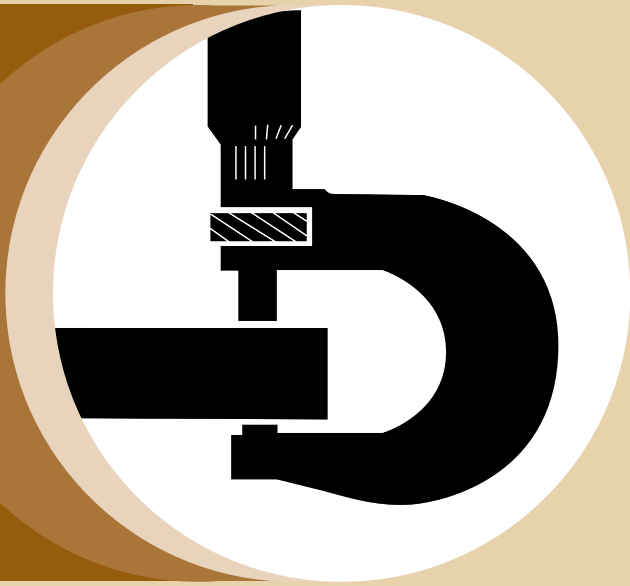
6076
Engines

Serial Number (—499999)

COMPONENT
TECHNICAL
MANUAL



Deere Power Systems Group

CTM6 (03OCT91)

LITHO IN U.S.A.

ENGLISH

JOHN DEERE

DEERE POWER

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 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 diagnostics. Repair sections contain necessary instructions to repair the component. Diagnostic 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 torques.

Binders, binder labels, and tab sets can be ordered by John Deere dealers direct from the John Deere Distribution Service Center.

This manual is part of a total product support program.

FOS MANUALS—REFERENCE

TECHNICAL MANUALS—MACHINE SERVICE

COMPONENT MANUALS—COMPONENT SERVICE

Fundamentals of Service (FOS) Manuals cover basic theory of operation, fundamentals of troubleshooting, general maintenance, and basic type of failures and their causes. FOS Manuals are for training new personnel and for reference by experienced technicians.

Technical Manuals are concise guides for specific machines. Technical manuals are on-the-job guides containing only the vital information needed for diagnosis, analysis, testing, and repair.

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

MANUAL ORGANIZATION

CTM6,IFC -19-24SEP91

Dealer Presentation Sheet

JOHN DEERE DEALERS

IMPORTANT: The important changes listed below make your current CTM obsolete. Discard CTM6, dated 15 Sep 89. Please remove this page and route through your service department.

Engine application charts have been updated to include new product models. See ENGINE APPLICATION CHART in Group 01.

Revised the engine oil module. See DIESEL ENGINE OIL in Group 02.

Revised the engine coolant module. See ENGINE COOLANT RECOMMENDATIONS in Group 02.

Revised valve lift specifications in Groups 05 and 105.

Included torque-turn procedure for tightening flanged-head cylinder head cap screws. See TORQUE-TURN FLANGED-HEAD CAP SCREWS in Group 05.

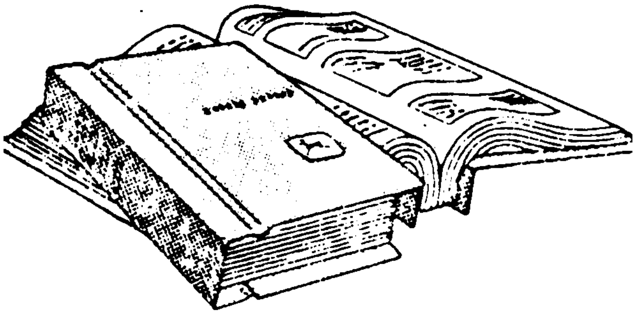
Added information on the manufacturing date codes stamped on cylinder liners. See INSTALL CYLINDER LINERS in Group 10.

Revised removal and installation procedures for the axuiliary drive in Groups 15 and 16.

Provided crankcase oil fill quantities for all 6076 engine applications. See ENGINE CRANKCASE OIL FILL QUANTITIES in Group 20.

CTM6,DPS -19-20MAR91

ABOUT THIS MANUAL



This Component Technical Manual (CTM6) covers the recommended repair procedure for all 6076, 7.6 L (466 cu. in.) diesel engines, serial no. (—499999), and produced in Waterloo, Iowa. For repair information on 6076 engines produced after serial no. (499999—) refer to CTM42.

Before beginning repair of an engine, clean engine and mount on a repair stand. (See ENGINE MOUNTING in Group 03.)

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

Follow only the procedures that apply to the engine model number you are working on. If only one procedure is given, that procedure applies to all 6076 diesel engines in this manual.

S55,2000,DA -19-24SEP91

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.

DX,FLAME -19-04JUN90

PREVENT BATTERY EXPLOSIONS

Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.

Never check battery charge by placing a metal object across the posts. Use a volt-meter or hydrometer.

Do not charge a frozen battery; it may explode. Warm battery to 16°C (60°F).

TS204 -UN-23AUG88

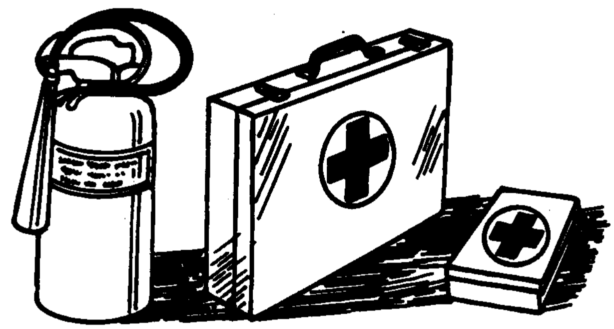
DX,SPARKS -19-04JUN90

PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

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



TS291 -UN-23AUG88

DX,FIRE2 -19-04JUN90

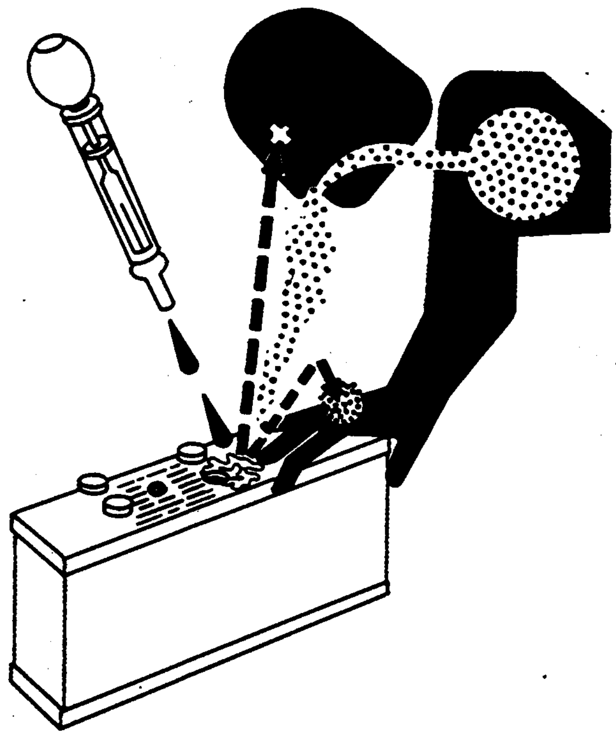
PREVENT ACID BURNS

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 10—15 minutes. Get medical attention immediately.

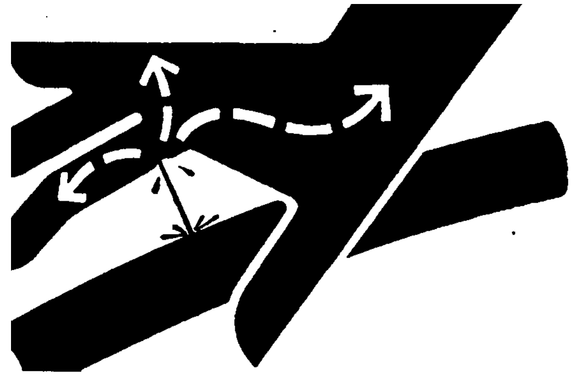
If acid is swallowed:
1. Drink large amounts of water or milk.
2. Then drink milk of magnesia, beaten eggs, or vegetable oil.
3. Get medical attention immediately.



TS203 -UN-23AUG88

DX,POISON -19-04JUN90

AVOID HIGH-PRESSURE FLUIDS



X9811 -UN-23AUG88

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

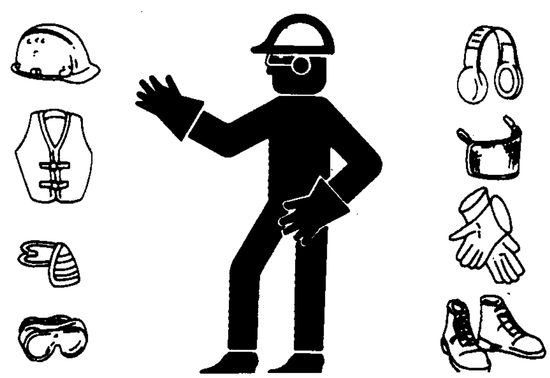
Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

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

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

DX,FLUID -19-09AUG91

WEAR PROTECTIVE CLOTHING



TS206 -UN-23AUG88

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

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

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

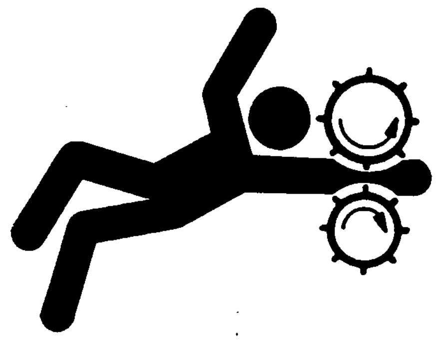
Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.

DX,WEAR -19-10SEP90

SERVICE MACHINES SAFELY

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

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



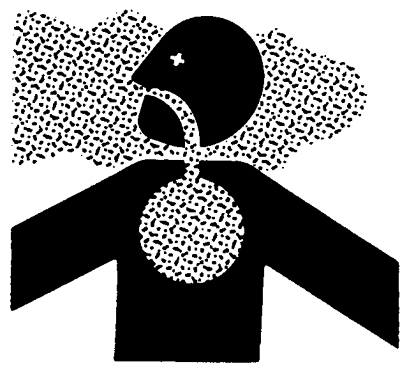
TS228 -UN-23AUG88

DX,LOOSE -19-04JUN90

WORK IN VENTILATED AREA

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

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

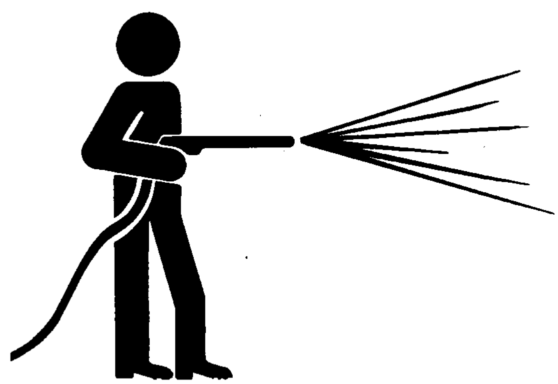


TS220 -UN-23AUG88

DX,AIR -19-04JUN90

WORK IN CLEAN AREA

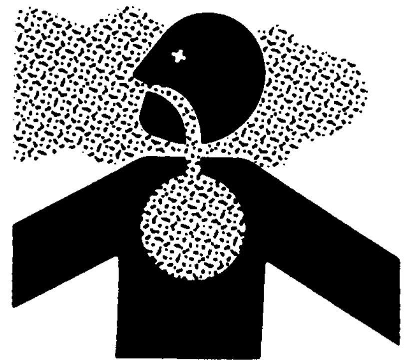
Before starting a job:
• Clean work area and machine.
• Make sure you have all necessary tools to do your job.
• Have the right parts on hand.
• Read all instructions thoroughly; do not attempt shortcuts.



T6642EJ -UN-18OCT88

DX,CLEAN -19-04JUN90

REMOVE PAINT BEFORE WELDING OR HEATING



TS220 -UN-23AUG88

Avoid potentially toxic fumes and dust.

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

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

Remove paint before welding or heating:

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

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

DX,PAINT -19-04JUN90

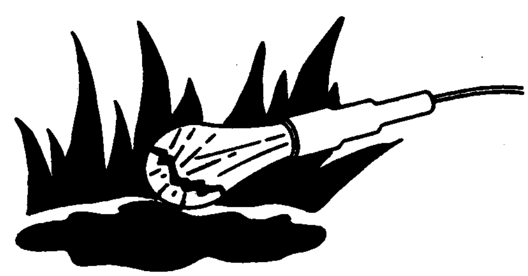
AVOID HEATING NEAR PRESSURIZED FLUID LINES

TS953 -UN-15MAY90

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

DX,TORCH -19-05OCT90

ILLUMINATE WORK AREA SAFELY



TS223 -UN-23AUG88

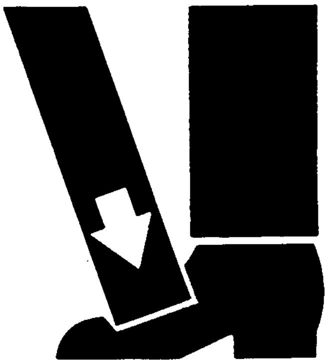
Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

DX,LIGHT -19-04JUN90

USE PROPER LIFTING EQUIPMENT

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

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



TS226 -UN-23AUG88

DX,LIFT -19-04JUN90

AVOID HARMFUL ASBESTOS DUST

Avoid breathing dust that may be generated when handling components containing asbestos fibers. Inhaled asbestos fibers may cause lung cancer.

Components in products that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates, and some gaskets. The asbestos used in these components is usually found in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust containing asbestos is not generated.

Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding material containing asbestos. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If not available, apply a mist of oil or water on the material containing asbestos.

Keep bystanders away from the area.

TS220 -UN-23AUG88

DX,DUST -19-15MAR91

PRACTICE SAFE MAINTENANCE

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

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

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

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

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

TS218 -UN-23AUG88

DX,SERV -19-04JUN90

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.

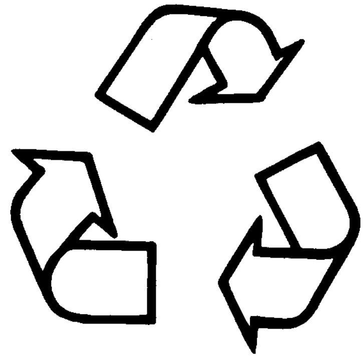
For loosening and tightening hardware, use the correct size tools. DO NOT use U.S. measurement tools on metric fasteners. Avoid bodily injury caused by slipping wrenches.

Use only service parts meeting John Deere specifications.

TS779 -UN-08NOV89

DX,REPAIR -19-04JUN90

DISPOSE OF WASTE PROPERLY



TS1133 -UN-26NOV90

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

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

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

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

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

DX,DRAIN -19-09AUG91

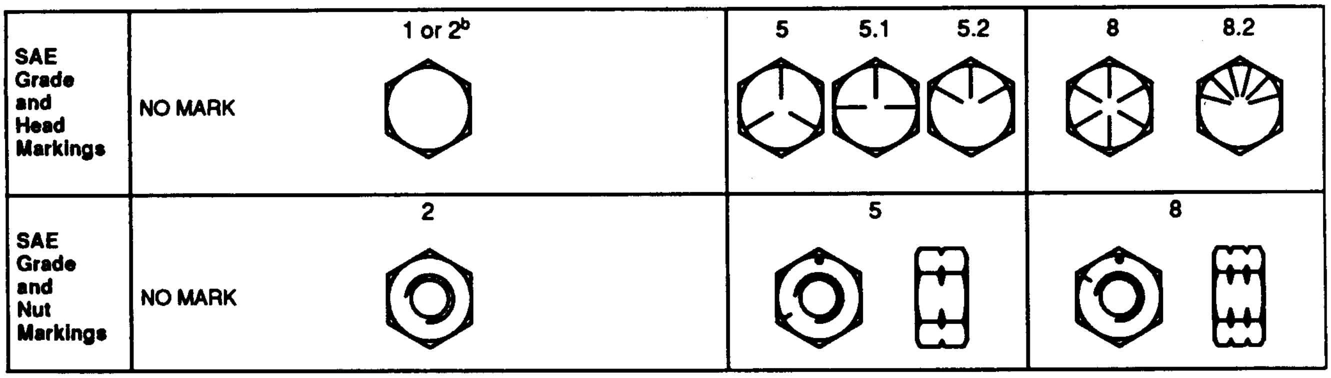
LIVE WITH SAFETY

TS231 -19-07OCT88

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

DX,LIVE -19-04JUN90

UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES



TS1162 -19-04MAR91

Size	Grade 1				Grade 2[b]				Grade 5, 5.1, or 5.2				Grade 8 or 8.2			
	Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]	
	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft
1/4	3.7	2.8	4.7	3.5	6	4.5	7.5	5.5	9.5	7	12	9	13.5	10	17	12.5
5/16	7.7	5.5	10	7	12	9	15	11	20	15	25	18	28	21	35	26
3/8	14	10	17	13	22	16	27	20	35	26	44	33	50	36	63	46
7/16	22	16	28	20	35	26	44	32	55	41	70	52	80	58	100	75
1/2	33	25	42	31	53	39	67	50	85	63	110	80	120	90	150	115
9/16	48	36	60	45	75	56	95	70	125	90	155	115	175	130	225	160
5/8	67	50	85	62	105	78	135	100	170	125	215	160	215	160	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	470	300	510	375	470	300	510	375	900	675	1150	850	1450	1075	1850	1350
1-1/4	570	425	725	530	570	425	725	530	1300	950	1650	1200	2050	1500	2600	1950
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2150	1550	2700	2000	3400	2550
1-1/2	1000	725	1250	925	990	725	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

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

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

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

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

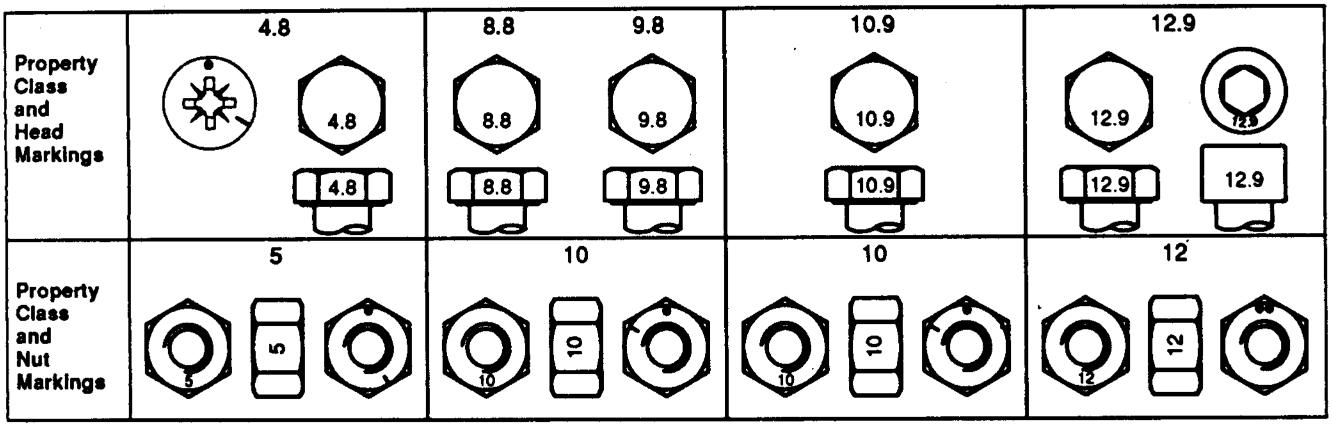
Fasteners should be replaced with the same or higher grade. If higher grade fasteners are used, these should only be tightened to the strength of the original.

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

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

DX,TORQ1 -19-15MAR91

METRIC BOLT AND CAP SCREW TORQUE VALUES



TS1163 -19-04MAR91

Size	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]	
	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft	N·m	lb-ft
M6	4.8	3.5	6	4.5	9	6.5	11	8.5	13	9.5	17	12	15	11.5	19	14.5
M8	12	8.5	15	11	22	16	28	20	32	24	40	30	37	28	47	35
M10	23	17	29	21	43	32	55	40	63	47	80	60	75	55	95	70
M12	40	29	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	47	80	60	120	88	150	110	175	130	225	165	205	150	260	190
M16	100	73	125	92	190	140	240	175	275	200	350	225	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	220	1650	2500	1850	3150	2350	2900	2150	3700	2750
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2750	4750	3500

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

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

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

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

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

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

DX,TORQ2 -19-05JUN91

BOLT IDENTIFICATION CHART

Grade Identification Marking on Bolt Head	GM Number	JD Grade Identification	JD Number	SAE Grade Designation	Nominal Size Diameter (inch)	Tensile Strength Min. (psi)
None	GM 255-M	None	A17A	1	No. 6 thru 1 1/2	60,000
None	GM260-M	None	A17B	2	No. 6 thru 3/4 over 3/4 to 1 1/2	74,000 60,000
Bolts and Screws	GM 280-M		A17D	5	No. 6 thru 1 over 1 to 1 1/2	120,000 105,000
Hex Head Sems Only	GM 275-M			5.1	No. 6 thru 3/8	120,000
Bolts and Screws	GM 290-M		NONE	7	1/4 thru 1 1/2	133,000
Bolts and Screws	GM 300-M		A17F	8	1/4 thru 1 1/2	150,000
Bolts and Screws	GM 455-M			None	No. 6 thru 1 1/2	55,000
		12.9 or 180c	A17G	180		180,000

-19-28FEB89 RG4729

S11,2000,DW -19-11MAR86

ENGINE MODEL DESIGNATION

1. John Deere Engine Model—6076 Engine

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

6076AF-00 Engine

6 . . . . Number of cylinders
07.6 . . . . Liter displacement
A . . . . Aspiration code
F . . . . User code
01 . . . . Application code

Aspiration Code

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

User Code

DW . . . . Davenport
N . . . . Des Moines
T . . . . Dubuque
H . . . . Harvester
L . . . . Mannheim
E . . . . Ottumwa
RW . . . . Tractor
F . . . . OEM
CZ . . . . Venezuela

Application Code

00, 01, 02, etc .

S55,2000,DB -19-03OCT91

2. Detroit Diesel Corporation (DDC) Engine Model—G063E600

DDC 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. Thus, the model 6076AF-00 engine previously discussed, becomes DDC model G063E600. For example:

G063E600

G	Engine series
06	Number of cylinders
3	Application type
E	Electronic fuel injection
6	Aspiration
00	Application code

Application Type

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

Aspiration

3	Turbocharged
6	Turbocharged and aftercooled
7	Turbocharged and air-to-air aftercooled

Application Code

00, 01, 02, etc	code for each specific application

S55,2000,DC -19-03OCT91

ENGINE SERIAL NUMBER PLATE

1. Engine Serial Number (A)

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

RG6076T000000

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

Factory Code Producing Engine

RG . . . . Waterloo Engine Works

Engine Model Designation

6076T . . . . . . Definition explained previously. (See "Engine Model Designation".)

Sequential Number

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

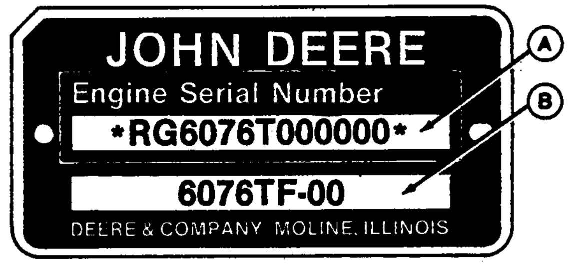
The engine serial number plate is either located on the right-hand side of engine between the oil filter base and fuel injection pump, or on the left-hand side of block directly above the starting motor (viewed from flywheel end).

2. Engine Application Data (B)

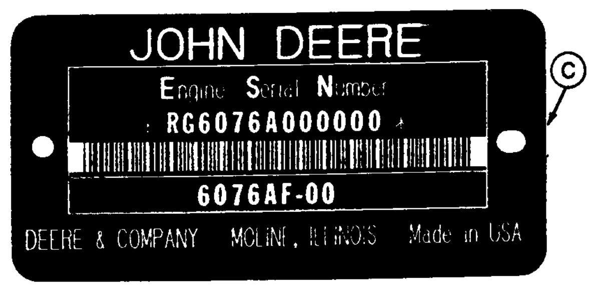
The second line of information on the nameplate identifies the engine/Deere machine or OEM relationship. See "Engine Application Chart" in this group.

NOTE: Current production engine are equipped with a laser-generated serial number plate (C) which contains the same information as the previous plate with the addition of bar coding.

IMPORTANT: The engine serial number plate can easily be destroyed. Remove the plate before hot tank cleaning of the block.



RG5343 -UN-15DEC88



RG5701 -UN-23JAN91

3. Unit Number (A)

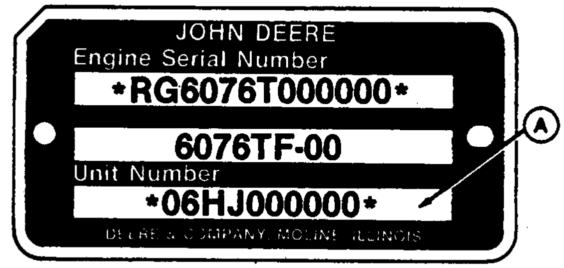
Engines marketed by Detroit Diesel Corporation (DDC) have a third line of information on the nameplate. The unit number is the DDC applied serial number and must be utilized for DDC service and customer reference purposes.

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

JD Engine Serial No.	DDC Unit No.
RG6076T000000	**06HJ000000**
6	06
RG	H
076	**J
000000	000000

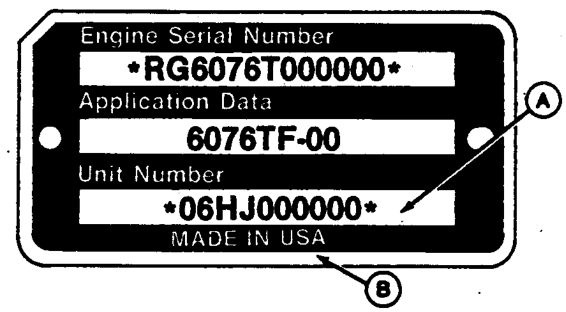
JD/DDC Factory Code	Model Codes Deere Engine Model	DDC Model Code** (4th position of Unit No.)
RG/H	6076T	J
RG/H	6076A	K
RG/H	6076H	L

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



RG5344 -UN-15DEC88

DDC Unit Number Nameplate

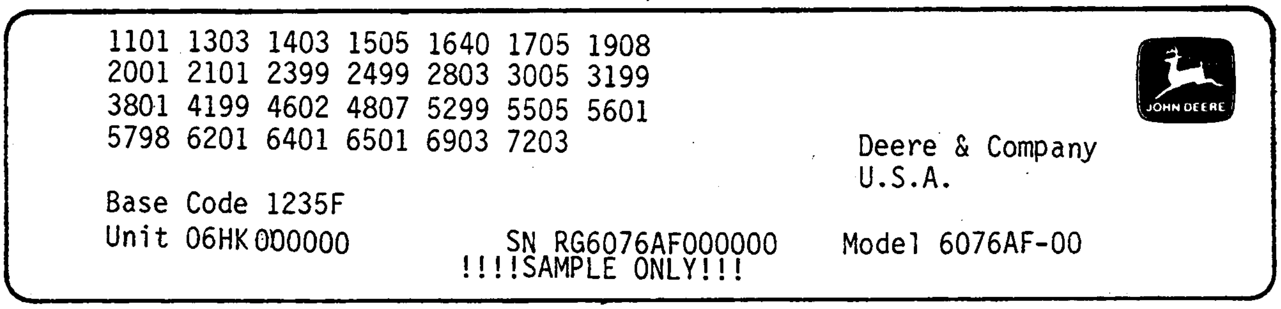


RG5345 -UN-15DEC88

Generic Engine Nameplate

S55,2000,DE -19-20MAR91

OPTION CODE LABEL



RG5348 -UN-15DEC88

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 option code label can be easily destroyed, so keep a copy of options on your engine in a safe place.

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.

S55,2000,DF -19-20MAR91

JOHN DEERE INDUSTRIAL EQUIPMENT APPLICATIONS

Machine Model No.	Engine Model
LOADERS	
644E	6076TDW01, 02
644EH	6076ADW01
FORKLIFTS, 4-WHEEL DRIVE	
644ER	6076ADW02
SKIDDERS	
740E, 740EH	6076TDW02
SP740E	6076ADW03

S55,2000,DG -19-22AUG91

OEM APPLICATIONS

Machine Model No.	Engine Model
Repower	6076TF, AF, HF
Kohler Air Compressor	6076AF010, 011, 012, 013, 014, and 6076TF010, 011
Marine	6076AFM

S55,2000,DH -19-22AUG91

JOHN DEERE AGRICULTURAL EQUIPMENT APPLICATIONS

Machine Model No.	Engine Model
COMBINES	
9500	6076TH001, 6076HH03, 6076HH004
9600	6076HH001, 6076HH03, 6076TH001
9600 Export	6076HH002
COTTON PICKERS	
9960	6076AN001
TRACTORS — WATERLOO	
4055	6076TRW06, 6076TRW08
4055 Export	6076TRW08
4255	6076TRW01
4255 Export	6076TRW03
4255 Hi-Crop	6076TRW02
4455	6076TRW04
4455 Export	6076TRW05
4555	6076TRW07
4560	6076TRW09
4755	6076ARW01, 6076ARW06
4755 Export	6076ARW02
4760	6076ARW07
4955	6076ARW03, 6076ARW05
4955 Export	6076ARW02, 6076ARW04
4960	6076ARW08, 6076ARW11
8560 4-Wheel Drive	6076HRW01, 6076HRW02
TRACTORS — VENEZUELA	
4255	6076TCZ01
4455	6076TCZ02
4555	6076TCZ03

S55,2000,MV -19-22AUG91

BASIC 6076 ENGINE SPECIFICATIONS

Item	Unit of Measure	6076T	6076A	6076H
Number of Cylinders	- - -	6	6	6
Fuel	- - -	Diesel	Diesel	Diesel
Bore	mm (in.)	116 (4.56)	116 (4.56)	116 (4.56)
Stroke	mm (in.)	121 (4.75)	121 (4.75)	121 (4.75)
Displacement	L (in.^{3})	7.64 (466)	7.64 (466)	7.64 (466)
Piston Speed at Rated Speed	m/min.(ft/min.)	531 (1742)	531 (1742)	531 (1742)
Compression Ratio	- - -	16.0:1	16.0:1	16.0:1
Cylinder Firing Order	- - -	1,5,3,6,2,4	1,5,3,6,2,4	1,5,3,6,2,4
Rated Speeds				
—Std. Mechanical Gov.	rpm	2200	2200	2200
—3-5% Mechanical Gov.	rpm	1800	- - -	- - -
—Electric Gov.	rpm	- - -	1800	- - -
Slow Idle Speed	rpm	850	850	850
Crankshaft Bearings				
—Number of Mains	- - -	7	7	7
—Main ID	mm (in.)	85.73 (3.375)	85.73 (3.375)	85.73 (3.375)
—Main Width	mm (in.)	36.53 (1.438)	36.53 (1.438)	36.53 (1.438)
—Thrust Width	mm (in.)	37.49 (1.476)	37.49 (1.476)	37.49 (1.476)
Connecting Rods				
—Rod Journal OD	mm (in.)	76.165 (2.998)	76.165 (2.998)	76.165 (2.998)
Camshaft				
—Journal OD	mm (in.)	67.008 (2.6378)	67.008 (2.6378)	67.008 (2.6378)
—Bushing ID	mm (in.)	67.089 (2.6413)	67.089 (2.6413)	67.089 (2.6413)
Lubrication System				
—Pump Type	- - -	Crankshaft-driven	Crankshaft-driven	Crankshaft-driven
—Pump Capacity	L/min. (gpm)	109.8 (29)	109.8 (29)	109.8 (29)
Physical Dimensions				
—Width	mm (in.)	572 (22.5)	572 (22.5)	572 (22.5)
—Height	mm (in.)	1173 (46.2)	1173 (46.2)	1173 (46.2)
—Length	mm (in.)	1229 (48.4)	1229 (48.4)	1229 (48.4)

S55,2000,DI -19-22AUG91

GENERAL ENGINE DESCRIPTION

All 6076 Engines are vertical stroke, in-line, valve-in-head, 6-cylinder diesel engines.

On 6076 Engines, direct fuel injection is provided by an in-line injection pump and 21 mm injection nozzles mounted in cylinder head. The pump is driven by an intermediate gear in the timing gear train meshing with the camshaft gear.

The pump has an engine-driven camshaft which rotates at one-half engine speed. Roller cam followers, riding on the camshaft lobes, operate the plungers to supply high-pressure fuel through the delivery valves to the injection nozzles. A governor-operated (mechanical or electronic) control rack is connected to the control sleeves and plungers to regulate the quantity of fuel delivered to the engine.

All engines are turbocharged. Operated by exhaust gases, the turbocharger compresses intake air from air cleaner and routes it to each cylinder's combustion chamber.

6076A Engines are turbocharged, and in addition, have a heat exchanger (called an aftercooler) located in the intake manifold. The aftercooler cools the compressed (and heated) intake air from the turbocharger before entering the combustion chamber. Engine coolant flowing through the aftercooler is the media used for heat exchange.

On 6076H Engines, an air-to-air aftercooler cools the turbocharger compressor discharge air by routing it through a heat exchanger (usually mounted in front of radiator) before it enters the intake manifold. The heat exchanger uses no liquid coolant, but relies on air flow to cool the charge air.

The camshaft is made of special alloy iron. The cam lobes are individually flame hardened to provide excellent wear characteristics. Spherically ground followers riding on tapered cam lobes help insure positive follower rotation.

Intake and exhaust valves are operated by cam followers, push rods, and rocker arm assembly. Cylinder heads have replaceable inserts and valves, and have positive rotators for both intake and exhaust valves.

The crankshaft is a one-piece, heat treated, dynamically balanced steel forging which rotates in replaceable two-piece main bearings. The rear thrust bearing has a flange on each side to reduce crankshaft deflection and to limit end play during high load operation.

Cylinder liners are of a wet sleeve, flanged, and centrifugally cast design. O-rings are used to seal the connection between cylinder block and liners. Liners are induction hardened and are individually replaceable.

Pistons are constructed of high-grade cast aluminum alloy and are cam ground. A double Ni-Resist ring carrier is cast integrally in the piston to greatly improve the life of the two ring grooves. A deep combustion chamber design provides maximum combustion efficiency. Pistons have a three ring combination. The top two rings are compression rings and the lower ring is an oil control ring.

The highly polished, hardened piston pins are fully-floating and held in position by means of snap rings. Spray jets (piston cooling orifices) in cylinder block direct pressure oil to lubricate piston pins and cool pistons.

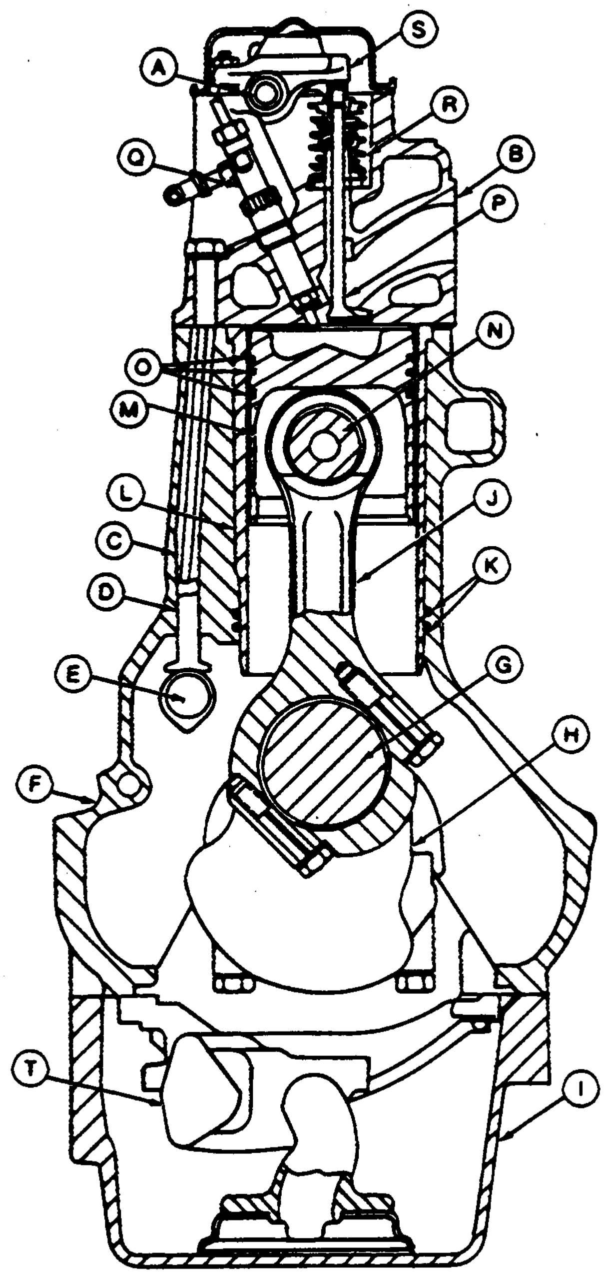
Connecting rods are of forged steel and have replaceable bushing and bearing inserts. They are weight controlled (by machining) on both ends to minimize engine vibration.

The engine is supplied with lubricating oil by a gear pump driven by the crankshaft. The lubricating oil passes through a full-flow oil filter in the main oil gallery of cylinder block. To ensure engine lubrication, the oil filter is provided with a by-pass valve which opens when the filter element is restricted. On most engines, engine oil is cooled by means of an oil cooler mounted externally on the cylinder block. Engine oil passes through the oil cooler before flowing to the oil filter. A by-pass valve located between oil pump and main gallery relieves any pressure build-up in this area.

S55,2000,DJ -19-20MAR91

ENGINE—SECTIONAL VIEW

A—Rocker Arm Shaft
B—Cylinder Head
C—Push Rod
D—Cam Follower
E—Camshaft
F—Cylinder Block
G—Crankshaft
H—Crankshaft Counterweight
I—Oil Pan
J—Connecting Rod
K—Liner Packing Rings
L—Cylinder Liner
M—Piston
N—Piston Pin
O—Piston Rings
P—Valve
Q—Fuel Injection Nozzle
R—Valve spring
S—Rocker Arm
T—Oil Pump



RG4967 -UN-15DEC88

S11,2000,FA -19-16FEB87

DIESEL FUEL

Use either Grade No. 1-D or Grade No. 2-D fuel as defined by ASTM Designation D975 for diesel fuels. In European countries, use ISO 1585 commercial diesel fuel.

NOTE: *At altitudes above 1500 m (5000 ft) use Grade 1-D for all temperatures. If engine is operated under "stand-by" conditions, use grade 1-D for all temperatures.*

If engine is operated at temperatures of -40° to -57°C (-40° to -70°F), Grade DF-A arctic fuel is recommended.

Fuel sulphur content of less than 0.5 percent is preferred, to prevent higher wear from corrosive combustion products.

IMPORTANT: If fuel sulphur content exceeds 0.7 per cent, the engine oil drain interval must be reduced by 50 percent.

Cetane number should be no less than 40 to assure satisfactory starting and overall performance. At low temperatures and/or high altitude, a cetane number of more than 45 is recommended.

NOTE: *Excessive white smoke at start-up could be the result of low cetane fuel.*

Cloud point should be at least 6°C (10°F) below lowest expected air temperature at time of starting. Wax can separate from fuel when temperature decreases to cloud point and may plug filter.

RG,CTM42,G2,1 -19-24SEP91

DIESEL ENGINE OIL

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

IMPORTANT: John Deere TORQ-GARD SUPREME PLUS-50™ engine oil is not recommended during engine break-in (first 100 hours on a new or overhauled engine). The superior lubricating properties of this oil will not allow the engine to properly wear during break-in period.

John Deere TORQ-GARD SUPREME PLUS-50 engine oil is recommended at all other times. This oil is specially formulated to provide superior protection against high temperature thickening and wear as well as exceptional cold weather starting performance; these properties may result in longer engine life.

NOTE: When John Deere TORQ-GARD SUPREME PLUS-50 engine oil and a John Deere oil filter are used, the change interval may be extended by 50 hours. ALWAYS follow recommendations in the operator's manual.

John Deere TORQ-GARD SUPREME® engine oil is also recommended but standard operator's manual oil change intervals must be maintained. Other oils may be used if they meet one or more of the following specifications:

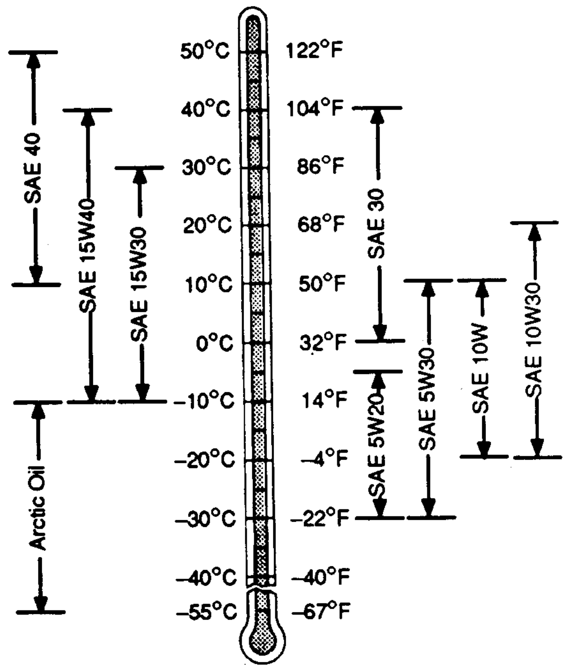
- API Service Classification CE or CD
- Military Specification MIL-L-2104E or MIL-L-2104D or MIL-L-2104C

In European countries, oils meeting CCMC Specification D4 or D5 may be used.

SAE 5W20, SAE 5W30, and arctic oil viscosity grades meeting API Service Classification CC may be used, but oil and filter must be changed at one-half the normal interval.

Oils meeting Military Specification MIL-L-46167B may be used as arctic oils.

NOTE: Some increase in oil consumption may be expected when low viscosity oils are used. Check oil levels more frequently.



TS238 -19-17MAY91

CTM8,GR02,1 -19-27SEP91

EXTREME PRESSURE OR MULTIPURPOSE GREASE

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

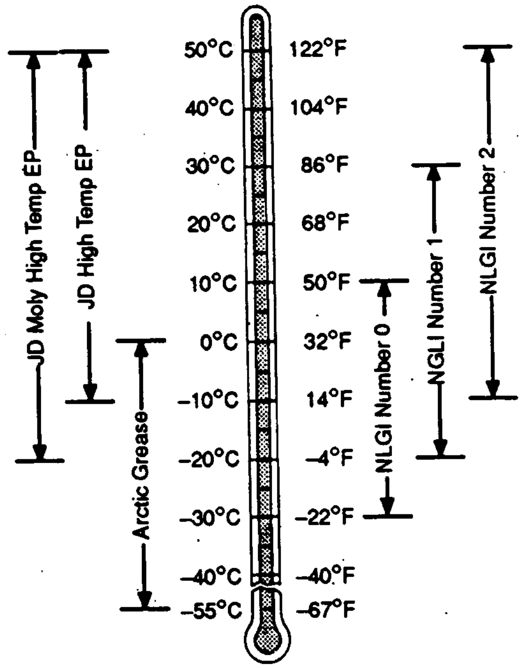
John Deere Moly High Temperature EP Grease and John Deere High Temperature EP Grease are recommended.

Other greases that may be used are:

• SAE Multipurpose EP Grease with 3 to 5 percent molybdenum disulfide.

• SAE Multipurpose EP Grease.

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



TS248 -19-28NOV90

DX,GREA1 -19-15MAR91

ENGINE COOLANT RECOMMENDATIONS

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.
Shut off engine. Remove the radiator filler cap only when the cap is cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

TS281 -UN-23AUG88

• Always maintain engine coolant at correct level.

• Coolant make-up should be mixed at same concentrations as original coolant, including inhibitors.

• In tropical areas where antifreeze or John Deere Cooling Fluid is not available, use water meeting quality specifications outlined in this group and John Deere RE23182 Liquid Coolant Conditioner. The liquid coolant conditioner should be added in the amount recommended on the label for your cooling system capacity.

RG5214 -UN-14DEC88

IMPORTANT: John Deere Liquid Coolant Conditioner does not protect against freezing.

In certain geographical areas where water quality is unacceptable, John Deere Engine Cooling Fluid is marketed for use in the engine cooling system. It protects the engine from corrosion and freezing down to -37˚C (-35˚F).

John Deere Engine Cooling Fluid or John Deere Low Silicate Antifreeze are recommended for all John Deere Diesel Engines. John Deere Cooling Fluid is ready to use as is without dilution or mixing. John Deere Low Silicate Antifreeze is concentrated and should be mixed minimum 40%—maximum 60% antifreeze and distilled or deionized water. Consult your John Deere Parts Network for local availability.

RG,OMFL,3 -19-25APR91

ENGINE COOLANT REQUIREMENTS

To meet critical cooling system protection requirements, the coolant has to consist of high quality water, the correct type antifreeze, and the correct supplemental coolant additive concentration. Refer to charts, water quality specifications (A) and water quality evaluations (B) when determining coolant requirements.

1. **Water Quality:**

   Preferred—Distilled or deionized

   Acceptable—Softened to 170 parts per million (10 grains per gallon)

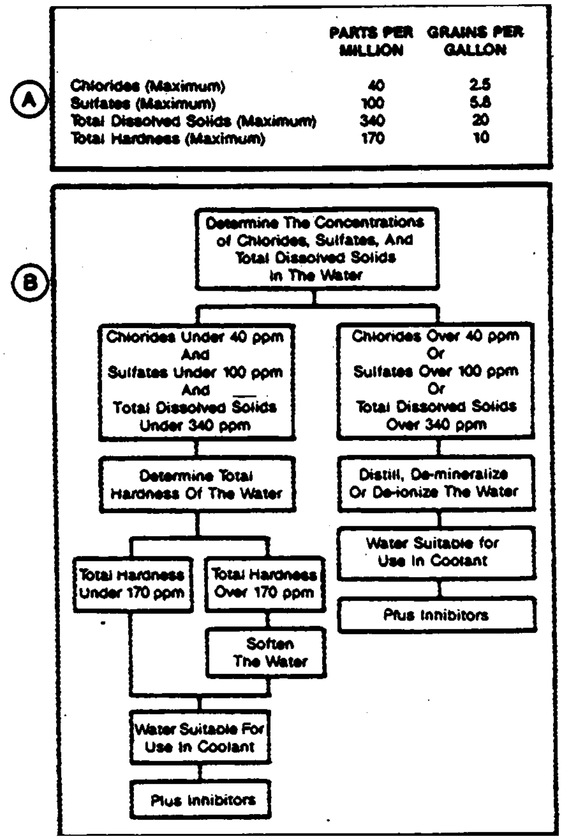
2. **Antifreeze:**

—Must be ethylene-glycol type, contain not more than 0.1 percent anhydrous metasilicate, and meet General Motors Performance Specification GM1899M, or be formulated to GM6038M (or equivalent).

IMPORTANT: Some types of ethylene-glycol antifreeze commonly available on the open market are intended for automotive use. These products are often labeled for use in aluminum engines and usually contain more than 0.1 percent anhydrous metasilicate. Use of this type antifreeze can cause a gel-like deposit to form that reduces heat transfer and coolant flow. When wet, the gel becomes the same color as the coolant. When dry, it is a white, powdery deposit. Check container label or consult with antifreeze supplier before using.

—Solutions containing 60 percent (maximum) to 40 percent (minimum) antifreeze mixed with clean soft water or deionized water are recommended.

—Antifreeze solutions should be used year-round for freeze protection, boil-over protection, and to provide a stable environment for seals and hoses. It is acceptable to use a properly inhibited coolant mix of clean soft water and John Deere Liquid Coolant Conditioner during warm weather operation on some applications in place of antifreeze solutions. Contact your authorized servicing dealer or engine distributor, if there are further questions.



	PARTS PER MILLION	GRAINS PER GALLON
Chlorides (Maximum)	40	2.5
Sulfates (Maximum)	100	5.8
Total Dissolved Solids (Maximum)	340	20
Total Hardness (Maximum)	170	10

RG5045 -19-28FEB89

A—Water Quality Specifications
B—Water Quality Evaluation

RG,OMFL,1 -19-22MAR91

ENGINE COOLANT REQUIREMENTS—CONTINUED

RG4690 -UN-14DEC88

2. **Antifreeze: (continued)**

—DO NOT use methyl alcohol base antifreeze.

—DO NOT use methoxy propanol antifreeze. Damage can occur to rubber seals on cylinder liners which are in contact with coolant.

—DO NOT use antifreeze-coolant mix containing sealer or stop-leak additives.

NOTE: John Deere Liquid Coolant Conditioner does not protect against freezing.

3. **Inhibitors:**

—ALWAYS inhibit the antifreeze-coolant mix with a non-chromate inhibitor such as RE23182 John Deere Liquid Coolant Conditioner.

—DO NOT use soluble oil.

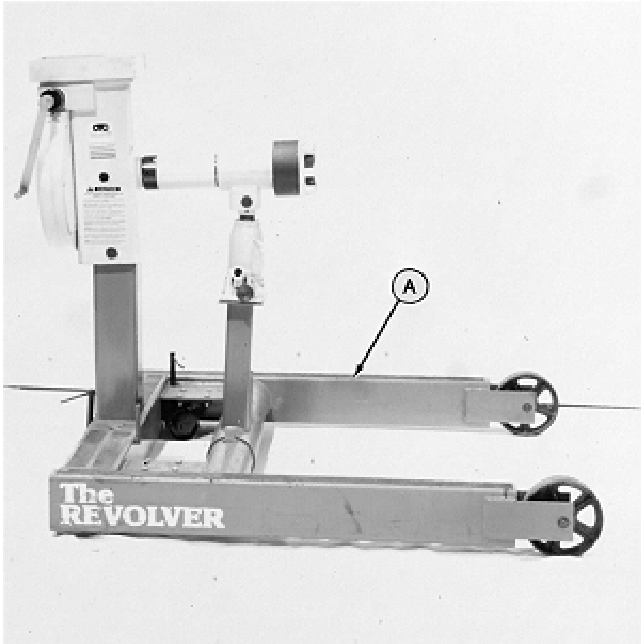
—ALWAYS follow the supplier's recommendations printed on the container. Over-inhibiting antifreeze solutions can cause silicate-dropout. When this happens, a gel-type deposit is created which retards heat transfer and coolant flow.

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

S11,2000,FS -19-24APR91

ENGINE REPAIR STAND

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



RG4929 -UN-15DEC88

S11,2000,EM -19-05APR90

SAFETY PRECAUTIONS

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

• To maintain shear strength specifications, alloy steel SAE Grade 8 or higher socket head cap screws must be used to mount adapters or engine.

• 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.

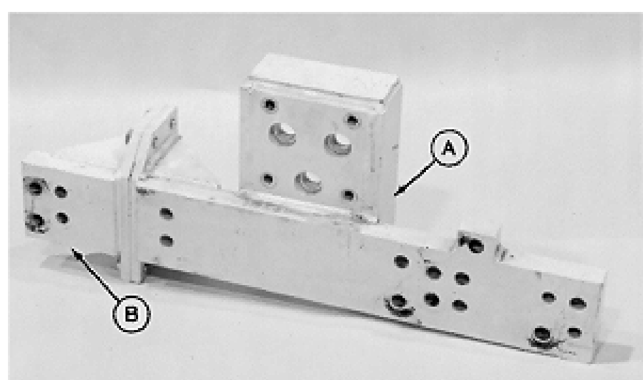
• To prevent possible personal injury due to sudden engine movement, lower engine by operating jack release valve slowly. Do not unscrew release valve knob more than two turns from its closed position.

S11,2000,DZ -19-05APR90

INSTALL 400 SERIES ADAPTERS ON REPAIR STAND

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

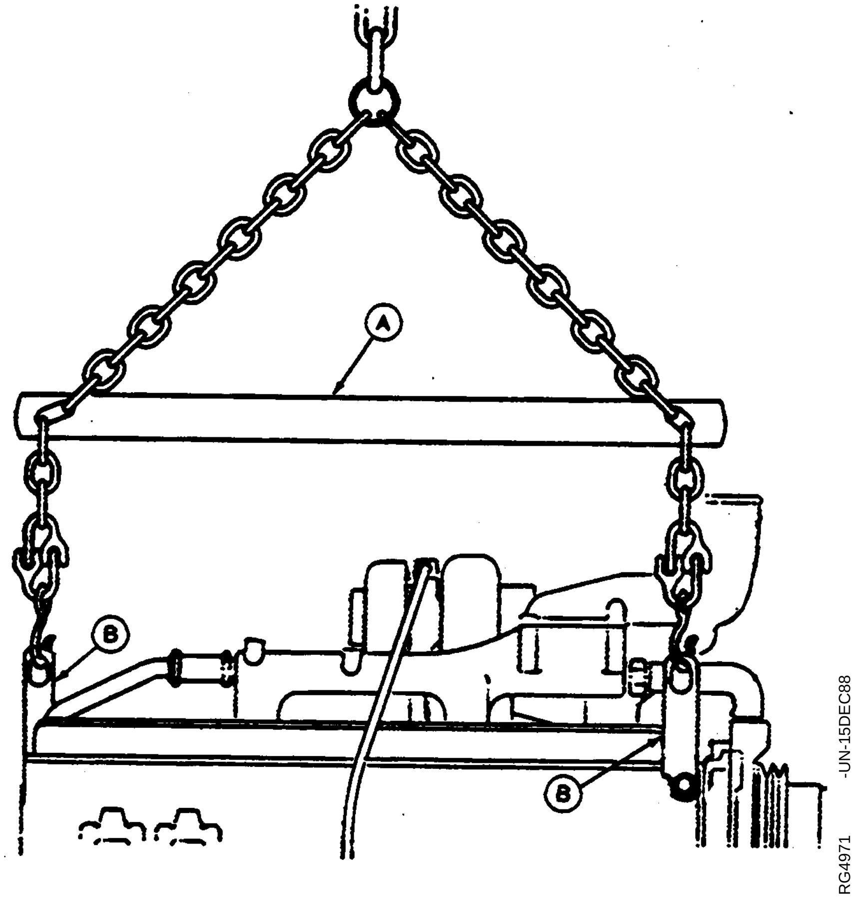
2. Attach the No. 51400 end adapter (B) to the engine adapter, using four 5/8-11 x 2 in. SAE Grade 8 cap screws. Tighten screws to 135 N·m (100 lb-ft).



RG4930 -UN-15DEC88

S11,2000,FB -19-07AUG91

ENGINE LIFTING PROCEDURE



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

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

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

2. Carefully lift engine to desired location.

S11,2000,FC -19-16FEB87

CLEAN ENGINE

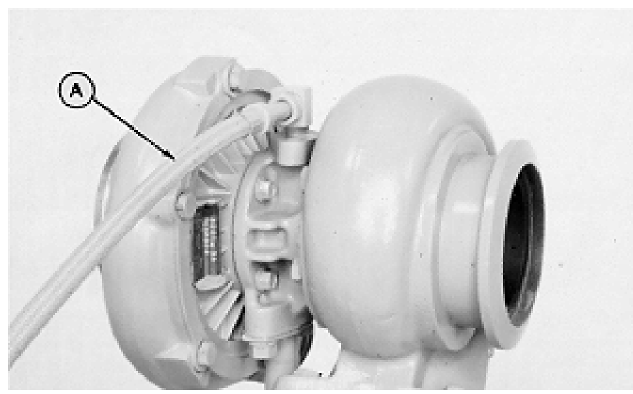
1. Cap or plug all openings on engine. If electrical components (starter, alternator, etc.) are not removed prior to cleaning, cover with plastic and tape securely to prevent moisture from entering.

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 -19-05APR90

DISCONNECT TURBOCHARGER OIL INLET LINE



RG5323 -UN-06DEC88

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

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

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

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

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

RG,CTM6,G03,1 -19-22AUG91

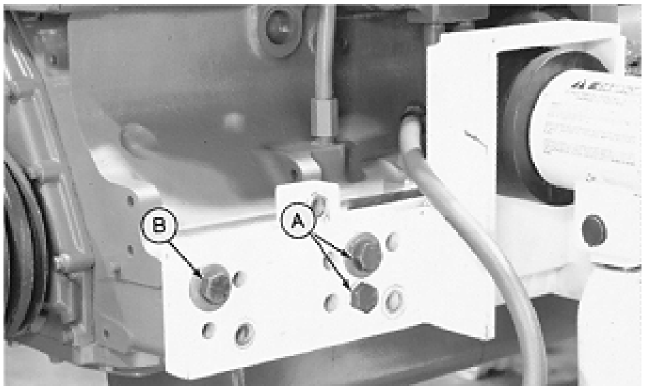
MOUNT ENGINE ON REPAIR STAND

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

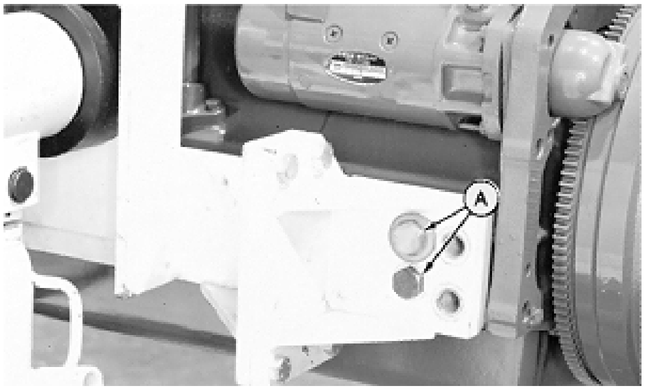
1. Mount the starter side of the engine to the engine adapter with five 3/4-10 UNC x 2-3/4 in. cap screws (A and B).

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

3. Slowly relieve tension on lift sling and carefully remove sling from engine.



RG4945 -UN-15DEC88



RG4946 -UN-15DEC88

S55,2000,DK -19-22AUG91

6076 ENGINE DISASSEMBLY SEQUENCE

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

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

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

2. Remove turbocharger oil inlet line.

3. Remove breather hose.

4. Remove fan pulley and water manifold assembly.

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

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

6. Remove rocker arm cover.

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

8. Remove alternator and mounting brackets.

9. Remove front crankshaft pulley and damper assembly.

10. Remove fuel injection lines and injection nozzles.

11. Remove water pump.

12. Remove engine oil filter and oil filter housing.

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

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

15. Remove exhaust manifold and air intake manifold.

16. Remove turbocharger oil return line.

17. Remove engine oil cooler assembly.

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

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

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

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

22. On engines equipped with front auxiliary drive assembly, remove auxiliary drive idler gear.

23. Remove front timing gear cover.

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

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

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

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

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

28. Remove piston cooling orifices.

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

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

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

S55,2000,DL -19-22AUG91

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):**

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

—Capscrews: injection pump access cover, electronic tachometer cover, oil filler inlet, flywheel.

—Oil pressure sending unit

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

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

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

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

—O-ring adapter for oil pump outlet tube

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

—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

—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):**

—Wear ring-to-crankshaft

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

—Timing gear cover-to oil pan

—Flywheel housing-to-oil pan

• **PT569 NEVER-SEEZ®** COMPOUND:

—Cap Screws: exhaust manifold and turbine housing-to-center housing.

• **PERMATEX (Form-A-Gasket No. 2):**

—Water pump and thermostat cover gaskets

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

—Rocker arm cover gasket

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

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

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

TEFLON® is a registered trademark of Dupont Company.

RG,CTM6,G04,1 -19-24SEP91

6076 ENGINE ASSEMBLY SEQUENCE

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

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

2. Install clean piston cooling orifices.

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

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

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

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

6. Install engine oil pump assembly.

7. Install crankshaft rear oil seal and wear sleeve.

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

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

10. Align camshaft thrust plate holes and secure plate-to-block. Check camshaft end play.

11. Install fuel injection pump and drive gear.

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

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

14. Install head gasket.

15. Install cylinder head.

16. Install timing gear gasket, cover, and front oil seal.

17. On engines equipped with front auxiliary drive assembly, install auxiliary drive idler gear. Install cover.

18. Install push rods.

19. Install rocker arm assembly.

20. Install oil cooler assembly.

21. Install air intake manifold

NOTE: On 6076A Engines, 2-5/16 x 4 in. cap screws located above the oil cooler must be installed with the aftercooler manifold base.

22. Install aftercooler assembly on 6076A Engines.

23. Install turbo oil return line.

24. Install exhaust manifold.

25. Install water pump.

26. Adjust all valves.

27. Install turbocharger with elbow and connector.

28. Install injection nozzles.

S55,2000,DM -19-22AUG91

6076 ENGINE ASSEMBLY SEQUENCE—CONTINUED

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

30. Install front pulley and damper as an assembly.

31. Install alternator.

32. Install fuel filter base, inlet and pump supply lines, and filter.

33. Install water manifold and thermostat housing as an assembly. Install fan pulley assembly.

34. Install breather hose.

35. Install turbocharger oil line.

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

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

S55,2000,DN -19-22AUG91

SPECIAL OR ESSENTIAL TOOLS

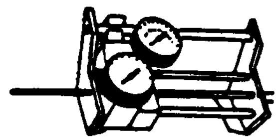
NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-05JUN91

RG5061 -UN-23AUG88

Spring Compression Tester D01168AA

Test valve spring compression

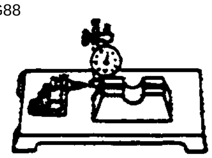


S53,D01168,AA -19-13FEB87

RG5062 -UN-23AUG88

Valve Inspection Center D05058ST

Check valves for out-of round.

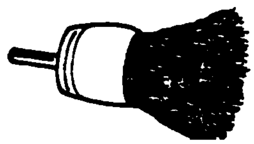


S53,D05058,ST -19-02APR87

RG5063 -UN-23AUG88

End Brush D17024BR

Clean valve seat and bores.



S53,D17024,BR -19-26JAN87

RG5099 -UN-23AUG88

Nozzle Thread Cleaning Brush D17030BR

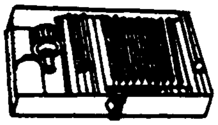
Used to clean nozzle threads in cylinder head.

S53,D17030,BR -19-16FEB87

RG5064 -UN-23AUG88

Valve Guide Knurling Tool Set D0002WI

Knurl valve guides.



S53,D20002,WI -19-26JAN87

RG5065 -UN-23AUG88

Valve Seat Pilot Driver JDE7

Install replacement valve seat inserts. Use with JDG05.

S53,JDE7A -19-23AUG91

RG5072 -UN-23AUG88

Torque Wrench Adapter JDE37A

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

S53,JDE37A -19-07AUG91

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

Rotate engine flywheel. Use with JDE81-4.

S53,JDE811 -19-07JUL89

RG5068 -UN-23AUG88

Timing Pin JDE81-4

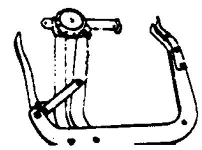
Lock engine at TDC when timing valve train. Use with JDE81-1 or JDE83.

S53,JDE814 -19-06APR90

RG5070 -UN-23AUG88

Valve Spring Compressor JDE138

Used to compress valve spring when removing and installing valves.

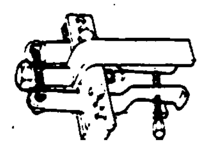


S53,JDE138 -19-04MAR87

RG5071 -UN-23AUG88

Valve Seat Puller JDE41296

Remove valve seats.

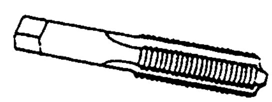


S53,JDE,41296 -19-26JAN87

RG5100 -UN-23AUG88

Tap JDF5

Used to restore nozzle threads in cylinder head.

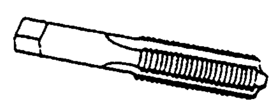


S53,JDF5 -19-16FEB87

RG5100 -UN-23AUG88

Tap JDG681

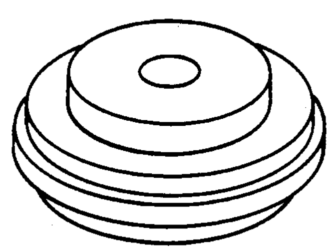
Used to restore threaded holes in cylinder block for cylinder head cap screws.



RG,JDG681 -19-25MAR91

Valve Seat Installer JDG605

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



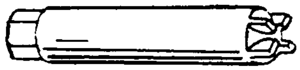
RG5240 -UN-23AUG88

S53,JDG605 -19-25MAR91

RG5289 -UN-23AUG88

Nozzle Seat Reamer JDG609

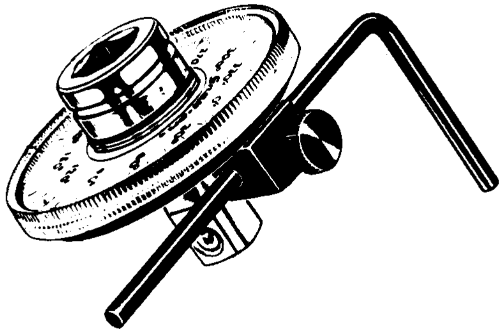
Used to clean carbon from nozzle seats in cylinder head.



S53,JDG609 -19-02DEC87

Torque Angle Gauge JT05993

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



RG5698 -UN-27AUG90

RG,JT05993 -19-22AUG91

05
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
D05012ST Precision “Bevelled Edge” Straightedge	Check cylinder head flatness
Plastic Brush	Clean valve guides

RG,CTM8,G05,1 -19-22AUG91

OTHER MATERIAL

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

S11,2505,BW -19-24SEP91

CYLINDER HEAD AND VALVES SPECIFICATIONS

ITEM	NEW PART SPECIFICATION	WEAR TOLERANCE
Valve Lift at 0.00 mm (in.) Clearance		
Engine Serial No. (—121169)		
Intake	14.05—14.48 mm (0.553—0.570 in.)	13.16 mm (0.518 in.)
Exhaust	15.88—16.31 mm (0.625—0.642 in.)	14.99 mm (0.590 in.)
Engine Serial No. (121170—) and converted 644E Loaders		
Intake	13.39—13.84 mm (0.527—0.545 in.)	12.50 mm (0.492 in.)
Exhaust	14.38—14.84 mm (0.566—0.584 in.)	13.49 mm (0.531 in.)
Valve Clearance (Rocker Arm-to-Valve Tip):		
Intake	0.38 mm (0.015 in.)	——
Exhaust	0.51 mm (0.020 in.)	——
Valve Spring Compressed Height:		
Engine Serial No. (—129678)		
Valve Closed-Intake	52.5 mm @ 353—407 N (2.07 in. @ 79—91 lb-force)	——
Exhaust	54.5 mm @ 301—355 N (2.15 in. @ 68—80 lb-ft)	——
Valve Open-Intake	38.1 mm @ 719—789 N (1.50 in. @ 162—177 lb-force)	——
Exhaust	38.5 mm @ 709—779 N (1.52 in. @ 159—175 lb-force)	——
Engine Serial No. (129679—)		
Valve Closed-Intake	52.5 mm @ 345—399 N (2.07 in. @ 78—90 lb-force)	——
Exhaust	54.5 mm @ 284—338 N (2.15 in. @ 64—76 lb-force)	——
Valve Open-Intake	38.1 mm @ 810—880 N (1.50 in. @ 182—198 lb-force)	——
Exhaust	38.5 mm @ 797—867 N (1.52 in. @ 179—195 lb-force)	——
Valve Head OD:		
Intake	50.87—51.13 mm (2.003—2.013 in.)	——
Exhaust	46.87—47.13 mm (1.845—1.856 in.)	——
Valve Stem OD:		
Exhaust	9.44—9.46 mm (0.3717—0.3724 in.)	——
Intake	9.46—9.49 mm (0.3724—0.3736 in.)	——
Oversize Valve (Stem) Available	0.08, 0.38, 0.76 mm (0.003, 0.015, 0.030 in.)	——
Valve Guide ID	9.51—9.54 mm (0.3745—0.3755 in.)	——
Valve Stem-to-Guide Clearance:		
Exhaust	0.051—0.102 mm (0.002—0.004 in.)	——
Intake	0.025—0.076 mm (0.001—0.003 in.)	——
Valve Face Angle	29.25° ± 0.25°	——
Valve Seat Angle	30° ± 0.25°	——
Valve Seat Width:		
Exhaust	2.0—3.8 mm (0.79—0.150 in.)	——
Intake	1.4—3.8 mm (0.055—0.150 in.)	——

S11,2005,NA -19-23AUG91

CYLINDER HEAD AND VALVES SPECIFICATIONS—CONTINUED

ITEM	NEW PART SPECIFICATION	WEAR TOLERANCE
Valve Seat Concentricity with Guide	0.051 mm (0.0020 in.)	——
Valve Recess in Cylinder Head:		
Intake	3.35—3.86 mm (0.132—0.152 in.)	4.62 mm (0.182 in.)
Exhaust	1.19—1.70 mm (0.047—0.067 in.)	2.46 mm (0.097 in.)
Maximum Valve Seat Runout	0.051 mm (0.0020 in.)	——
Maximum Valve Face Runout	0.051 mm (0.0020 in.)	——
Cylinder Firing Order	1-5-3-6-2-4	——
Rocker Arm ID	19.07—19.10 mm (0.7507—0.7520 in.)	——
Rocker Arm Shaft OD	19.01—19.05 mm (0.7484—0.7500 in.)	——
Cylinder Head Reconditioning:		
Thickness of Head (Rocker Arm Cover Gasket Rail-to-Combustion Face)	155.45—155.71 mm (6.120—6.130 in.)	——
Minimum Acceptable Thickness	154.69 mm (6.09 in.)	——
Maximum Acceptable Out-of-Flat (Entire Length or Width)	0.102 mm (0.0040 in.)	——
Combustion Face SurfaceFinish (surface grind only)	60—110AA	——
Maximum Material Removal for Resurfacing Head	0.762 mm (0.0300 in.)	——

S11,2005,NO -19-23AUG91

CYLINDER HEAD AND VALVES SPECIFICATIONS—CONTINUED

TORQUES

Cylinder Head-to-Cylinder Block:
SAE Grade 180 or 12.9 (G-Grade) Cap Screws with Washers
Step 1 . . . . 224 N·m (165 lb-ft)
Step 2 . . . . 245 N·m (180 lb-ft)
Step 3 . . . . Wait 2 Hours; loosen and tighten to 245 N·m (180 lb-ft)
Flanged-Head Cap Screws (no Washers)
Step 1 . . . . 100 N·m (75 lb-ft)
Step 2 . . . . 125 N·m (95 lb-ft)
Step 3 . . . . Tighten an Additional 90—100 degrees

Rocker Arm Shaft Clamps . . . . 75 N·m (55 lb-ft)

Rocker Arm Cover-to-Cylinder Head . . . . 8 N·m (6 lb-ft) (72 lb-in.)

Intake Manifold-to-Cylinder Head . . . . 47 N·m (35 lb-ft)

Exhaust Manifold-to-Cylinder Head . . . . 47 N·m (35 lb-ft)

Valve Adjusting Screw Locknut . . . . 27 N·m (20 lb-ft)

RG,CTM6,G05,1 -19-25MAR91

DIAGNOSING MALFUNCTIONS

- **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 standout.
  Coolant leakage into cylinder causing hydraulic failure of gasket.
  Leaking aftercooler.
  Cracked cylinder head.
  Cracked cylinder liner.
  Damaged or incorrect gasket.
  Overpowering or overfueling.
  Damaged cylinder head or block surfaces.
  Improper surface finish on cylinder head.
  Improperly tightened cylinder head cap screws.
  Faulty gasket installation (misaligned).

- **Worn or Broken Valve Seats:**

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

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

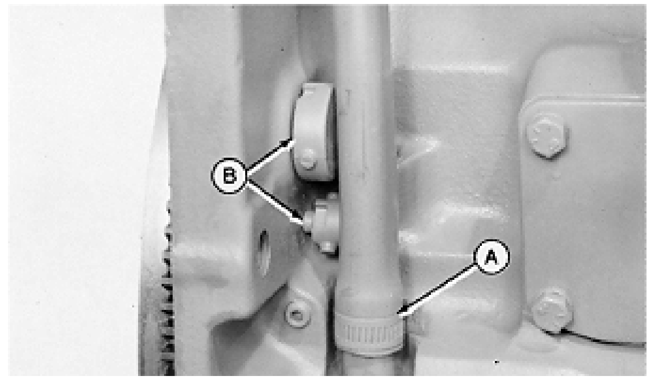
  Worn or distorted valve seats.
  Worn valve guides.
  Insufficient cooling.
  Cocked or broken valve springs.
  Improper engine operation.
  Improper valve train timing.
  Faulty valve rotators.
  Warped or distorted valve stems.
  “Stretched” valves due to excessive spring tension.
  Warped cylinder 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.

RG,CTM8,G05,6 -19-24SEP91

CHECK AND ADJUST VALVE CLEARANCE



RG3794 -UN-23FEB89

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.

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

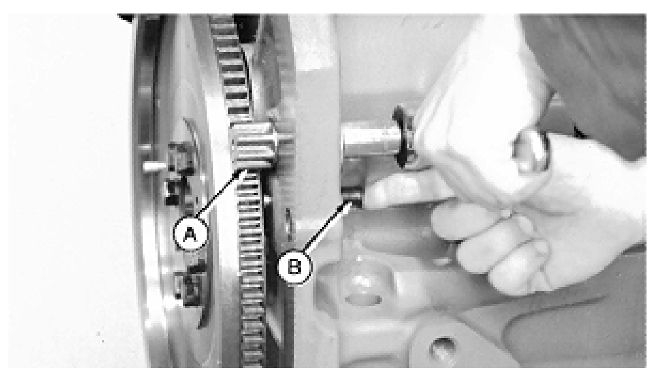
NOTE: Valve clearance can be checked with engine cold or warm.

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

2. Remove plastic plugs (B).

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

S11,2005,DO -19-23AUG91

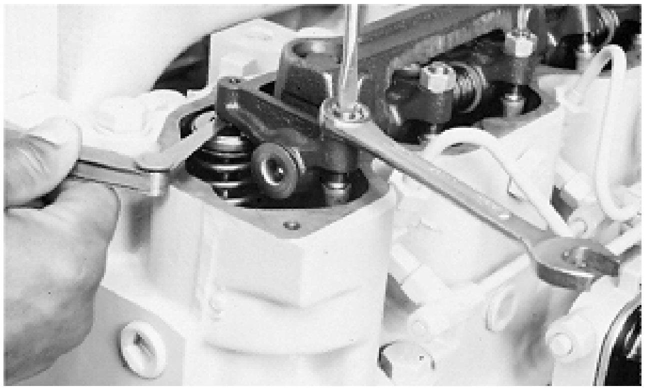


RG3795 -UN-23FEB89

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

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

S11,2005,DP -19-07FEB85



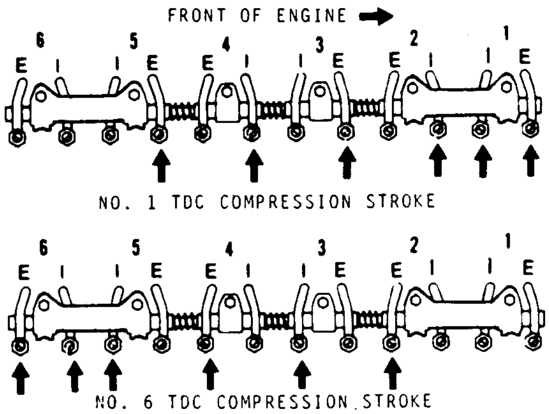
RG5241 -UN-06DEC88

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	0.38 mm (0.015 in.)
Exhaust Valves	0.51 mm (0.020 in.)

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



RG4295 -19-21AUG91

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

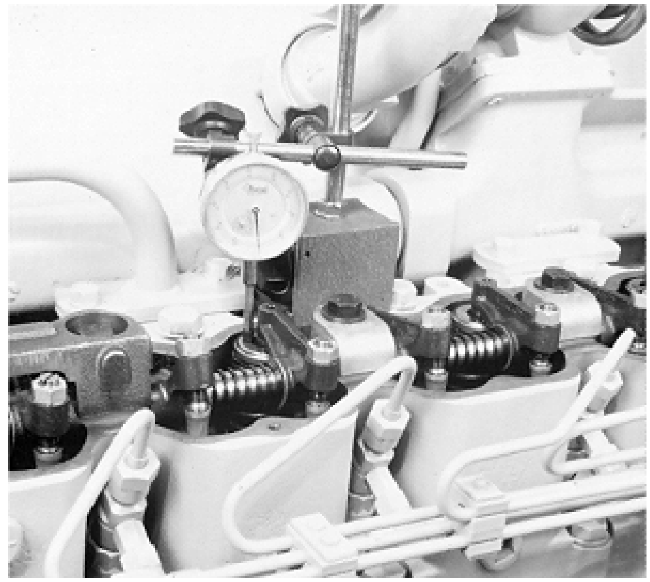
7. Check and adjust (as needed) valve clearance to the same specifications on Nos. 2, 4 and 6 exhaust and Nos. 3, 5, and 6 intake valves. Tighten valve adjusting screw locknut to 27 N·m (20 lb-ft).

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

S11,2005,NB -19-22AUG91

CHECK VALVE LIFT

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


RG5242 -UN-06DEC88

1. Remove rocker arm cover and loosen locknut on rocker arm. Set valve clearance at 0.00 mm (in.). Tighten locknut.

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

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

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

5. After rocker arm contacts valve wear cap, observe dial indicator reading as valve is moved to fully open position.

VALVE LIFT SPECIFICATION AT 0.00 MM (IN.) CLEARANCE

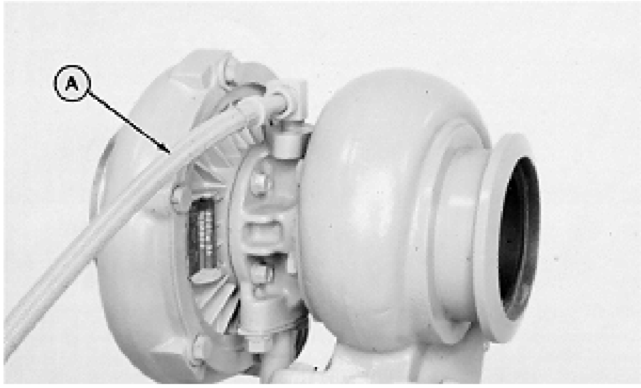
Engine Ser. No. (—121169)
Intake . . . . 14.05—14.48 mm (0.553—0.570 in.)
Minimum Acceptable . . . . 13.16 mm (0.518 in.)
Exhaust . . . . 15.88—16.31 mm (0.625—0.642 in.)
Minimum Acceptable . . . . 14.99 mm (0.590 in.)

Engine Ser. No. (121170—) and converted 644E Loaders
Intake . . . . 13.39—13.84 mm (0.527—0.545 in.)
Minimum Acceptable . . . . 12.50 mm (0.492 in.)
Exhaust . . . . 14.38—14.84 mm (0.566—0.584 in.)
Minimum Acceptable . . . . 13.49 mm (0.531 in.)

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

S11,2005,MN -19-18SEP91

DISCONNECT TURBOCHARGER OIL INLET LINE



RG5323 -UN-06DEC88

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

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

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

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

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

RG,CTM6,G03,1 -19-22AUG91

05
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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 your Machine Technical Manual for engine removal procedure, if required.

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

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

1. Drain engine coolant.

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

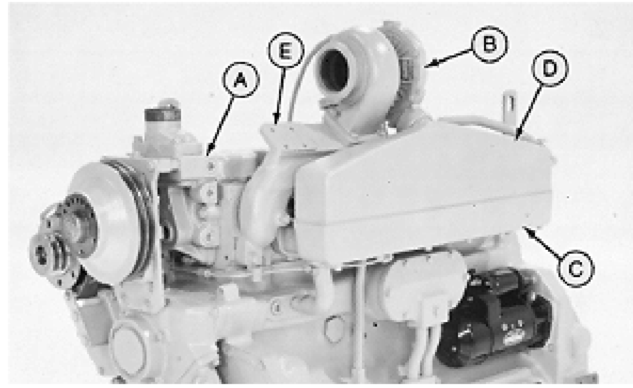
05
12

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

4. On 6076A Engines, remove aftercooler assembly (D). (Group 30.)

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

6. Remove exhaust manifold (E). (Group 30.)



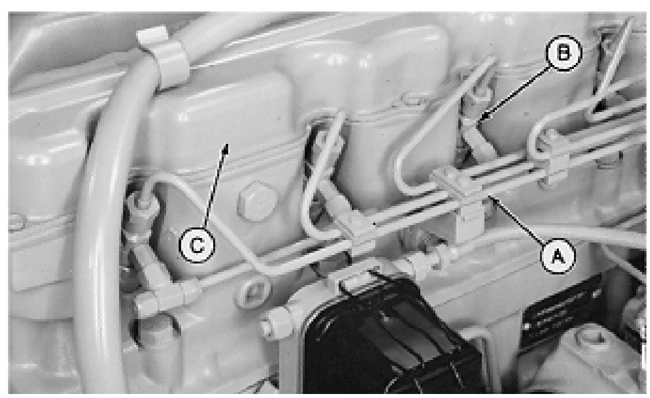
RG5243 -UN-06DEC88

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

S11,2005,MP -19-25MAR91

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

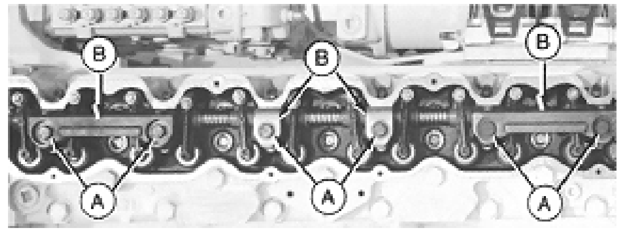
8. Remove rocker arm cover (C) and ventilator outlet hose assembly.



RG5244 -UN-06DEC88

S11,2005,MQ -19-09NOV87

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

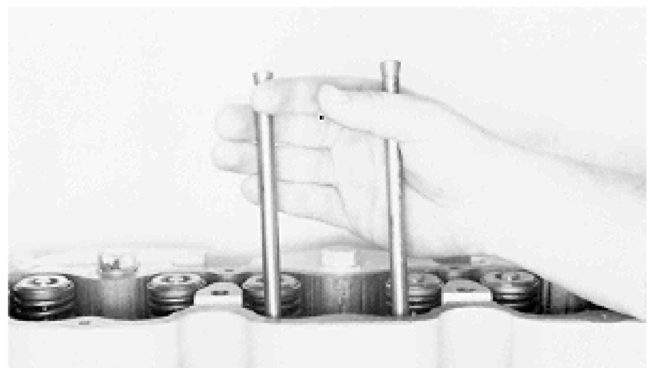


RG3920 -UN-23FEB89

S11,2005,MR -19-09NOV87

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

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



RG2862 -UN-23FEB89

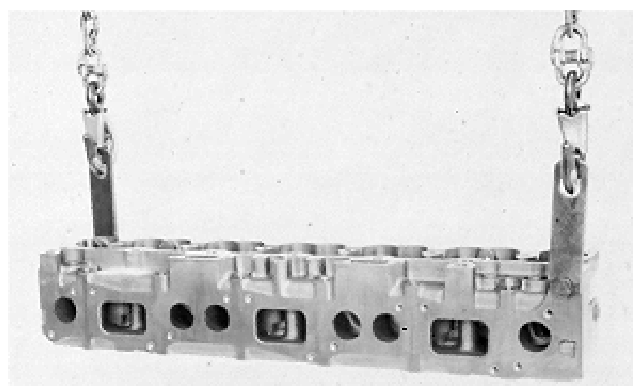
S11,2005,MS -19-09NOV87

11. Remove all 26 cylinder head cap screws.

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

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

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



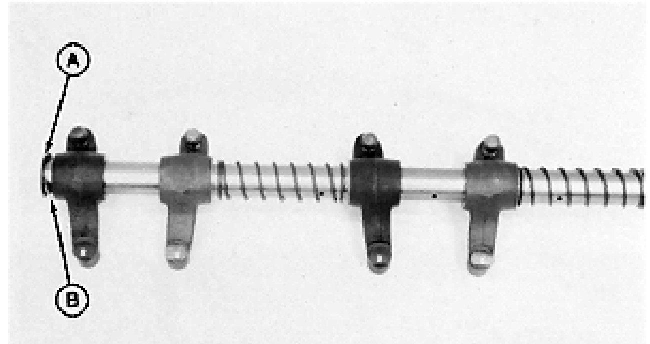
RG5245 -UN-06DEC88

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

NOTE: Do not rotate crankshaft with cylinder head removed unless all cylinder liners are secured with cap screws and large flat washers as described later in this group.

S11,2005,MT -19-15MAR88

DISASSEMBLE AND INSPECT ROCKER ARM SHAFT ASSEMBLY



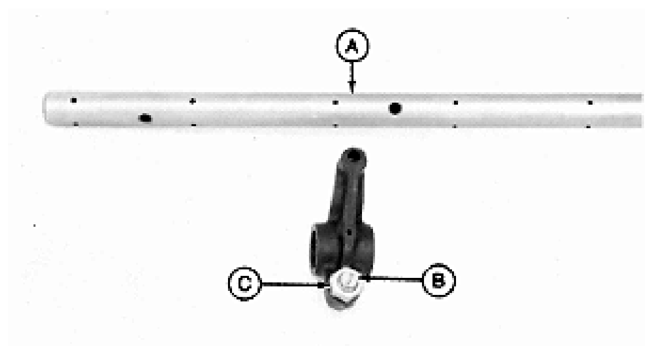
RG3801 -UN-23FEB89

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

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

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

S11,2005,HY1 -19-07AUG91



RG3802 -UN-23FEB89

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

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

ROCKER ARM ASSEMBLY SPECIFICATIONS

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

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

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

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

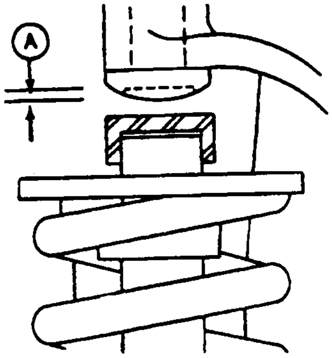
S11,2005,MB -19-22AUG91

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.

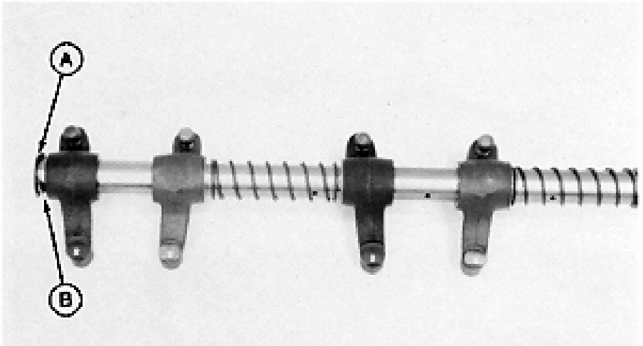


R26131 -UN-09DEC88

S11,0401,N -19-05FEB85

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

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



RG3801 -UN-23FEB89

S11,0401,O -19-23APR82

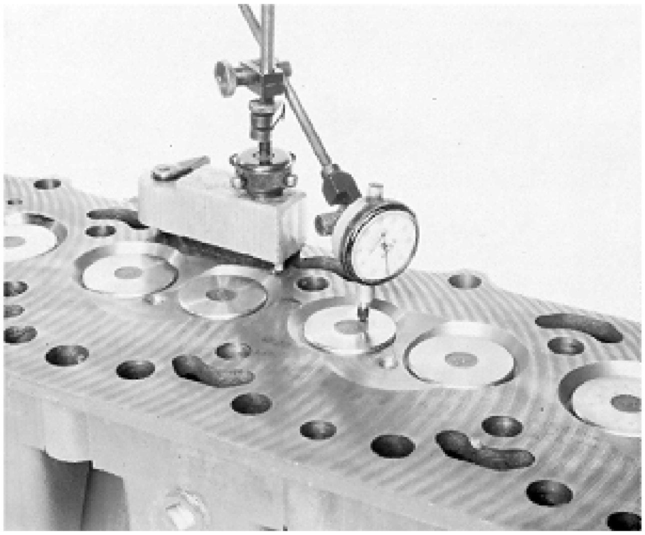
MEASURE VALVE RECESS

1. Measure and record valve recess dimensions for all valves using a magnetic base dial indicator.

VALVE RECESS SPECIFICATIONS

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

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



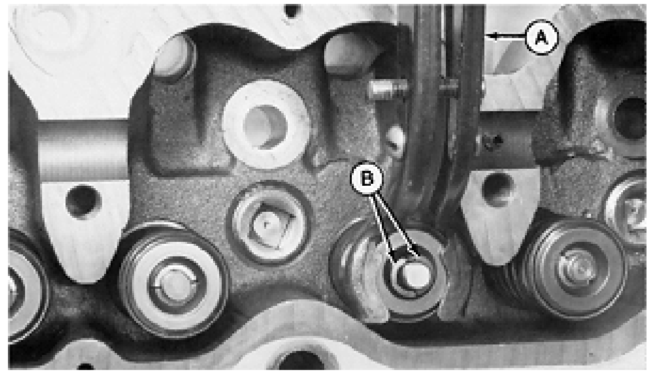
RG5250 -UN-06DEC88

S11,2005,MC -19-25JUL91

REMOVE VALVE ASSEMBLY

NOTE: Refer to DIAGNOSING MALFUNCTIONS, earlier in this group.

1. Compress valve spring compressor (A) over valve.
2. Remove retaining locks (B).
3. Remove valve spring compressor.



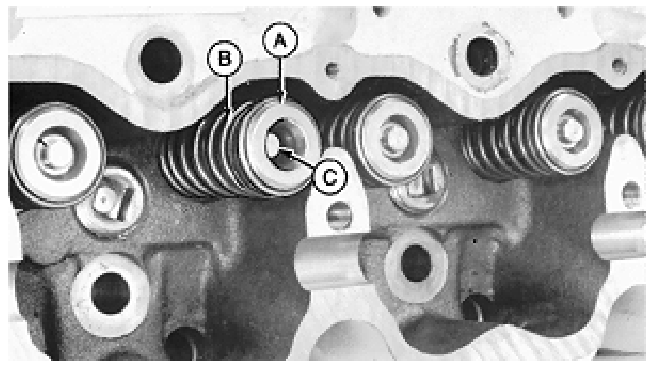
RG3803 -UN-23FEB89

S11,0401,Q -19-07AUG91

IMPORTANT: Permanently mark top or bottom of valve springs to assure correct reassembly. Early valve springs have a top and bottom, and must be installed in correct manner. Valve springs after Engine Serial No. (129679—) may be installed either way. Do not mix valve spring within a given engine.

4. Remove valve rotators (A) and valve springs (B).
5. Remove exhaust valve stem shields, if equipped.
6. Remove valves (C) from cylinder head.

NOTE: Identify all parts for correct reassembly.



RG3804 -UN-23FEB89

S11,2005,NR -19-23AUG91

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INSPECT AND MEASURE VALVE SPRINGS

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

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

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

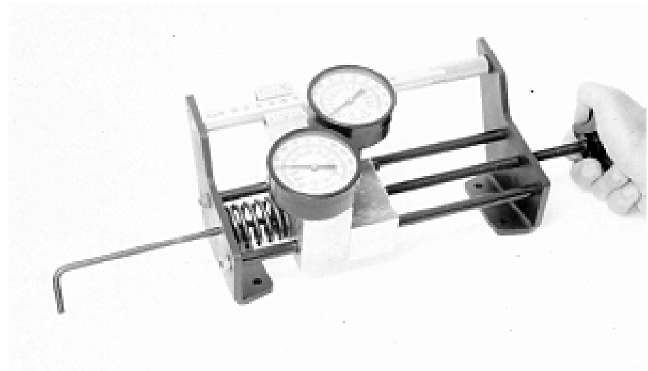
NOTE: Free spring length of 65 mm (2.56 in.) springs differ slightly, but compressed height must be within specification.

VALVE SPRING SPECIFICATIONS

Compression	**Height**
Engine Serial No. (—129678)	
Intake:	
Open: 719—789 N (162—177 lb-force)	38.1 mm (1.50 in.)
Closed: 353—407 N (79—91 lb-force)	52.5 mm (2.07 in.
Exhaust:	
Open: 709—779 N (159—175 lb-force)	38.5 mm (1.52 in.)
Closed: 301—355 N (68—80 lb-force)	54.5 mm (2.15 in.)
Engine Serial No. (129679—)	
Intake:	
Open: 815—880 N (183—198 lb-force)	38.1 mm (1.50 in.)
Closed: 345—399 N (78—90 lb-force)	52.5 mm (2.07 in.)
Exhaust:	
Open: 797—867 N (179—195 lb-force)	38.5 mm (1.52 in.)
Closed: 284—338 N (64—76 lb-force)	54.5 mm (2.15 in.)

IMPORTANT: Do not mix early production springs with current production springs within a given engine.

RG2732 -UN-23FEB89



T82054 -UN-08NOV88

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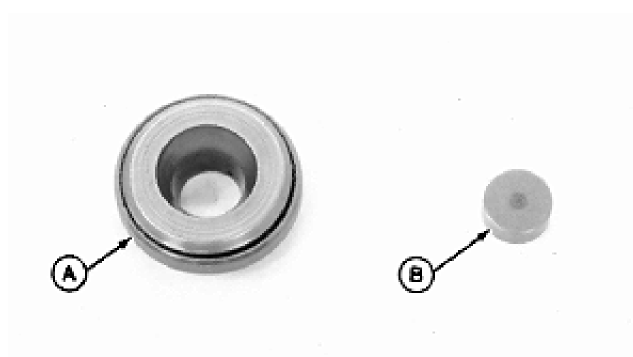
S11,2005,MD -19-23AUG91

INSPECT VALVE ROTATORS AND WEAR CAPS

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

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



RG3491 -UN-23FEB89

S11,0401,T -19-25SEP91

CLEAN VALVES

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

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

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

S11,0401,U -19-07AUG91

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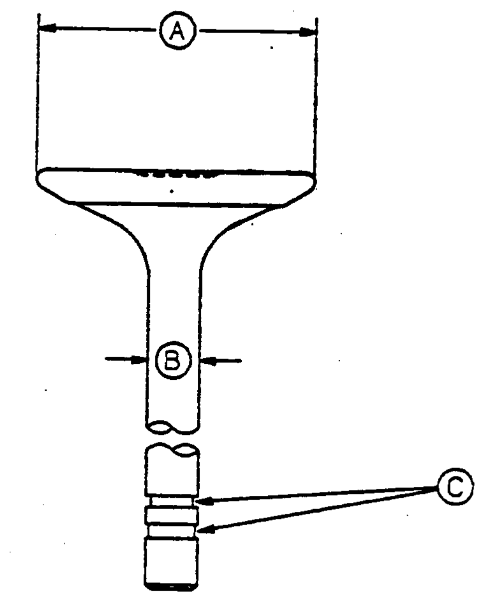
INSPECT AND MEASURE VALVES



RG5246 -UN-06DEC88

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

NOTE: Early intake valve shown. All exhaust valves and intake valves after Engine Serial No. (106215—) have only one retainer lock groove (C).

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

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

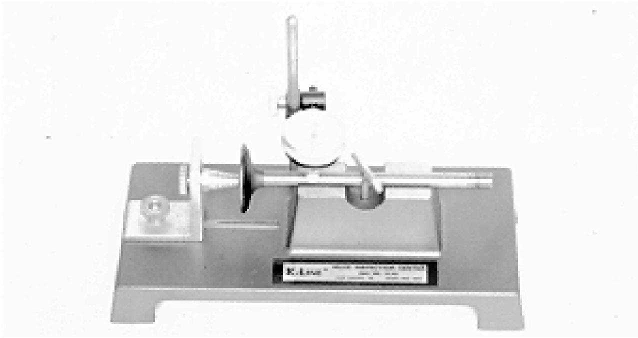
A—Valve Head OD:
Exhaust . . . . 46.87—47.13 mm (1.845—1.856 in.)
Intake . . . . 50.87—51.13 mm (2.003—2.013 in.)

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

S11,2005,MF -19-23AUG91

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

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



RG4234 -UN-23FEB89

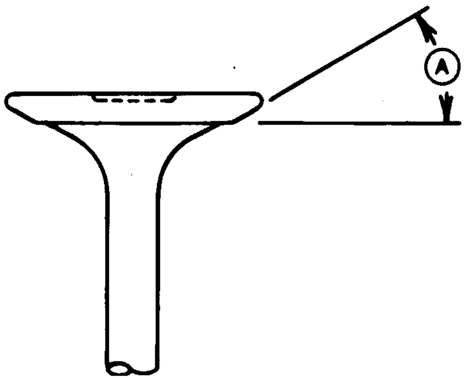
S11,2005,IZ -19-25MAR91

GRIND VALVES

If necessary to resurface, grind valve face to a 29.25° ± 0.25° angle (A).

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

Break all sharp edges after grinding.



RG5247 -UN-12AUG91

S11,2005,MG -19-23AUG91

INSPECT AND CLEAN CYLINDER HEAD

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

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

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

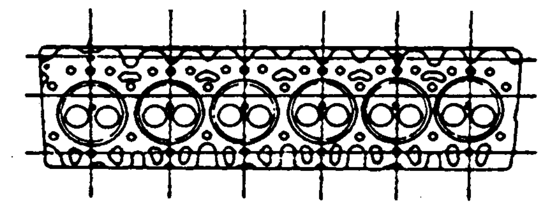
S11,2005,KW -19-07AUG91

CHECK CYLINDER HEAD FLATNESS

Check cylinder head for flatness using D05012ST Precision Straightedge and feeler gauge. Check lengthwise and crosswise in several places. A good secondary check is one that is on a diagonal. The out-of-flat measurement must not exceed 0.10 mm (0.004 in.) for the entire length or width.

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

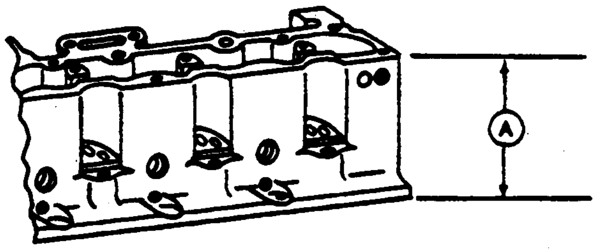
R26146 -UN-09DEC88



RG4629 -UN-06DEC88

S11,2005,KY -19-06SEP91

MEASURE CYLINDER HEAD THICKNESS



RG4421 -UN-23FEB89

If cylinder head thickness is less than 154.69 mm (6.09 in.), do not attempt to resurface it. Install a new cylinder head.

NOTE: If necessary to resurface cylinder head, a MAXIMUM of 0.726 mm (0.030 in.) can be surface ground from new part dimension (A). Remove ONLY what is necessary to correct damage.

Determine if head has been resurfaced previously by measuring distance from valve cover gasket rail-to-combustion face. The new part dimension is 155.45—155.71 mm (6.120—6.130 in.)

IMPORTANT: After resurfacing, check for flatness as described earlier and check surface finish on combustion face of head. Surface finish should be 60AA minimum to 110AA maximum.

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

S11,2005,KZ -19-22AUG91

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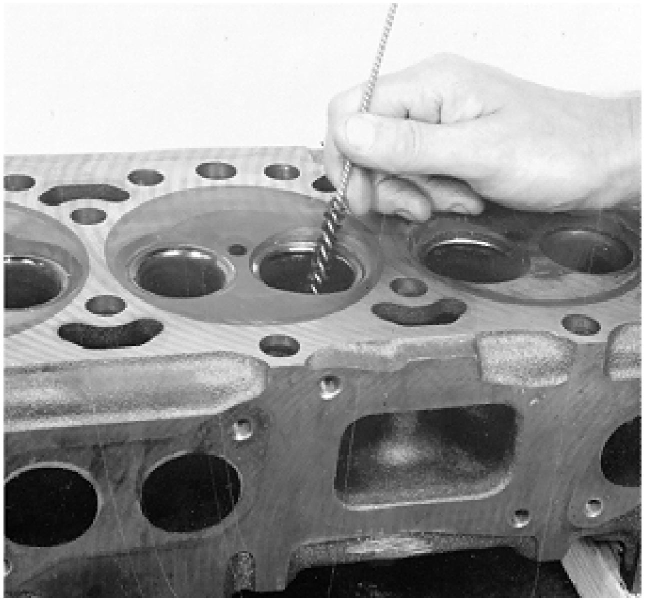
CLEAN VALVE GUIDES



RG5346 -UN-06DEC88

1. Use a D17011BR Valve Guide Cleaning Brush to clean valve guides before inspection or repair.

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

S11,2005,MY -19-07AUG91

MEASURE VALVE GUIDES

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

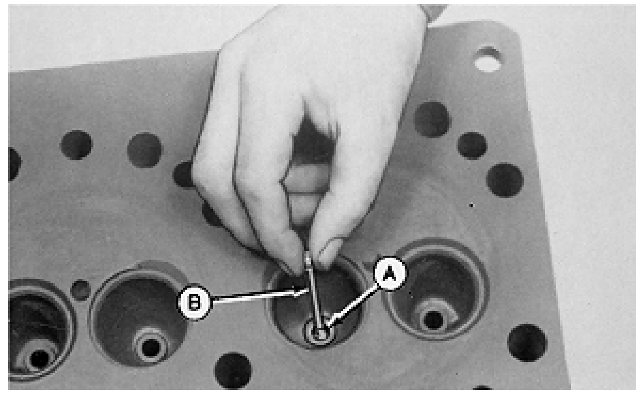
VALVE GUIDE SPECIFICATIONS

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

New Guide-to-Valve Stem Clearance:
Exhaust . . . . 0.051—0.102 mm (0.002—0.004 in.)
Intake . . . . 0.025—0.076 mm (0.001—0.003 in.)

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

IMPORTANT: ALWAYS knurl exhaust valve guides before reaming.



-UN-09DEC88 R23984

S11,2005,MH -19-07AUG91

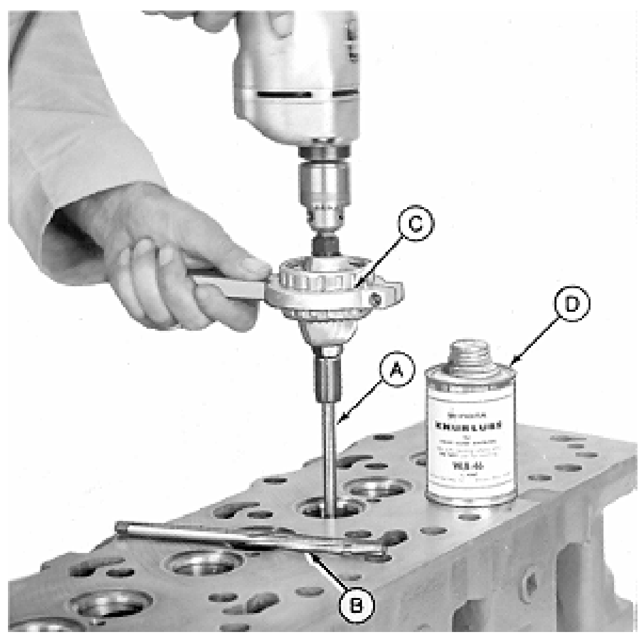
KNURL GUIDES

1. Use No. D20002WI Knurling Tool Set to knurl valve guides.

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

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

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



-UN-09DEC88 R26141

S11,0401,Z -19-07AUG91

CLEAN VALVE SEATS

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

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

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

R26142N -UN-09DEC88

S11,0401,AA -19-07AUG91

MEASURE VALVE SEATS

1. Measure valve seats for proper specifications listed below.

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

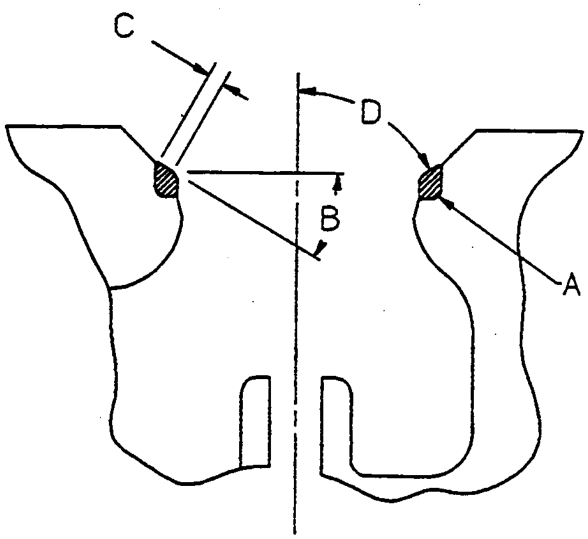
VALVE SEAT SPECIFICATIONS

A—Valve Seat Insert

B—Valve Seat Angle . . . . 30° ±0.25°

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

D—Max. Valve Seat Runout . . . . 0.051 mm (0.0020 in.)



RG5248 -UN-06DEC88

S11,2005,MI -19-22AUG91

GRIND VALVE SEATS

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

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

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

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

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

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

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

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

VALVE SEAT SPECIFICATIONS

A—Valve Seat Insert

B—Valve Seat Angle . . . . 30° ±0.25°

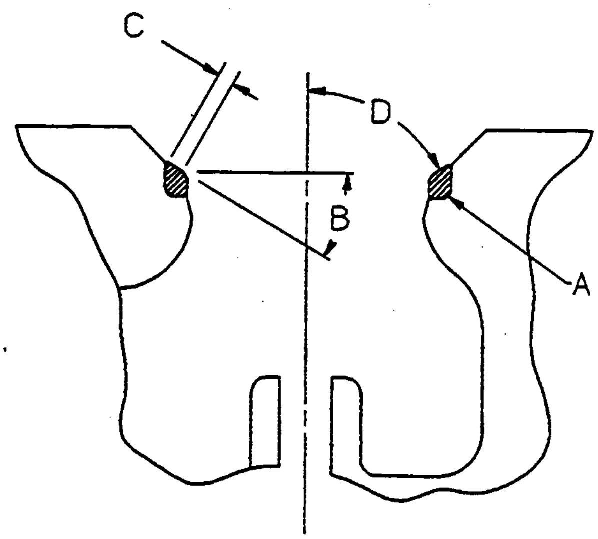
C—Valve Seat Width
—Exhaust . . . . 2.0—3.8 mm (0.079—0.150 in.)
—Intake . . . . 1.4—3.8 mm (0.055—0.150 in.)

D—Max. Valve Seat Runout . . . . 0.051 mm (0.0020 in.)

IMPORTANT: Blend or radius all sharp edges after grinding valve seats.

Always check valve recess in cylinder head after grinding as described later.

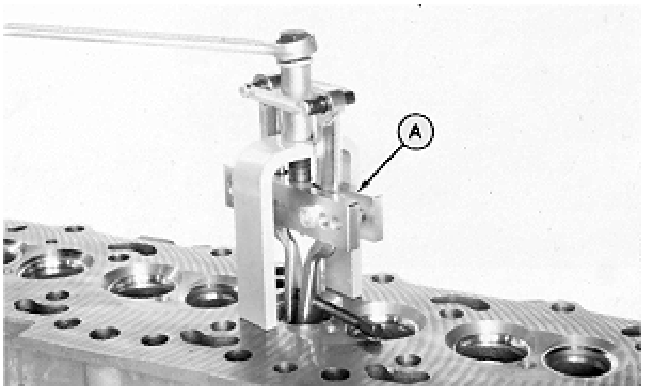
R26143N -UN-09DEC88



RG5248 -UN-06DEC88

S11,2005,MJ -19-22AUG91

REPLACE VALVE SEAT INSERTS



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

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

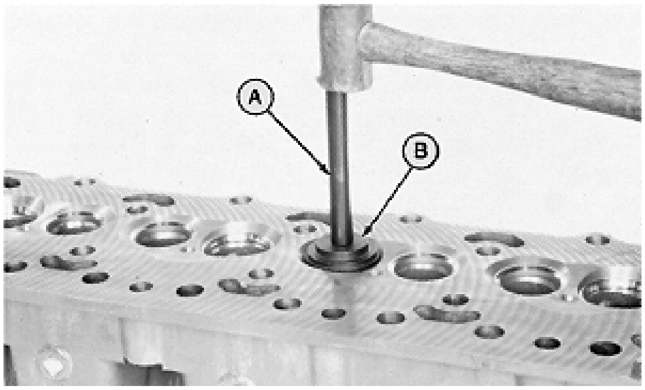
1. Remove valve seat (if necessary) with JDE41296 Valve Seat Puller (A).

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

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

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

S11,2005,ML -19-07AUG91



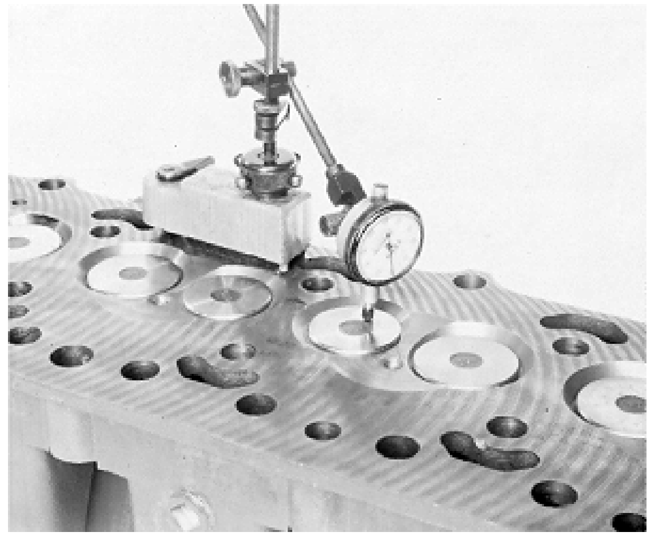
3. Use the JDE7 Driver (A) along with the JDG605 Valve Seat Installer (B) to drive inserts into place. The larger end of JDG605 Installer is used to install intake valves and the smaller end is used to install exhaust valves.

4. Install valves and check valve recess. (See MEASURE VALVE RECESS, earlier in this group.)

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

S11,2005,MM -19-07AUG91

INSTALL VALVES


RG5250 -UN-06DEC88

1. Apply engine oil to valve stems and guides.

NOTE: Valves must move freely and seat properly in head.

2. Insert reconditioned or new valves in head after grinding.

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

4. Install spring caps or rotators.

NOTE: Engines up to Serial No. (—106215) may not have exhaust valve stem shields. Shields MUST BE installed on exhaust valves upon reassembly of all engines.

05
26

5. Install R102882 valve stem oil shield on exhaust valve stems.

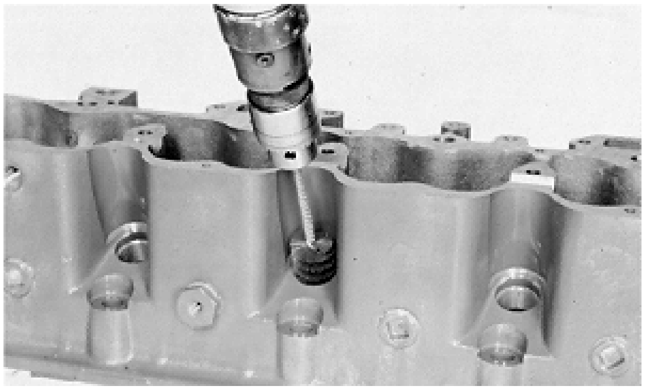
6. Compress valve springs using valve spring compressor and install keepers on valves.

7. Strike end of each valve three or four times with a soft mallet (non-metallic) to insure proper positioning of the keepers.

8. Measure valve recess. (See MEASURE VALVE RECESS, earlier in this group.)

S11,2005,HM -19-23AUG91

INSPECT AND CLEAN CYLINDER HEAD NOZZLE BORE



RG5251 -UN-14DEC88

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

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

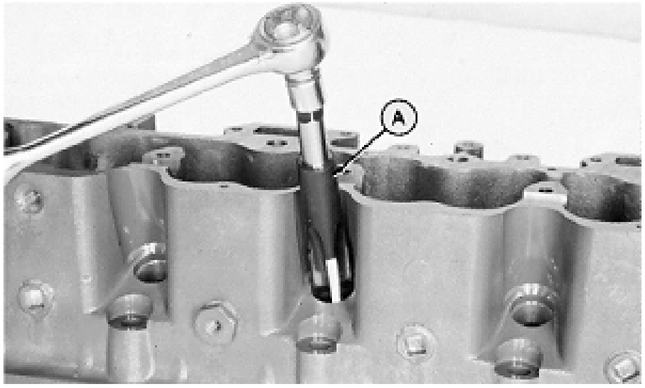
Cylinder head threads and nozzle seating surface must be free of debris and carbon deposits.

IMPORTANT: If 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.

05
27

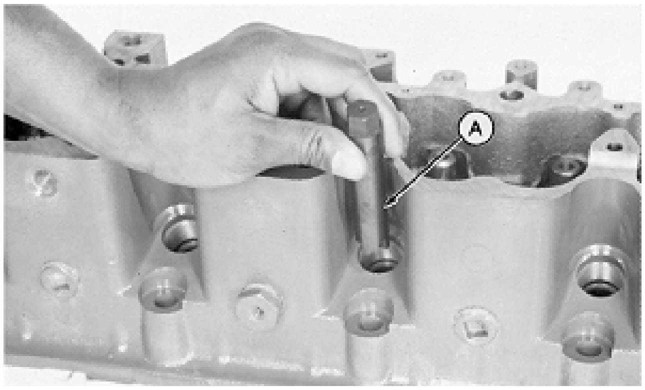
S11,2005,NS -19-23AUG91



RG5252 -UN-06DEC88

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.

S11,2005,NT -19-23AUG91



RG5253 -UN-06DEC88

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

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

S11,2005,NU -19-23AUG91

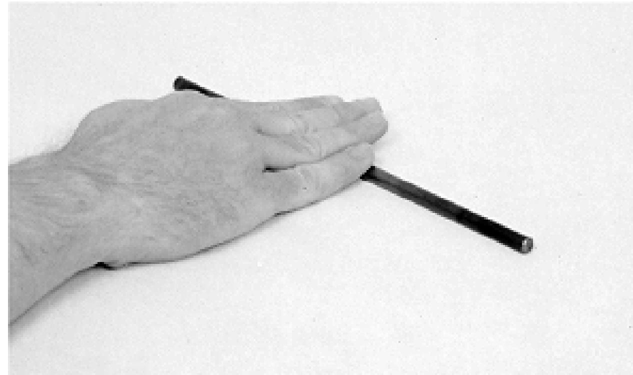
CLEAN AND INSPECT PUSH RODS

1. Clean push rods with solvent and compressed air.

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

3. Inspect for wear and damage.

4. Replace defective push rods.



T81233 -UN-01NOV88

S11,2005,JN -19-07AUG91

CLEAN AND INSPECT CYLINDER HEAD CAP SCREWS

IMPORTANT: When ordering new cylinder head cap screws for service, flanged-head cap screws are recommended, but, it is not necessary UNLESS there has been a cylinder head gasket problem (blown, etc.). If necessary to replace one or more of the cap screws with washers, replace the entire set. DO NOT MIX THE DIFFERENT GRADES AND STYLES OF CYLINDER HEAD CAP SCREWS ON ANY ONE ENGINE.

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

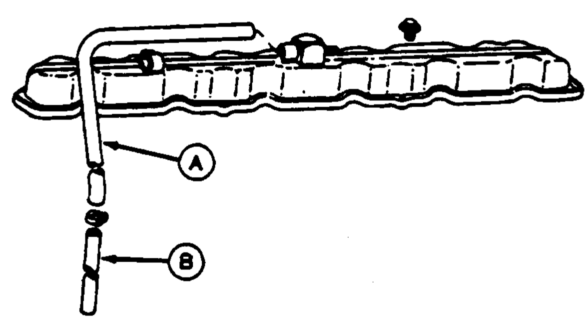
2. Inspect cap screws for corrosion damage and condition of threads. ANY CAP SCREW WITH CORROSION OR OTHER IMPERFECTIONS MUST BE REPLACED.

RG,CTM6,G05,2 -19-25MAR91

INSPECT AND CLEAN VENTILATOR OUTLET HOSE

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

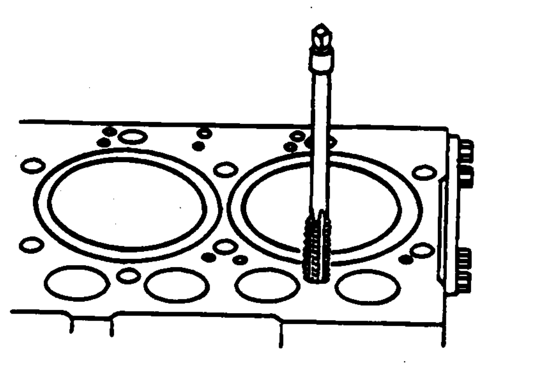
2. Clean ventilator hose and tube (B) if they are restricted.



RG4625 -UN-06DEC88

S11,2005,HO -19-01AUG91

CLEAN AND INSPECT TOP DECK OF CYLINDER BLOCK



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

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

3. Remove two cylinder head locating dowels from top deck of cylinder block.

4. Clean all cylinder head mounting cap screw holes using JDG681 Tap or an equivalent 9/16-12 UNC-2A Tap at least 89 mm (3-1/2 in.) long. Use compressed air to remove any debris and fluid present in threaded holes after cleaning.

5. Measure cylinder block top deck flatness. (See MEASURE CYLINDER BLOCK, in Group 10.)

6. Install two new locating dowels in top deck of cylinder block.

S11,2005,GZ -19-23AUG91

MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

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

NOTE: Liners having obvious defects must be replaced.

2. Use a magnetic base dial indicator (B) to measure the height (C) of bolted down liners (A) that are not obviously defective before removal from block (D). Cap screws must be tightened to 68 N·m (50 lb-ft) to achieve an accurate reading.

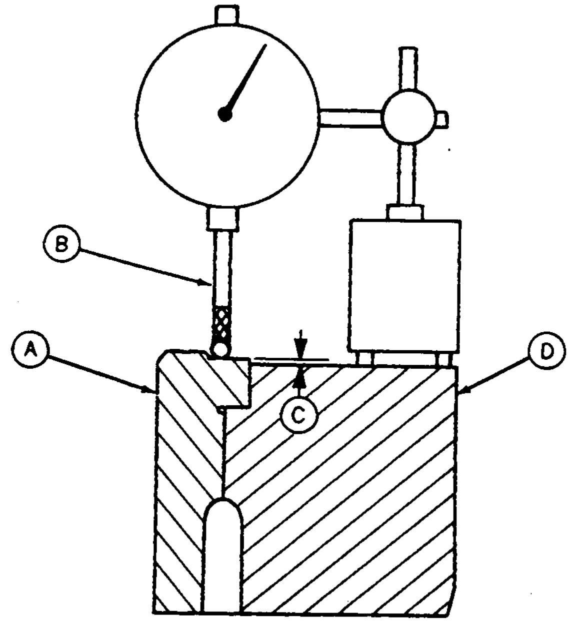
NOTE: Variations in measurement readings may occur within one cylinder and/or between adjacent cylinders.

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

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

LINER HEIGHT SPECIFICATIONS

Liner Height Above Block	0.025—0.102 mm (0.001—0.004 in.)



RG1178 -UN-13DEC88

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

S11,2005,HX1 -19-01AUG91

PROTECT CYLINDER BLOCK TOP DECK

If further disassembly of the engine is not required, cover top deck with plastic sheeting or other suitable material until ready to install cylinder head.

S11,2005,JD -19-07AUG91

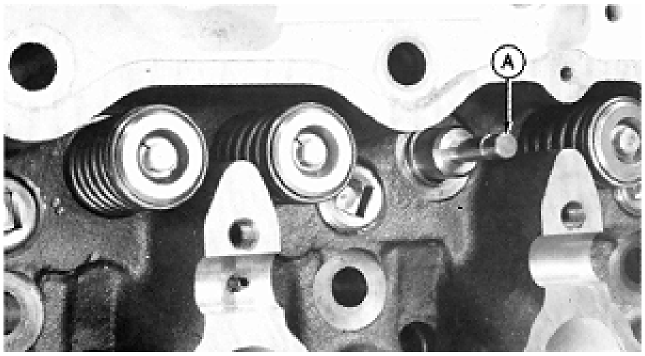
ASSEMBLE VALVE ASSEMBLY

1. Apply AR44402 Valve Stem Lubricant or its equivalent to valve stems and guides.

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

2. Install valves (A) in guides from which they were removed. Install valve stem shields on exhaust valve stems only.

NOTE: Valves must move freely and seat properly.



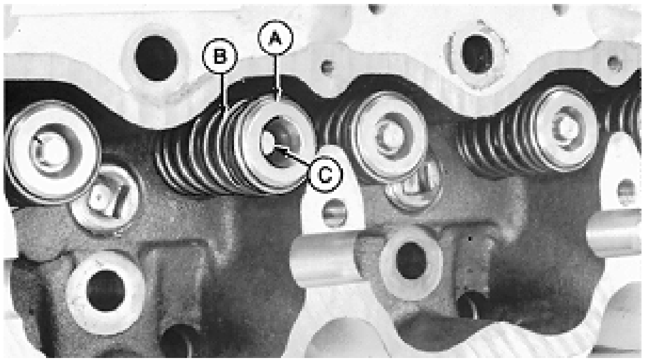
RG3806 -UN-23FEB89

S11,0401,AK -19-23AUG91

3. Engine Serial No. (—129678), determine top of valve spring by permanent mark put on spring during disassembly. Engine Serial No. after (129679—), valve springs may be installed either way.

4. Install valve springs (B) making certain that bottom of spring is correctly seating in machined counterbore of head.

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



RG3804 -UN-23FEB89

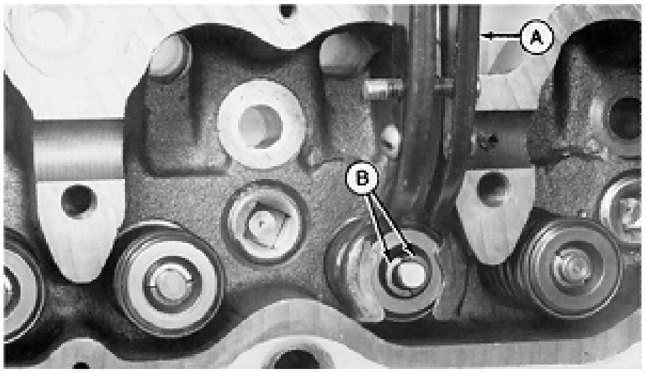
S11,2005,NV -19-25JUL91

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

7. Install retainer locks (B).

8. Release valve spring compressor.

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

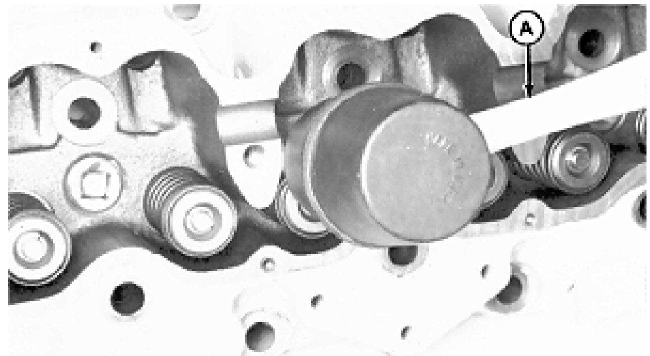


RG3803 -UN-23FEB89

S11,2005,LC -19-16FEB87

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

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



RG3807 -UN-23FEB89

S11,2005,LD -19-25MAR91

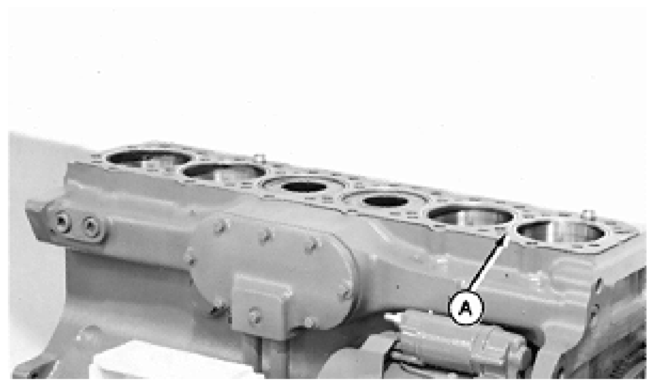
INSTALL CYLINDER HEAD

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

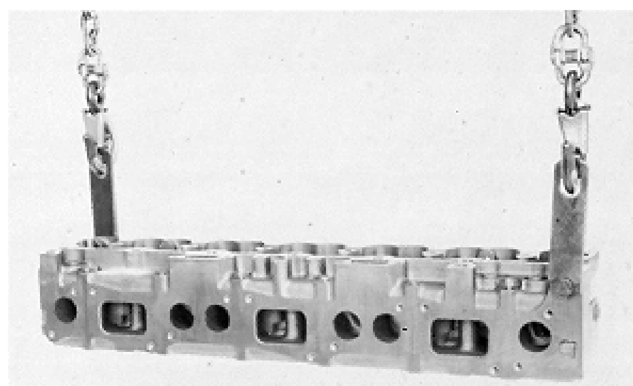
1. Put a new head gasket (A) on top of cylinder block. Do not use sealant on gasket.

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

2. Lower cylinder head into correct position on block using appropriate lifting equipment. Make sure that head is positioned correctly over dowels and that it is all the way down on gasket.



RG3808 -UN-23FEB89



RG5245 -UN-06DEC38

S11,2005,DX -19-23AUG91

Arrow (A) points toward front of engine.

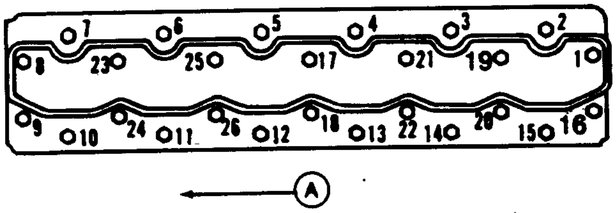
3. Dip entire cap screws and washers (if used) in clean SAE30 engine oil. Remove excess oil.

Flanged-head cap screws are now used in production and do not require washers.

4. Install cap screws and washers in proper location.

Use the following cap screws in location as shown:

Cap Screw Length	Location on Cylinder Head
136.7 mm (5.38 in.)	2,3,4,5,6,7,17,19,21,23,25
162.1 mm (6.38 in.)	1,8,10,11,12,13,14,15
190.5 mm (7.50 in.)	9,16,18,20,22,24,26



RG5699 -UN-31AUG90

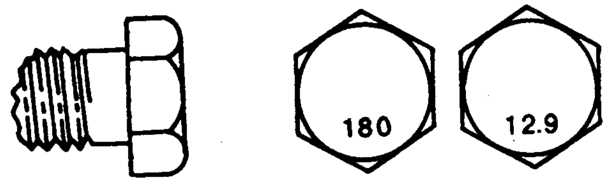
S11,2005,NF -19-23AUG91

05
33

TIGHTEN CYLINDER HEAD CAP SCREWS WITH WASHERS (GRADE 180 OR 12.9)

Arrow (A) points toward front of engine.

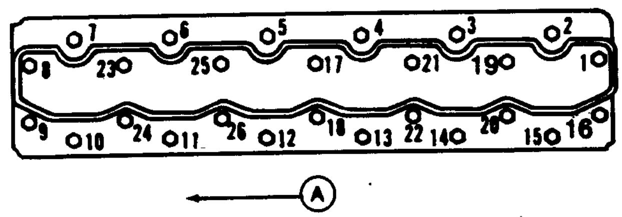
NOTE: Grade 180 or 12.9 cap screws are determined by head markings (upper illustration).



RG4627 -UN-06DEC88

1. Tighten cap screws No. 17 (lower illustration) to 224 N·m (165 lb-ft) first. This will prevent the cylinder head from tipping during tightening sequence.

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



RG5699 -UN-31AUG90

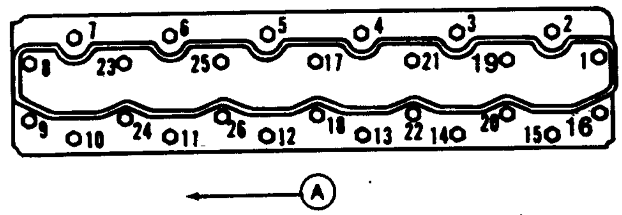
3. Starting with No. 1 cap screw, retighten all cap screws in the same sequence to 245 N·m (180 lb-ft), beginning at No. 1.

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

4. Complete engine final assembly as described later in this group.

S11,2005,NG -19-23AUG91

TIGHTEN FLANGED-HEAD CYLINDER HEAD CAP SCREWS



RG5699 -UN-31AUG90

NOTE: Flanged-head cap screws DO NOT require washers.

Arrow (A) points toward front of engine.

1. Tighten cap screw No. 17 to 100 N·m (75 lb-ft) first. This will prevent the cylinder head from tipping during tightening sequence.

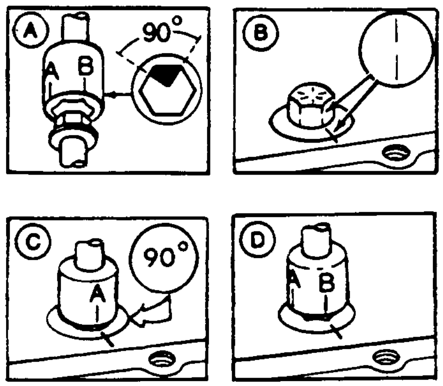
2. Start with cap screw No. 1 and proceed in numerical sequence, tighten all cap screws to 100 N·m (75 lb-ft), including cap screw No. 17.

3. Beginning with cap screw No. 1, retighten all cap screws in the same numerical sequence to 125 N·m (95 lb-ft).

4. TORQUE-TURN all flanged-head cap screws in the same sequence an additional 90°—100°, using one of the methods described in the following module. (See TORQUE-TURN FLANGED-HEAD CYLINDER HEAD CAP SCREWS.)

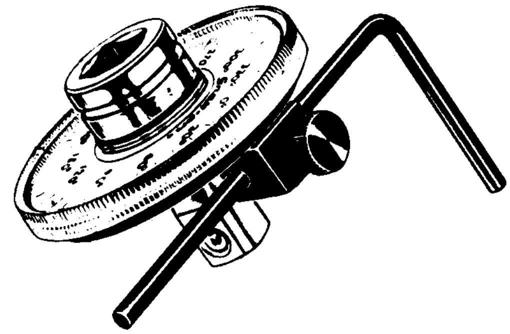
RG,CTM6,G05,3 -19-22AUG91

TORQUE-TURN FLANGED-HEAD CYLINDER HEAD CAP SCREWS



RG5563 -UN-04JUL89

Line Scribe Method



RG5698 -UN-27AUG90

JT05993 Torque Angle Gauge

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 125 N·m (95 lb-ft), follow steps A—D below for each cap screw beginning with the No. 1 cap screw and sequentially proceed thru to No. 26.

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

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

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

Step D— Tighten cap screw 1/4 turn (90˚) until second mark on socket aligns with mark on cylinder head.

• Using JT05993 Torque Angle Gauge:

After tightening cylinder head cap screws (in proper sequence) to 125 N·m (95 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.

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

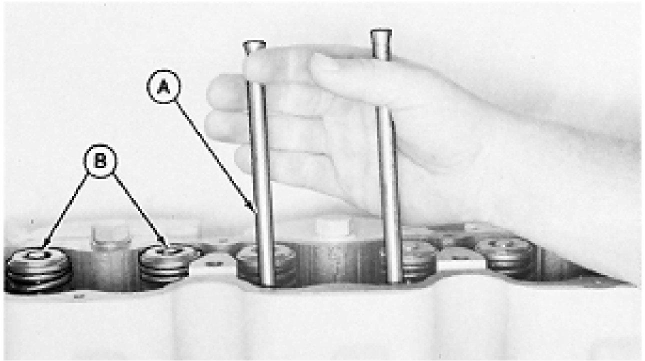
IMPORTANT: Retorque of cylinder head cap screws after engine run-in is not required when using flanged-head cap screws and the recommended TORQUE-TURN tightening procedure.

RG,CTM6,G05,4 -19-22AUG91

INSTALL ROCKER ARM ASSEMBLY

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

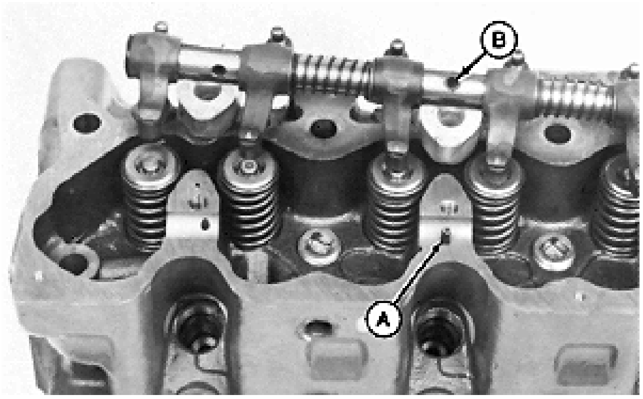
2. Install wear caps (B) on valves, making certain caps rotate freely.



RG3809 -UN-23FEB89

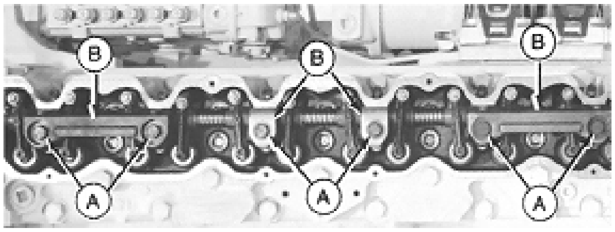
S11,2005,HT -19-07AUG91

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



RG3810 -UN-23FEB89

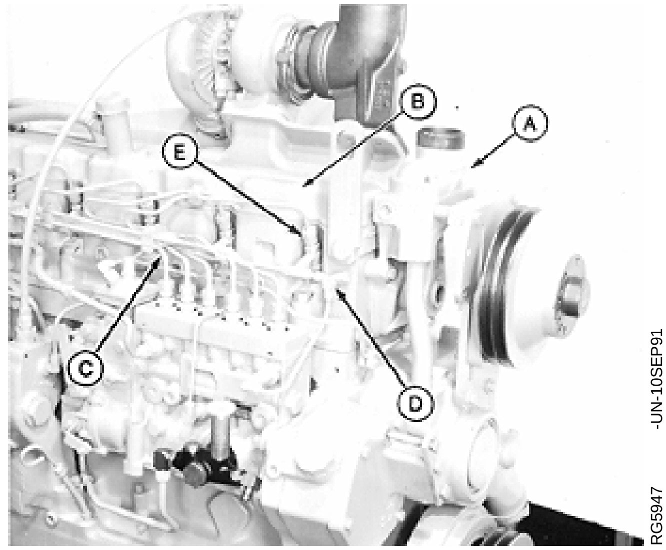
4. Install shaft clamps (B) and all six cap screws (A). Tighten cap screws to 75 N·m (55 lb-ft).



RG3920 -UN-23FEB89

S11,2005,NH -19-15MAR88

COMPLETE FINAL ASSEMBLY OF INJECTION PUMP SIDE



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

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

2. Apply AR31790 SCOTCH-GRIP EC-1099 Adhesive or equivalent to new gasket, and seal gasket to rocker arm cover (B). Be sure to follow the manufacturer's directions on the package for correct application procedures and curing times.

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

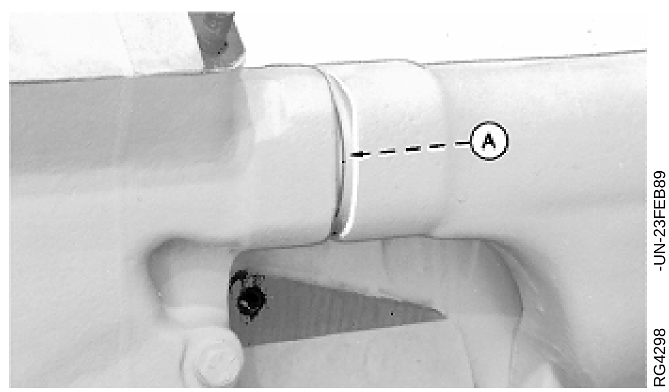
4. Install fuel injection nozzles (E), leak-off lines (D) and fuel injection lines (C). (See INSTALL FUEL INJECTION NOZZLES in Group 35.)

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

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

S11,2005,NI -19-23AUG91

COMPLETE FINAL ASSEMBLY ON EXHAUST MANIFOLD SIDE



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

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

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

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

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

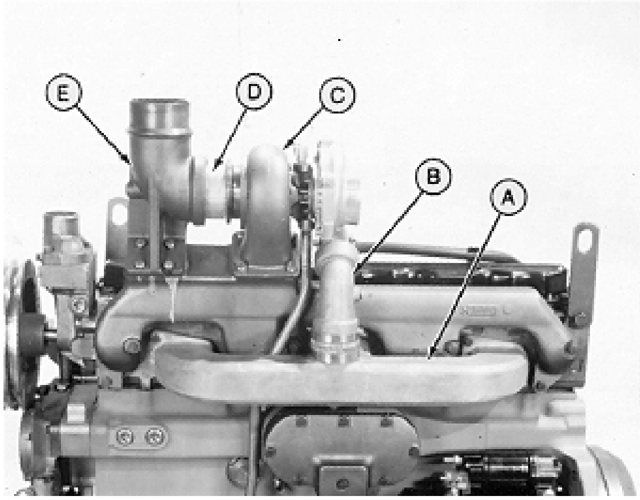
S11,2005,NJ -19-23AUG91

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

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

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

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



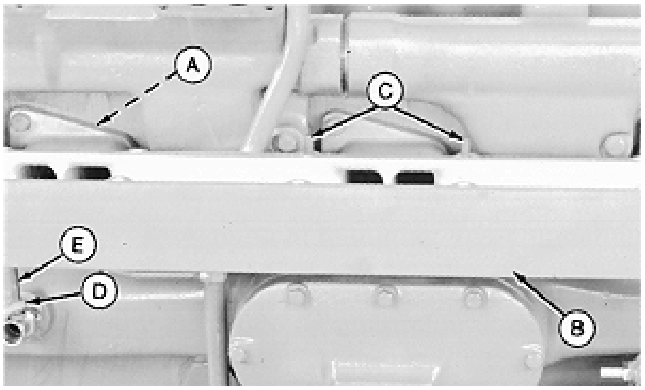
RG5256 -UN-06DEC88

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

S11,2005,NK -19-25MAR91

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

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



RG4979 -UN-06DEC88

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

S11,2005,MV -19-25MAR91

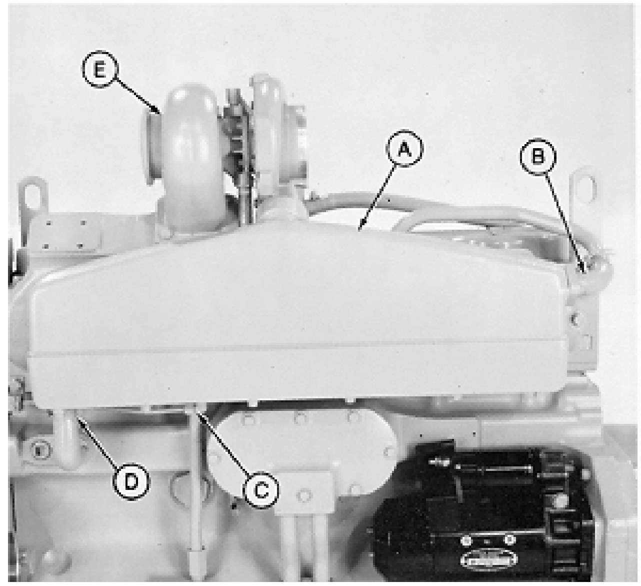
10. On 6076A Engines, using new gaskets and O-rings, install aftercooler and cover (A). (See INSTALL AFTERCOOLER AND COVER in Group 30.)

11. Install water inlet (B) and water outlet (D) hoses. Tighten hose clamps securely.

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

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

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



RG5257 -UN-06DEC88

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

05
40

S11,2005,MW -19-08AUG91

PERFORM ENGINE BREAK-IN

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

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

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

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

RG,CTM6,G05,5 -19-08AUG91

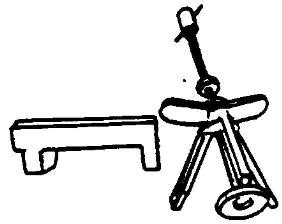
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

Cylinder Liner Puller D01062AA
(or D01073AA)

Remove cylinder liners.



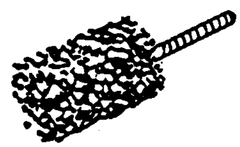
RG5019 -UN-23AUG88

S53,D01062,AA -19-07AUG91

RG5074 -UN-23AUG88

Flexible Cylinder Hone D17005BR

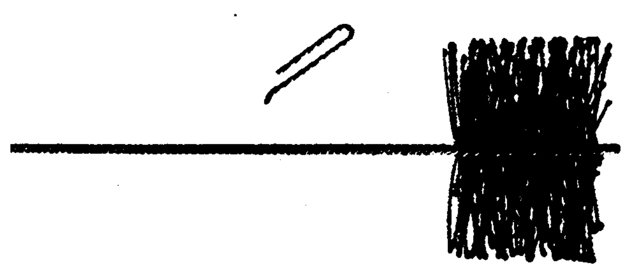
Hone cylinder liners.



S53,D17005,BR -19-07APR88

O-Ring Groove Cleaning Brush D17015BR

Clean cylinder liner O-ring groove in block.



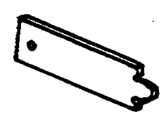
RG5075 -UN-23AUG88

S53,D17015,BR -19-25MAR91

RG5076 -UN-23AUG88

Ring Groove Wear Gauge JDE55

Check wear of keystone ring groove on pistons.

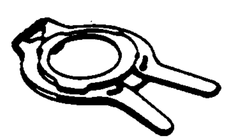


S53,JDE55 -19-25MAR91

RG5077 -UN-23AUG88

Piston Ring Expander JDE93

Remove and install piston rings.

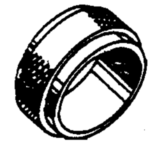


S53,JDE93 -19-17FEB87

RG5031 -UN-23AUG88

Piston Ring Compressor JDE96

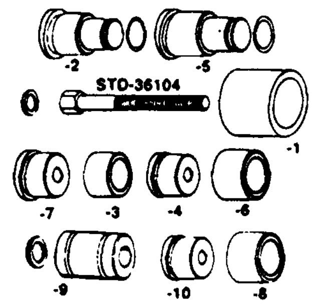
Compress rings while installing pistons.



S53,JDE96 -19-25MAR87

Connecting Rod Bushing Service Set JDE98A

Remove and install connecting rod bushings.



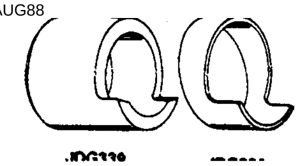
RG5078 -UN-23AUG88

S53,JDE98A -19-25MAR91

RG5079 -UN-23AUG88

Connecting Rod Bushing Service Set JDG337

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

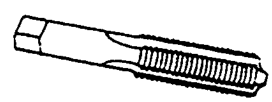


S53,JDG337,A -19-24NOV87

RG5100 -UN-23AUG88

Tap JDG681

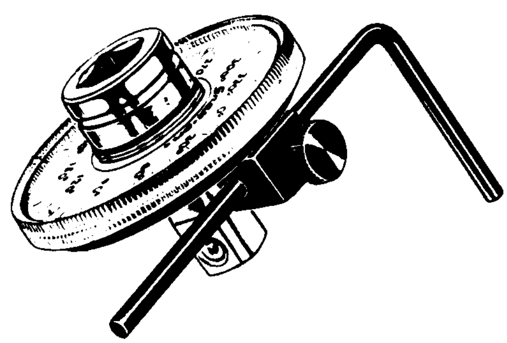
Used to restore threaded holes in cylinder block for cylinder head cap screws.



RG,JDG681 -19-25MAR91

Torque Angle Gauge JT05993

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



RG5698 -UN-27AUG90

RG,JT05993 -19-22AUG91

SERVICE EQUIPMENT AND TOOLS

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

Name	Use
D05012ST Precision Straightedge	Measure cylinder block top deck flatness.

RG,CTM6,G10,5 -19-23AUG91

CYLINDER BLOCK, LINERS, PISTONS, AND RODS SPECIFICATIONS

ITEM	NEW PART SPECIFICATION	WEAR TOLERANCE
Cylinder Liner Height Above Block	0.025—0.102 mm	——
	(0.001—0.004 in.)	——
Maximum Piston Protrusion Above Block	0.051—0.787 mm	——
	(0.002—0.031 in.)	——
Piston Oil Control Ring-to-Groove Clearance	0.064—0.102 mm	0.165 mm
	(0.0025—0.0040 in.)	(0.0065 in.)
Piston Oil Control Ring End Gap:		
No. 1 Ring	0.43—0.69 mm	——
	(0.017—0.027 in.)	——
No. 2 Ring	0.63—0.89 mm	——
	(0.025—0.035 in.)	——
ZOLLNER Piston OD @ Bottom of Skirt:		
—6 mm (0.24 in.) from Bottom of Piston		
Engine Serial No. (—170339)	115.760—115.778 mm	——
	(4.5575—4.5582 in.)	——
—19.1 mm (0.75 in.) from Bottom of Piston		
Engine Serial No. (170340—499999)	115.771—115.789 mm	——
	(4.5579—4.5586 in.)	——
MAHLE Piston OD @ Bottom of Skirt:		
—12 mm (0.47 in.) from Bottom of piston	115.775—115.793 mm	——
	(4.5581—4.5588 in.)	
ZOLLNER Piston-to-Liner Clearance @ Bottom of Skirt:		
—Engine Serial No. (—170339)	0.087—0.135 mm	0.152 mm
	(0.0034—0.0053 in.)	(0.0060 in.)
—Engine Serial No. (170340—499999)	0.076—0.124 mm	0.152 mm
	(0.0030—0.0049 mm)	(0.0060 in.)
MAHLE Piston-to-Liner Clearance @ Bottom of Skirt	0.072—0.120 mm	0.152 mm
	(0.0028—0.0047 in.)	(0.0060 in.)
Cylinder Liner ID	115.865—115.895 mm	——
	(4.5616—4.5628 in.)	——
OD	127.94—128.24 mm	——
	(5.037—5.049 in.)	——
Cylinder Liner Maximum Taper	0.051 mm (0.0020 in.)	——
Cylinder Liner Maximum Out-of-Round	0.051 mm (0.0020 in.)	——
Cylinder Liner Counterbore Depth	8.105—8.155 mm	——
	(0.319—0.321 in.)	——
Liner Flange Thickness	8.175—8.225 mm	——
	(0.322—0.324 in.)	——
Liner Flange OD	135.105—135.130 mm	——
	(5.319—5.321 in.)	——
Outer Diameter of Liner @ Upper Bore	129.085—129.135 mm	——
	(5.082—5.084 in.)	——
Outer Diameter of Liner @ Lower Bore	125.042—125.122 mm	——
	(4.923—4.926 in.)	——

S11,2010,KA -19-24SEP91

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

ITEM	NEW PART SPECIFICATION	WEAR TOLERANCE
Upper Bore Diameter in Block For Seating Liners	129.155—129.205 mm	——
	(5.085—5.087 in.)	——
Lower Bore Diameter in Block for Seating Liners	125.133—125.183 mm	——
	(4.9265—4.9285 in.)	——
Liner-to-Block Clearance at Upper Bore	0.026—0.126 mm	——
	(0.001—0.005 in.)	——
Liner-to-Block Clearance at Lower Bore	0.012—0.140 mm	——
	(0.0005—0.0055 in.)	——
Liner Shim Thickness	0.05 mm	——
	(0.002 in.)	——
Piston Pin OD	47.60—47.61 mm	——
	(1.8739—1.8745 in.)	——
Piston Pin Bore ID in Piston	47.62—47.63 mm	——
	(1.8748—1.8752 in.)	——
Rod Pin Bushing ID (After Honing)	47.65—47.68 mm	——
	(1.8762—1.8772 in.)	——
Rod Pin Bore Diameter Without Bushing	52.354—52.380 mm	——
	(2.0612—2.0622 in.)	——
Rod Pin-to-Bushing Oil Clearance	0.042—0.084 mm	0.102 mm
	(0.0017—0.0033 in.)	(0.0040 in.)
Rod-to-Pin Bushing Press Fit Specification	0.084—0.147 mm	——
	(0.0033—0.0058 in.)	——
Connecting Rod Bore Without Bearings	81.051—81.077 mm	——
	(3.191—3.192 in.)	——
Connecting Rod Bearing Assembled ID	76.21—76.26 mm	——
	(3.0004—3.0024 in.)	——
Crankshaft Rod Journal OD	76.15—76.18 mm	——
	(2.9980—2.9992 in.)	——
Bearing-to-Journal Clearance	0.030—0.110 mm	0.152 mm
	(0.0012—0.0044 in.)	(0.0060 in.)
Connecting Rod Cap End Gap		0.254 mm
		(0.0100 in.)
Connecting Rod Out-of-Round		0.025 mm
		(0.0010 in.)
Centerline of Main Bearing Bore-to-Top Deck of Cylinder Block	352.35—352.50 mm	——
	(13.872—13.878 in.)	——
Camshaft Bushing Bore Diameter in Block	69.987—70.013 mm	——
	(2.7554—2.7564 in.)	——
Camshaft Bushing Installed ID	67.076—67.102 mm	——
	(2.6408—2.6418 in.)	——
Cylinder Block Top Deck Maximum Out-of-Flat	0.10 mm (0.004 in.)	

S11,2010,KB -19-23AUG91

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	9.6—12.4 N·m (85—110 lb-in.)
Cylinder Liner Cap Screws (for checking liner standout)	68 N·m (50 lb-ft)

RG,CTM6,G10,1 -19-24JUL91

OTHER MATERIAL

Name	Use
AR54749 Soap Lubricant	Coat O-rings on Cylinder Liners
PLASTIGAGE®	Determine connecting rod bearing-to-journal oil clearance during engine disassembly.

S11,2010,BS -19-24SEP91

DIAGNOSING MALFUNCTIONS

• Scuffed or Scored Pistons:

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

• Worn or Broken Compression Rings:

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

• Clogged Oil Control Ring:

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

• Dull Satin Finish and Fine Vertical Scratches on Rings:

Dirt and abrasive in air intake system.

• Stuck Rings:

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

• Cylinder Liner Wear and Distortion:

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

• Warped Cylinder Block:

Insufficient cooling.

• Broken Connecting Rod:

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

• Piston Pin and Snap Ring Failure:

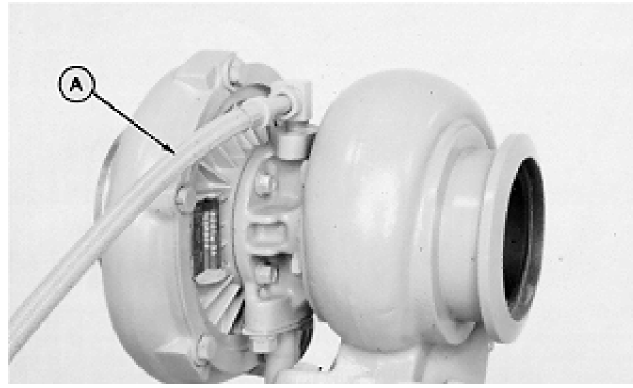
Misaligned connecting rod.
Excessive crankshaft end play.
Incorrect snap rings.

• Mottled, Grayish or Pitted Compression Rings:

Internal coolant leaks.

S11,0402,A -19-25MAR91

DISCONNECT TURBOCHARGER OIL INLET LINE



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

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

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

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

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

RG,CTM6,G03,1 -19-22AUG91

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.

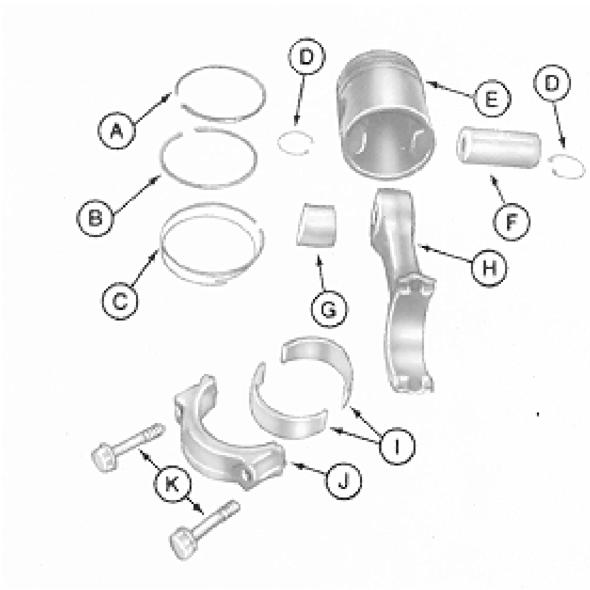
1. Drain all coolant and engine oil.

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 ENGINE OIL PUMP in Group 20.)

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



RG3657 -UN-13DEC88

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

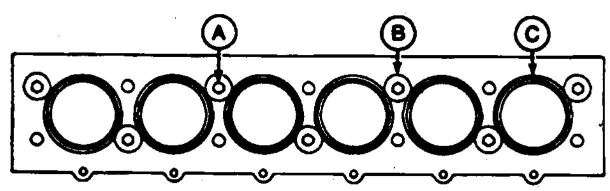
S11,2010,FD -19-12JUL91

10
9

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

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

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



RG3819 -UN-07DEC88

S11,2010,EV -19-07AUG91

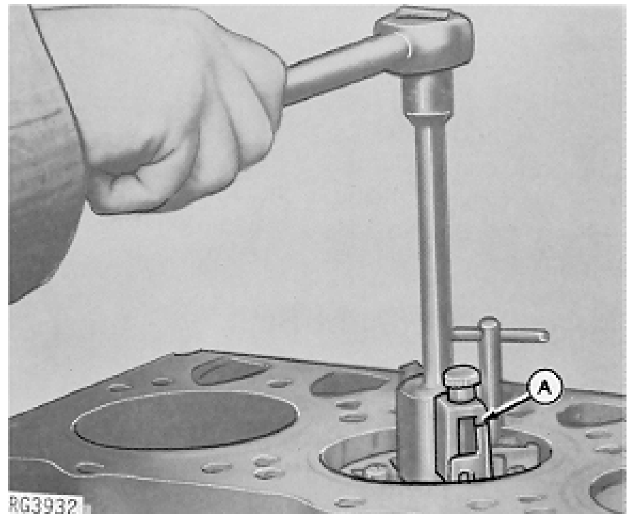
6. Remove carbon or ridge from liner bore with a scraper or ridge reamer (A) before removing pistons. Use compressed air to remove loose material from cylinders.

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

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

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

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



RG3932 -UN-07DEC88

S11,2010,IV -19-24NOV87

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

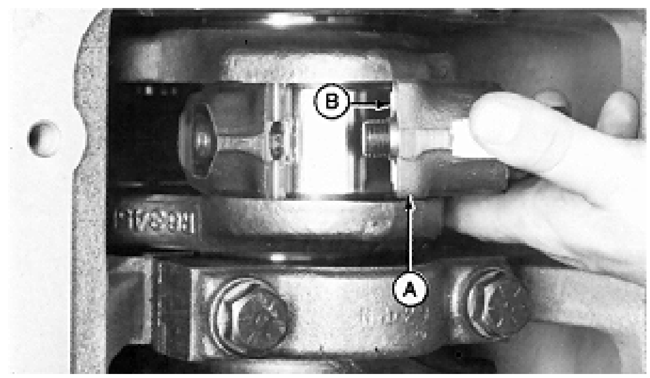
Rod bearing-to-journal oil clearance can be checked with PLASTIGAGE if rod is connected to crankshaft. If rod is out of engine, measure ID of assembled connecting rod bearings and compare with OD of crankshaft journal.

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

IMPORTANT: Using pneumatic wrenches may cause thread damage.

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

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



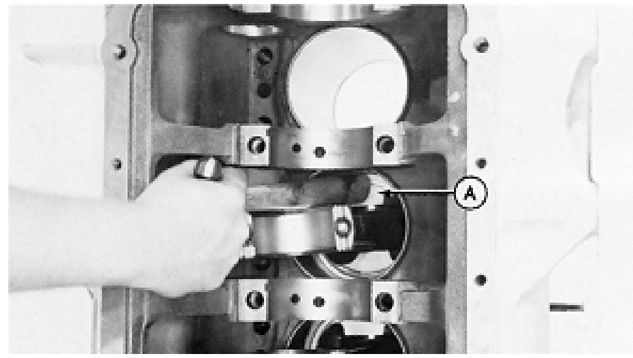
RG3820 -UN-07DEC88

S11,2010,KC -19-23AUG91

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

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

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

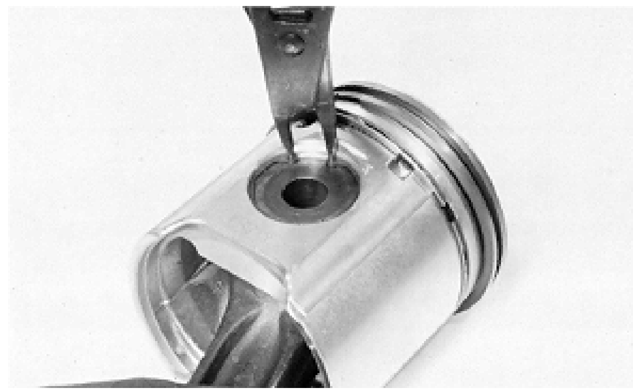


RG3821 -UN-07DEC88

S11,0402,G -19-05NOV86

9. Remove piston snap rings. Remove piston pins and connecting rods from pistons.

NOTE: Discard snap rings. DO NOT reuse.



RG5228 -UN-13DEC88

S11,2010,IW1 -19-25MAR91

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11

MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

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

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

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

2. Use a magnetic base dial indicator (B) to measure the height (C) of bolted down liners (A) that are not obviously defective before removal from block (D). Cap screws must be tightened to 68 N·m (50 lb-ft) to achieve an accurate reading.

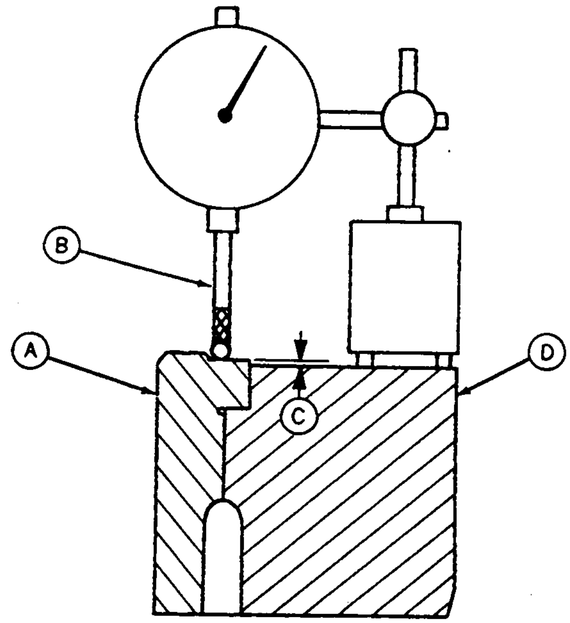
NOTE: Variations in measurement readings may occur within one cylinder and/or between adjacent cylinders.

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

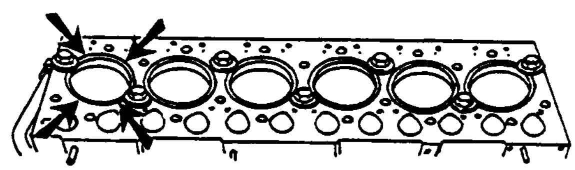
4. Remove any liner that does not meet standout specification at any location and measure liner flange thickness, as explained later in this group. Use liner shims or replace piston/liner sets as necessary.

LINER HEIGHT SPECIFICATIONS

Liner Height Above Block	0.025—0.102 mm (0.001—0.004 in.)



RG1178 -UN-13DEC88

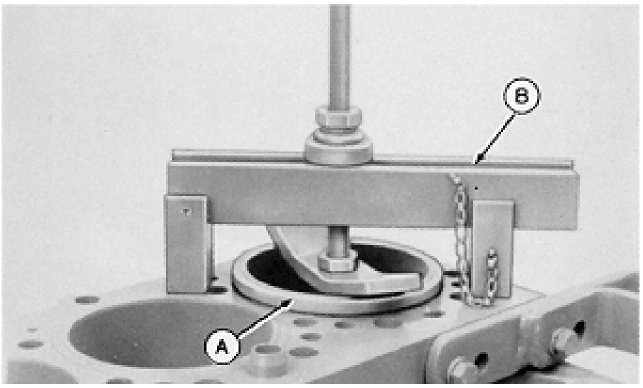


RG4720 -UN-13DEC88

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

S11,2010,EW -19-31JUL91

REMOVE CYLINDER LINERS



-UN-13DEC88 R24531

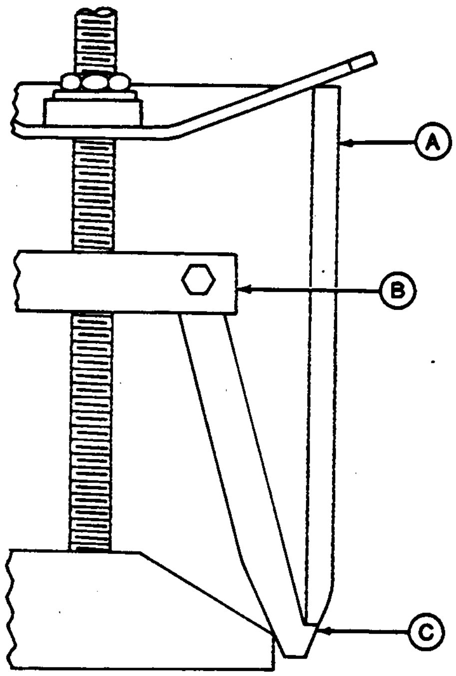
1. Remove cap screws and washers against liners.

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

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

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

S11,2010,IX -19-25MAR91



-UN-13DEC88 RG1179

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

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

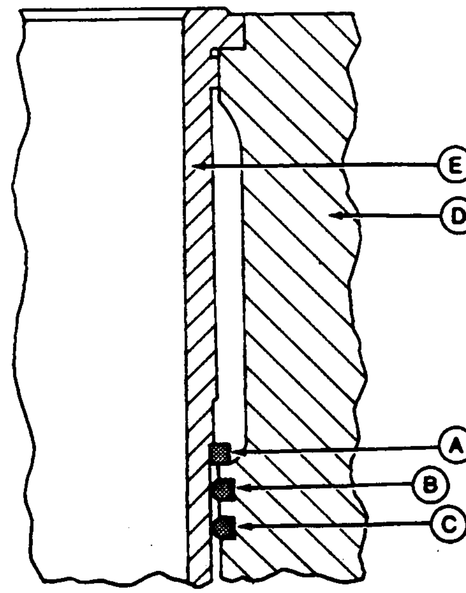
S11,0402,AK -19-25MAR91

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—Liner



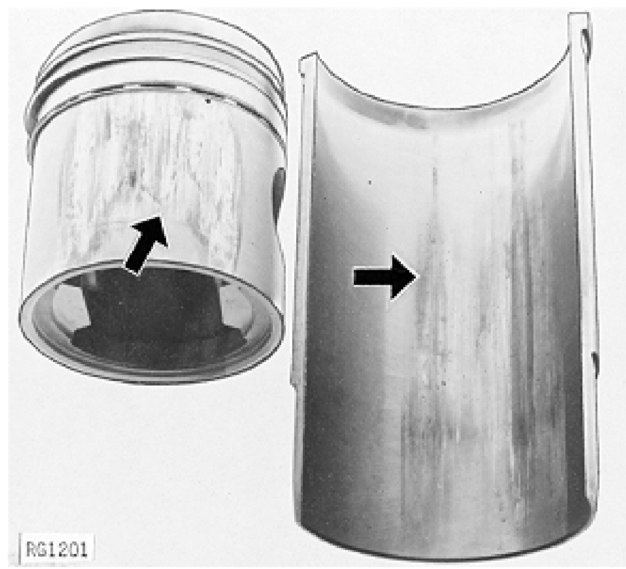
RG3825 -UN-13DEC88

S11,0402,AL -19-25MAR91

INSPECT PISTONS AND LINERS

1. Match piston with correct liner and check for scoring (arrows). Wear of this type could be caused by: engine overheating, or foreign material entering the cylinder through the oiling system. Check for any cracks or other obvious failures.

If any defects are found, replace the piston and liner as required. If no defects are found, proceed to next step.

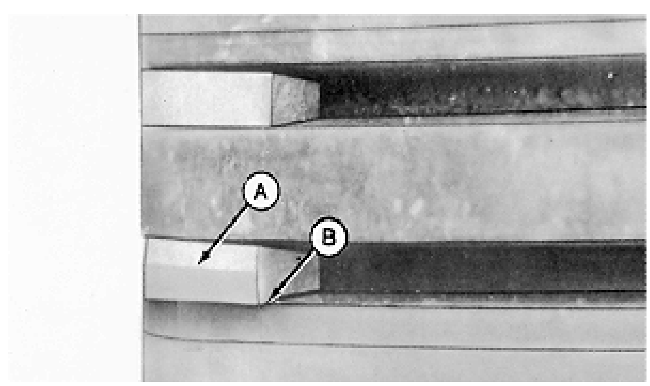


RG1201 -UN-13DEC88

S11,2010,DB -19-07AUG91

2. If piston ring face (A) and ring land (B) have excessive wear, replacement is necessary for both piston and liner.

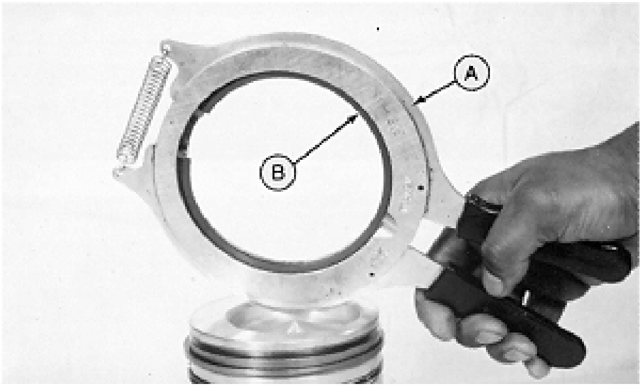
If no defects are found, proceed to next step.



RG4378 -UN-13DEC88

S11,2010,DC -19-05NOV86

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



RG5229 -UN-13DEC88

S11,2010,JA -19-24NOV87

4. Clean pistons by any of the following methods:

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

DO NOT bead blast ring groove areas.

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

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

S11,2010,DD -19-07AUG91

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

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

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

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

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

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

S11,2010,DD1 -19-07AUG91

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

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

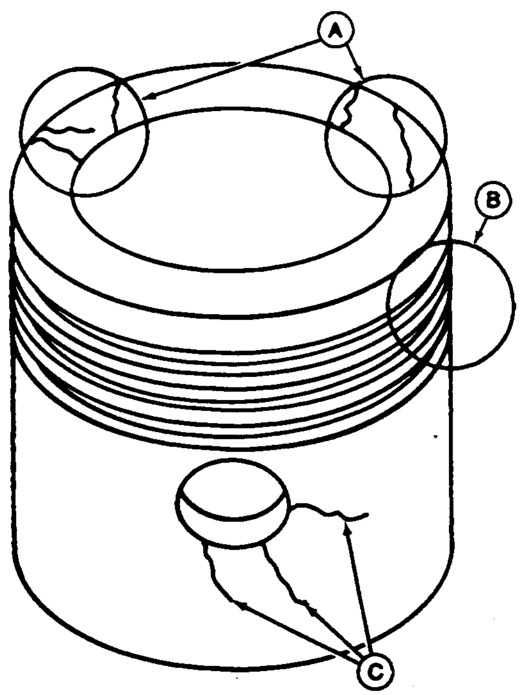
12. Inspect for bent or broken ring lands (B).

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

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

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

If no defects are found, proceed to next step.

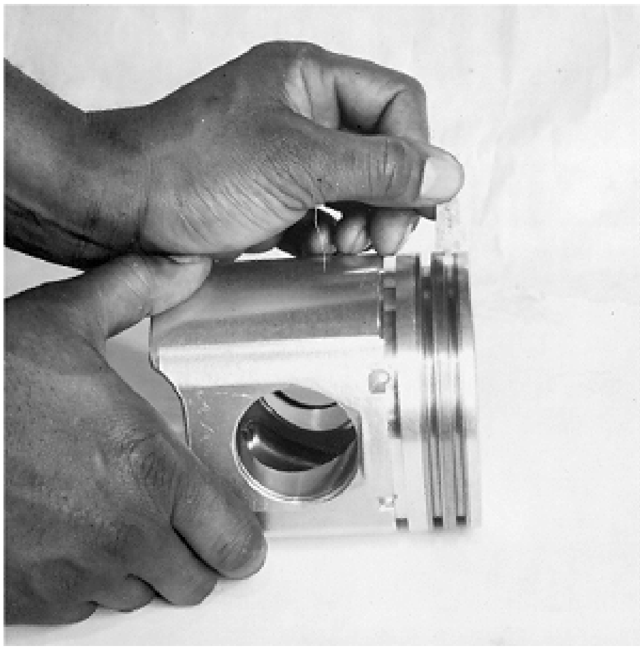


RG3326 -UN-13DEC88

(Defects Exaggerated)

S11,2010,DE -19-25MAR91

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

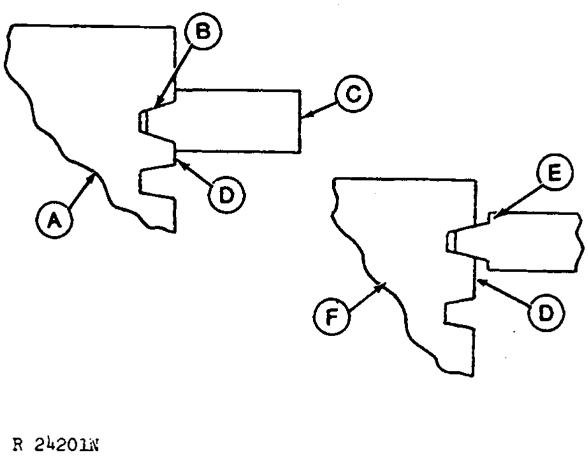


RG5230 -UN-13DEC88

S11,2010,JB -19-24SEP91

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

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



R24201 -UN-13DEC88

S11,2010,DG -19-17FEB87

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

16. Dip piston pin in clean engine oil.

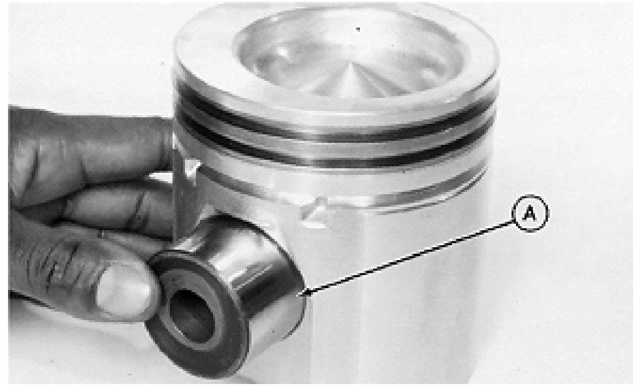
17. Install pin (A) through piston.

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

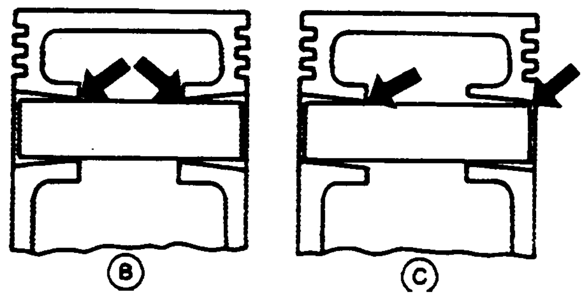
18. Check piston pin and piston bore specifications. If either are not within specification, replace pin, piston, and liner.

PISTON PIN/BORE SPECIFICATIONS

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



RG5231 -UN-13DEC88



RG4984 -UN-13DEC88

S11,2010,JC -19-15APR88

19. 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:

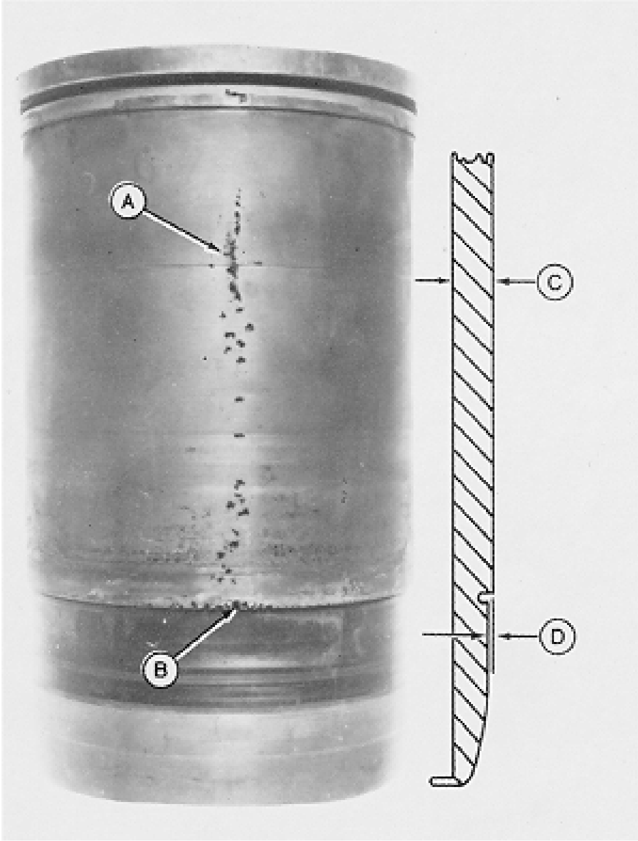
—Depth of any pit is one-half or more of liner thickness (C).

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

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

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

If no defects are found, proceed to next step.



RG4643 -UN-13DEC88

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

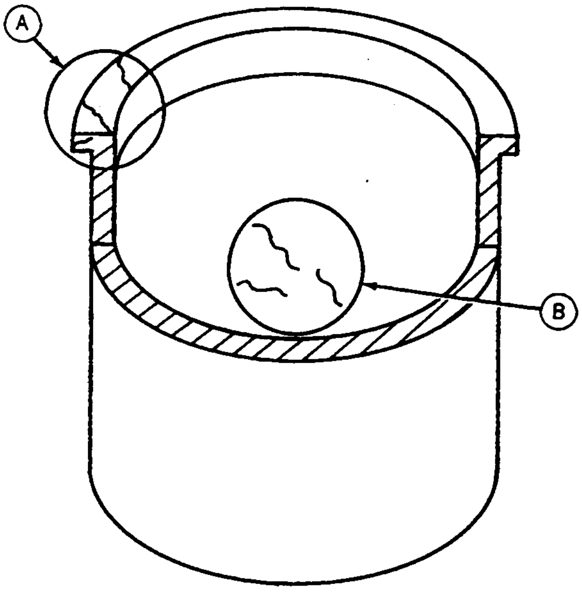
S11,2010,DI -19-25MAR91

20. Carefully examine the cylinder 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. Replace block if any of these defects are found.

If any defects are found, replace the piston and liner as a set. If no defects are found, proceed to next step.

If pistons and liners have passed all previous checks, proceed to check both for proper specifications.



RG1188 -UN-13DEC88

(Exaggerated defects)

S11,2010,DJ -19-25FEB85

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19

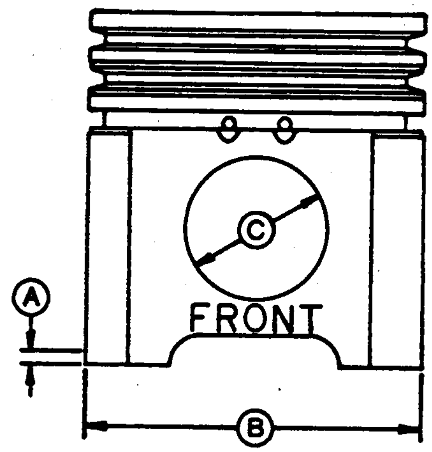
21. Measure piston skirt OD (B) at right angles to piston pin bore (C) and the following distance (A) from bottom of piston:

—ZOLLNER pistons engine serial no. (000—170339) —6 mm (0.24 in.)
—ZOLLNER pistons engine serial no. (170340—499999) —19.1 mm (0.75 in.)
—MAHLE pistons—12 mm (0.47 in.).

22. Measure cylinder liner ID as directed later in this group and compare with piston skirt OD measurement to determine piston-to-liner clearance.

PISTON OD SPECIFICATION @ BOTTOM OF SKIRT

ZOLLNER Pistons, Engine Serial No. (—170339)	115.760—115.778 mm (4.5575—4.5582 in.)
ZOLLNER Pistons, Engine Serial No. (170340—499999)	115.771—115.789 mm (4.5579—4.5586 in.)
MAHLE Pistons	115.775—115.793 mm (4.5581—4.5588 in.)



RG5232 -UN-13DEC88

S11,2010,JD -19-24SEP91

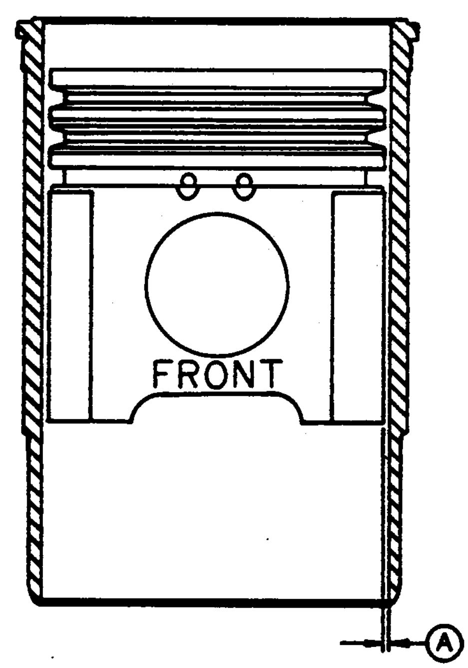
23. Compare liner ID measurement with piston skirt OD measurement to determine piston-to-liner clearance (A). New part piston-to-liner clearance specifications are:

PISTON-TO-LINER NEW PART CLEARANCE

ZOLLNER Pistons Engine Serial No. (000—170339)	0.087—0.135 mm (0.0034—0.0053in.)
ZOLLNER Pistons Engine Serial No. (170340—499999)	0.076—0.124 mm (0.0030—0.0049 in.)
MAHLE pistons	0.072—0.120 mm (0.0028—0.0047 in.)

Maximum acceptable piston-to-liner clearance on used parts is 0.152 mm (0.0060 in.). Replace piston and liner as a matched set if clearance exceeds this limit.

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



RG5233 -UN-13DEC88

S11,2010,JE -19-25SEP91

MEASURE OIL CONTROL RING GROOVE

RG5234 -UN-13DEC88

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

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

OIL CONTROL RING CLEARANCE SPECIFICATIONS

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

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

S11,2010,JF -19-07AUG91

MEASURE CYLINDER LINERS

IMPORTANT: ALWAYS measure liners at room temperature.

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

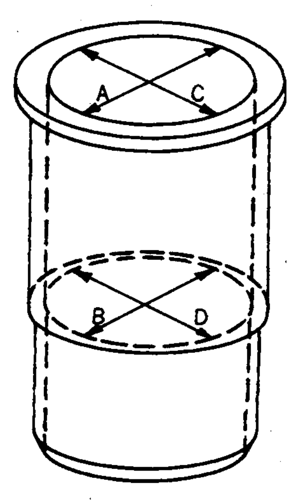
B—Measure bore in same position at bottom end of ring travel.

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

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

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

Compare liner ID with matched piston OD.



R25922N

R25922 -UN-13DEC88

CYLINDER LINER WEAR SPECIFICATIONS

Maximum Wear or Taper in Ring Travel Area . . . . 0.051 mm (0.0020 in.)
Maximum Liner Out-of-Round . . . . 0.051 mm (0.0020 in.)
Maximum Piston-to-Liner Clearance . . . . 0.152 mm (0.0060 in.)

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

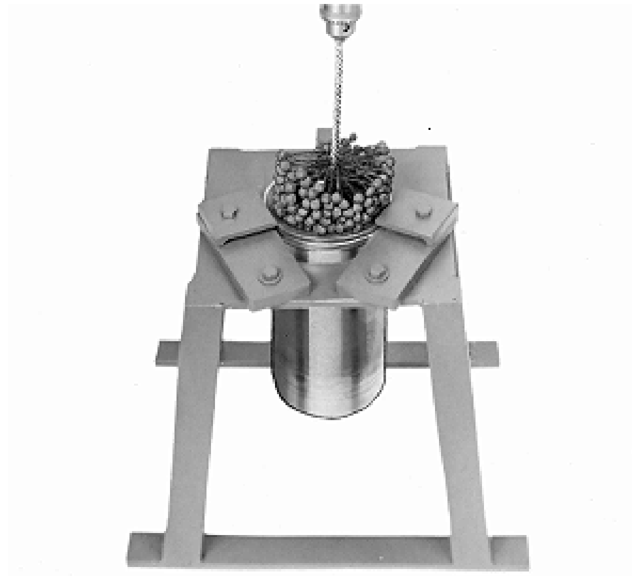
S11,2010,JQ -19-23AUG91

DEGLAZE CYLINDER LINERS

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

2. Use D17005BR Flexible Cylinder Hone to deglaze cylinder liner.

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

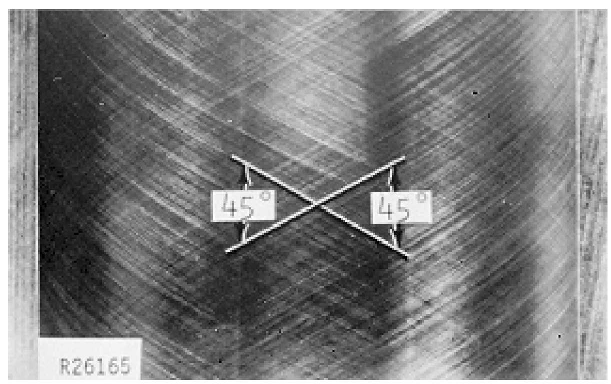


R26164 -UN-13DEC88

S11,0402,AS -19-07AUG91

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

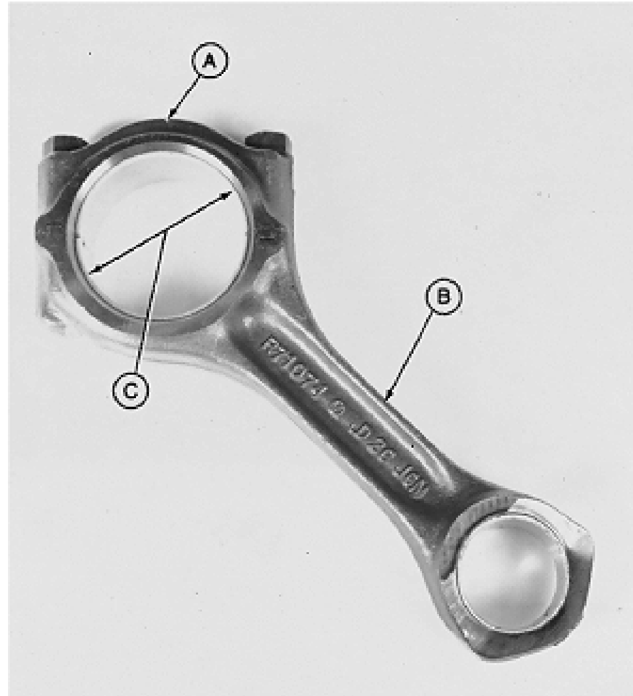
Thoroughly clean liners after deglazing. See INSPECT PISTONS AND LINERS, earlier in this group, for proper cleaning procedures.



R26165 -UN-13DEC88

S11,0402,AT -19-22AUG91

INSPECT AND MEASURE CONNECTING ROD BEARINGS



RG5705 -UN-01APR91

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

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

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

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

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

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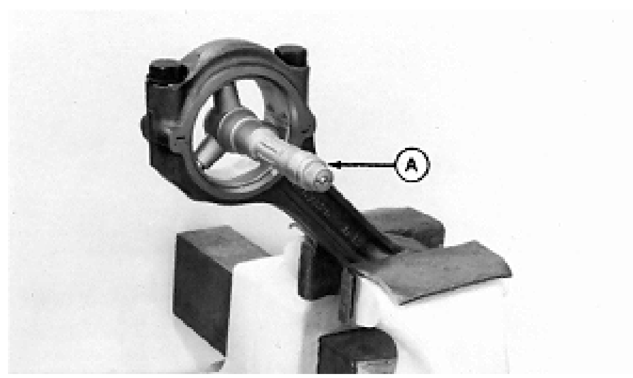
S11,2010,KD -19-23AUG91



RG3824 -UN-13DEC88

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

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

6. Compare measurements with the following specifications.

CONNECTING ROD BEARING AND JOURNAL SPECIFICATIONS

Crankshaft Journal OD	76.15—76.18 mm (2.9980—2.9992 in.)
Assembled Rod Bearing ID	76.21—76.26 mm (3.0005—3.0025 in.)
Oil Clearance (new parts)	0.030—0.110 mm (0.012—0.0044 in.)
Maximum Serviceable Clearance	0.152 mm (0.0060 in.)

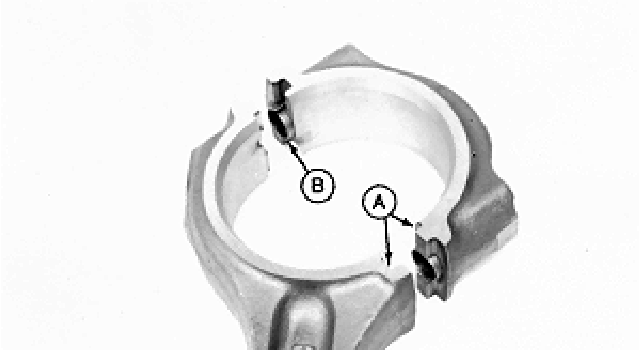
7. Inspect connecting rod bearings for wear or damage. If bearings are worn or not within specification, replace both connecting rod bearing and rod pin bearing.

S11,2010,JR -19-25MAR91

INSPECT ROD AND CAP

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

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



RG3749 -UN-13DEC88

S11,0402,AE -19-07AUG91

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

4. Install cap WITHOUT bearing inserts.

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

5. Tighten cap screws to 75 N·m (55 lb-ft), then tighten each cap screw an additional 90°—100°. (See USE TORQUE-TURN METHOD FOR PROPER TORQUE, later in this group.)

RG4982 -UN-13DEC88

S11,2010,JS -19-23AUG91

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

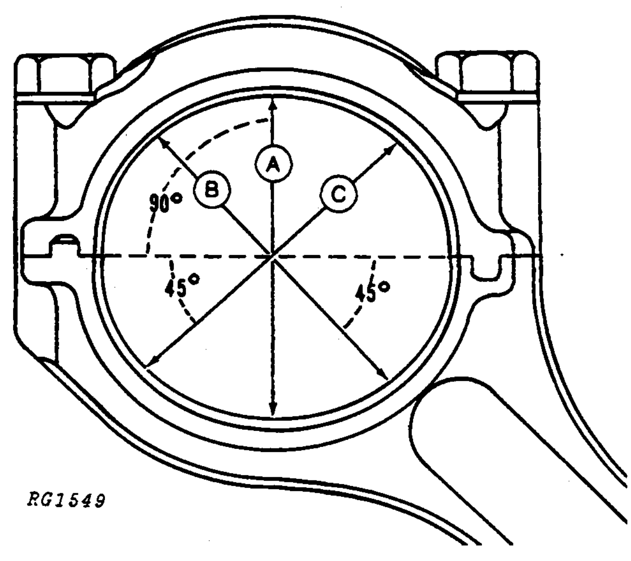
A. At right angle to rod/cap joint.
B. At 45° left of measurement “A”.
C. At 45° right of measurement “A”.

ROD BORE SPECIFICATIONS

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

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

RG5810 -UN-12AUG91



RG1549 -UN-13DEC88

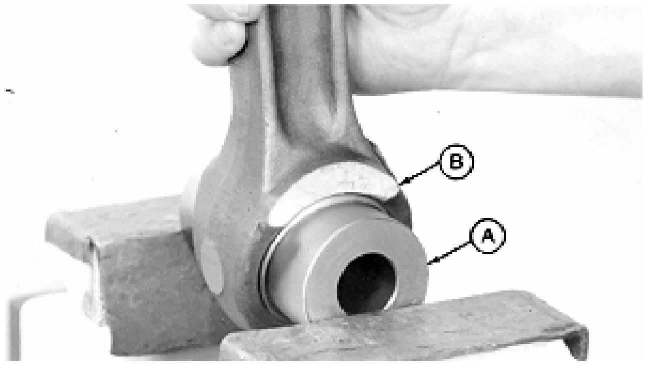
S11,2010,JU -19-22AUG91

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 bushing pin.

3. Remove piston pin from vise and connecting rod.



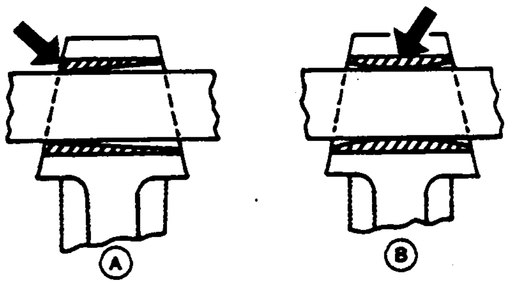
RG3172 -UN-13DEC88

S11,2010,DM -19-07AUG91

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 alignment, damage, excessive wear or contaminants.

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



RG4983 -UN-13DEC88

PISTON PIN BORE SPECIFICATIONS

OD of Piston Pin	47.60—47.61 mm (1.8739—1.8745 in.)
ID of Pin Bore in Piston	47.62—47.63 mm (1.8748—1.8752 in.)
ID of Installed Rod Pin Bushing (After Honing)	47.65—47.68 mm (1.8762—1.8772 in.)
Rod Pin-to-Bushing Oil Clearance	0.042—0.084 mm (0.0017—0.0033 in.)
Maximum Serviceable	0.102 mm (0.0040 in.)

7. If necessary, remove and replace piston pin bushing. See REMOVE PISTON PIN BUSHING, as described later in this group.

S11,2010,JG -19-22AUG91

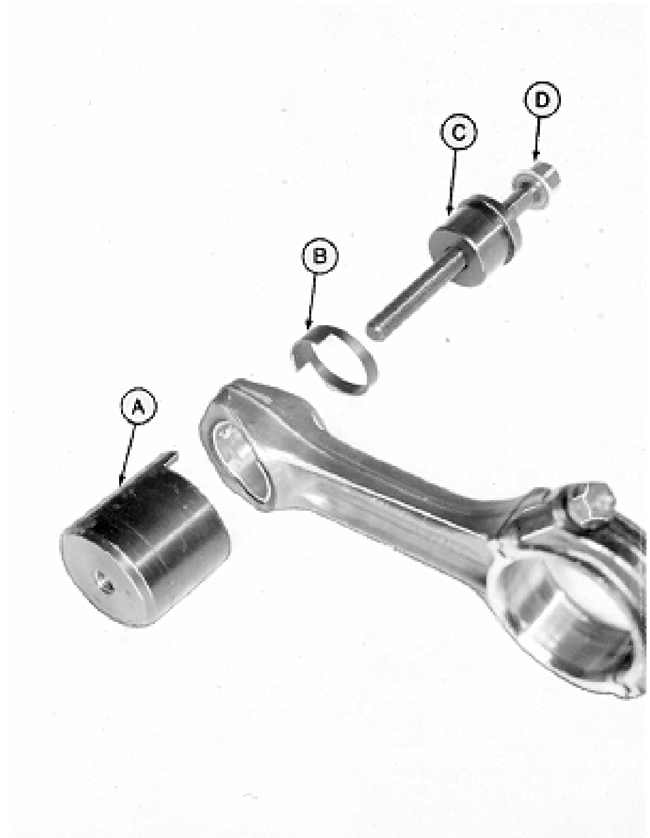
REMOVE PISTON PIN BUSHING

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

Use the following tools from the service set:

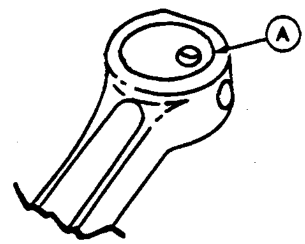
A—JDG339 Cup
B—JDG338 Adapter
C—JDE98-4 Driver
D—STD36104 Forcing Screw with Washer

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



S11,2010,J1 -19-07AUG91

CLEAN AND INSPECT ROD PIN BUSHING BORE



RG5227 -UN-13DEC88

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

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

3. Measure rod bushing bore in three places approximately 45° apart. Compare the measurements with the specifications given below:

ROD PIN BUSHING SPECIFICATIONS

Rod Pin Bore Diameter Without Bushing	52.354—52.380 mm (2.0612—2.0622 in.)
Rod Pin Bore-to-Bushing Press Fit Specification	0.084—0.147 mm (0.0033—0.0058 in.)
ID of Installed Service Rod Pin Bushing (Before Honing)	47.58—47.63 mm (1.8732—1.8751 in.)
ID of Installed Rod Pin Bushing (After Honing)	47.65—47.68 mm (1.8762—1.8772 in.)

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

S11,2010,JJ -19-24SEP91

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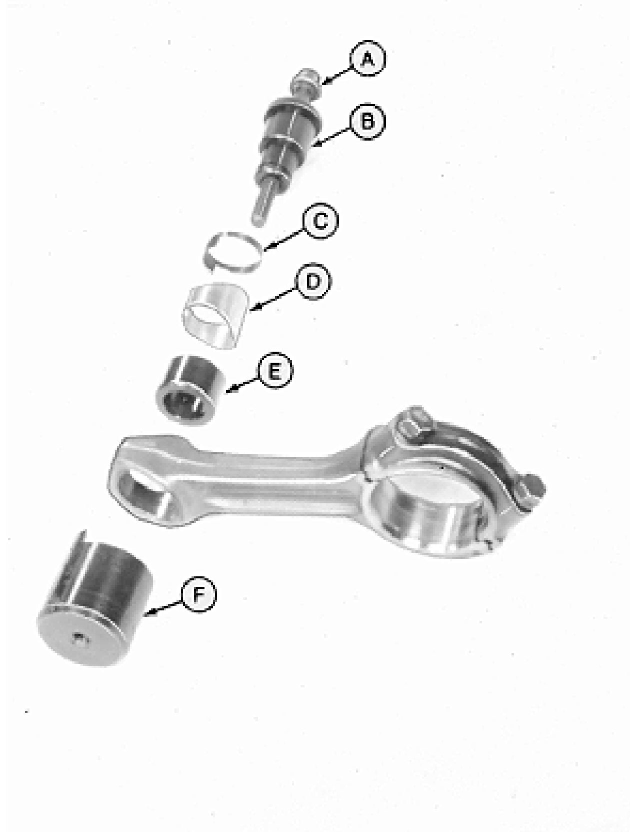
INSTALL ROD PIN BUSHING



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

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

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

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

2. If necessary, hone ID of newly installed bushing to 47.65—47.68 mm (1.8762—1.8772 in.) after installation. Remove all residue from honing operation.

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

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S11,2010,JK -19-07AUG91

COMPLETE DISASSEMBLY OF CYLINDER BLOCK (IF REQUIRED)

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

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

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

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

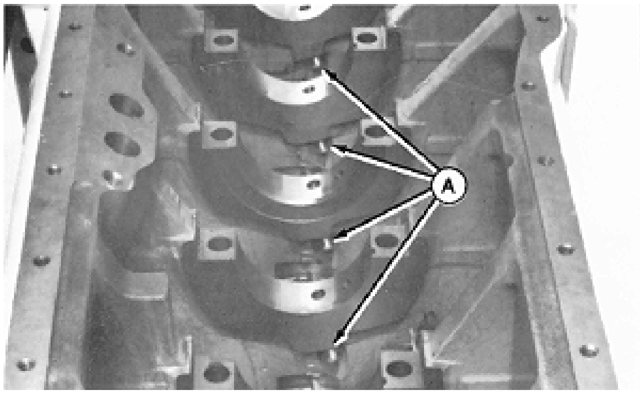
4. Remove auxiliary drive system components (if equipped), timing gear train and camshaft. (Group 16).

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

6. If necessary to "Hot Tank" the block, remove oil gallery plugs, water gallery plugs, piston cooling orifices and the engine serial number plate.

S11,2010,KE -19-28MAR88

REMOVE AND CLEAN PISTON COOLING ORIFICES



RG3752 -UN-14DEC88

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.

S11,2010,KF -19-25NOV87

INSPECT AND CLEAN CYLINDER BLOCK

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

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

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

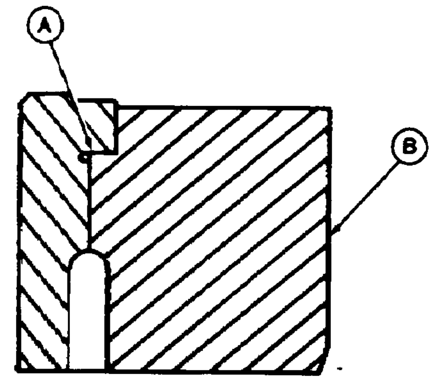
2. Make sure all passages and crevices are cleared of sludge and grease.

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

S11,2010,KG -19-22AUG91

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

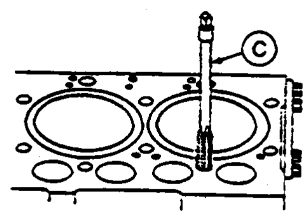
NOTE: DO NOT file liner support flange excessively. Excess filing can damage liner support flange and allow an improper liner fitting. Thoroughly clean all filings from cylinder block (B).



RG3329 -UN-13DEC88

5. Carefully inspect block for cracks or damage. If a cracked block is suspected, pressure-test the block. A procedure for pressure testing is outlined in FOS Manual-ENGINES. Replace block if there is evidence of physical damage.

Cylinder block liner counterbore depth	8.105—8.155 mm (0.319—0.321 in.)
Liner flange thickness	8.175—8.225 mm (0.322—0.324 in.)



RG4725 -UN-13DEC88

6. When determined that the cylinder block is serviceable, remove two cylinder head locating dowels from top deck of block.

7. Clean out threads for cylinder head cap screws in top deck of cylinder block. Use JDG681 Tap or an equivalent 9/16-12 UNC-2A tap (C) approximately 89 mm (3-1/2 in.) long. Use compressed air to remove any debris or fluid which may be present in the cap screw hole.

8. Install two new cylinder head locating in top deck of block after inspection is complete.

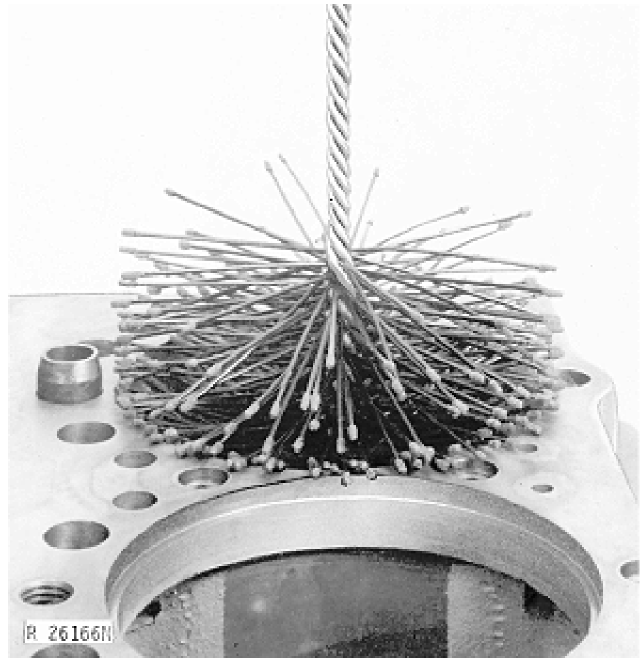
S11,2010,EY -19-23AUG91

CLEAN O-RING BORE

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

NOTE: Use brush exactly as directed by the manufacturer.

2. Thoroughly clean all debris from O-ring bore.



R26166 -UN-13DEC88

S11,0402,AY -19-25MAR91

MEASURE CYLINDER BLOCK

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

MAIN AND THRUST BEARING SPECIFICATIONS

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

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

S11,2010,JH -19-22AUG91

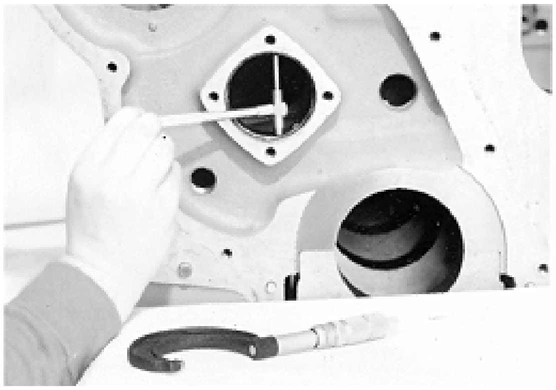
2. Measure cam follower bore diameter at all bore locations. Record measurements by bore location. Cam follower bore ID specification is 17.384—17.440 mm (0.6845—0.6865 in.).

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

New cam follower diameter is 17.33—17.35 mm (0.682—0.683 in.). Maximum cam follower-to-bore clearance is 0.114 mm (0.0045 in.).

S11,2010,JV -19-25MAR91

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



RG4991 -UN-13DEC88

CAMSHAFT BUSHING AND BORE SPECIFICATION

Camshaft Bushing ID Installed	67.076—67.102 mm (2.6408—2.6418 in.)
Camshaft Bushing Bore in Block	69.987—70.013 mm (2.7554—2.7564 in.)
Max. Runout of Camshaft Bushing Bore In Block	0.038 mm (0.0015 in.)
New Camshaft Bushing-to-Journal Clearance	0.063—0.115 mm (0.0025—0.0045 in.)
Maximum Clearance	0.152 mm (0.0060 in.)

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

S11,2010,JL -19-23AUG91

10
35

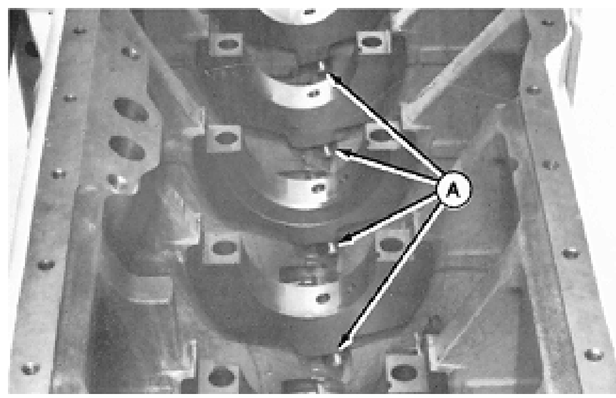
4. Measure cylinder block top deck flatness using D05012ST Precision Straightedge and feeler gauge. The maximum out-of-flat measurement must not exceed 0.10 mm (0.004 in.) for the entire length or width of top deck.

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

IMPORTANT: The centerline of the main bearing bore-to-top deck of cylinder block MUST be 352.35—352.50 mm (13.872—13.878 in.).

S11,2010,JW -19-23AUG91

INSTALL PISTON COOLING ORIFICES AND GALLERY PLUGS



RG3752 -UN-14DEC88

1. Use a soft wire and compressed air to clean orifices. 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.

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

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

S11,2010,KH -19-25NOV87

RECHECK CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)

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

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

1. Install liners (A) without O-ring and secure with cap screws and washers as directed earlier in this group.

NOTE: When installing liners, the liner identification mark “L3” or “LC” (stamped on flange), should be toward the front of the engine in same block bore from which it was removed. This will help with future repairs in knowing whether the liners have been moved or not during a previous repair. Rotate liner 90° if wear is within limits outlined during liner inspection.

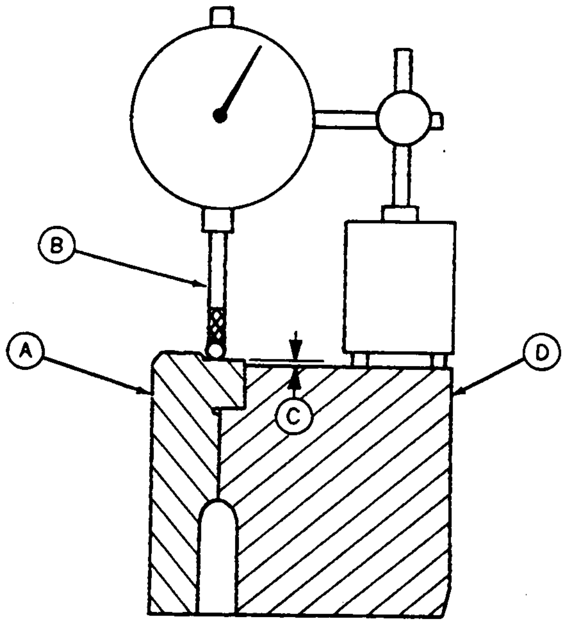
2. Measure liner height (C) with dial indicator (B), as directed earlier in this group.

LINER HEIGHT ABOVE BLOCK SPECIFICATION

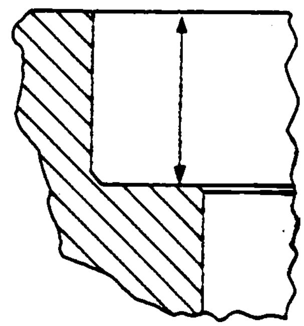
Liner Height	0.025—0.102 mm (0.001—0.004 in.)

If liner height 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 liner bore of any filings.

Counterbore depth as shown in lower illustration is 8.105—8.155 mm (0.319—0.321 in.).



RG1178 -UN-13DEC88



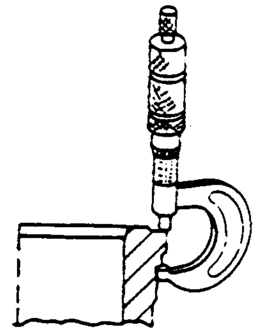
RG4726 -UN-13DEC88

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

S11,2010,JM -19-26SEP91

MEASURE LINER FLANGE THICKNESS

The thickness specification is 8.175—8.225 mm (0.322—0.324 in.).



RG4727 -UN-13DEC88

S11,2510,AV -19-07AUG91

INSTALL LINER SHIMS—IF REQUIRED

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

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

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

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

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

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

If standout is within specification, proceed to next step.

RG,CTM6,G10,2 -19-07AUG91

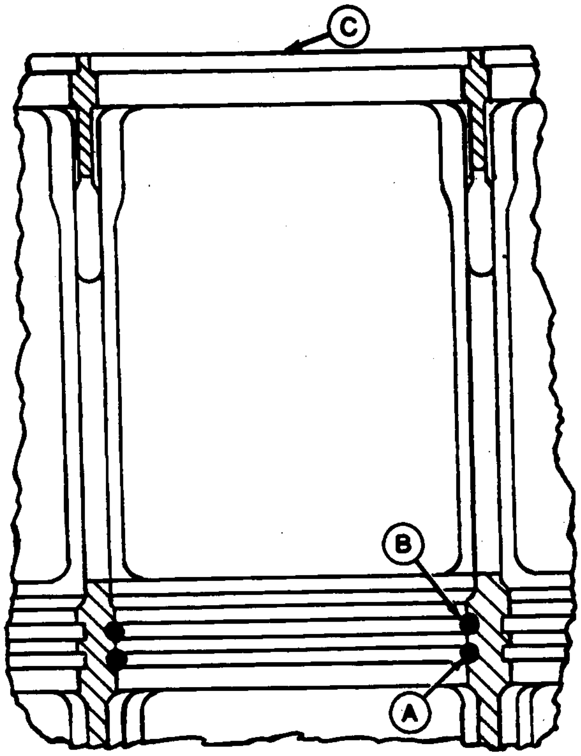
INSTALL CYLINDER LINER O-RINGS AND PACKINGS

1. Pour AR54749 Soap Lubricant into a suitable container.

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

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

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



RG3826 -UN-13DEC88

S11,0402,BA -19-07AUG91

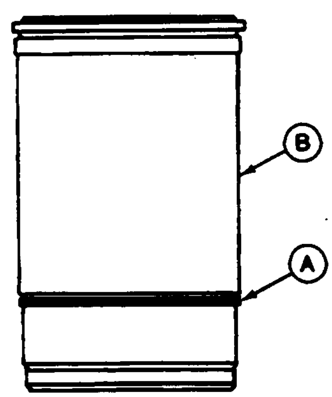
5. Turn cylinder liner (B) upside-down and install the square neoprene packing (A) over outside of liner.

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

NOTE: Make sure the square packing is not twisted.

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

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 possible cause a scored piston.



RG3827 -UN-13DEC88

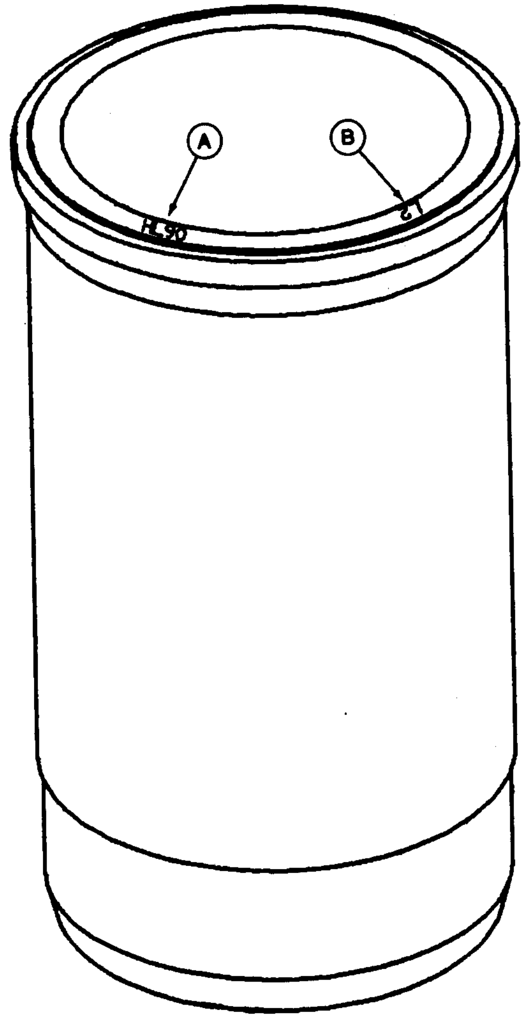
S11,2010,JT -19-25NOV87

INSTALL CYLINDER LINERS

Effective with Engine Serial No. (134594—), a manufacturing four digit date code (A) will appear on the liner. The following is an example of this four digit date code:

HE90

H . . . . Liner Material Type
E . . . . Month Liner was Manufactured
90 . . . . Year Liner was Manufactured



Liner Material Specification

H . . . . Hardened Bore
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

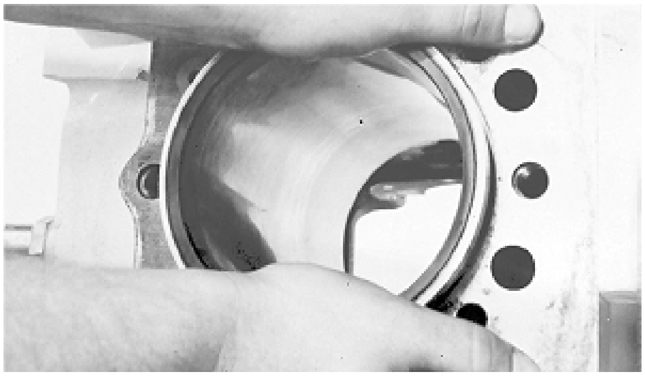
90 1990
91 1991
etc.

DO NOT confuse this four digit code with the liner identification marking (B) of “L2” or “LC”. The cylinder liner is sent through a stamping machine and the four digit date code is put on the liner first. The liner is sent through the stamping machine a second time and the liner identification marking of “L2” or “LC”, etc. There may be a time when the liner “L2” or “LC”, etc. marking will be stamped over the date code.

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

S11,2010,JN -19-25MAR91

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



RG2772 -UN-23FEB89

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

DO NOT scuff the packing across the upper bore.

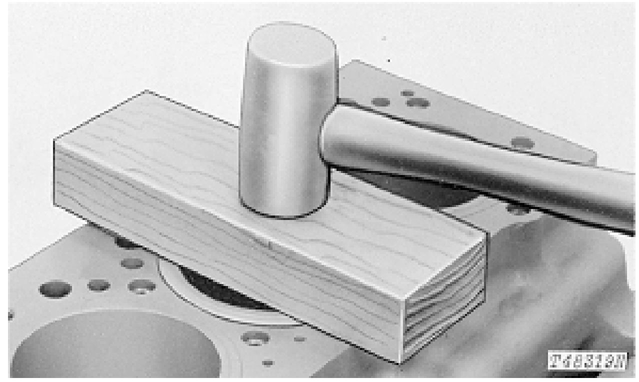
When liners are pitted or eroded on the OD and are under one-half the liner thickness, rotate liners 90° from their removed position. Rotate the pitted section of the liner either toward the front or rear of the engine.

If liners are not pitted or eroded, rotation will not be necessary. Install liners with the “L2”, “LC”, etc. mark toward the front of the engine.

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 with the upper flange of the cylinder liner and cylinder block.

RG,CTM6,G10,3 -19-25MAR91



T48319 -UN-23FEB89

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

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

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

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

5. With liners installed, hold in place with large flat washers and cap screws. Screw cap screws snug but do not tighten.

6. Clean cylinder liner bores with waterless hand cleaner after installation.

7. Wipe dry with clean towels.

8. Oil liners immediately to prevent rust.

S11,0402,BD -19-25MAR91

INSTALL PISTONS AND CONNECTING RODS

NOTE: Pistons must be installed on same connecting rod 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. Use the JDE93 Ring Expander to install piston rings (F) and oil control ring with expander ring (E).

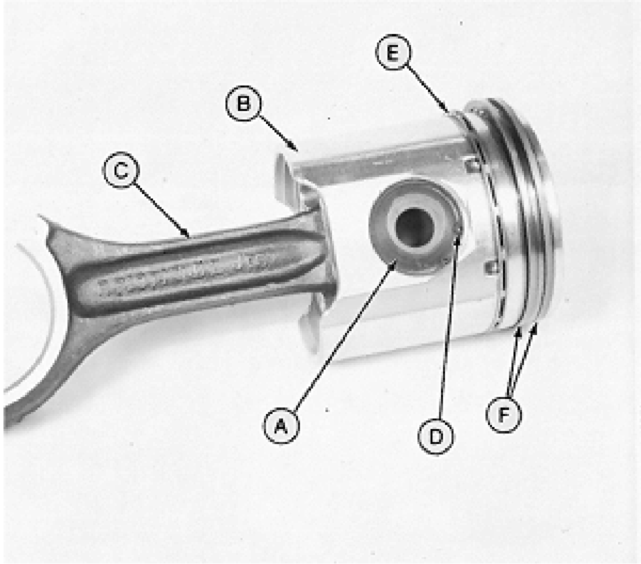
NOTE: New rings are furnished with the correct end gap, therefore, fitting to the liner is not necessary.

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

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

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

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



RG5239 -UN-13DEC88

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

10
43

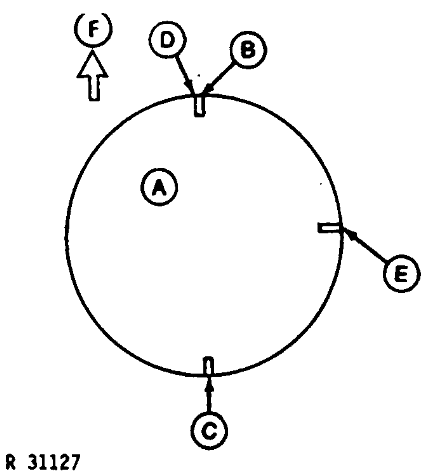
S11,2010,JO -19-07AUG91

5. Stagger ring gap on pistons as shown.

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

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

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



R31127 -UN-13DEC88

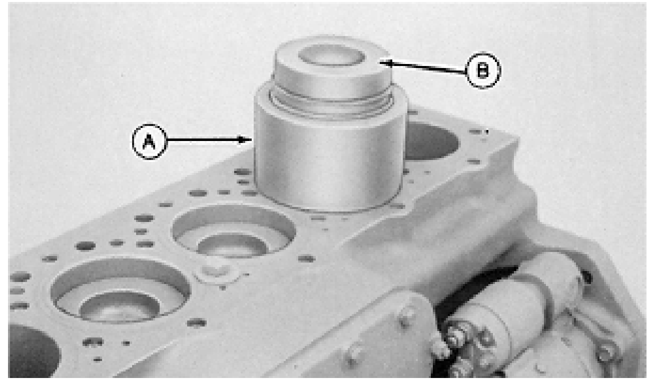
S11,2010,JW1 -19-07AUG91

7. 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 face toward the front of the engine.

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



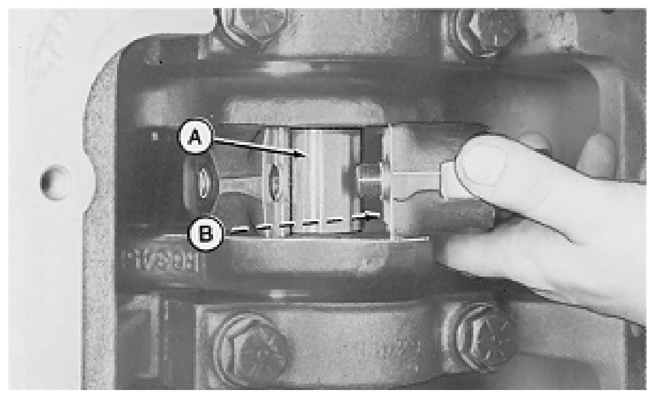
R26127 -UN-13DEC88

S11,2010,JX -19-25NOV87

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

IMPORTANT: DO NOT reuse connecting rod cap screws. ALWAYS replace old cap screws with new ones once they are removed or their torque is disturbed.

10. Lubricate bearing in clean engine oil and install connecting rod caps.



RG3829 -UN-13DEC88

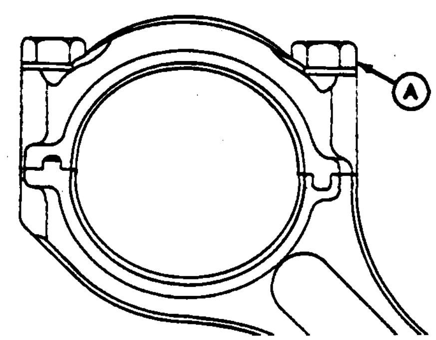
S11,2010,JY -19-25NOV87

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

12. Initially tighten the blind hole cap screw (A) on rod cap or cap screw closest to the piston pin end of connecting rod.

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

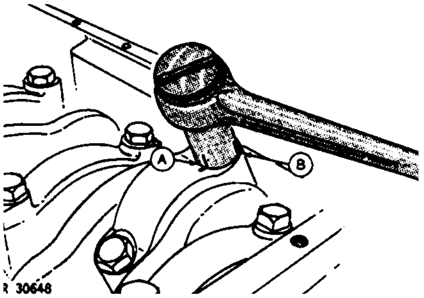
14. Finally, TORQUE-TURN all cap screws 90—100°. (See, USE TORQUE—TURN METHOD FOR PROPER TORQUE, next in this group.)



RG4375 -UN-13DEC88

S11,2010,JZ -19-24SEP91

USE TORQUE-TURN METHOD FOR PROPER TORQUE



R30648 -UN-17APR89

• 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).

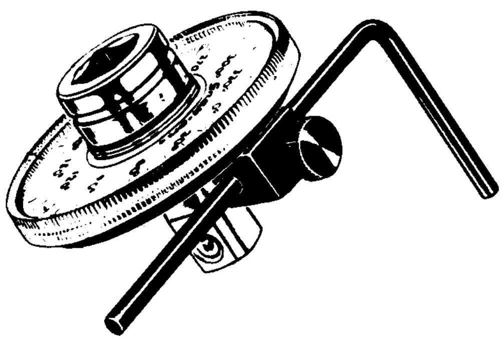
2. Make a second mark on socket (B) 90˚ counterclockwise from the first mark.

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

S11,2010,CE -19-22AUG91

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

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



RG5698 -UN-27AUG90

JT05993 Torque Angle Gauge

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

CHECK ENGINE ROTATION FOR EXCESSIVE TIGHTNESS

1. Rotate crankshaft several revolutions to be sure engine rotates without excessive tightness.

2. Check liners for deep scratches which would indicate an improperly installed or broken piston ring.

3. Check for proper side clearance in all rods. Should have slight movement in each rod by moving side-to-side.

S11,0402,BK -19-07AUG91

COMPLETE FINAL ASSEMBLY

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

1. Install camshaft, timing gear train and auxiliary drive system, if equipped. (Group 16)

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

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

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

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

6. Install crankshaft pulley. (Group 15)

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

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

9. Install the starting motor.

10. Fill engine with clean oil and proper coolant.

11. Install engine in unit and perform engine break-in, as required.

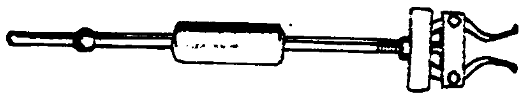
S11,2010,JP -19-23AUG91

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

RG5081 -UN-15DEC88



Internal Puller D01209AA

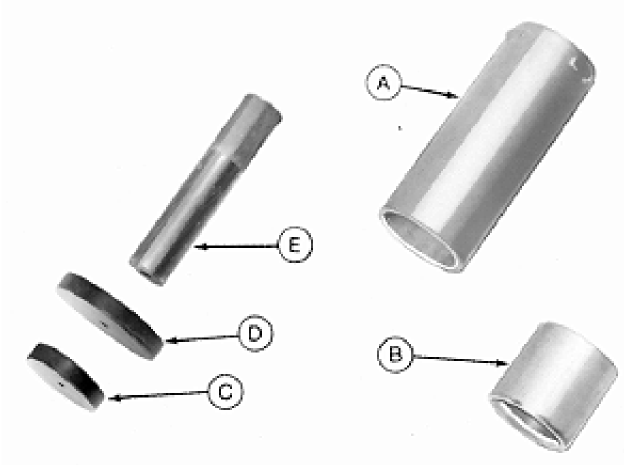
Used to remove clutch shaft pilot bushing.

NOTE: Tools from D01061AA Blind Hole Puller Set may also be used.

S11,2515,BH -19-28MAR91

A—JDH7; Used to install crankshaft gear.
B—JDE3; Used to install front crankshaft wear sleeve.

C—No. 27521* Used to install
D—No. 27536* front oil seal in
E—No. 27488* timing gear cover



R26391 -UN-15DEC88

** From D01045AA Bushing, Bearing, and Seal Driver Set*

S11,2515,BU -19-09SEP91

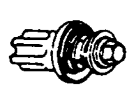
RG5021 -UN-15DEC88

Seal Removal Tool JDG22

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

S11,2515,BK -19-28MAR91

RG4950 -UN-23AUG88



Flywheel Turning Tool JDE81-1A

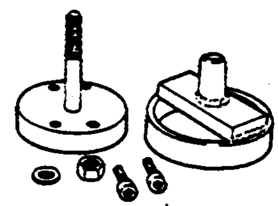
Used to check damper radial runout.

S11,2515,BV -19-28MAR91

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

Used to simultaneously install the new teflon unitized oil seal and wear sleeve on the rear crankshaft flange. JDG478 is also used as a pilot to install rear oil seal housing eliminating the need for a dial indicator to measure run out.

Consists of:
  JDG477(85) Pilot
  JDG478 Driver



RG5106 -UN-23AUG88

S11,2515,BW -19-28MAR91

SERVICE EQUIPMENT AND TOOLS

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

Name	Use
D01048AA 17-1/2 Ton Capacity Puller Set	Used to remove damper pulley and crankshaft gear.
D01045AA Bushing, Bearing, and Seal Driver Master Set	Used to install front oil seal in timing gear cover and to install clutch shaft pilot bushing.

RG,CTM6,G15,4 -19-28MAR91

OTHER MATERIAL

Name	Use
LOCTITE 242 Thread Sealant	Coat threads of flywheel mounting threads.
LOCTITE 609 Retaining Compound	Coat OD of crankshaft flange for installation of rear oil seal/wear sleeve.
PLASTIGAGE	Check main bearing-to-crankshaft journal oil clearance during engine disassembly.
Brake Kleen or Ignition Cleaner and Drier	Remove sealant from crankshaft flange.

S11,2015,EE -19-24SEP91

GROUP 15—CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS

ITEM	NEW PART SPECIFICATION	WEAR TOLERANCE
Crankshaft Fillet Radius:		
Pin Journal	3.94—4.44 mm (0.156—0.175 in.)	——
Thrust Journal	3.56—4.06 mm (0.140—0.160 in.)	——
Main Journal	3.94—4.44 mm (0.156—0.175 in.)	——
Crankshaft End Play	0.038—0.380 mm (0.0015—0.0150 in.)	——
Crankshaft Gear-to-Oil Pump Drive Gear Clearance	0.38 mm (0.015 in.)	——
Clutch Shaft Pilot Bushing:		
Bushing ID	25.59—25.61 mm (1.0073—1.0083 in.)	——
Shaft OD	25.40—25.43 mm (1.0000—1.0012 in.)	——
Crankshaft Rear Oil Seal-to-Housing Maximum Runout	0.152 mm (0.0060 in.)	——
Undersized Bearings Available	0.05, 0.25, 0.51 and 0.76 mm (0.002, 0.010, 0.020, and 0.030 in.)	——
Oversize Thrust Washer Available	0.18 mm (0.007 in.)	——
Connecting Rod Journal OD	76.15—76.18 mm (2.9980—2.9990 in.)	——
Main Bearing Journal OD	85.65—85.67 mm (3.3720—3.328 in.)	——
Journal Taper per 25.4 mm (1.00 in.) Length	0.0025 mm (0.0001 in.)	——
Journal Out-of-Round	0.025 mm (0.0010 in.)	——
Main Bearing Assembled ID	85.70—85.76 mm (3.3742—3.3762 in.)	——
Main Bearing-to-Journal Clearance	0.030—0.108 mm (0.0012—0.0042 in.)	0.152 mm (0.0060 in
Main Bearing Cap Bore Specifications:		
ID without Bearing Inserts	92.125—92.151 mm (3.6270—3.6280 in.)	——
Max Bore Diameter Taper	0.008 mm (0.0003 in.)	——
Max Bore Diameter Variation	0.013 mm (0.0005 in.)	——
Max. Straightness (Any Bore-to-Adjacent Bores)	0.038 mm (0.0015 in.)	——
Max. Straightness Variation (5 Centerbores to End Bores)	0.076 mm (0.0030 in.)	——
Centerline of Bore-to-Top Deck of Block	352.35—352.50 mm (13.872—13.878 in.)	——

S55,2015,A -19-28AUG91

15
3

GROUP 15—CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL SPECIFICATIONS—CONTINUED

ITEM	NEW PART SPECIFICATION	WEAR TOLERANCE
Main Bearing Cap Surface Width	36.28—36.78 mm (1.428—1.448 in.)	——
No. 5 Main (thrust) Bearing:		
Surface Width (thrust washer clearance)	37.44—37.54 mm (1.474—1.478 in.)	——
Overall Cap Width	39.16—39.66 mm (1.542—1.561 in.)	——
Base Circle OD for Thrust Washer Clearance*	123.70—125.30 mm (4.87—4.93 in.)	——
Crankshaft OD for Front Pulley	47.650—47.676 mm (1.8785—1.876 in.)	——
Front Pulley ID	47.594—47.630 mm (1.8738—1.8752 in.)	——
Damper Pulley Radial Runout (Maximum)	1.02 mm (0.040 in.)	——
Front Oil Seal Housing Install Below Front of Timing Gear Cover (Maximum)	8.4 mm (0.33 in.)	——
Maximum Rear Oil Seal Housing Runout	0.15 mm (0.006 in.)	——
Flywheel Housing Face Runout Maximum Variation	0.20 mm (0.008 in.)	——
Flywheel Face Flatness Maximum Variation	0.23 mm (0.009 in.)	——
Maximum Variation per 25 mm (1.0 in.) of travel	0.013 mm (0.0005 in.)	——
Flywhel Bearing Bore Concentricity Maximum Variation	0.127 mm (0.005 in.)	——

TORQUES

Flywheel Housing-to-Cylinder Block	407 N·m (300 lb-ft)
Damper Pulley-to-Crankshaft	230 N·m (170 lb-ft)
Main Bearing Caps	203 N·m (150 lb-ft)
Rear Crankshaft Oil Seal Housing	27 N·m (20 lb-ft)
Flywheel-to-Crankshaft	115 N·m (85 lb-ft)
Piston Cooling Orifices	11 N·m (8 lb-ft)
Damper Assembly-to-Pulley	41 N·m (30 lb-ft)
Auxiliary Drive Idler Gear-to-Block	203 N·m (150 lb-ft)
Rear Auxiliary Drive Mounting Stud Nuts	102 N·m (75 lb-ft)
Front Auxiliary Drive Idler Gear Cover Plate-to-Timing Gear Cover	14 N·m (10 lb-ft)
Timing Gear Cover-to-block	27 N·m (20 lb-ft)
Injection Pump Gear Cover-to-Timing Gear Cover	27 N·m (20 lb-ft)

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

S55,2015,B -19-02OCT91

DIAGNOSING MALFUNCTIONS

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

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

• **Galled or "Wiped" Bearings:**

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

• **Inconsistent Wear Pattern:**

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

• **Broken Main Bearing Caps:**

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

• **Cracked, Chipped or Broken Bearings:**

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

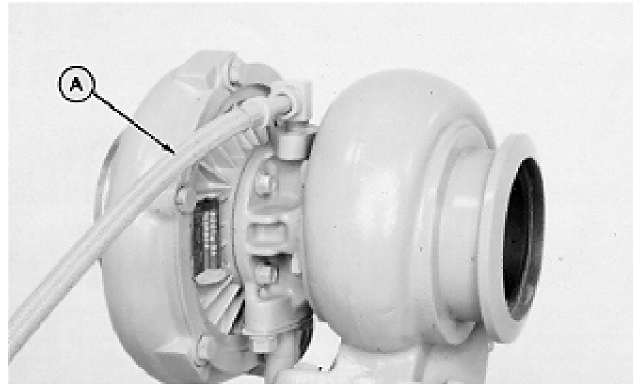
S11,2015,C -19-22AUG91

GENERAL INFORMATION

6076 Engines are available with gear-driven auxiliary drive options or non-auxiliary drive options. Follow the same repair procedure for both options unless otherwise noted.

S55,2015,J -19-25JAN88

DISCONNECT TURBOCHARGER OIL INLET LINE



RG5323 -UN-06DEC88

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

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

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

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

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

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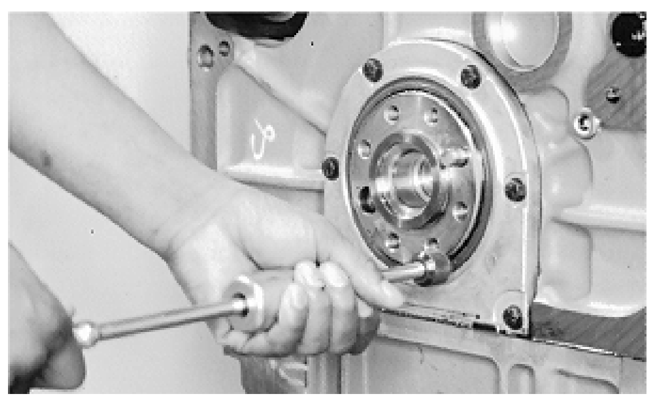
RG,CTM6,G03,1 -19-22AUG91

REMOVE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE (WITHOUT REMOVING OIL SEAL HOUSING)



RG5210 -UN-14DEC88

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

1. Remove flywheel as described later in this group.

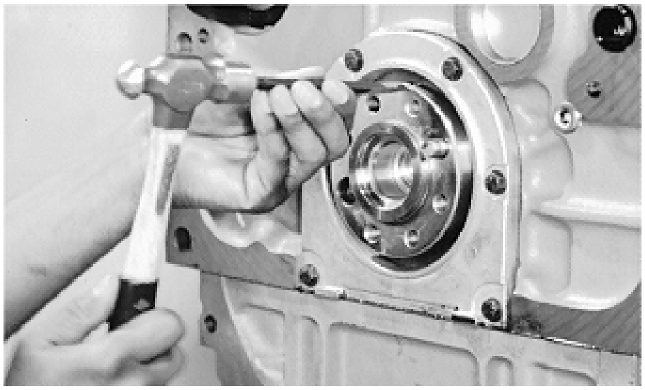
2. Drill a small hole in seal casing. Install a sheet metal screw in seal casing and attach JDG22 Seal Removal Tool and carefully remove seal.

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

S11,2515,BM -19-11JUN87

3. Carefully cut wear sleeve off crankshaft flange using a small, sharp hardened chisel.

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.



RG5211 -UN-14DEC88

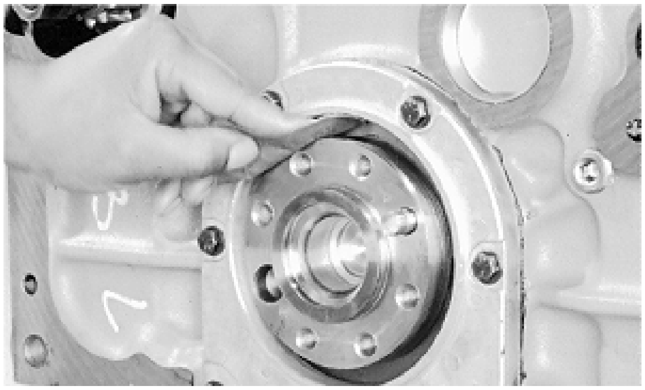
S11,2515,BN -19-11JUN87

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

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

Finish cleaning by wiping flange with a clean rag.

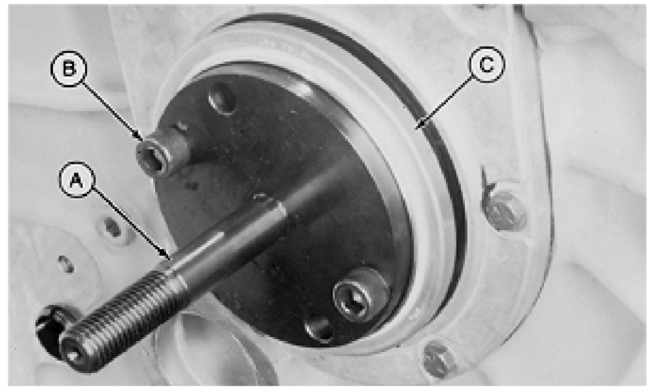
5. Check oil seal housing runout as explained later in this group.



RG5212 -UN-14DEC88

S11,2515,BO -19-28AUG91

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



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

IMPORTANT: Do not loosen the oil pan-to-cylinder block cap screws, as this will damage the gasket seal between the oil pan and cylinder block.

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

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

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

When installing the sleeve and wear sleeve, press only on wear sleeve to avoid cocking the seal on the wear sleeve.

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

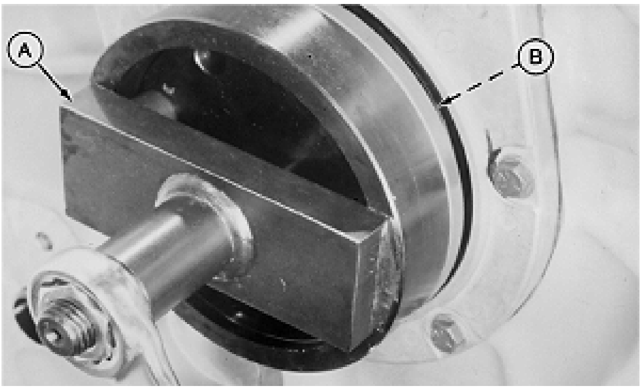
IMPORTANT: When installing the JDG478 Driver on JDG477(85) Pilot and crankshaft flange to position oil seal/wear sleeve assembly, locate crossbar of installer at right angle (90°) to Allen head cap screws. This allows the crossbar to bottom on pilot, not head of cap screws, assuring correct installation.

S11,2015,GQ -19-08AUG91

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

5. Tighten nut to draw JDG478 Driver in until it bottoms on oil seal housing flange (B). When the tool bottoms, seal and wear ring assembly will be correctly positioned.

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



RG4640 -UN-14DEC88

S11,2015,GR -19-08AUG91

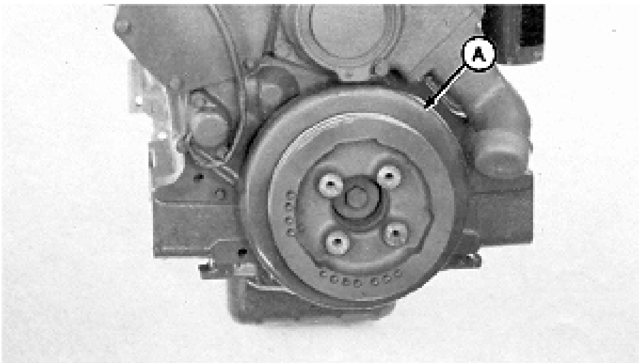
INSPECT VIBRATION DAMPER

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

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

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



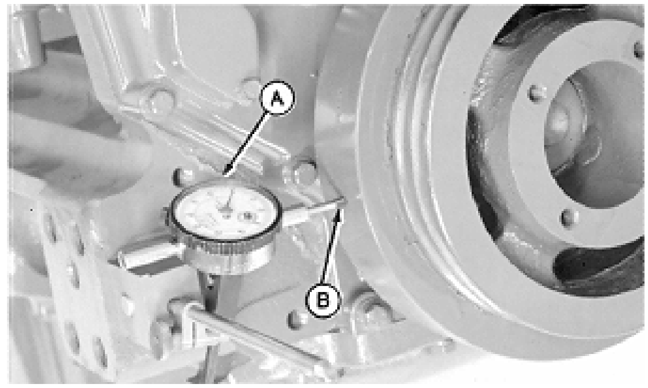
RG3502 -UN-14DEC88

S55,2015,D -19-03MAY88

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

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

4. Note dial indicator reading.



DAMPER RADIAL RUNOUT SPECIFICATION

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

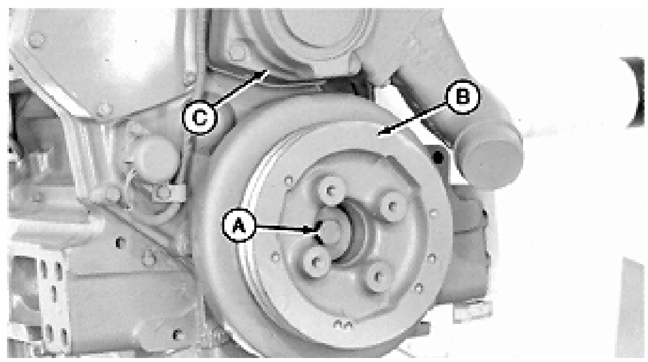
If runout exceeds specifications, replace vibration damper.

S11,2015,BJ -19-28AUG91

REMOVE WATER PUMP AND DAMPER PULLEY

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

2. Remove fan pulley assembly and water manifold from front face of cylinder head.



3. Remove water pump (C) if not previously removed. (See Group 25, Cooling System.)

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

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

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

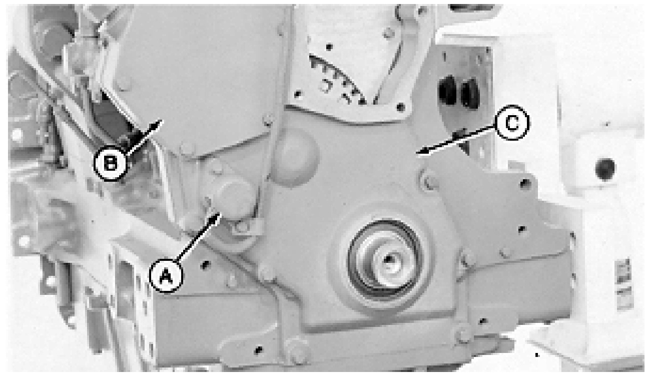
5. Remove pulley and damper from crankshaft using D01048AA Puller Set.

S55,2015,E -19-28MAR91

REMOVE TIMING GEAR COVER—NON-AUXILIARY DRIVE ENGINES

1. Remove magnetic pick-up (A, if equipped) and injection pump drive gear cover (B). Discard gaskets.

2. Remove timing gear cover (C). Discard gasket.



RG3927 -UN-14DEC88

S11,2015,DK -19-28MAR91

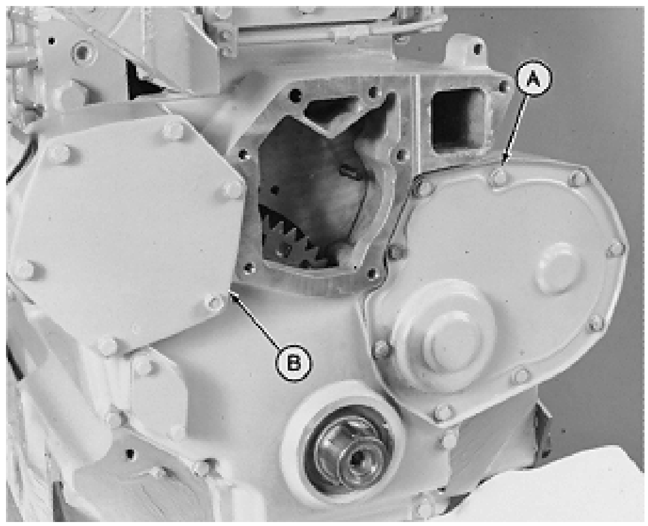
REMOVE AUXILIARY DRIVE GEAR AND TIMING GEAR COVER—AUXILIARY DRIVE ENGINES

IMPORTANT: Auxiliary drive output shaft assembly is a field installed option for your 6076 Engine. Retain Installation Instructions provided with kit at time of purchase for service recommendations.

1. Remove injection pump drive gear cover (A). Remove front auxiliary drive gear cover (B).

Remove and discard all gasket material.

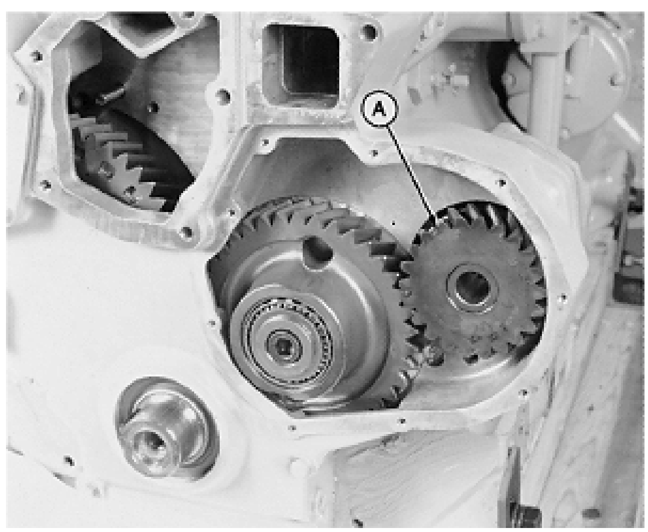
NOTE: Remove magnetic pickup assembly, if equipped.



RG5706 -UN-01APR91

S55,2015,F -19-28MAR91

2. Remove mounting nuts from rear of timing gear cover and remove auxiliary drive output gear/housing assembly (A) from engine.



RG5707 -UN-01APR91

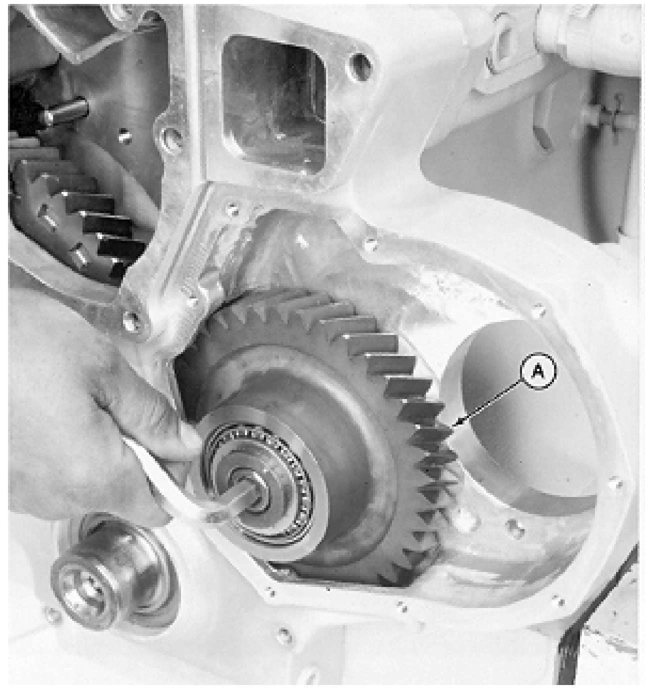
RG,CTM6,G15,1 -19-28MAR91

3. Loosen Allen head screw using appropriate size Allen wrench. Leave approximately three threads fully engaged.

NOTE: DO NOT remove Allen head screw until shaft is disengaged from bore in block so that spacers and bearings won't fall into timing gear cover causing possible damage.

4. Remove rear cover plate or auxiliary drive assembly (shown removed). Tap on auxiliary drive idler gear (A) lightly with a brass driver and hammer through opening at rear of timing gear cover.

5. Using the JDE81-1 Flywheel Turning Tool, rotate engine 1/8 to 1/4 revolution. Continue to rotate engine 1/8 to 1/4 revolution and tap with brass driver until shaft with gear assembly is free from bore in block.



RG5326 -UN-14DEC88

S55,2015,G -19-28MAR91

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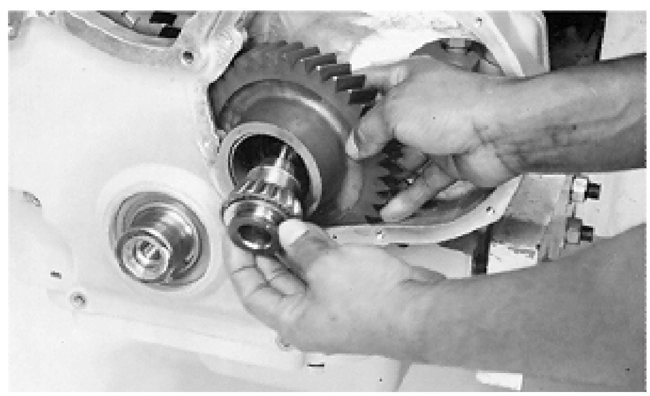
6. Remove Allen head screw (shown removed) while holding gear in place with other hand.

7. Tilt gear forward and grab bearing behind gear with right hand. Remove front bearing with shaft, snap ring and spacer. Discard Spacer. Remove drive gear.

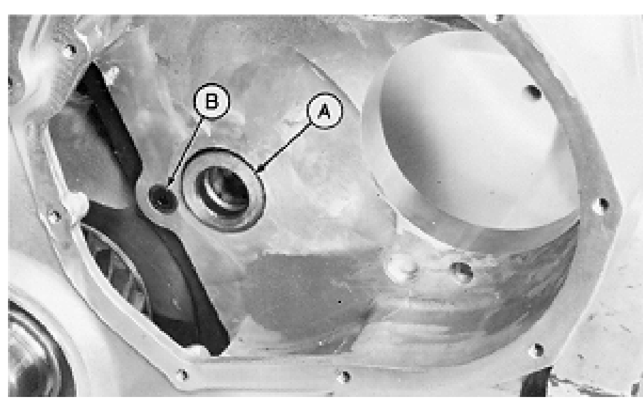

RG5327 -UN-14DEC88

S55,2015,H -19-28AUG91

8. Remove spacer (A) from timing gear cover.

9. Remove flat head cap screw (B). Remove all remaining timing gear cover cap screws and remove timing gear cover.

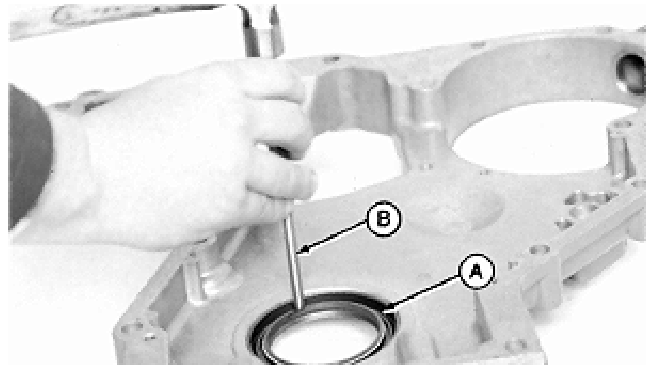
10. Remove and discard all gasket material.



RG5328 -UN-14DEC88

S55,2015,I -19-28MAR91

REMOVE FRONT OIL SEAL FROM TIMING GEAR COVER



RG3835 -UN-14DEC88

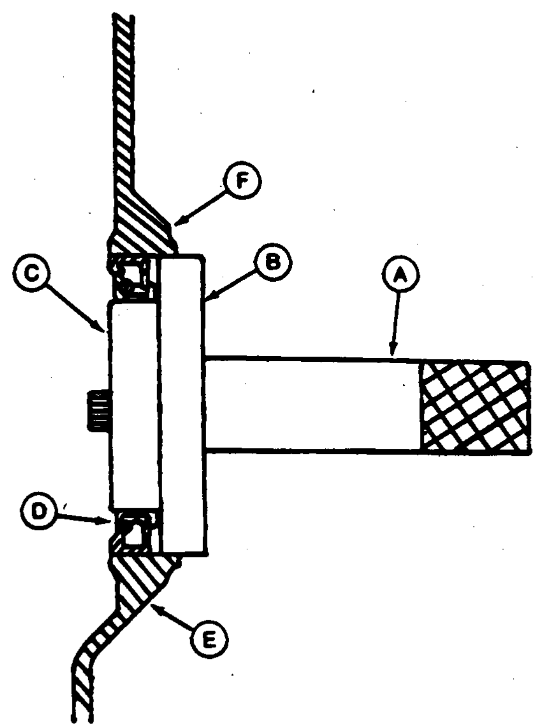
1. Check front oil seal (A) for wear, damage or deterioration.

2. If seal is damaged, tap around metal edge of seal with a small punch (B) and remove seal. Be careful not to damage gear cover.

3. Inspect and clean seal bore in cover. Check for nicks or burrs. Use a medium-grit emery cloth to smooth rough areas.

S55,2015,K -19-15JUN89

INSTALL FRONT OIL SEAL IN TIMING GEAR COVER



RG3842 -UN-14DEC88

1. Install front oil seal (D) in housing, with spring side of seal facing the engine using the D01045AA Master Driver Set.

2. Support timing gear cover (E) around seal bore.

3. Drive seal into front of cover using 27536 Disk (B), 27521 Disk (C) and 27488 Driver (A) until seal is 8.4 mm (0.33 in.) below housing face (F).

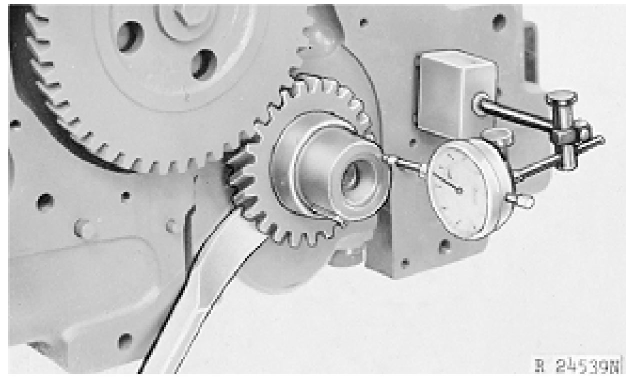
NOTE: If installing seal from backside of cover use 27539 Disk, 27522 Disk, and 27488 Driver. Drive seal until 27536 Disk bottoms against cover and seal is flush with inside face of cover.

4. Coat rubber tip of crankshaft front seal and outside of wear sleeve with light oil.

A—27488 Driver
B—27536 Disk
C—27521 Disk
D—Oil Seal
E—Timing Gear Cover
F—8.4 mm (0.33 in.) Below Housing Face

S11,0403,AS -19-11APR91

CHECK CRANKSHAFT END PLAY



-UN-15DEC88 R24539N

1. Position dial indicator on end of crankshaft.

2. Push crankshaft as far to rear of engine as possible.

3. Zero the dial indicator.

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

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

CRANKSHAFT END PLAY SPECIFICATIONS

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

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

S11,0403,M -19-28AUG91

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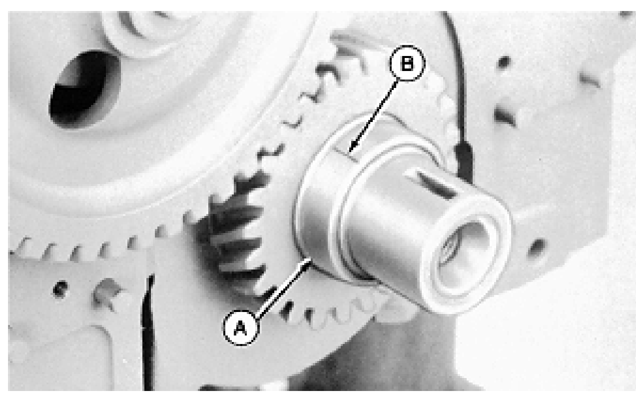
REMOVE FRONT WEAR SLEEVE



-UN-15DEC88 R24579

IMPORTANT: If a new front oil seal is to be installed, also replace wear sleeve. If the oil seal is not damaged, the wear sleeve does not have to be removed to remove crankshaft.

1. Check front wear sleeve (A) and oil seal for wear, damage or leakage.

2. Score (B) LIGHTLY with a dull chisel around OD of wear sleeve. DO NOT score too deeply. DO NOT cut through wear sleeve with chisel.

3. Remove crankshaft Woodruff key and gently pry wear sleeve from crankshaft.

4. Inspect crankshaft flange for nicks or burrs.

5. Clean up flange with a light file and emery cloth.

S11,0403,N -19-28MAR91

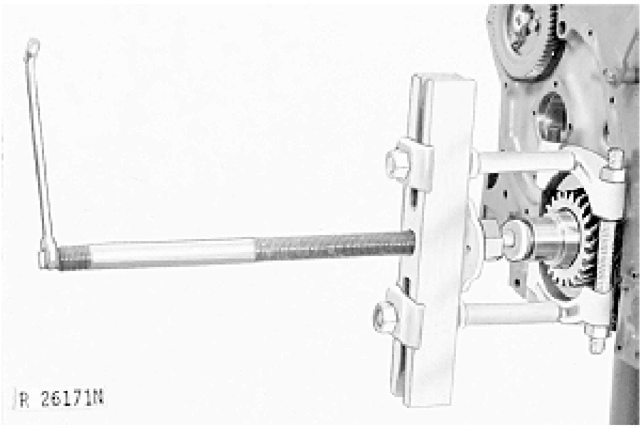
REMOVE AND INSPECT CRANKSHAFT GEAR

NOTE: To remove crankshaft gear, camshaft must first be removed. If crankshaft gear is not worn or damaged, it does not have to be removed to remove crankshaft.

1. Remove crankshaft gear using gear puller attachments from the D01048AA 17-1/2-Ton Puller Set or an equivalent puller set.

2. Inspect gear for wear or damage.

3. Remove Woodruff key from crankshaft, if crankshaft requires reconditioning.



R26171N -UN-15DEC88

S11,0403,Q -19-26JUL91

INSPECT, MEASURE, AND REPAIR FLYWHEEL

1. Inspect the clutch contact face for scoring, overheating, or cracks. Replace flywheel if defective.

2. Examine flywheel ring gear for worn or broken teeth. Replace ring gear if defective, as described later in this group.

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

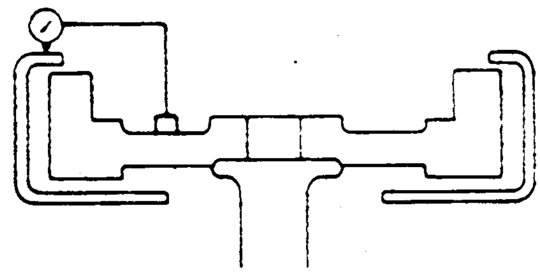
3. Measure flywheel housing face run-out, flywheel face flatness, and pilot bearing bore concentricity, as outlined later in this group. Repair or replace as required.

S55,2015,N -19-08AUG91

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.

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



R22212 -UN-14DEC88

FLYWHEEL HOUSING FACE RUNOUT SPECIFICATION

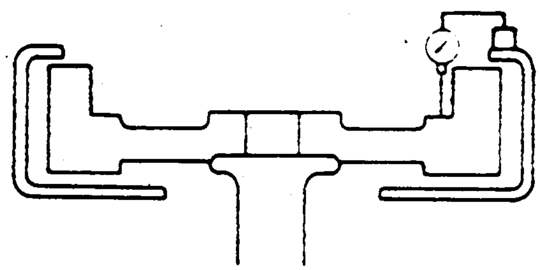
Maximum variation . . . . 0.20 mm (0.008 in.)

S55,2015,L -19-08AUG91

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.

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



R22213 -UN-14DEC88

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 -19-22AUG91

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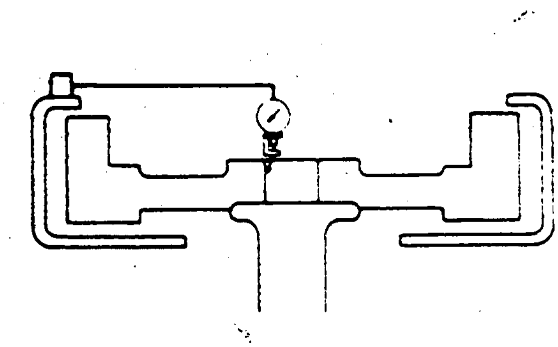
CHECK PILOT BEARING BORE CONCENTRICITY



1. Mount dial indicator on flywheel housing face and position pointer to contact ID of pilot bearing bore in flywheel.

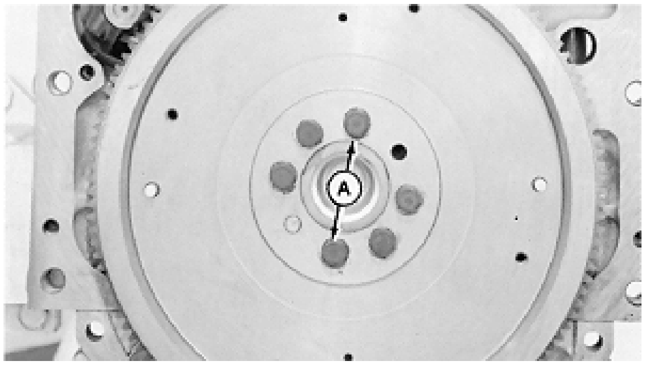
2. Rotate flywheel by turning crankshaft. Read dial indicator.

BEARING BORE CONCENTRICITY SPECIFICATION

Maximum variation . . . . 0.127 mm (0.005 in.)

S55,2015,M -19-08AUG91

REMOVE FLYWHEEL



NOTE: SAE 1 and SAE 2 flywheel housings MUST BE removed before flywheel can be removed from engine. See REMOVE SAE 1 AND SAE 2 FLYWHEEL HOUSING, later in this group.

CAUTION: Flywheel is heavy. Plan a proper lifting procedure to avoid personal injury.

1. Remove two flywheel attaching cap screws (A), and install two pilot studs in their place.

2. Remove remaining cap screws, and carefully pull flywheel from crankshaft.

S11,2015,BY -19-22AUG91

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REMOVE SAE 1 AND SAE 2 FLYWHEEL HOUSING

CAUTION: Flywheel housing is heavy. Plan a proper lifting procedure to avoid personal injury.

1. Remove attaching cap screws.

2. Remove flywheel housing.

3. Inspect mounting holes on flywheel housing for thread damage.

S11,2015,GK -19-22AUG91

REMOVE SAE 3 FLYWHEEL HOUSING

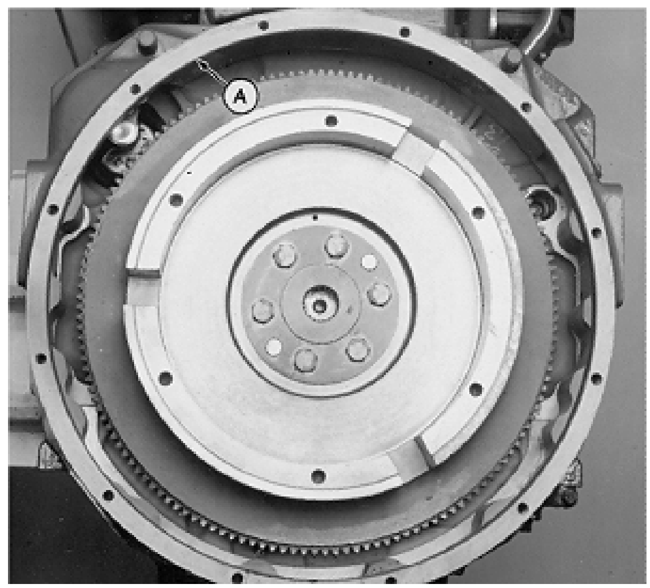
NOTE: The flywheel MUST be removed before removing the SAE 3 flywheel housing. See REMOVE FLYWHEEL earlier in this group.

CAUTION: Flywheel housing (A) is heavy. Plan a proper lifting procedure to avoid personal injury.

1. Remove flywheel housing attaching cap screws.

2. Remove flywheel housing.

3. Inspect mounting holes in flywheel housing for thread damage.



RG5005 -UN-14DEC88

S11,2015,GO -19-22AUG91

REPLACE FLYWHEEL RING GEAR

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

1. If ring gear is damaged, place the flywheel on a solid flat surface.

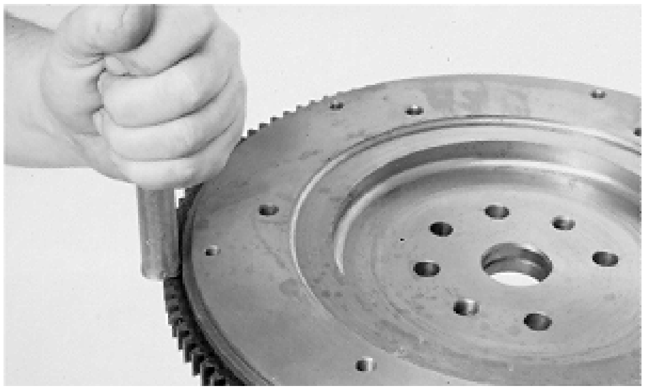
2. Drive ring gear off with a brass drift and hammer.

3. Heat new ring gear to 148°C (300°F) using either heated oil, oven heat, or flame heat.

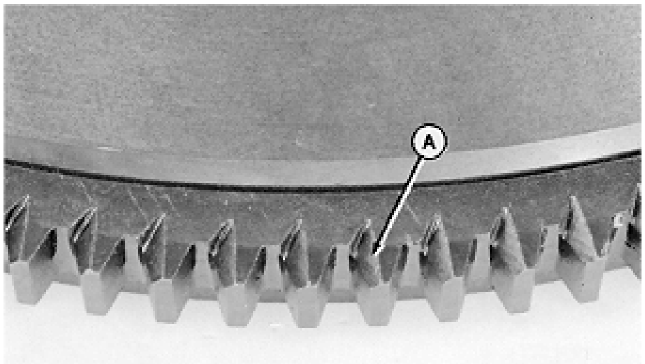
IMPORTANT: If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT. SEE CAUTION. Overheating may also destroy original heat treatment of gear.

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

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S11,2015,FX -19-08AUG91

SERVICE CLUTCH SHAFT PILOT BUSHING-QUAD RANGE TRANSMISSIONS

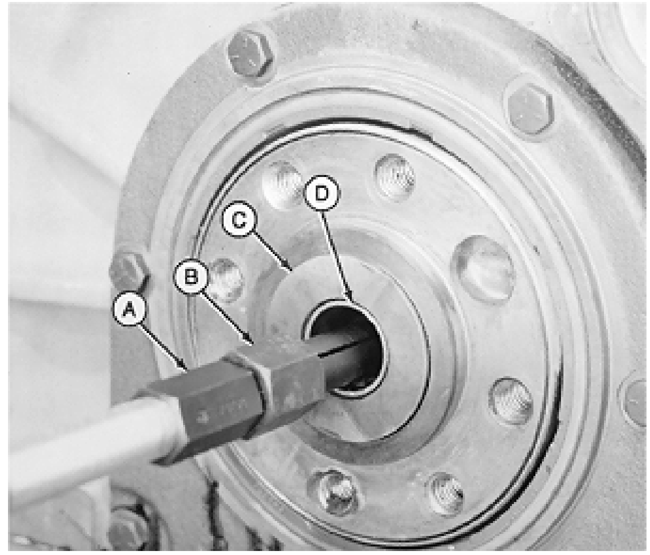
1. Inspect bushing adapter (C), clutch bushing (D) and end of shaft for excessive wear or damage.

Replace bushing, shaft, and adapter if not within the following specifications.

CLUTCH SHAFT PILOT BUSHING SPECIFICATIONS

Bushing ID . . . . 25.59—25.61 mm (1.007—1.008 in.)
Shaft OD . . . . 25.40—25.43 mm (1.000—1.001 in.)

2. Use the JTO1731 Collet (B), JTO1722 Actuator Pin (A), with the slide hammer from the D01061AA Blind Hole Puller Set to remove clutch shaft pilot bushing (D).



RG4338 -UN-14DEC88

A—JTO1722 Actuator Pin
B—JTO1731 Collet
C—Adapter
D—Bushing

S11,2015,DW -19-28AUG91

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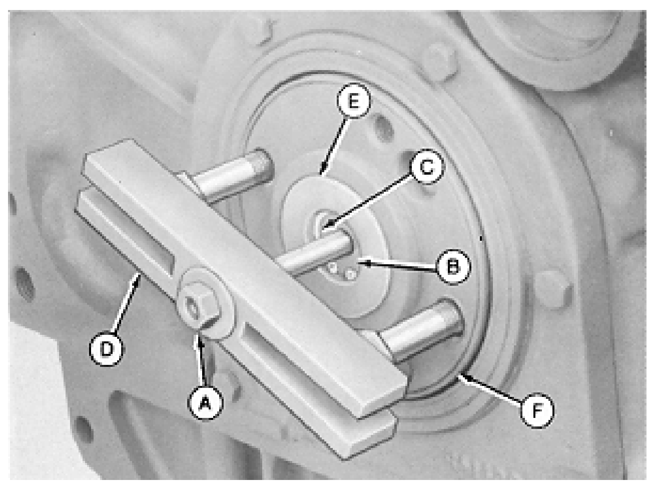
3. To remove adapter (E) place a 9.5 x 127 mm (3/8 x 5-in.) cap screw (A) and R43696 washer (B) in adapter bushing bore.

4. Install a H214R snap ring (C) in adapter bushing bore.

5. Use a D01219AA Cross-Block (D) with two cap screws in the crankshaft flange and pull adapter.



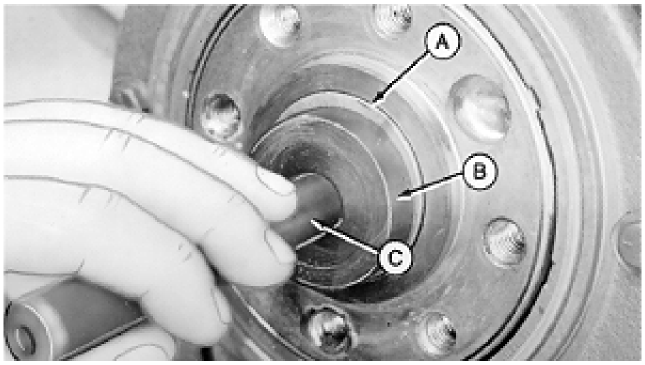
R25923 -UN-15DEC88

A—Cap Screw
B—Washer
C—Snap Ring
D—Cross-Block
E—Transmission Pump Drive Adapter
F—Crankshaft Flange

S11,2015,CZ -19-28MAR91

6. Install new adapter/bushing assembly (A) using the 27516 Disk (B) with the 27488 handle (C) from the D01045AA Bushing, Bearing, and Seal Driver Master Set.

Drive adapter until it bottoms in crankshaft bore.



RG4339 -UN-14DEC88

S11,2015,DA -19-17JAN83

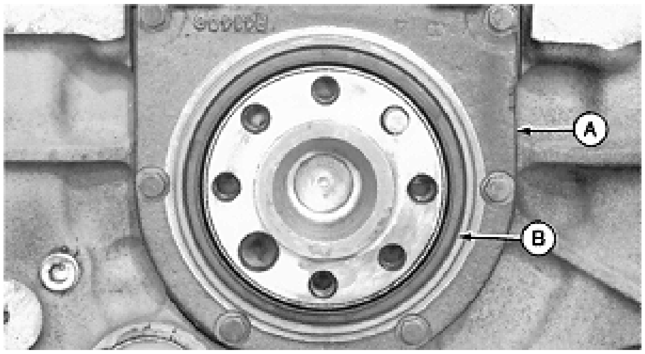
REMOVE REAR OIL SEAL HOUSING AND WEAR SLEEVE (WITH ENGINE DISASSEMBLED)

NOTE: These instructions are for use when the oil seal housing and oil pan will be removed. Refer to REMOVE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE (WITHOUT ENGINE DISASSEMBLY), earlier in this group, for instructions without the oil seal housing and oil pan being removed.

NOTE: If rear oil seal is replaced, also replace rear wear sleeve. If oil seal and wear sleeve are not damaged, the wear sleeve does not have to be removed to remove crankshaft.

1. Remove rear oil seal housing (A).

2. Rear oil seal (B) will come off with housing. Use a small punch and hammer to remove oil seal. Discard seal.



RG3839 -UN-14DEC88

S11,2020,G -19-28MAR91

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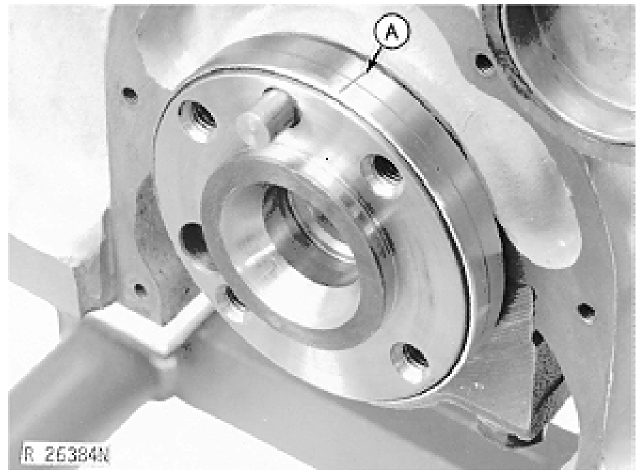
3. Remove rear wear sleeve by scoring lightly (A) the full width of wear sleeve in several places with a dull chisel. DO NOT cut through wear sleeve with chisel.

4. Gently pry wear sleeve from crankshaft.

5. Inspect crankshaft flange for burrs or nicks.

6. Clean flange with a light file and emery cloth.



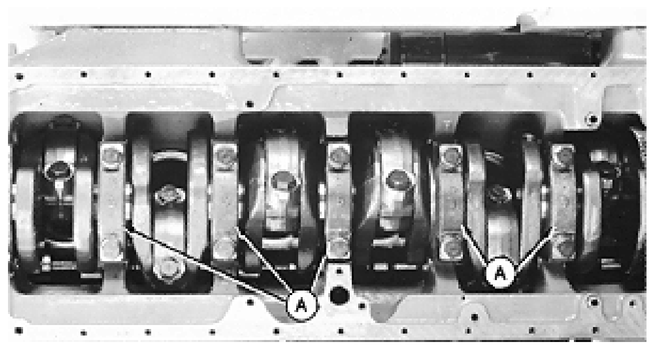
R26384 -UN-15DEC88

S11,2020,H -19-07APR86

REMOVE CRANKSHAFT MAIN BEARINGS

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. This will assure assembly of bearing caps in the correct location, if caps were not stamped during production.

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



RG3751 -UN-14DEC88

S11,2515,H -19-28AUG91

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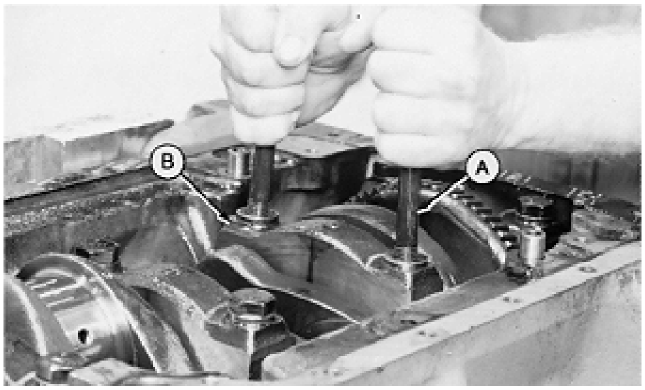
NOTE: Main bearing caps are numbered for reassembly on the same numbered main bearing bosses. Keep matched bearing inserts with their respective main bearing cap for comparison with crankshaft journal (surface) from which removed.

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 maesure oil clearance on each main bearing as they are removed. (See CHECK MAIN BEARING CLEARANCE, later in this group.)



RG4469 -UN-14DEC88

S11,2515,AJ -19-26JUL91

CHECK MAIN BEARING CLEARANCE

The use of PLASTIGAGE will determine wear but will not determine condition of the bearing or journal surfaces.

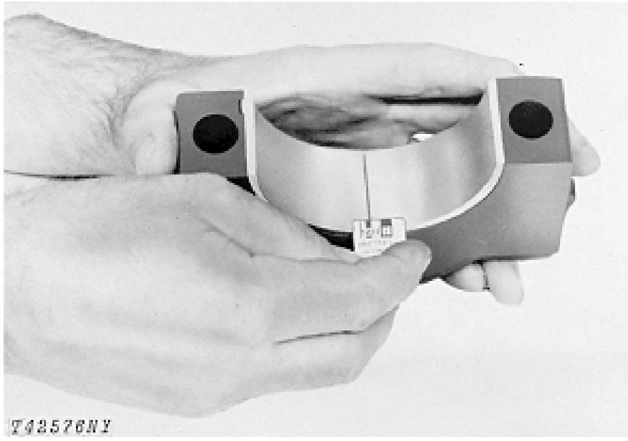
1. Put a strip of PLASTIGAGE in the center of the main bearing cap (with insert) about three-fourths of the width of the bearing.

2. Use oil (SAE30) on PLASTIGAGE to prevent smearing.

3. Install cap and tighten to 203 N·m (150 lb-ft).

4. Remove cap and compare width of PLASTIGAGE with scale provided on wrapper to determine oil clearance.

Oil clearance should be 0.030—0.108 mm (0.0012—0.0042 in.). Maximum acceptable oil clearance is 0.152 mm (0.0060 in.).



T42576NY -UN-09NOV88

S11,0403,Z -19-28AUG91

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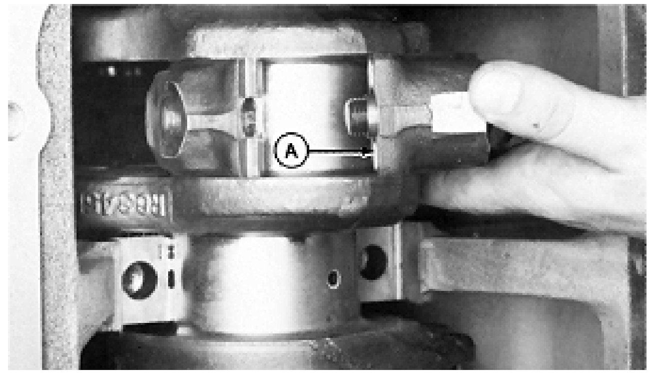
REMOVE CRANKSHAFT

1. Rotate crankshaft using the JDE81-1 Flywheel Turning Tool until connecting rod caps can be removed easily. You will be able to remove two rod caps at each position.

2. Remove all connecting rod caps (A) with bearings, then remove No. 1 and 7 main bearing caps and bearings. (See REMOVE PISTONS AND CONNECTING RODS in Group 10.)



RG3840 -UN-14DEC88

S11,0403,AA -19-26JUL91

3. Put a nylon sling (or other non-abrasive lifting sling) on each end of crankshaft.

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

CAUTION: Crankshaft is very heavy. DO NOT attempt to remove crankshaft by hand. Use proper lifting equipment to avoid injuries.

4. Carefully raise crankshaft out of cylinder block.

5. Clean crankshaft using solvent and compressed air.

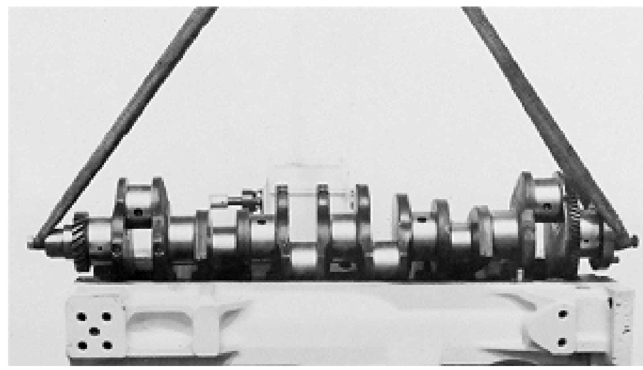
6. Put crankshaft on clean flat surface and support journals with V-blocks.

7. Inspect crankshaft for any signs of load stress, cracks or scratches on journals. (See INSPECT CRANKSHAFT, later in this group.)

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

8. Inspect crankshaft gear for cracks, chipped teeth, or excess wear. Replace gear as required. (See REPLACE CRANKSHAFT OIL PUMP DRIVE GEAR, later in this group.)

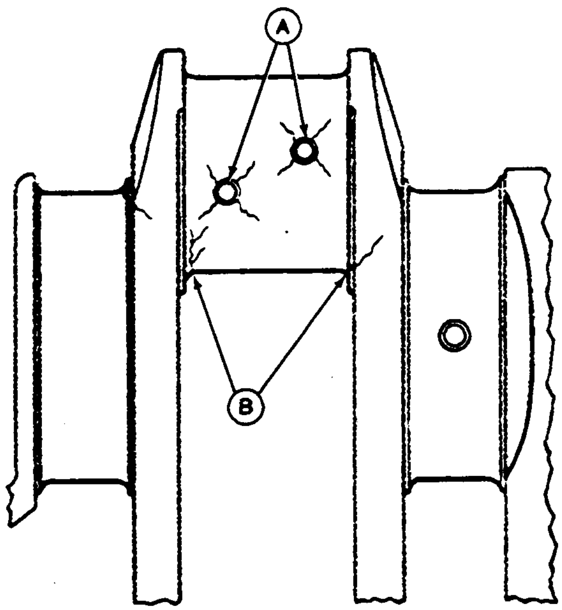
NOTE: If crankshaft gear requires replacement, inspect oil pump drive gear also. (See Lubrication System, Group 20.)



RG2794 -UN-23FEB89

S55,2015,O -19-28MAR91

INSPECT CRANKSHAFT



RG5093 -UN-15DEC88

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

2. 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.

3. Check the crankshaft timing gear and the oil pump drive gear for worn and chipped teeth. Replace the gears as necessary. (See REPLACE CRANKSHAFT OIL PUMP DRIVE GEAR, later in this group.)

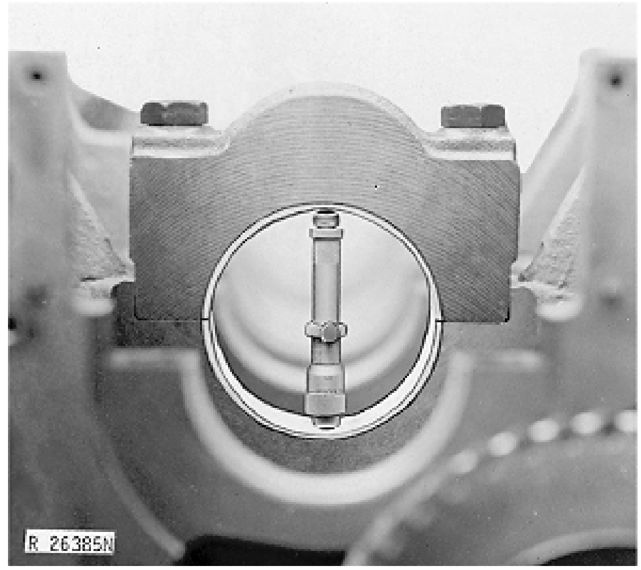
4. Check each journal for evidence of excessive overheating or discoloration. If either condition exists, replace crankshaft since heat treatment has probably been destroyed.

5. Carefully check the crankshaft for cracks in the area of rod journal oil holes (A) and at journal fillets (B). Replace crankshaft if any cracks are found.

IMPORTANT: When inspecting crankshaft for cracks, a method must be used that is capable of detecting minute cracks that are not visible to the eye such as the Fluorescent Magnetic Particle method. This method magnetizes the crank, employs magnetic particles which are fluorescent and glow under “black light”. The crankshaft must be de-magnetized after the test.

S11,2515,BR -19-08AUG91

MEASURE ASSEMBLED ID OF BEARINGS AND OD OF CRANKSHAFT JOURNALS



R26385N -UN-15DEC88

1. With crankshaft out of cylinder block, install main bearing inserts and caps (be sure inserts are installed correctly).

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

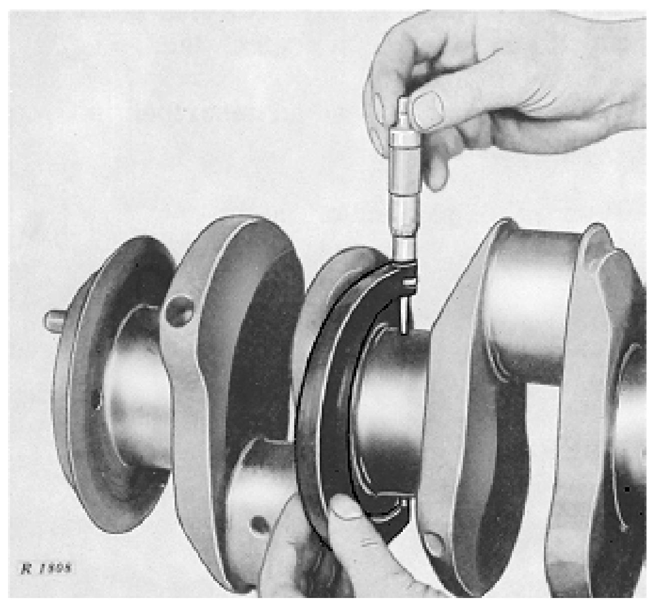
3. Measure I.D. of all bearings with an inside micrometer.

MAIN BEARING ID SPECIFICATIONS

With Bearing	85.70—85.76 mm (3.3742—3.3762 in.)
Without Bearing	92.125—92.151 mm (3.627—3.628 in.)

NOTE: Inspect and measure assembled ID of connecting rod bearings. Compare measurements with connecting rod journal OD on crankshaft. (See Group 10.)

S11,0403,AC -19-08AUG91



RG1808 -UN-14DEC88

4. Measure OD of all respective crankshaft journals at several points around journal.

CRANKSHAFT SPECIFICATIONS

OD of Main Bearing Journal	85.65—85.67 mm (3.3720—3.3730 in.)

NOTE: If engine has previously had a major overhaul and undersized bearing inserts were used, above listed ID and OD dimensions may not be the same as those recorded. However, oil clearance should be within specifications. Oil clearance is 0.030—0.108 mm (0.0012—0.0042 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.) Length	0.0025 mm (0.0001 in.)
Journal Out-of-Roundness	0.025 mm (0.0010 in.)

S11,0403,AD -19-08AUG91

MAIN BEARING CAP LINE BORE SPECIFICATIONS

1. With crankshaft removed from cylinder block, install main bearing caps without bearing inserts.

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

3. Measure ID of all bearing caps with an inside micrometer. Main bearing cap ID should be 92.125—92.151 mm (3.627—3.628 in.)

If any main bearing cap assembled ID is not within specification, blank (generic) bearing caps are available and must be line bored to specification. Replace individual bearing caps as needed.

IMPORTANT: Main bearing cap line boring should be done ONLY by experienced personnel on equipment capable of maintaining bore specifications.

MAIN BEARING CAP BORE SPECIFICATIONS

ID Without Bearings (Std)	92.125—92.151 mm (3.627—3.628 in.)
Max. Bore Diameter Variation	0.013 mm (0.0005 in.)
Max. Bore Diameter Taper	0.008 mm (0.0003 in.)
Max. Straightness Variation (Any bore-to-adjacent bore)	0.038 mm (0.0015 in.)
Max. Straightness Variation (5 center bores-to-end bores)	0.08 mm (0.003 in.)
Centerline of Bore-to-Top Deck	352.35—352.50 mm (13.872—13.878 in.)

S11,2515,BY -19-28AUG91

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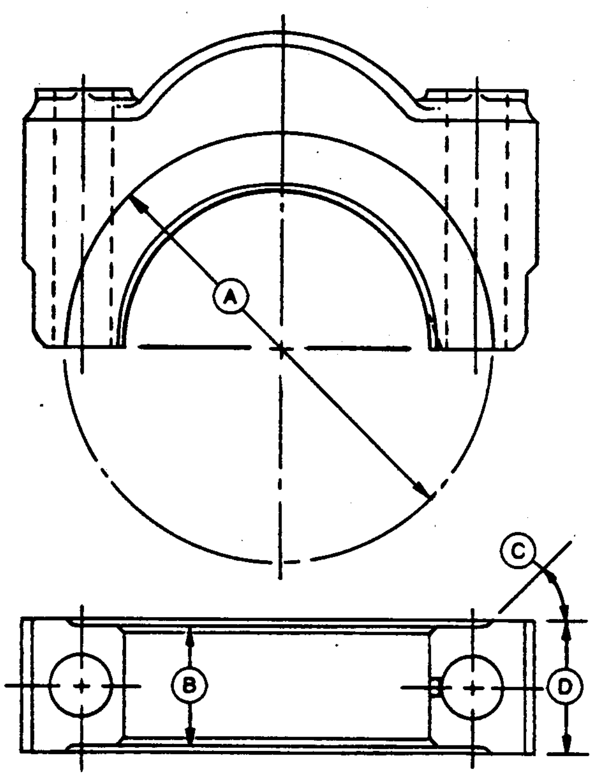
THRUST BEARING NEW PART SPECIFICATIONS

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	123.70—125.30 Dia. (4.87—4.93 in.)
B—Thrust Surface Thickness	37.44—37.54 mm (1.474—1.478 in.)
C—Relief Angle	45°
D—Bearing Overall Width	39.16—39.66 mm (1.542—1.561 in.)

Maximum runout for thrust surface is 0.025 mm (0.0010 in.).



RG5269 -UN-14DEC88

S55,2015,P -19-08AUG91

CRANKSHAFT GRINDING GUIDELINES

IMPORTANT: Crankshaft grinding should be done ONLY be experienced personnel on equipment capable of maintaining crankshaft size and finish specifications.

In addition to the standard size main and connecting rod bearings, 0.05, 0.25, 0.51 and 0.76 mm (0.002, 0.010, 0.020 and 0.030 in.) undersize bearings are available. If journals are tapered, out-of-round, scored or damaged, grind the crankshaft and install the proper undersize bearings.

NOTE: The 0.05 mm (0.002 in.) undersize bearings are used normally to compensate for slight un-even wear on crankshafts. Regrinding is usually unnecessary when this size bearing is used.

IMPORTANT: If undersize bearings are used, check bearing clearance after bearing caps have been tightened to specified torque. If undersize bearings are too tight and clearance is not within specifications, the journal and bearing will be wiped clean of all oil. This would result in premature wear of parts.

If the crankshaft is to be reground, use the following recommended procedure:

1. Compare the crankshaft journal measurements taken during inspection and determine the size which the journals are to be reground.

2. If one or more main or connecting rod journals require grinding, then grind all of the main journals or all of the connecting rod journals to the same required size.

3. All journal fillets radii must be free of any sharp grind marks or scratches. The fillet must blend smoothly into the journal and crank cheek. Check the radius with a fillet gage.

IMPORTANT: Care must be taken to avoid localized heating which often produces grinding cracks.

S11,2015,DM -19-28AUG91

CRANKSHAFT GRINDING GUIDELINES—CONTINUED

4. Cool the crankshaft while grinding by using coolant generously. DO NOT crowd the grinding wheel into the work.

IMPORTANT: Grind crankshaft with journals turning counterclockwise, as viewed from the front end of crankshaft. Lap or polish journals in opposite direction of grinding.

5. Polish or lap the ground surfaces to the specified finish to prevent excessive wear of the journals.

NOTE: Production crankshafts are induction hardened and shotpeened at the factory. Field shotpeening is not recommended due to the equipment required and part geometry.

6. If the thrust surfaces of the crankshaft are worn or grooved excessively, regrind and polish. Maintain the specified radius between each thrust surface and the bearing journal. An oversize thrust washer set containing one standard washer and two 0.18 mm (0.007 in.) oversize washers is available. (See THRUST BEARING NEW PART SPECIFICATIONS, later in this group.)

NOTE: When thrust surfaces are reground and an oversize washer is used, crankshaft end play specification must be maintained to within 0.038—0.380 mm (0.0015—0.0150 in.) (See CHECK CRANKSHAFT END PLAY, earlier in this group.)

7. Stone the edge of all oil holes in the journal surfaces smooth to provide a radius of approximately 1.50 mm (0.060 in.).

8. When finished grinding, inspect the crankshaft for cracks with the Florescent Magnetic Particle method, or similar method.

9. De-magnetize the crankshaft.

10. Thoroughly clean the crankshaft and oil passages with solvent. Dry with compressed air.

S11,2015,HD -19-28MAR91

CRANKSHAFT GRINDING SPECIFICATIONS

Item	Specification
Engine Stroke	121 mm (4.75 in.)
Main and Rod Journal Surface Finish	Lap 0.20 Um (8 AA)
Thrust Journal Surface Finish	Lap 0.40 Um (16AA)
Rod Journal Fillet Radius	3.94—4.44 mm (0.155—0.175 in.)
Main Journal Fillet Radius	3.94—4.44 mm (0.155—0.175 in.)
Thrust Journal Fillet Radius	3.56—4.06 mm (0.140—0.160 in.)
Thrust Journal Width	44.387—44.487 mm (1.7475—1.7515 in.)

Bearing Size	Crankshaft Main Journal OD	Crankshaft Rod Journal OD
Standard	85.65—85.67 mm (3.3720—3.3730 in.)	76.15—76.18 mm (2.9980—2.9990 in.)
0.05 mm (0.002 in.) Undersize	85.60—85.62 mm (3.3700—3.3710 in.)	76.10—76.13 mm (2.9960—2.9970 in.)
0.25 mm (0.010 in.) Undersize	85.40—85.42 mm (3.3620—3.3630 in.)	75.90—75.93 mm (2.9880—2.9890 in.)
0.51 mm (0.020 in.) Undersize	85.14—85.16 mm (3.3520—3.3530 in.)	75.64—75.67 mm (2.9780—2.9790 in.)
0.76 mm (0.030 in.) Undersize	84.89—84.91 mm (3.3420—3.3430 in.)	75.39—75.42 mm (2.9680—2.9690 in.)

S11,2015,HG -19-08AUG91

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.

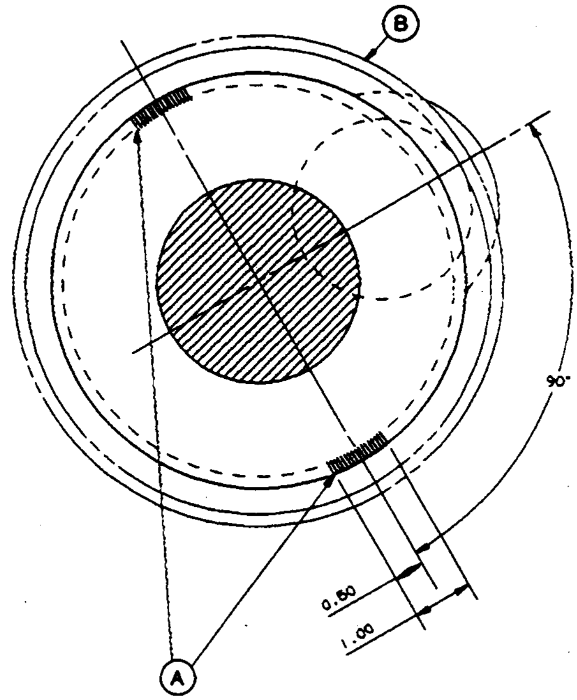
4. Heat new gear to 148°C (300°F) using either heated oil or oven heat.

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.

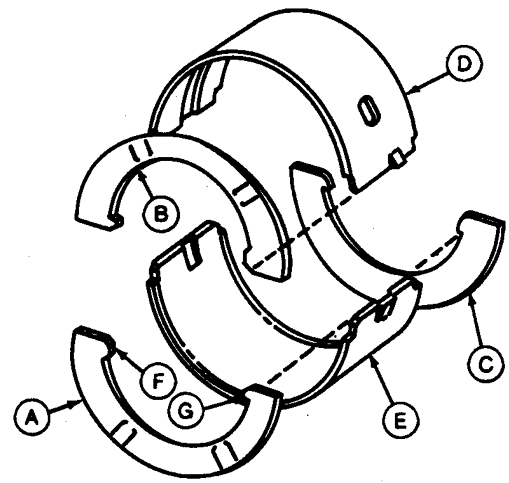
6. Weld two 25.4 mm (1 in.) beads according to illustration using 1/8 in. diameter 7018 welding rod. Grind away excess weld to eliminate the possibility of interference with cylinder block.



RG5018 -UN-14DEC88

S11,2515,BG -19-08AUG91

INSPECT THRUST BEARINGS



1. Check thrust surfaces of the thrust bearing and the thrust bearing journal on crankshaft and replace as necessary.

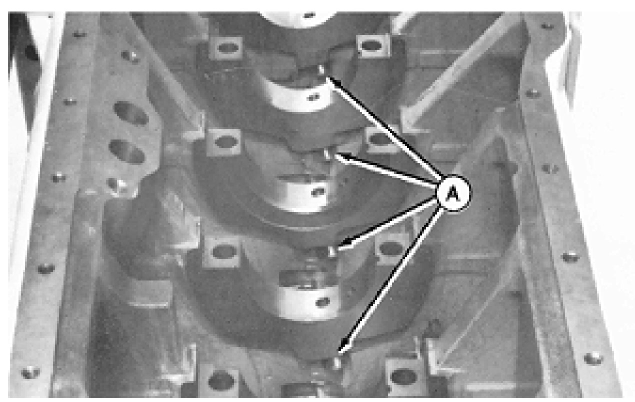
Thrust bearings are available in each of the previously mentioned insert undersizes. An oversize thrust washer set containing one regular size washer and two 0.18 mm (0.007 in.) oversize washers is also available.

NOTE: Thrust bearings must be installed with slots facing crankshaft flange.

A—Lower Rear Thrust Washer
B—Upper Rear Thrust Washer
C—Lower Front Thrust Washer
D—Main Bearing Block Thrust Bearing
E—Main Bearing Cap Thrust Bearing
F—Large Tang
G—Small Tang

S11,0403,AF -19-08AUG91

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 (8 lb-ft) (96 lb-in.).

S11,2015,CN -19-28MAR91

INSTALL MAIN BEARINGS AND CRANKSHAFT

1. Install main bearing inserts (A) (crankshaft shown removed).

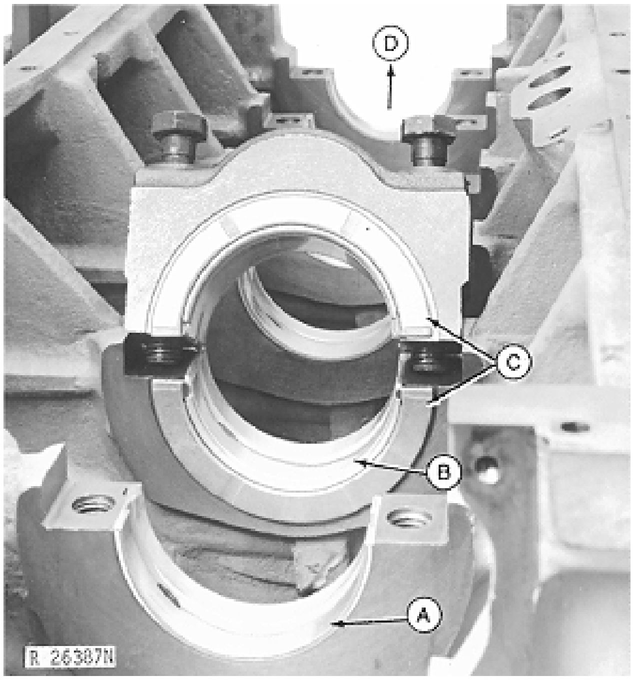
2. Be sure main thrust bearing insert (B) and thrust bearing washers (C) are installed in fifth bore from front of engine. Washers go on both sides of bearing cap; and on rear side of block web only with the slotted face toward the crankshaft.

3. Make sure tangs on all bearings fit in recesses in bore and that oil slots line up with oil passages in block.

4. Apply a film of clean oil to bearing ID surfaces and to crankshaft journals.

NOTE: Before installing any main bearing and connecting rod cap screws, immerse each cap screw and washer entirely in clean engine oil.

IMPORTANT: If new thrust bearing inserts or thrust bearing washers are installed, they must be installed as a set.



R26387 -UN-15DEC88

A—Main Bearing Insert
B—Main Thrust Bearing
C—Thrust Bearing Washers (3 used)
D—To Front of Engine

S11,0403,AI -19-03MAR87

5. Using proper lifting equipment, lower crankshaft onto main bearings.

6. Dip entire main bearing cap screws in clean engine oil and position them in the main bearing caps. Apply a liberal amount of oil to bearing inserts in caps.

7. Install each bearing cap (B), bearings (C), and cap screws with washer (A) with the recesses and tabs aligned in matching order. Make sure bearing tabs also match up before tightening cap screws.

NOTE: Make sure main bearing caps are installed on the bearing bosses from which they were removed. The numbers stamped on the caps should be on the same side as the numbers on the block. If there is an arrow on cap, arrow must point toward front of engine. If bearing caps have been rebored, make sure bearing caps have numbers stamped on them.

IMPORTANT: Do not use pneumatic wrench to install main bearing cap screws.

8. 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.

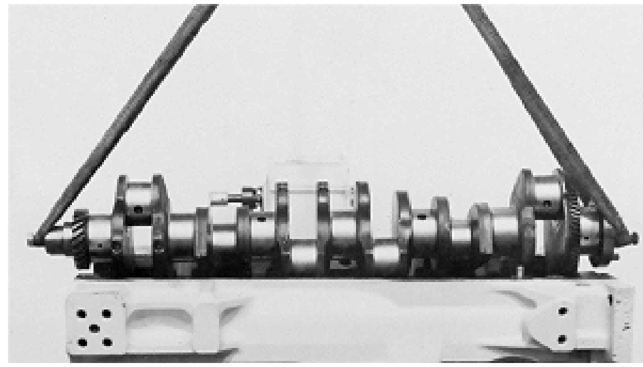
9. Tighten No.'s 1, 2, 3, 4, 6 and 7 main bearing cap screws to 68 N·m (50 lb-ft). Hand-tighten No. 5 main bearing cap screws.

10. Gently pry crankshaft rearward and then forward to align thrust washers on No. 5 main bearing.

NOTE: DO NOT PRY crankshaft on No. 5 main bearing.

11. Tighten all main bearing cap screws to 203 N·m (150 lb-ft).

12. Turn crankshaft by hand. If it does not turn easily, disassemble parts and determine the cause.



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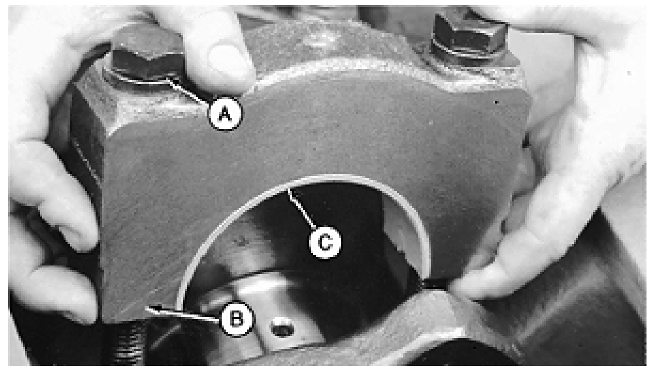


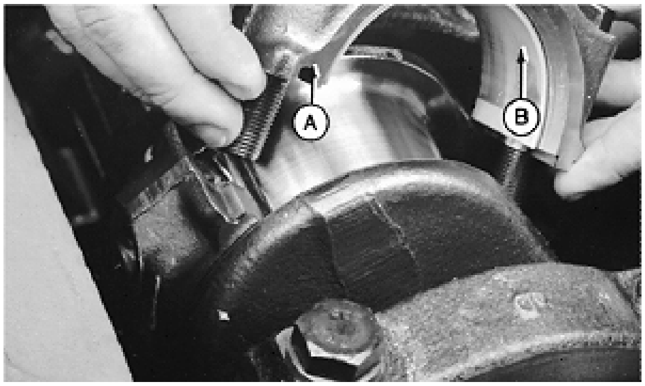
RG3741 -UN-14DEC88

S11,2515,O -19-28MAR91

13. Install connecting rod caps (A) with bearings (B), new cap screws and tighten cap screw closest to the piston pin end of rod to 27 N·m (20 lb-ft) first. Then, tighten remaining cap screws to 75 N·m (55 lb-ft) plus 90°. (See “TORQUE-TURN METHOD” in Group 10.)

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

14. Check crankshaft for 0.038—0.380 mm (0.0015—0.0150 in.) end play.



RG3743 -UN-14DEC88

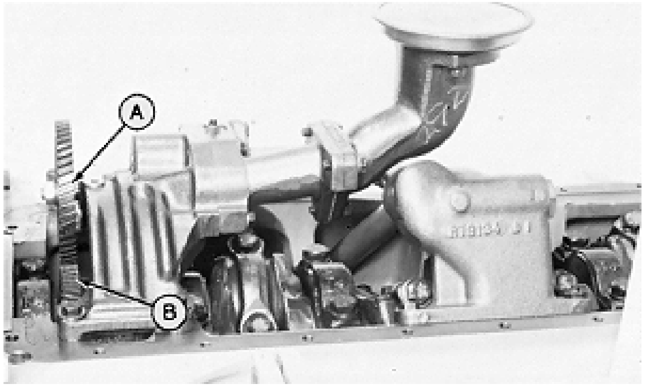
S11,0401,CL -19-28AUG91

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.



RG5329 -UN-14DEC88

S55,2015,Q -19-28MAR91

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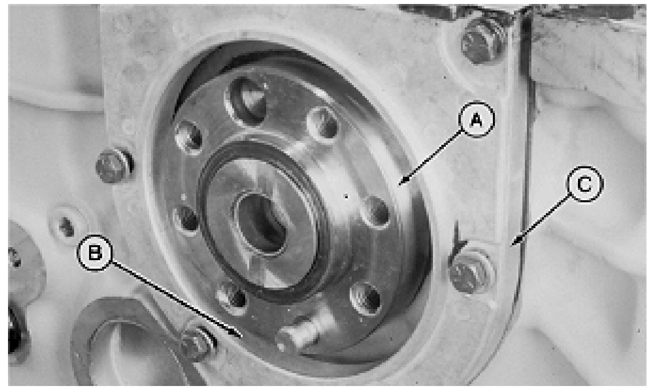
INSTALL REAR CRANKSHAFT OIL SEAL HOUSING



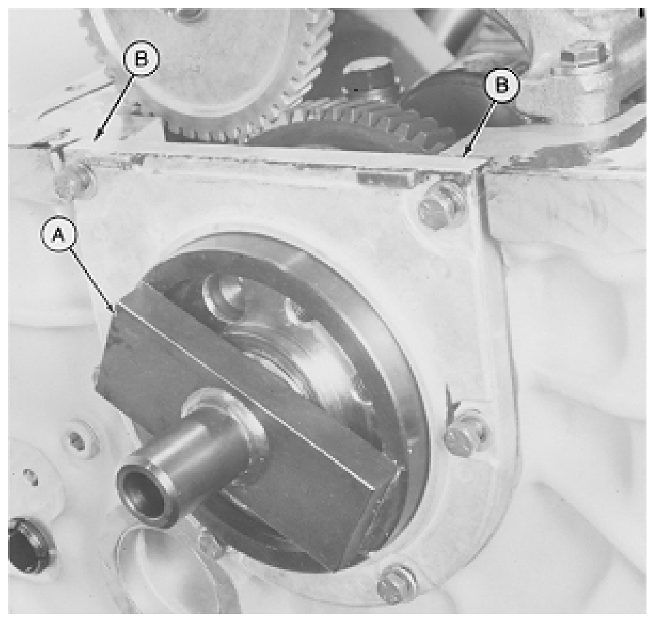
These instructions are for use when the rear oil seal housing and oil pan have been removed from cylinder block.

1. Make sure that OD of crankshaft flange (A) and ID of oil seal housing (B) are free from nicks and burrs. Restore damaged surfaces with a fine file or emery cloth. Clean with compressed air.

2. Install oil seal housing (C) on cylinder block using a new gasket. Install all six cap screws with washers and tighten finger tight.

RG,CTM6,G15,5 -19-02OCT91

IMPORTANT: Installation tools must be clean to assure proper positioning on crankshaft flange and to hold runout within specification so oil seal does not fail prematurely.



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3. Slip the JDG478* Driver (A) over crankshaft flange and into seal housing bore to center oil seal housing.

The JDG478 Driver is designed to center the oil seal housing in relation to crankshaft flange. However, the use of a magnetic base dial indicator is still recommended to measure oil seal housing runout. Runout should not exceed 0.15 mm (0.006 in.).

4. Position bottom of oil seal housing flush with cylinder block-to-oil pan mating surfaces (B). Tighten seal housing cap screw to 27 N·m (20 lb-ft).

5. Remove the JDG478 Driver from end of crankshaft flange.

6. Check oil seal housing runout with a magnetic base dial indicator. (See CHECK OIL SEAL HOUSING RUNOUT, later in this group.)

7. Trim off excess gasket material extending below bottom of oil seal housing.

** From JDG476 Oil Seal and Wear Sleeve Installer Set.*

RG,CTM6,G15,6 -19-28AUG91

CHECK OIL SEAL HOUSING RUNOUT

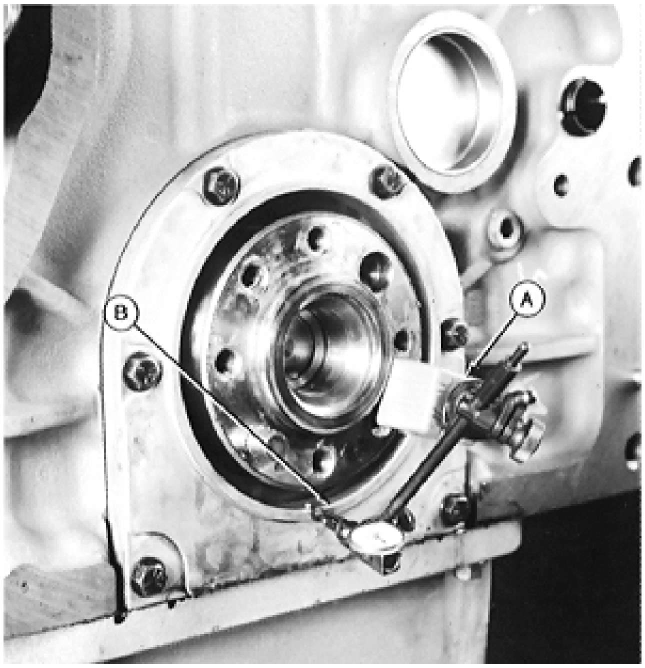
IMPORTANT: On service "shortblock" assemblies, rear oil seal housing runout is preset at the factory. Do not remove housing from block.

1. Position magnetic base dial indicator (A) on end of crankshaft flange as shown. Preset dial indicator tip on ID of oil seal housing bore (B).

2. Zero dial indicator and rotate crankshaft one full revolution, observe full indicator movement. The maximum oil seal housing bore runout is 0.15 mm (0.006 in.).

If runout exceeds specification, loosen cap screws and adjust housing to obtain an acceptable runout while keeping bottom of seal housing flush with oil pan mating surface.

3. Recheck oil seal housing bore runout. If runout still exceeds specification, oil seal housing bore is possibly distorted and should be replaced. See INSTALL REAR CRANKSHAFT OIL SEAL HOUSING, earlier in this group.



RG5751 -UN-05AUG91

S11,2515,AK -19-22AUG91

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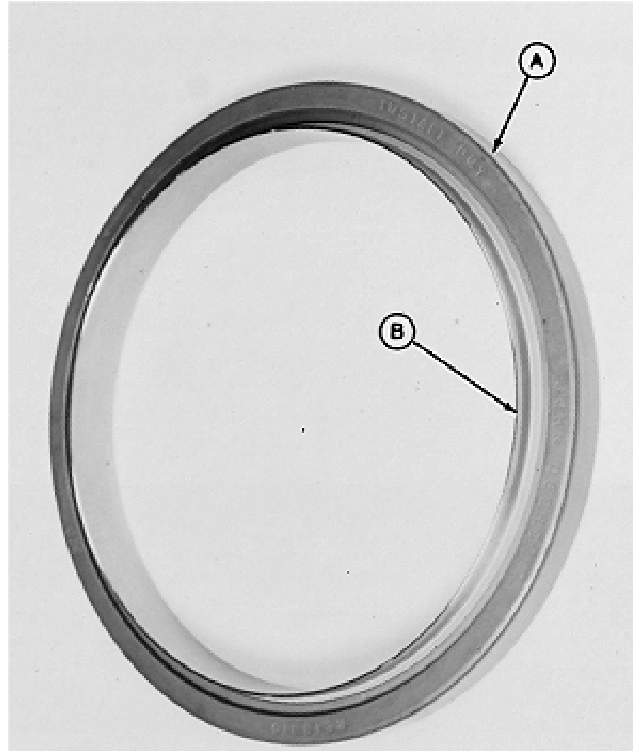
CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE HANDLING PRECAUTIONS



RG5575 -UN-07JUL89

Use the following precautions for handling seal and wear sleeve:

—Seal (A) and wear sleeve (B) are assembled. DO NOT SEPARATE. If parts become separated, discard and replace with a new assembly. Attempts to reassemble will cause the wear sleeve to damage the seal allowing engine oil to leak past seal.

—Always install seal and wear sleeve assembly immediately after removal from plastic bag to avoid possible dirt contamination.

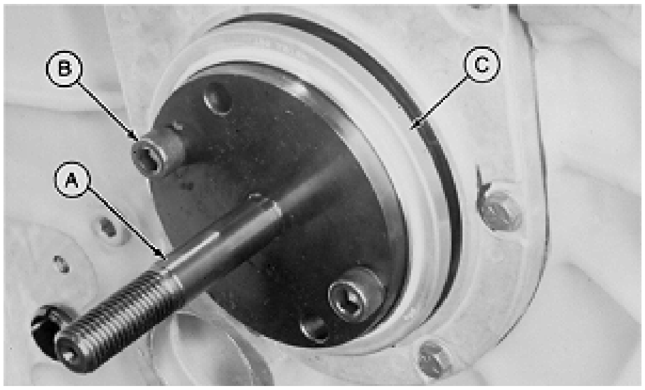
—No lubrication of any kind is to contact seal when installing. Use of a lubricant may result in premature seal failure.

—Install oil seal/wear sleeve assembly with the open side of seal and wear sleeve ID chamfer toward the engine. If seal is reversed, engine oil may be lost because grooves in oil seal lip would be incorrect with respect to direction of crankshaft rotation.

—Oil seal/wear sleeve assembly MUST be installed with the JDG476(85) Crankshaft Rear Oil Seal Installation Tool Set. Tool set consists of JDG477(85) Pilot and JDG478 Driver.

S11,2015,GP -19-22AUG91

INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE ASSEMBLY



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

IMPORTANT: DO NOT allow sealant to get on any part of wear sleeve OD or on oil seal.

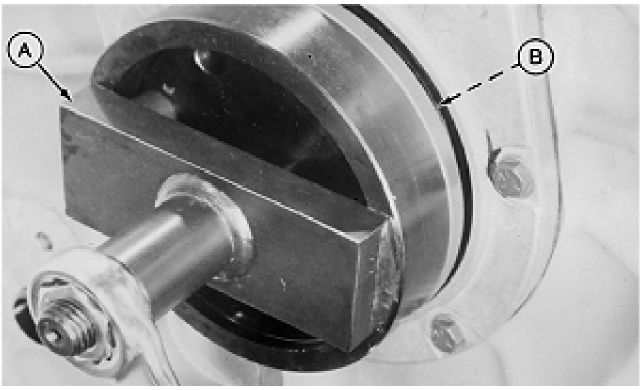
2. Install JDG477(85) Pilot (A) on end of crankshaft using the Allen head cap screws (B) supplied with tool set. Tighten cap screws securely.

IMPORTANT: Handle seal and wear sleeve assembly carefully. If assembly becomes separated, discard these parts and install a new assembly. Chamfer on wear sleeve and open side of seal must be on the same side.

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

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

S11,2015,DR -19-26JUL91



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

5. Tighten nut to draw JDG478 Driver in until it bottoms on oil seal housing flange (B). When the tool bottoms, seal and wear sleeve assembly will be correctly positioned.

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

S55,2015,R -19-26JUL91

INSTALL CRANKSHAFT GEAR

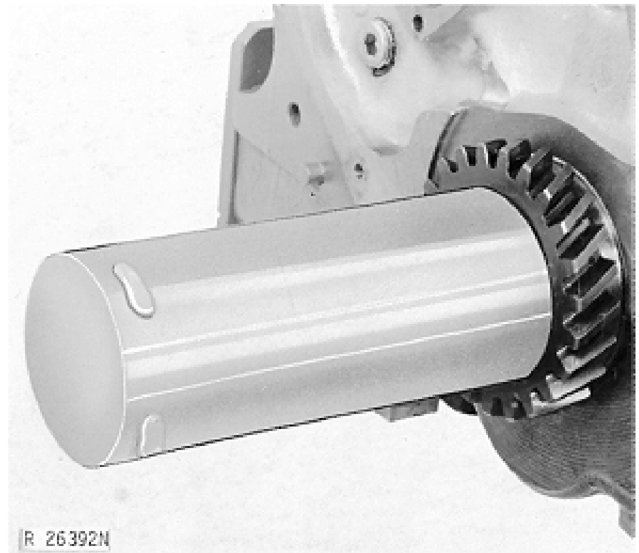
CAUTION: Oil Fumes or oil can ignite above 193˚C (380˚F). Use a thermometer and do not exceed 182˚C (360˚F). Do not allow a flame or heating element to be in direct contact with oil. Heat oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

1. Heat crankshaft gear (if removed) 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 destroy original heat treatment of gear.

2. With Woodruff key in place and timing marks visibly aligned, place gear on crankshaft.

3. Install crankshaft gear using JDH7 Driver.



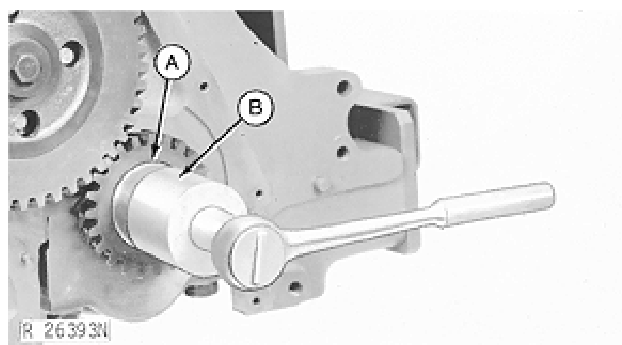
R26392 -UN-15DEC88

S55,2015,S -19-28MAR91

INSTALL FRONT WEAR SLEEVE

1. Coat I.D. of new wear sleeve (if removed) with LOCTITE 609 Retaining Compound or equivalent.

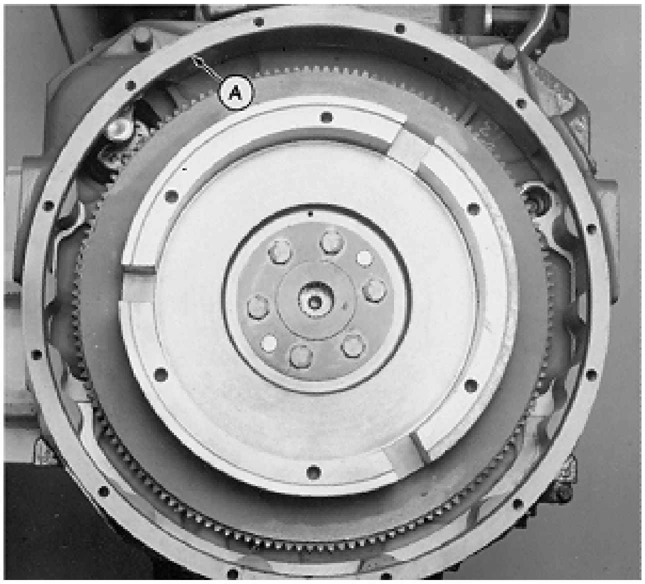
2. Use the JDE3 Driver (B), large washer, and a cap screw threaded in nose of crankshaft to press on wear sleeve (A).



R26393 -UN-15DEC88

S11,0403,AR -19-26JUL91

INSTALL SAE 3 FLYWHEEL HOUSING



RG5005 -UN-14DEC88

On SAE 1 and SAE 2 flywheel housings, the flywheel housing is installed AFTER the flywheel.

CAUTION: Flywheel housing (A) is heavy. Plan a proper lifting procedure to avoid personal injury.

1. On engines requiring a gasket between block and flywheel housing, inspect cylinder block and flywheel housing gasket surfaces to see that they are clean. Scrape off all old gasket material. Install a new gasket without sealant between block and flywheel housing.

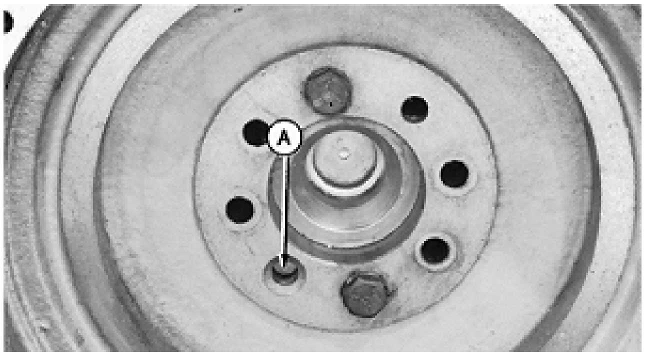
2. Install flywheel housing on cylinder block.

NOTE: Use new cap screws when installing flywheel housing.

3. Dip threads of cap screw in engine oil before installing. Install and tighten cap screws to 407 N·m (300 lb-ft).

S11,2015,GL -19-08AUG91

INSTALL FLYWHEEL



RG4383 -UN-14DEC88

CAUTION: Flywheel is heavy. Plan a proper handling procedure to avoid personal injuries.

NOTE: ALWAYS use new cap screws when installing flywheel. Flywheel must be clean and free of oil before installing.

1. Coat threads of flywheel attaching cap screws with LOCTITE 242 or its equivalent.

2. Position flywheel over dowel pin (A) and start two cap screws. Do not tighten.

3. Install remaining flywheel attaching cap screws.

4. Tighten flywheel attaching cap screws to 115 N·m (85 lb-ft).

S11,2020,L -19-08AUG91

INSTALL SAE 1 AND SAE 2 FLYWHEEL HOUSING

On SAE 3 flywheel housings, the housing MUST be installed BEFORE installing flywheel.

CAUTION: Flywheel housing is heavy. Plan a proper lifting procedures to avoid personal injury.

1. On engines requiring a gasket between block and flywheel housing, inspect cylinder block and flywheel housing gasket surfaces to see that they are clean. Scrape off all old gasket material. Install a new gasket without sealant between block and flywheel housing.

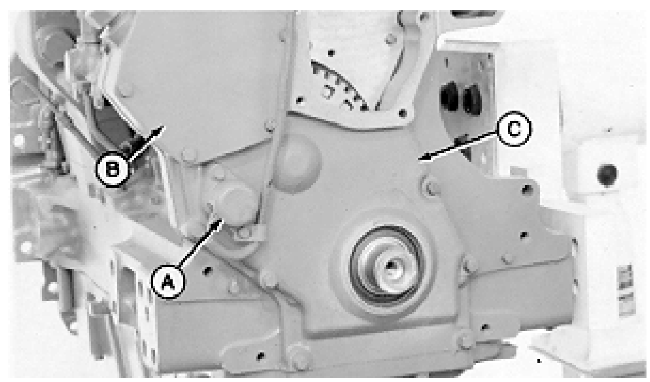
2. Install flywheel housing on cylinder block.

NOTE: ALWAYS use new cap screws when installing flywheel housing.

3. Dip threads of cap screw in engine oil before installing. Install and tighten cap screws to 407 N·m (300 lb-ft).

S11,2015,GT -19-08AUG91

INSTALL TIMING GEAR COVER—NON-AUXILIARY DRIVE ENGINES



RG3927 -UN-14DEC88

NOTE: Lubricate ID of crankshaft front oil seal with clean engine oil before installing timing gear cover. Be careful not to roll oil seal lip over during installation of timing gear cover.

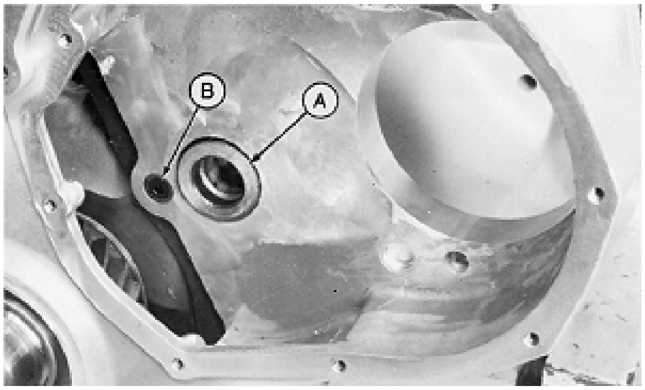
1. Using new gaskets that are lightly lubricated to hold them in place on engine block, install timing gear cover (C) and injection pump gear cover (B). (See COMPLETE FINAL ASSEMBLY in Camshaft and Timing Gear Train, Group 16 for cap screw tightening sequence.)

2. Trim gasket flush with oil pan mounting face.

3. Using a new gasket, install magnetic pickup (A, if equipped) and tighten securely.

S55,2015,T -19-28MAR91

INSTALL TIMING GEAR COVER AND AUXILIARY DRIVE GEARS—AUXILIARY DRIVE ENGINES



RG5328 -UN-14DEC88

NOTE: Lubricate ID of crankshaft front oil seal with clean engine oil before installing timing gear cover. Be careful not to roll oil seal lip over during installation of timing gear cover.

1. Using a new gasket that is lightly greased to hold it in place on engine block, install timing gear cover and tighten the lower five cap screws in sequence outlined in Group 16, Camshaft and Timing Gear Train. (See COMPLETE FINAL ASSEMBLY.)

2. Install flat head screw (B) with LOCTITE 242 (Blue) and tighten to 27 N·m (20 lb-ft).

3. Install spacer (A) in timing gear cover bore, using a heavy grease to hold in place.

S55,2015,U -19-28MAR91

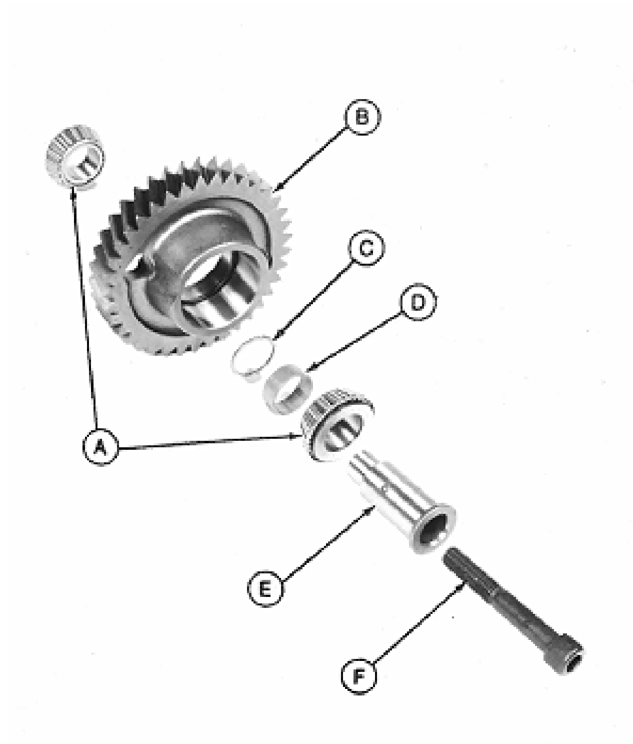
IMPORTANT: Whenever the auxiliary drive gear retaining screw (F) is loosened for removal, the spacer (D) MUST BE replaced due to the amount of crush during initial assembly.

Apply LOCTITE 242 to threads of mounting cap screw before installation.

4. Install one bearing (A), snap ring (C), spacer, and shaft (E) into long side of gear (B). Install other bearing into short side of gear.

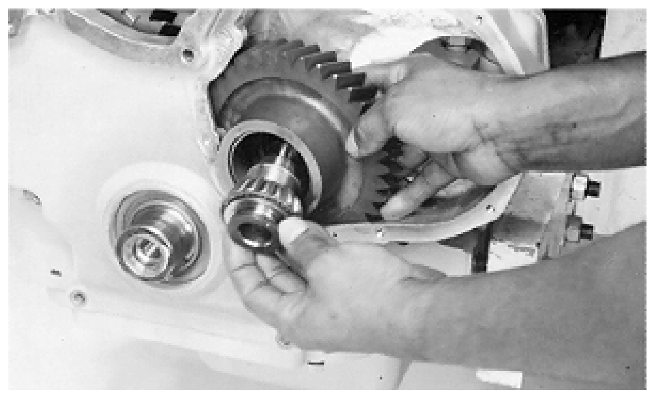
5. While holding bearing on back (short) side of gear, install gear with bearings and shaft into bore of spacer.

NOTE: Shaft will not slip easily into bore of spacer in timing gear cover, draw shaft in with tightening force of cap screw.



RG5708 -UN-01APR91

A—Bearing (2 Used)
B—Gear
C—Snap Ring
D—Spacer
E—Shaft
F—Retaining Screw



RG5327 -UN-14DEC88

RG,CTM6,G15,2 -19-28AUG91

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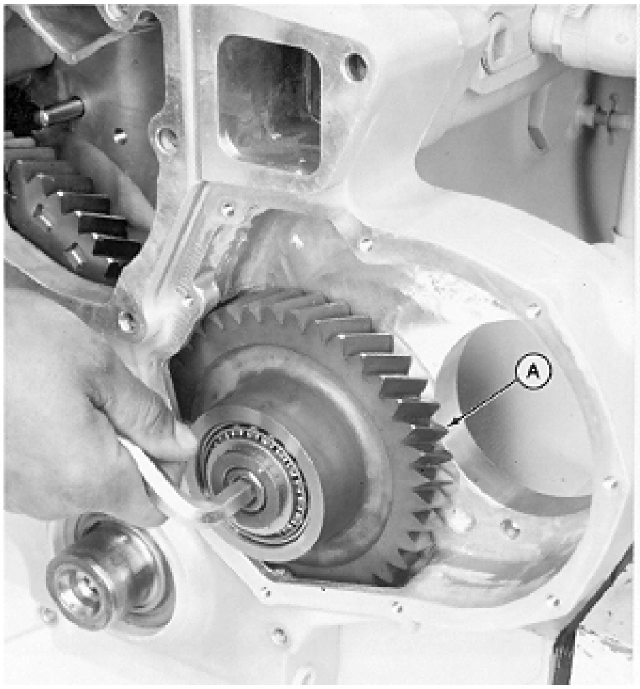
6. Be sure auxiliary drive idler gear (A) is properly meshed with crankshaft gear.

7. Install cap screw into bore of shaft and tighten to 203 N·m (150 lb-ft).



RG5326 -UN-14DEC88

S55,2015,W -19-28MAR91

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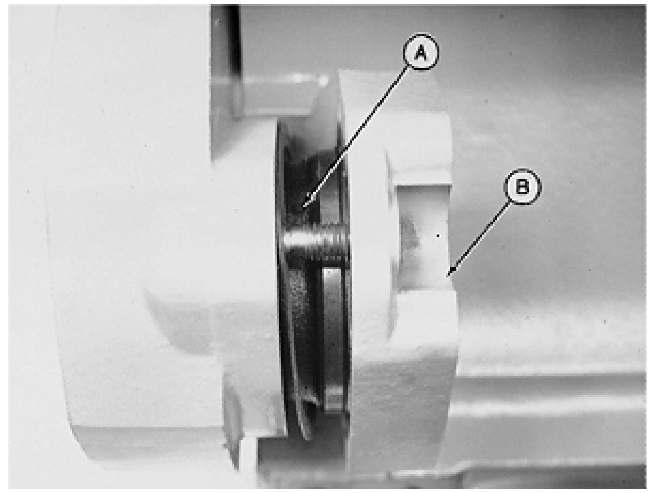
INSTALL REAR AUXILIARY DRIVE GEAR

IMPORTANT: The open ends (gap) of the snap ring installed in the rear auxiliary drive gear housing MUST align with the oil hole in the housing (A). Be sure that the oil hole in housing is in the upward position to assure proper lubrication of bearings in the auxiliary drive gear.



RG5709 -UN-01APR91

1. Using a new gasket, install auxiliary drive gear and housing assembly (B) onto mounting studs at rear of timing gear cover. Make sure that auxiliary drive gear and idler gear are properly meshed.

2. Install nuts on mounting studs and tighten to 102 N·m (75 lb-ft).

3. Install front auxiliary drive idler gear cover plate onto timing gear cover using a new gasket and tighten cap screws to 14 N·m (10 lb-ft).

4. Install injection pump gear cover and tighten cap screws to 27 N·m (20 lb-ft).

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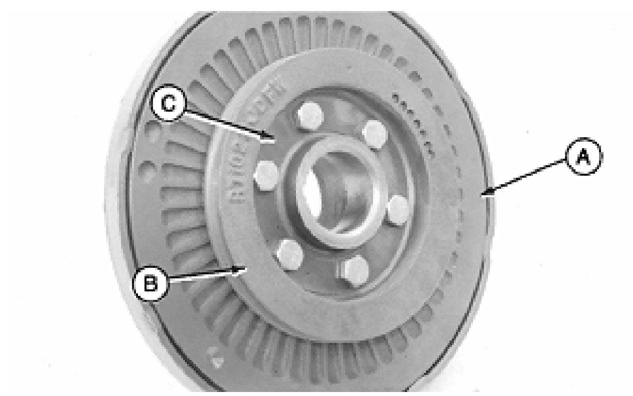
RG,CTM6,G15,3 -19-28AUG91

INSTALL DAMPER PULLEY ASSEMBLY

1. If vibration damper (A) was removed from damper pulley (B), install washer (C) and tighten cap screws to 41 N·m (30 lb-ft).

NOTE: Vibration damper and pulley orientation may vary depending on specific engine application. Be sure damper and pulley are assembled in the same orientation they were removed.



RG3928 -UN-14DEC88

S11,2015,DT -19-08AUG91

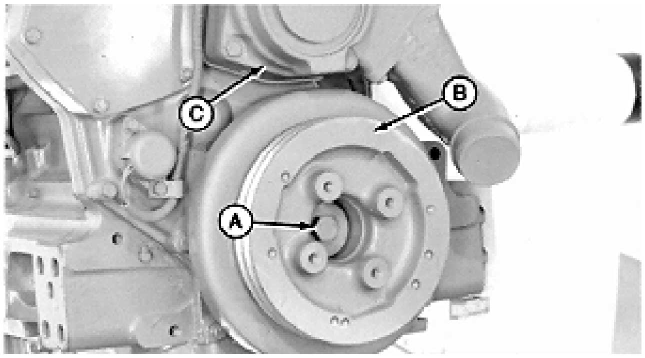
2. Make sure crankshaft Woodruff key is in place. Position damper pulley assembly (B) onto crankshaft.

3. Use hardened washer (part of damper assembly) and insert a cap screw that is 25 mm (1 in.) longer than original cap screw (A). Tighten cap screw until cap screw just bottoms out.

4. Remove cap screw and insert original cap screw with same hardened washer.

5. Tighten cap screw to 230 N·m (170 lb-ft).

6. Install water pump (C). (See INSTALL WATER PUMP in Group 25.)



RG3926 -UN-14DEC88

S55,2015,X -19-02OCT91

COMPLETE FINAL ASSEMBLY

1. Install water manifold with thermostats and fan pulley assembly. (See Cooling System, Group 25.)

2. Install oil pan and fill with clean engine oil.

3. Fill cooling system with proper coolant after engine installation and perform engine break-in. (See PERFORM ENGINE BREAK-IN at the end of Group 05.)

S55,2015,Y -19-22AUG91

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

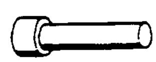
Rotate engine flywheel. Use with JDE81-4.

S53,JDE811 -19-07JUL89

RG5068 -UN-23AUG88

Timing Pin JDE81-4

Used to lock flywheel at “TDC” when timing engine and adjusting valves.



S53,JDE814,A -19-09SEP91

RG5073 -UN-23AUG88

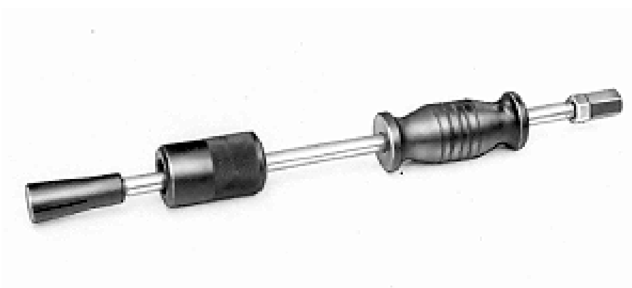
Magnetic Follower Holder Kit D15001NU

Hold cam followers when removing/installing camshaft.

S53,D15001,NU -19-14JUN89

Slide Hammer D01299AA

Used with JDG405 Camshaft Bushing Service Set and JDG606 Camshaft Bushing Adapter Set to service camshaft bushings.



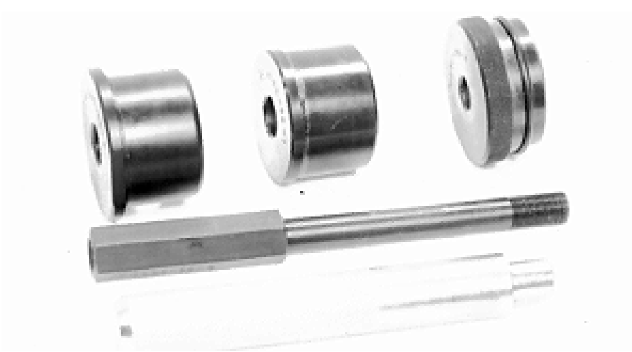
RG78104H1 -UN-15DEC88

S53,D01299,AAA -19-09SEP91

Camshaft Bushing Service Set JDG405

Used with JDG606 Camshaft Bushing Adapter Set and D01299AA Slide Hammer to service camshaft bushings.

NOTE: JDE6 Service Set may be used along with JDG602 Adapter Set if JDG405 is not available.



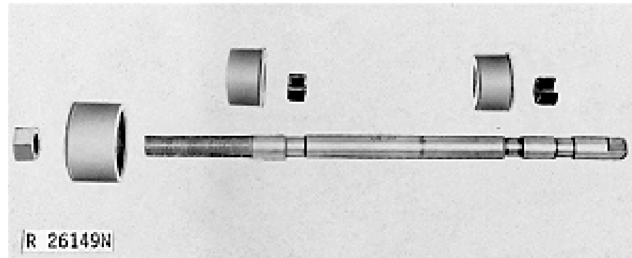
RG4228 -UN-15DEC88

S53,JDG405,A -19-09SEP91

Camshaft Bushing Service Set JDE6

Used with JDG602 Camshaft Bushing Adapter Set to service camshaft bushings.

NOTE: JDG405 Service Set may be used along with JDG606 Adapter Set if JDE6 is not available.

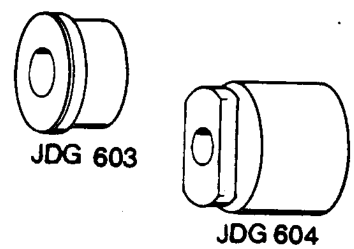


R26149N -UN-23AUG88

S53,JDE6A -19-09SEP91

Camshaft Bushing Adapter Set JDG602

Used with JDE6 Camshaft Bushing Service Set to service camshaft bushings. JDG602 consists of JDG603 Driver and JDG604 Receiver Cup.



RG5336 -UN-23AUG88

S53,JDG602 -19-09SEP91

Camshaft Bushing Adapter Set JDG606

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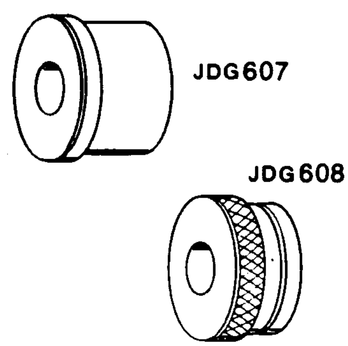
Used with JDG405 Camshaft Bushing Service Set and D01299AA Slide Hammer to service camshaft bushings. JDG606 consists of JDG607 Driver and JDG608 Pilot.



RG5337 -UN-28AUG91

S53,JDG606 -19-09SEP91

SERVICE EQUIPMENT AND TOOLS

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

Name	Use
D01048AA 17-1/2 Ton Capacity Puller Set	Used to remove damper pulley.
D01045AA Bushing, Bearing, and Seal Driver Master Set	Used to install front oil seal in timing gear cover.

RG,CTM6,G16,16 -19-11APR91

OTHER MATERIAL

Name	Use
TY6333 or TY6347 High Temperature Grease	Coat camshaft lobes during installation.
LOCTITE 242	Thrust plate cap screws.

S55,2016,B -19-11APR91

CAMSHAFT AND TIMING GEAR TRAIN SPECIFICATIONS

ITEM	NEW PART SPECIFICATION	WEAR TOLERANCE
Camshaft End Play	0.0634—0.2413 mm (0.0025—0.0095 in.)	0.38 mm (0.015 in.)
Camshaft Thrust Plate Thickness	4.72—4.80 mm (0.1860—0.1890 in.)	4.62 mm (0.1820 in.)
Camshaft Journal OD	66.987—67.013 mm (2.6373—2.6383 in.)	——
Camshaft Bushing ID	67.076—67.102 mm (2.6408—2.6418 in.)	——
Camshaft Bushing-to-Journal Clearance	0.063—0.115 mm (0.0025—0.0045 in.)	0.152 mm (0.0060 in.)
Camshaft Gear-to-Injection Pump Drive Gear Backlash	0.051 mm (0.0020 in.) minimum	——
Camshaft Bushing Bore in Block (without bushings)	69.987—70.013 mm (2.7554—2.7564 in.)	——
Maximum Runout of Camshaft Bore	0.038 mm (0.0015 in.)	——
Camshaft Drive Gear-to-Crankshaft Gear Backlash	0.076 mm (0.0030 in.) minimum	——
Camshaft Lobe Lift:		
Engine Serial No. (—121169)		
Intake	7.98—8.23 mm (0.314—0.324 in.)	7.48 mm (0.294 in.)
Exhaust	9.02—9.27 mm (0.355—0.365 in.)	8.52 mm (0.335 in.)
Engine Serial No. (121170—)		
Intake	7.61—7.87 mm (0.300—0.310 in.)	7.11 mm (0.280 in.)
Exhaust	8.17—8.43 mm (0.322—0.332 in.)	7.67 mm (0.302 in.)
Cam Follower OD	17.33—17.35 mm (0.682—0.683 in.)	——
Cam Follower Bore Diameter in Block	17.384—17.440 mm (0.6845—0.6865 in.)	——
Front Camshaft Journal-to-Thrust Plate Clearance	0.115—0.245 mm (0.0045—0.0096 in.)	0.345 mm (0.0136 in.)
Valve Lift at 0.00 mm (in.) Clearance:		
Engine Serial No. (—121169)		
Exhaust	15.88—16.31 mm (0.625—0.642 in.)	14.99 mm (0.590 in.)
Intake	14.05—14.48 mm (0.553—0.570 in.)	13.16 mm (0.518 in.)
Engine Serial No. (121170—) and converted 644E Loaders		
Exhaust	14.38—14.84 mm (0.566—0.584 in.)	13.49 mm (0.531 in.)
Intake	13.39—13.84 mm (0.527—0.545 in.)	12.50 mm (0.492 in.)

S55,2016,A -19-29AUG91

CAMSHAFT AND TIMING GEAR TRAIN SPECIFICATIONS—CONTINUED

TORQUES

Rocker Arm Shaft Clamps	75 N·m (55 lb-ft)
Rocker Arm Cover-to-Cylinder Head	8 N·m (6 lb-ft) (72 lb-in.)
Camshaft Thrust Plate*	17 N·m (13 lb-ft)
Camshaft Gear	203 N·m (150 lb-ft)
Timing Gear Cover-to-Cylinder Block	27 N·m (20 lb-ft)
Injection Pump Gear Cover	27 N·m (20 lb-ft)
Auxiliary Drive Idler Gear Cover Plate-to-Timing Gear Cover	14 N·m (10 lb-ft)
Auxiliary Drive Gear Housing-to-Timing Gear Cover Housing	102 N·m (75 lb-ft)
Auxiliary Drive Gear Assembly-to-Cylinder Block	203 N·m (150 lb-ft)

Use LOCTITE 242 on threads of cap screws.

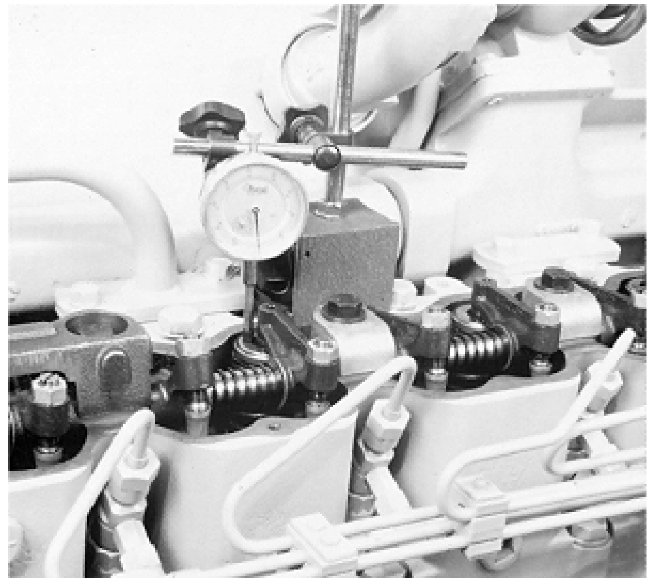
RG,CTM6,G16,1 -19-29AUG91

GENERAL INFORMATION

6076 Engines are available with gear-driven auxiliary drive options or non-auxiliary drive options. Follow the same repair procedure for both options unless otherwise noted.

S55,2015,J -19-25JAN88

CHECK VALVE LIFT


RG5242 -UN-06DEC88

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

1. Remove rocker arm cover and loosen locknut on rocker arm. Set valve clearance at 0.00 mm (in.). Tighten locknut.

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

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

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

5. Observe dial indicator reading as valve is moved to fully open position. Compare readings with specifications given below.

VALVE LIFT SPECIFICATION AT 0.00 MM (IN.) CLEARANCE

Engine Ser. No. (—121169)
Intake . . . . 14.05—14.48 mm (0.553—0.570 in.)
Minimum Acceptable . . . . 13.16 mm (0.518 in.)
Exhaust . . . . 15.88—16.31 mm (0.625—0.642 in.)
Minimum Acceptable . . . . 14.99 mm (0.590 in.)

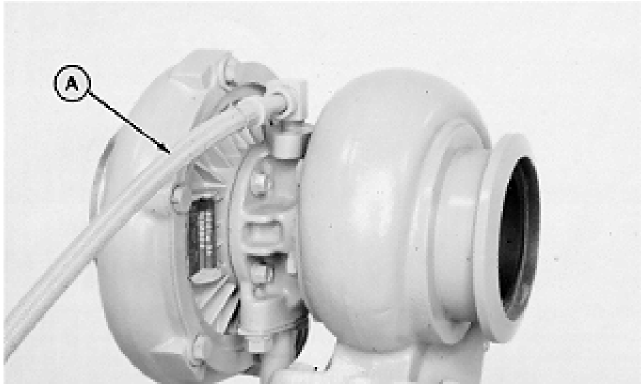
16
6
Engine Ser. No. (121170—) and converted 644E Loaders
Intake . . . . 13.39—13.84 mm (0.527—0.545 in.)
Minimum Acceptable . . . . 12.50 mm (0.492 in.)
Exhaust . . . . 14.38—14.84 mm (0.566—0.584 in.)
Minimum Acceptable . . . . 13.49 mm (0.531 in.)

Replace camshaft, followers, and/or push rods as necessary if valve lift is not within specification.

6. Adjust valve clearance to specification. (See CHECK AND ADJUST VALVE CLEARANCE in Group 05.)

RG,CTM6,G16,17 -19-29AUG91

DISCONNECT TURBOCHARGER OIL INLET LINE



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

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

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

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

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

RG,CTM6,G03,1 -19-22AUG91

PREPARE ENGINE FOR CAMSHAFT REMOVAL

1. Drain oil from engine crankcase, if not previously done.

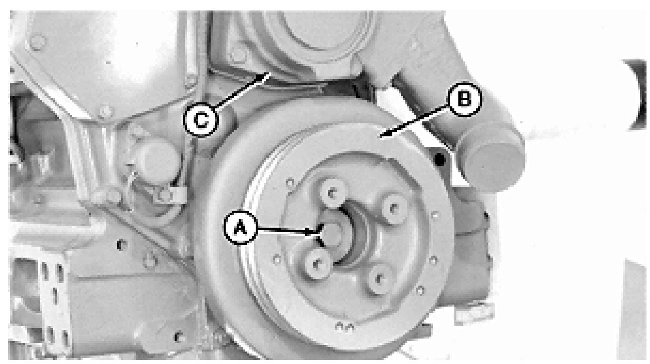
2. Lock engine at No. 1 cylinder's "TDC-Compression" stroke with JDE81-4 Timing Pin. (See Group 05, Cylinder Head and Valves.)

3. Remove rocker arm cover, rocker arm assembly and push rods. Remove cylinder head, if desired. (See Group 05, Cylinder Head and Valves.)

NOTE: It is not necessary to remove the cylinder head from engine for camshaft removal. Either use D15001NU Magnetic Follower Holder Kit to hold followers away from camshaft lobes or revolve engine until oil pan is in the upright position so followers fall away from camshaft lobes, if engine is mounted on a rollover stand.

S55,2016,C -19-11APR91

REMOVE DAMPER PULLEY AND TIMING GEAR COVER—NON-AUXILIARY DRIVE ENGINES



RG3926 -UN-14DEC88

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

2. Remove water pump (C) if not previously removed. (See Group 25, Cooling System.)

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

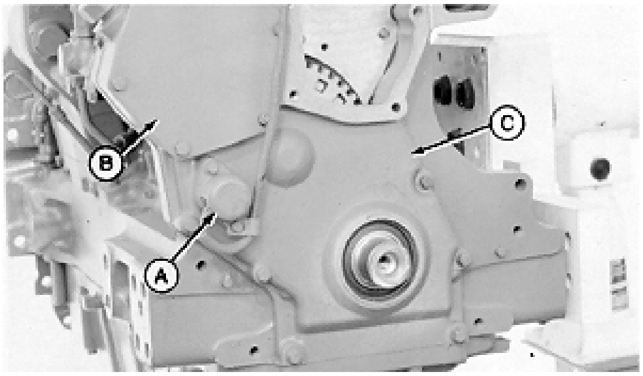
IMPORTANT: DO NOT use a jaw-type puller to remove vibration damper. Damage could result to the damper. Never apply thrust on outer ring of damper. Do not drop or hammer on damper.

4. Remove pulley and damper from crankshaft using D01048AA Puller Set.

RG,CTM6,G16,6 -19-11APR91

5. Remove magnetic pick-up (A, if equipped) and injection pump drive gear cover (B). Discard gaskets.

6. Remove timing gear cover (C). Discard gasket.



RG3927 -UN-14DEC88

RG,CTM6,G16,7 -19-11APR91

REMOVE DAMPER PULLEY, AUXILIARY DRIVE GEAR AND TIMING GEAR COVER—AUXILIARY DRIVE ENGINES

IMPORTANT: Auxiliary drive output shaft assembly is a field installed option for your 6076 Engine. Retain Installation Instructions provided with kit at time of purchase for service recommendations.

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

2. Remove fan pulley assembly and water manifold (shown removed) from front face of cylinder head.

3. Remove water pump (C) if not previously removed. (See Group 25, Cooling System.)

4. Remove cap screw (A) with washer securing damper pulley (B) to crankshaft.

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

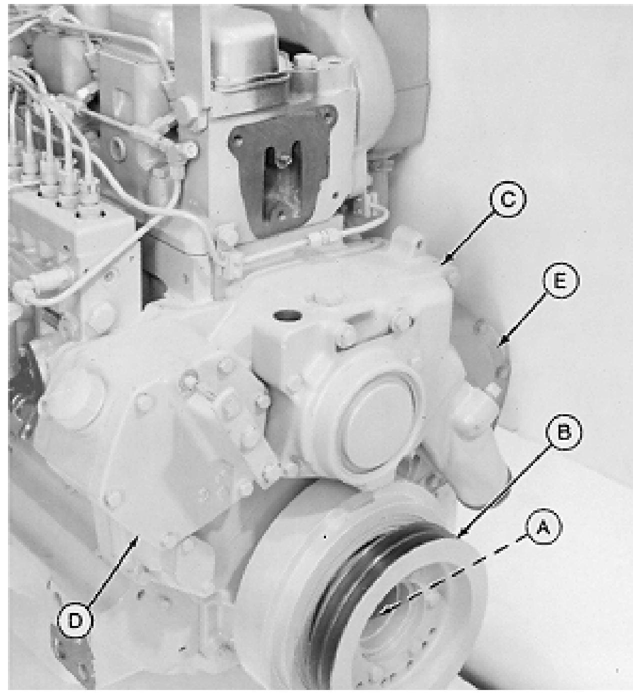
NOTE: On some applications, it may be necessary to remove the pulley from the damper before pulling damper from crankshaft flange.

5. Remove damper from crankshaft flange using D01048AA Puller Set.

6. Remove injection pump drive gear cover (D). Remove front auxiliary drive gear cover (E).

Remove and discard all gasket material.

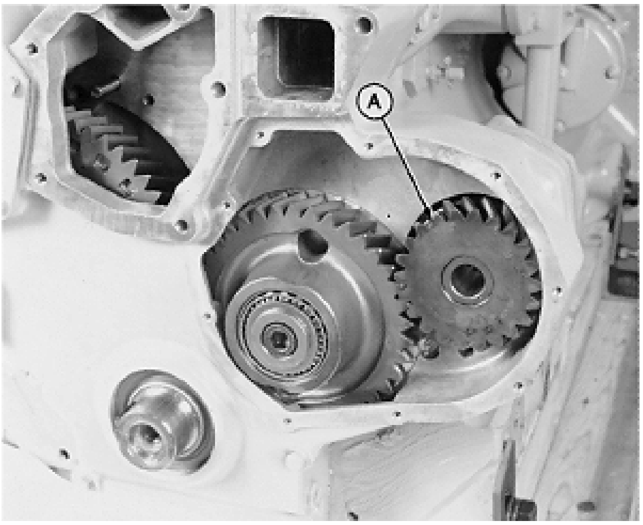
NOTE: Remove magnetic pickup assembly, if equipped.



A—Cap Screw With Washer
B—Damper Pulley
C—Water Pump
D—Injection Pump Drive Gear Cover
E—Front Auxiliary Drive Gear Cover

RG,CTM6,G16,2 -19-11APR91

7. Remove mounting nuts from rear of timing gear cover and remove auxiliary drive output/gear housing assembly (A) from engine.



RG5707 -UN-01APR91

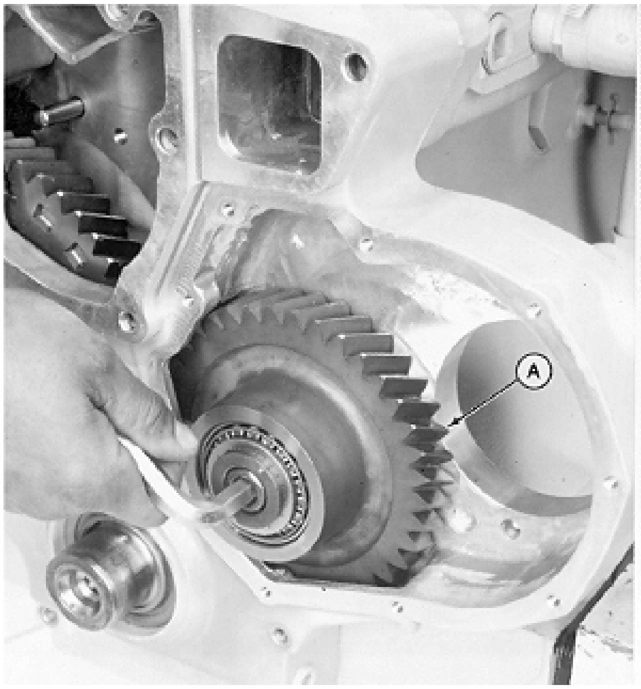
RG,CTM6,G16,8 -19-11APR91

8. Loosen Allen head screw using appropriate size Allen wrench. Leave approximately three threads fully engaged.

NOTE: DO NOT remove Allen head screw until shaft is disengaged from bore in block so that spacers and bearings won't fall into timing gear cover causing possible damage.

9. Tap on auxiliary drive gear (A) lightly with a brass driver and hammer through opening at rear of timing gear cover.

10. Using the JDE81-1 Flywheel Turning Tool, rotate engine 1/8 to 1/4 revolution and lightly tap auxiliary drive gear again. Continue to rotate engine 1/8 to 1/4 revolution and tap gear with brass driver until shaft with gear assembly is free from bore in block.



RG5326 -UN-14DEC88

RG,CTM6,G16,3 -19-11APR91

16
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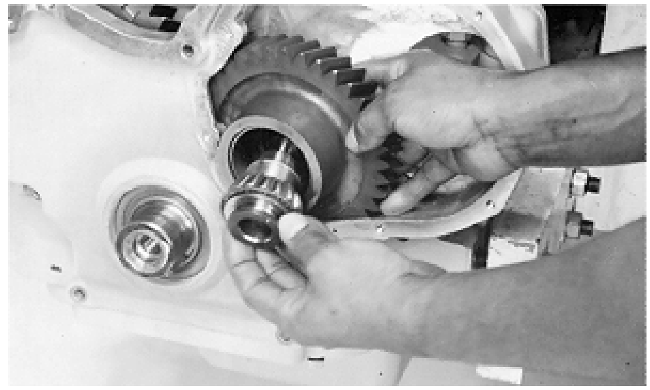
11. Remove Allen head screw (shown removed) while holding gear in place with other hand.

12. Tilt gear forward and grab bearing behind gear with right hand. Remove front bearing with shaft, snap ring and spacer. Discard spacer. Remove drive gear.



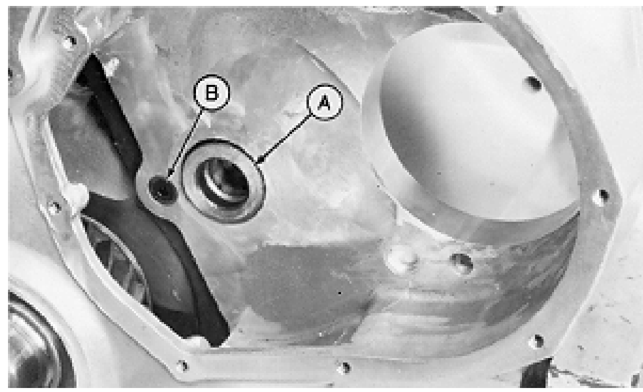
RG5327 -UN-14DEC88

RG,CTM6,G16,4 -19-29AUG91

13. Remove spacer (A) from timing gear cover.

14. Remove flat head cap screw (B). Remove all remaining timing gear cover cap screws and remove timing gear cover.

15. Remove and discard all gasket material.



RG5328 -UN-14DEC88

RG,CTM6,G16,5 -19-11APR91

REMOVE FRONT OIL SEAL FROM TIMING GEAR COVER

16
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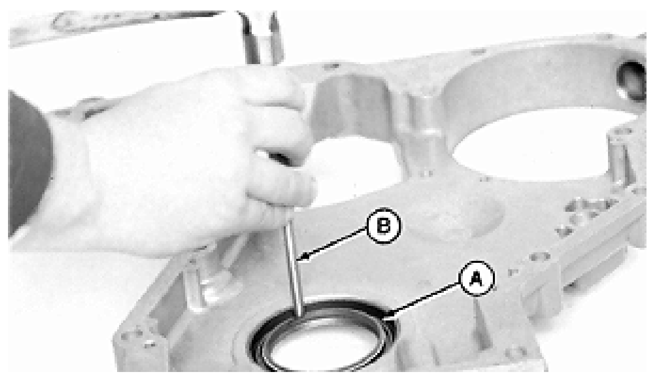
1. Check front oil seal (A) for wear, damage or deterioration.

2. If seal is damaged, tap around metal edge of seal with a small punch (B) and remove seal. Be careful not to damage gear cover.

3. Inspect and clean seal bore in cover. Check for nicks or burrs. Use a medium-grit emery cloth to smooth rough areas.



RG3835 -UN-14DEC88

S55,2015,K -19-15JUN89

INSTALL FRONT OIL SEAL IN TIMING GEAR COVER

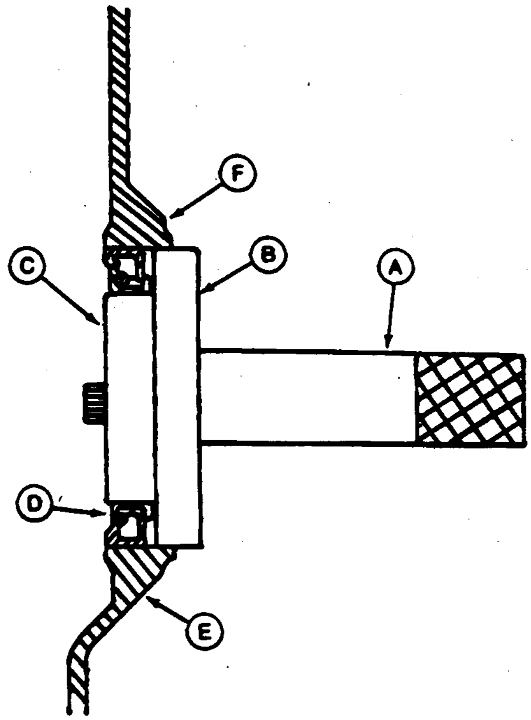
1. Install front oil seal (D) in housing, with spring side of seal facing the engine using the D01045AA Master Driver Set.

2. Support timing gear cover (E) around seal bore.

3. Drive seal into front of cover using 27536 Disk (B), 27521 Disk (C) and 27488 Driver (A) until seal is 8.4 mm (0.33 in.) below housing face (F).

NOTE: If installing seal from backside of cover use 27539 Disk, 27522 Disk, and 27488 Driver. Drive seal until 27536 Disk bottoms against cover and seal is flush with inside face of cover.

4. Coat rubber tip of crankshaft front seal and outside of wear sleeve with light oil.



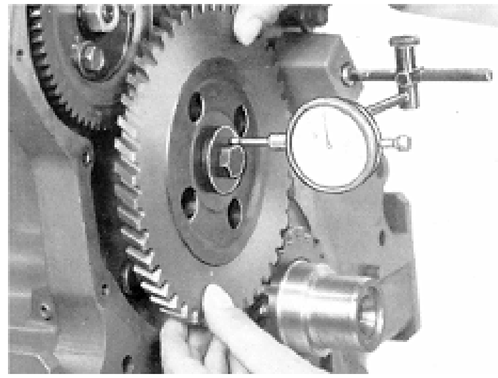
RG3842 -UN-14DEC88

A—27488 Driver
B—27536 Disk
C—27521 Disk
D—Oil Seal
E—Timing Gear Cover
F—8.4 mm (0.33 in.) Below Housing Face

16
13

S11,0403,AS -19-11APR91

CHECK CAMSHAFT END PLAY


RG3498 -UN-23FEB89

1. Install magnetic base dial indicator on front face of cylinder block.

2. Position dial indicator tip on front face of camshaft, as shown. Zero dial indicator.

3. Move camshaft gear back and forth and observe end play reading. Compare reading with specification given below.

CAMSHAFT END PLAY SPECIFICATIONS

New Engine End Play . . . . 0.0634—0.2413 mm (0.0025—0.0095 in.)
Maximum Allowable End Play . . . . 0.38 mm (0.0150 in.)

NOTE: If end play is excessive, check thrust plate thickness using a new thrust plate and a feeler gauge after camshaft is removed. If camshaft end play is correct, measure timing gear backlash.

S11,2005,DA -19-11APR91

MEASURE CAMSHAFT DRIVE GEAR-TO-CRANKSHAFT GEAR MINIMUM BACKLASH

Measure backlash between camshaft drive gear and crankshaft using a magnetic base dial indicator.

CAMSHAFT DRIVE GEAR-TO-CRANKSHAFT GEAR BACKLASH SPECIFICATION

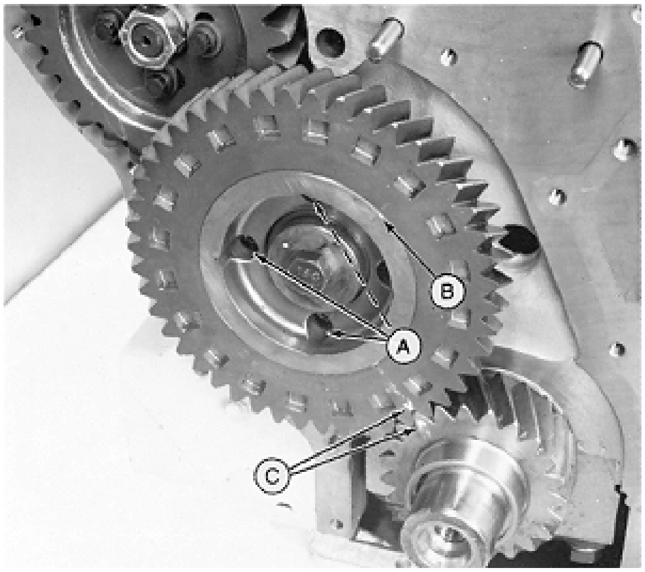
New Part Backlash Specification . . . . 0.076 mm (0.003 in.) Minimum

Replace gears if backlash is not within specification.

S55,2016,E -19-11APR91

REMOVE CAMSHAFT

NOTE: It is not necessary to remove cylinder head from engine for camshaft removal. If push rods are bent or show excessive scuffing, it may be necessary to remove cylinder head for inspection of block, head, cam lobes and cam followers.



RG5330 -UN-06DEC88

1. 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.

2. Remove three cap screws (A) from thrust plate.

IMPORTANT: Check camshaft gear for slippage between the two parts of the gear. An indexing mark (B) has been placed across the parting line of the two gear parts. If the mark has separated, the gear should be replaced.

3. Examine camshaft gear and injection pump drive gear for worn or damaged gear teeth. Gears should have a minimum backlash of 0.05 mm (0.002 in.).

NOTE: Timing marks (C) on crankshaft and camshaft gear should be aligned and No. 1 cylinder locked at "TDC Compression" stroke when removing camshaft.

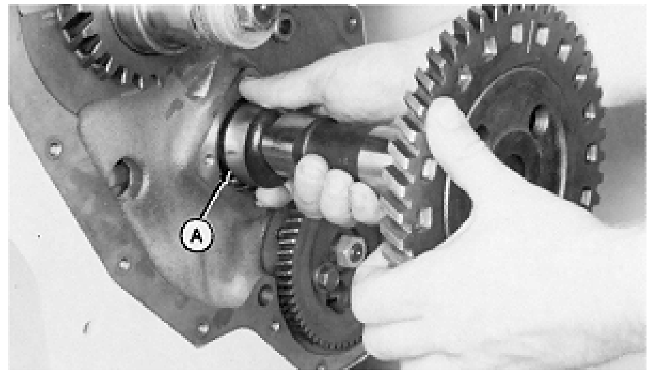
S55,2016,D -19-29AUG91

IMPORTANT: Be sure to set No. 1 Piston at TDC on compression stroke, using the JDE81-1 and JDE81-4 Engine Rotation Tool Set.

4. Carefully remove camshaft (A) from cylinder block so that camshaft lobes do not drag in bores.

NOTE: Rotate camshaft carefully to aid in removing.

5. Remove cam followers and identify each follower for assembly in same bore from which removed.



RG3818 -UN-23FEB89

S11,0401,BG -19-29AUG91

REMOVE CAMSHAFT GEAR, SPACER, AND THRUST PLATE

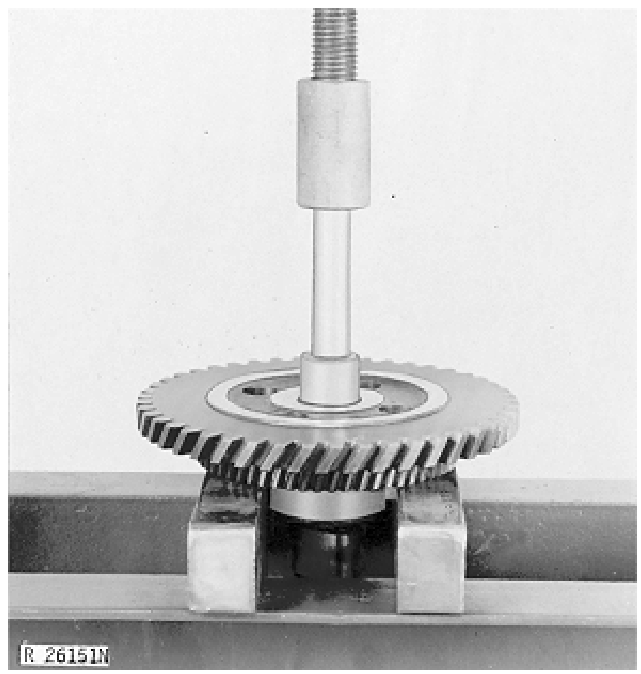
1. Remove cap screw with special washer and support camshaft gear in a press.

IMPORTANT: Prevent camshaft from striking floor when pressing camshaft from gear.

2. Press camshaft out of gear.

3. Remove spacer and thrust plate from camshaft.

4. Clean camshaft and thrust plate in solvent. Dry with compressed air.



R26151N -UN-09DEC88

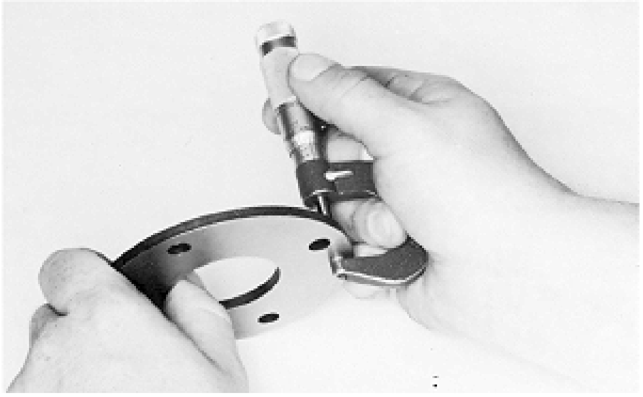
S11,0401,BH -19-11APR91

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 New Part Thickness . . . . 4.72—4.80 mm (0.186—0.189 in.)
Allowable Wear Thickness . . . . 4.62 mm (0.182 in.)
Spacer New Part Thickness . . . . 4.92—4.97 mm (0.194—0.196 in.)



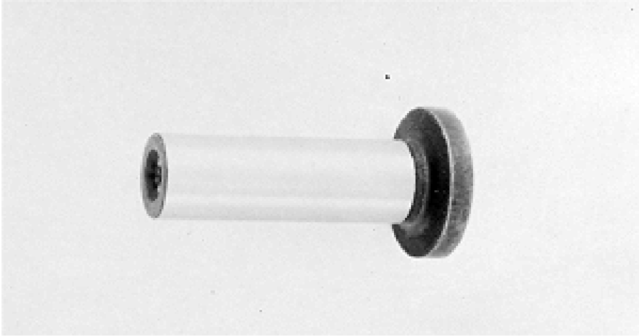
RG2743 -UN-17JUL89

S55,2016,G -19-11APR91

INSPECT AND MEASURE CAMSHAFT FOLLOWERS

1. Inspect camshaft followers for uneven wear or damage. Also inspect corresponding camshaft lobe for wear or damage. Replace as necessary.

Camshaft Follower OD . . . . 17.33—17.35 mm (0.682—0.683 in.)
Camshaft Follower Bore ID in Block . . . . 17.384—17.440 mm (0.6845—0.6865 in.)



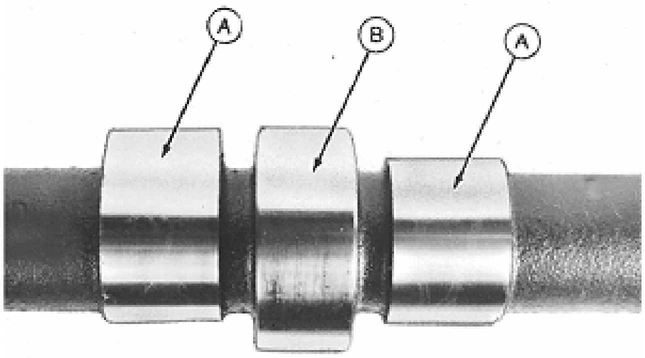
RG2745 -UN-23FEB89

S55,2016,H -19-27JAN88

VISUALLY INSPECT CAMSHAFT

1. Visually inspect camshaft lobes (A) and journals (B) for wear or damage. Replace as necessary. New cam followers can be used with old camshaft (if camshaft is serviceable). However, do not reuse old cam followers with a new camshaft.

NOTE: Very light score marks may be found, but are acceptable if valve lift is within specification. Pitting or galling dictates replacement. (See CHECK VALVE LIFT in Group 05.)



RG3500 -UN-06AUG91

S55,2016,I -19-11APR91

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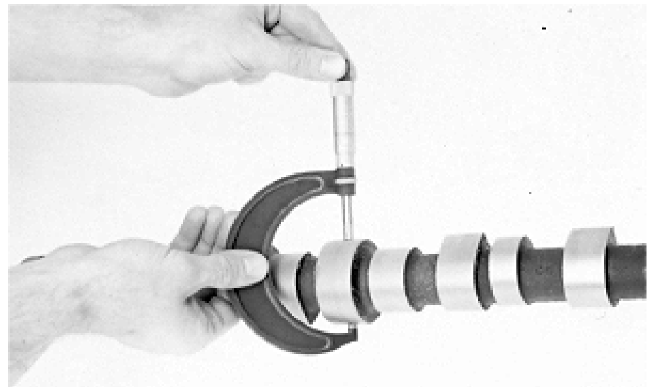
MEASURE CAMSHAFT JOURNAL OD AND BUSHING ID



T81260 -UN-07NOV88

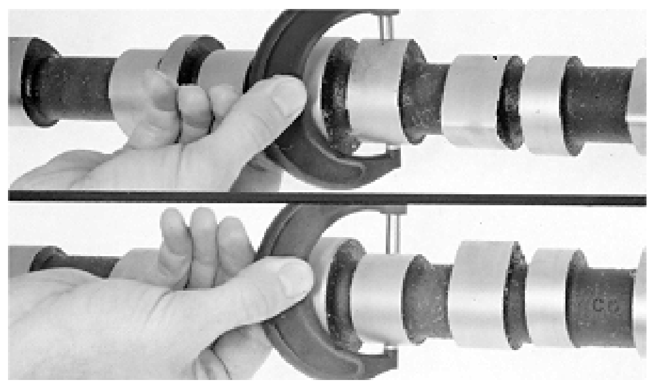
1. Measure each camshaft journal OD. New camshaft journal diameter is 66.987—67.013 mm (2.6373—2.6383 in.).

If camshaft journal OD is not within specification, install a new camshaft.

2. Measure each camshaft bushing ID in cylinder block. Bushing ID is 67.076—67.102 mm (2.6408—2.6418 in.). Maximum bushing-to-journal clearance is 0.152 mm (0.0060 in.)

S55,2016,J -19-11APR91

MEASURE CAMSHAFT LOBE LIFT



T81262 -UN-01NOV88

1. Measure each camshaft lobe at its highest point and at its narrowest point. Subtract narrowest dimension from highest dimension to find camshaft lobe lift.

If camshaft lobe lift is not within specification on any one lobe, install a new camshaft.

CAM LOBE LIFT NEW PART SPECIFICATION

Engine Serial No. (—121169)	
Intake Lobe	7.98—8.23 mm (0.314—0.324 in.)
Wear Tolerance	7.48 mm (0.294 in.)
Exhaust Lobe	9.02—9.27 mm (0.355—0.365 in.)
Wear tolerance	8.52 mm (0.335 in.)
Engine Serial No. (121170—)	
Intake Lobe	7.61—7.87 mm (0.300—0.310 in.)
Wear Tolerance	7.11 mm (0.280 in.)
Exhaust Lobe	8.17—8.43 mm (0.322—0.332 in.)
Wear Tolerance	7.67 mm (0.302 in.)

S55,2016,K -19-29AUG91

ASSEMBLE CAMSHAFT

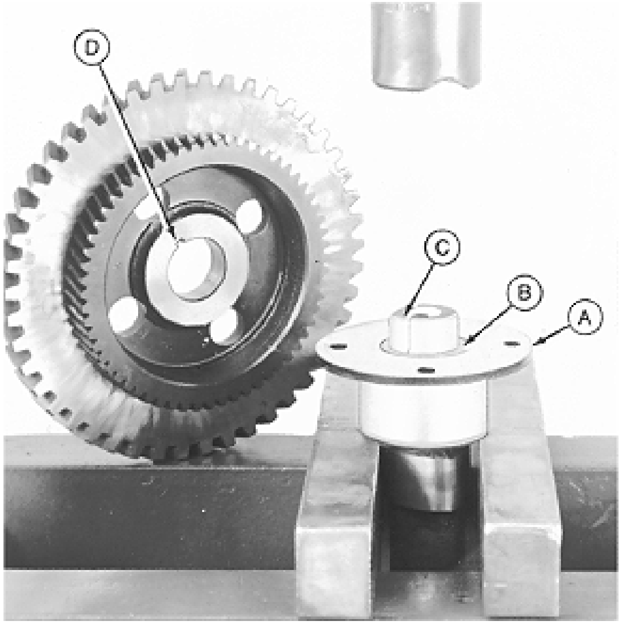
1. Support camshaft under first journal in a hydraulic press.

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.

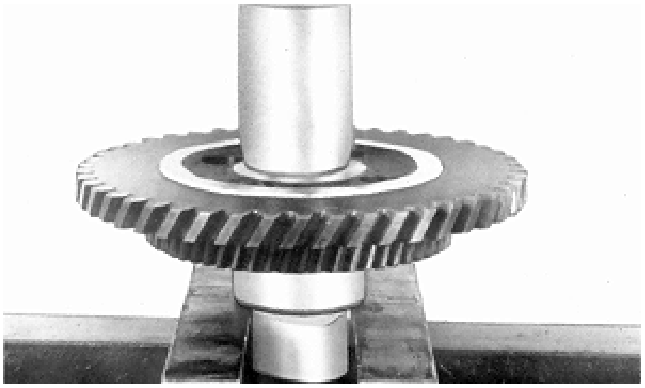
A—Thrust Plate
B—Spacer
C—Woodruff Key
D—Keyway



R26152 -UN-09FEB90

S55,2016,L -19-11APR91

5. Press gear on until tight against spacer.



RG3501 -UN-23FEB89

S11,0401,BO -19-13NOV86

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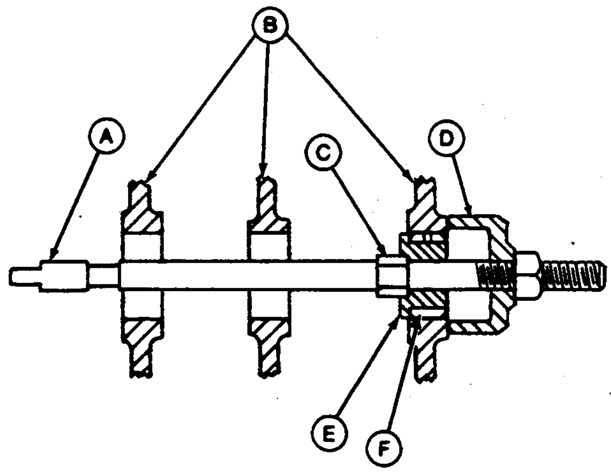
SERVICE CAMSHAFT BUSHINGS USING JDG602 ADAPTER SET



RG5272 -UN-06DEC88

A—Bushing Screw (JDE6-1)
B—Cylinder Block Web
C—Lock Bushing (No. 25916)
D—Receiver Cup (JDG604)
E—Bushing Driver (JDG603)
F—Camshaft Bushing

1. Inspect camshaft journals and bushings for wear or damage. Measure cam journals and bushings to determine if proper oil clearance exists. Replace camshaft and/or bushings as necessary.

CAMSHAFT JOURNAL AND BUSHING NEW PART SPECIFICATION

Camshaft Bushing Bore in Block	69.987—70.013 mm (2.7554—2.7564 in.)
Journal OD	66.987—67.013 mm (2.6373—2.6383 in.)
Bushing ID	67.076—67.102 mm (2.6408—2.6418 in.)
Oil Clearance	0.063—0.115 mm (0.0025—0.0045 in.)
Maximum Clearance	0.152 mm (0.0060 in.)

If camshaft bushing bore in block is not within specification, install a new cylinder block or short block assembly.

NOTE: The front two bushings can be reached from the front of the engine. The flywheel and camshaft bore freeze plug must be removed to reach the other two bushings.

2. Remove camshaft bushings (F) using JDG603 Bushing Driver (E) and JDG604 Receiver Cup (D) along with the components shown from JDE6 Camshaft Bushing Replacement Set (A and C).

3. Tighten nut on end of bushing screw until bushing is free from bore. Inspect and measure camshaft bushing bore in block (B). Follow same procedure for remaining bushings to be replaced.

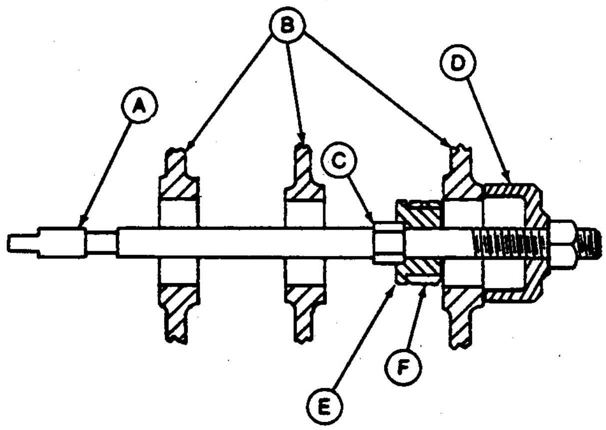
S55,2016,M -19-29AUG91

IMPORTANT: Oil holes in bushings and cylinder block must be aligned after installation or oil starvation will occur. The elongated hole in bushing must be toward the top. After installation, use a small mirror with extension to be sure oil holes are properly aligned.

4. Slide a new camshaft bushing (F) onto JDG603 Bushing Driver (E). Assemble driver and JDG604 Receiver Cup (D) along with components shown from JDE6 Camshaft Bushing Replacement Set (A and C).

5. Be sure bushing is started square in bore and oil holes are aligned with holes in block. Tighten nut to pull bushing in until it is properly positioned in bore.

6. Check bushing-to-cylinder block oil hole alignment using a small mirror with extension.



A—Bushing Screw (JDE6-1)
B—Cylinder Block Web
C—Lock Bushing (No. 25916)
D—Receiver Cup (JDG604)
E—Bushing Driver (JDG603)
F—Camshaft Bushing

S55,2016,N -19-23SEP91

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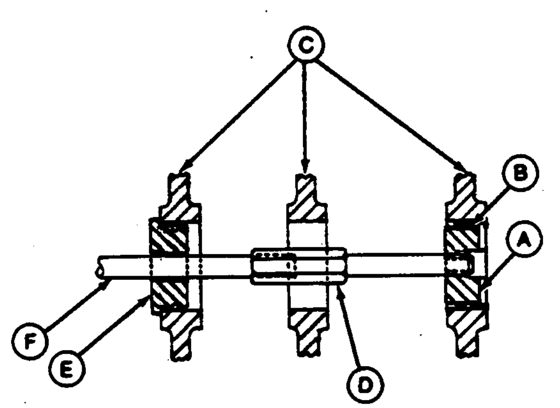
21

SERVICE CAMSHAFT BUSHINGS USING JDG606 ADAPTER SET



A—Bushing Driver (JDG607)
B—Camshaft Bushing
C—Cylinder Block Web
D—Slide Hammer Adapter (JDG408)
E—Bushing Pilot (JDG608)
F—Slide Hammer (D01299AA)

1. Inspect camshaft journals and bushings for wear or damage. Measure cam journals and bushings to determine if proper oil clearance exists. Replace camshaft and/or bushings as necessary.

CAMSHAFT JOURNAL AND BUSHING NEW PART SPECIFICATIONS

Camshaft Bushing Bore in Block	69.987—70.013 mm (2.7554—2.7564 in.)
Journal OD	66.987—67.013 mm (2.6373—2.6383 in.)
Bushing ID	67.076—67.102 mm (2.6408—2.6418 in.)
Oil Clearance	0.063—0.115 mm (0.0025—0.0045 in.)
Maximum Clearance	0.152 mm (0.0060 in.)

If camshaft bushing bore in block is not within specification, install a new cylinder block or short block assembly.

NOTE: The front two bushings can be reached from the front of the engine. The flywheel and camshaft bore freeze plug must be removed to reach the other two bushings.

Lubricate O-ring on JDG608 Bushing Pilot with clean engine oil before installing in cylinder block web (C).

2. Remove camshaft bushing (B) using JDG607 Bushing Driver (A), JDG408 Slide Hammer Adapter (D, from JDG405 Camshaft Bushing Service Set), JDG608 Bushing Pilot (E), and D01299AA Slide Hammer (F).

NOTE: End bushing at front and rear of cylinder block may be removed with just JDG607 Bushing Driver and D01299AA Slide Hammer.

3. Inspect and measure each camshaft bushing bore in block as bushings are removed.

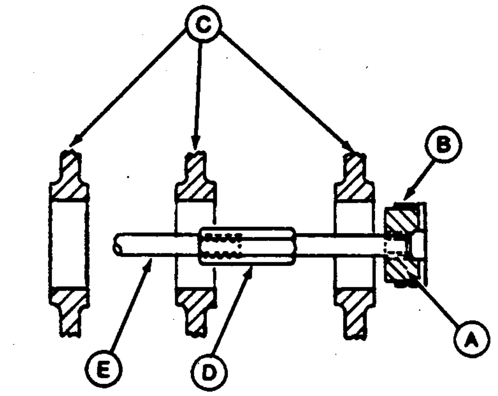
IMPORTANT: Oil holes in bushings and cylinder block must be aligned after installation. The elongated hole in bushing must be toward top. After installation, use a small mirror with extension to be sure oil holes are properly aligned.

4. Slide a new camshaft bushing (B) onto JDG607 Bushing Driver (A). With JDG608 Bushing Pilot installed in outside cylinder block web (C), assemble D01299AA Slide Hammer (E) and JDG408 Slide Hammer Adapter (D) with bushing driver as shown.

5. Be sure bushing is started square in bore and oil holes are aligned with holes in block. Pull bushing into bore with slide hammer until properly positioned.

6. Check bushing-to-cylinder block alignment using a small mirror with extension.

7. Apply sealant to new camshaft bore freeze plug and install plug in bore. Plug edge must be seated below edge of bore.



RG5333 -UN-06DEC88

A—Bushing Driver (JDG607)
B—Camshaft Bushing
C—Cylinder Block Web
D—Slide Hammer Adapter (JDG408)
E—Slide Hammer (D01299AA)

S55,2016,P -19-23SEP91

INSTALL CAMSHAFT

IMPORTANT: Lock engine at TDC of No. 1 piston's compression stroke before installing camshaft.

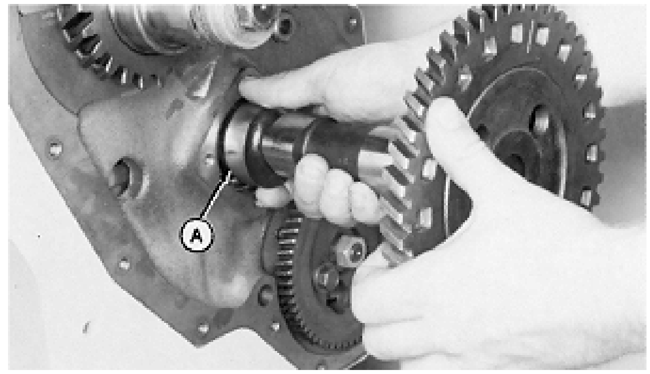
1. If camshaft followers were removed with engine on a rollover stand, reinstall followers but do not obstruct camshaft bore. Roll engine to an angle where followers fall away from camshaft bores.

NOTE: If D15001NU Magnetic Holding Tool Set is used, hold camshaft followers away from camshaft bore until camshaft is installed.

2. Coat camshaft lobes and bearings with TY6333 or TY6347 High Temperature Grease.

S55,2016,Q -19-11APR91

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

S55,2016,R -19-11APR91

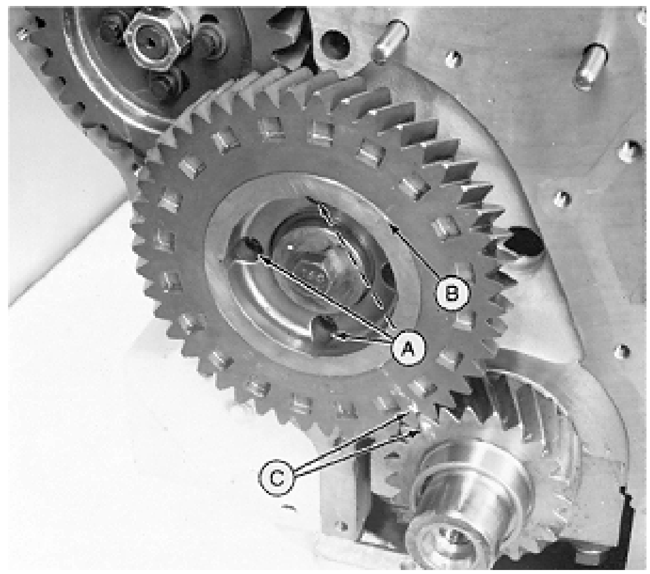
4. With No. 1 piston on “TDC” compression, align timing marks (C) on camshaft and crankshaft gears.

5. Turn camshaft gear to align thrust plate holes with cylinder block holes.

6. Apply LOCTITE 242 to threads of three thrust plate cap screws (A) and tighten to 17 N·m (13 lb-ft).

7. Install special washer and tighten camshaft gear cap screw to 203 N·m (150 lb-ft).

NOTE: Make sure location mark (B) on camshaft gear and hub are aligned properly.



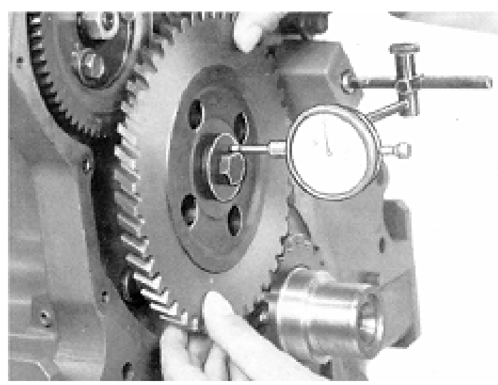
RG5330 -UN-06DEC88

S55,2016,S -19-11APR91

16
24

8. Check camshaft for 0.0634—0.2413 mm (0.0025—0.0095 in.) end play.

If end play is not within specification, check thrust plate and spacer thickness. Replace thrust plate and/or spacer, if necessary. (See MEASURE THRUST PLATE AND SPACER, earlier in this group.)



RG3498 -UN-23FEB89

S11,2005,DD -19-29AUG91

REPLACE AUXILIARY DRIVE GEAR BEARINGS

1. If necessary to replace auxiliary drive gear bearings (B), disassemble auxiliary drive assembly using a press. Remove bearing cones (C) from housing (D) and remove snap ring (F).

2. Install new snap ring from bearing set into auxiliary drive gear housing. Align open ends (gap) of snap ring with lube oil hole in top of housing.

IMPORTANT: Be sure that the oil hole in housing is in the upward position to assure proper lubrication of bearings in the auxiliary drive gear.

3. Install one bearing cup (small bore first) into one end of housing. Drive cup tight against snap ring.

4. While supporting outer end (large bore) of the first cup, install the second cup (small bore first) into other side of housing. Drive cup tight against other side of snap ring.

5. Install bearing cone onto shaft (G).

6. Position housing over shaft with large opening toward shouldered end of shaft.

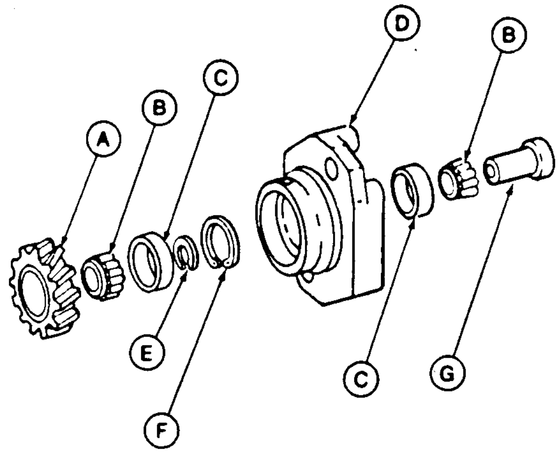
7. Install spacer ring (E) (from bearing set) on shaft tight against cone.

8. While supporting shouldered end of shaft, install second bearing tight against spacer ring.

9. Lubricate bearings with engine oil and rotate shaft several revolutions.

IMPORTANT: Make sure shaft spins freely in bearings before proceeding with next step. If shaft does not spin freely, recheck installation.

10. Support end of shaft and install gear (A) on shaft. Drive gear tight against cone. Check gear for free and smooth rotation.



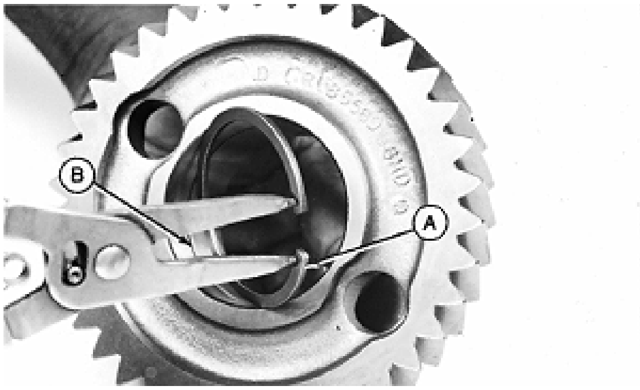
RG5727 -UN-22APR91

A—Drive Gear
B—Bearing Cone (2 Used)
C—Bearing Cup (2 Used)
D—Housing
E—Spacer Ring
F—Snap Ring
G—Shaft

16
25

RG,CTM6,G16,14 -19-11APR91

REPLACE AUXILIARY DRIVE IDLER GEAR BEARINGS



RG5966 -UN-10SEP91

1. Remove auxiliary drive idler gear from engine as detailed earlier in this group.

2. To disassemble idler gear, drive bearing cups out of each end of bearing bore. Discard old bearing cups.

3. Remove snap ring (A) from retainer groove (B) in bearing bore.

4. Thoroughly clean gear with solvent and dry with compressed air.

5. Inspect gear teeth and bearing bore for nicks and burrs. Replace gear as necessary.

6. To assemble idler gear, install snap ring in retainer groove of idler gear bearing bore. Be sure snap ring is firmly seated.

RG,CTM6,G16,18 -19-30AUG91

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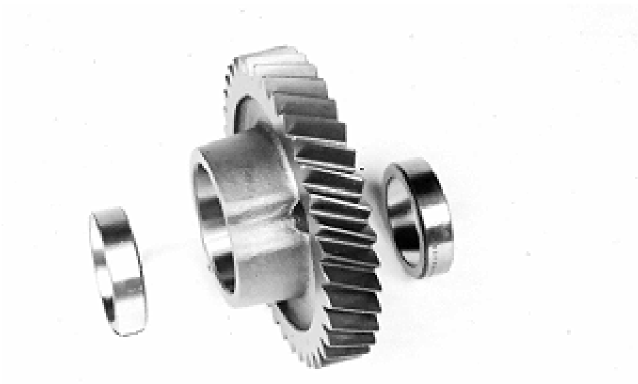


RG5967 -UN-10SEP91

7. Supprot gear on a flat surface and press a new bearing cup in each end of bearing bore until flat end of cup seats against snap ring. Tapered end of cup must face out when correctly installed to accept bearing cone.

8. Clean bearing surface of any debris with a clean cloth.

RG,CTM6,G16,19 -19-30AUG91

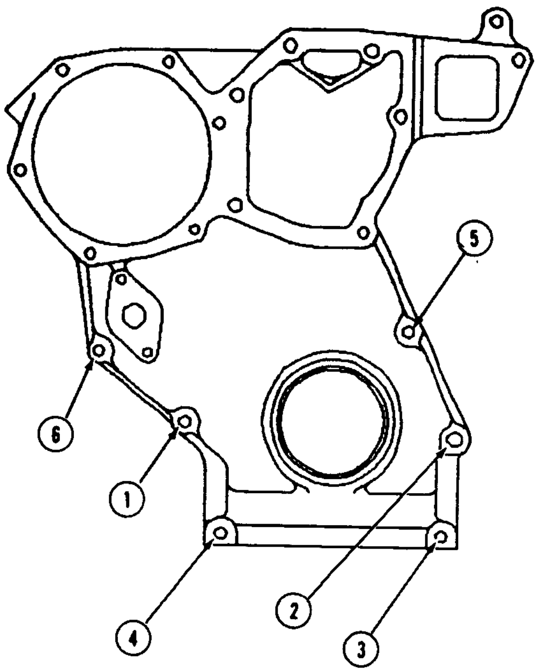
INSTALL TIMING GEAR COVER—NON-AUXILIARY DRIVE ENGINES

NOTE: Lubricate ID of front oil seal with clean engine oil before installing timing gear cover. Be careful not to roll oil seal lip during installation.

IMPORTANT: Tightening the timing gear cover in numerical sequence controls the total runout for the crankshaft oil seal.

1. Using new gaskets, install timing gear cover (A) and injection pump gear cover (B). Tighten cap screws in sequence one thru six to 27 N·m (20 lb-ft).

2. Trim timing gear cover gasket flush with oil pan gasket rail.



RG5725 -UN-22APR91

RG,CTM6,G16,10 -19-29AUG91

16
27

INSTALL TIMING GEAR COVER AND AUXILIARY DRIVE IDLER GEAR—AUXILIARY DRIVE ENGINES

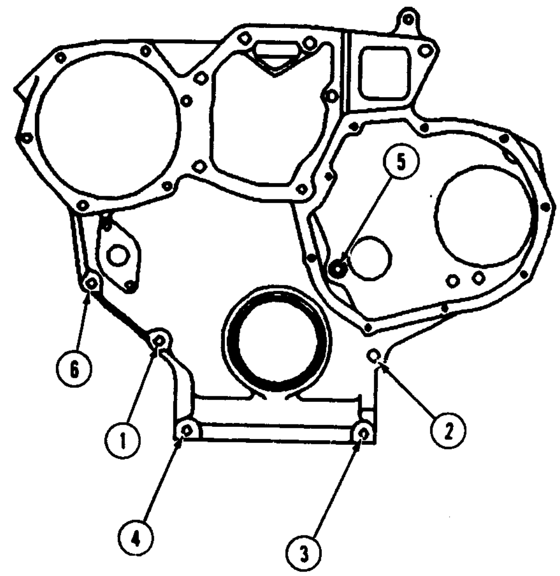
NOTE: Lubricate ID of crankshaft front oil seal with clean engine oil before installing timing gear cover. Be careful not to roll oil seal lip over during installation of timing gear cover.

IMPORTANT: Tightening the timing gear cover in sequence, controls the total runout for the front crankshaft oil seal.

1. Using a new gasket that is lightly greased to hold it in place on engine block, install timing gear cover. Tighten cap screws in sequence one thru six to 27 N·m (20 lb-ft).

NOTE: Cap screw No. 5 will be the flat head cap screw inside timing gear cover that requires LOCTITE 242.

2. Trim timing gear cover gasket flush with oil pan gasket rail.

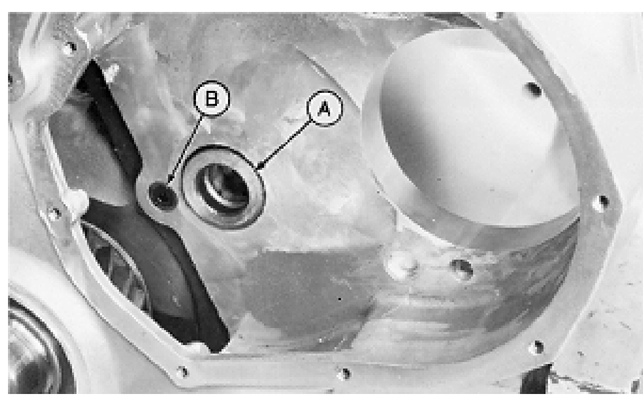


RG5726 -UN-22APR91

RG,CTM6,G16,9 -19-11APR91

3. Set spacer into hole (A) in timing gear cover bore, using a heavy grease to hold in place.

NOTE: Make sure flat head screw (B) is installed before installing auxiliary drive idler gear. Apply LOCTITE 242 and tighten screw to 27 N·m (20 lb-ft), if not previously done.



RG5328 -UN-14DEC88

RG,CTM6,G16,11 -19-11APR91

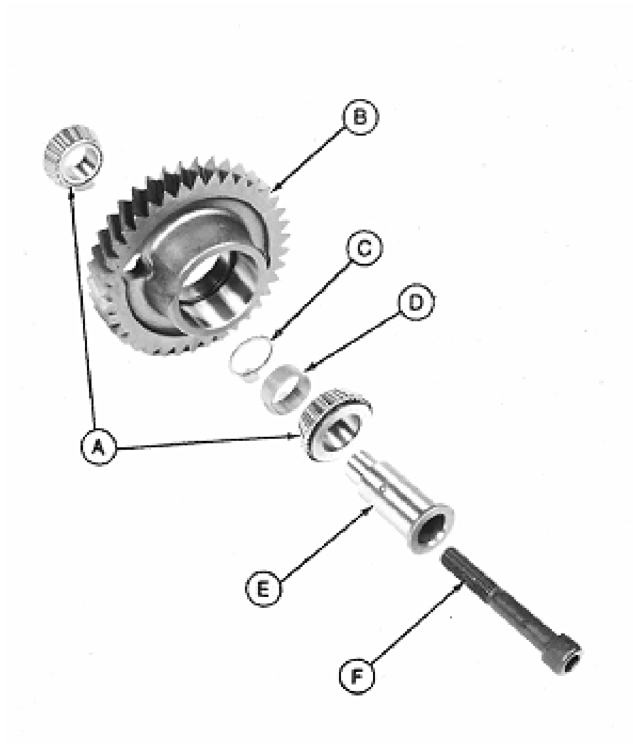
IMPORTANT: Whenever the auxiliary drive gear retaining screw (F) is loosened for removal, the spacer (D) MUST BE replaced due to the amount of crush during initial assembly.

Apply LOCTITE 242 to threads of mounting cap screw before installation.

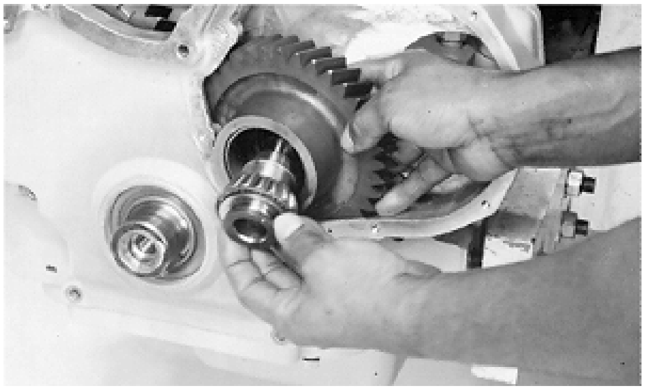
4. Install one bearing (A), snap ring (C), spacer, and shaft (E) into long side of gear (B). Install other bearing into short side of gear.

5. While holding bearing on back (short) side of gear, install gear with bearings and shaft into bore of spacer.

NOTE: Shaft will not slip easily into bore of spacer in timing gear cover, draw shaft in with tightening force of cap screw.



RG5708 -UN-01APR91



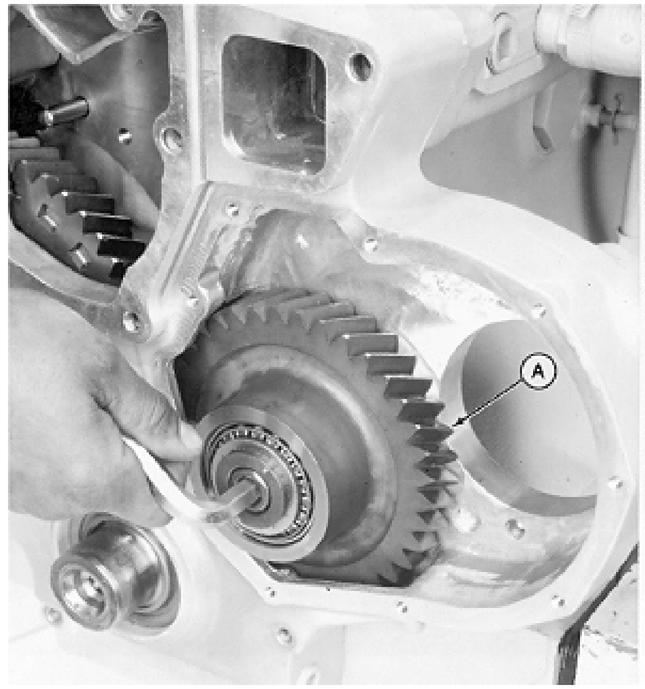
RG5327 -UN-14DEC88

A—Bearing (2 Used)
B—Gear
C—Snap Ring
D—Spacer
E—Shaft
F—Retaining Screw

RG,CTM6,G15,2 -19-28AUG91

6. Be sure auxiliary drive idler gear (A) is properly meshed with crankshaft gear.

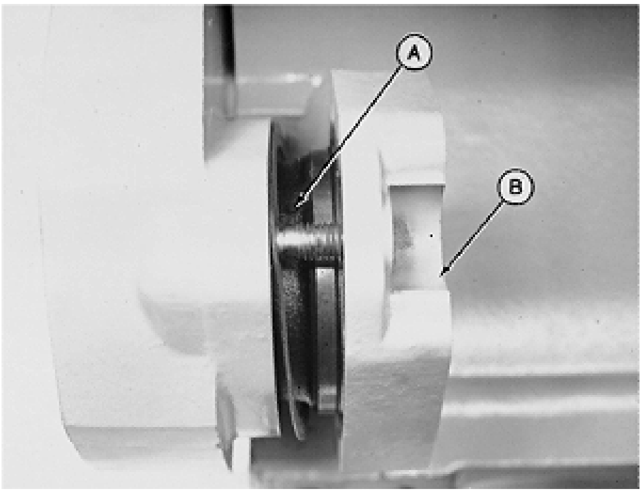
7. Install cap screw into bore of shaft and tighten to 203 N·m (150 lb-ft).



RG5326 -UN-14DEC88

RG,CTM6,G16,12 -19-11APR91

INSTALL REAR AUXILIARY DRIVE GEAR



RG5709 -UN-01APR91

IMPORTANT: The open ends (gap) of the snap ring installed in the rear auxiliary drive gear housing MUST align with the oil hole in the housing (A). Be sure that the oil hole in housing is in the upward position to assure proper lubrication of bearings in the auxiliary drive gear.

1. Using a new gasket, install auxiliary drive gear and housing assembly (B) onto mounting studs at rear of timing gear cover. Make sure that auxiliary drive gear and idler gear are properly meshed.

2. Install nuts on mounting studs and tighten to 102 N·m (75 lb-ft).

3. Install front auxiliary drive idler gear cover plate onto timing gear cover using a new gasket and tighten cap screws to 14 N·m (10 lb-ft).

4. Install injection pump gear cover and tighten cap screws to 27 N·m (20 lb-ft).

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31

RG,CTM6,G15,3 -19-28AUG91

COMPLETE FINAL ASSEMBLY

1. Using a new gasket, install magnetic pickup assembly and tighten securely (if equipped).

2. Install water pump as outlined in Group 25, Cooling System.

3. Install vibration damper and pulley assembly as outlined in Group 15, Crankshaft, Main Bearings and Flywheel.

4. Install cylinder, valve train, and rocker arm assembly. Make all necessary adjustments as outlined in Group 05, Cylinder Head and Valves.

5. Perform engine break-in as required. (See PERFORM ENGINE BREAK-IN, Group 05.)

S55,2016,T -19-11APR91

GROUP 20—LUBRICATION SYSTEM SPECIFICATIONS

ITEM	NEW PART SPECIFICATION
Engine Oil Pressure @ 1900 RPM	280—380 kPa (2.8—3.8 bar) (40—55 psi)
Oil Filter Bypass Valve Operating Pressure	210 kPa (2.1 bar) (30 psi)
Oil Pressure Regulating Valve Spring:	
Compressed Length	48.5 mm @ 133—147 N (1.91 in. @ 30—33 lb-force)
Free Length	66.0 mm (2.60 in.)
Oil Filter Bypass Valve Spring:	
Compressed Length	35.0 mm @ 80—98 N (1.38 in. @ 18—22 lb-force)
Free Length	51.5 mm (2.03 in.)
Oil Cooler Bypass Valve Spring:	
Compressed Length	30.0 mm @ 64—78 N (1.18 in. @ 14—18 lb-force)
Free Length	44.0 mm (1.73 in.)
Oil Pump:	
Drive Gear-to-Crankshaft Gear Minimum Backlash	0.08 mm (0.003 in.)
Pump Gear Backlash	0.33—2.00 mm (0.013—0.079 in.)
Drive Shaft Maximum End Play	0.15 mm (0.006 in.)
Drive Shaft Maximum Side Movement	0.17 mm (0.0065 in.)

TORQUES

Oil Cooler Cover-to-Cylinder Block	27 N·m (20 lb-ft)
Oil Filter Housing-to-Cylinder Block	47 N·m (35 lb-ft)
Oil Pump:	
Drive Gear-to-Drive Shaft Nut	54 N·m (40 lb-ft)
Cover-to-Housing Cap Screws	41 N·m (30 lb-ft)
Intake Screen-to-Elbow Cap Screws	24 N·m (18 lb-ft)
Housing-to-Cylinder Block	47 N·m (35 lb-ft)
Set Screw-to-Cover	8 N·m (6 lb-ft)
Locknut-to-Set Screw	8 N·m (6 lb-ft)
Intake Elbow-to-Pump Cover	41 N·m (30 lb-ft)
Oil Bypass Valve Housing-to-Block	75 N·m (55 lb-ft)
Oil Pan:	
3/8 in. Cap Screws	68 N·m (50 lb-ft)
1/2 in. Cap Screws	156 N·m (115 lb-ft)
Drain Plug:	
Aluminum Pans	47 N·m (35 lb-ft)
Cast Iron Pans	80 N·m (60 lb-ft)

**Initially tighten all cap screws to 54 N·m (40 lb-ft), starting at right rear corner of oil pan (facing toward flywheel end) and proceed counterclockwise. Finish tightening cap screws to torque specified above.*

S55,2020,A -19-24SEP91

ENGINE CRANKCASE OIL FILL QUANTITIES

Listed below are crankcase oil fill quantities with filter change for all 6076 Engine applications.

Fill crankcase with quantity of oil shown for your engine application.

• **JOHN DEERE AGRICULTURAL APPLICATIONS**

Machine Model No.	Engine Model	Crankcase Oil Fill Quantity with Filter Change
COMBINES*		
Harvester Works		
9500	6076TH001, TH004,	25.0 L (26.5 qt)
9500	6076HH001	25.0 L (26.5 qt)
9600	6076HH001, TH001	25.0 L (26.5 qt)
9600 Export	6076HH002	25.0 L (26.5 qt)
COTTON PICKERS		
Des Moines		
9960	6076AN001	24.0 L (25.5 qt)
TRACTORS - WATERLOO		
4055	6076TRW06, 08	18.0 L (19.0 qt)
4055 Export	6076TRW08	18.0 L (19.0 qt)
4255	6076TRW01	18.0 L (19.0 qt)
4255 Export	6076TRW03	18.0 L (19.0 qt)
4255 Hi-Crop	6076TRW02	18.0 L (19.0 qt)
4455	6076TRW04	18.0 L (19.0 qt)
4455 Export	6076TRW05	18.0 L (19.0 qt)
4555	6076TRW07	21.0 L (22.0 qt)
4560	6076TRW09	21.0 L (22.0 qt)
4755	6076ARW01, 06	21.0 L (22.0 qt)
4755 Export	6076ARW02	21.0 L (22.0 qt)
4760	6076ARW07	21.0 L (22.0 qt)
4955	6076ARW03, 05	21.0 L (22.0 qt)
4955 Export	6076ARW02, 04	21.0 L (22.0 qt)
4960	6076ARW08, 11	21.0 L (22.0 qt)
8560 4-Wheel Drive	6076HRW01, 02	24.0 L (25.5 qt)
TRACTORS - VENEZUELA		
4255	6076TCZ01	18.0 L (19.0 qt)
4455	6076TCZ02	18.0 L (19.0 qt)
4555	6076TCZ03	21.0 L (22.0 qt)

**Combine Serial Number (—644999)*

RG,CTM6,G20,1 -19-03SEP91

ENGINE CRANKCASE OIL FILL QUANTITIES—CONTINUED

• JOHN DEERE INDUSTRIAL APPLICATIONS

Machine Model No.	Engine Model	Crankcase Oil Fill Quantity with Filter Change
LOADERS, 4-WHEEL DRIVE		
644E	6076TDW01, 02	24.0 L (25.5 qt)
644EH	6076ADW01	24.0 L (25.5 qt)
FORKLIFTS, 4-WHEEL DRIVE		
644ER	6076ADW02	24.0 L (25.5 qt)
SKIDDERS		
740E	6076TDW02	24.0 L (25.5 qt)
748E	6076TDW02	24.0 L (25.5 qt)

• OEM APPLICATIONS

Engine Model	Option Code	Oil Pan Part No.*	Crankcase Oil Fill Quantity with Filter Change
6076TF, AF, HF	1904	R73692	21.0 L (22.0 qt)
	1906	RE18726	24.0 L (25.5 qt)
	1906	RE45439	24.0 L (25.5 qt)
	1916	R94338	26.0 L (27.5 qt)
	1922	R86396	29.0 L (30.5 qt)
	1952	RE45439	21.0 L (22.0 qt)
	1953	R94338	26.0 L (27.5 qt)
	1954	R86396	29.0 L (30.5 qt)

NOTE: Crankcase oil capacity may vary slightly from amount shown. ALWAYS fill crankcase to full mark or within crosshatch pattern on dipstick, whichever is present. DO NOT overfill.

**On cast aluminum oil pans, the part number is embossed on the oil pan. On sheet metal oil pans, the part number listed is the part number listed in the parts catalog.*

RG,CTM6,G20,2 -19-03SEP91

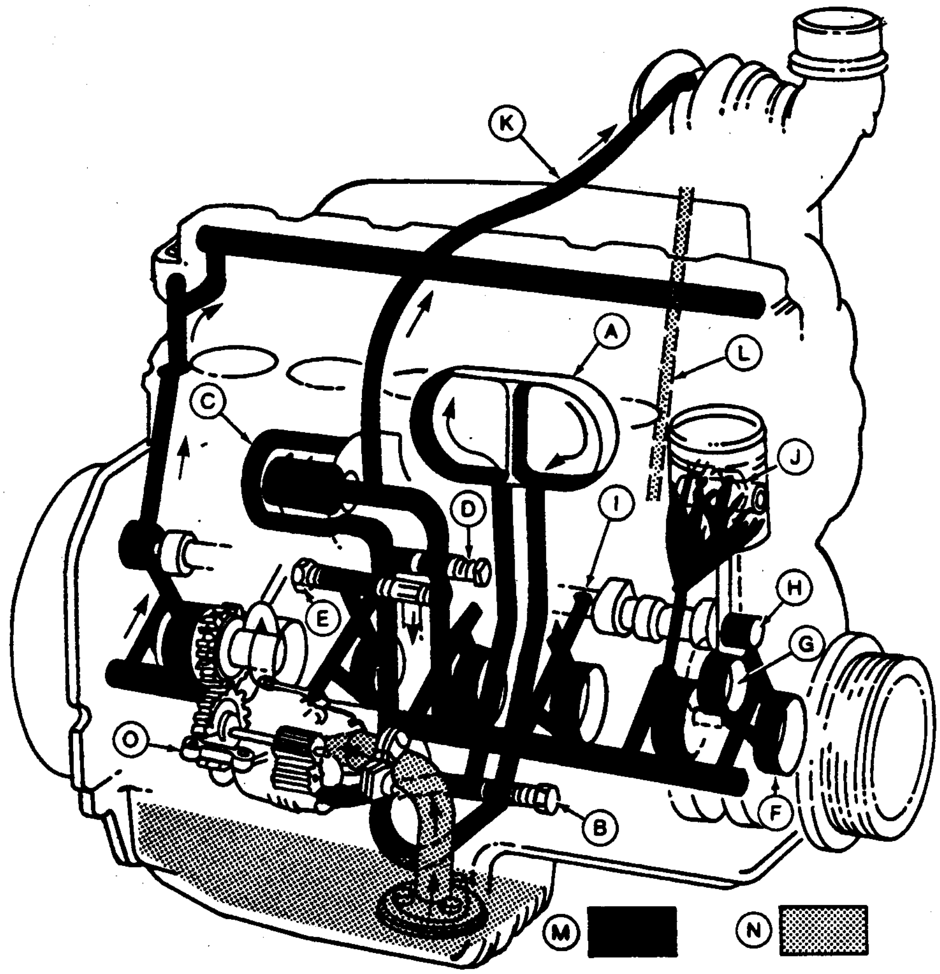
20
3

OTHER MATERIAL

Name	Use
PERMATEX AVIATION (Form-A-Gasket No. 3)	To seal gasket surfaces.
LOCTITE 592	To seal oil pan elbow drain fitting.

S11,2020,EI -19-24MAY91

HOW THE LUBRICATION SYSTEM WORKS



A—Engine Oil Cooler
B—Oil Cooler Bypass Valve
C—Oil Filter
D—Filter Bypass Valve
E—Oil Pressure Regulating Valve
F—Main Bearings
G—Connecting Rod Bearings
H—Camshaft Bushings
I—Piston Cooling Orifices
J—Piston Pin and Bushing
K—Turbocharger Oil Inlet Line
L—Turbocharger Oil Return Tube
M—Engine Oil Pressure
N—Oil Pan Oil
O—Engine Oil Pump

The engine lubrication system consists of a gear-driven (crankshaft), positive displacement pump, oil cooler, oil filter, cooler bypass valve, oil pressure regulating valve and filter bypass valve.

Oil is pumped from the oil pan by the engine oil pump (D) through the engine oil cooler (A), around the oil cooler bypass valve (B), and into the engine oil filter (C). Oil is directed to the top of the oil filter housing and through the oil inlet line (K) to lubricate the turbocharger. Oil is then returned to the oil pan as non-pressurized oil. Passing through the filter, the oil continues around the filter bypass valve (D) and in front of the engine oil pressure regulating valve (E) into the engine oil gallery in the cylinder block. Oil is then distributed, under pressure, to each main bearing (F) and piston cooling orifice (I). Oil from the piston cooling orifices lubricates the piston pin and bushing (J) through a hole in the top of the connecting rod.

During cold weather starting or if the oil cooler is plugged, the oil cooler bypass valve senses pressure on the inlet side of the oil cooler and opens, allowing oil to flow directly to the full-flow oil filter and cylinder block.

S55,22005,D -19-24MAY91

DIAGNOSING 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.

- **High Oil Pressure:**

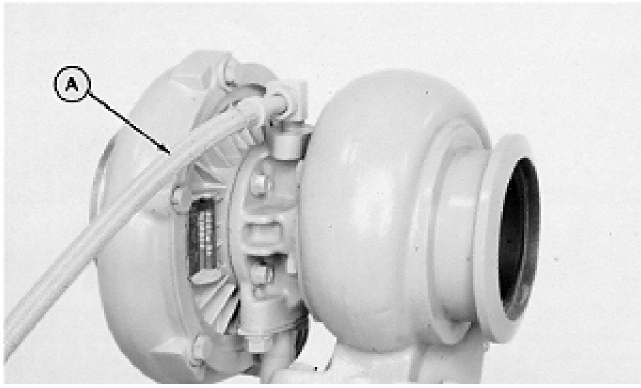
  Improper oil classification.
  Clogged oil lines.
  Oil pressure regulating valve failure.

- **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)

S11,0404,A -19-22AUG91

DISCONNECT TURBOCHARGER OIL INLET LINE



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

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

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

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

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

RG,CTM6,G03,1 -19-22AUG91

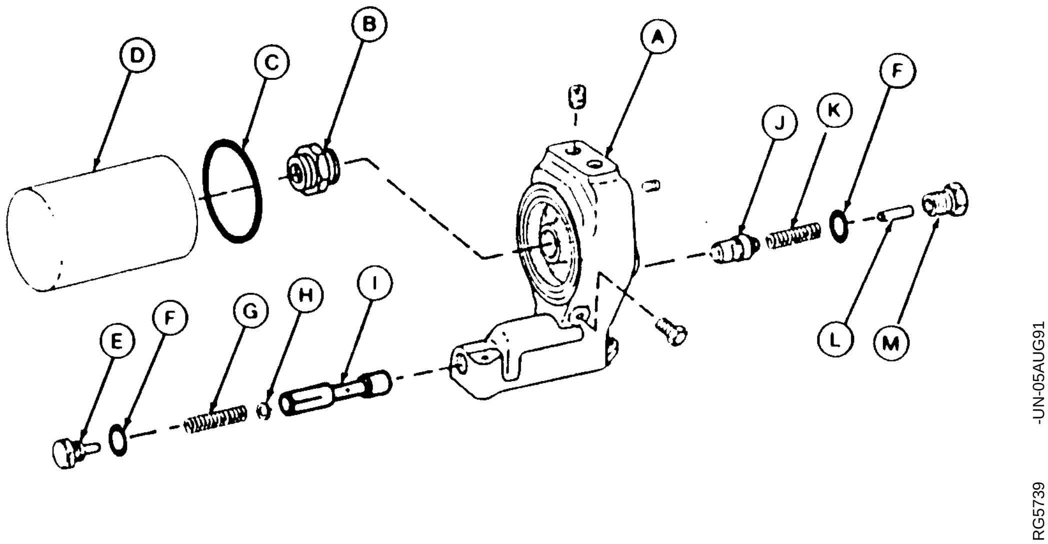
DRAIN ENGINE OIL AND REMOVE OIL PAN

1. Remove drain plug from connector on oil pan and drain oil.

2. Remove oil pan and discard gasket.

S11,0404,C -19-31JUL91

HORIZONTAL OIL FILTER AND HOUSING ASSEMBLY

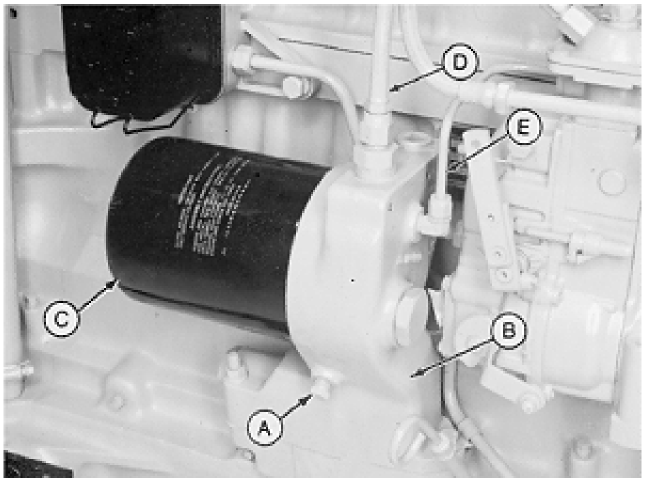


A—Oil Filter Housing
B—Adapter
C—Filter Packing
D—Oil Filter
E—Plug
F—O-Ring (2 Used)
G—Spring
H—Shim (As Required)
I—Oil Pressure Regulating Valve
J—Oil Filter Bypass Valve
K—Spring
L—Spring Pin
M—Plug

Horizontal Oil Filter/Hsg. Ass'y

RG,CTM6,G20,4 -19-21JUN91

REMOVE HORIZONTAL OIL FILTER AND HOUSING ASSEMBLY



RG5262 -UN-29NOV88

1. Remove plug (A), and drain oil from oil filter housing (B).

2. Turn oil filter (C) counterclockwise, and remove filter.

3. Disconnect turbocharger oil inlet line (D).

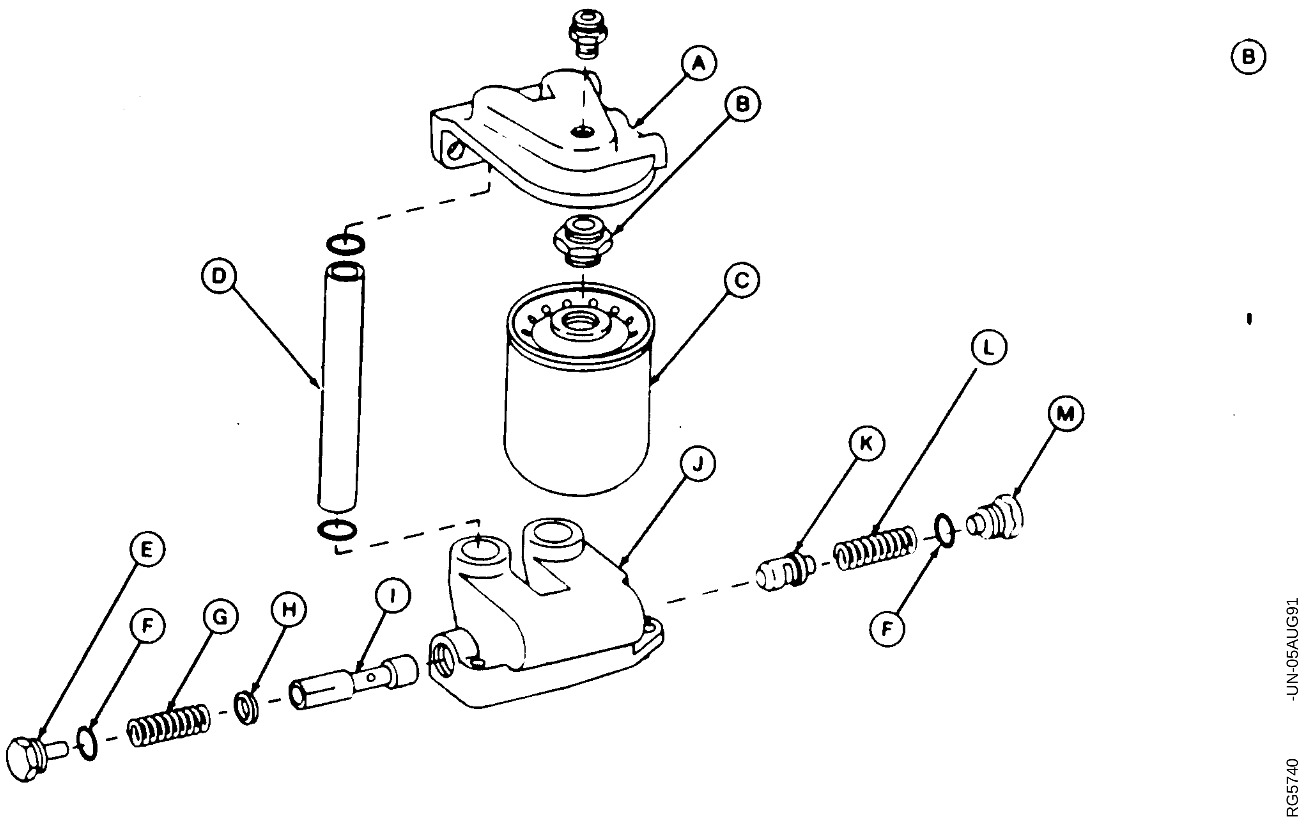
4. Disconnect fuel injection pump oil inlet line (E), if equipped.

5. Remove oil filter housing from cylinder block.

A—Drain Plug
B—Oil Filter Housing
C—Oil Filter
D—Turbocharger Oil Inlet Line
E—Injection Pump Oil Inlet Line

S55,2020,B -19-21JUN91

VERTICAL OIL FILTER AND HOUSING ASSEMBLY

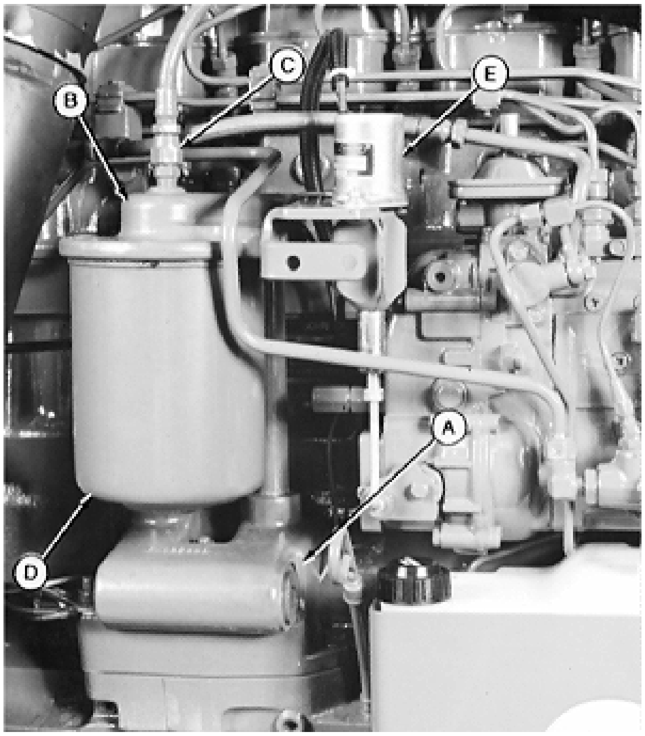


A—Oil Filter Base
B—Adapter
C—Oil Filter
D—Oil Tube (2 used)
E—Plug
F—O-Ring
G—Spring
H—Shim (as required)
I—Oil Pressure Regulating Valve
J—Valve Housing
K—Oil Filter Bypass
L—Spring
M—Plug

Vertical Oil Filter/Hsg. Assembly

RG,CTM6,G20,5 -19-21JUN91

REMOVE VERTICAL OIL FILTER AND HOUSING ASSEMBLIES



1. Turn oil filter (D) counterclockwise and remove filter from filter base.

2. Disconnect turbocharger oil inlet line (C) from oil filter base.

3. Disconnect electrical wiring connector and remove fuel shut-off solenoid and bracket (E) from oil filter base (B). Note location of solenoid ground wire for reassembly.

4. Remove two cap screws securing oil filter base to cylinder block and remove filter base. Remove two oil delivery tubes (not shown) and discard O-rings.

5. Remove valve housing (A) from cylinder block.

A—Valve Housing
B—Oil Filter Base
C—Turbocharger Oil Inlet Line
D—Oil Filter
E—Fuel Shut-off Solenoid

RG,CTM6,G20,6 -19-04SEP91

INSPECT OIL PRESSURE REGULATING VALVE

Oil pressure regulating valve service procedures and specifications are the same for both the vertical and horizontal oil filter engines.

1. Remove plug (A), O-ring (B), shims (C), spring (D) and oil pressure regulating valve (E) from housing (F). Discard O-ring.

2. Count shim(s) for reassembly.

3. Inspect valve and valve bore for damage. Replace if necessary.

4. Check spring for proper compression.

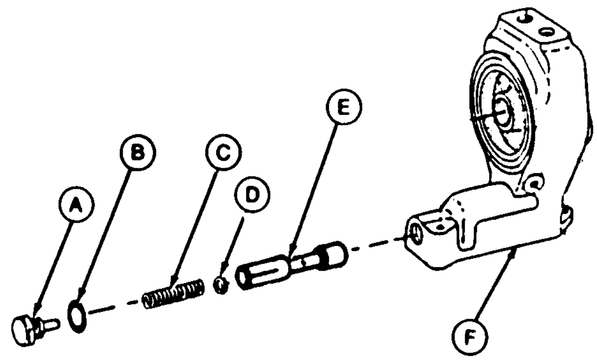
NEW SPRING SPECIFICATION

Working Load at 133—147 N (30—33 lb force) . . . . 48.5 mm (1.91 in.)

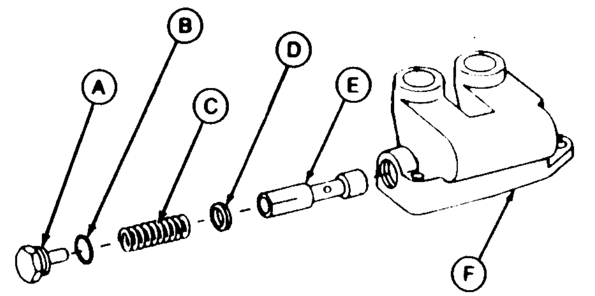
Spring Free Length . . . . 66.0 mm (2.60 in.)

5. Dip all parts in clean engine oil, insert valve and spring in housing.

6. Position shim(s) on plug. Install plug using a new O-ring and tighten securely.



RG5736 -UN-05AUG91

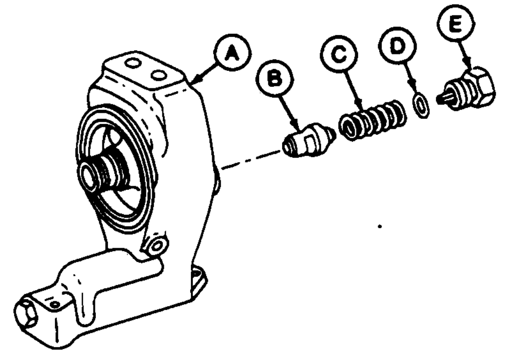


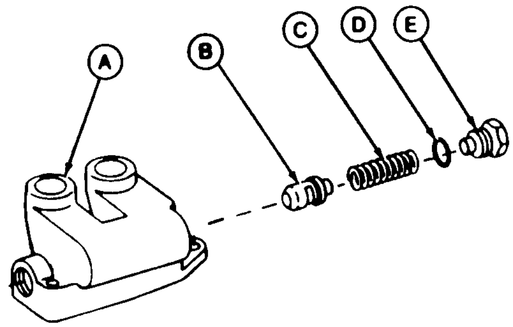
RG5737 -UN-05AUG91

A—Plug
B—O-Ring
C—Spring
D—Shim(s)
E—Oil Pressure Regulating Valve
F—Housing

RG,CTM6,G20,10 -19-21JUN91

INSPECT OIL FILTER BYPASS VALVE





A—Housing
B—Oil Filter Relief Valve
C—Spring
D—O-Ring
E—Plug

Oil filter bypass valve service procedures and specifications are the same for both the vertical and horizontal oil filter engines.

1. Remove plug (E) with O-ring (D), spring (C), and valve (B) from housing (A). Discard O-ring.

2. Inspect valve and housing bore for scoring or damage. Replace if necessary.

3. Check spring for proper compression. Replace if necessary.

NEW SPRING SPECIFICATION

Working Load at 80—98 N (18—22 lb force)	35.0 mm (1.38 in.)
Spring Free Length	51.5 mm (2.03 in.)

4. Dip all parts in clean engine oil, insert valve and spring in housing.

5. Install new O-ring on plug. Install plug and tighten securely.

NOTE: Filter bypass valve operating pressure is 210 kPa (2.10 bar) (30 psi).

RG,CTM6,G20,7 -19-21JUN91

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INSTALL HORIZONTAL OIL FILTER AND HOUSING

IMPORTANT: If oil filter housing is replaced, turbocharger lube oil line must be connected to out-board threaded hole on top of housing. The in-board threaded hole is a casting clean-out hole for manufacturing. Connecting turbo lube line to the in-board hole will route unfiltered oil to the turbocharger.

1. Remove all gasket material from cylinder block and filter base.

2. Install filter housing (B) using a new gasket.

3. Tighten hex nuts and cap screw to 47 N·m (35 lb-ft).

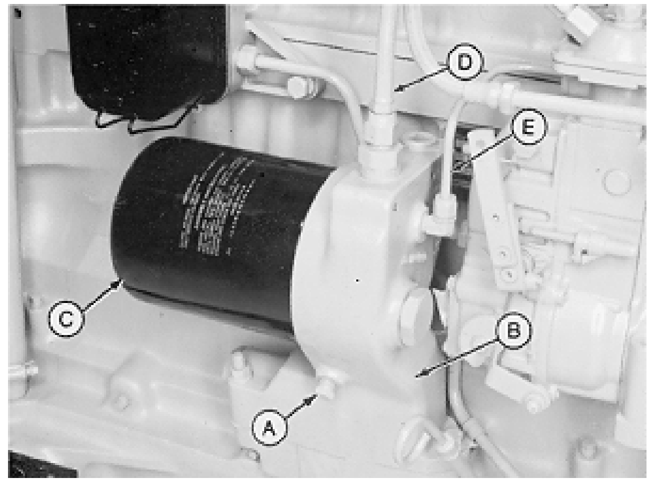
4. Connect turbocharger oil inlet line (D).

5. Connect fuel injection pump oil inlet line (E), if equipped.

6. Spread a layer of clean engine oil on new filter gasket and install oil filter (C).

7. Tighten oil filter an additional 1/2—3/4 turn after gasket contacts filter base. DO NOT overtighten.

8. Apply LOCTITE 242 Thread Lock and Sealant to oil filter drain plug (A). Install plug and tighten securely.



RG5262 -UN-29NOV88

A—Drain Plug
B—Oil Filter Housing
C—Oil Filter
D—Turbocharger Oil Inlet Line
E—Injection Pump Oil Inlet Line

S55,2020,P -19-21JUN91

INSTALL VERTICAL OIL FILTER AND HOUSING ASSEMBLIES

1. Remove all gasket material cylinder block and valve housing.

2. Install valve housing (A) onto cylinder block using a new gasket. Tighten hex nuts and cap screw to 47 N·m (35 lb-ft).

3. Lubricate new O-rings and install two oil delivery tubes (not shown) in valve housing.

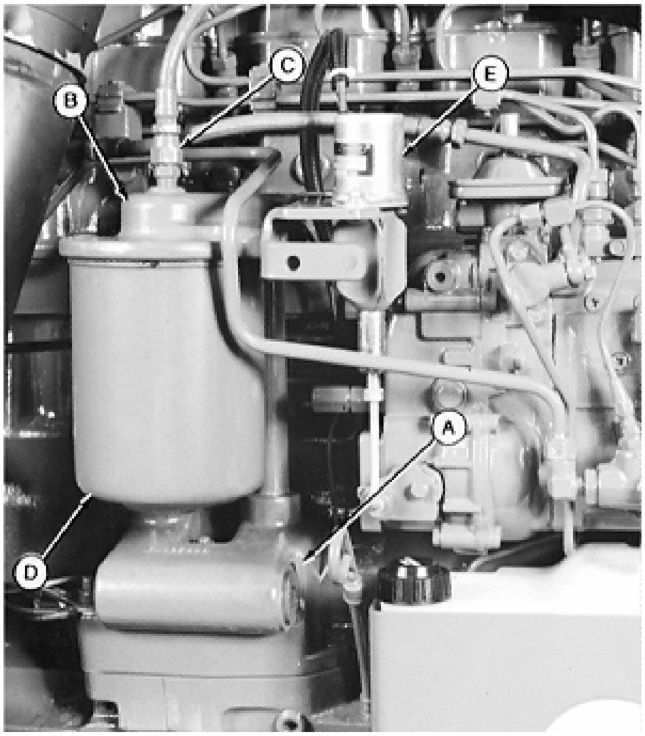
4. Lubricate new O-rings and install oil filter base (B) onto two oil delivery tubes. Position oil filter base on engine block, install cap screws and tighten to 47 N·m (35 lb-ft).

5. Install fuel shut-off solenoid and bracket (E) on oil filter base and tighten securely.

6. Connect turbocharger oil inlet line (C) and tighten securely.

7. Spread a thin layer of clean engine oil on new filter gasket and install oil filter (D).

8. Tighten oil filter until gasket contacts filter base. Tighten an additional 1/2—3/4 turn after gasket contacts base. DO NOT overtighten oil filter.



RG5735 -UN-05AUG91

A—Valve Housing
B—Oil Filter Base
C—Turbocharger Oil Inlet Line
D—Oil Filter
E—Fuel Shut-off Solenoid

RG,CTM6,G20,8 -19-21JUN91

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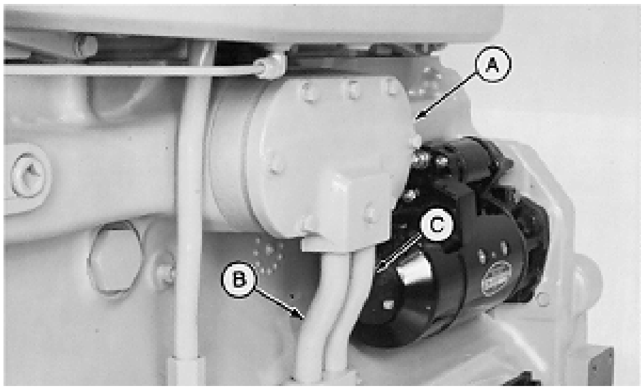
REMOVE ENGINE OIL COOLER

NOTE: 6076 Engines May be equipped with 8-plate or 12-plate engine oil coolers. Removal, inspection, and installation procedures for both oil coolers are similar, differences will be noted. (See CLEAN AND INSTALL ENGINE OIL COOLER, later in this group.)

1. Remove cover (A) and adapter at bottom of inlet and outlet tubes.

2. Remove cover and adapter with outlet (B) and inlet tubes.



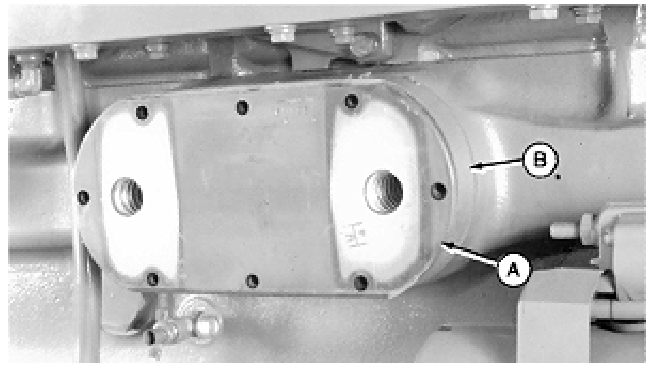
RG5263 -UN-29NOV88

S55,2020,C -19-03SEP91

3. Remove oil cooler (A).

4. On engines equipped with 12-plate oil coolers, remove spacer (B).

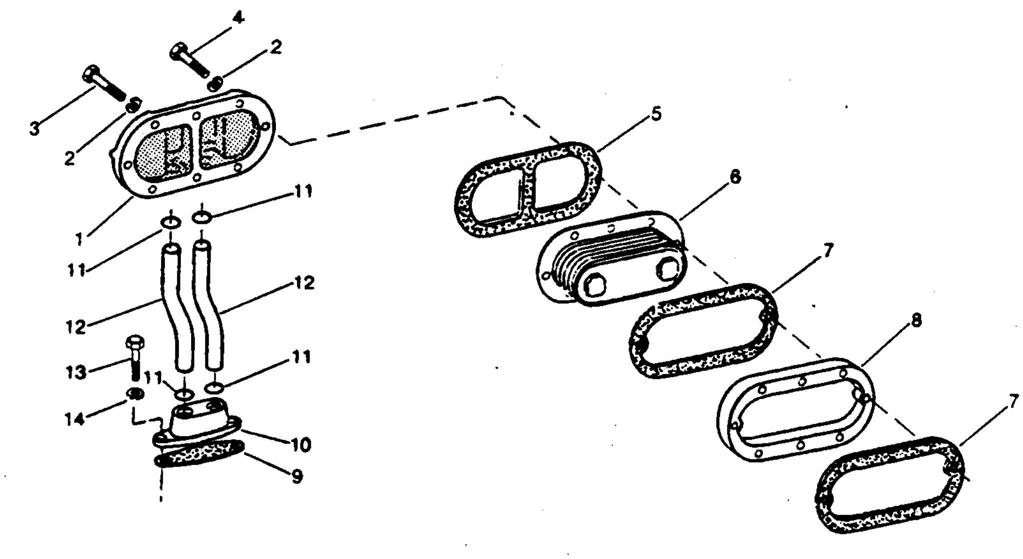
Clean all gasket material from spacer, adapter, cover, and cylinder block. Discard O-rings from tubes.



RG3847 -UN-29NOV88

S55,2020,D -19-24MAY91

CLEAN, INSPECT, AND INSTALL ENGINE OIL COOLER



RG5259 -UN-29NOV88

1—Cover
2—Lock Washer (8 used)
3—Cap Screw
4—Cap Screw (7 used)
5—Gasket
6—Oil Cooler
7—Gasket*
8—Spacer (12-plate oil cooler only)
9—Gasket
10—Adapter
11—O-ring (4 used)
12—Tube (2 used)
13—Cap Screw (2 used)
14—Lock Washer (2 used)

1. Once oil cooler is removed, scrape off all old gasket material.

2. Clean all parts with clean solvent and a brass wire brush. Dry with compressed air.

3. Inspect all parts for serviceability. Replace parts as necessary.

NOTE: If mixing of oil and coolant is suspected, pressure test oil cooler in liquid and compressed air. Use 140—170 kPa (1.4—1.7 bar) (20-25 psi) air pressure for testing. Replace oil cooler as necessary.

4. Install new gasket (9) with oil cooler adapter (10). Tighten cap screws (13) to 47 N·m (35 lb-ft).

5. Install new O-rings (11) on inlet and outlet tubes (12) and insert into adapter. Make certain O-rings are NOT pinched or rolled during assembly.

6. Install oil cooler spacer (8), if equipped, and new gasket(s) (7). Place large side towards cylinder block.

7. Install oil cooler (6).

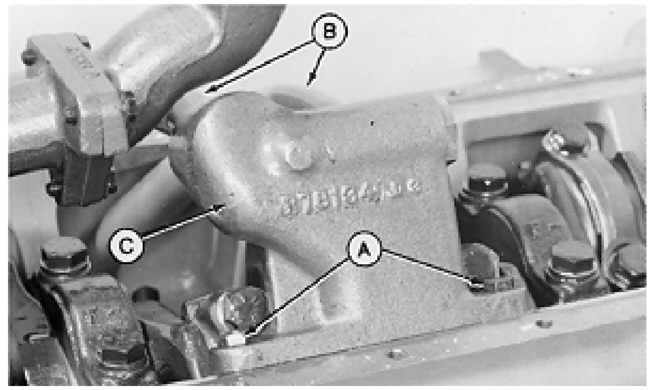
8. Install oil cooler cover (1) with new gasket (5).

9. Tighten cap screws (3 and 4) with washers to 27 N·m (20 lb-ft).

**8-plate oil cooler uses one gasket, 12-plate oil cooler takes two gaskets.*

S55,2020,E -19-21JUN91

REMOVE OIL COOLER BYPASS VALVE HOUSING



1. Roll engine over on roll-over stand until oil pan is in the upright position. Remove oil pan and clean all gasket material from mating surfaces.

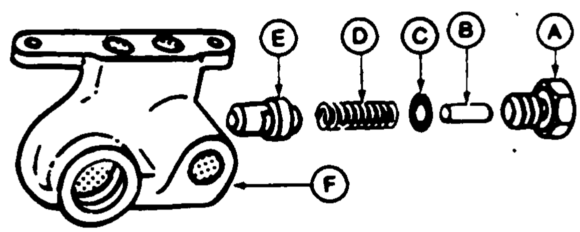
2. Remove both housing mounting cap screws (A).

3. Remove both bypass tubes (B) from housing bores. Discard O-rings.

4. Lift oil cooler bypass valve housing (C) from cylinder block. Remove all gasket material from housing and block.

S55,2020,F -19-21JUN91

REMOVE AND INSPECT OIL COOLER BYPASS VALVE



A—Plug
B—Spring Pin
C—O-ring
D—Spring
E—Bypass Valve
F—Oil Cooler Bypass Valve Housing

NOTE: Oil cooler bypass valve assembly can be removed without removing bypass housing from cylinder block.

1. Remove plug (A), spring pin (B), O-ring (C), spring (D), and bypass valve (E) from oil cooler bypass housing (F).

2. Check housing for clogged passages and all other parts for scale build-up.

3. Clean all parts with a stiff bristle brush and solvent, if necessary. Dry with compressed air.

4. Be sure oil cooler bypass housing tubes are clean.

5. Inspect bypass valve for damage. Replace if necessary.

6. Check bypass valve spring for proper specifications. Replace if not within specifications.

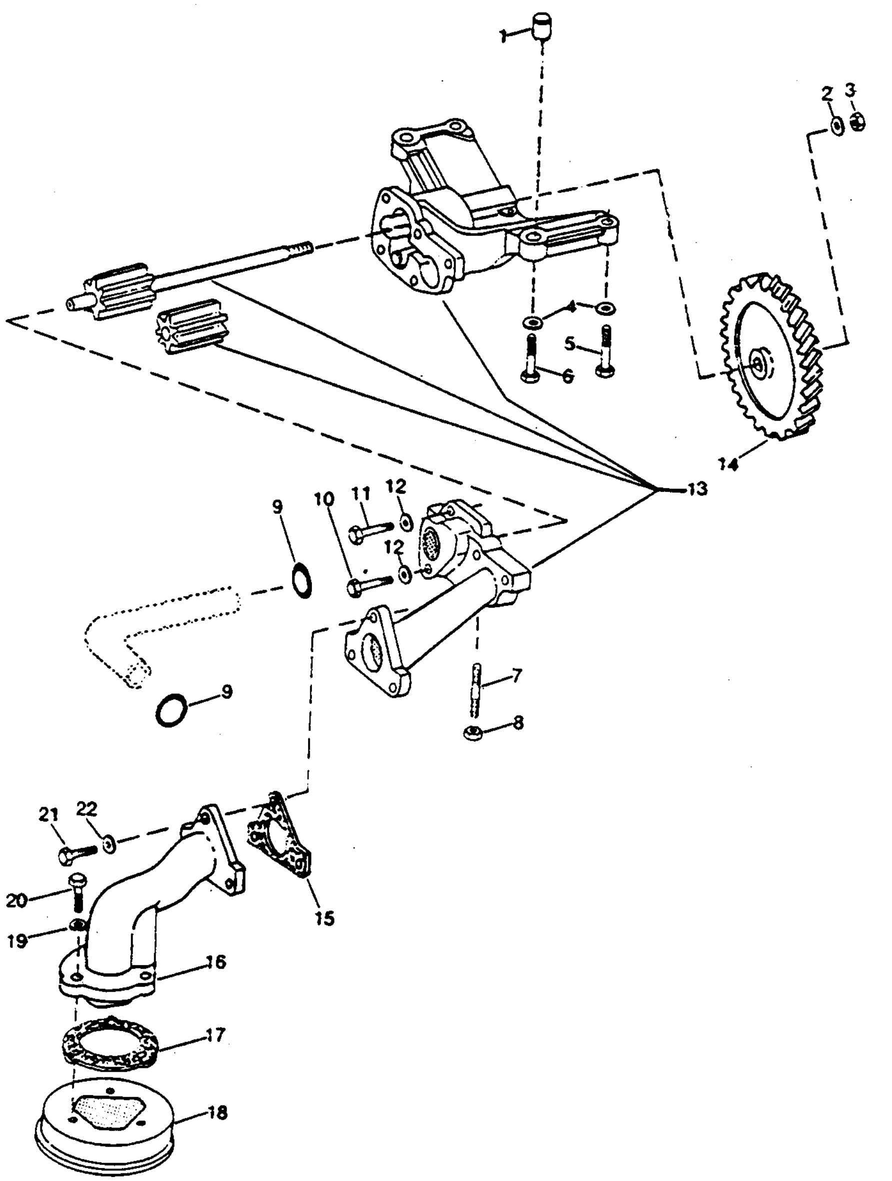
NEW SPRING SPECIFICATION

Working Load at 80—98 N (18-22 lb force) . . . . 35 mm (1.38 in.)

Spring Free Length . . . . 51.5 mm (2.03 in.)

RG,CTM6,G20,9 -19-21JUN91

ENGINE OIL PUMP ASSEMBLY—DEEP SUMP

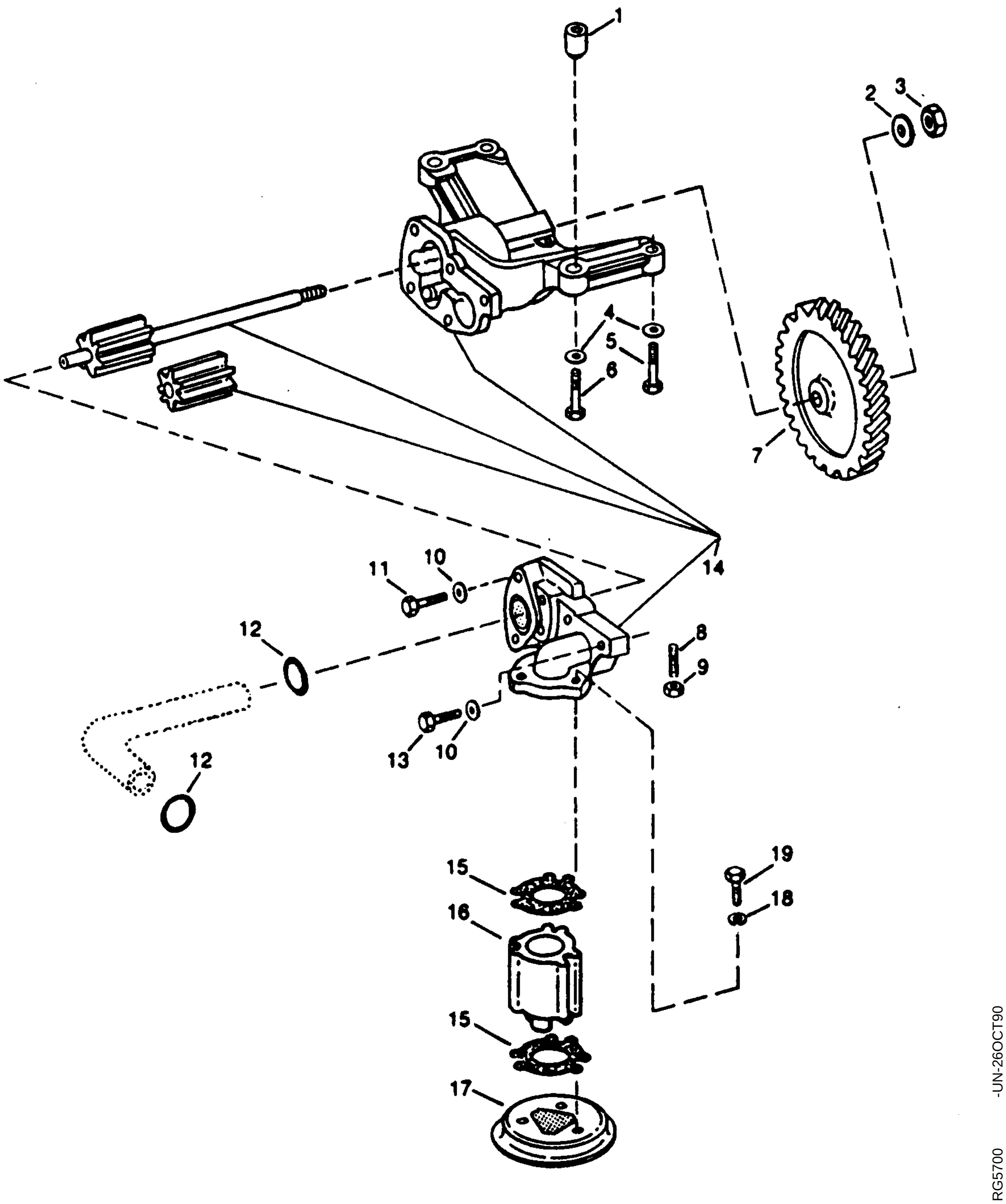


1—Hollow Dowel (2 used)
2—Special Washer
3—Jam Nut
4—Washer (4 used)
5—Cap Screw (2 used)
6—Cap Screw (2 used)
7—Set Screw
8—Lock Nut
9—O-ring (2 used)
10—Cap Screw (2 used)
11—Cap Screw (3 used)
12—Washer (5 used)
13—Oil Pump Assembly
14—Drive Gear
15—Gasket
16—Elbow*
17—Gasket
18—Screen
19—Lock Washer (3 used)
20—Cap Screw (3 used)
21—Cap Screw (3 used)
22—Washer (3 used)

*Used on deep sump oil pan applications only.

S55,2020,H -19-24MAY91

ENGINE OIL PUMP ASSEMBLY—STANDARD SUMP

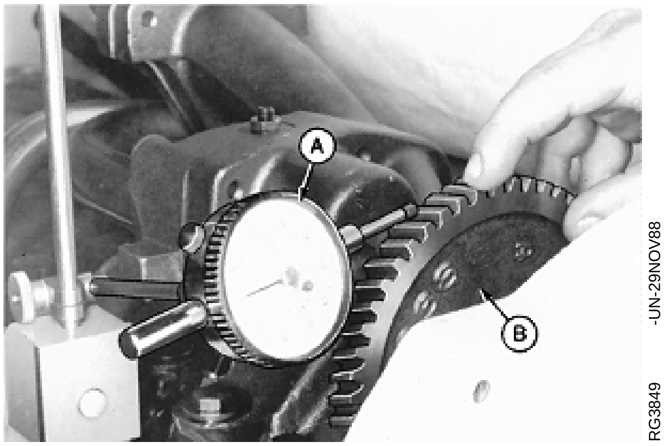


1—Bushing (2 used)
2—Washer
3—Nut
4—Washer (4 used)
5—Cap Screw (2 used)
6—Cap Screw (2 used)
7—Gear
8—Set Screw
9—Nut
10—Washer (5 used)
11—Cap Screw (2 used)
12—O-ring (2 used)
13—Cap Screw (3 used)
14—Oil Pump Assembly
15—Gasket (2 used)
16—Adapter*
17—Oil Pump Intake
18—Lock Washer (3 used)
19—Cap Screw (3 used)

**Used to lower the oil pump intake and improve vehicle off-level capability.*

RG,CTM6,G20,3 -19-24MAY91

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.

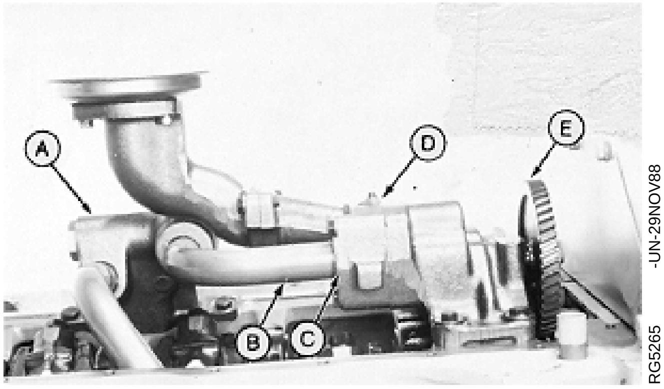
1. Remove gear shield, if equipped. Discard shield if desired.

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.

S11,2020,DH -19-27MAY87

REMOVE ENGINE OIL PUMP



1. Remove oil cooler bypass housing (A) cap screws as outlined earlier in this group.

2. Pull outlet tube (B) from bypass valve housing and pump cover (C).

3. Remove four oil pump housing cap screws.

4. Remove oil pump assembly with drive gear (E) attached.

IMPORTANT: DO NOT alter adjustment of set screw (D). If adjustment has been altered, see Adjust Set Screw, later in this group.

A—Oil Cooler Bypass Housing
B—Outlet Tube
C—Oil Pump Cover
D—Set Screw
E—Drive Gear

S55,2020,I -19-19MAY88

INSPECT AND CLEAN OIL PUMP

1. Visually inspect oil pump for wear or damage.

2. Flush pump assembly internally with clean solvent to remove oil. Spin pump gears to help remove solvent.

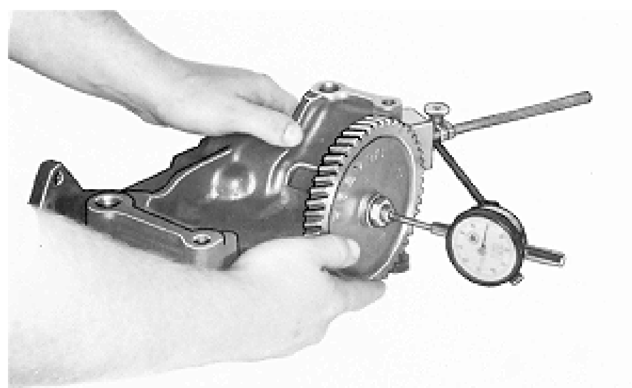
3. Place oil pump on a work bench with pump-to-cylinder block mounting surface facing upward (same as when mounted on engine).

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 -19-10DEC80

CHECK DRIVE SHAFT END PLAY


RG2678 -UN-29NOV88

1. Mount dial indicator with indicator plunger resting against end of pump drive shaft.

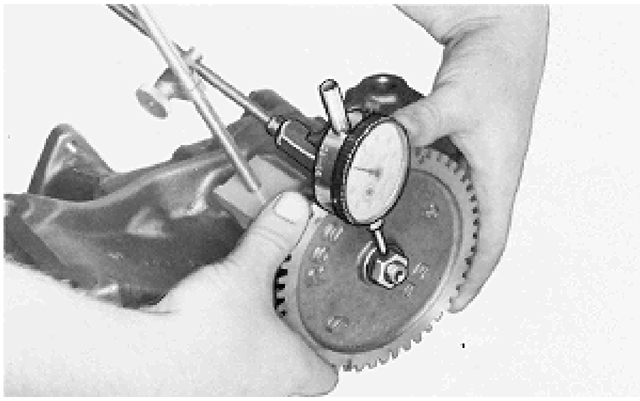
2. Move shaft toward and away from indicator.

If end play exceeds 0.15 mm (0.006 in.), there is excessive wear on pump cover and/or wear on end of pump drive gear.

Replace oil pump if end play exceeds 0.15 mm (0.006 in.).

S11,0404,U -19-21APR82

CHECK DRIVE SHAFT SIDE MOVEMENT



RG2679 -UN-29NOV88

1. Mount dial indicator with indicator plunger resting on one of the hex nut flats.

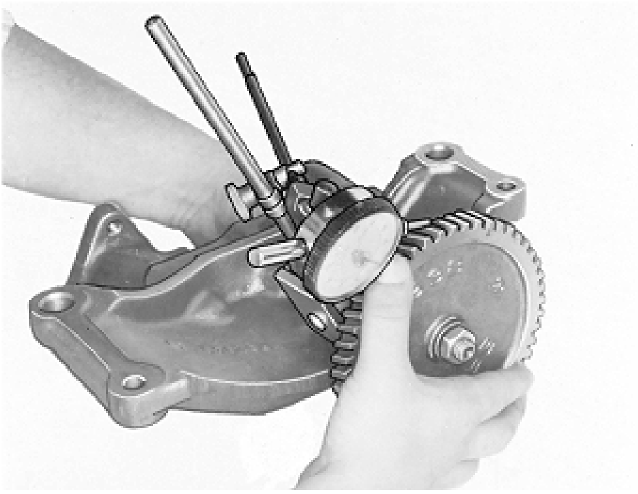
2. Move shaft from side-to-side.

If shaft side movement exceeds 0.17 mm (0.0065 in.), there is excessive wear on drive shaft bushing and/or drive shaft.

Replace oil pump if shaft side movement exceeds 0.17 mm (0.0065 in.).

S11,0404,V -19-17FEB86

CHECK PUMPING GEAR BACKLASH



RG3106 -UN-29NOV88

1. Mount dial indicator with indicator plunger resting against side of gear tooth.

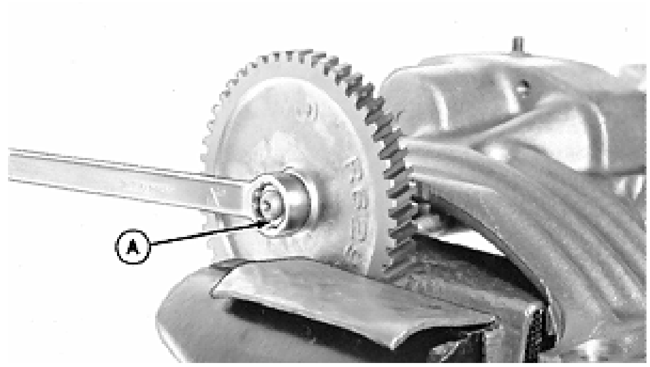
2. Hold idler gear stationary (by reaching through oil discharge hole) and slowly rotate drive gear back and forth until contact with idler gear is felt.

If backlash is not within 0.33—2.00 mm (0.013—0.079 in.) specification, there is excessive pumping gear wear and/or idler shaft and gear bushing wear. If there is less than 0.33 mm (0.013 in.) backlash, reclean gears and check backlash again.

3. Replace oil pump if pumping gear backlash exceeds 2.00 mm (0.079 in.).

S11,0404,W -19-27FEB87

REMOVE AND INSPECT OIL PUMP DRIVE GEAR



RG3507 -UN-29NOV88

1. Place drive gear in a soft-jawed vise.

2. Unscrew nut (A) and special washer from shaft until nut is flush with shaft end.

3. Lightly tap shaft with a soft hammer until gear comes loose from tapered shaft.

4. Remove nut, washer and drive gear.

S55,2020,K -19-24JUL91

RG3508 -UN-29NOV88

5. Inspect drive gear teeth for chips, cracks, or wear.

6. Inspect oil pump drive gear on crankshaft for chips, cracks, or wear.

7. Replace damaged gears as necessary.

8. Install drive gear on oil pump shaft.

9. Secure washer and nut to shaft but do not tighten until oil pump is installed.

S55,2020,L -19-25NOV87

INSTALL OIL COOLER BYPASS VALVE AND HOUSING

1. Lubricate and install valve (A), spring (B), new O-ring (C), spring pin (D), and plug (E) into oil cooler bypass housing (F).

2. Tighten plug securely.

3. Install oil cooler bypass housing with new gasket (G) into cylinder block.

4. Install long end of cooler bypass housing-to-block tube (H) with new O-ring (I) into the housing. Install the other end with new O-ring (I) into block.

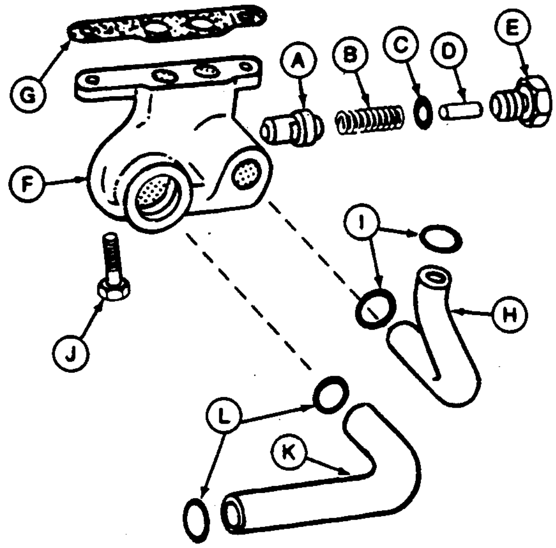
IMPORTANT: Make sure all O-rings are properly installed in grooves to prevent oil pressure leakage.

5. Adjust tube and housing with new gasket (G), so that housing is flat against the block mounting pad. Attach cap screws (J) to block, but do not tighten.

6. Install oil pump-to-bypass housing tube (K) with new O-rings (L) into bypass housing and oil pump cover.

7. Install one O-ring (L) on tube (K) and place tube into gland nut. Install other O-ring (L) into oil pump cover.

8. Tighten oil cooler bypass housing cap screws (J) to 75 N·m (55 lb-ft).

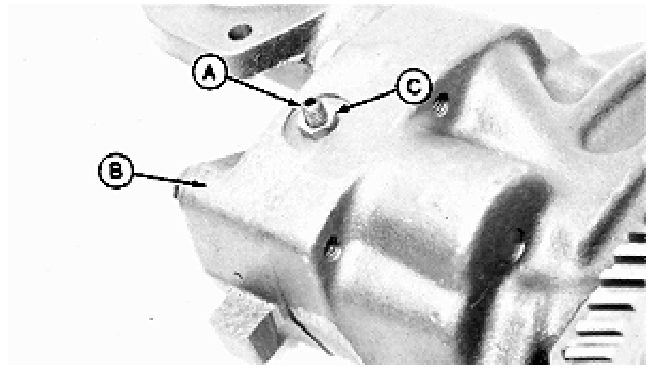


RG5261 -UN-29NOV88

A—Valve
B—Spring
C—O-Ring
D—Spring Pin
E—Plug
F—Oil Bypass Housing
G—Gasket
H—Tube
I—O-Ring (2 used)
J—Cap Screw (2 used)
K—Tube
L—O-Ring (2 used)

S55,2020,J -19-03MAY88

ADJUST OIL PUMP SET SCREW



IMPORTANT: Normally the set screw (A) should NOT need to be adjusted; but if the set screw is altered, the following steps should be followed.

1. Install drive gear and idler gear into oil pump housing.

2. Install oil pump cover (B) onto housing and tighten cover-to-housing cap screws to 41 N·m (30 lb-ft).

3. Loosen lock nut (C) and tighten set screw until it lightly contacts idler gear shaft. Shaft should spin freely with limited axial movement.

4. Hold set screw stationary and tighten lock nut (C) to 8 N·m (6 lb-ft). Do not overtighten set screw or lock nut.

5. Spin drive gear to assure shaft turns freely in housing. Readjust set screw if shaft does not turn freely.

S11,2020,BZ -19-03SEP91

INSTALL ENGINE OIL PUMP

NOTE: Remove oil cooler bypass housing (A) cap screws before installing engine oil pump assembly to ease installation of outlet tube (B) into pump cover (C).

1. Install oil pump assembly over hollow dowel pin in cylinder block. Tighten cap screws to 47 N·m (35 lb-ft).

NOTE: Make sure oil pump drive gear (E) meshes properly with crankshaft gear.

Replace all O-rings. Lightly lubricate new O-rings with clean engine oil before installing.

2. Insert outlet tube into oil pump cover. Be sure not to pinch or dislodge O-ring.

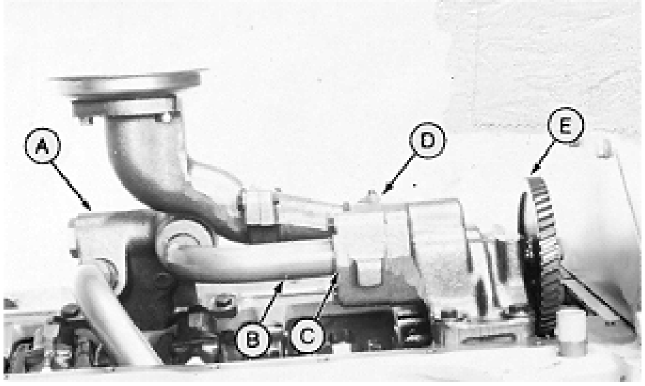
3. Make sure both tubes are properly seated in oil cooler bypass valve housing and tighten cap screws to 75 N·m (55 lb-ft).

4. If removed, attach intake screen to intake elbow (if equipped). Tighten cap screws to 27 N·m (20 lb-ft).

5. If equipped, install elbow and intake screen using a new gasket and tighten cap screws to 41 N·m (30 lb-ft).

NOTE: On engines not equipped with intake elbow, install intake screen directly onto oil pump cover.

6. Tighten oil pump drive gear nut to 54 N·m (40 lb-ft).



RG5265 -UN-29NOV88

A—Oil Cooler Bypass Housing
B—Outlet Tube
C—Oil Pump Cover
D—Set Screw
E—Oil Pump Drive Gear

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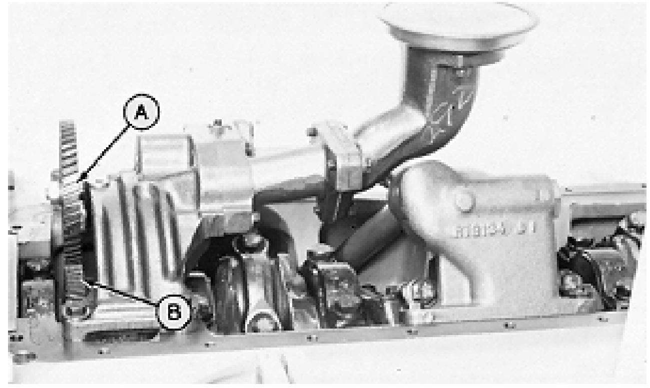
27

S55,2020,M -19-21JUN91

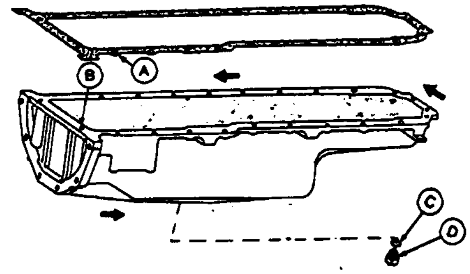
IMPORTANT: Push crankshaft rearward (toward flywheel end). Check clearance between oil pump drive gear face and throw of crankshaft. There should be a clearance of at least 0.38 mm (0.0015 in.). If clearance is below specification, check thrust bearings for proper placement. Gently pry crankshaft forward and check (after oil pump is installed) the oil pump drive gear (A), and crankshaft gear (B) to see that they are properly meshed.



RG5329 -UN-14DEC88

S55,2020,N -19-17MAR88

INSTALL OIL PAN



RG5010 -UN-29NOV88

Before installing oil pan, remove old gasket and sealant material from pan and cylinder block mating surfaces. Guide studs may be used if desired.

1. Apply a thin layer of PERMATEX AVIATION (Form-A-Gasket No. 3) across entire front and rear gasket rail of block. Install gasket onto cylinder block and apply a layer of sealant to gasket across front and rear gasket face. On engines equipped with multi-piece gaskets, also apply sealant to mating joints. Install oil pan.

2. Insert all 3/8 in. and 1/2 in. cap screws in their appropriate hole location.

3. Use a straightedge against oil pan and cylinder block (flywheel end) to be sure oil pan is flush with block flange.

4. Proceeding counterclockwise (bold arrows) from flywheel end (B), tighten all cap screws to 54 N·m (40 lb-ft).

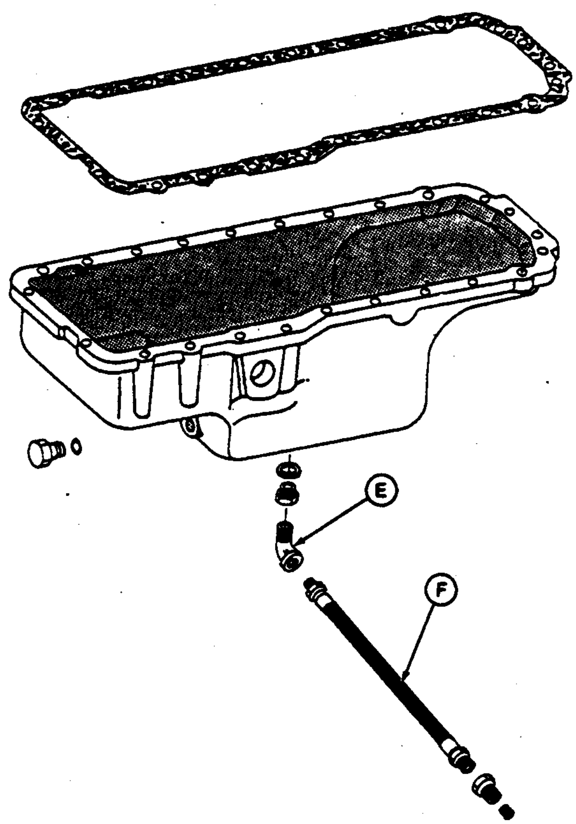
5. Repeat sequence by tightening all 3/8 in. cap screws to 68 N·m (50 lb-ft).

6. Complete sequence by tightening counterclockwise all 1/2 in. cap screws to 156 N·m (115 lb-ft). Check torque on all 3/8 in. cap screws after final torque of 1/2 in. cap screws. Trim gasket flush with rear of pan flange.

7. Bottom oil pan drain plug (D) uses either an aluminum washer or rubber O-ring (C) for sealing. Apply a light coat of engine oil to new rubber O-rings for bottom drain plug. Install aluminum washer on drain plug so raised center contacts head of plug.

Some engine oil pans may be equipped with an elbow fitting (E) and drain hose (F).

8. Install drain plug and tighten to specifications listed below.



RG5267 -UN-29NOV88

A—Oil Pan Gasket
B—Location For First Cap Screw
C—O-Ring or Aluminum Washer
D—Drain Plug
E—Elbow Fitting
F—Drain Hose

OIL PAN DRAIN PLUG TORQUE SPECIFICATIONS

Aluminum Oil Pans	47 N·m (35 lb-ft)
Cast Iron Oil Pans	80 N·m (60 lb-ft)

NOTE: On engine equipped with elbow fittings and drain hose, the threads and sealing surfaces must be free of any oil film to insure an effective seal. Apply a light coat of LOCTITE 592 to fittings except for the leading one to three threads. Tighten fittings securely.

S55,2020,O -19-31JUL91

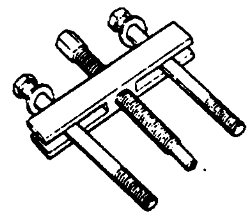
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

Gear Puller D01206AA

Used to remove water pump drive gear from water pump and to remove fan pulley from shaft pressed into water manifold.



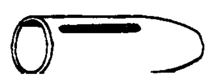
RG5097 -UN-23AUG88

S53,D01206,AA1 -19-17JUN91

RG5171 -UN-23AUG88

Water Pump Insertion Sleeve JDG249

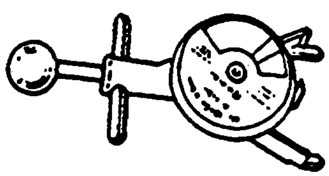
Used to install water pump bearing and shaft assembly into pump housing. Insertion sleeve prevents inversion of oil seal lip in housing during installation.



S53,JDG249 -19-27FEB87

Belt Tension Gauge JDG529

Used to check and adjust fan belt tension.



RG5082 -UN-23AUG88

S53,JDG529 -19-09SEP91

OTHER MATERIALS

Name	Use
JDT350 PERMATEX Form-a-Gasket No. 2	Water pump, thermostat cover and water manifold gaskets.
PT507 Multi-purpose Grease or TY6333 High Temperature Grease	Pack bearings.
LOCTITE 242 Thread Lock & Sealer	Water outlet manifold-to-cylinder head cap screws.
LOCTITE 277 Plastic Gasket (High Strength)	Press-fit mating surfaces of fixed fan drive assembly when parts are reused.

S11,2025,CI -19-04OCT91

25
2

COOLING SYSTEM SPECIFICATIONS

ITEM	NEW PART SPECIFICATION	WEAR TOLERANCE
Water Pump:		
Impeller Bore ID	15.85—15.88 mm (0.624—0.625 in.)	--
Shaft OD Impeller End	15.90—15.93 mm (0.626—0.627 in.)	--
Drive Gear Bore ID	24.92—24.94 mm (0.981—0.982 in.)	--
Shaft OD Drive Gear End	25.00—25.02 mm (0.984—0.985 in.)	--
Drive Gear OD	72.39—72.64 mm (2.850—2.860 in.)	--
Water Manifold Mounted, Fixed Fan Drive:		
Dimension From Manifold Mounting Face-to-End of Shaft in Manifold	33.31—33.47 mm (1.311—1.318 in.)	--
Dimension From Manifold Mounting Face-to-End of Shaft in Pulley	157.69—158.45 mm (6.208—6.238 in.)	--
Fan Pulley Bore ID	47.576—47.612 mm (1.8731—1.8745 in.)	--
Bearing OD Pulley End	47.612—47.625 mm (1.8745—1.8750 in.)	--
Shaft OD Manifold End	25.387—25.400 mm (0.9995—1.0000 in.)	--
Manifold Bore ID	25.336—25.362 mm (0.9975—0.9985 in.)	--
Medium Duty Adjustable Fan Drive:		
Bearing Bore ID in Housing	47.576—47.612 mm (1.8731—1.8745 in.)	--
Fan Hub Bore ID	25.311—25.337 mm (0.9965—0.9975 in.)	--
Bearing OD (housing end)	47.612—47.625 mm (1.8745—1.8750 in.)	--
Bearing Shaft OD (hub end)	25.387—25.400 mm (0.9995—1.0000 in.)	--
Heavy Duty Adjustable Fan Drive:		
Bearing Bore ID in Housing	71.999—72.025 mm (2.8346—2.8356 in.)	--
Shaft OD for Bearings	35.001—35.017 mm (1.3780—1.3786 in.)	--
Bearing OD	71.987—72.013 mm (2.8341—2.8351 in.)	--
Bearing ID	34.987—35.013 mm (1.3774—1.3785 in.)	--
Maximum Shaft End Play		0.50 mm (0.020 in.)
Thermostat(s) Opening Temperature	80—84°C (175—182°F)	--
Fan Belt Tension* Using JDG529 Gauge:		
New Belts	422—463 N (95—104 lb)	--
Belts in service (min. 10-minutes use)	378—418 N (85—94 lb)	--
Fan Belt Tension Using Tension Tester and Straight Edge	19 mm (3/4 in.) with an 89 N (20 lb) force halfway between pulleys	--

**On engines with dual belts, check tension on front belt only. Measure tension on long part of belt.*

S55,2025,A -19-04OCT91

COOLING SYSTEM SPECIFICATIONS—CONTINUED

Torques

Water Pump-to-Cylinder Block:
- 3/8 in. Cap Screw . . . . 47 N·m (35 lb-ft)
- 5/16 in. Cap Screw . . . . 27 N·m (20 lb-ft)

Water Manifold-to-Cylinder Head . . . . 60 N·m (45 lb-ft)

Thermostat Cover-to-Water Manifold . . . . 47 N·m (35 lb-ft)

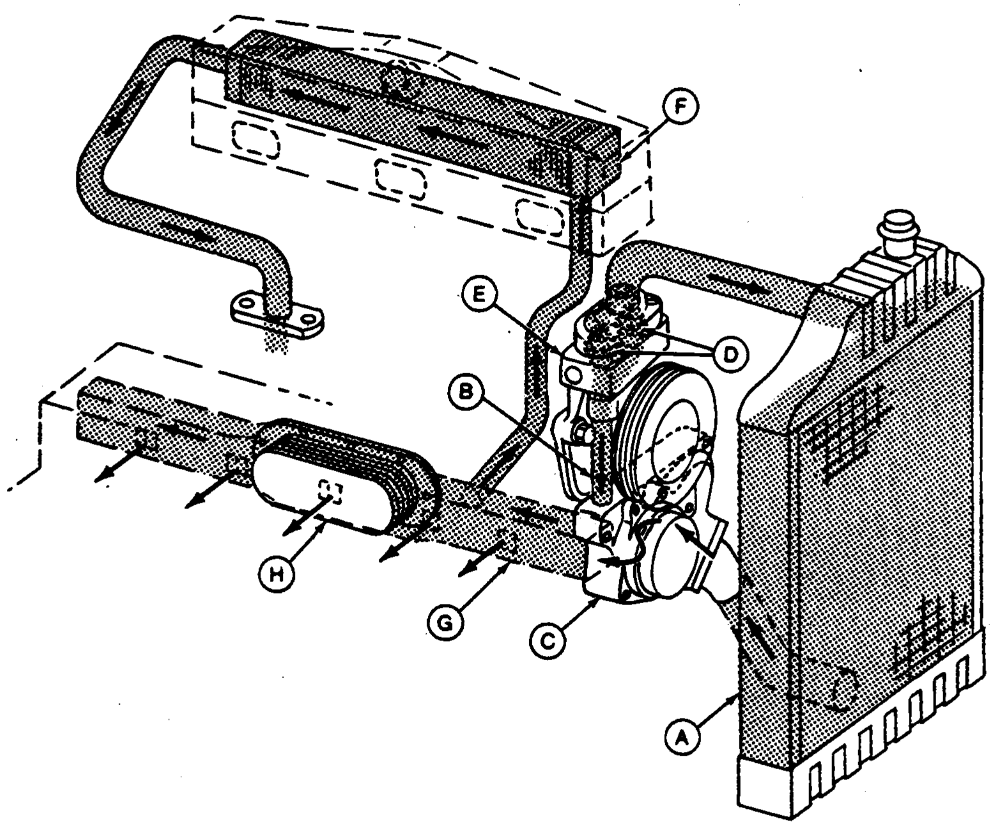
Inlet Elbow-to-Water Pump Housing . . . . 30 N·m (22 lb-ft)

Fan-to-Fan Hub or Pulley . . . . 40 N·m (30 lb-ft)

Fan Drive Assembly-to-Support Plate . . . . 80 N·m (60 lb-ft)

RG,CTM6,G25,6 -19-18JUN91

HOW THE COOLING SYSTEM WORKS



A—Radiator
B—Coolant Bypass Pipe
C—Water Pump
D—Thermostats (2 used)
E—Water Manifold
F—Aftercooler ('A' Engines)
G—Main Coolant Gallery
H—Engine Oil Cooler

6076A Engine Cooling System

The pressurized cooling system consists of a conventional radiator (A), water pump (C), thermostats (D), and water manifold (E).

The pump draws coolant from the bottom of the radiator and discharges it into the main coolant gallery (G) on the left-hand side of the engine block. 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.

If the thermostats are closed (as during warm-up periods), coolant is directed back to the pump through the bypass pipe (B) to be recirculated. This provides a faster and more uniform warm-up.

If the thermostats are open (engine at normal operating temperature), some coolant flows back through the thermostats to the top of the radiator.

On 6076A engines, coolant is also taken from the main gallery into the aftercooler (F) to cool intake air. It circulates through the aftercooler and back into the the cylinder head.

The engine oil cooler (H) located in the main gallery, receives its cooling capability from the coolant flow around it.

S55,22005,E -19-05SEP91

DIAGNOSING COOLING SYSTEM MALFUNCTIONS

Engine Overheats

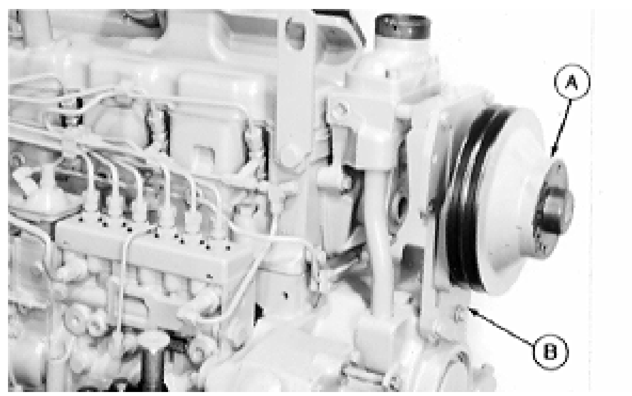
Loose or broken fan belt
Dirty radiator
Low coolant level
Low oil level
Engine overloaded
Defective head gasket
Incorrect timing (engine/injection pump)
Faulty thermostats
Faulty water pump
Corroded coolant passages
Improper grade of fuel
Excessive fuel delivery

Low Coolant Level

Improper maintenance
Improper operation
Damaged radiator
Water pump seal leakage
System leakage
Faulty radiator pressure cap

S11,2025,DH -19-17JUN91

REMOVE AND INSTALL MEDIUM DUTY, ADJUSTABLE FAN DRIVE ASSEMBLY



RG5743 -UN-05AUG91

1. Remove fan and fan belts, shown removed.

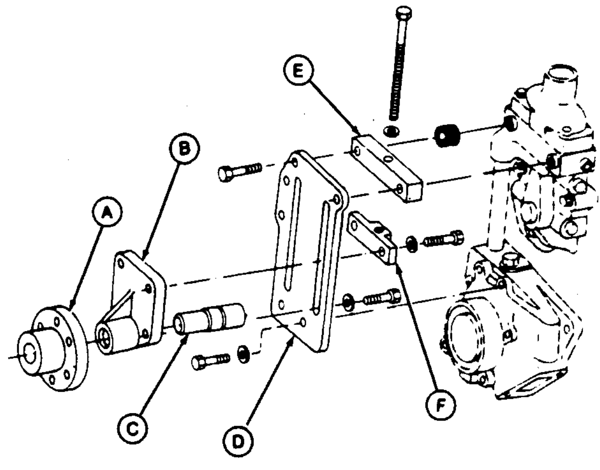
2. Remove four cap screws securing bearing housing assembly with fan or pulley hub (A) to support plate (B). Remove fan drive assembly from engine.

3. Reverse removal steps and install fan drive assembly. Center fan drive in fan shroud and tighten mounting cap screws to 80 N·m (60 lb-ft).

4. Install fan and fan belts. Refer to the appropriate operator's manual for proper belt tensioning.

RG,CTM6,G25,1 -19-17JUN91

REPLACE BEARINGS IN MEDIUM DUTY, ADJUSTABLE FAN DRIVE ASSEMBLY



A—Fan/Pulley Hub
B—Bearing Housing
C—Bearing Shaft
D—Support Plate
E—Support Spacer
F—Adjuster

1. Remove fan drive assembly from engine as detailed earlier in this group.

2. Support fan hub (A) and press bearing shaft (C) out of hub. Do not let bearing and housing (B) fall to floor.

3. Support bearing housing and press bearing shaft out of housing. Discard old bearing shaft.

4. Thoroughly clean and inspect bearing housing and fan hub. Measure parts and compare with specifications given below.

MEDIUM DUTY ADJUSTABLE FAN DRIVE SPECIFICATIONS

Bearing Housing ID	47.576—47.612 mm (1.8731—1.8745 in.)
Fan Hub ID	25.311—25.337 mm (0.9965—0.9975 in.)
Bearing OD	47.612—47.625 mm (1.8745—1.8750 in.)
Shaft OD	25.387—25.400 mm (0.9995—1.0000 in.)

Replace parts that are cracked or not within specification.

5. Support bearing housing flat and firm with bearing bore in the up position.

6. Apply clean engine oil to OD of bearing and press bearing into housing, using a driver that bears on outer bearing shell only, until bearing bottoms in housing. Long end of shaft should extend through housing.

7. Support the bearing shaft flat and firm on housing end of shaft.

8. Install fan hub onto bearing shaft until hub is flush-to-1.30 mm (0.051 in.) below end of bearing shaft using a driver which bears on machined surface of hub only.

9. Rotate hub by hand to assure bearing spins freely.

10. Install fan drive assembly as detailed earlier in this group.

25
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RG,CTM6,G25,2 -19-18JUN91

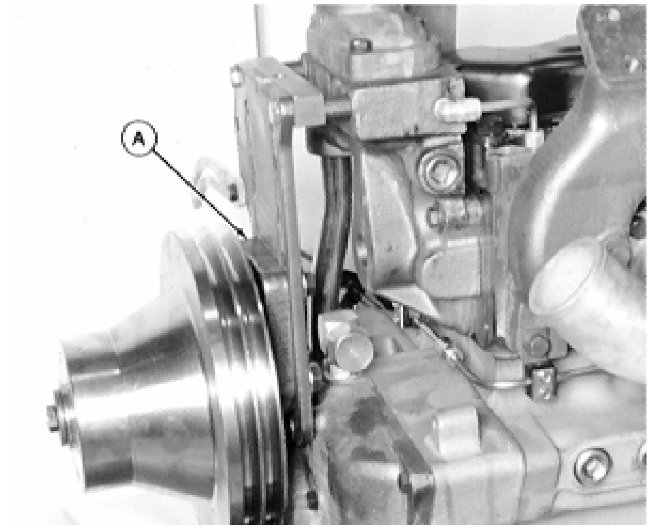
REMOVE AND INSTALL HEAVY DUTY, ADJUSTABLE FAN DRIVE ASSEMBLY

1. Remove fan belts and fan, shown removed.

2. Remove four cap screws securing bearing housing (A) to support plate (B) and remove fan drive assembly from engine.

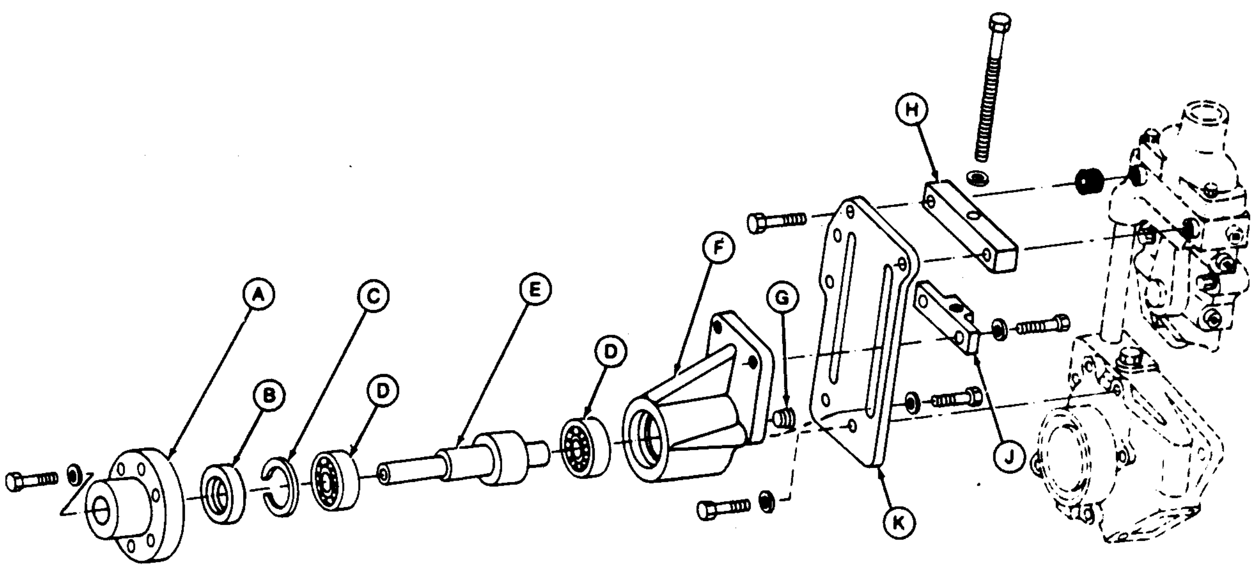
3. Reverse removal steps and install fan drive assembly. Center fan drive in fan shroud tighten mounting cap screws to 80 N·m (60 lb-ft).

4. Install fan and fan belts. Refer to the appropriate operator's manual for proper belt tensioning.



RG,CTM6,G25,3 -19-17JUN91

REPLACE BEARINGS IN HEAVY DUTY, ADJUSTABLE FAN DRIVE ASSEMBLY



A—Fan Hub
B—Grease Seal
C—Snap Ring
D—Ball Bearing (2 used)
E—Shaft
F—Bearing Housing
G—Pipe Plug
H—Support Spacer
J—Adjuster
K—Support Plate

Heavy Duty, Adjustable Fan Drive

RG,CTM6,G25,4 -19-17JUN91

(Refer to illustration on previous page)

1. Remove fan drive assembly as detailed earlier in this group.

2. Clamp fan hub (A) in a soft-jawed vise. Support fan hub (so it does not fall to floor), and remove cap screw securing hub to shaft (E).

3. Remove pipe plug (G), grease seal (B) and snap ring (C). Discard seal and snap ring.

4. Remove shaft with bearings (D) by lightly tapping with a rubber mallet or brass hammer.

5. Remove bearings from shaft using a press and discard bearings.

6. Thoroughly clean and inspect shaft and bearing housing for cracks or any other damage. Measure parts and compare with specifications given below.

HEAVY DUTY, ADJUSTABLE FAN DRIVE SPECIFICATIONS

Housing ID	71.999—72.025 mm (2.8346—2.8356 in.)
Shaft OD	35.001—35.017 mm (1.3780—1.3786 in.)
Bearing ID	34.987—35.013 mm (1.3774—1.3785 in.)
Bearing OD	71.987—72.025 mm (2.8341—2.8351 in.)

Replace parts that are cracked or not within specification.

7. Pack inner and outer bearings with high temperature grease. Apply clean engine oil to bearing ID and shaft OD.

8. Support end of shaft and install bearings onto end against shoulder by pressing on bearing inner race only.

9. Support bearing housing on a firm flat surface with bearing bore in the upward position.

10. Install bearing and shaft aseembly into housing, small end of shaft should extend through housing.

NOTE: Several thickness of snap rings are available through service parts, use the correct thickness to obtain correct end play. Refer to your engine parts catalog or microfische.

11. Determine proper snap ring to use to obtain 0.10 mm (0.004 in.) end play.

12. Install proper snap ring in housing groove. Visually inspect snap ring installation for proper seating in housing groove.

13. Apply a thin coat of clean engine oil to OD of seal casing and rubber seal lips. Install seal in housing bore until metal casing is flush-to-0.50 mm (0.020 in.) below housing face.

14. While supporting shaft through pipe plug hole in bearing housing, apply clean engine oil to ID of fan hub. Install hub onto shaft until it bottoms on shoulder.

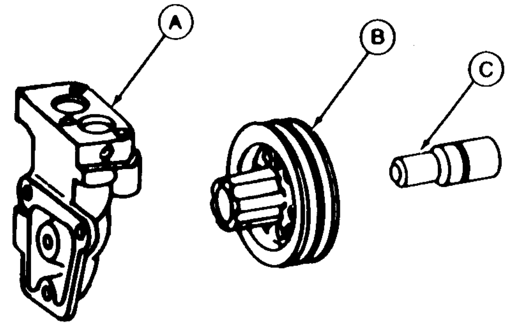
15. Install washer and cap screw. Tighten cap screw to 80 N·m (60 lb-ft).

16. Apply LOCTITE 592 to threads of pipe plug, install plug in bearing housing and tighten securely.

17. Install fan drive assembly onto support plate as detailed earlier in this group.

RG,CTM6,G25,4A -19-05SEP91

REPLACE WATER MANIFOLD MOUNTED, FIXED FAN DRIVE BEARING



RG5745 -UN-05AUG91

1. Remove three cap screws securing water manifold (A) and fan pulley (B) assembly to front face of cylinder head.

2. Remove assembly from head as water bypass pipe is dislodged from manifold. Clean all gasket material from mounting surfaces.

3. Support front face of water manifold housing and press bearing (C) and pulley out of manifold. Do not let pulley and bearing fall to the floor when parts are separated.

4. Support front face of fan pulley and press bearing out of pulley. Discard bearing.

5. Thoroughly inspect water manifold and pulley for cracks or damage. Measure ID of both parts in three places and compare readings with specifications given below.

WATER MANIFOLD MOUNTED, FIXED FAN DRIVE SPECS

Shaft OD	25.387—25.400 mm (0.9995—1.0000 in.)
Bearing OD	47.612—47.625 mm (1.8745—1.8750 in.)
Pulley ID	47.576—47.612 mm (1.8731—1.8745 in.)
Manifold ID	25.336—25.362 mm (0.9975—0.9985 in.)
Dimension From Manifold Mounting Face-to-End of Shaft in Manifold	33.31—33.47 mm (1.311—1.318 in.)
Dimension From Manifold Mounting Face-to-End of Shaft in Pulley	157.69—158.45 mm (6.208—6.238 in.)

ALWAYS replace parts that are either cracked or not within the specifications given above.

IMPORTANT: Apply LOCTITE 271 to mating surfaces of all parts that are being reused. It is not necessary to apply LOCTITE 271 to surfaces of new parts. To disassemble parts that were assembled with LOCTITE, apply heat with a torch.

NOTE: Support fan pulley on a flat, firm surface and press on bearing outer race to prevent damage.

6. Press new bearing into pulley until it bottoms against stop. End of shaft will extend through bearing stop.

NOTE: Support water manifold machined mounting surface and press on inner shaft only to prevent damage.

7. Press bearing shaft into water manifold until end of shaft is 33.31—33.47 mm (1.311—1.318 in.) from manifold mounting surface.

8. Hold water manifold firmly and turn fan pulley by hand to assure bearings rotate freely.

9. Using a new gasket and o-rings, position water bypass pipe in manifold and install assembly onto locating pin at front face of cylinder head. Tighten cap screws to 60 N·m (45 lb-ft).

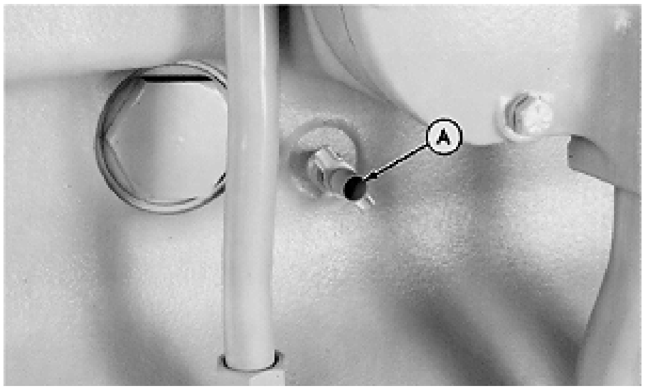
10. Install fan and fan belts. Refer to the appropriate operator's manual for proper belt tensioning.

RG,CTM6,G25,5 -19-07OCT91

REMOVE WATER PUMP

CAUTION: DO NOT drain engine coolant until it is below operating temperature. Then loosen cylinder block drain valve (A) slowly to relieve any pressure.

1. Open drain valve and drain coolant from cylinder block, if not previously done.



RG5277 -UN-14DEC88

S55,2025,B -19-05SEP91

2. Remove fan pulley assembly (shown removed).

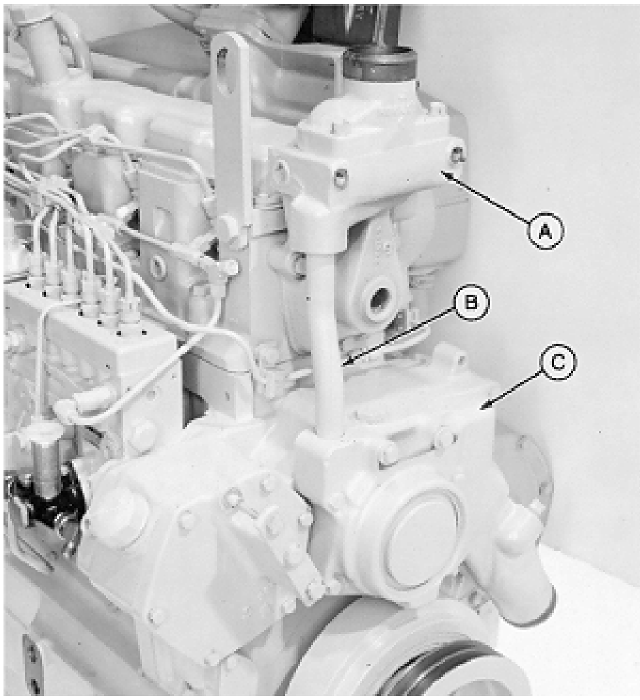
NOTE: On engines equipped with fan pulley pressed into the water manifold, remove pulley and manifold as an assembly.

3. Remove water manifold (A).

4. Remove water bypass pipe (B) from water pump housing. Discard O-rings.

5. Remove mounting cap screws and lift water pump (C) from cylinder block.

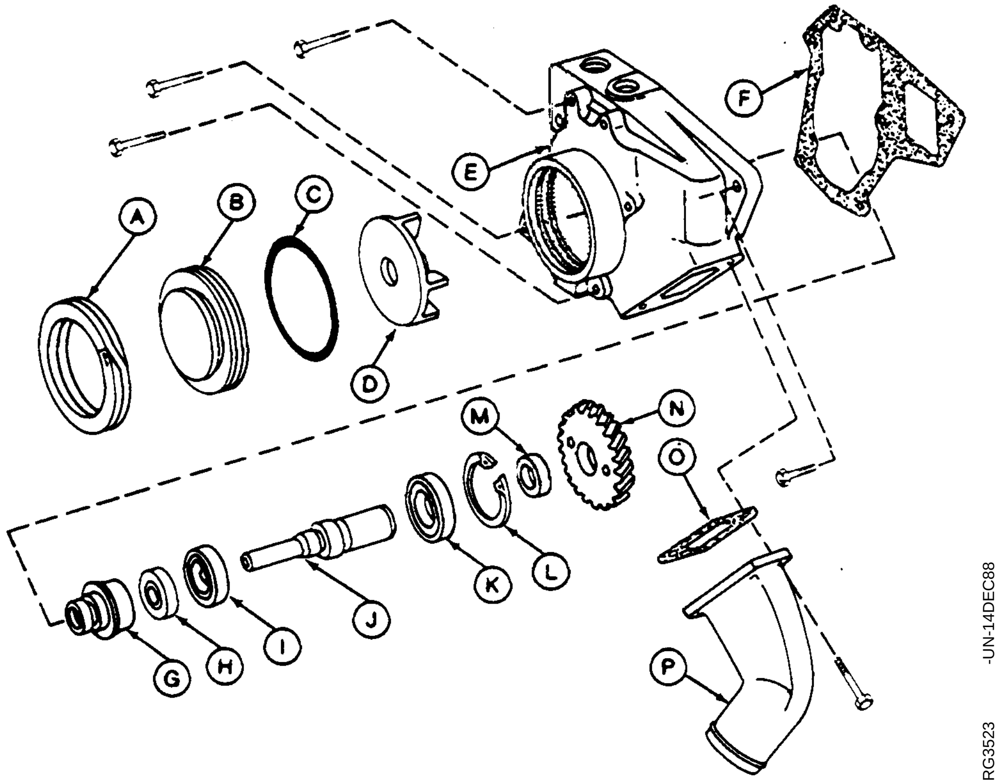
6. Clean all gasket material from cylinder block and water pump housing.



RG5278 -UN-14DEC88

S55,2025,C -19-03MAY88

DISASSEMBLE WATER PUMP



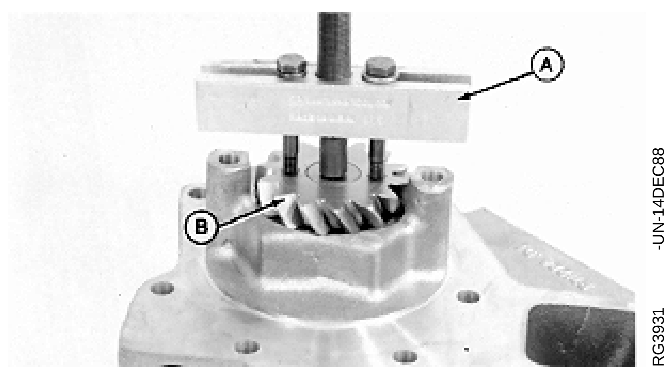
A—Retaining Ring
B—Cover
C—O-Ring
D—Impeller
E—Housing
F—Gasket
G—Seal (water pump)
H—Seal (grease)
I—Bearing (front)
J—Shaft
K—Bearing (rear)
L—Retaining Ring
M—Spacer
N—Drive Gear
O—Gasket
P—Inlet Elbow

6076 Water Pump

25
12

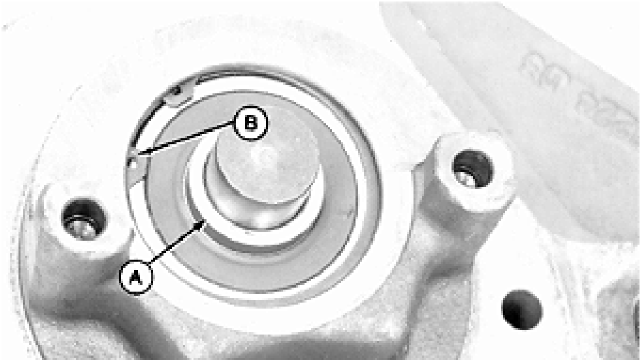
S55,2025,D -19-17JUN91

1. Remove water pump drive gear (B) using the D01206AA Gear Puller (A) with two 3/8-16 cap screws and flat washers.



S11,2025,BI -19-18JUN91

2. Remove spacer (A) and retaining ring (B).



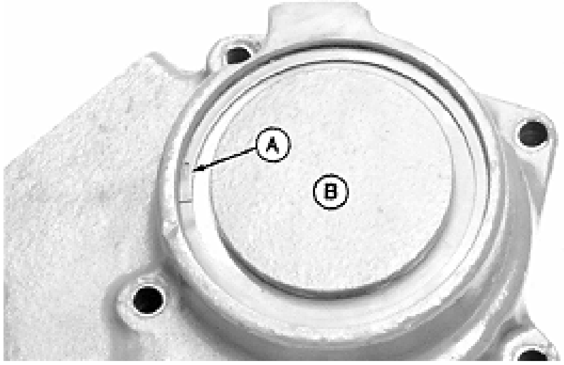
RG3514 -UN-14DEC88

S11,2025,BJ -19-17JUN91

3. Remove retaining ring (A).

4. Pry water pump cover (B) from housing using two screwdrivers.

5. Discard O-ring on water pump cover.



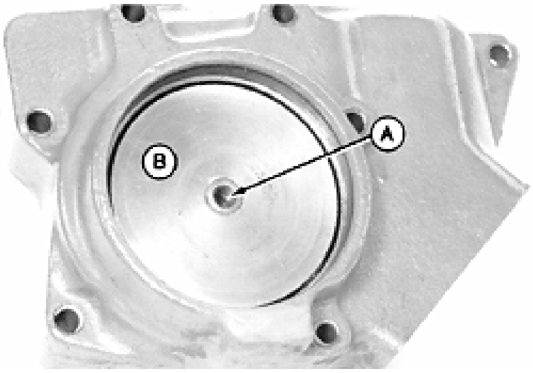
RG3515 -UN-14DEC88

S11,2025,BK -19-09APR85

6. Install an Allen-head screw into water pump shaft (A).

7. Use a press and press on screw only.

8. Remove impeller (B).

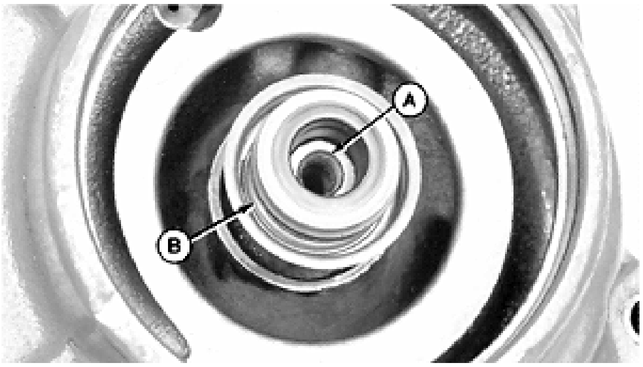


RG3516 -UN-14DEC88

S11,2025,BL -19-09APR85

9. Press shaft (A) and bearing assembly from water pump housing.

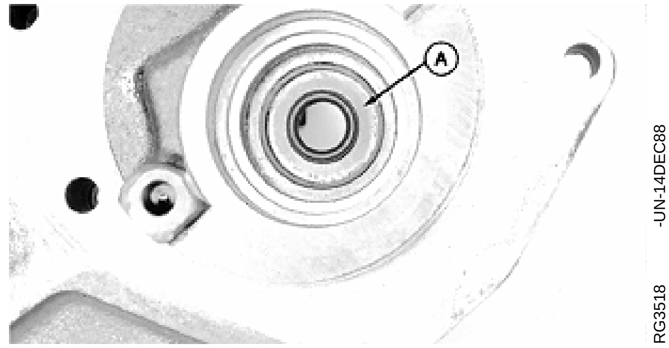
10. Drive seal (B) from housing using a small driver. Discard seal.



RG3517 -UN-14DEC88

S11,2025,BM -19-09APR85

11. Remove and discard grease seal (A).



S11,2025,BN -19-18JUN91

INSPECT WATER PUMP PARTS

1. Visually inspect and measure OD of shaft (A) at both ends, ID of impeller (B) and ID of drive gear (C). Compare measurements with specifications given below.

WATER PUMP SPECIFICATIONS

Shaft OD impeller end	15.90—15.93 mm (0.626—0.627 in.)
Shaft OD drive gear end	25.00—25.02 mm (0.984—0.985 in.)
Impeller bore ID	15.85—15.88 mm (0.624—0.625 in.)
Drive gear bore ID	24.92—24.94 mm (0.981—0.982 in.)
Drive gear OD	72.39—72.64 mm (2.85—2.86 in.)

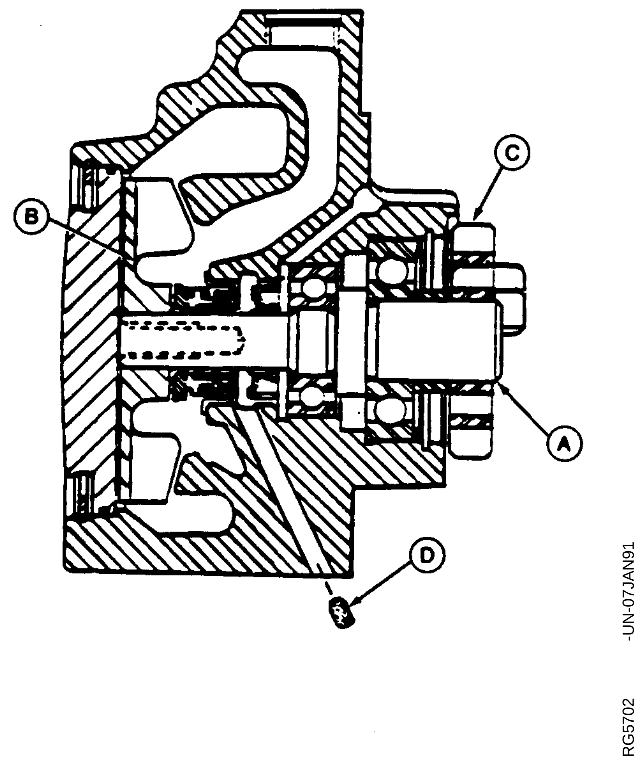
2. When replacing bearings or shaft, support bearings and press on shaft only to disassemble.

3. Install new bearings onto shaft using a tubular driver. Drive on INNER bearing race only.

4. Inspect water pump housing for debris, cracks, or damage. Be sure the “weep hole” in the housing is cleaned while pump is disassembled and foam filter (D) removed from weep hole.

Replace parts if worn, damaged, cracked, or not within specifications.

5. Clean all reusable parts, except bearings, with clean solvent, and dry with compressed air.



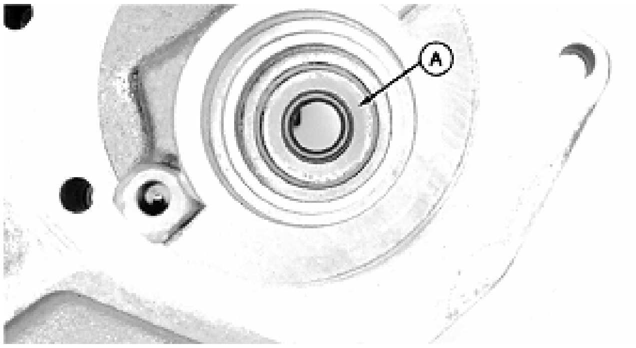
A—Shaft
B—Impeller
C—Drive Gear
D—Foam Filter

S55,2025,E -19-05SEP91

ASSEMBLE WATER PUMP

1. Install new oil seal (A) from rear side of housing with spring loaded lip toward drive gear end of housing using a suitable driver.

Install new bearings onto shaft against shoulder using a driver which bears on inner races only and pack bearings with a high temperature grease. If old bearings are reused, pack bearings with clean high temperature grease.



RG3518 -UN-14DEC88

S11,2025,DM -19-05SEP91

2. Apply a light coat of clean engine oil on O.D. of JDG249 Seal Protector (A). Install seal protector over shaft.

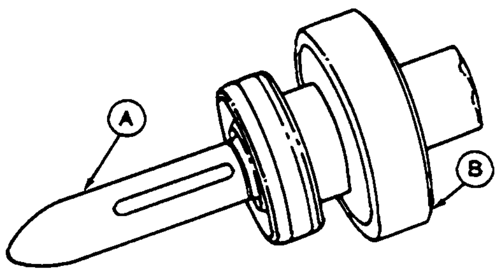
3.Pack grease seal cavity between sealing lips and within cup with a generous amount of PT507 Multi-purpose Grease or TY6333 High Temperature Grease.

4. Install shaft bearing assembly into water pump housing with the JDG249 Seal Protector.

5. Gently drive shaft bearing assembly into housing bore using a driver that bears on outer race of large bearing (B).

6. Remove JDG249 Protector from end of shaft after shaft bearing assembly is firmly seated in housing bore.

NOTE: The JDG249 Seal Protector is used to relieve any excess pressure build up when installing shaft/bearing assembly, and to keep oil seal lips from rolling over.



RG3520 -UN-15DEC88

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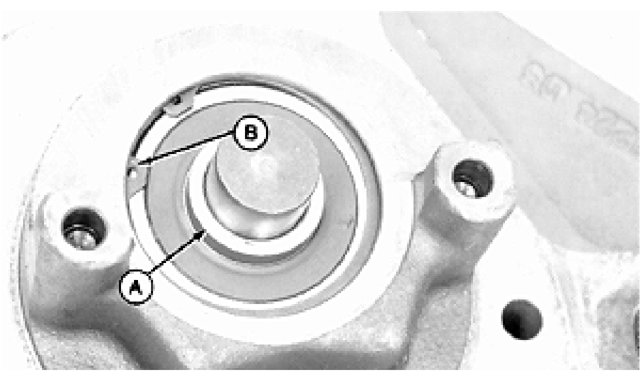
S11,2025,BQ -19-05SEP91

7. Install retaining ring (B) in groove in housing with flat side of ring facing bearing.

8. Install gear spacer (A) over shaft.

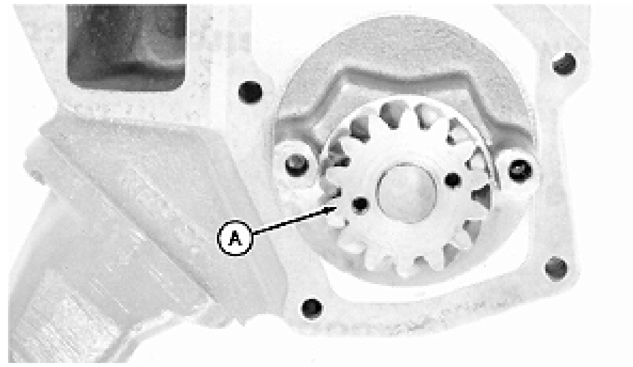


RG3514 -UN-14DEC88

S11,2025,BR -19-17JUN91

9. Support opposite end of shaft and press drive gear (A) onto shaft against spacer.

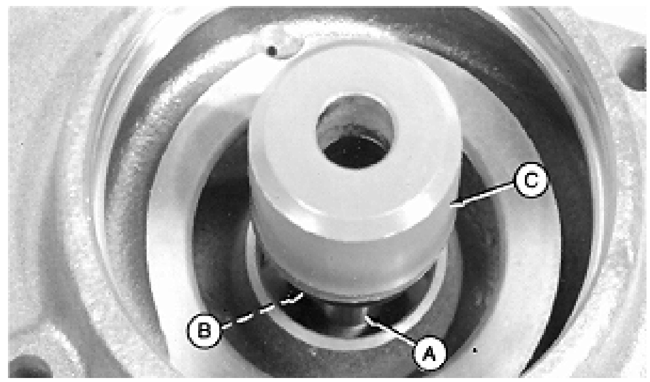
10. Rotate gear by hand to be sure assembly turns freely. Disassemble and correct problem if resistance is felt.



RG3513 -UN-14DEC88

S11,2025,BS -19-17JUN91

11. Turn pump housing over and position water pump seal (B) onto shaft (A). Install seal into housing using the R78350 Driver (C) included in seal kit.

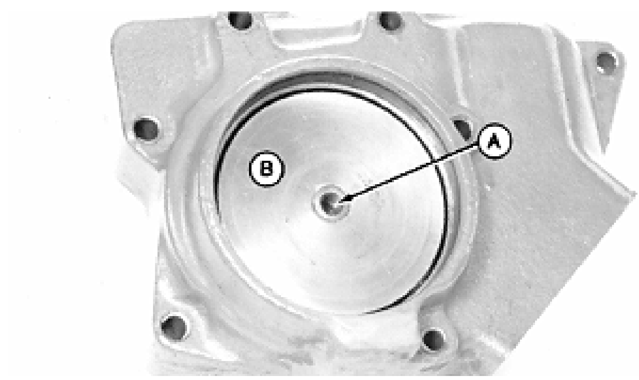


RG3933 -UN-14DEC88

S11,2025,BU -19-17JUN91

12. Support shaft (A) and press impeller (B) in place. Press impeller until flush-to-0.130 mm (0.0051 in.) below end of shaft (A).

13. Turn shaft to be sure impeller does not rub against housing.



RG3516 -UN-14DEC88

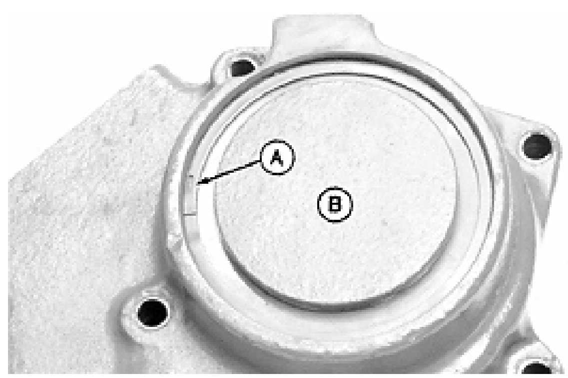
S11,2025,BV -19-18JUN91

14. Lubricate new O-ring with liquid soap and install on cover. Press cover (B) into housing.

15. Install retaining ring (A). Be sure ring is fully seated in retaining groove.

16. Install a new foam filter in weep hole of water pump housing.

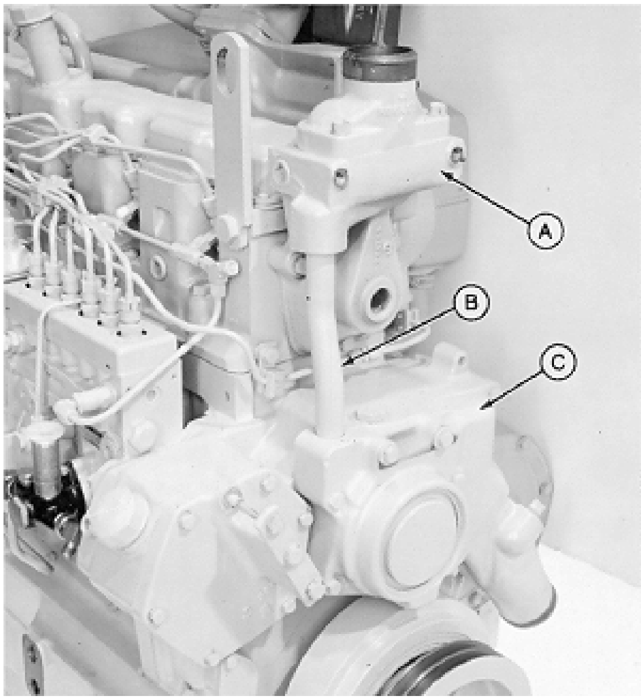
17. Install inlet elbow onto housing using a new gasket. Tighten cap screws to 30 N·m (22 lb-ft).



RG3515 -UN-14DEC88

S11,2025,BW -19-05SEP91

INSTALL WATER PUMP



RG5278 -UN-14DEC88

1. Use JDT350 PERMATEX Form-a-Gasket No. 2 along with a new gasket and install water pump (C) onto timing gear cover. Make sure pump drive gear is properly meshed with camshaft gear.

IMPORTANT: Apply LOCTITE 242 Thread Sealer to threads of top two (longest) 3/8-in. cap screws to prevent leakage from mounting holes that are tapped all the way through.

2. Install and tighten all 3/8-in. cap screws to 47 N·m (35 lb-ft) and all 5/16-in. cap screws to 27 N·m (20 lb-ft).

NOTE: Lubricate O-ring with grease to ease installation of bypass tube.

3. Install a new O-ring into groove of water outlet manifold (A) and install bypass pipe (B) into water outlet manifold.

4. Install a new O-ring into groove of water pump housing.

5. Using JDT350 PERMATEX Form-a-Gasket No. 2 and a new gasket, install water outlet manifold. Be sure water outlet manifold is properly positioned on spring pin (in front face of cylinder head) and that water bypass pipe is fully seated in bores.

6. Apply LOCTITE 242 Thread Sealer to water outlet manifold-to-cylinder head cap screw threads 360 degrees (except for the leading one to three threads). Tighten cap screws to 60 N·m (45 lb-ft).

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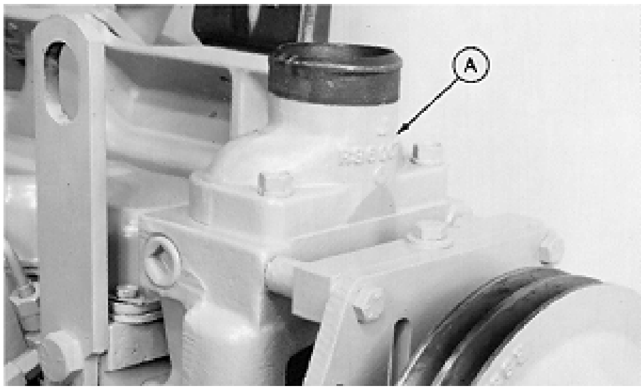
17

S55,2025,G -19-05SEP91

REMOVE AND TEST THERMOSTATS



RG5279 -UN-14DEC88

1. Visually inspect area around water manifold for leaks. Partially drain coolant from cooling system.

2. Remove thermostat cover (A).

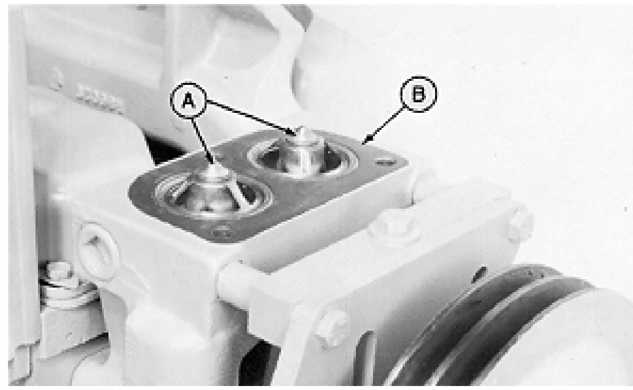
S55,2025,H -19-17MAR88

3. Remove thermostats (A). Discard gasket (B).

4. Inspect thermostats for debris or damage.

5. Refer to Group 105 for an approved thermostat testing procedure. (See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE.)

If either thermostat fails to open within the specified range for it's rating, replace both thermostats.



RG5280 -UN-09DEC88

S55,2025,I -19-05SEP91

INSTALL THERMOSTATS

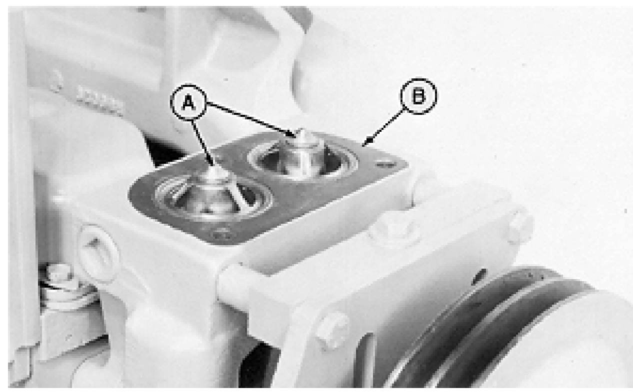
1. Apply JDT350 PERMATEX Form-a-Gasket No. 2 to water manifold-to-thermostat cover mating surface.

NOTE: Install thermostats in slot in housing first, then install gasket after thermostat is properly seated in housing.

2. Install thermostats (A) and a new gasket (B).

3. Install cover and tighten cap screws to 47 N·m (35 lb-ft).

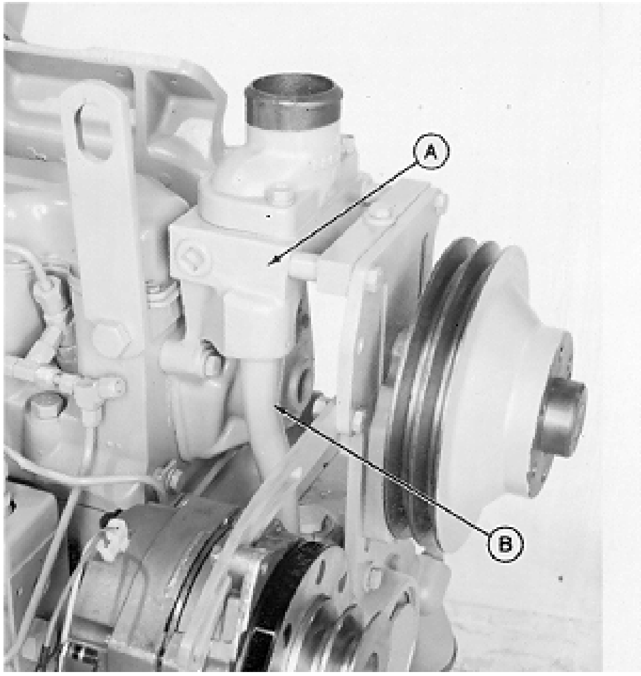
IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing to allow air to escape when filling system. Retighten fitting or plug when all the air has been expelled. Later production engines are equipped with a special air bleed line from thermostat housing-to-cylinder head, loosen this line when filling cooling system.



RG5280 -UN-09DEC88

S55,2025,J -19-05SEP91

REMOVE WATER MANIFOLD



RG5281 -UN-14DEC88

1. Remove three water manifold-to-cylinder head cap screws and remove water manifold assembly (A).

NOTE: Pull water manifold straight ahead (toward) front of engine approximately 6.35 mm (0.25 in.) to disengage from locator (spring) pin, then lift straight up to disengage from bypass pipe (B).

2. Remove bypass pipe. Remove and discard O-rings from slots in water manifold and water pump housing bores.

S55,2025,K -19-17JUN91

INSPECT AND CLEAN WATER MANIFOLD

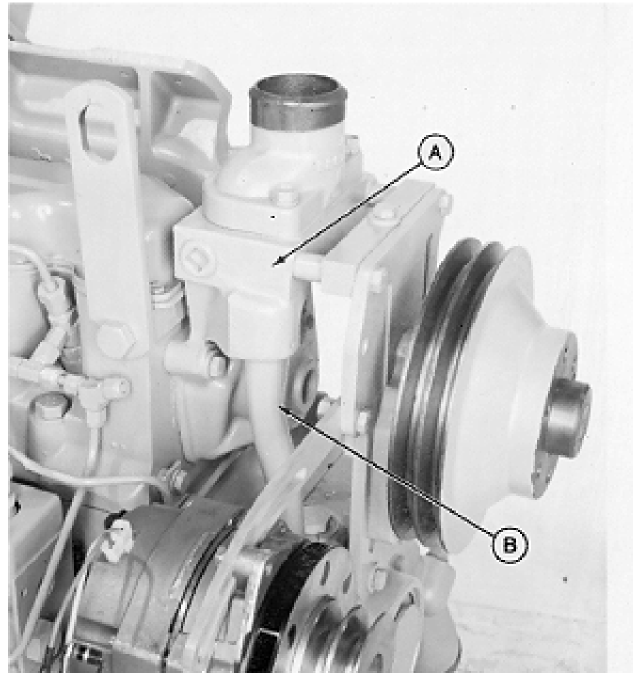
1. Remove all gasket material from manifold and cylinder head.

2. Inspect water manifold for debris and damage. Replace as necessary.

3. Clean water manifold with solvent and dry with compressed air.

S11,2030,Q -19-17JUN91

INSTALL WATER MANIFOLD



RG5281 -UN-14DEC88

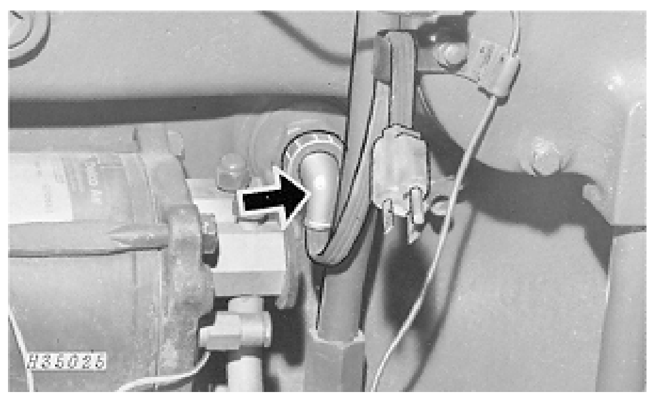
1. Install a new O-ring into slots of water manifold and water pump housing bores. Lubricate ID of O-rings with grease to ease bypass pipe installation. Install bypass pipe (B) into bore of water manifold (A), be careful not to cut O-ring.

2. JDT350 Using PERMATEX Form-a-Gasket No. 2 and a new gasket, install water manifold assembly. Be sure water manifold is properly positioned on spring pin (in front face of cylinder head) and that bypass pipe is fully seated in water manifold and water pump housing bores.

3. Apply LOCTITE 242 Thread Sealer to water manifold-to-cylinder head cap screw threads 360 degrees (except for the leading one to three threads). Tighten water manifold cap screws to 60 N·m (45 lb-ft).

S55,2025,L -19-17JUN91

REMOVE COOLANT HEATER—IF EQUIPPED



H35025 -UN-23FEB89

1. Unplug heater from electrical power source.

2. Drain cooling system.

3. Remove electrical cord, loosen nut, and pull heater element (arrow) out of block.

S11,2025,GJ -19-02DEC86

INSTALL COOLANT HEATER—IF EQUIPPED

NOTE: The heater element (A) cannot be repaired. If defective, replace with a new one.

1. Lubricate O-ring (B) with clean engine oil and install onto groove of flange nut (D). Install gasket (C) onto heater element (A) and install element into flange nut.

2. Install nut (E) onto threads of heater element finger tight only.

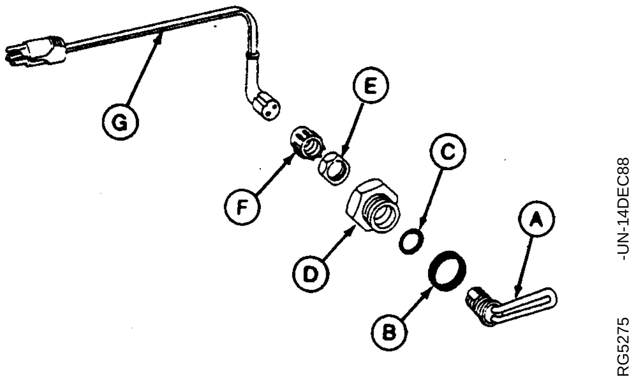
3. Install assembly into threaded heater hole in block. While holding heater element in the upward, vertical position, tighten flange nut to 68 N·m (50 lb-ft) making sure O-ring seals against block.

IMPORTANT: HEATER element must remain in the upright vertical position after installation and must not touch internal walls of the block.

4. Hold assembly so that flats on threaded end of heater element are vertical. Tighten nut to 34 N·m (25 lb-ft).

CAUTION: To avoid shock or hazardous operation, always use a three-wire heavy-duty electrical cord equipped with three-wire connectors. If a two-to-three contact adapter is used at the wall receptacle, always connect green wire to a good ground. Keep electrical connectors clean to prevent arcing.

5. Install wiring lead (G) or dust cap (F) when wiring lead is not being used.



110-Volt Shown, 220-Volt Similar

A—Heating Element
B—O-Ring
C—Gasket
D—Flange Nut Adapter
E—Nut
F—Dust Cap
G—Wiring Lead

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21

S55,2025,N -19-05SEP91

COMPLETE FINAL ASSEMBLY

NOTE: Consult your engine operator's manual or see Group 02 of this CTM for coolant recommendations in your area.

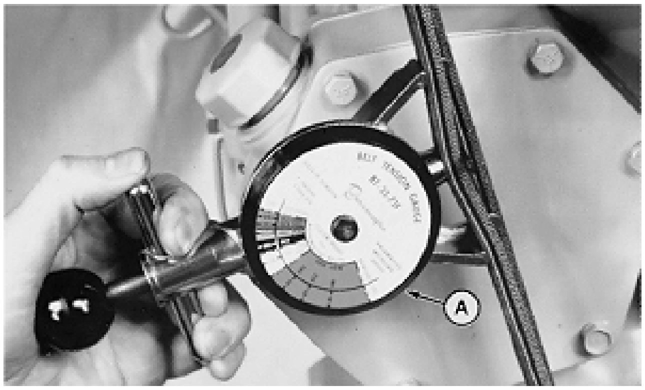
1. Fill cooling system to proper level with the proper coolant.

2. Start engine and run for several minutes to check for leaks in the cooling system.

3. After fan belts cool, check belt tension. (See ADJUST FAN BELT TENSION later in this group.

RG,CTM42,G25,31-19-10SEP91

INSPECT AND TENSION FAN AND ALTERNATOR V-BELTS



RG4683 -UN-15DEC88

1. Check condition of fan belt(s) and replace (as a matched set) if cracked, frayed or excessively worn.

2. Check belts tension and adjust as necessary.

IMPORTANT: Belts must not be hot when tension is checked or adjusted. Belt tension specified is for a warm belt.

Do not pry against alternator rear frame when adjusting belt tension.

3. Use JDG-529 Belt Tension Gauge (A) or equivalent belt tension gauge to check belt tension. Use this same gauge to adjust belt tension is needed.

NOTE: Engines having dual belts, check front belt tension only. Measure tension on long part of belt as shown in illustration.

4. To adjust belt tension, loosen alternator bracket cap screw and nut and apply outward pressure to alternator front frame until strand tension is read on tension gauge.

	Tension New Belt	**Tension Used* Belt**
Single Belt	578—622 N (130—140 lb force)	378—423 N (85—94 lb force)
Dual Belt	423—467 N (95—104 lb force)	378—423 N (85—94 lb force)

* Belts are considered used after 10 minutes of operation.

IMPORTANT: The tension on newly installed v-belts should be checked daily for the first few days of operation because of the initial stretching.

Sheave alignment is extremely important in order to avoid early belt failure and side wear. Misalignment can also cause bearing failure.

5. Tighten alternator bracket cap screw and nut securely.

6. Immediately after a 10 minute run-in of a new or used belt, recheck belt tension as shown in table above.

7. If tension is not within specifications, wait 10 minutes, loosen belt and retighten to 378—423 N (85—94 lb force) strand tension.

S55,22010,H -19-02OCT91

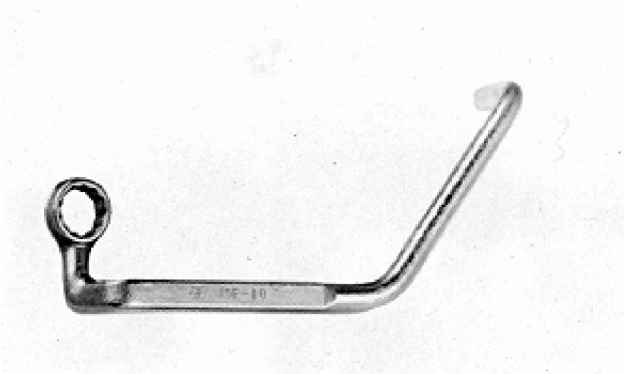
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

Starter Wrench JDE80

Use with JDG626 and standard 9/16 12-point, 3/8 in. drive socket to remove and install rear cap screw on turbocharger drain tube.

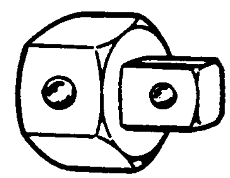


R26547 -UN-09FEB90

RG,CTM42,G30,32-19-10SEP91

Special Socket Adapter JDG626

Use with JDE80 and standard 9/16 12-point, 3/8 in. drive socket to remove and install rear cap screw on turbocharger drain tube.

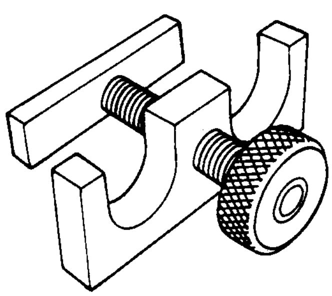


RG5367 -UN-14DEC88

S53,JDG626 -19-09SEP91

Sealing Ring Compression Tool JDG683

Used to compress aftercooler sealing ring for cover-to-intake manifold alignment during assembly.



RG5571 -UN-04JUL89

S53,JDG683 -19-20JUN89

OTHER MATERIAL

Name	Use
PT569 NEVER-SEEZ® Compound	Exhaust manifold cap screws and aftercooler cover-to-intake manifold cap screws
TY9375 (LOCTITE 592) Pipe Sealant with TEFLON®	Turbocharger oil supply and drain lines.

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

S11,3005,MT -19-09SEP91

AIR INTAKE AND EXHAUST SYSTEM SPECIFICATIONS

Item	New Part Specification	Wear Tolerance
Total Indicator Reading Limits (AiResearch):		
Bearing Clearance (max.)	0.08—0.15 mm (0.003—0.006 in.)	--
Bearing End Play (max.)	0.025—0.102 mm (0.001—0.004 in.)	--
Total Indicator Reading Limits (Schwitzer):		
Bearing Clearance (max.)	0.53 mm (0.021 in.)	--
Bearing End Play (max.)	0.05—0.13 mm (0.002—0.005 in.)	--
Exhaust Adapter End Play (max.)	1.59 mm (0.0625 in.)	--

Torques

Compressor Housing-to-Backplate (AiResearch)	12.4—14.7 N·m (110—130 lb-in.)
Turbine Housing-to-Center Housing (AiResearch)	11.3—14.7 N·m (100—130 lb-in.)
Compressor Housing-to-Backplate (Schwitzer)	7 N·m (60 lb-in.)
Turbine Housing-to-Center Housing (Schwitzer)	7 N·m (60 lb-in.)
Turbocharger-to-Exhaust Manifold	24 N·m (18 lb-ft)
Exhaust Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Intake Manifold-to-Cylinder Head	47 N·m (35 lb-ft)
Exhaust Elbow-to-Exhaust Manifold	24 N·m (18 lb-ft)
Exhaust Adapter V-Band Clamp	20 N·m (15 lb-ft)
Aftercooler Cover (6076A only)	34 N·m (25 lb-ft)
Aftercooler End Adapter (6076A only)	34 N·m (25 lb-ft)

S55,3005,A -19-09SEP91

HOW THE AIR INTAKE AND EXHAUST SYSTEM WORKS

Engine vacuum draws outside air into the cleaner through the intake pipe. This intake air is then filtered through dry-type primary and secondary filter elements in the air cleaner canister. Next, the exhaust-driven turbocharger compresses the air and sends it through the intake manifold on to the engine cylinders.

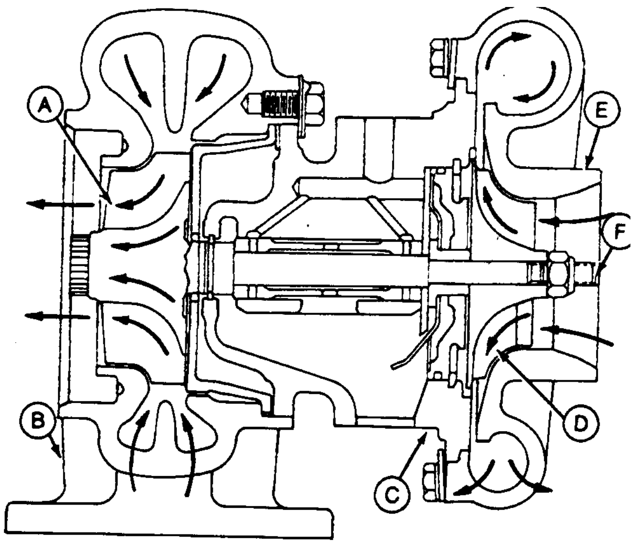
The air intake system on the 6076A engine is the same as 6076T and 6076H models except it uses an aftercooler to cool the air before it reaches the engine cylinders.

S55,3005,B -19-15MAR88

HOW THE TURBOCHARGER WORKS

Exhaust gases from the engine pass through the turbine housing (B) causing the shaft (center housing) (C) to rotate the turbine wheel (A) before the exhaust gas is discharged to the atmosphere.

The compressor wheel, (D) also mounted on the shaft (F), rotates in the compressor housing (E). Inlet air is drawn into the housing, where it is compressed and delivered to engine cylinders.



R28273 -UN-14DEC88

A—Turbine Wheel
B—Turbine Housing
C—Center Housing
D—Compressor Wheel
E—Compressor Housing
F—Shaft

S55,3005,C -19-03MAY88

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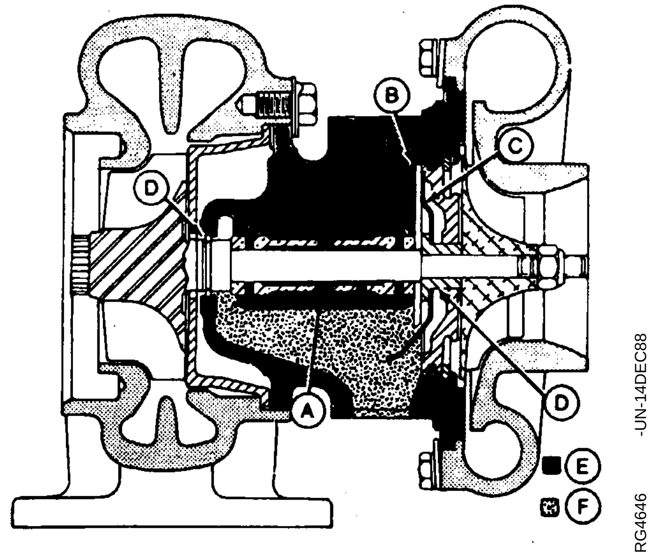
HOW THE TURBOCHARGER IS LUBRICATED

Engine oil under pressure from the engine lubrication system is pumped through a passage in the bearing housing and directed to the bearings (A), thrust plate (B), and thrust sleeve (C). Oil is sealed from the compressor and turbine by a piston ring (D) at both ends of the bearing housing.

The Garrett/AiResearch turbocharger contains two floating bearings and the Schwitzer turbocharger contains a single floating bearing. These bearings have clearance between the bearing OD and the housing bore as well as clearance between the bearing ID and the shaft OD. These clearances are lubricated by the oil supply (E) and the bearings are protected by a cushion of oil. Discharge oil (F) drains by gravity from the bearing housing to the engine crankcase.



Schwitzer Turbocharger Lubrication

A—Bearing(s)
B—Thrust Plate
C—Thrust Sleeve
D—Piston Ring
E—Pressure Oil
F—Discharge Oil

S11,3005,JE -19-09SEP91

EXTENDING TURBOCHARGER LIFE

Turbochargers are designed to last the life of the engine, but because they operate at such high speeds (100,000 rpm or more); a moment’s carelessness can cause them to fail in seconds.

The principle “turbo killers” are attributed to:

- Lack of lube oil
- Oil contamination
- Ingestion of foreign objects

S55,3005,E -19-20JUN90

• **Lack of Oil**

Engine oil not only lubricates the turbo'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 turbo 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 turbo bearing lubrication problems are low oil pressure, a bent, plugged or undersized oil lube supply line, plugged or restricted oil galleries in the turbo, 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 turbo 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 turbo is through improper start-up and shutdown procedures.

Always idle the engine for at least 30 seconds after start-up and before shutdown. Warming the engine up before applying a load to the engine allows oil pressure to build up and lines to fill with oil.

Idling the engine before shutdown allows the engine and turbo to cool. A "hot" shutdown can cause the turbo to fail because after high-speed operation the turbo 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 -19-20JUN90

• **Oil Contamination**

The second cause of turbo failure 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 will 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 filter before adding oil.

— Use a clean container when adding oil.

S11,3005,MK -19-20JUN90

• **Ingestion of Foreign Objects**

The third cause of turbo damage is the ingestion of foreign objects. Foreign objects or particles can be ingested and damage the turbo 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.

S11,3005,ML -19-20JUN90

DIAGNOSING TURBOCHARGER MALFUNCTIONS

The following is a guide for diagnosing air intake system malfunctions by inspection of the turbocharger when removed from the engine. Refer to Operation and Tests section of the machine technical manual for diagnosis of air intake system malfunctions BEFORE removal of turbocharger from engine.

Symptom	Problem	Solution
COMPRESSOR HOUSING INLET DEFECTS:		
Foreign Object Damage	Objects left in intake system.	Disassemble and inspect intake system for foreign objects (this group).
	Leaking and/or defective intake system.	Inspect air intake system connections including air filter; repair as required (this group).
		Inspect air intake related engine components
Compressor Wheel Rub	Bearing failure.	Determine if engine and/or operator contributed to lack of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in progress. Correct as required.
	Manufacturing defects.	Correct as required.
COMPRESSOR HOUSING OUTLET DEFECTS:		
Oil and/or Dirt in Housing	Restricted air intake system.	Inspect and clean air cleaner.
	Prolonged periods of low RPM engine idling.	Check with operator to confirm conditions. (See Operators manual.)
	Defective oil seal ring.	Repair as required. (This group.)
	Restricted oil drain line.	Inspect and clear oil drain line as required.
TURBINE HOUSING INLET DEFECTS:		
Oil in Housing	Internal engine failure.	Inspect and repair engine as required.

Continued on next page

Symptom	Problem	Solution
	Oil leaking from compressor housing seal.	Verify that oil is in compressor housing and refer to “Compressor Housing Outlet Defects” as listed earlier in this chart.
Center Wall Deteriorated	Excessive operating temperature.	Check for restricted air intake. Check engine for overfueling. Check injection pump timing.
TURBINE HOUSING OUTLET DEFECTS:		
Turbine Wheel Rub	Bearing Failure.	Determine if engine and/or operator contributed to lack of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in progress. Correct as required.
	Manufacturing defect.	Correct as required (this group).
Foreign Object Damage	Internal engine failure.	Inspect and repair engine as required.
	Objects left in intake or exhaust system.	Disassemble and inspect air intake or exhaust system, (this group).
	Leaking air intake system.	Correct as required, (this group).
Oil and/or Excessive Carbon in Housing	Internal engine failure.	Verified by oil in turbine housing. Correct as required.
	Turbine seal failure.	Inspect for excessive heat from overfueling and/or restricted air intake.
	Prolonged periods of low RPM engine idling.	Verify with operator to run engine under load or a high RPM. (Operator’s Manual).
	Restricted oil drain line.	Inspect and clear oil drain line as required.
EXTERNAL CENTER HOUSING AND JOINT DEFECTS:		
Leaks from Casting	Defective casting.	Replace turbocharger, (this group).

Continued on next page

Symptom	Problem	Solution
	Defective gasket.	Verify that leaks are not occurring at gasket joints.
Leaks from Joints	Loose attaching screws.	Tighten to specifications in CTM, (this group).
	Defective gasket.	Inspect and repair as required.
INTERNAL CENTER HOUSING DEFECTS:		
Excessive Carbon Build up in Housing or on Shaft	Hot engine shut-down.	Review proper operation with operator as shown in Operator's manual.
	Excessive operating temperature.	Restricted air intake; Overfueling or Mistimed engine
	Restricted oil drain line.	Inspect and clean oil drain lines as required.
	Operating engine at high speeds & loads immediately after start-up.	Idle engine for a few minutes to allow oil to reach bearings before applying heavy loads.

RG,CTM42,G30,10-19-10SEP91

REMOVE TURBOCHARGER

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

1. Clean exterior of turbocharger to prevent entry of dirt into the air intake system during removal.

IMPORTANT: When cleaning turbocharger, do not spray directly into compressor cover or turbine housing. If turbocharger inspection is required, do not clean exterior prior to removal. Doing so may wash away evidence of a potential failure mode. (See Turbocharger Seven Step Inspection, later in this group.)

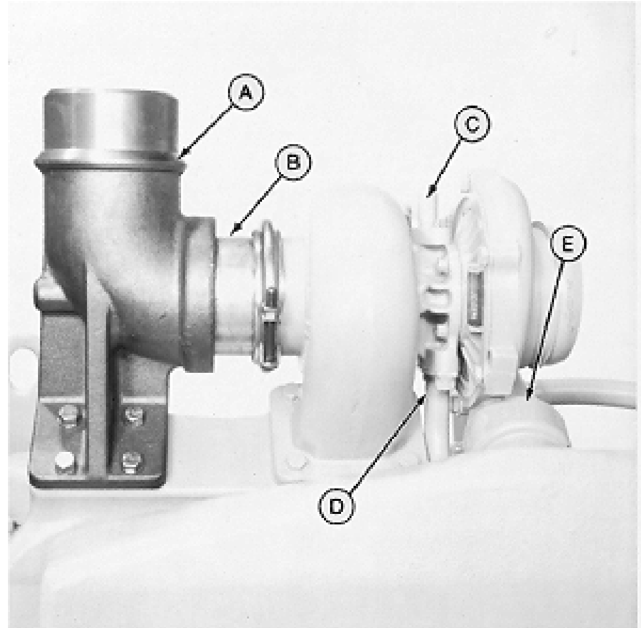
NOTE: Your 6076 Engine is equipped with either AiResearch/Garrett, Holset, or Schwitzer turbochargers. Removal and installation procedures are the same for all turbochargers, but repair of AiResearch/Garrett and Schwitzer differ. Refer to the proper repair section when repairing turbocharger. Repair parts are not available for Holset turbochargers; if defective, install a replacement.

2. Remove exhaust elbow (A). Remove clamp and exhaust adapter (B).

3. Disconnect oil inlet line (C). Loosen oil return tube cap screws using JDG626 Special Socket Adapter with JDE80 and standard 9/16 12-point, 3/8 in. drive socket and remove oil return tube (D). Discard gasket.

4. Remove four turbocharger mounting cap screws with washers and lift turbocharger from exhaust manifold. Disengage turbocharger from intake manifold coupling (E). Discard turbocharger-to-coupling O-ring.

5. Cap or plug all openings (exhaust and intake manifold related) and place turbocharger on a clean flat table for inspection.



6076A shown, 6076T and H similar

A—Exhaust Elbow
B—Exhaust Adapter
C—Oil Inlet Line
D—Oil Return Tube
E—Intake Manifold Coupling

S55,3005,G -19-12JUL91

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:

A—Compressor Housing Inlet and Compressor Wheel.
B—Compressor Housing Outlet.
C—Turbine Housing Inlet.
D—Turbine Housing Outlet and Turbine Wheel.
E—External Center Housing and Joints.
F—Internal Center Housing.
G—Turbo Bench Test.

NOTE: To enhance the turbocharger inspection, an inspection chart (following page) 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 note any problems.

S11,3005,IF -19-05MAR90

TURBOCHARGER FAILURE REPORT

Sales Branch or Region ____________________

Dealer ____________________

Town ____________ State ________ Date ________

Customer Name ____________ Delivery Date ________

Vehicle Model ____________ Serial No. ____________

Engine Model ____________ Serial No. ________ Hrs. ____

Failed Turbo Part No. ____________ Serial No. ________ Hrs. ____

Replacement Turbo Part No. ________ Serial No. ____________

REASON FOR TURBOCHARGER REMOVAL IN DETAIL ____________________

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Inspect Turbocharger Following the Steps Listed Below. Reference Appropriate Technical Information for Observed Failure Modes and Make Necessary Repairs to the Engine and/or Air Intake System.

Inspection Steps	Failure Modes	Check Appropriate Box
1 Compressor Housing Inlet and Compressor Wheel	Foreign Object Damage	☐
	Compressor Wheel Rub	☐
	No Defects	☐
	Other	☐
2 Compressor Housing Outlet	Oil and/or Dirt in Housing	☐
	No Defects	☐
	Other	☐
3 Turbine Housing Inlet	Oil in Housing	☐
	Center Wall Eroded	☐
	No Defects	☐
	Other	☐
4 Turbine Housing Outlet and Turbine Wheel	Foreign Object Damage	☐
	Turbine Wheel Rub	☐
	Oil and/or Excess Carbon	☐
	No Defects	☐
	Other	☐
5 External Center Housing and Joints	Leaks from Casting	☐
	Leaks at Joints	☐
	No Defects	☐
	Other	☐
6 Internal Center Housing	Excessive Carbon Build-Up in Housing or on Shaft	☐
	Excessively Discolored Shaft	☐
	No Defects	☐
	Other	☐
7 Turbo Bench Test	Restricted Shaft Rotation	☐
	Excessive Radial Play	☐
	Excessive Shaft Endplay	☐
	No Defects	☐
	Other	☐
8 Other	____________________	
	____________________	

RG5042 -19-09MAR90

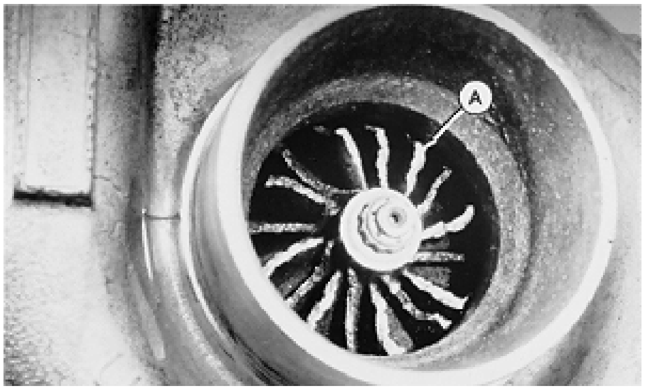
S11,3005,IV -19-05MAR90

A—COMPRESSOR HOUSING INLET AND COMPRESSOR WHEEL

1. Check compressor inlet and compressor wheel (A) for foreign object damage.

NOTE: Foreign object damage may be extensive or minor. In either case, the source of the foreign object must be found and corrected to eliminate further damages.

2. Mark findings on your checklist and continue the inspection.

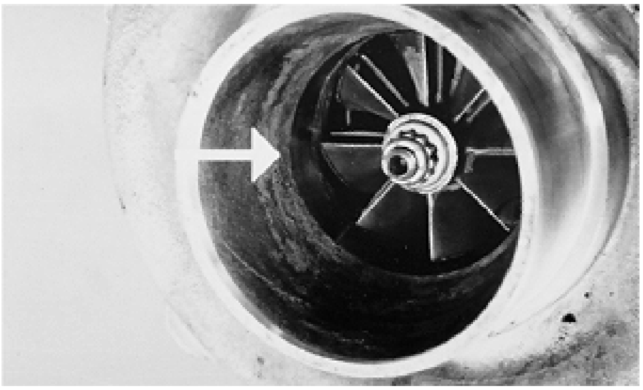


RG4523 -UN-20DEC88

S11,3005,IG -19-05MAR90

NOTE: You will need a good light source for this check.

3. Check compressor inlet for wheel rub on the housing (arrow). Look very closely for any score marks on the housing itself and check the tips of the compressor wheel blades for damage.



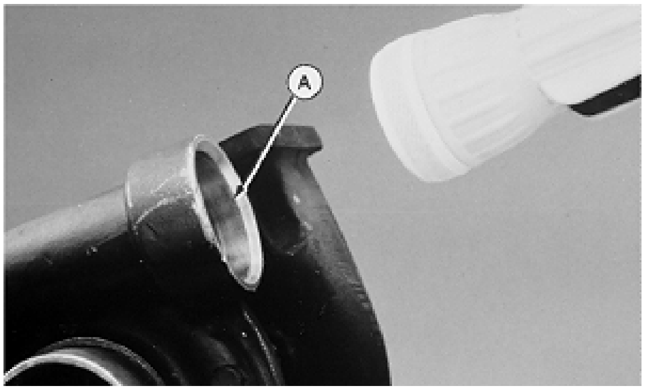
RG4524 -UN-20DEC88

S11,3005,IH -19-05MAR90

B—COMPRESSOR HOUSING OUTLET

1. Check compressor housing outlet (A). The outlet should be clean and free of dirt or oil.

2. Mark it on your checklist if dirt or oil is found and continue the inspection.



RG4525 -UN-20DEC88

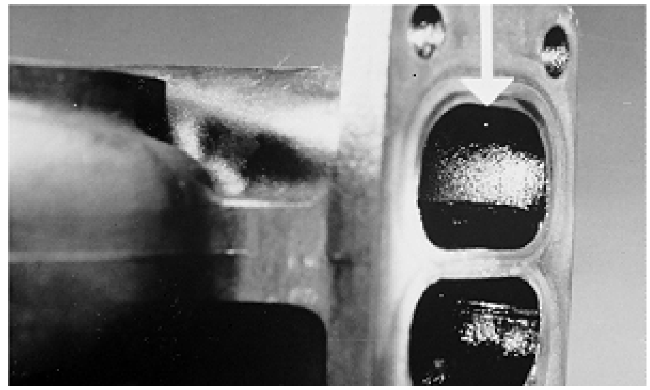
S11,3005,II -19-05MAR90

C—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.

2. Record defects on your checklist and continue inspection.



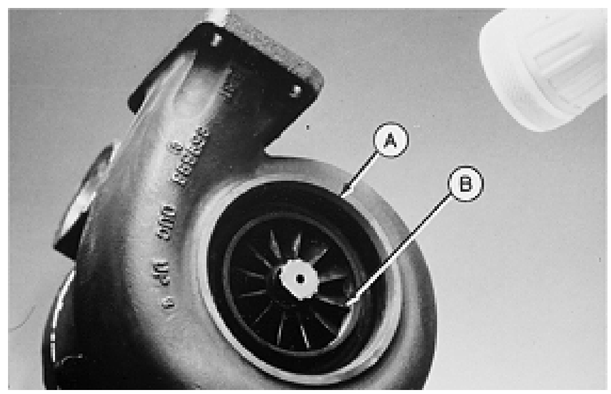
RG4526 -UN-20DEC88

S11,3005,IJ -19-05MAR90

D—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.

2. Note any damage on your checklist because inspection of the engine will be required.

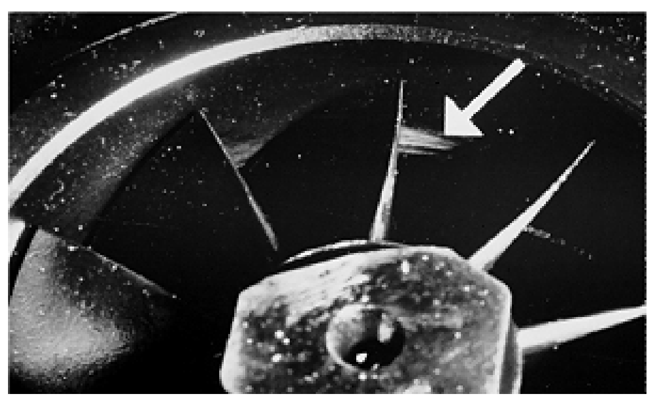


RG4527 -UN-20DEC88

S11,3005,IK -19-05MAR90

3. 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.

4. Note any excessive oil or carbon build-up on your checklist.



RG4528 -UN-20DEC88

S11,3005,IL -19-05MAR90

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E—EXTERNAL CENTER HOUSING AND JOINTS

1. Visually check the outside of the center housing, all connections to the compressor, and turbine housing for oil.

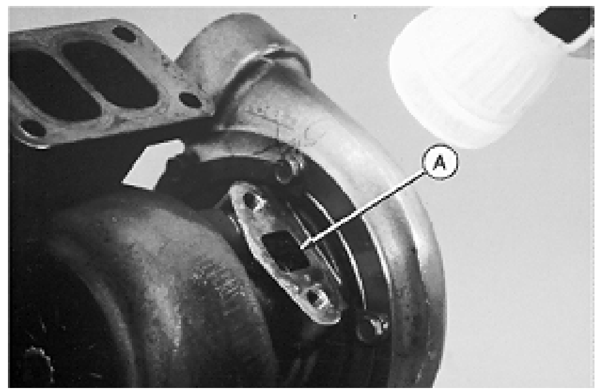
NOTE: If oil is present, make sure it is not coming from a leak at the oil supply or return line.

RG4529 -UN-20DEC88

S11,3005,IM -19-05MAR90

F—INTERNAL CENTER HOUSING

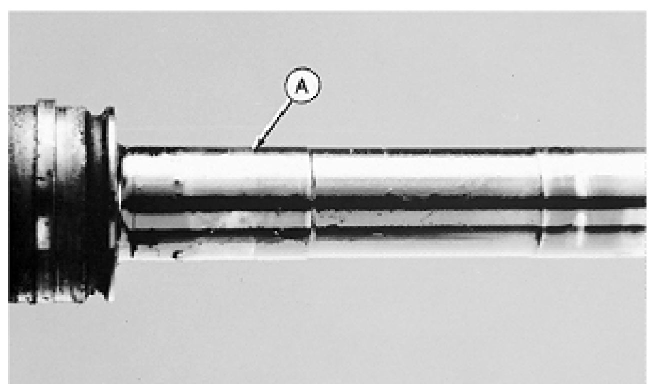
1. Using a flashlight, look through the oil return hole (A), to check the condition of the shaft and/or bearings. There should not be excess carbon deposits on the shaft or in the housing.



RG4530 -UN-20DEC88

S11,3005,IN -19-05MAR90

2. Excessive “blueing” or “coking” of oil along the complete length of the shaft (A) indicates a possible lack of lubrication caused by an engine failure, or improper operation, such as hot shutdowns.



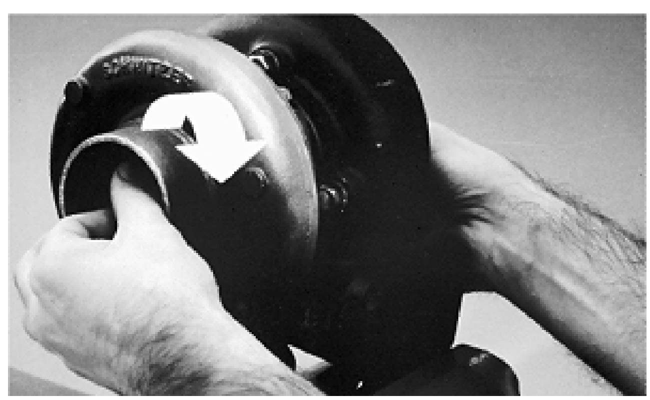
RG4531 -UN-20DEC88

S11,3005,IO -19-05MAR90

G—TURBO BENCH TEST

1. Mount the turbocharger in a vise.

2. Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely, however, there may be a slight amount of drag.

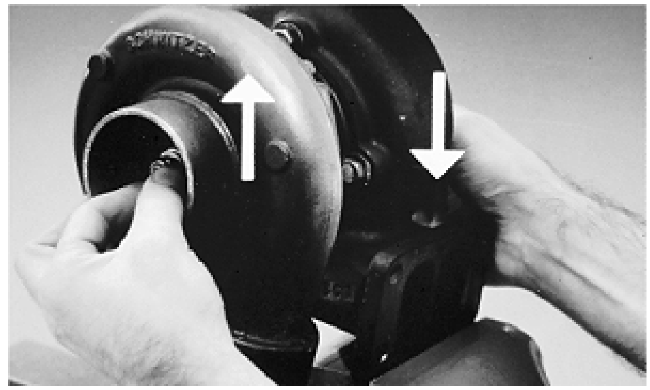


RG4532 -UN-20DEC88

S11,3005,IP -19-05MAR90

3. Next, pull up on the compressor end of the shaft and press down on the turbine end while rotating shaft. Neither the compressor wheel nor the turbine wheel should contact the housing at any point.

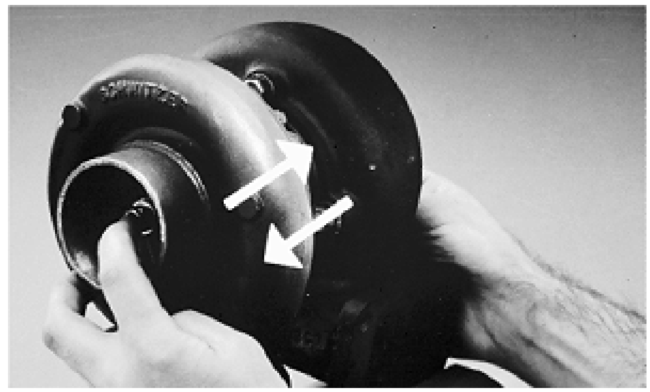
NOTE: There will be some “play” because the bearings inside the center housing are free floating.



RG4533 -UN-20DEC88

S11,3005,IQ -19-05MAR90

4. Next, check shaft endplay by moving the shaft back and forth while rotating. There will be some endplay but not to the extent that the wheels contact the housings.



RG4534 -UN-20DEC88

S11,3005,IR -19-05MAR90

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 Diagnosing Turbocharger Malfunctions, 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 bearing radial play and endplay with a dial indicator be performed. These procedures are not required if a failure mode has already been identified.

S11,3005,IS -19-05MAR90

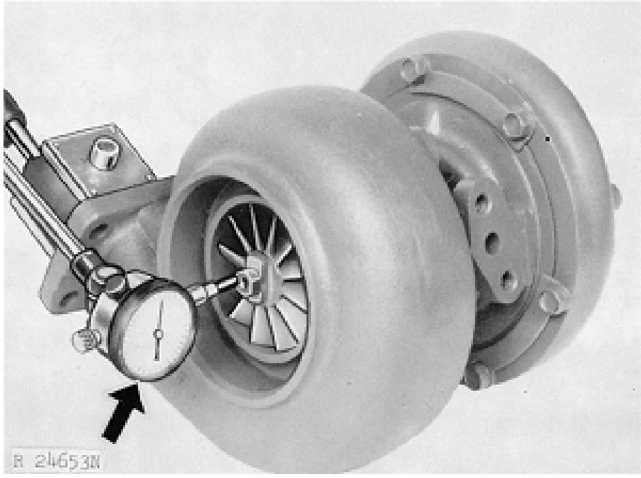
PERFORM AXIAL END PLAY BEARING TEST (SCHWITZER)

This test will give an indication of the condition of thrust bearing within the center housing and rotating assembly.

1. Mount a dial indicator (arrow) so indicator tip rests on flat surface on turbine end of shaft.

2. Move shaft axially back and forth by hand.

If total indicator reading is not within 0.05—0.13 mm (0.002—0.005 in.), the center housing and rotating assembly must be replaced. (See REPLACE CENTER HOUSING AND ROTATING ASSEMBLY, SCHWITZER).



R24653N -UN-20DEC88

S11,3005,JJ -19-12JUL91

PERFORM RADIAL BEARING CLEARANCE TEST (SCHWITZER)

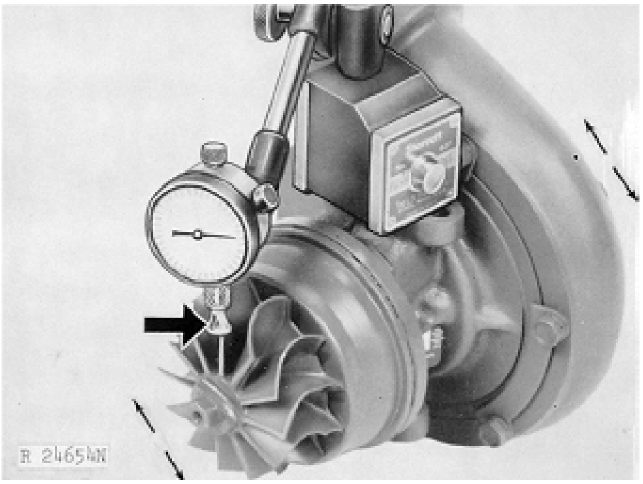
This test will give an indication of the condition of the radial bearing within the center housing and rotating assembly.

NOTE: Radial clearance check can be done with or without compressor cover attached.

1. Position a dial indicator [plunger-type with 25 mm (1.0 in.) travel] and check the radial shaft movement by moving shaft up and down.

Radial shaft movement should be a maximum 0.53 mm (0.021 in.).

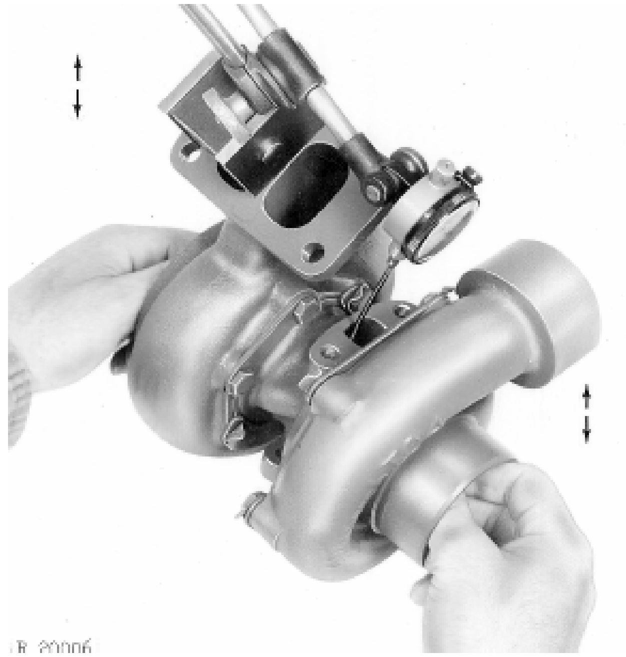
If bearing end play is not within specification, replace center housing and rotating assembly as explained later in this group. (See REPLACE CENTER HOUSING AND ROTATING ASSEMBLY, SCHWITZER).



R24654N -UN-20DEC88

S55,3005,AD -19-12JUL91

PERFORM RADIAL BEARING CLEARANCE TEST (AIRESEARCH)



R20006 -UN-20DEC88

This test will give an indication of the condition of radial bearings within the center housing and rotating assembly.

1. Use a maximum adapter and 51 mm (2.0 in.) indicator extension rod.

2. Fasten a dial indicator (plunger-type with 25 mm [1.0 in.] travel) to the turbocharger.

3. Move the rotating shaft toward the indicator and then away from the indicator. Use care to move the shaft in the same direction as the dial indicator travels.

4. Apply side pressure at both ends of the shaft toward the dial indicator.

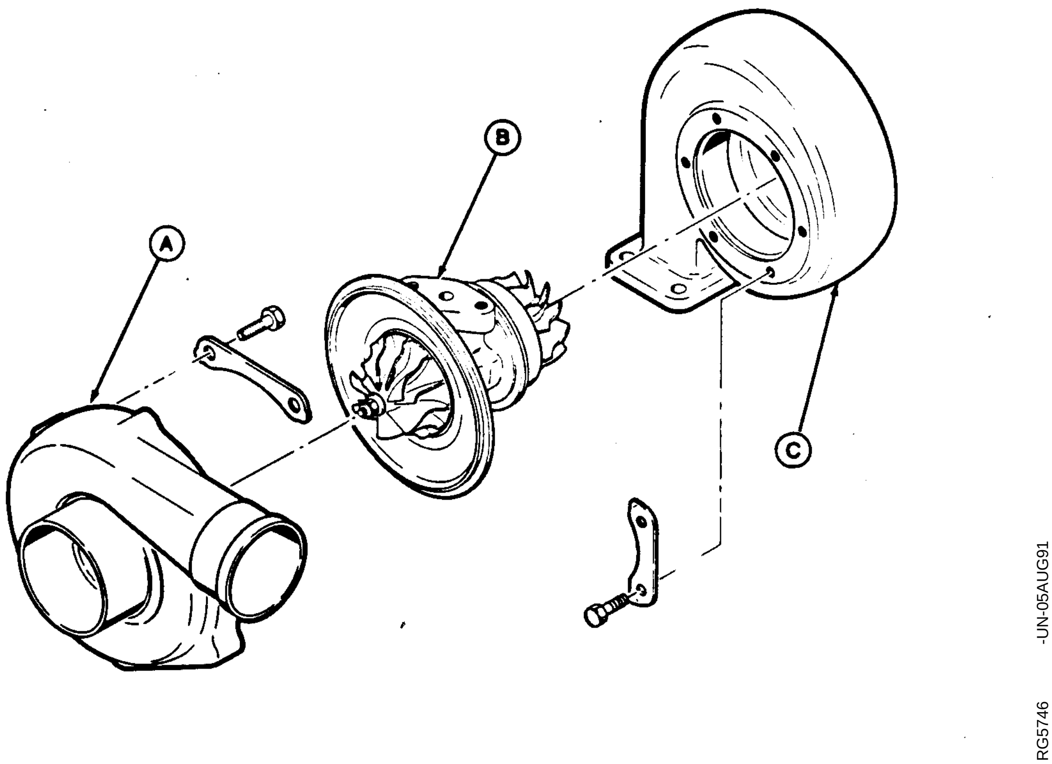
Equal pressure should be applied to both ends of the shaft at the same time.

5. Check total dial indicator movement to see that the range of travel is limited to 0.08—0.15 mm (0.003—0.006 in.).

If total indicator reading is not within 0.08—0.15 mm (0.003—0.006 in.), the center housing and rotating assembly must be replaced. (See REPLACE CENTER HOUSING AND ROTATING ASSEMBLY, AIRESEARCH).

S55,3005,J -19-12JUL91

DISASSEMBLE TURBOCHARGER



A—Compressor Housing **B—Center Housing and Rotating Assembly** **C—Turbine Housing**

The only available AiResearch and Schwitzer turbocharger service parts on 6076 Engines is the center housing and rotating assembly (B) or a completely remanufactured replacement turbocharger.

Holset only has available a remanufactured replacement turbocharger. Refer to the appropriate parts catalog for your engine application when ordering service parts.

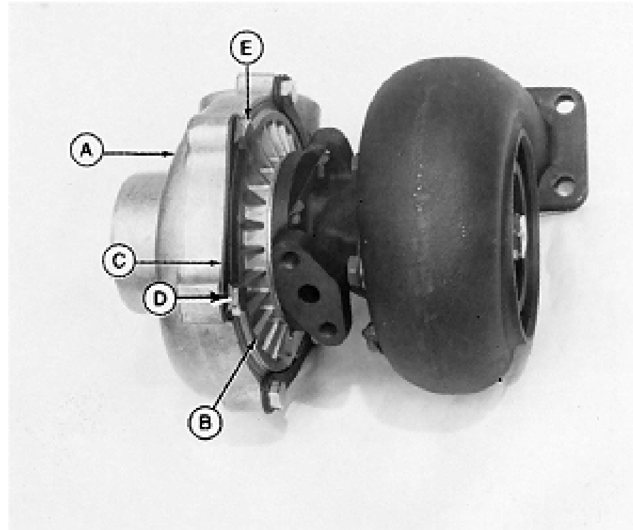
RG,CTM6,G30,1 -19-12JUL91

IMPORTANT: Use a scribe to mark a reference index position for the turbine, center, and compressor housings prior to disassembly. These reference marks are essential for proper indexing of turbine and compressor housings when turbocharger is reassembled.

1. Straighten ears on lock plates (D, if equipped). Remove cap screws (E), lock plates, and clamps (C).

NOTE: DO NOT press on center housing when disassembling turbocharger. Carefully remove turbine and compressor housings to eliminate any further damage.

2. Gently tap compressor housing (A) with a soft hammer, if necessary, to remove. Be careful not to damage compressor housing.



RG3945 -UN-20DEC88

A—Compressor Housing
B—Back Plate
C—Clamp
D—Lock Plate
E—Cap Screws

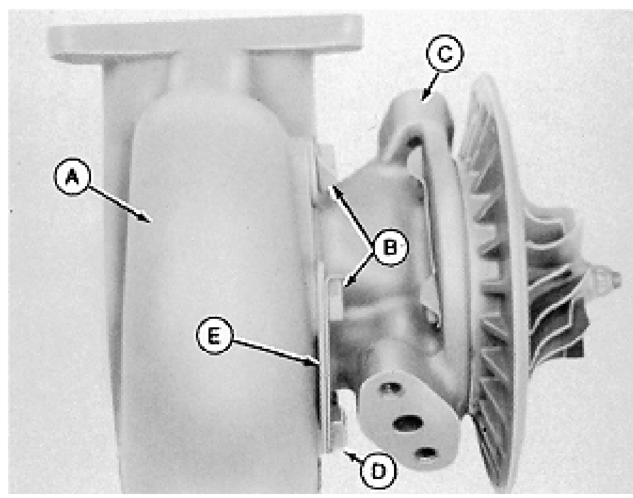
RG,CTM6,G30,2 -19-12JUL91

3. Straighten ears on lock plates (B, if equipped). Remove cap screws (D), lock plates, and clamps (E).

4. Gently tap turbine housing (A) with a soft hammer, if necessary, to remove. Be careful not to damage turbine housing.

5. Clean and inspect turbine and compressor housings as outlined later in this group.

A—Turbine Housing
B—Lock Plates
C—Center Housing and Rotating Assembly
D—Cap Screws (6 used)
E—Clamp



R26752 -UN-20DEC88

RG,CTM6,G30,3 -19-12JUL91

CLEAN AND INSPECT TURBINE AND COMPRESSOR HOUSINGS

1. Thoroughly clean the compressor and turbine housings using a commercially approved solvent only. Caustic solutions may damage housings. Dry housings with compressed air after cleaning.

2. Inspect turbine housing for:

• Wheel rub damage within the contour area that cannot be polished out with 60-grit silicon carbide abrasive cloth.

• Nicks, dents or warpage that could prevent proper sealing between the turbine housing and center housing.

• Corroded or stripped threaded mounting holes.

3. Inspect compressor housing for:

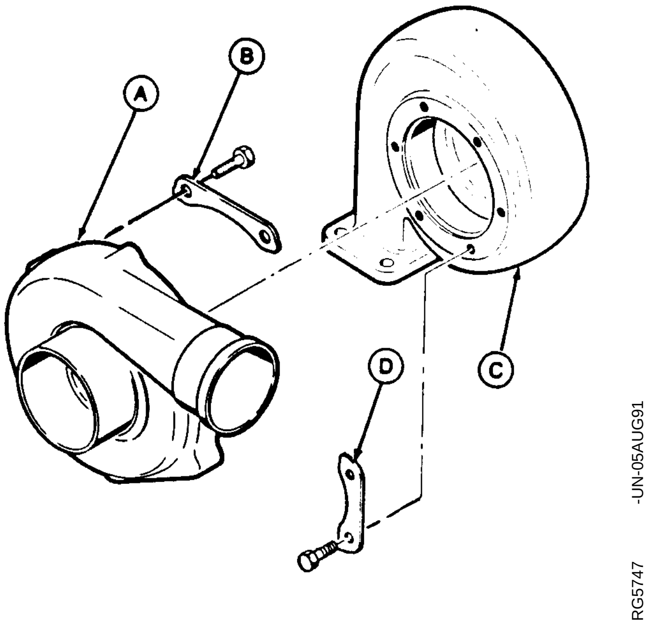
• Wheel rub damage within the contour area that cannot be polished out with 80-grit silicon carbide abrasive cloth.

• Nicks, dents, or warpage that could prevent proper sealing between the compressor housing and center housing.

• Corroded or stripped threaded mounting holes.

4. Clean all threads in housings with a tap. Clean all cap screws with a wire brush.

Replace either housing if any of the above defects are found.



A—Compressor Housing
B—Compressor Clamp
C—Turbine Housing
D—Turbine Clamp

RG,CTM6,G30,4 -19-12JUL91

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REPLACE CENTER HOUSING AND ROTATING ASSEMBLY

1. Carefully transfer the scribed marks from the original center housing (C) to the replacement assembly, if necessary. Use the same procedure for the turbine housing (A) and compressor housing if they are also being replaced.

NOTE: Coat threads of all cap screws with PT569 NEVER-SEEZ® Compound before installing.

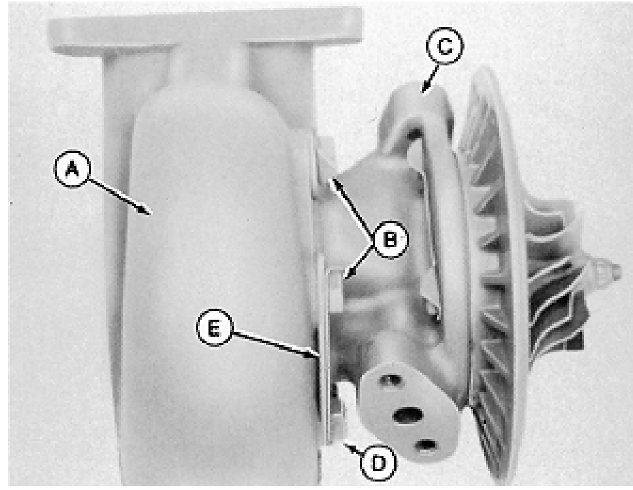
2. Lay turbine housing on it's side and install center housing and rotating assembly. Align scribed reference marks, install clamps (E), lock plates (B, if equipped), and capscrews.

3. Tighten turbine housing cap screws as follows:

• AiResearch........16—19 N·m (12—14 lb-ft)(140—170 lb-in.)

• Schwitzer.........16 N·m (12 lb-ft)(140 lb-in.)

4. Bend lock plate ears (if equipped) against heads of cap screws.



R26752 -UN-20DEC88

A—Turbine Housing
B—Lock Plate
C—Center Housing and Rotating Assembly
D—Cap Screw
E—Clamp

RG,CTM6,G30,5 -19-09SEP91

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5. Position compressor housing (A) onto center housing assembly. Align scribed reference marks on compressor housing and back plate (B).

NOTE: Coat threads of all cap screws with PT569 NEVER-SEEZ® Compound before installing.

6. Install clamps (C), lock plates (D, if equipped) cap screws (E).

7. Tighten compressor housing cap screws as follows:

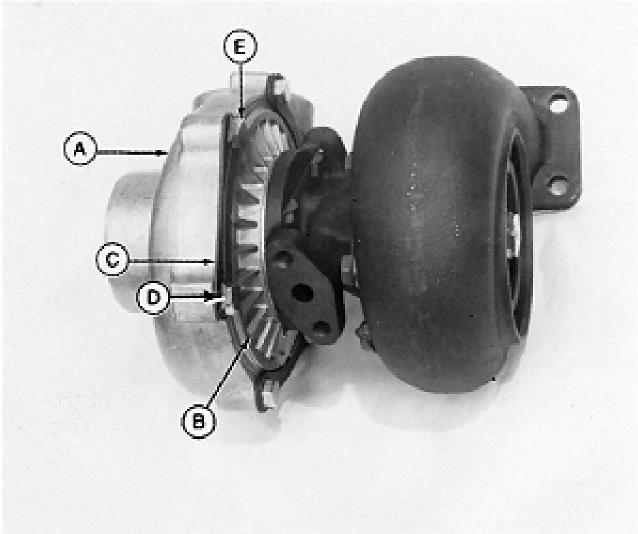
• AiResearch........16—19 N·m (12—14 lb-ft)(140—170 lb-in.)

• Schwitzer.........16 N·m (12 lb-ft)(140 lb-in.)

IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

8. After assembly, spin rotating assembly by hand to check for binding and wheel rub. If either condition exists, disassemble turbocharger and determine the cause.

9. Prelube bearing of rotating assembly with clean engine oil before putting turbocharger into service.



A—Compressor Housing
B—Compressor Back Plate
C—Clamp
D—Lock plate
E—Cap Screw

RG,CTM6,G30,6 -19-09SEP91

PRELUBE TURBOCHARGER

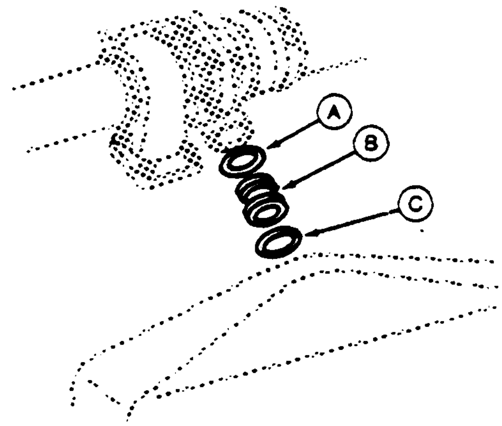
IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

1. Fill oil inlet or return (drain) port with clean engine oil and spin rotating assembly by hand to properly lubricate bearings.

If turbocharger is to be stored for an extended period of time, lubricate internally and install protective covers on all openings.

RG,CTM6,G30,7 -19-09SEP91

INSTALL TURBOCHARGER



R26788 -UN-20DEC88

IMPORTANT: If turbocharger failed because of foreign material entering the air intake system, be sure to examine the system and clean as required to prevent a repeat failure.

Just prior to mounting the turbocharger, prime the turbocharger lubrication system. Fill the center housing with clean engine oil through the oil inlet hole. Turn the rotating assembly by hand to lubricate the bearings.

Inspect the air cleaner-to-turbocharger hose to see that it is in good condition. Replace hose if it is hard, cracked or shows any signs of deterioration.

1. On 6076T Engines, coat new O-ring with liquid soap and install on coupling.

2. Position coupling onto intake manifold inside sealing hose. Tighten hose clamps securely.

3. On 6076A Engines, coat O-rings (A and C) with grease and install on coupling (B).

4. On all engines, position a new sealing gasket (not shown) on turbocharger-to-exhaust manifold mounting surface.

RG,CTM6,G30,8 -19-12JUL91

NOTE: Coat coupling O-rings with liquid soap or grease as an aid during assembly.

5. Mount turbocharger on engine, making sure compressor housing is properly seated in coupling (E).

NOTE: Guide studs may be used to securely position exhaust gasket during turbocharger installation.

6. Apply PT569 NEVER-SEEZ® Compound or equivalent to all turbocharger mounting cap screws. Install cap screws and tighten to 24 N·m (18 lb-ft).

NOTE: Remove all caps or plugs from turbocharger openings.

7. Using a new gasket, install oil return tube (D). Tighten cap screws securely using JDG626 Special Socket Adapter with JDE80 and standard 9/16, 12-point, 3/8 in. drive socket. Connect oil inlet line (C) and tighten securely.

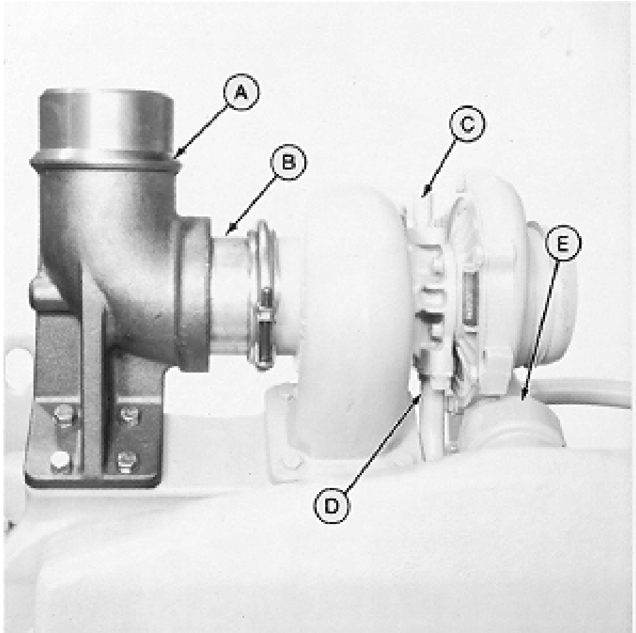
8. Install exhaust adapter (B) to turbine housing outlet with V-band clamp. Tighten clamp securely.

9. Install exhaust elbow (A). Apply PT569 NEVER-SEEZ Compound or equivalent to mounting cap screws and tighten to 24 N·m (18 lb-ft).

10. Inspect the air cleaner-to-turbocharger hoses to see that they are in good condition. If they are not, replace with new one. Install air intake hose and tighten hose clamps securely.

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.

11. Start and run engine at low idle. Check oil inlet and air intake piping connections for leaks.



RG5283 -UN-20DEC88

A—Exhaust Elbow
B—Exhaust Adapter
C—Turbocharger Oil Inlet
D—Turbocharger Oil Return
E—Coupling

S55,3005,Q -19-09SEP91

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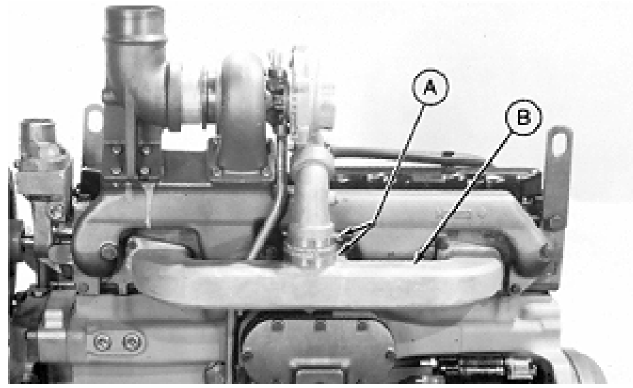
25

REMOVE AND INSPECT INTAKE MANIFOLD (6076T AND 6076H ENGINES)



RG5285 -UN-20DEC88

IMPORTANT: All intake manifold connections at the turbocharger and engine cylinder head must be tight to prevent loss of power resulting from lower manifold pressure.

Intake manifold piping and cap screw torque should be checked periodically and kept tight.

Whenever a tune-up has been performed on the engine, or whenever it is suspected that the horsepower output might be low, the intake manifold pressure should be checked. (See CHECK INTAKE MANIFOLD PRESSURE in Group 110.)

1. On 6076T Engines, loosen hose clamps (A) on lower air intake hose.

2. On 6076H Engines, remove connections from compressor outlet and intake manifold (B).

3. Disconnect aneroid line from intake manifold, if equipped.

4. Disconnect ether starting aid line from intake manifold, if equipped.

5. Remove six cap screws securing intake manifold to cylinder head and remove manifold. Remove and discard all gaskets.

6. Inspect the intake manifold for general condition. Always repair or replace manifold if it has cracked or is not sound in every way.

7. Inspect the machined mating surfaces of cylinder head and intake manifold. Clean, as required, by using a scraper and/or wire brush, and compressed air.

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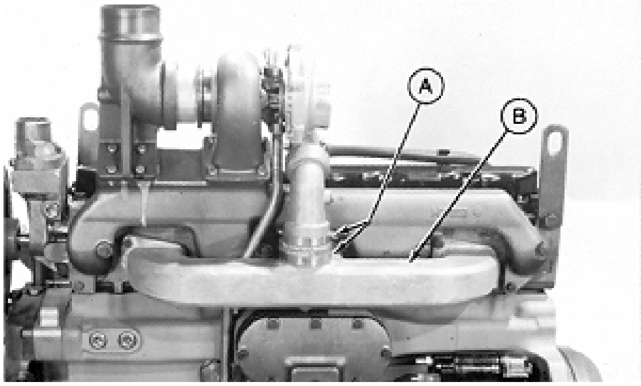
S55,3005,U -19-12JUL91

INSTALL INTAKE MANIFOLD (6076T AND 6076H ENGINES)



RG5285 -UN-20DEC88

1. Use a new gasket and install intake manifold (B).

2. Install cap screws and tighten to 47 N·m (35 lb-ft).

3. On 6076T Engines, be sure lower intake hose clamps (A) are properly positioned. Tighten hose clamps securely.

4. Install ether starting aid pipe and aneroid line, if equipped. Tighten all connections securely.

5. Check intake manifold pressure. (See CHECK INTAKE MANIFOLD PRESSURE in Group 110.)

S55,3005,S -19-12JUL91

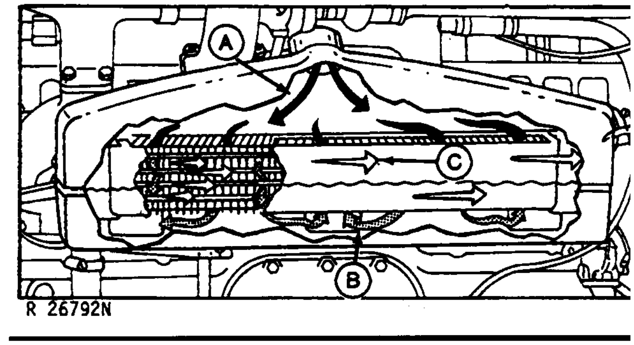
HOW THE AFTERCOOLER WORKS—6076A ENGINES

Early production engines were produced with a single-pass aftercooler (Upper Illustration), current production engines are equipped with a dual-pass aftercooler (Lower Illustration)

Air entering the intake manifold has been compressed (and heated) by the turbocharger. As this heated, compressed air (A) enters the intake manifold, it flows around the aftercooler before entering the engine cylinders.

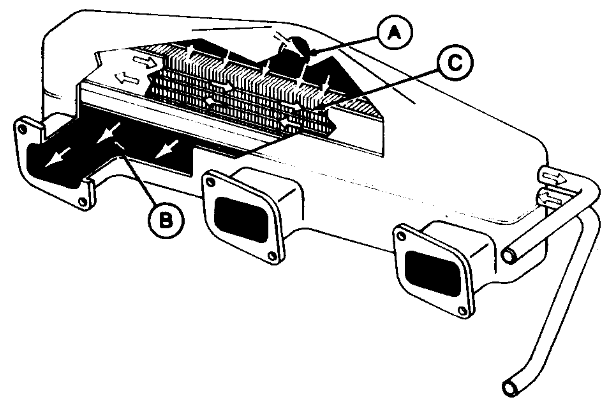
The aftercooler functions as a heat exchanger, lowering the intake air (B) temperatures as much as 27—32˚C (80—90˚F) on single-pass aftercoolers and as much as 35—47˚C (95—116˚F) on dual-pass aftercoolers. Lowering the air temperature makes the air more dense, permitting an even greater volume (compared with not having an aftercooler) to be delivered to the engine cylinders. This increased volume of air, when combined with a predetermined quantity of additional fuel, produces more power.

Engine coolant (C) circulating through the aftercooler core is the media used for heat exchange. Extreme care must be exercised to insure that the engine coolant does not leak into the intake manifold, resulting in possible damage to the engine.



R26792N -UN-27OCT88

Single-Pass Aftercooler



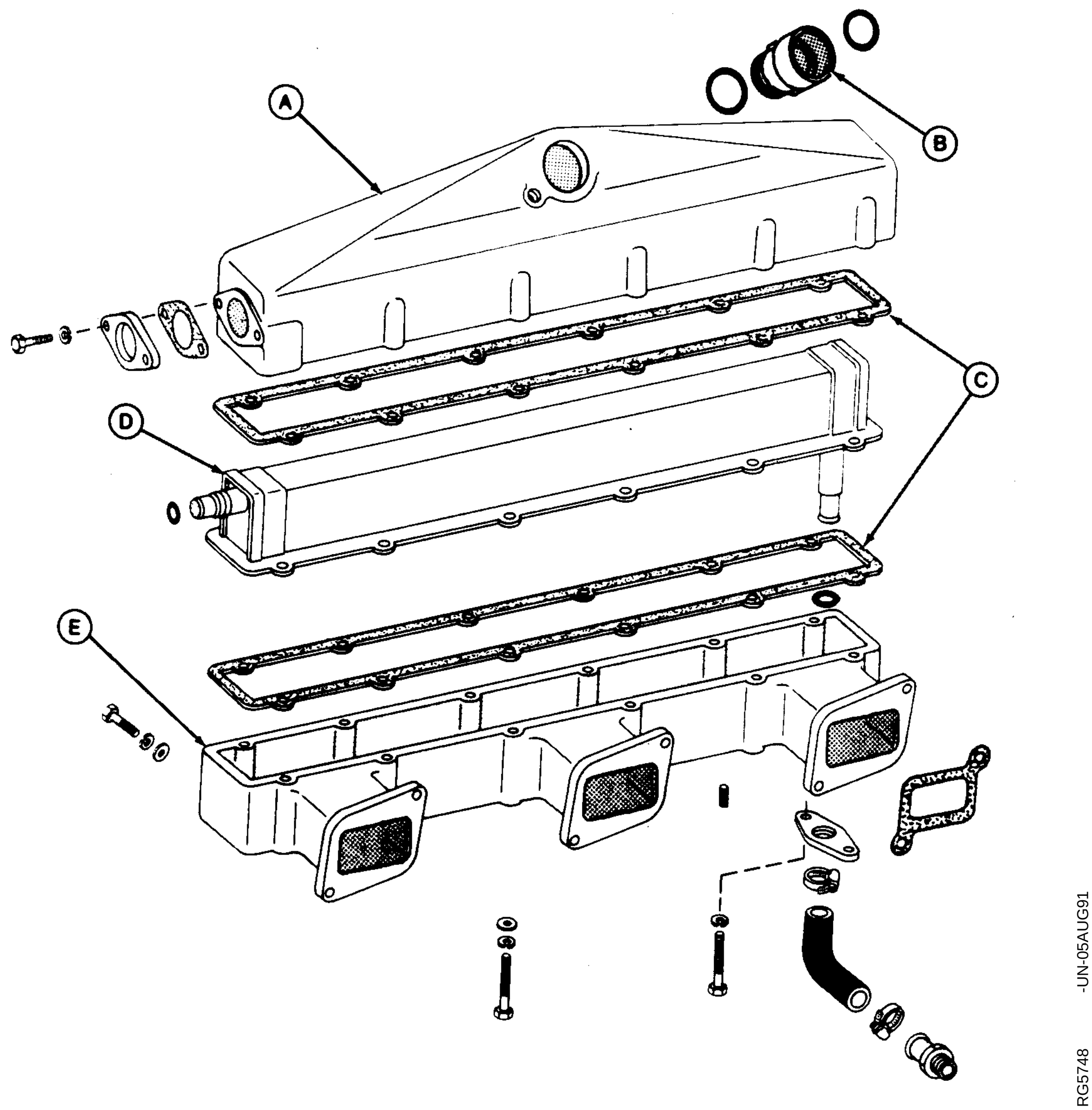
RG5972 -UN-24SEP91

Dual-Pass Aftercooler

A—Heated Air
B—Cooled Air
C—Engine Coolant

S55,23005,D -19-18SEP91

SINGLE-PASS AFTERCOOLER ASSEMBLY

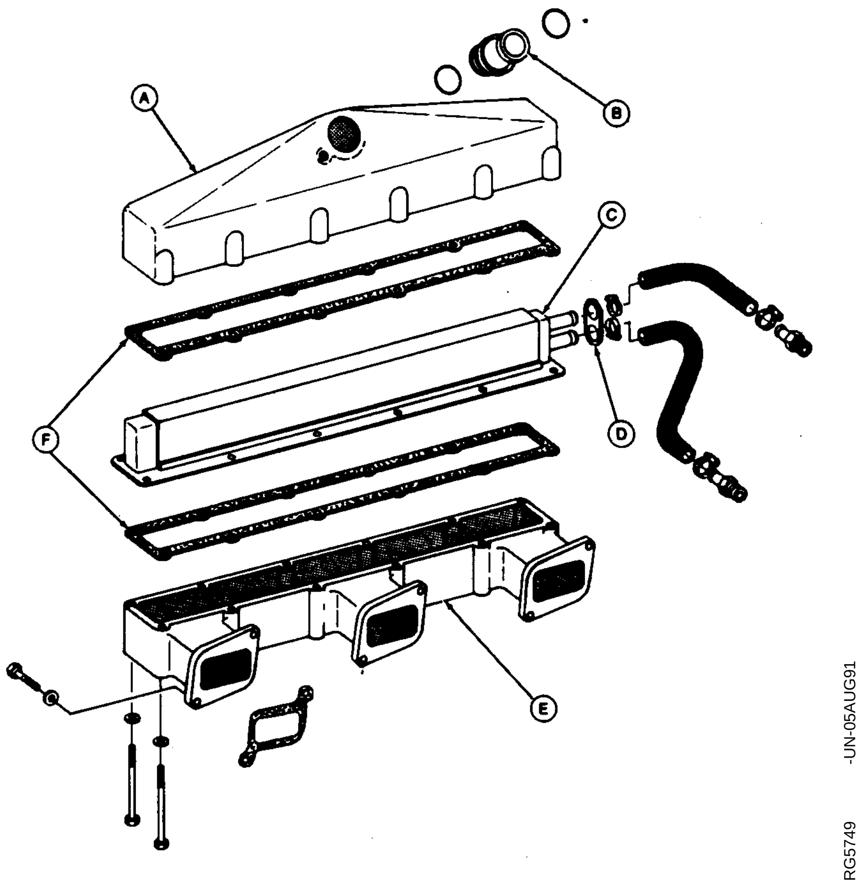


A—Aftercooler Cover
B—Coupling
C—Gasket (2 used)
D—Aftercooler
E—Intake Manifold

Single-Pass Aftercooler Assembly

RG,CTM6,G30,9 -19-12JUL91

TWO-PASS AFTERCOOLER ASSEMBLY



A—Aftercooler Cover
B—Coupling
C—Aftercooler
D—Seal Ring
E—Intake Manifold
F—Gaskets (2 used)

Two-Pass Aftercooler Assembly

RG,CTM6,G30,10 -19-12JUL91

REMOVE AFTERCOOLER AND INTAKE MANIFOLD (6076A ENGINES)

Removal of the single-pass aftercooler and two-pass aftercooler are similar, differences will be noted.

CAUTION: Do not drain engine coolant until the coolant temperature is below operating temperature. Next, open drain cock slowly to relieve any excess pressure.

1. Thoroughly clean exterior of turbocharger, intake manifold and adjacent areas to prevent entry of dirt into the engine when parts are removed.

2. Remove turbocharger as described earlier in this group.

3. Loosen clamps on inlet and outlet hoses. Remove hoses from aftercooler.

4. Remove front and rear adapter plates (A).

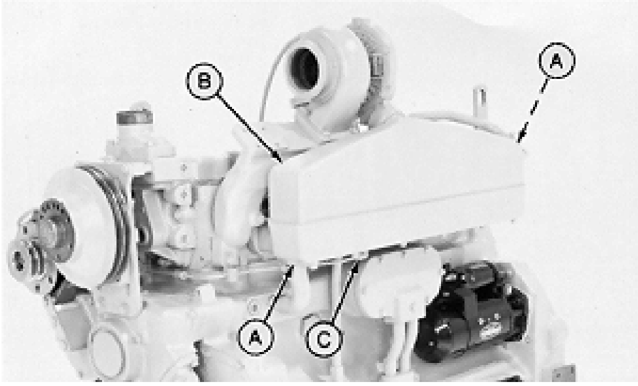
5. Remove aneroid-to-intake manifold connector (C), if equipped.

6. Remove all intake manifold cover (B) cap screws.

7. Carefully lift aftercooler with cover from intake manifold. Place cover on a clean flat surface.

8. Remove aftercooler from cover. Remove and discard gaskets and O-rings or seal ring.

9. Remove all intake manifold-to-cylinder head cap screws and remove intake manifold. Remove and discard all manifold gaskets.



RG5286 -UN-20DEC88

Single-pass aftercooler shown

S55,3005,V -19-09SEP91

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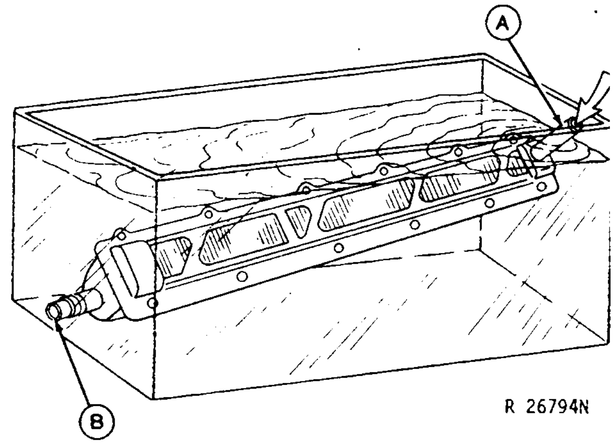
31

INSPECT AND REPAIR AFTERCOOLER (6076A ENGINES)



-UN-20DEC88

R26794N

Single-pass aftercooler shown, two-pass similar.

1. Inspect aftercooler for overall condition. The fins should be reasonably straight. Check entire assembly for fatigue or cracks, especially the cross straps surrounding the fins.

2. Inspect aftercooler inlet and outlet hoses. Replace either tube if cracked or damaged.

3. Test the aftercooler for leaks by plugging coolant outlet nipple (B).

4. Apply compressed air to the coolant inlet opening (A) 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 by a qualified radiator shop. 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 solvent and dry with compressed air.

S55,3005,W -19-09SEP91

INSPECT AND REPAIR INTAKE MANIFOLD (6076A ENGINES)

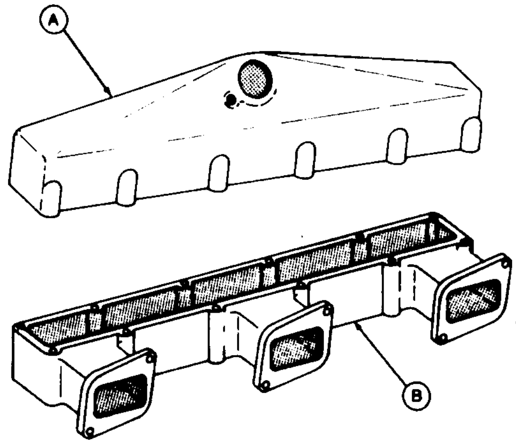
1. Check intake manifold (B) and aftercooler cover (A) for damage.

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 aftercooler cover.

IMPORTANT: Do not use a hot tank to clean aluminum parts as damage and severe deterioration can occur.

4. Scrape all gasket material from cylinder head and intake manifold mounting surfaces.



RG5750 -UN-05AUG91

S55,3005,X -19-09SEP91

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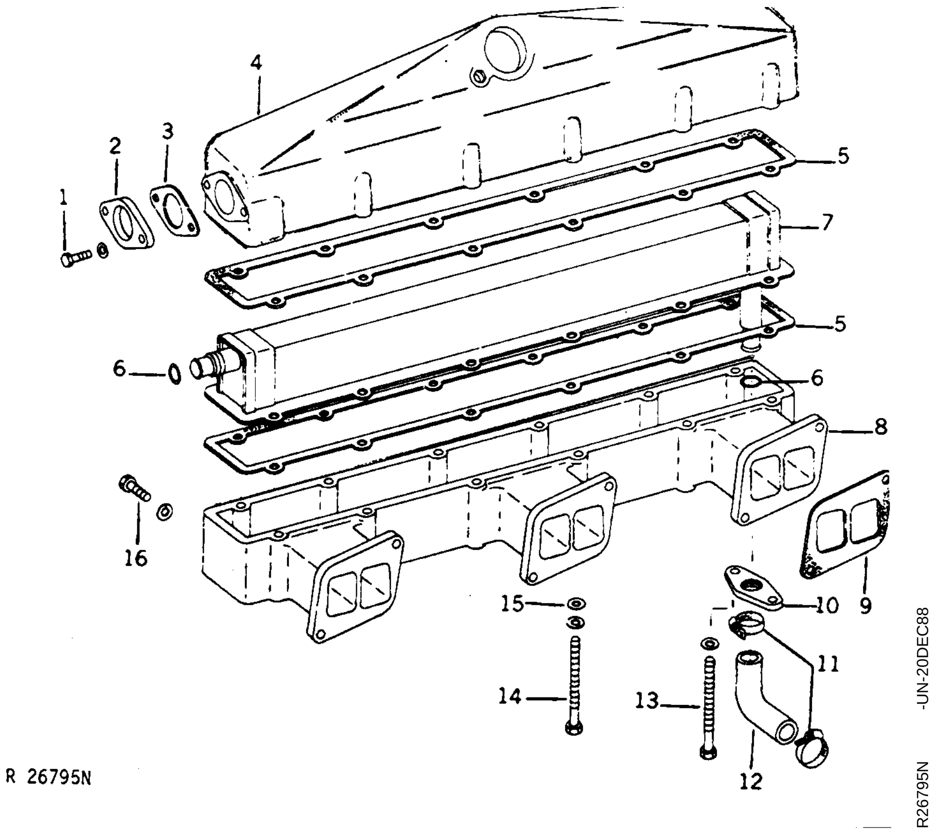
33

INSTALL INTAKE MANIFOLD AND SINGLE-PASS AFTERCOOLER (6076A ENGINES)



1—Cap Screw	**5—Gasket (2 used)**	**9—Gasket**	**13—Cap Screw (2 used)**
2—Rear Adapter Plate	**6—O-Ring**	**10—Front Adapter Plate**	**14—Cap Screw (10 used)**
3—Gasket (2 used)	**7—Aftercooler**	**11—Hose Clamp (2 used)**	**15—Flat Washer (10 used)**
4—Cover	**8—Intake Manifold**	**12—Inlet Hose**	**16—Cap Screw (6 used)**

Single-Pass Aftercooler Assembly

NOTE: Install the O-ring (6) in bore of front adapter plate (10). Place adapter plate (with O-ring bore toward manifold) on manifold and insert cap screw (13) with lock washer through adapter plate and into manifold.

S55,3005,Y -19-12JUL91

IMPORTANT: Make sure that the manifold is clean inside before assembly.

Install cap screws with washers in third and fourth inside holes (from front of engine) in intake manifold (directly over oil cooler) BEFORE installing manifold onto cylinder head and secure cap screws until manifold is installed. Cap screws can not be installed after manifold is installed.

1. Install the intake manifold onto cylinder head using new gaskets.

2. Apply PT569 NEVER-SEEZ Compound to all manifold cap screws. Install cap screws and tighten to 47 N·m (35 lb-ft).

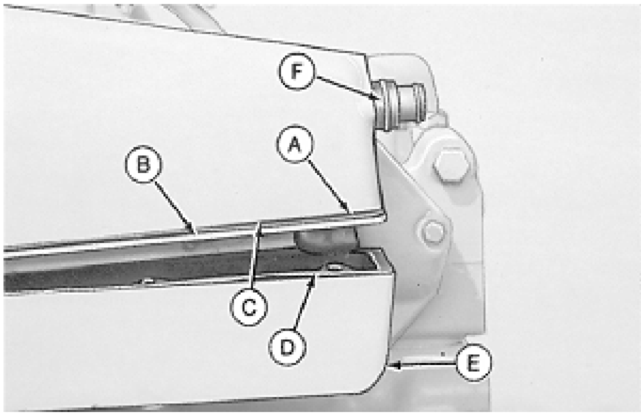
NOTE: Guide studs may be used to align gaskets, aftercooler and cover during assembly.

3. Position new upper gasket (A) on top of aftercooler (B).

4. Install a new O-ring (F) on aftercooler inlet and outlet nipple. Install aftercooler into intake manifold cover (C).

5. Position new lower gasket (D) on intake manifold (E).

6. Position cover and aftercooler on manifold. Use guide studs to assure proper alignment.



RG3949 -UN-20DEC88

A—Upper Gasket
B—Aftercooler
C—Manifold Cover
D—Lower Gasket
E—Intake Manifold
F—O-Ring (2 used)

RG,CTM6,G30,13 -19-09SEP91

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35

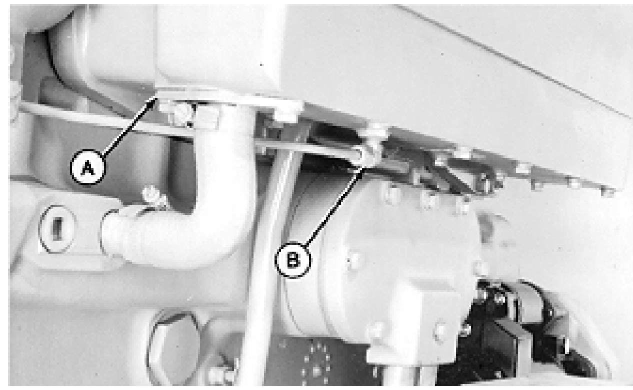
NOTE: Apply PT569 NEVER-SEEZ Compound to all intake manifold-to-aftercooler cover cap screws before installing cap screws.

7. Align cover and gaskets and install all intake manifold-to-cover cap screws with lock washers and flat washers. Tighten cap screws to 34 N·m (25 lb-ft).

8. Install inlet adapter plate (A). Tighten cap screws to 34 N·m (25 lb-ft). Install inlet hose on nipple and tighten hose clamp securely.

IMPORTANT: All intake manifold and aftercooler must be tight to prevent severe engine damage from dusting. As you know, dirt is extremely abrasive and can rapidly wear internal engine parts.

9. Install aneroid-to-intake manifold pipe (B), if equipped. Tighten securely.

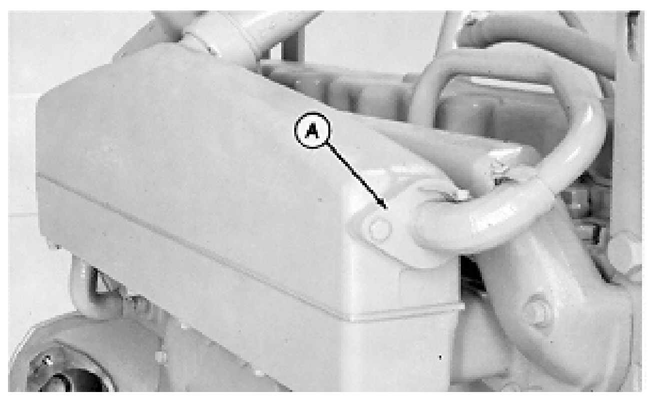


RG5969 -UN-13SEP91

S55,3005,Z1 -19-10SEP91

10. Install outlet adapter plate (A) on rear end of aftercooler cover. Tighten cap screws to 34 N·m (25 lb-ft). Install outlet hose on nipple and tighten hose clamp securely.

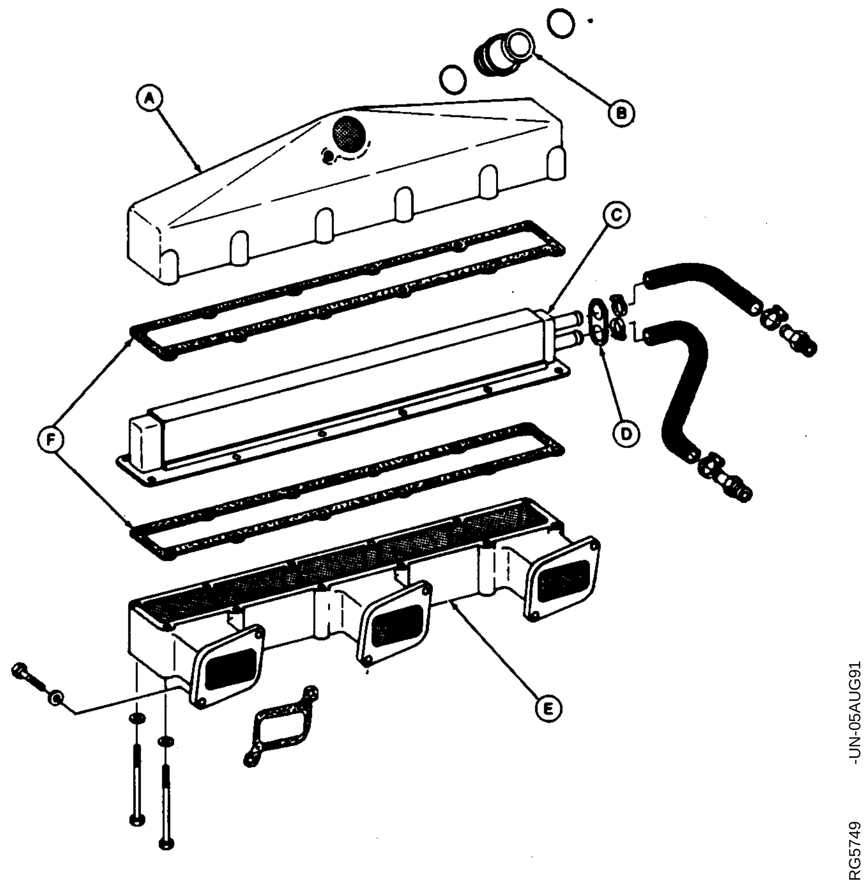
11. Install turbocharger as described earlier in this group. (See INSTALL TURBOCHARGER.)



RG5970 -UN-13SEP91

S55,3005,Z2 -19-09SEP91

INSTALL INTAKE MANIFOLD AND TWO-PASS AFTERCOOLER (6076 ENGINES)



A—Cover
B—Intake Coupling
C—Aftercooler
D—Sealing Ring
E—Intake Manifold
F—Gasket (2 used)

Two-Pass Aftercooler Assembly

IMPORTANT: Make sure that the inside of intake manifold (E) is clean before assembly.

Install cap screws with washers in third and fourth inside holes (from front of engine) of intake manifold (directly over oil cooler) BEFORE installing manifold onto cylinder head and secure cap screws until manifold is installed. Cap screws can not be installed after manifold is installed.

1. Install the intake manifold onto cylinder head using new gaskets.

2. Apply PT569 NEVER-SEEZ Compound to all manifold cap screws. Install cap screws and tighten to 47 N·m (35 lb-ft).

3. Using new gaskets (F) and sealing ring (D), install aftercooler into intake manifold.

IMPORTANT: Make sure sealing ring is properly positioned in intake manifold and not crimped.

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RG,CTM6,G30,11 -19-09SEP91

4. Position cover (A) over aftercooler assembly. Install JDG683 Sealing Ring Compression Tool (B) onto aftercooler nipple (C) with crossbar across slot as shown.

Tool is designed to pull on aftercooler nipples while pushing on cover to compress sealing gasket (as tool is tightened).

5. Tighten tool until mounting holes in cover, aftercooler, gaskets and intake manifold are all aligned.

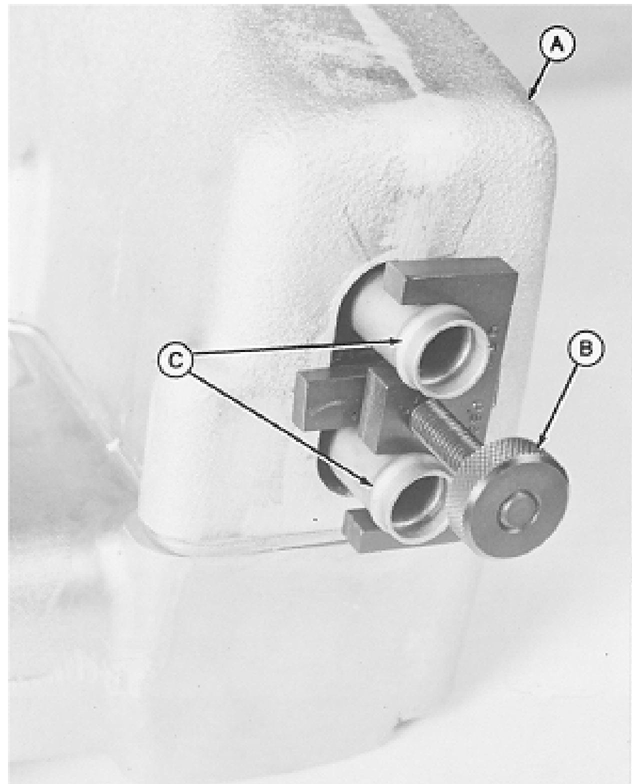
6. Apply PT569 NEVER-SEEZ Compound to all intake manifold-to-cover cap screws and tighten to 34 N·m (25 lb-ft).

7. Install coolant inlet and outlet hoses. Tighten connections securely.

8. Install aneroid-to-intake manifold pipe.

IMPORTANT: All intake manifold and aftercooler must be tight to prevent severe engine damage from dusting. As you know, dirt is extremely abrasive and can rapidly wear internal engine parts.

9. Install turbocharger as detailed earlier in this group.



RG5570 -UN-09JAN90

RG,CTM6,G30,12 -19-10SEP91

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38

REMOVE, INSPECT, INSTALL EXHAUST MANIFOLD ASSEMBLY

1. Remove turbocharger and air intake assembly as described earlier in this group.

2. Remove turbocharger oil return pipe (D).

3. Remove cap screws and lift off front exhaust manifold (A) and rear exhaust manifold (B).

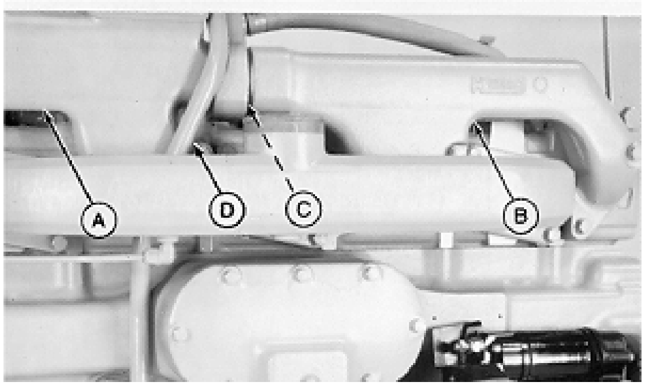
4. Remove and discard front-to-rear exhaust manifold sealing ring (C).

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

6. Thoroughly clean passages in exhaust manifolds and exhaust elbow.

7. Inspect each exhaust manifold for cracks or damage and replace parts as necessary.

NOTE: Apply PT569 NEVER-SEEZ Compound to all exhaust manifold cap screws prior to assembly.



RG5255 -UN-06DEC88

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

S55,3005,AA -19-09SEP91

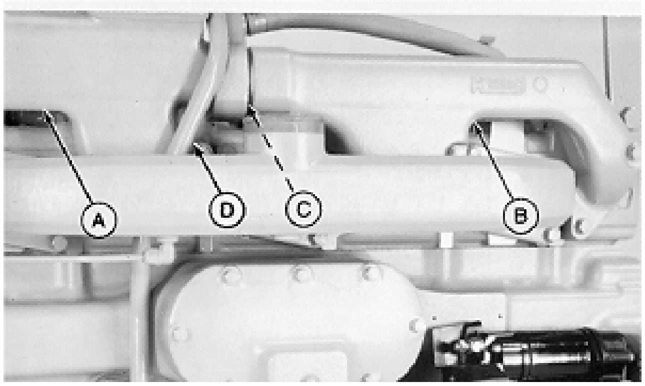
8. Install front exhaust manifold (A) using new gaskets. Do not tighten cap screws.

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

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

11. Coat a new O-ring with clean engine oil and install turbocharger oil return pipe (D).

12. Install air intake assembly and turbocharger as described earlier in this group.



RG5255 -UN-06DEC88

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

S55,3005,AB -19-09SEP91

SPECIAL OR ESSENTIAL TOOLS

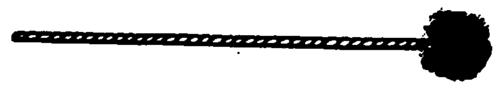
NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-05JUN91

RG5099 -UN-23AUG88

Nozzle Thread Cleaning Brush D17030BR

Used to clean nozzle threads in cylinder head.



S53,D17030,BR -19-16FEB87

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

Used to rotate engine flywheel when timing injection pump. Use with JDE81-4.

S53,JDE811,A -19-02DEC87

RG5068 -UN-23AUG88

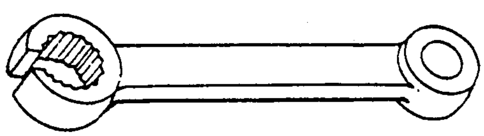
Timing Pin JDE81-4

Used to lock engine at TDC when timing injection pump. Use with JDE81-1.

S53,JDE814,B -19-02DEC87

Serrated Wrench JDE90

Use to hold injection pump fuel outlet fittings on Bosch “P” pump from turning when loosening and tightening fuel pipe connections.

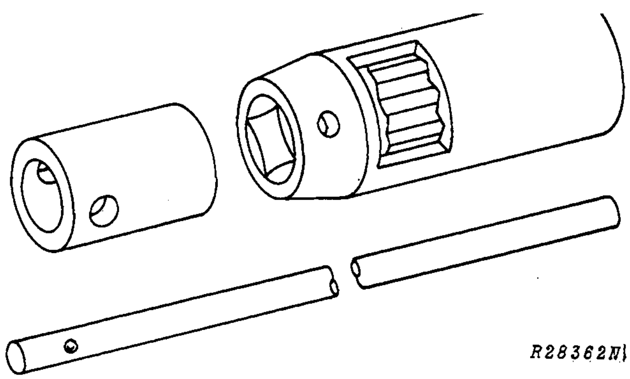


RG5290 -UN-23AUG88

S54,JDE90 -19-09SEP91

Nozzle Socket JDE92

Used to remove and install 21 mm injection nozzles.



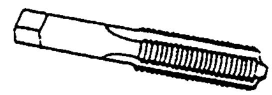
R28362N -UN-20DEC88

S11,3010,OU -19-09SEP91

RG5100 -UN-23AUG88

Tap JDF5

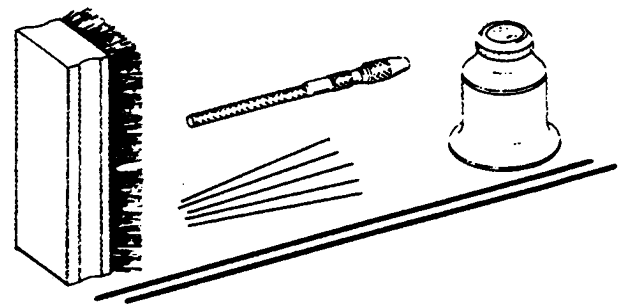
Used to restore nozzle threads in cylinder head.



S53,JDF5 -19-16FEB87

Nozzle Cleaning Kit JDF13 (JDE105)

Used to clean injection nozzles.

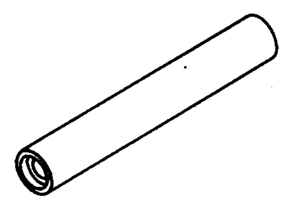


RG4953 -UN-14DEC88

S11,3010,OW -19-09SEP91

Driver JDF15

Used to install spindle seals in fuel supply pumps.



RG2017

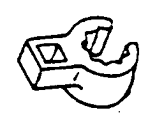
RG2017 -UN-30NOV88

S55,3010,BA -19-25JUL91

RG5288 -UN-23AUG88

Crowsfoot Wrench JDF22

Use to loosen and tighten fuel pipes at injection nozzles and at injection pump.

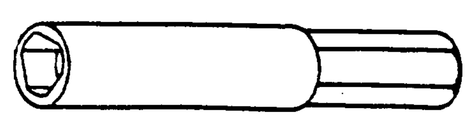


S53,JDF22,1 -19-02DEC87

RG5287 -UN-23AUG88

Special Socket JDF33

Used to loosen and tighten fast idle stop screw on Nippondenso injection pumps when adjusting engine speeds.

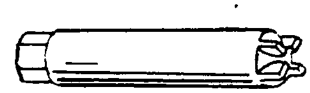


S53,JDF33 -19-02DEC87

RG5289 -UN-23AUG88

Nozzle Seat Reamer JDG609

Used to clean carbon from nozzle seats in cylinder head.



S53,JDG609 -19-02DEC87

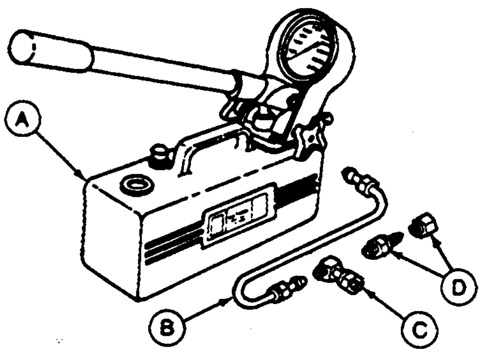
A—Fuel Injection Nozzle Tester . . . D01109AA (Y900)

B—Fuel Line Assembly Y900-2A*

C—Adapter Nut Y900-21**

D—Straight Adapters . . . . Y900-7* and Y900-15*

Used to test operational performance and opening pressure of nozzles.



RG4954 -UN-14DEC88

**Included in D01110AA (Y910A) Adapter Set.*

***May be used instead of Y900-7 and Y900-15.*

S11,3010,OX -19-09SEP91

OTHER MATERIAL

Name	Use
PT569 NEVER-SEEZ Compound	Gland nut threads and fuel injection nozzle barrel.
TY9370 (LOCTITE 242) Thread Lock and Sealer	Injection pump timing hole plug.

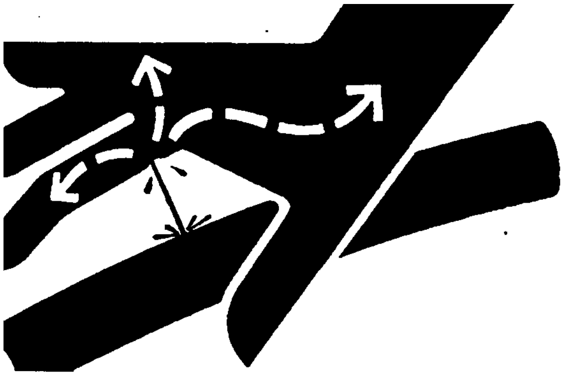
S55,3010,BB -19-11SEP91

DIESEL FUEL SYSTEM SPECIFICATIONS

Item	Specification
Engine Operating Speeds:	
OEM Applications	See Groups 01 and 105 of this CTM
All Other Machine Applications	See Applicable Machine TM
Injection Pump Timing to Engine	TDC
Hydraulic Aneroid Activator Operating Pressure (If Equipped)	100 kPa (1.0 bar) (14.5 psi)
Overflow Valve Opening Pressure	130—180 kPa (1.3—1.8 bar) (19—26 psi)
Fuel Injection Nozzles	21 mm
New Nozzle Opening Pressure (by tip size)	
7 x 0.22 mm, 7 x 0.23 mm, 7 x 0.255 mm	29,000 kPa (290 bar) (4200 psi)
Used Nozzle Minimum Opening Pressure (by tip size)	
7 x 0.22 mm, 7 x 0.23 mm, 7 x 0.255 mm	26,200 kPa (262 bar) (3800 psi)
Torques	
Injection Pump-to-Cylinder Block Stud Nuts	47 N·m (35 lb-ft)
Injection Pump Drive Gear-to-Pump Hub Cap Screws:	
A-Series Injection Pumps	47 N·m (35 lb-ft)
P-Series Injection Pumps	61 N·m (45 lb-ft)
Fuel Pipe Connectors	27 N·m (20 lb-ft)
Nozzle Gland Nut-to-Cylinder Head	88 N·m (65 lb-ft)
Nozzle Retaining Nut	60—79 N·M (44—58 lb-ft)
Supply Pump Mounting Stud Nuts	5—7 N·m (4—6 lb-ft)
Leak-off Connectors	Tighten Securely
Fuel Filter Base-to-Cylinder Block:	
Single Filter System	34—54 N·m (25—40 lb-ft)
Dual Filter System	75 N·m (55 lb-ft)
Fuel Shutoff Solenoid Bracket-to-Oil Filter Base	23 N·m (17 lb-ft)
Fuel Shutoff Solenoid-to-Mounting Bracket	7 N·m (5 lb-ft)
Fuel Pipe Connections at Filter Base (Single Filter System)	17 N·m (12 lb-ft) Max.
Injection Pump Drive Hub Hex Nut:	
A-Series Injection Pump	80—90 N·m (60—66 lb-ft)
P-Series Injection Pump	100—110 N·m (74—81 lb-ft)

S55,3010,A -19-02OCT91

RELIEVE SYSTEM PRESSURE

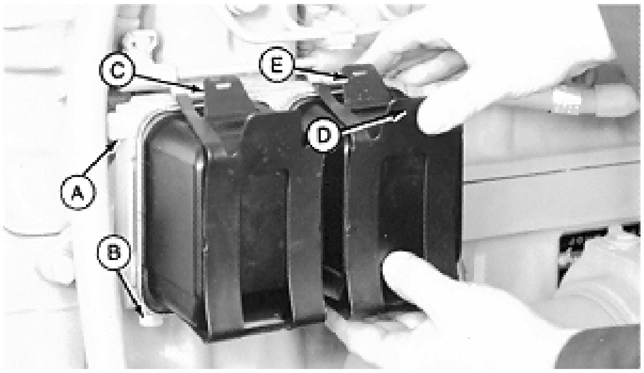


CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of 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.

S11,3010,OZ -19-20JUN89

REPLACE DUAL FUEL FILTERS



A—Bleed Plug
B—Drain Plugs (2 used)
C—Retaining Spring (2 used)
D—Outside Finger Tab
E—Inside Finger Tab

1. Close the fuel shut-off valve at bottom of fuel tank (not illustrated).

2. Loosen bleed plug (A) and remove both drain plugs (B) to drain fuel filters.

NOTE: Keep a small container under drain plugs to catch draining fuel.

3. Release the retaining spring (C). Remove fuel filters from fuel filter base and discard.

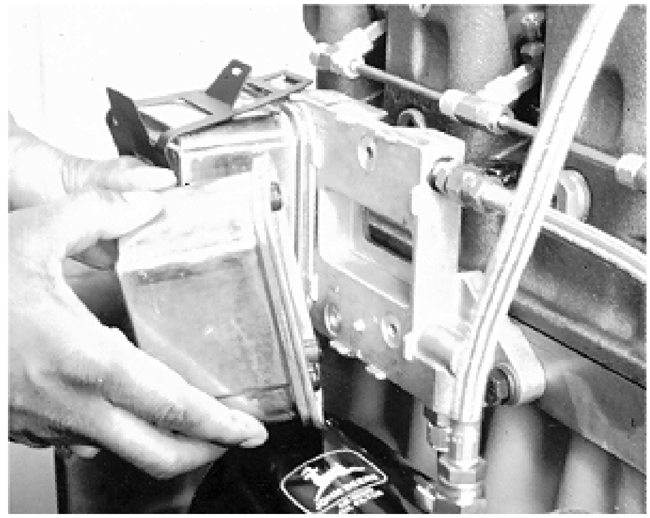
NOTE: The spring may be released by pressing inward on the outside finger tab (D) until the top hook of the spring can be disengaged. Disengage the top hook by pulling upward on the inside finger tab (E).

S55,3010,B -19-25MAR88

4. Position new fuel filter on filter base and hook bottom end of retaining spring first; then hook the top end.

5. Install drain plugs and bleed plug. Tighten securely.

6. Open fuel shut-off valve and bleed the fuel system as described later in this group.



RG5296 -UN-14DEC88

S55,3010,C -19-23MAR88

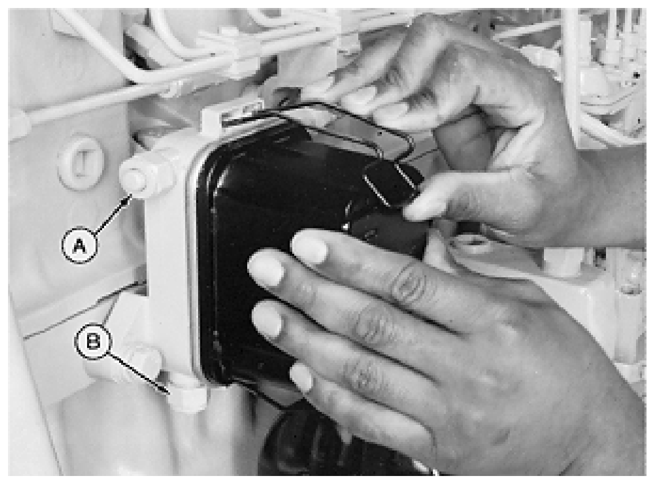
REPLACE SINGLE FUEL FILTER

1. Close the fuel shut-off valve at bottom of fuel tank (not illustrated).

2. Loosen bleed plug (A) and remove drain plug (B) to drain fuel from filter.

NOTE: Keep a small container under drain plug to catch draining fuel.

3. With fuel filter firm against base, lift up on top retaining spring and pull down on bottom retaining spring. Pull fuel filter off guide pins of fuel filter base and discard.



RG5291 -UN-14DEC88

S55,3010,D -19-22MAR91

35
6

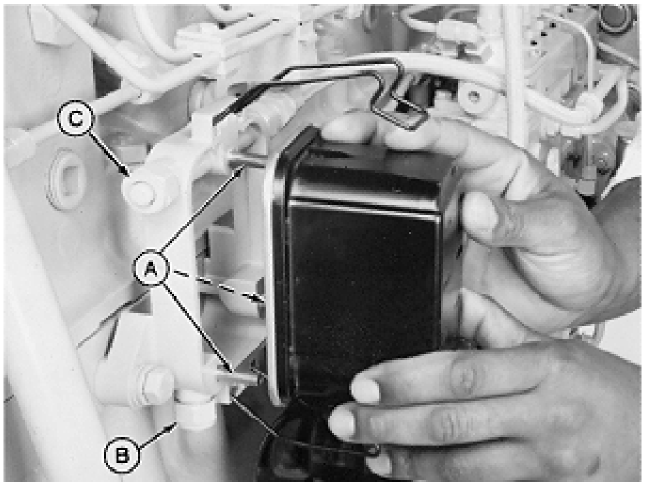
4. Install fuel filter onto guide pins (A) on fuel filter base. Hold filter firmly against base.

NOTE: Secure retaining spring by pushing on center (at highest point) until it is seated in groove.

5. Secure bottom retaining spring first, then secure top retaining spring.

6. Install drain plug (B), shown installed. Tighten bleed plug (C) and drain plug securely. Do not overtighten.

7. Open fuel shut-off valve and bleed the fuel system as described later in the Service section.



RG5292 -UN-14DEC88

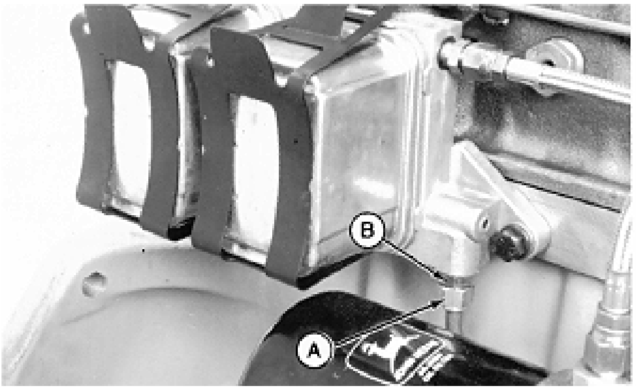
S55,3010,E -19-28SEP88

REMOVE AND INSPECT FUEL CHECK VALVE ASSEMBLY—DUAL FUEL FILTER SYSTEMS

1. Drain and remove both fuel filters as described earlier.

NOTE: If desired, engine oil filter may be removed for easy access to check valve assembly.

2. Disconnect fuel inlet pipe (A) at connector (B). Remove connector and check valve will fall out of housing when removed.



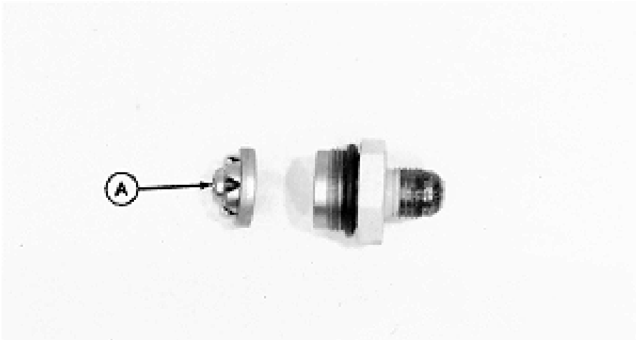
RG5297 -UN-14DEC88

S55,3010,F -19-02DEC87

3. Inspect check valve (A) for foreign material which could keep valve open.

4. Remove foreign material from valve using compressed air.

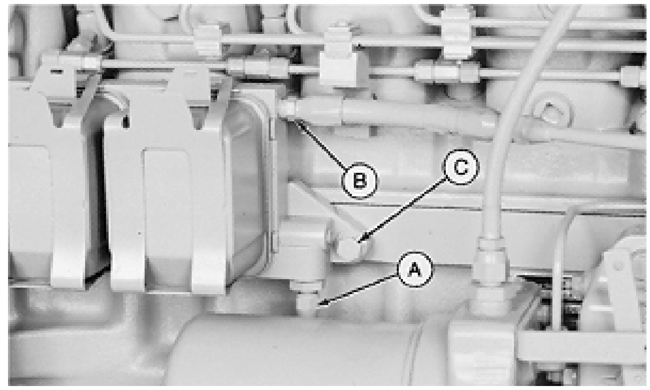
NOTE: The check valve cannot be repaired. Replace if damaged.



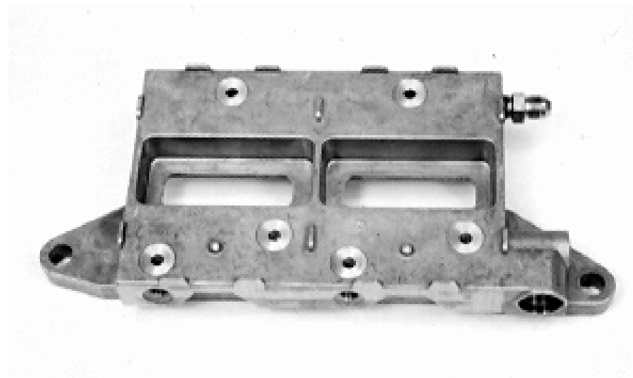
RG3868 -UN-20OCT88

S55,3010,G -19-02DEC87

INSPECT AND CLEAN DUAL FUEL FILTER BASE



RG5284 -UN-14DEC88



RG5755 -UN-05AUG91

1. Drain and remove both fuel filters as described earlier.

2. Disconnect fuel inlet line (A) and fuel outlet line (B). Remove fuel check valve assembly as described earlier.

3. Remove both drain plugs and bleed plug from filter base.

4. Remove two mounting cap screws (C) and remove filter base from engine.

5. Inspect fuel filter base where filters seat for dirt and contaminants.

6. Thoroughly clean filter base with clean solvent.

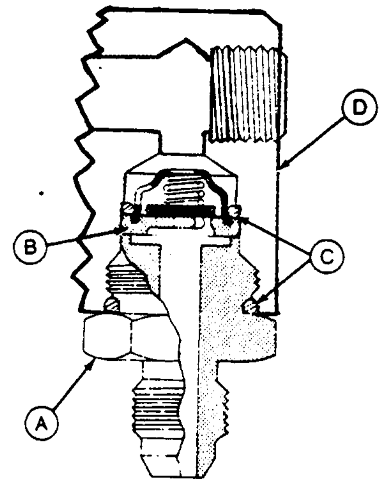
7. Blow-dry all passages with compressed air.

8. Inspect entire base for cracks and inspect condition of all internal threads.

Replace filter base as necessary.

S55,3010,H -19-25JUL91

INSTALL FUEL CHECK VALVE ASSEMBLY—DUAL FILTER FUEL SYSTEMS



RG5294 -UN-14DEC88

1. Apply a light coating of Permatex No. 2 or equivalent to threads of connector (B) 360 degrees around except for leading one to three threads to be free from sealant.

2. Position new O-rings (C) on check valve (B) and connector (A).

3. Install check valve and connector in valve body (D). Tighten connector securely.

4. Connect fuel inlet line and tighten securely.

5. Install fuel filters and bleed the fuel system as described later in this group.

A—Connector
B—Check Valve
C—O-Rings
D—Valve Body

S55,3010,I -19-14APR88

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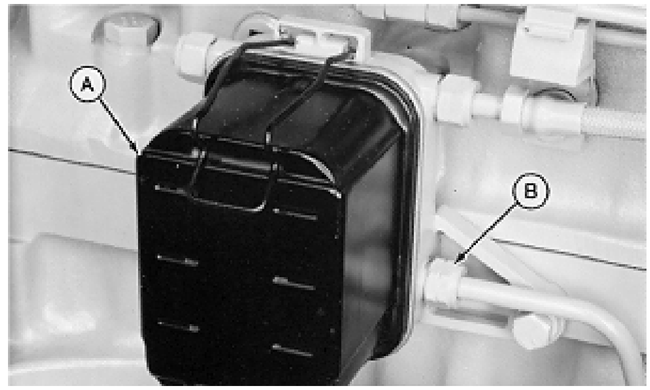
REPLACE FUEL CHECK VALVE ASSEMBLY—SINGLE FILTER FUEL SYSTEMS



RG5298 -UN-14DEC88

IMPORTANT: Remove fuel check valve only for replacement purposes, since O-ring seals tightly in bore, removal usually damages check valve assembly.

1. Drain and remove fuel filter (A) as described earlier in this group.

2. Remove filter base fuel inlet line (B).

3. Remove check valve using an O-ring pick or any sharp point object with a curved tip. Discard check valve.

4. Inspect and clean fuel filter base as described later in this group.

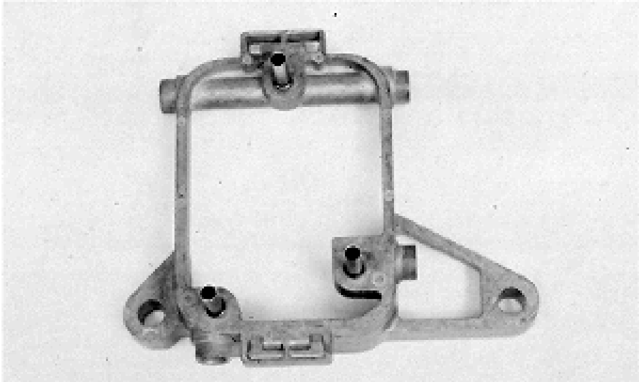
5. Lubricate new check valve assembly with clean diesel fuel and install. The end with O-rings must enter bore in filter base first.

6. Install filter base fuel inlet line and tighten connection 17—20 N·m (12—15 lb-ft). DO NOT overtighten.

7. Install fuel filter and bleed the fuel system as described in this group.

S55,3010,J -19-25MAR88

INSPECT AND CLEAN SINGLE FUEL FILTER BASE


RG5299 -UN-14DEC88

1. Remove fuel filter and check valve as described earlier in this group.

2. Remove fuel filter base and inspect all filter-to-base sealing surfaces for dirt, contaminants or damage.

3. Inspect all threads for damage that could cause leakage. Inspect entire filter base for hairline cracks.

Replace fuel filter base as required.

4. Carefully clean filter base with solvent. Thoroughly blow dry all passages with compressed air.

IMPORTANT: Any debris left in the guide pins or at the end of pins by cleaning efforts will be washed into the injection system and may result in severe damage to the injection pump and/or nozzles.

5. Reverse removal steps and install fuel filter base. Install a new check valve and a new fuel filter.

S55,3010,L -19-25MAR88

BLEED THE 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.

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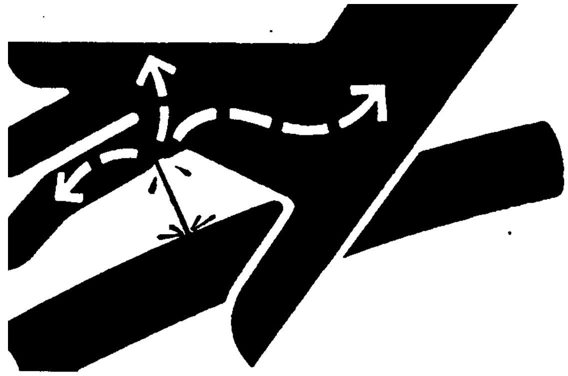


X9811 -UN-23AUG88

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.

S11,0408,AC -19-27SEP91

NOTE: Single fuel filter system shown; use same procedure for bleeding dual-filter fuel systems.

1. Loosen bleed plug (A) on fuel filter base.

IMPORTANT: When bleeding the fuel system on engines equipped with electronic governors, the key switch must be at the 'ON' position.

RG5293 -UN-09DEC88

S55,3010,N -19-14APR88

2. Unscrew hand primer (A) on fuel supply pump until it can be pulled by hand.

3. Operate the hand primer until a smooth flow of fuel, free of bubbles, comes out of the filter plug hole.

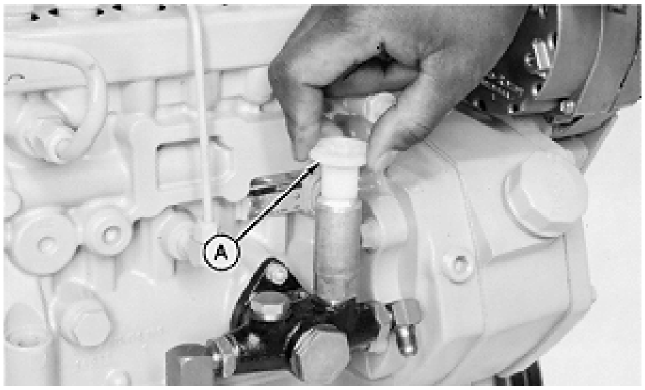
IMPORTANT: Be sure hand primer is all the way down in barrel before tightening to prevent internal thread damage.

4. Simultaneously stroke the hand primer down and close the port plug. This prevents air from entering the system. Tighten plug securely. DO NOT overtighten.

5. Lock hand primer in position.

NOTE: If the engine will not start, it may be necessary to loosen the fuel pipes at the injection nozzles to bleed air from system. Put the hand throttle in slow idle position. Push the engine fuel shut-off control knob all the way in. Turn the engine with the starter until fuel without air flows from the loose fuel pipe connections. Tighten the connections.

6. If the engine still will not start, refer to Fuel System Operation and Tests, Group 115.



RG5295 -UN-09DEC88

S55,3010,O -19-02DEC87

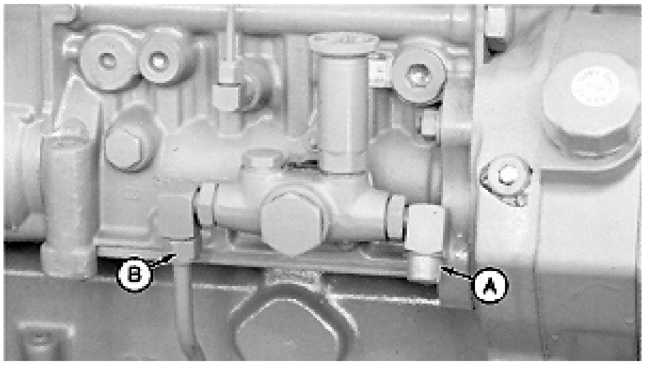
DIAGNOSING FUEL SUPPLY PUMP MALFUNCTIONS

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-Size Pump	Supply pump from A-Series Injection pump may have been installed.	Install correct supply pump on injection pump.
Supply Pump Mounting Flange Breaks When Mounted on A-Size Pump and Operated	Supply pump from P-Series Injection pump may have been installed.	Install correct supply pump on injection pump.

S55,3010,P -19-02JUL91

REMOVE FUEL SUPPLY PUMP



RG3539 -UN-20DEC88

Thoroughly clean the exterior of the supply pump. Also clean around the supply pump mounting area on the injection pump housing.

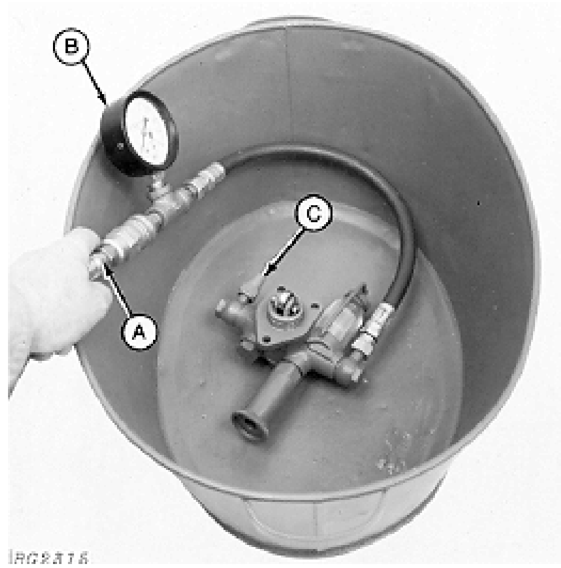
1. Disconnect fuel inlet line (A), shown disconnected, and outlet line (B). Cap all line openings so contaminants do not enter fuel system.

2. Remove three mounting nuts using a 10 mm wrench.

3. Pull fuel supply pump straight out from injection pump housing. Cover supply pump mounting bore so debris cannot enter.

S55,3010,Q -19-20JUN89

TEST FUEL SUPPLY PUMP FOR LEAKS



RG2315 -UN-30NOV88

Fuel delivery pressure should be checked before removing supply pump from injection pump. (See CHECK SUPPLY PUMP OPERATION, Group 105.)

1. Connect compressed air line (A) to a pressure gauge (B) and to the supply pump inlet fitting. The air line should have a regulating valve to control pressure.

2. Cap or plug supply pump outlet fitting (C).

3. Submerge supply pump in a container of clean diesel fuel. Regulate air pressure to 200 kPa (2.0 bar) (29 psi).

4. Move roller tappet in and out by hand. No air bubbles should appear around roller tappet bore.

NOTE: If bubbles appear, it is an indication that either the spindle seal is defective or that the spindle is worn (or possibly both).

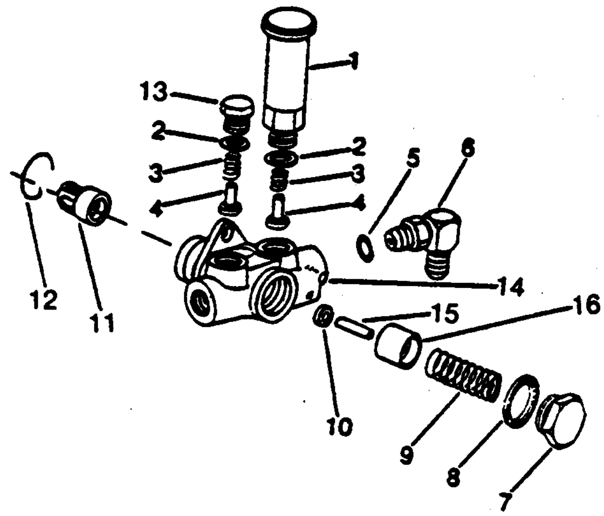
IMPORTANT: If enough diesel fuel leaks past the spindle and seal, possible serious damage to the injection pump or engine (or both) could occur.

Any fuel leakage that takes place flows into the injection pump crankcase. Remember that the injection pump and engine both share a common lubricating oil supply.

S55,3010,R -19-11SEP91

DISASSEMBLE FUEL SUPPLY PUMP

1. Remove elbow fitting (6) by loosening locknut and unscrewing elbow fitting from pump housing. Remove and discard O-ring (5).



RG5364 -UN-14DEC88

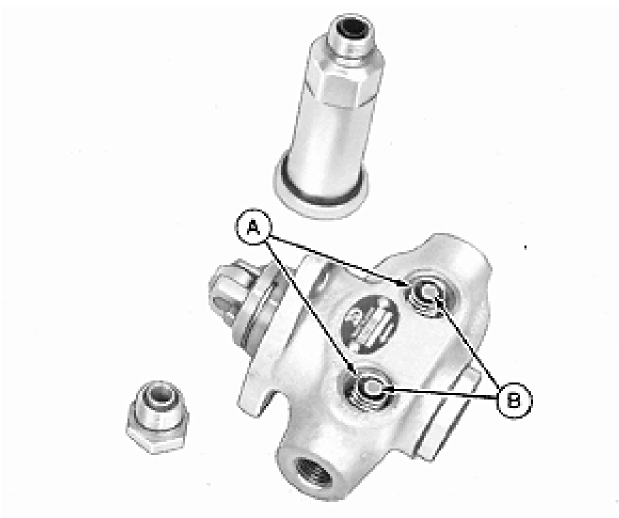
1—Hand Primer
2—Washer (2 used)
3—Spring (2 used)
4—Valve (2 used)
5—O-Ring (2 used)
6—Elbow Fitting (2 used)
7—Plug
8—Washer
9—Spring
10—O-Ring/Spindle Seal
11—Roller Tappet
12—Snap Ring
13—Plug
14—Pump Housing
15—Pressure Spindle
16—Plunger

S55,3010,S -19-20JUN89

2. Remove hand primer from housing, shown removed. Discard copper washer.

3. Remove plug from housing, shown removed. Discard copper washer.

4. Remove valves (B) and springs (A).



RG4026 -UN-30NOV88

S55,3010,X -19-25MAR88

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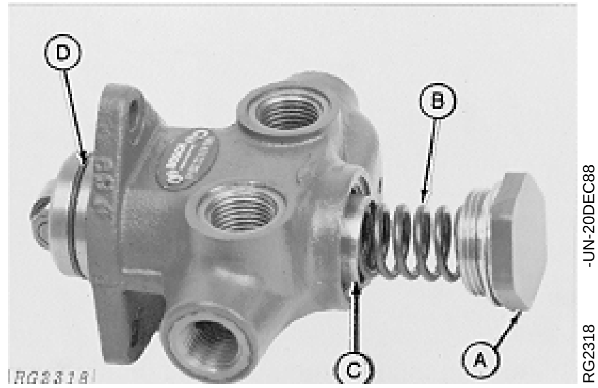
17

5. Remove plug (A), spring (B) and plunger (C) from pump housing. Discard copper washer.

6. Remove snap ring (D) from outer circumference of pump housing neck.

NOTE: Snap ring has a tang on one end which extends vertically down through a hole in pump housing to retain the roller tappet assembly.

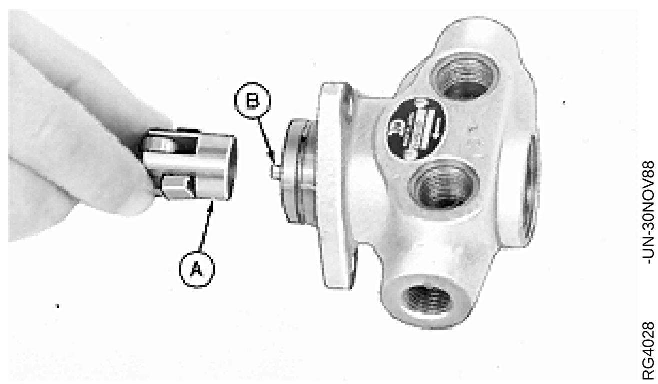


A—Plug
B—Spring
C—Plunger
D—Snap Ring

S55,3010,Y -19-25MAR88

7. Remove roller tappet (A) and spindle (B) from pump housing. Remove and discard O-ring on spindle.

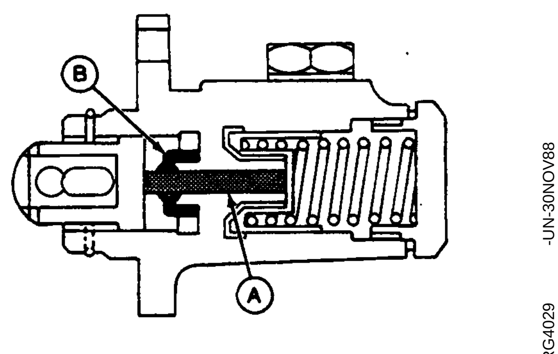
NOTE: It may be necessary to push on spindle to remove plunger as shown earlier in disassembly procedure.



S55,3010,Z -19-25MAR88

NOTE: The spindle/seal O-ring (B) is pressed into the pump housing. This seal keeps diesel fuel from leaking past the spindle (A) and entering the injection pump crankcase.

8. Remove spindle seal from housing using needle nose pliers. Discard seal. DO NOT reuse.



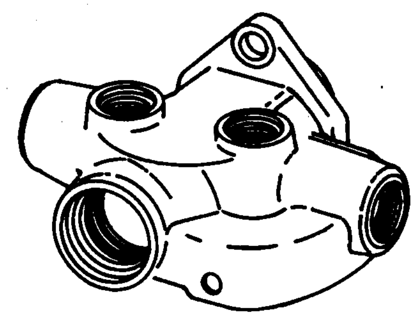
S55,3010,AA -19-07JUL89

INSPECT AND REPAIR FUEL SUPPLY PUMP

1. Inspect supply pump housing for cracks and wear. Be sure valve seating areas are not pitted. Replace housing as necessary.

2. Check roller tappet and plunger bore for wear and scoring. Remove any deposits in housing with a suitable solvent. Rinse housing in clean diesel fuel.

3. Check condition of threads for inlet and outlet fittings. Pump elbow fittings have 1/2-20 threads.



RG2320

RG2320 -UN-30NOV88

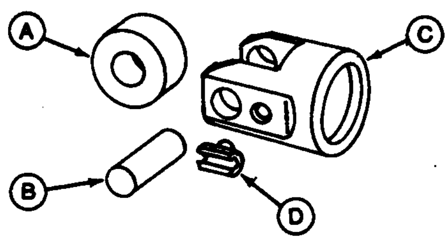
S55,3010,U -19-13JUL89

4. Inspect roller (A) OD for excessive wear. Be sure roller turns freely on pin (B) and in tappet (C).

5. Inspect sliding blocks (D). Edges should be square and unpitted. Blocks should slide in and out of tappet easily.

6. Inspect tappet for wear and scoring. Remove any deposits with a suitable solvent.

Be sure land on tappet that contacts pressure spindle is flat and undamaged.



RG2321

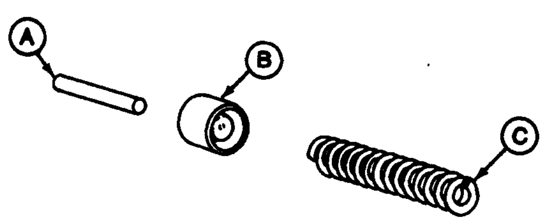
RG2321 -UN-30NOV88

A—Roller
B—Pin
C—Tappet
D—Sliding Block (2 used)

S11,3010,QN -19-24NOV86

7. Inspect pressure spindle (A) and plunger (B) for pits and burrs. Replace parts as necessary.

8. Inspect spring (C) for cracks and distortion. Replace parts as necessary.



RG2322

RG2322 -UN-30NOV88

S11,32010,QO -19-24NOV86

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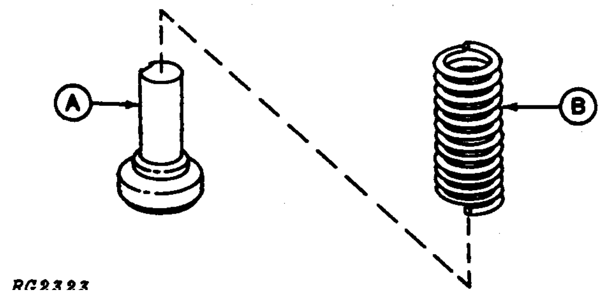
19

9. Inspect valves (A), especially valve face, for cracks, pits and wear. Replace as necessary.

10. Spring (B) should not be bent or broken.



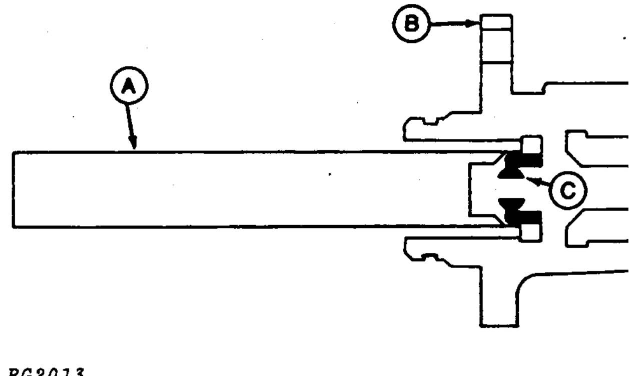
RG2323 -UN-30NOV88

S11,3010,QP -19-24NOV86

ASSEMBLE FUEL SUPPLY PUMP

IMPORTANT: Always use new copper gaskets. Dip parts in clean diesel fuel before assembly and hands should be wet with diesel fuel when assembling internal components of fuel supply pump.

1. Install a new spindle seal (C) into pump housing (B) using JDF15 Driver (A). Be sure seal is started straight in housing bore and drive until driver contacts housing.



RG2013 -UN-30NOV88

S55,3010,V -19-02DEC87

2. Install a new O-ring (10) in housing bore.

3. Insert pressure spindle (15) and plunger (16) in housing (14).

4. Position spring (9) in plunger. Install plug (7) with a new washer (8) over spring. Tighten plug securely.

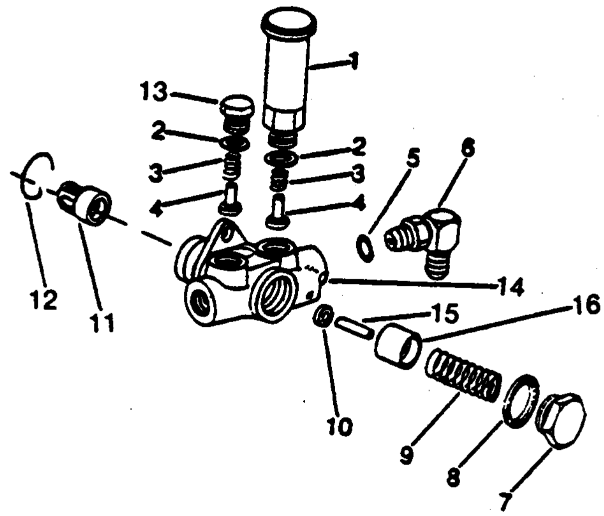
5. Insert tappet assembly (11) in housing and secure with snap ring (12).

6. Position valves (4) with springs (3) in housing.

7. Install plug (13) and hand primer (1) using new washers (2). Tighten plug and hand primer securely.

8. Install fittings (6) with new O-rings (5). Tighten lock nut securely.

Perform leak test described earlier in this group.



RG5364 -UN-14DEC88

1—Hand Primer
2—Washer (2 used)
3—Spring (2 used)
4—Valve (2 used)
5—O-Ring (2 used)
6—Elbow Fitting (2 used)
7—Plug
8—Washer
9—Spring
10—O-Ring
11—Roller Tappet
12—Snap Ring
13—Plug
14—Pump Housing
15—Pressure Spindle
16—Plunger

S55,3010,W -19-11SEP91

35
21

INSTALL FUEL SUPPLY PUMP

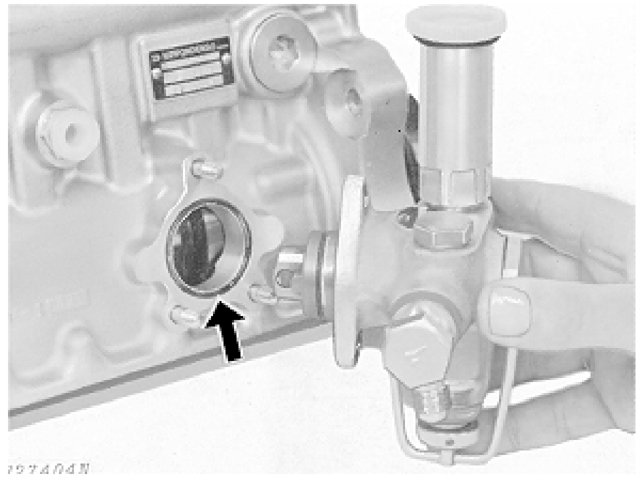
IMPORTANT: Before installing supply pump, test pump to make sure that fuel will not leak around spindle and spindle seal. (See TEST FUEL SUPPLY PUMP FOR LEAKS, earlier in this group.)

1. Put a new O-ring in counterbore of pump housing next to mounting face (arrow).

2. Position pump over mounting studs. Tighten mounting stud nuts 5—7 N·m (4—5 lb-ft).

3. Install fuel inlet and outlet lines when engine is installed in vehicle. Tighten all connections securely.

4. Bleed the fuel system as described earlier in this group.



R27404 -UN-29NOV88

S55,3010,AB -19-11SEP91

GENERAL INFORMATION FOR ANEROID—IF EQUIPPED

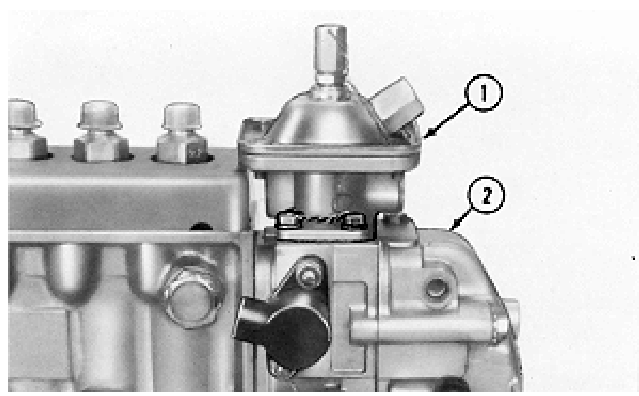
NOTE: Aneroids are used only on certain applications of the 6076 Engine.

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:

— When load is moderate to heavy with engine speed from 800 to approximately 1000 rpm.

— When load is light at any engine speed.



RG2906 -UN-20DEC88

S55,3010,AC -19-25MAR88

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 the aneroid has been disassembled or the adjustments have been altered, the injection pump (including aneroid) must be calibrated on the test stand before releasing the pump for service.

S11,3010,PG -19-09SEP91

REMOVE HYDRAULIC ANEROID ACTIVATOR

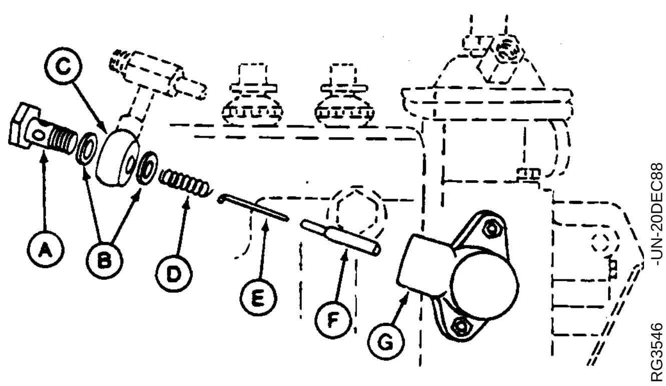
NOTE: The hydraulic aneroid activator is located on the back side of the governor housing next to the cylinder block. Remove the injection pump as described later in this group.

1. Remove special screw (A), copper washers (B) and banjo connector (C). Discard copper washers.

2. Remove spring (D), restrictor wire (E) and capillary valve (F) from activator housing (G).

3. Remove activator housing.

NOTE: Do not bend restrictor wire or other activator parts.



A—Special Screw
B—Copper Washer (2 used)
C—Banjo Connector
D—Spring
E—Restrictor Wire
F—Capillary Valve
G—Activator Housing

S55,3010,AD -19-11SEP91

DISASSEMBLE AND CLEAN HYDRAULIC ANEROID ACTIVATOR PARTS

1. Remove gasket (G), piston (F) and piston spring (E).

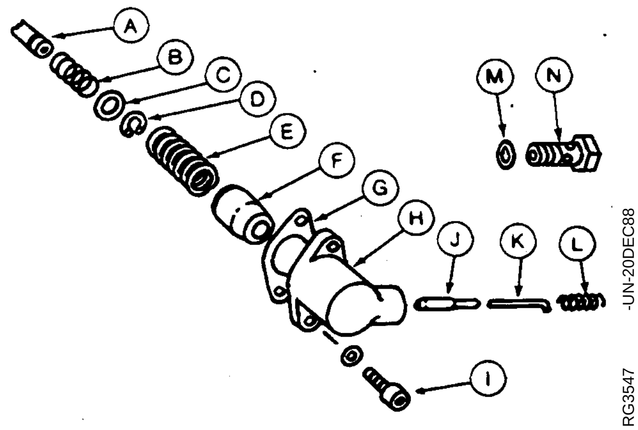
2. Wash all parts in clean solvent and dry with compressed air. Blow out all openings to make sure they are open.

3. Check piston (F) and activator housing (H) for general condition. Piston must move freely in its bore.

4. Inspect piston spring (E) and capillary valve spring (L). Replace if weak or broken.

5. Inspect condition of restrictor wire (K). Wire must not be bent or broken and must fit loosely in capillary valve (J).

6. Check condition of return spring (B), washer (C) and retaining ring (D) on starting fuel control shaft (A). Replace spring if weak or broken. Be sure retaining ring is secure on shaft.



A—Starting Fuel Control Shaft
B—Return Spring
C—Washer
D—Retaining Ring
E—Piston Spring
F—Piston
G—Gasket
H—Activator Housing
I—Mounting Screw (2 used)
J—Capillary Valve
K—Restrictor Wire
L—Capillary Valve Spring
M—Washers
N—Special Screw

S11,3010,DT -19-11SEP91

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) and washers securely.

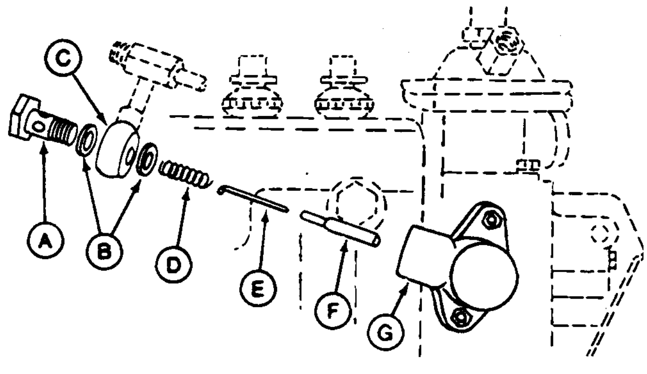
S11,3010,DU -19-09SEP91

3. Assemble capillary valve (F), restrictor wire (E) and spring (D) into activator housing (G).

4. Using two new copper washers (B) install banjo connector (C) and special screw (A).

5. Install injection pump as described later in this group.

6. Connect lube lines to banjo connector.



RG3546 -UN-20DEC88

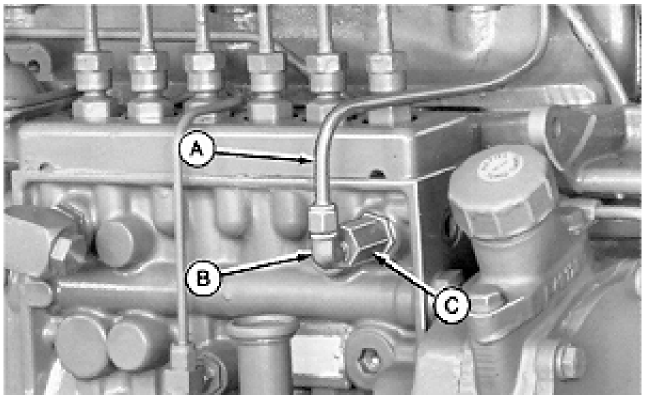
S11,3010,DV -19-17DEC81

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.



RG3548 -UN-20DEC88

S11,3010,DW -19-17DEC81

3. Remove reducer (A) and copper washer (B) from valve body (C). Discard copper washers.

4. Unscrew spring seat (D); then remove spring (E) and valve (F).

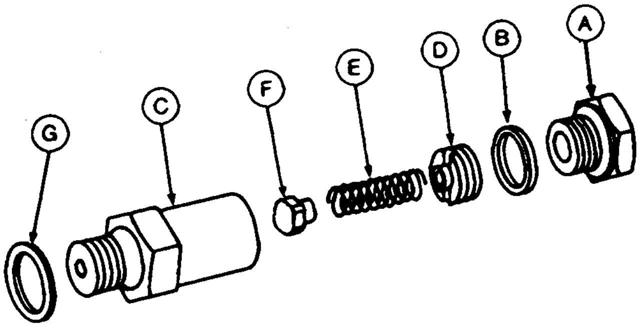
5. Inspect for foreign material imbedded in seat of nylon valve.

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. Install new copper washers.



RG3549 -UN-20DEC88

A—Reducer
B—Washer
C—Valve Body
D—Spring Seat
E—Spring
F—Valve
G—Washer

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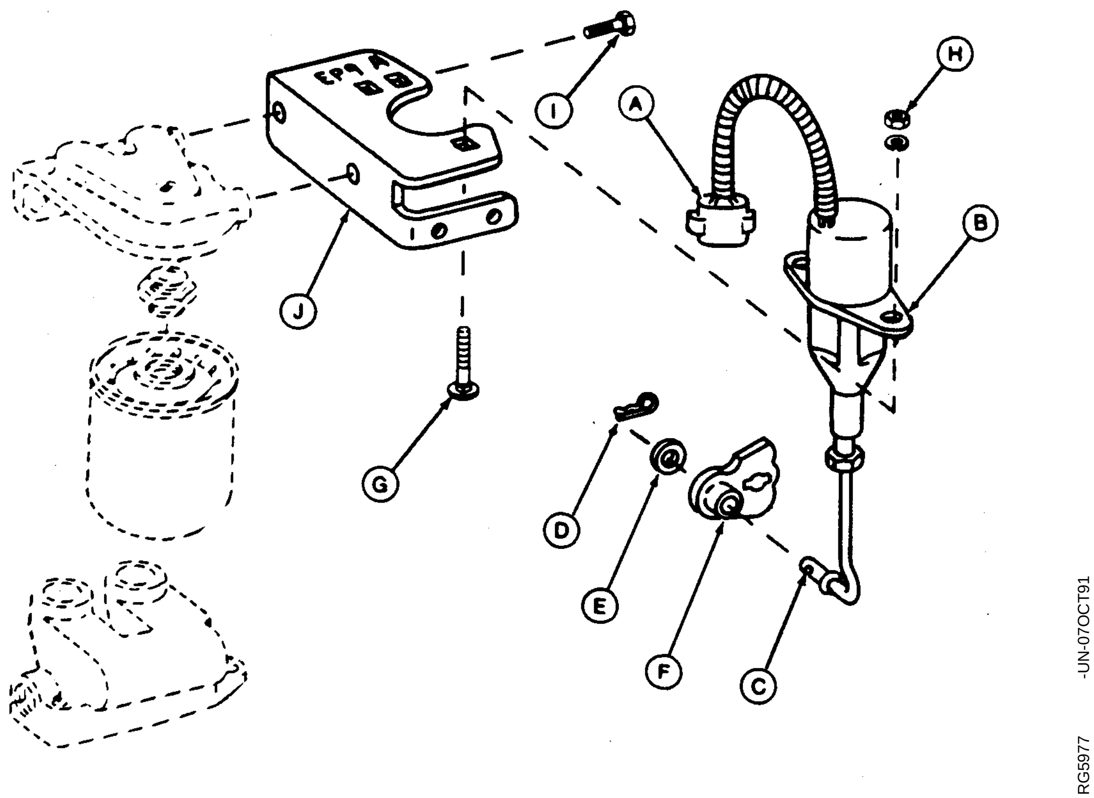
S11,3010,DX -19-11SEP91

REMOVE FUEL SHUTOFF SOLENOID



A—Wiring Connector
B—Fuel Shutoff Solenoid
C—Solenoid Shaft
D—Cotter Pin
E—Washer
F—Fuel Shutoff Lever
G—Machine Screw (2 used)
H—Hex Nut (2 used)
I—Cap Screw (2 used)

IMPORTANT: electric fuel shutoff solenoids are factory adjusted to a specified length and should not require adjustment.

1. Disconnect shutoff solenoid electrical wiring connector (A).

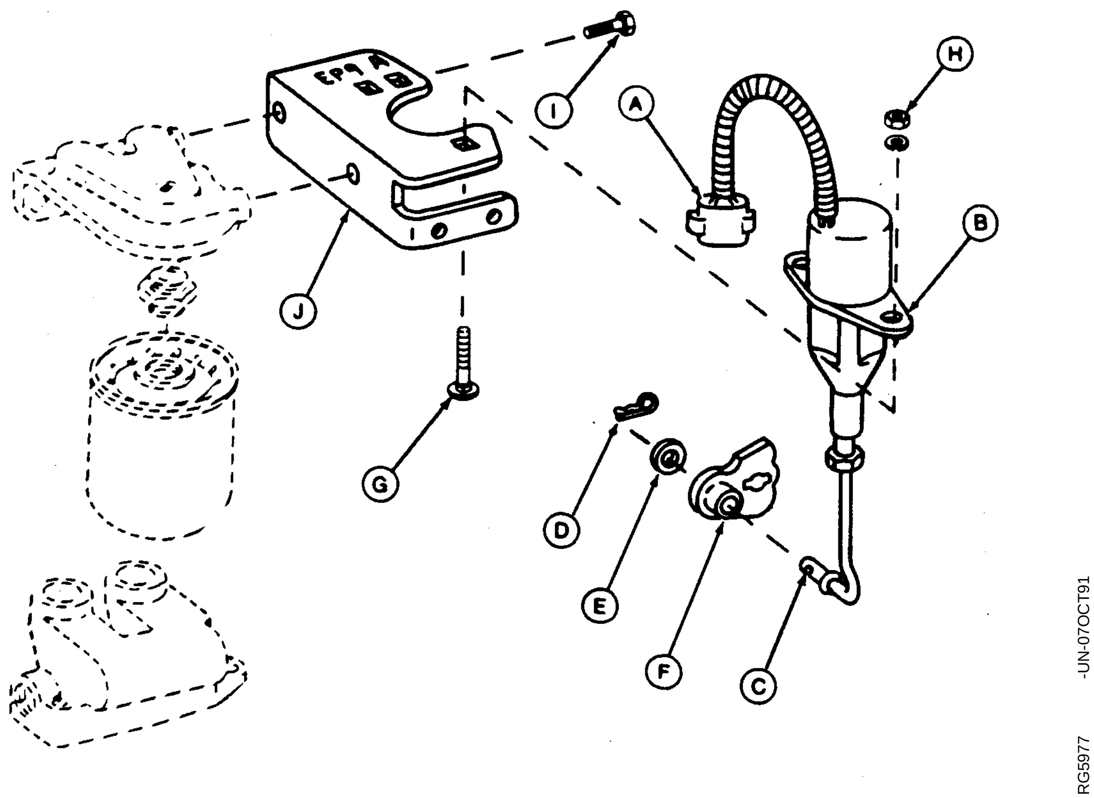
2. Remove cotter pin (D), washer (E), and pull solenoid shaft (C) out of fuel shutoff lever (F).

3. Remove fuel shutoff solenoid (B) from solenoid mounting bracket (J) by removing hex nuts (H), lock washers, and machine screws (G).

4. If solenoid mounting bracket is to be removed, remove the two capscrews (I) and lock washers that fasten the bracket to the oil filter housing.

RG,CTM6,G35,1 -19-02OCT91

INSTALL FUEL SHUTOFF SOLENOID



A—Wiring Connector
B—Fuel Shutoff Solenoid
C—Solenoid Shaft
D—Cotter Pin
E—Washer
F—Fuel Shutoff Lever
G—Machine Screw (2 used)
H—Hex Nut (2 used)
I—Cap Screw (2 used)

1. If removed, install solenoid mounting bracket (J), cap screws (I), and lock washers. Tighten cap screws to 23 N·m (17 lb-ft)

2. Mount shutoff solenoid (B) onto bracket with two machine screws (G). Install hex nuts with washers and tighten to 7 N·m (5 lb-ft).

3. Insert solenoid shaft (C) into fuel shutoff lever (F) and install washer (E) and cotter pin (D).

4. Plug solenoid wiring connector (A) into engine wiring harness.

IMPORTANT: electric fuel shutoff solenoids are factory adjusted to a specified length and should not require adjustment.

5. Turn key switch to “ON” position. Check clearance between fuel shutoff lever and stop on injection pump housing. Clearance should be about o.25 mm (0.010 in.) or less to ensure engine is receiving full fuel.

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27

RG,CTM6,G35,2 -19-02OCT91

REMOVE FUEL INJECTION PUMP

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

1. Clean injection lines and area around the injection pump with cleaning solvent or a steam cleaner to keep debris out of fuel system.

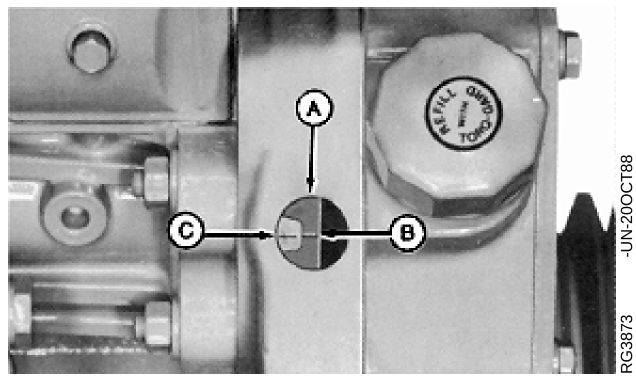
NOTE: Follow the same removal procedure for injection pumps equipped with mechanical governor and electronic governor. Differences will be noted.

S55,3010,AG -19-02JUL91

2. Remove timing hole plug (A, shown removed).

3. Rotate the engine flywheel (in normal running direction) with the JDE81-1 Engine Rotation Tool until the No. 1 piston is at “TDC” of its compression stroke. At this point, the JDE81-4 Timing Pin should enter hole in flywheel.

4. The timing marks on the injection pump drive hub (B) and the timing pointer (C) should be in alignment.



S55,3010,AE -19-25JUL91

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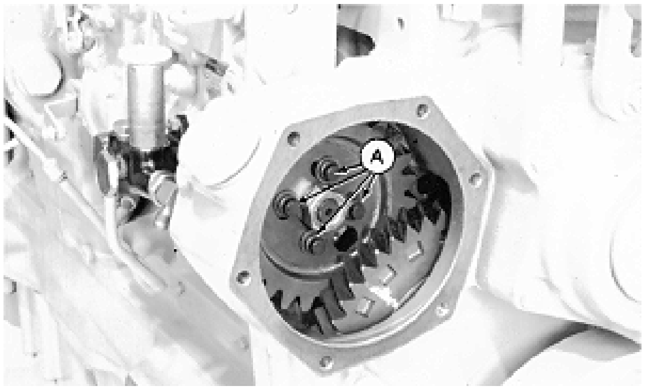
NOTE: Remove alternator at this time if not previously removed.



5. Remove injection pump drive gear cover (shown removed), remove and discard all gasket material.

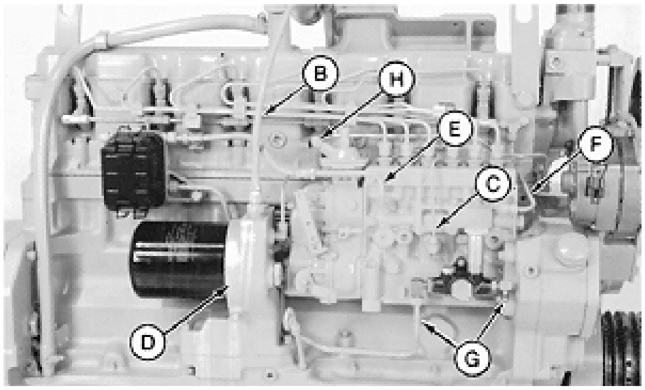
6. Remove four injection pump drive gear cap screws (A) and remove drive gear from pump drive hub.

7. Disconnect turbocharger lube line (B) at turbocharger. Disconnect injection pump lube line (C) from oil filter housing (D). Remove oil filter housing assembly as outlined in Group 20.

8. Remove fuel inlet line (E). Remove fuel leak-off line (F).

9. Disconnect fuel supply pump lines (G). Photo shows only one line.

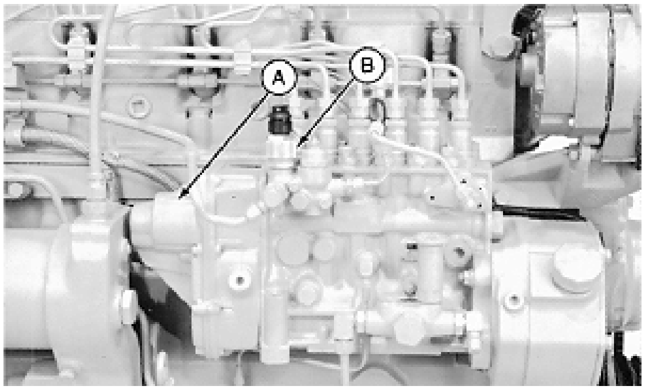
10. Disconnect aneroid line (H), if equipped.



A—Drive Gear Cap Screws (4 used)
B—Turbocharger Lube Line
C—Injection Pump Lube Line
D—Oil Filter Housing
E—Fuel Inlet Line
F—Leak-Off Line
G—Fuel Supply Pump Lines
H—Aneroid Line

S55,3010,AF -19-25MAR88

NOTE: For injection pumps equipped with electronic governors (A), disconnect wiring harness at governor and shut-off solenoid (B). Protect connectors on wiring harness while pump is disconnected so debris does not enter connector ends.



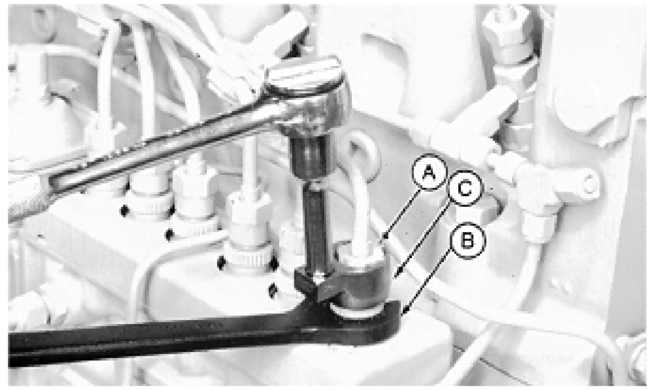
S55,3010,AH -19-02DEC87

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 Crowsfoot Wrench mentioned above.

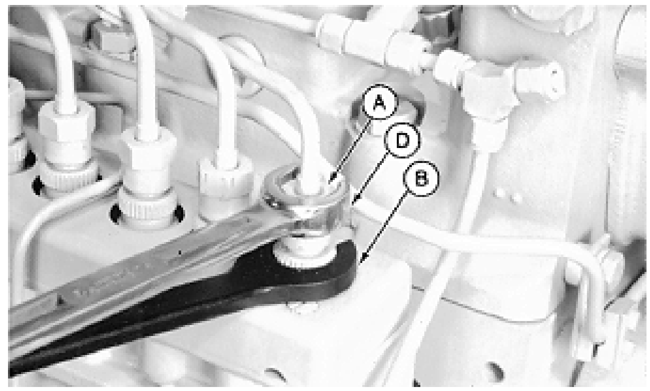
IMPORTANT: The JDE-90 Serrated Wrench (Robert Bosch) and the 22 mm Open End Wrench (Nippondenso) must be used to keep the delivery valve fittings stationary while loosening the line nuts. If a delivery valve and barrel housing rotates while loosening or tightening a fuel line nut the injection pump delivery will be altered. The pump will have to be recalibrated on a test stand.

12. Remove four mounting stud nuts which secure injection pump to cylinder block.

13. Carefully remove injection pump and place it on a clean flat surface.



RG5365 -UN-14DEC88



RG5366 -UN-14DEC88

A—Fuel Injection Line Nuts
B—JDE-90 Serrated Wrench
C—JDF-22 Crowsfoot Wrench
D—3/4 in. Line Wrench

S11,3010,GZ -19-14APR88

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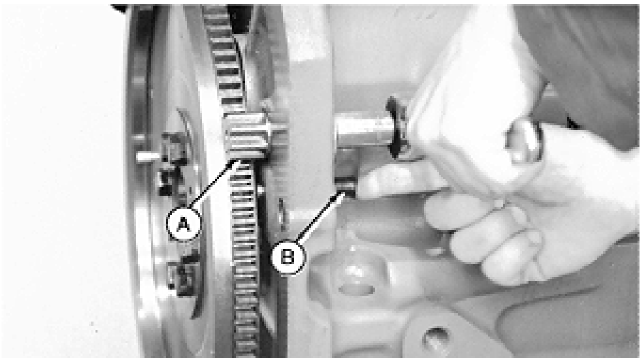
INSTALL FUEL INJECTION PUMP

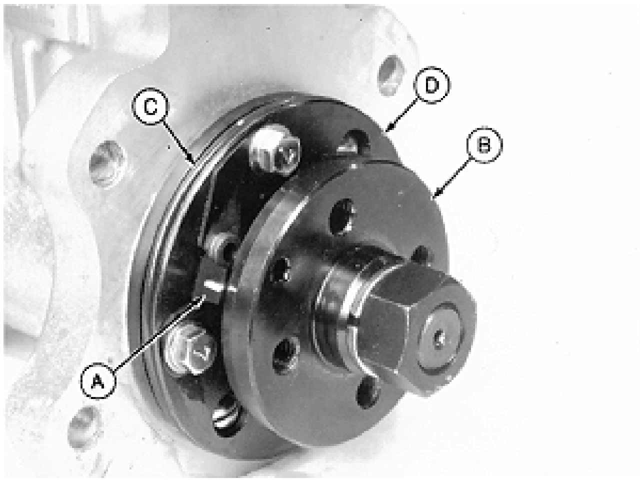


NOTE: When turning the flywheel with the JDE81-1 Flywheel Turning Tool (A), the JDE81-4 Timing Pin (B) can engage in the flywheel at No. 1 or No. 6 cylinder's "TDC" compression stroke. When installing the fuel injection pump, engine should be at No. 1 cylinder's "TDC" compression stroke.

1. If the engine was rotated after the injection pump was removed, rotate the flywheel using the Flywheel Turning Tool until the timing pin enters the flywheel at No. 1 cylinder's "TDC" compression stroke.

NOTE: When No. 1 cylinder is at "TDC" compression stroke, the intake and exhaust valves for No. 1 cylinder will be closed and both rocker arms will be loose.

S55,3010,AI -19-25JUL91



2. Loosen drive hub cap screw and rotate injection pump drive hub until marks on drive hub (B) and pointer (A) are in alignment.

3. Install a new O-ring (C) on bearing plate (D). Lightly lubricate O-ring with clean engine oil to aid in pump installation and prevent O-ring damage.

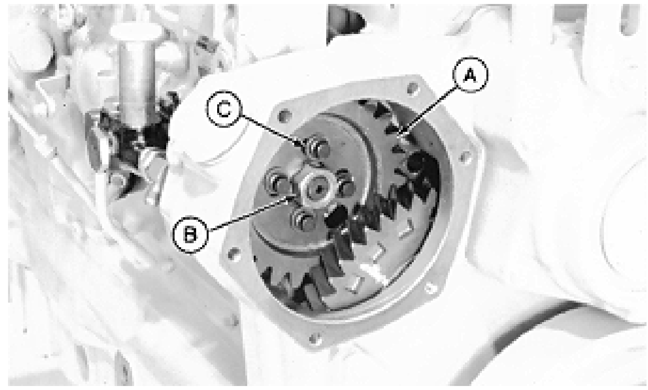
4. Install injection pump using moderate forward pressure and slight rocking motion to work O-ring into mounting bore. Injection pump flange should seat solid against cylinder block.

5. Install mounting stud nuts and tighten to 47 N·m (35 lb-ft).

A—Pointer
B—Drive Hub
C—O-Ring
D—Bearing Plate

S55,3010,AJ -19-25MAR88

6. Position injection pump drive gear (A) in timing gear housing (if previously removed) with the chamfered side of gear toward injection pump. Chamfer is at outer edge of gear ID for easier installation of gear on pump drive hub (B).



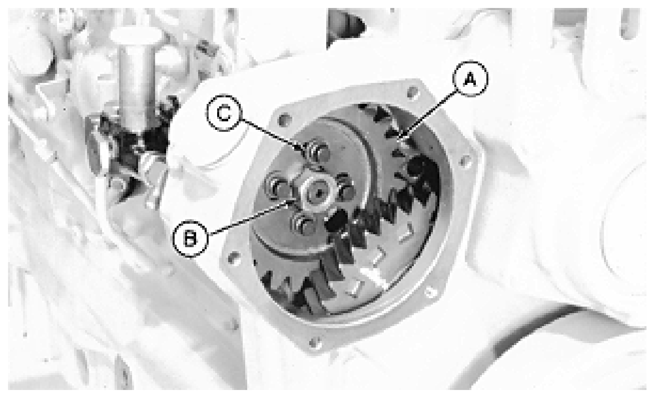
RG5303 -UN-14DEC88

7. Carefully install drive gear on pump drive hub, position gear so that mounting cap screws (C) are approximately centered in mounting slots. This allows minor adjustment of pump timing, should the need arise.

8. Install drive gear cap scews and tighten to:
—47 N·m (35 lb-ft) on A-Series pumps.
—61 N·m (45 lb-ft) on P-Series pumps.

S55,3010,AK -19-16SEP91

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.



RG5303 -UN-14DEC88

NOTE: Normal engine rotation is counter-clockwise, viewed from flywheel end.

9. To check alignment of injection pump, remove the JDE81-4 Timing Pin from the flywheel. Rotate the flywheel 1-1/2 revolutions opposite direction of normal rotation. Replace the timing pin and rotate in direction of normal rotation until timing pin engages in timing pin hole. If the marks ARE NOT in alignment, loosen the pump drive gear cap screws (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 using TY9370 (LOCTITE 242) Thread Lock and Sealer.

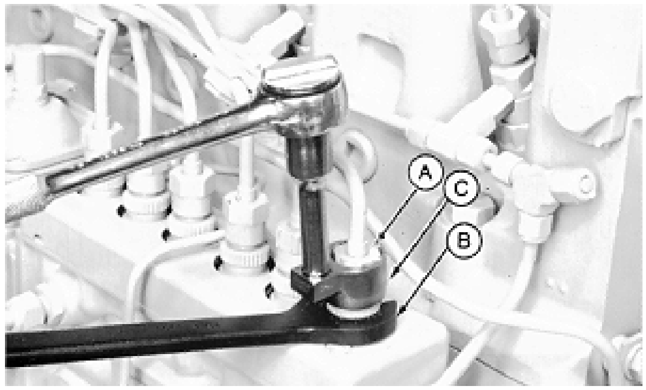
10. Tighten drive gear cap screws to:
—47 N·m (35 lb-ft) on A-Series pumps.
—61 N·m (45 lb-ft) on P-Series pumps.

S55,3010,AL -19-16SEP91

NOTE: Remove protective caps and plugs from fuel system components install during injection pump removal.

11. Connect the fuel delivery lines using the JDE90 Serrated Wrench (B) and the JDF22 Crowsfoot Wrench (C). Tighten line nuts (A) to 27 N·m (20 lb-ft).

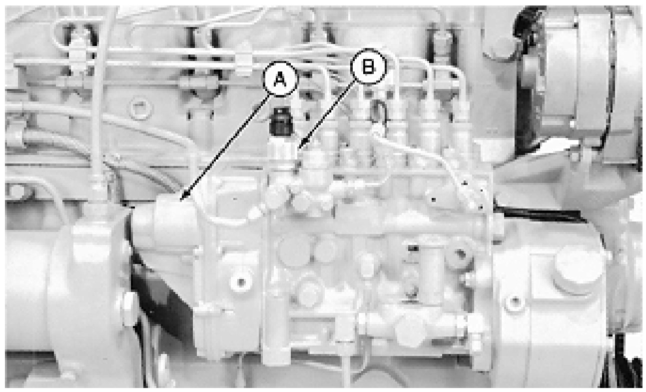
IMPORTANT: DO NOT move delivery valve fittings while tightening line nuts. If delivery valve and barrel housing rotates while tightening a fuel line nut, the injection pump fuel delivery will be altered. The injection pump will have to be recalibrated on a test stand by an authorized diesel repair station.



RG5365 -UN-14DEC88

S55,3010,AM -19-14APR88

12. On injection pumps equipped with electronic governors (A), connect wiring harness at governor and shut-off solenoid (B). Tighten connections securely.



RG5301 -UN-14DEC88

S55,3010,AN -19-02DEC87

13. Connect aneroid line (A), if equipped.

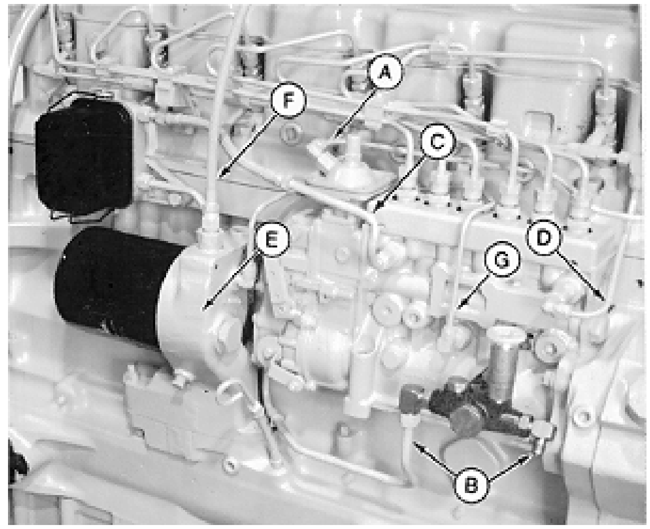
14. Connect fuel supply pump lines (B).

15. Connect fuel inlet line (C) and leak-off line (D).

16. On engines equipped with “P”-size injection pumps, install oil filter housing (E) as outlined in Group 20.

17. Connect turbocharger lube line (F) at turbocharger. Connect injection pump lube line (G).

18. Tighten all connections securely.



RG5304 -UN-14DEC88

A—Aneroid Line
B—Supply Pump Lines
C—Fuel Inlet Line
D—Fuel Leak-Off Line
E—Oil Filter Housing
F—Turbocharger Lube Line
G—Injection Pump Lube Line

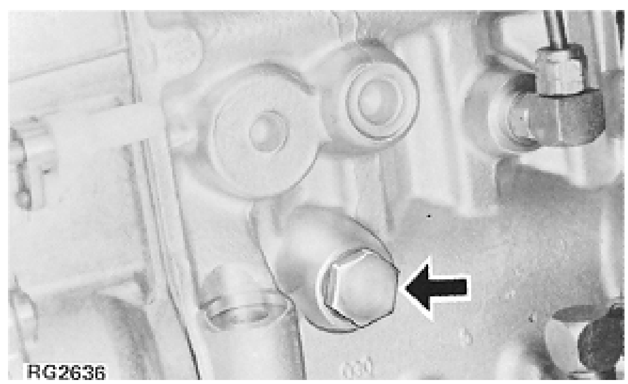
S55,3010,AO -19-25MAR88

IMPORTANT: Oil fill locations may vary by injection pump applications. Familiarize yourself with the location on your engine before adding oil to the pump.

19. Remove oil fill plug (arrow) and add enough clean engine oil until oil comes out oil fill hole. Engine should be level when checking oil level.

20. Bleed the fuel system as outlined earlier in this group.

21. Connect throttle levers and adjust engine speeds as required. (See Adjust Engine Speeds in Group 115.)

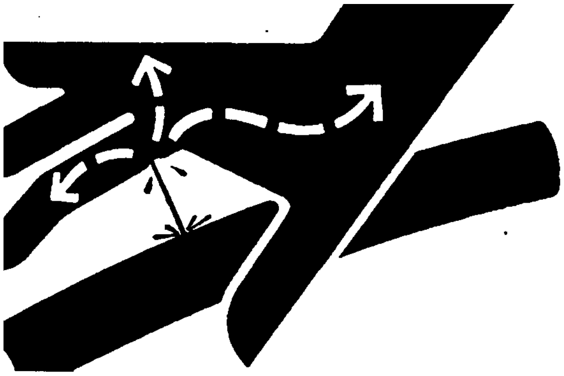


RG2636 -UN-20DEC88

S55,3010,AP -19-10SEP91

REMOVE FUEL INJECTION NOZZLES

IMPORTANT: Plug or cap all lines and hoses as they are disconnected.



-UN-23AUG88

X9811

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

S11,0408,AH -19-02JUL91

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1. Thoroughly clean area around the injection pump and nozzles, including all line connections, using compressed air.

IMPORTANT: Cap or plug all fuel lines as they are disconnected.

2. Disconnect injection lines from injection pump using JDF22 Crowsfoot Wrench (C).

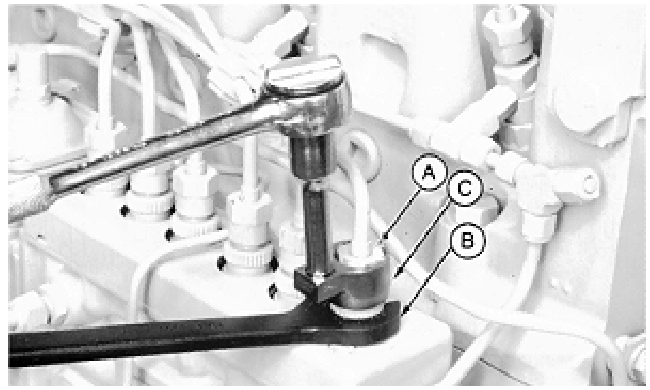
IMPORTANT: On "P" injection pumps, JDE90 Serrated Wrench (B, Bosch) and a 22 mm Open End Wrench (Nippondenso) must be used to keep the delivery valve fittings stationary while loosening the line nuts (A). If a delivery valve and barrel housing rotates while loosening or tightening a fuel line nut, the injection pump fuel delivery will be altered. The pump MUST BE recalibrated on a test stand.

3. To remove fuel injection line nuts on Bosch P110 injection pumps, use JDE90 Serrated Wrench with either JDF22 Crowsfoot Wrench or a standard 3/4-in. line wrench (D). For Nippondenso P110 injection pumps, use a 22 mm Open End Wrench with JDF22 Crowsfoot Wrench mentioned above. A3000 injection pumps use the JDF22 Crowsfoot Wrench.

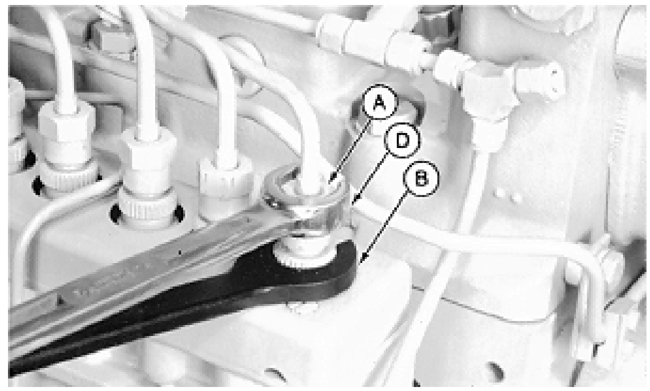
4. Disconnect turbocharger oil inlet line at turbocharger.

5. Remove fuel delivery lines from injection nozzles. Lift injection line assembly from engine.

6. Disconnect fuel leak-off line from injection nozzle leak-off connector. Remove complete leak-off assembly.



RG5365 -UN-14DEC88



RG5366 -UN-14DEC88

A—Fuel Injection Line Nut
B—JDE90 Serrated Wrench
C—JDF22 Crowsfoot Wrench
D—3/4-in. Line Wrench

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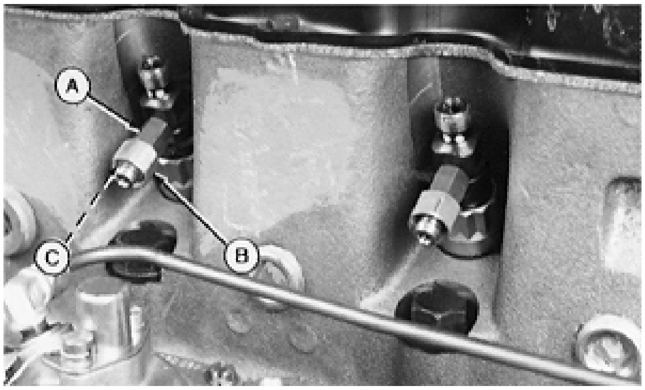
S11,3010,KY -19-16SEP91

7. Loosen leak-off connector nut (A) and remove connector with line nut (B), packing (C), and O-ring. Discard O-ring.

8. Remove packing and line nut from eack leak-off connector. Discard packing.



RG5756 -UN-05AUG91

S55,3010,AR -19-25JUL91

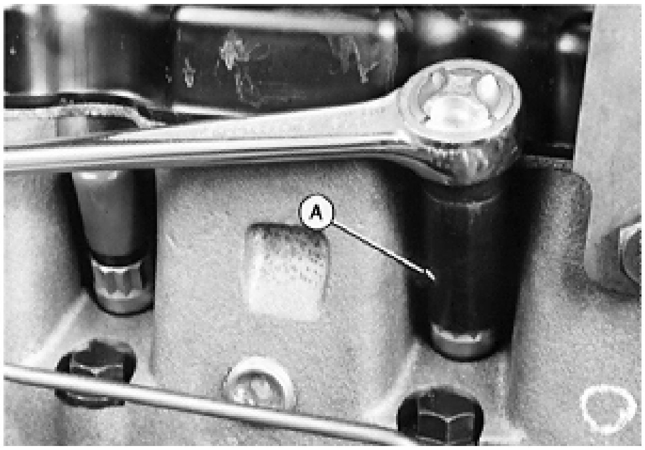
NOTE: *The socket portion of the JDE92 Nozzle Wrench (A) may be used to remove nozzles from cylinder head.*

9. If the JDE92 Nozzle Wrench is not used, use a 24 mm (15/16 in.) deep socket on nozzle gland nut to remove nozzles. The gland nut will act as a jack screw to raise nozzle out of the cylinder head bore.

10. Remove nozzle and special steel washer from nozzle bore.

IMPORTANT: Special steel washer MUST BE removed from nozzle bore during nozzle removal. ALWAYS install a new washer when reinstalling nozzles.

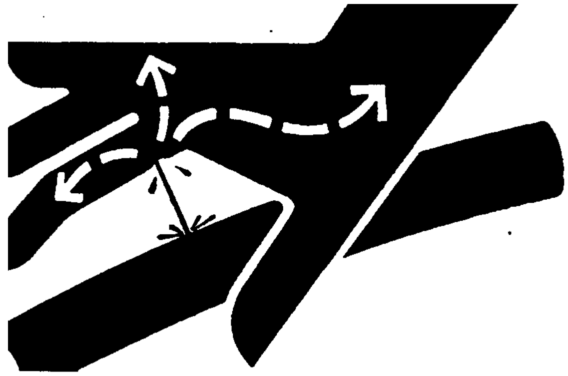
11. Insert a 12.7 mm (1/2 in.) hardwood dowel in the nozzle bore to prevent debris from entering the combustion chamber after nozzles are removed.



RG5757 -UN-05AUG91

S55,3010,AS -19-25JUL91

TEST FUEL INJECTION NOZZLES


X9811 -UN-23AUG88

Test the injection nozzle before disassembling to determine its condition. Test for: Opening Pressure, Leakage, Chatter and Spray Pattern. Always use clean filtered fuel when performing tests.

CAUTION: The nozzle tip should always be directed away from the operator. Fuel from the spray orifices can penetrate skin and clothing, causing serious personal injury. Enclosing the nozzle in a transparent cover, or glass beaker is recommended.

Before applying pressure to the nozzle tester, be sure that all connections are tight and that the fittings are not damaged. Fuel escaping from a very small hole can be almost invisisble. 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 Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

S55,3010,CZ -19-20JUN89

MAKE OPENING PRESSURE TEST

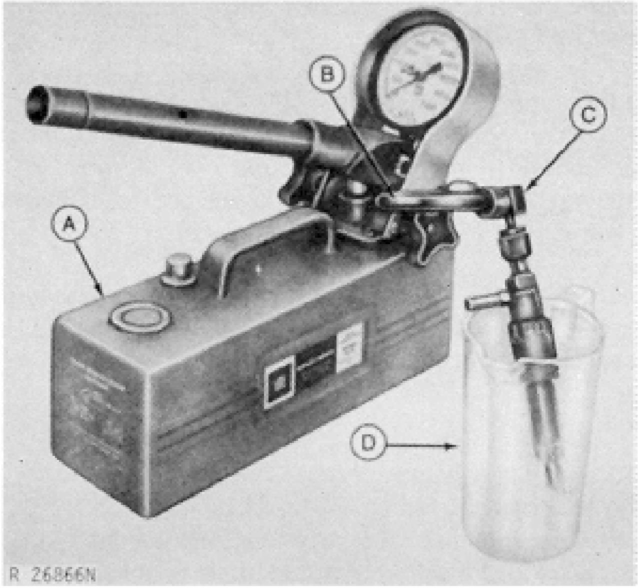
1. Connect the KDEL injection nozzle to the D01109AA Nozzle Tester (Y900) (A), using No. Y900-2A Fuel Line (B) and Y900-7 and Y900-15 Straight Adapters (C). The Y900-21 90° Adapter may also be used. Place a glass beaker (D) around the nozzle.

2. Pump the handle several times to flush out nozzle fittings. Tighten the fittings.

3. Expel air from the nozzle by operating the pump handle several strokes. Then raise the pressure at which the valve opens.

4. Recheck by completely releasing pressure, then gradually building pressure until the valve opens.

IMPORTANT: Nozzle tester should be checked periodically for accuracy.



-UN-20DEC88

R26866

A—Nozzle Tester
B—Fuel Line
C—Adapter
D—Beaker

S11,3010,PS -19-25MAR88

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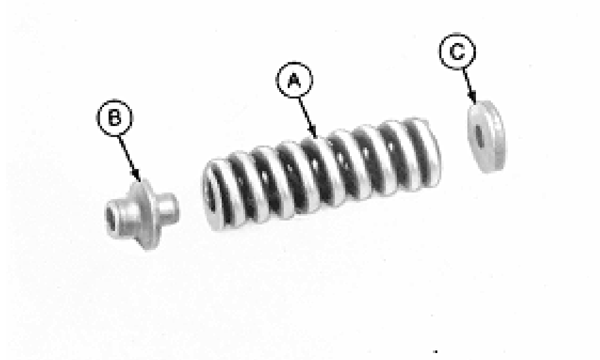


A new nozzle or a used nozzle with a new spring (A), should open at approximately the following pressures. A used nozzle that has been rebuilt should be reset to the same opening pressure as a new nozzle. New nozzle opening pressures are:

New Nozzle Opening Pressures (by nozzle tip size)

7 x 0.22 mm	29 000 kPa (290 bar) (4200 psi)
7 x 0.23 mm	29 000 kPa (290 bar) (4200 psi)
7 x 0.255 mm	29 000 kPa (290 bar) (4200 psi)

On nozzles which have been in service, the spring (A) and spring seat (B) will have taken a normal set. In this case, a satisfactory opening pressure should be at least (but not more than the new opening pressure given above) as follows:

Used Nozzle Minimum Opening Pressures (by nozzle tip size)

7 x 0.22 mm	26 200 kPa (262 bar) (3800 psi)
7 x 0.23 mm	26 200 kPa (262 bar) (3800 psi)
7 x 0.255 mm	26 200 kPa (262 bar) (3800 psi)

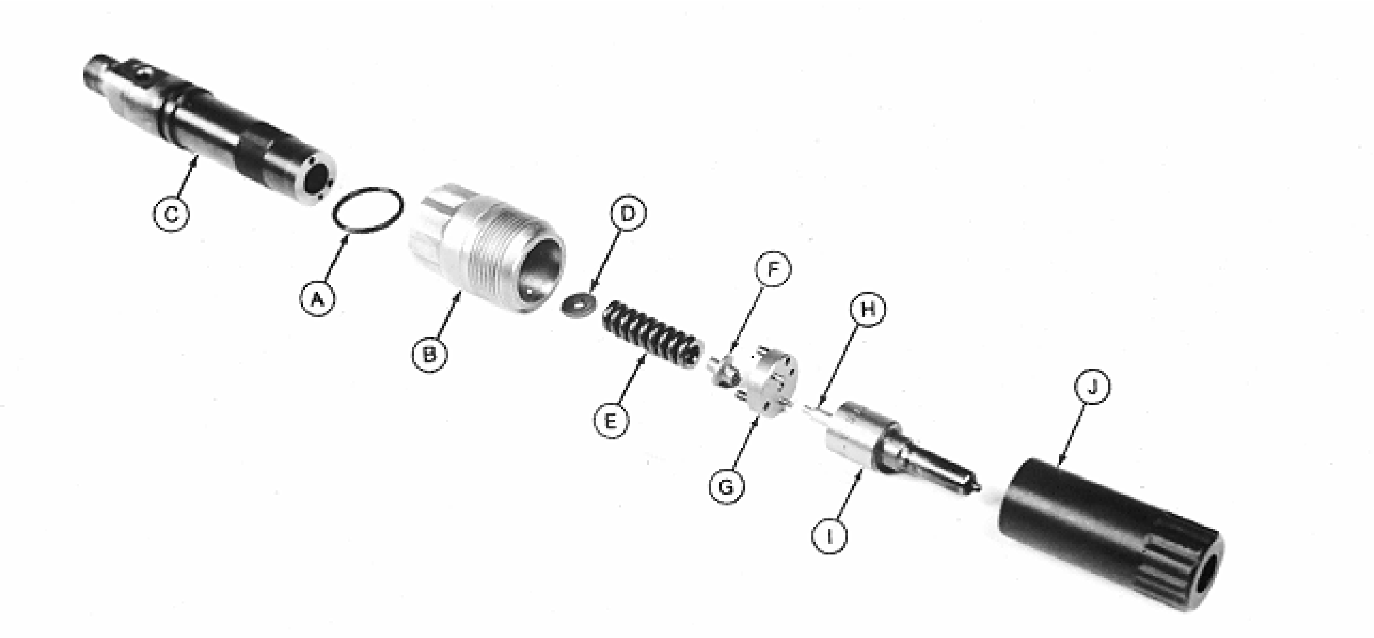
Shims (C) are available in various thicknesses for changing the nozzle opening pressure adjustment. Each 0.05 mm (0.002 in.) shim changes the opening pressure approximately 700 kPa (7 bar) (100 psi).

IMPORTANT: Always use John Deere nozzle adjusting shims which are specially hardened. Other shims will not be satisfactory.

If the opening pressure is not correct, disassemble the injection nozzle (as described in this group) and change shims until nozzle opens at the proper new 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).

S55,3010,AT -19-16SEP91

PERFORM NOZZLE LEAKAGE TEST



A—Gland Nut O-Ring
B—Gland Nut
C—Nozzle Holder
D—Shim
E—Nozzle Valve Spring
F—Spring Seat
G—Intermediate Plate
H—Nozzle Valve
I—Nozzle
J—Nozzle Retaining Nut

Nippondenso Nozzle (Bosch Similar)

1. Wipe nozzle dry.

2. Bring pressure up slowly to 1970 kPa (20 bar) (285 psi) below the opening pressure. Watch for an accumulation of fuel from the spray orifice, indicating a bad seat.

If the nozzle drips within 10 seconds, replace the nozzle valve (H) and nozzle (I).

3. Check for leakage around the nozzle retaining nut (J) thread connection with nozzle holder (C).

Leakage indicates a bad seat either between the nozzle and intermediate plate (G) or between nozzle holder and intermediate plate.

RG,CTM42,G35,32-19-12SEP91

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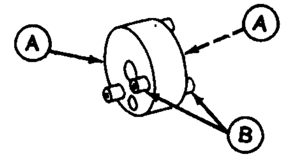
41

RG2248 -UN-20APR89



RG2248

IMPORTANT: Do not lap the machined surfaces (A) of the intermediate plate in an attempt to stop fuel leakage at these locations. The dowels (spring pins) (B) in plate have to be removed before the surfaces can be lapped. Removing these dowels is not recommended as removal is likely to damage them, and replacement dowels are not available as service parts.

If leakage is observed, tighten the nozzle retaining nut to a maximum of 79 N·m (58 lb-ft). Replace the injection nozzle if leakage continues.

S11,0408,AP -19-19MAY88

MAKE CHATTER AND SPRAY PATTERN TEST

1. The injection nozzle should chatter very softly, and only when the 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 the chattering range is reached, the test oil emerges as non-atomized streams. When the lever movement is accelerated, the sprays should be very broad and finely atomized.

A partially clogged or eroded orifice will usually cause the spray to deviate from the correct angle. The spray will also be steady rather than finely atomized.

3. Disassemble the nozzle for cleaning or reconditioning if it fails to chatter or spray properly.

S11,0408,AQ -19-11DEC80

DISASSEMBLE FUEL INJECTION NOZZLE

IMPORTANT: Cover the workbench with clean paper before disassembling the injection nozzle.

As parts are disassembled, place them in a pan of clean diesel fuel and leave them there until needed. Do not permit these parts to strike each other.

Use a separate pan of clean diesel fuel for washing parts before assembly.

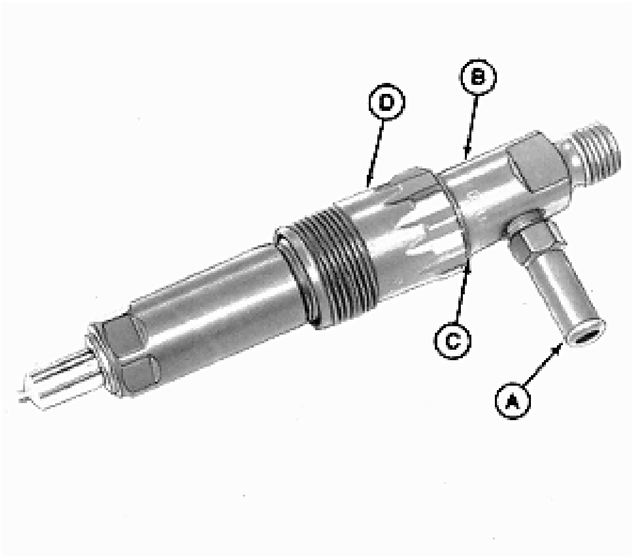
S11,0408,AR -19-02JUL91

NOTE: The KDEL injection nozzle is a metric unit and only metric tools should be used.

1. Use a 11 mm box or open-end wrench and unscrew the leak-off connector (A) (if not removed previously) out of nozzle holder (B).

2. Remove the O-ring and upper snap ring (C) from nozzle holder.

3. Slip gland nut (D) off nozzle holder.



RG3887 -UN-20DEC88

A—Leak-Off Connector
B—Nozzle Holder
C—O-Ring and Upper Snap Ring
D—Gland Nut

S11,0408,AS -19-09MAR87

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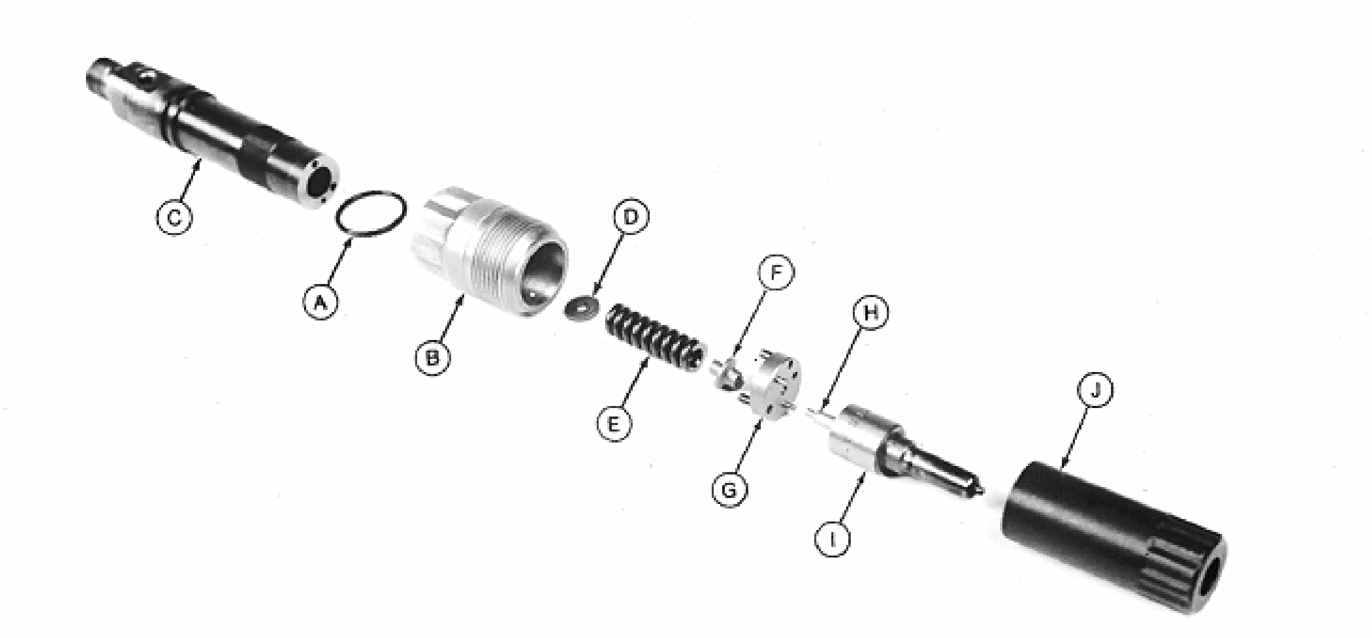
43



RG5951 -UN-30AUG91

A—Gland Nut O-Ring
B—Gland Nut
C—Nozzle Holder
D—Shim
E—Nozzle Valve Spring
F—Spring Seat
G—Intermediate Plate
H—Nozzle Valve
I—Nozzle
J—Nozzle Retaining Nut

4. Remove nozzle assembly (H and I).

5. Pull off intermediate plate (G).

6. Remove spring seat (F), spring (E), and shims (D).

7. Remove gland nut O-ring (A).

8. Withdraw nozzle valve (H) from nozzle (I). If valve is stuck, it may be necessary to soak the 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 the lapped surfaces of the valve and nozzle to come in contact with any hard substance. DO NOT touch the valve unless your hands are wet with fuel.

RG,CTM42,G35,51-19-12SEP91

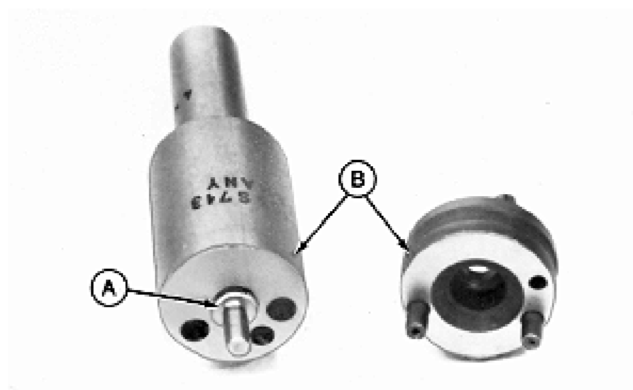
CLEAN AND INSPECT FUEL INJECTION NOZZLE ASSEMBLY

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.

S11,0408,AU -19-23SEP91



RG3411 -UN-20DEC88

3. After removing carbon or lacquer from nozzle exterior, inspect lapped surface for nicks or scratches. Replace nozzle if not in usable condition.

4. Inspect piston (A) part of nozzle valve to see that it is not scratched or scored. If any of these conditions are present, replace the nozzle assembly.

5. Inspect nozzle valve seat, nozzle, and intermediate plate. Contact area of parts (B) must not be scored or pitted. Use the inspection magnifier in the JDF13 (JDE105) Nozzle Cleaning Kit to aid inspection.

NOTE: A bad nozzle valve seat will cause fuel to drip from nozzle. This condition will usually be noted when making the "Leakage Test".

S11,3010,CY -19-11SEP91

PERFORM NOZZLE SLIDE TEST

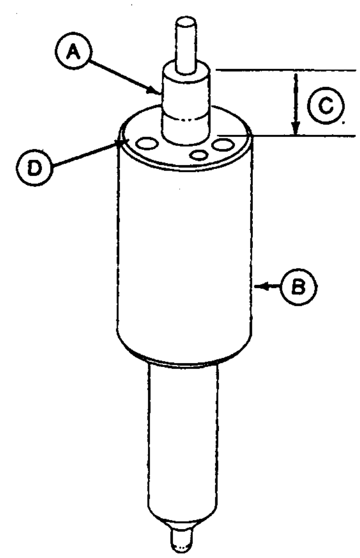
NOTE: DO NOT touch lapped surface (D) unless hands are wet with diesel fuel.

1. Dip the 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 -19-02JUL91

CLEAN SPRAY ORIFICES

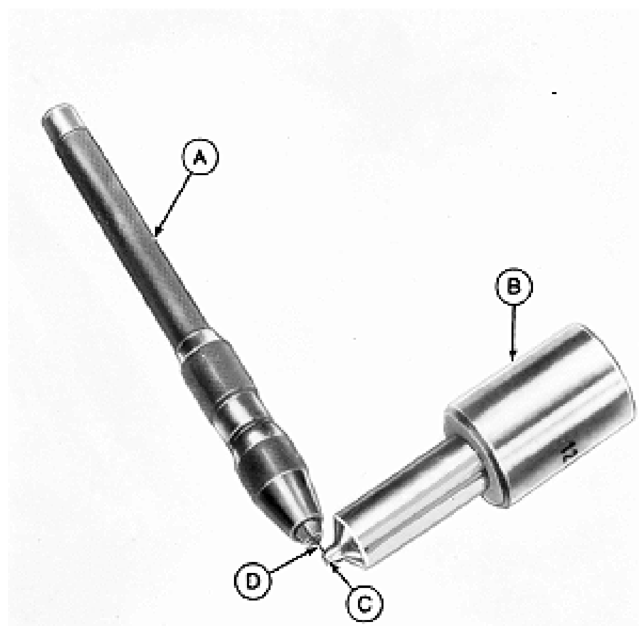
1. Begin with cleaning wire (D) 0.007—0.10 mm (0.003—0.004 in.) smaller than the nominal orifice size of 0.33 mm (0.13 in.) from the JDF13 (JDE105) Nozzle Cleaning Kit.

NOTE: Stoning the wire to provide a flat surface on one side will help in reaming carbon from clogged hole.

2.Clamp the cleaning wire in pin vise (A). Wire should not protrude from vise more than 0.8 mm (1/32 in.).

3. Insert wire into orifice (C) and rotate.

4. For final cleaning, use cleaning wire 0.03 mm (0.001 in.) smaller than orifice size. Follow previous steps until orifices are clean of any carbon deposits.



A—Pin Vise
B—Nozzle
C—Orifice
D—Cleaning Wire

35
46

S11,3010,DA -19-02JUL91

INSPECT NOZZLE HOLDER

1. Inspect the lapped surface (A) on bottom end of nozzle holder (B) for nicks or scratches. Replace holder if not in good condition.

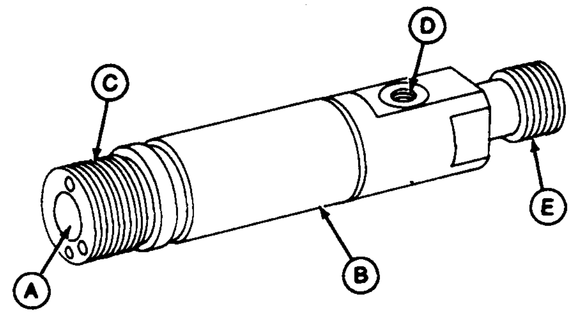
2. Inspect threads M19 x 1 (C), M6 x 1 (D), and M14 x 1.5 (E) on nozzle holder for general condition. Threads that are nicked slightly may be “dressed-up.” Replace holder if threads cannot be restored to a serviceable condition.

3. Check fuel passages in nozzle holder to make sure they are open. Clean with compressed air.

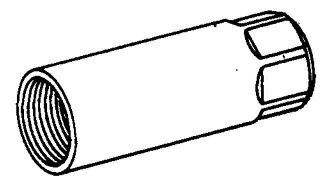
4. Remove carbon deposits on both inner and outer surfaces of the nozzle retaining nut.

5. Inspect the retaining nut for cracks caused by overtightening or a damaged lower seating surface. A seat may be restored by rubbing the surface with emery cloth.

Any nozzle nut which cannot be reconditioned, must be replaced.



RG3413 -UN-20DEC88



RG2247

RG2247 -UN-20DEC88

A—Lapped Surface
B—Nozzle Holder
C—M19 x 1
D—M6 x 1
E—M14 x 1.5

S11,3010,DB -19-11SEP91

35
47

6. Examine the lapped surfaces on the intermediate plate (A) for nicks, scratches, or worn areas which would permit the fuel to leak past.

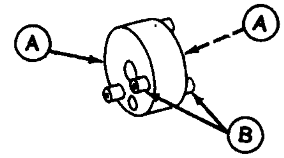
7. Replace the intermediate plate if the lapped surfaces are worn or damaged.

IMPORTANT: Do not lap machined surfaces of the intermediate plate. The dowel pins (B) in plate have to be removed before the 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.

8. 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

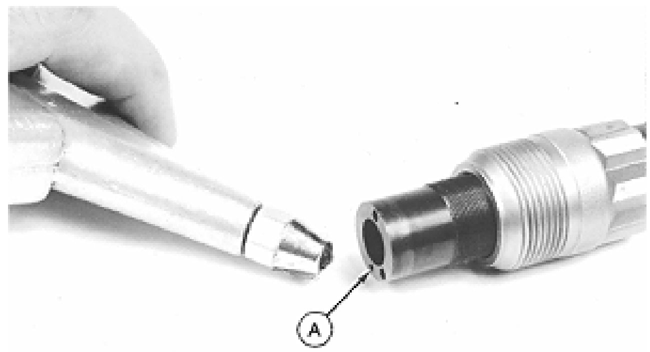
S11,3010,DC -19-11SEP91

9. Examine spring and shims for pitting or excessive wear. Replace as necessary.

NOTE: The edge-type filter is pressed into the nozzle holder (B) and is not removable for service.

10. Clean the filter by applying compressed air to the nozzle holder fuel passage (A) at nozzle end.

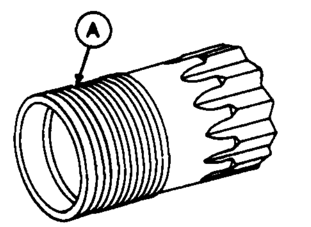
RG5955 -UN-30AUG91



RG5962 -UN-30AUG91

S11,0408,BD -19-16SEP91

INSPECT GLAND NUT



RG3414 -UN-20DEC88

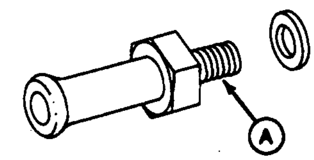
1. Inspect nozzle holder gland nut for general condition, be sure that it is not cracked or split.

2. Inspect the M28 x 1.5 threads (A) for general condition. Threads which are slightly nicked or damaged may be “dressed up.”

Replace gland nut if unable to restore to a serviceable condition.

S11,0408,BF -19-02JUL91

RG3888 -UN-20DEC88



3. Check passage in leak-off connector to see that it is open.

4. Blow through connector passage with compressed air.

5. Inspect the M6 x 1 threads (A) for general condition. Replace connector if threads are damaged and can not be restored to a serviceable condition.

S11,0408,BG -19-19JUL82

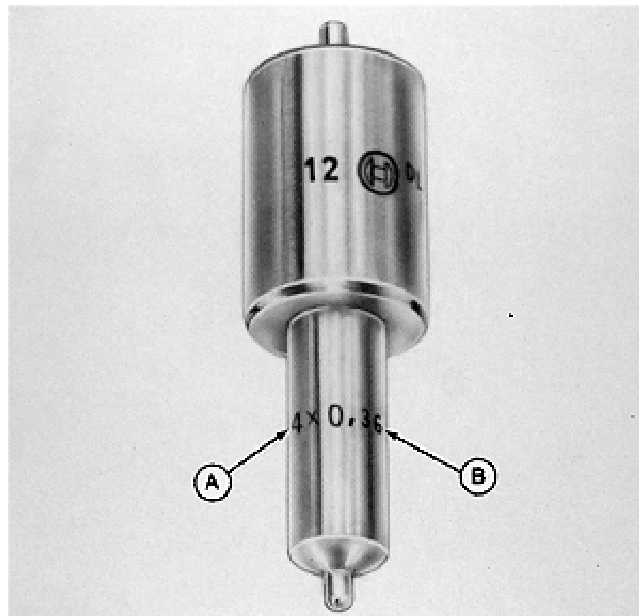
ASSEMBLE FUEL INJECTION NOZZLE

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.

IMPORTANT: Immerse parts in clean fuel before assembly. Do not dry parts with towels or compressed air. Dust particles might collect and stay on pressure faces of nozzle valve and nozzle holder.



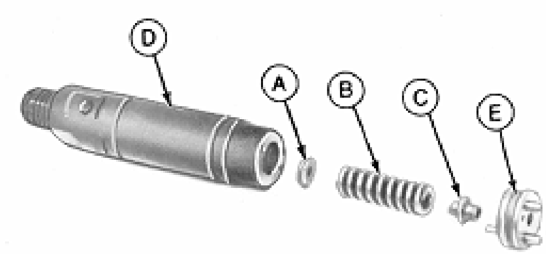
R28734 -UN-20DEC88

S11,3010,LE -19-09APR85

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



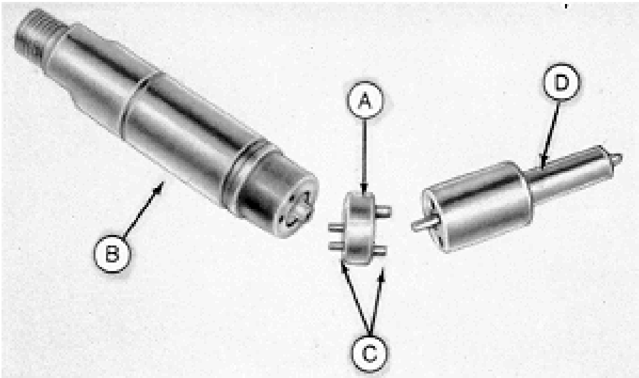
RG3415 -UN-20DEC88

S11,3010,DF -19-19JUL82

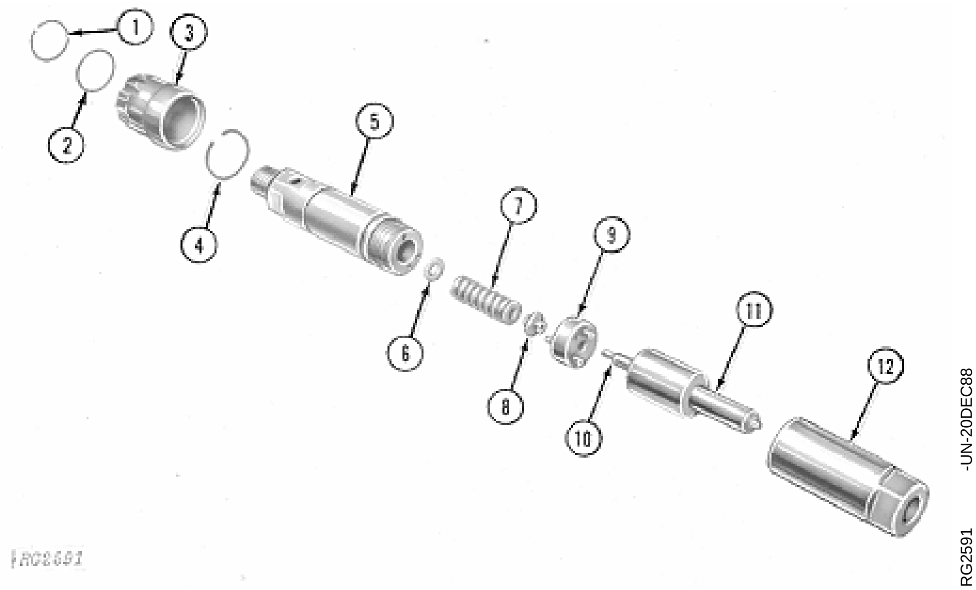
2. Position the intermediate plate (A) on nozzle holder (B). Note that the dowel pins (C) in plate will permit installation only one way.

3. Insert nozzle valve into nozzle (D) while holding parts below the diesel fuel level in pan.

A—Intermediate Plate
B—Nozzle Holder
C—Dowel Pins
D—Nozzle and Valve



S11,3010,DG -19-19JUL82



1—Snap Ring (upper)	**4—Snap Ring (Lower)**	**7—Nozzle Valve Spring**	**10—Nozzle Valve**
2—Gland Nut O-Ring	**5—Nozzle Holder**	**8—Spring Seat**	**11—Nozzle**
3—Gland Nut	**6—Shim**	**9—Intermediate Plate**	**12—Nozzle Retaining Nut**

4. Install nozzle assembly on nozzle holder (5) and secure with nozzle retaining nut (12).

5. Clamp the nozzle holder in a soft-jawed vise. Tighten the nozzle retaining nut (12) 60—79 N·m (44—58 lb-ft).

6. Install lower snap ring (4) on nozzle holder.

7. Coat bore of gland nut (3) liberally with an anti-seize compound (such as NEVER-SEEZ) to prevent gland nut from seizing on holder body.

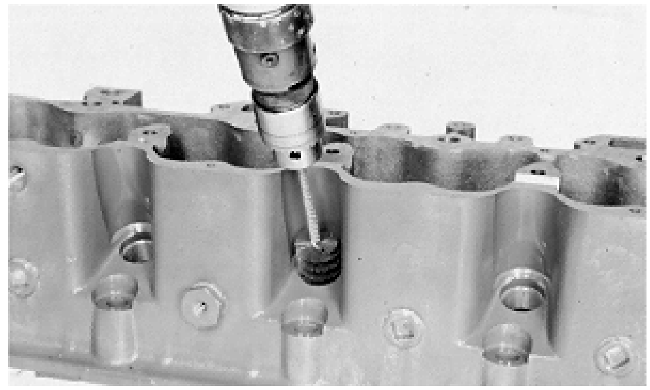
8. Install upper snap ring (1) on nozzle holder and position O-ring (2) against gland nut.

9. Install leak-off connector on nozzle holder (5), using a new washer.

NOTE: The leak-off connector and washer should be installed on the nozzle holder even though they will have to be removed to install the injection nozzle in cylinder head. This will prevent misplacement of connector and washer before installation on engine.

S55,3010,BJ -19-02OCT91

INSPECT AND CLEAN CYLINDER HEAD NOZZLE BORE


RG5251 -UN-14DEC88

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

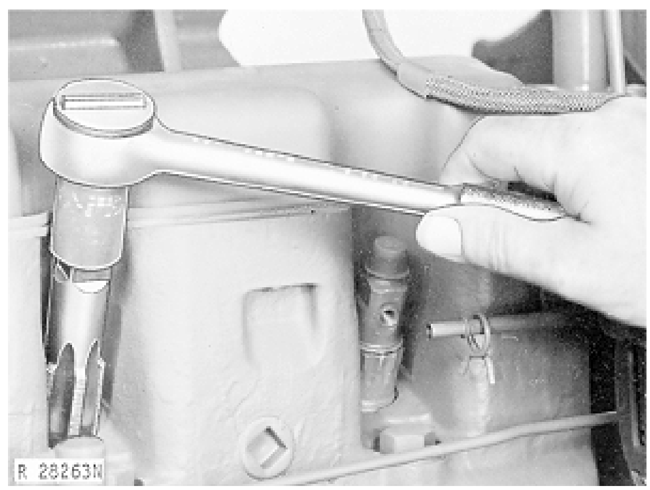
2. Inspect condition of nozzle seating surface in cylinder head.

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

IMPORTANT: If the injection nozzle gland nut threads are not clean, a false torque wrench 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 an electric drill and the D17030BR Thread Cleaning Brush. Work brush up and down several times to clean threads.

S55,3010,AU -19-09SEP91



R28263N -UN-20DEC88

4. Clean threads with heavy foreign deposits or clean up damaged threads using the 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 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 hardwood dowel.

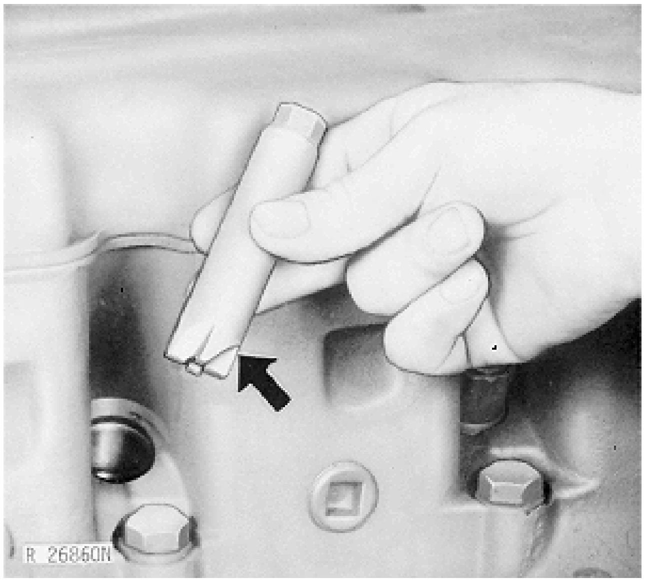
S11,0408,BM -19-25JUL91

INSPECT AND CLEAN NOZZLE SEATING SURFACE

1. Inspect nozzle seating surface for carbon deposits.

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

3. Insert tapered hardwood dowel in nozzle tip bore and blow out debris with compressed air. Remove hardwood dowel.



R26860N -UN-20DEC88

S55,3010,AV -19-25JUL91

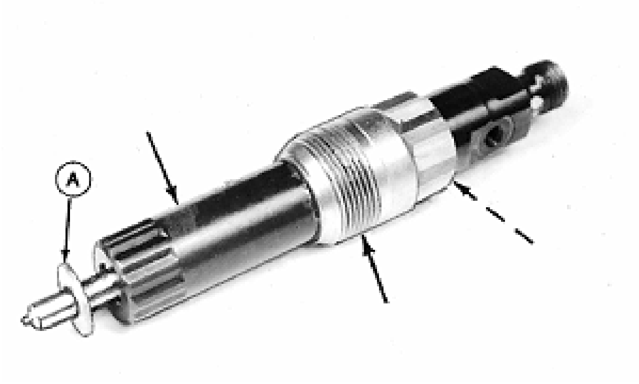
INSTALL FUEL INJECTION NOZZLES

1. Apply PT569 NEVER-SEEZ compound to the gland nut threads and nozzle barrel (arrows). Be sure that anti-seize compound was also applied to inside bore of gland nut during assembly.

NOTE: Applying anti-seize compound at these locations will help prevent possible seizure of the gland nut to the holder body.

2. Install a new R84472 Special Steel Washer (A) on tip end of assembled injection nozzle.

IMPORTANT: Do not intermix injection nozzles of different suppliers or different tip sizes within any one engine.



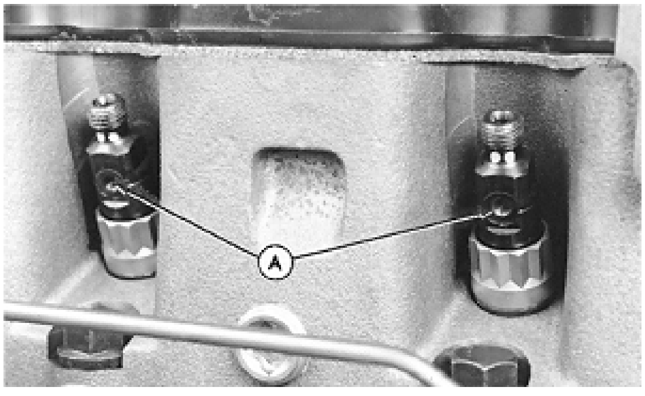
RG5888 -UN-19AUG91

RG,CTM42,G35,39-19-10SEP91

3. Insert injection nozzle into the cylinder head. Turn gland nut by hand to make sure that it is threaded straight in cylinder head.

4. Use outer socket of JDE92 Nozzle socket and turn gland nut down to remove most of the looseness.

5. Rotate nozzle holder so that the hole for the leak-off connector threads (A) are facing straight out from the cylinder head.



RG5889 -UN-19AUG91

RG,CTM42,G35,41-19-10SEP91

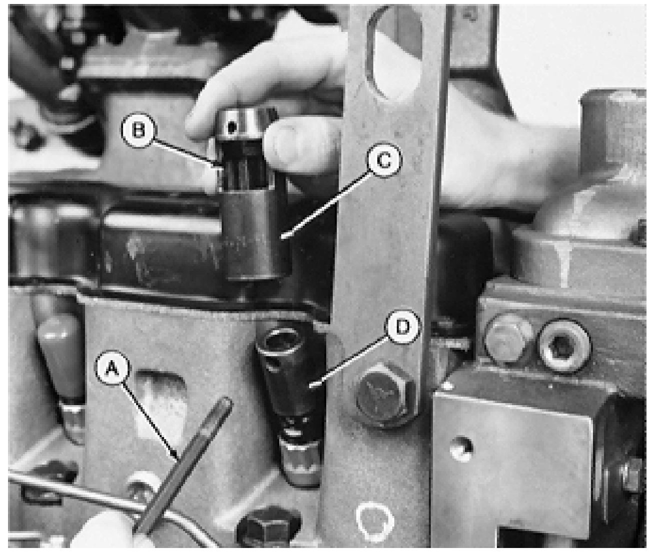
6. Position the inner socket (D) over the nozzle holder and engage with the two flats at top of nozzle holder.

7. Place outer socket (C) portion of JDE92 Nozzle Socket on gland nut with socket “window” (B) facing outward.

8. Insert handle (A) through window into inner socket. The ball detent in handle will keep it secured to the inner socket.

NOTE: The handle simulates the position of the leak-off connector, which must be square with the engine to permit proper installation of leak-off lines.

A—Handle
B—Window
C—Outer Socket
D—Inner Socket



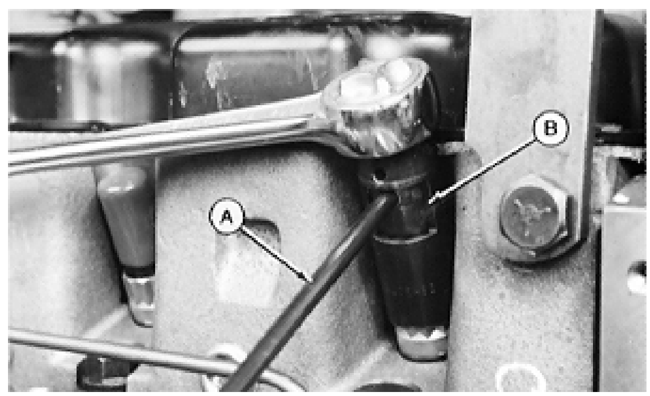
RG5758 -UN-05AUG91

RG,CTM42,G35,42-19-10SEP91

9. Tighten the injection nozzle gland nut to 88 N·m (65 lb-ft). Keep the handle (A) pointing straight out while tightening.

Socket window (B) is cut deep enough to obtain a new “bite” without removing the inner socket.

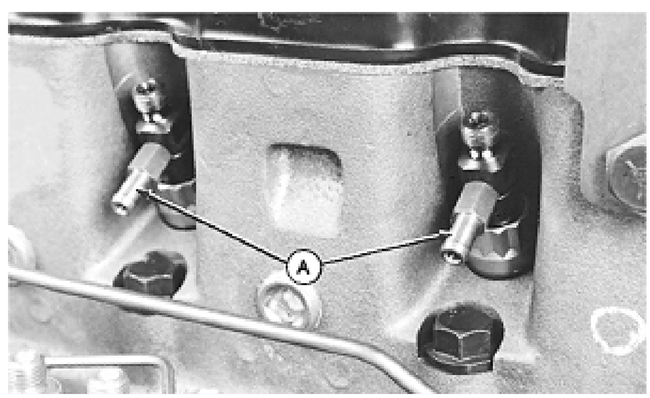
10. Be sure that O-ring is positioned against the injection nozzle gland nut.



RG5759 -UN-05AUG91

RG,CTM42,G35,43-19-02OCT91

11. Install leak-off connectors (A) with O-rings on injection nozzles. Tighten securely.



RG5890 -UN-19AUG91

RG,CTM42,G35,44-19-10SEP91

12. For all-metal, multi-piece leak-off lines, loosen all fittings (A), remove pipes (B) and inspect all packings (C). Discard any packings that are worn or cut.

NOTE: Mark each leak-off pipe before disassembly to assure assembly in correct location.

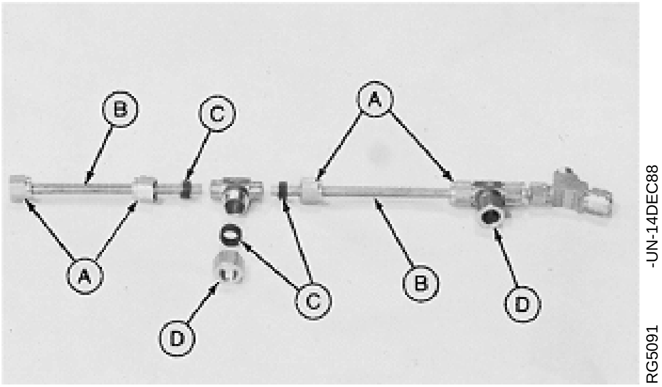
13. Check all pipes and fittings for wear or damage and replace as necessary.

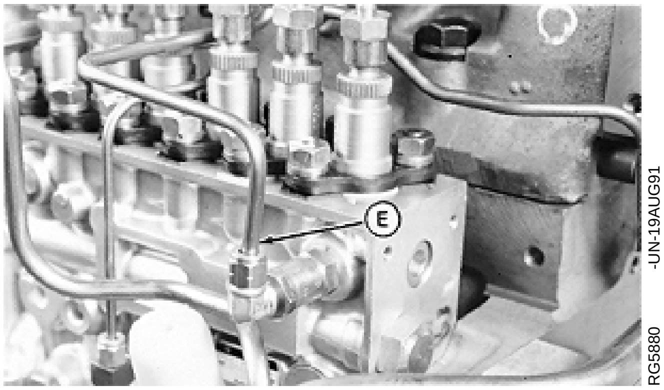
14. Reinstall new packings (if needed), and pipes into tee-fittings. Tighten all connections securely.

15. Install nuts (D) and packings onto leak-off connectors. Install complete assembly over appropriate leak-off line connectors.

16. Tighten all leak-off line connections securely at each injection nozzle.

17. Connect leak-off line at injection pump (E) and tighten securely.

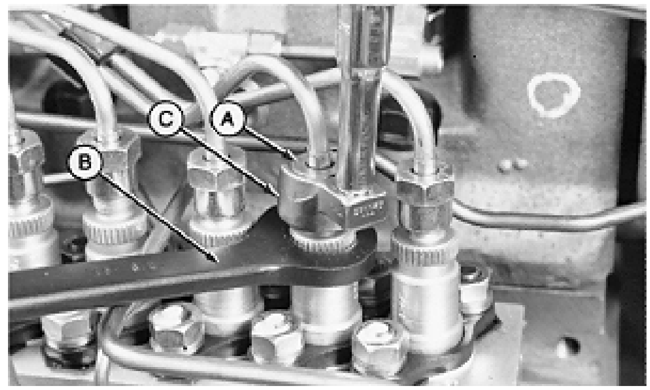




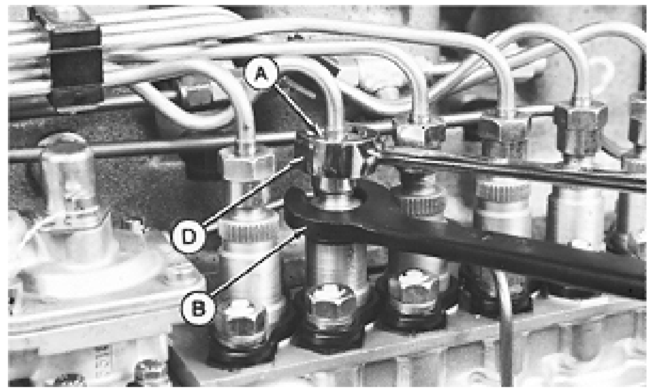
A—Fittings
B—Pipes
C—Packings
D—Nuts
E—Pump Leak-off Line

RG,CTM42,G35,45-19-10SEP91

IMPORTANT: On Robert Bosch “P” injection pumps, the JDE90 Serrated Wrench (B) or a 22 mm open end wrench (Nippondenso “P” and all “A” pumps) must be used to keep the delivery valve fittings stationary while tightening fuel line nuts. If a delivery valve and barrel housing rotates while tightening a fuel line nut the injection pump fuel delivery will be altered. The pump will have to be recalibrated on a test stand.



RG5877 -UN-19AUG91



RG5878 -UN-19AUG91

18. Remove protective caps and plugs, that were installed during disassembly, from injection lines, nozzles and delivery valves. Install and connect injection line assembly at each respective injection nozzle and delivery valve.

19. Tighten fuel injection line nozzle nuts (A) to 27 N·m (20 lb-ft).

20. Tighten line nuts at delivery valves to 27 N·m (20 lb-ft) using the JDF22 Crowsfoot Wrench (C) or a 3/4 in. Line Wrench (D) along with the JDE90 Serrated Wrench (B) (Robert Bosch “P” Pumps) or a 22 mm open end wrench (all other pump applications).

21. Bleed the fuel system as outlined earlier in this group.

A—Fuel Injection Line Nuts
B—JDE90 Serrated Wrench
C—JDF22 Crowsfoot Wrench
D—3/4 in. Line Wrench

RG,CTM42,G35,46-19-10SEP91

PRELIMINARY ENGINE TESTING

Before tuning-up an engine, determine whether a tune-up will restore operating efficiency. When there is doubt, the following preliminary tests will help to determine if the engine should be tuned-up or if the problem requires further diagnosis. Choose from the following list of recommended tests only those necessary to restore the unit to peak operating power and efficiency.

1. After engine has been stopped for several hours, carefully loosen crankcase oil 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 an 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 in Group 105. Repeat dynamometer test after tune-up, so power output before and after tune-up can be compared.

High elevations may affect engine performance. As a general rule, the following guidelines will apply:

- One-half of one percent reductions per 300 m (1000 ft) rise in elevation above sea level. Engine may have to be defueled when a substantial percentage of operating time occurs at 2250 m (7500 ft) or higher.

- If engine requires less fuel for acceptable performance at higher elevation, contact your local authorized fuel injection pump repair station for service.

4. Perform engine compression pressure test for each cylinder. See TEST ENGINE COMPRESSION PRESSURE in Group 105.

RG,CTM6,G100,1 -19-22AUG91

GENERAL TUNE-UP RECOMMENDATIONS

A tune-up should be performed as often as necessary to maintain optimum performance within the general condition limits of the engine. Refer to your operator's manual.

The following services are recommended each time a tune-up is performed. Disregard those services that do not apply to any particular application.

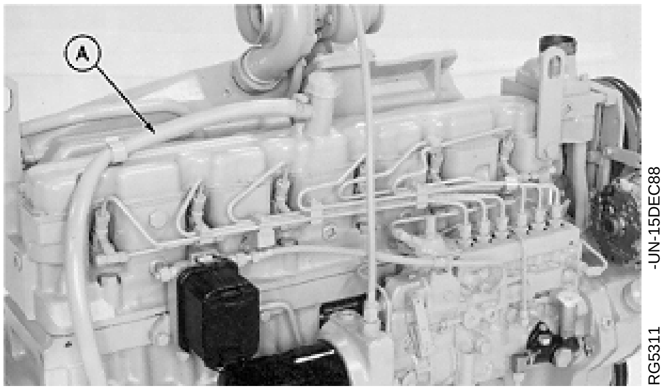
Operation	Detailed Reference
Change engine oil and filters.	Operator's Manual
Lubricate PTO clutch internal levers and linkage.	Operator's Manual
Replace fuel filter.	Group 35
Clean crankcase vent tube.	This Group
Check air intake system. Replace air cleaner elements.	This Group/Operator's Manual
Check entire exhaust system.	This Group
Check and service engine cooling system.	This Group/Operator's Manual
Check entire electrical system.	This Group
Check crankshaft vibration damper.	Group 105
Inspect turbocharger and check turbocharger boost pressure.	Group 110
Check fuel injection system: Check engine-to-injection pump timing, clean injection nozzles, and adjust nozzle opening pressure.	Group 35 and 115
Check engine oil pressure. Adjust if necessary.	Group 105
Check engine valve clearance. Adjust if necessary.	Group 105
Check engine speeds. Adjust if necessary.	Group 115
Check engine performance on dynamometer.	Group 105

RG,CTM6,G100,2 -19-17SEP91

CHECK CRANKCASE VENTILATION SYSTEM

1. Inspect crankcase ventilation system for restrictions. Lack of ventilation causes sludge to form in engine crankcase. This can lead to clogging of oil passages, filters, and screens, resulting in serious engine damage.

2. Clean crankcase vent tube (A) with solvent and compressed air if restricted. Install and tighten hose clamps securely.



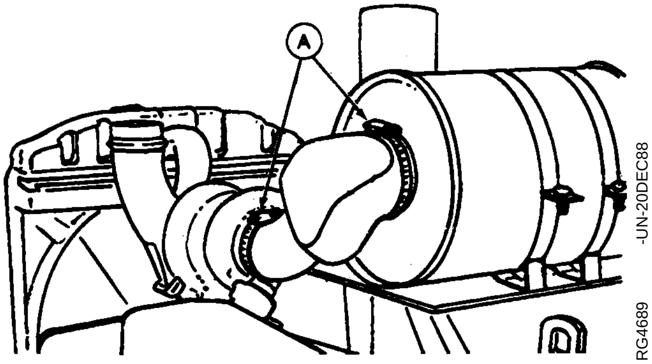
S55,22010,B -19-23FEB88

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 (A) 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,CU -19-25JUL91

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 clamps are securely tightened and do not leak.

S55,22010,C -19-25JUL91

CHECK AND SERVICE ENTIRE COOLING SYSTEM

1. Visually inspect entire cooling system and all components for leaks or damage. Repair or replace as necessary.

2. Remove any trash that has accumulated on or near radiator.

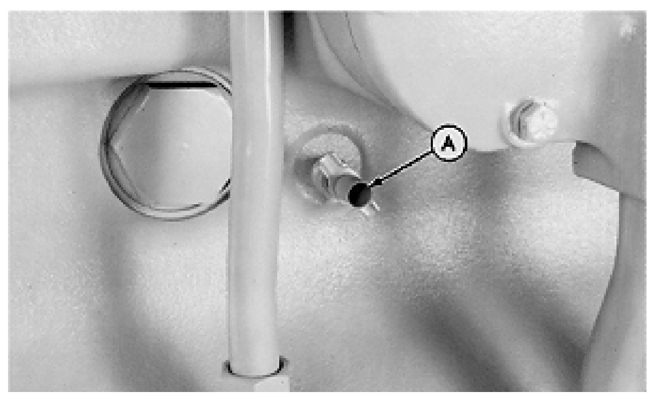
3. Remove the foam filter from weep hole (A) located in the bottom of water pump housing. Inspect the weep hole for any restrictions.

4. Insert a heavy gauge wire about 63.5 mm (2.5 in.) deep into weep hole to make sure hole is open.

5. Install a new R98527 Foam Filter flush with pump housing if pump assembly passes inspection.

6. Inspect radiator hoses for signs of leakage or rot. Replace hoses as necessary.

RG,CTM6,G100,3 -19-31JUL91



CAUTION: Do not drain coolant until the coolant temperature is below operating temperature. Always loosen drain cock (A) slowly to relieve any excess pressure.

7. Drain coolant, remove thermostats, and flush cooling system. (See your operator's manual for details.)

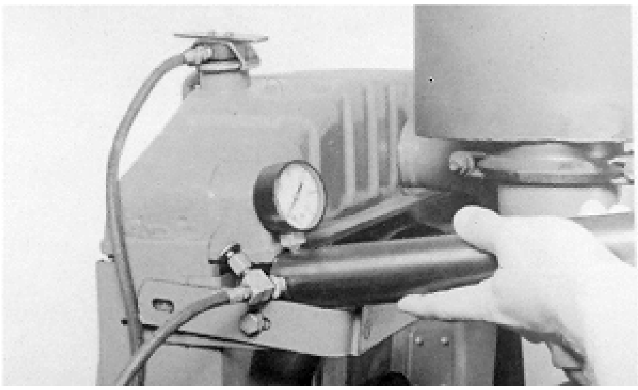
8. Test thermoststs per rating for temperature they start to open and the temperature at which it is fully open. Replace defective thermostats as needed. (See INSPECT THERMOSTATS AND TEST OPENING TEMPERATURE, in Group 105.)

9. Install thermostats, fill cooling system with recommended coolant and inhibitors. (See your operator's manual for recommendations.)

100
4

RG,CTM6,G100,4 -19-17SEP91

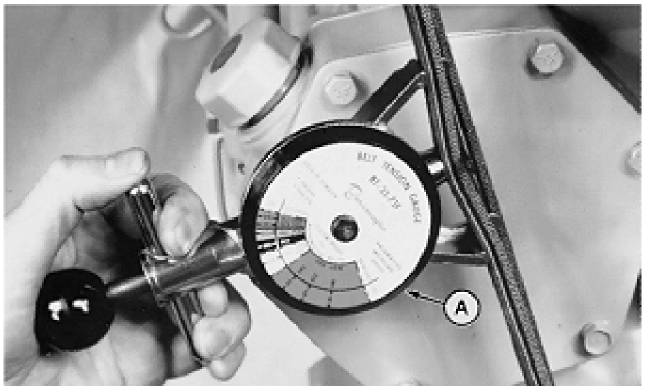
10. Pressure test radiator and cap to insure efficient operation and eliminate the chance for engine damage due to overheating. (See PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP in Group 105.)



RG78199D1 -UN-14DEC88

RG,CTM6,G100,5 -19-20SEP91

INSPECT AND ADJUST V-BELTS



RG4683 -UN-15DEC88

1. Check condition of fan belt(s) and replace (as a matched set) if cracked, frayed or excessively worn.

NOTE: Engines having dual belts, check front belt tension only. Measure tension on long part of belt as shown in illustration.

2. Check belts tension and adjust as necessary. (See INSPECT FAN AND ALTERNATOR V-BELTS in Group 25.)

IMPORTANT: Belts must not be hot when tension is checked or adjusted. Belt tension specified is for a warm belt.

Do not pry against alternator rear frame when adjusting belt tension.

RG,CTM6,G100,6 -19-31JUL91

CHECK ELECTRICAL SYSTEM

TS204 -UN-23AUG88

CAUTION: Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.

Always remove grounded (-) battery clamp first and replace it last.

RG4694 -UN-15DEC88

1. Clean batteries, and cables with a damp cloth. If corrosion is present, remove it and wash the terminals with a solution of ammonia or baking soda in water. Then flush area with clean water.

2. Coat battery terminals and connectors with petroleum jelly mixed with baking soda to retard corrosion.

3. Test batteries. If batteries are not near full charge, try to find out why.

4. On low-maintenance batteries, check level of electrolyte in each cell of each battery. Level should be to bottom of filler neck. If water is needed, use clean, mineral-free water.

If water must be added to batteries more often than every 250 hours, alternator may be overcharging.

NOTE: Water can not 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 CTM11, Engine Accessories.

6. Check tension of fan belts, as instructed on previous page.

7. Check operation of starting motor and gauges.

S11,22010,CZ -19-31JUL91

SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

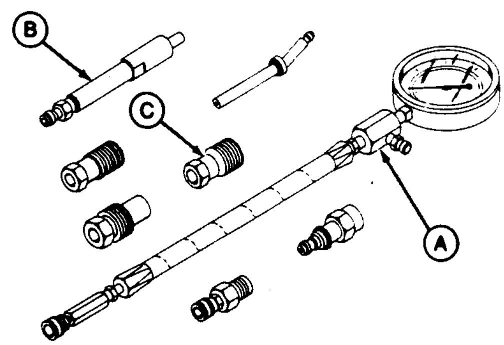
Compression Test Kit JT01674 (D14546BA)

A—Gauge and Hose Assembly JT01682 (D14547BA)

B—Nozzle Adapter JT01675A (D14557BA)

C—Adapter Nut JT01677

Used to test each cylinder's compression pressure.

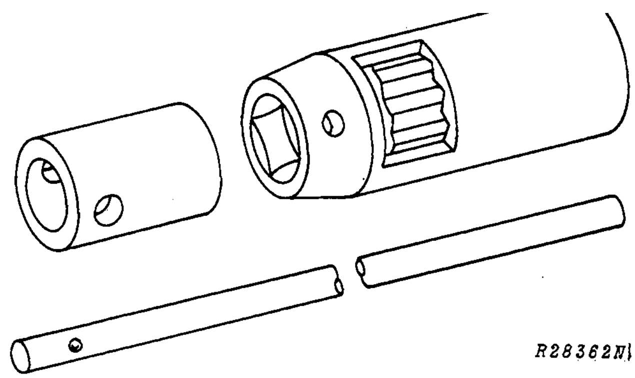


RG5784 -UN-09AUG91

RG,JT01674 -19-17SEP91

Nozzle Socket JDE92

Used to remove and install fuel injection nozzles.



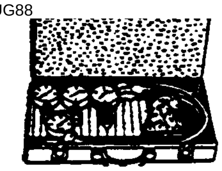
R28362N -UN-20DEC88

S11,22005,R -19-17SEP91

RG5162 -UN-23AUG88

Universal Pressure Test Kit JT05470 (D15027NU)

Used for testing engine oil pressure.

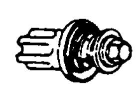


S55,22005,B -19-17SEP91

RG4950 -UN-23AUG88

Flywheel Turning Tool JDE81-1

Rotate engine flywheel. Use with JDE81-4.

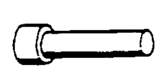


S53,JDE811 -19-07JUL89

RG5068 -UN-23AUG88

Timing Pin JDE81-4

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



S55,JDE814,B -19-24FEB88

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)	
6076T, A, and H	2380—2790 kPa (23.8—27.9 bar) (345—405 psi)
Valve Clearance:	
Intake	0.38 mm (0.015 in.)
Exhaust	0.51 mm (0.020 in.)
Valve Lift at 0.00 mm (in.) Clearance):	
Engine Serial No. (—121169):	
Intake Valve	14.05—14.48 mm (0.553—0.570 in.)
Minimum Acceptable	13.16 mm (0.518 in.)
Exhaust Valve	15.88—16.31 mm (0.625—0.642 in.)
Minimum Acceptable	14.99 mm (0.590 in.)
Engine Serial No. (121170—) :	
Intake Valve	13.39—13.84 mm (0.527—0.545 in.)
Minimum Acceptable	12.50 mm (0.492 in.)
Exhaust Valve	14.38—14.84 mm (0.566—0.584 in.)
Minimum Acceptable	13.49 mm (0.531 in.)
Crankshaft End Play	0.038—0.380 mm (0.0015—0.0150 in.)
Max. Damper Radial Runout	1.02 mm (0.040 in.)
Oil Pressure:	
Minimuum No Load at 850 RPM (Slow Idle)	138 kPa (1.4 bar) (20 psi)
Maximum Full Load at 2200 RPM (Rated Speed)	380 kPa (3.8 bar) (55 psi)
Cooling System Leakage Test Pressure	120 kPa (1.2 bar) (18 psi)

S55,22005,F -19-17SEP91

DIAGNOSING MALFUNCTIONS

• ENGINE WILL NOT START

Fuel System Malfunction - See Group 115
- Empty fuel tank
- Fuel shut off cable not pushed in
- Improper fuel
- Plugged fuel filter
- Fuel shut off at tank

Electrical System Malfunction
- Corroded or loose battery connections
- Weak Battery

• ENGINE RUNS IRREGULARLY OR MISSES

Basic Engine Problem
- Improper valve clearance
- Low compression
- Engine overheating
- Valves sticking or burned
- Worn camshaft lobes
- Detonation

Fuel System Malfunction - See Group 115
- Low fuel supply
- Restricted fuel line or filter
- Air in fuel
- Incorrect injection pump timing
- Plugged or defective injection nozzle
- Faulty injection pump
- Faulty fuel pump
- Improper fuel

• LACK OF POWER

Basic Engine Problem
- Low compression
- Engine overheating
- Incorrect valve clearance
- Blown cylinder head gasket
- Worn camshaft lobes
- Burned, warped, pitted or sticking valves
- Weak valve springs

Service Problem
- Dirty or obstructed air cleaners
- Improper fuel

Fuel System Malfunction - See Group 115
- Plugged fuel filters
- Faulty injection nozzles
- Restricted exhaust system
- Plugged fuel tank vent

Power Train Malfunction
- Clutch Slipping

• FREQUENT STALLING

Operator Error
- Engine not at operating temperature

Fuel System Malfunction - See Group 115
- Restricted fuel lines
- Faulty fuel pump
- Plugged fuel filter
- Vent on fuel tank cap obstructed
- Dirty or faulty injectors

• ENGINE OVERHEATS

Basic Engine Problem
- Loosen or broken fan belt
- Faulty thermostats
- Defective radiator pressure cap
- Faulty water pump

Service Problem
- Low coolant level
- Crankcase oil level low
- Engine overloaded
- Improper fuel

Fuel System Malfunction - See Group 115
- Excessive fuel delivery
- Improper injection pump timing

• EXCESSIVE OIL CONSUMPTION

Basic Engine Problem
- Worn valve guides or valve stems
- Oil control rings worn or broken
- Worn or scored liners or pistons
- Piston ring gaps not staggered
- Excessive main or connecting rod bearing clearance

Service Problem
- Engine oil too thin
- Oil level too high

• WHITE EXHAUST SMOKE

Basic Engine Problem
- Low compression

Fuel System Malfunction - See Group 115
- Faulty injection nozzles
- Improper fuel

S11,22010,BO -19-22AUG91

DIAGNOSING 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
- 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

DYNAMOMETER TEST

IMPORTANT: Specifications given below apply to OEM applications only. For machine applications, consult the appropriate machine technical manual for a recommended method of loading engine for dynamometer testing.

If possible, test the engine on a dynamometer and record horsepower output before it is tuned. This test gives the horsepower output and fuel consumption of the engine as is. This will help determine if a tune-up can restore engine power or whether an overhaul is needed. Test engine on a dynamometer after tune-up and horsepower output with reading obtained before tune-up.

Satisfactory engine performance depends on these basic things listed below:

• An adequately balanced supply of clean air and fuel.

• Good compression pressure.

• Proper valve train-to-injection pump timing for good combustion.

• Proper air and fuel temperatures.

• Proper fuel setting for altitude level at which engine is operated. (See GENERAL TUNE-UP RECOMMENDATIONS, Group 100.)

Perform engine dynamometer test using the following guidelines:

1. Connect the engine to the dynamometer following the manufacture's instructions.

2. Start engine and operate at one-half load until the coolant and crankcase oil temperatures are within normal operating range.

3. Run engine at fast idle and gradually increase the load on the engine until its speed is reduced to full load rated rpm.

4. Read the horsepower on the dynamometer and record reading for future reference.

5. Compare the horsepower 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)*
6076TF ENGINE					
Standard Mechanical	850	2450	2200	RE32036	142 (190)
3—5% Mechanical	850	1890	1800	RE32029	150 (200)
3—5% Mechanical	850	1890	1800	RE38824	150 (200)
6076AF ENGINE					
Standard Mechanical	850	2450	2200	RE32033	180 (240)
Standard Mechanical	850	2450	2200	RE32034	160 (215)
3—5% Mechanical	850	1890	1800	RE38825	186 (250)
3—5% Mechanical	850	1890	1800	RE38826	225 (300)
Electronic	850	1800	1800	RE36112	205 (275)
6076HF ENGINE					
Standard Mechanical	850	2450	2200	RE32035	194 (260)
Standard Mechanical	850	2450	2200	RE32033	182 (245)
Standard Mechanical	850	2450	2200	RE32035	205 (275)

**Average power rating given, allow ± 5% for maximum and minimum power.*

S55,22005,G -19-18SEP91

ENGINE BREAK-IN INSTRUCTIONS

Use a dynamometer to perform the following break-in procedure. If necessary, engine break-in can be performed without a dynamometer if under controlled operating conditions.

IMPORTANT: During the first 100 hours of operation on a new engine or engine that has had a major overhaul, DO NOT use TORQ-GARD SUPREME PLUS-50™ engine oil. TORQ-GARD SUPREME PLUS-50 oil will not allow a new or overhauled engine to properly wear during this break-in period.

Fill engine crankcase with TORQ-GARD SUPREME™ multi-viscosity oil (according to expected ambient operating temperatures) to proper level for use during the break-in operation.

Time	Load	*Engine Speed	Remarks
5 Minutes	No Load	850 rpm	Check oil pressure, coolant, temperature, and leakage.
5 Minutes	No Load	1500 to 2000 rpm	
5 Minutes	1/4 Load	1900 to 2100 rpm	
10 Minutes	1/2 Load	1900 to 2100 rpm	
10 Minutes	1/2 to 3/4 Load	1900 to 2100 rpm	
10 Minutes	3/4 to Full Load	Rated Speed	

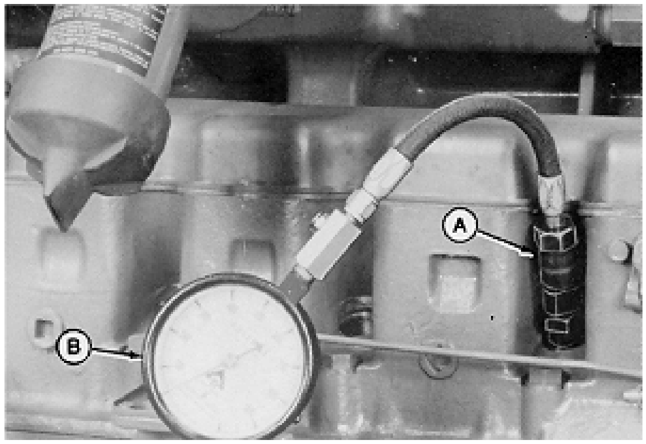
Check and readjust valve clearance as necessary. Cylinder head retorque is not required. (See Group 05, Cylinder Head and Valves.)

During the first 100 hours of operation, avoid over-loads, excessive idling, and no-load operation. Do NOT use foot throttle. After 100 hours maximum, drain crankcase oil and change oil filter. Fill crankcase with oil of proper viscosity and service classification. (See DIESEL ENGINE OIL in Group 02.)

**Engine speeds listed are for engines equipped with a regular governor (8—10 per cent regulation). For engines with 3—5 per cent regulation, reduce speeds by 200 rpm EXCEPT for 5 minute/No Load at 850 rpm. For engines equipped with electronic governors, run at rated speed.*

S55,22005,H -19-18SEP91

TEST ENGINE COMPRESSION PRESSURE



-UN-27OCT88

RG4118

IMPORTANT: Compression pressures are affected by the cranking speed of the engine. Before beginning test, insure that batteries are in good condition and fully charged.

1. Start engine and run at rated speed until it warms up to normal operating temperature

2. Remove injection lines, leak-off lines, and injection nozzles. (See REMOVE 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. Pull fuel shut-off knob all the way out, if equipped, and close fuel shut-off valve.

6. Crank engine over at 200—250 rpm cranking speed and record compression readings.

ENGINE COMPRESSION

Engine	Compression Pressure
6076	2380—2790 kPa (23.8—27.9 bar) (345—405 psi)

NOTE: Pressure given was taken at 300 m (1000 ft) above sea level. A 3.6 percent reduction in gauge pressure will result for each additional 300 m (1000 ft) of altitude.

7. If pressure is much lower than shown, remove gauge and apply oil to ring area of piston through injection nozzle bore. Do not use too much oil and do not get oil on valves.

8. Crank engine over and record compression reading again.

If pressure is higher than 2790 kPa (27.9 bar) (405 psi), worn or stuck rings are indicated.

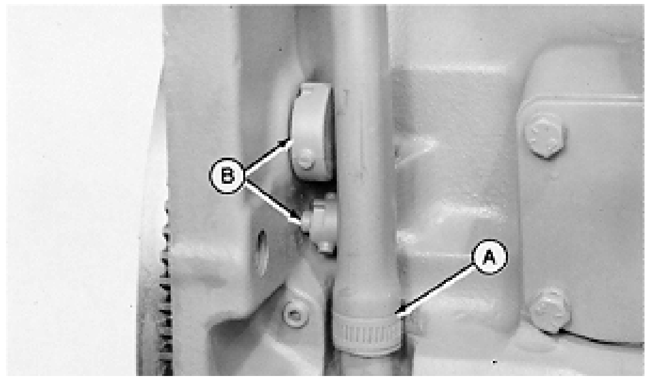
If pressure is below 2380 kPa (23.8 bar) (345 psi), it is possible that valves are worn or sticking.

9. Measure compression pressure in all remaining cylinders and compare readings. Recondition cylinders and valves as required.

NOTE: All cylinder pressures should be approximately alike. There should be less than 340 kPa (3.4 bar) (50 psi) difference between cylinder pressures.

S55,22005,I -19-17SEP91

CHECK AND ADJUST VALVE CLEARANCE



RG3794 -UN-23FEB89

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.

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

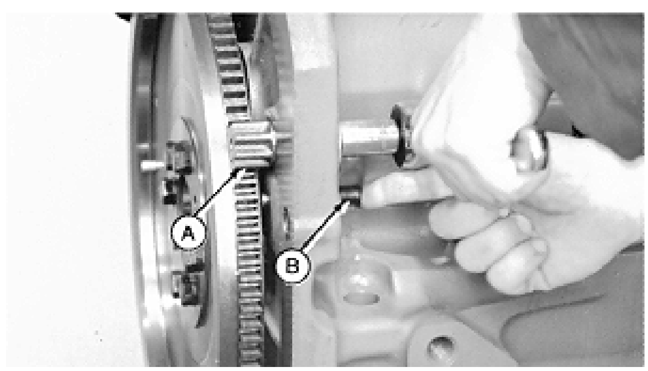
NOTE: Valve clearance can be checked with engine cold or warm.

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

2. Remove plastic plugs (B).

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

S11,2005,DO -19-23AUG91



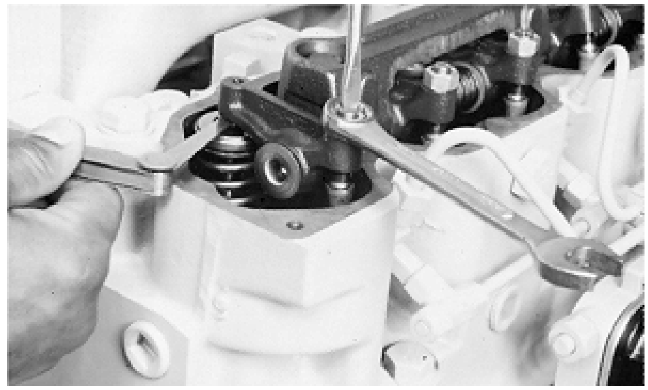
RG3795 -UN-23FEB89

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

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

S11,2005,DP -19-07FEB85

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

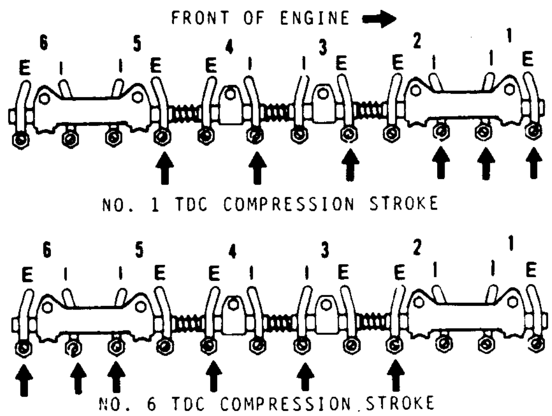


RG5241 -UN-06DEC88

VALVE CLEARANCE SPECIFICATIONS

Intake Valves	0.38 mm (0.015 in.)
Exhaust Valves	0.51 mm (0.020 in.)

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



RG4295 -19-21AUG91

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

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

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

S11,2005,NB -19-22AUG91

CHECK VALVE LIFT

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

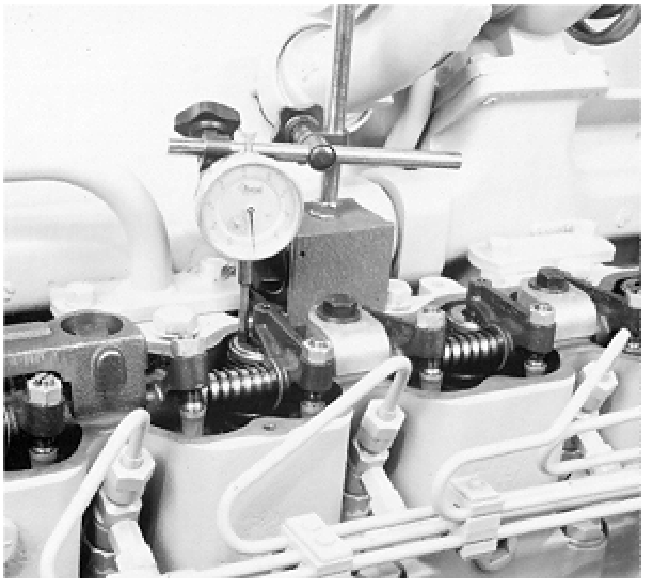
1. Remove rocker arm cover and loosen locknut on rocker arm. Set valve clearance at 0.00 mm (in.). Tighten locknut.

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

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

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

5. After rocker arm contacts valve wear cap, observe dial indicator reading as valve is moved to fully open position.


RG5242 -UN-06DEC88

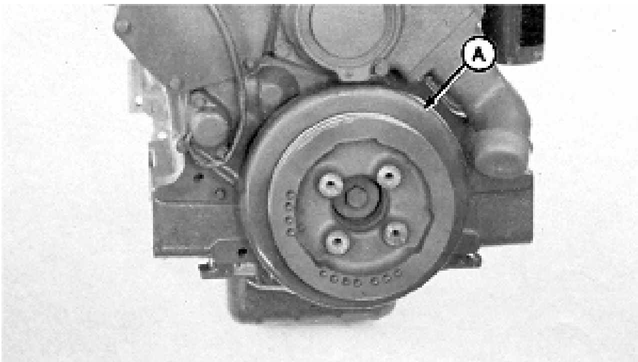
VALVE LIFT SPECIFICATION AT 0.00 MM (IN.) CLEARANCE

Engine Ser. No. (—121169)	
Intake	14.05—14.48 mm (0.553—0.570 in.)
Minimum Acceptable	13.16 mm (0.518 in.)
Exhaust	15.88—16.31 mm (0.625—0.642 in.)
Minimum Acceptable	14.99 mm (0.590 in.)
Engine Ser. No. (121170—) and converted 644E Loaders	
Intake	13.39—13.84 mm (0.527—0.545 in.)
Minimum Acceptable	12.50 mm (0.492 in.)
Exhaust	14.38—14.84 mm (0.566—0.584 in.)
Minimum Acceptable	13.49 mm (0.531 in.)

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

S11,2005,MN -19-18SEP91

INSPECT VIBRATION DAMPER



RG3502 -UN-14DEC88

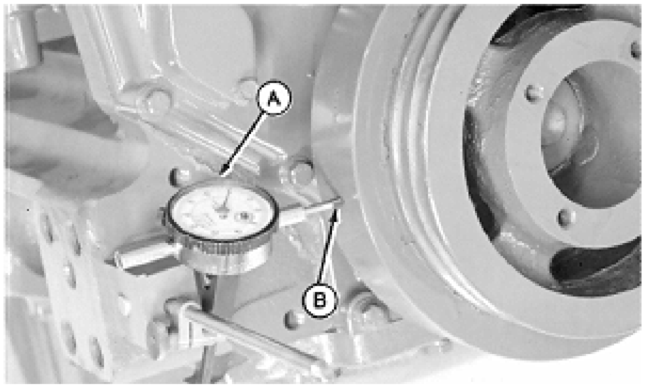
IMPORTANT: Do not immerse the vibration damper or the damper pulley in cleaning solvent. Doing so may damage the rubber portions of these components.

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

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

S55,2015,D -19-03MAY88



RG3833 -UN-14DEC88

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

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

4. Note dial indicator reading.

DAMPER RADIAL RUNOUT SPECIFICATION

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

If runout exceeds specifications, replace vibration damper.

S11,2015,BJ -19-28AUG91

CHECK CRANKSHAFT END PLAY

1. Completely engage then release the clutch lever.

2. Place a dial indicator (A) on damper face.

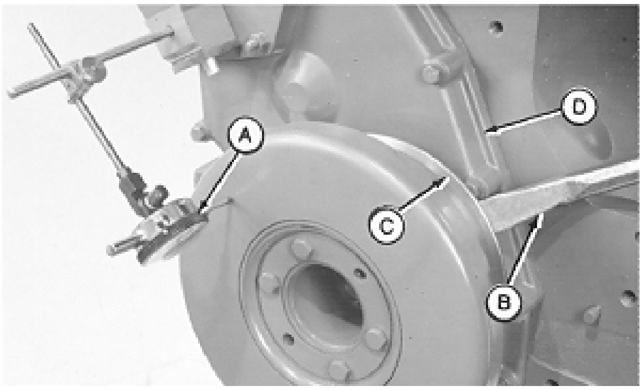
IMPORTANT: Use care not to damage or distort the timing gear cover or bearing inserts when prying. Do not pry on rubber inertia ring at rear of damper pulley.

3. Pry with flat bar (B) between the damper pulley (C) and timing gear cover (D).

CRANKSHAFT END PLAY SPECIFICATIONS

New part end play . . . . 0.038—0.380 mm (0.0015—0.0150 in.)

If crankshaft end play is not within the above specified limits, disassemble engine and check condition of thrust bearings.

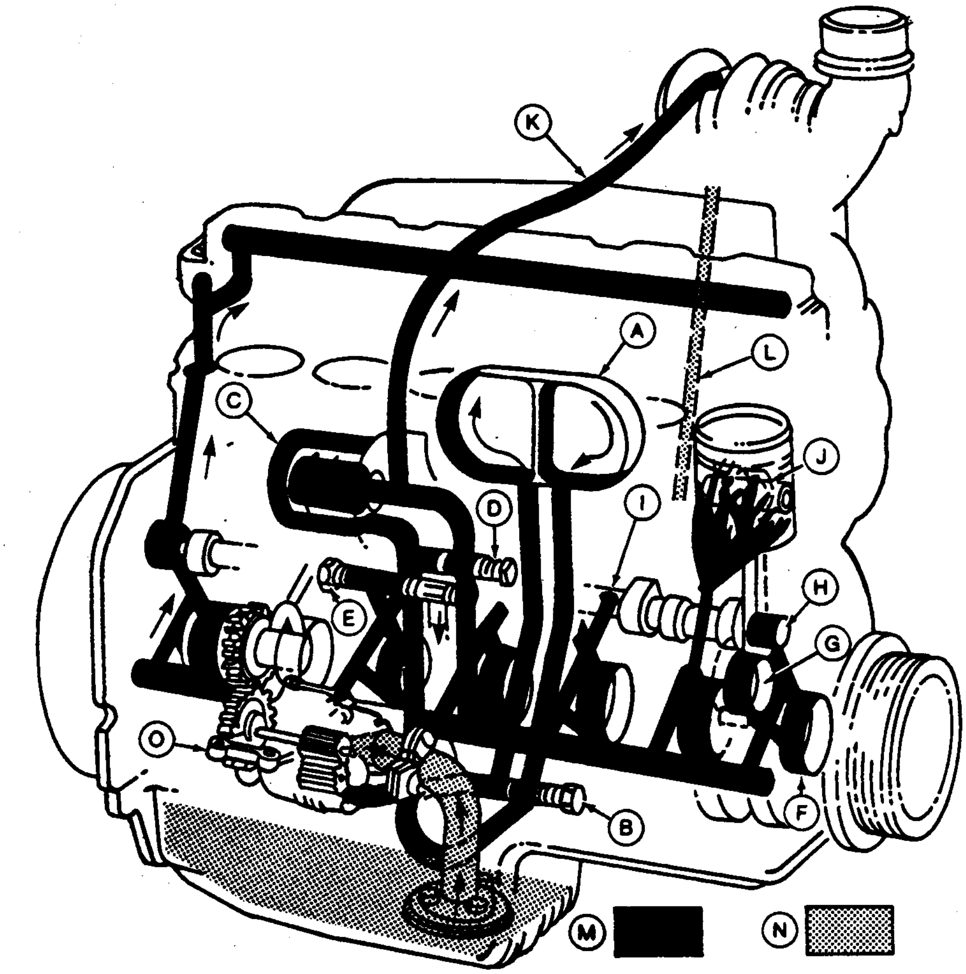


RG3110 -UN-09AUG91

A—Dial Indicator
B—Flat Bar
C—Damper Pulley
D—Timing Gear Cover

S55,22005,J -19-17SEP91

HOW THE LUBRICATION SYSTEM WORKS



A—Engine Oil Cooler
B—Oil Cooler Bypass Valve
C—Oil Filter
D—Filter Bypass Valve
E—Oil Pressure Regulating Valve
F—Main Bearings
G—Connecting Rod Bearings
H—Camshaft Bushings
I—Piston Cooling Orifices
J—Piston Pin and Bushing
K—Turbocharger Oil Inlet Line
L—Turbocharger Oil Return Tube
M—Engine Oil Pressure
N—Oil Pan Oil
O—Engine Oil Pump

The engine lubrication system consists of a gear-driven (crankshaft), positive displacement pump, oil cooler, oil filter, cooler bypass valve, oil pressure regulating valve and filter bypass valve.

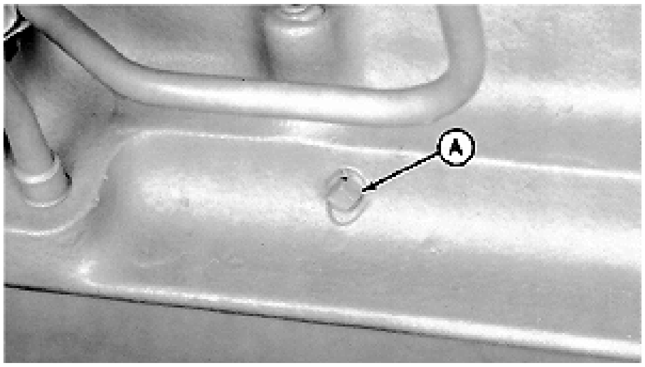
Oil is pumped from the oil pan by the engine oil pump (D) through the engine oil cooler (A), around the oil cooler bypass valve (B), and into the engine oil filter (C). Oil is directed to the top of the oil filter housing and through the oil inlet line (K) to lubricate the turbocharger. Oil is then returned to the oil pan as non-pressurized oil. Passing through the filter, the oil continues around the filter bypass valve (D) and in front of the engine oil pressure regulating valve (E) into the engine oil gallery in the cylinder block. Oil is then distributed, under pressure, to each main bearing (F) and piston cooling orifice (I). Oil from the piston cooling orifices lubricates the piston pin and bushing (J) through a hole in the top of the connecting rod.

During cold weather starting or if the oil cooler is plugged, the oil cooler bypass valve senses pressure on the inlet side of the oil cooler and opens, allowing oil to flow directly to the full-flow oil filter and cylinder block.

S55,22005,D -19-24MAY91

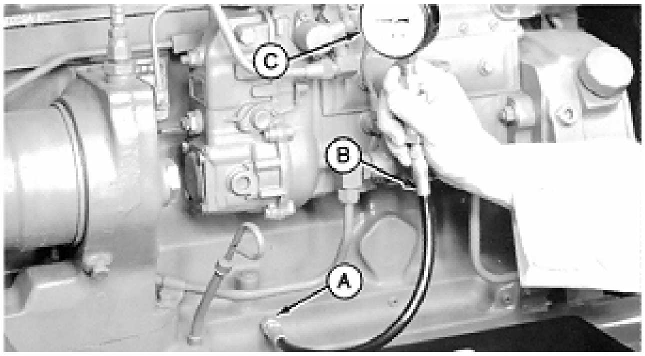
CHECK ENGINE OIL PRESSURE

1. Remove pipe plug (A) from main oil gallery.



S11,22010,AM -19-17SEP91

2. Install No. 0070 (D1) Fitting (A), No. 2106 (19-HP) Hose (B), and JT05472* Gauge (C).



IMPORTANT: Oil pressure given is measured with engine oil at 105° C (220° F) operating temperature.

3. Start engine and run until engine oil reaches 105° C (220° F).

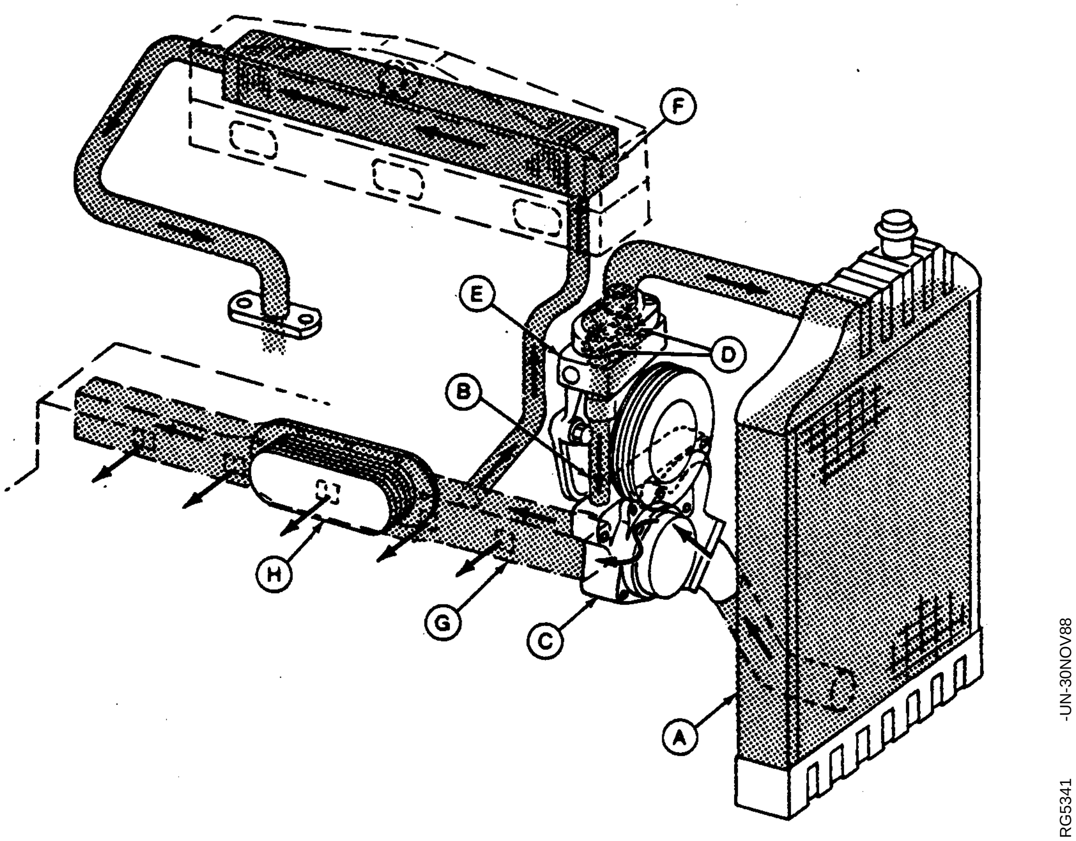
4. Measure engine oil pressure. Pressure should be:
—Minimum 138 kPa (1.4 bar) (20 psi) at 850 RPM, No Load (Slow Idle).
—Maximum 380 kPa (3.8 bar) (55 psi) at 2200 RPM, Full Load (Rated Speed).

If engine oil pressure is not within the specifications given, pressure may be adjusted. To adjust oil pressure, remove oil pressure regulating valve plug at filter base and add washers to increase oil pressure. Subtract washers to decrease oil pressure.

IMPORTANT: DO NOT use more than a total of five washers on oil pressure regulating valve assembly.

S11,22010,AN -19-17SEP91

HOW THE COOLING SYSTEM WORKS



A—Radiator
B—Coolant Bypass Pipe
C—Water Pump
D—Thermostats (2 used)
E—Water Manifold
F—Aftercooler ('A' Engines)
G—Main Coolant Gallery
H—Engine Oil Cooler

6076A Engine Cooling System

The pressurized cooling system consists of a conventional radiator (A), water pump (C), thermostats (D), and water manifold (E).

The pump draws coolant from the bottom of the radiator and discharges it into the main coolant gallery (G) on the left-hand side of the engine block. 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.

If the thermostats are closed (as during warm-up periods), coolant is directed back to the pump through the bypass pipe (B) to be recirculated. This provides a faster and more uniform warm-up.

If the thermostats are open (engine at normal operating temperature), some coolant flows back through the thermostats to the top of the radiator.

On 6076A engines, coolant is also taken from the main gallery into the aftercooler (F) to cool intake air. It circulates through the aftercooler and back into the the cylinder head.

The engine oil cooler (H) located in the main gallery, receives its cooling capability from the coolant flow around it.

PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP

1. Visually inspect radiator for leaks or damage.

CAUTION: Remove the radiator filler cap only when the coolant temperature is below the boiling point. Always loosen the cap slightly to the stop to relieve pressure before removing the cap.

TS281 -UN-23AUG88

2. Remove radiator cap.

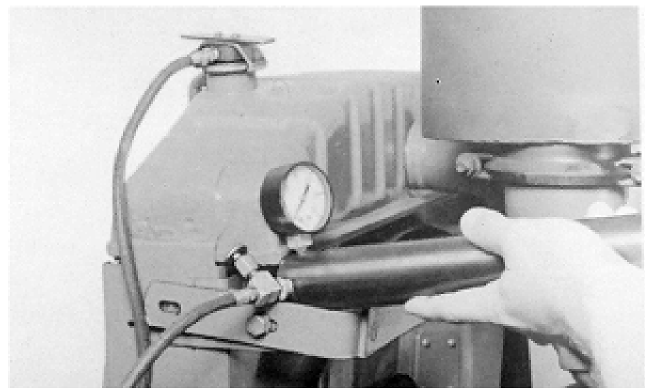
3. Disconnect hose from overflow valve, if equipped. Plug hose using a cap screw and hose clamp so that system will hold pressure.

4. Attach D05104ST Pressure Pump to radiator filler neck, following manufacturers instructions.

5. Pressurize cooling system to 120 kPa (1.2 bar) (18 psi).

6. Check engine, radiator, and hoses for coolant leaks.

7. Repair system as necessary, if it does not hold pressure.



RG78199D1 -UN-14DEC88

S11,22010,BS -19-17SEP91

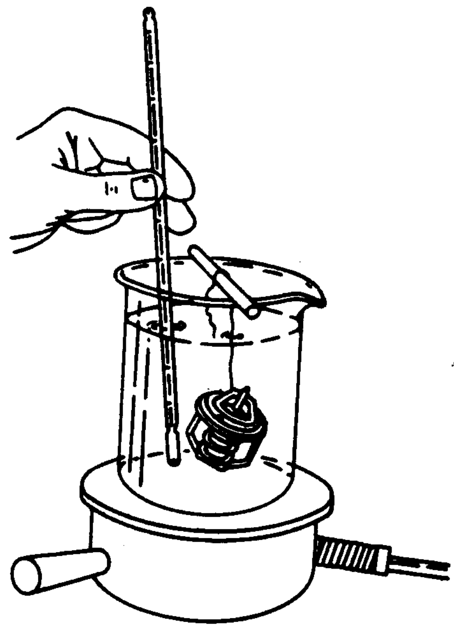
7. Install radiator cap onto D05104ST tester as shown.

8. Pressurize cap according to specification listed in machine technical manual or on cap. Replace cap if it does not hold pressure.

R26406N -UN-29NOV88

S11,22010,BH -19-17SEP91

INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE


RG5971 -UN-17SEP91

Visually inspect thermostat for corrosion or damage. Replace as necessary.

• Test thermostat as follows:

CAUTION: DO NOT allow thermostat or thermometer to rest against the side or bottom of container when heating water. Either may rupture if overheated.

1. Suspend thermostat and a thermometer in a container of water.

2. Heat and stir the water. Observe opening action of thermometer and compare temperatures with specification given in chart below.

NOTE: Due to varying tolerances of different suppliers, initial opening and full open temperatures may vary slightly from specified temperatures.

THERMOSTAT TEST SPECIFICATIONS

Rating	Initial Opening (Range)	Full Open (Nominal)
71˚C (160˚F)	69—72˚C (156—162˚F)	84˚C (182˚F)
77˚C (170˚F)	74—78˚C (166—172˚F)	89˚C (192˚F)
82˚C (180˚F)	80—84˚C (175—182˚F)	94˚C (202˚F)
89˚C (192˚F)	86—90˚C (187—194˚F)	101˚C (214˚F)
90˚C (195˚F)	89—93˚C (192—199˚F)	103˚C (218˚F)
92˚C (197˚F)	89—93˚C (193—200˚F)	105˚C (221˚F)
96˚C (205˚F)	94—97˚C (201—207˚F)	100˚C (213˚F)
99˚C (210˚F)	96—100˚C (205—212˚F)	111˚C (232˚F)

3. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.

4. If either thermostat is defective on a multiple thermostat engine, replace all thermostats.

CTM42,G105,13 -19-17SEP91

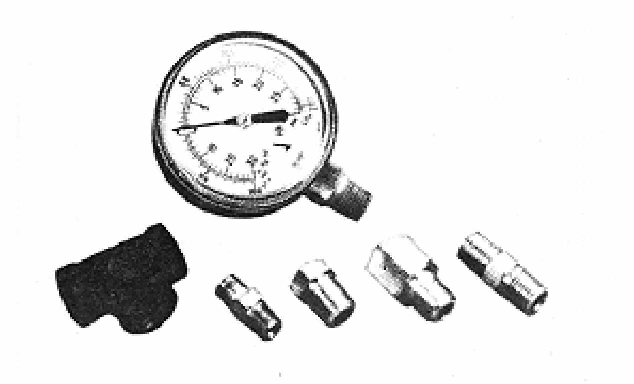
SPECIAL OR ESSENTIAL TOOLS

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

DX,TOOLS -19-05JUN91

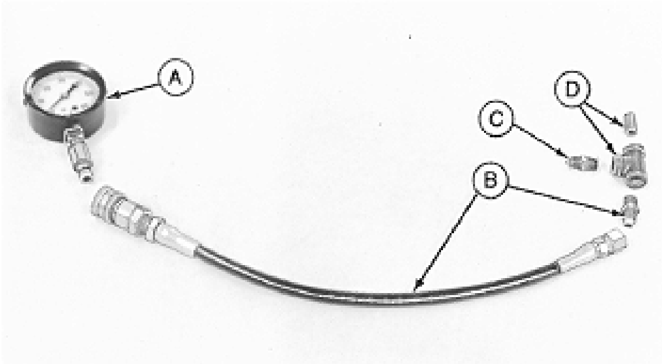
Water Vacuum Gauge Set D05022ST

Test air intake restriction indicator switch.



RG5921 -UN-16AUG91

RG,D05022ST -19-18SEP91



R28266 -UN-15DEC88

A—JT03092 Gauge *

B—JT03017 Hose and Connector *

C—Connector

1/8 in. Pipe Nipple 1/4 in.—1/8 in. Pipe Reducer 1/8 NPT-7/16-20 UNC Adapter	**Used with above hose and gauge to check intake manifold pressure at aneroid.**
D—"T" Fitting	
D—JT03104 Fitting*	**Used with above hose and gauge to check intake manifold pressure at aftercooler on 6076A Engines.**

*** Part of JT05412 Hydraulic Test Kit**

S55,23005,A -19-12SEP91

AIR INTAKE AND EXHAUST SYSTEM TEST SPECIFICATIONS

ENGINE MODEL NO.	INJECTION PUMP P/N	SPECIFICATION
Intake Manifold Pressure (Turbo Boost)* @ Full Load and Rated Speed:		
6076TF	RE32036	134—156 kPa (1.3—1.6 bar) (19—23 psi)
6076TF, TF010, TF011 . .	RE38824, RE32029	131—149 kPa (1.3—1.5 bar) (19—22 psi)
6076AF, HF	RE32033	122—138 kPa (1.2—1.4 bar) (18—20 psi)
6076AF	RE32034	113—127 kPa (1.1—1.3 bar) (16—18 psi)
6076AF	RE36112	179—201 kPa (1.8—2.0 bar) (26—29 psi)
6076AF, AF011	RE38825	168—192 kPa (1.7—1.9 bar) (24—28 psi)
6076AF, AF010, AF012 . .	RE38826	161—179 kPa (1.6—1.8 bar) (23—26 psi)
6076HF	RE32035	158—162 kPa (1.6 bar) (23—24 psi)

Air Restriction Indicator Test Vacuum . . . . 5.6—6.8 kPa (56—68 mbar) (22.7—27.3 in. water) (1.6—2.0 in. hg)

IMPORTANT: Specifications given above apply to OEM Engine applications only. For machine applications, refer to the appropriate machine technical manual for specifications.

S55,23005,B -19-18SEP91

HOW THE AIR INTAKE AND EXHAUST SYSTEM WORKS

Engine suction draws dust-laden outside air through an air inlet stack into the air cleaner. Air is filtered through dry type primary and secondary (safety) filter elements in the air cleaner canister. Clean air travels through the air intake hose to the turbocharger and intake manifold to the engine.

Exhaust, as it is expelled out the exhaust elbow, drives the turbocharger to deliver a larger quantity of air to meet the engine requirements than what could be delivered under naturally aspirated (non-turbocharged) conditions.

On 6076A (aftercooled) Engines, intake air, which has been compressed (and heated) by the turbocharger, flows around the aftercooler and lowers the air temperature as much as 27—32°C (80—90°F) before entering the engine cylinders. Lowering the air temperature makes the air more dense and permits an even greater volume of air to be delivered to engine cylinders for combustion.

On 6076H Engines, an air to air aftercooler cools the turbocharger compressor discharge air by routing it through a remote mounted heat exchanger before aie enters the engine. The heat exchanger uses no liquid coolant but relies on air flow to cool the charge air.

This increased volume of air, when combined with a predetermined quantity of additional fuel, enables more power to be produced.

S55,23005,C -19-14AUG91

AIR CLEANER OPERATION

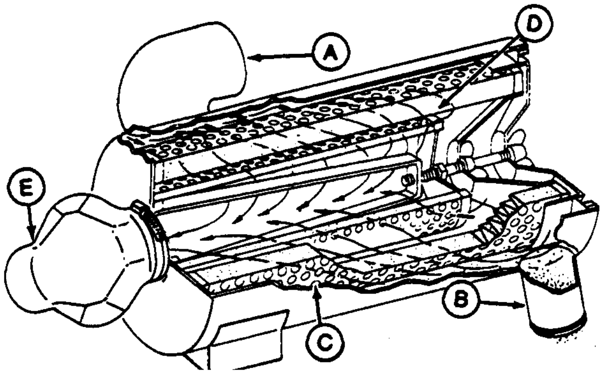
Dust-laden air enters the air cleaner inlet (A) and is forced into a high-speed centrifugal motion.

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 and service intervals.



R28270 -UN-14DEC88

A—Air Inlet
B—Dust Outlet
C—Primary Element
D—Secondary (Safety) Element
E—Air Outlet

S11,23005,AO -19-09SEP91

DIAGNOSING AIR INTAKE MALFUNCTIONS

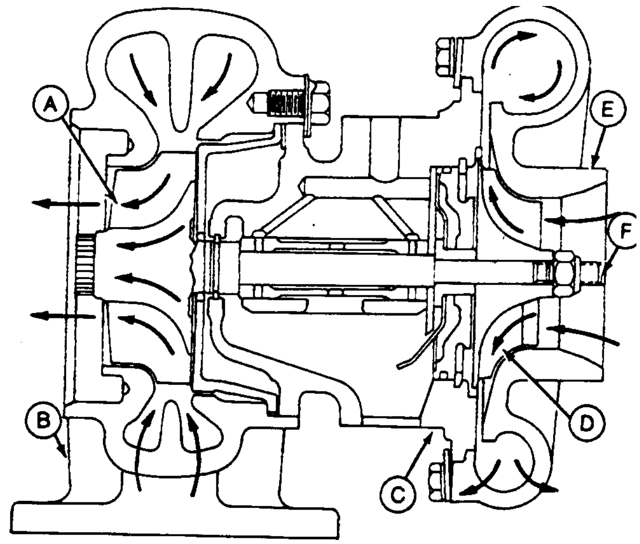
Symptom	Problem	Solution
Engine Starts Hard or Won't Start	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (See Group 30).
Erratic Engine Operation	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required (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 -19-14AUG91

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.



R28273 -UN-14DEC88

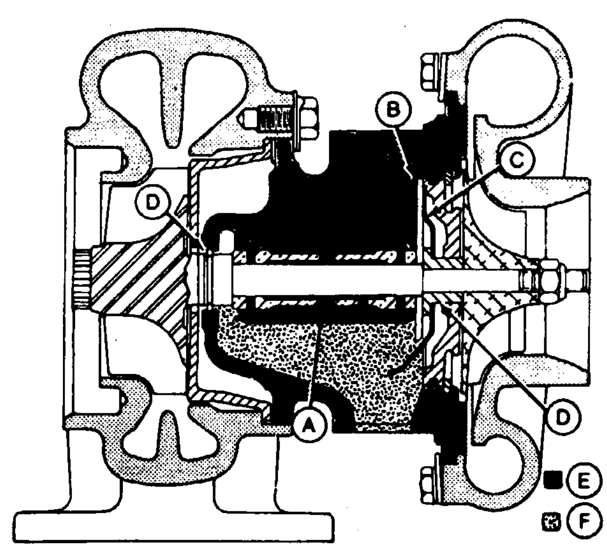
A—Turbine Wheel
B—Turbine Housing
C—Center Housing
D—Compressor Wheel
E—Compresssor Housing
F—Shaft

S11,23005,L -19-09SEP91

HOW THE TURBOCHARGER IS LUBRICATED

Engine oil under pressure from the engine lubrication system is pumped through a passage in the bearing housing and directed to the bearings (A), thrust plate (B), and thrust sleeve (C). Oil is sealed from the compressor and turbine by a piston ring (D) at both ends of the bearing housing.

The Garrett/AiResearch turbocharger contains two floating bearings and the Schwitzer turbocharger contains a single floating bearing. These bearings have clearance between the bearing OD and the housing bore as well as clearance between the bearing ID and the shaft OD. These clearances are lubricated by the oil supply (E) and the bearings are protected by a cushion of oil. Discharge oil (F) drains by gravity from the bearing housing to the engine crankcase.



RG4646 -UN-14DEC88

Schwitzer Turbocharger Lubrication

A—Bearing(s)
B—Thrust Plate
C—Thrust Sleeve
D—Piston Ring
E—Pressure Oil
F—Discharge Oil

S11,3005,JE -19-09SEP91

DIAGNOSING TURBOCHARGER MALFUNCTIONS

Before replacing the turbocharger, determine what caused the failure of the defective unit, and correct the condition. This will prevent an immediate repeat failure of the replacement unit. Refer to Air Intake and Exhaust System Group 30 for repair information.

NOISE OR VIBRATION*

Bearings not lubricated (insufficient oil pressure).
Air leak in engine intake or exhaust manifold.
Improper clearance between turbine wheel and turbine housing.
Broken blades (or other wheel failures).

ENGINE WILL NOT DELIVER RATED POWER

Clogged manifold system.
Foreign material lodged in compressor, impeller, or turbine.
Excessive dirt build-up in compressor.
Leak in engine intake or exhaust manifold.
Leak in intake manifold-to-aneroid pipe.
Rotating assembly bearing failure.
Damaged compressor or turbine blades.

OIL ON COMPRESSOR WHEEL OR IN COMPRESSOR HOUSING (Oil Being Pushed or Pulled Through Center Housing)

Excessive crankcase pressure.
Air intake restriction.
Drain tube restriction.

OIL IN MANIFOLD OR DRIPPING FROM HOUSING

Excessive crankcase pressure.
Air intake restriction.
Drain tube restriction.
Damaged or worn journal bearings.
- Unbalance of rotating assembly:
  - Damage to turbine or compressor wheel or blade.
  - Dirt or carbon build-up on wheel or blade.
- Bearing wear.
  - Oil starvation or insufficient lubrication.
- Shaft seals worn.

TURBINE WHEEL DRAG

Carbon build-up behind turbine wheel caused by coked oil or combustion deposits.
Dirt build-up behind compressor wheel caused by air intake leaks.
Bearing seizure or dirty, worn bearings caused by excessive temperatures, unbalanced wheel, dirty oil, oil starvation, or insufficient lubrication.

**Do not confuse the whine heard during run down with noise which indicates a bearing failure.*

S11,23005,K -19-20SEP91

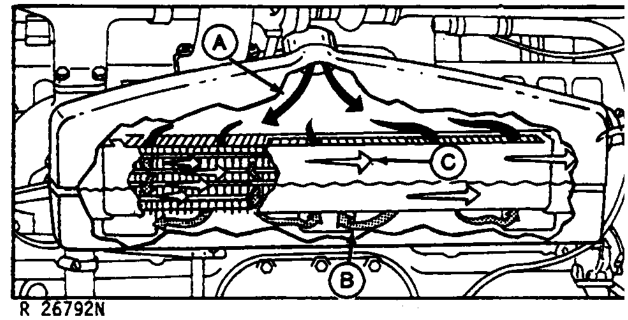
HOW THE AFTERCOOLER WORKS—6076A ENGINES

Early production engines were produced with a single-pass aftercooler (Upper Illustration), current production engines are equipped with a dual-pass aftercooler (Lower Illustration)

Air entering the intake manifold has been compressed (and heated) by the turbocharger. As this heated, compressed air (A) enters the intake manifold, it flows around the aftercooler before entering the engine cylinders.

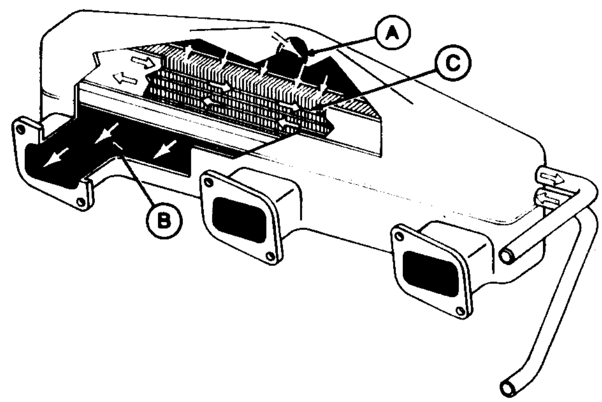
The aftercooler functions as a heat exchanger, lowering the intake air (B) temperatures as much as 27—32°C (80—90°F) on single-pass aftercoolers and as much as 35—47°C (95—116°F) on dual-pass aftercoolers. Lowering the air temperature makes the air more dense, permitting an even greater volume (compared with not having an aftercooler) to be delivered to the engine cylinders. This increased volume of air, when combined with a predetermined quantity of additional fuel, produces more power.

Engine coolant (C) circulating through the aftercooler core is the media used for heat exchange. Extreme care must be exercised to insure that the engine coolant does not leak into the intake manifold, resulting in possible damage to the engine.



R26792N -UN-27OCT88

Single-Pass Aftercooler



RG5972 -UN-24SEP91

Dual-Pass Aftercooler

A—Heated Air
B—Cooled Air
C—Engine Coolant

S55,23005,D -19-18SEP91

CHECK INTAKE MANIFOLD PRESSURE AT ANEROID (IF EQUIPPED)

NOTE: Intake manifold pressure can also be checked at the intake manifold as described later in this group.

1. Remove aneroid line (A) from aneroid (B).

2. Install a 1/8-in. pipe nipple and “T” fitting (C) into aneroid with a 1/4-in. to 1/8-in. pipe reducer (D).

3. Connect aneroid line to “T” fitting.

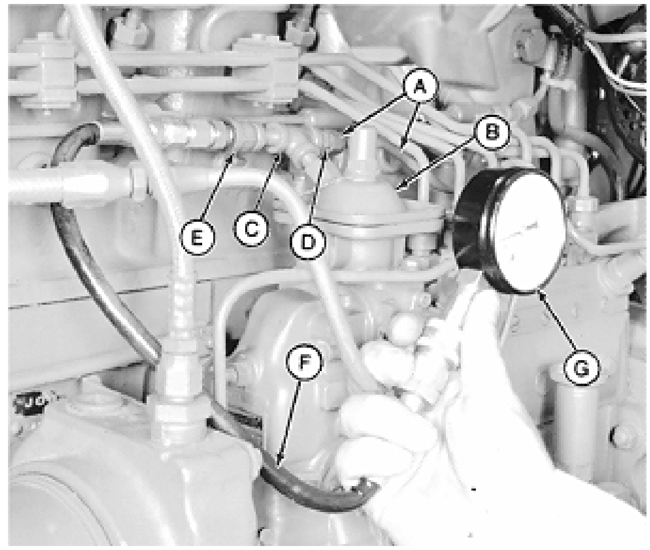
4. Attach 1/8-in. NPT to 7/16-20 UNC Adapter (E) and JT03017 Hose (F) to JT03092 Pressure Gauge (G).

5. With engine at operating temperature, connect to a dynamometer. Operate engine at rated full load speed.

6. Observe pressure readings and compare with specifications given below. If readings is not within the given range, 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.

7. Remove test equipment and reinstall aneroid line when test is complete.



A—Aneroid Line
B—Aneroid
C—T-Fitting
D—1/4—1/8 in. Pipe Reducer
E—Adapter
F—JT03017 Hose
G—JT03092 Pressure Gauge

INTAKE MANIFOLD PRESSURE (TURBO-BOOST) @ FULL LOAD AND RATED SPEED

ENGINE MODEL NO.	INJECTION PUMP P/N	SPECIFICATION
6076TF	RE32036	134—156 kPa (1.3—1.6 bar) (19—23 psi)
6076TF, TF010, TF011 . .	RE38824, RE32029	131—149 kPa (1.3—1.5 bar) (19—22 psi)
6076AF, HF	RE32033	122—138 kPa (1.2—1.4 bar) (18—20 psi)
6076AF	RE32034	113—127 kPa (1.1—1.3 bar) (16—18 psi)
6076AF	RE36112	179—201 kPa (1.8—2.0 bar) (26—29 psi)
6076AF, AF011	RE38825	168—192 kPa (1.7—1.9 bar) (24—28 psi)
6076AF, AF010, AF012 . .	RE38826	161—179 kPa (1.6—1.8 bar) (23—26 psi)
6076HF	RE32035	158—162 kPa (1.6 bar) (23—24 psi)

S55,23005,E -19-20SEP91

CHECK INTAKE MANIFOLD PRESSURE AT INTAKE MANIFOLD

6076A Engine shown, use same procedure for 6076T and 6076H.

NOTE: Intake manifold pressure can also be checked from aneroid line, if equipped, as described earlier in this group.

1. Remove ether aid starting line (A), if equipped, nozzle adapter and plug from intake manifold cover.

2. Install JT03104 Fitting (B) into cover.

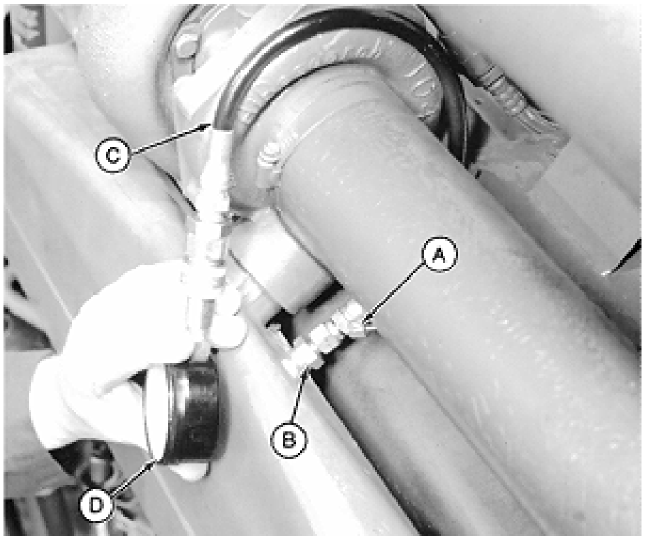
3. Install a JT03017 Hose (C) with JTO3092 Pressure Gauge (D).

4. With engine at operating temperature, connect machine to a dynamometer. Operate engine at rated full load speed.

5. Observe pressure reading and compare with specifications given below. If reading is not within the given range, 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.

6. After completing test, remove test equipment and reinstall ether starting aid line.



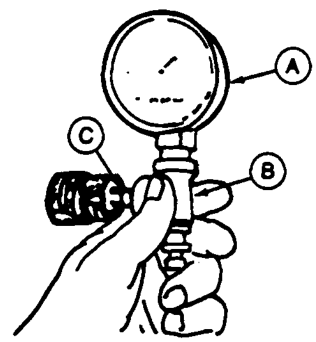
A—Ether Starting Aid
B—JT03104 Fitting
C—JD03017 Hose
D—JT03092 Pressure Gauge

INTAKE MANIFOLD PRESSURE (TURBO-BOOST) @ FULL LOAD AND RATED SPEED

ENGINE MODEL NO.	INJECTION PUMP P/N	SPECIFICATION
6076TF	RE32036	134—156 kPa (1.3—1.6 bar) (19—23 psi)
6076TF, TF010, TF011 . .	RE38824, RE32029	131—149 kPa (1.3—1.5 bar) (19—22 psi)
6076AF, HF	RE32033	122—138 kPa (1.2—1.4 bar) (18—20 psi)
6076AF	RE32034	113—127 kPa (1.1—1.3 bar) (16—18 psi)
6076AF	RE36112	179—201 kPa (1.8—2.0 bar) (26—29 psi)
6076AF, AF011	RE38825	168—192 kPa (1.7—1.9 bar) (24—28 psi)
6076AF, AF010, AF012 . .	RE38826	161—179 kPa (1.6—1.8 bar) (23—26 psi)
6076HF	RE32035	158—162 kPa (1.6 bar) (23—24 psi)

S55,23005,F -19-20SEP91

AIR FILTER RESTRICTION INDICATOR SWITCH TEST



T6188AQ -UN-09DEC88

1. Remove air filter restriction indicator switch from air intake piping.

2. Install pipe nipple (C), tee fitting (B), and gauge (A) from D05022ST Water Vacuum Gauge Kit into air filter restriction indicator hole. Install air filter restriction indicator into tee fitting.

3. Start engine and slowly cover the air cleaner inlet with a piece of paper or cardboard.

4. Air restriction indicator must show red at 5.6—6.8 kPa (56—68 mbar) (22.7—27.3 in. water) (1.6—2.0 in. hg) vacuum.

If air restriction indicator shows red at any other value than listed above, install a new indicator.

RG,CTM6,G110,1 -19-14AUG91

SPECIAL OR ESSENTIAL TOOLS

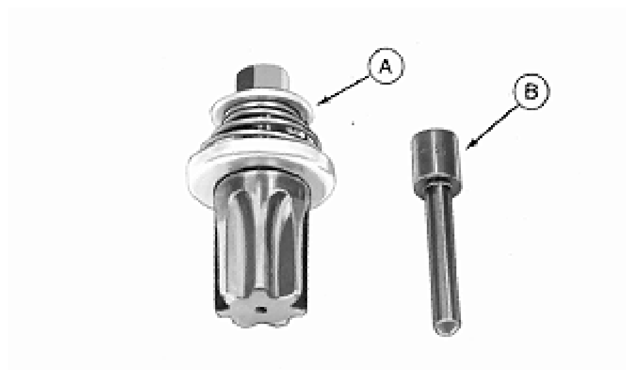
NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

DX,TOOLS -19-05JUN91

A—Flywheel Rotation Tool JDE81-1

B—Timing Pin JDE81-4

Used to rotate engine and lock at No. 1 piston 'TDC' compression stroke when checking injection pump timing.



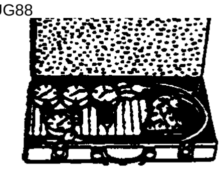
R26134 -UN-05JAN89

S55,23010,C -19-09SEP91

Universal Pressure Test Kit . . . JT05470 (D015027NU)

Used to measure fuel supply pump output pressure.

RG5162 -UN-23AUG88



RG,CTM6,G115,1 -19-15AUG91

FUEL SYSTEM TEST SPECIFICATIONS

Item	Specifications
Fuel Supply Pump Minimum Output Pressure	200 kPa (2.0 bar) (29.0 psi) minimum
Hydraulic Aneroid Activator Operating Pressure	48—75 kPa (0.5—0.8 bar) (7—11 psi)
Fuel injection Pump Timing to Engine	TDC

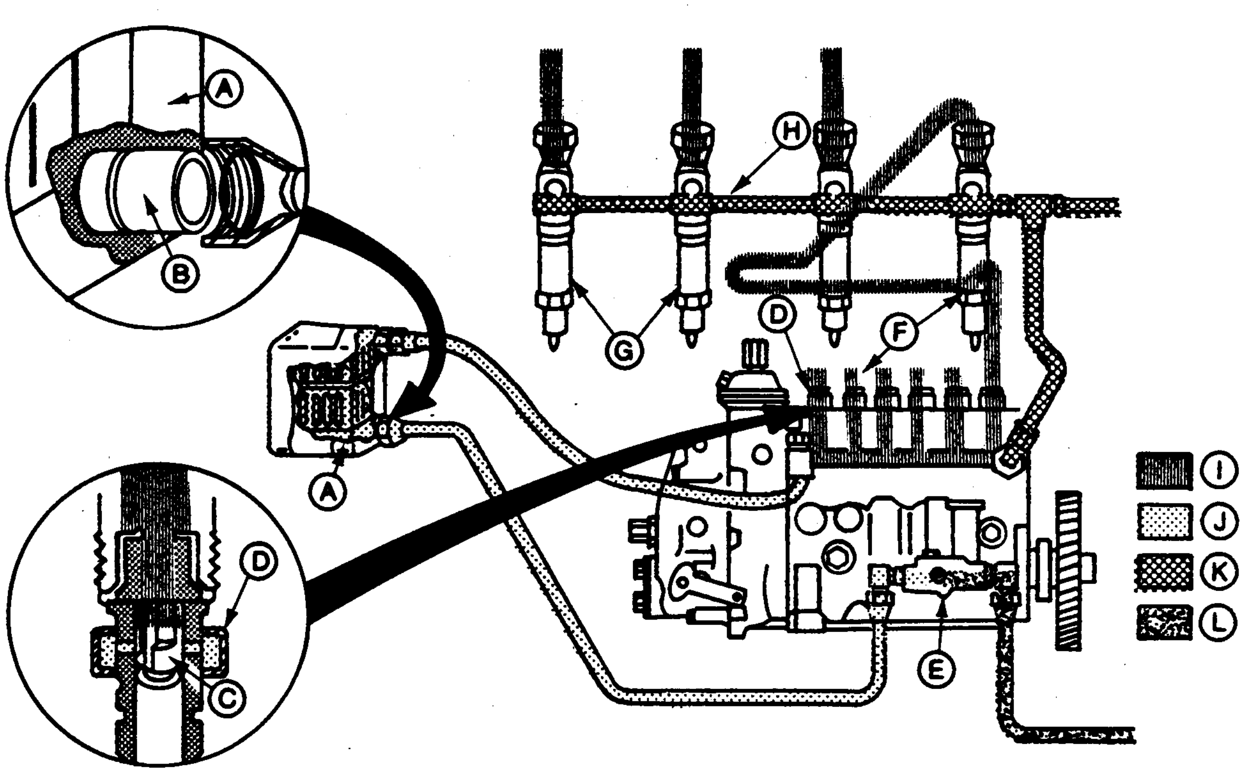
Engine Speeds (RPM)*

	Slow Idle	Fast Idle	Rated
Standard Mechanical Governor	850	2450	2200
3—5% Mechanical Governor	850	1890	1800
Electronic Governor	850	1800	1800

**Applies only to OEM (6076TF, AF, and HF) applications. For all other applications, refer to the appropriate machine technical manual or operator's manual.*

S55,23010,D -19-15AUG91

FUEL SYSTEM OPERATION



-UN-14DEC88

RG5342

A—Fuel Filter	**D—Fuel Gallery**	**G—Injection Nozzles**	**J—Supply Pump Pressure**
B—Check Valve	**E—Supply Pump**	**H—Leak-Off Line**	**K—Fuel Return**
C—Pump Plungers	**F—Delivery Lines**	**I—Injection Pressure**	**L—Gravity Pressure**

The supply pump (E) draws fuel from the vented fuel tank through the pre-filter. The fuel tank is vented through the filler cap.

Pressurized fuel (K) flows from the supply pump through a check valve (B), to the fuel filter (A). The check valve prevents fuel from draining from the filters when the engine is not running which would cause hard starting. Fuel flows through the filters to the fuel gallery (D) in the injection pump.The gallery is kept full by the supply pump. Injection pump plungers (C) further pressurize the fuel. Delivery pipes (F) route the fuel to the nozzles (G). The high pressure fuel opens the nozzle valve and forces fuel out the small orifices in the nozzle tip. This atomizes the fuel as it enters the combustion chamber.

There are two sources of excess fuel incorporated into the system. The supply pump supplies more fuel to the pump than is required by the engine, and the nozzle requires excess fuel to lubricate the nozzle vavle. A leak-off line (H) returns this excess fuel to the tank from both the pump and nozzles.

S55,23010,E -19-19SEP91

DIAGNOSE FUEL SYSTEM MALFUNCTIONS

The folling diagnostic information apply to either mechanical or electronic governor fuel injection pumps. Refer to CTM11 for additional diagnostic information on electronic governor fuel injection pump.

Symptom	Problem	Solution
Fuel Not Reaching Injection Nozzles	Fuel filter restricted	Replace fuel filter (See Group 35)
	Fuel line restricted	Clean lines as required
	Supply pump filter (if used) restricted	Service (See Group 35)
	Fuel too heavy at low temperatures	Use correct grade of fuel (See Group 02)
	Air in system	Correct problem and bleed fuel system (this group)
	Fuel tank valve shut off	Open fuel tank valve
	Low supply pump pressure	Check fuel lines for restrictions; check pump output pressure (this group)
Engine Starts Hard or Won’t Start	Fuel too heavy at low temperature	Use correct grade of fuel (See Group 02)
	Injection nozzles faulty or sticking	Repair or replace as required (See Group 35)
	Incorrect timing	Adjust timing (this group)
	Faulty injection pump	Repair or replace
	Water in fuel	Drain water from fuel (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

Continued on next page

Symptom	Problem	Solution
	Low cetane fuel	Use correct grade of fuel (See Group 02)
	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 (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

Continued on next page

Symptom	Problem	Solution
	Low cetane fuel	Use correct grade of fuel (See Group 02)
	Injection nozzle return lines restricted	Clean lines as required
Engine Emits Excessive Black Smoke	Injection nozzles faulty or sticking	Repair (See Group 35)
	Injection pump timing incorrect	Adjust timing (this group)
	Low cetane fuel	Use correct grade of fuel (See Group 02)
	Over-fueling	Repair and adjust (See Group 35)
	Aneroid defective	Repair and adjust (See Group 35)
Engine Emits Excessive Blue or White Smoke	Cranking speed too low	Check batteries and electrical system
	Injection pump timing incorrect	Adjust timing (this group)
	Injection nozzles faulty or sticking	Repair (See Group 35)
	Excessive wear in liners and/or piston rings stuck	Refer to Engine Repair Section
	Incorrect cetane fuel for ambient temperature	Use correct grade of fuel (See Group 02)
	Engine running too “cold”	Check thermostat (See Group 25)
Engine Idles Poorly	Injection nozzles faulty or sticking	Repair (See Group 35)
	Incorrect timing	Adjust timing (this group)
	Pump slow idle speed not correctly adjusted	Adjust slow idle speed (this group)
	Fuel lines restricted	Clean as required
	Water in fuel	Drain water from filter, (or separator if equipped). Install new filters (See Group 35)
	Injection pump return lines or fittings restricted	Clean as required
	Injection nozzle return lines clogged	Clean as required

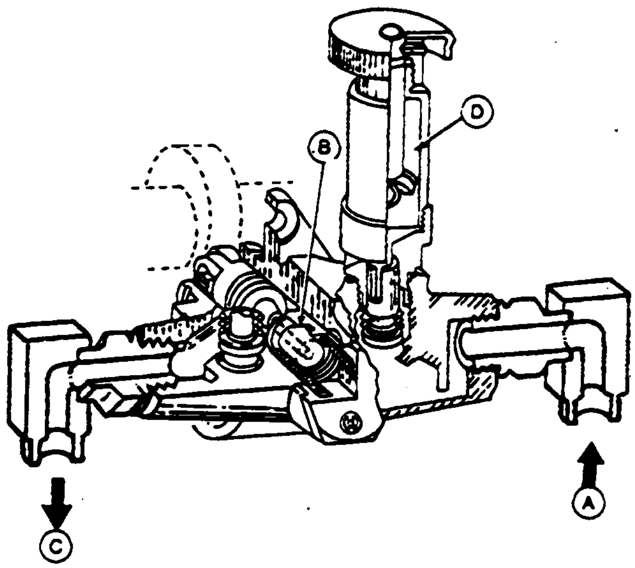
Continued on next page

Symptom	Problem	Solution
	Low cetane fuel	Use correct grade of fuel (See Group 02)
Engine Does Not Develop Full Power	Low cetane fuel	Use correct grade of fuel (See Group 02)
	Incorrect timing	Adjust timing (this Group)
	Injection pump or governor faulty	Repair (See Group 35)
	Fuel filter clogged	Replace fuel filter (See Group 35)
	Injection nozzles faulty or sticking	Repair (See Group 35)
	Injection pump return fuel line or fittings restricted	Clean as required
	Water in fuel (or gasoline in fuel)	Drain water or replace with clean fuel Install new filters (this Group)
	Incorrect fast idle speed	Adjust speed (this Group)
	Manifold pressure pipe to aneroid loose or broken	Repair as required
	Fuel shut-off cable improperly adjusted	Adjust

S11,23010,FF -19-19SEP91

SUPPLY PUMP OPERATION

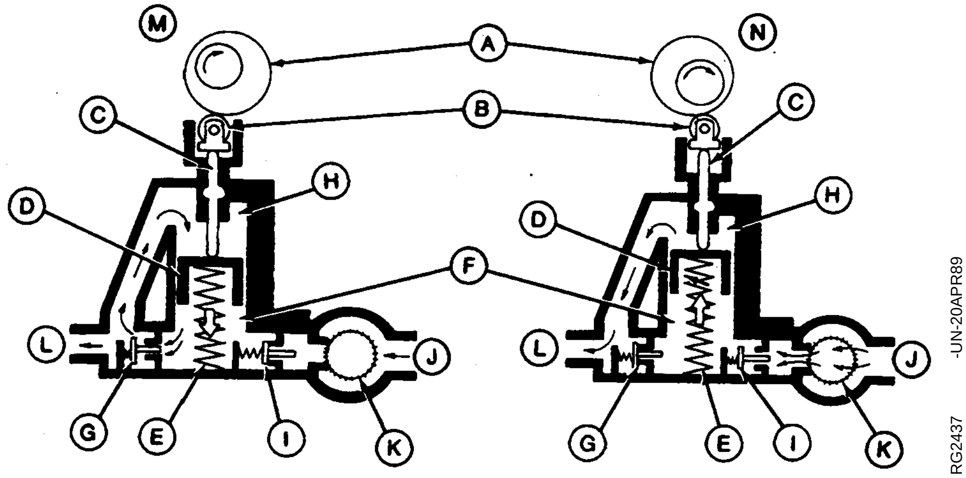
The plunger-type Robert Bosch or Nippondenso fuel supply pump is used on all 6076 engines. It is mounted on the side of the injection pump housing and is driven by the injection pump camshaft. Fuel enters the supply pump at (A), is pressurized by the plunger (B), and discharged through outlet (C). The hand primer (D) provides manual pump operation for bleeding the fuel system.



RG4451 -UN-14SEP89

A—Fuel Inlet
B—Plunger
C—Fuel Outlet
D—Hand Primer

S55,23010,F -19-24FEB88



A—Camshaft
B—Roller Tappet
C—Pressure Spindle
D—Plunger
E—Plunger Spring
F—Suction Chamber
G—Pressure Valve
H—Pressure Chamber
I—Suction Valve
J—Fuel Inlet
K—Filter
L—Fuel Outlet
M—Intermediate Stroke Position
N—Suction and Discharge Stroke Position

As the pump camshaft (A) rotates toward the “high cam” intermediate stroke position, the roller tappet (B) and pressure spindle (C) cause the plunger (D) to move against and compress the plunger spring (E).

Plunger movement forces the fuel out of the suction chamber (F), through the pressure valve (G), and into the pressure chamber (H). The amount of fuel discharged from the suction chamber is equal to the amount of fuel delivered for each stroke of the plunger. Towards the end of the intermediate stroke, the spring-loaded pressure valve closes again.

As the camshaft rotates toward the “low cam” or suction and discharge position (N), plunger spring pressure causes the plunger, pressure spindle, and roller tappet to follow the camshaft.

Movement of the plunger pushes the fuel from the pressure chamber, and delivers it to the fuel filters and injection pump. At the same time, plunger suction pressure is permitting fuel to enter the suction chamber through the suction valve (I). With the suction chamber charged with fuel, the pumping cycle begins again.

Fuel is allowed to work its way around the pressure spindle to lubricate the spindle as it moves back and forth in housing. To prevent the fuel from entering the pump crankcase, a rubber O-ring is positioned in the spindle bore of housing at the roller tappet end.

Unscrewing the knurled knob and pulling upward causes the suction valve to open and fuel to flow into the suction chamber. When the hand plunger is pushed downward, the suction valve closes, and fuel is forced out of the pressure valve.

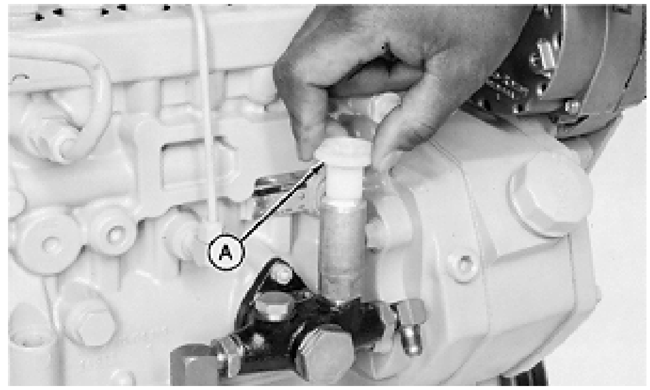
S11,23010,F -19-19SEP91

DIAGNOSE SUPPLY PUMP MALFUNCTION

Symptom	Problem	Solution
Low Supply Pump Pressure or Pump Not Functioning Correctly	Out of fuel	Add fuel to fuel tank.
	Fuel shut off at tank	Open fuel shut-off valve.
	Restricted fuel line	Clean as required.
	Air leak in fuel line between pump and tank	Repair as required.
	Loose or damaged fuel line connections	Repair.
	Hand primer left in upward position	Bleed fuel system, gently push hand primer down and tighten securely.
	Worn or damaged valve assemblies	Repair or replace. (See Group 35)
	Broken valve spring(s)	Repair or replace. (See Group 35)

S11,23010,II -19-02JUL91

CHECK SUPPLY PUMP OPERATION



RG5295 -UN-09DEC88

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.

2. Start engine and bring to operating temperature. Shut-off engine.

NOTE: If fuel leaks around a hand primer that is screwed down tight when engine is running, replace the hand primer.

3. Check operation of hand primer. 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: Be sure hand primer is seated all the way down in barrel before tightening to prevent internal thread damage.

4. Tighten hand primer knob, but do not overtighten. If knob will not tighten (indicating internal thread damage), replace hand primer.

S55,23010,G -19-24MAR88

5. Test operation of suction side of pump. Disconnect suction and discharge lines at pump.

6. Drain all fuel from pump by operating hand primer. Then reconnect suction line to pump.

7. Operate hand primer until fuel flows from pump outlet (discharge). Fuel should flow within 15—25 strokes. If not, the suction line may be obstructed or leaking air, (replace in-line filter when used).

NOTE: When operating hand primer, a moderate resistance should be felt. When only a slight resistance (or no resistance) occurs, replace hand primer or repair pump (valves may be defective).

If fuel does not flow and if no leak or obstruction is found, pump is defective. It must be repaired or replaced.

S11,23010,FJ -19-09SEP91

8. Test operation of discharge side of pump. Suction line must be connected and discharge (pressure) line disconnected.

9. Tighten hand primer and place injection pump fuel shut-off control in “stop” position to prevent engine from starting.

10. Crank engine with starting motor. Fuel should flow from pump outlet within 10 seconds. If not, the suction line may be obstructed (replace in-line filter when used), or leaking air.

S11,23010,FK -19-21JUN85

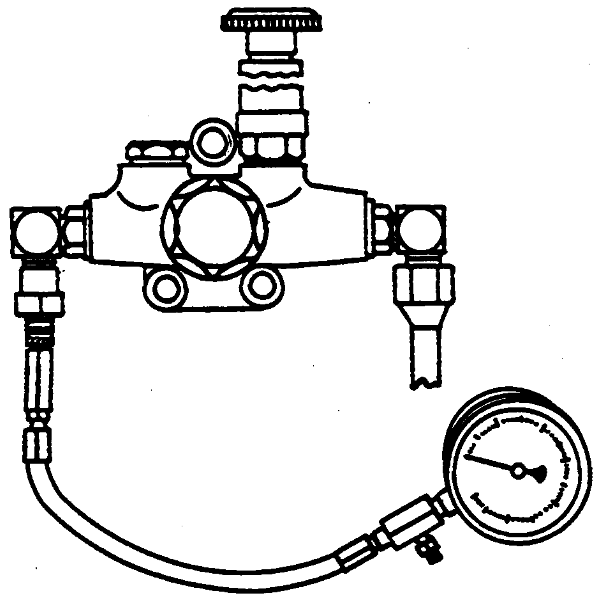
11. Test pump output pressure while cranking engine with starting motor.

Connect a 0—400 kPa (0—4 bar) (0—60 psi) pressure gauge (A) to one end of a pressure hose (B) about 250—300 mm (10—12 in.) long. Connect other end of hose to pump outlet (C). All air must be out of system.

12. Crank engine for 10 seconds with starting motor (approximately 200 engine rpm). Supply pump minimum outlet pressure should be 200 kPa (2.0 bar) (29.0 psi).

IMPORTANT: The starting motor must crank the engine at normal cranking speed. Use booster batteries if necessary.

13. Compare measured output with the following minimum pressure specifications. If pressure is below the minimum specified and if no obstruction or leak is found, repair or replace the pump.



RG4642 -UN-14DEC88

S55,23010,H -19-19SEP91

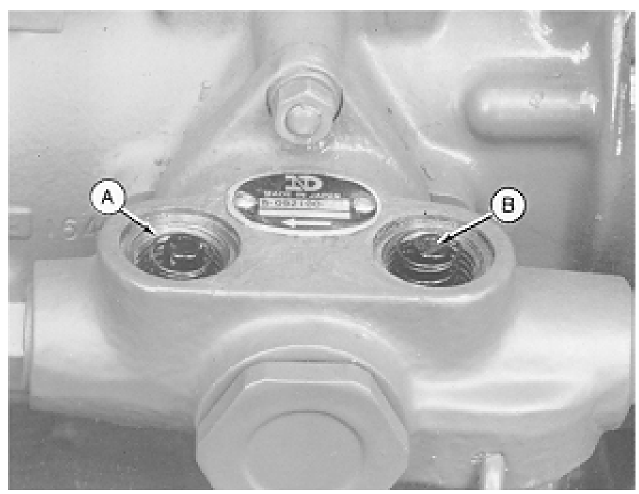
SERVICE SUPPLY PUMP

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.

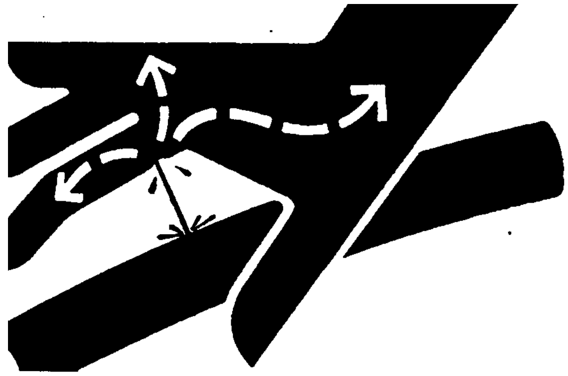
4. Reassemble parts, open tank shut-off valve, and check operation. If the pump operation is still not normal, the pump will have to be repaired or replaced. (See Group 35.)



RG78153D1 -UN-14DEC88

S55,23010,I -19-16FEB88

BLEED THE FUEL SYSTEM



X9811 -UN-23AUG88

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

Whenever the fuel system has been opened up for service (lines disconnected or filters removed), it will be necessary to bleed air from the system.

S11,0408,AC -19-27SEP91

RG5293 -UN-09DEC88

NOTE: Single fuel filter system shown; use same procedure for bleeding dual-filter fuel systems.

1. Loosen bleed plug (A) on fuel filter base.

IMPORTANT: When bleeding the fuel system on engines equipped with electronic governors, the key switch must be at the 'ON' position.

S55,3010,N -19-14APR88

2. Unscrew hand primer (A) on fuel supply pump until it can be pulled by hand.

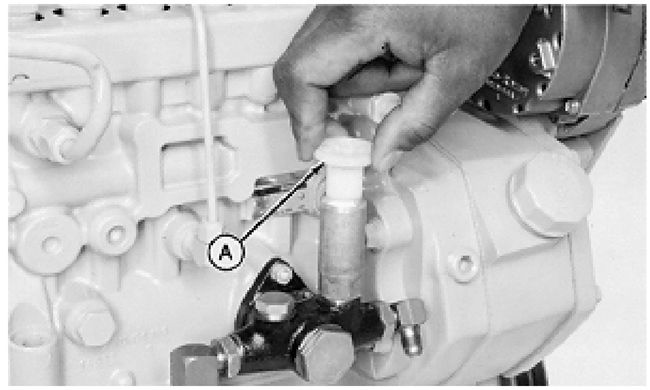
3. Operate the hand primer until a smooth flow of fuel, free of bubbles, comes out of the filter plug hole.

IMPORTANT: Be sure hand primer is seated all the way down in barrel before tightening to prevent internal damage.

4. Simultaneously stroke the hand primer down and close the port plug. This prevents air from entering the system. Tighten plug securely. DO NOT overtighten.

5. Lock hand primer in position.

NOTE: If the engine will not start, it may be necessary to loosen the fuel pipes at the injection nozzles to bleed air from the system. Put the hand throttle in slow idle position. Push the engine fuel shut-off control knob all the way in. Turn the engine with the starter until fuel without air flows from the loose fuel pipe connections. Tighten the connections.



RG5295 -UN-09DEC88

S55,23010,J -19-15MAR88

DIAGNOSE IN-LINE TYPE INJECTION PUMP MALFUNCTIONS

Symptom	Problem	Solution
Engine Starts Hard or won't start	Incorrect fuel shut-off lever position (pump control rack not moving all the way forward)	Adjust Shut-off cable as required.
	Defective injection pump	Remove pump from engine and repair (see Group 35)
	Injection pump not correctly timed	Check pump timing
Slow Idle Speed Irregular	Slow idle stop screw improperly adjusted	Recheck stop screw adjustment
	Supplementary idling spring improperly adjusted	Recheck adjustment
	Defective injection pump	Remove pump from engine and repair (See Group 35)
Engine Horsepower Low	Pump not properly timed	Check timing
	Defective injection pump	Remove pump from engine and repair (See Group 35)

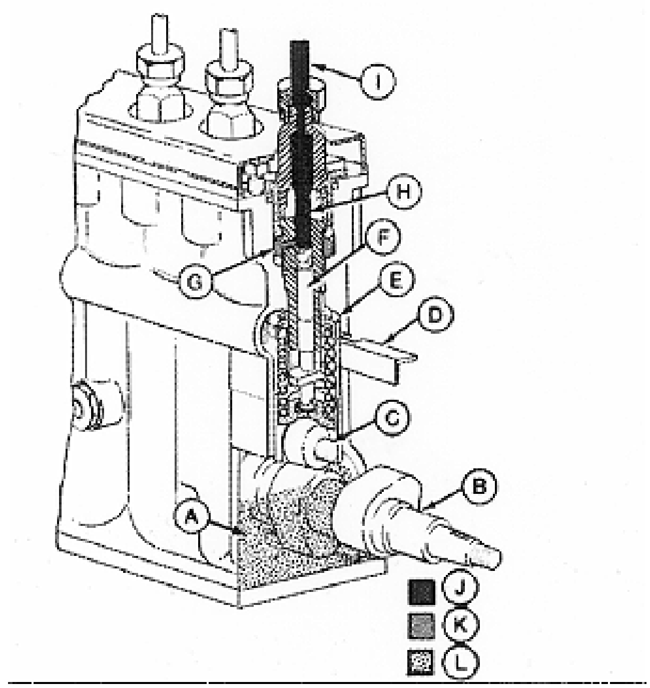
S11,23010,FQ -19-09SEP91

IN-LINE TYPE FUEL INJECTION PUMP OPERATION

Filtered fuel under pressure by the supply pump fills the injection pump fuel gallery (G). As the camshaft rotates, roller tappets (C) riding on the camshaft (B) lobes operate the plungers (F) to supply high pressure fuel through the delivery valves (H) to the injection nozzles.

A governor-operated control rack (D) is connected to the control sleeves (E) and plungers to regulate the quantity of fuel delivered to the engine.

Engine lubricating oil is piped to the injection pump crankcase (A) to provide splash lubrication of the working parts. Two drain holes at the front end of the pump determine the level of oil maintained in the crankcase. Excess oil drains out these holes and returns back to the engine through the timing gear housing.



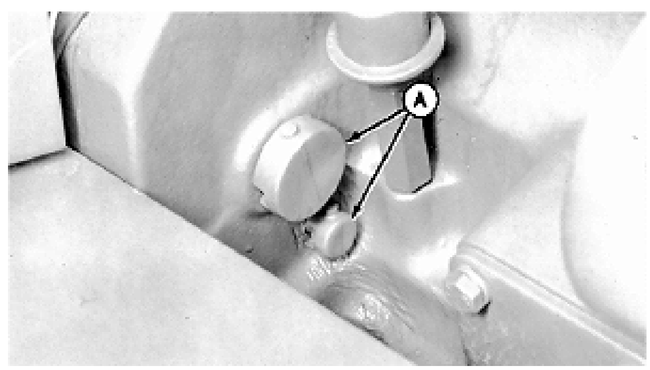
RG4650 -UN-14DEC88

A—Crankcase
B—Camshaft
C—Roller Tappet
D—Control Rack
E—Control Sleeve
F—Plunger
G—Fuel Gallery
H—Delivery Valve
I—Delivery Pipe
J—Injection Pressure
K—Supply Pump Pressure
L—Engine Lubricating Oil

S11,23010,GF -19-09SEP91

CHECK AND ADJUST INJECTION PUMP TIMING

1. Remove vent tube (shown removed) from hole in cylinder block. Remove two plastic plugs (A) from timing hole.



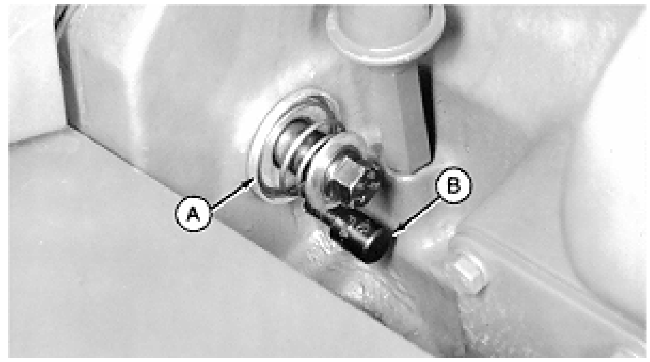
RG4119 -UN-23FEB89

S55,23010,K -19-16FEB88

2. Install JDE81-1 Flywheel Rotation Tool (A) and JDE81-4 Timing Pin (B) in their respective timing holes.

3. Position engine at 'TDC' with No. 1 piston on it's compression stroke. (See Check Valve Clearance, Group 05.)

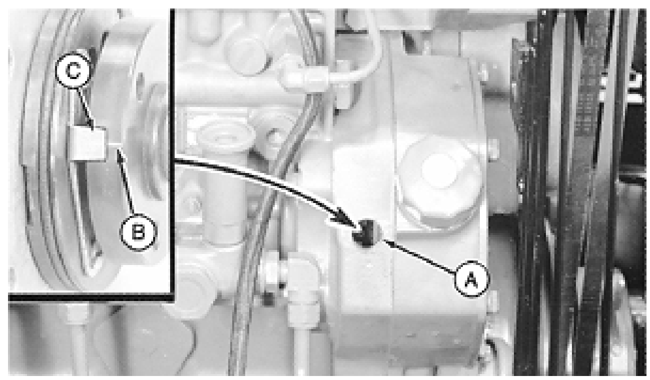
NOTE: The compression stroke can be determined by removing the rocker arm cover and rotating the engine until both valves are closed (rocker arms loose) on No. 1 cylinder.



RG4120 -UN-23FEB89

S55,23010,L -19-16FEB88

4. Remove the timing hole plug and look into hole (A). As the flywheel is turned, observe when the pump drive hub mark (B) comes in alignment with the pointer mark (C). At this position, the JDE81-4 Timing Pin should enter the hole in flywheel.



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S11,23010,BK -19-07DEC81

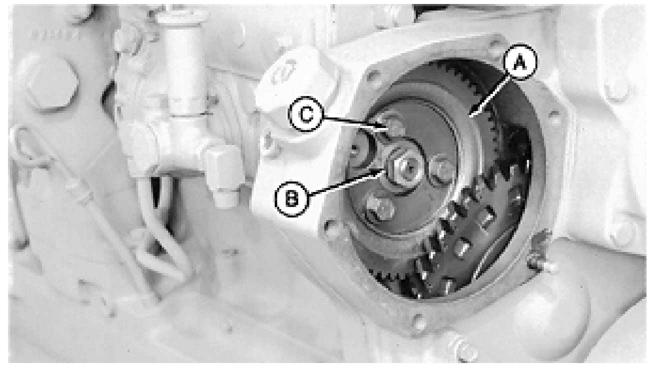
IMPORTANT: The normal backlash of gears is enough to throw the pump timing off by several degrees, resulting in poor engine performance. Therefore, it is very important that pump timing be rechecked after it has been installed. To avoid backlash, always approach the timing mark on pointer by rotating crankshaft in direction of normal engine rotation.

NOTE: Normal engine rotation is counter-clockwise, viewed from flywheel end.

5. If the timing marks are not aligned when timing pin enters hole in flywheel, remove timing pin from the flywheel. Rotate the flywheel 1-1/2 revlutions 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 screw 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).



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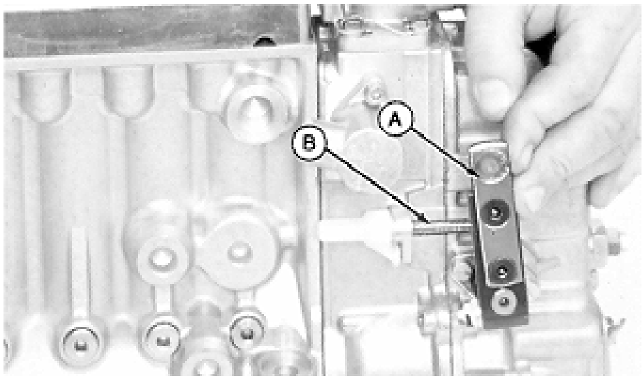
S11,23010,IP -19-19SEP91

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. Disconnect speed control rod. 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:

6076TF, AF AND HF ENGINES

Standard Mechanical Governor	2430—2470 rpm
3—5% Mechanical Governor	1880—1900 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.

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CHECK AND ADJUST ENGINE SLOW IDLE SPEED

NOTE: Both the slow idle stop screw (A) and the supplementary idling spring screw (B) may be used to adjust the slow idle speed.

IMPORTANT: Minor adjustment of the slow idle speed may be made with the 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.

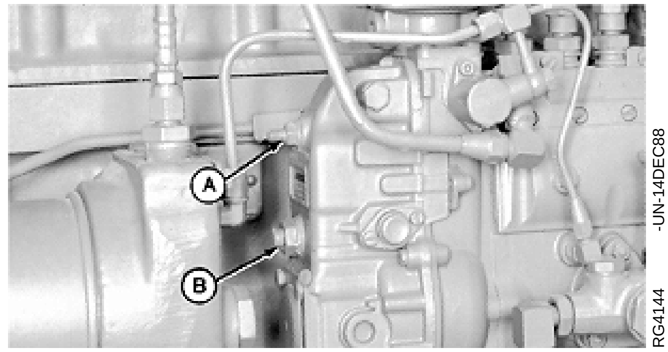
If slow idle stop screw and supplementary idling spring screw are not adjusted according to instruction, engine damage could result because of overspeeding.

CAUTION: ALWAYS STOP ENGINE before making adjustments.

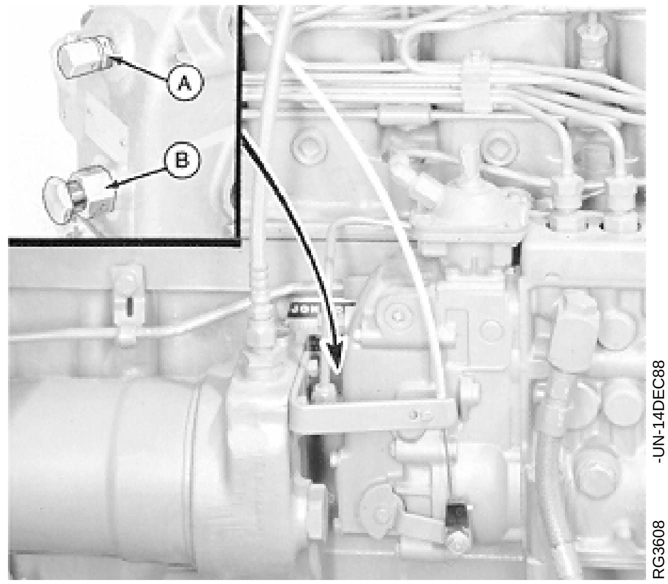
1. With the engine running, pull the governor control lever rearward to the slow idle speed position. Check and adjust slow idle speed to the following specifications.

6076TF, AF and HF Engines . . . . 850 rpm

NOTE: Refer to the appropriate machine technical manual for slow idle speed specifications pertaining to applications other than those using 6076TF, AF and HF Engines.



(Robert Bosch Pump Shown)



(Nippondenso Pump Shown)

S55,23010,N -19-14APR88

NOTE: On Nippondenso first remove slow idle stop screw cover.

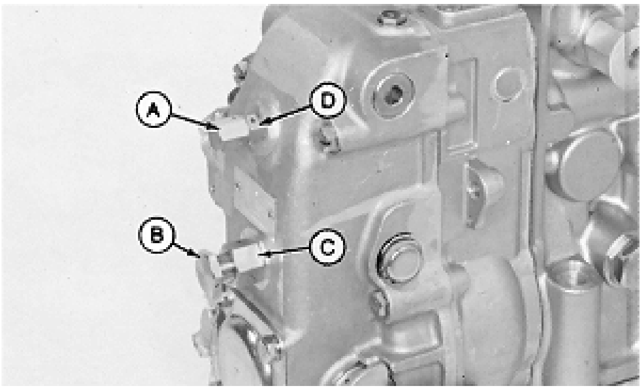
2. Loosen lock nut (C) and back out the supplementary idling spring adjusting screw (B) three full turns.

3. Loosen lock nut (D) and adjust slow idle stop screw (A) to obtain an idle speed on the low side of desired slow idle speed setting within 30 rpm.

4. Turn the supplementary idling spring adjusting screw in to increase engine speed a maximum of 30 rpm.

For example, to obtain an 850 rpm slow idle speed, use the slow idle stop screw to set speed at approximately 835 or 840 rpm. Then increase speed to 850 rpm using the supplementary idling spring adjusting screw.

NOTE: Increasing the slow idle speed a slight amount above the specified speed range may help to reduce engine surge (or hunting). If this occurs, use the procedure given above; but do not exceed 850 rpm.



RG5943 -UN-23AUG91

Robert Bosch Shown (Nippondenso Similar)

A—Slow Idle Stop Screw
B—Supplementary Idling Spring Adjusting Screw
C—Lock Nut
D—Lock Nut

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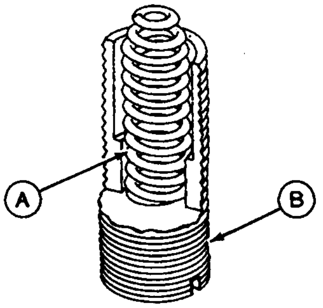
5. If engine continues surging or hunting at slow idle, the supplementary idling spring (A) and adjusting screw (B) may need to be replaced with a new one. Remove injection pump from engine and have it repaired by an authorized diesel repair station (ADS Shop). (See Group 35 for injection pump removal and installation.)

6. Again, check engine fast and slow idle speeds. Readjust slow idle speed if not correct.

7. Check all adjusting screw lock nuts for tightness. Install covers (and copper washers) on slow idle stop screw and idling spring adjusting screw (on Nippondenso Pumps).

8. Connect fuel shut-off cable and speed control rod.



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HOW THE ANEROID WORKS (IF EQUIPPED)

Intake manifold pressure (created by the turbocharger) enters aneroid at (A). It is directed to upper side of diaphragm chamber (C) and exerts pressure on diaphragm (D).

When the pressure rises to about (100 kPa) (1 bar) 15 psi, or about 1000 engine rpm under moderate to heavy loads, spring pressure (E) is overcome. Diaphragm then moves adjusting shaft screw (F) downward.

Arm (G) has two “legs”. The inner leg bears on the flat surface of adjusting shaft screw (F). The outer leg bears against a block riveted to the control rack (H).

NOTE: Diaphragm adjusting screw (B) regulates the minimum fuel delivery quantity at a specified rpm and zero pressure acting on the diaphragm. The diaphragm spring determines acceleration time (the greater the spring tension, the greater the manifold pressure required to overcome spring tension; hence, a slower acceleration).

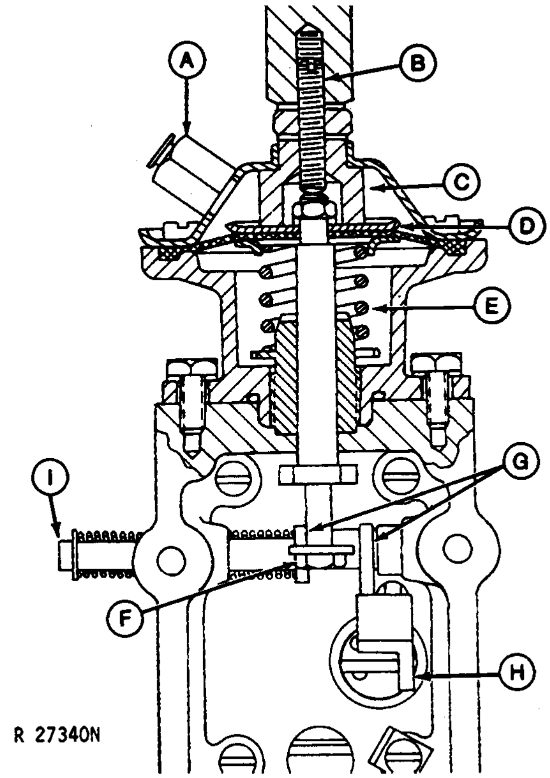
Downward movement of the adjusting shaft causes arm to rotate on starting fuel control shaft (I), permitting control rack to move its normal amount.

If the intake manifold pressure is below 100 kPa (1 bar) (15 psi) because of low engine speed, or is under light load at higher engine speeds, the aneroid spring pressure is greater than the intake manifold pressure. As a result, the control rack travel is limited (therefore, fuel delivery is limited) by the arm and adjusting shaft.

Aneroid control will be in effect until the manifold pressure is high enough to overcome diaphragm spring pressure.

A hydraulic aneroid activator (described in this group) is used to control the lever arm engagement with the control rack by moving the starting fuel control shaft in or out.

During starting, the hydraulic aneroid activator disengages the lever arm from the control rack block to permit the rack to move all the way forward to the starting fuel delivery position.



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A—Intake Manifold Pressure Opening
B—Adjusting Screw
C—Diaphragm Chamber
D—Diaphragm
E—Spring
F—Adjusting Shaft Screw
G—Arm
H—Control Rack
I—Starting Fuel Shaft

S11,23010,IU -19-09SEP91

DIAGNOSE ANEROID MALFUNCTION

Symptom	Problem	Solution
Slow Engine Acceleration	Loose pipe or broken connection at inlet fitting	Repair as required. (See Group 35)
	Aneroid cover cracked around inlet fitting	Repair as required. (See Group 35)
	Defective diaphragm	Repair as required. (See Group 35)
	Aneroid not correctly adjusted	Remove injection pump (See Group 35) and adjust on test stand.
Excessive Smoke When Accelerating Engine	Aneroid not correctly adjusted	Remove injection pump. (See Group 35) and adjust on test stand.

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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.

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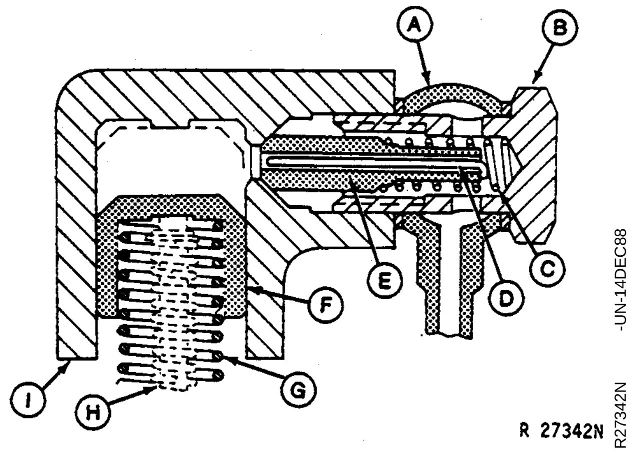
HOW THE HYDRAULIC ANEROID ACTIVATOR WORKS (IF EQUIPPED)



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 hydraulic aneroid activator mounts on the inboard side of the governor housing. It has an internal piston (F) that is operated by engine oil pressure to hydraulically move the starting fuel control shaft inward for aneroid control.

Engine lubricating oil is piped from the oil filter body to operate the activator. This oil is then piped to the injection pump housing to lubricate the internal working parts.

Engine oil upon starting the engine is routed to the aneroid activator housing (I) through a banjo connector (A), special screw (B), and an orifice in the capillary valve (E) to head of piston (F).

Whenever the engine oil pressure is about (60 kPa) (0.6 bar) 9 psi or higher, the piston will overcome resistance of piston spring (G) and move the starting fuel control shaft (H) inward to provide aneroid control.

Loss of oil pressure permits a return spring on the starting fuel control shaft to hold the lever arm out of engagement with the control rack. This prevents the aneroid from limiting rack travel.

A restrictor wire (D) is inserted in the capillary valve for two reasons.

(1) To retard engagement of the aneroid when engine is cold.

(2) To help maintain an open passage in the capillary valve (oil pressure action moves the wire enough to prevent orifice from plugging).

The length of time required to achieve aneroid control depends on the ambient air temperature and the viscosity of the engine oil. Warm ambient air temperatures will permit the aneroid to activate in a few seconds. Cold temperatures may delay activation for several minutes.

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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 -19-19MAY88

DIAGNOSE MALFUNCTIONS—HYDRAULIC ANEROID ACTIVATOR

Symptom	Problem	Solution
Engine Starts Hard	Broken return spring on starting fuel control shaft.	Repair (See Group 35)
	Retaining ring missing from starting fuel control shaft.	Repair (See Group 35)
Excessive Smoke When Accelerating Engine	Check for restriction in oil supply passages to activator piston.	Disassemble activator (See Group 35)

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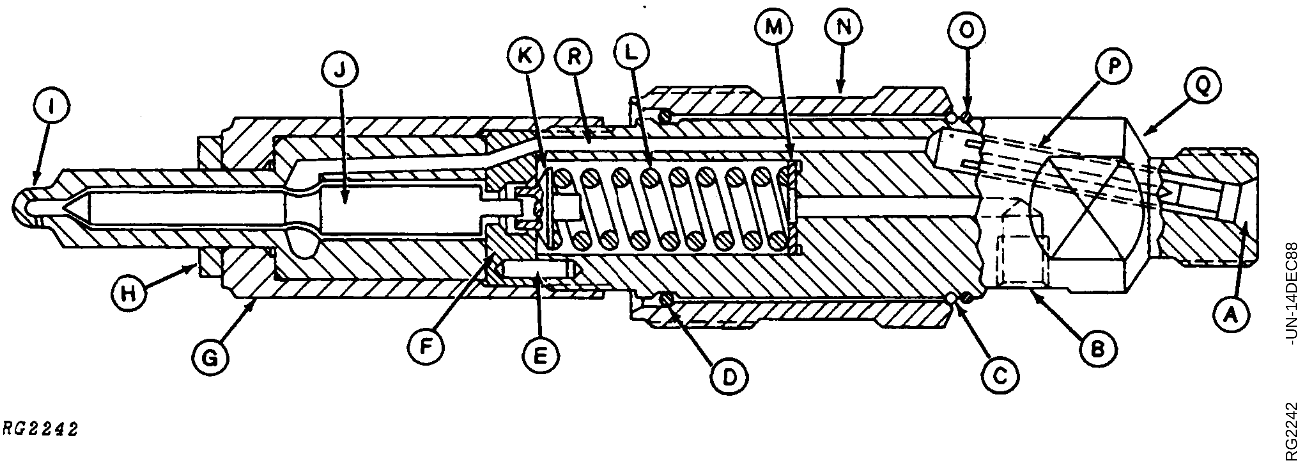
FUEL INJECTION NOZZLES—GENERAL INFORMATION



A—Fuel Inlet
B—Leak-Off Connection
C—O-Ring
D—Snap Ring
E—Dowel Pin
F—Intermediate Plate
G—Nozzle Retaining Nut
H—Washer
I—Nozzle
J—Valve
K—Spring Seat
L—Spring
M—Shims
N—Gland Nut
O—Snap Ring
P—Edge-Type Filter
Q—Nozzle Holder
R—Fuel Passage

The nozzle valve (J) is held on its seat by a spring (L). Shims (M) are used to regulate the nozzle opening pressure.

The nozzle (I) and valve fit together by precision lapping. These parts are referred to as a nozzle assembly, and are not serviced separately.

Correct alignment of the nozzle assembly with its holder is essential so that the atomized fuel will be sprayed into the combustion chamber at the angle and location intended by design. KDEL holders use an intermediate plate (F) with dowel pins (E) on both sides to insure alignment.

A retaining nut (G) is used to fasten the nozzle assembly to the holder body. The diameter of the holder body is 21 mm, and from this dimension the fuel injection nozzles are known as 21 mm nozzles.

An edge-type filter (P) is placed in the fuel inlet of the nozzle holder. Its purpose is to prevent coarse, foreign particles from damaging the nozzle assembly or plugging the orifices. Finer particles pass through the filter without harm. The filter is not removable.

To provide a seal between the injection nozzle and the engine cylinder head, a steel washer (H) is used at the base of the nozzle retaining nut.

The fuel injection nozzle is fastened to the engine cylinder head by a gland nut (N). The gland nut also functions as a jack screw to raise the injection nozzle out of cylinder head during removal.

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FUEL INJECTION NOZZLE OPERATION

Fuel lines (A) deliver the fuel to injection nozzles. Fuel enters the injection nozzle inlet (B), and passes through the edge-type filter (C). Coarse foreign particles are retained by the filter.

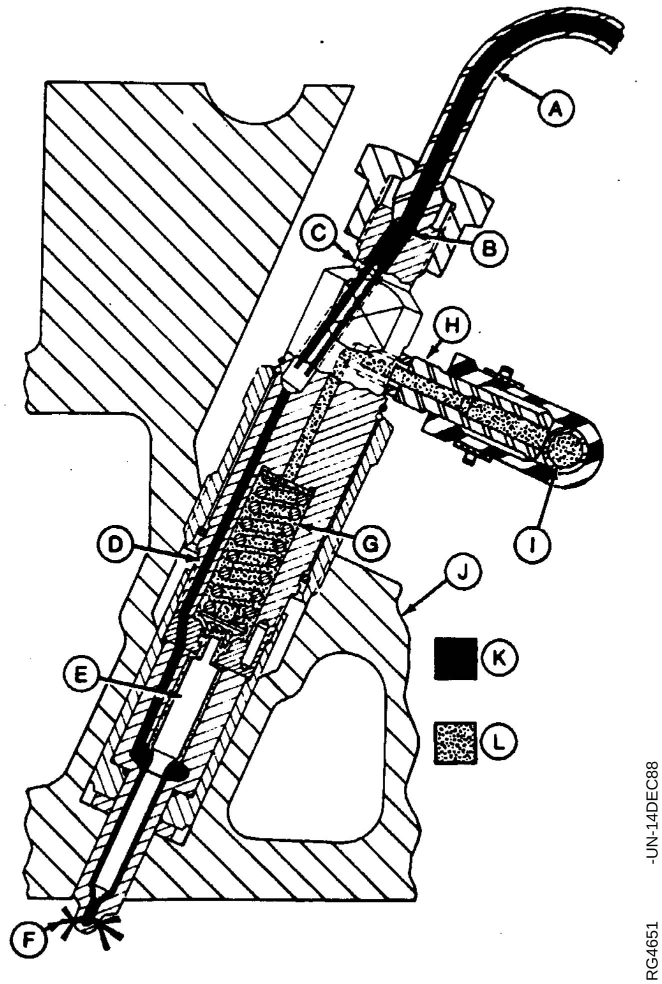
A passage (D) routes fuel through the nozzle holder to the nozzle valve (E). The nozzle valve is lifted instantly off its seat by the high pressure inlet fuel acting on an annulus in the valve.

NOTE: Since the nozzle valve opening pressure is considerably lower than the injection pump output pressure, the inlet fuel pressure easily overcomes the resistance of the nozzle valve spring (G).

When the nozzle valve opens, a definite quantity of fuel (determined by the injection pump output for each plunger stroke) is forced out through orifices (F). The fuel becomes finely atomized as it is sprayed into the combustion chamber at high velocity.

The nozzle assembly is lubricated by a small amount of fuel which seeps between the lapped surfaces of the nozzle and valve which accumulates around the spring (G, refer to previous illustrations).

The leakage fuel is routed out the nozzle holder through a leak-off connector (H) and returned back to the fuel tank by means of a leak-off pipe (I).



Fuel Flow Through KDEL Injection Nozzle

A—Fuel Delivery Line
B—Fuel Inlet
C—Edge-Type Filter
D—Fuel Passage
E—Nozzle Valve
F—Orifices
G—Nozzle Valve Spring
H—Leak-Off Connector
I—Leak-Off Pipe
J—Engine Cylinder Head
K—High Pressure Fuel
L—Low Pressure (Return) Fuel

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DIAGNOSE MALFUNCTION—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 Diesel Fuel System)
	Broken or damaged parts	Repair as required (See Group 35) Diesel Fuel System
	a. Broken nozzle valve spring b. Cracked or split nozzle tip c. Cracked or split nozzle body d. Internal leak	
	Wrong nozzle and valve in holder	Install nozzle assembly (See Group 35 Diesel Fuel System)
	Worn nozzle valve seal	Replace nozzle assembly (See Group 35 Diesel Fuel System)

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TEST FUEL INJECTION NOZZLES (ENGINE RUNNING)

1. Operate engine at intermediate speed and no load.

2. Slowly loosen the fuel pressure line at one of the nozzles until fuel escapes at the connection (fuel not opening nozzle valve).

3. If engine speed changes, the injection nozzle is probably working satisfactory. If engine speed does not change, the nozzle is faulty and must be checked and repaired (or replaced).

4. Repeat test for each remaining nozzle assembly.

5. Remove faulty injection nozzles and repair as required. See Group 35.

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FUEL DRAIN BACK TEST PROCEDURE

Fuel draining back through the fuel system may cause hard starting. This procedure will determine if air is entering the system at connections and allowing fuel to siphon back to the fuel tank.

1. Disconnect fuel supply line and fuel return line at fuel tank.

IMPORTANT: Fuel return line MUST extend below fuel level in fuel tank before performing this test. Fill fuel tank if necessary.

2. Drain all fuel from the system, including the fuel transfer pump, fuel injection pump, fuel filters, and water separator (if equipped).

3. Securely plug off the end of the fuel return pipe.

4. Using a low pressure air source, pressurize the fuel system at the fuel supply line.

CAUTION: Maximum air pressure should be 103 kPa (1.03 bar) (15 psi) when performing this test.

5. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

NOTE: Connections may allow air to enter the system without allowing fuel to leak out.

6. If any leaks are found, take necessary steps to repair.

7. Reconnect supply and return lines and prime system.

8. Start engine and run for approximately 10 minutes.

9. Allow engine to sit overnight and try starting the following morning.

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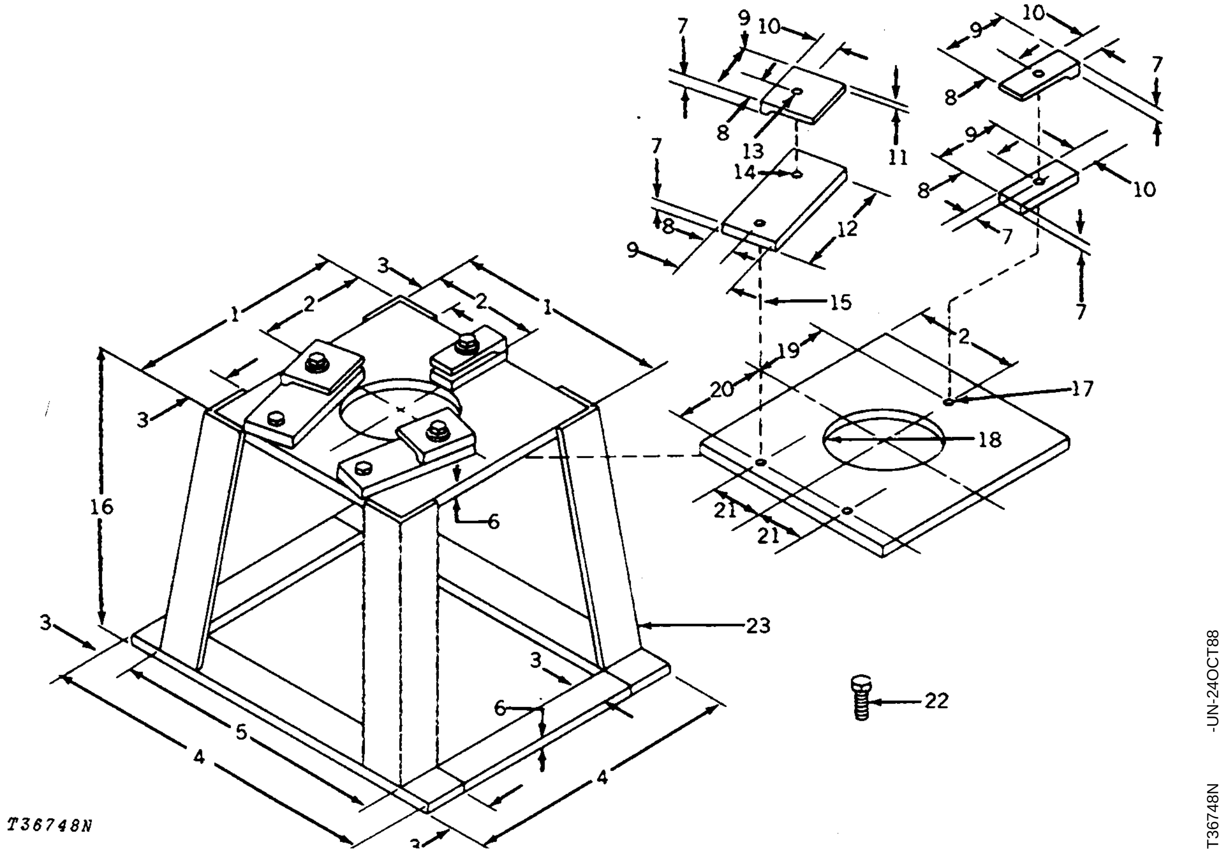
FABRICATED TOOLS—CYLINDER LINER HOLDING FIXTURE



1—254.0 mm (10 in.)
2—127.0 mm (5 in.)
3—38.1 mm (1.5 in.)
4—406.4 mm (16 in.)
5—330.2 mm (13 in.)
6—9.52 mm (0.375 in.)
7—12.7 mm (0.5 in.)
8—31.8 mm (1.25 mm)
9—63.5 mm (2.5 in.)
10—25.4 mm (1 in.)
11—6.35 mm (0.25 in.)
12—152.4 mm (6 in.)
13—0.328 in. Drill Through
14—5/16 in.—18 Tap
15—2 used
16—304.8 mm (12 in.)
17—5/16 in.—18 Tap
18—69.85 mm (2.75 in.) Radius
19—101.6 mm (4 in.)
20—111.25 mm (4.38 in.)
21—60.45 mm (2.38)
22—5/16 in. x 1 in. Cap Screw
23—38.1 mm (1.5 in.) Angle Iron

NOTE: These tools can be made in a service shop using common shop tools and locally obtained materials.

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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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SAFETY
live with it