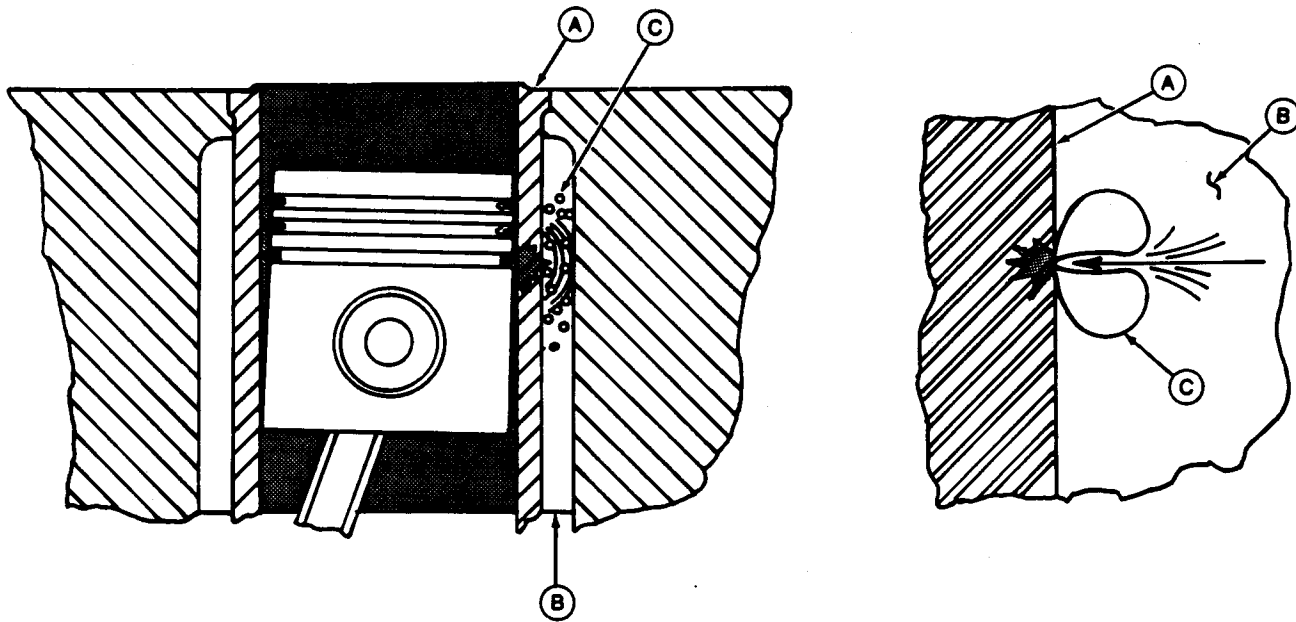
IMPORTANT: Supplemental coolant additives **MUST** be added to the coolant solution. Ethylene glycol concentrate (antifreeze) **DOES NOT** contain chemical inhibitors needed to control liner pitting or erosion, rust, scale, and acidity.

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.

RG.COOL1 -19-25JAN96

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ENGINE COOLANT REQUIREMENTS—CONTINUED



A—Cylinder Liner Walls

B—Engine Coolant

C—Vapor Bubbles

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

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

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

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

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

RG.COOL1A -19-25JAN96

RG6263 -UN-22APR92

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ENGINE COOLANT RECOMMENDATIONS

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.

The following engine coolant is preferred for service:

—John Deere Prediluted Antifreeze/Summer Coolant

—John Deere COOL-GARD™, where available

The following engine coolant is also recommended:

— John Deere Antifreeze/Summer Coolant Concentrate in a 40 to 60 percent mixture of concentrate and quality water

• 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 Antefreeze/Summer Coolant permits extended service life to 3000 hours or 36 months of operation.

• 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 2000 hours or 24 months of operation.

• 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 2000 hours or 24 months of operation.

RG,COOL2,CTM -19-25JAN96

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.

Coolant solutions of quality water, ethylene glycol concentrate (antifreeze), 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, noncorrosive environment for seals, hoses, and metal engine parts.

Water Quality:

Water quality is important to the performance of the cooling system. Distilled, deionized, or demineralized water is recommended for mixing with ethylene glycol base engine coolant concentrate. Mineral (hard/tap) water should **NEVER** be put in a cooling system unless first tested. All water used in the cooling system should meet the following minimum specifications for quality:

Water Quality Specifications

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

Ethylene Glycol Concentrate (Antifreeze):

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

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

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

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

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

IMPORTANT: Never use automotive coolants (such as those meeting ASTM D3306 or ASTM D4656). These coolants do not contain the correct additives to protect heavy-duty diesel engines. They often contain high concentrations of silicates and may damage the engine or cooling system.

ENGINE COOLANT SPECIFICATIONS—CONTINUED



RG7298 -UN-13FEB95

Supplemental Coolant Additives (SCA's):

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

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.

Operating without proper coolant additive will result in increased corrosion, cylinder liner erosion and pitting, and other damage to the engine and cooling system. A simple mixture of ethylene glycol and water WILL NOT give adequate protection. However, the use of supplemental coolant additives will reduce the number of vapor bubbles in the coolant and help form a protective film on cylinder liner surfaces. This film

acts as a barrier against the harmful effects of collapsing vapor bubbles.

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

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

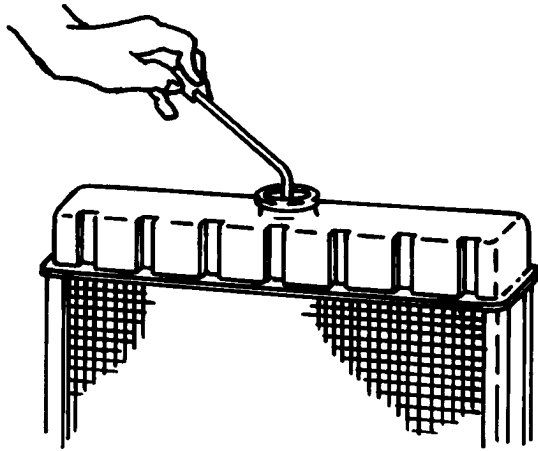
DO NOT use soluble oil.

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

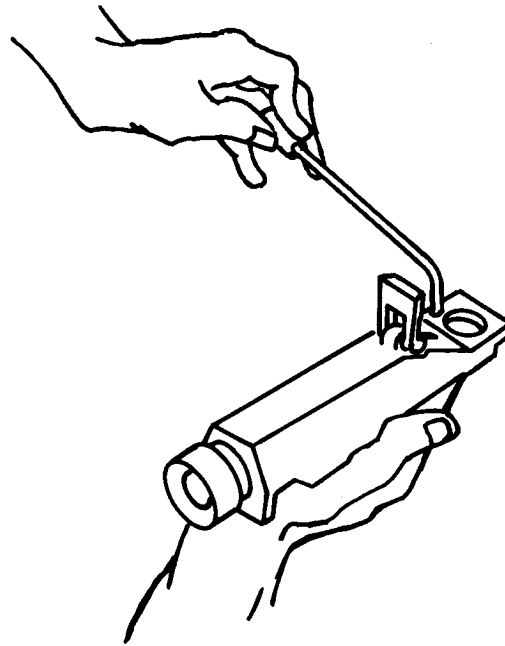
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REPLENISHING SUPPLEMENTAL COOLANT ADDITIVES (SCA'S) BETWEEN COOLANT CHANGES



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

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

Test the coolant solution at 600 hours or 12 months of operation using either John Deere coolant strips or Cool-Scan analysis. If a Cool-Scan analysis is not available, recharge system per instructions printed on label of John Deere Liquid Coolant Conditioner. **ALWAYS** follow the manufacturer's recommendations printed on the container label.

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.

TESTING ENGINE COOLANT

Maintaining adequate concentrations of glycol and inhibiting additives in the coolant is critical to protect the engine and cooling system against freezing, corrosion, and cylinder liner erosion and pitting.

Test the coolant solution at recommended intervals to ensure the necessary protection.

Coolant Test Strips

Coolant test strips are available from your John Deere dealer. These test strips provide a simple, effective method to check the freeze point and additive levels of your engine coolant.

Compare the results to the supplemental coolant additive (SCA) chart to determine the amount of inhibiting additives in your coolant and whether more John Deere Liquid Coolant Conditioner should be added.

Cool-Scan

For a more thorough evaluation of your coolant, perform a Cool-Scan analysis. See your John Deere engine distributor or servicing dealer for information about Cool-Scan.

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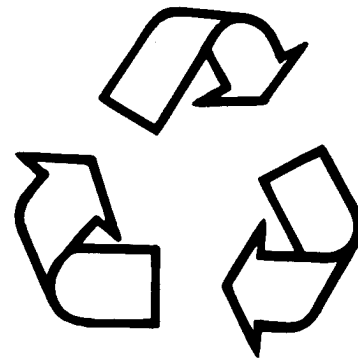
DISPOSING OF COOLANT

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

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

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

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

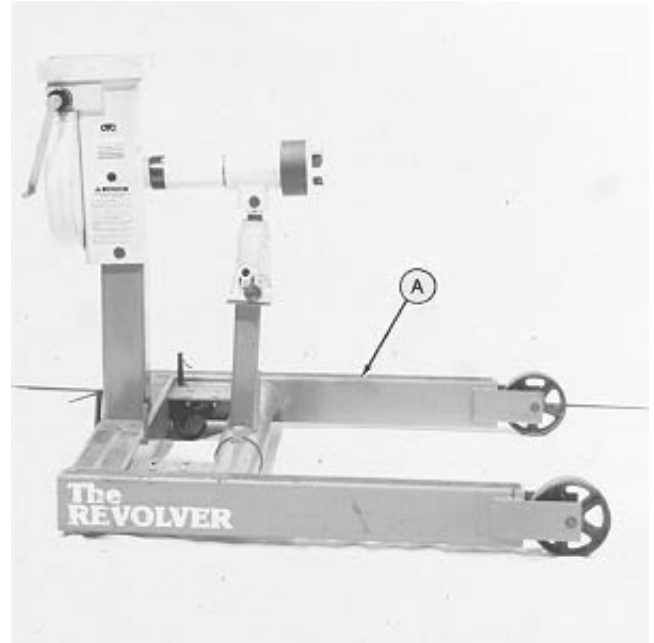


TS1133 -JUN-26NOV90

RG,COOL5 -19-25JAN96

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.



S11,2000,EM -19-08MAR94

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03

SAFETY PRECAUTIONS

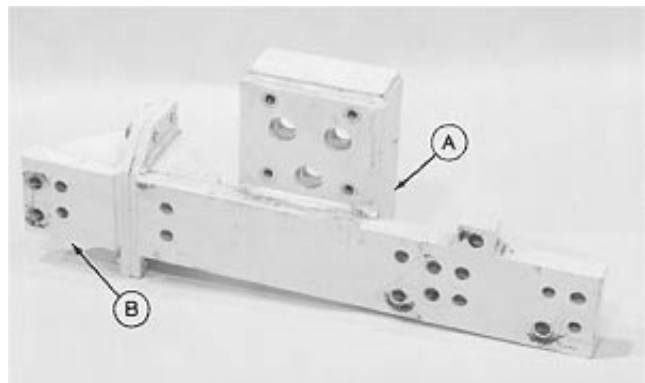
- The engine repair stand should be used only by qualified service technicians familiar with this equipment.
- To maintain shear strength specifications, alloy steel SAE Grade 8 or higher cap screws must be used to mount adapters and engine to repair stand. Use LOCTITE 242 Thread Lock and Sealer on cap screws when installing lifting straps on engine. Tighten cap screws to 245 N·m (180 lb-ft).
- For full thread engagement, be certain that tapped holes in adapters and engine blocks are clean and not damaged. A thread length engagement equal to 1-1/2 screw diameters minimum is required to maintain strength requirements.
- To avoid structural or personal injury, do not exceed the maximum capacity rating of 2722 kg (6000 lb). Maximum capacity is determined with the center of the engine located not more than 330 mm (13 in.) from the mounting hub surface of the engine stand.
- To avoid an unsafe off-balance load condition, the center of balance of an engine must be located within 51 mm (2 in.) of the engine stand rotating shaft. Engine center of balance is generally located a few millimeters above the crankshaft.
- To prevent possible personal injury due to engine slippage, recheck to make sure engine is solidly mounted before releasing support from engine lifting device.
- Never permit any part of the body to be positioned under a load being lifted or suspended. Accidental slippage may result in personal injury.
- The lifting jack is to be used when it is necessary to lift the engine for rotation. When working on the engine, the jack should be at its lowest position to keep the center of gravity low and the possibility of tipping low.
- To prevent possible personal injury due to sudden engine movement, lower engine by operating jack release valve slowly. Do not unscrew release valve knob more than two turns from its closed position.

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S11,2000,DZ -19-25JAN96

INSTALL 6619 ENGINE ADAPTERS ON REPAIR STAND


1. Attach the No. 60581 Engine Adapter (A) to mounting hub of engine repair stand using three SAE Grade 8 socket head screws. Tighten screws to 135 N·m (100 lb-ft).
2. Attach the No. 51400 End Adapter (B) to engine adapter using four 5/8-11 x 2 in. SAE Grade 8 cap screws. Tighten cap screws to 135 N·m (100 lb-ft).



S11,2000,EN -19-25JAN96

RG4930 -JUN-15DEC88

ENGINE LIFTING PROCEDURE


 **CAUTION:** The only approved method for lifting the 6619 Engine is with the use of JDG23 Lifting Sling and RE61025 Lift Straps.

IMPORTANT: Ensure that engine lifting straps are secured with SAE Grade 8 (or higher grade) cap screws. Apply TY9370 LOCTITE 242 Thread Lock and Sealer to lift strap cap screws.

1. Install RE61025 Lift Straps and tighten cap screws to 245 N.m (180 lb-ft).

NOTE: Lift chain spacing on sling is adjustable. Position each chain 381 mm (15 in.) from center of bar.

2. Attach the JDG-23 Engine Lifting Sling to lift straps and overhead hoist or floor crane of adequate lifting capacity.

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

3. Carefully lift engine to desired location.

RG,2000,EQ -19-25JAN96

CLEAN ENGINE

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

2. Steam-clean engine thoroughly.

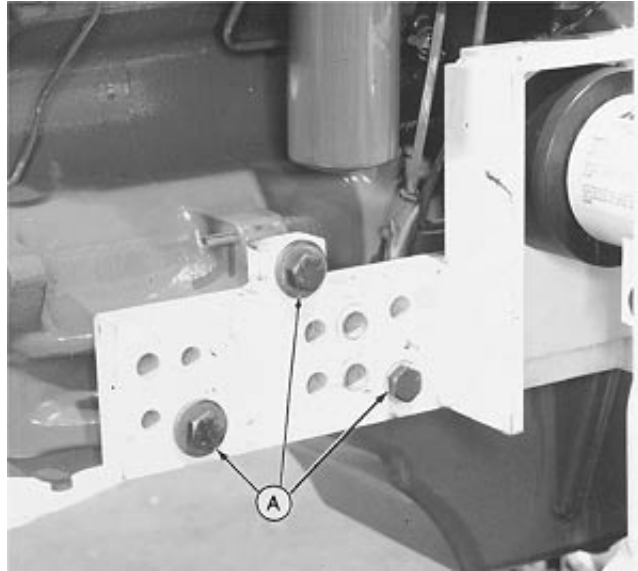
IMPORTANT: Never steam clean or pour cold water on an injection pump while it is still warm. To do so may cause seizure of pump parts.

S11,2000,EC -19-20AUG92

MOUNT ENGINE ON REPAIR STAND

NOTE: For engines equipped with bypass oil filter and/or engine oil dipstick assembly on the starter side of engine, these parts must be removed so engine can be mounted on repair stand.

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



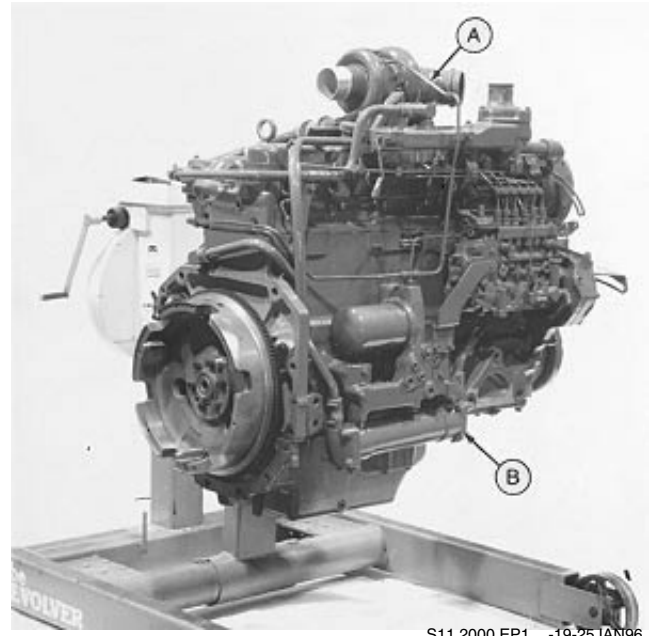
RG4931
-JUN-19JAN90



RG4932
-JUN-19JAN90

S11,2000,EO -19-18MAR87

IMPORTANT: When servicing a 6619 engine on a rollover stand, disconnect the turbocharger oil inlet line (A) from the oil pressure regulating housing before inverting the engine. Also, drain oil from engine oil cooler (B). Failure to do so may cause hydraulic lock upon starting the engine. Hydraulic lock can cause possible engine failure.



S11,2000,EP1 -19-25JAN96

RG4933
-UN-26JAN90
03

Engine Mounting/Mount Engine on Repair Stand

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DISASSEMBLY SEQUENCE

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

1. Drain all coolant and engine oil. Check engine oil for metal contaminants.
2. Remove fan, fan belts, and alternator.
3. Remove exhaust elbow and turbocharger.
4. Disconnect water piping, remove intake manifold cover and aftercooler (if equipped). Remove coolant filter conditioner assembly (if equipped).
5. Remove exhaust manifold. Remove water manifold and thermostats.
6. Disconnect water piping and remove water pump.
7. Remove bypass oil filter assembly (if equipped).
8. Remove dipstick, oil filter, oil pressure regulating housing, and engine oil cooler assembly.
9. Remove fuel filters and base (if equipped).
10. Remove starting motor.
11. Remove injection pump drive gear from pump hub.
12. Remove fuel injection lines, fuel injection pump and fuel injection nozzles.
13. Remove rocker arm cover with vent tube. On engines having an Option Code Label on rocker arm cover, be careful not to damage label.
14. Remove rocker arm assembly and push rods. Remove cylinder head and cam followers. Identify parts for reassembly.
15. Remove mechanical tachometer drive assembly from side of block (if equipped).
16. Remove engine oil pan and oil pump.
17. Remove damper pulley assembly and remove timing gear cover.
18. Check camshaft endplay and remove camshaft.
19. Remove pistons and connecting rods. Identify for reassembly.
20. Remove main bearings and crankshaft. Perform wear checks.
21. Remove cylinder liners and piston cooling orifices. Mark liners for reassembly in same bore from which removed.
22. Remove cylinder block plugs and serial number plate (as required, if block is to be put in a "hot tank").
23. Refer to appropriate group for inspection and repair or engine components.

RG,0000,AQ -19-25JAN96

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) tube

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

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

—Oil pressure sending unit.

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

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

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

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

T43514 50 mL (1.7 oz) bottle

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

—O-ring adapter for oil pump outlet tube.

—Bypass oil check valve adapter.

—Coolant conditioner filter adapter.

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

TY6304 50 mL (1.7 oz) bottle

—Water pump, water manifold and thermostat cover gaskets.

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

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

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

—Injection pump governor cover fitting (fuel return).

—Threaded nipples and elbows in water pump housing.

—Threads of water pump and coolant conditioner lines.

—Temperature sending unit.

—Oil pan (drain hose and drain valve).

—Connectors: turbo line and turbo drain.

—Adapter fitting for turbo oil inlet line.

• LOCTITE 609 Retaining Compound (green):

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

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

—Front wear sleeve ID.

SEALANT APPLICATION GUIDELINES—CONTINUED

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

TY6299 227 g (8 oz) container

- Timing gear cover-to oil pan.
- Timing gear cover-to-cylinder block.
- Rear crankshaft oil seal housing-to-cylinder block.
- Oil pressure regulating housing.
- Flywheel housing-to-oil pan.
- Camshaft bore steel cap plug.

- **PT569 NEVER-SEEZ® COMPOUND:**

PT569 227 g (8 oz) Brush

PT506 453 g (16 oz) Spray

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

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

AR31790 141 g (5 oz) tube

- Rocker arm cover gasket.

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

TEFLON® is a registered trademark of DuPont Company.

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

RG,CTM61,G4,4 -19-25JAN96

ASSEMBLY SEQUENCE

The following assembly sequence is suggested when engine has been completely disassembled. Be sure to check run-out and torque specifications during assembly. Refer to the appropriate repair group when assembling engine components.

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

2. Install clean piston cooling orifices.

3. Install cylinder liners without O-rings and measure liner stand-out. Install liners with O-rings.

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4
4. Install crankshaft and main bearings. Install rear seal housing and new seal/wear sleeve assembly.

5. Install pistons and connecting rods. Rotate crankshaft to assure correct assembly.

6. Install camshaft. Check camshaft end play. Install timing gear cover. Check runout.

7. Install oil pump and engine oil pan.

8. Install tachometer drive assembly on side of cylinder block (if equipped).

9. Install damper pulley assembly. Install cam followers.

10. Install cylinder head gasket, cylinder head, valve assembly, push rods, and rocker arm assembly.

11. Install fuel injection nozzles in cylinder head.

12. Install fuel injection pump. Install and connect fuel injection lines. Install injection pump drive gear cover.

13. Install fuel filter base and fuel filters (if equipped)

14. Install engine oil cooler, oil pressure regulating housing, new oil filter, and dipstick.

15. Install flywheel and flywheel housing.

16. Install starting motor.

17. Install bypass oil filter assembly (if equipped).

18. Install water pump assembly.

19. Install water manifold with thermostats. Install exhaust manifold.

NOTE: Install turbocharger oil return pipe at this time.

20. Install aftercooler assembly (if equipped). Install intake manifold cover.

21. Install coolant filter conditioner assembly (if equipped). Install intake manifold cover.

22. Install turbocharger and exhaust elbow.

23. Install alternator, fan, and fan belts.

24. Adjust valves and install rocker arm cover with vent tube.

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

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

Group 05 Cylinder Head And Valves

SPECIAL OR ESSENTIAL TOOLS

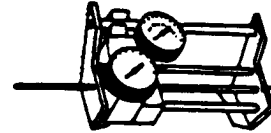
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-20JUL95

Spring Compression Tester D01168AA

RG5061 -UN-23AUG88

Test valve spring compression.

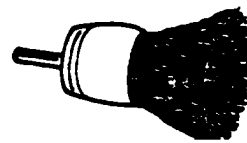


S53,D01168,AA -19-13MAR92

End Brush D17024BR

RG5063 -UN-23AUG88

Clean valve seat and bores.



S53,D17024,BR -19-26JAN87

Valve Guide Knurler Kit JT05949

RG5064 -UN-23AUG88

Knurl valve guides.



S53,D20002,WI -19-16SEP92

Pilot Driver JDE7-1

RG5065 -UN-23AUG88

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

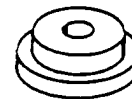


S53,JDE7 1 -19-14JUN95

Exhaust Valve Insert Adapter JDE72

RG5066 -UN-23AUG88

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

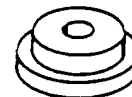


S53,JDE72 -19-14JUN95

Intake Valve Insert Adapter JDE73

RG5066 -UN-23AUG88

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



S53,JDE73 -19-14JUN95

Valve Guide Driver JDE75

RG5067 -UN-06APR89

Install replacement valve guides. Use with JDE7-1.



S53,JDE75 -19-14JUN95

Cylinder Head And Valves/Essential Tools

Flywheel Turning Tool JDE81-1

RG4950 -UN-23AUG88

Rotate engine flywheel. Use with JDE81-4.



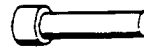
NOTE: JDG820 may be used on engines not equipped with mechanical tachometer drives.

RG,JDE811,619 -19-25JAN96

Timing Pin JDE81-4

RG5068 -UN-23AUG88

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

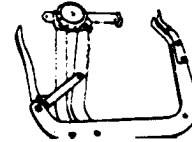


S55,JDE814,B -19-24FEB88

Valve Spring Compressor JDE138

RG5070 -UN-23AUG88

Used to compress valve spring when removing and installing valves.



S53,JDE138 -19-04MAR87

Torque Wrench Adapter JDE-141

RG5069 -UN-06APR89

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

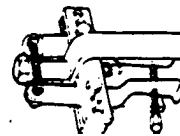


S53,JD3141 -19-26JAN87

Valve Seat Puller JDE41296

RG5071 -UN-23AUG88

Remove valve seats.

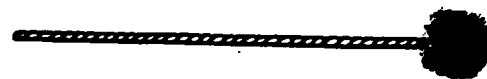


S53,JDE,41296 -19-26JAN87

Nozzle Thread Cleaning Brush D17030BR

RG5099 -UN-23AUG88

Used to clean nozzle threads in cylinder head.

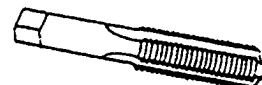


S53,D17030,BR -19-16FEB87

Tap JDF5

RG5100 -UN-23AUG88

Used to restore nozzle threads in cylinder head.



S53,JDF5 -19-08MAR94

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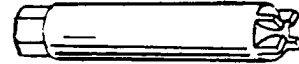
Cylinder Head And Valves/Other Materials

RG5289

-UN-23AUG88

Nozzle Seat Reamer JDE99

Clean injection nozzle seats.



NOTE: JDG609 Nozzle Seat Reamer may be used also.

RG,JDE99

-19-25JAN96

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
JT05993 Torque Angle Gauge	Torque-turn cylinder head connecting rod cap screws

S55,2505,AH

-19-25JAN96

OTHER MATERIAL

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

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

SCOTCH GRIP is a trademark of 3M Co.

S11,2505,BW

-19-25JAN96

CYLINDER HEAD AND VALVES SPECIFICATIONS

Item	New Part Specification	Wear Tolerance
Valve Clearance (Engine Cold):		
Intake Valve	0.33—0.43 mm (0.013—0.017 in.)	—
Exhaust Valve	0.58—0.68 mm (0.023—0.027 in.)	—
Valve Lift, at 0.00 mm (00 in.) clearance		
Intake Valve	13.20—13.38 mm (0.520—0.527 in.)	—
Exhaust Valve	11.85—12.03 mm (0.467—0.474 in.)	—
Valve Springs Working Height:		
Inner Spring—Valve Closed	45 mm @ 187—205N (1.77 in. @ 42—46 lb-force)	—
—Valve Open	31.5 mm @ 376—437 N (1.24 in. @ 84—98 lb-force)	—
Outer Spring—Valve Closed	51.1 mm @ 311—347 N (2.01 in. @ 70—78 lb-force)	—
—Valve Open	37.6 mm @ 721—836 N (1.48 in. @ 162—188 lb-force)	—
Valve Stem OD	11.011—11.036 mm (0.4335—0.4345 in.)	—
Valve Guide ID	11.074—11.100 mm (0.4360—0.4370 in.)	—
Valve Stem-to-Guide Clearance	0.038—0.089 mm (0.0015—0.0035 in.) 0.102 mm (0.0040 in.)	—
Valve Guide Installed Height	48.0 mm (1.89 in.) from bottom of head	—
Standard Valve Seat Inserts:		
Valve Seat Bore in Head:		
Intake	53.37—53.47 mm (2.101—2.105 in.)	—
Exhaust	49.65—49.75 mm (1.955—1.959 in.)	—
Valve Seat OD:		
Intake	54.241—54.267 mm (2.1355—2.1365 in.)	—
Exhaust	50.546—50.571 mm (1.9900—1.9910 in.)	—
Oversize Valve Seat Inserts:		
Available Size	0.25 mm (0.010 in.)	—
Valve Seat Bore in Head:		
Intake	53.62—53.72 mm (2.1110—2.1150 in.)	—
Exhaust	49.91—50.01 mm (1.9650—1.9690 in.)	—
Valve Seat OD:		
Intake	54.496—54.521 mm (2.1455—2.1465 in.)	—
Exhaust	50.800—50.826 mm (2.0000—2.0010 in.)	—
Valve Seat Insert Counterbore Depth:		
Intake	9.91 mm (0.390 in.)	—
Exhaust	10.95 mm (0.431 in.)	—

**CYLINDER HEAD AND VALVES
SPECIFICATIONS—CONTINUED**

Item	New Part Specification	Wear Tolerance
Valve Head OD:		
Intake Valve	51.46—51.71 mm (2.026—2.036 in.)	—
Exhaust Valve	47.50—47.75 mm (1.870—1.880 in.)	—
Valve Face Angle:		
Intake Valve	19.5°	—
Exhaust Valve (—010696)	44.5°	—
(010697—)	29.5°	—
Valve Seat Angle		
Intake Valve	20°	—
Exhaust Valve (—010696)	45°	—
(010697—)	30°	—
Valve Seat Width	2.77—3.20 mm (0.109—0.126 in.)	—
Valve Seat Concentricity with Guide	0.051 mm (0.020 in.)	—
Valve Relation to Head Surface:		
Intake Valve—R75690 and R81087	0.06—0.56 mm (0.002—0.022 in.) above	—
R63981	0.13 mm (0.005 in.) above	—
	—0.36 mm (0.014 in.) below	
Exhaust Valve	0.32—0.82 mm (0.012—0.032 in.) below	1.04 mm (0.041 in.) below
Max. Valve Seat Runout	0.051 mm (0.002 in.)	—
Max. Valve Face Runout	0.05 mm (0.002 in.)	—
Nominal Cylinder Head Height (Rocker Arm Cover Gasket Rail-to-Combustion Face)		
	166.55—168.80 mm (6.557—6.567 in.)	165.53 mm (6.517 in.)
Max. Material Removed to Resurface Head		1.02 mm (0.040 in.)
Max. Head Warpage for Entire Length of Head		0.10 mm (0.004 in.)
Combustion Face Surface Finish (Surface Grind Only) (AA)	0.0015—0.0028 mm (60-110 micro-in.)	—
Rocker Arm ID	25.418—25.458 mm (1.0007—1.0023 in.)	—
Rocker Arm Shaft OD	25.360—25.400 mm (0.9984—1.0000 in.)	—

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TORQUES

Cylinder Head Cap Screws:

Initial Torque	200 N.m (150 lb-ft)
TORQUE-TURN an additional	90°—100°

Rocker Arm Shaft Clamps	88 N.m (65 lb-ft)
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Valve Adjusting Screw Locknut	27 N.m (20 lb-ft)
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Rocker Arm Cover Cap Screws:

SAE Grade 2	2 N.m (20 lb-in.)
SAE Grade 5	11 N.m (96 lb-in.)

Intake Manifold-to-Cylinder Head	75 N.m (55 lb-ft)
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Exhaust Manifold-to-Cylinder Head	75 N.m (55 lb-ft)
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Aftercooler Cover (6619A Engines):

Engine Serial No. (—044592)	47 N.m (35 lb-ft)
Engine Serial No. (044593—)	60 N.m (44 lb-ft)

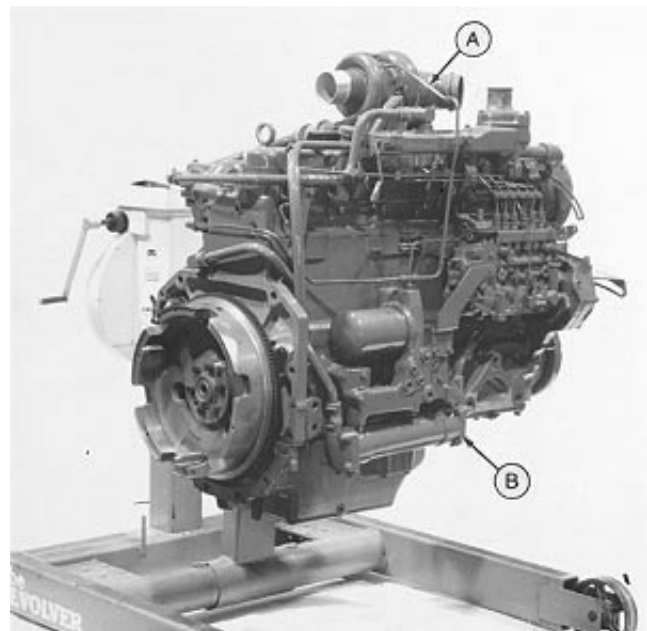
Coolant Conditioner Filter Bracket-to-Cylinder Head	75 N.m (55 lb-ft)
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Coolant Manifold to Cylinder Head	47 N.m (35 lb-ft)
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Turbocharger Mounting Stud Nuts.	47 N.m (35 lb-ft)
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S11,2505,BY -19-25JAN96

IMPORTANT: When servicing a 6619 engine on a rollover stand, disconnect the turbocharger oil inlet line (A) from the oil pressure regulating housing before inverting the engine. Also, drain oil from engine oil cooler (B). Failure to do so may cause hydraulic lock upon starting the engine. Hydraulic lock can cause possible engine failure.



S11,2000,EP1 -19-25JAN96

-UN-26JAN90
RG4933

CHECK AND ADJUST VALVE CLEARANCE

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

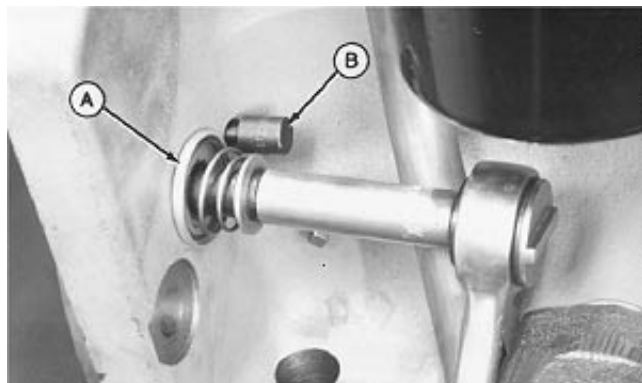
Too much valve clearance causes a lag in valve timing causing engine valve train imbalance. The fuel-air mixture enters the cylinders late during intake stroke. The exhaust valve closes early and prevents waste gases from being completely removed from cylinders. Also, the valves close with a great deal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

NOTE: Valve clearance should be checked with engine cold.

1. Remove turbocharger heat shield and rocker arm cover.
2. Use JDE81-1 Flywheel Turning Tool (A) and JDE81-4 Timing Pin (B).
3. Rotate engine until timing pin engages timing hole in flywheel.

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

NOTE: 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.



RG5521 -UN-09JAN90

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S11,0401,C -19-25JAN96

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

VALVE CLEARANCE SPECIFICATIONS

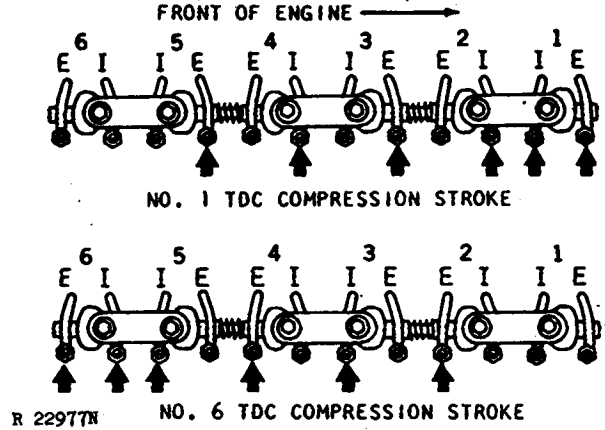
Intake Valves	0.33—0.43 mm (0.013—0.017 in.)
Exhaust Valves	0.58—0.68 mm (0.023—0.027 in.)

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

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

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

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



-19-05JUN89
R22977N

05-8

CHECK VALVE LIFT

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

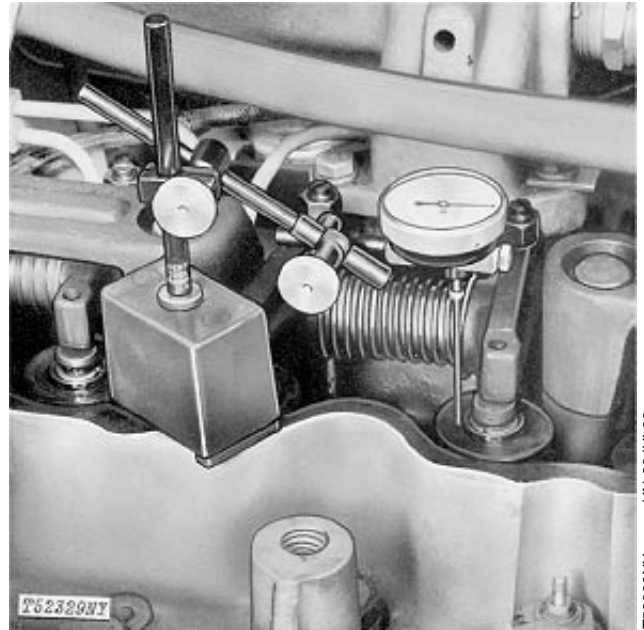
IMPORTANT: For a more accurate measurement, it is recommended that valve lift be measured at 0.00 mm (0.0 in.) clearance.

1. Remove rocker arm cover.
2. Loosen locknut on rocker arm shaft and set valve clearance at zero (0.00) using a wrench and screwdriver. Tighten locknut.
3. Place dial indicator tip on top of valve spring cap, as shown. Preload indicator tip and set dial at zero (0.00).
4. Manually turn engine in running direction one full revolution using the JDE81-1 Flywheel Turning Tool.
5. Observe dial indicator reading as valve is moved to full open. Record readings and compare with specifications given below.

VALVE LIFT SPECIFICATIONS @ 0.00 mm (0.0 in.) CLEARANCE

Intake Valves 13.20—13.38 mm (0.520—0.527 in.)
Exhaust Valves 11.85—12.03 mm (0.467—0.474 in.)

6. Follow same procedure for all remaining valves and adjust valve clearance when valve lift measurements are complete. (See CHECK VALVE CLEARANCE in this group.)



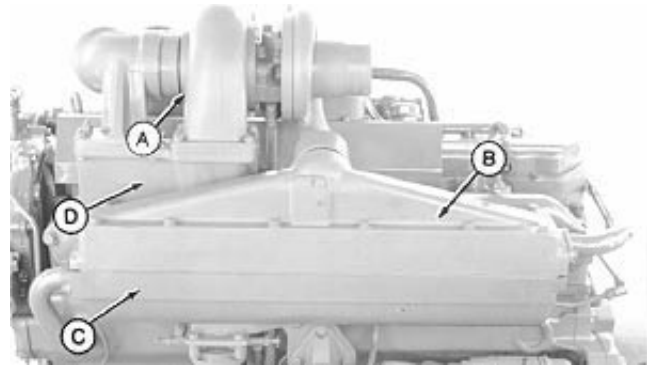
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-UN-28JUL88
T52329NY

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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 the engine, allow enough time for the exhaust system to cool before removal of components. DO NOT drain coolant until the coolant temperature is below operating temperature. Always loosen coolant drain valves slowly to relieve any excess pressure.



A—Turbocharger
B—Intake Cover and Aftercooler
C—Intake Manifold
D—Exhaust Manifold

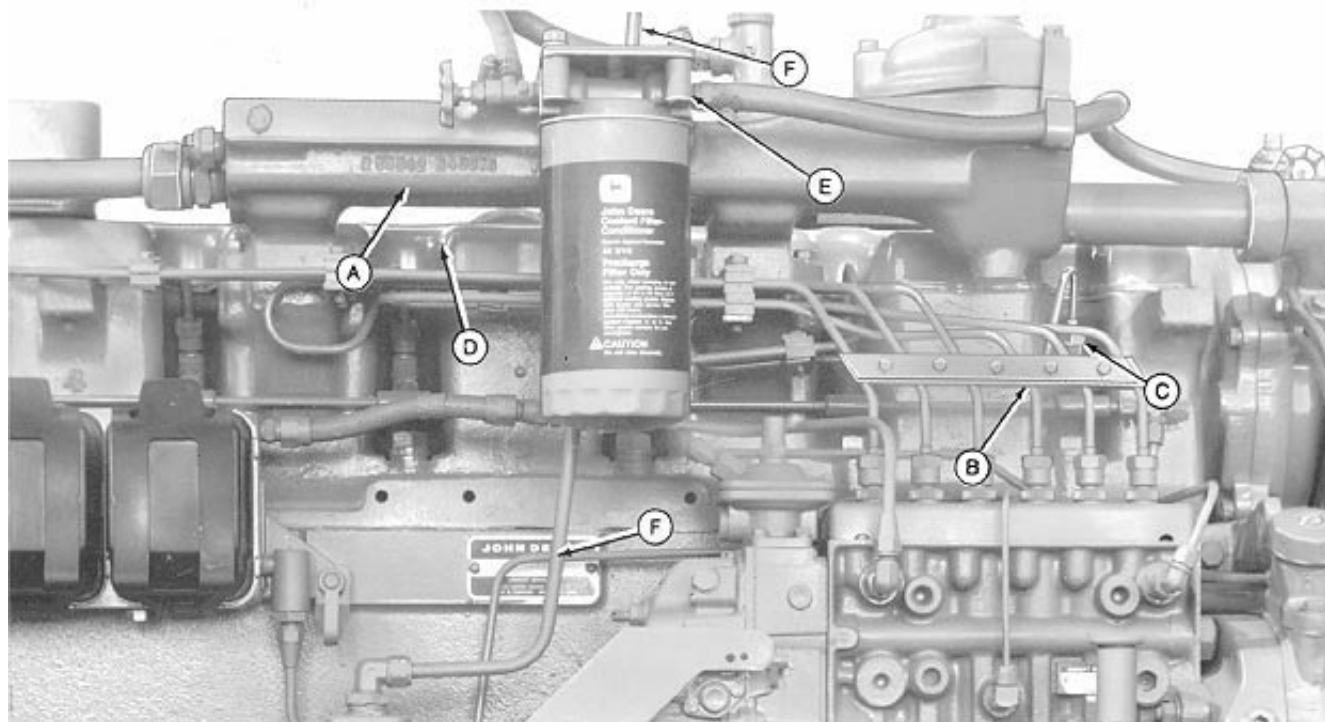
1. Drain engine coolant.
2. Remove turbocharger and exhaust elbow (A). (See REMOVE TURBOCHARGER in group 30.)
3. On 6619A Engines: Remove intake manifold (C) and aftercooler (B). (See REMOVE AFTERCOOLER AND INTAKE MANIFOLD-6619A ENGINES in Group 30.)
4. On 6619T Engines: Remove intake manifold (C). (See REMOVE, INSPECT AND INSTALL INTAKE MANIFOLD-6619T ENGINES in Group 30.)
5. Remove exhaust manifold (D). (See REMOVE, INSPECT AND INSTALL EXHAUST MANIFOLD ASSEMBLY in Group 30.)

S11,2505,CB -19-14JUN95

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10

RG3528 -JUN-31JUL89

Cylinder Head And Valves/Remove Cylinder Head



RG4318 -UN-09NOV89

A—Water Manifold
B—Fuel Injection Lines

C—Fuel Injection Nozzles
D—Rocker Arm Cover

E—Coolant Filter Conditioner
F—Turbocharger Oil Inlet
Line

NOTE: Water manifold mounted coolant filter conditioner shown, air intake mounted similar.

6. Remove water manifold (A) and coolant filter conditioner (E), if equipped. (See REMOVE WATER MANIFOLD in Group 25.)

7. Remove fuel injection lines (B). Cap or plug fittings on injection pump and injection nozzles.

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

9. Remove turbocharger heat shield, if equipped.

10. Remove rocker arm cover (D) and turbocharger oil inlet line (F).

S11,2505,CC -19-25JAN96

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

12. Remove all three clamps (B).

13. Lift and remove rocker arm assembly.

RG4336 -UN-09NOV89



S11,2505,F -19-25JAN96

Cylinder Head And Valves/Remove Cylinder Head

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



S11,0401,J -19-14JUN95

NOTE: If desired, check and record all cylinder head cap screw torques before removal.

15. Remove all 26 cylinder head cap screws.

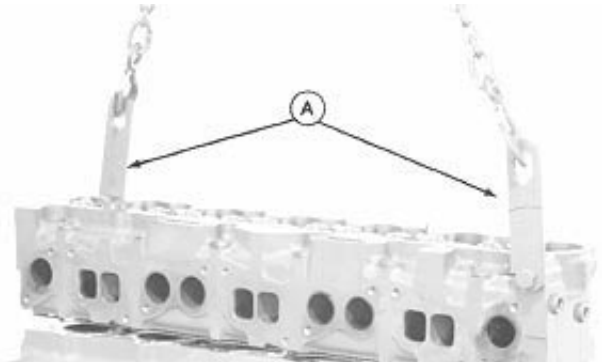
IMPORTANT: DO NOT use screwdrivers or pry bars between cylinder block and cylinder head to loosen head-to-block gasket seal.

16. Lift cylinder head from block using lift straps (A) and hoist. If cylinder head sticks, tap the head with a soft hammer to loosen gasket seal.

17. Remove cylinder head and gasket. Inspect for possible oil, coolant or combustion chamber leaks. Check for incorrect or defective head gasket.

NOTE: Do not rotate crankshaft with cylinder head removed unless all cylinder liners are secured with cap screws and large flat washers as described in Group 10. (See REMOVE PISTONS AND CONNECTING RODS in Group 10.)

18. If desired, check valve height and record results. (See CHECK VALVE HEIGHT IN RELATION TO HEAD SURFACE, later in this group.)



S11,2005,DJ -19-25JAN96

CHECK VALVE HEIGHT IN RELATION TO HEAD SURFACE

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

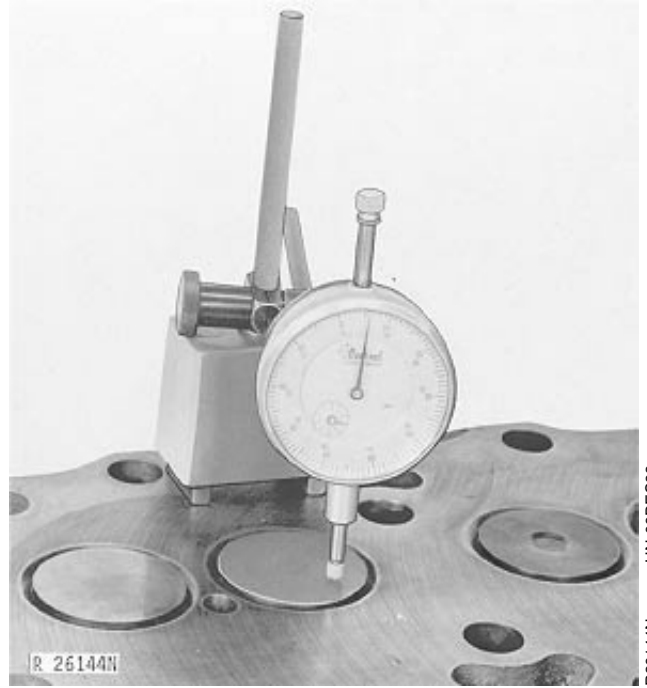
1. Use a dial indicator to check valve height.

Intake valves R75690 and R81087 should be 0.06—0.56 mm (0.002—0.022 in.) above head surface. Intake valve R63981 should be 0.13 mm (0.005 in.) above —0.36 mm (0.014 in.) below head surface.

Exhaust valves should be 0.32—0.82 mm (0.012—0.032 in.) below head surface.

The maximum allowed below head surface for exhaust valves is 1.04 mm (0.041 in.).

NOTE: If valve height is not within specification, check valve face angle and valve seat angle. If valve is recessed beyond the maximum specification, install either new valves, valve seats or both to obtain proper valve height.



-UN-09DEC88

R26144H

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S11,2505,V -19-25JAN96

DISASSEMBLE AND INSPECT ROCKER ARM SHAFT ASSEMBLY

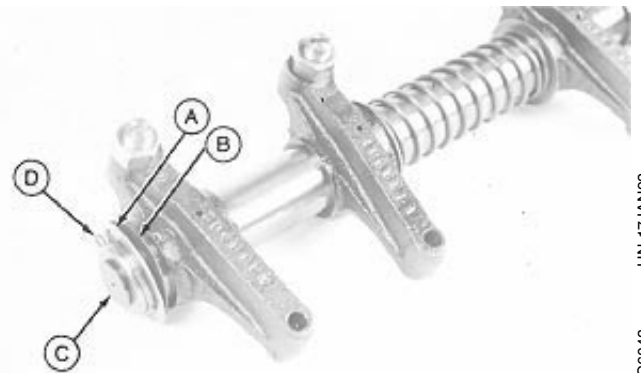
NOTE: Make preliminary inspection during disassembly.

Look for:

- Worn or scored rocker arms, shaft, and shaft support clamps
- Weak or broken springs
- Lube oil restriction

1. Remove spring washer (A), washer (B), end plug (C), and cotter pin (D) 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.



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

-UN-17JAN92

RG6043

RG,CTM61,G5,46 -19-25JAN96

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

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

ROCKER ARM ASSEMBLY SPECIFICATIONS

Rocker Arm ID 25.418—25.458 mm
(1.0007—1.0023 in.)

Rocker Arm Shaft OD 25.360—25.400 mm
(0.9984—1.0000 in.)

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

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

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

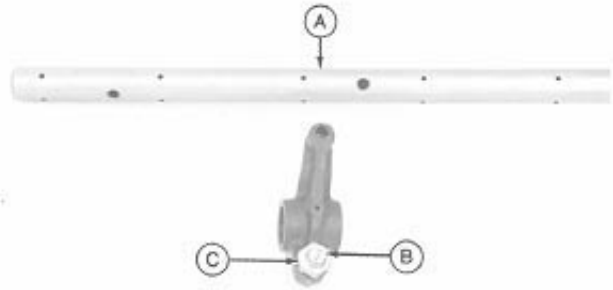


FIG3802 -UN-23FEB89

S11,2505,I -19-13MAY93

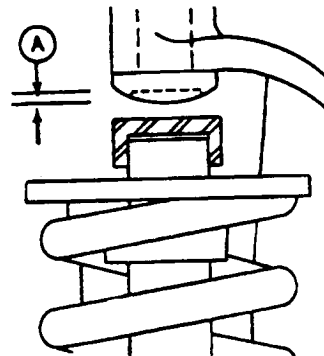
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6. Check for cups or concave wear (A) on ends of rocker arms where they contact wear caps.

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

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

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



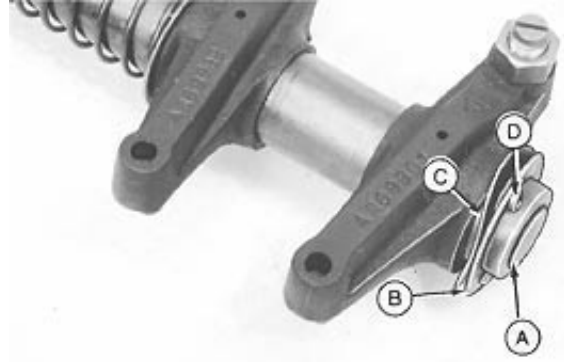
R26131 -UN-09DEC88

S11,0401,N -19-05FEB85

ASSEMBLE ROCKER ARM SHAFT ASSEMBLY

1. Assemble parts on rocker arm shaft in reverse of sequence removed.
2. Make sure rocker arm shaft end plugs (A) are firmly seated in shaft.
3. Check for proper installation of washer (B) and spring washer (C). Be sure cotter pin (D) is bent securely.

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



RG3031 -UN-17JUL89

S11,2505,J -19-14JUN95

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15

PRELIMINARY CYLINDER HEAD AND VALVE CHECKS

• Sticking Valves:

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

• Warped, Worn, or Distorted Valve Guides:

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

• Distorted Cylinder Head and Gasket Leakage:

Loss of cylinder head cap screw torque.
Broken cylinder head cap screw.
Overheating from low coolant level operation.
Insufficient liner stand-out.
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.

• Burned, Pitted, Worn, or Broken Valves:

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

• 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.

REMOVE VALVE ASSEMBLY

NOTE: Refer to PRELIMINARY CYLINDER HEAD AND VALVE CHECKS earlier in this group to help recognize possible valve assembly malfunctions.

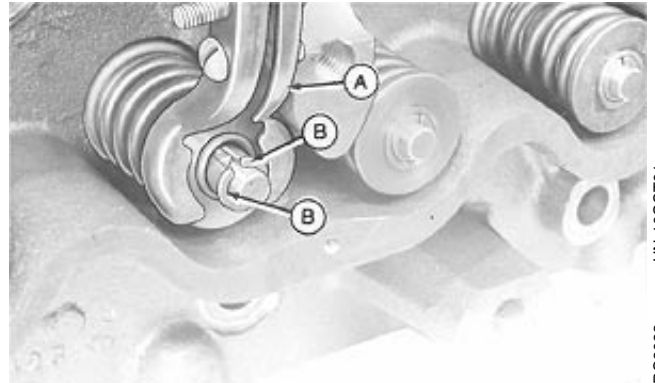
1. Remove cylinder head and rocker arm assembly. (See REMOVE CYLINDER HEAD earlier in this group.)

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

2. Compress valve springs using valve spring compressor (A).

3. Remove wear caps (shown removed) and retaining locks (B).

4. Remove valve spring compressor.

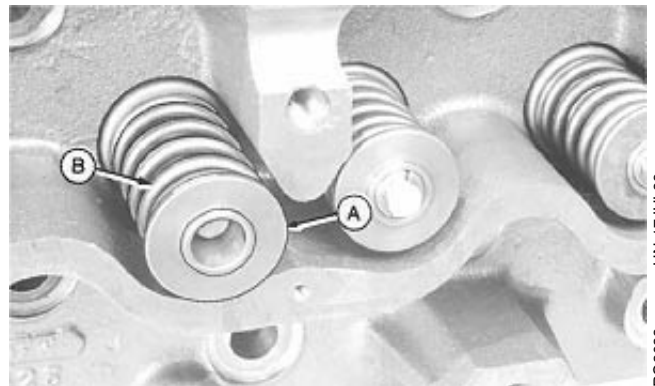


RG3032
-UN-16OCT91

S11,2005,EE -19-25JAN96

5. Remove spring cap (A).

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

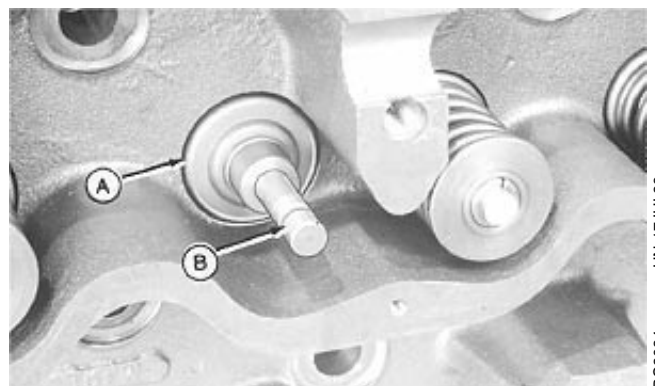


RG3033
-UN-17JUL89

S11,2005,EF -19-14JUN95

7. Remove valve rotator (A).

8. Remove valve (B).



RG3034
-UN-17JUL89

S11,2005,EG -19-14JUN95

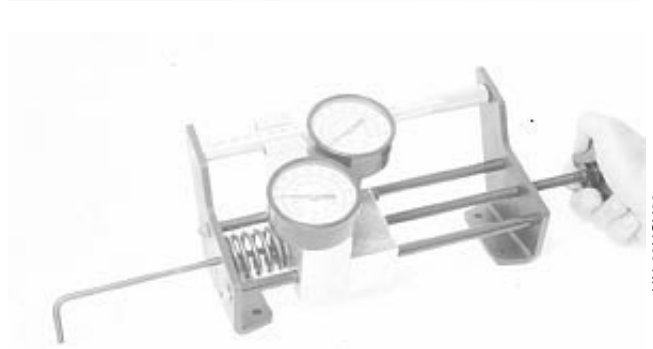
INSPECT VALVE SPRINGS

1. Inspect valve springs for alignment, wear and damage.
2. Place springs on a flat surface to see that they are square and parallel.
3. Check valve spring tension using D01168AA Spring Compression Tester.

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

VALVE SPRING NEW PART SPECIFICATIONS

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

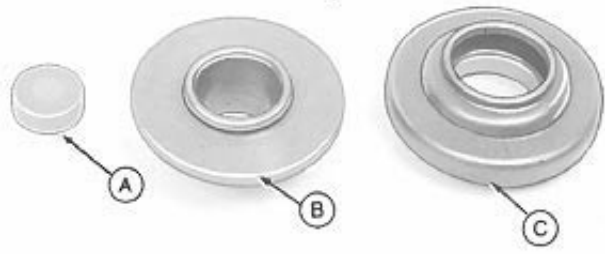


-UN-23FEB89
RG2732
-UN-08NOV88
T82054

S11,2505,N -19-14JUN95

INSPECT SPRING CAPS, WEAR CAPS AND VALVE ROTATORS

1. Inspect wear caps (A) for wear or damage.
2. Inspect spring caps (B) for concave wear on face or for damage.
3. Insure that valve rotators (C) will turn freely in both directions.
4. Replace parts if they are worn or show any signs of damage.



-UN-17JUL89
RG3035

S11,2505,O -19-25JAN96

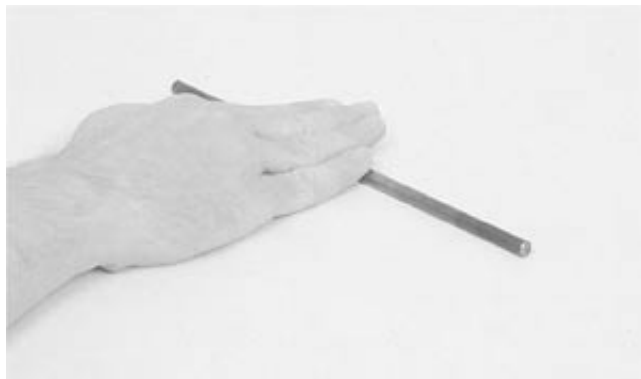
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CLEAN AND INSPECT PUSH RODS

1. Clean push rods with solvent and compressed air.

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

2. Check push rods for straightness by rolling on a flat surface.
3. Inspect contact ends for wear and damage.
4. Replace defective push rods.



T81233 -UN-01NOV88

S11,2005,JN -19-01NOV95

CLEAN VALVES

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

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

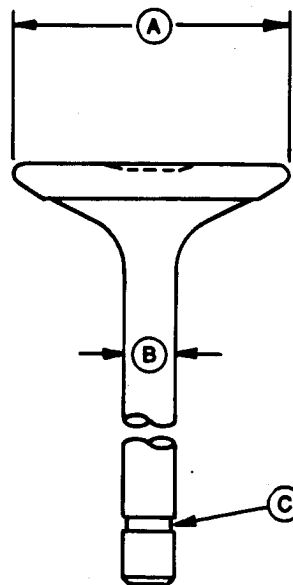
2. Make sure all carbon is removed from valve head, face and unplated portion of stem.

RG,CTM8,G05,33 -19-14JUN95

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19

INSPECT AND MEASURE VALVES

1. Replace valves that are burned, cracked, eroded, chipped, scuffed, or otherwise damaged.
2. Inspect valve retainer lock groove (C) on valve stem for damage.
3. Measure valve head OD (A).
4. Measure valve stem OD (B). Compare valve stem OD with guide ID to determine clearance. (See MEASURE VALVE GUIDES in this group.)



VALVE SPECIFICATIONS

A—Valve Head OD:	
Intake	51.46—51.71 mm 2.026—2.036 in.)
Exhaust	47.50—47.75 mm 1.870—1.880 in.)
B—Valve Stem OD. 11.011-11.036 mm (0.4335-0.4345 in.)	

05
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S11,2005,EA -19-14JUN95

-JUN-12AUG91

RG6795

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

VALVE FACE RUNOUT SPECIFICATION

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

NOTE: Valves determined to be serviceable should be refaced. (See GRIND VALVES later in this group.)



RG,CTM61,G5,51 -19-25JAN96

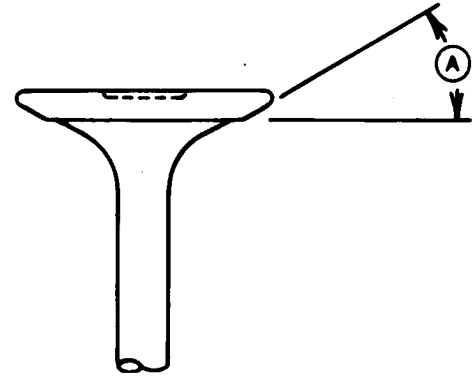
-JUN-23FEB89

RG4234

GRIND VALVES

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

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



Measure valve face angle (A). Regrind valve face angle or replace valves as necessary.

VALVE FACE ANGLE SPECIFICATIONS

Intake	19.5°
Exhaust (010697—)	29.5°
(—010696)	44.5°

RG5247 -UN-12AUG91

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21

INSPECT AND CLEAN CYLINDER HEAD

1. Inspect combustion face for evidence of physical damage, oil or coolant leakage, or gasket failure prior to cleaning the cylinder head. Repair or replace cylinder head if there is evidence of physical damage; such as cracking, abrasion, distortion, or valve seat "torching". Inspect all cylinder head passages for restrictions.
2. Scrape gasket material, oil, carbon, and rust from head. Use a powered wire brush to clean sealing surfaces.
3. If front plate is present on cylinder head, remove prior to dipping head in chemical hot tank.

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

4. Clean cylinder head in a chemical hot tank, or with solvent and a brush.
5. Dry with compressed air and blow out all passages.

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

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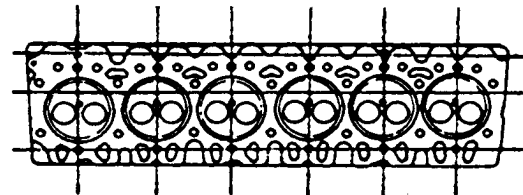
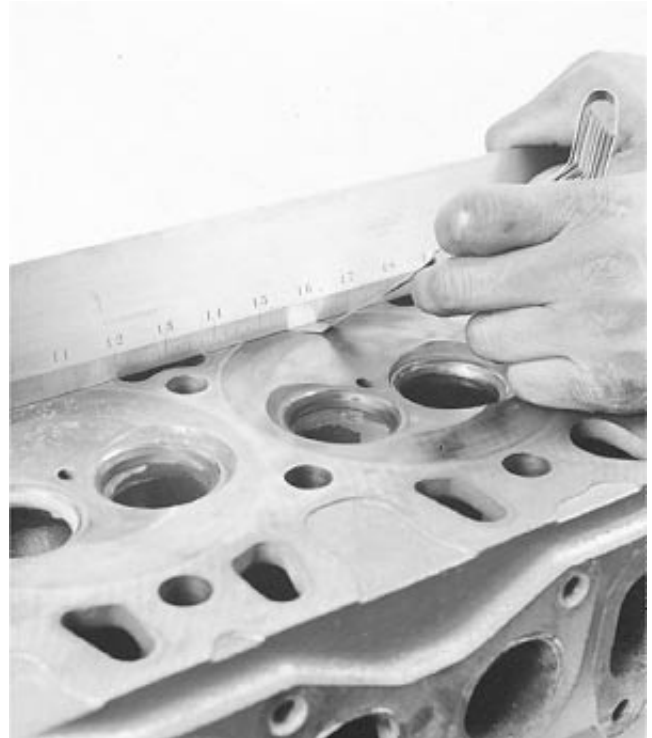
CHECK CYLINDER HEAD COMBUSTION FACE FLATNESS

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

CYLINDER HEAD FLATNESS SPECIFICATIONS

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

NOTE: If out-of-flat exceeds specifications, the cylinder head must be resurfaced or replaced. Measure cylinder head thickness to determine appropriate corrective action. (See MEASURE CYLINDER HEAD THICKNESS, later in this group.)



RG,CTM61,G5,53 -19-14JUN95

RG6050 -UN-17JAN92

RG4629 -UN-06DEC88

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MEASURE CYLINDER HEAD THICKNESS

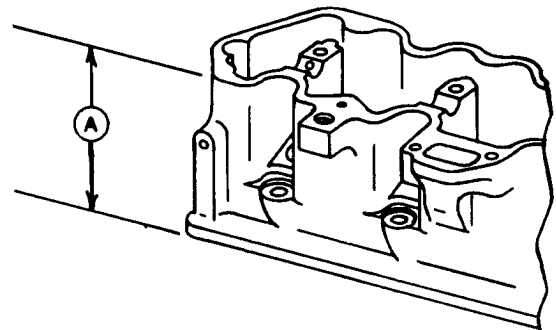
Measure cylinder head thickness (A) from valve cover gasket rail to combustion face.

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

If cylinder head thickness is greater than wear limit, a MAXIMUM of 1.02 mm (0.040 in.) can be ground from new part dimension for a minimum overall thickness of 165.53 mm (6.517 in.).

CYLINDER HEAD SPECIFICATIONS

New Part Thickness 166.55—166.80 mm
(6.557—6.567 in.)
Minimum Acceptable 165.53 mm (6.517 in.)



RG6036 -UN-17JAN92

S11,2005,EC -19-25JAN96

RESURFACE CYLINDER HEAD

NOTE: If necessary to resurface cylinder head, a **MAXIMUM** of 1.02 mm (0.040 in.) can be ground from minimum new part dimension. Remove **ONLY** what is necessary to restore flatness.

IMPORTANT: After resurfacing, check flatness (see **CHECK CYLINDER HEAD COMBUSTION FACE FLATNESS** in this group), and check surface finish on combustion face of head.

Check valve height after grinding. (See CHECK VALVE HEIGHT earlier in this group.) Valve seat or valve face may be ground to bring within specifications.

CYLINDER HEAD SPECIFICATIONS

Combustion Face Surface Finish (Surface Grind Only) (AA)	0.0015—0.0028 mm (60—110 micro-in.)
Minimum Overall Thickness of Cylinder Head	165.53 mm (6.517 in.)

S11,2005,EC1 -19-25JAN96

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.



R26140N -UN-09FEB90

S11,0401,X -19-14JUN95

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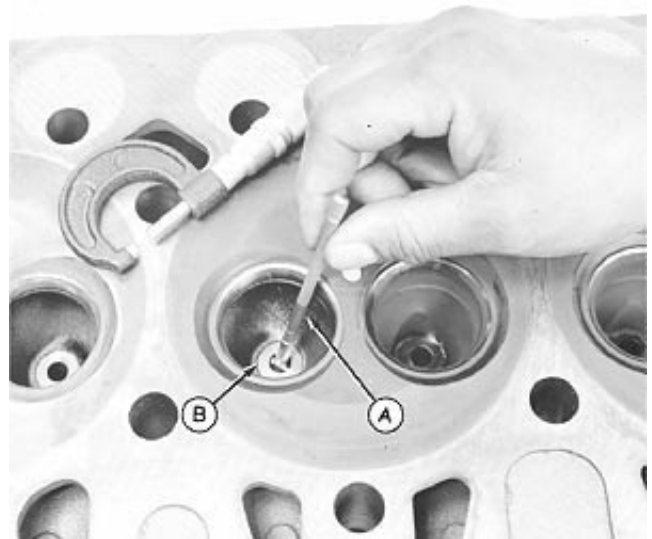
MEASURE VALVE GUIDES

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

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

VALVE GUIDE SPECIFICATIONS

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



-UN-17JAN92

RG6052

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S11,2505,Q -19-14JUN95

KNURL VALVE GUIDES

NOTE: Worn guides can be knurled if they do not allow more than 0.25 mm (0.010 in.) clearance.

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

1. Use No. JTO5949 Knurling Tool Set to knurl valve guides.

2. After knurling, ream valve guide to provide a 0.038—0.089 mm (0.0015—0.0035 in.) valve stem-to-guide clearance.

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



-UN-09DEC88

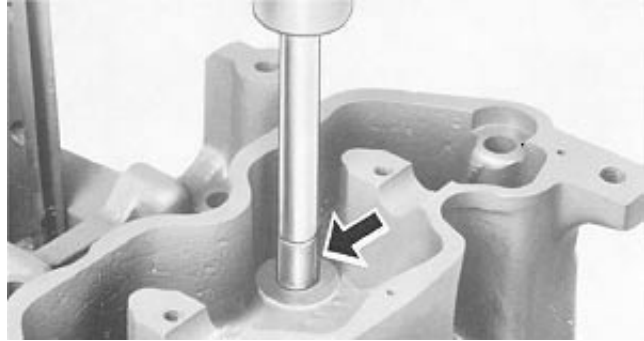
R26141

S11,2505,R -19-14JUN95

REPLACE VALVE GUIDES

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

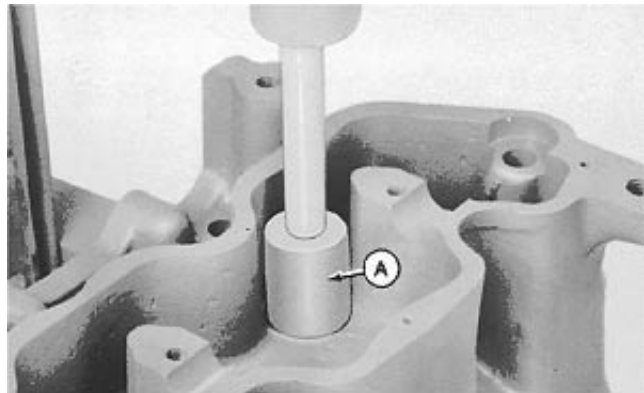
1. Guides allowing more than 0.25 mm (0.010 in.) clearance should be replaced. Remove valve guide (arrow) with a press and driver.



S11,2505,S -19-14JUN95

R24565 -UN-09FEB90

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



S11,2505,T -19-14JUN89

R24566 -UN-09FEB90

CLEAN AND INSPECT VALVE SEATS

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



S11,0401,AA -19-14JUN95

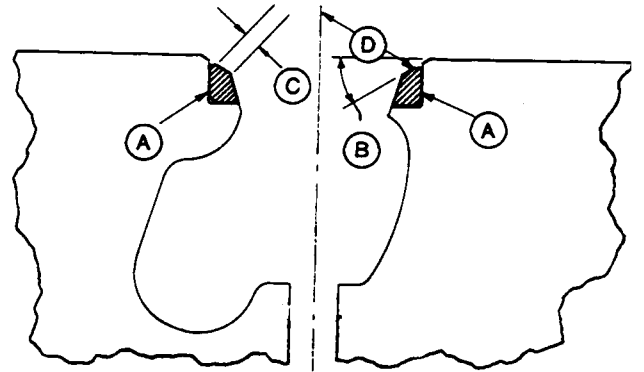
R26142N -UN-09DEC88

MEASURE VALVE SEATS

1. Measure valve seats for proper specifications.
2. If valve seats are not within specifications, recondition valve seats by grinding. (See GRIND VALVE SEATS in this group.) Replace valve seats if reconditioning is not possible.

VALVE SEAT SPECIFICATIONS

A—Valve Seat Insert	
B—Valve Seat Angle:	
Intake	20°
Exhaust (—010696)	45°
(010697—)	30°
C—Valve Seat Width	2.77—3.20 mm (0.109—0.126 in.)
D—Valve Seat Runout (Maximum)	0.05 mm (0.002 in.)



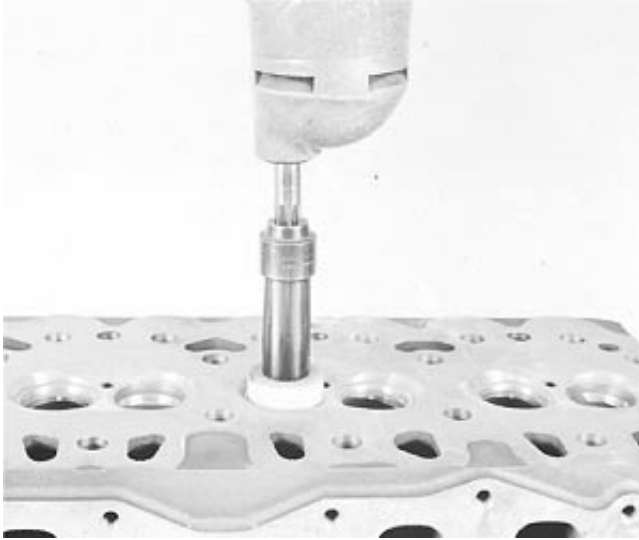
R26126N

R26126N -JUN-11APR89

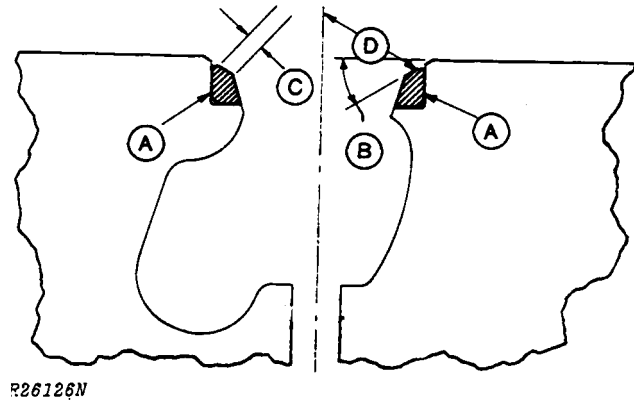
S11,2505,CH -19-14JUN95

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27

GRIND VALVE SEATS



-JUN-20APR92
RG6257



-JUN-11APR89
R26126N

A—Valve Seat Insert

B—Valve Seat Angle

C—Valve Seat Width

D—Maximum Valve Seat Runout

IMPORTANT: Valve seat grinding should only be done by experienced personnel familiar with equipment. A 120-grit stone **MUST** be used for grinding both intake and exhaust valve seat inserts.

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

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

5. ALWAYS measure valve seat runout after grinding, using D11010KW Eccentrimeter.

2. Only a few seconds are required to recondition the average valve seat. Avoid the tendency to grind off too much.

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

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

4. 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.

VALVE SEAT SPECIFICATIONS

A—Valve Seat Insert	
B—Valve Seat Angle:	
Intake	20°
Exhaust (—010696)	45°
(010697—)	30°
C—Valve Seat Width	2.77—3.20 mm
	(0.109—0.126 in.)
D—Valve Seat Runout	
(Maximum)	0.05 mm (0.002 in.)

IMPORTANT: Blend or radius all sharp edges after grinding valve seats. Measure valve height after grinding. (See MEASURE VALVE HEIGHT in this group.)

REMOVE VALVE SEAT INSERTS

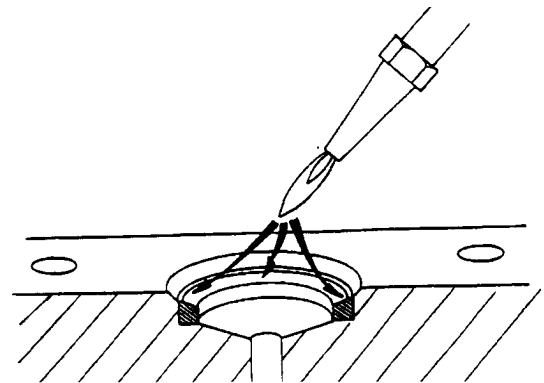
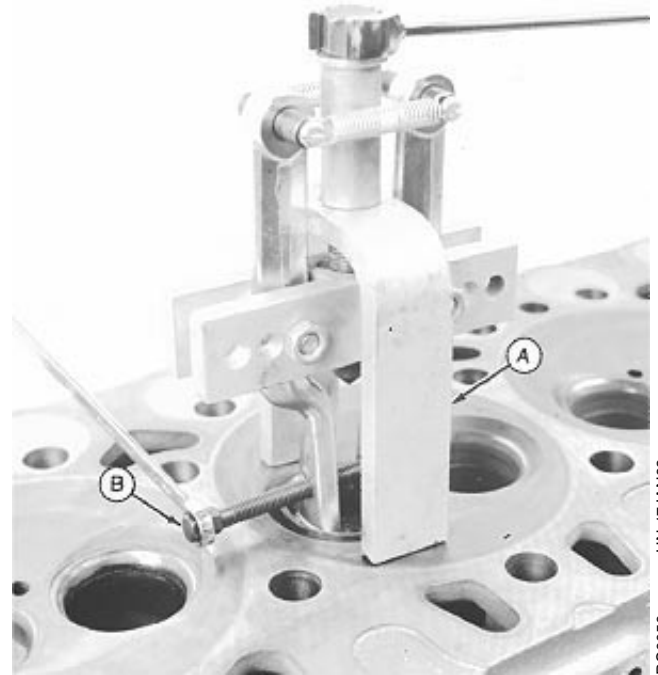
IMPORTANT: Be careful not to damage cylinder head when removing valve seats.

Valve seat inserts may be removed using one of the following methods:

- Use JDE41296 Valve Seat Puller (A). Adjusting screw (B) may need to be retightened during removal of inserts.
- Using an arc welder, weld two or three short beads equidistant from each other around the face of the valve seat insert. Allow seat to cool and carefully pry out the insert(s) with a screwdriver.

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

After removal of inserts, thoroughly clean area around valve seat bore and inspect for damage or cracks. Measure bore ID. (See MEASURE VALVE SEAT BORES IN CYLINDER HEAD in this group.)



RG,CTM9,G5,31 -19-14JUN95

RG6056 -JUN-17JAN92

RG6055 -JUN-17JAN90

RG6055

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MEASURE VALVE SEAT BORES IN CYLINDER HEAD

1. Measure valve seat bores in cylinder head and compare with specifications given below.

VALVE SEAT INSERT SPECIFICATIONS

Standard Valve Seat Inserts:

Valve Seat Bore in Head	
Intake	53.37—53.47 mm (2.101—2.105 in.)
Exhaust	49.65—49.75 mm (1.955—1.959 in.)
Valve Seat OD	
Intake	54.241—54.267 mm (2.1355—2.1365 in.)
Exhaust	50.546—50.571 mm (1.9900—1.9910 in.)

Oversize Valve Seat Inserts:

Available Size	0.25 mm (0.010 in.)
Valve Seat Bore in Head	
Intake	53.62—53.72 mm (2.1110—2.1150 in.)
Exhaust	49.91—50.01 mm (1.9650—1.9690 in.)
Valve Seat OD	
Intake	54.496—54.521 mm (2.1455—2.1465 in.)
Exhaust	50.800—50.826 mm (2.0000—2.0010 in.)

Valve Seat Insert

Counterbore Depth in Head:	
Intake	9.91 mm (0.390 in.)
Exhaust	10.95 mm (0.431 in.)

2. If valve seat bores are not within the new part specification limits for standard valve seat inserts, have a qualified machine shop machine the valve seat bores to specifications given and install oversize valve seat inserts. (See **INSTALL VALVE SEAT INSERTS—STANDARD OR OVERSIZE**, later in this group.)

3. If valve seat bores are not within specification limits for oversize valve seat inserts, replace cylinder head.

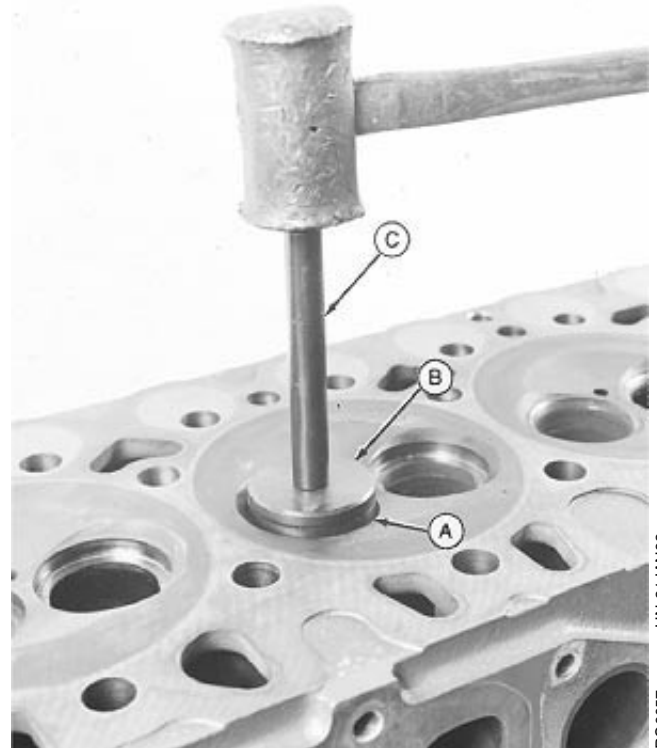
RG,CTM9,G5,72 -19-25JAN96

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30

INSTALL VALVE SEAT INSERTS (STANDARD OR OVERSIZE)

NOTE: If the valve seat insert bore is damaged, it will require machining. In this case, oversize inserts are available in 0.25 mm (0.010 in.) oversize only. Machine seat inside bore to 53.62 to 53.72 mm (2.1110 to 2.1150 in.) for intake valves and 49.91 to 50.01 mm (1.9650 to 1.9690 in.) for exhaust valves.

1. Use JDE73 (intake valve seats) and JDE72 (exhaust valve seats) replacement rings (B) to install new valve seat inserts (A). Chill inserts and replacement rings to -29°C (-20°F) in dry ice before installing.
2. Use JDE7-1 Driver (C) and replacement rings to drive inserts into place.
3. Grind valve seats. (See GRIND VALVE SEATS in this group.)



RG,CTM9,A1 -19-14JUN95

-UN-21JAN92
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31
RG6057

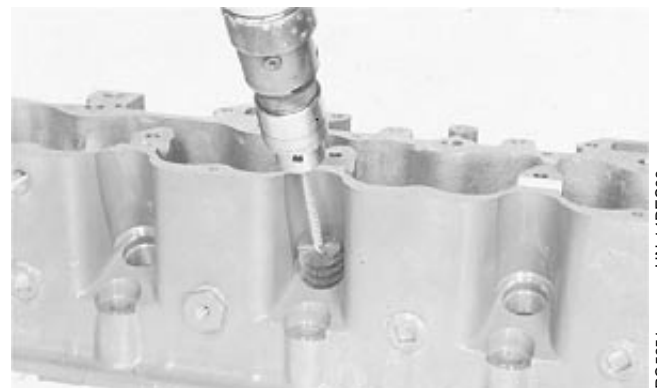
CLEAN AND INSPECT CYLINDER HEAD NOZZLE BORE

1. Inspect condition of threads for gland nut. Threads are metric (M28 x 1.5).
2. Inspect condition of nozzle seating surface in cylinder head.

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

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

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



S11,2005,NS -19-14JUN95

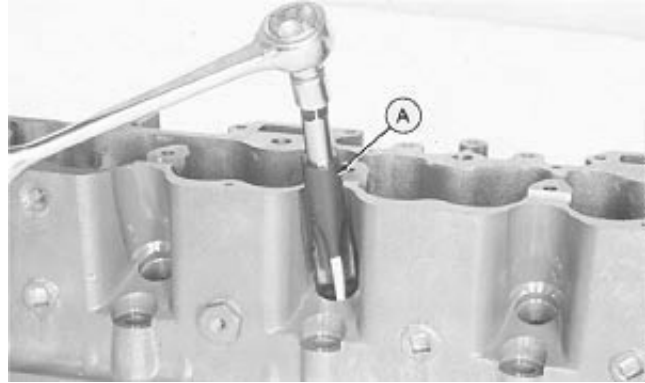
-UN-14DEC88
RG5251

Cylinder Head And Valves/Clean and Inspect Nozzle Seating Surface

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

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

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



RG5252 -UN-06DEC88

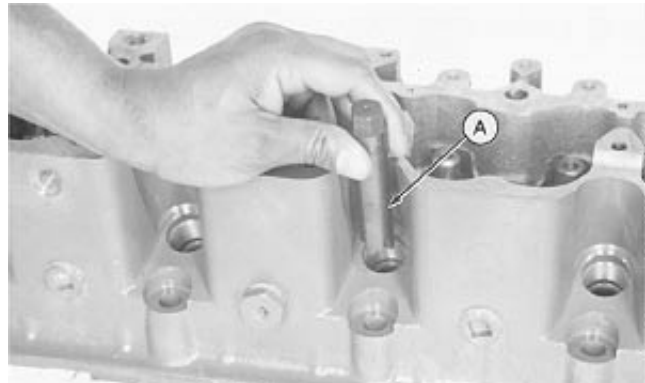
S11,2005,NT -19-14JUN95

CLEAN AND INSPECT NOZZLE SEATING SURFACE

1. Inspect nozzle seating surface for carbon deposits.

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

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



RG5253 -UN-06DEC88

S55,2505,P -19-14JUN95

CLEAN AND INSPECT TOP DECK OF CYLINDER BLOCK

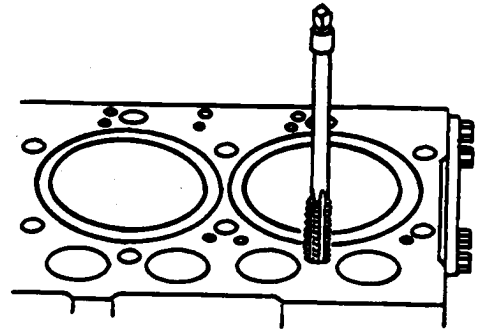
1. Clean rust, scale, and gasket material from top deck of block. Make sure that all old gasket material, carbon, and rust are removed.

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

2. Using a 5/8-11 in. tap about 127 mm (5 in.) long, clean all 26 cylinder head cap screw threads in block. Use compressed air to remove debris and any fluids which may be present in the cap screw hole.

3. Replace block if there is evidence of physical damage.

4. Measure cylinder liner standout. (See MEASURE CYLINDER LINER STANDOUT in Group 10.)



RG4718 -UN-13DEC88

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S11,2505,CD -19-25JAN96

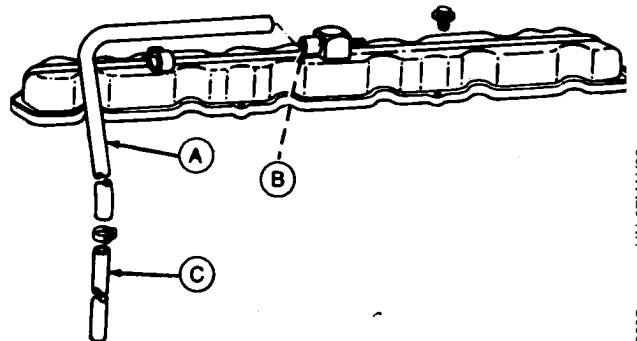
CLEAN AND INSPECT CRANKCASE VENTILATION ASSEMBLY

•Engine Serial No. (—050465)

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

2. Clean ventilator hose and tube (C) if restricted.

3. Check condition of O-ring (B) in rocker arm cover. If any damage or deterioration is noted, replace O-ring.



RG3805 -UN-07MAY92

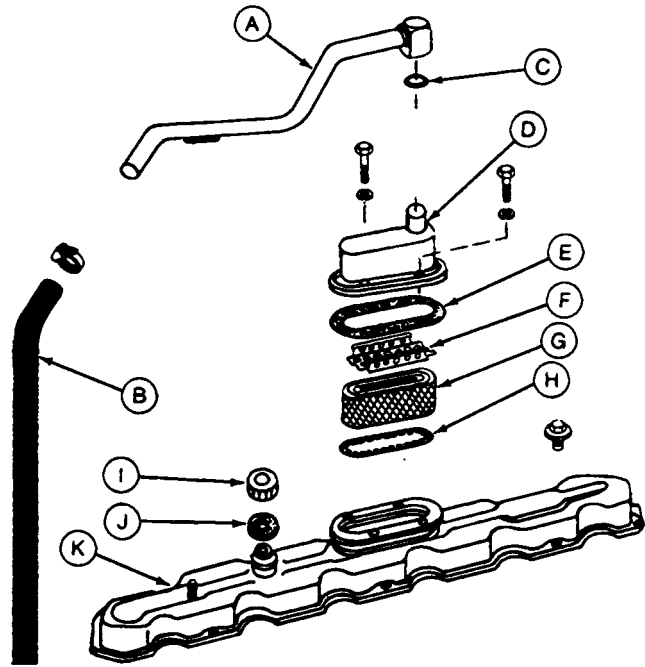
S11,2505,CE -19-25JAN96

•Engine Serial No. (050466—)

1. Remove outlet tubes (A) and (B). Discard O-ring (C).
2. Remove cover (D), gasket (E), deflector (F), filter element (G), and isolator (H). Discard gasket.
3. Remove oil filler cap (I) and discard gasket (J).
4. Inspect components for restrictions or damage. Clean or replace as necessary.
5. Use new gaskets and O-ring when reassembling ventilation assembly.

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

6. Reverse order to assemble ventilation components.



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

S11,2505,CF -19-25JAN96

RG3530 -UN-06APP88

INSPECT AND CLEAN EXHAUST MANIFOLD

1. Remove all residue and gasket material from gasket surfaces.
2. Thoroughly clean passages in exhaust manifold and exhaust elbow.
3. Inspect entire exhaust manifold for cracks or damage and replace parts as necessary.

S11,0401,AJ -19-25JAN96

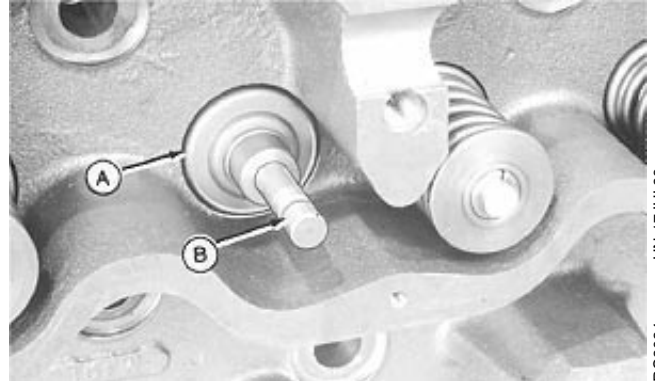
INSTALL VALVE ASSEMBLY

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

NOTE: Valves must move freely and seat properly.

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

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

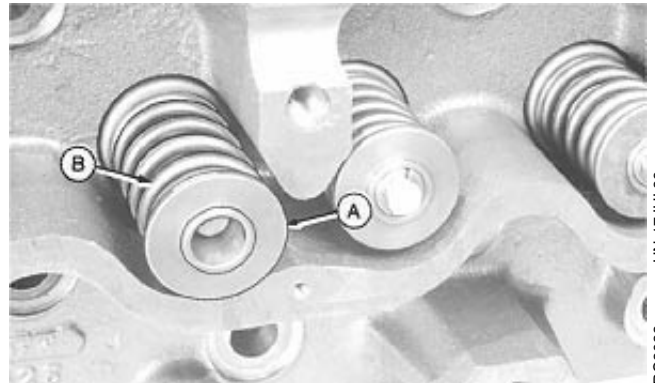


RG3034
-UN-17JUL89

S11,2505,AC -19-14JUN95

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

5. Install spring cap (A).



RG3033
-UN-17JUL89

S11,2505,AD -19-14JUN95

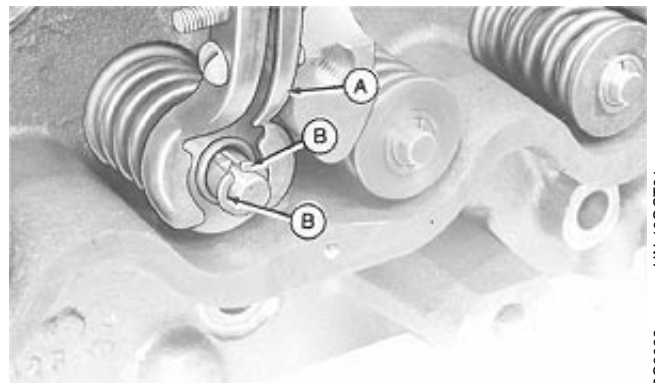
6. Compress valve springs with valve spring compressor (A).

7. Install retaining locks (B).

8. Remove valve spring compressor.

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

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



RG3032
-JUN-16OCT91

S11,2505,AE -19-14JUN95

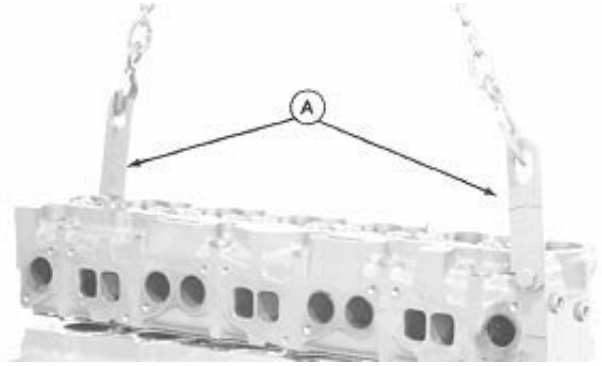
INSTALL CYLINDER HEAD

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

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

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

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



RG3492 -UN-10NOV89

05
36

S11,2505,IN -19-14JUN95

3. Using a wire brush and solvent, clean entire length of cap screw (if reusing) to remove rust and scale. Dry cap screws with compressed air.

4. Inspect cap screws for corrosion damage and condition of threads.

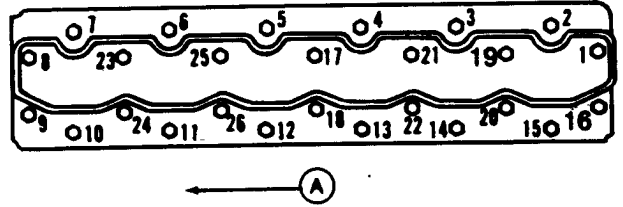
IMPORTANT: ANY CAP SCREW WITH CORROSION OR OTHER IMPERFECTIONS MUST BE REPLACED.

5. Dip all cap screws and washers in clean SAE30 engine oil. Make sure washers are covered with oil.

IMPORTANT: The cap screw at No. 12 location DOES NOT require a washer. If a washer is used at this location, it can interfere with the turbocharger oil return pipe and result in a hole being worn in the pipe.

6. Install washers on cap screws.

7. Install cap screws and washers in proper location.



Arrow (A) points toward front of engine.

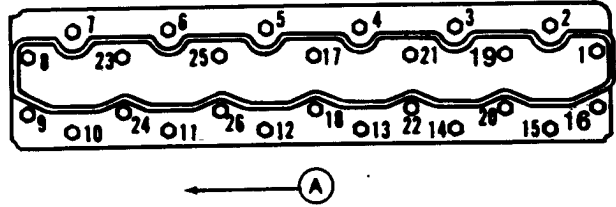
RG5699 -UN-31/AUG90

05
37

ENGINE SERIAL NO.	CAP SCREW LENGTH	LOCATION ON CYLINDER HEAD
(000001—023998).	140 mm (5.50 in.)	2,3,4,5,6,7,9,11,12,14 16,17,18,19,20,21,22,23, 24,25,26
	171 mm (6.75 in.)	10,13,15
	197 mm (7.75 in.)	1,8
(023999—055424).	140 mm (5.50 in.)	2,3,4,5,6,7
	171 mm (6.75 in.)	10,13,15
	197 mm (7.75 in.)	9,11,12,14,16,17,18,19, 20,21,22,23,24,25,26
	248 mm (9.75 in.)	1,8
(055425—060414).	171 mm (6.75 in.)	2,3,4,5,6,7,10,13,15
	197 mm (7.75 in.)	9,11,12,14,16,17,18,19, 20,21,22,23,24,25,26
	248 mm (9.75 in.)	8,1
(060415—)	171 mm (6.75 in.)	2,3,4,5,6,7
	197 mm (7.75 in.)	10,11,12,13,14,15,16,17, 18,19,20,21,22,23,24,25,26
	248 mm (9.75 in.)	1,8,9

TIGHTEN FLANGED-HEAD CYLINDER HEAD CAP SCREWS (WITH FLAT WASHERS)

1. Initially tighten cap screw No. 17 (illustration) to 200 N·m (150 lb-ft). This will prevent the cylinder head from tipping during tightening sequence.
2. Start with cap screw No. 1 and proceed in numerical sequence, tightening all cap screws to 200 N·m (150 lb-ft), including cap screw No. 17.
3. Finally, TORQUE-TURN all flanged-head cap screws in the same sequence an additional 90°—100°. (See TORQUE-TURN FLANGED-HEAD CYLINDER HEAD CAP SCREWS in this group.)

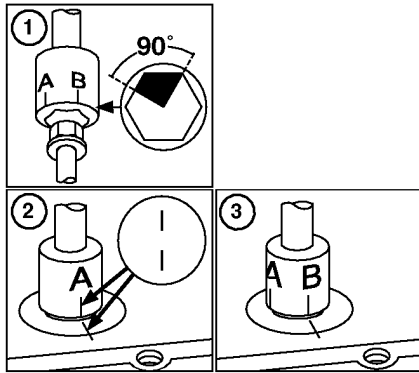


Arrow (A) points toward front of engine.

S11,2505,BT,1 -19-14JUN95

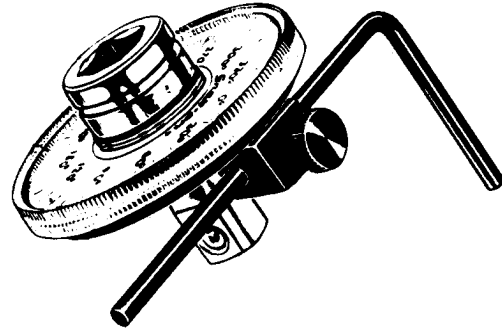
RG5699 -UN-31/AUG90

TORQUE-TURN FLANGED-HEAD CYLINDER HEAD CAP SCREWS



Line Scribe Method

RG7349
-UN-05OCT95



JT05993 Torque Angle Gauge

RG5698
-UN-27AUG90

Refer to illustration in previous module for numerical location of cylinder head cap screws.

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

After tightening cylinder head cap screws (in proper sequence) to 200 N·m (150 lb-ft), follow steps 1—3 below for each cap screw beginning with the No. 1 cap screw and sequentially proceed thru to No. 26.

Step 1— Make a mark on socket (A) and a second mark (B) 90°—100° (1/4 turn) counterclockwise from first mark on socket.

Step 2— Place socket on cap screw and make a reference mark on cylinder head in line with first mark (A) on socket.

Step 3— Tighten cap screw 1/4 turn (90°—100°) until second mark on socket (B) aligns with mark on cylinder head.

• Using JT05993 Torque Angle Gauge:

After tightening cylinder head cap screws (in proper sequence) to 200 N·m (150 lb-ft), 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.

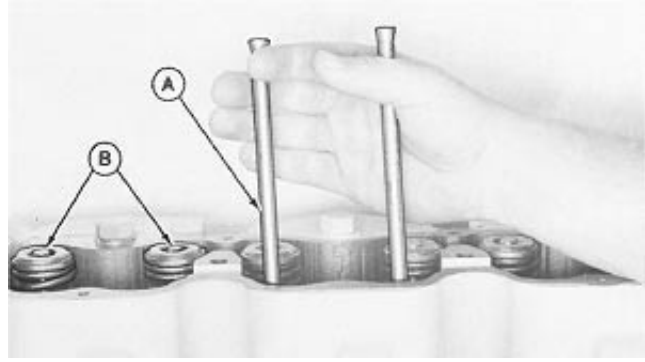
Complete engine final assembly following procedures outlined later in this group.

IMPORTANT: Retorque of cylinder head cap screws after engine run-in is not required when using flanged-head cap screws with washers and the recommended TORQUE-TURN tightening procedure.

RG,CTM61,G5,19 -19-25JAN96

INSTALL PUSH RODS

1. Install push rods (A) in holes from which they were removed.
2. Install wear caps (B) on valves making certain caps rotate freely.

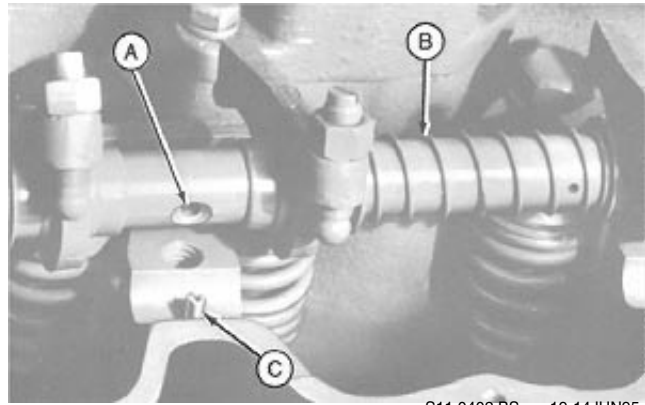


S11,0401,AR -19-14JUN95

RG3809 -UN-23FEB89

INSTALL ROCKER ARM ASSEMBLY

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



S11,0402,BS -19-14JUN95

RG3652 -UN-25SEP89

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

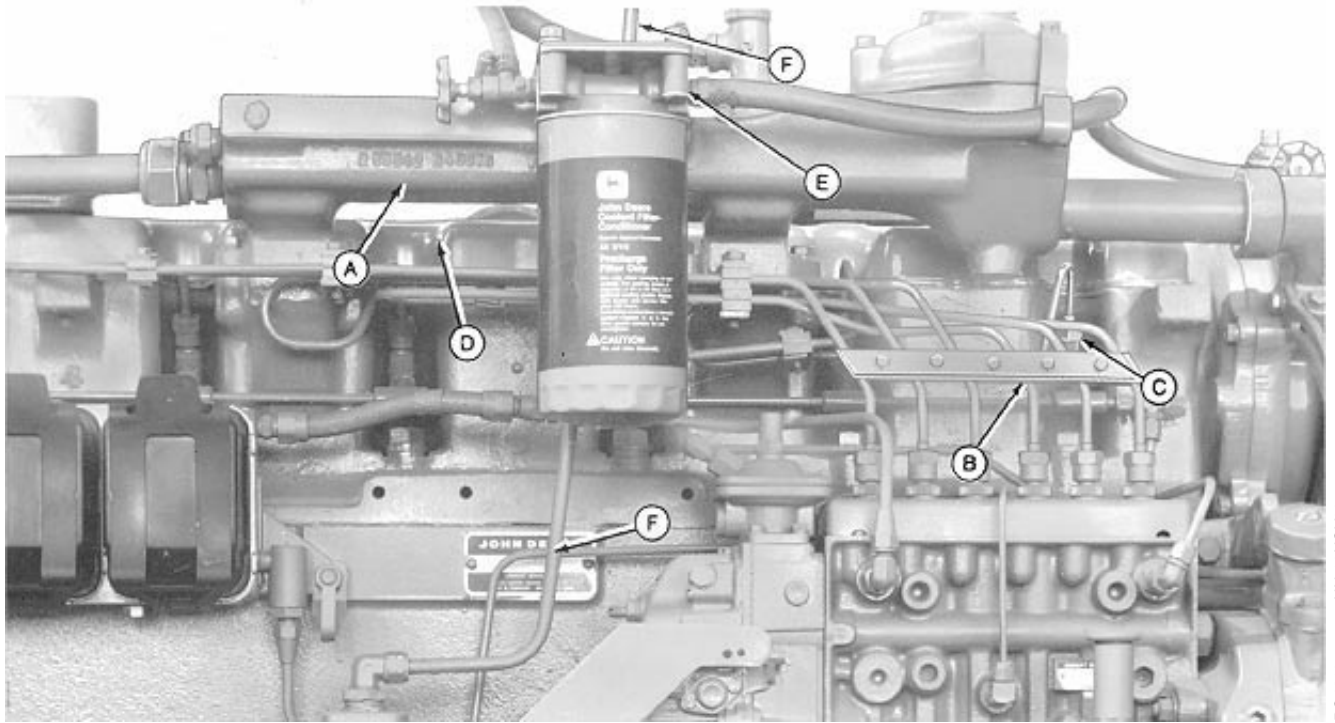


RG4336 -UN-09NOV89

S11,2505,AI -19-03APR86

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COMPLETE FINAL ASSEMBLY ON INJECTION PUMP SIDE



-UN-09NOV/89
05
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RG4318

A—Water Manifold
B—Fuel Injection Lines

C—Fuel Injection Nozzles
D—Rocker Arm Cover

E—Coolant Filter Conditioner
F—Turbocharger Oil Inlet Line

1. Adjust valve clearance. (See ADJUST VALVE CLEARANCE earlier in this group.)

2. Using AR31790 Scotch-Grip® Plastic Adhesive (or equivalent), cement gasket to rocker arm cover. Allow gasket cement to set approximately 10 minutes. Install rocker arm cover (D) and tighten to the following specifications: DO NOT OVERTIGHTEN.

ROCKER ARM COVER SPECIFICATIONS

Cap Screw	Torque
SAE Grade 2 (plain head)	2 N·m (2 lb-ft) (20 lb-in.)
SAE Grade 5 (three slash marks)	11 N·m (8 lb-ft) (96 lb-in.)

3. Install fuel injection nozzles (C) and fuel injection lines (B). (See INSTALL FUEL INJECTION NOZZLES in Group 35.)

4. Install turbocharger oil inlet line (F).

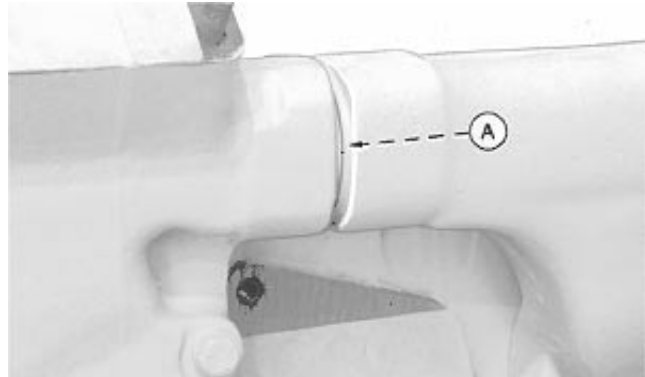
NOTE: Water manifold mounted coolant conditioner shown.

5. Install water manifold (A), coolant filter conditioner (E), if equipped, and piping. (See INSTALL WATER MANIFOLD in Group 25.)

COMPLETE FINAL ASSEMBLY ON EXHAUST MANIFOLD SIDE—6619A ENGINES

NOTE: Be sure turbocharger oil return pipe is in place before installing exhaust manifold.

1. Install a new sealing ring (A) in groove on front end of rear exhaust manifold sections.

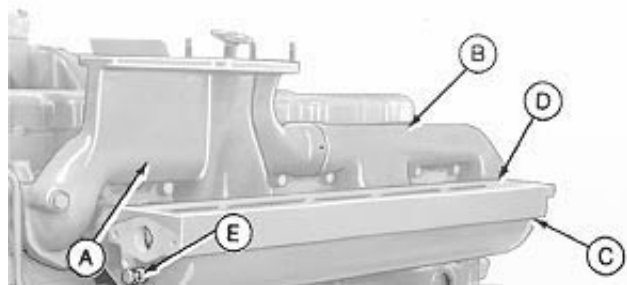


S11,2505,CJ -19-25JAN96

RG4298 -UN-23FEB89

NOTE: Guide studs may be used to aid in installation of exhaust and intake manifolds.

2. Apply PT569 NEVER-SEEZE Lubricant or its equivalent to all exhaust manifold cap screws.
3. Install front exhaust manifold (A) using new gaskets. Do not tighten cap screws.
4. Install rear exhaust manifold (B) using new gaskets. Sealing ring should be in place at this time.
5. Tighten exhaust manifold-to-cylinder head cap screws to 75 N-m (55 lb-ft).
6. Install intake manifold (C) using new gaskets and tighten cap screws to 75 N-m (55 lb-ft).
7. Install new aftercooler gasket (D) onto intake manifold.
8. Install intake manifold-to-aneroid pipe (E). Tighten connection securely.



- A—Front Exhaust Manifold
- B—Rear Exhaust Manifold
- C—Intake Manifold
- D—Aftercooler Gasket
- E—Intake Manifold-to-Aneroid Pipe

S11,2505,CK1 -19-25JAN96

RG4319 -UN-09NOV89

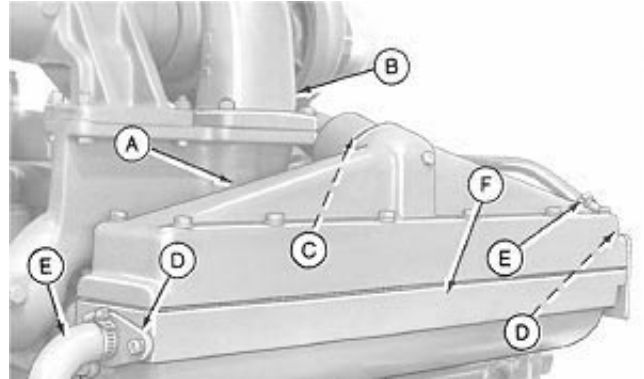
05
42

NOTE: Guide studs may be used to assure proper alignment of aftercooler, intake manifold, cover and two gaskets.

9. Place new gaskets onto aftercooler, then install aftercooler into intake manifold (F).
10. Install aftercooler cover (A) and tighten cap screws to 47 N·m (35 lb-ft).
11. Install O-rings in inlet and outlet tubes on aftercooler.
12. Install adapter plates (D). Tighten cap screws to 27 N·m (20 lb-ft).
13. Install inlet and outlet hoses (E). Tighten hose clamps securely.

NOTE: Make sure O-rings on coupling (C) between compressor cover and aftercooler cover are not twisted when turbocharger is installed. A light coating of liquid soap and water on coupling O-rings will aid in turbocharger installation.

14. Install turbocharger (B) and heat shield. (See INSTALL TURBOCHARGER—6619A ENGINES in Group 30.)
15. Complete final assembly and perform engine break-in. (See PERFORM ENGINE BREAK-IN later in this group.)



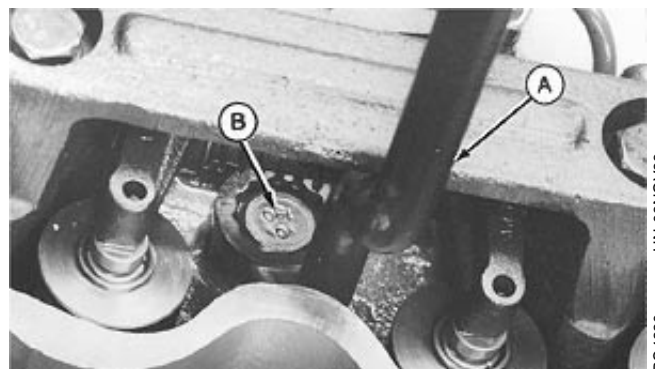
A—Intake Manifold Cover
 B—Turbocharger
 C—Coupling
 D—Adapter Plates (2 used)
 E—Hoses (2 used)
 F—Intake Manifold

RG3531 -JUN-31JUL89

05
43

S11,2505,BK -19-25JAN96

NOTE: If necessary to retorque cylinder head cap screws after rocker arm assembly has been installed, use JDE141 Torque Wrench Adapter (A) to properly tighten cap screws (B) located under the rocker arm shaft clamps.



RG4320 -JUN-09NOV89

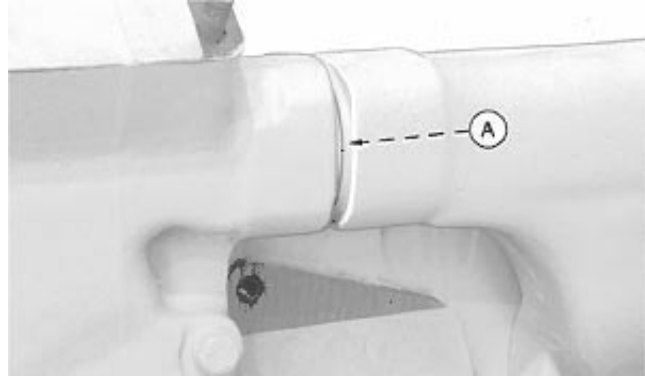
S11,2505,DF -19-25JAN96

COMPLETE FINAL ASSEMBLY ON EXHAUST MANIFOLD SIDE—6619T ENGINES

NOTE: Be sure turbocharger oil return pipe is in place before installing exhaust manifold.

1. Install a new sealing ring (A) in groove on front end of rear exhaust manifold section.

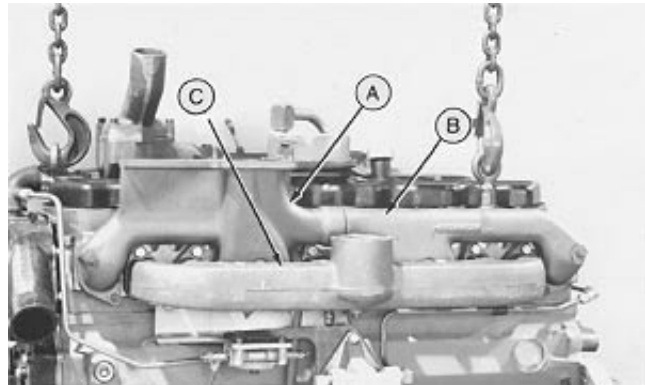
NOTE: Guide studs may be used to aid in installation of exhaust and intake manifolds.



RG4298 -UN-23FEB89

S11,2505,CL -19-25JAN96

2. Apply JDT364 NEVER-SEEZ Lubricant or its equivalent to all exhaust manifold cap screws.
3. Install front exhaust manifold (A) using new gaskets. Do not tighten cap screws.
4. Install rear exhaust manifold (B) using new gaskets. Sealing ring should be in place at this time.
5. Tighten exhaust manifold-to-cylinder head cap screws to 75 N·m (55 lb-ft).
6. Install intake manifold (C) using new gaskets and tighten cap screws to 75 N·m (55 lb-ft).



RG4921 -UN-19JAN90

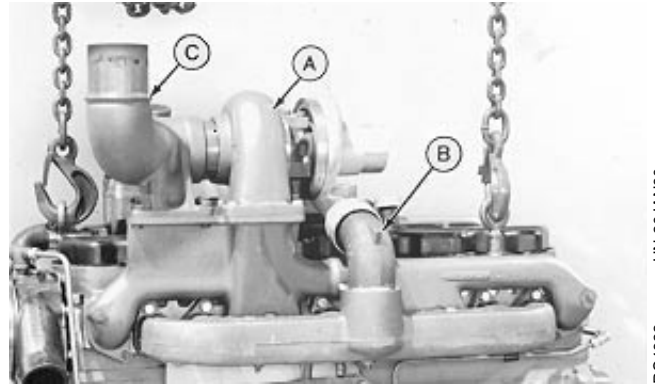
S11,2505,CM11 -19-25JAN96

NOTE: Make sure O-rings on coupling between compressor cover and intake manifold are not twisted when turbocharger is installed. A light coating of liquid soap and water on coupling O-rings will aid in turbocharger installation.

7. Install turbocharger (A) and coupling (B). Install turbocharger heat shield. (See **INSTALL TURBOCHARGER—6619T ENGINES** in Group 30.)

8. Install exhaust elbow (C).

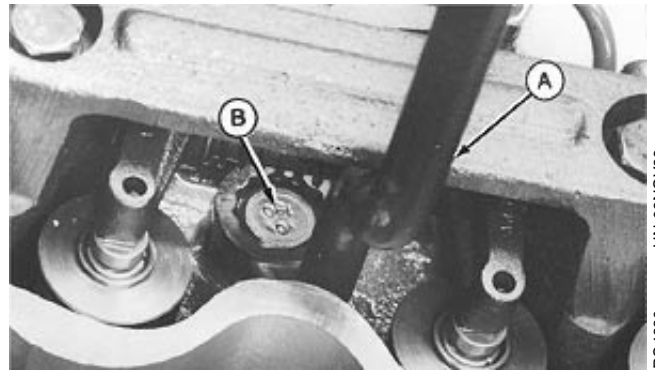
9. Complete final assembly and perform engine break-in. (See **PERFORM ENGINE BREAK-IN** later in this group.)



RG4922 -UN-26JAN90

S11,2505,CN -19-25JAN96

NOTE: If necessary to retorque cylinder head cap screws after rocker arm assembly has been installed, use JDE141 Torque Wrench Adapter (A) to properly tighten cap screws (B) located under the rocker arm shaft clamps.



RG4320 -UN-09NOV89

S11,2505,DF -19-25JAN96

PERFORM ENGINE BREAK-IN

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

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

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

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

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

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

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

RG,CTM20,G05.5 -19-25JAN96

Group 10 Cylinder Block, Liners, Pistons and Rods

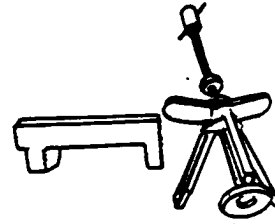
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

Cylinder Liner Puller D01062AA
(or D01073AA)

Remove cylinder liners.



S53,D01062,AA -19-07AUG91

RG5019 -UN-23AUG88

Magnetic Follower Holder Kit D15001NU

Hold cam followers when removing or installing camshaft.



S53,D15001,NU -19-24APR92

RG5073 -UN-23AUG88

Flexible Cylinder Hone D17006BR

Deglaze cylinder liners.

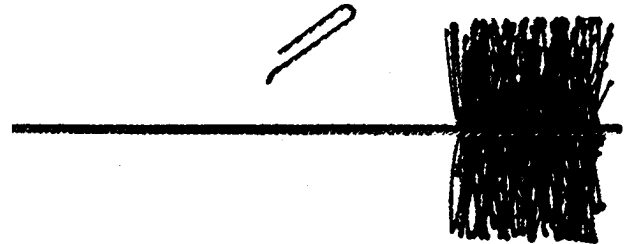


S53,D17006,BR -19-25JAN96

RG5074 -UN-23AUG88

O-Ring Groove Cleaning Brush D17015BR

Clean cylinder liner O-ring groove in block.

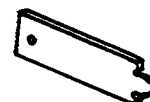


S53,D17015,BR -19-25MAR91

RG5075 -UN-23AUG88

Ring Groove Wear Gauge JDE55

Check wear of keystone ring groove on pistons.



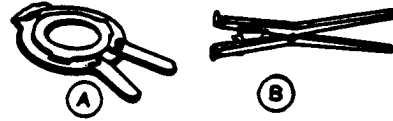
S53,JDE55 -19-25MAR91

RG5076 -UN-23AUG88

Cylinder Block, Liners, Pistons and Rods/Essential tools

Piston Ring Expander A—JDE94
 B—JDE135

RG6244 -UN-23MAR92



Remove and install piston rings.

S55,JDE94 -19-27APR92

Piston Ring Compressor JDE97

RG5031 -UN-23AUG88



Compress rings while installing pistons.

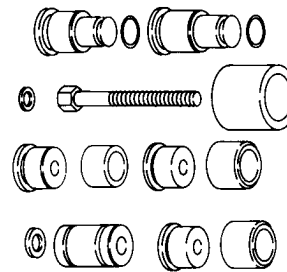
S53,JDE97 -19-14JUN89

Connecting Rod Bushing Service Set JDE98A

Remove and install connecting rod bushings.

Set consists of:

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



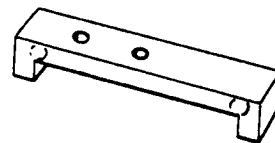
-UN-16FEB94
RG5078

S53,JDE98A -19-16AUG94

Piston and Liner Height Gauge JDG451

Measure piston and liner heights.

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



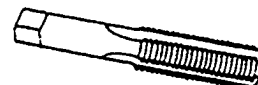
-UN-30SEP94
RG7029

RG,JDG451 -19-28SEP94

Tap JDG682

RG5100 -UN-23AUG88

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



S55,JDG682 -19-24APR92

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.

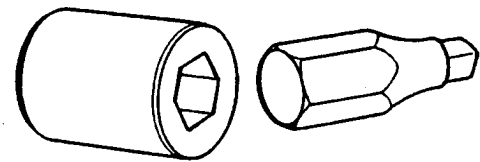


RG,D17526CI -19-29OCT92

-UN-27MAR92
RG6246

Oil Galley Plug Tool JDG782

Used to remove and install oil galley plug.



RG,JDG782 -19-02APR93

-UN-25JAN93
RG6612

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3

SERVICE EQUIPMENT AND TOOLS

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

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

RG,CTM61,G10,6 -19-25JAN96

OTHER MATERIAL

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

PLASTIGAGE is a trademark of the TRW Company.

S11,2010,BS -19-25JAN96

CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS

Item	New Part Specification	Wear Tolerance
Cylinder Block Out-of-Flat (Max)		0.10 mm (0.004 in.)
Liner Standout (Height Above Block)	0.025—0.102 mm (0.0010—0.0040 in.)	—
Liner Counterbore Depth	9.46—9.51 mm (0.3725—0.3745 in.)	—
Max. Height of Piston Above Block	0.254 mm (0.010 in.)	—
Piston Oil Control Ring Clearance	0.061—0.102 mm (0.0024—0.0040 in.)	0.165 mm (0.0065 in.)
Piston OD at 49.53 mm (1.95 in.)		
From Bottom:		
L	130.022—130.035 mm (5.1190—5.1195 in.)	—
M	130.035—130.048 mm (5.1195—5.1200 in.)	—
H	130.048—130.060 mm (5.1200—5.1205 in.)	—
P	130.033—130.043 mm (5.1194—5.1198 in.)	—
Q	130.043—130.053 mm (5.1198—5.1202 in.)	—
R	130.053—130.063 mm (5.1202—5.1206 in.)	—
S	130.063—130.073 mm (5.1206—5.1210 in.)	—
Cylinder liner ID at 75 mm (2.95 in.)		
From Top (Average of Two Measurements):		
LL or L2	130.162—130.175 mm (5.1245—5.1251 in.)	—
MM or M2	130.175—130.193 mm (5.1251—5.1257 in.)	—
HH or H2	130.193—130.205 mm (5.1257—5.1263 in.)	—
H3	130.183—130.190 mm (5.1253—5.1256 in.)	—
P	130.165—130.175 mm (5.1246—5.1250 in.)	—
Q	130.175—130.185 mm (5.1250—5.1254 in.)	—
R	130.185—130.195 mm (5.1254—5.1258 in.)	—
S	130.195—130.205 mm (5.1258—5.1262 in.)	—
Piston-to-Liner Clearance:		
L—LL/L2	0.127—0.155 mm (0.0050—0.0061 in.)	—
M—MM/M2	0.130—0.157 mm (0.0051—0.0062 in.)	—
H—HH/H2	0.132—0.160 mm (0.0052—0.0063 in.)	—
H—H3, P—P, Q—Q, R—R, S—S	0.122—0.142 mm (0.0048—0.0056 in.)	—
Cylinder Liner Thickness	7.26—7.42 mm (0.286—0.292 in.)	—
Packing Step Dimension	2.13—2.29 mm (0.084—0.090 in.)	—
Lower Bore For Seating Liners	140.465—140.515 mm (5.530—5.532 in.)	—
Upper Bore For Seating Liners	145.845—145.895 mm (5.742—5.744 in.)	—
Outer Dia. of Liner at Upper Bore	145.795—145.845 mm (5.740—5.742 in.)	—
Outer Dia. of Liner at Lower Bore	140.398—140.448 mm (5.527—5.529 in.)	—

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

Item	New Part Specification	Wear Tolerance
Liner-to-Block Clearance at Lower Bore	0.014—0.114 mm (0.0005—0.0045 in.)	—
Liner-to-Block Clearance at Upper Bore	0.00—0.10 mm (0.000—0.004 in.)	—
Centerline of Main Bearing Bore-to-		
Top Deck of Cylinder Block	374.57—374.73 mm (14.747—14.753 in.)	—
Liner Counterbore Depth	9.46—9.51 mm (0.3725—0.3745 in.)	—
Cylinder Liner Out-of-Round (Max.)	0.05 mm (0.002 in.)	—
Cylinder Liner Wear or Taper	0.038 mm (0.0015 in.)	—
Cylinder Liner Taper in Ring		
Travel Area (Max.)	0.038 mm (0.0015 in.)	—
Liner Flange Thickness	9.538—9.563 mm (0.3755—0.3765 in.)	—
Liner Shim Thickness:		
R81276	0.05 mm (0.002 in.)	—
R81277	0.10 mm (0.004 in.)	—
Shim Thickness Per Cylinder (Max.)	0.10 mm (0.004 in.)	—
Centerline of Piston Pin Bore-to-		
Crankshaft Bore	222.55—228.65 mm (8.998—9.002 in.)	—
Piston Pin OD	50.772—50.787 mm (1.9989—1.9995 in.)	—
Piston Pin Bore ID in Piston	50.793—50.801 mm (1.9997—2.0000 in.)	—
Connecting Rod Pin Bore ID		
Without Bushing	55.529—55.555 mm (2.1862—2.1872 in.)	—
Connecting Rod Pin Bushing ID:		
Before Boring	50.729—50.781 mm (1.9972—1.9992 in.)	—
After Boring	50.805—50.830 mm (2.0002—2.0012 in.)	—
Connecting Rod Pin-to-Bushing		
Oil Clearance	0.017—0.059 mm (0.0007—0.0023 in.)	0.076 mm (0.0030 in.)
Connecting Rod Bearing		
Assembled ID	88.93—88.98 mm (3.501—3.503 in.)	—
Connecting Rod		
Bearing Bore ID	93.76—93.79 mm (3.6915—3.6925 in.)	—
Crankshaft Connecting Rod		
Journal OD	88.844—88.874 mm (3.498—3.499 in.)	—
Connecting Rod Bearing-to-		
Crankshaft Journal Clearance	0.06—0.13 mm (0.002—0.005 in.)	0.15 mm (0.006 in.)
Connecting Rod Pin Bore Out-of-Round	0.038 mm (0.0015 in.)	—
Connecting Rod Pin Bushing Bore	55.529—55.555 mm (2.1862—2.1872 in.)	—
Press Fit of Bushing in		
Connecting Rod Pin Bore	0.100—0.163 mm (0.0039—0.0064 in.)	—
Main Bearing Bore ID Without Bearings	101.651—101.677 mm (4.0020—4.0030 in.)	—
Cylinder Block Main Thrust Bearing		
Cap Width	34.52—34.62 mm (1.359—1.363 in.)	—
Cam Follower Bore ID	34.976—35.027 mm (1.3770—1.3790 in.)	—
Cam Follower OD	34.874—34.900 mm (1.3730—1.3740 in.)	—
Camshaft Bore ID in Block		
Without Bushings	69.987—70.013 mm (2.7554—2.7564 in.)	—
With Bushings	67.076—67.102 mm (2.6408—2.6418 in.)	—

**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°

Piston Cooling Orifices 11 N·m (8 lb-ft) (97 lb-in.)

Cylinder Liner Cap Screws

(For Checking Liner Standout) 68 N·m (50 lb-ft)

Tachometer Drive Housing

or Cover Plate 47 N·m (35 lb-ft)

Oil Galley Plugs 20 N·m (15 lb-ft)

S11,2510,AW1 -19-25JAN96

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.

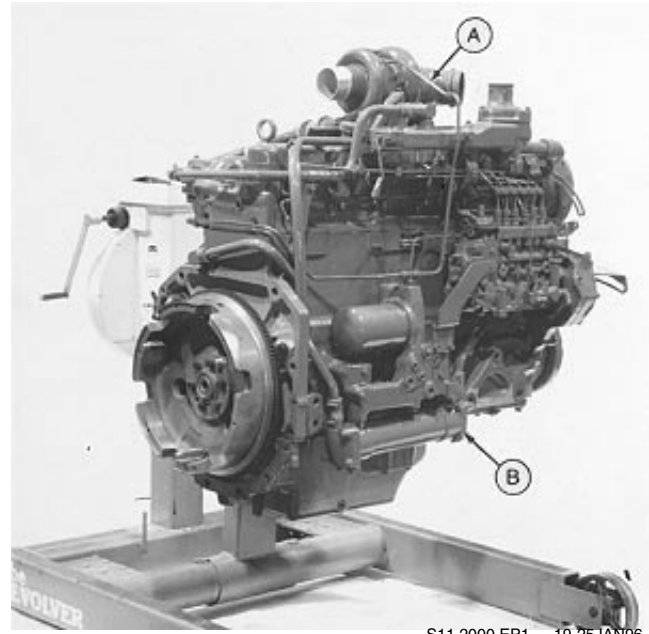
• Piston Pin and Snap Ring Failure:

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

• Mottled, Grayish or Pitted Compression Rings:

Internal coolant leaks.

IMPORTANT: When servicing a 6619 engine on a rollover stand, disconnect the turbocharger oil inlet line (A) from the oil pressure regulating housing before inverting the engine. Also, drain oil from engine oil cooler (B). Failure to do so may cause hydraulic lock upon starting the engine. Hydraulic lock can cause possible engine failure.



S11,2000,EP1 -19-25JAN96

RG4933 -UN-26JAN90

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.

1. Drain all coolant and engine oil.

NOTE: If engine is to be completely disassembled, follow disassembly sequence in Group 04.

2. Remove cylinder head. (See REMOVE CYLINDER HEAD in Group 05.)
3. Remove oil pan and oil pump. (See REMOVE OIL PUMP in Group 20.)
4. Remove crankshaft (if desired). (See REMOVE CRANKSHAFT in Group 15.)



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

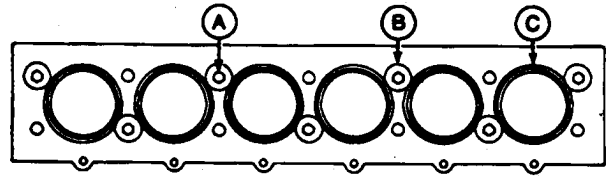
S11,2510,AJ -19-25JAN96

RG3657 -UN-13DEC88

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 stand-out (height above block), later in this group.



-UN-07DEC88

RG3819

S11,2010,EV -19-07AUG91

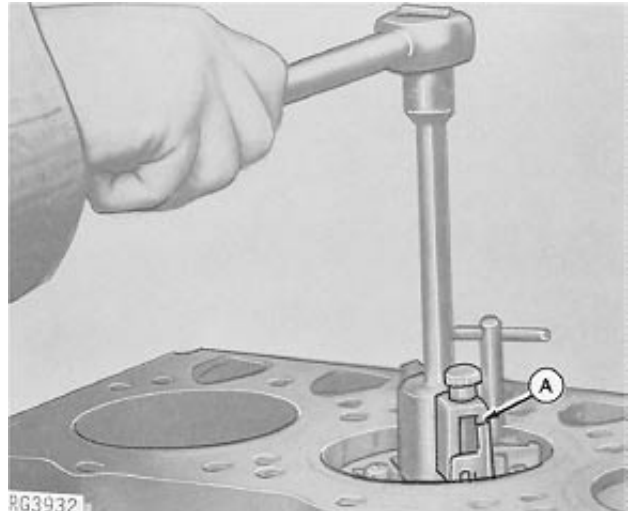
6. Remove carbon or ridge from liner bore with a scraper or ridge reamer (A) before removing pistons. Use compressed air to remove loose material from cylinders.

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.

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

If any one of the above conditions is found, replace piston and liner as a set.



RG3932

-UN-07DEC88

RG3932

RG,CTM61,G10,28-19-16JUN95

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).

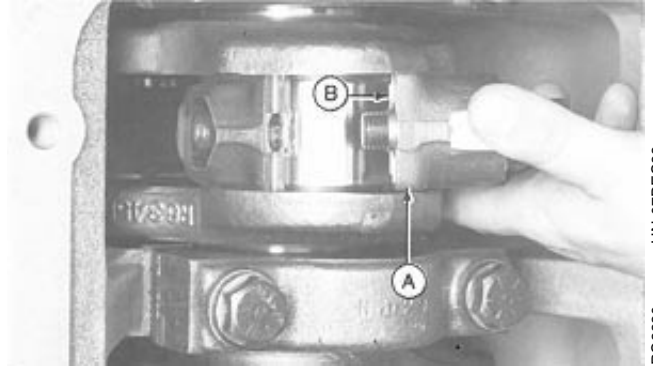
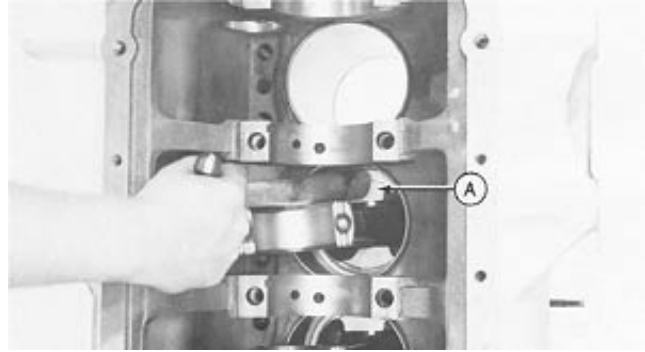


FIG3820 -JUN-07DEC88

S11,0402,F -19-08AUG94

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

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



RG3821 -UN-07DEC88

8. Mark piston and liner as a set.

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

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

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S11,0402,G -19-16JUN95

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

NOTE: Discard snap rings; DO NOT reuse.



RG3171 -UN-28JUL89

S11,2010,DA1 -19-16JUN95

MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

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

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



RG6062 -UN-21JAN92

1. Bolt liners down in seven locations using cap screws and washers. (See REMOVE PISTONS AND CONNECTING RODS, earlier in this group.) Tighten cap screws to 68 N·m (50 lb-ft).
2. Using JDG451 Gauge along with D17526CI (English scale) or D17527CI (Metric scale) Dial Indicator or KJD10123 Gauge, measure liner height for all cylinders.
3. Measure each liner in four places at approximately 1, 5, 7 and 11 o'clock positions as viewed from rear of engine (flywheel end). Record all measurements by cylinder number.
4. Replace any liner that does not meet standout specification and measure liner flange thickness. (See INSTALL LINER SHIMS—IF REQUIRED, later in this group.) Use liner shims or replace piston/liner sets as necessary.

LINER HEIGHT SPECIFICATION

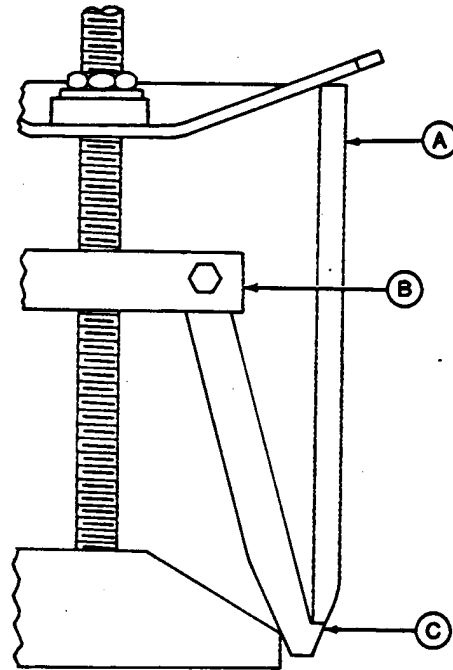
Liner Height Above Block	0.025—0.102 mm
	(0.0010—0.0040 in.)

RG,CTM9,G10,5 -19-25JAN96

REMOVE CYLINDER LINERS

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.



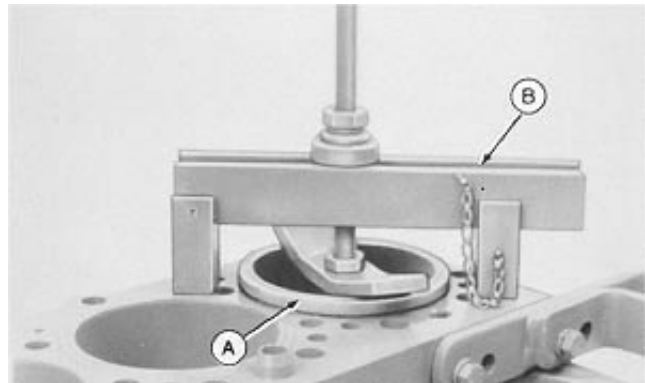
CTM9,0402,AK -19-25JAN96

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

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

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

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



S11,0402,AI -19-16JUN95

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

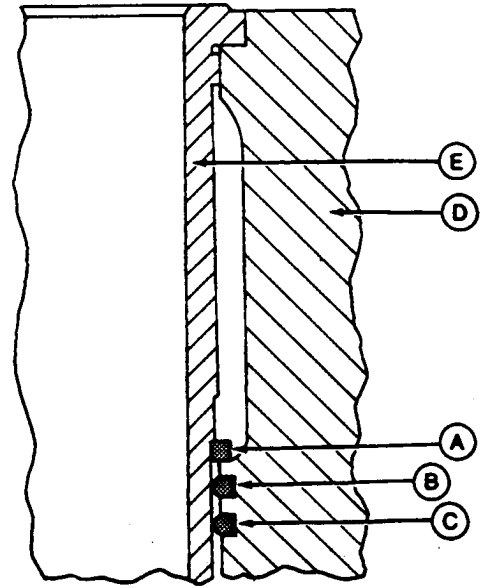


FIG3825 -UN-13DEC88

S11,0402,AL -19-08AUG94

REMOVE PISTON RINGS

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

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



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15

R26155 -UN-09FEB90

S11,2510,AX -19-16JUN95

CLEAN PISTONS

⚠ 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

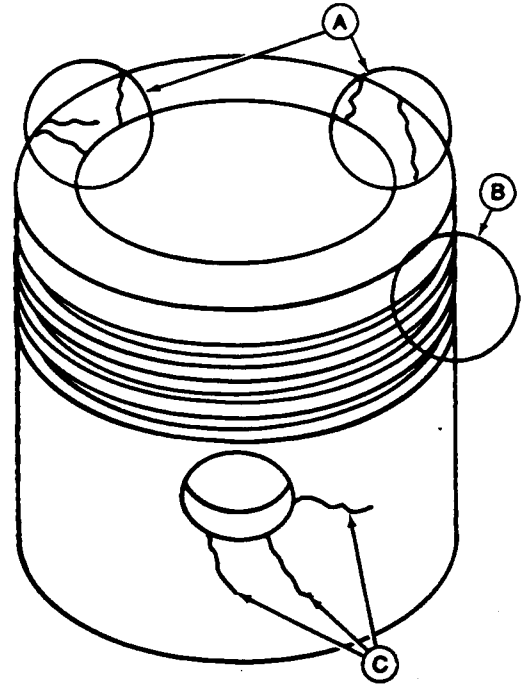
RG,CTM61,G10,8 -19-16JUN95

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.



(Defects Exaggerated)

RG3326 -JUN-13DEC88

RG,CTM61,G10,10-19-16JUN95

CLEAN CYLINDER LINERS

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

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

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

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

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

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

RG,CTM61,G10,9 -19-16JUN95

VISUALLY INSPECT CYLINDER LINERS

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

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

Replace liner if:

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

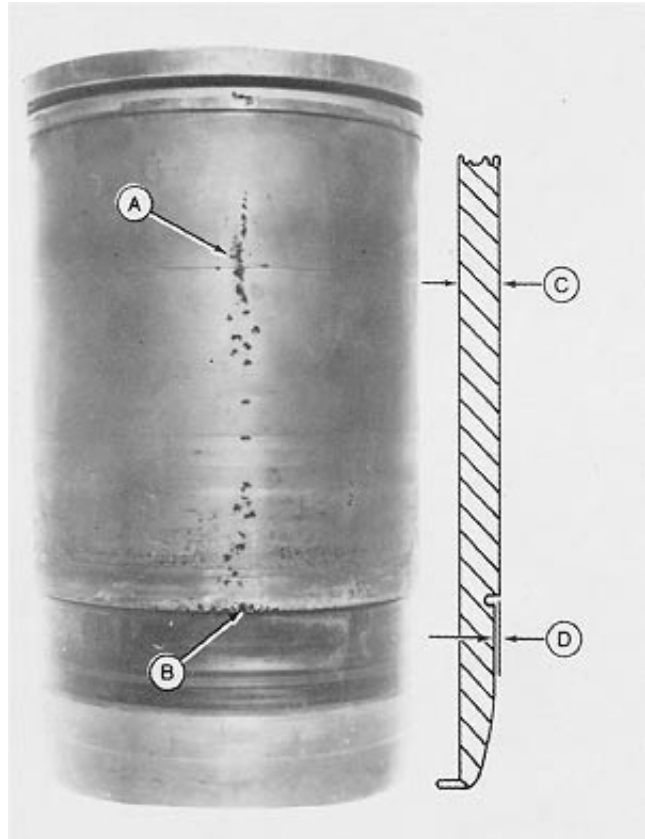
—Depth of erosion is one-half or more of the packing step (D).

LINER SPECIFICATIONS

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

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

If no defects are found, proceed to next step.



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

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

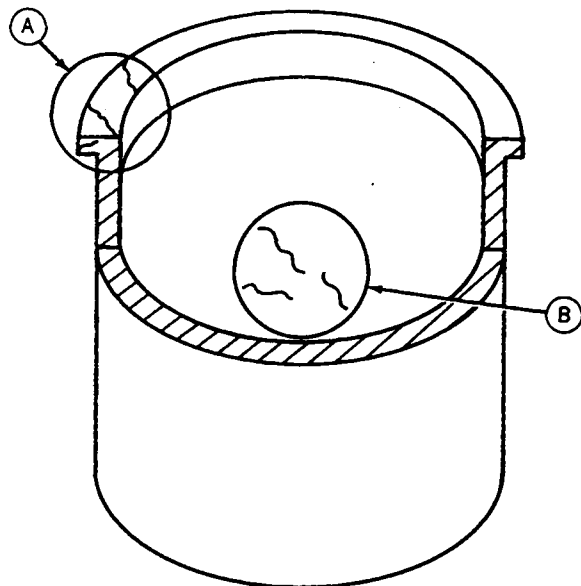
2. Visually examine liner ID. Replace piston and liner if:

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

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

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

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



(Exaggerated defects)

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

PISTON AND LINER IDENTIFICATION MARKINGS

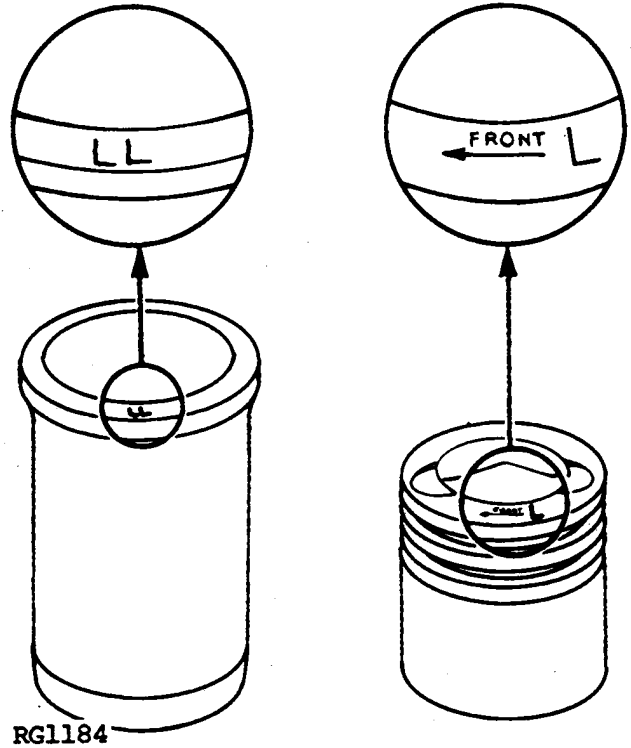
Piston and liners are selectively fitted to maintain piston-to-liner clearance. Always keep matched pistons and liners together.

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

PISTON-TO-LINER MATCHED COMBINATIONS

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

NOTE: Do not confuse piston and liner identification markings with the four-digit liner manufacturing date code. (See *CYLINDER LINER MANUFACTURING DATE CODE EXPLANATION*, later in this group.)



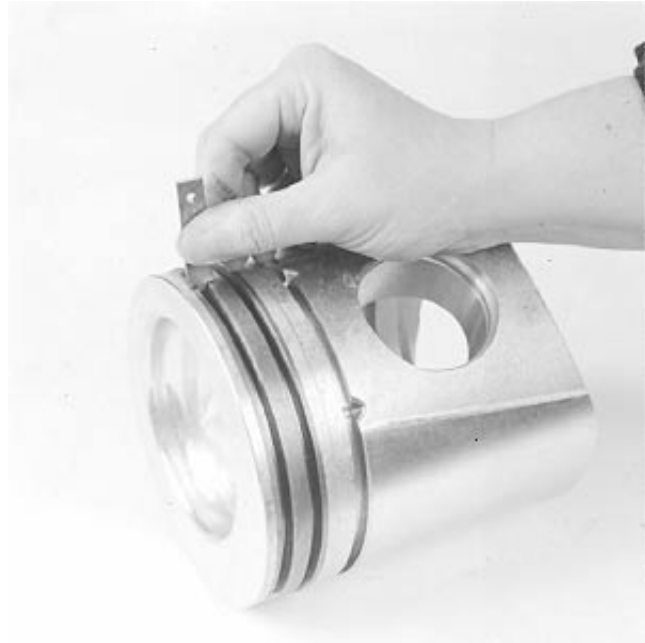
RG1184 -JUN-20/APR89

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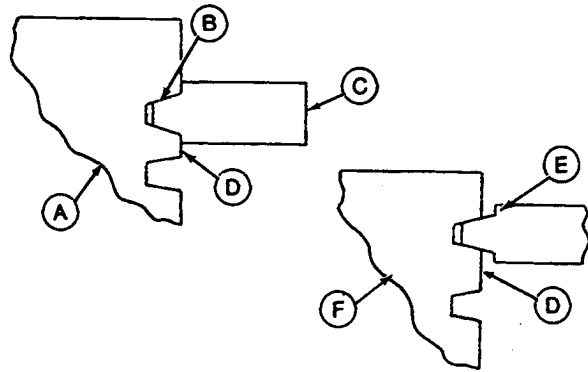
CHECK PISTON RING GROOVE WEAR

1. Use JDE55 Ring Groove Wear Gauge (C) to check wear of keystone ring grooves (B). Gauge shoulders (E) should not contact ring land (D) of piston. If ring grooves are worn (A), replace piston and liner as a set. If ring grooves are good (F), 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



RG6089 -UN-27JAN92



R 24201W

R24201 -UN-13DEC88

RG,CTM61,G10,11-19-16JUN95

MEASURE OIL CONTROL RING GROOVE

1. Check oil control ring groove clearance by installing a new ring in groove.
2. Measure clearance with a feeler gauge at several points. Compare measurements with specifications given below.

OIL CONTROL RING-TO-GROOVE CLEARANCE SPECIFICATIONS

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

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

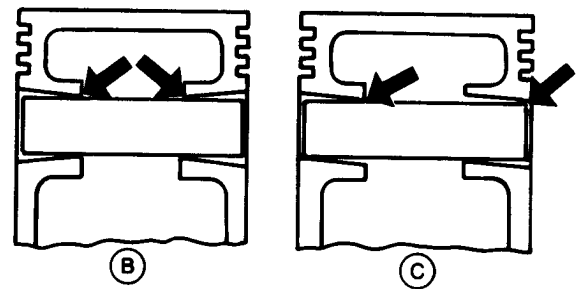
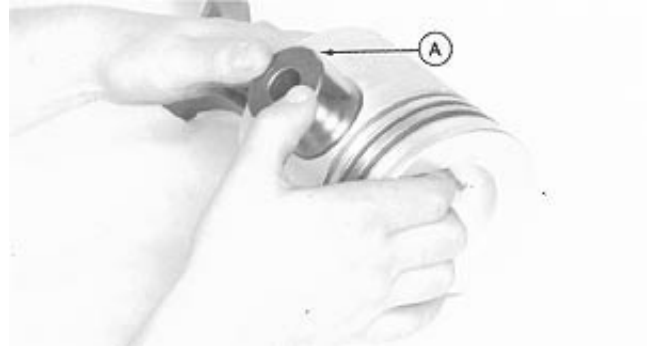


R26157 -JUN-09FEB90

S11,2010,CA -19-16JUN95

INSPECT PISTON PIN BORE IN PISTON

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

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21
-JUN-13DEC88
RG3747
-JUN-26JUL94
RG4984

RG,CTM9,G10,12 -19-25JAN96

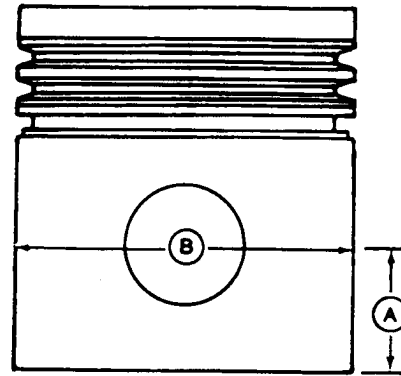
MEASURE PISTON OD

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

PISTON OD SPECIFICATIONS

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

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



RG5581 -UN-11JUL89

S11,2510,X -19-16JUN95

MEASURE CYLINDER LINERS

IMPORTANT: ALWAYS measure liners at room temperature.

• Measure Taper and Out-of-Round

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

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

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

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

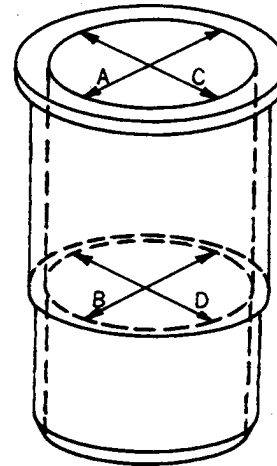
Compare measurements A, B, C, and D to determine if liner is tapered or out-of-round.

CYLINDER LINER SPECIFICATIONS

Maximum Wear or Taper in Ring Travel Area 0.038 mm
(0.0015 in.)

Maximum Liner Out-of-Round 0.05 mm
(0.002 in.)

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



R25922N

R25922 -UN-13DEC88

• **Measure Cylinder Liner ID**

1. Measure cylinder liner ID twice, 90° apart, 75 mm (2.95 in.) from top of liner.
2. Determine average of two measurements.
3. Compare results to specifications given.

CYLINDER LINER SPECIFICATIONS

LL OR L2	130.162—130.175 mm (5.1245—5.1251 in.)
MM or M2.	130.175—130.193 mm (5.1251—5.1257 in.)
HH or H2	130.193—130.205 mm (5.1257—5.1263 in.)
H3	130.183—130.190 mm (5.1253—5.1256 in.)
P	130.165—130.175 mm (5.1246—5.1250 in.)
Q	130.175—130.185 mm (5.1250—5.1254 in.)
R	130.185—130.195 mm (5.1254—5.1258 in.)
S	130.195—130.205 mm (5.1258—5.1262 in.)

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

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S11,2510,Y1 -19-25JAN96

DETERMINE PISTON-TO-LINER CLEARANCE

1. Measure piston skirt OD. (See MEASURE PISTON OD in this group.)
2. Measure cylinder liner ID. (See MEASURE CYLINDER LINERS in this group.)
3. Subtract piston skirt OD measurement from cylinder liner ID measurement to determine piston-to-liner clearance.
4. Compare results to specifications given.

PISTON-TO-LINER CLEARANCE SPECIFICATIONS

L—LL/L2	0.127—0.155 mm (0.0050—0.0061 in.)
M—MM/M2	0.130—0.157 mm (0.0051—0.0062 in.)
H—HH/H2	0.132—0.160 mm (0.0052—0.0063 in.)
H—H3, P—P, Q—Q, R—R, S—S	0.122—0.142 mm (0.0048—0.0056 in.)

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

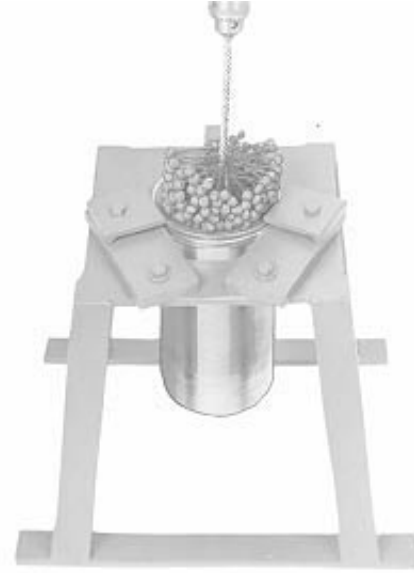
S11,2510,Y2 -19-16JUN95

DEGLAZE CYLINDER LINERS

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

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

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

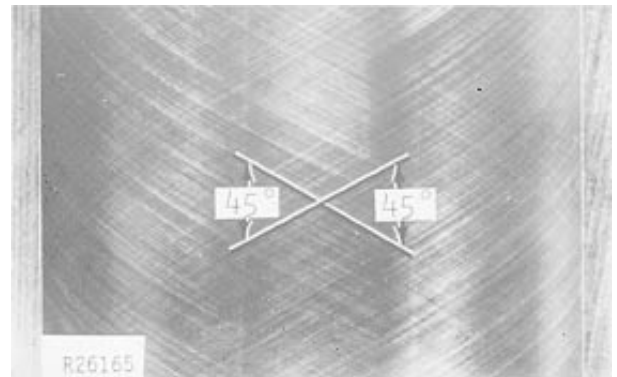


S11,2510,K -19-16JUN95

R26164 -UN-13DEC88

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

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



S11,0402,AT -19-16JUN95

R26165 -UN-13DEC88

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25

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 ID. Use new cap screws only for final assembly of connecting rods.

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

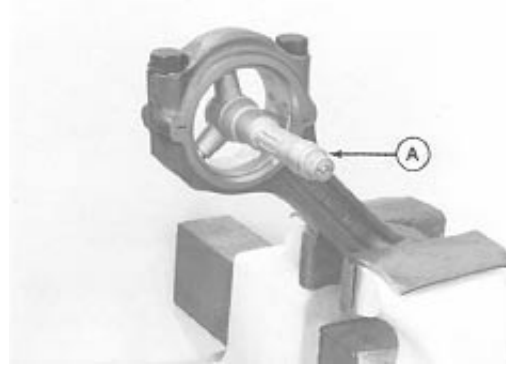
NOTE: Use PLASTIGAGE® as directed by the manufacturer. The use of PLASTIGAGE® will determine bearing journal clearance, but will not indicate the condition of either surface.

1. With crankshaft removed, measure connecting rod journal OD at several points.
2. Install connecting rod cap (A) on rod (B) with bearings (C) in correct position.
3. Tighten connecting rod cap screws using TORQUE-TURN method. (See TORQUE TURN CONNECTING ROD CAP SCREWS in this group.)



FIG3823 -UN-13DEC88

4. Using an inside micrometer (A), measure assembled ID of bearing.
5. Subtract OD of each crankshaft journal from ID of each respective rod bearing to obtain oil clearance.
6. Compare measurements with the specifications given.



CONNECTING ROD BEARING-TO-JOURNAL SPECIFICATIONS

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

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

S11,2510,H -19-16JUN95

-UN-13DEC88
RG3824

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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.



S11,0402,AE -19-16JUN95

-UN-13DEC88
RG3749

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

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

4. Install cap WITHOUT bearing inserts.

5. Tighten cap screws using the “torque-turn” method. (See TORQUE-TURN CONNECTING ROD CAP SCREWS in this group.)



RG4982 -UN-13DEC88

S11,0402,AF -19-16JUN95

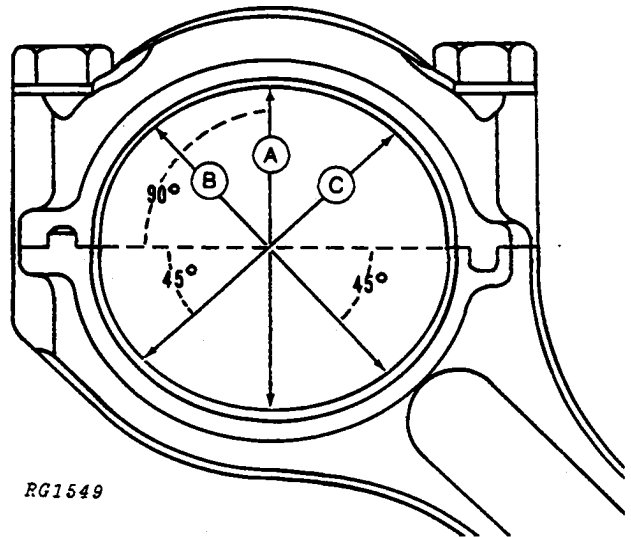
6. Using an inside micrometer, measure rod bore at center of bore and record measurements as follows:

- (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

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

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



RG1549 -UN-13DEC88

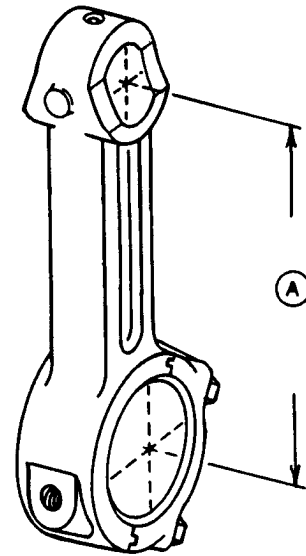
S11,2010,FO -19-16JUN95

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8. Measure rod's piston pin bore-to-crankshaft 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 SPECIFICATION

New part 228.55—228.65 mm (8.998—9.002 in.)

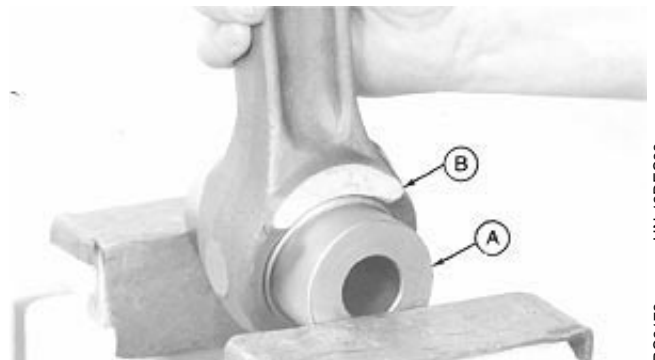


RG6123 -UN-06FEB92

RG,CTM61,G10,25-19-25JAN96

INSPECT PISTON PINS AND BUSHINGS

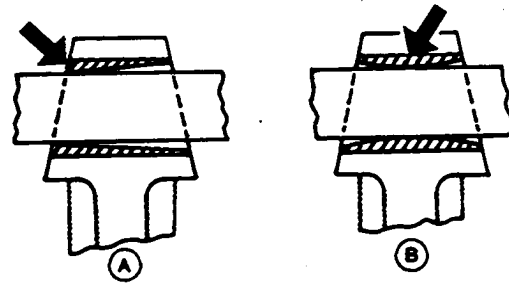
1. Insert piston pin (A) through piston pin bushing and carefully clamp in a soft-jawed vise.
2. Rotate connecting rod (B) back and forth several times to make sure connecting rod moves freely on piston pin.
3. Remove piston pin from connecting rod.



RG3172 -UN-13DEC88

S11,2010,DM -19-16JUN95

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



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

6. Measure pin bushing ID for specified clearance.

PISTON PIN BORE SPECIFICATIONS

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

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

S11,2510,AN -19-16JUN95

RG4924 -UN-06APR89

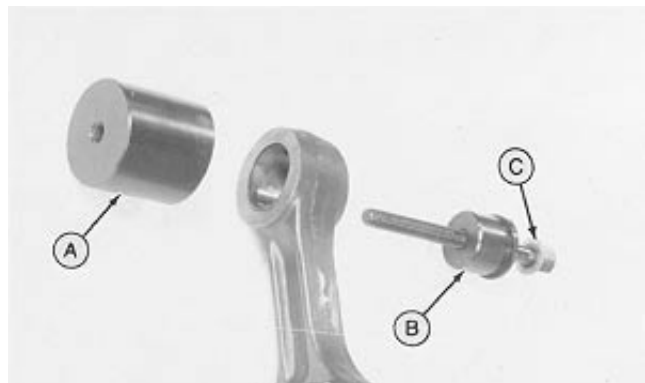
REMOVE 6° TAPER PISTON PIN BUSHING

NOTE: Early 6619 Engines used a 6° taper connecting rod.

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

Use care to properly align the JDE-98-7 Driver with bushing so that the connecting rod is not damaged.

1. Remove the used 6° taper bushing with the JDE98A Connecting Rod Bushing Service Set.



A—JDE98-1 Cup
B—JDE98-7 Driver
C—STD36104 Forcing Screw

S11,2510,AO -19-16JUN95

RG4925 -UN-19JAN90

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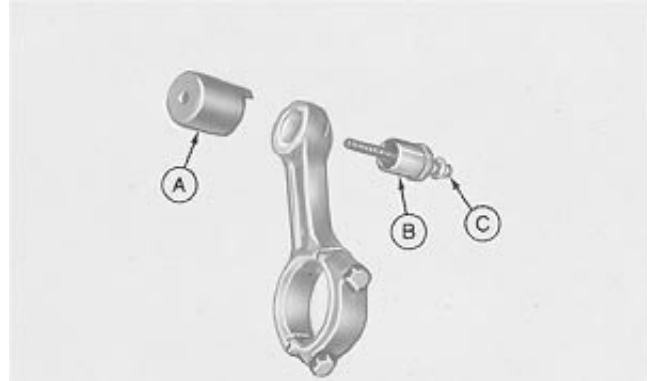
REMOVE 19° TAPER PISTON PIN BUSHING

NOTE: Beginning with Engine Serial No. (031522—), a 19° taper connecting rod was used on some 6619 Engine applications.

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

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

1. Remove the used 19° taper bushing with the JDE98A Connecting Rod Bushing Service Set.



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

S11,2510,AP -19-16JUN95

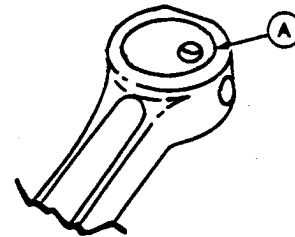
RG4723 -UN-09APR90

CLEAN AND INSPECT PISTON PIN BUSHING BORE IN CONNECTING ROD

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

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

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



CONNECTING ROD PIN BUSHING SPECIFICATIONS

Connecting Rod Pin Bushing Bore 55.529—55.555 mm
(2.1862—2.1872 in.)

Press Fit of Bushing in Rod Pin Bore 0.100—0.163 mm
(0.0039—0.0064 in.)

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

S11,2510,AZ -19-16JUN95

RG5227 -UN-13DEC88

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INSTALL 6° TAPER PISTON PIN BUSHING

1. Lubricate connecting rod bore with clean engine oil.

IMPORTANT: Do not use power tools to install bushing.

2. Install new bushing (C) onto the JDE98-5 Driver (B). Lubricate O.D. of bushing. Install and lubricate forcing screw threads (A).

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

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

4. Engage forcing screw threads with threads in JDE98-1 Cup (E) and install new bushing.

IMPORTANT: Boring the connecting rod bushing should be done ONLY by experienced personnel on equipment capable of maintaining bushing finish specification.

5. Bore new bushing to specification to obtain a "thumb press" fit with piston pin. Remove all debris from boring operation.



A—*STD36104 Forcing Screw
B—*JDE98-5 Driver
C—6° Taper Bushing
D—*JDE98-6 Pilot
E—*JDE98-1 Cup

* From JDE98A Connecting Rod Bushing Service Set.

S11,2510,AQ -19-25JAN96

INSTALL 19° TAPER PISTON PIN BUSHING

1. Lubricate connecting rod bore with clean engine oil.

IMPORTANT: Do not use power tools to install bushing.

2. Assemble Drive (B) with Pilot (C). Install new bushing (E) onto driver. Lubricate O.D. of bushing. Install and lubricate forcing screw threads (D).

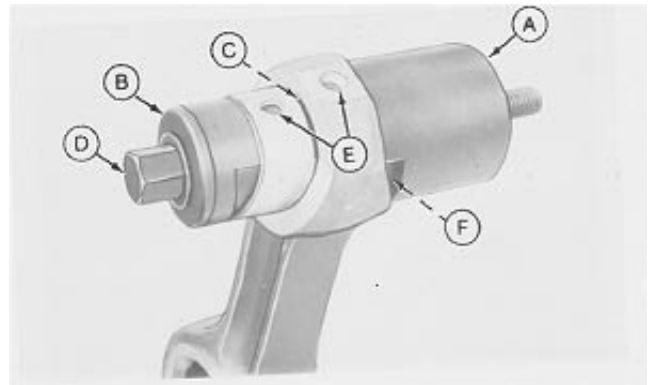
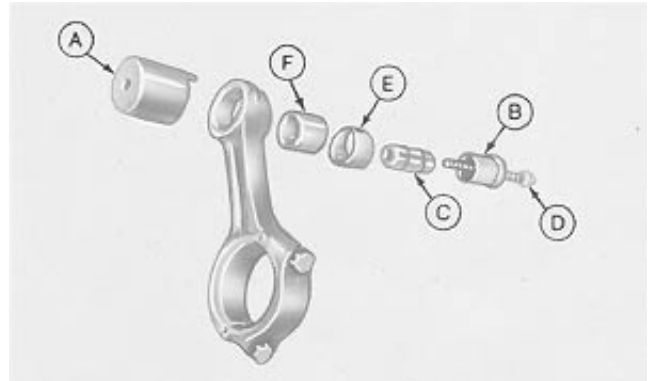
3. Assemble JDE98-6 Pilot onto driver.

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

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

IMPORTANT: Boring the connecting rod bushing should be done ONLY by experienced personnel on equipment capable of maintaining bushing finish specification.

5. Bore new bushing to specification to obtain a "thumb press" fit with piston pin. Remove all debris from boring operation.



- A—*JDE98-8 Cup
- B—*JDE98-10 Driver
- C—*JDE98-9 Pilot
- D—*STD36104 Forcing Screw
- E—19° Taper Bushing/Lubrication Holes
- F—*JDE98-6 Pilot

* From JDE98A Connecting Rod Bushing Service Set.

S11,2510,AR -19-25JAN96

RG4722 -UN-26JAN90

RG781531 -UN-09JAN90

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COMPLETE DISASSEMBLY OF CYLINDER BLOCK (IF REQUIRED)

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

1. Remove crankshaft and pulley if not previously removed. (Group 15.)
2. Remove all remaining lubrication system components. (Group 20.)
3. Remove starting motor. (See Machine Technical Manual.)
4. Remove water pump and all remaining cooling system components. (Group 25.)

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

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

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

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S55,2510,F -19-16JUN95

INSPECT AND CLEAN CYLINDER BLOCK

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.

S11,0402,AV -19-16JUN95

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.

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

S11,0402,AW -19-16JUN95

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

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

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

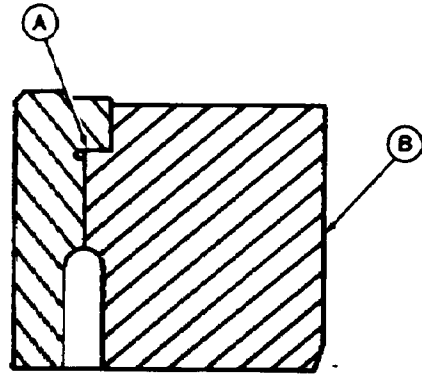
COUNTERBORE DEPTH AND LINER FLANGE SPECIFICATIONS

Cylinder Liner Counterbore Depth 9.46—9.51 mm
(0.3725—0.3745 in.)

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

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

7. Install new locating dowel pins in cylinder block.



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-UN-13DEC88

RG3329

-UN-06JAN90

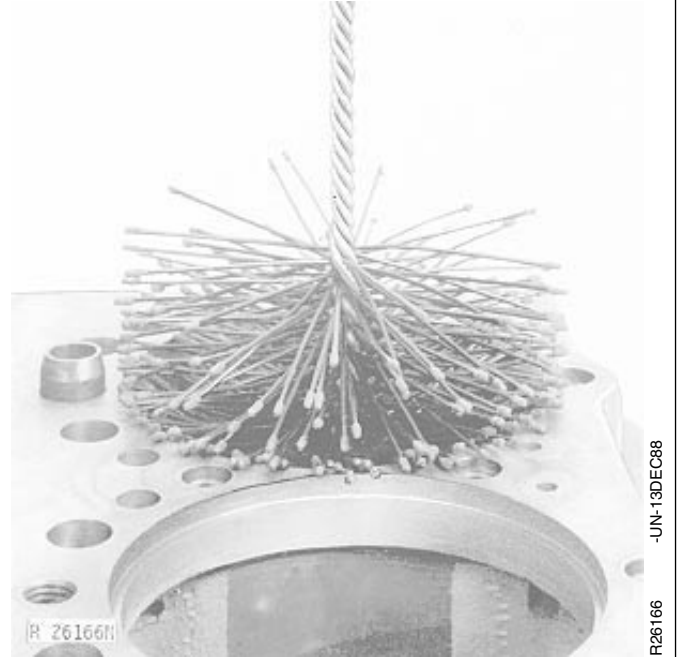
RG5580

S11,0402,CL -19-16JUN95

CLEAN CYLINDER LINER O-RING BORES IN BLOCK

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

NOTE: Use brush exactly as directed by the manufacturer.



R26166
-UN-13DEC88

S11,0402,AY -19-16JUN95

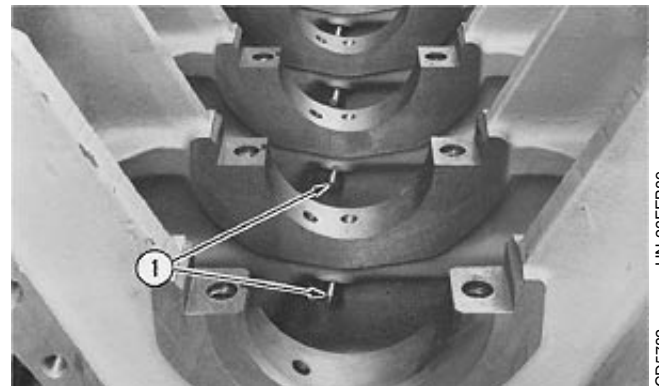
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REMOVE AND CLEAN PISTON COOLING ORIFICES

1. Remove all piston cooling orifices.
2. Inspect each cooling orifice (1) to make sure it is not plugged or damaged.
3. 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 piston, piston pin, pin bushing, and liner. If a piston cooling orifice is left out, low oil pressure will result.

4. Install and tighten orifices to 11 N·m (8 lb-ft) (97 lb-in.).



CD5782
-UN-23FEB89

S11,2010,HI -19-25JAN96

MEASURE CYLINDER BLOCK

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

1. Measure main bearing bore diameter (without bearings). Main bearing bore diameter is 101.651—101.677 mm (4.0020—4.0030 in.). Also measure cylinder block main thrust bearing cap width (thrust washer clearance cut). Width must be 34.52—34.62 mm (1.359—1.363 in.).

2. Measure cam follower bore diameter at all bore locations. Record measurements by bore location. Cam follower bore diameter specification is 34.976—35.027 mm (1.3770—1.3790 in.).

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

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

4. Measure camshaft bore diameter at all locations and record readings. Bore diameter is 69.987—70.013 mm (2.7554—2.7564 in.) without bushings, and 67.076—67.102 mm (2.6408—2.6418 in.) with bushings.

Replace bushings and/or camshaft as needed.

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

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

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

**RECHECK CYLINDER LINER STANDOUT
(HEIGHT ABOVE BLOCK)**

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

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

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

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

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

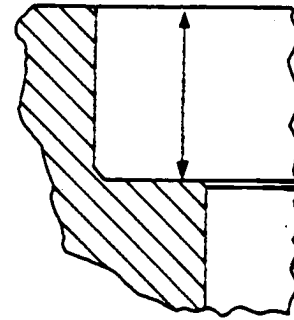
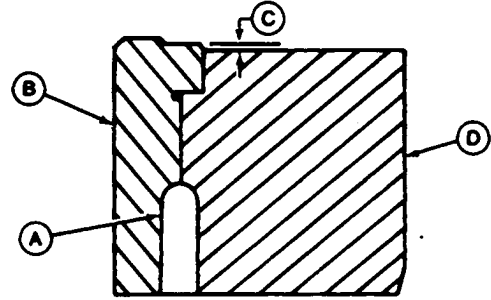
LINER STANDOUT (HEIGHT ABOVE BLOCK) SPECIFICATION

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

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

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

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



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

FIG3330 -UN-06APP88

FIG4726 -UN-13DEC88

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MEASURE LINER FLANGE THICKNESS

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

LINER FLANGE SPECIFICATION

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



-UN-27JAN92
RG6090

S11,2510,AG -19-16JUN95

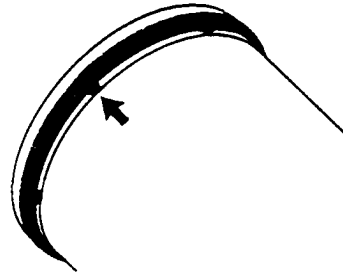
INSTALL LINER SHIMS—IF REQUIRED

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

LINER SHIM SPECIFICATIONS

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



-UN-04MAY89
RG4728

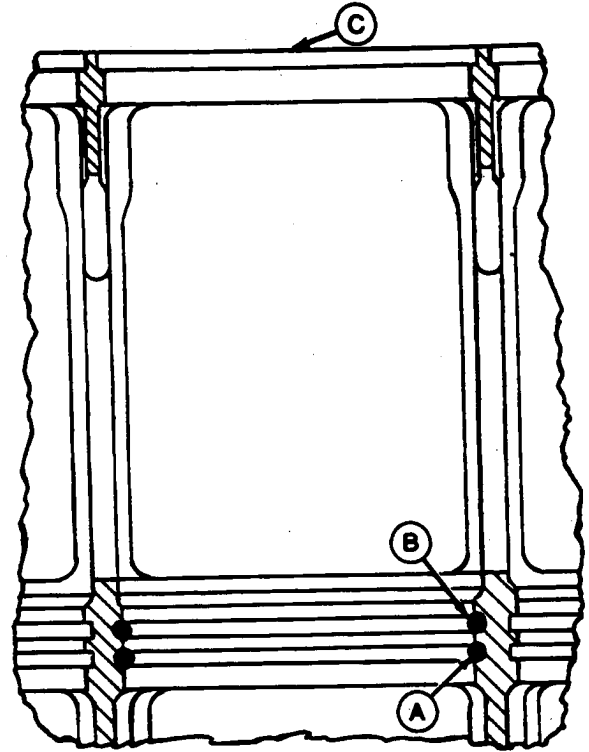
2. Install a maximum of **two thin** shims or **one thick** shim on liner. Shims have tangs on the ID to help hold them in place against bottom of liner flange when installing liner.
3. Make sure counterbore of block is clean and free of burrs. Install liner(s) in block without O-rings and secure liners with cap screws and washers as done previously. (See REMOVE PISTONS in this group.) Tighten cap screws to 68 N·m (50 lb-ft).
4. Measure liner standout again at 1, 5, 7, and 11 O'clock positions. Record measurements.
5. If standout is still not within specification, remove liner and determine cause.

S11,2510,AH -19-16JUN95

INSTALL CYLINDER LINER O-RINGS AND PACKINGS

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

1. Pour AR54749 Soap Lubricant into a suitable container.
2. Dip new packings and O-rings in soap before installation. Do not leave packings or O-rings in soap to soak.
3. Install the black viton O-ring (A) in the lower O-ring groove of the cylinder block (C).
4. Install the red silicone O-ring (B) in the upper O-ring groove of the cylinder block.



S11,0402,BA -19-16JUN95

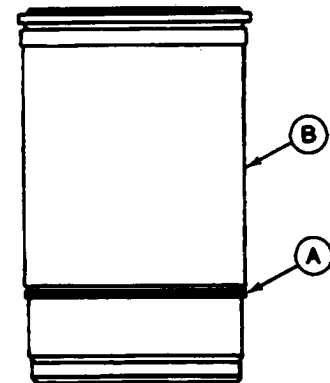
RG3826 -UN-13DEC88

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5. Turn cylinder liner (B) upside-down and install the neoprene square packing (A) over outside of liner.
6. Slide packing down firmly against second shoulder on the liner.

NOTE: Make sure the packing is not twisted.

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



S11,0402,BB -19-02APR93

RG3827 -UN-13DEC88

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:

SF91

S Liner Material Type
 F Month Liner was Manufactured
 91 Year Liner was Manufactured

Liner Material Specification

S Non-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

91 1991
 92 1992
 etc.



Four-Digit Date Code

-UN-27JAN92
RG6091

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

INSTALL CYLINDER LINERS

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

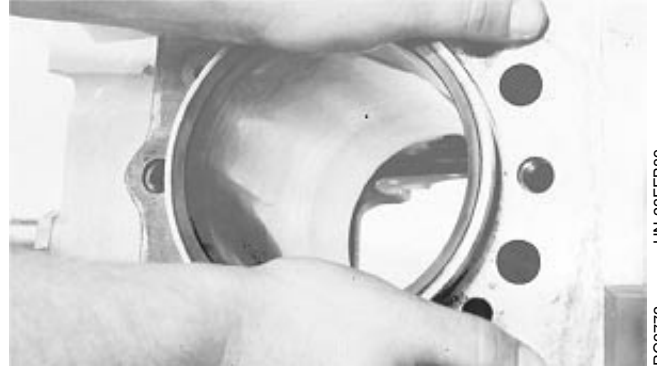
When liner OD's are pitted or eroded and are under one-half the liner thickness, rotate liners 90° from their removed position. Rotate the pitted section of the liner either toward the front or rear of the engine.

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

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

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

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



RG2772 -UN-23FEB89

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43

S11,2510,N -19-16JUN95

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

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

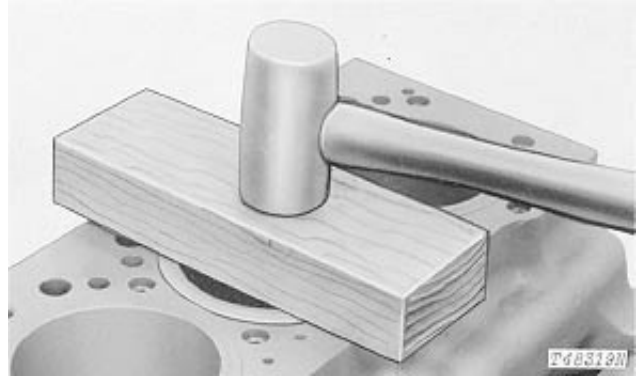
4. Gently tap hardwood block over top of cylinder liner with mallet.

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

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

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

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



T48319
-JUN-23FEB89

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S11,0402,BD -19-25JAN96

INSTALL PISTONS AND CONNECTING RODS

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

IMPORTANT: If a new piston and liner assembly is to be installed, DO NOT remove piston from liner. Push piston out of liner bottom only far enough to install piston pin.

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



FG3180
-JUN-28JUL89

S11,0402,BE -19-16JUN95

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

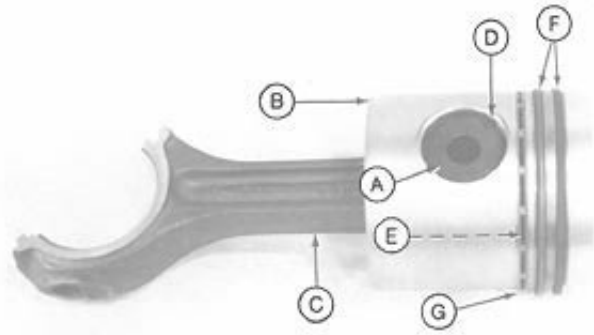
3. Insert NEW piston pin snap rings (D) in grooves. Make certain snap rings have expanded in grooves of piston.

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

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

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

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



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

FIG3828 -UN-25SEP89

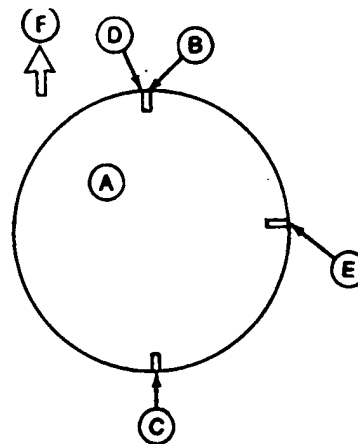
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45

S11,2510,AY -19-16JUN95

6. Stagger ring gaps on pistons as shown.

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

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



R 31127

R81127 -UN-13DEC88

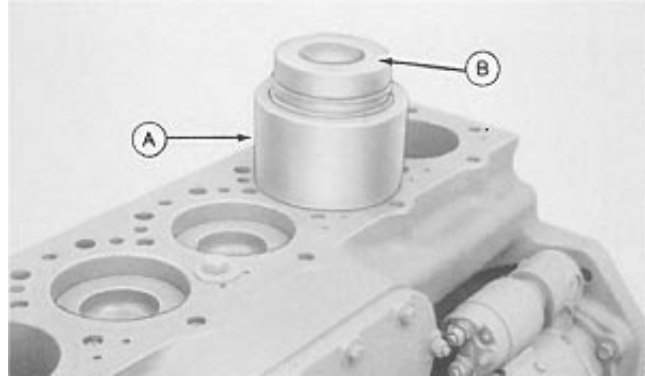
S11,2510,AT -19-05MAY93

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

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

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

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



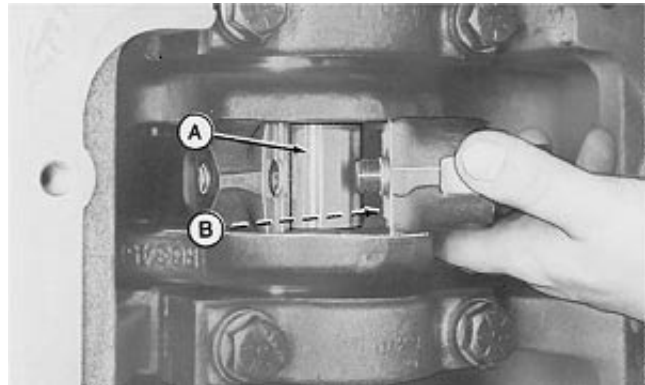
RG26127 -UN-13DEC88

S11,0402,BH -19-08AUG94

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

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

11. Install connecting rod caps.



RG3829 -UN-13DEC88

S11,0402,BI -19-08MAR94

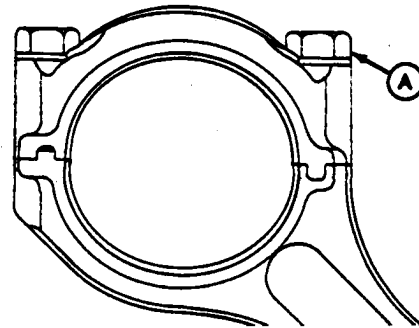
12. Dip new cap screws and washers in clean engine oil. Make sure top of cap screws have oil on them also.

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

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

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

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



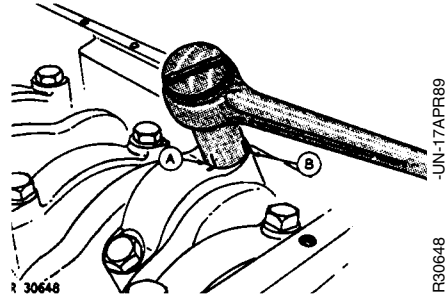
RG4375 -UN-13DEC88

S11,0402,BI -19-16JUN95

TORQUE-TURN CONNECTING ROD CAP SCREWS

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

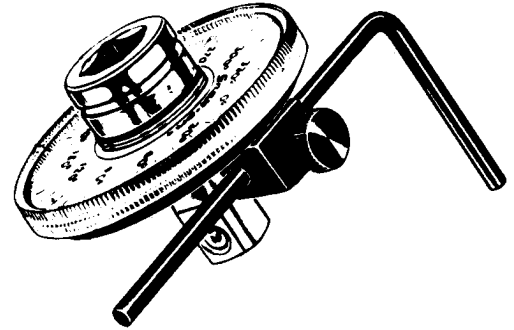
1. After tightening cap screws to 75 N·m (55 lb-ft), mark connecting rod cap and socket (A).
2. Make a second mark on socket (B) 90° counterclockwise from the first mark.
3. Tighten 1/4 turn (90—100°) clockwise until mark (B) is in line with reference mark on rod cap.



S11,2010,CE -19-16JUN95

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

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



JT05993 Torque Angle Gauge

S11,2010,CE1 -19-16JUN95

CHECK ENGINE ROTATION FOR EXCESSIVE TIGHTNESS

1. Rotate crankshaft several revolutions to be sure engine rotates without excessive tightness.
2. Check liners for deep scratches caused by an improperly installed or broken piston ring.
3. Check side clearance of rods. Must have slight side-to-side movement.

S11,0402,BK -19-16JUN95

MEASURE PISTON PROTRUSION

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" (0.000) with top of block.
3. Position gauge across piston. While pressing gauge downward, rotate crankshaft until piston is at "TDC".
4. Measure and record piston height at several positions around outer most diameter of piston.
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 0.254 mm (0.010 in.)

- 10
48
6. Repeat procedure on remaining pistons and record measurements.

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

RG,CTM9,G10,37 -19-25JAN96

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. (See Group 16.)
2. Install lubrication system components. (See Group 20.)
3. Install the cylinder head with new head gasket. (See Group 05.)
4. Install fuel injection system components. (See Group 35.)
5. Install the water pump and water piping. (See Group 25.)
6. Install crankshaft pulley. (See Group 15.)
7. Install the exhaust manifold and intake assembly. (See Group 30.)
8. Install the starting motor. (See Machine Technical Manual.)
9. Install the alternator, fan, and fan belts. (See Machine Technical Manual.)
10. Fill engine with clean oil and proper coolant. (See Group 02.)
11. Perform engine break-in. (See Group 105.)

S11,2010,FL -19-16JUN95

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49

Group 15 Crankshaft Main Bearings and Flywheel

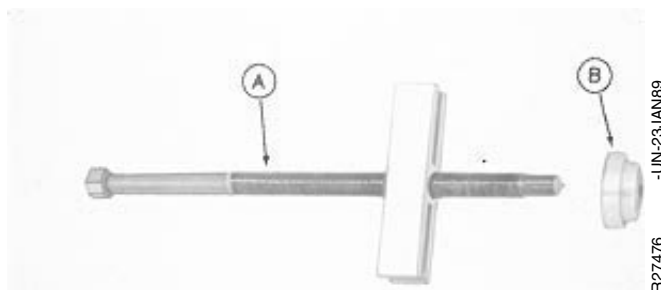
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

- A—Gear and Pulley Puller D01206AA*
- B—Step Plate 630-6**

Used to remove vibration damper and pulley.



* From D01048AA Puller Set.

** From D01212AA Step Plate Adapter Set.

S11,2515,AY -19-25JAN96

- Seal Removal Tool JDG22

RG5021 -UN-15DEC88

Remove front and rear crankshaft oil seals without removing timing gear cover or rear oil seal housing.

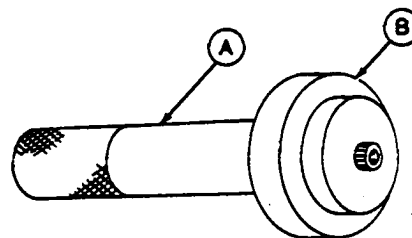


NOTE: May be used if JDG719 is not available. JDG719 is the preferred tool for removing the seals.

CTM9,JDG22 -19-03JUL95

- A—Handle 27488
- B—Disk 27516

Used to install clutch shaft pilot bushing.



Tools are from D01044AA or D01045AA Bushing, Bearing, and Seal Driver Sets.

S11,2515,BJ -19-03JUL95

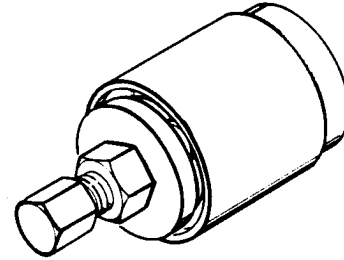
Crankshaft Main Bearings and Flywheel/Essential Tools

Front Wear Sleeve Puller JDG726

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

Set consists of:

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



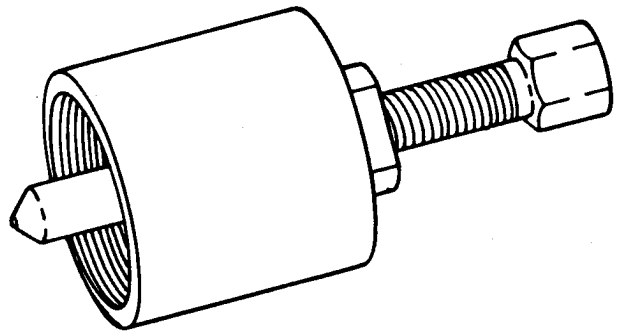
RG,JDG726 -19-02APR93

RG6216 -UN-06MAR92

Front Wear Sleeve Puller JDG786

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

NOTE: JDG726 Front Wear Sleeve Puller may be used in place of JDG786.

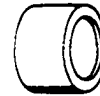


RG,JDG786,1 -19-02APR93

RG6428 -UN-13OCT92

Front Wear Sleeve Installer JDE3

Install front oil seal in timing gear cover.



RG5080 -UN-23AUG88

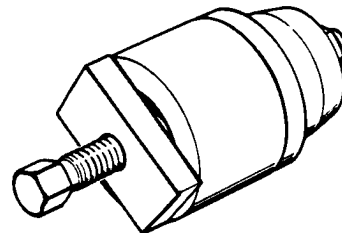
S53,JDE3A -19-16AUG94

Front Seal Installer JDG720

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

Set consists of:

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

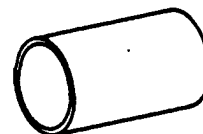


RG,JDG720 -19-25JAN96

RG6215 -UN-06MAR92

Gear Driver JDH7

Install crankshaft drive gear.



RG5108 -UN-23AUG88

S53,JDH7 -19-04AUG94

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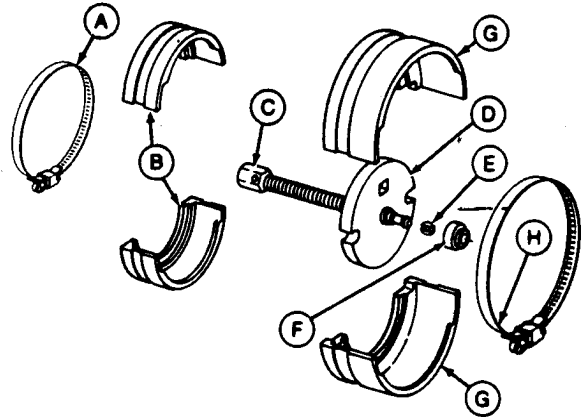
Crankshaft Main Bearings and Flywheel/Essential Tools

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

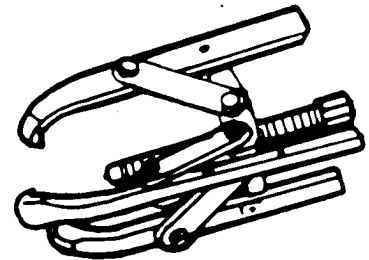


RG,JDG790 -19-03OCT94

RG6457 -UN-22OCT92

Vibration Damper and Pulley Puller Set JDG728

Used to remove multi-groove vibration damper and pulley



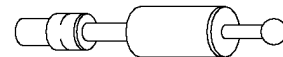
RG,JDG728 -19-25JAN96

RG6218 -UN-06MAR92

Shank JDE38-2
 Hammer JDE38-3

RG7341 -UN-23JUN95

Use with JDG719 to remove crankshaft rear oil seal.



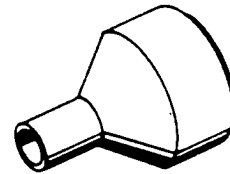
These tools are part of JDE38B Injection Nozzle Puller.

RG,JDE38 -19-03JUL95

Crankshaft Main Bearings and Flywheel/Essential Tools

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:

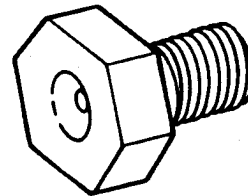
- 1—Adapter JDG719-1
- 2—Screw (not shown) 11200

RG,JDG719 -19-29OCT92

RG6214 -UN-06MAR92

Forcing Screw Spud JDG787

Used to protect crankshaft threads.



RG,JDG787,A -19-03JUL95

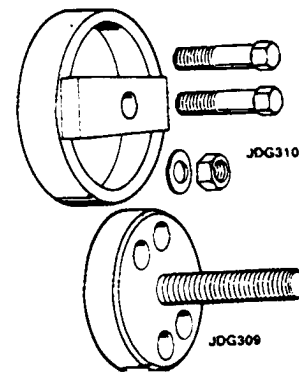
RG6429 -UN-13OCT92

Oil Seal and Wear Sleeve Installer JDG300

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

Set consists of:

- Pilot JDG309
- Installer JDG310



S53,JDG300 -19-16MAR92

RG5022 -UN-06APR89

Flywheel Turning Tool JDE81-1

Rotate engine flywheel. Use with JDE81-4.



S53,JDE811 -19-25JAN96

RG4950 -UN-23AUG88

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SERVICE EQUIPMENT AND TOOLS

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

Name	Use
D01061AA Puller Set	Remove clutch shaft pilot bushing

RG,CTM9,G15,19 -19-25JAN96

OTHER MATERIALS

Name	Use
PLASTIGAGE®	Use to measure main bearing-to-crankshaft journal clearance.
LOCTITE®242 (TY9370) Thread Lock and Sealer	Use on flywheel and starter cap screws.
LOCTITE®609 (TY15969) Retaining Compound	Use to coat OD of crankshaft flanges for front and rear wear sleeve installation.

PLASTIGAGE is a registered trademark of the TRW Corporation.

LOCTITE is a registered trademark of Loctite Corporation.

S11,2015,BS -19-25JAN96

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CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL SPECIFICATIONS

Item	New Part Specification	Wear Tolerance
Crankshaft End Play (—032181)	0.102—0.279 mm (0.0040—0.0110 in.) . . .	0.380 mm (0.0150 in.)
(032182—)	0.038—0.380 mm (0.0015—0.0150 in.)	—
Main Bearing Journal OD:		
Standard.	95.200—95.225 mm (3.7480—3.7490 in.)	—
0.05 mm (0.002 in.) Undersize	94.950—95.175 mm (3.7460—3.7470 in.)	—
0.25 mm (0.010 in.) Undersize	94.750—94.975 mm (3.7380—3.7390 in.)	—
0.51 mm (0.020 in.) Undersize	94.490—94.715 mm (3.7280—3.7290 in.)	—
0.76 mm (0.030 in.) Undersize	94.240—94.465 mm (3.7180—3.7190 in.)	—
Main Bearing Assembled ID	95.270—95.320 mm (3.7508—3.7528 in.)	—
Main Bearing Cap Surface Width	36.28—36.78 mm (1.428—1.448 in.)	—
Main Bearing-to-Journal Oil Clearance	0.046—0.122 mm (0.0018—0.0048 in.) . . .	0.152 mm (0.0060 in.)
Journal Taper Per Inch of Journal		
Length	0.0025 mm (0.0001 in.)	—
Journal Out-of-Round	0.025 mm (0.001 in.)	—
Undersize Bearings Available	0.05, 0.25, 0.51, 0.76 mm (0.002, 0.010, 0.020, 0.030 in.)	—
Oversize Thrust Washer Available	0.18 mm (0.007 in.)	—
Crankshaft Rod Journal OD:		
Standard	88.844—88.874 mm (3.4980—3.4990 in.)	—
0.05 mm (0.002 in.) Undersize	88.794—88.824 mm (3.4960—3.4970 in.)	—
0.25 mm (0.010 in.) Undersize	88.594—88.624 mm (3.4880—3.4890 in.)	—
0.51 mm (0.020 in.) Undersize	88.334—88.364 mm (3.4780—3.4790 in.)	—
0.76 mm (0.030 in.) Undersize	88.064—88.114 mm (3.4680—3.4690 in.)	—
Main Bearing Cap Bore Specifications:		
ID (Without Bearings)	101.651—101.677 mm (4.0020—4.0030 in.)	—
Max. Bore Diameter Variation	0.013 mm (0.0005 in.)	—
Max. Bore Diameter Taper	0.005 mm (0.0002 in.)	—
Max. Straightness (5 Center Bores- to-Adjacent Bore)	0.076 mm (0.003 in.)	—
Max. Straightness (Any Bore-to-Adjacent Bore)	0.038 mm (0.0015 in.)	—
Centerline of Bore-to-Top Deck	374.57—374.73 mm (14.747—14.753 in.)	—
Damper Pulley Radial Runout (Max)	0.76 mm (0.030 in.)	—
Rear Oil Seal Housing Runout (Max)	0.15 mm (0.006 in.)	—
Main and Rod Journal Fillet Radius	3.94—4.44 mm (0.145—0.185 in.)	—
Clutch Shaft OD	25.40—25.43mm (1.000—1.001 in.)	—
Clutch Shaft Pilot Bushing ID	25.50—25.55 mm (1.004—1.006 in.)	—
Clutch Shaft Pilot Bushing		
Recess Below Sleeve.	0.00—0.051 mm (0.0—0.02 in.)	—
Flywheel Face Flatness		
(Max. Variation)	0.23 mm (0.009 in.)	—
Flywheel Housing Face Runout		
(Max. Variation)	0.20 mm (0.009 in.)	—
Crankshaft Dowel Pin Protrusion	13.5—14.5 mm (0.53—0.57 in.)	—
Engine Stroke	127 mm (5.0 in.)	—
Main and Rod Journal Surface Finish.	Lap 0.25 Um (9.8 AA)	—
Thrust Journal Surface Finish	Lap 0.40 Um (16 AA)	—
Rod Journal Fillet Radius.	4.49—4.85 mm (0.177—0.191 in.)	—
Main and Thrust Journal Fillet Radius	3.94—4.44 mm (0.155—0.175 in.)	—
Thrust Journal Width.	47.57—47.67 mm (1.873—1.877 in.)	—
Front Oil Seal Bore Runout (Max)	0.254 mm (0.010 in.)	—

CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL SPECIFICATIONS—CONTINUED

Item	New Part Specification	Wear Tolerance
Thrust Bearing Cap Specifications:		
Thrust Washer Clearance	129.28—130.81 mm (5.09—5.15 in.)	—
Thrust Surface Width	40.615—40.716 mm (1.559—1.603 in.)	—
Relief Angle	45°	—
Cap Overall Width	41.81—42.31 mm (1.646—1.666 in.)	—
Thrust Surface Max. Runout	0.025 mm (0.0010 in.)	—
Crankshaft-to-Oil Pump Drive		
Gear Face Clearance	0.38 mm (0.015 in.)	—
Crankshaft Grinding Specifications:		
Engine Stroke	127 mm (5.0 in.)	
Main and Rod Journal Surface Finish	Lap 0.25 Um (9.8 AA)	
Thrust Journal Surface Finish	Lap 0.40 Um (16 AA)	
Rod Journal Fillet Radius	4.49—4.85 mm (0.177—0.191 in.)	
Main and Thrust Journal Fillet Radius	3.94—4.44 mm (0.155—0.175 in.)	
Thrust Journal Width	47.57—47.67 mm (1.873—1.877 in.)	
Torques		
Pulley-to-Crankshaft	203 N·m (150 lb-ft)	
Damper-to-Pulley		
3/8 in. Cap Screws	41 N·m (30 lb-ft)	
M10 Cap Screws	75 N·m (55 lb-ft)	
Main Bearing Caps	285 N·m (210 lb-ft)	
Rear Crankshaft Oil Seal Housing	27 N·m (20 lb-ft)	
Flywheel-to-Crankshaft	176 N·m (130 lb-ft)	
Piston Cooling Orifices	11 N·m (98 lb-in.)	
Timing Gear Cover Cap Screws	47 N·m (35 lb-ft)	
Flywheel Housing-to-Cylinder Block	407 N·m (300 lb-ft)	
Starter Motor-to-Flywheel Housing	102 N·m (75 lb-ft)	
Flywheel Housing-to-Oil Pan	325 N·m (240 lb-ft)	

S11,2515,AP,1 -19-25JAN96

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CRANKSHAFT AND MAIN BEARING FAILURE ANALYSIS

• Scored Main Bearing:

(Diagnosis also applies to connecting rod bearing.)

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

• Galled or “Wiped” Bearings:

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

• Inconsistent Wear Pattern:

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

• Broken Main Bearing Caps:

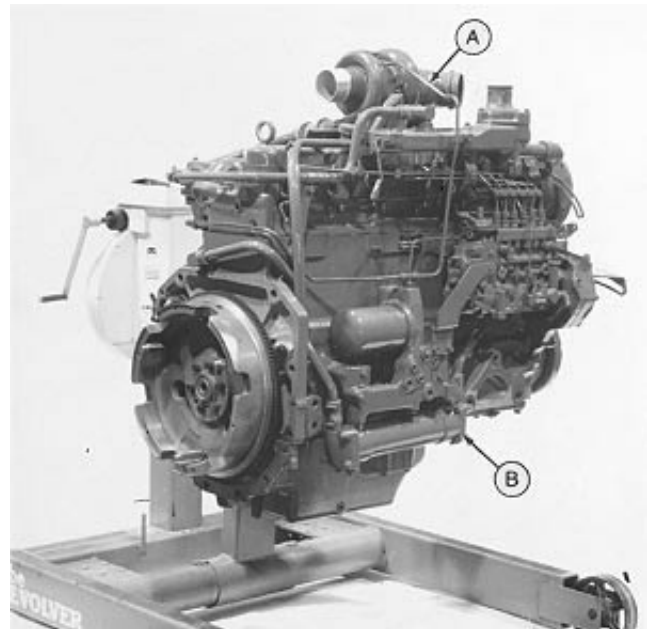
Improper installation.
Dirt between bearing and crankshaft journal.
Low oil pressure.
Oil pump failure.

• Cracked, Chipped or Broken Bearings:

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

S11,2515,A -19-25JAN96

IMPORTANT: When servicing a 6619 engine on a rollover stand, disconnect the turbocharger oil inlet line (A) from the oil pressure regulating housing before inverting the engine. Also, drain oil from engine oil cooler (B). Failure to do so may cause hydraulic lock upon starting the engine. Hydraulic lock can cause possible engine failure.



S11,2000,EP1 -19-25JAN96

UN-26JAN90
RG4933

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

IMPORTANT: Whenever rear oil seal is replaced, wear sleeve **MUST** be replaced also.

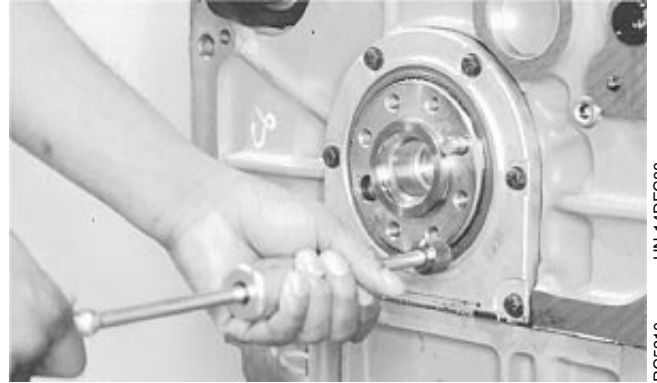
NOTE: If oil seal housing is to be removed, remove seal and wear sleeve after housing is removed.

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

1. Remove flywheel. (See REMOVE FLYWHEEL AND FLYWHEEL HOUSING in this group.)
2. Drill two small holes approximately 20° apart in bottom of seal casing. Install sheet metal screws in seal casing with JDG22 Seal Remover attached.

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

3. Cock seal at 12 o'clock position (180° opposite drilled hole) using a small punch and carefully pull seal from housing.

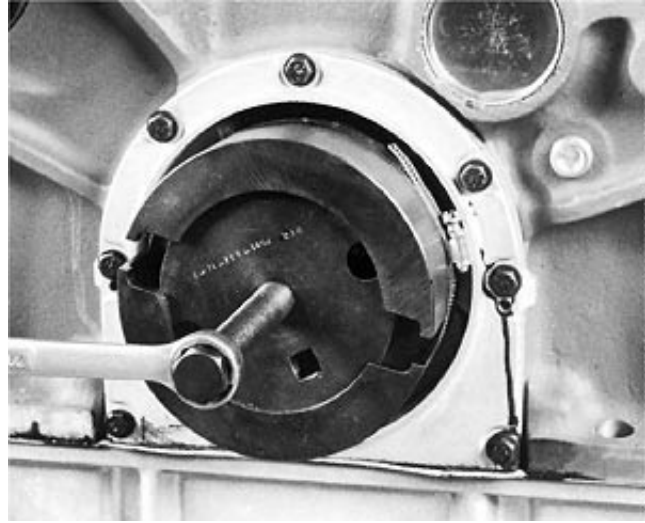


RG5210 -UN-14DEC88

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S11,2515,BM -19-25JAN96

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.



RG6615 -UN-17FEB93

RG,CTM9,G15,23 -19-25JAN96

IMPORTANT: Do not gouge flange of crankshaft with the chisel. Nicks or burrs should be removed with a medium-grit stone. Polishing cloth (180-grit or finer) may also be used when a stone is not available.

If JDG790 Rear Wear Sleeve Puller is not available, carefully cut wear sleeve off crankshaft flange using a small, sharp hardened chisel.



RG5211 -UN-14DEC88

S11,2515,BN -19-03JUL95

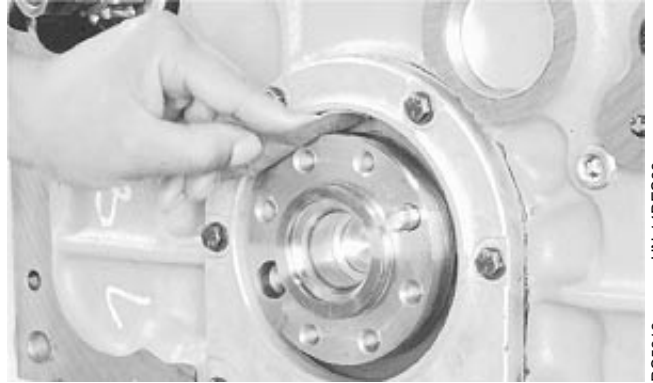
7. Clean OD of crankshaft flange with cleaning solvent, acetone, or any other suitable cleaner that will remove sealant. (Brake Kleen, Ignition Cleaner and Drier are examples of commercially available solvents that will remove sealant from flange.)

8. Look for nicks or burrs on wear ring surface and bore in flywheel housing. Any small nicks should be removed with 180-grit or finer polishing cloth. Finish cleaning by wiping flange with a clean rag.

9. Check oil seal housing runout. (See CHECK OIL SEAL HOUSING RUNOUT in this group.)

10. Rear oil seal and wear sleeve are installed as an assembly. Use appropriate precautions for handling. (See CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE HANDLING PRECAUTIONS in this group.)

11. Install rear oil seal and wear sleeve assembly. (See INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE ASSEMBLY in this group.)



RG5212 -UN-14DEC88

S11,2515,BO -19-03JUL95

INSPECT VIBRATION DAMPER

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

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



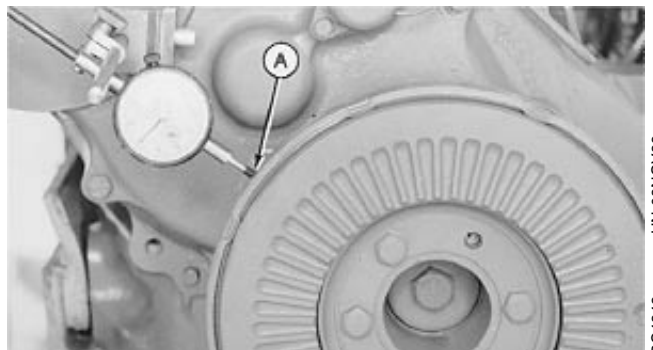
RG4341 -UN-08NOV89

S11,2515,AA -19-25JAN96

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

3. With engine at operating temperature, rotate crankshaft using JDE-81-1 Flywheel Rotation Tool.

4. Note dial indicator reading. Replace vibration damper if radial runout exceeds 0.76 mm (0.030 in.).



RG4342 -UN-08NOV89

S11,2515,AB -19-03JUL95

REMOVE VIBRATION DAMPER AND PULLEY

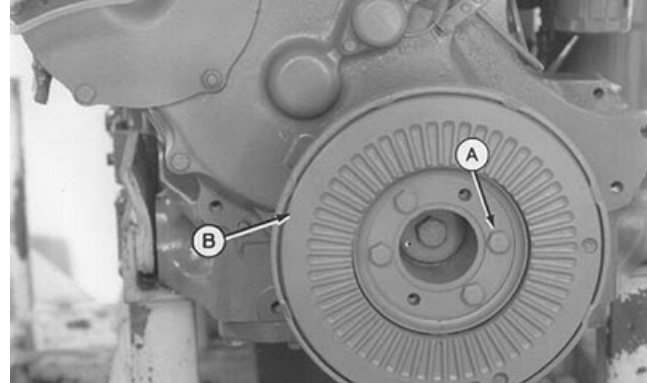
1. Remove fan belts.

CAUTION: Damper and pulley are very heavy. Plan proper handling procedures to avoid injury. ALWAYS use an assistant when removing and installing pulley.

IMPORTANT: DO NOT immerse damper assembly in petroleum products (such as gasoline, oil, solvent, etc.). Doing so can damage the rubber portion of the assembly. Never apply thrust on outer ring of damper. The damper is sensitive to impact damage from being dropped or struck with a hammer. Always remove damper from pulley first, if possible.

NOTE: Various damper/pulley configurations are used. Note installed sequence of damper/pulley assembly.

2. Remove cap screws (A) and damper (B).



RG7340 -UN-23JUN95

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12

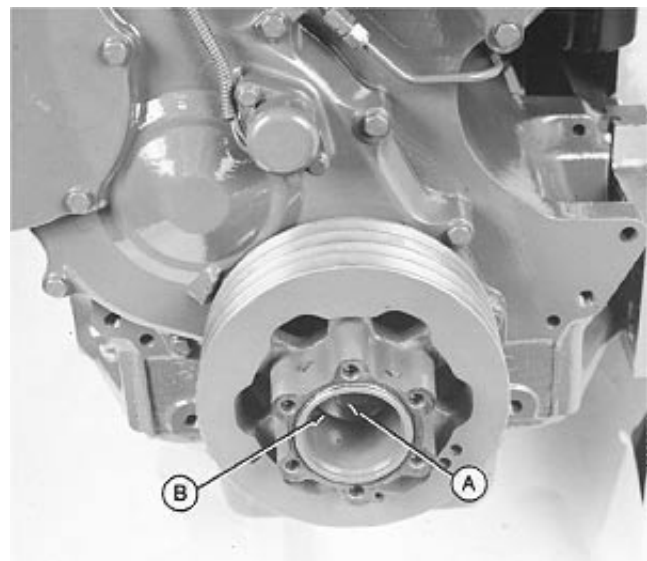
S11,2515,AR1 -19-25JAN96

IMPORTANT: When using a jaw-type puller, pull only on back side of pulley closest to engine. Pulley can be damaged if pulled from belt groove.

3. Remove cap screw (A) and washer (B). Remove pulley using JDG787 Forcing Screw Spud and JDG728 puller.

NOTE: Some damper/pulley configurations require damper and pulley to be removed as an assembly. Use D01206AA Puller and 630-6 Step Plate.

4. Carefully and thoroughly inspect the pulley for cracks or any visible damage (ID, V-belt grooves, keyway, etc.). Replace pulley as needed.



RG6101 -UN-27JAN92

S11,2515,AR1 -19-25JAN96

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

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

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

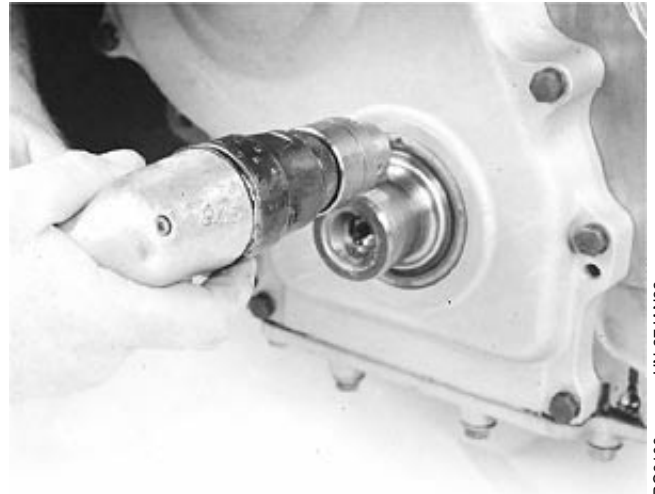
1. Check oil seal and wear sleeve for wear, damage, or leakage.
2. Center punch seal casing at 12 o'clock position.



RG6105
-UN-27JAN92

RG,CTM61,G15,9 -19-25JAN96

3. Drill hole at 12 o'clock position.

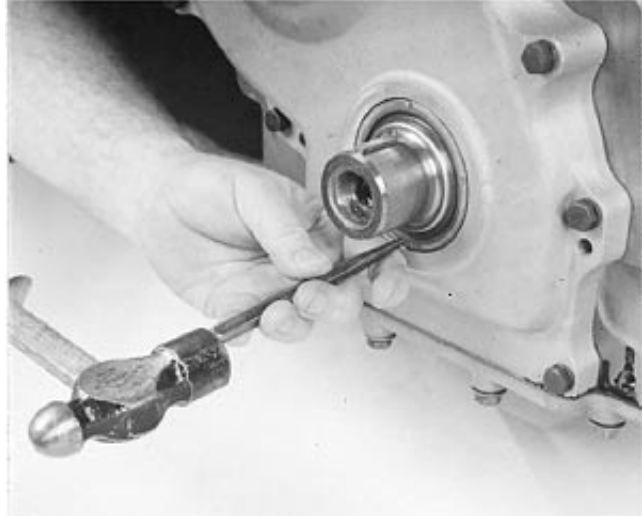


RG6106
-UN-27JAN92

RG,CTM61,G15,17-19-25JAN96

Crankshaft Main Bearings and Flywheel/Remove Crankshaft Front Oil Seal (Timing Cover Installed)

4. Using a punch, cock seal at 6 o'clock position.



RG6107
-UN-27JAN92

RG,CTM61,G15,18-19-25JAN96

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

6. Remove keyway on stub of crankshaft.



RG6108
-UN-27JAN92

RG,CTM61,G15,10-19-25JAN96

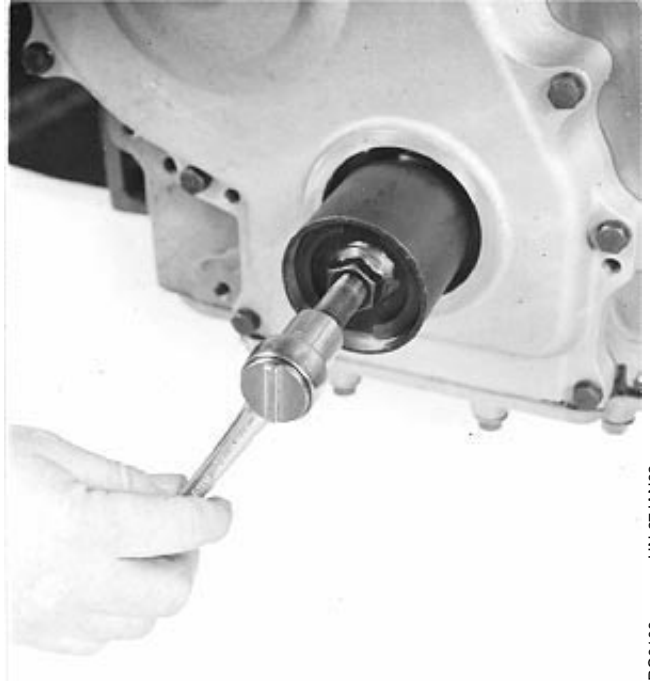
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REMOVE CRANKSHAFT FRONT WEAR SLEEVE (WITH TIMING GEAR COVER INSTALLED)

NOTE: Front wear sleeve can be removed with timing gear cover installed or removed using either JDG726 or JDG786 puller set.

• Remove Wear Sleeve Using JDG726:

1. Position pulling jaws and jack screw assembly onto lip of wear sleeve. Slide collar over pulling jaws.
2. Hold collar onto pulling jaws and tighten jack screw until wear sleeve is free from crankshaft flange.
3. Inspect crankshaft flange for nicks or burrs.
4. Clean up flange with a light file and emery cloth.
5. Measure crankshaft front oil seal bore runout. Maximum allowable runout is 0.254 mm (0.010 in.).



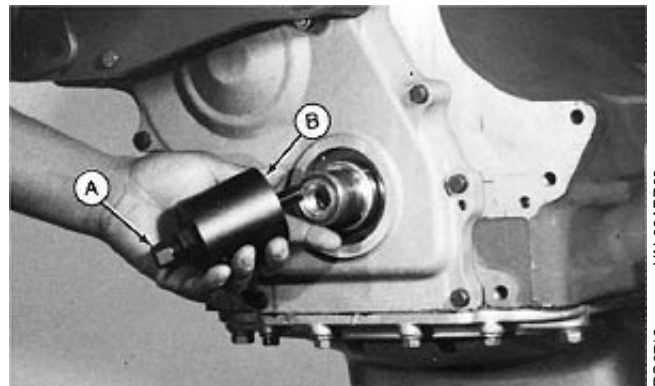
-UN-27JAN92

RG6109

RG,CTM61,G15,11-19-03JUL95

• Remove Wear Sleeve Using JDG786:

1. Start fully threaded centering screw (A) through hex head end of puller (B) until head of screw is approximately 12 mm (0.5 in.) from hex on puller.
2. Thread centering screw into nose of crankshaft and tighten until it bottoms.
3. Tighten puller until it is securely threaded onto wear sleeve.
4. Remove centering screw from nose of crankshaft and puller.



-UN-02APR93

RG6713

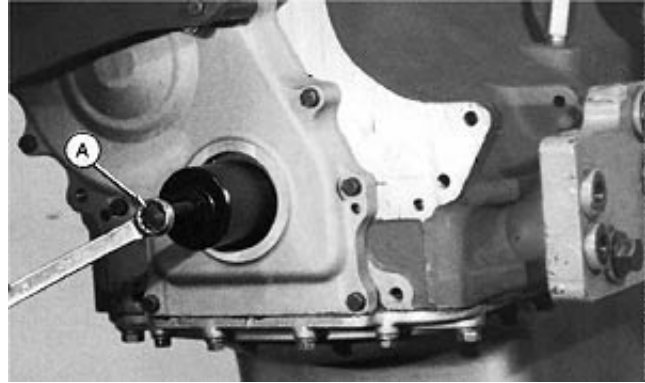


-UN-02APR93

RG6714

RG,CTM61,G15,25-19-03JUL95

5. Install forcing screw (A) into puller and tighten until it bottoms in nose of crankshaft. There is no thread engagement in crankshaft; just with puller.
6. Continue to tighten forcing screw until puller and wear sleeve are free from crankshaft flange.
7. Inspect crankshaft flange for nicks or burrs.
8. Clean up flange with a light file and emery cloth.
9. Measure crankshaft front oil seal bore runout. Maximum allowable runout is 0.254 mm (0.010 in.).



RG6715
-UN-02APR93

RG,CTM61,G15,26-19-03JUL95

INSTALL CRANKSHAFT FRONT WEAR SLEEVE (WITH TIMING GEAR COVER INSTALLED)

NOTE: Wear sleeve may be installed with timing gear cover removed or installed.

1. Coat ID of new wear sleeve with LOCTITE 609 Retaining Compound.
2. Install wear sleeve using JDG467 Driver along with washer and cap screw that secures damper pulley assembly to crankshaft.

NOTE: On current applications, the JDG468 Spacer (not shown) must be used with the JDG467 Driver to properly seat the wear sleeve on crankshaft flange.

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



RG6110
-UN-27JAN92

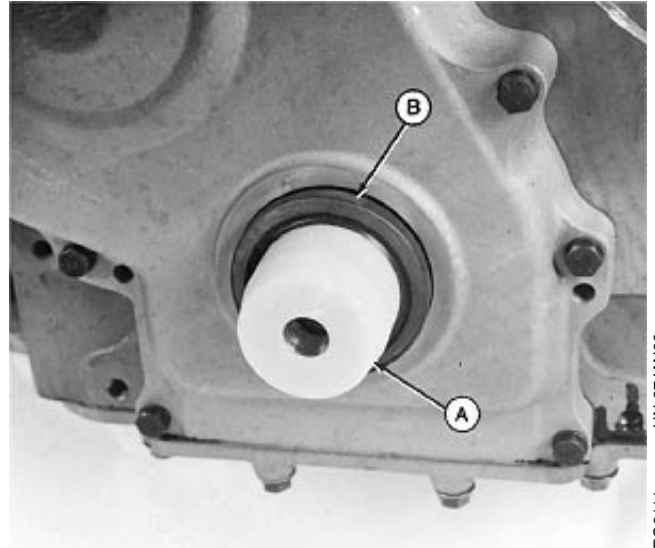
RG,CTM9,G15,12 -19-03JUL95

INSTALL CRANKSHAFT FRONT OIL SEAL

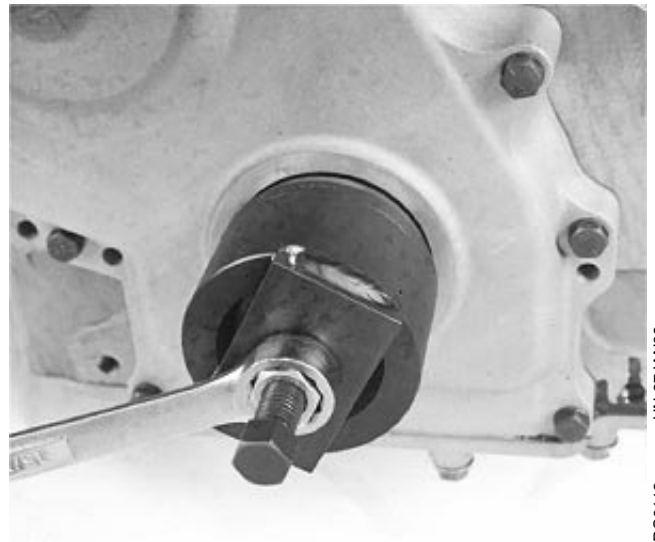
IMPORTANT: Whenever front oil seal is replaced, wear sleeve MUST be replaced also.

1. Place JDG720-2 Seal Protector (A) on nose of crankshaft. Lubricate ID of front oil seal (B) lips with clean engine oil and slide seal onto seal protector. Be careful not to roll oil seal lips.
2. Position JDG720-4 Spacer Ring on end of JDG720-3 Seal Installer and place installer onto seal protector against seal.
3. With nut installed onto JDG720-1 Forcing Screw, thread forcing screw into nose of crankshaft until it bottoms.
4. Tighten nut against crossplate of installer until installer bottoms on front face of timing gear cover.
5. Remove installation tools.

IMPORTANT: Verify seal is installed squarely in bore, flush with front face of timing gear cover, and that seal lips are not rolled on wear sleeve.



RG6111
-UN-27JAN92

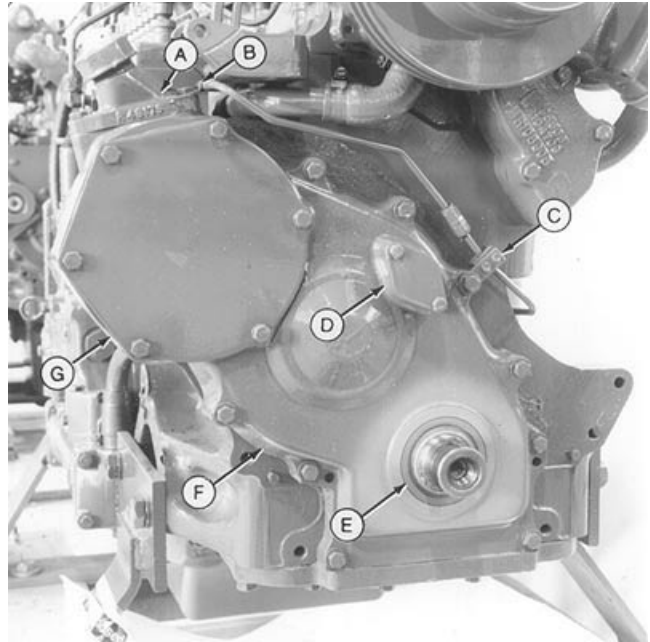


RG6112
-UN-27JAN92

RG,CTM61,G15,13-19-25JAN96

REMOVE TIMING GEAR COVER

1. If not previously done, remove vibration damper and pulley. (See REMOVE VIBRATION DAMPER AND PULLEY in this group.)
2. Drain engine oil if not previously done and remove engine oil pan. (See group 20.)
3. Disconnect and remove magnetic pickup, if equipped. Magnetic pickup located in place of cover plate (D).
4. Remove pipe clamps (B) and (C).
5. Remove cap screws and timing gear cover (F).
6. Inspect filler (A), cover (G) and plate (D) for signs of leakage. Replace gaskets if necessary.
7. Inspect seal (E). Replace if necessary. (See REMOVE CRANKSHAFT FRONT OIL SEAL/TIMING GEAR COVER REMOVED in this group.)



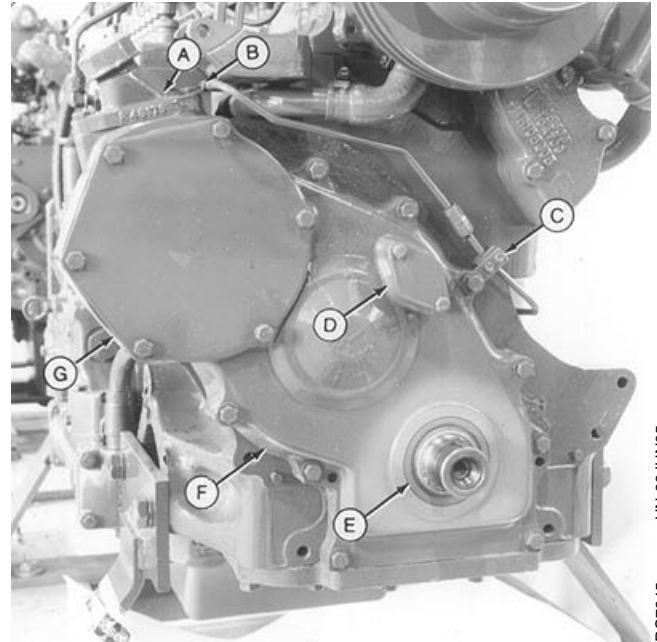
Late model engine shown.

- A—Filler Tube
- B—Clamp
- C—Clamp
- D—Cover Plate
- E—Front Oil Seal
- F—Timing Gear Cover
- G—Injection Pump Gear Cover

S11,2515,AR2 -19-25JAN96

REMOVE TIMING GEAR COVER

1. If not previously done, remove vibration damper and pulley. (See REMOVE VIBRATION DAMPER AND PULLEY in this group.)
2. Drain engine oil if not previously done and remove engine oil pan. (See group 20.)
3. Disconnect and remove magnetic pickup, if equipped. Magnetic pickup located in place of cover plate (D).
4. Remove pipe clamps (B) and (C).
5. Remove cap screws and timing gear cover (F).
6. Inspect filler (A), cover (G) and plate (D) for signs of leakage. Replace gaskets if necessary.
7. Inspect seal (E). Replace if necessary. (See REMOVE CRANKSHAFT FRONT OIL SEAL/TIMING GEAR COVER REMOVED in this group.)



Late model engine shown.

- A—Filler Tube
- B—Clamp
- C—Clamp
- D—Cover Plate
- E—Front Oil Seal
- F—Timing Gear Cover
- G—Injection Pump Gear Cover

S11,2515,AR2 -19-25JAN96

RG7345 -UN-23JUN95

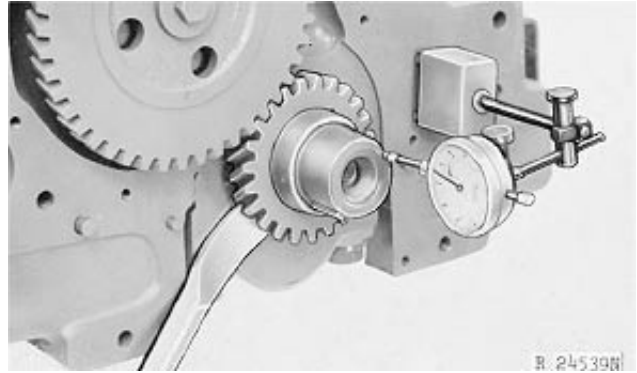
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19

CHECK CRANKSHAFT END PLAY

1. Position dial indicator on end of crankshaft.
2. Push crankshaft as far to rear of engine as possible.
3. Zero the dial indicator.

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

4. Using a bar, gently pry the crankshaft as far forward as possible and record endplay.



CRANKSHAFT END PLAY SPECIFICATIONS

Engine S.N. (—032181)	0.102—0.279 mm (0.0040—0.0110 in.)
Maximum Servicable	0.380 mm (0.0150 in.)
Engine S.N. (032182—)	0.038—0.380 mm (0.0015—0.0150 in.)

NOTE: If endplay is not within specifications, new thrust bearings will usually restore proper end play.

S11,2515,AQ -19-25JAN96

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20

REMOVE FRONT WEAR SLEEVE (WITH TIMING GEAR COVER REMOVED)

IMPORTANT: Whenever front oil seal is replaced, also replace wear sleeve.

1. Remove front wear sleeve (A) from crankshaft using JDG726 or JDG786 Front Wear Sleeve Puller. (See REMOVE FRONT WEAR SLEEVE/WITH TIMING GEAR COVER INSTALLED earlier in this group.)

NOTE: Wear sleeve can also be removed with a dull chisel. DO NOT score too deeply or cut through wear sleeve with chisel.

2. Score (B) LIGHTLY around OD of wear sleeve.
3. Remove crankshaft Woodruff key and gently pry wear sleeve from crankshaft.
4. Inspect crankshaft flange for nicks or burrs. Clean up flange with a light file and emery cloth.

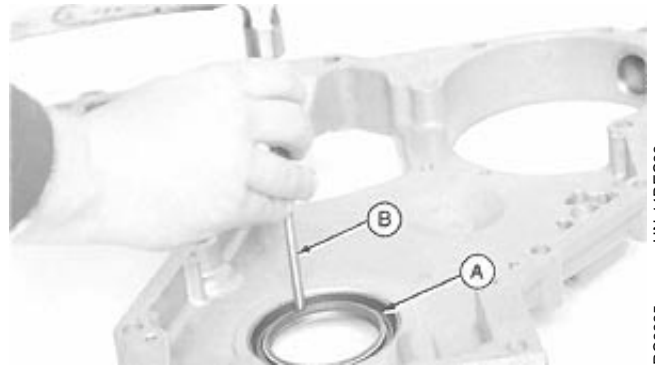


S11,0403,N -19-03JUL95

REMOVE FRONT OIL SEAL (WITH TIMING GEAR COVER REMOVED)

NOTE: Whenever front oil seal (A) is replaced, also replace wear sleeve.

1. Use a small punch (B), to tap around metal edge of seal to remove. Be careful not to damage timing gear cover.
2. Clean and inspect seal bore in cover. Check for nicks or burrs. Use medium grit emery cloth to smooth rough edges.



-JUN-14DEC88
RG3835

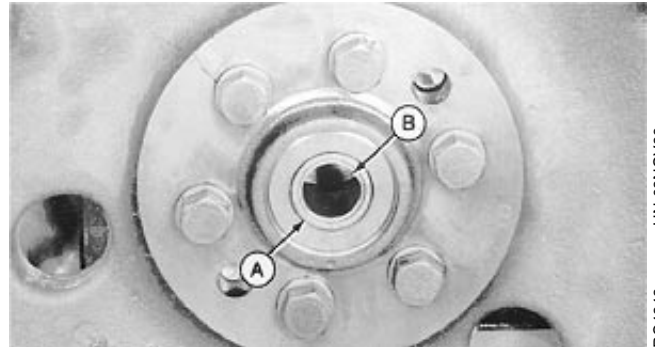
S11,0403,P -19-25JAN96

SERVICE CLUTCH SHAFT PILOT BUSHING

1. Inspect bushing sleeve (A) for excessive wear or damage. Replace as necessary.
2. Inspect clutch bushing (B) and end of clutch shaft for wear or damage. Replace as necessary.

CLUTCH SHAFT PILOT BUSHING SPECIFICATIONS

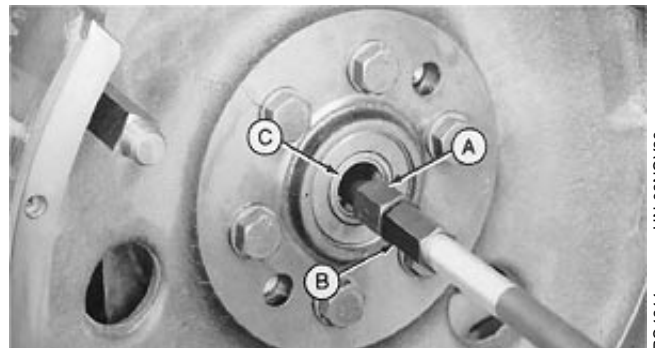
Shaft O.D.	25.40—25.43 mm (1.000—1.001 in.)
Bushing I.D.	25.50—25.55 mm (1.004—1.006 in.)



-JUN-08NOV89
RG4343

S11,2515,AD -19-03JUL95

3. Use the JT01731 Collet (A) and JT01722 Actuator Pin (B) with the slide hammer from the D01061AA Blind-Hole Puller Set to remove clutch shaft pilot bushing with sleeve (C).

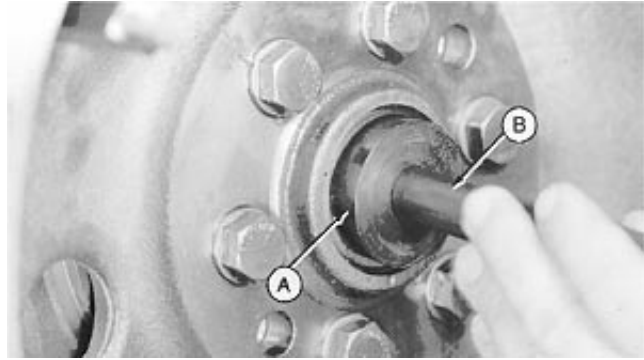


-JUN-08NOV89
RG4344

S11,2515,AE -19-03JUL95

4. Install new sleeve/bushing assembly using the 27516 Disk (A) with the 27488 Handle (B) from the D01045AA Bushing, Bearing, and Seal Driver Master Set.

Drive until flush to 0.051 mm (0.020 in.) below sleeve surface.



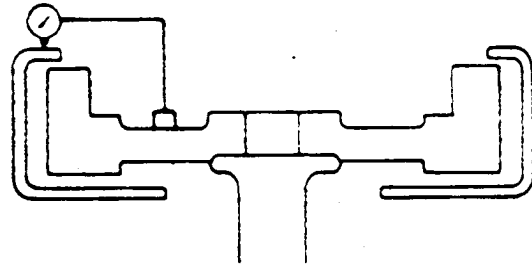
RG4345 -UN-08NOV89

S11,2515,AF -19-03JUL95

CHECK FLYWHEEL HOUSING FACE RUNOUT

1. Mount dial indicator on flywheel. Set pointer to contact PTO mounting surface on flywheel housing at right angles. Pointer should not contact holes in flywheel housing.

IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel housing face runout.



R22212 -UN-14DEC88

2. Rotate flywheel by turning crankshaft. Read total dial indicator movement.

FLYWHEEL HOUSING FACE RUNOUT SPECIFICATION

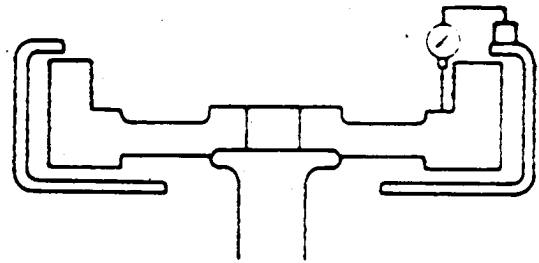
Maximum Variation 0.20 mm (0.008 in.)

S55,2015,L -19-03JUL95

15
22

CHECK FLYWHEEL FACE FLATNESS

1. Mount dial indicator base on flywheel housing. Position pointer to contact driving ring mounting surface. Do not allow pointer to contact driving ring mounting holes.



IMPORTANT: Maintain constant end pressure on crankshaft to hold shaft against thrust bearing when measuring flywheel face runout.

2. Rotate flywheel by turning crankshaft. Read total dial indicator movement. Resurface flywheel face or replace as required.

FLYWHEEL FACE FLATNESS SPECIFICATION

Maximum Variation 0.23 mm (0.009 in.)
Maximum Variation per 25 mm
(1.0 in.) of Travel 0.013 mm (0.0005 in.)

S11,5005,AM -19-02FEB94

-UN-14DEC88
R22213

REMOVE FLYWHEEL AND FLYWHEEL HOUSING

1. Disconnect clutch housing and clutch, if not previously done.
2. Remove starting motor.

CAUTION: Flywheel housing and flywheel are very heavy. Plan proper handling procedure to avoid injuries.

3. Remove flywheel housing (A).
4. Remove two flywheel attaching cap screws (B), and install two pilot studs in their place.
5. Remove the remaining cap screws, and carefully pull flywheel from crankshaft.



S11,2515,G -19-02APR93

-UN-09NOV89
RG4323

INSPECT AND REPAIR FLYWHEEL

1. Inspect the clutch contact face for scoring, overheating or cracks.
2. Replace a defective flywheel.
3. Examine ring gear for worn or broken teeth. If ring gear is damaged, replace gear.

S11,0403,S -19-03JUL95

REPLACE FLYWHEEL RING GEAR

⚠ CAUTION: Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer and do not exceed 182°C (360°F). Do not allow a flame or heating element to be in direct contact with the oil. Heat the oil in a well ventilated area. Plan a safe handling procedure to avoid burns.

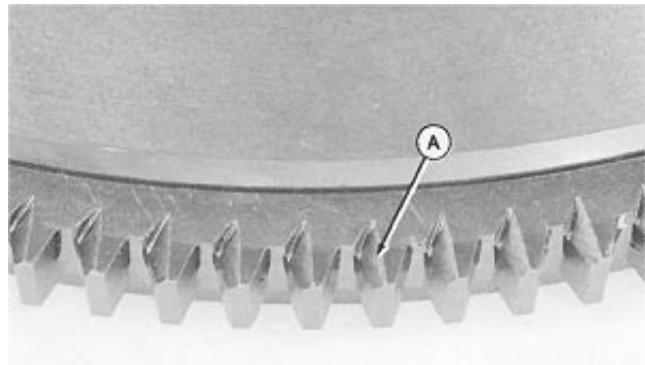
1. Place the flywheel on a solid flat surface.
2. Drive ring gear off with a brass drift and hammer.
3. Heat new ring gear to 148°C (300°F) using either heated oil, oven heat, or flame heat.

IMPORTANT: If flame heat is used, be sure gear is heated uniformly around circumference. **DO NOT OVERHEAT. SEE CAUTION.** Overheating may also destroy original heat treatment of gear.

4. Turn gear so side with chamfer (A) is toward engine with flywheel installed.
5. Install ring gear against shoulder of flywheel.



T90596 -UN-14OCT88



RG3838 -UN-14OCT88

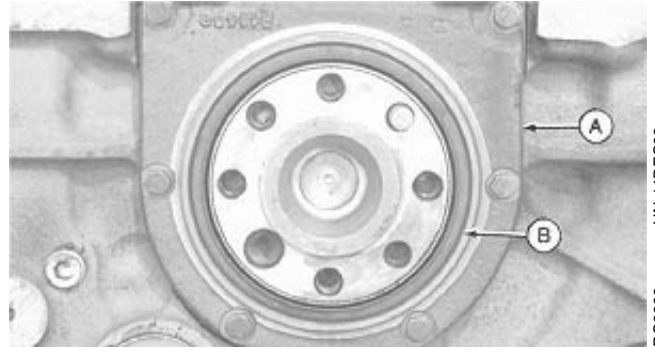
S11,2015,FX -19-03JUL95

REMOVE REAR OIL SEAL HOUSING

1. Remove seven cap screws and rear oil seal housing (A).

NOTE: Rear oil seal (B) will come off with housing.

2. Inspect rear oil seal and wear sleeve. Replace if necessary. (See REMOVE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE/WITH OIL SEAL HOUSING REMOVED in this group.)



Serial No. (—040390) shown.

S11,2020,G -19-03JUL95

RG3839 -JUN-14DEC88

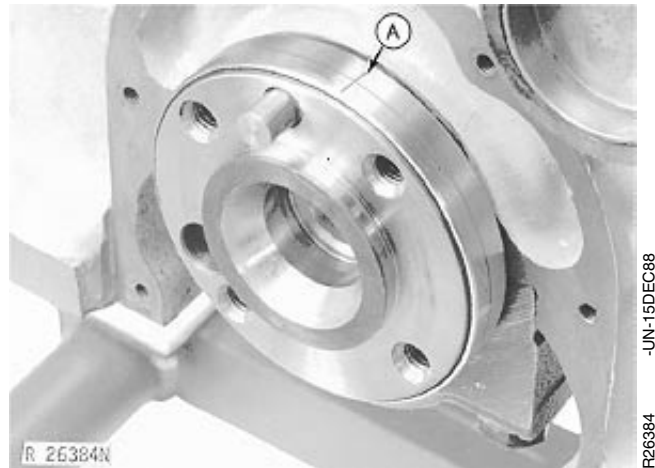
REMOVE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE (WITH OIL SEAL HOUSING REMOVED)

NOTE: These instructions are for use when the oil seal housing and oil pan will be removed.

1. Remove rear oil seal from housing using a small punch and chisel.

NOTE: The JDG790 Rear Wear Sleeve Puller is the preferred method for removing the rear wear sleeve. (See REPLACE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE/WITH OIL SEAL HOUSING INSTALLED in this group.)

2. If JDG790 Rear Wear Sleeve Puller is unavailable, remove rear wear sleeve by scoring lightly (A) the full width of wear sleeve in several places with a dull chisel. DO NOT cut through wear sleeve with chisel.
3. Gently pry wear sleeve from crankshaft.
4. Inspect crankshaft flange for burrs or nicks.
5. Clean flange with a light file and emery cloth.



S11,2020,H -19-25JAN96

R26384 -JUN-15DEC88

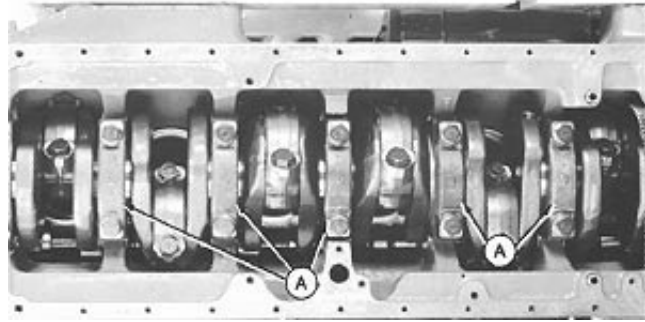
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REMOVE CRANKSHAFT MAIN BEARINGS

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 web. Keep matched bearing inserts with their respective main bearing cap for comparison with crankshaft journal (surface) from which removed.

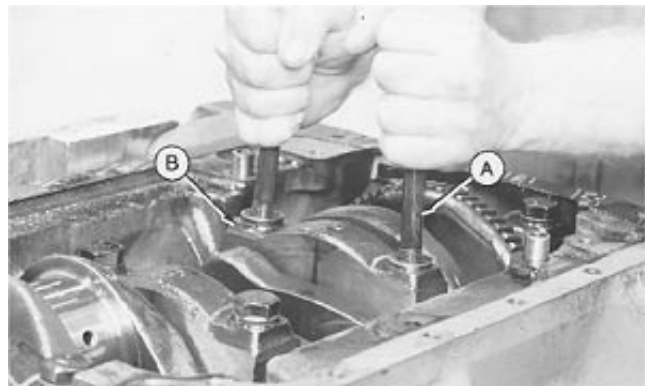
NOTE: When removing main bearings and caps, leave No. 1 and 7 main bearing caps installed until all connecting rod caps have been removed.



S11,2515,H -19-25JAN96

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26

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.



S11,2515,AJ -19-08MAR94

CHECK MAIN BEARING CLEARANCE

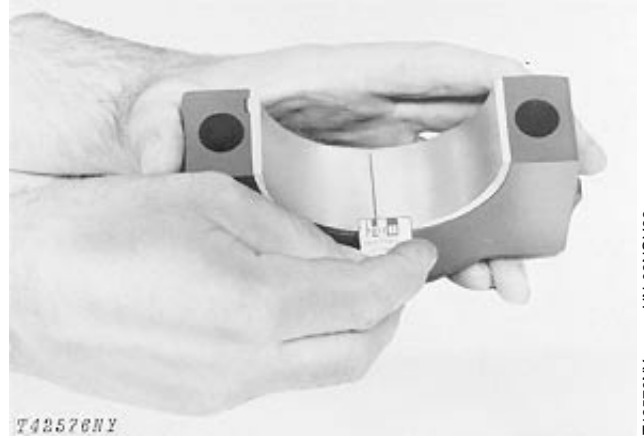
1. Place a strip of PLASTIGAGE in the center of the main bearing cap about three-fourths of the width of the bearing.
2. Use clean engine oil on PLASTIGAGE to prevent smearing.
3. Install cap and tighten cap screws to 285 N·m (210 lb-ft).
4. Remove cap and compare width of PLASTIGAGE with scale provided to determine clearance.

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

MAIN BEARING CLEARANCE SPECIFICATION

Main Bearing-to-Journal Clearance 0.046—0.122 mm
(0.0018—0.0048 in.)

Maximum Acceptable Oil Clearance 0.152 mm
(0.0060 in.)



T42576NY -JUN-09NOV88

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.

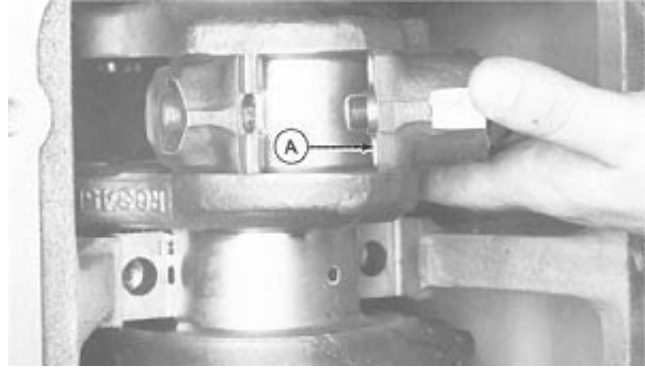
NOTE: Install a screw on each end of crankshaft to aid in lifting crankshaft.

3. Attach a lifting strap to crankshaft.

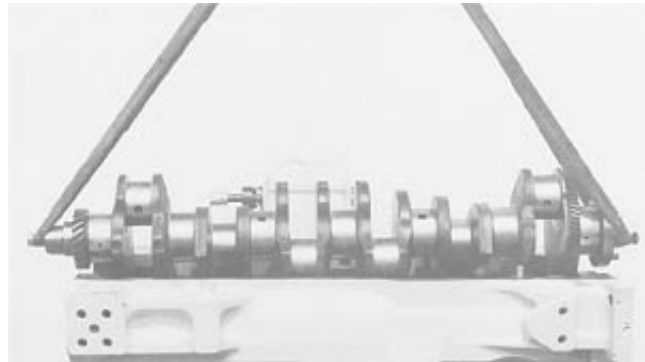
4. Using proper lifting equipment, carefully raise crankshaft out of cylinder block.

5. Clean crankshaft, especially oil passages, using solvent and compressed air.

6. Put crankshaft on clean V-blocks.



RG3840 -UN-14DEC88



RG2794 -UN-23FEB89

INSPECT CRANKSHAFT

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

1. Thoroughly clean crankshaft. Clear restrictions from all oil passages.
2. Inspect crankshaft for signs of load stress, cracks, or scratches on journals. Also check each journal for evidence of excessive overheating or discoloration. If either condition exists, replace crankshaft since heat treatment has probably been destroyed.
3. Inspect (front) crankshaft gear and (rear) oil pump drive gear for cracks, chipped teeth, or excess wear. Replace gear(s) as required. (See REPLACE CRANKSHAFT TIMING GEAR and REPLACE CRANKSHAFT OIL PUMP DRIVE GEAR, later in this group.)

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

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

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

IMPORTANT: The vibration damper MUST BE replaced whenever the crankshaft is replaced.

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7. Carefully check the crankshaft for cracks in the area of rod journal oil holes (A) and at journal fillets (B). Replace crankshaft if any cracks are found.

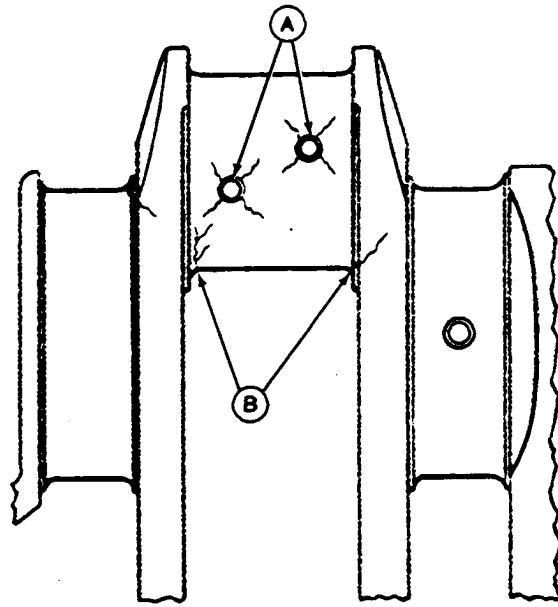
IMPORTANT: Small cracks may not be visible to the eye. Use a procedure such as the Fluorescent Magnetic Particle method. This method magnetizes the crank, employing magnetic particles which are fluorescent and glow under "black light". The crankshaft must be de-magnetized after the test.

8. Check condition of dowel pin in crankshaft rear flange. Dowel pin must not be cracked or chipped. Measure protrusion of dowel pin from face of flange. If dowel pin is damaged, or protrusion is not within specifications, replace dowel pin. If dowel pin is damaged, also inspect flywheel for damage.

NOTE: If replacing dowel pin, crankshaft must be removed to prevent damage to crankshaft thrust bearings.

CRANKSHAFT DOWEL PIN SPECIFICATIONS

Dowel Pin Protrusion From	
Rear Flange	13.5—14.5 mm (0.53—0.57 in.)



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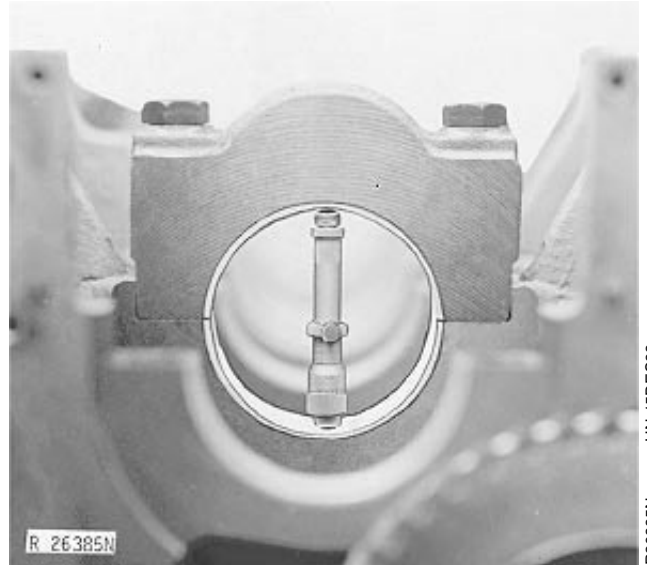
MEASURE ASSEMBLED I.D. OF BEARINGS AND O.D. OF CRANKSHAFT JOURNALS

1. With crankshaft out of cylinder block, install main bearing inserts and caps (be sure inserts are installed correctly).
2. Tighten main bearing cap screws to 285 N·m (210 lb-ft).
3. Measure I.D. of all bearings with an inside micrometer.

MAIN BEARING ID SPECIFICATIONS

With Bearing	95.270—95.320 mm (3.7508—3.7528 in.)
Without Bearing	101.651—101.677 mm (4.0020—4.0030 in.)

NOTE: *Inspect and measure assembled ID of connecting rod bearings. Compare measurements with connecting rod journal OD on crankshaft (See Group 10.)*



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4. Measure OD of all respective crankshaft journals at several points around journal.

CRANKSHAFT SPECIFICATIONS

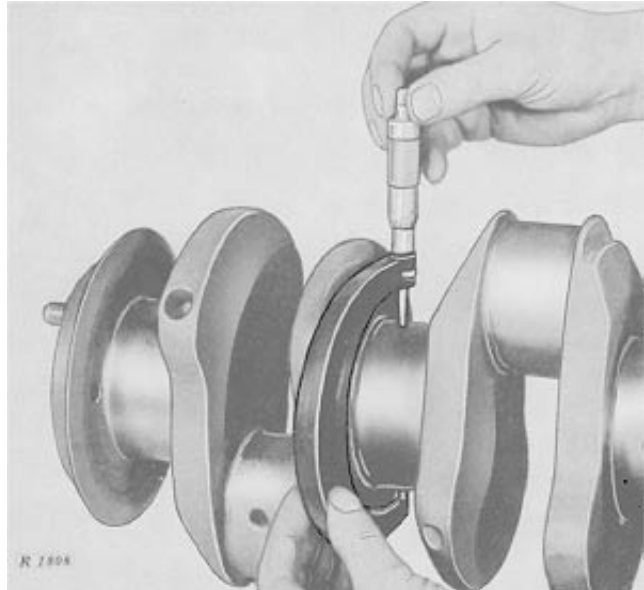
OD of Main Bearing Journal	95.200—95.225 mm (3.7480—3.7490 in.)
ID of Main Bearing (assembled)	95.270—95.320 mm (3.7508—3.7528 in.)

NOTE: If engine has previously had a major overhaul and undersized bearing inserts were used, above listed ID and OD dimensions may not be the same as those recorded. However, oil clearance should be within specifications. Oil clearance is 0.046—0.122 mm (0.0018—0.0048 in.). The maximum serviceable clearance is 0.152 mm (0.0060 in.).

Use crankshaft journal OD measurements to determine if journal is out-of-round or tapered.

CRANKSHAFT WEAR SPECIFICATIONS

Journal Taper per 25.4 mm (1.0 in.) of Journal Length	0.0025 mm (0.0001 in.)
Journal Out-of-Roundness	0.025 mm (0.0010 in.)



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MEASURE ASSEMBLED I.D. OF MAIN BEARING CAPS (WITHOUT BEARINGS)

1. With crankshaft removed from cylinder block, install main bearing caps without bearing inserts.
2. Tighten main bearing cap screws to 285 N·m (210 lb-ft).
3. Measure I.D. of all bearing caps with an inside micrometer. Compare to specifications given.

If any main bearing cap assembled I.D. is not within specification, blank (generic) bearing caps are available and must be line bored to specification. Replace individual bearing caps as needed.

IMPORTANT: Main bearing cap line boring should be done ONLY by experienced personnel on equipment capable of maintaining bore specifications.

MAIN BEARING CAP BORE SPECIFICATION

I.D. Without Bearings	101.651—101.677 mm (4.0020—4.0030 in.)
Maximum Bore Diameter Variation	0.013 mm (0.0005 in.)
Maximum Bore Diameter Taper	0.005 mm (0.0002 in.)
Maximum Straightness (Any bore-to-adjacent bore)	0.038 mm (0.0015 mm)
Maximum Straightness (5 center bores-to-adjacent bore)	0.076 mm (0.0030 in.)
Centerline of Bore-to-Top Deck	374.57—374.73 mm (14.747—14.753 in.)

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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.

CRANKSHAFT GRINDING GUIDELINES—CONTINUED

4. Cool the crankshaft while grinding by using coolant generously. DO NOT crowd the grinding wheel into the work.

IMPORTANT: Grind crankshaft with journals turning clockwise, as viewed from the front end of crankshaft. Lap or polish journals in opposite direction of grinding.

5. Polish or lap the ground surfaces to the specified finish to prevent excessive wear of the journals.

NOTE: Production crankshafts are induction hardened and shotpeened at the factory. Field shotpeening is not recommended due to the equipment required and port geometry.

6. If the thrust surfaces of the crankshaft are worn or grooved excessively, regrind and polish. Maintain the specified radius between each thrust surface and the bearing journal. An oversize thrust washer set containing one standard washer and two 0.18 mm (0.007 in.) oversize washers is available. (See THRUST BEARING NEW PART SPECIFICATIONS, later in this group.)

NOTE: When thrust surfaces are reground and oversize washers used, crankshaft end play specification must be maintained to within 0.038—0.380 mm (0.0015—0.0150 in.). See CHECK CRANKSHAFT END PLAY, earlier in this group.

7. Stone the edge of all oil holes in the journal surfaces smooth to provide a radius of approximately 1.50 mm (0.060 in.).

8. When finished grinding, inspect the crankshaft for cracks with the Florescent Magnetic Particle method, or similar method.

9. De-magnetize the crankshaft.

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

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CRANKSHAFT GRINDING SPECIFICATIONS

Engine Stroke	127 mm (5.0 in.)
Main and Rod Journal Surface Finish	Lap 0.25 Um (9.8 AA)
Thrust Journal Surface Finish	Lap 0.40 Um (16 AA)
Rod Journal Fillet Radius	4.49—4.85 mm (0.177—0.191 in.)
Main and Thrust Journal Fillet Radius	3.94—4.44 mm (0.155—0.175 in.)
Thrust Journal Width	47.57—47.67 mm (1.873—1.877 in.)

Bearing Size	Crankshaft Main Journal OD	Crankshaft Rod Journal OD
Standard	95.000—95.225 mm (3.7480—3.7490 in.)	88.844—88.874 mm (3.4980—3.4990 in.)
0.05 mm (0.002 in.) Undersize	94.950—95.175 mm (3.7460—3.7470 in.)	88.794—88.824 mm (3.4960—3.4970 in.)
0.25 mm (0.010 in.) Undersize	94.750—94.975 mm (3.7380—3.7390 in.)	88.594—88.624 mm (3.4880—3.4890 in.)
0.51 mm (0.020 in.) Undersize	94.490—94.715 mm (3.7280—3.7290 in.)	88.334—88.364 mm (3.4780—3.4790 in.)
0.76 mm (0.030 in.) Undersize	94.240—94.465 mm (3.7180—3.7190 in.)	88.064—88.114 mm (3.4680—3.4690 in.)

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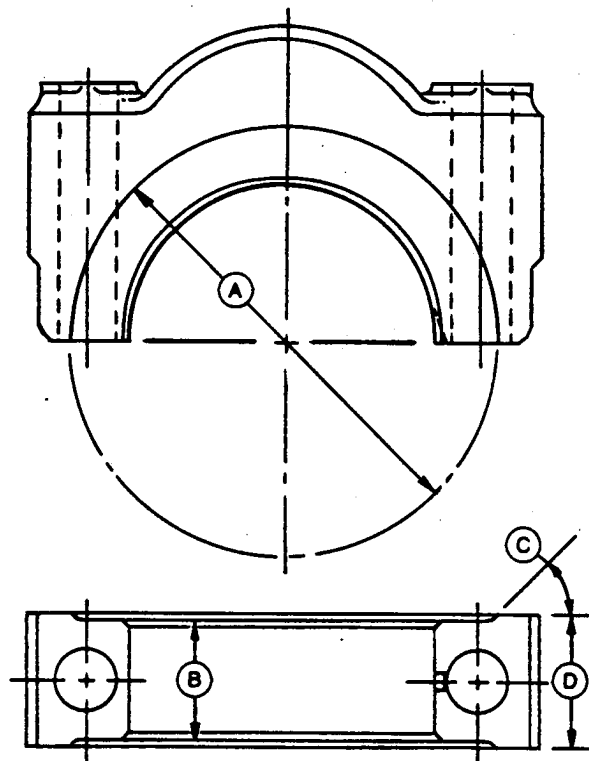
THRUST BEARING NEW PART SPECIFICATIONS

IMPORTANT: Install thrust bearing in cylinder block and tighten to specification before regrinding or polishing thrust surfaces to assure that all surfaces on bearing and on block web are correctly aligned.

THRUST BEARING NEW PART SPECIFICATION

A—Thrust Washer Clearance Base Circle	129.28—130.81 mm (5.09—5.15 in.)
B—Thrust Surface Width	40.615—40.716 mm (1.559—1.603 in.)
C—Relief Angle	45°
D—Bearing Cap Overall Width	41.81—42.31 mm (1.646—1.666 in.)

Maximum runout for thrust surface is 0.025 mm (0.0010 in.)



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RG5299

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REPLACE CRANKSHAFT DRIVE GEAR

IMPORTANT: Crankshaft must be removed before replacing drive gear.

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

1. Install JDG787 Forcing Screw Spud in nose of crankshaft.
2. Protect crankshaft wear sleeve surface with masking tape.
3. Remove crankshaft gear using D01218AA* Puller, 630-0* Step Place, D01222AA* Legs, and D01219AA* Hydraulic Puller.
4. Discard gear after removal.
5. Remove Woodruff key from crankshaft keyway.
6. Remove masking tape.

IMPORTANT: Crankshaft gear must be installed on crankshaft before crankshaft is installed in engine, otherwise damage to thrust bearings could occur.



CAUTION: Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer and do not exceed 182°C (360°F). Do not allow a heating element to be in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

7. Heat crankshaft gear (if removed) to 148°C (300°F), using either heated oil or oven heat.

IMPORTANT: If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT. SEE CAUTION. Overheating may also destroy original heat treatment of gear.

8. Install Woodruff key in crankshaft.
 9. Place gear on crankshaft flange. Be sure key on crankshaft is properly aligned with keyway in gear.
- IMPORTANT: When installing gear, do not gouge or nick crankshaft flange.**
10. Use JDH7 Driver to firmly seat gear against crankshaft flange.
 11. Once gear cools, reseal gear using JDH7 Driver.

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

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.

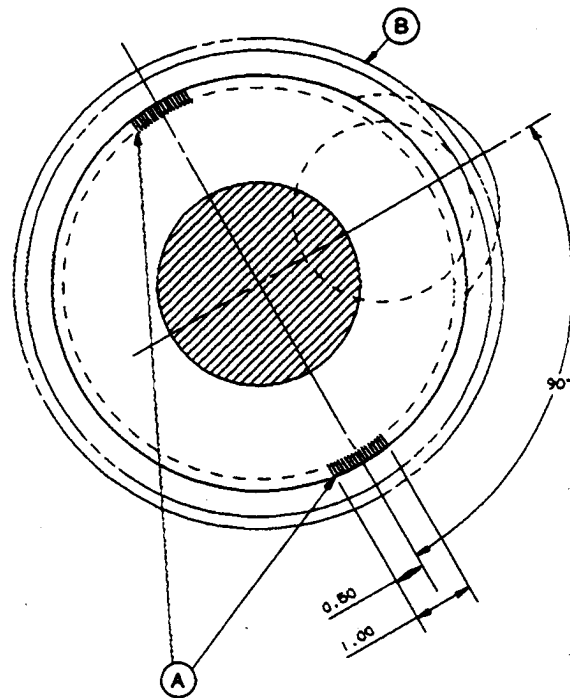
4. Heat new gear to 148°C (300°F) using either heated oil or oven heat.

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.



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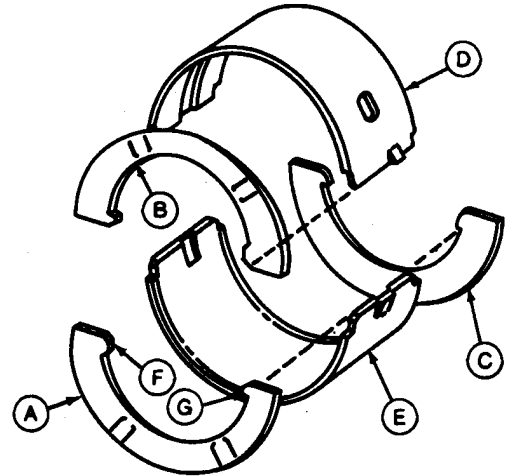
INSPECT THRUST BEARINGS

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



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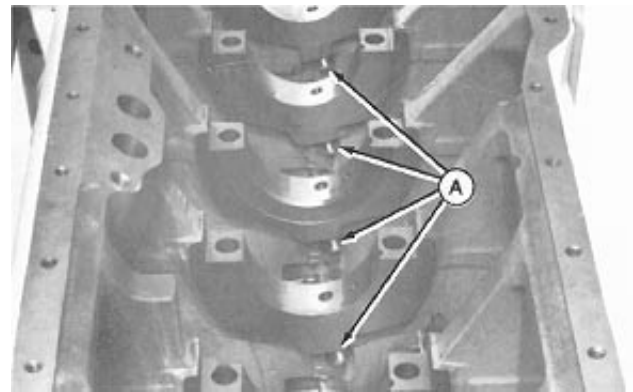
REMOVE AND CLEAN PISTON COOLING ORIFICES

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.).



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INSTALL MAIN BEARING INSERTS IN BLOCK

IMPORTANT: If new main or thrust bearing inserts or thrust washers are installed, they must be installed as a matched set.

During assembly, apply a liberal coating of clean engine oil to:

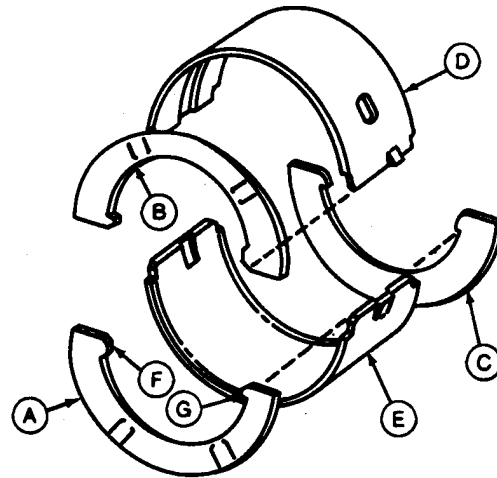
- All main bearing webs in block
- Both sides of main bearing inserts, thrust bearing inserts, and thrust washers
- Entire OD of crankshaft main bearing journals

1. Install six main bearing inserts in block except No. 5 thrust bearing insert. Be sure locating tabs on inserts are properly positioned with slot in block web.

IMPORTANT: Thrust washers (A) and (C) go on both sides of bearing cap and thrust washer (B) on rear side of block web only with the slots facing the crankshaft.

2. Install No. 5 main thrust bearing insert (D) in block. Install upper thrust washer on bearing insert at rear of block web. Be sure tangs on washer are properly positioned on thrust bearing insert.

3. Check to make sure that oil holes in main bearing web are properly aligned with oil holes in bearing inserts.



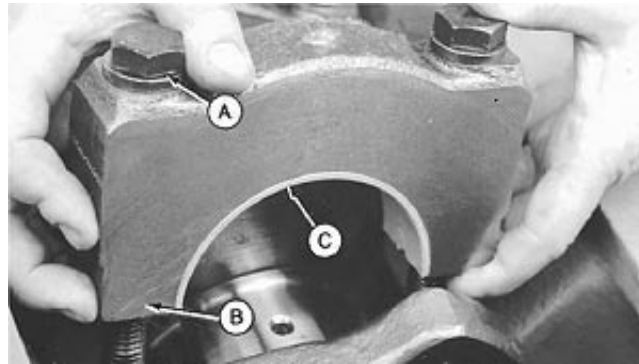
A—Lower Rear Thrust Washer
B—Upper Rear Thrust Washer
C—Lower Front Thrust Washer
D—Main Bearing Block Thrust Bearing
E—Main Bearing Cap Thrust Bearing
F—Large Tang
G—Small Tang

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S11,0403,AI -19-25JAN96

INSTALL CRANKSHAFT



RG3741 -JUN-14DEC88

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 all 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.

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.

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.

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.

NOTE: DO NOT PRY crankshaft on No. 5 main thrust bearing.

6. Gently pry crankshaft rearward and then forward to align thrust washers 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 285 N·m (210 lb-ft).
9. Turn crankshaft by hand. If it does not turn easily, disassemble parts and determine the cause.

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10. Install connecting rod caps (A) with bearings (B), using new cap screws and tighten to 75 N·m (55 lb-ft). Tighten an additional 90°—100° after initial tightening. (See TORQUE TURN CONNECTING ROD CAP SCREWS in Group 10.)

IMPORTANT: Do not use pneumatic wrenches to tighten connecting rod cap screws. Threads can be damaged.

11. Check crankshaft end play. (See CHECK CRANKSHAFT ENDPLAY in this group.)



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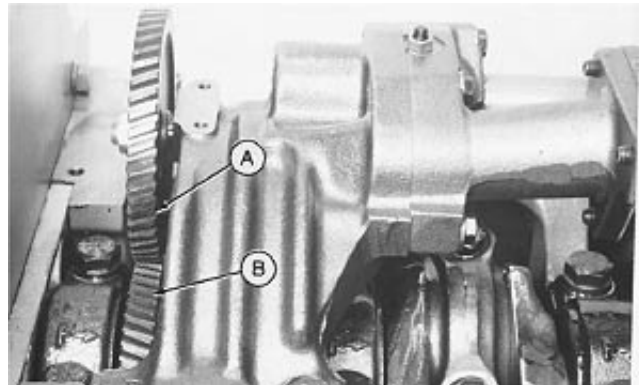
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INSTALL OIL PUMP AND CHECK DRIVE GEAR-TO-CRANKSHAFT CLEARANCE

1. Install engine oil pump at this time. (See INSTALL OIL PUMP in Group 20.)

IMPORTANT: Gently pry crankshaft forward and check that oil pump drive gear (A) and crankshaft gear (B) are properly meshed.

Gently pry crankshaft rearward (toward flywheel end), and check for clearance between oil pump drive gear face and throw of crankshaft. There should be at least 0.38 mm (0.015 in.) clearance. If clearance is below specification, check thrust bearing for proper placement.



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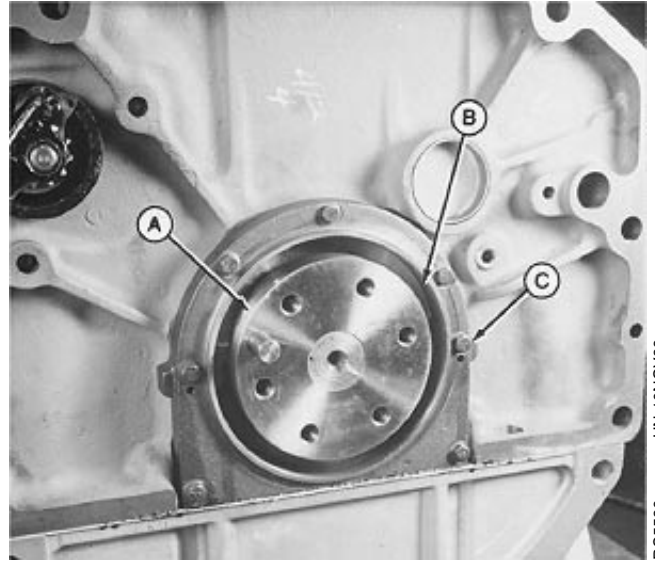
INSTALL CRANKSHAFT REAR OIL SEAL HOUSING

NOTE: Oil pan (shown installed) must be either removed or cap screws loosened and pan lowered to accurately install crankshaft rear oil seal housing.

Make sure the OD of crankshaft flange (A) and ID of seal housing (B) are free from nicks or burrs. Restore damaged surfaces with file or emery cloth. Clean with compressed air.

1. Using a new gasket, install oil seal housing (C) on locating dowels in cylinder block. Install all seven cap screws and tighten to 27 N·m (20 lb-ft).

2. Check oil seal housing runout. (See CHECK OIL SEAL HOUSING RUNOUT, later in this group.)



Serial No. (—040390) shown.

RG5526 -UN-10NOV89

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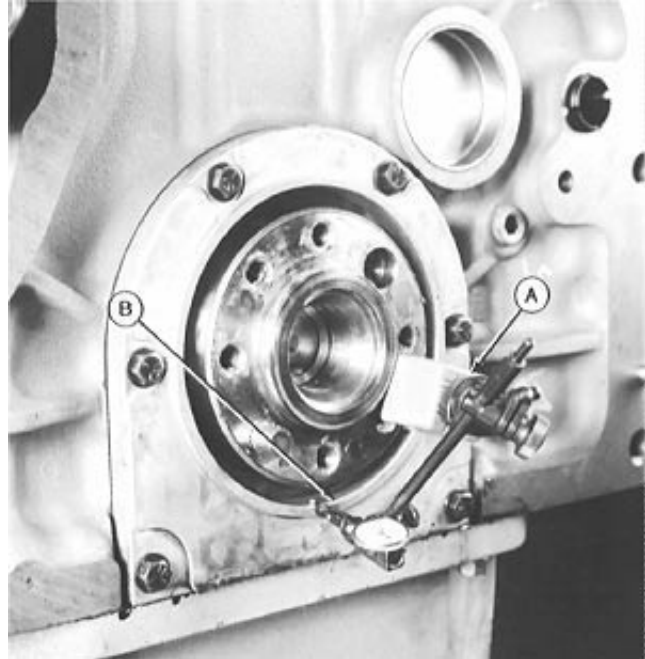
CHECK OIL SEAL HOUSING RUNOUT

IMPORTANT: Rear oil seal housing is positioned by two locating dowels in cylinder block. If housing bore runout is not within specification, install a new housing; there is no adjustment for runout specification.

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, install a new housing and check runout.

3. Recheck oil seal housing bore runout. If runout still exceeds specification, oil seal housing bore is possibly distorted and should be replaced.



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CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE HANDLING PRECAUTIONS

Use the following precautions for handling seal and wear sleeve:

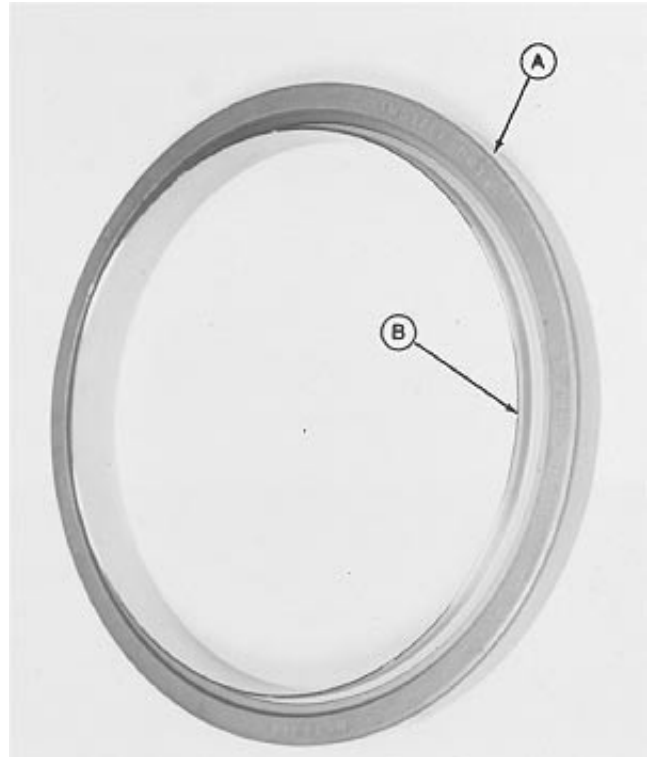
—Seal (A) and wear sleeve (B) are assembled. DO NOT SEPARATE. If parts become separated, discard and replace with a new assembly. Attempts to reassemble will cause the wear sleeve to damage the seal allowing engine oil to leak past seal.

—Always install seal and wear sleeve assembly immediately after removal from plastic bag to avoid possible dirt contamination.

—No lubrication of any kind is to contact seal when installing. Use of a lubricant may result in premature seal failure.

—Install oil seal/wear sleeve assembly with the black seal lip and wear sleeve ID chamfer toward the engine. If seal is reversed, engine oil may be lost because grooves in oil seal lip would be incorrect with respect to direction of crankshaft rotation.

—Oil seal/wear sleeve assembly MUST be installed with the JDG300 Oil Seal and Wear Sleeve Installer. Tool set consists of JDG309 Pilot and JDG310 Installer.



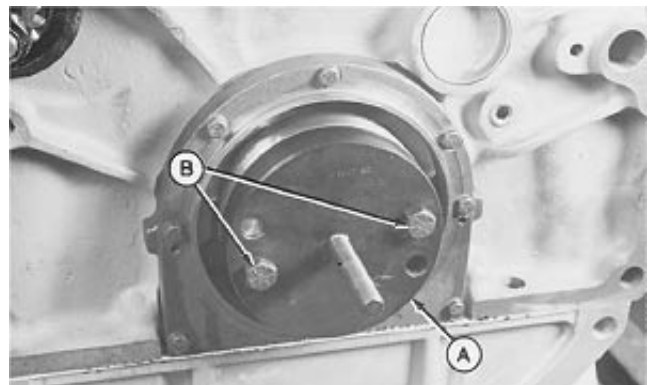
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S11,2515,AL -19-03JUL95

INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE ASSEMBLY

IMPORTANT: Installation tools must be clean to assure proper positioning on crankshaft flange and to hold run-out within specification so oil seal does not fail prematurely.

1. Install JDG309 Pilot (A) over dowel pin on rear end of crankshaft.
2. Tighten two cap screws (B) securely.

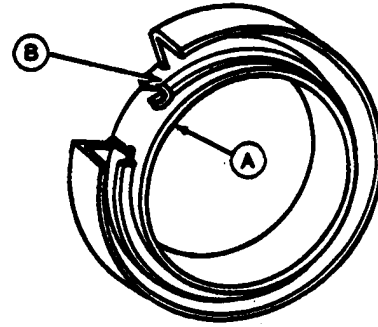


RG5576 -UN-10NOV89

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

Chamfer on wear sleeve (A), upper illustration, and open side of seal (B, upper illustration) must be on the same side.

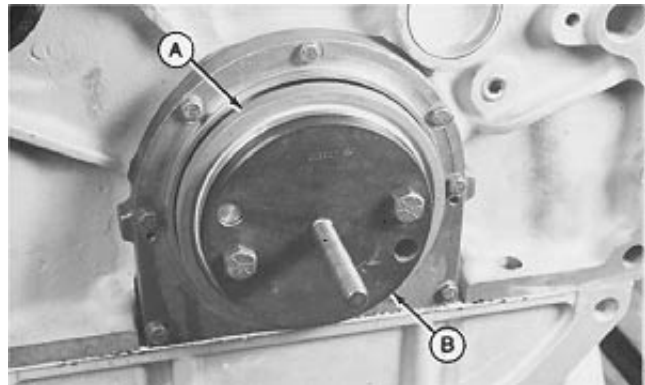


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3. Apply a light coating of LOCTITE 609 Retaining Compound around the leading edge of crankshaft.

IMPORTANT: DO NOT allow sealant to get on any part of wear sleeve OD or oil seal.

4. Carefully install oil seal/wear sleeve assembly (A) over JDG309 Pilot (B) on crankshaft flange with black seal lip toward engine.



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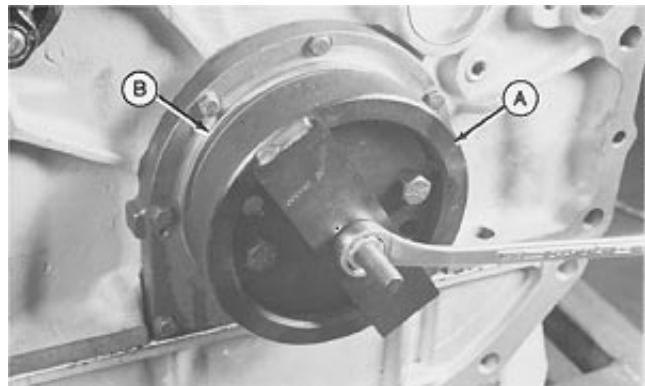
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5. Position JDG310 Installer (A) so that hole in the installer cross plate goes over threaded stud of pilot and that cross plate can not bottom on cap screws of pilot. Install washer and nut on stud.

6. Tighten nut to draw JDG310 Installer in until it bottoms on oil seal housing flange (B). When the tool bottoms, seal and wear sleeve assembly will be correctly positioned.

7. Remove JDG309 and JDG310 Tools from end of crankshaft.

8. Run engine for 5—10 minutes and check for leaks, after completing final assembly.



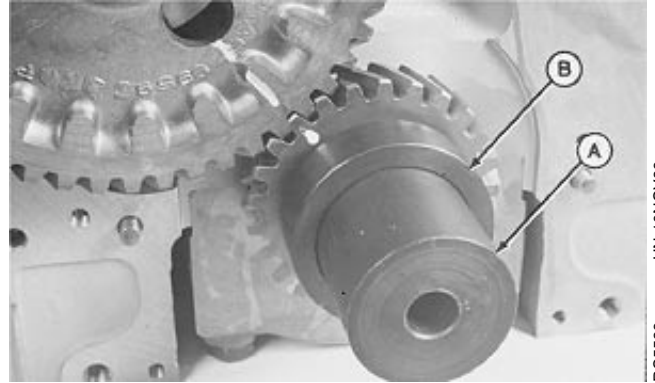
RG5578 -UN-10NOV89

S11,2515,AO -19-20NOV95

INSTALL CRANKSHAFT FRONT WEAR SLEEVE

NOTE: Front wear sleeve can be installed with timing gear cover removed or installed on engine.

1. Coat ID of new wear sleeve with LOCTITE 609 Retaining Compound or equivalent.
2. Use the JDG467 Driver (A) and JDG468 Spacer (B), from the JDE3 Front Wear Sleeve Installer Set to properly seat wear sleeve on crankshaft flange.



RG5529 -UN-10NOV89

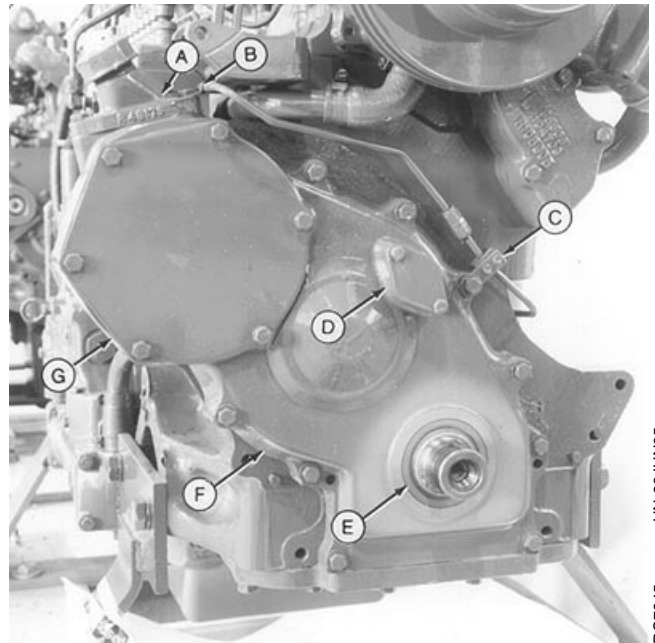
S55,2515,Q -19-25JAN96

INSTALL TIMING GEAR COVER

1. Using a new gasket, install timing gear cover (F). Tighten cap screws to 47 N.m (35 lb-ft).
2. Trim gasket flush with oil pan mounting surface.
3. Install clamps (B) and (C).

NOTE: Engine Serial No. (053817—): Coat threads of lower two cap screws for injection pump gear cover with LOCTITE 242 Thread Lock and Sealer (medium strength) to prevent oil leakage.

4. Install filler tube (A), cover (G) and plate (D), if removed, using new gaskets.
5. Install and connect magnetic pickup, if equipped.
6. Install front oil seal (E). (See INSTALL CRANKSHAFT FRONT OIL SEAL/TIMING GEAR COVER INSTALLED, next in this group.)



Late model engine shown.

- A—Filler Tube
- B—Clamp
- C—Clamp
- D—Magnetic Pickup/Block-Off Plate
- E—Front Oil Seal
- F—Timing Gear Cover
- G—Injection Pump Gear Cover

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47

RG7345 -UN-23JUN95

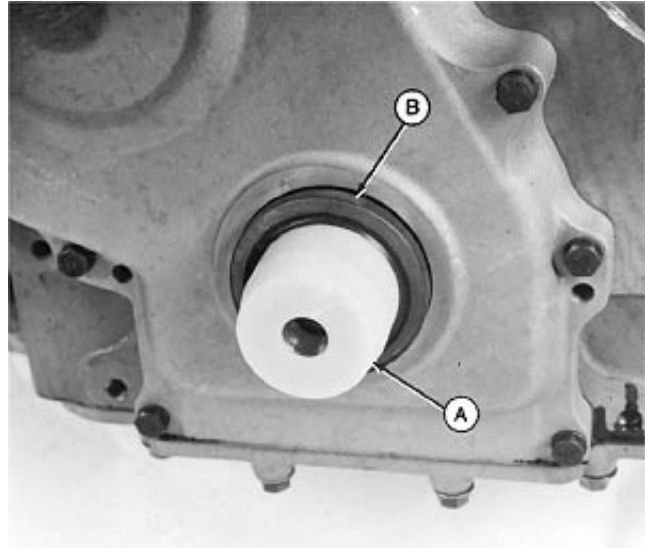
S11,2515,AR3 -19-25JAN96

INSTALL CRANKSHAFT FRONT OIL SEAL

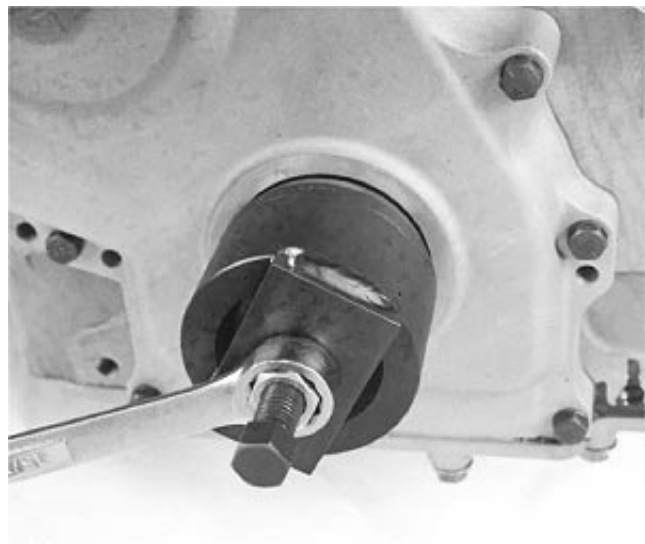
IMPORTANT: Whenever front oil seal is replaced, wear sleeve MUST be replaced also.

1. Place JDG720-2 Seal Protector (A) on nose of crankshaft. Lubricate ID of front oil seal (B) lips with clean engine oil and slide seal onto seal protector. Be careful not to roll oil seal lips.
2. Position JDG720-4 Spacer Ring on end of JDG720-3 Seal Installer and place installer onto seal protector against seal.
3. With nut installed onto JDG720-1 Forcing Screw, thread forcing screw into nose of crankshaft until it bottoms.
4. Tighten nut against crossplate of installer until installer bottoms on front face of timing gear cover.
5. Remove installation tools.

IMPORTANT: Verify seal is installed squarely in bore, flush with front face of timing gear cover, and that seal lips are not rolled on wear sleeve.



RG6111
-UN-27JAN92



RG6112
-UN-27JAN92

RG,CTM61,G15,13-19-25JAN96

INSTALL VIBRATION DAMPER AND PULLEY

IMPORTANT: Improper damper installation may cause damper inertia ring/crankshaft pulley contact. This contact severely hampers damper operation and can result in gear train failures.

1. If vibration damper (A) was removed from damper pulley (B), refer to the following application diagrams to assure all parts are assembled in the correct sequence for your engine application. Tighten NEW M10 cap screws to 75 N·m (55 lb-ft). Tighten 3/8 in. cap screws to 41 N·m (30 lb-ft).

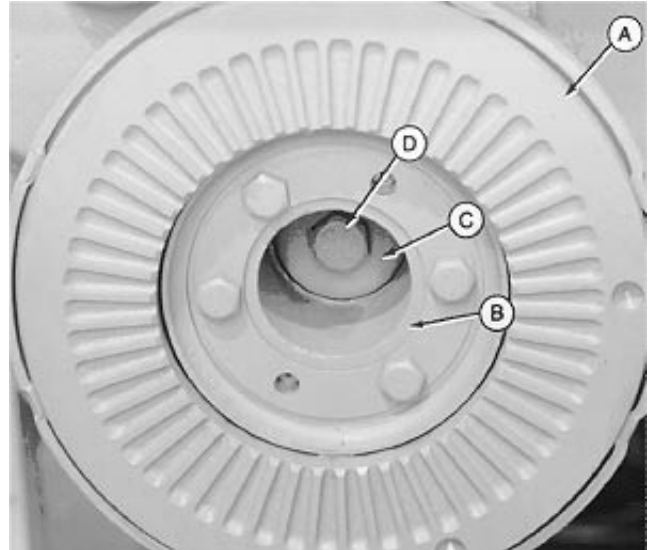
2. Make sure Woodruff key on crankshaft is in place. Position damper pulley assembly onto crankshaft.

3. Use the special washer (C) and insert a cap screw that is 25.4 mm (1 in.) longer than original cap screw (D). Tighten cap screw until it just bottoms out.

IMPORTANT: Always use a new cap screw in nose of crankshaft when installing vibration damper assembly.

4. Remove longer cap screw and insert a new 5/8-11 cap screw with special washer.

5. Tighten cap screw to 203 N·m (150 lb-ft).



A—Vibration Damper
B—Damper Pulley
C—Washer
D—Cap Screw

RG4347 -UN-09APR90

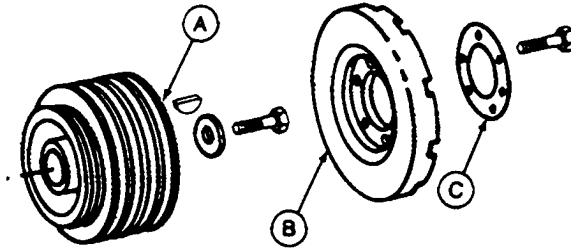
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49

S11,2515,BA -19-25JAN96

Crankshaft Main Bearings and Flywheel/Install Vibration Damper and Pulley

Engine Applications: 6619AE-01, 02, 03 6619AR-01, 06, 08, 09, 10, 11, 12, 13, 14

NOTE: Damper pulley (A) and vibration damper (B) may be removed and installed individually or as an assembly for this application. Radius side of vibration damper **MUST** face away from engine on 6619AR-01, -06, -10, and -13 engines. Radius side of vibration damper **MUST** face engine on all other applications listed above.



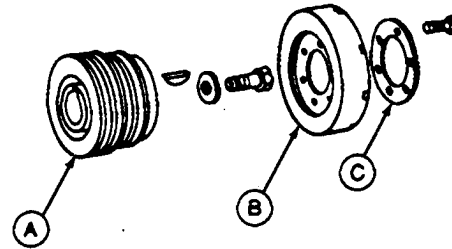
- A—Damper Pulley
- B—Vibration Damper
- C—Washer

S11,2515,BB -19-25JAN96

RG5013 -UN-06APR89

Engine Applications: 6619AT-02, 6619TT-01, 02

NOTE: Damper pulley (A) and vibration damper (B) may be removed and installed individually or as an assembly for this application.



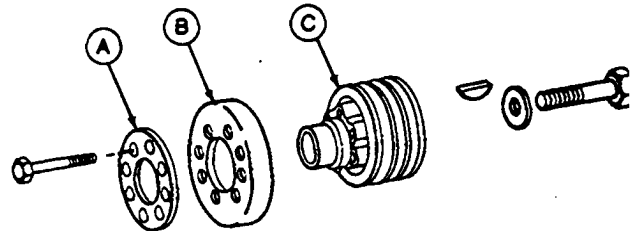
- A—Damper Pulley
- B—Vibration Damper
- C—Washer

S11,2515,BC -19-26FEB87

RG5014 -UN-06APR89

Engine Applications: 6619AT-01, 04

NOTE: Damper pulley (C) and vibration damper (B) must be installed as an assembly for this application. Radius side of vibration damper **MUST** face engine.



- A—Washer
- B—Vibration Damper
- C—Damper Pulley

S11,2515,BD -19-04DEC86

RG5015 -UN-06APR89

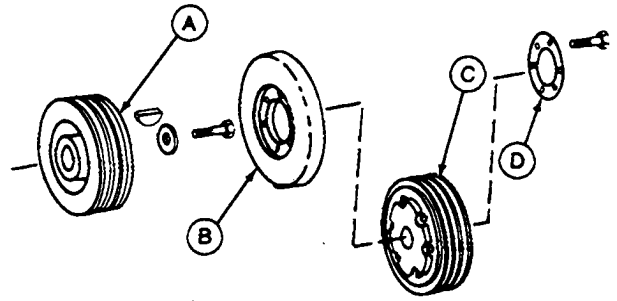
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50

Crankshaft Main Bearings and Flywheel/Install Vibration Damper and Pulley

Engine Applications: 6619AF, 6619TF-01

NOTE: Damper pulley (A), vibration damper (B) and sheave (C) may be removed and installed individually or as an assembly for this application. Radius side of vibration damper MUST face engine.

- A—Damper Pulley
- B—Vibration Damper
- C—Sheave (Option)
- D—Washer



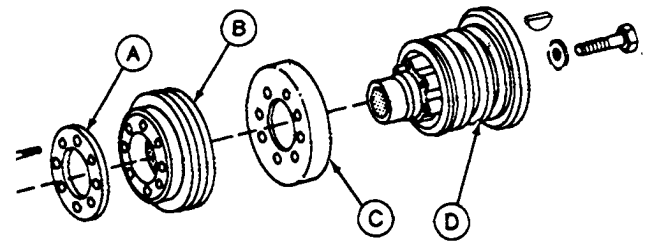
S11,2515,BE -19-04DEC86

RG5016 -UN-06APR89

Engine Applications: 6619AT-03, 05, 07

NOTE: Damper pulley (B), vibration damper (C), and sheave (D) must be installed as an assembly for this application. Radius side of vibration damper MUST face engine.

- A—Washer
- B—Damper Pulley
- C—Vibration Damper
- D—Sheave



S11,2515,BF -19-03JUL95

RG5017 -UN-06APR89

INSTALL FLYWHEEL HOUSING AND FLYWHEEL

1. Coat threads of NEW flywheel attaching cap screws with LOCTITE 242 Thread Lock and Sealer or its equivalent.
2. Position flywheel over dowel pin and start two cap screws (B). Do not tighten.
3. Install remaining flywheel attaching cap screws.
4. Tighten flywheel attaching cap screws to 176 N·m (130 lb-ft).

NOTE: For wet clutch applications, use a new gasket while installing flywheel housing.

5. Install flywheel housing (A) and tighten flywheel housing-to-cylinder block cap screws with lock washers to 407 N·m (300 lb-ft). Tighten flywheel housing-to-oil pan cap screws to 325 N·m (240 lb-ft).

IMPORTANT: Perform flywheel-to-flywheel housing runout checks as outlined earlier in this group.

6. Coat threads of cap screws with LOCTITE 242 and install starting motor, if removed. Tighten cap screws to 102 N·m (75 lb-ft).



RG4323
-UN-09NOV89

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52

S11,2515,X -19-25JAN96

COMPLETE FINAL ASSEMBLY

1. Install oil pan and clean engine oil. (See Lubrication System, Group 20.)
2. Fill cooling system with proper coolant. (See Fuels, Lubricants, and Coolant, Group 02.)
3. Perform engine break-in as instructed in Group 05 or your machine technical manual.

S11,2515,AX -19-03JUL95

Group 16 Camshaft and Timing Gear Train

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

Magnetic Follower Holder Kit D15001NU

RG5073 -UN-23AUG88

Hold cam followers when removing or installing camshaft.

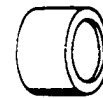


S53,D15001,NU -19-24APR92

Front Wear Sleeve Installer JDE3

RG5080 -UN-23AUG88

Install front oil seal in timing gear cover.



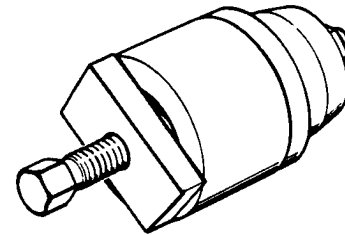
S53,JDE3A -19-16AUG94

Front Seal Installer JDG720

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

Set consists of:

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



RG,JDG720 -19-25JAN96

-UN-06MAR92

Camshaft Bushing Replacement Set JDE6

Used to remove and install camshaft bushings.

NOTE: JDG405 Camshaft Bushing Replacement Set may also be used if JDE6 is not available.



-UN-23AUG88
R26149N

S53,JDE6 -19-15JUN89

Camshaft and Timing Gear Train/Essential Tools

Camshaft Bushing Service Set JDG405

Used with D01299AA Slide Hammer to remove and install camshaft bushings.

NOTE: Use JDE6 if JDG405 is not available.



S12,JDG405 -19-03JUL95

RG4228 -UN-27JAN92

Slide Hammer D01299AA

Used with JDG405 Camshaft Bushing Service Set to remove camshaft bushings.



S53,D01299,AA -19-15JUN89

RG78104H1 -UN-15DEC88

Flywheel Turning Tool JDE81-1

RG4950 -UN-23AUG88

Rotate engine flywheel. Use with JDE81-4.



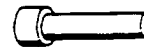
S53,JDE811 -19-25JAN96

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2

Timing Pin JDE81-4

RG5068 -UN-23AUG88

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

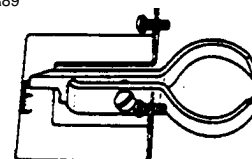


RG,JDE814 -19-03JAN95

Cam Wear Indicator JDE149

RG4939 -UN-06APR89

Measure camshaft gear-to-oil pump gear backlash.

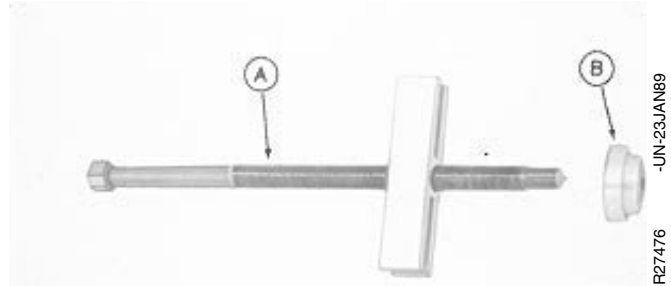


S53,JDE149 -19-25JUL95

Camshaft and Timing Gear Train/Essential Tools

- A—Gear and Pulley Puller D01206AA*
- B—Step Plate 630-6**

Used to remove vibration damper and pulley.



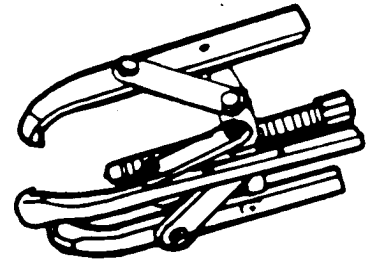
* From D01048AA Puller Set.

** From D01212AA Step Plate Adapter Set.

S11.2515,AY -19-25JAN96

Vibration Damper and Pulley Puller Set JDG728

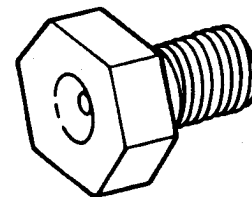
Used to remove multi-groove vibration damper and pulley



RG,JDG728 -19-25JAN96

Thread Protector JDG787

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



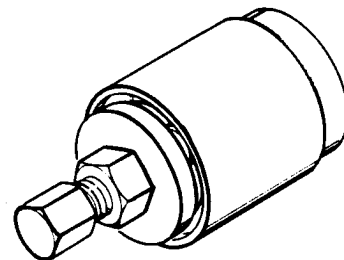
RG,JDG787 -19-25JAN96

Front Wear Sleeve Puller JDG726

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

Set consists of:

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

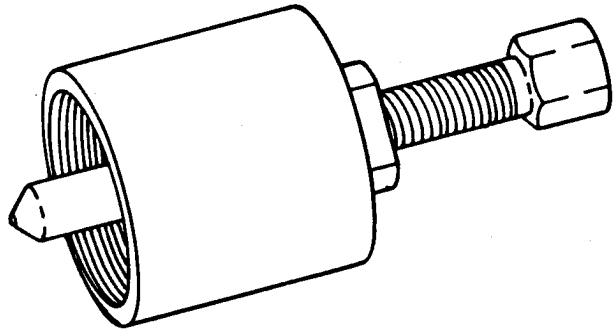


RG,JDG726 -19-02APR93

Front Wear Sleeve Puller JDG786

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

NOTE: JDG726 Front Wear Sleeve Puller may be used in place of JDG786.



RG6428 -UN-13OCT92

RG,JDG786,1 -19-02APR93

OTHER MATERIAL

Name	Use
High Temperature Grease (TY6333 or TY6347)	Lubricate camshaft lobes and bearing journals before camshaft installation.
LOCTITE 609 Retaining Compound (TY9372/T43515)	Coat ID of wear sleeve.
LOCTITE 242 Thread Lock and Sealer (TY9370/T43512)	Coat threads of lower two injection pump drive gear cover cap screws, camshaft thrust plate cap screws and tachometer drive cap screws.
PERMATEX AVIATION (Form-a-Gasket No. 3) (TY6299)	Seal camshaft bore plug.

RG,CTM9,G16,1 -19-25JAN96

16
4

CAMSHAFT AND TIMING GEAR TRAIN SPECIFICATIONS

Item	New Part Specification	Wear Tolerance
Valve Lift at 00.0 mm (0.0 in.) Clearance:		
Intake Valve	13.20—13.38 mm (0.520—0.527 in.)	—
Exhaust Valve	11.85—12.03 mm (0.467—0.474 in.)	—
Cam Lobe Lift:		
Intake Lobe	8.02—8.18 mm (0.316—0.322 in.)	—
Exhaust Lobe	7.19—7.35 mm (0.283—0.289 in.)	—
Camshaft End Play	0.063—0.279 mm (0.0025—0.0110 in.)	0.38 mm (0.0150 in.)
Thrust Plate Thickness:		
(—058209)	3.010—3.086 mm (0.1185—0.1215 in.)	2.883 mm (0.1135 in.)
(058210—)	4.724—4.800 mm (0.1860—0.1890 in.)	4.623 mm (0.1820 in.)
Thrust Spacer Thickness:		
(—058209)	3.213—3.289 mm (0.1256—0.1295 in.)	—
(058210—)	4.915—4.965 mm (0.1935—0.1955 in.)	—
Cam Follower OD	34.874—34.900 mm (1.3730—1.3740 in.)	—
Cam Follower Bore Diameter in Block	34.976—35.026 mm (1.377—1.379 in.)	—
Camshaft Bushing Bore in Block		
(Without Bushing)	63.487—63.513 mm (2.4995—2.5005 in.)	—
Maximum Runout	0.038 mm (0.0015 in.)	—
Camshaft Bushing ID	60.389—60.439 mm (2.3775—2.3795 in.)	—
Camshaft Journal OD	60.312—60.338 mm (2.3745—2.3755 in.)	—
Camshaft Bushing-to-Journal		
Clearance	0.051—0.127 mm (0.0020—0.0050 in.)	—
Front Camshaft Journal-to-Thrust		
Plate Clearance	0.127—0.279 mm (0.0050—0.0110 in.)	0.406 mm (0.0160 in.)
Camshaft Gear-to-Injection Pump		
Drive Gear Backlash	0.05 mm (0.002 in.) Minimum	—
Camshaft Gear-to-Oil Pump		
Drive Gear Backlash		
(Engine Installed)*	3.5° Max	0.5° or less
Camshaft-Gear-to-Oil Pump		
Driven Gear Backlash		
(Engine Disassembled)*	2.03 mm (0.080 in.) Max	0.25 mm (0.010 in.) or less
Camshaft Drive Gear-to-Crankshaft		
Gear Backlash	0.08 mm (0.003 in.) minimum	—

*Camshaft-driven oil pumps only.

S11,2505,CS -19-25JAN96

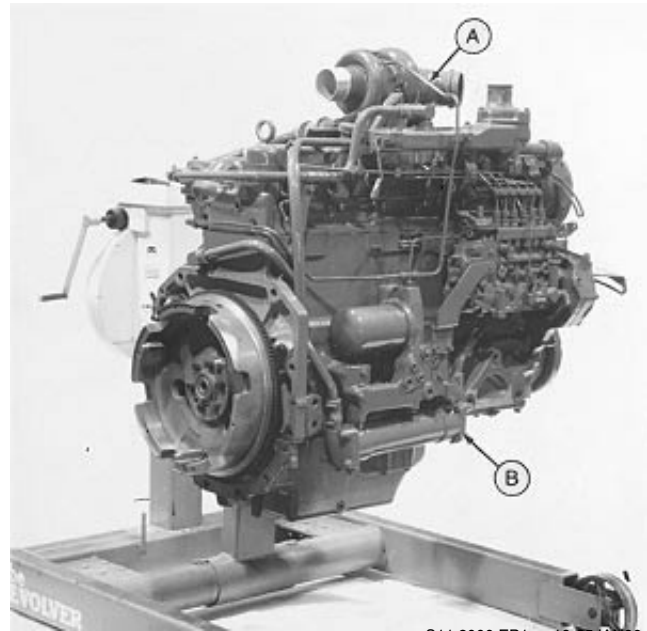
CAMSHAFT AND TIMING GEAR TRAIN SPECIFICATIONS—CONTINUED

Torques

Camshaft Thrust Plate	27 N·m (20 lb-ft)
Camshaft Drive Gear Cap Screw	
Grade 5 or 5.2—57.15 mm (2-1/4 in.) Long	115 N·m (85 lb-ft)
Grade 8 or 180—114.30 mm (4-1/2 in. Long	163 N·m (120 lb-ft)
Timing Gear Cover	47 N·m (35 lb-ft)
Mechanical Tachometer Drive or Cover Plate-to-Block	41 N·m (30 lb-ft)
Electronic Tachometer Drive-to-Timing Gear Cover	14 N·m (10 lb-ft)

S11,2505,CS,1 -19-25JAN96

IMPORTANT: When servicing a 6619 engine on a rollover stand, disconnect the turbocharger oil inlet line (A) from the oil pressure regulating housing before inverting the engine. Also, drain oil from engine oil cooler (B). Failure to do so may cause hydraulic lock upon starting the engine. Hydraulic lock can cause possible engine failure.



S11,2000,EP1 -19-25JAN96

-UN-26JAN90
RG-4933

16
6

CHECK VALVE LIFT

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

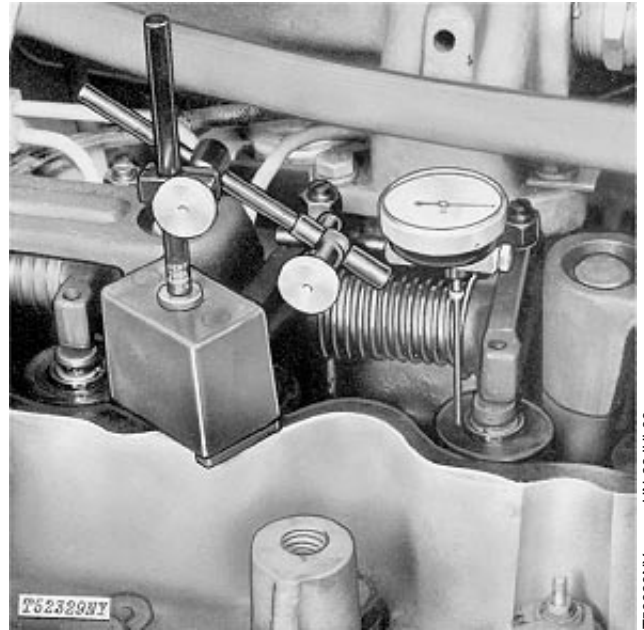
IMPORTANT: For a more accurate measurement, it is recommended that valve lift be measured at 0.00 mm (0.0 in.) clearance.

1. Remove rocker arm cover.
2. Loosen locknut on rocker arm shaft and set valve clearance at zero (0.00) using a wrench and screwdriver. Tighten locknut.
3. Place dial indicator tip on top of valve spring cap, as shown. Preload indicator tip and set dial at zero (0.00).
4. Manually turn engine in running direction one full revolution using the JDE81-1 Flywheel Turning Tool.
5. Observe dial indicator reading as valve is moved to full open. Record readings and compare with specifications given below.

VALVE LIFT SPECIFICATIONS @ 0.00 mm (0.0 in.) CLEARANCE

Intake Valves 13.20—13.38 mm (0.520—0.527 in.)
Exhaust Valves 11.85—12.03 mm (0.467—0.474 in.)

6. Follow same procedure for all remaining valves and adjust valve clearance when valve lift measurements are complete. (See CHECK VALVE CLEARANCE in this group.)



CHECK CAMSHAFT GEAR-TO-OIL PUMP DRIVE GEAR BACKLASH—(CAMSHAFT DRIVEN OIL PUMP ENGINES ONLY) (ENGINE INSTALLED)

NOTE: When measuring gear backlash, the engine should be at normal operating temperature. This test may be performed with engine installed in vehicle.

1. Remove oil pressure regulating housing, if not previously removed. (See REMOVE OIL PRESSURE REGULATING HOUSING AND OIL COOLER ASSEMBLY in this group.)
2. Remove tachometer drive housing or cover plate, however equipped.
3. Install pointer ring assembly (A) from JDE149 Camshaft Wear Indicator on top flange of engine oil pump drive gear. Do not tighten pointer assembly screw.
4. Install gauge (B) from JDE149 Camshaft Wear Indicator on engine block using the two cap screws provided with tool set. Tighten cap screws securely.
5. Align the point (C) over the center mark on gauge and tighten pointer assembly screw securely.

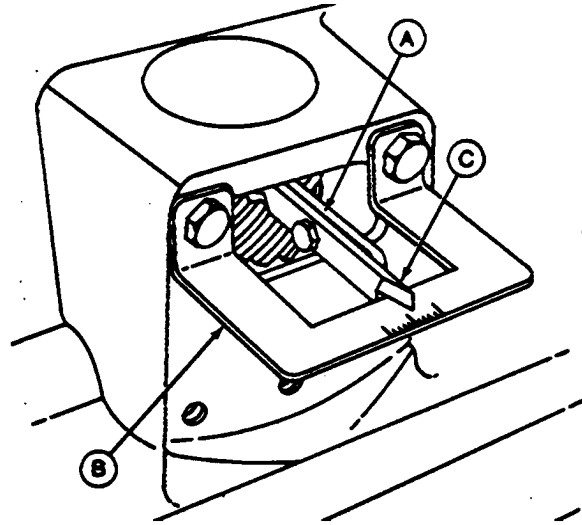
NOTE: Check backlash at four gear positions, 90° apart.

6. Grasp pointer assembly with fingers and move the pointer back and forth by hand. DO NOT use excessive force to move the pointer assembly.

NOTE: Each mark on gauge is equivalent to 1° of backlash.

If the total movement of the pointer 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 the total movement of the pointer is 0.5° or less, or if camshaft cannot be rotated through one revolution without binding, replace camshaft.



-UN-06APR89
RG4968

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CHECK CAMSHAFT GEAR-TO-OIL PUMP DRIVEN GEAR BACKLASH—CAMSHAFT-DRIVEN OIL PUMP ENGINES ONLY

NOTE: This test can be performed with the engine installed in the vehicle if oil pan is easily accessible.

1. Remove engine oil pan. (See REMOVE OIL PAN 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.



RG4969 -UN-19JAN90

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.)

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, replace camshaft.

S11,2505,CV -19-25JAN96

REMOVE VIBRATION DAMPER AND PULLEY

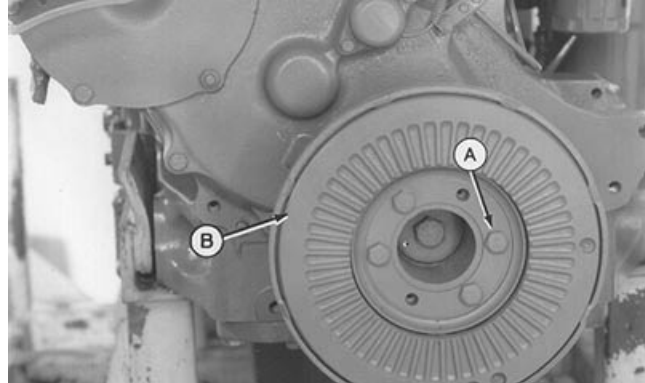
1. Remove fan belts.

CAUTION: Damper and pulley are very heavy. Plan proper handling procedures to avoid injury. ALWAYS use an assistant when removing and installing pulley.

IMPORTANT: DO NOT immerse damper assembly in petroleum products (such as gasoline, oil, solvent, etc.). Doing so can damage the rubber portion of the assembly. Never apply thrust on outer ring of damper. The damper is sensitive to impact damage from being dropped or struck with a hammer. Always remove damper from pulley first, if possible.

NOTE: Various damper/pulley configurations are used. Note installed sequence of damper/pulley assembly.

2. Remove cap screws (A) and damper (B).



RG7340 -UN-23JUN95

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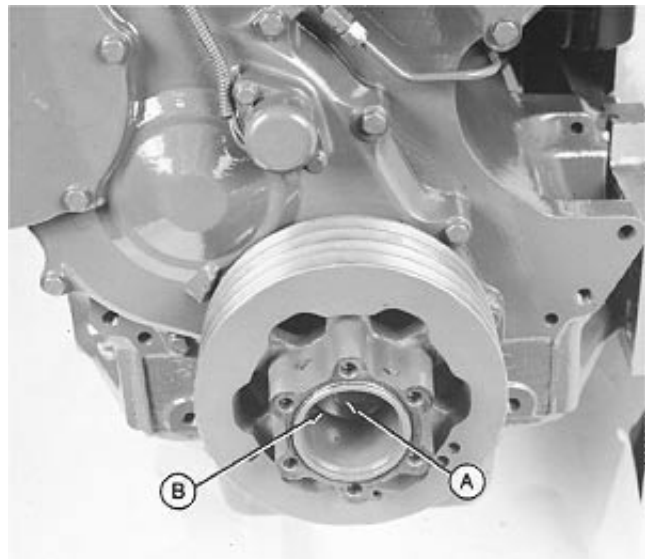
S11,2515,AR1 -19-25JAN96

IMPORTANT: When using a jaw-type puller, pull only on back side of pulley closest to engine. Pulley can be damaged if pulled from belt groove.

3. Remove cap screw (A) and washer (B). Remove pulley using JDG787 Forcing Screw Spud and JDG728 puller.

NOTE: Some damper/pulley configurations require damper and pulley to be removed as an assembly. Use D01206AA Puller and 630-6 Step Plate.

4. Carefully and thoroughly inspect the pulley for cracks or any visible damage (ID, V-belt grooves, keyway, etc.). Replace pulley as needed.

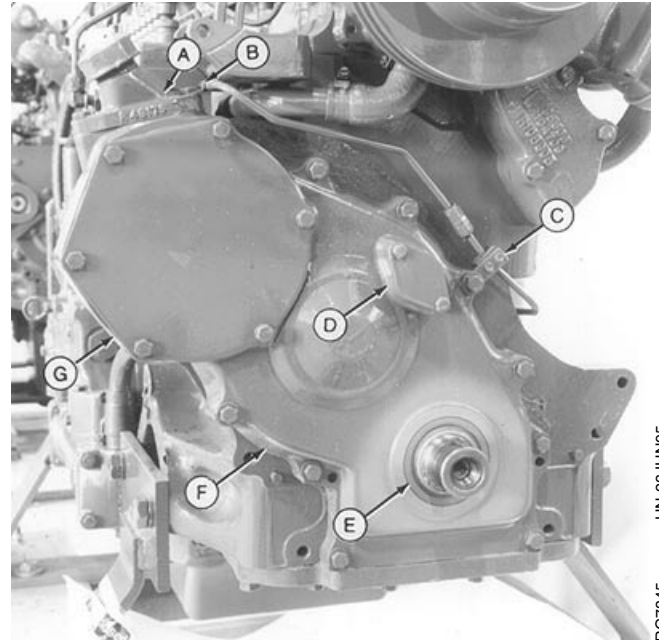


RG6101 -UN-27JAN92

S11,2515,AR1 -19-25JAN96

REMOVE TIMING GEAR COVER

1. If not previously done, remove vibration damper and pulley. (See REMOVE VIBRATION DAMPER AND PULLEY in this group.)
2. Drain engine oil if not previously done and remove engine oil pan. (See group 20.)
3. Disconnect and remove magnetic pickup, if equipped. Magnetic pickup located in place of cover plate (D).
4. Remove pipe clamps (B) and (C).
5. Remove cap screws and timing gear cover (F).
6. Inspect filler (A), cover (G) and plate (D) for signs of leakage. Replace gaskets if necessary.
7. Inspect seal (E). Replace if necessary. (See REMOVE CRANKSHAFT FRONT OIL SEAL/TIMING GEAR COVER REMOVED in this group.)



Late model engine shown.

- A—Filler Tube
- B—Clamp
- C—Clamp
- D—Cover Plate
- E—Front Oil Seal
- F—Timing Gear Cover
- G—Injection Pump Gear Cover

S11,2515,AR2 -19-25JAN96

RG7345 -UN-23JUN95

16
11

REMOVE FRONT WEAR SLEEVE (WITH TIMING GEAR COVER REMOVED)

IMPORTANT: Whenever front oil seal is replaced, also replace wear sleeve.

1. Remove front wear sleeve (A) from crankshaft using JDG726 or JDG786 Front Wear Sleeve Puller. (See REMOVE FRONT WEAR SLEEVE/WITH TIMING GEAR COVER INSTALLED earlier in this group.)

NOTE: Wear sleeve can also be removed with a dull chisel. DO NOT score too deeply or cut through wear sleeve with chisel.

2. Score (B) LIGHTLY around OD of wear sleeve.

3. Remove crankshaft Woodruff key and gently pry wear sleeve from crankshaft.

4. Inspect crankshaft flange for nicks or burrs. Clean up flange with a light file and emery cloth.



R24579 -UN-15DEC88

S11,0403,N -19-03JUL95

REMOVE FRONT OIL SEAL (WITH TIMING GEAR COVER REMOVED)

NOTE: Whenever front oil seal (A) is replaced, also replace wear sleeve.

1. Use a small punch (B), to tap around metal edge of seal to remove. Be careful not to damage timing gear cover.

2. Clean and inspect seal bore in cover. Check for nicks or burrs. Use medium grit emery cloth to smooth rough edges.



RG3835 -UN-14DEC88

S11,0403,P -19-25JAN96

CHECK CAMSHAFT END PLAY

1. Place dial indicator on camshaft.
2. Move camshaft gear forward and backwards while reading dial indicator.

CAMSHAFT END PLAY SPECIFICATION

New Parts End Play	0.063—0.279 mm (0.0025—0.0110 in.)
Allowable End Play	0.380 mm (0.0150 in.)

NOTE: If end play exceeds specifications, check thrust washer thickness during disassembly.



RG78139M1 -UN-09JAN90

S11,2505,AQ -19-03JUL95

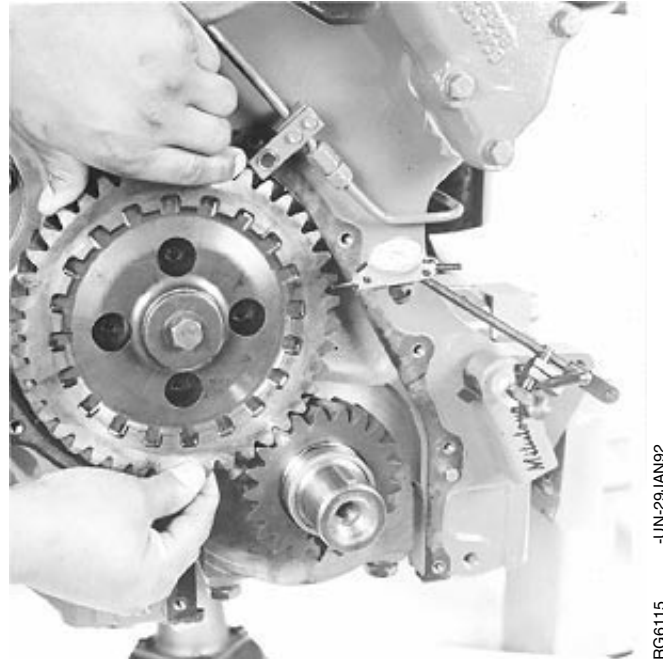
MEASURE CAMSHAFT DRIVE GEAR-TO-CRANKSHAFT GEAR BACKLASH

Measure backlash between camshaft drive gear and crankshaft using a magnetic base dial indicator.

CAMSHAFT DRIVE GEAR-TO-CRANKSHAFT GEAR BACKLASH SPECIFICATION

Minimum Camshaft Gear Backlash	0.08 mm (0.003 in.)
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Replace gears if backlash is not within specification.



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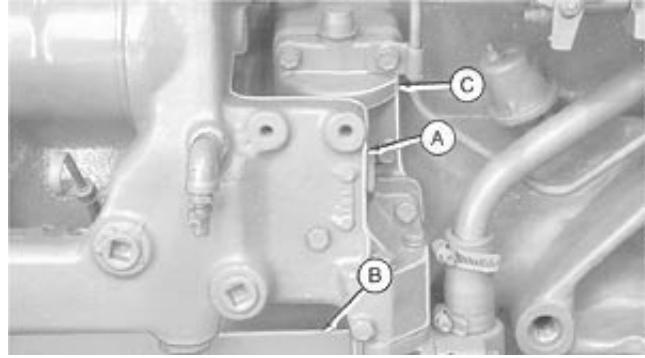
RG6115 -UN-29JAN92

RG,CTM61,G16,4 -19-03JUL95

REMOVE TACHOMETER DRIVE ASSEMBLY

1. Remove oil pressure regulating housing (A) and engine oil cooler (B) as an assembly. (See Group 20.)
2. Remove four cap screws securing tachometer drive assembly (C) to block and remove assembly.

NOTE: Inspection and repair of tachometer drive assembly is outlined later in this group.



S11,2505,DA -19-03JUL95

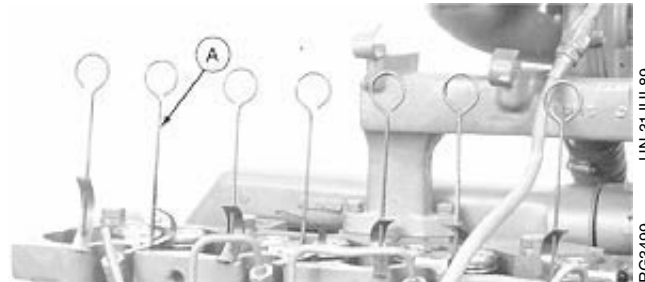
RG3660 -UN-25SEP89

REMOVE CAMSHAFT

NOTE: It is not necessary to remove cylinder head to remove camshaft. If camshaft lobes show excessive wear, cylinder head should be removed so block, head, cam lobes, cam followers and pushrods can be inspected.

On engines equipped with camshaft-driven oil pumps, remove oil pump before removing camshaft. (See REMOVE CAMSHAFT-DRIVEN OIL PUMP in Group 20.)

1. Remove rocker arm assembly, pushrods and wear caps. (See group 05.)
2. When removing camshaft with engine on rollover stand, roll engine to a vertical position (horizontal shown) and hold cam followers away from camshaft lobes with D15001NU Magnetic Holding Set (A).



S11,2505,CX -19-03JUL95

RG3499 -UN-31JUL89

Camshaft and Timing Gear Train/Remove Camshaft

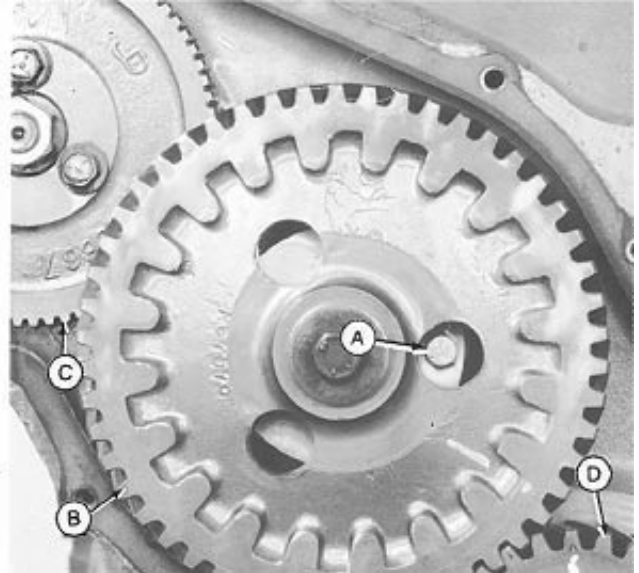
3. Use the JDE81-1 and JDE81-4 Engine Rotation Tools and rotate flywheel to align thrust plate cap screws (A) with camshaft gear. Remove all four cap screws.

NOTE: Do not remove nut securing gear to camshaft unless gear is being replaced.

4. Examine camshaft gear (B), injection pump drive gear (C), and crankshaft gear (D) for unusual wear, chips or cracks.

IMPORTANT: Set No. 1 Piston at TDC on compression stroke, using the JDE81-1 and JDE81-4 Engine Rotation Tools. This will align timing marks on crankshaft and camshaft gears and aid in correct timing during assembly.

A—Thrust Plate Cap Screws (4 used)
B—Camshaft Gear
C—Injection Pump Drive Gear
D—Crankshaft Gear



RG3040 -UN-17JUL89

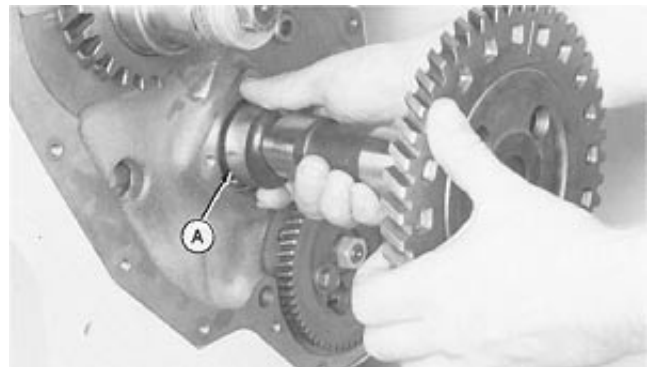
S11,2505,AR -19-03JUL95

IMPORTANT: Ensure No. 1 Piston is at TDC on compression stroke.

NOTE: Rotate camshaft carefully to aid in removal.

5. Carefully remove camshaft (A) from cylinder block so that camshaft lobes do not drag in bores.

NOTE: If cam followers are to be removed, the cylinder head must be removed. (See REMOVE CYLINDER HEAD in Group 05.)



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RG3818 -UN-23FEB89

S11,0401,BG -19-25JAN96

REMOVE CAMSHAFT GEAR, SPACER, AND THRUST PLATE

NOTE: Camshaft gears are installed onto the camshaft using a press.

1. Remove cap screw with special washer and support camshaft gear in a press.

IMPORTANT: Prevent camshaft from striking floor when pressing camshaft from gear.

2. Press camshaft out of gear.
3. Remove spacer and thrust plate from camshaft.
4. Clean camshaft, thrust plate, and thrust spacer in solvent. Dry with compressed air.



RG78153H1 -UN-09JAN90

S11,2505,AS -19-03JUL95

MEASURE THRUST PLATE AND SPACER

1. After removal of camshaft gear, check thrust plate and spacer for proper thickness.

THRUST PLATE AND SPACER SPECIFICATIONS

Thrust Plate	
(—058209)	3.010—3.086 mm (0.1185—0.1215 in.)
(058210—)	4.724—4.800 mm (0.1860—0.1890 in.)
Allowable Wear Thickness	
(—058209)	2.883 mm (0.1135 in.)
(058210—)	4.623 mm (0.1820 in.)
Thrust Spacer	
(—058209)	3.213—3.289 mm (0.1265—0.1295 in.)
(058210—)	4.915—4.965 mm (0.1935—0.1955 in.)



RG2743 -UN-17JUL89

S11,2505,AT -19-03JUL95

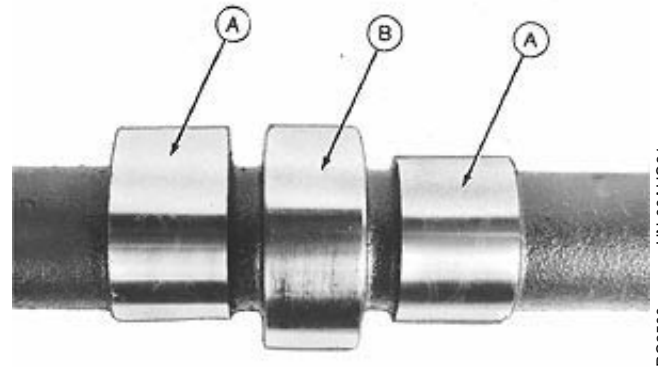
INSPECT AND MEASURE CAMSHAFT

1. Inspect camshaft lobes (A) and journals (B) for wear or damage. Replace camshaft as necessary.

IMPORTANT: Very light score marks may be found, but are acceptable if valve lift is within specification. Pitting or galling dictates replacement. (See CHECK VALVE LIFT, earlier in this group.)

It is not always necessary to replace cam followers when camshaft is replaced. (See REMOVE, INSPECT, AND MEASURE CAMSHAFT FOLLOWERS, later in this group.)

2. If camshaft lobes show excessive pitting or galling, remove cylinder head. Remove and thoroughly inspect camshaft followers.



RG3500 -UN-06AUG91

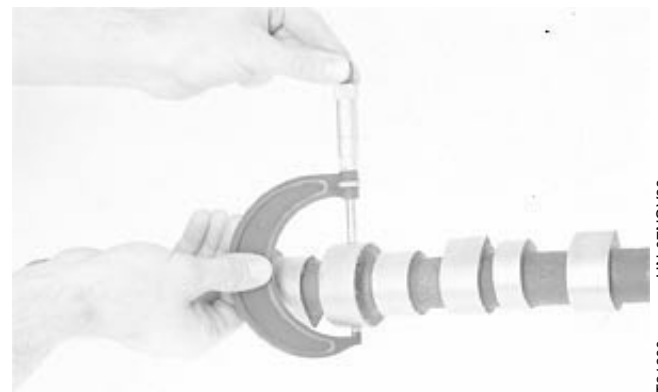
S11,2505,CY1 -19-25JAN96

3. Measure each camshaft journal OD. If not within specification, install a new camshaft.

4. Measure each camshaft bushing ID when installed in cylinder block. Replace bushings if not within specifications. (See REPLACE CAMSHAFT BUSHINGS in this group.)

CAMSHAFT JOURNAL AND BUSHING SPECIFICATIONS

Journal OD	60.312—60.338 mm (2.3745—2.3755 in.)
Bushing ID	60.389—60.439 mm (2.3775—2.3795 in.)
Bushing-to-Journal Clearance	0.051—0.127 mm (0.0020—0.0050 in.)



T81260 -UN-07NOV88

S11,2505,DG -19-25JAN96

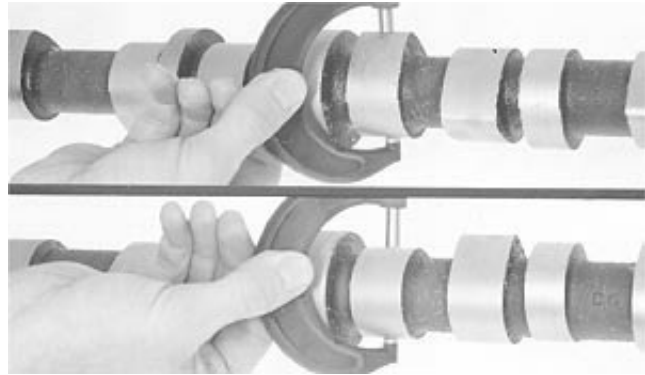
Camshaft and Timing Gear Train/Inspect and Measure Camshaft

5. Measure each camshaft lobe at its highest point and at its narrowest point. Subtract narrowest height from highest to find cam lobe lift.

If camshaft lobe lift is not within specification on any lobe, install a new camshaft.

CAM LOBE LIFT NEW PART SPECIFICATION

Intake Lobe	8.0518—8.3758 mm (0.317—0.327 in.)
Exhaust Lobe	7.2136—7.4676 mm (0.284—0.294 in.)



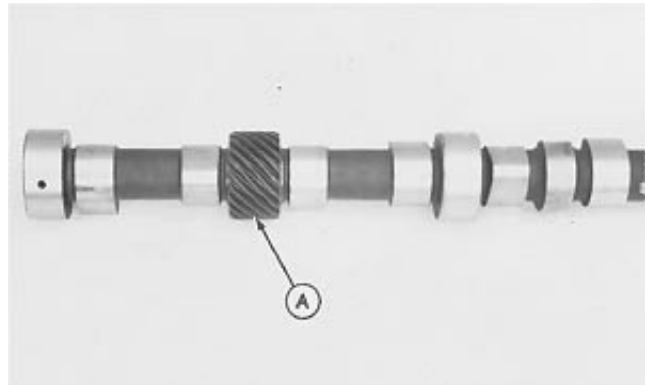
-JUN-01NOV88
T81262

S11,2505,DH -19-15NOV95

On engines equipped with tachometer drive and/or camshaft driven oil pumps, inspect oil pump drive gear (A) for wear or damage. Replace camshaft as needed.

If camshaft is replaced due to a damaged tachometer drive gear, check gear and shaft in tachometer drive housing for damage. Replace as necessary.

If camshaft is replaced due to a damaged oil pump drive gear, check gear and shaft on oil pump for damage. Replace as necessary. (See REMOVE AND INSPECT CAMSHAFT-DRIVEN OIL PUMP in Group 20.)



-JUN-19JAN90
RG4628

S11,2505,CZ -19-03JUL95

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REMOVE, INSPECT, AND MEASURE CAMSHAFT FOLLOWERS

IMPORTANT: It is not always necessary to replace camshaft followers when a camshaft is replaced.

1. Remove cylinder head. (See REMOVE CYLINDER HEAD in Group 05).
2. Remove camshaft followers from bores in block.
3. Inspect camshaft followers for uneven wear or damage. Also inspect corresponding camshaft lobe for wear or damage.
4. Measure camshaft follower and bore in block. Compare measurements with specifications given. Replace camshaft followers or cylinder block as necessary.

CAMSHAFT FOLLOWER AND BORE SPECIFICATIONS

Camshaft Follower OD	34.874—34.900 mm (1.3730—1.3740 in.)
Camshaft Follower Bore in Block	34.976—35.026 mm (1.3770—1.3790 in.)



RG3041 -JUN-17JUL89

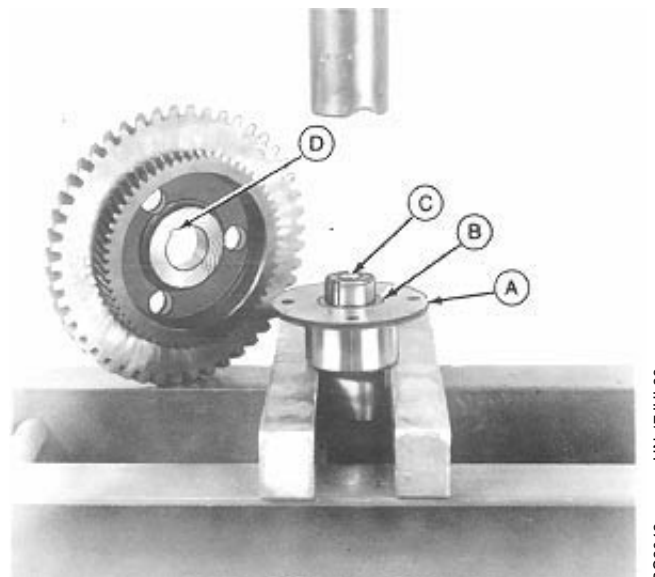
S11,2505,AV -19-03JUL95

16
19

ASSEMBLE CAMSHAFT

1. Support camshaft under first journal in a hydraulic press.
2. 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



RG3042 -JUN-17JUL89

S11,2505,AW -19-25JAN96

5. Press gear on until tight against spacer.

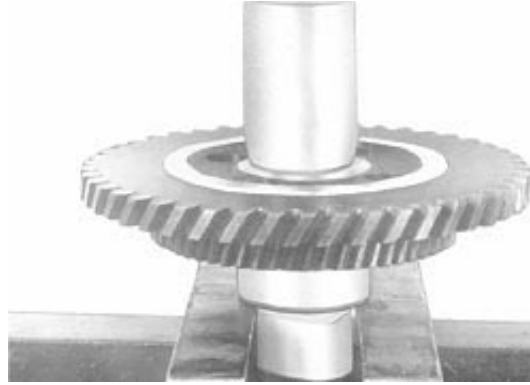


FIG3501 -UN-23FEB89

S11,0401,BO -19-25JAN96

REPLACE CAMSHAFT BUSHINGS

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 front 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).

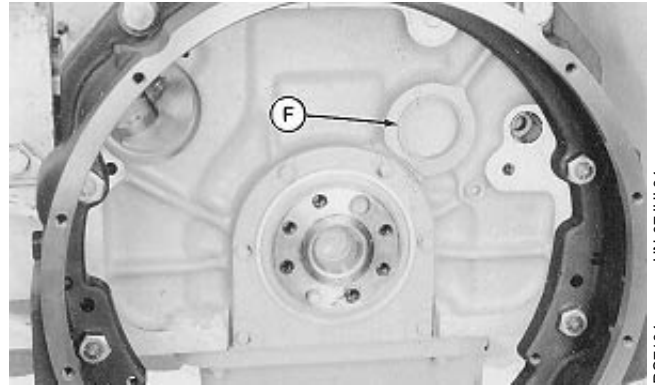
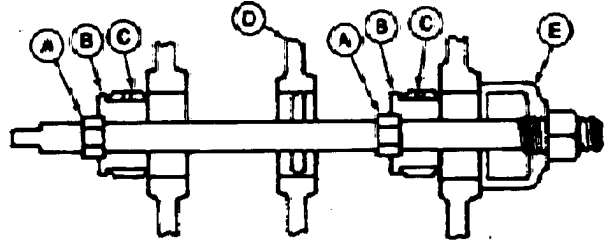
CAMSHAFT JOURNAL AND BUSHING NEW PART SPECIFICATIONS

Camshaft Bushing Bore in Block	63.487—63.513 mm (2.4995—2.5005 in.)
Maximum Runout	0.038 mm (0.0015 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.)

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 (F) and install plug in bore. Plug edge must be seated below edge of bore.



- A—Lock
- B—Mandrel
- C—Bushing
- D—Cylinder Block
- E—Cup
- F—Camshaft Bore Plug

RG3320 -UN-06APR89

RG7104 -UN-07JUL94

S11,0401,BJ -19-25JAN96

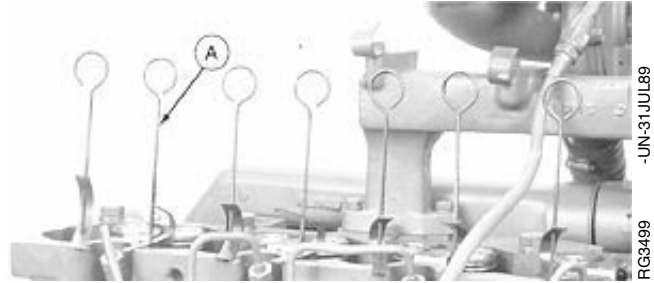
INSTALL CAMSHAFT

IMPORTANT: Set engine at TDC of No. 1 piston's compression stroke before installing camshaft so timing marks on camshaft and crankshaft gears will be aligned.

1. If camshaft followers were removed with engine on a rolover stand, reinstall followers but do not obstruct camshaft bore. Roll engine to an angle where followers fall away from camshaft bores.

NOTE: If D15001NU Magnetic Follower Holder Kit (A) is used, hold camshaft followers away from camshaft bore until camshaft is installed.

2. Lubricate camshaft lobes with TY6333 or TY6347 High Temperature Grease and lubricate bearings, bushings and gear with clean engine oil.



RG3499
-UN-31JUL89

S11,0401,BP -19-13NOV95

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.



RG3818
-UN-23FEB89

S11,0401,BQ -19-17MAR94

4. With No. 1 piston at "TDC" compression, align timing marks (D) on camshaft and crankshaft gears.

5. Turn camshaft gear to align thrust plate holes with cylinder block holes.

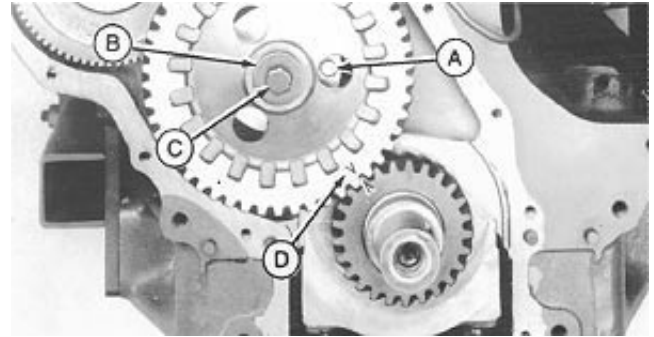
6. Coat thrust plate-to-block cap screws (A) with LOCTITE 242 Thread Lock and Sealer and tighten to 27 N-m (20 lb-ft).

7. Install special washer (B) and cap screw (C). Torque cap screw to specifications.

NOTE: Present production camshafts use an SAE Grade 8 or 180, 114.30 mm (4-1/2 in.) long drive gear cap screw. Refer to proper torque specifications on early and present camshafts. Do not interchange cap screws.

CAMSHAFT CAP SCREW SPECIFICATION

SAE Grade 8 or 180	
114.30 mm (4-1/2 in.) Long	
(Present)	163 N-m (120 lb-ft)
SAE Grade 5 or 5.2	
57.15 mm (2-1/4 in.) Long	
(Early)	115 N-m (85 lb-ft)



A—Cap Screws
 B—Special Washer
 C—Cap Screw
 D—Timing Marks

-JUN-09NOV89
 FG4322

16
 23

S11,2505,AX -19-25JAN96

8. Check camshaft for 0.063—0.279 mm (0.0025—0.011 in.) end play. (See CHECK CAMSHAFT ENDPLAY in this group.) Replace thrust plate and/or thrust washer if end play is not within specification.

9. Check injection pump timing and reset as required. (See CHECK AND ADJUST INJECTION PUMP TIMING in Group 35.)



-JUN-09JAN90
 FG78139M1

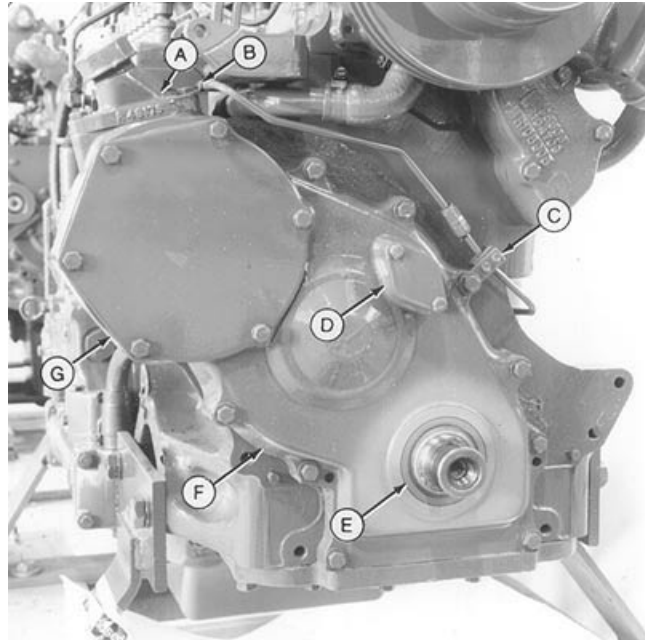
S11,2505,AY -19-03JUL95

INSTALL TIMING GEAR COVER

1. Using a new gasket, install timing gear cover (F). Tighten cap screws to 47 N.m (35 lb-ft).
2. Trim gasket flush with oil pan mounting surface.
3. Install clamps (B) and (C).

NOTE: Engine Serial No. (053817—): Coat threads of lower two cap screws for injection pump gear cover with LOCTITE 242 Thread Lock and Sealer (medium strength) to prevent oil leakage.

4. Install filler tube (A), cover (G) and plate (D), if removed, using new gaskets.
5. Install and connect magnetic pickup, if equipped.
6. Install front oil seal (E). (See INSTALL CRANKSHAFT FRONT OIL SEAL/TIMING GEAR COVER INSTALLED, next in this group.)



Late model engine shown.

- A—Filler Tube
- B—Clamp
- C—Clamp
- D—Magnetic Pickup/Block-Off Plate
- E—Front Oil Seal
- F—Timing Gear Cover
- G—Injection Pump Gear Cover

RG7345 -UN-23JUN95

INSTALL CRANKSHAFT FRONT WEAR SLEEVE (WITH TIMING GEAR COVER INSTALLED)

NOTE: Wear sleeve may be installed with timing gear cover removed or installed.

1. Coat ID of new wear sleeve with LOCTITE 609 Retaining Compound.
2. Install wear sleeve using JDG467 Driver along with washer and cap screw that secures damper pulley assembly to crankshaft.

NOTE: On current applications, the JDG468 Spacer (not shown) must be used with the JDG467 Driver to properly seat the wear sleeve on crankshaft flange.

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



RG6110
-UN-27/JAN92

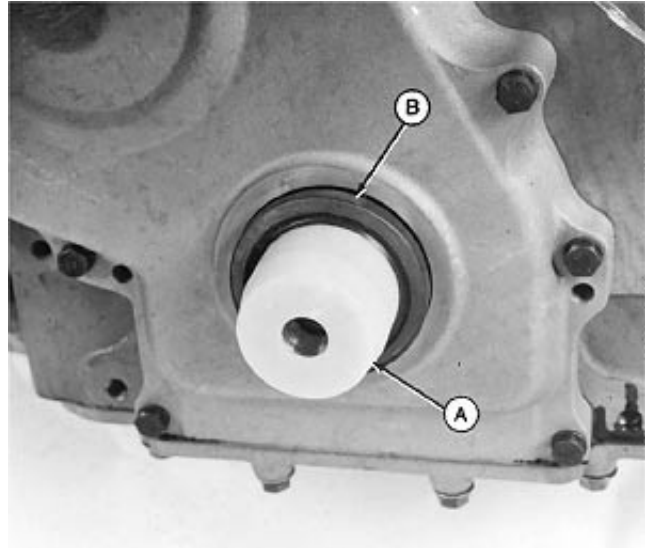
RG,CTM9,G15,12 -19-03JUL95

INSTALL CRANKSHAFT FRONT OIL SEAL

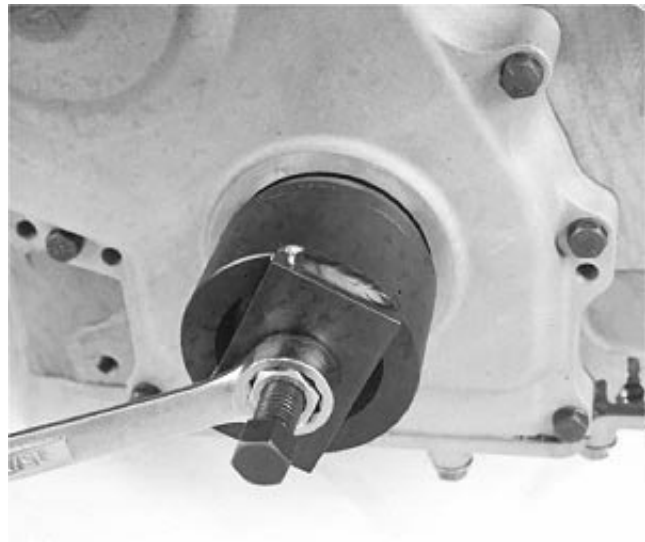
IMPORTANT: Whenever front oil seal is replaced, wear sleeve MUST be replaced also.

1. Place JDG720-2 Seal Protector (A) on nose of crankshaft. Lubricate ID of front oil seal (B) lips with clean engine oil and slide seal onto seal protector. Be careful not to roll oil seal lips.
2. Position JDG720-4 Spacer Ring on end of JDG720-3 Seal Installer and place installer onto seal protector against seal.
3. With nut installed onto JDG720-1 Forcing Screw, thread forcing screw into nose of crankshaft until it bottoms.
4. Tighten nut against crossplate of installer until installer bottoms on front face of timing gear cover.
5. Remove installation tools.

IMPORTANT: Verify seal is installed squarely in bore, flush with front face of timing gear cover, and that seal lips are not rolled on wear sleeve.



RG6111
-UN-27JAN92

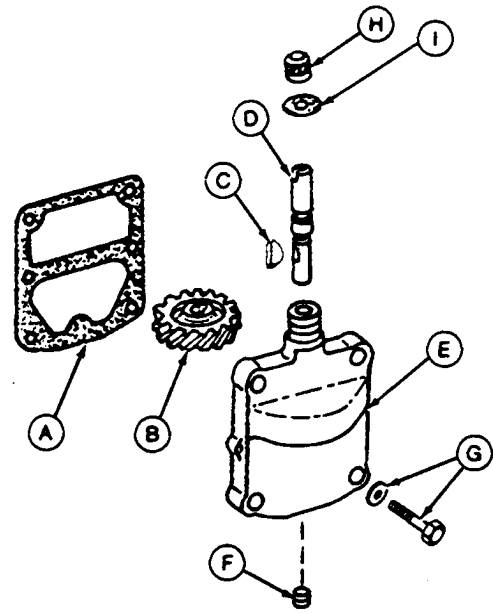


RG6112
-UN-27JAN92

RG,CTM61,G15,13-19-25JAN96

SERVICE MECHANICAL TACHOMETER DRIVE ASSEMBLY—CAMSHAFT DRIVEN OIL PUMP ENGINES SERIAL NO. (—046655)

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 a joint sealing compound; then add a new gasket and cap. Tighten hex pipe plug securely.



- 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

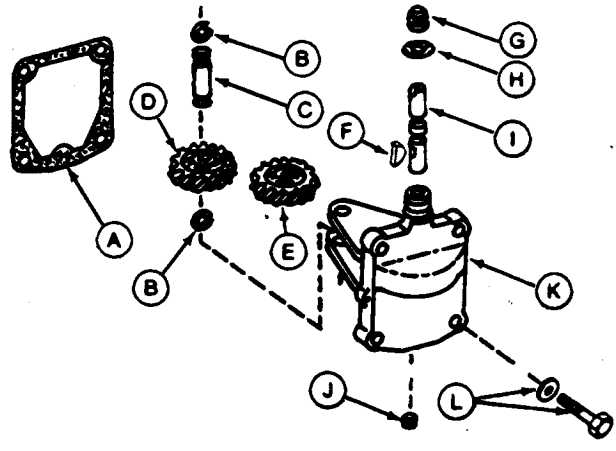
RG4630 -UN-06APR89

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S11,2505,DD -19-25JAN96

SERVICE MECHANICAL TACHOMETER DRIVE ASSEMBLY—CRANKSHAFT DRIVEN OIL PUMP ENGINES SERIAL NO. (046656—)

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 with 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 a joint sealing compound; 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)

RG3987 -UN-27NOV89

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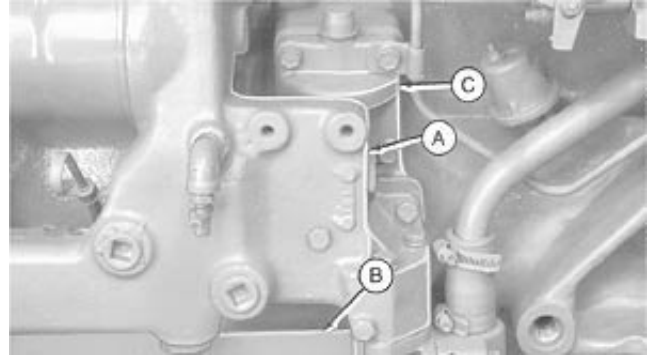
INSTALL MECHANICAL TACHOMETER DRIVE ASSEMBLY

1. Install tachometer drive assembly (C) on engine block using a new gasket.

NOTE: Make sure that the tachometer idler gear is meshed correctly with drive gear on camshaft or oil pump, however your engine is equipped.

2. Coat all four cap screws with LOCTITE 242 Thread Lock and Sealer (medium strength) except for the first three threads. Install cap screws with washers and tighten to 41 N·m (30 lb-ft).

3. Install oil pressure regulating housing (A) and engine oil cooler (B) as an assembly. (See INSTALL OIL PRESSURE REGULATING HOUSING AND OIL COOLER ASSEMBLY in Group 20.)



RG3660 -UN-25SEP89

S11,2505,DB -19-25JAN96

COMPLETE FINAL ASSEMBLY

1. Install damper pulley and vibration damper. (See Group 15.)

2. Install camshaft followers and cylinder head, if removed. (See Group 05.)

3. Install push rods, wear caps, and rocker arm shaft assembly. (See Group 05.)

4. Measure valve lift and compare readings with specifications. (See CHECK VALVE LIFT in this Group.)

5. Adjust engine valve clearance and install rocker arm cover. (See Group 05.)

6. Perform engine break-in as required. (See Group 05.)

RG,CTM9,G16,13 -19-25JAN96

16
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Camshaft and Timing Gear Train/Complete Final Assembly

16
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SPECIAL OR ESSENTIAL TOOLS

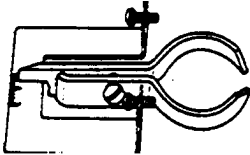
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-20JUL95

Cam Wear Indicator JDE149

Measure camshaft gear-to-oil pump gear backlash.

RG4939 -UN-06APR89



S53,JDE149 -19-25JUL95

OTHER MATERIAL

Name	Use
PERMATEX AVIATION (Form-A-Gasket No. 3)	To seal oil pan gasket surfaces.
LOCTITE 242 Thread Lock and Sealer (TY9370/T43512)	To coat oil pan drain elbow threads.

RG,CTM9,G20,1 -19-25JUL95

LUBRICATION SYSTEM SPECIFICATIONS

Item	New Par Specification
Engine Oil Pressure @ Rated Speed	280—380 kPa (2.80—3.80 bar) (40—55 psi)
Oil Filter Bypass Valve Operating Pressure	210 kPa (2.10 bar) (30 psi)
Oil Filter Bypass Valve Spring:	
Compressed	35.1 mm at 80—98 N (1.38 in. at 18—22 lb-force)
Free Length	51.6 mm (2.03 in.)
Oil Cooler Bypass Valve Spring:	
Compressed	35.1 mm at 80—98 N (1.38 in. at 18—22 lb-force)
Free Length	51.6 mm (2.03 in.)
Oil Pressure Regulating Valve Spring:	
Compressed	48.5 mm at 133—160 N (1.91 in. at 30—36 lb-force)
Free Length	66.0 mm (2.60 in.)
Camshaft Driven Oil Pump:	
Drive Gear Shaft OD	19.012—19.037 mm (0.7485—0.7495 in.)
Idler Shaft OD	19.136—19.152 mm (0.7534—0.7540 in.)
Idler Gear OD	19.177—19.202 mm (0.7550—0.7560 in.)
Driven and Idler Gear Thickness	50.80—50.85 mm (2.000—2.002 in.)
Driven and Idler Gear OD	85.855—85.880 mm (3.3801—3.3811 in.)
Driven Gear ID	18.974—18.999 mm (0.7470—0.7480 in.)
Gear Bore Depth in Housing	50.876—50.978 mm (2.003—2.007 in.)
Gear Bore ID in Housing	85.954—86.004 mm (3.3840—3.3860 in.)
Idler Shaft Recess in Housing	0.00 mm—0.51 mm (0.0 in.—0.02 in.)
Pump Shaft Height Above Housing	2.59mm (1.02 in.)
Camshaft Gear-To-Oil Pump Drive Gear Backlash:	
Maximum	3.5°
Minimum	0.5°
Camshaft Gear-To-Oil Pump Driven Gear Backlash:	
Maximum	2.03 mm (0.080 in.)
Minimum	0.25 mm (0.010 in.)

LUBRICATION SYSTEM SPECIFICATIONS—CONTINUED

Item	New Par Specification
Crankshaft Driven Oil Pump:	
Driveshaft End Play (Max.)	0.15 mm (0.006 in.)
Driveshaft Side Movement (Max.)	0.17 mm (0.007 in.)
Pumping Gear Backlash	0.33—2.00 mm (0.013—0.079 in.)
Crankshaft Gear-To-Oil Pump Drive	
Gear Backlash (Min.)	0.08 mm (0.003 in.)
Oil Pump Drive Gear Face-to- Crankshaft Clearance	0.38 mm (0.0015 in.)
Torques	
Oil Pressure Regulating Housing-to-Cylinder Block	47 N·m (35 lb-ft)
Oil Pressure Regulating Housing-to-Oil Cooler	47 N·m (35 lb-ft)
Camshaft Driven Oil Pump:	
Oil Pump-to-Cylinder Block	41 N·m (30 lb-ft)
Oil Pump Cover-to-Housing	41 N·m (30 lb-ft)
Pump Cover-to-Pickup Screen	24 N·m (18 lb-ft)
Crankshaft Driven Oil Pump:	
Drive Gear-to-Pump Drive Shaft Nut	54 N·m (40 lb-ft)
Oil Pump Cover-to-Housing	41 N·m (30 lb-ft)
Gear Shield-to-Housing—Engine Serial No. (—054879)	27 N·m (20 lb-ft)
Pickup Screen-to-Intake Elbow	24 N·m (18 lb-ft)
Intake Elbow-to-Pump Cover	41 N·m (30 lb-ft)
Oil Pump-to-Cylinder Block	47 N·m (35 lb-ft)
Outlet Elbow-to-Cylinder Block	47 N·m (35 lb-ft)
Oil Pump Set Screw Lock Nut	8 N·m (6 lb-ft)
Oil Cooler End Caps-to-Oil Cooler	41 N·m (30 lb-ft)
Oil Cooler-to-Regulating Housing	47 N·m (35 lb-ft)
Bypass Oil Filter-to-Mounting Bracket	47 N·m (35 lb-ft)
Oil Pan*:	
3/8 in. Cap Screw SAE Grade 5	47 N·m (35 lb-ft)
3/8 in. Cap Screw SAE Grade 8 and Grade 180	68 N·m (50 lb-ft)
1/2 in. Cap Screw SAE Grade 5	115 N·m (35 lb-ft)
1/2 in. Cap Screw SAE Grade 8 and Grade 180	156 N·m (115 lb-ft)
3/4 in. Cap Screw	325 N·m (240 lb-ft)
Oil Pan-to-Flywheel Housing*	325 N·m (240 lb-ft)
Oil Pan Drain Plug:	
Aluminum Pan	102 N·m (75 lb-ft)
Cast Iron Pan	47 N·m (35 lb-ft)

See *INSTALL OIL PAN* in this group for proper tightening procedure.

S11,2520,X -19-25JAN96

DIAGNOSING LUBRICATION SYSTEM MALFUNCTIONS

• Low Oil Pressure:

Low oil level.
Clogged cooler or filter.
Excessive oil temperature.
Incorrect oil.
Oil pressure regulating valve failure.
Excessive main or rod bearing clearance.
Clogged oil pump screen.
Excessive clearance between oil pump gears and cover.
Piston cooling orifice not installed.

• High Oil Pressure:

Improper oil classification.
Clogged oil lines.
Oil pressure regulating valve failure.

• Oil Sludge and Dilution:

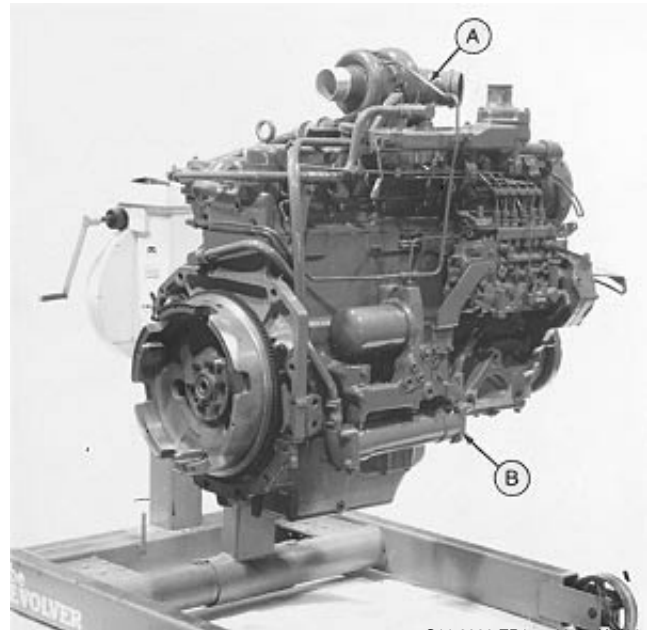
Improper operation and servicing.
Coolant leakage into lubrication system.
Incomplete combustion.
Excessive oil consumption.
Defective injection pump (Failed internal O-ring seals)

• Low Oil Pressure at Slow Idle:

Bypass oil check valve failure.

S11,0404,A -19-08AUG94

IMPORTANT: When servicing a 6619 engine on a rollover stand, disconnect the turbocharger oil inlet line (A) from the oil pressure regulating housing before inverting the engine. Also, drain oil from engine oil cooler (B). Failure to do so may cause hydraulic lock upon starting the engine. Hydraulic lock can cause possible engine failure.



S11,2000,EP1 -19-25JAN96

RG4933 -JUN-26JAN90

REMOVE OIL PAN

1. Drain engine coolant.
2. Disconnect turbocharger oil inlet line at turbocharger. (See MOUNT ENGINE ON REPAIR STAND in Group 03.)
3. Remove drain plug from bottom of oil pan and drain engine oil.
4. Remove oil level sight gauge (if equipped).
5. Remove oil pan and discard gasket.

S11,0404,C -19-25JUL95

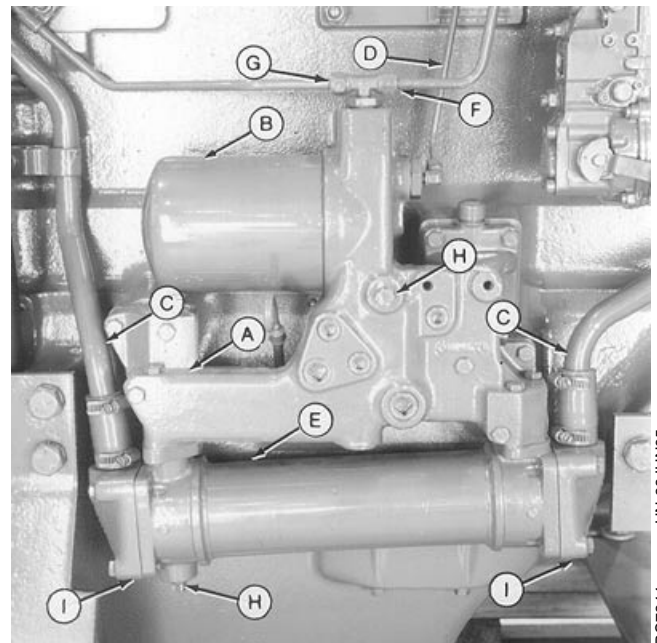
REMOVE OIL PRESSURE REGULATING HOUSING AND OIL COOLER ASSEMBLY

1. Remove drain plugs (H) and drain oil. Remove oil filter (B).
2. Remove drain plugs (I) and drain coolant.
3. Remove inlet and outlet tubes (C).
4. Remove injection pump oil inlet line (D), turbocharger oil inlet line (F), and bypass oil line (G).

CAUTION: Oil pressure regulating housing (A) and cooler housing (E) are heavy. Plan proper handling procedure to avoid injuries.

NOTE: As mounting cap screws are removed, install guide studs in three or four locations to aid in removal of assembly.

5. Remove oil pressure regulating housing cap screws. Remove pressure regulating and oil cooler housings as an assembly.

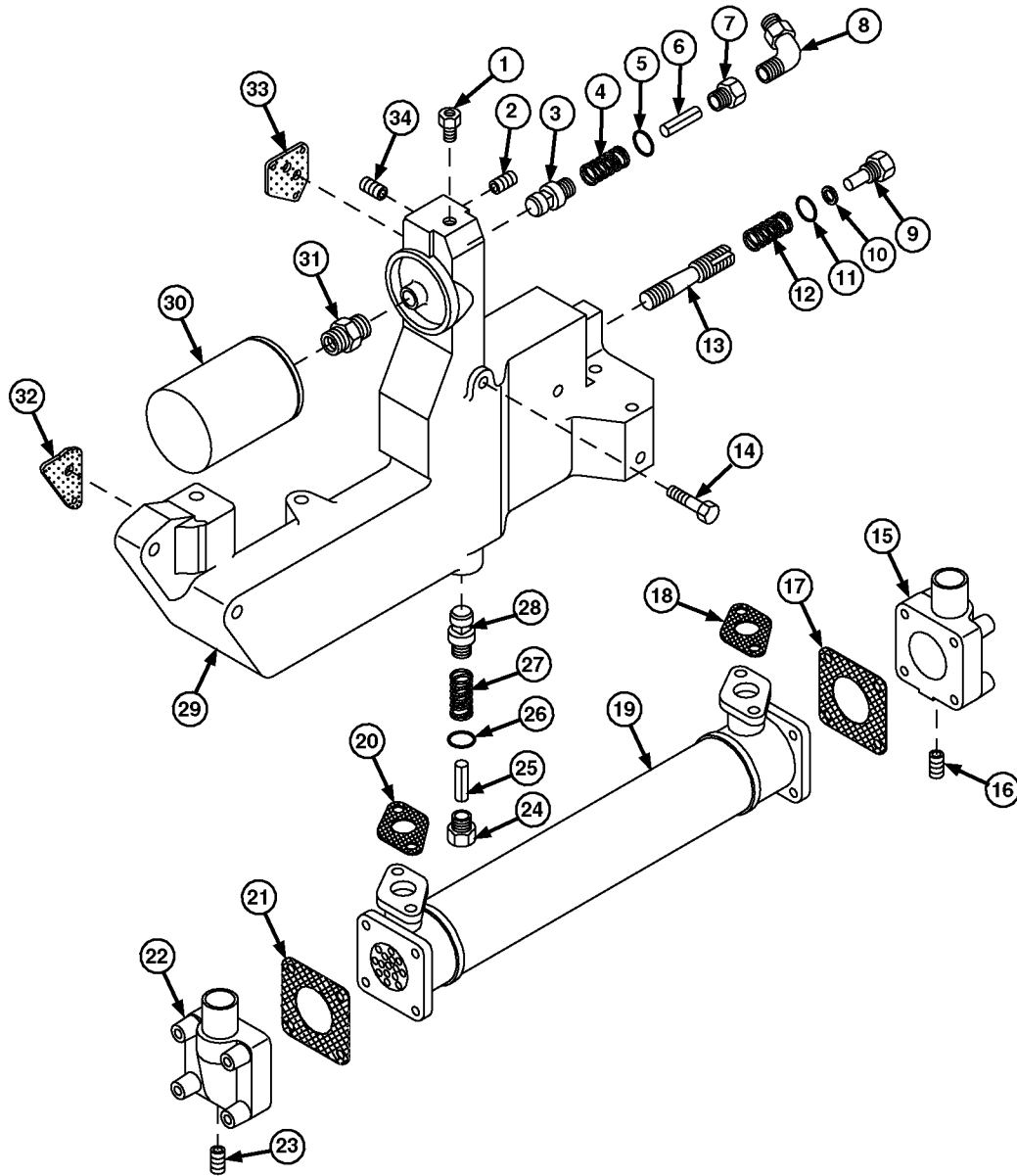


Late model shown.

- A—Oil Pressure Regulating Housing
- B—Oil Filter
- C—Inlet and Outlet Tubes
- D—Injection Pump Oil Inlet Line
- E—Oil Cooler Housing
- F—Turbocharger Oil Inlet Line
- G—Bypass Oil Line
- H—Oil Drain Plugs
- I—Coolant Drain Plugs

S11,2520,O -19-25JAN96

OIL PRESSURE REGULATING VALVE HOUSING AND OIL COOLER ASSEMBLY



- | | | | |
|---------------------------|----------------------------------|---------------|----------------------------|
| 1—Pipe Bushing | 10—Washer | 18—Gasket | 27—Spring |
| 2—Plug | 11—O-Ring | 19—Oil Cooler | 28—Oil Cooler Bypass Valve |
| 3—Oil Filter Bypass Valve | 12—Spring | 20—Gasket | 29—Regulator Valve Housing |
| 4—Spring | 13—Oil Pressure Regulating Valve | 21—Gasket | 30—Filter |
| 5—O-Ring | 14—Pipe Plug | 22—Cap | 31—Adapter |
| 6—Spring Pin | 15—Cap | 23—Pipe Plug | 32—Gasket |
| 7—Adapter | 16—Pipe Plug | 24—Cap | 33—Gasket |
| 8—Elbow Fitting | 17—Gasket | 25—Spring Pin | 34—Pipe Plug |
| 9—Cap | | 26—O-Ring | |

S11,2520,C,1 -19-25JUL95

REMOVE AND INSPECT OIL COOLER BYPASS, OIL FILTER BYPASS AND OIL PRESSURE REGULATING VALVE ASSEMBLIES

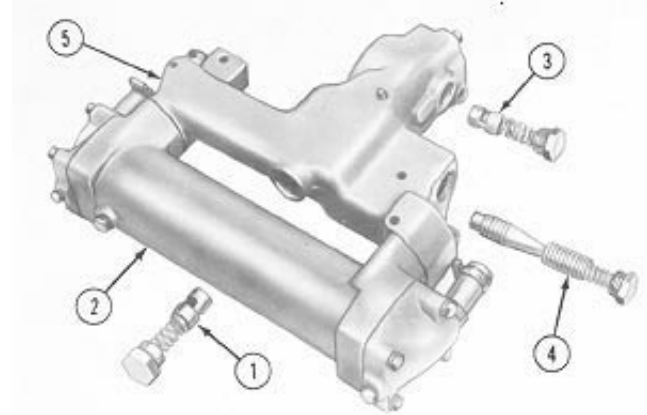
NOTE: Before disassembling oil cooler/oil pressure regulating housing, inspect all mating surfaces and plugs for evidence of oil or coolant leaks. Correct as necessary. When replacing plugs, always use a new plug and coat threads with a teflon sealant.

1. Remove oil cooler (2) from oil pressure regulating housing (5).

2. Remove oil cooler bypass valve (1), oil filter bypass valve (3), and oil pressure regulating valve (4) from oil pressure regulating housing.

3. Inspect valves and valve bores for wear or damage; replace as necessary.

NOTE: If mixing of oil and water is suspected, pressure test oil cooler in solvent (not water) with compressed air. Use 140—170 kPa (1.4—1.7 bar) (20—25 psi) air pressure for testing. Replace oil cooler as necessary.



- 1—Oil Cooler Bypass Valve
- 2—Oil Cooler
- 3—Oil Filter Bypass Valve
- 4—Oil Pressure Regulating Valve
- 5—Oil Pressure Regulating Housing

-JUN-17JUL89

FIG3029

S11,2520,B -19-25JAN96

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4. Check valve springs for proper tension, If springs do not meet specifications, replace as needed.

SPRING TENSION SPECIFICATIONS

Oil Filter Bypass Valve Spring
Compressed 35.1 mm at 80—98 N
(1.38 in. at 18—22 lb-force)
Free Length 51.6 mm (2.03 in.)

Oil Cooler Bypass Valve Spring
Compressed 35.1 mm at 80—98 N
(1.38 in. at 18—22 lb-force)
Free Length 51.6 mm (2.03 in.)

Oil Pressure Regulating Valve Spring
Compressed 48.5 mm at 133—160 N
(1.91 in. at 30—36 lb-force)
Free Length 66.0 mm (2.60 in.)

5. Make sure all passages in regulating housing and oil cooler are clean.

NOTE: Under normal conditions, the oil cooler need not be removed to clean water passages. remove cooler end caps, clean and inspect tubes with a brush and compressed air.

S11,2520,C -19-25JUL95

INSTALL OIL COOLER BYPASS, OIL FILTER BYPASS AND OIL PRESSURE REGULATING VALVES

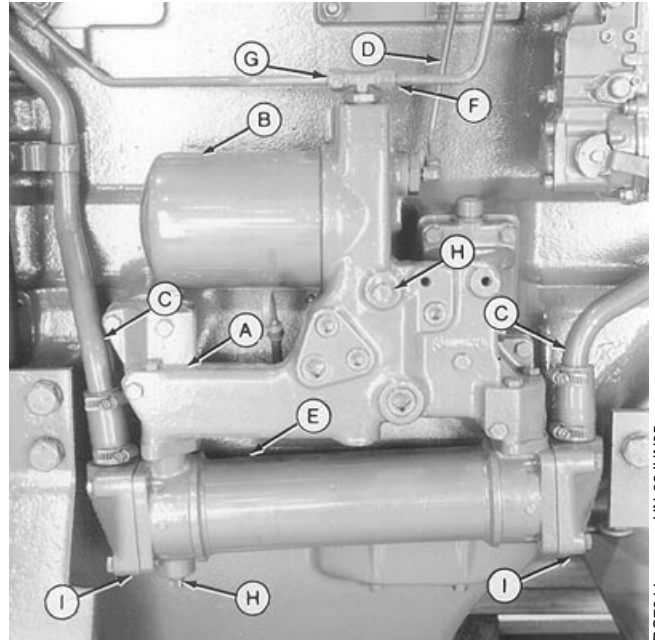
1. Dip valves in clean engine oil, and install in their respective bores. Be sure to include all pressure adjusting washers removed from pressure regulating valve (if reusing existing spring and valve). Tighten all plugs securely.
2. If removed, install cooler end caps and tighten to 41 N.m (30 lb-ft).
3. Install oil cooler and tighten end caps to 47 N.m (35 lb-ft).

S11,2520,D -19-25JAN96

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INSTALL OIL PRESSURE REGULATING AND OIL COOLER HOUSING ASSEMBLY

1. Install guide studs in several housing mount locations to aid in installation.
2. Install new gaskets. Do not use sealant of any type.
3. Install housings (A) and (E) as an assembly. Tighten cap screws to 47 N.m (35 lb-ft).
4. Install oil lines (D), (F) and (G).
5. Install inlet and outlet tubes (C).
6. Lubricate filter packing with clean engine oil. Tighten until packing contacts filter base. Tighten an additional 1/2 to 3/4 turn.
7. Position packing onto filter (B) and install.
8. Install drain plugs (H) and (I).
9. Fill oil and coolant levels to specifications.
10. Start engine and check for leaks.



Late model shown.

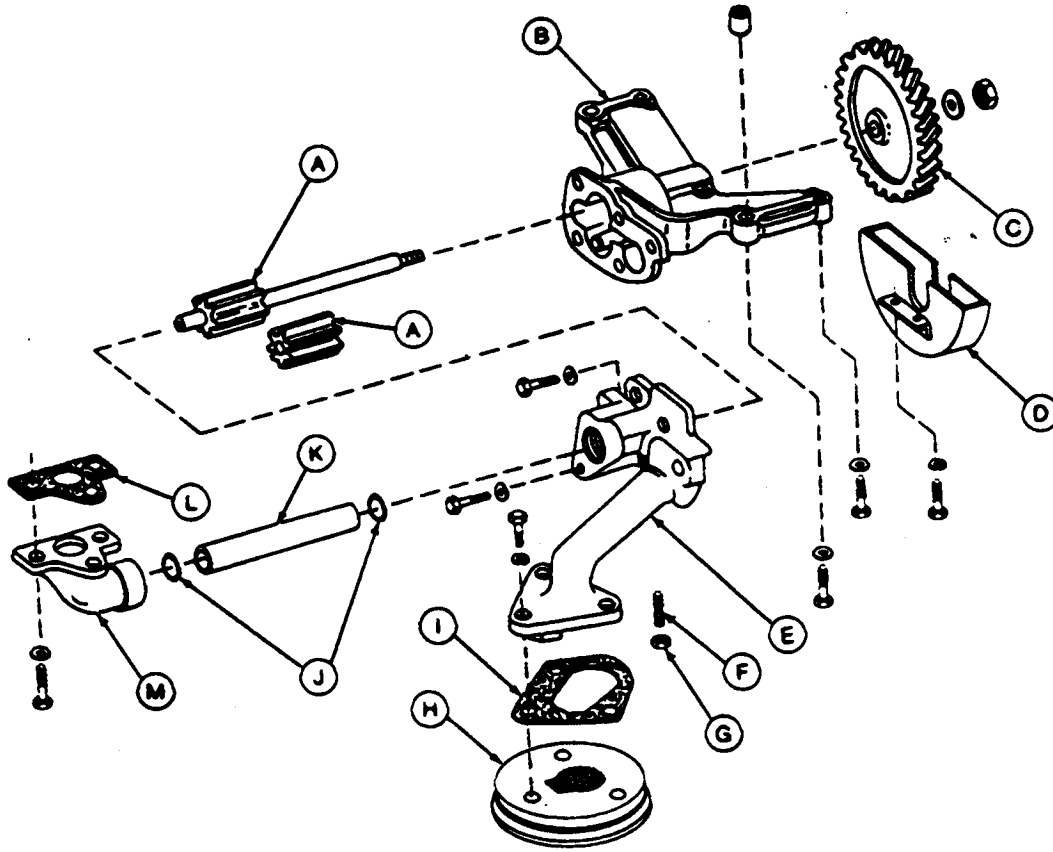
- A—Oil Pressure Regulating Housing
- B—Oil Filter
- C—Inlet and Outlet Tubes
- D—Injection Pump Oil Inlet Line
- E—Oil Cooler Housing
- F—Turbocharger Oil Inlet Line
- G—Bypass Oil Line
- H—Oil Drain Plugs
- I—Coolant Drain Plugs

S11,2520,D,1 -19-25JAN96

RG7344 -UN-23JUN95

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9

CRANKSHAFT DRIVEN OIL PUMP



-JUN-06APR88
 RG-4940

- | | | | |
|----------------|----------------------|-------------------|----------------|
| A—Pump Gears | E—Pump Housing Cover | H—Screen | K—Outlet Tube |
| B—Pump Housing | F—Set Screw | I—Gasket | L—Gasket |
| C—Drive Gear | G—Lock Nut | J—O-Ring (2 used) | M—Outlet Elbow |
| D—Gear Shield* | | | |

*Used on Engine Serial No. (—054879). May be discarded if desired.

gasket and extension elbow for use with deep sump oil pans.

NOTE: Agricultural oil pump shown. Some industrial pumps may be equipped with an additional

S11,2520,Y -19-25JAN96

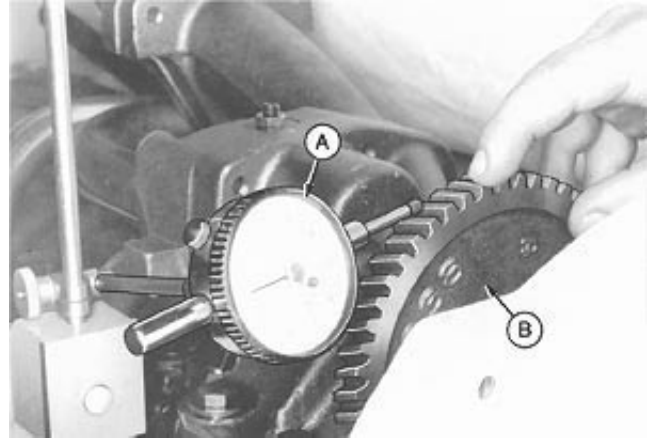
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CHECK CRANKSHAFT GEAR-TO-OIL PUMP DRIVE GEAR BACKLASH

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.



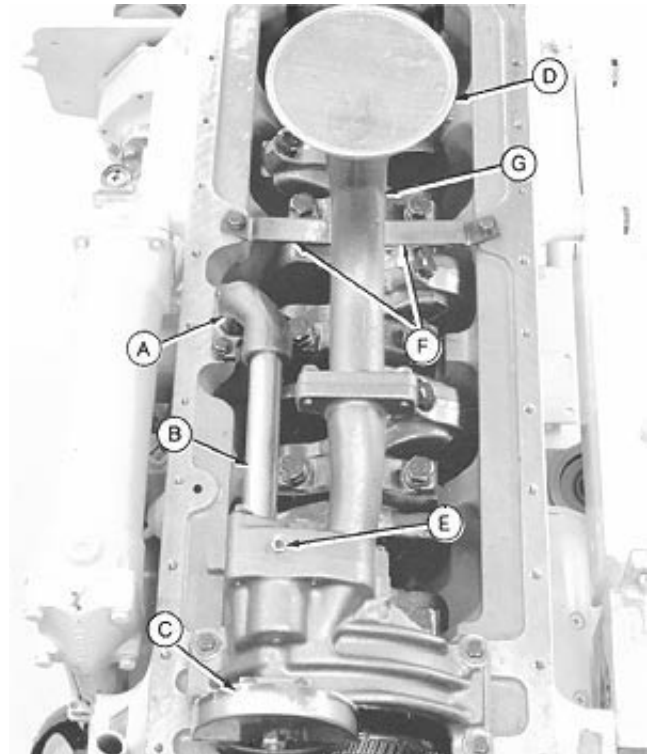
-UN-29NOV88
RG3849

S11,2020,DH -19-25JUL95

REMOVE CRANKSHAFT DRIVEN OIL PUMP

1. Remove outlet elbow (A) and outlet tube (B) with O-rings. Discard O-rings.
2. On early industrial applications, remove brackets (F). On all industrial applications, remove elbow (G) with screen (D).
3. Remove two cap screws and remove drive gear shield (C) if equipped. Discard gear shield if desired.
4. Remove four oil pump-to-cylinder block cap screws and carefully lift pump assembly from cylinder block.
5. Place pump assembly on a clean flat table and remove all gasket material.

IMPORTANT: Do not alter adjustment of set screw and lock nut (E). If adjustment has been altered, follow procedure during assembly. (See ADJUST OIL PUMP SET SCREW, later in this group.)



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11
-UN-25SEP89
RG3754

- A—Outlet Elbow
- B—Outlet Tube
- C—Gear Shield
- D—Intake Screen
- E—Set Screw and Lock Nut
- F—Brackets (Early industrial only)
- G—Elbow (Industrial only)

S11,2520,Z -19-25JUL95

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.

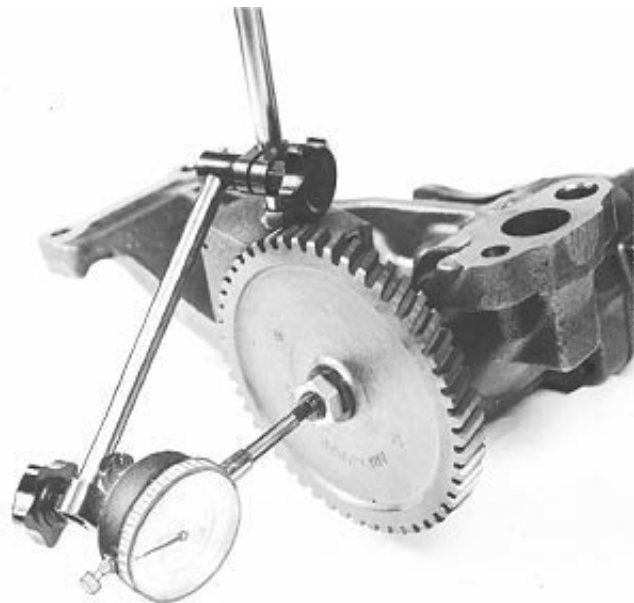
IMPORTANT: To help insure accurate wear measurements, be sure the oil pump is clean and faces the same way as when mounted on the cylinder block.

S11,0404,T -19-25JUL95

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.



RG5916
-UN-16AUG91

S11,0404,U -19-25JUL95

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.



RG5917 -UN-16AUG91

S11,0404,V -19-25JUL95

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.), 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

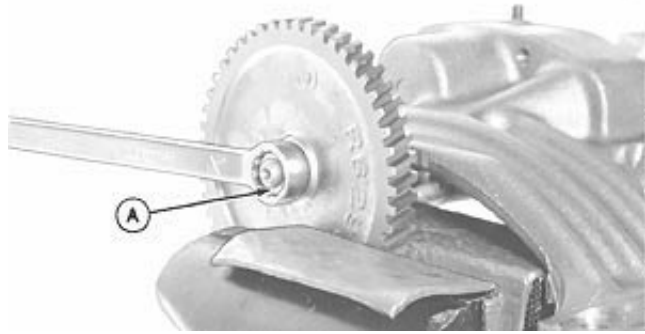
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S11,0404,W -19-25JUL95

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.
2. Remove nut (A) to replace gear, if necessary.



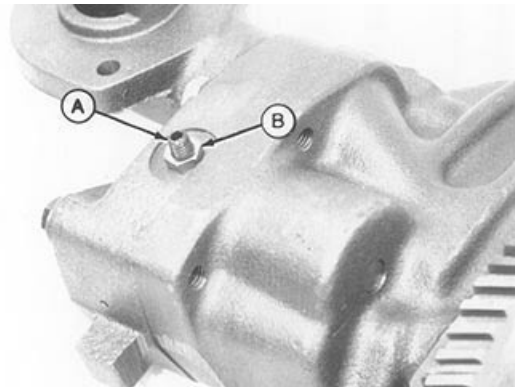
S11,0404,X -19-25JAN96

RG3507 -JUN-29NOV88

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, perform the following steps.

1. Loosen locknut (B) and tighten set screw until it lightly contacts idler shaft.
2. Continue to hold set screw and tighten lock nut to 8 N·m (6 lb-ft) (72 lb-in.). Do not overtighten set screw or lock nut.

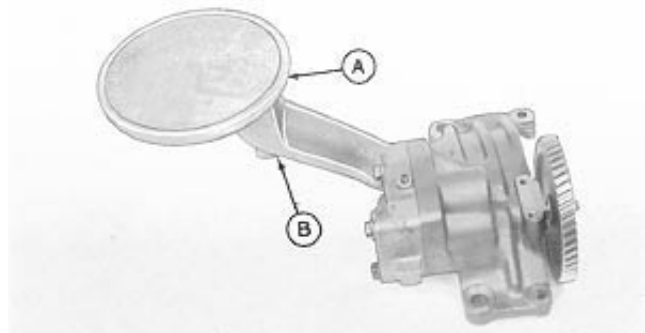


S11,2020,BZ -19-25JAN96

RG7337 -JUN-23JUN95

INSTALL CRANKSHAFT DRIVEN OIL PUMP (AGRICULTURAL AND OEM APPLICATIONS)

1. Install intake screen (A) with new gasket onto pump housing cover elbow (B).
2. Tighten cap screws to 24 N·m (18 lb-ft).



S11,2520,AB -19-25JAN96

RG4324 -JUN-09NOV89

3. Install oil pump, using the two hollow dowels (A) (on the cylinder block mounting surface) as guides. Finish seating oil pump assembly and dowels using a hard rubber mallet.

IMPORTANT: Be sure oil pump drive gear (F) is properly meshed with crankshaft drive gear.

4. Finger tighten all oil pump mounting cap screws.

5. Install O-ring (B), lubricated with clean engine oil, into cover.

6. Install outlet tube (C), being careful not to dislodge or damage O-ring.

7. Install O-ring (D), lubricated with clean engine oil, into outlet elbow (E).

8. Slide outlet elbow over tube, being careful not to dislodge or damage O-ring.

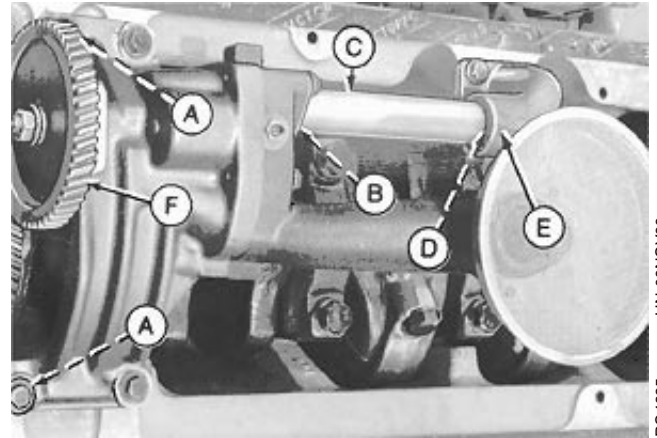
9. Using a new gasket, install outlet elbow and tighten cap screws to 47 N·m (35 lb-ft).

10. Tighten oil pump mounting cap screws to 47 N·m (35 lb-ft).

11. Tighten drive gear (F) nut to 54 N·m (40 lb-ft).

NOTE: Oil pump drive gear shield may be discarded, if desired.

12. On Engine Serial No. (—054879), install gear shield over oil pump drive gear. Tighten cap screws to 27 N·m (20 lb-ft).



A—Hollow Dowels
B—O-Ring
C—Outlet Tube
D—O-Ring
E—Outlet Elbow
F—Oil Pump Drive Gear

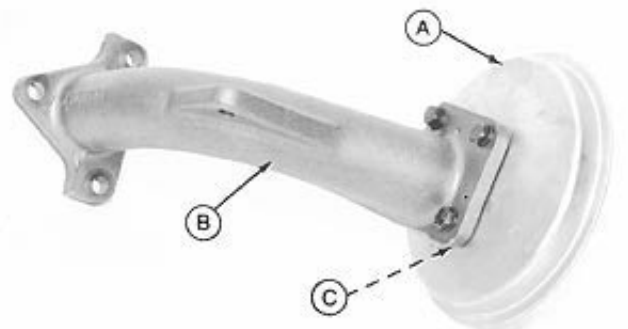
RG4325 -UN-09NOV89

S11,2520,I -19-25JAN96

INSTALL CRANKSHAFT DRIVEN OIL PUMP (INDUSTRIAL APPLICATIONS)

1. Install intake screen (A) with new gasket (C) to elbow (B).

2. Tighten cap screws to 24 N·m (18 lb-ft).



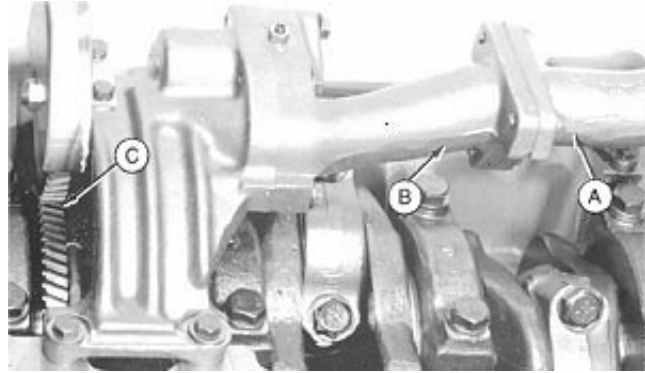
RG3756 -UN-25SEP89

S11,2520,AC -19-25JAN96

3. Install elbow with new gasket (A) onto pump cover (B). Tighten cap screws to 41 N·m (30 lb-ft).

4. Install oil pump using two hollow dowels as guides. Install pump mounting cap screws and finger tighten.

IMPORTANT: Be sure oil pump drive gear is properly meshed (C) with crankshaft gear.



S11,0407,AV -19-25JUL95

RG3757 -UN-25SEP89

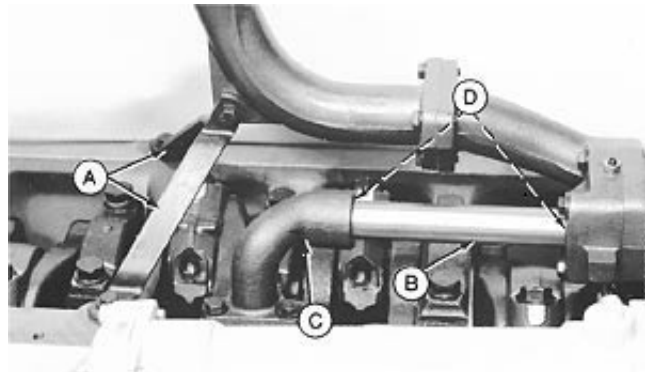
5. On early applications, install both brackets (A).

IMPORTANT: Be careful not to slice or dislodge O-rings when installing outlet tube.

6. Use clean engine oil and install new O-rings (D) into cover and outlet elbow.

7. Install outlet tube (B) and outlet elbow (C) using a new gasket under elbow.

- A—Bracket (2 used, early applications only)
- B—Outlet Tube
- C—Outlet Elbow
- D—O-Ring (2 used)



S11,2520,AD -19-25JUL95

RG3758 -UN-25SEP89

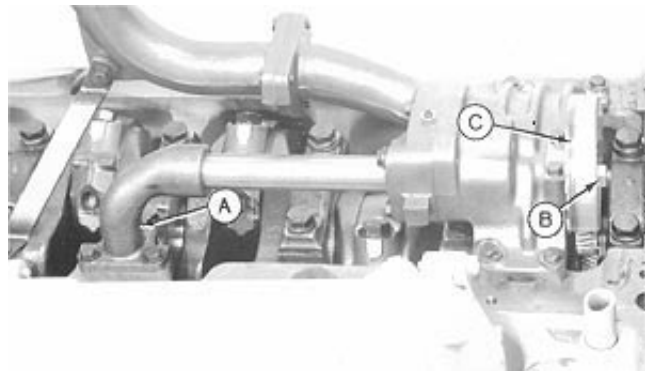
8. Tighten outlet elbow (A) cap screws to 47 N·m (35 lb-ft).

9. Tighten all oil pump mounting cap screws to 47 N·m (35 lb-ft).

10. Tighten drive gear nut (B) to 54 N·m (40 lb-ft).

NOTE: Oil pump drive gear shield (C) may be discarded if desired.

11. On Engine Serial No. (—054879), install gear shield (C) and tighten cap screws to 27 N·m (20 lb-ft).

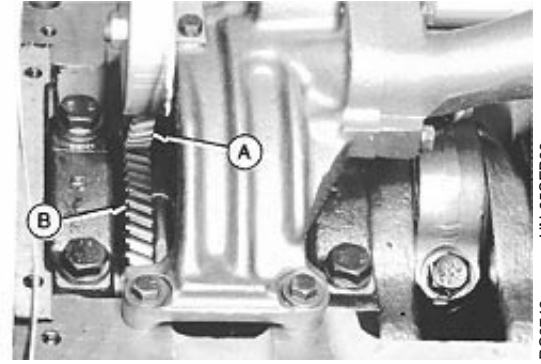


S11,2520,AE -19-25JUL95

RG3759 -UN-25SEP89

IMPORTANT: Push crankshaft rearward (toward flywheel end). Check clearance between oil pump drive gear face and throw of crankshaft. There should be a clearance of at least 0.38 mm (0.0015 in.). If clearance is below specification, check thrust bearing for proper placement.

Gently pry crankshaft forward and check (after oil pump is installed) the oil pump drive gear (A), and crankshaft gear (B) to see that they are properly meshed.



-UN-25SEP89
RG3742

S55,2520,N,1 -19-25JUL95

CHECK CAMSHAFT GEAR-TO-OIL PUMP DRIVE GEAR BACKLASH—(CAMSHAFT DRIVEN OIL PUMP ENGINES ONLY) (ENGINE INSTALLED)

NOTE: When measuring gear backlash, the engine should be at normal operating temperature. This test may be performed with engine installed in vehicle.

1. Remove oil pressure regulating housing, if not previously removed. (See REMOVE OIL PRESSURE REGULATING HOUSING AND OIL COOLER ASSEMBLY in this group.)
2. Remove tachometer drive housing or cover plate, however equipped.
3. Install pointer ring assembly (A) from JDE149 Camshaft Wear Indicator on top flange of engine oil pump drive gear. Do not tighten pointer assembly screw.
4. Install gauge (B) from JDE149 Camshaft Wear Indicator on engine block using the two cap screws provided with tool set. Tighten cap screws securely.
5. Align the point (C) over the center mark on gauge and tighten pointer assembly screw securely.

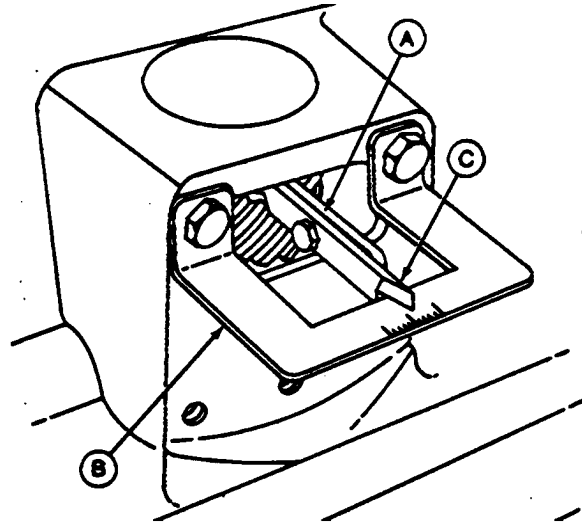
NOTE: Check backlash at four gear positions, 90° apart.

6. Grasp pointer assembly with fingers and move the pointer back and forth by hand. DO NOT use excessive force to move the pointer assembly.

NOTE: Each mark on gauge is equivalent to 1° of backlash.

If the total movement of the pointer 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 the total movement of the pointer is 0.5° or less, or if camshaft cannot be rotated through one revolution without binding, replace camshaft.



20
18

CHECK CAMSHAFT GEAR-TO-OIL PUMP DRIVEN GEAR BACKLASH— CAMSHAFT-DRIVEN OIL PUMP ENGINES ONLY

NOTE: This test can be performed with the engine installed in the vehicle if oil pan is easily accessible.

1. Remove engine oil pan. (See REMOVE OIL PAN 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.



RG4969 -UN-19JAN90

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.)

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, replace camshaft.

S11,2505,CV -19-25JAN96

REMOVE AND INSPECT CAMSHAFT DRIVEN OIL PUMP

NOTE: Tachometer drive assembly must be removed (if equipped) before removing camshaft driven oil pump. (See REMOVE TACHOMETER DRIVE ASSEMBLY in Group 16).

1. Remove two oil pump mounting cap screws (bold arrows, upper photo).
2. Carefully pry between pump and cylinder block to loosen sealing surface. Remove oil pump.
3. Remove intake screen (E) and pump housing cover (D) from pump housing (B). Clean all parts with solvent and dry with compressed air.

IMPORTANT: Worn gears, shaft or housing can reduce pump output and could indicate oil contamination, sludge, or bent or warped shaft.

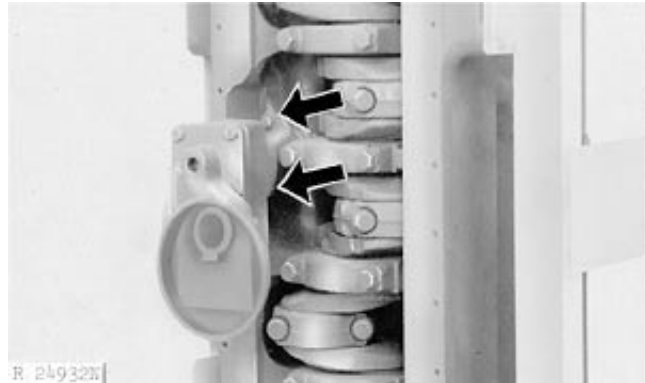
4. Examine gears and housing for wear or damage.

NOTE: If drive gear on top of shaft (A) is worn or damaged, check the oil pump drive gear on the camshaft for wear or damage. Replace pump drive gear and camshaft as necessary.

5. Inspect gears for embedded debris. Remove lightly embedded material with a wire brush. If material is heavily embedded, replace gears.

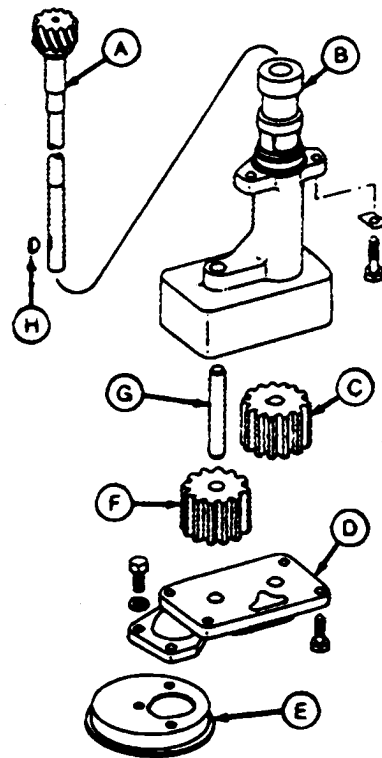
NOTE: If either the idler gear (F) or driven gear (C) must be replaced, replace both gears as a set. (See REMOVE CAMSHAFT DRIVEN OIL PUMP GEARS, later in this group.)

6. Inspect housing and sealing edge of housing to ensure that no holes or other defects are present in casting that might allow engine oil to bypass the filter.



R 24932N

R24932N -UN-09FEB90



- A—Drive Shaft
- B—Pump Housing
- C—Driven Gear
- D—Pump Cover
- E—Intake Screen
- F—Idler Gear
- G—Idler Shaft
- H—Woodruff Key

-UN-06APR89

RG4941

7. Check oil pump components with the specifications given below. Replace parts as necessary.

OIL PUMP SPECIFICATIONS

Drive Gear Shaft OD	19.012—19.037 mm (0.7485—0.7495 in.)
Idler Shaft OD	19.136—19.152 mm (0.7534—0.7540 in.)
Idler Gear ID	19.177—19.202 mm (0.7550—0.7560 in.)
Driven and Idler Gear Thickness	50.80—50.85 mm (2.000—2.002 in.)
Driven and Idler Gear OD	85.855—85.880 mm (3.3801—3.3811 in.)
Driven Gear ID	18.974—18.999 mm (0.7470—0.7480 in.)
Gear Bore Depth in Housing	50.876—50.978 mm (2.003—2.007 in.)
Gear Bore ID in Housing	85.954—86.004 mm (3.3840—3.3860 in.)

S11,2520,AF,1 -19-25JUL95

REMOVE CAMSHAFT DRIVEN OIL PUMP GEARS

1. Remove idler gear (shown removed) by sliding from idler shaft (C).

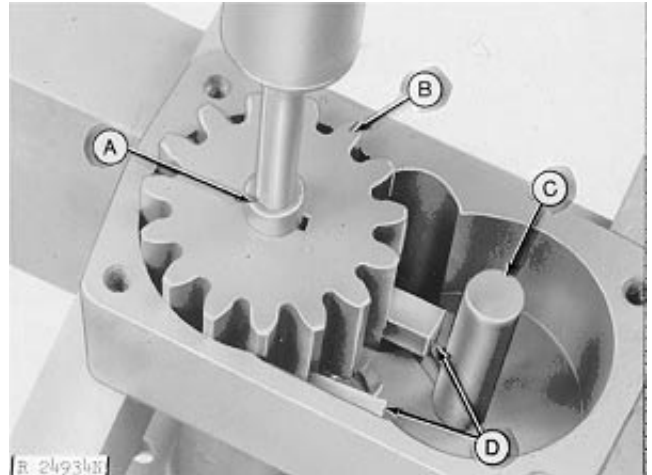
NOTE: Be very careful when removing the driven gear from shaft so the Woodruff key does not damage the oil pump housing.

2. Support the base of the pump housing in a press and press the shaft (A) 6.4 mm (0.25 in.) from the driven gear (B). Place two 6.4 mm (0.25 in.) shims (D) between the gear and housing.

3. Press the shaft another 6.4 mm (0.25 in.) from the driven gear and place two 12.7 mm (0.50 in.) shims between gear and housing.

4. Pressing the shaft another 12.7 mm (0.50 in.) should remove the driven gear.

5. Inspect and clean all parts that will be re-used during assembly.



A—Driven Shaft
B—Driven Gear
C—Idler Shaft
D—Shims

S11,2520,AG -19-25JAN96

INSTALL CAMSHAFT DRIVEN OIL PUMP GEARS

If idler shaft must be replaced, press new shaft into housing until pressed-in end of shaft is flush to 0.51 mm (0.02 in.) below outside surface of housing.

1. Install oil pump drive gear and shaft in pump housing (2).
2. Install Woodruff key (1) in keyway.



T33164N -UN-27JUL89

S11,2520,AH -19-25JUL95

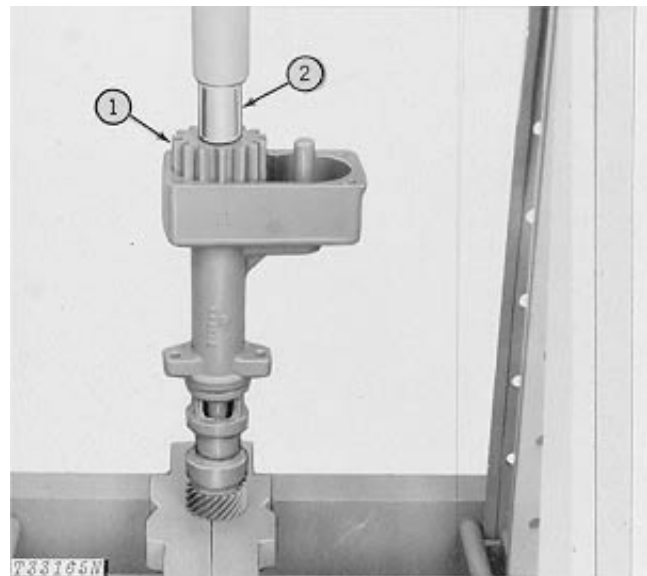
NOTE: Support oil pump housing as shown and use a press adapter (2) that has a bore with an ID larger than the pump shaft OD to install driven gear (1). Adapter bore must be deeper than 25.9 mm (1.02 in.). Press on gear only, DO NOT press on shaft.

3. With key in shaft and keyway in driven gear aligned, press gear FLUSH with sealing edge of housing. Pump shaft will extend approximately 25.9 mm (1.02 in.) above driven gear and edge of housing.

4. Install idler gear on idler shaft and spin oil pump drive gear by hand. Both the idler gear and the driven gear must turn freely before and after pump cover is installed.

5. Lubricate both oil pump gears and mating face of the housing with clean engine oil.

6. Install pump cover and tighten cap screws to 41 N·m (30 lb-ft). Install pickup screen to pump cover and tighten cap screws to 24 N·m (18 lb-ft) (216 lb-in.).



T33165N -UN-27JUL89

S11,2520,AI -19-25JUL95

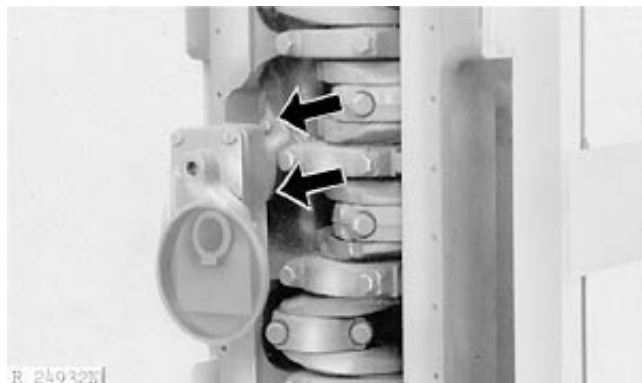
INSTALL CAMSHAFT DRIVEN OIL PUMP

1. Install oil pump in cylinder block, making sure that gears on oil pump and camshaft mesh.

IMPORTANT: Always replace oil pump mounting cap screws once they are removed or their torque disturbed.

2. Install new cap screws and hardened washers (arrows). Tighten cap screw to 41 N·m (30 lb-ft).

3. Install tachometer drive assembly, if equipped. (See INSTALL TACHOMETER DRIVE ASSEMBLY in Group 16.)



S11,2520,AJ -19-25JUL95

INSTALL OIL PAN

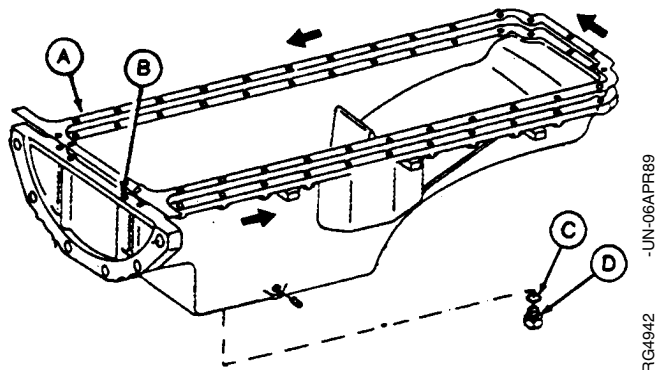
Before installing oil pan, remove old gasket material and sealant from pan and cylinder block mating surfaces. Be sure all gasket surfaces are clean before assembling.

NOTE: 6619 Engines are equipped with either a cast iron oil pan which has a 20.5 mm (0.81 in.) thick pan rail or an aluminum alloy oil pan which has 11.1 mm (0.43 in.) thick pan rail and 20.5 mm (0.81 in.) cap screw bosses. Differences in installation procedures will be noted.

IMPORTANT: Apply a thin layer of PERMATEX AVIATION (Form-A-Gasket No. 3) at timing gear cover-to-cylinder block mating surfaces, along entire surface of timing gear cover, at rear oil seal housing-to-cylinder block mating surfaces and along entire rear face of block before installing oil pan gasket.

S11,2520,AK -19-25JUL95

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23



A—Oil Pan Gasket

B—Location For First Cap Screw

C—O-Ring or Aluminum Washer

D—Drain Plug*

1. Place a new gasket (A) on cylinder block and install oil pan. Be sure oil pan is flush with cylinder block (flywheel end). Guide studs may be used if desired.

NOTE: Use a straightedge against oil pan and flywheel end of cylinder block to assure a flush ± 0.5 mm (0.002 in.) alignment for proper flywheel housing installation.

2. Insert all 3/8 in. and 1/2 in. cap screws in their appropriate hole locations. First, tighten all 1/2 in. cap screws to specifications starting at right rear corner (B) of oil pan and proceed counterclockwise (bold arrows).

3. Tighten all 3/8 in. cap screws to specifications starting at right rear corner (B) of oil pan and proceed counterclockwise (bold arrows).

4. Trim gasket flush at rear surface of cylinder block and oil pan.

5. Retighten all 3/8 in. cap screws to specifications.

6. Retighten all 1/2 in. cap screws to specifications.

7. Install all 3/4 in. oil pan-to-flywheel housing cap screws and tighten to specifications.

OIL PAN CAP SCREW TORQUE SPECIFICATIONS

3/8 in. Cap Screw SAE Grade 5	47 N·m (35 lb-ft)
3/8 in. Cap Screw SAE Grade 8	
and Grade 180	68 N·m (50 lb-ft)
1/2 in. Cap Screw SAE Grade 5	115 N·m (35 lb-ft)
1/2 in. Cap Screw SAE Grade 8	
and Grade 180	156 N·m (115 lb-ft)
3/4 in. Cap Screw.	325 N·m (240 lb-ft)

*Some oil pans may be equipped with an elbow fitting and drain hose.

NOTE: Bottom oil pan drain plugs (D) use either an aluminum washer or rubber O-ring (C) for sealing.

NOTE: If oil pan drain plug threads are damaged, replacement HELICOIL® inserts are available. Follow manufacturer's installation instructions very carefully.

8. Apply a light coat of engine oil to new rubber O-ring for bottom drain plug. If aluminum washer is used, install so raised center contacts head of drain plug.

9. Install drain plug and tighten to specification listed below.

OIL PAN DRAIN PLUG TORQUE SPECIFICATION

Aluminum Oil Pans	101 N·m (75 lb-ft)
Cast Iron Oil Pans	47 N·m (35 lb-ft)

NOTE: On engine 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 242 Thread Lock and Sealer to fitting except for the leading one to three threads. Tighten fitting securely.

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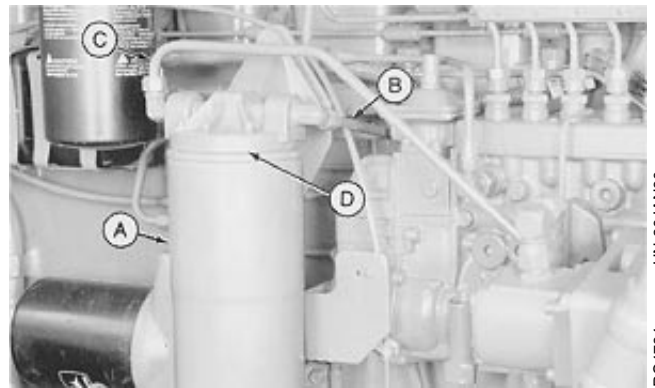
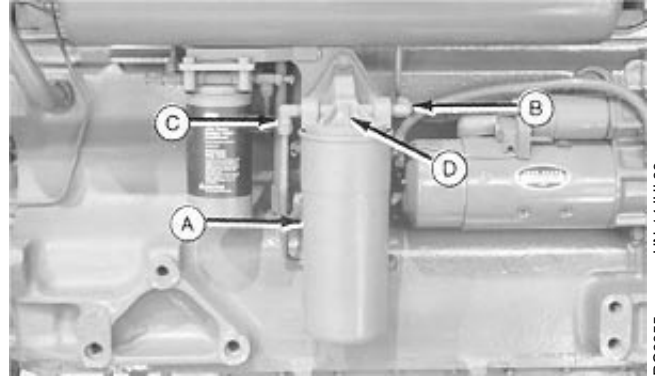
REMOVE BYPASS OIL FILTER ASSEMBLY

NOTE: Location of bypass oil filter assembly may vary by engine model, however, service procedure is the same for all applications

CAUTION: Allow engine to cool before removing bypass oil filter system.

1. Remove bypass oil filter element (A) and discard.
2. Remove inlet line (B) and outlet line (C) at filter base (D). Remove filter base. Remove and discard all packing at line connections.

A—Filter Element
B—Inlet Line
C—Outlet Line
D—Filter Base



S11,2520,AM -19-25JUL95

INSPECT AND CLEAN BYPASS OIL FILTER ASSEMBLY

1. Inspect filter base for cracks, damage, or debris around mounting surface.
2. Inspect lines and connectors for cracks or damage. Replace parts as necessary.
3. Clean all parts using clean solvent. Dry with compressed air.

S11,2520,M -19-25JUL95

20
25

INSTALL BYPASS OIL FILTER ASSEMBLY

1. Install filter base (D). Tighten cap screws to 47 N.m (35 lb-ft).

NOTE: Always use new packing at line connections to prevent oil leaks.

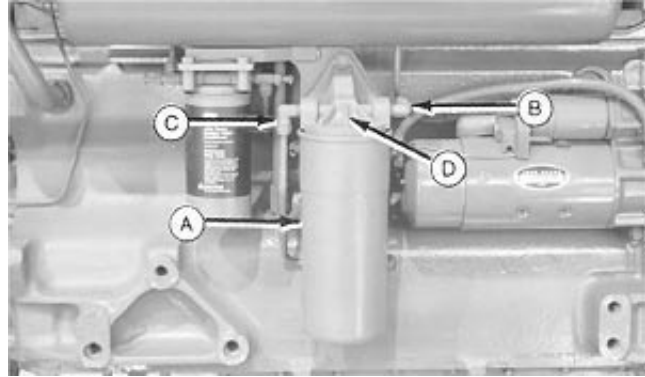
2. Install inlet line underneath starter. Tighten connector securely.

3. Install inlet line (B) and outlet line (C). Tighten all connections securely.

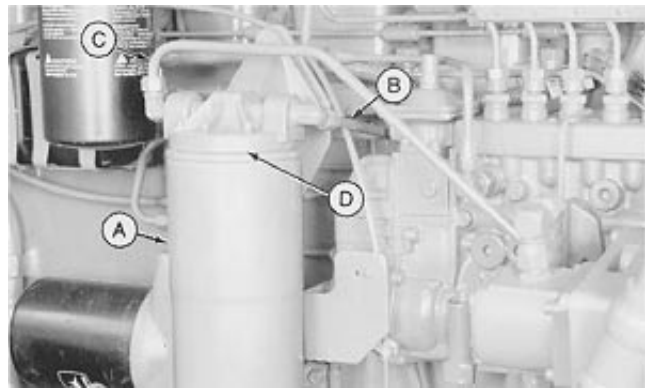
4. Spread a thin layer of clean engine oil on bypass oil filter packing and install new filter (A). Tighten new filter one full turn after packing contacts filter base (D). Do not overtighten.

5. Add engine oil to proper level.

A—Bypass Oil Filter
B—Inlet Line
C—Outlet Line
D—Filter Base



RG32955 -UN-14JUL89



RG4784 -UN-26JAN90

S11,2520,AN -19-25JAN96

SPECIAL OR ESSENTIAL TOOLS

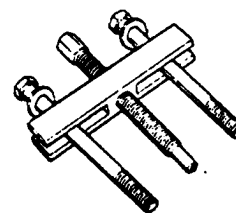
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-20JUL95

Push Puller D01290AA

Used to remove fan pulley from belt driven water pump.

NOTE: D01206AA Push Puller, may be used to remove fan pulley, if available.



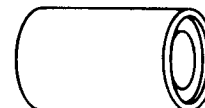
-UN-23AUG88
RG5097

S53,D01206,AA -19-25JUL95

Water Pump Shaft and Bearing Driver JDE74

RG5095 -UN-06APR89

Used to install bearing and shaft assembly into standard-duty water pump housing.

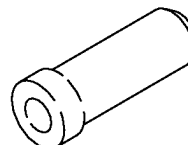


S53,JDE74,A -19-25JUL95

Water Pump Bearing Driver JDG743

RG7348 -UN-12JUL95

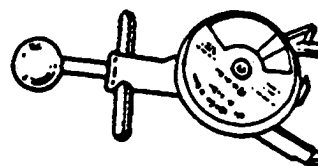
Used to install bearings and shaft assembly in heavy-duty water pump.



S53,JDG743 -19-25JUL95

Belt Tension Gauge JDG529

Used to check and adjust fan belt tension.



-UN-23AUG88
RG5082

S53,JDG529 -19-06APR94

Cooling System/Other Material

Belt Tension Gauge JDST28

RG5588 -UN-13SEP89

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	Install inner grease seal in water pump housing.

S55,2525,A,1 -19-25JAN96

OTHER MATERIAL

Name	Use
LOCTITE 515 Flexible Sealant (TY6304)	Water pump, thermostat cover and water manifold gaskets.
High Temperature Grease (TY6341)	Pack heavy-duty water pump bearings.
LOCTITE 592 Pipe Sealant with TEFLON (TY9374/TY9375)	Coat threads of water pump pipes and coolant filter/conditioner lines.

RG,CTM9,G25,1 -19-25JUL95

25
2

COOLING SYSTEM SPECIFICATIONS

Item	New Part Specification
Heavy Duty Water Pump:	
Impeller Bore ID	15.854—15.880 mm (0.6242—0.6252 in.)
Shaft OD Impeller End	15.905—15.931 mm (0.6262—0.6272 in.)
Shaft OD Pulley End	30.200—30.226 mm (1.1890—1.1900 in.)
Pulley Bore ID	30.137—30.163 mm (1.1865—1.1875 in.)
Bearing Bore in Water Pump Housing	71.996—72.025 mm (2.8345—2.8356 in.)
Maximum Serviceable	72.047 mm (2.8365 in.)
Impeller-to-Housing Clearance	0.39—0.89 mm (0.015—0.035 in.)
Pump Shaft Max. End Play	0.25 mm (0.010 in.)
Pulley-to-Shaft Interference Press Fit	0.037—0.089 mm (0.0015—0.0035 in.)
Shaft OD for Bearing	35.001—35.017 mm (1.3780—1.3786 in.)
Standard Duty Water Pump:	
Impeller Bore ID	15.85—15.88 mm (0.624—0.625 in.)
Bearing Shaft OD Impeller End	15.90—15.92 mm (0.626—0.627 in.)
Bearing Shaft OD Pulley End	25.39—25.40 mm (0.999—1.000 in.)
Pulley Bore ID	25.31—25.34 mm (0.996—0.997 in.)
Bearing Bore in Water Pump Housing	47.576—47.602 mm (1.8731—1.8741 in.)
Maximum Serviceable	47.624 mm (1.8750 in.)
Impeller Installed Dimension	Flush to 0.5 mm (0.02 in.) below cover side of pump housing
Bearing Installed Dimension	0.00—0.13 mm (0.0—0.005 in.) above housing
Impeller Installed Dimension	0.00—0.5 mm (0.0—0.02 in.) below housing
Pulley-to-Shaft Interference Press Fit	0.0381—0.0889 mm (0.0015—0.0035 in.)
Pump Shaft Max. End Play	0.15 mm (0.006 in.)
Thermostat Opening Temperature	80—84° C (175—182°F)
V-Belt Tension (2-Belt System, Tension Front Belt Only):	
New Belts	422—463 N (95—104 lb-force)
Belts in Service (Minimum 10-Minutes Use)	378—418 N (85—94 lb-force)
Pulley Installed Dimension (Pulley Front Face-to-Housing Rear Face):	
6619AT-01, 03 (—030299)	144.6 mm (5.69 in.)
6619AT-5	174.5 mm (6.87 in.)
6619AT-04, 6619TT-01	188 mm (7.40 in.)
6619AE-02 (044593—), 6619AE-03, 6619AR-08, 09, 6619AR-10, 13 (044789—)	198 mm (7.80 in.)
6619AR-11, 12, 14, 6619AT-01, 03 (030300—)	153 mm (6.02 in.)
6619AR-01, 06, 6619AF, 6619TF, 6619AR-10, 13 (—044790)	212.6 mm (8.37 in.)
6619AE-01	Press pulley on shaft until shoulder in pulley bore is flush with end of shaft.
6619AT-02, 6619TT-02	Tighten cap screws to 115 N.m (85 lb-ft).

COOLING SYSTEM SPECIFICATIONS—CONTINUED

Torques

Water Pump Cover-to-Housing:	
Standard	27 N·m (20 lb-ft)
Heavy-Duty	24 N·m (18 lb-ft)
Water Pump-to-Cylinder Block:	
SAE Grade 5	47 N·m (35 lb-ft)
SAE Grade 8	61 N·m (45 lb-ft)
Bypass Elbow-to-Water Pump	27 N·m (20 lb-ft)
Water Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Thermostat Housing-to-Water Manifold	27 N·m (20 lb-ft)
Coolant Filter Conditioner Mounting Bracket:	
Water Manifold Mounted	47 N·m (35 lb-ft)
Air Intake Manifold Mounted	75 N·m (55 lb-ft)
Coolant Filter Conditioner Base-to-Mounting Bracket	47 N·m (35 lb-ft)
Fan Pulley-to-Water Pump Shaft (6619AT-02 & 6619TT-02)	115 N·m (85 lb-ft)
Coolant Heater Nut	34 N·m (25 lb-ft)

S11,2025,FX,1 -19-25JAN96

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

25
4

S11,2025,DH -19-17AUG94

GENERAL INFORMATION

6619 Engines are equipped with two basic belt-driven water pumps, a standard-duty water pump (with shaft and roller bearing all one piece) and a heavy-duty water pump (with a separate shaft and bearings pressed on each end of shaft). Removal and installation of standard-duty and heavy-duty water pumps are the same, but repair procedures differ. Use the appropriate repair procedure for the water pump installed on your engine.

S11,2525,BC -19-25JUL95

REMOVE WATER PUMP

⚠ CAUTION: Explosive release of fluids from pressurized cooling systems can cause serious burns. Do not drain engine coolant until the temperature is below operating temperature, then loosen drain cock (A) slowly to relieve any pressure.

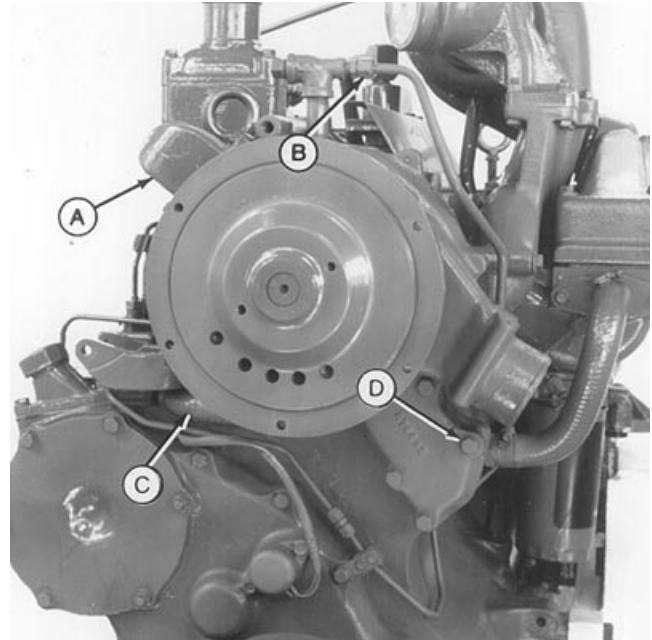
1. Drain coolant from cylinder block if not previously done.
2. Remove fan and fan belts.



S11,2525,BA -19-25JAN96

3. Remove coolant filter line (B).
4. Remove bypass elbow (A).
5. Remove water pump-to-oil cooler hose (C).
6. Remove four mounting cap screws (D) and lift water pump from engine.
7. Place water pump on a clean flat surface. Remove all gasket material from water pump cover and engine block.

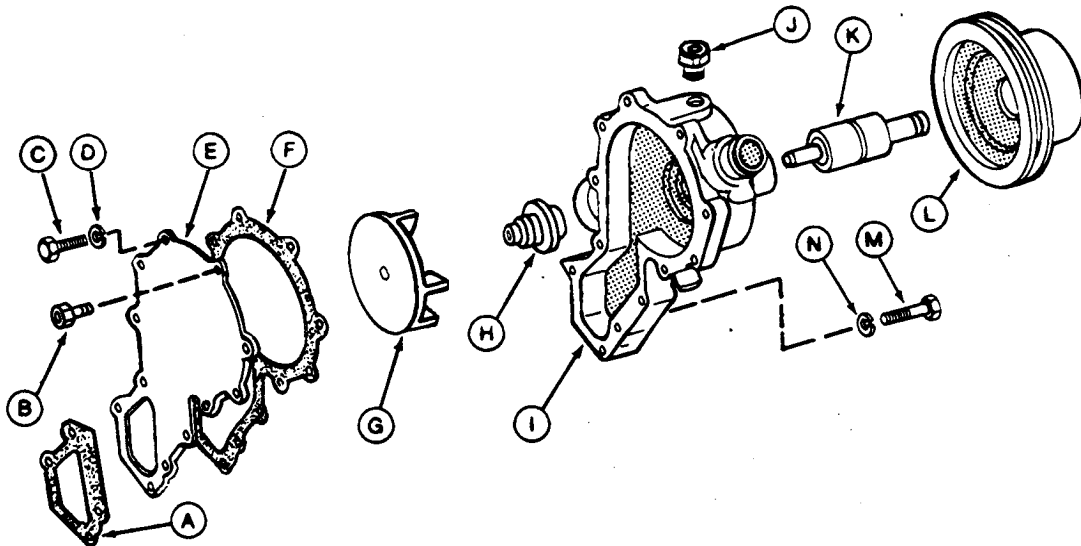
- A—Bypass Elbow
- B—Coolant Filter Line
- C—Water Pump-To-Oil Cooler Hose
- D—Mounting Cap Screws (4 used)



-UN-23JUN95
RG7335

S11,2525,BB -19-25JAN96

DISASSEMBLE STANDARD-DUTY WATER PUMP



- A—Gasket
- B—Socket Head Screw
- C—Cap Screw (8 used)
- D—Lock Washer (8 used)

- E—Cover
- F—Gasket
- G—Impeller
- H—Seal

- I—Housing
- J—Connector
- K—Shaft/Bearing Assembly

- L—Pulley
- M—Cap Screw (4 used)
- N—Lock Washer (4 used)*

*Serial No. (—060414)

S11,2525,BD -19-25JUL95

-UN-22NOV89
RG3686

1. Remove cover (A) and all gasket material.



S11,0417,F -19-25JUL95

RG3776 -UN-25SEP89

IMPORTANT: DO NOT attempt to press shaft from pulley end. A flange in the bearing bore prevents bearing passage through housing.

2. Remove fan pulley using D01290AA Push-Puller from D01173AA 17-1/2 Ton Puller Set, and two 3/8-16 UNC-2B cap screws (with flat washers) approximately 4.0 inches long.

NOTE: D01206AA Push Puller (shown) may be used if D01290AA Push-Puller is not available.

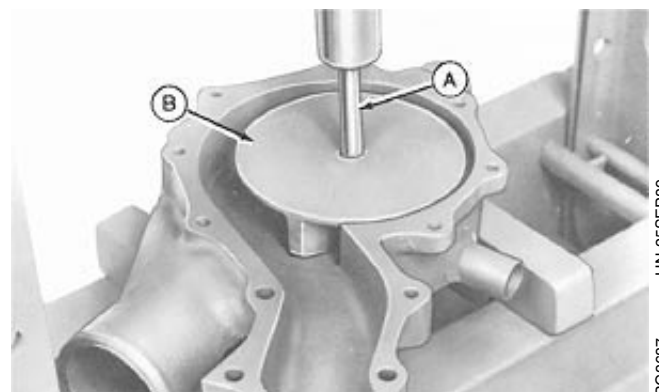


S11,2525,BE -19-25JAN96

T52338 -UN-28JUL89

3. Use a drift (A) slightly smaller than shaft at impeller end and press bearing/shaft assembly from impeller (B).

4. Remove impeller.



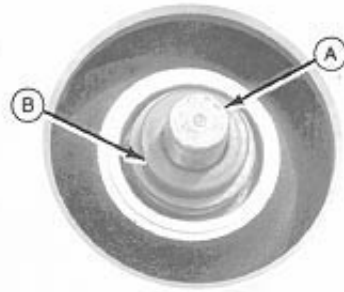
S11,0417,H -19-15APR82

RG3687 -UN-25SEP89

NOTE: Press only on diameter of shaft and not on water pump seal (B).

5. Use a press to remove shaft and bearing assembly (A) and press until assembly is clear from water pump housing.

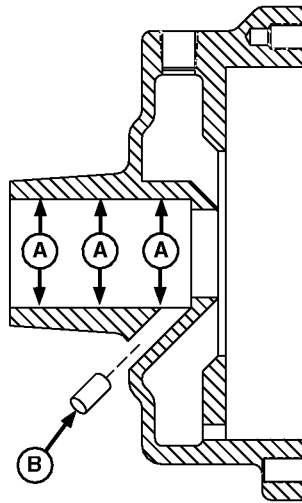
6. Remove seal with a small driver inserted from pulley end of housing bore.



RG3688 -UN-25SEP89

S11,0417,I -19-25JUL95

INSPECT STANDARD-DUTY WATER PUMP PARTS



-UN-12/JUL95
FG7946

1. Make sure all gasket material is removed from water pump housing and cover.
2. Clean all parts with clean solvent and dry with compressed air.
3. Remove weep filter (B), if equipped. Ensure passage is clean and install new filter.
4. Inspect shaft and bearing assembly for warpage or damage. Replace as necessary.
5. Inspect water pump housing and cover for debris, cracks or damage. Replace as necessary.
6. Inspect impeller for debris, cracks or damage. Replace as necessary.
7. Measure bearing bore in pump housing at locations (A) using a telescoping gauge or dial bore gauge. Compare readings to specifications given.
8. Measure all parts and compare to specifications given. Replace as necessary.

WATER PUMP SPECIFICATIONS

Impeller Bore ID	15.85—15.88 mm (0.624—0.625 in.)
Bearing Shaft OD Impeller End	15.90—15.92 mm (0.626—0.627 in.)
Fan Pulley Bore ID	25.31—25.34 mm (0.996—0.997 in.)
Bearing Shaft OD Fan Pulley End	25.39—25.40 mm (0.999—1.00 in.)
Bearing Bore in Pump Housing	47.576—47.602 mm (1.8731—1.8741 in.)
Maximum Servicable	47.624 mm (1.8750 in.)
Pulley-to-Shaft Interference	
Press Fit	0.0381—0.0889 mm (0.0015—0.0035 in.)
Pump Shaft Max. End Play	0.15 mm (0.006 in.)

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9

ASSEMBLE STANDARD-DUTY WATER PUMP

1. Coat shaft/bearing assembly with a light coat of SAE 10W engine oil.
2. Using the JDE74 Driver (A), press shaft/bearing assembly (B) into housing (C) until bearing is flush to 0.13 mm (0.005 in.) above edge of housing.



S11,2525,BF -19-25JUL95

RG3689 -UN-25SEP89

IMPORTANT: Use R78350 Driver (A) that is included with water pump seal kit to drive seal to proper depth.

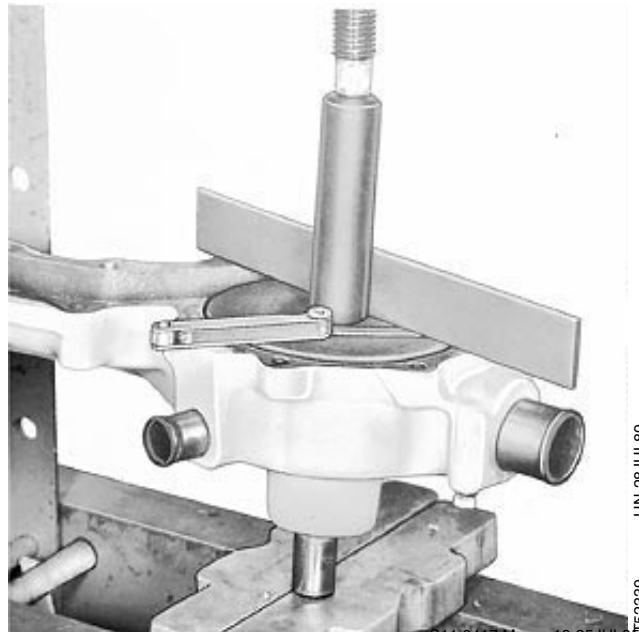
3. Place new seal (B) onto shaft with R78350 Driver over seal. Drive seal until it bottoms on water pump housing (C).



S11,0417,L -19-25JUL95

RG3690 -UN-09NOV89

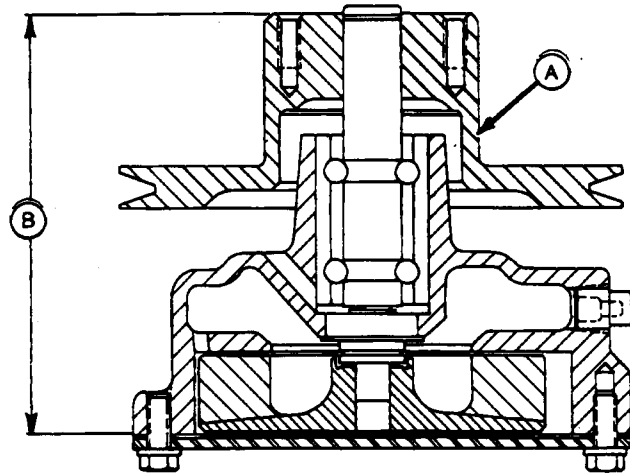
4. Support pump shaft and press impeller in place. Press until the solid side of the impeller is 0.0—0.5 mm (0.00—0.02 in.) below the cover side of the housing.
5. Remove pump and turn shaft with impeller to be sure the impeller does not drag on housing.



S11,0417,M -19-25JUL95

T52339 -UN-28JUL89

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RG3714 -JUN-22NOV89

6. Support bearing shaft assembly through impeller bore and press on pulley (A) until pulley-to-rear housing face measurement (B) is obtained according to specifications given.

Front Pulley Face-to-Rear Housing Face Measurement (B):

6619AT-01, 03 (—030299)	144.6 mm (5.69 in.)
6619AR-11, 12, 14, 6619AT-01, 03 (030300—)	153 mm (6.02 in.)
6619AT-05	174.5 mm (6.87 in.)
6619AT-04, 6619TT-01	188 mm (7.40 in.)
6619AE-02 (044593—), 6619AE-03, 6619AR-08, 09, 6619AR-10, 13 (044789—)	198 mm (7.80 in.)
6619AR-01, 06, 6619AF, 6619TF, 6619AR-10, 13 (—044790)	212.6 mm (8.37 in.)
6619AE-01	Press pulley on shaft until shoulder in pulley shaft bore is flush with end of shaft.
6619AT-02, 6619TT-02	Tighten cap screws to 115 N-m (85 lb-ft)

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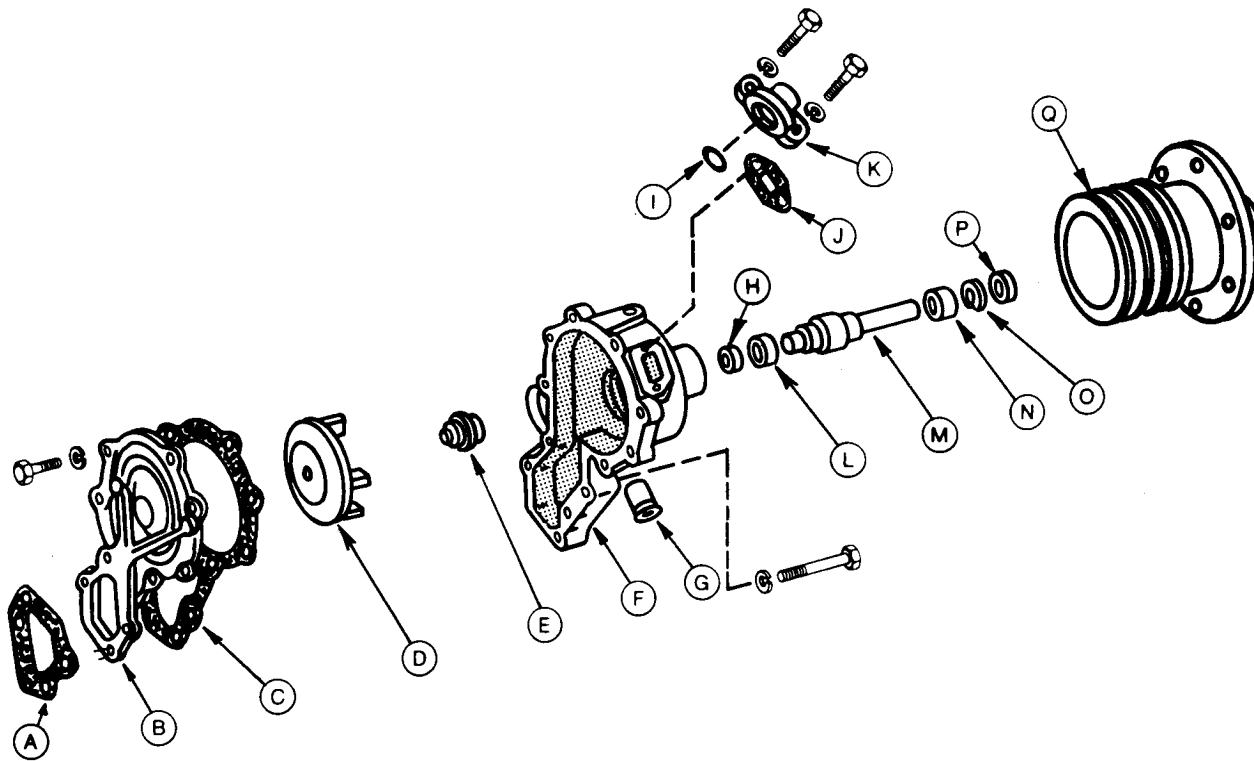
7. Using a new gasket, install cover (A) and tighten cap screws to 27 N-m (20 lb-ft).



RG3776 -UN-25SEP89

S11,00417,O -19-21OCT86

DISASSEMBLE HEAVY-DUTY WATER PUMP



RG3558 -UN-25JUN94

- | | | | |
|----------------------------|-----------|----------------|--------------------------|
| A—Gasket | F—Housing | J—Gasket | N—Ball Bearing |
| B—Cover | G—Tube | K—Elbow | O—Snap Ring |
| C—Gasket | H—Seal | L—Ball Bearing | P—Seal |
| D—Impeller (Design Varies) | I—O-Ring | M—Shaft | Q—Pulley (Design Varies) |
| E—Seal | | | |

S11,2525,BH -19-25JUL95

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12

NOTE: D01206AA Push-Puller may be used if D01290AA Push-Puller is not available.

1. Remove water pump pulley using D01290AA Push-Puller from D01173AA 17-1/2 Ton Puller Set and two 3/8-16 UNC-2B cap screws (with flat washers) approximately 4.0 in. long.

2. Measure pulley bore and shaft OD. If measurements are not within specification, replace pulley or shaft.

WATER PUMP PULLEY SPECIFICATIONS

Pulley Bore	.....	30.137—30.163 mm (1.1865—1.1875 in.)
Shaft OD Pulley End	.....	30.200—30.226 mm (1.189—1.190 in.)



-UN-17NOV92
RG6491

S11,2525,BJ -19-25JAN96

3. Remove six cap screws and remove cover (A). Scrape all gasket material from cover and housing face.

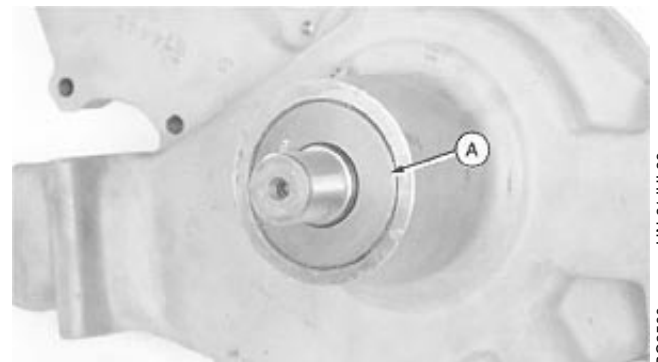


-UN-31JUL89

RG3571
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S11,2525,BI -19-25JUL95

4. Use a small sharp punch and punch a hole through outer seal (A). Pry outer grease seal from housing. Discard seal.



-UN-31JUL89

RG3560

S11,2525,AC -19-05MAY93

5. Remove snap ring (A).

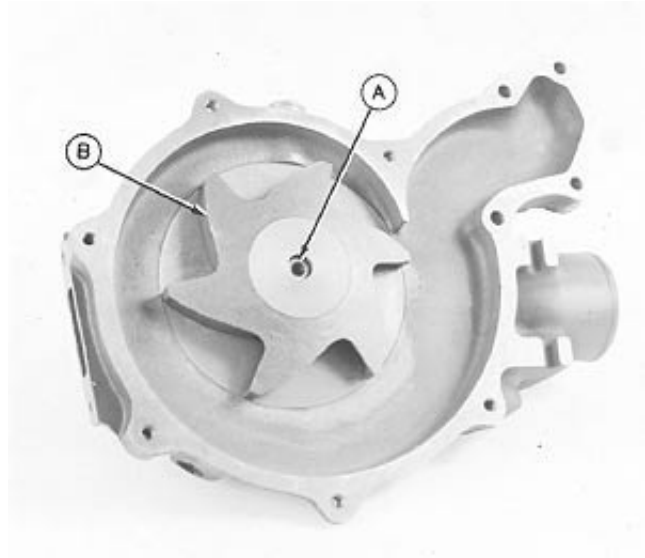


S11,2525,AD -19-05MAY93

RG3561 -UN-31JUL89

IMPORTANT: Whenever an impeller is removed from a shaft, it should be replaced with a new one. This assures that adequate pump shaft-to-impeller bore press fit is maintained.

6. Use a press and press shaft (A) through impeller (B). Press on shaft only. Remove impeller and discard.

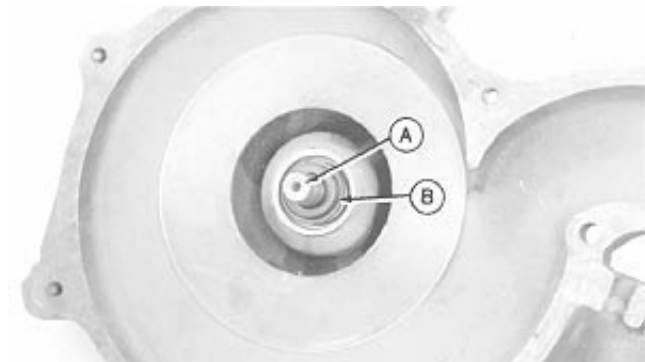


RG,CTM61,G25,7 -19-05MAY93

RG6157 -UN-24FEB92

7. Use a press to remove shaft and bearing assembly (A). Press until bearing and shaft assembly are clear from pump housing.

NOTE: Press only on diameter of shaft and not on water pump seal (B).



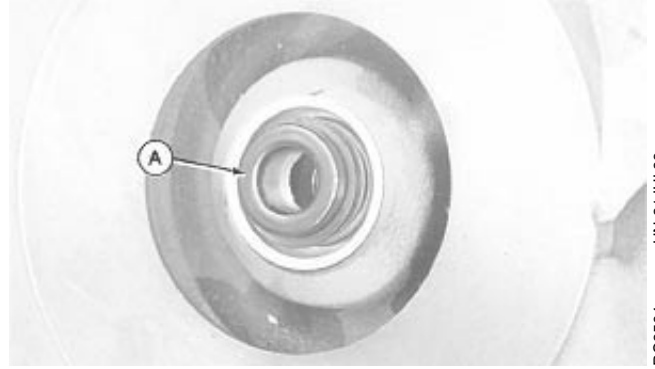
S11,2525,AF -19-05MAY93

RG3563 -UN-31JUL89

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Cooling System/Disassemble Heavy-Duty Water Pump

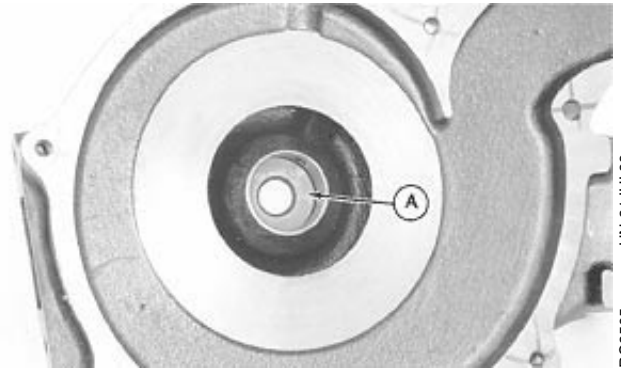
8. Use a small punch to drive unitized seal (A) from housing. Discard seal.



RG3564 -UN-31JUL89

S11,2525,AG -19-05MAY93

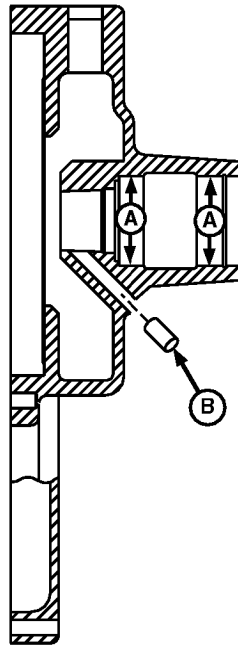
9. Use a driver with approximately the same O.D. as the O.D. of the inner grease seal (A) and drive seal from housing. Discard seal.



RG3565 -UN-31JUL89

S11,2525,AH -19-05MAY93

INSPECT HEAVY-DUTY WATER PUMP PARTS



RG7347 -UN-12JUL95

1. Make sure all gasket material is removed from water pump housing and cover.
2. Clean all parts with clean solvent and dry with compressed air.
3. Remove weep filter (B), if equipped. Ensure passage is clean and install new filter.
4. Inspect shaft and bearing assembly for warpage or damage. Replace as necessary.
5. Inspect water pump housing and cover for debris, cracks or damage. Replace as necessary.
6. Inspect impeller for debris, cracks or damage. Replace as necessary.
7. 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 and compare to specifications.
8. Measure all parts and compare to specifications given. Replace as necessary.

NOTE: New water pump will be supplied without pump housing cover and fan pulley. These parts must be reused from existing water pump.

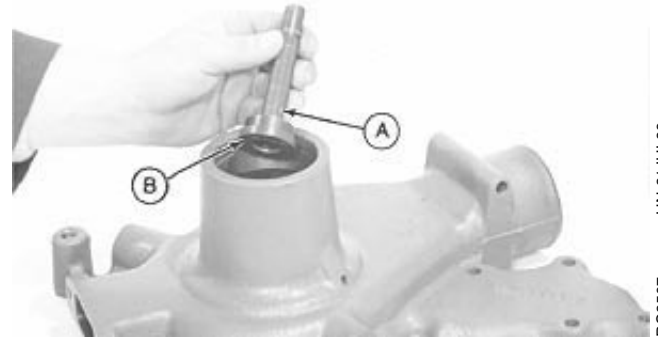
HEAVY-DUTY WATER PUMP SPECIFICATIONS

Bearing Bore in Housing	71.996—72.025 mm (2.8345—2.8356 in.)
Maximum Serviceable	72.047 mm (2.8365 in.)
Impeller Bore ID	15.854—15.880 mm (0.6242—0.6252 in.)
Shaft OD Impeller End	15.905—15.931 mm (0.6262—0.6272 in.)
Shaft OD Pulley End	30.200—30.226 mm (1.1890—1.1900 in.)
Pulley Bore ID	30.137—30.163 mm (1.1865—1.1875 in.)
Pulley-to-Shaft Interference Press Fit	0.037—0.089 mm (0.0015—0.0035 in.)
Shaft OD for Bearing	35.001—35.017 mm (1.3780—1.3786 in.)

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ASSEMBLE HEAVY-DUTY WATER PUMP

1. Use handle and driver (A) from D01045AA Bushing, Bearing and Seal Driver Set to install inner grease seal (B) into housing bore until seal bottoms against shoulder.



RG3567 -JUN-31JUL89

S55,2525,1 -19-25JUL95



RG6255 -JUN-20APR92



RG6256 -JUN-20APR92

2. Pack bearings with TY6341 High Temperature Grease. Install bearings onto shaft with a press and JDG743 Water Pump Bearing Driver which bears on INNER and OUTER bearing race.

3. Fill the cavity between bearings about half full with grease around the entire OD of bearing shaft before installing into housing.

4. Install shaft and bearing assembly into water pump housing using JDG743 Driver and lightly tap with a hard RUBBER mallet until inner bearing bottoms in housing bore.

IMPORTANT: The bearing shaft assembly should slip into housing with little resistance. DO NOT use excessive force to install assembly.

RG,CTM61.G25,9 -19-05MAY93

5. Install 1.96 mm (0.077 in.) thick green snap ring (A) in housing groove with sharp edge of snap ring facing up.



RG3561 -UN-31JUL89

S11,2525,BN -19-17MAR92

6. Use a magnetic base dial indicator and measure shaft end play. The maximum end play allowed is 0.25 mm (0.010 in.).

7. Install the correct thickness of snap ring which will achieve the proper end play.

Snap Ring Thickness

- 1.57 mm (0.062 in.)
- 1.70 mm (0.067 in.)
- 1.96 mm (0.077 in.)
- 2.21 mm (0.087 in.)
- 2.46 mm (0.097 in.)

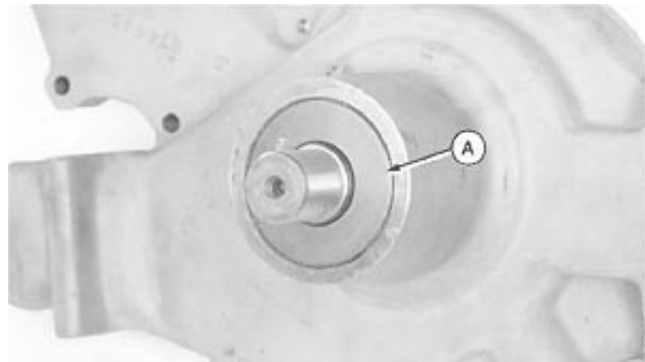


RG2656 -UN-17JUL89

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.



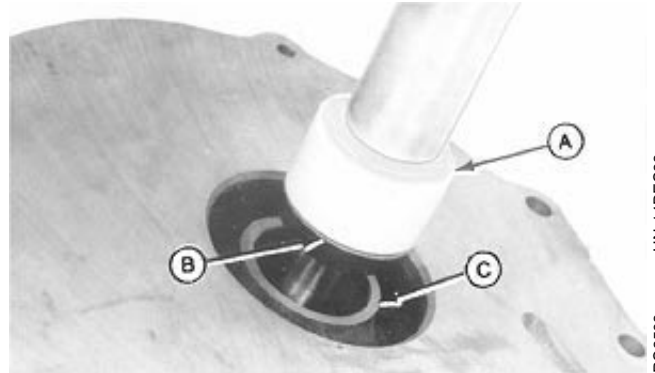
RG3560 -UN-31JUL89

S11,2525,AO -19-17MAR92

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18

IMPORTANT: Use R78350 Driver (A), that is included with water pump seal kit, to drive seal to proper depth.

9. Support pump assembly on front pulley shaft. Place a new seal (B) onto impeller shaft. Position R78350 Driver on seal and drive seal until it bottoms on water pump housing lip (C).

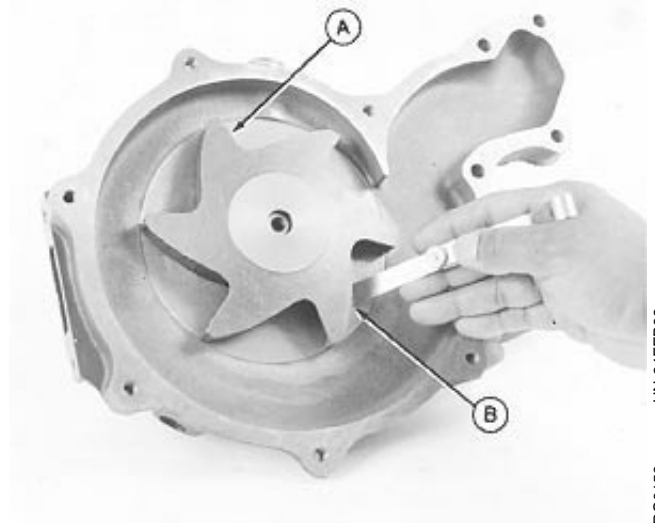


RG3568 -UN-14DEC88

S11,2525,BP -19-25JUL95

IMPORTANT: Pump seal should NOT touch impeller.

10. Support pulley end of shaft and press impeller (A) onto shaft until there is 0.039—0.89 mm (0.015—0.035 in.) clearance (B) between machined surface of housing and impeller.



RG6159 -UN-24FEB92

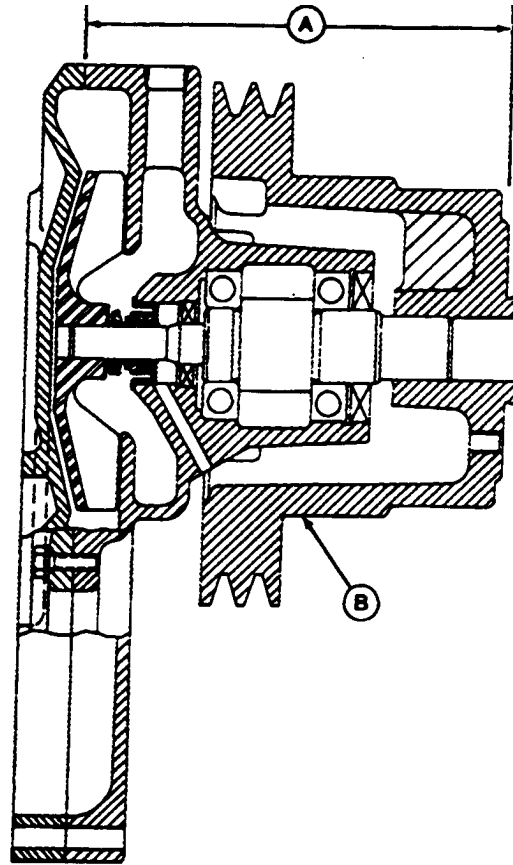
S11,2525,BQ -19-25JUL95

11. Support bearing shaft assembly through impeller bore. Press pulley (B) onto shaft until dimension (A) from front face of pulley-to-rear housing face, is obtained. Refer to the application chart below for dimension.

IMPORTANT: The interference press fit of pulley must be 0.0381 mm (0.0015 in.) minimum to 0.0889 mm (0.0035 in.) maximum. Replace pulley if press fit is not within this range.

Front Pulley Face-to-Rear Housing Face Dimension (A):

6619AT-01, 03 (—030299)	144.6 mm (5.69 in.)
6619AR-11, 12, 14, 6619AT-01, 03 (030300—)	153 mm (6.02 in.)
6619AT-05	174.5 mm (6.87 in.)
6619AT-04, 6619TT-01	188 mm (7.40 in.)
6619AE-02 (044593—), 6619AE-03, 6619AR-08, 09, 6619AR-10, 13 (044789—)	198 mm (7.80 in.)
6619AR-01, 06, 6619AF, 6619TF, 6619AR-10, 13 (—044790)	212.6 mm (8.37 in.)
6619AE-01	Press pulley on shaft until shoulder in pulley shaft bore is flush with end of shaft.
6619AT-02, 6619TT-02	Tighten cap screw to 115 N-m (85 lb-ft)



RG4944 -UN-06APR89

S11,2525,BS -19-25JUL95

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12. Using a new gasket, install pump housing cover (A). Tighten cap screws to 24 N-m (18 lb-ft).



RG3571 -UN-31JUL89

S11,2525,BS -19-25JUL95

INSTALL WATER PUMP

NOTE: Guide studs may be used as an aid to installing water pump.

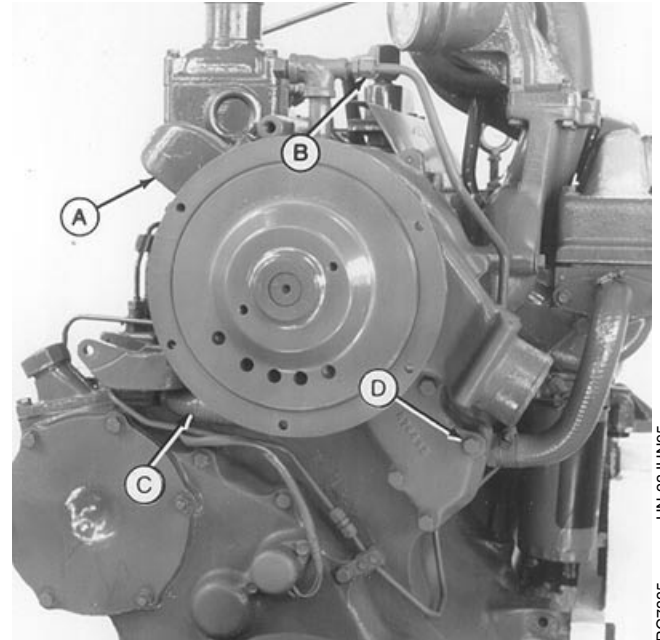
1. Using a hoist or an assistant, install water pump with new gasket onto cylinder block.
2. Tighten four mounting cap screws (D) to specifications given.
3. Connect hose (C) and tighten clamp securely.
4. Install bypass elbow (A). Tighten cap screws to 27 N·m (20 lb-ft).
5. Install coolant filter line (B). Tighten connection 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 air has been expelled.

6. Start engine and check the entire cooling system for leaks.

Water Pump Mounting Cap Screw Specifications

SAE Grade 5	47 N·m (35 lb-ft)
SAE Grade 8	61 N·m (45 lb-ft)



A—Bypass Elbow
 B—Coolant Filter Line
 C—Water Pump-To-Oil Cooler Hose
 D—Water Pump Cap Screws (4 used)

-UN-23JUN95
RG7335

S11,2525,BT -19-25JUL95

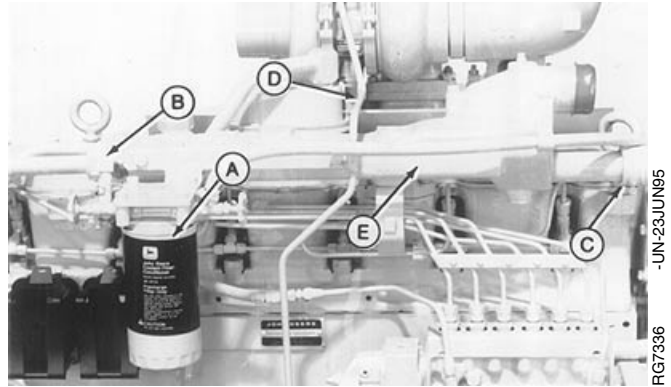
25
21

REMOVE WATER MANIFOLD

⚠ CAUTION: Do not drain engine coolant until the coolant temperature is below operating temperature. Then open drain cock slowly to relieve any excess pressure.

1. Drain coolant from the cooling system.
2. On engines with coolant filter conditioner assembly (A) mounted on water manifold, remove coolant filter, mounting bracket, and hoses. (See REMOVE COOLANT FILTER CONDITIONER—WATER MANIFOLD MOUNTED later in this group.)
3. Disconnect inlet tube gland nut (B) and outlet hose (C) from water manifold (E).
4. Remove water manifold attaching hardware. Carefully lift water manifold and remove from under turbocharger oil inlet line (D).

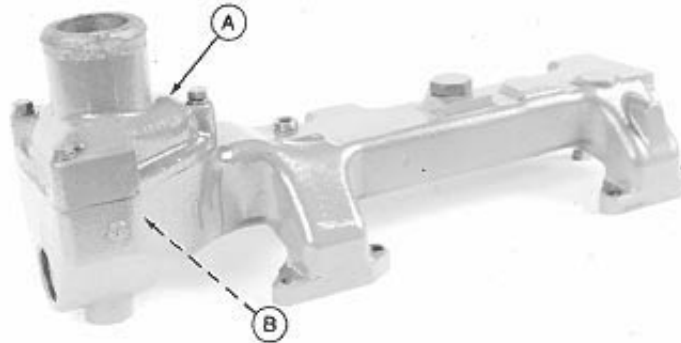
NOTE: Thermostat cover may be removed without removing water manifold. (See REMOVE THERMOSTATS, later in this group.)



A—Coolant Filter Conditioner Assembly
B—Gland Nut
C—Outlet Hose
D—Turbocharger Oil Inlet Line
E—Water Manifold

S11,2525,BU -19-25JUL95

INSPECT AND CLEAN WATER MANIFOLD



-UN-18FEB92

RG6139

1. Remove thermostat cover (A) and thermostats (B).
(See REMOVE THERMOSTATS in this group.)

2. Remove all gasket material and debris from manifold and cylinder head.

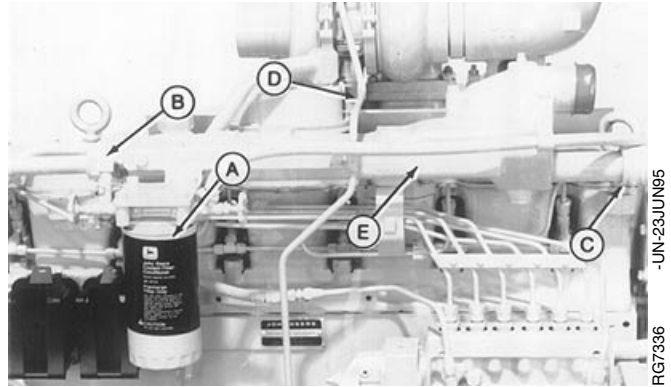
3. Inspect water manifold for cracks or damage.

4. Clean all passages to remove debris with clean solvent. Dry with compressed air.

RG,CTM61,G25,19-19-25JUL95

INSTALL WATER MANIFOLD

1. Install thermostats and thermostat cover. (See INSTALL THERMOSTATS in this group.)
2. Apply LOCTITE 515 Flexible Sealant to water manifold mounting surfaces.
3. Install new gaskets and place water manifold (E) on cylinder head, under turbocharger oil inlet line (D).
4. Install water manifold-to-cylinder head cap screws and finger tighten.
5. Install outlet hose (C) and tighten connections securely.
6. Install lube gland nut (B) and tighten securely.
7. Tighten all water manifold-to-cylinder head cap screws to 47 N·m (35 lb-ft).
8. On engines with coolant filter conditioner assembly (A) mounted on water manifold, install mounting bracket, filter and connect hoses. (See INSTALL COOLANT FILTER CONDITIONER—WATER MANIFOLD MOUNTED, later in this group.)



A—Coolant Filter Conditioner Assembly
 B—Gland Nut
 C—Outlet Hose
 D—Turbocharger Oil Inlet Line
 E—Water Manifold

S11,2525,BW -19-25JUL95

REMOVE THERMOSTATS

NOTE: Thermostats may be removed without removing water manifold.

1. Remove thermostat cover (shown removed). Inspect cover for cracks or damage.
2. Remove thermostats (A) from water manifold. Remove all gasket material from water manifold.
3. Clean and inspect thermostats. If required, test each thermostat. (See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE in Group 105.)

If any thermostat is defective, replace all thermostats.



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S11,2525,BX -19-25JUL95

INSTALL THERMOSTATS

1. Apply LOCTITE 515 Flexible Sealant on water manifold-to-thermostat cover gasket surfaces.
2. Install thermostats where previously removed, using a new gasket.
3. Install thermostat cover and tighten cap screws to 27 N-m (20 lb-ft).

S11,2525,S -19-25JUL95

COOLANT FILTER CONDITIONER GENERAL INFORMATION

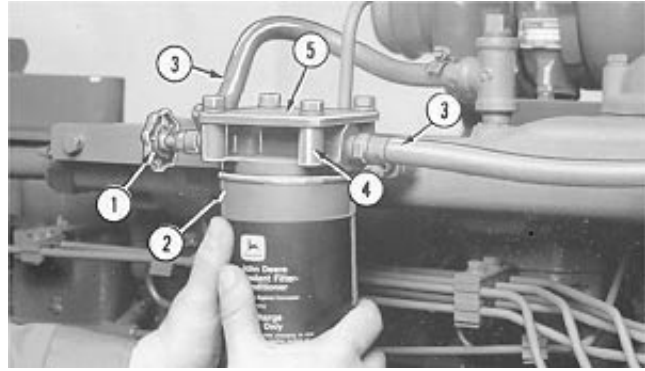
The coolant filter conditioner assembly on 6619 Engines is mounted to either the water manifold or the air intake manifold. Servicing of these two assemblies is identical, however, removal and installation procedures differ. Differences will be noted.

NOTE: Early production engines were not equipped with coolant filter conditioners, however, field installation kits are available for updating these engines.

S11,2525,BY -19-25JUL95

REMOVE COOLANT FILTER CONDITIONER—WATER MANIFOLD MOUNTED

⚠ CAUTION: Do not remove coolant filter conditioner until the coolant temperature is below operating temperature. Then loosen drain cock slowly to relieve any excess pressure. Put all coolant in a clean container and cover to prevent contamination.



1. Close outlet shut-off valve (1) and inlet shut-off valve on water pump.
2. Remove and discard coolant filter element (2).
3. Remove attaching hardware and remove both inlet and outlet hoses (3).
4. Remove cap screws and washers and remove filter base (4).
5. Remove mounting base (5).

- 1—Outlet Shut-Off Valve
- 2—Coolant Filter Element
- 3—Inlet and Outlet Hoses
- 4—Filter Base Element
- 5—Mounting Base

S11,2525,BZ -19-25JUL95

RG3054 -UN-17JUL89

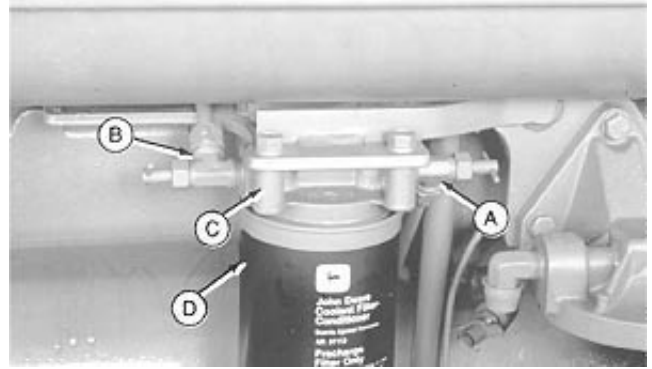
REMOVE COOLANT FILTER CONDITIONER—INTAKE MANIFOLD MOUNTED

CAUTION: Do not remove coolant filter conditioner until the coolant temperature is below operating temperature. Then loosen drain cock slowly to relieve any excess pressure. Put all coolant in a clean container and cover to prevent contamination.

NOTE: Installation of intake mounted coolant filter conditioners can vary.

1. Close outlet shut-off valve (A) and inlet shut-off valve (B).
2. Remove and discard coolant filter element (D).
3. Remove attaching hardware and remove both inlet and outlet lines.
4. Remove filter base (C).

NOTE: If filter mounting bracket must be removed, remove bypass oil filter assembly. (See REMOVE BYPASS OIL FILTER ASSEMBLY in Group 20.)



A—Outlet Shut-Off Valve and Line
B—Inlet Shut-Off Valve and Line
C—Filter Base
D—Filter Element

S11,2525,CA -19-25JUL95

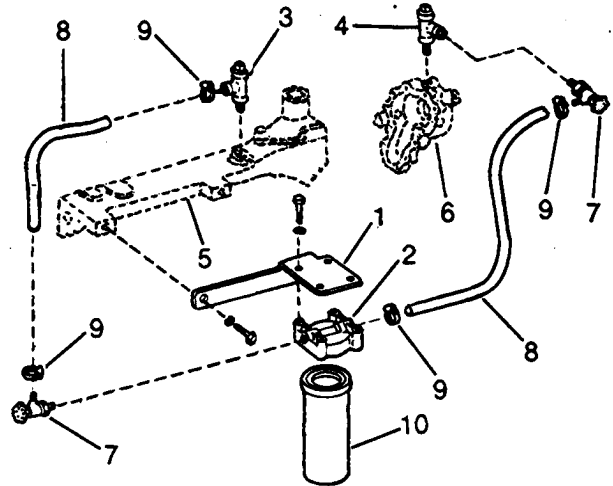
INSPECT COOLANT FILTER CONDITIONER COMPONENTS

1. Inspect all hoses 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.

S11,2525,V -19-11FEB92

INSTALL COOLANT FILTER CONDITIONER—WATER MANIFOLD MOUNTED

1. Attach mounting bracket (1) to water manifold. Tighten cap screws with lock washers to 47 N·m (35 lb-ft).
 2. Install filter base (2), and tighten cap screws with lock washers to 47 N·m (35 lb-ft).
 3. Apply LOCTITE 592 Thread Sealer or its equivalent to threads of T-pipes (3) and (4) and shut-off valves (7).
 4. Install T-pipe (3) into water manifold (5), and T-pipe (4) into water pump (6). Tighten securely.
 5. Screw shut-off valves (7) into filter base and T-pipe on water pump. Tighten securely.
- NOTE: Inspect all hose clamps that are to be reused. Replace as necessary.*
6. Attach inlet and outlet hoses (8) with hose clamps (9). Tighten all hose clamps securely.
 7. Apply a thin layer of engine oil on new filter element (10) gasket.
 8. Install filter and hand-tighten until gasket contacts filter base. Tighten filter element another 1/2—3/4 turn. DO NOT overtighten.



- 1—Mounting Bracket
- 2—Filter Base
- 3—T-Pipe
- 4—T-Pipe
- 5—Water Manifold
- 6—Water Pump
- 7—Shut-Off Valve
- 8—Hoses
- 9—Hose Clamps (4 used)
- 10—Filter

-JUN-22NOV/89
RG3055

INSTALL COOLANT FILTER CONDITIONER—INTAKE MANIFOLD MOUNTED

1. Apply LOCTITE 592 Pipe Sealant to all fittings before installation.

NOTE: If mounting bracket (B) was removed, install filter base to bracket first, then, install filter and bracket as an assembly. Tighten mounting bracket cap screws to 75 N.m (55 lb-ft).

2. Install filter base (A) to mounting bracket (B). Tighten cap screws to 47 N.m (35 lb-ft).

NOTE: Replace all O-ring packing at coolant line connections.

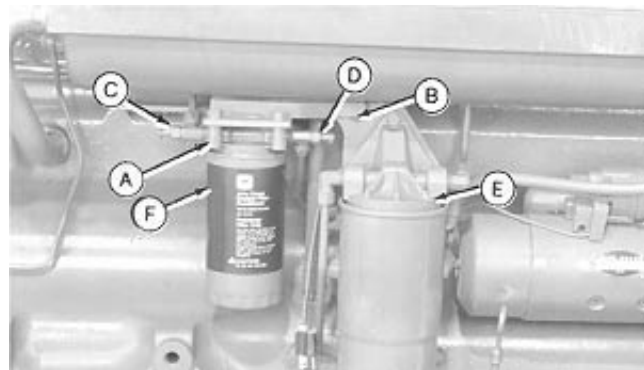
3. Install inlet shut-off valve (C) and outlet shut-off valve (D).

4. Install inlet and outlet lines. Tighten connections securely.

5. If removed, install bypass oil filter assembly (E) at this time. (See INSTALL BYPASS OIL FILTER ASSEMBLY, in Group 20.)

6. Apply a thin layer of clean engine oil on new coolant filter element (F) gasket, and install filter.

7. Hand-tighten until filter gasket contacts filter base. Tighten filter element another 1/2—3/4 turn. DO NOT overtighten.



A—Filter Base
B—Mounting Bracket
C—Inlet Shut-Off Valve
D—Outlet Shut-Off Valve
E—Bypass Oil Filter Assembly
F—Coolant Filter Element

UN-31JUL89
RG3574

S11,2525,CC -19-25JUL95

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COMPLETE FINAL ASSEMBLY

1. Fill cooling system to proper level with the proper coolant. (See ENGINE COOLANT AND GENERAL COOLANT RECOMMENDATIONS in Group 02.)

2. Start engine and run for several minutes to check for leaks in the cooling system.

3. After fan belts cool, check belt tension. (See CHECK AND ADJUST V-BELT TENSION, later in this group.)

S11,2525,CD -19-25JUL95

CHECK AND ADJUST V-BELT TENSION



IMPORTANT: Do not check tension or release belts when hot.

NOTE: Measure tension on long part of front belt. Replace both belts if either of the pair is to be replaced. The belts must be a matched set to obtain satisfactory service life.

1. Check belt tension and replace belts as required. If adjustment is necessary, use JDG529 Belt Tension Gauge (A) for standard V-belts. Follow manufacturer's instructions.

2. Loosen alternator mounting cap screws.

IMPORTANT: DO NOT pry against alternator rear frame as this may damage the alternator housing.

3. Apply outward force to the front frame of the alternator until belt tension is correct.

4. Tighten alternator mounting cap screws securely.

After installing a new belt, run engine for about 10 minutes. Stop engine and check belt tension. If tension is not within new belt specifications, wait 10 minutes, loosen belt and adjust to used belt specifications.

• JDG529 Gauge Method:

V-BELT TENSION SPECIFICATIONS

	New Belt	Belt in Service*
2-Belt System (Front belt only)	422—463 N (95—104 lb-force)	378—418 N (85—94 lb-force)

• JDST28 Belt Tension Gauge/Straightedge Method:

On new and used standard V-belts, an 89 N (20 lb-force) halfway between the pulleys should deflect the belt 19 mm (3/4 in.).

*Belts are considered used after 10 minutes of operation.

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OTHER MATERIAL

Name	Use
PT569 NEVER-SEEZ Compound	T-bolt threads on turbocharger V-band clamps, turbocharger cap screws/nuts, aftercooler cover cap screws and exhaust manifold cap screws.
LOCTITE 592 Pipe Sealant with TEFLON (TY9374/TY9375)	Turbocharger oil supply and drain lines.

RG,CTM9,G30,1 -19-07JUL95

AIR INTAKE AND EXHAUST SYSTEMS SPECIFICATIONS

Item	New Part Specification
Turbocharger—AiResearch/Garrett (TV-61)	
Total Indicator Reading Limits:	
Radial Bearing Clearance	0.08—0.15 mm (0.003—0.006 in.)
Axial Bearing End Play	0.03—0.10 mm (0.001—0.004 in.)
Exhaust Adapter End Play	1.59 mm (0.063 in.)
V-Band Clamp (Compressor End)	12—15 N·m (110—130 lb-in.)
V-Band Clamp (Turbine End)	12—15 N·m (110—130 lb-in.)
Mounting Stud Nut/Cap Screw Torque	47 N·m (35 lb-ft)
Exhaust Elbow Cap Screw Torque	47 N·m (35 lb-ft)
Turbocharger—Schwitzer (4LE and 4LF)	
Total Indicator Reading Limits:	
Radial Bearing Clearance (Max)	0.84 mm (0.033 in.)
Axial Bearing End Play	0.081—0.119 mm (0.0032—0.0047 in.)
Compressor V-band Clamp Nut Torque	9.5—11 N·m (84—96 lb-in.)
Turbine V-Band Clamp Nut Torque	9.5—11 N·m (84—96 lb-in.)
Mounting Stud Nut/Cap Screw Torque	47 N·m (35 lb-ft)
Exhaust Elbow Cap Screw Torque	47 N·m (35 lb-ft)
Exhaust Adapter End Play	1.59 mm (0.063 in.)
Intake Manifold, Exhaust Manifold and Aftercooler	
Intake Manifold-to-Cylinder Head	75 N·m (55 lb-ft)
Aftercooler Cover (6619A Engine):	
SAE Grade 5 Cap Screws	47 N·m (35 lb-ft)
SAE Grade 8 Cap Screws	60 N·m (44 lb-ft)
Aftercooler End Adapter (6619A Engine)	27 N·m (20 lb-ft)
Exhaust Manifold-to-Cylinder Head	75 N·m (55 lb-ft)

S11,3005,LQ -19-25JAN96

EXTENDING TURBOCHARGER LIFE

Turbochargers are designed to last the life of the engine, but, because they operate at such high speeds (100,000 rpm or more); a moment's carelessness can cause them to fail in seconds.

The major causes of turbocharger failures are attributed to:

- **Lack of lube oil (quick starts and hot shutdowns)**
- **Oil contamination**
- **Ingestion of foreign objects**
- **Restricted oil drainage**
- **Low oil level**
- **Operation on excessive side slopes**
- **Abnormally high exhaust temperatures**

S55,3005,E -19-06APR94

• **Lack of Lube Oil**

Oil not only lubricates the turbocharger's spinning shaft and bearings, it also carries away heat. When oil flow stops or is reduced, heat is immediately transferred from the hot turbine wheel to the bearings, which are also heating up because of the increased friction due to the lack of oil. This combination causes the turbocharger shaft temperature to increase rapidly.

If oil flow does not increase and the process continues, bearings will fail. Once the bearings fail (which can happen in just seconds) seals, shaft, turbine and compressor wheels can also be damaged.

The principle causes of turbocharger bearing lubrication problems are low oil pressure, a bent, plugged or undersized oil lube supply line, plugged or restricted oil galleries in the turbocharger, or improper machine start-up and shutdown procedure.

Oil levels and pressure should always be closely monitored and all worn hoses and lines should be replaced. The turbocharger oil supply line should be checked frequently to make sure it is not kinked or bent and it should always be replaced with a line of equal size, length and strength.

The easiest way to damage a turbocharger is through improper start-up and shutdown procedures. Always idle the engine for at least 30 seconds (no load) after start-up and before shutdown. Warming the engine up before applying a load allows oil pressure to build up and lines to fill with oil.

Idling the engine before shutdown allows the engine and turbocharger to cool. "Hot" shutdowns can cause the turbocharger to fail because after high-speed operation the turbocharger will continue to rotate long after the engine has been shut off and oil pressure has dropped to zero. This will cause heat to build up and possible bearing damage. It can also cause carbon and varnish deposits to form.

S55,3005,F -19-04JUN93

• **Oil Contamination**

A second cause of turbocharger failures is contaminated oil. It can be caused by a worn or damaged oil filter or not changing the lube oil at recommended intervals. Expecting the oil filter to remove dirt, sand, metal chips, etc. from the oil before they reach the engine or turbocharger can be a costly mistake because contaminated oil may completely bypass the engine oil filter if the oil filter or oil cooler is clogged, if the filter element is improperly installed, or if the oil is thick during cold weather.

Four good ways of avoiding oil contamination are:

- Always inspect the engine thoroughly during major overhaul. Look especially for any sludge or debris left in lube oil galleries.
- Change lube oil at recommended intervals. Analysis of oil samples at filter change periods can help identify potentially harmful contaminants in the oil.
- Clean the area around the oil fill cap before adding oil.
- Use a clean container when adding oil.

S11,3005,MK -19-04JUN93

• **Ingestion of Foreign Objects**

The third cause of turbocharger damage is the ingestion of foreign objects. Foreign objects or particles can be ingested and cause damage to the turbocharger on both compressor and turbine sides. This is easy to avoid.

On the compressor side, foreign objects usually take the form of dust, sand, or shreds of air cleaner element that enter through improperly installed air cleaner elements. Leaky air inlet piping (loose clamps or torn rubber joints) or torn pleats in dry-type air cleaner elements also create problems.

The result is erosion of compressor blades that can cause the delicately balanced wheel to wobble.

IMPORTANT: Whenever an internal engine failure (valve, valve seat, piston) occurs, a thorough inspection of the turbocharger MUST BE performed before returning engine to service.

S11,3005,ML -19-07JUL95

• **Restricted Oil Drainage**

A fourth cause of turbocharger damage is restricted lube oil drainage. The lubricating oil carries away heat generated by friction of the bearings and from the hot exhaust gases. If drainage back to the sump is impeded, the bearings will overheat with damage that will ultimately lead to failure.

There are two primary reasons for restricted drainage. A blocked drain tube, due to either damage or a buildup of sludged oil, or high crankcase pressure, which can be due to restricted crankcase breather or excessive engine blowby.

Periodically check both the turbocharger oil drain tube and engine breather tube for damage or restriction. Correction of these conditions leads to longer turbocharger life.

RG,CTM8,G30,R1 -19-07JUL95

• **Abnormally High Exhaust Temperatures**

A fifth cause of turbocharger damage is abnormally high exhaust temperatures. Elevated exhaust temperatures cause coking of oil which can lead to bearing failure. Extreme over-temperature operation can cause 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

NOTE: If an air intake malfunction exists, refer to the machine technical manual for diagnosis of the air intake system before removing the turbocharger.

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

NOTE: 6619T and 6619A Engines have either AiResearch/Garrett or Schwitzer turbochargers. Removal and installation procedures are similar for both turbochargers.

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.)

Clean exterior of turbocharger to prevent entry of dirt into the air intake system during removal.

S11,3005,LU -19-07JUL95

Air Intake and Exhaust System/Remove Turbocharger

1. Remove exhaust elbow (A) from adapter (B).

NOTE: Do not let adapter jam against turbine wheel during removal.

2. Disconnect the oil inlet line (C) and return oil tube (D).
3. Remove mounting stud nuts/cap screws (E).

NOTE: Scribe location marks on compressor housing and backplate. The location marks will insure correct alignment when turbocharger is installed.

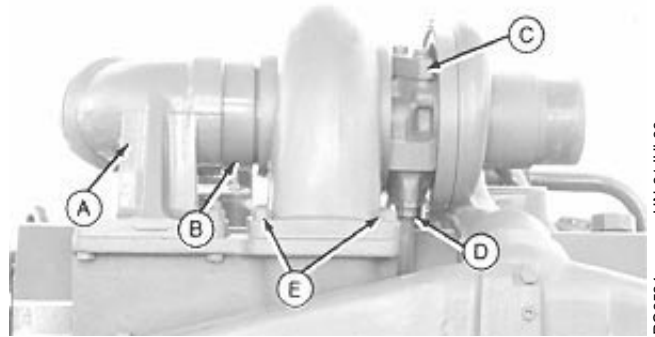


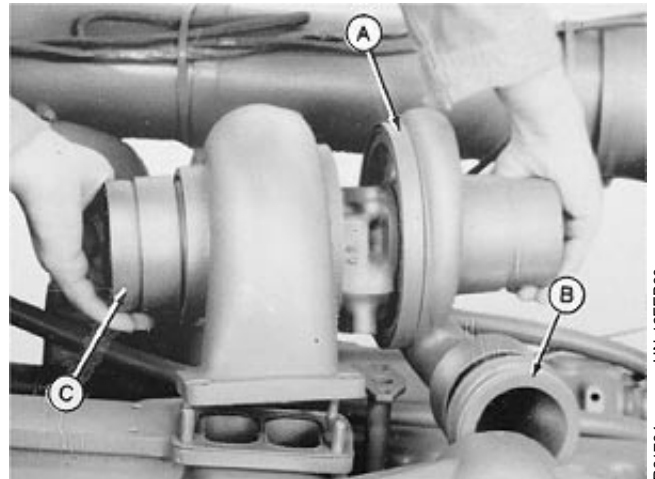
FIG3534 -UN-31JUL89

A—Exhaust Elbow
B—Adapter
C—Oil Inlet Line
D—Return Oil Tube
E—Stud Nut/Cap Screw
(4 used)

S11,3005,EC -19-07JUL95

NOTE: 6619A Engine shown, 6619T Engine similar.

4. Loosen the compressor housing V-band clamp (A) for easier removal of coupling (B) from aftercooler on 6619A Engines or from intake manifold on 6619T Engines.
5. Remove exhaust elbow adapter (C), if not previously removed.
6. Carefully lift turbocharger from exhaust manifold.
7. Place turbocharger on a clean flat surface. Remove coupling from turbocharger, if not previously removed.
8. Cap or plug all air intake or exhaust openings.
9. Inspect turbocharger if failure mode has not yet been established. (See TURBOCHARGER SEVEN-STEP INSPECTION in this group.)



R31764 -UN-12FEB90

S11,3005,LV -19-07JUL95

DIAGNOSING TURBOCHARGER MALFUNCTIONS

The following is a guide for diagnosing air intake system malfunctions by inspection of the turbocharger when removed from the engine. Refer to Operation and Tests section of the machine technical manual for diagnosis of air intake system malfunctions BEFORE removal of turbocharger from engine.

Symptom	Problem	Solution
COMPRESSOR HOUSING INLET DEFECTS:		
Foreign Object Damage	Objects left in intake system.	Disassemble and inspect intake system for foreign objects (this group).
	Leaking and/or defective intake system.	Inspect air intake system connections including air filter; repair as required (this group). Inspect air intake related engine components
Compressor Wheel Rub	Bearing failure.	Determine if engine and/or operator contributed to lack of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in progress. Correct as required.
	Manufacturing defects.	Correct as required.
COMPRESSOR HOUSING OUTLET DEFECTS:		
Oil and/or Dirt in Housing	Restricted air intake system.	Inspect and clean air cleaner.
	Prolonged periods of low RPM engine idling.	Check with operator to confirm conditions. (See Operators manual.)
	Defective oil seal ring.	Repair as required. (This group.)
	Restricted oil drain line.	Inspect and clear oil drain line as required.
TURBINE HOUSING INLET DEFECTS:		
Oil in Housing	Internal engine failure.	Inspect and repair engine as required.

Continued on next page

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Symptom	Problem	Solution
	Oil leaking from compressor housing seal.	Verify that oil is in compressor housing and refer to "Compressor Housing Outlet Defects" as listed earlier in this chart.
Center Wall Deteriorated	Excessive operating temperature.	Check for restricted air intake. Check engine for overfueling. Check injection pump timing.
TURBINE HOUSING OUTLET DEFECTS:		
Turbine Wheel Rub	Bearing Failure.	Determine if engine and/or operator contributed to lack of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in progress. Correct as required.
	Manufacturing defect.	Correct as required (this group).
Foreign Object Damage	Internal engine failure.	Inspect and repair engine as required.
	Objects left in intake or exhaust system.	Disassemble and inspect air intake or exhaust system, (this group).
	Leaking air intake system.	Correct as required, (this group).
Oil and/or Excessive Carbon in Housing	Internal engine failure.	Verified by oil in turbine housing. Correct as required.
	Turbine seal failure.	Inspect for excessive heat from overfueling and/or restricted air intake.
	Prolonged periods of low RPM engine idling.	Verify with operator to run engine under load or at high RPM. (Operator's Manual).
	Restricted oil drain line.	Inspect and clear oil drain line as required.
EXTERNAL CENTER HOUSING AND JOINT DEFECTS:		
Leaks from Casting	Defective casting.	Replace turbocharger, (this group).

Continued on next page

Symptom	Problem	Solution
Leaks from Joints	Defective gasket.	Verify that leaks are not occurring at gasket joints.
	Loose attaching screws.	Tighten to specifications in CTM, (this group).
INTERNAL CENTER HOUSING DEFECTS: Excessive Carbon Build up in Housing or on Shaft	Defective gasket.	Inspect and repair as required.
	Hot engine shut-down.	Review proper operation with operator as shown in Operator's manual.
	Excessive operating temperature.	Restricted air intake; Overfueling or Mistimed engine
	Restricted oil drain line.	Inspect and clean oil drain lines as required.
	Operating engine at high speeds and loads immediately after start-up.	Idle engine for a few minutes to allow oil to reach bearings before applying heavy loads.

RG,CTM9,G30,10 -19-25JAN96

TURBOCHARGER SEVEN-STEP INSPECTION

The following inspection procedure is recommended for systematic failure analysis of a suspected failed turbocharger. This procedure will help to identify when a turbocharger has failed, and why it has failed so the primary cause of the failure can be corrected.

Proper diagnosis of a non-failed turbocharger is important for two reasons. First, identification of a non-failed turbocharger will lead to further investigation and repair of the cause of a performance complaint.

Second, proper diagnosis eliminates the unnecessary expense incurred when a non-failed turbocharger is replaced.

The seven recommended inspection steps, which are explained in detail on following pages, are:

- Compressor Housing Inlet and Compressor Wheel.
- Compressor Housing Outlet.
- Turbine Housing Inlet.
- Turbine Housing Outlet and Turbine Wheel.
- External Center Housing and Joints.
- Internal Center Housing.
- Turbocharger Bench Test.

NOTE: To enhance the turbocharger inspection, an inspection sheet (Form No. DF-2280 available from Distribution Service Center) can be used that lists the inspection steps in the proper order and shows potential failure modes for each step. Check off each step as you complete the inspection and record any details or problems obtained during inspection. Retain this with the work order for future reference.

S11,3005,IF -19-07JUL95

Compressor Housing Inlet and Compressor Wheel

1. Check compressor inlet and compressor wheel (A) for foreign object damage.

NOTE: Foreign object damage may be extensive or minor. In either case, the source of the foreign object must be found and corrected to eliminate further damages.

2. Mark findings on your checklist and continue the inspection.



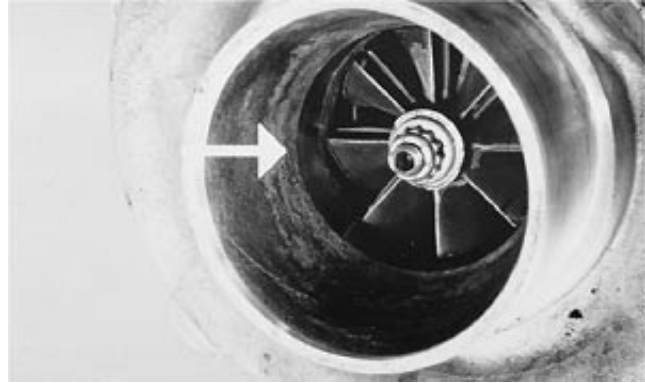
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S11,3005,IG -19-07AUG92

Air Intake and Exhaust System/Turbocharger Seven-Step Inspection

NOTE: You will need a good light source for this check.

3. Check compressor inlet for wheel rub on the housing (arrow). Look very closely for any score marks on the housing itself and check the tips of the compressor wheel blades for damage.

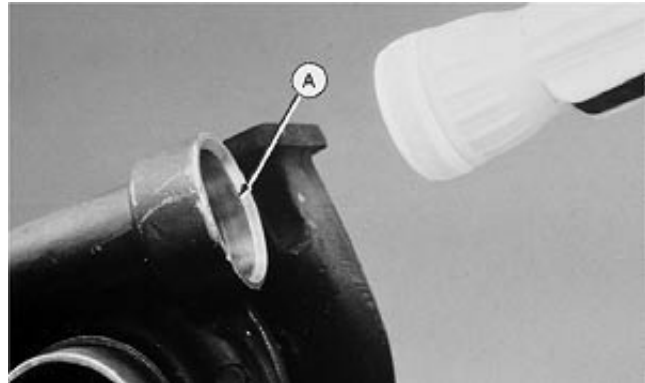


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Compressor Housing Outlet

1. Check compressor housing outlet (A). The outlet should be clean and free of dirt or oil.
2. Mark it on your checklist if dirt or oil is found and continue the inspection.



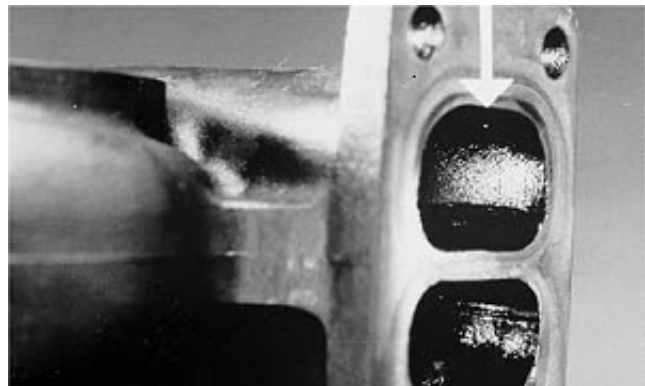
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-UN-20DEC88

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.



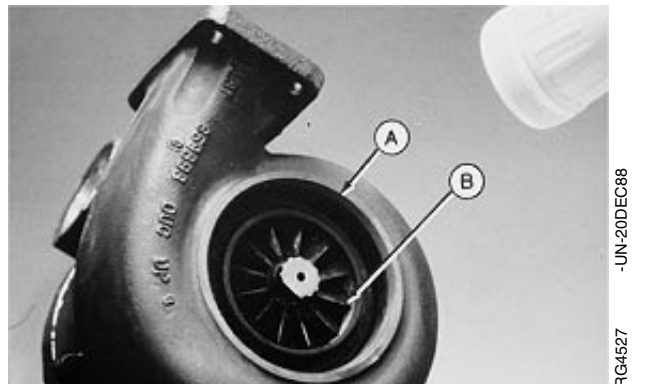
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-UN-20DEC88

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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

RG4527
-UN-20DEC88

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

RG4528 -UN-20DEC88

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.

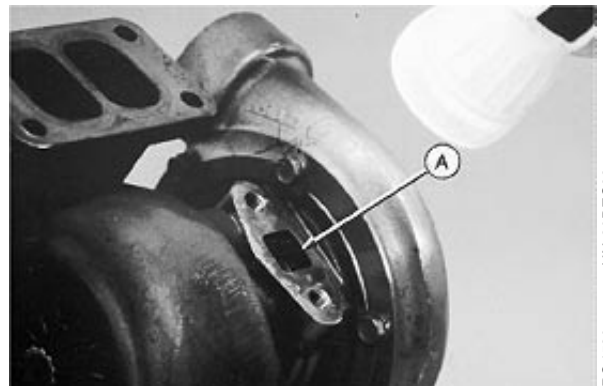


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Internal Center Housing

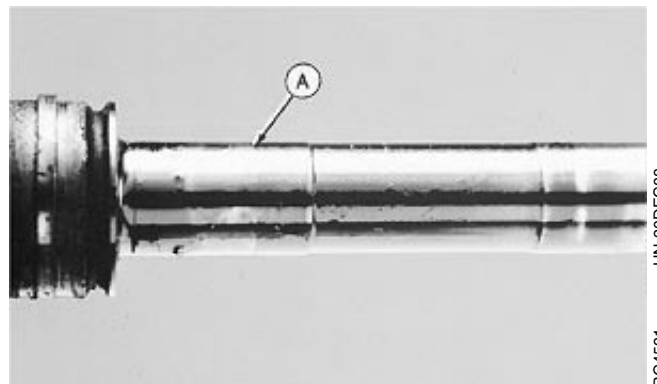
1. Using a flashlight, look through the oil return hole (A), to check the condition of the shaft and/or bearings. There should not be excess carbon deposits on the shaft or in the housing.



S11,3005,IN -19-07AUG92

RG4530 -UN-20DEC88

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

RG4531 -UN-20DEC88

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.

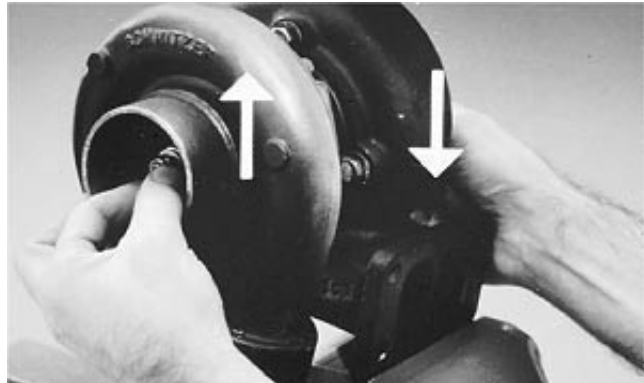


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RG4532
-UN-20DEC88

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

RG4533
-UN-20DEC88

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.



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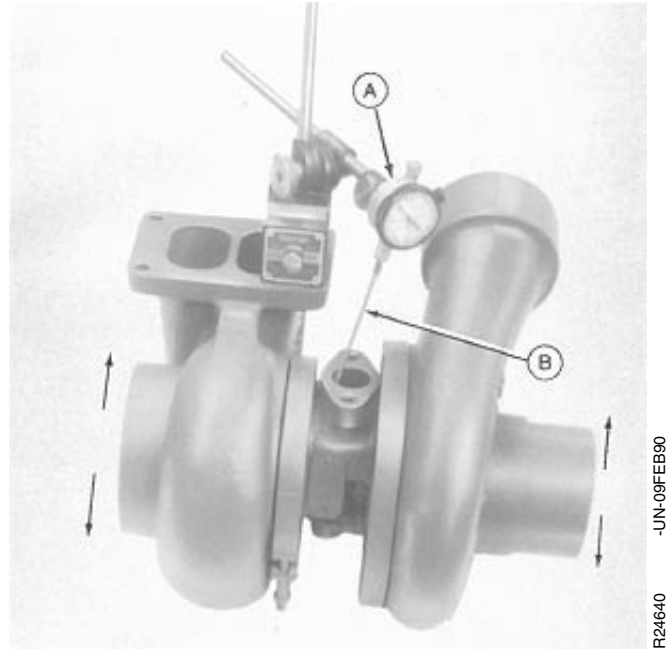
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NOTE: These diagnostic procedures will allow you to determine the condition of the turbocharger. If the turbocharger has failed, analysis of your inspection notes should direct you to the specific areas of the engine to correct the problems causing 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

RADIAL BEARING CLEARANCE TEST



Perform this test before disassembly to determine whether it is necessary to replace the center housing and rotating assembly.

1. Fasten a plunger-type dial indicator (A), having 25 mm (1-in.) travel, to the turbocharger mounting base.
2. Attach a 50 mm (2-in.) extension rod (B).
3. Insert indicator rod into the lubricating oil return outlet of center housing. Tip of rod must contact the turbocharger shaft.
4. Lock indicator in position and set dial at "0".

5. Apply side pressure at both ends of the shaft, first toward the dial indicator, then away. Equal pressures should be applied simultaneously to both ends of the shaft.

6. Check the total dial indicator movement to see that the range of travel is within specifications.

If the indicator movement exceeds specifications, replace center housing and rotating assembly. (See **REPLACE CENTER HOUSING AND ROTATING ASSEMBLY** in this group.)

BEARING CLEARANCE SPECIFICATIONS

AiResearch/Garrett	0.08—0.15 mm (0.003—0.006 in.)
Schwitzer (Max)	0.84 mm ((0.033 in.)

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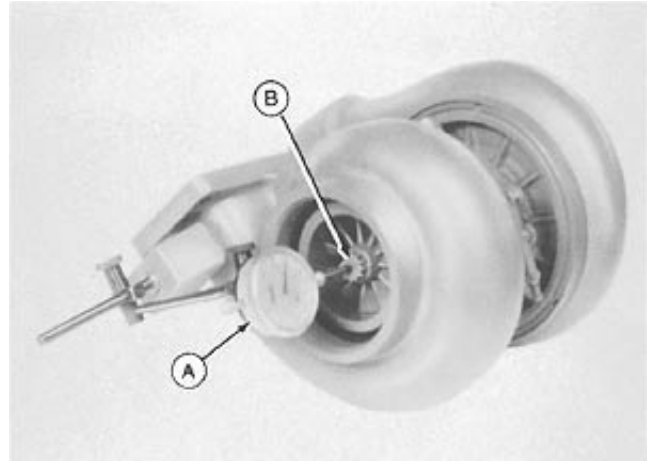
AXIAL END PLAY BEARING TEST

1. Fasten dial indicator (A) to the turbine housing. Rest indicator probe (B) on end of shaft.
2. Move shaft axially back and forth by hand, and check for end play.

If indicator reading is not within specifications, replace center housing and rotating assembly. (See REPLACE CENTER HOUSING AND ROTATING ASSEMBLY in this group.)

END PLAY SPECIFICATIONS

AiResearch/Garrett	0.03—0.10 mm (0.001—0.004 in.)
Schwitzer	0.081—0.119 mm (0.0032—0.0047 in.)



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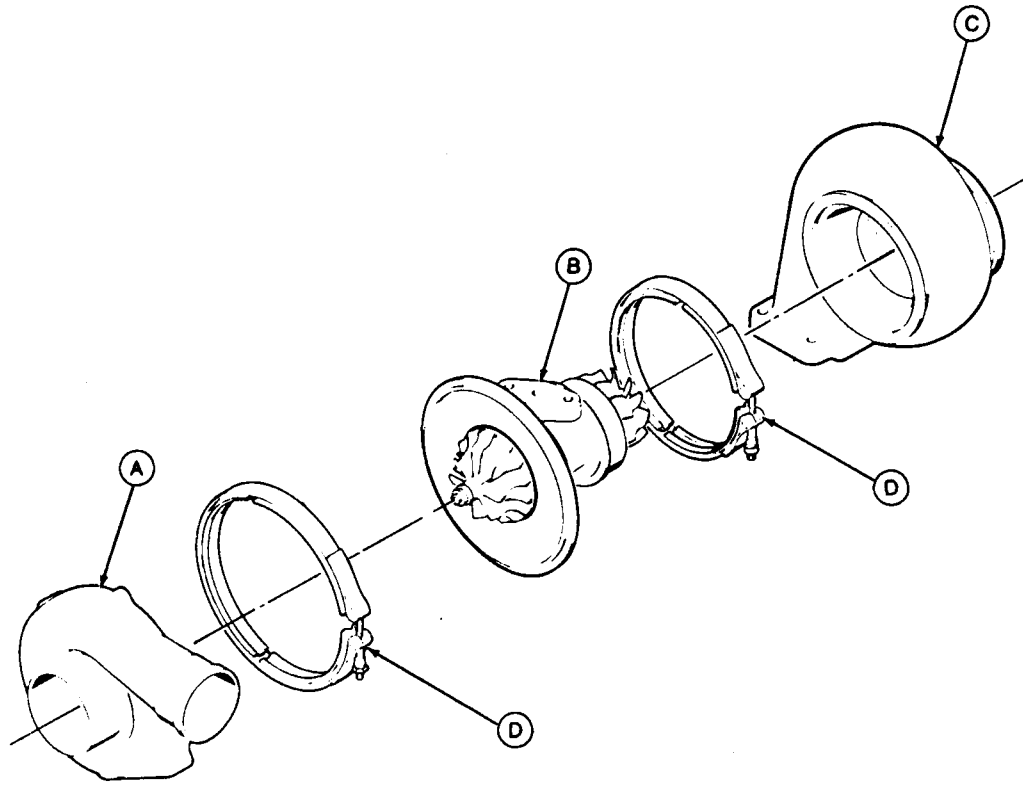
REPAIR TURBOCHARGER

AiResearch/Garrett and Schwitzer turbochargers used on the engines covered in this manual are available through service parts as a complete remanufactured assembly or as a new center housing and rotating assembly only. When a new center housing and rotating assembly are being installed, thoroughly inspect and reuse turbine and compressor housings from existing turbocharger. New mounting hardware **MUST** be used.

IMPORTANT: Repairing a turbocharger center housing and rotating assembly requires specialized tooling and highly trained personnel and thus it is not recommended that the turbocharger be disassembled completely.

CTM8,GR30,7 -19-13JAN95

DISASSEMBLE AND INSPECT TURBOCHARGER



A—Compressor Housing

B—Center Housing and Rotating Assembly

C—Turbine Housing

D—V-Band Clamps (2 used)

RG5553 -JUN-04-JUL89

RG,CTM61,G30,13-19-07JUL95

IMPORTANT: When cleaning turbocharger, do not spray directly into compressor cover or turbine housing. Spinning rotor with high pressure spray and without lubricating oil may cause bearing damage.

1. Cap or plug all openings and clean exterior of turbocharger with a pressure spray of cleaning solvent. Dry turbocharger with compressed air.

2. Place turbocharger on a clean flat surface.

IMPORTANT: Use a scribe to index positions of the compressor, center and turbine housings prior to disassembly. These reference marks are essential for proper indexing of turbine and compressor housings, when turbocharger is reassembled.

3. Loosen V-band clamp nut (A) on both clamps. Remove locknut if necessary.

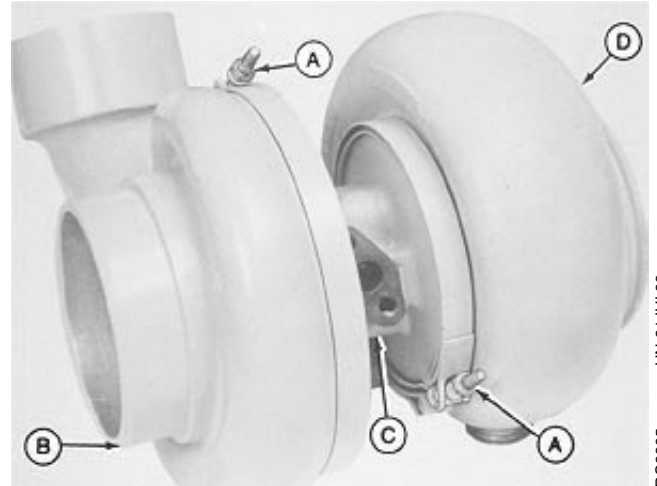
NOTE: DO NOT press on rotating assembly. Carefully remove housings to eliminate any further component damage.

4. Remove the compressor housing (B) and turbine housing (D) from center housing and rotating assembly (C).

5. Thoroughly clean compressor and turbine housings using a commercially approved solvent only. A caustic solution may damage housings. Dry housings with compressed air.

6. Inspect the compressor and turbine housings for:
—Wheel rub damage within the contour area that cannot be polished out with 80-grit (60-grit for turbine housing) silicon carbide abrasive cloth.
—Nicks, dents or warpage that could prevent proper sealing between the turbine/compressor housing and center housing.

Replace either housing if any of the above defects are found.

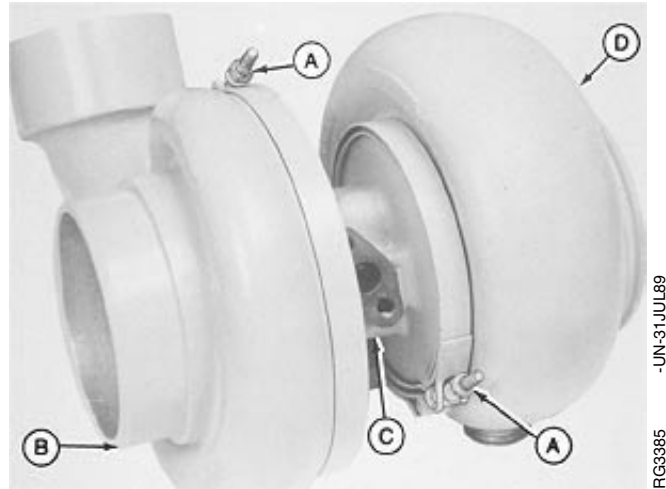


A—V-Band Clamp (2 used)
B—Compressor Housing
C—Center Housing and Rotating Assembly
D—Turbine Housing

RG3385 -UN-31JUL89

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17

REPLACE CENTER HOUSING AND ROTATING ASSEMBLY



A—V-Band Clamp (2 used)

B—Compressor Housing

C—Center Housing and Rotating Assembly

D—Turbine Housing

1. Carefully transfer the scribed marks from the original center housing (C) to the replacement assembly, if necessary. Use the same procedure for compressor (B) and turbine (D) housings if they are being replaced.

2. Install both V-band clamps (A) loosely on center housing. Align the turbine and center housing scribed marks and position the V-band clamp.

3. Coat T-bolt threads on the turbine V-band clamps with PT569 NEVER-SEEZ and tighten clamp nut to specifications given.)

4. Follow the same above procedure and install the compressor housing. Tighten compressor V-band clamp nut to specifications given.

V-BAND CLAMP TORQUE SPECIFICATIONS

AiResearch/Garrett (Both Clamps)	12—15 N.m (9-11 lb-ft) (110—130 lb-in.)
Schwitzer (Both Clamps)	9.5-11 N.m (7-8 lb-ft) (84-96 lb-in.)

5. After assembly, prelube center housing and check the center housing and rotating assembly for binding or wheel rub. If either condition exists, disassemble turbocharger and correct the cause. (See PRELUBE TURBOCHARGER in this group.)

6. Check bearing/shaft radial and axial end play. (See RADIAL BEARING TEST and AXIAL END PLAY BEARING TEST in this group.)

RG,CTM9,G30,14 -19-25JAN96

PRELUBE TURBOCHARGER

IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

Fill oil inlet or drain port with clean engine oil and spin rotating assembly by hand to properly lubricate bearings.

If turbocharger is to be stored for an extended period of time, lubricate internally and install protective covers on all openings.



RG4361 -UN-20DEC88

S55,3005,BA -19-07JUL95

INSTALL TURBOCHARGER

IMPORTANT: If turbocharger failed because of foreign material entering the air intake system, be sure to examine the system and clean as required.

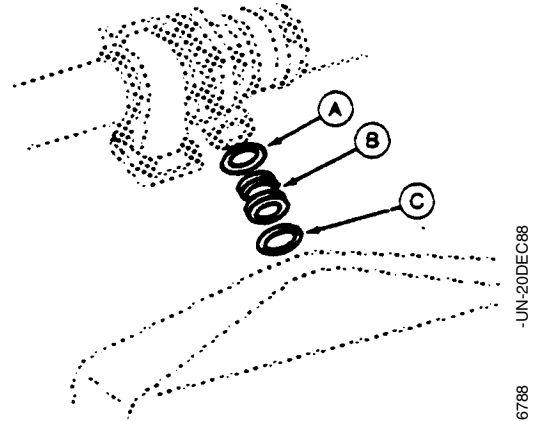
Just prior to mounting the turbocharger, prime the turbocharger lubrication system. Fill the center housing with new engine oil through the oil drain hole. Turn the rotating assembly by hand to lubricate the bearings and thrust washer. (See PRELUBE TURBOCHARGER in this group.)

Inspect the air cleaner-to-turbocharger air intake hose to see that it is in good condition. Replace hose if it is hard or shows any sign of deterioration.

S11,3005,MB -19-07JUL95

6619A Engines:

1. Coat O-rings (A and C) with grease and install on coupling (B).
2. Place a new gasket on exhaust manifold (not shown).

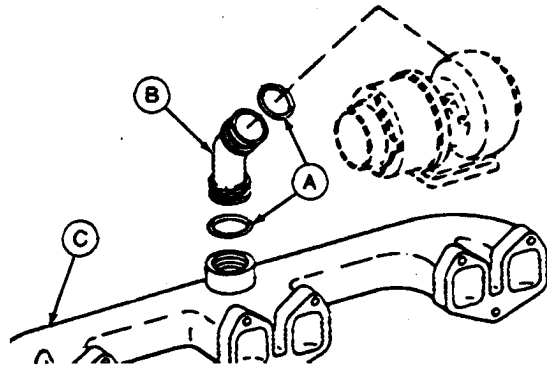


R26788 -UN-20DEC88

S11,3005,MB,1 -19-07JUL95

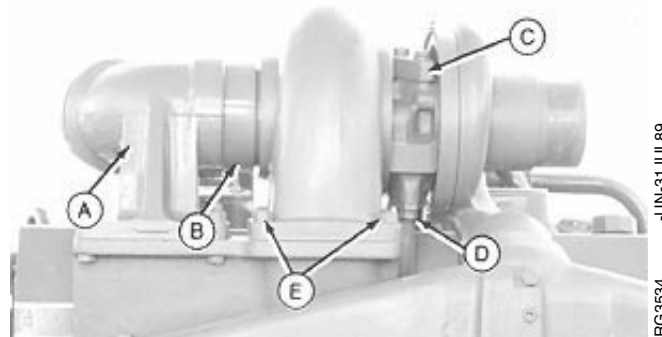
6619T Engines:

1. Apply a light coating of liquid soap or lubricating grease to the turbocharger-to-intake manifold coupling O-rings (A). Position coupler (B) on intake manifold (C).
2. Place a new gasket on exhaust manifold.



RG4949 -UN-06APR89

S11,3005,MB,2 -19-25JAN96



A—Exhaust Elbow

B—Exhaust Adapter

C—Inlet Oil Line

D—Return Oil Tube

NOTE: Guide studs may be used to position exhaust gasket during turbocharger installation.

3. Mount turbocharger on engine.
4. Coat turbocharger mounting stud nuts/cap screws with PT569 NEVER-SEEZ, install, and tighten to specifications.
5. Install new gaskets on return oil tube (D) and inlet oil line (C). Coat cap screws with LOCTITE 592 Pipe Sealant with Teflon and tighten securely.
6. Install and tighten compressor V-band clamp to specifications.
7. Install and tighten turbine V-band clamp to specifications.
8. Install exhaust adapter (B) and elbow (A). Tighten cap screws to specifications.

IMPORTANT: Make sure that installation does not apply a force on the turbine housing. The exhaust adapter must have 1.59 mm (0.063 in.) minimum end play and 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.

TURBOCHARGER TORQUE SPECIFICATIONS

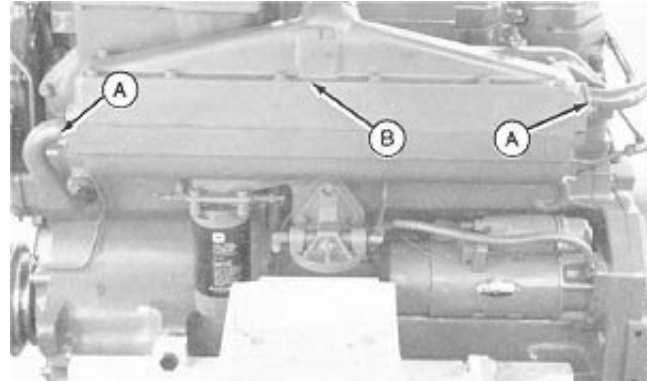
Turbocharger Mounting Nuts/Caps.	47 N.m (35 lb-ft)
V-Band Clamps	
AiResearch/Garrett.	12—15 N.m (110—130 lb-in.) (9-11 lb-ft)
Schwitzer.	9.5—11 N.m (84—96 lb-in.) (7-8 lb-ft)
Exhaust Elbow Cap Screws	47 N.m (35 lb-ft)

IMPORTANT: BEFORE STARTING an engine with a new or repaired turbocharger, crank the engine over (but do not start) for several seconds to allow engine oil to reach turbocharger bearings.

9. Start and run engine at low idle while checking turbocharger oil inlet and air passage connections for leaks.

REMOVE AFTERCOOLER AND INTAKE MANIFOLD (6619A ENGINES)

CAUTION: Explosive release of fluids from pressurized cooling systems can cause serious burns. Wait until engine coolant is cool enough to touch with bare hands before draining. Slowly loosen radiator cap first to relieve pressure.

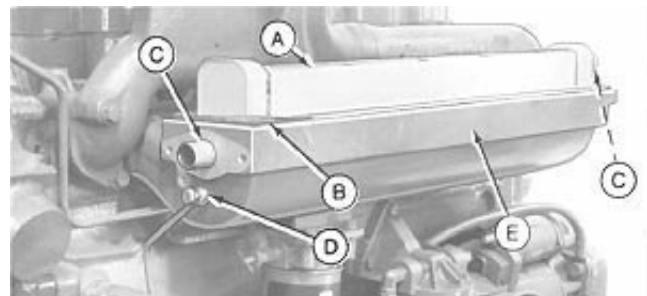


RG3536 -JUN-31JUL89

1. Drain coolant.
2. Remove turbocharger and exhaust elbow. (See REMOVE TURBOCHARGER in this group.)
3. Remove inlet and outlet hoses and adapter plates (A).
4. Remove all cap screws and lift-off intake manifold cover (B).

S11,3005,EF -19-25JAN96

5. Carefully lift aftercooler (A) from intake manifold.
6. Remove and discard aftercooler gasket (B) and O-rings (C).
7. Remove aneroid-to-intake manifold pipe (D).
8. Remove bypass oil filter assembly if equipped. (See REMOVE BYPASS OIL FILTER ASSEMBLY in Group 20.)
9. Remove coolant filter conditioner lines, if equipped.
10. Remove intake manifold (E) along with coolant filter conditioner/mounting bracket assembly, if equipped.



RG3537 -JUN-20DEC88

A—Aftercooler
B—Gasket (2 used)
C—O-Ring (2 used)
D—Aneroid-to-Intake Manifold Pipe
E—Intake Manifold

S11,3005,EG -19-07JUL95

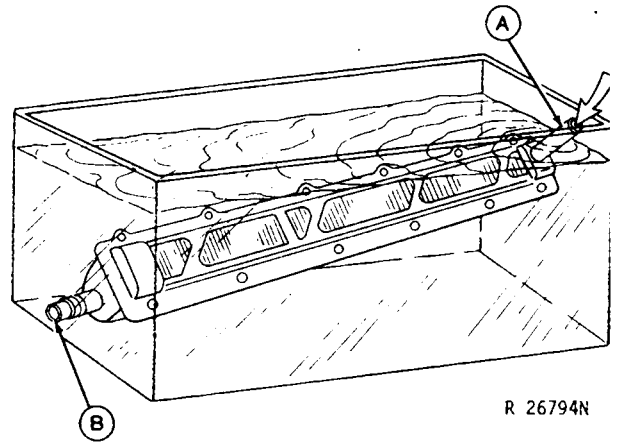
INSPECT AND REPAIR AFTERCOOLER (6619A ENGINES)

1. Inspect aftercooler for overall condition. The fins should be reasonably straight.
2. Inspect aftercooler inlet and outlet hoses. Replace either if cracked or damaged.
3. Test the aftercooler for leaks by plugging either (A) or (B) opening.
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.

A minor leak that is accessible may be repaired. However, if the condition of the core is questionable, replace aftercooler.

IMPORTANT: Coolant leakage from the aftercooler may cause severe engine damage.

5. Inspect air intake cover for cracks or damage. Replace as necessary.
6. Clean cover with clean solvent and dry with compressed air.



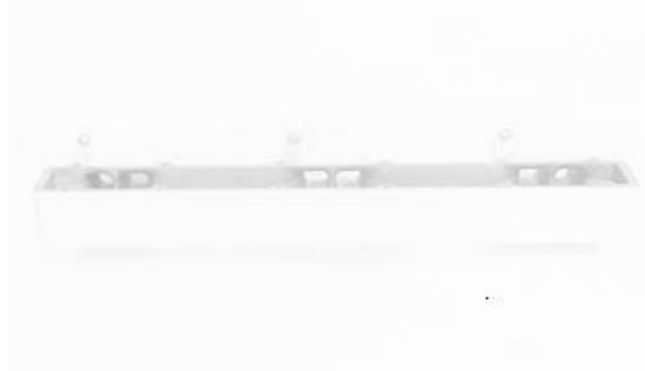
S11,3005,MD -19-07JUL95

INSPECT AND REPAIR INTAKE MANIFOLD (6619A ENGINES)

1. Check intake manifold for damage.
2. Inspect machined mounting surfaces for burrs or other defects which might prevent gaskets from sealing properly. Repair as required.
3. Thoroughly steam clean interior of intake manifold and covers.

IMPORTANT: Do not use a hot tank to clean aluminum parts as damage and severe deterioration can occur.

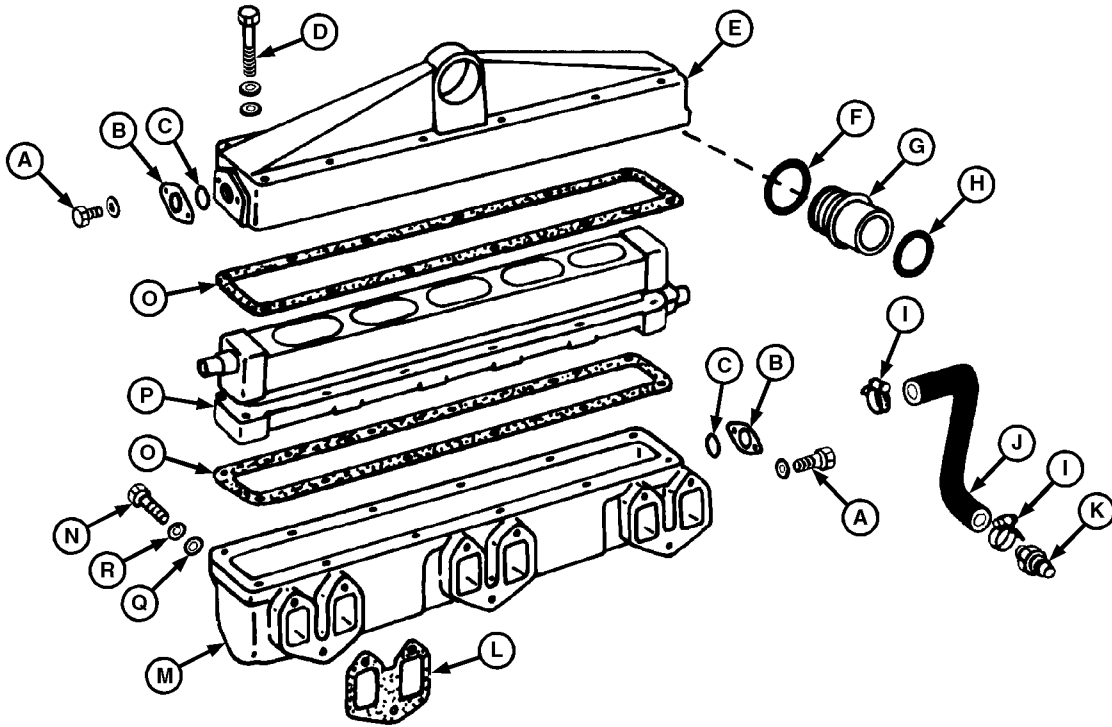
4. Scrape all gasket material from cylinder head and intake manifold.



RG2822 -UN-23FEB89

S11,3005,ME -19-25JAN96

INSTALL INTAKE MANIFOLD AND AFTERCOOLER (6619A ENGINES)



- A—Cap Screw (4 used)
- B—Adapter Plate (2 used)
- C—O-Ring (2 used)
- D—Cap Screw (13 used)
- E—Cover

- F—O-Ring
- G—Adapter
- H—O-Ring
- I—Hose Clamp (4 used)
- J—Hose (2 used)

- K—Fitting
- L—Gasket (3 used)
- M—Intake Manifold
- N—Cap Screw (9 used)

- O—Gasket (2 used)
- P—Aftercooler
- Q—Flat Washer (9 used)
- R—Lock Washer (9 used)

NOTE: Replace washers (Q) and (R) with new hardened flat washers. Do not use lockwashers.

NOTE: Guide studs may be used to keep gaskets straight when installing aftercooler cover.

1. Using new gaskets (L), install intake manifold and coolant filter conditioner/mounting bracket assembly to cylinder head. Tighten all cap screws with washers to 75 N·m (55 lb-ft).

4. Position cover (E) over aftercooler. Apply PT569 Never-Seez to cap screws (D) and tighten to following specifications:

2. Using new gaskets (O) and O-rings (C), install aftercooler (P) into intake manifold.

AFTERCOOLER COVER CAP SCREW TORQUE SPECIFICATIONS

SAE Grade 5	47 N·m (35 lb-ft)
SAE Grade 8	60 N·m (44 lb-ft)

IMPORTANT: Make sure O-rings are properly positioned and are not crimped or twisted.

5. Install adapters (B) and tighten cap screws (A) with washers to 27 N·m (20 lb-ft).

3. Install second inner cap screw (viewed from front of engine) into aftercooler cover before installing cover.

6. Install inlet and outlet hoses (J). Tighten clamps (I) securely.

FIG 7338 -JUN-06OCT95

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25

7. Install aneroid-to-intake manifold pipe.

IMPORTANT: All intake manifold and aftercooler connections at the turbocharger and engine cylinder head must be tight to prevent loss of power resulting from low manifold pressure.

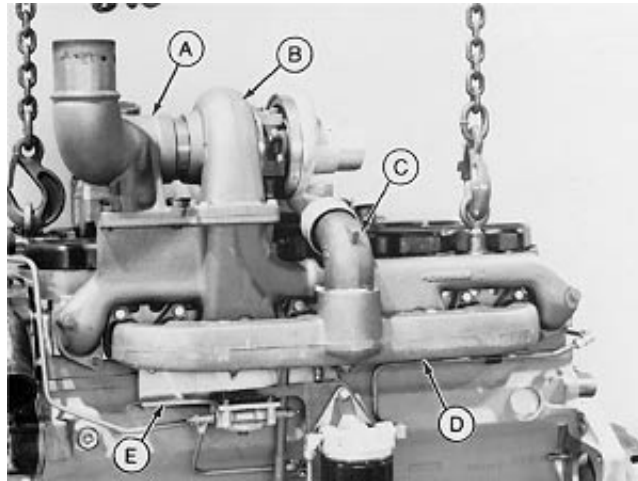
8. Install turbocharger and exhaust elbow. (See INSTALL TURBOCHARGER in this group.)

9. Install coolant filter conditioner lines, if equipped.

10. Install bypass oil filter assembly, if equipped. (See INSTALL BYPASS OIL FILTER ASSEMBLY in Group 20.)

S11,3005,EI,1 -19-07JUL95

REMOVE, INSPECT AND INSTALL INTAKE MANIFOLD (6619T ENGINES)



A—Exhaust Elbow
B—Turbocharger

C—Turbocharger-To-Intake
Manifold Coupling

D—Intake Manifold

E—Bracket

1. Remove exhaust elbow (A) and turbocharger (B) along with coupling (C). (See REMOVE TURBOCHARGER in this group.)
2. Remove bypass oil filter assembly, if equipped. (See REMOVE BYPASS OIL FILTER ASSEMBLY in Group 20.)
3. Disconnect coolant filter conditioner lines, if equipped.
4. Remove nine cap screws and remove intake manifold (D) along with coolant filter conditioner/mounting bracket assembly, if so equipped.
5. Check intake manifold for damage. Scrape all gasket material from cylinder head and intake manifold.
6. Inspect machined mounting surfaces for burrs or other defects which might prevent gaskets from sealing properly. Repair or replace as required.

IMPORTANT: Make sure intake manifold is clean and free of debris before assembly.

NOTE: If intake manifold cap screws have flat washers with lock washers, remove and discard them. Install new hardened flat washers.

7. Install intake manifold (D) and coolant filter conditioner/mounting bracket assembly. Tighten intake manifold cap screws to 75 N·m (55 lb-ft).
8. Connect coolant filter conditioner lines, if equipped.
9. Install bypass oil filter assembly, if equipped. (See INSTALL BYPASS OIL FILTER ASSEMBLY in Group 20.)
10. Install turbocharger (B) along with coupling (C). Install exhaust elbow (A). (See INSTALL TURBOCHARGER in this group.)

S11,3005,MF -19-25JAN96

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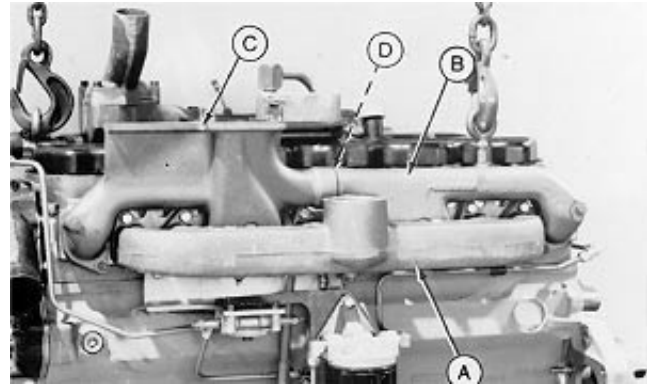
REMOVE, INSPECT, AND INSTALL EXHAUST MANIFOLD ASSEMBLY

NOTE: 6619T Engine show, 6619A Engine similar. Differences will be noted.

1. On 6619A Engines, remove intake manifold and aftercooler. (See REMOVE INTAKE MANIFOLD AND AFTERCOOLER—6619A ENGINES, in this group.)
2. On 6619T Engines, remove intake manifold. (See REMOVE, INSPECT AND INSTALL INTAKE MANIFOLD—6619T ENGINES, in this group.)
3. Remove rear exhaust manifold (B) and front exhaust manifold (C). Remove and discard sealing ring (D).
4. Scrape all gasket material from cylinder head and exhaust manifolds. Check exhaust manifolds for damage or cracks.
5. Inspect machined mounting surfaces and front/rear mating surfaces for burrs or other defects which might prevent gaskets from sealing properly. Repair or replace as required.
6. Install new sealing ring in groove on front end of rear exhaust manifold section.

NOTE: Apply PT569 Anti-Seez compound or its equivalent to all exhaust manifold cap screws.

7. Install front exhaust manifold using new gaskets. Install, but do not tighten cap screws.
8. Install rear exhaust manifold using new gaskets. Sealing ring should be in place at this time.
9. Tighten exhaust manifold-to-cylinder head cap screws to 75 N·m (55 lb-ft).
10. On 6619A engines, install intake manifold and aftercooler. (See INSTALL INTAKE MANIFOLD AND AFTERCOOLER—6619A ENGINES in this group.)
11. On 6619T engines, install intake manifold. (See INSTALL INTAKE MANIFOLD—6619T ENGINES in this group.)



A—Intake Manifold
B—Rear Exhaust Manifold
C—Front Exhaust Manifold
D—Sealing Ring

RG4961 -UN-19JAN90

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SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

Flywheel Turning Tool JDE81-1

RG4950 -UN-23AUG88

Rotate engine flywheel. Use with JDE81-4.

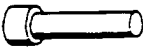


S53,JDE811 -19-25JAN96

Timing Pin JDE81-4

RG5068 -UN-23AUG88

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



S55,JDE814,B -19-24FEB88

3/4 in. Special Crowsfoot Wrench JDF22

RG5154 -UN-23AUG88

Tighten injection lines at pump and nozzles.

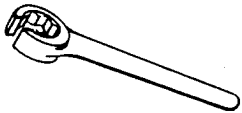


S53,JDF22 -19-10JUL89

Serrated Wrench JDE90

RG5290 -UN-15OCT92

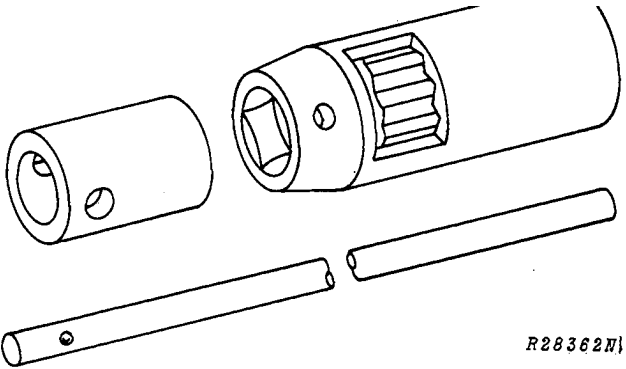
Use to hold injection pump fuel outlet fittings from turning when loosening and tightening fuel pipe connections.



S53,JDE90 -19-13MAY93

Nozzle Socket JDE92

Used to remove and install 21 mm injection nozzles.



R28362N

-UN-20DEC88
R28362N

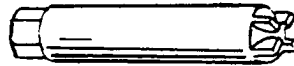
S11,3010,OU -19-16AUG94

Fuel System/Essential Tools

Nozzle Seat Reamer JDG609

RG5289 -UN-23AUG88

Used to clean carbon from nozzle seats in cylinder head.



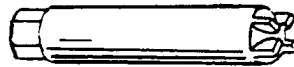
NOTE: JDE99 may be used on 6466 and 6619 Engines if JDG609 is not available.

S53,JDG609 -19-25JAN96

Nozzle Seat Reamer JDE99

RG5289 -UN-23AUG88

Clean injection nozzle seats.



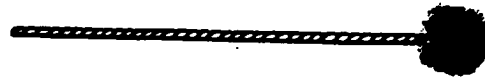
NOTE: JDG609 Nozzle Seat Reamer may be used also.

RG,JDE99 -19-25JAN96

Nozzle Thread Cleaning Brush D17030BR

RG5099 -UN-23AUG88

Used to clean nozzle threads in cylinder head.



S53,D17030,BR -19-16FEB87

Tap JDF5

RG5100 -UN-23AUG88

Used to restore nozzle threads in cylinder head.

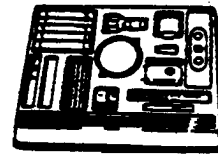


S53,JDF5 -19-08MAR94

Injection Nozzle Cleaning Kit JDF13 (JDE105)

RG5224 -UN-23AUG88

Clean 9.5 mm injection nozzles.

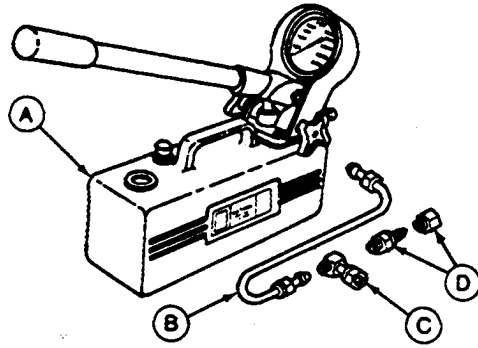


RG,JDF13 -19-17JUL92

Fuel System/Other Material

- A—Fuel Injection Nozzle Tester D01109AA
- B—Fuel Line Assembly 36352*
- C—Adapter Nut 208369**
- D—Straight Adapters 23623* and 23693*

Used to test operational performance and opening pressure of nozzles.



RG4954 -UN-14DEC88

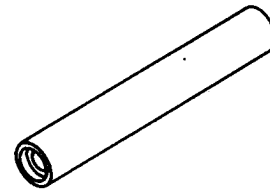
*Included in D01110AA (Y910A) Adapter Set.

**May be used instead of 23623 or 23693.

S11,3010,OX -19-20JUL95

- Driver JDF15

Used to install spindle seals in fuel supply pumps.



RG2017

RG2017 -UN-30NOV88

S55,3010,BA -19-25JUL91

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 and gear cover.
LOCTITE 592 (TY9374/TY9375) Pipe Sealant with TEFLON	Fuel filter drain plug, bleed plug and check valve body.

RG,CTM42,G35,76-19-20JUL95

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3

FUEL SYSTEM SPECIFICATIONS

Item	New Part Specification
Engine Speeds:	
Machine applications	See applicable machine TM
OEM applications	See Groups 01 and 105 in this CTM
Fuel Injection Pump Timing to Engine	TDC
Overflow Valve Regulating Pressure	Approx. 100 kPa (1 bar) (15 psi)
Hydraulic Aneroid Activator Opening Pressure	48—75 kPa (0.5—0.8 bar) (7—11 psi)
Fuel Supply Pump Minimum Operating Pressure	
Standard Pressure (With Filter Bowl)	100 kPa (1.0 bar) (14.5 psi)
High Pressure (Without Filter Bowl)	200 kPa (2.0 bar) (29.0 psi)
Fuel Injection Nozzles—Model KDEL-21 mm	
New Nozzle Opening Pressures (By Nozzle Tip Size)	
4 x 0.36 mm	29400 kPa (294 bar) (4250 psi)
4 x 0.40 mm	27900 kPa (279 bar) (4050 psi)
6 x 0.285 mm	29400 kPa (294 bar) (4250 psi)
Used Nozzle Opening Pressures (By Nozzle Tip Size)	
4 x 0.36 mm	26200 kPa (262 bar) (3800 psi)
4 x 0.40 mm	26200 kPa (262 bar) (3800 psi)
6 x 0.285 mm	26200 kPa (262 bar) (3800 psi)
Maximum Deviation Between Cylinders	350 kPa (3.5 bar) (50 psi)
Torques	
Supply Pump Mounting Stud Nuts	6 N.m (54 lb-in.) (4.5 lb-ft)
Supply Pump Banjo Fitting Screws	41 N.m (30 lb-ft)
Injection Pump-to-Cylinder Block Stud Nuts	47 N.m (35 lb-ft)
Injection Pump Drive Gear-to-Hub Cap Screws	
A-Series Pumps	47 N.m (35 lb-ft)
P-Series Pumps	61 N.m (45 lb-ft)
Injection Pump Drive Hub Nut	105 N.m (78 lb-ft)
Injection Pump Line Nuts	27 N.m (20 lb-ft)
Injection Nozzle Gland Nut	82 N.m (60 lb-ft)
Injection Nozzle Retaining Nut	88 N.m (65 lb-ft)

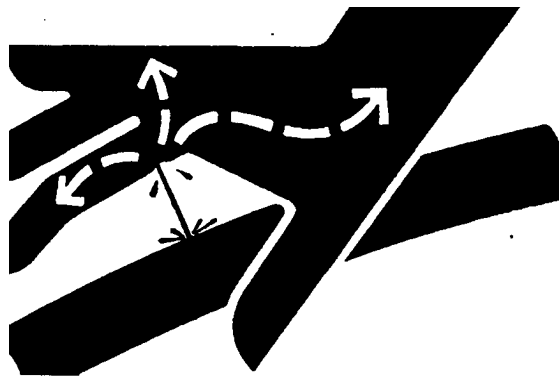
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4

RELIEVE FUEL SYSTEM PRESSURE

⚠ CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin, causing serious injury. Before disconnecting lines, be sure to relieve pressure. Before applying pressure to the system, be sure ALL connections are tight and lines, pipes and hoses are not damaged. Keep hands and body away from pinholes and nozzles which eject fluid under pressure. Use a piece of cardboard or wood, rather than hands, to search for suspected leaks.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

Any time the fuel system has been opened up for service (lines disconnected or filters removed), it will be necessary to bleed air from the system. (See BLEED FUEL SYSTEM in Group 115.)



-JUN-23AUG88

X9811

RG,CTM8,G35,6 -19-20JUL95

REMOVE FUEL FILTERS

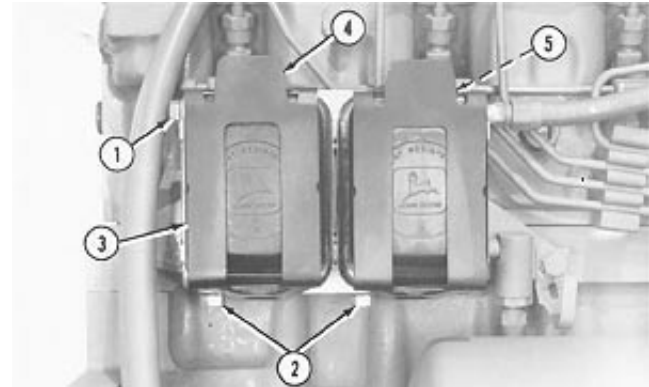
1. Close the fuel shut-off valve at bottom of fuel tank (not illustrated).

NOTE: Keep a small container under drain plug(s) to catch draining fuel.

2. Loosen bleed plug (1) and remove drain plug(s) (2) to drain fuel filters.

3. Release the retaining spring (3) and pull fuel filter off fuel filter body.

NOTE: The spring may be released by pressing inward on the outside finger tab (4) until the top hook of the spring can be disengaged. Disengage the top hook by pulling upward on the inside finger tab (5).



Engine Serial No. (—054066) shown.

- 1—Bleed Plug
- 2—Drain Plug(s)
- 3—Retaining Spring
- 4—Outside Finger Tab
- 5—Inside Finger Tab

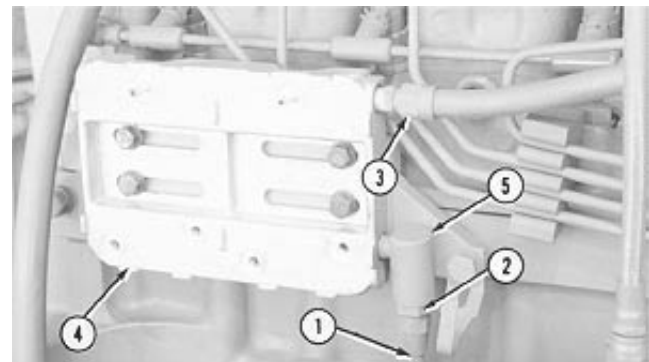
S11,3010,AJ -19-20JUL95

REMOVE FUEL CHECK VALVE ASSEMBLY

NOTE: On early engine applications, the fuel check valve and connector were installed in a check valve body (as shown). On later applications, they are installed directly into the bottom of the fuel filter body. Removal and installation of the check valve is the same.

1. Disconnect fuel inlet pipe (1) and unscrew connector (2). Check valve will fall out of housing when connector is removed.

NOTE: On early applications, remove fuel line (3) and fuel filter body (4) to unscrew check valve body (5), if required.



Engine Serial No. (—054066) shown.

- 1—Fuel Inlet Pipe
- 2—Connector
- 3—Injection Pump Inlet Line
- 4—Fuel Filter Body
- 5—Check Valve Body (-054066)

S11,3010,AK -19-25JAN96

INSPECT CHECK VALVE

1. Inspect check valve (A) for foreign material which could keep valve open.
2. Use compressed air to remove foreign material from valve.

NOTE: The check valve cannot be repaired. Replace if damaged.



RG3868 -UN-20OCT88

S11,0408,I -19-20JUL95

REMOVE INSPECT AND CLEAN FUEL FILTER BODY

1. Remove fuel filters if not already accomplished.. (See REMOVE FUEL FILTERS in this group.)
2. Remove fuel check valve if not already accomplished. (See REMOVE FUEL CHECK VALVE in this group.)
3. Disconnect remaining fuel lines and remove fuel filter body.

NOTE: On early engine applications, the filter body is attached to a support.

4. Remove bleed plug, drain plug(s) and pipe plug as required.
5. Inspect fuel filter body for dirt and contaminants. Inspect contact surfaces for damage.
6. Carefully clean filter body with clean solvent.
7. Blow dry all passages with compressed air.

IMPORTANT: Any dirt lodged in the spring pin groove or at the end of the spring pin will be washed into the injection system and may result in severe damage to the injection pump or nozzles.

8. Apply a light coat of LOCTITE 592 Pipe Sealant with Teflon to plug threads. Install all plugs.
9. Install fuel check valve. (See INSTALL FUEL CHECK VALVE in this group.)
10. Install fuel filters. (See INSTALL FUEL FILTERS in this group.)



Engine Serial No. (—054066) shown.

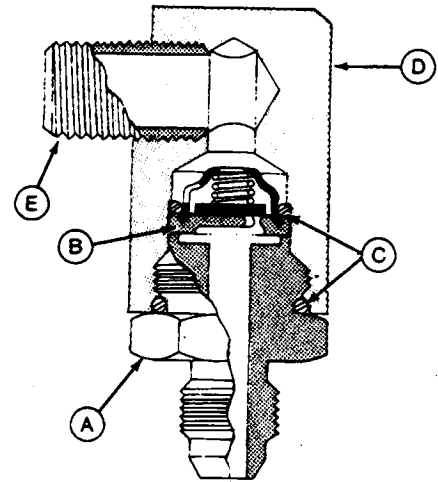
FIG2832 -UN-27JUL89

INSTALL FUEL CHECK VALVE ASSEMBLY

NOTE: On early engine applications, the fuel check valve and connector were installed in a check valve body (as shown). On later applications, they are installed directly into the bottom of the fuel filter body. Removal and installation of the check valve is the same.

NOTE: If check valve body (D) was removed, apply a light coat of LOCTITE 592 Pipe Sealant with Teflon to nipple threads (E) and attach valve body to fuel filter body. Install assembly on engine.

1. Position new O-rings (C) on check valve (B) and connector (A).
2. Install check valve and connector in valve body or fuel filter body, however equipped.
3. Connect fuel pipe.



R 26811N

- A—Connector
- B—Check Valve
- C—O-Rings
- D—Valve Body (—054066)
- E—Pipe Nipple Threads (—054066)

-UN-01JUN89

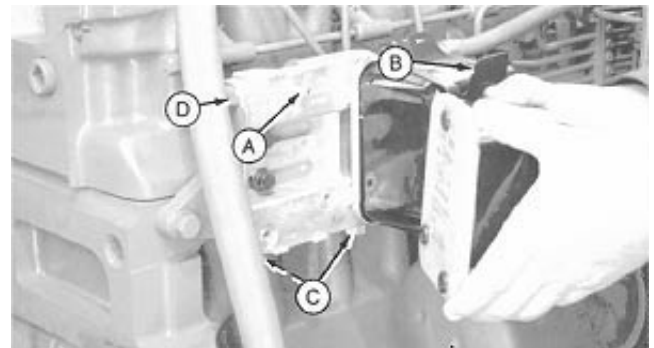
R26811

S11,0408,K -19-25JAN96

INSTALL NEW FUEL FILTERS

NOTE: Engines with metal fuel filters do not have spring pins (A) on filter body. Engines with glass fuel filters have spring pins on filter body.

1. Hook bottom end of retaining spring first (B); then hook the top end.
2. Install drain plug(s) (C) and bleed plug (D) and tighten securely.
3. Open fuel shut-off valve and bleed filters. (See BLEED FUEL SYSTEM in this group.)



- A—Spring Pin
- B—Retaining Spring
- C—Drain Plug (2 used)
- D—Bleed Plug

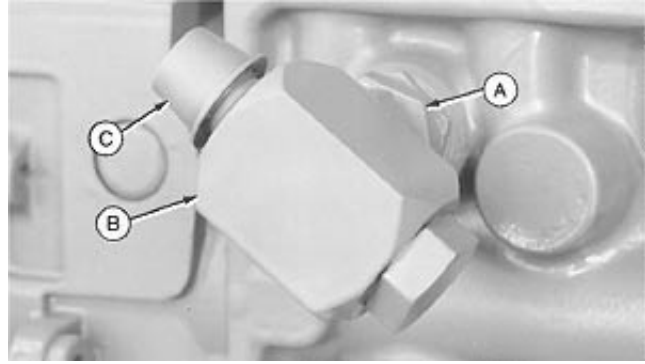
-UN-09NOV89

FG3869

S11,3010,AL -19-25JAN96

SERVICE FUEL INLET FINAL FILTER—6619AR-11, 12, AND 14 ENGINES, SERIAL NO. (0000—052656)

1. Remove fuel inlet line and cap connection (C).
2. Remove fuel inlet connector (A).
3. Remove tee body (B).

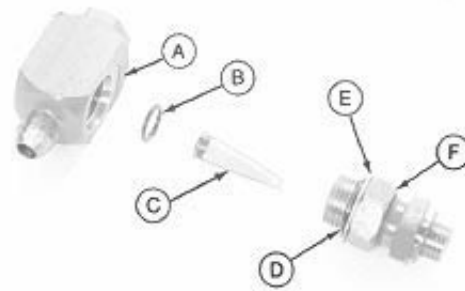


S11,3010,PC -19-25JAN96

RG3541 -UN-31JUL89

4. Remove and discard O-rings (B) and (D).
5. Inspect fuel inlet filter (C) for debris or damage. Replace as necessary.
6. Clean all parts in clean solvent and dry with compressed air.

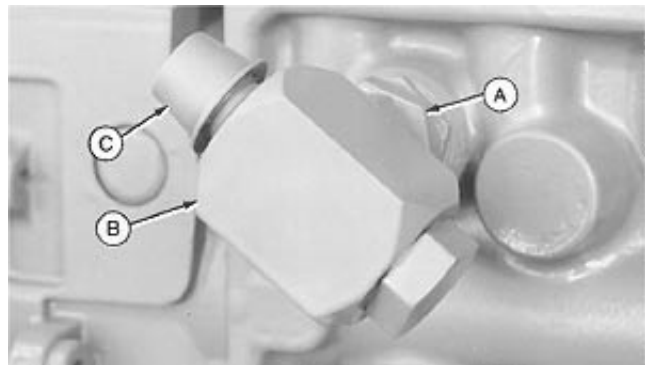
- | | |
|---------------------|-------------|
| A—Tee Body | D—O-Ring |
| B—O-Ring | E—Washer |
| C—Final Fuel Filter | F—Connector |



S11,3010,DM -19-20JUL95

RG3542 -UN-31JUL89

7. Install new O-rings and install tee body (B).
8. Install fuel inlet connector (A).
9. Install fuel inlet line on connector (C).
10. Bleed fuel system. (See BLEED FUEL SYSTEM in this group.)



S11,3010,DM,1 -19-20JUL95

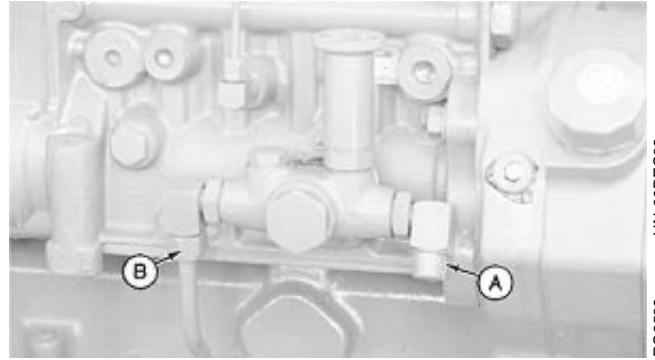
RG3541 -UN-31JUL89

REMOVE FUEL SUPPLY PUMP

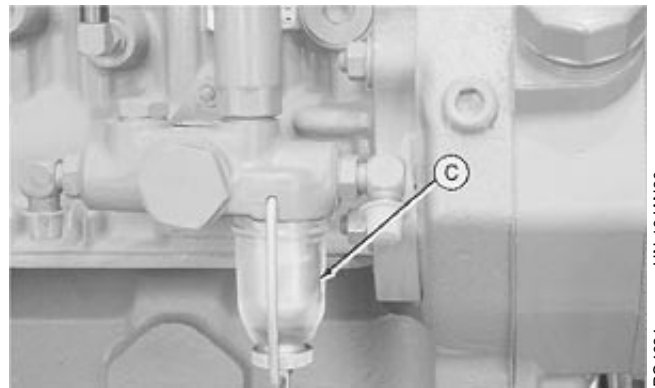
Thoroughly clean the exterior of the supply pump and mounting area on the injection pump housing.

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.
3. Pull fuel supply pump straight out from injection pump housing.



RG3539 -UN-20DEC88



RG4634 -UN-19JAN90

Robert Bosch pump shown.

S11,3010,QX -19-20JUL95

TEST FUEL SUPPLY PUMP FOR LEAKS

Fuel delivery pressure should be checked before removing supply pump from injection pump (See CHECK SUPPLY PUMP OPERATION in Group 115). If a test stand is available, output performance may be checked with the injection pump mounted on stand.

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) (29.0 psi).
4. Move roller tappet in and out by hand. No air bubbles should appear around roller tappet bore.

NOTE: If bubbles appear, it is an indication that either the spindle seal is defective or that the spindle is worn (or possibly both).

IMPORTANT: If enough diesel fuel leaks past the spindle and seal, possible serious damage to the injection pump or engine (or both) could occur.

Any fuel leakage that takes place flows into the injection pump crankcase, diluting the engine oil. Remember that the injection pump and engine both share a common lubricating oil supply.

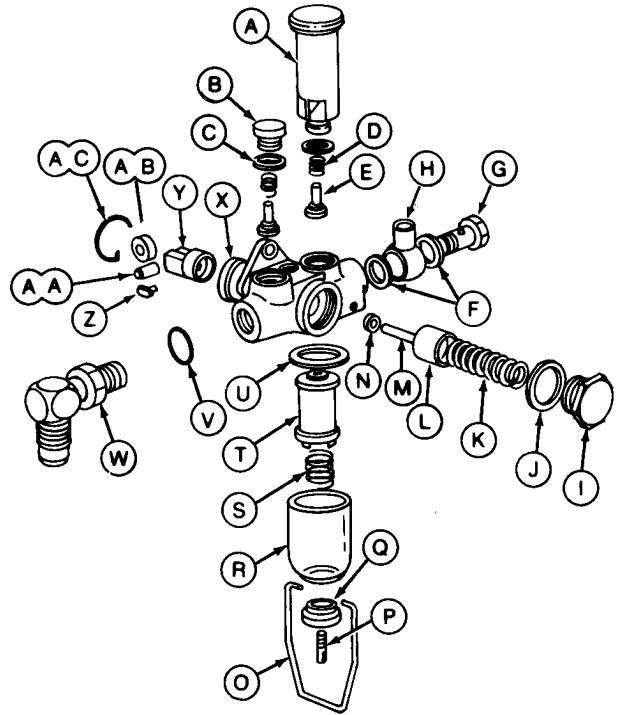


RG2315
-JUN-30NOV88

S11,3010,QY -19-25JAN96

DISASSEMBLE FUEL SUPPLY PUMP

- | | |
|-----------------------------|-------------------------------------|
| A—Hand Primer | P—Stud Bolt |
| B—Plug | Q—Clamp Nut |
| C—Gasket (2 used) | R—Glass Bowl |
| D—Spring (2 used) | S—Spring |
| E—Valve (2 used) | T—Filter |
| F—Gasket (4 used)* | U—Gasket |
| G—Hollow Screw
(2 used)* | V—O-Ring (2 used)** |
| H—Banjo Fitting
(2 used) | W—Elbow with Lock
Nut (2 used)** |
| I—Plug | X—Pump Housing |
| J—Gasket | Y—Roller Tappet |
| K—Spring | Z—Sliding Blocks
(2 used) |
| L—Plunger | AA—Pin |
| M—Pressure Spindle | AB—Roller |
| N—Seal | AC—Snap Ring |
| O—Ball | |



RG2325 -JN-20APR89

*Used only on pumps with banjo fittings

**Used only on pumps with elbow fittings

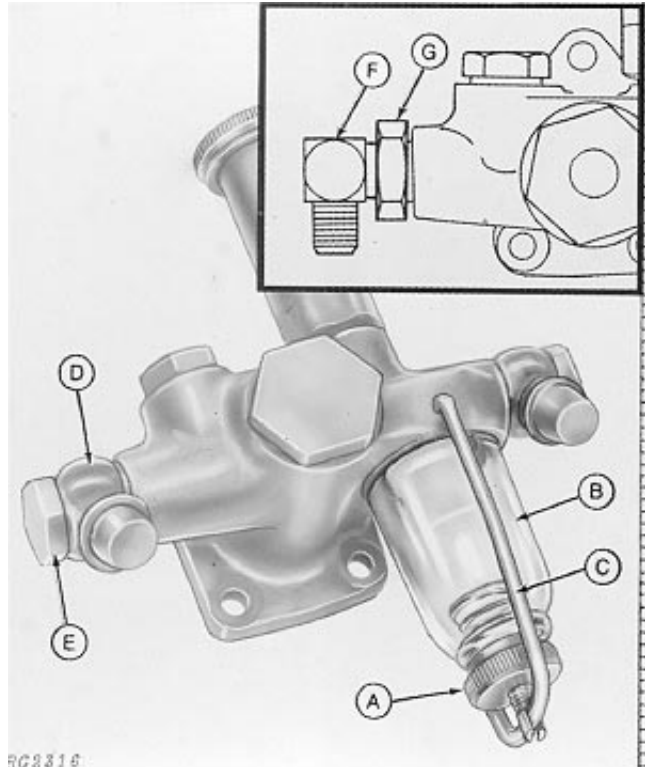
Robert Bosch pump shown.

S11,3010,QZ -19-20JUL95

NOTE: Engines which have a final filter at fuel filter base will NOT have a glass or metal bowl and filter on fuel supply pump.

1. If pump has a bowl with filter (B), loosen clamping nut (A) as far as possible.
2. Push bowl up to compress spring, swing bail (C) aside and remove bowl with filter.
3. Remove and discard gasket.
4. On supply pumps with banjo fittings (D), remove hollow screw (E) and banjo fitting. Remove and discard copper washers.
5. On supply pumps with elbow fittings (F), loosen lock nut (G) and unscrew elbow fitting from pump housing. Remove and discard O-ring.

- A—Clamping Nut
- B—Glass or Metal Bowl and Filter
- C—Bail
- D—Banjo Fitting
Injection Pump
(Early Type)
- E—Hollow Screw
- F—Elbow Fitting
Injection Pump
(Late Type)
- G—Lock Nut

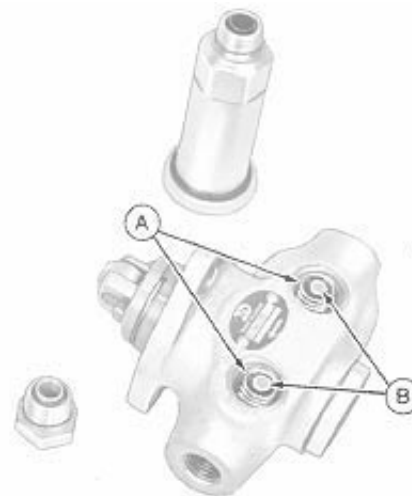


RG2316

-UN-21APR89
RG2316

S11,3010,QH -19-20JUL95

6. Remove hand primer from housing, shown removed. Discard copper washer.
7. Remove plug from housing, shown removed. Discard copper washer.
8. Remove valves (B) and springs (A).



-UN-30NOV88
RG4026

S11,3010,QI -19-20JUL95

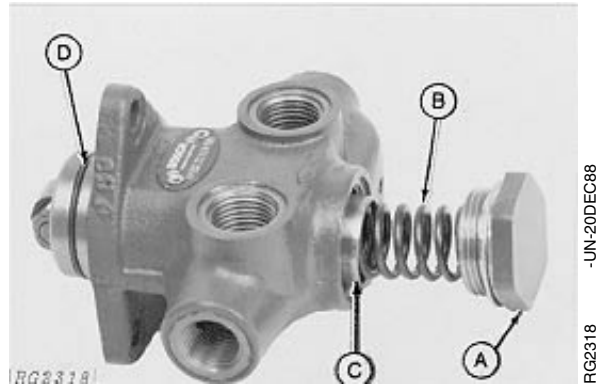
35
14

9. Remove plug (A), spring (B) and plunger (C) from pump housing. Discard copper washer.

10. Remove snap ring (D) from outer circumference of pump housing neck.

NOTE: Snap ring has a tang on one end which extends vertically down through a hole in pump housing to retain the roller tappet assembly.

- A—Plug
- B—Spring
- C—Plunger
- D—Snap Ring



S11,3010,QJ -19-20JUL95

11. Remove roller tappet (A) and spindle (B) from pump housing. Remove and discard O-ring on spindle.

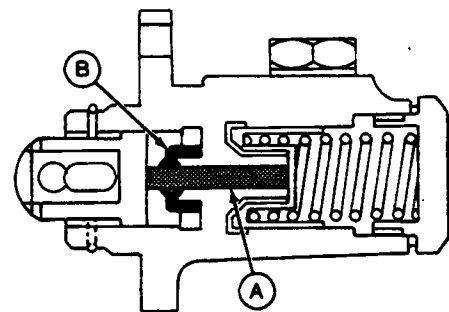
NOTE: It may be necessary to push on spindle to remove plunger as shown earlier in disassembly procedure.



S11,3010,QK -19-20JUL95

NOTE: The spindle seal is pressed into the pump housing. This seal keeps diesel fuel from leaking past the spindle (A) and entering the injection pump crankcase.

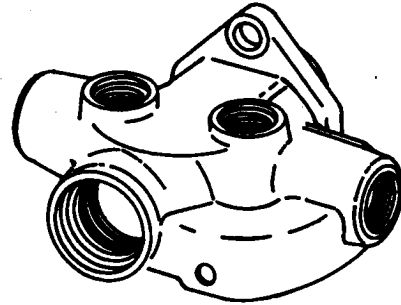
12. Remove spindle seal (B) and spindle (A) from housing using needle nose pliers. Discard seal.



S11,3010,QL -19-20JUL95

INSPECT AND REPAIR FUEL SUPPLY PUMP

1. Inspect supply pump housing for cracks and wear. Be sure valve seating areas are not pitted. Replace housing as necessary.
2. Check roller tappet and plunger bore for wear and scoring. Remove any deposits in housing with a suitable solvent. Rinse housing in clean diesel fuel.
3. Check condition of threads for inlet and outlet fittings. Pump with banjo fittings have M14 x 1.5 threads, while pumps with elbow fittings have 1/2-20 threads.

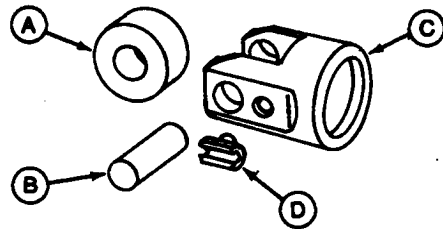


RG2320

S11,3010,RA -19-20JUL95

UN-30NOV88
RG2320

4. Inspect roller (A) OD for excessive wear. Be sure roller turns freely on pin (B) and in tappet (C).
5. Inspect sliding blocks (D). Edges should be square and unpitted. Blocks should slide in and out of tappet easily.
6. Inspect tappet for wear and scoring. Remove any deposits with a suitable solvent.



RG2321

- A—Roller
- B—Pin
- C—Tappet
- D—Sliding Block (2 used)

Be sure land on tappet that contacts pressure spindle is flat and undamaged.

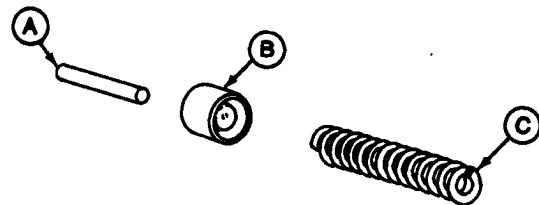
7. Replace parts as required.

NOTE: Tappet assembly is not repairable on Robert Bosch pumps. Replace assembly as required.

S11,3010,QN -19-20JUL95

UN-30NOV88
RG2321

8. Inspect pressure spindle (A) and plunger (B) for pits and burrs. If defective, replace supply pump.
9. Inspect spring (C) for cracks and distortion. Replace parts as necessary.



RG2322

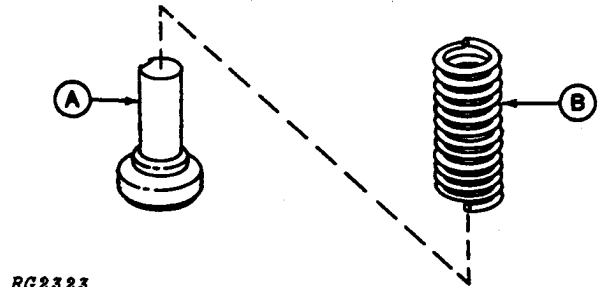
S11,3010,QO -19-20JUL95

UN-30NOV88
RG2322

35
16

10. Inspect valves (A), especially valve face, for cracks, pits and wear. Replace as necessary.

11. Spring (B) should not be bent or broken.



RG2323

-JUN-30NOV88
RG2323

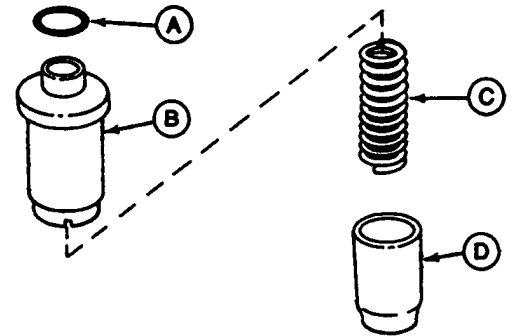
S11,3010,QP -19-20JUL95

12. Check condition of gasket (A). Replace as necessary.

13. Be sure wire fabric filter (B) is not ripped. Clean filter in fresh diesel fuel.

14. Be sure spring (C) is in good condition.

15. Inspect glass bowl (D) for damage, especially for chips on the upper sealing edge.



RG2324

-JUN-20APR88
RG2324

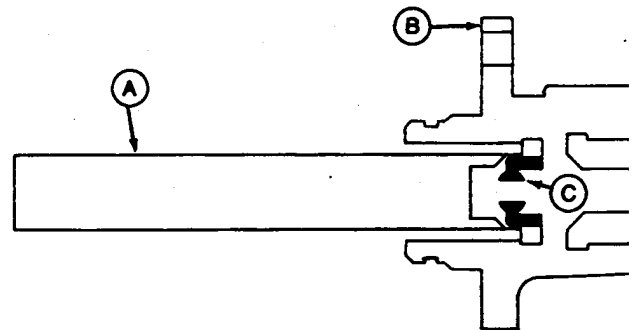
S11,3010,QQ -19-20JUL95

- A—Gasket
- B—Filter
- C—Spring
- D—Glass Bowl

ASSEMBLE FUEL SUPPLY PUMP

IMPORTANT: Always use new copper gaskets. Dip parts in clean diesel fuel before assembly. Hands should be wet with diesel fuel when assembling internal components of fuel supply pump.

1. On Nippondenso pumps, install a new spindle seal (C) into pump housing (B) using JDF-15 Driver (A). Be sure seal is started straight in housing bore and drive until driver contacts housing.

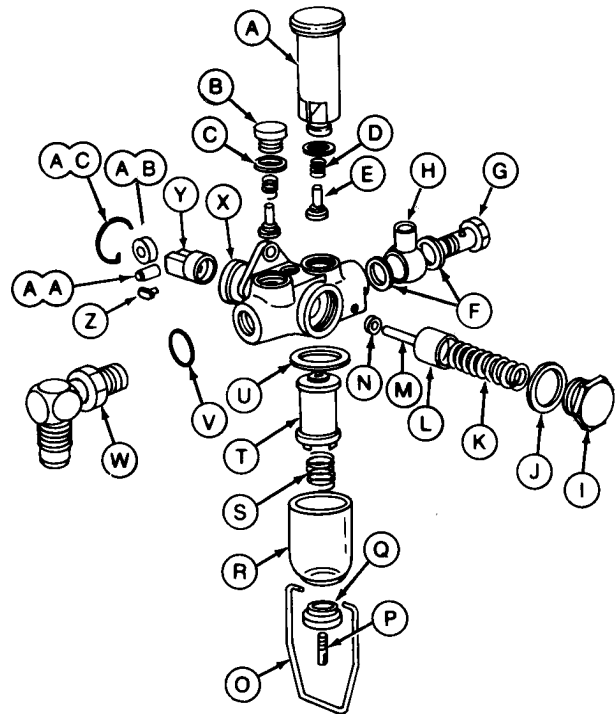


RG2013

-JUN-30NOV88
RG2013

S11,3010,RB -19-20JUL95

2. On Robert Bosch pumps, install a new O-ring (N) in housing bore.
3. Insert pressure spindle (M) and plunger (L) in housing.
4. Position spring (K) in plunger. Install plug (I) with a new gasket (J) over spring. Tighten plug securely.
5. Assemble sliding blocks (Z), roller (AB), and pin (AA) to roller tappet (Y).
6. Insert assembled tappet in housing and secure with snap ring (AC).
7. Position valves (E) with springs (D) in housing.
8. Install plug (B) and hand primer (A) using new gaskets (C). Tighten plug and hand primer securely.
9. On pumps with glass bowl and filter, install bail (O) with stud bolt (P) and clamp nut (Q) on housing.
10. Position a new gasket (U) on housing. Insert spring (S) and filter (T) in bowl (R) and install on pump. Tighten clamp nut securely.
11. On pumps with banjo fittings (H), install fitting using new gaskets (F). Tighten hollow screw (G) to 41 N·m (30 lb-ft).
12. On pumps with elbow fittings (W) install fitting with new O-rings (V). Tighten lock nut securely.
13. Perform leak test. (See TEST FUEL SUPPLY PUMP FOR LEAKS in this group.)



- | | |
|---------------------------|----------------------------------|
| A—Hand Primer | P—Stud Bolt |
| B—Plug | Q—Clamp Nut |
| C—Gasket (2 used) | R—Glass Bowl |
| D—Spring (2 used) | S—Spring |
| E—Valve (2 used) | T—Filter |
| F—Gasket (4 used)* | U—Gasket |
| G—Hollow Screw (2 used)* | V—O-Ring (2 used)** |
| H—Banjo Fitting (2 used)* | W—Elbow with Lock Nut (2 used)** |
| I—Plug | X—Pump Housing |
| J—Gasket | Y—Roller Tappet |
| K—Spring | Z—Sliding Blocks (2 used) |
| L—Plunger | AA—Pin |
| M—Pressure Spindle | AB—Roller |
| N—O-Ring | AC—Snap Ring |
| O—Bail | |

*Used only on pumps with banjo fittings

**Used only on pumps with elbow fittings

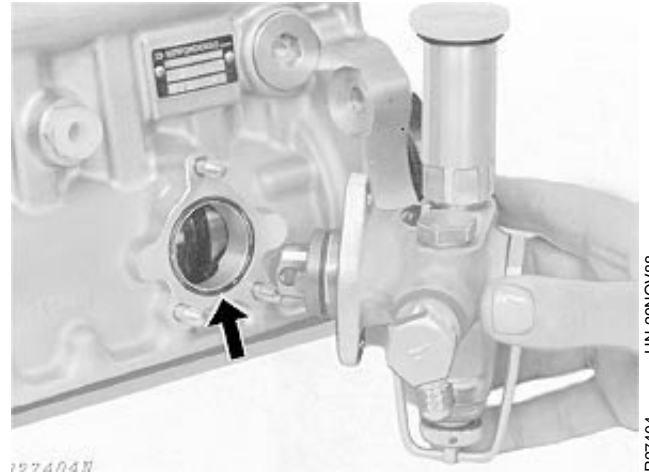
RG2325 -JUN-20APR89

S11,3010,QS -19-20JUL95

INSTALL FUEL SUPPLY PUMP

IMPORTANT: Before installing supply pump, test pump to make sure that fuel will not leak around spindle and spindle seal. (See TEST FUEL SUPPLY PUMP FOR LEAKS, in this group.)

1. Place a new O-ring in counterbore of pump housing next to mounting face (arrow).
2. Position pump over mounting studs. Tighten mounting stud nuts to 6 N·m (54 lb-in.).
3. Install fuel inlet and outlet lines when engine is installed in vehicle. Tighten all connections securely.
4. Bleed the fuel system. (See BLEED FUEL SYSTEM in this group.)



-UN-29NOV88
R27404

S11,3010,RC -19-20JUL95

GENERAL INFORMATION FOR ANEROID

NOTE: Aneroids are used only on certain applications of the 6619 Engine.

The aneroid (1) is a diaphragm-type control unit that mounts on top of the injection pump governor housing (2).

Its purpose is to limit black smoke produced during acceleration under two conditions:

- 1—When load is moderate to heavy with engine speed from 800 to approximately 1000 rpm.
- 2—When load is light at any engine speed.



-UN-20DEC88
RG2906

S11,3010,PF -19-20JUL95

35
19

REPAIR ANEROID

For aneroid repair and adjustment, have an authorized diesel repair station perform the work.

The aneroid controls fuel delivery when intake manifold pressure is about 100 kPa (1.00 bar) (15 psi) or less. Therefore, all final adjustments are to be made on the test stand with aneroid mounted on injection pump.

IMPORTANT: Correct aneroid adjustments are essential for satisfactory engine performance. Whenever aneroid has been disassembled or adjustments have been altered, injection pump (including aneroid) must be calibrated on test stand before releasing pump for service.

S11,3010,PG -19-20JUL95

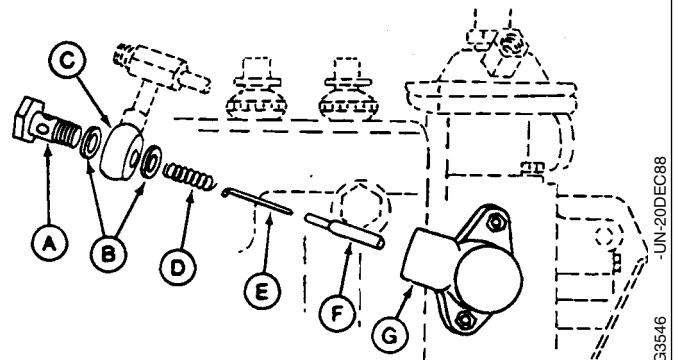
REMOVE HYDRAULIC ANEROID ACTIVATOR

NOTE: The hydraulic aneroid activator used on the P-110 Injection Pump is located on the back side of the governor housing next to the cylinder block.

1. Remove fuel injection pump. (See REMOVE FUEL INJECTION PUMP in this group.)
2. Remove special screw (A), copper washers (B) and banjo connector (C).

NOTE: Do not bend restrictor wire or other activator parts.

3. Remove spring (D), restrictor wire (E) and capillary valve (F) from activator housing (G).
4. Remove activator housing.



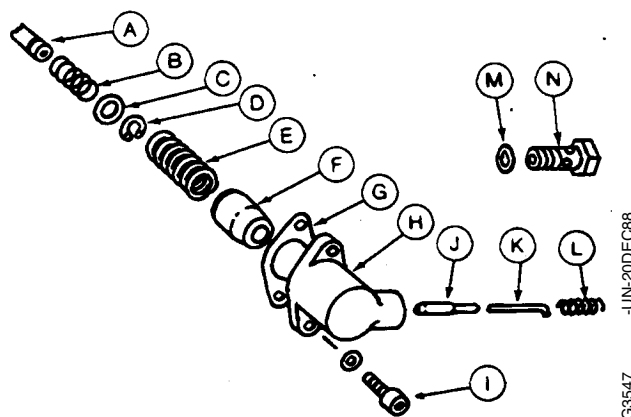
- A—Special Screw
- B—Copper Washer
(2 used)
- C—Banjo Connector
- D—Spring
- E—Restrictor Wire
- F—Capillary Valve
- G—Activator Housing

RG3546 -UN-20DEC88

S11,3010,DS -19-20JUL95

DISASSEMBLE AND CLEAN HYDRAULIC ANEROID ACTIVATOR

1. Remove gasket (G), piston (F) and piston spring (E).
2. Wash all parts in clean solvent and dry with compressed air. Blow out all openings to make sure they are open.
3. Check piston (F) and activator housing (H) for general condition. Piston must move freely in its bore.
4. Inspect piston spring (E) and capillary valve spring (L). Replace if weak or broken.
5. Inspect condition of restrictor wire (K). Wire must not be bent or broken and must fit loosely in capillary valve (J).
6. Check condition of return spring (B), washer (C) and retaining ring (D) on starting fuel control shaft (A). Replace spring if weak or broken. Be sure retaining ring is secure on shaft.



- | | |
|-------------------------------|---------------------------|
| A—Starting Fuel Control Shaft | I—Mounting Screw (2 used) |
| B—Return Spring | J—Capillary Valve |
| C—Washer | K—Restrictor Wire |
| D—Retaining Ring | L—Capillary Valve Spring |
| E—Piston Spring | M—Washers |
| F—Piston | N—Special Screw |
| G—Gasket | |
| H—Activator Housing | |

S11,3010,DT -19-20JUL95

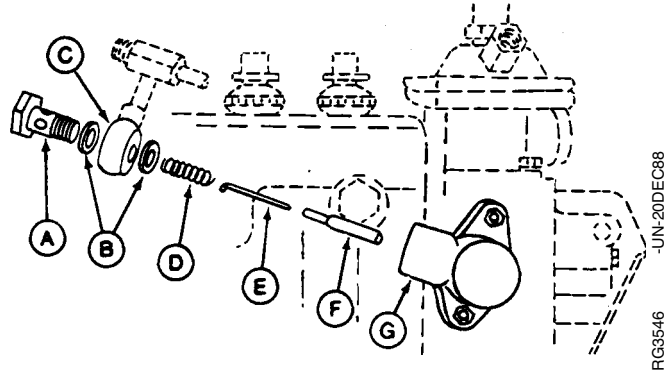
ASSEMBLE AND INSTALL HYDRAULIC ANEROID ACTIVATOR

NOTE: Refer to previous illustration.

1. Insert piston spring (E) into piston (F). Place these parts in activator housing (H).
2. Using a new gasket (G) mount activator assembly on governor housing. Tighten Allen head mounting screws (I) with washers securely.

S11,3010,DU -19-20JUL95

3. Assemble capillary valve (F), restrictor wire (E) and spring (D) into activator housing (G).
4. Using two new copper washers (B) install banjo connector (C) and special screw (A).
5. Install injection pump. (See INSTALL FUEL INJECTION PUMP in this group.)
6. Connect lube lines to banjo connector.



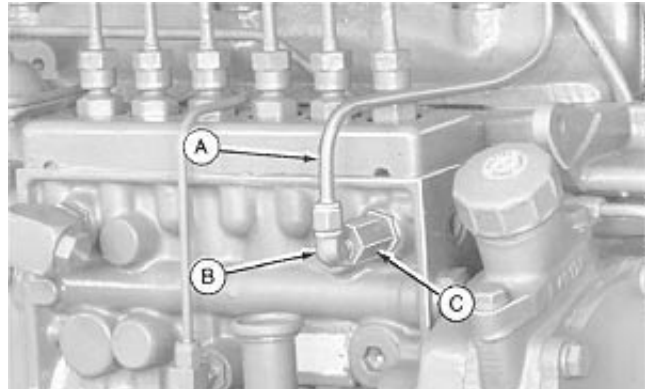
- A—Special Screw
- B—Copper Washers
- C—Banjo Connector
- D—Spring
- E—Restrictor Wire
- F—Capillary Valve
- G—Activator Housing

RG,CTM61,G35,48-19-20JUL95

SERVICE OVERFLOW VALVE

NOTE: The overflow valve can be serviced with injection pump installed.

1. Remove leak-off line (A) and remove elbow (B).
2. Remove valve assembly (C) from pump.

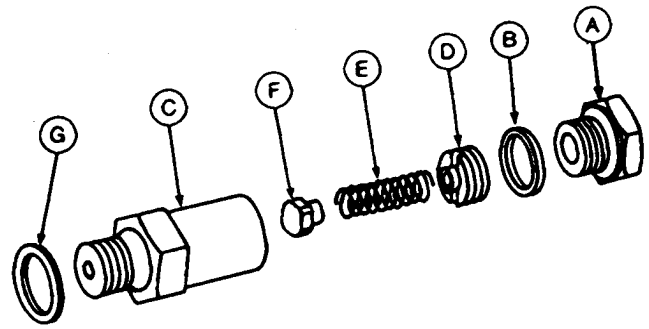


S11,3010,DW -19-20JUL95

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.



- A—Reducer
- B—Washer
- C—Valve Body
- D—Spring Seat
- E—Spring
- F—Valve
- G—Washer

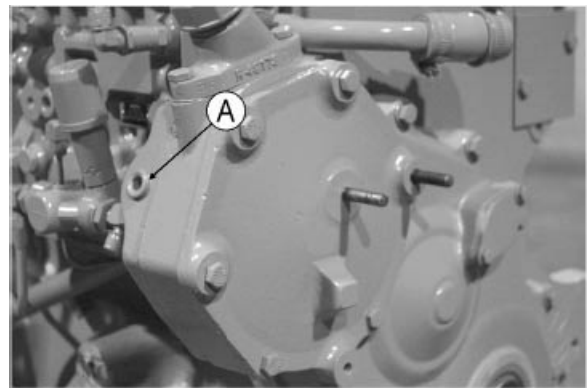
S11,3010,DX -19-10AUG94

-UN-20DEC88
RG3549

REMOVE FUEL INJECTION PUMP

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

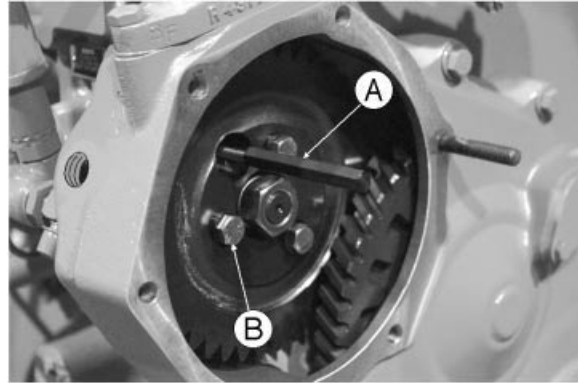
1. Clean injection lines and area around the injection pump with cleaning solvent or a steam cleaner.
2. Remove timing hole plug (A).
3. Rotate engine flywheel (in normal direction) with JDE81-1 Flywheel Turning Tool until No. 1 piston is at "TDC" of its compression stroke. At this point, JDE81-4 Timing Pin should enter hole in flywheel.
4. Timing marks on injection pump drive hub and fixed timing pointer should be aligned.



-UN-29SEP95
RG7353

CTM9,3010,PD -19-25JAN96

IMPORTANT: To assure that accurate injection pump timing is maintained when pump is removed and installed, it is recommended that JDG886 Injection Pump Timing Pin (A) is used prior to removal and installation of injection pump. If injection pump will be serviced at an authorized repair station, remove timing pin prior to shipping for service.



RG7354 -UN-29SEP95

5. Remove injection pump drive gear cover (shown removed). Remove and discard all gasket material.

NOTE: It may be necessary to rotate injection pump drive hub slightly to install timing pin.

6. Install JDG886 Timing Pin through hole in injection pump drive gear. Thread timing pin into injection pump hub until it bottoms.

IMPORTANT: Leave injection pump drive gear in housing so that gear train timing is maintained during pump removal and installation.

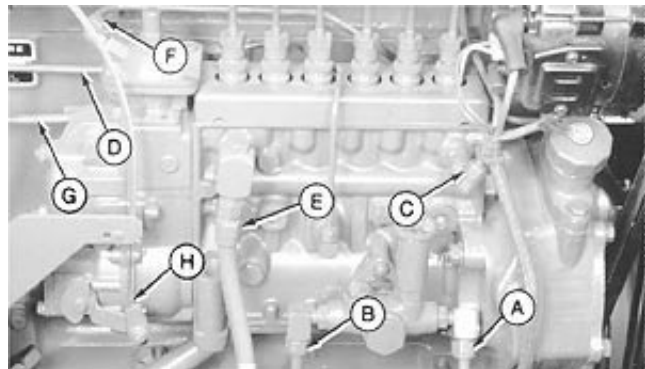
7. Remove injection pump drive gear cap screws (B) that secure injection pump drive gear to pump hub.

CTM9,3010,PH -19-25JAN96

8. Remove inlet (A) and outlet (B) fuel lines from fuel supply pump and fuel leak-off line (C).

9. Remove lubrication line (D), fuel inlet connection (E) and intake manifold to aneroid pipe (F, if equipped).

10. Disconnect the speed control rod (G) and fuel shut-off cable (H).



RG3544 -UN-31JUL89

- A—Inlet Line
- B—Outlet Line
- C—Leak-Off Line
- D—Lubrication Line
- E—Fuel Inlet Connection
- F—Aneroid Pipe
- G—Speed Control Rod
- H—Fuel Shut-Off Cable

S11,3010,PI -19-20JUL95

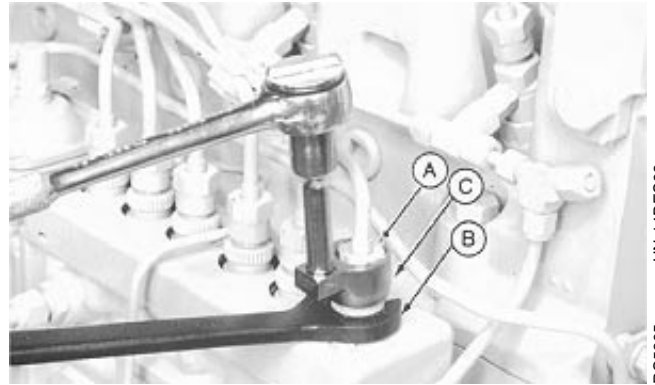
11. To remove fuel injection line nuts (A) on Robert Bosch P110 injection pumps use the JDE90 Serrated Wrench (B) with either the JDF22 Crowsfoot Wrench (C) or a standard 3/4 in. line wrench (D). On Nippondenso P110 injection pumps, use a 22 mm open end wrench with either the 3/4 in. line wrench or JDF22 Crowsfoot Wrench.

IMPORTANT: The JDE90 Serrated 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.

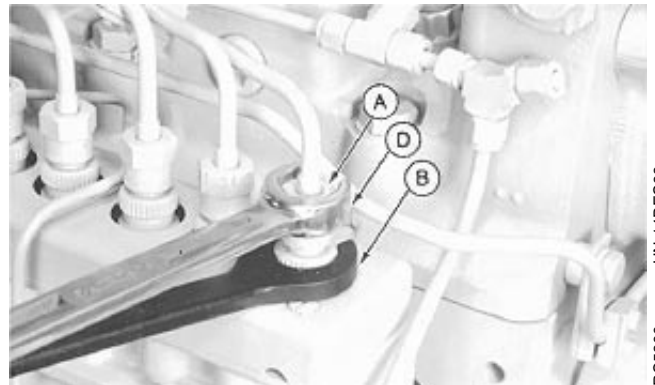
12. Remove four mounting stud nuts securing injection pump to cylinder block.

13. Carefully remove injection pump and place it on a clean flat surface.

- A—Fuel Injection Line Nuts
- B—JDE90 Serrated Wrench
- C—JDF22 Crowsfoot Wrench
- D—3/4 in. Line Wrench



RG5365 -UN-14DEC88



RG5366 -UN-14DEC88

S11,3010,GZ -19-20JUL95

REPAIR FUEL INJECTION PUMP

IMPORTANT: Do not disassemble fuel injection pump further than necessary for installing available service parts, not even for cleaning.

Be sure that injection pump serial number tag is in place and that all identification numbers are legible so that pump is set to the correct specifications for its intended application.

For injection pump repair and testing, have an authorized diesel injection repair station perform the work. Unauthorized repairs made to fuel injection pump will void warranty.

Once injection pump has been returned and installed on engine, run engine on a dynamometer to check engine power levels.

S11,3010,PE -19-17NOV95

INSTALL FUEL INJECTION PUMP

1. If engine was rotated after injection pump was removed, rotate flywheel until timing pin enters flywheel at No. 1 cylinder's "TDC" compression stroke.

NOTE: When No. 1 cylinder is at "TDC" compression stroke, intake and exhaust valves for No. 1 cylinder will be closed and both rocker arms will be loose.

2. Rotate injection pump drive hub until marks on drive hub (B) and pointer (A) are aligned.

NOTE: It may be necessary to rotate pump hub slightly to get timing pin to enter bearing plate.

3. Thread JDG886 Timing Pin (E) into drive hub, as shown, and tighten until it bottoms against bearing plate (D).

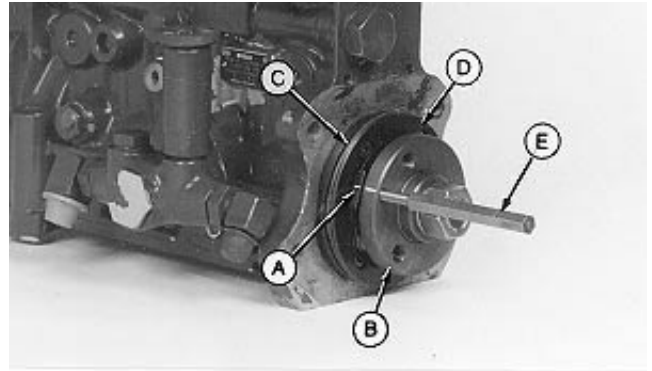
4. Install a new O-ring (C) on pump mounting hub. Lightly lubricate O-ring with JDT308 Soap to aid in pump installation and prevent O-ring damage.

NOTE: Place injection pump drive gear in timing gear housing (if previously removed) with chamfered side of gear toward injection pump or with the part number on gear facing out, toward front of engine. Chamfer is at outer edge of bore for easier installation of gear to pump drive hub. Assure that gear train is properly timed during installation.

5. Install injection pump using moderate forward pressure and slight rocking motion to work O-ring into mounting bore.

Injection pump flange should seat solidly against cylinder block and injection pump drive hub nut should be positioned in ID of pump drive gear.

6. Install mounting stud nuts and tighten to 47 N·m (35 lb-ft).



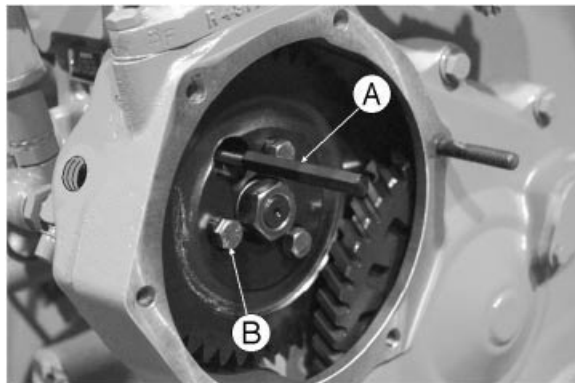
A—Pointer
 B—Drive Hub
 C—O-Ring
 D—Bearing Plate
 E—JDG886 Timing Pin

RG7741 -UN-07SEP94

7. Carefully install drive gear against pump drive hub, so that cap screws (B) are centered in gear slots.

8. Tighten the four injection pump-to-cylinder block mounting stud nuts to 47 N·m (35 lb-ft).

IMPORTANT: The normal backlash of gears is enough to throw the pump timing off by a few degrees, resulting in poor engine performance. Therefore, it is very important that pump timing be rechecked after it has been installed. To avoid backlash, always approach the timing mark on pointer by rotating crankshaft in direction of engine rotation.



RG7354 -UN-29SEP95

9. To check alignment of injection pump, remove the JDE81-4 Timing Pin from the flywheel. Rotate the flywheel 1-1/2 revolutions in direction of normal rotation. Replace the timing pin and continue rotating 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. Install timing hole plug.

10. Tighten drive hub cap screws to 47 N·m (35 lb-ft) on A-Series Pumps and 61 N·m (45 lb-ft) on P-Series Pumps.

11. Remove JDG886 Timing Pin (A) from injection pump hub. Install timing hole plug using LOCTITE 242 (TY9370) Thread Lock and Sealer, tighten plug securely.

NOTE: Engine Serial No. (053817—), apply LOCTITE 242 Thread Lock and Sealer to the lower two cap screws, before securing cover plate, to prevent oil leakage.

12. Install injection pump gear cover with new gasket and tighten cap screws to 47 N·m (35 lb-ft).

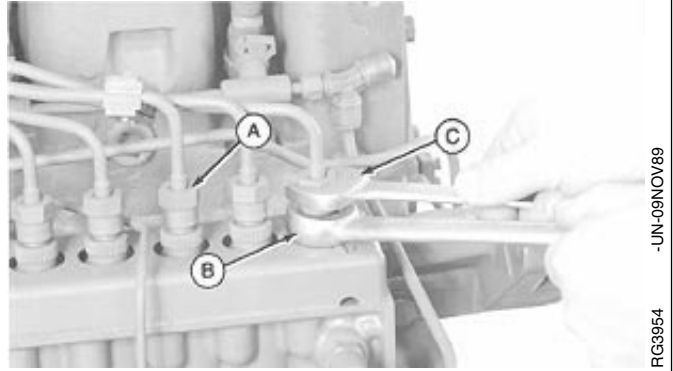
Fuel System/Install Fuel Injection Pump

13. Remove protective caps and plugs from injection lines.

14. Connect the fuel delivery lines (A) using the JDE90 Wrench (B) and the JDF22 Wrench (C).

NOTE: Do not move delivery valve fittings while tightening the line nuts. To do so may cause pump timing to be off.

15. Tighten line nuts to 27 N·m (20 lb-ft).



S11,3010,AD -19-25JAN96

RG3954
-UN-09NOV89

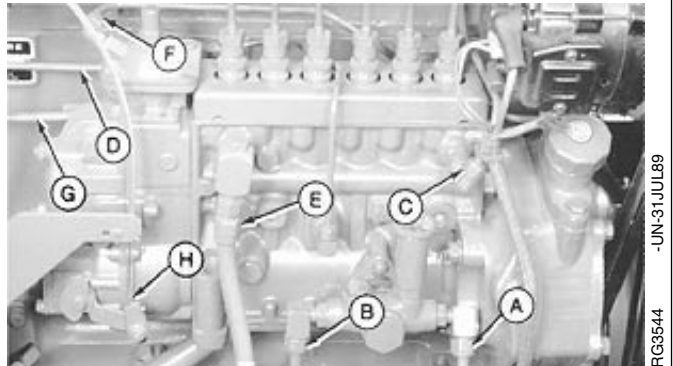
16. Install lines (A), (B), and (C).

17. Install lubrication line (D) fuel inlet line (E) and aneroid-to-intake manifold line (F), if equipped.

18. Connect the speed control rod (G) and fuel shut-off cable (H).

19. Tighten all connections securely.

- A—Inlet Line
- B—Outlet Line
- C—Leak-Off Line
- D—Lubrication Line
- E—Fuel Inlet Line
- F—Aneroid-to-Intake Line
- G—Speed Control Rod
- H—Fuel Shut-Off Cable



S11,3010,PJ -19-25JAN96

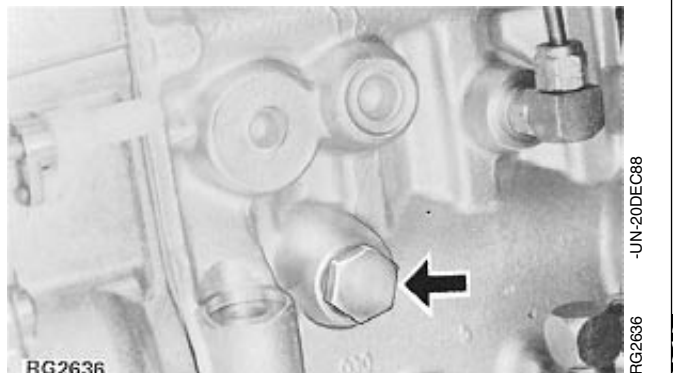
RG3544
-UN-31JUL89

IMPORTANT: Oil fill locations may vary by injection pump locations. Familiarize yourself with the location on your engine before adding oil.

20. Remove oil filler cap (arrow) and pour 0.47 L (3/4 U.S. pint) or enough clean engine oil into pump to bring oil level up to full.

21. Adjust engine speed. (See CHECK AND ADJUST FAST IDLE SPEED and CHECK AND ADJUST SLOW IDLE SPEED in Group 115.)

22. Bleed the fuel system. (See BLEED FUEL SYSTEM in group 115.)



S11,3010,PK -19-25JAN96

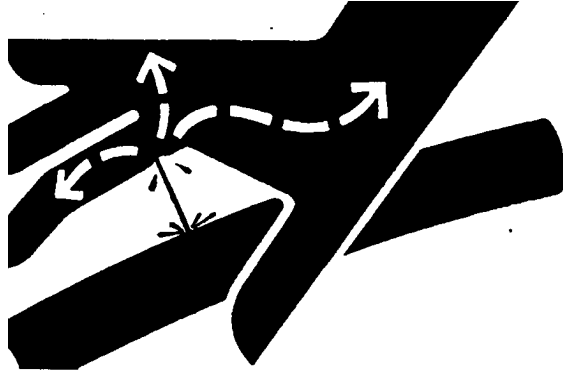
RG2636
-UN-20DEC88

REMOVE FUEL INJECTION NOZZLES

IMPORTANT: Plug or cap all lines and hoses as they are disconnected.

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.



-UN-23AUG88
X9811

S11,0408,AH -19-20JUL95

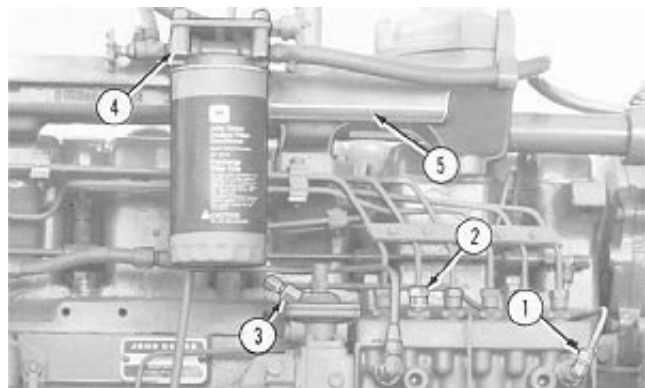
1. Remove coolant filter conditioner (4), if equipped. (See REMOVE COOLANT FILTER CONDITIONER—WATER MANIFOLD MOUNTED in Group 25.)

2. Thoroughly clean area around the injection pump and nozzles, including all line connections, using compressed air.

3. Remove the leak-off line (1) and intake manifold-to-aneroid pipe (3), if equipped.

4. Remove the fuel delivery line connections (2) at injection pump using JDE-90 Wrench and the JDF-22 Wrench as described earlier in this group. (See REMOVE FUEL INJECTION PUMP in this group.)

5. Remove water manifold. (See REMOVE WATER MANIFOLD in Group 25.)



- 1—Leak-Off Line
- 2—Fuel Delivery Line
Line Connections
- 3—Intake Manifold-
to-Aneroid Pipe
- 4—Coolant Filter
Conditioner Assembly
- 5—Water Manifold

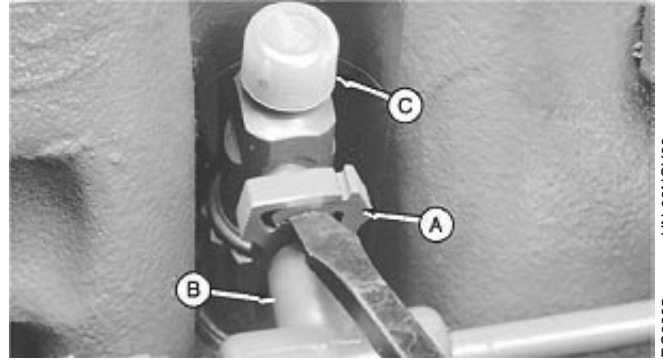
-UN-17JUL89
RG3072

S11,3010,PO -19-20JUL95

Fuel System/Remove Fuel Injection Nozzles

6. Engine Serial No. (—050291), remove fuel delivery line connections (shown removed). Cap or plug (C) all fuel injection nozzles.

7. Use a screwdriver or other suitable tool to pry leak-off clamp (A) from leak-off line (B). Remove fuel leak-off assembly.



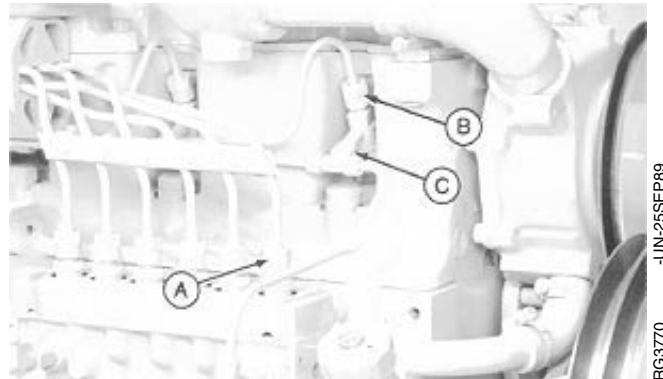
S11,3010,PP -19-20JUL95

RG3885 -UN-09NOV89

NOTE: Engine Serial No. (050292—), all metal fuel leak-off lines were used in production.

8. Engine Serial No. (050292—), disconnect fuel delivery line connections (A) and (B), at nozzles and injection pump, if not previously removed. Cap or plug all fuel injection nozzles.

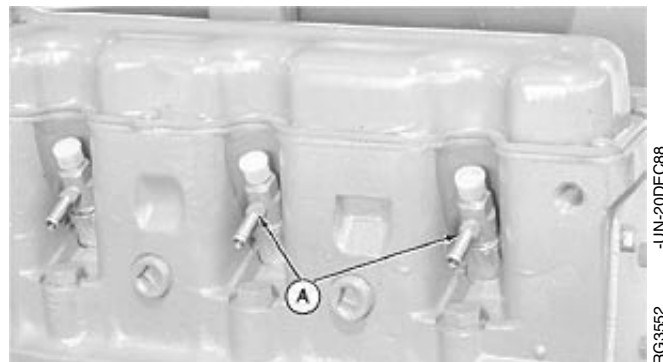
9. Disconnect all fuel leak-off connections (C). Remove fuel leak-off assembly. Cap or plug all fuel injection openings.



S11,3010,PQ -19-20JUL95

RG3770 -UN-25SEP89

10. Remove leak-off connectors (A) with washers.



S11,3010,PR, -19-20JUL95

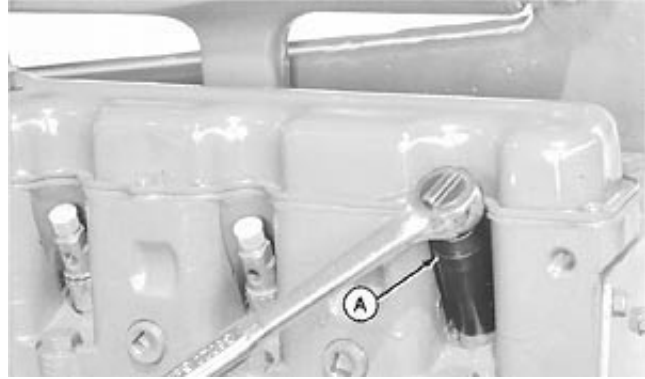
RG3552 -UN-20DEC88

Fuel System/Remove Fuel Injection Nozzles

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.



RC3886 -JUN-20DEC88

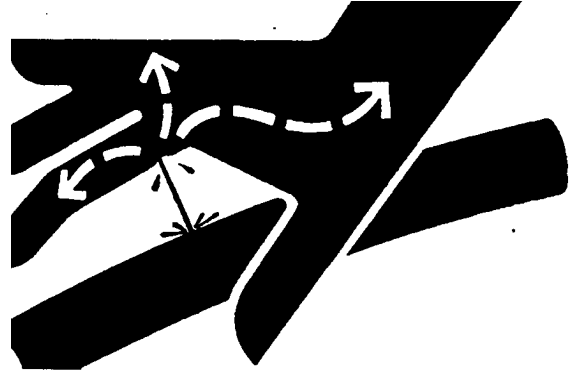
S11,3010,PR,1 -19-20JUL95

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



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. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

X9811
-JUN-23AUG88

S11,0408,AL -19-20JUL95

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PERFORM OPENING PRESSURE TEST

IMPORTANT: Nozzle tester should be checked periodically for accuracy.

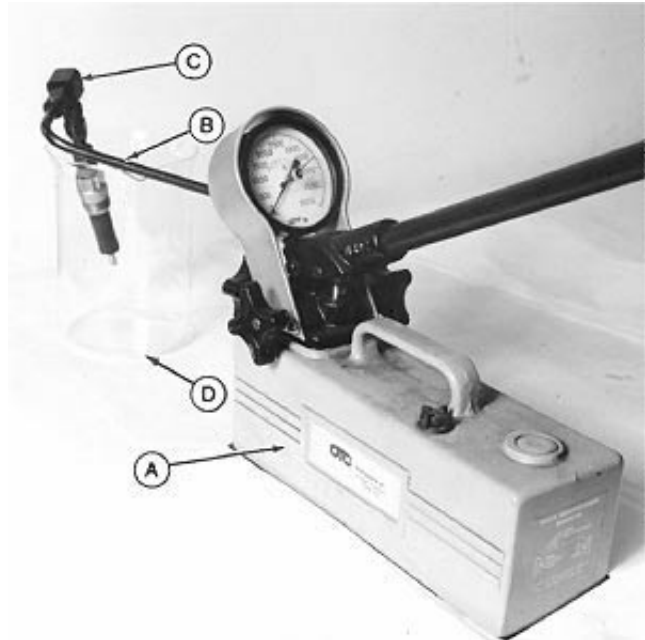
1. Connect KDEL injection nozzle to D01109AA (Y900) Nozzle Tester (A), using 36352 (Y900-2A) Fuel Line (B) and 23623 (Y900-7) and 23693 (Y900-15) Straight Adapters (C). The 208369 (Y900-21) 90° Adapter may also be used.

CAUTION: To avoid personal injuries, place a glass beaker (D) around nozzle during opening pressure test.

2. Pump handle several times to flush out nozzle fittings. Tighten fittings.

3. Expel air from nozzle by operating pump handle several strokes. Then raise pressure until valve opens.

4. Recheck by completely releasing pressure, then gradually building pressure until valve opens.



A—Nozzle Tester
B—Fuel Line
C—Adapter
D—Beaker

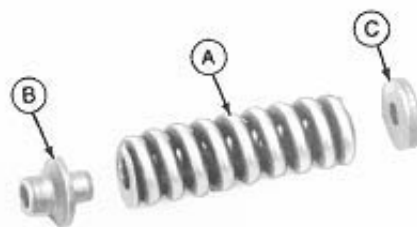
S11,3010,PS -19-20JUL95

RG5883 -UN-19AUG91

A new nozzle or a used nozzle that has been rebuilt with a new spring and/or valve should open at the following pressures:

New Nozzle Opening Pressures

4 x 0.36 mm	29400 kPa (294 bar) (4250 psi)
4 x 0.40 mm	27900 kPa (279 bar) (4050 psi)
6 x 0.285 mm	29400 kPa (294 bar) (4250 psi)



-JUN-20DEC88
RG3410

On nozzles which have been in service, the spring (A) and spring seat (B) will have taken a normal seat. Opening pressure should not exceed new opening pressures, but should be at least as follows:

Used Nozzle Opening Pressures

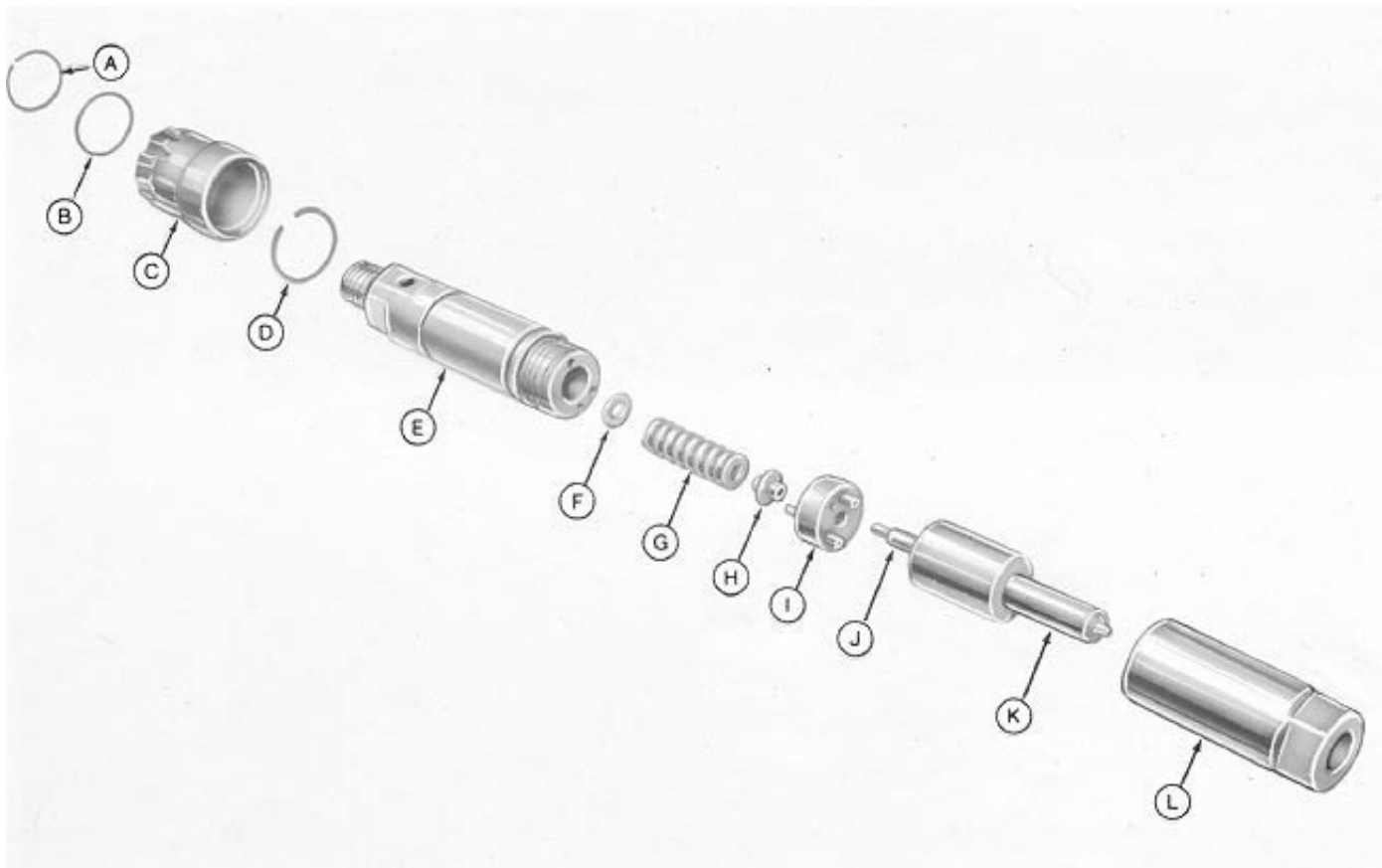
4 x 0.36 mm	26200 kPa (262 bar) (3800 psi)
4 x 0.40 mm	26200 kPa (262 bar) (3800 psi)
6 x 0.285 mm	26200 kPa (262 bar) (3800 psi)

Shims (C) are available for changing the opening pressure. Each 0.05 mm (0.002 in.) shim changes the opening pressure approximately 700 kPa (7 bar) (100 psi).

IMPORTANT: Always use John Deere nozzle adjusting shims which are specially hardened. Other shims will not be satisfactory.

If the opening pressure is not correct, disassemble the injection nozzle (as described in this group) and change shims until nozzle opens at the proper used nozzle pressure given above. The difference in nozzle opening pressure in any one cylinder of the engine should not exceed 350 kPa (3.5 bar) (50 psi).

TEST NOZZLE LEAKAGE



FG2591 JUN-16FEB94

A—Snap Ring (Bosch Only)
B—Gland Nut O-Ring
C—Gland Nut

D—Snap Ring (Bosch Only)
E—Nozzle Holder
F—Shim

G—Nozzle Valve Spring
H—Spring Seat
I—Intermediate Plate

J—Nozzle Valve
K—Nozzle
L—Nozzle Retaining Nut

1. Wipe nozzle dry.

2. Bring pressure up slowly to 1970 kPa (20 bar) (285 psi) below the opening pressure. Watch for an accumulation of fuel from the spray orifice, indicating a bad seat.

If the nozzle drips within 10 seconds, replace nozzle valve (J) and nozzle (K).

3. Check for leakage around nozzle retaining nut (L) thread connection with nozzle holder (E).

Leakage indicates a bad seat either between nozzle and intermediate plate (I) or between nozzle holder and intermediate plate.

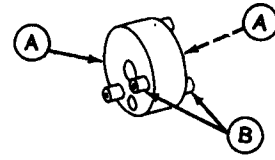
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IMPORTANT: Do not lap the machined surfaces (A) of the intermediate plate in an attempt to stop fuel leakage at these locations. Dowels (spring pins) (B) in plate have to be removed before surfaces can be lapped. Removing dowels is not recommended as removal is likely to damage them, and replacement dowels are not available as service parts.

RG2248

-UN-20APR89

RG2248



If leakage is observed, tighten nozzle retaining nut to a maximum of 88 N·m (65 lb-ft). Replace injection nozzle if leakage continues.

S11,0408,AP -19-20JUL95

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.

S11,0408,AQ -19-20JUL95

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DISASSEMBLE FUEL INJECTION NOZZLE

General Nozzle Repair Notes:

NOTE: Disassembly of nozzles is not recommended unless servicing is indicated by nozzle operation and testing.

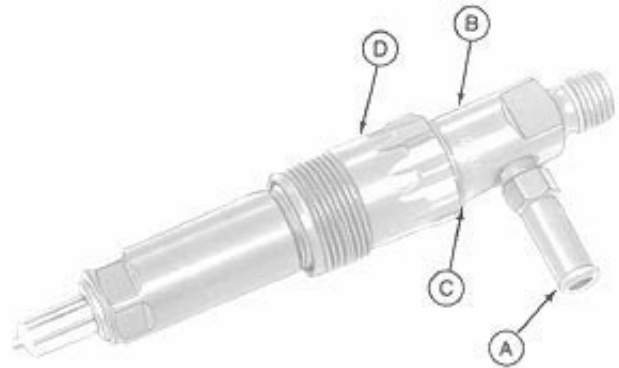
- Since dirt and water are the worst contaminants in fuel injection system, working area, tools and cleaning materials must be kept spotlessly clean. Whenever possible, work in an isolated, dust-free area.
- Cover workbench with clean paper before disassembly of injection nozzles.
- As parts are disassembled, 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

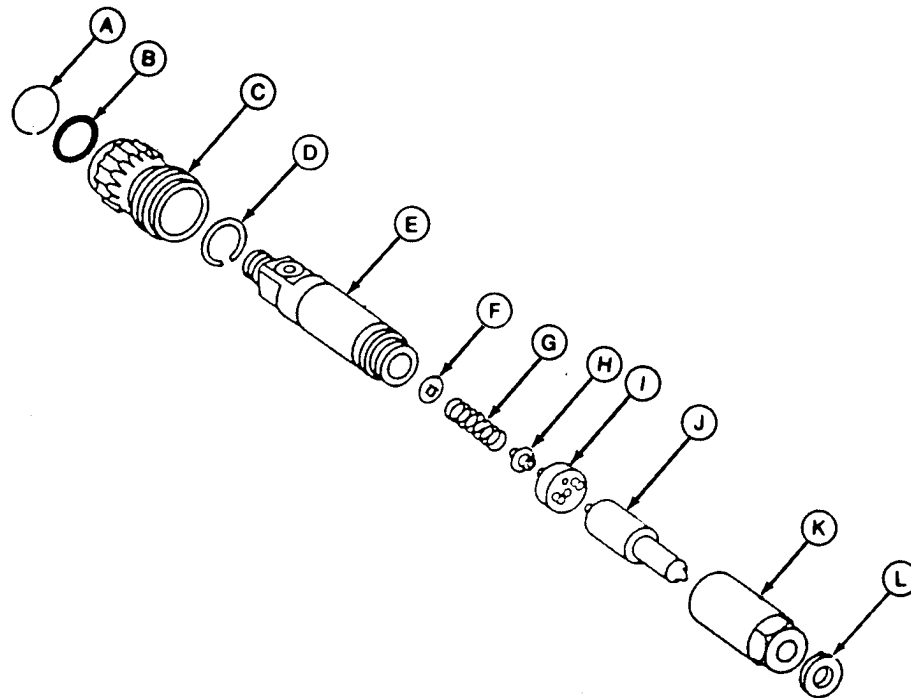


-UN-20DEC88

RG3887

S11,0408,AS -19-08APR94

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38



RG6184 -UN-24FEB92

A—Snap Ring (Bosch only)
B—Gland Nut O-Ring
C—Gland Nut

D—Snap Ring (Bosch only)
E—Nozzle Holder
F—Shim

G—Nozzle Valve Spring
H—Spring Seat
I—Intermediate Plate

J—Nozzle
K—Nozzle Retaining Nut
L—Washer

4. Remove lower snap ring (D).
5. Clamp the two flats of the nozzle holder (fuel inlet end) in a soft-jawed vise and remove nozzle retaining nut (K), using a 12-point 19 mm wrench.
6. Remove nozzle assembly (J and K).
7. Pull off intermediate plate (I).
8. Remove spring seat (H), spring (G), and shims (F).

9. Withdraw nozzle valve from nozzle. If valve is stuck, it may be necessary to soak nozzle assembly in Bendix cleaner, acetone, or other commercial cleaners sold especially for freeing stuck valves.

⚠ CAUTION: Use these nozzle cleaning fluids in accordance with manufacturer's instructions.

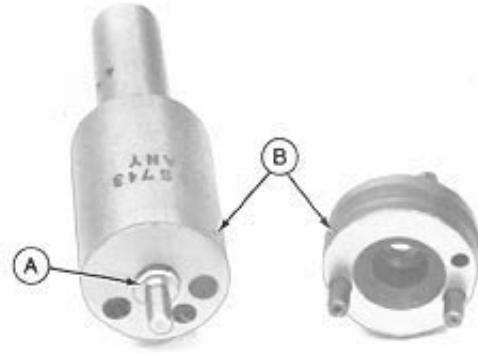
Do not permit lapped surfaces of valve and nozzle to come in contact with any hard substance. DO NOT touch valve unless your hands are wet with fuel.

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

PERFORM NOZZLE SLIDE TEST

NOTE: DO NOT touch lapped surface (D) unless hands are wet with diesel fuel.

1. Dip nozzle valve (A) in clean diesel fuel.
2. Insert valve in nozzle (B).
3. Hold nozzle vertical and pull valve out about one-third of its engaged length.
4. Release valve. Valve should slide down (C) to its seat by its own weight. Always replace a nozzle assembly if the valve does not fall freely to its seat.

A—Nozzle Valve
 B—Nozzle
 C—Free-Fall Distance
 D—Lapped Surface



S11,3010,CZ -19-20JUL95

RG5953 -UN-30AUG91

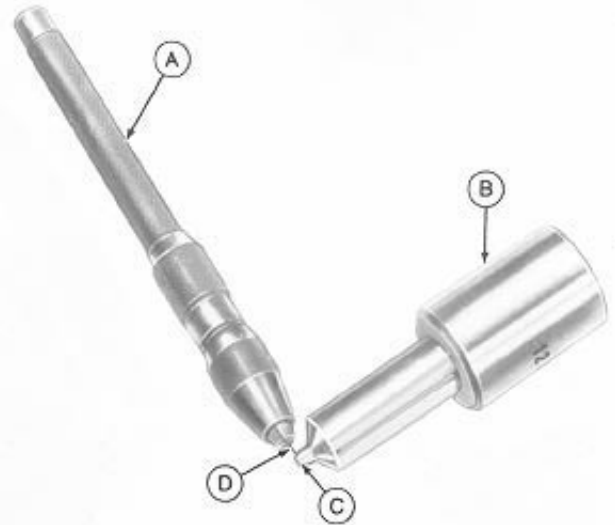
CLEAN SPRAY ORIFICES

1. Begin with a cleaning wire (D) 0.07—0.10 mm (0.003—0.004 in.) smaller than nominal orifice size of 0.33 mm (0.13 in.) from JDF13 (JDE105) Nozzle Cleaning Kit.

NOTE: Stoning wire to provide a flat surface on one side will help in reaming carbon from clogged hole.

2. Clamp cleaning wire in pin vise (A). Wire should not protrude from vise more than 0.8 mm (0.03 in.).
3. Insert wire into orifice (C) and rotate.
4. For final cleaning, use a cleaning wire 0.03 mm (0.001 in.) smaller than orifice size. Follow previous steps until orifices are clean of any carbon deposits.

A—Pin Vise
 B—Nozzle
 C—Orifice
 D—Cleaning Wire

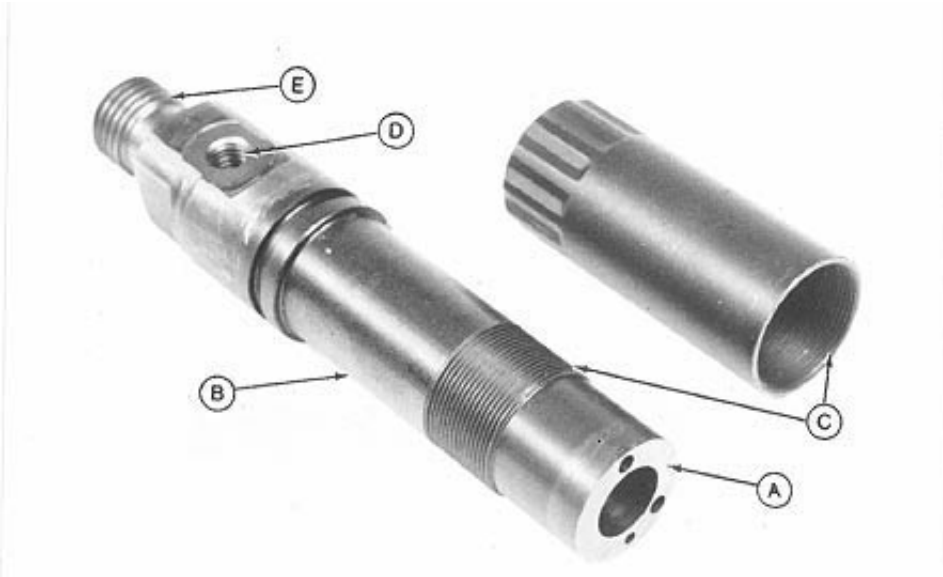


S11,3010,DA -19-20JUL95

RG3412 -UN-20DEC88

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41

INSPECT NOZZLE HOLDER



RG5959 -UN-30AUG91

A—Lapped Surface
B—Nozzle Holder

C—M19 x 1

D—M6 x 1

E—M14 x 1.5

1. Inspect lapped surface (A) on bottom end of nozzle holder (B) for nicks or scratches. Replace holder if not in good condition.

2. Inspect threads M19 x 1 (C), M6 x 1 (D), and M14 x 1.5 (E) on nozzle holder for general condition. Threads that are nicked slightly may be “dressed-up.” Replace holder if threads cannot be restored to a serviceable condition.

Check fuel passages in nozzle holder to make sure they are open. Clean with compressed air.

3. Remove carbon deposits on both inner and outer surfaces of nozzle retaining nut.

4. Inspect retaining nut for cracks caused by overtightening or a damaged lower seating surface. A seat may be restored by rubbing the surface with emery cloth. Any nozzle nut which cannot be reconditioned must be replaced.

S11,3010,DB -19-20JUL95

5. Examine lapped surfaces on intermediate plate (A) for nicks, scratches, or worn areas which would permit fuel to leak past.

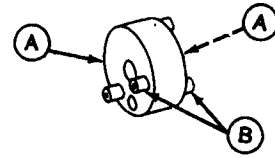
6. Replace intermediate plate if lapped surfaces are worn or damaged.

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 and is not removable for service.

9. Clean filter by applying compressed air to nozzle holder fuel passage (A) at nozzle end.



-UN-30AUG91

RG5962

S11,0408,BD -19-20JUL95

INSPECT GLAND NUT

1. Inspect nozzle holder gland nut to insure it is not cracked or split.

2. Inspect the M28 x 1.5 threads (A). Threads which are slightly nicked or damaged may be "dressed up."

Replace gland nut if unable to restore to a serviceable condition.



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-UN-30AUG91

RG5956

S11,0408,BF -19-20JUL95

3. Check passage in leak-off connector to see that it is open.
4. Blow through connector passage with compressed air.
5. Inspect M6 x 1 threads (A). Replace connector if threads are damaged and can not be restored to a serviceable condition.



S11,0408,BG -19-20JUL95

RG5886 -UN-19AUG91

ASSEMBLE FUEL INJECTION NOZZLE

IMPORTANT: Be sure to install correct nozzle assembly on nozzle holder. Do not intermix different size nozzle assemblies.

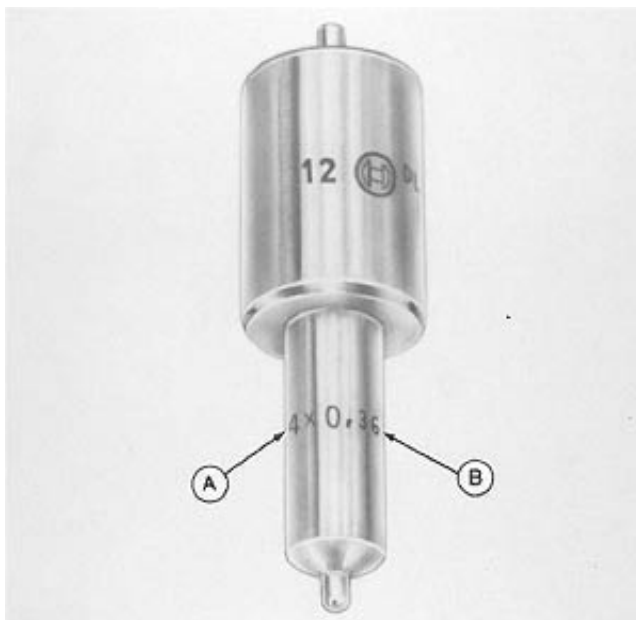
To help determine the right nozzle assembly for each application, note that markings appear on the lower part of the nozzle.

The illustration shows a nozzle marked 4 x 0.36. The number "4" (A) indicates the number of orifices and "0.36" (B) indicates the orifice size in millimeters.

The 6619 Engine will have one of the following nozzle sizes:

- 4 x 0.36
- 4 x 0.40
- 6 x 0.285

IMPORTANT: Immerse parts in clean fuel before assembly and throughout assembly process. Do not dry parts with towels or compressed air. Dust particles might collect and stay on pressure faces of nozzle valve and nozzle holder.



S11,3010,PU -19-20JUL95

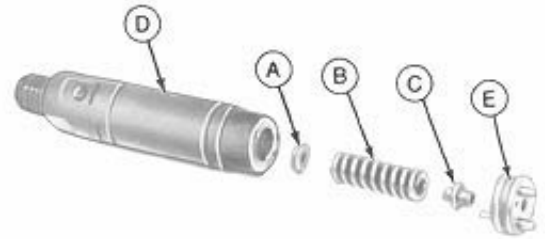
R28734 -UN-20DEC88

Fuel System/Assemble Fuel Injection Nozzle

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



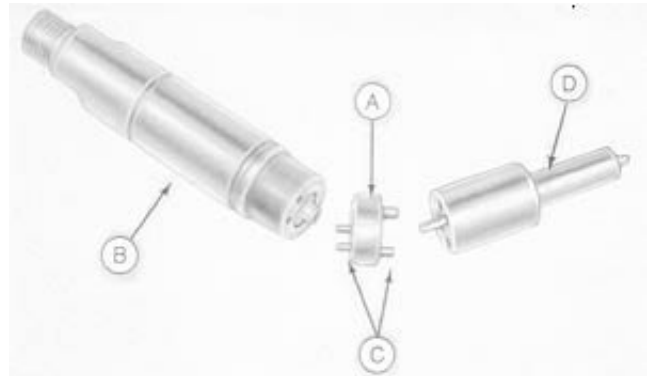
RG3415 -UN-20DEC88

S11,3010,DF -19-20JUL95

NOTE: Make sure intermediate plate (A) is clean before installing.

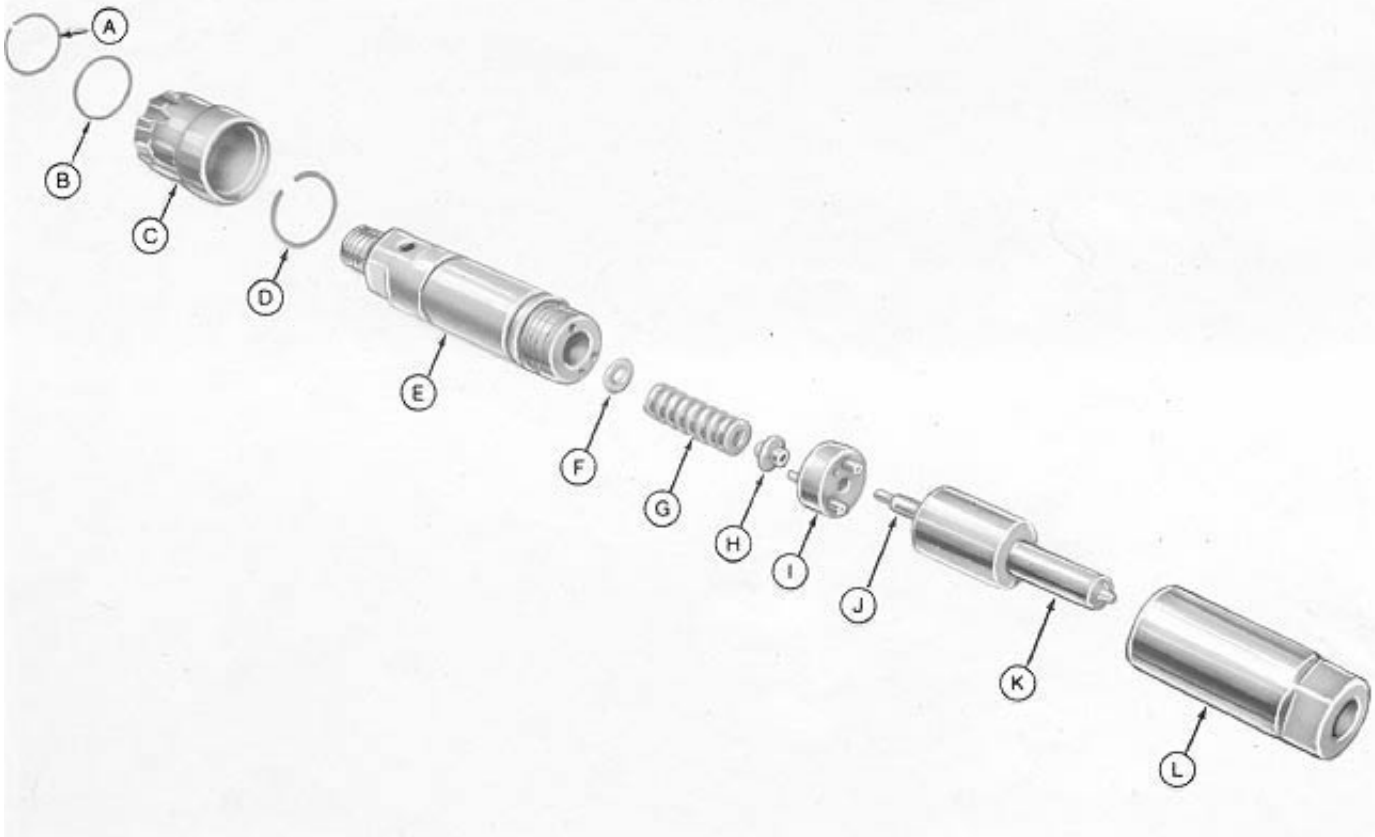
2. Position intermediate plate (A) on nozzle holder (B). Dowel pins (C) in plate will permit installation only one way.
3. Insert nozzle valve into nozzle (D) while holding parts below diesel fuel level in pan.

- A—Intermediate Plate
- B—Nozzle Holder
- C—Dowel Pins
- D—Nozzle and Valve



RG2254 -UN-29NOV88

S11,3010,DG -19-20JUL95



JUN-16FEB94
FC2591

- | | | | |
|--------------------------|--------------------------|-----------------------|------------------------|
| A—Snap Ring (Bosch Only) | D—Snap Ring (Bosch Only) | G—Nozzle Valve Spring | J—Nozzle Valve |
| B—Gland Nut O-Ring | E—Nozzle Holder | H—Spring Seat | K—Nozzle |
| C—Gland Nut | F—Shim | I—Intermediate Plate | 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) 88 N·m (65 lb-ft).
6. On Robert Bosch nozzle: 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. On Robert Bosch nozzle: Install upper snap ring (A) on nozzle holder.

9. Position O-ring (B) against gland nut.

NOTE: For engines Serial No. (—312216), a washer is used between leak-off connector and nozzle holder. For engines Serial No. (312217—), an O-ring is used in place of the washer.

BRK:

10. 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.

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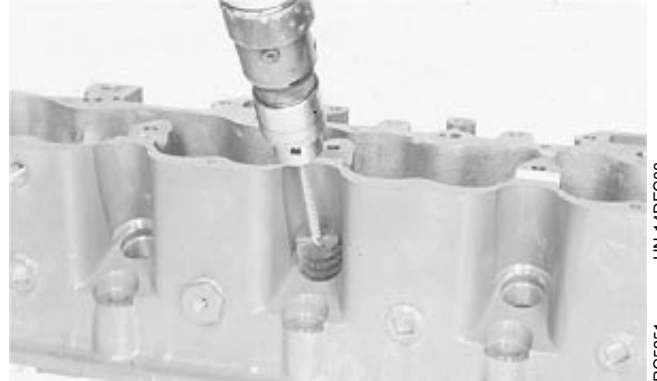
INSPECT AND CLEAN CYLINDER HEAD NOZZLE BORE

1. Inspect condition of threads for gland nut. Threads are metric (M28 X 1.5).
2. Inspect condition of nozzle seating surface in cylinder head.

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

IMPORTANT: If 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.



RG5251 -UN-14DEC88

S11,0408,BL -19-17AUG94

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

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

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



R28263N -UN-20DEC88

S11,0408,BM -19-20JUL95

INSPECT AND CLEAN NOZZLE SEATING SURFACE

1. Inspect nozzle seating surface for carbon deposits.
2. If seat is not clean, use JDE99 or JDG609 Nozzle Seat Reamer to remove carbon. Stop using tool when seat comes clean.
3. Insert a 13 mm (1/2 in.) tapered hardwood dowel to plug nozzle tip bore.
4. Blow out debris with compressed air, then remove wood dowel.



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.



S11,0408,BO -19-10AUG94

Fuel System/Install Fuel Injection Nozzle

2. Install a new R64840 special steel washer (1) on tip end of injection nozzle.



RG2856 -UN-23FEB89

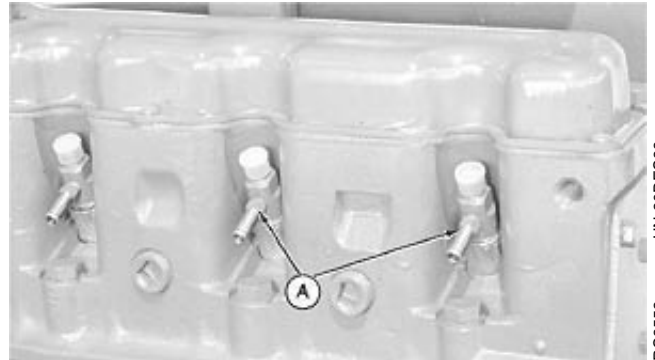
S11,0408,BP -19-20JUL95

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.



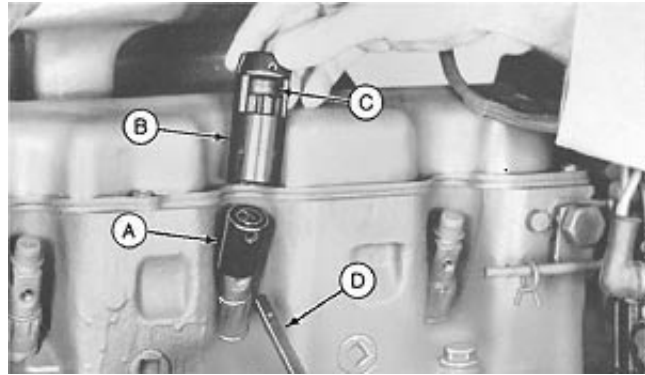
RG3552 -UN-20DEC88

S11,0408,BQ -19-08APR94

Fuel System/Install Fuel Injection Nozzle

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.



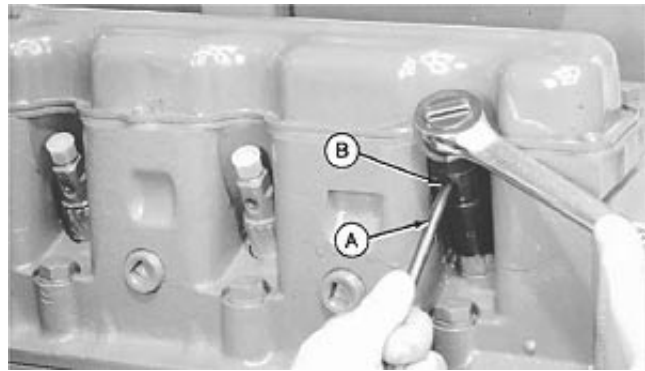
A—Inner Socket
B—Outer Socket
C—Window
D—Handle

S11,0413,X -19-08APR94

10. Tighten injection nozzle gland nut to 82 N·m (60 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.

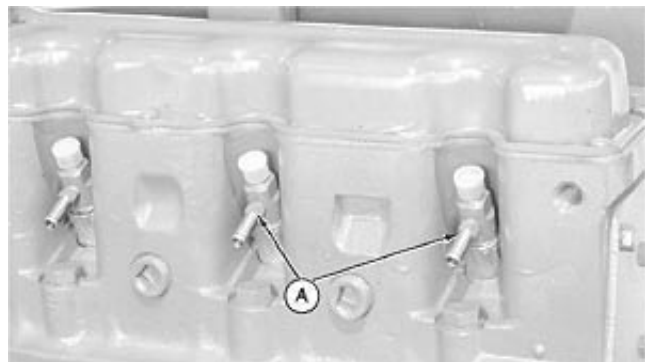


S11,0408,BS -19-20JUL95

NOTE: Engine Serial No. (—312216) use washers between leak-off connectors and nozzle holders. 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.

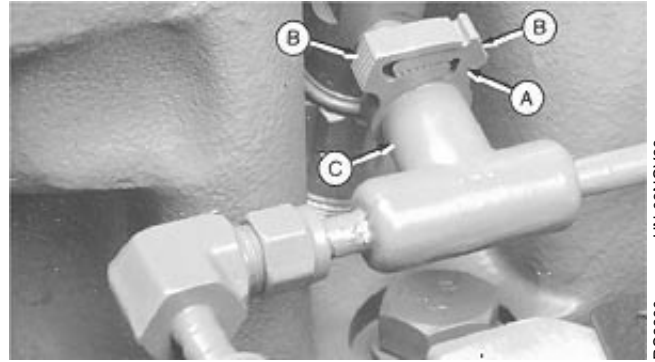


S11,0408,BT -19-20JUL95

INSTALL FUEL LEAK-OFF LINE ASSEMBLY AND FUEL DELIVERY LINES (ENGINE SERIAL NO. —050290)

1. Install molded rubber leak-off line assembly onto all six nozzle leak-off connectors.
2. Install fuel leak-off line clamp (A) over rubber leak-off line (C). Snug line tight against nozzle.
3. 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.



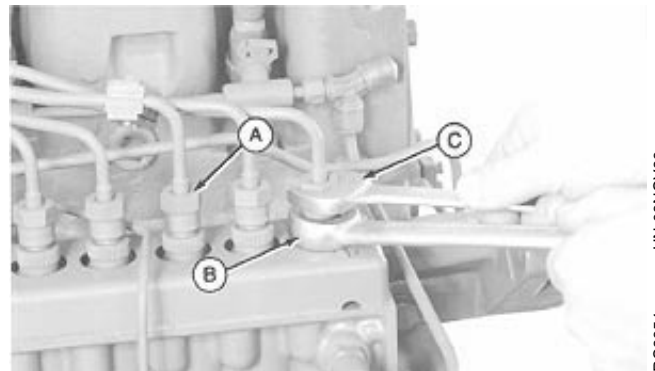
RG3980 -UN-09NOV89

S11,3010,PV -19-20JUL95

4. Remove protective caps and plugs from injection lines and nozzles.
5. Install fuel injection line assembly and connect the fuel delivery lines (A) using the JDE90 Wrench (B) and the JDF22 Wrench (C).

IMPORTANT: Do not move delivery valve fittings while tightening the line nuts. To do so may cause pump timing to be off, requiring calibration on a test bench.

6. Tighten line nuts (at pump and at nozzles) to 27 N·m (20 lb-ft).
7. Install leak-off line to injection pump and tighten connections securely.
8. Install intake manifold-to-aneroid pipe (if equipped). Tighten connection securely.



RG3954 -UN-09NOV89

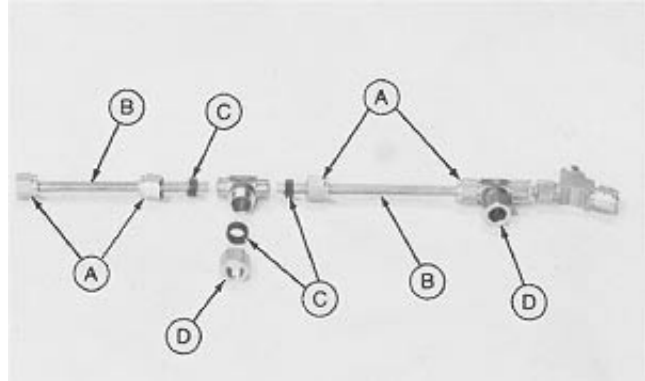
S11,3010,PW -19-20JUL95

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51

INSTALL FUEL LEAK-OFF LINE ASSEMBLY AND FUEL DELIVERY LINES (ENGINE SERIAL NO. 050291—) AND ALL 6619AR-11, 12, 14

NOTE: Mark each leak-off pipe before disassembly to ensure assembly in correct location.

1. Before installing the all-metal leak-off line, loosen all fittings (A), remove pipes (B), and inspect all packings (C). Discard any packings that are worn or slit.
2. Check all pipes and fittings for wear or damage and replace as necessary.
3. Reinstall new packings (if needed), and pipes into tee-fittings. Tighten all connections securely.
4. Install nuts (D) and packings onto leak-off connectors. Install complete assembly over appropriate leak-off line connectors.



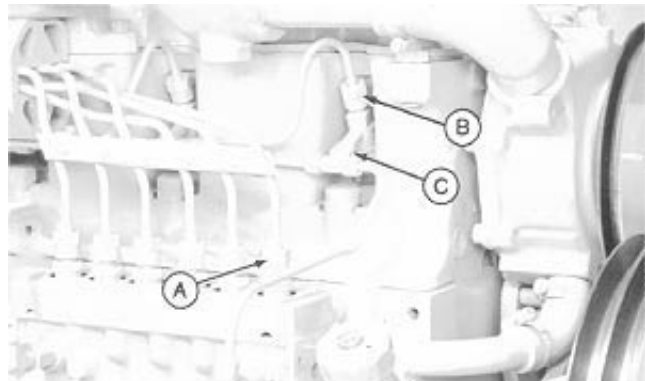
**A—Line Nuts
B—Leak-Off Pipes
C—Packings
D—Leak-Off Connector Nuts**

S11,3010,PX -19-20JUL95

5. Tighten all leak-off line connections securely.
6. Push leak-off assembly against nozzle and tighten connection (C) securely.
7. Install leak-off line to injection pump and tighten connections securely.

IMPORTANT: Do not move delivery valve fittings while tightening the line nuts. To do so may cause pump timing to be off, requiring calibration on a test bench.

8. Install fuel delivery lines using the JDF22 Wrench and JDE90 Wrench. Tighten line nuts (A) and (B) to 27 N·m (20 lb-ft).
9. Install intake manifold-to-aneroid pipe (if equipped). Tighten connections securely.



S11,3010,PY -19-20JUL95

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COMPLETE FINAL ASSEMBLY

1. Install water manifold and all water piping. Tighten connections securely. (See **INSTALL WATER MANIFOLD** in Group 25.)
2. Install coolant filter conditioner, if equipped. (See **INSTALL COOLANT FILTER CONDITIONER—WATER MANIFOLD MOUNTED** in Group 25.)
3. Bleed the fuel system. (See **BLEED FUEL SYSTEM** in this group.)

S11,3010,PZ -19-20JUL95

**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.*

PRELIMINARY ENGINE TESTING

Before tuning-up an engine, determine if a tune-up will restore operating efficiency. If in doubt, the following preliminary tests will help determine if the engine can be tuned-up. Choose from the following procedures only those necessary to restore the unit.

1. After engine has stopped for several hours, loosen crankcase drain plug and watch for any water to seep out. A few drops could be due to condensation, but any more than this would indicate problems which require engine repairs rather than just a tune-up.
2. With engine stopped, inspect engine coolant for oil film. With engine running, inspect coolant for air bubbles. Either condition would indicate problems which require engine repairs rather than just a tune-up.
3. Perform a dynamometer test and record power output. (See DYNAMOMETER TEST later in this group.) Repeat dynamometer test after tune-up. Compare power output before and after tune-up.
4. Perform compression test (See TEST ENGINE COMPRESSION PRESSURE in Group 105).

S11,22010,BW -19-25JUL95

GENERAL TUNE-UP RECOMMENDATIONS

The following services are recommended each time a tune-up is performed. Disregard those services that do not apply to any particular application.

Recommended Service	Detailed Reference
Change engine oil and filters.	Operator's Manual
Lubricate PTO clutch internal levers and linkage.	Operator's Manual
Replace fuel filter.	Group 35
Clean crankcase vent tube.	This Group
Check air intake system. Replace air cleaner elements.	This Group/Operator's Manual
Check exhaust system.	This Group
Check and service engine cooling system.	This Group/Operator's Manual
Check electrical system.	This Group
Check crankshaft vibration damper.	Group 15
Inspect turbocharger and check intake manifold pressure.	Group 110
Check fuel injection system: Check engine/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 16
Check engine speeds. Adjust if necessary.	Group 115
Check engine performance on dynamometer.	Group 105

S11,22010,DB -19-25JAN96

DYNAMOMETER TEST

NOTE: Specifications given below apply to OEM applications only. For machine applications, consult the appropriate machine technical manual.

If possible, test the engine on a dynamometer before it is tuned-up. This test gives the horsepower output and fuel consumption of the engine as it is. This will help determine if a tune-up can restore the engine or whether an overhaul is needed.

Good performance by the engine depends on these basic things:

- An adequate supply of clean air and fuel.
- Good compression.
- Proper valve and injection pump timing for good combustion.
- Proper air and fuel temperatures.
- Proper fuel setting for elevation at which engine is operating. (See Group 100.)

Make the dynamometer test as follows:

1. Connect the engine to the dynamometer using the manufacturer's instructions.
2. Operate the engine at one-half load until the coolant and crankcase oil temperatures are up to normal.
3. Run engine at fast idle.
4. Gradually increase the load on the engine until its speed is reduced to full load rpm.
5. Read the power rating on the dynamometer.
6. Compare the reading taken with the following chart.

Governor Regulation	Slow Idle (RPM)	Fast Idle (RPM)	Full Load (RPM)	Injection Pump Part No.	Power Rating KW (HP)*
8—10% (Std.) Gov.	800	2300	2100	AR76759	209 (280)
8—10% (Std.) Gov.	800	2300	2100	AR93102	207 (276)
8—10% (Std.) Gov.	800	2300	2100	RE13572	204 (272)
8—10% (Std.) Gov.	800	2300	2100	RE18151	217 (290)
8—10% (Std.) Gov.	800	2300	2100	RE77761	209 (280)
3—5% Gov.	800	1870	1800	AR88927	178 (238)
3—5% Gov.	800	1870	1800	RE18153	230 (308)

*Average power rating given, allow $\pm 5\%$ for maximum and minimum power.

ENGINE BREAK-IN GUIDELINES

Engine break-in should be performed when the following repairs have been made:

- Main bearings, rod bearings, crankshaft, or any combination of these parts have been replaced.
- Pistons, rings, or liners have been replaced.

RG,CTM61,G105,2-19-17NOV95

ENGINE BREAK-IN INSTRUCTIONS

Use a dynamometer to perform the following preliminary break-in procedure. If necessary, preliminary engine break-in can be performed without a dynamometer if under controlled operating conditions.

IMPORTANT: DO NOT use TORQ-GARD SUPREME PLUS-50™ Engine Oil during break-in period of an engine that has had a major overhaul. TORQ-GARD SUPREME PLUS-50 oil will not allow an overhauled engine to properly wear during the break-in period.

Do not add makeup oil until the oil level is BELOW the add mark. John Deere Break-In Oil should be used to make up any oil consumed during break-in period.

1. Fill engine crankcase to proper level with John Deere Break-In Oil during break-in operation. This oil is specifically formulated to enhance break-in of John Deere diesel engines.

IMPORTANT: During preliminary break-in, periodically check engine oil pressure and coolant temperature. Also check for signs of fuel, oil, or coolant leaks.

2. Start engine, run at loads and speeds shown in following chart for time limits given.

PRELIMINARY ENGINE BREAK-IN AFTER MAJOR OVERHAUL

Time	Load	Engine Speed
1 Minute	No Load	850 rpm
2 Minutes	No Load	Fast Idle
15 Minutes	1/2—3/4 Load	2000 rpm to rated
10 Minutes	Full Load	Rated speed

3. After preliminary break-in, run engine 1—2 minutes at 1500 rpm, with no load before shut-down.

4. Check and readjust valve clearance as necessary. Cylinder head retorque is not required.

5. Operate the engine at heavy loads with minimal idling during the break-in period.

If the engine has significant operating time at idle, constant speeds, and/or light load usage, an additional 100 hour break-in period is recommended using a new change of John Deere Engine Break-In Oil and new John Deere oil filter.

As a general rule, makeup oil should not need to be added during 100-hour break-in period. However, if makeup oil is required in the first 100-hour break-in, an additional 100-hour break-in period is required. Use a new change of John Deere Engine Break-In Oil and a new John Deere oil filter.

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. (See INSPECT VENTILATOR ASSEMBLY in Group 05.)

S11,22010,DD -19-25JUL95

CHECK AIR INTAKE SYSTEM

1. Replace air cleaner primary and secondary filter elements.
2. Check condition of air intake hose(s) between air cleaner and turbocharger. Replace any hose that is cracked, split, or otherwise in poor condition.
3. Check hose clamps for tightness. Replace any clamp that cannot be properly tightened. This will help prevent dust from entering the air intake system which could cause serious engine damage.

S11,22010,DE -19-25JUL95

CHECK EXHAUST SYSTEM

1. Inspect exhaust system for leaks or restrictions. Check manifold for cracks. Repair or replace as necessary.
 2. Check turbocharger-to-exhaust elbow adapter to make sure it has adequate end play and rotates freely. Check clamps to ensure they are secure and do not leak.
- Oil in exhaust stack may be caused by excessive valve stem-to-guide clearance or excessive light load engine idling.

S11,22010,DF -19-25JUL95

CHECK AND SERVICE COOLING SYSTEM



-UN-23AUG88

TS281

-UN-23JUN85

RG7343

1. Visually inspect entire cooling system and all components for leaks or damage. Repair or replace as necessary.
2. Remove trash that has accumulated on or near radiator.
3. Inspect radiator hoses for signs of leakage or rot. Replace hoses as necessary.

CAUTION: Do not drain coolant until it has cooled below operating temperature. Always loosen block drain valve (arrow) slowly to relieve any excess pressure.

4. Drain coolant at drain valve (A), remove thermostats, and flush cooling system. (See REMOVE THERMOSTATS in Group 25.)
5. Test thermostat opening temperature. (See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE in Group 105.)

IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen plug in water manifold to allow air to escape when filling system. Retighten plug when cooling system is full and all air has been expelled.

NOTE: If a coolant conditioner filter is used on engine, do not add additional inhibitors during coolant change; install a new coolant filter element.

6. Fill cooling system with recommended concentration of coolant, clean soft water, and inhibitors. (See HEAVY-DUTY DIESEL ENGINE COOLANT in Group 02.)
7. Run engine until it reaches operating temperature. Check cooling system for leaks.
8. After engine cools, check coolant level.

NOTE: Coolant level should be approximately 19 mm (3/4 in.) below bottom of radiator filler neck.

9. Check system for holding pressure. (See TEST COOLING SYSTEM AND RADIATOR CAP in Group 105.)
10. Check condition of fan belt and replace if cracked, frayed or worn. Check belt tension. (See CHECK AND ADJUST V-BELT TENSION in Group 25.)

CHECK ELECTRICAL SYSTEM

⚠ CAUTION: Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

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

Always remove grounded (-) cable clamp from battery first and replace it last.



TS204 -UN-23AUG88

1. Clean batteries and cables with damp cloth. If corrosion is present, remove it and wash terminals with a solution of ammonia or baking soda in water. Then flush area with clean water.
2. Coat battery terminals and connectors with petroleum jelly mixed with baking soda to retard corrosion.
3. Test batteries. If batteries are not near full charge, try to find out why.
4. On low-maintenance batteries, check level of electrolyte in each cell of each battery. Level should be to bottom of filler neck. If water is needed, use clean, mineral-free water.

If water must be added to batteries more often than every 250 hours, alternator may be overcharging.

NOTE: Water cannot be added to maintenance-free batteries.

5. If batteries appear to be either undercharged or overcharged, check alternator and charging circuit. Follow diagnosis and testing procedures outlined in CTM77.
6. Check tension of fan belts. (See Engine Operator's Manual.)
7. Check operation of starting motor and gauges.

100
9

Tune-Up/Check and Service Cooling System

100
10

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

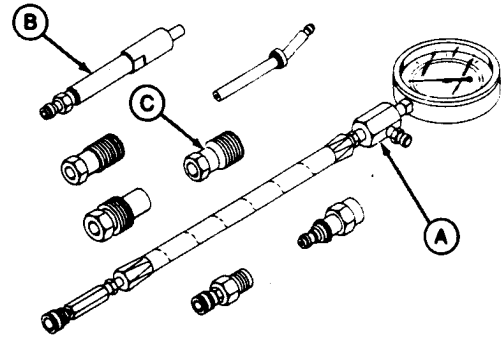
Compression Test Kit JT01674 (D14546BA)

A—Gauge and Hose Assembly JT01682 (D14547BA)

B—Nozzle Adapter JT01675A (D14557BA)

C—Adapter Nut JT01677

Used to test each cylinder's compression pressure.

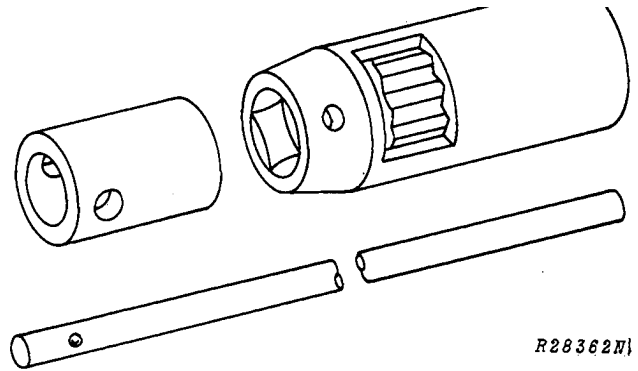


-UN-09AUG91
RG5784

RG, JT01674 -19-17SEP91

Nozzle Socket JDE92

Used to remove and install fuel injection nozzles.



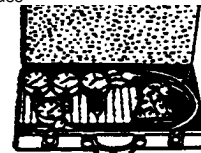
-UN-20DEC88
R28362N

S11,22005,R -19-16AUG94

Universal Pressure Test Kit JT05470 (D15027NU)

Used for testing engine oil pressure.

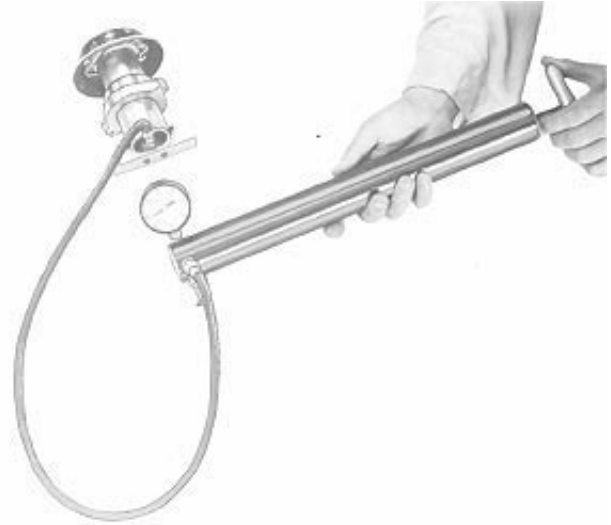
RG5162 -UN-23AUG88



S55,22005,B -19-17SEP91

Cooling System Pressure Pump D05104ST

Used to pressure test radiator cap and cooling system.



R26406N -UN-29NOV88

S55,22005,C -19-17SEP91

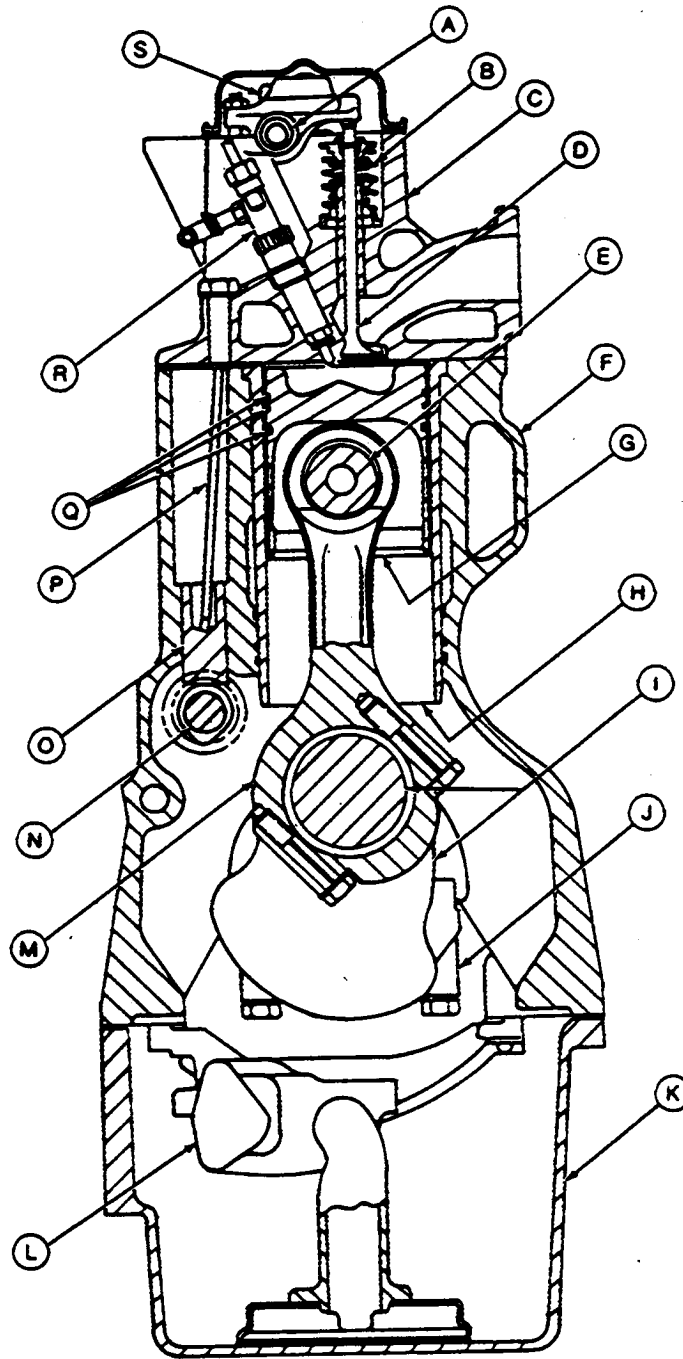
ENGINE TEST SPECIFICATIONS

Item	Specifications
Compression Pressure	
At 200—250 rpm cranking speed	2280—2620 kPa (22.8—26.2 bar) (330—380 psi)
Maximum difference between cylinders	340 kPa (3.4 bar) (50 psi)
Crankshaft End Play	
Engine Serial No. (032182—)	0.038—0.380 mm (0.0015—0.0150 in.)
Engine Serial No. (—032181).	0.102—0.279 mm (0.0040—0.0110 in.)
Radiator Leakage Test	50 kPa (0.5 bar) (7 psi)
Oil Pressure	
At 2100 RPM	280—380 kPa (2.80—3.80 bar) (40-55 psi)
At 800 RPM	103 kPa (1 bar) (15 psi)
Maximum Engine Blow-By	17 m ³ /h (600 ft ³ /h)

NOTE: Specifications given above apply to OEM applications only. For machine applications, consult the appropriate machine technical manual.

S11,22005,Z -19-25JUL95

ENGINE SECTIONAL VIEW



A—Rocker Arm Shaft
 B—Valve Spring
 C—Cylinder Head
 D—Valve
 E—Piston Pin

F—Cylinder Block
 G—Piston
 H—Cylinder Liner
 I—Crankshaft
 J—Main Bearing

K—Oil Pan
 L—Oil Pump
 M—Connecting Rod
 N—Camshaft
 O—Cam Follower

P—Push Rod
 Q—Piston Rings
 R—Fuel Injection Nozzle
 S—Rocker Arm

RG6035 -JUN-06APR89

GENERAL DESCRIPTION

Model 6619 engines are vertical stroke, in-line, valve in head, 6-cylinder engines.

Direct fuel injection is provided by an in-line, multi-plunger injection pump and 21 mm injection nozzles mounted in cylinder head. The pump is driven by an intermediate gear in the timing gear train connected to the camshaft gear.

6619 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 intake air from the turbocharger before entering the combustion chamber. Engine coolant flowing through the aftercooler is the media used for heat exchange.

The camshaft is driven by the crankshaft gear. The camshaft rotates in honed machined bores in cylinder block, (replaceable bushings are used).

Intake and exhaust valves are operated by cam followers, push rods and rocker arm assembly, valve seat inserts and valve rotators are used in cylinder head to increase valve seat life and to prevent valve stem scuffing.

The crankshaft is a one-piece, heat-treated, dynamically balanced, steel forging which rotates in replaceable two-piece main bearings. The rear thrust bearing has a flange on each side to reduce crankshaft deflection and to limit end play during high load operation.

Cylinder liners are of a wet sleeve, flanged, and centrifugally cast design. O-rings are used to seal the connection between cylinder block and liners. Liners are induction hardened and are individually replaceable as a piston/liner set only.

Pistons are cast of high grade aluminum alloy and cam ground. The deep combustion chamber design provides maximum combustion efficiency. Two compression rings and one oil control ring are used. The top self-cleaning characteristics that reduces ring groove deposits and eliminates ring sticking. The oil control ring is a cast iron rail type with expander.

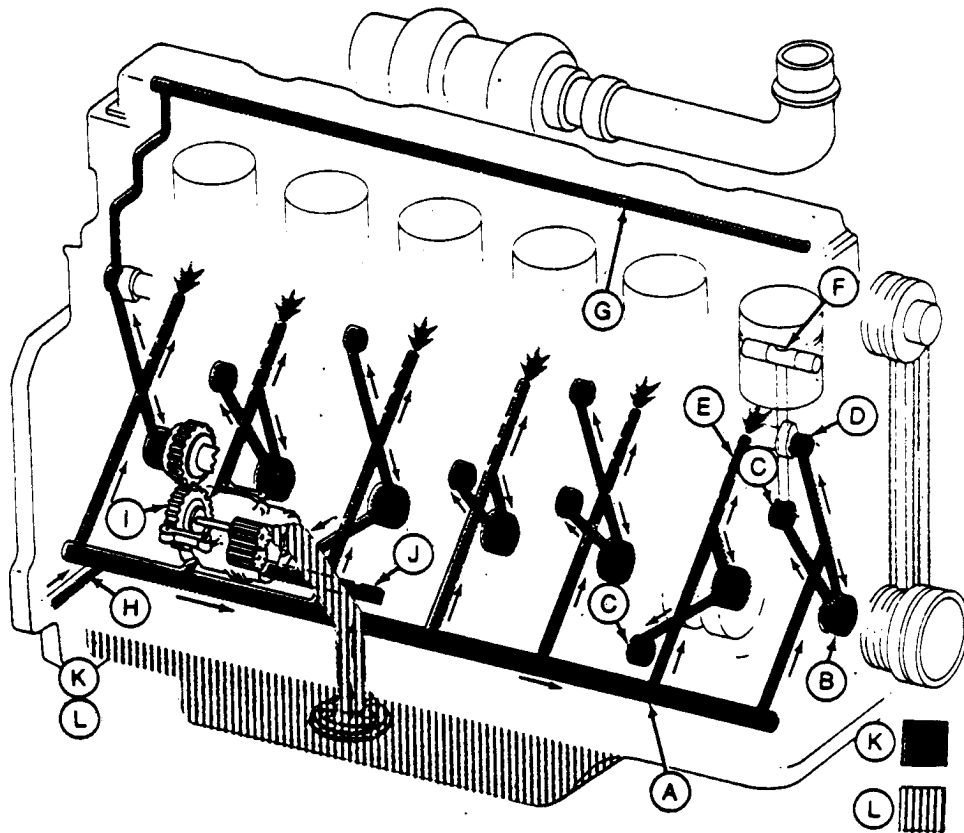
The highly polished, hardened piston pins are full-floating and held in position by means of snap rings. Spray jets (piston cooling orifices) in cylinder block direct pressure oil to lubricate piston pins and cool pistons.

Connecting rods are of forged steel and have replaceable bushing and bearing inserts. They are weight controlled (by machining) on both ends to minimize engine vibration.

The engine lubrication system consists of a gear driven, (camshaft or crankshaft) positive displacement oil pump, and oil pressure regulating housing containing filter, filter relief valve, pressure regulating valve, oil cooler relief valve. Oil is pumped from the oil pan, by the oil pump, into the oil pressure regulating valve housing, through the oil gallery in the cylinder block. Oil is then distributed, under pressure, to each main bearing, piston cooling orifice, camshaft bearings, and cylinder head components.

S11,0000,AP -19-25JAN96

HOW THE LUBRICATION SYSTEM WORKS



RG5038 -UN-20JUL89

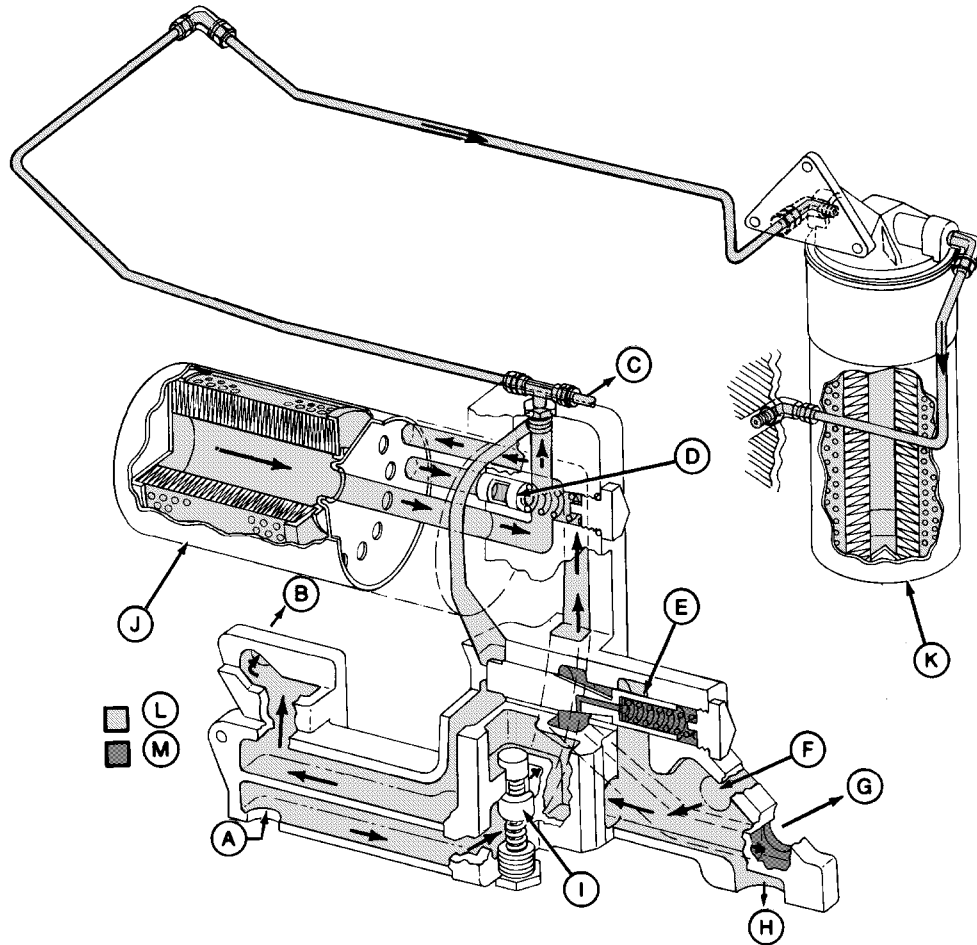
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|------------------------------------|--|--|---|
| A—Main Oil Gallery | E—Piston Cooling Orifices (6 used) | G—Rocker Arm Shaft | J—Outlet to Oil Pressure Regulating Valve Housing |
| B—Main Bearing (7 used) | F—Connecting Rod Pin Bushings (6 used) | H—Inlet From Oil Pressure Regulating Valve Housing | K—Engine Oil Pressure |
| C—Connecting Rod Bearings (6 used) | | I—Engine Oil Pump | L—Oil Pan Oil |
| D—Camshaft Bushings (4 used) | | | |

The engine lubrication system consists of a gear-driven (camshaft or crankshaft), positive displacement pump (I), an oil pressure regulating housing containing a full flow filter, oil filter relief valve, oil pressure regulating valve, an oil cooler, and bypass oil filter.

Oil is pumped from the oil pan by the oil pump into the oil pressure regulating valve housing. The oil goes through the oil cooler and filter and into the main oil gallery (A) in the cylinder block. Oil is then distributed, under pressure, to each main bearing (B) and piston cooling orifice (E).

Drilled passages in the crankshaft distribute oil from the main bearing journals to the connecting rod journals to lubricate connecting rod bearings (C). Numbers 1, 3, 5 and 7 main bearing supports are also drilled to lubricate the four camshaft bushings (D). A drilled passage from the rear camshaft bushing through the cylinder block and cylinder head provides lubrication to the rocker arm shaft.

The piston cooling orifices (E) spray oil to cool pistons and liners and lubricate the connecting rod piston pin bushings through an oil cup in the top of the connecting rod.



RG5039 -UN-02OCT95

A—From Oil Cooler
 B—To Main Oil Gallery
 C—To Turbocharger
 D—Filter Bypass Valve

E—Pressure Regulating Valve
 F—From Oil Pump
 G—To Oil Pan

H—To Oil Cooler
 I—Cooler Bypass Valve
 J—Oil Filter (Full Flow)

K—Bypass Oil Filter
 L—Engine Oil Pressure
 M—Return Oil

As shown, engine oil is pumped into the oil pressure regulating valve housing (E), through the oil cooler and back into the housing (A). The oil then flows through the full-flow oil filter (J), down across the pressure regulating valve (E) and into the main oil gallery (B) in the cylinder block.

During cold weather starting, or if the oil cooler is plugged, the oil cooler bypass valve (I) 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.

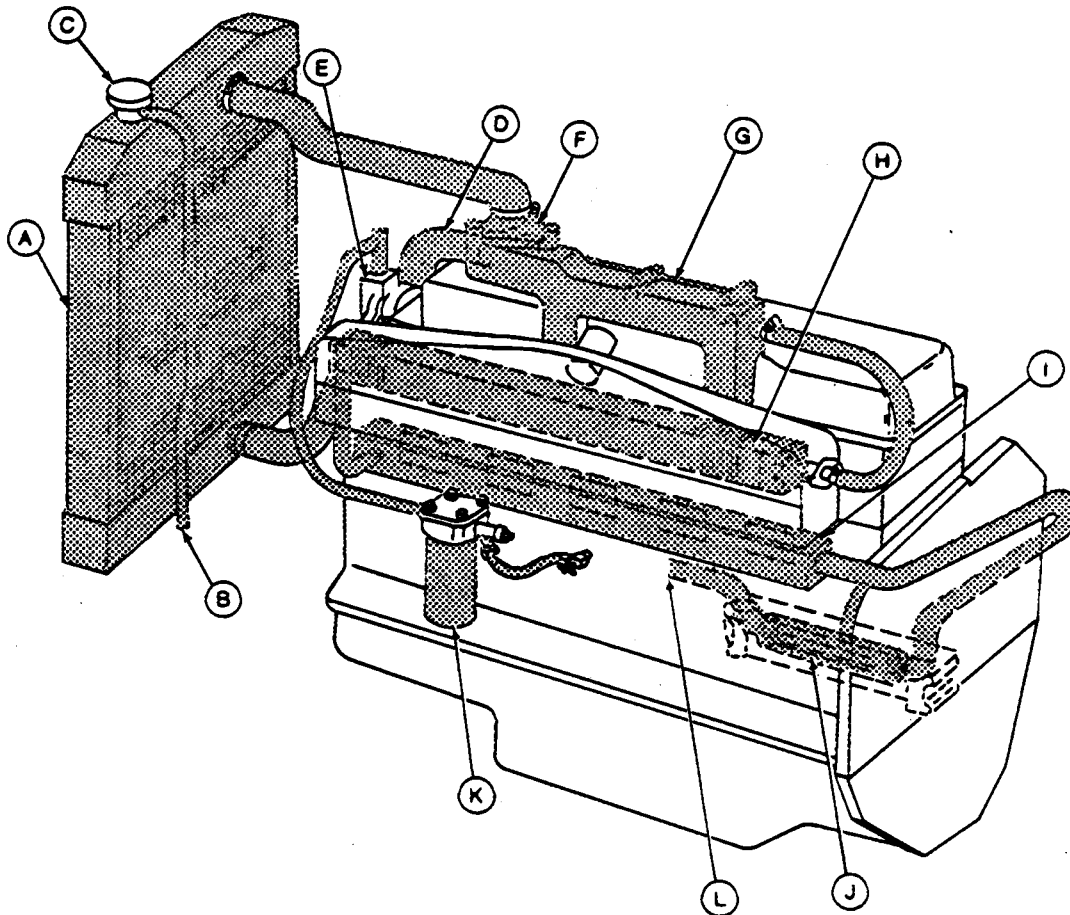
The oil filter bypass valve (D) senses pressure on the outside of the full-flow filter and opens when the pressure is 200 kPa (2 bar) (30 psi) or greater than

the pressure on the filtered side of the system. This allows unfiltered oil into the cylinder block and insures engine lubrication.

The oil pressure regulating valve (E) maintains a specified 280—350 kPa (2.80—3.50 bar) (40—55 psi). If pressure is greater than specified on the filtered side of the housing, the valve opens, allowing oil on the inlet side to return to the oil pan (G), thus reducing pressure.

A tee fitting and associated lines at top of oil pressure regulating valve housing directs oil to the turbocharger (C) and to bypass filter (K). Return oil from both the turbocharger and bypass filter flows back to the oil pan.

HOW THE COOLING SYSTEM WORKS



-UN-30NOV88
RG5041

- | | | | |
|-----------------|------------------------|------------------------|------------------------------|
| A—Radiator | D—Coolant Bypass Pipe | G—Water Manifold | J—Engine Oil Cooler |
| B—Overflow Hose | E—Water Pump | H—Aftercooler | K—Coolant Conditioner Filter |
| C—Radiator Cap | F—Thermostats (3 used) | I—Main Cooling Gallery | L—Coolant-To-Water Pump |

The 6619 Engine cooling system consists of a conventional-type radiator (A), belt-driven water pump (E), water manifold (G), and three thermostats (F). Additionally 6619's are fitted with a coolant conditioner filter (K). The cooling system also supplies coolant to the engine oil cooler (J) and aftercooler (H) to cool engine oil and intake air.

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.

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 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 and thermostat housing.

105
8

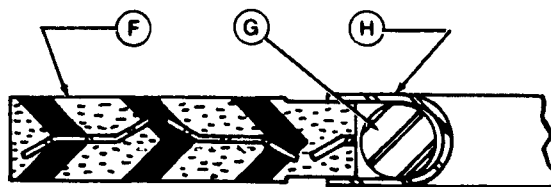
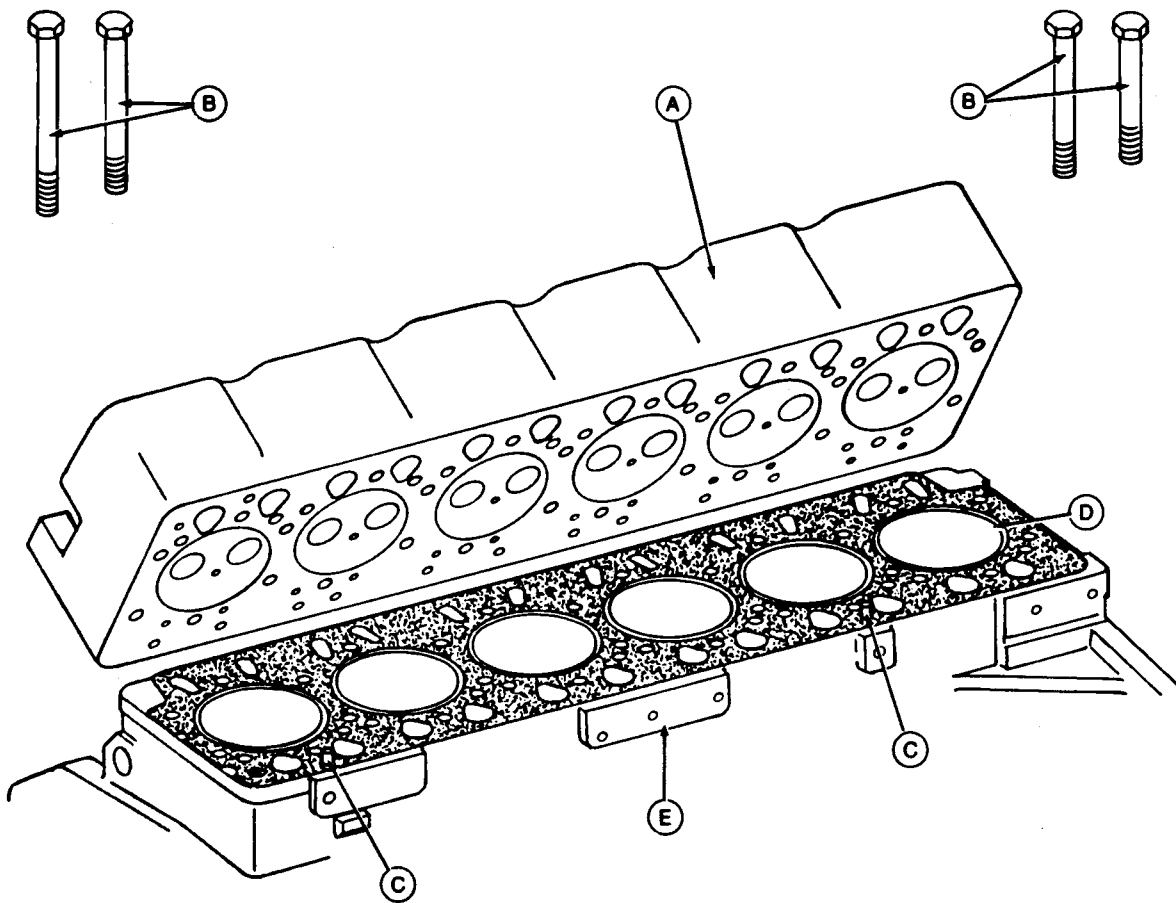
HOW THE COOLING SYSTEM WORKS—CONTINUED

Additionally, coolant is drawn off the main gallery and routed through the coolant conditioner filter canister. Here an anticorrosive chemical is added to the coolant while any debris that may be present in the cooling system is removed. The coolant returns to the system at the inlet side of the water pump.

The engine oil cooler, mounted beneath the oil pressure regulating valve housing, receives coolant from the water pump and returns it to the cylinder block.

S11,22005,Y1 -19-25JUL95

HEAD GASKET JOINT CONSTRUCTION AND OPERATION



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

RG6667 -JUN-13/MAR93

HEAD GASKET JOINT CONSTRUCTION AND OPERATION—CONTINUED

Refer to illustration on previous page.

The head gasket joint consists of:

- Cylinder head gasket (F)
- Cylinder head (A)
- Cylinder block (E)
- Cylinder liners (D)
- Cylinder head cap screws (B)

The head gasket must form an air-tight seal between cylinder liners and cylinder head that can withstand the temperatures and pressures of the combustion process. The gasket must also form a liquid-tight seal between the cylinder head and cylinder block to retain coolant and oil in their respective passages. The gasket is constructed of thin, formed sheets of steel-inserted, non-asbestos material. The surface of gasket is treated to improve liquid sealing and anti-stick characteristics. A fire ring combustion seal (G) is located at each cylinder bore and is held in place by a U-shaped stainless steel flange (H).

The cylinder head and block must be flat to provide an even clamping pressure over the entire surface of gasket, and must have the proper surface finish to keep gasket material from moving in the joint. Dowel pins (C) are used to properly locate head gasket on block.

The cylinder liners must protrude evenly from top of cylinder block the specified amount to provide adequate clamping force on fire ring of each cylinder.

The cap screws must be proper length, made of proper material, and be tightened to proper torque in order to provide an adequate clamp load between other joint components.

Each of the above components contributes to the integrity of the head gasket joint. If any of these components do not conform to specifications, gasket joint may fail resulting in combustion leaks, coolant leaks, or oil leaks.

Operating conditions such as coolant, oil, and combustion temperatures, and combustion pressures can reduce the ability of the head gasket joint to function properly. Failure of head gasket and mating parts may occur when coolant and oil temperatures become excessive, or when abnormally high combustion temperatures and pressures persist.

CTM61,G105,26 -19-13MAY93

DIAGNOSING HEAD GASKET JOINT FAILURES

Head gasket failures generally fall into three categories:

- Combustion seal leakage.
- Coolant seal leakage.
- Oil seal leakage.

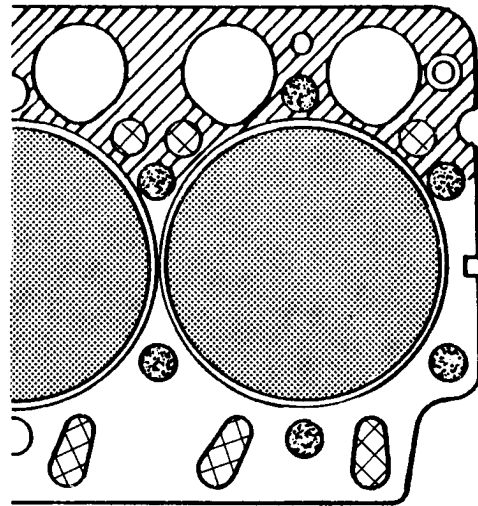
Combustion seal leakage failures occur when combustion gases escape between cylinder head and head gasket combustion flange, or between combustion flange and cylinder liner. Leaking combustion gases may vent to an adjacent cylinder, to a coolant or oil passage, or externally.

Coolant or oil seal leakage failures occur when oil or coolant escapes between cylinder head and gasket body, or between cylinder block and gasket body. The oil or coolant may leak to an adjacent coolant or oil passage, or externally. Since oil and coolant passages are primarily on right hand (camshaft) side of engine, fluid leaks are most likely to occur in that area.

Follow these diagnostic procedures when a head gasket joint failure occurs, or is suspected.

1. Before starting or disassembling engine, conduct a visual inspection of machine, and note any of the following:

- Oil or coolant in head gasket seam, or on adjacent surfaces. Especially right rear corner of gasket joint.
- Displacement of gasket from normal position.
- Discoloration or soot from combustion gas leakage.
- Leaking radiator, overflow tank, or hoses.
- Leaking coolant from water pump weep hole.
- Damaged or incorrect radiator, fan, or shroud.
- Obstructed air flow or coolant flow.
- Worn or slipping belts.
- Damaged or incorrect pressure cap.
- Presence of oil in coolant.
- Low coolant levels.
- Improper coolant.
- Unusually high or low oil levels.
- Oil degradation, dilution, or contamination.
- Correctly specified injection pump.
- Indications of fuel or timing adjustments.
- Unburned fuel or coolant in exhaust system.



- A—Combustion Sealing Areas
- B—Coating Sealing Around Push Rod Holes
- C—Coolant Sealing Areas
- D—Cylinder Head Cap Screws

RG6664 -JUN-13MAR93

2. Obtain coolant and oil samples for further analysis.

3. Start and warm up engine if it can be safely operated. Examine all potential leakage areas again as outlined previously. Using appropriate test and measurement equipment, check for the following:

- White smoke, excessive raw fuel, or moisture in exhaust system.
- Rough, irregular exhaust sound, or misfiring.
- Air bubbles, gas entrainment in radiator or overflow tank.
- Loss of coolant from overflow.
- Excessive cooling system pressure.
- Coolant overheating.
- Low coolant flow.
- Loss of cab heating (air lock).

4. Shut engine down. Recheck crankcase, radiator, and overflow tank for any significant differences in fluid levels, viscosity, or appearance.

5. Compare your observations from above steps with the following diagnostic charts. If diagnostic evaluations and observations provide conclusive evidence of combustion gas, coolant, or oil leakage from head gasket joint, the cylinder head must be removed for inspection and repair of gasket joint components.

RG,CTM8,G105,11-19-29OCT92

Combustion Seal Leakage

Symptoms:

- Exhaust from head gasket crevice
- Air bubbles in radiator/overflow tank
- Coolant discharge from overflow tube
- Engine overheating
- Power loss
- Engine runs rough
- White exhaust smoke
- Loss of cab heat
- Gasket section dislodged, missing (blown)
- Coolant in cylinder
- Coolant in crankcase oil
- Low coolant level

Possible Causes:

- Insufficient liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Rough/damaged liner flange surface
- Cracked/deformed gasket combustion flange
- Out-of-flat/damaged/rough cylinder head surface
- Missing/mislocated gasket fire ring
- Block cracked in liner support area
- Excessive fuel delivery
- Advanced injection pump timing
- Hydraulic or mechanical disturbance of combustion seal

NOTE: Cracked cylinder head or liners may also allow combustion gas leakage into coolant.

RG,CTM8,G105,12-19-16SEP92

Coolant Seal Leakage

Symptoms:

- Coolant discharge from head gasket crevice
- Coolant in crankcase oil
- Low coolant level
- High oil level
- Coolant discharge from crankcase vent

Possible Causes:

- Excessive liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface
- Out-of-flat/damaged/rough cylinder head surface
- Oil or coolant overheating
- Cracks/creases in gasket body surfaces
- Damage/voids in elastomer beading

NOTE: Cracked cylinder head, liners, liner packings, defective oil cooler or aftercooler may also allow coolant leakage into crankcase.

RG,CTM8,G105,13-19-13MAY93

Oil Seal Leakage

Symptoms:

- Oil discharge from head gasket crevice
- Oil in coolant
- Low crankcase oil level
- Reduced oil to rocker arms (noisy)

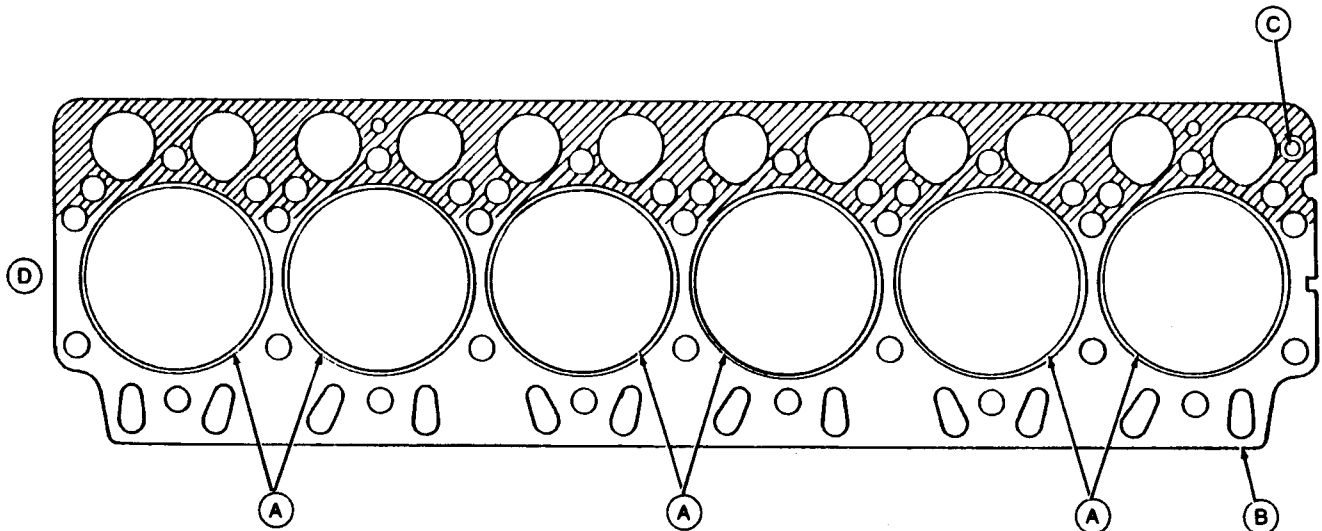
Possible Causes:

- Excessive liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface
- Out-of-flat/damaged/rough cylinder head surface
- Oil or coolant overheating
- Cracks/creases in gasket body surfaces
- Damage/voids in elastomer beading
- Damaged/missing O-ring seal at oil port to rocker arms

NOTE: Defective oil cooler may also allow oil leakage into coolant.

RG,CTM8,G105,14-19-16SEP92

HEAD GASKET INSPECTION AND REPAIR SEQUENCE



**A—Combustion Seals
(Flanges)**

B—Gasket Body

C—Rocker Arm Oil Port

D—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/abraded/channelled.

Examine gasket body (B) for the following:

- Combustion gas erosion paths or soot deposits originating at combustion seals.
- Extreme discoloration/hardening/embrittlement in localized areas.
- O-ring seal missing/damaged in port area (C).
- Oil or coolant paths from port areas.
- Localized areas of low compression.

6. Before cleaning components, inspect head, block, and liners for evidence of combustion gas and fluid leakage. Inspect cylinders and valve ports for unusual deposits.

-UN-13MAR93
RG6663

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

DIAGNOSING ENGINE MALFUNCTIONS—CONTINUED

• Low Oil Pressure:

Basic Engine Problem

- Stuck or improper regulating valve adjustment
- Excessive main and connecting rod bearing clearance
- Plugged oil pump intake screen
- Faulty bypass oil check valve
- Leakage at internal oil passages
- Faulty oil pump Service Problem
- Low oil level
- Improper viscosity of oil
- Faulty gauge

• High Oil Pressure:

Basic Engine Problem

- Stuck or improperly adjusted regulating valve

• Excessive Fuel Consumption:

Basic Engine Problem

- Low compression

Fuel System Malfunction - See Group 115

- Leaks in fuel system
- Restricted air cleaners
- Faulty injection pump timing
- Improper valve clearance
- Service problem
- Improper grade of fuel

Fuel System Malfunction - See Group 115

- Excessive fuel delivery
- Faulty injection nozzles
- Restricted air cleaners
- Improper injection pump timing

• Slow Acceleration:

Fuel System Malfunction - See Group 115

- Faulty injection pump
- Faulty injection nozzles

• Detonation:

Fuel System Malfunction - See Group 115

- Faulty injection pump
- Faulty injection nozzles
- Improper fuel

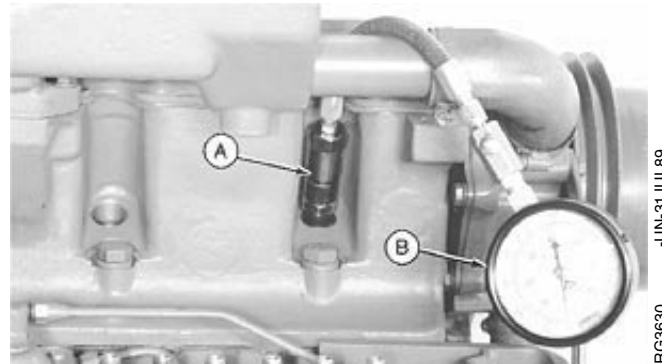
• Abnormal Engine Noise:

Basic Engine Problem

- Low engine oil level
- Excessive valve clearance
- Worn cam followers
- Bent push rods
- Worn rocker arm shafts
- Worn main or connecting rod bearings
- Foreign material in combustion chamber
- Worn Piston pin bushings and pins
- Scored piston
- Incorrect engine timing
- Excessive crankshaft end play
- Loosen main or connecting rod bearing caps
- Crankshaft oil pump drive gear worn or broken
- Crankshaft vibration damper worn or separated

RG,CTM61,G105,8-19-25JUL95

TEST ENGINE COMPRESSION PRESSURE



IMPORTANT: Compression pressures are affected by the cranking speed of the engine. Before beginning test, insure that batteries are fully charged and injection nozzle area is thoroughly cleaned.

1. Start engine and run at rated speed until it warms up to normal operating temperature. From a cold start, operate engine 10—15 minutes.
2. Remove all injection nozzles from head. (See REMOVE FUEL INJECTION NOZZLES in Group 35.)
3. Install the JT01675A Nozzle adapter and JT01677 Adapter Nut (A) into injection nozzle bore. Tighten adapter nut to 80 N·m (60 lb-ft).
4. Connect JT01682 Gauge and Hose Assembly (B) to nozzle adapter.
5. Crank engine over at 200—250 rpm cranking speed and record compression readings. Compare readings with specifications given below.

ENGINE COMPRESSION SPECIFICATIONS

200—250 RPM	2280—2620 kPa (22.8—26.2 bar) (330—380 psi)
Maximum variation between cylinders	340 kPa (3.4 bar) (50 psi)

NOTE: Pressure given was taken at 305 m (1000 ft) above sea level. A 3.6 percent reduction in gauge pressure will result for each additional 305 m (1000 ft) rise in altitude.

6. If pressure is much lower than shown, remove gauge and apply oil to ring area of piston through injection nozzle bore. Do not use too much oil. Do not get oil on valves.

7. Crank engine over and record compression reading again.

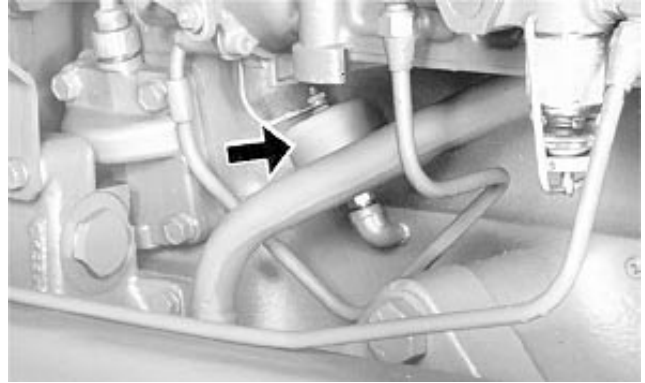
If pressure is higher than 2620 kPa (26.2 bar) (380 psi), worn or stuck rings are indicated. Either replace piston rings or install new piston and liner set as needed. (See Group 10.)

If pressure is below 2280 kPa (22.8 bar) (330 psi), it is possible that valves are worn or sticking. Recondition cylinder head as needed. (See Group 05.)

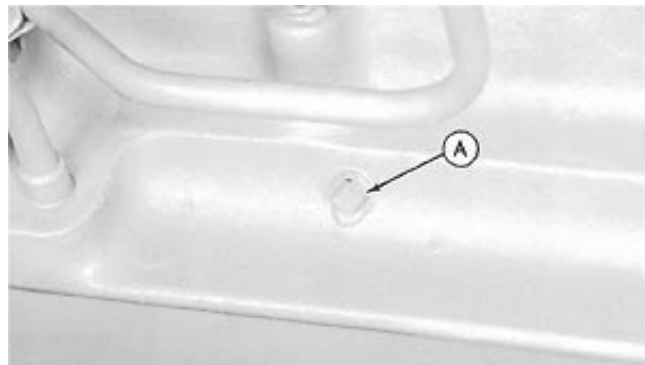
8. Measure compression pressure in all remaining cylinders and compare readings. Recondition cylinders and valves as required.

CHECK ENGINE OIL PRESSURE

1. If equipped, remove oil pressure sending unit (arrow) from engine block or remove pipe plug (A) from main oil gallery.



F78205C5 -UN-16/JAN90



RG4124 -UN-30/NOV88

S11,22005,AG -19-25/JUL95

2. Install JT05487 Fitting, JT05498 Hose with JT01609 Coupler, and JT05472 Pressure Gauge from JT05470 Universal Pressure Test Kit.

3. Warm engine until oil temperature is 115°C (240°F).

4. Operate engine at specified RPM and check oil pressure.

OIL PRESSURE SPECIFICATIONS

800 RPM	103 kPa (1 bar) (15 psi)
2100RPM	280—380 kPa (2.80—3.80 bar) (40—55 psi)

NOTE: To adjust oil pressure, remove regulating valve spring at filter base and add washers to increase oil pressure and subtract washers to decrease oil pressure.

IMPORTANT: Do not use more than a total of five washers.



F78205B1 -UN-16/JAN90

S11,22010,L -19-25/JAN96

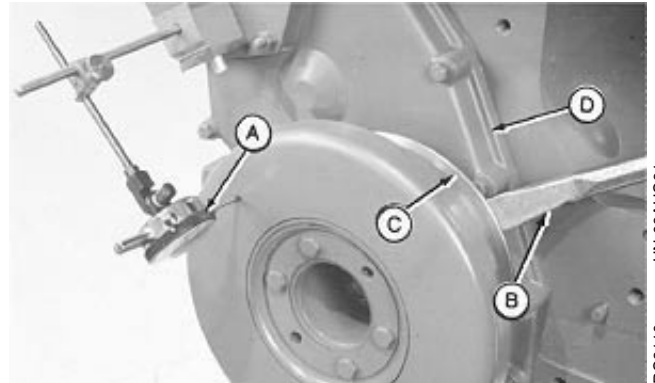
CHECK CRANKSHAFT END PLAY (DAMPER INSTALLED)

Use the following procedure to check crankshaft end play:

1. Completely depress and release the clutch pedal.
2. Place a dial indicator (A) on crankshaft pulley or damper.

IMPORTANT: Use care not to damage or distort the timing gear cover or bearing inserts when prying. Do not pry on rubber damper at rear of pulley.

3. Pry (B) between the damper pulley (C) and timing gear cover (D).



RG3110 -UN-09AUG91

A—Dial Indicator
B—Pry Bar
C—Damper Pulley
D—Timing Gear Cover

CRANKSHAFT END PLAY SPECIFICATIONS

Engine Serial No. (032182—) 0.038—0.380 mm
(0.0015—0.0150 in.)

Engine Serial No. (—032181) 0.102—0.279 mm
(0.0040—0.0110 in.)

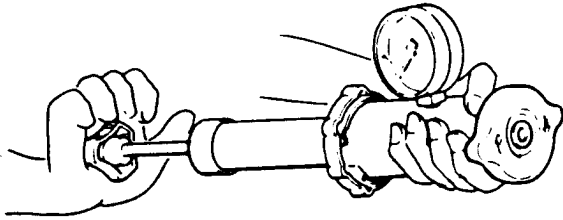
S11,22510,I -19-25JAN96

MEASURE ENGINE CRANKCASE PRESSURE (BLOW-BY)

1. Place a hose with a standard gas gauge in end of crankcase vent tube.
2. Run engine at rated speed and load. Engine should be at operating temperature and run-in (with at least 100 operating hours).
3. Measure blow-by over a period of 5 minutes. Multiply figure obtained by 12 (hourly rate). Maximum engine blow-by is 17m³/h (600 ft³/h).
4. If blow-by is lower, there probably is no undue wear between piston rings and liners. If blow-by is higher, there could be excessive wear between piston rings and liners, resulting in loss of engine power. An overhaul of the engine should be considered only after other possible repair options (if any) are evaluated.

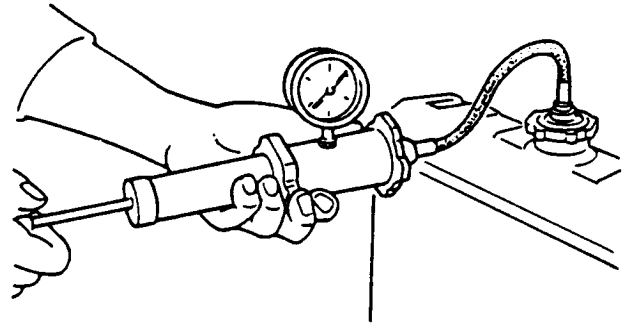
CTM9,GR105,16 -19-25JAN96

PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP



RG6657

-UN-20JAN93



RG6658

-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)*, using D05104ST Pressure Pump.
4. With pressure applied, check all cooling system hose connections, radiator, and overall engine for leaks.

If leakage is detected, correct as necessary and pressure test system again.

If no leakage is detected, but the gauge indicated a drop in pressure, coolant may be leaking internally within the system or at the block-to-head gasket. Have your servicing dealer or distributor correct this problem immediately.

*Test pressures recommended are for all Deere OEM cooling systems. On specific vehicle applications, test cooling system and pressure cap according to the recommended pressure for that vehicle.

INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE

Visually inspect thermostat for corrosion or damage.
Replace as necessary.

- Test thermostat as follows:

⚠ CAUTION: DO NOT allow thermostat or thermometer to rest against the side or bottom of container when heating water. Either may rupture if overheated.

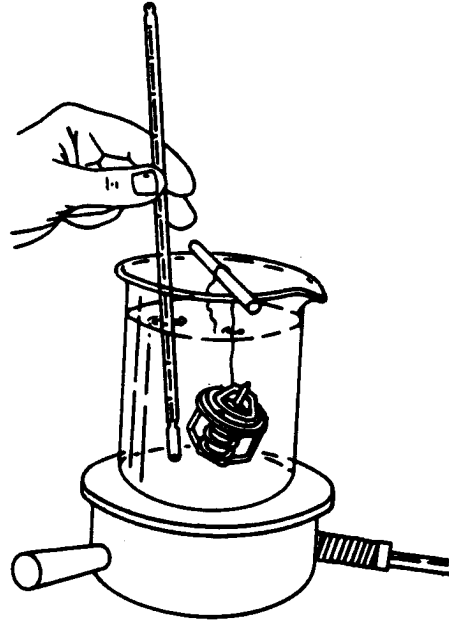
1. Remove thermostats. (See REMOVE THERMOSTATS in Group 25.)
2. Suspend thermostat and a thermometer in a container of water.
3. Stir the water as it heats. Observe opening action of thermometer and compare temperatures with specification given in chart below.

NOTE: Due to varying tolerances of different suppliers, initial opening and full open temperatures may vary slightly from specified temperatures.

THERMOSTAT TEST SPECIFICATIONS

Rating	Initial Opening (Range)	Full Open (Nominal)
71°C (160°F)	69—72°C (156—162°F)	84°C (182°F)
77°C (170°F)	74—78°C (166—172°F)	89°C (192°F)
82°C (180°F)	80—84°C (175—182°F)	94°C (202°F)
89°C (192°F)	86—90°C (187—194°F)	101°C (214°F)
90°C (195°F)	89—93°C (192—199°F)	103°C (218°F)
92°C (197°F)	89—93°C (193—200°F)	105°C (221°F)
96°C (205°F)	94—97°C (201—207°F)	100°C (213°F)
99°C (210°F)	96—100°C (205—212°F)	111°C (232°F)

4. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.
5. If any thermostat is defective on a multiple thermostat engine, replace all thermostats.



RG5971 -UN-17SEP91

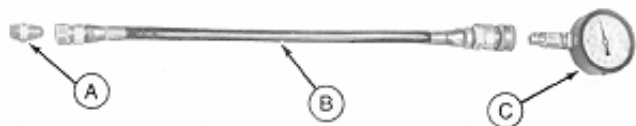
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

- A-Fitting or Elbow JT05487 or JT03002
- B-Hose JT03017
- C-Pressure gauge JT03092

Used to check intake manifold pressure (turbo boost pressure).



-JUN-14DEC88
R27490N

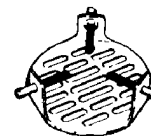
Above components are part of JT05412 Universal Pressure Test Kit

S11,23005,AV -19-25JUL95

- Turbo Shield JDG576

RG7342 -UN-23JUN95

Used to cover turbocharger inlet during testing.



S11,JDG576 -19-25JUL95

AIR INTAKE AND EXHAUST SYSTEM TEST SPECIFICATIONS

Engine Application	Fuel Injection Pump Part No.	Air Intake Manifold Pressure (Turbo-Boost)		
		KPa	(bar)	(psi)
6619AF	RE18150	143—165	1.4—1.7	21—24
6619AF	RE29166	162—188	1.6—1.9	23—27
6619AF	RE23749	143—165	1.4—1.7	21—24
6619TF-01	AR88760	93—107	0.9—1.1	14—16
6619AE-03	RE42224	129—151	1.3—1.5	19—22
6619AT-04	RE29146	125—145	1.3—1.5	18—22
6619AT-07	RE36078	140—160	1.4—1.6	20—23

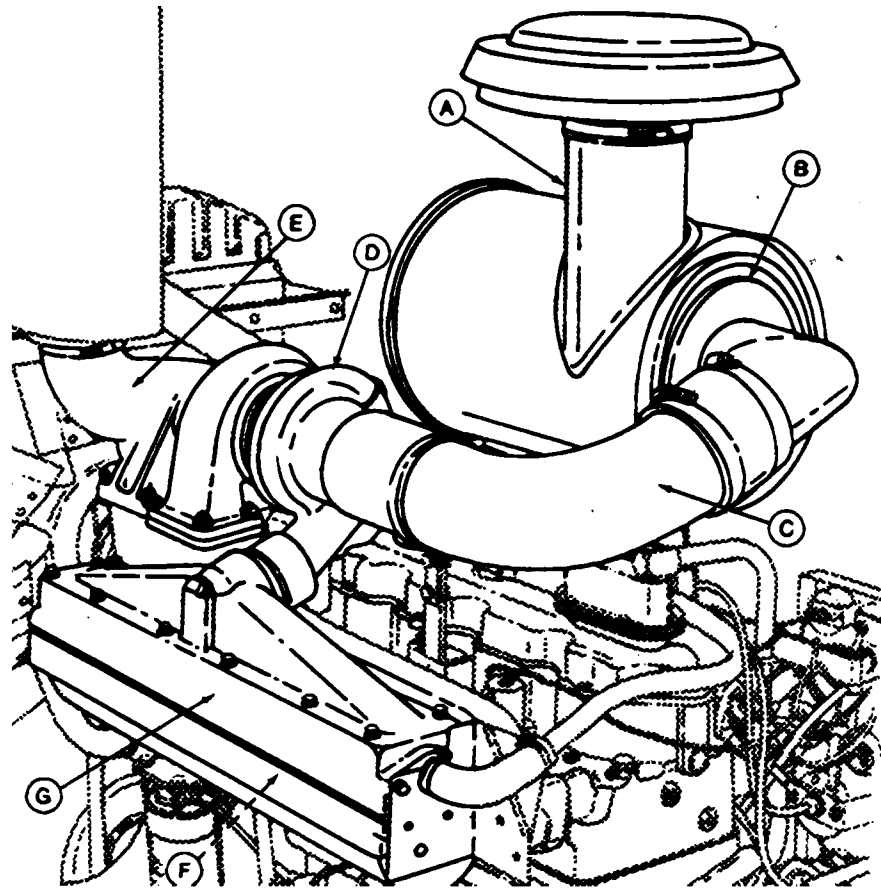
S11,23005,AW -19-25JAN96

DIAGNOSING AIR INTAKE MALFUNCTIONS

Symptom	Problem	Solution
Engine Starts Hard or Won't Start	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
	Erratic Engine Operation	Air leak on suction side of system Check hose and pipe connections for tightness; repair as required (See Group 30).
Engine Emits Excessive Black Smoke	Air cleaner element restricted	Clean or replace elements (See operator's manual).
	Turbocharger defective	Repair or replace (See Group 30).
	Air leak in manifold	Check hose and pipe connections for tightness; repair as required (See Group 30).
Engine Idles Poorly	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
Engine Does Not Develop Full Power	Air cleaner restricted	Clean or replace elements (See operator's manual).
	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
	Turbocharger defective	Repair or replace (See Group 30).
	Manifold pressure pipe to aneroid loose or broken	Check hose and pipe connections for tightness; repair as required (See Group 30).
Turbocharger "Screams"	Air leak in manifold	Check intake manifold gasket and manifold; repair as required (See Group 30).

S11,23005,AJ -19-25JUL95

HOW THE AIR INTAKE AND EXHAUST SYSTEM WORK



RG5030
-UN-06APR89

A—Air Inlet Stack
B—Air Cleaner

C—Intake Hose
D—Turbocharger

E—Exhaust Elbow
F—Intake Manifold

G—Aftercooler

Engine suction draws dust-laden outside air through an air inlet stack (A) into the air cleaner (B). Air is filtered through dry type primary and secondary (safety) filter elements in the air cleaner canister. Clean air travels through the air intake hose (C) to the turbocharger (D) and intake manifold (F) of the engine.

Exhaust, as it is expelled out the exhaust elbow (E), drives the turbocharger to deliver a larger quantity of air to meet the engine requirements than what could be delivered under naturally aspirated (non-turbocharged) conditions.

On 6619A Engines, intake air, which has been compressed (and heated) by the turbocharger, flows around the aftercooler (G) and lowers the air temperature as much as 27—32°C (80—90°F) before entering the engine cylinders. Lowering the air temperature makes the air more dense and permits an even greater volume of air to be delivered to engine cylinders for combustion.

This increased volume of air, when combined with a predetermined quantity of additional fuel, enables more power to be produced.

AIR CLEANER OPERATION

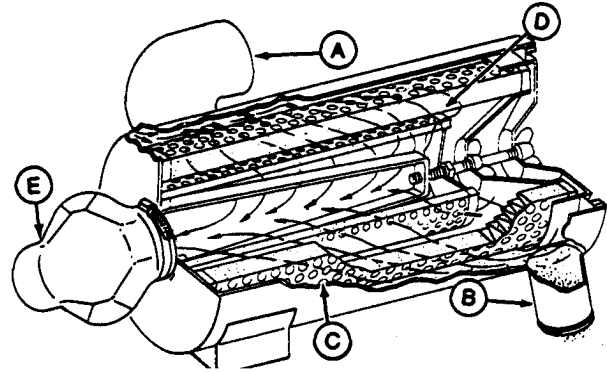
Dust-laden air enters the air cleaner inlet (A) and is forced into a high-speed centrifugal motion.

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.



A—Air Inlet
B—Dust Outlet
C—Primary Element
D—Secondary (Safety) Element
E—Air Outlet

R28270 -UN-14DEC88

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.
Unbalanced rotating assembly:
 Damage to turbine or compressor wheel or blade.
 Dirt or carbon build-up on wheel or blade.
 Bearing wear.
 Oil starvation or insufficient lubrication.
Shaft seals worn.

• Turbine Wheel Drag:

Carbon build-up behind turbine wheel caused by coked oil or combustion deposits.
Dirt build-up behind compressor wheel caused by air intake leaks.
Bearing seizure or dirty, worn bearings caused by excessive temperatures, unbalanced wheel, dirty oil, oil starvation, or insufficient lubrication.

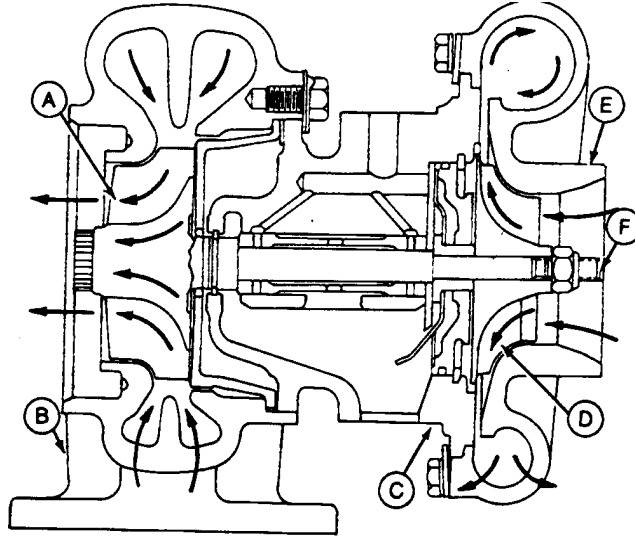
*Do not confuse the whine heard during run down with noise which indicates a bearing failure.

HOW THE TURBOCHARGER WORKS

Exhaust gases from the engine pass through the turbine housing (B) causing the shaft (F) to rotate before the exhaust gas is discharged to the atmosphere.

The compressor wheel (D), also mounted on shaft (F), rotates in the compressor housing (E). Inlet air is drawn into the housing, where it is compressed and delivered to engine cylinders.

- A—Turbine Wheel
- B—Turbine Housing
- C—Center Housing
- D—Compressor Wheel
- E—Compressor Housing
- F—Shaft



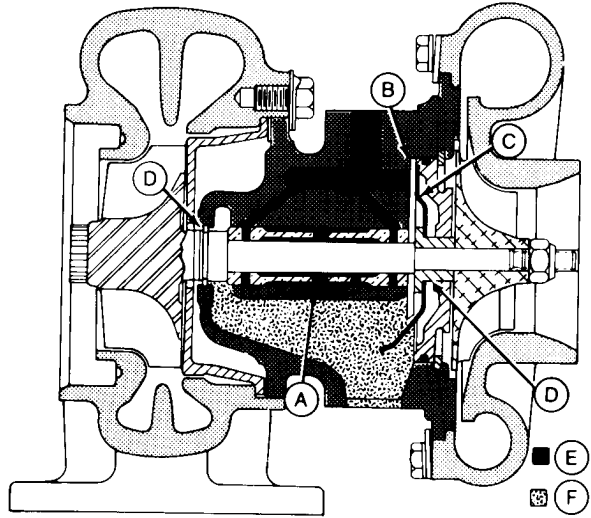
S11,23005.L -19-17MAR92

R28273 -JUN-14DEC88

HOW THE TURBOCHARGER IS LUBRICATED

Engine oil under pressure from the engine lubrication system is pumped through a passage in the bearing housing and directed to the bearing (A), thrust plate (B), and thrust sleeve (C). Oil is sealed from the compressor and turbine by a piston ring (D) at both ends of bearing housing.

The AiResearch/Garrett 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 wall as well as clearance between the bearing ID and the shaft OD. These clearances are lubricated by the oil supply and the bearings are protected by a cushion of oil. Discharge oil drains by gravity from the bearing housing to the engine crankcase.



Schwitzer Turbocharger Lubrication

- A—Bearing
- B—Thrust Plate
- C—Thrust Sleeve
- D—Piston Ring
- E—Pressure Oil
- F—Discharge Oil

S11,23005,JE -19-25JUL95

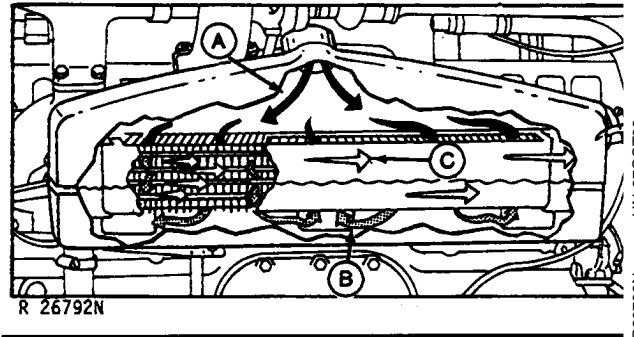
RG4646 -UN-29AUG94

HOW THE AFTERCOOLER WORKS—6619A ENGINES

Air entering the intake manifold has been compressed (and heated) by the turbocharger. As this heated, compressed air (A) enters the intake manifold, it flows around the aftercooler before going to the engine cylinders.

The aftercooler functions as a heat exchanger, lowering the intake air (B) temperatures as much as 27—32°C (80—90°F). Lowering the air temperature makes the air more dense, permitting an even greater volume (compared with not having an aftercooler) to be delivered to the engine cylinders. This increased volume of air, when combined with a predetermined quantity of additional fuel, enables more power to be produced.

Engine coolant (C) circulating through the aftercooler core is the media used for heat exchange. Extreme care must be used to insure that the engine coolant does not leak into the intake manifold, resulting in possible damage to the engine.



A—Heated Air
B—Cooled Air
C—Engine Coolant

S11,23005,AY -19-25JUL95

CHECK INTAKE MANIFOLD PRESSURE (TURBO-BOOST)—6619AF ENGINES

NOTE: This procedure is for checking intake manifold pressure on 6619AF Engines. Refer to your machine technical manual for intake manifold pressures on all other 6619 engine applications.

Intake manifold pressure can be checked in either of two places. DO NOT disconnect both ether and fuel pressurizing lines.

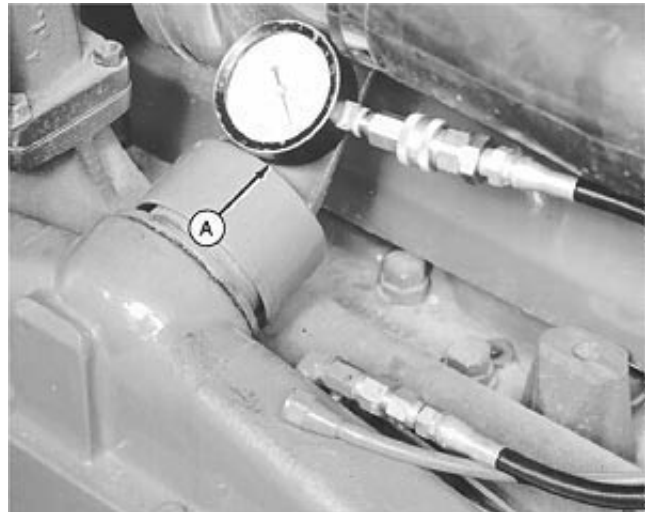
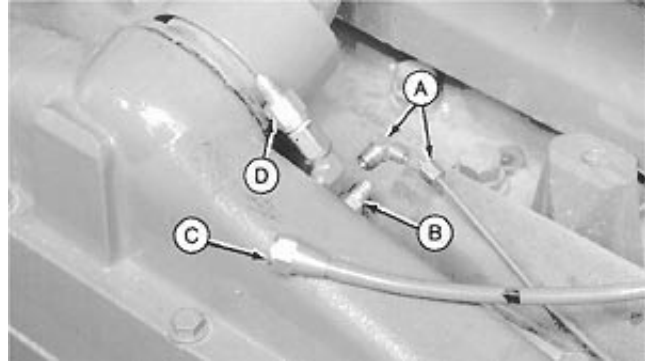
1. Disconnect either the ether starting line and elbow (A) or fuel tank pressurizing line (C).
2. If using ether hole, install JT05487 Fitting (B). If using pressurizer elbow, install JT03002 Fitting (D).
3. Install JT03092 Pressure Gauge (A, lower photo) with JT03017 Hose to previously installed fitting.

NOTE: Lower photo at right shows gauge connected to pressurized fuel line elbow.

4. Bring engine to operating temperature. Connect machine to a dynamometer and run at 2100 rpm under full load.
5. Observe reading on gauge. Compare reading with specifications given at the beginning of this group. (See AIR INTAKE AND EXHAUST SYSTEM TEST SPECIFICATIONS.)
6. Remove gauge, fittings, and reconnect lines.

If pressure was below specification, check for:

- 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



SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-20JUL95

Flywheel Turning Tool JDE81-1

RG4950 -UN-23AUG88

Rotate engine flywheel. Use with JDE81-4.

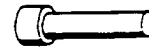


S53,JDE811 -19-25JAN96

Timing Pin JDE81-4

RG5068 -UN-23AUG88

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

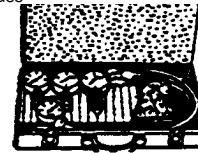


RG,JDE814 -19-03JAN95

Universal Pressure Test Kit . . . JT05470 (D015027NU)

RG5162 -UN-23AUG88

Used to measure fuel supply pump output pressure.



RG,CTM6,G115,1 -19-15AUG91

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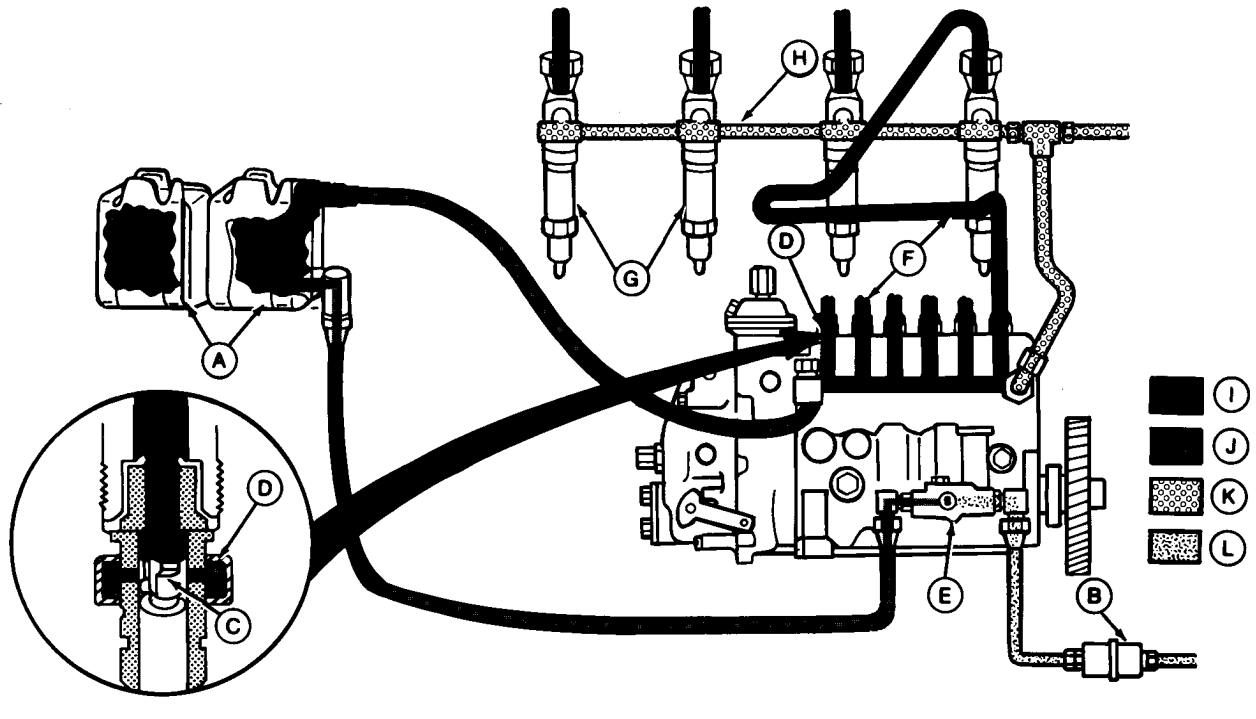
FUEL SYSTEM TEST SPECIFICATIONS

Item	Specification		
Fuel Supply Pump Minimum Output Pressure			
Standard pressure (with filter bowl)	100 kPa (1.0 bar) (14.5 psi)		
High pressure (without filter bowl)	200 kPa (2.0 bar) (29 psi)		
Aneroid Activator			
Operating pressure	48—75 kPa (0.5—0.8 bar) (7—11 psi)		
Fuel Injection Pump			
Timing to engine	TDC		
OEM Engine Speeds*			
	Slow Idle	Fast Idle	Full Load
8—10% (Standard) Governor	800—850	2300	2100
3—5% Governor	800—850	1870	1800
Torques			
Injection Pump Drive Gear-to-Hub Cap Screws			
A-Series Pump			47 N.m (35 lb-ft)
P-Series Pump			61 N.m (45 lb-ft)
Injection Pump Gear Cover Cap Screws			27 N.m (20 lb-ft)

* Applies to OEM applications only. For machine applications, consult the appropriate machine technical manual.

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FUEL SYSTEM OPERATION



- A—Fuel Filters
- B—Pre-Filter—Optional
- C—Pump Plungers
- D—Fuel Gallery
- E—Supply Pump
- F—Delivery Pipes

- G—Nozzles
- H—Leak-Off Line
- I—Injection Pressure
- J—Supply Pump Pressure
- K—Fuel Return
- L—Gravity Pressure

The supply pump (E) draws fuel from the vented fuel tank through the pre-filter.

The supply pump pressurizes the fuel to 103—340 kPa (1.0—3.4 bar) (15—50 psi) which permits the fuel to flow through the filters (A) to the gallery in the injection pump (D). Supply pump output pressures will vary depending on load and application.

The gallery is kept full by the supply pump. Injection pump plungers (C) further pressurize the fuel to about

69 000 kPa (690 bar) (10 000 psi). Delivery pipes (F) route the fuel to the nozzles (G). The high pressure fuel opens the nozzle valve tip. This atomizes the fuel as it enters the combustion chamber.

There are two sources of excess fuel incorporated into the system. The supply pump supplies more fuel to the pump than is required by the engine, and the nozzle requires excess fuel to lubricate the nozzle valve. A leak-off line (H) returns this excess fuel to the tank from both the pump and nozzles.

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 3
 -UN-23APR94
 RG4648

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 (See this group)
	Fuel tank valve shut off	Open fuel tank valve
	Low supply pump pressure	Check fuel lines for restrictions; check pump output pressure (See 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 (See this group)
	Faulty injection pump	Repair or replace
	Water in fuel	Drain water from fuel (or separator if equipped). Install new filter (See Group 35)
	Fuel filter restricted	Replace fuel filters (See Group 35)
	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)

Continued on next page

Symptom	Problem	Solution
	Broken starting fuel control shaft spring	Repair (See Group 35)
	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, (or separator if equipped). Install new filter (See Group 35)
	Injection pump return fuel line or fittings restricted	Clean lines as required
Erratic Engine Operations	Fuel filter restricted	Replace fuel filter (See Group 35)
	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 (See this group)
	Governor faulty	Repair (See Group 35)
	Water in fuel	Drain water from fuel (or separator, if equipped). Install new filter
	Injection pump return fuel line or fittings restricted	Clean lines as required
	Low cetane fuel	Use correct grade of fuel (See Group 02)

Continued on next page

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6

Symptom	Problem	Solution
Engine Emits Excessive Black Smoke	Injection nozzle return lines restricted	Clean lines as required.
	Injection nozzles faulty or sticking	Repair (See Group 35)
	Injection pump timing incorrect	Adjust timing (See this group)
	Low cetane fuel	Use correct grade of fuel (See Group 02)
	Over-fueling	Repair and adjust (See Group 35)
Engine Emits Excessive Blue or White Smoke	Aneroid defective	Repair and adjust (See Group 35)
	Cranking speed too low	Check batteries and electrical system
	Injection pump timing incorrect	Adjust timing (See this group)
	Injection nozzles faulty or sticking	Repair (See Group 35)
	Excessive wear in liners and/or piston rings stuck	Repair (See Group 10)
	Incorrect cetane fuel for ambient temperature	Use correct grade of fuel (See Group 02)
	Engine running too "cold"	Check thermostat (See Group 25)
Engine Idles Poorly	Injection nozzles faulty or sticking	Repair (See Group 35)
	Incorrect timing	Adjust timing (See this group)
	Pump slow idle speed not correctly adjusted	Adjust slow idle speed (See this group)
	Fuel lines restricted	Clean as required
	Water in fuel	Drain water from filter, (or separator if equipped). Install new filters (See Group 35)
	Injection pump return lines or fittings restricted	Clean as required
	Injection nozzle return lines clogged	Clean as required
	Low cetane fuel	Use correct grade of fuel (See Group 02)

Continued on next page

Fuel System Operation and Tests/Diagnose Fuel System Malfunctions

Symptom	Problem	Solution
Engine Does Not Develop Full Power	Low cetane fuel	Use correct grade of fuel (See Group 02)
	Incorrect timing	Adjust timing (See 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 (See this group)
	Incorrect fast idle speed	Adjust speed (See this group)
	Manifold pressure pipe to aneroid loose or broken	Repair as required
Fuel shut-off cable improperly adjusted	Adjust	

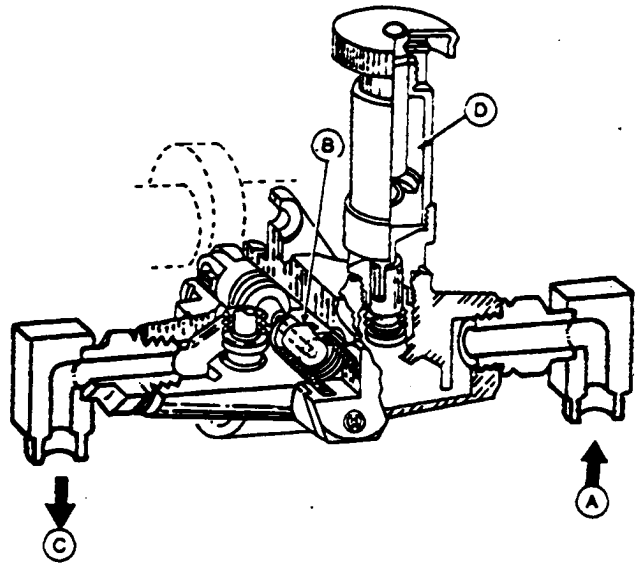
S11,23010,FC -19-24JUL95

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SUPPLY PUMP OPERATION

The plunger-type Robert Bosch or Nippondenso fuel supply pump is used on all 6619 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.

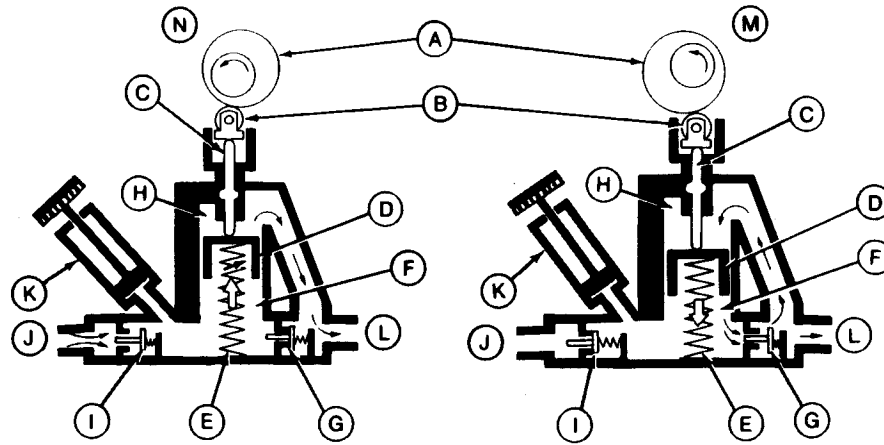
- A—Fuel Inlet
- B—Plunger
- C—Fuel Outlet
- D—Hand Primer



RG4451 -JUN-14SEP89

S11,23010,IH -19-24JUL95

FUEL SUPPLY PUMP OPERATION—(CONTINUED)



RG5787 -UN-06AUG91

A—Camshaft
B—Roller Tappet
C—Pressure Spindle
D—Plunger

E—Plunger Spring
F—Suction Chamber
G—Pressure Valve
H—Pressure Chamber

I—Suction Valve
J—Fuel Inlet
K—Hand Primer Pump
L—Fuel Outlet

M—Intermediate Stroke Position
N—Suction and Discharge Stroke Position

As the pump camshaft (A) rotates toward the “high cam” intermediate stroke position (M), the roller tappet (B) and pressure spindle (C) cause the plunger (D) to move against and compress the plunger spring (E).

Plunger movement forces the fuel out of the suction chamber (F), through the pressure valve (G), and into the pressure chamber (H). The amount of fuel discharged from the suction chamber is equal to the amount of fuel delivered for each stroke of the plunger. Towards the end of the intermediate stroke, the spring-loaded pressure valve closes again.

As the camshaft rotates toward the “low cam” or suction and discharge position (N), plunger spring pressure causes the plunger, pressure spindle, and roller tappet to follow the camshaft.

Movement of the plunger pushes the fuel from the pressure chamber and delivers it to the fuel filters and injection pump. At the same time, plunger suction pressure is permitting fuel to enter the suction chamber through the suction valve (I). With the suction chamber charged with fuel, the pumping cycle begins again.

Fuel is allowed to flow in around the pressure spindle to lubricate the spindle as it moves back and forth in housing. To prevent the fuel from entering the pump crankcase, a rubber O-ring is positioned in the spindle bore of housing at the roller tappet end.

Pulling upward on the hand primer pump (K) causes the suction valve to open and fuel to flow into the suction chamber. When the hand plunger is pushed downward, the suction valve closes, and fuel is forced out of the pressure valve.

RG,CTM9,115,3 -19-24JUL95

DIAGNOSING FUEL SUPPLY PUMP MALFUNCTIONS

IMPORTANT: Visually inspect the fuel inlet banjo fitting and pump filter for possible plugging before disassembling to determine cause of malfunction.

Symptom	Problem	Solution
Low Output Pressure	Restriction at fuel inlet fitting and/or pump filter.	Thoroughly clean fuel tank, lines, banjo fitting and filter.
	Hand primer not screwed down tight allowing dirt to enter hand primer plunger chamber.	Advise customer to tighten hand primer after use.
	Worn or pitted valves (and/or valve seats) caused by foreign material lodging in valve chamber.	Replace pump if valve seats are excessively worn; otherwise, replace valves as required.
	Missing or broken spring(s).	Replace spring(s).
	Broken spindle.	Replace pump.
Diesel Fuel Leaking into Injection Pump Crankcase	Worn spindle and/or pump housing.	Replace pump.
	Defective seal.	Replace seal.
Supply Pump Will Not Pump on P-Series Pump	Supply pump from A-Series Pump may have been installed.	Install correct supply pump on injection pump.
Supply Pump Mounting Flange Breaks When Mounted on A-Series Pump and Operated	Supply pump from P-Series Pump may have been installed.	Install correct supply pump on injection pump.

S11,3010,QW -19-24JUL95

CHECK SUPPLY PUMP OPERATION

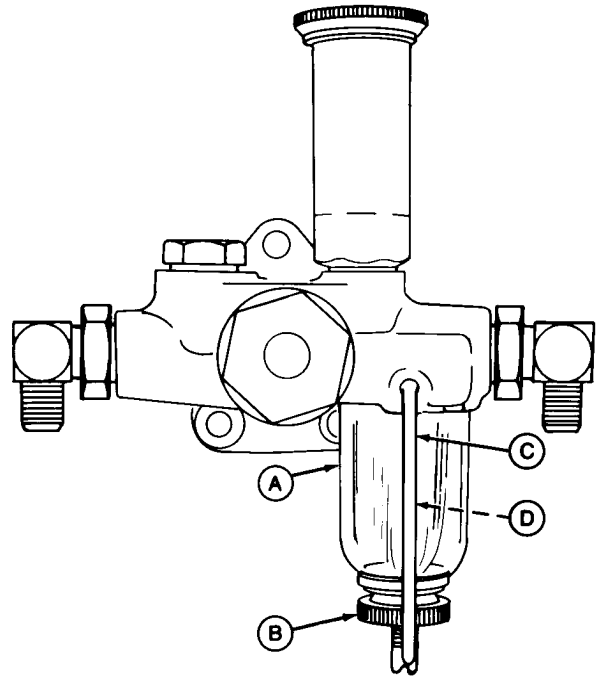
NOTE: The following procedure can best be performed under moderate air temperature conditions to reduce electrical loads when cranking the engine is required.

1. Make a preliminary inspection of supply pump. Thoroughly clean area around pump. All connections must be tight and not leaking. On supply pumps with a glass bowl (A) and filter (D), make sure fuel does not leak at bowl gasket. If fuel in glass bowl is contaminated or leaking, loosen clamping nut (B) on wire bail (C) and service the filter.

2. Start engine and bring to operating temperature. Shut-off engine.

NOTE: If fuel leaks around a hand primer (screwed down tight) when engine is running, replace the hand primer.

A—Glass Bowl C—Wire Bail
B—Nut D—Filter



S11,23010,FH -19-25JAN96

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-UN-03APR89
RG2825

• Check operation of hand primer:

1. With engine shut-off, unscrew knob (A) and operate hand primer through several strokes. Moderate to heavy leakage of fuel between plunger and barrel indicates seal is defective. Replace hand primer.

NOTE: Appearance of a slight quantity of fuel around the plunger is normal.

IMPORTANT: Tighten hand primer only when it is completely depressed in barrel, or internal threads can be damaged.

2. Tighten hand primer knob, but do not overtighten. If knob will not tighten (indicating internal thread damage), replace hand primer.



S11,23010,FI -19-24JUL95

-UN-09NOV89
RG3883

• **Test operation of suction side of pump:**

1. Disconnect suction and discharge lines at pump.
2. Drain all fuel from pump by operating hand primer. Then reconnect suction line to pump.
3. Operate hand primer until fuel flows from pump outlet (discharge). Fuel should flow within 15—25 strokes. If not, the suction line may be obstructed or leaking air; (replace in-line filter when used).

NOTE: When operating hand primer, a moderate resistance should be felt. When only a slight resistance (or no resistance) occurs, replace hand primer or repair pump (valves may be defective).

If fuel does not flow, and if no leak or obstruction is found, pump is defective. Repair or replace pump. (See Group 35.)

• **Test operation of discharge side of pump:**

1. Suction line must be connected and discharge (pressure) line disconnected.
2. Tighten hand primer (Nippondenso only) and place injection pump fuel shut-off control in "STOP" position to prevent engine from starting.
3. Crank engine with starting motor. Fuel should flow from pump outlet within 10 seconds. If not, the suction line may be obstructed or leaking air; (replace in-line filter when used).

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S11,23010,FJ -19-14FEB95

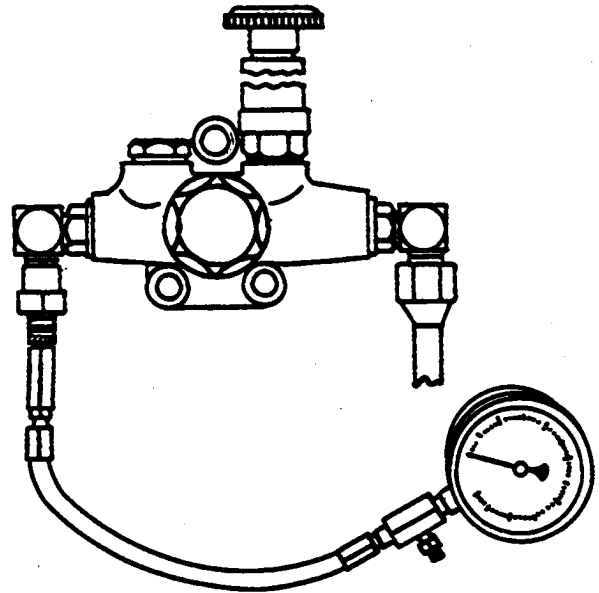
• **Test pump output pressure while cranking engine with starting motor.**

1. Connect a 0—400 kPa (0—4 bar) (0—60 psi) pressure gauge to one end of a pressure hose about 250—300 mm (10—12 in.) long. Connect other end of hose to pump outlet. All air must be out of system.

IMPORTANT: The starting motor must crank the engine at normal cranking speed. Use booster batteries if necessary.

2. Crank engine for 10 seconds with starting motor (approximately 200 engine rpm).

3. Compare measured output with the following minimum pressure specifications. If pressure is below the minimum specified and no obstruction or leak is found, repair or replace the pump.



BOSCH SUPPLY PUMPS

JD Part No.	Model No.	Min. Output Press.
AR63831	FP/KE22AD290	100 kPa (1 bar) (14.5 psi)
AR89955	FP/KE22P42	100 kPa (1 bar) (14.5 psi)
AR89956	FP/KE22AD299	100 kPa (1 bar) (14.5 psi)
RE10605	FP/K22P54	200 kPa (2 bar) (29 psi)
RE12386	FP/KE22AD306	200 kPa (2 bar) (29 psi)
RE18708	FP/KE22AD306-1	200 kPa (2 bar) (29 psi)

NIPPONDENSO SUPPLY PUMPS

AR81819	ND-FP/KE22PND90	100 kPa (1 bar) (14.5 psi)
AR89553	ND-FP/KE22PND108	100 kPa (1 bar) (14.5 psi)
AR96288	ND-FP/KE22ACND126	100 kPa (1 bar) (14.5 psi)
RE10588	ND-FP/KE22PND146	200 kPa (2 bar) (29 psi)
RE11188	ND-FP/KE22ACND150	200 kPa (2 bar) (29 psi)

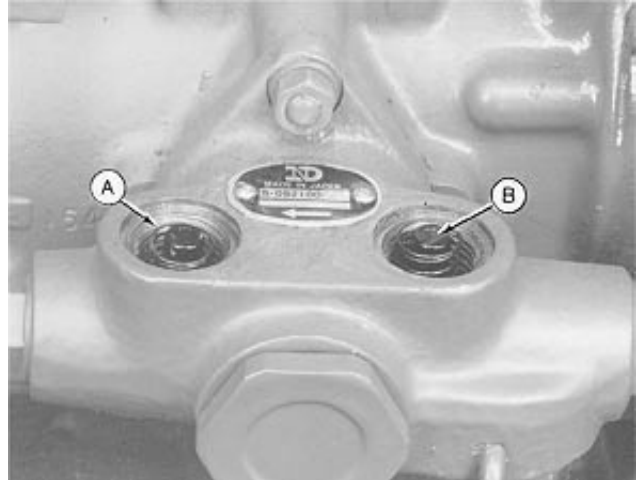
S11,23010,FL -19-25JAN96

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RG4642 -JUN-14DEC88

SERVICE SUPPLY PUMP

1. To gain access to the valves, remove hand primer and plug from top of supply pump (shown removed).
2. Remove valves (B) and springs (A).
3. Inspect valves and valve seats for foreign material, wear or pitting. Valve springs must not be cracked or broken.
4. Reassemble parts, open tank shut-off valve, and check operation. If pump operation is still not normal, the pump will have to be repaired or replaced. (See Group 35.)



RG78153D1 -UN-14DEC88

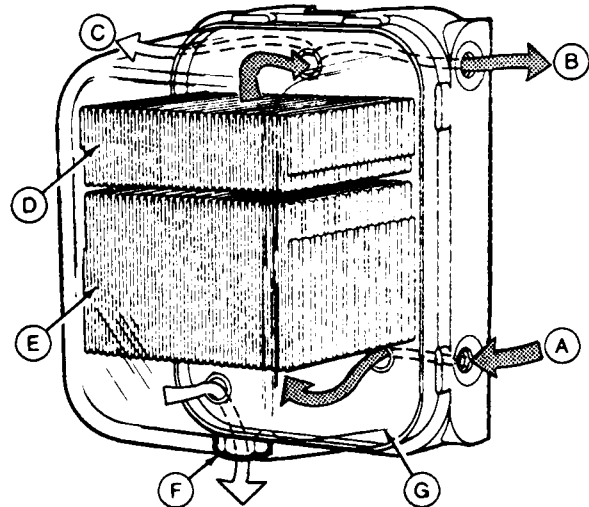
S11,23010,IJ -19-24JUL95

FUEL FILTER OPERATION

Fuel enters the filter at (A) and flows through a first stage filtering media (E) and a second stage filtering media (D) before flowing through outlet (B) to the injection pump. The filtering media is housed in the metal sediment bowl (G) and epoxied to the bowl as one assembly.

Since water and other contaminants may settle to the bottom of the sediment bowl, a drain plug (F) is provided to permit their removal.

An air vent (C) enables air in the fuel system to be expelled to the outside through the filters when bleed plug is removed.



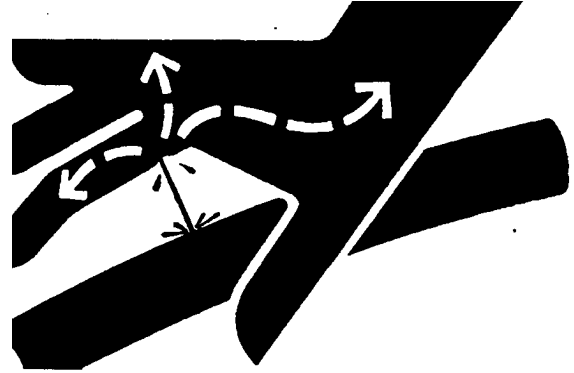
R26812 -UN-28APR89

- A—Inlet
- B—Outlet
- C—Air Vent
- D—Second Stage Filtering Media
- E—First Stage Filtering Media
- F—Drain Plug
- G—Sediment Bowl

S11,23010,I -19-24JUL95

BLEED FUEL SYSTEM

⚠ CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.



If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

Whenever the fuel system has been opened up for service (lines disconnected or filters removed), it will be necessary to bleed air from the system.

The fuel system may be bled at one of several locations. On some engine applications it may be necessary to consult your operator's manual and choose the location best for your engine/machine application.

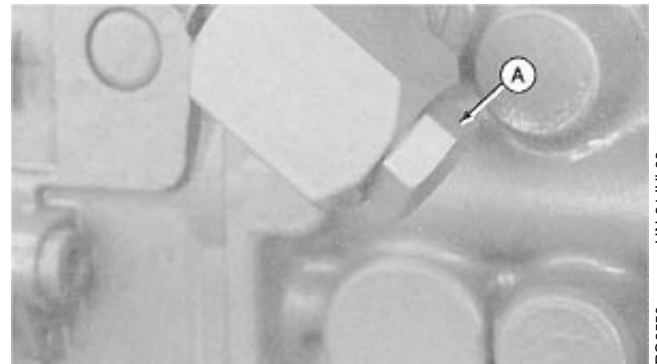
S11,0408,AC -19-20JUL95

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X9811

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•At Fuel Filter or Final Fuel Filter

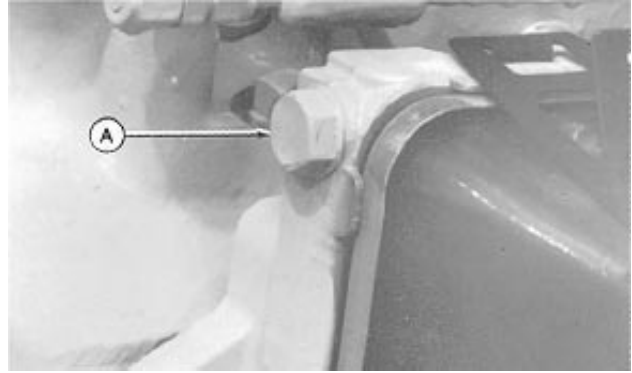
On 6619 AR11, 12, 14 Engines, Serial No. (—052657), loosen port plug (A) on final filter tee body at least three or four turns.



S11,0408,AC,1 -19-20JUL95

-UN-31JUL89
RG3550

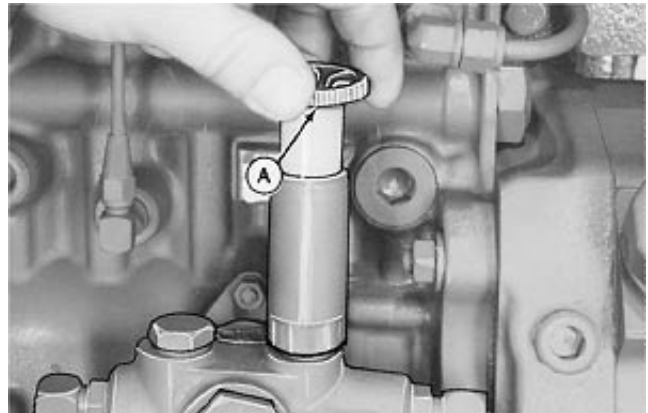
On all other engines, loosen bleed plug (A) on fuel filter base.



RG3400 -UN-20DEC88

S11,3010,PL -19-20JUL95

1. Unscrew hand primer (A) on fuel supply pump until it can be pulled by hand.
2. Operate the hand primer until a smooth flow of fuel, free of bubbles, comes out of the filter plug hole.
3. Simultaneously stroke the hand primer down and close the port plug. This prevents air from entering the system. Tighten plug securely, but DO NOT overtighten.



RG3955 -UN-20DEC88

IMPORTANT: Hand primer must be all the way down in barrel to prevent internal thread damage.

4. Lock hand primer in position.

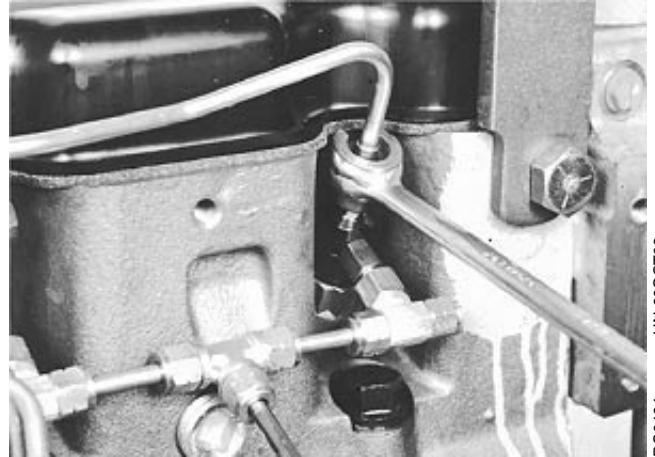
NOTE: If the engine will not start, it may be necessary to loosen the fuel lines at the injection nozzles to bleed air from system.

S11,3010,PM -19-20JUL95

• **At Fuel Injection Nozzles**

NOTE: If the engine will not start, it may be necessary to loosen the fuel lines at the injection nozzles to bleed air from system.

1. Put the hand throttle in fast idle position.
2. Loosen fuel line connection at No.1 injection nozzle.
3. Push the engine fuel shut-off control knob all the way in. Turn the engine with the starter until fuel without air flows from the loose fuel pipe connections.
4. Retighten the connections.
5. Repeat procedure at remaining nozzles (if necessary) until all air has been expelled from fuel system.



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RG6484

S11,0408,AF -19-10AUG94

DIAGNOSE FUEL INJECTION PUMP MALFUNCTIONS

Symptom	Problem	Solution
Engine Starts Hard or Won't Start	Incorrect fuel shut-off lever position (pump control rack not moving all the way forward)	Adjust shut-off cable as required
	Defective injection pump	Remove pump from engine and repair (See Group 35)
	Injection pump not correctly timed	Check pump timing
Slow Idle Speed Irregular	Slow idle stop screw improperly adjusted	Recheck stop screw adjustment
	Supplementary idling spring improperly adjusted	Recheck adjustment
	Defective injection pump	Remove pump from engine and repair (See Group 35)
Engine Horsepower Low	Pump not properly timed	Check pump timing
	Defective injection pump	Remove pump from engine and repair (See Group 35)

S11,23010,FQ,9 -19-24JUL95

HOW THE FUEL INJECTION PUMP WORKS

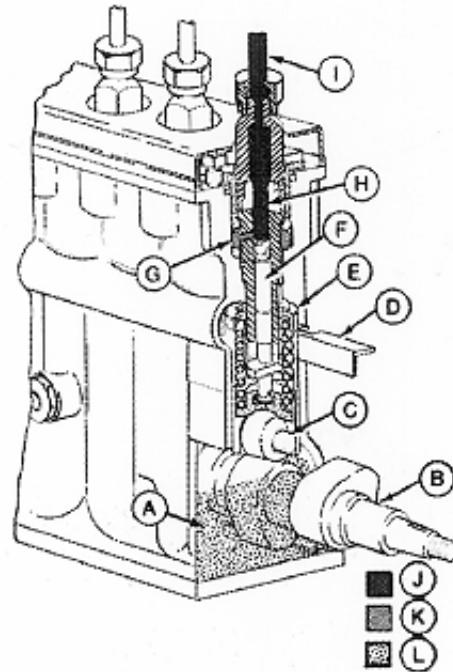
The fuel injection pump is a multiple-plunger, in-line type pump equipped with a mechanical flyweight governor and aneroid control. An engine-driven gear on the pump camshaft drives the pump at one-half engine speed.

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18 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 to the engine through the timing gear housing.

For injection pump repair and testing, see an authorized diesel injection repair station.



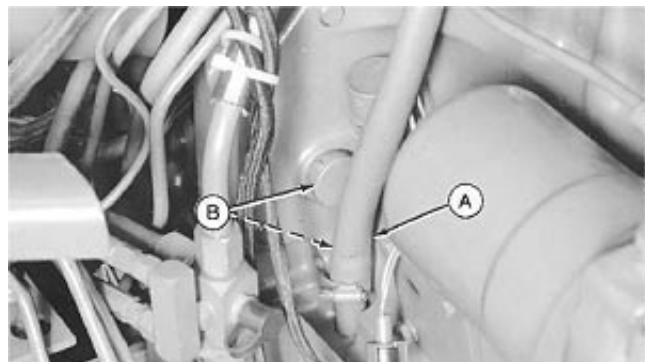
Section View of P-110 Injection Pump

- A—Crankcase
- B—Camshaft
- C—Roller Tappet
- D—Control Rack
- E—Control Sleeve
- F—Plunger
- G—Fuel Gallery
- H—Delivery Valve
- I—Delivery Pipe
- J—Injection Pressure
- K—Supply Pump Pressure
- L—Engine Lubricating Oil

S11,23010,IN -19-24JUL95

CHECK AND ADJUST INJECTION PUMP TIMING

1. Remove vent tube (A) from hole in cylinder block. Remove two plastic plugs (B) from timing holes.

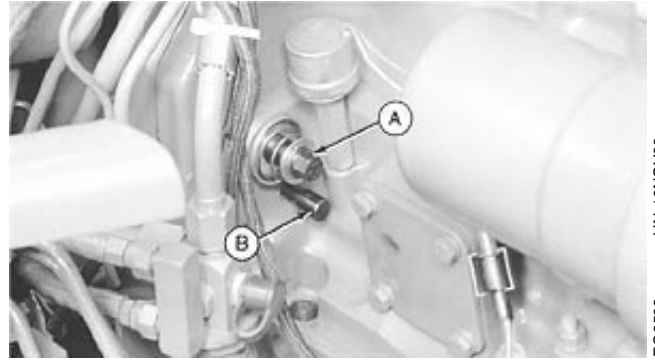


S11,23010,IO -19-24JUL95

Fuel System Operation and Tests/Check and Adjust Injection Pump Timing

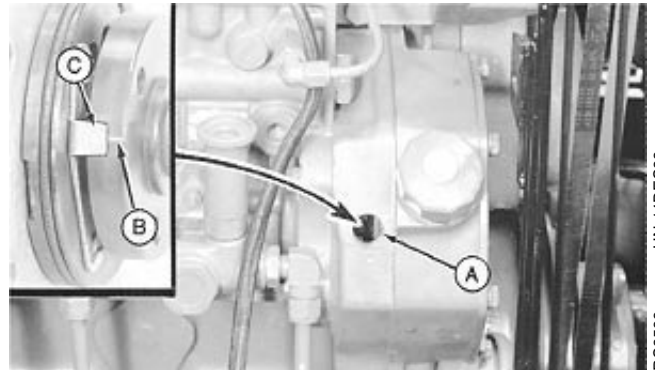
2. Install JDE81-1 Engine Rotation Tool (A) and JDE81-4 Timing Pin (B) in flywheel housing.

3. Position engine at TDC, with No. 1 piston on the compression stroke.



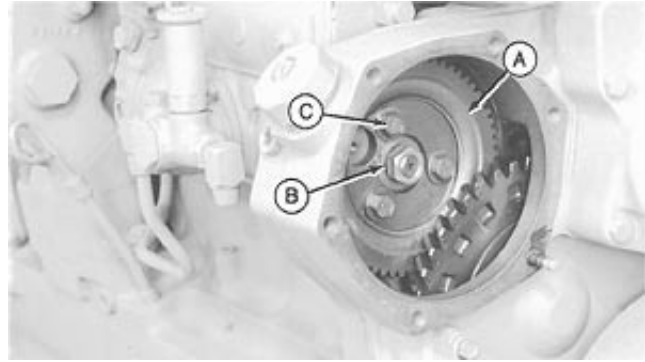
S11,23010,BJ1 -19-24JUL95

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.



S11,23010,BK -19-18APR94

IMPORTANT: The normal backlash of gears is enough to throw the pump timing off by several degrees, resulting in poor engine performance. Therefore, it is very important that pump timing be rechecked after it has been installed. To avoid backlash, always approach the timing mark on pointer by rotating crankshaft in direction of normal engine rotation.



RG3879 -UN-20DEC88

NOTE: Normal engine rotation is counter-clockwise, viewed from flywheel end.

5. If the timing marks are not aligned when timing pin enters hole in flywheel, remove timing pin from the flywheel. Rotate the flywheel 1-1/2 revolutions opposite direction of normal rotation. Replace the timing pin and rotate in direction of normal rotation until timing pin engages hole in flywheel. If timing marks are still not aligned, loosen the pump drive gear (A) cap screws (C). Rotate pump drive hub (B) and bring pump hub timing marks into alignment. Repeat timing check to be sure marks are aligned. Install timing hole plug.

6. Tighten injection pump drive gear-to-pump hub cap screws to:

- 47 N·m (35 lb-ft) on A-Series injection pumps.
- 61 N·m (45 lb-ft) on P-Series injection pumps.

7. Install injection pump gear cover using a new gasket and tighten cap screws to 27 N·m (20 lb-ft).

S11,23010,IP -19-24JUL95

CHECK ENGINE FAST IDLE SPEED

IMPORTANT: Injection pump fast idle adjustment should only be done by a authorized diesel repair station or qualified OEM dealer or John Deere Engine Distributor.

1. With the engine running, move governor control lever (A) against the fast idle stop screw (B).

NOTE: The governor control lever on injection pump may be inboard (next to engine block) or outboard (away from engine block), depending upon engine application.

2. Using a tachometer, check engine fast idle speed to see if it is within specifications given below:

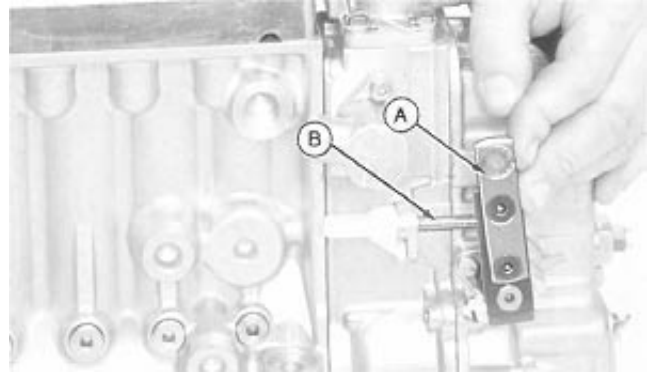
FAST IDLE SPECIFICATIONS

6619AF 3—5% Governor 1850—1890 rpm
6619AF 8—10% (Standard) Governor 2370—2420 rpm

NOTE: The above speeds are for OEM applications only. Refer to the appropriate machine technical manual for all other applications.

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.



RG3600
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S11,23010,M,9 -19-25JAN96

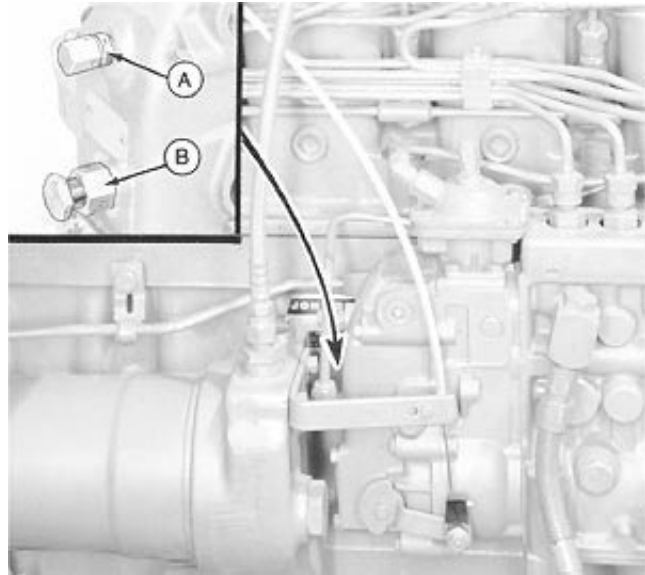
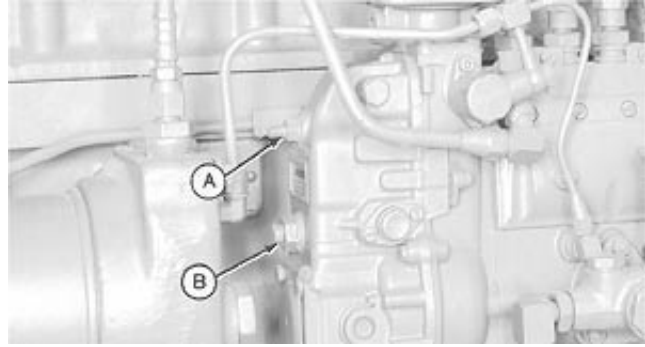
CHECK AND ADJUST SLOW IDLE SPEED

NOTE: Both the slow idle stop screw (A) and the supplementary idling spring (B) may be used to adjust the slow idle speed.

IMPORTANT: Minor adjustment of the slow idle speed may be made with the supplementary idling spring screw. However, it should not be used by itself to change engine speed more than 20 rpm, as overspeeding of the engine may result.

If slow idle stop screw and supplementary idling spring screw are not adjusted according to instruction, engine damage could result because of overspeeding.

CAUTION: ALWAYS STOP ENGINE before making adjustments.



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RG4144

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RG3608

S11,23010,IS -19-25JAN96

1. With the engine running, pull the governor control lever rearward to the slow idle speed position. Check and adjust slow idle speed to the following specification.

6619AF Engines 800—850 rpm

NOTE: The above specification is for OEM applications only. Refer to the appropriate machine technical manual for all other applications.

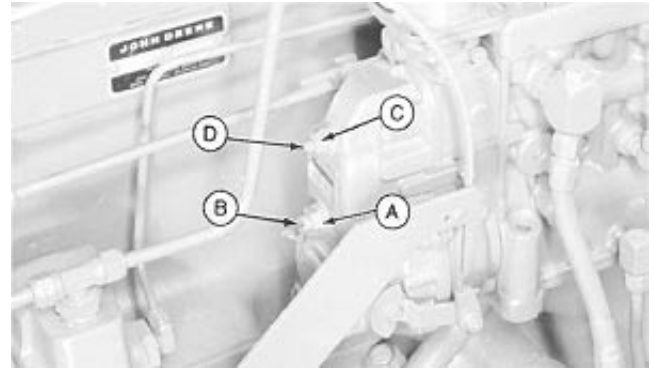
S11,23010,IT -19-25JAN96

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.



Bosch Shown (Nippondenso similar)

- A—Lock Nut
- B—Bumper Spring Adjusting Screw
- C—Lock Nut
- D—Slow Idle Stop Screw

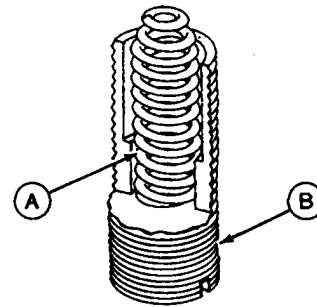
S11,23010,BU -19-10AUG94

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.



S11,23010,BW -19-10AUG94

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R28387N

HOW THE ANEROID WORKS

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).

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24 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).

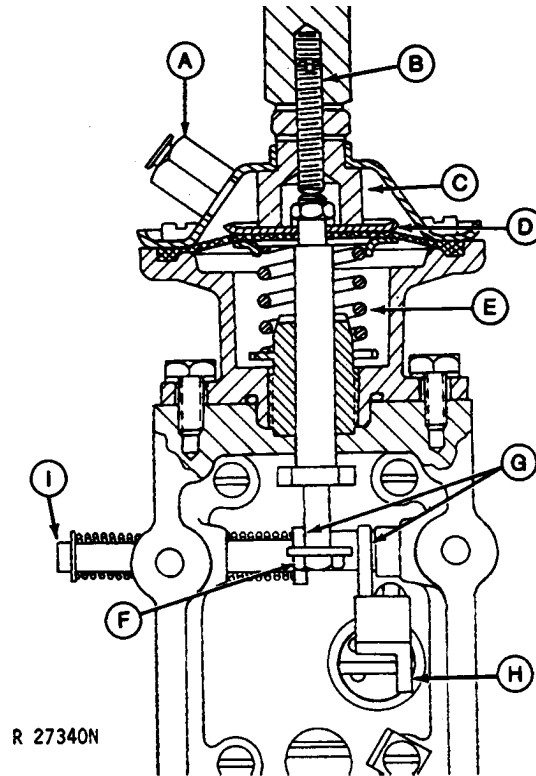
Downward movement of the adjusting shaft causes arm to rotate on starting fuel control shaft (I), permitting control rack to move its normal amount.

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.



- 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

-JUN-14DEC88
R27340N

DIAGNOSE ANEROID MALFUNCTIONS

Symptom	Problem	Solution
Slow Engine Acceleration	Loose pipe or broken connection at inlet fitting	Repair as required. (See Group 35)
	Aneroid cover cracked around inlet fitting	Repair as required. (See Group 35)
	Defective diaphragm	Repair as required. (See Group 35)
	Aneroid not correctly adjusted	Remove injection pump (See Group 35) and adjust on test stand.
Excessive Smoke When Accelerating Engine	Aneroid not correctly adjusted	Remove injection pump. (See Group 35) and adjust on test stand.

S11,23010,IV -19-24JUL95

Use information contained in the chart above to help diagnose aneroid malfunctions.

See Group 35 for instructions on how to repair and adjust the aneroid.

The aneroid controls fuel delivery when intake manifold pressure is about 100 kPa (1 bar) (15 psi) or less. Therefore, all final adjustments are to be made on the test stand with aneroid mounted on injection pump.

IMPORTANT: Correct aneroid adjustments are essential for satisfactory engine performance. Whenever the aneroid has been disassembled or the adjustments have been altered, the injection pump (including aneroid) must be calibrated on the test stand by an authorized diesel injection repair station before releasing the pump for service.

S11,23010,IV1 -19-09SEP91

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HOW THE HYDRAULIC ANEROID ACTIVATOR WORKS

The hydraulic aneroid activator mounts on the inboard side of the governor housing. It has an internal piston (F) that is operated by engine oil pressure to hydraulically move the starting fuel control shaft inward for aneroid control.

Engine lubricating oil is piped from the oil filter body to operate the activator. This oil is then piped to the injection pump housing to lubricate the internal working parts.

When 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).

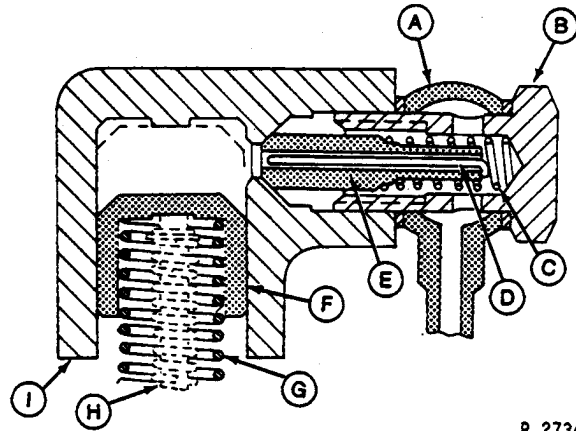
Whenever the engine oil pressure is about 60 kPa (0.6 bar) (9 psi) or higher, the piston will overcome resistance of piston spring (G) and move the starting fuel control shaft (H) inward to provide aneroid control.

Loss of oil pressure permits a return spring on the starting fuel control shaft to hold the lever arm out of engagement with the control rack. This prevents the aneroid from limiting rack travel.

A restrictor wire (D) is inserted in the capillary valve for two reasons:

- (1) To retard engagement of the aneroid when engine is cold.
- (2) To help maintain an open passage in the capillary valve (oil pressure action moves the wire enough to prevent orifice from plugging).

The length of time required to achieve aneroid control depends on the ambient air temperature and the viscosity of the engine oil. Warm ambient air temperatures will permit the aneroid to activate in a few seconds. Cold temperatures may delay activation for several minutes.



R 27342N
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- A—Activator Banjo Connector
- B—Special Screw
- C—Capillary Valve Spring
- D—Restrictor Wire
- E—Capillary Valve
- F—Piston
- G—Piston Spring
- H—Starting Fuel Control Shaft
- I—Activator Housing

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

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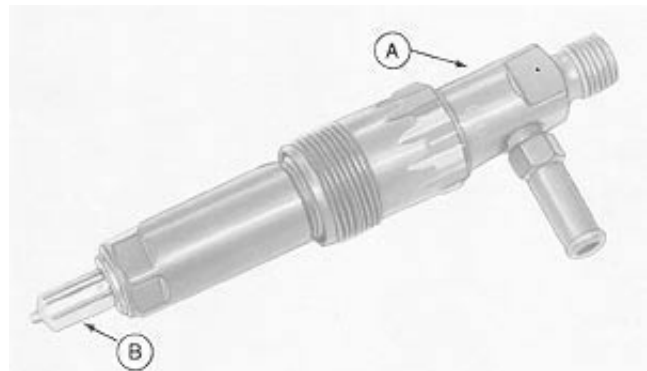
DIAGNOSE MALFUNCTIONS—HYDRAULIC ANEROID ACTIVATOR

Symptom	Problem	Solution
Engine Starts Hard	Broken return spring on starting fuel control shaft.	Repair (See Group 35)
	Retaining ring missing from starting fuel control shaft.	Repair (See Group 35)
Excessive Smoke When Accelerating Engine	Restriction in oil supply passages to activator piston.	Disassemble, clean and inspect activator (See Group 35)

S11,23010,IW -19-24JUL95

FUEL INJECTION NOZZLES—GENERAL INFORMATION

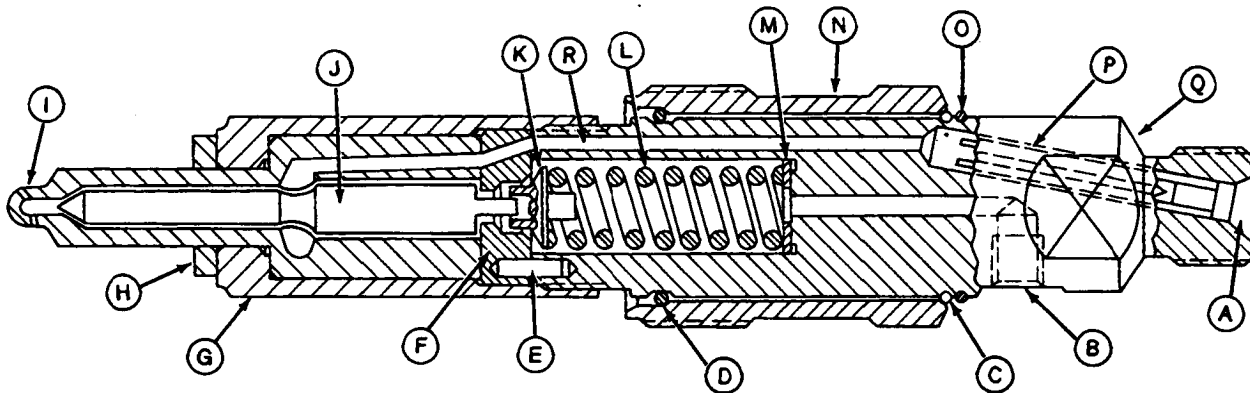
The KDEL 21 mm injection nozzle consists of the nozzle holder (A) and the DLLA nozzle assembly (B).



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S11,23010,AE -19-18APR94

FUEL INJECTION NOZZLES—GENERAL INFORMATION—CONTINUED



RG2242

-UN-14DEC88

RG2242

- | | | | |
|-----------------------|------------------------|---------------|--------------------|
| A—Fuel Inlet | F—Intermediate Plate | K—Spring Seat | O—Snap Ring |
| B—Leak-Off Connection | G—Nozzle Retaining Nut | L—Spring | P—Edge-Type Filter |
| C—O-Ring | H—Washer | M—Shims | Q—Nozzle Holder |
| D—Snap Ring | I—Nozzle | N—Gland Nut | R—Fuel Passage |
| E—Dowel Pin | J—Valve | | |

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 51 700 kPa (517 bar) (7500 psi) on A-sized pumps, and 69 000 kPa (690 bar) (10,000 psi) on P-sized pumps. Fuel pipes (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.

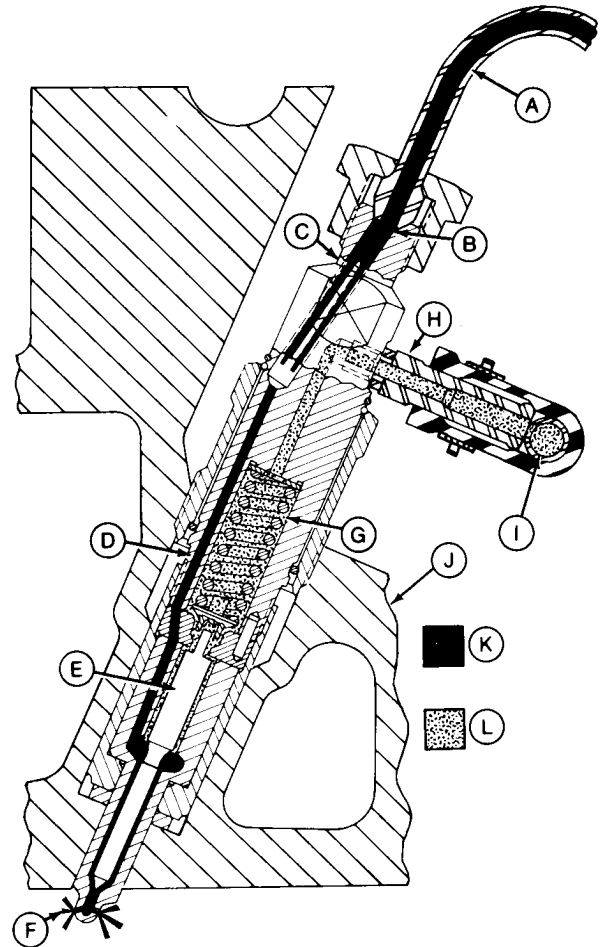
A passage (D) routes fuel through the nozzle holder to the nozzle valve (E). The nozzle valve is lifted instantly off its seat by the high pressure inlet fuel acting on an annulus in the valve.

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 definitive 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, accumulating around the spring (G).

The leakage fuel is routed out the nozzle holder through a leak-off connector (H) and returned back to the fuel tank by means of a leak-off pipe (I).



Fuel Flow Through KDEL Injection

- | | |
|-----------------------|------------------------|
| A—Fuel Delivery Pipe | H—Leak-Off Connector |
| B—Fuel Inlet | I—Leak-Off Pipe |
| C—Edge-Type Filter | J—Engine Cylinder Head |
| D—Fuel Passage | K—High Pressure Fuel |
| E—Nozzle Valve | L—Return Fuel |
| F—Orifices | |
| G—Nozzle Valve Spring | |

S11,23010,IX -19-24JUL95

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RG4651 -UN-29AUG94

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)

TEST FUEL INJECTION NOZZLES (ENGINE RUNNING)

1. Operate engine at intermediate speed with no load.
2. Slowly loosen the fuel pressure line at one of the nozzles until fuel escapes at the connection (fuel not opening nozzle valve).

NOTE: The injection nozzle before and/or after nozzle being checked could be the faulty nozzle.

- If engine speed changes, the injection nozzle is probably working satisfactory.
 - If engine speed does not change, a nozzle is faulty and must be checked and repaired (or replaced).
3. Repeat test for each remaining nozzle assembly.
 4. Remove faulty injection nozzles and repair as required. (See Group 35.)

S11,23010,HR -19-24JUL95

FUEL DRAIN BACK TEST PROCEDURE

Fuel draining back through the fuel system may cause hard starting. This procedure will determine if air is entering the system at connections and allowing fuel to siphon back to the fuel tank.

1. Disconnect fuel supply and return lines at fuel tank.

IMPORTANT: Fuel return line MUST extend below fuel level in fuel tank before performing this test. Fill fuel tank if necessary.

2. Drain all fuel from the system, including the fuel transfer pump, fuel injection pump, fuel filters, and water separator (if equipped).
3. Securely plug off the end of the fuel return pipe.



CAUTION: Maximum air pressure should be 100 kPa (1 bar) (15 psi) when performing this test.

4. Using a low pressure air source, pressurize the fuel system at the fuel supply line.

5. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

NOTE: Connections may allow air to enter the system without allowing fuel to leak out.

6. If any leaks are found, take necessary steps to repair.
7. Reconnect supply and return lines and prime system.
8. Start engine and run for approximately 10 minutes.
9. Allow engine to sit overnight and try starting the following morning.

S11,23010,JA -19-24JUL95

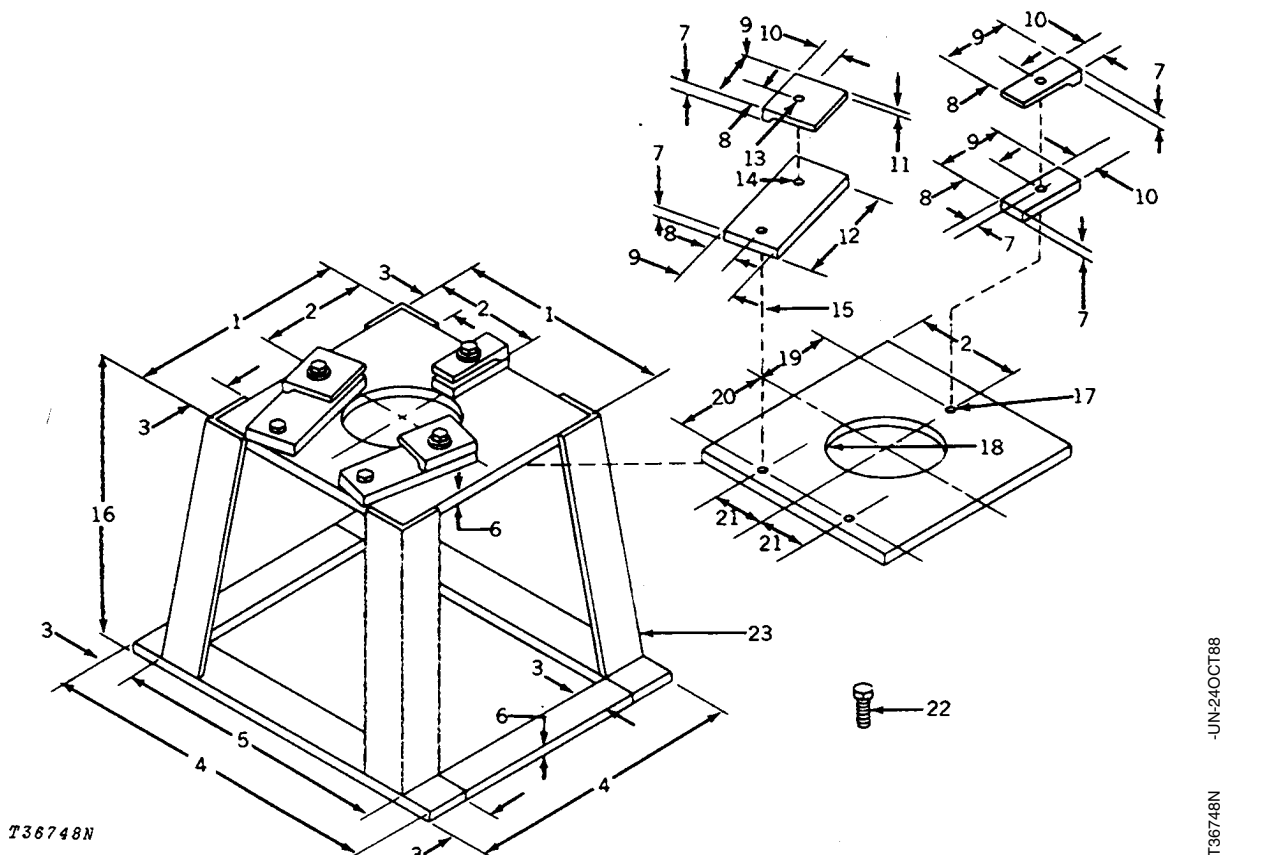
HOW TO MAKE TOOLS

These tools can be made in a service shop using common shop tools and locally obtained materials.

S55,DFRG -19-24JUL95

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CYLINDER LINER HOLDING FIXTURE



- 1—254.0 mm (10 in.)
- 2—127.0 mm (5 in.)
- 3—38.1 mm (1.5 in.)
- 4—406.4 mm (16 in.)
- 5—330.2 mm (13 in.)
- 6—9.52 mm (0.375 in.)
- 7—12.7 mm (0.5 in.)

- 8—31.8 mm (1.25 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)
- 22—5/16 in. x 1 in. Cap Screw
- 23—38.1 mm (1.5 in.) Angle Iron

NOTE: This tool can be made in a service shop using common shop tools and locally obtained materials.

T36748N -UN-24OCT88

S11,9900,BE -19-24JUL95

Fabricated Tools/Cylinder Liner Holding Fixture

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