TM 5-3805-280-24-2

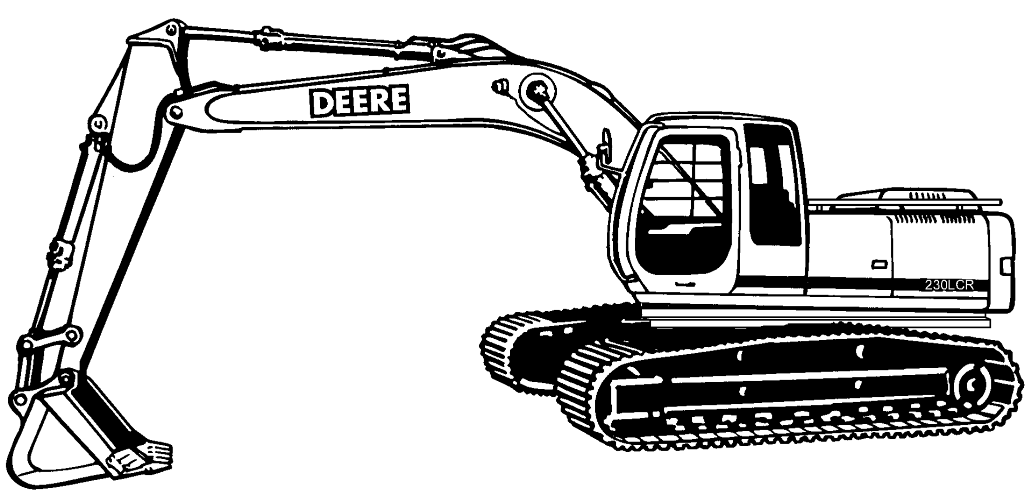
TECHNICAL MANUAL

UNIT, DIRECT SUPPORT
AND GENERAL SUPPORT MAINTENANCE MANUAL

HYDRAULIC EXCAVATOR
JOHN DEERE
MODEL 230LCR
NSN 3805-01-463-0804

AND

MODEL 230LCRD WITH ROCK DRILL
NSN 3805-01-463-0806



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HEADQUARTERS, DEPARTMENT OF THE ARMY

15 FEBRUARY 2000

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Page No.	*Revision No.	Page No.	*Revision No.	Page No.	*Revision No.
TM 5-3805-280-24-2		23-1 — 23-209	0		
		23-210 blank	0		
Cover	0	24-1 — 24-12	0		
A	0	A-1 — A-39	0		
B blank	0	A-40 blank	0		
i — xx	0	B-1 — B-20	0		
13-1 — 13-612	0	C-1 — C-3	0		
14-1 — 14-44	0	C-4 blank	0		
15-1 — 15-4	0	Foldout 57	0		
16-1 — 16-97	0	Foldout 58 blank	0		
16-98 blank	0	Foldout 59	0		
17-1 — 17-6	0	Foldout 60 blank	0		
18-1 — 18-59	0	Foldout 61	0		
18-60 blank	0	Foldout 62 blank	0		
19-1 — 19-2	0	Foldout 63	0		
20-1 — 20-34	0	Foldout 64 blank	0		
21-1 — 21-216	0	Foldout 65	0		
22-1 — 22-55	0	Foldout 66 blank	0		
22-56 blank	0				

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Technical Manual
No. 5-3805-280-24-2

HEADQUARTERS,
DEPARTMENT OF THE ARMY
Washington, DC, *15 February 2000*

UNIT, DIRECT SUPPORT
AND GENERAL SUPPORT
MAINTENANCE MANUAL

HYDRAULIC EXCAVATOR
JOHN DEERE
MODEL 230LCR
NSN 3805-01-463-0804

AND

MODEL 230LCRD WITH ROCK DRILL
NSN 3805-01-463-0806

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

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TABLE OF CONTENTS

TM 5-3805-280-24-1

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Page

CHAPTER 13

SECTION 04

ENGINE REPAIR

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Group 0400
Removal and Installation

ESSENTIAL TOOLS

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

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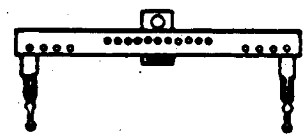
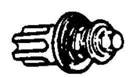
CED,OUOE003,1159 –19–18SEP98–1/6


T6585NV –UN–18OCT88

Lifting Sling JDG23

To remove engine.

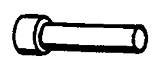
CED,OUOE003,1159 –19–18SEP98–2/6


T6585NO –UN–18OCT88

Flywheel Turning Tool JDG820

To rotate crankshaft to position number one piston at “TDC” on compression stroke.

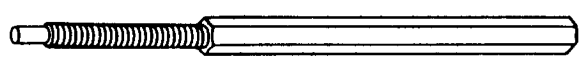
CED,OUOE003,1159 –19–18SEP98–3/6


T6585NP –UN–18OCT88

Timing Pin JDE81-4

To lock engine at TDC.

CED,OUOE003,1159 –19–18SEP98–4/6


RG7212 –UN–23NOV97

Injection Pump Timing Pin. JDG886

To lock fuel injection pump timing prior to removal of pump.

Continued on next page

CED,OUOE003,1159 –19–18SEP98–5/6

Removal and Installation

RG5154 –UN–23AUG88

3/4 in. Special Crowsfoot JDF22

To disconnect injection lines.

CED,OUOE003,1159 –19–18SEP98–6/6

SERVICE EQUIPMENT AND TOOLS

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

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CED,OUOE003,513 –19–15MAY98–1/2

Pump Support . . . . DFT1119[1]

To support main hydraulic pump when engine is removed.

[1]Fabricated tool, dealer made. (See Section 99 for instructions to make tool.)

CED,OUOE003,513 –19–15MAY98–2/2

OTHER MATERIAL

Number	Name	Use
TY6304 (U.S.) TY9484 (Canadian) 515 (LOCTITE®)	Flexible Sealant	Apply to oil pan rail where flywheel housing, front plate, and timing gear cover contact cylinder block.
TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®)	Pipe Sealant	Apply to elbow drain fittings.
AR54749 (U.S.)	Soap Lubricant	To aid in pump installation and prevent O-ring damage.

LOCTITE is a trademark of Loctite Corp.

CED,OUOE003,1160 –19–18SEP98–1/1

SPECIFICATIONS

Item	Measurement	Specification
Engine:		
Hydraulic Pump and Gearbox	Weight	167 kg (370 lb) approximate
Engine	Weight	954 kg (2100 lb) approximate
Bracket and Mount-to-Frame Cap Screw	Torque	350 N•m (260 lb-ft)
Oil Pan:		
Oil Pan and Gasket-to-Engine Block Cap Screw	Torque	35 N•m (26 lb-ft)
Oil Pan Drain Plug	Torque	47 N•m (35 lb-ft)
Fuel Injection Pump:		
Mounting Stud Nut	Torque	70 N•m (52 lb-ft)
Drive Gear-to-Pump Hub Cap Screw	Torque	47 N•m (35 lb-ft)
Injection Pump Drive Gear-to-Hub Cap Screw	Torque	27 N•m (20 lb-ft)
Fuel Delivery Line Nut	Torque	27 N•m (20 lb-ft)
Engine Valve:		
Exhaust Valve (E)	Clearance	0.46 mm (0.018 in.)
Intake Valve (I)	Clearance	0.36 mm (0.014 in.)
Intake and Exhaust Valve Jam Nut	Torque	27 N•m (20 lb-ft)
Rocker Arm Cover Cap Screw	Torque	10.8 N•m (96 lb-in.)
Starter:		
Starter	Weight	23 kg (50 lb) approximate

Continued on next page

CED,OUOE003,1161 –19–18SEP98–1/2

Removal and Installation

Item	Measurement	Specification
Starter Mounting Flange-to-Flywheel Housing Cap Screw	Torque	47 N•m (35 lb-ft)

CED,OUOE003,1161 –19–18SEP98–2/2

REMOVE ENGINE

TS281 –UN–23AUG88

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

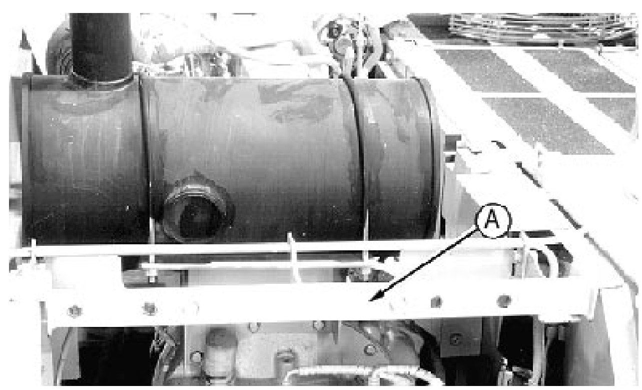
Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

1. Disconnect negative (-) battery cable.

2. Drain coolant. Cooling capacity is approximately 28.4 L (30 qt).

TX,04,UU3872 –19–18SEP98–1/5

3. Remove hood and hood support (A).



T104488 –UN–17OCT96

A—Hood Support

Continued on next page

TX,04,UU3872 –19–18SEP98–2/5

4. Remove air intake hoses and coupling (B) above the rocker arm cover.

5. Remove fan guard.

6. Remove upper and lower radiator hoses.

7. Remove fan and fan spacer.

8. Remove muffler and muffler bracket.

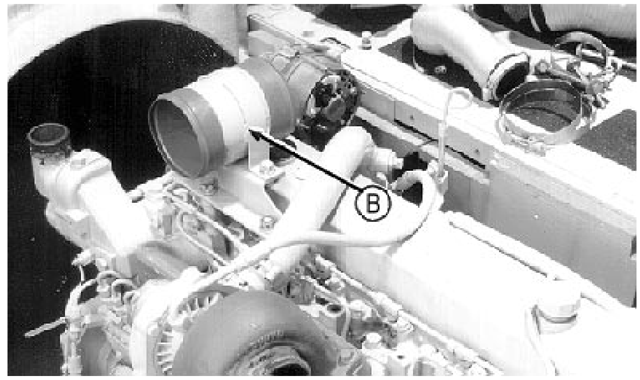
9. Disconnect wiring harnesses.

10. Disconnect fuel lines. Plug openings.

11. Disconnect heater hoses. Plug openings.

12. Remove air conditioner compressor and bracket from engine. It is not necessary to discharge the air conditioning system.

13. Secure compressor so it does not interfere when removing the engine.



T104490 –UN–17OCT96

B—Coupling

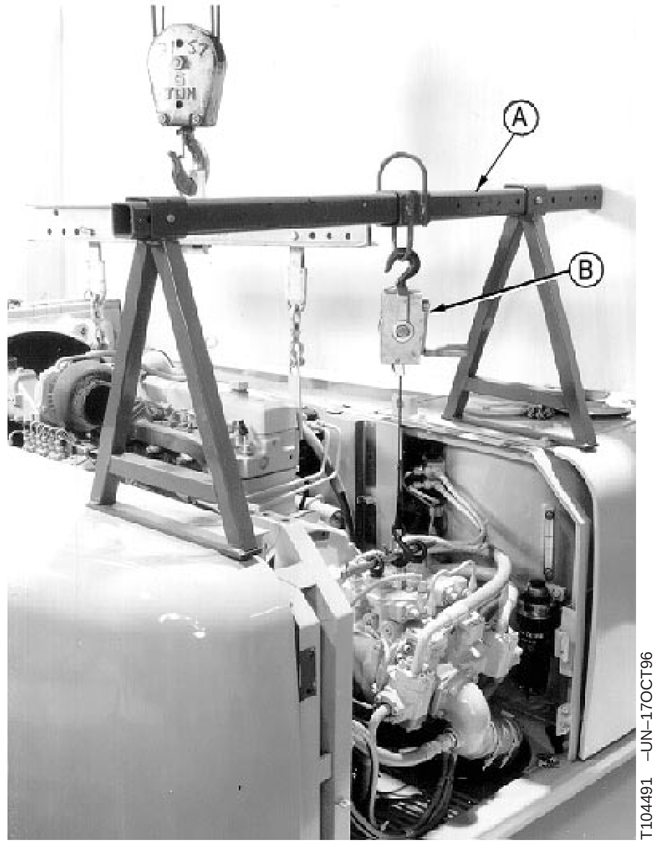
Continued on next page TX,04,UU3872 –19–18SEP98–3/5

CAUTION: The approximate weight of hydraulic pump and gearbox is 167 kg (370 lb).

Hydraulic Pump and Gearbox—Specification

Weight.. 167 kg (370 lb) approximate

14. Support main hydraulic pump and gearbox using DFT1119 Pump Support (A) and a small winch hoist (B). (See Section 99 for instructions to make tool.)



A—DFT1119 Pump Support
B—Winch Hoist

Continued on next page TX,04,UU3872 –19–18SEP98–4/5

CAUTION: The approximate weight of engine is 954 kg (2100 lb).

The recommended method for lifting the engine is using the JDG23 Lifting Sling. The lifting force must be at 90° at the lifting points.

Engine—Specification

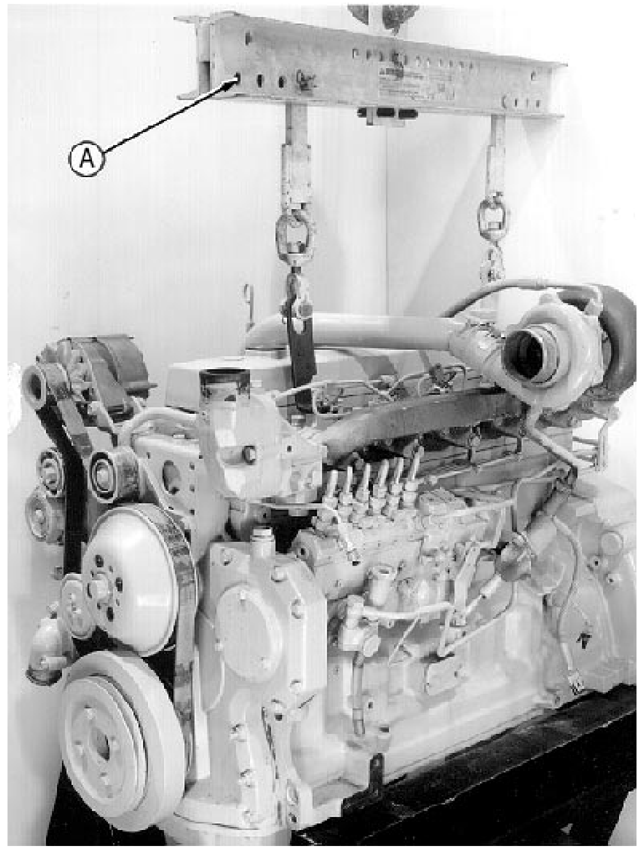
Weight.. 954 kg (2100 lb) approximate

15. Attach JDG23 lifting sling (A) to engine as shown.

16. Remove pump gearbox-to-flywheel housing cap screws.

17. Remove engine mount cap screws.

18. Raise engine slightly and push engine away from hydraulic pump. Lift engine when engine is disengaged from pump drive coupling.

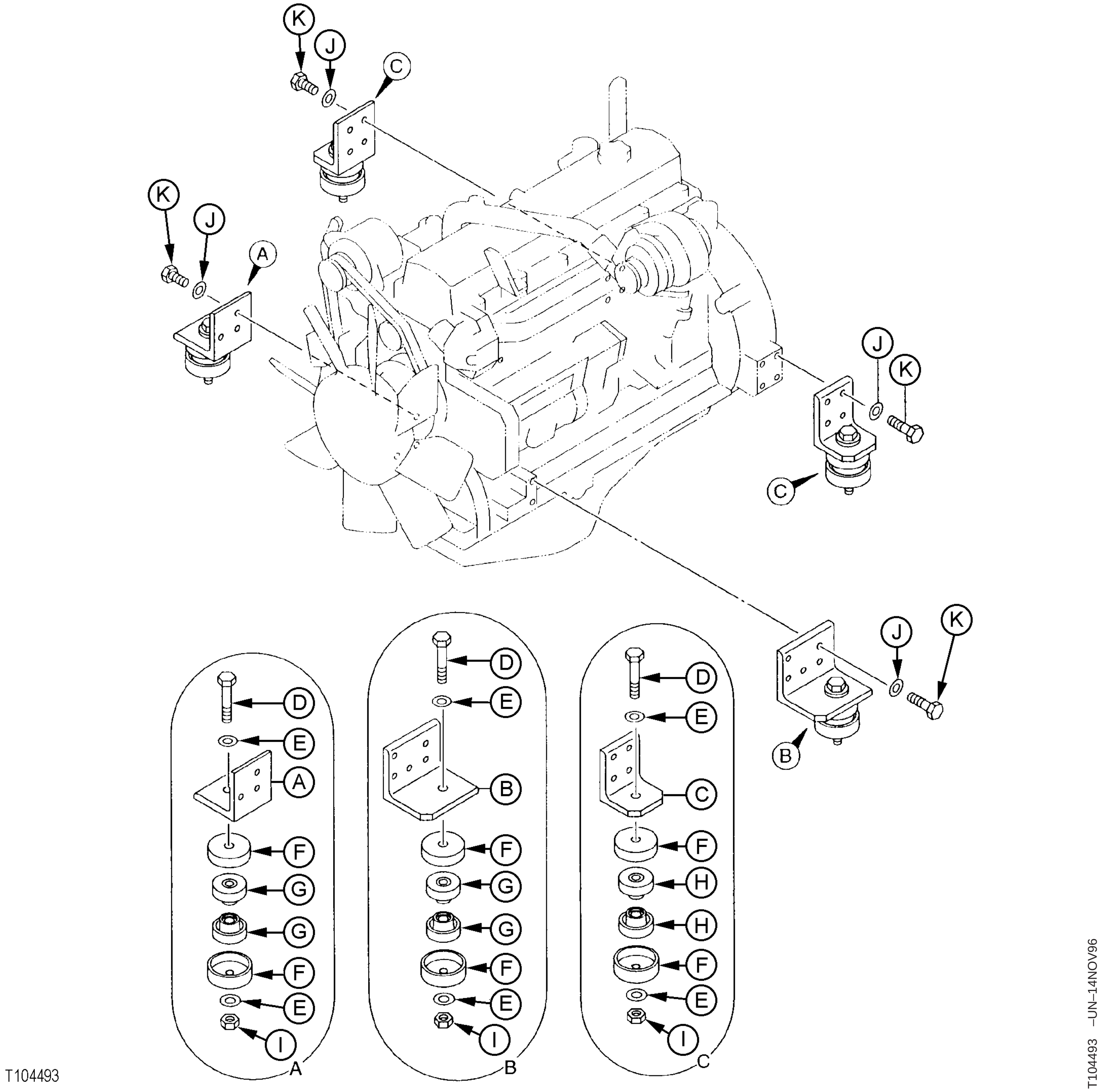


T104492 –UN–17OCT96

A—JDG23 Lifting Sling

TX,04,UU3872 –19–18SEP98–5/5

INSTALL ENGINE



A—Bracket, Right Front	**D—Cap Screw (4 used)**	**G—Rubber Mount (4 used)**	**J—Washer (14 used)**
B—Bracket, Left Front	**E—Washer (8 used)**	**H—Rubber Mount (4 used)**	**K—Cap Screw (14 used)**
C—Bracket, Rear (2 used)	**F—Stop (8 used)**	**I—Nut (4 used)**	

1. Lower engine into excavator.

Continued on next page

Removal and Installation

2. Slide engine toward hydraulic pump to engage pump coupler.

3. Install cap screws (D) and nuts (I). Tighten cap screws.

Bracket and Mount-to-Frame Cap Screw—Specification

Torque.. 350 N•m (260 lb-ft)

TX,04,UU3873 –19–18SEP98–2/4

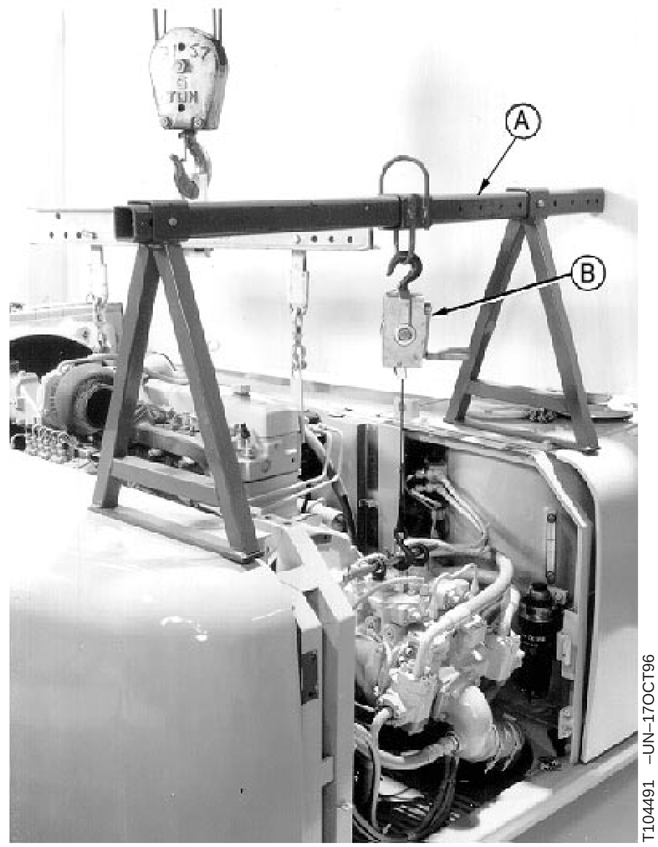
4. Install hydraulic pump using DFT1119 Pump Support (A) and a small winch hoist (B). (See procedure in Group 3360.)

5. Connect heater hoses.

6. Install air conditioner compressor and bracket, if equipped.

7. Connect all wiring harnesses and starter cables.

8. Install speed control linkage. (See procedure in Group 0515.)



A—DFT1119 Pump Support
B—Winch Hoist

Continued on next page

TX,04,UU3873 –19–18SEP98–3/4

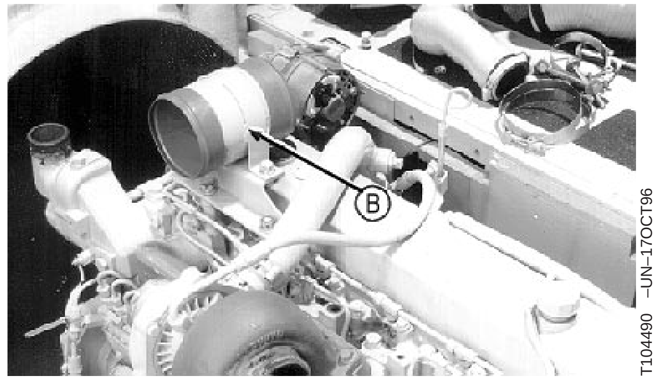
9. Install air intake hose coupler (B) and intake hoses.

10. Install fan, shroud, and guards. (See procedure in Group 0510.)

11. Fill radiator and reservoir to proper level.

12. Bleed fuel system. (See procedure in this group.)

13. Connect battery cables.



B— Hose Couple

TX,04,UU3873 –19–18SEP98–4/4

REMOVE OIL PAN

Engine must be removed to remove oil pan. (See procedure in this group.)

TX,04,SB147 –19–26SEP98–1/1

INSTALL OIL PAN

1. Apply flexible sealant on oil pan rail where flywheel housing, front plate, and timing gear cover attach to cylinder block.

2. Install oil pan gasket.

3. Install oil pan and tighten cap screws.

Oil Pan and Gasket-to-Engine Block Cap Screw—Specification

Torque .... 35 N•m (26 lb-ft)

4. Install aluminum or copper washer on drain plug with raised center against plug. Tighten drain plug.

Oil Pan Drain Plug—Specification

Torque .... 47 N•m (35 lb-ft)

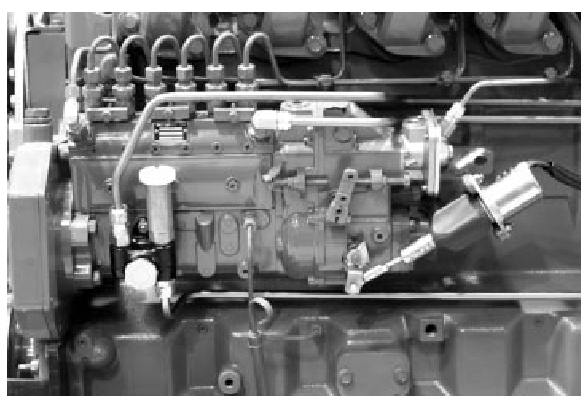
If equipped with elbow drain fittings, the threads and sealing surfaces must be free of oil film to insure an effective seal. Apply pipe sealant to fitting, except for the leading one to three threads. Install and tighten fitting.

5. Fill engine crankcase with correct grade and viscosity engine oil. (See Diesel Engine and Pump Gearbox Oils in Group 0004.)

TX,04,DH5306 –19–17SEP98–1/1

REMOVE IN-LINE FUEL INJECTION PUMP

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



RG7748 –UN–06DEC96

1. Clean injection lines and area around the injection pump with cleaning solvent or a steam cleaner.

2. Rotate engine flywheel (in normal running direction) until No. 1 piston is at “TDC” of its compression stroke using JDG820 Flywheel Turning Tool. At this point, JDE81-4 Timing Pin should enter hole in flywheel.

Continued on next page

TX,04,UU3874 –19–18SEP98–1/3

3. Remove injection pump drive gear cover and O-ring.

4. Install JDG886 Injection Pump Timing Pin (A) through injection pump drive gear into injection pump hub until it bottoms. In some instances it may be necessary to rotate the pump drive hub slightly to get the pin installed.

5. Disconnect injection pump lubrication line (B).

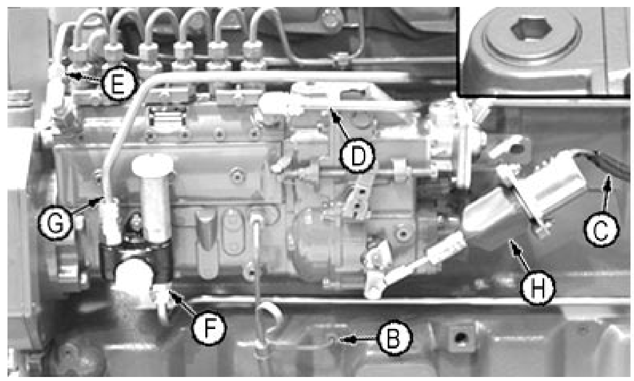
6. Disconnect fuel shut-off solenoid electrical connector (C).

7. Remove fuel inlet line (D). Remove fuel leak-off line (E).

8. Disconnect fuel tank-to-transfer pump line (F).

9. Disconnect transfer pump-to-fuel filter line. (G).

T105061 –UN–12NOV96



T105065 –UN–12NOV96

A—JDG886 Injection Pump Timing Pin
B—Injection Pump Lubrication Line
C—Fuel Shut-off Solenoid Electrical Connector
D—Fuel Filter-to-Injection Pump Inlet Line
E—Fuel Leak-off Line
F—Fuel Tank-to-Transfer Pump Line
G—Transfer Pump-to-Fuel Filter Line
H—Fuel Shutoff Solenoid

Continued on next page TX,04,UU3874 –19–18SEP98–2/3

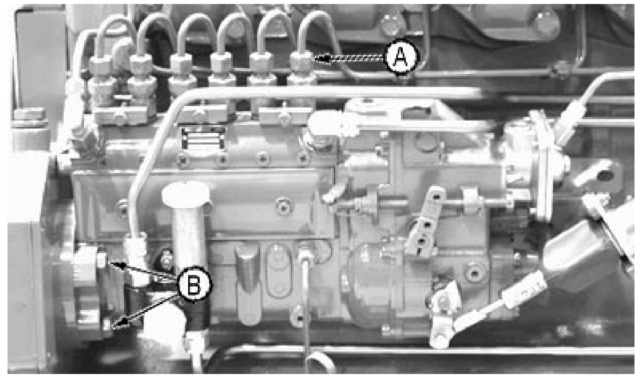
Removal and Installation

10. Remove fuel injection line nuts (A). Remove four injection pump-to-cylinder block mounting stud nuts (B).

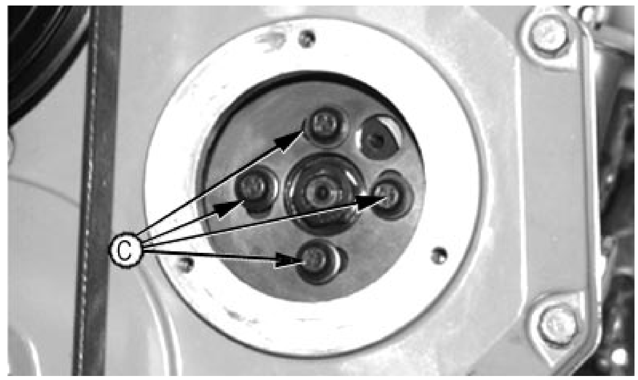
11. Remove four injection pump drive gear cap screws (C).

12. Remove four injection pump-to-cylinder block mounting stud nuts (B).

13. Remove injection pump from mounting studs and place pump on a clean, flat surface.



T105070 –UN–12NOV96



T105079 –UN–12NOV96

A—Fuel Injection Line Nuts
B—Mounting Stud Nut (4 used)
C—Cap Screw (4 used)

TX,04,UU3874 –19–18SEP98–3/3

04
0400
14

REPAIR IN-LINE FUEL INJECTION PUMP

IMPORTANT: Do not disassemble fuel injection pump further than necessary for installing available service parts, not even for cleaning.

Be sure injection pump serial tag is in place and all identification numbers are legible so pump is set to the correct specifications for its intended use.

NOTE: Remove JDG886 Injection Pump Timing Pin (A) when sending an injection pump out for repair.

For injection pump repair and testing, have an authorized diesel injection station perform the work. Unauthorized repairs made to the injection pump will void warranty.

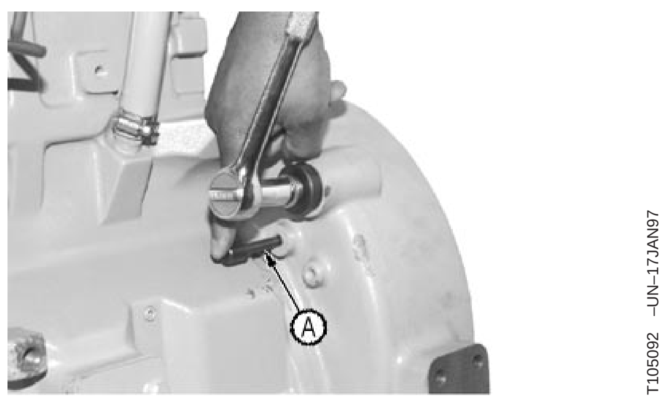
A—JDG886 Injection Pump Timing Pin

TX,04,UU3875 –19–11NOV96–1/1

INSTALL IN-LINE FUEL INJECTION PUMP

1. If engine was rotated after injection pump was removed rotate flywheel until JDE81-4 Timing Pin (A) enters flywheel at No. 1 cylinder's "TDC" compression stroke.

NOTE: When No. 1 cylinder is at "TDC" compression stroke, intake and exhaust valves for No. 1 cylinder will be closed, and both rocker arms will be loose.



A—JDE81-4 Timing Pin

Continued on next page

TX,04,UU3876 –19–18SEP98–1/6

2. Rotate injection pump drive hub (B) until marks on drive hub and pointer (A) are aligned.

NOTE: It may be necessary to rotate pump hub slightly to allow JDG886 Injection Pump Timing Pin (E) to enter bearing plate.

3. Thread JDG886 Timing Pin into drive hub as shown, and tighten until it bottoms against bearing plate (D).

4. Install a new O-ring (C) on bearing plate (D). Lightly lubricate O-ring with AR54749 Soap Lubricant to aid in pump installation, and prevent O-ring damage.

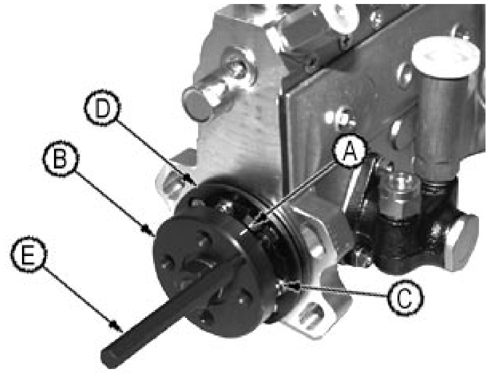
5. Install injection pump using forward pressure and slight rocking motion to work O-ring into mounting bore. Injection pump flange should seat solidly against cylinder block.

6. Install mounting stud nuts and tighten.

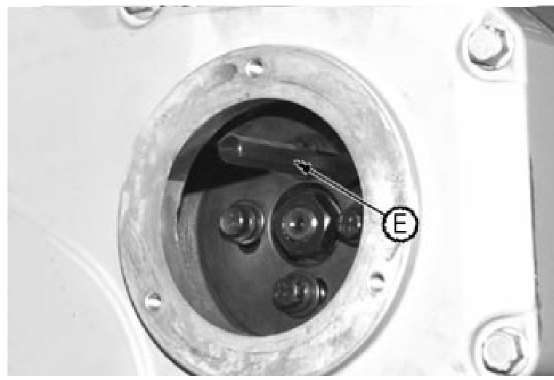
Mounting Stud Nut—Specification

Torque .... 70 N•m (52 lb-ft)

7. Install drive gear on pump drive hub, positioning gear so mounting screws are approximately centered in mounting slots.



T105102 –UN–12NOV96



T105107 –UN–12NOV96

A—Pointer
B—Drive Hub
C—O-Ring
D—Bearing Plate
E—JDG886 Injection Pump Timing Pin

Continued on next page TX,04,UU3876 –19–18SEP98–2/6

8. Install drive gear-to-pump hub cap screws (B) and tighten.

Drive Gear-to-Pump Hub Cap Screw—Specification

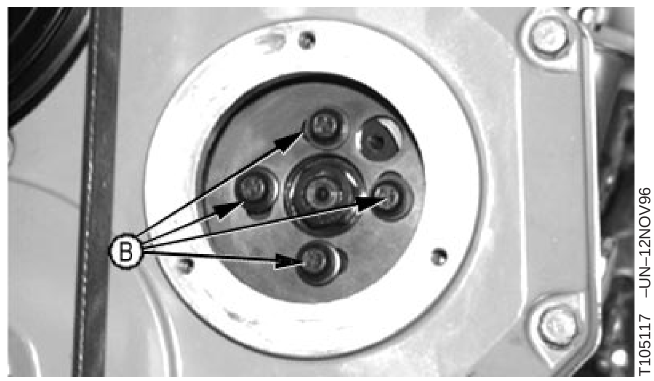
Torque .... 47 N•m (35 lb-ft)

9. Remove JDG886 Injection Pump Timing Pin (A) from injection pump hub.

10. Install injection pump drive gear and new O-ring, if needed. Tighten cap screws.

Injection Pump Drive Gear-to-Hub Cap Screw—Specification

Torque .... 27 N•m (20 lb-ft)



A—JDG886 Injection Pump Timing Pin
B—Cap Screw

Continued on next page TX,04,UU3876 –19–18SEP98–3/6

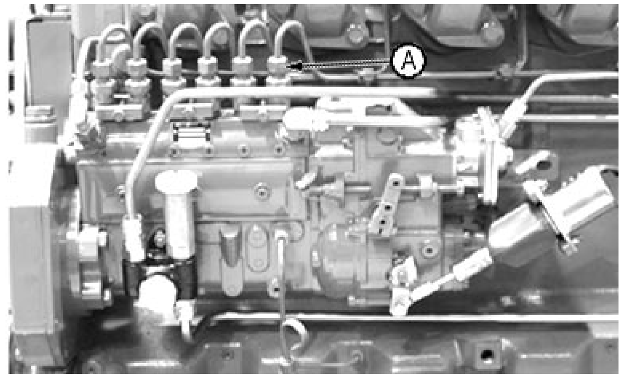
IMPORTANT: DO NOT move delivery valve fittings while tightening line nuts. If delivery valve and barrel housing rotate while tightening a fuel line nut, injection pump fuel delivery will be altered. The injection pump will have to be recalibrated on a test stand at an authorized diesel repair station.

NOTE: Remove protective caps and plugs that were installed on fuel system components during injection pump removal.

11. Connect fuel delivery lines (A). Tighten line nuts.

Fuel Delivery Line Nut—Specification

Torque .... 27 N•m (20 lb-ft)



A—Fuel Delivery Lines

TX,04,UU3876 –19–18SEP98–4/6

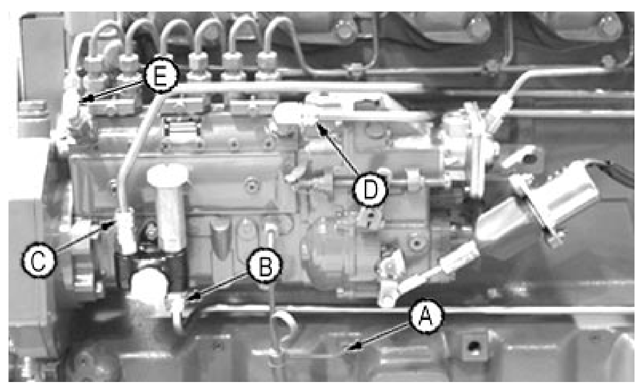
12. Connect fuel tank-to-transfer pump line (B).

13. Connect transfer pump-to-fuel filter line (C).

14. Connect fuel inlet line (D) and fuel leak-off line (E).

15. Connect injection pump lubrication line (A) to cylinder block fitting.

16. Before connecting fuel shut-off solenoid linkage, check adjustment. (See Check and Adjust Fuel Shut-Off Solenoid Linkage in Group 0515.)



A—Injection Pump Lubrication Line
B—Fuel Tank-to-Transfer Pump line
C—Transfer Pump-to-Fuel Filter Line
D—Fuel Inlet Line
E—Fuel Leak-off Line

Continued on next page

TX,04,UU3876 –19–18SEP98–5/6

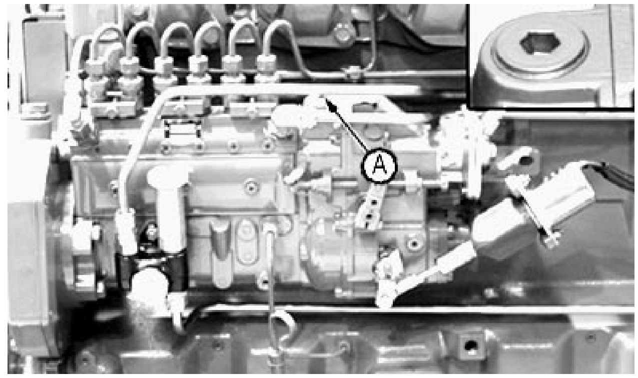
17. Remove oil fill plug (A) from governor housing and add 0.237 L (1/2 pint) of clean engine oil. Install plug.

18. Bleed fuel system. (See Bleed Fuel System in this group.)

19. Check and adjust fast and slow idle stops. (See Injection Pump Fast and Slow Idle Stops Adjustment in Group 0515.)

20. Connect engine speed control cable.

21. Do Engine Control Motor and Sensor Adjustment and then the Engine Speed Learning Procedure. (See procedures in Group 0515.)



A—Oil Fill Plug

04
0400
18

TX,04,UU3876 –19–18SEP98–6/6

BLEED FUEL SYSTEM

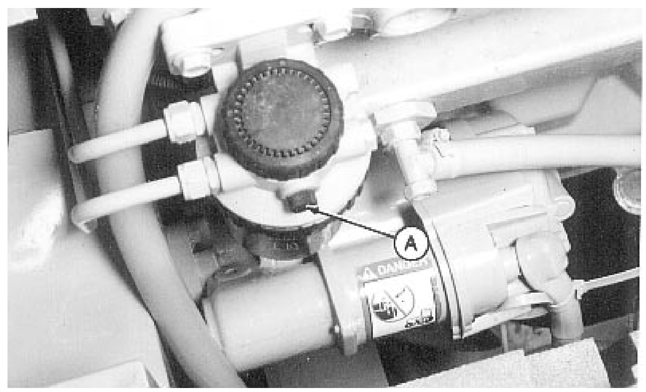
1. Open bleed screws (A) on final fuel filter and primary fuel filter (water separator).

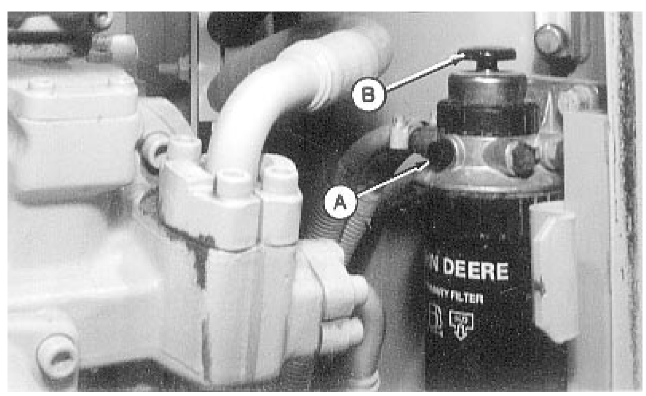
2. Operate hand primer (B) until fuel fills separator bowl and until fuel escapes from bleed screw on primary fuel filter.

3. Tighten bleed screw.

4. Operate hand primer (B) until fuel escapes from final fuel filter bleed screw.

5. Tighten final fuel filter bleed screw.



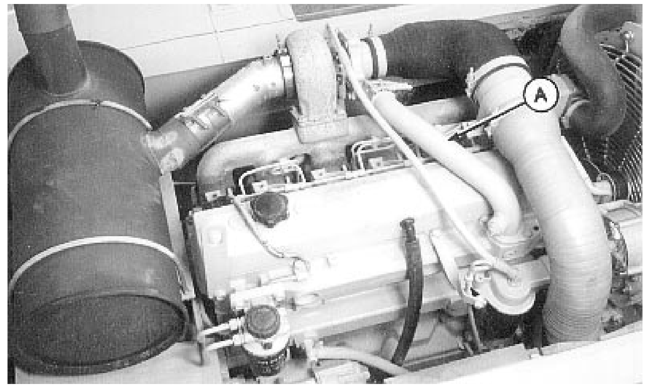


A—Bleed Screws
B—Hand Primer

TX,04,DH5310 –19–17SEP98–1/1

CLEAN THE ENGINE CRANKCASE VENTILATION TUBE

Clean the engine crankcase ventilation tube (A) when you measure and adjust engine valve clearance (lash).



A—Crankcase Ventilation Tube

TX,85,DH5151 –19–17SEP98–1/1

CHECK AND ADJUST ENGINE VALVE LASH (CLEARANCE)

CAUTION: Prevent accidental starting of engine while performing valve adjustments. Always disconnect NEGATIVE (-) battery terminal.

IMPORTANT: Valve clearance MUST BE checked and adjusted with engine COLD.

1. Remove rocker arm cover and engine crankcase ventilation tube. Clean tube with solvent or diesel fuel. Check that O-ring in rocker arm cover is in good condition.

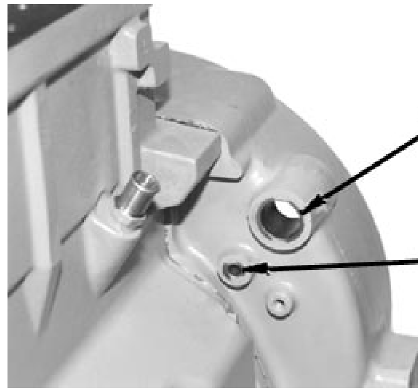
Continued on next page

TX,04,UU3877 –19–18SEP98–1/4

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

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

2. Remove plug (A). Install JDG820 Flywheel Turning Tool. Remove cap screw (B). Install JDE81-4 Timing Pin.



RG7408 –UN–06AUG96

A—Plug
B—Cap Screw

TX,04,UU3877 –19–18SEP98–2/4

3. Turn flywheel until timing pin goes into hole in flywheel.

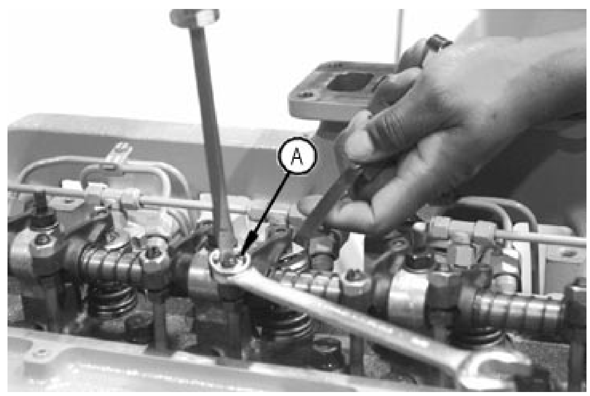
4. Using engine rotation tool, rotate engine flywheel in running direction (clockwise viewed from front) until No. 1 cylinder is at “TDC” Compression stroke.

   If No. 1 cylinder rocker arms are loose, the engine is at No. 1 “TDC” Compression. If No. 1 cylinder rocker arms are not loose, rotate engine one full revolution (360°) to No. 1 “TDC” Compression

   To change piston position, remove timing pin and rotate flywheel.

5. Check and adjust valve clearance to specifications as directed in the following procedures.

6. Loosen jam nut (A) and adjust clearance with a screwdriver, as shown.



RG7409 –UN–06AUG96

A—Jam Nut

Continued on next page

TX,04,UU3877 –19–18SEP98–3/4

7. Adjust No. 1, 3, and 5 exhaust valves and No. 1, 2, and 4 intake valves.

Exhaust Valve (E)—Specification

Clearance .... 0.46 mm (0.018 in.)

Intake Valve (I)—Specification

Clearance .... 0.36 mm (0.014 in.)

8. Rotate engine 360° and repeat Step 7 for the remaining intake and exhaust valves.

9. Tighten jam nut.

Intake and Exhaust Valve Jam Nut—Specification

Torque .... 27 N•m (20 lb-ft)

10. Clean cylinder head and rocker arm cover mating surfaces.

11. Install rocker arm cover gasket. Do not use sealant on the gasket

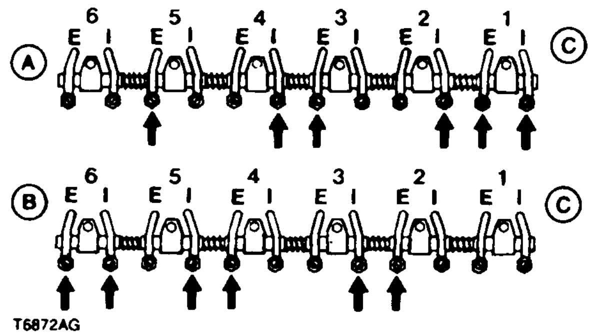
12. Install rocker arm cover. Tighten screws. Do not over tighten cap screws.

Rocker Arm Cover Cap Screw—Specification

Torque .... 10.8 N•m (96 lb-in.)

13. Remove turning tool and timing pin.

14. Install parts. Center muffler to turbocharger inlet tube before fastening muffler into place.



T6872AG –UN–18MAY94

A—No. 1 TDC Compression Stroke
B—No. 1 TDC Exhaust Stroke
C—Fan End of Engine

04
0400
21

TX,04,UU3877 –19–18SEP98–4/4

FIRING ORDER, 6-CYLINDER ENGINE:

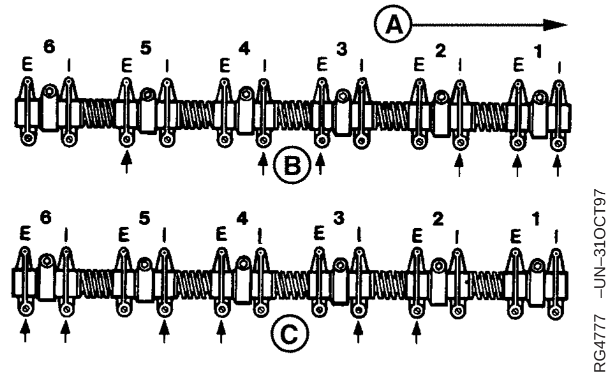
NOTE: Firing order is 1-5-3-6-2-4.

Lock No. 1 piston at TDC Compression stroke (B).

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

Turn crankshaft 360°. Lock No. 6 piston is at TDC Compression stroke (C).

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



A—Fan End of Engine
B—No. 1 TDC Compression Stroke
C—No. 6 TDC Compression Stroke

TX,85,DH5134 –19–17SEP98–1/1

REMOVE AND INSTALL STARTER

IMPORTANT: Always disconnect the negative (-) battery cables before removing starter or a short circuit could result.

1. Disconnect negative (-) battery cables at battery.
2. Remove nut (A) to disconnect positive battery cable.
3. Remove nut (B) to disconnect negative (ground) cable.
4. Disconnect solenoid connector (C).

CAUTION: The approximate weight of starter is 23 kg (50 lb).

Starter—Specification

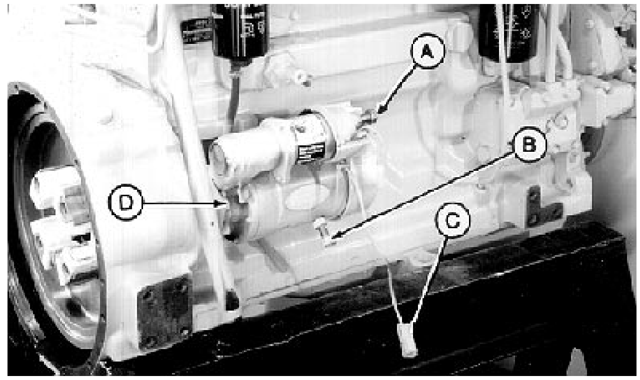
Weight.. 23 kg (50 lb) approximate

5. Remove cap screws and lock washers (D). Remove starter.
6. Replace parts as necessary.
7. Install starter.
8. Tighten cap screws.

Starter Mounting Flange-to-Flywheel Housing Cap Screw—Specification

Torque .... 47 N•m (35 lb-ft)

9. Connect solenoid connector.
10. Connect positive battery cable.
11. Connect negative cable.
12. Connect negative battery cables at battery.



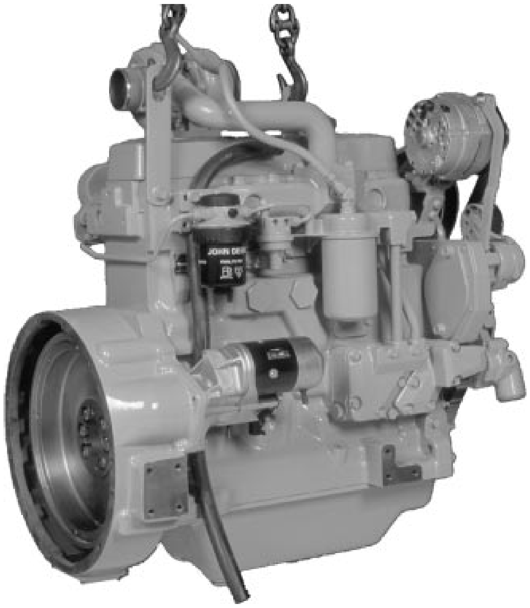
T104596 –UN–23OCT96

A—Nut
B—Nut
C—Solenoid Connector
D—Cap Screw and Lock Washer (3 used)

04
0400
23

TX,04,UU3878 –19–18SEP98–1/1

POWERTECH® 4.5 L ENGINE

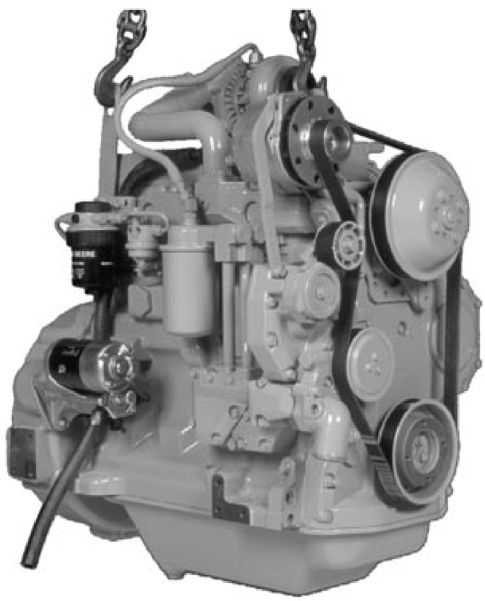


RG7636 –UN–23NOV97

3/4 Right Rear View

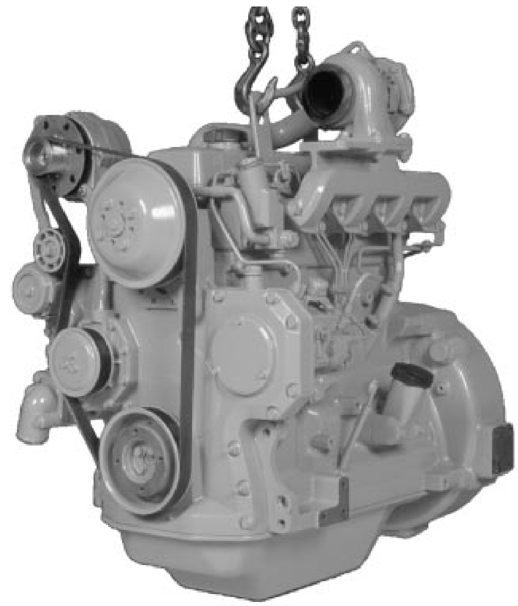
RG7638 –UN–23NOV97

3/4 Left Rear View



RG7639 –UN–23NOV97

3/4 Right Front View



RG7637 –UN–23NOV97

3/4 Left Front View

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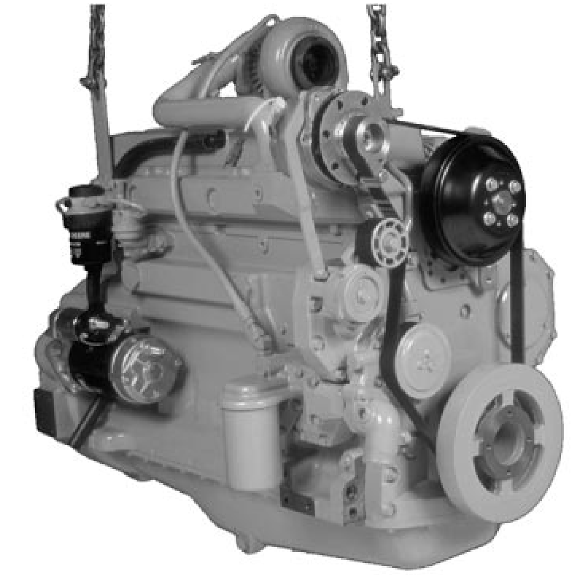
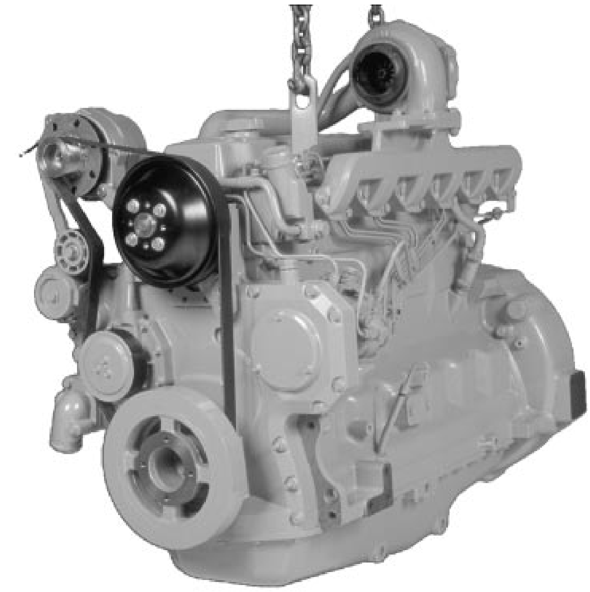
DPSG,OUO1004,129 –19–15MAY98–1/1

POWERTECH® 6.8 L ENGINE



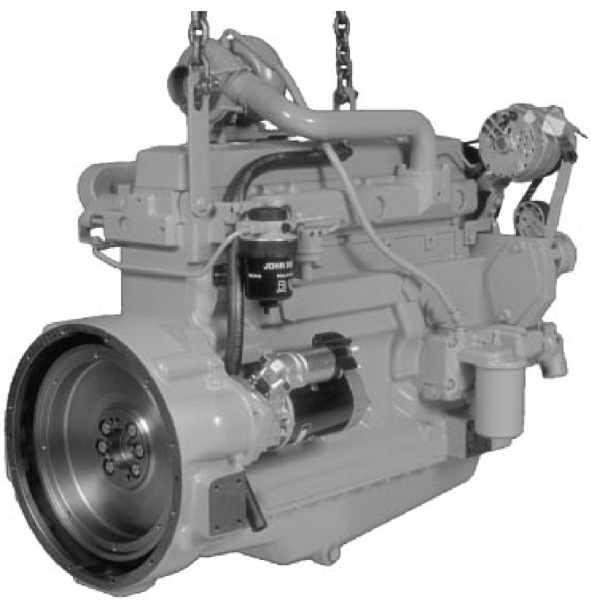
RG7641 –UN–23NOV97

3/4 Right Front View



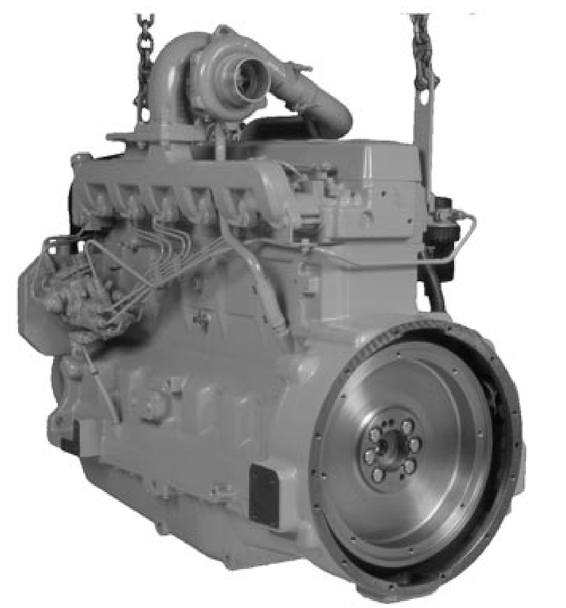
RG7640 –UN–23NOV97

3/4 Left Front View



RG7643 –UN–23NOV97

3/4 Right Rear View



RG7642 –UN–23NOV97

3/4 Left Rear View

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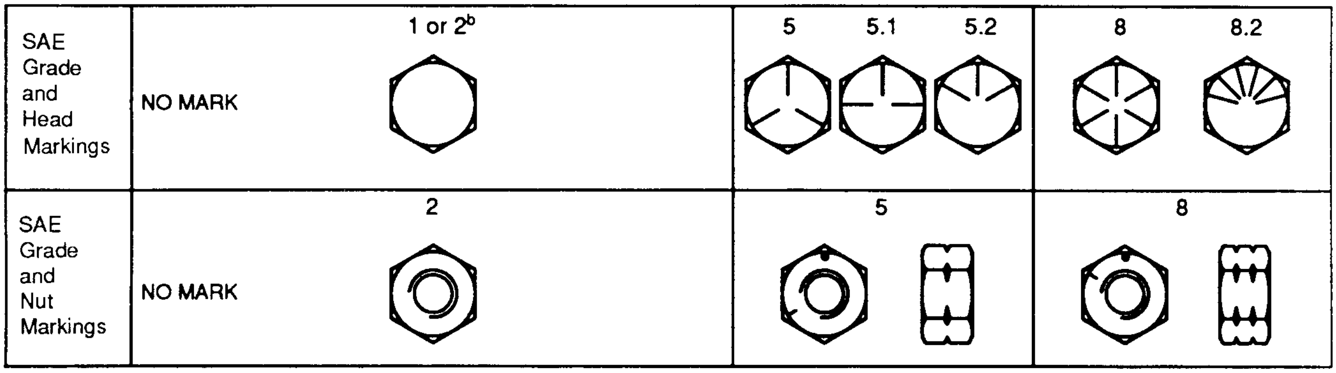
DPSG,OUO1004,130 –19–15MAY98–1/1

UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES



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

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

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

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

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

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

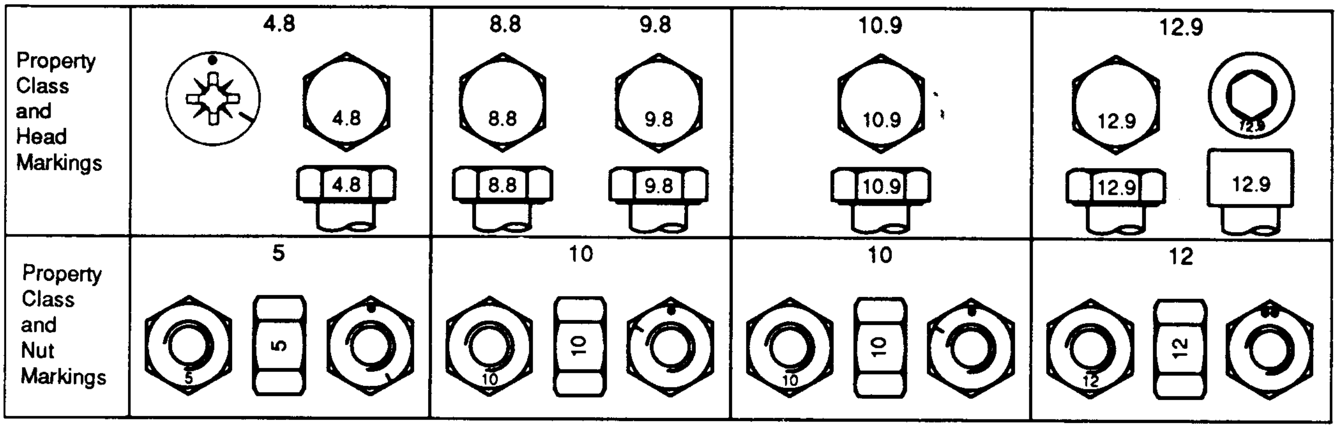
Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

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

TS1656 –19–02APR97

DX,TORQ1 –19–20JUL94–1/1

METRIC BOLT AND CAP SCREW TORQUE VALUES



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

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

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

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

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

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

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

TS1657 –19–02APR97

DX,TORQ2 –19–20JUL94–1/1

ENGINE MODEL DESIGNATION

John Deere Engine Model—4045 and 6068 Engines

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

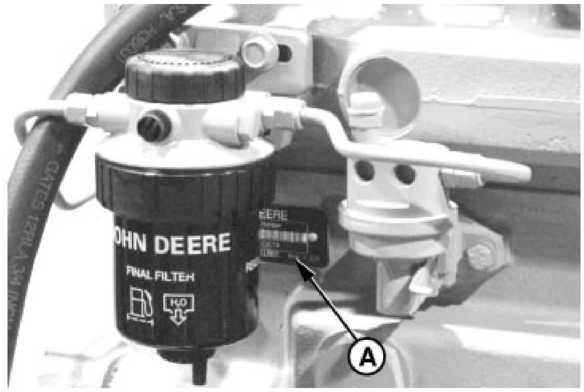
4045TF150 Engine	
4	Number of cylinders
4.5	Liter displacement
T	Aspiration code
F	User code
1	Internal engine configuration type
50	PowerTech® application code
Aspiration Code	
D	Naturally aspirated
T	Turbocharged and Air-to-Coolant Aftercooled
H	Turbocharged and Air-to-Air Aftercooled
User Factory Code	
AP	Saltillo (Mexico)
CQ	S.L.C. Horizontina (Brazil)
DW	John Deere Davenport Works
E	John Deere Ottumwa Works
F	OEM (Outside Equipment Manufacturers)
FF	Kernersville Deere-Hitachi (North Carolina)
H	John Deere Harvester Works
KV	John Deere Knoxville (Tennesee)
L	John Deere WERKE Mannheim (Germany)
LV	John Deere Augusta, Georgia
N	John Deere DesMoines Works
P	Monterrey (Mexico)
RW	John Deere Waterloo Tractor Works
T	John Deere Dubuque Works
Z	John Deere WERKE Zweibrucken (Germany)
Model Designation	
1 or 2	Indicates different internal engine components
Application Code	
50 or above	PowerTech® code for specific application

PowerTech is a trademark of Deere & Company.

RG,01,DT7028 –19–29OCT97–1/1

ENGINE SERIAL NUMBER PLATE INFORMATION

IMPORTANT: The engine serial number plate (A) can be easily destroyed. Before "hot tank" cleaning the block, remove the plate.

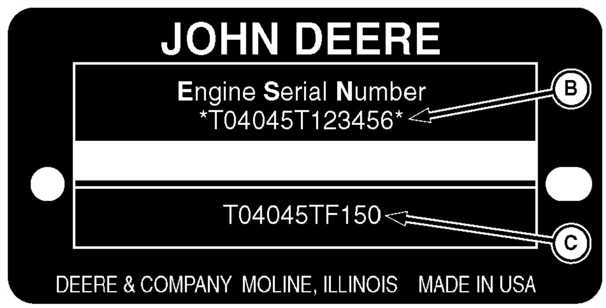


RG7778 –UN–11NOV97

Engine Serial Number (B)

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

T04045T000000	
T0	Factory producing engine
4045T	Engine model designation
000000	Sequential serial number
Factory Code (Manufacturer)	
T0	Dubuque, Iowa
CD	Saran, France
PE	Torreon, Mexico
Engine Model Designation	
4045T	Definition explained previously. (See ENGINE MODEL DESIGNATION earlier in this group.
Sequential Number	
000000	6-digit sequential serial number

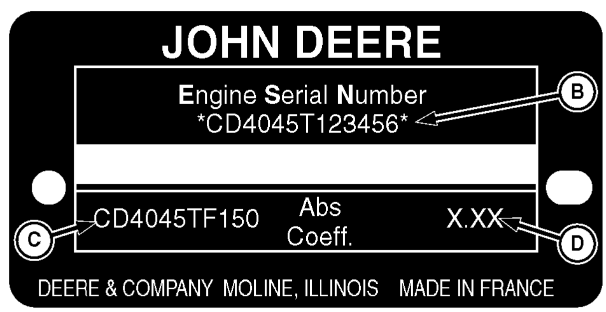


RG9060 –UN–16MAR98

Dubuque Engine Serial Number Plate

Engine Application Data (C)

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



RG9061 –UN–16MAR98

Saran Engine Serial Number Plate

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

The second line of information on Saran serial number plate also contains the coefficient of absorption value for smoke emissions.

RG9062 –UN–16MAR98

Torreon Engine Serial Number Plate

A—Engine Serial Number Plate
B—Engine Serial Number
C—Engine Application Data
D—Coefficient of Absorption (Saran Engines Only)

RG,01,DT7029 –19–29OCT97–1/1

GENERAL OEM ENGINE SPECIFICATIONS

ITEM	ENGINE								
	4045DF150	4045TF150	4045TF250	4045HF150	6068DF150	6068TF150	6068TF250	6068HF150	6068HF250
Number of Cylinders	4	4	4	4	6	6	6	6	6
Bore	106 mm (4.19 in.)	106 mm (4.19 in.)	106 mm (4.19 in.)	106 mm (4.19 in.)	106 mm (4.19 in.)	106 mm (4.19 in.)	106 mm (4.19 in.)	106 mm (4.19 in.)	106 mm (4.19 in.)
Stroke	127 mm (5.0 in.)	127 mm (5.0 in.)	127 mm (5.0 in.)	127 mm (5.0 in.)	127 mm (5.0 in.)	127 mm (5.0 in.)	127 mm (5.0 in.)	127 mm (5.0 in.)	127 mm (5.0 in.)
Displacement	4.5 L (276 cu in.)	4.5 L (276 cu in.)	4.5 L (276 cu in.)	4.5 L (276 cu in.)	6.8 L (414 cu in.)	6.8 L (414 cu in.)	6.8 L (414 cu in.)	6.8 L (414 cu in.)	6.8 L (414 cu in.)
Compression	17.6:1	17.0:1	17.0:1	17.0:1	17.6:1	17.0:1	17.0:1	17.0:1	17.0:1
Max. Crank Pressure	0.5 kPa (2 H_2O)	0.5 kPa (2 H_2O)	0.5 kPa (2 H_2O)	0.5 kPa (2 H_2O)	0.5 kPa (2 H_2O)	0.5 kPa (2 H_2O)	0.5 kPa (2 H_2O)	0.5 kPa (2 H_2O)	0.5 kPa (2 H_2O)
Governor Regulation (Industrial)	7—10 %	7—10 %	7—10 %	7—10 %	7—10 %	7—10 %	7—10 %	7—10 %	7—10 %
Governor Regulation (Generator)	5 %	5 %	5 %	5 %	5 %	5 %	5 %	5 %	5 %
Oil Pressure Rated Speed	345 kPa (50 psi)	345 kPa (50 psi)	345 kPa (50 psi)	345 kPa (50 psi)	345 kPa (50 psi)	345 kPa (50 psi)	345 kPa (50 psi)	345 kPa (50 psi)	345 kPa (50 psi)
Oil Pressure Low Idle	105 kPa (15 psi)	105 kPa (15 psi)	105 kPa (15 psi)	105 kPa (15 psi)	105 kPa (15 psi)	105 kPa (15 psi)	105 kPa (15 psi)	105 kPa (15 psi)	105 kPa (15 psi)
Length	861.0 mm (33.9 in.)	861.0 mm (33.9 in.)	861.0 mm (33.9 in.)	861.0 mm (33.9 in.)	1117 mm (44.0 in.)	1117 mm (44.0 in.)	1117 mm (44.0 in.)	1116 mm (43.9 in.)	1141 mm (44.9 in.)
Width	598 mm (23.5 in.)	598 mm (23.5 in.)	598 mm (23.5 in.)	598 mm (23.5 in.)	598 mm (23.5 in.)	598 mm (23.5 in.)	598 mm (23.5 in.)	623 mm (24.5 in.)	623 mm (24.5 in.)
Height	854 mm (33.6 in.)	980 mm (38.6 in.)	980 mm (38.6 in.)	980 mm (38.6 in.)	956 mm (37.6 in.)	984 mm (38.7 in.)	984 mm (38.7 in.)	1009 mm (39.7 in.)	1009 mm (39.7 in.)
Weight	387 kg (851 lb)	396 kg (872 lb)	396 kg (872 lb)	396 kg (872 lb)	522 kg (1149 lb)	533 kg (1172 lb)	533 kg (1172 lb)	550 kg (1210 lb)	568 kg (1250 lb)

DPSG,OUO1004,102 –19–28APR98–1/1

Group 02
Fuels, Lubricants and Coolant

DIESEL FUEL

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

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

Diesel fuels specified to A-A-52557, EN 590 or ASTM D975 are recommended.

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

- **Cetane Number of 40 minimum.** Cetane number greater than 50 is preferred, especially for temperatures below —20° C (—4° F) or elevations above 1500 m (5000 ft).
- **Cold Filter Plugging Point (CFPP)** below the expected low temperature OR Cloud Point at least 5° C (9° F) below the expected low temperature.
- **Fuel Lubricity** should pass a minimum of 3100 gram load level as measured by the SL BOCLE scuffing test.
- **Sulfur Content**
  - Sulfur content should not exceed 0.5%. Sulfur content less than 0.05% is preferred.
  - If diesel fuel with sulfur content greater than 0.5% sulfur content is used, reduce the service interval for engine oil and filter by 50%.
  - DO NOT use diesel fuel with sulfur content greater than 1.0%.

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

DO NOT mix used engine oil or any other type of lubricant with diesel fuel.

RG,02,DT7324 –19–10NOV97–1/1

LUBRICITY OF DIESEL FUELS

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

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

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

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

Fuel lubricity should pass a minimum of 3100 gram load level as measured by the SL BOCLE scuffing test.

A-A-52557, ASTM D975 and EN 590 specifications do not require fuels to pass a fuel lubricity test.

If fuel of low or unknown lubricity is used, add John Deere PREMIUM DIESEL FUEL CONDITIONER or Inhibitor, Corrosion/Lubricity Improver, Fuel Soluble (MIL-PRF-25017) at the recommended concentration. John Deere PREMIUM DIESEL FUEL CONDITIONER is available in winter and summer formulas. Consult your John Deere engine distributor or servicing dealer for more information.

RG,02,DT7325 –19–10NOV97–1/1

ENGINE BREAK-IN OIL

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

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

After engine overhaul, fill the engine with John Deere ENGINE BREAK-IN OIL or oil meeting MIL-PRF-21260.

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

- API Service Classification CE
- ACEA Specification E1
- MIL-PRF-21260

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

IMPORTANT: Do not use John Deere PLUS-50® oil or engine oils meeting API CG4, API CF4, ACEA E3, or ACEA E2 performance levels during the first 100 hours of operation of a new or rebuilt engine. These oils will not allow the engine to break-in properly.

PLUS-50 is a trademark of Deere & Company.

RG,02,DT7326 –19–10NOV97–1/1

DIESEL ENGINE OIL

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

John Deere PLUS-50® engine oil is preferred.

If John Deere PLUS-50® engine oil and a John Deere oil filter are used, the service interval for oil and filter changes may be extended by 50 %. If other than PLUS-50® oil and the specified John Deere filter are used, change the engine oil and filter at the normal service interval.

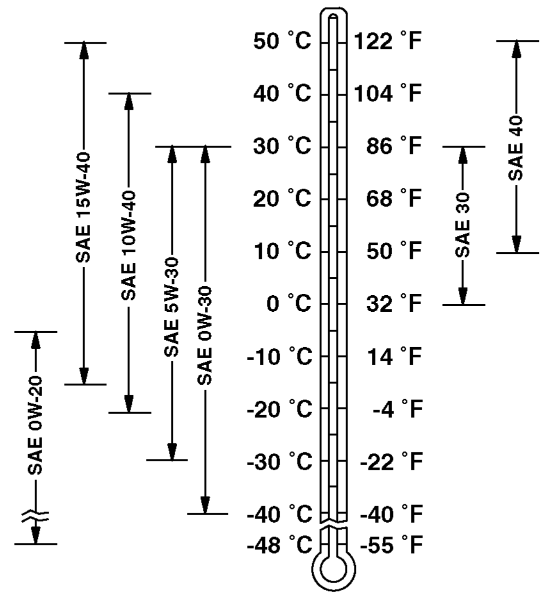
John Deere TORQ-GARD SUPREME® oil is also recommended.

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

- API Service Classification CG-4
- API Service Classification CF-4
- ACEA Specification E3
- ACEA Specification E2
- MIL-PRF-2104G
- MIL-PRF-46167C

Multi-viscosity diesel engine oils are preferred.

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



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PLUS-50 is a trademark of Deere & Company.
TORQ-GARD SUPREME is a trademark of Deere & Company.

DX,ENOIL –19–18MAR96–1/1

02
4

ALTERNATIVE AND SYNTHETIC LUBRICANTS

Conditions in certain geographical areas may require lubricant recommendations different from those printed in this manual.

Some John Deere brand coolants and lubricants may not be available in your location.

Consult your John Deere dealer to obtain information and recommendations.

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

The temperature limits and service intervals shown in this manual apply to both conventional and synthetic oils.

Re-refined base stock products may be used if the finished lubricant meets the performance requirements.

DX,ALTER –19–18MAR96–1/1

MIXING OF LUBRICANTS

In general, avoid mixing different types of oils. Oil manufacturers blend additives in their oils to meet certain specifications and performance requirements.

Mixing different types of oils can interfere with the proper functioning of these additives and degrade lubricant performance.

Consult your John Deere dealer to obtain specific information and recommendations.

DX,LUBMIX –19–18MAR96–1/1

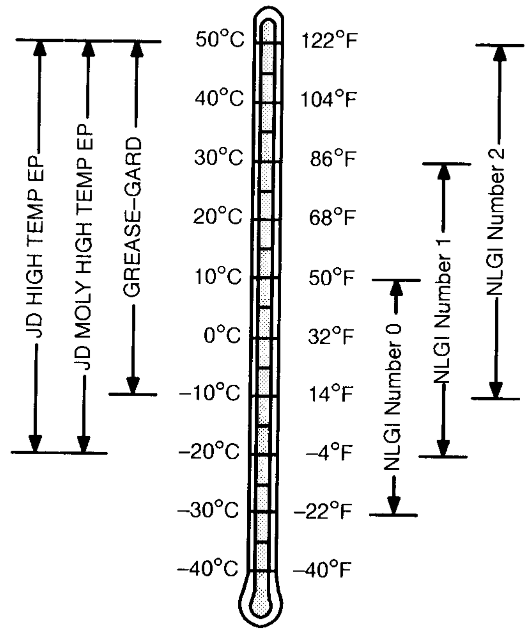
GREASE

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

The following greases are preferred:

- MIL-PRF-10924
- John Deere HIGH TEMPERATURE EP GREASE
- John Deere MOLY HIGH TEMPERATURE EP GREASE
- John Deere GREASE-GARD™

Other greases may be used if they meet NLGI Performance Classification GC-LB.



TS1654 –UN–14MAR96

GREASE-GARD is a trademark of Deere & Company.

DX,GREA1 –19–18MAR96–1/1

DIESEL ENGINE COOLANT RECOMMENDATIONS

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

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

The following engine coolant is preferred for service:

- CID A-A-52624 Type 1 is a fully formulated ethylene glycol-based engine coolant concentrate.
- CID A-A-52624 Type 1P is a pre diluted (60% by vol. Glycol) fully formulated ethylene glycol based engine coolant.
- CID A-A-52624 Type 11 is a fully formulated propylene glycol based engine coolant concentrate.
- CID A-A-52624 Type 1 and Type 11 require dilution with water before use.
- CID A-A-52624 Type 1P is ready to use as packaged.
- John Deere PREDILUTED ANTIFREEZE/SUMMER COOLANT
- John Deere COOL-GARD™, where available.

John Deere ANTIFREEZE/SUMMER COOLANT CONCENTRATE in a 40 to 60 percent mixture of concentrate with quality water is also recommended.

JOHN DEERE PREDILUTED ANTIFREEZE/SUMMER COOLANT

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

John Deere Prediluted Antifreeze/Summer Coolant permits extended service life to 36 months or 75,000 miles of operation.

JOHN DEERE COOL-GARD™

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

John Deere COOL-GARD™has a service life of 2000 hours or 24 months of operation.

JOHN DEERE ANTIFREEZE/SUMMER COOLANT CONCENTRATE

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

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

COOL-GARD is a trademark of Deere & Company.

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John Deere Antifreeze/Summer Coolant Concentrate has a service life of 24 months or 50,000 miles of operation.

RG,02,JW7721 –19–01DEC97–2/2

ENGINE COOLANT SPECIFICATIONS

Engine coolants are a combination of three chemical components: ethylene glycol (antifreeze), inhibiting coolant additives, and quality water.

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

Some products, including John Deere PREDILUTED ANTIFREEZE/SUMMER COOLANT and CID A-A-52624, are fully formulated coolants that contain all three components in their correct concentrations. Do not add an initial charge of supplemental coolant additives to these fully formulated products.

Some coolant concentrates, including John Deere ANTIFREEZE/SUMMER COOLANT CONCENTRATE and CID A-A-52624 Type I, contain both ethylene glycol antifreeze and inhibiting coolant additives. Mix these products and quality water, but do not add an initial charge of supplemental coolants additives.

Coolants meeting ASTM D6210 (prediluted coolant) or ASTM D6211 (coolant concentrate) require an initial charge of supplemental coolant additives.

Water Quality:

Water quality is important to the performance of the cooling system. Distilled, deionized, or demineralized water is recommended for mixing with ethylene glycol base engine coolant concentrate. All water used in the cooling system should meet the following minimum specifications for quality:

Water Quality Specifications

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

Ethylene Glycol Concentrate (Antifreeze):

IMPORTANT: Do not use cooling system sealing additives or antifreeze that contains sealing additives.

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

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

- ASTM D5345 (prediluted coolant)
- ASTM D4985 (coolant concentrate) in a 40% to 60% mixture of concentrate with quality water.
- ASTM D6210
- ASTM D6211

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

Continued on next page

RG,02,DT7036 –19–29OCT97–1/3

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

Supplemental Coolant Additives (SCAs):

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

NOTE: John Deere Prediluted Antifreeze/Summer Coolant, John Deere Antifreeze/Summer Coolant Concentrate or equivalent supplemental coolant additives are recommended. As the coolant solution loses its effectiveness, additives will need to be added.

Operating without proper coolant additive will result in increased corrosion, cylinder liner erosion and pitting, and other damage to the engine and cooling system. A simple mixture of ethylene glycol and water WILL NOT give adequate protection.

The use of supplemental coolant additives reduces corrosion, erosion, and pitting. These chemicals reduce the number of vapor bubbles in the coolant and help form a protective film on cylinder liner surfaces. This film acts as a barrier against the harmful effects of collapsing vapor bubbles.

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

RG7276 –UN–05DEC97

John Deere Liquid Coolant Conditioner

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IMPORTANT: Check inhibitors between drain intervals every 6 months or 30,000 miles at low speed operation service interval or 12 months or 25,000 miles at normal operation service interval. Replenish inhibitors by the addition of a supplemental coolant additive as necessary.

DO NOT use soluble oil.

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

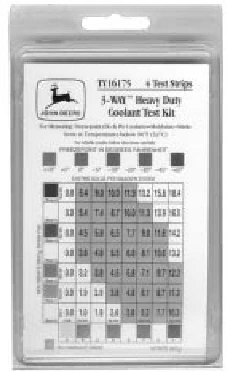
RG,02,DT7036 –19–29OCT97–3/3

02
10

TESTING DIESEL ENGINE COOLANT

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

Test the coolant solution at 6 month/15,000 mile low speed operation or 12 month/25,000 mile normal operation intervals and whenever excessive coolant is lost through leaks or overheating to ensure the necessary protection.



RG7297 –UN–22SEP99

COOLANT TEST STRIPS

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

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

RG7397 –UN–05DEC97

COOLSCAN™

For a more thorough evaluation of your coolant, perform a CoolScan™ analysis. See your engine servicing dealer for information about CoolScan™.

CoolScan is a trademark of Deere & Company.

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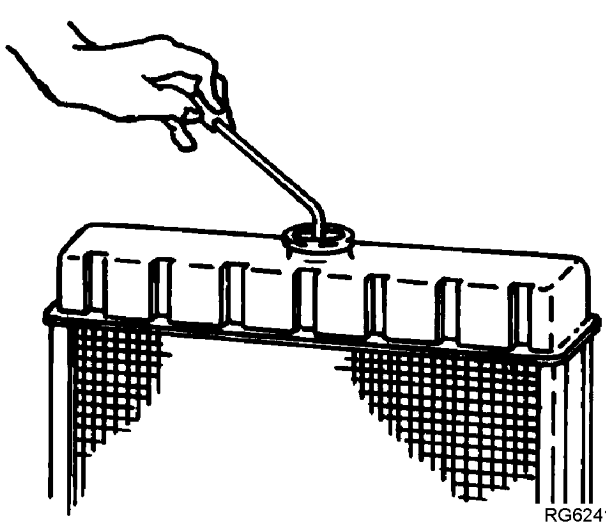
REPLENISHING SUPPLEMENTAL COOLANT ADDITIVES (SCA'S) BETWEEN COOLANT CHANGES



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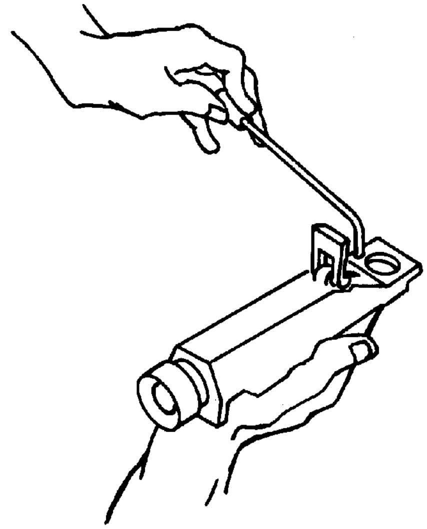

RG6262 RG6262 –UN–05DEC97

IMPORTANT: Do not add supplemental coolant additives when the cooling system is drained and refilled with John Deere ANTIFREEZE/SUMMER COOLANT or John Deere COOL-GARD™.

NOTE: If a system is to be filled with coolant that does not contain SCA's, the coolant must be precharged. Determine the total system capacity and premix with 3 % John Deere Coolant Conditioner.

Through time and use, the concentration of coolant additives is gradually depleted during engine operation. Periodic replenishment of inhibitors is required, even when John Deere ANTIFREEZE/SUMMER COOLANT is used. The cooling system must be recharged with additional supplemental coolant additives available in the form of liquid coolant conditioner.

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

John Deere LIQUID COOLANT CONDITIONER is recommended as a supplemental coolant additive in John Deere engines.

Do Not mix one brand of SCA with a different brand.

Test the coolant solution at 6 months or 15,000 miles at low speed operation service interval or 12 months or 25,000 miles at normal operation service interval using either John Deere coolant test strips or a CoolScan™ analysis. If a CoolScan™ analysis is not available, recharge system per instructions printed on label of John Deere Liquid Coolant Conditioner.

COOL-GARD is a trademark of Deere & Company.
CoolScan is a trademark of Deere & Company.

Continued on next page

02
12

IMPORTANT: ALWAYS maintain coolant at correct level and concentration. DO NOT operate engine without coolant for even a few minutes.

If frequent coolant makeup is required, the glycol concentration should be checked with JT05460 Refractometer to assure that the desired freeze point is maintained. Follow manufacturer's instructions provided with refractometer.

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

The use of non-recommended supplemental coolant additives may result in additive drop-out and gelation of the coolant.

If other coolants are used, consult the coolant supplier and follow the manufacturer's recommendation for use of supplemental coolant additives.

See ENGINE COOLANT SPECIFICATIONS earlier in this group for proper mixing of coolant ingredients before adding to the cooling system.

RG,01,DT7035 –19–29OCT97–2/2

OPERATING IN WARM TEMPERATURE CLIMATES

John Deere engines are designed to operate using glycol base engine coolants.

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

IMPORTANT: Water may be used as coolant *in emergency situations only*.

Foaming, hot surface aluminum and iron corrosion, scaling, and cavitation will occur when water is used as the coolant, even when coolant conditioners are added.

Drain cooling system and refill with recommended glycol base engine coolant as soon as possible.

RG,01,DT7034 –19–29OCT97–1/1

FLUSH AND SERVICE COOLING SYSTEM

TS281 –UN–23AUG88

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

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

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

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

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

FLEETGUARD is a registered trademark of the Cummins Engine Company.
RESTORE is a registered trademark of FLEETGUARD.
RESTORE PLUS is a registered trademark of FLEETGUARD.

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RG,01,DT7033 –19–29OCT97–1/2

02
14

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

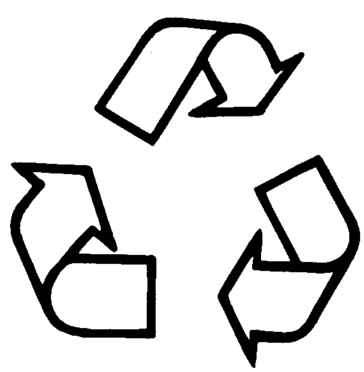
Air must be expelled from cooling system when system is refilled. Loosen plug in side of thermostat housing to allow air to escape when filling system. Retighten plug when all the air has been expelled.

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

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

RG,01,DT7033 –19–29OCT97–2/2

DISPOSING OF COOLANT



TS1133 –UN–26NOV90

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

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

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

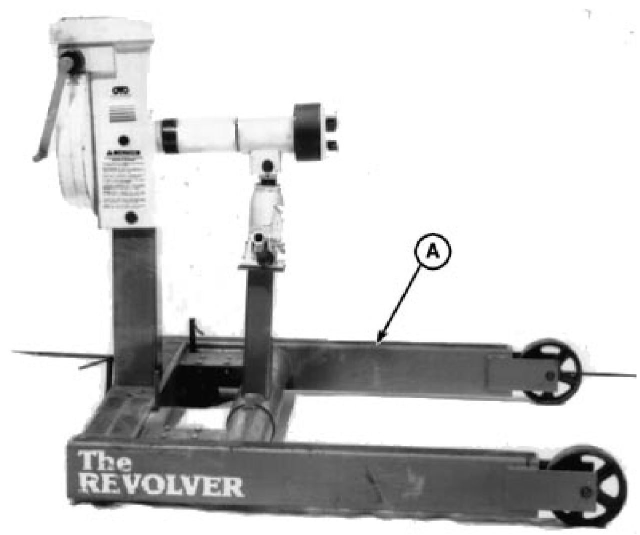
Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your engine servicing dealer.

RG,01,DT7032 –19–29OCT97–1/1

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.

Refer to machine technical manual for steps to remove engine from machine.



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RG,01,DT7044 –19–29OCT97–1/1

03
2

SAFETY PRECAUTIONS

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

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

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

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

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

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

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

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

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

LOCTITE is a registered trademark of the Loctite Corp.

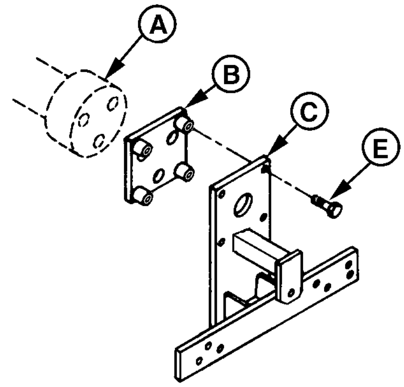
RG,01,DT7050 –19–29OCT97–1/1

03
3

INSTALL ADAPTERS ON ENGINE REPAIR STAND

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

2. Attach the 62835[1] Engine Adapter (C) to the special adapter, using four 5/8—11 x 2 in. SAE Grade 8 cap screws (E). Tighten screws to 135 N•m (100 lb-ft).



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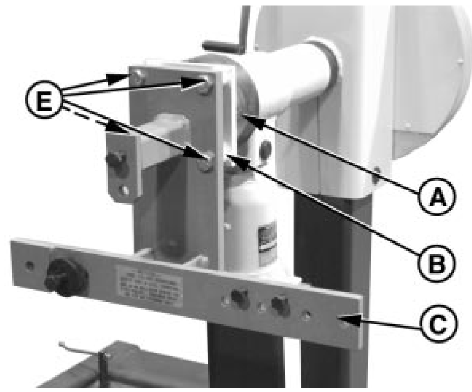

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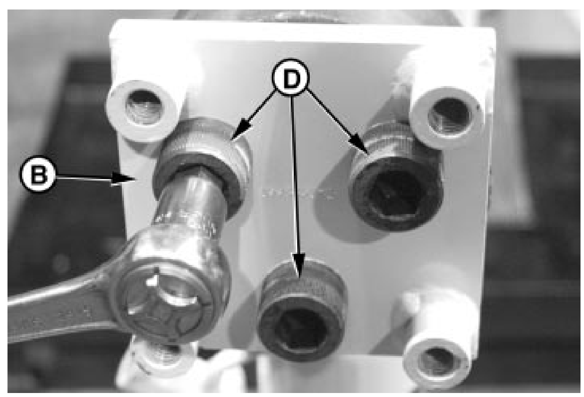

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A—Mounting Hub
B—D05226ST Special Adapter
C—62835 Engine Adapter
D—Cap Screws
E—Cap Screws

[1]*Part of JT07268 Engine Adapter Kit*

RG,01,DT7049 –19–29OCT97–1/1

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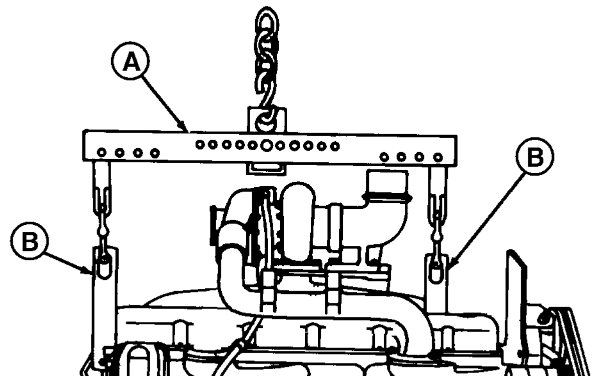
ENGINE LIFTING PROCEDURE



CAUTION: The only recommended method for lifting the engine is with JDG23 Engine Lifting Sling and safety approved lifting straps that come with engine. Use extreme caution when lifting and NEVER permit any part of the body to be positioned under an engine being lifted or suspended.

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

1. Attach 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 network or made locally. Use of an engine lifting sling (as shown) is the ONLY APPROVED 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 and slowly lower to desired location.

RG,03,JW7723 –19–01DEC97–1/1

03
5

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.

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03
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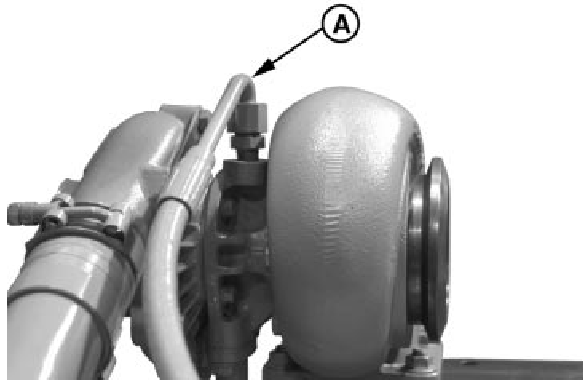
DISCONNECT TURBOCHARGER OIL INLET LINE



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

IMPORTANT: When servicing turbocharged engines on a rollover stand, disconnect turbocharger oil inlet line (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 turbocharger or oil filter housing.

RG,01,DT7046 –19–29OCT97–1/1

MOUNT ENGINE ON REPAIR STAND

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

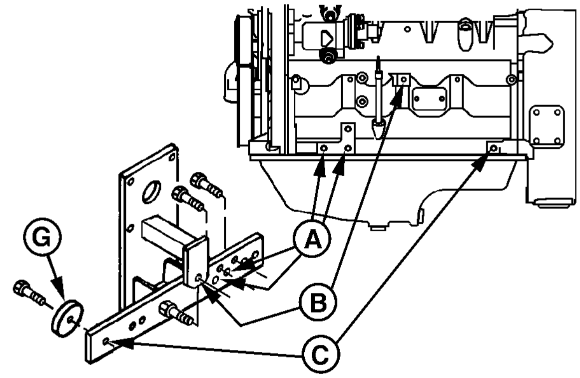
On engines equipped with a low-profile turbocharger, remove turbocharger before attaching engine to repair stand.

On engines with a left-hand oil fill tube, remove tube before mounting engine to repair stand.

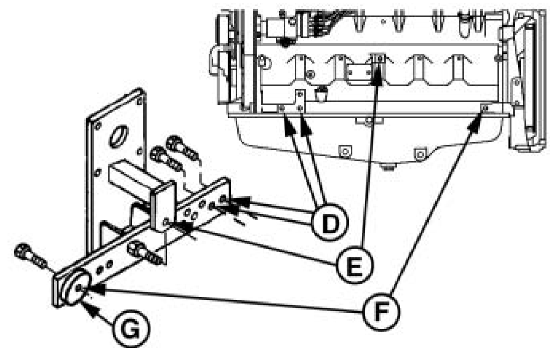
NOTE: See next module for illustration of an engine that has been mounted on repair stand.

Mount the engine to 62835[1] Engine Adapter as described below. A label (H) is affixed to the engine adapter for aid in explaining spacer used for each engine model.

NOTE: No. 221668[1] Spacer (G) is used on the outside of the engine adapter for the 4045 Engines and on the inside (next to engine) on 6068 Engines.



4045 Engine



6068 Engine

4045 Engines

Hole A—(2) No. 214490[1] (M12 x 1.75 x 35 mm)

Hole B—(1) No. 221664[1] (M14 x 2.00 x 35 mm)

Hole C—(1) No. 221665[1] (M14 x 2.00 x 60 mm) with No. 221668[1] Spacer

6068 Engines

Hole D— (2) No. 214490[1] (M12 x 1.75 x 35 mm)

Hole E—(1) No. 221664[1] (M14 x 2.00 x 35 mm)

[1]*Part of JT07268 Engine Adapter Kit*

Continued on next page

03
8

Hole F— (1) No. 221665[1] (M14 x 2.00 x 60 mm) with No. 221668[1] Spacer

NOTE: Four threaded holes in engine mounting adapter are for storing mounting hardware.

Engine Repair Stand M12 Cap Screws—Specification

Torque .... 140 N•m (105 lb-ft)

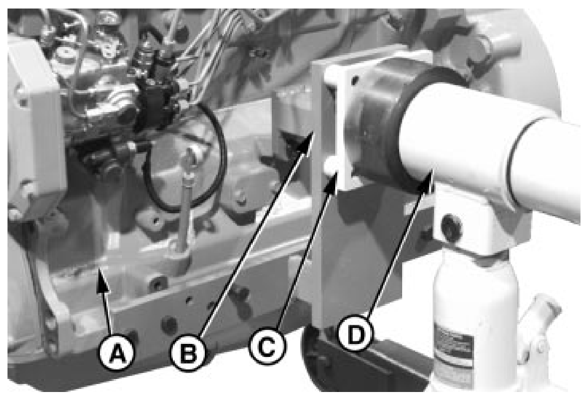
Engine Repair Stand M14 Cap Screws—Specification

Torque .... 225 N•m (165 lb-ft)

[1]*Part of JT07268 Engine Adapter Kit*

RG,03,JW7724 –19–01DEC97–2/2

ENGINE MOUNTED ON REPAIR STAND



6068 Engine

A—Engine
B—62835 Engine Adapter
C—D05226ST Special Adapter
D—Engine Repair Stand

RG,03,DT7334 –19–11NOV97–1/1

ENGINE DISASSEMBLY SEQUENCE

The following sequence is suggested when complete disassembly for overhaul is required. Refer to the appropriate repair group for removal, inspection and repair of individual engine components.

1. Mount engine on a safety approved repair stand. (Group 03)
2. Drain coolant and oil. Perform John Deere OILSCAN® and CoolScan™ analysis. (Group 02)
3. Remove fan belts, fan, and belt tensioner. (Group 25)
4. Remove alternator. (Group 40)
5. Remove turbocharger (if equipped) and exhaust manifold. (Group 30)
6. Remove rocker arm cover and vent tube. If option code label is located on rocker arm cover, be careful not to damage label. (Group 05)
7. On applications where the water manifold is not an integral part of cylinder head, remove water manifold or thermostat housing. (Group 25)
8. Remove oil cooler piping and water pump. (Groups 20 and 25)
9. Remove dipstick, oil filter, oil cooler, and adapter housing (if equipped). (Group 20)
10. Remove oil pressure regulating valve assembly. (Group 20)
11. Remove fuel filter, fuel supply pump, and fuel line. (Group 35)
12. Remove injection lines, injection pump, and injection nozzles. (Group 35)
13. Remove starting motor. (Group 40)
14. Remove rocker arm assembly and push rods. Keep rods in order (Group 05). Check for bent push rods and condition of wear pad contact surfaces on rockers.
15. Remove cylinder head. Check piston protrusion. (Groups 05 and 10).
16. Remove cam followers. Keep followers in order. (Groups 05 and 16)
17. Remove flywheel and flywheel housing. (Group 15)
18. Remove oil pan. (Group 20)
19. Remove crankshaft pulley. (Group 15)
20. Remove timing gear cover. (Group 16)
21. Remove oil pump drive gear, outlet tube, and pump body. (Group 20)
22. Remove timing gears and camshaft. Perform wear checks. (Group 16)
23. Remove balancer shafts (4045 engines). (Group 16)
24. Remove engine front plate. (Group 16)
25. Remove oil by-pass valve. (Group 20)
26. Stamp cylinder number on connecting rod. Remove pistons and rods. Perform wear checks with PLASTIGAGE®. (Group 10)

OILSCAN is a registered trademark of Deere & Company.
CoolScan is a trademark of Deere & Company.
PLASTIGAGE is a registered trademark of the DANA Corp.

Continued on next page

RG,04,JW7725 –19–01DEC97–1/2

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

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

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

30. Remove balancer shaft bushings (4045 engines) and camshaft bushing. (Group 16)

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

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

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

PLASTIGAGE is a registered trademark of the DANA Corp.

RG,04,JW7725 –19–01DEC97–2/2

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 Natural Gas Engine to assure quality performance.

LOCTITE® thread sealants 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.

IMPORTANT: LOCTITE® gasket materials are NOT designed to work with oil residue present. Oil residues must be cleaned from surfaces before applying gasket material.

LOCTITE® 242—THREAD LOCK & SEALER (MEDIUM STRENGTH) (BLUE):

TY9370 6 ml tube/T43512 50 ml tube

- Plugs and fitting: fuel filter base, fuel transfer pump, and oil filter base housing.
- Cap screws: vibration damper/pulley, injection pump access cover, electronic tachometer cover, oil filler inlet, flywheel, fuel transfer pump, oil cooler housing-to-cylinder block (open holes only) and timing hole cover.
- Oil pressure sending unit.

LOCTITE® 271—THREAD LOCK & SEALER (HIGH STRENGTH) (CLEAR):

TY9371 6 ml tube/T43513 50 ml bottle

- Studs: water pump-to-cylinder block, injection pump-to-front plate, exhaust manifold-to-turbocharger.
- Oil filter nipple
- Oil dipstick tube and fitting.
- Crankshaft wear sleeve.

LOCTITE® 277—RIGID FORM-IN-PLACE GASKET (HIGH STRENGTH) (RED):

T43514 50 ml bottle

- Steel cap plugs: cylinder block and cylinder head.
- O-ring adapter for oil pump outlet tube.
- Nipples and elbows which are pressed into place, water pump housing, and oil cooler cover.

LOCTITE® 515—FLEXIBLE FORM-IN-PLACE GASKET (GENERAL PURPOSE) (PURPLE):

TY6304 50 ml bottle

- Flywheel housing-to-cylinder block
- Flywheel housing-to-oil pan
- Front and rear face of cylinder block
- Front plate/timing gear cover-to-oil pan

LOCTITE® 592—PIPE SEALANT WITH TEFLON™ (WHITE):

TY9374 6 ml tube/TY9375 50 ml tube

- Pipe plugs: cylinder block (water manifold), thermostat housing, water pump, flywheel housing (drain).
- Injection pump governor cover fitting (fuel return).
- Temperature sending unit.
- Oil pan (drain hose, drain valve, and elbow drain fitting).
- Connectors: turbo line, turbo drain, and water return-to-cylinder block.
- Adapter fitting and plug for turbo lube on dual oil filter base.

LOCTITE is a registered trademark of Loctite Corp.
TEFLON is a registered trademark of the DuPont Co.

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RG,04,JW7726 –19–01DEC97–1/2

04
4

RTV SILICONE SEALANT FORM-IN-PLACE GASKET (CLEAR):[1]

TY15130 3 oz. tube

Injection pump timing gear cover ONLY when traditional gasket is not available.

PT569 NEVER-SEEZ® COMPOUND:

PT569 227g brush/PT506 453g spray

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

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

[1]Use DD14928 Sealing Compound Kit when servicing an engine within the European Market/Service Area. Follow manufacturer's directions on package when using and storing sealant.

RG,04,JW7726 –19–01DEC97–2/2

ENGINE ASSEMBLY SEQUENCE

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

1. Install all plugs and serial number plate in cylinder block (if removed). (Groups 10 and 15)
2. Install piston cooling orifices. (Group 10)
3. Install new balancer shaft bushings (4045 engines) and a new camshaft bushing. (Group 16)
4. Install cylinder liners without O-rings. Measure liner height. Install liners with O-rings. (Group 10)
5. Install main bearings and crankshaft. PLASTIGAGE® bearings. (Group 15)
6. Install flywheel housing, rear oil seal, and flywheel. (Group 15)
7. Install pistons and rods. Measure piston protrusion. (Group 10)
8. Install oil by-pass valve. (Group 20)
9. Install front plate. (Group 16)
10. Install balancer shafts (4045 engines). Check end play. (Group 16)
11. Install oil outlet tube, O-ring in block, and oil pump. (Group 20)
12. Install injection pump. (Group 35)
13. Install camshaft and timing gears. (Group 16)
14. Time all gears with No. 1 cylinder at TDC compression stroke. (Group 16)
15. Install timing gear cover. Install new front seal. (Group 16)
16. Install oil pan. (Group 20)
17. Install oil pressure regulating valve. (Group 20)
18. Install cam followers in same order as removed. (Group 16)
19. Install cylinder head gasket, cylinder head, push rods, and rocker arm assembly. (Group 05)
20. Install starting motor. (Group 40)
21. Install injection nozzles (with new seals) and injection lines. (Group 35)
22. Install fuel filter, fuel supply pump, and fuel lines. (Group 35)
23. Install oil cooler, new oil filter, and dipstick. (Group 20)
24. Install water manifold or thermostat housing and thermostats. (Group 25)
25. Install exhaust manifold and turbocharger. Prelube the turbocharger. (Group 30)
26. Install water pump and houses. (Group 25)
27. Install crankshaft pulley or vibration damper. (Group 15)
28. Install alternator. (Group 40)
29. Install belt tensioner, fan, and fan belts. (Group 25)

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

31. Install vent tube.

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

33. Perform engine break-in and standard performance checks. (Group 105)

RG,04,DT7335 –19–11NOV97–2/2

Group 05
Cylinder Head and Valves

ESSENTIAL TOOLS

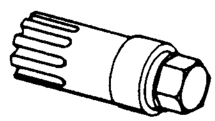
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

SERVICEGARD is a trademark of Deere & Company

DPSG,OUO1004,166 –19–07JUL98–1/15

Flywheel Turning Tool JDE83

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

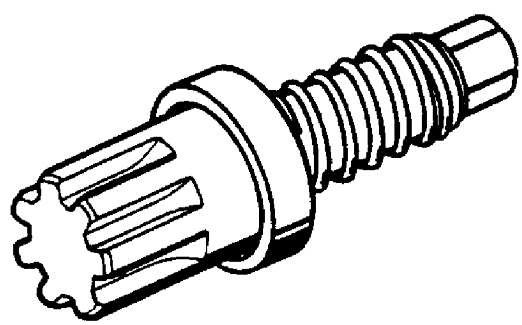


RG6251 –UN–22JUL92

DPSG,OUO1004,166 –19–07JUL98–2/15

Flywheel Turning Tool JDG820

Used to rotate flywheel on engines with 129-tooth flywheel ring gear and a 29.9 mm (1.18 in.) ID flywheel housing guide bore diameter.



RG7056

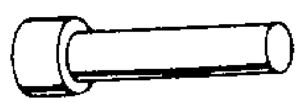
RG7056 –UN–05DEC97

DPSG,OUO1004,166 –19–07JUL98–3/15

RG5068 –UN–05DEC97

Timing Pin JDE81-4

Lock engine at TDC.



RG5068

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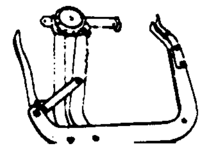
DPSG,OUO1004,166 –19–07JUL98–4/15

Cylinder Head and Valves

RG5070 –UN–23AUG88

Valve Spring Compressor JDE138

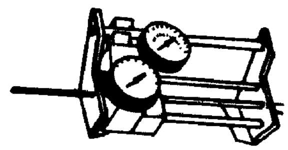


Used to compress valve springs when removing and installing valves.

DPSG,OUO1004,166 –19–07JUL98–5/15

RG5061 –UN–05DEC97

Spring Compression Tester D01168AA



RG5061

Test valve spring compression.

DPSG,OUO1004,166 –19–07JUL98–6/15

RG5084 –UN–23AUG88

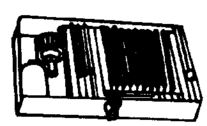
Nozzle Bore Cleaning Tool JDE39

Clean injection nozzle bores in cylinder head.

DPSG,OUO1004,166 –19–07JUL98–7/15

RG5064 –UN–05DEC97

Valve Guide Knurler Kit JT05949



RG5064

Knurl valve guides.

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DPSG,OUO1004,166 –19–07JUL98–8/15

RG5065 –UN–05DEC97

Valve Seat Driver JDG676

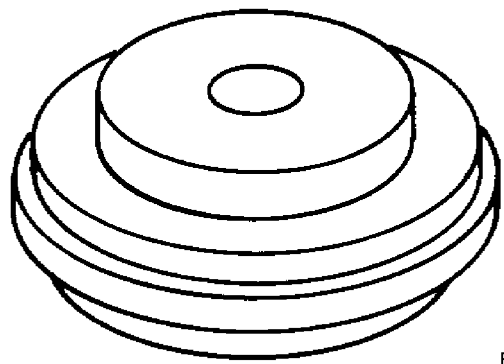
Use with JDG675 Adapter to install intake and exhaust valve seat inserts in cylinder head.

RG5065

DPSG,OUO1004,166 –19–07JUL98–9/15

Valve Seat Insert Installing Adapter. JDG675

Use with JDG676 Pilot Driver to install intake and exhaust valve seat inserts.



RG5240

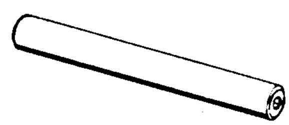
RG5240 –UN–05DEC97

DPSG,OUO1004,166 –19–07JUL98–10/15

RG5612 –UN–12APR90

Valve Stem Seal Installer JDG678

Use to install valve stem seals.

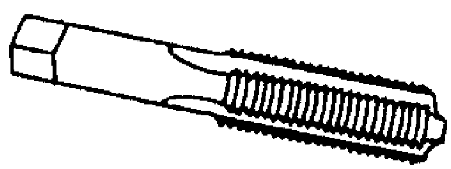


DPSG,OUO1004,166 –19–07JUL98–11/15

RG5100 –UN–05DEC97

Tap JDG680

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



RG5100

Continued on next page DPSG,OUO1004,166 –19–07JUL98–12/15

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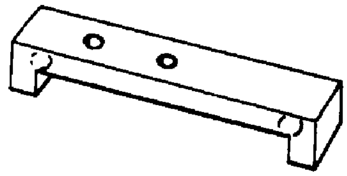
4

RG7029 –UN–05DEC97

Height Gauge . . . . JDG451 or KJD10123

Used with a dial indicator to measure valve recess in cylinder head. Also used to measure piston and liner height.



RG7029

DPSG,OUO1004,166 –19–07JUL98–13/15

RG6246 –UN–05DEC97

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

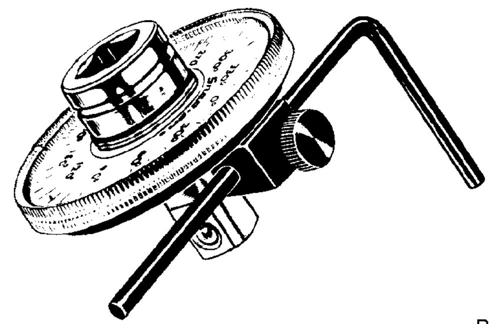
Use with JDG451, KJD10123 or magnetic base to measure valve recess in cylinder head and piston and liner height.

RG6246

DPSG,OUO1004,166 –19–07JUL98–14/15

Torque Angle Gauge JT05993

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



RG5698

RG5698 –UN–05DEC97

DPSG,OUO1004,166 –19–07JUL98–15/15

SERVICE EQUIPMENT AND TOOLS

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

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DPSG,OUO1004,167 –19–07JUL98–1/8

Cylinder Head and Valves

Crankshaft Front/Rear Rotation Adapter. JDG966

Rotate crankshaft from front and rear with flywheel removed.

DPSG,OUO1004,167 –19–07JUL98–2/8

Valve Inspection Center

Check valves for out of round.

DPSG,OUO1004,167 –19–07JUL98–3/8

Precision “Bevelled Edge” Straightedge D05012ST

Check cylinder head flatness.

DPSG,OUO1004,167 –19–07JUL98–4/8

Plastic Brush

Clean valve guides.

DPSG,OUO1004,167 –19–07JUL98–5/8

End Brush D17024BR

Remove carbon on valve seats.

DPSG,OUO1004,167 –19–07JUL98–6/8

Heavy-Duty Seat Grinder JT05893

Grind valve seats.

DPSG,OUO1004,167 –19–07JUL98–7/8

Eccentrimeter

Measure valve seat runout.

DPSG,OUO1004,167 –19–07JUL98–8/8

05
6

OTHER MATERIAL

Number	Name	Use
AR44402 (U.S.)	Valve Stem Lubricant	Lubricate valve stems.

DPSG,OUO1004,168 –19–07JUL98–1/1

CYLINDER HEAD AND VALVES SPECIFICATIONS

Item	Measurement	Specification
Intake Valve Clearance Checking (Rocker Arm-to-Valve Tip) (Engine Cold)	Clearance	0.31—0.38 mm (0.012—0.015 in.)
Exhaust Valve Clearance Checking (Rocker Arm-to-Valve Tip) (Engine Cold)	Clearance	0.41—0.48 mm (0.016—0.019 in.)
Intake Valve Clearance Adjustment (Rocker Arm-to-Valve Tip) (Engine Cold)	Clearance	0.36 mm (0.014 in.)
Exhaust Valve Clearance Adjustment (Rocker Arm-to-Valve Tip) (Engine Cold)	Clearance	0.46 mm (0.018 in.)
Rocker Arm Adjusting Screw Jam Nut	Torque	27 N•m (20 lb-ft)
Intake Valves	Lift Wear Limit	11.77—12.21 mm (0.463—0.481 in.) 11.34 mm (0.447 in.)
Exhaust Valves	Lift Wear Limit	11.51—11.94 mm (0.453—0.470 in.) 11.08 mm (0.436 in.)
Rocker Arm Assembly		
Spring Tension at 46 mm (1.81 in.) Compressed Height	Spring Tension	18—27 N (4—6 lb-force)
Spring Compressed Height	Height	46 mm @ 18—27 N (1.81 in. @ 4—6 lb force)
Shaft	OD Wear Limit	19.99—20.02 mm (0.787—0.788 in.) 19.94 mm (0.785 in.)
Shaft Support ID	Maximum ID	20.17 mm (0.794 in.)
Bore	ID Wear Limit	20.07—20.12 mm (0.790—0.792 in.) 20.17 mm (0.794 in.)

Continued on next page

DPSG,OUO1004,229 –19–10JUL98–1/3

Cylinder Head and Valves

Item	Measurement	Specification
Fuel Supply Pump Push Rod	OD	9.891—9.917 mm (0.3894—0.3904 in.)
Fuel Supply Pump Push Rod Bore in Block	ID	10.00—10.05 mm (0.3937—0.3957 in.)
Camshaft Follower	OD	31.61—31.64 mm (1.245—1.246 in.)
Intake Valves	Recess in Cylinder Head Worn Limit	0.61—1.11 mm (0.024—0.044 in.) 1.63 mm (0.064 in.)
Exhaust Valve	Recess in Cylinder Head Worn Limit	1.22—1.72 mm (0.048—0.068 in.) 2.26 mm (0.089 in.)
Valve Springs		
Spring Free Length 0 N (0 lb-force)	Height	54.0 mm (2.125 in.)
Spring Compressed 240—280 N (54—62 lb-force)	Height	46.0 mm (1.81 in.)
Spring Compressed 590—680 N (133—153 lb-force)	Height	34.5 mm (1.36 in.)
Intake Valve Head	OD	46.47—46.73 mm (1.830—1.840 in.)
Exhaust Valve Head	OD	42.37—42.63 mm (1.668—1.678 in.)
Intake Valve Stem	OD	7.864—7.884 mm (0.3096—0.3104 in.)
Exhaust Valve Stem	OD	7.848—7.874 mm (0.3090—0.3100 in.)
Valve Face Runout	Maximum Valve Face Runout (Intake and Exhaust)	0.038 mm (0.0015 in.)
Valves	Face Angle	29.25° ±0.25°
Cylinder Head Flatness	Maximum Acceptable Out-of-Flat: For Entire Length or Width Maximum Acceptable Out-of-Flat: For Every 150 mm (5.90 in.)	0.08 mm (0.003 in.) 0.03 mm (0.001 in.)

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DPSG,OUO1004,229 –19–10JUL98–2/3

Cylinder Head and Valves

Item	Measurement	Specification
Cylinder Head Thickness and Finish	New Cylinder Head Thickness	104.87—105.13 mm (4.129—4.139 in.)
	Minimum Acceptable Thickness	104.24 mm (4.104 in.)
	Combustion Face Surface Finish (Surface Grind Only) (AA)	0.7—3.2 micrometers (31—125 micro-in.)
	Maximum Wave Depth	0.012 mm (0.0005 in.)
	Maximum Material Removal for Resurfacing	0.76 mm (0.030 in.)
Valve Guide Bore (New)	ID	7.912—7.938 mm (0.312—0.313 in.)
Valve Guide-to-Valve Stem (New)	Clearance	0.05—0.10 mm (0.002—0.004 in.)
	Wear Limit	0.15 mm (0.006 in.)
Valve Seat Grinding	Valve Seat Angle (D)	30°
	Valve Seat Width (E)	1.50—2.00 mm (0.059—0.079 in.)
	Maximum Valve Seat Runout (F)	0.08 mm (0.003 in.)
Cylinder Liner Height Above Block	Height	0.030—0.100 mm (0.001—0.004 in.)
Cylinder Liner Height Difference At Nearest Point of Two Adjacent Liners, or Within a Single Liner	Maximum Permissible Height Difference	0.05 mm (0.002 in.)
Cylinder Head Cap Screws		
Step 1-Initial Torque	Torque	100 N•m (75 lb-ft)
Step 2-Second Torque	Torque	150 N•m (110 lb-ft)
Step 3-Verify Torque (After 5 Minutes)	Torque	150 N•m (110 lb-ft)
Step 4-Torque Turn	Torque Turn	Tighten each screw an additional 60°± 10°)
Rocker Arm Support Studs	Torque	80 N•m (60 lb-ft)
Rocker Arm Cover Nuts	Torque	35 N•m (26 lb-ft)

DPSG,OUO1004,229 –19–10JUL98–3/3

05
10

CHECK AND ADJUST VALVE CLEARANCE

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

IMPORTANT: Valve clearance MUST BE checked and adjusted with engine COLD.

1. Remove rocker arm cover and crankcase ventilator tube.

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

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

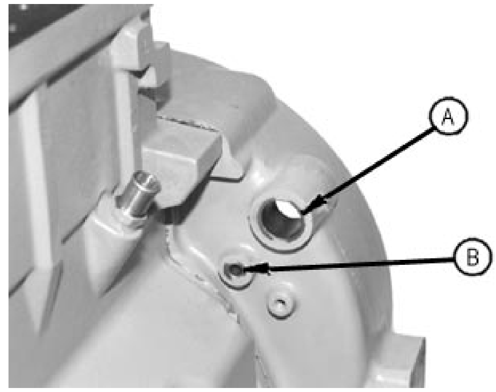
2. Remove plastic plugs or cover plate from engine timing/rotation hole (A).

NOTE: Some engines are equipped with flywheel housings which do not allow use of an engine flywheel rotation tool. These engines may be rotated from front nose of engine, using JDG966 Crankshaft Rotation Tool.

3. Using JDE83 or JDG820 Flywheel Turning Tool, rotate engine flywheel in running direction (clockwise viewed from front) until No. 1 cylinder is at “TDC” Compression stroke. Insert JDE81-4 Timing Pin in flywheel.

   If No. 1 cylinder rocker arms are loose, the engine is at No. 1 “TDC” Compression.

   If No. 1 cylinder rocker arms are not loose, rotate engine one full revolution (360°) to No. 1 “TDC” Compression.



RG7408 –UN–06AUG96

A—Timing/Rotation Hole
B—Timing Pin Hole

Continued on next page

RG,05,DT7375 –19–11NOV97–1/5

4. With engine lock-pinned at “TDC” of Number 1 piston’s compression stroke, check valve clearance to following specifications. (Use sequence for 4 or 6-cylinder engines as outlined on following pages.)

Intake Valve Clearance Checking (Rocker Arm-to-Valve Tip) (Engine Cold)—Specification

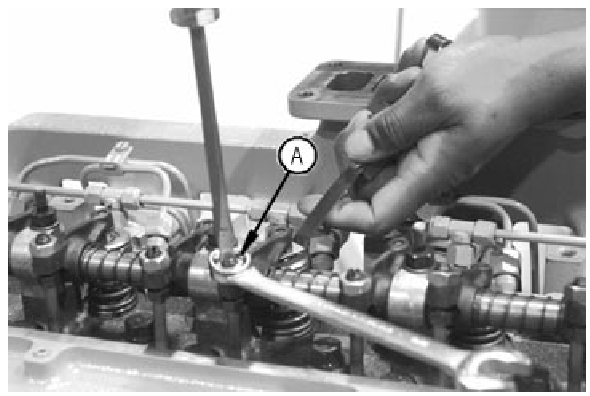
Clearance .... 0.31—0.38 mm (0.012—0.015 in.)

Exhaust Valve Clearance Checking (Rocker Arm-to-Valve Tip) (Engine Cold)—Specification

Clearance .... 0.41—0.48 mm (0.016—0.019 in.)

RG,05,DT7375 –19–11NOV97–2/5

5. If valves need adjusting, use following valve clearance adjustment procedure and specifications. Loosen the locknut (A) 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 specifications. Recheck clearance again after tightening locknut. Readjust clearance as necessary.



RG7409 –UN–06AUG96

A—Adjusting Screw Jam Nut

Intake Valve Clearance Adjustment (Rocker Arm-to-Valve Tip) (Engine Cold)—Specification

Clearance .... 0.36 mm (0.014 in.)

Exhaust Valve Clearance Adjustment (Rocker Arm-to-Valve Tip) (Engine Cold)—Specification

Clearance .... 0.46 mm (0.018 in.)

Rocker Arm Adjusting Screw Jam Nut—Specification

Torque .... 27 N•m (20 lb-ft)

6. Replace rocker arm cover and crankcase ventilator tube.

Continued on next page

RG,05,DT7375 –19–11NOV97–3/5

4-CYLINDER ENGINE:

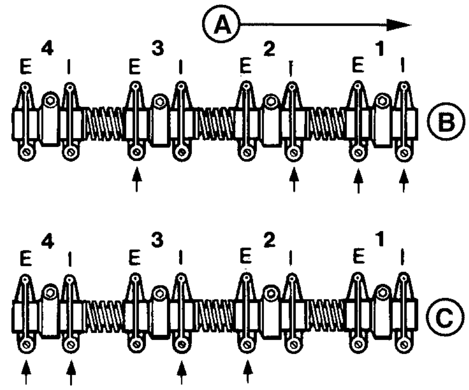
NOTE: Firing order is 1-3-4-2.

1. Using JDE81-4 Timing Pin, lock No. 1 piston at TDC compression stroke (B).

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

3. Turn crankshaft 360°. Lock No. 4 piston is at TDC compression stroke (C).

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



RG4776 –UN–31OCT97

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

RG,05,DT7375 –19–11NOV97–4/5

6-CYLINDER ENGINE:

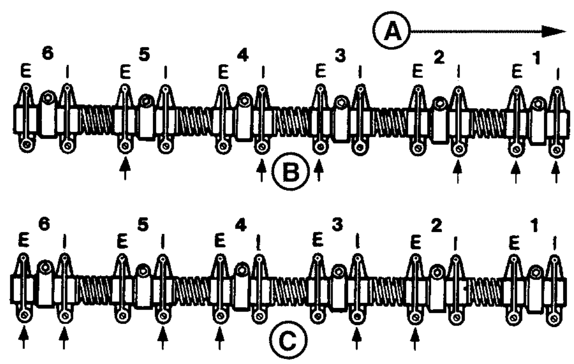
NOTE: Firing order is 1-5-3-6-2-4.

1. Lock No. 1 piston at TDC compression stroke (B).

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

3. Turn crankshaft 360°. Lock No. 6 piston is at TDC compression stroke (C).

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



RG4777 –UN–31OCT97

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

RG,05,DT7375 –19–11NOV97–5/5

MEASURE VALVE LIFT

IMPORTANT: For a more accurate measurement, measure valve lift at 0.00 mm (in.) rocker arm-to-valve tip clearance and with engine COLD.

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

1. Remove rocker arm cover.

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

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

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

4. Place dial indicator tip on top of valve spring cap (retainer) or rotator. Preload indicator tip and set dial at 0.0 mm (in.).

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

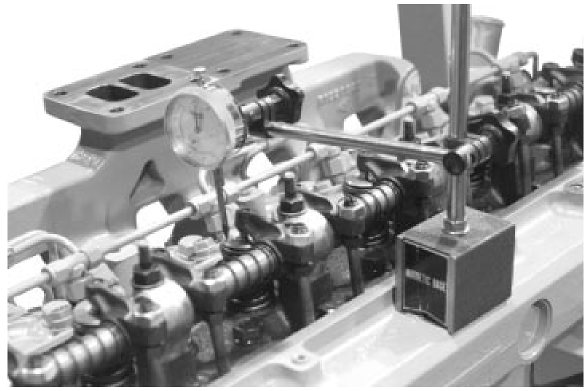
6. Observe dial indicator reading as valve is moved to full open. Record maximum reading and compare with specifications given below.

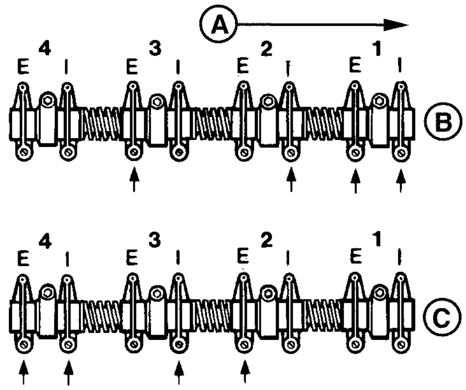
Intake Valves—Specification

Lift	11.77—12.21 mm (0.463—0.481 in.)
Wear Limit	11.34 mm (0.447 in.)

Exhaust Valves—Specification

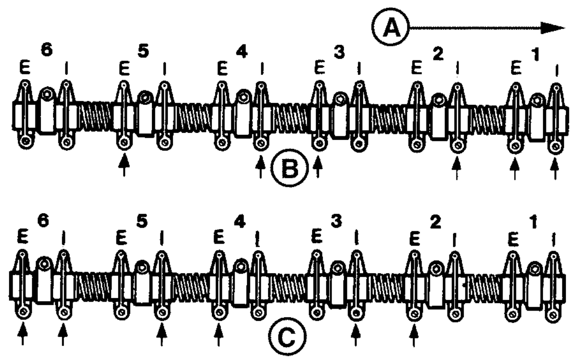
Lift	11.51—11.94 mm (0.453—0.470 in.)
Wear Limit	11.08 mm (0.436 in.)


RG7410 –UN–23NOV97



RG4776 –UN–31OCT97

4-Cylinder Engine



RG4777 –UN–31OCT97

6-Cylinder Engine

A—Front of Engine
B—No. 1 Piston TDC Compression
C—No. 4 Piston or No. 6 Piston TDC Compression
E—Exhaust Valve
I—Intake Valve

Continued on next page

RG,05,DT7374 –19–11NOV97–1/2

05
14

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

   If valve lift on all valves is within specifications, adjust valve lash to specified clearance. (See CHECK AND ADJUST VALVE CLEARANCE earlier in this group.)

   If valve lift on one or more valves is not within specification, remove and inspect entire valve train and camshaft.

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

   - TDC No. 4 compression stroke for 4-cylinder engines.
   - TDC No. 6 compression stroke for 6-cylinder engines.

9. Set rocker arm-to-valve tip clearance to 0.0 mm (in.) for:

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

10. Repeat steps 4—7.

RG,05,DT7374 –19–11NOV97–2/2

REMOVE CYLINDER HEAD

In some applications, it may be necessary to remove engine from machine to service cylinder head. Refer to your Machine Technical Manual for engine removal procedure.

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

Do NOT drain coolant until the coolant temperature is below operating temperature. Only remove 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.

1. Drain engine oil and coolant.

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

2. Remove air inlet elbow. (See Group 30.)

Continued on next page RG,05,DT7373 –19–11NOV97–1/12

05
16

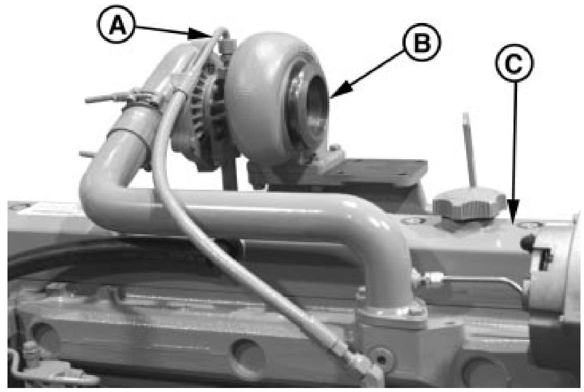
NOTE: Turbocharger and exhaust elbow may be removed from engine while assembled to exhaust manifold, if desired.

3. On turbocharged engines, disconnect turbocharger oil inlet line (A) at turbocharger (B). Remove turbocharger and exhaust elbow (shown removed).

IMPORTANT: Rocker arm cover sealing ring (D) can be reused if there is no evidence of physical damage. Remove sealing ring from groove for replacement only.

4. Remove hex nuts and O-rings from rocker arm cover (C).

   Lift off cover. Save O-rings for reassembly or replace as necessary.



RG7454A –UN–04NOV97

RG7450A –UN–04NOV97

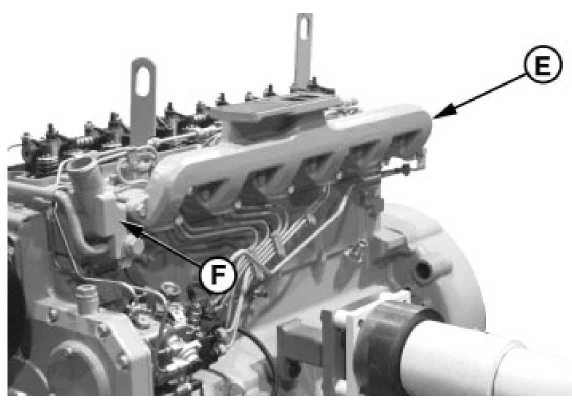
A—Turbocharger Oil Inlet Line
B—Turbocharger
C—Rocker Arm Cover
D—Rocker Arm Cover Sealing Ring

RG,05,DT7373 –19–11NOV97–2/12

5. Using guide studs, remove exhaust manifold (E).

NOTE: On some engines, the thermostat housing/water manifold (F) is part of the cylinder head.

6. Remove thermostat housing/water manifold (F).



RG7411 –UN–03NOV97

E—Exhaust Manifold
F—Thermostat Housing/Water Manifold

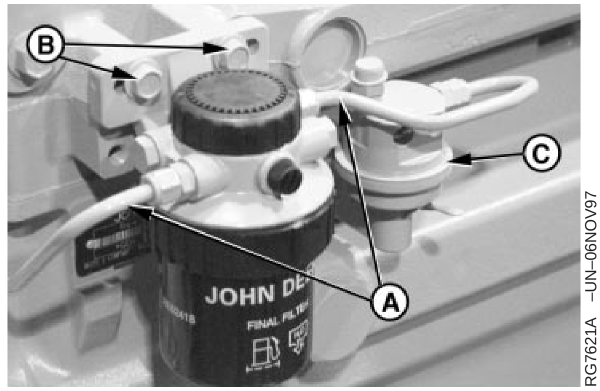
Continued on next page RG,05,DT7373 –19–11NOV97–3/12

7. Disconnect fuel lines (A) from fuel filter.

8. Remove fuel filter and mounting bracket (B).

9. Remove fuel supply pump (C). Inspect face of pump lever for wear. If worn flat or concave, replace supply pump.

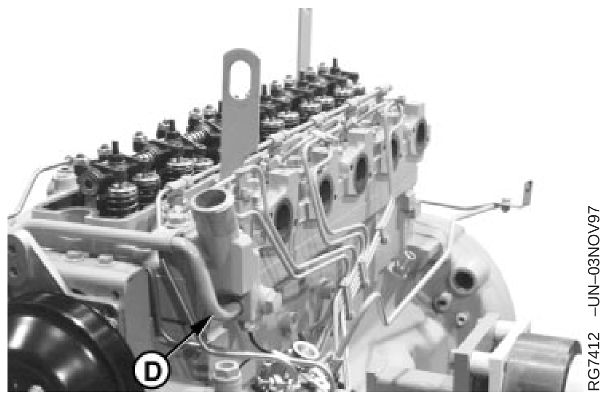
10. Remove alternator if desired. (See Group 40.)



A—Fuel Lines
B—Mounting Bracket
C—Fuel Supply Pump

RG,05,DT7373 –19–11NOV97–4/12

11. Remove thermostat housing-to-water pump tube (D).

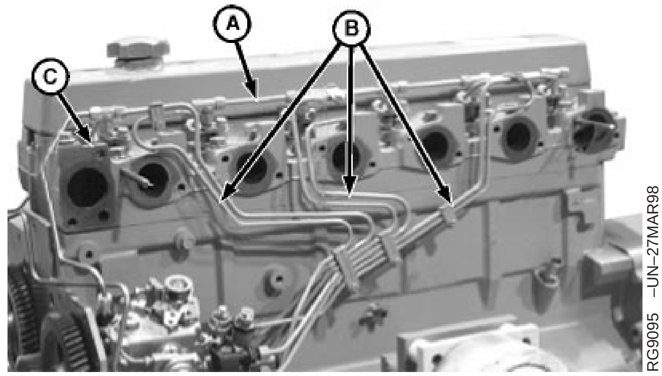


D—Thermostat Housing-to-Water Pump Tube

Continued on next page

RG,05,DT7373 –19–11NOV97–5/12

12. Remove fuel leakoff line (A) and fuel delivery lines (B) as an assembly. Remove fuel injection nozzles (C). (See Group 35.)

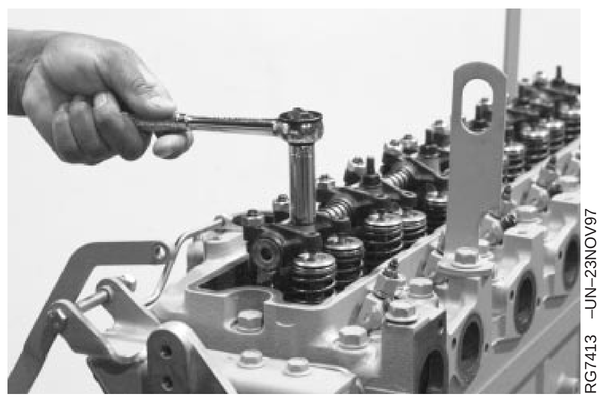


A—Fuel Leakoff line
B—Fuel Delivery Lines
C—Injection Nozzles

RG,05,DT7373 –19–11NOV97–6/12

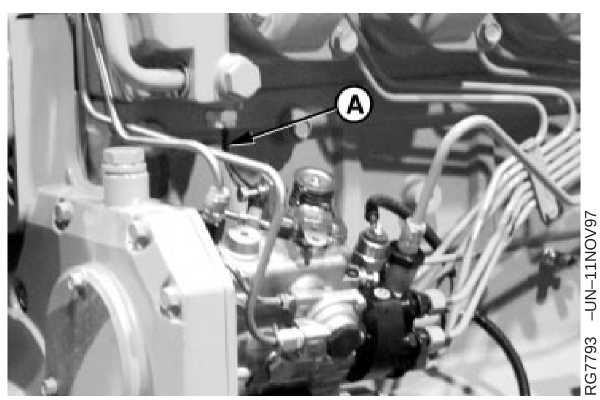
NOTE: Loosen all rocker arm adjusting screws prior to removing assembly.

13. Remove rocker arm assembly.



RG,05,DT7373 –19–11NOV97–7/12

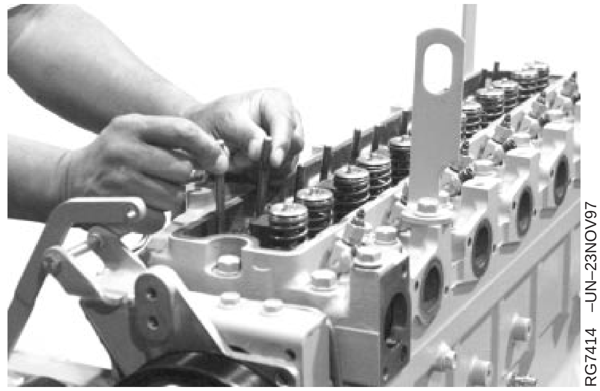
14. Disconnect coolant temperature connector (A) from injection pump wiring harness.



A—Coolant Temperature Connector

Continued on next page RG,05,DT7373 –19–11NOV97–8/12

15. Remove all push rods and identify for reassembly in the same location. Clean and inspect push rods.



RG,05,DT7373 –19–11NOV97–9/12

16. If a cylinder head gasket failure has occurred, check and record torque on each cylinder head cap screw before removing.

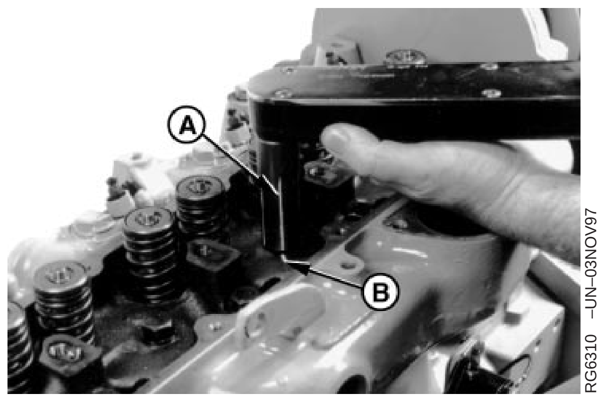
    To check cylinder head cap screw torque:

    a. Make a reference mark (in-line) on socket (A) and cylinder head surface (B).

    b. Loosen cap screw at least 1/2 turn.

    c. Retighten cap screw (using a torque wrench) until reference marks align and record torque.

17. Remove all cylinder head cap screws.

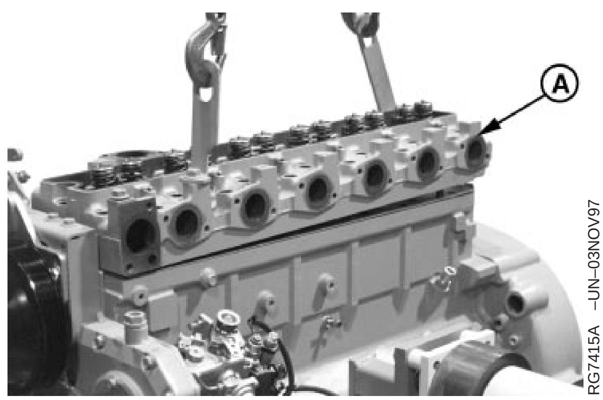


A—Mark on Socket
B—Mark on Head Surface

RG,05,DT7373 –19–11NOV97–10/12

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

18. Lift cylinder head (A) from block. If cylinder head sticks, use a soft hammer to tap cylinder head.



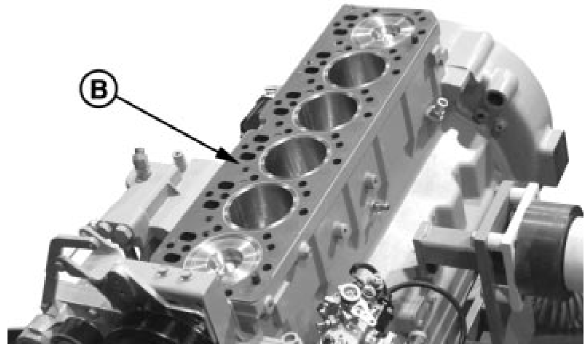
A—Cylinder Head

Continued on next page RG,05,DT7373 –19–11NOV97–11/12

05
20

19. Remove cylinder head gasket (B). Inspect for possible oil, coolant, or combustion chamber leaks. Also, check for evidence of incorrect head gasket being used.

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



RG7416 –UN–03NOV97

B—Head Gasket

RG,05,DT7373 –19–11NOV97–12/12

DISASSEMBLE AND INSPECT ROCKER ARM SHAFT ASSEMBLY

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

2. Disassemble and inspect all parts for wear or damage. Replace any parts that are damaged or not within specifications.

Spring Tension at 46 mm (1.81 in.) Compressed Height—Specification

Spring Tension .... 18—27 N (4—6 lb-force)

Spring Compressed Height—Specification

Height .... 46 mm @ 18—27 N (1.81 in. @ 4—6 lb force)

Shaft—Specification

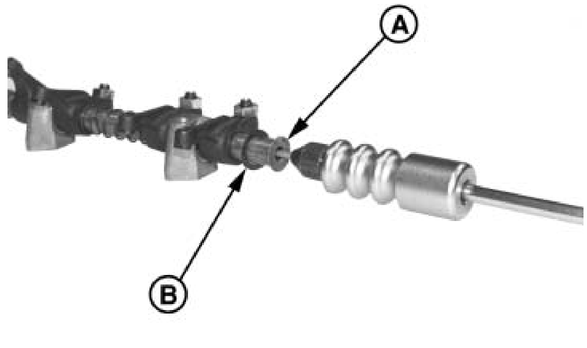
OD .... 19.99—20.02 mm (0.787—0.788 in.)
Wear Limit .... 19.94 mm (0.785 in.)

Shaft Support ID—Specification

Maximum ID .... 20.17 mm (0.794 in.)

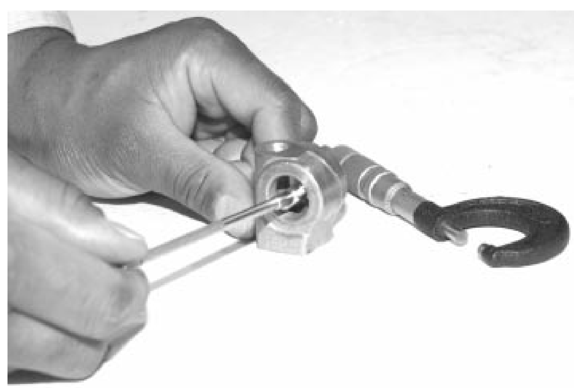
Bore—Specification

ID .... 20.07—20.12 mm (0.790—0.792 in.)
Wear Limit .... 20.17 mm (0.794 in.)



RG7417 –UN–03NOV97

RG7418 –UN–23NOV97



RG7419 –UN–23NOV97

RG7420 –UN–23NOV97

A—Plug
B—Washer

RG,05,DT7372 –19–11NOV97–1/1

05
22

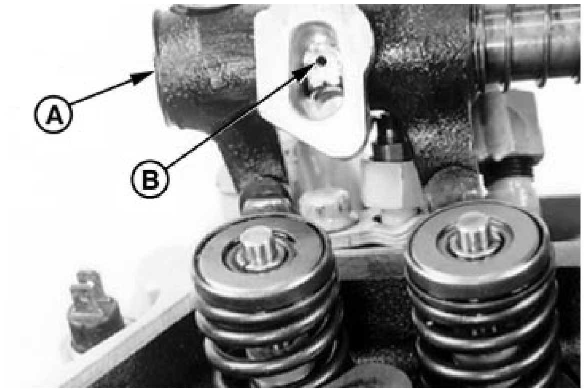
ASSEMBLE ROCKER ARM ASSEMBLY

1. Lubricate shaft OD, rocker arm bores, and rocker arm supports with clean engine oil.

IMPORTANT: The oil supply hole (B) on the rocker arm shaft must be toward the flywheel end of the engine.

2. Assemble springs, rocker arms, and rocker arm supports onto shaft in the same location as removed from.

3. Install bowed washers and new end plugs (A) firmly in end of shaft.



RG8112 –UN–18NOV97

A—End Plugs
B—Oil Supply Hole

RG,05,DT7371 –19–11NOV97–1/1

INSPECT, MEASURE, AND INSTALL FUEL SUPPLY PUMP PUSH ROD—IF APPLICABLE

1. Remove and clean push rod (A). Label end(s) for reassembly in same orientation.

RG7447 –UN–04NOV97

A—Push Rod

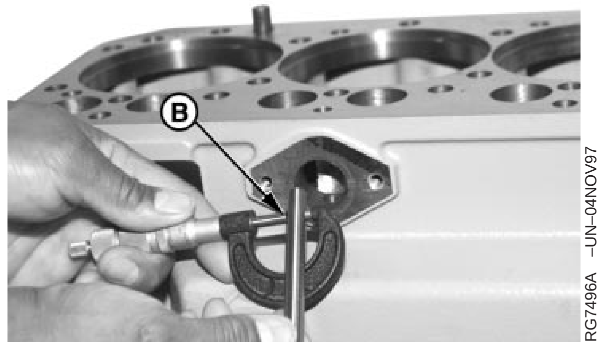
Continued on next page

RG,05,DT7370 –19–11NOV97–1/4

2. Measure push rod OD (B). If OD is less than specification, install a new push rod.

Fuel Supply Pump Push Rod—Specification

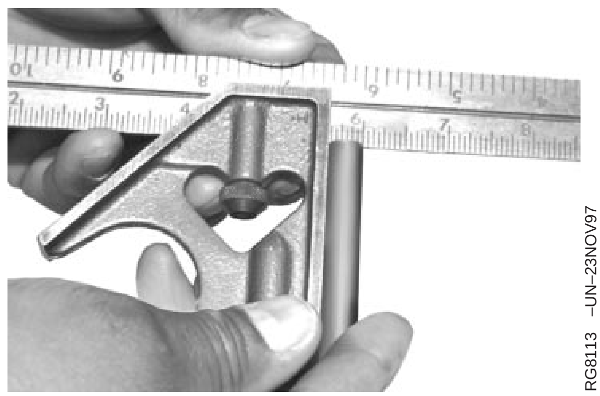
OD .... 9.891—9.917 mm
(0.3894—0.3904 in.)



B—Push Rod OD

RG,05,DT7370 –19–11NOV97–2/4

3. Check crown on push rod ends. If flat or concave, replace push rod and check camshaft lobe for wear. (See Group 16).



RG,05,DT7370 –19–11NOV97–3/4

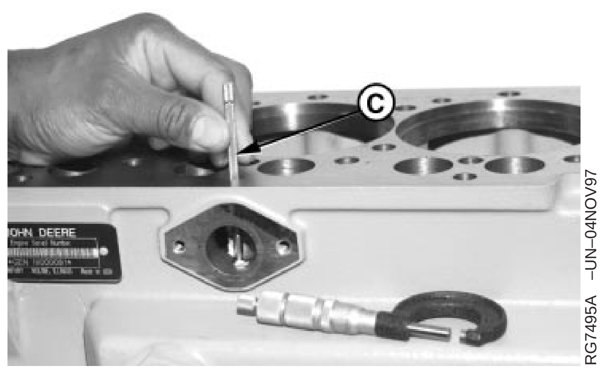
4. Measure push rod bore ID (C) in block.

Fuel Supply Pump Push Rod Bore in Block—Specification

ID .... 10.00—10.05 mm
(0.3937—0.3957 in.)

Repair or replace block as necessary.

5. Lubricate push rod with clean engine oil and install in bore with same end orientation as removed.



C—Bore ID

RG,05,DT7370 –19–11NOV97–4/4

05
24

INSPECT, MEASURE, AND ASSEMBLE CAMSHAFT FOLLOWERS

1. Remove and clean camshaft followers. Label for reassembly in same location.

RG7421 –UN–23NOV97

RG,05,DT7369 –19–11NOV97–1/3

2. Measure camshaft follower OD. If camshaft follower OD is less than specified, install a new follower.

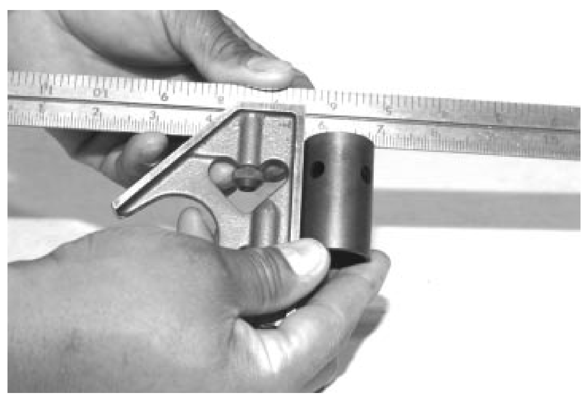
Camshaft Follower—Specification

OD .... 31.61—31.64 mm (1.245—1.246 in.)

RG7422 –UN–23NOV97

RG,05,DT7369 –19–11NOV97–2/3

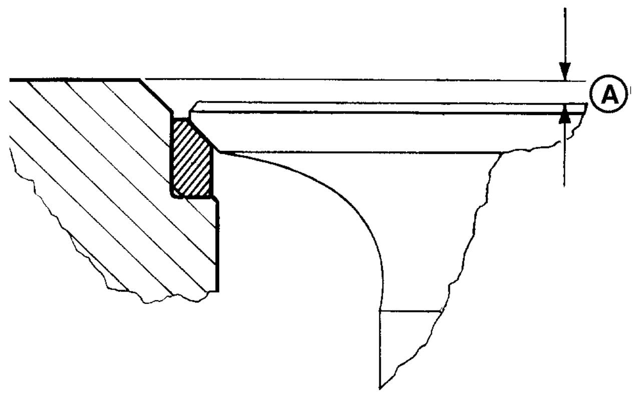
3. Check crown on follower face. If flat or concave, replace follower and check camshaft lobes for wear. (See Group 16.)
4. Measure camshaft follower bore in block and determine if clearance is within specification. (See Group 10.)
5. Lubricate camshaft followers in clean engine oil and install in same bore from which removed.



RG7423 –UN–23NOV97

RG,05,DT7369 –19–11NOV97–3/3

MEASURE VALVE RECESS IN CYLINDER HEAD



Measure and record valve recess (A) using a depth micrometer, magnetic base dial indicator or a dial indicator with JDG451 Height Gauge (B). Measurements must be made a maximum of 3.0 mm (0.12 in.) in from edge of valve head.

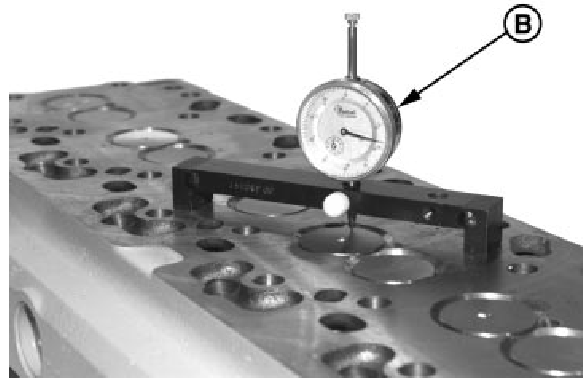
Intake Valves—Specification

Recess in Cylinder Head .... 0.61—1.11 mm (0.024—0.044 in.)
Worn Limit .... 1.63 mm (0.064 in.)

Exhaust Valve—Specification

Recess in Cylinder Head .... 1.22—1.72 mm (0.048—0.068 in.)
Worn Limit .... 2.26 mm (0.089 in.)

Install new valves, inserts, or grind existing valves and inserts, as necessary, to obtain proper valve recess. Grind valve seat inserts as required. (See REMOVE VALVE SEAT INSERTS later in this group.)



A—Valve Recess
B—Dial Indicator

RG,05,DT7368 –19–11NOV97–1/1

PRELIMINARY CYLINDER HEAD AND VALVE CHECKS

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

Look for the following conditions:

Sticking Valves:

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

Warped, Worn, or Distorted Valve Guides:

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

Distorted Cylinder Head and Gasket Leakage:

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

Worn or Broken Valve Seats:

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

Burned, Pitted, Worn, or Broken Valves:

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

Improper Valve Clearance:

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

Excessive Recession:

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

RG,05,DT7367 –19–11NOV97–1/1

05
27

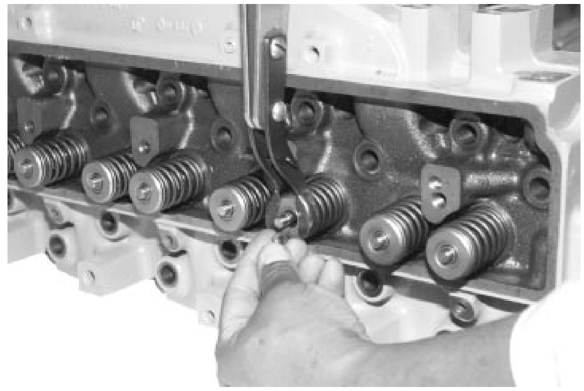
REMOVE VALVE ASSEMBLY

NOTE: A small magnet may be used to aid removal of valve retainer locks.

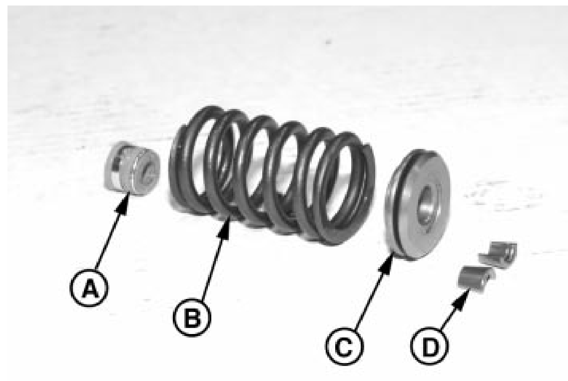
1. Using JDE138 Valve Spring Compressor, compress valve springs far enough to remove retainer locks (D).
2. Release spring tension and remove valve rotator (C) and valve spring (B).
3. Remove valves from cylinder head.

NOTE: Identify all parts for assembly in same location.

4. Remove valve stem seals (A) (if equipped) from valve guide tower.



RG7425 –UN–23NOV97



RG7426 –UN–03NOV97

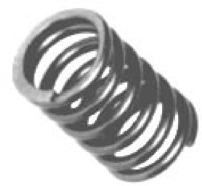
A—Valve Stem Seal
B—Valve Spring
C—Valve Rotator
D—Retainer Locks

RG,05,DT7366 –19–11NOV97–1/1

INSPECT AND MEASURE VALVE SPRINGS

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

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



RG2732 –UN–04DEC97

Spring Free Length 0 N (0 lb-force)[1]—Specification

Height .... 54.0 mm (2.125 in.)

Spring Compressed 240—280 N (54—62 lb-force)—Specification

Height .... 46.0 mm (1.81 in.)

Spring Compressed 590—680 N (133—153 lb-force)—Specification

Height .... 34.5 mm (1.36 in.)

RG7427 –UN–21MAY98

[1]*Free length may vary slightly between valve springs.*

RG,05,DT7365 –19–11NOV97–1/1

INSPECT VALVE ROTATORS

Valve rotators cannot be repaired. Replace valve rotators when valves are replaced or reground.

Insure that valve rotators turn freely in both directions. Replace if defective.

RG7428 –UN–23NOV97

RG,05,DT7364 –19–11NOV97–1/1

05
29

CLEAN VALVES

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

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

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

RG,05,DT7363 –19–11NOV97–1/1

INSPECT AND MEASURE VALVES

1. Clean and inspect valves, valve stems, stem tips, and retainer lock groove (A). Replace valves that are worn or damaged.

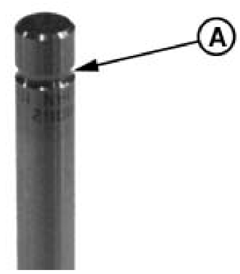
Intake Valve Head—Specification

OD .... 46.47—46.73 mm (1.830—1.840 in.)

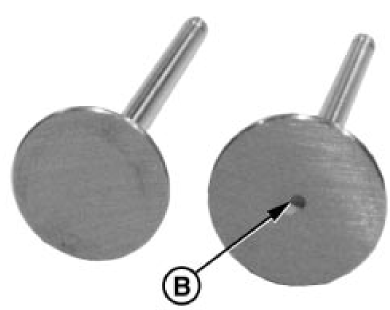
Exhaust Valve Head—Specification

OD .... 42.37—42.63 mm (1.668—1.678 in.)

NOTE: Intake valve has a larger head OD and is also identified with a dimple (B) on valve head.



RG7429 –UN–03NOV97



RG7759 –UN–10NOV97

A—Retainer Lock Groove
B—Dimple

Continued on next page

RG,05,DT7362 –19–11NOV97–1/3

2. Measure valve stem OD. Record measurements and compare with valve guide ID. (See MEASURE VALVE GUIDES later in this group.)

Intake Valve Stem—Specification

OD .... 7.864—7.884 mm (0.3096—0.3104 in.)

Exhaust Valve Stem—Specification

OD .... 7.848—7.874 mm (0.3090—0.3100 in.)

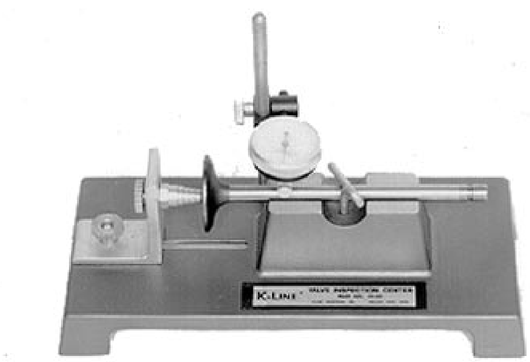
RG7430 –UN–23NOV97

RG,05,DT7362 –19–11NOV97–2/3

3. Using a valve inspection center, determine if valves are out of round, bent, or warped.

Valve Face Runout—Specification

Maximum Valve Face Runout .... 0.038 mm (0.0015 in.) (Intake and Exhaust)



RG4234 –UN–05DEC97

RG,05,DT7362 –19–11NOV97–3/3

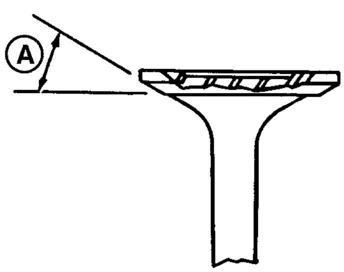
GRIND VALVES

IMPORTANT: DO NOT nick valve head-to-stem radius when grinding valves. A nick could cause the valve to break. Break all sharp edges after grinding.

Reface serviceable valves to specified angle (A).

Valves—Specification

Face Angle .... 29.25° ±0.25°



RG4755 –UN–31OCT97

A—Valve Face Angle

RG,05,DT7361 –19–11NOV97–1/1

INSPECT AND CLEAN CYLINDER HEAD

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

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

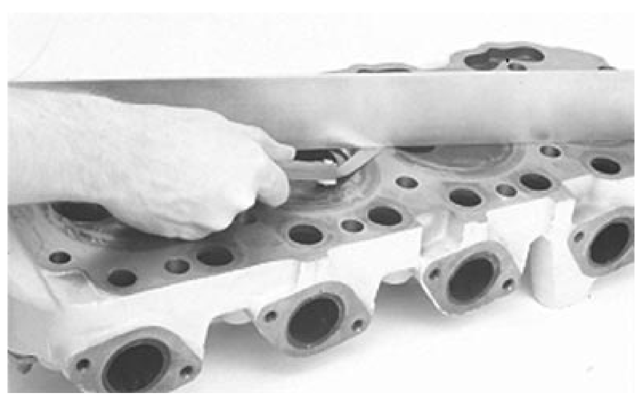
IMPORTANT: Be sure to remove all plugs before cleaning head, as parts can be damaged or destroyed by hot tank solutions.

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

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

RG,05,DT7360 –19–11NOV97–1/1

CHECK CYLINDER HEAD FLATNESS



RG7645 –UN–23NOV97

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

Cylinder Head Flatness—Specification

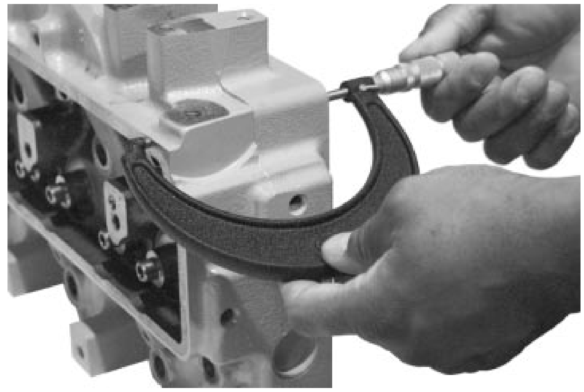
Maximum Acceptable Out-of-Flat: .... 0.08 mm (0.003 in.)
For Entire Length or Width
Maximum Acceptable Out-of-Flat: .... 0.03 mm (0.001 in.)
For Every 150 mm (5.90 in.)

If out-of-flat exceeds specifications, the cylinder head must be reconditioned or replaced. (See MEASURE CYLINDER HEAD THICKNESS later in this group.)

RG,05,DT7359 –19–11NOV97–1/1

05
32

MEASURE CYLINDER HEAD THICKNESS



RG7432 –UN–23NOV97

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

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

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

Cylinder Head Thickness and Finish—Specification

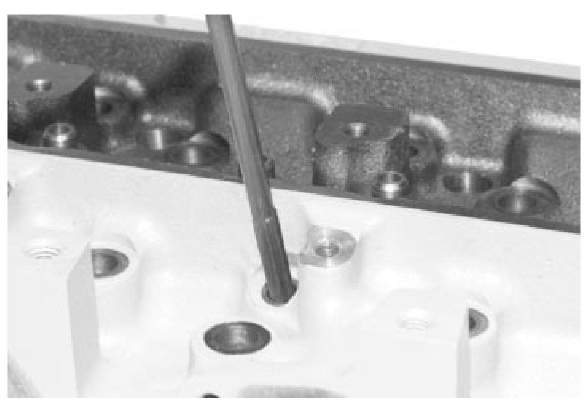
New Cylinder Head Thickness	104.87—105.13 mm (4.129—4.139 in.)
Minimum Acceptable Thickness	104.24 mm (4.104 in.)
Combustion Face Surface Finish (Surface Grind Only) (AA)	0.7—3.2 micrometers (31—125 micro-in.)
Maximum Wave Depth	0.012 mm (0.0005 in.)
Maximum Material Removal for Resurfacing	0.76 mm (0.030 in.)

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

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

RG,05,DT7358 –19–11NOV97–1/1

CLEAN INJECTION NOZZLE BORES



RG7433 –UN–23NOV97

IMPORTANT: Always turn the tool clockwise through the bore, even when pulling back. This will prevent premature wear on the tool.

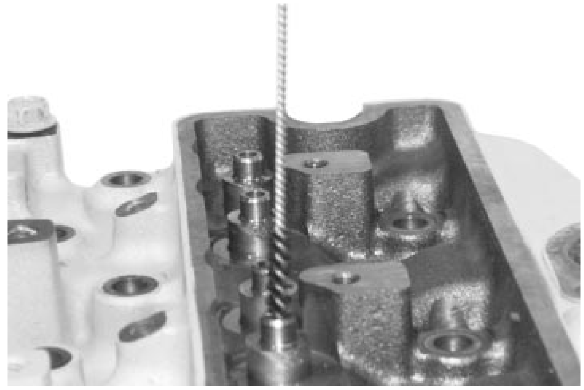
Clean carbon deposits from nozzle bores with JDE39 Nozzle Bore Cleaning Tool. Blow debris from bore with compressed air.

RG,05,DT7357 –19–11NOV97–1/1

CLEAN VALVE GUIDES

Clean valve guides before inspection or repair, with a plastic brush.

NOTE: A few drops of light oil or kerosene will help clean the guides.

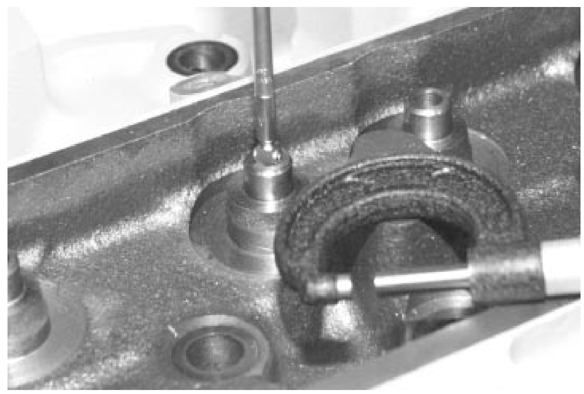


RG7434 –UN–23NOV97

RG,05,DT7356 –19–11NOV97–1/1

MEASURE VALVE GUIDES

Using a telescopic gauge, measure valve guide wear.



RG7435 –UN–23NOV97

Valve Guide Bore (New)—Specification

ID .... 7.912—7.938 mm (0.312—0.313 in.)

Valve Guide-to-Valve Stem (New)—Specification

Clearance .... 0.05—0.10 mm (0.002—0.004 in.)
Wear Limit .... 0.15 mm (0.006 in.)

NOTE: Valves are available with 0.38 mm (0.015 in.) and 0.76 mm (0.030 in.) oversize stems.

If valve guide-to-stem oil clearance exceeds the wear limit, oversize valve stems are available. Have a qualified machine shop ream valve guides to assure guide-to-stem clearance is within specification.

If valve guide-to-stem oil clearance exceeds the wear limit, but is less than 0.20 mm (0.008 in.), it is acceptable to knurl guides and ream to size. However, installing oversize valve stems is preferred. (See KNURL VALVE GUIDES, later in this group.)

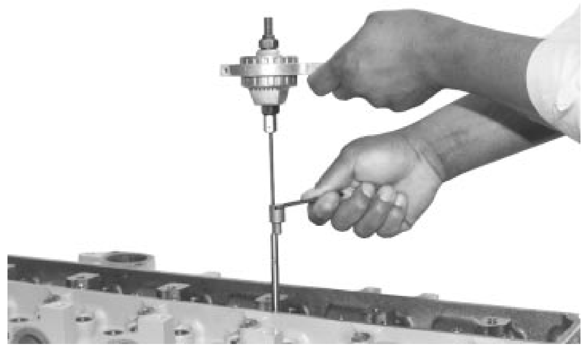
IMPORTANT: Production valve guides have a 5/6-24NF modified internal thread the entire length of guide with major diameter of 8.052—8.128 mm (0.3170—0.3199 in.) Have qualified machine shop thread valve guides accordingly after reaming for oversize valve stems.

RG,05,DT7355 –19–11NOV97–1/1

KNURL VALVE GUIDES

IMPORTANT: Valve guide knurling should only be done by experienced personnel familiar with equipment and capable of maintaining required specification.

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



RG7437 –UN–23NOV97

1. Use JT05949 Valve Guide Knurler Kit to knurl valve guides. Use kit exactly as directed by the manufacturer.

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

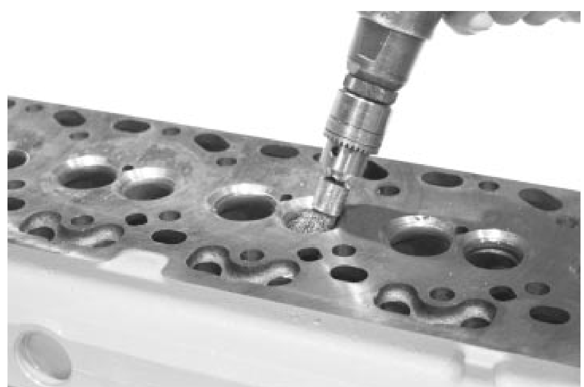
RG,05,DT7354 –19–11NOV97–1/1

CLEAN AND INSPECT VALVE SEATS

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

2. Inspect seats for excessive wear, cracks, or damage.

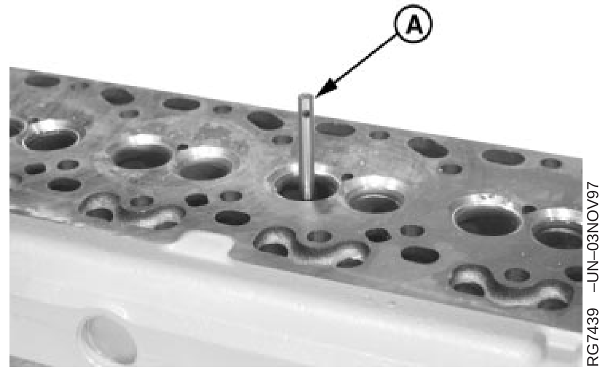
3. Check entire combustion face for rust, scoring, pitting, or cracks.



RG7438 –UN–23NOV97

RG,05,DT7379 –19–11NOV97–1/1

GRIND VALVE SEATS



A—Pilot

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

Grinding valve seats increases seat width and valve recess in cylinder head. DO NOT grind excessively. Only a few seconds are required to recondition the average valve seat. Dress grinding stone as necessary to maintain specified seat angle.

Support the weight of grinder to avoid excessive pressure on the stone.

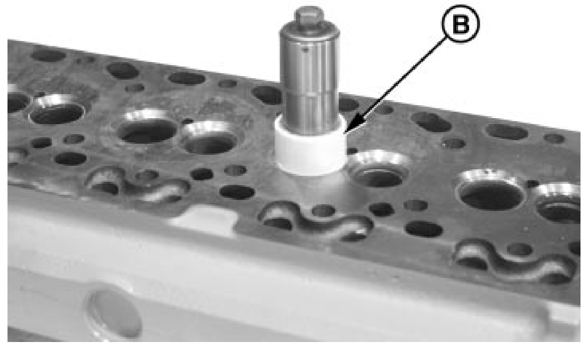
Blend or radius all sharp edges after grinding valve seats for a more effective valve face-to-seat seal.

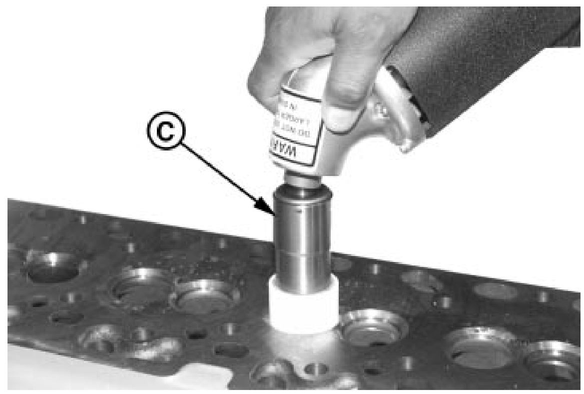
1. Install appropriate pilot (A) in valve guide bore.

Continued on next page RG,05,DT7353 –19–11NOV97–1/4

05
36

2. Install appropriate grinding stone (B) on arbor (C) and position onto valve seat.





B—Grinding Stone
C—Arbor

Continued on next page RG,05,DT7353 –19–11NOV97–2/4

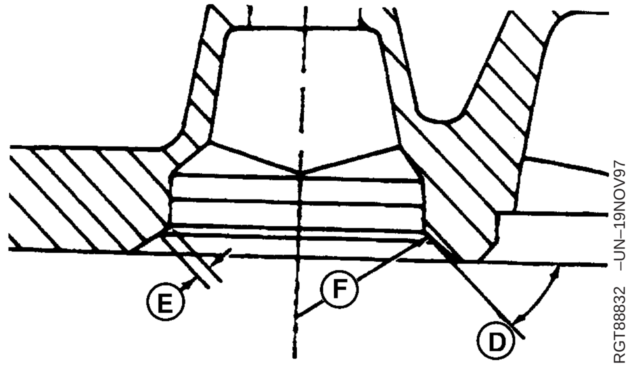
3. Using drill from JT05893 Heavy Duty Seat Grinder Set, grind valve seats to the following specifications:

Valve Seat Grinding—Specification

Valve Seat Angle (D).. 30°
Valve Seat Width (E)........................... 1.50—2.00 mm (0.059—0.079 in.)
Maximum Valve Seat Runout (F)............................... 0.08 mm (0.003 in.)

4. Use a vernier caliper or scale to measure seat width. If valve seat is too wide, reduce the width with a narrowing stone.

NOTE: A narrowing stone will change the top angle of the seat and reduce the outer diameter of the valve seating area. Varying the width changes the fine contact between valve face and seat. If seat width is too narrow, valve may burn or erode.

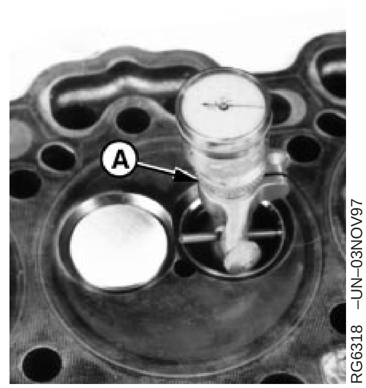


D—Valve Seat Angle
E—Valve Seat Width
F—Valve Seat Runout

RG,05,DT7353 –19–11NOV97–3/4

5. If valve does not seat properly, use an eccentrimeter (A) to check valve seat runout. Use a new or refaced valve and blueing to check contact between valve seat and face. If necessary, lap the valve onto its seat using a lapping tool and lapping compound. Replace valves and inserts as necessary.

6. Install new or refaced valve and check valve recess in cylinder head after grinding. (See CHECK VALVE RECESS IN CYLINDER HEAD earlier in this group.)



A—Eccentrimeter

RG,05,DT7353 –19–11NOV97–4/4

05
38

REMOVE VALVE SEAT INSERTS

IMPORTANT: Be careful not to damage cylinder head when removing valve seats. Valve seat removal should only be done by experienced personnel familiar with procedures.

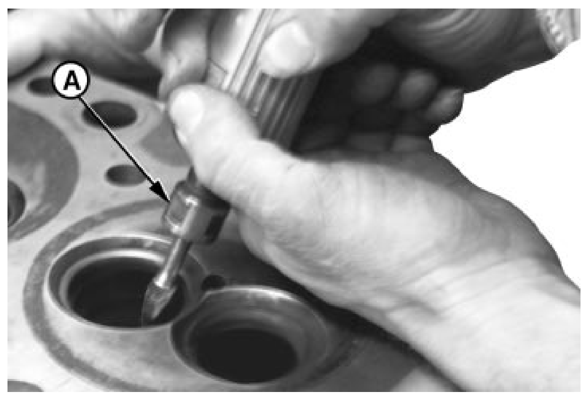
DO NOT use an oxy-acetylene torch to remove valve seat inserts, as it alters the hardness of the cylinder head.

Valve seat inserts are made of sintered (powdered) metal. Remove inserts by one of the following methods:

RG,05,DT7352 –19–11NOV97–1/4

RAISING BURR ON VALVE SEAT INSERT

1. Using a carbide deburring tool, (A) raise a burr (B) on bottom of valve seat insert.



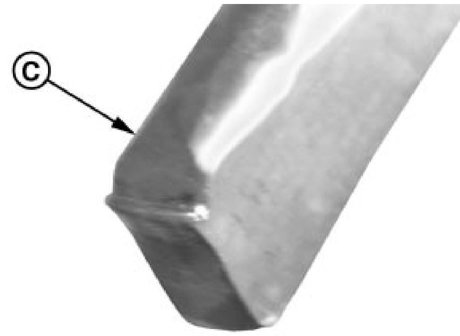
RG7816 –UN–13NOV97

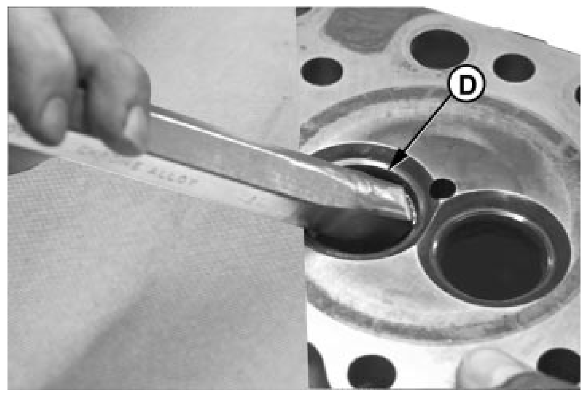
RG7817 –UN–13NOV97

A—Deburring Tool
B—Burr

Continued on next page RG,05,DT7352 –19–11NOV97–2/4

2. Protect surface of cylinder head with cardboard or cloth. Using a chisel with special ground end (C), tap handle of chisel with hammer until valve seat insert (D) comes loose.





C—Special Ground Chisel
D—Valve Seat Insert

Continued on next page RG,05,DT7352 –19–11NOV97–3/4

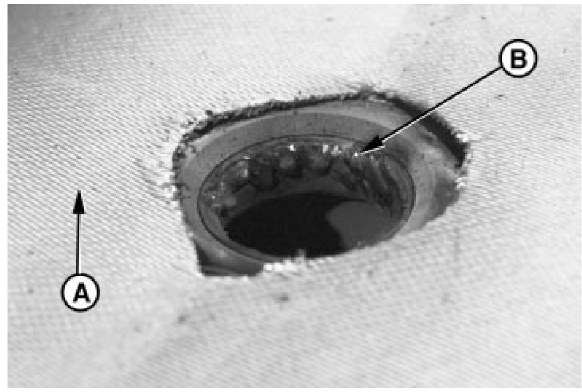
05
40

USING AN ARC WELDER

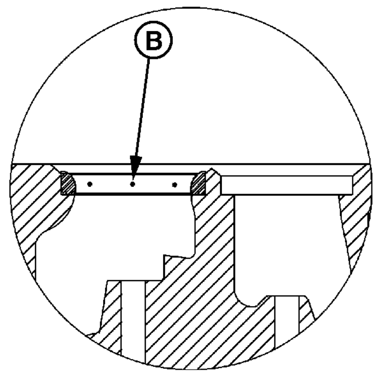
1. Protect the valve guide by installing a cap screw or dowel in guide to protect from weld spatter.

2. Protect the cylinder head surface with a non-flammable welder's cloth (A). Apply a thin bead of weld (B) around ID of valve seat insert. Allow insert to cool and use a screwdriver (C) or similar tool and carefully pry insert from bore.

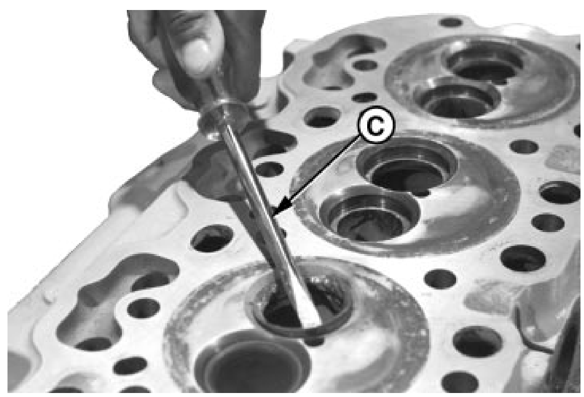
3. After removal of inserts, thoroughly clean area around valve seat bore and inspect for damage or cracks. Replace cylinder head as necessary.



RG7761 –UN–10NOV97



RG7813 –UN–13NOV97

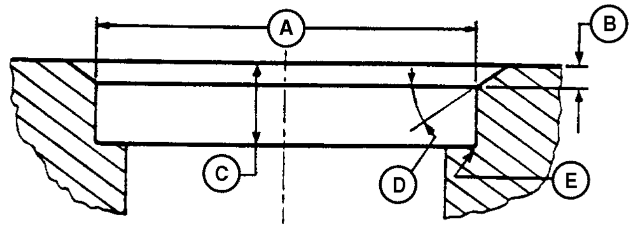


RG7763 –UN–10NOV97

A—Welders Cloth
B—Weld Bead
C—Screwdriver

RG,05,DT7352 –19–11NOV97–4/4

MEASURE VALVE SEAT BORE IN CYLINDER HEAD



If bore dimensions are not within specification, machine head to the following specifications:

Exhaust Valve Seat Insert Bore Specifications:

A	42.987—43.013 mm (1.6924—1.6934 in.)
B	3.82 mm (0.150 in.) Reference
C	9.936—10.064 mm (0.3912—0.3962 in.)
D	38—42°
E	Maximum Radius 0.5 mm (0.019 in.)
Maximum surface finish of bore “A”	0.00158 mm (0.000062 in.)

Intake Valve Seat Insert Bore Specifications:

A	47.104—47.130 mm (1.8545—1.8555 in.)
B	3.45 mm (0.136 in.) Reference
C	9.936—10.064 mm (0.3912—0.3962 in.)
D	38—42°
E	Maximum Radius 0.5 mm (0.019 in.)
Maximum surface finish of bore “A”	0.00158 mm (0.000062 in.)

Replacement Valve Seat Insert OD:

Intake	47.155—47.181 mm (1.8565—1.8575 in.)
Exhaust	43.038—43.064 mm (1.6944—1.6954 in.)

RG,05,DT7351 –19–11NOV97–1/1

05
42

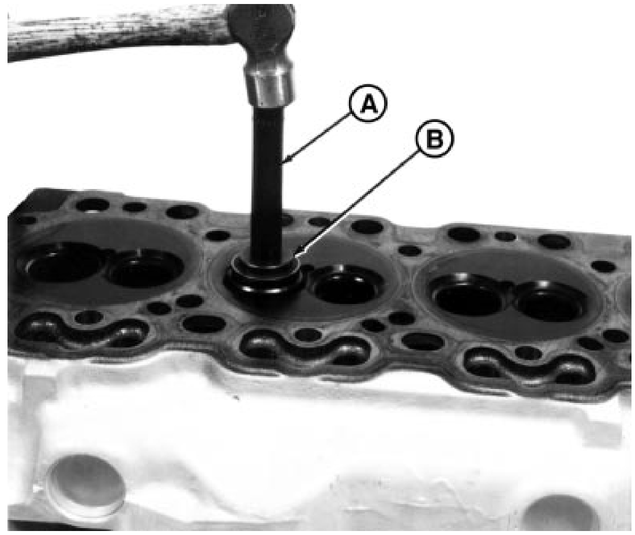
INSTALL VALVE SEAT INSERTS

1. Use JDG676 Pilot Driver (A) and JDG675 Valve Seat Insert Installing Adapter (B) to install valve seat inserts in cylinder head.

   Use one end of JDG675 Adapter to install intake valve seat inserts and the other end to install exhaust valve seat inserts.

2. Install valves and measure valve recess. (See MEASURE VALVE RECESS IN CYLINDER HEAD, earlier in this group.)

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



RG5653 –UN–31OCT97

A—Pilot Driver
B—Adapter

RG,05,DT7350 –19–11NOV97–1/1

INSTALL VALVES

1. Lubricate valve stems and guides with AR44402 Valve Stem Lubricant or clean engine oil.

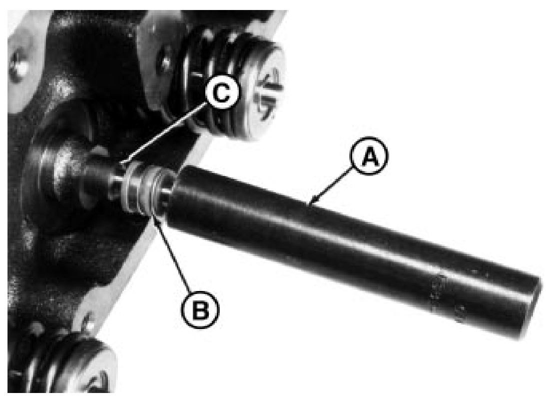
NOTE: Valves must move freely in guide and seat properly in head to form an effective seal.

2. Insert valves in head (if valves are reused, install in same location from which removed).

3. Use JDG678 Valve Stem Seal Installer (A) to slide valve stem seals (B) over valve stems and onto valve guide tower (C).

NOTE: JDG678 Installer may also be used to install oversize valve stem seals on oversize valve stems.

4. Install valve springs and rotators.



RG5654 –UN–31OCT97

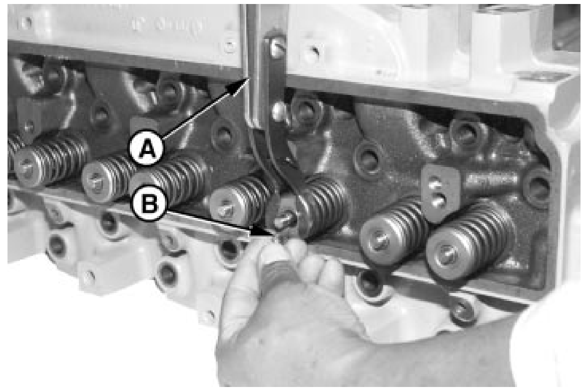
A—Seal Installer
B—Valve Stem Seals
C—Valve Guide Tower

Continued on next page RG,05,DT7349 –19–11NOV97–1/2

5. Compress valve springs using JDE138 Valve Spring Compressor (A) and install retainer locks (B) on valve stems.

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

7. Recheck valve recess. (See MEASURE VALVE RECESS IN CYLINDER HEAD, earlier in this group.)



RG7425A –UN–03NOV97

A—Spring Compressor
B—Retainer Locks

RG,05,DT7349 –19–11NOV97–2/2

CLEAN AND INSPECT CYLINDER HEAD CAP SCREWS

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

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

RG6319 –UN–23NOV97

RG,05,DT7348 –19–11NOV97–1/1

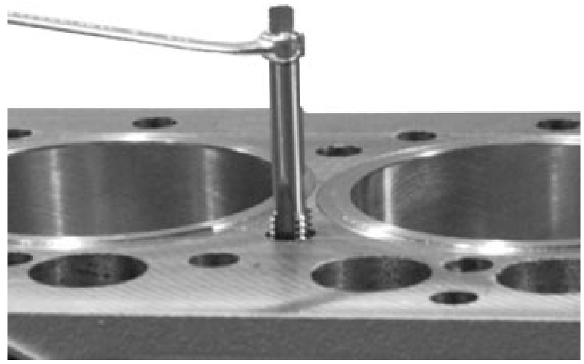
INSPECT AND CLEAN EXHAUST MANIFOLD

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

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

RG,05,DT7347 –19–11NOV97–1/1

CLEAN AND INSPECT TOP DECK OF CYLINDER BLOCK


RG7444 –UN–23NOV97

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

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

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


RG7421 –UN–23NOV97

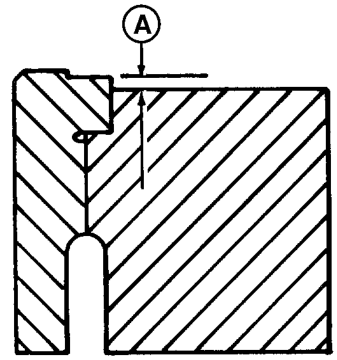
IMPORTANT: All debris must be cleaned from the camshaft followers before assembling the engine.

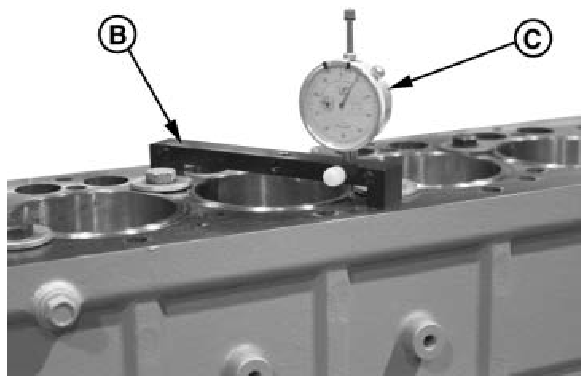
4. If not previously done, remove camshaft followers from block and wash in solvent. Lubricate with clean engine oil and install in the same bore.

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

RG,05,DT7346 –19–11NOV97–1/1

MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK)





A—Liner Height
B—Gauge
C—Dial Indicator

1. Secure 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).

2. Using JDG451 or KJD10123 Gauge (B) and D17526CI or D17527CI Dial Indicator (C), measure liner height (A) at 1, 5, 7, and 11 o'clock positions as viewed from flywheel end of engine. Record all measurements by cylinder number.

Cylinder Liner Height Above Block—Specification

Height .... 0.030—0.100 mm (0.001—0.004 in.)

Cylinder Liner Height Difference At Nearest Point of Two Adjacent Liners, or Within a Single Liner—Specification

Maximum Permissible Height Difference.................................... 0.05 mm (0.002 in.)

IMPORTANT: ONE LINER SHIM ONLY may be installed under each liner flange.

3. Remove and shim, or replace, any liner that does not meet height specifications. (See Group 10.)

NOTE: Two sizes of shims are available: 0.05 mm (0.002 in.) and 0.10 mm (0.004 in.).

RG,05,DT7345 –19–11NOV97–1/1

05
46

INSTALL CYLINDER HEAD

1. Dip fuel supply pump push rod (A) (if equipped) in clean engine oil and carefully install in cylinder block before installing cylinder head.

A—Fuel Supply Pump Push Rod

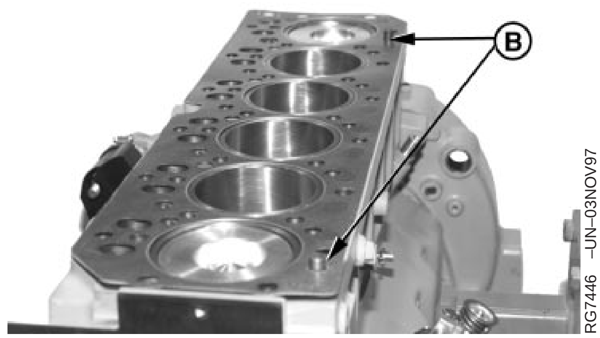
RG,05,DT7344 –19–11NOV97–1/4

IMPORTANT: The O-ring seals in head gasket can be damaged if head is repositioned while resting on engine block. Use guide studs to position cylinder head on block.

2. Install two guide studs (B) in cylinder block at locating holes.

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

3. Place new head gasket on cylinder block. Do not use sealant; install dry.

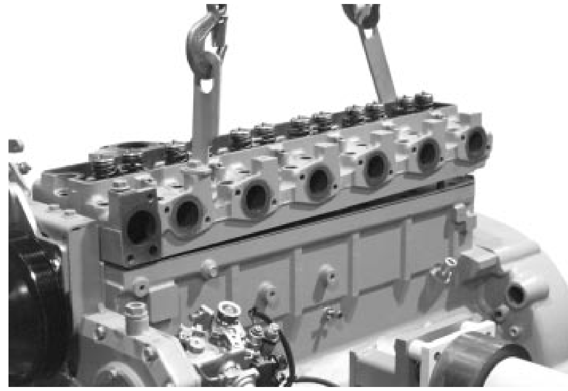


B—Guide Studs

Continued on next page

RG,05,DT7344 –19–11NOV97–2/4

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



RG7415 –UN–23NOV97

RG,05,DT7344 –19–11NOV97–3/4

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

6. Remove guide studs. Install flanged-head cylinder head cap screws.

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

Step 1-Initial Torque—Specification

Torque .... 100 N•m (75 lb-ft)

Step 2-Second Torque—Specification

Torque .... 150 N•m (110 lb-ft)

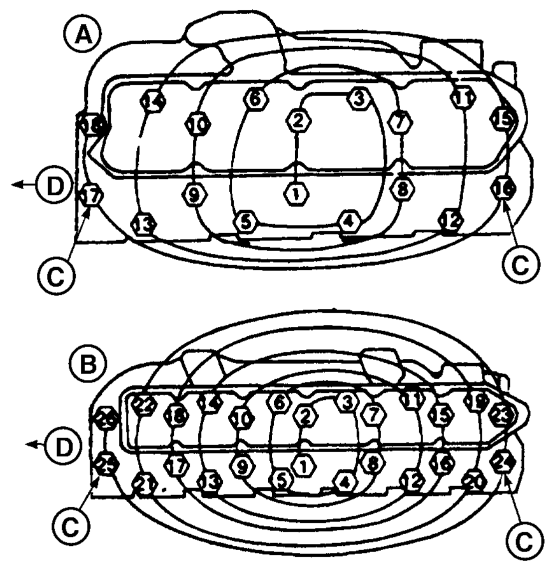
Step 3-Verify Torque (After 5 Minutes)—Specification

Torque .... 150 N•m (110 lb-ft)

Step 4-Torque Turn—Specification

Torque Turn.......... Tighten each screw an additional 60°± 10° (See TORQUE-TURN METHOD FOR PROPER TORQUE next in this group.)

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



RG7646 –UN–07NOV97

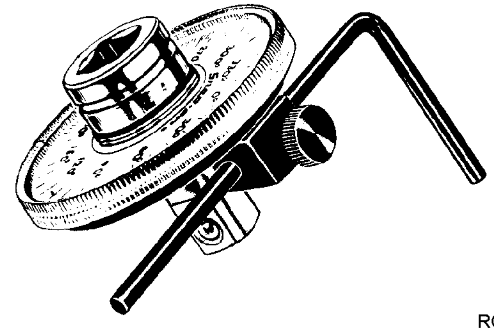
A—4-Cylinder Engine
B—6-Cylinder Engine
C—Locating Holes (Guide Stud Locations)
D—Arrow Toward Front of Engine

RG,05,DT7344 –19–11NOV97–4/4

05
48

TORQUE-TURN METHOD FOR PROPER TORQUE

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



RG5698

RG5698 –UN–05DEC97

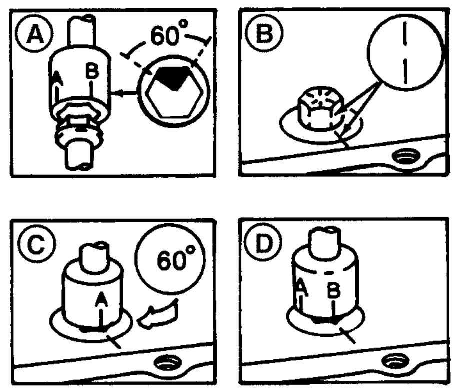
Line scribe method:

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

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

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

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

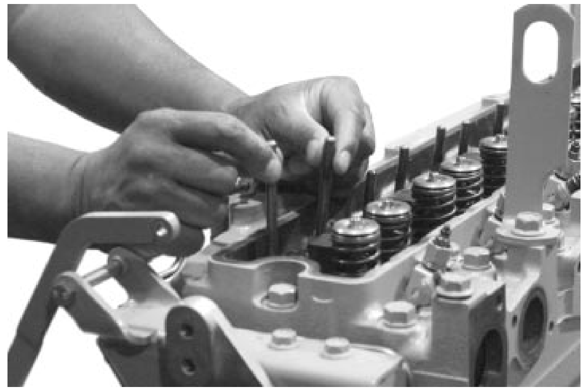


RG5587 –UN–31OCT97

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

RG,05,DT7343 –19–11NOV97–1/1

INSTALL ROCKER ARM ASSEMBLY



RG7448 –UN–23NOV97

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

NOTE: Valve stem tips are specially hardened, wear caps are not required

IMPORTANT: Relieve tension on rocker arm adjusting screw to avoid damaging rocker arm shaft during installation.

2. Position rocker arm assembly on engine.

IMPORTANT: Oil supply hole in rocker arm shaft must be positioned at the flywheel end of engine and facing downward when rocker shaft is installed.

3. Lubricate all rocker arms with engine oil and make sure they move freely. Tighten rocker arm support studs in a criss-cross sequence to specifications.

Rocker Arm Support Studs—Specification

Torque .... 80 N•m (60 lb-ft)

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

RG,05,DT7342 –19–11NOV97–1/1

INSPECT AND CLEAN VENTILATOR OUTLET HOSE

RG7941 –UN–13NOV97

A—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 if they are restricted.

RG,05,DT7341 –19–11NOV97–1/1

INSTALL ROCKER ARM COVER

IMPORTANT: Dispose of sealing ring (A) if there is evidence of damage. Otherwise, do NOT remove seal from groove.

If the sealing ring is defective, the following procedure should be used to install a new sealing ring:

- Carefully remove the old sealing ring from rocker arm cover. Do not use any cutting tool that could damage the cover.
- Clean the groove with acetone. Dry with compressed air.
- When installing new ring in groove, start at ends and work toward the center of the cover. Do not use sealant on seal ring.

1. Install rocker arm cover with seal ring.

RG7450B –UN–04NOV97

A—Sealing Ring

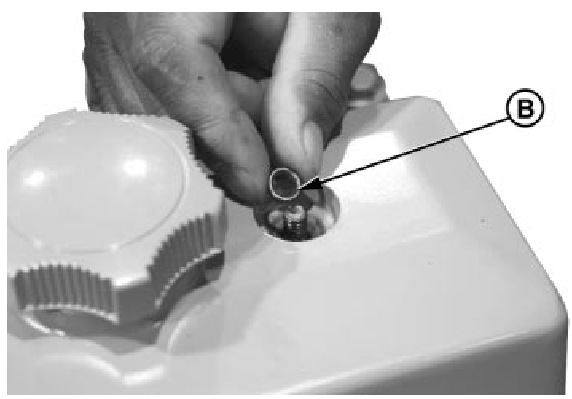
RG,05,DT7340 –19–11NOV97–1/3

2. Install O-rings (B) and nuts.

3. Tighten all nuts to specifications, starting at the center and alternate sides until reaching the ends. DO NOT OVERTIGHTEN.

Rocker Arm Cover Nuts—Specification

Torque	35 N•m (26 lb-ft)



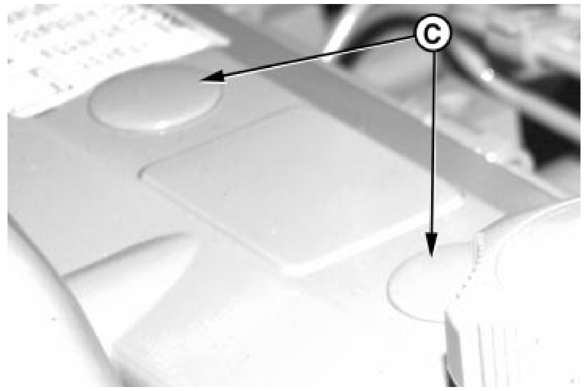
RG7451 –UN–04NOV97

B—O-Rings

Continued on next page

RG,05,DT7340 –19–11NOV97–2/3

4. Install rocker arm cover button plugs (C).

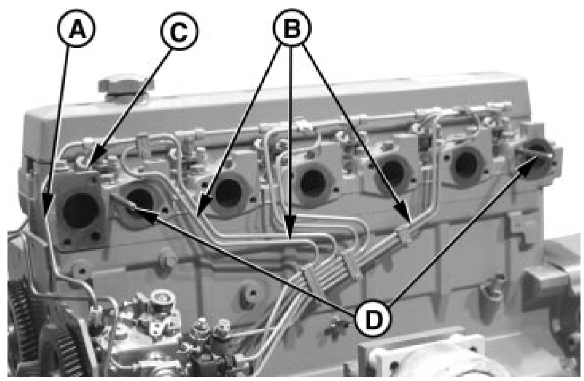


C—Plugs

RG,05,DT7340 –19–11NOV97–3/3

COMPLETE FINAL ASSEMBLY

1. Install injection nozzles (C). Install injection lines (B) as an assembly. (See Group 35.)
2. Install fuel leak-off line (A). (See Group 35.)
3. Install guide pins (D) in cylinder head to aid in installation of exhaust manifold.



A—Fuel Leak-off Line
B—Injection Lines
C—Injection Nozzles
D—Guide Pins

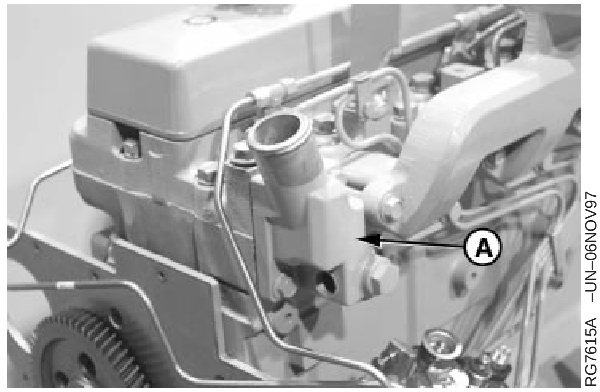
Continued on next page

RG,05,DT7339 –19–11NOV97–1/7

05
52

NOTE: On some engines, the thermostat housing/water manifold is part of the cylinder head.

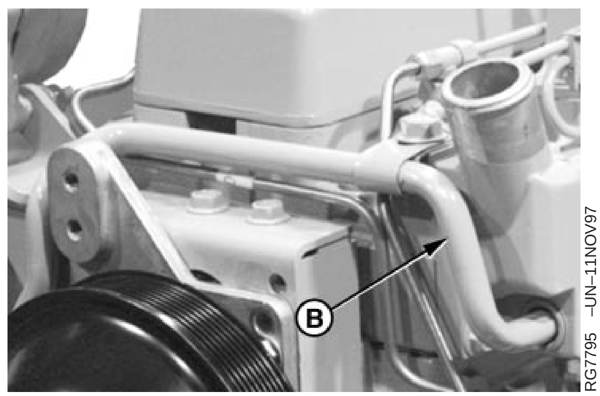
4. Install thermostat housing/water manifold (A). (See Group 25.)



A—Thermostat Housing/Water Manifold

RG,05,DT7339 –19–11NOV97–2/7

5. Install thermostat housing-to-water pump tube (B).



B—Thermostat Housing to Water Pump Tube

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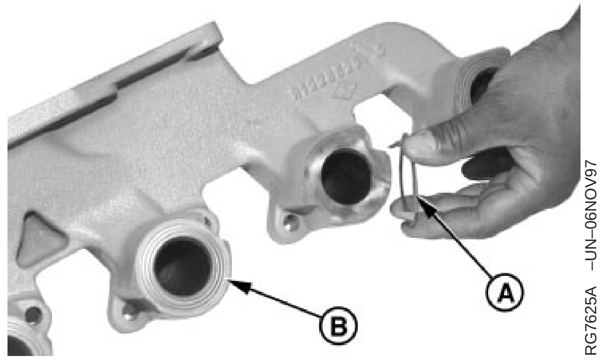
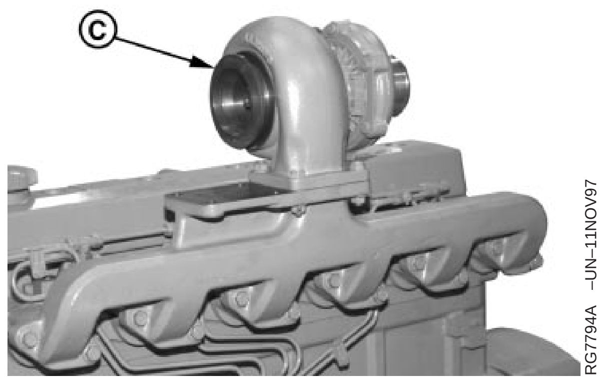
6. Using guide studs, install exhaust manifold (B) with gasket(s) (A). (See Group 30.)



A—Stainless Steel Gasket Shown
B—Exhaust Manifold

RG,05,DT7339 –19–11NOV97–4/7

7. Install turbocharger (C, if equipped) and exhaust elbow (shown removed). (See Group 30.)



C—Turbocharger

Continued on next page

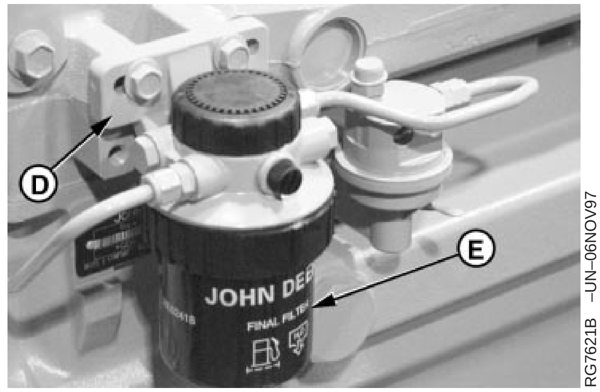
RG,05,DT7339 –19–11NOV97–5/7

05
54

8. Install fuel filter base (D) and fuel filter (E). (See Group 35.)

9. Install fuel supply pump. (See Group 35.)

10. Install air intake elbow. (See Group 30.)



D—Fuel Filter Base
E—Fuel Filter

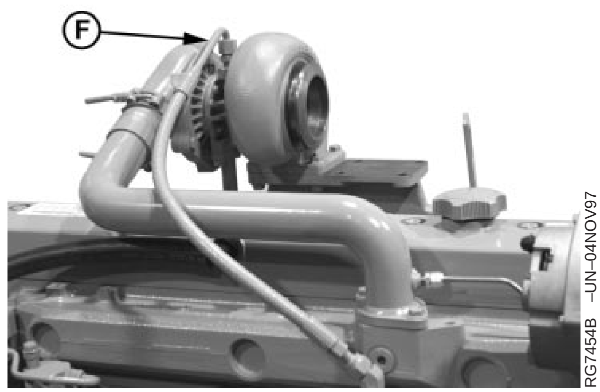
RG,05,DT7339 –19–11NOV97–6/7

11. On turbocharged engines, connect turbocharger oil inlet line (F).

12. Install alternator if removed. (See Group 40.)

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

14. Fill cooling system with clean coolant. (See Group 02.)



F—Turbocharger Oil Inlet Line

RG,05,DT7339 –19–11NOV97–7/7

PERFORM ENGINE BREAK-IN

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

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

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

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

4. Install rocker arm cover. (See INSTALL ROCKER ARM COVER earlier in this group.)

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

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

RG,05,DT7338 –19–11NOV97–1/1

Group 10
Cylinder Block, Liners, Pistons and Rods

ESSENTIAL TOOLS

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

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DPSG,OUO1004,170 –19–07JUL98–1/15

RG6246 –UN–05DEC97

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

Use with JDG451, KJD10123 or magnetic base to measure valve recess in cylinder head and piston and liner height.

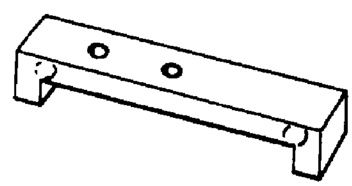
RG6246

DPSG,OUO1004,170 –19–07JUL98–2/15

RG7029 –UN–05DEC97

Height Gauge. . . . . JDG451 or KJD10123

Used with a dial indicator to measure valve recess in cylinder head. Also used to measure piston and liner height.

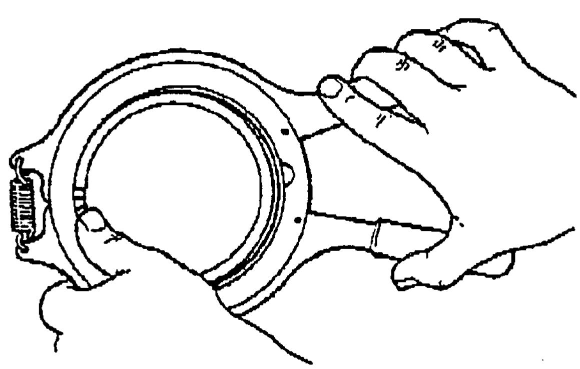


RG7029

DPSG,OUO1004,170 –19–07JUL98–3/15

Piston Ring Expander JDE85, JDE135, KJD10140

Remove and install piston rings.



RG7406 –UN–21MAY98

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DPSG,OUO1004,170 –19–07JUL98–4/15

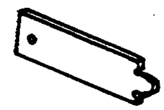
RG5076 –UN–23AUG88

Piston Ring Groove Wear Gauge JDE62

Check wear of keystone ring groove on pistons with tapered rods.

Piston Ring Groove Wear Gauge JDG957

Check wear of keystone ring groove on pistons with straight rods.

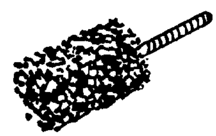


DPSG,OUO1004,170 –19–07JUL98–5/15

RG5074 –UN–07NOV97

Flexible Cylinder Hone D17004BR

Hone cylinder liners.



RG5074

DPSG,OUO1004,170 –19–07JUL98–6/15

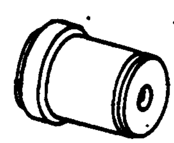
RG5107 –UN–23AUG88

Piston Pin Bushing Remover and Installer JD286

Remove and install large 41 mm (1.6 in.) piston pin bushings.

Piston Pin Bushing Remover and Installer JDE88

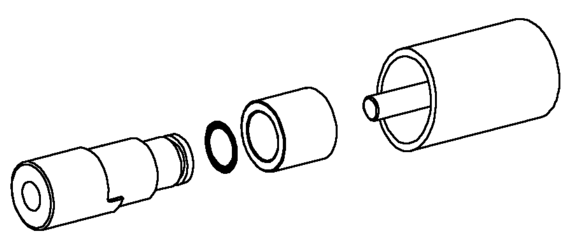
Remove and install small 35 mm (1.3 in.) piston pin bushings.



DPSG,OUO1004,170 –19–07JUL98–7/15

Connecting Rod Bushing Service Set JDG953

Replace pin bushing in connecting rods with tapered pin-end.



RG9126 –UN–22APR98

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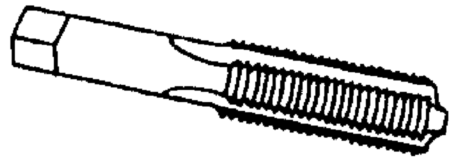
DPSG,OUO1004,170 –19–07JUL98–8/15

RG5100 –UN–05DEC97

Tap JDG680

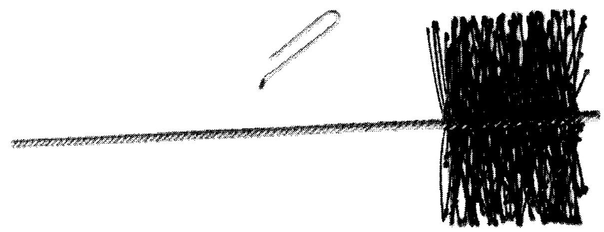
Used to restore threaded holes in cylinder block for cylinder head cap screws.



DPSG,OUO1004,170 –19–07JUL98–9/15

O-Ring Groove Cleaning Brush D17015BR

Clean cylinder liner O-ring groove in block.

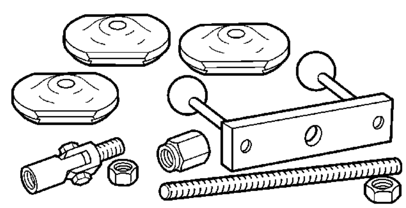


RG5075 –UN–07NOV97

DPSG,OUO1004,170 –19–07JUL98–10/15

Cylinder Liner Puller JDG1145

Used to remove and install cylinder liners.



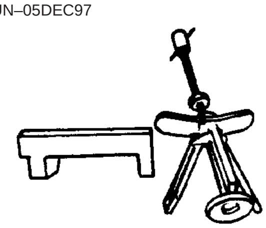
RG9441 –UN–10JUL98

DPSG,OUO1004,170 –19–07JUL98–11/15

RG5019 –UN–05DEC97

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

Used to remove and install cylinder liners.



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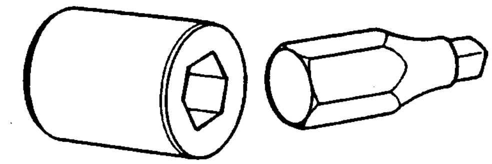
DPSG,OUO1004,170 –19–07JUL98–12/15

Oil Galley Plug Tool. JDG782

Used to remove and install oil galley plug.



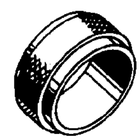
RG6612 –UN–29JAN93

DPSG,OUO1004,170 –19–07JUL98–13/15

RG5031 –UN–05DEC97

Piston Ring Compressor JDE84

Compress rings while installing pistons.

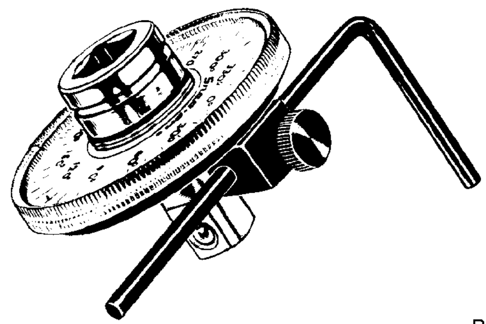


RG5031

DPSG,OUO1004,170 –19–07JUL98–14/15

Torque Angle Gauge JT05993

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



RG5698

RG5698 –UN–05DEC97

DPSG,OUO1004,170 –19–07JUL98–15/15

SERVICE EQUIPMENT AND TOOLS

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

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DPSG,OUO1004,171 –19–07JUL98–1/3

Piston Ring Groove Cleaning Tool . . . . N/A

Clean piston ring grooves.

DPSG,OUO1004,171 –19–07JUL98–2/3

Precision “Bevelled Edge” Straightedge 05012ST

Check cylinder head flatness.

DPSG,OUO1004,171 –19–07JUL98–3/3

OTHER MATERIAL

Number	Name	Use
N/A (U.S.)	PLASTIGAGE®	Determine connecting rod bearing-to-journal oil clearance.
AR54749 (U.S.)	Soap Lubricant	Apply to cylinder liner O-rings and packing.

PLASTIGAGE is a registered trademark of DANA Corp.

DPSG,OUO1004,172 –19–07JUL98–1/1

10
6

CYLINDER BLOCK, LINERS, PISTONS AND RODS SPECIFICATIONS

Item	Measurement	Specification
Piston Rings—4045DF, TF150 and 6068DF, TF150 Engines	End Gap (No. 1 Compression) End Gap (No. 2 Compression) End Gap (No. 3 Oil Control)	0.33—0.58 mm (0.013—0.023 in.) 1.24—1.49 mm (0.049—0.059 in.) 0.30—0.56 mm (0.011—0.022 in.)
Piston Rings—4045TF250 and 6068TF250 Engines	End Gap (No. 1 Compression) End Gap (No. 2 Compression) End Gap (No. 3 Oil Control)	0.33—0.64 mm (0.013—0.025 in.) 0.75—1.00 mm (0.030—0.039 in.) 0.33—0.64 mm (0.013—0.025 in.)
Cylinder Liner Height	Height above block Maximum permissible difference between readings within one cylinder or between adjacent cylinders	0.030—0.100 mm (0.001—0.004 in.) 0.05 mm (0.002 in.)
Cylinder Liner	Thickness	5.875—6.375 mm (0.2313—0.2510 in.)
Cylinder Liner Packing Step	Dimension	2.0185—2.2865 mm (0.07947—0.09002 in.)
Piston Ring-to-Groove Clearance—New Piston Ring (Second and Third Ring Grooves)	Maximum Clearance	0.20 mm (0.008 in.)
Piston Pin Bore (Small Pin)	ID	34.935—34.945 mm (1.3754—1.3758 in.)
Piston Pin Bore (Large Pin)	ID	41.285—41.295 mm (1.6254—1.6258 in.)
Piston Skirt (Measurement taken bottom of skirt 28 mm (1.1 in.) from bottom of piston)	Diameter	106.38—106.40 mm (4.188—4.189 in.)
Piston	Height (Measured From Center of Pin Bore to Top of Piston)	71.64—71.70 mm (2.820—2.823 in.)

Continued on next page

DPSG,OUO1004,230 –19–10JUL98–1/6

Item	Measurement	Specification
Piston-to-Liner Clearance: (Measured at Bottom of Piston Skirt) (Naturally Aspirated Engines)	Clearance	0.08—0.14 mm (0.003—0.005 in.)
Piston-to-Liner Clearance: (Measured at Bottom of Piston Skirt) (Turbocharged Engines)	Clearance	0.08—0.15 mm (0.003—0.006 in.)
Cylinder Liner Out-Of-Round (Top or Bottom)	Maximum Out-of-Round	0.05 mm (0.002 in.)
Cylinder Liner Taper	Maximum Taper	0.05 mm (0.002 in.)
Crankshaft Journal	OD	77.800—77.826 mm (3.0629—3.0640 in.)
Assembled Rod Bearing	ID	77.876—77.927 mm (3.0659—3.0679 in.)
Connecting Rod Bearing-to-Journal (New Parts)	Oil Clearance	0.050—0.127 mm (0.0020—0.0050 in.)
	Wear Limit	0.152 mm (0.0600 in.)
Connecting Rod Bore (Without Bearing Inserts)	ID	82.677—82.703 mm (3.2550—3.2560 in.)
Connecting Rod Bore Maximum Permissible Out-of-Round	Out-of-Round	0.038 mm (0.0015 in.)
Piston Pin (Small)	OD	34.920—34.930 mm (1.3748—1.3752 in.)
	Wear Limit	34.907 mm (1.3743 in.)
Piston Pin (Large)	OD	41.270—41.280 mm (1.6248—1.6252 in.)
	Wear Limit	41.257 mm (1.6243 in.)
Piston Pin	Length	71.51—72.11 mm (2.815—2.839 in.)
Piston Pin Bushing Installed (Small Pin)	ID	34.950—34.976 mm (1.3760—1.3770 in.)
	Wear Limit	35.026 mm (1.3790 in.)

Continued on next page

Item	Measurement	Specification
Piston Pin Bushing Installed (Large Pin)	ID	41.300—41.326 mm (1.6260—1.6270 in.)
	Wear Limit	41.376 mm (1.6290 in.)
Piston Pin-to-Bushing	Oil Clearance	0.020—0.056 mm (0.0008—0.0022 in.)
	Wear Limit	0.102 mm (0.0040 in.)
Connecting Rod Small Pin Bore (Bushing Removed)	ID	38.087—38.113 mm (1.4995—1.5005 in.)
Connecting Rod Large Pin Bore (Bushing Removed)	ID	46.025—46.051 mm (1.8120—1.8130 in.)
Connecting Rod Pin-to-Bushing (Tapered Pin-End)	Oil Clearance	0.020—0.056 mm (0.0008—0.0022 in.)
Connecting Rod Pin-to-Bushing (Straight Pin-End)	Oil Clearance	0.020 —0.056 mm (0.0008—0.0022 in.)
	Wear Limit	0.102 mm (0.0040 in.)
Rod Bearing Bore-to-Piston Pin Bushing Bore (Center-to-Center)	Measurement	202.95—203.05 mm (7.990—7.994 in.)
Cylinder Block Main Bearing Bore	ID	84.455—84.481 mm (3.3250—3.3260 in.)
Camshaft Follower Bore in Block	ID	31.70—31.75 mm (1.248—1.250 in.)
Camshaft Follower (New)	OD	31.61—31.64 mm (1.245—1.246 in.)
Camshaft Follower-to-Bore	Clearance	0.06—0.13 mm (0.002—0.005 in.)
Camshaft Bore in Block, Front No. 1 (Without Bushing)	ID	59.961—59.987 mm (2.3607—2.3617 in.)
Camshaft Bore in Block, Front No. 1 (With Bushing)	ID	55.961—55.987 mm (2.2031—2.2042 in.)
Camshaft Bore in Block (All Except No. 1)	ID	55.986—56.012 mm (2.2042—2.2052 in.)
Camshaft Journal-to-Bushing (No. 1 Bore With Bushing)	Oil Clearance	0.063—0.115 mm (0.0025—0.0045 in.)

Continued on next page DPSG,OUO1004,230 –19–10JUL98–3/6

Item	Measurement	Specification
Camshaft Journal-to-Bushing (All Except No. 1)	Oil Clearance	0.088—0.140 mm (0.0035—0.0055 in.)
Balancer Shaft Bore in Block (Bushing Removed)	ID	43.262—43.288 mm (1.7032—1.7042 in.)
Balancer Shaft Bushing	ID	40.177—40.237 mm (1.5818—1.5841 in.)
Balancer Shaft Journal-to-Bushing	Clearance	0.016—0.102 mm (0.0006—0.0040 in.)
Lower Block Bore for Seating Liner	ID	115.75—115.80 mm (4.557—4.559 in.)
Upper Block Bore for Seating Liner	ID	120.70—120.75 mm (4.752—4.754 in.)
Liner Flange ID in Block	ID	126.33—126.35 mm (4.973—4.974 in.)
OD of Liner at Upper Bore	OD	120.61—120.69 mm (4.7484—4.7516 in.)
Liner-to-Cylinder Block Clearance at Lower Bore	Clearance	0.035—0.100 mm (0.001—0.004 in.)
Liner-to-Cylinder Block Clearance at Upper Bore	Clearance	0.10—0.14 mm (0.004—0.005 in.)
Cylinder Liner	ID	106.48—106.52 mm (4.192—4.194 in.)
Cylinder Wear	Maximum Wear	0.10 mm (0.004 in.)
Cylinder Taper	Maximum Taper	0.05 mm (0.002 in.)
Cylinder Out-of-Round	Maximum Out-of-Round	0.05 mm (0.002 in.)
Cylinder Liner Flange Counterbore Depth in Block	Depth	5.952—5.988 mm (0.2343—0.2357 in.)
Cylinder Liner Flange	Thickness	6.022—6.058 mm (0.2371—0.2385 in.)

Continued on next page

DPSG,OUO1004,230 –19–10JUL98–4/6

Item	Measurement	Specification
Cylinder Block Top Deck		
Maximum Acceptable Out-of-Flat, Entire Length or Width (Used)	Measurement	0.08 mm (0.003 in.)
Maximum Acceptable Out-of-Flat (Any 150 mm (5.90 in.) Length	Measurement	0.025 mm (0.001 in.)
Top Deck Surface Finish (Surface Grind Only) (AA)	Surface Finish	0.8—3.2 micrometers (32—125 micro-in.)
Top Deck Surface Finish Wave Depth	Maximum Depth	0.012 mm (0.0005 in.)
Main Bearing Bore Centerline-to-Cylinder Block Top Deck	Distance	337.896—337.972 mm (13.3029—13.3059 in.)
Piston Cooling Orifice	Diameter	1.4 mm (0.055 in.)
Piston Cooling Orifice	Torque	11 N•m (8 lb-ft) (96 lb-in.)
Push Rod	OD	9.891—9.917 mm (0.3894—0.3904 in.)
Push Rod Bore in Block	ID	10.00—10.05 mm (0.3937—0.3957 in.)
Cylinder Liner Height Above Block	Height	0.030—0.100 mm (0.001—0.004 in.)
Cylinder Liner Height Difference At Nearest Point of Two Adjacent Liners, or Within a Single Liner	Maximum Permissible Height Difference	0.05 mm (0.002 in.)
Connecting Rod Cap Screws	Initial Torque	58 N•m (43 lb-ft)
Connecting Rod Cap Screws	Torque Turn	1/4 Turn (90—100°) After Initial Torque

Continued on next page DPSG,OUO1004,230 –19–10JUL98–5/6

Item	Measurement	Specification
Piston Protrusion (Using JDG451 or KJD10123 Gauge)		
4-Cyl Standard Duty Codes 4801, 4803, 4809. 6-Cyl Standard Duty Codes 4805, 4807.	Piston Protrusion	0.08—0.31 mm (0.003—0.012 in.)
4-Cyl Heavy Duty Code 4804. 6-Cyl Heavy Duty Codes 4808, 4810.	Piston Protrusion	0.08—0.25 mm (0.003—0.010 in.)
Piston Protrusion (Using Magnetic Base Dial Indicator)		
4-Cyl Standard Duty Codes 4801, 4803, 4809. 6-Cyl Standard Duty Codes 4805, 4807.	Piston Protrusion	0.15—0.38 mm (0.006—0.015 in.)
4-Cyl Heavy Duty Code 4804. 6-Cyl Heavy Duty Codes 4808, 4810.	Piston Protrusion	0.15—0.33 mm (0.006—0.013 in.)

DPSG,OUO1004,230 –19–10JUL98–6/6

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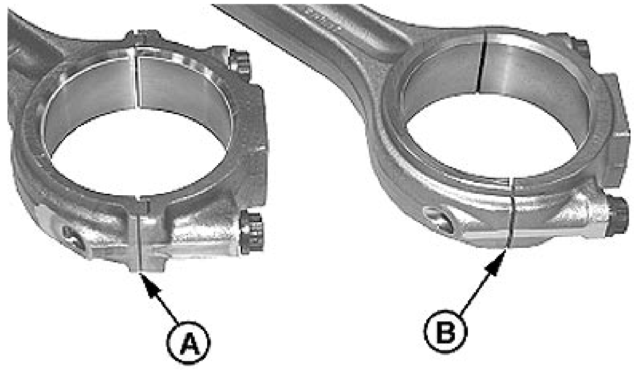
12

CONNECTING RODS—GENERAL INFORMATION

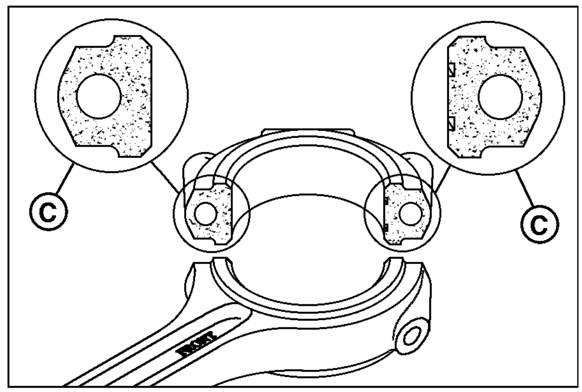
Earlier engines have the traditional tongue-and-groove between the connecting rod and cap (A). Later engines have the Precision Joint™ rod and cap (B).

To create the Precision Joint™, the connecting rod is notched with a laser beam. Then a precision mandrel in the rod bore is powered to separate the cap from the rod at the joints (C).

Both types of rods provide a strong joint and torque on cap screws is the same. Removal and installation is similar, with differences noted. See INSPECT ROD AND CAP and INSTALL PISTON AND CONNECTING ROD later in this Group.



RG9447 –UN–27JUL98



RG9556 –UN–02JUL98

A—Tongue-and-Groove Rod (Early Engines)
B—Precision Joint™ Rod (Later Engines)
C—Precision Joint™ Details

Precision Joint is a trademark of Deere & Company

DPSG,OUO1004,165 –19–06JUL98–1/1

REMOVE PISTONS AND CONNECTING RODS

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

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

1. Drain coolant and engine oil.

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

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

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

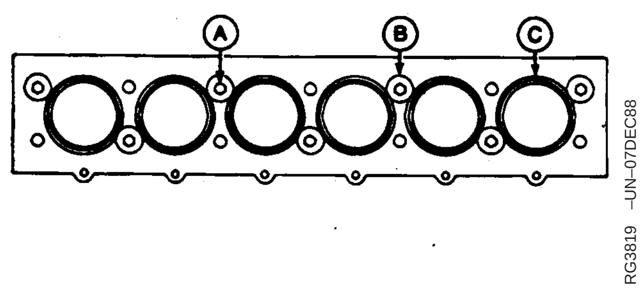
4. Clean all foreign material from cylinder block top deck.

RG,10,DT7421 –19–12NOV97–1/5

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

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

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



A—Cap Screws
B—Washers
C—Liners

Continued on next page RG,10,DT7421 –19–12NOV97–2/5

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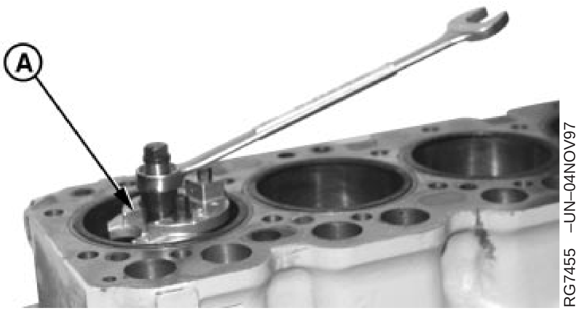
14

NOTE: Always follow manufacturer's directions provided with ridge reamer.

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



A—Ridge Reamer

RG,10,DT7421 –19–12NOV97–3/5

7. Remove oil pan, oil pump, and outlet tube. (See Group 20.)

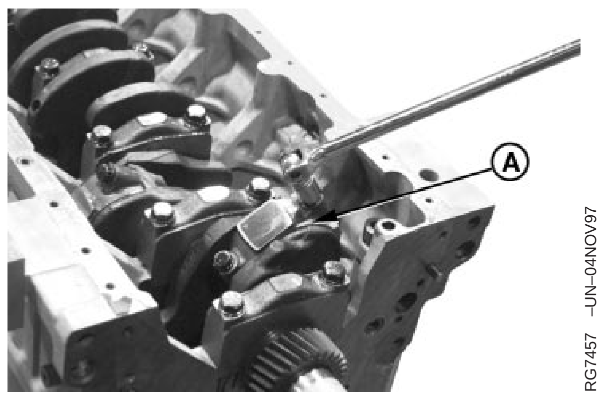
8. Mark rods, pistons, and caps to insure correct assembly in same location.

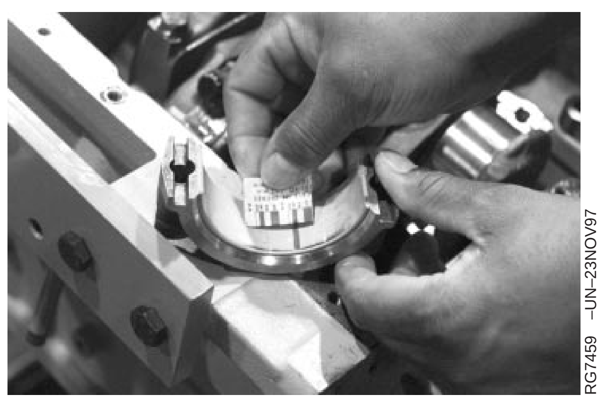
IMPORTANT: Keep inserts with their respective caps for rod and main bearings.

9. Remove all rod caps (A) with bearings.

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

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





A—Rod Caps

PLASTIGAGE is a registered trademark of the DANA Corp.

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RG,10,DT7421 –19–12NOV97–4/5

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

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

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

12. Remove pistons and rods from engine.

13. If piston rings are to be reused, measure piston ring end gap and compare to the following specifications:

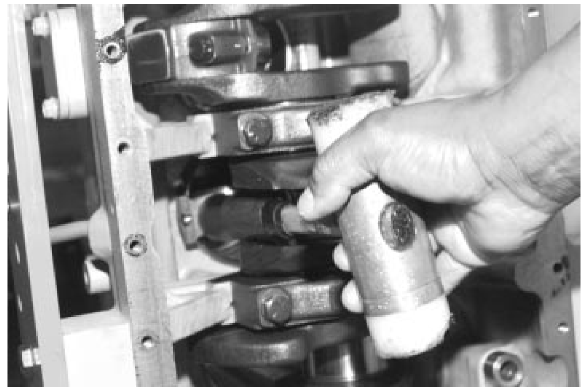
Piston Rings—4045DF, TF150 and 6068DF, TF150 Engines—Specification

End Gap (No. 1 Compression)	0.33—0.58 mm (0.013—0.023 in.)
End Gap (No. 2 Compression)	1.24—1.49 mm (0.049—0.059 in.)
End Gap (No. 3 Oil Control)	0.30—0.56 mm (0.011—0.022 in.)

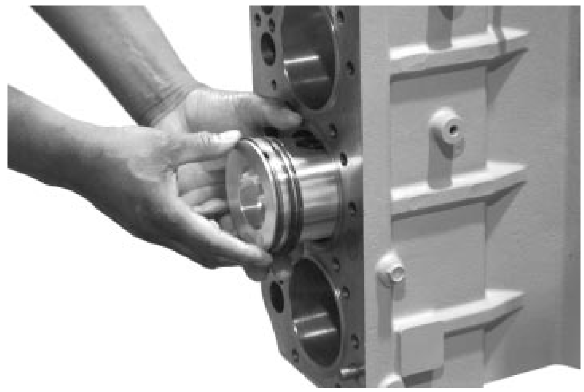
Piston Rings—4045TF250 and 6068TF250 Engines—Specification

End Gap (No. 1 Compression)	0.33—0.64 mm (0.013—0.025 in.)
End Gap (No. 2 Compression)	0.75—1.00 mm (0.030—0.039 in.)
End Gap (No. 3 Oil Control)	0.33—0.64 mm (0.013—0.025 in.)

14. Remove all main bearing caps with bearings. Remove crankshaft from engine.



RG7460 –UN–23NOV97



RG7934 –UN–05JAN98

RG,10,DT7421 –19–12NOV97–5/5

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16

REMOVE CYLINDER LINERS

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

1. Using D17526CI (or D17527CI) Dial Indicator and JDG451 Gauge (or KJD10123 Gauge), measure height (A) of each liner at 1, 5, 7, and 11 o'clock positions as viewed from rear of engine. Record all measurements.

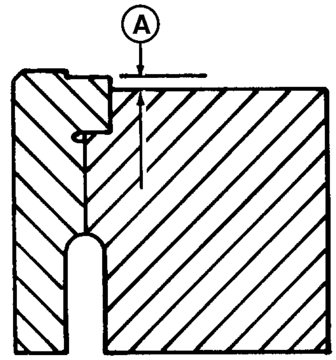
Cylinder Liner Height—Specification

Height above block	0.030—0.100 mm (0.001—0.004 in.)
Maximum permissible difference between readings within one cylinder or between adjacent cylinders	0.05 mm (0.002 in.)

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

IMPORTANT: DO NOT stamp top of piston. Piston may be damaged.

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



RG6439 –UN–03NOV97

RG7461 –UN–23NOV97

A—Liner Height

Continued on next page

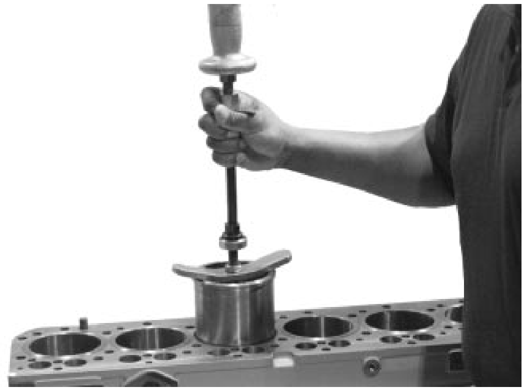
RG,10,DT7420 –19–12NOV97–1/3

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

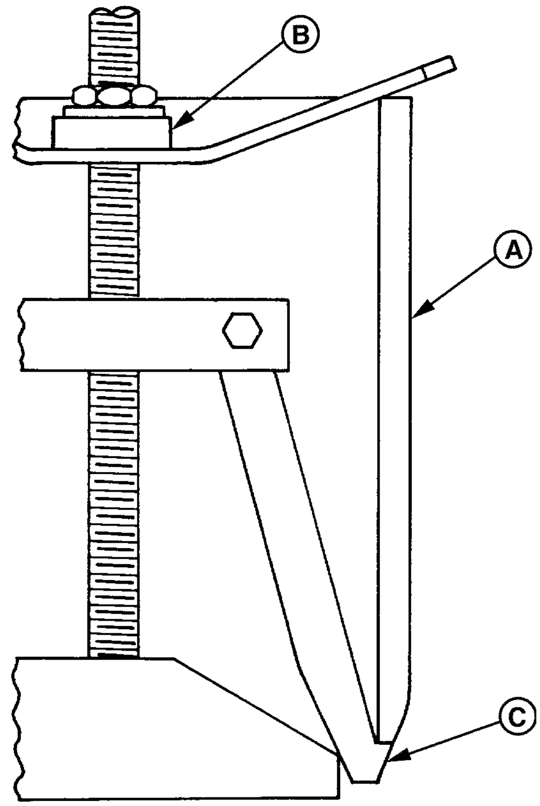
4. Pull liners out of cylinder block with D01062AA, D01073AA, KCD10001 or JDG1145 Puller.

NOTE: If the KCD10001 Puller is used, secure puller with two cylinder head cap screws.

IMPORTANT: When using D01062AA (or D01073AA) Cylinder Liner Puller (B) to remove liners (A), be sure jaw (C) of puller is correctly positioned before attempting to remove liner. DO NOT over-tighten liner puller to remove liners. Doing so could easily break liners.



RG7462 –UN–23NOV97



RG1179 –UN–05DEC97

A—Liners
B—Cylinder Liner Puller
C—Jaw

Continued on next page RG,10,DT7420 –19–12NOV97–2/3

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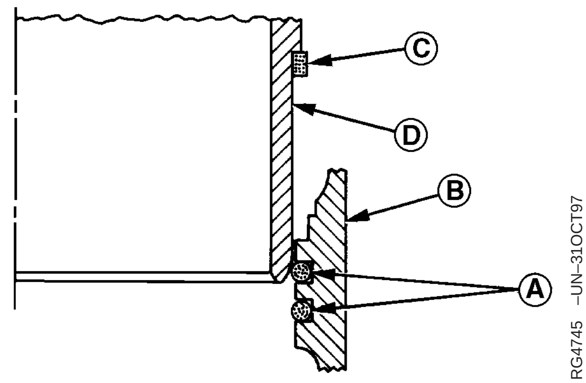
18

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



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

RG,10,DT7420 –19–12NOV97–3/3

COMPLETE DISASSEMBLY OF CYLINDER BLOCK (IF REQUIRED)

If not previously removed, also remove:

1. Crankshaft pulley. (Group 15)
2. Oil pressure regulating plug, valve, and spring in timing gear cover. (Group 16)
3. Timing gear cover, timing gears, and camshaft. (Group 16)
4. Camshaft bushing. (Group 16)
5. Balancer shafts and balancer shaft bushings (if equipped). (Group 16)
6. Front plate and oil-bypass valve. (Group 16)
7. Crankshaft and main bearings. (Group 15)
8. Piston cooling orifices.
9. Remove water gallery plugs.
10. If necessary to “Hot Tank” the block, also remove screw-in type oil gallery plugs and the engine serial number plate.

RG,10,DT7419 –19–12NOV97–1/1

PRELIMINARY LINER, PISTON AND ROD CHECKS

Scuffed or Scored Pistons:

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

Worn or Broken Compression Rings:

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

Clogged Oil Control Ring:

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

Dull Satin Finish and Fine Vertical Scratches on Rings:

Dirt and abrasive in air intake system.

Stuck Rings:

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

Cylinder Liner Wear and Distortion:

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

Warped Cylinder Block:

Insufficient cooling.

Broken Connecting Rod:

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

Piston Pin and Snap Ring Failure:

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

Mottled, Grayish or Pitted Compression Rings:

Internal coolant leaks.

RG,10,DT7418 –19–12NOV97–1/1

DISASSEMBLE PISTON AND ROD ASSEMBLY

IMPORTANT: DO NOT reuse piston rings.

1. Remove piston rings using the JDE135 (shown), JDE85, or KJD10140 Piston Ring Expander.

RG7463 –UN–23NOV97

RG,10,DT7417 –19–12NOV97–1/2

2. Remove and discard piston pin snap rings.

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

RG7464 –UN–23NOV97

RG,10,DT7417 –19–12NOV97–2/2

CLEAN PISTONS


RG7465 –UN–23NOV97

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

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

IMPORTANT: When washing pistons, always use a stiff bristle brush—NOT A WIRE BRUSH—to loosen carbon residue. DO NOT bead blast ring groove areas.

2. Clean pistons by any of the following methods:

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

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

RG,10,DT7424 –19–12NOV97–1/1

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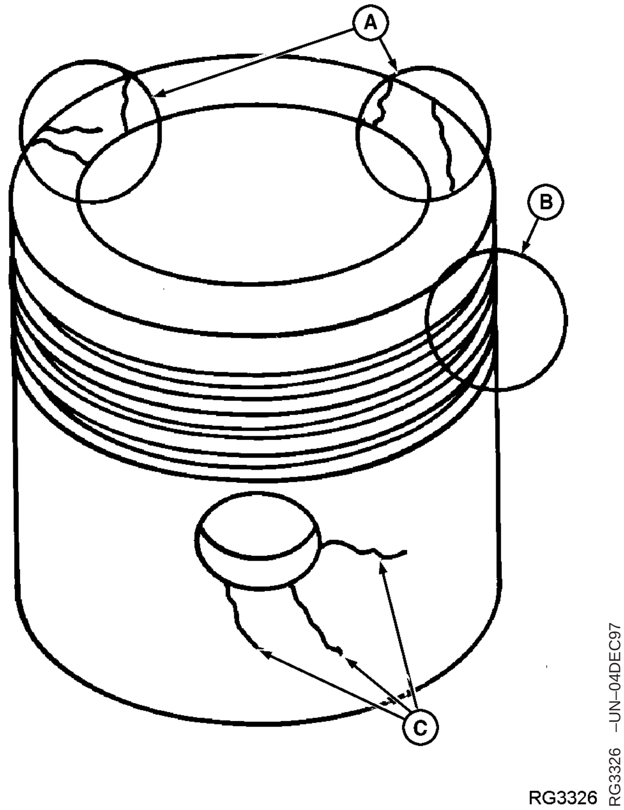
22

VISUALLY INSPECT PISTONS

Carefully inspect pistons under magnification. Check for:

- signs of fatigue
- fine cracks in the piston head (A)
- bent or broken ring lands (B)
- cracks in the skirt (C) at inner and outer ends of piston pin bore
- excessive piston skirt wear. (Original machining marks must be visible.)

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



Piston (Defects Exaggerated)

A—Piston Head
B—Ring Lands
C—Piston Pin Bore

RG,10,DT7416 –19–12NOV97–1/1

CLEAN CYLINDER LINERS

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

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

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

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

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

RG,10,DT7425 –19–12NOV97–1/1

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24

VISUALLY INSPECT CYLINDER LINERS

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

NOTE: When installing reusable liners, rotate 90° from original position. The liners should be deglazed and ring sets installed in pistons.

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

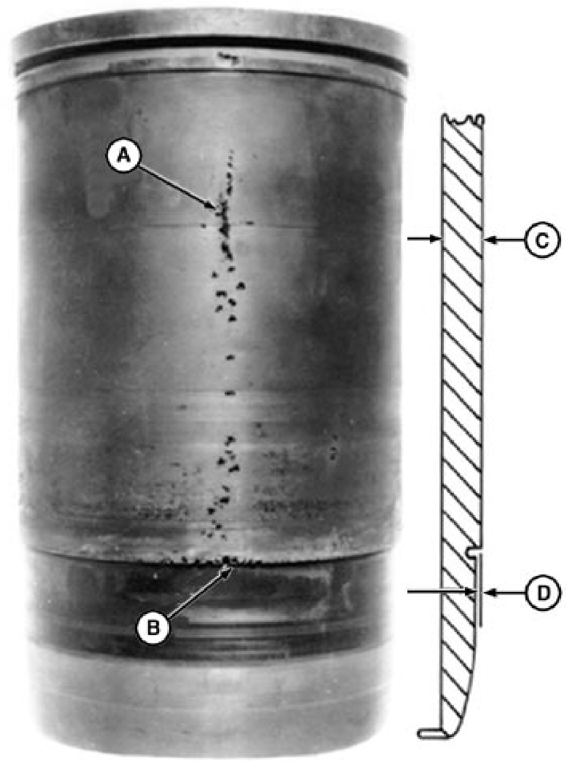
   - Depth of any pit is one-half or more of liner thickness (C).
   - Depth of erosion is one-half or more of the packing step (D).

Cylinder Liner—Specification

Thickness... 5.875—6.375 mm (0.2313—0.2510 in.)

Cylinder Liner Packing Step—Specification

Dimension.. 2.0185—2.2865 mm (0.07947—0.09002 in.)



RG4643 –UN–05DEC97

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

Continued on next page

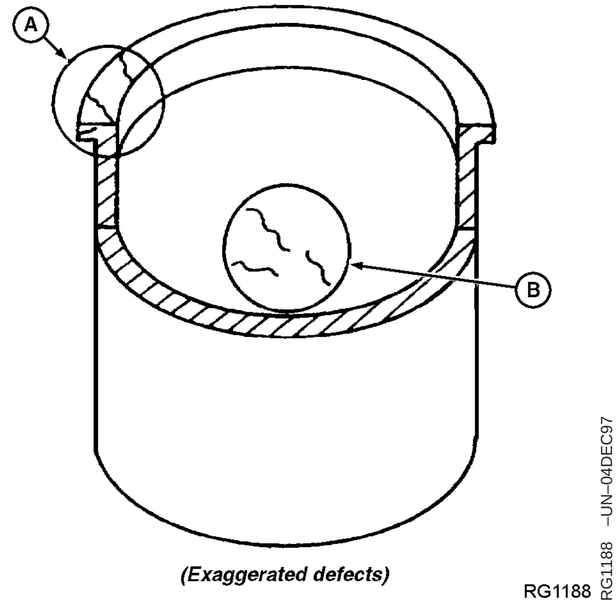
RG,10,DT7415 –19–12NOV97–1/2

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

    - The crosshatch honing pattern is not visible immediately below the top ring turn-around area for turbocharged engines.
    - The hone pattern is not visible all the way around the liner in over 75 percent of the ring travel area for naturally aspirated engines.
    - Liners are pitted or contain deep vertical scratches that can be detected by the fingernail.

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

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



Cylinder Liner (Exaggerated Defects)

A—Flange Area
B—Ring Travel Area

RG,10,DT7415 –19–12NOV97–2/2

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26

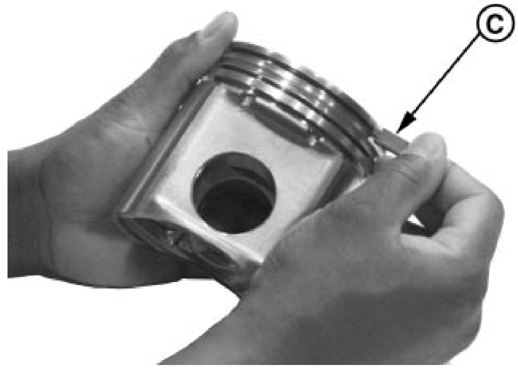
CHECK PISTON RING GROOVE WEAR

Pistons with tapered rods will use JDE62 Ring Groove Wear Gauge and pistons with straight rods will use JDG957 Ring Groove Wear Gauge.

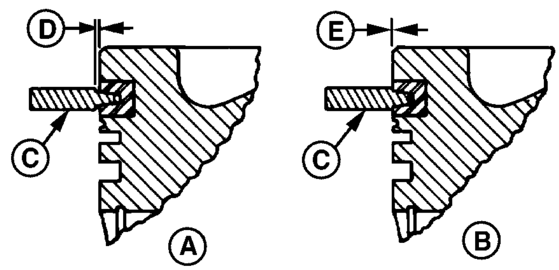
1. Use the appropriate ring groove wear gauge (C) to check wear of keystone ring groove (top groove). Check grooves at several locations around the circumference of piston.

   Gauge shoulders should not contact ring land. Clearance (D) between shoulders of tool and ring land indicate ring groove is good.

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



RG7467 –UN–04NOV97



RG9059 –UN–16MAR98

A—Piston with Good Keystone Ring Groove
B—Piston with Worn Keystone Ring Groove
C—Ring Groove Wear Gauge
D—Clearance (Normal)
E—No Clearance (Replace)

RG,10,DT7414 –19–12NOV97–1/2

2. Check second and third ring grooves using a new piston ring and a feeler gauge. Measure clearance at several points. Compare measurements with specifications.

Piston Ring-to-Groove Clearance—New Piston Ring (Second and Third Ring Grooves)—Specification

Maximum Clearance.. 0.20 mm (0.008 in.)

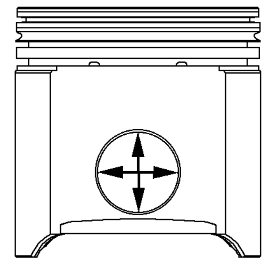
3. Replace piston and liner (as a set) if clearance exceeds specification.

RG7468 –UN–23NOV97

RG,10,DT7414 –19–12NOV97–2/2

MEASURE PISTON PIN BORE

Measure piston pin bore. If bore is not within specification, replace piston and liner set.


RG7402 –UN–23NOV97

Piston Pin Bore (Small Pin)—Specification

ID .... 34.935—34.945 mm (1.3754—1.3758 in.)

Piston Pin Bore (Large Pin)—Specification

ID .... 41.285—41.295 mm (1.6254—1.6258 in.)

RG,10,DT7413 –19–12NOV97–1/1

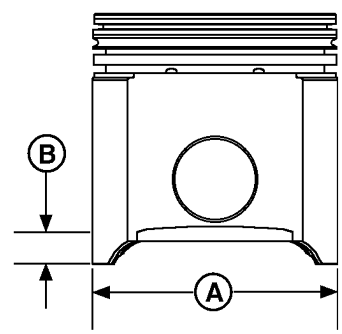
MEASURE PISTON SKIRT

1. Measure piston skirt (A) 90° to piston pin bore and 28 mm (1.1 in.) from bottom of piston (B). Record measurement.

Piston Skirt (Measurement taken bottom of skirt 28 mm (1.1 in.) from bottom of piston)—Specification

Diameter .... 106.38—106.40 mm (4.188—4.189 in.)

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



RG7403 –UN–03NOV97

A—Piston Skirt
B—Measurement Area

RG,10,DT7412 –19–12NOV97–1/1

MEASURE PISTON HEIGHT

Measure piston height from center of piston pin bore-to-top of piston.

Piston—Specification

Height (Measured From Center of Pin Bore to Top of Piston) .... 71.64—71.70 mm (2.820—2.823 in.)

DPSG,OUO1004,212 –19–09JUL98–1/1

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28

DETERMINE PISTON-TO-LINER CLEARANCE

1. Put piston (without rings) in matched liner with piston “front” and liner “front”[1] aligned. Move piston down until bottom edge of piston skirt is 25.4 mm (1.00 in.) (A) from bottom of liner. Use a feeler gauge to measure clearance (B) between piston skirt and liner 90° to pin bore. Record the measured clearance.

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

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

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

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

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

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

Piston-to-Liner Clearance: (Measured at Bottom of Piston Skirt) (Naturally Aspirated Engines)—Specification

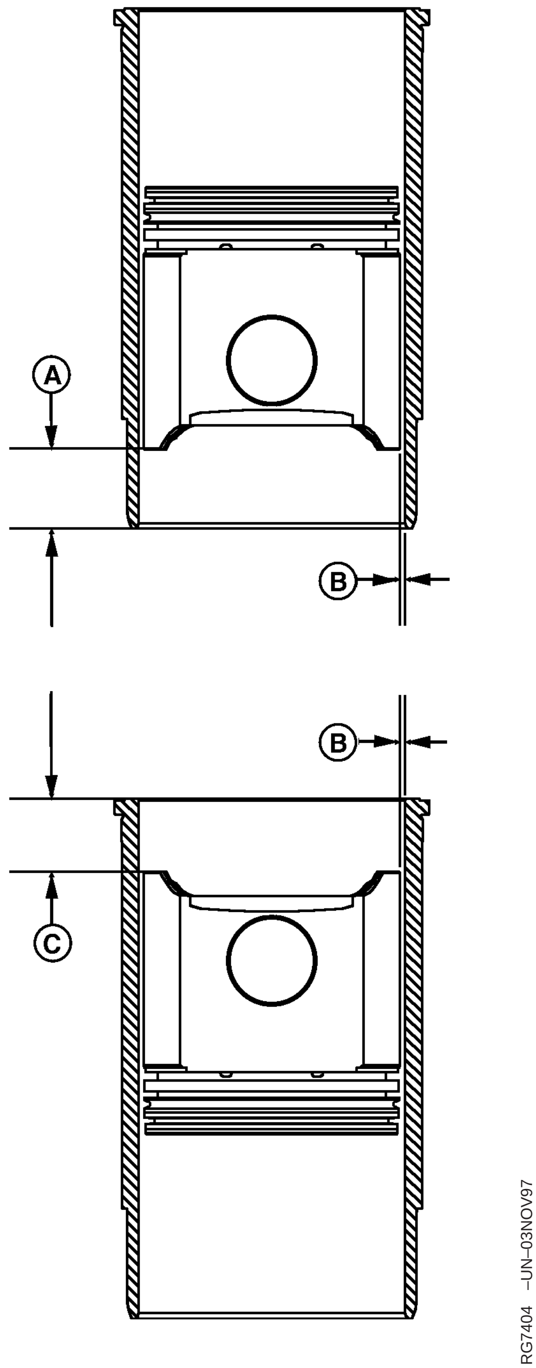
Clearance .... 0.08—0.14 mm (0.003—0.005 in.)

Piston-to-Liner Clearance: (Measured at Bottom of Piston Skirt) (Turbocharged Engines)—Specification

Clearance .... 0.08—0.15 mm (0.003—0.006 in.)

Cylinder Liner Out-Of-Round (Top or Bottom)—Specification

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



A—25.4 mm (1.00 in.)
B—Skirt-to-Liner Clearance
C—25.4 mm (1.00 in.)

[1] *As marked during liner removal from engine.*

Continued on next page RG,10,DT7411 –19–12NOV97–1/2

Cylinder Liner Taper—Specification

Maximum Taper.. 0.05 mm (0.002 in.)

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

RG,10,DT7411 –19–12NOV97–2/2

DEGLAZE CYLINDER LINERS

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

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

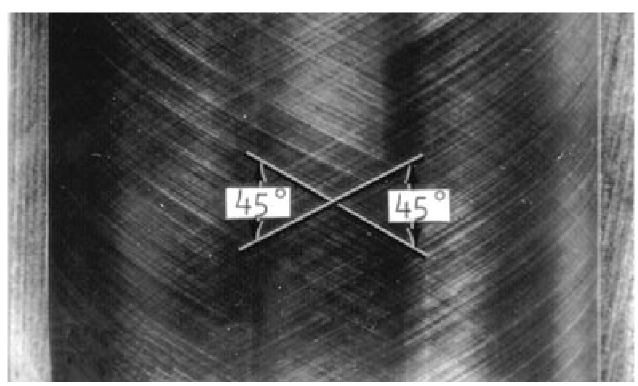
NOTE: Use honing oil along with flex hone when deglazing liners.

RGR26164 –UN–11DEC97

RG,10,DT7410 –19–12NOV97–1/2

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

   Thoroughly clean liners after deglazing. See CLEAN CYLINDER LINERS earlier in this group for proper cleaning procedures.



RGR26165 –UN–11DEC97

RG,10,DT7410 –19–12NOV97–2/2

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30

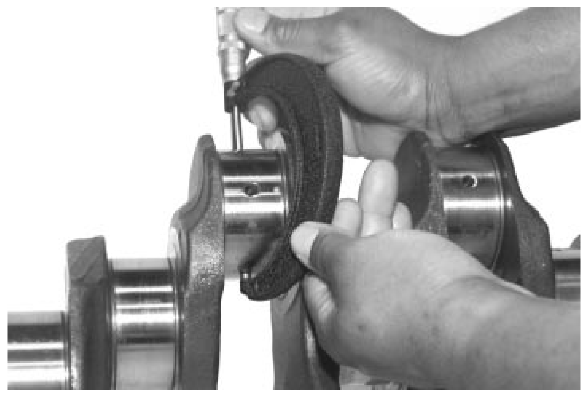
REPLACE PISTON AND LINER SETS

IMPORTANT: ALWAYS install a new (matched set) liner when replacing a piston. DO NOT stamp top of piston. Piston may be damaged.

Mark matched piston and liner for placement in the same cylinder location.

RG,10,DT7426 –19–12NOV97–1/1

INSPECT AND MEASURE CONNECTING ROD BEARINGS (RODS REMOVED FROM ENGINE)



RG7471 –UN–23NOV97

1. Inspect rod bearings for damage or wear.

2. Measure crankshaft rod journal OD at several points.

Crankshaft Journal—Specification

OD .... 77.800—77.826 mm (3.0629—3.0640 in.)

3. Assemble connecting rod, cap, and bearings with OLD cap screws. Tighten cap screws to 68 N•m (50 lb-ft). Tighten cap screw an additional 90—100°. (See TORQUE-TURN CONNECTING ROD CAP SCREWS later in this group.)

Continued on next page

RG,10,DT7409 –19–12NOV97–1/2

4. Measure assembled rod bearing ID.

Assembled Rod Bearing—Specification

ID .... 77.876—77.927 mm (3.0659—3.0679 in.)

5. Subtract crankshaft journal OD from rod bearing ID to determine oil clearance. Replace bearings if oil clearance is out of specification.

Connecting Rod Bearing-to-Journal (New Parts)—Specification

Oil Clearance... 0.050—0.127 mm (0.0020—0.0050 in.)
Wear Limit .... 0.152 mm (0.0600 in.)

RG7472 –UN–23NOV97

RG,10,DT7409 –19–12NOV97–2/2

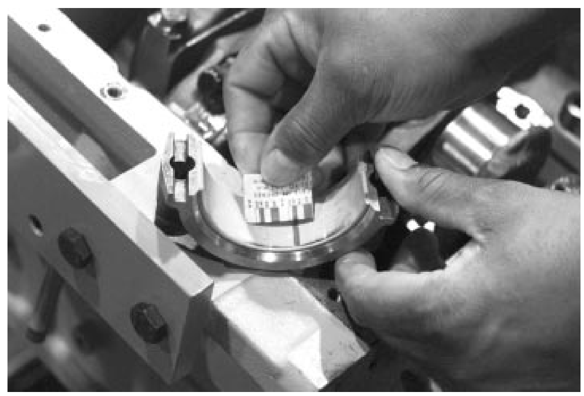
INSPECT AND MEASURE CONNECTING ROD BEARINGS (ROD AND CRANKSHAFT IN ENGINE)

IMPORTANT: Use hand wrenches. Pneumatic wrenches may cause thread damage.

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

1. Remove rod cap. Place a piece of PLASTIGAGE® in center of bearing. Install rod cap using OLD cap screws. Tighten cap screws to 58 N•m (43 lb-ft). Tighten cap screw an additional 90—100°. (See TORQUE-TURN CONNECTING ROD CAP SCREWS later in this group.)

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



RG7459 –UN–23NOV97

PLASTIGAGE is a registered trademark of the DANA Corp.

DPSG,OUO1004,52 –19–16APR98–1/1

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32

INSPECT ROD AND CAP

1. Inspect rod and cap for wear or damage, such as chips or nicks in the joint area (A).

IMPORTANT: Do not nick the joint surfaces of the rod and cap. This is very critical on Precision Joint™ rods to assure proper seating. Never scrape these surfaces (C) with a wire brush or other tool. The interlocking mating surfaces must be preserved.

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

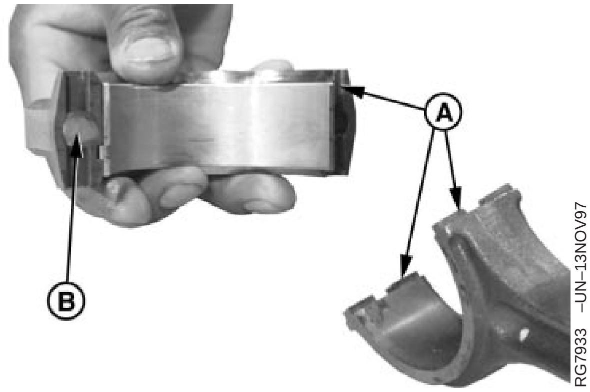
3. Carefully clamp rod in a soft-jawed vise (cap end upward).

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

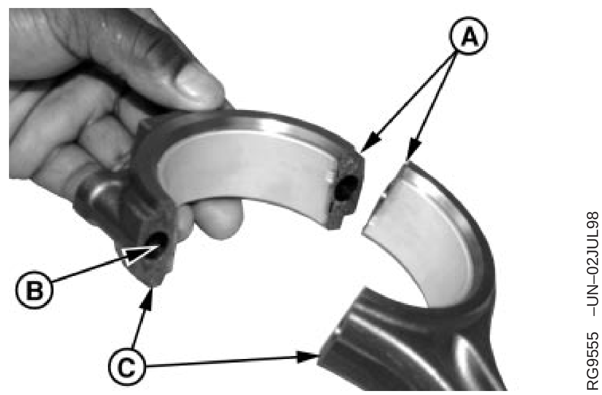
4. Install cap WITHOUT bearing inserts. Use old cap screws.

5. Tighten cap screws to 58 N•m (43 lb-ft). Turn cap screw an additional 90—100°.

   See TORQUE-TURN CONNECTING ROD CAP SCREWS later in this group.



Tongue-and-Groove Rod and Cap



Precision Joint™ Rod and Cap

A—Joint Area
B—Cap Holes
C—Precision Joint™ Surfaces

Precision Joint is a trademark of Deere & Company

Continued on next page

RG,10,DT7408 –19–12NOV97–1/2

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

   - At right angle to rod-to-cap joint.
   - At 45 degrees left of measurement step “A”.
   - At 45 degrees right of measurement step “A”.

7. Compare measurements to specifications.

Connecting Rod Bore (Without Bearing Inserts)—Specification

ID .... 82.677—82.703 mm (3.2550—3.2560 in.)

8. If difference between the greatest and least measurement exceeds out-of-round specification, replace connecting rod.

Connecting Rod Bore Maximum Permissible Out-of-Round—Specification

Out-of-Round.. 0.038 mm (0.0015 in.)

RG7470 –UN–23NOV97

RG,10,DT7408 –19–12NOV97–2/2

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34

INSPECT PISTON PINS AND BUSHINGS

1. Visually inspect piston pin. Pin must be in good condition with no visible wear.

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

2. Dip piston pin in clean engine oil.

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

4. Insert pin from both sides. If pin enters freely, but binds in the center, the bore could be tapered (B).

5. Insert pin to check for bore alignment (C). Pin should not “click” or need to be forced into bore on opposite side.

6. Measure piston pin OD. Replace if not within specification.

Piston Pin (Small)—Specification

OD	34.920—34.930 mm (1.3748—1.3752 in.)
Wear Limit	34.907 mm (1.3743 in.)

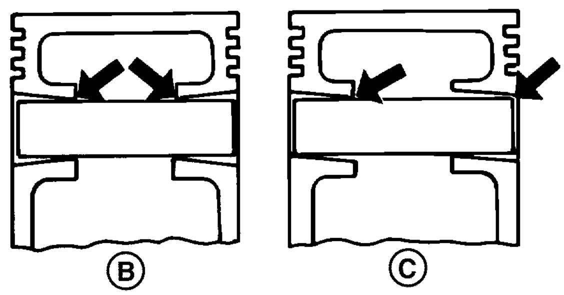
Piston Pin (Large)—Specification

OD	41.270—41.280 mm (1.6248—1.6252 in.)
Wear Limit	41.257 mm (1.6243 in.)

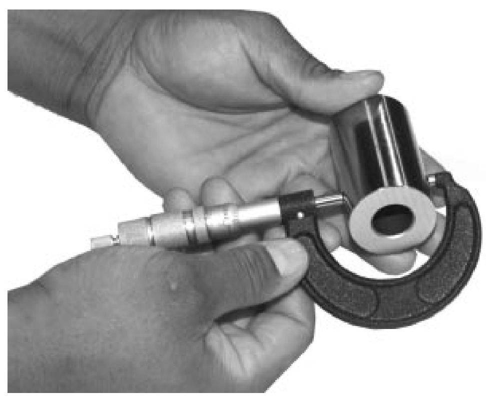
Piston Pin—Specification

Length	71.51—72.11 mm (2.815—2.839 in.)

RG7466 –UN–04NOV97



RG4747 –UN–31OCT97



RG7473 –UN–23NOV97

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

Continued on next page RG,10,DT7407 –19–12NOV97–1/2

NOTE: Straight-end rods have an oil hole; tapered-end rods do not.

7. Lubrication hole must be open.

8. Measure pin bushing ID and compare to pin OD to determine oil clearance.

Piston Pin Bushing Installed (Small Pin)—Specification

ID	34.950—34.976 mm (1.3760—1.3770 in.)
Wear Limit	35.026 mm (1.3790 in.)

Piston Pin Bushing Installed (Large Pin)—Specification

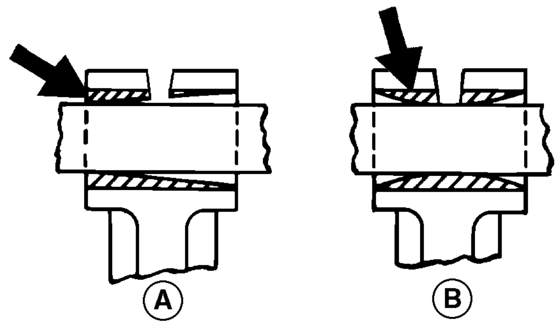
ID	41.300—41.326 mm (1.6260—1.6270 in.)
Wear Limit	41.376 mm (1.6290 in.)

Piston Pin-to-Bushing—Specification

Oil Clearance	0.020—0.056 mm (0.0008—0.0022 in.)
Wear Limit	0.102 mm (0.0040 in.)

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


RG7474 –UN–23NOV97



RG7647 –UN–07NOV97

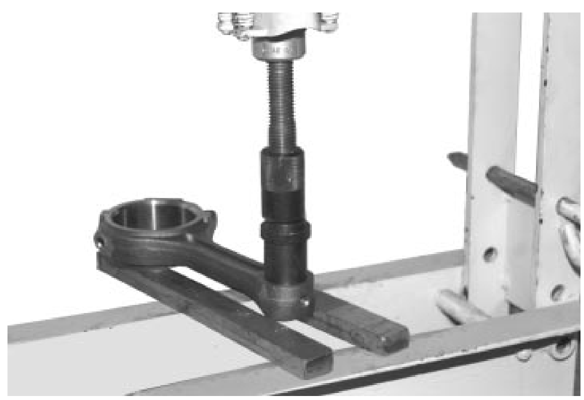
A—Tapered Bore
B—Bell Mouthed Bore

RG,10,DT7407 –19–12NOV97–2/2

REMOVE PISTON PIN BUSHING

REMOVING PISTON PIN BUSHING ON STRAIGHT PIN-END ROD

Use JD286 Driver for 41 mm (1.6 in.) pin, or JDE88 Driver for 35 mm (1.3 in.) pin to remove bushing.


RG7476 –UN–23NOV97

Straight Pin-End Rod

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RG,10,DT7406 –19–12NOV97–1/2

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36

REMOVING PISTON PIN BUSHING ON TAPERED PIN-END ROD

1. Select Driver JDG953-1 (A) and Receiver Cup JDG953-2 (B) from JDG 953 Connecting Rod Bushing Service Set to remove bushing (C) from tapered rod.

2. Slide driver into one side of rod bushing. Turn driver until taper on driver flange matches up with taper on the bushing.

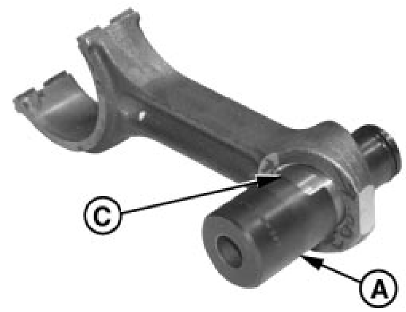
3. Install receiver cup onto opposite side of rod bushing.

NOTE: Stud in cup keeps rod properly located on the cup.

4. Using hydraulic press, press bushing out of the rod until driver and bushing fall into receiver cup.

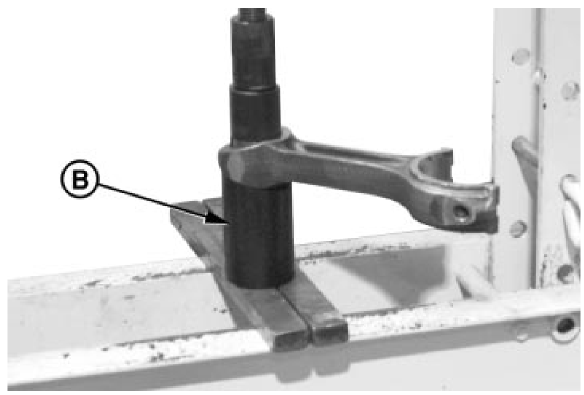
IMPORTANT: If bushing is heavily worn, the driver may contact the I.D. of the rod bore. Be careful not to damage the rod bore.

Clean, inspect, and measure I.D. of rod pin bore, as described later in this group.



RG7475 –UN–04NOV97

Tapered Pin-End Rod



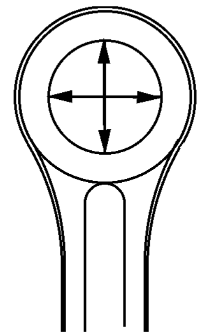
RG7477 –UN–04NOV97

Tapered Pin-End Rod

A—JDG953-1
B—JDG9532
C—Bushing

RG,10,DT7406 –19–12NOV97–2/2

CLEAN AND INSPECT CONNECTING ROD PIN BORE


RG7478 –UN–23NOV97

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

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

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

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

Connecting Rod Small Pin Bore (Bushing Removed)—Specification

ID .... 38.087—38.113 mm (1.4995—1.5005 in.)

Connecting Rod Large Pin Bore (Bushing Removed)—Specification

ID .... 46.025—46.051 mm (1.8120—1.8130 in.)

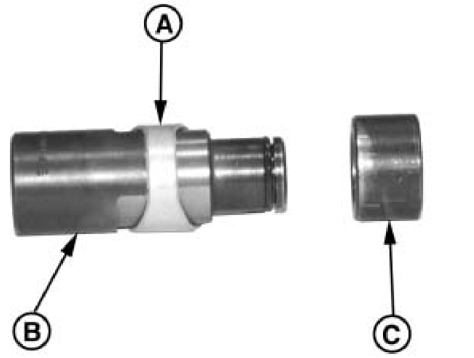
RG,10,DT7405 –19–12NOV97–1/1

10
38

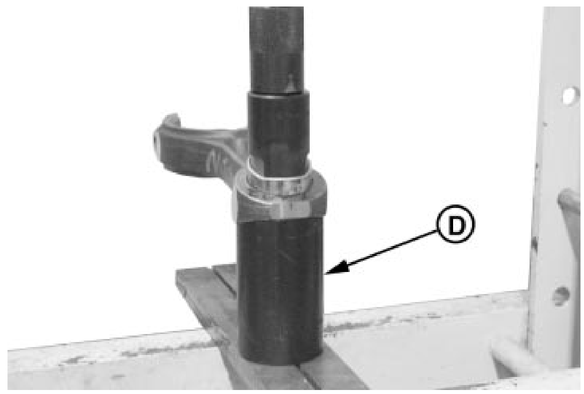
INSTALL PISTON PIN BUSHING IN CONNECTING ROD

Carefully file a slight chamfer on edge of rod pin bore. Remove any burrs or sharp edges from edge of bushing bore.

NOTE: Tapered pin-end rods do not have a lubrication hole in the rod or bushing.



RG7480 –UN–04NOV97



RG7481 –UN–04NOV97

A—Piston Pin Bushing
B—JDG953-1 Driver
C—JDG738-2 Installer Pilot
D—JDG953-3 Receiver Cup

INSTALLING PISTON PIN BUSHING IN TAPERED PIN-END ROD

1. Slide bushing (A) onto JDG953-1 Driver (B) and install JDG738-2 Installer Pilot (C) onto O-ring end of driver. Apply clean engine oil or grease to O.D. of new bushing, O.D. of pilot ring, and I.D. of rod pin bore.

2. Insert driver into rod pin bore so pilot ring pilots in rod bore, and bushing taper aligns with taper on driver flange.

3. Install JDG953-2 Receiver Cup (D) onto the opposite side of rod.

4. Press bushing into rod bore until edge of bushing is flush or just slightly below rod face.

5. If necessary, have the new bushing reamed by a specialized machine shop to obtain specified oil clearance with piston pin.

Connecting Rod Pin-to-Bushing (Tapered Pin-End)—Specification

Oil Clearance.. 0.020—0.056 mm (0.0008—0.0022 in.)

Continued on next page RG,10,DT7404 –19–12NOV97–1/2

INSTALLING PISTON PIN BUSHING IN STRAIGHT PIN-END ROD

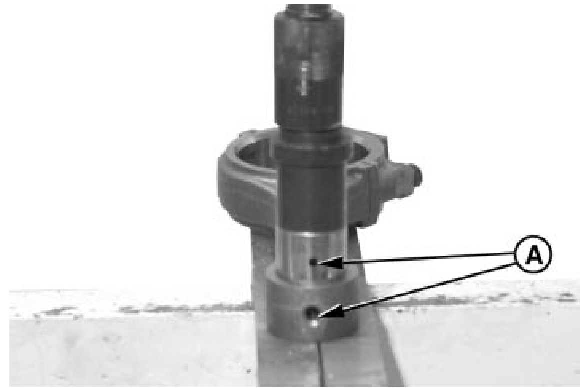
IMPORTANT: Oil holes (A) MUST be aligned. If holes are not aligned, remove and discard bushing. Install a new bushing. DO NOT attempt to reuse the bushing. Install bushing in rod.

1. Use JD286 Driver for 41 mm (1.6 in.) pin or JDE88 Driver for 35 mm (1.3 in.) pin to install bushing.

2. Press bushing into rod bore until edge of bushing is flush or just slightly below machined surface on face of rod.

3. Remove rod from press.

4. I.D. of new bushing must be precision bored by specialized machine shop to specifications.



A—Oil Holes

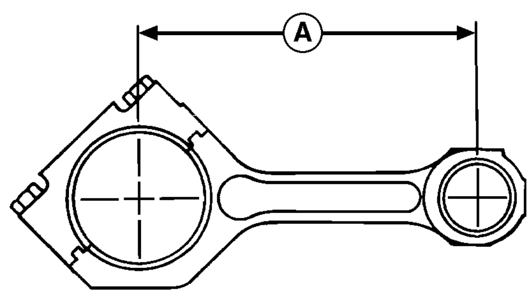
Connecting Rod Pin-to-Bushing (Straight Pin-End)—Specification

Oil Clearance	0.020 —0.056 mm (0.0008—0.0022 in.)
Wear Limit	0.102 mm (0.0040 in.)

RG,10,DT7404 –19–12NOV97–2/2

MEASURE ROD CENTER-TO-CENTER BORES

Measure rod center-to-center bores (A) (with bushings removed). Compare to specifications given below. Replace rod if necessary.



A—Center-to Center Measurement

Rod Bearing Bore-to-Piston Pin Bushing Bore (Center-to-Center)—Specification

Measurement	202.95—203.05 mm (7.990—7.994 in.)

RG,10,DT7403 –19–12NOV97–1/1

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40

INSPECT AND CLEAN CYLINDER BLOCK

Before inspecting and cleaning cylinder block, remove all of the following:

- piston cooling orifices (A)
- soft plugs (B)
- oil galley plugs (C) (using JDG782 Oil Galley Plug Tool)

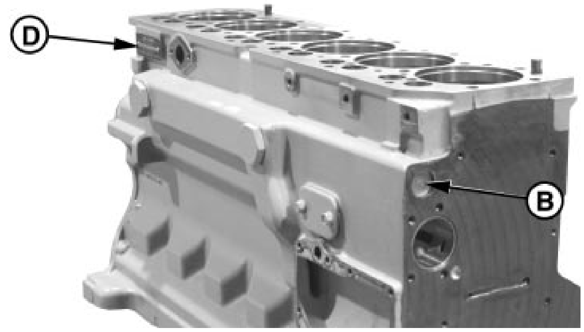
- all external and internal mounted components (refer to the proper group for removal procedures)

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

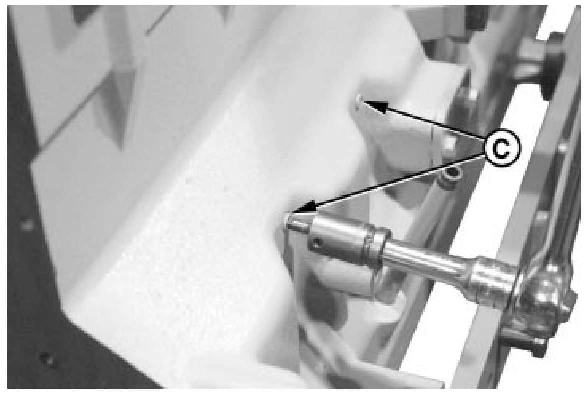
1. Clean block thoroughly using cleaning solvent, pressure steam, or a hot tank.

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

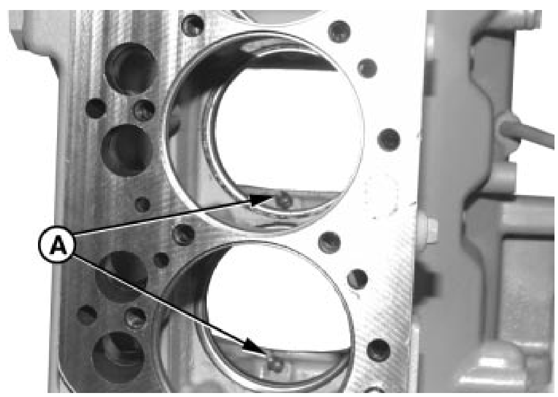
3. All coolant passages must be clear of lime deposits and scale.



RG7483 –UN–04NOV97



RG7484A –UN–04NOV97



RG7796 –UN–11NOV97

A—Piston Cooling Orifice
B—Soft Plug
C—Oil Galley Plug
D—Nameplate

Continued on next page RG,10,DT7402 –19–11NOV97–1/2

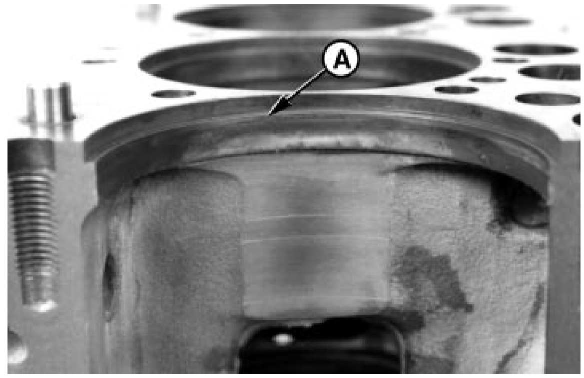
10
41

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

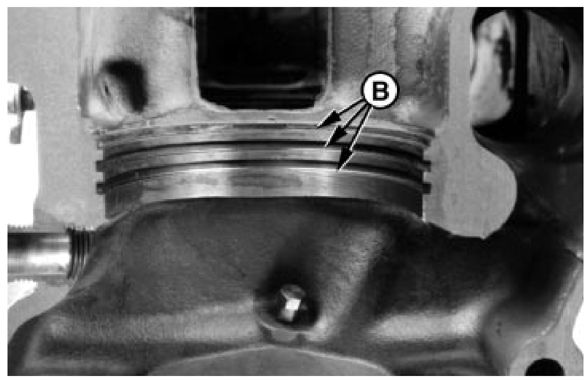
4. Inspect liner support flange (A) for burrs. If burrs are present, use a small half-moon file and LIGHTLY file (in a circular motion) burr off at a 60° angle. DO NOT let file hit top of cylinder block while filing.

5. Carefully inspect block for cracks or damage. If a cracked block is suspected, pressure-test the block. A procedure for pressure testing is outlined in FOS (Fundamentals of Service) Manual-ENGINES. Check for erosion or cracks in the liner O-ring/packing area (B). Replace cracked or damaged blocks.

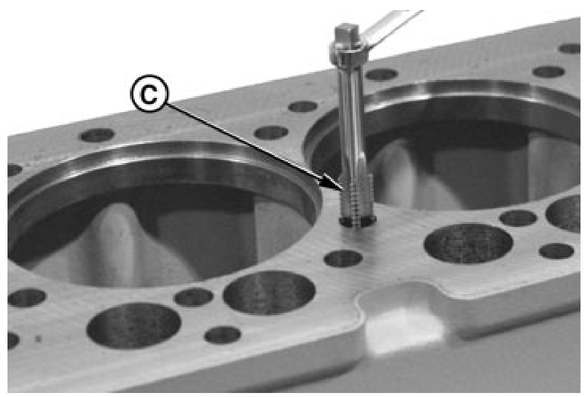
6. If cylinder block is serviceable, clean out all threaded holes for cylinder head mounting cap screws in top deck of cylinder block, using JDG680 Tap (C) or an equivalent 1/2-13 UNC-2A x 76 mm (3.0 in.) long tap. Remove debris or fluid from tapped holes with compressed air.



RG6403 –UN–03NOV97



RG6404 –UN–03NOV97



RG7485 –UN–04NOV97

A—Liner Support Flange
B—O-Ring/Packing Area
C—JDG680 Tap

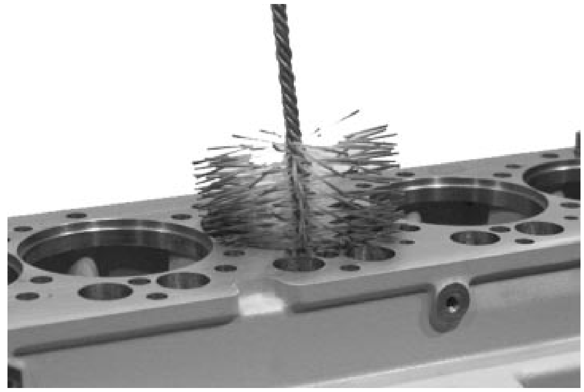
RG,10,DT7402 –19–11NOV97–2/2

10
42

CLEAN CYLINDER LINER O-RING BORE

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

NOTE: Use brush exactly as directed by the manufacturer.



RG7486 –UN–23NOV97

RG,10,DT7401 –19–11NOV97–1/1

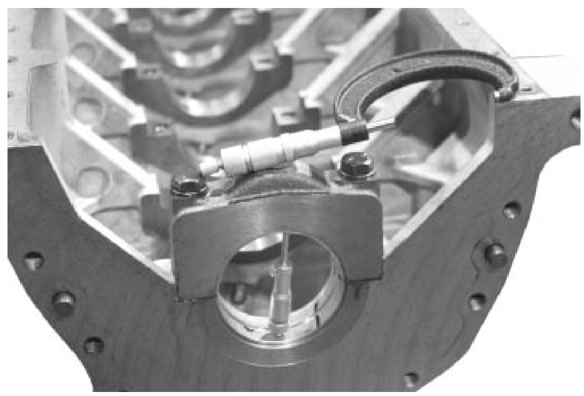
MEASURE CYLINDER BLOCK MAIN BEARING BORE

Measure main bearing bore diameter.

Cylinder Block Main Bearing Bore—Specification

ID .... 84.455—84.481 mm (3.3250—3.3260 in.)

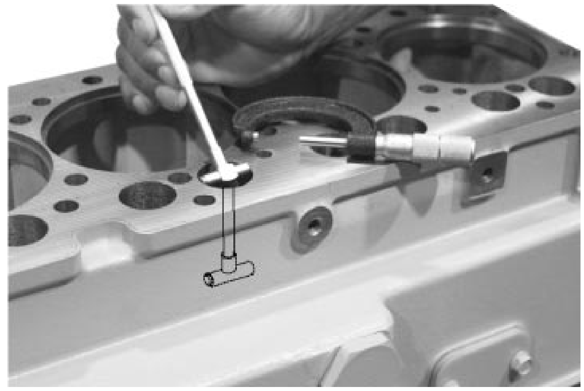
If bearing caps are damaged, or bore is not within specification, replace caps and line bore to specifications. (See MEASURE ASSEMBLED ID OF MAIN BEARING CAPS in Group 15.)



RG7487 –UN–23NOV97

RG,10,DT7427 –19–12NOV97–1/1

MEASURE CAMSHAFT FOLLOWER MACHINED BORE IN BLOCK



Measure camshaft follower bore diameter at all bore locations.

Camshaft Follower Bore in Block—Specification

ID .... 31.70—31.75 mm (1.248—1.250 in.)

Camshaft Follower (New)—Specification

OD .... 31.61—31.64 mm (1.245—1.246 in.)

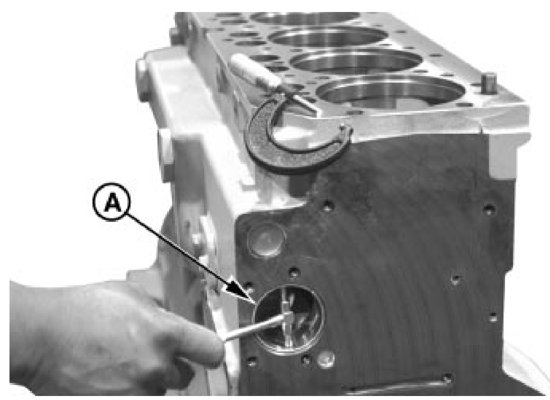
Camshaft Follower-to-Bore—Specification

Clearance .... 0.06—0.13 mm (0.002—0.005 in.)

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

RG,10,DT7400 –19–11NOV97–1/1

MEASURE CAMSHAFT BUSHING BORES IN BLOCK



A—Bushings

Replaceable bushings (A) are installed in front camshaft bore only. Remaining bores in cylinder block act as camshaft bushings.

1. Visually inspect and measure front camshaft bushing ID. If bushing is worn or not within specification, install new bushings. (See REMOVE AND INSTALL CAMSHAFT BUSHING in Group 16.)

Continued on next page RG,10,DT7399 –19–11NOV97–1/2

10
44

2. If necessary to replace bushing, remove bushing and measure bore diameter in block. If bushing bore (B) in block is not within specification, repair or replace cylinder block as required.

3. Measure remaining camshaft bores in block and compare with specification given. Repair or replace cylinder block as required.

Camshaft Bore in Block, Front No. 1 (Without Bushing)—Specification

ID .... 59.961—59.987 mm (2.3607—2.3617 in.)

Camshaft Bore in Block, Front No. 1 (With Bushing)—Specification

ID .... 55.961—55.987 mm (2.2031—2.2042 in.)

Camshaft Bore in Block (All Except No. 1)—Specification

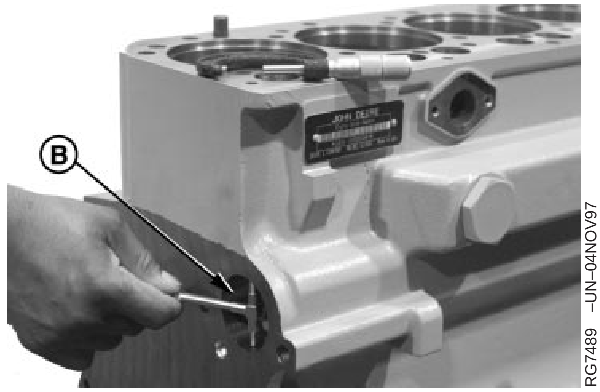
ID .... 55.986—56.012 mm (2.2042—2.2052 in.)

Camshaft Journal-to-Bushing (No. 1 Bore With Bushing)—Specification

Oil Clearance... 0.063—0.115 mm (0.0025—0.0045 in.)

Camshaft Journal-to-Bushing (All Except No. 1)—Specification

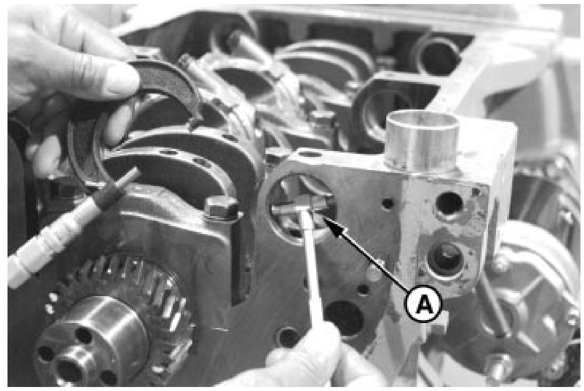
Oil Clearance... 0.088—0.140 mm (0.0035—0.0055 in.)



A—Bushing Bore

RG,10,DT7399 –19–11NOV97–2/2

MEASURE BALANCER SHAFT BUSHING ID IN BLOCK—4-CYLINDER ENGINES



A—Bore Without Bushing
B—Bore With Bushing

1. Visually inspect and measure balancer shaft bushing ID with bushing removed (A) and with bushing installed (B).

   If bushing is worn or not within specification, install new bushings. (See REPLACE BALANCER SHAFT BUSHINGS in Group 16.)

2. If necessary to replace bushing, remove bushing and measure bore diameter in block.

   If bore diameter in block is not within specification, install a new cylinder block.

Balancer Shaft Bore in Block (Bushing Removed)—Specification

ID .... 43.262—43.288 mm (1.7032—1.7042 in.)

Balancer Shaft Bushing—Specification

ID .... 40.177—40.237 mm (1.5818—1.5841 in.)

Balancer Shaft Journal-to-Bushing—Specification

Clearance .... 0.016—0.102 mm (0.0006—0.0040 in.)

RG,10,DT7398 –19–11NOV97–1/1

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46

MEASURE CYLINDER LINERS AND BLOCK BORES

Measure cylinder liners and block bores. Replace liners not within specifications.

Lower Block Bore for Seating Liner—Specification

ID .... 115.75—115.80 mm (4.557—4.559 in.)

Upper Block Bore for Seating Liner—Specification

ID .... 120.70—120.75 mm (4.752—4.754 in.)

Liner Flange ID in Block—Specification

ID .... 126.33—126.35 mm (4.973—4.974 in.)

OD of Liner at Upper Bore—Specification

OD .... 120.61—120.69 mm (4.7484—4.7516 in.)

Liner-to-Cylinder Block Clearance at Lower Bore—Specification

Clearance .... 0.035—0.100 mm (0.001—0.004 in.)

Liner-to-Cylinder Block Clearance at Upper Bore—Specification

Clearance .... 0.10—0.14 mm (0.004—0.005 in.)

Cylinder Liner—Specification

ID .... 106.48—106.52 mm (4.192—4.194 in.)

Cylinder Wear—Specification

Maximum Wear .... 0.10 mm (0.004 in.)

Cylinder Taper—Specification

Maximum Taper... 0.05 mm (0.002 in.)

Cylinder Out-of-Round—Specification

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

DPSG,OUO1004,213 –19–09JUL98–1/1

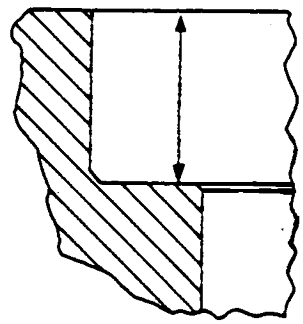
MEASURE LINER FLANGE COUNTERBORE DEPTH IN BLOCK

Measure liner flange counterbore depth in block and compare to specification given below. If depth is not within specification, liner shims are available.

Cylinder Liner Flange Counterbore Depth in Block—Specification

Depth .... 5.952—5.988 mm
(0.2343—0.2357 in.)


RG7490 –UN–23NOV97


RG4726 –UN–13DEC88

RG,10,DT7397 –19–11NOV97–1/1

MEASURE LINER FLANGE THICKNESS

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

Cylinder Liner Flange—Specification

Thickness.. 6.022—6.058 mm
(0.2371—0.2385 in.)


RG7494 –UN–23NOV97

RG,10,DT7396 –19–11NOV97–1/1

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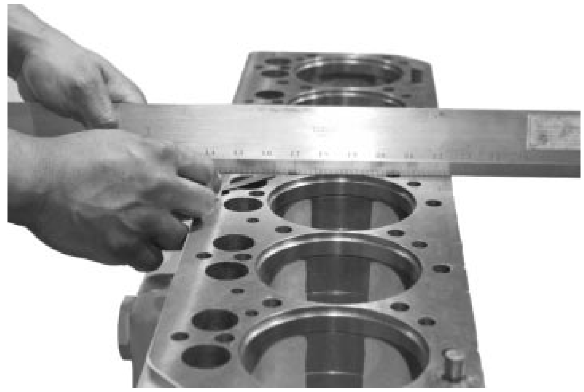
48

MEASURE CYLINDER BLOCK TOP DECK FLATNESS



Measure cylinder block top deck flatness using D05012ST Precision Straightedge and feeler gauge. If flatness is not as specified, clean up top deck of cylinder block.

Maximum Acceptable Out-of-Flat, Entire Length or Width (Used)—Specification

Measurement... 0.08 mm (0.003 in.)

Maximum Acceptable Out-of-Flat (Any 150 mm (5.90 in.) Length—Specification

Measurement... 0.025 mm (0.001 in.)

Top Deck Surface Finish (Surface Grind Only) (AA)—Specification

Surface Finish.. 0.8—3.2 micrometers (32—125 micro-in.)

Top Deck Surface Finish Wave Depth—Specification

Maximum Depth .... 0.012 mm (0.0005 in.)

Main Bearing Bore Centerline-to-Cylinder Block Top Deck—Specification

Distance... 337.896—337.972 mm (13.3029—13.3059 in.)

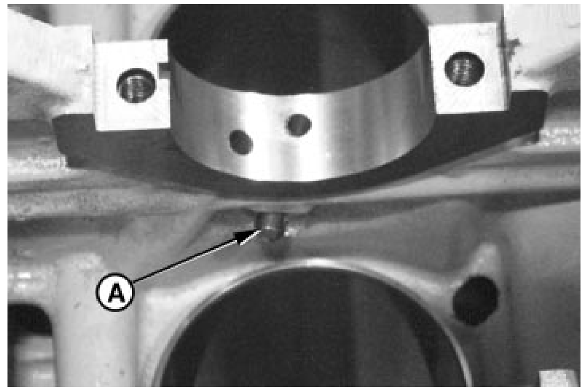
IMPORTANT: When cylinder block top deck or main bearing bores are machined, the dimension from crankshaft centerline to top deck will be changed. Make sure this dimension is within specifications, otherwise, piston may contact cylinder head.

RG,10,DT7395 –19–11NOV97–1/1

REMOVE, INSPECT, AND INSTALL PISTON COOLING ORIFICES

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

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



RG7543A –UN–05NOV97

RG,10,DT7394 –19–11NOV97–1/2

NOTE: If equipped with early design orifice (B), add a punch mark (C) to each orifice as shown. This is not necessary on later design orifice (D) because of its different shape. Adding a punch mark to orifice (B) will also prevent cooling jets from being mistakenly used on 300-Series Engines. &pwrtec;® Engines use a larger orifice diameter cooling jet for proper lubrication and cooling of piston skirts.

2. Install and tighten orifices.

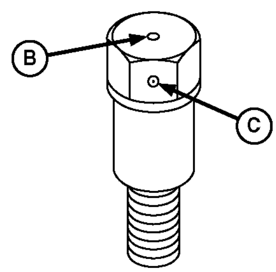
Piston Cooling Orifice—Specification

Diameter .... 1.4 mm (0.055 in.)

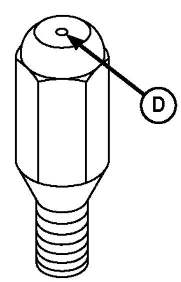
Piston Cooling Orifice—Specification

Torque .... 11 N•m (8 lb-ft) (96 lb-in.)

3. If removed, install new oil and water galley plugs as required.



RG9065 –UN–16MAR98



RG9066 –UN–16MAR98

B—Early Design Orifice
C—Punch Mark
D—Later Design Orifice

RG,10,DT7394 –19–11NOV97–2/2

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50

MEASURE FUEL SUPPLY PUMP PUSH ROD BORE AND PUSH ROD OD

RG7495 –UN–23NOV97

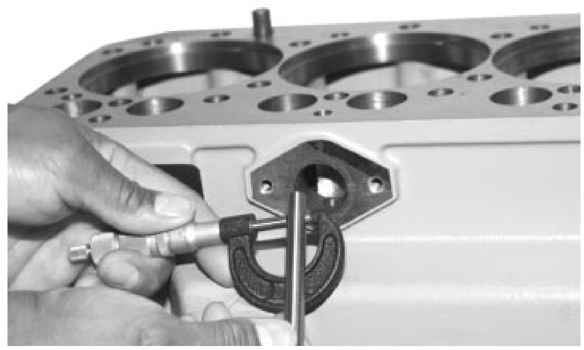
1. Visually inspect and measure fuel supply pump push rod OD.
2. If rod is worn or not within specification, install a new rod.

Push Rod—Specification

OD .... 9.891—9.917 mm (0.3894—0.3904 in.)

Push Rod Bore in Block—Specification

ID .... 10.00—10.05 mm (0.3937—0.3957 in.)



RG7496 –UN–26NOV97

RG,10,DT7393 –19–11NOV97–1/1

MEASURE 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.

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

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

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

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

Continued on next page RG,10,DT7392 –19–11NOV97–1/3

10
52

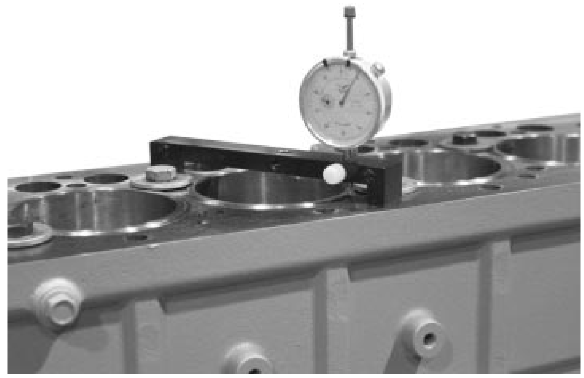
3. Using JDG451 or KJD10123 Gauge and D17526CI or D17527CI Dial Indicator, measure height (A) of liner at 1, 5, 7, and 11 o'clock positions as viewed from flywheel end of engine.

Cylinder Liner Height Above Block—Specification

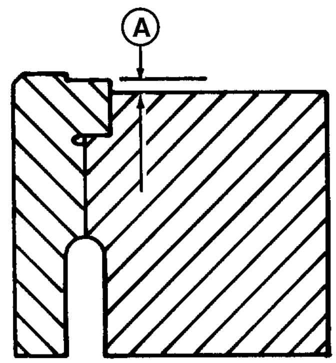
Height .... 0.030—0.100 mm (0.001—0.004 in.)

Cylinder Liner Height Difference At Nearest Point of Two Adjacent Liners, or Within a Single Liner—Specification

Maximum Permissable Height Difference.................................... 0.05 mm (0.002 in.)



RG7445 –UN–23NOV97



RG6439 –UN–03NOV97

A—Liner Height

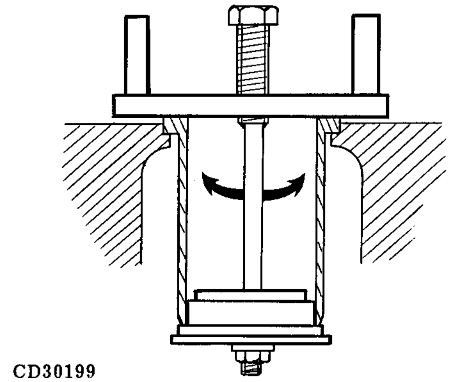
Continued on next page RG,10,DT7392 –19–11NOV97–2/3

4. If liner height is above specification, check cylinder block for burrs on liner support flange or incorrect counterbore depth. If burrs are present, apply lapping compound to liner flange shoulder in the block, then install liner and turn to left and right using KCD10001or JDG1145 Cylinder Liner Puller to rub off enough material to seat liner as necessary.

IMPORTANT: ONE LINER SHIM ONLY may be installed under each liner flange. If liner requires more than one shim, install a new liner or cylinder block.

5. If liner height is no more than 0.08 mm (0.003 in.) below top deck of block, install one liner shim under liner flange.

NOTE: Two shim sizes are available; 0.05 mm (0.002 in.) and 0.10 mm (0.004 in.).



KCD10001 Shown

CD30199 –UN–07MAR95

RG,10,DT7392 –19–11NOV97–3/3

INSTALL PACKING ON CYLINDER LINER AND O-RINGS IN BLOCK

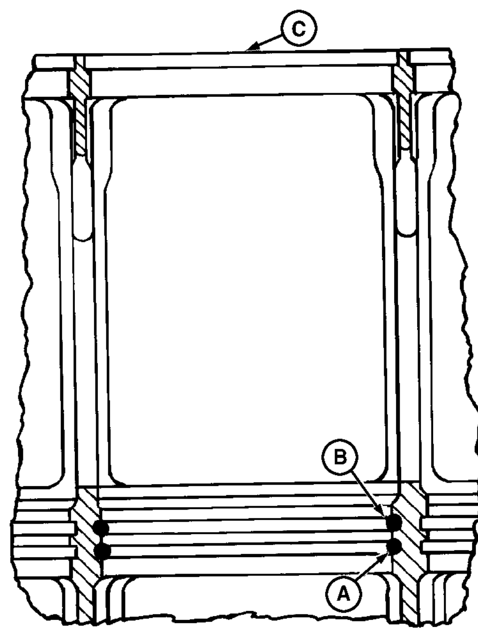
IMPORTANT: DO NOT use oil or hand cleaner soap on cylinder liner packing or O-rings. Petroleum products will cause the red (or white) O-ring to swell, which may result in O-ring damage during liner installation.

1. Pour AR54749 Soap Lubricant into a suitable container.

2. Dip O-rings in AR54749 Soap Lubricant.

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

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



RG3826 –UN–04DEC97

A—Black O-Ring
B—Red or White O-Ring
C—Cylinder Block

Continued on next page

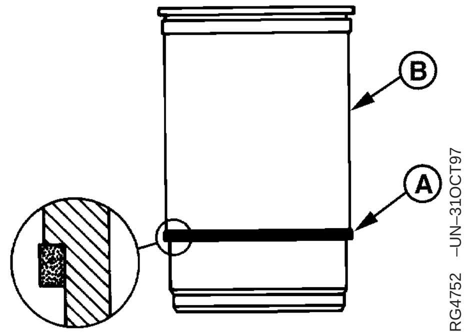
RG,10,DT7391 –19–11NOV97–1/2

10
54

5. Turn cylinder liner (B) upside-down. Dip square packing (A) in soap and install over outside of liner.

6. Slide packing down firmly against shoulder on liner. Make sure packing is not twisted.

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



A—Square Packing
B—Cylinder Liner

RG,10,DT7391 –19–11NOV97–2/2

INSTALL CYLINDER LINER IN BLOCK

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

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

1. Install liner in block bore with mark (made during disassembly) toward front of engine, unless liner OD is pitted or eroded.

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

Continued on next page

RG,10,DT7390 –19–11NOV97–1/2

2. A resistance will be felt when cylinder liner is aligned in pilot bore. Finish seating liners using clean, hardwood block and mallet. Gently tap hardwood block over top of cylinder liner with mallet. KCD10001 (A) or JDG1145 Puller may also be used to seat liners.

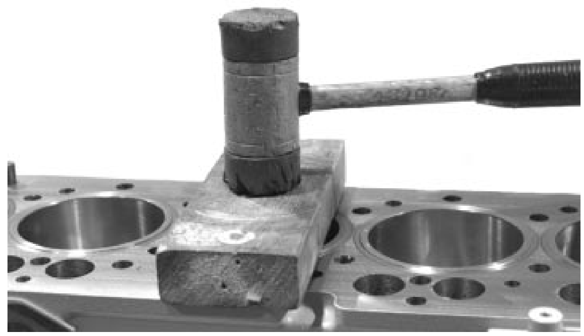
NOTE: Cylinder liner will protrude over top of cylinder block more than normal due to uncompressed packings and O-rings.

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

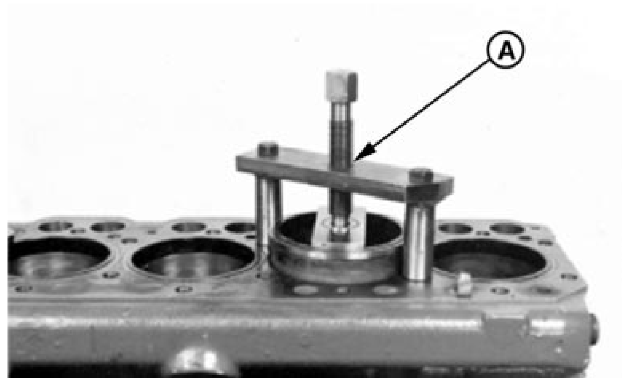
3. Hold liners in place with large flat washers and cap screws. Turn cap screws snug but do not tighten.

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

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



RG7497 –UN–23NOV97



RGCD6373 –UN–31OCT97

A—KCD10001 Liner Puller

RG,10,DT7390 –19–11NOV97–2/2

ASSEMBLE PISTON AND CONNECTING ROD

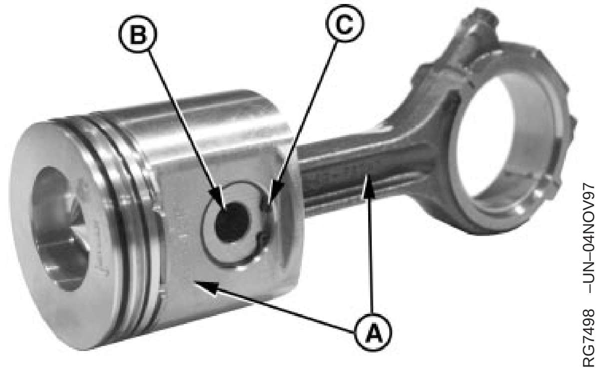
IMPORTANT: If a new piston and liner assembly is to be installed, DO NOT remove piston from liner. Push piston out of liner bottom only far enough to install piston pin.

1. Lubricate piston pin and bushing with clean engine oil.

Continued on next page RG,10,DT7389 –19–11NOV97–1/2

10
56

IMPORTANT: Pistons must be installed on connecting rods from which they were removed and new piston pin snap rings must be used. Piston and connecting rod must be assembled so combustion bowl in piston is offset toward fuel injection pump side of engine when long side of connecting rod is toward the camshaft side of engine.



A—Stamped “Front”
B—Piston Pin
C—Snap Rings

2. Assemble pistons and connecting rods, making sure the word “FRONT” (A) on side of piston and side of connecting rod are facing same direction.

3. Insert piston pin (B) into piston pin bore.

NOTE: Some piston pin snap rings have sharp edges on both sides. These rings are reversible.

4. Install NEW piston pin snap rings (C) with sharp edge of ring facing away from piston pin. Make sure snap rings are seated in grooves of piston pin bore.

RG,10,DT7389 –19–11NOV97–2/2

INSTALL PISTON RINGS

IMPORTANT: Piston rings can be damaged if expanded too far. Expand piston rings only as far as necessary to install rings on piston.

1. When installing new piston rings, use JDE85, JDE135, or KJD10140 Piston Ring Expander. Install oil ring expander in bottom ring groove. Position end gap toward either side of piston pin.

2. Install oil control ring (C) in bottom ring groove over ring expander. Install with end gap on opposite side of piston from ring expander gap.

NOTE: If standard-duty top piston ring is used, identify top as follows: hold ring with gap facing you and turn ring so that paint strip is to the left side of gap.

If heavy-duty top ring is used, the "pip" mark should be on top as shown (A).

3. Identify top side of compression rings. Top side of rectangular and keystone compression rings will be identified by depression marks (A) on the top side of two rings.

NOTE: Rectangular compression ring with two depression marks goes in the second groove.

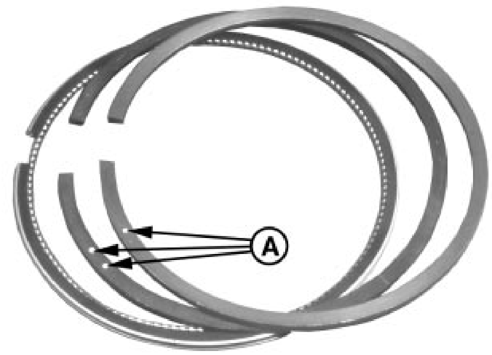
4. Install rectangular compression ring (B) in center ring groove with top of ring toward top of piston.

5. Position gap in rectangular compression ring on opposite side of piston from oil control ring (C) gap.

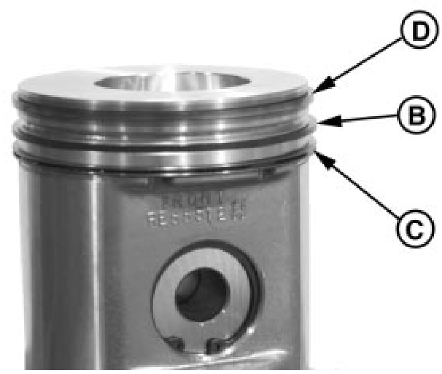
6. Install keystone compression ring (D) in top ring groove with top of ring toward top of piston.

7. Position gap in Keystone compression ring on opposite side of piston from rectangular compression ring gap.

RG7499 –UN–04NOV97



RG7797 –UN–11NOV97



RG7500 –UN–04NOV97

A—Depression Marks
B—Rectangular Compression Ring
C—Oil Control Ring
D—Keystone Compression Ring

Continued on next page RG,10,DT7388 –19–11NOV97–1/2

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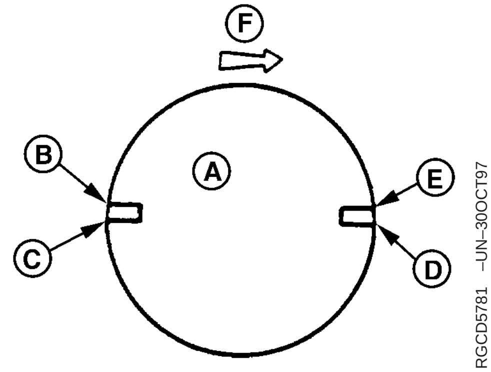
58

8. Stagger ring gaps on pistons as shown.

9. Coat pistons, liners and inside of JDE84 Ring Compressor with clean engine oil.

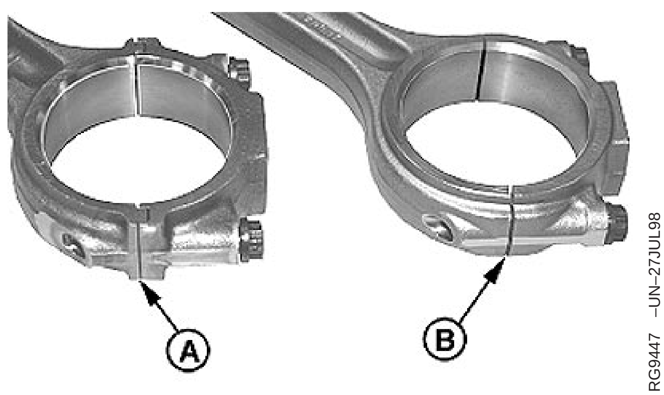


A—Piston Head
B—Top Compression Ring
C—Oil Control Ring Gap
D—Expander Ring Gap
E—Bottom Compression Ring Gap
F—Front of Engine

RG,10,DT7388 –19–11NOV97–2/2

INSTALL PISTON AND CONNECTING ROD ASSEMBLY

Earlier engines have the traditional tongue-and-groove between the connecting rod and cap (A). Later engines have the Precision Joint™ rod and cap (B). Installation of each rod is similar, with differences noted in the following procedure.



A—Tongue-and-Groove Rod and Cap
B—Precision Joint™ Rod and Cap

Precision Joint is a trademark of Deere & Company

Continued on next page

RG,10,DT7387 –19–11NOV97–1/5

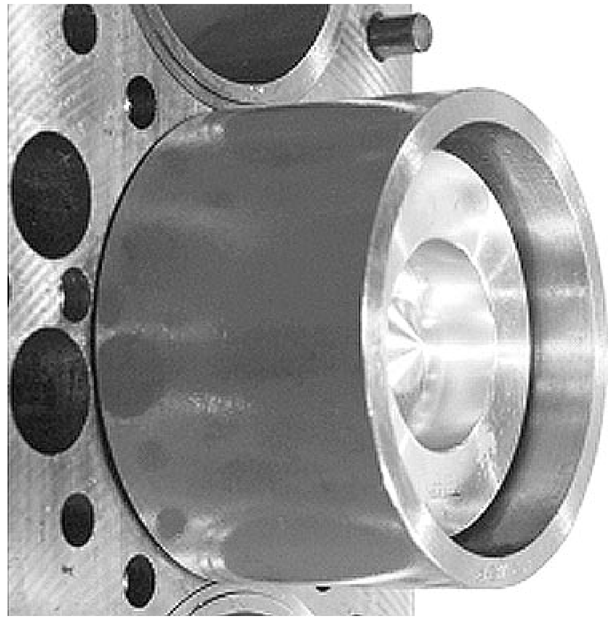
10
59

IMPORTANT: Be careful so crankshaft journals and liner walls are not damaged by connecting rod when installing piston and rod in liner.

1. Carefully place JDE84 Piston Ring Compressor with piston and rod over liner so the word "FRONT" on side of rod and on the side of piston faces toward the front of the engine.

NOTE: If arrow indicating "FRONT" is not visible on top of pistons, install piston and rod so combustion bowl in piston is offset toward fuel injection pump side of engine, and the long side of the connecting rod is toward camshaft side of engine.

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

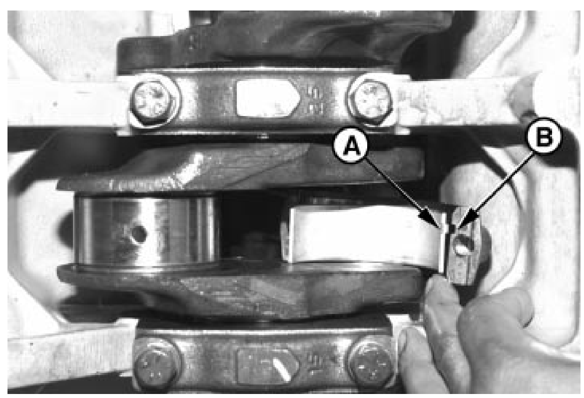


RG9445 –UN–07JUL98

RG,10,DT7387 –19–11NOV97–2/5

3. Install bearing insert in connecting rod with tang (A) in groove (B).

4. Apply clean engine oil on insert and crankshaft journal. Carefully pull connecting rod and insert against crankshaft journal.



RG7503 –UN–04NOV97

Tongue-and-Groove Rod Shown

A—Tang
B—Groove

Continued on next page

RG,10,DT7387 –19–11NOV97–3/5

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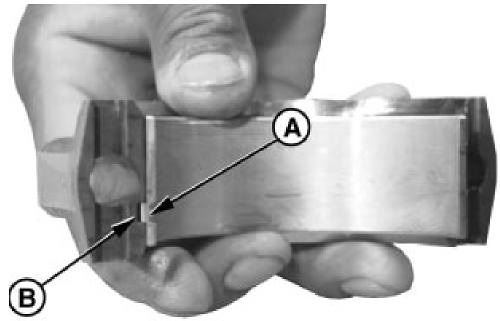
60

NOTE: Due to the manufacturing process, Precision Joint™ rod and cap both have a groove, while the bearing insert has a single tang. Only the groove in the cap is used for the bearing tang.

5. Install bearing insert in connecting rod cap with tang (A) in groove (B).

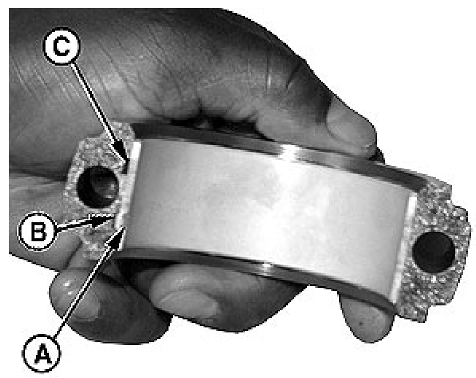
IMPORTANT: On Precision Joint™ connecting rods, make sure cap is properly aligned on rod with edges flush and interlocking surfaces sealed tightly.

6. Apply clean engine oil to bearing insert. Install cap on connecting rod with tangs to same side.



RG7504 –UN–04NOV97

Tongue-and-Groove Rod



RG9448 –UN–27JUL98

Precision Joint™ Rod

A—Tang
B—Groove
C—Extra Groove (Not Used)

Precision Joint is a trademark of Deere & Company

Continued on next page

RG,10,DT7387 –19–11NOV97–4/5

IMPORTANT: NEVER use connecting rod cap screws more than once for final engine assembly. Once rod cap screws have been tightened to final torque-turn specification, they must not be reused for another final assembly.

Cap screws for Precision Joint™ rod and cap are 3mm shorter than tongue-and-groove cap screws. DO NOT mix hardware.

7. Dip NEW connecting rod cap screws in clean oil and install.

8. Tighten cap screws alternately to initial torque specification.

Connecting Rod Cap Screws—Specification

Initial Torque.. 58 N•m (43 lb-ft)

9. Secondly, TORQUE-TURN all cap screws to 90—100 degrees. (See TORQUE-TURN CONNECTING ROD CAP SCREWS next in this group.)

Precision Joint is a trademark of Deere & Company

RG,10,DT7387 –19–11NOV97–5/5

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62

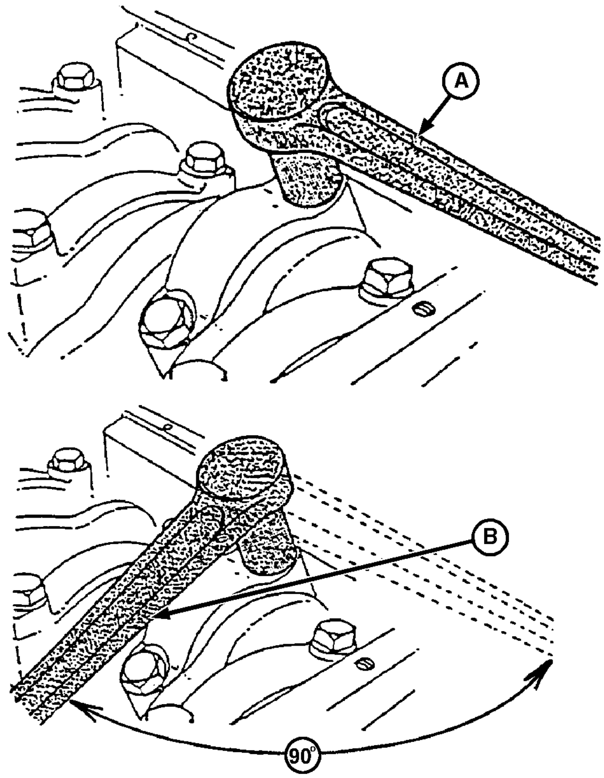
TORQUE-TURN CONNECTING ROD CAP SCREWS

USING ENGINE AXIS METHOD TO TORQUE-TURN CONNECTING ROD CAP SCREWS

1. After tightening cap screws to initial torque values, mark connecting rod cap and socket.
2. Position handle of wrench parallel to centerline of engine crankshaft axis (A).
3. Tighten 1/4 turn (90—100°) clockwise until handle of wrench is perpendicular to centerline of engine crankshaft axis (B) as shown.

Connecting Rod Cap Screws—Specification

Torque Turn... 1/4 Turn (90—100°) After Initial Torque

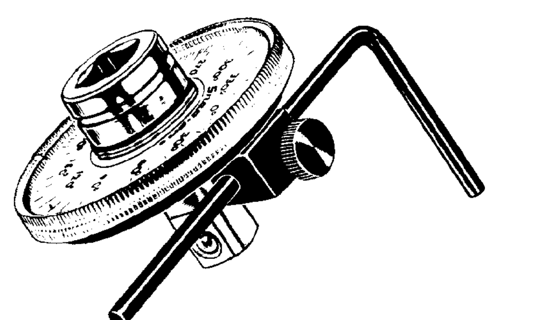


A—Parallel to Centerline Crankshaft
B—Perpendicular to Centerline Crankshaft

RG,10,DT7386 –19–11NOV97–1/2

USING JT05993 TORQUE ANGLE GAUGE TO TORQUE-TURN CONNECTING ROD CAP SCREWS

After tightening cap screws to initial torque values provided earlier, follow directions provided with JT05993 Gauge and TORQUE-TURN each cap screw 90°—100°.



RG,10,DT7386 –19–11NOV97–2/2

CHECK ENGINE ROTATION FOR EXCESSIVE TIGHTNESS

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

2. Check liners for deep scratches caused by an improperly installed or broken piston ring.

3. Check side clearance of rods. Must have slight side-to-side movement.

RG,10,DT7385 –19–11NOV97–1/1

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64

MEASURE PISTON PROTRUSION

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

NOTE: If JDG451 or KJD10123 are not available, a dial indicator with magnetic base can be used to measure piston protrusion, however, specifications will be different.

2. Use JDG451 or KJD10123 Gauge (or use a magnetic base dial indicator) to measure piston protrusion. Place gauge on top of cylinder block so dial indicator can be set to “zero” with top of block.

3. Position gauge across piston. While pressing gauge downward, rotate crankshaft until piston is at TDC position. Measure piston height at several positions around the piston. If using JDG451 Gauge, piston height must be checked at outer most diameter of piston.

4. Piston protrusion must be within specifications to prevent piston-to-exhaust valve contact.

5. Piston protrusion for pistons measured with JDG451 or KJDG10123 Gauge must meet the following specifications:

4-Cyl Standard Duty Codes 4801, 4803, 4809. 6-Cyl Standard Duty Codes 4805, 4807.—Specification

Piston Protrusion .... 0.08—0.31 mm (0.003—0.012 in.)

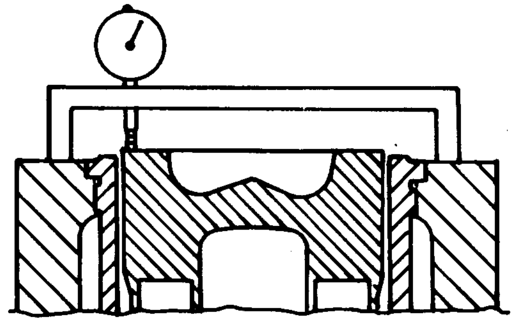
4-Cyl Heavy Duty Code 4804. 6-Cyl Heavy Duty Codes 4808, 4810.—Specification

Piston Protrusion .... 0.08—0.25 mm (0.003—0.010 in.)

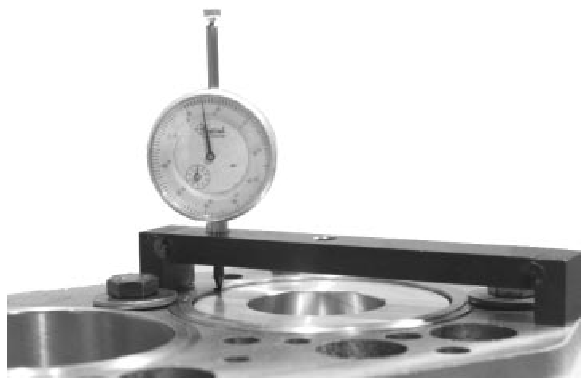
6. Piston protrusion for pistons measured using dial indicator with magnetic base must meet the following specifications:

4-Cyl Standard Duty Codes 4801, 4803, 4809. 6-Cyl Standard Duty Codes 4805, 4807.—Specification

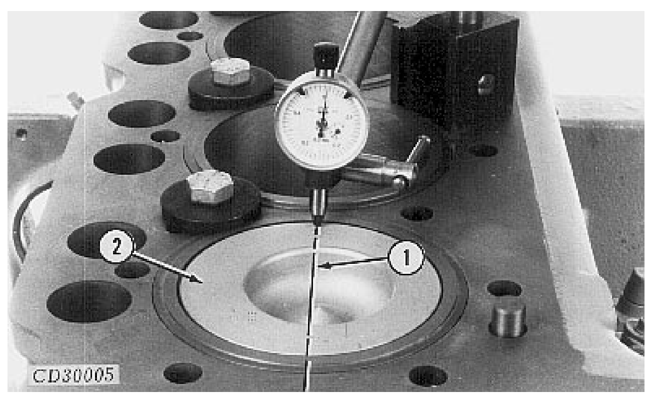
Piston Protrusion .... 0.15—0.38 mm (0.006—0.015 in.)



RG6440 –UN–22SEP92



RG7506 –UN–23NOV97



CD30005 –UN–07FEB95

1—Centerline of Cylinder Liner Bore
2—Position at “TDC”

Continued on next page

RG,10,DT7384 –19–11NOV97–1/2

4-Cyl Heavy Duty Code 4804. 6-Cyl Heavy Duty Codes 4808, 4810.—Specification

Piston Protrusion .... 0.15—0.33 mm (0.006—0.013 in.)

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

RG,10,DT7384 –19–11NOV97–2/2

COMPLETE FINAL ASSEMBLY

1. Install oil pump outlet tube O-ring in cylinder block. Install oil pump and outlet tube. (See Group 20.)
2. Install balancer shaft bushings (4-cylinder engines) and camshaft bushings. (See Group 16.)
3. Install oil bypass valve (in front of block) and front plate. (See Group 16.)
4. Install balancer shafts (if equipped). (See Group 16.)
5. Install camshaft, timing gears, and timing gear cover. (See Group 16.)
6. Install oil pressure regulator valve, spring, and plug in timing gear cover. (See Group 16.)
7. Install oil pan. (See Group 20.)
8. Install crankshaft pulley. (See Group 15.)
9. Install camshaft followers. (See Group 16.)
10. Install cylinder head with new gasket. (See Group 05.)
11. Fill engine with clean oil and proper coolant.
12. Perform engine break-in. (See Group 05.).

RG,10,DT7383 –19–11NOV97–1/1

Group 15
Crankshaft, Main Bearings and Flywheel

15
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ESSENTIAL TOOLS

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

DPSG,OUO1004,174 –19–07JUL98–1/15

RG6246 –UN–05DEC97

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

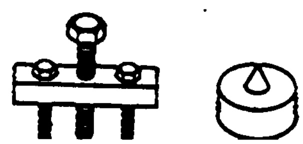
Used with magnetic base to measure radial runout and wobble on vibration damper.

DPSG,OUO1004,174 –19–07JUL98–2/15

RG5112 –UN–06APR89

Vibration Damper Puller Set JDG410

Remove vibration damper and pulley.

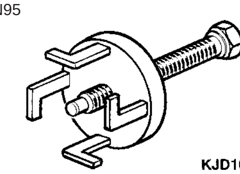


DPSG,OUO1004,174 –19–07JUL98–3/15

KJD10206 –UN–19JUN95

Crankshaft Pulley Puller KJD10206

Remove crankshaft pulley without threaded holes on 6000-Series tractors.



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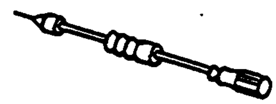
DPSG,OUO1004,174 –19–07JUL98–4/15

RG5109 –UN–23AUG88

Seal Remover JDG22

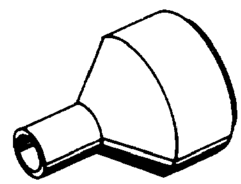


Remove crankshaft front oil seal with timing gear cover installed. Also used to remove crankshaft rear oil seal without removing flywheel housing.

DPSG,OUO1004,174 –19–07JUL98–5/15

RG6214 –UN–05DEC97

Seal Puller Adapter JDG719

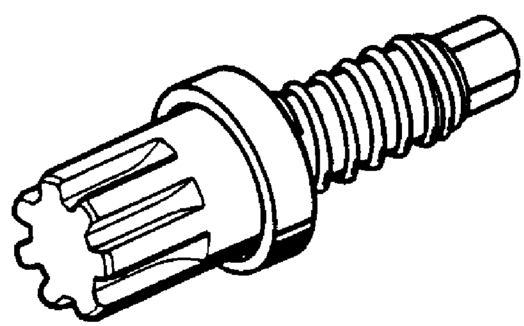


RG6214

Used with standard metal screw, JDE38-2 shank, and JDE38-3 Slide Handle to remove front crankshaft oil seal with timing gear cover installed. Also used to remove rear crankshaft oil seal with seal housing installed.

DPSG,OUO1004,174 –19–07JUL98–6/15

Flywheel Turning Tool JDG820



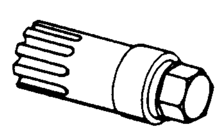
RG7056

RG7056 –UN–05DEC97

Used to rotate flywheel on engines with 129-tooth flywheel ring gear and a 29.9 mm (1.18 in.) flywheel housing guide bore diameter. JDE81-1 may be used if JDG820 is not available.

DPSG,OUO1004,174 –19–07JUL98–7/15

Flywheel Turning Tool JDE83



RG6251 –UN–22JUL92

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

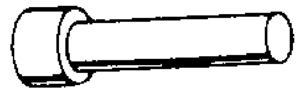
Continued on next page

DPSG,OUO1004,174 –19–07JUL98–8/15

RG5068 –UN–05DEC97

Timing Pin JDE81-4

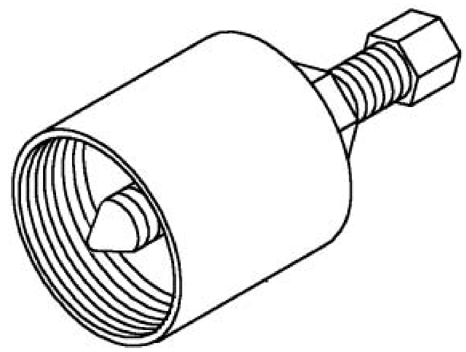
Used to lock engine/flywheel.



DPSG,OUO1004,174 –19–07JUL98–9/15

Front Wear Sleeve Puller JDG992-1

Used with JDG992-2 Front Wear Sleeve Puller to remove front wear sleeve with timing gear cover installed.

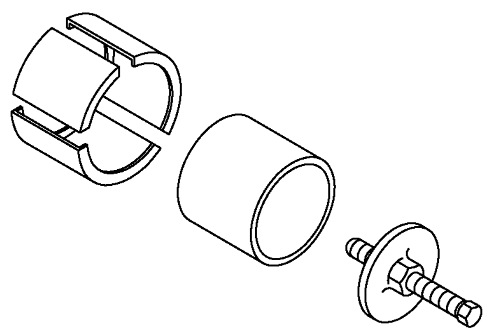


RG9124 –UN–22APR98

DPSG,OUO1004,174 –19–07JUL98–10/15

Front Wear Sleeve Puller JDG992-2

Used with JDG992-1 to remove front wear sleeve with timing gear cover installed.

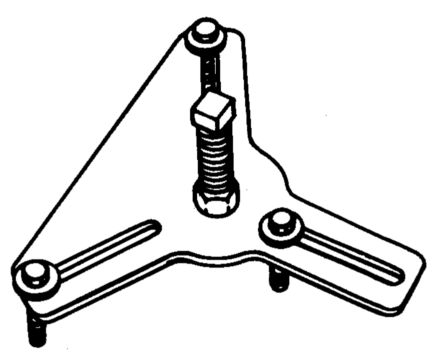


RG9125 –UN–19MAY98

DPSG,OUO1004,174 –19–07JUL98–11/15

Seal and Wear Sleeve Remover. JDG698

Remove unitized crankshaft rear oil seal and wear sleeve.



RG5631 –UN–12APR90

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DPSG,OUO1004,174 –19–07JUL98–12/15

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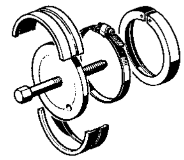
4

Rear Crankshaft Oil Seal/Wear Sleeve Puller . . JDG645E

Remove rear oil seal/wear sleeve from crankshaft flange.

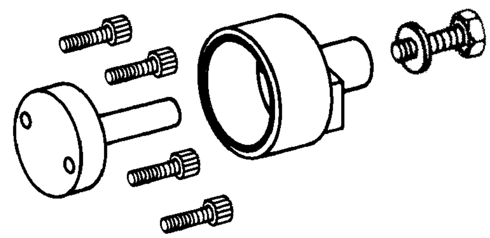


CD30241 –UN–08MAR95

DPSG,OUO1004,174 –19–07JUL98–13/15

Rear Oil Seal/Wear Sleeve Installer Set. . . . . JT30040 or KCD10002

Install crankshaft rear oil seal/wear sleeve assembly.

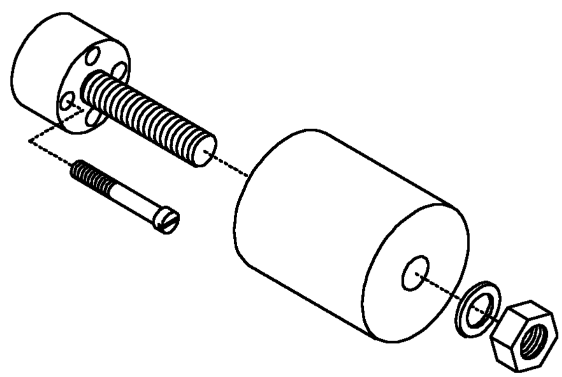


RG9122 –UN–22APR98

DPSG,OUO1004,174 –19–07JUL98–14/15

Crankshaft Gear and Front Oil Seal Installer JDG954

Used to install the crankshaft gear either prior to, or after installing crankshaft into engine. Also used to install front oil seal with timing gear cover installed on engine. **JDG954-1 Installer** may be used to install the crankshaft gear when the crankshaft is REMOVED from the engine.



RG9120 –UN–22APR98

DPSG,OUO1004,174 –19–07JUL98–15/15

SERVICE EQUIPMENT AND TOOLS

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

SERVICEGARD is a trademark of Deere & Company

DPSG,OUO1004,175 –19–07JUL98–1/4

Bushing, Bearing and Seal Driver Set D01045AA

Install pilot bearing in flywheel.

Continued on next page

DPSG,OUO1004,175 –19–07JUL98–2/4

Pulling Attachment. D01218AA

Use with D01200AA Push Puller to remove crankshaft gear from crankshaft.

DPSG,OUO1004,175 –19–07JUL98–3/4

Push Puller D01200AA

Use with D01218AA to remove crankshaft gear from crankshaft.

DPSG,OUO1004,175 –19–07JUL98–4/4

OTHER MATERIAL

Number	Name	Use
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to 45 mm damper single mount cap screw and flywheel mount cap screws.
(U.S.)	Brake Kleen or Ignition Cleaner	Remove sealant from crankshaft flange.
T43513 (U.S.) TY9474 (Canadian) 271 (LOCTITE®)	Thread Lock and Sealer (High Strength)	Apply to crankshaft wear sleeve.
TY15969 (U.S.) TY9479 (Canadian) 680 (LOCTITE®)	Retaining Compound (Maximum Strength)	Apply to crankshaft flange.
(U.S.)	PLASTIGAGE®	Check main bearing-to-crankshaft journal oil clearance.
TY6304 (U.S.) TY9484 (Canadian) LOCTITE® 515 (LOCTITE®)	Flexible Sealant	Apply to rear face of cylinder block prior to installing flywheel housing.
T43514 (U.S.) TY9475 (Canadian) 277 (LOCTITE®)	Plastic Gasket	Apply to torque converter access hole plug.

LOCTITE is a trademark of Loctite Corp.
PLASTIGAGE is a registered trademark of DANA Corp.

DPSG,OUO1004,176 –19–07JUL98–1/1

CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL SPECIFICATIONS

Item	Measurement	Specification
Damper	Maximum Radial Runout	1.50 mm (0.060 in.)
Damper Pulley Outer Ring	Wobble (Maximum)	1.50 mm (0.060 in.)
Damper Pulley Inner Ring	Wobble (Maximum)	0.5 mm (0.020 in.)
Crankshaft Damper Pulley (4 or 5 Cap Screw Mounted)		
6068H (4 Outer Cap Screws)	Torque	95 N•m (70 lb-ft)
6068H (Center Cap Screw)	Torque	150 N•m (111 lb-ft)
All Other Engines	Torque	80 N•m (60 lb-ft)
Crankshaft Damper Pulley (Single 45 mm Cap Screw Mounted)	Torque	183 N•m (135 lb-ft)
Crankshaft Damper Pulley (Single 112 mm Cap Screw Mounted)	Initial Torque	150 N•m (110 lb-ft)
Crankshaft Damper Pulley (Single 112 mm Cap Screw Mounted)	Torque Turn (Final Torque)	50—70°
Vibration Damper Only	Maximum radial run-out (A) Maximum wobble (B)	1.50 mm (0.060 in.) 1.50 mm (0.060 in.)
Crankshaft, New Parts: Two-Piece Thrust Bearing	End Play	0.05—0.25 mm (0.002—0.010 in.)
Flywheel Face Flatness	Maximum Variation Maximum Variation per 25 mm (1.0 in.) of Travel	0.23 mm (0.009 in.) 0.013 mm (0.0005 in.)
Flywheel Bearing Bore Concentricity	Maximum Variation	0.127 mm (0.005 in.)
Flywheel Housing	Maximum Face Runout (12 O’Clock) Maximum Face Runout (3 and 9 O’Clock)	0.30 mm (0.012 in.) 0.25 mm (0.010 in.)

Continued on next page DPSG,OUO1004,231 –19–10JUL98–1/3

Crankshaft, Main Bearings and Flywheel

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Item	Measurement	Specification
Flywheel Pilot Bearing Bore (Option Code 1508)	ID	34.978—35.004 mm (1.3770—1.3781 in.)
Flywheel Pilot Bearing Bore (Option Code 1502 and 1515)	ID	44.978—45.004 mm (1.7708—1.7719 in.)
Flywheel Mounting Cap Screws	Torque	138 N•m (102 lb-ft)
Rear Crankshaft Flange	OD	55.387—55.413 mm (2.1806—2.1816 in.)
Crankshaft Main Bearing-to-Journal	Oil Clearance	0.041—0.109 mm (0.0016—0.0043 in.)
Crankshaft Main Bearing	ID	79.391—79.433 mm (3.1256—3.1273 in.)
Crankshaft Main Journal	OD	79.324—79.350 mm (3.1229—3.1240 in.)
Crankshaft Rod Journal	OD	77.800—77.826 mm (3.0629—3.0640 in.)
Crankshaft Main Bearing-to-Journal	Oil Clearance	0.041—0.109 mm (0.0016—0.0043 in.)
Crankshaft Main or Rod Journal	Maximum Taper	0.010 mm (0.0004 in.)
Crankshaft Main or Rod Journal	Maximum Out-of-Round	0.005 mm (0.0002 in.)
Crankshaft Main Thrust Bearing Journal (New)	Width	38.952—39.028 mm (1.5335—1.5365 in.)
Crankshaft Main Thrust Bearing	Overall Width	38.79—38.87 mm (1.527—1.530 in.)
Crankshaft Main Bearing Bore (Without Bearings)	ID	84.455—84.481 mm (3.3250—3.3260 in.)
Crankshaft Main Bearing Bore Centerline-to-Top Deck	Distance	337.896—337.972 mm (13.3029—13.3059 in.)
Piston Cooling Orifice	Diameter	1.4 mm (0.055 in.)
Piston Cooling Orifice	Torque	11 N•m (8 lb-ft) (96 lb-in.)

Continued on next page DPSG,OUO1004,231 –19–10JUL98–2/3

Item	Measurement	Specification
Crankshaft Main Bearing Cap Screws	Torque	135 N•m (100 lb-ft)
Crankshaft Rear Main (Thrust) Bearing Cap Screws	Torque	135 N•m (100 lb-ft)
Crankshaft	End Play	0.05—0.25 mm (0.002—0.010 in.)
Flywheel Housing M12 Cap Screws	Torque	80 N•m (60 lb-ft)
Flywheel Housing M18 Cap Screws (Option Code 1418)	Torque	125 N•m (92 lb-ft)
Flywheel Housing Seal Bore	Maximum Permissible Run-Out	0.152 mm (0.006 in.)

DPSG,OUO1004,231 –19–10JUL98–3/3

CRANKSHAFT AND MAIN BEARING FAILURE ANALYSIS

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

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

Galled or “Wiped” Bearings:

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

Inconsistent Wear Pattern:

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

Broken Main Bearing Caps:

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

Cracked, Chipped or Broken Bearings:

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

RG,15,DT7461 –19–14NOV97–1/1

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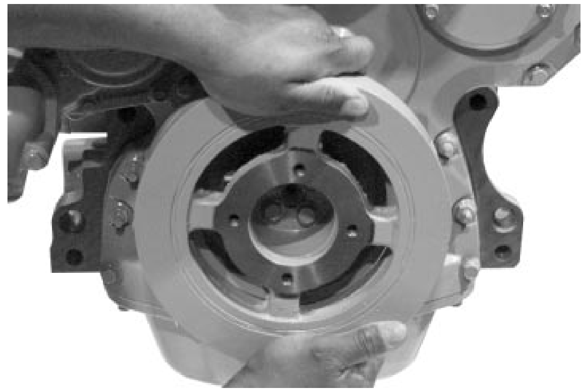
INSPECT VIBRATION DAMPER (6-CYLINDER ENGINE)

IMPORTANT: Do not immerse the vibration damper in cleaning solvent or any petroleum product. Rubber portion of damper may be damaged.

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

The damper assembly is not repairable. Replace damper every 5 years or 4500 hours, whichever occurs first. Also, replace damper whenever crankshaft is replaced or after major engine overhaul.

1. Grasp outer ring of damper and attempt to turn it in both directions. If rotation is felt, damper is defective and should be replaced. Also, if rubber is separated, partially missing, or displaced, replace damper.



RG7507 –UN–23NOV97

RG,15,DT7460 –19–14NOV97–1/3

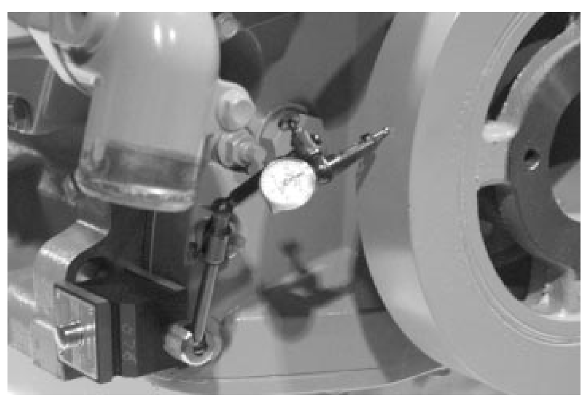
2. Check vibration damper radial runout by positioning a dial indicator so probe contacts damper OD.

3. With engine at operating temperature, rotate crankshaft using JDG820 or JDE83 Flywheel Turning Tool.

4. Note dial indicator reading. If runout exceeds specifications given below, replace vibration damper.

Damper—Specification

Maximum Radial Runout .... 1.50 mm (0.060 in.)



RG7508 –UN–23NOV97

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5. Check vibration damper wobble using a dial indicator. Measure wobble at the outer edges of damper face (A).

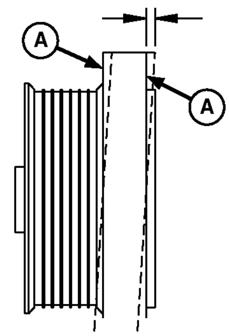
6. Rotate crankshaft one complete revolution using engine rotation tool, and note total dial indicator movement. Compare readings with specifications below.

Damper Pulley Outer Ring—Specification

Wobble (Maximum) .... 1.50 mm (0.060 in.)

Damper Pulley Inner Ring—Specification

Wobble (Maximum) .... 0.5 mm (0.020 in.)



RG9053 –UN–16MAR98

A—Vibration Damper Wobble

RG,15,DT7460 –19–14NOV97–3/3

REMOVE PULLEY OR VIBRATION DAMPER AND PULLEY

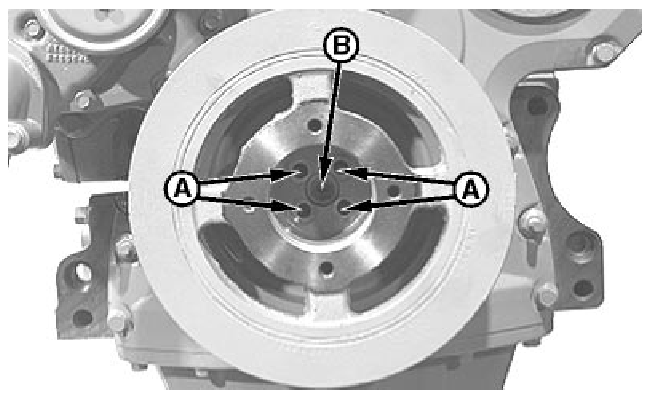
FOUR OR FIVE CAP SCREW MOUNTED DAMPERS

IMPORTANT: Never apply thrust on outer ring of damper. Do not drop or hammer on damper.

1. Remove four cap screws (A) from vibration damper.

2. On 6068H Engines (air-to-air), remove center cap screw (B).

3. Grasp damper and remove from crankshaft.

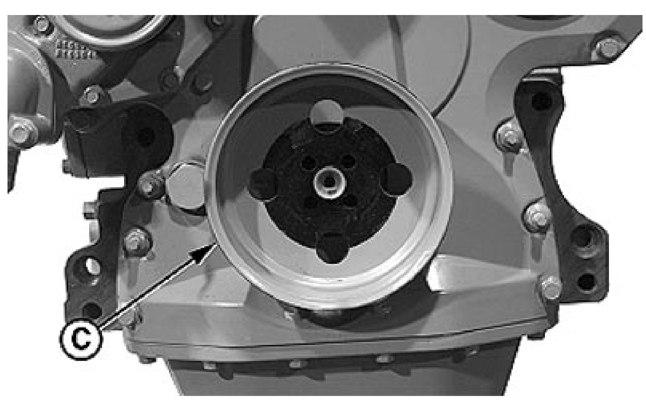


RG9078 –UN–16MAR98

A—Cap Screws
B—Center Cap Screw

RG,15,DT7459 –19–14NOV97–1/4

4. Remove belt pulley (C).



RG9079 –UN–16MAR98

Continued on next page

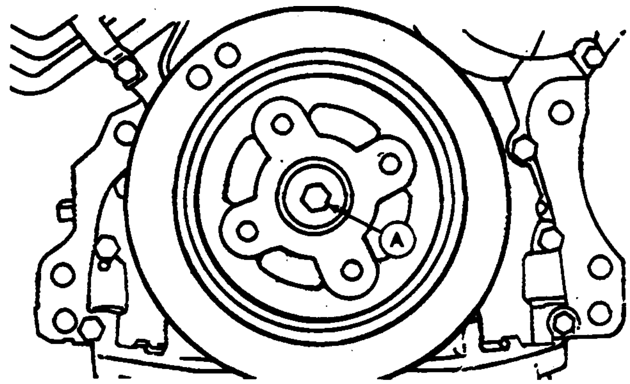
RG,15,DT7459 –19–14NOV97–2/4

15
12

SINGLE CAP SCREW MOUNTED DAMPERS

IMPORTANT: Never apply thrust on outer ring of damper. Do not drop or hammer on damper.

1. Remove pulley or damper pulley cap screw (A).



RG5113 –UN–14DEC88

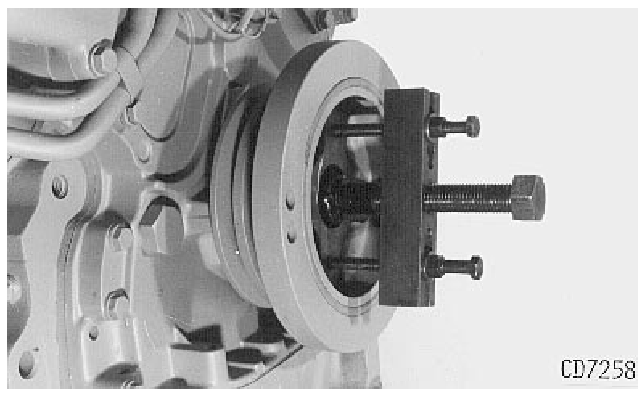
A—Cap Screw

RG,15,DT7459 –19–14NOV97–3/4

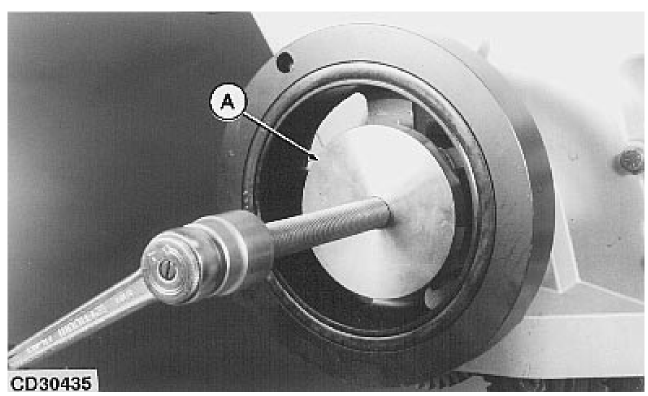
NOTE: Lubricate threads of JDG410 Puller before installing.

2. Using JDG410 Puller, remove damper pulley from crankshaft.

NOTE: The vibration damper may not have threaded holes on 6000 Series Tractor engines. In this case, use KJD10206 Puller (A) to remove damper.



CD7258 –UN–23MAY95



CD30435 –UN–10MAY95

Puller for 6000 Series Tractors

RG,15,DT7459 –19–14NOV97–4/4

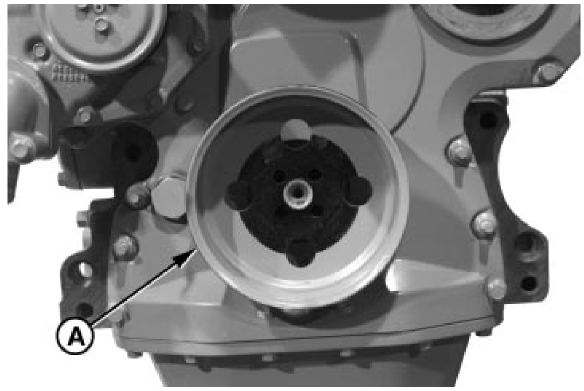
15
13

INSTALL PULLEY OR VIBRATION DAMPER PULLEY

FOUR OR FIVE CAP SCREW MOUNTED DAMPERS

1. Install belt pulley (A).

2. Position damper on crankshaft. Handle vibration damper with care to avoid impact damage.



RG7510A –UN–04NOV97

A—Pulley

RG,15,DT7458 –19–14NOV97–1/3

IMPORTANT: Damper or pulley-to-crankshaft cap screw must be SAE Grade 8 or higher.

3. Dip cap screws (B) in clean SAE30 engine oil.

4. Install cap screws (B) and tighten in a cross sequence to 20 N•m (15 lb-ft).

5. On 6068H Engines (air-to-air), install cap screw (C).

6. Tighten all cap screws to specifications.

6068H (4 Outer Cap Screws)—Specification

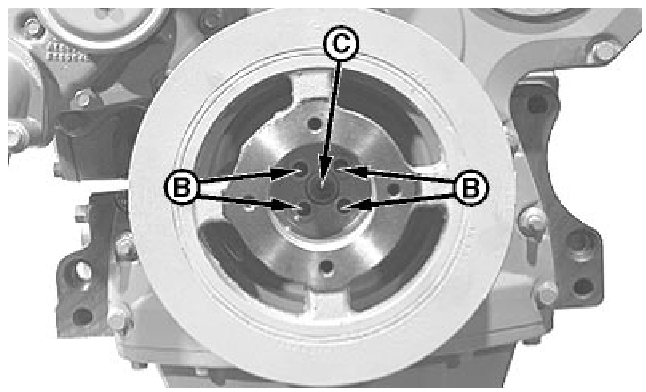
Torque .... 95 N•m (70 lb-ft)

6068H (Center Cap Screw)—Specification

Torque .... 150 N•m (111 lb-ft)

All Other Engines—Specification

Torque .... 80 N•m (60 lb-ft)



RG9080 –UN–16MAR98

B—Cap Screws
C—Center Cap Screw

Continued on next page

RG,15,DT7458 –19–14NOV97–2/3

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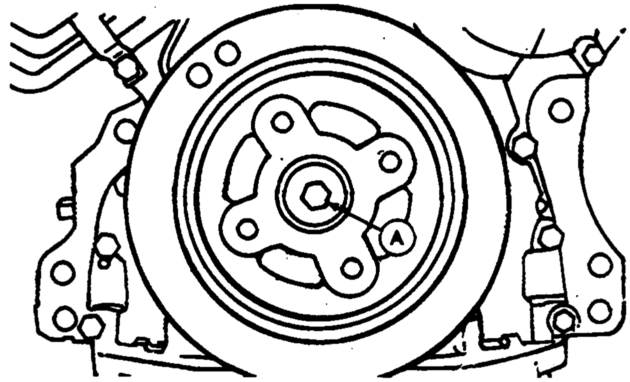
14

45 MM SINGLE CAP SCREW MOUNTED DAMPERS



A—Cap Screw

1. Position damper pulley on crankshaft. Handle damper with care to avoid impact damage.

IMPORTANT: Damper pulley-to-crankshaft cap screw must be SAE Grade 8 or higher. If a lower grade cap screw was previously used on engine, replace it with an appropriate SAE Grade 8 or higher cap screw.

2. Apply 242 Thread Lock and Sealer to cap screw (A) threads. Install cap screw and 12 mm (0.47 in.) thick washer (with flat side toward crankshaft).

NOTE: Some engines are equipped with a 10 mm (0.39 in.) thick washer, but cap screw torque remains the same.

3. Tighten cap screw (A) to specifications.

Crankshaft Damper Pulley (Single 45 mm Cap Screw Mounted)—Specification

Torque .... 183 N•m (135 lb-ft)

112 MM SINGLE CAP SCREW MOUNTED DAMPERS

NOTE: A Series 300 Engine head bolt is used to retain the vibration damper.

1. Position damper pulley on crankshaft. Handle damper with care to avoid impact damage.

2. Apply clean engine oil to threads and under head of cap screw (A). Install washer with the flat side toward crankshaft.

3. Tighten cap screw to specifications.

Crankshaft Damper Pulley (Single 112 mm Cap Screw Mounted)—Specification

Initial Torque... 150 N•m (110 lb-ft)

Crankshaft Damper Pulley (Single 112 mm Cap Screw Mounted)—Specification

Torque Turn (Final Torque)... 50—70°

RG,15,DT7458 –19–14NOV97–3/3

CHECKING VIBRATION DAMPER OR PULLEY

NOTE: When cleaning damper, never soak in a cleaning solvent. Use a steam cleaner, soap solution or water only.

1. Prior to disassembly, check damper total run-out (A) or wobble (B) and compare to the following specifications:

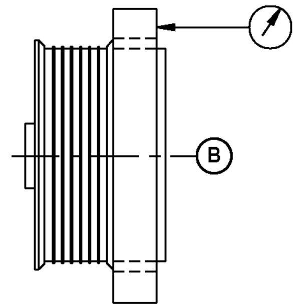
Vibration Damper Only—Specification

Maximum radial run-out (A)	1.50 mm (0.060 in.)
Maximum wobble (B)	1.50 mm (0.060 in.)

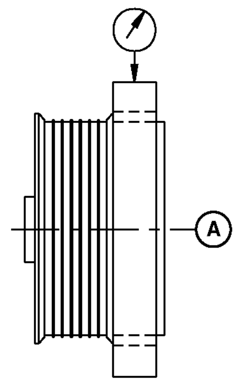
2. Replace damper if total run-out or wobble exceeds specifications.

3. Grasp damper and attempt to turn in both directions (clockwise and counterclockwise). If rotation is felt, outer ring has slipped relative to rubber member or drive hub. Replace damper.

IMPORTANT: Replace damper after 4500 hours or every five years, whichever occurs first.



RG9054 –UN–16MAR98



RG9055 –UN–16MAR98

A—Radial Run-Out
B—Wobble

RG,15,DT7457 –19–14NOV97–1/1

REPLACE FRONT CRANKSHAFT OIL SEAL AND WEAR SLEEVE

NOTE: This procedure is for removing seal and wear sleeve with timing gear cover installed.

REMOVE FRONT CRANKSHAFT OIL SEAL:

1. Remove poly-vee belts.

2. Remove vibration damper/pulley or pulley from crankshaft as previously instructed in this group.

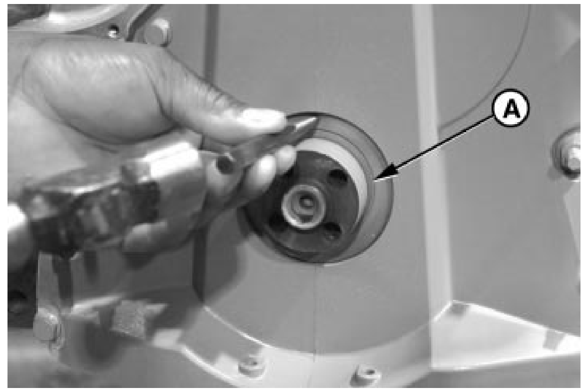
Continued on next page RG,15,DT7455 –19–14NOV97–1/10

15
16

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

3. Check oil seal (A) for wear, damage, or leakage.

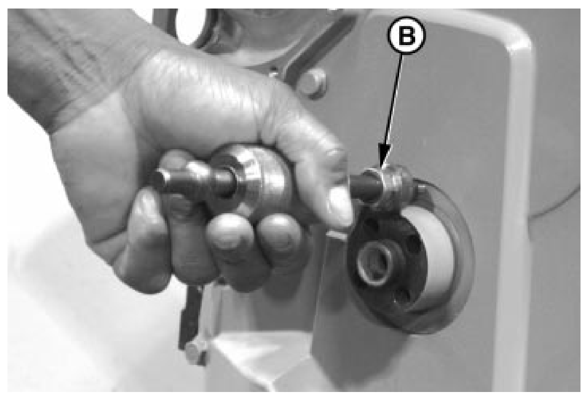
4. Center punch seal casing at 12 o’clock position and drill 1/8 in. hole in casing.



A—Oil Seal

RG,15,DT7455 –19–14NOV97–2/10

5. Remove seal from timing gear cover using JDG22 Seal Remover or JDG719 Seal Puller along with JDE38-2 Shank and JDE38-3 Slide Hammer (B). Be careful not to damage seal bore in timing gear cover.



B—Seal Removing Tool

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RG,15,DT7455 –19–14NOV97–3/10

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17

REMOVE CRANKSHAFT WEAR SLEEVE:

1. Rotate crankshaft using JDG820 or JDE83 Flywheel Turning Tool and lock flywheel with JDE81-4 Timing Pin.

2. Back out forcing screw and position JDG992-1 Collet onto crankshaft flange until threaded ID contacts wear sleeve.

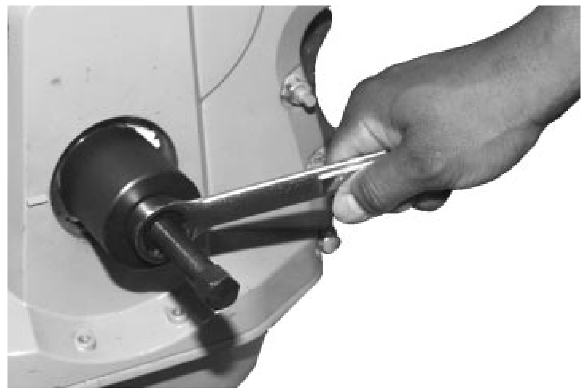
NOTE: You may want to apply inward pressure on collet as it is threaded onto wear sleeve.

3. Thread collet onto wear sleeve and tighten securely. Use a long breaker bar and tighten collet until wear sleeve spins on crank flange.

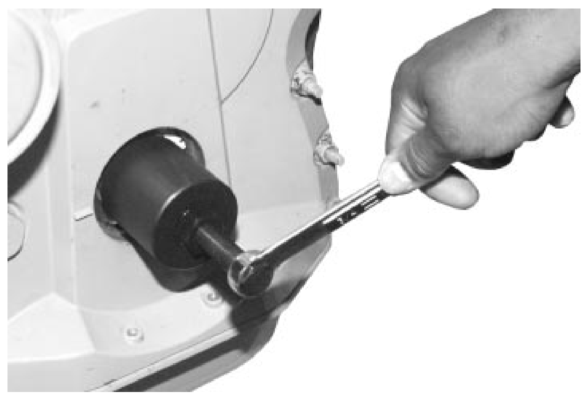
4. Lubricate threads of forcing screw. Tighten forcing screw until flange on wear sleeve is at least 3.2 mm (0.13 in.) from crankshaft gear.

5. Loosen forcing screw and remove threaded collet from wear sleeve.

RG8092 –UN–23NOV97



RG8093 –UN–23NOV97



RG8094 –UN–23NOV97

RG,15,DT7455 –19–14NOV97–4/10

6. Position three 313727 Split Collets from JDG992-2 Front Wear Sleeve Puller (using narrower lip) around OD of wear sleeve flange with 221761 End Cap and 311099 Forcing Screw.

RG8143 –UN–23APR98

Continued on next page RG,15,DT7455 –19–14NOV97–5/10

15
18

7. Slide 221760 Sleeve over collets to secure puller assembly.

RG8144 –UN–23APR98

RG,15,DT7455 –19–14NOV97–6/10

NOTE: If wear sleeve flange begins to roll during removal, remove puller assembly and use the wider lip of collets to grasp wear sleeve.

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

9. Clean crankshaft flange using Brake Kleen, Ignition Cleaner, or equivalent.

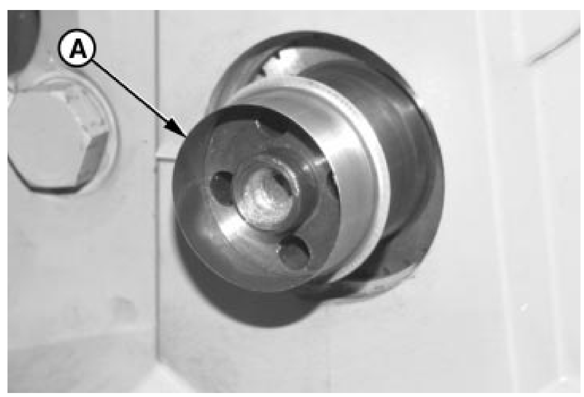
RG8145 –UN–23APR98

RG,15,DT7455 –19–14NOV97–7/10

INSTALL CRANKSHAFT WEAR SLEEVE:

1. Coat ID of new wear sleeve with LOCTITE® 271 Thread Lock and Sealer.

2. Install wear sleeve (A) on nose of crankshaft with flange of sleeve toward crankshaft.



RG8095A –UN–18NOV97

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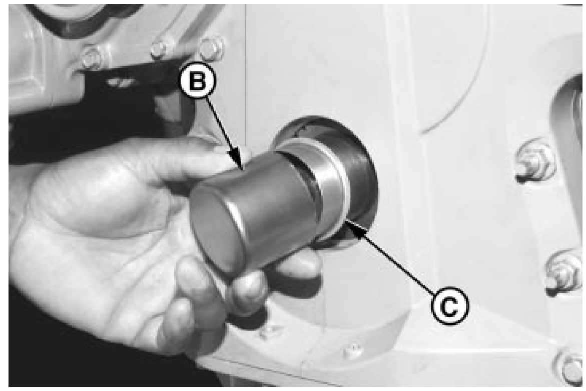
RG,15,DT7455 –19–14NOV97–8/10

3. Position installation tool (B) provided in front wear sleeve kit over wear sleeve. Install wear sleeve until tool bottoms on nose of crankshaft, using a dead blow hammer. Flange on wear sleeve should contact crankshaft gear.

4. Clean any sealant from OD of crankshaft flange (C) and wear sleeve.



RG8096A –UN–18NOV97

RG8097 –UN–23NOV97

Continued on next page RG,15,DT7455 –19–14NOV97–9/10

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20

INSTALL FRONT CRANKSHAFT OIL SEAL:

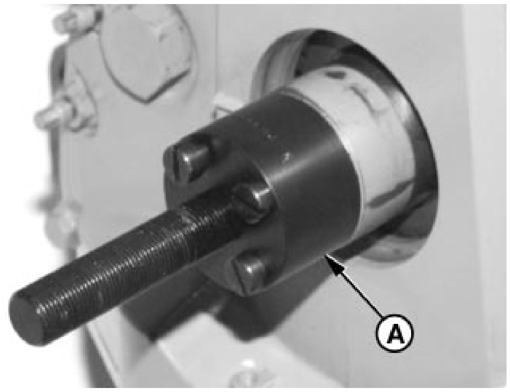
1. Inspect and clean seal bore in timing gear cover. Check for nicks or burrs. Use a medium-grit emery cloth to smooth rough areas.

IMPORTANT: To assure proper sealing, the OD of the crankshaft and wear sleeve MUST BE cleaned with Brake Kleen, Ignition Cleaner, or equivalent and dry prior to installing seal (C).

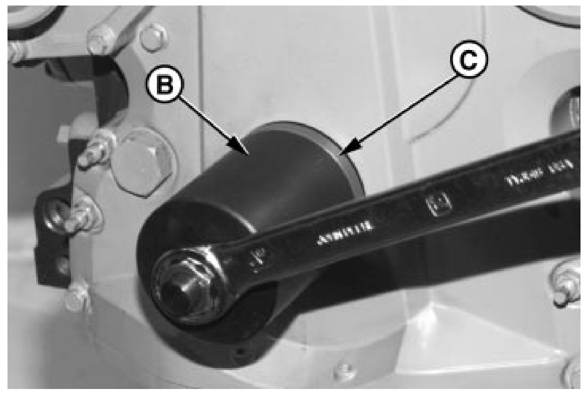
2. Slide JDG954-2 Adapter (A) on nose of crankshaft and tighten cap screws.

IMPORTANT: DO NOT allow oil to contact coating on OD of seal.

3. Apply a light coating of clean engine oil to lips of seal and position seal on crankshaft flange. (The spring-loaded side of seal goes into timing gear cover first.)
4. Place JDG954-1 Installer (B) over adapter. Tighten screw until driver bottoms on nose of crankshaft.
5. Install vibration damper/pulley or pulley on crankshaft as previously instructed in this group.
6. Install poly-vee belts.



RG7515A –UN–04NOV97



RG7516A –UN–04NOV97

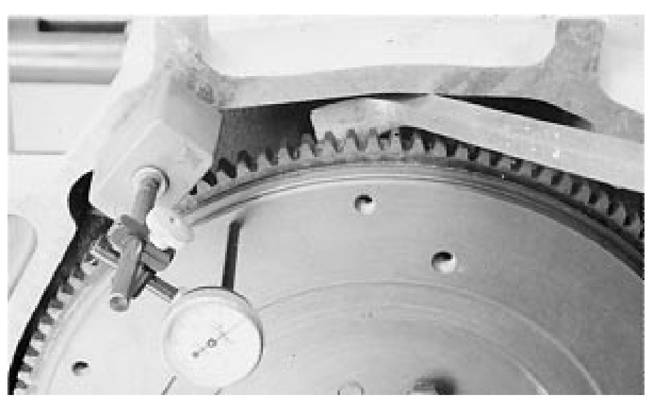
RG7511 –UN–23NOV97

RG,15,DT7455 –19–14NOV97–10/10

CHECK CRANKSHAFT END PLAY

Measure end play prior to removing crankshaft to determine condition of thrust bearings.

1. Position dial indicator on contact face of flywheel, on front crankshaft nose, on damper, or front pulley assembly if installed.



T88331 –UN–14OCT88

Continued on next page

RG,15,DT7454 –19–14NOV97–1/3

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

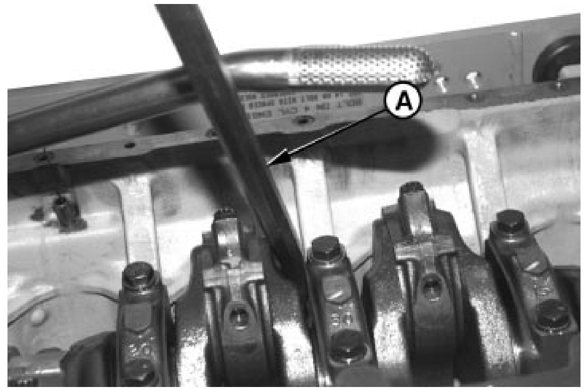
2. Using a pry bar, gently push crankshaft as far to rear of engine as possible.

3. Zero the dial indicator.

4. Gently pry the crankshaft as far forward as possible. Note indicator reading. If end play is not within specifications, install new thrust bearing.

Crankshaft, New Parts: Two-Piece Thrust Bearing—Specification

End Play .... 0.05—0.25 mm (0.002—0.010 in.)



RG7517 –UN–05NOV97

A—Pry Bar

RG,15,DT7454 –19–14NOV97–2/3

5. If new thrust bearing does not restore proper end play, install a two-piece thrust bearing with oversize thrust washers.

RG7542 –UN–23NOV97

RG,15,DT7454 –19–14NOV97–3/3

INSPECT FLYWHEEL

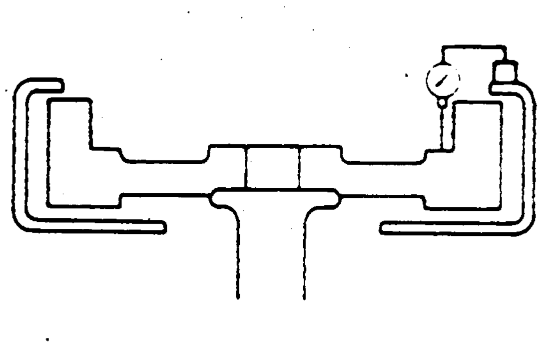
1. Inspect the clutch contact face for scoring, overheating, or cracks. Replace or resurface flywheel if defective.

2. Examine flywheel ring gear for worn or broken teeth. Replace ring gear if defective, as described later in this group.

RG,15,DT7465 –19–14NOV97–1/1

15
22

CHECK FLYWHEEL FACE FLATNESS



R22213 –UN–14DEC88

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

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

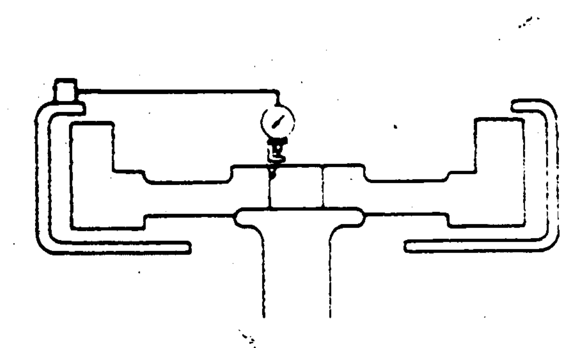
2. Rotate flywheel by turning crankshaft. Read total indicator movement. Resurface flywheel face or replace as required.

Flywheel Face Flatness—Specification

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

RG,15,DT7453 –19–14NOV97–1/1

CHECK PILOT BEARING BORE CONCENTRICITY



R22214 –UN–14DEC88

1. Mount dial indicator on flywheel housing face and position pointer to contact I.D. of pilot bearing bore in flywheel.

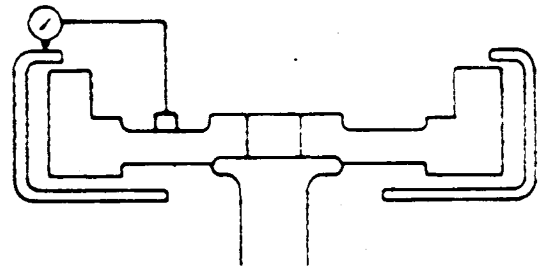
2. Rotate flywheel by turning crankshaft. Read total dial indicator movement.

Flywheel Bearing Bore Concentricity—Specification

Maximum Variation.. 0.127 mm (0.005 in.)

DPSG,OUO1004,69 –19–21APR98–1/1

CHECK FLYWHEEL HOUSING FACE RUNOUT


R22212 –UN–14DEC88

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

2. Preload indicator tip. Set dial indicator to 0.0 mm (in.).

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

3. Rotate flywheel by turning crankshaft. Read total dial indicator movement. It should not exceed specifications.

Flywheel Housing—Specification

Maximum Face Runou (12 O'Clock)	0.30 mm (0.012 in.)
Maximum Face Runout (3 and 9 O'Clock)	0.25 mm (0.010 in.)

4. If runout exceeds specifications, resurface flywheel housing face or replace housing as necessary.

DPSG,OUO1004,214 –19–09JUL98–1/1

15
24

REMOVE FLYWHEEL

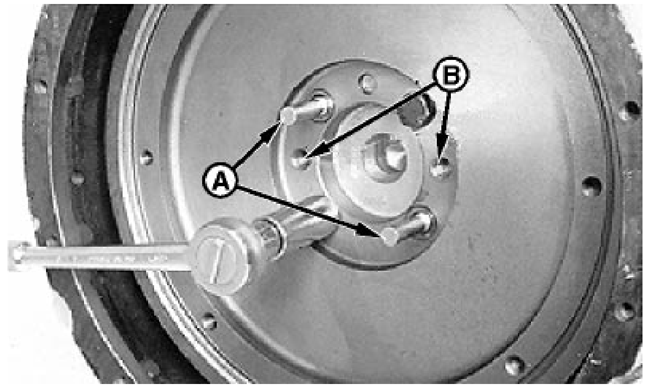
CAUTION: Flywheel is heavy. Plan a proper lifting procedure to avoid personal injury.

1. Remove two cap screws and install guide studs (A) in their place. Remove the remaining cap screws.

2. **On flywheels secured with four cap screws:** Install two cap screws in threaded jack screw holes (B). Tighten cap screws evenly to remove flywheel.

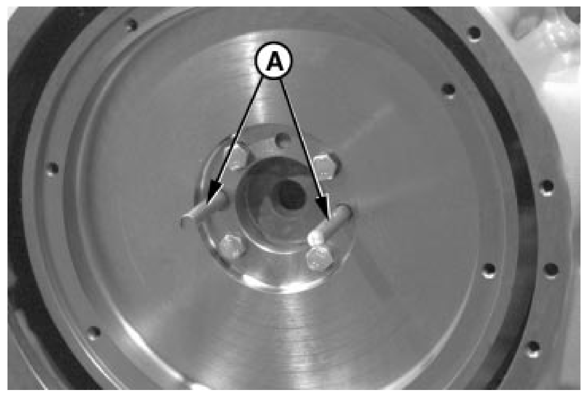
3. **On flywheels secured with six cap screws:** Pry flywheel off of crankshaft.

NOTE: If flywheel to housing clearance will not allow use of a pry bar, install a punch through timing pin hole and tap on flywheel face to drive from crankshaft.



RG9075 –UN–16MAR98

Four Cap Screw Flywheel



RG7518A –UN–05NOV97

Six Cap Screw Flywheel

A—Guide Studs
B—Jack Screw Holes

RG,15,DT7452 –19–14NOV97–1/1

REPLACE FLYWHEEL RING GEAR

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

1. Place the flywheel on a solid flat surface.

Continued on next page RG,15,DT7451 –19–14NOV97–1/3

2. Drive ring gear off with a brass drift (A) and hammer.

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.

3. Heat new ring gear to 148°C (300°F) using either heated oil, oven heat, or flame heat.

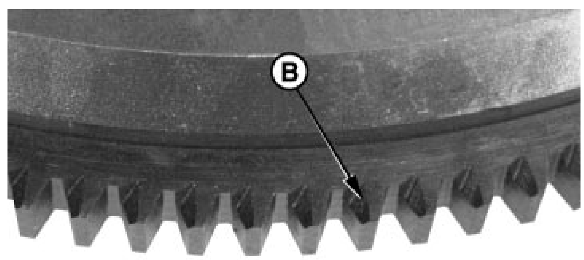
RG7519 –UN–05NOV97

A—Brass Drift

RG,15,DT7451 –19–14NOV97–2/3

4. Turn gear so side with chamfer (B) is toward engine with flywheel installed.

5. Install ring gear against shoulder of flywheel.



RG7520 –UN–05NOV97

B—Chamfer

RG,15,DT7451 –19–14NOV97–3/3

15
26

REPLACE PILOT BEARING IN FLYWHEEL—IF EQUIPPED

NOTE: Some engines are equipped with a pilot bearing (B) in flywheel (C). Flywheel must be removed from the engine to replace this bushing.

1. With flywheel removed from engine, drive bearing out of flywheel using appropriate disks and handle (A) from D01045AA Bushing, Bearing and Seal Driver Set. Discard bearing.

2. Measure flywheel bore diameter. If bore is larger than specifications, replace flywheel.

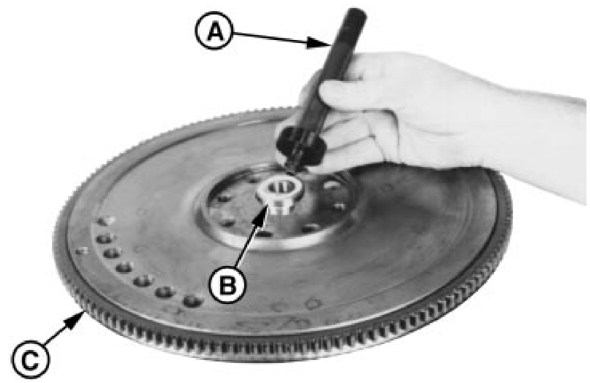
Flywheel Pilot Bearing Bore (Option Code 1508)—Specification

ID .... 34.978—35.004 mm (1.3770—1.3781 in.)

Flywheel Pilot Bearing Bore (Option Code 1502 and 1515)—Specification

ID .... 44.978—45.004 mm (1.7708—1.7719 in.)

3. Drive new pilot bearing into rear face of flywheel using appropriate disks and handle from same driver set, until bearing shoulder bottoms on flywheel face. Check bearing for smooth operation.



RG8035 –UN–14NOV97

A—Bushing Driver
B—Pilot Bearing
C—Flywheel

RG,15,DT7450 –19–14NOV97–1/1

INSTALL FLYWHEEL

CAUTION: Flywheel is heavy. Plan a proper handling procedure to avoid injuries.

IMPORTANT: Flywheel MUST BE clean and free of any oil, grease or debris.

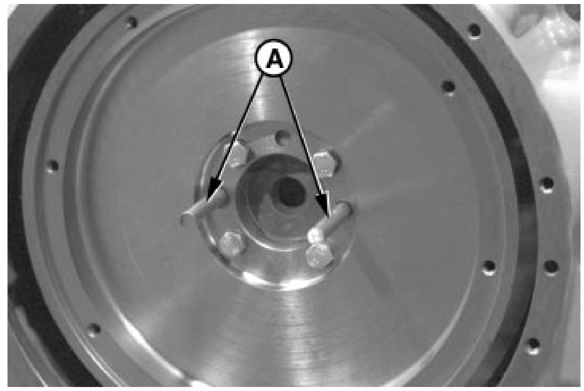
1. Install two guide studs (A) in crankshaft cap screw threaded holes. Place flywheel on studs and slide into position against crankshaft.

IMPORTANT: ALWAYS install new flywheel cap screws when flywheel has been removed.

2. Apply LOCTITE® 242 Thread Lock and Sealer to cap screws and start cap screws in crankshaft. Do not tighten until guide studs are removed and all cap screws are started. Tighten cap screws to specifications.

Flywheel Mounting Cap Screws—Specification

Torque .... 138 N•m (102 lb-ft)



RG7518A –UN–05NOV97

A—Guide Studs

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RG,15,DT7449 –19–14NOV97–1/1

15
28

CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE HANDLING PRECAUTIONS

Use the following precautions for handling seal and wear sleeve assembly (A):

- Seal and wear sleeve 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.

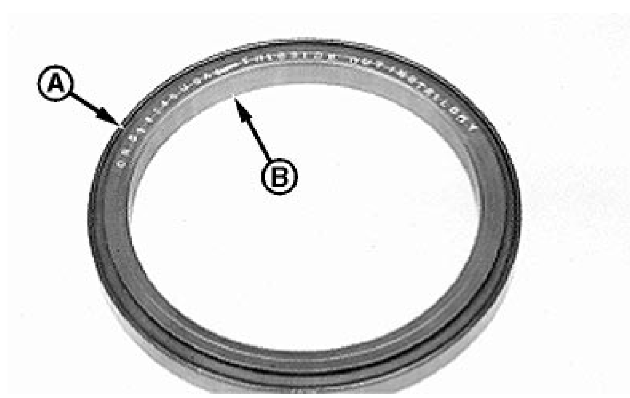
RG5640A –UN–31OCT97

A—Wear Sleeve

RG,15,DT7448 –19–14NOV97–1/1

REMOVE CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE

The crankshaft rear oil seal (A) and wear sleeve (B) are fabricated as a non-separable part. To remove the oil seal/wear sleeve assembly, the two following procedures can be used depending on special tool availability.



RG9083 –UN–16MAR98

A—Oil Seal
B—Wear Sleeve

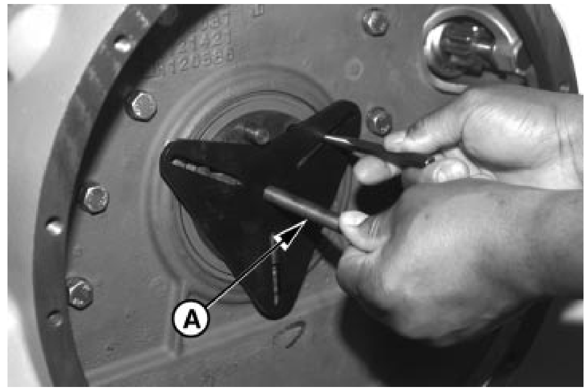
Continued on next page

RG,15,DT7447 –19–14NOV97–1/9

REMOVE OIL SEAL/WEAR SLEEVE USING JDG698

1. Adjust forcing screw (A) on JDG698 Seal and Wear Sleeve Remover and position screw so it centers tool on crankshaft flange.

2. Use the slots in JDG698 Remover as a template, mark three locations on seal casing where screws should be installed for removal purposes. Remove tool from crankshaft flange.



RG7399 –UN–03NOV97

A—Forcing Screw

RG,15,DT7447 –19–14NOV97–2/9

IMPORTANT: Holes must be drilled at outer edge of seal case. Screws will pull seal against wear ring, thereby removing both pieces.

3. Drill a 3/16 in. hole through wear sleeve lip and seal casing at the three marked locations.

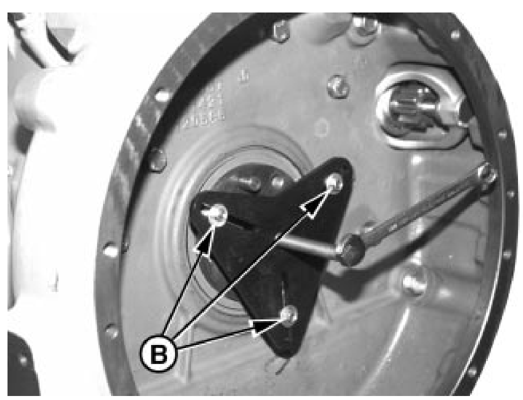
4. Position JDG698 Remover on end of crankshaft.

RG7400 –UN–23NOV97

RG,15,DT7447 –19–14NOV97–3/9

5. Install three 2-1/2 in. (approximate) sheet metal screws with washers (B) into slots of removal tool and thread screws into holes in seal casing. Evenly tighten screws until plate is flush with rear face of crankshaft.

6. Tighten forcing screw (plate should pull evenly against the three screws) until seal and wear sleeve assembly is removed from engine.



RG7401 –UN–03NOV97

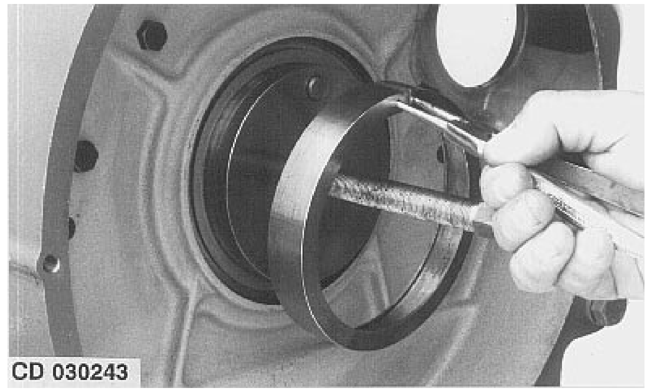
B—Sheet Metal Screws

Continued on next page

RG,15,DT7447 –19–14NOV97–4/9

REMOVE OIL SEAL/WEAR SLEEVE USING JDG645E

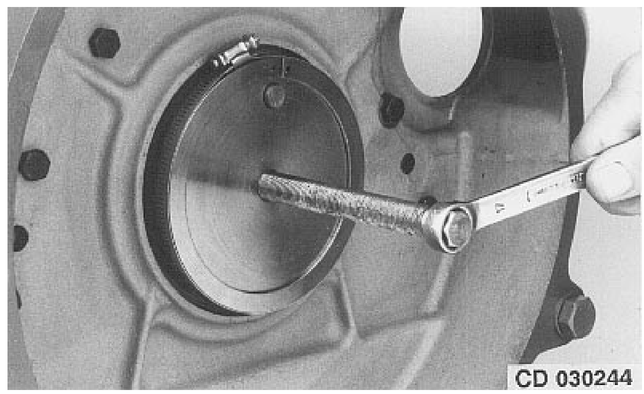
1. Place and center JDG645E cap screws and driver plate asembly onto crankshaft rear face. Then, using snap ring pliers, set the thinner shoulder of ring tool between sleeve flange and seal case.



CD30243 –UN–06MAR95

RG,15,DT7447 –19–14NOV97–5/9

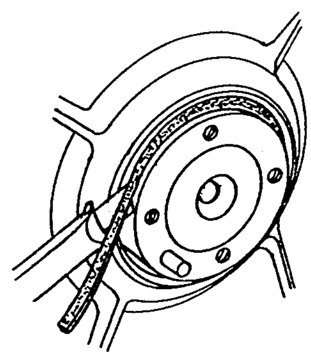
2. Secure the assembly with a clamp then gradually tighten the screw until wear sleeve is extracted.



CD30244 –UN–06MAR95

RG,15,DT7447 –19–14NOV97–6/9

3. Cut the rubber lip (now accessible) and remove it.

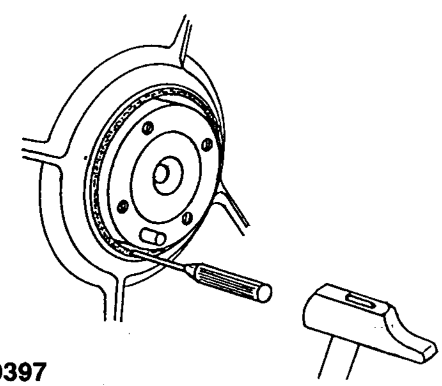


CD30396

CD30396 –UN–10MAY95

RG,15,DT7447 –19–14NOV97–7/9

4. Using a punch and hammer, tap the seal case toward engine at any location until seal case pivots.



CD30397

CD30397 –UN–10MAY95

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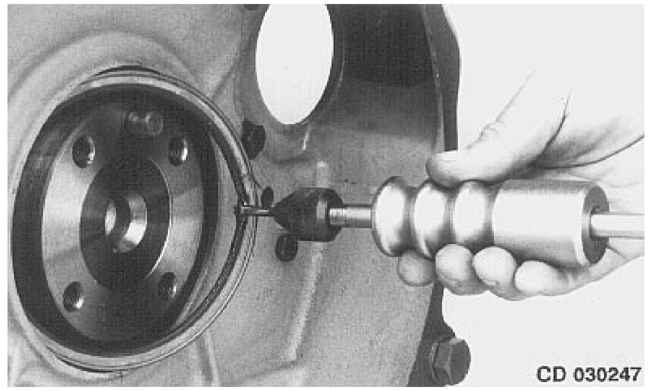
RG,15,DT7447 –19–14NOV97–8/9

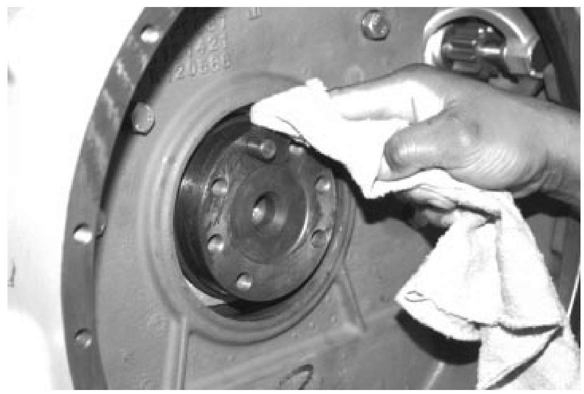
5. Using JDG22 Slide Hammer Puller, extract seal case.



CD30247 –UN–06MAR95

RG,15,DT7447 –19–14NOV97–9/9

CLEAN AND INSPECT CRANKSHAFT FLANGE



RG7522 –UN–23NOV97

1. Clean OD of crankshaft flange and ID of flywheel housing with cleaning solvent, trichloroethylene, acetone, or any other suitable cleaner that will remove sealant.

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

   Finish cleaning by wiping flange with a clean rag.

3. Measure crankshaft flange and compare to specifications below.

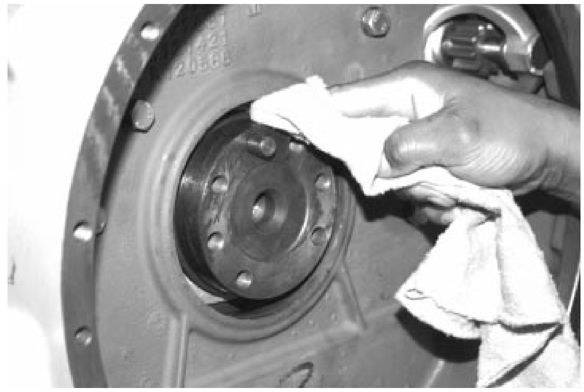
Rear Crankshaft Flange—Specification

OD .... 55.387—55.413 mm (2.1806—2.1816 in.)

DPSG,OUO1004,75 –19–23APR98–1/1

15
32

INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE



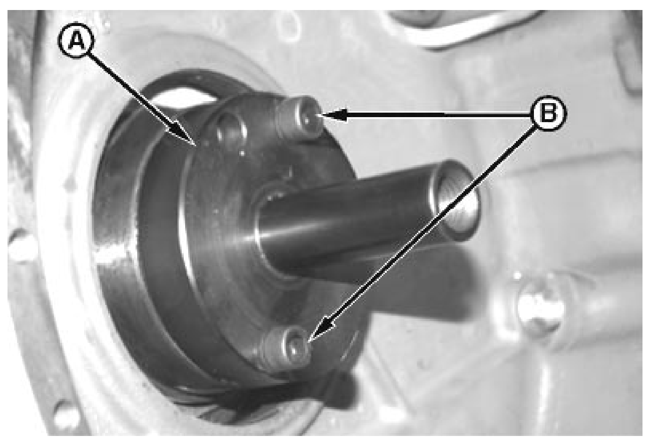
IMPORTANT: No lubrication of any kind is to contact seal when installing. Use of a lubricant may result in premature seal failure. Install seal and wear sleeve assembly immediately after removal from plastic bag to avoid possible dirt contamination.

1. Clean OD of crankshaft flange and ID of wear sleeve with trichloroethylene or equivalent just prior to application of sealant. Make sure that OD of crankshaft flange and ID of seal housing bore are free from nicks or burrs.

2. The oil seal/wear sleeve assembly can be installed using JT30040 or KCD10002 Installer Set.

RG,15,DT7446 –19–14NOV97–1/4

INSTALL REAR OIL SEAL/WEAR SLEEVE USING JT30040



A—Pilot
B—Cap Screws

1. Install JT30041A Pilot (A) from the JT30040B Seal and Wear Sleeve Installer Set on end of crankshaft using two socket-head cap screws. Tighten both cap screws until they touch base of pilot then back them off approximately 1/2 turn.

2. Install JT30042 Driver over JT30041A Pilot until driver cross-plate bottoms on pilot. This will properly center pilot with crankshaft flange.

NOTE: It may be necessary to lift up on pilot to install driver to full depth over pilot and crankshaft flange.

3. Tighten two pilot socket head cap screws (B) securely. Remove driver from pilot.

Continued on next page

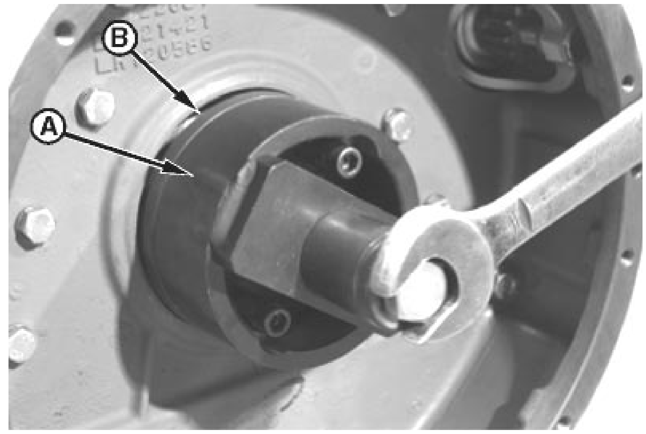
RG,15,DT7446 –19–14NOV97–2/4

IMPORTANT: Handle the rear oil seal and sleeve assembly carefully. If wear sleeve surface is scratched, gouged or any sealant (liquid) is present, order a new seal assembly.

4. Carefully start oil seal (B) and wear sleeve over pilot and crankshaft flange with open side of seal toward engine.

5. Attach JT30042 Driver (A) and thrust washer to the guide plate with cap screw. Tighten the cap screw until driver bottoms on pilot.

6. Remove seal driver and pilot plate. Check that seal and wear sleeve assembly is properly positioned on crankshaft flange and installed square in flywheel housing bore.



RG9443 –UN–07JUL98

A—Driver
B—Seal

Continued on next page

RG,15,DT7446 –19–14NOV97–3/4

15
34

INSTALL REAR OIL SEAL/WEAR SLEEVE USING KCD10002A

1. Apply a light coating of LOCTITE® 609 (TY15969) completely around leading edge of crankshaft flange.

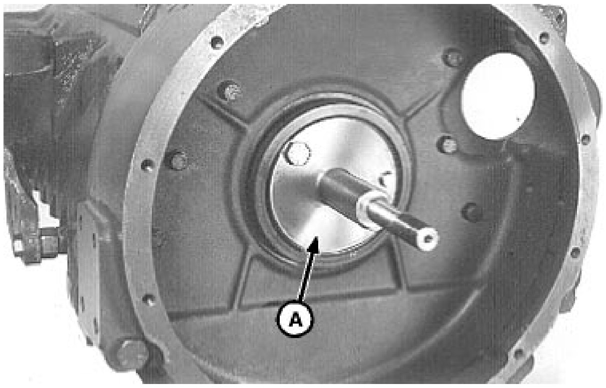
NOTE: Due to a diameter change of the crankshaft bore, it may be necessary to suppress the pilot pin from KCD10002.With this modification, KCD10002 becomes KCD10002A

2. Position guide (A) from KCD10002A Installer Set on crankshaft end with two cap screws finger tight.

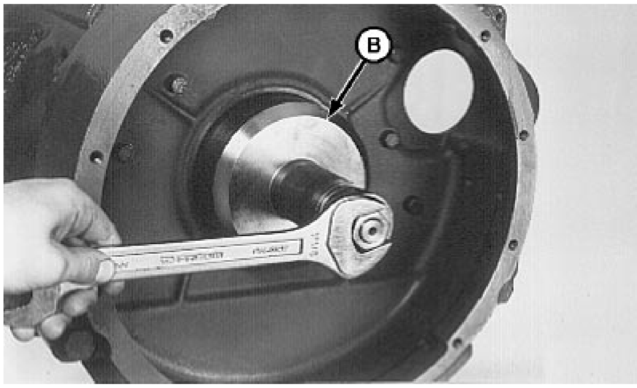
3. Install new oil seal/wear sleeve assembly on guide with open side of seal toward engine, center the guide and tighten cap screws..

4. Slide driver (B) onto guide (A) and gradually tighten hex nut until driver bottoms on guide.

5. Remove seal driver and guide. Check that seal and wear sleeve assembly is properly positioned on crankshaft flange and installed square in flywheel housing bore.



RG9136 –UN–18MAY98



RG9137 –UN–18MAY98

A—Guide
B—Driver

RG,15,DT7446 –19–14NOV97–4/4

REMOVE FLYWHEEL HOUSING

1. Remove flywheel. (See REMOVE FLYWHEEL earlier in this group.)

2. Remove starter if desired (see Group 40). Starter and flywheel housing may be removed as an assembly.

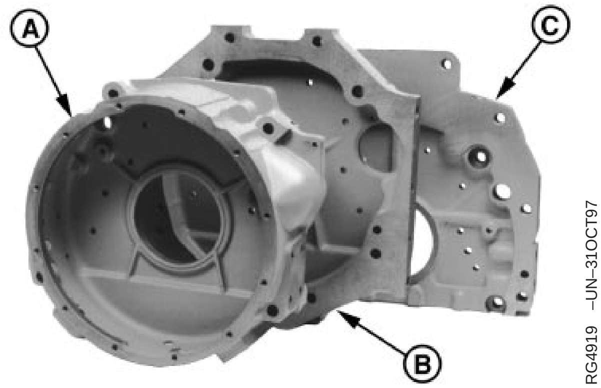
3. Remove crankshaft real oil seal as described earlier in this group.

CAUTION: The flywheel housing is heavy. Plan a proper handling procedure to avoid injuries.

4. Remove flywheel housing-to-cylinder block cap screws and flywheel housing-to-oil pan cap screws. Remove flywheel housing from block.

NOTE: Illustration shows three different types of flywheel housings used:

- *SAE 2, 3, and 4 housings (A).*
- *Standard flat housings (B).*
- *Special flat housings (C).*



A—SAE 2, 3 and 4 Housing
B—Standard Flat Housing
C—Special Flat Housing

RG,15,DT7445 –19–14NOV97–1/1

REMOVE CRANKSHAFT MAIN BEARINGS

1. Drain oil from engine crankcase and remove oil pan. (See Group 20.)

2. Remove timing gear cover and front plate. (See Group 16.)

3. Remove flywheel housing. (See Group 15.)

4. Remove connecting rods from crankshaft. (See Group 10.)

Continued on next page

RG,15,DT7444 –19–14NOV97–1/3

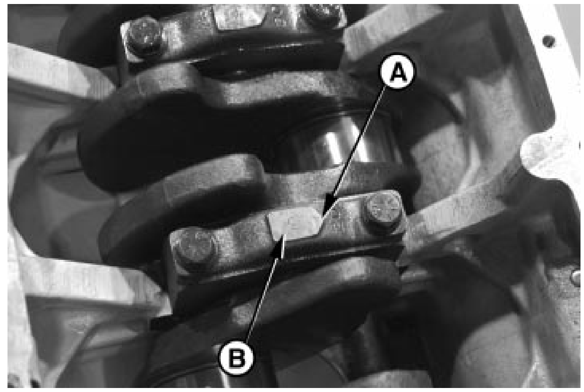
15
36

IMPORTANT: Before removing main bearing caps, check for proper torque on all main bearings.

NOTE: When crankshaft is to be removed, leave front and rear main bearing caps installed until all connecting rod caps have been removed.

5. Check main bearing caps for arrows (A) cast in main bearing cap, and numbers (B) stamped on cap and oil pan rail. Arrow points toward camshaft side of engine.

   If there are no numbers, stamp corresponding numbers on cap and oil pan rail to assure correct placement of bearing caps during reassembly.



RG7525A –UN–05NOV97

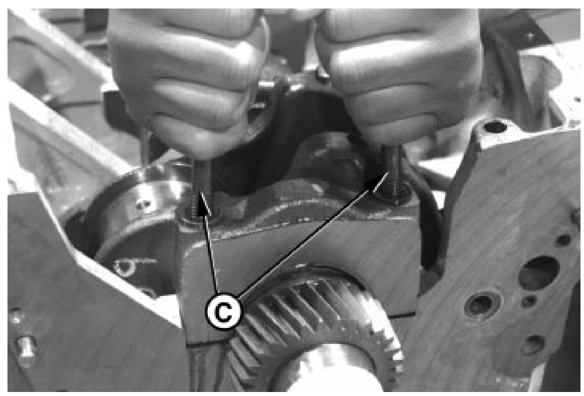
A—Cast Arrows
B—Stamped Numbers

RG,15,DT7444 –19–14NOV97–2/3

6. Remove main bearing caps by extending cap screws (C) and forcing heads of screws together. Wiggle bearing cap back and forth while applying an upward force with cap screws until free from main bearing cap support.

IMPORTANT: Keep matched bearings with their respective main bearing cap for comparison with crankshaft journal (surface wear) from which removed.

7. Visually inspect condition of bearing inserts and crankshaft main journals as bearing caps are removed.

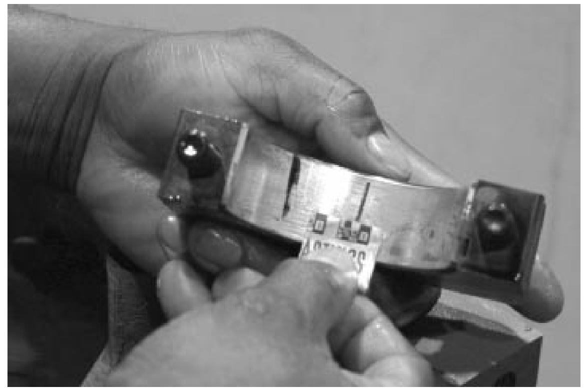


RG7526 –UN–05NOV97

C—Cap Screws

RG,15,DT7444 –19–14NOV97–3/3

CHECK MAIN BEARING OIL CLEARANCE



RG7528 –UN–23NOV97

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

1. Place a strip of PLASTIGAGE® in the center of the main bearing cap (with insert) about three-fourths of the width of the bearing or on crankshaft journal to measure oil clearance.

2. Use clean (SAE30) oil on PLASTIGAGE® to prevent smearing.

3. Install cap and tighten cap screws to 135 N•m (100 lb-ft).

4. Remove cap and compare width of PLASTIGAGE® with scale provided on wrapper to determine clearance.

Crankshaft Main Bearing-to-Journal—Specification

Oil Clearance.. 0.041—0.109 mm (0.0016—0.0043 in.)

PLASTIGAGE is a registered trademark of the DANA Corp.

RG,15,DT7443 –19–14NOV97–1/1

15
38

REMOVE AND INSTALL CRANKSHAFT GEAR (CRANKSHAFT INSTALLED IN ENGINE)

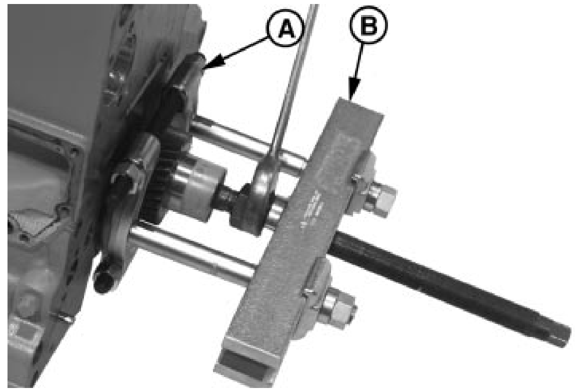
NOTE: Remove crankshaft gear for replacement only; it is not necessary to remove gear for crankshaft removal.

REMOVE CRANKSHAFT GEAR

1. Lock engine at No. 1 “TDC” compression.
2. Remove timing gear cover. (See Group 16.)
3. Remove oil pump. (See Group 20.)
4. Remove upper idler gear and lower idler gear and shaft. (See Group 16.)
5. Remove front plate. (See Group 16.)

NOTE: On 4-cylinder engines it is not necessary to remove balancer shafts, if equipped.

6. Install No. 1123 (D01218AA) Pulling Attachment (A) or larger onto crankshaft gear.
7. Install D01200AA Push Puller (B). Remove crankshaft gear.



RG7529 –UN–05NOV97

A—Pulling Attachment
B—Push Puller

Continued on next page

RG,15,DT7442 –19–14NOV97–1/2

INSTALL CRANKSHAFT GEAR

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.

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

1. Heat crankshaft gear to 148°C (300°F) using either heated oil or oven heat.

2. Install JDG954-2 Adapter (A) on nose of crankshaft. Tighten cap screws securely.

IMPORTANT: When installing gear, do not gouge or nick crankshaft flange or wear sleeve.

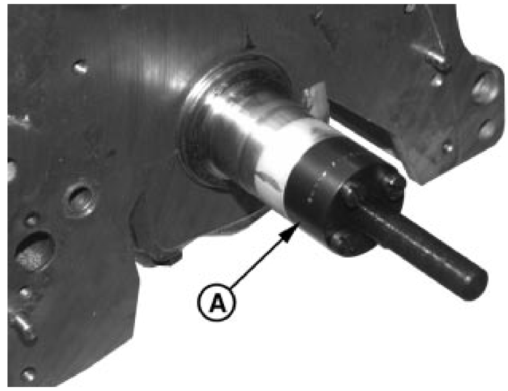
NOTE: Chamfered side of gear should be installed toward engine.

3. Place gear on crankshaft flange. Be sure Woodruff key (B) on crankshaft is properly aligned with keyway in gear

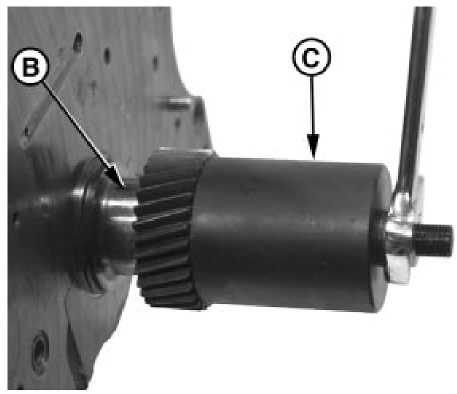
4. Install JDG954-1 Installer (C) over adapter.

5. Tighten nut clockwise until gear firmly seats against crankshaft flange. Allow gear to cool before removing installer.

6. Refer to appropriate group to complete final assembly of parts removed to access crankshaft gear.



RG7533 –UN–05NOV97



RG7534 –UN–05NOV97

A—JDG954-2 Adapter
B—Woodruff Key
C—JDG954-1 Installer

RG,15,DT7442 –19–14NOV97–2/2

REMOVE CRANKSHAFT

1. Remove engine front plate. (See Group 16.)

2. Remove flywheel housing and flywheel. (See REMOVE FLYWHEEL HOUSING earlier in this group.)

3. Remove main bearing caps and connecting rod caps, as described earlier in this group.

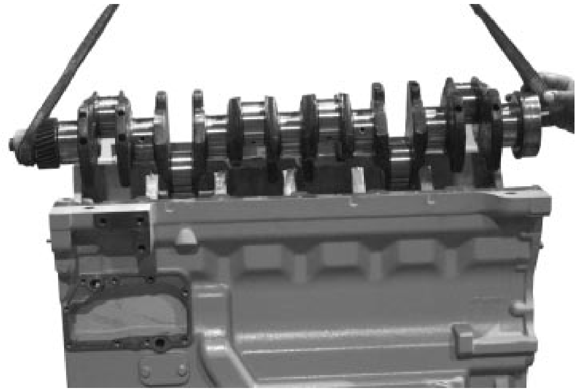
CAUTION: Crankshaft is very heavy. Plan a proper handling procedure to avoid injury.

4. Attach a lifting sling to crankshaft. Using proper lifting equipment, carefully raise crankshaft out of cylinder block.

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

6. Place crankshaft on clean V-blocks.

7. If main bearing inserts are to be replaced, remove inserts from cylinder block. Otherwise, leave bearing inserts in block until assembled ID has been measured.



RG7535 –UN–23NOV97

RG,15,DT7441 –19–14NOV97–1/1

INSPECT CRANKSHAFT

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

1. Thoroughly clean crankshaft. Clear restrictions from all oil passages.

IMPORTANT: Small cracks may not be visible to the eye. Use a method such as the Fluorescent Magnetic Particle Method. This method magnetizes the crank, employs magnetic particles which are fluorescent and glow under "black light". The crankshaft must be de-magnetized after inspection.

2. Inspect crankshaft for signs of load stress, cracks, scoring, or journal scratches. Replace crankshaft if cracks are found.

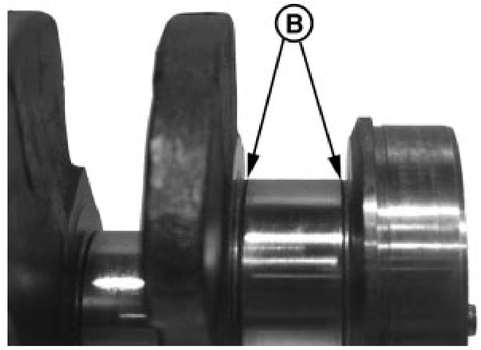
3. Check each journal for evidence of excessive overheating or discoloration. If either condition exists, replace crankshaft since heat treatment has probably been destroyed.

4. Inspect front crankshaft gear for cracks, chipped teeth, or excess wear. Replace gear as required.

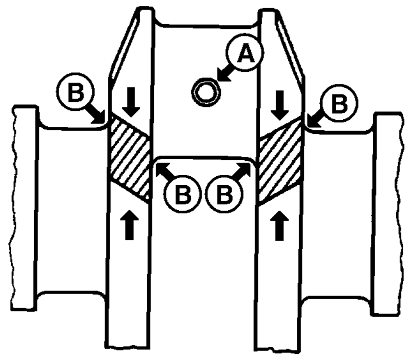
5. Inspect the keyway for evidence of cracks or wear. Replace crankshaft as necessary.

6. 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 or crocus cloth.

7. Carefully check the crankshaft for cracks in the area of rod journal holes (A) and at journal fillets (B). Replace crankshaft if any cracks are found.



RG7536B –UN–05NOV97



RGCD7147 –UN–30OCT97

A—Rod Journal Holes
B—Journal Fillets

RG,15,DT7440 –19–14NOV97–1/1

15
42

MEASURE CRANKSHAFT JOURNALS AND MAIN BEARING ID

1. With crankshaft removed from engine, assemble main bearing caps with bearing inserts. Be sure inserts are installed correctly.
2. Tighten main bearing cap screws to 135 N•m (100 lb-ft).
3. Measure and record main bearing assembled ID (A) at several points with an inside micrometer.
4. Measure and record crankshaft main journal OD (B) and rod journal OD (C) at several points around each journal.

NOTE: If an undersized crankshaft has been installed, measured dimensions will not meet specifications. However, bearing-to-journal oil clearance must be within specification. See CRANKSHAFT GRINDING GUIDELINES later in this group.

5. Compare measurements with specifications given below.

Crankshaft Main Bearing—Specification

ID .... 79.391—79.433 mm (3.1256—3.1273 in.)

Crankshaft Main Journal—Specification

OD .... 79.324—79.350 mm (3.1229—3.1240 in.)

Crankshaft Rod Journal—Specification

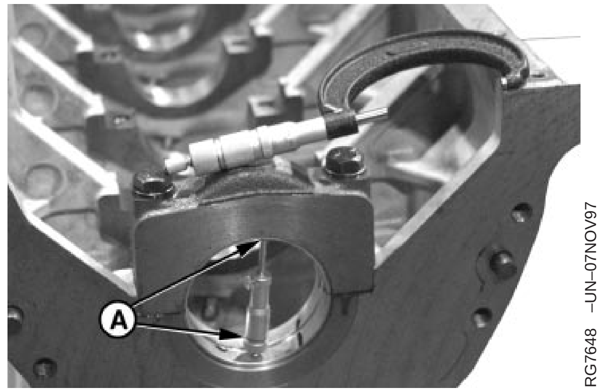
OD .... 77.800—77.826 mm(3.0629—3.0640 in.)

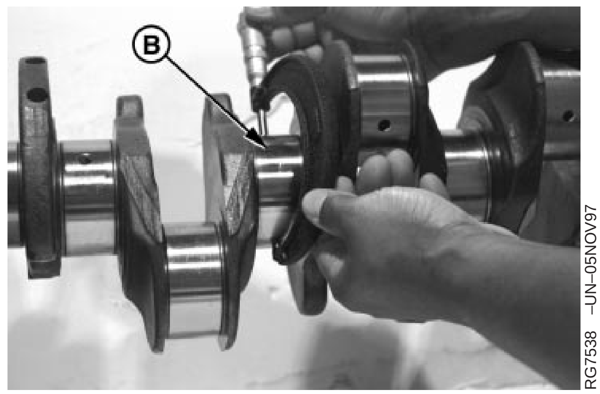
Crankshaft Main Bearing-to-Journal—Specification

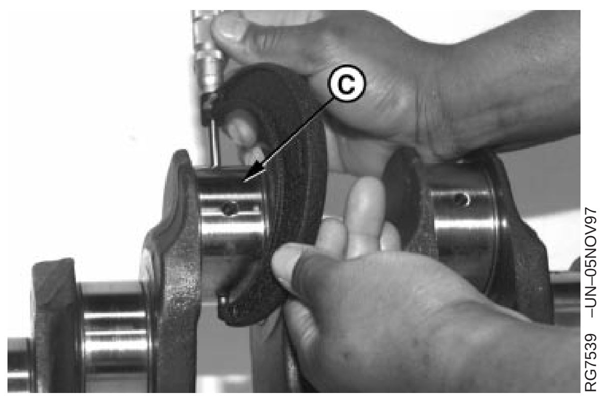
Oil Clearance.. 0.041—0.109 mm (0.0016—0.0043 in.)

Crankshaft Main or Rod Journal—Specification

Maximum Taper... 0.010 mm (0.0004 in.)







A—Main Bearing ID
B—Main Journal OD
C—Rod Journal OD

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RG,15,DT7439 –19–14NOV97–1/2

Crankshaft Main or Rod Journal—Specification

Maximum Out-of-Round .... 0.005 mm (0.0002 in.)

Replace or recondition crankshaft if it does not fall within above specifications.

RG,15,DT7439 –19–14NOV97–2/2

MEASURE MAIN THRUST JOURNAL WIDTH AND THRUST BEARING WIDTH

NOTE: If crankshaft has been previously reconditioned, thrust journal width may not be within above specifications. However, oil (side) clearance must be within specification.

1. Measure and record crankshaft main thrust journal width.

   If crankshaft thrust journal width is not within specifications, install a new crankshaft.

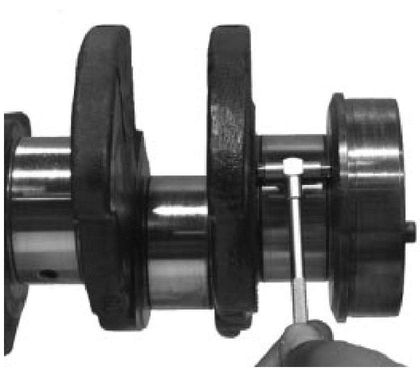
2. Measure and record width of main thrust bearing. Oil (side) clearance between thrust bearing and thrust journal must be within specifications.

Crankshaft Main Thrust Bearing Journal (New)—Specification

Width.. 38.952—39.028 mm (1.5335—1.5365 in.)

Crankshaft Main Thrust Bearing—Specification

Overall Width... 38.79—38.87 mm (1.527—1.530 in.)



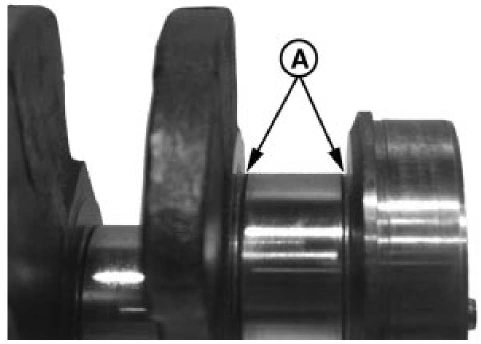
RG7540 –UN–23NOV97

RG7541 –UN–23NOV97

RG7542 –UN–23NOV97

RG,15,DT7438 –19–14NOV97–1/1

CRANKSHAFT GRINDING GUIDELINES



RG7536A –UN–23NOV97

RG7542 –UN–23NOV97

A—Fillets

IMPORTANT: Crankshaft grinding should be done ONLY by experienced personnel on equipment capable of maintaining crankshaft size and finish specifications. Undercut and rolled fillets (A) have taken the place of ground (tangential) fillets. DO NOT grind within this undercut area when undersize bearings are used.

Crankshafts have micro-finished journal surfaces.

IMPORTANT: If undersize bearings are installed, recheck bearing-to-journal clearance. If oil clearance is not within specifications, premature wear of bearings and journals will result.

If the crankshaft is to be reground, use the following recommended guidelines:

1. Compare the crankshaft journal measurements taken during inspection and determine the size which the journals are to be reground.

2. Grind all main journals or all connecting rod journals to the same required size.

IMPORTANT: Care must be taken to avoid localized heating which often produces grinding cracks. Use coolant generously to cool the crankshaft while grinding. DO NOT crowd the grinding wheel into the work. Grind crankshaft with journals turning counterclockwise, as viewed from the front end of the crankshaft. Lap or polish journals in opposite direction of grinding.

3. Polish or lap the ground surfaces to the specified finish to prevent excessive wear of the journals.

Continued on next page RG,15,DT7437 –19–14NOV97–1/2

4. Stone the edge of all oil holes in the journal surfaces smooth to provide a radius of approximately 1.50 mm (0.060 in.).

5. When finished grinding, inspect the crankshaft by the fluorescent magnetic particle method, or other similar method to determine if cracks have originated due to the grinding operation.

6. De-magnetize the crankshaft after inspection.

7. Thoroughly clean the crankshaft and oil passages with solvent. Dry with compressed air.

RG,15,DT7437 –19–14NOV97–2/2

CRANKSHAFT GRINDING SPECIFICATIONS

Bearing Size	Crankshaft Main Journal OD	Crankshaft Rod Journal OD
Standard	79.324—79.350 mm (3.1229—3.1240 in.)	77.800—77.826 mm (3.0629—3.0640 in.)
0.25 mm (0.010 in.) Undersize	79.074—79.100 mm (3.1131—3.1141 in.)	77.550—77.576 mm (3.0531—3.0541 in.)

Main and Connecting Rod Journal Surface Finish (AA) .... Lap 0.20 um (8 AA)
Thrust Surface Finish (AA) .... Lap 0.40 um (16 AA)
Thrust Bearing Journal Width .... 38.952—39.028 mm (1.5335—1.5365 in.)

Direction of Crankshaft Rotation (viewed from flywheel end):
Grinding .... clockwise
Lapping .... counterclockwise
Engine Stroke .... 127 mm (5.00 in.)

RG,15,DT7435 –19–14NOV97–1/1

15
46

MEASURE ASSEMBLED ID OF MAIN BEARING CAPS

1. Remove bearing inserts from caps and cylinder block. Keep inserts in correct order if they are to be reused.

2. Clean and inspect caps for damage. Small burrs or nicks on flat surfaces may be removed with a file. Use a medium-grit polishing cloth to dress curved bearing surfaces.

3. Install bearing caps (without bearings) in cylinder block. Tighten cap screws to 135 N•m (100 lb-ft).

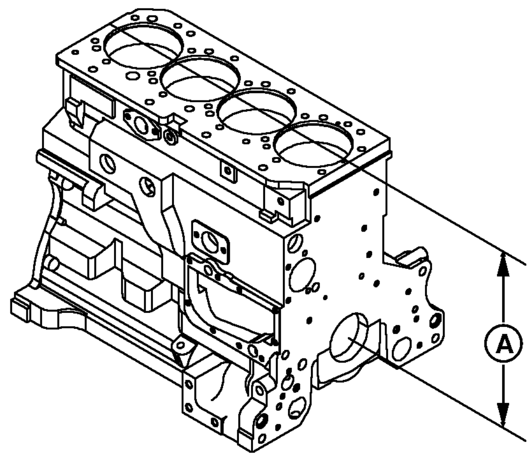
4. Measure ID of bearing cap bores.

Crankshaft Main Bearing Bore (Without Bearings)—Specification

ID .... 84.455—84.481 mm (3.3250—3.3260 in.)

Crankshaft Main Bearing Bore Centerline-to-Top Deck—Specification

Distance.. 337.896—337.972 mm (13.3029—13.3059 in.)



A—Top Deck-to-Centerline Bearing Bore

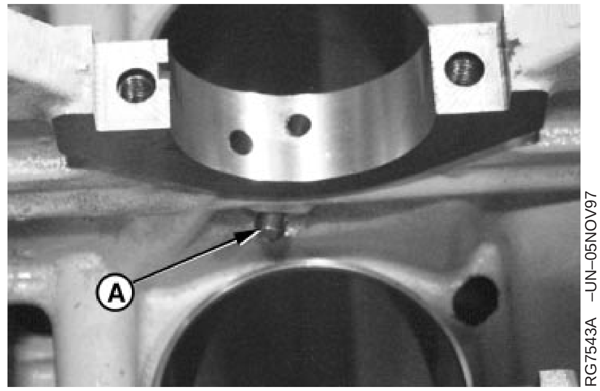
IMPORTANT: When cylinder block is line bored, dimension (A) from centerline of main bearing bore to cylinder block top deck will be changed. Piston may contact cylinder head if this dimension is less than specified above. Main bearing line boring should be done ONLY by experienced personnel on equipment capable of maintaining bore specifications.

5. If bearing caps are damaged or bore is not within specification, install a new cap and line bore to specified size. (See MEASURE MAIN BEARING ID AND CRANKSHAFT JOURNAL OD, earlier in this group.)

NOTE: Replacement bearing caps are supplied with unfinished bearing bore.

RG,15,DT7436 –19–14NOV97–1/1

REMOVE, INSPECT, AND INSTALL PISTON COOLING ORIFICES



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

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

RG,15,DT7434 –19–14NOV97–1/2

NOTE: If equipped with early design orifice (B), add a punch mark (C) to each orifice as shown. This is not necessary on later design orifice (D) because of its different shape. Adding a punch mark to orifice (B) will also prevent cooling jets from being mistakenly used on 300-Series Engines. &pwrtec;® Engines use a larger orifice diameter cooling jet for proper lubrication and cooling of piston skirts.

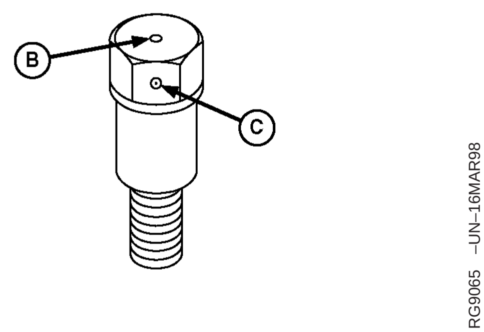
2. Install and tighten orifices.

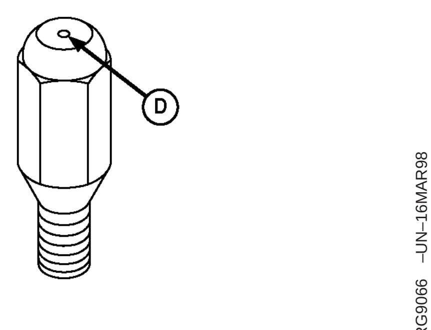
Piston Cooling Orifice—Specification

Diameter .... 1.4 mm (0.055 in.)

Piston Cooling Orifice—Specification

Torque .... 11 N•m (8 lb-ft) (96 lb-in.)





B—Early Design Orifice
C—Punch Mark
D—Later Design Orifice

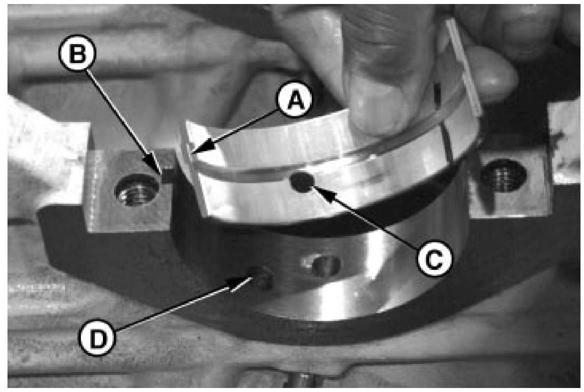
RG,15,DT7434 –19–14NOV97–2/2

15
48

INSTALL MAIN AND THRUST BEARING INSERTS IN BLOCK

NOTE: Lower half of bearing insert with oil hole goes in block.

1. Install main bearing inserts. Make sure that tang (A) in insert is engaged with slot (B) in the cylinder block and main bearing caps. Also make sure oil holes in insert (C) line up with oil passages in block (D).



RG7544 –UN–05NOV97

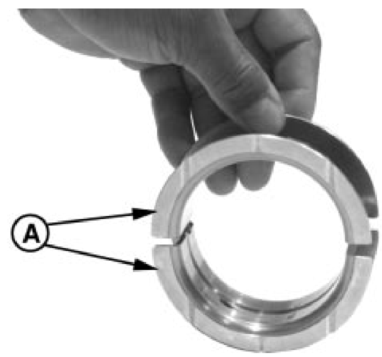
A—Tang in Insert
B—Slot in Block
C—Oil Holes in Insert
D—Oil Passages in Block

RG,15,DT7433 –19–14NOV97–1/3

NOTE: Only two-pieces bearings (A) are provided for service.

During assembly, apply a liberal coating of clean engine oil to:

- *All main bearing webs in block*
- *Both sides of main bearing inserts and thrust bearing inserts*
- *Entire OD of crankshaft main bearing journal*



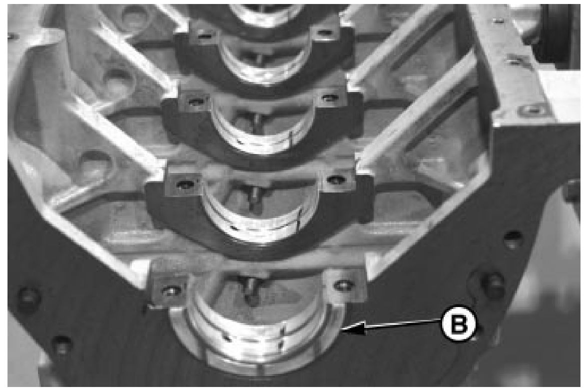
RG7542A –UN–05NOV97

A—Two-Piece Bearing

Continued on next page

RG,15,DT7433 –19–14NOV97–2/3

2. Install main thrust bearing (B) in thrust web of cylinder block.



B—Main Thrust Bearing

RG,15,DT7433 –19–14NOV97–3/3

INSTALL CRANKSHAFT

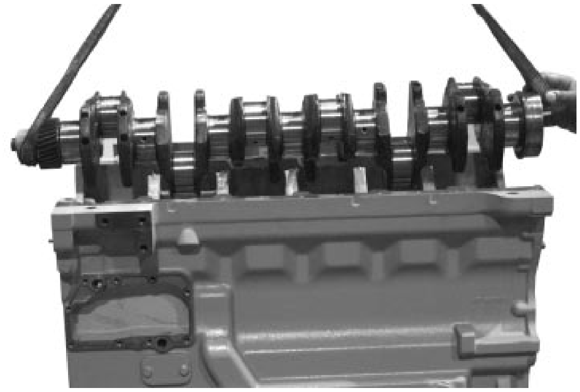
CAUTION: Crankshaft is heavy. Plan a proper lifting procedure to avoid injuries.

1. Carefully position crankshaft onto main bearing inserts using a hoist and lift sling.

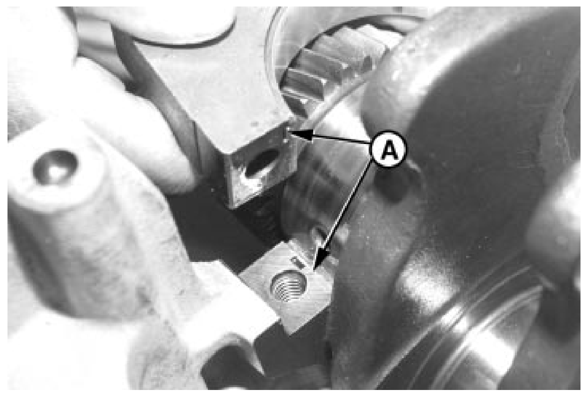
2. Apply a liberal amount of clean oil to bearing insert. Dip entire main bearing cap screws in clean engine oil and position them in main bearing caps.

IMPORTANT: Make sure main bearing caps are installed in locations from which they were removed. Numbers (B) stamped on the caps should match number stamped on pan rail of block. Arrow (C) on cap must point toward camshaft side of block.

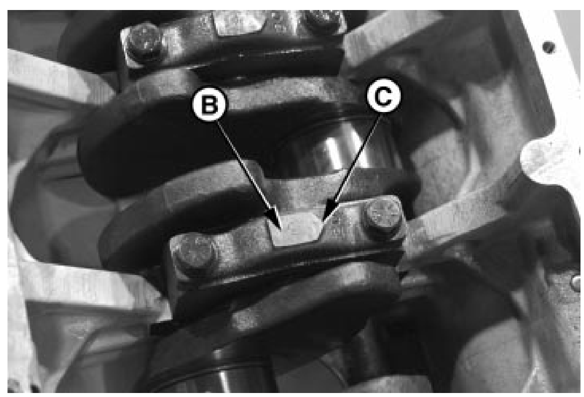
3. Install main bearing caps so bearing tang (A) in cap and cylinder block are together on same side of cylinder block.



RG7535 –UN–23NOV97



RG7547 –UN–05NOV97



RG7525B –UN–05NOV97

A—Bearing Tang
B—Stamped Numbers
C—Cast Arrow

Continued on next page RG,15,DT7432 –19–14NOV97–1/3


RG7548 –UN–23NOV97

IMPORTANT: Do not use pneumatic wrench to install main bearing cap screws, as damage may occur to threads.

4. Tighten all main bearing cap screws to specifications except rear main (thrust) bearing cap screws. Tighten rear main (thrust) bearing cap screw fingertight.

Crankshaft Main Bearing Cap Screws—Specification

Torque .... 135 N•m (100 lb-ft)

IMPORTANT: DO NOT pry on thrust washer when forcing crankshaft back and forth to align thrust bearings.

5. Before tightening rear main (thrust) bearing cap screws, align upper and lower thrust bearings. Carefully force crankshaft and main thrust bearing cap to rear using a prybar between crank throw and block web. Then, force crankshaft to front to line up thrust bearing surfaces.

6. Tighten rear main (thrust) bearing cap screws to specified torque.

Crankshaft Rear Main (Thrust) Bearing Cap Screws—Specification

Torque .... 135 N•m (100 lb-ft)

7. Turn crankshaft by hand. If crankshaft does not turn easily, disassemble parts and determine the cause.

Continued on next page RG,15,DT7432 –19–14NOV97–2/3

15
52

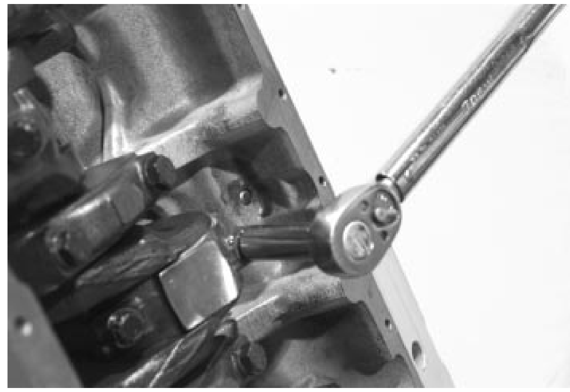
IMPORTANT: Using pneumatic wrenches to install cap screws may cause damage to the threads. Never reuse connecting rod cap screws.

8. Install connecting rod caps and bearings. Install new cap screws and tighten to specification. (See Group 10.)

9. Check crankshaft for specified end play.

Crankshaft—Specification

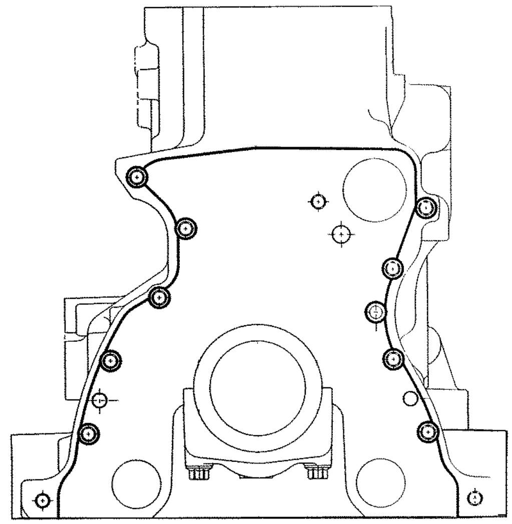
End Play .... 0.05—0.25 mm (0.002—0.010 in.)



RG7549 –UN–23NOV97

RG,15,DT7432 –19–14NOV97–3/3

INSTALL FLYWHEEL HOUSING



1. Inspect and clean cylinder block and flywheel housing gasket surfaces using a brass scraper and/or steam cleaner. Remove any previously applied sealant.

2. Rinse well with plain water to remove all soap residue from gasket surfaces.

IMPORTANT: Surfaces to be bonded MUST BE free of oil, dirt, or cleaning agents.

3. Apply LOCTITE® 515 (TY6304) General Purpose Flexible Sealant in a continuous 1.5—2 mm bead to cylinder block as shown.

4. Locate bead in the center of mating surfaces and completely encircle cap screw and dowels holes.

IMPORTANT: Tighten cap screws to specifications using a cross pattern, within 10 minutes after parts are assembled.

NOTE: Option Code 1418 Air Compressor (Ingersoll-Rand) also uses 4 each M18 cap screws in flywheel housing. These cap screws should be torqued to 125 N•m (92 lb-ft).

5. Install flywheel housing on cylinder block and tighten cap screws to specifications.

Flywheel Housing M12 Cap Screws—Specification

Torque .... 80 N•m (60 lb-ft)

Flywheel Housing M18 Cap Screws (Option Code 1418)—Specification

Torque .... 125 N•m (92 lb-ft)

6. Check flywheel housing seal bore run-out. If run-out exceeds specification replace housing.

Flywheel Housing Seal Bore—Specification

Maximum Permissible Run-Out.......... 0.152 mm (0.006 in.)

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Continued on next page

7. Install crankshaft rear oil seal assembly. (See INSTALL CRANKSHAFT REAR OIL SEAL AND WEAR SLEEVE earlier in this group.)

8. If torque converter access hole plug was removed, apply LOCTITE® 277 to plug and install.

RG,15,DT7431 –19–14NOV97–2/2

COMPLETE FINAL ASSEMBLY

Use new gaskets and O-rings during final engine assembly. Clean all engine components as necessary prior to assembly.

1. Install oil by-pass valve assembly in front face of block. (Group 20)

2. Install front plate, balancer shafts (if equipped), timing gear train, and camshaft. (Group 16)

3. Install oil pump assembly. (Group 20)

4. Install timing gear cover gasket, timing gear cover, oil pressure regulating valve assembly, and front oil seal. (Groups 15 and 16)

5. Install oil pan. (Group 20)

6. Install crankshaft pulley, or vibration damper. (Group 15)

7. Install push rods, and rocker arm assembly. (Groups 05)

8. Install fuel supply pump and injection pump. (Group 35)

9. Install starting motor. (Group 40)

10. Adjust valve clearance. (Group 05)

11. Install and adjust poly-vee belts. (Group 25)

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

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

RG,15,DT7430 –19–14NOV97–1/1

Group 16
Camshaft, Balancer Shafts and Timing Gear Train

ESSENTIAL TOOLS

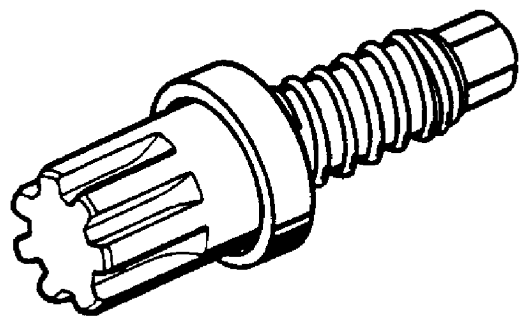
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

SERVICEGARD is a trademark of Deere & Company

DPSG,OUO1004,178 –19–07JUL98–1/12

Flywheel Turning Tool JDG820

Used to rotate flywheel on engines with 129-tooth flywheel ring gears and a 29.9 mm (1.18 in.) ID flywheel housing guide bore diameter. JDE81-1 may be used also if JDG820 is not available.



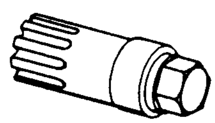
RG7056

RG7056 –UN–05DEC97

DPSG,OUO1004,178 –19–07JUL98–2/12

Flywheel Turning Tool JDE83

Used to rotate flywheel on engines with 142-tooth flywheel ring gears and a 26.5 mm (1.04 in.) ID flywheel housing guide bore diameter.



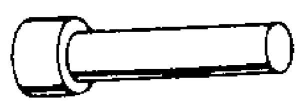
RG6251 –UN–22JUL92

DPSG,OUO1004,178 –19–07JUL98–3/12

RG5068 –UN–05DEC97

Timing Pin JDE81-4

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



RG5068

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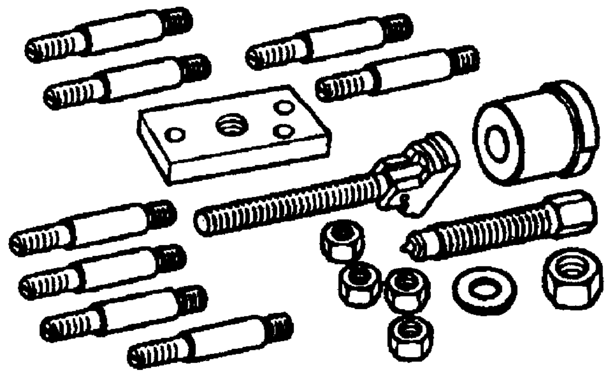
DPSG,OUO1004,178 –19–07JUL98–4/12

Camshaft Bushing Service Set. JDG739B

Used to remove and install front camshaft bushing.



RG9121 –UN–22APR98

DPSG,OUO1004,178 –19–07JUL98–5/12

Balancer Shaft Bushing Driver JD249

Use with JDG963 Balancer Shaft Bushing Adapter to replace balancer shaft bushings.

RG5120

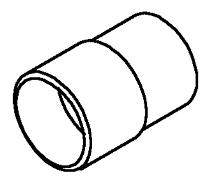
RG5120 –UN–05DEC97

DPSG,OUO1004,178 –19–07JUL98–6/12

RG7940 –UN–15JAN98

Balancer Shaft Bushing Adapter. JDG963

Use with JD249 Balancer Shaft Bushing Driver to remove and install balancer shaft bushings.

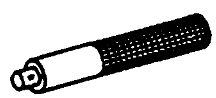


DPSG,OUO1004,178 –19–07JUL98–7/12

RG9117 –UN–17APR98

Handle JDG537 (OTC815)

Use with discs to remove and install idler gear bushings.



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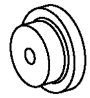
DPSG,OUO1004,178 –19–07JUL98–8/12

RG9118 –UN–17APR98

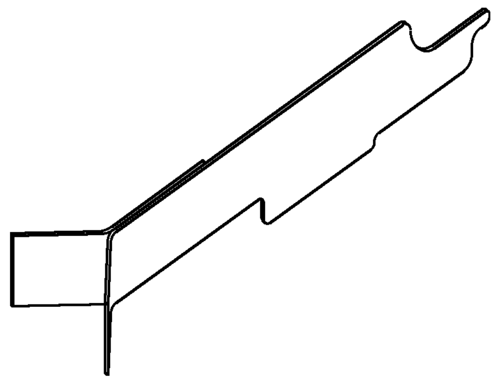
Idler Gear Bushing Driver JD252



Use with JDG537 Handle to remove and install idler gear bushings.

DPSG,OUO1004,178 –19–07JUL98–9/12

Gear Timing Tool JD254A



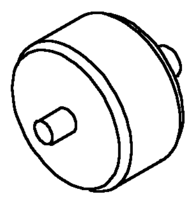
RG7443 –UN–23NOV97

Time camshaft gear, injection pump gear and balancer shafts.

DPSG,OUO1004,178 –19–07JUL98–10/12

RG7939 –UN–05JAN98

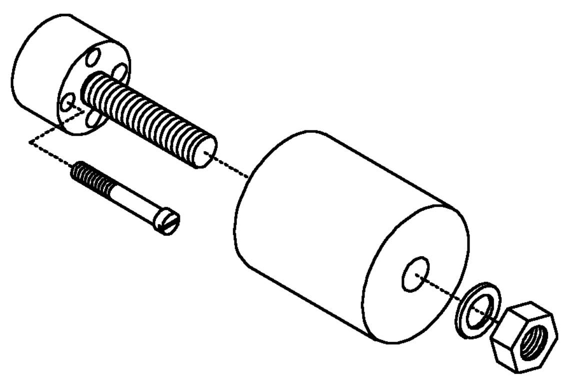
Idler Gear Installer Pilot JDG791A



Guide upper idler gear onto idler shaft.

DPSG,OUO1004,178 –19–07JUL98–11/12

Crankshaft Gear and Front Oil Seal Installer. . . . JDG954



RG9120 –UN–22APR98

Used to install crankshaft front oil seal.

DPSG,OUO1004,178 –19–07JUL98–12/12

SERVICE EQUIPMENT AND TOOLS

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

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DPSG,OUO1004,179 –19–07JUL98–1/5

Magnetic Follower Holder Kit D15001NU

Hold cam followers when removing and installing cam.

DPSG,OUO1004,179 –19–07JUL98–2/5

Balancer Shaft Holding Tool JD247

Hold balancer shaft while pressing gear on shaft.

DPSG,OUO1004,179 –19–07JUL98–3/5

TORX Driver Set

Remove and install engine front plate mounting hardware.

DPSG,OUO1004,179 –19–07JUL98–4/5

Master Driver Set D01045AA

Use discs with JDG537 Handle to remove and install idler gear bushings. Install pilot bearing in flywheel.

DPSG,OUO1004,179 –19–07JUL98–5/5

OTHER MATERIAL

Number	Name	Use
TY6333 (U.S.)	High-Temperature Grease	Coat cam followers, cam lobes, journals and bushings during installation. Coat idler gear, bushing, and shaft during installation.
T43513 (U.S.) TY9474 (Canadian) 271 (LOCTITE®)	Thread Lock and Sealer (High Strength)	Front crankshaft wear sleeve and camshaft nose.
TY6304 (U.S.) TY9484 (Canadian) 515 (LOCTITE®)	Flexible Sealant	Apply to cylinder block front plate.
TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®)	Pipe Sealant	Apply to timing gear cover cap screws.

DPSG,OUO1004,180 –19–07JUL98–1/1

16
6

CAMSHAFT, BALANCER SHAFTS AND TIMING GEAR TRAIN SPECIFICATIONS

Item	Measurement	Specification
Intake Valves	Valve Lift [at 0.00 mm (in.) Valve Clearance]	11.77—12.21 mm (0.463—0.481 in.)
	Wear Limit	11.34 mm (0.447 in.)
Exhaust Valves	Valve Lift [at 0.00 mm (in.) Valve Clearance]	11.51—11.94 mm (0.453—0.470 in.)
	Wear Limit	11.08 mm (0.436 in.)
Auxiliary Drive-to-Cylinder Block Plate	Torque	95 N•m (70 lb-ft)
Auxiliary Drive Cover Plate	Torque	55 N•m (41 lb-ft)
Camshaft	End Play	0.08—0.23 mm (0.003—0.009 in.)
Balancer Shaft	End Play	0.05—0.26 mm (0.002—0.010 in.)
Upper Idler Gear	End Play	0.070—0.170 mm (0.0027—0.0066 in.)
Lower Idler Gear	End Play	0.070—0.330 mm (0.0027—0.0129 in.)
Timing Gear Backlash Specifications		
Camshaft-to-Upper Idler (A)	Backlash	0.077—0.7466 mm (0.0030—0.0291 in.)
Injection Pump-to-Upper Idler (B)	Backlash	0.077—0.7466 mm (0.0030—0.0291 in.)
Upper Idler-to-Crankshaft (C)	Backlash	0.065—0.5799 mm (0.0025—0.0226 in.)
Crankshaft-to-Lower Idler (D)	Backlash	0.067—0.6062 mm (0.0026—0.0236 in.)

Continued on next page DPSG,OUO1004,232 –19–10JUL98–1/5

Camshaft, Balancer Shafts and Timing Gear Train

Item	Measurement	Specification
Oil Pump-to-Lower Idler (E)[1]	Backlash	0.081—0.6037 mm (0.0032—0.0235 in.)
Balancer Shaft-to-Oil Pump (4-Cyl Only) (F)[1]	Backlash	0.065—0.6521m (0.0025—0.0254 in.)
Lower Idler-to-Balancer Shaft (4-Cyl Only) (G)	Backlash	0.071—0.6476 mm (0.0028—0.0253 in.)
Camshaft-to-Auxiliary Drive (Not Shown)	Backlash	0.053—0.6818 mm (0.0021—0.0266 in.)
Camshaft Thrust Plate	Clearance	0.08—0.23 mm (0.003—0.009 in.)
Camshaft Thrust Plate	Thickness	3.96—4.01 mm (0.156—0.158 in.)
Camshaft Bearing Bores and Journals		
Camshaft Journal	OD	55.872—55.898 mm (2.1997—2.2007 in.)
Camshaft Bore, Front No. 1 in Block (Without Bushing)	ID	59.961—59.987 mm (2.3607—2.3617 in.)
Camshaft Bore, Front No. 1 in Block (With Bushing)	ID	55.961—55.987 mm (2.2031—2.2042 in.)
Camshaft Bore, All Except No. 1	ID	55.986—56.012 mm (2.2042—2.2052 in.)
Camshaft Journal-to-Bushing, No.1 Bore (With Bushing)	Oil Clearance	0.063—0.115 mm (0.0025—0.0045 in.)
Camshaft Journal-to-Bushing, All Except No.1 Bore	Oil Clearance	0.088—0.140 mm (0.0035—0.0055 in.)
Camshaft Intake Lobes	Height	7.05—7.31 mm (0.278—0.288 in.)
Camshaft Exhaust Lobe	Height	6.89—7.15 mm (0.271—0.281 in.)

[1]*4-cylinder engine only*

Continued on next page

DPSG,OUO1004,232 –19–10JUL98–2/5

Camshaft, Balancer Shafts and Timing Gear Train

16
8

Item	Measurement	Specification
Fuel Supply Pump Camshaft Lobe	Diameter	41.15—41.41 mm (1.62—1.63 in.)
Camshaft Follower	OD	31.61—31.64 mm (1.245—1.246 in.)
Camshaft Follower Bore in Block	ID	31.70—31.75 mm (1.248—1.250 in.)
Camshaft Follower-to-Bore	Clearance	0.06—0.13 mm (0.002—0.005 in.)
Fuel Supply Pump Push Rod	OD	9.891—9.917 mm (0.3894—0.3904 in.)
Fuel Supply Pump Push Rod Bore in Block	ID	10.00—10.05 mm (0.3937—0.3957 in.)
Electronic Tachometer Sensor (Magnetic Pick-Up)	Torque	20 N•m (15 lb-ft)
Mechanical Tachometer Adapter (Stanadyne DB2)	Torque	122 N•m (90 lb-ft)
Mechanical Tachometer Adapter (Stanadyne DB4)	Torque	203 N•m (150 lb-ft)
Mechanical Tachometer Adapter (Lucas)	Torque	81 N•m (60 lb-ft)
Mechanical Tachometer Cover Plate	Torque	2 N•m (20 lb-in.)
Balancer Shaft Bushing (New)	ID	40.177—40.237 mm (1.5818—1.5841 in.)
Balancer Shaft Journal	OD	40.135—40.161 mm (1.5801—1.5811 in.)
Balancer Shaft Journal-to-Bushing	Oil Clearance	0.016—0.102 mm (0.0006—0.0040 in.)
Cylinder Block Bore ID for Balancer Shaft Bushing	ID	43.262—43.288 mm (1.7032—1.7042 in.)
Balancer Shaft Thrust Plate (New)	Thickness	2.97—3.02 mm (0.117—0.119 in.)
Balancer Shaft Thrust Plate-to-Gear	Clearance	0.05—0.26 mm (0.002—0.010 in.)

Continued on next page DPSG,OUO1004,232 –19–10JUL98–3/5

Item	Measurement	Specification
Upper Idler Gear Bushing	ID	69.802—69.832 mm (2.7481—2.7493 in.)
Upper Idler Gear Bushing, 6010-6910, 7405, 7410 Tractors (S. N. 517001CD—)	ID	44.48—44.53 mm (1.751-1.753 in.)
Lower Idler Gear Bushing	ID	44.489—44.539 mm (1.7515—1.7535 in.)
Upper Idler Gear Shaft	OD	69.757—69.777 mm (2.7463—2.7471 in.)
Upper Idler Gear Shaft, 6010-6910, 7405, 7410 Tractors (S. N. 517001CD—)	OD	44.43—44.46 mm (1.749-1.750 in.)
Lower Idler Gear Shaft	OD	44.437—44.463 mm (1.7495—1.7505 in.)
Upper Idler Gear Bushing-to-Shaft	Oil Clearance	0.075—0.125 mm (0.0030—0.0049 in.)
Lower Idler Gear Bushing-to-Shaft	Oil Clearance	0.026—0.102 mm (0.0010—0.0040 in.)
Upper and Lower Idler Gear	End Play	0.095—0.145 mm (0.0037—0.057 in.)
Lower and Upper Idler Shaft Spring Pin Protrusion (D)	Protrusion	2.79—4.83 mm (0.11—0.19 in.)
Front Plate Countersunk TORX® Screws (A)	Torque	25 N•m (18 lb-ft)
Front Plate Threaded Studs (B) and (C)	Torque	35 N•m (26 lb-ft)
Balancer Shaft Thrust Plate Cap Screws	Torque	40 N•m (29.5 lb-ft)
Balancer Shaft Removable Weights	Torque	58 N•m (43 lb-ft)

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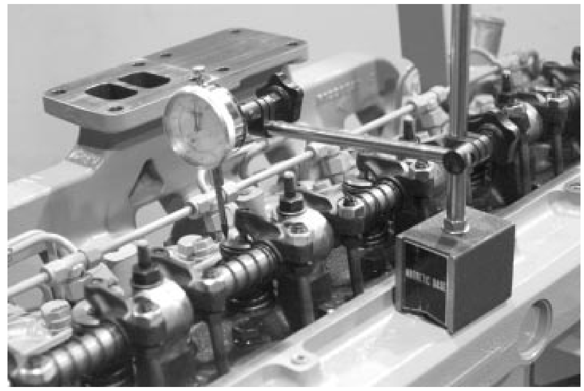
Continued on next page

Item	Measurement	Specification
Oil Pump Drive Gear Staked Nut	Torque	50 N•m (37 lb-ft)
Lower Idler Gear Cap Screw (Lubricated Threads)	Torque	70 N•m (53 lb-ft)
Injection Pump-to-Front Plate Nuts	Torque	27 N•m (20 lb-ft).
Injection Pump Drive Gear Retaining Nut		
Stanadyne: Model DB2	Torque	125 N•m (92 lb-ft)
Stanadyne: Model DB4	Torque	195 N•m (144 lb-ft)
Lucas: Model DP201 and DP203	Torque	81 N•m (60 lb-ft)
Camshaft Thrust Plate Cap Screws	Torque	35 N•m (26 lb-ft)
Upper Idler Gear Cap Screw	Torque	70 N•m (53 lb-ft)
Rotary Injection Pump Drive Gear Cover	Torque	2 N•m (17 lb-in.)
In-Line Injection Pump Drive Gear Cover	Torque	5 N•m (44 lb-in.)
Timing Gear Cover-to-Front Plate and Cylinder Block	Torque	35 N•m (26 lb-ft)
Oil Pan-to-Timing Gear Cover	Torque	35 N•m (26 lb-ft)
Electronic Tachometer (Magnetic Pick-up) Sensor-to-Timing Cover	Torque	20 N•m (15 lb-ft)

DPSG,OUO1004,232 –19–10JUL98–5/5

MEASURE VALVE LIFT


RG7550 –UN–23NOV97

IMPORTANT: For a more accurate measurement, measure valve lift at 0.00 mm (in.) rocker arm-to-valve tip clearance.

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

1. Remove rocker arm cover.

2. Using JDG820 or JDE83 Flywheel Turning Tool and JDE81-4 Timing Pin, lock No. 1 piston at TDC compression stroke.

   See CHECK AND ADJUST VALVE CLEARANCE in Group 05 for engine valve locations.

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

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

4. Place dial indicator tip on top of valve rotator. Preload indicator tip and set dial at 0.0 mm (in.).

5. Remove timing pin from flywheel and manually rotate engine one full revolution (360°) in running direction.

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

Intake Valves—Specification

Valve Lift [at 0.00 mm (in.) Valve Clearance]	11.77—12.21 mm (0.463—0.481 in.)
Wear Limit	11.34 mm (0.447 in.)

Exhaust Valves—Specification

Valve Lift [at 0.00 mm (in.) Valve Clearance]	11.51—11.94 mm (0.453—0.470 in.)
Wear Limit	11.08 mm (0.436 in.)

Continued on next page

RG,16,DT7507 –19–14NOV97–1/2

7. If valve lift on all valves is within specifications, adjust valve lash to specified clearance. (See CHECK AND ADJUST VALVE CLEARANCE in Group 05.)

   If valve lift on one or more valves is not within specification, remove and inspect entire valve train and camshaft.

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

   - TDC No. 4 compression stroke for 4-cylinder engines.
   - TDC No. 6 compression stroke for 6-cylinder engines.

9. Set rocker arm-to-valve tip clearance to 0.0 mm (in.) for:

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

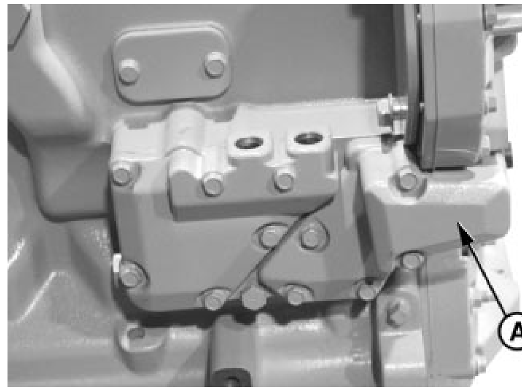
10. Repeat steps 4—7.

RG,16,DT7507 –19–14NOV97–2/2

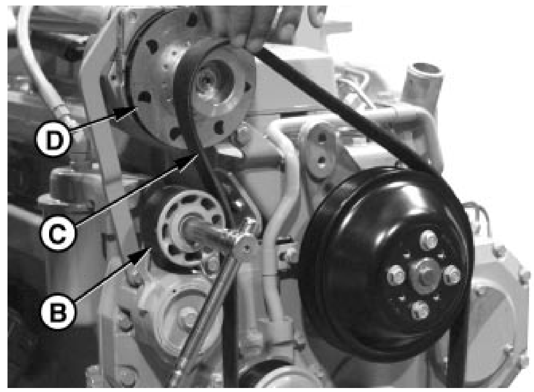
REMOVE TIMING GEAR COVER

NOTE: It is not necessary to remove water pump pulley, water pump, or belt tightener when removing timing gear cover.

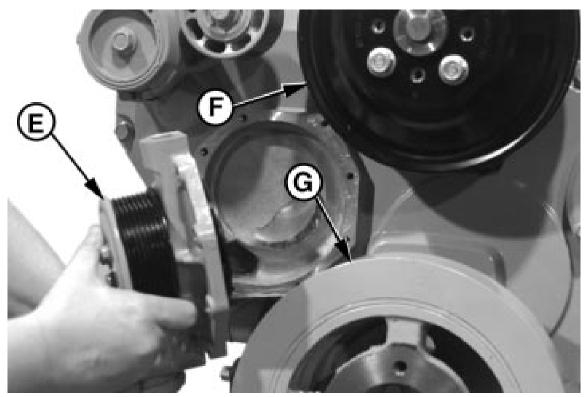
1. Drain oil from engine crankcase.
2. Remove fan.
3. Remove oil pan.
4. Remove oil cooler-to-water manifold elbow (A) at front plate.
5. Release fan belt tensioner (B) and remove fan belt (C).
6. Remove alternator (D) and alternator mounting bracket.
7. On non-auxiliary drive engines, remove tensioner bracket.
8. Remove water pump (E), if desired.
9. Remove fan pulley (F).
10. Remove crankshaft pulley or damper (G). (See Group 15.)



RG7590A –UN–05JAN98



RG7937A –UN–13NOV97



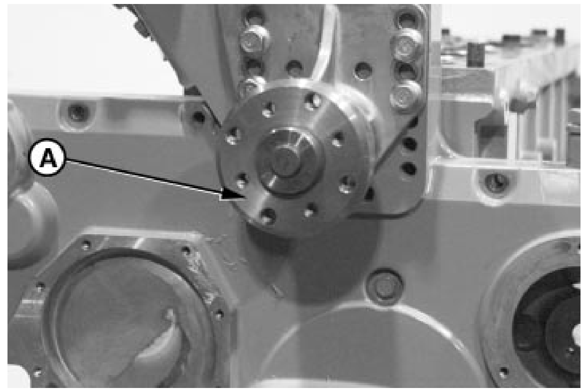
RG7953 –UN–13NOV97

A—Oil Cooler-to-Water Manifold Elbow
B—Fan Belt Tensioner
C—Fan Belt
D—Alternator
E—Water Pump
F—Fan Pulley
G—Crankshaft Pulley or Damper

Continued on next page RG,16,DT7506 –19–14NOV97–1/4

16
14

11. Remove adjustable fan drive assembly (A).



RG7551A –UN–05NOV97

A—Adjustable Fan Drive

RG,16,DT7506 –19–14NOV97–2/4

12. Unscrew oil pressure regulating valve plug. Remove spring and valve.

13. Remove auxiliary drive cover and gears, if equipped, as described later in this group.

14. Remove wear sleeve. (See Group 15.)

RG8047 –UN–05JAN98

RG8048 –UN–05JAN98

Continued on next page RG,16,DT7506 –19–14NOV97–3/4

NOTE: Mark and identify location of timing gear cover hardware before removal to aid in reassembly.

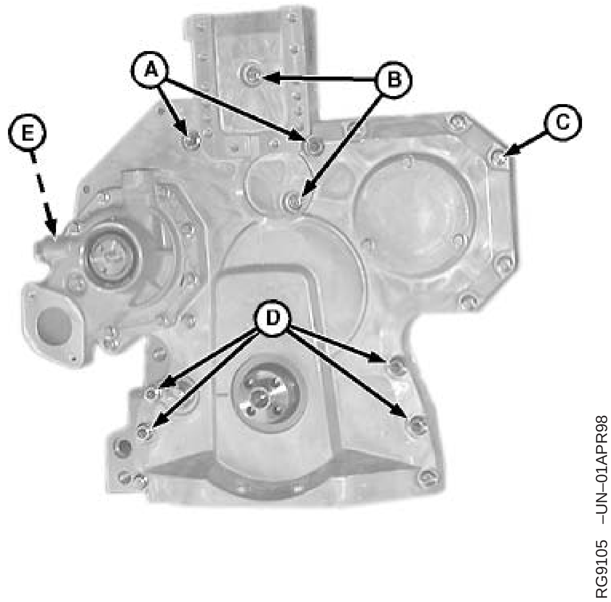
15. On later engines[1], remove timing gear cover-to-cylinder block stud nuts and washers (A).

16. Remove timing gear cover-to-cylinder block stud nuts and washers (D).

17. Remove cap screws (B) and remove cap screw (E) on back of cover.

18. Remove cap screws (C) bordering timing cover. Remove cover.

19. Remove oil seal from timing gear cover.



A—Stud Nuts and Washers
B—Cap Screws
C—Cap Screws
D—Stud Nuts and Washers
E—Cap Screw

[1]*Serial Numbers: Dubuque-built engines (703905—), Saran-built engines (516218—), Torreon-built engines (001000—).*

RG,16,DT7506 –19–14NOV97–4/4

16
16

REMOVE AND INSTALL CAMSHAFT BUSHING WITH FRONT PLATE INSTALLED

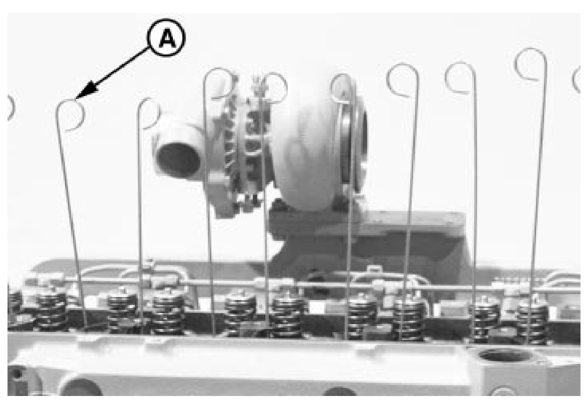
NOTE: A camshaft bushing is installed in front (No. 1) camshaft bore only. The front plate has a chamfered edge allowing camshaft bushing removal and installation with the front plate installed.

REMOVE CAMSHAFT BUSHING

1. Set engine at No. 1 “TDC” compression.
2. On turbocharged engines, disconnect the turbocharger oil inlet line. (See DISCONNECT TURBOCHARGER OIL INLET LINE in Group 03.)
3. Remove timing gear cover, as described earlier in this group.
4. Remove rocker arm cover and rocker arm assembly. (See procedure in Group 05.)
5. Remove push rods. (See procedure in Group 05.)
6. On engines with rotary fuel injection pumps, remove fuel supply pump. (See Group 35.)

RG,16,DT7505 –19–14NOV97–1/4

7. Revolve engine to an angle where camshaft followers fall away from camshaft or use D15001NU Magnetic Holding Set (A) to hold followers.



RG7556A –UN–05NOV97

Continued on next page RG,16,DT7505 –19–14NOV97–2/4

8. Remove camshaft. (See procedure later in this group.)

IMPORTANT: Engine MUST remain in a position where camshaft followers rest against cylinder head or are held in up position by magnetic holders so that followers do not fall into engine crankcase. If camshaft followers fall into crankcase, cylinder head removal will be required.

9. Remove countersunk TORX® cap screw (A). Install JDG739-7 (M8 x 1.25) tapered bottom leg (B) from JDG739B Camshaft Bushing Service Kit into hole that has chamfered screw and star washer.

IMPORTANT: Block must be replaced if camshaft bore is damaged. Be careful when removing or installing bushing.

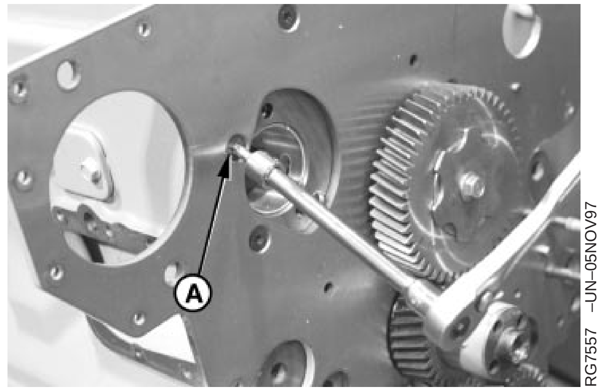
10. Install JDG739-8 (M8 x 1.25) flat bottom legs and JDG739-3 Removing/Installing Plate (C) to cylinder block so plate is parallel with front plate and centered over camshaft bore. Tighten legs and hex nuts securely.

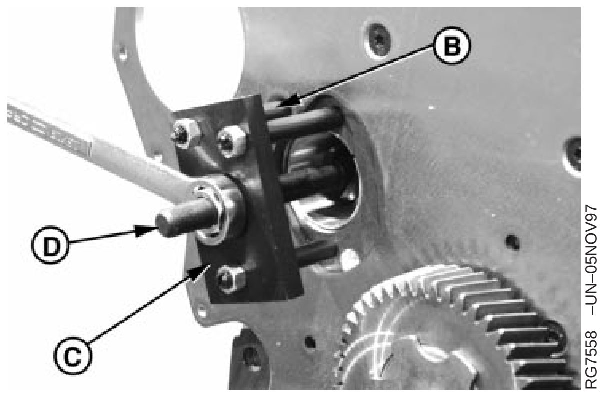
IMPORTANT: Cylinder block bore may be damaged if puller is not properly piloted in bushing. Be sure puller is properly piloted before pulling bushing.

11. Insert JDG739-1 Bushing Remover into camshaft bore so puller pilots in bushing ID and JDG739-4 Bushing Installer Screw (D) extends through plate.

12. Install thrust washer and hex nut. Tighten hex nut until bushing is free of block bore. Remove puller and discard bushing.

13. Clean and inspect bore in cylinder block. If bore is damaged, replace cylinder block.





A—Cap Screw
B—JDG739-7 Tapered Bottom Leg (8 mm)
C—JDG739-3 Removing/Installing Plate
D—JDG739-4 Bushing Installer Screw

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Continued on next page

16
18

INSTALL CAMSHAFT BUSHING

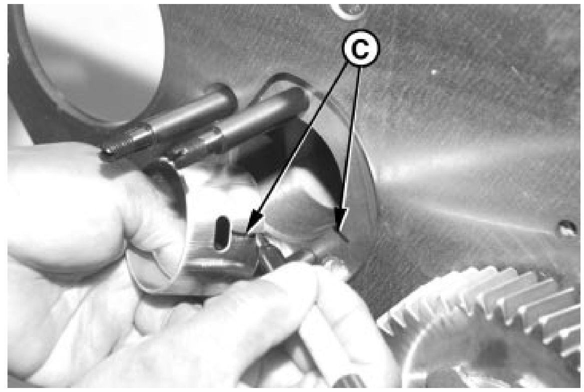
IMPORTANT: Bushings must be installed so oil supply hole in bushing aligns with oil drilling in block bore.

1. Mark orientation of oil supply hole (C) on front face of block and on bushing to help with bushing alignment during installation.

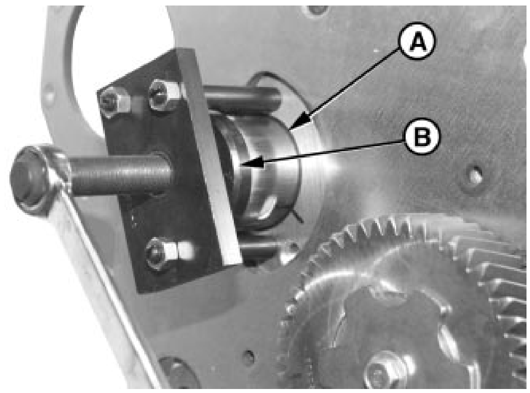
2. Apply TY6333 High-Temperature Grease to ID and OD of new bushing (A), and to ID of bushing bore. Slide bushing onto JDG739-5B Bushing Installer (B) so notched end of bushing will be toward front end of engine when installed.

3. Thread JDG739-4 Bushing Installer Screw into JDG739-3 Removing/Installing Plate. With bushing started, square in bore and oil hole aligned, tighten forcing screw until flange of bushing driver bottoms against face of block.

4. Remove bushing tool from cylinder block and check oil supply hole for correct alignment. If holes are not aligned, remove and discard bushing. Install a new bushing.



RG7559 –UN–05NOV97



RG7560 –UN–05NOV97

A—Bushing
B—JDG739-5B Bushing Installer
C—Oil Supply Hole

RG,16,DT7505 –19–14NOV97–4/4

16
19

REMOVE AND INSTALL CAMSHAFT GEAR-DRIVEN AUXILIARY DRIVE

NOTE: Various auxiliary drive options are available; removal and installation of all options are similar. The auxiliary drive is integrated into the engine front timing gear cover.

1. Remove lube line.

2. Remove auxiliary drive gear cover (A).

3. Clean and inspect cover for cracks or damage.

4. Remove auxiliary drive assembly (B).

NOTE: Auxiliary drive assembly is repairable. Refer to CTM67 - OEM Accessories for additional service information.

5. Inspect for cracked housing, worn or damaged bearings, damaged gear or spline.

6. Repair or replace auxiliary drive assembly as needed.

7. Install gasket on auxiliary drive assembly and position in the cylinder block plate. Install cap screws and tighten to specifications.

Auxiliary Drive-to-Cylinder Block Plate—Specification

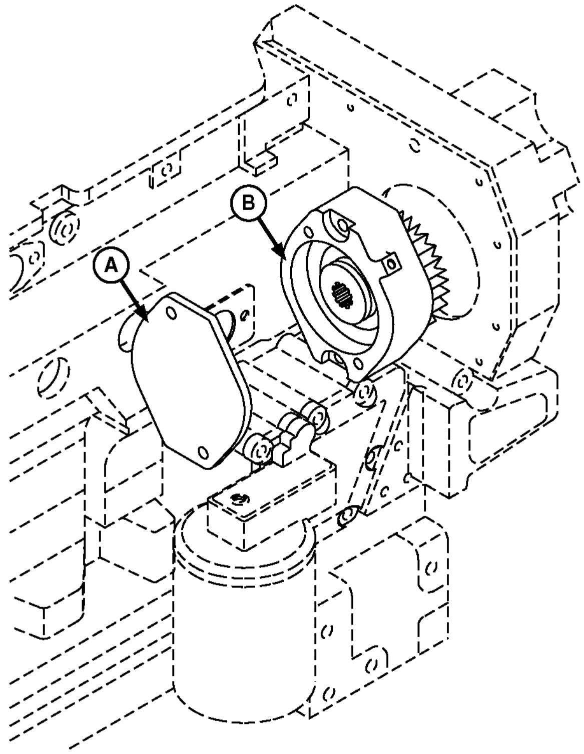
Torque .... 95 N•m (70 lb-ft)

8. Install cover and tighten cap screws or nuts to specifications.

Auxiliary Drive Cover Plate—Specification

Torque .... 55 N•m (41 lb-ft)

9. Install lube line.



RG9049 –UN–16MAR98

A—Gear Cover
B—Auxiliary Drive Assembly

RG,16,DT7504 –19–14NOV97–1/1

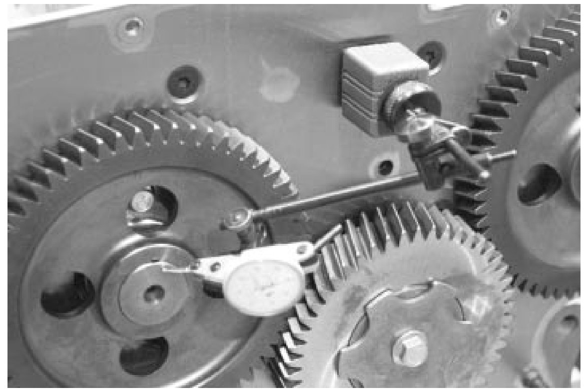
MEASURE CAMSHAFT END PLAY

Measure camshaft end play.

Camshaft—Specification

End Play .... 0.08—0.23 mm (0.003—0.009 in.)

If end play is excessive, check thrust plate thickness with camshaft removed. (See MEASURE CAMSHAFT THRUST PLATE CLEARANCE, later in this group.)



RG7561 –UN–23NOV97

RG,16,DT7503 –19–14NOV97–1/1

MEASURE BALANCER SHAFT END PLAY (4-CYLINDER ENGINES)

Measure balancer shaft end play.

Balancer Shaft—Specification

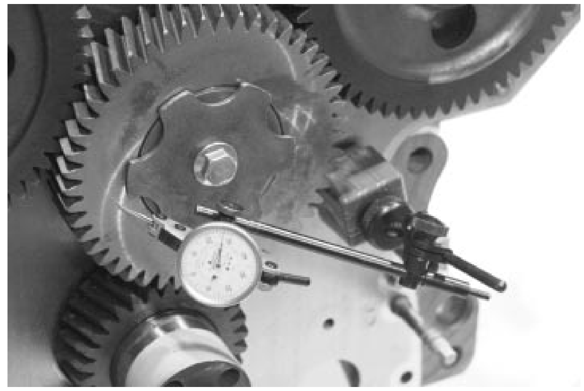
End Play .... 0.05—0.26 mm (0.002—0.010 in.)

If balancer shaft end play exceeds specifications, check thrust plate thickness. (See INSPECT BALANCER SHAFT GEARS AND THRUST PLATES, later in this group.)

RG7702 –UN–23NOV97

RG,16,DT7502 –19–14NOV97–1/1

MEASURE IDLER GEAR END PLAY


RG7562 –UN–23NOV97

Check end play of upper and lower idler gears.

Upper Idler Gear—Specification

End Play .... 0.070—0.170 mm (0.0027—0.0066 in.)

Lower Idler Gear—Specification

End Play .... 0.070—0.330 mm (0.0027—0.0129 in.)

If idler gear end play does not meet specifications, check idler gear, idler shaft, and thrust washer for wear. (See MEASURE IDLER GEAR, BUSHING AND SHAFT later in this group.)

RG,16,DT7501 –19–14NOV97–1/1

16
22

MEASURE TIMING GEAR BACKLASH

NOTE: All gears have helical cut teeth.

Measure timing gear backlash. Compare against the following specifications.

Camshaft-to-Upper Idler (A)—Specification

Backlash .... 0.077—0.7466 mm
(0.0030—0.0291 in.)

Injection Pump-to-Upper Idler (B)—Specification

Backlash .... 0.077—0.7466 mm
(0.0030—0.0291 in.)

Upper Idler-to-Crankshaft (C)—Specification

Backlash .... 0.065—0.5799 mm
(0.0025—0.0226 in.)

Crankshaft-to-Lower Idler (D)—Specification

Backlash .... 0.067—0.6062 mm
(0.0026—0.0236 in.)

Oil Pump-to-Lower Idler (E)[1]—Specification

Backlash .... 0.081—0.6037 mm
(0.0032—0.0235 in.)

Balancer Shaft-to-Oil Pump (4-Cyl Only) (F)[1]—Specification

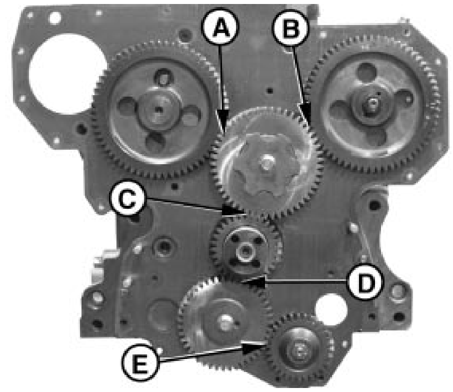
Backlash .... 0.065—0.6521mm
(0.0025—0.0254 in.)

Lower Idler-to-Balancer Shaft (4-Cyl Only) (G)—Specification

Backlash .... 0.071—0.6476 mm
(0.0028—0.0253 in.)

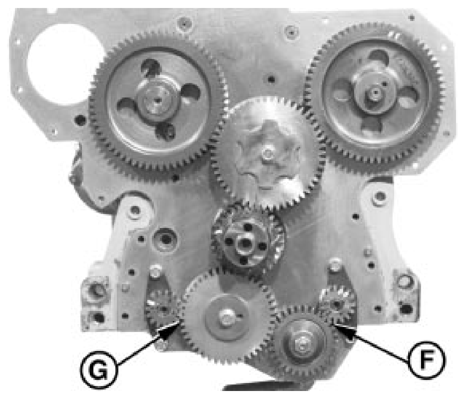
Camshaft-to-Auxiliary Drive (Not Shown)—Specification

Backlash .... 0.053—0.6818 mm
(0.0021—0.0266 in.)



6-Cylinder Engine

RG7530 –UN–05NOV97



4-Cylinder Engine

RG7703B –UN–07NOV97

A—Camshaft Gear-to-Upper Idler Gear
B—Injection Pump Gear-to-Upper Idler Gear
C—Upper Idler Gear-to-Crankshaft Gear
D—Crankshaft Gear-to-Lower Idler Gear
E—Oil Pump Gear-to-Lower Idler Gear
F—Balancer Shaft Gear-to-Oil Pump Gear
G—Lower Idler Gear-to-Balancer Shaft Gear

[1] *4-cylinder engine only*

RG,16,DT7500 –19–14NOV97–1/1

16
23

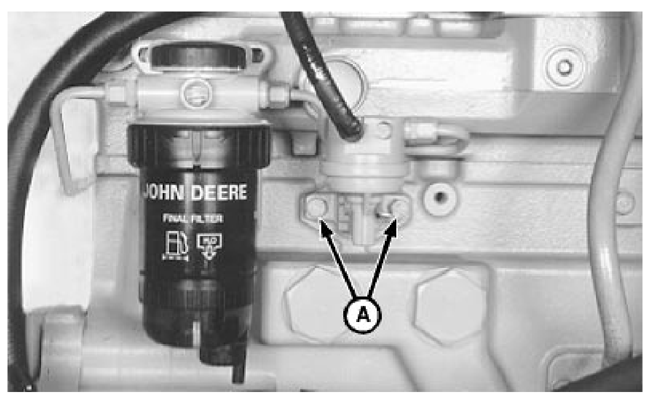
REMOVE CAMSHAFT

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 and cam followers. (See REMOVE CYLINDER HEAD in Group 05.)

1. Drain engine oil and coolant, if not previously done.
2. Measure valve lift. (See MEASURE VALVE LIFT, earlier in this group).
3. Remove rocker arm assembly and push rods. (See Group 05.)
4. Remove timing gear cover. (See REMOVE TIMING GEAR COVER, earlier in this group.)

RG,16,DT7499 –19–14NOV97–1/5

5. Remove cap screws (A) and camshaft activated fuel supply pump. (See REMOVE FUEL SUPPLY PUMP in Group 35.)



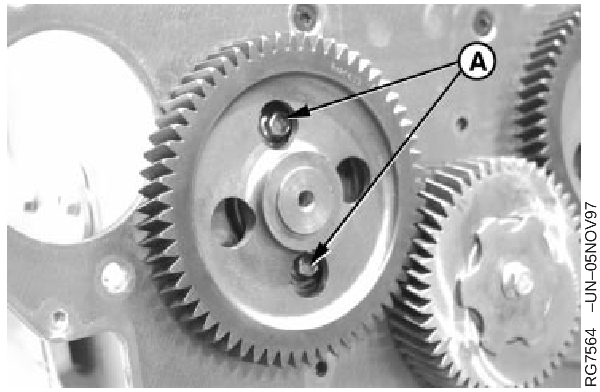
RG9050 –UN–16MAR98

A—Cap Screws

Continued on next page RG,16,DT7499 –19–14NOV97–2/5

16
24

6. Rotate engine gear train until cap screws (A) can be removed.



A—Cap Screws

RG,16,DT7499 –19–14NOV97–3/5

IMPORTANT: Engine MUST remain in a position where camshaft followers rest against cylinder head or are held in up position with magnetic holders so that followers do not fall into engine crankcase. If camshaft followers fall into crankcase, cylinder head removal is required.

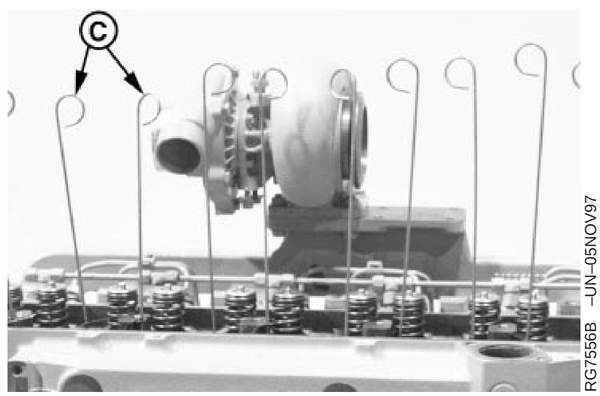
NOTE: D1500NU Magnetic Follower Holder Kit (C) may also be used to hold camshaft followers away from lobes.

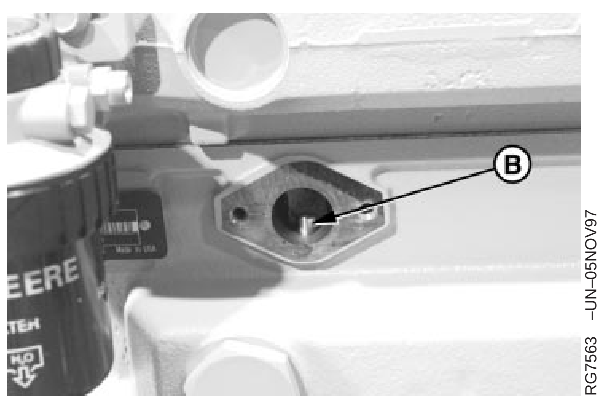
7. Revolve engine on repair stand to an angle where camshaft followers and fuel supply pump activator pin (B) falls away from camshaft lobes.

IMPORTANT: DO NOT allow camshaft lobes to drag in bushing or honed bores.

8. Carefully pull camshaft straight up, out of cylinder block.

NOTE: Rotate camshaft carefully to aid in removing.





B—Pump Actuator Pin
C—Magnetic Follower Holder Kit

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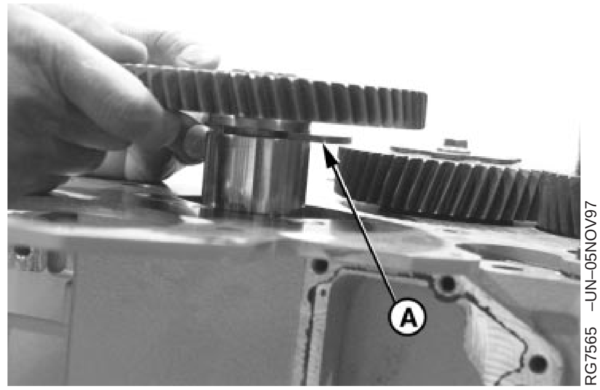
RG,16,DT7499 –19–14NOV97–4/5

9. Remove thrust plate (A) from slot behind camshaft gear.



A—Thrust Plate

RG,16,DT7499 –19–14NOV97–5/5

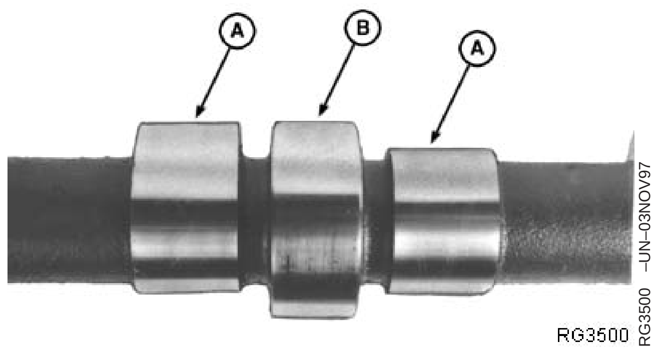
VISUALLY INSPECT CAMSHAFT

1. Clean camshaft in solvent. Dry with compressed air.

2. Inspect all camshaft lobes (A) and journals (B) for wear or damage. Replace camshaft as necessary.

IMPORTANT: New camshaft followers can be used with old camshaft. DO NOT reuse old camshaft followers with a new camshaft. (See Group 05 for camshaft follower replacement.)

NOTE: Very light score marks are acceptable if valve lift is within specification. If pitting or galling exists, replace camshaft. (See MEASURE VALVE LIFT earlier in this group.)



A—Lobes
B—Journals

RG,16,DT7498 –19–14NOV97–1/1

16
26

MEASURE CAMSHAFT THRUST PLATE CLEARANCE AND THICKNESS

Clean camshaft thrust plate and check clearance using a feeler gauge. Replace parts as necessary.

Camshaft Thrust Plate—Specification

Clearance .... 0.08—0.23 mm (0.003—0.009 in.)

NOTE: Thrust plate clearance determines camshaft end play.

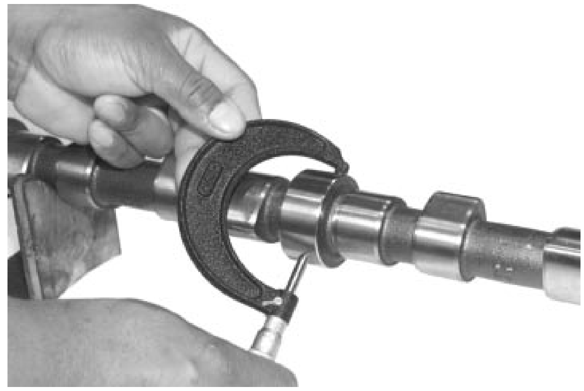
Check thrust plate thickness.

Camshaft Thrust Plate—Specification

Thickness.. 3.96—4.01 mm (0.156—0.158 in.)

RG,16,DT7514 –19–15NOV97–1/1

INSPECT AND MEASURE CAMSHAFT BUSHING ID AND JOURNAL OD


RG7566 –UN–23NOV97

All engine camshafts have a (replaceable) bushing installed in No. 1 (front) camshaft bore.

1. Measure camshaft journals. If a camshaft journal is damaged or does not meet specification, install a new camshaft.

Camshaft Journal—Specification

OD .... 55.872—55.898 mm (2.1997—2.2007 in.)

Camshaft Bore, Front No. 1 in Block (Without Bushing)—Specification

ID .... 59.961—59.987 mm (2.3607—2.3617 in.)

Camshaft Bore, Front No. 1 in Block (With Bushing)—Specification

ID .... 55.961—55.987 mm (2.2031—2.2042 in.)

Camshaft Bore, All Except No. 1—Specification

ID .... 55.986—56.012 mm (2.2042—2.2052 in.)

Camshaft Journal-to-Bushing, No.1 Bore (With Bushing)—Specification

Oil Clearance... 0.063—0.115 mm (0.0025—0.0045 in.)

Camshaft Journal-to-Bushing, All Except No.1 Bore—Specification

Oil Clearance... 0.088—0.140 mm (0.0035—0.0055 in.)

2. Measure camshaft bushing ID and remaining bores in cylinder block. If camshaft bore is damaged or is not within specification, have a qualified machine shop install new bushings.

If No. 1 camshaft bushing ID does not meet specifications, replace camshaft bushing. (See REMOVE AND INSTALL CAMSHAFT BUSHING earlier in this group.)

RG,16,DT7497 –19–14NOV97–1/1

16
28

MEASURE CAMSHAFT LOBE HEIGHT

1. Measure each camshaft lobe at highest point (A) and at narrowest point (B). The difference between these dimensions is camshaft lobe height. If height is not within specification on any lobe, install a new camshaft.

Camshaft Intake Lobes—Specification

Height .... 7.05—7.31 mm (0.278—0.288 in.)

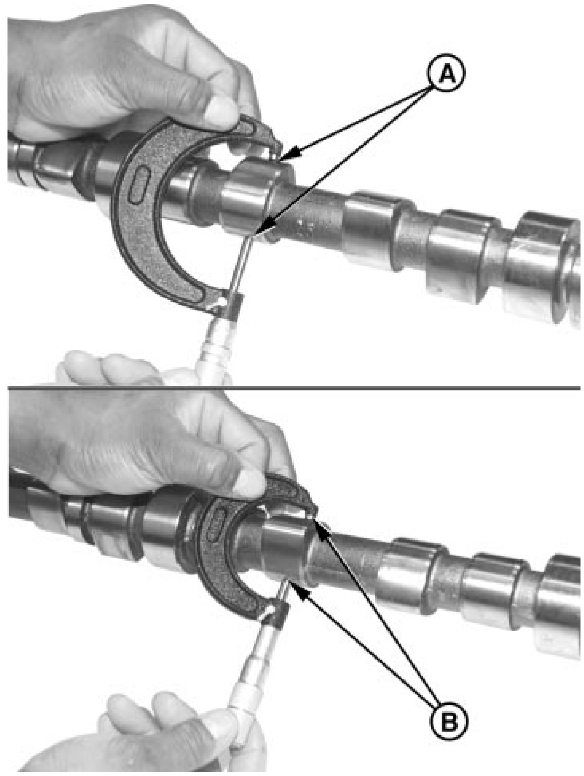
Camshaft Exhaust Lobe—Specification

Height .... 6.89—7.15 mm (0.271—0.281 in.)

2. Measure fuel supply pump camshaft lobe diameter. If diameter is not within specification or lobe surface is grooved, install a new camshaft.

Fuel Supply Pump Camshaft Lobe—Specification

Diameter .... 41.15—41.41 mm (1.62—1.63 in.)



RG7567 –UN–05NOV97

A—High Point
B—Narrow Point

RG,16,DT7496 –19–14NOV97–1/1

REMOVE AND INSTALL CAMSHAFT GEAR

IMPORTANT: Camshaft must be replaced if dropped or damaged, do not allow camshaft to strike floor when removing gear.

1. Press camshaft out of gear.

2. Clean camshaft and gears in solvent. Dry with compressed air.

3. Inspect cam journals for nicks and scratches. Replace camshaft if damage is found.

RG7568 –UN–23NOV97

Continued on next page RG,16,DT7495 –19–14NOV97–1/2

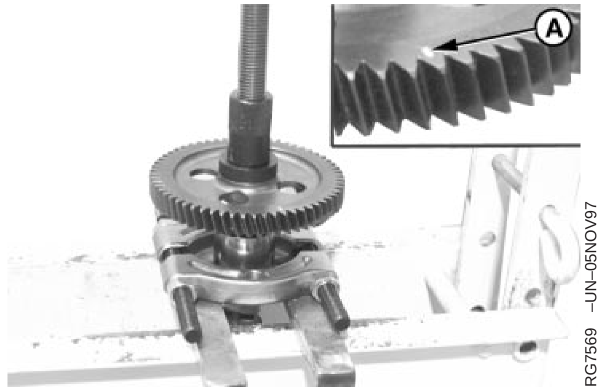
4. Support camshaft under first bearing journal in a hydraulic press.

5. Heat gear to 66—93°C (140—160°F) before pressing onto shaft to prevent metal transfer.

6. Apply LOCTITE® 271 Thread Lock and Sealer to camshaft nose.

7. Install Woodruff key in camshaft nose.

8. Install gear with timing mark (A) away from camshaft (towards front timing gear cover). Press gear onto camshaft with a tubular driver until gear bottoms against camshaft shoulder.



A—Timing mark

LOCTITE is a trademark of Loctite Corp.

RG,16,DT7495 –19–14NOV97–2/2

16
30

INSPECT CAMSHAFT FOLLOWERS

RG6324 –UN–23NOV97

NOTE: Cylinder head must be removed before camshaft followers can be removed from engine. (See Group 05.)

1. Inspect followers for uneven wear or damage. Also inspect corresponding camshaft lobe for wear or damage. Replace as necessary.

2. Measure follower OD and follower bore ID in cylinder block.

Camshaft Follower—Specification

OD .... 31.61—31.64 mm (1.245—1.246 in.)

Camshaft Follower Bore in Block—Specification

ID .... 31.70—31.75 mm (1.248—1.250 in.)

Camshaft Follower-to-Bore—Specification

Clearance .... 0.06—0.13 mm (0.002—0.005 in.)

Replace cam followers that are not within specification.

Replace cylinder block if any one cam follower bore is not within specification.

RG,16,DT7494 –19–14NOV97–1/1

INSPECT, MEASURE, AND INSTALL FUEL SUPPLY PUMP PUSH ROD

1. Remove and clean push rod (A). Label end(s) for reassembly in same orientation.

2. Measure push rod OD (B). If OD is less than specifications listed, install a new push rod.

Fuel Supply Pump Push Rod—Specification

OD .... 9.891—9.917 mm
(0.3894—0.3904 in.)

3. Check crown on push rod ends. If flat or concave, replace push rod and check camshaft lobe for wear. (See Group 16).

4. Measure push rod bore ID (C) in block.

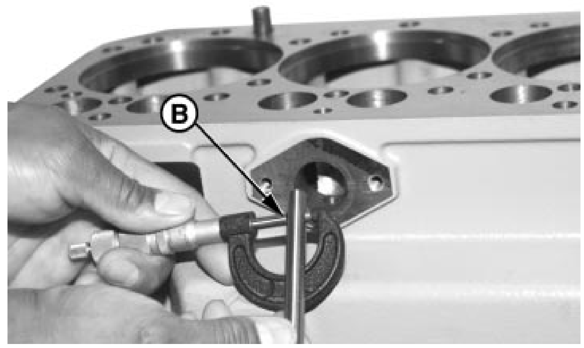
Fuel Supply Pump Push Rod Bore in Block—Specification

ID .... 10.00—10.05 mm
(0.3937—0.3957 in.)

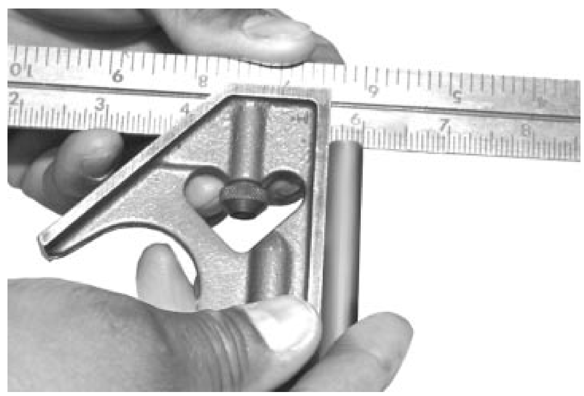
Repair or replace block as necessary.

5. Lubricate push rod with clean engine oil and install in bore with same end orientation as removed.

RG7447 –UN–04NOV97



RG7496A –UN–04NOV97



RG8113 –UN–23NOV97

RG7495A –UN–04NOV97

A—Push Rod
B—Push Rod OD
C—Push Rod Bore ID

RG,16,DT7493 –19–14NOV97–1/1

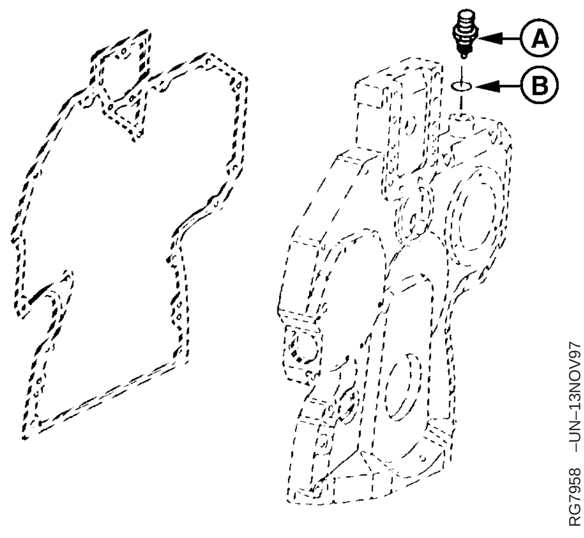
16
32

REPLACE ELECTRONIC TACHOMETER (MAGNETIC PICK-UP) SENSOR

Replace sensor (A) and O-ring (B), in timing gear cover, as needed. Tighten to specifications.

Electronic Tachometer Sensor (Magnetic Pick-Up)—Specification

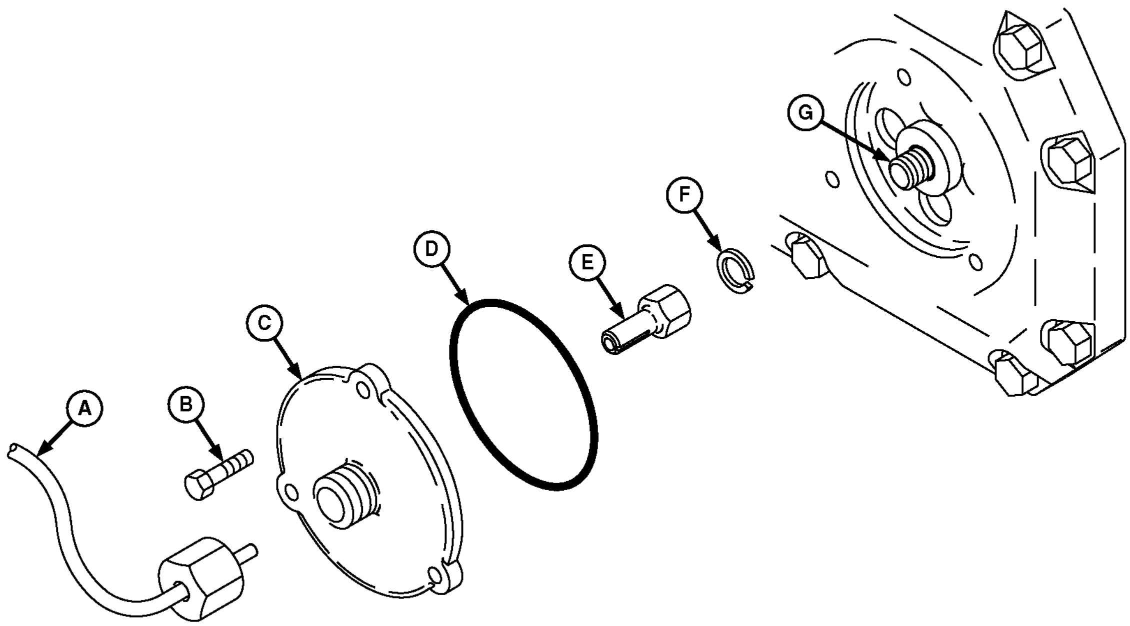
Torque .... 20 N•m (15 lb-ft)



A—Sensor
B—O-Ring

RG,16,DT7492 –19–14NOV97–1/1

REPLACE MECHANICAL TACHOMETER ADAPTER



RG9113 –UN–01APR98

A—Tachometer Cable
B—Cap Screws
C—Cover
D—O-Ring
E—Adapter
F—Lock Washer

1. Disconnect cable (A) and remove cover (C) and O-ring (D).

2. Remove adapter (E) and lock washer from end of injection pump shaft (G). Be careful not to let adapter or washer fall inside timing cover.

3. Replace parts as required.

4. Install adapter (E) and lock washer on injection pump shaft. Tighten adapter to specifications.

Mechanical Tachometer Adapter (Stanadyne DB2)—Specification

Torque.. 122 N•m (90 lb-ft)

Mechanical Tachometer Adapter (Stanadyne DB4)—Specification

Torque.. 203 N•m (150 lb-ft)

Mechanical Tachometer Adapter (Lucas)—Specification

Torque.. 81 N•m (60 lb-ft)

5. Install new O-ring and cover. Tighten cap screws (B) to specifications.

Mechanical Tachometer Cover Plate—Specification

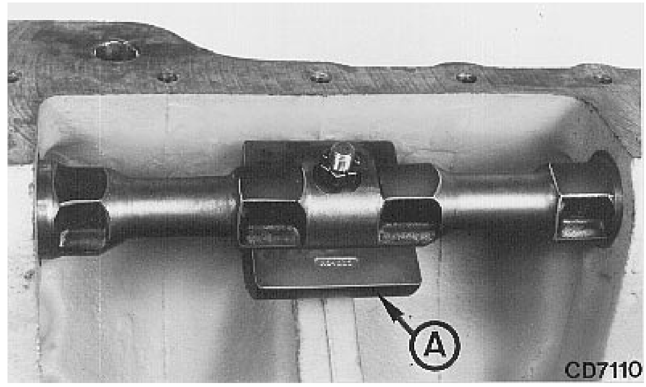
Torque... 2 N•m (20 lb-in.)

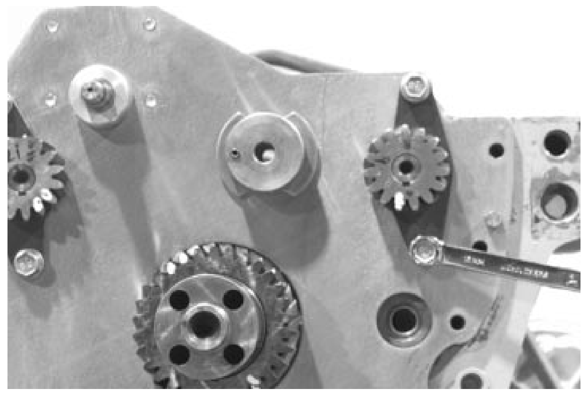
DPSG,OUO1004,42 –19–09APR98–1/1

16
34

REMOVE BALANCER SHAFTS—IF EQUIPPED (4-CYLINDER ENGINES)

1. Remove lower idler gear and oil pump gear (shown removed).
2. On later engines[1], with removable weights, weights (A) must be removed before removing balancer shaft.
3. Remove cap screws from balancer shaft thrust plate.





A—Weights

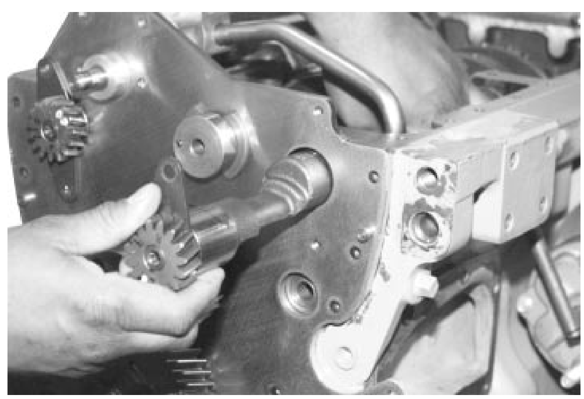
[1]*Serial Numbers: Dubuque-built engines (700877—), Saran-built engines (500212—), Torreon-built engines (001000—).*

RG,16,DT7491 –19–14NOV97–1/2

IMPORTANT: Identify left and right balancer shafts for correct assembly. Permanently mark a letter "R" or letter "L" on the rear of the shaft for identification. Interchanging shaft locations could cause premature wear of shafts and bushings.

NOTE: When removing balancer shafts, use care that neither shaft journals nor bushings are damaged in cylinder block.

4. Remove balancer shafts.



Balancer Shaft (S.N. — 700876 Shown)

RG,16,DT7491 –19–14NOV97–2/2

16
35

INSPECT AND MEASURE BALANCER SHAFT BUSHINGS AND JOURNALS

1. Inspect, measure and record bushing ID (A) at all locations.

2. Measure balancer shaft journal OD (B). Difference between journal OD and bushing ID is oil clearance.

   If oil clearance is not within specification, install new bushings and, if necessary, new balancer shaft.

Balancer Shaft Bushing (New)—Specification

ID .... 40.177—40.237 mm
(1.5818—1.5841 in.)

Balancer Shaft Journal—Specification

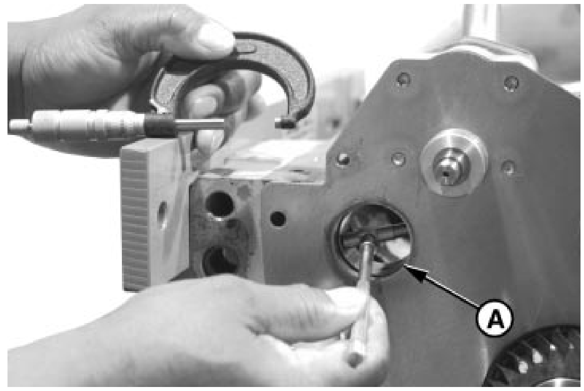
OD .... 40.135—40.161 mm
(1.5801—1.5811 in.)

Balancer Shaft Journal-to-Bushing—Specification

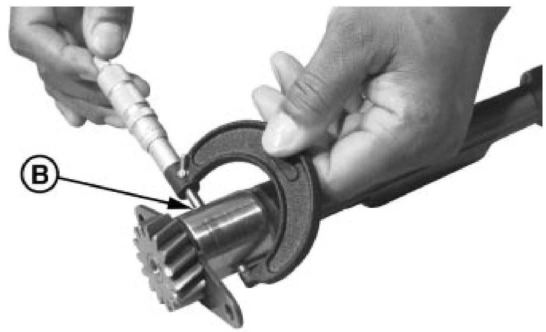
Oil Clearance.. 0.016—0.102 mm
(0.0006—0.0040 in.)

Cylinder Block Bore ID for Balancer Shaft Bushing—Specification

ID .... 43.262—43.288 mm
(1.7032—1.7042 in.)



RG7705A –UN–07NOV97



RG7706 –UN–07NOV97

A—Bushing ID
B—Journal OD

RG,16,DT7490 –19–14NOV97–1/1

16
36

REMOVE AND INSTALL BALANCER SHAFT BUSHINGS (4-CYLINDER ENGINES)

IMPORTANT: Cylinder block front plate must be removed in order to replace balancer shaft bushings.

1. Remove all fuel lines from injection or rotary pump.

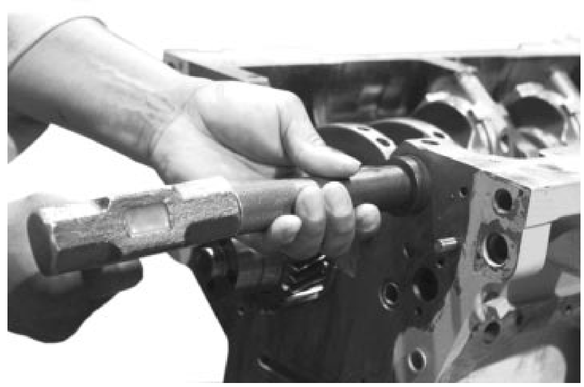
2. Remove front plate. See REMOVE CYLINDER BLOCK FRONT PLATE, later in this group.

3. Remove bushings from block with JD249 Balancer Shaft Bushing Driver and JDG963 Adapter. To remove the rear (third) bushing, the flywheel housing must be removed.

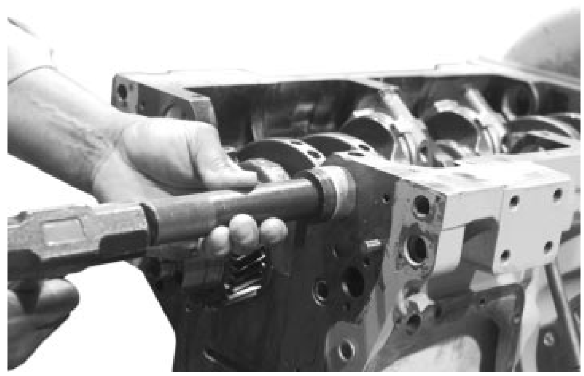
IMPORTANT: Make sure oil holes in bushing and block are aligned for proper bushing and journal lubrication.

4. Install new bushings in block with same tools used during removal.

5. Insert balancer shaft to check for bushing-to-shaft clearance. If shaft can be rotated by hand with a slight-to-moderate drag, adequate bushing-to-balancer shaft clearance exists. It is not necessary to hone bushings to obtain specified oil clearance. Excessive clearance can result in shaft seizure.


RG7959 –UN–15JAN98

Removing Bushing


RG7960 –UN–15JAN98

Installing Bushing

RG,16,DT7489 –19–14NOV97–1/1

INSPECT BALANCER SHAFT GEARS AND THRUST PLATES

1. Inspect for broken, cracked or excessively worn gears.

NOTE: Gear removal is required for thrust plate removal.

Continued on next page

RG,16,DT7488 –19–14NOV97–1/2

2. Inspect thrust plate (A) for scoring or excessive wear.

Balancer Shaft Thrust Plate (New)—Specification

Thickness.. 2.97—3.02 mm (0.117—0.119 in.)

RG7708 –UN–07NOV97

A—Thrust Plate

RG,16,DT7488 –19–14NOV97–2/2

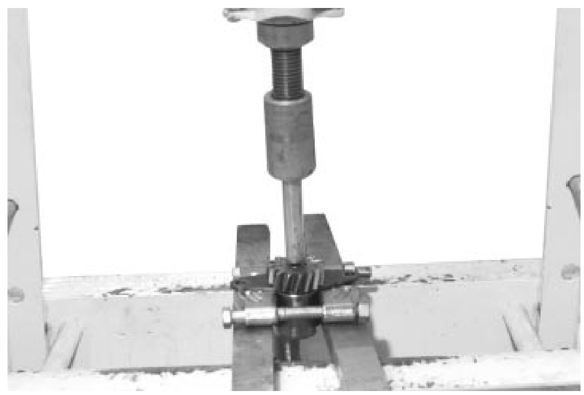
REMOVE AND INSTALL BALANCER SHAFT GEARS

IMPORTANT: DO NOT intermix gears and shafts. Shafts are finish lapped in different locations, therefore, balancer shafts MUST BE installed in the location from which removed. Reversing shaft locations could result in excessive bushing and shaft wear. If in doubt about proper shaft locations, replace the balancer shaft and bushings.

NOTE: Balancer shaft kits provided for service are delivered without gear.

1. Support back side of gear in a press and push on balancer shaft to remove gear.

2. Inspect woodruff key or spring pin (later engines), gear, and thrust plate for cracks and wear. Replace if necessary.



RG7709 –UN–23NOV97

Continued on next page

RG,16,DT7487 –19–14NOV97–1/2

16
38

3. Position balancer shaft in JD247 Balancer Shaft Holding Tool or bearing pulling attachment (A).

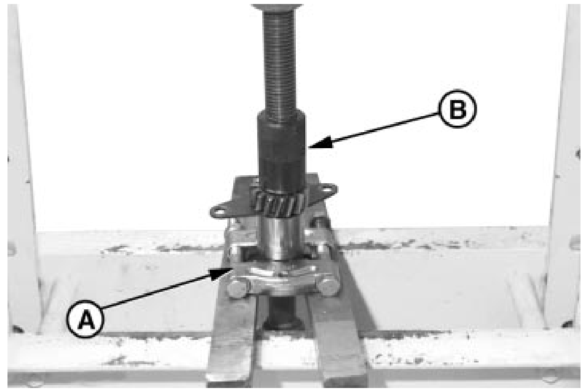
4. Install thrust plate.

5. Use woodruff key or spring pin (later engines) to index gear on balancer shaft. Be sure timing mark is on front face of gear.

6. Press gear onto shaft with a tube-type driver (B) until gear is flush with shaft.

Balancer Shaft Thrust Plate-to-Gear—Specification

Clearance .... 0.05—0.26 mm (0.002—0.010 in.)



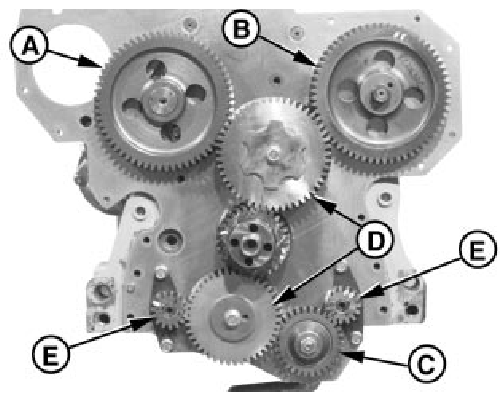
A—Bearing Pulling Attachment
B—Tube Type Driver

RG,16,DT7487 –19–14NOV97–2/2

REMOVE CYLINDER BLOCK FRONT PLATE

Before the front plate can be removed, the following components must first be removed:

- Timing gear cover
- Camshaft and gear (A)
- Injection pump drive gear (B)
- Injection pump (See Group 35)
- Oil pump drive gear (C)
- Oil pump (See Group 20)
- Idler gears (D)
- Balancer shafts (E)[1]



4-Cylinder Engine

A—Camshaft and Gear
B—Injection Pump Drive Gear
C—Oil Pump Drive Gear
D—Idler Gears (Upper and Lower)
E—Balancer Shafts[1]

[1] *4-cylinder engine only*

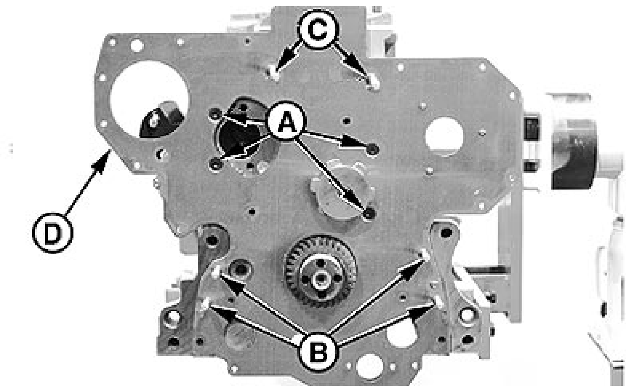
Continued on next page RG,16,DT7486 –19–14NOV97–1/4

1. Remove four countersunk, TORX® screws (A) from gear and oil pump T-40 TORX® adapter.

NOTE: On earlier engines[1], there are two countersunk TORX® screws used in place of threaded studs (C).

2. Remove six threaded studs (B) and (C) using E-8 TORX® Socket.

3. Remove front plate (D).



RG9064 –UN–16MAR98

A—Screws
B—Threaded Studs
C—Threaded Studs
D—Front Plate

TORX is a registered trademark of Camcar/Textron

[1]Serial Numbers: Dubuque-built engines (—703904), Saran-built engines (—516217), Torreon-built engines (Does not apply).

RG,16,DT7486 –19–14NOV97–2/4

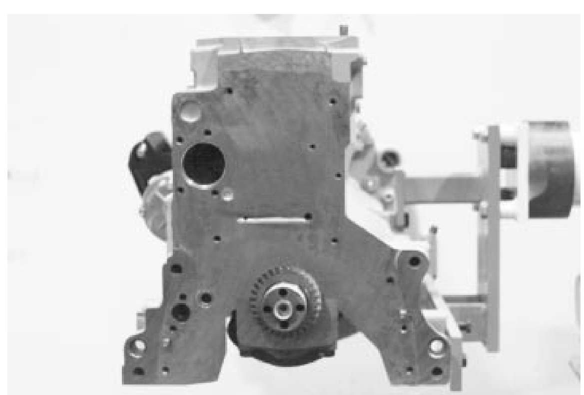
4. Remove oil by-pass valve and spring.

RG7571 –UN–23NOV97

RG,16,DT7486 –19–14NOV97–3/4

IMPORTANT: All surfaces must be free of oil and dirt.

5. Thoroughly clean front face of cylinder block.



RG7572 –UN–23NOV97

RG,16,DT7486 –19–14NOV97–4/4

16
40

MEASURE IDLER GEAR BUSHING AND SHAFT

RG7573 –UN–23NOV97

RG7574 –UN–23NOV97

1. Measure idler gear bushing ID and shaft OD to determine oil clearance. If oil clearance exceeds specification, replace worn parts.

Upper Idler Gear Bushing—Specification

ID .... 69.802—69.832 mm (2.7481—2.7493 in.)

Upper Idler Gear Bushing, 6010-6910, 7405, 7410 Tractors (S. N. 517001CD—)—Specification

ID .... 44.48—44.53 mm (1.751-1.753 in.)

Lower Idler Gear Bushing—Specification

ID .... 44.489—44.539 mm (1.7515—1.7535 in.)

Upper Idler Gear Shaft—Specification

OD .... 69.757—69.777 mm (2.7463—2.7471 in.)

Upper Idler Gear Shaft, 6010-6910, 7405, 7410 Tractors (S. N. 517001CD—)—Specification

OD .... 44.43—44.46 mm (1.749-1.750 in.)

Lower Idler Gear Shaft—Specification

OD .... 44.437—44.463 mm (1.7495—1.7505 in.)

Upper Idler Gear Bushing-to-Shaft—Specification

Oil Clearance .... 0.075—0.125 mm (0.0030—0.0049 in.)

Lower Idler Gear Bushing-to-Shaft—Specification

Oil Clearance .... 0.026—0.102 mm (0.0010—0.0040 in.)

Upper and Lower Idler Gear—Specification

End Play .... 0.095—0.145 mm (0.0037—0.057 in.)

Continued on next page

RG,16,DT7484 –19–14NOV97–1/2

2. If idler gear end play, measured earlier in this group, was out of specification, remove idler shaft and thrust washer from front plate. (See REMOVE LOWER AND UPPER IDLER SHAFTS, later in this group.)

3. Check thrust washer for wear.

4. Measure idler gear hub width and shaft width. Replace worn parts that are out of specification.

RG,16,DT7484 –19–14NOV97–2/2

REMOVE IDLER GEAR BUSHINGS

NOTE: Bushing for "wide" 30 mm (1.18 in.) upper idler gear is not replaceable. If bushing is worn, replace gear assembly.

1. For "narrow" 22 mm (0.87 in.) upper idler gear bushing, press worn bushing out of gear using 27527 Disc Driver from D01045AA Master Driver Set and JDG537 (OTC815) Handle.

2. For lower idler gear bushing, press worn bushing out of gear using discs from D01045AA Master Driver Set and JGD537 (OTC815) Handle.

RG7575 –UN–23NOV97

22 mm (0.87 in.) Upper Idler Gear

RG7576 –UN–23NOV97

Lower Idler Gear

RG,16,DT7483 –19–14NOV97–1/1

16
42

INSTALL IDLER GEAR BUSHINGS

NOTE: Bushing for "wide" 30 mm (1.18 in.) upper idler gear is not replaceable. If bushing is worn, replace gear assembly.

IMPORTANT: Bushing failure will result if upper and lower bushings are interchanged. Lower idler gear bushings are splash lubricated and have a spiral oil groove; upper idler gear bushings are pressure lubricated and DO NOT have oil grooves.


RG7577 –UN–23NOV97

Upper Idler Gear


RG7578 –UN–23NOV97

Lower Idler Gear

1. Coat ID and OD of idler gear bushing and ID of gear with TY6333 High-Temperature Grease.

2. Install bushing into upper "narrow" 22 mm (0.087 in.) idler gear using JD252 Driver[1] and JDG537 (OTC815) Handle.

3. Install bushing into lower idler gear using discs and driver from D01045AA Master Driver Set.

[1]*Discs from D01045AA Master Driver set can be used if JD252 Driver is not available.*

DPSG,OUO1004,43 –19–10APR98–1/1

16
43

REMOVE LOWER AND UPPER IDLER SHAFTS

1. Remove lower idler shaft and thrust washer by driving or pressing on shaft from block side of front plate.

2. Remove upper idler shaft and thrust washer by driving or pressing on shaft from block side of front plate.


RG7579 –UN–23NOV97

Upper Idler Shaft


RG7580 –UN–23NOV97

Lower Idler Shaft

RG,16,DT7482 –19–14NOV97–1/1

CLEAN AND INSPECT FRONT PLATE

IMPORTANT: All surfaces must be free of oil and dirt.

1. Clean front plate with hot soapy water.

2. Rinse well with plain water to remove all soap residue from gasket surface.

3. Inspect front plate for damage.

RG,16,DT7481 –19–14NOV97–1/1

16
44

TRANSFER FUEL INJECTION PUMP TIMING MARK ONTO REPLACEMENT FRONT PLATE

IMPORTANT: Replacement front plates do not have an injection pump timing mark. It is extremely important that the timing mark be accurately transferred from original front plate to the replacement plate in the exact location for correct injection pump timing.

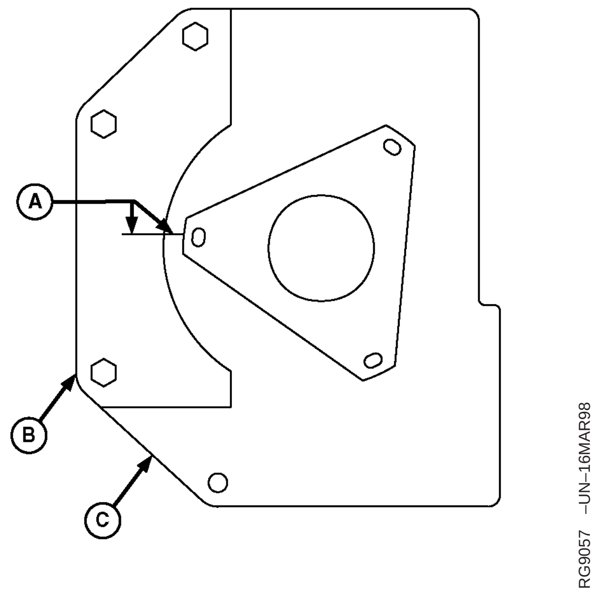
1. Position DFRG5 Aluminum Template (B) onto original front plate (C) as shown. (See Group 199, Dealer Fabricated Tools for manufacturing detail.) Install and tighten three 3/8-16 cap screws securely.

2. Transfer injection pump timing mark (A) from previous front plate onto template using a fine tip marker and straightedge. Remove template from front plate being replaced.

3. Attach template (with timing mark) to new replacement front plate and tighten cap screws securely.

4. Transfer timing mark from the template to the new front plate using a scribe. Scribe deep enough so mark becomes a permanent reference.

5. Remove template from front plate and install front plate (see procedure later in this group).



A—Timing Mark
B—Aluminum Template
C—Front Plate

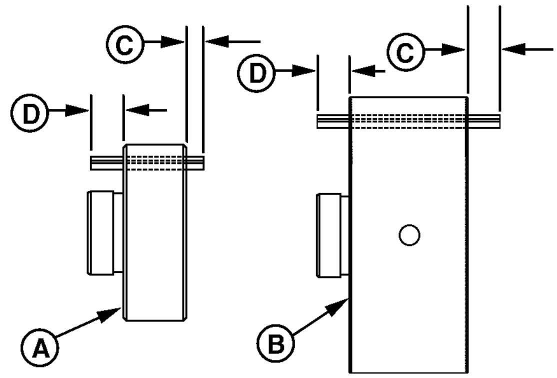
RG,16,DT7480 –19–14NOV97–1/1

INSTALL IDLER SHAFT SPRING PINS (IF EQUIPPED)

Install spring pins in lower (A) and upper (B) idler gear shaft. This locks thrust washer to shaft to allow 4.32 mm (0.170 in.) (C) projection above front face of each shaft. The pins on idler shafts extend through both rear and front thrust washers.

Lower and Upper Idler Shaft Spring Pin Protrusion (D)—Specification

Protrusion .... 2.79—4.83 mm (0.11—0.19 in.)



A—Lower Idler Gear Shaft
B—Upper Idler Gear Shaft
C—4.32 mm (0.170 in.) Projection
D—2.79—4.83 mm (0.11—0.19 in.) Protrusion

RG,16,DT7479 –19–14NOV97–1/1

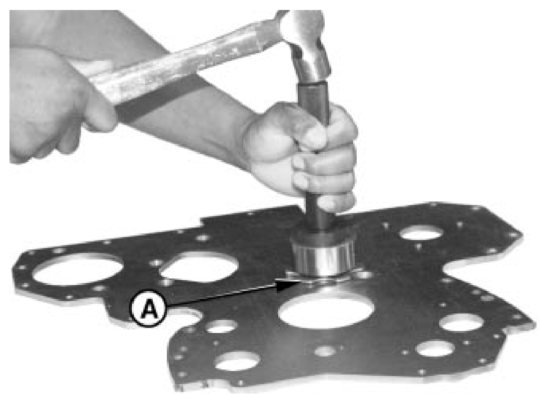
INSTALL UPPER IDLER SHAFT IN FRONT PLATE

IMPORTANT: Oil holes in idler shaft must be properly indexed to provide adequate lubrication to idler gear bushing.

1. Install thrust washer (A) and upper idler shaft into front plate. Spring pin (if equipped) must extend through hole in thrust washer and front plate.

IMPORTANT: Install thrust washer (A) with “X” mark facing away from gear (toward plate).

2. Drive or press shaft into front plate until thrust washer is fully seated.



A—Thrust Washer

RG,16,DT7478 –19–14NOV97–1/1

16
46

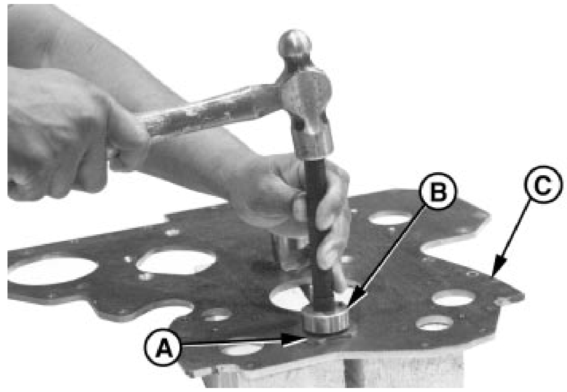
INSTALL LOWER IDLER SHAFT IN FRONT PLATE

NOTE: Spring pin (B) is only used on later engines.

1. Install thrust washer (A) and lower idler shaft with spring pin (B). Spring pin must extend through hole in thrust washer and front plate.

IMPORTANT: Install thrust washer (A) with "X" mark facing away from gear (toward plate).

2. Drive shaft into plate (C) until thrust washer is fully seated.



RG7582 –UN–05NOV97

A—Thrust washer
B—Spring pin
C—Front Plate

RG,16,DT7477 –19–14NOV97–1/1

INSTALL ENGINE FRONT PLATE

1. Install oil by-pass valve and spring into block.

2. If not previously done, use a brass scraper and remove any previously applied sealant.

IMPORTANT: Be sure cylinder block and front plate surfaces are free of oil, dirt, previously applied sealant, and cleaning agents.

3. Wash gasket surfaces with a steam cleaner using hot soapy water. Rinse well with plain water to remove all soap residue from gasket surface.

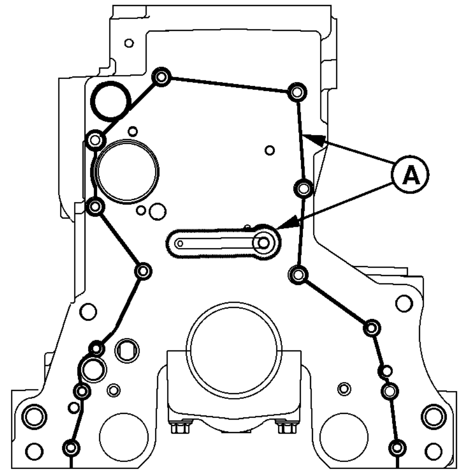
RG7571 –UN–23NOV97

Continued on next page

RG,16,DT7476 –19–14NOV97–1/3

4. Apply LOCTITE® 515 Flexible Form-In-Place Gasket (TY6304) in a continuous 1.5—2.0 mm bead (A) to cylinder block.

5. Locate bead in the center of the mating surfaces and completely encircle cap screw and dowel holes.



A—Flexible Gasket Pattern

LOCTITE is a registered trademark of the Loctite Corp.

RG,16,DT7476 –19–14NOV97–2/3

6. Install front plate (D).

IMPORTANT: Tighten screws to specified torque using a cross pattern, within 10 minutes after parts are assembled.

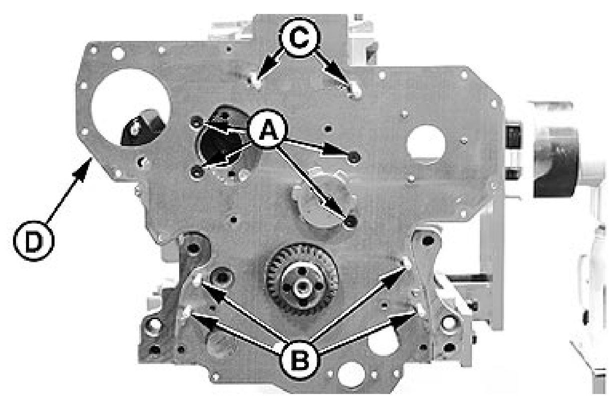
NOTE: On earlier engines[1], there are two countersunkTORX® screws in place of threaded studs (C).

Front Plate Countersunk TORX® Screws (A)—Specification

Torque .... 25 N•m (18 lb-ft)

Front Plate Threaded Studs (B) and (C)—Specification

Torque .... 35 N•m (26 lb-ft)



A—Countersunk TORX®Screws
B—Threaded Studs
C—Threaded Studs
D—Front Plate

TORX is a registered trademark of Camcar/Textron

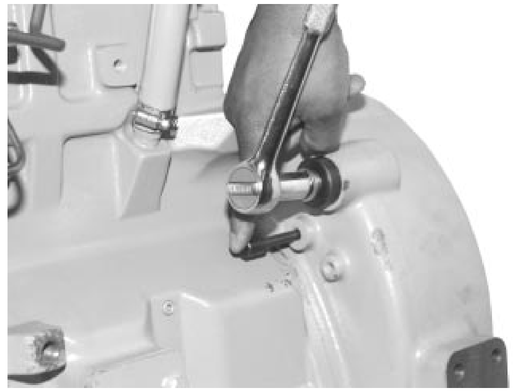
[1]Serial Numbers: Dubuque-built engines (—703904), Saran-built engines (—516217), Torreon-built engines (Does not apply).

RG,16,DT7476 –19–14NOV97–3/3

16
48

INSTALL AND TIME BALANCER SHAFTS (4-CYLINDER ENGINES)

1. Using JDG820 or JDE83 Flywheel Turning Tool and JDE81-4 Timing Pin, lock No. 1 piston at TDC compression stroke.



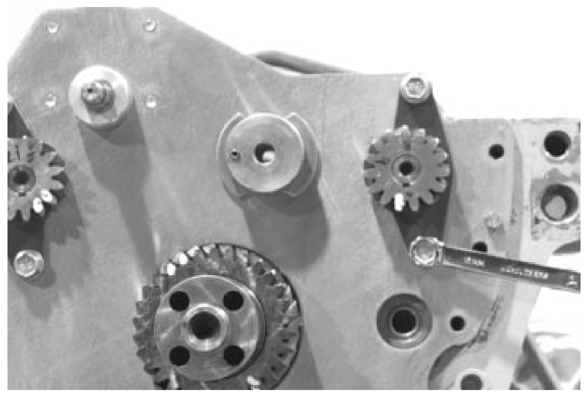
RG7711 –UN–23NOV97

RG,16,DT7475 –19–14NOV97–1/7

2. Lubricate balancer shaft bushings and journals with clean engine oil.

IMPORTANT: Balancer shafts MUST BE installed in the location from which removed. Reversing shaft locations could result in excessive bushing and shaft wear. If in doubt about proper shaft locations, replace the balancer shaft and bushings.

3. Install balancer shafts and thrust plates. Tighten thrust plate cap screws to specifications.



RG7704 –UN–23NOV97

Balancer Shaft Thrust Plate Cap Screws—Specification

Torque .... 40 N•m (29.5 lb-ft)

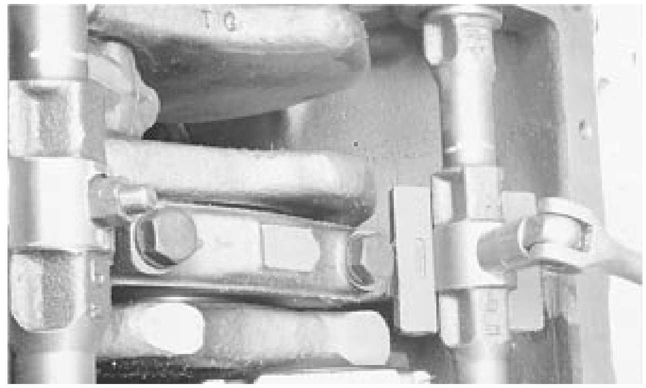
Continued on next page

RG,16,DT7475 –19–14NOV97–2/7

4. Later engines[1] have balancer shafts with removable weights. Install weights to balancer shafts using new cap screws and nuts. Tighten to specifications.

Balancer Shaft Removable Weights—Specification

Torque .... 58 N•m (43 lb-ft)



T91157 –UN–09NOV88

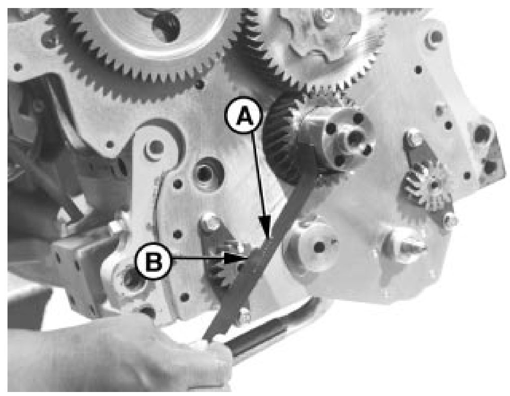
[1]*Serial Numbers: Dubuque-built engines (700877—), Saran-built engines (500212—), Torreon-built engines (001000—).*

RG,16,DT7475 –19–14NOV97–3/7

5. Turn right (camshaft side) balancer shaft so timing mark on gear is aligned with JD254A Timing Tool (A). Timing mark on balancer shaft gear must point to centerline of crankshaft when correctly timed.

NOTE: Keyway (B) in balancer shaft gear will be at 12 O'clock position, when engine is locked at No. 1 TDC compression.

6. Apply TY6333 High-Temperature Grease to idler gear bushing ID and shaft OD. Install lower idler gear without turning balancer shaft.



RG7712 –UN–07NOV97

A—Timing Tool
B—Keyway

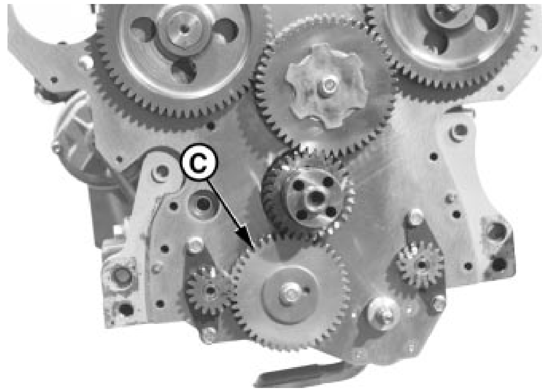
Continued on next page

RG,16,DT7475 –19–14NOV97–4/7

NOTE: Install thrust washer with "X" mark facing away from gear.

7. Install thrust washer over lower idler gear (C) and shaft.

8. Lubricate and install cap screw through idler shaft into threaded leg of oil pump housing and finger tighten only.



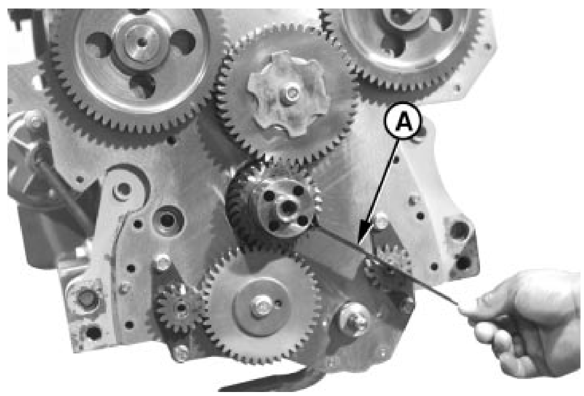
C—Lower Idler Gear

RG,16,DT7475 –19–14NOV97–5/7

9. Turn left (injection pump side) balancer shaft so timing mark on gear is aligned with JD254A Timing Tool (A).

10. Install oil pump gear. Finger tighten gear retaining nut.

11. Recheck gear timing for both balancer shafts.



A—Timing Tool

Continued on next page

RG,16,DT7475 –19–14NOV97–6/7

12. Tighten oil pump drive gear retaining nut to specifications. Stake nut to shaft in three places (B). (See Group 20 for oil pump installation.)

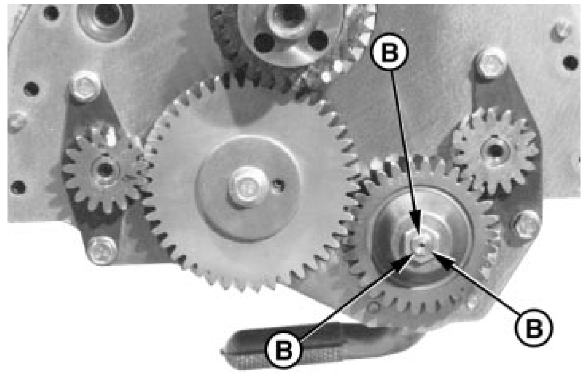
Oil Pump Drive Gear Staked Nut—Specification

Torque .... 50 N•m (37 lb-ft)

13. Tighten lubricated lower idler gear cap screws to specifications.

Lower Idler Gear Cap Screw (Lubricated Threads)—Specification

Torque .... 70 N•m (53 lb-ft)



Early Model Shown

B—Stake Points

RG,16,DT7475 –19–14NOV97–7/7

16
52

INSTALL AND TIME CAMSHAFT AND ROTARY FUEL INJECTION PUMP


RG7583 –UN–23NOV97

1. Using JDG820 or JDE83 Flywheel Turning Tool and JDE81-4 Timing Pin, lock No. 1 piston at TDC compression stroke.

2. Install fuel injection pump on front plate.

3. Install fuel injection pump drive gear and new retaining nut. Time injection pump to engine. (See Group 35 for injection pump timing.)

4. Tighten injection pump-to-front plate hex nuts to specifications.

Injection Pump-to-Front Plate Nuts—Specification

Torque .... 27 N•m (20 lb-ft).

5. Tighten injection pump drive gear retaining nut to specifications listed below:

Stanadyne: Model DB2—Specification

Torque .... 125 N•m (92 lb-ft)

Stanadyne: Model DB4—Specification

Torque .... 195 N•m (144 lb-ft)

Lucas: Model DP201 and DP203—Specification

Torque .... 81 N•m (60 lb-ft)

6. Lubricate camshaft bearing journals, lobes, and followers with TY6333 High-Temperature Grease.

IMPORTANT: DO NOT allow camshaft lobes to drag on camshaft bore or bushing surfaces while installing camshaft. Bearing surfaces may become scratched or scored. Rotate camshaft during installation to avoid obstruction in any bore.

7. Install camshaft and thrust plate in cylinder block. Be careful not to damage bushing ID.

Continued on next page RG,16,DT7474 –19–14NOV97–1/5

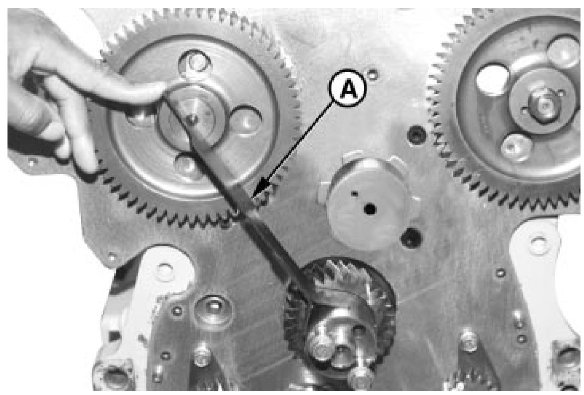
8. Install thrust plate cap screws and tighten to specifications.

Camshaft Thrust Plate Cap Screws—Specification

Torque .... 35 N•m (26 lb-ft)

RG,16,DT7474 –19–14NOV97–2/5

9. With JD254A Timing Tool resting on nose of crankshaft and center of camshaft (as shown), turn camshaft until timing mark (A) on camshaft gear aligns with timing tool.

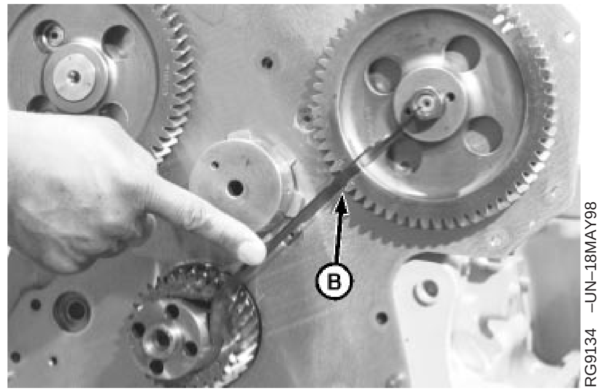


A—Timing Mark

Continued on next page RG,16,DT7474 –19–14NOV97–3/5

IMPORTANT: Use the timing mark corresponding to the number of cylinders the engine has that is being timed.

10. Check injection pump gear timing with JD254A Timing Tool resting on nose of crankshaft and center of injection pump shaft. Timing mark (B) on injection pump drive gear, as described in table below, must align with timing tool (as shown).



B—Timing Mark

INJECTION PUMP GEAR TIMING MARKS

Injection Pump Model	Timing Mark
4-Cylinder Engine:	
Stanadyne DB2	SD2 4
Stanadyne DB4	SD4 4
Lucas DP201 and DP203	L4
6-Cylinder Engine:	
Stanadyne DB4	S6
Lucas DP201 and DP203	L6
Lucas (Early 1170 Combines)	L6
Lucas (Late 1170 Combines)	6C or 6Z

IMPORTANT: To ensure proper lubrication of new upper idler gear bushing and camshaft bushing, install new upper idler gear with the reference number facing away from engine.

11. Lubricate upper idler gear bushing ID and shaft OD with TY6333 High-Temperature Grease. Using JDG791A Idler Gear Installer Pilot[1], install idler gear without turning camshaft gear or injection pump gear.

NOTE: Install thrust washer with “X” mark facing away from gear.

12. Lubricate upper idler gear cap screw threads with oil. Install upper idler gear thrust washer and cap screw. Tighten cap screw to specifications.

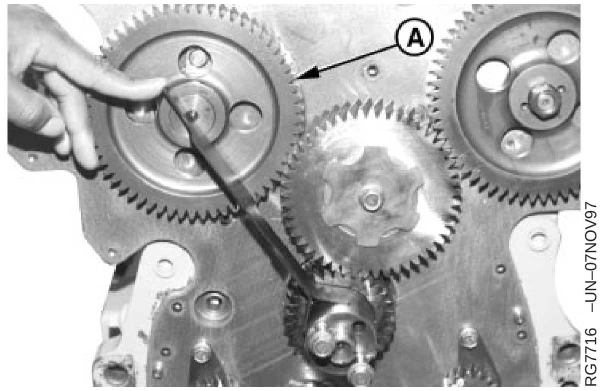
Upper Idler Gear Cap Screw—Specification

Torque .... 70 N•m (53 lb-ft)

[1]JDG791A needs to be modified to allow space for the spring pin in idler shaft.

Continued on next page

13. Recheck camshaft gear (A) and injection pump drive gear timing to make sure they are correct.



A—Camshaft Gear

RG,16,DT7474 –19–14NOV97–5/5

CLEAN AND INSPECT TIMING GEAR COVER

1. Drive crankshaft front oil seal out of cover.

2. Remove material and sealant from cylinder block and timing gear cover gasket surfaces. If necessary, remove oil filler neck and gasket and injection pump drive gear nut cover plate and gasket.

CAUTION: Do not spin bearings when drying with compressed air.

3. If engine is equipped with the auxiliary drive, remove auxiliary drive as described earlier in this group.

4. If engine is equipped with electronic tachometer (magnetic pick-up) sensor, remove sensor and O-ring. See REPLACE ELECTRONIC TACHOMETER (MAGNETIC PICK-UP) SENSOR, as described earlier in this group.

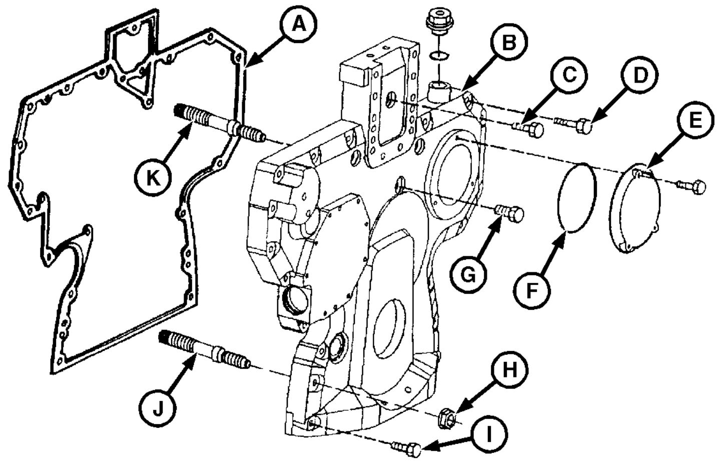
5. Clean timing gear cover in solvent. Dry with compressed air.

6. Inspect cover for cracks or damage. Make sure seal bore is clean and free of nicks.

RG,16,DT7472 –19–14NOV97–1/1

16
56

INSTALL TIMING GEAR COVER



A—Gasket
B—Timing Gear Cover
C—Cap Screw M8 x 35 mm (1 Used)
D—Cap Screw M8 x 40 mm (10 Used W/Aux Drive) (6 Used W/O Aux Drive)
E—Injection Pump Drive Gear Cover Plate
F—O-Ring
G—Cap Screw (2 Used W/Aux Drive)(1 Used W/O Aux Drive)
H—Flange Nut M10 (4 Used)
I—Cap Screw M8 x 55 (2 Used)
J—Stud (4 Used)
K—Stud (2 Used)[1]

1. Make sure gasket surfaces on cover and front plate are clean. See CLEAN AND INSPECT ENGINE FRONT PLATE, earlier in this group.

2. Install injection pump drive gear cover plate (C) using a new O-ring (D), if necessary. Apply LOCTITE® 242 (T43512) to cap screws on rotary injection pump covers. Tighten screws to specifications.

Rotary Injection Pump Drive Gear Cover—Specification

Torque.. 2 N•m (17 lb-in.)

In-Line Injection Pump Drive Gear Cover—Specification

Torque.. 5 N•m (44 lb-in.)

3. Install timing gear cover (B) on engine.

4. Apply LOCTITE® 592 (TY9375) to cap screw (G) and torque timing cover cap screws and nuts to specifications.

Timing Gear Cover-to-Front Plate and Cylinder Block—Specification

Torque... 35 N•m (26 lb-ft)

Oil Pan-to-Timing Gear Cover—Specification

Torque... 35 N•m (26 lb-ft)

LOCTITE is a trademark of Loctite Corp.

[1]Serial Numbers: Dubuque-built engines (703905—), Saran-built engines (516218—), Torreon-built engines (001000—).

Continued on next page

Electronic Tachometer (Magnetic Pick-up) Sensor-to-Timing Cover—Specification

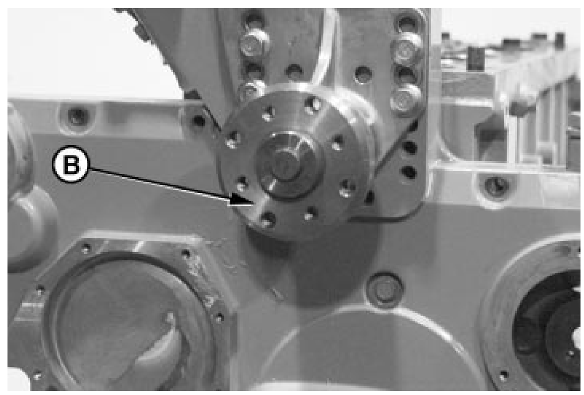
Torque.. 20 N•m (15 lb-ft)

5. Install oil pressure regulating valve assembly. (See Group 20.)

RG,16,DT7471 –19–14NOV97–2/5

6. Install adjustable fan drive and fan pulley (B). (See Group 25.)

7. Install water pump, if removed. (See Group 25.)

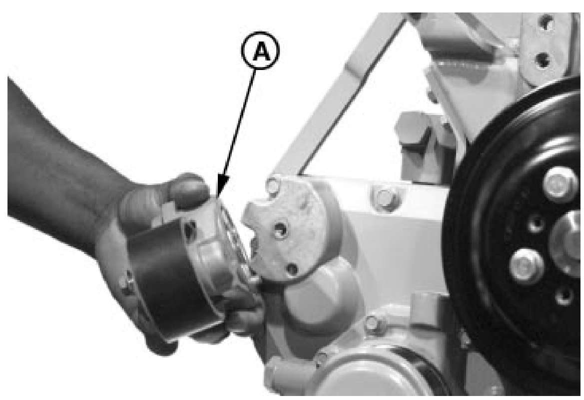


RG7551B –UN–05NOV97

B—Fan Pulley

RG,16,DT7471 –19–14NOV97–3/5

8. Install belt tensioner (A), if removed. (See Group 25.)



RG7951 –UN–13NOV97

A—Belt Tensioner

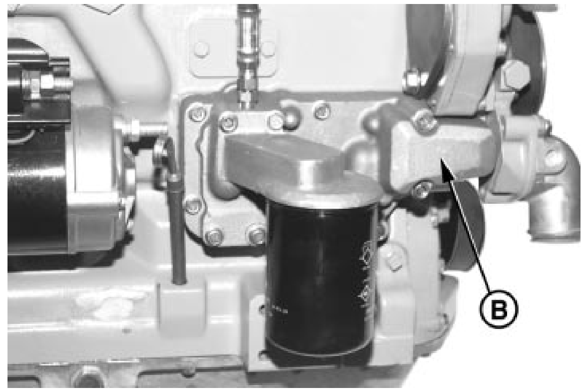
Continued on next page

RG,16,DT7471 –19–14NOV97–4/5

16
58

9. Install oil cooler-to-water manifold elbow (B) at front plate. (See Group 20.)

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



RG8034 –UN–14NOV97

A—Oil Cooler-to-Water Manifold Elbow

RG,16,DT7471 –19–14NOV97–5/5

INSTALL CRANKSHAFT FRONT WEAR SLEEVE AND OIL SEAL

INSTALL FRONT CRANKSHAFT WEAR SLEEVE

1. Coat ID of new wear sleeve with LOCTITE® 271 (T43513) Thread Lock and Sealant.

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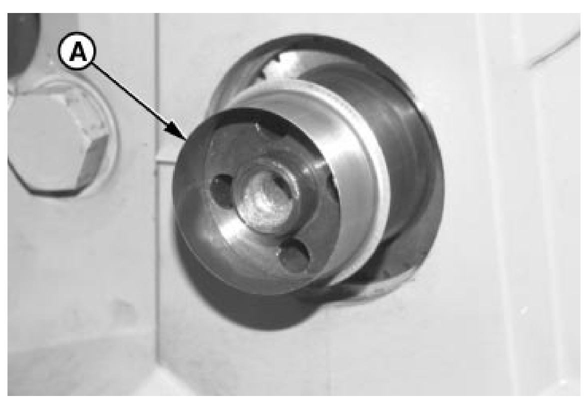
RG,16,DT7470 –19–14NOV97–1/4

2. Install wear sleeve (A) on nose of crankshaft with lip of sleeve toward crankshaft.



RG8095A –UN–18NOV97

A—Crankshaft Wear Sleeve

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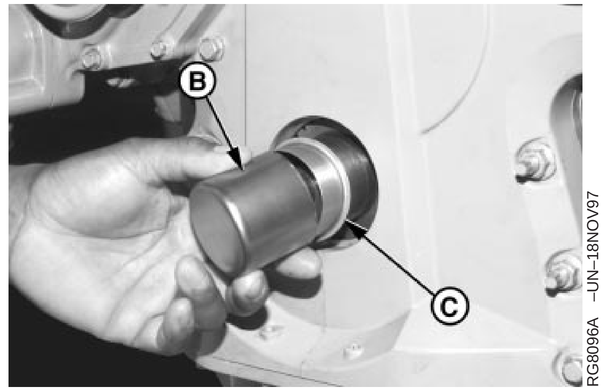
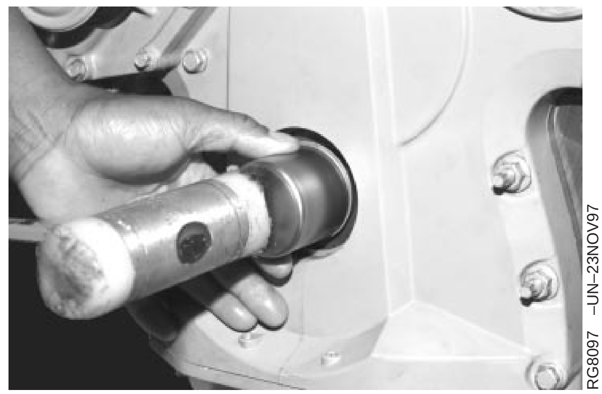
RG,16,DT7470 –19–14NOV97–2/4

NOTE: *Flange on wear sleeve should be seated against crankshaft drive gear when properly installed.*

3. Position installation tool (B), provided in front wear sleeve kit, over wear sleeve. Install wear sleeve using a dead blow hammer until tool bottoms on nose of crankshaft.

4. Clean any sealant from OD of crankshaft flange (C) and wear sleeve.





B—Wear Sleeve Tool
C—Crankshaft Flange

Continued on next page RG,16,DT7470 –19–14NOV97–3/4

INSTALL FRONT CRANKSHAFT OIL SEAL

IMPORTANT: To assure proper sealing, the OD of the crankshaft and wear sleeve MUST BE cleaned with Brake Kleen, Ignition Cleaner, or equivalent and dry prior to installing seal (C).

1. Inspect and clean seal bore in timing gear cover. Check for nicks or burrs. Use a medium-grit emery cloth to smooth rough areas.

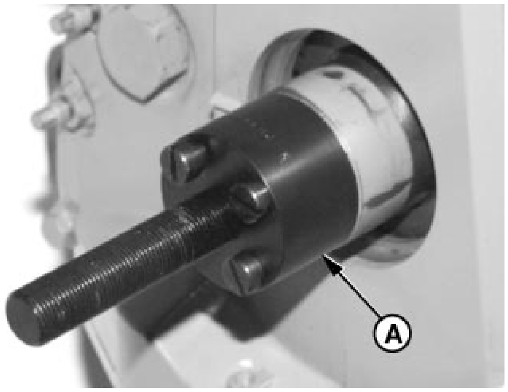
2. Slide JDG954-2 Adapter (A) on nose of crankshaft and tighten cap screws.

IMPORTANT: DO NOT allow oil to contact coating on OD of seal.

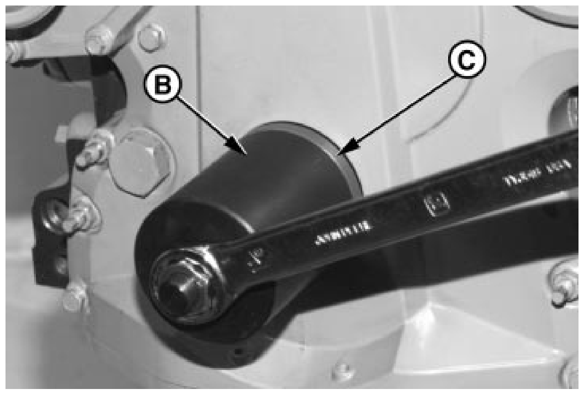
3. Apply a light coating of clean engine oil to lips of seal and position seal on crankshaft flange. (The spring-loaded side of seal goes into timing gear cover first.)

4. Place JDG954-1 Installer (B) over adapter. Tighten screw until driver bottoms on flange of timing gear cover.

5. Install belt pulley or vibration damper. (See Group 15.)



RG7515A –UN–04NOV97



RG7516A –UN–04NOV97

RG7511 –UN–23NOV97

A—JDG954-2 Adapter
B—JDG954-1 Installer
C—Oil Seal

RG,16,DT7470 –19–14NOV97–4/4

COMPLETE FINAL ASSEMBLY

1. Install fuel supply pump. (Group 35)

2. Remove cam follower holding tools (if used for camshaft removal).

3. Install push rods and rocker arm assembly. (Group 05)

4. Adjust valve clearance and install rocker arm cover and sealing ring. (Group 05)

5. Install fan. (Group 25)

6. Install alternator. (Group 04)

7. Fill engine crankcase with clean oil having correct viscosity and grade specifications. (Group 02)

8. Perform engine break-in as outlined in Group 05.

RG,16,DT7469 –19–14NOV97–1/1

Group 20
Lubrication System

ESSENTIAL TOOLS

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

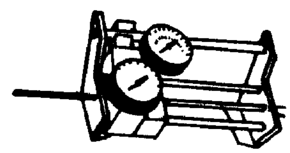
SERVICEGARD is a trademark of Deere & Company

DPSG,OUO1004,182 –19–07JUL98–1/9

RG5061 –UN–05DEC97

Spring Compression Tester D01168AA

Test oil bypass valve and oil pressure regulating valve spring compression.



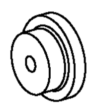
RG5061

DPSG,OUO1004,182 –19–07JUL98–2/9

RG9118 –UN–17APR98

Bushing Driver JD248A

Use with JDG536 to install oil pressure relief valve bushing.

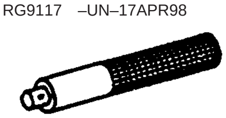


DPSG,OUO1004,182 –19–07JUL98–3/9

RG9117 –UN–17APR98

Handle JDG536 (OCT813)

Use with JD248A to install oil pressure relief valve bushing.



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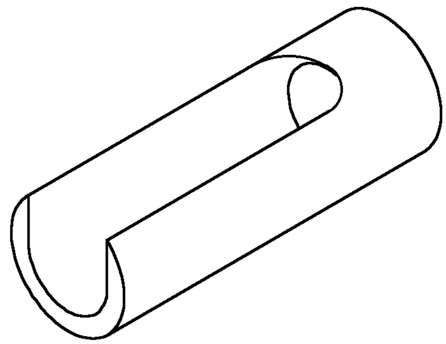
DPSG,OUO1004,182 –19–07JUL98–4/9

Dipstick Driver JDG965

Install dipstick tube in block.

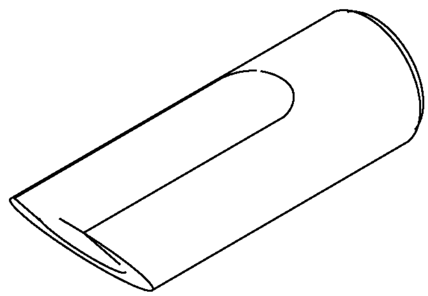


RG7982 –UN–15JAN98

DPSG,OUO1004,182 –19–07JUL98–5/9

Dipstick Fitting Installer. JDG1146

Install dipstick tube fitting in block.

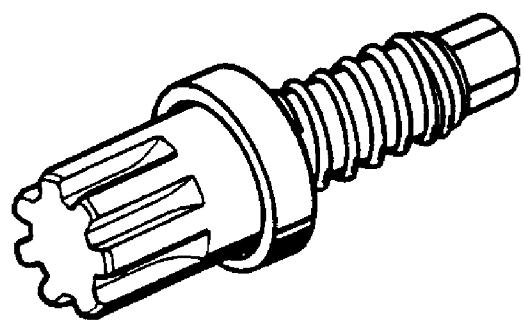


RG9114 –UN–07APR98

DPSG,OUO1004,182 –19–07JUL98–6/9

Flywheel Turning Tool JDG820

Used to rotate flywheel on engines with 129-tooth flywheel ring gear and a 29.9 mm (1.18 in.) flywheel housing guide bore diameter. JDE81-1 may be used if JDG820 is not available.



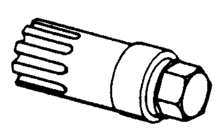
RG7056

RG7056 –UN–05DEC97

DPSG,OUO1004,182 –19–07JUL98–7/9

Flywheel Turning Tool JDE83

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



RG6251 –UN–22JUL92

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DPSG,OUO1004,182 –19–07JUL98–8/9

RG5068 –UN–05DEC97

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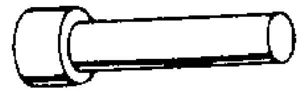
Timing Pin JDE81-4

Used to lock engine/flywheel.



RG5068

DPSG,OUO1004,182 –19–07JUL98–9/9

SERVICE EQUIPMENT AND TOOLS

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

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DPSG,OUO1004,183 –19–07JUL98–1/5

Blind Hole Puller Set D01061AA

Remove oil pressure regulating valve seat and dipstick tube from block.

DPSG,OUO1004,183 –19–07JUL98–2/5

Collet (5/16 in.) . . . . .No. 33856

Used with No. 28250 and D01299AA to remove dipstick tube from cylinder block.

Continued on next page

DPSG,OUO1004,183 –19–07JUL98–3/5

Actuator Pin . . . . .No. 28250

Used with No. 33856 and D01299AA to remove dipstick tube from cylinder block.

DPSG,OUO1004,183 –19–07JUL98–4/5

Slide Hammer D01299AA

Used with No. 33856 and No. 28250 to remove dipstick tube from cylinder block.

DPSG,OUO1004,183 –19–07JUL98–5/5

OTHER MATERIAL

Number	Name	Use
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to oil cooler to housing cap screws.
T43513 (U.S.) TY9474 (Canadian) 271 (LOCTITE®)	Thread Lock and Sealer (High Strength)	Apply to end of dipstick tube and fitting.
TY6304 (U.S.) TY9484 (Canadian) 515 (LOCTITE®)	Flexible Sealant	Apply to oil pan rail.
TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®)	Pipe Sealant	Apply to oil pan elbow drain fitting.

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DPSG,OUO1004,184 –19–07JUL98–1/1

LUBRICATION SYSTEM SPECIFICATIONS

Item	Measurement	Specification
Oil Filter Header Cap Screws	Torque	35 N•m (26 lb-ft)
Oil Tube Adapter/Oil Cooler Cover Cap Screws	Torque	35 N•m (26 lb-ft)
Oil Cooler-to-Housing Allen Head Cap Screws	Torque	12 N•m (106 lb-in.)
Oil Cooler Cover Cap Screws	Torque	35 N•m (26 lb-ft)
Oil Cooler Elbow Adapter Cap Screws	Torque	35 N•m (26 lb-ft)
Oil Bypass Valve Springs	Free Length Spring Load at 29 mm (1.14 in.) Compressed Length	51 mm (2.00 in.) 87.8 N (20 lb-force)
Oil Pressure Regulating Valve Spring Specifications		
4-Cylinder Engine	Spring Free Length	115.5 mm (4.55 in.)
4-Cylinder Engine	Spring Tension at 42.5 mm (1.68 in.)	45 N•m (9.1—11.1 lb-force)
6-Cylinder Engine	Spring Free Length	119 mm (4.68 in.)
6-Cylinder Engine	Spring Tension at 42.5 mm (1.68 in.)	66 N•m (13.5—16.5 lb-force)
Oil Press Regulating Valve	Torque	95 N•m (70 lb-ft)
OIl Fill Tube Cap Screws	Torque	35 N•m (26 lb-ft)
Oil Pump Pick-Up Tube Cap Screws	Torque	35 N•m (26 lb-ft)
Oil Pump Axial Clearance	Thickness of Gears Axial Clearance	35.975—36.025 mm (1.4163—1.4183 in.) 0.045—0.165 mm (0.0018—0.0065 in.)
Oil Pump Radial Clearance	Radial Clearance	0.131—0.211 mm (0.005—0.008 in.)

Continued on next page DPSG,OUO1004,233 –19–10JUL98–1/2

Item	Measurement	Specification
Oil Pump Drive Shaft	OD	16.017—16.037 mm (0.6306—0.6314 in.)
Oil Pump Bushing in Housing	ID	16.052—16.102 mm (12.316—12.332 in.)
Oil Pump Idler Shaft	OD	12.316—12.332 mm (0.4849—0.4855 in.)
Oil Pump Idler Gear	ID	12.355—12.363 mm (0.4864—0.4867 in.)
Oil Pump Drive Gear “Staked” Nut	Torque	50 N•m (37 lb-ft)
Oil Pump-to-Front Plate and Oil Pump Pick-Up Tube Cap Screws	Torque	35 N•m (26 lb-ft)
Oil Pump Lower Idler Gear Cap Screw (Lubricated Threads)	Torque	70 N•m (53 lb-ft)
Oil Pan Cap Screws		
M8 Cap Screws	Torque	35 N•m (26 lb-ft)
M10 Cap Screws up to 110 mm	Torque	70 N•m (52 lb-ft)
M10 Cap Screws 110 mm and Above	Torque	60 N•m (44 lb-ft)
M10 Cap Screws on PE4045DLV50 and PE4045TLV50 Engines Only	Torque	44 N•m (33 lb-ft)
Oil Pan Drain Plug		
Plug for PE4045DLV50 and PE4045TLV50 Engines	Torque	70 N•m (52 lb-ft)
Plug for Aluminum Oil Pans	Torque	20 N•m (15 lb-ft)
Plug for All Other Engines	Torque	47 N•m (35 lb-ft)

DPSG,OUO1004,233 –19–10JUL98–2/2

GENERAL LUBRICATION SYSTEM INFORMATION

The oil filter can be located on right side of the engine or remotely located on left side.

Dipsticks and oil fill locations can be located on either side of the engine. The oil fill can also be specified in the rocker arm cover.

The pressure regulating valve and the bypass valve are located in the front face of the block. Two regulating valve springs are available: one for 4-cylinder engines and one for 6-cylinder engines.

Oil coolers are full-flow, plate-type coolers. They may be equipped with 3-, 5-, 7-, or 9-plates.

One oil pump is available and is used on both 4- and 6-cylinder engines.

NOTE: For lubrication system diagnostics, see DIAGNOSING ENGINE MALFUNCTIONS in Group 105.

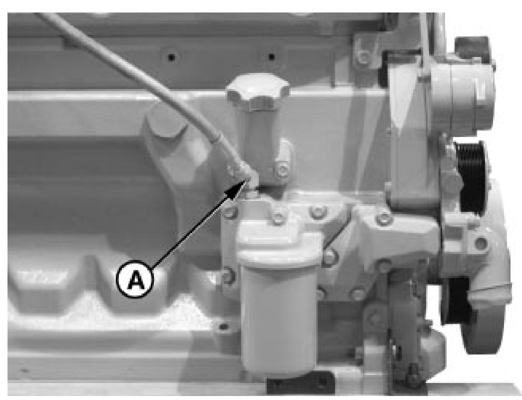
RG,20,DT7533 –19–17NOV97–1/1

REMOVE, INSPECT, AND INSTALL OIL FILTER BASE

Several oil filter locations are available. Two versions are being shown in this procedure.

1. Disconnect turbocharger oil inlet line (A) from oil filter header.

2. On left hand and remote mount filters, disconnect oil inlet and outlet lines.



RG7962A –UN–13NOV97

A—Turbocharger Oil Inlet Line

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RG,20,DT7532 –19–17NOV97–1/3

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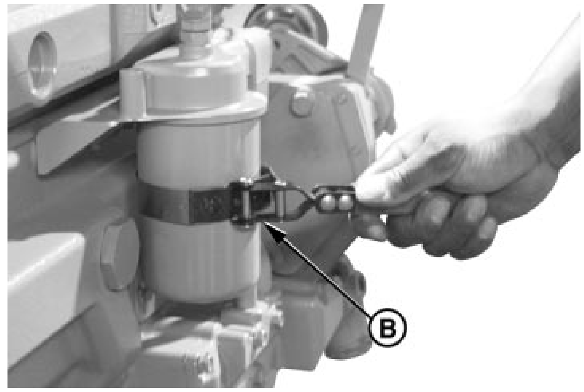
3. Remove oil filter (B) using a suitable filter wrench.



B—Oil Filter

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4. Remove oil filter header (on left hand and remote mount filters) or header/rear adapter (A).

5. Remove oil tube adapter (B) and remove tubes (D), if equipped.

6. Clean all gasket material from mating surfaces. Inspect all parts and replace if needed.

7. Install new gasket and O-rings (if required) and install oil filter header (A). Tighten cap screws to specifications.

Oil Filter Header Cap Screws—Specification

Torque .... 35 N•m (26 lb-ft)

NOTE: For left hand and remote mount filters, use general torque specifications for header retaining cap screws.

8. Using a new gasket and O-rings, install adapter (B), if equipped. Tighten cap screws to specifications.

Oil Tube Adapter/Oil Cooler Cover Cap Screws—Specification

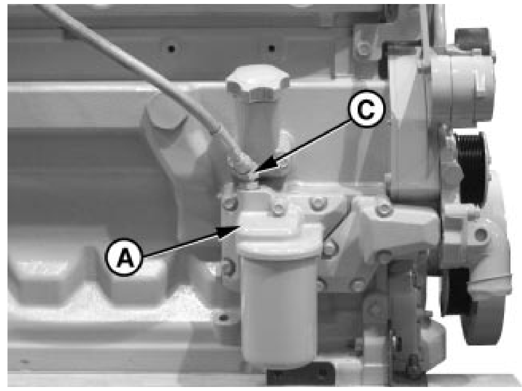
Torque .... 35 N•m (26 lb-ft)

9. Connect turbocharger oil inlet line (C).

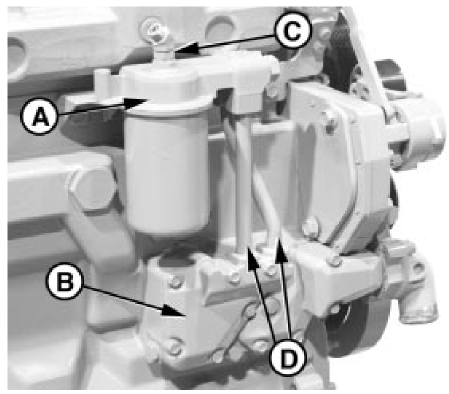
10. On left hand and remote mount filters, connect oil inlet and outlet lines.

IMPORTANT: Insure oil inlet and outlet lines are properly clamped and protected to prevent excessive motion or abrasion.

11. Spread a layer of clean engine oil on new filter packing. Install filter and tighten until packing contacts filter base. Tighten an additional 1/2—3/4 turn after packing contacts base. DO NOT overtighten oil filter.



RG7962B –UN–13NOV97



RG7588A –UN–05NOV97

A—Oil Filter Header/Rear Adapter
B—Oil Tube Adapter/Oil Cooler Cover
C—Turbocharger Oil Inlet Line
D—Tubes

RG,20,DT7532 –19–17NOV97–3/3

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REMOVE, INSPECT, AND INSTALL OIL COOLER

REMOVE OIL COOLER ASSEMBLY:

1. Remove oil cooler drain plug (D) and drain coolant.

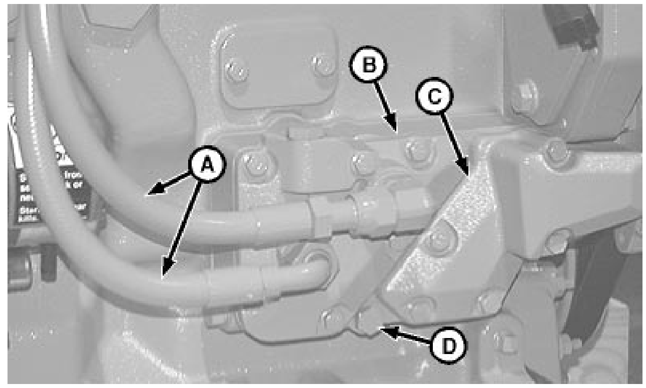
2. On high mount, rear and front mount oil filters, remove oil filter header with tubes and adapter/cooler cover if equipped. See REMOVE, INSPECT, AND INSTALL OIL FILTER BASE, earlier in this group.

3. On left hand or remote oil filters, disconnect oil lines (A) and remove cooler cover (B).

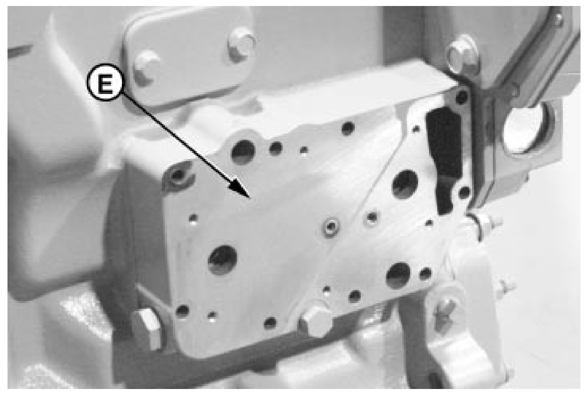
4. Remove elbow adapter (C).

5. Remove housing (E).

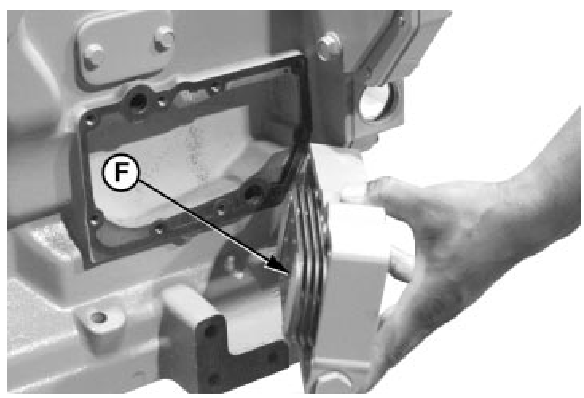
6. Remove oil cooler (F).



RG9129 –UN–19MAY98



RG7591 –UN–05JAN98



RG7592A –UN–05JAN98

A—Oil Lines
B—Cover
C—Adapter
D—Oil Drain Plug
E—Oil Cooler Housing
F—Oil Cooler

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RG,20,DT7531 –19–17NOV97–1/5

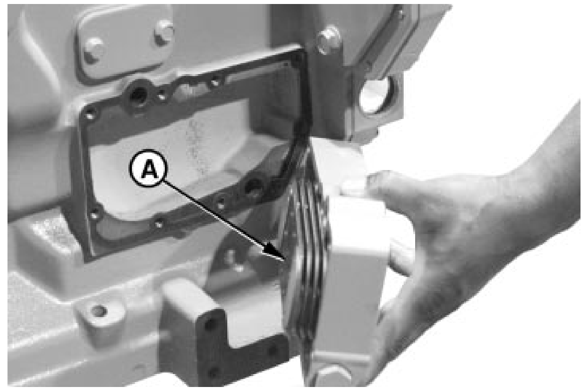
INSPECT OIL COOLER ASSEMBLY:

1. Inspect oil cooler (A) (shown installed in housing) for physical damage, plugging, or leakage which may allow mixing of oil and coolant.

2. Back flush oil cooler to clean all debris from core.

3. Pressure test oil cooler in liquid and compressed air if mixing of oil and coolant is suspected.

   Oil cooler should show no leakage when 140—170 kPa (1.4—1.7 bar) (20—25 psi) air pressure is applied for a minimum of 30 seconds.



RG7592B –UN–05JAN98

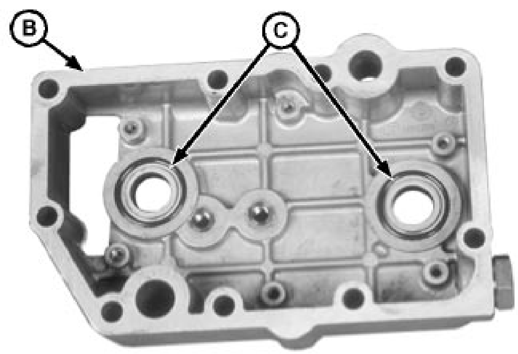
A—Oil Cooler

RG,20,DT7531 –19–17NOV97–2/5

4. Inspect oil cooler housing (B).

5. Replace parts as needed. DO NOT attempt to repair oil cooler.

6. Replace O-rings (C).



RG9085 –UN–16MAR98

B—Oil Cooler Housing
C—O-Rings

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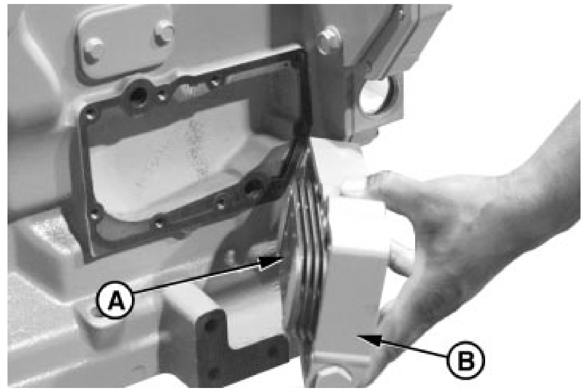
INSTALL OIL COOLER ASSEMBLY:

1. Lubricate new O-rings with clean engine oil.
2. Install oil cooler (A) in oil cooler housing (B).
3. Apply LOCTITE® 242 Thread Lock and Sealer to two short bolts (C) for open holes in oil cooler. Install oil cooler-to-oil cooler housing six allen head cap screws. Tighten to specifications.

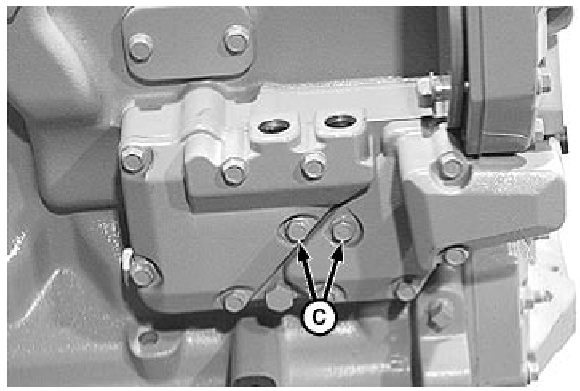
Oil Cooler-to-Housing Allen Head Cap Screws—Specification

Torque .... 12 N•m (106 lb-in.)

4. Using a new gasket, install oil cooler assembly. Be sure gasket is properly aligned with cap screw holes.



RG7592C –UN–05JAN98



RG9140 –UN–18MAY98

A—Oil Cooler
B—Oil Cooler Housing
C—Cap Screws

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RG,20,DT7531 –19–17NOV97–4/5

5. On high mount, rear and front mount oil filters, install oil filter header, tubes and adapter/cooler cover. (See REMOVE, INSPECT AND INSTALL OIL FILTER BASE earlier in this group.

6. On left hand or remote oil filters, install cooler cover (B) and oil lines (A).

Oil Cooler Cover Cap Screws—Specification

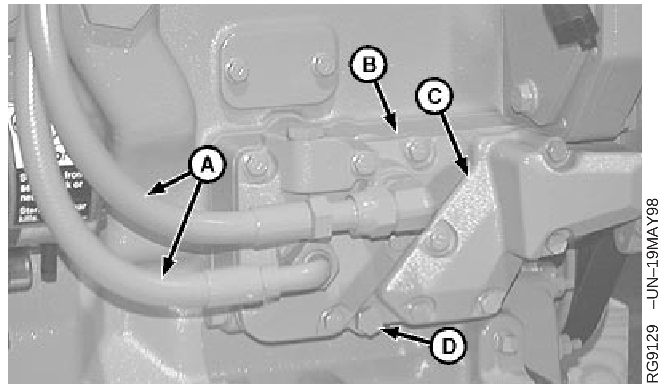
Torque .... 35 N•m (26 lb-ft)

7. Install elbow adapter (C) and tighten cap screws to specifications.

Oil Cooler Elbow Adapter Cap Screws—Specification

Torque .... 35 N•m (26 lb-ft)

8. Install drain plug (D).



A—Oil Lines
B—Cooler Cover
C—Elbow Adapter
D—Drain Plug

RG,20,DT7531 –19–17NOV97–5/5

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14

REMOVE, INSPECT, AND INSTALL OIL BYPASS VALVE


RG7571 –UN–23NOV97

1. Remove timing gear cover and front plate as described in Group 16.
2. Remove oil bypass valve and spring.
3. Inspect valve and spring for damage. Replace parts if necessary.
4. Check bypass valve spring free length and compression strength using D01168AA Spring Compression Tester. Replace parts if not within specification.

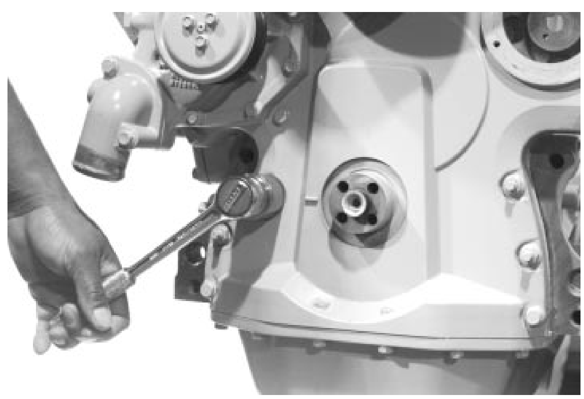
Oil Bypass Valve Springs—Specification

Free Length	51 mm (2.00 in.)
Spring Load at 29 mm (1.14 in.) Compressed Length	87.8 N (20 lb-force)

5. Install oil bypass valve and spring in cylinder block.
6. Install front plate and timing gear cover as described earlier in Group 16.

RG,20,DT7530 –19–17NOV97–1/1

REMOVE AND INSTALL OIL PRESSURE REGULATING VALVE AND SEAT


RG7554 –UN–23NOV97

1. Remove oil pressure regulating valve plug from timing gear cover.

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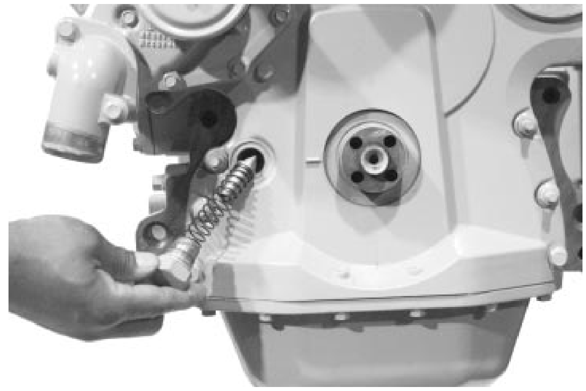
RG,20,DT7529 –19–17NOV97–1/5

2. Remove oil pressure regulating valve and spring.

3. Check valve cone for excessive wear and damaged sealing face.

4. Check oil pressure regulating spring free length and compression strength using D01168AA Spring Compression Tester. Replace parts if not within specification.



4-Cylinder Engine—Specification

Spring Free Length.. 115.5 mm (4.55 in.)

4-Cylinder Engine—Specification

Spring Tension at 42.5 mm (1.68 in.) .... 45 N•m (9.1—11.1 lb-force)

6-Cylinder Engine—Specification

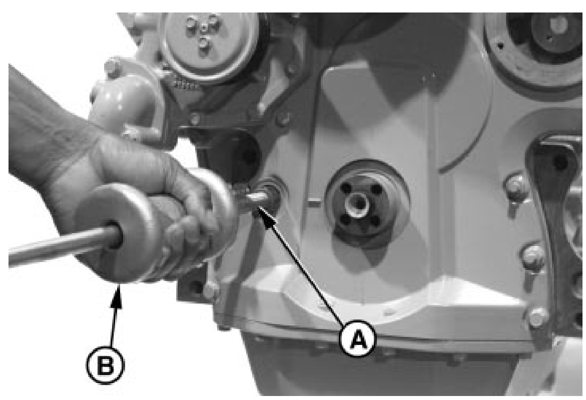
Spring Free Length... 119 mm (4.68 in.)

6-Cylinder Engine—Specification

Spring Tension at 42.5 mm (1.68 in.) .... 66 N•m (13.5—16.5 lb-force)

RG,20,DT7529 –19–17NOV97–2/5

5. Pull valve seat out of cylinder block with JT01727 Collet (A) and JT01718 Slide Hammer (B) from D01061AA Blind-Hole Puller Set, or equivalent.



A—JT01727 Collet
B—D01061AA Blind-Hole Puller

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RG,20,DT7529 –19–17NOV97–3/5

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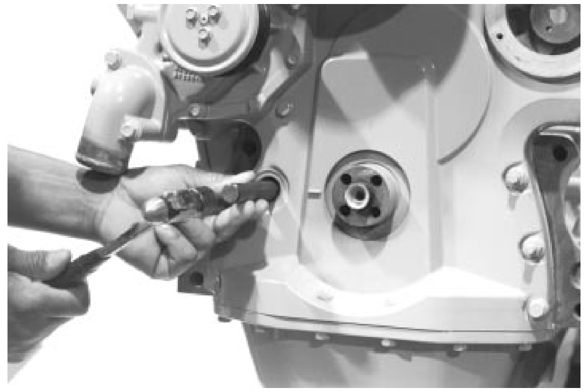
16

IMPORTANT: DO NOT drive against raised inner rim of valve seat so that valve seat bore is not damaged.

6. Drive valve seat into cylinder block with JD248A Oil Pressure Relief Valve Bushing Driver and JDG536 (OTC813) Handle until the seat bottoms in bore.



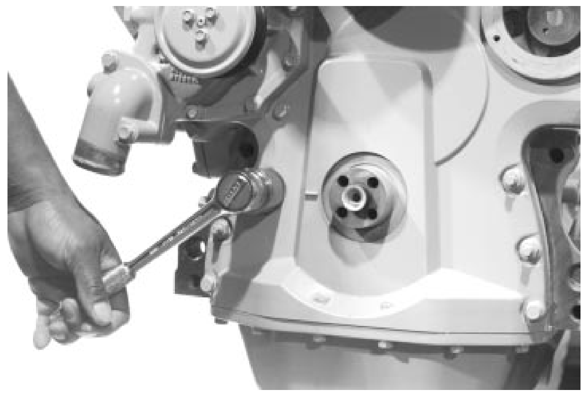
RG7594 –UN–23NOV97

RG,20,DT7529 –19–17NOV97–4/5

7. Install valve, spring, washer, and plug in timing gear cover. Tighten plug to specification.

Oil Press Regulating Valve—Specification

Torque .... 95 N•m (70 lb-ft)



RG7554 –UN–23NOV97

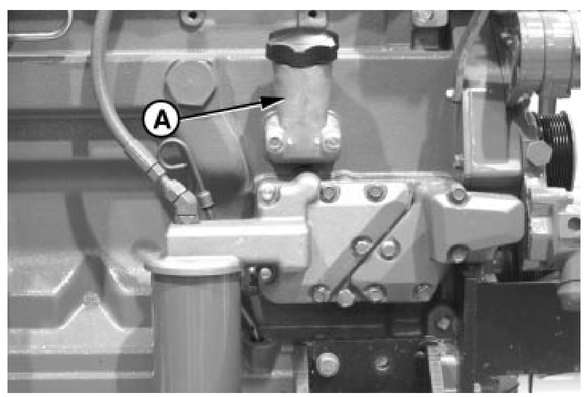
RG,20,DT7529 –19–17NOV97–5/5

REMOVE AND INSTALL OIL FILL TUBE

1. Remove oil fill tube (A).
2. Inspect and replace tube as needed.
3. Using a new gasket, install oil fill tube.
4. Apply LOCTITE® 242 Thread Lock and Sealer to threads of cap screws.
5. Tighten cap screws to specifications.

OIl Fill Tube Cap Screws—Specification

Torque .... 35 N•m (26 lb-ft)



RG7964 –UN–13NOV97

A—Oil Fill Tube

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RG,20,DT7528 –19–17NOV97–1/1

REMOVE AND INSTALL DIPSTICK TUBE WITH OIL PAN INSTALLED

REMOVE DIPSTICK TUBE

1. Remove dipstick (A).

2. Using No. 33856 (5/16 in.) Collet, No. 28250 Actuator Pin, and D01299AA Slide Hammer, remove dipstick tube (B) from block.

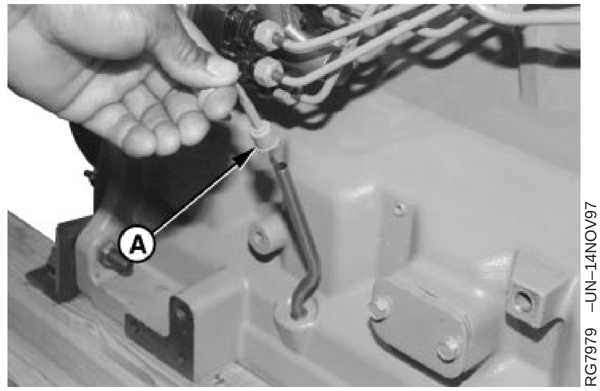
INSTALL DIPSTICK TUBE

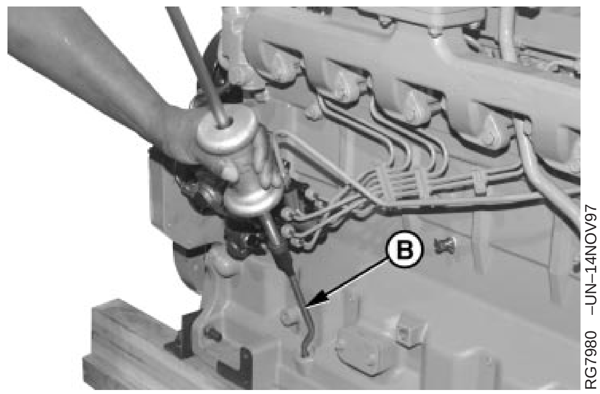
1. Coat end of new dipstick tube with LOCTITE® 271 Thread Lock and Sealer.

NOTE: 6010—6910 Tractors use a straight dipstick tube.

2. Orient RH dipstick tube with first bend directed toward rear of engine and centerline plane of first bend angled 20 degrees toward the crankshaft centerline.

   Orient LH dipstick tube with first bend directed toward rear of engine and centerline plane of first bend parallel with the crankshaft centerline.





A—Dipstick
B—Dipstick Tube

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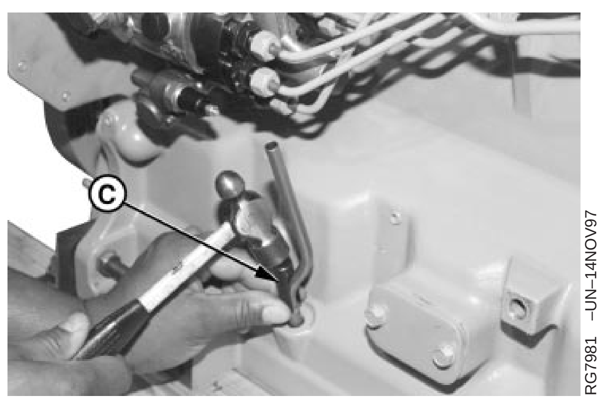
RG,20,DT7527 –19–17NOV97–1/2

NOTE: JDG965 Dipstick Driver cannot be used for straight dipsiick tube used on 6010—6910 Tractors. Use Engine Oil Dipstick Tube Driver (dealer fabricated tool) on these tractors. Refer to Group 199 Dealer Fabricated Tools.

3. Using JDG965 Dipstick Driver (C), install dipstick tube until shoulder bottoms.

4. Install dipstick.



C—Dipstick Driver

RG,20,DT7527 –19–17NOV97–2/2

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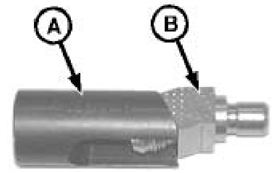
18

REMOVE AND INSTALL DIPSTICK TUBE WITH FITTING



A—JDG1146 Dipstick Fitting Installer Tool
B—Dipstick Fitting (Angled Design)

1. Unscrew dipstick tube from fitting and remove.

2. Remove fitting from block.

3. Coat smooth end of dipstick fitting with LOCTITE® 271 Thread Lock and Sealer.

4. Position fitting (B) in JDG1146 Dipstick Fitting Installer (A) as shown.

   Orient fitting with threaded end pointing out and straight up from block.

   Drive fitting flush with block.

5. Install dipstick tube on fitting.

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DPSG,OUO1004,80 –19–24APR98–1/1

REMOVE, INSPECT AND INSTALL OIL PUMP PICK-UP TUBE ASSEMBLY

A loose or damaged suction tube or O-ring can cause a temporary loss of prime for the engine oil pump at start-up. There will be low or no oil pressure at starting, followed by normal engine oil pressure.

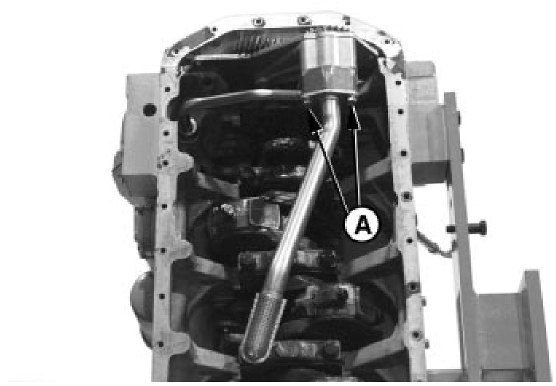
NOTE: If the pick-up tube is to be inspected only and not removed, verify mounting cap screw torque to insure proper seating and seal.

1. Remove oil pan.
2. Loosen cap screws (A) and remove oil pump pick-up tube assembly.
3. Inspect pick-up tube for cracks, restrictions or damage. Replace if necessary.
4. Install assembly with new O-ring and tighten cap screws to specifications.

Oil Pump Pick-Up Tube Cap Screws—Specification

Torque .... 35 N•m (26 lb-ft)

5. Reinstall oil pan. See INSTALL OIL PAN, as described later in this group.



RG7596 –UN–05JAN98

A—Cap Screws

RG,20,DT7526 –19–17NOV97–1/1

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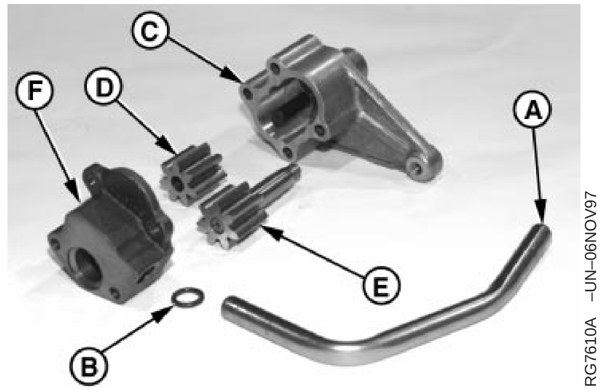
20

ENGINE OIL PUMP ASSEMBLY



A—Outlet Tube
B—O-Ring
C—Pump Housing
D—Idler Gear
E—Drive Gear
F—Cover

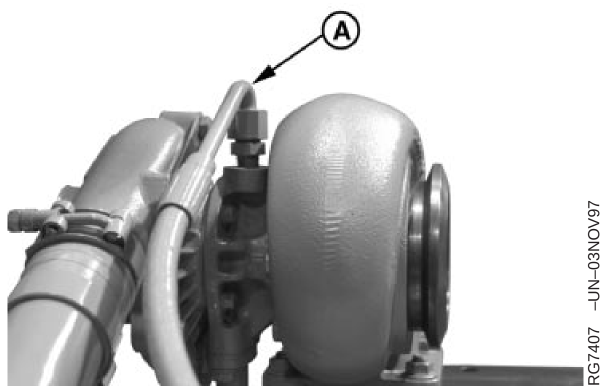
RG,20,DT7525 –19–17NOV97–1/1

REMOVE ENGINE OIL PUMP

1. Drain oil and disconnect turbocharger oil inlet line (A) at the turbocharger.

2. Remove oil pan. See REMOVE OIL PAN, as described later in this group.

3. Remove gasket from oil pan and oil pan rail.



A—Oil Inlet Line

Continued on next page

RG,20,DT7524 –19–17NOV97–1/3

4. On 4-cylinder engines with balancer shafts, lock crankshaft at TDC using JDG820 or JDE83 Flywheel Turning Tool and JDE81-4 Timing Pin, then lock the balancer shaft (inj. pump side) using a lock-grip plier so that balancer shaft cannot turn while oil pump gear is being removed.

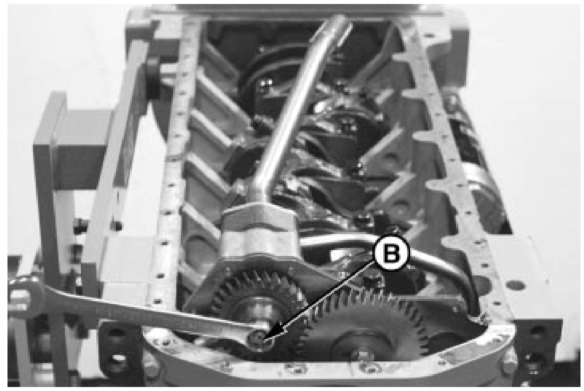
IMPORTANT: When removing nut and gear from tapered oil pump drive shaft, take care not to damage fine threads on end of shaft.

5. Remove nut (B) and pull gear from tapered oil pump drive shaft.

   To remove oil pump gear, loosen nut several turns and apply force between the front plate and gear on two sides of gear with pry bars.

   If above method does not work, loosen oil pump housing cap screws and strike the nut on end of shaft with a small **lead** hammer while applying force to gear until gear is free of tapered shaft.

6. Remove oil pump pick-up tube, as described earlier in this group.



B—Gear Retaining Nut

Continued on next page RG,20,DT7524 –19–17NOV97–2/3

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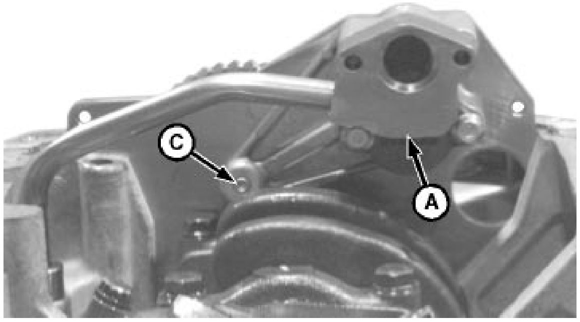
22

7. Remove upper two cap screws and remove cover (A).

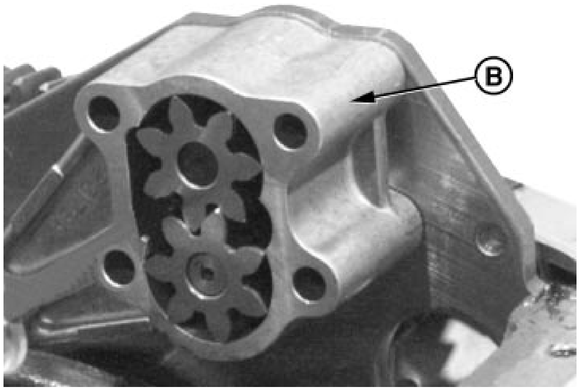
NOTE: The lower idler gear cap screw (C) has to be removed to remove the oil pump housing.

8. Loosen idler cap screw (C).

9. Remove lower oil pump housing cap screws and turn idler cap screw (C) out while removing oil pump housing assembly (B) .



RG9077 –UN–12MAR98



RG7967B –UN–14NOV97

A—Cover
B—Oil Pump Housing
C—Idler Cap Screw

RG,20,DT7524 –19–17NOV97–3/3

INSPECT AND MEASURE CLEARANCES

Inspect oil pump components for excessive wear. Replace parts or oil pump assembly, as necessary.

Continued on next page RG,20,DT7523 –19–17NOV97–1/5

1. Check gear-to-pump cover axial clearance.

Oil Pump Axial Clearance—Specification

Thickness of Gears .... 35.975—36.025 mm (1.4163—1.4183 in.)
Axial Clearance .... 0.045—0.165 mm (0.0018—0.0065 in.)

RG7601 –UN–23NOV97

RG7602 –UN–23NOV97

RG,20,DT7523 –19–17NOV97–2/5

2. Check gear-to-pump housing radial clearance.

Oil Pump Radial Clearance—Specification

Radial Clearance.................................. 0.131—0.211 mm (0.005—0.008 in.)

RG7603 –UN–23NOV97

Continued on next page RG,20,DT7523 –19–17NOV97–3/5

20
24

3. Check housing and cover bore ID and shaft OD. Inspect cover and housing for evidence of gear rub. Light contact is acceptable.

4. Measure bushing ID in housing and bore in cover.

Oil Pump Drive Shaft—Specification

OD .... 16.017—16.037 mm (0.6306—0.6314 in.)

Oil Pump Bushing in Housing—Specification

ID .... 16.052—16.102 mm (12.316—12.332 in.)

RG7605 –UN–23NOV97

RG7606 –UN–23NOV97

RG,20,DT7523 –19–17NOV97–4/5

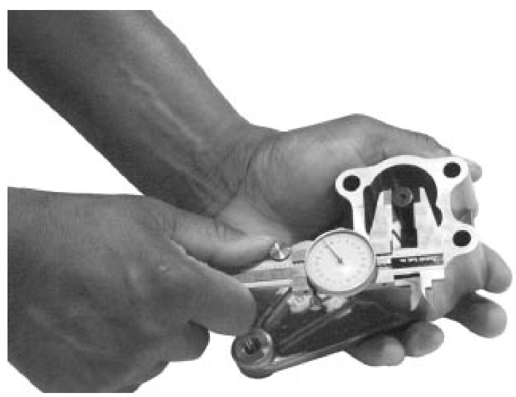
5. Measure idler shaft OD and idler gear ID

Oil Pump Idler Shaft—Specification

OD .... 12.316—12.332 mm (0.4849—0.4855 in.)

Oil Pump Idler Gear—Specification

ID .... 12.355—12.363 mm (0.4864—0.4867 in.)



RG7607 –UN–23NOV97

RG7608 –UN–23NOV97

RG,20,DT7523 –19–17NOV97–5/5

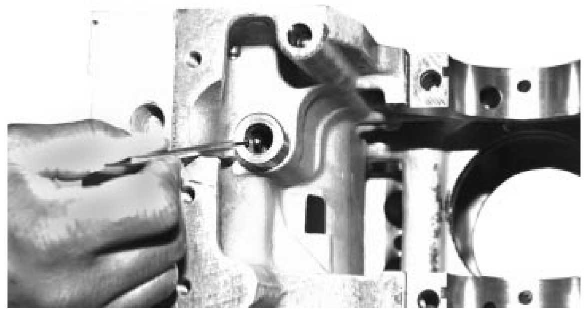
COMPLETE OIL PUMP DISASSEMBLY

1. Remove O-ring from pump housing and cylinder block (for outlet tube).

2. Remove O-ring from oil pick-up tube.

3. Clean oil pump parts in solvent. Dry with compressed air.

4. Inspect pick-up tube. Check flange-to-pick-up tube weld for cracks. If cracks or other defects are found, replace pick-up tube. See REPLACE OIL PUMP PICK-UP TUBE ASSEMBLY, earlier in this group.



RG7609 –UN–23NOV97

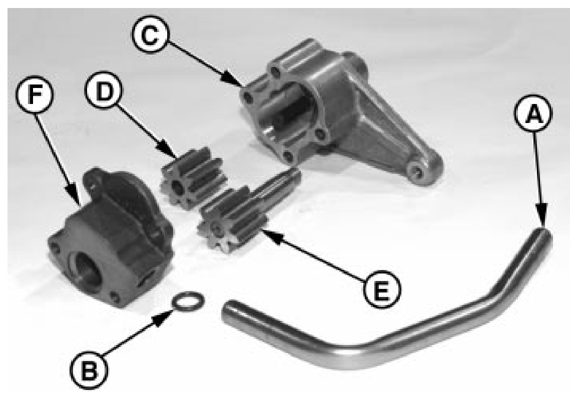
RG,20,DT7522 –19–17NOV97–1/1

ASSEMBLE ENGINE OIL PUMP

IMPORTANT: Lubricate gears and shaft with clean engine oil before assembling.

1. Install new O-ring (B) in pump cover (F).

2. Put idler gear (D) and drive gear (E) in pump housing (C).



RG7610A –UN–06NOV97

A—Outlet Tube
B—O-Ring
C—Pump Housing
D—Idler Gear
E—Drive Gear
F—Cover

RG,20,DT7521 –19–17NOV97–1/1

20
26

INSTALL ENGINE OIL PUMP

NOTE: This procedure is for installing the oil pump with timing gear cover installed. If timing gear cover is removed from engine, refer to INSTALL AND TIME BALANCER SHAFTS in Group 16 (for 4-cylinder engines only).

1. On 4-cylinder engines with balancer shafts, lock No. 1 piston at TDC compression stroke.

2. Install new O-rings in cylinder block and oil pump cover (for outlet tube). Install tube into cover and block.

Continued on next page RG,20,DT7520 –19–17NOV97–1/4

3. Lubricate lower idler gear cap screw threads (C) and draw into leg of housing finger tight while installing oil pump housing with gears (A) onto front plate.

4. Wedge a hardened round punch between the drive gear and idler gear.

5. Install oil pump drive gear (D) so that it meshes with lower idler gear (E) and balancer shaft gear (4045 engines only) without altering gear train timing.

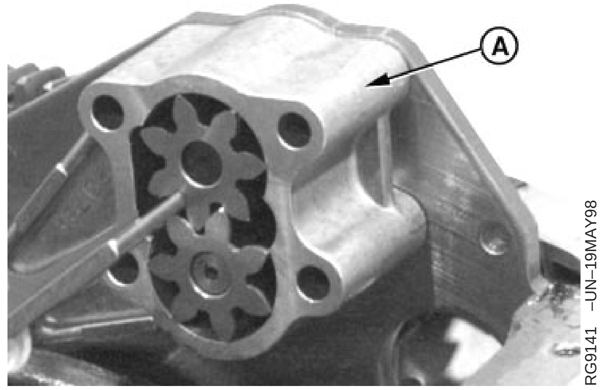
6. Install new retaining nut and tighten to specifications.

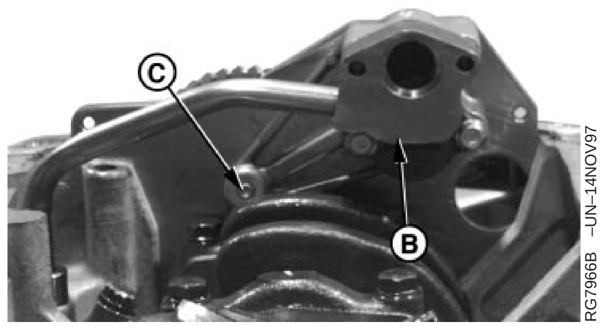
Oil Pump Drive Gear "Staked" Nut—Specification

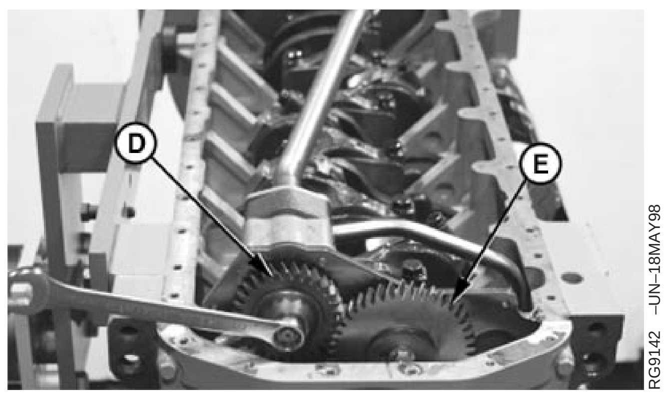
Torque .... 50 N•m (37 lb-ft)

7. Stake oil pump drive gear nut by applying three center punch marks near ID of shaft.

8. Swing (position) oil pump cover (B) onto pump housing and install two lower cap screws finger tight.







A—Oil Pump Housing
B—Oil Pump Cover
C—Idler Gear Cap Screw
D—Oil Pump Drive Gear
E—Lower Idler Gear

Continued on next page RG,20,DT7520 –19–17NOV97–2/4

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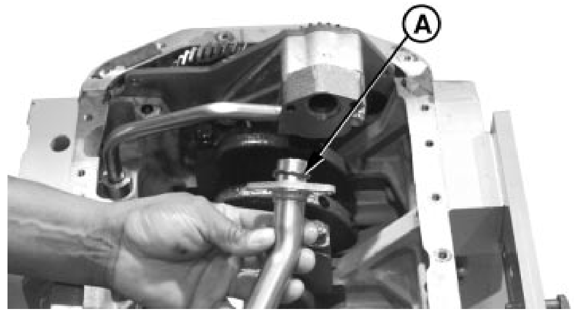
28

9. Install new O-ring (A) on neck of pick-up tube. Install pick-up tube.



A—O-Ring

RG,20,DT7520 –19–17NOV97–3/4

NOTE: Idler gear cap screw threads (5) must be lubricated.

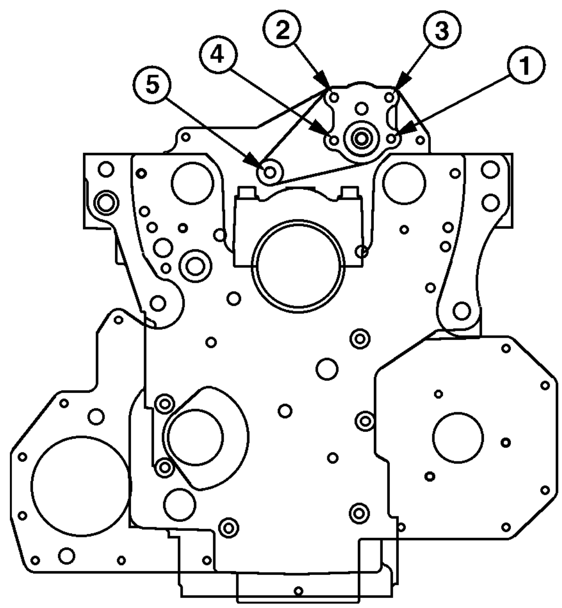
10. Tighten four cap screws and lower idler gear cap screw to specified torque according to sequence shown.

Oil Pump-to-Front Plate and Oil Pump Pick-Up Tube Cap Screws—Specification

Torque .... 35 N•m (26 lb-ft)

Oil Pump Lower Idler Gear Cap Screw (Lubricated Threads)—Specification

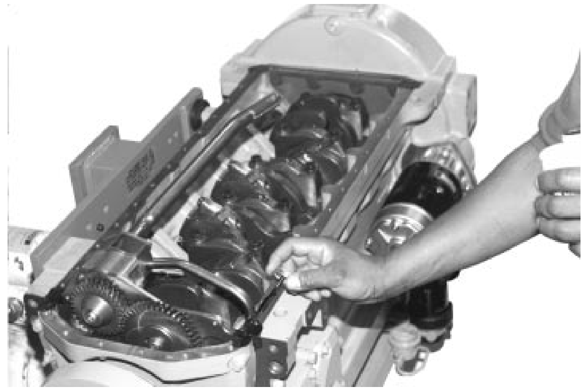
Torque .... 70 N•m (53 lb-ft)



Viewed from Rear of Engine

RG,20,DT7520 –19–17NOV97–4/4

INSTALL OIL PAN


RG7611 –UN–28AUG96

1. Apply LOCTITE® 515 Flexible Form-In-Place Gasket on oil pan rail as shown where flywheel housing, front plate, and timing gear cover attach to cylinder block.

2. Install oil pan gasket.

3. Install oil pan and tighten cap screws to specifications.

M8 Cap Screws—Specification

Torque .... 35 N•m (26 lb-ft)

M10 Cap Screws up to 110 mm—Specification

Torque .... 70 N•m (52 lb-ft)

M10 Cap Screws 110 mm and Above—Specification

Torque .... 60 N•m (44 lb-ft)

M10 Cap Screws on PE4045DLV50 and PE4045TLV50 Engines Only—Specification

Torque .... 44 N•m (33 lb-ft)

4. Install aluminum or copper washer on drain plug with raised center against plug. Install plug in oil pan. Tighten drain plug to specifications.

Plug for PE4045DLV50 and PE4045TLV50 Engines—Specification

Torque .... 70 N•m (52 lb-ft)

Plug for Aluminum Oil Pans—Specification

Torque .... 20 N•m (15 lb-ft)

Plug for All Other Engines—Specification

Torque .... 47 N•m (35 lb-ft)

If equipped with elbow drain fittings, the threads and sealing surfaces must be free of oil film to insure an effective seal. Apply LOCTITE® 592 Pipe Sealant with TEFLON® to fitting except for the leading one to three threads. Install and tighten fitting.

LOCTITE is a registered trademark of the Loctite Corp.
TEFLON is a registered trademark of the DuPont Co.

Continued on next page

RG,20,DT7519 –19–17NOV97–1/2

5. Fill engine crankcase with correct grade and viscosity engine oil. (See Group 02.)

RG,20,DT7519 –19–17NOV97–2/2

ESSENTIAL TOOLS

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

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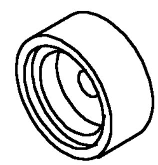
DPSG,OUO1004,186 –19–07JUL98–1/2

RG7950 –UN–05JAN98

Water Pump Bearing Installer JDG956

Install water pump bearing.



DPSG,OUO1004,186 –19–07JUL98–2/2

SERVICE EQUIPMENT AND TOOLS

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

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DPSG,OUO1004,187 –19–07JUL98–1/2

Bushing, Bearing and Seal Driver Set D01045AA

Remove inner seal in water pump housing.

DPSG,OUO1004,187 –19–07JUL98–2/2

25
2

OTHER MATERIAL

Number	Name	Use
PT507 (U.S.)	Multi-Purpose Grease	Thermostat housing O-rings.

DPSG,OUO1004,188 –19–07JUL98–1/1

COOLING SYSTEM SPECIFICATIONS

Item	Measurement	Specification
Water Manifold/Thermostat Cover (Single Thermostat)	Torque	70 N•m (52 lb-ft)
Water Pump Impeller Bore	ID	11.973—11.999 mm (0.4714—0.4724 in.)
Water Pump Bearing Shaft (Impeller End)	OD	12.025—12.038 mm (0.4734—0.4739 in.)
Water Pump Bearing Shaft (Pulley End)	OD	39.997—40.013 mm (1.5747—1.5753 in.)
Water Pump Housing Bearing Bore	ID	61.961—61.987 mm (2.4394—2.4404 in.)
Water Pump Impeller (Standard Flow)	Position	2.46—2.58 mm (0.096—0.102 in.) below end of shaft
Water Pump Impeller (High Flow)	Position	Flush ± 0.13 mm (0.005 in.) with end of shaft
Water Pump Housing-to-Impeller	Minimum Clearance	0.27 mm (0.010 in.)
Water Pump Pulley	Torque	16 N•m (12 lb-ft)
Water Pump-to-Timing Cover	Torque	16 N•m (12 lb-ft)
Water Pump Inlet Elbow	Torque	35 N•m (26 lb-ft)
Fan-to-Pulley Hub M8 Cap Screws	Torque	35 N•m (26 lb-ft)
Fan-to-Pulley Hub M10 Cap Screws	Torque	70 N•m (52 lb-ft)
Belt Tensioner-to-Timing Cover and Engine	Torque	50 N•m (37 lb-ft)
Belt Tensioner Pulley	Torque	40 N•m (29 lb-ft)
Belt Tensioner	Spring Tension	18—22 N•m (13—16 lb-ft)
Fan-to-Pulley Hub M8 Cap Screws	Torque	35 N•m (26 lb-ft)

Continued on next page

DPSG,OUO1004,234 –19–10JUL98–1/3

Item	Measurement	Specification
Fan-to-Pulley Hub M10 Cap Screws	Torque	70 N•m (52 lb-ft)
Fan Drive (Option Code 2301 and 2302)		
Bearing Housing	ID	38.018—38.038 mm (1.4968—1.4976 in.)
Bearing	OD	38.087—38.100 mm (1.4995—1.5000 in.)
Shaft	OD	18.948—18.961 mm (0.7460—0.7465 in.)
Hub	ID	18.910—18.936 mm (0.7445—0.7455 in.)
Fan Drive (Option Codes 2303, 2304, 2312, 2313, and 2314)		
Bearing Housing	ID	47.538—47.558 mm (1.8165—1.8724 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.)
Hub	ID	25.337—25.353 mm (0.9975—0.9985 in.)
Fan Drive		
Rear Housing Face-to-Hub Front Face (Option Code 2301 and 2303)	Distance	110.85—110.87 mm (4.364—4.365 in.)
Rear Housing Face-to-Hub Front Face (Option Code 2302, 2304, 2312, 2313 and 2314)	Distance	106.65—106.67 mm (4.199—4.200 in.)
Fan Drive Idler	Torque	50 n•m (37 lb-ft)

Continued on next page

DPSG,OUO1004,234 –19–10JUL98–2/3

Item	Measurement	Specification
Fan Drive Assembly-to-Timing Cover	Torque	70 N•m (52 lb-ft)
Fan Pulley-to-Pulley Hub M8 Cap Screws	Torque	35 N•m (26 lb-ft)
Fan Pulley-to-Pulley Hub M10 Cap Screws	Torque	70 N•m (52 lb-ft)
Coolant Heater Lock Nut	Torque	34 N•m (25 lb-ft)
Temperature Switch (Cold Start Advance)	Torque	5 N•m (44 lb-in.)

DPSG,OUO1004,234 –19–10JUL98–3/3

DIAGNOSING COOLING SYSTEM MALFUNCTIONS

Engine Overheats:

- Loose or broken fan belt
- Dirty radiator
- Low coolant level
- Low oil level
- Engine overloaded
- Defective head gasket
- Incorrect timing (engine/injection pump)
- Faulty thermostats
- Faulty water pump
- Corroded coolant passages
- Improper grade of fuel
- Excessive fuel delivery

Low Coolant Level:

- Improper maintenance
- Improper operation
- Damaged radiator
- Water pump seal leakage
- Leakage
- Faulty radiator cap

DPSG,OUO1004,24 –19–03APR98–1/1

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6

REMOVE WATER MANIFOLD/THERMOSTAT COVER AND THERMOSTAT

NOTE: On some engines, the water manifold/thermostat housing is an integral part of the cylinder head.

1. Partially drain coolant from system.

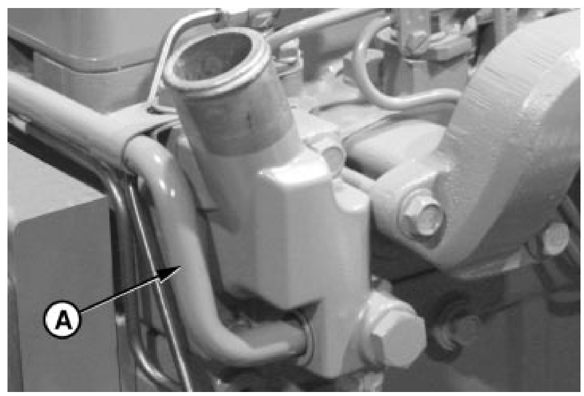
TS281 –UN–23AUG88

RG,25,JW7561 –19–20NOV97–1/3

2. Remove thermostat cover-to water pump tube (A) and seal.

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

3. Visually inspect area around water manifold/thermostat cover for leaks.

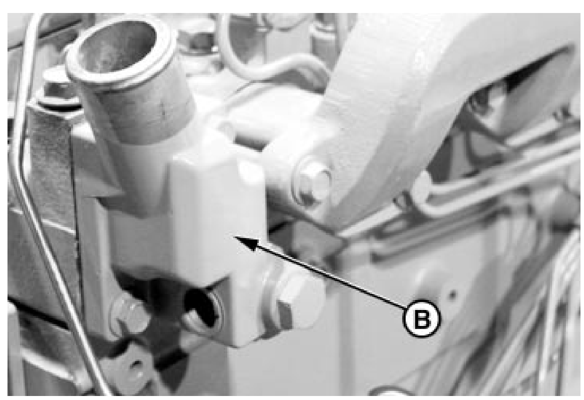


RG8115A –UN–15JAN98

A—Tube

RG,25,JW7561 –19–20NOV97–2/3

4. Remove water manifold/thermostat cover (B) with gasket.
5. Remove thermostat.
6. Remove and discard all gasket material. Clean gasket surfaces.
7. Clean and inspect cover for cracks or damage.



RG7921A –UN–13NOV97

B—Cover

RG,25,JW7561 –19–20NOV97–3/3

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7

INSTALL WATER MANIFOLD/THERMOSTAT COVER AND THERMOSTAT

IMPORTANT: Install manifold gasket so that smaller (round) holes are at lower left and upper right corners of manifold (matching studs A).

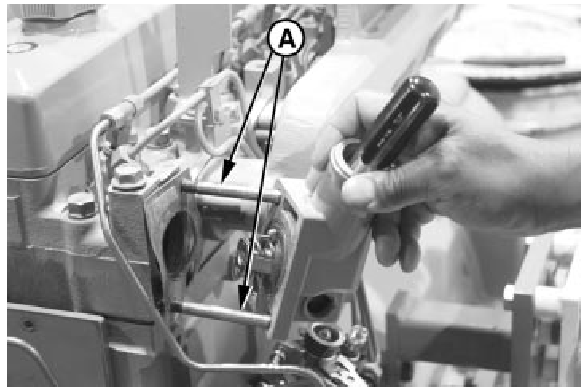
1. Using guide studs (A) to keep gasket in place, install a new gasket on cylinder head.

NOTE: Thermostat must be installed with jiggle wire facing up in the 12 o'clock position.

2. Using a screwdriver to hold thermostat in place, install thermostat and water manifold/thermostat cover. Tighten cover cap screws to specifications.

Water Manifold/Thermostat Cover (Single Thermostat)—Specification

Torque .... 70 N•m (52 lb-ft)



A—Guide Studs

RG,25,JW7559 –19–20NOV97–1/3

3. Lubricate new O-ring with PT507 Multi-Purpose Grease. Install seal (B) in thermostat cover.

B—Seal

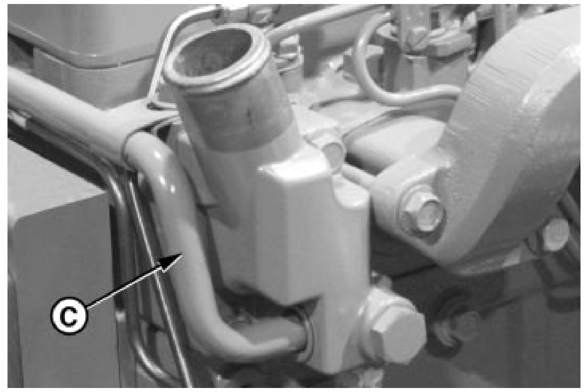
Continued on next page

RG,25,JW7559 –19–20NOV97–2/3

4. Install water manifold/thermostat cover-to-water pump tube (C). Tighten clamps.

5. Fill cooling system and check for leaks.

IMPORTANT: Air must be expelled from cooling system when filling. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing to allow air to escape when filling system. Tighten fitting or plug when all air has been expelled.



C—Tube

RG,25,JW7559 –19–20NOV97–3/3

REMOVE AND INSTALL WATER MANIFOLD AND THERMOSTATS (DUAL THERMOSTATS)

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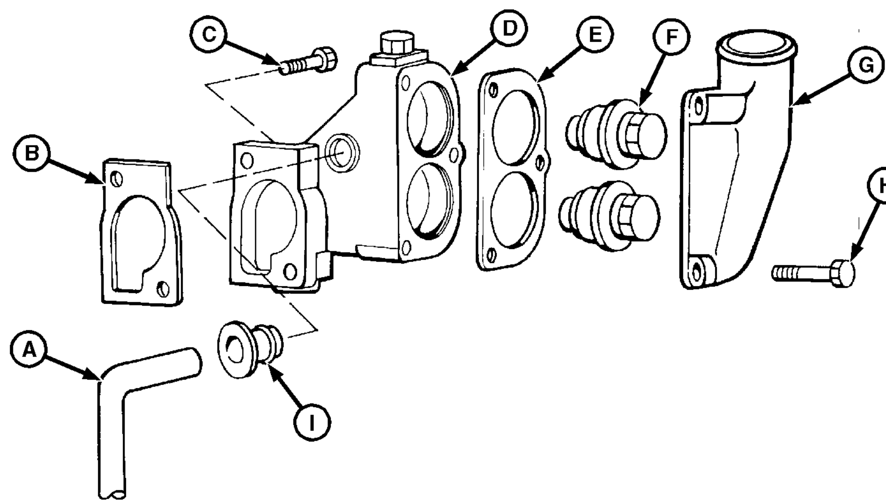
9



RG9112 –UN–02APR98

A—Tube
B—Gasket
C—Cap Screw (2 used)
D—Water Manifold
E—Gasket
F—Thermostat (2 used)
G—Cover
H—Cap Screw (3 used)
I—Seal

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until the coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

1. Partially drain coolant from system.
2. Remove water manifold-to-water pump tube (A) and seal (I).
3. Remove parts (E—H).
4. Remove water manifold (D) and gasket (B).
5. Disgard all gasket material and clean mating surfaces.
6. Clean and inspect manifold and cover for cracks and damage.

NOTE: Thermostats must be installed with jiggle wire facing up in the 12 o'clock position.

7. Install parts (B—H).
8. Lubricate O-ring with PT507 Multi-Purpose Grease and install seal (I) and tube (A).

IMPORTANT: Air must be expelled from cooling system when filling. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing to allow air to escape when filling system. Tighten fitting or plug when all air has been expelled.

DPSG,OUO1004,18 –19–02APR98–1/1

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10

TEST THERMOSTAT(S)

Inspect thermostat(s) for debris or damage, and test each thermostat using an approved testing procedure. See INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE in Group 105 for testing procedure and specifications.

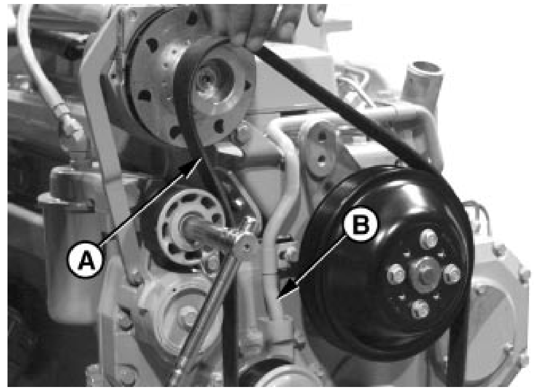
NOTE: Deaeration is accomplished by a jiggle wire or groove in thermostat flange area (positioned at top).

RG,25,JW7560 –19–20NOV97–1/1

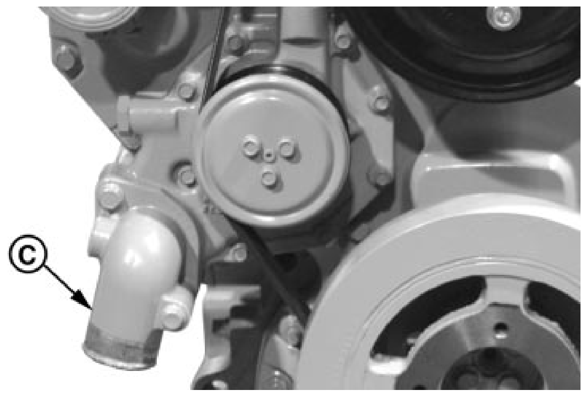
REMOVE WATER PUMP

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns. Do not drain coolant until the coolant temperature is below operating temperature. Always loosen cooling system filler cap, radiator cap, or drain valve slowly to relieve pressure.

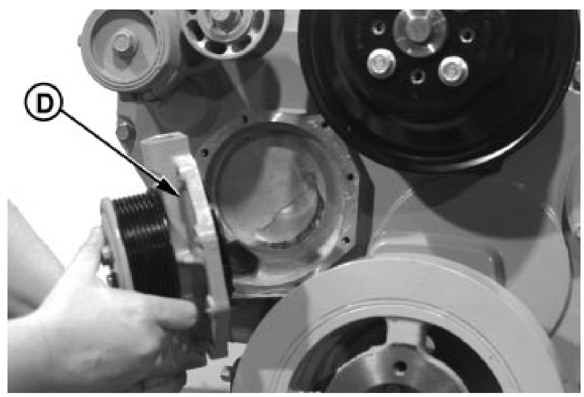
1. Drain coolant.
2. Remove fan (shown removed).
3. Release tension on belt (A) using a breaker bar and socket.
4. Remove poly-vee belt from pulleys.
5. Remove thermostat housing-to-water pump tube (B).
6. Remove water pump inlet elbow (C) and O-ring, if desired.
7. Remove water pump (D).
8. Remove pulley from water pump.



RG7937B –UN–13NOV97



RG7922A –UN–13NOV97



RG7616B –UN–06NOV97

A—Belt
B—Thermostat Housing-to-Water Pump Tube
C—Inlet Elbow
D—Water Pump

RG,25,JW7558 –19–20NOV97–1/1

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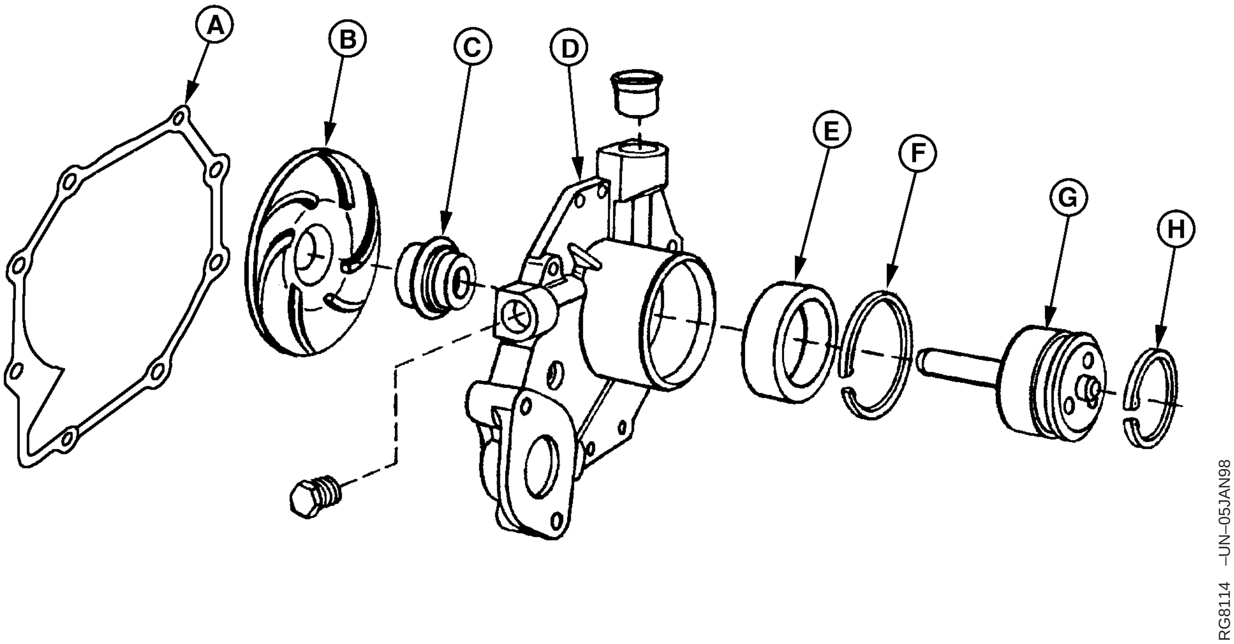
12

WATER PUMP ASSEMBLY



A—Gasket
B—Impeller
C—Seal
D—Housing
E—Bearing
F—External Snap Ring
G—Shaft
H—Internal Snap Ring

RG,25,JW7557 –19–20NOV97–1/1

DISASSEMBLE WATER PUMP

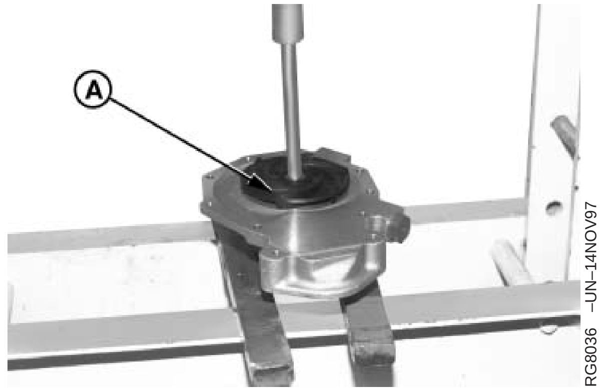
1. Using appropriate external snap ring pliers, remove internal snap ring from front bore of pump housing.

Continued on next page

RG,25,JW7556 –19–20NOV97–1/4

IMPORTANT: If plastic impeller breaks while pressing shaft through impeller, remove brass bushing from shaft before pressing shaft through rest of housing. Use a knife-edge puller to remove bushing.

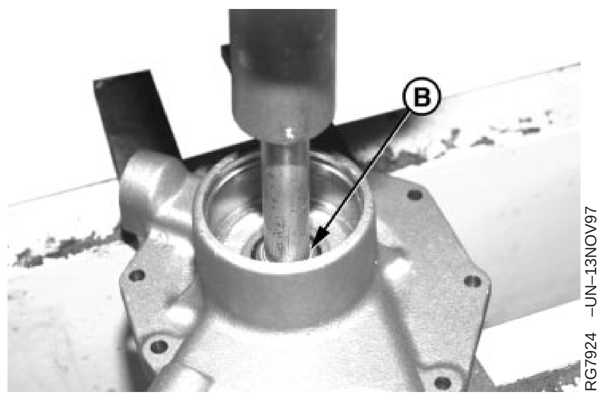
2. Support nose of water pump housing and press shaft through impeller (A) until impeller is free from shaft and bearing/shaft assembly is removed from housing. Discard impeller.



A—Impeller

RG,25,JW7556 –19–20NOV97–2/4

3. Using the appropriate driver from D01045AA Bushing, Bearing and Seal Driver Set, drive or press seal (B) from pump housing.



B—Seal

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RG,25,JW7556 –19–20NOV97–3/4

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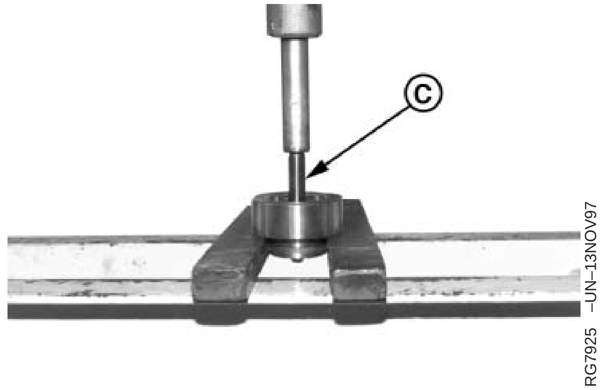
14

4. Support inner bearing race and press shaft (C) out of bearing. Discard bearing.



C—Shaft

RG,25,JW7556 –19–20NOV97–4/4

INSPECT, CLEAN, AND MEASURE WATER PUMP PARTS

1. Inspect water pump housing (A) for cracks or damage.

2. Remove gasket material from housing and clean with solvent. Dry with compressed air.

3. Inspect parts for wear or damage.

Water Pump Impeller Bore—Specification

ID .... 11.973—11.999 mm (0.4714—0.4724 in.)

Water Pump Bearing Shaft (Impeller End)—Specification

OD .... 12.025—12.038 mm (0.4734—0.4739 in.)

Water Pump Bearing Shaft (Pulley End)—Specification

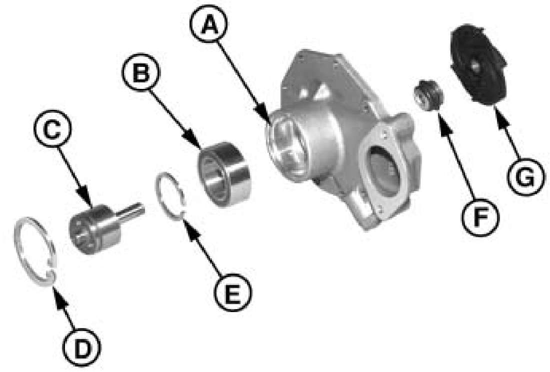
OD .... 39.997—40.013 mm (1.5747—1.5753 in.)

Water Pump Housing Bearing Bore—Specification

ID .... 61.961—61.987 mm (2.4394—2.4404 in.)

4. Remove foam filters and clean out weep holes in housing. Inspect weep holes for oil or coolant leakage.

   - Oil leakage indicates a damaged sealed bearing (B).
   - Coolant leakage indicates a damaged housing seal (F).



RG7926 –UN–13NOV97

RG7927 –UN–05JAN98

A—Housing
B—Bearing
C—Shaft
D—Internal Snap Ring
E—External Snap Ring
F—Seal
G—Impeller

25
16

ASSEMBLE WATER PUMP

1. Thoroughly clean and inspect water pump mounting surface in timing gear cover before installing water pump assembly.

2. Using appropriate snap ring pliers, install external snap ring (C) into groove in shaft (B).

3. Using appropriate driver which bears on inner bearing race, install bearing (A) onto shaft against snap ring.

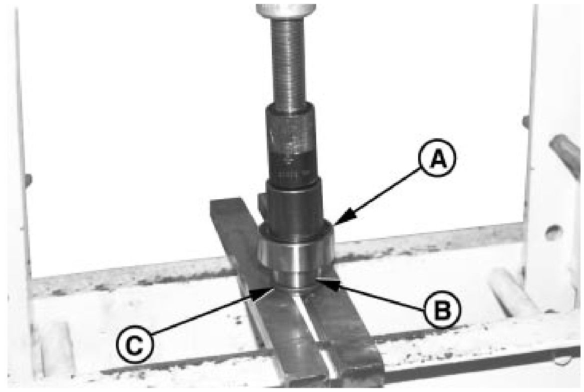
IMPORTANT: Do not push against end of bearing shaft. Push against outer race only, when installing bearing and shaft assembly into housing.

4. Using JDG956 Water Pump Bearing Installer (D), install bearing and shaft assembly into housing until it bottoms in housing bore.

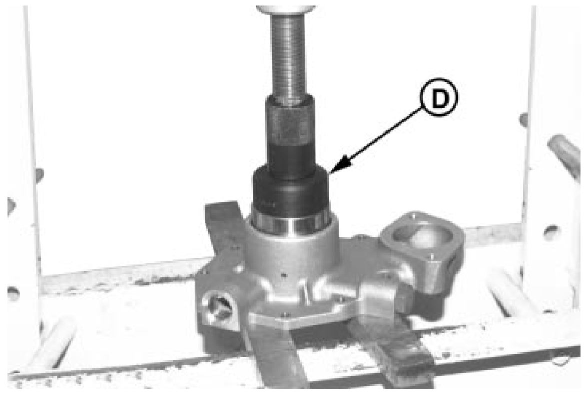
5. Install large internal snap ring into groove in front bore of pump housing.

NOTE: Water pumps have a unitized (one-piece) water seal.

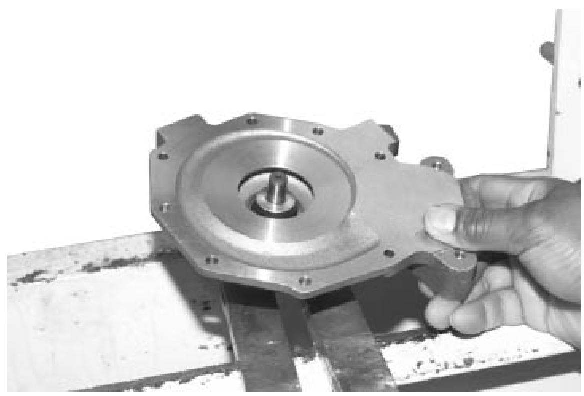
6. Using installation tool provided in seal kit, install seal (dry) onto water pump shaft and into housing until it is firmly seated.



RG7928 –UN–13NOV97



RG7929 –UN–13NOV97



RG7930 –UN–05JAN98

A—Bearing
B—Shaft
C—Snap Ring
D—JDG956 Water Pump Bearing Installer

Continued on next page RG,25,JW7554 –19–20NOV97–1/2

NOTE: Water pumps are available with two different types of impellers to assure adequate coolant flow for a given engine application. Standard flow pumps have fins on both sides of impeller (A). High flow pumps have fins on one side of impeller (B). Be sure to replace impeller with the same type of impeller to assure proper engine cooling.

7. Support front nose of water pump shaft.

IMPORTANT: When installing impeller, press only on brass bushing (C) as impeller could crack.

8. Using an appropriate driver, install impeller onto shaft to the specified dimension below.

Water Pump Impeller (Standard Flow)—Specification

Position .... 2.46—2.58 mm (0.096—0.102 in.) below end of shaft

Water Pump Impeller (High Flow)—Specification

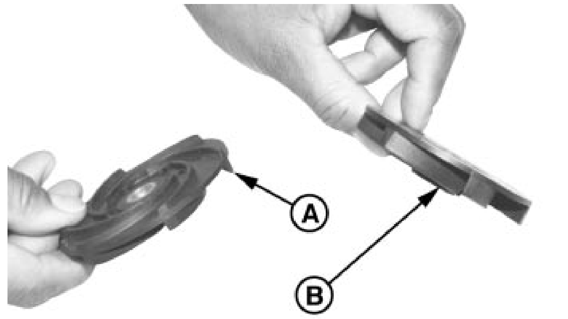
Position .... Flush ± 0.13 mm (0.005 in.) with end of shaft

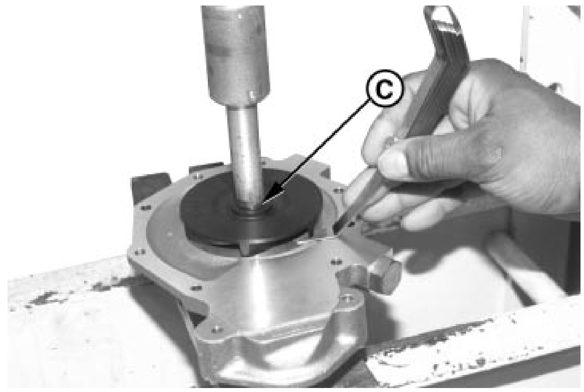
Water Pump Housing-to-Impeller—Specification

Minimum Clearance... 0.27 mm (0.010 in.)

9. Rotate impeller a complete revolution by hand and check with feeler gauge for impeller-to-housing clearance.

10. Install new foam filters in weep holes.





A—Standard Flow Impeller
B—High Flow Impeller
C—Bushing

RG,25,JW7554 –19–20NOV97–2/2

25
18

INSTALL WATER PUMP

1. Install pulley (A) onto water pump (B). Tighten cap screws to specifications.

Water Pump Pulley—Specification

Torque .... 16 N•m (12 lb-ft)

2. Clean gasket surfaces. Using a new gasket, install water pump onto timing gear cover. Tighten cap screws to specifications.

Water Pump-to-Timing Cover—Specification

Torque .... 16 N•m (12 lb-ft)

A—Pulley
B—Water Pump

Continued on next page

RG,25,JW7553 –19–20NOV97–1/2

3. Using a new O-ring, install water pump inlet elbow (C), if removed. Tighten cap screws to specifications.

Water Pump Inlet Elbow—Specification

Torque .... 35 N•m (26 lb-ft)

4. Install poly-vee belts. Be sure that belt is correctly seated in all pulley grooves.

5. Install fan and tighten cap screws with lock washers to the following specification:

Fan-to-Pulley Hub M8 Cap Screws—Specification

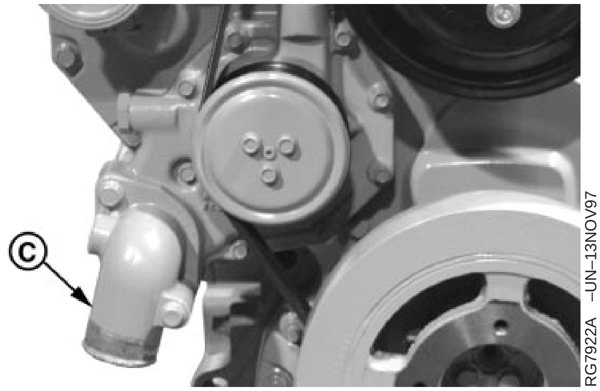
Torque .... 35 N•m (26 lb-ft)

Fan-to-Pulley Hub M10 Cap Screws—Specification

Torque .... 70 N•m (52 lb-ft)

6. Fill cooling system with proper coolant. (See Fuels, Lubricants, and Coolant—Group 02.)

IMPORTANT: Air must be expelled from cooling system when refilled. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing to allow air to escape when filling system. Tighten fitting or plug when all the air has been expelled.



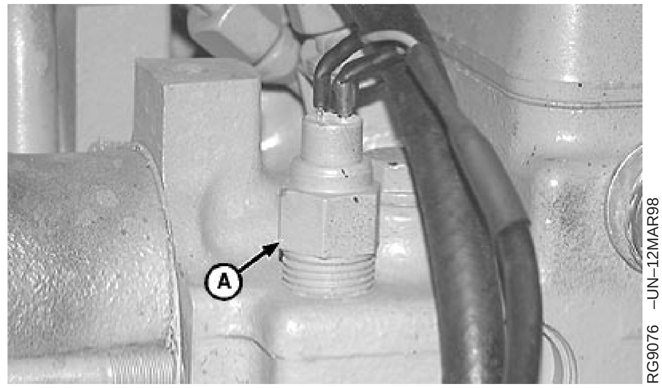
C—Inlet Elbow

RG,25,JW7553 –19–20NOV97–2/2

25
20

COOLING SYSTEM DEAERATION

Deaeration is normally accomplished by the jiggle pin in the thermostat flange. However, a pocket of air can stay on the top rear of the engine. When refilling the cooling system, loosen the coolant temperature sensor (A) or plug at the rear of the cylinder head to allow air to escape.



A—Coolant Temperature Sensor

DPSG,OUO1004,19 –19–03APR98–1/1

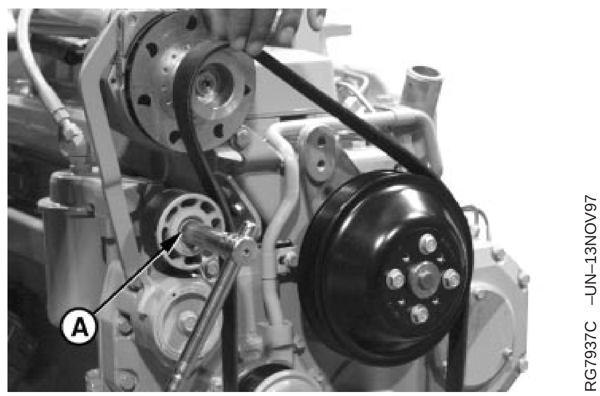
REMOVE AND INSTALL AUTOMATIC (SPRING) BELT TENSIONER

NOTE: Belt tensioner cap screw (A) is left-hand threaded.

1. Release tension on belts using a breaker bar and socket.

2. Remove poly-vee belts from pulleys.

3. Remove belt tensioner.



A—Belt Tensioner Cap Screw

Continued on next page RG,25,JW7552 –19–20NOV97–1/2

4. Inspect sheave (B).

NOTE: If belt tensioner mounting plate was removed, tighten cap screws to timing gear cover first and then tighten cap screws to engine.

5. Install belt tensioner and tighten cap screws to specifications.

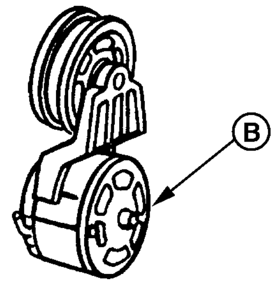
Belt Tensioner-to-Timing Cover and Engine—Specification

Torque .... 50 N•m (37 lb-ft)

Belt Tensioner Pulley—Specification

Torque .... 40 N•m (29 lb-ft)

6. Install poly-vee belts. Be sure that belt is correctly seated in all pulley grooves.



RG7972 –UN–14NOV97

B—Sheave

RG,25,JW7552 –19–20NOV97–2/2

CHECKING BELT TENSIONER SPRING TENSION AND BELT WEAR

Belt drive systems equipped with automatic (spring) belt tensioners cannot be adjusted or repaired. The automatic belt tensioner is designed to maintain proper belt tension over the life of the belt. If tensioner spring tension is not within specification, replace tensioner.

Continued on next page

RG,25,JW7551 –19–20NOV97–1/3

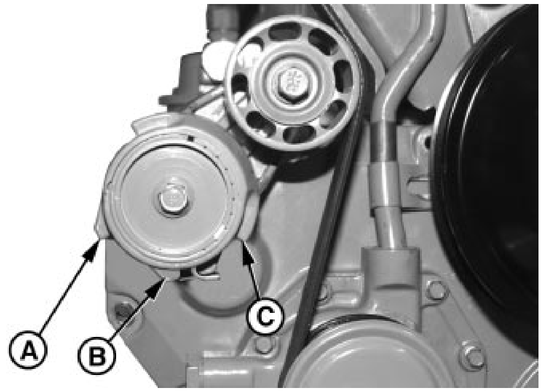
25
22

CHECKING BELT WEAR

The belt tensioner is designed to operate within the limit of arm movement provided by the cast stops (A and B) when correct belt length and geometry is used.

1. Visually inspect cast stops (A and B) on belt tensioner assembly.

2. If the tensioner stop on swing arm (C) is hitting the fixed stop (B), check mounting brackets (alternator, belt tensioner, etc.) and the belt length. Replace belt as needed.



RG9127 –UN–01JUL98

A—Cast Stop
B—Cast Stop
C—Swing Arm

RG,25,JW7551 –19–20NOV97–2/3

CHECKING TENSIONER SPRING TENSION

A belt tension gauge will not give an accurate measure of the belt tension when automatic spring tensioner is used. Measure tensioner spring tension using a torque wrench and procedure outlined below:

1. Release tension on belt using a breaker bar and socket on tension arm. Remove belt from pulleys.

2. Release tension on tension arm and remove breaker bar.

3. Put a mark (A) on swing arm of tensioner as shown.

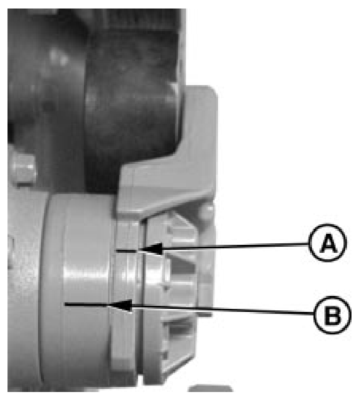
4. Measure 21 mm (0.83 in.) from (A) and put a mark (B) on tensioner mounting base.

5. Rotate the swing arm using a torque wrench until marks (A and B) are aligned (C).

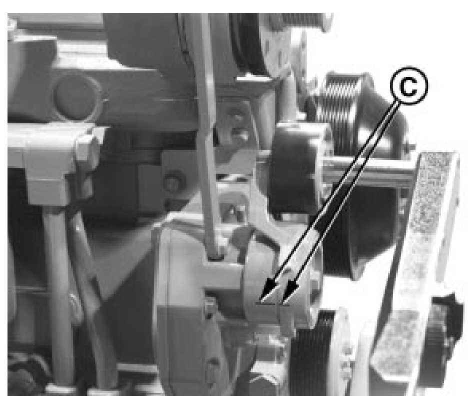
6. Record torque wrench measurement and compare with specification below. Replace tensioner assembly as required.

Belt Tensioner—Specification

Spring Tension .... 18—22 N•m (13—16 lb-ft)



RG7977 –UN–14NOV97



RG8037 –UN–14NOV97

A—Reference Mark
B—Reference Mark
C—Alignment

RG,25,JW7551 –19–20NOV97–3/3

MANUAL BELT TENSIONER ADJUSTMENT

Inspect belts for cracks, fraying, or stretched out areas. Replace if necessary.

NOTE: Belt adjustment is measured using a gauge stamped on the top edge of the alternator bracket.

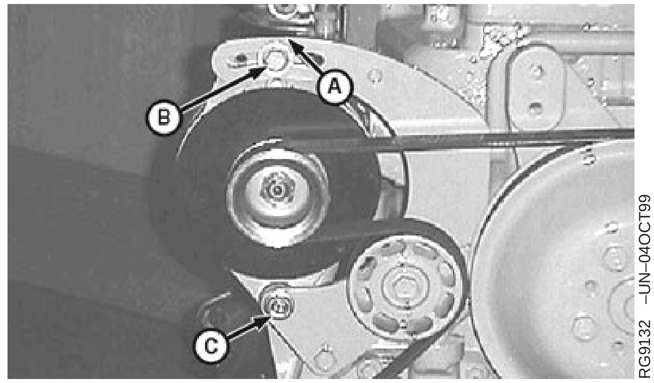
1. Loosen cap screws (B) and (C).

2. Slide alternator in slot by hand to remove all excess slack in belt.

IMPORTANT: Do not pry against alternator rear frame.

3. Using the gauge (A) on the alternator bracket, stretch belt by prying outward on alternator front frame. Stretch the belt 1 gauge unit for a used belt and 1.5 gauge units for a new belt.

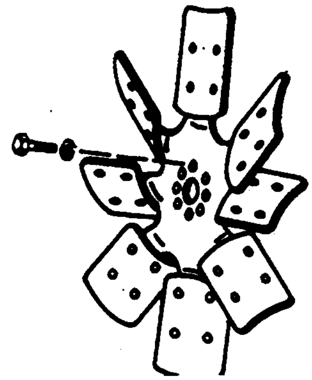
4. Tighten cap screws (B) and (C).



A—Belt Gauge
B—Cap Screw
C—Cap Screw

DPSG,OUO1004,128 –19–14MAY98–1/1

INSPECT AND INSTALL FAN ASSEMBLY



RG4797 –UN–14DEC88

Several fan drive ratios are available allowing a closer matching of fan speed to application.

1. Inspect fan blades for bent or damaged condition. Bent blades reduce cooling system efficiency and throw the fan out of balance. Replace fan if blades are bent or damaged.

NOTE: Engines may be equipped with either suction-type fan or a blower-type fan, depending on application.

2. Install fan on pulley or pulley hub. Tighten cap screws (with lock washers) to specifications.

Fan-to-Pulley Hub M8 Cap Screws—Specification

Torque .... 35 N•m (26 lb-ft)

Fan-to-Pulley Hub M10 Cap Screws—Specification

Torque .... 70 N•m (52 lb-ft)

RG,25,JW7550 –19–20NOV97–1/1

REMOVE AND INSPECT FAN DRIVE ASSEMBLY

Fan assemblies can be mounted in several positions to accommodate different application and engine cooling requirements.

1. Remove fan.

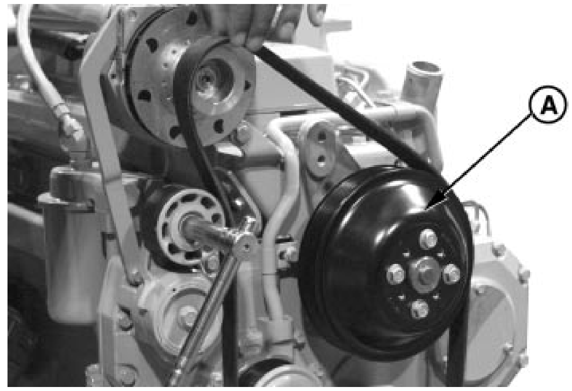
2. Release tension on belt and remove poly-vee belt from pulleys.

Continued on next page

RG,25,JW7549 –19–20NOV97–1/4

3. Remove fan pulley (A).

4. Inspect pulley and grooves

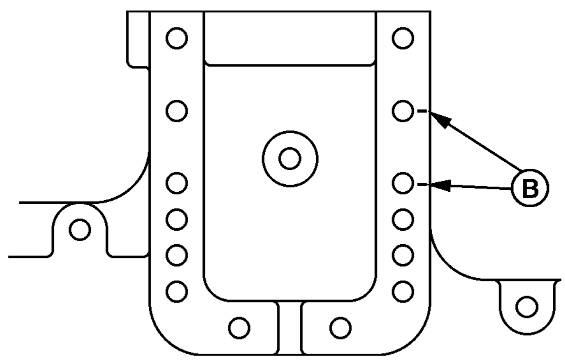


A—Fan Pulley

RG,25,JW7549 –19–20NOV97–2/4

NOTE: Cap screw position (B) is used as an example only. Position of fan drive varies by application.

5. Mark cap screw positions (B) on timing gear cover before removal to assure that fan pulley is installed in same position as removed to assure proper belt tension.



B—Fan Drive Mounting Position

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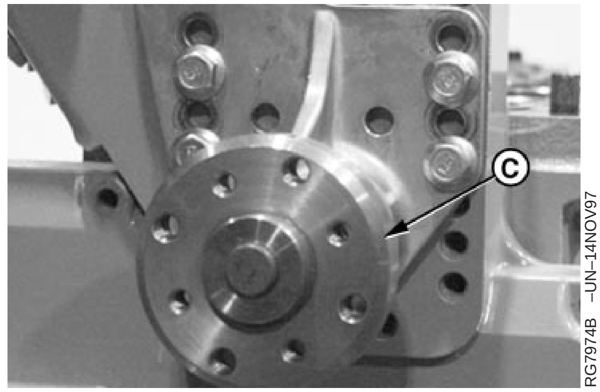
RG,25,JW7549 –19–20NOV97–3/4

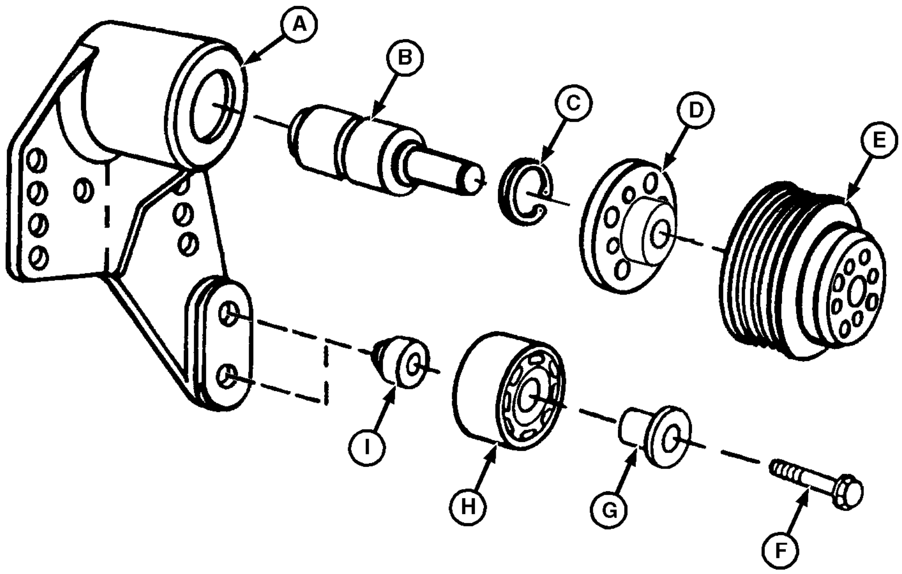
6. Remove hub (C) and fan drive.



C—Hub

RG,25,JW7549 –19–20NOV97–4/4

REPLACE BEARINGS IN ADJUSTABLE FAN DRIVE ASSEMBLY



A—Bearing Housing
B—Bearing/Shaft
C—Snap Ring
D—Hub
E—Pulley
F—Cap Screw
G—Sleeve
H—Idler Pulley
I—Spacer

DISASSEMBLE FAN DRIVE ASSEMBLY

1. Support back side of fan hub (D) and press nose of bearing/shaft (B) out of hub.
2. Remove snap ring (C) from front bore of bearing housing (A).
3. Support front nose of bearing housing and press bearing/shaft out of housing. Discard bearing.
4. Remove parts (F—I) if required.
5. Thoroughly clean and inspect fan hub, bearing housing and idler pulley for cracks or any other damage.
6. **On fan drive assemblies (option codes 2301 and 2302)**, measure parts and compare with specifications given. Replace parts not within specifications.

Bearing Housing—Specification

ID .... 38.018—38.038 mm (1.4968—1.4976 in.)

Bearing—Specification

OD.......... 38.087—38.100 mm (1.4995—1.5000 in.)

Shaft—Specification

OD.......... 18.948—18.961 mm (0.7460—0.7465 in.)

Hub—Specification

ID .... 18.910—18.936 mm (0.7445—0.7455 in.)

Continued on next page RG,25,JW7548 –19–20NOV97–1/4

7. **On fan drive assemblies (option codes 2303, 2304, 2312, 2313, and 2314)**, measure parts and compare with specifications given. Replace parts not within specifications.

Bearing Housing—Specification

ID .... 47.538—47.558 mm (1.8165—1.8724 in.)

Bearing—Specification

OD.. 47.612—47.625 mm (1.8745—1.8750 in.)

Shaft—Specification

OD.. 25.387—25.400 mm (0.9995—1.0000 in.)

Hub—Specification

ID .... 25.337—25.353 mm (0.9975—0.9985 in.)

RG,25,JW7548 –19–20NOV97–2/4

ASSEMBLE FAN DRIVE ASSEMBLY

1. Support rear face of bearing housing and drive bearing into housing by pressing on outer bearing shell until bearing bottoms in housing bore.

2. Install internal snap ring into front groove of housing bore.

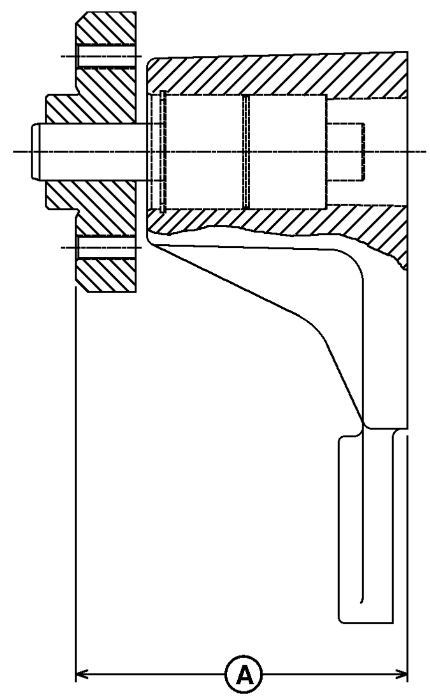
3. Support shaft through rear housing bore and press fan hub onto shaft to dimension (A).

Rear Housing Face-to-Hub Front Face (Option Code 2301 and 2303)—Specification

Distance.. 110.85—110.87 mm (4.364—4.365 in.)

Rear Housing Face-to-Hub Front Face (Option Code 2302, 2304, 2312, 2313 and 2314)—Specification

Distance.. 106.65—106.67 mm (4.199—4.200 in.)



RG8038 –UN–14NOV97

A—Dimension

Continued on next page

RG,25,JW7548 –19–20NOV97–3/4

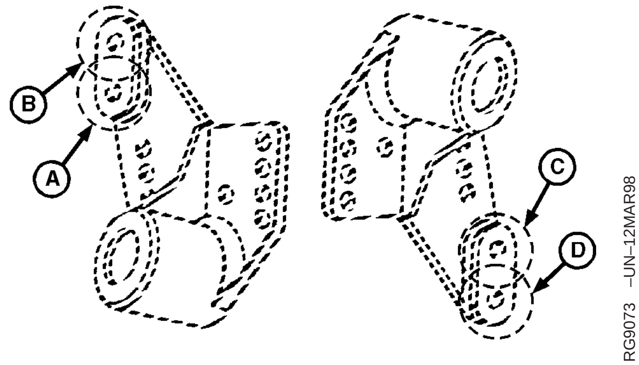
4. If idler pulley was removed, reinstall according to following table:

Fan Pulley	Fan Height	Idler Position
140 mm (5.51 in.) 168 mm (6.61 in.)	226 mm (8.9 in.) 290 mm (11.42 in.)	A
203.2 mm (8.0 in.)	226 mm (8.9 in.) 290 mm (11.42 in.)	B
140 mm (5.51 in.) 168 mm (6.61 in.) W/LH AC)	402 mm (15.83 in.)	C
203.2 mm (8.0 in.) W/LH AC)	402 mm (15.83 in)	D

5. Torque idler retaining cap screw to specifications.

Fan Drive Idler—Specification

Torque .... 50 n•m (37 lb-ft)



A—Idler Position A
B—Idler Position B
C—Idler Position C
D—Idler Position D

RG,25,JW7548 –19–20NOV97–4/4

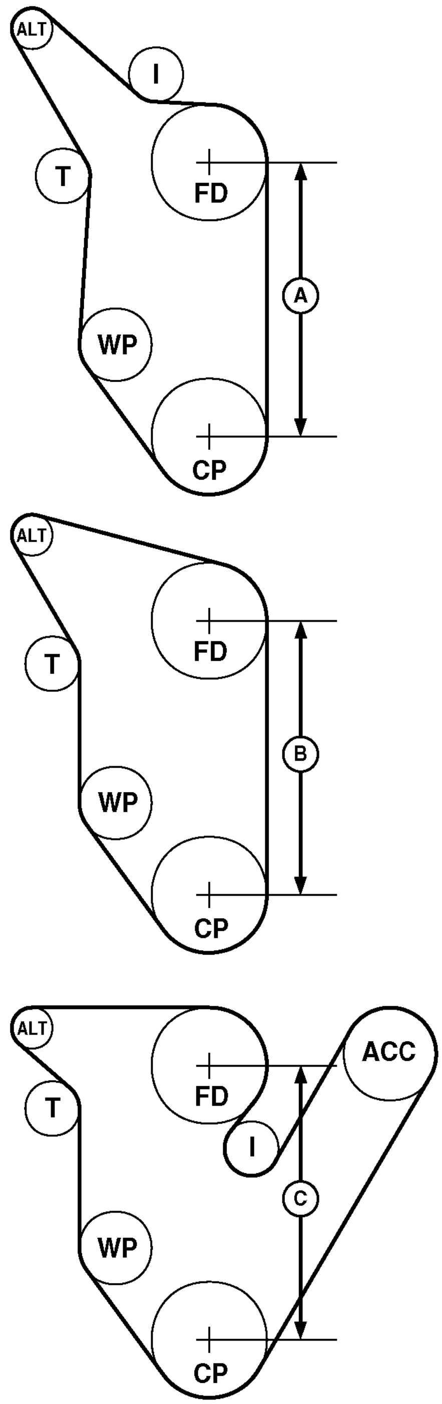
25
30

INSTALL FAN DRIVE ASSEMBLY

IMPORTANT: Be sure adjustable fan drive assembly is installed in correct position as removed to assure proper belt tension.

1. If reference marks were not made on timing gear cover during removal of fan drive assembly, use the following table to determine proper fan height.

4.5 L Fan Belt Option	Fan Height	6.8L Fan Belt Option
226mm (8.9 in.) W/Idler Pulley (A)		
2401, 2402, 2406, 2408, 2415, 2435, 2436, 2461		2401, 2402, 2403, 2404, 2405, 2407, 2412, 2471, 2472, 2473, 2474
290mm (11.42 in.) W/Idler Pulley (A)		
2404, 2407, 2409, 2410, 2411, 2412, 2413, 2437, 2439, 2440, 2460, 2462		2408, 2409, 2410, 2411, 2413, 2414, 2415, 2435, 2436, 2438, 2475, 2476
338mm (13.31 in.) (B)		
2416, 2417, 2419, 2420, 2421, 2423, 2424, 2442, 2443, 2463, 2466, 2468		2416, 2418, 2420, 2421, 2422, 2423, 2424, 2441, 2477, 2478, 2479, 2482
402mm (15.83 in.) (B)		
2426, 2428, 2430, 2431, 2432, 2444, 2445, 2464, 2465, 2469, 2470		2417, 2419, 2425, 2427, 2429, 2480
402mm (15.83 in.) W/Idler Pulley (C)		
2434, 2446		2433



RG9128 –UN–01JUL98

ALT—Alternator
CP—Crank Pulley
ACC—Air Conditioning Compressor
FD—Fan Drive
I—Idler
T—Tensioner
WP—Water Pump

Continued on next page

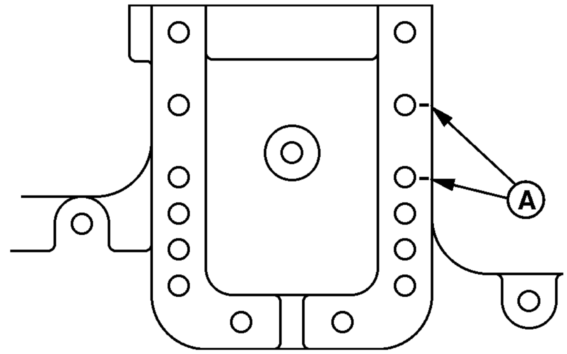
RG,25,JW7547 –19–20NOV97–1/3

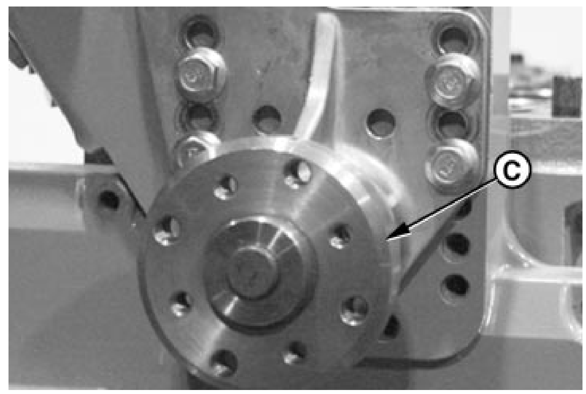
NOTE: Cap screw position A is used as an example only. Position of fan drive varies by application.

2. Install hub (C) with fan drive assembly, in positions (A) marked during disassembly, and tighten cap screws to specifications.

Fan Drive Assembly-to-Timing Cover—Specification

Torque .... 70 N•m (52 lb-ft)





A—Cap Screw Position
C—Fan Drive Hub

RG,25,JW7547 –19–20NOV97–2/3

3. Install fan pulley (C) and tighten cap screws to specifications.

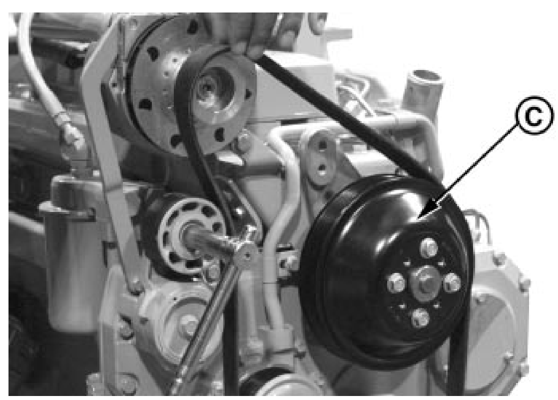
Fan Pulley-to-Pulley Hub M8 Cap Screws—Specification

Torque .... 35 N•m (26 lb-ft)

Fan Pulley-to-Pulley Hub M10 Cap Screws—Specification

Torque .... 70 N•m (52 lb-ft)

4. Install poly-vee belt. Be sure belt is correctly seated in all pulley grooves.



C—Fan Pulley

RG,25,JW7547 –19–20NOV97–3/3

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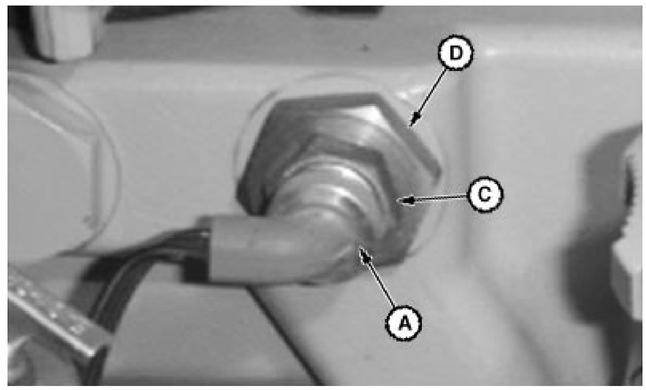
32

REMOVE AND INSTALL COOLANT HEATER—IF EQUIPPED

CAUTION: To avoid shock or hazardous operation, always use a three-wire heavy-duty electrical cord equipped with three-wire connectors. If a two-to-three contact adapter is used at the wall receptacle, always connect green wire to a good ground. Keep electrical connectors clean to prevent arcing. Only plug coolant heater into electrical power if heating element is immersed in coolant. Sheath could burst and result in personal injury.

TS210 –UN–23AUG88



RG9082 –UN–12MAR98

1. Unplug heater from electrical power source.

2. Drain cooling system.

3. Disconnect cord (A) from heater assembly.

4. Loosen retaining nut (C) and remove adapter (D) and heater element from block.

5. Inspect and replace parts as necessary.

NOTE: The heater element (G) cannot be repaired. Replace if defective.

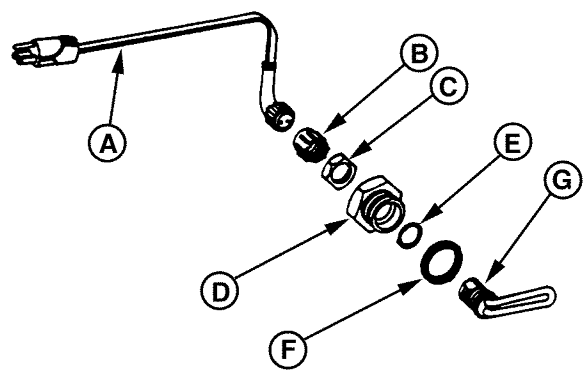
6. Install a new gasket (E) and O-ring (F). Install heater element through adapter (D) and install nut (C) loosely.

7. Install heater into cylinder block with element pointing to the rear.

8. Tighten adapter (D).

9. Turn element clockwise and then counterclockwise until element contacts casting. Move element midway between contact points.

10. Hold element with a wrench and tighten retaining nut (C) to specifications.



RG5619 –UN–31OCT97

A—Cord
B—Dust Cap
C—Retaining Nut
D—Adapter
E—Gasket
F—O-Ring
G—Heater Element

Coolant Heater Lock Nut—Specification

Torque .... 34 N•m (25 lb-ft)

Continued on next page

NOTE: If heater has been ordered as an attachment only, it will include a dust cover (B). The cover is used to protect the electrical connectors when cord assembly (A) has been removed.

11. Install cord.

12. Service engine with coolant.

RG,25,JW7546 –19–20NOV97–2/2

REMOVE AND INSTALL TEMPERATURE SWITCH (COLD START ADVANCE)

A temperature switch is mounted in the thermostat housing on machines equipped with fuel injection pumps that have cold start advance.

1. Reinstall temperature switch with new O-ring.

2. Torque switch to specifications.

Temperature Switch (Cold Start Advance)—Specification

Torque .... 5 N•m (44 lb-in.)

DPSG,OUO1004,25 –19–06APR98–1/1

OTHER MATERIAL

Number	Name	Use
PT569 (U.S.)	NEVER-SEEZ®	Exhaust manifold-to-cylinder head cap screws.
TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®)	Pipe Sealant	Air heater threads.

NEVER-SEEZ is a registered trademark of Emhart Chemical Group
LOCTITE is a trademark of Loctite Corp.

DPSG,OUO1004,192 –19–07JUL98–1/1

30
2

AIR INTAKE AND EXHAUST SYSTEM SPECIFICATIONS

Item	Measurement	Specification
Turbocharger (AiResearch/Garret)	Radial Bearing Clearance	0.8—0.18 mm (0.003-0.007 in.) maximum
Turbocharger (CZ)	Radial Bearing Clearance	0.37—0.46 mm (0.015-0.018 in.) maximum
Turbocharger (AiResearch/Garret)	Axial Bearing End Play	0.025—0.102 mm (0.001—0.004 in.)
Turbocharger (CZ)	Axial Bearing End Play	0.11—0.16 mm (0.004—0.006 in.)
Turbocharger	Actuator End Play	0.05—0.056 mm (0.002—0.022 in.)
Turbocharger-to-Exhaust Manifold Nuts	Torque	70 N•m (52 lb-ft)
Turbocharger Oil Return Pipe Cap Screws	Torque	24 N•m (18 lb-ft)
Turbocharger Oil Inlet Line	Torque	27N•m (20 lb-ft)
Turbocharger Air Outlet Hose Clamp	Torque	6 N•m (53 lb-in.)
Turbocharger Exhaust Adapter	Torque	47 N•m (35 lb-ft)
Turbocharger Exhaust Elbow	Torque	47 N•m (35 lb-ft)
Exhaust Manifold-to-Cylinder Head Cap Screws	Torque	70 N•m (52 lb-ft)
Air Intake Pipe-to-Cylinder Head	Torque	70 N•m (52 lb-ft)
Air Intake Pipe Hose Clamp	Torque	6 N•m (53 lb-in.)

DPSG,OUO1004,235 –19–10JUL98–1/1

EXTENDING TURBOCHARGER LIFE

Turbochargers are designed to last the life of the engine, but, because they operate at such high speeds (100,000 rpm or more); a moment's carelessness can cause them to fail in seconds.

The major causes of turbocharger failures are attributed to:

- Lack of lube oil (quick starts and hot shutdowns)
- Oil contamination
- Ingestion of foreign objects
- Restricted oil drainage
- Low oil level
- Operation on excessive side slopes
- Abnormally high exhaust temperatures

LACK OF LUBE OIL

Oil not only lubricates the turbocharger's spinning shaft and bearings, it also carries away heat. When oil flow stops or is reduced, heat is immediately transferred from the hot turbine wheel to the bearings, which are also heating up because of the increased friction due to the lack of oil. This combination causes the turbocharger shaft temperature to increase rapidly.

If oil flow does not increase and the process continues, bearings will fail. Once the bearings fail (which can happen in just seconds) seals, shaft, turbine and compressor wheels can also be damaged.

The principle causes of turbocharger bearing lubrication problems are low oil pressure, a bent, plugged or undersized oil lube supply line, plugged or restricted oil galleries in the turbocharger, or improper machine start-up and shutdown procedure.

Oil levels and pressure should always be closely monitored and all worn hoses and lines should be replaced. The turbocharger oil supply line should be checked frequently to make sure it is not kinked or bent and it should always be replaced with a line of equal size, length and strength.

The easiest way to damage a turbocharger is through improper start-up and shutdown procedures. Always idle the engine for at least 30 seconds (no load) after start-up and before shutdown. Warming the engine up before applying a load allows oil pressure to build up and lines to fill with oil.

Idling the engine before shutdown allows the engine and turbocharger to cool. “Hot” shutdowns can cause the turbocharger to fail because after high-speed operation the turbocharger will continue to rotate long after the engine has been shut off and oil pressure has dropped to zero. This will cause heat to build up and possible bearing damage. It can also cause carbon and varnish deposits to form.

OIL CONTAMINATION

A second cause of turbocharger failures is contaminated oil. It can be caused by a worn or damaged oil filter or not changing the lube oil at recommended intervals. Expecting the oil filter to remove dirt, sand, metal chips, etc. from the oil before they reach the engine or turbocharger can be a costly mistake because contaminated oil may completely bypass the engine oil filter if the oil filter or oil cooler is clogged, if the filter element is improperly installed, or if the oil is thick during cold weather.

Four good ways of avoiding oil contamination are:

- Always inspect the engine thoroughly during major overhaul. Look especially for any sludge or debris left in lube oil galleries.
- Change lube oil at recommended intervals. Analysis of oil samples at filter change periods can help identify potentially harmful contaminants in the oil.
- Clean the area around the oil fill cap before adding oil.
- Use a clean container when adding oil.

Continued on next page RG,30,JW7583 –19–20NOV97–1/2

INGESTION OF FOREIGN OBJECTS

The third cause of turbocharger damage is the ingestion of foreign objects. Foreign objects or particles can be ingested and cause damage to the turbocharger on both compressor and turbine sides. This is easy to avoid.

On the compressor side, foreign objects usually take the form of dust, sand, or shreds of air cleaner element that enter through improperly installed air cleaner elements. Leaky air inlet piping (loose clamps or torn rubber joints) or torn pleats in dry-type air cleaner elements also create problems.

The result is erosion of compressor blades that can cause the delicately balanced wheel to wobble.

IMPORTANT: Whenever an internal engine failure (valve, valve seat, piston) occurs, a thorough inspection of the turbocharger MUST BE performed before returning engine to service.

RESTRICTED OIL DRAINAGE

A fourth cause of turbocharger damage is restricted lube oil drainage. The lubricating oil carries away heat generated by friction of the bearings and from the hot exhaust gases. If drainage back to the sump is impeded, the bearings will overheat with damage that will ultimately lead to failure.

There are two primary reasons for restricted drainage. A blocked drain tube, due to either damage or a buildup of sludged oil, or high crankcase pressure, which can be due to restricted crankcase breather or excessive engine blowby.

Periodically check both the turbocharger oil drain tube and engine breather tube for damage or restriction. Correction of these conditions leads to longer turbocharger life.

ABNORMALLY HIGH EXHAUST TEMPERATURES

A fifth cause of turbocharger damage is abnormally high exhaust temperatures. Elevated exhaust temperatures cause coking of oil which can lead to bearing failure. Extreme over-temperature operation can case wheel burst.

There are two basic causes of over-temperature. The first is restricted air flow and the second is overpowering the engine. In either case the engine has more fuel than available air for proper combustion, this overfueled condition leads to elevated exhaust temperatures.

Causes of restricted air flow can include damaged inlet piping, clogged air filters, excessive exhaust restriction, or operation at extreme altitudes. Overpowering generally is due to improper fuel delivery or injection timing. If overtemperature operation has been identified, an inspection of the air inlet and exhaust systems should be performed. Also, check the fuel delivery and timing.

RG,30,JW7583 –19–20NOV97–2/2

REMOVE TURBOCHARGER

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

Thoroughly clean exterior of turbocharger and surrounding area to prevent entry of dirt into the air intake system during removal.

IMPORTANT: When cleaning turbocharger, do not spray directly into compressor cover or turbine housing. If turbocharger inspection is required, do not clean exterior prior to removal. Doing so may wash away evidence of a potential failure mode. See TURBOCHARGER SEVEN-STEP INSPECTION later in this Group.)

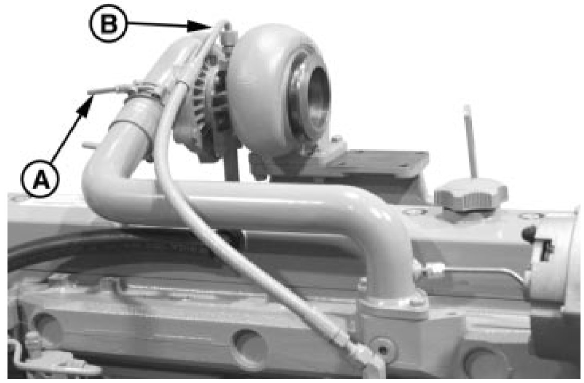
1. Remove air intake hose and exhaust elbow (shown removed). Loosen hose clamp (A).

2. Disconnect oil inlet line (B) and oil return pipe (C) from turbocharger (D).

3. Remove mounting cap screws and nuts and lift turbocharger from exhaust manifold. Remove stainless steel gasket.

4. Place turbocharger on a clean flat surface. Cap or plug all air intake and exhaust openings.

5. Perform turbocharger seven-step inspection as described later, if failure mode has not yet been determined. See TURBOCHARGER SEVEN-STEP INSPECTION in this Group.



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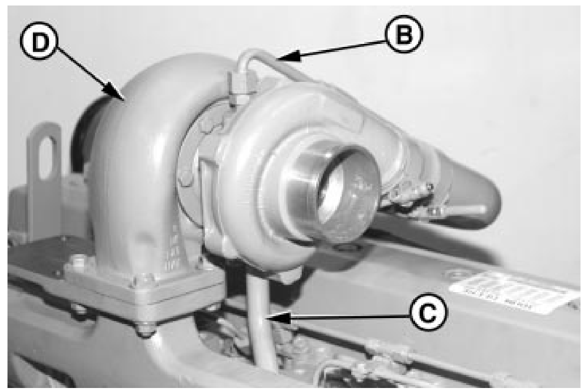


RG7619A –UN–06NOV97

A—Hose Clamp
B—Oil Inlet Line
C—Oil Return Pipe
D—Turbocharger

RG,30,JW7582 –19–20NOV97–1/1

30
6

TURBOCHARGER FAILURE ANALYSIS

The following is a guide for diagnosing the cause of turbocharger failures after removal from the engine.

COMPRESSOR HOUSING INLET DEFECTS

Problem	Possible Cause	Suggested Remedy
Foreign Object Damage	Objects left in intake system.	Disassemble and inspect intake system for foreign objects (this group). Inspect engine for internal damage.
	Leaking and/or defective intake system.	Inspect air intake system connections including air filter; repair as required (this group). Inspect air intake related engine components.
Compressor Wheel Rub	Bearing failure.	Determine if engine and/or operator contributed to lack of lubrication,contaminated lubrication, excessive temperature,or debris generating engine failure in progress. Correct as required.
	Manufacturing defects.	Correct as required.

COMPRESSOR HOUSING OUTLET DEFECTS

Problem	Possible Cause	Suggested Remedy
Oil and/or Dirt in Housing	Restricted air intake system.	Inspect and clean air cleaner.
	Prolonged periods of low RPM engine idling.	Check with operator to confirm conditions. (See operator's manual.)
	Defective oil seal ring.	Repair as required. (This group.)
	Restricted oil drain line.	Inspect and clear oil drain line as required.

TURBINE HOUSING INLET DEFECTS

Problem	Possible Cause	Suggested Remedy
Oil in Housing	Internal engine failure.	Inspect and repair engine as required.
	Oil leaking from compressor housing seal.	Verify that oil is in compressor housing and refer to "Compressor Housing Outlet Defects" as listed earlier in this chart.
Center Wall Deteriorated	Excessive operating temperature.	Check for restricted air intake. Check engine for overfueling. Check injection pump timing.

Continued on next page RG,30,JW7581 –19–20NOV97–1/2

TURBINE HOUSING OUTLET DEFECTS

Problem	Possible Cause	Suggested Remedy
Turbine Wheel Rub	Bearing failure.	Determine if engine and/or operator contributed to lack of lubrication, contaminated lubrication, excessive temperature, or debris generating engine failure in progress. Correct as required.
	Manufacturing defect.	Correct as required (this group).
Foreign Object Damage	Internal engine failure.	Inspect and repair engine as required
	Objects left in intake system.	Disassemble and inspect air intake system, (this group).
	Leaking air intake system.	Correct as required, (this group).
Oil and/or Excessive Carbon	Internal engine failure.	Verified by oil in turbine housing.Correct as required.
	Turbine seal failure.	Inspect for excessive heat from overfueling and/or restricted air intake.
	Prolonged periods of low RPM engine idling.	Verify with operator to run engine underload or at a higher RPM. (Operator’s Manual.)
	Restricted oil drain line.	Inspect and clear oil drain line as required.

EXTERNAL CENTER HOUSING AND JOINT DEFECTS

Problem	Possible Cause	Suggested Remedy
Leaks from Casting	Defective casting.	Replace turbocharger, (this group).
	Defective gasket.	Verify that leaks are not occurring at gasket joints.
Leaks from Joints	Loose attaching screws.	Tighten to specifications in CTM, (this group).
	Defective gasket.	Inspect and repair as required.

INTERNAL CENTER HOUSING DEFECTS

Problem	Possible Cause	Suggested Remedy
Excessive Carbon Build up in Housing or on Shaft	Hot engine shut-down.	Review proper operation with operator as shown in operator’s manual.
	Excessive operating temperature.	Restricted air intake; Overfueling or mistimed engine.
Restricted oil drain line.	Inspect and clean oil drain lines as required.	
	Operating engine at high speeds and loads immediately after start-up.	Idle engine for a few minutes to allow oil to reach bearings before applying heavy loads.

RG,30,JW7581 –19–20NOV97–2/2

30
8

TURBOCHARGER SEVEN-STEP INSPECTION

The following inspection procedure is recommended for systematic failure analysis of a suspected failed turbocharger. This procedure will help to identify when a turbocharger has failed, and why it has failed so the primary cause of the failure can be corrected.

Proper diagnosis of a non-failed turbocharger is important for two reasons. First, identification of a non-failed turbocharger will lead to further investigation and repair of the cause of a performance complaint.

Second, proper diagnosis eliminates the unnecessary expense incurred when a non-failed turbocharger is replaced.

The seven recommended inspection steps, which are explained in detail on following pages, are:

- Compressor Housing Inlet and Compressor Wheel.
- Compressor Housing Outlet.
- Turbine Housing Inlet.
- Turbine Housing Outlet and Turbine Wheel.
- External Center Housing and Joints.
- Internal Center Housing.
- Turbocharger Bench Test.

Continued on next page RG,30,JW7574 –19–20NOV97–1/13

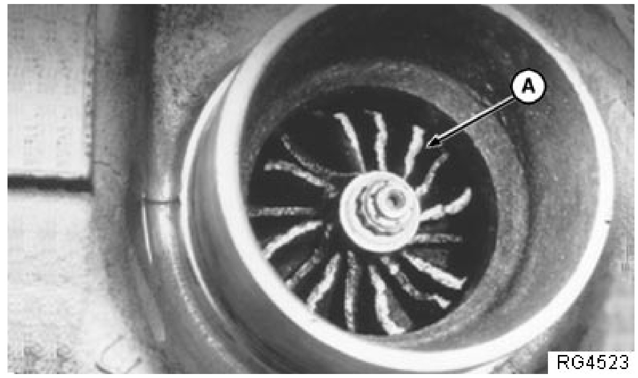
NOTE: To enhance the turbocharger inspection, an inspection sheet (Form No. DF-2280 available from Distribution Service Center—English only) can be used that lists the inspection steps in the proper order and shows potential failure modes for each step. Check off each step as you complete the inspection and record any details or problems obtained during inspection. Retain this with the work order for future reference.

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.



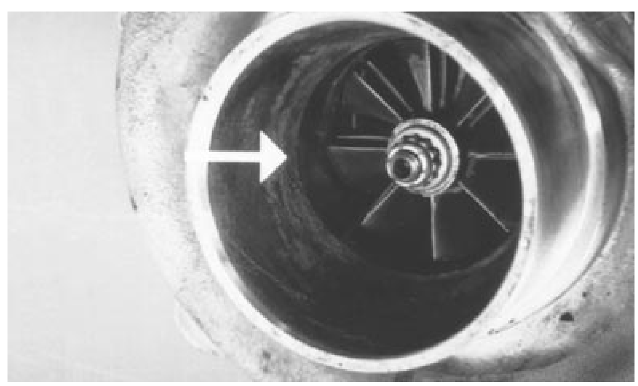
RG4523 –UN–03NOV97

A—Compressor Wheel

RG,30,JW7574 –19–20NOV97–2/13

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–05DEC97

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RG,30,JW7574 –19–20NOV97–3/13

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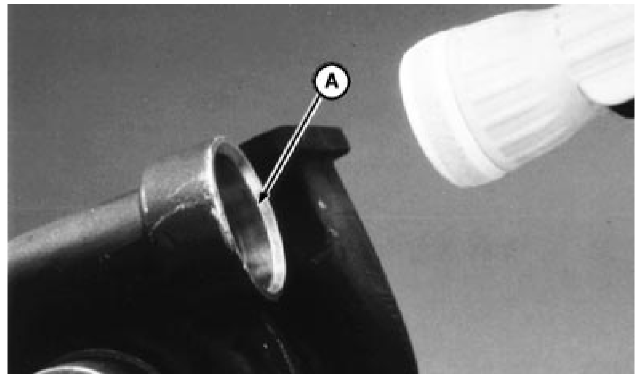
COMPRESSOR HOUSING OUTLET

1. Check compressor housing outlet (A). The outlet should be clean and free of dirt or oil.

2. Mark it on your checklist if dirt or oil is found and continue the inspection.



RG4525 –UN–05DEC97

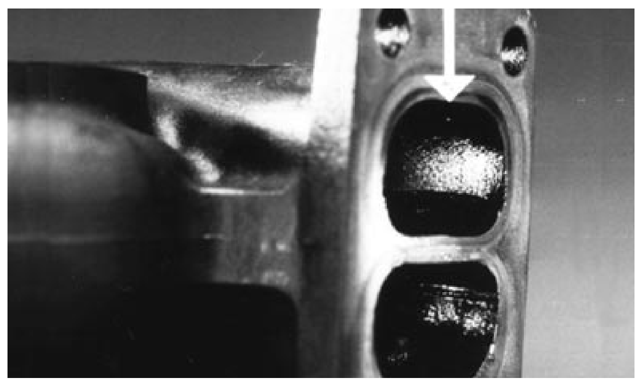
A—Compressor Outlet

RG,30,JW7574 –19–20NOV97–4/13

TURBINE HOUSING INLET

Check the turbine housing inlet ports (arrow) for oil in housing, excessive carbon deposit or erosion of center walls.

NOTE: If the inlet is wet with oil, or has excessive carbon deposits, an engine problem is likely. Center wall erosion (cracking or missing pieces), indicate excessive exhaust temperature.



RG4526 –UN–05DEC97

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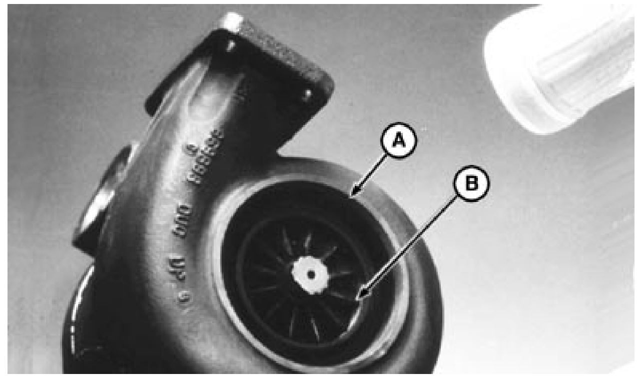
RG,30,JW7574 –19–20NOV97–5/13

TURBINE HOUSING OUTLET AND TURBINE WHEEL

1. Use a flashlight to look up inside the turbine housing outlet (A) and check blades (B) for foreign object damage.

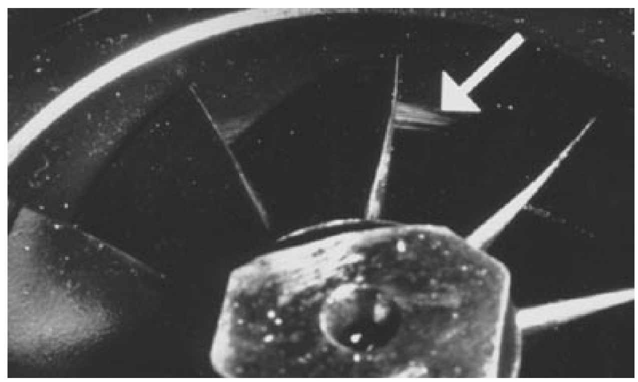


RG4527 –UN–05DEC97

A—Turbine Outlet
B—Turbine Blades

RG,30,JW7574 –19–20NOV97–6/13

2. Inspect the wheel blades and housing for evidence of wheel rub (arrow). Wheel rub can bend the tips of the blades with the housing showing wear or damage.



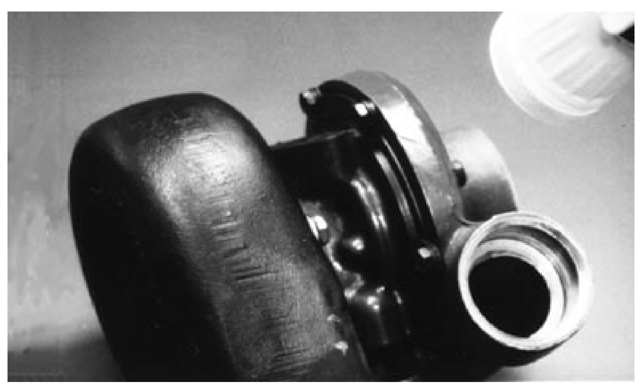
RG4528 –UN–05DEC97

RG,30,JW7574 –19–20NOV97–7/13

EXTERNAL CENTER HOUSING AND JOINTS

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–05DEC97

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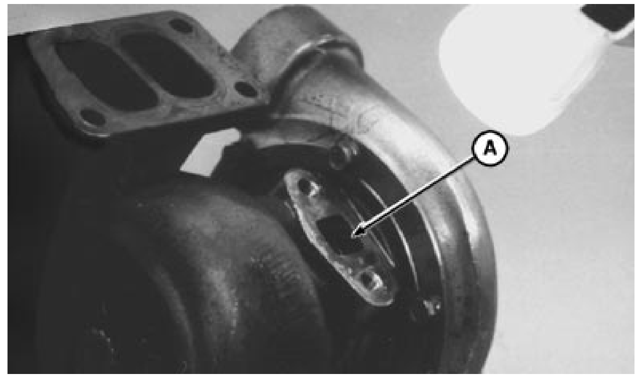
RG,30,JW7574 –19–20NOV97–8/13

INTERNAL CENTER HOUSING

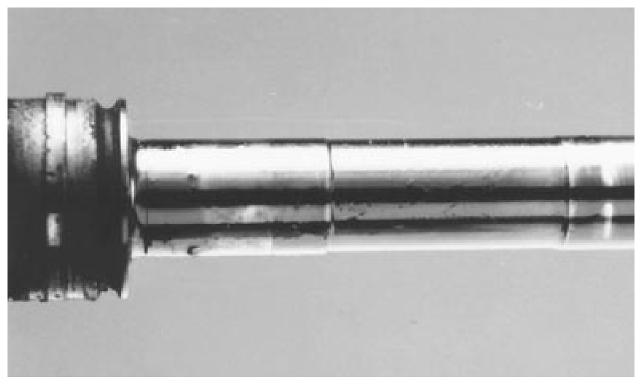
1. Using a flashlight, look through the oil return hole (A), to check the condition of the shaft and/or bearings. There should not be excess carbon deposits on the shaft or in the housing.



A—Oil Return

RG,30,JW7574 –19–20NOV97–9/13

2. Excessive “blueing” or “coking” of oil along the complete length of the shaft indicates a possible lack of lubrication caused by an engine failure, or improper operation, such as hot shutdowns.



RG,30,JW7574 –19–20NOV97–10/13

TURBOCHARGER BENCH TEST

1. Mount the turbocharger in a vise.

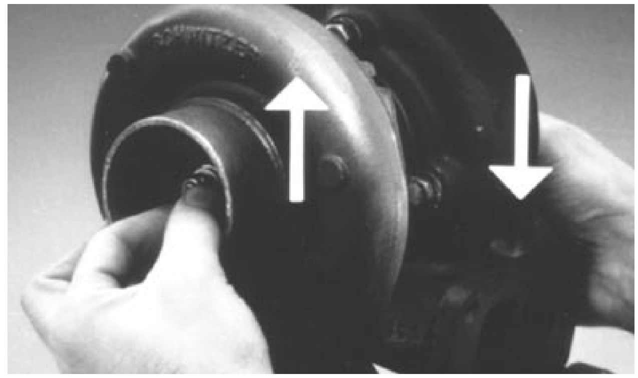
2. Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely, however, there may be a slight amount of drag.

Continued on next page

RG,30,JW7574 –19–20NOV97–11/13

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.



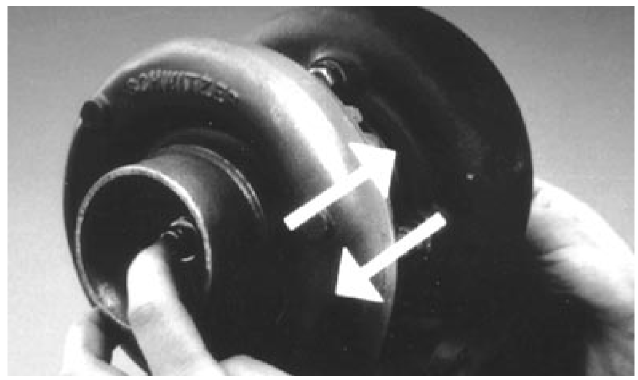
RG4533 –UN–05DEC97

RG,30,JW7574 –19–20NOV97–12/13

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.

IMPORTANT: Before you finalize your conclusion that the turbocharger has not failed, it is strongly recommended that the following procedures of checking radial bearing clearance and axial bearing endplay with a dial indicator be performed. These procedures are not required if a failure mode has already been identified.

NOTE: These diagnostic procedures will allow you to determine the condition of the turbocharger. If the turbocharger has failed, analysis of your inspection notes should direct you to the specific areas of the engine to correct the problems causing the turbocharger failure (See TURBOCHARGER FAILURE ANALYSIS, outlined earlier in this Group). It is not unusual to find that a turbocharger has not failed. If your turbocharger passes all the inspections, the problem lies somewhere else.



RG4534 –UN–05DEC97

RG,30,JW7574 –19–20NOV97–13/13

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14

PERFORM RADIAL BEARING CLEARANCE TEST

RG7622 –UN–06NOV97

This test will give an indication of the condition of the radial bearings within the center housing and rotating assembly.

NOTE: Prelube center housing bearings prior to performing radial clearance test. (See PRELUBE TURBOCHARGER, later in this Group.)

1. Position dial indicator with extension adapter onto center housing so that tip rests on shaft extending through oil return cavity.

IMPORTANT: Use only moderate force (3—4 lbs.) on each end of the shaft when checking clearance.

2. Grasp rotating shaft at both ends and move the shaft toward the indicator then away from the indicator (arrows) by applying moderate force of 3—4 lbs.

3. Observe and record total indicator movement.

Turbocharger (AiResearch/Garret)—Specification

Radial Bearing Clearance .... 0.8—0.18 mm (0.003-0.007 in.) maximum

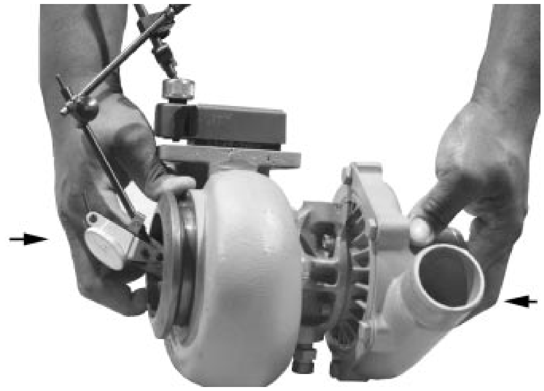
Turbocharger (CZ)—Specification

Radial Bearing Clearance .... 0.37—0.46 mm (0.015-0.018 in.) maximum

4. If total indicator reading is not within specification, replace turbocharger.

RG,30,JW7573 –19–20NOV97–1/1

PERFORM AXIAL BEARING END PLAY TEST



This test will give an indication of the condition of the axial bearing within the center housing and rotating assembly.

1. Mount magnetic base dial indicator so that indicator tip rests on end of shaft. Preload indicator tip and zero dial on indicator.

2. Move shaft axially back and forth by hand.

3. Observe and record total dial indicator movement.

Turbocharger (AiResearch/Garret)—Specification

Axial Bearing End Play .... 0.025—0.102 mm (0.001—0.004 in.)

Turbocharger (CZ)—Specification

Axial Bearing End Play .... 0.11—0.16 mm (0.004—0.006 in.)

If bearing end play is not within specification, replace turbocharger.

RG,30,JW7572 –19–20NOV97–1/1

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16

ADJUST TURBOCHARGER WASTEGATE ACTUATOR

1. Loosen jam nut (A).

2. Disconnect hose and pressurize actuator to 12 psi and hold at this calibration pressure.

3. Push bypass lever (D) as far as possible toward the actuator and apply pressure to keep lever in that position.

IMPORTANT: Twisting or forcing the entire rod in or out will change the calibration, causing damage to engine from overboost.

4. Turn rod end (B) in either direction until rod eye can just be slipped over bypass lever pin. Loosen rod end an additional half turn, install onto pin and secure with retainer clip (C). Release pressure on actuator.

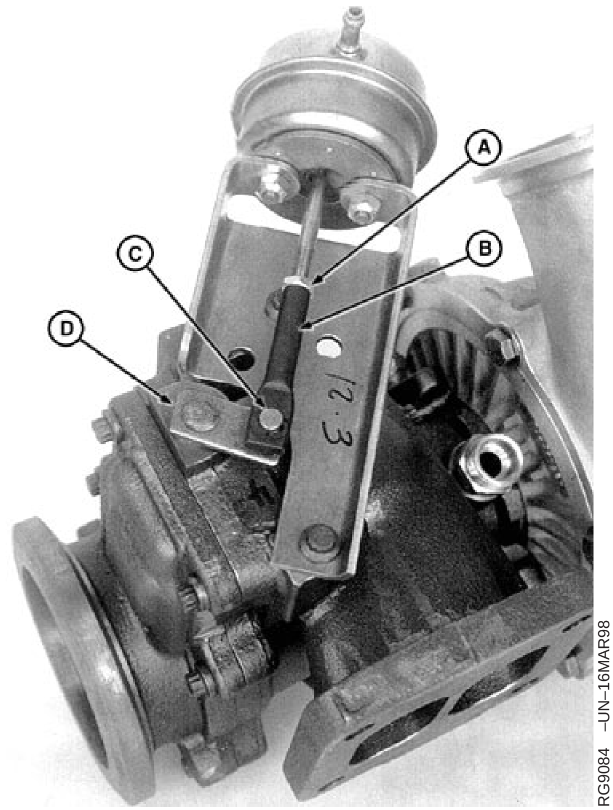
5. Pressurize the actuator to 12 psi. Measure the end play with a dial indicator, moving the bypass assembly back and forth in a direction perpendicular to the actuator rod. End play should be within specifications listed. If necessary to adjust, set end play at 0.38 mm (0.015 in.)

Turbocharger—Specification

Actuator End Play .... 0.05—0.056 mm (0.002—0.022 in.)

6. Vary the pressure from 9—12 psi. a few times to verify smooth and free operation of the bypass assembly.

7. Attach hose to actuator and secure with hose clamp.



A—Jam Nut
B—Rod End
C—Retainer Clip
D—Bypass Lever

DPSG,OUO1004,4 –19–31MAR98–1/1

REPAIR TURBOCHARGER

Turbochargers used on the engines covered in this manual are available through service parts as a complete remanufactured assembly only. Individual components for repair are not available.

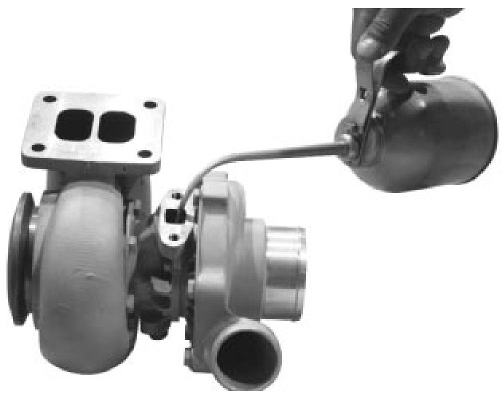
RG,30,JW7571 –19–20NOV97–1/1

PRELUBE TURBOCHARGER

IMPORTANT: DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur, when using compressed air.

Fill oil inlet or drain port with clean engine oil and spin rotating assembly (by hand) to properly lubricate bearings.

If turbocharger is to be stored for an extended period of time, lubricate internally and install protective covers on all openings.



RG7624 –UN–23NOV97

RG,30,JW7570 –19–20NOV97–1/1

30
18

INSTALL TURBOCHARGER

IMPORTANT: If turbocharger failed because of foreign material entering the air intake system, be sure to examine the system and clean as required to prevent a repeat failure.

If not done previously, prime (prelube) the turbocharger rotating assembly prior to mounting turbocharger on engine. Prelube center housing with clean engine oil through the oil drain hole. Turn rotating assembly by hand to lubricate bearings.

1. Position turbocharger (D) and new stainless steel gasket onto exhaust manifold. Tighten stud nuts to specifications.

Turbocharger-to-Exhaust Manifold Nuts—Specification

Torque .... 70 N•m (52 lb-ft)

2. Install oil return pipe (C) to turbocharger. Tighten oil return pipe cap screws to specifications.

Turbocharger Oil Return Pipe Cap Screws—Specification

Torque .... 24 N•m (18 lb-ft)

3. Connect turbocharger oil inlet line (B) and tighten to specifications.

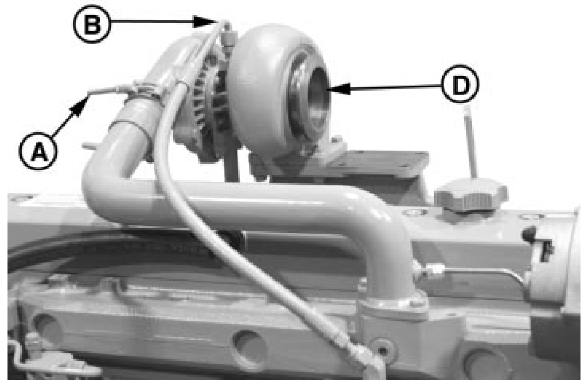
Turbocharger Oil Inlet Line—Specification

Torque .... 27N•m (20 lb-ft)

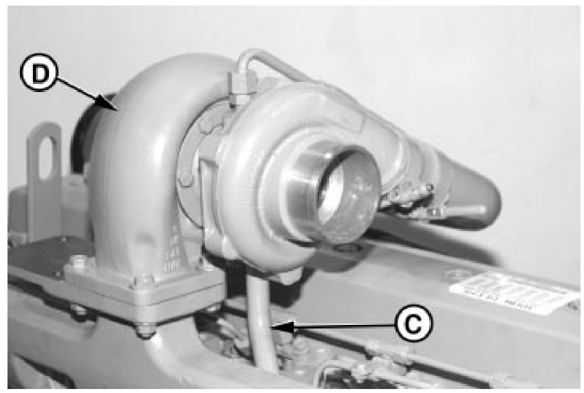
4. Connect air inlet hose-to-turbocharger compressor housing. Tighten hose clamp (A) on air inlet line to specifications.

Turbocharger Air Outlet Hose Clamp—Specification

Torque .... 6 N•m (53 lb-in.)



RG7618B –UN–06NOV97



RG7619B –UN–06NOV97

A—Hose Clamp
B—Oil Inlet Line
C—Oil Return Pipe
D—Turbocharger

Continued on next page

RG,30,JW7569 –19–20NOV97–1/2

IMPORTANT: Since the greatest suction force occurs between air cleaner and turbocharger, ensure that hose connections are tight to prevent entry of dirt into system.

5. Install exhaust adapter and exhaust elbow. The exhaust adapter must have a minimum end play of 0.8—1.6 mm (0.03—0.06 in.). Tighten cap screws to specifications.

Turbocharger Exhaust Adapter—Specification

Torque .... 47 N•m (35 lb-ft)

Turbocharger Exhaust Elbow—Specification

Torque .... 47 N•m (35 lb-ft)

RG,30,JW7569 –19–20NOV97–2/2

TURBOCHARGER BREAK-IN

IMPORTANT: A new or repaired turbocharger DOES NOT have an adequate oil supply for immediate start-up of engine. Perform the steps below to prevent damage to turbocharger bearings.

1. Either push the throttle lever to the “STOP” position, hold the engine shut-off knob out, or disconnect electrical wire from injection pump.

IMPORTANT: DO NOT crank engine longer than 30 seconds at a time to avoid damage to starting motor.

2. Crank engine over with starting motor until oil pressure gauge needle registers within the “GREEN” zone of pressure gauge.

3. Start and run engine at low idle while checking oil inlet and air piping connections for leaks.

RG,30,JW7568 –19–20NOV97–1/1

RECOMMENDATIONS FOR TURBOCHARGER USE

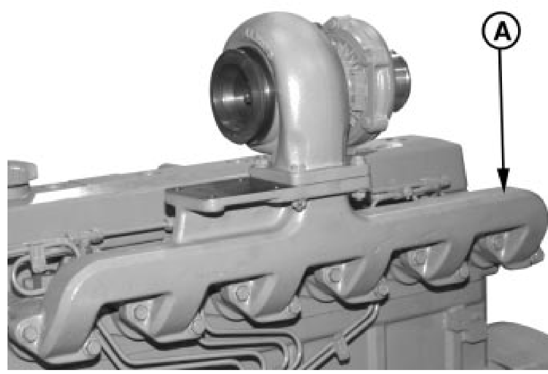
IMPORTANT: Should the engine stall when operating under load, IMMEDIATELY restart the engine to prevent overheating of turbocharger parts.

In most cases, turbocharger damage is caused by improper start-up and shutdown procedures. Always idle the engine for at least 30 seconds (no load) after start-up and before shutdown.

DPSG,OUO1004,5 –19–31MAR98–1/1

REMOVE, INSPECT, AND INSTALL EXHAUST MANIFOLD

1. Remove turbocharger (if equipped), exhaust elbow, or exhaust pipe if desired. Turbocharger can be removed with exhaust manifold (A). (See REMOVE TURBOCHARGER, earlier in this Group.)



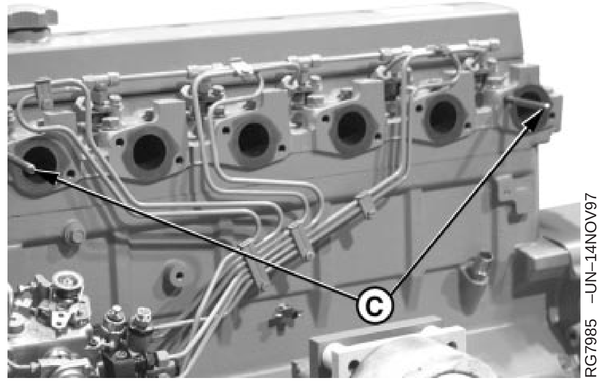
RG7794B –UN–11NOV97

A—Exhaust Manifold

Continued on next page

RG,30,JW7567 –19–20NOV97–1/3

2. Remove exhaust manifold using guide studs (C).



C—Guide Studs

RG,30,JW7567 –19–20NOV97–2/3

3. Inspect exhaust manifold and gasket(s) (B).

4. Thoroughly clean passages in exhaust manifold.

5. Inspect each exhaust manifold for cracks or damage. Inspect machined mounting surfaces for burrs or other defects which might prevent gasket(s) from sealing properly. Replace parts as needed.

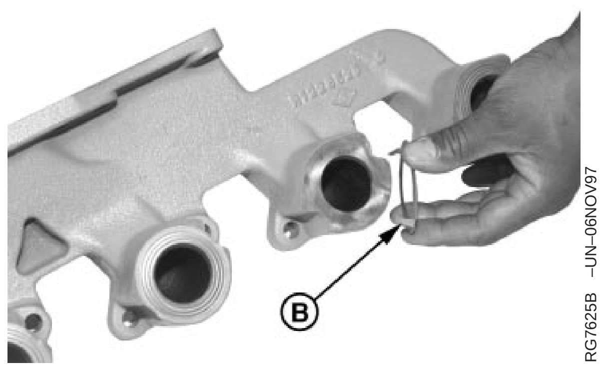
6. Install gasket(s) on exhaust manifold.

NOTE: Stainless steel gaskets can be reused if not damaged. Graphite gaskets must be replaced.

7. Using guide studs, install exhaust manifold.

8. Apply PT569 NEVER-SEEZ® Compound to cap screws.

9. Tighten exhaust manifold-to-cylinder head cap screws to specifications. **On 6-cylinder engines F250,** tighten cap screws on No. 3 and No. 4 cylinders first. **On all other engines,** tighten No. 2 and No. 3 cylinders first.



B—Gasket

Exhaust Manifold-to-Cylinder Head Cap Screws—Specification

Torque .... 70 N•m (52 lb-ft)

NEVER-SEEZ is a registered trademark of Emhart Chemical Group

RG,30,JW7567 –19–20NOV97–3/3

30
22

REMOVE AND INSTALL AIR-TO-AIR AFTERCOOLER

Refer to machine technical manual for removal, inspection, and installation procedures.

RG,30,JW7566 –19–20NOV97–1/1

REMOVE AND INSTALL AIR INTAKE PIPE

NOTE: Configuration of air intake pipe varies by application.

1. Remove cap screws (B).
2. Loosen hose clamp (A) and remove air intake pipe.
3. Inspect and repair as required.
4. Install new gasket and air intake pipe. Tighten cap screws to specifications.

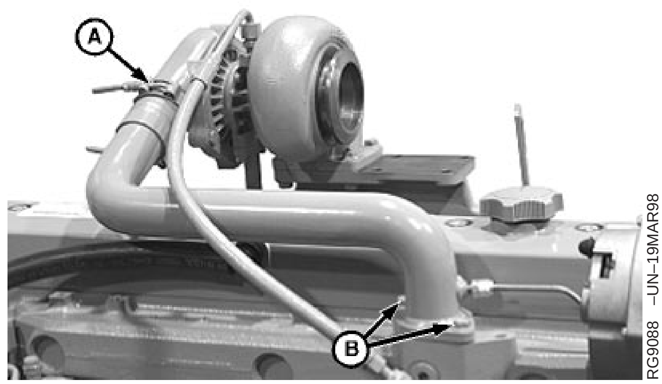
Air Intake Pipe-to-Cylinder Head—Specification

Torque .... 70 N•m (52 lb-ft)

5. Tighten hose clamp (A) to specifications.

Air Intake Pipe Hose Clamp—Specification

Torque .... 6 N•m (53 lb-in.)



A—Hose Clamp
B—Cap Screws

DPSG,OUO1004,6 –19–31MAR98–1/1

REMOVE AND INSTALL AIR HEATER

NOTE: Two types of air heaters shown.

1. Disconnect wiring.

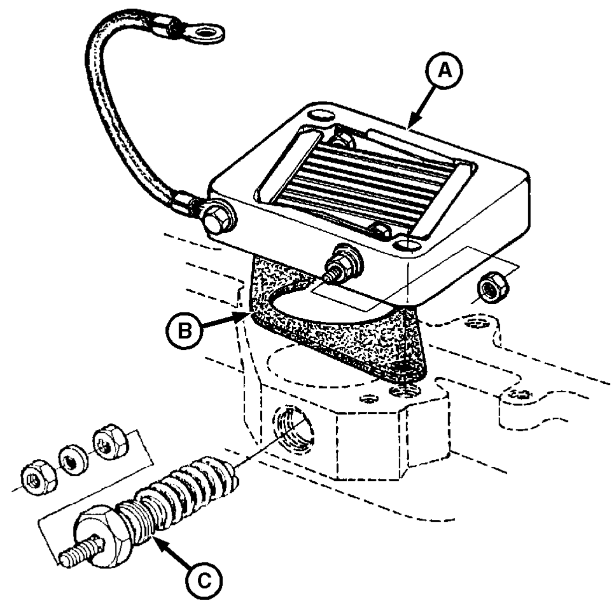
2. If machine is equipped with air heater (A), remove air intake pipe. See REMOVE AND INSTALL AIR INTAKE PIPE in this Group.

3. Remove air heater (A) or (C).

4. Replace parts as required.

5. Install air heater (A) with new gasket (B). Coat threads of air heater (C) with LOCTITE® 592 Thread Sealant With TEFLON® and install.

6. Install air intake pipe if required.



RG9081 –UN–16MAR98

A—Air Heater
B—Gasket
C—Air Heater

LOCTITE is a registered trademark of Loctite Corp.
TEFLON is a registered trademark of Du Pont Co.

DPSG,OUO1004,7 –19–31MAR98–1/1

ESSENTIAL TOOLS

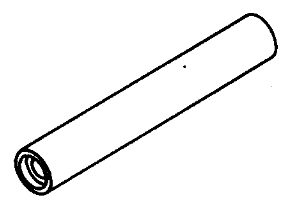
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

SERVICEGARD is a trademark of Deere & Company

DPSG,OUO1004,194 –19–07JUL98–1/12

Driver JDF15

Used to install spindle seals in fuel supply pumps.



RG2017

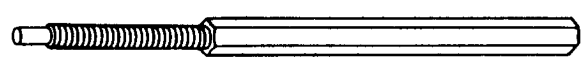
RG2017 –UN–30NOV88

DPSG,OUO1004,194 –19–07JUL98–2/12

RG7212 –UN–23NOV97

Injection Pump Timing Pin. JDG886

Used to lock Nippondenso in-line fuel injection pump timing prior to removal of pump.

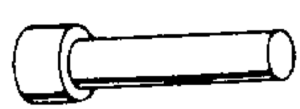


DPSG,OUO1004,194 –19–07JUL98–3/12

RG5068 –UN–05DEC97

Timing Pin JDE81-4

Used to lock flywheel at No. 1 TDC for injection pump timing.



RG5068

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DPSG,OUO1004,194 –19–07JUL98–4/12

35
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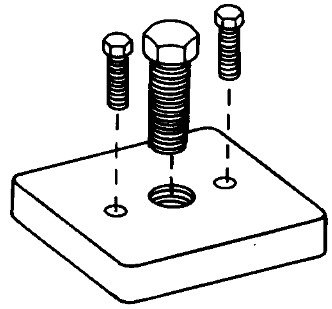
Injection Pump Drive Gear Puller JDG670A

Remove drive gear from tapered shaft on Stanadyne DB2 (with retained drive shafts) and DB4 fuel injection pumps. Also used to remove drive gear on Lucas injection pumps.

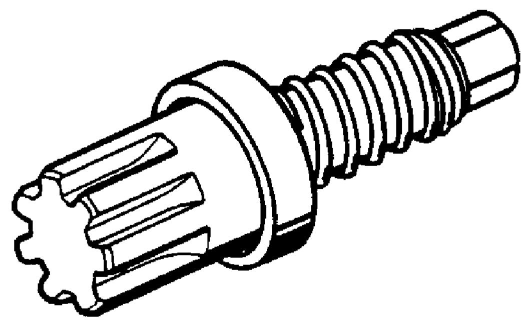


RG6032 –UN–13JAN92

DPSG,OUO1004,194 –19–07JUL98–5/12

Flywheel Turning Tool JDG820

Used to rotate flywheel on engines with 129-tooth flywheel ring gear and a 29.9 mm (1.18 in.) ID flywheel housing guide bore diameter. JDE81-1 may be used if JDG820 is not available.



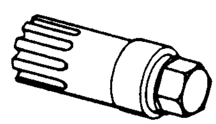
RG7056

RG7056 –UN–05DEC97

DPSG,OUO1004,194 –19–07JUL98–6/12

Flywheel Turning Tool JDE83

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



RG6251 –UN–22JUL92

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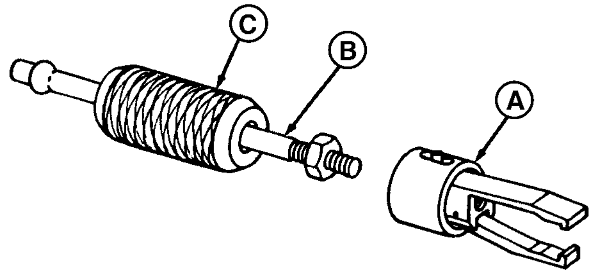
DPSG,OUO1004,194 –19–07JUL98–7/12

Injection Nozzle Puller JDE38B

Remove injection nozzles.

If JDE38B is not available, JDE38A Nozzle Puller with JDG716 Adapter can be used. JDG716 can be used with slide handle adapter from JDE38 or JDE38A to remove 9.5 mm nozzles without removing the rocker arm cover.

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



RG6436 –UN–03NOV97

DPSG,OUO1004,194 –19–07JUL98–8/12

RG5084 –UN–23AUG88

Nozzle Bore Cleaning Tool JDE39

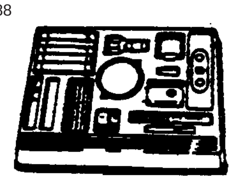
Clean injection nozzle bore in cylinder head.

DPSG,OUO1004,194 –19–07JUL98–9/12

RG5224 –UN–23AUG88

Nozzle Cleaning Kit JDF13

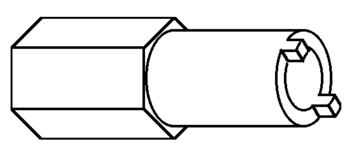
Clean injection nozzles.



DPSG,OUO1004,194 –19–07JUL98–10/12

Injection Nozzle Wrench JDG949

Used to loosen or tighten lift adjusting screws on injection nozzles.



RG7644 –UN–23NOV97

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DPSG,OUO1004,194 –19–07JUL98–11/12

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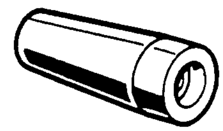
4

Nozzle Carbon Stop Seal Installer JD258

Used to install carbon stop seal in injection nozzle groove.



RG6254 –UN–22JUL92

DPSG,OUO1004,194 –19–07JUL98–12/12

SERVICE EQUIPMENT AND TOOLS

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

DPSG,OUO1004,195 –19–07JUL98–1/8

Bosch Bench Mounted Nozzle Tester JT25510

Check nozzle opening pressure.

DPSG,OUO1004,195 –19–07JUL98–2/8

Fuel Line KJD10109

Use with JT25510 Nozzle Tester to check nozzle opening pressure.

DPSG,OUO1004,195 –19–07JUL98–3/8

Fuel Injection Nozzle Tester Adapter Set D01110AA

Check nozzle opening pressure.

Continued on next page

DPSG,OUO1004,195 –19–07JUL98–4/8

OTC Portable Nozzle Tester D01109AA

Check nozzle opening pressure.

DPSG,OUO1004,195 –19–07JUL98–5/8

Nozzle Holding Fixture ROS17787

Support fuel injection nozzles for service.

DPSG,OUO1004,195 –19–07JUL98–6/8

Inspection Magnifier. ROS16487

Inspect injection nozzle tips.

DPSG,OUO1004,195 –19–07JUL98–7/8

Torque Wrench Adapter . . . . ROS18958 (English) or No. 24374 (Metric)

Tighten pressure adjusting screw locknut on injection nozzle.

DPSG,OUO1004,195 –19–07JUL98–8/8

OTHER MATERIAL

Number	Name	Use
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to fuel supply pump mounting screws and fuel line fittings. Apply to injection pump front access plate cap screws.
AR54749 (U.S.)	Soap Lubricant	Injection pump mounting flange O-ring.

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DPSG,OUO1004,196 –19–07JUL98–1/1

35
6

FUEL SYSTEM SPECIFICATIONS

Item	Measurement	Specification
Fuel Filter Base Mounting Bracket-to-Cylinder Head	Torque	35 N•m (26 lb-ft)
Primary Fuel Filter/Water Separator Mounting Base-to-Bracket	Torque	35 N•m (26 lb-ft)
Final Fuel Filter Mounting Base-to-Bracket	Torque	35 N•m (26 lb-ft)
Rotary Fuel Supply Pump	Pressure	28—41 kPa (0.28—0.41 bar) (4—6 psi)
Fuel Supply Pump Cap Screws	Torque	30 N•m (22 lb-ft)
Fuel Supply Pump (On In-Line Injection Pumps) Cap Screws	Torque	5—7 N•m (4—5 lb-ft) (45—60 lb-in.)
Fuel Shutoff Solenoid Actuator Rod Cap Screw/Nut	Torque	15—20 N•m (11—15 lb-ft)
Rotary Injection Pump Mounting Nuts	Torque	27 N•m (20 lb-ft)
Nippondenso Injection Pump Drive Gear Cap Screws	Torque	47 N•m (35 lb-ft)
Stanadyne DB2 Fuel Injection Pump Drive Gear-To-Shaft Retaining Nut Torque	Torque	122 N•m (90 lb-ft)
Stanadyne DB4 Fuel Injection Pump Drive Gear-To-Shaft Retaining Nut Torque	Torque	203 N•m (150 lb-ft)
Rotary Injection Pump Front Access Plate Cap Screws	Torque	2 N•m (1.7 lb-ft) (20 lb-in.)
Rotary Injection Pump Mounting Nuts	Torque	27 N•m (20 lb-ft)
Fuel Injection Pump Delivery Lines (At Pump)	Torque	27 N•m (20 lb-ft)

Continued on next page

DPSG,OUO1004,276 –19–20JUL98–1/3

Item	Measurement	Specification
DP201 and DP203 Lucas Fuel Injection Pump Drive Gear-To-Shaft Retaining Nut	Torque	81 N•m (60 lb-ft)
Nippondenso Injection Pump Mounting Nuts	Torque	70 N•m (52 lb-ft)
Nippondenso Injection Pump Drive Gear Cap Screws	Torque	47 N•m (35 lb-ft)
Nippondenso Injection Pump Drive Gear Cover	Torque	5 N•m (3.7 lb-ft) (44 lb-in.)
Aneroid Pressure (Lever Lift-Off)	Pressure	76—102 mm Hg (3—4 in. Hg) 10—14 kPa (1.5—2.0 psi)
Aneroid Pressure (Lever at Full Travel)	Pressure	330—380 mm Hg (13—14 in. Hg) 44—51 kPa (6.4—7.4 psi)
Fuel Injection RE60062 Nozzles (Naturally Aspirated Engines)		
Opening Pressure of New or Reconditioned Nozzle With New Internal Parts	Opening Pressure For Setting	24130—24480 kPa (241—244 bar) (3500—3550 psi)
	Opening Pressure For Checking (Minimum)	21800 kPa (218 bar) (3160 psi)
Minimum Acceptable Opening Pressure of Used Nozzle	Opening Pressure For Checking (Minimum)	19850 kPa (198 bar) (2880 psi)
Maximum Opening Pressure Difference Between Cylinders	Maximum Pressure Difference	700 kPa (7 bar) (100 psi)
Fuel Injection RE48786 Nozzles (Turbocharged Engines)		
Opening Pressure of New or Reconditioned Nozzle With New Internal Parts	Opening Pressure For Setting	25900—26200 kPa (259—262 bar) (3750—3800 psi)
	Opening Pressure For Checking (Minimum)	25200 kPa (252 bar) (3660 psi)
Minimum Acceptable Opening Pressure of Used Nozzle	Opening Pressure For Checking (Minimum)	22950 kPa (230 bar) (3330 psi)

Continued on next page DPSG,OUO1004,276 –19–20JUL98–2/3

Fuel System

Item	Measurement	Specification
Maximum Opening Pressure Difference Between Cylinders	Maximum Pressure Difference	700 kPa (7 bar) (100 psi)
Fuel Injection Nozzle Tip	Spray Angle	144°
Nozzle Valve/Seat Tightness Condition at Pressure Test of 2800—3500 kPa (28—35 bar) (400—500 psi)	Leakage	Nozzle tip dry after 5 seconds. (Slight dampness permissible on used nozzles.)
Fuel Injection Nozzle Return Leakage at Pressure Test of 10300 kPa (103 bar) (1500 psi)	Leakage	3—10 Drops/30 Seconds
Fuel Injection Nozzle Tip Orifice	Number of Orifices Per Nozzle	4
Fuel Injection Nozzle Tip Orifice (Naturally Aspirated Engines)	ID	0.27 mm (0.0106 in.)
Fuel Injection Nozzle Tip Orifice (Turbocharged Engines)[1]	ID	0.29 mm (0.0116 in.)
Injection Nozzle Pressure Adjusting Screw Locknut	Torque	10 N•m (7 lb-ft)
Fuel Injection Nozzle Valve Needle Lift	Needle Lift (Based on Zero Lift)	3/4 Turn Counterclockwise
Fuel Injection Nozzle Lift Adjusting Screw Lock Nut	Torque	5 N•m (3.5 lb-ft) (42 lb-in.)
Fuel Injection Nozzle Hold-Down Clamp Cap Screws	Torque	40 N•m (30 lb-ft)
Fuel Leak-Off Hex Nut	Torque	5 N•m (3.7 lb-ft) (44 lb-in.)
Fuel Injection Nozzle Delivery Line	Torque	27 N•m (20 lb-ft)

[1]In a few applications, "D" engine nozzles could be specified in a "T" or "H" engine (verify part number on nozzle). In these cases, set the nozzle to specifications as listed for "D" engine nozzles above.

DPSG,OUO1004,276 –19–20JUL98–3/3

FUEL SYSTEM—GENERAL INFORMATION

Engines may be equipped with a Stanadyne or Lucas rotary-type injection pump or a Nippondenso in-line injection pump. Engines with rotary pumps are dynamically timed at the factory. See Group 115.

Some injection pumps are equipped with an aneroid.

Engines may be equipped with a primary fuel filter/water strainer.

All engines use 9.5 mm pencil-type nozzles.

On rotary pumps, the fuel supply pump is a separate component mounted on upper right-hand side of engine block and is actuated by a pin in block that rides on engine camshaft lobe.

On rotary pumps, a cold start switch may be installed in the thermostat housing/water manifold and is connected to a wiring harness from the pump. This switch helps during cold start-up operation.

On in-line pumps, the fuel supply pump is a component mounted on the side of the pump actuated by lobe on injection pump camshaft.

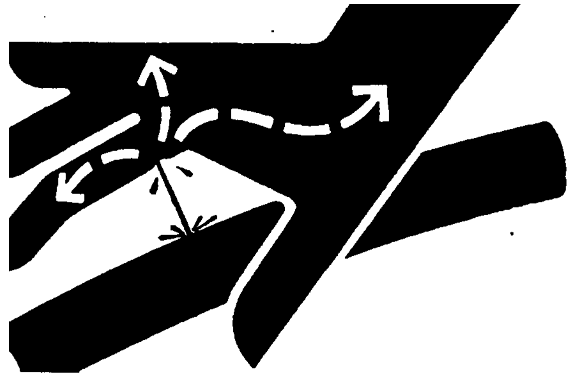
All engines are equipped with a round final fuel filter. Hand primer on top of filter element is optional.

Field-installed options include fuel heater, water separator bowl and hand fuel primer.

RG,35,JW7626 –19–20NOV97–1/1

35
10

RELIEVE FUEL SYSTEM PRESSURE



CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin, causing serious injury. Before disconnecting lines, be sure to relieve pressure. Before applying pressure to the system, be sure ALL connections are tight and lines, pipes and hoses are not damaged. Keep hands and body away from pinholes and nozzles which eject fluid under pressure. Use a piece of cardboard or wood, rather than hands, to search for suspected leaks.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

Any time the fuel system has been opened up for service (lines disconnected or filters removed), it will be necessary to bleed air from the system. (See BLEED FUEL SYSTEM in Group 115.)

RG,35,JW7625 –19–20NOV97–1/1

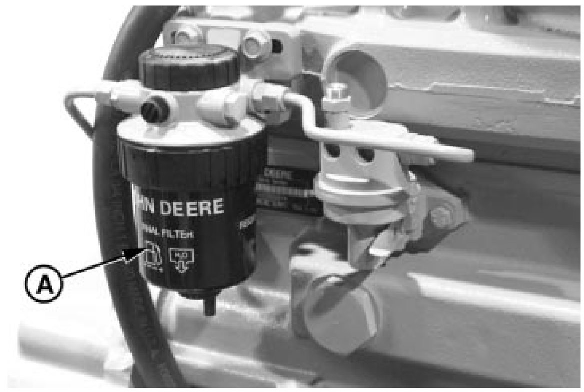
REMOVE FINAL FUEL FILTER AND/OR PRIMARY FUEL FILTER/WATER SEPARATOR BASE

Refer to operator's manual for proper servicing and (hourly) replacement intervals.

Some engines may be equipped with a final fuel filter (A) and an optional primary fuel filter/water separator (B).

Final fuel filters can be equipped with a water separator bowl and/or hand primer on machines equipped with only one filter.

RG7745A –UN–07NOV97



RG7986 –UN–14NOV97

A—Final Fuel Filter
B—Primary Fuel Filter/Water Separator

Continued on next page RG,35,JW7624 –19–20NOV97–1/2

35
12

1. Thoroughly clean fuel filter/water separator assembly and surrounding area to keep from getting dirt and debris into fuel system.

2. Connect a drain line to filter drain adapters and drain all fuel from system.

NOTE: The primary fuel filter/water separator is keyed to the filter header. If both primary and final filters are removed, insure that they are reinstalled in the correct headers.

3. Remove final fuel filter and primary (round) fuel filter/water separator, if desired. See REPLACE PRIMARY FUEL FILTER/WATER SEPARATOR, as described later in this group.

4. Disconnect fuel lines from all ports.

5. Remove final fuel filter base (A).

6. If equipped, remove primary fuel filter base (B).

7. Replace parts as necessary.

8. Install mounting brackets and tighten to torque specifications provided below.

Fuel Filter Base Mounting Bracket-to-Cylinder Head—Specification

Torque .... 35 N•m (26 lb-ft)

Primary Fuel Filter/Water Separator Mounting Base-to-Bracket—Specification

Torque .... 35 N•m (26 lb-ft)

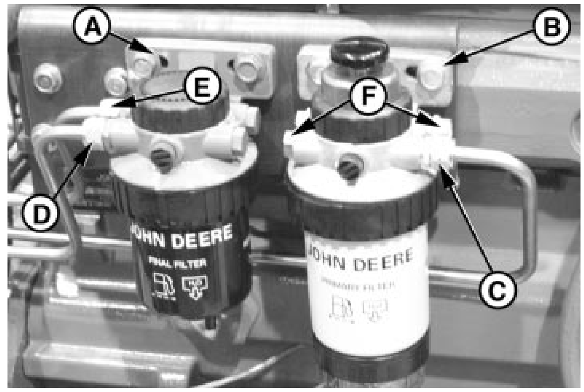
Final Fuel Filter Mounting Base-to-Bracket—Specification

Torque .... 35 N•m (26 lb-ft)

9. Install water separator and fuel filters. See REPLACE PRIMARY FUEL FILTER/WATER SEPARATOR, as described later in this group.

10. Connect fuel lines to all ports.

11. Bleed the fuel system as detailed in Group 115.



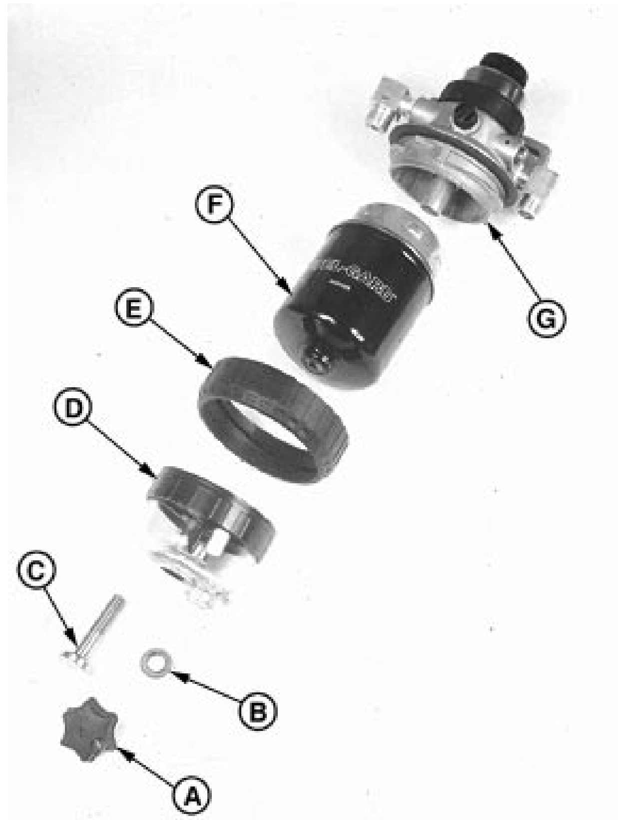
RG7745B –UN–07NOV97

A—Final Fuel Filter Base
B—Primary Fuel Filter Base
C—Primary Filter Outlet to Supply Pump
D—Final Filter Outlet to Injection Pump
E—Final Filter Inlet from Supply Pump
F—Primary Filter Inlet from Pump

RG,35,JW7624 –19–20NOV97–2/2

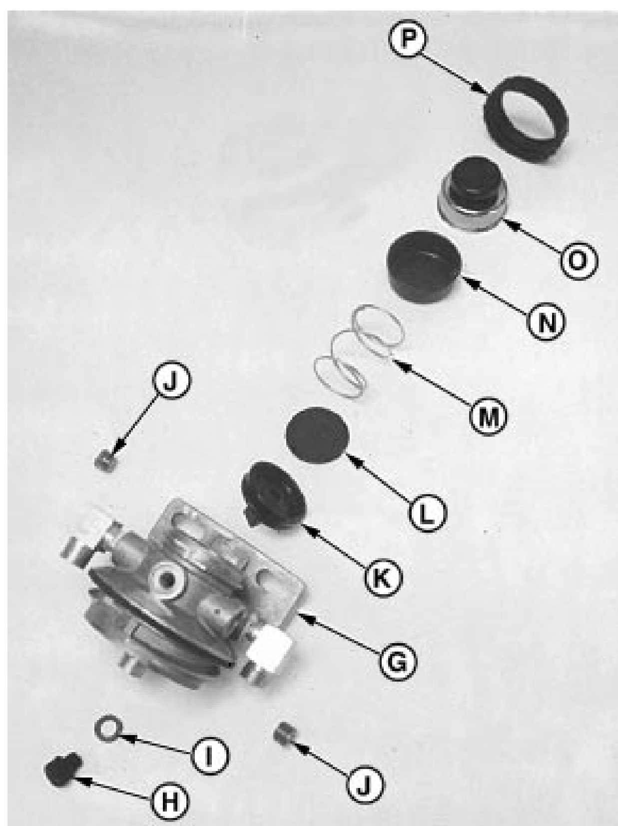
35
13

PRIMARY FUEL FILTER/WATER SEPARATOR ASSEMBLY



RGT7751HR –UN–19NOV97

Primary Filter/Water Separator Assembly



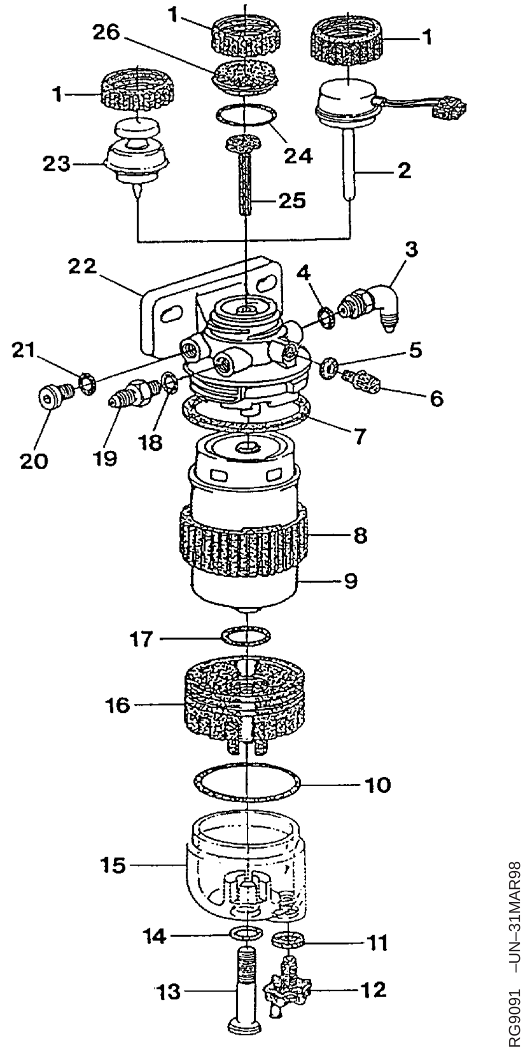
RGT7751HS –UN–19NOV97

Filter Base Assembly

A—Drain Adapter
B—Packing
C—Cap Screw
D—Water Separator Bowl
E—Retaining Ring
F—Filter Element
G—Filter Base with Seal Ring
H—Vent Plug
I—Packing
J—Plug (2 used)
K—Diaphragm
L—Spring Seat
M—Spring
N—Spring Cover
O—Pump Knob
P—Retaining Ring

RG,35,JW7623 –19–20NOV97–1/1

FINAL FUEL FILTER ASSEMBLY



Final Fuel Filter

1—Retaining Ring
2—Fuel Heater (Optional)
3—Fitting
4—O-Ring
5—O-Ring
6—Bleed Screw
7—O-Ring
8—Retaining Ring
9—Filter
10—O-Ring
11—O-Ring
12—Drain Adapter
13—Screw
14—O-Ring
15—Water Separator Bowl
16—Adapter
17—O-Ring
18—O-Ring
19—Fitting
20—Plug
21—O-Ring
22—Filter Base
23—Primer Assembly (Optional)
24—O-Ring
25—Stem
26—Cap

RG,35,JW7623 –19–20NOV97–1/1

REPLACE FINAL FUEL FILTER AND PRIMARY FUEL FILTER/WATER SEPARATOR

A—Retaining Ring
B—Filter Element

NOTE: Refer to operator's manual for proper servicing and (hourly) replacement intervals.

Final fuel filters can be equipped with a water separator bowl and/or hand primer on machines equipped with only one filter.

Replacement of primary and final fuel filter elements are similar, differences will be noted.

1. Thoroughly clean fuel filter/water separator assembly and surrounding area, if not previously done.

2. Connect a drain line to filter drain adapters and drain all fuel from filters.

NOTE: Lifting up on retaining ring (A) as it is rotated helps to get it past raised locators.

3. Firmly grasp the retaining ring and rotate it counterclockwise 1/4 turn. Remove ring with filter element (B).

4. Inspect filter mounting base for cleanliness. Clean as required.

5. Remove water separator bowl, if equipped. Drain and clean separator bowl. Dry with compressed air.

6. Install water separator bowl, if equipped, onto new filter element. Tighten securely.

7. Thoroughly inspect filter base seal ring. Replace as needed.

NOTE: The primary fuel filter must be indexed properly and the key on canister must be oriented in slot of mounting base for correct installation.

8. Install new filter element onto mounting base and position element using a slight rocking motion. Be sure element is properly indexed on mounting base.

Continued on next page RG,35,JW7622 –19–20NOV97–1/2

9. Install retaining ring onto mounting base and tighten about 1/3 turn until ring “snaps” into the detent. DO NOT overtighten the retaining ring.

10. Bleed fuel system. (See BLEED THE FUEL SYSTEM, in Group 115.)

RG,35,JW7622 –19–20NOV97–2/2

REMOVE FUEL SUPPLY PUMP

IMPORTANT: A backup wrench must always be used when disconnecting fittings or fuel lines from supply pump to avoid damage to fittings.

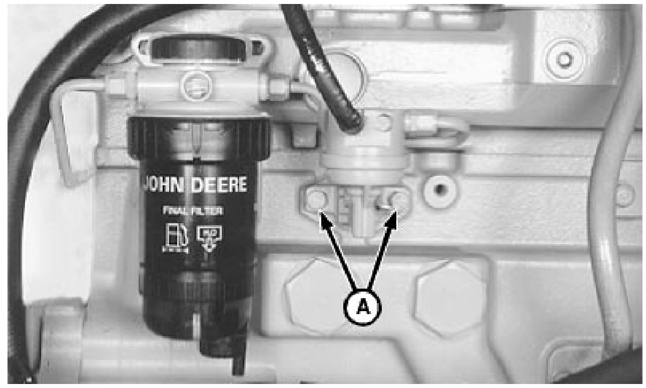
1. Disconnect fuel lines and cap connections on fuel supply pump and fuel lines to keep debris out of fuel system.

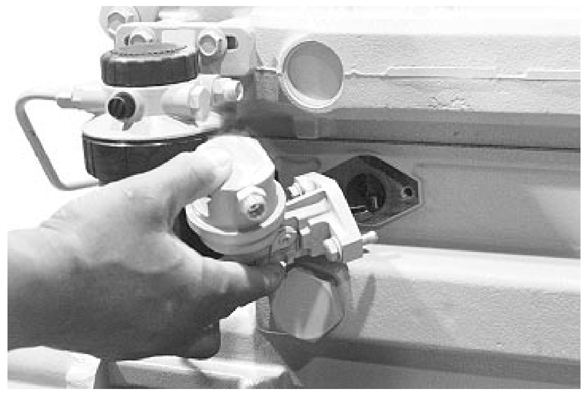
2. Remove cap screws (A) and remove fuel supply pump assembly from cylinder block.

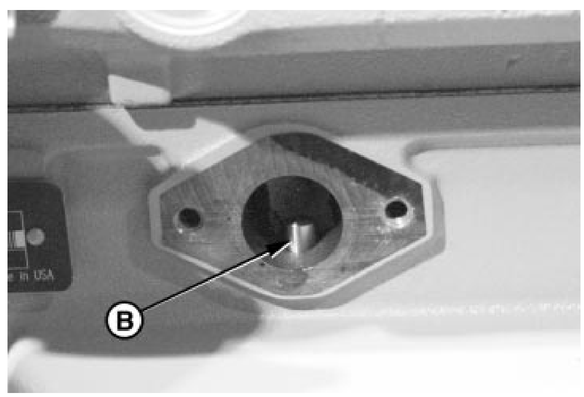
NOTE: The fuel supply pump is driven by a push rod (B) that rides on an eccentric camshaft lobe. The cylinder head must be removed to remove this push rod.

3. Cover opening on cylinder block to prevent dirt from entering the engine.

4. Inspect face of pump lever for wear. If lever face is worn flat or concave, replace pump.





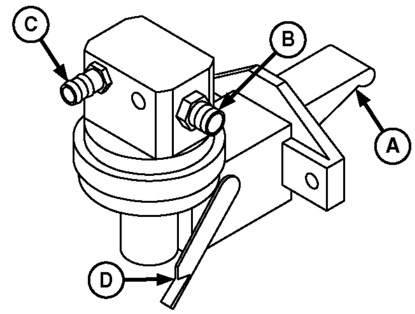


A—Cap Screws
B—Push Rod

RG,35,JW7621 –19–20NOV97–1/1

35
18

BENCH TEST FUEL SUPPLY PUMP



A—Lever
B—Outlet Side of Pump
C—Inlet Side of Pump
D—Primer Lever

The following bench tests can be performed on a supply pump installed on the engine when the pump is suspected to be defective. (See MEASURE FUEL SUPPLY PUMP PRESSURE in Group 115.)

Perform the Vacuum/Pressure Test and Leakage Test, listed below. Replace the supply pump if either test shows the pump to be defective, there is no repair procedure.

VACUUM/PRESSURE TEST:

NOTE: This test will give a good indication of condition of both the inlet and outlet valves, as well as the diaphragm. The numerical values obtained on both the vacuum and pressure sides are not important; rather it is the needle movement that is important (very slow for a good pump; very fast or not at all for a defective pump).

1. Remove inlet and outlet fittings.

2. Install vacuum/pressure gauge to inlet side of pump (C).

3. Move primer lever (D) all the way downward. Release lever and at the same time observe gauge:

   - The gauge needle should read the same value each time, and then very slowly return to “0”. This indicates that the inlet valve and diaphragm are in good condition. Proceed to next step.
   - If the gauge needle does not move at all, or the needle rapidly returns to “0”, the pump is defective and must be replaced.

4. Remove vacuum/pressure gauge and install onto outlet side of pump (B).

5. Move priming lever all the way to upward position. Release lever and at same time observe gauge reading:

Continued on next page RG,35,JW7620 –19–20NOV97–1/3

- The gauge needle should initially read 28—41 kPa (0.28—0.41 bar) (4—6 psi), then return to “0” very slowly. This indicates that the outlet valve and diaphragm are in good condition. Supply pump is operating properly and should be reinstalled on engine.

Fuel Supply Pump—Specification

Pressure .... 28—41 kPa (0.28—0.41 bar) (4—6 psi)

- If the gauge needle initially reads same value as above and then returns immediately back to “0”, the pump is defective and must be replaced.

RG,35,JW7620 –19–20NOV97–2/3

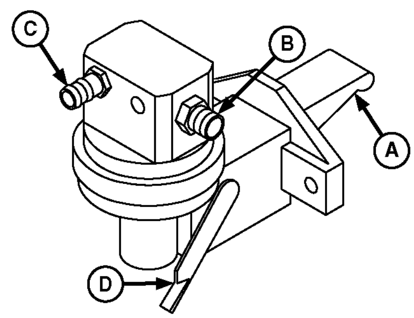
LEAKAGE TEST:

The leakage test should be performed if a supply pump suspected of leaking fuel externally, or internally into the engine crankcase.

1. Install an air line on inlet side of pump (C) and apply 140 kPa (1.4 bar) (20 psi) pressure.

2. Hold finger over outlet side of pump (B) or install a plug. Submerge pump into a container of clean diesel fuel.

   - If air bubbles occur around banded connection holding the two halves of pump together (indicating leakage), replace pump.
   - If the diaphragm is bad, there will be leakage through vent holes (if equipped) and around the rocker arm. Replace pump as necessary.



RG9052 –UN–16MAR98

A—Lever
B—Outlet Side of Pump
C—Inlet Side of Pump
D—Primer Lever

RG,35,JW7620 –19–20NOV97–3/3

35
20

INSTALL FUEL SUPPLY PUMP

IMPORTANT: Apply LOCTITE 242 to threads of supply pump mounting screws (A) and fuel line fittings when reinstalling supply pump. DO NOT allow sealant to get into fuel system.

1. Install the fuel supply pump to cylinder block with pumping lever resting on top of push rod, using a new O-ring. Tighten cap screws to specifications.

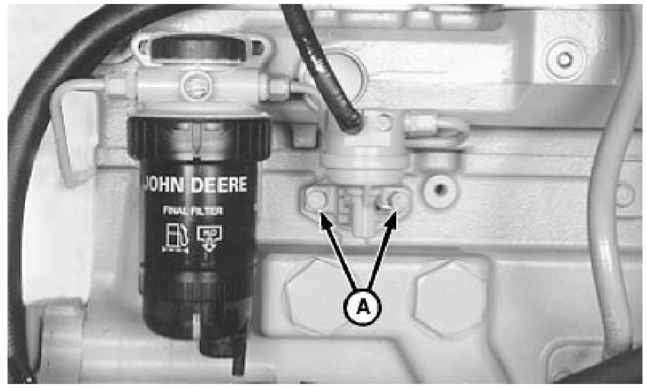
Fuel Supply Pump Cap Screws (Rotary)—Specification

Torque .... 30 N•m (22 lb-ft)

IMPORTANT: ALWAYS use a backup wrench when installing fittings and/or fuel lines onto supply pump to avoid damage to fittings.

2. Connect fuel lines and tighten securely.

3. Bleed fuel system. (See BLEED THE FUEL SYSTEM in Group 115.)



RG9050 –UN–16MAR98

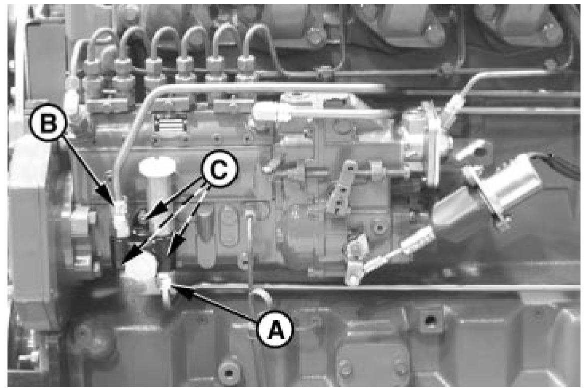
A—Mounting Screws

RG,35,JW7619 –19–20NOV97–1/1

REMOVE FUEL SUPPLY PUMP ON IN-LINE FUEL INJECTION PUMP

NOTE: To diagnose fuel supply pump malfunctions or test for leaks, refer to Group 115.

1. Thoroughly clean exterior of supply pump. Also clean around supply pump mounting area on injection pump housing
2. Disconnect fuel inlet line (A), and outlet line (B). Cap all line openings so contaminates do not enter fuel system.
3. Remove mounting nuts (C).
4. Pull fuel supply pump straight out from injection pump housing. Cover supply pump mounting bore so debris cannot enter injection pump.



A—Fuel Inlet Line
B—Fuel Outlet Line
C—Mounting Nuts

RG,35,JW7618 –19–20NOV97–1/1

35
22

TEST IN-LINE FUEL SUPPLY PUMP FOR LEAKS

Fuel delivery pressure should be checked before removing supply pump from injection pump. (See CHECK FUEL SUPPLY PUMP OPERATION, in Group 115.)

1. Connect compressed air line (A) to a pressure gauge (B) and to supply pump inlet fitting. Air line should have a regulating valve to control pressure.

2. Cap or plug supply pump outlet fitting (C).

3. Submerge supply pump in a container of clean diesel fuel. Regulate air pressure to 200 kPa (2.0 bar) (29 psi).

4. Move roller tappet in and out by hand. No air bubbles should appear around roller tappet.

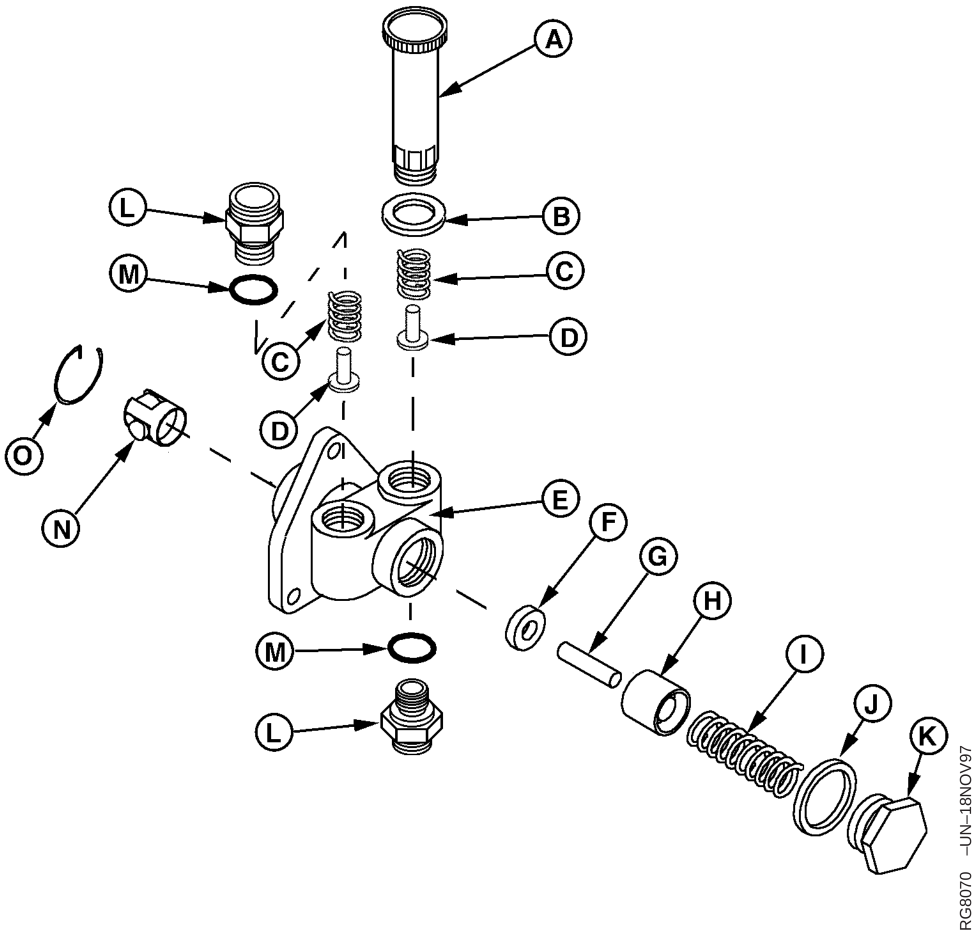
NOTE: If bubbles appear, it is an indication that either the O-ring seal is defective or spindle or tappet is worn (or possibly both).

IMPORTANT: Serious injection pump or engine damage could occur, if enough diesel fuel leaks past spindle and seal. Fuel leakage past spindle dilutes engine oil.

A—Air Line
B—Pressure Gauge
C—Outlet Fitting

RG,35,JW7617 –19–20NOV97–1/1

DISASSEMBLE FUEL SUPPLY PUMP

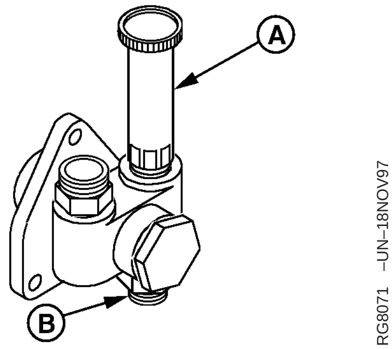


A—Hand Primer
B—Washer (4 used)
C—Spring (2 used)
D—Valve
E—Pump Housing
F—O-Ring/Spindle Seal
G—Pressure Spindle
H—Plunger
I—Spring
J—Washer
K—Plug
L—Flex Fitting
M—O-Ring
N—Roller/Tappet Assembly
O—Snap Ring

Continued on next page RG,35,JW7616 –19–20NOV97–1/6

35
24

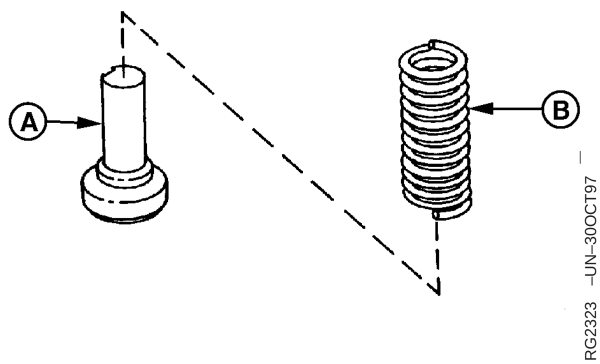
1. Remove hand primer (A) and flex fittings (B) from housing. Discard O-rings.



A—Hand Primer
B—Flex Fittings

RG,35,JW7616 –19–20NOV97–2/6

2. Remove valves (A) and springs (B).



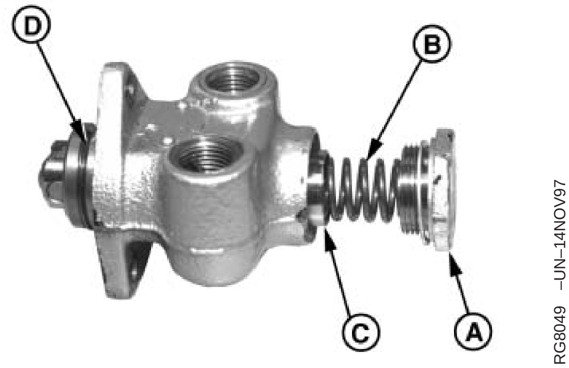
A—Valve
B—Spring

Continued on next page RG,35,JW7616 –19–20NOV97–3/6

3. Remove plug (A), spring (B), and plunger (C) from pump housing. Discard copper washer.

4. Remove snap ring (D) from outer circumference of pump housing neck.

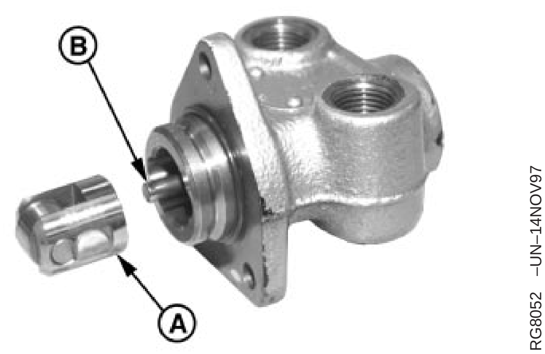
NOTE: Snap ring has a tang on one end which extends vertically down through a hole in pump housing to retain roller tappet assembly.



A—Plug
B—Spring
C—Plunger
D—Snap Ring

RG,35,JW7616 –19–20NOV97–4/6

5. Remover roller tappet (A) and spindle (B) from pump housing. Remove and discard O-ring on spindle.



A—Roller Tappet
B—Spindle

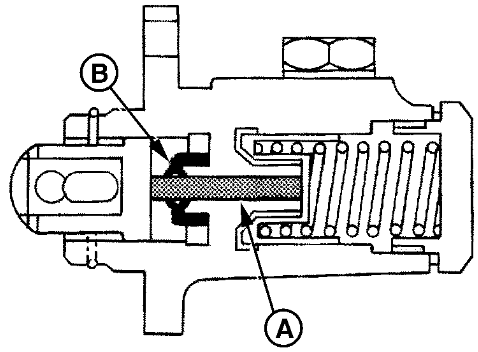
Continued on next page

RG,35,JW7616 –19–20NOV97–5/6

35
26

NOTE: Spindle/seal O-ring (B) is pressed into pump housing. This seal keeps diesel fuel from leaking past spindle (A) and entering injection pump crankcase.

6. Remove spindle seal from housing using needle nose pliers. Discard seal.



RG4029 –UN–30OCT97

A—Spindle
B—O-Ring

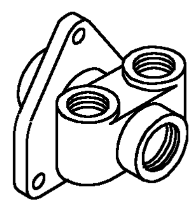
RG,35,JW7616 –19–20NOV97–6/6

INSPECT AND REPAIR FUEL SUPPLY PUMP COMPONENTS

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.



RG8050 –UN–15JAN98

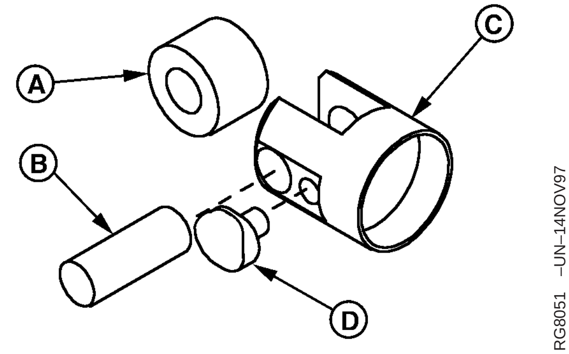
Continued on next page RG,35,JW7615 –19–20NOV97–1/4

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.

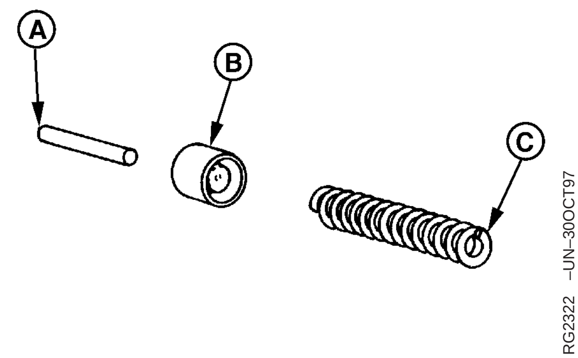


A—Roller
B—Pin
C—Tappet
D—Sliding Block (2 used)

RG,35,JW7615 –19–20NOV97–2/4

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.



A—Spindle
B—Plunger
C—Spring

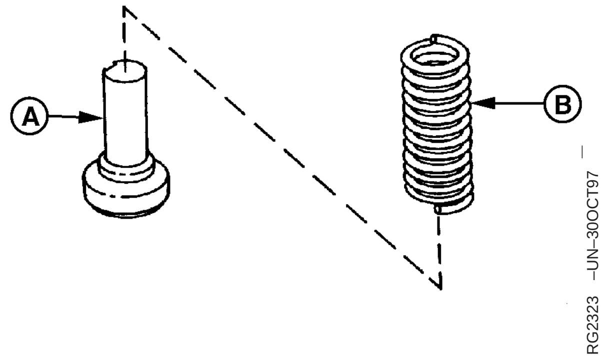
Continued on next page

RG,35,JW7615 –19–20NOV97–3/4

35
28

9. Inspect valves (A), especially valve face, for cracks, pits and wear. Replace as necessary.

10. Spring (B) should not be bent or broken.



A—Valve
B—Spring

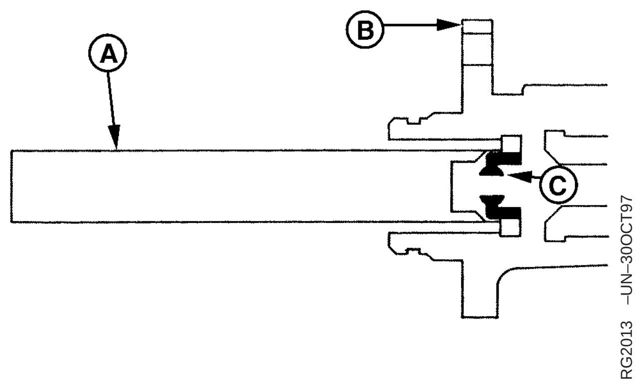
RG,35,JW7615 –19–20NOV97–4/4

ASSEMBLE FUEL SUPPLY PUMP

IMPORTANT: Hands should be wet with diesel fuel when assembling internal components of fuel supply pump.

1. Install new spindle seal (C) into pump housing (B) using JDF15 Driver (A). Be sure seal is started straight in housing bore and drive until driver contacts housing.

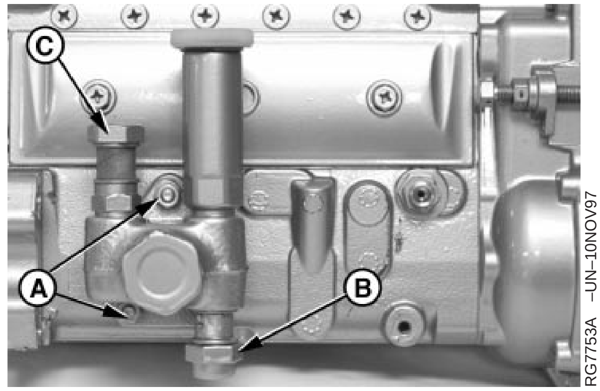
2. To assemble supply pump, reverse disassembly procedure using new O-rings. Perform leak test described in Group 115.



A—Driver
B—Pump Housing
C—Seal

RG,35,JW7614 –19–20NOV97–1/1

INSTALL FUEL SUPPLY PUMP ON IN-LINE FUEL INJECTION PUMP



A—Mounting Studs
B—Inlet Line
C—Outlet Line

IMPORTANT: Before installing supply pump, test pump to make sure fuel will not leak around spindle and spindle seal. (See TEST MECHANICAL FUEL SUPPLY FOR LEAKS, in Group 115.)

1. Put a new O-ring in counterbore of injection pump housing next to fuel supply pump mounting face.

2. Position pump over mounting studs (A). Tighten mounting studs to specifications.

Fuel Supply Pump (On In-Line Injection Pumps) Cap Screws—Specification

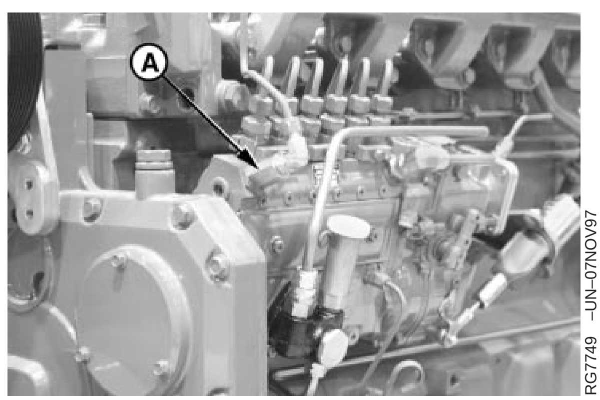
Torque .... 5—7 N•m (4—5 lb-ft) (45—60 lb-in.)

3. Install fuel inlet (B) and outlet lines (C) when engine is installed in vehicle. Tighten all connections securely.

4. Bleed fuel system. (See BLEED THE FUEL SYSTEM in Group 115.)

RG,35,JW7613 –19–20NOV97–1/1

SERVICE INJECTION PUMP OVERFLOW VALVE



A—Overflow Valve

NOTE: Overflow valve (A) can be serviced with injection pump installed.

1. Disconnect leak-off line and remove overflow valve (A).

Continued on next page

RG,35,JW7612 –19–20NOV97–1/2

35
30

2. Remove reducer (A) and copper washer (B) from valve body (C). Discard copper washer.

3. Unscrew spring seat (D); then remove spring (E) and valve (F).

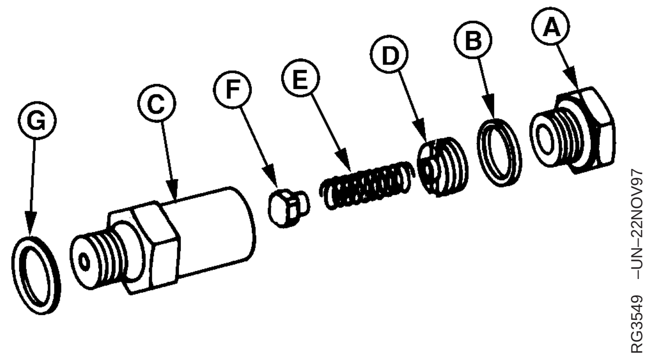
4. Inspect for foreign material imbedded in seat of nylon valve.

5. Check spring to see that it is not weak or broken.

6. Wash all parts in solvent and air dry.

NOTE: There is no adjustment on valve to regulate housing pressure. If suspected that valve is malfunctioning, replace valve to restore proper operation.

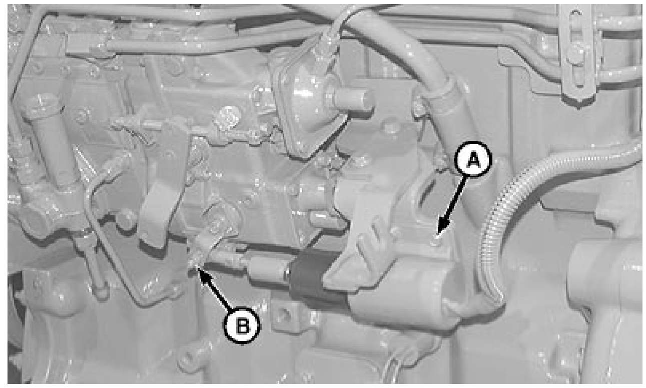
7. Reverse order of removal for reassembly of overflow valve. Install new copper washers.



A—Reducer
B—Washer
C—Valve Body
D—Spring Seat
E—Spring
F—Valve
G—Washer

RG,35,JW7612 –19–20NOV97–2/2

REMOVE AND INSTALL FUEL SHUTOFF SOLENOID



A—Cap Screw
B—Cap Screw and Nut

1. Disconnect electrical wiring connector on solenoid lead.

2. Remove actuator rod cap screw and nut (B).

3. Remove four cap screws (A) and fuel shutoff solenoid assembly from mounting bracket.

4. Fuel shutoff solenoid linkage should move freely back and forth.

NOTE: Electric fuel shutoff solenoids are factory adjusted to a specified length and should not require additional adjustment. See machine technical manual for fuel shutoff solenoid diagnostics.

5. To install fuel shutoff solenoid, reverse removal procedure. Tighten cap screw to specifications.

Fuel Shutoff Solenoid Actuator Rod Cap Screw/Nut—Specification

Torque .... 15—20 N•m (11—15 lb-ft)

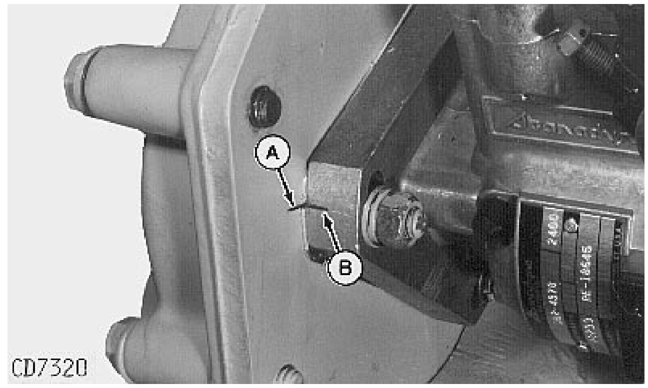
6. Connect electrical wiring connector.

RG,35,JW7611 –19–20NOV97–1/1

35
32

ROTARY FUEL INJECTION PUMP TIMING

STATIC TIMING WITH EXTERNAL MARKS



CD7320 –UN–23MAY95

A—Mark on Front Plate
B—Mark on Pump

1. Loosen attaching hex nuts of fuel injection pump and pivot pump housing away from cylinder block as far as slots will allow. Then pivot it back again, but only far enough to align timing mark on pump flange (B) exactly with timing mark on cylinder block front plate (A).

2. Tighten the three hex nuts securing pump to front plate to specifications.

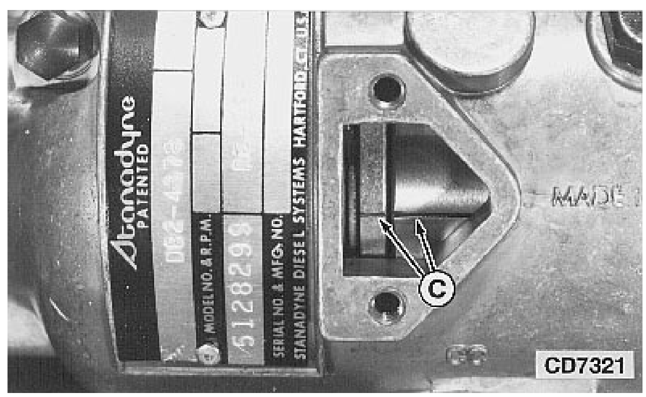
Rotary Injection Pump Mounting Nuts—Specification

Torque .... 27 N•m (20 lb-ft)

Also see “Dynamic Timing” in Group115.

RG,35,JW7610 –19–20NOV97–1/2

STATIC TIMING WITHOUT TIMING MARKS (STANADYNE PUMPS)



CD7321 –UN–23MAY95

1. Make sure piston no. 1 is at TDC compression stroke and remove timing hole cover from injection pump.

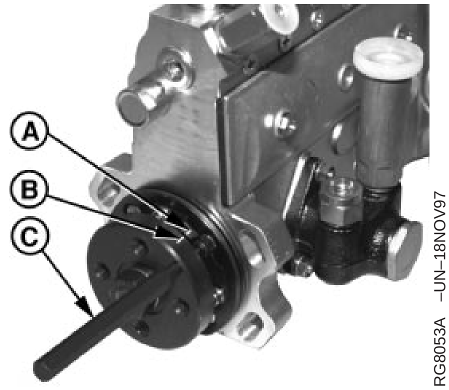
2. With attaching hex nuts finger tight, pivot the pump housing away from the block as far as slots will allow. Then pivot it back until the timing marks (C) on cam ring and governor weight retainer are aligned. Tighten pump attaching nuts to specifications.

Rotary Injection Pump Mounting Nuts—Specification

Torque .... 27 N•m (20 lb-ft)

RG,35,JW7610 –19–20NOV97–2/2

IN-LINE FUEL INJECTION PUMP TIMING



A—Timing Pointer
B—Mark on Drive Hub
C—Timing Pin

In-line fuel injection pumps are static lock-pin timed during installation of pump.

Static Lock-Pin Timing, is accomplished by locking engine at No. 1 TDC compression stroke. Align pump timing mark on drive hub (B) and stationary timing pointer (A). Lock the pump at this position with JDG886 Injection Pump Timing Pin (C).

IMPORTANT: The normal backlash of gears is enough to throw the pump timing off by several degrees, resulting in poor engine performance. It is important that pump timing be rechecked after pump has been installed.

NOTE: Normal engine rotation is counterclockwise, viewed ftom flywheel end.

To check alignment of injection pump and eliminate backlash of timing gear train, remove both timing pins and rotate the flywheel opposite the direction of normal rotation. Install JDE81-4 Timing Pin and rotate flywheel in the direction of normal rotation until timing pin engages in timing pin hole.

If JDG886 Timing Pin will not install through drive hub into pointer hole (A), loosen drive gear cap screws and rotate hub until timing pin can be installed and locked in place.

NOTE: When tightening pump drive gear cap screws, apply light force (clockwise) to gear to eliminate any backlash with camshaft gear.

Tighten pump drive gear cap screws to specifications.

Nippondenso Injection Pump Drive Gear Cap Screws—Specification

Torque .... 47 N•m (35 lb-ft)

RG,35,JW7610 –19–20NOV97–1/1

35
34

REMOVE STANADYNE MODEL DB2 AND DB4 INJECTION PUMP

All Stanadyne DB2 and DB4 injection pumps will have a retained drive shaft (shaft stays in the pump when pump is removed from engine).

IMPORTANT: Never steam clean or pour cold water on a fuel injection pump while the pump is running or while it is warm. Doing so may cause seizure of internal rotating pump parts.

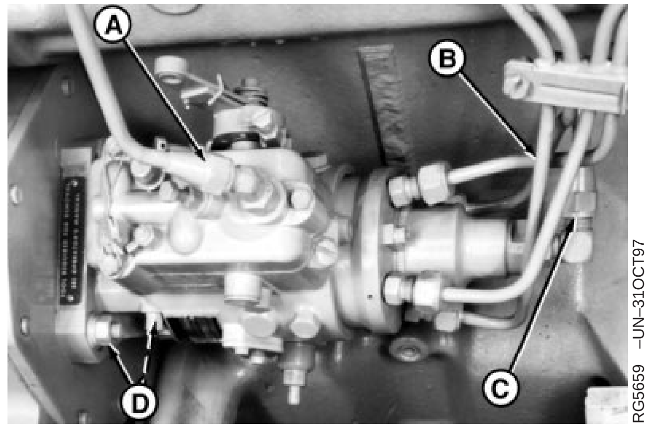
1. Clean the fuel injection pump, lines and area around the pump with cleaning solvent or a steam cleaner.

2. Disconnect shut-off cable and speed control linkage, if equipped. Disconnect electrical connection to shut-off solenoid or throttle positioning solenoid, if equipped. Disconnect cold start switch, if equipped. Tag electrical wires for correct reassembly.

IMPORTANT: ALWAYS use a backup wrench when loosening or tightening fuel lines at injection pump so that discharge fittings are not altered to prevent possible internal pump damage.

3. Disconnect fuel return line (A) and fuel supply line (C).

4. Disconnect all fuel delivery (pressure) lines (B) from injection pump using a suitable 17 mm deep-well crowsfoot socket.



A—Fuel Return Line
B—Fuel Delivery (Pressure) Lines
C—Fuel Supply Line
D—Mounting Stud Nuts

Continued on next page RG,35,JW7609 –19–20NOV97–1/3

NOTE: The injection pump drive gear fits snugly onto a tapered drive shaft and is indexed by a hollow pin or Woodruff key installed in drive shaft.

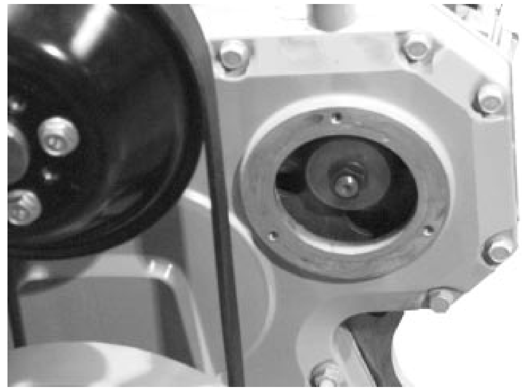
5. Remove injection pump drive gear cover (shown removed). Remove drive gear retaining nut and washer from end of pump shaft. Be careful not to let washer fall inside timing gear cover.

6. Attach JDG670A Drive Gear Puller (A) to injection pump drive gear as shown.

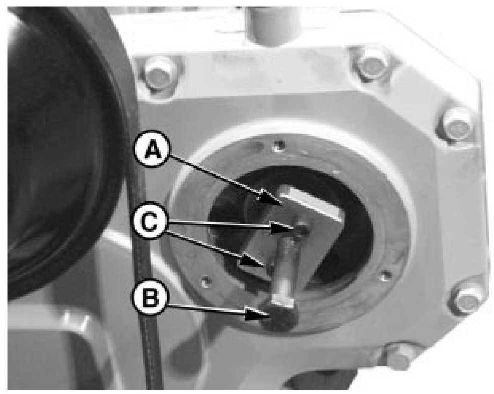
NOTE: Replace 6 mm Grade 12.9 cap screws (C) as needed.

7. Evenly tighten the two 6 mm, Grade 12.9 screws (threaded in drive gear) and snugly tighten center forcing screw (B) against end of pump shaft.

8. Tighten center forcing screw until pump drive gear is free from tapered shaft. Remove JDG670A Puller from drive gear.



RG7630 –UN–23NOV97



RG7757 –UN–10NOV97

A—Drive Gear Puller
B—Forcing Screw
C—Cap Screws

Continued on next page

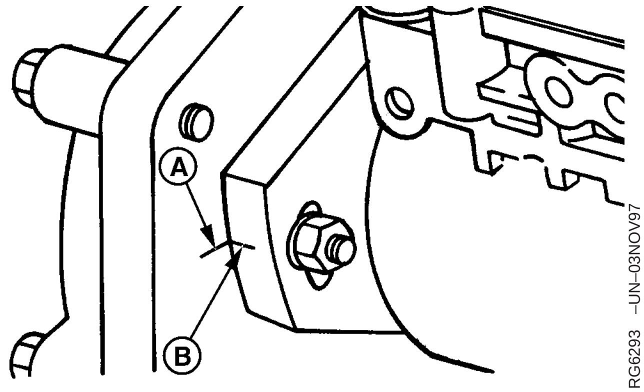
RG,35,JW7609 –19–20NOV97–2/3

35
36

9. Check to make sure that timing marks on back side of front plate (A) and injection pump flange (B) are present and properly aligned. This assures that repaired or replacement pump can be properly timed to engine when installed.

   If timing mark is not clearly visible on front plate, scribe a visible reference mark as accurately as possible in-line with mark on pump flange.

10. Remove three injection pump mounting stud nuts. Remove injection pump from mounting studs. Place pump on a clean flat surface and inspect shaft O.D. and drive gear as outlined later in this group. (See INSPECT INJECTION PUMP DRIVE GEAR I.D. AND SHAFT O.D. later in this group).



A—Timing Mark on Front Plate
B—Timing Mark on Pump

RG,35,JW7609 –19–20NOV97–3/3

INSPECT INJECTION PUMP DRIVE GEAR I.D. AND SHAFT O.D.

IMPORTANT: Use a good light source to thoroughly inspect gear I.D. and shaft O.D.

1. Inspect injection pump drive gear I.D. full 360° for metal transfer as a result of slippage on shaft.

2. Inspect injection pump drive shaft O.D. full 360° for presence of metal transfer from gear slippage. Also, check to see if index pin in shaft is not damaged, indicating gear slippage. If there is clear evidence of metal transfer on pump shaft O.D., in drive gear I.D., or if index pin in pump shaft is damaged, injection pump and drive gear MUST BE replaced.

IMPORTANT: When replacing injection pump drive gear or installing a new pump, the tapered surfaces of the pump drive shaft O.D. and drive gear I.D. MUST BE cleaned to remove protective coatings and oily residue. Use a suitable cleaner that does not leave a residue. Mating surfaces MUST BE ASSEMBLED DRY and LUBRICANTS MUST NOT BE USED.

RG,35,JW7608 –19–20NOV97–1/1

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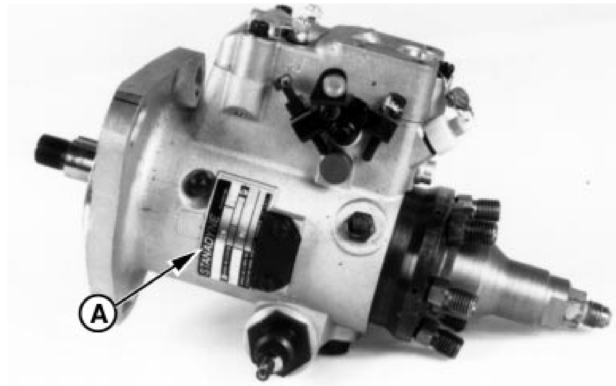
37

REPAIR STANADYNE FUEL INJECTION PUMP



A—Serial Number Tag

IMPORTANT: Do not disassemble the fuel injection pump further than necessary for installing available repair parts—not even for cleaning.

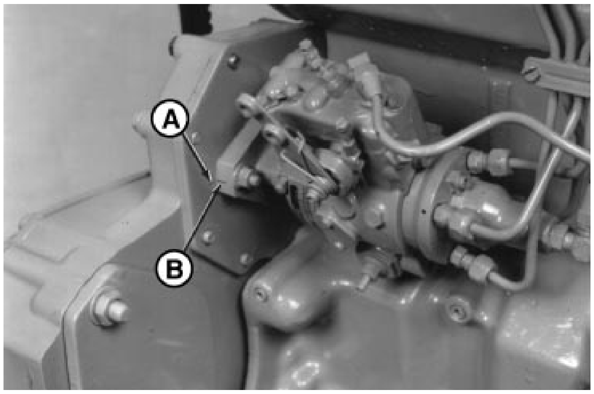
Be sure that injection pump serial number tag (A) is in place and that all identification numbers are legible so that pump is set to the correct specification for its intended application.

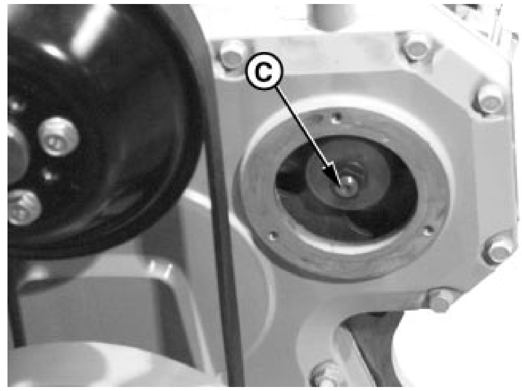
For injection pump repair and testing, have an authorized ADS diesel injection repair station perform the work. Unauthorized repairs made to fuel injection pumps will void warranty.

RG,35,JW7607 –19–20NOV97–1/1

35
38

INSTALL STANADYNE MODEL DB2 AND DB4 INJECTION PUMP





A—Front Plate Timing Mark
B—Pump Timing Mark
C—Pump Drive Gear Retaining Nut

Injection pump mounting flange timing mark (B) and front plate timing mark (A) presence and alignment MUST BE verified before removing pumps from engine. When pump is reinstalled on engine, time pump by aligning these two (external) marks. DO NOT reference internal timing marks (on pump cam ring and governor weight retainer) for accurate pump timing.

1. Lubricate a new square sealing ring with clean engine oil, install ring into groove on front face of pump mounting flange. Slide injection pump onto mounting studs while inserting pump shaft into drive gear.

IMPORTANT: Shaft roll pin may be easily damaged if improperly assembled. Pump drive gear should not move when initially installing pump index pin into drive gear key slot.

2. Check pump shaft and index pin for proper alignment with pump drive gear key slot.

3. Install injection pump partially onto mounting studs without engaging pump pilot hub into engine front plate.

IMPORTANT: DO NOT tighten hex nuts more than three full turns on mounting studs. Pump drive shaft index pin may be damaged if pin is not properly aligned with drive gear key slot and nuts are tightened more than three turns.

4. Install three flat washers, lock washers, and hex nuts onto pump mounting studs. Tighten nuts three turns only so that pump will not fall off mounting studs.

NOTE: The pump drive gear should begin to move forward (away from engine front plate) with the pump when flange is approximately 3.2 mm (1/8 in.) away from engine front plate.

5. Install pump mounting flange flush to engine front plate with drive gear held flush against front side of engine front plate.

IMPORTANT: DO NOT use tightening force of pump mounting stud nuts to pull pump shaft into drive gear I.D.

6. With the pump shaft index pin properly engaged in the drive gear key slot, finger tighten mounting stud nuts.

Continued on next page RG,35,JW7606 –19–20NOV97–1/4

7. Push pump drive gear firmly onto shaft taper. Install washer and retaining nut (C) onto end of shaft. Tighten retaining nut to the following torque specification:

Stanadyne DB2 Fuel Injection Pump Drive Gear-To-Shaft Retaining Nut Torque—Specification

Torque.. 122 N•m (90 lb-ft)

Stanadyne DB4 Fuel Injection Pump Drive Gear-To-Shaft Retaining Nut Torque—Specification

Torque.. 203 N•m (150 lb-ft)

Continued on next page RG,35,JW7606 –19–20NOV97–2/4

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40

IMPORTANT: Do NOT overtighten cap screws on pump cover plate to avoid damage to O-ring.

8. Install access cover plate using a new O-ring, if needed. Apply LOCTITE® 242 (TY9370) to cap screw threads and tighten to specifications.

Rotary Injection Pump Front Access Plate Cap Screws—Specification

Torque .... 2 N•m (1.7 lb-ft) (20 lb-in.)

9. Align timing mark on pump flange with timing mark on front plate.

10. Tighten three hex nuts securing the pump to the front plate to specifications.

Rotary Injection Pump Mounting Nuts—Specification

Torque .... 27 N•m (20 lb-ft)

11. Connect injection pump pressure lines (E). Beginning with outlet (B) and continue around the pump head in counterclockwise direction, attaching lines in same order as engine firing (1-5-3-6-2-4 on 6-cylinder engines and 1-3-4-2 on 4-cylinder engines).

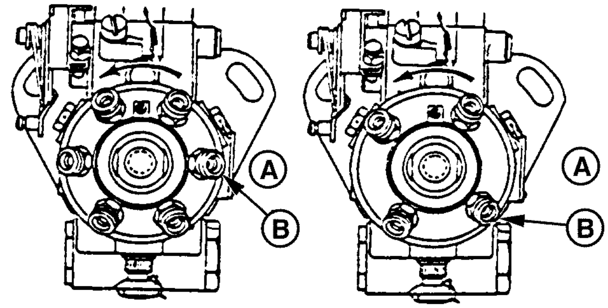
12. Tighten fuel delivery (pressure) lines at pump to specifications, using a suitable 17 mm deep-well socket.

Fuel Injection Pump Delivery Lines (At Pump)—Specification

Torque .... 27 N•m (20 lb-ft)

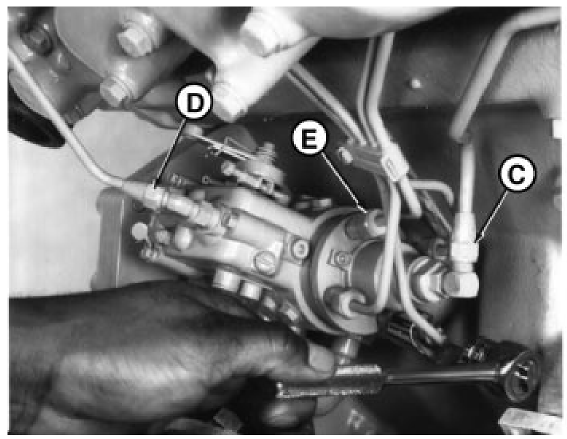
IMPORTANT: ALWAYS use a backup wrench when loosening or tightening fuel delivery lines at fuel injection pump, so that the pump discharge fittings are not altered. This prevents possible internal pump damage.

13. Connect fuel supply line (C) and fuel return line (D).



RG9089 –UN–19MAR98

6-Cyl Engine (Left) 4-Cyl Engine (Right)



RG5664 –UN–03NOV97

A—Engine Block Side
B—Outlet Connection to No.1 Cylinder
C—Fuel Supply Line
D—Fuel Return Line
E—Fuel Delivery (Pressure) Lines

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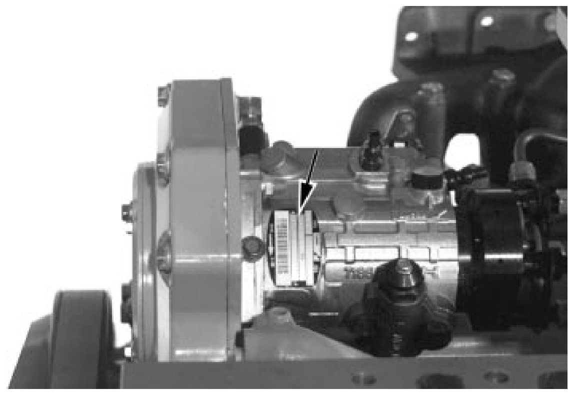
RG,35,JW7606 –19–20NOV97–3/4

14. Connect fuel shut-off cable and speed control linkage, if equipped. Install and securely tighten electrical connections to shut-off solenoid and throttle positioning solenoid, if equipped. Connect cold start switch, if equipped.

15. Bleed air from fuel system as outlined in Group 115. Start engine, run for several minutes and check entire fuel system for leaks.

RG,35,JW7606 –19–20NOV97–4/4

REMOVE LUCAS FUEL INJECTION PUMP

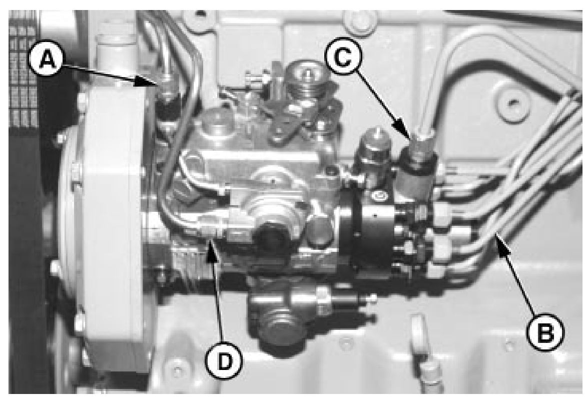

RG7722 –UN–07NOV97

NOTE: The injection pump serial number tag (bold arrow) is located on the bottom of the pump.

IMPORTANT: Never steam clean or pour cold water on a fuel injection pump while the pump is running or while it is warm. Doing so may cause seizure of internal rotating pump parts.

1. Clean the fuel injection pump, lines and area around the pump with cleaning solvent or a steam cleaner.

2. Disconnect shut-off cable and speed control linkage, if equipped. Disconnect electrical connection to shut-off solenoid or throttle positioning solenoid, if equipped. Disconnect cold start switch, if equipped. Tag electrical wires for correct reassembly.



RG9069 –UN–16MAR98

A—Fuel Return Line
B—Fuel Delivery (Pressure) Lines
C—Fuel Supply Line
D—Aneroid Line

IMPORTANT: ALWAYS use a backup wrench when loosening or tightening fuel lines at injection pump so that discharge fittings are not altered to prevent possible internal pump damage.

3. Disconnect fuel return line (A), fuel supply line (C) and aneroid line (D).

4. Disconnect all fuel delivery (pressure) lines (B) from injection pump using a suitable 17 mm deep-well crowsfoot socket.

Continued on next page

RG,35,JW7605 –19–20NOV97–1/4

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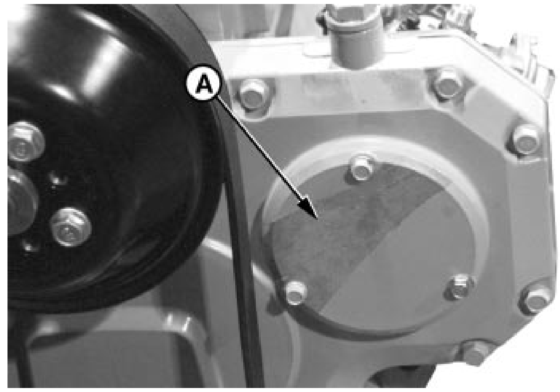
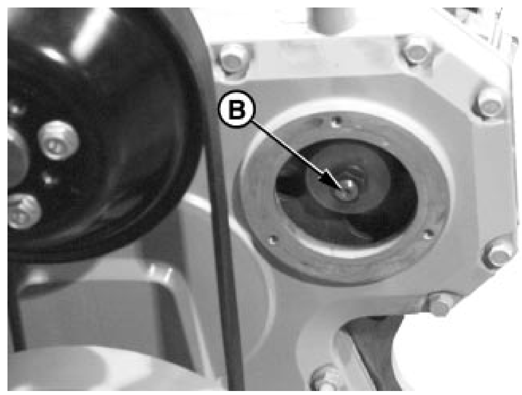
5. Remove injection pump drive gear cover (A). Remove drive gear retaining nut (B) and washer from end of pump shaft. Be careful not to let washer fall inside timing gear cover.





A—Drive Gear Cover
B—Drive Gear Retaining Nut

Continued on next page RG,35,JW7605 –19–20NOV97–2/4

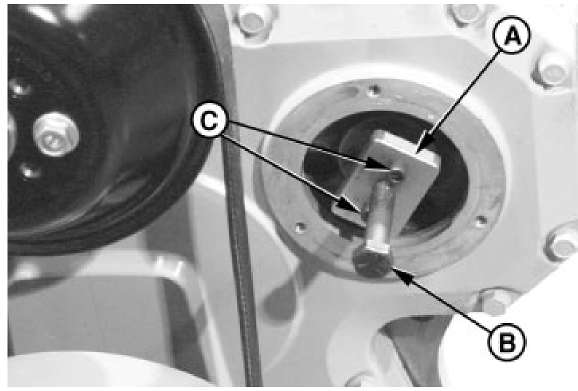
NOTE: *The injection pump drive gear fits snugly onto a tapered drive shaft and is indexed by a Woodruff key installed in drive shaft. Use JDG670A Drive Gear Puller (A) to remove drive gear from shaft.*

6. Attach JDG670A Drive Gear Puller to injection pump drive gear as shown. Follow instructions provided with tool set.

NOTE: *Replace 6 mm, Grade 12.9 cap screws (C) as needed.*

7. Evenly tighten the two 6 mm, Grade 12.9 screws (threaded in drive gear) and snugly tighten center forcing screw (B) against end of pump shaft.

8. Tighten center forcing screw until pump drive gear is free from tapered shaft. Remove JDG670A Puller from drive gear.



RG7631 –UN–06NOV97

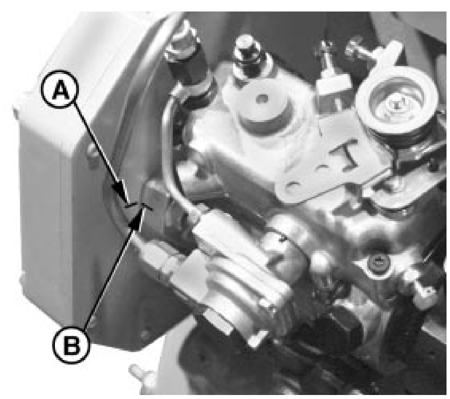
A—Drive Gear Puller
B—Forcing Screw
C—Cap Screws

RG,35,JW7605 –19–20NOV97–3/4

9. Check to make sure that timing marks on back side of front plate (A) and injection pump flange (B) are present and properly aligned. This assures that repaired or replacement pump can be properly timed to engine when installed.

   If timing mark is not clearly visible on front plate, scribe a visible reference mark as accurately as possible in-line with mark on pump flange.

10. Remove injection pump mounting stud nuts. Remove injection pump from mounting studs.



RG7723A –UN–07NOV97

A—Timing Mark on Front Plate
B—Timing Mark on Injection Pump

RG,35,JW7605 –19–20NOV97–4/4

REPAIR LUCAS FUEL INJECTION PUMP

IMPORTANT: DO NOT disassemble the Lucas fuel injection pump any further than necessary for installing available repair parts, not even for cleaning.

Have an authorized ADS Diesel Repair Station perform all injection pump testing, adjustments, and repairs.

RG,35,JW7604 –19–20NOV97–1/1

INSTALL LUCAS FUEL INJECTION PUMP

IMPORTANT: When replacing injection pump drive gear or installing a new pump, the tapered surfaces of the pump drive shaft O.D. and drive gear I.D. MUST BE cleaned to remove protective coatings and oily residue. Use a suitable cleaner that does not leave a residue. Mating surfaces MUST BE assembled dry. LUBRICANTS MUST NOT BE USED.

1. Place a new O-ring onto front face of pump mounting flange with mounting slots aligned. Slide injection pump onto mounting studs while inserting pump shaft into drive gear.

2. Check pump shaft Woodruff key for proper alignment with pump drive gear key slot.

3. Install injection pump partially onto mounting studs with engaging pump pilot hub into engine front plate.

4. Install three flat washers, lock washers, and hex nuts onto pump mounting studs. Tighten nuts three turns only so that pump will not fall off mounting studs.

5. Install pump mounting flange flush to engine front plate with drive gear held flush against front side of engine front plate.

6. With the pump shaft key properly engaged in the drive gear key slot, finger tighten mounting stud nuts.

Continued on next page

RG,35,JW7603 –19–20NOV97–1/5

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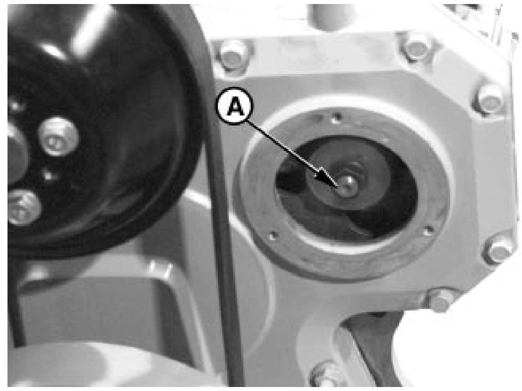
45

7. Push pump drive gear firmly onto shaft taper. Install washer and retaining nut (A) onto end of shaft. Tighten retaining nut to following specifications:

DP201 and DP203 Lucas Fuel Injection Pump Drive Gear-To-Shaft Retaining Nut—Specification

Torque .... 81 N•m (60 lb-ft)



RG7630A –UN–06NOV97

A—Drive Gear Retaining Nut

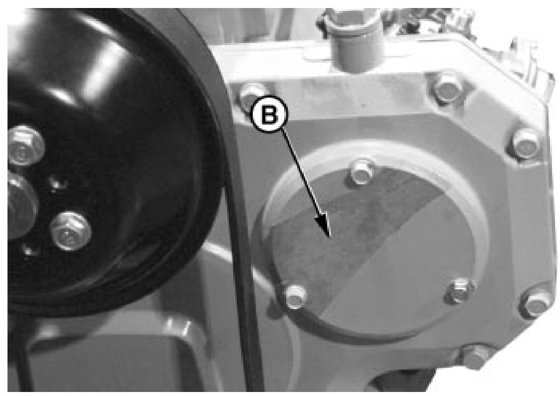
RG,35,JW7603 –19–20NOV97–2/5

IMPORTANT: DO NOT overtighten cap screws on pump cover plate to avoid damage to O-ring.

8. Install access cover plate (B) using a new O-ring, if needed. Apply LOCTITE® 242 (TY9370) to cap screw threads and tighten to specifications.

Rotary Injection Pump Front Access Plate Cap Screws—Specification

Torque .... 2 N•m (1.7 lb-ft) (20 lb-in.)



RG7629B –UN–06NOV97

B—Injection Pump Drive Cover

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RG,35,JW7603 –19–20NOV97–3/5

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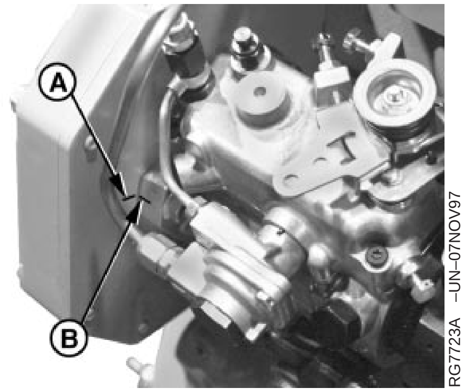
9. Align timing mark on the pump flange (B) with timing mark on front plate (A).

10. Tighten hex nuts securing the pump to the front plate to specifications.

Rotary Injection Pump Mounting Nuts—Specification

Torque .... 27 N•m (20 lb-ft)



A—Timing Mark on Front Plate
B—Timing Mark on Injection Pump

Continued on next page RG,35,JW7603 –19–20NOV97–4/5

11. Connect injection pump pressure lines (E). Beginning with outlet (B) and continue around the pump head in counterclockwise direction, attaching lines in same order as engine firing (1-5-3-6-2-4 on 6-cylinder engines and 1-3-4-2 on 4-cylinder engines).

12. Tighten fuel delivery (pressure) lines at pump to specifications, using a suitable 17 mm deep-well socket.

Fuel Injection Pump Delivery Lines—Specification

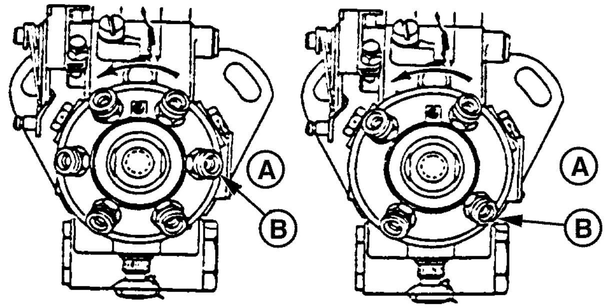
Torque .... 27 N•m (20 lb-ft)

IMPORTANT: ALWAYS use a backup wrench when loosening or tightening fuel delivery lines at fuel injection pump, so that the pump discharge fittings are not altered. This prevents possible internal pump damage.

13. Connect fuel supply line (C), fuel return line (D) and aneroid line (F).

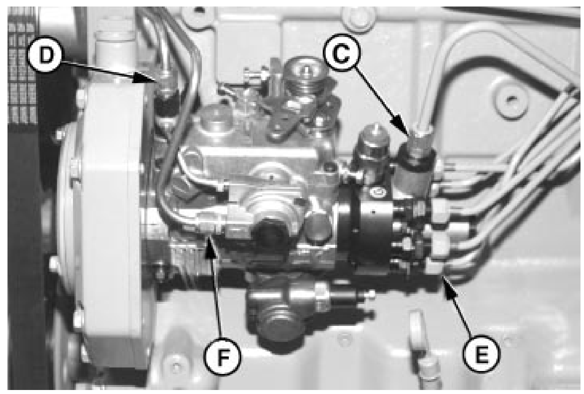
14. Connect fuel shut-off cable and speed control linkage, if equipped. Install and securely tighten electrical connections to shut-off solenoid and throttle positioning solenoid, if equipped. Connect cold start switch, if equipped.

15. Bleed air from fuel system as outlined in Group 115. Start engine, run for several minutes and check entire fuel system for leaks.



RG9089 –UN–19MAR98

6-Cyl Engine (Left) 4-Cyl Engine (Right)



RG9070 –UN–16MAR98

A—Engine Block Side
B—Outlet Connection to No. 1 Cylinder
C—Fuel Supply Line
D—Fuel Return Line
E—Fuel Delivery (Pressure) Lines
F—Aneroid Line

RG,35,JW7603 –19–20NOV97–5/5

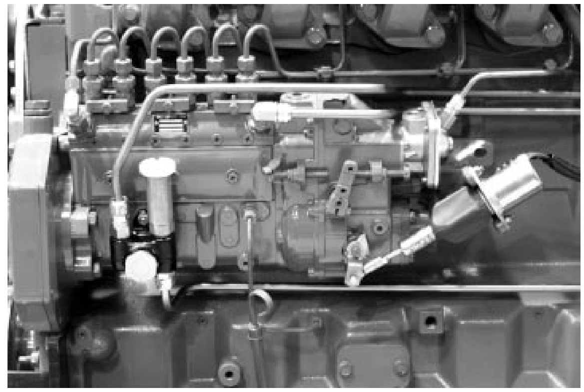
35
48

REMOVE IN-LINE FUEL INJECTION PUMP

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

1. Clean injection lines and area around the injection pump with cleaning solvent or a steam cleaner.

2. Using JDG820 or JDE83 Flywheel Turning Tool, rotate engine flywheel (in normal running direction) until No. 1 piston is at "TDC" of its compression stroke. At this point, JDE81-4 Timing Pin should enter hole in flywheel.



RG7748 –UN–06DEC96

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RG,35,JW7602 –19–20NOV97–1/3

3. Remove injection pump drive gear cover and O-ring.

4. Install JDG886 Injection Pump Timing Pin (A) through injection pump drive gear into injection pump hub until it bottoms. In some instances, it may be necessary to rotate the pump drive hub slightly to get the pin installed.

5. Disconnect injection pump lube line (B).

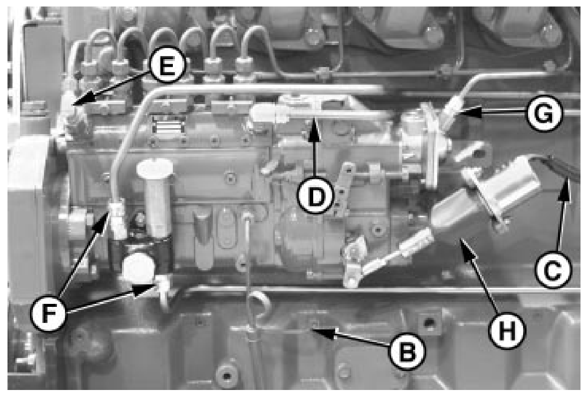
6. Disconnect fuel shutoff solenoid electrical connector (C).

7. Remove fuel inlet line (D). Remove fuel leak-off line (E).

8. Disconnect fuel supply pump lines (F).

9. Disconnect aneroid line (G).

RG8065A –UN–18NOV97



RG7750A –UN–07NOV97

A—JDG886 Injection Pump Timing Pin
B—Injection Pump Lube Line
C—Fuel Shutoff Solenoid Electrical Connector
D—Fuel Inlet Line
E—Fuel Leak-off Line
F—Fuel Supply Pump Lines
G—Aneroid Line
H—Fuel Shutoff Solenoid

Continued on next page RG,35,JW7602 –19–20NOV97–2/3

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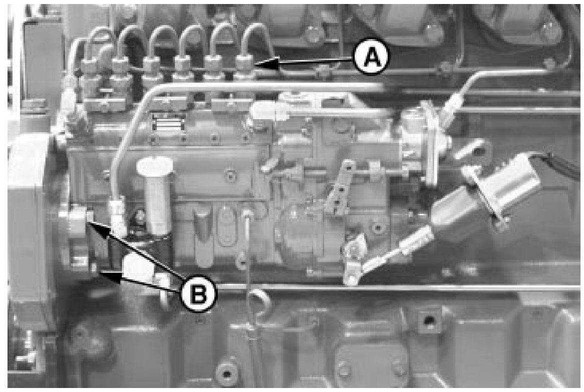
10. Remove fuel injection line nuts (A).

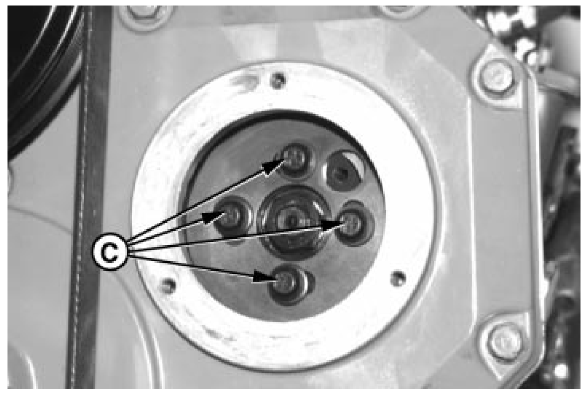
11. Remove four injection pump drive gear cap screws (C).

12. Remove four mounting stud nuts (B) which secure injection pump to cylinder block.

13. Carefully remove injection pump from mounting studs and place it on a clean flat surface.



RG7750B –UN–07NOV97



RG8066B –UN–18NOV97

A—Injection Line Nuts
B—Mounting Nuts
C—Cap Screws

RG,35,JW7602 –19–20NOV97–3/3

REPAIR IN-LINE FUEL INJECTION PUMP

IMPORTANT: Do not disassemble fuel injection pump further than necessary for installing available service parts, not even for cleaning.

Be sure that injection pump serial number tag is in place and that all identification numbers are legible so that pump is set to the correct specifications for its intended use.

NOTE: Remove JDG886 Injection Pump Timing Pin (A) when sending an injection pump out for repair.

For injection pump repair and testing, have an authorized diesel injection repair station perform the work. Unauthorized repairs made to the injection pump will void warranty.

A—Timing Pin

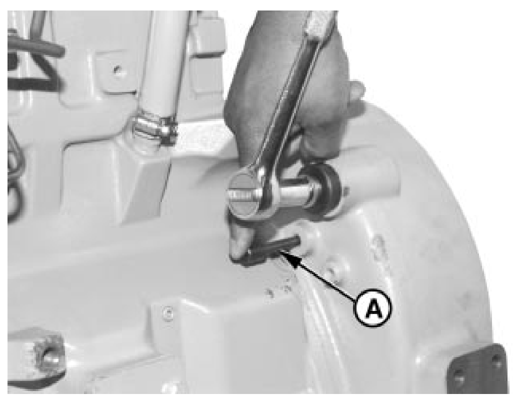
RG,35,JW7601 –19–20NOV97–1/1

INSTALL IN-LINE FUEL INJECTION PUMP

NOTE: To eleminate any backlash that might exist in the timing gear train, rotate flywheel in the direction of normal engine rotation (counterclockwise viewed from flywheel end) when installing JDE81-4 Timing Pin.

1. If engine was rotated after injection pump was removed, rotate flywheel in the direction of normal engine rotation until JDE81-4 Timing Pin (A) enters flywheel at No. 1 cylinder's "TDC" compression stroke.

NOTE: When No. 1 cylinder is at "TDC" compression stroke, intake and exhaust valves for No. 1 cylinder will be closed and both rocker arms will be loose.



A—Timing Pin

Continued on next page

RG,35,JW7600 –19–20NOV97–1/6

35
52

2. Rotate injection pump drive hub until marks on drive hub (B) and pointer (A) are aligned.

NOTE: It may be necessary to rotate pump hub slightly to allow JDG886 Injection Pump Timing Pin (E) to enter bearing plate.

3. Thread JDG886 Timing Pin into drive hub as shown, and tighten until it bottoms against the drive hub with the timing pin located in hole of pointer (A).

4. Install a new O-ring (C) on bearing plate. Lightly lubricate O-ring with AR54749 Soap Lubricant to aid in pump installation and prevent O-ring damage.

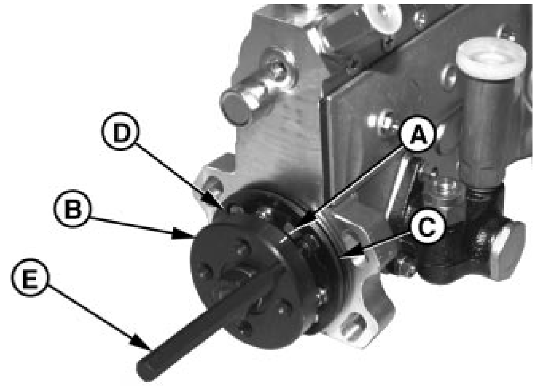
5. Install injection pump using moderate forward pressure and slight rocking motion to work O-ring into mounting bore. Injection pump flange should seat solidly against cylinder block.

6. Install mounting stud nuts and tighten to specifications.

Nippondenso Injection Pump Mounting Nuts—Specification

Torque .... 70 N•m (52 lb-ft)

7. Carefully install drive gear on pump drive hub, position gear so mounting cap screws are approximately centered in mounting slots. This will allow for minor adjustment of pump timing, should the need arise.



RG8053B –UN–18NOV97

RG8065B –UN–18NOV97

A—Pointer
B—Drive Hub
C—O-Ring
D—Bearing Plate
E—JDG886 Injection Pump Timing Pin

Continued on next page RG,35,JW7600 –19–20NOV97–2/6

35
53

NOTE: When installing drive gear-to-pump hub cap screws (B), apply a slight clockwise force to drive gear to eliminate any backlash with camshaft gear.

8. Install drive gear-to-pump hub cap screws (B) and tighten to specifications.

Nippondenso Injection Pump Drive Gear Cap Screws—Specification

Torque .... 47 N•m (35 lb-ft)

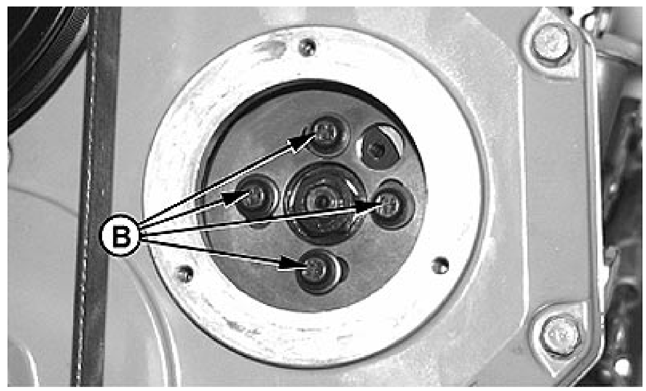
9. Remove JDG886 Injection Pump Timing Pin (A) from injection pump hub.

10. Install injection pump drive gear cover using a new O-ring, if needed. Tighten cap screws to specifications.

Nippondenso Injection Pump Drive Gear Cover—Specification

Torque .... 5 N•m (3.7 lb-ft) (44 lb-in.)

RG8065A –UN–18NOV97



RG9138 –UN–18MAY98

A—Timing Pin
B—Cap Screws

Continued on next page

RG,35,JW7600 –19–20NOV97–3/6

35
54

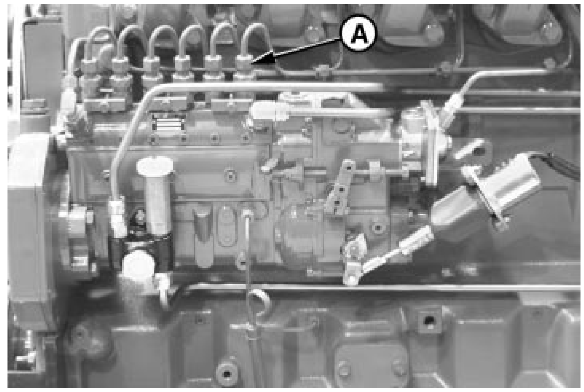
IMPORTANT: DO NOT move delivery valve fittings while tightening line nuts. If delivery valve and barrel housing rotates while tightening a fuel line nut, injection pump fuel delivery will be altered. The injection pump will have to be recalibrated on a test stand by an authorized diesel repair station.

NOTE: Remove protective caps and plugs that were installed on fuel system components during injection pump removal.

11. Connect fuel delivery lines (A). Tighten line nuts to specifications.

Fuel Injection Pump Delivery Lines—Specification

Torque .... 27 N•m (20 lb-ft)



RG7750C –UN–07NOV97

A—Fuel Delivery Lines

RG,35,JW7600 –19–20NOV97–4/6

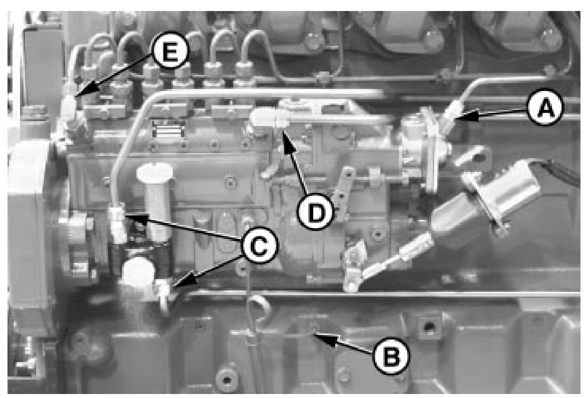
12. Connect aneroid line (A).

13. Connect fuel supply pump lines (C).

14. Connect fuel inlet line (D) and leak-off line (E).

15. Connect injection pump oil line (B) to cylinder block fitting.

16. Connect fuel shutoff solenoid connector.



RG7750D –UN–26NOV97

A—Aneroid Line
B—Injection Pump Oil Line
C—Fuel Supply Pump Lines
D—Fuel Inlet Line
E—Leak-Off Line

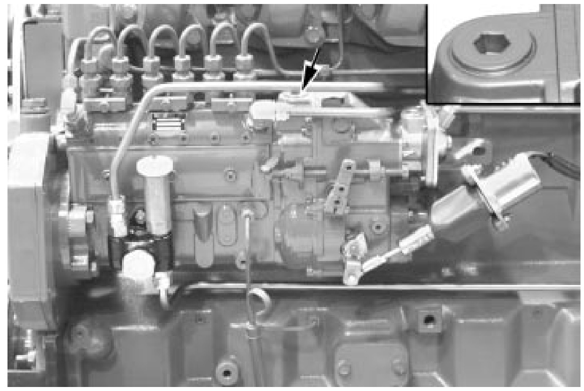
Continued on next page

RG,35,JW7600 –19–20NOV97–5/6

17. Remove oil fill plug (arrow) from governor housing and add 3/4 pint of clean engine oil. (On later pumps with no oil plug, remove supply pump from side of pump housing and pour oil in.)

18. Bleed fuel system. (See BLEED THE FUEL SYSTEM in Group 115.)

19. Connect throttle levers and adjust engine speeds as required. (See ADJUST ENGINE SPEEDS in Group 115.)



RG7752 –UN–10NOV97

RG,35,JW7600 –19–20NOV97–6/6

REPAIR ANEROID

For aneroid (A) 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.

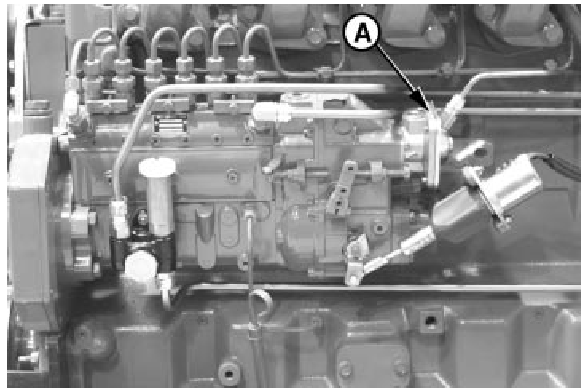
Aneroid Pressure (Lever Lift-Off)—Specification

Pressure .... 76—102 mm Hg (3—4 in. Hg)
10—14 kPa (1.5—2.0 psi)

Aneroid Pressure (Lever at Full Travel)—Specification

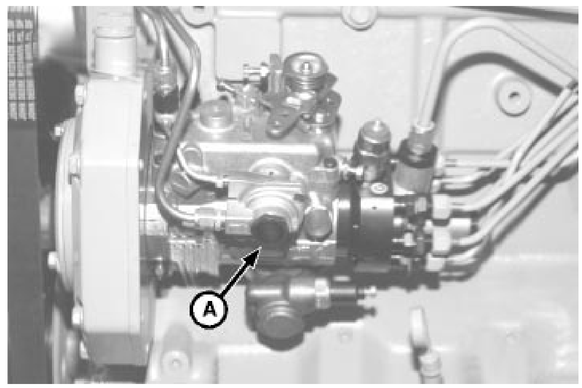
Pressure .... 330—380 mm Hg (13—14 in. Hg)
44—51 kPa (6.4—7.4 psi)

IMPORTANT: Correct aneroid adjustments are essential for satisfactory engine performance. Whenever aneroid has been disassembled or adjustments have been altered, injection pump (including aneroid) must be calibrated on test stand before releasing pump for service.



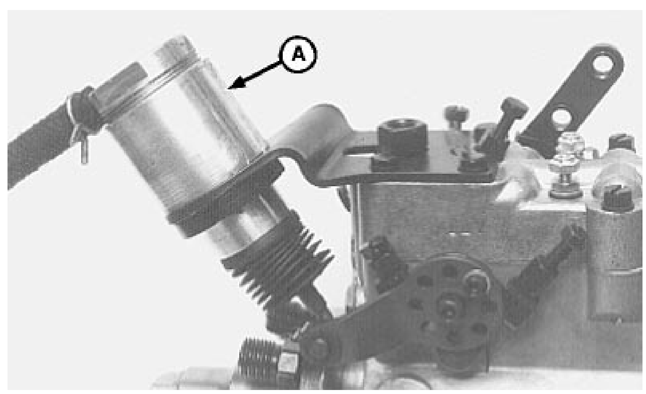
RG7748B –UN–07NOV97

Nippondenso Aneroid



RG9092 –UN–27MAR98

Lucas Aneroid



RG9093 –UN–27MAR98

Stanadyne Aneroid

A—Aneroid

RG,35,JW7599 –19–20NOV97–1/1

TRANSFER FUEL INJECTION PUMP TIMING MARK ONTO REPLACEMENT FRONT PLATE

IMPORTANT: Replacement front plates do not have an injection pump timing mark. It is extremely important that the timing mark be accurately transferred from original front plate to the replacement plate in the exact location for correct injection pump timing.

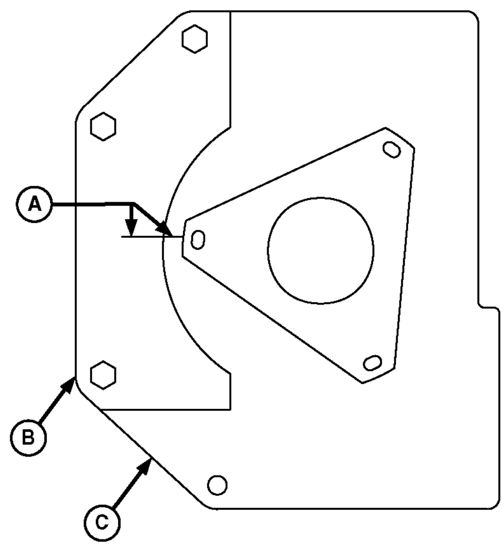
1. Position DFRG5 Aluminum Template (B) onto original front plate (C) as shown. (See Group 199, Dealer Fabricated Tools for manufacturing details.) Install three 3/8-16 cap screws securely.

2. Transfer injection pump timing mark (A) from previous front plate onto template using a fine tip marker and straightedge. Remove template from front plate being replaced.

3. Attach template (with timing mark) to new replacement front plate and tighten cap screws securely.

4. Transfer timing mark from the template to the new front plate using a scribe. Scribe deep enough so mark becomes a permanent reference.

5. Remove template from front plate and refer to Group 16 for front plate installation procedure.



RG9057 –UN–16MAR98

Front Plate (Viewed From Pump Side)

A—Injection Pump Timing Mark
B—Aluminum Template
C—Front Plate

RG,35,JW7598 –19–20NOV97–1/1

35
58

REMOVE FUEL INJECTION NOZZLES

General Nozzle Service Precautions:

Before removal, thoroughly remove all dirt from the cylinder head around fuel injection nozzles. Clean with compressed air to prevent dirt from entering the cylinders. Plug the bore in the cylinder head after each nozzle has been removed. Cap fuel line openings as soon as they are disconnected.

Immediately fit protective caps over the nozzle tips and the line connections to avoid handling damage and getting debris in fuel system.

Do not bend the fuel delivery lines, as this may affect their durability. When loosening the fuel pressure lines, hold male union of nozzle line stationary with a backup wrench.

RG,35,JW7597 –19–20NOV97–1/4

NOTE: When all fuel injection nozzles have to be removed, disconnect leak-off line and remove as a complete assembly. For individual nozzle removal, remove only the section of leak-off line necessary for nozzle removal.

1. Loosen tube nuts at each nozzle to remove leak-off lines and T-fittings as an assembly.

RG7724 –UN–23NOV97

RG,35,JW7597 –19–20NOV97–2/4

2. Disconnect fuel injection line from nozzle using a backup wrench on nozzle connection as shown.

3. Remove cap screw securing nozzle in cylinder head nozzle bore.

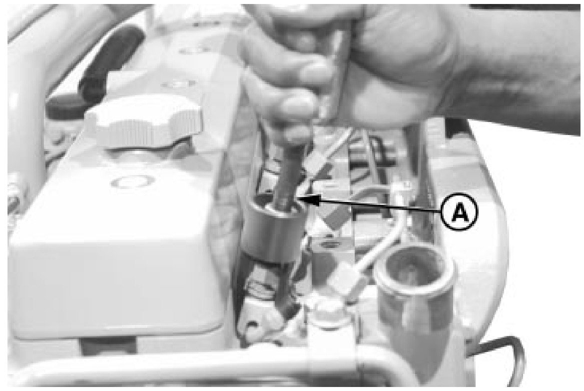
RG7725 –UN–08JAN97

Continued on next page

RG,35,JW7597 –19–20NOV97–3/4

4. Pull injection nozzle out of cylinder head using JDE38B Injection Nozzle Puller Set (A) or JDG716 Adapter and slide handle from JDE38 or JDE38A Puller Set.

IMPORTANT: Do not use screwdrivers, pry bars, or similar tools for this as they might damage the injection nozzle beyond repair.



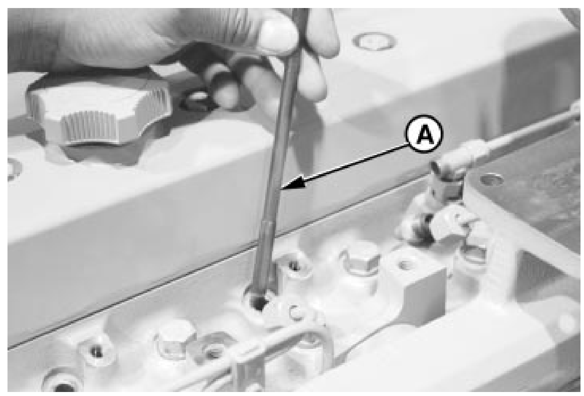
A—Nozzle Puller

RG,35,JW7597 –19–20NOV97–4/4

CLEAN FUEL INJECTION NOZZLE BORE

IMPORTANT: Always turn tool clockwise in bore to prevent dulling of cutting edges, even when removing tool from bore.

Clean injection nozzle bore using JDE39 Nozzle Bore Cleaning Tool (A). Blow debris from bore using compressed air, and plug the bore to prevent entry of foreign material.



A—Nozzle Bore Cleaning Tool

RG,35,JW7596 –19–20NOV97–1/1

35
60

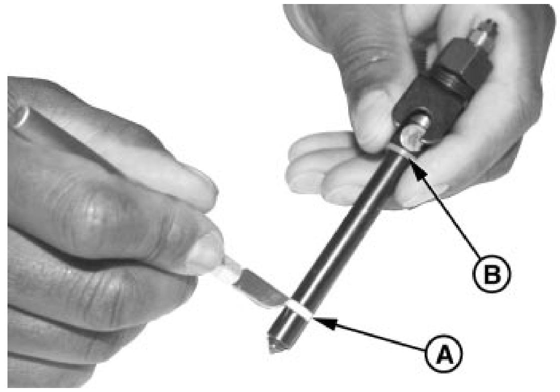
CLEAN FUEL INJECTION NOZZLES

1. Remove carbon stop seal (A) from groove in nozzle body using razor blade or sharp knife and remove upper sealing washer (B). Discard seal and washer.

2. Place nozzle in solvent or clean diesel fuel, so carbon stop seal groove is submerged, and soak for a while.

IMPORTANT: Do not scrape or disturb the TEFLON® coating on the nozzle body above the carbon stop seal groove. This coating will become discolored during normal operation, but this is not harmful. Do not use a motor-driven brush to clean nozzle body.

3. After soaking, clean nozzle tip with brass wire brush. Never use a steel wire brush or scraper.



RG7798 –UN–11NOV97

A—Carbon Stop Seal
B—Upper Sealing Washer

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RG,35,JW7595 –19–20NOV97–1/1

DIAGNOSE FUEL INJECTION NOZZLE MALFUNCTION

Problem	Possible Cause	Suggested Remedy
Failed Carbon Stop Seal Washer	Nozzle replaced without using new seal or washer.	Install new seal or washer.
	Carbon stop seal groove not cleaned when new seal was installed.	Clean groove. Install new seal.
Incorrect Opening Pressure	Improper adjustment.	Adjust opening pressure.
	Broken spring.	Replace spring.
Nozzle Will Not Open	Plugged orifices.	Clean.
	Chipped orifices.	Replace nozzle.
	Bottomed lift screw.	Adjust lift screw.
Poor Spray Pattern	Plugged orifices.	Clean.
	Chipped orifices.	Replace nozzle.
	Cracked nozzle tip.	Replace nozzle.
Poor Atomization	Plugged orifice.	Clean.
	Chipped orifice.	Replace nozzle.
	Cracked nozzle tip.	Replace nozzle.
	Valve not free.	See “Inconsistent Chatter”.
Inconsistent Chatter	Spring components misaligned.	Adjust opening pressure.
	Varnish on valve.	Clean guide area.
	Deposits in seat area.	Clean seat.
	Bent valve.	Replace nozzle.
	Distorted body.	Replace nozzle.
No Chatter	Spring components misaligned.	Adjust opening pressure.
	Varnish on valve.	Clean guide area.
	Deposits in seat area.	Clean seat.
	Bent valve.	Replace nozzle.
	Valve seat eroded or pitted.	Lap valve to seat. Replace nozzle as necessary.
	Tip seat pitted.	Lap tip to seat. Replace nozzle as necessary.
	Seat interference angle worn.	Replace nozzle.
	Distorted body.	Replace nozzle.
Seat Leakage	Deposits in seat area.	Clean seat.
	Valve seat eroded or pitted.	Lap valve to seat. Replace nozzle as necessary.
	Tip seat pitted.	Lap tip to seat. Replace nozzle as necessary.
	Valve not free.	See “Inconsistent Chatter”. See “No Chatter”.
	Distorted body.	Replace nozzle.
	Cracked tip.	Replace nozzle.
High Leak-Off	Wear or Scratched at Guide	Lap valve to guide. Replace nozzle as necessary.
Low Leak-Off	Varnish on valve.	Clean guide area.
	Insufficient clearance.	Clean nozzle. Lap valve to guide. Replace nozzle as necessary.

RG,35,JW7594 –19–20NOV97–1/1

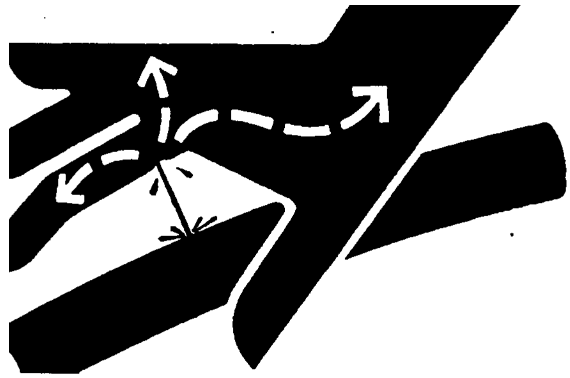
35
62

TEST FUEL INJECTION NOZZLES

CAUTION: The nozzle tip should always be directed away from the operator. Fuel from the spray orifices can penetrate clothing and skin causing serious personal injury. Enclosing the nozzle in a clear glass beaker is recommended.

Before applying pressure to the nozzle tester, be sure that all connections are tight, and that the fittings are not damaged. Fluid escaping from a very small hole can be almost invisible. To search for suspected leaks, use a piece of cardboard or wood, rather than hands.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.



X9811 –UN–23AUG88

1. Connect injection nozzle to nozzle tester.

Continued on next page

RG,35,JW7592 –19–20NOV97–1/6

NOTE: When using the Bosch tester (JT25510), use the KJD10109 Fuel Line and connect line to tester and nozzle.

2. Use Y900-3, Y900-5 Adapters (C) and Y900-2 Fuel Line (B) from D01110AA Adapter Set to connect nozzles to D01109AA Nozzle Tester.

3. Position tip of nozzle below top of beaker (D) and back out 30° from vertical. This is necessary to contain all spray in beaker, as nozzle spray pattern is at an angle to the nozzle centerline. Leave connections slightly loose.

NOTE: Rapid operation of pump handle will result in inaccurate cracking pressure readings and cause undue wear on gauge.

4. Pump handle several strokes to flush air from lines and to determine the pumping rate required for proper fuel atomization. Tighten all connections securely after all air has been expelled from nozzle and line.

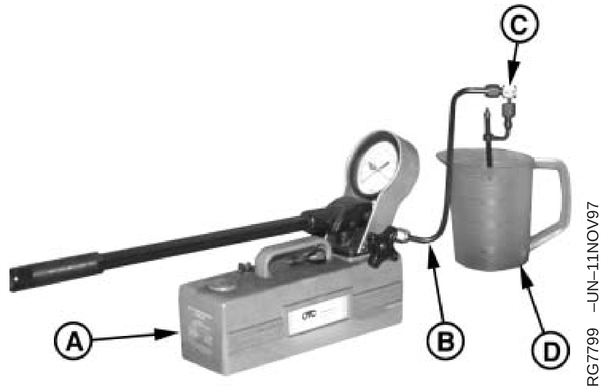
IMPORTANT: Make sure that nozzle tester is in good condition and that gauge works properly. Service nozzle tester as recommended in the operating instructions provided with tester.

OPENING PRESSURE TEST

NOTE: Actual nozzle opening pressure is less important than equal opening pressure of all nozzles. For maximum variation between nozzles see specifications below.

1. Actuate the nozzle tester rapidly several times to allow the valve to seat rapidly.

2. Open gauge valve, actuate the tester and raise the pressure to a point where the gauge needle falls rapidly. This is the nozzle opening pressure, and should be as specified for a new or used nozzle.



A—Nozzle Tester
B—Fuel Line
C—Adapters
D—Beaker

Continued on next page

RG,35,JW7592 –19–20NOV97–2/6

35
64

NOTE: In a few applications, RE60062 Nozzles (normally used on aspirated engines), may be specified for turbocharged (T or H) engines. In these cases, use specifications listed below for naturally aspirated (D) engines.

3. Refer to the following specifications for RE60062 nozzles on naturally aspirated (D) engines:

Opening Pressure of New or Reconditioned Nozzle With New Internal Parts—Specification

Opening Pressure For Setting .... 24130—24480 kPa (241—244 bar) (3500—3550 psi)
Opening Pressure For Checking............ 21800 kPa (218 bar) (3160 psi) (Minimum)

Minimum Acceptable Opening Pressure of Used Nozzle—Specification

Opening Pressure For Checking............ 19850 kPa (198 bar) (2880 psi) (Minimum)

Maximum Opening Pressure Difference Between Cylinders—Specification

Maximum Pressure Difference.......................... 700 kPa (7 bar) (100 psi)

4. Refer to the following specifications for RE48786 nozzles on turbocharged (T or H engines):

Opening Pressure of New or Reconditioned Nozzle With New Internal Parts—Specification

Opening Pressure For Setting .... 25900—26200 kPa (259—262 bar) (3750—3800 psi)
Opening Pressure For Checking............ 25200 kPa (252 bar) (3660 psi) (Minimum)

Minimum Acceptable Opening Pressure of Used Nozzle—Specification

Opening Pressure For Checking............ 22950 kPa (230 bar) (3330 psi) (Minimum)

Maximum Opening Pressure Difference Between Cylinders—Specification

Maximum Pressure Difference.......................... 700 kPa (7 bar) (100 psi)

Continued on next page

RG,35,JW7592 –19–20NOV97–3/6

IMPORTANT: If any of the nozzle opening pressures are not within specified range, reset pressure and valve lift BEFORE checking chatter and spray pattern. Otherwise, these characteristics may be affected. (See ADJUST FUEL INJECTION NOZZLES later in this group.)

CHATTER TEST

1. Close gauge shut-off valve and operate nozzle tester at a pumping rate that will cause the nozzle to chatter. Nozzle should chatter softly, and spray pattern should be broad and finely atomized.

   If nozzle fails to chatter, the nozzle valve may be bent or tight in its guide due to accumulated lacquer deposits. Disassemble nozzle and correct as detailed later in this group.

NOTE: Until the chattering range is reached, fuel will emerge in non-atomized streams.

2. Using the pumping rate for proper atomization, operate tester for ten strokes. The nozzle must atomize on at least eight of the ten strokes without consecutive misses.

   If the nozzle fails to meet this requirement, repeat procedure. Nozzles which do not meet the requirement after second test should be considered unacceptable and should be either repaired or replaced.

SPRAY PATTERN TEST

1. Close gauge shut-off valve and operate nozzle tester at a pumping rate that will cause the nozzle to chatter.

NOTE: Partially clogged, chipped, or eroded orifices will cause the spray to deviate from the correct angle. Spray will be streaky, rather than finely atomized.

2. Observe spray pattern and check for plugged orifices.

Continued on next page

RG,35,JW7592 –19–20NOV97–4/6

If nozzle fails to chatter or spray properly, disassemble, clean and recondition as outlined later in this group.

Fuel Injection Nozzle Tip—Specification

Spray Angle .... 144°

LEAKAGE TEST

1. Check nozzle for fuel leakage past valve seat by positioning nozzle on nozzle tester with nozzle tip down.

2. Operate pump handle rapidly to firmly seat valve. Wipe the nozzle tip dry with a clean, lint-free cloth.

3. Slowly raise pressure at nozzle to about 2800—3500 kPa (28—35 bar) (400—500 psi) under specified opening pressure and hold at that pressure. Watch for an accumulation of fuel around the nozzle tip orifices.

   If fuel drips from nozzle within 5 seconds, nozzle must be lapped.

Nozzle Valve/Seat Tightness Condition at Pressure Test of 2800—3500 kPa (28—35 bar) (400—500 psi)—Specification

Leakage .... Nozzle tip dry after 5 seconds. (Slight dampness permissible on used nozzles.)

VALVE STEM AND GUIDE WEAR TEST

1. Position nozzle with tip slightly above the horizontal plane.

CAUTION: Completely enclose spray zone in a glass beaker to avoid possible personal injury from spray.

2. Slowly raise pressure to 10 300 kPa (103 bar) (1500 psi) on test gauge

Continued on next page RG,35,JW7592 –19–20NOV97–5/6

NOTE: Leakage rate based on use of No. 2 diesel fuel or an equivalent viscosity of test oil at 18°—24°C (65°—75°F) ambient temperature.

3. Look for leakage from the return end of nozzle. After one drop, leakage should be within specifications.

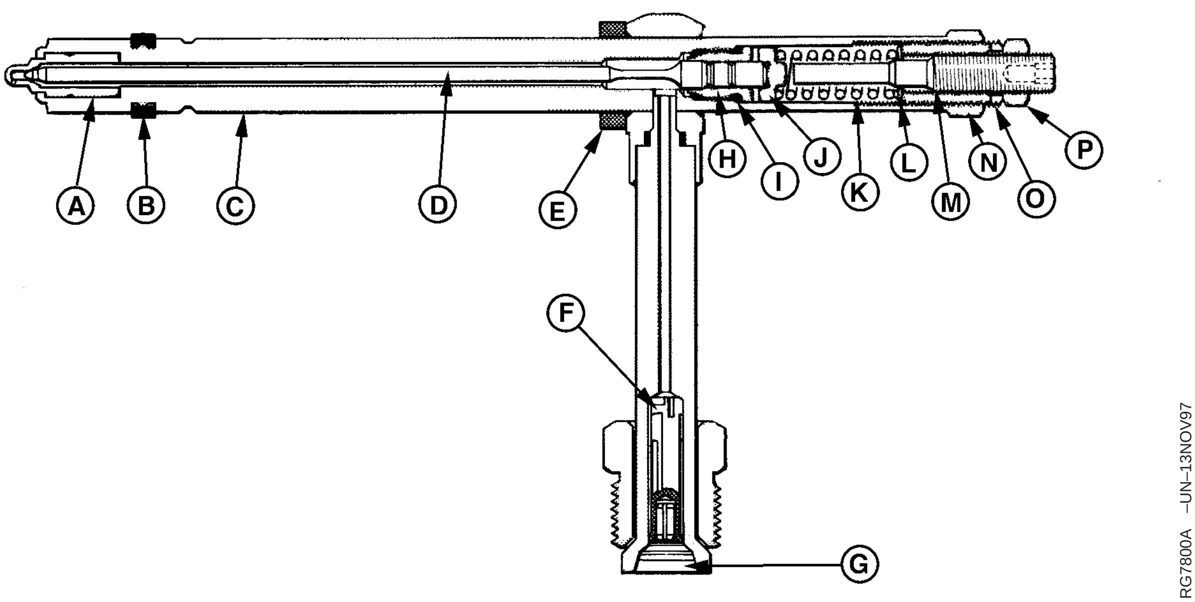
Fuel Injection Nozzle Return Leakage at Pressure Test of 10300 kPa (103 bar) (1500 psi)—Specification

Leakage .... 3—10 Drops/30 Seconds

If nozzle leakage is not within specified range, nozzle must be reconditioned as outlined later in this group.

RG,35,JW7592 –19–20NOV97–6/6

DISASSEMBLE FUEL INJECTION NOZZLES



A—Nozzle Tip
B—Carbon Stop Seal
C—Nozzle Body
D—Nozzle Valve
E—Upper Sealing Washer
F—Edge-Type Filter
G—Fuel Inlet
H—Upper Guide
I—Upper Seal
J—Spring Seat
K—Spring Screw
L—Spring Washer
M—Lift Adjusting Screw
N—Lock Nut
O—Pressure Adjusting
P—Lock Nut

Continued on next page RG,35,JW7591 –19–20NOV97–1/4

35
68

General Nozzle Repair Notes:

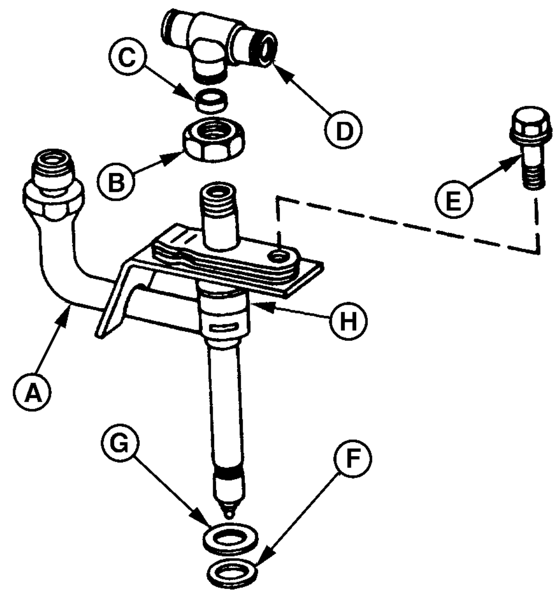
NOTE: Disassembly of nozzles is not recommended unless servicing is indicated by nozzle operation and testing.

Since dirt and water are the worst contaminants in the fuel injection system, the working area, tools and cleaning materials must be kept spotlessly clean. Whenever possible, work in an isolated, dust-free area.

Cover the work bench with clean paper before beginning disassembly of injection nozzles.

As parts are disassembled, place then in a pan of clean diesel fuel and leave there until needed. Do not permit these parts to strike each other.

Use a separate pan of clean fuel for washing parts before assembly.



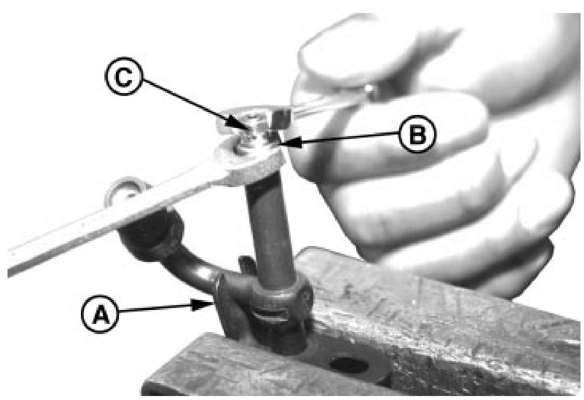
RG9086 –UN–16MAR98

A—Nozzle Assembly
B—Tube Nut
C—Packing
D—Leak-Off-Fitting
E—Cap Screw
F—Carbon Stop Seal
G—Upper Sealing Washer
H—Spacer

RG,35,JW7591 –19–20NOV97–2/4

To Disassemble Fuel Injection Nozzle:

1. Place nozzle in ROS17787 Holding Fixture or nozzle index clamp (A) and secure fixture or clamp in a vise.
2. Loosen pressure adjusting lock nut (B).
3. Back out lift adjusting screw lock nut (C) and lift assembly.
4. Invert nozzle and allow pressure adjusting spring seat and lift adjusting assembly to fall into your hand. Do not bend stem during removal.



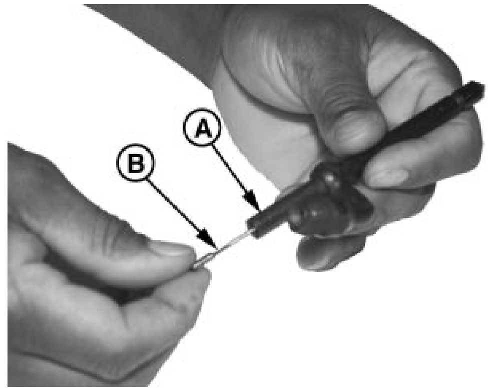
RG7802 –UN–11NOV97

A—Nozzle Index Clamp
B—Pressure Adjusting Lock Nut
C—Lift Adjusting Lock Nut

Continued on next page RG,35,JW7591 –19–20NOV97–3/4

5. If valve does not slide freely from body (A), use No. 16481 Valve Retractor (B) to remove valve.

6. Remove locating clamps and spacer from nozzle body.



RG7803 –UN–11NOV97

A—Valve Body
B—Valve Retractor

RG,35,JW7591 –19–20NOV97–4/4

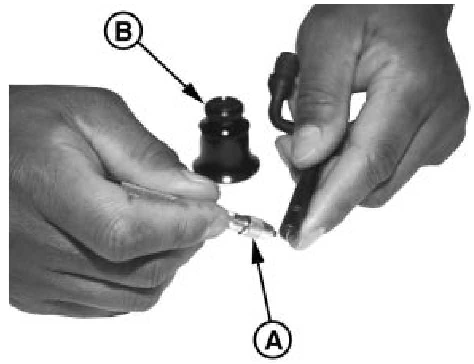
35
70

INSPECT AND CLEAN FUEL INJECTION NOZZLE BODY

NOTE: Unless otherwise indicated, all tools required for nozzle cleaning can be found in the JDF13 Nozzle Cleaning Kit.

Clean carbon stop seal groove and nozzle tip with a nozzle cleaning wire inserted in holder (A).

Inspect tip for cracks and spray orifices for chipping and erosion using ROS16487 Inspection Magnifier (B).



A—Holder
B—Inspection Magnifier

To clean carbon from nozzle orifices:

NOTE: Stoning the wire to provide a flat surface on one side will help in reaming carbon from a clogged hole.

1. Begin with a cleaning wire 0.07—0.10 mm (0.003—0.004 in.) smaller than the nominal orifice size given in specifications below.

Fuel Injection Nozzle Tip Orifice—Specification

Number of Orifices Per Nozzle 4

Fuel Injection Nozzle Tip Orifice (Naturally Aspirated Engines)—Specification

ID .... 0.27 mm (0.0106 in.)

Fuel Injection Nozzle Tip Orifice (Turbocharged Engines)—Specification

ID .... 0.29 mm (0.0116 in.)

NOTE: In a few applications, RE60062 Nozzles (normally used on aspirated engines), may be specified for turbocharged (T or H) engines. In these cases, use specifications listed for naturally aspirated (D) engines.

2. Clamp the wire in pin vise from nozzle cleaning kit. Wire should not protrude from the vise more than 0.8 mm (1/32 in.).

3. Insert wire in orifice and rotate.

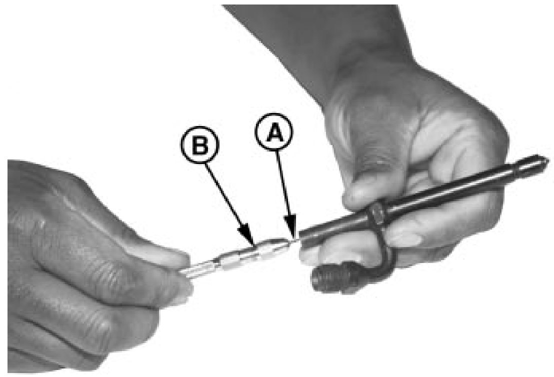
Continued on next page

RG,35,JW7590 –19–20NOV97–1/3

4. Use scraper from cleaning kit to clean deposits from valve seating area.

RG,35,JW7590 –19–20NOV97–2/3

5. Grasp sack hole drill (A) with valve retractor (B).
6. For final cleaning, use a cleaning wire 0.03 mm (0.001 in.) smaller than the nominal orifice size and repeat Steps 2 and 3.



RG7805 –UN–11NOV97

A—Sac Hole Drill
B—Valve Retractor

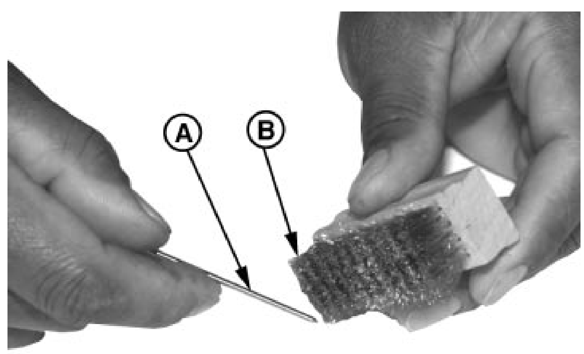
RG,35,JW7590 –19–20NOV97–3/3

INSPECT AND CLEAN VALVE AND VALVE SEAT

IMPORTANT: NEVER use a steel wire brush on nozzle parts.

Use brass wire brush (B) to remove deposits from seating area on tip of nozzle valve (A). Use a felt pad to remove varnish deposits.

Inspect guide area of valve scratches which could cause sticking. This area will generally be polished on one side during operation. Visible vertical marks are normal.



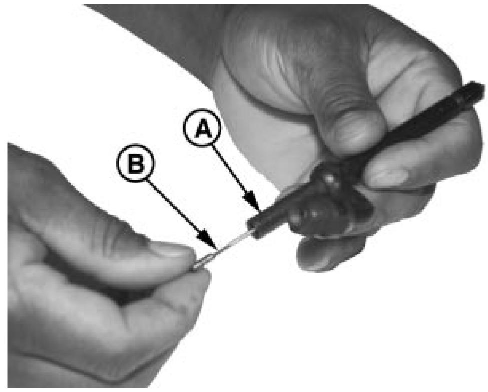
RG7806 –UN–11NOV97

A—Nozzle Valve
B—Brass Wire Brush

Continued on next page RG,35,JW7589 –19–20NOV97–1/2

35
72

INCONSISTENT CHATTER OR NO CHATTER



RG7803 –UN–11NOV97

A nozzle which during test had spotty chatter or showed definite signs of sticking accompanied by low return leakage, may be corrected by polishing the valve guide area as follows:

1. Place a small amount of nozzle lapping compound on the nozzle valve in guide area only. DO NOT use any other compound for this purpose.

2. Slide valve into body (A).

IMPORTANT: Never attempt to rotate the valve in a motor driven chuck for this purpose.

3. Grip top of the valve with retractor (B) and rotate valve in the guide by turning retractor. The amount of lapping required can be accomplished in 10—20 turns by hand. The valve should be raised and lowered in the guide every 3—4 revolutions and direction of rotation changed for best results.

4. Wash nozzle body and valve thoroughly in clean fuel before reassembly.

SEAT LEAKAGE

Seat leakage may be caused by dirt, carbon or fuel deposits in valve area. Inspect valve seat and clean as follows:

1. Apply a small amount of lapping compound to valve tip and insert valve in nozzle body.

2. Gripping valve with retractor, rotate valve 3 to 5 turns to clean up seat.

3. Wash valve and nozzle body thoroughly in clean fuel.

RG,35,JW7589 –19–20NOV97–2/2

35
73

INSPECT VALVE ADJUSTING MECHANISM

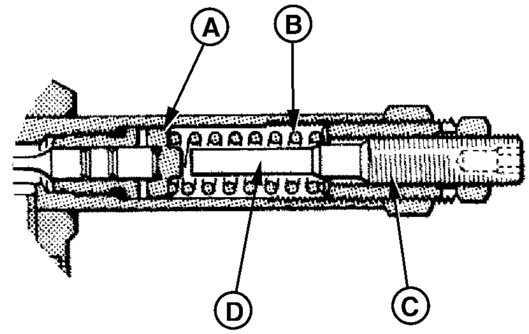
1. Inspect lift adjusting screw (D). Replace if bent or otherwise damaged.

2. Inspect pressure adjusting screw (C). Replace if worn or damaged.

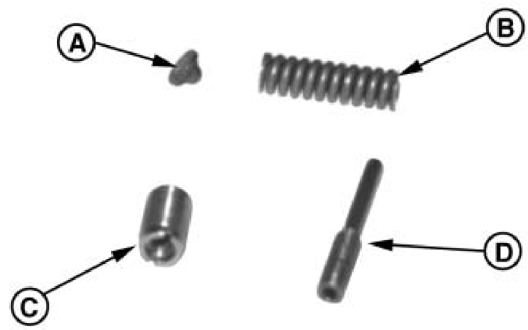
3. Inspect pressure adjusting spring (B). Replace if broken or distorted.

4. Inspect spring seat (A) for wear. Replace as necessary.

5. Replace nozzle clamp if bent.



RG7810A –UN–11NOV97



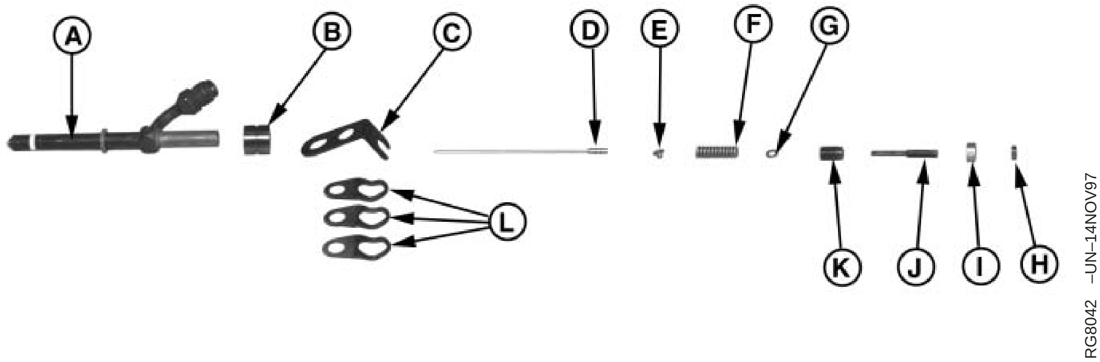
RG7808 –UN–11NOV97

A—Spring Seat
B—Pressure Adjusting Spring
C—Pressure Adjusting Screw
D—Lift Adjusting Screw

RG,35,JW7588 –19–20NOV97–1/1

35
74

ASSEMBLE FUEL INJECTION NOZZLES



A—Nozzle Body
B—Spacer
C—Indexing Clamp
D—Nozzle Valve
E—Spring Seat
F—Pressure Adjusting Spring
G—Washer
H—Lift Adjusting Screw Lock Nut
I—Pressure Adjusting Screw Lock Nut
J—Lift Adjusting Screw
K—Pressure Adjusting Screw
L—Hold-Down Clamps

1. Install nozzle spacer (B) onto upper nozzle body (A). Position nozzle locating clamp (C) over upper nozzle body with flanges pointing downward. Install three remaining clamps (L) onto nozzle body.

IMPORTANT: Wear rubber gloves when assembling nozzles.

2. Dip valve (D) in clean fuel and insert into nozzle body.

3. Thread lift adjusting screw (J) into pressure adjusting screw (K) until top just enters screw.

4. Invert adjusting screw assembly and assemble spring seat (E) and spring (F) to adjusting screw.

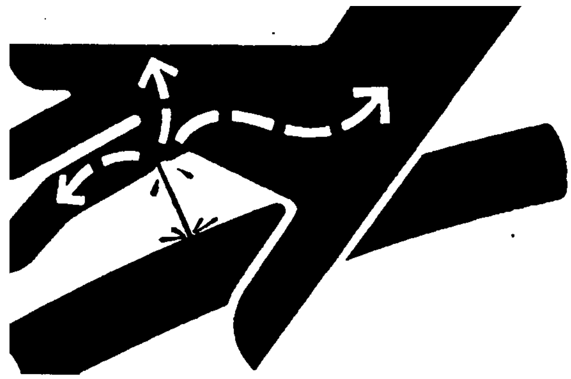
5. Tilt body, DO NOT allow valve to fall out, and install spring and adjusting screws to body. Be careful not to dislodge spring or seat during initial assembly.

6. Turn pressure adjusting screw down as far as possible by hand; usually about ten full turns. Adjust nozzle as detailed later in this group.

RG,35,JW7587 –19–20NOV97–1/1

35
75

ADJUST FUEL INJECTION NOZZLES



X9811 –UN–23AUG88

CAUTION: Nozzle tip should always be directed away from operator. Fuel from spray orifices can penetrate clothing and skin causing serious personal injury. Enclosing nozzle in a glass beaker is recommended.

Before applying pressure to nozzle tester, be sure all connections are tight, and fittings are not damaged. Fluid escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood, rather than hands, to search for suspected leaks.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

Connect nozzle to nozzle tester. (See TEST INJECTION NOZZLES earlier in this group.)

Continued on next page RG,35,JW7631 –19–21NOV97–1/7

35
76

ADJUST NOZZLE OPENING PRESSURE

Close pressure gauge valve and flush nozzle by operating pump rapidly.

Raise pressure on pump until nozzle opens (gauge drops sharply).

Refer to nozzle opening pressure specifications below.

NOTE: In a few applications, RE60062 Nozzles (normally used on aspirated engines), may be specified for turbocharged (T or H) engines. In these cases, use specifications listed below for naturally aspirated (D) engines.

Refer to the following specifications for RE60062 nozzles on naturally aspirated (D) engines:

Opening Pressure of New or Reconditioned Nozzle With New Internal Parts—Specification

Opening Pressure For Setting .... 24130—24480 kPa (241—244 bar) (3500—3550 psi)
Opening Pressure For Checking............. 21800 kPa (218 bar) (3160 psi) (Minimum)

Minimum Acceptable Opening Pressure of Used Nozzle—Specification

Opening Pressure For Checking............. 19850 kPa (198 bar) (2880 psi) (Minimum)

Maximum Opening Pressure Difference Between Cylinders—Specification

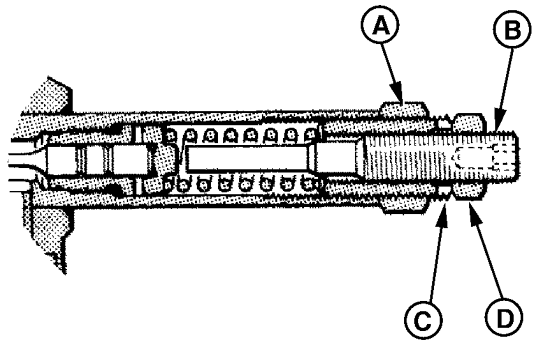
Maximum Pressure Difference.......................... 700 kPa (7 bar) (100 psi)

Refer to the following specifications for RE48786 nozzles on turbocharged (T or H engines):

Opening Pressure of New or Reconditioned Nozzle With New Internal Parts—Specification

Opening Pressure For Setting .... 25900—26200 kPa (259—262 bar) (3750—3800 psi)
Opening Pressure For Checking............. 25200 kPa (252 bar) (3660 psi) (Minimum)

RG7809 –UN–15JAN98



RG7810B –UN–11NOV97

A—Pressure Adjusting Screw Lock Nut
B—Lift Adjusting Screw
C—Pressure Adjusting Screw
D—Lift Adjusting Lock Nut

Continued on next page

RG,35,JW7631 –19–21NOV97–2/7

Minimum Acceptable Opening Pressure of Used Nozzle—Specification

Opening Pressure For Checking............ 22950 kPa (230 bar) (3330 psi) (Minimum)

Maximum Opening Pressure Difference Between Cylinders—Specification

Maximum Pressure Difference.......................... 700 kPa (7 bar) (100 psi)

RG,35,JW7631 –19–21NOV97–3/7

If opening pressure is incorrect:

1. Remove nozzle from tester and install in holding fixture.

2. Remove lift adjusting lock nut (D).

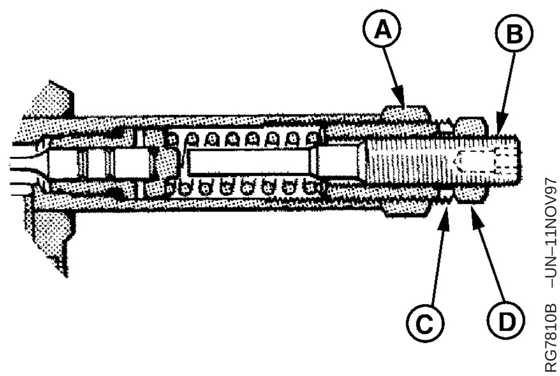
3. Loosen pressure adjusting screw lock nut (A), using JDG949 Nozzle Wrench.

4. Reconnect nozzle to tester with tip pointing downward.

5. Back out lift adjusting screw (B) far enough (two or three turns) to prevent bottoming when pressure adjusting screw (C) is turned.

6. Turn pressure adjusting screw in (clockwise) to increase opening pressure, or out (counterclockwise) to decrease opening pressure.

NOTE: It is desirable to set opening pressure to the high limit of specification. If required, repeat procedure to obtain proper result.



A—Pressure Adjusting Screw Lock Nut
B—Lift Adjusting Screw
C—Pressure Adjusting Screw
D—Lift Adjusting Lock Nut

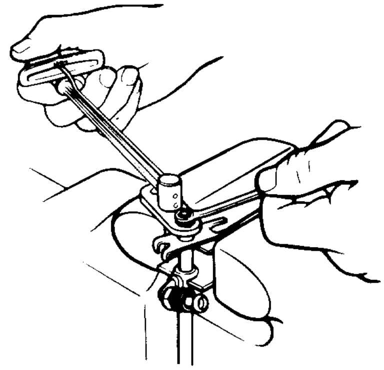
Continued on next page RG,35,JW7631 –19–21NOV97–4/7

35
78

7. Remove nozzle from tester and secure in holding fixture. While holding pressure adjusting screw, tighten pressure adjusting screw lock nut to specifications using the ROS18958 (English size) or No. 24374 (metric size) Torque Wrench Adapter.

Injection Nozzle Pressure Adjusting Screw Locknut—Specification

Torque .... 10 N•m (7 lb-ft)



RG7811 –UN–15JAN98

RG,35,JW7631 –19–21NOV97–5/7

ADJUST NOZZLE VALVE LIFT

1. Reconnect nozzle to tester. While pumping fuel through nozzle, hold pressure adjusting screw and slowly turn lift adjusting screw in (clockwise) until valve ceases to open.

IMPORTANT: DO NOT manually bottom the valve with excessive force as bending of the valve may result.

2. Check for valve bottoming by raising pressure to 1380—3450 kPa (14—34 bar) (200—500 psi) above nozzle opening pressure.

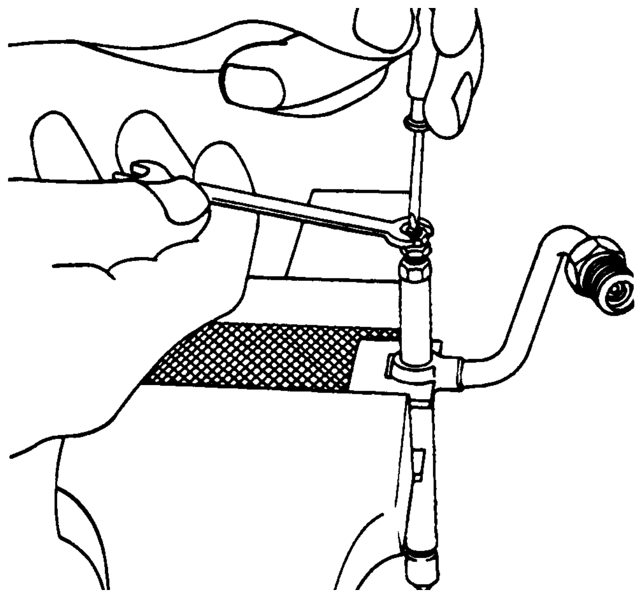
   Although some fuel may collect at nozzle tip, a rapid dribble should not occur.

3. Remove nozzle from tester and install in holding fixture.

4. Carefully turn lift adjusting screw out specified amount. A tolerance of 1/8 turn is permissible.

Fuel Injection Nozzle Valve Needle Lift—Specification

Needle Lift (Based on Zero Lift)...................... 3/4 Turn Counterclockwise



RG9103 –UN–31MAR98

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RG,35,JW7631 –19–21NOV97–6/7

Hold pressure adjusting screw stationary while tightening lock nut. Use ROS18958 Torque Wrench Adapter on English-type lock nuts; No. 24374 on metric-type lock nuts.

5. Tighten lift adjusting screw lock nut to specifications .

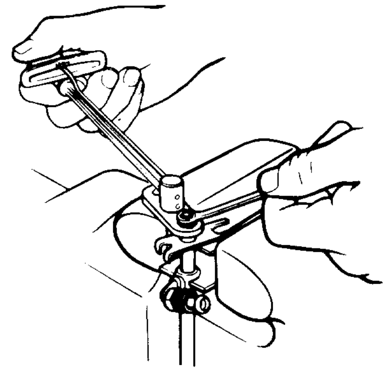
Fuel Injection Nozzle Lift Adjusting Screw Lock Nut—Specification

Torque .... 5 N•m (3.5 lb-ft) (42 lb-in.)

6. Recheck nozzle opening pressure.

   If nozzle chatter is incorrect after servicing, valve parts may be misaligned. To correct, screw pressure adjusting screw through its range of adjustment several times and reset valve lift. Recheck nozzle for chatter.

7. Clean nozzle with brass wire brush.



RG7811 –UN–15JAN98

RG,35,JW7631 –19–21NOV97–7/7

INSTALL SEALS ON FUEL INJECTION NOZZLE

IMPORTANT: Each time an injection nozzle is removed from the cylinder head, replace carbon stop seal (B) with a new one.

1. Position JD258 (ROS16477) Pilot Tool (A) over nozzle tip.

2. Install a new seal washer (C) onto nozzle body.

3. Position a new carbon stop seal (B) on pilot tool. Slide the carbon seal until it seats in its groove on nozzle body.

NOTE: If nozzle is not going to be installed at this time, install a No. 16189 Nozzle Protector Cap over nozzle tip. Plug all other openings in nozzle to prevent contamination.

RG9096 –UN–27MAR98

A—Pilot Tool
B—Carbon Stop Seal
C—Seal Washer

RG,35,JW7586 –19–20NOV97–1/1

35
80

INSTALL FUEL INJECTION NOZZLES

IMPORTANT: Before installing injection nozzles, make sure nozzles are clean and free from oil or grease.

NOTE: If nozzle bore in cylinder head must be cleaned, use JDE39 Nozzle Bore Cleaning Tool. (See REMOVE FUEL INJECTION NOZZLES earlier in this group.)

1. Remove plug (if installed previously) from nozzle bore in cylinder head and blow out bore with compressed air.

NOTE: Make sure that the sealing surface of the cylinder head (on which the seal washer will be resting) is smooth and free of damage or dirt. This could prevent proper sealing. Dirt and roughness could also cause nozzle to be distorted when the attaching screw is tightened, making the valve stick.

2. Install nozzle with spacer and clamps in cylinder head using a slight twisting motion as nozzle is seated in bore. Illustration shows relationship of parts required for proper installation.

3. Align nozzle clamps and install cap screw. Do not tighten cap screw at this stage.

4. Connect fuel pressure line to nozzle. Leave connection slightly loose until air is bled from system.

5. Tighten nozzle hold-down clamp cap screws to specifications.

Fuel Injection Nozzle Hold-Down Clamp Cap Screws—Specification

Torque .... 40 N•m (30 lb-ft)

6. Install leak-off line assembly.

Fuel Leak-Off Hex Nut—Specification

Torque .... 5 N•m (3.7 lb-ft) (44 lb-in.)

RG7744 –UN–23NOV97

RG7725 –UN–08JAN97

Continued on next page

RG,35,JW7632 –19–21NOV97–1/2

7. Bleed air from loose injection line connection. Tighten connection using two wrenches to the following specifications.

Fuel Injection Nozzle Delivery Line—Specification

Torque .... 27 N•m (20 lb-ft)

(See BLEED THE FUEL SYSTEM in Group 115.)

RG,35,JW7632 –19–21NOV97–2/2

Group 40
Starting and Charging Systems

ESSENTIAL TOOLS

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

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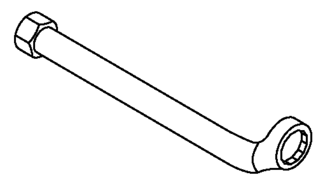
DPSG,OUO1004,198 –19–07JUL98–1/2

Starting Motor Removal Tool KJD10213

Remove starting motor on 6000 Series Tractors.



RG9116 –UN–19MAY98

DPSG,OUO1004,198 –19–07JUL98–2/2

STARTING AND CHARGING SYSTEM SPECIFICATIONS

Item	Measurement	Specification
Alternator Pulley Nut	Torque	80 N•m (60 lb-ft)

DPSG,OUO1004,237 –19–10JUL98–1/1

REMOVE AND INSTALL STARTER

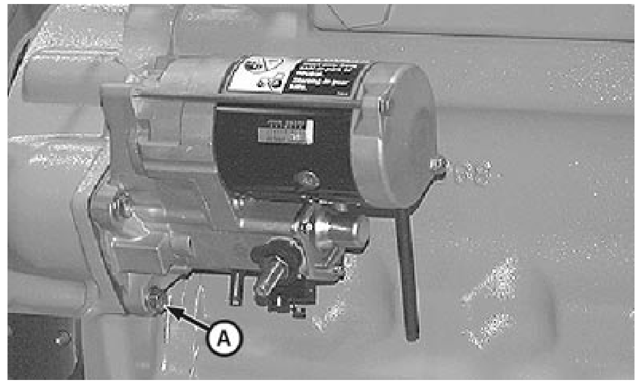
NOTE: Refer to Electrical System Chapter for repair and testing of starter motor.

CAUTION: Disconnect battery ground strap or serious injury could result if tools ground electrical system.

1. Disconnect ground strap from battery.
2. Disconnect wiring to starter motor.
3. If equipped with RH dipstick tube, remove tube.

NOTE: On Model 6010-6910 and 7210-7610 Tractors, use KJD10213 Starting Motor Removal Tool as necessary to remove cap screws.

4. Remove three mounting cap screws and/or nuts (A).
5. Remove starting motor.
6. Install starting motor and tighten cap screws and/or nuts.
7. Connect starter wiring and ground strap.
8. Install dipstick tube if removed.

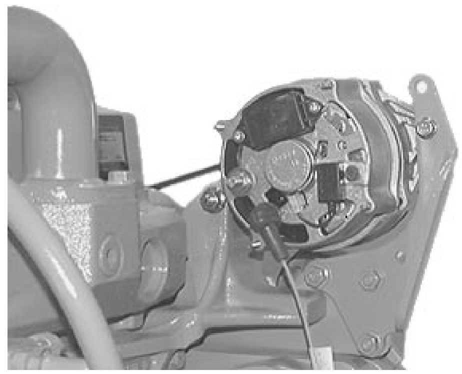


RG9106 –UN–04OCT99

A—Cap Screw

DPSG,OUO1004,37 –19–08APR98–1/1

REMOVE AND INSTALL ALTERNATOR



RG9107 –UN–04OCT99

NOTE: Refer to Electrical System Chapter for repair and testing of alternator.

IMPORTANT: Always disconnect battery negative (—) cables before removing alternator or a short circuit could result.

1. Disconnect battery ground (—) cable.
2. Disconnect positive (+) red wire and regulator connector.
3. Remove belt guard.
4. Remove alternator belt using 1/2 in. drive ratchet on belt tensioner.
5. Remove alternator.

NOTE: If mounting plate for alternator and tensioner was removed, tighten plate-to-timing gear cover hardware first, then plate-to-engine hardware.

6. Install alternator. Tighten all mounting hardware.
7. If removed, install alternator pulley and tighten pulley nut to specifications.

Alternator Pulley Nut—Specification

Torque .... 80 N•m (60 lb-ft)

8. Install alternator belt using 1/2 in. drive ratchet on belt tensioner.
9. Install belt guard.
10. Connect positive (+) red wire and regulator connector.
11. Connect battery ground (—) cable.

DPSG,OUO1004,39 –19–08APR98–1/1

EFFECTS OF ALTITUDE AND TEMPERATURE ON ENGINE PERFORMANCE

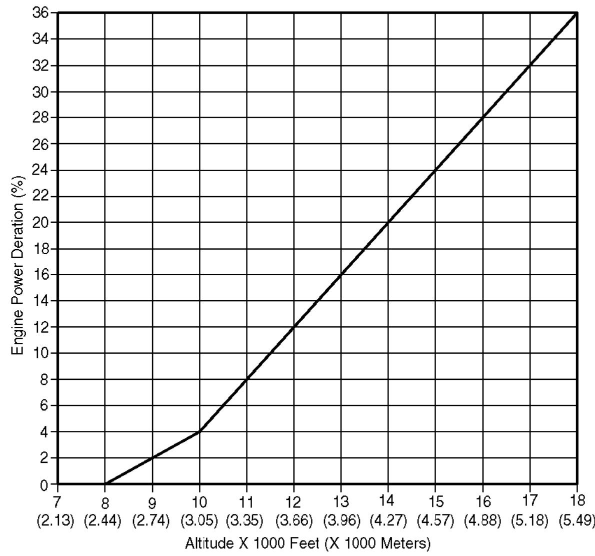
Altitude, fuel temperature, air temperature, and humidity may affect engine performance. As a general rule, atmospheric changes will usually cause a decrease in engine power by the percentages shown below.

NATURALLY ASPIRATED ENGINES

ATMOSPHERIC CHANGE	% POWER DECREASE
Fuel Temperature Rise of 1° C (1.8° F) above 40° C (104° F)	0.17
Air Temperature Rise of 5.5° C (10° F) above 25° C (77° F)	1.50
Altitude Rise of 300 m (1000 ft) above 180 m (600 ft)	3.00
Relative Humidity Rise of 10% above 0%	0.10

TURBOCHARGED ENGINES

ATMOSPHERIC CHANGE	% POWER DECREASE
Fuel Temperature Rise of 1° C (1.8° F) above 40° C (104° F)	0.19
Air Temperature Rise of 5.5° C (10° F) above 25° C (77° F)	0.50
Altitude rise	See figure above.
Relative Humidity Rise of 10% above 0%	0.07



RG9094 –UN–27MAR98

Turbocharged Engines

RG,100,JW7633 –19–21NOV97–1/1

PRELIMINARY ENGINE TESTING

Before tuning-up an engine, determine if a tune-up will restore operating efficiency. If in doubt, the following preliminary tests will help determine if the engine can be tuned-up. Choose from the following procedures only those necessary to restore the unit.

1. After engine has stopped for several hours, loosen crankcase drain plug and watch for any water to seep out. A few drops could be due to condensation, but any more than this would indicate problems which require engine repairs rather than just a tune-up.

2. With engine stopped, inspect engine coolant for oil film. With engine running, inspect coolant for air bubbles. Either condition would indicate problems which require engine repairs rather than just a tune-up.

3. Perform a dynamometer test and record power output. (See DYNAMOMETER TEST later in this group.) Repeat dynamometer test after tune-up. Compare power output before and after tune-up.

4. Perform compression test (See TEST ENGINE COMPRESSION PRESSURE in Group 105).

RG,100,JW7642 –19–21NOV97–1/1

GENERAL TUNE-UP RECOMMENDATIONS

As a general rule, an engine tune-up is not necessary if ALL recommended operator's manual hourly service procedures are performed on schedule. If your engine performance is not within the rated application guidelines, the following service procedures are recommended to help restore engine to normal operating efficiency.

Operation	Detailed Reference
Change engine oil and filter.	Operator's Manual
Lubricate PTO clutch internal levers and linkage, if equipped.	Operator's Manual
Replace fuel filter and water separator, if equipped.	Group 35/Operator's Manual
Clean crankcase vent tube.	Group 35/Operator's Manual
Check air intake system. Replace air cleaner elements.	This Group/Operator's Manual
Check exhaust system.	This Group
Check and service engine cooling system.	This Group/Operator's Manual
Check and adjust fan and alternator belts. Replace if necessary.	Group 25/Operator's Manual
Check electrical system.	This Group
Check crankshaft vibration damper.	Group 15/Operator's Manual
Inspect turbocharger and check turbocharger boost pressure.	Group 110
Check fuel injection system: Check engine/injection pump timing: check and adjust speed advance; clean injection nozzles, and adjust opening pressure.	Group 35 and 115
Check engine oil pressure. Correct as necessary.	Group 105
Check engine valve clearance. Adjust if necessary.	Group 05
Check engine speeds. Correct as necessary.	Group 115
Check engine performance on dynamometer.	This Group

RG,100,JW7643 –19–21NOV97–1/1

DYNAMOMETER TEST

IMPORTANT: Dynamometers should be periodically checked for accuracy and calibrated as necessary.

NOTE: High elevations may affect engine performance. (See EFFECTS OF ALTITUDE AND TEMPERATURE ON ENGINE PERFORMANCE, earlier in this group.)

1. Connect engine to dynamometer using manufacturer's instructions.

2. Operate engine at one-half load until coolant and crankcase oil temperatures are up to normal operating range.

3. Run engine at fast idle.

4. Gradually increase load on engine until speed is reduced to rated speed rpm.

NOTE: Refer to appropriate machine technical manual for average power ratings of specific applications. Allow ±5% for minimum and maximum power.

5. Read horsepower on dynamometer and record reading over a period of several minutes after engine stabilizes.

6. Compare readings taken with power rating level for your engine application, as listed in following module.

RG,100,JW7644 –19–21NOV97–1/1

DYNAMOMETER TEST SPECIFICATIONS

Power ratings for various injection pump options are provided for OEM applications on the charts that follow. For Construction Equipment applications, refer to SP458 Specifications Handbook. For North American Agricultural applications, refer to DB1216 Specifications Handbook. If specifications are not listed in handbooks, refer to factory DTAC for assistance.

Continued on next page

RG,100,JW7641 –19–21NOV97–1/4

NOTE: The power specifications shown below apply to Dubuque, Torreon and Saran-built engines.Specifications are subject to change. Refer to factory DTAC for assistance.

Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset depending upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.

POWER RATINGS ON DYNAMOMETER FOR OEM ENGINES							
Engine Model	**Injection Pump Option Code**	**Original Injection Pump (Part No.)**	**Replaced By Injection Pump (Part No.)**	**Governor Regulation**	**Rated Speed (rpm)**	**Fast Idle (rpm)**	**Power Rating Kw (BHP)**
4045DF150	1601	RE67557		STD	2500	2700	60 (80)
	1602	RE59809		STD	2500	2700	63 (84)
	1603	RE67558		3—5%	1800	1870	53 (71)
	1663	RE71089	RE500949	STD	2500	2700	60 (80)
	1663	RE500949		STD	2500	2700	60 (80)
	1671	RE67559		3—5%	2500	2700	60 (80)
	1673	RE67560		3—5%	1800	1870	53 (71)
	1674	RE67561		3—5%	1800	1870	53 (71)
	1691	RE500831	RE500948	STD	2500	2700	60 (80)
	1691	RE500948		STD	2500	2700	60 (80)
	16BG	RE69778		STD	2500	2700	63 (84)
	16BH	RE500873		STD	2500	2700	63 (84)
	16BJ	RE500589		STD	2250	2450	36 (48)
	16CL	RE501364		STD	2200	2400	58 (78)
	16DL	RE70452		STD	2400	2600	60.5 (82)
4045HF150	1610	RE68826		STD	2400	2600	104 (140)
	1611	RE60237		3—5%	1800	1870	95 (127)
	160B	RE68827		3—5%	1800	1870	95 (127)
	160C	RE69588		STD	2400	2600	104 (140)
4045TF150	1605	RE61668	RE69781	STD	2500	2700	86 (115)
	1605	RE69781		STD	2500	2700	86 (115)
	1656	RE67562		3—5%	1800	1870	75 (100)
	1675	RE60091	RE69782	STD	2500	2700	86 (115)
	1675	RE69782		STD	2500	2700	86 (115)
	1677	RE67563		3—5%	1800	1870	75 (100)

Continued on next page

RG,100,JW7641 –19–21NOV97–2/4

POWER RATINGS ON DYNAMOMETER FOR OEM ENGINES							
Engine Model	**Injection Pump Option Code**	**Original Injection Pump (Part No.)**	**Replaced By Injection Pump (Part No.)**	**Governor Regulation**	**Rated Speed (rpm)**	**Fast Idle (rpm)**	**Power Rating Kw (BHP)**
4045TF150 (Continued)	1692	RE500881		STD	2500	2700	86 (115)
	1694	RE67863	RE69779	STD	2500	2700	75 (100)
	1694	RE69779		STD	2500	2700	75 (100)
	1695	RE69739	RE69780	STD	2500	2700	75 (100)
	1695	RE69780		STD	2500	2700	75 (100)
	16AB	RE69779		STD	2500	2700	75 (100)
	16BF	RE500848		STD	2200	2400	73 (98)
	16CE	RE501180		STD	2500	2700	75 (100)
	16CM	RE501365		STD	2200	2400	66.5 (89)
4045TF153	16EP	RE501899		STD	2200	2400	72 (97)
4045TF250	1606	RE64133		STD	2400	2600	93 (125)
	1608	RE67564		3—5%	1800	1870	84 (113)
	1667	RE59968		STD	2400	2600	93 (125)
	1682	RE67566		3—5%	1800	1870	84 (113)
	1683	RE60124		STD	2400	2600	93 (125)
	160R	RE70941		3—5%	1800	1870	84 (113)
	16CV	RE501346		STD	2200	2400	85 (114)
6068DF150	1613	RE59861		STD	2500	2700	93 (125)
	1678	RE60101		STD	2500	2700	93 (125)
6068HF150	1621	RE66575		STD	2400	2600	157 (210)
	160D	RE69589		STD	2400	2600	157 (210)
	16CY	RE501345		STD	2200	2400	143 (192)
6068HF250	1622	RE59521		STD	2400	2600	168 (225)
	1623	RE66761		3—5%	1800	1870	148 (198)
6068TF150	1614	RE61669	RE69789	STD	2500	2700	127 (170)
	1614	RE69789		STD	2500	2700	127 (170)
	1680	RE60105	RE69790	STD	2500	2700	127 (170)
	1680	RE69790		STD	2500	2700	127 (170)
	1681	RE67571		3—5%	1800	1870	112 (150)
	1688	RE67572		3—5%	1800	1870	112 (150)
	1696	RE67864	RE69787	STD	2500	2700	116 (155)
	1696	RE69787		STD	2500	2700	116 (155)
	1697	RE68740	RE69788	STD	2500	2700	116 (155)

Continued on next page

POWER RATINGS ON DYNAMOMETER FOR OEM ENGINES							
Engine Model	**Injection Pump Option Code**	**Original Injection Pump (Part No.)**	**Replaced By Injection Pump (Part No.)**	**Governor Regulation**	**Rated Speed (rpm)**	**Fast Idle (rpm)**	**Power Rating Kw (BHP)**
6068TF150 (Continued)	1697	RE69788		STD	2500	2700	116 (155)
	16BE	RE63559		STD	2200	2400	117 (157)
	16CN	RE501522		STD	2100	2300	110.5 (148)
	16CP	RE501523		STD	2200	2400	94 (126)
	16DK	RE70938		STD	2100	2300	96 (129)
	16DY	RE501758		STD	2500	2700	116 (155)
6068TF250	1615	RE62366		STD	2400	2600	138 (185)
	1619	RE67573		3—5%	1800	1870	124 (166)
	1668	RE59969		STD	2400	2600	138 (185)
	1685	RE67574		3—5%	1800	1870	124 (166)
	1686	RE60131		STD	2400	2600	138 (185)
	16CW	RE501344		STD	2200	2400	106 (142)
	16CX	RE70390		STD	2300	2500	128 (172)

RG,100,JW7641 –19–21NOV97–4/4

ENGINE BREAK-IN GUIDELINES

Engine break-in should be performed when the following repairs have been made:

- Main bearings, rod bearings, crankshaft, or any combination of these parts have been replaced.
- Pistons, rings, or liners have been replaced.

RG,100,JW7640 –19–21NOV97–1/1

PERFORM ENGINE BREAK-IN

Use a dynamometer to perform the following preliminary break-in procedure. If necessary, preliminary engine break-in can be performed without a dynamometer if under controlled operating conditions.

IMPORTANT: DO NOT use John Deere PLUS-50 oil or engine oils meeting API CG4, API CF4, ACEA E3 or ACEA E2, performance levels during break-in period of an engine that has had a major overhaul. These oils will not allow an overhauled engine to properly wear during the break-in period.

Do not add makeup oil until the oil level is BELOW the add mark. John Deere Break-In Oil should be used to make up any oil consumed during break-in period.

DO NOT fill above the crosshatch pattern or FULL mark. Oil levels anywhere within the crosshatch are acceptable.

1. Fill engine crankcase to proper level with John Deere ENGINE BREAK-IN OIL during break-in operation. This oil is specifically formulated to enhance break-in of John Deere diesel engines.

   If John Deere Engine Break-In Oil is not available, use diesel engine oil meeting API Service Classification CE or ACEA Specification E1.

IMPORTANT: During preliminary break-in, periodically check engine oil pressure and coolant temperature. Also check for signs of fuel, oil, or coolant leaks.

2. Start engine, run at loads and speeds shown in following chart for time limits given.

PRELIMINARY ENGINE BREAK-IN AFTER MAJOR OVERHAUL

Time	Load	Engine Speed
1 minute	No load	850 rpm
2 minutes	No load	Fast Idle
15 minutes	1/2—3/4 load	2000 rpm to rated speed
10 Minutes	Full load	Rated speed

3. After preliminary break-in, run engine 1—2 minutes at 1500 rpm, with no load before shut-down.

4. Check and readjust valve clearance as necessary. Cylinder head retorque is not required.

NOTE: During the first 20 hours, avoid prolonged periods of engine idling or sustained maximum load operation. If engine will idle longer than 5 minutes, stop engine.

5. Operate the engine at heavy loads with minimal idling during the break-in period.

If the engine has significant operating time at idle, constant speeds, and/or light load usage, an additional 100 hour break-in period is recommended using a new change of John Deere ENGINE BREAK-IN OIL and new John Deere oil filter.

As a general rule, makeup oil should not need to be added during 100-hour break-in period. However, if makeup oil is required in the first 100-hour break-in, an additional 100-hour break-in period is required. Use a new change of John Deere ENGINE BREAK-IN OIL and a new John Deere oil filter.

RG,100,JW7645 –19–21NOV97–1/1

100
9

ENGINE OIL CONSUMPTION

All engines consume some oil. The consumption rate depends on loading, design of key parts and engine condition. Since fuel consumption is an indicator of operating power levels, fuel used versus oil consumed is a critical factor in analyzing oil consumption. Oil consumption should be measured over a 100 hour period.

Long term oil consumption (3 oil drain intervals after the engine is broken in) with consumption rates poorer than 400:1 (100 gallons of fuel and 1 quart of oil) indicates a need to monitor/investigate. Suggested steps would be:

- Check for signs of ingested dust or perform an OILSCAN Test to check for silicon.
- Check for proper crankcase oil fill level.
- Perform compression test to find low compression cylinders.
- Remove head and inspect for glazed or worn liners.
- Inspect pistons for carbon deposits in the ring land grooves.
- Measure valve stem OD and valve guide ID to determine clearance.

NOTE: Ring gap alignment does not identify the leak source.

Intake valves do not have valve stem seals and some oil deposits on the valve stem tulip is normal.

When changing to a premium oil such as TORQ-GARD SUPREME® PLUS-50®, little oil consumption change is expected although a small percentage of engines may experience a noticeable change in consumption rates. This may be due to the following:

- The previous oil may have left deposits on internal components. Use of PLUS-50® oil will cause different chemical reactions in those deposits. The time required for the engine to regain the previous oil consumption rate will vary from one to three normal drain intervals.
- TORQ-GARD SUPREME® PLUS-50® contains a high performance anti-oxidant along with other additives resulting in the oil remaining in the specified viscosity grade throughout the recommended drain interval. API oil grades CD, CE, and CF-4 universal engine oils do not provide this oxidation resistance which results in more rapid thickening. Increased oil viscosity can reduce oil consumption.

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PLUS-50 is a registered trademark of Deere & Company

DPSG,OUO1004,114 –19–07MAY98–1/1

100
10

CHECK CRANKCASE VENTILATION SYSTEM

1. Inspect crankcase ventilation system for restrictions and bent or damaged condition. Lack of ventilation causes excessive oil consumption or sludge to form in crankcase. This can lead to clogging of oil passages, filters, and screens, resulting in serious engine damage.

2. Clean crankcase vent tube or hose with solvent and compressed air if restricted. Replace hose if necessary.

RG7941 –UN–13NOV97

A—Crankcase Breather

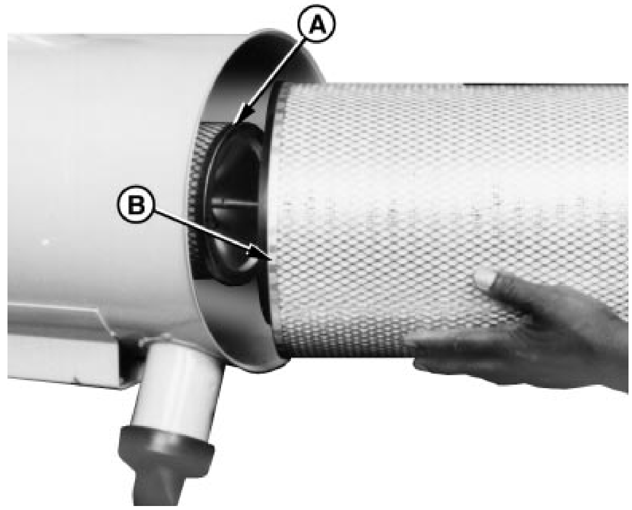
RG,100,JW7638 –19–21NOV97–1/1

CHECK AIR INTAKE SYSTEM

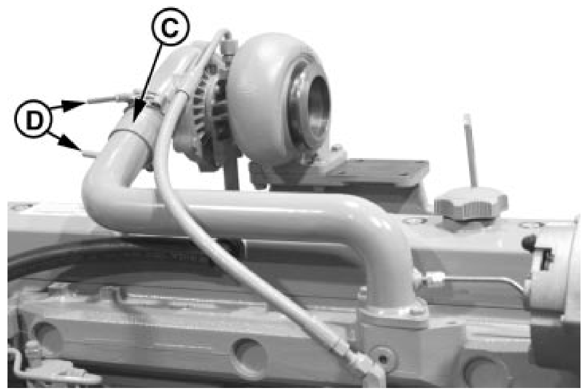
1. Replace air cleaner primary filter element (B). Replace secondary element (A) if primary element has holes in it.

2. Check condition of air intake hose(s) (C). Replace hoses that are cracked, split, or otherwise in poor condition.

3. Check hose clamps (D) for tightness. Replace clamps that cannot be properly tightened. This will help prevent dust from entering the air intake system which could cause serious engine damage.



RG7766A –UN–10NOV97



RG7618C –UN–06NOV97

A—Secondary Filter Element
B—Primary Filter Element
C—Air Intake Hose(s)
D—Hose Clamps

RG,100,JW7637 –19–21NOV97–1/1

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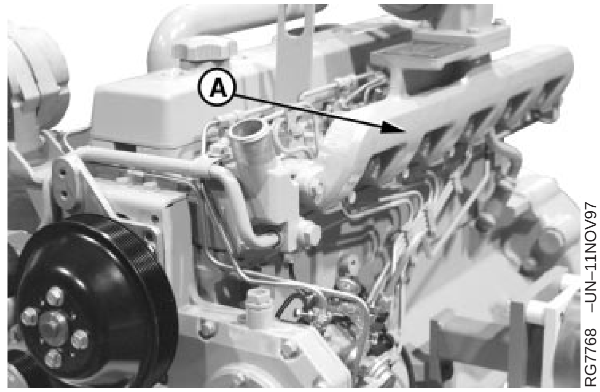
12

CHECK EXHAUST SYSTEM

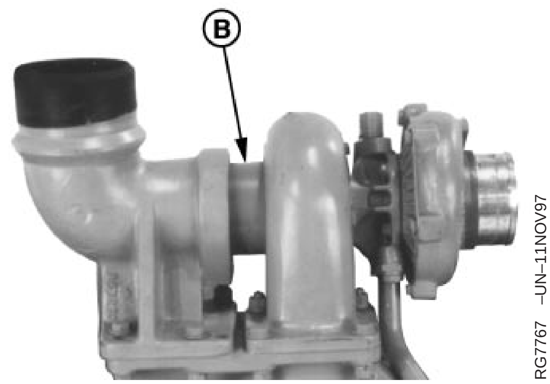
1. Inspect exhaust system for leaks or restrictions. Check manifold (A) for cracks. Repair or replace as necessary.



A—Exhaust Manifold

RG,100,JW7636 –19–21NOV97–1/2

2. On turbocharged engines, check exhaust adapter (B) to make sure it has end play and rotates freely. Correct as necessary.



B—Exhaust Adapter

RG,100,JW7636 –19–21NOV97–2/2

CHECK AND SERVICE COOLING SYSTEM

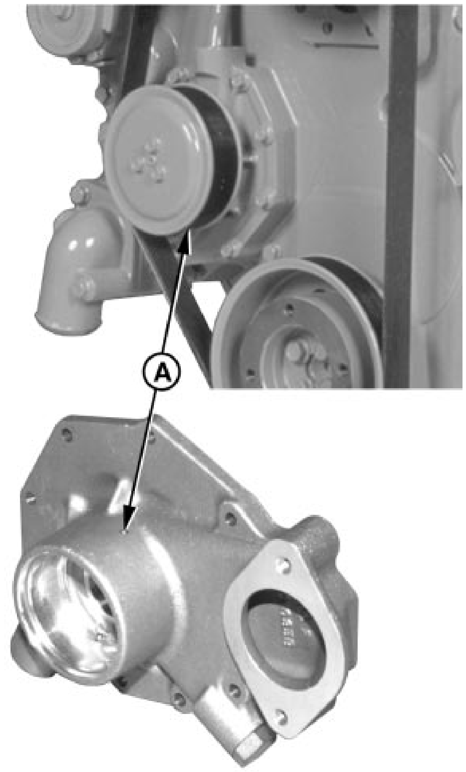
1. Remove trash that has accumulated on or near radiator.

2. Visually inspect entire cooling system and all components for leaks or damage. Repair or replace as necessary.

3. Inspect radiator hoses for signs of leakage or rot. Replace hoses as necessary.

4. Inspect the water pump weep hole (A) for any restrictions.

5. Insert a heavy gauge wire deep into weep hole to make sure hole is open.



A—Weep Holes

Continued on next page RG,100,JW7635 –19–21NOV97–1/2

100
14

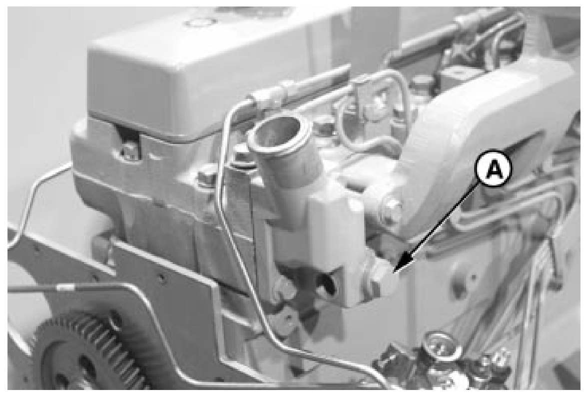
CAUTION: Do not drain coolant until it has cooled below operating temperature. Always loosen block drain valve slowly to relieve any excess pressure.

TS281 –UN–23AUG88

6. Remove and check thermostat(s) (B). (See REMOVE, TEST, AND INSTALL THERMOSTATS in Group 25.)

7. Drain coolant at drain valve (C) and flush cooling system. (See FLUSHING AND SERVICING COOLING SYSTEM in Group 02.)

IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing (A) to allow air to escape when filling system. Retighten fitting or plug when all the air has been expelled.



RG7615B –UN–06NOV97

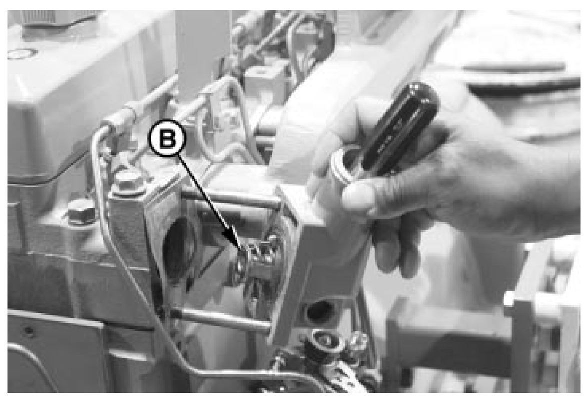
8. Fill cooling system with recommended concentration of coolant, clean soft water, and inhibitors. (See ENGINE COOLANT RECOMMENDATIONS/SPECIFICATIONS in Group 02.)

9. Run engine until it reaches operating temperature. Check entire cooling system for leaks.

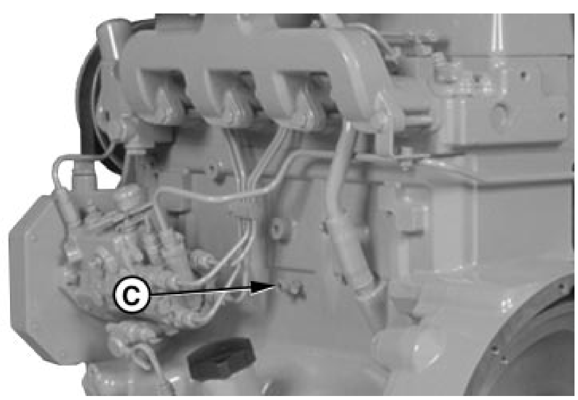
10. After engine cools, check coolant level.

NOTE: Coolant level should be even with bottom of radiator filler neck.

11. Check system for holding pressure. (See PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP in Group 105.)



RG7614B –UN–06NOV97



RG7991 –UN–14NOV97

A—Thermostat Housing
B—Thermostats
C—Drain Valve

RG,100,JW7635 –19–21NOV97–2/2

CHECK ELECTRICAL SYSTEM

TS204 –UN–23AUG88

CAUTION: Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

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

Always remove grounded (-) cable clamp from battery first and replace it last, when disconnecting and reconnecting battery.

1. Clean batteries and cables with damp cloth. If corrosion is present, remove it and wash terminals with a solution of ammonia or baking soda in water. Then flush area with clean water.

2. Coat battery terminals and connectors with petroleum jelly mixed with baking soda to retard corrosion.

3. Test batteries. If batteries are not near full charge, try to find out why.

4. On low-maintenance batteries, check level of electrolyte in each cell of each battery. Level should be to bottom of filler neck.

   If water is needed, use clean, mineral-free water. If water must be added to batteries more often than every 250 hours, alternator may be overcharging.

NOTE: Water cannot be added to maintenance-free batteries.

5. If batteries appear to be either undercharged or overcharged, check alternator and charging circuit. Follow diagnosis and testing procedures outlined in CTM77.

6. Check poly-vee belt wear. (See Group 30.)

7. Check operation of starting motor and gauges.

RG,100,JW7634 –19–21NOV97–1/1

Group 105
Engine System Operation and Tests

ESSENTIAL TOOLS

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

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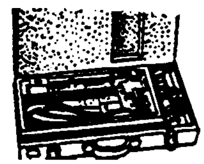
DPSG,OUO1004,201 –19–07JUL98–1/5

RG5161 –UN–23AUG88



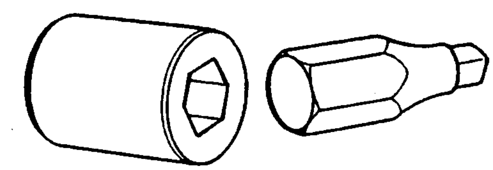
Compression Test Set . . JT01674 (formerly D14546BA or FKM10021)

Used to check cylinder compression pressure. Use adapter and gauge/hose assembly from set.

DPSG,OUO1004,201 –19–07JUL98–2/5

Oil Galley Plug Tool. JDG782

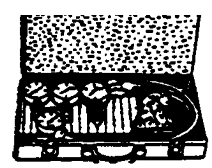
Used to remove and install oil galley plug.



RG6612 –UN–29JAN93

DPSG,OUO1004,201 –19–07JUL98–3/5

RG5162 –UN–23AUG88



Universal Pressure Test Kit . . . . . JT05470 (D15027NU or FKM10002)

Used to check engine oil pressure.

Continued on next page

DPSG,OUO1004,201 –19–07JUL98–4/5

Cooling System Pressure Pump D05104ST

Used to pressure test radiator cap and cooling system.


R26406N –UN–29NOV88

DPSG,OUO1004,201 –19–07JUL98–5/5

ENGINE TEST SPECIFICATIONS

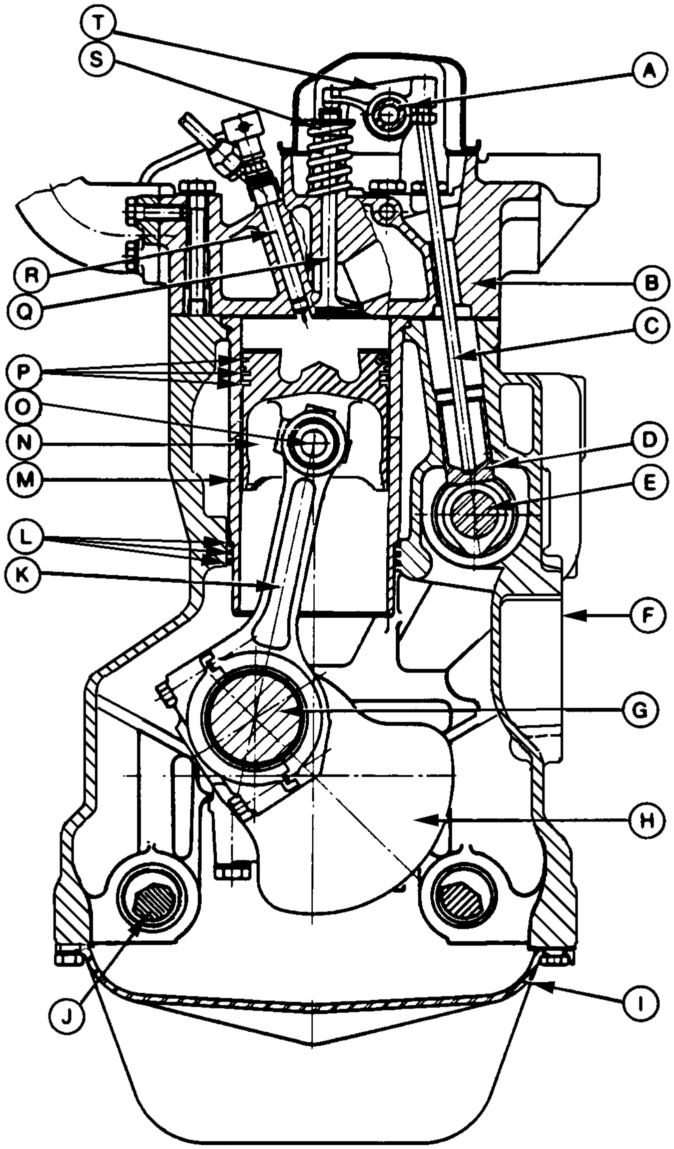
Item	Measurement	Specification
Engine Compression Pressure Test	Engine Compression Pressure: Minimum	2400 kPa (24 bar) (350 psi)
	Maximum Difference Between Cylinders	350 kPa (3.5 bar) (50 psi)
Minimum Oil Pressure-No Load at Slow Idle and 93°C (200°F) Oil Temperature	Minimum Pressure	100 kPa (1.0 bar) (14 psi)
Minimum Oil Pressure-Full Load at Rated Speed and 105°C (220°F) Oil Temperature[1]	Minimum Pressure	275 kPa (2.75 bar) (40 psi)
Cooling System[2]	Test Pressure	70 kPa (0.7 bar) (10 psi)

[1]Gauge fluctuations and tolerance extremes can result in readings up to 586 kPa (5.86 bar) (85 psi).

[2]Test pressures recommended for all Deere OEM cooling systems. On specific vehicle applications, test cooling system and pressure cap according to the recommended pressure for that vehicle.

DPSG,OUO1004,238 –19–10JUL98–1/1

ENGINE—SECTIONAL VIEW



As viewed from flywheel end

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—Balancer Shafts[1]
K—Connecting Rod
L—Liner Packing Rings
M—Cylinder Liner
N—Piston
O—Piston Pin
P—Piston Rings
Q—Valve
R—Fuel Injection Nozzle
S—Valve Spring
T—Rocker Arm

[1]*4-Cylinder Engines Only*

RG,105,JW7662 –19–21NOV97–1/1

GENERAL ENGINE DESCRIPTION

Engines are vertical, in-line, valve-in-head, 4-cycle (stroke) diesel engines.

Direct fuel injection is provided by a rotary-type injection pump or an in-line injection pump and 9.5 mm injection nozzles mounted in cylinder head. The camshaft and injection pump are timed to the crankshaft by the timing gear train.

Some engines are equipped with a turbocharger. The turbocharger uses energy from exhaust gases to compress intake air and force it into the combustion chamber.

The cylinder block (F) is a one-piece casting. The block is available in structural and non-structural configurations.

The camshaft (E) is timed to the crankshaft (G) through the timing gear train. The camshaft rotates in honed bores in the cylinder block. All engines use a bushing in No. 1 camshaft bore. The camshaft lobes determine the duration and lift of each valve, and operate the fuel supply pump on rotary-type injection pumps.

Intake and exhaust valves (Q) are operated by camshaft followers (D), push rods (C) and rocker arm assembly (T). Valve seat inserts in cylinder head are used for intake and exhaust valves.

The crankshaft (G) is a one-piece, heat treated, nodular-iron or steel forging which operates in replaceable two-piece main bearings. Crankshafts are dynamically balanced and are machined with undercut and rolled fillets. Two-piece main thrust bearing inserts are used to control crankshaft end-play.

Cylinder liners (M) are “wet” sleeve type and are individually replaceable. Liner packing rings (L) are used at the lower connection between cylinder block and liners.

Pistons (N) are made of high-grade cast aluminum alloy with internal ribbing. The skirt is cam ground to allow for expansion during operation. The piston crown has a cut-out combustion bowl with a truncated cone center. All piston rings (P) are located above the piston pin. Two compression rings and one oil control ring are used. The top compression ring is a keystone shaped ring located close to the top of the piston for improved engine performance.

The hardened, fully-floating piston pins (O) are held in place by snap rings. Spray jets (piston cooling orifices) in cylinder block spray pressurized oil on the underside of the piston to lubricate piston pins and cool pistons.

The forged steel connecting rods (K) have replaceable pin bushing and bearing inserts. Some connecting rods have a tapered pin-end while others have a straight pin-end. Rods and caps have a tongue-and-groove on earlier engines and a Precision Joint™ on later engines.

The engine is equipped with a gear driven oil pump and full-flow oil filter. The oil filter has an internal bypass valve which opens if the filter element becomes restricted. Engines are equipped with an oil cooler mounted on the right side of the cylinder block. The engine is equipped with a pressure regulator valve to relieve excessive pressure build-up in the main oil gallery, and a bypass valve to prevent oil starvation if the oil cooler and filter become plugged.

Balancer shafts (J) are used on four-cylinder engines to reduce vibration. The two shafts rotate on bushings in cylinder block and are counter-rotating at twice engine speed.

The engine has a pressurized cooling system, consisting of radiator, water pump, multi-blade fan, and one or two thermostats.

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RG,105,JW7661 –19–21NOV97–1/1

FOLDOUT PAGE 13-483 IS AT REAR OF MANUAL

A—Oil Pump
B—Oil Suction Line
C—Oil Outlet Tube
D—Oil Cooler Housing
E—Coolant Passage Adapter
F—Oil Filter
G—Oil Filter Header/Adapter
H—Oil Fill Tube
I—Oil Cooler
J—Balancer Shaft Bushings
K—Crankshaft Drilled Cross-Passages
L—Main Bearing Bushings
M—Oil Passages
N—Main Oil Gallery
O—Connecting Rod Bearings
P—Piston Cooling Orifice
Q—Camshaft Bushings
R—Piston Pin and Bushing
S—Rocker Arm Shaft
T—Turbocharger Oil Supply Line
U—Turbocharger Drain Line
V—Rocker Arms
W—Machined Groove
X—Cross-Drillings
Y—Oil Pressure Regulating Valve
Z—Oil ByPass Valve
AA—Pressurized Oil
AB—Pressure-Free Oil
AC—High-Mount Vertical Oil Filter Assembly
AD—Low-Mount Rear Vertical Oil Filter Assembly
AE—Low-Mount Front Vertical Oil Filter Assembly
AF—Remote Mount Filter Assembly

HOW THE ENGINE LUBRICATION SYSTEM WORKS

The engine lubrication system consists of a positive displacement gear-driven oil pump (A), full-flow oil filter (F), oil cooler (I), oil pressure regulating valve (Y), and an oil by-pass valve (Z).

The oil pump pulls oil from the oil pan sump through a strainer and a suction line (B). The pump forces oil through the outlet tube (C) into a vertical drilling in the cylinder block, and up to the oil cooler and filter. After flowing through the cooler and filter, oil flows into the main oil gallery (N).

The main oil gallery runs the length of the cylinder block and delivers oil to oil passages (M) that feed the camshaft bushings (Q) and main bearing bushings (L). The cross-drillings (X) intersect with those same oil passages and feed oil to the balancer shaft bushings (J).

From the main bearings, oil flows to the connecting rod bearings (O) through drilled cross-passages (K) in the crankshaft between the main journals and connecting rod journals. Oil from the main bearing also supplies oil to the piston cooling orifices (P).

Oil from the piston cooling orifices sprays on the underside of the piston to keep the piston crown cool. The oil spray also provides splash lubrication for the piston pin and bushing (R) by splashing oil into a hole drilled in the top end of the connecting rod.

At the rear of the cylinder block, oil flows from the rear camshaft bore (Q), up through the cylinder head, and into the rocker arm shaft (S). Oil flows through the rocker arm shaft and lubricates each of the rocker arms (V). Oil drips from the rocker arms to lubricate the adjusting screws, push rods, and camshaft followers.

At the front of the cylinder block, oil flows from the oil passage into a machined groove (W) in the front face of the block. This groove connects with the upper idler gear shaft to provide oil to the idler gear bushing. The lower idler gear bushing is splash lubricated.

The turbocharger oil supply line (T) supplies oil to the turbocharger from filtered side of oil filter adapter. Oil returns from the turbocharger through the drain line (U).

DPSG,OUO1004,131 –19–15MAY98–2/2

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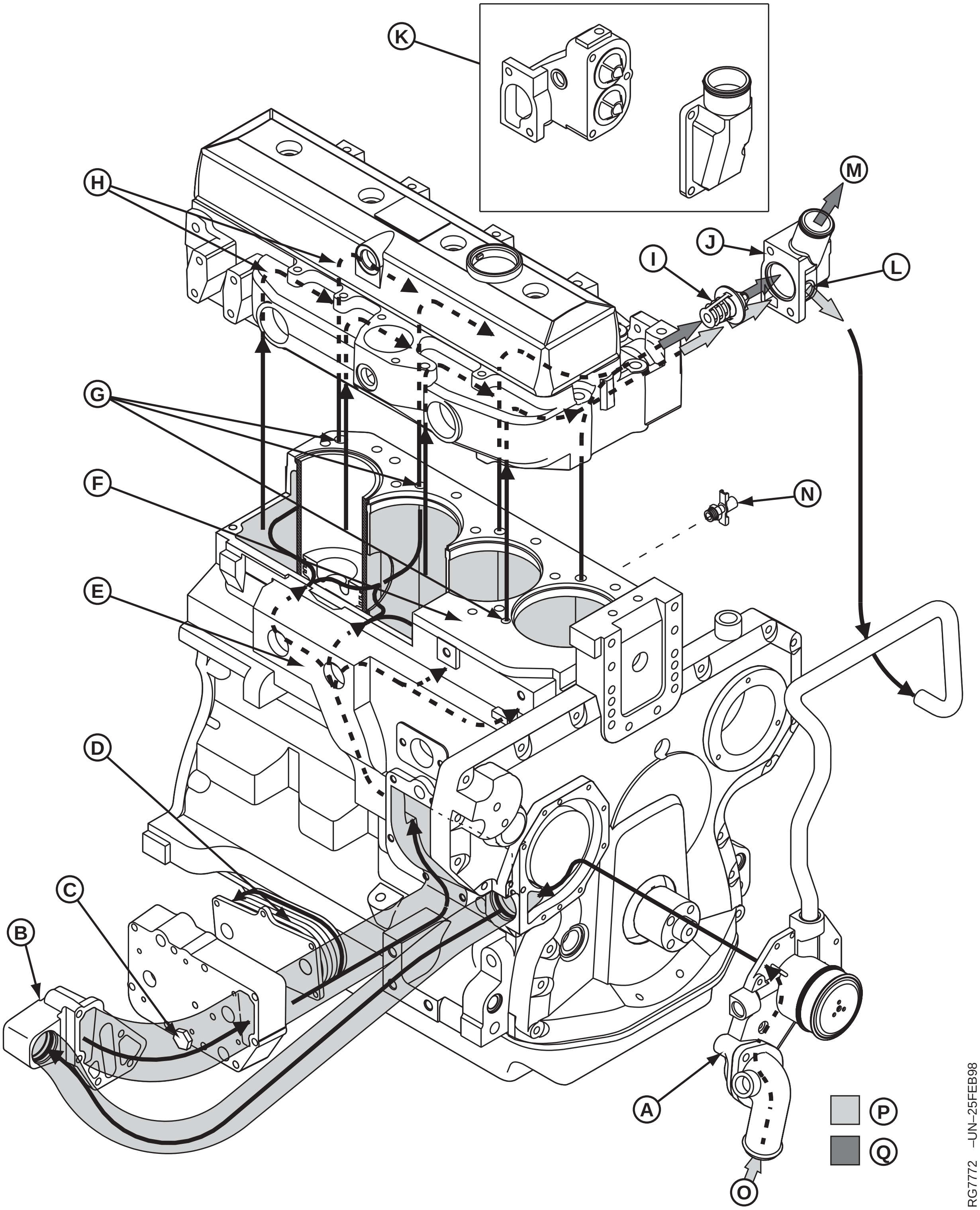
HOW THE COOLING SYSTEM WORKS



Continued on next page RG,105,JW7659 –19–21NOV97–1/2

A—Water Pump
B—Coolant Passage Adapter
C—Oil Cooler Drain Plug
D—Oil Cooler Plates
E—Main Coolant Gallery
F—Coolant Jacket
G—Block Deck Passages
H—Passages
I—Thermostat(s)
J—Water Manifold/Thermostat Housing
K—Dual Thermostat Assembly
L—Bypass Circuit
M—To Radiator Top Tank
N—Drain Valve
O—Suction Side of Water Pump
P—High Temperature Coolant
Q—Low Temperature Coolant

The cooling system includes the radiator, water pump (A), and thermostat(s) (H).

Coolant is circulated from the water pump into the coolant passage adapter (B) and circulates around the oil cooler plates (D). From the oil cooler, coolant flows into the main coolant gallery (E). From the gallery coolant flows into the coolant jacket (F), around the cylinder liners, up through the block deck passages (G), and into the cylinder head. In the cylinder head, the coolant flows through passages (H) around the intake and exhaust ports, valve seats, and injection nozzles. Coolant flows toward the front end of the cylinder head and exits through the water manifold/thermostat housing (J). Engines may be equipped with a dual thermostat assembly (K).

During the warm-up period, thermostat(s) (I) are closed and coolant is directed through a bypass circuit (L) into suction side of water pump. The coolant continues circulating through the cylinder block, cylinder head, and water pump to provide a uniform and fast warm-up period.

Once the engine has reached operating temperature, the thermostat(s) open and allow coolant to flow through the upper radiator hose to the radiator top tank (M). Coolant circulates through the radiator, dissipates heat, and then flows out of the radiator through the lower hose and into the suction side (O) of the water pump. Coolant continues flowing through the engine and radiator circuit until the coolant temperature drops below the thermostat opening temperature.

RG,105,JW7659 –19–21NOV97–2/2

105
10

HEAD GASKET JOINT CONSTRUCTION AND OPERATION

The head gasket joint consists of the following components:

- Cylinder head gasket
- Cylinder head (A)
- Cylinder block (E)
- Cylinder liners (C)
- Cylinder head cap screws (B)

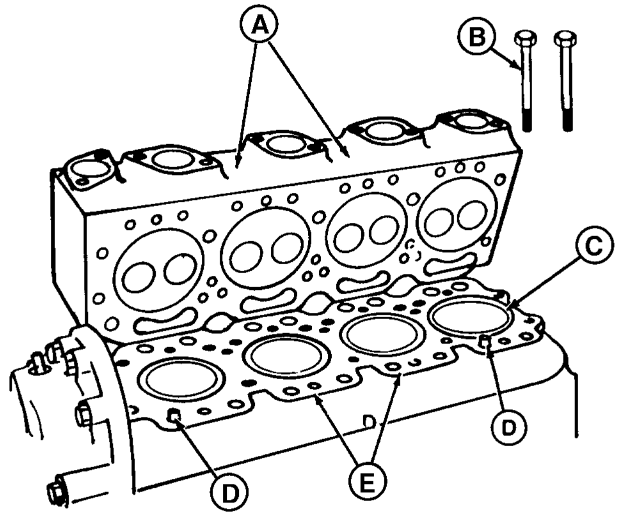
The head gasket must form an air-tight seal between cylinder liners and cylinder head that can withstand the temperatures and pressures of the combustion process. The gasket must also form a liquid-tight seal between the cylinder head and cylinder block to retain coolant and oil in their respective passages. The gasket is constructed of thin, formed sheets of steel-inserted, non-asbestos material (F). The surface of gasket is treated to improve liquid sealing and anti-stick characteristics. A fire ring combustion seal (G) is located at each cylinder bore and is held in place by a U-shaped stainless steel flange (H).

The cylinder head and block must be flat to provide an even clamping pressure over the entire surface of gasket, and must have the proper surface finish to keep gasket material from moving in the joint. Dowels (D) are used to properly locate head gasket on block.

The cylinder liners must protrude evenly from top of cylinder block the specified amount to provide adequate clamping force on fire ring of each cylinder.

The cap screws must be proper length, made of proper material, and be tightened to proper torque in order to provide an adequate clamp load between other joint components.

Each of the above components contributes to the integrity of the head gasket joint. If any of these components do not conform to specifications, gasket joint may fail resulting in combustion leaks, coolant leaks, or oil leaks.



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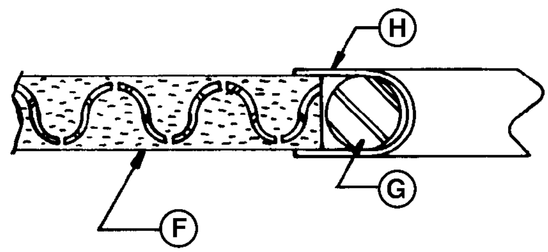


RG6430 –UN–03NOV97

A—Cylinder Head
B—Cylinder Head Cap Screws
C—Cylinder Liners
D—Dowel Pins
E—Cylinder Block
F—Gasket Body
G—Fire Ring Combustion Seal
H—Stainless Steel Flange

Continued on next page RG,105,JW7658 –19–21NOV97–1/2

Operating conditions such as coolant, oil, and combustion temperatures, and combustion pressures can reduce the ability of the head gasket joint to function properly. Failure of head gasket and mating parts may occur when coolant and oil temperatures become excessive, or when abnormally high combustion temperatures and pressures persist.

RG,105,JW7658 –19–21NOV97–2/2

DIAGNOSING HEAD GASKET JOINT FAILURES

NOTE: Booklet DB1119—CYLINDER HEAD GASKET FAILURES for 6466 and 6076 Engines can be used as a guide for diagnosing head gasket failures on POWERTECH® 4.5 L and 6.8 L Engines. However, use specifications provided in this manual.

Head gasket failures generally fall into three categories:

- Combustion seal failures.
- Coolant seal failures.
- Oil seal failures.

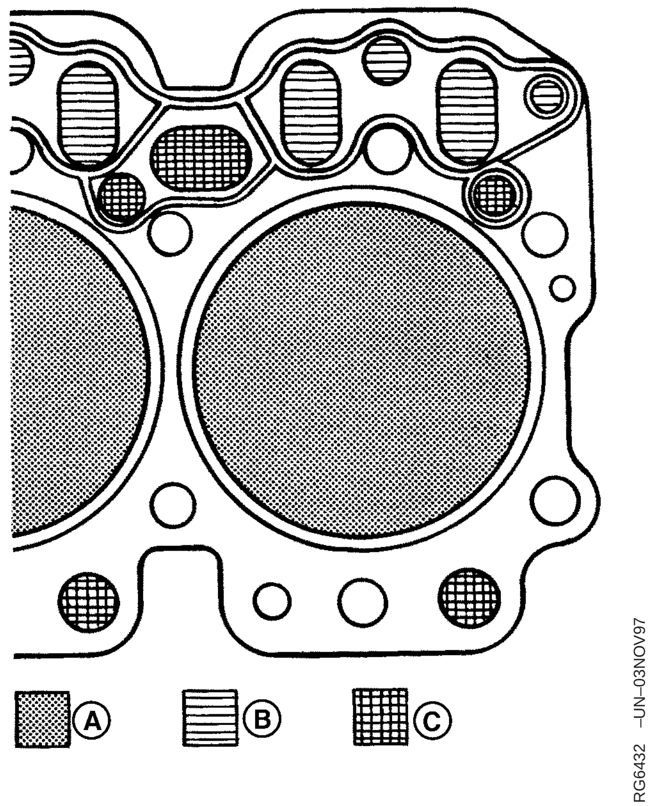
Combustion seal failures occur when combustion gases escape between cylinder head and head gasket combustion flange, or between combustion flange and cylinder liner. Leaking combustion gases may vent to an adjacent cylinder, to a coolant or oil passage, or externally.

Coolant or oil seal failures occur when oil or coolant escapes between cylinder head and gasket body, or between cylinder block and gasket body. The oil or coolant may leak to an adjacent coolant or oil passage, or externally. Since oil and coolant passages are primarily on right hand (camshaft) side of engine, fluid leaks are most likely to occur in that area.

Follow these diagnostic procedures when a head gasket joint failure occurs, or is suspected.

1. Before starting or disassembling engine, conduct a visual inspection of machine, and note any of the following:

   - Oil or coolant in head gasket seam, or on adjacent surfaces. Especially right rear corner of gasket joint.
   - Displacement of gasket from normal position.
   - Discoloration or soot from combustion gas leakage.
   - Leaking radiator, overflow tank, or hoses.
   - Leaking coolant from water pump weep hole.



A—Combustion Sealing Area
B—Oil Sealing Areas
C—Coolant Sealing Areas

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Continued on next page

- Damaged or incorrect radiator, fan, or shroud.
- Obstructed air flow or coolant flow.
- Worn or slipping belts.
- Damaged or incorrect pressure cap.
- Presence of oil in coolant.
- Low coolant levels or Improper coolant.
- Unusually high or low oil levels.
- Oil degradation, dilution, or contamination.
- Correctly specified injection pump.
- Indications of fuel or timing adjustments.
- Unburned fuel or coolant in exhaust system.

2. Obtain coolant and oil samples for further analysis.

3. Start and warm up engine if it can be safely operated. Examine all potential leakage areas again as outlined previously. Using appropriate test and measurement equipment, check for the following:

   - White smoke, excessive raw fuel, or moisture in exhaust system.
   - Rough, irregular exhaust sound, or misfiring.
   - Air bubbles, gas trapped in radiator/overflow tank.
   - Loss of coolant from overflow.
   - Excessive cooling system pressure.
   - Coolant overheating.
   - Low coolant flow.
   - Loss of cab heating (air lock).

4. Shut engine down. Recheck crankcase, radiator, and overflow tank for any significant differences in fluid levels, viscosity, or appearance.

5. Compare your observations from above steps with the diagnostic charts on the following pages. If diagnostic evaluations provide conclusive evidence of combustion gas, coolant, or oil leakage from head gasket joint, the cylinder head must be removed for inspection and repair of gasket joint components.

COMBUSTION SEAL LEAKAGE

Symptoms:

- Exhaust from head gasket crevice
- Air bubbles in radiator/overflow tank

Continued on next page

- Coolant discharge from overflow tube
- Engine overheating
- Power loss
- Engine runs rough
- White exhaust smoke
- Loss of cab heat
- Gasket section dislodged, missing (blown)
- Coolant in cylinder
- Coolant in crankcase oil
- Low coolant level

Possible Causes:

- Insufficient liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Rough/damaged liner flange surface
- Cracked/deformed gasket combustion flange
- Out-of-flat/damaged/rough cylinder head surface
- Missing/mislocated gasket fire ring
- Block cracked in liner support area
- Excessive fuel delivery
- Advanced injection pump timing
- Hydraulic or mechanical disturbance of combustion seal

NOTE: Cracked cylinder head or liners may also allow combustion gas leakage into coolant.

COOLANT SEAL LEAKAGE

Symptoms:

- Coolant discharge from head gasket crevice
- Coolant in crankcase oil
- Low coolant level
- High oil level
- Coolant discharge from crankcase vent

Possible Causes:

- Excessive liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface
- Out-of-flat/damaged/rough cylinder head surface
- Oil or coolant overheating

Continued on next page

- Cracks/creases in gasket body surfaces
- Damage/voids in elastomer beading

OIL SEAL LEAKAGE

Symptoms:

- Oil discharge from head gasket crevice
- Oil in coolant
- Low crankcase oil level
- Reduced oil to rocker arms (noisy)

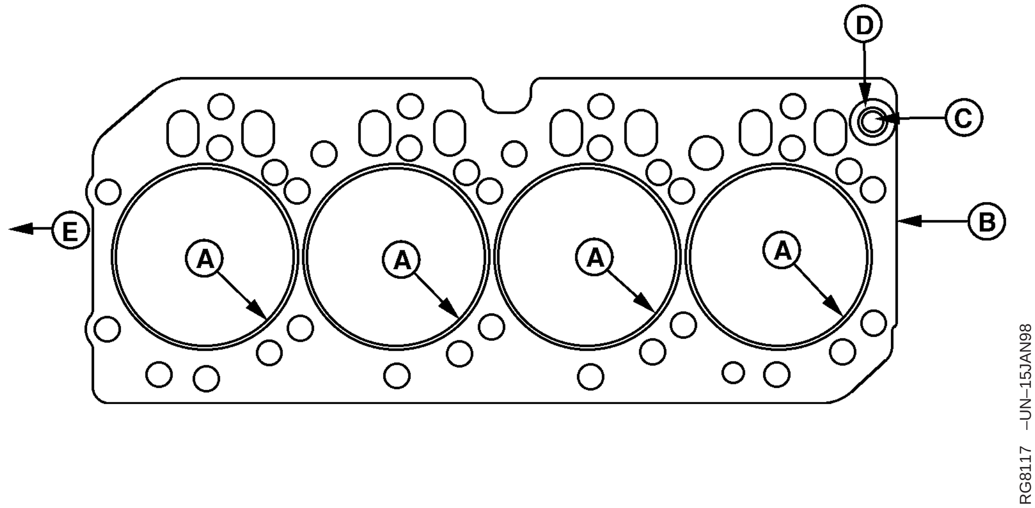
Possible Causes:

- Excessive liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface
- Out-of-flat/damaged/rough cylinder head surface
- Oil or coolant overheating
- Cracks/creases in gasket body surfaces
- Damage/voids in elastomer beading
- Damaged/missing O-ring seal at oil port to rocker arms

NOTE: Defective oil cooler may also allow oil leakage into coolant.

RG,105,JW7657 –19–21NOV97–4/4

HEAD GASKET INSPECTION AND REPAIR SEQUENCE



A—Combustion Seals (Flanges)
B—Gasket Body
C—Rocker Arm Oil Port
D—Elastomer Beading Strip
E—Front of Engine

The following inspection procedures are recommended whenever a head gasket joint failure occurs, or when joint disassembly takes place.

1. Review historical data relating to machine operation, maintenance and repair, along with diagnostic observations. Note all areas requiring further inspection and analysis.

2. Remove rocker arm cover and check for presence of coolant in the oil.

3. Record head cap screw torques prior to removal. Upon removal, check cap screw length differences.

4. Remove cylinder head using appropriate lifting devices to prevent handling damage to head gasket. (See REMOVE CYLINDER HEAD in Group 05.)

5. Observe surfaces of removed head gasket.

   Examine combustion seals (A) for the following:

   - Flange severed/expanded/cracked/deformed.
   - Adjacent body area burned/eroded.
   - Fire ring severed/displaced/missing.
   - Flange sealing pattern eccentric/contains voids.
   - Discoloration of flange and adjacent body areas.
   - Flange surfaces rough/abraided/channelled.

   Examine gasket body (B) for the following:

   - Combustion gas erosion paths or soot deposits originating at combustion seals.
   - Extreme discoloration/hardening/embrittlement in localized areas.
   - O-ring seal missing/damaged in port area (C).
   - Elastomer missing/damaged in port area (D).
   - Oil or coolant paths from port areas.
   - Localized areas of low compression.

6. Before cleaning components, inspect head, block, and liners for evidence of combustion gas and fluid leakage. Inspect cylinders and valve ports for unusual deposits.

7. Clean block, head, liners, and cap screws. (See Groups 05 and 10.)

8. Proceed with the following dimensional checks and visual inspections:

   Cylinder Head (See Group 05.)

Continued on next page

RG,105,JW7656 –19–21NOV97–1/2

- Check surface flatness/finish.
- Inspect for surface damage.
- Check cylinder head thickness, if resurfacing.

Cylinder Block and Liners (assembled and clamped) (See Group 05 or 10.)

- Check liner standout at four places on each liner.
- Check liner standout difference between cylinders.

Cylinder Block (See Group 10.)

- Check surface flatness/finish.
- Inspect for surface damage.
- Check liner counterbore depth (if liner is removed).
- Check top deck to crankshaft centerline dimension.
- Inspect cap screw bosses, must be clean/intact.

Cylinder Liner (See Group 10.)

- Check liner flange flatness/finish.
- Check liner flange thickness (if liner is removed).
- Inspect flange for damage.

Cylinder Head Cap Screws (See Group 05.)

- Inspect for corrosion damage.
- Inspect condition of threads.
- Inspect for straightness.
- Check length.

9. When inspections and measurements have been completed, determine most probable causes of joint failure. Make all necessary repairs to joint components, cooling system, and fuel injection system.

10. Reassemble the engine according to procedures and specifications in the repair groups of this manual.

RG,105,JW7656 –19–21NOV97–2/2

DIAGNOSING ENGINE MALFUNCTIONS

Engine Will Not Crank

Electrical System Malfunction

- Weak battery
- Corroded or loose battery connections
- Defective main switch or start safety switch
- Starter solenoid defective
- Starter defective

Engine Hard to Start or Will Not Start

Electrical System Malfunction

- Loose or corroded battery connections
- Weak battery
- Excessive resistance in starter circuit

Fuel System Malfunction - See Group 115

- Empty fuel tank
- Improper fuel
- Water, dirt or air in fuel system
- Plugged fuel filter
- Stuck shut-off control
- Dirty or faulty fuel injection nozzles
- Defective fuel injection pump
- Defective fuel transfer pump
- Fuel injection pump incorrectly timed

Service Problem

- Too high viscosity crankcase oil

Engine Runs Irregularly or Stalls Frequently

Basic Engine Problem

- Coolant temperature too low
- Improper valve clearance
- Cylinder head gasket leaking
- Worn or broken compression rings
- Valves sticking or burned
- Exhaust system restricted
- Engine compression too low
- Engine overheating
- Worn camshaft lobes

Fuel System Malfunction - See Group 115

- Defective fuel injection pump
- Low fuel supply
- Fuel injection nozzles defective or leaking
- Fuel filter or fuel lines restricted
- Defective fuel transfer pump
- Fuel injection pump incorrectly timed

Engine Misfiring

Service Problem

- Water in fuel
- Mixture of gasoline and diesel fuel

Fuel System Malfunction - See Group 115

- Air in fuel system
- Defective fuel injection nozzles
- Defective fuel injection pump
- Fuel injection nozzles improperly installed
- Leaking fuel injection nozzle seals
- Worn or defective fuel transfer pump
- Fuel injection pump incorrectly timed

Basic Engine Problem

- Engine overheated
- Lobes of camshaft worn
- Weak valve springs
- Pre-ignition
- Engine compression too low
- Improper valve clearance
- Burnt, damaged or stuck valves

Lack of Engine Power

Service Problem

Continued on next page

- Air cleaner restricted or dirty
- Excessive resistance in air intake system
- Improper crankcase oil

Fuel System Malfunction - See Group 115

- Fuel filter restricted
- Defective fuel transfer pump
- Defective fuel injection pump
- Fuel injection pump incorrectly timed

Basic Engine Problem

- Engine overheated
- Engine clutch slipping
- Defective cylinder head gasket
- Lobes of camshaft worn
- Improper valve clearance
- Improper valve timing
- Burnt, damaged or stuck valves
- Weak valve springs
- Piston rings and cylinder liners excessively worn
- Engine compression too low
- Improper coolant temperature

Engine Overheats

Service Problem

- Lack of coolant in cooling system
- Radiator core and/or side screens dirty
- Cooling system limed up
- Engine overloaded
- Too low crankcase oil level

Basic Engine Problem

- Loose or defective fan belt
- Defective thermostat(s)
- Damaged cylinder head gasket
- Defective water pump
- Defective radiator cap

Fuel System Malfunction - See Group 115

- Fuel injection pump delivers too much fuel
- Fuel injection pump incorrectly timed

Excessive Oil Consumption

Basic Engine Problem

- Oil control rings worn or broken
- Scored cylinder liners or pistons
- Excessive resistance in air intake system
- Oil flow through oil passages restricted
- Worn valve guides or stems
- Excessive oil pressure
- Piston ring grooves excessively worn
- Piston rings sticking in ring grooves
- Insufficient piston ring tension
- Piston ring gaps not staggered
- Excessive main or connecting rod bearing clearance
- Front and/or rear crankshaft oil seal faulty
- Glazed cylinder liners (insufficient load during engine break-in)

Service Problem

- Too low viscosity crankcase oil
- Crankcase oil level too high
- External oil leaks

Low Oil Pressure

Service Problem

- Low crankcase oil level
- Clogged cooler or filter
- Improper crankcase oil
- Excessive oil temperature
- Oil pressure regulating valve failure
- Defective oil pressure warning switch or engine oil pressure indicator light

Basic Engine Problem

- Leakage at internal oil passages
- Defective oil pump

Continued on next page

- Excessive clearance between oil pump gears and cover
- Clogged oil pump screen
- Excessive main and connecting rod bearing clearance
- Improper regulating valve adjustment
- Piston cooling orifice missing

Low Oil Pressure at Slow Idle

Basic Engine Problem

- Bypass oil check valve failure

High Oil Pressure

Basic Engine Problem

- Clogged oil lines
- Improper oil classification
- Oil pressure regulating valve bushing loose (wanders)
- Improperly operating regulating valve
- Stuck or damaged filter bypass valve

Oil Sludge and Dilution

Basic Engine Problem

- Coolant leakage into lubrication system
- Incomplete combustion
- Excessive oil consumption
- Defective injection pump (failed internal O-ring seals)

Excessive Fuel Consumption

Service Problem

- Engine overloaded
- Air cleaner restricted or dirty

Basic Engine Problem

- Compression too low

Fuel System Malfunction - See Group 115

- Leaks in fuel system
- Fuel injection nozzles dirty or faulty
- Fuel injection pump defective (delivers too much fuel)
- Fuel injection pump incorrectly timed

Black or Grey Exhaust Smoke

Service Problem

- Excess fuel
- Engine overloaded
- Air cleaner restricted or dirty
- Defective muffler (causing back-pressure)

Fuel System Malfunction - See Group 115

- Fuel injection nozzles dirty or faulty
- Incorrect engine timing

White Exhaust Smoke

Basic Engine Problem

- Engine compression too low
- Defective thermostat(s) (does not close)

Fuel System Malfunction - See Group 115

- Defective fuel injection nozzles
- Fuel injection pump incorrectly timed

Coolant in Crankcase

Basic Engine Problem

- Cylinder head gasket defective
- Cylinder head or block cracked
- Cylinder liner seals leaking

Abnormal Engine Noise

Basic Engine Problem

Continued on next page

RG,105,JW7655 –19–21NOV97–3/4

- Worn main or connecting rod bearings
- Excessive crankshaft end play
- Loose main bearing caps
- Foreign material in combustion chamber
- Worn connecting rod bushings and piston pins
- Scored pistons
- Worn timing gears
- Excessive valve clearance
- Worn cam followers
- Bent push rods
- Worn camshaft
- Worn rocker arm shaft
- Insufficient engine lubrication
- Worn turbocharger bearings

Fuel System Malfunction - See Group 115

- Fuel injection pump incorrectly timed

Detonation or Pre-Ignition

Basic Engine Problem

- Oil picked up by intake air stream (intake manifold)

Fuel System Malfunction - See Group 115

- Dirty or faulty fuel injection nozzles
- Incorrect fuel injection pump timing
- Fuel injection nozzle tip holes enlarged
- Fuel injection nozzle tips broken
- Carbon build-up in compression chamber

Water Pump Leaking

Seal ring or pump shaft worn

Coolant Temperature Below Normal

Defective thermostat(s)

Coolant temperature gauge defective

Engine Vibrating

Fan blades bent or broken

Water pump shaft worn

Balancer shaft/gear broke (4-cylinder)

RG,105,JW7655 –19–21NOV97–4/4

TEST ENGINE COMPRESSION PRESSURE

IMPORTANT: Compression pressures are affected by the cranking speed of the engine. Before beginning test, insure that batteries are fully charged and injection nozzle area is thoroughly cleaned.

1. Start engine and run at rated speed until it warms up to normal operating temperature. (From a cold start, operate engine 10—15 minutes at slow idle.)

   Shut off fuel supply and remove fuel injection nozzles. (See Group 35.)

Continued on next page RG,105,JW7652 –19–21NOV97–1/3

2. Install JT01679[1] Adapter with O-ring (or D14550BA[2] Adapter) in injection nozzle bore. Use JT02017 Holding Clamp[2] to hold JT01679 Adapter in position. Install hold-down screw in clamp and tighten screw to 37 N•m (27 lb-ft). Attach JT01682[2] Test Gauge (or D14547BA[2]) to adapter.

NOTE: If using FKM10021 Compression Test Set, install 19.58—90.578 Adapter (A) in injection nozzle bore with R73788 nozzle spacer (B) and two R92352 nozzle seals (C). Use holding plate (D) to secure. Then attach FKM10022 test gauge (E) to adapter.

3. Push throttle lever to “STOP” position. Turn crankshaft for 10—15 seconds with starting motor (minimum cranking speed —150 rpm cold/200 rpm hot).

4. Compare readings from all cylinders. Compression pressure must be within specification.

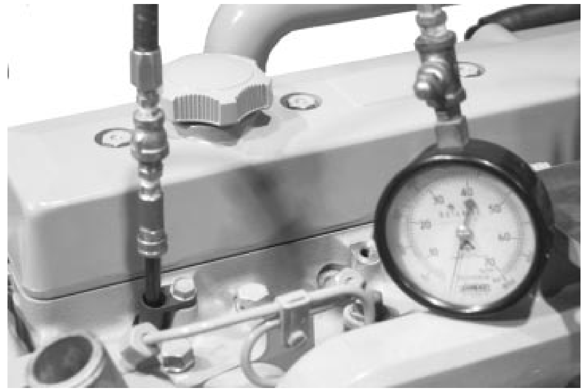
Engine Compression Pressure Test—Specification

Engine Compression Pressure: Minimum	2400 kPa (24 bar) (350 psi)
Maximum Difference Between Cylinders	350 kPa (3.5 bar) (50 psi)

NOTE: Pressure given was taken at 183 m (600 ft) above sea level. A 3.6 percent reduction in gauge pressure will result for each additional 300 m (1000 ft) rise in altitude.

All cylinders within an engine should have approximately the same pressure. There should be less than 340 kPa (3.4 bar) (50 psi) difference between cylinders.

5. If pressure is much lower than shown, remove gauge and apply oil to ring area of piston through injection nozzle bore. Do not use too much oil. Do not get oil on the valves.



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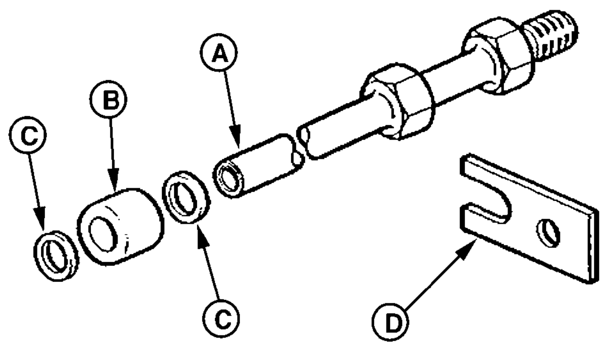

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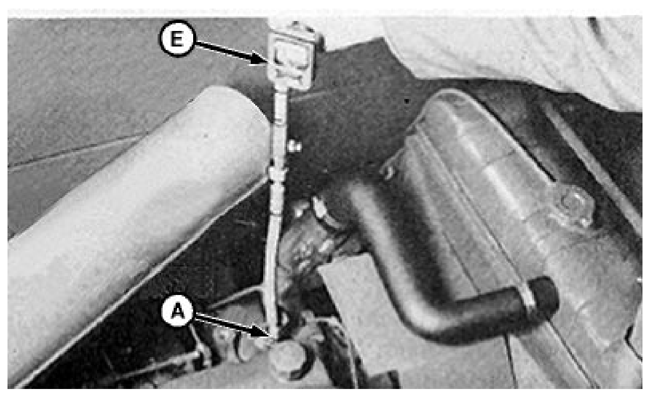


RG9139 –UN–18MAY98

A—19.58—90.578 Adapter
B—R73788 Nozzle Spacer
C—R92352 Nozzle Seal
D—Holding Plate
E—FKM10022 Test Gauge

[1]*Part of JT01674 Compression Test Set*

[2]*Part of D14546BA Compression Test Set*

Continued on next page

RG,105,JW7652 –19–21NOV97–2/3

6. Test compression pressure again.

   If pressure is high, worn, or stuck rings are indicated, replace piston rings or install new piston and liner set as needed. (See Group 10.)

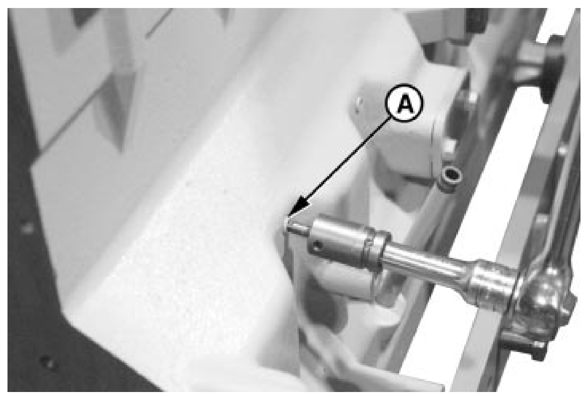
   If pressure is low, valves could be worn or sticking. Recondition cylinder head as required. (See Group 05.)

7. Measure compression pressure in all remaining cylinders and compare readings. Recondition cylinders and valves as required.

RG,105,JW7652 –19–21NOV97–3/3

CHECK ENGINE OIL PRESSURE

1. Remove main oil gallery plug (A) using JDG782 Oil Gallery Plug Tool.



A—Oil Gallery Plug

Continued on next page RG,105,JW7651 –19–21NOV97–1/2

2. Attach pressure gauge (B) from JT05470 Universal Pressure Test Kit to oil gallery.

IMPORTANT: To achieve an accurate oil pressure reading, warm up engine crankcase oil to 105°C (220°F) or high oil pressure readings will occur.

3. Start engine and run at speeds given below.

4. Measure oil pressure and compare readings.

Minimum Oil Pressure-No Load at Slow Idle and 93°C (200°F) Oil Temperature—Specification

Minimum Pressure... 100 kPa (1.0 bar) (14 psi)

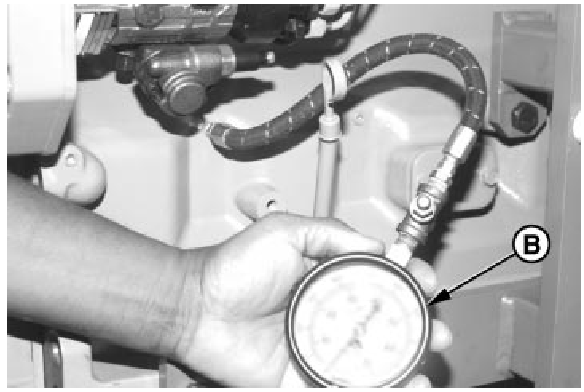
Minimum Oil Pressure-Full Load at Rated Speed and 105°C (220°F) Oil Temperature—Specification

Minimum Pressure... 275 kPa (2.75 bar) (40 psi)

NOTE: Tolerance extremes and gauge fluctuations can result in the gauge reading up to 586 kPa (5.86 bar) 85 psi. This is not detrimental to the engine.

The oil pressure regulating valve is designed so that adjustment of oil pressure should not be required.

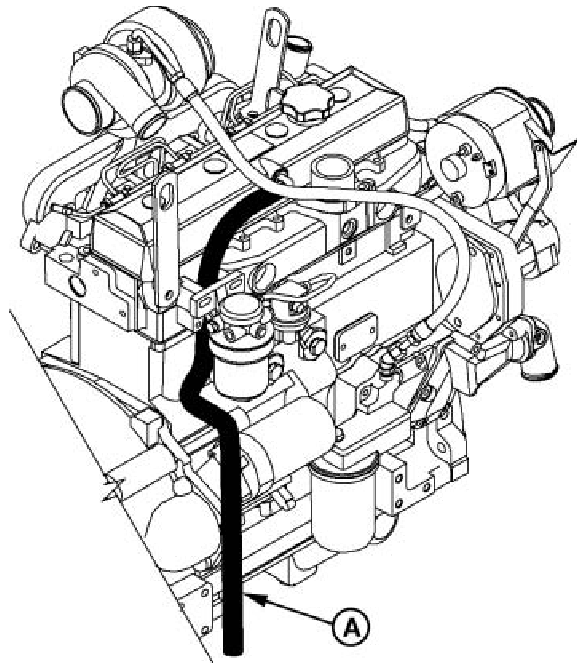
5. Replace oil pressure regulating valve if oil pressure is not within specified range.



B—Pressure Gauge

RG,105,JW7651 –19–21NOV97–2/2

CHECK FOR EXCESSIVE ENGINE CRANKCASE PRESSURE (BLOW-BY)



A—Breather Tube

Excessive blow-by coming out of the crankcase breather tube (A) indicates that either the turbocharger (if equipped) seals are faulty or the piston rings and cylinder liners are not adequately sealing off the combustion chamber. This is a comparative check that requires some experience to determine when blow-by is excessive.

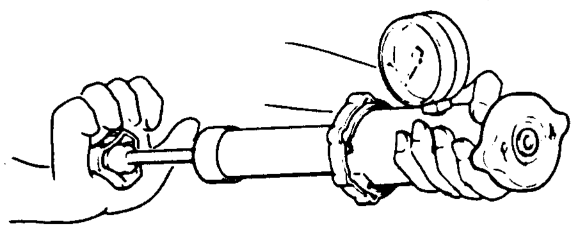
Run engine at high idle and check crankcase breather tube. Look for significant fumes and/or dripping oil coming out of the breather tube at fast idle, with no load.

If excessive blow-by is observed, perform the following to determine if the turbocharger (if equipped) is causing the blow-by:

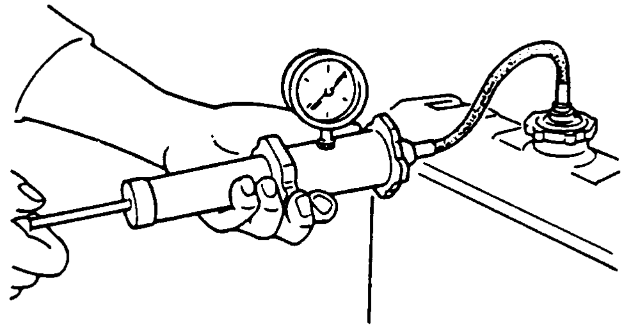
1. Remove the turbocharger oil drain line where it connects to the engine block and run line into a bucket.
2. Run engine at high idle, slightly loaded and determine if boost pressure is forcing oil through the drain line, and check crankcase breather tube to determine if blow-by has decreased.
3. If it appears that boost pressure is forcing oil through the drain line, and/or blow-by decreases with the drain line disconnected from block, replace the turbocharger, and retest.

RG,105,JW7650 –19–21NOV97–1/1

PRESSURE TEST COOLING SYSTEM AND RADIATOR CAP



RG6557 –UN–20JAN93



RG6558 –UN–20JAN93

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

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

TEST RADIATOR CAP:

1. Remove radiator cap and attach to D05104ST Pressure Pump as shown.

2. Pressurize cap to the following specification:[1].

Cooling System—Specification

Test Pressure .... 70 kPa (0.7 bar) (10 psi)

Gauge should hold pressure for 10 seconds within the normal range if cap is acceptable.If gauge does not hold pressure, replace radiator cap.

3. Remove the cap from gauge, turn it 180°, and retest cap. This will verify that the first measurement was accurate.

TEST COOLING SYSTEM:

NOTE: Engine should be warmed up to test overall cooling system.

1. Allow engine to cool, then carefully remove radiator cap.

2. Fill radiator with coolant to the normal operating level.

IMPORTANT: DO NOT apply excessive pressure to cooling system, doing so may damage radiator and hoses.

3. Connect gauge and adapter to radiator filler neck. Pressurize cooling system to 70 kPa (0.7 bar) (10 psi)[1], using D05104ST Pressure Pump.

4. With pressure applied, check all cooling system hose connections, radiator, and overall engine for leaks.

   If leakage is detected, correct as necessary and pressure test system again.

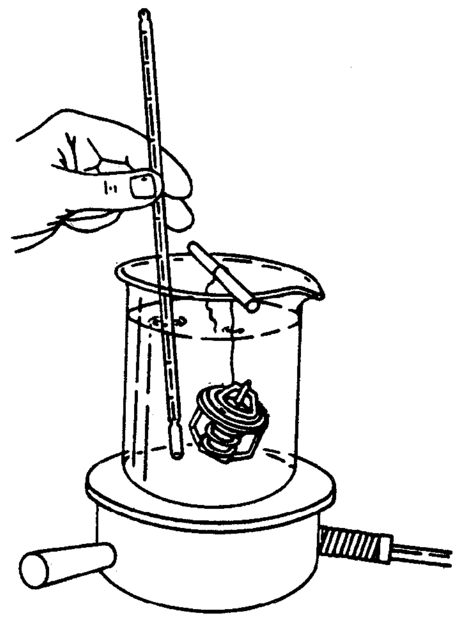
[1]Test pressures recommended are for all Deere OEM cooling systems. On specific vehicle applications, test cooling system and pressure cap according to the recommended pressure for that vehicle.

Continued on next page

If no leakage is detected, but the gauge indicated a drop in pressure, coolant may be leaking internally within the system or at the block-to-head gasket.

RG,105,JW7649 –19–21NOV97–2/2

INSPECT THERMOSTAT AND TEST OPENING TEMPERATURE



Visually inspect thermostat for corrosion or damage. Replace as necessary.

Test thermostat as follows:

CAUTION: DO NOT allow thermostat or thermometer to rest against the side or bottom of container when heating water. Either may rupture if overheated.

1. Remove thermostats. (See REMOVE THERMOSTATS in Group 25.)
2. Suspend thermostat and a thermometer in a container of water.
3. Stir the water as it heats. Observe opening action of thermometer and compare temperatures with specification given in chart below.

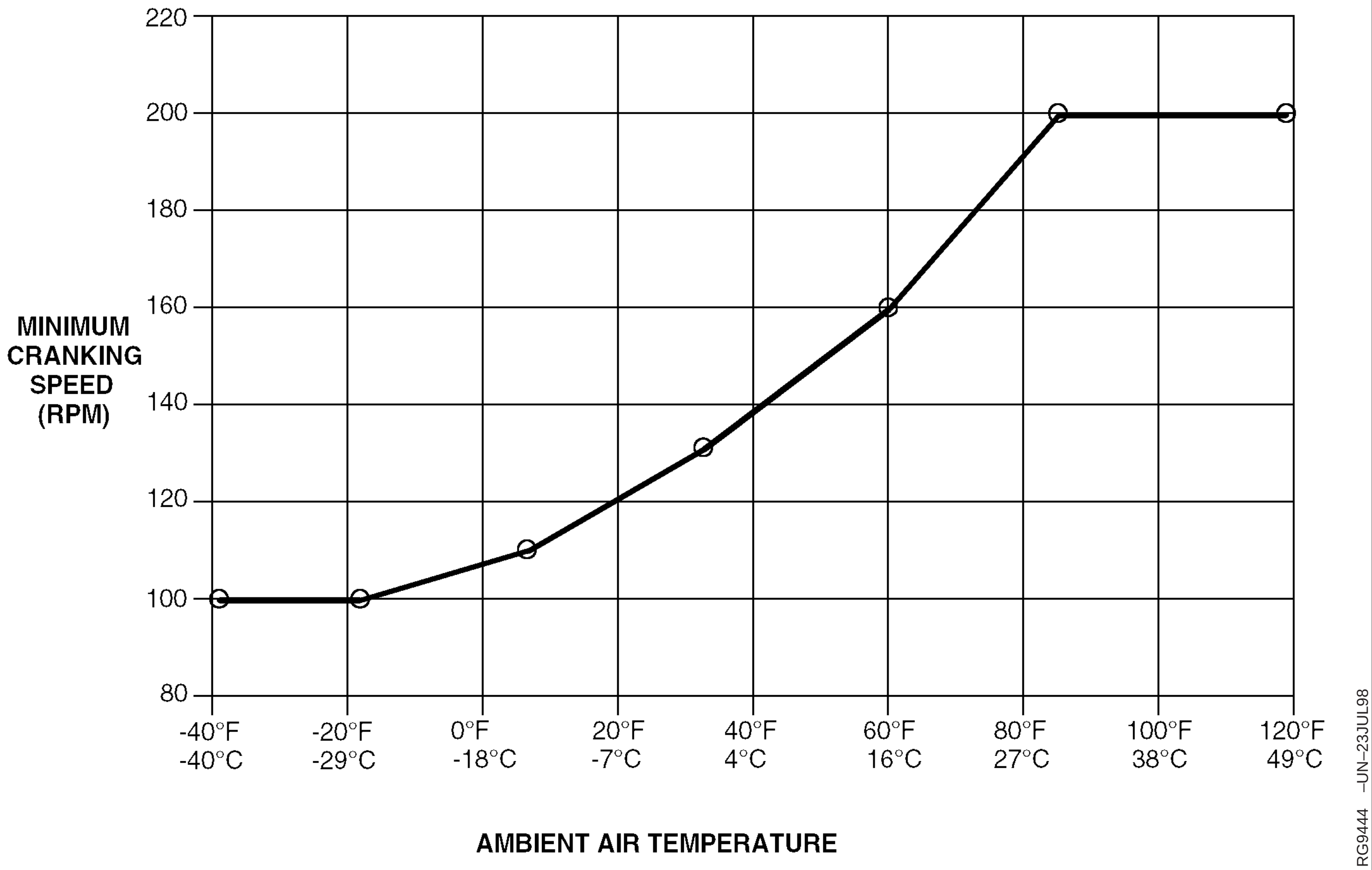
NOTE: Due to varying tolerances of different suppliers, initial opening and full open temperatures may vary slightly from specified temperatures.

THERMOSTAT TEST SPECIFICATIONS

Rating	Initial Opening (Range)	Full Open (Nominal)
71°C (160°F)	69—72°C (156—162°F)	84°C (182°F)
77°C (170°F)	74—78°C (166—172°F)	89°C (192°F)
82°C (180°F)	80—84°C (175—182°F)	94°C (202°F)
89°C (192°F)	86—90°C (187—194°F)	101°C (214°F)
90°C (195°F)	89—93°C (192—199°F)	103°C (218°F)
92°C (197°F)	89—93°C (193—200°F)	105°C (221°F)
96°C (205°F)	94—97°C (201—207°F)	100°C (213°F)
99°C (210°F)	96—100°C (205—212°F)	111°C (232°F)

4. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.
5. If any thermostat is defective on a multiple thermostat engine, replace all thermostats.

ENGINE CRANKING SPEED TEST



IMPORTANT: Make sure that batteries are fully charged before performing this test.

1. Disable the fuel supply system at the injection pump so fuel delivery is in the OFF position.

2. If not using the machine tachometer, install a photo tach or TIME TRAC®.

3. Crank the engine for 15 seconds and record engine speed.

4. Compare recorded engine speed to chart above.

Cranking speed should meet or exceed specified engine rpm for a given ambient air temperature. For example, at 85°F (29°C) ambient air temperature, cranking speed should be at least 200 rpm.

If cranking speed is below specifications, check the following:

- Starting system problems (low battery, loose or defective wiring, defective starter, etc.).
- Excessive engine loads (hydraulic pumps/thick oil, thick engine oil, etc.).

TIME TRAC is a registered trademark of Stanadyne Automotive Corp.

DPSG,OUO1004,164 –19–06JUL98–1/1

Group 110
Air Intake and Exhaust System Operation and Tests

ESSENTIAL TOOLS

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

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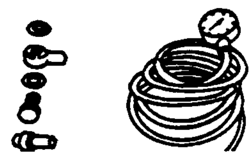
DPSG,OUO1004,204 –19–07JUL98–1/2

RG5163 –UN–23AUG88



Manifold Pressure Tester . . . . JDE147 or FKM10002

Used to test intake manifold pressure on turbocharged engines.

DPSG,OUO1004,204 –19–07JUL98–2/2

SERVICE EQUIPMENT AND TOOLS

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

SERVICEGARD is a trademark of Deere & Company

DPSG,OUO1004,245 –19–13JUL98–1/3

Water Vacuum Gauge Kit D05022ST

Used to test air filter restriction indicator switch.

Continued on next page

DPSG,OUO1004,245 –19–13JUL98–2/3

Turbocharger Shield JDG576

Cover turbocharger inlet when testing engine with air filter system removed.

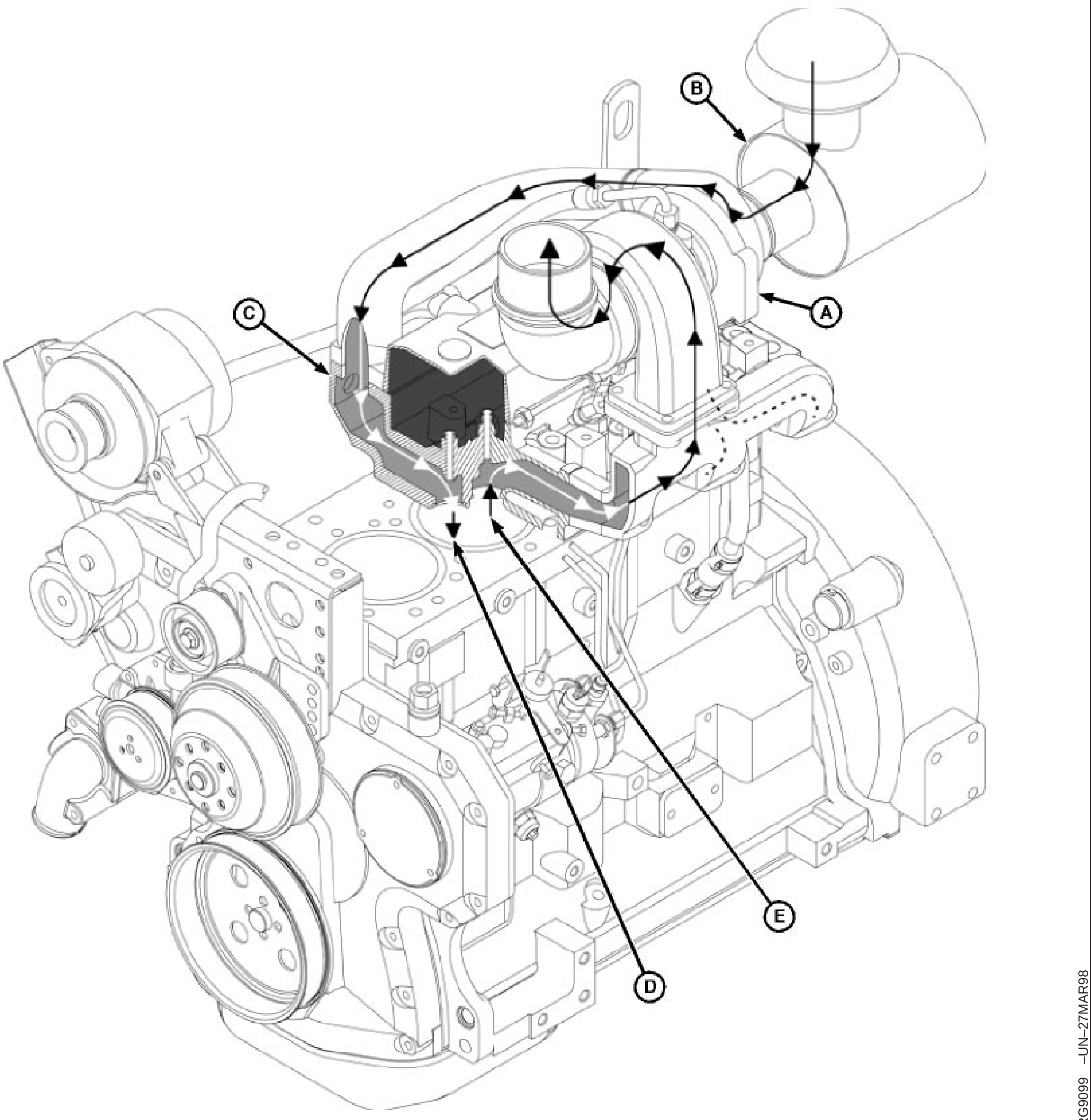
DPSG,OUO1004,245 –19–13JUL98–3/3

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.)

RG,110,JW7674 –19–24NOV97–1/1

HOW THE AIR INTAKE AND EXHAUST SYSTEM WORKS



A—Turbocharger
B—Air Cleaner
C—Intake Side of Cylinder Head
D—Outside Intake Air
E—Exhaust Air

Engine suction draws dust-laden outside air (D) through an air inlet stack into the air cleaner (B). Air is filtered through dry type primary and secondary (safety) filter elements in the air cleaner canister.

Clean air travels through the air intake hose to the turbocharger (A) and into the intake side of the cylinder head (C).

Continued on next page

Exhaust (E), drives the turbocharger to deliver a larger quantity of air to meet the engine requirements than what could be delivered under naturally aspirated (non-turbocharged) conditions.

On some engines, an air-to-air aftercooler cools the turbocharger compressor discharge air by routing it through a heat exchanger before it enters the engine. The heat exchanger uses no liquid coolant but relies on air flow to cool the charge air.

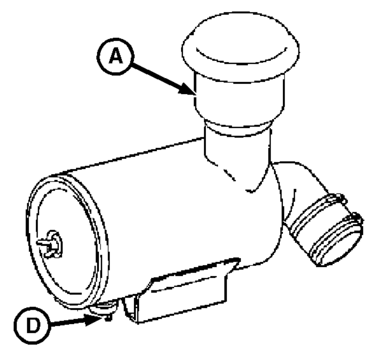
RG,110,JW7673 –19–24NOV97–2/2

AIR CLEANER OPERATION

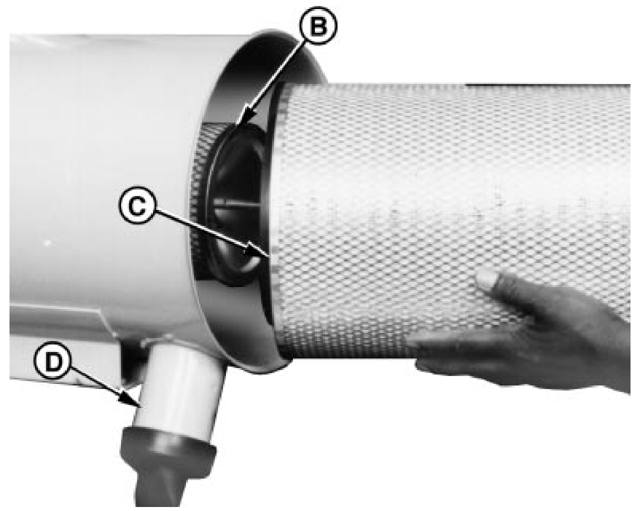
Under suction generated by the engine, unfiltered air flows through air inlet tube (A) and is forced into a high-speed centrifugal motion by tilted fins in the element. By this circulating action most of the dust and dirt particles are separated from the air and collected in the dust unloading valve (D).

The remaining dirt is removed as the air flows through the primary element (C) and the secondary (safety) filter (B) before being drawn into the engine.

The secondary (safety) filter ensures that should primary element fail, no unfiltered air is drawn into the engine.



RG9097 –UN–27MAR98



RG7766B –UN–10NOV97

A—Air Inlet Tube
B—Secondary (Safety) Filter
C—Primary Element
D—Dust Unloading Valve

RG,110,JW7672 –19–24NOV97–1/1

110
6

AIR FILTER RESTRICTION INDICATOR SWITCH TEST

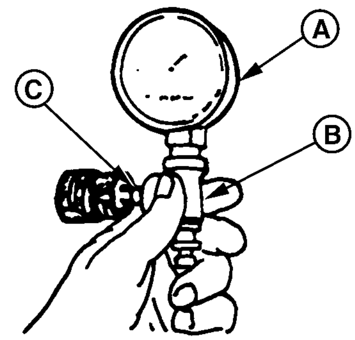
1. Remove air filter restriction indicator switch from air intake piping.

2. Install pipe nipple (C), tee fitting (B), and gauge (A) from D05022ST Water Vacuum Gauge Kit into air filter restriction indicator hole. Install air filter restriction indicator into tee fitting.

3. Start engine and slowly cover the air cleaner inlet with a piece of paper or cardboard.

4. Air restriction indicator must show red at 5.6—6.8 kPa (56—68 bar) (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.



RGT6188AQ –UN–19NOV97

A—Gauge
B—Tee Fitting
C—Pipe Nipple

RG,110,JW7671 –19–24NOV97–1/1

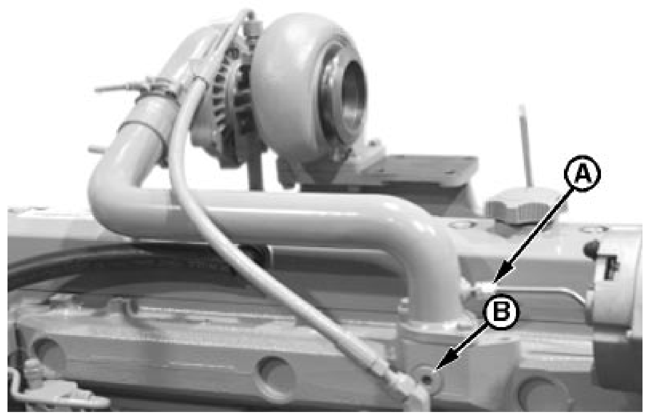
INTAKE AIR LEAK TEST

Loose connections or cracks in the suction side of the air intake pipe can allow debris to be ingested into the engine causing rapid wear in the cylinders. Additionally, on turbocharged engines, compressor damage may occur and cause an imbalance resulting in bearing failure.

Air leaking from loose connections or cracks on the pressure side of the turbocharger can cause excessive smoke and low power.

NOTE: The following test procedure requires that the air intake be sealed off to pressurize the system. Using a plastic bag to seal the air intake filter is used as an example.

CAUTION: Do not start engine during this test procedure. Plastic bag (or whatever material/object used to seal intake) can be sucked into the engine.



A—Start Aid Line
B—Plug

1. Remove air cleaner cover and main filter element

2. Put a plastic bag over secondary filter element and install main element and cover.

3. Remove plug (B) from manifold or disconnect line (A) from crossover tube if (equipped) and using suitable adapter, connect a regulated air source.

4. Pressurize air intake system to 13.8—20.7 kPa (0.13-0.21 bar) (2—3 psi).

5. Spray soap and water solution over all connections from the air cleaner to the turbocharger or air inlet to check for leaks. Repair all leaks.

6. Remove plastic bag from filter element and reinstall element and cover.

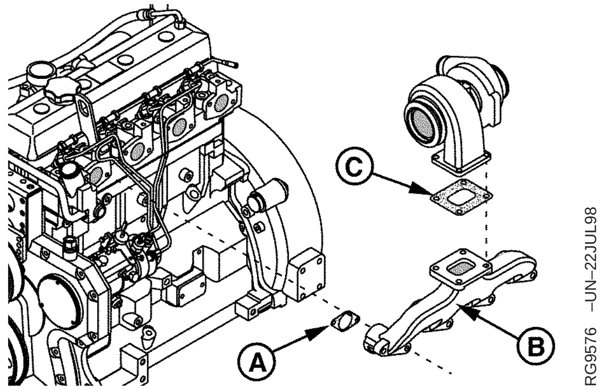
DPSG,OUO1004,220 –19–10JUL98–1/1

110
8

EXHAUST LEAK CHECK (TURBOCHARGED ENGINES)

Exhaust leaks, upstream of the turbocharger, will cause the turbocharger turbine to rotate at a reduced speed resulting in low boost pressure, low power, and excessive black smoke.

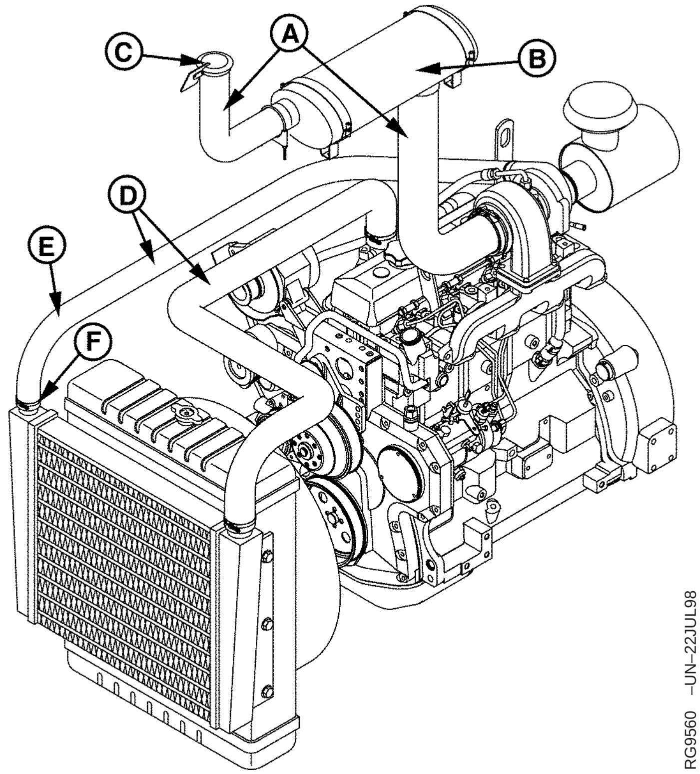
Inspect the exhaust manifold gasket (A), the exhaust manifold (B), and the turbocharger gasket (C) for damage and any signs of leakage. Replace components as needed.



A—Exhaust Manifold Gasket
B—Exhaust Manifold
C—Turbocharger Gasket

DPSG,OUO1004,288 –19–23JUL98–1/1

INTAKE AND EXHAUST RESTRICTION CHECK



A—Exhaust Piping
B—Muffler
C—Rain Cap
D—Intake Piping
E—Elbows
F—Connections

Low power, low boost pressure, and excessive black exhaust smoke can be caused by an intake air or exhaust restriction.

1. Inspect the exhaust piping (A), the muffler (B), and the rain cap (C) for damage or any possible restrictions.
2. Inspect the intake piping (D), any elbows (E), and any connections (F). Look for collapsed pipes, dented pipes and loose connections. Replace components as needed.

DPSG,OUO1004,222 –19–10JUL98–1/1

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[1] :

- Bearings not lubricated (insufficient oil pressure).
- Air leak in engine intake or exhaust manifold.
- Improper clearance between turbine wheel and turbine housing.
- Broken blades (or other wheel failures).

Engine Will Not Deliver Rated Power:

- Clogged manifold system.
- Foreign material lodged in compressor, impeller, or turbine.
- Excessive dirt build-up in compressor.
- Leak in engine intake or exhaust manifold.
- Leak in intake manifold-to-aneroid pipe.
- Rotating assembly bearing failure.
- Damaged compressor or turbine blades.

Oil On Compressor Wheel Or In Compressor Housing (Oil Being Pushed or Pulled Through Center Housing):

- Excessive crankcase pressure.
- Air intake restriction.
- Drain tube restriction.

Oil In Manifold Or Dripping From Housing:

- Excessive crankcase pressure.
- Air intake restriction.
- Drain tube restriction.
- Damaged or worn journal bearings.
- Unbalanced rotating assembly:
  - Damage to turbine or compressor wheel or blade.
  - Dirt or carbon build-up on wheel or blade.

- Bearing wear:
  - Oil starvation or insufficient lubrication.
  - Shaft seals worn.

Turbine Wheel Drag:

- Carbon build-up behind turbine wheel caused by coked oil or combustion deposits.
- Dirt build-up behind compressor wheel caused by air intake leaks.
- Bearing seizure or dirty, worn bearings caused by excessive temperatures, unbalanced wheel, dirty oil, oil starvation, or insufficient lubrication.

[1]Do not confuse the whine heard during run down with noise which indicates a bearing failure.

RG,110,JW7670 –19–24NOV97–1/1

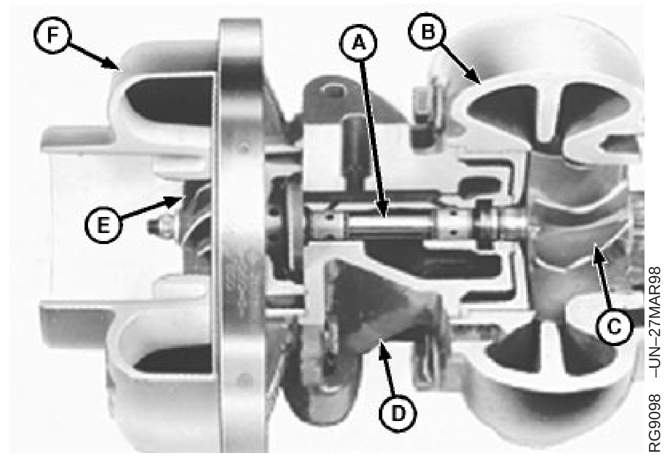
TURBOCHARGER OPERATION

The turbocharger, which is basically an air pump that is driven by exhaust gases, allows the engine to produce added power without increasing displacement. Turbochargers are specially matched for the power ratio requirements of each specific application.

The turbine wheel (C) is driven by the hot engine exhaust gases. These gases flowing through the turbine housing (B) act on the turbine wheel causing shaft (A) to turn.

Compressor wheel (E) brings in filtered air and discharges the compressed air into the intake manifold where it is then delivered to engine cylinders.

Engine oil under pressure from the engine lubrication system is forced through passages in center housing (D) to bearings.



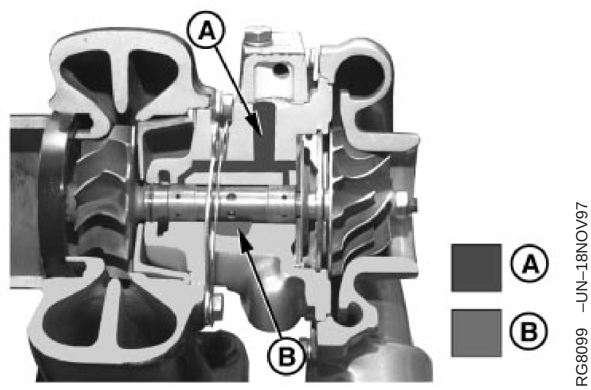
A—Shaft
B—Turbine Housing
C—Turbine Wheel
D—Center Housing
E—Compressor Wheel
F—Compressor Housing

RG,110,JW7669 –19–24NOV97–1/1

HOW THE TURBOCHARGER IS LUBRICATED

Engine oil under pressure from the engine lubrication system is pumped through a passage in the bearing housing and directed to the bearings, thrust plate, and thrust sleeve. Oil is sealed from the compressor and turbine by a piston ring at both ends of the bearing housing.

The turbocharger contains two floating bearings. These bearings have clearance between the bearing OD and the housing bore as well as clearance between the bearing ID and the shaft OD. These clearances are lubricated by the oil supply (A) and the bearings are protected by a cushion of oil. Discharge oil (B) drains by gravity from the bearing housing to the engine crankcase.



A—Pressure Oil
B—Discharge Oil

RG,110,JW7668 –19–24NOV97–1/1

110
12

CHECK INTAKE MANIFOLD PRESSURE (TURBOCHARGER BOOST)

IMPORTANT: If testing the engine with the air filter system removed, install JDG576 Turbocharger Shield to inlet of turbocharger.

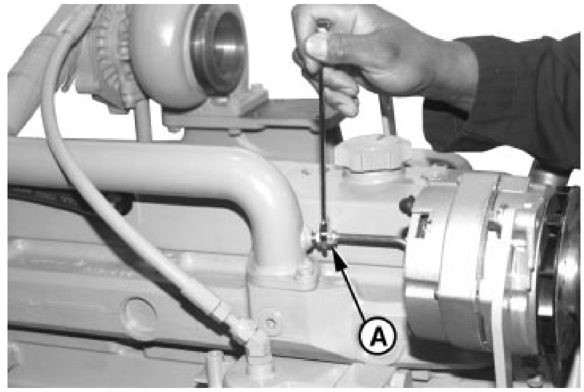
NOTE: On “H” engines, pressure reading should be taken at intake manifold after the aftercooler.

1. Disconnect line (A) from intake manifold and install the appropriate fitting from JDE147 Manifold Pressure Test Kit or FKM10002 Universal Pressure Test Kit. Connect gauge (B) and hose assembly to fitting. Be sure all connections are tight.

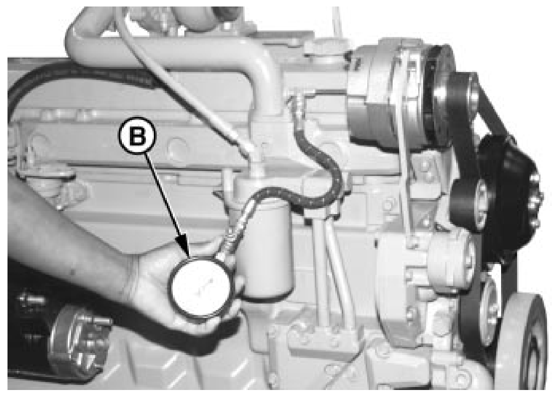
IMPORTANT: Engine speed and load should be stabilized before taking a gauge reading. Be sure that gauge works properly and familiarize yourself with the use of the gauge.

Turbo-boost pressure checks are only a guide to determine if there is an engine problem (valve leakage, faulty nozzles, etc.). Low pressure readings are not a conclusive reason for increasing injection pump fuel delivery. Pump adjustment should be within specifications as established by an authorized diesel repair station.

2. Before checking boost pressure, warm up engine to allow the lubricating oil to reach operating temperature.



RG7776 –UN–11NOV97



RG7777 –UN–11NOV97

A—Intake Manifold Plug
B—Pressure Gauge

Continued on next page
DPSG,OUO1004,134 –19–20MAY98–1/2

IMPORTANT: On some vehicles, it may not be possible to meet the turbo boost pressure due to inability to get full load rated speed. In these cases, see machine operation and test manual for the appropriate test method and pressure.

3. Observe pressure reading on gauge. Boost pressure should be within ranges shown in charts on following pages when engine is developing rated power at full load rated speed.

4. If boost pressure is too high, remove fuel injection pump and have it checked for high fuel delivery by an authorized diesel repair station.

   If boost pressure is too low, check the following:

   - Restricted air filter elements.
   - Restricted fuel filter elements.
   - Incorrect fast idle adjustment.
   - Incorrect injection pump timing.
   - Exhaust manifold leaks.
   - Intake manifold leaks.
   - Faulty fuel transfer pump.
   - Low compression pressure.
   - Faulty fuel injection nozzles.
   - Carbon build-up in turbocharger.
   - Turbocharger compressor or turbine wheel rubbing housing.
   - Low fuel injection pump fuel delivery.
   - Restricted exhaust.

5. After completing test, remove test equipment and reinstall nozzle adapter and plug. Tighten securely.

DPSG,OUO1004,134 –19–20MAY98–2/2

INTAKE MANIFOLD PRESSURE (TURBOCHARGER BOOST) SPECIFICATIONS

TURBO BOOST PRESSURES (JOHN DEERE AGRICULTURAL EQUIPMENT)				
Machine Model	**Engine Model**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
Des Moines				
4700 Sprayer	T06068TN050	138 (185)	2400	113—137 kPa (1.1—1.4 bar) (16—120 psi)
6700/6700S Sprayer	T04045TN050	79 (106)	2200	72—88 kPa (0.7—0.9 bar) (10—13 psi)
9935 Cotton Picker	T06068TN051	117 (157)	2200	79—97 kPa (0.8—1.0 bar) (12—14 psi)
7455 Cotton Stripper	T06068TN051	117 (157)	2200	79—97 kPa (0.8—1.0 bar) (12—14 psi)
Harvester				
9400 Combine	T06068HH050	138 (185)	2200	93—113 kPa (0.9—1.1 bar) (14—16 psi)
9410 Combine	T06068HH051	143 (192)	2200	94—116 kPa (0.9—1.2 bar) (14—17 psi)
Horizontina, Brazil				
1170 Combine	CD6068TCQ50	133 (178)	2200	95—117 kPa (1.0—1.2 bar) (14—17 psi)
Zweibrucken, Germany				
2254 Combine	CD6068HZ050	144 (193)	2200	94—116 kPa (0.9—1.2 bar) (14—17 psi)
Waterloo				
7210 Tractor (PQT)	T06068TRW50	88 (118) PTO	2100	49—61 kPa (0.5—0.6 bar) (7—9 psi)
7210 Tractor (PST)	T06068TRW53	88 (118) PTO	2100	49—61 kPa (0.5—0.6 bar) (7—9 psi)
7410 Tractor (PQT)	T06068TRW51	96 (129) PTO	2100	58—70 kPa (0.6—0.7 bar) (8—10 psi)
7410 Tractor (PST)	T06068TRW54	96 (129) PTO	2100	58—70 kPa (0.6—0.7 bar) (8—10 psi)
7610 Tractor	T06068TRW52	105 (141) PTO	2100	65—79 kPa (0.7—0.8 bar) (9—12 psi)
Mannheim, Germany (European Market)				
6110 Tractor (Direct Fan Drive)	CD4045TL058	58 (79)	2300	51—63 kPa (0.5—0.6 bar) (7—9 psi)
6110 Tractor (Viscous Fan Drive)	CD4045TL050	59 (80)	2300	51—63 kPa (0.5—0.6 bar) (7—9 psi)
6210 Tractor (Direct Fan Drive)	CD4045TL059	65 (88)	2300	58—71 kPa (0.6—0.7 bar) (8—10 psi)
6210 Tractor (Viscous Fan Drive)	CD4045TL051	66 (90)	2300	58—71 kPa (0.6—0.7 bar) (8—10 psi)
6310 Tractor (Direct Fan Drive)	CD4045TL060	73 (99)	2300	68—83 kPa (0.7—0.8 bar) (10—12 psi)
6310 Tractor (Viscous Fan Drive)	CD4045TL052	74 (100)	2300	68—83 kPa (0.7—0.8 bar) (10—12 psi)
6410 Tractor (Direct Fan Drive)	CD4045TL061	76 (103)	2300	69—84 kPa (0.7—0.8 bar) (10—12 psi)
6410 Tractor (Viscous Fan Drive)	CD4045TL053	77 (105)	2300	69—84 kPa (0.7—0.8 bar) (10—12 psi)
6610 Tractor	CD6068TL050	84 (114)	2300	49—61 kPa (0.5—0.6 bar) (7—9 psi)
6810 Tractor	CD6068TL051	92 (125)	2100	67—82 kPa (0.7—0.8 bar) (10—12 psi)
6910 Tractor	CD6068TL052	99 (135)	2100	71—87 kPa (0.7—0.9 bar) (10—13 psi)

Continued on next page DPSG,OUO1004,290 –19–23JUL98–1/6

TURBO BOOST PRESSURES (JOHN DEERE AGRICULTURAL EQUIPMENT)				
Machine Model	**Engine Model**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
Mannheim, Germany (North American Market)				
6110/6110L Tractor	CD4045TL063	48 (65) PTO	2300	54—67 kPa (0.5—0.7 bar) (8—10 psi)
6210/6210L Tractor	CD4045TL054	54 (72) PTO	2300	61—75 kPa (0.6—0.8 bar) (9—11 psi)
6310/6310L/6310S Tractor	CD4045TL055	60 (80) PTO	2300	72—88 kPa (0.7—0.9 bar) (10—13 psi)
6405 Tractor	CD4045TL062	67 (90) PTO	2300	72—88 kPa (0.7—0.9 bar) (10—13 psi)
6410/6410L/6410S Tractor	CD4045TL056	67 (90) PTO	2300	84—102 kPa (0.8—1.0 bar) (12—15 psi)
6510L/6510S Tractor	CD4045TL057	71 (95) PTO	2300	88—108 kPa (0.9—1.1 bar) (13—16 psi)
6605 Tractor	CD6068TL053	75 (100) PTO	2300	49—60 kPa (0.5—0.6 bar) (7—9 psi)
Monterrey, Mexico				
7405 Tractor	CD6068TP051	78 (105) PTO	2100	67—82 kPa (0.7—0.8 bar) (10—12 psi)
7410 Tractor	CD6068TP052	78 (105) PTO	2100	72—88 kPa (0.7—0.9 bar) (10—13 psi)

Continued on next page DPSG,OUO1004,290 –19–23JUL98–2/6

TURBO BOOST PRESSURES (JOHN DEERE CONSTRUCTION EQUIPMENT)				
Machine Model	**Engine Model**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
Davenport				
344H Loader	CD4045TF152	63 (84)	2200	50—62 kPa (0.5—0.6 bar) (7—9 psi)
444H, Loader TC 44H Tool Carrier	T04045TDW50	85 (114)	2200	79—97 kPa (0.8—1.0 bar) (11—14 psi)
544H Loader, TC 54H Tool Carrier	T06068TDW50	97 (130)	2100	62—83 kPa (0.6—0.8 bar) (9—12 psi)
624H Loader, TC 62H Tool Carrier	T06068HDW50	127 (170)	2200	91—111 kPa (0.9—1.1 bar) (13—16 psi)
LX100 Loader (Hitachi Construction)	T06068TDW53	103 (138)	2100	62—76 kPa (0.6—0.8 bar) (9—11 psi)
LX120 Loader (Hitachi Construction)	T06068HDW70	127 (170)	2200	91—111 kPa (0.9—1.1 bar) (13—16 psi)
540G Cable Skidder, 548G Grappel Skidder (558205—)	T06068TDW51	94 (126)	2200	52—64 kPa (0.5—0.6 bar) (7—9 psi)
540G-II Cable Skidder, 548G-II Grapple Skidder	T06068TDW54	94 (126)	2200	52—64 kPa (0.5—0.6 bar) (7—9 psi)
640G/648G Skidder (558325—)	T06068TDW52	117 (151)	2200	94—114 kPa (0.9—1.1 bar) (14—17 psi)
640G-II Cable Skidder, 648G-II Grapple Skidder	T06068TDW55	117 (151)	2200	94—114 kPa (0.9—1.1 bar) (14—17 psi)
670C Motor Grader	T06068HDW53	112 (150)	2000	94—114 kPa (0.9—1.1 bar) (14—17 psi)
670CH/672CH Motor Grader	T06068HDW55	127 (170)	2000	105—125 kPa (1.1—1.3 bar) (15—18 psi)
690E LC Excavator (559603—)	T06068TDW56 (RE67765 Injection Pump)	107 (143)	2100	62—76 kPa (0.6—0.8 bar) (9—11 psi)
	T06068TDW56 (RE501328 Injection Pump)	110 (148)	2100	76—94 kPa (0.8—0.9 bar) (11—14 psi)
Dubuque				
310E Backhoe Loader (Alt Comp)	T04045TT056	58 (78)	2200	44—54 kPa (0.4—0.5 bar) (6—8 psi)
310E Backhoe Loader	T04045TT055	66 (89)	2200	56—68 kPa (0.6—0.7 bar) (8—10 psi)
310SE Backhoe Loader	T04045TT050	66 (89)	2200	56—68 kPa (0.6—0.7 bar) (8—10 psi)
315SE Backhoe Loader	T04045TT060	66 (89)	2200	56—68 kPa (0.6—0.7 bar) (8—10 psi)

Continued on next page

DPSG,OUO1004,290 –19–23JUL98–3/6

TURBO BOOST PRESSURES (JOHN DEERE CONSTRUCTION EQUIPMENT)				
Machine Model	**Engine Model**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
410E Backhoe Loader	T04045TT053	73 (98)	2200	66—80 kPa (0.7—0.8 bar) (10—12 psi)
710D, 710E Backhoe Loader	T06068TT055	92 (123)	2200	53—65 kPa (0.5—0.7 bar) (8—9 psi)
450G Series IV Crawler Dozer (840461—)	T04045TT061	58 (78)	2100	38—47 kPa (0.4—0.5 bar) (6—7 psi)
450GTC Series IV Crawler Dozer (840461—)	T04045TT067	58 (78)	2100	38—47 kPa (0.4—0.5 bar) (6—7 psi)
455G Series IV Crawler Loader (840461—)	T04045TT067	52.2 (70)	2100	38—47 kPa (0.4—0.5 bar) (6—7 psi)
550G Crawler Dozer (840461—)	T04045TT062	66 (89)	2100	51—63 kPa (0.5—0.6 bar) (7—9 psi)
550GTC Crawler Dozer (840461—)	T04045TT068	66 (89)	2100	51—63 kPa (0.5—0.6 bar) (7—9 psi)
555G Crawler Loader (840461—)	T04045TT063	67.1 (90)	2100	63—77 kPa (0.6—0.8 bar) (9—11 psi)
650G Crawler Dozer (840461—)	T04045TT063	74 (99)	2100	63—77 kPa (0.6—0.8 bar) (9—11 psi)
650GTC Crawler Dozer (840461—)	T04045TT069	74 (99)	2100	63—77 kPa (0.6—0.8 bar) (9—11 psi)
643G/653E Feller Buncher	T06068TT053	120 (161)	2200	90—110 kPa (0.9—1.1 bar) (13—16 psi)
843G Feller Buncher	T06068HT050	140 (186)	2200	90—110 kPa (0.9—1.1 bar) (13—16 psi)
Saltillo (Mexico)				
110 Excavator	T04045TT054	63 (84)	2200	50—62 kPa (0.5—0.6 bar) (7—9 psi)
120 Excavator	T04045TT052	69 (93)	2200	63—77 kPa (0.6—0.8 bar) (9—11 psi)
160LC Excavator	T04045TT055	81 (109)	2300	89—109 kPa (0.9—1.1 bar) (13—16 psi)
Kernersville (Deere-Hitachi)				
200LC Excavator	T06068TT051	110 (148)	2150	68—84 kPa (0.7—0.8 bar) (10—12 psi)
230LC Excavator	T06068HT051	134 (180)	2100	82—102 kPa (0.8—1.0 bar) (12—15 psi)
270LC Excavator	T06068HT052	141 (189)	2150	85—105 kPa (0.9—1.1 bar) (12—15 psi)
Augusta				
5510/5510N Tractor	PE4045TLV50, CD4045TLV50	56 (75) PTO	2400	60 kPa (0.6 bar) (9 psi)

Continued on next page DPSG,OUO1004,290 –19–23JUL98–4/6

TURBO BOOST PRESSURES (JOHN DEERE OEM/OUTSIDE EQUIPMENT MANUFACTURERS)						
Engine Number	**Injection Pump Option Code**	**Injection Pump Part No.**	**Replacement Injection Pump**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
4045HF150	1610	RE68826		104 (140)	2400	99—121 kPa (1.0—1.2 bar) (14—18 psi)
	1611	RE60237		95 (127)	1800	85—103 kPa (0.9—1.0 bar) (12—15 psi)
	160B	RE68827		95 (127)	1800	85—103 kPa (0.9—1.0 bar) (12—15 psi)
	160C	RE69588		104 (140)	2400	99—121 kPa (1.0—1.2 bar) (14—18 psi)
4045TF150	1605	RE61668	RE69781	86 (115)	2500	97—119 kPa (1.0—1.2 bar) (14—17 psi)
	1605	RE69781		86 (115)	2500	97—119 kPa (1.0—1.2 bar) (14—17 psi)
	1656	RE67562		75 (100)	1800	65—79 kPa (0.7—0.8 bar) (9—12 psi)
	1675	RE60091	RE69782	86 (115)	2500	96—118 kPa (1.0—1.2 bar) (14—18 psi)
	1675	RE69782		86 (115)	2500	96—118 kPa (1.0—1.2 bar) (14—18 psi)
	1677	RE67563		75 (100)	1800	65—79 kPa (0.7—0.8 bar) (9—12 psi)
	1692	RE500881		86 (115)	2500	97—119 kPa (1.0—1.2 bar) (14—17 psi)
	1694	RE67863	RE69779	75 (100)	2500	81—99 kPa (0.8—1.0 bar) (12—14 psi)
	1694	RE69779		75 (100)	2500	81—99 kPa (0.8—1.0 bar) (12—14 psi)
	1695	RE69739	RE69780	75 (100)	2500	81—99 kPa (0.8—1.0 bar) (12—14 psi)
	1695	RE69780		75 (100)	2500	81—99 kPa (0.8—1.0 bar) (12—14 psi)
	16AB	RE69779		75 (100)	2500	81—99 kPa (0.8—1.0 bar) (12—14 psi)
	16BF	RE500848		73 (98)	2200	66—80 kPa (0.7—0.8) (10—12 psi)
	16CE	RE501180		75 (100)	2500	81—99 kPa (0.8—1.0 bar) (12—14 psi)
	16CM	RE501365		66.5 (89)	2200	56—68 kPa (0.6—0.7 bar) (8—10 psi)
4045TF153	16EP	RE501899		72 (97)	2200	56—69 kPa (0.6—0.7 bar) (8—10 psi)
4045TF250	1606	RE64133		93 (125)	2400	109—133 kPa (1.1—1.3 bar) (16—19 psi)
	1608	RE67564		84 (113)	1800	82—100 kPa (0.8—1.0 bar) (12—15 psi)
	1667	RE59968		93 (125)	2400	109—133 kPa (1.1—1.3 bar) (16—19 psi)
	1682	RE67566		84 (113)	1800	82—100 kPa (0.8—1.0 bar) (12—15 psi)
	1683	RE60124		93 (125)	2400	109—133 kPa (1.1—1.3 bar) (16—19 psi)
	160R	RE70941		84 (113)	1800	82—100 kPa (0.8—1.0 bar) (12—15 psi)
	160CV	RE501346		85 (114)	2200	79—97 kPa (0.8—1.0 bar) (12—14 psi)
6068HF150	1621	RE66575		157 (210)	2400	108—132 kPa (1.1—1.3 bar) (16—19 psi)
	160D	RE69589		157 (210)	2400	108—132 kPa (1.1—1.3 bar) (16—19 psi)
	16CY	RE501345		143 (192)	2200	94—116 kPa (0.9—1.2 bar) (14—17 psi)
6068HF250	1622	RE59521		168 (225)	2400	117—143 kPa (1.2—1.4 bar) (17—21 psi)
	1623	RE66761		148 (198)	1800	100—122 kPa (1.0—1.2 bar) (15—18 psi)

Continued on next page DPSG,OUO1004,290 –19–23JUL98–5/6

TURBO BOOST PRESSURES (JOHN DEERE OEM/OUTSIDE EQUIPMENT MANUFACTURERS)						
Engine Number	**Injection Pump Option Code**	**Injection Pump Part No.**	**Replacement Injection Pump**	**Rated Power at Full Load Rated Speed kW (hp)**	**Full Load Rated Speed rpm**	**Turbo Boost Pressure at Full Load Rated Speed kPa (bar) (psi)**
6068TF150	1614	RE61669	RE69789	127 (170)	2500	95—116 kPa (1.0—1.2 bar) (14—17 psi)
	1614	RE69789		127 (170)	2500	95—114 kPa (1.0—1.1 bar) (14—17 psi)
	1680	RE60105	RE69790	127 (170)	2500	95—116 kPa (1.0—1.2 bar) (14—17 psi)
	1680	RE69790		127 (170)	2500	95—114 kPa (1.0—1.1 bar) (14—17 psi)
	1681	RE67571		112 (150)	1800	80—98 kPa (0.8—1.0 bar) (12—14 psi)
	1688	RE67572		112 (150)	1800	80—98 kPa (0.8—1.0 bar) (12—14 psi)
	1696	RE67864	RE69787	116 (155)	2500	85—105 kPa (0.8—1.1 bar) (12—15 psi)
	1696	RE69787		116 (155)	2500	85—105 kPa (0.8—1.1 bar) (12—15 psi)
	1697	RE68740	RE69788	116 (155)	2500	85—105 kPa (0.8—1.1 bar) (12—15 psi)
	1697	RE69788		116 (155)	2500	85—105 kPa (0.8—1.1 bar) (12—15 psi)
	16BE	RE63559		117 (157)	2200	79—97 kPa (0.8—1.0 bar) (12—14 psi)
	16CN	RE501522		110.5 (148)	2100	76—94 kPa (0.8—0.9 bar) (11—14 psi)
	16CP	RE501523		94 (126)	2200	52—64 kPa (0.5—0.6 bar) (7—9 psi)
	16DK	RE70938		96 (129)	2100	58—70 kPa (0.6—0.7 bar) (8—10 psi)
	16DY	RE501758		116 (155)	2500	85—105 kPa (0.8—1.1 bar) (12—15 psi)
6068TF250	1615	RE62366		138 (185)	2400	110—134 kPa (1.1—1.3 bar) (16—19 psi)
	1619	RE67573		124 (166)	1800	88—108 kPa (0.9—1.1 bar) (13—16 psi)
	1668	RE59969		138 (185)	2400	115—141 kPa (1.2—1.4 bar) (17—20 psi)
	1685	RE67574		124 (166)	1800	88—108 kPa (0.9—1.1 bar) (13—16 psi)
	1686	RE60131		138 (185)	2400	110—134 kPa (1.1—1.3 bar) (16—19 psi)
	16CW	RE501344		106 (142)	2200	74—88 kPa (0.7—0.9 bar) (11—13 psi)
	16CX	RE70390		128 (172)	2300	100—122 kPa (1.0—1.2 bar) (15—18 psi)
T04045TF151 (MCII)	1677	RE67563		75 (101)	1800	65—79 kPa (0.7—0.8 bar) (9—12 psi)
CD4045TF152 (LIEBHERR)	16AX	RE500511		76 (102)	2400	75—91 kPa (0.8—0.9 bar) (11—13 psi)
CD4045TF251 (LUCASSEN YOUNG)	1606	RE64133		93 (125)	2400	108—132 kPa (1.1—1.3 bar) (16—19 psi)
T06068TF151 (MCII)	1681	RE67571		112 (150)	1800	80—98 kPa (0.8—1.0 bar) (12—14 psi)

DPSG,OUO1004,290 –19–23JUL98–6/6

TURBOCHARGER WASTEGATE TEST

1. Check hose to wastegate actuator for kinks or cracks. Replace if damaged.

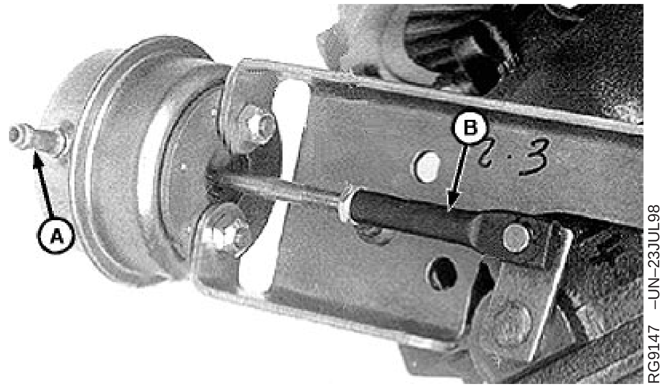
2. Discconnect hose from wastegate actuator.

3. Connect a regulated air source to actuator fitting (A).

4. Vary pressure to wastegate actuator from 9—12 psi.

   Actuator rod (B) should move in and out freely as pressure is varried.

   If rod does not move freely, check wastegate adjustment. (See ADJUST TURBOCHARGER WASTEGATE ACTUATOR in Group 30.)



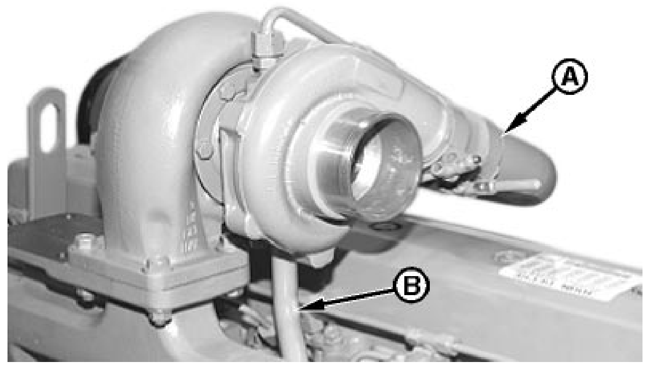
A—Actuator Fitting

DPSG,OUO1004,224 –19–10JUL98–1/1

TURBOCHARGER OIL SEAL LEAK TEST

Seals are used on both sides of the turbocharger rotor assembly. The seals are used to prevent exhaust gasses and air from entering the turbocharger housing. Oil leakage past the seals is uncommon but can occur.

A restricted or damaged turbocharger oil return line can cause the housing to pressurize causing oil to leak by the seals. Additionally, intake or exhaust restrictions can cause a vacuum between the compressor and turbocharger housing causing oil to leak by the seals.



RG9440 –UN–23JUL98

A—Intake Hose
B—Oil Return Line

1. Remove exhaust pipe (shown removed) and crossover tube (A).

2. Inspect the turbine casing and crossover tube for evidence of oil leakage.

   If oil leakage is present, perform the following:

   - Inspect turbocharger oil return line (B) for kinks or damage. Replace if necessary.
   - Check the air intake filter, hoses, and crossover tube for restrictions.
   - Check the exhaust system for restrictions to include position of exhaust outlet.

3. Perform necessary repairs and repeat test.

DPSG,OUO1004,225 –19–10JUL98–1/1

Group 115
Fuel System Operation and Tests

ESSENTIAL TOOLS

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

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DPSG,OUO1004,207 –19–07JUL98–1/6

TIME TRAC®Kit JT07158 (FKM10429A)

Used to perform the dynamic timing of engines with rotary injection pumps.

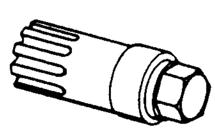
RG7246 –UN–23NOV97

TIME TRAC is a registered trademark of Stanadyne Automotive Corp.

DPSG,OUO1004,207 –19–07JUL98–2/6

Flywheel Turning Tool JDE83

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



RG6251 –UN–22JUL92

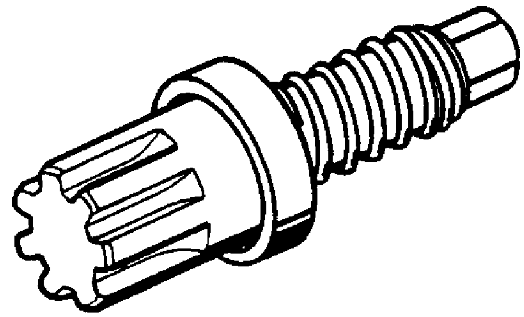
Continued on next page

DPSG,OUO1004,207 –19–07JUL98–3/6

115
2

Flywheel Turning Tool JDG820

Used to rotate flywheel on engines with 129-tooth flywheel ring gear and a 29.9 mm (1.18 in.) ID flywheel housing guide bore diameter.



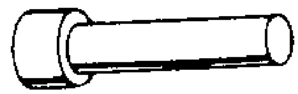
RG7056 RG7056 –UN–05DEC97

DPSG,OUO1004,207 –19–07JUL98–4/6

RG5068 –UN–05DEC97

Timing Pin JDE81-4

Used to lock engine at TDC.



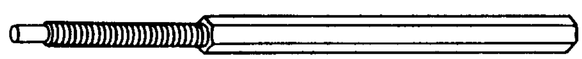
RG5068

DPSG,OUO1004,207 –19–07JUL98–5/6

RG7212 –UN–23NOV97

Injection Pump Timing Pin. JDG886

Used to lock Nippondenso in-line fuel injection pump timing prior to removal of pump.



DPSG,OUO1004,207 –19–07JUL98–6/6

SERVICE EQUIPMENT AND TOOLS

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

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DPSG,OUO1004,208 –19–07JUL98–1/5

Clamp-On Transducer JT07177

Use with TIME-TRAC® meter to measure engine speed.

DPSG,OUO1004,208 –19–07JUL98–2/5

Cable JT07172

Use with TIME-TRAC® meter to measure engine speed.

DPSG,OUO1004,208 –19–07JUL98–3/5

Pressure Gauge 0—200 kPa (0—2 bar) (0—30 psi), hose and fittings.

Measure transfer pump pressure in rotary injection pump systems.

DPSG,OUO1004,208 –19–07JUL98–4/5

Pressure Gauge 0—400 kPa (0—4 bar) (0—60 psi), hose and fittings.

Leak test in-line fuel injection pump. Measure transfer pump pressure in in-line injection pump systems.

DPSG,OUO1004,208 –19–07JUL98–5/5

FUEL SYSTEM TEST SPECIFICATIONS

Item	Measurement	Specification
Rotary Injection Pump Mounting Nuts	Torque	27 N•m (20 lb-ft)
Injection Pump Drive Gear-to-Pump Hub Cap Screws.	Torque	47 N•m (35 lb-ft)
In-Line Injection Pump Drive Gear Cover	Torque	5 N•m (3.7 lb-ft) (44 lb-in.)
Fuel Supply Pump (Rotary)		
Fuel Static Pressure	Pressure	25—30 kPa (0.25—0.30 bar) (3.5—4.5 psi)
Minimum Static Pressure at 850 rpm Engine Speed	Pressure	15 kPa (0.15 bar) (2.0 psi)
Minimum Positive Pressure at 2400 rpm Engine Speed	Pressure	21—34 kPa (0.21—0.34 bar) (3—5 psi)
Minimum Flow at 2400 rpm Engine Speed	Flow	1.5 L/min (0.42 gpm)
Fuel Supply Pump (In-Line)		
Minimum Positive Pressure at 2400 rpm Engine Speed	Minimum Pressure	69 kPa (0.69 bar) (10 psi)
Minimum Flow at 2400 rpm Engine Speed	Flow	2.0 L/min. (0.53 gpm)
Fuel Supply Pump (In-Line)	Minimum Outlet Pressure at Cranking Speed	69 kPa (0.69 bar) (10 psi)
Cold Start Switch	Torque	5 N•m (3.5 lb-ft) (42 lb-in.)
Fuel Injection Pump Return Line	Torque	27 N•m (20 lb-ft)
Fuel Injection Nozzle Delivery Lines	Torque	27 N•m (20 lb-ft)

DPSG,OUO1004,256 –19–17JUL98–1/1

ROTARY FUEL INJECTION PUMP SPECIFICATIONS[1]

Injection pump timing specifications are provided for rotary pumps (Lucas and Stanadyne). The following charts include pumps for John Deere Agricultural Equipment, Construction Equipment, and Commercial and Consumer Equipment, as well as OEM engine applications. They apply to Dubuque, Torreon and Saran-built engines.

Other sources for rotary pump timing specifications are as follows:

- Agricultural Equipment–DB1216 Specifications Handbook
- Construction Equipment–SP458 Specifications Handbook

If your pump specifications are not listed in the above sources, refer to DTAC solutions K000413 (Construction Equipment), K000414 (OEM Engines), or K000415 (Agricultural Equipment).

If your rotary pump application is not listed in any of these sources, contact the factory DTAC for assistance.

[1] *Engine speeds are as preset by the injection pump suppliers. In most cases, slow idle speed will be reset at the vehicle-producing factory, depending upon application. Refer to your machine Technical Manual to verify the final engine speeds for the machine.*

Continued on next page RG,115,JW7713 –19–24NOV97–1/11

115
6

ROTARY FUEL INJECTION PUMP SPECIFICATIONS (JOHN DEERE AGRICULTURAL APPLICATIONS)							
Machine Model	**Engine Model**	**Original Injection Pump (Part No.)**	**Replaced By Injection Pump (Part No.)**	**Slow Idle Speed (rpm)[a]**	**Rated Speed (rpm)**	**Fast Idle (rpm)**	**Dynamic Timing (DBTDC)**
Des Moines							
4700 Sprayer	T06068TN050	RE62366	RE69791	925	2400	2600	6.5
		RE69791		925	2400	2600	8.5
6700/6700S Sprayer	T04045TN050	RE69155		850	2200	2400	6.5
9935 Cotton Picker	T06068TN051	RE63559	RE501302	950	2200	2400	6.6
		RE501302		950	2200	2400	7.3
7455 Cotton Stripper	T06068TN051	RE63559	RE501302	950	2200	2400	6.6
		RE501302		950	2200	2400	7.3
Harvester							
9400 Combine	T06068HH050	RE69757		1350	2200	2400	9.0
9410 Combine	T06068HH051	RE500758		1350	2200	2400	9.0
Horizontina, Brazil							
1170 Combine	CD6068TCQ50	RE68367		1200	2200	2390	6.5
Zweibrucken, Germany							
2254 Combine	CD6068HZ050	RE500574		N/A	2200	2390	N/A
Ottumwa							
4890 Windrower	T04045TE050	RE69779		850	2500	2700	7.0
Waterloo							
7210 Tractor (PQT)	T06068TRW50	RE59526	RE70937	900	2100	2300	6.5
		RE70937	RE502824	900	2100	2300	6.5
		RE502824		900	2100	2300	6.5
7210 Tractor (PST)	T06068TRW53	RE59526	RE70937	900	2100	2300	6.5
		RE70937	RE502824	900	2100	2300	6.5
		RE502824		900	2100	2300	6.5
7410 Tractor (PQT)	T06068TRW51	RE59527	RE70938	900	2100	2300	6.5
		RE70938	RE502825	900	2100	2300	6.5
		RE502825		900	2100	2300	6.5
7410 Tractor (PST)	T06068TRW54	RE59527	RE70938	900	2100	2300	6.5

[a]Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.

Continued on next page RG,115,JW7713 –19–24NOV97–2/11

ROTARY FUEL INJECTION PUMP SPECIFICATIONS (JOHN DEERE AGRICULTURAL APPLICATIONS)							
Machine Model	**Engine Model**	**Original Injection Pump (Part No.)**	**Replaced By Injection Pump (Part No.)**	**Slow Idle Speed (rpm)[a]**	**Rated Speed (rpm)**	**Fast Idle (rpm)**	**Dynamic Timing (DBTDC)**
		RE70938	RE502825	900	2100	2300	6.5
		RE502825		900	2100	2300	6.5
7610 Tractor	T06068TRW52	RE59514	RE70939	900	2100	2300	6.5
		RE70939	RE502826	900	2100	2300	7.0
		RE502826		900	2100	2300	7.0
Mannheim, Germany (European Market)							
6010 Tractor	CD4045DL050	RE501104		875	2300	2495	6.0
6110 Tractor (Direct Fan Drive)	CD4045TL058	RE501222		875	2300	2495	7.5
6110 Tractor (Viscous Fan Drive)	CD4045TL050	RE501222		875	2300	2495	7.5
6210 Tractor (Direct Fan Drive)	CD4045TL059	RE501223		875	2300	2495	6.0
6210 Tractor (Viscous Fan Drive)	CD4045TL051	RE501223		875	2300	2495	6.0
6310 Tractor (Direct Fan Drive)	CD4045TL060	RE501224		875	2300	2495	6.0
6310 Tractor (Viscous Fan Drive)	CD4045TL052	RE501224		875	2300	2495	6.0
6310 Tractor (Viscous Fan Drive)	CD4045TL052[b]	RE501225		850[c]	2300	2460	6.0
[a]Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.							
[b]Fuel injection pump is electronically controlled							
[c]1050 rpm when engine is cold							

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RG,115,JW7713 –19–24NOV97–3/11

ROTARY FUEL INJECTION PUMP SPECIFICATIONS (JOHN DEERE AGRICULTURAL APPLICATIONS)							
Machine Model	**Engine Model**	**Original Injection Pump (Part No.)**	**Replaced By Injection Pump (Part No.)**	**Slow Idle Speed (rpm)[a]**	**Rated Speed (rpm)**	**Fast Idle (rpm)**	**Dynamic Timing (DBTDC)**
6410 Tractor (Direct Fan Drive)	CD4045TL061	RE501226		875	2300	2495	6.5
6410 Tractor (Viscous Fan Drive	CD4045TL053	RE501226		875	2300	2495	6.5
6410 Tractor (Viscous Fan Drive)	CD4045TL053[b]	RE501227		850[c]	2300	2460	6.5
6510 Tractor	CD6068DL050	RE501230		875	2300	2495	6.0
6510 Tractor	CD6068DL050[b]	RE501231		850[c]	2300	2460	6.0
6610 Tractor	CD6068TL050	RE501232		875	2300	2495	6.0
6610 Tractor	CD6068TL050[b]	RE501233		850[c]	2300	2460	6.0
6810 Tractor	CD6068TL051	RE501234		875	2100	2290	6.0
	CD6068TL051[b]	RE501235		850[c]	2100	2250	6.0
6910 Tractor	CD6068TL052	RE501236		875	2100	2290	6.0
	CD6068TL052[b]	RE501237		850[c]	2100	2250	6.0
Mannheim, Germany (North American Market)							
6110/6110L Tractor	CD4045TL063	RE501222		875	2300	2495	4.0
6210/6210L Tractor	CD4045TL054	RE501441		875	2300	2495	5.0
6310/6310L/6310S Tractor	CD4045TL055	RE501442		875	2300	2495	4.5
6405 Tractor	CD4045TL062	RE501006		875	2300	2495	6.0
6410/6410L/6410S Tractor	CD4045TL056	RE501443		875	2300	2495	4.0
6510L/6510S Tractor	CD4045TL057	RE501287		875	2300	2495	4.5
6605 Tractor	CD6068TL053	RE500993		875	2300	2495	8.0
Monterrey, Mexico							
7405 Tractor	CD6068TP051	RE64720	RE59527	875	2100	2275	6.0
		RE59527		875	2100	2275	6.0
7410 Tractor	CD6068TP052	RE64721	RE501236	875	2100	2275	6.0
		RE501236		875	2100	2275	6.0

[a]Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.

[b] Fuel injection pump is electronically controlled.

[c] 1050 rpm when engine is cold

Continued on next page

ROTARY FUEL INJECTION PUMP SPECIFICATIONS (JOHN DEERE CONSTRUCTION EQUIPMENT APPLICATIONS)							
Machine Model	**Engine Model**	**Original Injection Pump (Part No.)**	**Replaced By Injection Pump (Part No.)**	**Slow Idle Speed (rpm)[a]**	**Rated Speed (rpm)**	**Fast Idle (rpm)**	**Dynamic Timing (DBTDC)**
Davenport							
344H Loader	CD4045TF152	RE500551		875	2400	2600	N/A
444H Loader, TC44H Tool Carrier	T04045TDW50	RE69547		950	2200	2400	5.0
544H Loader, TC54H Tool Carrier	T0608TDW50	RE67598		950	2200	2400	6.5
624H Loader, TC62H Tool Carrier	T06068HDW50	RE59958		950	2200	2400	6.0
LX100 Loader (Hitachi Construction Machine)	T06068TDW53	RE59962		950	2100	2300	5.0
LX120 Loader (Hitachi Construction Machine)	T06068HDW70	RE59958		950	2200	2400	6.0
540G Cable Skidder/ 548G Grapple Skidder (558205—)	T06068TDW51	RE67669		950	2200	2400	6.5
540G-II Cable Skidder/548G-II Grapple Skidder	T06068TDW54	RE67669		1000	2200	2400	6.5
640G/648G Skidder (558325—)	T06068TDW52	RE59920	RE500196	950	2200	2400	5.0
		RE500196		1000	2200	2400	5.0
640G-II Cable Skidder/648G-II Grapple Skidder	T06068TDW55	RE500196		1000	2200	2400	5.0
670C Motor Grader	T06068HDW53	RE59964	RE500922	850	2000	2200	5.0
		RE500922	RE501033	900	2000	2200	5.0
		RE501033		825	2000	2200	4.0
670CH/672CH Motor Grader	T06068HDW55	RE69563		800	2000	2200	3.0
690E LC Excavator (559603—)	T06068TDW56	RE67765	RE501328	875	2100	2300	6.0
		RE501328		950	2100	2300	6.0
Dubuque							
[a]Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.							

Continued on next page

115
10

ROTARY FUEL INJECTION PUMP SPECIFICATIONS (JOHN DEERE CONSTRUCTION EQUIPMENT APPLICATIONS)							
Machine Model	**Engine Model**	**Original Injection Pump (Part No.)**	**Replaced By Injection Pump (Part No.)**	**Slow Idle Speed (rpm)[a]**	**Rated Speed (rpm)**	**Fast Idle (rpm)**	**Dynamic Timing (DBTDC)**
310E Backhoe Loader (Alt Comp)	T04045TT056	RE67925	RE500878	950	2200	2400	6.5
		RE500878	RE502377	950	2200	2400	6.0
		RE502377		950	2200	2400	6.0
310E Backhoe Loader	T04045DT055	RE67594	RE500877	950	2200	2400	8.0
		RE500877	RE502380	950	2200	2400	6.5
		RE502380		950	2200	2400	6.5
310SE Backhoe Loader	T04045TT050	RE67595	RE502387	950	2200	2400	6.5
		RE502378		950	2200	2400	6.5
315SE Backhoe Loader	T04045TT060	RE67595	RE502378	950	2200	2400	6.5
		RE502378		950	2200	2400	6.5
410E Backhoe Loader	T04045TT053	RE67599	RE502376	950	2200	2400	6.0
		RE502376		950	2200	2400	6.0
710D Backhoe Loader (834730—)	T06068TT055	RE67597	RE502379	900	2200	2400	6.5
		RE502379		900	2200	2400	6.5
710E Backhoe Loader	T06068TT055	RE67597	RE502379	900	2200	2400	6.5
		RE502379		900	2200	2400	6.5
450G Series IV Crawler Dozer (840461—)	T04045TT061	RE500616		950	2100	2300	6.5
450GTC Series IV Crawler Dozer (840461—)	T04045TT067	RE500616		950	2100	2300	6.5
455G Series IV Crawler Loader (840461—)	T04045TT061	RE500616		950	2100	2300	6.5
550G Crawler Dozer (840461—)	T04045TT062	RE500617		950	2100	2300	6.5

[a]Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.

Continued on next page

RG,115,JW7713 –19–24NOV97–6/11

ROTARY FUEL INJECTION PUMP SPECIFICATIONS (JOHN DEERE CONSTRUCTION EQUIPMENT APPLICATIONS)							
Machine Model	**Engine Model**	**Original Injection Pump (Part No.)**	**Replaced By Injection Pump (Part No.)**	**Slow Idle Speed (rpm)[a]**	**Rated Speed (rpm)**	**Fast Idle (rpm)**	**Dynamic Timing (DBTDC)**
550GTC Crawler Dozer (840461—)	T04045TT068	RE500617		950	2100	2300	6.5
555G Crawler Loader (840461—)	T04045TT063	RE500618		950	2100	2300	6.0
650G Crawler Dozer (840461—)	T04045TT063	RE500618		950	2100	2300	6.0
650GTC Crawler Dozer (840461—)	T04045TT069	RE500618		950	2100	2300	6.0
750C Crawler Dozer (831372—)	T06068TT052	RE71275		950	2100	2300	6.0
643G/653E Feller Buncher	T06068TT053	RE59959		1050	2200	2400	5.0
843G Feller Buncher	T06068HT050	RE59930		1050	2200	2400	6.5
485E/486E/488E Forklift	T04045DT050	RE67594	RE500877	950	2200	2400	8.0
		RE500877		950	2200	2400	6.5
210LE Landscape Loader	T04045DT050	RE67594	RE500877	950	2200	2400	8.0
		RE500877		950	2200	2400	6.5
Saltillo (Mexico)							
110 Excavator	T04045TT054	RE60200		950	2200	2400	7.0
120 Excavator	T04045TT052	RE59910		950	2200	2400	5.0
160LC Excavator	T04045TT055	RE59944		950	2300	2500	4.0
Kernersville (Deere-Hitachi)							
200LC Excavator	T06068TT051	RE59911		950	2150	2350	5.0
230LC Excavator	T06068HT051	RE59948		950	2100	2300	6.0
270LC Excavator	T06068HT052	RE59946		950	2150	2350	7.0

[a]Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.

Continued on next page RG,115,JW7713 –19–24NOV97–7/11

115
12

ROTARY FUEL INJECTION PUMP SPECIFICATIONS (JOHN DEERE COMMERCIAL AND CONSUMER EQUIPMENT APPLICATIONS)							
Machine Model	**Engine Model**	**Original Injection Pump (Part No.)**	**Replaced By Injection Pump (Part No.)**	**Slow Idle Speed (rpm)[a]**	**Rated Speed (rpm)**	**Fast Idle (rpm)**	**Dynamic Timing (DBTDC)**
5410 Tractor	CD4045DLV50	RE70452		850	2400	2605	9.0
	PE4045DLV50	RE70452		850	2400	2605	9.0
5510/5510N Tractor	CD4045TLV50	RE70453		850	2400	2605	8.0
	PE4045TLV50	RE70453		850	2400	2605	8.0

[a]Engine speeds listed are as preset to factory specification. In most cases, slow idle speed will be reset upon specific vehicle application requirements. Refer to your machine technical manual for engine speeds that are different from those preset at the factory.

Continued on next page RG,115,JW7713 –19–24NOV97–8/11

ROTARY FUEL INJECTION PUMP SPECIFICATIONS (OEM APPLICATIONS)							
Engine Model	Injection Pump Option Code	Original Injection Pump (Part No.)	Replaced By Injection Pump (Part No.)	Slow Idle Speed (rpm)	Rated Speed (rpm)	Fast Idle Speed (rpm)	Dynamic Timing (DBTDC)
4045DF150	1601	RE67557		850	2500	2700	8.5
	1602	RE59809		850	2500	2700	7.0
	1603	RE67558			1800	1870	7.0
	1663	RE71089	RE500949	1600	2500	2700	4.5
	1663	RE500949		1600	2500	2700	4.5
	1671	RE67559		850	2500	2700	8.5
	1673	RE67560			1800	1870	7.0
	1674	RE67561			1800	1870	7.0
	1691	RE500831	RE500948	1400	2500	2700	8.5
	1691	RE500948		1400	2500	2700	8.5
	16BG	RE69778		850	2500	2700	8.5
	16BH	RE500873		850	2500	2700	8.5
	16BJ	RE500589		850	2250	2450	8.5
	16CL	RE501364		950	2200	2400	6.5
	16DL	RE70452		850	2400	2600	9.0
4045HF150	1610	RE68826		850	2400	2600	8.5
	1611	RE60237			1800	1870	9.8
	160B	RE68827			1800	1870	9.8
	160C	RE69588		850	2400	2600	8.5
4045TF150	1605	RE61668	RE69781	850	2500	2700	6.0
	1605	RE69781		850	2500	2700	7.0
	1656	RE67562			1800	1870	6.0
	1675	RE60091	RE69782	850	2500	2700	6.0
	1675	RE69782		850	2500	2700	7.0
	1677	RE67563			1800	1870	6.0
	1692	RE500881		1400	2500	2700	6.0
	1694	RE67863	RE69779	850	2500	2700	6.0
	1694	RE69779		850	2500	2700	7.0
	1695	RE69739	RE69780	850	2500	2700	6.0
	1695	RE69780		850	2500	2700	7.0
	16AB	RE69779		850	2500	2700	7.0
	16BF	RE500848		950	2200	2400	6.0
	16CE	RE501180		850	2500	2700	7.0

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RG,115,JW7713 –19–24NOV97–9/11

ROTARY FUEL INJECTION PUMP SPECIFICATIONS (OEM APPLICATIONS)							
Engine Model	**Injection Pump Option Code**	**Original Injection Pump (Part No.)**	**Replaced By Injection Pump (Part No.)**	**Slow Idle Speed (rpm)**	**Rated Speed (rpm)**	**Fast Idle Speed (rpm)**	**Dynamic Timing (DBTDC)**
	16CM	RE501365		950	2200	2400	6.5
4045TF153	16EP	RE501899			2200	2400	6.0
4045TF250	1606	RE64133		850	2400	2600	4.0
	1608	RE67564			1800	1870	6.0
	1667	RE59968		850	2400	2600	4.0
	1682	RE67566			1800	1870	6.0
	1683	RE60124		850	2400	2600	4.0
	160R	RE70941			1800	1870	6.0
	16CV	RE501346		950	2200	2400	5.0
6068DF150	1613	RE59861		850	2500	2700	6.0
	1678	RE60101		850	2500	2700	6.0
6068HF150	1621	RE66575		850	2400	2600	9.0
	160D	RE69589		850	2400	2600	9.0
	16CY	RE501345		1350	2200	2400	9.0
6068HF250	1622	RE59521		850	2400	2600	7.0
	1623	RE66761			1800	1870	6.9
6068TF150	1614	RE61669	RE69789	850	2500	2700	5.5
	1614	RE69789		850	2500	2700	8.0
	1680	RE60105	RE69790	850	2500	2700	5.5
	1680	RE69790		850	2500	2700	8.0
	1681	RE67571			1800	1870	8.0
	1688	RE67572			1800	1870	8.0
	1696	RE67864	RE69787	850	2500	2700	7.3
	1696	RE69787		850	2500	2700	7.5
	1697	RE68740	RE69788	850	2500	2700	7.3
	1697	RE69788		850	2500	2700	7.5
	16BE	RE63559		950	2200	2400	6.6
	16CN	RE501522		950	2100	2300	6.0
	16CP	RE501523		950	2200	2400	6.5
	16DK	RE70938		900	2100	2300	6.5
	16DY	RE501758		850	2500	2700	7.5
6068TF250	1615	RE62366		850	2400	2600	6.5
	1619	RE67573			1800	1870	7.5

Continued on next page RG,115,JW7713 –19–24NOV97–10/11

ROTARY FUEL INJECTION PUMP SPECIFICATIONS (OEM APPLICATIONS)							
Engine Model	**Injection Pump Option Code**	**Original Injection Pump (Part No.)**	**Replaced By Injection Pump (Part No.)**	**Slow Idle Speed (rpm)**	**Rated Speed (rpm)**	**Fast Idle Speed (rpm)**	**Dynamic Timing (DBTDC)**
	1668	RE59969		850	2400	2600	4.0
	1685	RE67574			1800	1870	7.5
	1686	RE60131		850	2400	2600	6.5
	16CW	RE501344		950	2200	2400	6.5
	16CX	RE70390		900	2300	2500	6.5

RG,115,JW7713 –19–24NOV97–11/11

FUEL INJECTION PUMP—GENERAL INFORMATION

Most engines are equipped with a Stanadyne or Lucas rotary-type injection pump. Rotary injection pumps are dynamically timed at the producing factory and reference timing marks are accurately stamped on front plate and injection pump hub. Timing can be checked and adjusted as covered below using theTIME TRAC® Kit.

Higher horsepower engines use multiple-plunger, in-line type Nippondenso fuel injection pump with a mechanical flyweight governor and aneroid control.

In-line injection pumps are statically timed by locking engine at No.1 TDC compression and installing pump with injection pump drive hub lock-pinned (refer to Group 35, INSTALL IN-LINE INJECTION PUMP and/or IN-LINE FUEL INJECTION PUMP TIMING).

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RG,115,JW7712 –19–24NOV97–1/1

115
16

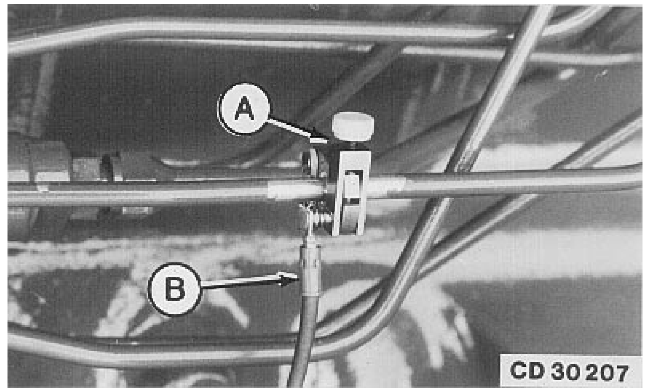
USING TIME TRAC® AS A TACHOMETER

The TIME-TRAC® meter can be used as a tachometer by using clamp on transducer JT07177 (A) at nozzle end of any high pressure fuel injection line.

1. Remove paint and thoroughly clean the area of the high-pressure line to which the clamp-on transducer is to be attached.

2. Install transducer (A) and connect JT07172 cable (B) between transducer and JT07170 meter port marked "SR".

3. Switch on meter and start the engine to measure and record engine speed.



CD30207 –UN–07MAR95

A—Transducer
B—Cable

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DPSG,OUO1004,115 –19–11MAY98–1/1

CHECK AND ADJUST ROTARY INJECTION PUMP DYNAMIC TIMING

The JT07158 (or FKM10429A) TIME TRAC® Kit electronically indicates start of injection with respect to piston top dead center (TDC), and allows accurate setting of injection pump timing to provide optimum power, smoke, and exhaust emissions.

Timing engines with this timing kit improves consistency between engines and helps to control cylinder firing pressures which can be a factor in head gasket failures as well as improve overall engine performance efficiencies.

RG7246 –UN–23NOV97

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RG,115,JW7711 –19–24NOV97–1/9

INSTALL JT07158 (OR FKM10429A) TIME TRAC® KIT:

IMPORTANT: All transducers and sensors must be installed at nozzle end of No. 1 fuel injection line. If access to No. 1 line is restricted, sensor can be installed on No. 4 injection line (4-cylinder engines) and No. 6 injection line (6-cylinder engines).

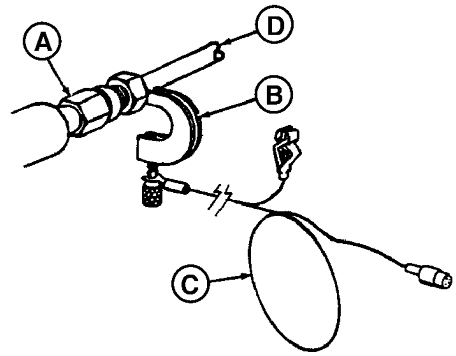
Remove all paint from injection line where clamp-on transducer will be installed and be sure this location is thoroughly clean.

1. On engines with optional JT07155 In-Line SOI Sensor (A) installed between injection nozzle and fuel delivery line, install JT07173 SOI Clamp Assembly (B) onto clean sensor and tighten securely.

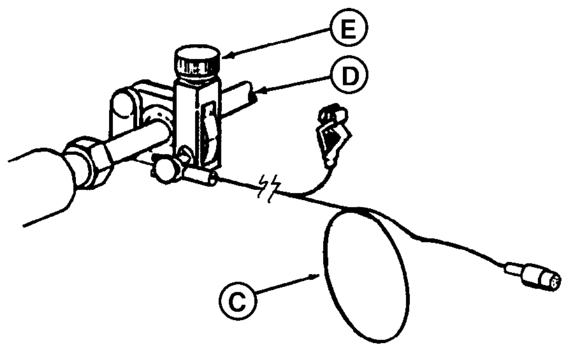
2. On engines without optional JT07155 In-Line Sensor, install JT07177 6 mm (green) Clamp-on Transducer (E) onto clean, paint-free injection line and tighten securely.

3. Assemble red lead of JT07172 Transducer Cable (C) onto in-line sensor or transducer, however equipped.

4. Attach spring clip to a solid ground. Plug connector into JT07170 meter port marked SR.



RG7285 –UN–03NOV97



RG7286 –UN–03NOV97

A—JT07155 In-Line SOI Sensor
B—JT07173 SOI Clamp Assembly
C—JT07172 Transducer Cable
D—Fuel Injection (Delivery) Line
E—JT07177 6 mm (Green) Clamp-On Transducer

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RG,115,JW7711 –19–24NOV97–2/9

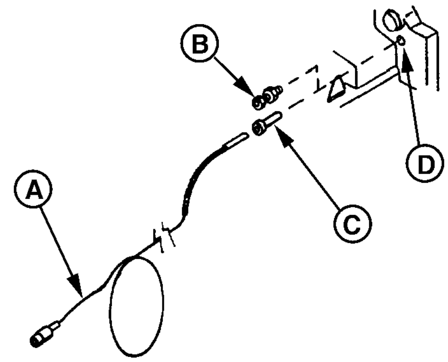
115
18

5. Use JDE81-4 Timing Pin in flywheel timing hole (D) to ensure engine is NOT stopped at TDC. Magnetic pick-up probe will enter TDC timing hole in flywheel and be damaged when engine is started. An air gap of 0.64 mm (0.025 in.) is recommended between tip of probe and flywheel face.

6. Install JDG793 Threaded Magnetic Pick-up Adapter (B) into flywheel housings with tapped hole until it bottoms. Insert probe of magnetic pickup (A) into adapter until it contacts flywheel. Back out hex head of adapter two flats and tighten lock nut; this will provide recommended air gap.

7. Install JDG821 Tapered Magnetic Pick-up Adapter (C) into flywheel housings without tapped hole. Lightly tap adapter to lock into position. Insert probe into adapter until it contacts the flywheel. Pull probe back out to provide 0.64 mm (0.025 in.) gap.

8. Plug magnetic pick-up connector into JT07170 meter port marked MP.



RG7287 –UN–03NOV97

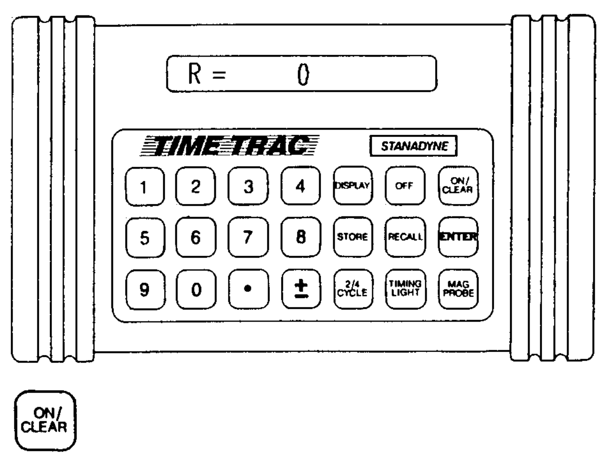
A—Magnetic Pick-Up
B—JDG793 Threaded Magnetic Pick-Up Adapter
C—JDG821 Tapered Magnetic Pick-Up Adapter
D—Flywheel Timing Hole

RG,115,JW7711 –19–24NOV97–3/9

CHECK ROTARY INJECTION PUMP RATED LOAD DYNAMIC TIMING:

1. Engine OFF. Push ON/CLEAR button.

   Display shows: R=0



RG7031 –UN–27SEP94

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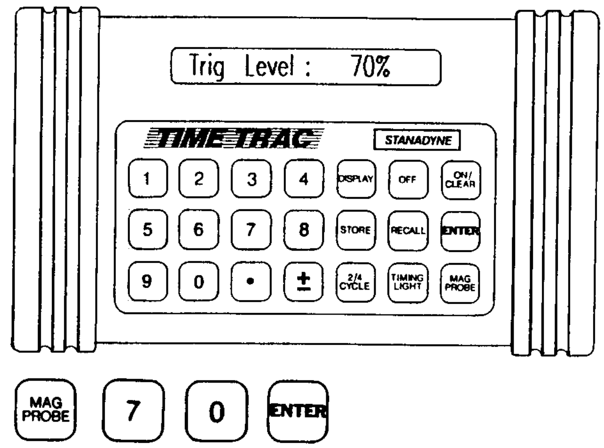
2. Push MAG PROBE button.

   Display shows: Trig Level: 30%

3. Change to 70% and push ENTER.

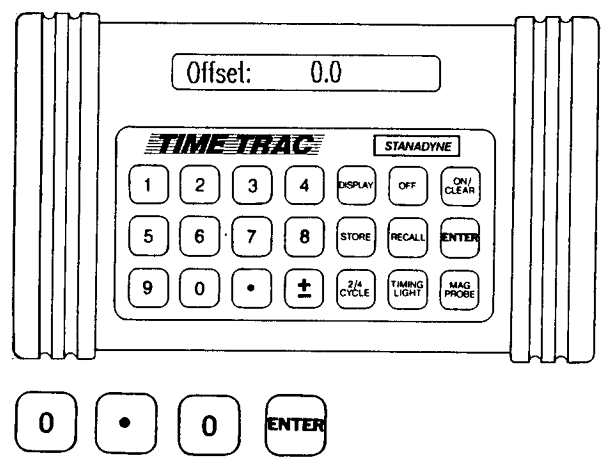


RG7032 –UN–27SEP94

RG,115,JW7711 –19–24NOV97–5/9

4. Display shows: Offset: 20.0°

   Change to offset 0° and push ENTER.



RG7033 –UN–27SEP94

Continued on next page RG,115,JW7711 –19–24NOV97–6/9

115
20

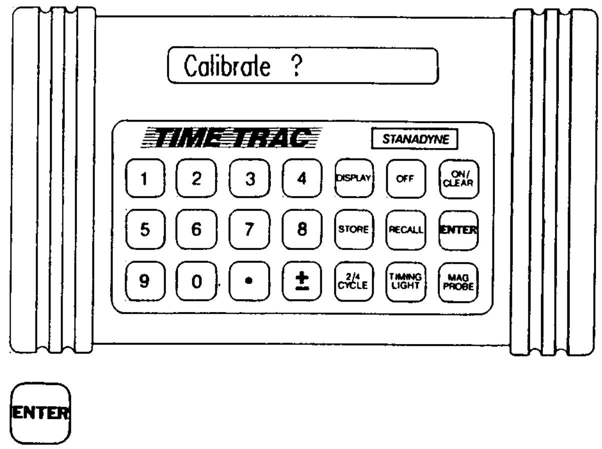
5. Display shows: Calibrate?

   Start engine and push ENTER.

6. Run engine at 1300 rpm. Push ENTER. Display shows: Calibrating then Engine RPM and timing.

NOTE: If display shows NO PROBE, the magnetic pick-up probe has not been installed properly [air gap exceeds 0.64 mm (0.025 in.)] or there is debris on the back of the flywheel. Check for proper air gap or clean the back side of the flywheel by inserting a soft wooden dowel into the engine timing pin hole with the engine running at low idle speed.

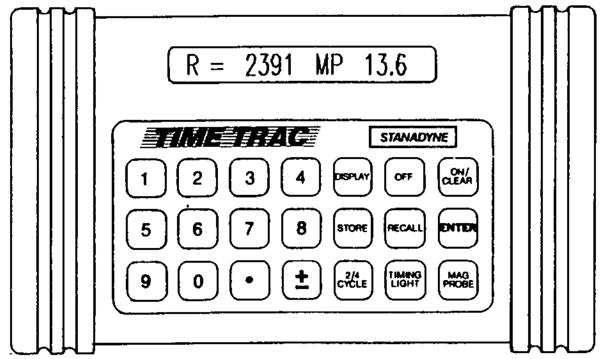
7. Warm engine to normal operating temperature, check slow and fast idle rpm. (See ROTARY FUEL INJECTION PUMP SPECIFICATIONS earlier in this group.) Adjust speeds as necessary.



RG7129 –UN–06OCT94

Continued on next page RG,115,JW7711 –19–24NOV97–7/9

IMPORTANT: Many machines have hydraulic pumps that have adequate flow to load engine well below rated load rpm. Some equipment may need to be driven in high gear or pull a load to bring engine speed to rated load rpm.



RG7037 –UN–27SEP94

8. Run engine at wide open throttle (WOT) and load engine down gradually to rated speed rpm.

9. Record engine speed (rpm) and timing degrees.

10. Compare recorded speeds and timing degrees to charts earlier in this group for OEM applications or refer to machine technical manual.

IMPORTANT: Stop engine prior to making timing adjustments. Injection pump can seize if adjustment is made with engine running.

11. Stop engine.

If dynamic timing reading is more than 8 degrees retarded with pump flange and front plate timing marks at original location as shipped from factory, this may indicate the pump advance is not functioning. Check the following:

- Change fuel filter(s).
- Check transfer pump for positive fuel pressure to injection pump.
- Check camshaft movement on injection pumps with rectangular timing window.
- Check pump drive shaft-to-gear key or pin to ensure key or pin has not sheared.
- If none of the above checks are conclusive, remove pump and have necessary repairs made at an authorized diesel repair station.

Continued on next page

RG,115,JW7711 –19–24NOV97–8/9

115
22

ADJUST ROTARY INJECTION PUMP DYNAMIC TIMING:

1. Loosen injection pump mounting flange nuts and adjust pump timing.

   To advance pump timing, rotate top of pump clockwise view from rear (flywheel end) of engine. To retard timing, rotate top of pump counterclockwise. Pump flange movement of 1.524 mm (0.060 in.) is equivalent to 2 degrees of engine timing.

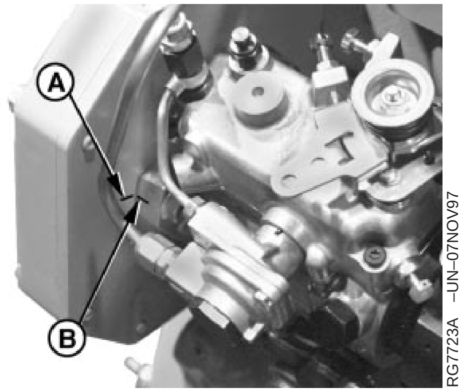
2. Tighten injection pump mounting flange nuts to specifications.

Rotary Injection Pump Mounting Nuts—Specification

Torque .... 27 N•m (20 lb-ft)

Start engine and check injection pump dynamic timing again. Adjust timing as needed.

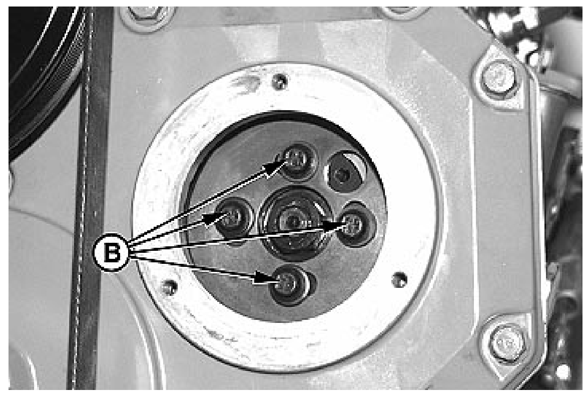
3. Grind away original timing mark and stamp new timing mark (B) onto injection pump flange to align with timing mark (A) on front plate after all final adjustments have been made and satisfactory engine performance is achieved.



A—Front Plate Timing Mark
B—Pump Timing Mark

RG,115,JW7711 –19–24NOV97–9/9

CHECK AND ADJUST IN-LINE INJECTION PUMP STATIC TIMING



A—Timing Pin
B—Gear-to-Hub Cap Screws

1. Using JDE83 or JDG820, rotate engine flywheel (in normal running direction) until No. 1 piston is at “TDC” of it’s compression stroke. At this point, JDE81-4 Timing Pin should enter hole in flywheel.

2. Remove injection pump drive gear cover and O-ring.

3. Look through the drive gear timing hole to see if the timing hole in the injection pump hub is visible. If it isn’t, remove JDE81-4 Timing Pin from flywheel and rotate the engine (in normal running direction) one more revolution and reinstall timing pin in flywheel.

4. Attempt to install JDG886 Injection Pump Timing Pin (A) through injection pump drive gear into injection pump hub unitil it bottoms out. It may be necessary to rotate the pump drive hub slightly to get the pin installed. If pin can be installed, injection pump is correctly timed.

5. If timing pin won’t engage in injection pump drive gear into injection pump hub, loosen drive gear-to-pump hub cap screws (B) and rotate hub slightly until timing pin will fully engage.

6. Tighten drive gear-to-pump hub cap screws to specifications.

In-Line Injection Pump Drive Gear-to-Pump Hub Cap Screws—Specification

Torque .... 47 N•m (35 lb-ft)

7. Remove JDG886 Injection Pump Timing Pin from injection pump hub.

8. Install injection pump drive gear cover using a new O-ring, if needed. Tighten cap screws to specifications.

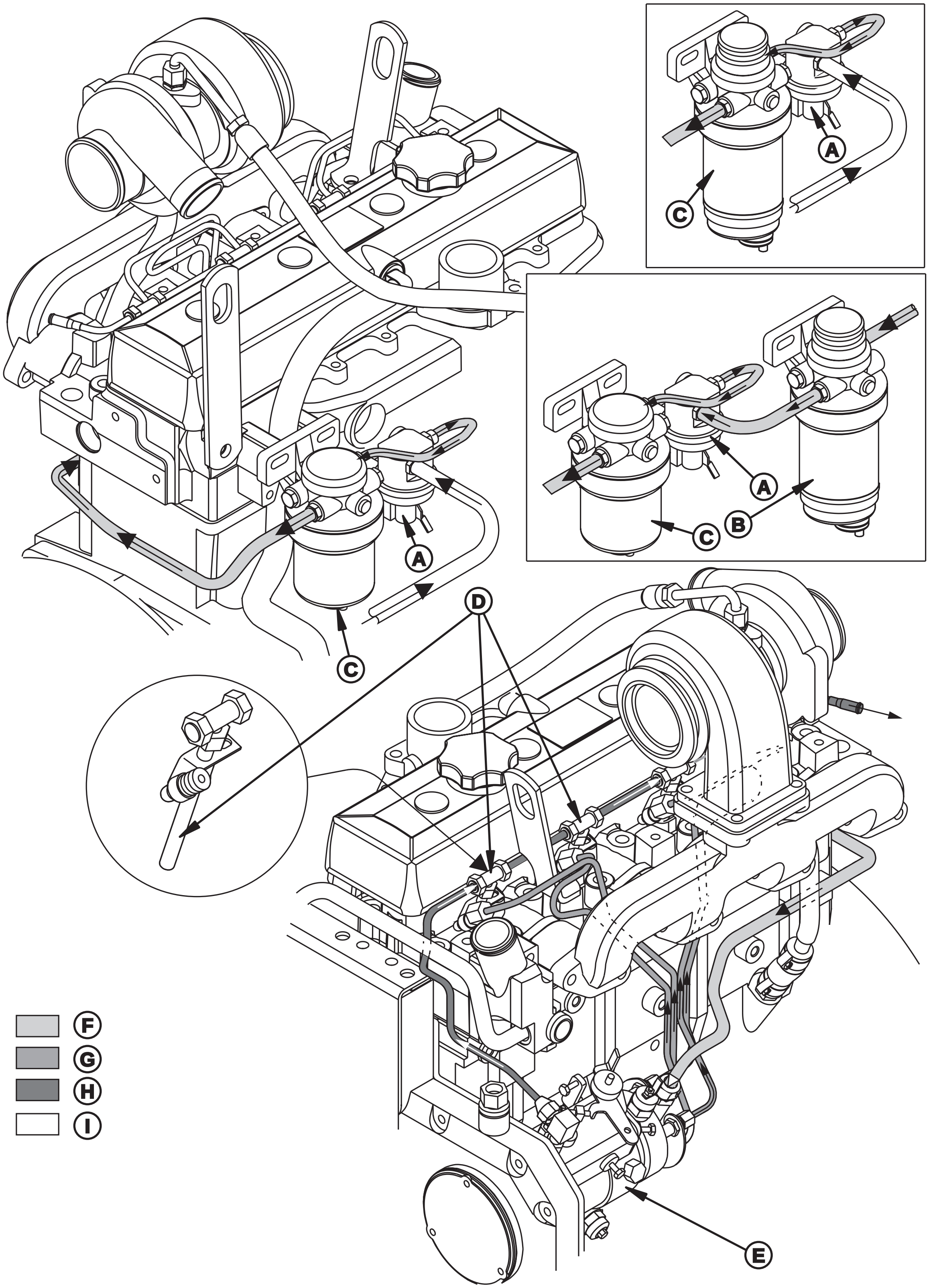
In-Line Injection Pump Drive Gear Cover—Specification

Torque .... 5 N•m (3.7 lb-ft) (44 lb-in.)

9. Remove JDE81-4 Timing Pin from flywheel.

DPSG,OUO1004,254 –19–17JUL98–1/1

FUEL SYSTEM OPERATION—ROTARY FUEL INJECTION PUMP



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RG,115,JW7716 –19–24NOV97–1/2

A—Fuel Supply (Transfer) Pump
B— Primary Fuel Filter/Water Separator
C—Final Fuel Filter
D—Fuel Injection Nozzles
E—Fuel Injection Pump
F—Supply Pump Pressure Fuel
G—Injection Pressure Fuel
H—Fuel Return Leak-off
I—Suction Fuel from Tank

Refer to illustration on previous page.

The fuel supply pump (A) draws fuel from the tank and pressurizes it. This pressure permits the fuel to flow through the optional primary filter (B) and final filter (C) and charge the transfer pump of the injection pump (E).

With the fuel injection pump charged with fuel by the fuel supply pump, the injection pump plungers pressurize the fuel to approximately 50 000 kPa (500 bar) (7255 psi). Delivery (pressure) lines are used to route this high pressure fuel to the fuel injection nozzles (D).

Fuel enters the injection nozzle at a pressure which easily overcomes the pressure required to open the nozzle valve. When the nozzle valve opens, fuel is forced out through the orifices in the nozzle tip and atomizes as it enters the combustion chamber.

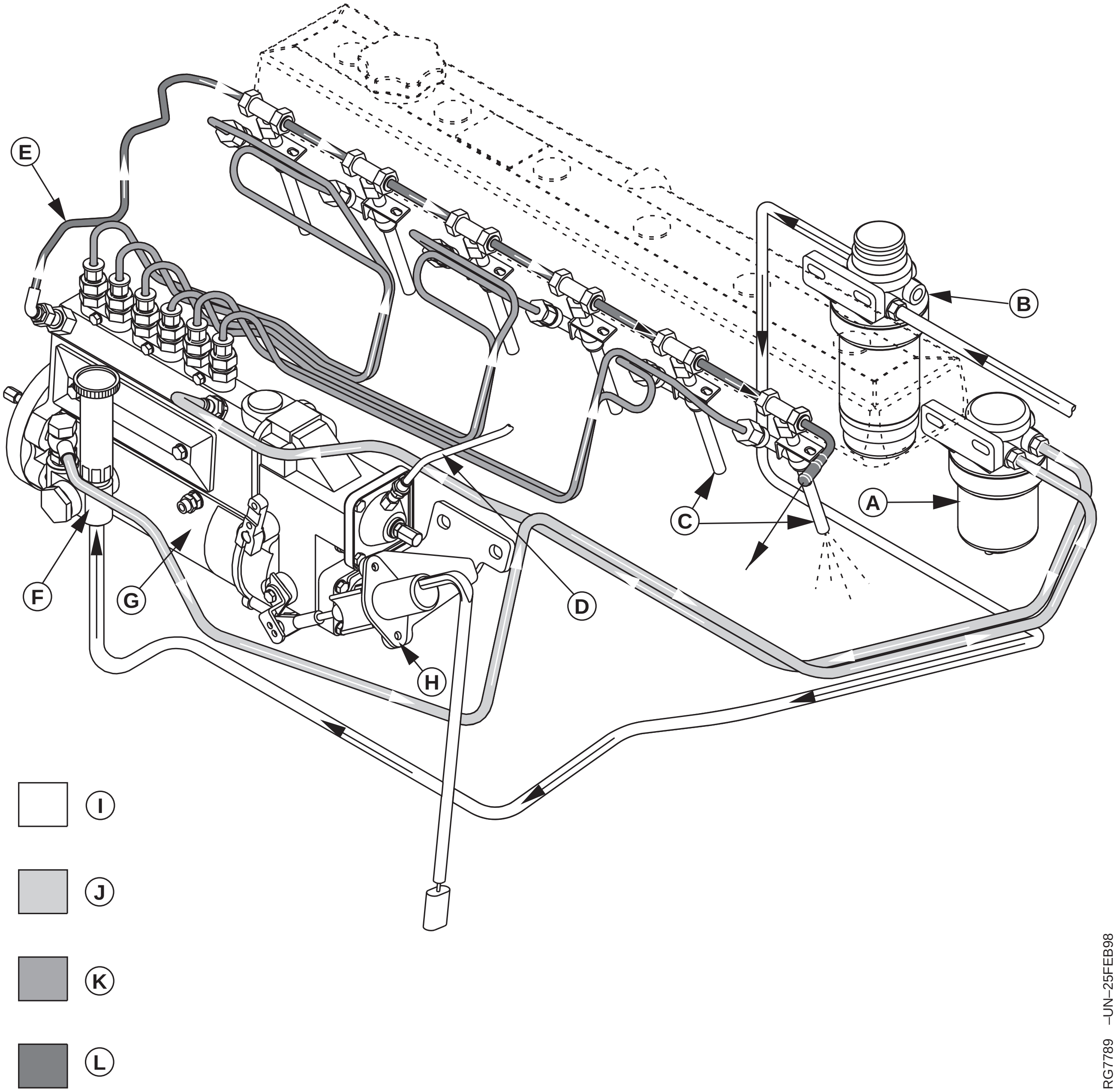
Incorporated into the fuel system is a means of returning excess (or unused) fuel (H) back to the fuel tank. Excess fuel comes from two sources:

1. Fuel Injection Pump: A quantity of fuel greater than that required by the engine is supplied to the fuel injection pump.
2. Fuel Injection Nozzles: A small amount of fuel seeps past the nozzle valve for lubrication purposes.

To get the excess fuel back to the tank, a return line from the injection pump is connected to the middle of the nozzle leak-off line. Fuel from both sources is then returned to the tank by a return pipe connected to the front end of the leak-off pipe.

RG,115,JW7716 –19–24NOV97–2/2

FUEL SYSTEM OPERATION—IN-LINE FUEL INJECTION PUMP



A—Final Fuel Filter
B—Primary Fuel Filter/Water Separator
C—Injection Nozzles
D—Aneroid Inlet Line
E—Fuel Return (Leak-off) Line
F—Fuel Supply Pump
G—Fuel Injection Pump
H—Fuel Shut-off Solenoid
I—Suction Fuel from Tank
J—Supply Pump Pressure Fuel
K—Injection Pressure Fuel
L—Return (Leak-off) Line

The supply pump (F) draws fuel from the vented fuel tank through the primary filter (B).

Continued on next page

The supply pump pressurizes the fuel so that it flows through the filter to the injection pump galley. Supply pump output pressure will vary depending on load and application.

The galley is kept full by the supply pump. Injection pump plungers further pressurize the fuel. Injection pressure lines route the fuel to the nozzles (C).

The high pressure fuel (K) opens the nozzle valve and forces fuel out the small orifices in the nozzle tip. This atomizes the fuel as it enters the combustion chamber.

There are two sources of excess fuel incorporated into the system. The supply pump supplies more fuel to the pump than is required by the engine, and the nozzle requires excess fuel to lubricate the nozzle valve. A leak-off line (L) returns this excess fuel to the tank from both the pump and nozzles.

RG,115,JW7717 –19–24NOV97–2/2

115
28

DIAGNOSE FUEL SYSTEM MALFUNCTIONS

Symptom	Problem	Solution
Fuel Not Reaching Injection Nozzles	Fuel filter restricted.	Replace fuel filter. (See Group 35.)
	Fuel line restricted.	Clean lines as required.
	Fuel too heavy at low temperatures.	Use correct grade of fuel.
	Air in system.	Correct problem and bleed fuel system (this group).
	Fuel tank valve shut off.	Open fuel tank valve.
	Low supply pump pressure.	Check fuel lines for restrictions; check pump output pressure (this group).
Engine Starts Hard or Won’t Start	Fuel too heavy at low temperature.	Use correct grade of fuel. (See Fuels, Group 02.)
	Injection nozzles faulty or sticking.	Repair or replace as required. (See Group 35.)
	Incorrect timing.	Adjust timing (this group).
	Faulty injection pump.	Repair or replace.
	Water in fuel.	Drain water from filter (or separator if equipped).
	Fuel filter restricted.	Install new filter. See Group 35.
	Low supply pump pressure.	Check pump output pressure (this group).
	Injection pump return fuel line or fittings restricted.	Clean lines as required.
	Low cetane fuel.	Use correct grade of fuel. (See Group 02.)
Engine Starts and Stops	Air in system.	Correct problem and bleed fuel system. (See this group.)

Continued on next page

RG,115,JW7710 –19–24NOV97–1/4

Symptom	Problem	Solution
	Fuel filter restricted.	Replace fuel filter.
	Fuel lines restricted.	Clean lines as required.
	Water in fuel.	Drain water from filter, (or separator if equipped). Install new filter. (See Group 35.)
	Injection pump return fuel line or fittings restricted.	Clean lines as required.
Erratic Engine Operations	Fuel filter restricted.	Replace fuel filter. (See Group 35.)
	Fuel too heavy at low temperatures.	Use correct grade of fuel. (See Group 02.)
	Injection nozzles faulty or sticking.	Repair or replace nozzles. (See Group 35.)
	Fuel lines restricted.	Clean as required.
	Incorrect timing.	Adjust timing (this group).
	Governor faulty.	Repair. (See Group 35.)
	Water in fuel.	Drain water from filter (or separator, if equipped). Install new filter.
	Injection pump return fuel line or fittings restricted.	Clean lines as required.
	Low cetane fuel.	Use correct grade of fuel. (See Group 02.)
	Injection nozzle return lines restricted.	Clean lines as required.
Engine Emits Excessive Black Smoke	Injection nozzles faulty or sticking.	Repair. (See Group 35.)
	Injection pump timing incorrect.	Adjust timing (this group).
	Low cetane fuel.	Use correct grade of fuel. (See Group 02.)

Continued on next page RG,115,JW7710 –19–24NOV97–2/4

Symptom	Problem	Solution
	Over-fueling.	Repair injection pump. (See Group 35.)
Engine Emits Excessive Blue or White Smoke	Cranking speed too slow.	Check batteries and electrical system.
	Injection pump timing incorrect.	Adjust timing (this group).
	Injection nozzles faulty or sticking.	Repair. (See Group 35.)
	Excessive wear in liners and/or piston rings stuck.	See Group 10.
	Incorrect cetane fuel for ambient temperature.	Use correct grade of fuel. (See Group 02.)
	Engine running too “cold”.	Check thermostat. (See Group 25.)
Engine Idles Poorly	Injection nozzles faulty or sticking.	Repair. (See Group 35.)
	Incorrect timing.	Adjust timing (this group).
	Pump slow idle speed not correctly adjusted.	Adjust slow idle speed (this group).
	Fuel lines restricted.	Clean as required.
	Water in fuel.	Drain water from filter, (or separator, if equipped). Install new filter. (See Group 35.)
	Injection pump return lines or fittings restricted.	Clean as required.
	Injection nozzle return lines clogged.	Clean as required.
	Low cetane fuel.	Use correct grade of fuel. (See Group 02.)
Engine Does Not Develop Full Power	Low cetane fuel.	Use correct grade of fuel. (See Group 02.)
	Incorrect timing.	Adjust timing (this group).

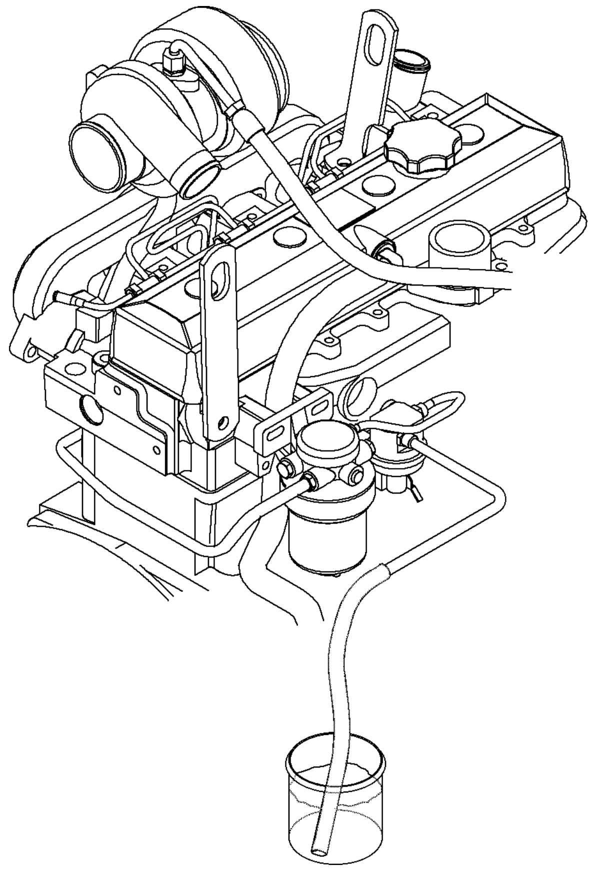
Continued on next page

Symptom	Problem	Solution
	Injection pump or governor faulty.	Repair. (See Group 35.)
	Fuel filter clogged.	Replace fuel filter. (See Group 35.)
	Injection nozzles faulty or sticking.	Repair. (See Group 35.)
	Defective supply pump.	Test (this group).
	Injection pump return fuel line or fittings restricted.	Clean as required.
	Water or gasoline in diesel fuel.	Drain water or replace with clean fuel. Install new filters (this group).
	Incorrect fast idle speed.	Adjust speed (this group).
	Speed control linkage incorrectly adjusted.	Adjust (this group).

RG,115,JW7710 –19–24NOV97–4/4

115
32

FUEL SUPPLY QUALITY CHECK



RG9566 –UN–17JUL98

NOTE: Illustration shows fuel supply pump on engines with rotary injection pumps. On engines with in-line injection pumps, the supply pump is mounted on the side of the injection pump. The following procedure is the same for both.

The quality of diesel fuel affects engine performance. Check your operators manual for correct fuel specifications.

Poor quality or contaminated fuel will make the engine hard to start, misfire, run rough or produce low power.

If poor quality or contaminated fuel is suspected, perform the following:

1. Check primary (if equipped) and final fuel filters for servicability. If filter is equipped with with a water separator, empty and clean separator bowl.

2. Start engine and operate under load, observing engine performance.

3. Disconnect fuel line from inlet side of primary fuel filter (if equipped) or inlet side of supply pump on engines without primary filter.

4. Connect a hose to inlet port.

5. Submerge hose in a container of clean, good quality fuel meeting engine specifications.

6. Operate engine under load and observe performance.

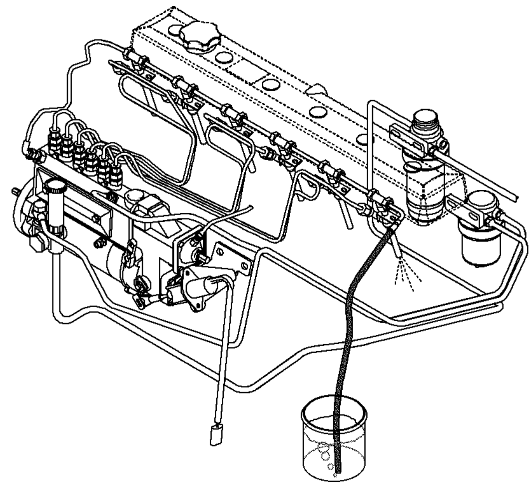
   If performance improves, fuel is contaminated or not of the proper grade. Check fuel source.

DPSG,OUO1004,158 –19–01JUL98–1/1

115
33

AIR IN FUEL TEST

NOTE: Illustration shows in-line injection pump. Rotary pump is similar.



Air in the fuel system will make the engine hard to start, run rough, misfire or produce low power. Additionally, it can cause excessive smoke and knocking.

Whenever the fuel system is opened for repair, it must be bled to remove any air that has entered the system.

1. Disconnect hose from end of fuel leak-off line assembly. Connect a hose to end of leak-off line assembly and place opposite end of hose in a suitable container filled with fuel as shown.

2. Operate engine and check for air bubbles in container. If bubbles are present, bleed the fuel system and repeat test. (See BLEED THE FUEL SYSTEM in this group.)

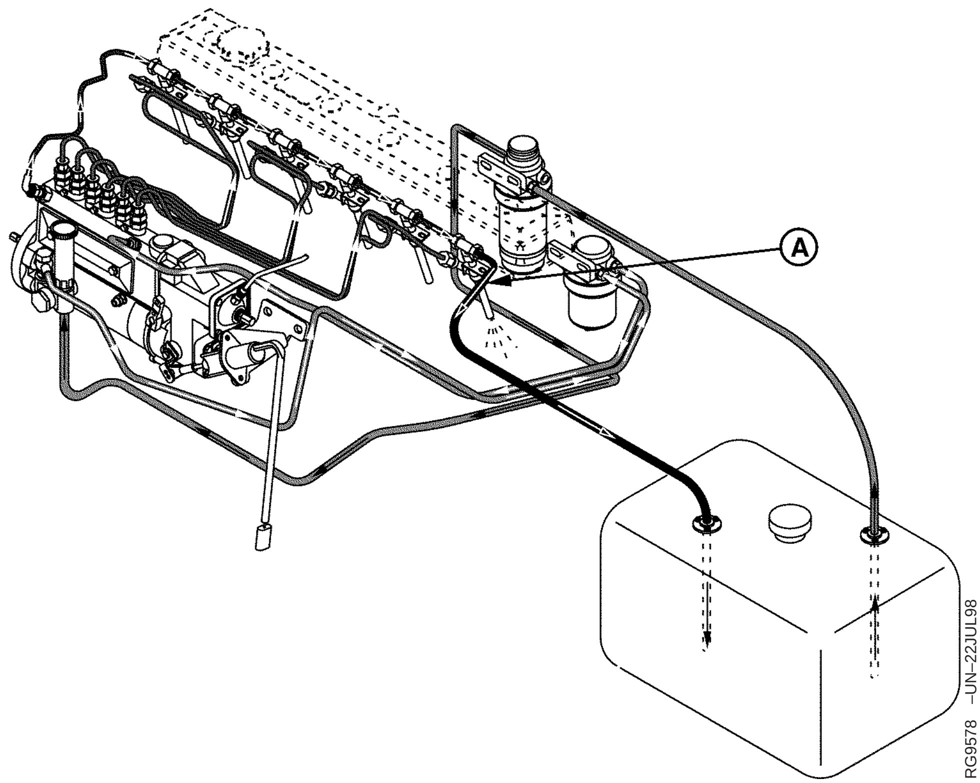
3. If bubbles are still present, check the following:

- Check for loose fuel fittings from the suction side of the fuel supply pump to the fuel tank to inckude all lines and filters.
- Check fuel tank suction tube (if equipped) and welded joints for cracks or holes.

Perform any necessary repairs, bleed fuel system and repeat test.

DPSG,OUO1004,157 –19–01JUL98–1/1

RESTRICTED FUEL RETURN LINE CHECK



A—Fuel Leak-Off Line

This check will help determine if the fuel return line is restricted.

1. Disconnect fuel leak-off line at the engine (A).

2. Remove fuel tank cap.

3. Force compressed air through the fuel return line while listening at the fuel tank filler neck

4. If the return line isn't restricted, the compressed air bubbling into the fuel tank should be audible through the tank filler neck.

5. If no air bubbling through the tank is audible, completely check the fuel return line for any possible restrictions.

DPSG,OUO1004,289 –19–23JUL98–1/1

FUEL SUPPLY PUMP OPERATION—ROTARY INJECTION PUMP

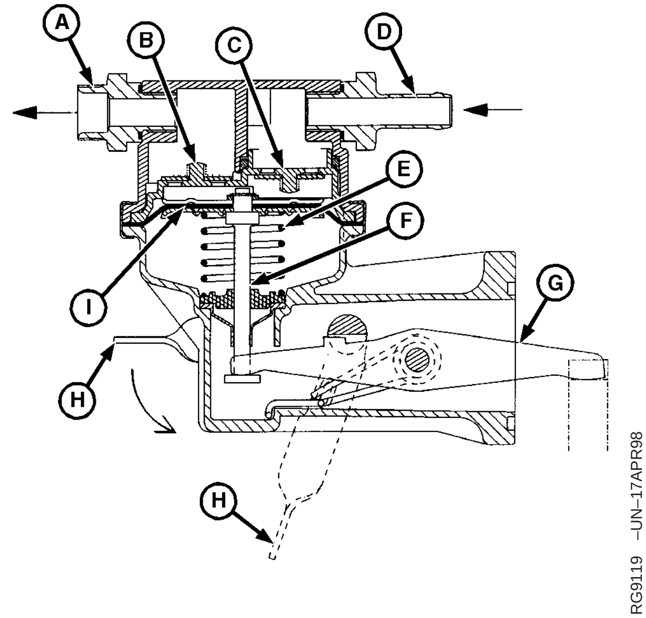
The Sofabex fuel supply pump used with Lucas and Stanadyne rotary fuel injection pumps uses an eccentric lobe on the engine camshaft to operate lever (G) on supply pump to pressurize fuel system.

Fuel flows from the fuel tank at gravity pressure to the inlet side (D) of the diaphragm-type pump.

As lever (G) rides on the high side of the camshaft lobe, rod (F) pulls diaphragm (I) down. Suction pressure opens the inlet check valve (C) and fuel is drawn into the pump.

As the camshaft lobe rotates to the low side, return spring (E) forces diaphragm (I) upward. The resulting fuel pressure closes inlet check valve (C) and opens oultlet check valve (B), delivering fuel through outlet (A) to the injection pump.

Hand primer lever (H) is provided for manually forcing fuel through the system to bleed air from the fuel filter, lines, etc.



A—Fuel Outlet
B—Outlet Check Valve
C—Inlet Check Valve
D—Fuel Inlet
E—Return Spring
F—Rod
G—Lever
H—Hand Primer Lever
I—Diaphragm

RG,115,JW7709 –19–24NOV97–1/1

DIAGNOSE FUEL SUPPLY PUMP MALFUNCTIONS—ROTARY INJECTION PUMP

Symptom	Problem	Solution
Low Supply Pump Pressure or Pump Not Functioning Correctly	Out of fuel.	Add fuel to tank.
	Fuel shut off at tank.	Open shut-off valve.
	Restricted fuel line.	Clean as required.
	Air leak in fuel line between pump and tank.	Repair as required.
	Loose or damaged fuel line connections.	Repair as required.
	Hand primer lever left in upward position.	Move lever toward engine block as far as it will go.
	Punctured or leaking diaphragm.	Replace pump. (See Group 35.)
	Worn or damaged valve assemblies.	Replace pump. (See Group 35.)
	Broken valve spring(s).	Replace pump. (See Group 35.)
	Foreign material under diaphragm (from vent holes).	Replace pump. (See Group 35.)
	Wear or damage to hand primer linkage.	Replace pump. (See Group 35.)

RG,115,JW7708 –19–24NOV97–1/1

MEASURE FUEL SUPPLY PUMP PRESSURE—ROTARY INJECTION PUMP

RG7946 –UN–15JAN98

1. Remove plug on fuel filter base.

2. Install test equipment as shown.

3. Start engine. Fuel pump should maintain minimum positive pressure listed below. If pressure is low, replace filter element and recheck pressure.

Fuel Static Pressure—Specification

Pressure .... 25—30 kPa (0.25—0.30 bar) (3.5—4.5 psi)

Minimum Static Pressure at 850 rpm Engine Speed—Specification

Pressure .... 15 kPa (0.15 bar) (2.0 psi)

Minimum Positive Pressure at 2400 rpm Engine Speed—Specification

Pressure .... 21—34 kPa (0.21—0.34 bar) (3—5 psi)

Minimum Flow at 2400 rpm Engine Speed—Specification

Flow .... 1.5 L/min (0.42 gpm)

If pressure is still low, perform the following:

1. Disconnect pump-to-filter fuel line at the filter.

2. With throttle set at no-fuel position (or injection pump shut-off solenoid wire disconnected) so engine will not start, turn engine over several times with starting motor.

3. If fuel spurts from the line, the pump is operating properly.

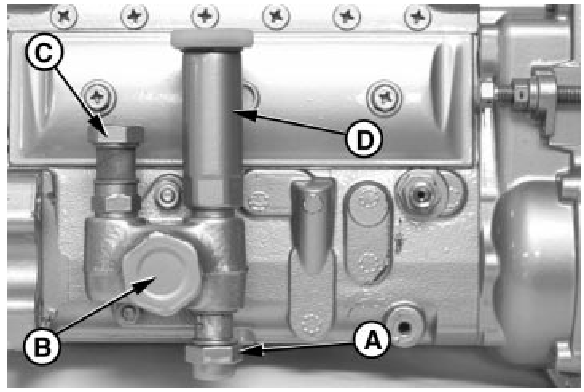
NOTE: Look for a possible restriction in filter/filter base. Make sure pressure gauge/hose assembly is not at fault.

RG,115,JW7707 –19–24NOV97–1/1

115
38

FUEL SUPPLY PUMP OPERATION—IN-LINE INJECTION PUMP

The plunger-type Nippondenso fuel supply pump 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.



RG7753B –UN–10NOV97

A—Fuel Inlet
B—Plunger
C—Fuel Outlet
D—Hand Primer

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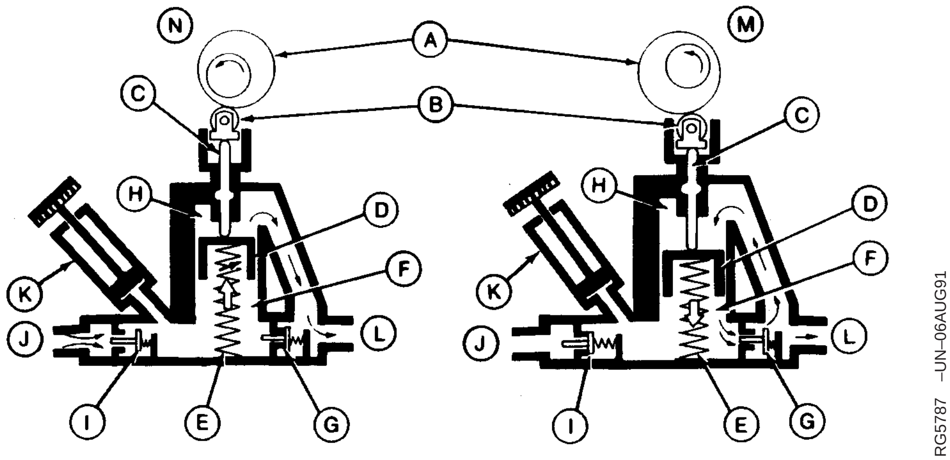
RG,115,JW7706 –19–24NOV97–1/2



A—Camshaft
B—Roller Tappet
C—Pressure Spindle
D—Plunger
E—Plunger Spring
F—Suction Chamber
G—Pressure Valve
H—Pressure Chamber
I—Suction Valve
J—Fuel Inlet
K—Hand Primer Pump
L—Fuel Outlet
M—Intermediate Stroke Position
N—Suction and Discharge Stroke Position

As the pump camshaft (A) rotates toward the “high cam” intermediate stroke position (M), the roller tappet (B) and pressure spindle (C) cause the plunger (D) to move against and compress the plunger spring (E).

Plunger movement forces the fuel out of the suction chamber (F), through the pressure valve (G), and into the pressure chamber (H). The amount of fuel discharged from the suction chamber is equal to the amount of fuel delivered for each stroke of the plunger. Towards the end of the intermediate stroke, the spring-loaded pressure valve closes again.

As the camshaft rotates toward the “low cam” or suction and discharge position (N), plunger spring pressure causes the plunger, pressure spindle, and roller tappet to follow the camshaft.

Movement of the plunger pushes the fuel from the pressure chamber, and delivers it to the fuel filters and injection pump. At the same time, plunger suction pressure is permitting fuel to enter the suction chamber through the suction valve (I). With the suction chamber charged with fuel, the pumping cycle begins again.

Fuel is allowed to flow in around the pressure spindle to lubricate the spindle as it moves back and forth in housing. To prevent the fuel from entering the pump crankcase, a rubber O-ring is positioned in the spindle bore of housing at the roller tappet end.

Unscrewing the knurled knob on the hand primer pump (K) and pulling upward causes the suction valve to open and fuel to flow into the suction chamber. When the hand plunger is pushed downward, the suction valve closes, and fuel is forced out of the pressure valve.

RG,115,JW7706 –19–24NOV97–2/2

MEASURE FUEL SUPPLY PUMP PRESSURE (IN-LINE INJECTION PUMPS)

RG9146 –UN–23JUL98

1. Remove plug on fuel filter base.
2. Install test equipment as shown.
3. Start engine and run at 2400 rpm. Fuel pump should maintain minimum positive pressure listed below. If pressure is low, replace filter element and recheck pressure.

Minimum Positive Pressure at 2400 rpm Engine Speed—Specification

Pressure .... 69 kPa (0.69 bar) (10 psi)

Minimum Flow at 2400 rpm Engine Speed—Specification

Flow .... 2.0 L/min. (0.53 gpm)

If pressure is still low, perform the following:

1. Disconnect pump-to-filter fuel line at the filter.
2. With throttle set at no-fuel position (or injection pump shut-off solenoid wire disconnected) so engine will not start, turn engine over several times with starting motor.
3. If fuel spurts from the line, the pump is operating properly.

NOTE: Look for a possible restriction in filter/filter base. Make sure pressure gauge/hose assembly is not at fault.

DPSG,OUO1004,152 –19–29JUN98–1/1

DIAGNOSE FUEL SUPPLY PUMP MALFUNCTIONS—IN-LINE INJECTION PUMP

115
41

IMPORTANT: Visually inspect the fuel inlet fitting and pump filter for possible plugging before disassembling to determine cause of malfunction.

Symptom	Problem	Solution
Low Supply Pump Output Pressure or Pump Not Functioning Correctly	Restriction at fuel inlet fitting.	Thoroughly clean fuel tank, lines, filters, and inlet fitting.
	Hand primer not screwed down tight, allowing dirt to enter hand primer plunger chamber.	Advise customer to tighten hand primer after use.
	Worn or pitted valves caused by foreign material lodging in valve.	Replace valves as required.
	Missing or broken spring(s).	Replace spring(s).
	Broken spindle.	Replace pump.
	Out of fuel.	Add fuel to fuel tank.
	Fuel shut off at tank.	Open fuel shut-off valve.
	Restricted fuel line.	Clean as required.
	Air leak in fuel line between pump and tank.	Repair as required.
	Loose or damaged fuel line 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.
	Broken valve spring(s).	Repair or replace.
Diesel Fuel Leaking Into Injection Pump Crankcase	Worn spindle and/or pump housing.	Replace pump.

Continued on next page RG,115,JW7704 –19–24NOV97–1/2

Symptom	Problem	Solution
	Defective O-ring seal.	Replace O-ring seal.

RG,115,JW7704 –19–24NOV97–2/2

TEST FUEL SUPPLY PUMP FOR LEAKS—IN-LINE INJECTION PUMP

Fuel delivery pressure should be checked before removing supply pump from injection pump. (See FUEL SUPPLY PUMP OPERATION—IN-LINE INJECTION PUMP, earlier in this group).

1. Connect compressed air line (A) to a pressure gauge (B) and to supply pump inlet fitting. Air line should have a regulating valve to control pressure.

2. Cap or plug supply pump outlet fitting (C).

3. Submerge supply pump in a container of clean diesel fuel. Regulate air pressure to 200 kPa (2.0 bar) (29 psi).

4. Move roller tappet in and out by hand. No air bubbles should appear around roller tappet.

NOTE: If bubbles appear, it is an indication that either the O-ring seal is defective or tappet is worn (or possibly both).

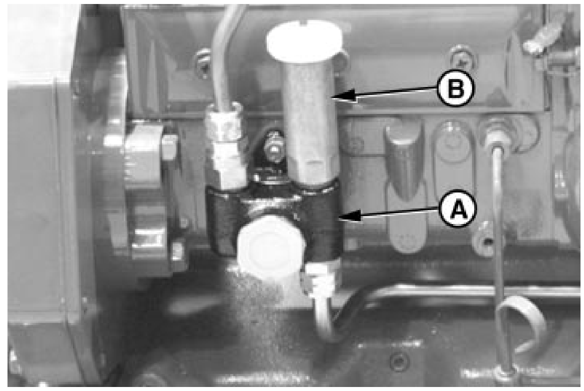
IMPORTANT: Serious injection pump or engine damage could occur, if enough diesel fuel leaks past spindle and seal. Fuel leakage past spindle dilutes engine oil.

RG5894 –UN–03NOV97

A—Air Line
B—Pressure Gauge
C—Outlet Fitting

RG,115,JW7703 –19–24NOV97–1/1

CHECK FUEL SUPPLY PUMP OPERATION—IN-LINE INJECTION PUMP



A—Supply Pump
B—Hand Primer

NOTE: The following test procedure can best be performed under moderate air temperature conditions to reduce electrical loads when cranking the engine is required.

Test fuel supply pump and hand primer for leaks:

1. Make a preliminary inspection of supply pump (A). 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 hand primer (B) 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 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.

Test operation of suction side of pump:

1. Disconnect suction and discharge lines at pump.

2. Drain all fuel from pump by operating hand primer. Then reconnect suction line to pump.

Continued on next page RG,115,JW7702 –19–24NOV97–1/3

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).

3. Operate hand primer until fuel flows from pump outlet (discharge). Fuel should flow within 15—25 strokes. If not, the suction line may be obstructed or leaking air; (replace in-line filter when used).

   If fuel does not flow, and if no leak or obstruction is found, pump is defective. Repair or replace pump. (See Group 35).

Test operation of discharge side of pump:

1. Suction line must be connected and discharge (pressure) line disconnected.

2. Tighten hand primer and place injection pump fuel shut-off control in “STOP” position to prevent engine from starting.

3. Crank engine with starting motor. Fuel should flow from pump outlet within 10 seconds. If not, the suction line may be obstructed or leaking air; (replace in-line filter when used).

Test pump output pressure while cranking engine:

1. Connect a 0—400 kPa (0—4 bar) (0—60 psi) pressure gauge to one end of a pressure hose about 250—300 mm (10— 12 in.) long. Connect other end of hose to pump outlet. All air must be out of system.

IMPORTANT: The starting motor must crank the engine at normal cranking speed. Use booster batteries if necessary.

2. Crank engine for 10 seconds with starting motor (approximately 300 engine rpm).

3. Compare measured output with the minimum pressure specifications.

Continued on next page

RG,115,JW7702 –19–24NOV97–2/3

Fuel Supply Pump (In-Line)—Specification

Minimum Outlet Pressure at Cranking Speed .... 69 kPa (0.69 bar) (10 psi)

4. If pressure is below the minimum specified and if no obstruction or leak is found, repair or replace the pump.

RG,115,JW7702 –19–24NOV97–3/3

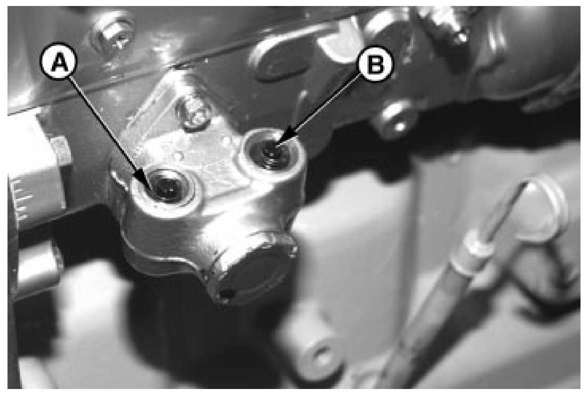
SERVICE FUEL SUPPLY PUMP

1. To gain access to the valves, remove hand primer, banjo fitting, and plug from top of supply pump (shown removed).

2. Remove valves (B) and springs (A).

3. Inspect valves and valve seats for foreign material, wear, or pitting. Valve springs must not be cracked or broken.

4. Reassemble parts, open tank shut-off valve, and check operation. If the pump operation is still not normal, the pump will have to be repaired or replaced. (See Group 35.)



RG8063 –UN–18NOV97

A—Springs
B—Valves

RG,115,JW7701 –19–24NOV97–1/1

115
46

COLD START ADVANCE SYSTEM OPERATION (ROTARY PUMPS)

To comply with exhaust emissions regulations, the timing of injection pumps should be around 6—9 degrees before TDC. This timing value does not allow for proper start-up when the engine is cold. A cold start advance system is used to temporarily advance injection pump timing during cold engine start-up conditions.

STANADYNE COLD START ADVANCE

On engines equipped with Stanadyne injection pumps, the major components of the cold start advance system are the cold start advance switch, cold start advance solenoid and cold start advance piston.

The cold start advance switch is mounted in the water manifold/thermostat housing. The switch is normally closed at coolant temperatures below 60° C (140°F), providing current to energize the cold start solenoid. At cold start-up, the solenoid plunger is unseated, allowing pressurized fuel to flow to the cold start advance piston. Piston movement advances engine timing 7—10 degrees.

When engine coolant temperature raises above 60° C (140°F), the cold start advance switch opens, cutting off current flow to the solenoid. The solenoid plunger seats, cutting off fuel flow to the cold start advance piston and timing returns to normal operating levels.

LUCAS COLD START ADVANCE

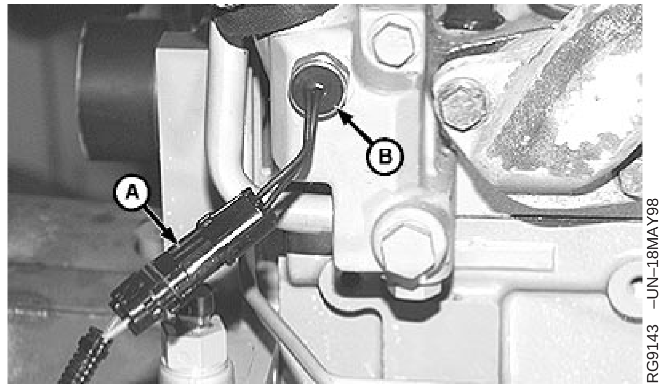
On engines equipped with Lucas injection pumps, the major components of the cold start advance system are the cold start advance switch, wax motor, cold start advance piston and springs, auto advance housing, piston and springs.

The cold start advance switch is mounted in the water manifold/thermostat housing. The switch is normally open at coolant temperatures below 60° C (140°F). At cold start-up, there is no current flow to the wax motor. Maximum fuel pressure is applied to the auto advance piston and engine timing is advanced 7—10 degrees.

When engine coolant temperature raises above 60° C (140°F), the cold start advance switch closes and current flows to the wax motor. A heating element in the wax motor heats the wax, causing it to expand. As the wax expands, the wax motor plunger extends, opening a ball valve and applying fuel pressure to the cold start advance piston. Equal pressure between the cold start advance piston and the auto advance piston and the net force applied to the advance springs returns injection pump timing to normal operating levels.

DPSG,OUO1004,122 –19–13MAY98–1/1

COLD START SWITCH OPERATIONAL CHECK (ROTARY PUMPS)



A—Connector
B—Cold Start Switch

The cold start switch (B) is an option available on rotary injection pumps.

1. Disconnect cold start switch connector (A) from pump wiring harness.

2. Remove cold start switch from thermostat housing/water manifold.

3. Submerge switch in water at 60° C (140° F) for a few minutes.

4. Check for open or closed switch. On Lucas pumps, the switch should be closed. On Stanadyne pumps, the switch should be open.

5. Replace switch if defective.

6. Install switch in thermostat housing/water manifold and tighten to specifications.

Cold Start Switch—Specification

Torque .... 5 N•m (3.5 lb-ft) (42 lb-in.)

7. Connect cold start switch connector to pump wiring harness.

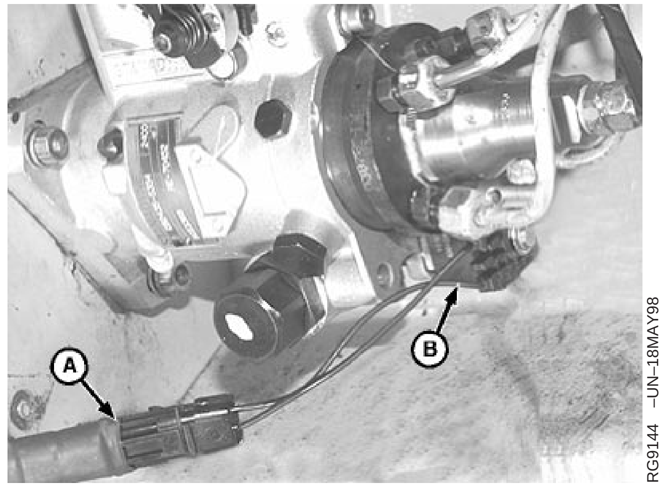
RG,115,JW7700 –19–24NOV97–1/1

115
48

COLD START ADVANCE SYSTEM OPERATIONAL CHECK (ROTARY PUMPS)

NOTE: To check operation of the cold start advance system, the engine will be operating in an advanced timing mode. After checks are completed, ensure that cold start circuits are returned to their original configuration to ensure proper injection pump timing and conformance to emission control standards.

Use JT07158 (FKM10429A) TIME TRAC® Kit to check injection pump timing when performing operational checks on the cold start advance system. (See CHECK AND ADJUST ROTARY INJECTION PUMP TIMING earlier in this group.)



A—Connector
B—Cold Start Advance Solenoid

STANADYNE COLD START ADVANCE

NOTE: Checks must be performed on a cold engine.

1. Install JT07158 (FKM10429A) TIME TRAC® Kit .

2. Insure that cold start switch is working by verifying a voltage potential (12 or 24 volts, depending on application) to the cold start solenoid.

3. Disconnect wiring connector (A) from the cold start advance solenoid (B).

4. Start cold engine and run at 1200 rpm. Check and record injection pump timing.

5. Connect wiring connector (A) to cold start advance solenoid. After approximately 30 seconds, check injection pump timing.

   There should be a 7—10° increase in timing, indicating proper operation of the cold start advance system.

   If no increase in timing was noted, have the injection pump serviced/repaired by an authorized ADS Diesel Repair Station.

TIME TRAC is a registered trademark of Stanadyne Automotive Corp.

Continued on next page

DPSG,OUO1004,123 –19–13MAY98–1/2

115
49

LUCAS COLD START ADVANCE

NOTE: Checks must be performed on a cold engine.

The cold start advance solenoid is located on the bottom, outboard side of the injection pump. There is a single terminal input lead to the wax motor.

1. Install JT07158 (FKM10429A) TIME TRAC® Kit .

2. Disconnect wiring connector from the cold start switch to wax motor harness. Verify that there is a voltage potential (12 or 24 volts, depending on application) at the wax motor connector.

3. Start cold engine and run at 1200 rpm. Check and record injection pump timing.

4. Connect a jumper wire across the wax motor connector terminals. After approximately 30 seconds, check injection pump timing.

   There should be a 7—10° decrease in timing indicating proper operation of the cold start advance system.

   If no decrease in timing was noted, have the injection pump serviced/repaired by an authorized ADS Diesel Repair Station.

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DPSG,OUO1004,123 –19–13MAY98–2/2

115
50

LIGHT LOAD ADVANCE OPERATION (ROTARY PUMPS)

Light load advance is used on engines with rotary injection pumps to maintain injection pump timing and engine speed as load decreases. Under full and/or consistent loads, transfer pressure in the injection pump is stable, acting on the advance piston to maintain pump timing and rated engine speed.

As the load begins to decrease, a corresponding decrease in transfer pressure occurs which tends to retard timing and drop engine rpm under the remaining load. To compensate, the governor begins to close a metering valve in the light load advance circuit. As flow through the metering valve drops, transfer pressure begins to rise again and acts on the advance piston to advance pump timing and maintain engine rpm.

DPSG,OUO1004,135 –19–01JUN98–1/1

LIGHT LOAD ADVANCE OPERATIONAL CHECKOUT (ROTARY PUMPS)

To check operation of the light load advance, perform the following:

1. Install JT07158 (FKM10429A) TIME TRAC® Kit.

2. Operate engine at full load and rated speed. Note injection pump timing on TIME TRAC®.

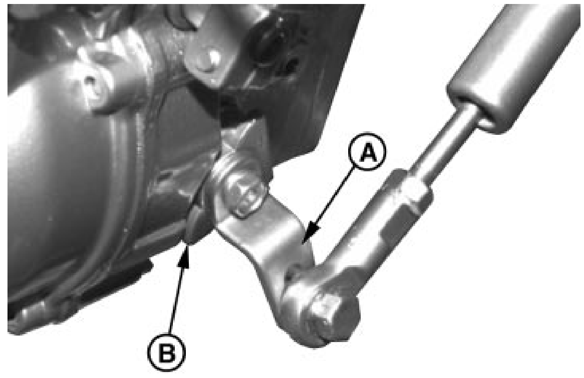
3. Gradually decrease load to the engine. Timing should continue to retard as the load is removed, but should start to advance again as the light load advance begins to operate at about 50 percent load.

4. If timing does not advance, the light load advance is not operating properly. Have the injection pump serviced/repaired by an authorized ADS Diesel Repair Station.

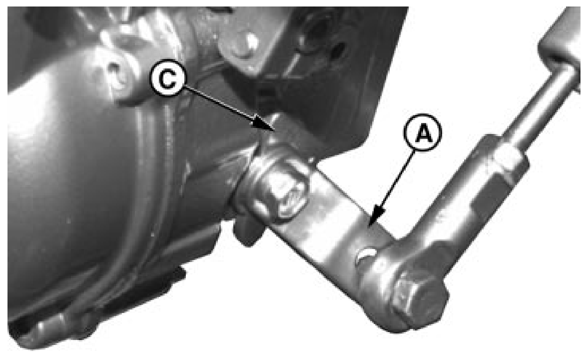
TIME TRAC is a registered trademark of Stanadyne Automotive Corp.

DPSG,OUO1004,136 –19–01JUN98–1/1

FUEL SHUT-OFF SOLENOID OPERATIONAL CHECK (IN-LINE INJECTION PUMPS)



RG8067A –UN–15JAN98



RG8068A –UN–18NOV97

A—Shut-Off Lever
B—NO FUEL Position
C—RUN Position

1. Observe fuel shut-off lever (A) when key switch is turned from “OFF” to “START” (engine running at slow idle) and then released to “ON” position.

2. Fuel shut-off lever should move from “NO FUEL” position (B) to “RUN” position (C) when starting motor begins to crank. The lever should remain at the “RUN” position after key switch is released to “ON” position.

   If fuel shut-off lever returns to “NO FUEL” position with key switch at “ON” position, check for:

   - Loss of battery voltage to fuel shut-off winding. Check voltage and wiring connection to solenoid.
   - Binding of fuel shut-off lever, solenoid rod or linkage does not allow solenoid to lock in position. Repair or replace linkage.
   - Torn or leaking rubber boot allowing dirt or moisture to enter at spring end of solenoid rod.
   - Improperly adjusted fuel shut-off solenoid linkage. See FUEL SHUT-OFF SOLENOID LINKAGE ADJUSTMENT, later in this group.

3. Start engine and run at slow idle. Turn key switch to “OFF” position.

4. Fuel shut-off lever should move to “NO FUEL” position and engine should stop.

If the solenoid stops just short of the “NO FUEL” position, slight adjustment of the linkage is required. See FUEL SHUT-OFF SOLENOID LINKAGE ADJUSTMENT, later in this group.

If engine continues to run with key switch at “OFF” position, unplug shut-off solenoid 3-way connector.

- If solenoid moves lever to “NO FUEL” position, problem is in the electrical circuit.
- If solenoid does not shut off fuel to engine, check linkage for binding or excessive tightness. Replacement service kit is available with a swivel rod which is less sensitive to misalignment and binding.

RG,115,JW7699 –19–24NOV97–1/1

115
52

FUEL SHUT-OFF SOLENOID RESISTANCE TEST (NIPPONDENSO PUMP)

Disconnect shut-off solenoid 3-way WEATHER PACK™ connector.

1. Measure "PULL" coil resistance between black lead wire "C" and white lead wire "B".

2. Measure "HOLD" coil resistance between black lead wire "C" and red lead wire "A".

   Replace solenoid if resistance is not within specification given below.

PULL AND HOLD COIL RESISTANCE SPECIFICATIONS

Solenoid Part Number	Pull Coil Resistance (Ohms)	Hold Coil Resistance (Ohms)
12-Volt System:		
RE67325	0.134—0.200	6.63—8.11
24-Volt System:		
RE67256	0.560—0.684	24.35—29.76

WEATHER PACK is a trademark of Packard Electric.

RG,115,JW7698 –19–24NOV97–1/1

FUEL SHUT-OFF SOLENOID RESISTANCE TEST (LUCAS PUMP)

1. Disconnect wire to solenoid.

2. Remove solenoid noting if plunger is binding in bore.

3. Check coil resistance with ohmmeter. Resistance should be 9 ohms.

4. Check plunger retraction using a 12 volt source.

   Connect positive cable to connector terminal and negative cable to solenoid body. From the relaxed position, plunger should retract into the solenoid body when voltage is applied.

   If resistance specification is not met and/or plunger does not retract, replace solenoid.

DPSG,OUO1004,124 –19–13MAY98–1/1

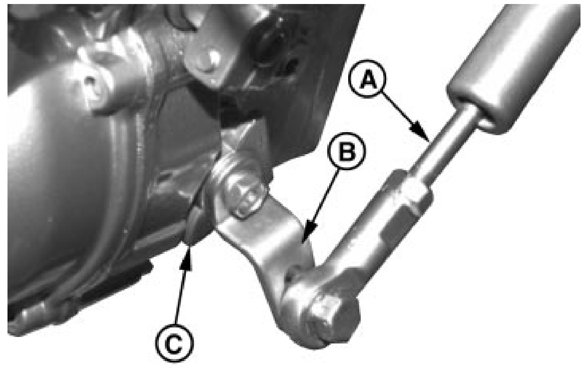
FUEL SHUT-OFF SOLENOID LINKAGE ADJUSTMENT (IN-LINE INJECTION PUMPS)

Shut-off solenoid linkage is factory adjusted and usually will not require additional field adjustment. ALWAYS check linkage and lever for alignment and binding before making adjustments.

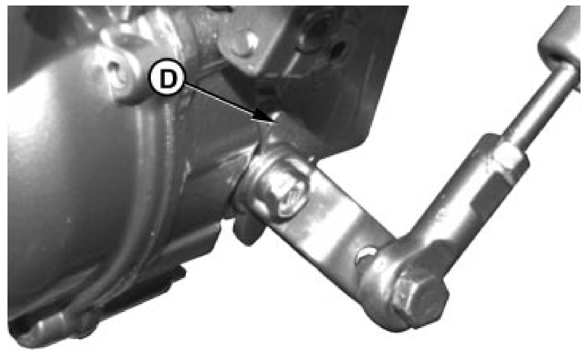
1. Thoroughly lubricate all linkage and lever pivot points.

2. If necessary, adjust linkage (A) so that lever (B) contacts stop (C) with key switch “OFF” and engine not running.

3. Start engine and run at slow idle. Lever should contact stop (D) or nearly contact when the lever is being pushed up.



RG8067B –UN–15JAN98



RG8068B –UN–18NOV97

A—Link
B—Lever
C—Stop
D—Stop

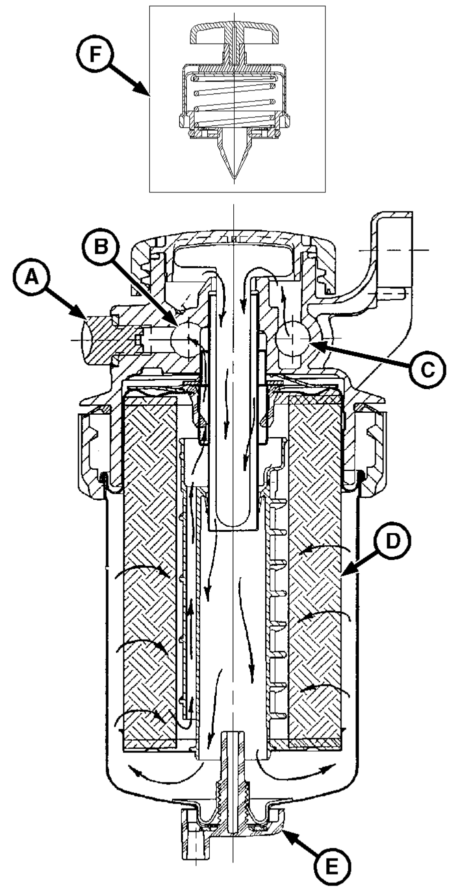
RG,115,JW7697 –19–24NOV97–1/1

FINAL FUEL FILTER/WATER SEPARATOR OPERATION

Fuel enters the filter at inlet (C), then flows through filter element (D) and exits through outlet (B) to the fuel injection pump. The filter element is housed in a sediment bowl attached to the base with a threaded retaining ring.

Since water and contaminants settle at the bottom of the sediment bowl, a drain plug (E) is provided.

Air in the system can be expelled through the air vent when bleed screw (A) is loosened. Optional priming pump (F) draws fuel from the fuel tank to fill the filter bowl when the filter element is changed. The priming pump also supplies fuel from the filter to the injection pump.



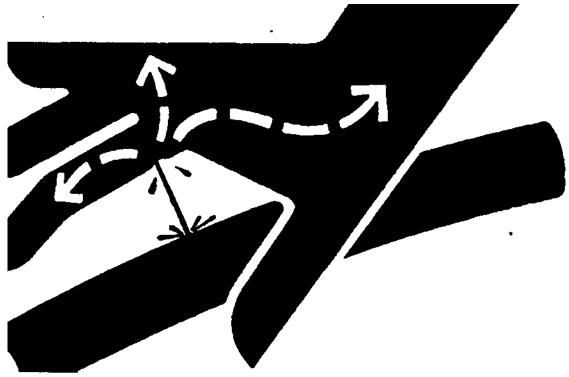
RG9090 –UN–27MAR98

A—Bleed Screw
B—Fuel Outlet
C—Fuel Inlet
D—Filter Element
E—Drain Plug
F—Primer Assembly

RG,115,JW7696 –19–24NOV97–1/1

115
56

BLEED THE FUEL SYSTEM


X9811 –UN–23AUG88

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid hazards by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

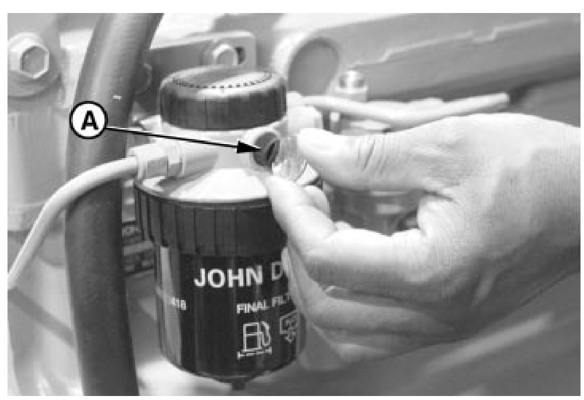
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

Any time the fuel system has been opened up for service (lines disconnected or filters removed), it will be necessary to bleed air from the system.

The fuel system may be bled at one of several locations. On some engine applications it may be necessary to consult your operator's manual and choose the location best for your engine/machine application.

RG,115,JW7695 –19–24NOV97–1/6

AT FINAL FUEL FILTER:



RG7947 –UN–13NOV97

A—Bleed Vent Screw

1. Open air bleed vent screw (A) two full turns by hand.
2. Pump the hand primer (if equipped) on filter mounting base until a noticeable amount of fuel and air comes out of vent opening. Continue pumping and close vent screw when fuel starts to flow.
3. Pump the hand primer several times until resistance is felt. Continue pumping and open air bleed vent screw again.
4. Close air bleed vent screw and pump the hand primer several times until resistance is felt again.

Continued on next page RG,115,JW7695 –19–24NOV97–2/6

115
57

AT FUEL INJECTION PUMP:

On Stanadyne rotary pumps:

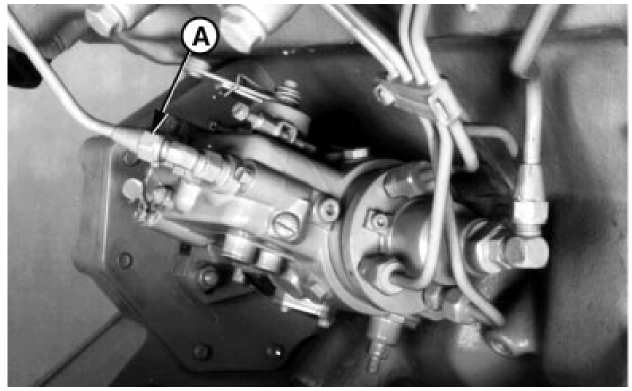
1. Loosen fuel return line (A) at fuel injection pump.

2. Operate fuel supply pump primer lever.

3. As soon as fuel flow is free from air bubbles, tighten fuel return line to specifications.

Fuel Injection Pump Return Line—Specification

Torque .... 27 N•m (20 lb-ft)



A—Fuel Return Line

RG,115,JW7695 –19–24NOV97–3/6

On Lucas rotary pumps:

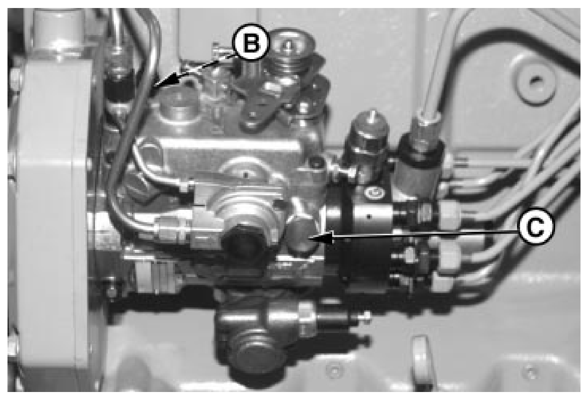
CAUTION: NEVER loosen screw (C) securing pump head, otherwise pump damage may occur.

1. Loosen bleed screw (B) on pump cover.

NOTE: On Models DP200/201 Injection Pumps, bleed screw is located on top of cover near the fuel return line.

2. Operate supply pump primer lever or turn ignition switch to “ON”.

3. Wait until fuel flow is free from air bubbles. Retighten bleed screw.



B—Bleed Screw
C—Pump Head Screw

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RG,115,JW7695 –19–24NOV97–4/6

On Nippondenso in-line pumps:

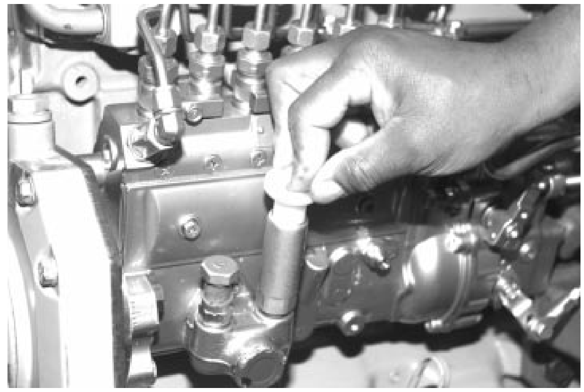
1. Unscrew hand primer on fuel supply pump until it can be pulled by hand.

2. Operate the hand primer until a smooth flow of fuel, free of bubbles, comes out of the filter plug hole.

IMPORTANT: Be sure hand primer is all the way down in barrel before tightening to prevent internal thread damage.

3. Simultaneously stroke the hand primer down and close the filter port plug. This prevents air from entering the system. Tighten plug securely. DO NOT overtighten.

4. Lock hand primer in position.



RG8069 –UN–23NOV97

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AT FUEL INJECTION NOZZLES:


RG7725 –UN–08JAN97

1. Place throttle lever in half-throttle position.

   On engines equipped with electronic fuel shut-off solenoid, energize solenoid.

IMPORTANT: Always use a backup wrench when loosening or tightening fuel lines at nozzles and/or injection pump to avoid damage.

2. Using two open-end wrenches, loosen fuel line connection at injection nozzle.

3. Crank engine over with starting motor, (but do not start engine), until fuel free from bubbles flows out of loosened connection. Retighten connection to specifications.

Fuel Injection Nozzle Delivery Lines—Specification

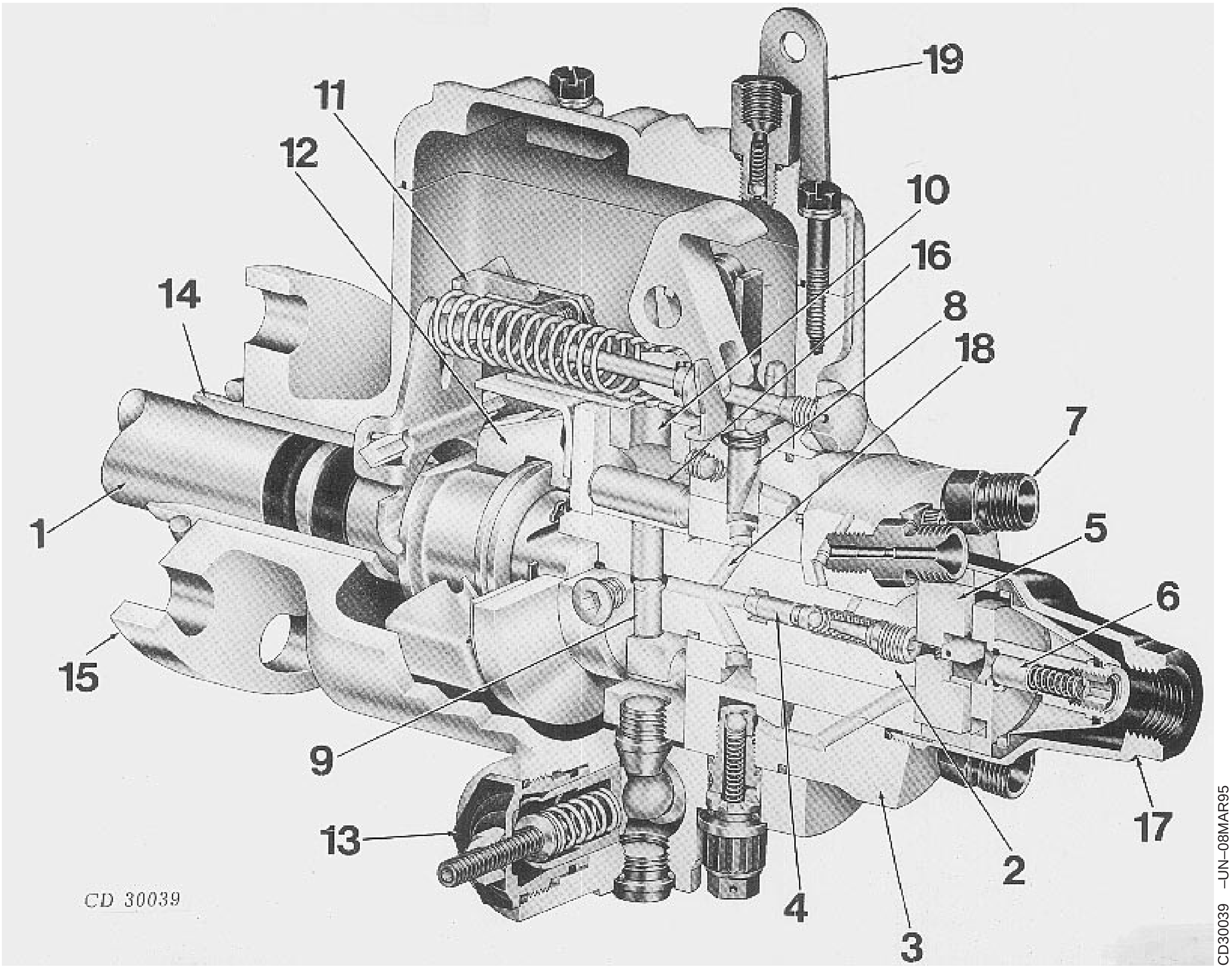
Torque .... 27 N•m (20 lb-ft)

4. Repeat procedure for remaining injection nozzles (if necessary) until all air has been removed from fuel system.

RG,115,JW7695 –19–24NOV97–6/6

115
60

STANADYNE ROTARY FUEL INJECTION PUMP OPERATION



DB2 Pump shown, DB4 Pump similar

1—Drive Shaft
2—Distributor Rotor
3—Hydraulic Head
4—Delivery Valve
5—Supply Pump
6—Pressure Regulator
7—Discharge Fitting
8—Metering Valve
9—Pumping Plungers
10—Internal Cam Ring
11—Governor
12—Governor Weights
13—Automatic Advance
14—Drive Shaft Bushing
15—Housing
16—Rollers
17—Supply Pump Inlet
18—Charging Ports
19—Throttle Lever

The main rotating components are the drive shaft (1), distributor rotor (2), supply pump (5) and governor (11).

The drive shaft engages the distributor rotor in hydraulic head (3). The drive end of rotor incorporates two pumping plungers (9).

The plungers are actuated toward each other simultaneously by an internal cam ring (10) through rollers (16) and shoes which are carried in slots at drive end of the rotor. The number of cam lobes normally equal the number of engine cylinders.

Continued on next page RG,115,JW7694 –19–24NOV97–1/2

The supply pump at rear of rotor is a positive displacement vane-type pump enclosed in the end cap. The end cap also houses supply pump inlet (17), fuel strainer and pressure regulator (6). Supply pump pressure is automatically compensated for viscosity effects due to temperature changes and fuel grade variations.

The distributor rotor incorporates two charging ports (18) and a single axial bore (passage) with one discharge port to serve all head outlets (7) to the injection lines. The rotor rotates in bore of hydraulic head. Metering valve (8) bore, charging ports and discharge fittings are located in the head.

This pump contains its own mechanical governor. The centrifugal force of the weights (12) in their retainer is transmitted through a sleeve to a governor arm and through a positive linkage to the metering valve. The metering valve can be closed to shut off fuel through a solid linkage by an independently operated shut-off lever.

The automatic speed advance (13), advances or retards (hydraulically) the beginning of fuel delivery from the pump. The advance responds to changes in speed only, or to a combination of speed and load changes.

Fuel is drawn from the supply tank through filters into the pump inlet through the inlet filter screen by the vane type fuel transfer pump. Some fuel is bypassed through the pressure regulator assembly to the suction side.

Fuel under transfer pump pressure flows through the center of the transfer pump rotor, past the rotor retainer into a circular groove on the rotor. It then flows through a connecting passage in the head to the automatic advance and up through a radial passage and then through a connecting passage to the metering valve. The radial position of the metering valve, controlled by the governor, regulates flow of the fuel into the radial charging passages which incorporates the head charging ports.

As the rotor revolves, the two rotor inlet passages register with the charging ports in the hydraulic head, allowing fuel to flow into the pumping chamber. With further rotation, the inlet passages move out of registry and the discharge port of the rotor registers with one of the head outlets. While the discharge port is opened, the rollers contact the cam lobes forcing the plungers together. Fuel trapped between the plungers is then pressurized and delivered by the nozzle to the combustion chamber.

Self-lubrication is an inherent feature of the pump’s design. As fuel at transfer pump pressure reaches the charging ports, slots on the rotor shank allow fuel and any entrapped air to flow into the pump housing cavity.

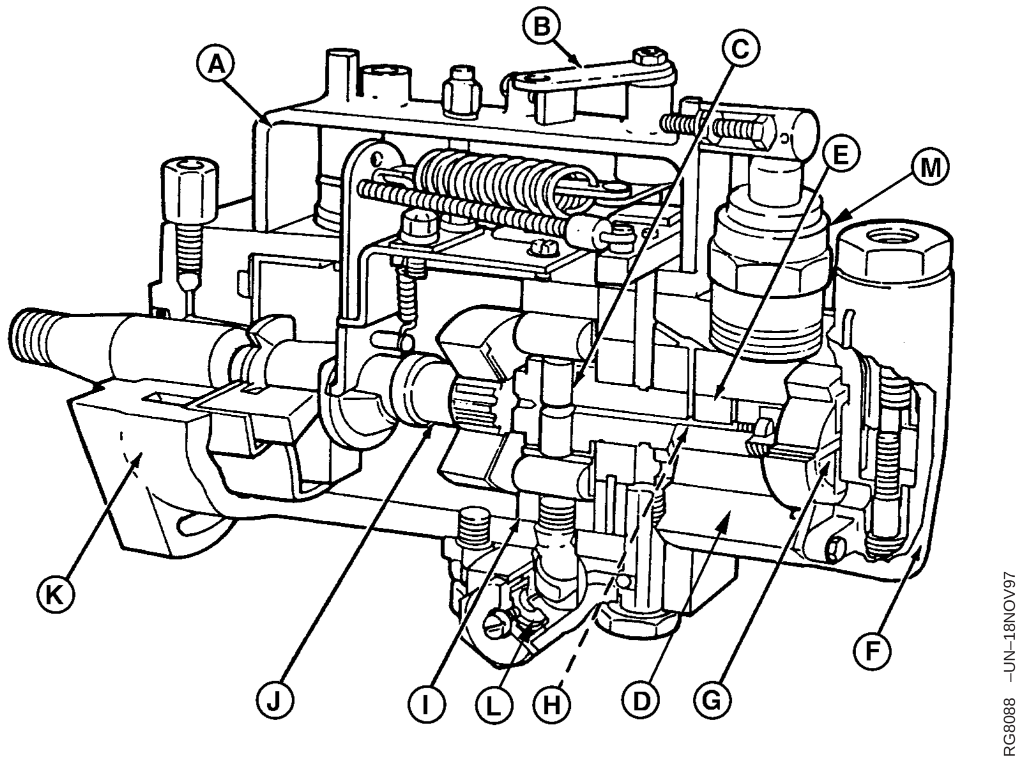
Additionally, an air vent passage in the hydraulic head connects the outlet side of the transfer pump with the pump housing. This allows air and some fuel to be bled back to the fuel tank via the return line. The fuel thus bypassed fills the housing, lubricates the internal components, cools and carries off any small air bubbles. The pump operates with the housing completely full of fuel; there are no dead air spaces anywhere within the pump.

A cold start switch is optional and aids in cold start-up operation.

RG,115,JW7694 –19–24NOV97–2/2

115
62

LUCAS ROTARY FUEL INJECTION PUMP OPERATION



A—Governor Housing
B—Throttle Lever
C—Pumping Plungers
D—Hydraulic Head
E—Distributor Rotor
F—End Plate
G—Supply Pump
H—Delivery Valve
I—Internal Cam Ring
J—Drive Shaft
K—Pump Housing
L—Automatic Advance
M—Electric Shutoff

The Lucas fuel injection pump is a horizontally mounted distributor pump with mechanical governor and automatic hydraulic speed advance. The moving parts of the pump are simultaneously lubricated and cooled by diesel fuel flowing through the pump, no additional lubricant is required.

Diesel fuel for injection is fed to the cylinders by a single unit. The pumping plungers (C) and distributor rotor (E) is fitted with two opposed plungers controlled by an internal cam ring (I).

On the other end of the rotor, there is a supply pump (G) which delivers the fuel, drawn from the fuel filter, through the metering valve into the inlet bore in the pump hydraulic head (D), at a pressure that varies with engine speed.

As the rotor rotates, the inlet bore in pump head aligns with inlet bore in the rotor. Fuel coming from the transfer pump reaches the pump plunger chamber's through bore, regulated by the metering valve and forces the two plungers apart.

During further rotation of the distributor rotor, inlet bore in the pump head is closed and distributor channel in the rotor eventually aligns with one of the outlet bores in the pump head. Meanwhile the two pump plungers have reached the cam so that they move toward each other. The trapped, metered fuel is forced, (under high pressure) through a channel in the rotor and outlet opening in the pump head. Then, through pressurizing valve and pressure line, to the injection nozzle and into the appropriate cylinder.

Continued on next page RG,115,JW7693 –19–24NOV97–1/2

A pressurizing valve is located at each outlet in the pump head where the pressure line leading to the fuel injection nozzle is connected. After injection, the pressure valve closes again, and with its small relief piston, draws in a quantity of fuel from the pressure line.

A pressurizing valve is located at each outlet in the pump head where the pressure line leading to the fuel injection nozzle is connected. After injection, the pressure valve closes again, and with its small relief piston, draws in a quantity of fuel from the pressure line.

The resulting relief in the pressure line causes a quick and firm closing of the nozzle valve. This prevents fuel from leaking into the combustion chamber.

The quantity of fuel which is needed at any given moment for each cylinder and combustion cycle is regulated by a metering valve. The metering valve is controlled by the speed control rod and throttle lever (B), and by the governor inside the governor housing (A). In the “NO-FUEL” (“OFF”) position, the metering valve completely cuts the supply of fuel from supply pump to the rotor.

At slow idle speed or under full load, the supply pump feeds more fuel to the metering valve than is needed for injection. The excessive fuel flows through the pressure regulating valve back to the suction side of the transfer pump. A very small amount of this surplus fuel escapes through the top of the governor housing.

To obtain the best possible performance over the entire speed range, the fuel injection pump is fitted with an automatic, hydraulically operated speed advance (L). This speed advance is preset at the factory. The speed advance adjusts timing of the fuel injection pump in relation to engine speed and load.

The light load advance is standard on Model DP203 pumps and optional on DP201 pumps.

A cold advance switch is optional on these pumps. The switch consists of a housing to which is fitted a spring-loaded piston assembly, a “wax motor”, and a spring-loaded ball valve. It is fitted at top of the spring end of the auto advance housing.

IMPORTANT: Remember that all adjustments to the injection pump, except for slow idle, MUST BE carried out on a test bench by a specialist injection pump repair station only. Internal adjustments in the field are not permitted, as this pump is a sealed unit.

RG,115,JW7693 –19–24NOV97–2/2

115
64

DIAGNOSE ROTARY FUEL INJECTION PUMP MALFUNCTIONS

Symptom	Problem	Solution
Engine Starts Hard or Won’t Start	Shut-off solenoid not functioning properly; or wiring lead loose or broken.	Repair.
	Injection pump not correctly timed.	Check pump timing (refer to this group).
	Defective injection pump.	Remove pump from engine and repair.
	Automatic advance faulty or not operating.	Adjust or repair.
Slow Idle Speed Irregular	Nozzle faulty or sticking.	Repair (See Group 35.)
	Automatic advance faulty or not operating.	Inspect and adjust or repair.
	Injection pump not properly timed.	Check pump timing (refer to this group).
	Defective injection pump.	Remove pump and repair.
Engine Horsepower Low	Pump not properly timed.	Check timing (refer to this group).
	Insufficient throttle arm travel.	Inspect and adjust.
	Automatic advance faulty or not operating.	Adjust or repair.
	Nozzle faulty or sticking.	Repair. (See Group 35.)
	Defective injection pump.	Remove pump and repair.

RG,115,JW7692 –19–24NOV97–1/1

CHECK AND ADJUST ENGINE SPEEDS ON LUCAS PUMP

NOTE: Before checking and adjusting engine speed, make sure engine has reached its normal operating temperature.

CHECK SLOW AND FAST IDLE SPEEDS:

1. Start engine and run at 50% load and rated speed until engine reaches normal operating temperature.
2. Stop engine and disconnect speed control rod from fuel injection pump throttle lever (C).

NOTE: Refer to FUEL INJECTION PUMP SPECIFICATIONS, earlier in this group, for slow and fast idle speeds.

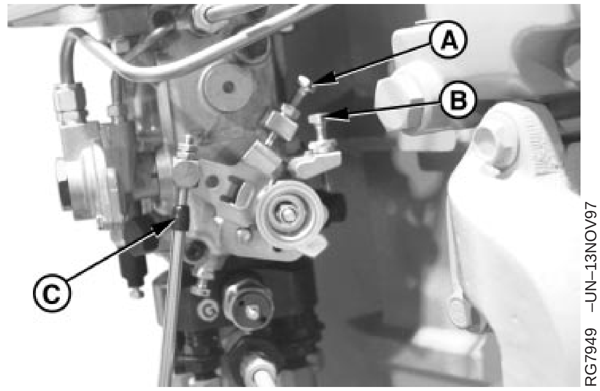
3. Start engine and move injection pump lever to slow idle position against slow idle adjusting screw (A). Using a tachometer, read and record engine speed. Compare reading with specifications. Adjust slow idle as necessary as detailed below.
4. Move injection pump lever to fast idle position against fast idle adjusting screw (B). Using a tachometer, read and record engine speed. Compare reading with specifications.

IMPORTANT: If fast idle is not within specification, have an authorized diesel repair station, servicing dealer, or engine distributor adjust as necessary.

ADJUST SLOW IDLE SPEED:

Move pump throttle lever to slow idle position against slow idle adjusting screw (A). See specifications for specified engine speeds.

Loosen slow idle screw lock nut. Turn adjusting screw clockwise to increase speed and counterclockwise to decrease engine speed.



A—Slow Idle Adjusting Screw
B—Fast Idle Adjusting Screw
C—Throttle Lever

RG,115,JW7691 –19–24NOV97–1/1

115
66

ADJUST VARIABLE SPEED ON GENERATOR SET ENGINES (LUCAS PUMPS ONLY)

See your authorized Lucas Repair Station for speed droop adjustment. This service requires that an internal pump adjustment be made.

RG,115,JW7718 –19–25NOV97–1/1

CHECK AND ADJUST ENGINE SPEEDS ON STANADYNE PUMP

NOTE: Before checking and adjusting engine speed, make sure engine has reached its normal operating temperature.

CHECK SLOW AND FAST IDLE SPEEDS:

1. Start engine and run at 50% load and rated speed until engine reaches normal operating temperature.

2. Stop engine and remove control rod pin (B, if used). Disconnect speed control rod (or control cable) from fuel injection pump throttle lever.

NOTE: Refer to FUEL INJECTION PUMP SPECIFICATIONS, earlier in this group, for slow and fast idle speeds.

3. Start engine and move injection pump lever to slow idle position against slow idle adjusting screw (A or D). Using a tachometer, read and record engine speed. Compare reading with specifications. Adjust as necessary as detailed below.

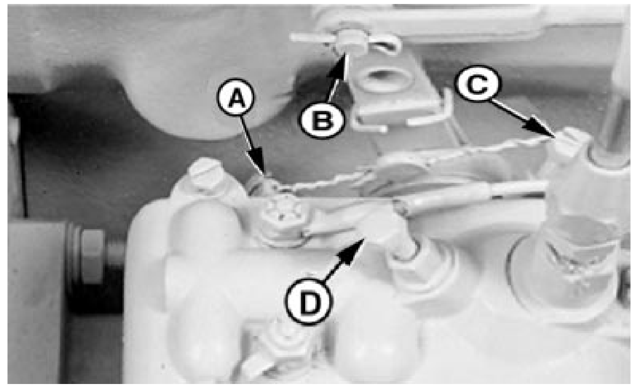
4. Move injection pump lever to fast idle position against fast idle adjusting screw (C). Using a tachometer, read and record engine speed. Compare reading with specifications.

IMPORTANT: If fast idle is not within specification, have an authorized diesel repair station, servicing dealer, or engine distributor adjust as necessary.

ADJUST SLOW IDLE SPEED:

1. Move pump throttle lever in slow idle position against slow idle adjusting screw (A or D). See specifications for specified engine speeds.

2. Loosen slow idle screw lock. Turn adjusting screw clockwise to increase speed and counterclockwise to decrease engine speed.



RGT6005AA –UN–19NOV97

A—Slow Idle Adjusting Screw[1]
B—Control Rod Pin
C—Fast Idle Adjusting Screw
D—Slow Idle Adjusting Screw[1]

[1]Slow idle adjusting screw location varies by injection pump application. Will either be at location A or D.

RG,115,JW7690 –19–24NOV97–1/1

115
68

ADJUST VARIABLE SPEED (DROOP) ON GENERATOR SET ENGINES (3—5% GOVERNOR REGULATION)—STANADYNE DB2 AND DB4 INJECTION PUMPS

An external speed droop adjusting cap (A) at the rear of the injection pump housing provides precise control of governor sensitivity by decreasing or increasing the effective length (and thereby the rate) of the governor control spring. Fine adjustments can be made while the engine is operating.

1. Start engine and run at rated speed with 50% load applied until it reaches normal operating temperature.

NOTE: If serious surging occurs during the warm-up period, turn the speed droop adjusting cap clockwise until surging stops.

2. When engine has warmed to normal operating temperature, position throttle lever (D or E) to attain full load rated speed (e.g., 1500, 1800 RPM) and apply 100% (full) load.

   Adjust the throttle if necessary to obtain satisfactory full load performance.

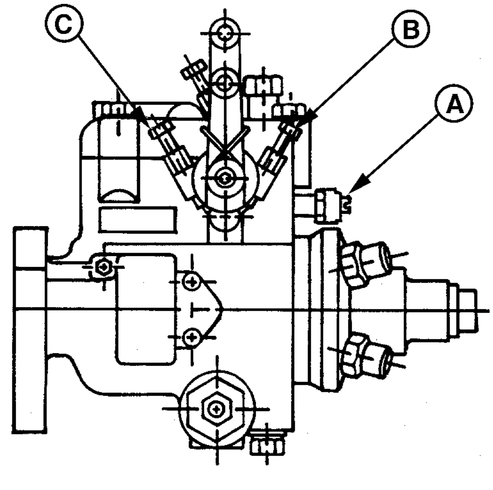
NOTE: Whenever speed droop adjustments are made, throttle position adjustments will also be necessary.

3. Remove load and check for specified no-load speed or frequency.

   If incorrect, adjust speed droop adjusting cap slightly (clockwise for increased droop or counterclockwise for less droop).

   If surging exists upon removing the load, turn the adjusting cap clockwise to eliminate.

4. Recheck full load and no-load performance and readjust as necessary.



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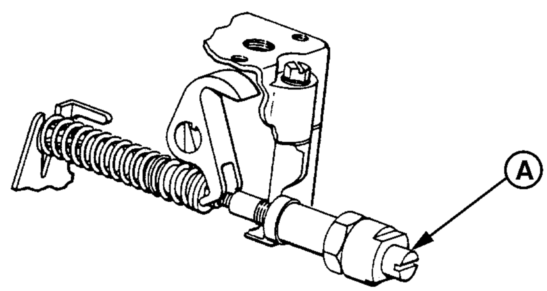

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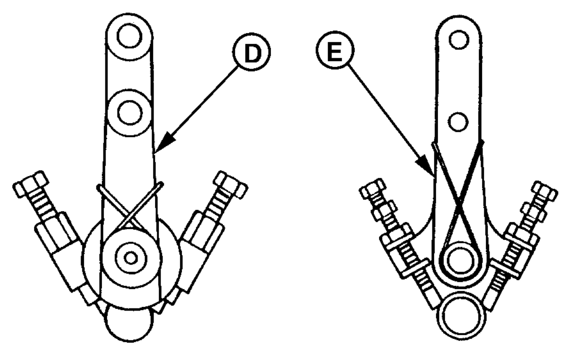


RG6397 –UN–03NOV97

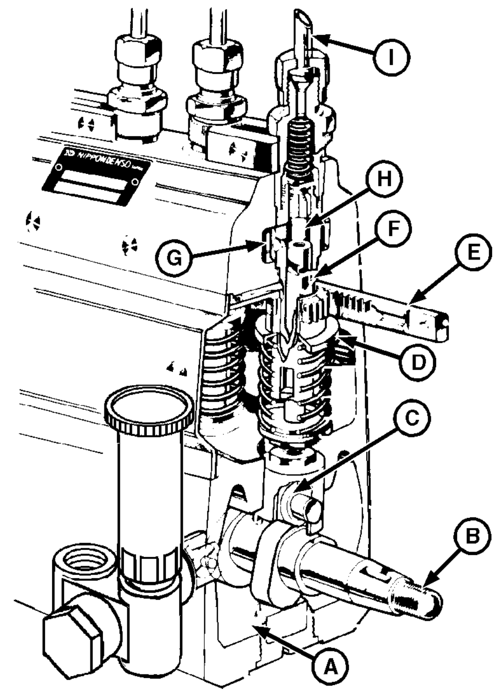
A—Speed Droop Adjusting Cap
B—Fast Idle Screw
C—Slow Idle Screw
D—Early Throttle Lever
E—Current Throttle

IN-LINE FUEL INJECTION PUMP OPERATION

Filtered fuel under pressure by the supply pump fills the injection pump fuel gallery (G). As the camshaft rotates, roller tappets (C) riding on the camshaft (B) lobes operate the plungers (F) to supply high pressure fuel through the delivery valves (H) to the injection nozzles.

A governor-operated control rack (E) is connected to the control sleeves (D) 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.



RG9100 –UN–27MAR98

A—Crankcase
B—Camshaft
C—Roller Tappet
D—Control Sleeve
E—Control Rack
F—Plunger
G—Fuel Gallery
H—Delivery Valve
I—Delivery Pipe

RG,115,JW7688 –19–24NOV97–1/1

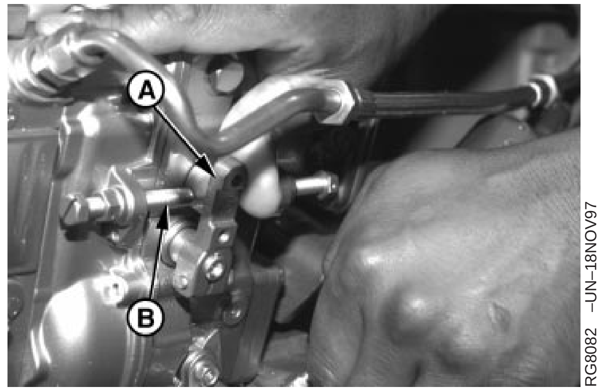
115
70

DIAGNOSE IN-LINE FUEL INJECTION PUMP MALFUNCTIONS

Symptom	Problem	Solution
Engine Starts Hard or Won’t Start	Incorrect fuel shut-off lever position (pump control rack not moving all the way forward).	Adjust shut-off cable as required.
	Defective injection pump.	Remove pump from engine and repair. (See Group 35.)
	Injection pump not correctly timed.	Check pump timing.
Slow Idle Speed Irregular	Slow idle stop screw improperly adjusted.	Recheck stop screw adjustment.
	Supplementary idling spring improperly adjusted.	Recheck adjustment.
	Defective injection pump.	Remove pump from engine and repair. (See Group 35.)
Engine Horsepower Low	Pump not properly timed.	Check timing.
	Defective injection pump.	Remove pump from engine and repair. (See Group 35.)

RG,115,JW7687 –19–24NOV97–1/1

CHECK FAST IDLE SPEED—IN-LINE FUEL INJECTION PUMP



A—Governor Control Lever
B—Fast Idle Stop Screw

1. Remove 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 fast idle speed to see if it is within specification.

IMPORTANT: If fast idle speed must be adjusted, see your authorized diesel repair station.

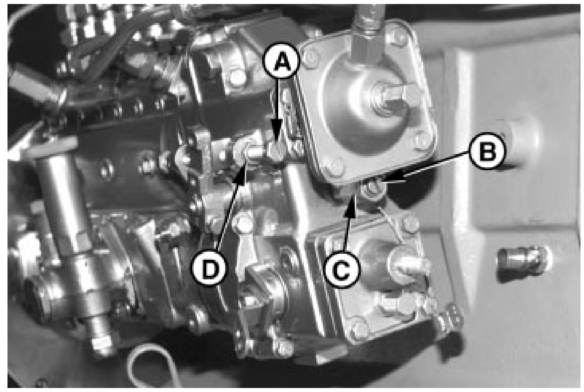
NOTE: For each application, refer to the appropriate machine technical manual for fast idle speed specifications.

NOTE: For some applications such as generator sets, special equipment may be required for fast idle adjustment in conjunction with droop adjustment. See your OEM dealer or John Deere Engine Distributor.

RG,115,JW7686 –19–24NOV97–1/1

115
72

CHECK AND ADJUST SLOW IDLE SPEED—IN-LINE FUEL INJECTION PUMP



A—Slow Idle Stop Screw
B—(Bumper) Spring Screw
C—Lock Nut
D—Lock Nut

CAUTION: ALWAYS STOP ENGINE before making adjustments.

IMPORTANT: Minor adjustment of the slow idle speed may be made with the (bumper) spring screw. However, it should not be used by itself to change engine speed more than 50 rpm, as overspeeding of the engine may result.

If slow idle stop screw and bumper spring screw are not adjusted according to instruction, engine damage could result because of overspeeding.

NOTE: Both the slow idle stop screw (A) and the (bumper) spring screw (B) may be used to adjust the slow idle speed.

1. With the engine running, pull the governor control lever rearward to the slow idle speed position. Check and adjust slow idle speed to specification.

NOTE: For each application, refer to the appropriate machine technical manual for slow idle speed specifications.

2. Remove slow idle stop screw cover.

3. Loosen lock nut (C) and back out the (bumper) spring adjusting screw (B) three turns.

4. Loosen lock nut (D) and adjust slow idle stop screw (A) to obtain an idle speed 30—50 rpm less than the desired slow idle speed setting.

5. Turn the (bumper) spring adjusting screw in to increase engine speed a maximum of 30—50 rpm to desired slow idle speed.

Continued on next page

RG,115,JW7685 –19–24NOV97–1/3

For example, to obtain an 850 rpm slow idle speed, use the slow idle stop screw to set speed at approximately 800 rpm. Then increase speed to 850 rpm using the (bumper) spring adjusting screw.

NOTE: Increasing the slow idle speed a slight amount above the specified speed range may help to reduce engine surge (or hunting). If this occurs, use the procedure given above; but do not exceed 850 rpm.

RG,115,JW7685 –19–24NOV97–2/3

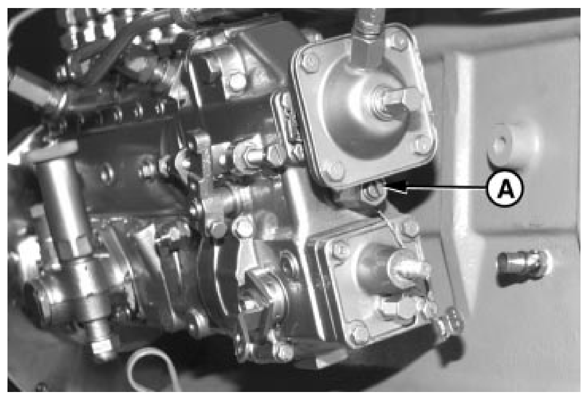
6. If engine surging or hunting persists at slow idle, the bumper spring and adjustment screw (A) may need to be replaced with a new one.

IMPORTANT: Remove the pump from the engine and have it repaired by an authorized diesel repair station (ADS shop). See Group 35 for fuel injection pump removal and installation.

7. Again check the fast and slow idle speeds. Readjust slow idle speed if not correct.

8. Check all adjusting screw lock nuts for tightness. Install covers (and copper washers) on slow idle stop screw and idling spring adjusting screw.

9. Connect fuel shut-off cable and speed control rod.



RG8080A –UN–18NOV97

A—Adjustment Screw

RG,115,JW7685 –19–24NOV97–3/3

115
74

CHANGE ENGINE RATED SPEED AND ADJUST DROOP—IN-LINE INJECTION PUMPS

1. Start engine and apply 50% load at rated speed until it reaches operating temperature. Remove cap nuts from adjusting screws before making adjustments.

2. When the engine has reached normal operating temperature, adjust fast idle (stop) screw (A) clockwise (CW) to 1500 rpm (50 Hz) with 100% (full) load.

3. Remove load and back out the idle (bumper) spring screw (E), while observing the corresponding drop in engine rpm's until engine quits losing speed.

4. Screw in idle (bumper) spring screw until engine speed increases 5—10 rpm.

5. Check for specified no-load (frequency). If governor regulation is within 5—7% range, proceed to Step 8.

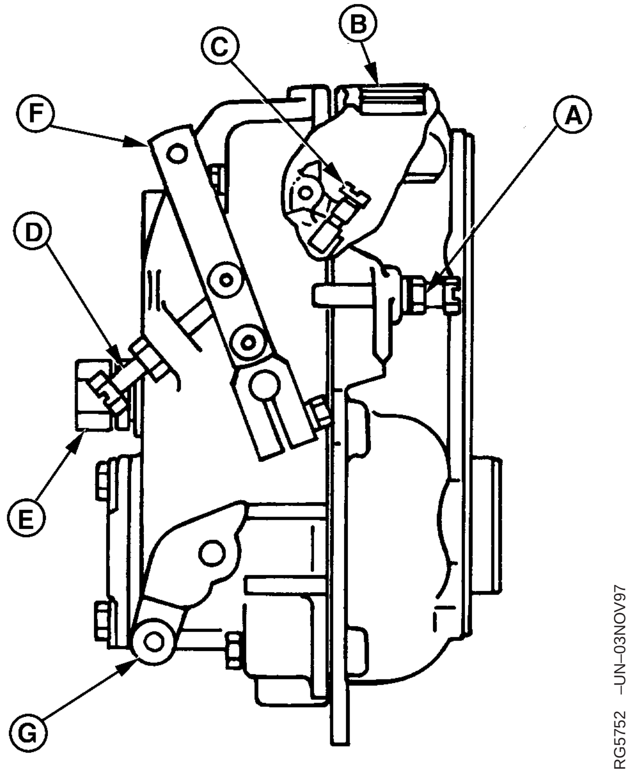
NOTE: A noticeable click will occur at each 1/4 turn of droop adjusting screw. One click CW will increase no-load speed approximately 10 rpm, counter-clockwise (CCW) will reduce speed by 10 rpm.

6. If governor regulation is above 7% or below 5%, stop engine and remove droop adjusting screw access plug (B, shown removed) from top of governor housing.

   a. Back out slow idle (adjusting) screw (D) and bumper screw. Pull back on throttle lever (F, toward rear of governor housing) by hand until the droop adjusting screw (C) inside housing can be adjusted through the access plug hole.

   b. Screw the droop screw in (CW) counting the turns until screw bottoms out. Then, return screw to original setting.

   c. Screw in the droop screw (CW) no more than 1/2 turn (two clicks) at a time to reduce governor droop. CCW no more than two clicks at a time to increase governor droop (to reduce governor sensitivity).



A—Fast Idle (Stop) Screw
B—Droop Adjusting Screw Access Plug Location
C—Droop Adjusting Screw
D—Slow Idle (Adjusting) Screw
E—Idle (Bumper) Spring Screw
F—Throttle Lever
G—Mechanical Shutoff Lever

Continued on next page RG,115,JW7684 –19–24NOV97–1/2

d. Replace access plug in top of governor housing. Start engine, apply full (100%) load, and readjust high idle adjusting screw until 1500 rpm (50 Hz) is obtained at the specified power.

e. Screw in idle (bumper) spring until engine speed increases 5—10 rpm.

7. Repeat Steps 6 (a-d) until governor regulation is within the 5—7% range.

8. Replace all cap nuts onto adjusting screws and tighten lock nuts securely.

RG,115,JW7684 –19–24NOV97–2/2

115
76

HOW THE ANEROID WORKS (IF EQUIPPED)

NOTE: In-line injection pump shown. Operation of aneroid on rotary pumps is similar in theory.

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 (E) pressure is overcome. Diaphragm then moves aneroid control shaft (F) downward.

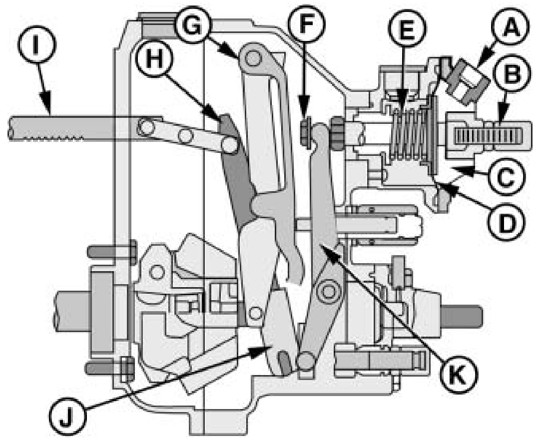
Control lever (H) has “two” legs. The inner leg connects with control block (J) and the aneroid control lever (K) and bears on the flat surface of aneroid control shaft. The outer leg bears against a block riveted to the control rack (I).

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 throttle lever (L) causes arm to rotate on fuel control shaft, permitting control rack to move its normal amount.

In 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.



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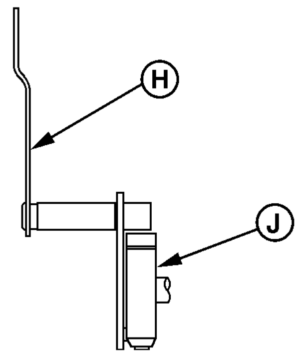

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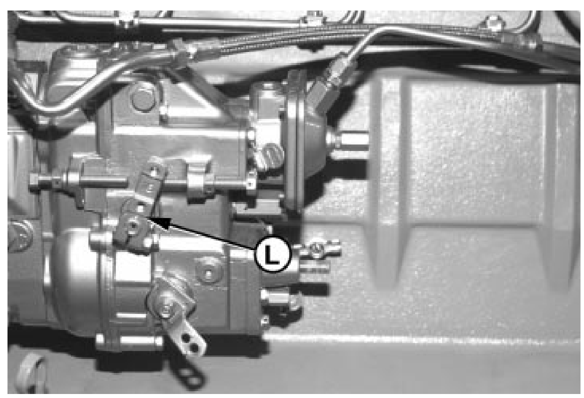

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A—Intake Manifold Pressure Line Connection
B—Diaphragm Adjusting Screw
C—Diaphragm Chamber
D—Diaphragm
E—Spring
F—Aneroid Control Shaft
G—Guide Lever
H—Control Lever
I—Control Rack
J—Control Block
K—Aneroid Control Lever
L—Throttle Lever

RG,115,JW7683 –19–24NOV97–1/1

DIAGNOSE ANEROID MALFUNCTIONS

Symptom	Problem	Solution
Slow Engine Acceleration	Loose pipe or broken connection at inlet fitting.	Repair as required. (See Group 35.)
	Aneroid cover cracked around inlet fitting.	Repair as required. (See Group 35.)
	Defective diaphragm.	Repair as required. (See Group 35)
	Aneroid not correctly adjusted.	Remove injection pump (see Group 35) and adjust on test stand.
Excessive Smoke When Accelerating Engine	Aneroid not correctly adjusted	Remove injection pump (see Group 35) and adjust on test stand.

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.

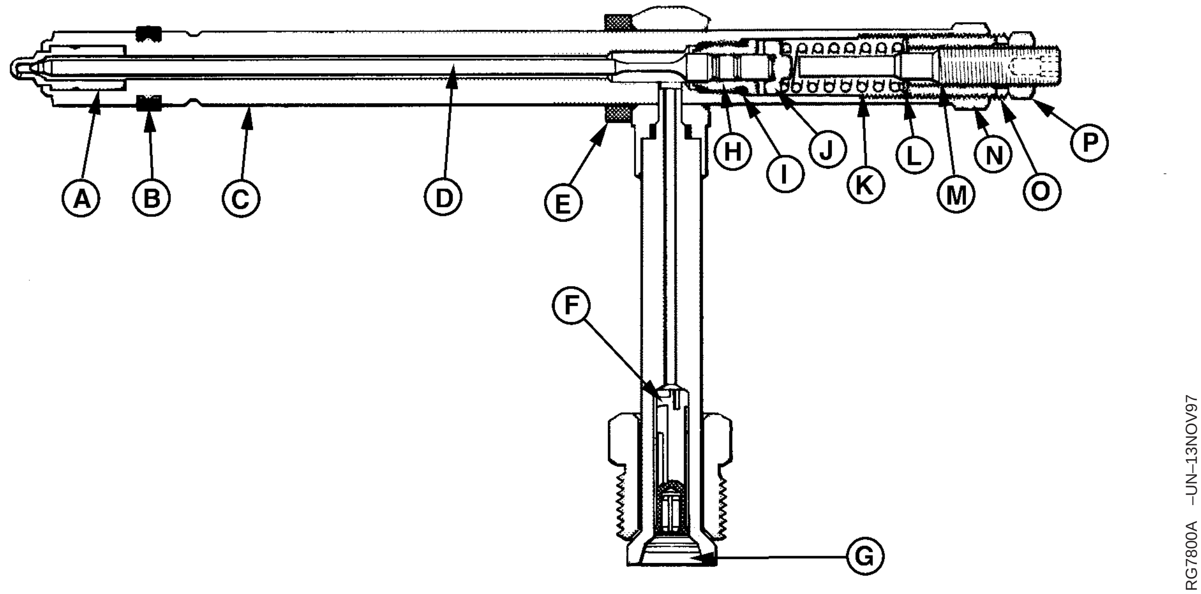
The aneroid controls fuel delivery when intake manifold pressure is about 100 kPa (1 bar) (15 psi) or less. Therefore, all final adjustments are to be made on the test stand with aneroid mounted on injection pump.

IMPORTANT: Correct aneroid adjustments are essential for satisfactory engine performance. Whenever the aneroid 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.

RG,115,JW7682 –19–24NOV97–1/1

115
78

FUEL INJECTION NOZZLES—GENERAL INFORMATION AND OPERATION



A—Nozzle Tip
B—Carbon Stop Seal
C—Nozzle Body
D—Nozzle Valve
E—Upper Seal Washer
F—Edge-Type Filter
G—Fuel Inlet
H—Upper Guide
I—Upper Seal
J—Spring Seat
K—Valve Spring
L—Spring Washer
M—Lift Adjusting Screw
N—Lock Nut
O—Pressure Adjusting Screw
P—Lock Nut

The injection nozzles are located in the engine cylinder head and are of the spring and valve type, hydraulically operated by fuel delivered from the injection pump.

A locating clamp positions the nozzle assembly in the cylinder head. The nozzle is sealed at the top end by a seal washer (E). A carbon stop seal (B), located on the lower end of the nozzle body (C), prevents carbon from collecting around the nozzle in the cylinder head.

Enclosed in the nozzle body are the valve (D), valve spring (K), and spring seat (J). The nozzle operating pressure is controlled by the pressure adjusting screw (O) in the upper end of the nozzle body. Valve lift is adjusted by the lift adjusting screw (M) located in the pressure adjusting screw. The nozzle tip (A) is pressed into the nozzle body and cannot be separated.

A leak-off line tee is attached to the upper end of the injection nozzle, secured by a grommet and hex nut.

Metered fuel, under high pressure, is delivered by the injection pump through the nozzle inlet (G) on the valve body into the area surrounding the valve. When fuel pressure reaches nozzle opening pressure, the valve is forced from its seat against the pressure of the spring, permitting a measured amount of fuel to enter the combustion chamber through four small holes in the nozzle tip.

After fuel has been injected, the spring closes the valve. In actual operation, the valve opens and closes very rapidly, providing a distinct chatter.

Continued on next page

RG,115,JW7681 –19–24NOV97–1/2

A small amount of fuel leaks past the valve into the spring area. This provides lubrication for the nozzle working parts. This excess fuel is then removed from the nozzle at the top by means of a leak-off line routed to the fuel source.

RG,115,JW7681 –19–24NOV97–2/2

115
80

DIAGNOSE FUEL INJECTION NOZZLE MALFUNCTIONS

Fuel injection nozzles are usually removed and tested or replaced when there is a noticeable loss of power or excessive smoking.

Listed in the following chart are various malfunctions which may occur on the 9.5 mm nozzles. Only possible defects related to these nozzles are listed. Failures in other components of the fuel injection system are listed under their respective headings in this group.

Refer to Group 35 for repair information.

Symptom	Problem	Solution
Engine Has Low Horsepower	Nozzle orifices plugged.	Repair. (See Group 35.)
	Incorrect nozzle valve opening pressure.	Adjust. (See Group 35.)
	Broken, worn or damaged parts:	Repair as required. (See Group 35.)
	Broken nozzle valve spring	
	Cracked or split nozzle tip	
	Cracked or split nozzle body	
	Internal leak	
	Wrong nozzle assembly installed.	Install correct nozzle assembly. (See Group 35.)
	Nozzle loose in cylinder head.	Make sure nozzle assembly is correctly installed. Tighten clamp cap screw to specified torque. (See Group 35.)
Engine Emits Too Much Smoke	Nozzle orifices plugged.	Repair. (See Group 35.)

Continued on next page

RG,115,JW7680 –19–24NOV97–1/2

115
81

Symptom	Problem	Solution
	Broken, worn or damaged parts:	Repair as required. (See Group 35.)
	Broken nozzle valve spring	
	Cracked or split nozzle tip	
	Cracked or split nozzle body	
	Internal leak	
	Wrong nozzle assembly installed.	Install correct nozzle assembly. (See Group 35.)

RG,115,JW7680 –19–24NOV97–2/2

TEST FUEL INJECTION NOZZLES (ENGINE RUNNING)

1. Operate engine at intermediate speed with no load.

2. Slowly loosen the fuel pressure line at one of the nozzles until fuel escapes at the connection (fuel not opening nozzle valve).

   If engine speed changes, the injection nozzle is probably working satisfactory.

   If engine speed does not change, a nozzle is faulty and must be checked and repaired (or replaced).

NOTE: The injection nozzle before and/or after nozzle being checked could be the faulty nozzle.

3. Repeat test for each remaining nozzle assembly.

4. Remove faulty injection nozzles and repair as required. (See Group 35.)

5. Tighten fuel lines to specifications.

Fuel Injection Nozzle Delivery Lines—Specification

Torque .... 27 N•m (20 lb-ft)

RG,115,JW7679 –19–24NOV97–1/1

FUEL DRAIN BACK TEST PROCEDURE

Fuel draining back through the fuel system may cause hard starting. This procedure will determine if air is entering the system at connections and allowing fuel to siphon back to the fuel tank.

1. Disconnect fuel supply and return lines at fuel tank.

IMPORTANT: Fuel return line MUST extend below fuel level in fuel tank before performing this test. Fill fuel tank if necessary.

2. Drain all fuel from the system, including the fuel transfer pump, fuel injection pump, fuel filters, and water separator (if equipped).

3. Securely plug off the end of the fuel return pipe.

CAUTION: Maximum air pressure should be 100 kPa (1 bar) (15 psi) when performing this test.

4. Using a low pressure air source, pressurize the fuel system at the fuel supply line.

5. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

NOTE: Connections may allow air to enter the system without allowing fuel to leak out.

6. If any leaks are found, take necessary steps to repair.

7. Reconnect supply and return lines and prime system.

8. Start engine and run for approximately 10 minutes.

9. Allow engine to sit overnight and try starting the following morning.

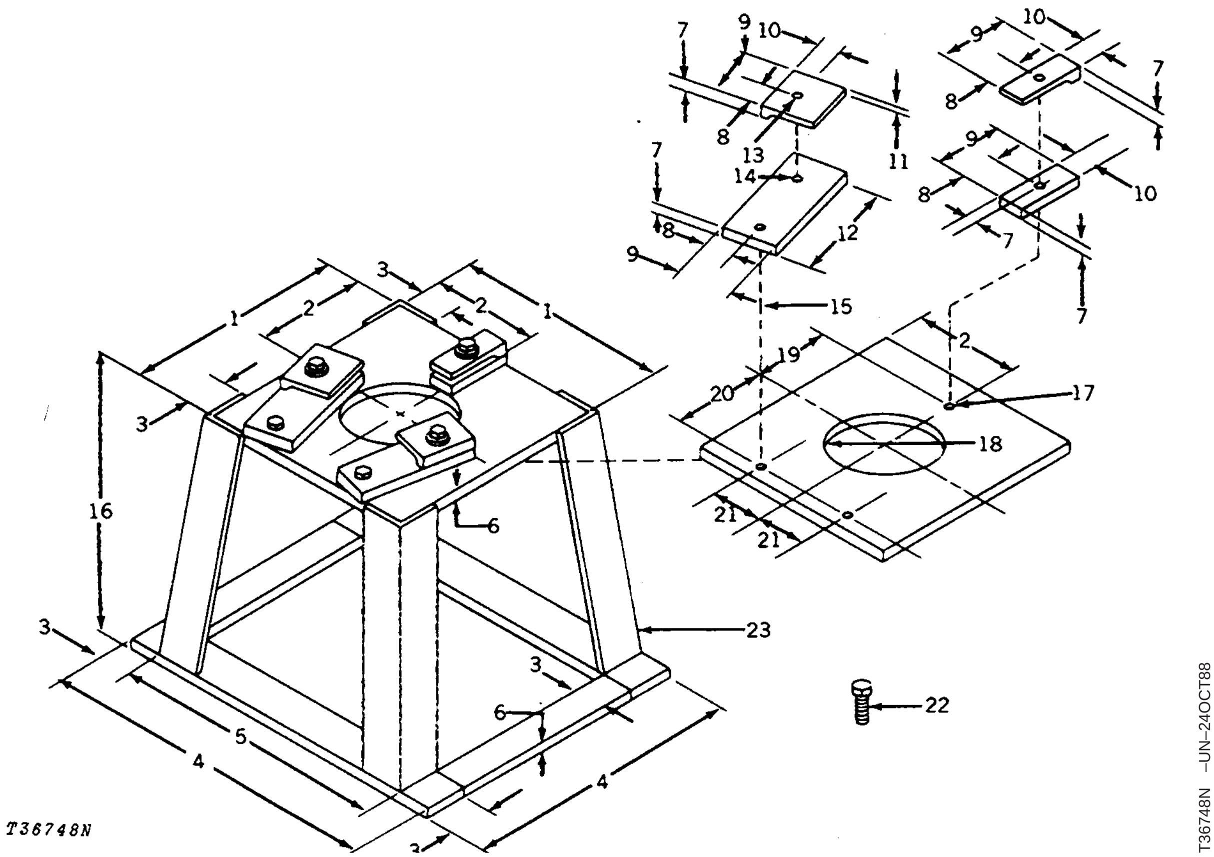
RG,115,JW7678 –19–24NOV97–1/1

HOW TO MAKE TOOLS

These tools can be made in a service shop using common shop tools and locally obtained materials.

RG,199,JW7719 –19–25NOV97–1/1

DFRG3—CYLINDER LINER HOLDING FIXTURE

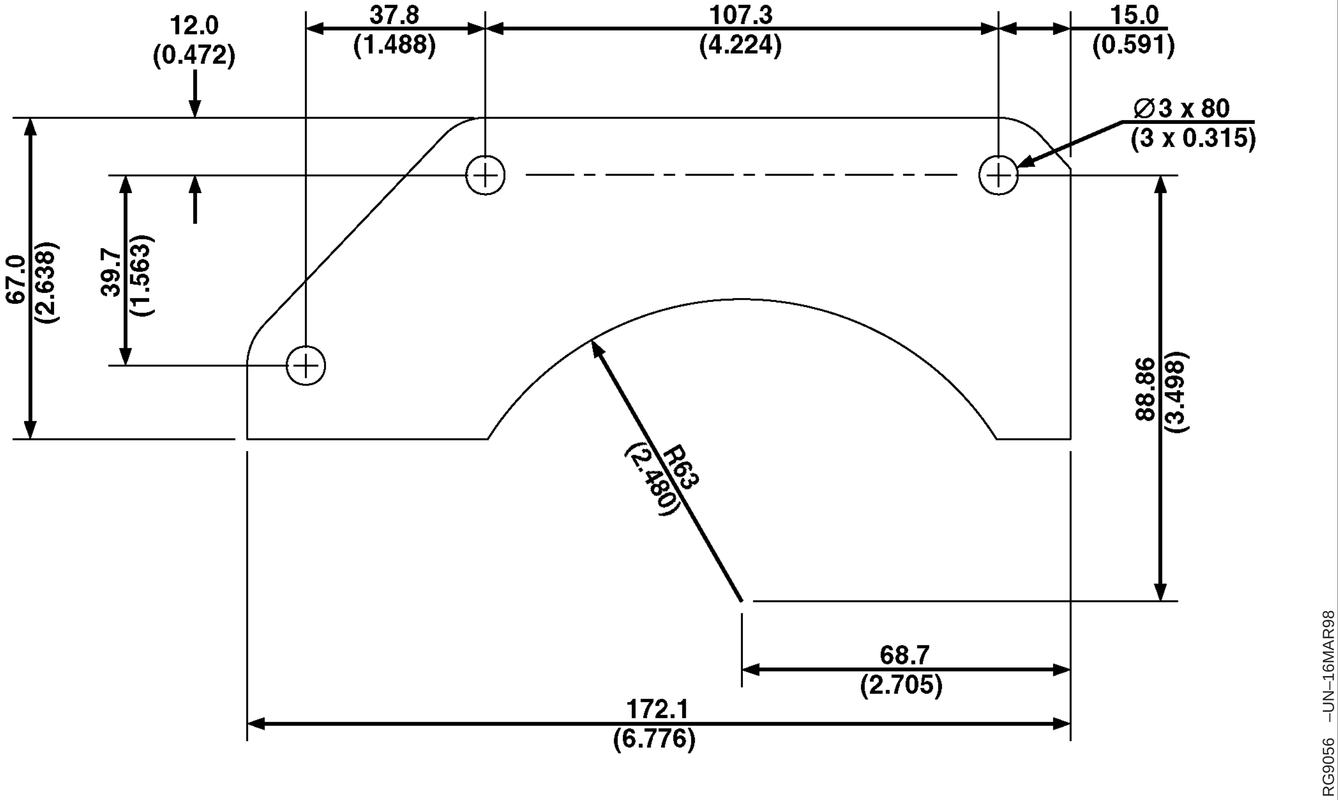


1—254.0 mm (10 in.)
2—127.0 mm (5 in.)
3—38.1 mm (1.5 in.)
4—405.4 mm (16 in.)
5—330.2 mm (13 in.)
6—9.52 mm (0.38 in.)
7—12.7 mm (0.5 in.)
8—31.8 mm (1.25 in.)
9—63.5 mm (2.5 in.)
10—25.4 mm (1 in.)
11—6.35 mm (0.25 in.)
12—152.4 mm (6 in.)
13—0.328 in. Drill Through
14—5/16 in. —18 Tap
15—2 used
16—304.8 mm (12 in.)
17—5/16 in. —18 Tap
18—69.85 mm (2.75 in.) Radius
19—101.6 mm (4 in.)
20—111.25 mm (4.38 in.)
21—60.45 mm (2.38 in.)
22—5/16 in. x 1 in. Cap Screw
23—38.1 mm (1.5 in.) Angle Iron

RG,199,JW7720 –19–25NOV97–1/1

199
2

DFRG5—INJECTION PUMP FRONT PLATE TIMING MARK TRANSFER TOOL

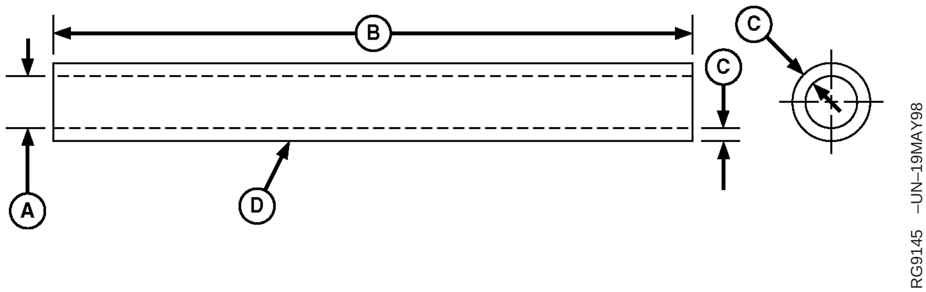


Material—Aluminum

This template is used to transfer the injection pump timing mark from the engine's original front plate to the replacement front plate (which does not have the mark). Refer to Group 16 for procedure to use this tool.

RG,199,JW7720 –19–25NOV97–1/1

ENGINE OIL DIPSTICK TUBE DRIVER (6010-6910 SERIES TRACTOR ENGINES)



A—Inside Diameter 9.75—10 mm (0.38—0.39 in.)
B—Length of Tubing 146 mm (5.75 in.)
C—Tubing Wall Thickness 3 mm (0.12 in.)
D—Steel Tubing 12.5 mm (0.50 in.)

This tool is required to install the straight engine oil dipstick tube in engine block on 6010-6910 Tractors.

For service procedure to use this tool, refer to Group 20.

DPSG,OUO1004,132 –19–18MAY98–1/1

CHAPTER 14

SECTION 05

ENGINE AUXILIARY SYSTEM REPAIR

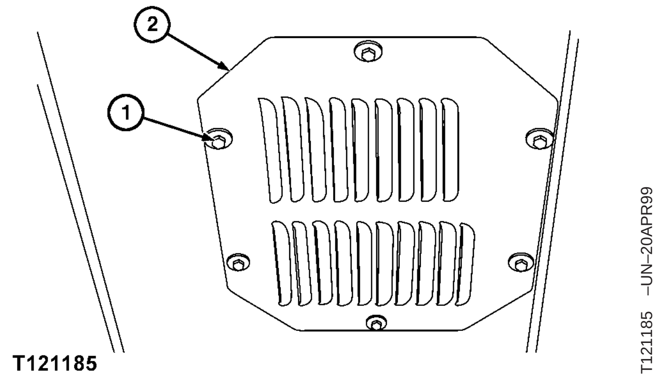
BLANK

REMOVE AND INSTALL ENGINE COOLANT HEATER

1. Remove cap screws (1) and remove cover (2).

NOTE: Cap screws holding injection pump lever were installed with LOCTITE® 242. Use heat in order to soften the LOCTITE®.

2. Disconnect injection pump lever.



1—Cap Screw (6 used)
2—Cover

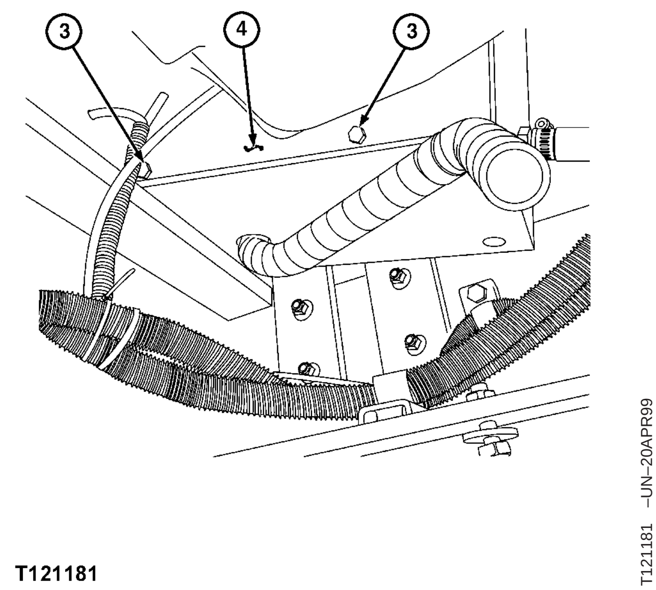
LOCTITE is a trademark of Loctite Corp.

CED,OUOE042,5066 –19–15APR99–1/3

3. Remove cap screws (3) and remove cover (4).

4. Disconnect all electrical connections.

5. Disconnect all lines, hoses and pipes.



3—Cap Screw (2 used)
4—Cover

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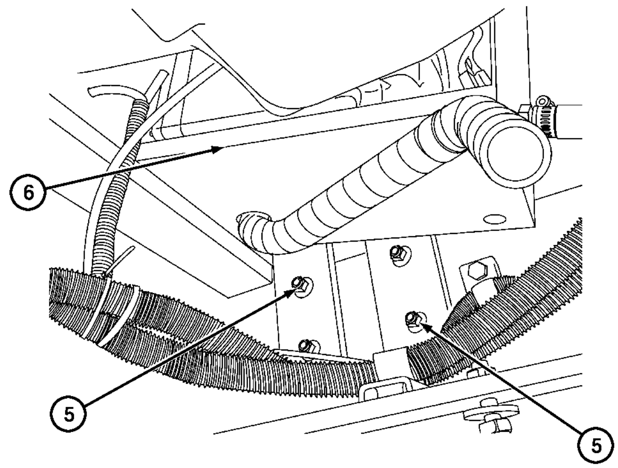
CED,OUOE042,5066 –19–15APR99–2/3

6. Remove cap screws (5) and coolant heater (6).

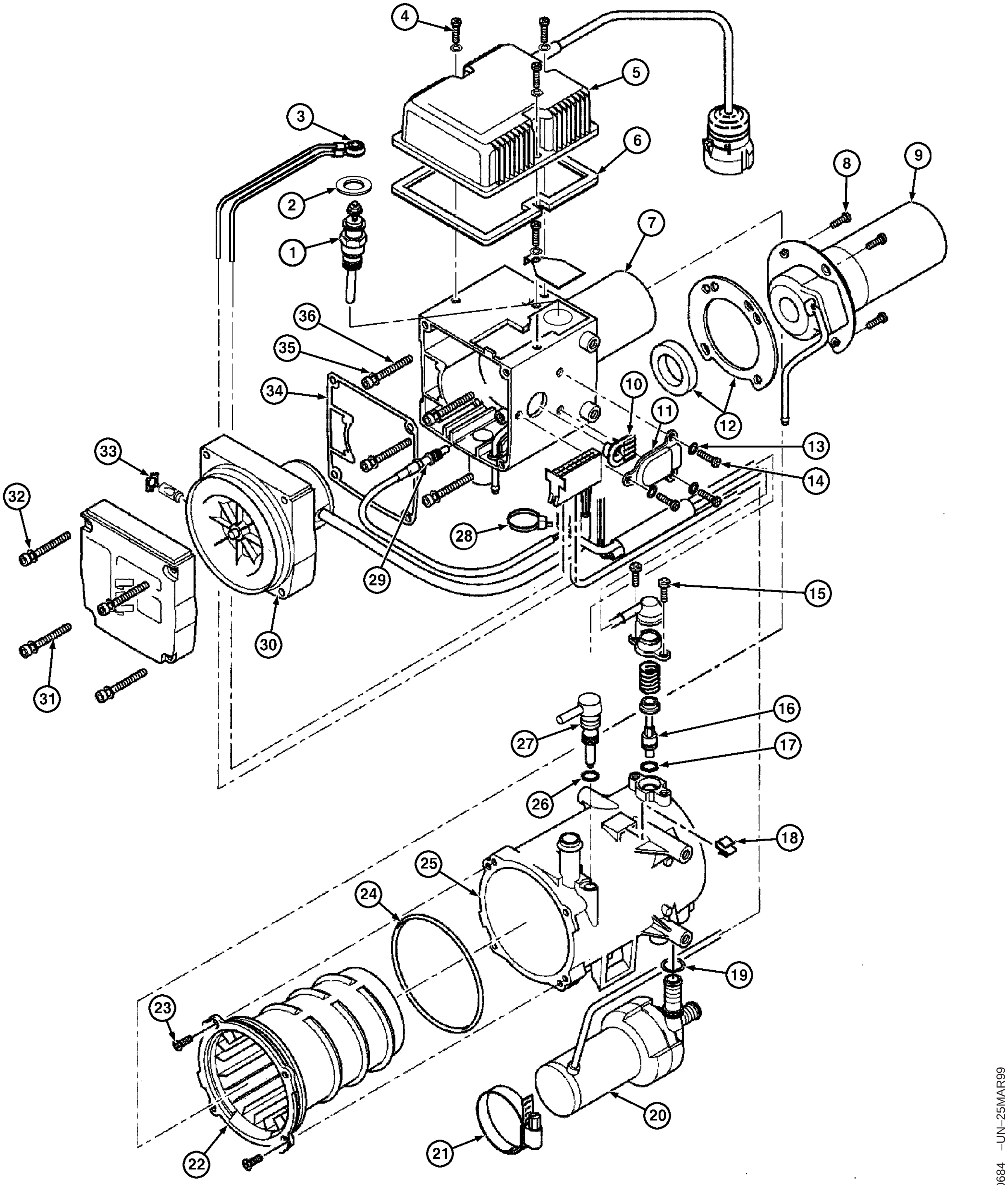


T121179

5—Cap Screws (4 used)
6—Coolant Heater

CED,OUOE042,5066 –19–15APR99–3/3

DISASSEMBLE AND ASSEMBLE ENGINE COOLANT HEATER



T120684

Continued on next page

Cold Weather Starting Aids

1—Glow Plug
2—Sleeve
3—Cable
4—Cap Screw (3 used)
5—Control Unit
6—Seal
7—Burner
8—Cap Screw (4 used)
9—Burner
10—Sleeve
11—Cover
12—Seal
13—Spring Washer (3 used)
14—Cap Screw (3 used)
15—Cap Screw (2 used)
16—Sensor
17—O-Ring
18—Clip
19—O-Ring
20—Water Pump
21—Hose Clamp
22—Heat Exchanger
23—Cap Screw (2 used)
24—O-Ring
25—Casing
26—O-Ring
27—Sensor
28—Tie Band
29—Sensor
30—Combustion Air Blower
31—Cap Screw (4 used)
32—Washer (4 used)
33—Indented Ring
34—Seal
35—Washer
36—Cap Screw (4 used)

CED,OUOE020,38 –19–18MAR99–2/2

Group 0510
Cooling System

SPECIFICATIONS

Item	Measurement	Specification
Engine Fan-to-Pulley Cap Screw	Torque	70 N•m (50 lb-ft)
Thermostat Cover-to-Housing Cap Screw	Torque	70 N•m (50 lb-ft)
Cooling System	Capacity	22.0 L (6 gal)

CED,OUOE003,1164 –19–18SEP98–1/1

REMOVE AND INSTALL RADIATOR, OIL COOLER, AND FAN SHROUD

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

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

TS281 –UN–23AUG88

1. Drain coolant from radiator. Approximate capacity is 22.0 L (6 gal.).

Continued on next page

TX,05,UU3881 –19–18SEP98–1/2

2. Remove parts (A—E).

3. Unlock and remove reservoir cap.

4. Install vacuum pump.

5. Remove access panel under the radiator and oil cooler.

6. Disconnect oil cooler lines. Cap lines.

7. Remove cap screws from radiator braces (F).

8. Remove four cap screws from radiator brackets (G).

9. Lift radiator, oil cooler, and fan shroud.

10. Remove fan shroud.

11. Replace parts as necessary.

12. Install fan shroud.

13. Install radiator and oil cooler.

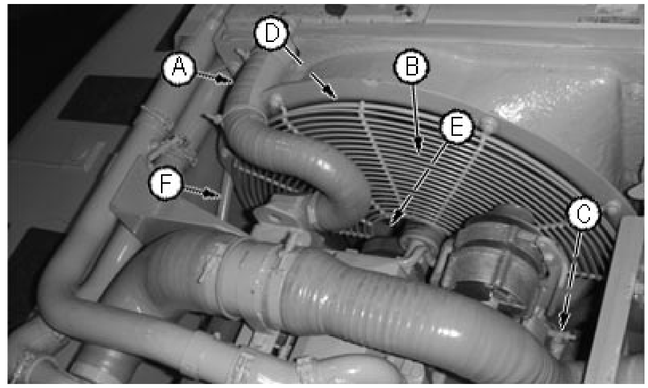
14. Install hardware, fan, and guard.

15. Connect cooler lines.

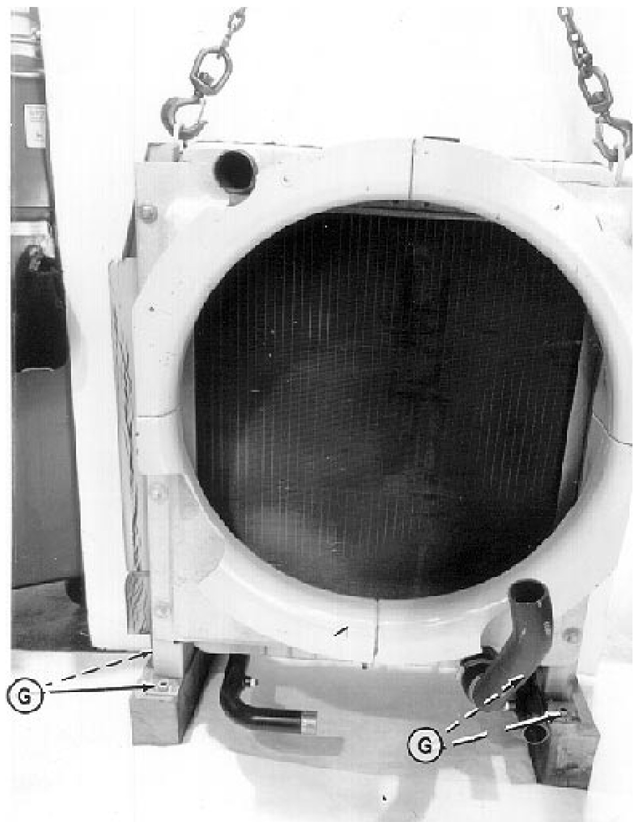
16. Install radiator hoses.

17. Fill radiator with coolant.

18. Start engine. Check for leaks.



T109138B –UN–17APR97



T105162 –UN–14NOV96

A—Upper Radiator Hose
B—Fan Guard
C—Lower Radiator Hose
D—Fan
E—Fan Spacer
F—Radiator Braces (2 used)
G—Radiator Bracket-to-Frame (4 used)

TX,05,UU3881 –19–18SEP98–2/2

REMOVE AND INSTALL FAN AND FAN GUARD


TS281 —UN–23AUG88

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

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

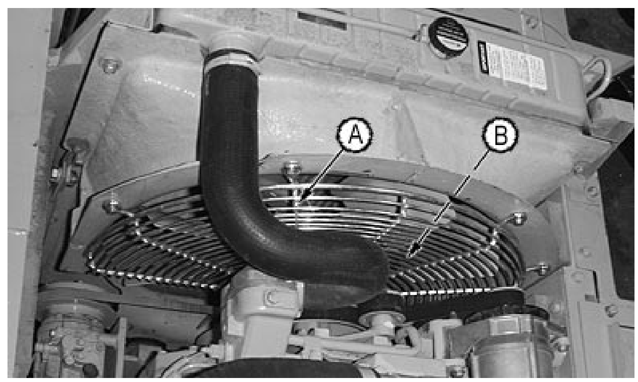
1. Open hood.

TX,05,UU3882 –19–14NOV96–1/2

2. Remove cap screws (A). Remove fan guard.
3. Remove cap screws (B). Remove fan.
4. Replace parts as necessary.
5. Install fan. Tighten cap screws.

Engine Fan-to-Pulley Cap Screw—Specification

Torque .... 70 N•m (50 lb-ft)



T105161C —UN–19NOV96

A—Cap Screw (4 used)
B—Cap Screw (4 used)

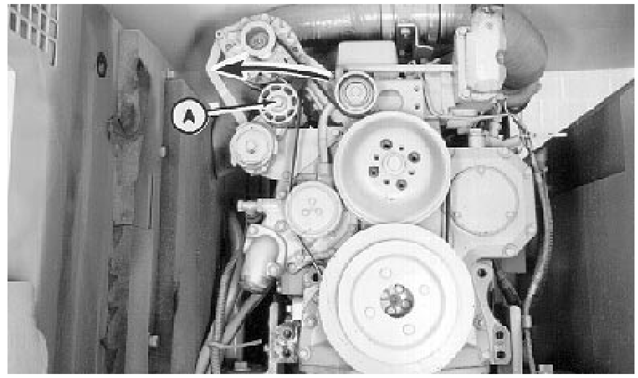
TX,05,UU3882 –19–14NOV96–2/2

REMOVE AND INSTALL FAN BELT

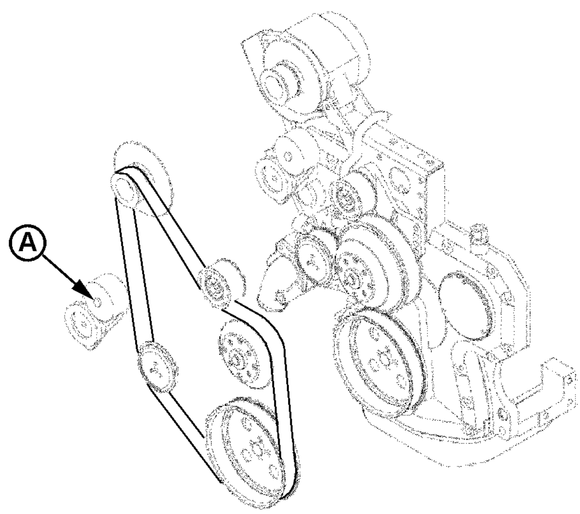
1. Remove fan guard. (See procedure in this group.)
2. Place a 15 mm wrench over the hex head of cap screw (A) in the center of the tension adjuster idler.
3. Pull idler away from belt (see arrow) to release belt tension. Remove old belt.
4. Loosen air conditioning compressor (if equipped) and remove compressor belt from crankshaft pulley.

NOTE: It is not necessary to remove fan to replace fan belt.

5. Remove fan belt.
6. Install new fan belt.
7. Fit belt around all pulleys except adjuster idler.
8. Pull adjuster forward and slide belt behind adjuster idler.
9. Slowly release adjusters.
10. Adjust and tighten compressor belt.
11. Install fan guard.



T105164 –UN–14NOV96



T108219

T108219 –UN–25MAR97

A—Hex Head of Cap Screw

TX,05,UU3883 –19–18SEP98–1/1

REMOVE AND INSTALL THERMOSTATS

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

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

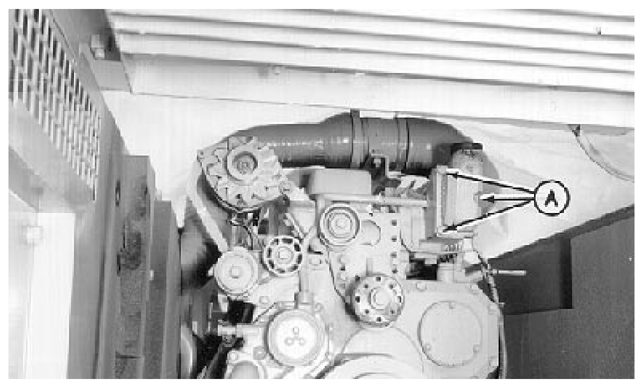
TS281 –UN–23AUG88

1. Remove radiator fill cap.

2. Remove upper radiator hose from thermostat housing.

TX,05,UU3884 –19–18SEP98–1/3

3. Remove cap screws (A). Remove thermostat housing front cover.



T105183 –UN–14NOV96

A—Cap Screw (3 used)

Continued on next page

TX,05,UU3884 –19–18SEP98–2/3

IMPORTANT: Note the location of the thermostats. Top and bottom thermostats (B and C) are different. Failure to install each thermostat in the correct port may cause engine to overheat.

4. Remove thermostats (B and C).

5. Remove gasket from mounting surface.

6. Install blocking thermostat (B) (AR48675) in top hole.

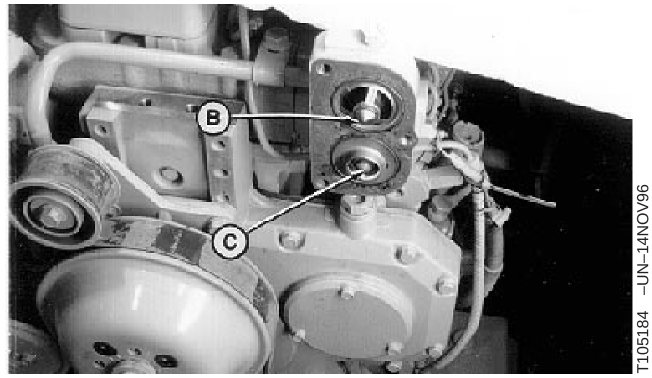
7. Install non-blocking thermostat (C) (RE33705) in bottom hole.

8. Install new gasket. Install cover.

9. Tighten cap screws.

Thermostat Cover-to-Housing Cap Screw—Specification

Torque .... 70 N•m (50 lb-ft)



B—Blocking Thermostat (AR48675)
C—Non-Blocking Thermostat (RE33705)

TX,05,UU3884 –19–18SEP98–3/3

COOLING SYSTEM FILL AND DEAERATION

FREEZING TEMPERATURES

IMPORTANT: Use only permanent-type low silicate ethylene glycol base antifreeze in coolant solution. Other types of antifreeze may damage cylinder seals.

Fill cooling system with permanent-type, low silicate, ethylene glycol antifreeze (without stop-leak additive) and clean, soft water.

FILL

1. Fill the radiator to the bottom of the fill neck.
2. Fill the coolant recovery tank to the FULL mark.

Cooling System—Specification

Capacity	22.0 L (6 gal)

DEAERATION

IMPORTANT: The cooling system requires several warm-up and cool down cycles to deaerate. It will NOT deaerate during normal operation. Only during warm-up and cool down cycles will the system deaerate.

1. Start engine. Run engine until coolant reaches a warm temperature.
2. Stop engine. Allow coolant to cool.
3. Check coolant level at recovery tank.
4. If necessary, fill recovery tank to FULL mark.
5. Repeat Steps 1—4 until recovery tank coolant level is repeatedly at the same level (stabilized).

NOTE: The level of the coolant in the cooling system MUST BE repeatedly checked after all drain and refill procedures to ensure that all air is out of the system which allows the coolant level to stabilize. Check coolant level only when the engine is cold.

6. Install recovery tank and radiator caps.

CED,OUOE003,1163 –19–18SEP98–1/1

Group 0515
Speed Controls

SERVICE EQUIPMENT AND TOOLS

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

SERVICEGARD is a trademark of Deere & Company.

CED,OUOE003,1166 –19–18SEP98–1/4

Clamp-On Electronic Tachometer JT05801

To measure engine speed.

CED,OUOE003,1166 –19–18SEP98–2/4

Laptop Computer JT07294

To check engine speeds.

CED,OUOE003,1166 –19–18SEP98–3/4

Feeler Gauge

Check clearance between fuel shut-off lever and stops.

CED,OUOE003,1166 –19–18SEP98–4/4

Speed Controls

05
0515
2

SPECIFICATIONS

Item	Measurement	Specification
Fast and Slow Idle:		
Engine Fast Idle Stop Screw	Speed	2250 ± 25 rpm
Engine Slow Idle Stop Screw	Speed	900 ± 25 rpm
Engine Slow Idle	Speed	900 ± 25 rpm
Engine Auto-Idle	Speed	1200 ± 25 rpm
Engine E (Economy) Mode	Speed	1980 ± 25 rpm
Engine Fast Idle in Standard Mode	Speed	2180 ± 25 rpm
Engine Control Motor Arm-to-Shaft Cap Screw	Torque	13 N•m (115 lb-in.)
Ball Joint-to-Shut-Off Lever Overtravel	Distance	3—6 mm (1/8—1/4 in.) short with key switch ON and solenoid plunger bottomed
Fuel Shut-Off Solenoid Plunger-to-Ball Joint Nut	Torque	8 N•m (70 lb-in.)
Fuel Shut-Off Lever-to-Run Position Stop	Clearance	Less than 0.025 mm (0.001 in.) with key switch ON and solenoid plunger bottomed
Fuel Shut-Off Lever-to-Stop Position Stop	Distance	Within 3 mm (0.125 in.) of stop position with key switch OFF

CED,OUOE003,1167 –19–18SEP98–1/1

INJECTION PUMP FAST AND SLOW IDLE STOPS ADJUSTMENT

1. Connect a tachometer or the JT07294 Laptop Computer to check engine speeds.

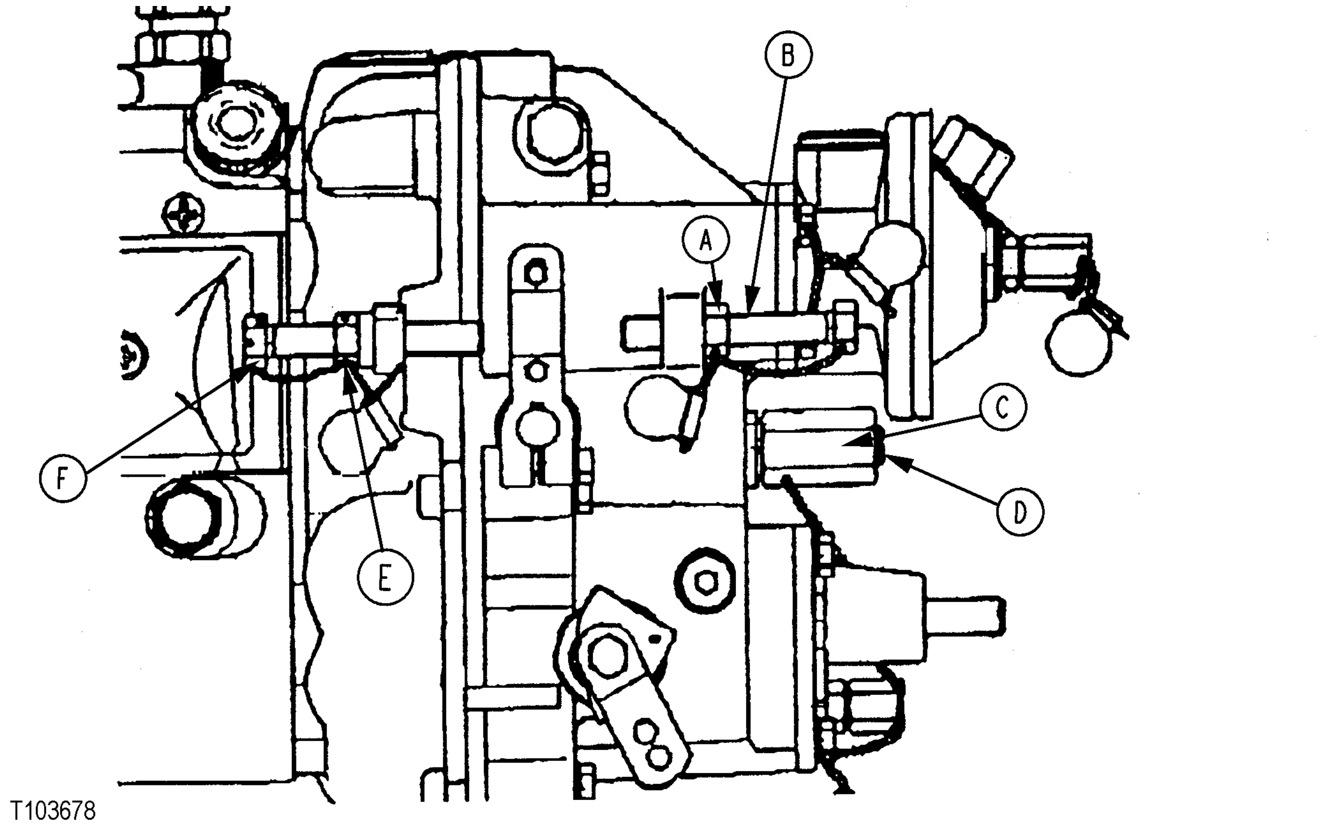
2. Warm engine to normal operating temperature.

3. Stop the engine.

4. Disconnect speed control cable at injection pump lever.

5. Start the engine.

Continued on next page TX,05,UU3886 –19–03APR98–1/3



A—Nut
B—Slow Idle Stop Screw
C—Nut
D—Supplementary Idle Screw
E—Nut
F—Fast Idle Stop Screw

6. Push injection pump lever against fast idle stop screw (F). Record engine speed.

   Push injection pump lever against slow idle stop screw (B). Record engine speed.

   Adjust fast and slow idle stop screws on injection pump as needed.

Engine Fast Idle Stop Screw—Specification

Speed.. 2250 ± 25 rpm

Engine Slow Idle Stop Screw—Specification

Speed.. 900 ± 25 rpm

7. Loosen nut (C) on the supplementary idle screw (D). Turn the screw out three turns.

8. Loosen nut (A) on the slow idle stop screw (B).

9. Hold injection pump lever against the slow idle stop screw.

   Adjust the slow idle stop screw to obtain an engine speed that is 30—40 rpm less than the slow idle specification.

   Hold screw and tighten nut.

10. Turn the supplementary idle screw in to increase engine speed to the slow idle specification. Hold screw and tighten nut.

Continued on next page

For example, to obtain the 900 rpm slow idle speed, turn the slow idle stop screw (B) out to get approximately 865 rpm. Hold screw and tighten the nut. Then turn the supplementary idle screw (D) in to increase engine speed to 900 rpm. Hold screw and tighten nut.

11. Pull injection pump lever rapidly to fast idle then decelerate to slow idle. Slow idle must be to specification.

NOTE: Increasing slow idle setting a small amount, but no more than the maximum specifications, may help to reduce surging or hunting. If surging or hunting continues, repair injection pump.

12. Loosen nut (E) on fast idle stop screw (F).

    Pull lever against fast idle stop screw. Turn screw in to decrease engine speed; turn screw out to increase engine speed. Hold screw and tighten nut.

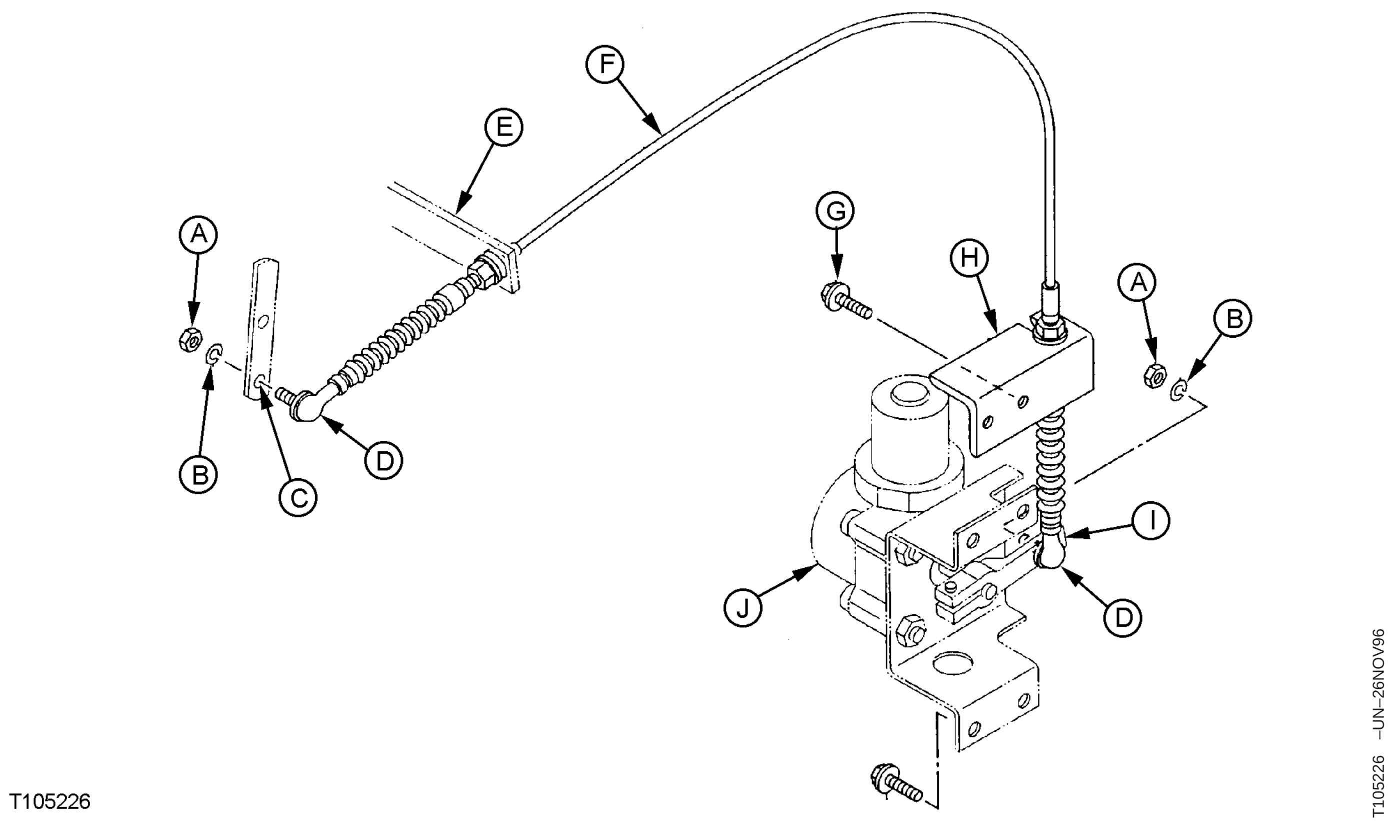
NOTE: The fast idle stop screw serves as the stop when the HP (high power) mode is actuated.

13. Stop the engine. Connect the cable to lever.

14. Do Engine Control Motor and Sensor Adjustment and then the Engine Speed Learning Procedure. (See procedures in this group.)

TX,05,UU3886 –19–03APR98–3/3

REMOVE AND INSTALL ENGINE SPEED CONTROL CABLE



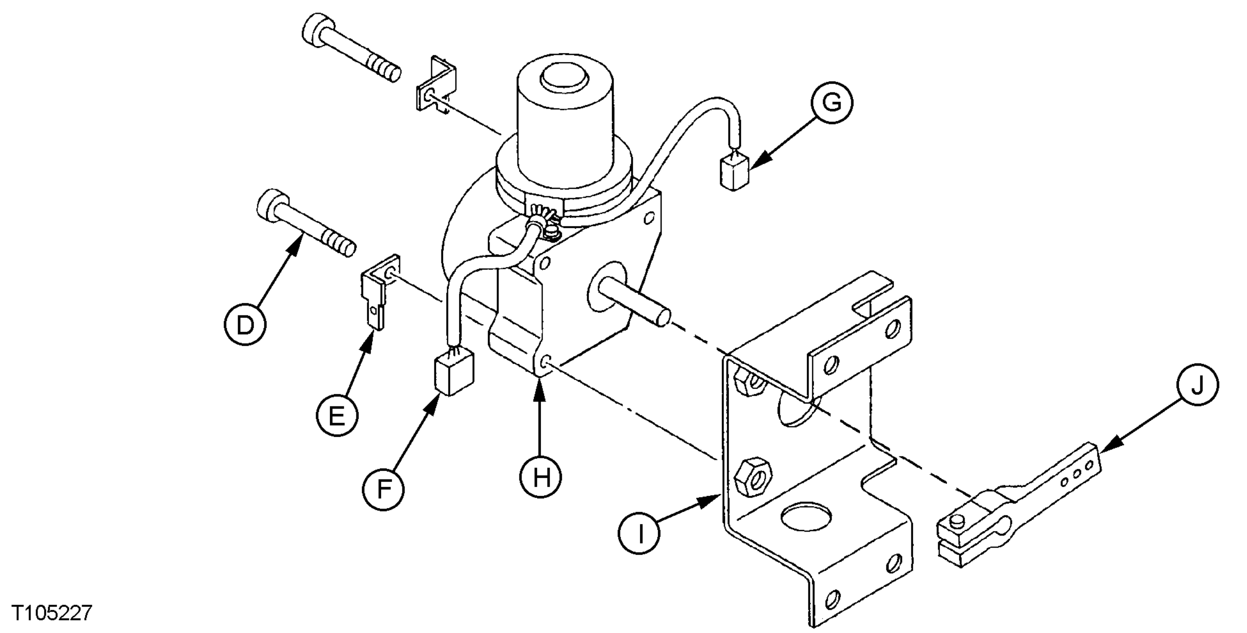
A—Nut (2 used)
B—Lock Washer (2 used)
C—Injection Pump Lever
D—Ball Joint (2 used)
E—Bracket
F—Speed Control Cable
G—Cap Screw and Lock Washer (6 used)
H—Bracket
I—Engine Control Motor Arm
J—Engine Control Motor and Sensor

IMPORTANT: The ball joints (D) are installed on the cable to full thread engagement. A ball joint can be used to lengthen a cable end, if needed, but must have at least 6 mm (1/4 in.) of thread engagement to avoid stripping the threads on cable end.

1. Install ball joints (D) to full thread engagement. Tighten the nuts.
2. Install speed control cable (F) in brackets (E and H). Initially, tighten nuts so threaded portions of cable are centered in brackets. As needed, adjust cable in brackets to connect ball joint to lever or arm.
3. Connect ball joint to the OUTER hole of engine control motor arm (I).
4. Do Engine Control Motor and Sensor Adjustment and then the Engine Speed Learning Procedure. (See procedures in this group.)

TX,05,UU3887 –19–18SEP98–1/1

REMOVE AND INSTALL ENGINE CONTROL MOTOR AND SENSOR



A—Speed Control Cable
B—Ball Joint
C—Inner Hole
D—Cap Screw (3 used)
E—Bracket (2 used)
F—Engine Control Motor Connector (4-Wire)
G—Engine Control Motor Sensor Connector (3-Wire)
H—Engine Control Motor and Sensor
I—Bracket
J—Arm

NOTE: The engine control angle sensor is located inside the engine control motor housing. Sensor is serviced as an assembly with the engine control motor.

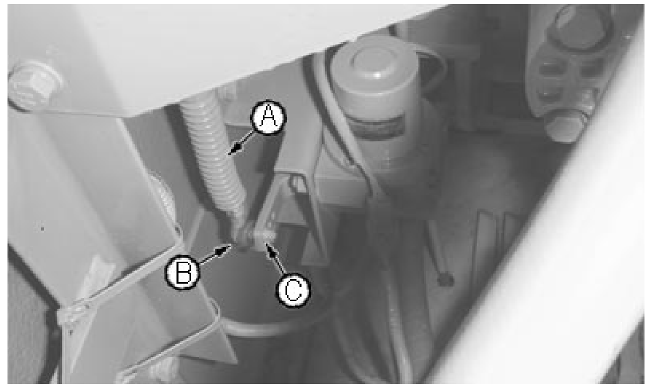
1. Install arm (J). Do not tighten cap screw in arm at this time.

Continued on next page TX,05,UU3888 –19–18SEP98–1/2

2. Install ball joint (B) in the OUTER hole of arm (C).

3. Adjust arm on control motor shaft or speed control cable (A) in bracket so cable is vertical.

4. Do Engine Control Motor and Sensor Adjustment and then the Engine Speed Learning Procedure. (See procedures in this group.)



T108915B –UN–24APR97

A—Speed Control Cable
B—Ball Joint
C—Outer Hole of Arm

TX,05,UU3888 –19–18SEP98–2/2

ENGINE CONTROL MOTOR AND SENSOR ADJUSTMENT

When the following components are repaired or replaced, or when engine speeds deviate from specification, the engine control motor adjustment and engine speed learning procedure must be performed.

- Engine
- Engine speed control cable
- Engine control motor and sensor
- Engine and pump controller
- Fast and slow idle stop screws

1. Compare the fast and slow idle stop screws on the injection pump to speed specification. (See Injection Pump Fast and Slow Idle Stops Adjustment in this group.)

2. Turn key switch to ON.

3. Turn the engine rpm dial to slow idle.

Continued on next page

TX,05,UU3889 –19–18SEP98–1/2

4. Check that engine speed control cable is connected to the outer hole of engine control motor arm (B).

5. Loosen cap screw (A) in engine control motor arm (B).

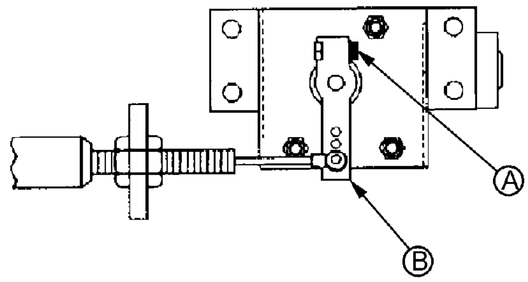
6. Adjust the arm (B) on the shaft so the injection pump lever just makes contact with the slow idle stop screw.

7. Tighten cap screw (A).

Engine Control Motor Arm-to-Shaft Cap Screw—Specification

Torque .... 13 N•m (115 lb-in.)

8. Do Engine Speed Learning Procedure. (See procedure in this group.)



T109243 –UN–24APR97

A—Cap Screw
B—Arm

TX,05,UU3889 –19–18SEP98–2/2

ENGINE SPEED LEARNING PROCEDURE

When the following components are repaired or replaced, or when engine speeds deviate from specification, the engine speed learning procedure must be performed.

- Engine
- Engine speed control cable
- Engine control motor and angle sensor
- Engine and pump controller
- Fast and slow idle stop screws

1. Stop engine. Ignition key OFF.

2. Disconnect the laptop computer from test connector.

   Wait for 5 seconds.

Continued on next page TX,05,GG2769 –19–18SEP98–1/2

Speed Controls

NOTE: The three position switch, protected by an angle guard, is located just below and behind the computer test connector.

3. Push engine learning switch (C) up to the TOP position. The switch is a three-position switch. Make sure it is in the top position.

4. Turn key switch ON. Wait for 5 seconds.

5. Turn key switch OFF. Wait for 5 seconds.

6. Push engine learning switch to MIDDLE position.

7. Check engine speeds.

Engine Slow Idle—Specification

Speed .... 900 ± 25 rpm

Engine Auto-Idle—Specification

Speed .... 1200 ± 25 rpm

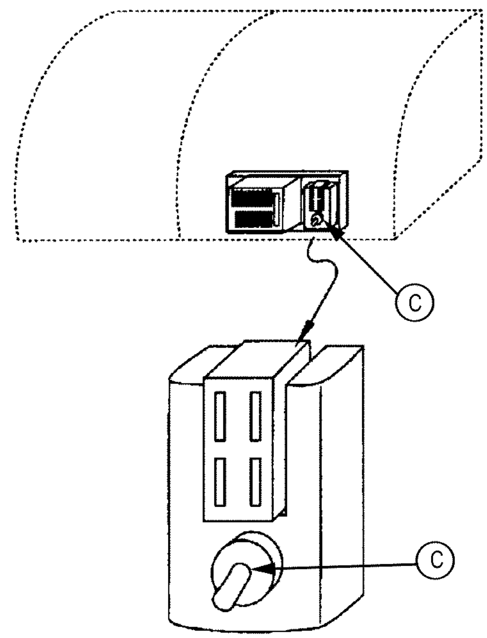
Engine E (Economy) Mode—Specification

Speed .... 1980 ± 25 rpm

Engine Fast Idle in Standard Mode—Specification

Speed .... 2180 ± 25 rpm

NOTE: The laptop computer with the excavator diagnostic software can be used to change the default speeds for slow idle, auto-idle, economy mode, and fast idle in standard mode. See Excavator Diagnostics Program Special Function—Engine Speed Adjustment in Group 9025-25.



T103674 –UN–11SEP96

A—Engine Learning Switch

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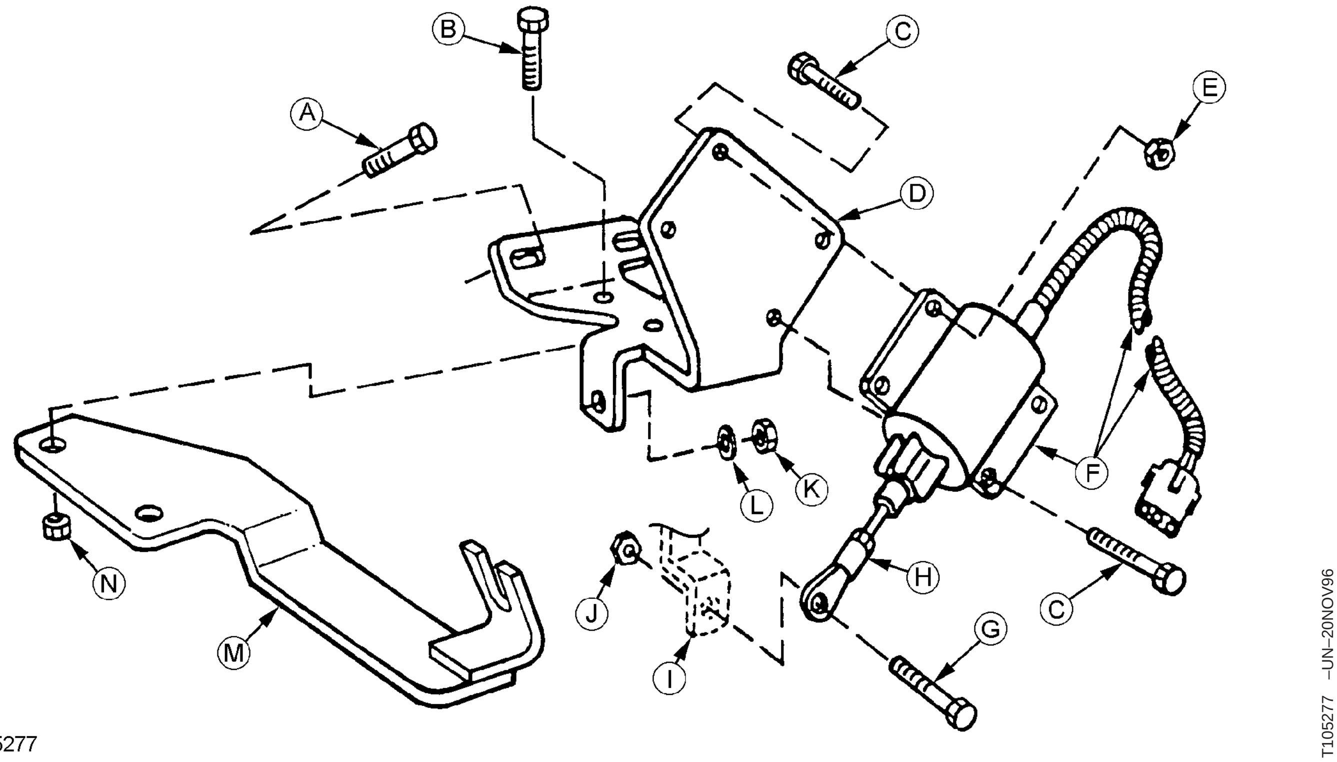
TX,05,GG2769 –19–18SEP98–2/2

REMOVE AND INSTALL FUEL SHUT-OFF SOLENOID LINKAGE



T105277

A—Cap Screw (2 used)
B—Cap Screw (2 used)
C—Cap Screw (4 used)
D—Shut-Off Solenoid Bracket
E—Nut (4 used)
F—Shut-Off Solenoid
G—Cap Screw
H—Ball Joint
I—Fuel Shut-Off Lever
J—Lock Nut
K—Nut
L—Washer
M—Speed Control Cable Bracket
N—Washer (2 used)

The shut-off solenoid (F) and ball joint (H) are replaced as an assembly. When a solenoid and ball joint assembly are replaced, check the linkage adjustment. (See Check and Adjust Fuel Shut-Off Solenoid Linkage in this group.)

TX,05,UU3891 –19–16JUL97–1/1

CHECK AND ADJUST FUEL SHUT-OFF SOLENOID LINKAGE

1. Disconnect ball joint (C) from fuel shut-off lever (D).

2. Turn key switch to ON. It is not necessary to start engine for this procedure.

3. Push plunger (F) into solenoid housing until the plunger bottoms. With key switch ON, solenoid hold coil is energized and will hold plunger in the run position

4. Manually pull fuel shut-off lever (D) up against the run position stop (upper stop) (H).

5. Check that hole in ball joint (C) is 3—6 mm (1/8—1/4 in.) short of aligning with hole in fuel shut-off lever.

   The 3—6 mm (1/8—1/4 in.) is the amount of overtravel needed to compress the spring in the plunger to hold the shut-off lever against the run position stop when plunger is bottomed in the solenoid housing.

Ball Joint-to-Shut-Off Lever Overtravel—Specification

Distance... 3—6 mm (1/8—1/4 in.) short with key switch ON and solenoid plunger bottomed

Adjust ball joint as necessary.

6. Manually pull fuel shut-off lever up against the run position stop (upper stop).

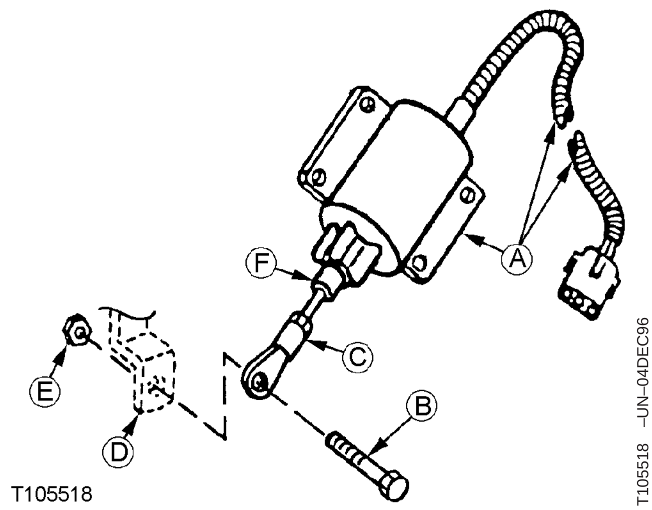
   Adjust ball joint so hole is aligned with hole in shut-off lever and then turn ball joint to shorten linkage by three turns.

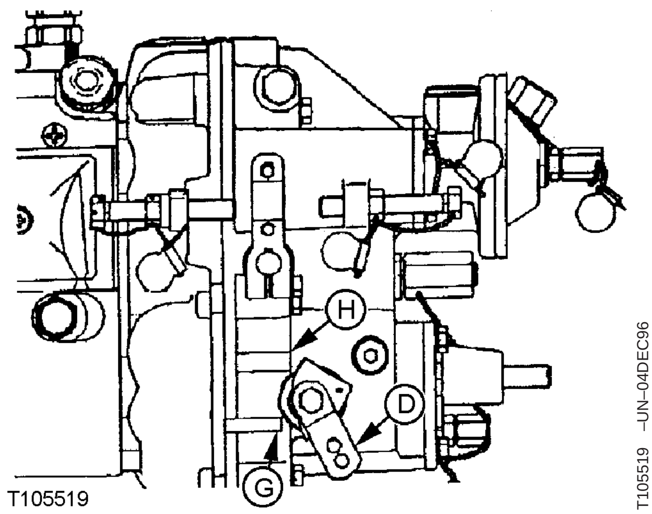
   Hold ball joint and tighten nut.

Fuel Shut-Off Solenoid Plunger-to-Ball Joint Nut—Specification

Torque .... 8 N•m (70 lb-in.)

7. Turn key switch to OFF.





A—Shut-Off Solenoid
B—Cap Screw
C—Ball Joint
D—Fuel Shut-Off Lever
E—Lock Nut
F—Plunger
G—Stop Position Stop (Lower Stop)
H—Run Position Stop (Upper Stop)

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Continued on next page TX,05,UU3892 –19–18SEP98–1/2

8. Connect ball joint to fuel shut-off lever using cap screw (B) and nut (E).

IMPORTANT: Failure to have the shut-off lever tight against run position stop (upper stop) can result in low engine horsepower.

9. Turn the key switch to ON.

   Push plunger into solenoid housing so hold coil holds the plunger in the run position.

   Check that shut-off lever is tight against run position stop using a 0.025 mm (0.001 in.) feeler gauge. If feeler gauge passes between shut-off lever and stop, shorten the linkage two more turns.

Fuel Shut-Off Lever-to-Run Position Stop—Specification

Clearance .... Less than 0.025 mm (0.001 in.) with key switch ON and solenoid plunger bottomed

10. Turn key switch to OFF.

    The spring inside the solenoid housing boot will extend the plunger to push the shut-off lever down to the stop position stop (lower stop) (G).

    Check that shut-off lever is within 3 mm (0.125 in.) of stop position stop.

Fuel Shut-Off Lever-to-Stop Position Stop—Specification

Distance... Within 3 mm (0.125 in.) of stop position with key switch OFF

TX,05,UU3892 –19–18SEP98–2/2

Group 0520
Intake System

ESSENTIAL TOOLS

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

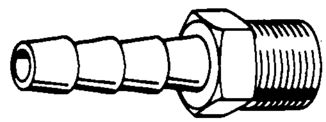
SERVICEGARD is a trademark of Deere & Company.

CED,OUOE003,520 –19–15MAY98–1/2

T6606AJ –UN–23AUG88

Inlet Air Adapter JDG51

Used for air intake system leakage test.



CED,OUOE003,520 –19–15MAY98–2/2

SERVICE EQUIPMENT AND TOOLS

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

SERVICEGARD is a trademark of Deere & Company.

CED,OUOE003,521 –19–15MAY98–1/3

Air Pressure Regulator

To regulate air pressure for air intake system test.

CED,OUOE003,521 –19–15MAY98–2/3

1/4 in. Plastic Hose

To connect air pressure regulator to adapter for intake system leakage test.

CED,OUOE003,521 –19–15MAY98–3/3

SPECIFICATIONS

Item	Measurement	Specification
Air Intake System:		
Leakage Test	Pressure	14—21 kPa (0.14—0.21 bar) (2—3 psi)
Air Cleaner Hose Clamp	Tighten	Until hose starts to deform around clamp band
Air Cooler Hose Clamp	Tighten	Until hose starts to deform around clamp band

CED,OUOE003,1169 –19–19SEP98–1/1

AIR INTAKE SYSTEM LEAKAGE TEST

1. Remove air cleaner cover. Remove primary filter element.
2. Put a large plastic bag inside and over end of element as shown. Install element and cover.
3. Remove fitting for start aid nozzle from intake manifold.
4. Install the JDG51 Inlet Air Adapter (A).
5. Connect air pressure regulator to adapter using hose and fitting.

IMPORTANT: Plastic bag could be drawn into the engine causing damage if engine starts. Do not start the engine when turning the engine crankshaft to close valves.

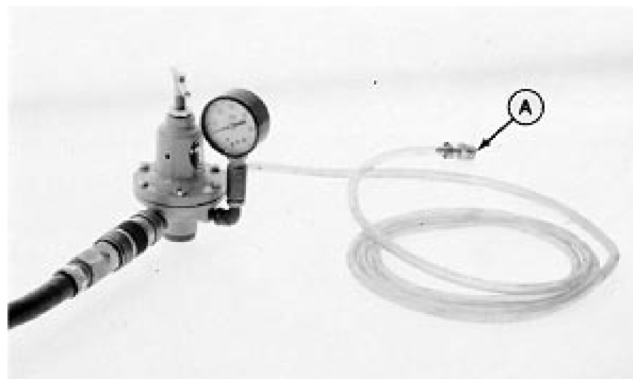
6. Pressurize air intake system to 14—21 kPa (0.14—0.21 bar) (2—3 psi). If intake system cannot be pressurized, turn engine crankshaft slightly to close valves.

Leakage Test—Specification

Pressure .... 14—21 kPa (0.14—0.21 bar) (2—3 psi)

7. Spray a soap solution over all connections from the air cleaner to turbocharger and intake manifold. Check for leaks. Correct all leaks
8. Install plug.

T5906AP –UN–23FEB89



T6089AR –UN–25OCT88

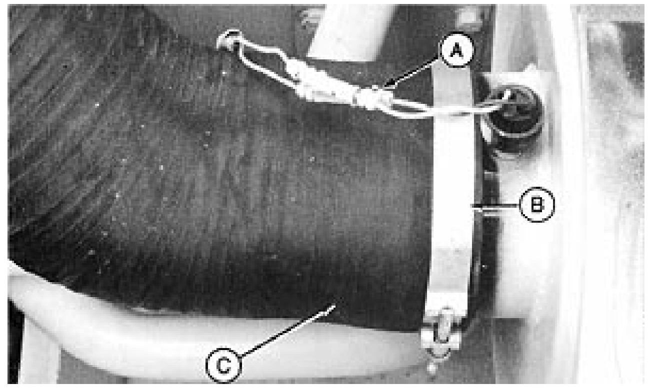
A—JDG51 Inlet Air Adapter

TX,05,VV2770 –19–19SEP98–1/1

REMOVE AND INSTALL AIR CLEANER

1. Disconnect wiring connector (A).

2. Loosen clamp (B). Disconnect hose (C).



T7685HC –UN–05MAR92

A—Wiring Connector
B—Clamp
C—Hose

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4

TX,05,UU3894 –19–20NOV96–1/2

3. Remove cap screws, washers, and lock washers (A). Remove air cleaner.

4. Replace parts as necessary.

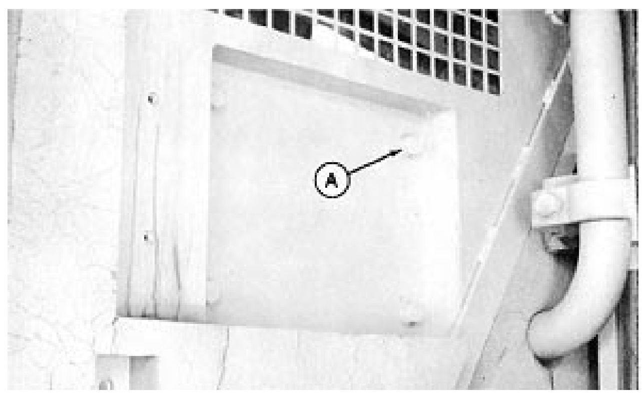
5. Install air cleaner.

6. Connect hose. Tighten clamp until hose starts to deform around clamp band.

Air Cleaner Hose Clamp—Specification

Tighten.. Until hose starts to deform around clamp band

7. Connect wiring connector.

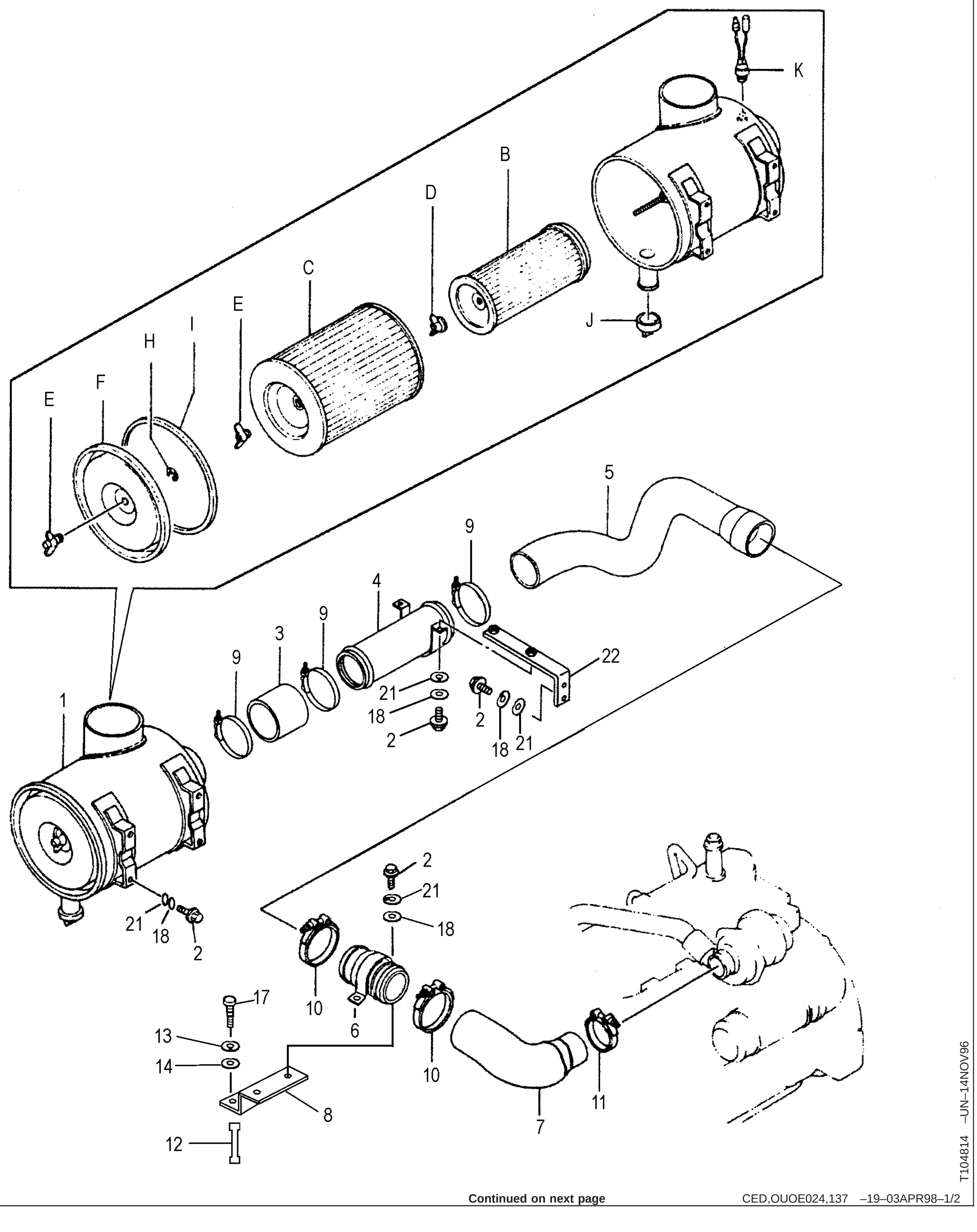


T7685HD –UN–05MAR92

A—Cap Screws, Washers, and Lock Washers

TX,05,UU3894 –19–20NOV96–2/2

DISASSEMBLE AND ASSEMBLE AIR CLEANER



T104814

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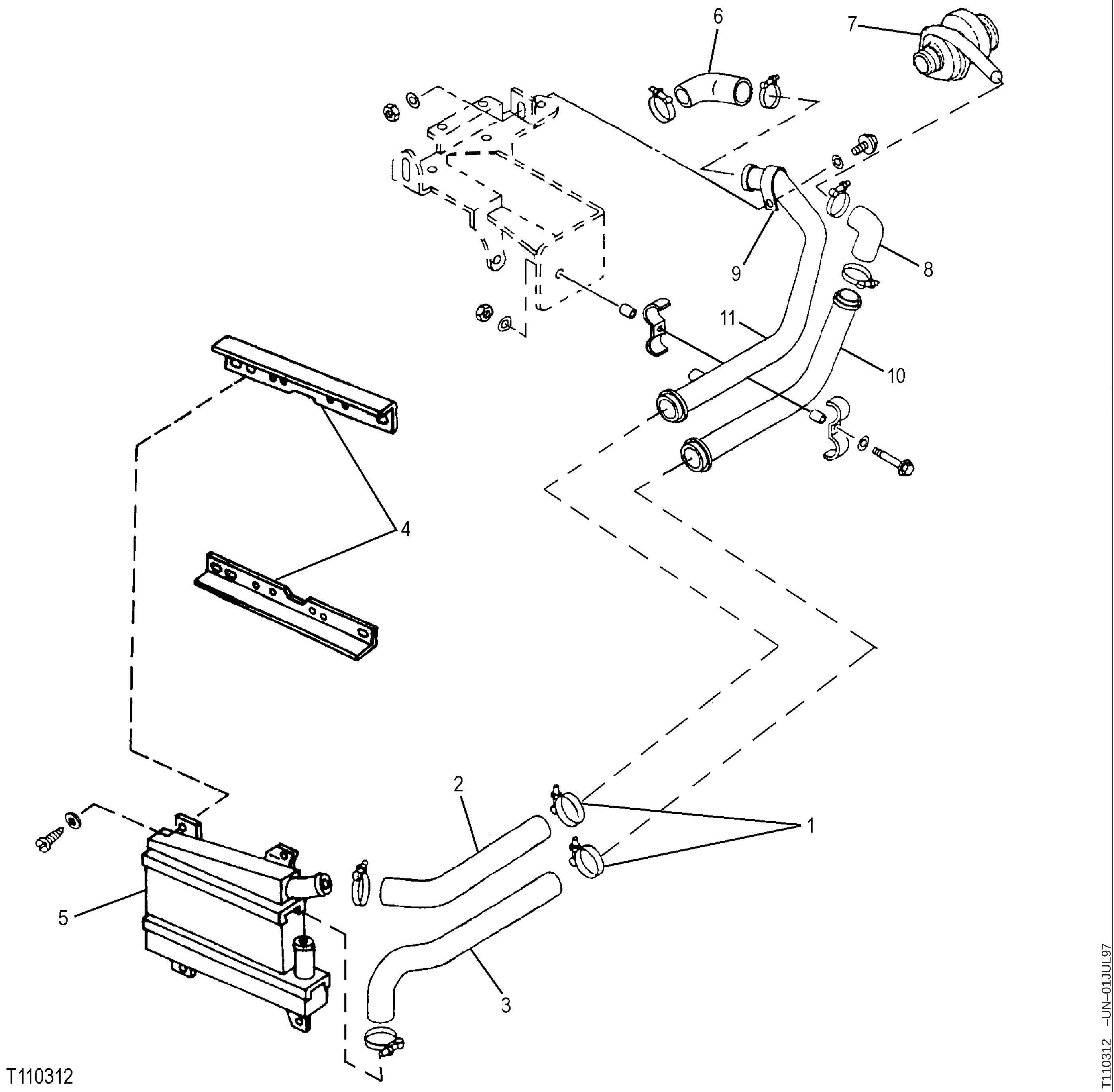
CED,OUOE024,137 –19–03APR98–1/2

Intake System

B—Secondary Filter Element	**I—Gasket**	**5—Hose**	**12—Spacer (Pipe) (2 used)**
C—Primary Filter Element	**J—Valve**	**6—Pipe**	**13—Lock Washer (2 used)**
D—Wing Nut	**K—Air Restriction Indicator**	**7—Hose**	**14—Washer (2 used)**
E—Wing Nut (2 used)	**1—Air Cleaner**	**8—Bracket**	**17—Cap Screw (2 used)**
F—Cover	**2—Cap Screw (10 used)**	**9—Hose Clamp (3 used)**	**18—Washer (10 used)**
H—Snap Ring	**3—Hose**	**10—Hose Clamp (2 used)**	**21—Washer (10 used)**
	4—Pipe	**11—Hose Clamp**	**22—Bracket**

CED,OUOE024,137 –19–03APR98–2/2

REMOVE AND INSTALL CHARGE AIR COOLER



1—Hose Clamps (8 used)
2—Hose
3—Hose
4—Mounting Brackets (2 used)
5—Air Cooler
6—Hose
7—Turbo Charger
8—Hose
9—Clamp
10—Tube
11—Tube

Continued on next page TX,05,VV2926 –19–19SEP98–1/2

Tighten hose clamps (1) until hose starts to deform around clamp band.

Air Cooler Hose Clamp—Specification

Tighten .... Until hose starts to deform around clamp band

TX,05,VV2926 –19–19SEP98–2/2

Group 0560
External Fuel Supply System

OTHER MATERIAL

Number	Name	Use
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to threads of screws.

LOCTITE is a trademark of Loctite Corp.

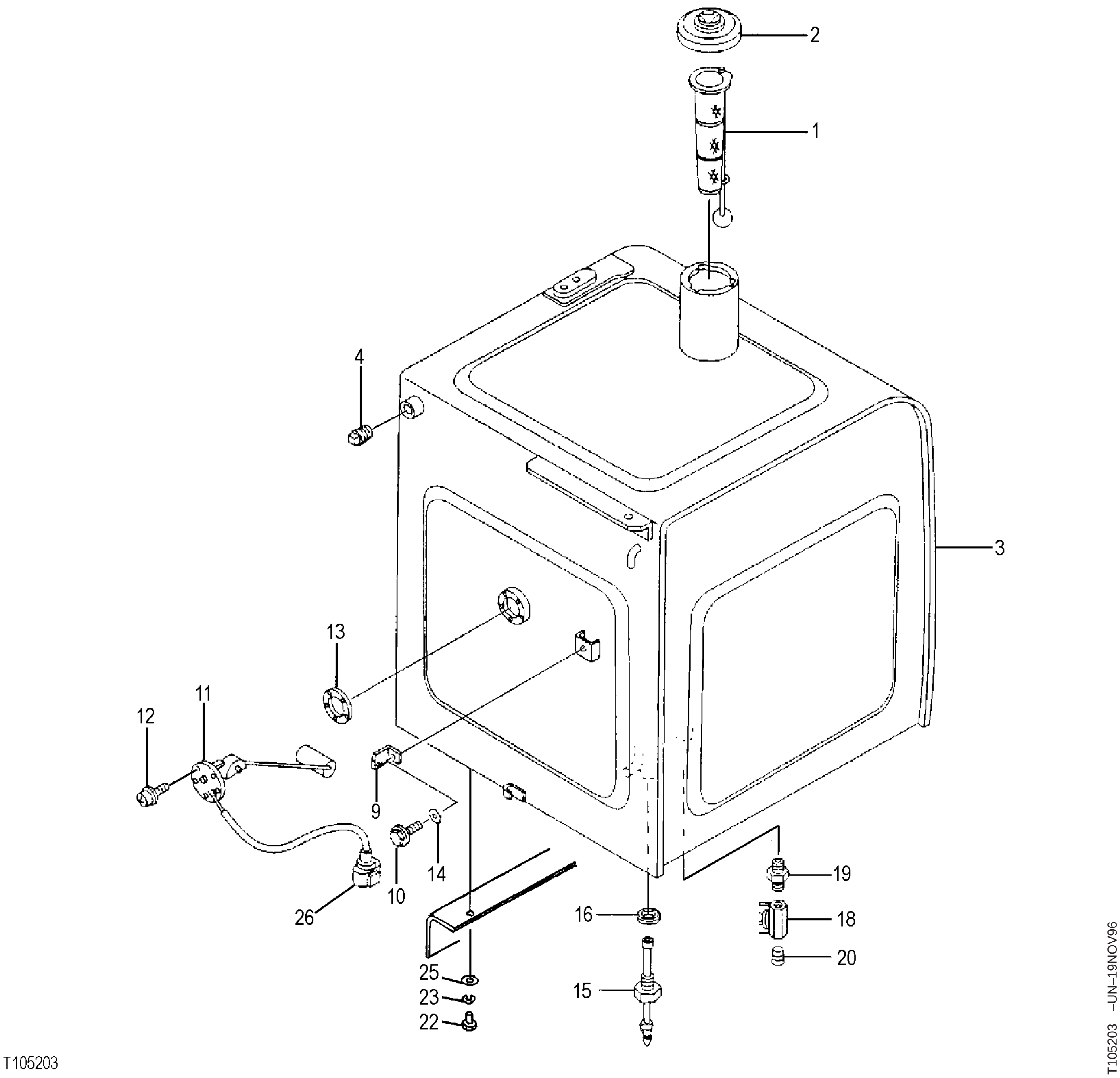
CED,OUOE003,524 –19–15MAY98–1/1

SPECIFICATIONS

Item	Measurement	Specification
Fuel Tank:		
Fuel Tank	Weight	65 kg (144 lb) approximate without fuel
Float (Fuel Level Sender) and Gasket-to-Fuel Tank Cap Screw	Torque	4.5 N•m (40 lb-in.)
Fuel Tank-to-Frame Cap Screw	Torque	205 N•m (152 lb-ft)

CED,OUOE003,1170 –19–19SEP98–1/1

REMOVE AND INSTALL FUEL TANK



1—Fuel Strainer
2—Filler Cap
3—Fuel Tank
4—Plug
9—Bracket
10—Cap Screw
11—Float (Fuel Level Sender)
12—Screw (5 used)
13—Gasket
14—Lock Washer
15—Switch
16—Sealing Washer
18—Drain Valve
19—Fitting
20—Plug
22—Cap Screw (4 used)
23—Lock Washer (4 used)
25—Washer (4 used)
26—Wiring Connector

Continued on next page TX,05,UU3896 –19–19SEP98–1/2

CAUTION: The approximate weight of fuel tank (without fuel) is 65 kg (144 lb).

Fuel Tank—Specification

Weight.. 65 kg (144 lb) approximate without fuel

1. Drain fuel from fuel tank; approximate capacity is 310 L (82 gal).

2. Disconnect wiring connector (26).

3. Apply thread lock and sealer (medium strength) to thread of screws (12). Tighten screws.

Float (Fuel Level Sender) and Gasket-to-Fuel Tank Cap Screw—Specification

Torque... 4.5 N•m (40 lb-in.)

4. Tighten cap screws (22).

Fuel Tank-to-Frame Cap Screw—Specification

Torque.. 205 N•m (152 lb-ft)

5. Fill fuel tank with proper fuel. (See Diesel Fuel in Group 0004.)

TX,05,UU3896 –19–19SEP98–2/2

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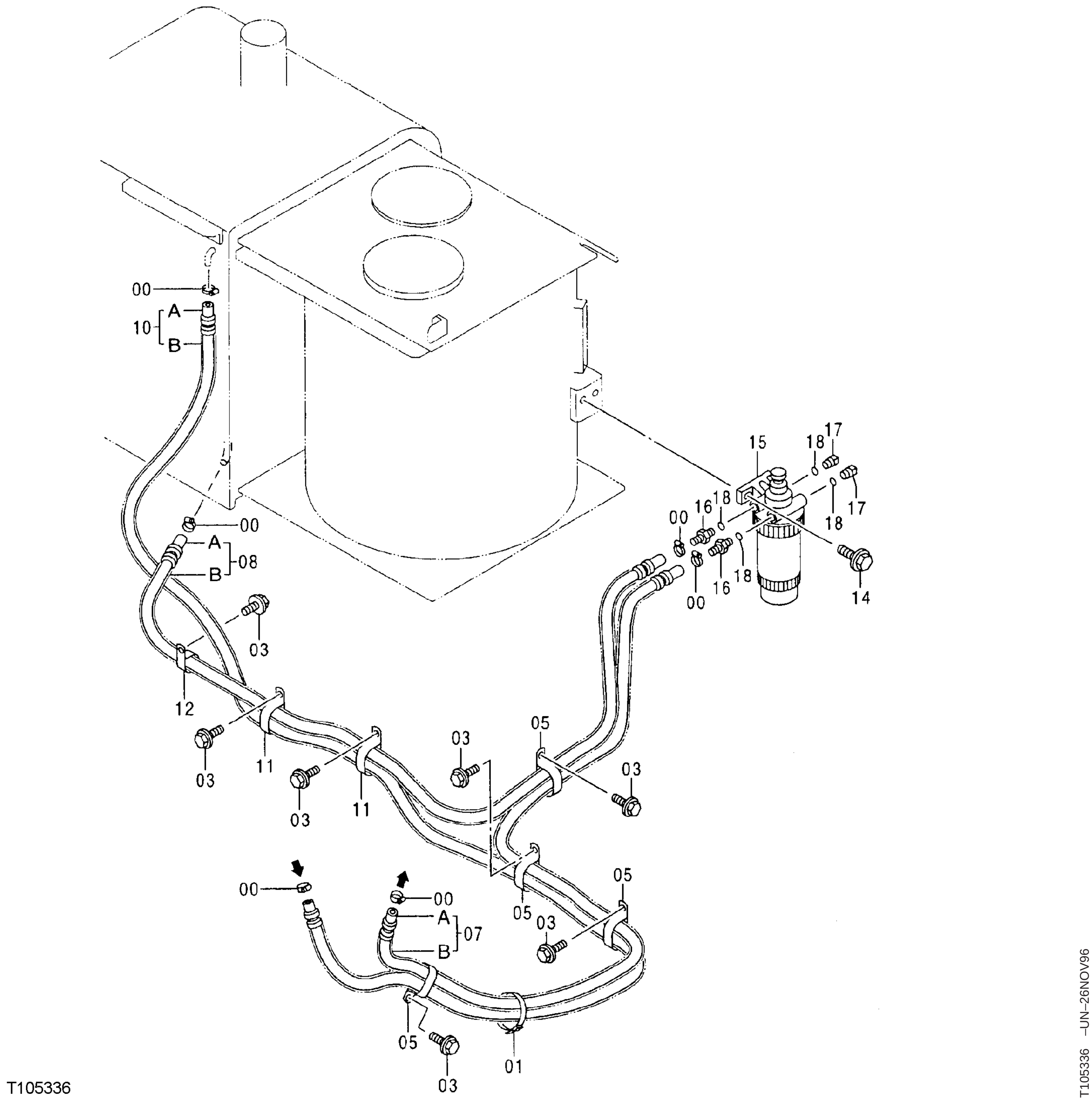
4

REMOVE AND INSTALL PRIMARY FUEL FILTER (WATER SEPARATOR)



00—Clamp (6 used)
01—Tie Band
03—Cap Screw and Lock Washer (7 used)
05—Clip (4 used)
07A—Filter-to-Transfer Pump Hose
07B—Hose Guard
08A—Fuel Tank-to-Filter Hose
08B—Hose Guard
10A—Injection Pump Overflow-to-Fuel Tank Hose
10B—Hose Guard
11—Clamp (2 used)
12—Clip
14—Cap Screw, Lock Washer and Washer
15—Primary Fuel Filter Head
16—Fitting (2 used)
17—Plug (2 used)
18—O-Ring (4 used)

Continued on next page

TX,05,UU3897 –19–21NOV96–1/2

External Fuel Supply System

1. Loosen drain valve to drain fuel into a container. Dispose of fuel properly.

2. Loosen clamps (00) to disconnect hoses (08A and 07A).

3. Remove cap screws (14) to remove primary fuel filter (15).

TX,05,UU3897 –19–21NOV96–2/2

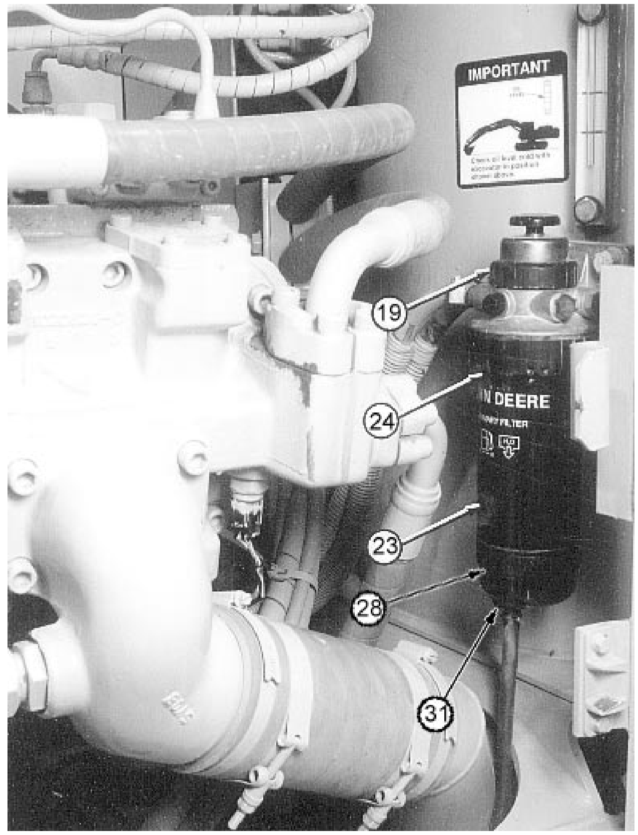
REMOVE AND INSTALL PRIMARY FUEL FILTER ELEMENT (WATER SEPARATOR)

1. Loosen drain valve (31) to drain fuel into a container. Dispose of fuel properly.

2. Loosen element retainer (24) to remove filter element (23). Remove sediment bowl (28). Clean the bowl.

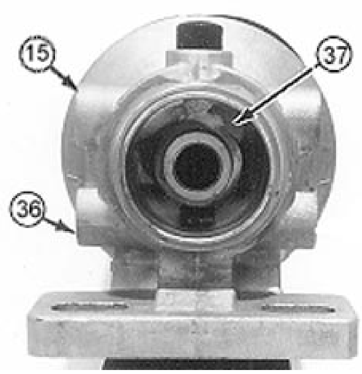
3. Slowly loosen retainer for hand primer (19) to release spring force. Remove hand primer. Remove the diaphragm and O-ring from filter head (15).

4. Remove plug from inlet passage (36). Clean debris from cavity (37) in filter head.



T105348 –UN–26NOV96

T105353B –UN–22NOV96



T105349 –UN–26NOV96

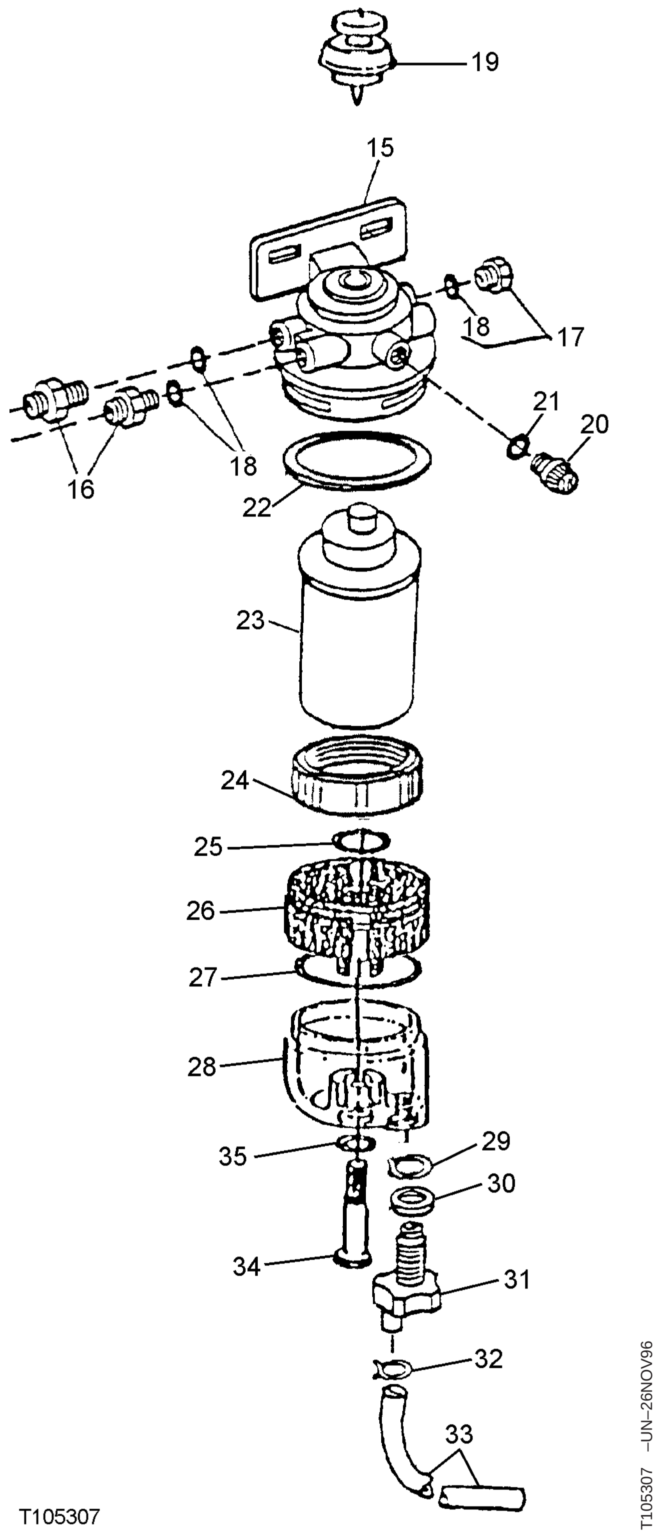
15—Filter Head
19—Hand Primer
23—Filter Element
24—Retainer
28—Sediment Bowl
31—Drain Valve
36—Inlet Passage
37—Cavity

Continued on next page TX,05,UU3898 –19–22NOV96–1/2

IMPORTANT: The filter elements for the final and primary filter are not interchangeable because of the filter medium. The final filter element has three keys and the primary filter element has four keys. To install, the keys on the filter element must align with the notches in filter head.

5. Install filter element so keys on element engage notches in filter head.

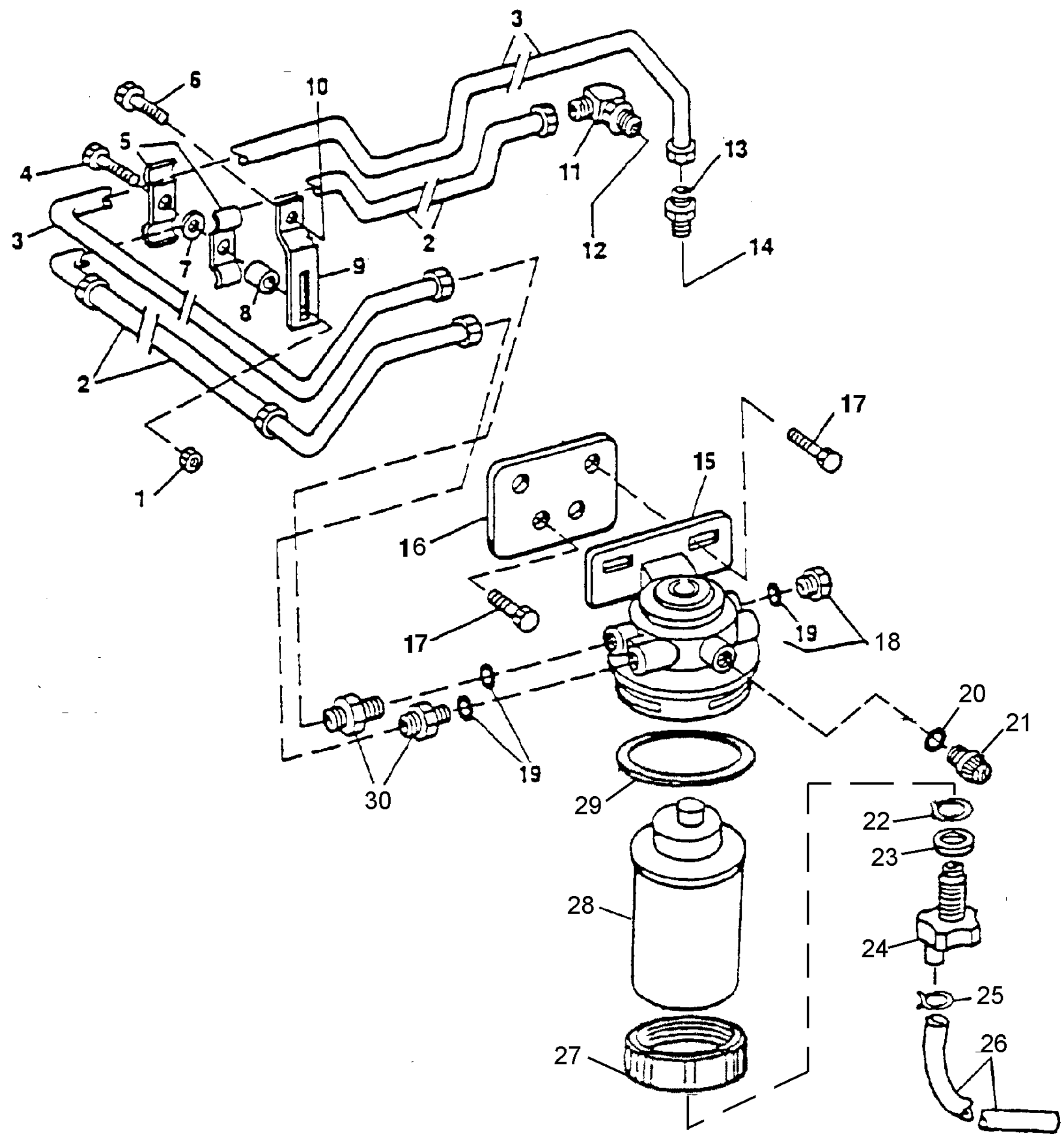
6. Bleed the fuel system. (See procedure in this group.)



15—Filter Head
16—Fitting (2 used)
17—Plug (2 used)
18—O-Ring (4 used)
19—Hand Primer
20—Bleed Screw
21—O-Ring
22—Seal
23—Primary Filter Element
24—Element Retainer
25—O-Ring
26—Sediment Bowl Adapter
27—O-Ring
28—Sediment Bowl
29—Seal
30—O-Ring
31—Drain Valve
32—Clamp
33—Drain Hose
34—Screw
35—O-Ring

TX,05,UU3898 –19–22NOV96–2/2

REMOVE AND INSTALL FINAL FUEL FILTER



T105312

T105312 –UN–26NOV96

1—Flange Nut
2—Filter-to-Injection Pump Fuel Line
3—Transfer Pump-to-Filter Fuel Line
4—Cap Screw
5—Clamp
6—Cap Screw
7—Washer
8—Washer
9—Bracket
10—To Exhaust Manifold
11—90° Elbow
12—To Injection Pump
13—Fitting
14—To Transfer Pump
15—Filter Head
16—Bracket (To Cylinder Head)
17—Cap Screw (4 used)
18—Plug
19—O-Ring (4 used)
20—O-Ring
21—Bleed Screw
22—O-Ring
23—Seal
24—Drain Valve
25—Clamp
26—Drain Hose
27—Element Retainer
28—Filter Element
29—Seal
30—Fitting (2 used)

1. Loosen drain valve (24) to drain fuel into a container. Dispose of fuel properly.
2. Disconnect lines (2 and 3). Remove cap screw (17) to remove final filter.

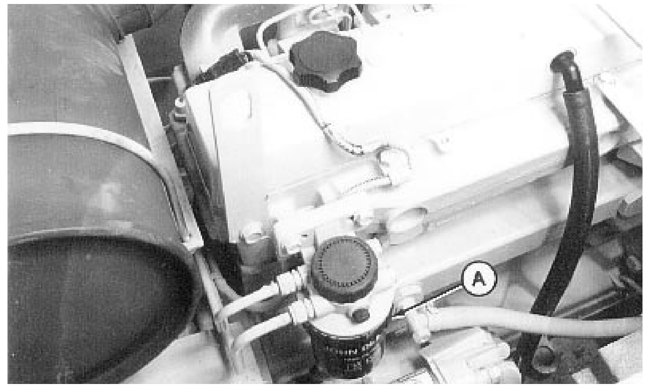
TX,05,UU3899 –19–20NOV96–1/1

REMOVE AND INSTALL FINAL FUEL FILTER ELEMENT

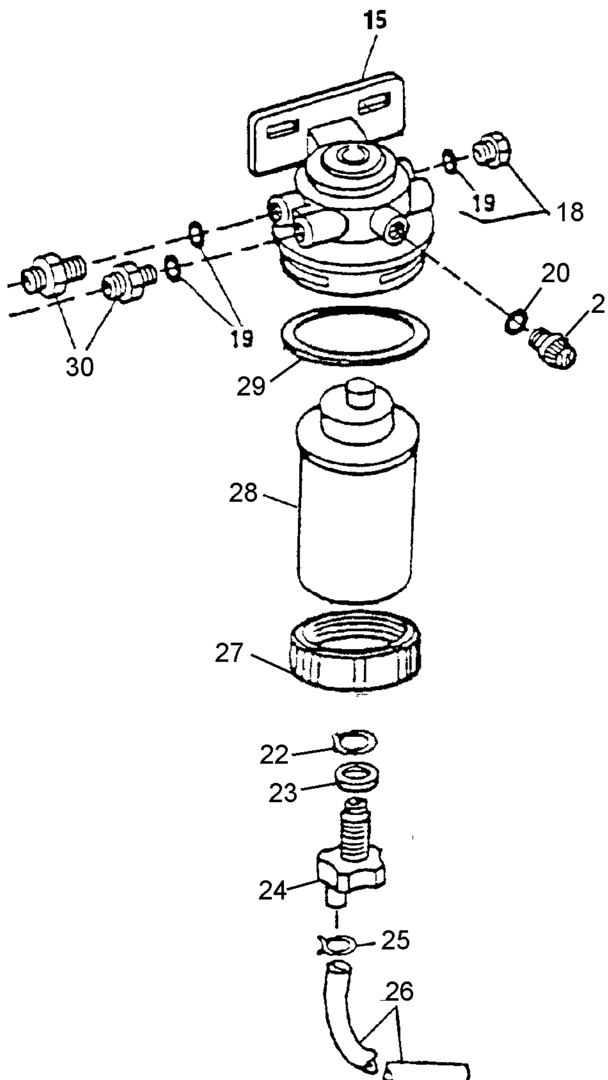
1. Loosen drain valve (24) to drain fuel into a container. Dispose of fuel properly.

2. Turn element retainer (27) to remove filter element (28).

3. Remove drain valve (24), clamp (25) and hose (26).



T102304 –UN–30JUL96



T105327

T105327 –UN–26NOV96

A—Final Fuel Filter
15—Filter Head
18—Plug
19—O-Ring (4 used)
20—O-Ring
21—Bleed Screw
22—O-Ring
23—Seal
24—Drain Valve
25—Clamp
26—Drain Hose
27—Element Retainer
28—Filter Element
29—Seal
30—Fitting (2 used)

Continued on next page

TX,05,UU3900 –19–22NOV96–1/2

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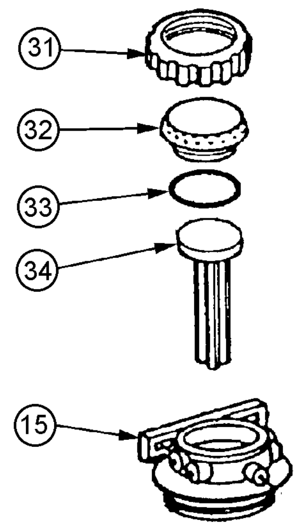
4. Remove parts (31—34) and plug from inlet passage (36) to clean debris from cavity (37) in filter head (15)

IMPORTANT: The filter elements for the final and primary filter are not interchangeable because of the filter medium. The final filter element has three keys and the primary filter element has four keys. To install, the keys on the filter element must align with the notches in filter head.

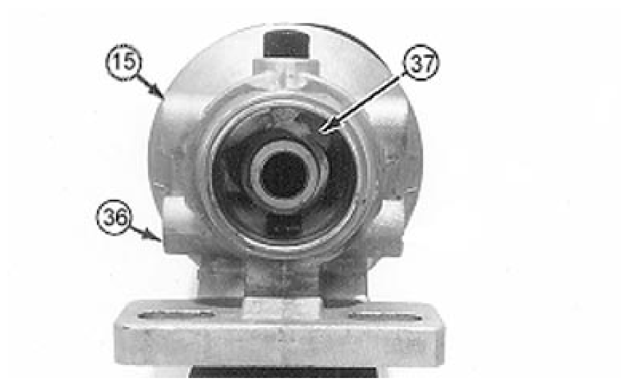
5. Install filter element so keys on element engage notches in filter head.

6. Bleed the fuel system. (See procedure in this group.)



T105324

T105324 –UN–26NOV96



T105349 –UN–26NOV96

15—Filter Head
31—Header Cap Retainer
32—Header Cap
33—O-Ring
34—Volume Plug
36—Inlet Passage
37—Cavity

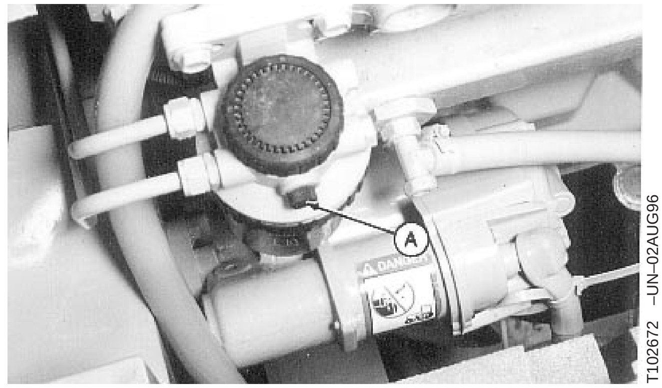
TX,05,UU3900 –19–22NOV96–2/2

BLEED FUEL SYSTEM

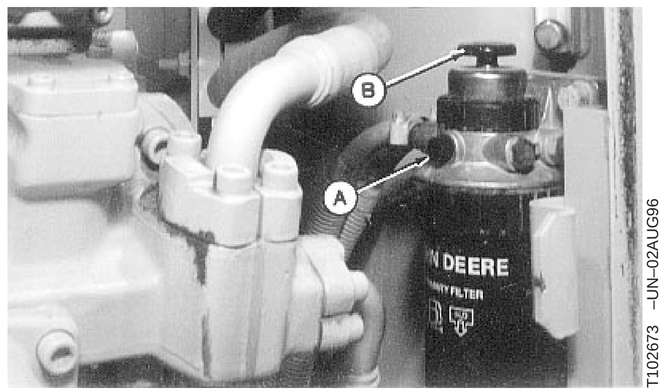
1. Loosen bleed screws (A) on the final fuel filter and primary fuel filter (water separator).

2. Push and release hand primer (B) until fuel fill the sediment bowl and fuel flows from bleed screw. Tighten bleed screw on primary filter.

3. Continue to operate hand primer until fuel flows from bleed screw of final filter. Tighten bleed screw.



Final Fuel Filter

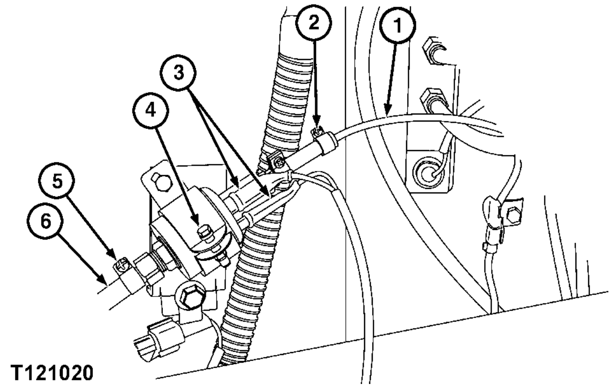


Primary Fuel Filter

A—Bleed Screws
B—Hand Primer

TX,05,UU3901 –19–22NOV96–1/1

REMOVE AND INSTALL ARCTIC/COLD WEATHER HEATER FUEL SUPPLY PUMP



T121020 –UN–14APR99

1. Remove two electrical connectors (3).
2. Loosen clamp (2) and remove line (1).
3. Remove clamp (5) and remove line (6).
4. Remove cap screw (4) and remove pump.
5. Install fuel supply pump into bracket and install cap screw (4).
6. Install line (3) and tighten clamp (2).
7. Install line (6) and tighten clamp (5).
8. Connect two electrical connectors (3).

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CED,OUOE042,5067 –19–15APR99–1/1

CHAPTER 15

SECTION 07

DAMPENER DRIVE (FLEX COUPLING) REPAIR

BLANK

Group 0752
Elements

SERVICE EQUIPMENT AND TOOLS

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

SERVICEGARD is a trademark of Deere & Company.

CED,OUOE003,1173 –19–19SEP98–1/2

Metric Lifting Eyebolt (2 used) . . . . JT05550 (M12 x 1.75)

To lift hydraulic pump.

CED,OUOE003,1173 –19–19SEP98–2/2

OTHER MATERIAL

Number	Name	Use
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to flex coupling cap screws.

LOCTITE is a trademark of Loctite Corp.

CED,OUOE003,527 –19–15MAY98–1/1

Elements

SPECIFICATIONS

Item	Measurement	Specification
Dampener Drive (Flex Coupling):		
Hydraulic Pump	Weight	170 kg (375 lb) approximate
Coupling-to-Pump Shaft Set Screw	Torque	108 N•m (80 lb-ft)
Insert-to-Flywheel Cap Screw	Torque	215 N•m (160 lb-ft)
Insert-to-Coupling Cap Screw	Torque	215 N•m (160 lb-ft)
Pump-to-Flywheel Housing Cap Screw	Torque	49 N•m (36 lb-ft)

CED,OUOE003,1174 –19–19SEP98–1/1

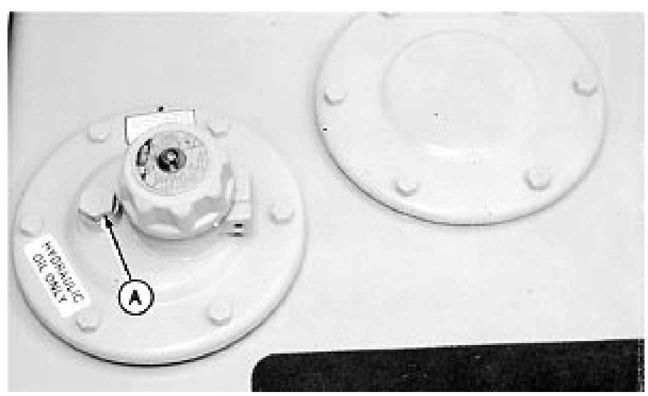
REMOVE AND INSTALL DAMPENER DRIVE (FLEX COUPLING)

CAUTION: High pressure release of oil from pressurized system can cause serious burns or penetrating injury. The hydraulic tank is pressurized. Do not remove vent plug (A). Relieve pressure by loosening vent plug.

1. Loosen vent plug (A) to relieve reservoir pressure.

2. Drain hydraulic oil tank. Approximate oil capacity is 148 L (39 gal).

3. Drain pump drive gearbox. Approximate oil capacity is 1.0 L (1.1 qt).



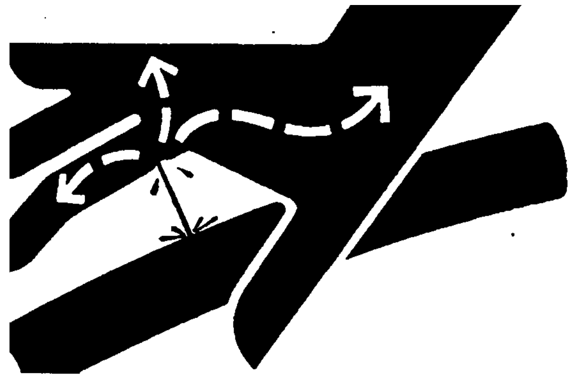
T7869AT –UN–12NOV92

A—Vent Plug

Continued on next page TX,07,UU3905 –19–19SEP98–1/3

Elements

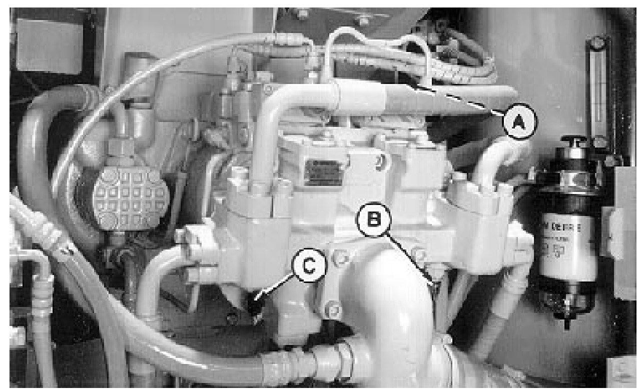
CAUTION: To avoid injury from escaping fluid under pressure, stop engine and relieve the pressure in the system before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.



4. Remove cover over pump, muffler, and muffler bracket. Pull pump away from engine to remove.

5. Disconnect all hydraulic lines from the pump.

6. Disconnect electrical connectors (A, B, and C).



A—Electrical Connector
B—Electrical Connector
C—Electrical Connector

CAUTION: Approximate weight of hydraulic pump is 170 kg (375 lb).

Hydraulic Pump—Specification

Weight.. 170 kg (375 lb) approximate

7. Install lifting eyebolts in top of hydraulic pump.

8. Attach hoist to lifting eyes using a lifting strap.

9. Remove cap screws that attach hydraulic pump to engine.

10. Pull pump away from engine to remove.

Continued on next page TX,07,UU3905 –19–19SEP98–2/3

07
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Elements

NOTE: Flex coupling may come off with pump or stay on flywheel.

11. Remove parts (A—H).

12. Replace parts as necessary.

13. Install parts (A—H). Apply thread lock and sealer (medium strength) to set screws (B) and to cap screws (D and G).

14. Tighten set screws (B).

Coupling-to-Pump Shaft Set Screw—Specification

Torque .... 108 N•m (80 lb-ft)

15. Tighten cap screws (D and G).

Insert-to-Flywheel Cap Screw—Specification

Torque .... 215 N•m (160 lb-ft)

Insert-to-Coupling Cap Screw—Specification

Torque .... 215 N•m (160 lb-ft)

16. Install pump. Tighten cap screws.

Pump-to-Flywheel Housing Cap Screw—Specification

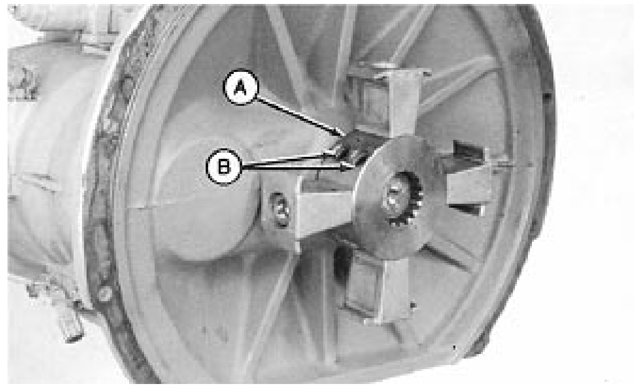
Torque .... 49 N•m (36 lb-ft)

17. Connect hydraulic hoses and lines.

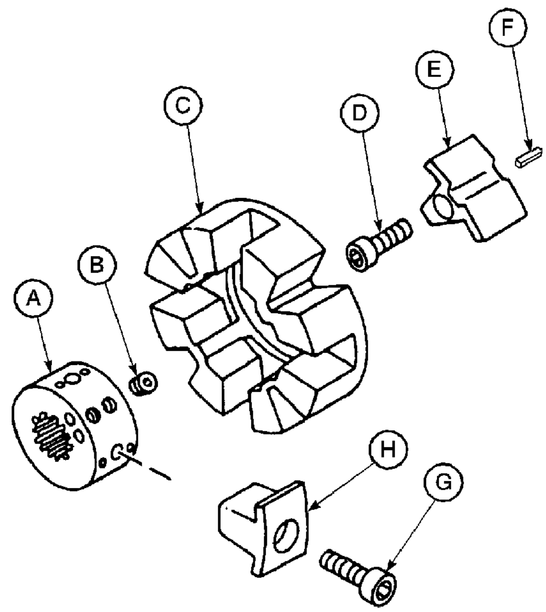
18. Connect wiring harnesses.

19. Install muffler and bracket.

20. Do Hydraulic Pump and Drive Gearbox Start-Up Procedure. (See procedure in Group 3360.)



T7685JE –UN–13MAY92



T105285

T105285 –UN–20NOV96

A—Coupling
B—Set Screw (2 used)
C—Flex Coupling
D—Cap Screw (4 used)
E—Insert (4 used)
F—Spring Pin (4 used)
G—Cap Screw (4 used)
H—Insert (4 used)

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TX,07,UU3905 –19–19SEP98–3/3

CHAPTER 16

SECTION 16

ELECTRICAL SYSTEM REPAIR

BLANK

Group 1671
Batteries, Support, and Cables

SERVICE EQUIPMENT AND TOOLS

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

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CED,OUOE003,1221 –19–26SEP98–1/4

Battery Post/Clamp Cleaner JT05838

To clean corrosion off battery posts and clamps.

CED,OUOE003,1221 –19–26SEP98–2/4

Coolant/Battery Tester JT05460

To check battery specific gravity.

CED,OUOE003,1221 –19–26SEP98–3/4

Battery Load Tester JT05832

To check battery capacity.

CED,OUOE003,1221 –19–26SEP98–4/4

SPECIFICATIONS

Item	Measurement	Specification
Fast and Slow Idle:		
Engine Slow Idle	Speed	900 ± 25 rpm
Engine Auto-Idle	Speed	1200 ± 25 rpm
Engine E (Economy) Mode	Speed	1980 ± 25 rpm
Engine Fast Idle in Standard Mode	Speed	2180 ± 25 rpm
Batteries:		
Battery	Voltage	12 Volts
	Cold Cranking Amps	1400 amps at -18°C (0°F)
	Reserve Capacity	440 minutes at 25 amps and 27°C (80°F)
	BCI Group Size	4D
	Electrolyte Specific Gravity	1.265—1.280 fully charged
Electrical System	Voltage	24 Volts
Battery Clamp-to-Battery Terminal Nut	Torque	18 N•m (156 lb-in.)

16
1671
2

CED,OUOE003,1176 –19–19SEP98–1/1

HANDLE BATTERIES SAFELY


TS204 –UN–23AUG88

CAUTION: An explosive gas is produced while batteries are in use or being charged. Keep flames or sparks away from the battery area. Make sure the batteries are charged in a well ventilated area.

Never lay a metal object on top of a battery as a short circuit can result.

Battery acid is harmful on contact with skin or fabrics. If acid spills, follow these first aid tips:

1. Immediately remove any clothing on which acid spills.
2. If acid contacts the skin, rinse the affected area with running water for 10 to 15 minutes.
3. If acid comes into contact with the eyes, flood the eyes with running water for 15 to 30 minutes. See a doctor at once. Never use any medication or eye drops unless prescribed by the doctor.
4. To neutralize acid spilled on the floor, use one of the following mixtures: 0.5 kg (1 lb) of baking soda in 4 L (1 gal) of water, or 0.4 L (1 pt) of household ammonia in 4 L (1 gal) of water.
5. Acid from the batteries can also damage the paint and metal surfaces of the machine. Avoid over filling the battery cells.

TX,16,UU3537 –19–04MAR97–1/1

PROCEDURE FOR TESTING BATTERIES

1. VISUAL CHECK

   a. Check for damage such as cracked or broken case and electrolyte leakage.

   If damage is seen, replace battery.

   b. Check electrolyte level. (See procedure in this group.)

   If low, add distilled water to specified level and charge battery.

   c. Check terminals for corrosion.

   If corroded, clean using a wire brush or battery post cleaner such as JT05838 Battery Post/Clamp Cleaner.

   d. Check posts for looseness.

   If posts are loose, replace battery.

2. HYDROMETER TEST

   a. Check specific gravity with a hydrometer or battery tester such as JT05460 Coolant/Battery Tester.

   b. Record specific gravity reading for each cell.

   c. If high and low readings vary LESS than 0.050 and average specific gravity is between 1.225 and 1.280, battery is fully charged, go to LOAD TEST.

   d. If high and low readings vary LESS than 0.050 and average specific gravity is LESS than 1.225, charge battery and repeat test. If average specific gravity is still LESS than 1.225, replace both batteries.

   e. If high and low readings vary MORE than 0.050, charge battery and repeat test. If high and low readings still vary MORE than 0.050, replace both batteries.

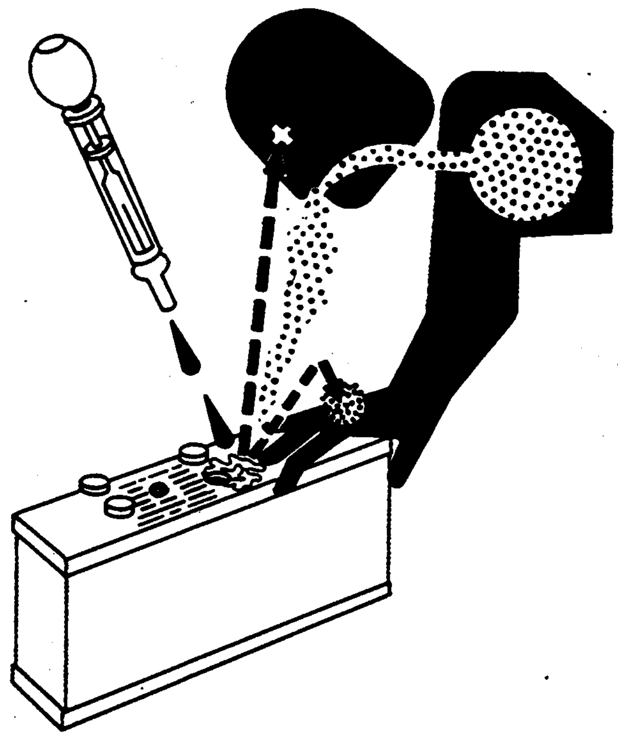
3. LOAD TEST

   a. Check battery capacity with a load tester such as JT05832 Battery Load Tester. Follow tester manufacturer's instructions for proper load test procedures.

   b. If one battery fails load test, replace both batteries.

TX,16,UU3538 –19–19SEP98–1/1

CHECK BATTERY ELECTROLYTE LEVEL AND TERMINALS



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.

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.**

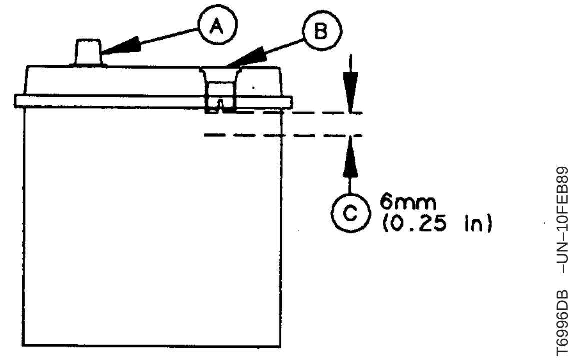
1. Remove hold-down clamps.

2. Remove battery covers.

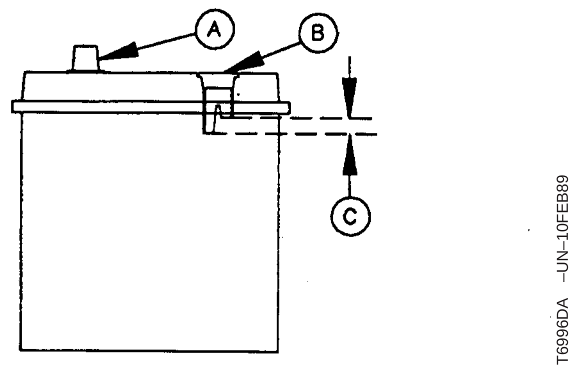
Continued on next page TX,16,UU3540 –19–01SEP95–1/2

IMPORTANT: During freezing weather, batteries must be charged after water is added to prevent battery freezing. Charge battery using a battery charger or by running the engine.

3. Fill each cell to within specified range with distilled water. DO NOT overfill.



Single Level Fill Tube Application



Dual Level Fill Tube Application

A—Battery Post
B—Fill Tube
C—Electrolyte Level Range

16
1671
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TX,16,UU3540 –19–01SEP95–2/2

USING BOOSTER BATTERIES—24-VOLT SYSTEM

1. Turn key switch to OFF.

Continued on next page TX,16,UU3541 –19–19SEP98–1/3

CAUTION: Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

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

Always remove grounded (-) battery clamp first and replace it last.

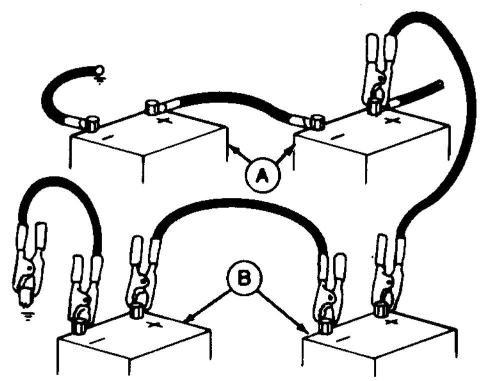
TS204 —UN—23AUG88

IMPORTANT: Machine electrical system is 24-volt negative (-) ground. Use only 24-volt booster batteries Disconnect PVC and monitor controller from harness in case batteries are connected incorrectly.

2. Disconnect engine and pump controller and monitor controller connectors and connect booster batteries (B) to machine batteries (A) making the last connection at machine frame, away from batteries.

   Rock the clamps to make sure they make good contact.

   When possible, use equipment with a switch in the cable that connects booster batteries to machine batteries.



T7233JN —UN—21MAY90

Booster Batteries, 2-Battery Application

A—Machine Batteries
B—Booster Batteries

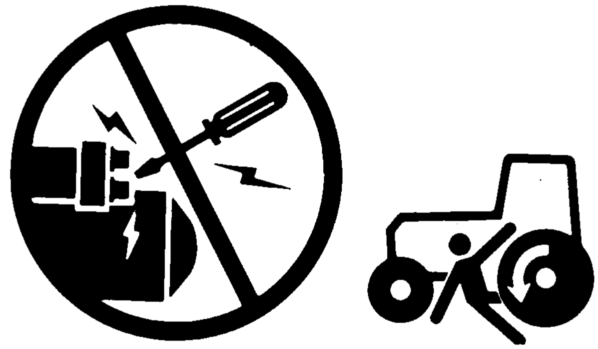
Continued on next page

TX,16,UU3541 –19–19SEP98–2/3

CAUTION: Avoid possible injury or death from machinery runaway.

Do not start engine by shorting across starter terminals. Machine will start in gear if normal circuitry is bypassed.

NEVER start engine while standing on ground. Start engine only from operator's seat, with transmission in neutral or park.



TS177 –UN–11JAN89

3. Start engine while seated on operator's seat.

   After engine starts, disconnect clamp at machine frame first and then disconnect remaining clamps.

TX,16,UU3541 –19–19SEP98–3/3

CHARGE BATTERY

CAUTION: Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

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

Always remove grounded (-) battery clamp first and replace it last.

TS204 –UN–23AUG88

16
1671
8

IMPORTANT: When charging a battery in the machine, battery cables and engine and pump controller connectors must be disconnected to avoid damage to electrical components and controllers if battery charger cables are inadvertently connected to battery incorrectly.

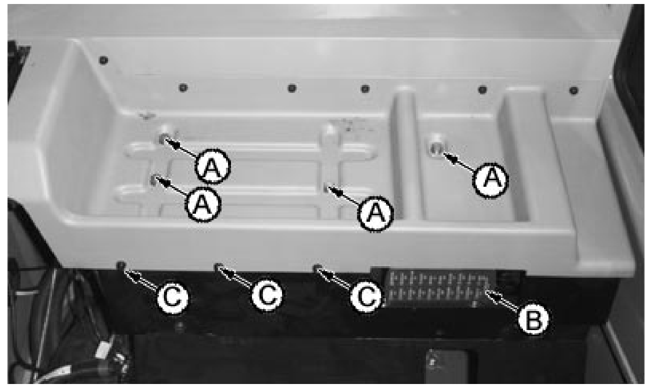
NOTE: Follow manufacturer's instructions to use battery charger as a booster to start engine.

1. Disconnect all battery cables starting at the negative (-) ground cable.

Continued on next page

TX,16,UU3955 –19–19SEP98–1/3

2. Remove cap screws (A and C) and the fuse box cover (B) to remove the rear console cover.



A—Cap Screw
B—Cover
C—Cap Screw

TX,16,UU3955 –19–19SEP98–2/3

3. Loosen EPC connectors and remove connectors (A—C).

4. Turn charger off before connecting or disconnecting it.

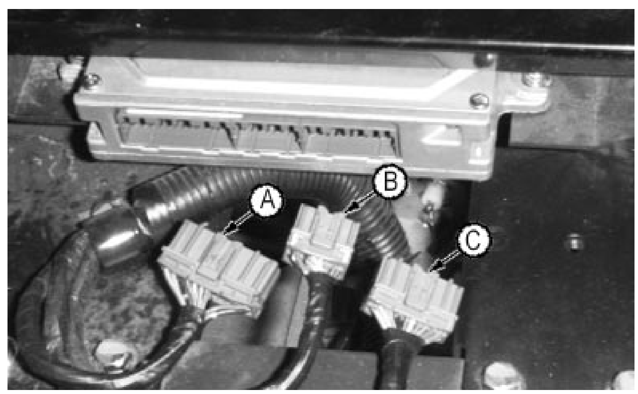
5. Charge battery following manufacturer's instructions for your battery charger.

6. After battery is charged, connect the positive (+) cable, then connect the negative (-) ground cable.

7. Push connectors into EPC controller.

8. Install rear console cover and fuse box cover

9. After connecting engine and pump controller, do the Engine Speed Learning Procedure. (See procedure in this group.)



A—Connector
B—Connector
C—Connector

TX,16,UU3955 –19–19SEP98–3/3

ENGINE SPEED LEARNING PROCEDURE

When the following components are repaired or replaced, or when engine speeds deviate from specification, the engine speed learning procedure must be performed.

- Engine
- Engine speed control cable
- Engine control motor and angle sensor
- Engine and pump controller
- Fast and slow idle stop screws

1. Stop engine. Ignition key OFF.

2. Disconnect the laptop computer from test connector.

   Wait for 5 seconds.

Continued on next page

TX,05,GG2769 –19–18SEP98–1/2

NOTE: The three position switch, protected by an angle guard, is located just below and behind the computer test connector.

3. Push engine learning switch (C) up to the TOP position. The switch is a three-position switch. Make sure it is in the top position.
4. Turn key switch ON. Wait for 5 seconds.
5. Turn key switch OFF. Wait for 5 seconds.
6. Push engine learning switch to MIDDLE position.
7. Check engine speeds.

Engine Slow Idle—Specification

Speed .... 900 ± 25 rpm

Engine Auto-Idle—Specification

Speed .... 1200 ± 25 rpm

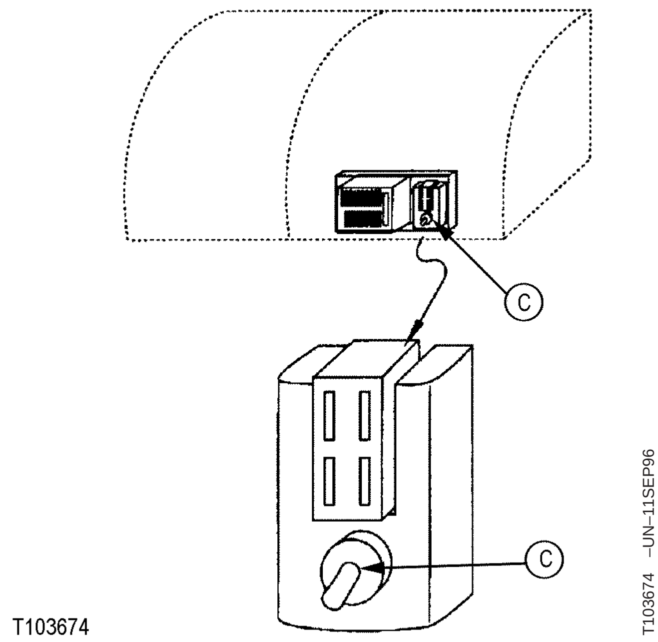
Engine E (Economy) Mode—Specification

Speed .... 1980 ± 25 rpm

Engine Fast Idle in Standard Mode—Specification

Speed .... 2180 ± 25 rpm

NOTE: The laptop computer with the excavator diagnostic software can be used to change the default speeds for slow idle, auto-idle, economy mode, and fast idle in standard mode. See Excavator Diagnostics Program Special Function—Engine Speed Adjustment in Group 9025-25.



A—Engine Learning Switch

REMOVE AND INSTALL BATTERIES

CAUTION: Prevent personal injury from exploding battery. Keep sparks and flames away from battery.

TS204 –UN–23AUG88

1. Disconnect ground cables (E).
2. Disconnect positive cable (C) and jumper cable (D).
3. Remove parts (B—F).
4. Remove batteries.
5. Check cables and clamps for wear or corrosion. Make sure batteries are fully charged.

IMPORTANT: If one battery in a 24-volt system has failed, replace both batteries.

6. Install batteries.

Battery—Specification

Voltage	12 Volts
Cold Cranking Amps	1400 amps at -18°C (0°F)
Reserve Capacity	440 minutes at 25 amps and 27°C (80°F)
BCI Group Size	4D
Electrolyte Specific Gravity	1.265—1.280 fully charged

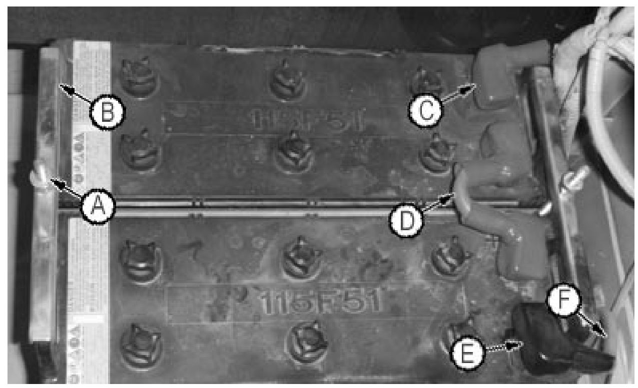
Electrical System—Specification

Voltage	24 Volts

7. Clean battery posts and cables.
8. Install parts (A and B).
9. Connect positive cables (C), ground cables (E) and jumper cable (D). Tighten terminal nuts.

Battery Clamp-to-Battery Terminal Nut—Specification

Torque	18 N•m (156 lb-in.)



T105555B –UN–10DEC96

A—Nut (2 used)
B—Bracket (2 used)
C—Positive Cable
D—Jumper Cable
E—Ground Cable
F—Ground Cable

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1671
12

TX,16,GG2754 –19–19SEP98–1/1

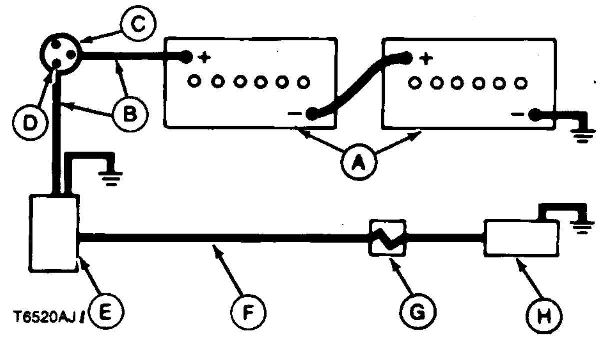
ADDING 12-VOLT ACCESSORIES

IMPORTANT: This machine has a 24-volt electrical system. Installing 12-volt accessories without addition of 24-volt-to-12-volt converter may cause battery failure. See your John Deere dealer.

When possible, use 24-volt accessories. If 12-volt accessories are added, use a 24-volt-to-12-volt converter. Converters are available from your John Deere dealer (see the Industrial Equipment Attachment Guide) or electronic retail stores. This converter may be wired into the ACC terminal of the ignition switch (see drawing).

Converter capacity requirements depend on the load of the accessories installed. Follow electronic dealer and manufacturer's recommendations to determine the capacity of the converter required and its installation requirements.

DO NOT connect an accessory to one battery. Connecting a 12-volt accessory to one battery will cause one battery to overcharge, and the other battery to undercharge, causing battery failure.



T6520AJ1 –UN–18OCT88

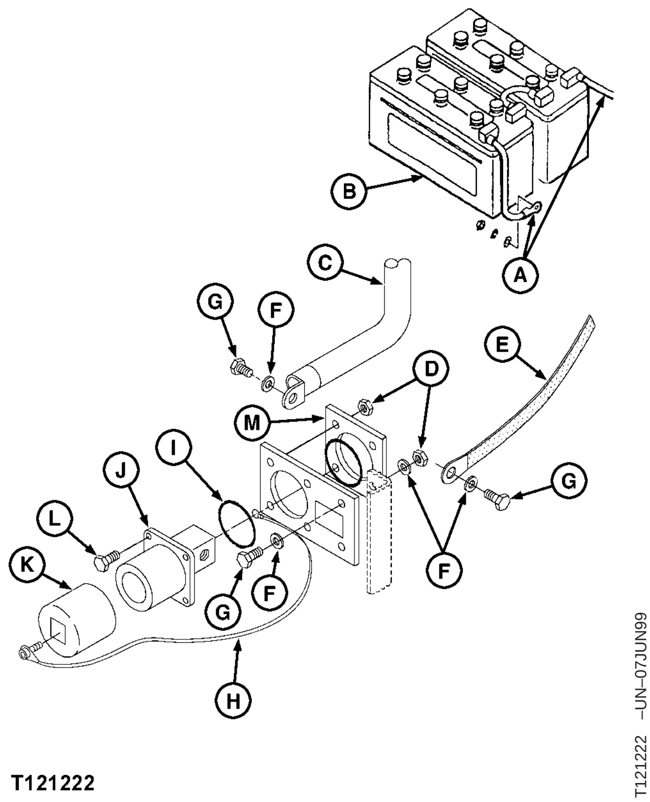
A—Battery
B—24 Volts
C—Ignition Switch
D—ACC Terminal
E—Converter
F—12 Volts
G—In-Line Fuse
H—12-Volt Accessory

16
1671
13

TX,16,UU3545 –19–30SEP94–1/1

REMOVE AND INSTALL 24-VOLT SLAVE RECEPTACLE

1. Disconnect negative (-) battery cables (A) from battery (B).
2. Remove cap screws (G) and washers (F).
3. Disconnect cables (C and E).
4. Remove cover (K).
5. Remove cap screws (L) and flange nuts (D).
6. Remove 24-volt slave receptacle (J), backing plate (M), insulators (I) and cover keeper (H). Replace parts as necessary.



T121222

A—Negative (-) Battery Cable
B—Battery
C—Positive (+) Cable
D—Flange Nut (4 used)
E—Negative (-) Cable
F—Washer (2 used)
G—Cap Screw (2 used)
H—Cover Keeper
I—Insulator (2 used)
J—24-Volt Slave Receptacle
K—Cover
L—Cap Screw (4 used)
M—Backing Plate

16
1671
14

CED,OUOE020,55 –19–20APR99–1/1

Group 1672
Alternator, Regulator, and Charging System Wiring

SERVICE EQUIPMENT AND TOOLS

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

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CED,OUOE003,1222 –19–26SEP98–1/2

15 mm Wrench

To pull tension adjuster idler away from belt.

CED,OUOE003,1222 –19–26SEP98–2/2

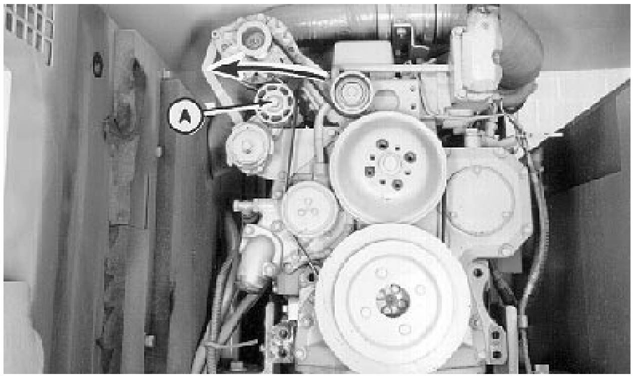
SPECIFICATIONS

Item	Measurement	Specification
Alternator:		
5/16 in. Cap Screw	Torque	27 N•m (20 lb-ft)
3/8 in. Cap Screw	Torque	47 N•m (35 lb-ft)
Ground Terminal Nut	Torque	2.3 N•m (20 lb-in.)
BAT (Output) Terminal Nut	Torque	3.6 N•m (32 lb-in.)

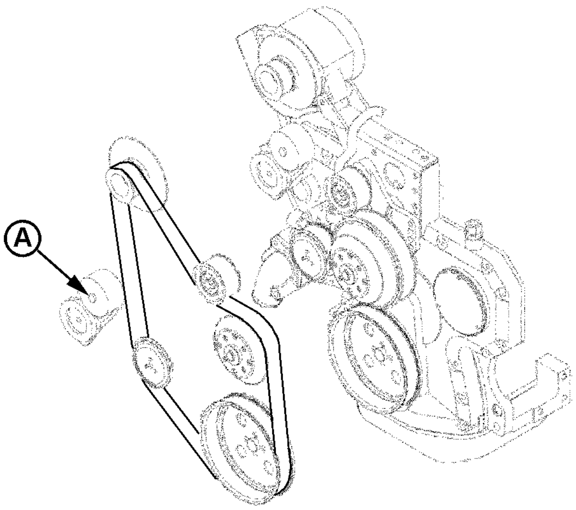
AG,OUOE003,7922 –19–27APR98–1/1

INSPECT, REMOVE, AND INSTALL FAN BELT

1. Check belt regularly for wear, especially for cracks at the bottom of grooves and for frayed edges.
2. If necessary, replace belt.
3. Pull tension adjuster idler away from belt using a 15 mm wrench on hex head of cap screw (A) in idler.
4. Remove the old belt.
5. Install the belt around all pulleys except adjuster idler.
6. Pull adjuster idler out just far enough to slide belt behind idler.
7. Slowly release adjuster idler against belt.



T105164 –UN–14NOV96



T108219

T108219 –UN–25MAR97

A—Hex Head of Cap Screw

TX,16,UU3251 –19–19SEP98–1/1

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2

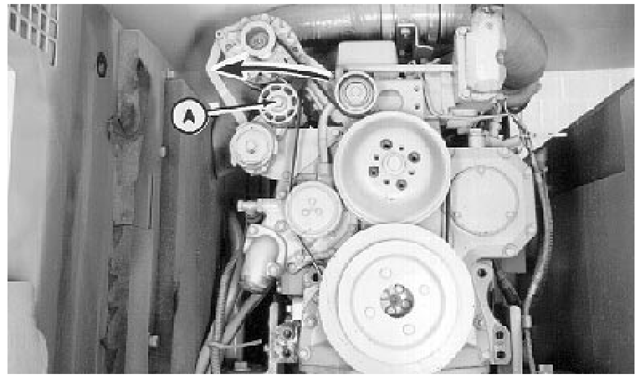
REMOVE AND INSTALL ALTERNATOR

IMPORTANT: Always disconnect battery negative (-) cables before removing alternator or a short circuit could result.

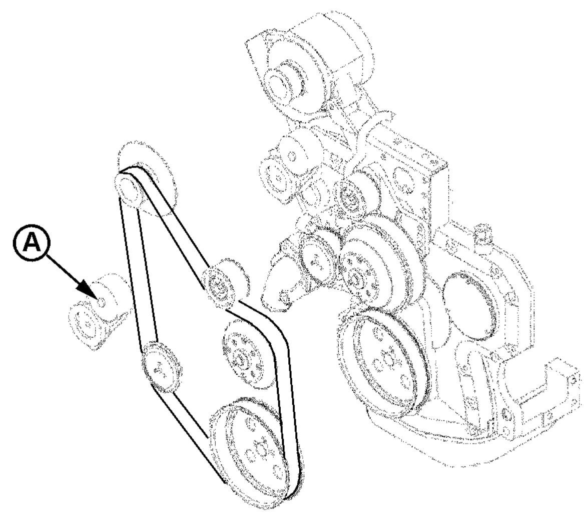
1. Disconnect the battery negative (-) cables.

2. Pull tension adjuster idler away from belt using a 15 mm wrench on hex head of cap screw (A) in idler.

3. Slide belt off alternator pulley.



T105164 –UN–14NOV96



T108219

T108219 –UN–25MAR97

A—Hex Head of Cap Screw

Continued on next page

TX,16,UU3548 –19–19SEP98–1/2

Alternator, Regulator, and Charging System Wiring

4. Disconnect wiring leads (C—E).

5. Remove cap screw and washer (A) and cap screw and nut (B) to remove alternator.

6. Replace parts as necessary.

7. Install alternator. Install lower cap screw and nut (B) so head of cap screw is toward belt.

8. Install cap screw and washer (A).

9. Tighten cap screw (A).

5/16 in. Cap Screw—Specification

Torque .... 27 N•m (20 lb-ft)

10. Tighten cap screw and nut (B).

3/8 in. Cap Screw—Specification

Torque .... 47 N•m (35 lb-ft)

11. Connect wiring leads. Tighten ground terminal nut.

Ground Terminal Nut—Specification

Torque .... 2.3 N•m (20 lb-in.)

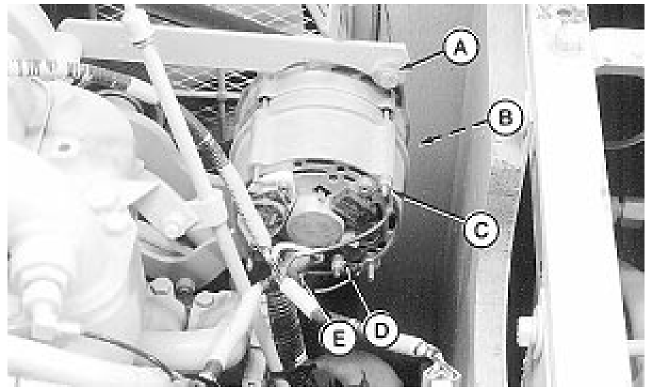
12. Tighten output BAT terminal nut.

BAT (Output) Terminal Nut—Specification

Torque .... 3.6 N•m (32 lb-in.)

13. Pull adjuster idler out just far enough to slide belt over alternator pulley and behind idler.

14. Slowly release adjuster idler against belt.



T8314AC –UN–06SEP94

A—Cap Screw, Washer
B—Cap Screw, Nut
C—Ground Terminal Wiring Lead
D—D+ Terminal (BLU/YEL)
E—BAT Terminal Wiring Lead

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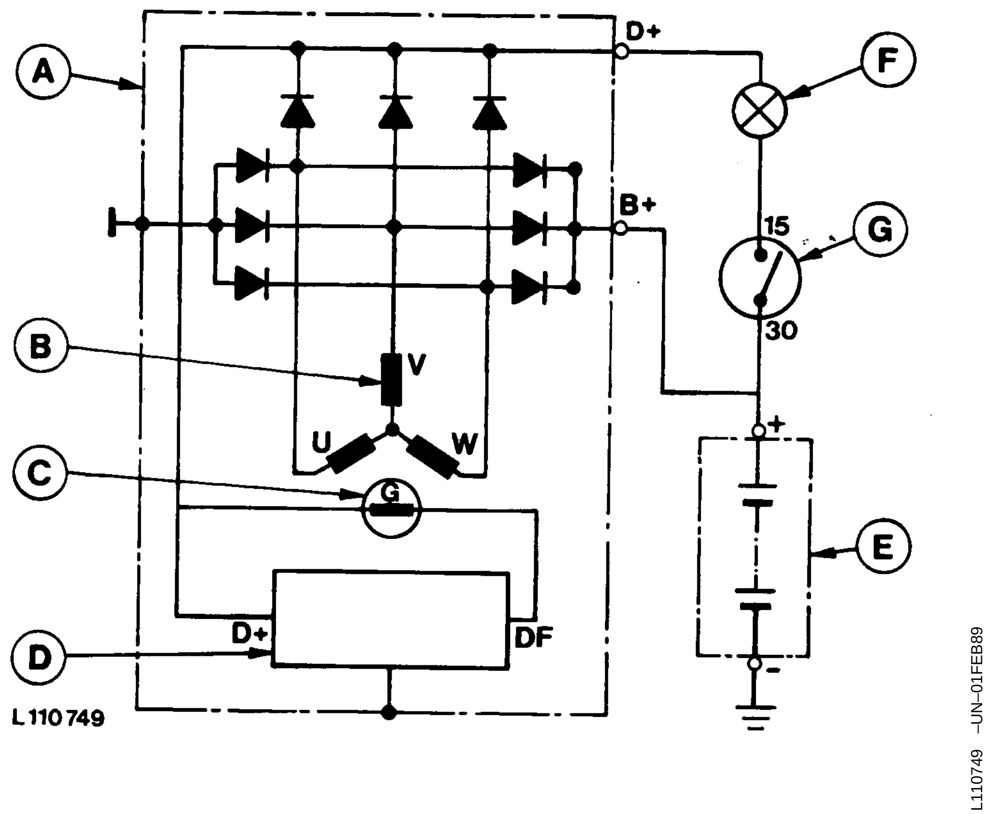
1672
4

TX,16,UU3548 –19–19SEP98–2/2

Group 05
Robert Bosch Theory of Operation

FUNCTION OF ALTERNATOR



A—Alternator
B—Current Coil (Stator)
C—Exciting Coil (Rotor)
D—Regulator
E—Battery
F—Alternator Indicator Light
G—Starting Motor Switch

The Bosch 14-volt alternator is a 12-pole, self-induced synchronous generator. The current coil is located in the stator, and the exciting coil in the rotor. The exciting current is supplied by the rectifier (terminal D+) through the regulator, two carbon brushes and slip rings to the exciting coil in the rotor.

The alternator is normally driven by a fan belt from the engine crankshaft. The rotor is supported by two permanently lubricated bearings.

The alternator generates alternating current which is then transformed into direct current by the rectifier diodes.

The alternator windings are Y-connected. The coil ends U, V and W (see illustration) are connected to the rectifier diodes. The current flows through the diode and terminal B+ directly to the positive pole of the battery.

Alternator current is generated in each stator coil (B) of the alternator. During one revolution of the rotor (C), the voltage in the stator coil rises from 0 to the positive maximum, drops to 0, rises to the negative maximum and again drops to 0. Then the process is repeated.

As the stator coils are Y-connected, a three-phase or alternating current is generated. The individual phases are shifted 120°.

Continued on next page RG,RG34710,2143 –19–15Mar97–1/2

Robert Bosch Theory of Operation

A sealed electronic regulator is used to regulate the alternator voltage. This regulator, which cannot be adjusted, limits the alternator voltage to approximately 14 volts.

RG,RG34710,2143 –19–15Mar97–2/2

Group 10
Robert Bosch Alternator Repair

SPECIAL OR ESSENTIAL TOOLS

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

SERVICEGARD is a trademark of Deere & Company.

RG,RG34710,2144 –19–15Mar97–1/2

Digital Multimeter JT05791

Test electrical components for voltage, resistance, or current flow. It is especially good for measuring low voltage or high resistance circuits.

RW11274 –UN–12DEC88

RG,RG34710,2144 –19–15Mar97–2/2

ROBERT BOSCH CHARGING CIRCUIT SPECIFICATIONS

			Rating	
John Deere Part No.	**Robert Bosch Part No.**	**Alternator Model/Series**	**Volts**	**Amps**
AE53101	9 120 060 042	K1	12 (14)	120
AH137883	0 120 484 011	K1	12 (14)	95
AL78690	0 120 484 016	K1	12 (14)	85
AL78692	0 120 484 017	K1	12 (14)	120
AL78689	0 120 488 267	K1	12 (14)	55
AL81436	0 120 488 290	K1	12 (14)	55
AL81437	0 120 484 020	K1	12 (14)	85
AL81438	0 120 488 019	K1	12 (14)	120
AT161324	0 120 488 206	K1	24 (28)	45
AT168711	0 120 468 136	N1	24 (28)	80
AT173624	0 120 488 205	K1	12 (14)	65
AT175194	9 120 060 041	K1	12 (14)	95
AT175195	9 120 060 039	K1	24 (28)	45
AT175839	0 120 468 055	N1R	12 (14)	135
AT85458	0 122 469 004	N1	24 (28)	50
AZ38462	0 120 484 012	K1	12 (14)	95
RE36267	0 120 484 011	K1	12 (14)	90
RE36268	0 120 468 055	N1	12 (14)	135

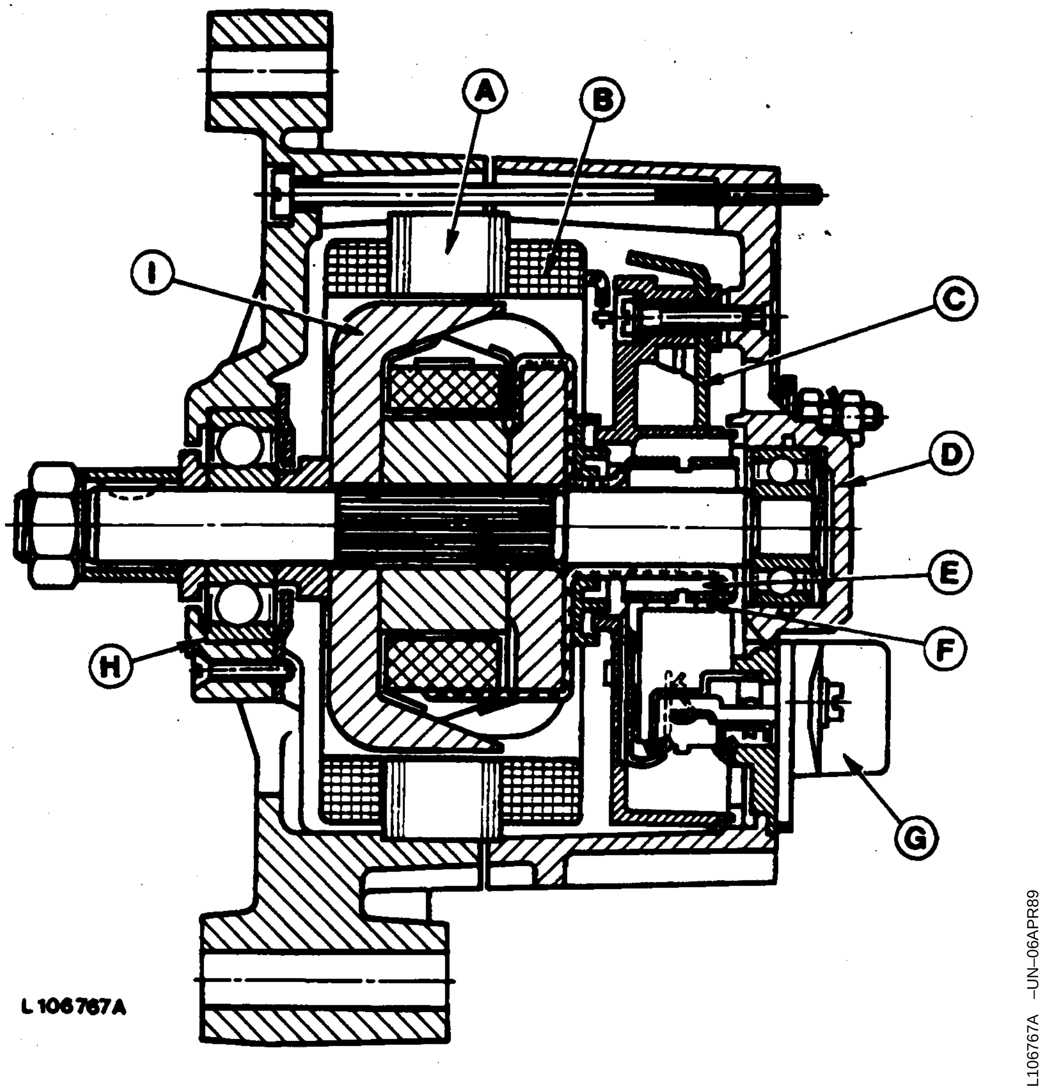
Item	Specification
Minimum length of carbon brushes	5 mm (0.2 in.)
When soldering new brushes, make sure they do not protrude beyond brush bracket by more than	10 mm (0.4 in.)
Minimum slip ring diameter	26.8 mm (1.055 in.)
Maximum radial run-out of slip rings	0.03 mm (0.0012 in.)
Maximum radial run-out of rotor shaft	0.05 mm (0.002 in.)
Stator winding resistance	0.40—0.44 ohms
Rotor winding resistance	4.0—4.40 ohms
Armature end play	0.1—0.3 mm (0.004—0.012 in.)

Torques

Drive and frame-to-end frame	4.0—5.5 N•m (33—48 lb-in.)
Fan pulley shaft nut	35—45 N•m (25—32 lb-ft)

RG,RG34710,2145 –19–15Mar97–1/1

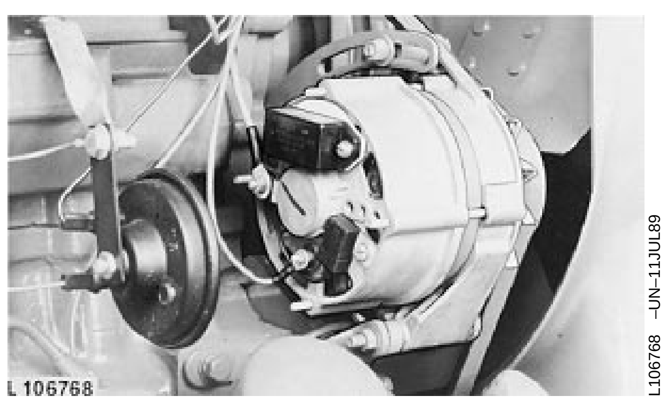
ALTERNATOR, SECTION VIEW



A—Stator Assembly
B—Stator Winding
C—Heat Sink
D—Bearing and End Frame
E—Slip Ring
F—Carbon Brush
G—Regulator
H—Bearing and Drive End Frame
I—Rotor

RG,RG34710,2146 –19–15Mar97–1/1

ALTERNATOR—REMOVAL



Disconnect ground straps of battery.

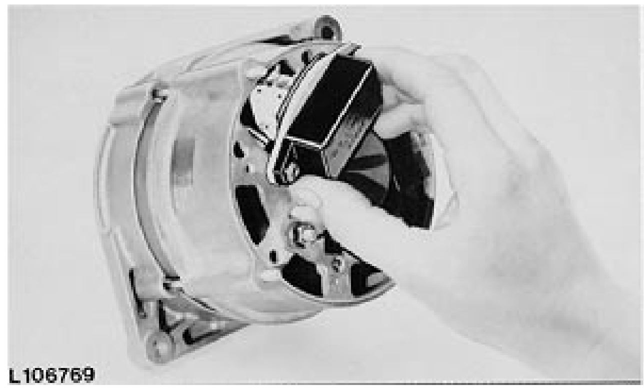
Disconnect cables from alternator.

Remove alternator per instructions in machine technical manual.

RG,RG34710,2147 –19–15Mar97–1/1

REMOVING BRUSH HOLDER WITH REGULATOR

NOTE: Before dismantling alternator, first remove brush holder with regulator so carbon brushes will not break during disassembly.



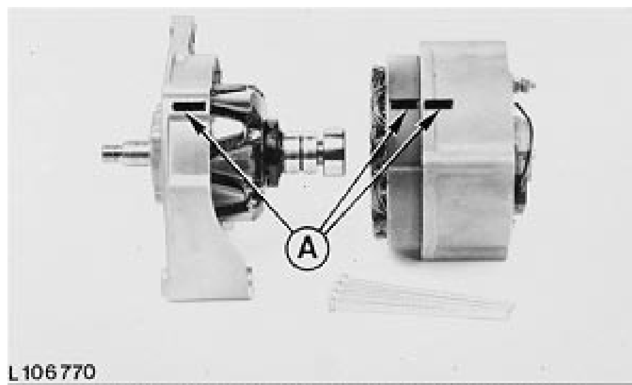
L106769 –UN–11JUL89

RG,RG34710,2148 –19–15Mar97–1/1

ALTERNATOR—DISASSEMBLY

Mark position of both bearing end frames and stator for later assembly (A).

Press rotor out of drive end frame.



L106770 –UN–11JUL89

RG,RG34710,2149 –19–15Mar97–1/1

STATOR—REMOVAL

Unsolder stator windings from diode leads of diode plate.

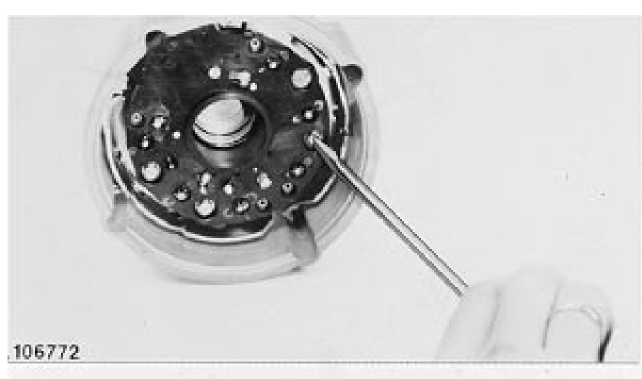
L106771 –UN–11JUL89

RG,RG34710,2150 –19–15Mar97–1/1

DIODE PLATE—REMOVAL

Remove screws from connections “D+” and “B+”.

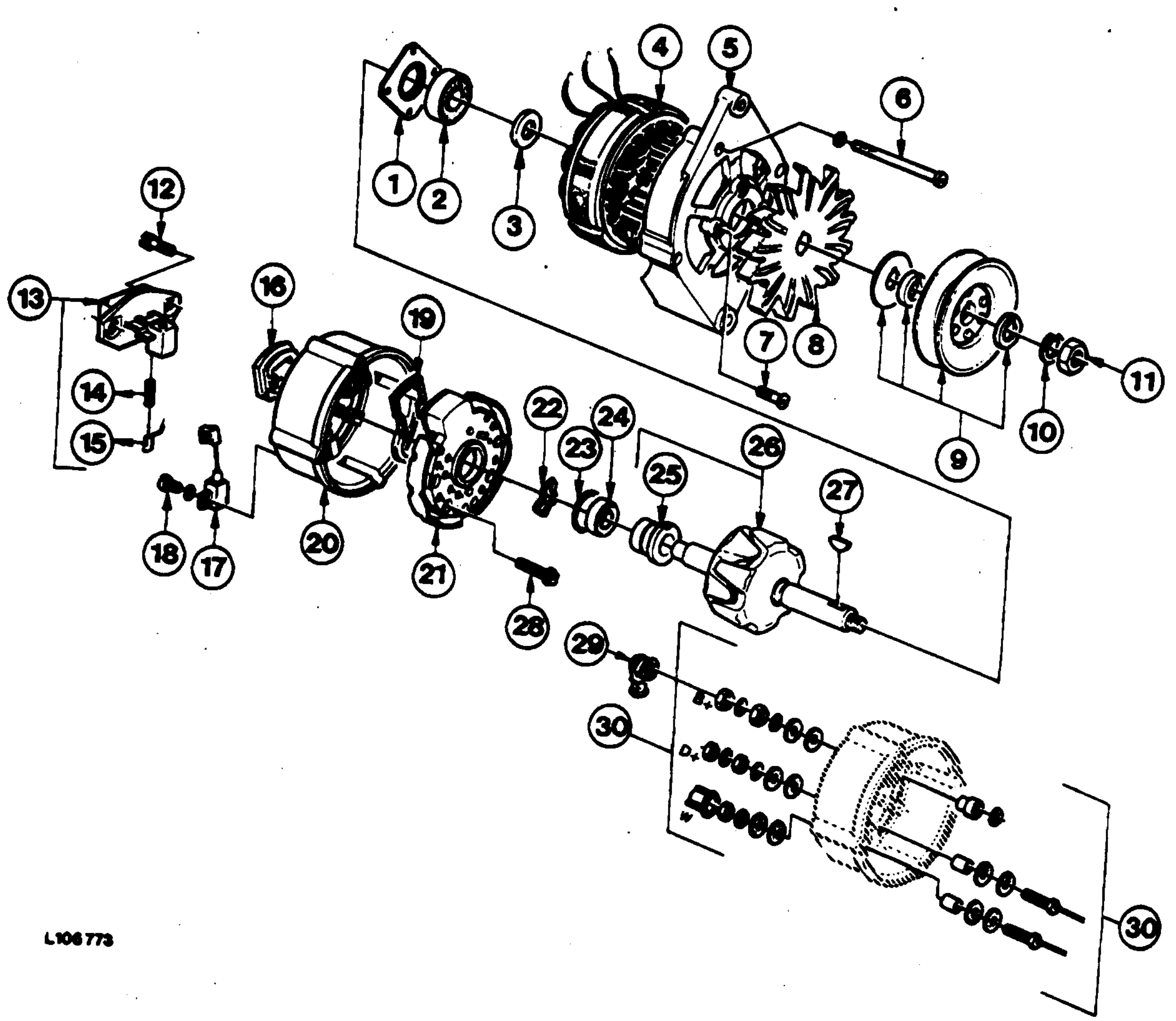
Lift out diode plate.



L106772 –UN–11JUL89

RG,RG34710,2151 –19–15Mar97–1/1

ALTERATOR, EXPLODED VIEW



L106773 –UN–06APR89

1—Retaining Plate
2—Ball Bearing
3—Washer
4—Stator Coil
5—Drive End Frame
6—Cylinder Screw (4 Used)
7—Countersunk Screw (4 Used)[1]
8—Fan
9—Belt Pulley Repair Set
10—Snap Ring[1]
11—Hex. Nut[1]
12—Screw With Spring Washer (2 Used)
13—Regulator With brush Holder
14—Compression Spring (2 Used)
15—Carbon Brush (2 Used)
16—Gasket
17—Suppression Capacitor
18—Cylinder Screw
19—Gasket
20—End Frame
21—Diode Plate
22—Spring Washer[1]
23—O-Ring
24—Ball Bearing
25—Slip Ring
26—Rotor
27—Woodruff Key[1]
28—Screw With Spring Washer (3 Used)
29—Protective Cap
30—Repair Kit for Terminals W, D+ and B+

[1]Rotor Repair Kit.

RG,RG34710,2152 –19–15Mar97–1/1

TESTING ROTOR FOR SHORT CIRCUIT

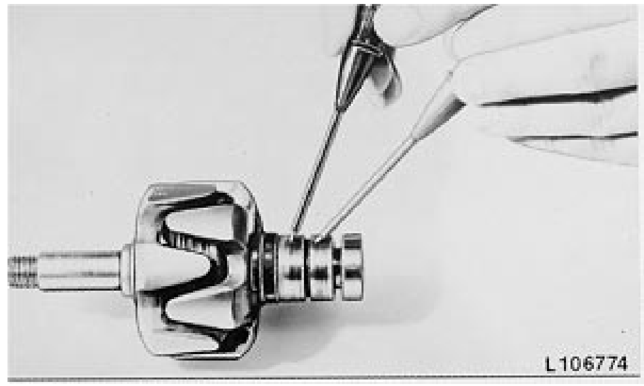
With a test lamp:

Test lamp must light brightly.

With an ohmmeter:

Ohmmeter indication must be between 4.0 and 4.4 ohms.

If test fails, replace rotor.



L106774 –UN–11JUL89

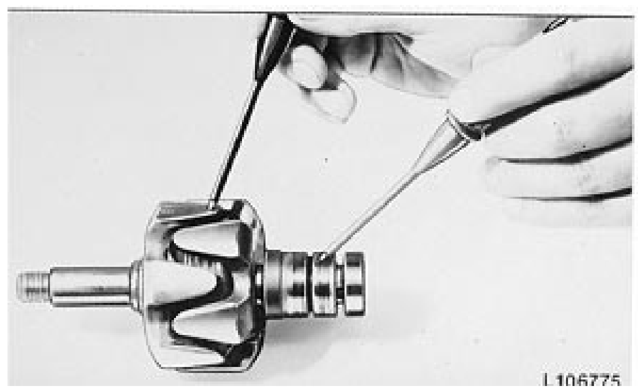
RG,RG34710,2153 –19–15Mar97–1/1

TESTING ROTOR FOR GROUND

Use an ohmmeter to test for continuity.

Attach ohmmeter to rotor and each slip ring.

Replace rotor if test shows continuity.



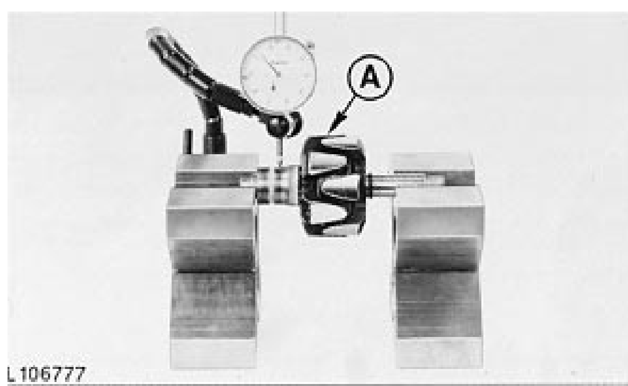
L106775 –UN–11JUL89

RG,RG34710,2154 –19–15Mar97–1/1

TESTING SLIP RINGS AND ROTOR SHAFT FOR RADIAL RUNOUT

Maximum radial runout of slip rings: 0.03 mm (0.0012 in.)

Maximum radial runout of rotor shaft: 0.05 mm (0.002 in.)



L106777 –UN–11JUL89

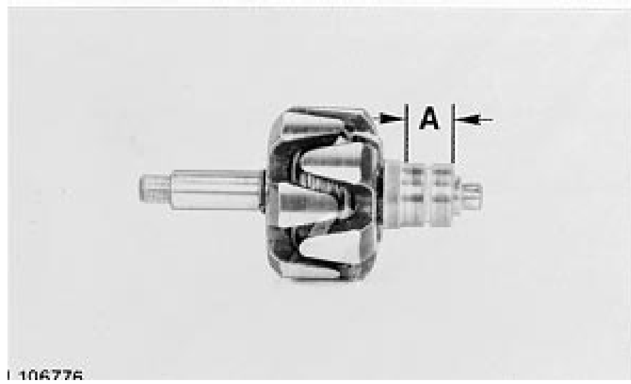
A—Rotor Shaft Test Point

RG,RG34710,2155 –19–15Mar97–1/1

TURNING DOWN SLIP RINGS

Turn down slip rings to a length of 20 mm (0.79 in.) only; refer to (A).

Minimum diameter of slip rings 26.8 mm (1.055 in.).



L106776 –UN–11JUL89

RG,RG34710,2156 –19–15Mar97–1/1

TESTING STATOR COIL FOR SHORT CIRCUIT

Test phase outlets with respect to each other as follows: A and B; B and C; A and C.

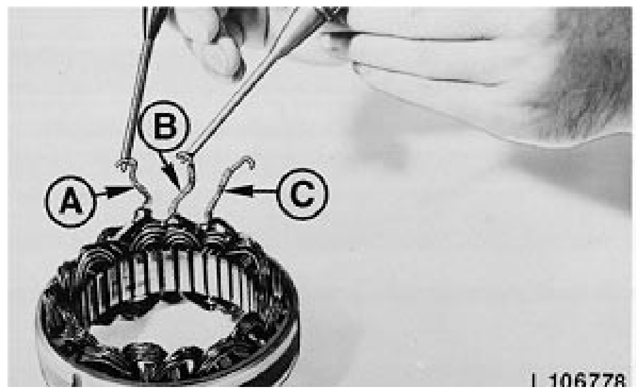
With test lamp:

Test lamp must light up brightly

With ohmmeter:

Indications between 0.40 and 0.44 ohms.

If test fails, replace stator coil.



L106778 –UN–11JUL89

RG,RG34710,2157 –19–15Mar97–1/1

TESTING STATOR COIL FOR GROUNDS

Connect ohmmeter (or test lamp) to stator lead and stator frame.

Repeat test for each stator lead.

If test shows continuity, replace stator.

L106779 –UN–11JUL89

RG,RG34710,2158 –19–15Mar97–1/1

30
10
8

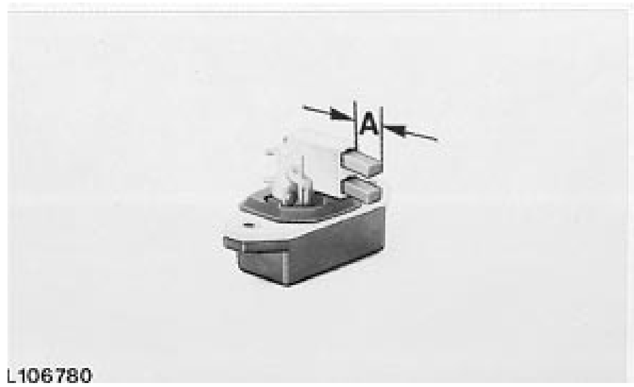
REPLACING CARBON BRUSHES

Replace carbon brushes if dimension (A) is less than 5 mm (0.2 in.).

Solder new carbon brushes in such a way that dimension (A) does not exceed 10 mm (0.4 in.).

IMPORTANT: The service life of carbon brushes and ball bearings are matched to each other. Therefore, always replace ball bearings when renewing carbon brushes. Before installing new carbon brushes, slip rings must be checked and turned down if necessary.

NOTE: When soldering copper lead, make sure solder (rosin/tin solder only) does not seep into the copper leads.



L106780 –UN–11JUL89

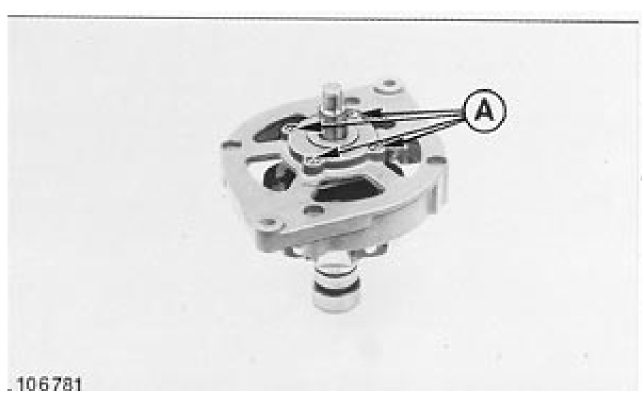
RG,RG34710,2159 –19–15Mar97–1/1

REPLACING BALL BEARINGS

Remove attaching screws (A) of drive end frame retaining plate and force rotor out of drive end frame.

Pull off rotor ball bearing.

Removed ball bearings must be replaced.



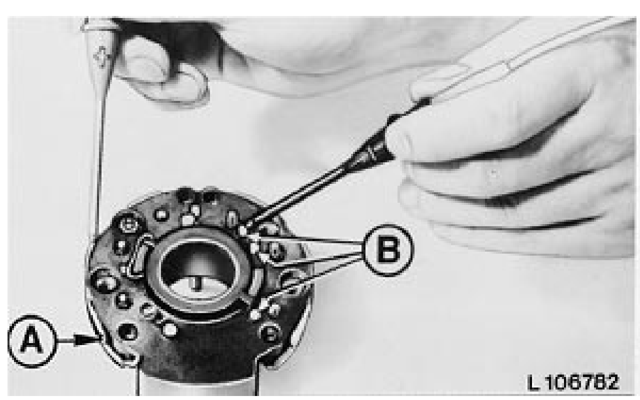
L106781 –UN–11JUL89

RG,RG34710,2160 –19–15Mar97–1/1

CHECKING POSITIVE DIODES

Consecutively place positive test probe of ohmmeter to positive heat sink (A) and negative test probe to leads (B) of diodes.

Meter must not show continuity.



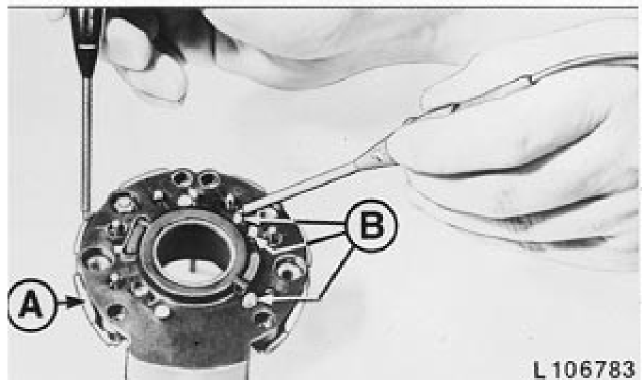
L106782 –UN–11JUL89

Continued on next page RG,RG34710,2161 –19–15Mar97–1/2

If no fault is found in the above described test, carry out this test with reversed polarity (see illustration).

Meter must show continuity.

NOTE: Test voltage 6—12 volts DC.



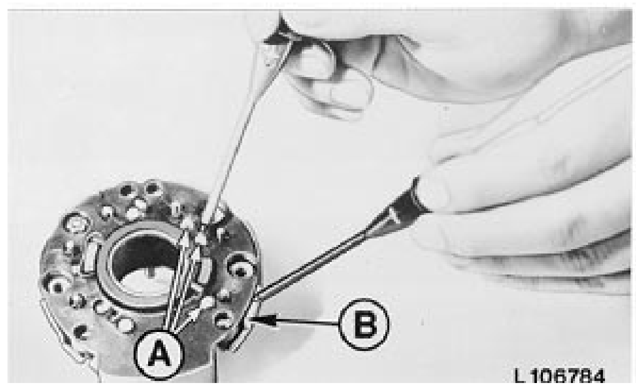
L106783 –UN–11JUL89

RG,RG34710,2161 –19–15Mar97–2/2

CHECKING NEGATIVE DIODES

Consecutively place positive test probe of ohmmeter to positive heat sink (B) and negative test probe to leads (A) of diodes.

Meter must not show continuity.



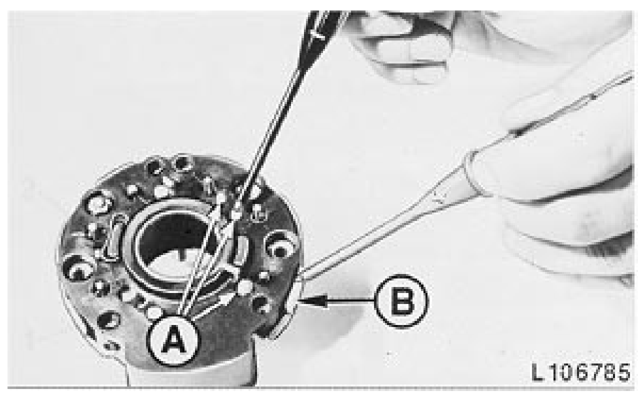
L106784 –UN–11JUL89

RG,RG34710,2162 –19–15Mar97–1/2

If no fault is found in the above described test, carry out this test with reversed polarity (see illustration).

Meter must show continuity.

NOTE: Test voltage 6—12 volts DC.



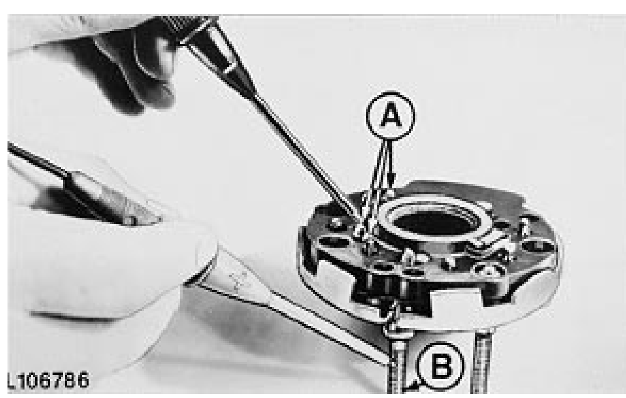
L106785 –UN–11JUL89

RG,RG34710,2162 –19–15Mar97–2/2

TESTING EXCITING DIODES

Place positive test probe of an ohmmeter on connection “D+” (B) and negative probe onto diode lead (A).

Meter must not show continuity.



L106786 –UN–11JUL89

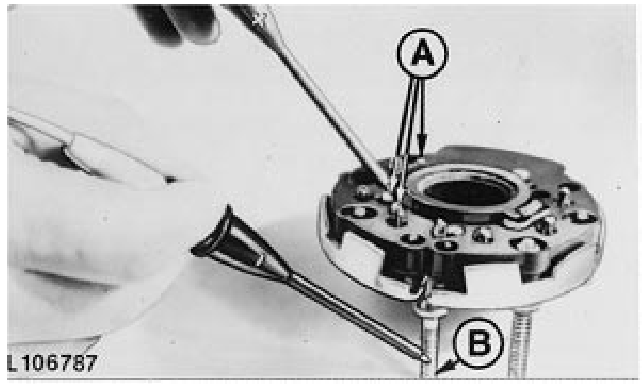
Continued on next page

RG,RG34710,2163 –19–15Mar97–1/2

If no fault is found in the above described test, carry out this test with reversed polarity (see illustration).

Meter must show continuity.

NOTE: Test voltage 6—12 volts DC.



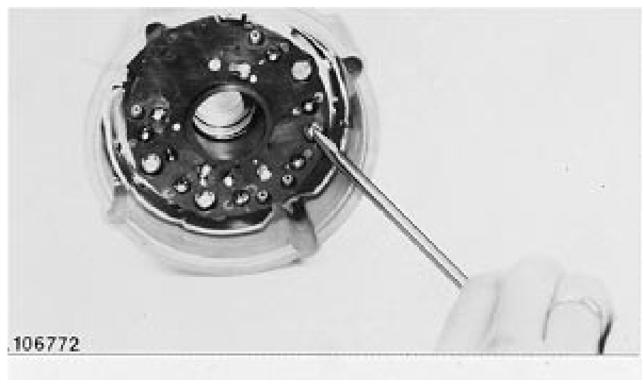
L106787 –UN–11JUL89

RG,RG34710,2163 –19–15Mar97–2/2

DIODE PLATE INSTALLATION

Pay attention to perfect insulation connections “B+”, “D+” and the positive diode heat sink in respect to end frame.

Install diode plate as shown and tighten screws.



L106772 –UN–11JUL89

RG,RG34710,2164 –19–15Mar97–1/1

SOLDERING STATOR COILS

IMPORTANT: Use only rosin core solder.

Make sure that no solder seeps inside diode plate.

Avoid overheating diodes.

L106771 –UN–11JUL89

RG,RG34710,2165 –19–15Mar97–1/1

PRESSING BALL BEARING ONTO ROTOR SHAFT

For pressing on, use a sleeve which presses against the ball bearing inner race.

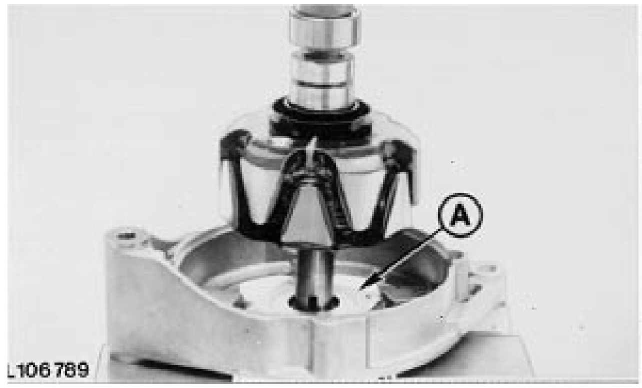
IMPORTANT: Never press onto drive end frame; damage may result.

L106788 –UN–11JUL89

RG,RG34710,2166 –19–15Mar97–1/1

PRESSING ROTOR INTO DRIVE END FRAME

Use a new retaining plate (A) when installing new ball bearing.



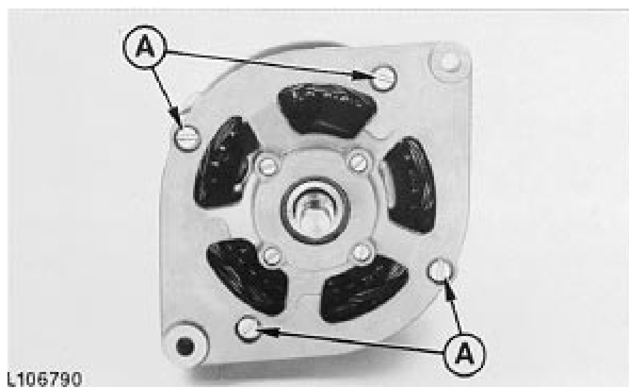
L106789 –UN–11JUL89

RG,RG34710,2167 –19–15Mar97–1/1

ALTERNATOR—ASSEMBLY

Apply high temperature bearing grease such as Bosch Ft70v1 or Delco Remy No. 194891 to end frame bearing seat. Place spring washer end in frame and carefully join both alternator halves, paying attention to markings.

Tighten screws (A) to 4—5.5 N•m (33—48 lb-in.)

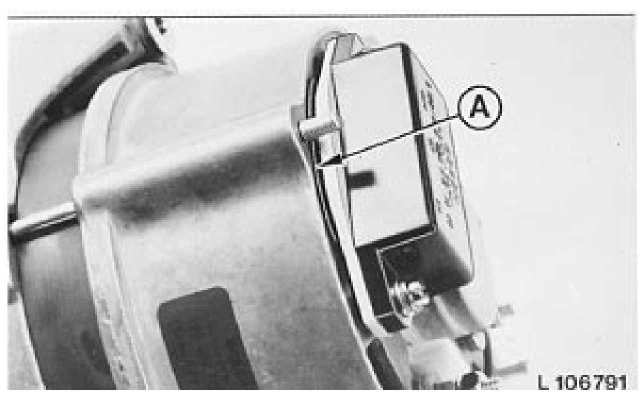


L106790 –UN–11JUL89

RG,RG34710,2168 –19–15Mar97–1/1

INSTALLING BRUSH HOLDER WITH REGULATOR

Carefully insert brush holder with regulator. Make sure that gasket (A) fits correctly. Tighten screws securely.



L106791 –UN–11JUL89

RG,RG34710,2169 –19–15Mar97–1/1

FAN AND BELT PULLEY—INSTALLATION

Tighten securing nut to 35—45 N•m (25—32 ft-lb).

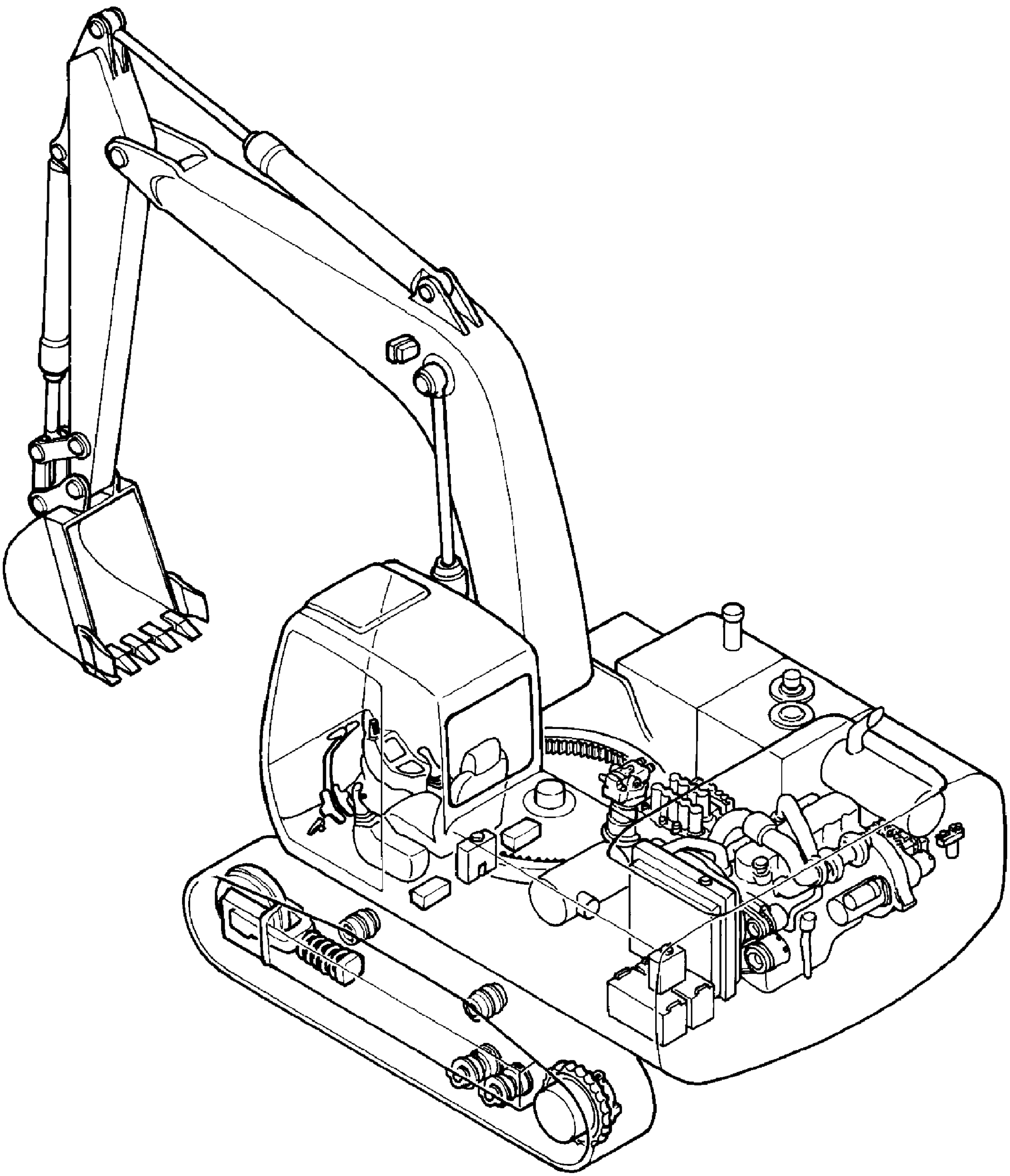
NOTE: To install alternator and adjust belt tension, refer to machine technical manual.

L106792 –UN–11JUL89

RG,RG34710,2170 –19–15Mar97–1/1

Group 1674
Wiring Harness and Switches

EXCAVATOR OVERVIEW



T115683

T115683 –UN–02JUN98

CED.TX08227,2993 –19–10FEB98–1/1

COMPONENT LOCATION DRAWING LEGEND

- A1—Radio
- A2—Engine and Pump Controller
- A3—Air Conditioner Controller
- A4—Engine Mode and RPM Control Unit
- A5—Monitor Controller and Display
- A6—Quick Hitch Control Box

- B1—Air Filter Restriction Switch
- B2—Fuel Level Switch
- B3—Engine Coolant Temperature Switch
- B4—Engine Oil Pressure Switch
- B5—Hydraulic Oil Level Switch
- B6—Engine Coolant Level Switch
- B7—Engine Oil Level Switch
- B8—Fuel Level Sensor
- B9—Engine Coolant Temperature Sensor
- B10—Not Used
- B11—Not Used
- B12—Charge Air Temperature Switch
- B13—Boom Up Pressure Switch
- B14—Dig Pressure Switch
- B15—Propel Pressure Switch
- B16—Engine Speed (N) Sensor
- B17—Engine Control (EC) Sensor (Located Inside Engine Control Motor Housing)
- B18—Rear Pump Pressure Sensor
- B19—Front Pump Pressure Sensor
- B20—Arm In Pressure Sensor
- B21—Rear Pump Control Pressure Sensor
- B22—Front Pump Control Pressure Sensor
- B23—Right Speaker
- B24—Left Speaker
- B25—High Note Horn
- B26—Low Note Horn
- B27—Air Conditioner High and Low Pressure Switch
- B28—Not Used
- B29—Air Conditioner and Heater Thermistor
- B30—Hydraulic Oil Filter Restriction Switch (Model 230LCRD)
- B31—Not Used
- B32—Overload Alarm Proximity Switch
- B33—Overload Alarm Pressure Switch
- B34—Auxiliary Hydraulic Control Switch

- E1—Left Work Light
- E2—Not Used
- E3—Cab Dome Light
- E4—Monitor Controller and Display Backlight
- E5—Engine RPM Dial Backlight
- E6—Right Work Light
- E7—Left Cab Drive Light
- E8—Right Cab Drive Light
- E9—Left Rear Light
- E10—Right Rear Light

- F1—Radio and Monitor Controller Backup 5 Amp Fuse (marked Back Up)
- F2—Engine and Pump Controller 10 Amp Fuse (marked Controller)
- F3—Engine Control (EC) Motor 10 Amp Fuse (marked EC Motor)
- F4—Solenoid 5 Amp Fuse (marked Solenoid)
- F5— Power On 10 Amp Fuse (marked Pow. On)
- F6—Monitor Controller and Display 5 Amp Fuse (marked Sw. Box)
- F7—Switched Power 5 Amp Fuse (marked Option 1)
- F8—Switched Power 10 Amp Fuse (marked Option 2)
- F9—Battery Power 5 Amp Fuse (marked Option 3)
- F10—Travel Alarm 5 Amp Fuse (marked Option 1)
- F11—Work and Drive Lights 20 Amp Fuse (marked Lamp)
- F12—Windshield Wiper 10 Amp Fuse (marked Wiper)
- F13—Blower Motor 20 Amp Fuse (marked Heater)
- F14—Air Conditioner Controller and Relays 5 Amp Fuse (marked Heater)
- F15—Horn 10 Amp Fuse (marked Horn)
- F16—Radio 5 Amp Fuse (marked Radio)
- F17—Lighter 10 Amp Fuse (marked Lighter)
- F18—Dome Light 5 Amp Fuse (marked Room Lamp)
- F19—Auxiliary 10 Amp Fuse (marked Auxiliary)
- F20—Start Aid 20 Amp Fuse (marked Start Aid)
- F21—Battery Power 40 Amp Fusible Link
- F22—Alternator Power 60 Amp Fusible Link

Continued on next page CED,TX14795,4107 –19–12SEP98–1/4

- F23—Fuel Shutoff 40 Amp Fusible Link
- F24—Quick Hitch 5 Amp Fuse

- G1—Battery
- G2—Battery
- G3—Alternator
- G4—24 Volt Power Plug
- G5—24 Volt Slave Receptacle

- H1—Dig Mode Indicator Light
- H2—Grading Mode Indicator Light
- H3—Precision Mode Indicator Light
- H4—Attachment Mode Indicator Light
- H5—High Power Mode Indicator Light
- H6—Economy Mode Indicator Light
- H7—Auto Idle Mode Indicator Light
- H8—Monitor Controller and Display Alarm
- H9—Overload Alarm
- H10—Travel Alarm
- H11—Spare Indicator Light
- H12—Hydraulic Oil Level Indicator Light
- H13—Fuel Level Indicator Light
- H14—Air Filter Restriction Indicator Light
- H15—Charge Air Temperature Indicator Light
- H16—Engine Coolant Temperature Indicator Light
- H17—Engine Oil Pressure Indicator Light
- H18—Alternator Voltage Indicator Light
- H19—Engine Oil Level Indicator Light
- H20—Engine Coolant Level Indicator Light
- H21—Hydraulic Oil Filter Restriction Indicator Light
- H22—Quick Hitch Alarm
- H23—Quick Hitch Indicator Light

- K1—Alternator Shut Down Relay (Marked R1)
- K2—Windshield Washer Relay (Marked R2)
- K3—Work Light Relay (Marked R3)
- K4—Drive Light Relay (Marked R4)
- K5—Horn Relay (Marked R5)
- K6—Windshield Wiper Relay (Motor Ground and Intermittent) (Marked R6)
- K7—Windshield Wiper Relay (Wiper Run) (Marked R7)
- K8—Windshield Wiper Relay (Hold for Park) (Marked R8)
- K9—Windshield Wiper Relay (Motor Ground for Park) (Marked R9)
- K10—Propel Auto Idle Relay (Marked R10)
- K11—Starter Protection Relay (Marked R11)
- K12—Start Aid Relay (Marked R12)
- K13—Starter Relay
- K14—Battery Relay
- K15—Fuel Shutoff Relay
- K16—Overload Alarm Relay
- K17—Not Used
- K18—Not Used
- K19—Not Used
- K20—Not Used
- K21—Not Used
- K22—Not Used
- K23—Not Used
- K24—Air Conditioner Blower Motor and Main Power (Low Speed) Relay
- K25—Air Conditioner Compressor Clutch Relay
- K26—Air Conditioner Blower Motor (Low Medium Speed) Relay
- K27—Air Conditioner Blower Motor (Medium Speed) Relay
- K28—Air Conditioner Blower Motor (High Speed) Relay

- M1—Starter
- M2—Engine Control (EC) Motor
- M3—Windshield Wiper Motor
- M4—Windshield Washer Motor
- M5—Heater Blower Motor (Without Air Conditioner)
- M6—Air Conditioner and Heater Blower Motor
- M7—Not Used
- M8—Not Used
- M9—Air Conditioner Internal and External Cab Air Servomotor
- M10—Air Conditioner Blower Port Change Servomotor
- M11—Air Conditioner Air Mixer Servomotor

- P1—Hour Meter
- P2—Engine Coolant Temperature Gauge
- P3—Fuel Gauge

- R1—Not Used

16
1674
3

Continued on next page

CED,TX14795,4107 –19–12SEP98–2/4

- R2—Heater Blower Motor Dropping Resistor Block (Without Air Conditioner)
- R3—Not Used
- R4—Engine Coolant Temperature Gauge Resistor (150 ohms)
- R5—Fuel Gauge Resistor (220 ohms)
- R6—Alternator Excitation Resistor
- R7—Not Used
- R8—Not Used
- R9—Not Used
- R10—Engine RPM Dial
- R11—Air Conditioner and Heater Blower Motor Dropping Resistor Block

- S1—Key Switch
- S2—Horn Switch
- S3—Dome Light Switch
- S4—Heater Blower Motor Switch (Without Air Conditioner)
- S5—Fluid Level Check Switch
- S6—Buzzer Stop Switch
- S7—Work Mode Selection Switch
- S8—Propel Speed Change Switch
- S9—Wiper Speed Switch
- S10—Drive and Work Light Switch
- S11—Economy (E) Mode Switch
- S12—High Power (HP) Mode Switch
- S13—Auto Idle Switch
- S14—Windshield Wiper Enable Switch
- S15—Windshield Washer Switch
- S16—Learning Switch
- S17—Travel Alarm Cancel Switch
- S18—Start Aid Switch
- S19—Power Boost Switch
- S20—Rear Lights Switch
- S21—Quick Hitch Switch
- S22—Low Idle Sense Switch
- S23—Hand Held Tool Switch

- V1—Start Aid Diode
- V2—Alternator Shut Down Relay Isolation Diode (Red/Wht and Red/Blk)
- V3—Switched Power Fuse (F8) Suppression Diode (Blk and Red)
- V4—Propel Auto Idle Relay (marked R10) Isolation Diode (Wht/Blk and Yel)
- V5—Windshield Wiper Relay (marked R8) Isolation Diode (Blu/Blk and Blu/Red)
- V6—Windshield Wiper Motor Suppression Diode (Blk and LGrn/Wht)
- V7—Windshield Wiper Motor Suppression Diode (Blk and Blu/Wht)
- V8—Fuel Shutoff Solenoid Hold-In Coil Suppression Diode (Brn/Blk and Blk)
- V9—Start Relay Coil Suppression Diode (Yel/Grn and Blk/Wht)
- V10—Fuel Shutoff Solenoid Pull-In Coil Suppression Diode (Red/Blk and Blk)
- V11—Battery Relay Coil Suppression Diode (Blk and Red/Wht)

- W1—Engine and Frame Harness
- W2—Cab Harness
- W3—Monitor and Relay Harness
- W4—Radio Antenna
- W5—Battery to Frame Ground
- W6—Engine to Frame Ground
- W7—Cab to Frame Ground
- W8—Starter to Frame Ground
- W9—Air Conditioner Harness
- W10—Air Compressor and Rock Drill Harness (Model 230LCRD)

- X1—Diagnostic Connector
- X2—Learning Switch Connector
- X3—Attachment Pressure Switch Connector
- X4—Accel Connector
- X5—Optional Connector
- X6—Auxiliary Connector
- X7—Optional Right Speaker Connector
- X8—Engine and Frame Harness to Cab Harness Connector
- X9—Engine and Frame Harness to Cab Harness Connector
- X10—Monitor Controller and Display Connector (20-Pin)
- X11—Monitor Controller and Display Connector (16-Pin)
- X12—Monitor Controller and Display Connector (12-Pin)

Continued on next page

CED,TX14795,4107 –19–12SEP98–3/4

- X13—Engine and Pump Controller Connector (26-Pin)
- X14—Engine and Pump Controller Connector (16-Pin)
- X15—Engine and Pump Controller Connector (22-Pin)
- X16—Air Conditioner Harness to Cab Harness Connector
- X17—Air Conditioner Controller Connector (16-Pin)
- X18—Air Conditioner Controller Connector (12-Pin)
- X19—Monitor and Relay Harness to Cab Harness Connector (2-Pin)
- X20—Monitor and Relay Harness to Cab Harness Connector (6-Pin)
- X21—Monitor and Relay Harness to Cab Harness Connector (12-Pin)
- X22—Monitor and Relay Harness to Cab Harness Connector (16-Pin)
- X23—Monitor and Relay Harness to Cab Harness Connector (8-Pin)
- X24—Optional Connector
- X25—Optional Connector
- X26—Engine and Frame Harness to Cab Harness Connector
- X27—Auxiliary Power Terminal Strip
- X28—Rear Light Switch Harness to Rear Light Harness Connector

- Y1—Air Conditioner Compressor Clutch
- Y2—Quick Hitch Solenoid
- Y3—Not Used
- Y4—Start Aid Solenoid
- Y5—Power Boost Proportional Solenoid
- Y6—Propel Speed Change Proportional Solenoid
- Y7—Fuel Shutoff Solenoid
- Y8—Speed Sense Proportional Solenoid
- Y9—Arm Regenerative Proportional Solenoid
- Y10—Not Used
- Y11—Hand Held Tools Solenoid

CED,TX14795,4107 –19–12SEP98–4/4

FOLDOUT PAGES 16-37 THRU 16-40 ARE AT REAR OF MANUAL

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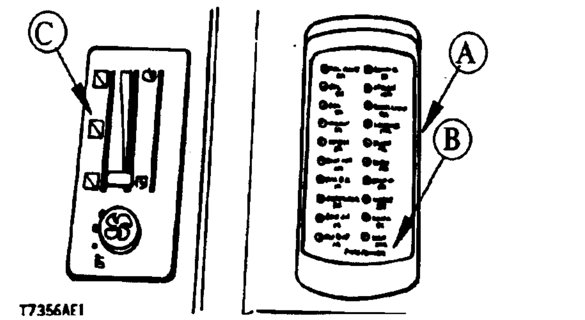
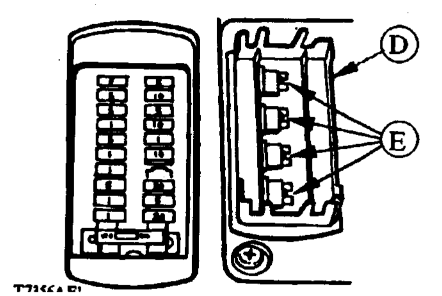
REPLACING FUSES

Fuse box (A) is located behind the right control lever console, next to heater/air conditioner control panel (C). Fuse location/specification decal (B) is attached to fuse box cover.

Remove fuse box cover (D) by lifting outward. Spare fuses (E) are located on underside of cover.



T7356AE1 –UN–06SEP90



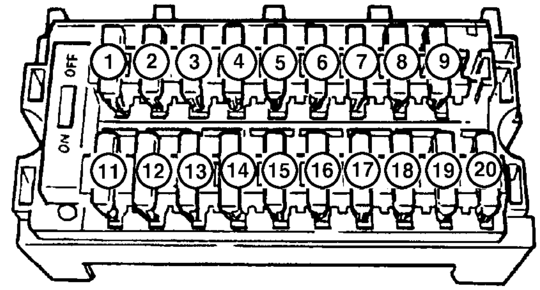
T7356AF1 –UN–06SEP90

A—Fuse Box
B—Decal
C—Heater Control Panel
D—Fuse Box Cover
E—Spare Fuses

16
1674
10

Continued on next page TX,16,UU3961 –19–19SEP98–1/2

IMPORTANT: Install fuse with correct amperage rating to prevent electrical system damage from overload.



T113934

T113934 –UN–07APR98

1—5 Amp Backup
2—10 Amp Controller
3—10 Amp EC Motor
4—5 Amp Solenoid
5—10 Amp Power On
6—5 Amp Switch Box
7—5 Amp Option 1
8—10 Amp Option 2
9—5 Amp Option 3
10—5 Amp Travel (Alarm)
11—20 Amp Lamp
12—10 Amp Wiper (Windshield and Washer)
13—20 Amp Heater
14—5 Amp AirCon (Air Conditioning)
15—10 Amp Horn
16—5 Amp Radio
17—10 Amp Lighter
18—5 Amp Room Lamp (Dome Light)
19—10 Amp Auxiliary
20—20 Amp Start Aid

TX,16,UU3961 –19–19SEP98–2/2

FUSE (BLADE-TYPE) COLOR CODES

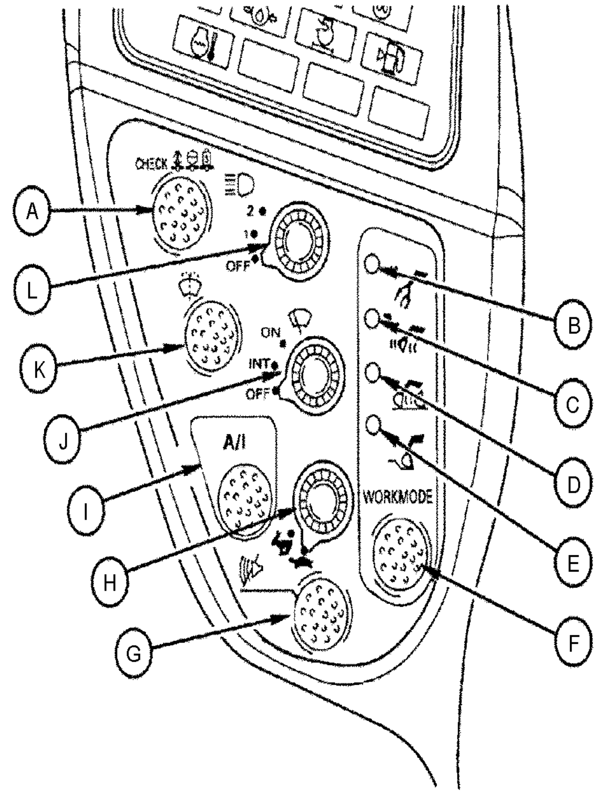
Amperage Rating	Color
1	Black
3	Violet
4	Pink
5	Tan
7-1/2	Brown
10	Red
15	Light Blue
20	Yellow
25	Natural (White)
30	Light Green

TX,16,UU3555 –19–28SEP92–1/1

REMOVE AND INSTALL CONTROL PANEL SWITCHES

1. Remove screws

2. Replace monitor control panel.



T101584 –UN–27JUN96

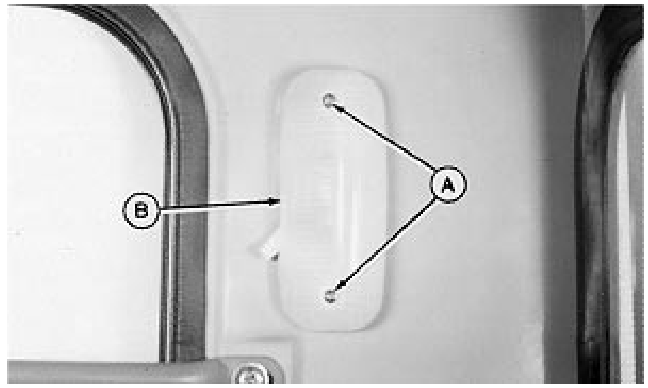
A—Level Check Switch
B—Attachment Mode Indicator
C—Precision Mode Indicator
D—Grading Mode Indicator
E—Dig Mode Indicator
F—Work Mode Switch
G—Buzzer Stop Switch
H—Propel Speed Switch
I—Auto-Idle Switch
J—Wiper Switch
K—Washer Switch
L—Operating Lights Switch

16
1674
13

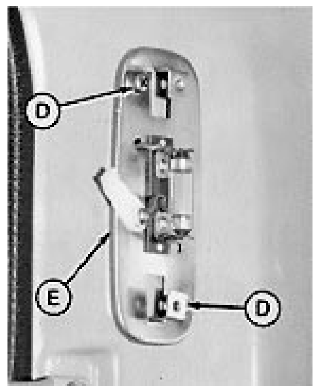
TX,16,UU3556 –19–19SEP98–1/1

REMOVE AND INSTALL DOME LIGHT SWITCH

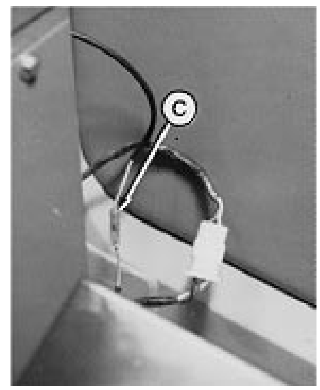
1. Remove cap screws (A) and cover (B).
2. Disconnect connector (C).
3. Remove caps screws (D) and switch (E). Repair or replace as needed.
4. Install parts (A—E).



T6557JI –UN–19OCT88



T6557LM –UN–19OCT88



T6585NG –UN–19OCT88

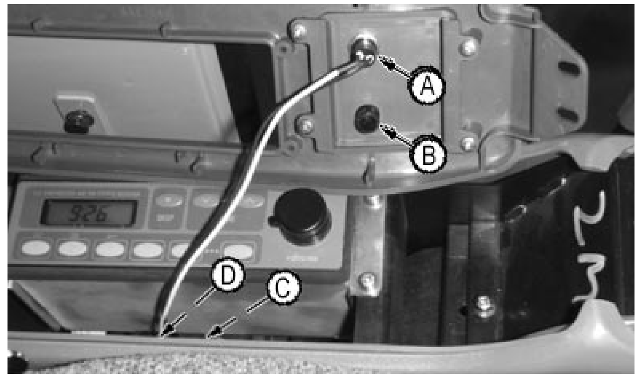
A—Cap Screw (2 used)
B—Cover
C—Connector
D—Cap Screw (2 used)
E—Switch

16
1674
14

TX,16,UU3962 –19–08JUN87–1/1

REMOVE AND INSTALL PROPEL ALARM CANCEL SWITCH AND START AID SWITCH

1. Disconnect battery ground (-) cable.
2. Remove cap screws. Remove upper cover.
3. Disconnect wires (C and D). Remove switches (A and B).
4. Replace parts as necessary.
5. Install switches.
6. Connect wiring connectors.
7. Install covers.
8. Connect battery ground (-) cable.



T105433B –UN–06MAR97

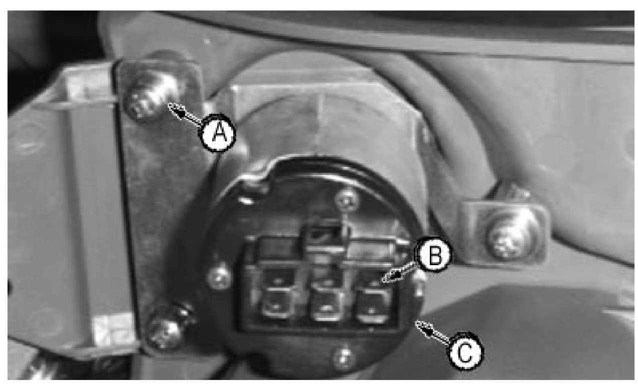
A—Propel Alarm Cancel Switch
B—Start Aid Switch (not shown)
C—Start Aid Wire (not shown)
D—Propel Alarm Wire

TX,16,UU3963 –19–19SEP98–1/1

16
1674
15

REMOVE AND INSTALL STARTER SWITCH

1. Disconnect battery ground (-) cable.
2. Remove four cap screws from under control lever boot.
3. Turn cover. Remove cap screws.
4. Disconnect wiring harness connector (B).
5. Replace parts as necessary.



T105435B –UN–06MAR97

A—Screw (3 used)
B—Connector
C—Key Switch

Continued on next page

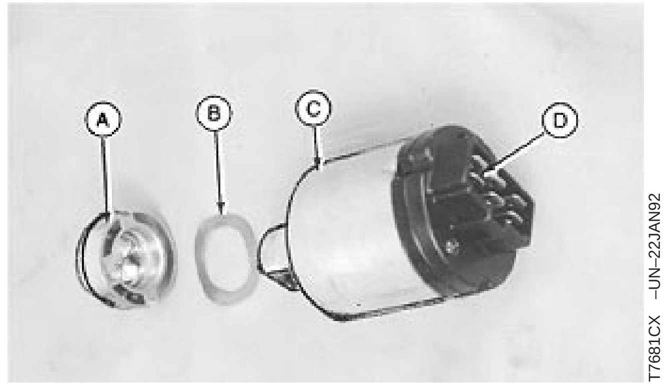
TX,16,UU3964 –19–19SEP98–1/2

6. Connect wiring harness to connector (D).

7. Install switch (C) and spring washer (B) through bracket and install nut (A).

8. Install covers and boot.

9. Connect battery ground (-) cable.

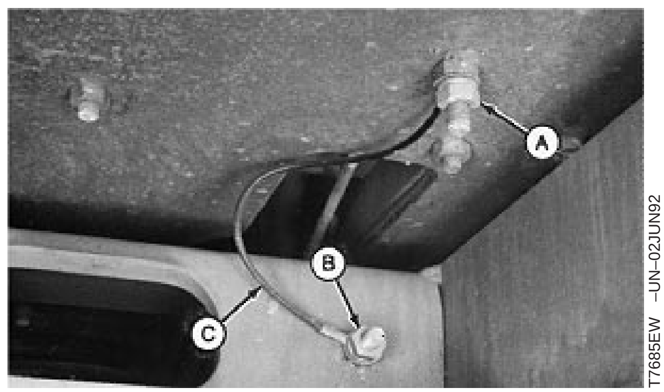


A—Nut
B—Spring Washer
C—Key Switch
D—Wiring Harness Connector

TX,16,UU3964 –19–19SEP98–2/2

REMOVE AND INSTALL CAB GROUND STRAPS

Remove cover under cab for access to ground straps (C) and nuts (A and B).



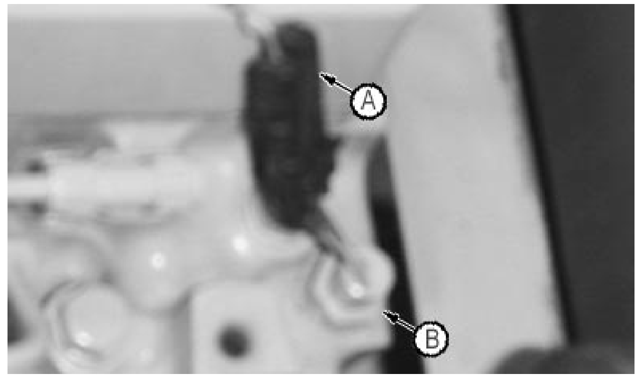
A—Nut
B—Nut
C—Ground Strap (4 used)

TX,16,UU3965 –19–08JUN92–1/1

REMOVE AND INSTALL ENGINE TEMPERATURE SWITCH

1. Disconnect connector (A) to remove and replace switch (B).

2. Install and tighten switch (B) and connect connector (A).



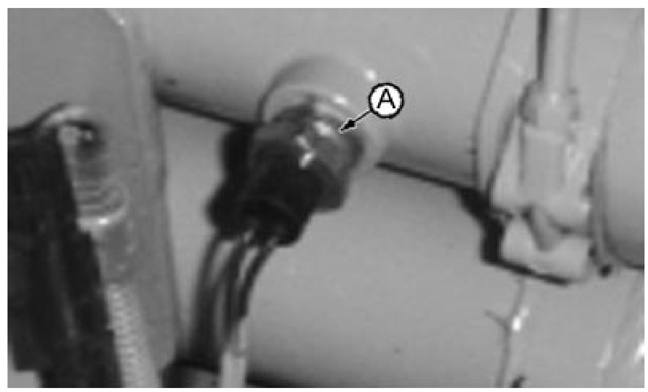
A—Connector
B—Switch

TX,16,UU3966 –19–19SEP98–1/1

REMOVE AND INSTALL CHARGE AIR TEMPERATURE SWITCH

1. Disconnect connector to remove and replace switch (A).

2. Install and tighten switch (A) and connect connector.



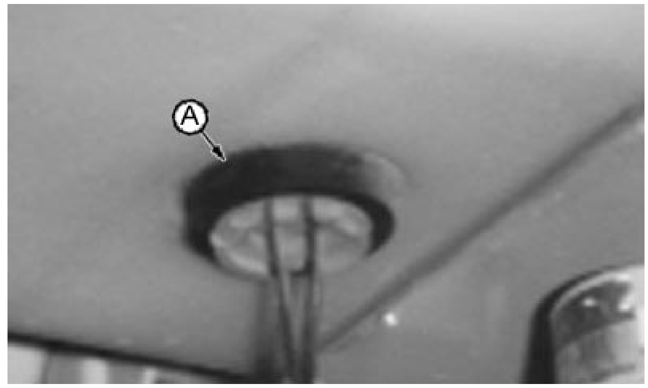
A—Switch

TX,16,UU3967 –19–19SEP98–1/1

REMOVE AND INSTALL COOLANT LEVEL SWITCH

1. Disconnect connector to remove and replace switch (A).

2. Install and tighten switch (A) and connect connector.



T109518B –UN–15MAY97

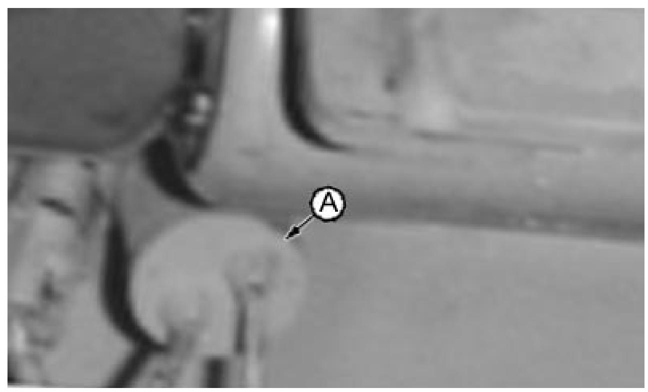
A—Switch

TX,16,UU3968 –19–19SEP98–1/1

REMOVE AND INSTALL ENGINE OIL PRESSURE SWITCH

1. Disconnect connector to remove and replace switch (A).

2. Install and tighten switch (A) and connect connector.



T109621B –UN–28MAY97

A—Switch

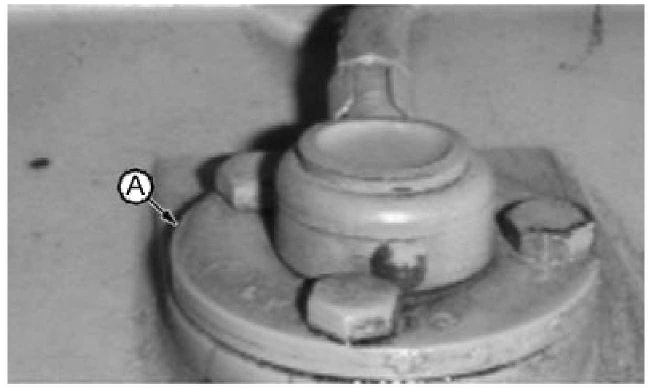
TX,16,UU3969 –19–19SEP98–1/1

16
1674
18

REMOVE AND INSTALL ENGINE OIL LEVEL SWITCH

1. Disconnect connector and remove cap screws to remove and replace switch (A).

2. Install switch (A) and tighten cap screws. Connect connector.



T109620B –UN–27MAY97

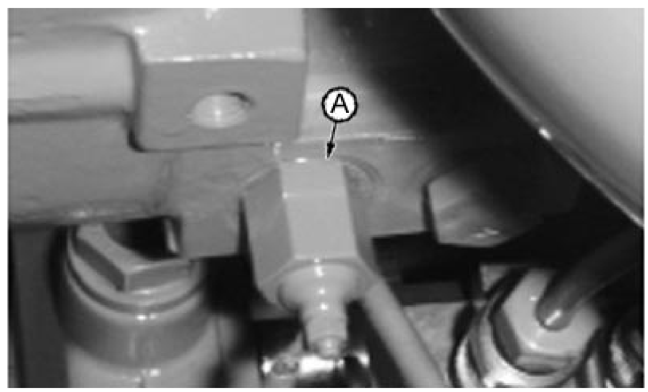
A—Switch

TX,16,UU3970 –19–19SEP98–1/1

REMOVE AND INSTALL ENGINE COOLANT TEMPERATURE SENSOR

1. Disconnect connector to remove and replace sensor (A).

2. Install and tighten sensor (A) and connect connector.



T109619B –UN–27MAY97

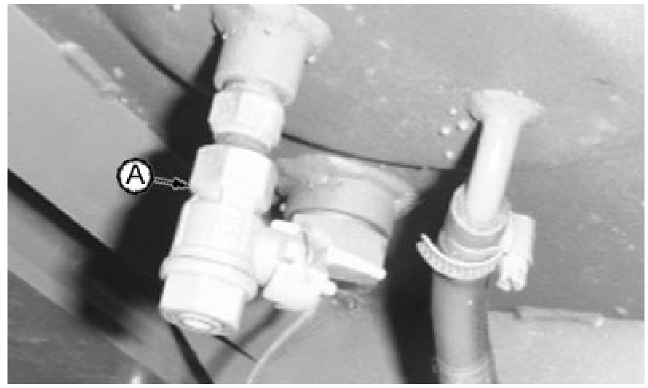
A—Sensor

TX,16,UU3566 –19–19SEP98–1/1

REMOVE AND INSTALL FUEL LEVEL SWITCH

1. Disconnect connector to remove and replace switch (A).

2. Install and tighten switch (A) and connect connector.



T109519B –UN–15MAY97

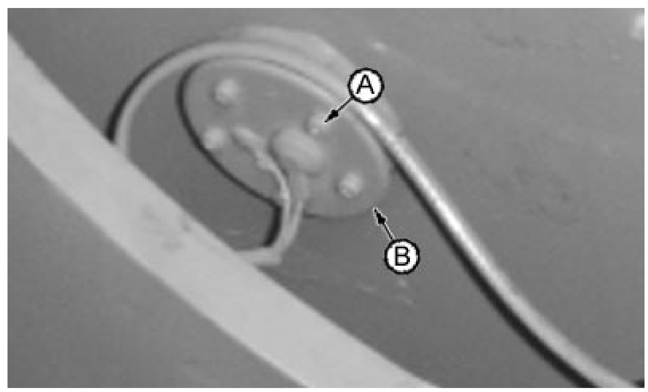
A—Switch

TX,16,UU3971 –19–19SEP98–1/1

REMOVE AND INSTALL FUEL LEVEL SENSOR

1. Disconnect connector and remove cap screws (A) to remove and replace sensor (B).

2. Install sensor (B) and tighten cap screws (A). Connect connector.



T109512B –UN–15MAY97

A—Cap Screw
B—Sensor

TX,16,UU3568 –19–19SEP98–1/1

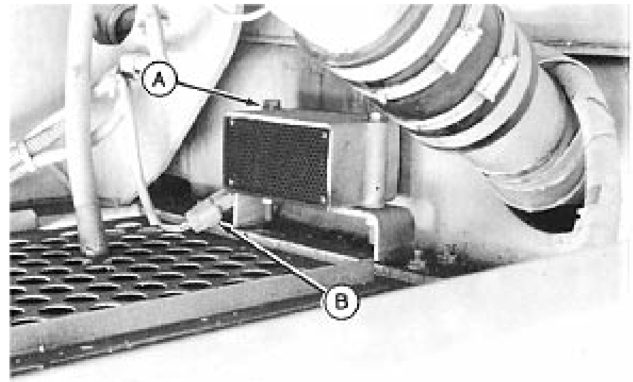
16
1674
20

REMOVE AND INSTALL TRAVEL ALARM

1. Disconnect wiring connector (B).

NOTE: The travel alarm is located in the hydraulic pump compartment.

2. Remove two cap screws (A).
3. Remove travel alarm.
4. Replace alarm as necessary.
5. Install travel alarm. Connect wiring harness.



T7685HF –UN–05MAR92

A—Cap Screws
B—Connector

TX,16,UU3972 –19–19SEP98–1/1

CHANGING TRAVEL ALARM VOLUME

IMPORTANT: It may be necessary to adjust travel alarm volume to meet local regulations.

NOTE: Alarm removed from machine for clarity of photograph.

1. Remove four sheet metal screws to remove travel alarm front cover.

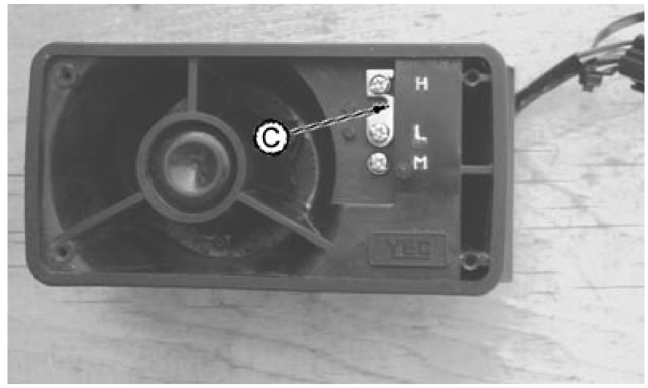
Continued on next page TX,16,UU3973 –19–19SEP98–1/2

16
1674
21

NOTE: This machine is shipped with the travel alarm set in the "High" volume position.

2. Adjust volume level of travel alarm by connecting metallic bar to appropriate terminals. The alarm can be set at "LOW" "MED" (medium), or "HIGH," (C) volume levels.

3. Install front cover.



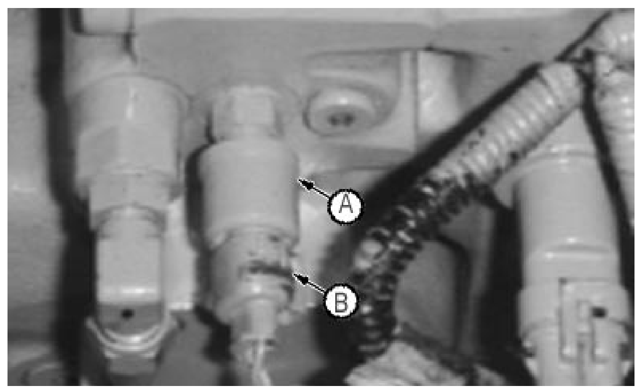
C—High Volume Position

TX,16,UU3973 –19–19SEP98–2/2

REMOVE AND INSTALL PROPEL PRESSURE SWITCH

1. Disconnect connector (B) to remove and replace switch (A).

2. Install and tighten switch (A) and connect connector (B).



A—Switch
B—Connector

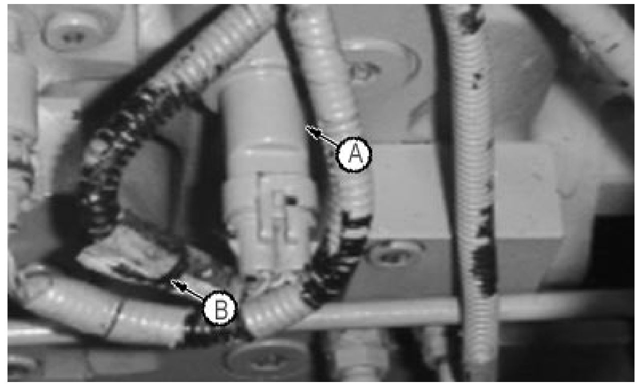
TX,16,UU3246 –19–19SEP98–1/1

16
1674
22

REMOVE AND INSTALL DIG PRESSURE SWITCH

1. Disconnect connector (B) to remove and replace switch (A).

2. Install and tighten switch (A) and connect connector (B).



T105557B –UN–10DEC96

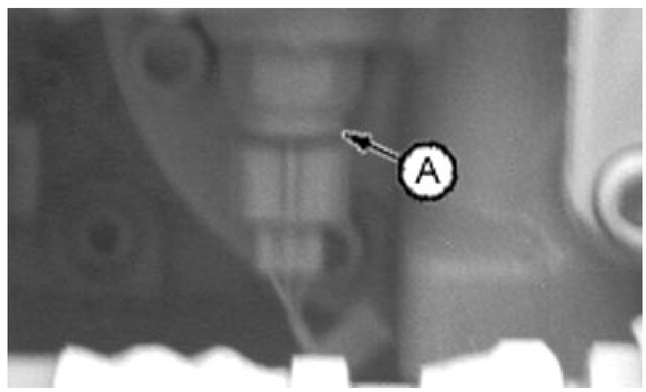
A—Switch
B—Connector

TX,16,UU3247 –19–19SEP98–1/1

REMOVE AND INSTALL REAR PUMP PRESSURE SENSOR

1. Disconnect connector to remove and replace sensor (A).

2. Install and tighten sensor (A) and connect connector.



T109430B –UN–08MAY97

A—Sensor

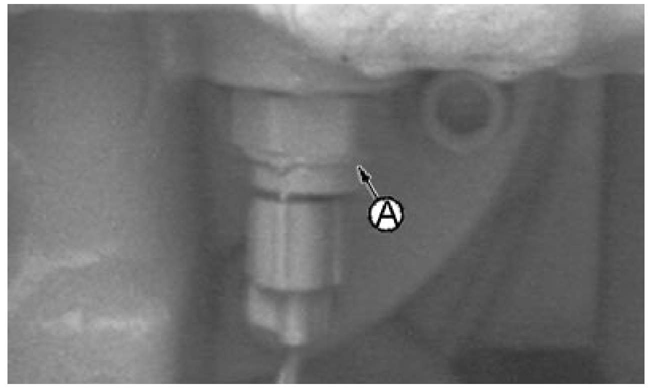
TX,16,UU3976 –19–19SEP98–1/1

16
1674
23

REMOVE AND INSTALL FRONT PUMP PRESSURE SENSOR

1. Disconnect connector to remove and replace sensor (A).

2. Install and tighten sensor (A) and connect connector.



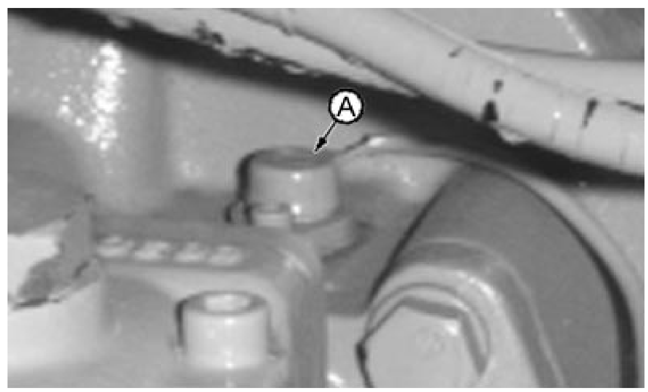
A—Sensor

TX,16,UU3977 –19–19SEP98–1/1

REMOVE AND INSTALL ENGINE SPEED SENSOR

1. Disconnect connector to remove and replace sensor (A).

2. Install and tighten sensor (A) and connect connector.



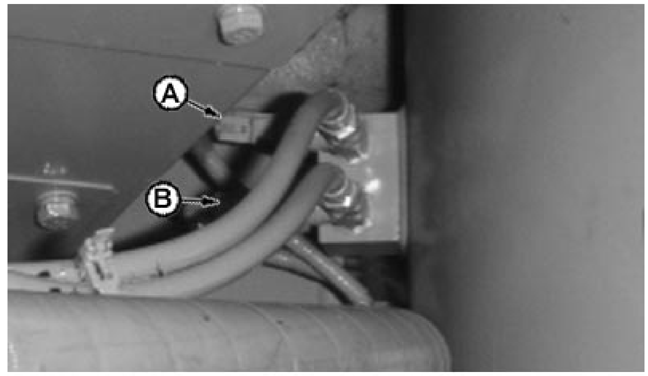
A—Sensor

TX,16,UU3978 –19–19SEP98–1/1

REMOVE AND INSTALL PUMP CONTROL PRESSURE SENSOR

1. Disconnect connector to remove and replace front pump control pressure sensor (A) or rear pump control pressure sensor (B).

2. Install and tighten sensor (A or B) and connect connector.



T109459B –UN–09MAY97

A—Front Pump Control Pressure Sensor
B—Rear Pump Control Pressure Sensor (not shown)

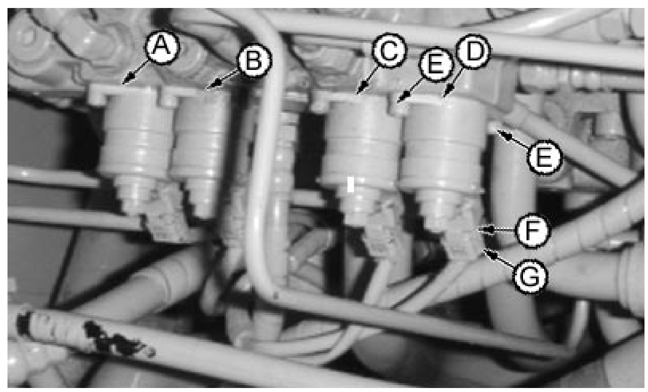
TX,16,UU3979 –19–02JAN97–1/1

REMOVE AND INSTALL PROPORTIONAL SOLENOIDS

1. Remove wire clip (F) to disconnect connector (G) or to remove and replace solenoid (A).

2. Remove screws (E) to replace solenoids (A—D).

3. Install solenoid, connect connector and install wire clip.



T109444B –UN–08MAY97

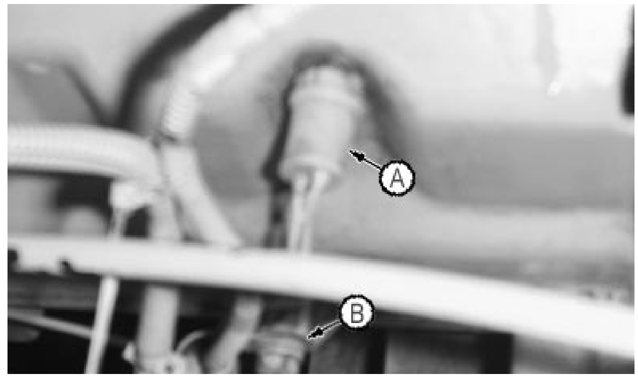
A—Arm Regenerative Proportional Solenoid
B—Speed Sensing Proportional Solenoid
C—Propel Speed Change Proportional Solenoid
D—Power Boost Proportional Solenoid
E—Screw
F—Wire Clip
G—Connector

TX,16,UU3980 –19–02JAN97–1/1

REMOVE AND INSTALL ENGINE HOURMETER SWITCH

1. Disconnect connector (B) to remove and replace switch (A).

2. Install and tighten switch (A) and connect connector (B).



T105550B –UN–12DEC96

A—Switch
B—Connector

TX,16,UU3981 –19–19SEP98–1/1

REMOVE AND INSTALL WINDSHIELD WIPER ENABLE SWITCH

1. Remove plate (A).

2. Disconnect electrical connector (B) and wiring lead (C).

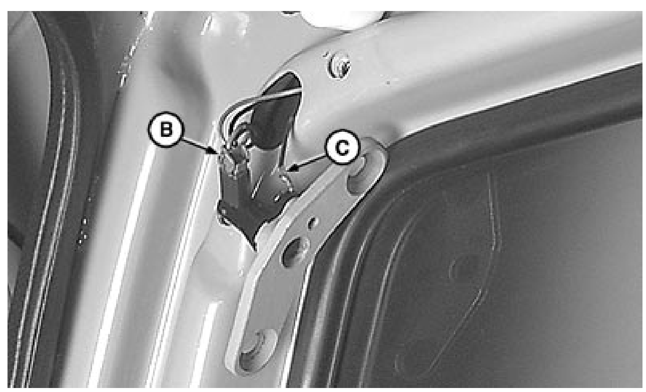
3. Remove and replace windshield wiper enable switch.

4. Install switch.

5. Connect electrical connector and wiring lead.

6. Install plate.

T113349 –UN–08MAY98



T115213 –UN–08MAY98

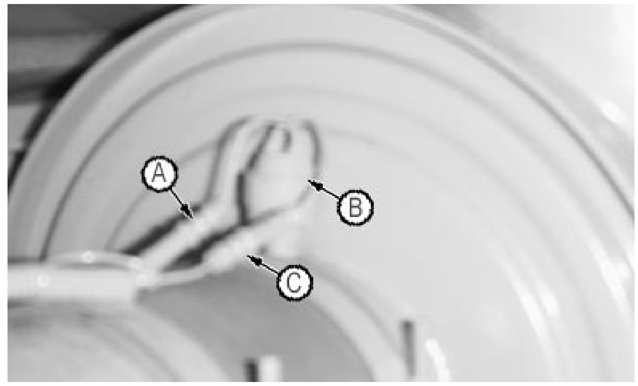
A—Plate
B—Electrical Connector
C—Wiring Lead

CED,OUOE002,1423 –19–06MAY98–1/1

REMOVE AND INSTALL AIR CLEANER RESTRICTION INDICATOR SWITCH

1. Disconnect connectors (A and C) to remove and replace switch (B).

2. Install and tighten switch (B) and connect connectors (A and C).



T105553B –UN–13DEC96

A—Connector
B—Switch
C—Connector

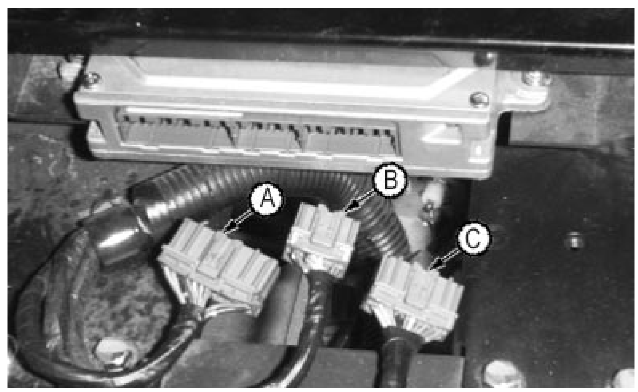
TX,16,UU3983 –19–19SEP98–1/1

CONNECTING ENGINE AND PUMP CONTROLLER (EPC) HARNESS CONNECTOR

IMPORTANT: Do not disconnect electrical connectors while the engine is running. Damage to Engine and Pump Controller, or other components may result. Disconnect connectors only when instructed during a test or check.

1. Push connectors into engine and pump controller.

2. Do Engine Speed Learning Procedure. (See procedure in Group 1671.)



T105437B –UN–06MAR97

A—Connector
B—Connector
C—Connector

TX,16,UU3984 –19–19SEP98–1/1

REMOVE AND INSTALL ENGINE AND PUMP CONTROLLER (EPC)

IMPORTANT: If a controller problem is indicated, the real problem may be poor connector pin contact. Before replacing engine and pump controller or troubleshooting the circuits, clean all termials in the monitor controller, engine and pump controller, and harness connectors using a non-conductive, lubricating contact cleaner. Check machine operation again before proceeding. TY16324 Contact Cleaner may be used.

1. Disconnect battery ground cable.

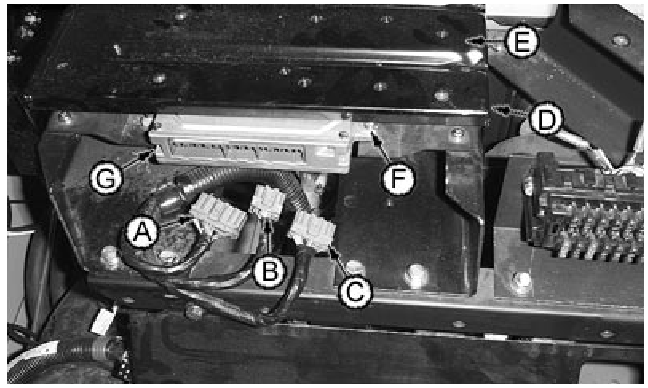
2. Move seat forward and remove access cover.

3. Disconnect cable connectors (A—C).

4. Remove cap screws (F) and remove engine and pump controller (G).

5. Install engine and pump controller.

6. Do Engine Speed Learning Procedure. (See procedure in Group 1671.)



T105437C –UN–06MAR97

A—Connector
B—Connector
C—Connector
D—Cover Plate
E—Screws
F—Screw (4 used)
G—Engine and Pump Controller (EPC)

TX,16,UU3985 –19–19SEP98–1/1

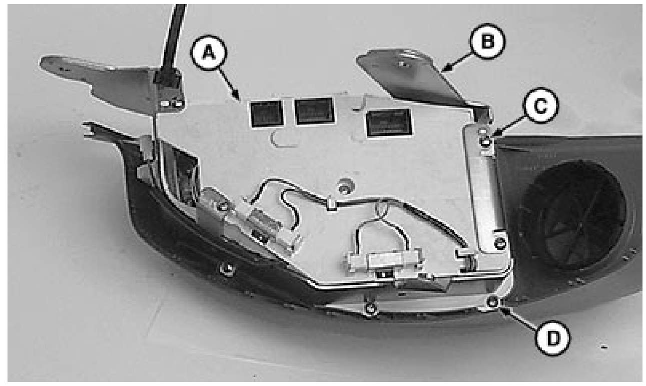
REPLACE MONITOR PANEL AND SWITCH PANEL BULB

1. Remove monitor controller. (See procedure in Group 1675.)

2. Remove cap screws (C) and bracket (B).

3. Remove cap screws (D) and monitor controller (A).

4. Replace bulbs (E and F) as necessary.



T113808 –UN–18MAR98

T113809 –UN–18MAR98

A—Monitor Controller
B—Bracket
C—Cap Screw (4 used)
D—Cap Screw (6 used)
E—Monitor Panel Bulb (12 used)
F—Switch Panel Bulb (2 used)

16
1674
29

CED,OUOE024,229 –19–20MAY98–1/1

REMOVE AND INSTALL MONITOR PANEL

1. Remove monitor controller. (See Remove and Install Monitor Controller in Group 1675.)

Continued on next page CED,OUOE042,183 –19–23JAN98–1/3

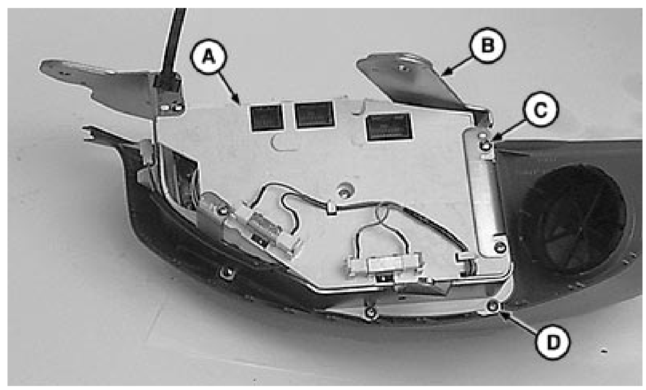
2. Remove panel control knobs (A).

T113813 –UN–18MAR98

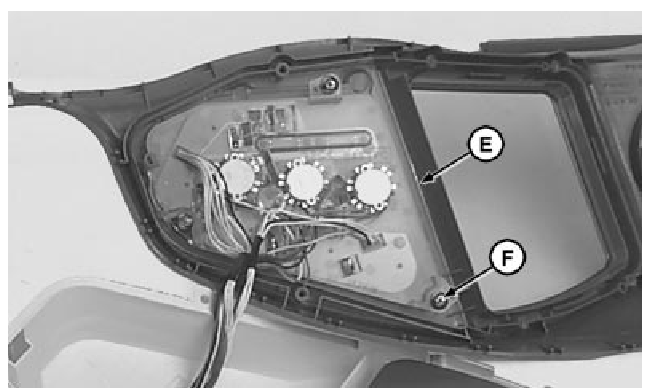
A—Control Knob (3 used)

CED,OUOE042,183 –19–23JAN98–2/3

3. Remove cap screws (C) and bracket (B).
4. Remove cap screws (D) and monitor controller (A).
5. Remove cap screws (F) and switch panel (E).
6. Replace parts as necessary.



T113808 –UN–18MAR98



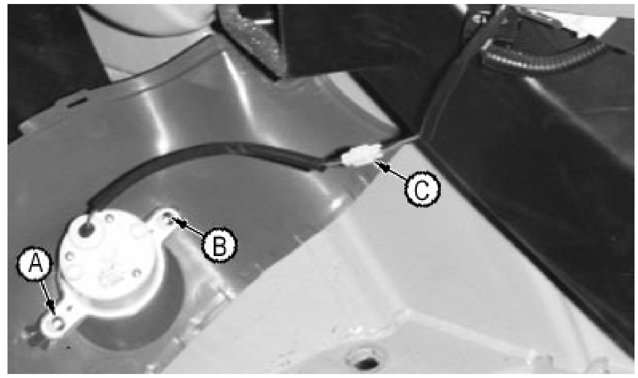
T113814 –UN–18MAR98

A—Monitor Controller
B—Bracket
C—Cap Screw (4 used)
D—Cap Screw (6 used)
E—Switch Panel
F—Cap Screw (3 used)

CED,OUOE042,183 –19–23JAN98–3/3

REMOVE AND INSTALL HOUR METER

1. Remove bottom panel.
2. Remove connector (C).
3. Remove screws (A and B). Remove hour meter.
4. Repair or replace parts as required.
5. Install hour meter.
6. Install bottom panel.



T105416B –UN–06MAR97

A—Screw
B—Screw
C—Connector

TX,16,UU3327 –19–11JUL92–1/1

CHANGING PROPEL ALARM VOLUME

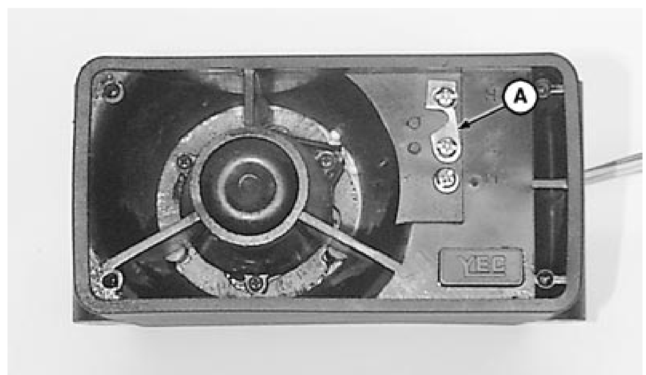
IMPORTANT: It may be necessary to adjust propel alarm volume to meet local regulations.

NOTE: Alarm removed from machine for clarity.

1. Remove four sheet metal screws to remove propel alarm front cover.

NOTE: This machine is shipped with the propel alarm set in the "High" position.

2. Adjust volume level of propel alarm by connecting metallic bar to appropriate terminals. The alarm can be set at "LOW", "MED" (medium), or "HIGH" volume levels.
3. Install front cover.



T113342 –UN–12MAR98

A—Volume Level

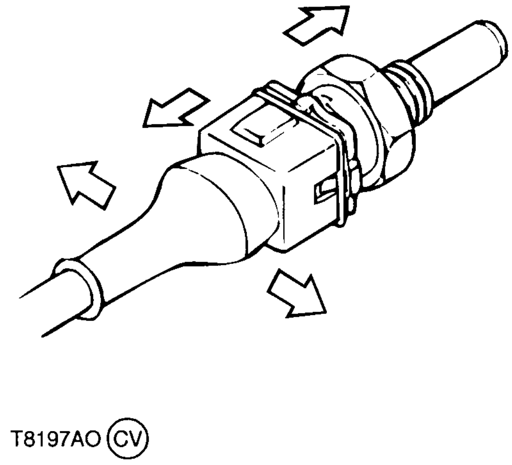
CED,OUOE042,232 –19–12MAR98–1/1

16
1674
31

DISCONNECTING SPRING WIRE RETAINER CONNECTORS

1. Grasp connector halves; move half of connector from side-to-side as it's being pulled apart. Wire retainer will slide over retaining tabs. Do not pull on wiring leads.

2. To reconnect, push together until wire retainer "clicks" over tabs.



T8197AO –UN–14MAR94

TX,16,UU3988 –19–18JUL94–1/1

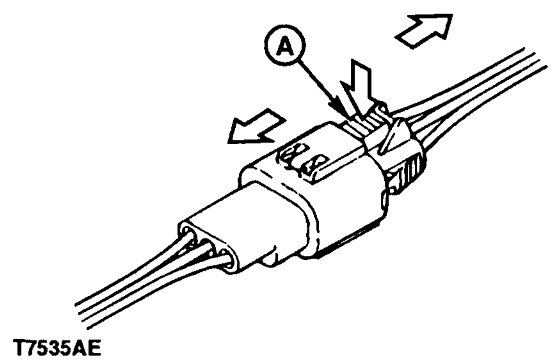
DISCONNECTING TAB RETAINER CONNECTORS

IMPORTANT: Do not disconnect electrical connectors while the engine is running. Damage to engine and pump controller or other components may result. Disconnect connectors only when instructed during a test or check.

16
1674
32

1. Push retainer tab (A).

2. Hold tab and pull connector halves apart; do not pull on wiring leads.



T7535AE –UN–22MAY91

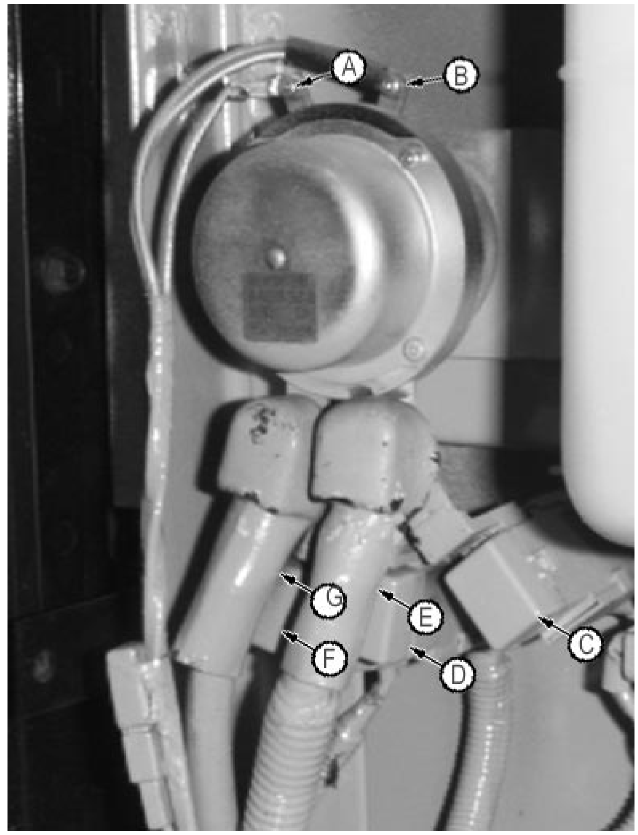
A—Retainer Tab

TX,16,UU3308 –19–19SEP98–1/1

REMOVE AND INSTALL BATTERY RELAY

1. Disconnect cables and fusible links (A—G) to remove and replace relay.

2. Install and tighten relay and connect cables and fusible links (A—G).



T105554B –UN–10DEC96

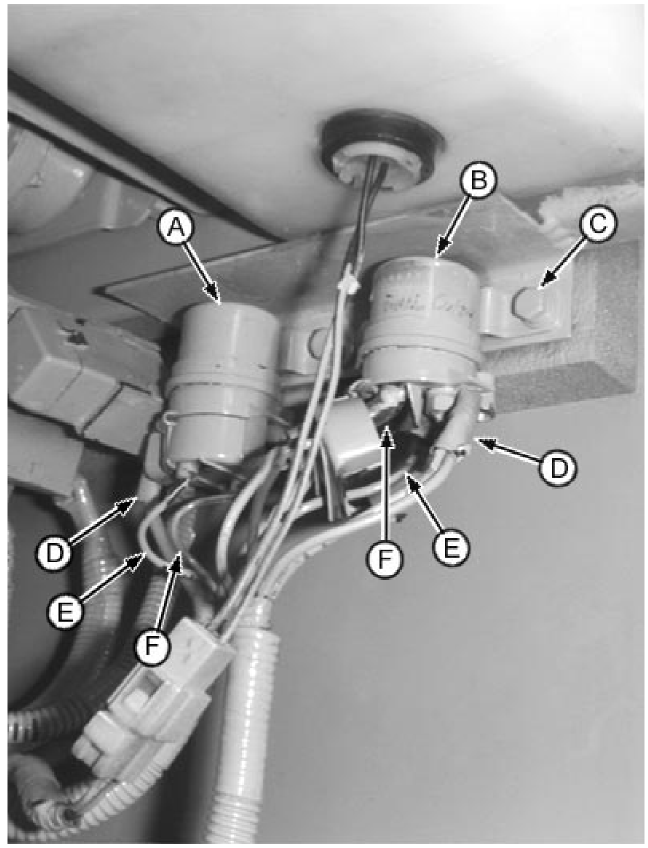
A—Positive Lead-to-Ignition
B—Negative Ground
C—Fusible Link
D—Fusible Link
E—Cable
F—Fusible Link
G—Cable

16
1674
33

TX,16,UU3250 –19–02JAN97–1/1

REMOVE AND INSTALL STARTER RELAY

1. Disconnect battery ground cable.
2. Disconnect wiring leads (D—F).
3. Remove cap screws and washers (C) to remove starter relay (A).
4. Install relay. Connect wiring leads.



T116768B –UN–12AUG98

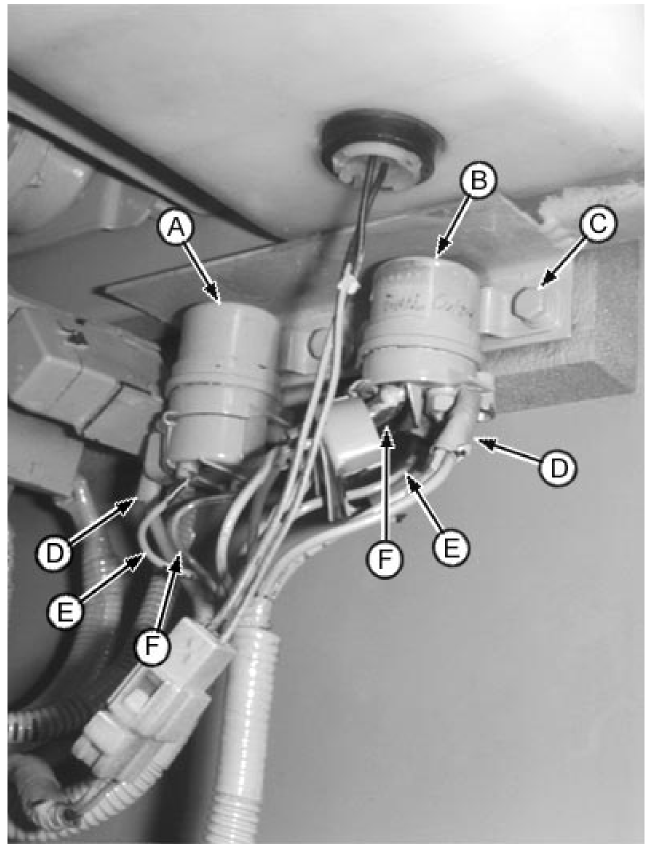
A—Starter Relay
B—Fuel Shutoff Relay
C—Cap Screw and Washer (2 used)
D—Wiring Lead
E—Wiring Lead
F—Wiring Lead

16
1674
34

TX,16,UU3990 –19–19SEP98–1/1

REMOVE AND INSTALL FUEL SHUTOFF RELAY

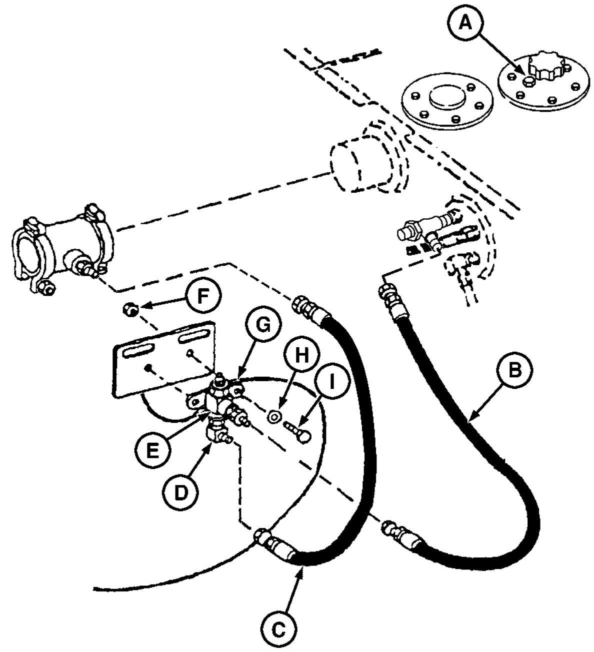
1. Disconnect battery ground cable.
2. Disconnect wiring leads (D—F).
3. Remove cap screws and washers (C) to remove fuel shutoff relay (B).
4. Install relay. Connect wiring leads.



A—Starter Relay
B—Fuel Shutoff Relay
C—Cap Screw and Washer (2 used)
D—Wiring Lead
E—Wiring Lead
F—Wiring Lead

REMOVE AND INSTALL HYDRAULIC OIL FILTER RESTRICTION SWITCH (230LCRD)

1. Loosen vent plug (A) to relieve hydraulic oil tank pressure.
2. Remove connector (G).
3. Disconnect hoses (B and C).
4. Remove elbow (D).
5. Remove cap screws (I), washers (H) and nuts (F).
6. Remove switch (E). Replace parts as necessary.



T121226

T121226 –UN–07JUN99

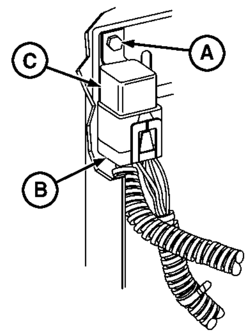
A—Vent Plug
B—Hose
C—Hose
D—Elbow
E—Switch
F—Nut (2 used)
G—Connector
H—Washer (2 used)
I—Cap Screw (2 used)

CED,OUOE020,57 –19–25MAY99–1/1

REMOVE AND INSTALL OVERLOAD ALARM RELAY

1. Disconnect connector (B).

2. Remove cap screw and nut (A) and relay (C). Replace parts as necessary.



T121225

T121225 –UN–07JUN99

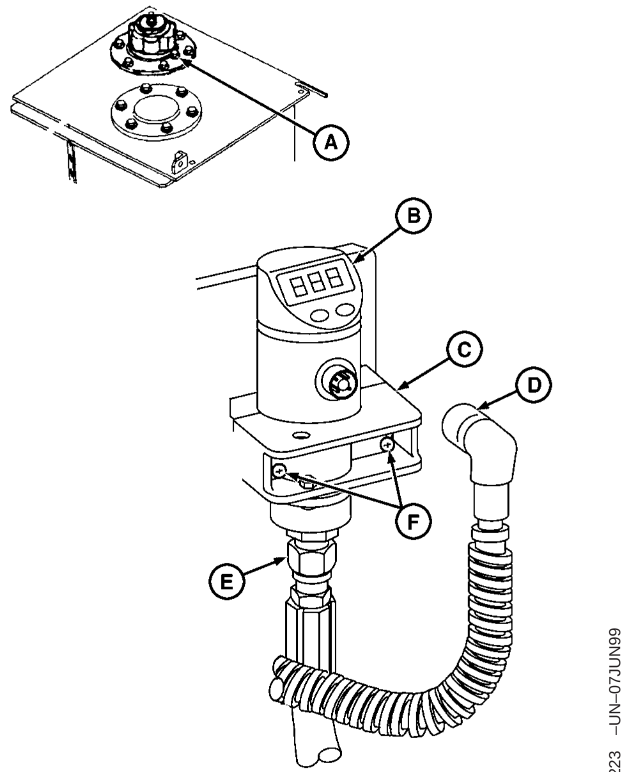
A—Cap Screw
B—Connector
C—Relay

CED,OUOE020,58 –19–25MAY99–1/1

16
1674
37

REMOVE AND INSTALL OVERLOAD ALARM PRESSURE SWITCH

1. Loosen vent plug (A) on hydraulic oil tank to relieve hydraulic oil tank pressure.
2. Disconnect connector (D).
3. Disconnect hose (E).
4. Remove cap screws (F), mount (C) and pressure switch (B). Replace parts as necessary.



T121223

A—Vent Plug
B—Pressure Switch
C—Mount
D—Connector
E—Hose
F—Cap Screw (2 used)

16
1674
38

CED,OUOE020,59 –19–20APR99–1/1

REMOVE AND INSTALL OVERLOAD ALARM PROXIMITY SWITCH

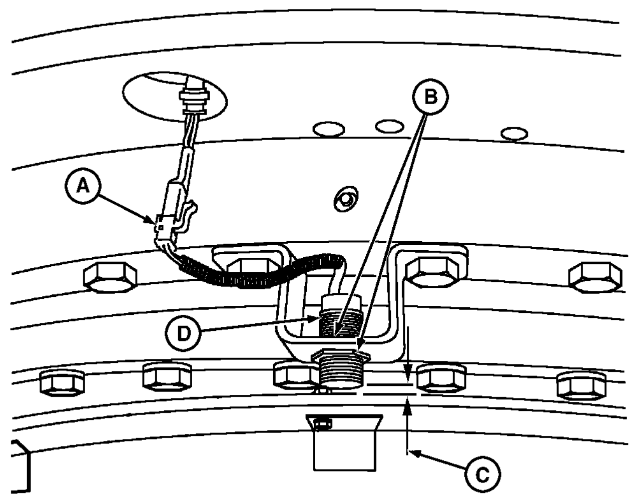
1. Operate excavator to place boom on side of excavator (cab perpendicular to tracks).

2. Turn excavator Off.

3. Disconnect connector (A).

4. Remove nuts (B) and proximity switch (D). Replace parts as necessary.

5. Adjust gap (C) to 6.5—9.5 mm (1/4—3/8 in.).



T121224

T121224 –UN–07JUN99

A—Connector
B—Nut (2 used)
C—Gap 6.5—9.5 mm (1/4—3/8 in.)
D—Proximity Switch

16
1674
39

CED,OUOE020,60 –19–25MAY99–1/1

Group 1675
System Controls

SPECIFICATIONS

Item	Measurement	Specification
Fast and Slow Idle:		
Engine Slow Idle	Speed	900 ± 25 rpm
Engine Auto-Idle	Speed	1200 ± 25 rpm
Engine E (Economy) Mode	Speed	1980 ± 25 rpm
Engine Fast Idle in Standard Mode	Speed	2180 ± 25 rpm

CED,OUOE003,1180 –19–19SEP98–1/1

WELDING ON MACHINE

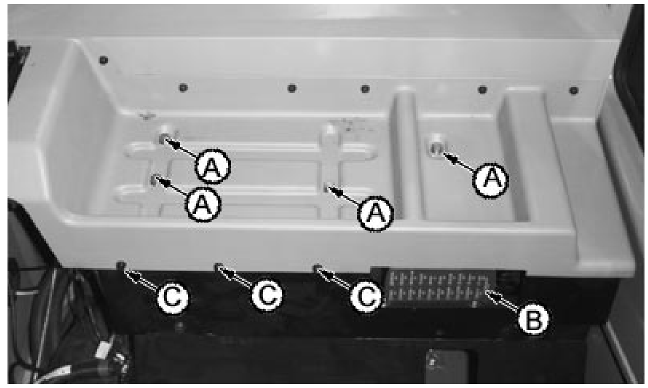
IMPORTANT: Electrical current traveling from the welder through the machine electrical system may damage the machine electrical system, including battery, EPC controller. Disconnect battery ground cable and EPC electrical connectors before welding on the machine.

Before welding on the machine, follow the steps listed below to protect the machine electrical system.

Continued on next page TX,16,UU3588 –19–19SEP98–1/3

1. Disconnect the battery ground and positive cables.

2. Inside the cab, remove four cap screws (A and C) and the fuse box cover (B) to remove the rear console cover.



T107932B –UN–07MAR97

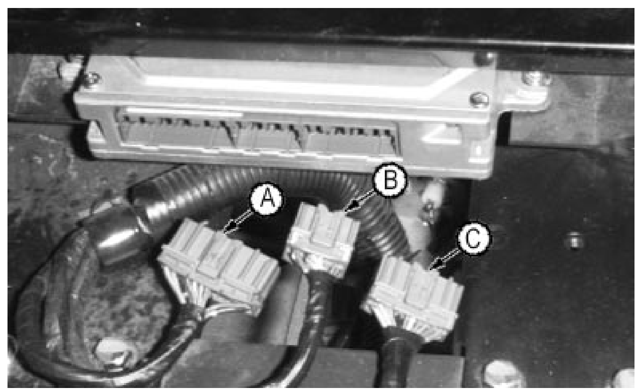
A—Cap Screws
B—Fuse Box Cover
C—Cap Screws

TX,16,UU3588 –19–19SEP98–2/3

3. Disconnect the engine and pump controller electrical connectors.

4. After the welding on machine is completed, install the connectors to the engine and pump controller and then connect the battery cables.

5. Do the Engine Speed Learning Procedure. (See procedure in this group.)



T105437B –UN–06MAR97

A—Connector
B—Connector
C—Connector

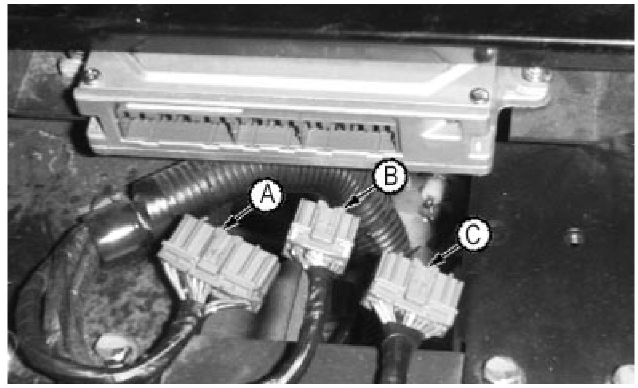
TX,16,UU3588 –19–19SEP98–3/3

CONNECTING ENGINE AND PUMP CONTROLLER (EPC) HARNESS CONNECTOR

IMPORTANT: Do not disconnect electrical connectors while the engine is running. Damage to Engine and Pump Controller, or other components may result. Disconnect connectors only when instructed during a test or check.

1. Push connectors into engine and pump controller.

2. Do Engine Speed Learning Procedure. (See procedure in Group 1671.)



T105437B –UN–06MAR97

A—Connector
B—Connector
C—Connector

TX,16,UU3984 –19–19SEP98–1/1

REMOVE AND INSTALL ENGINE AND PUMP CONTROLLER (EPC)

IMPORTANT: If a controller problem is indicated, the real problem may be poor connector pin contact. Before replacing engine and pump controller or troubleshooting the circuits, clean all terminals in the monitor controller, engine and pump controller, and harness connectors using a non-conductive, lubricating contact cleaner. Check machine operation again before proceeding. TY16324 Contact Cleaner may be used.

1. Disconnect battery ground cable.

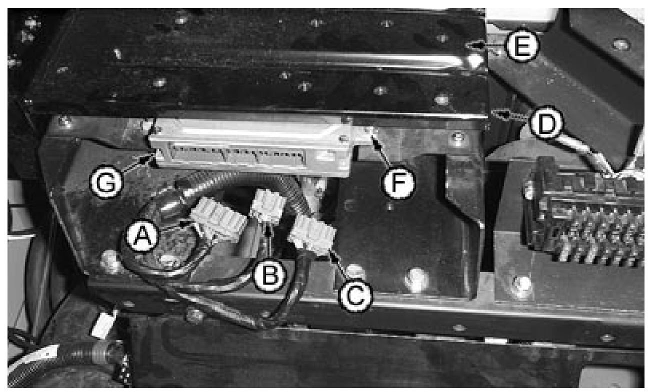
2. Move seat forward and remove access cover.

3. Disconnect cable connectors (A—C).

4. Remove cap screws (F) and remove engine and pump controller (G).

5. Install engine and pump controller.

6. Do Engine Speed Learning Procedure. (See procedure in Group 1671.)



T105437C –UN–06MAR97

A—Connector
B—Connector
C—Connector
D—Cover Plate
E—Screws
F—Screw (4 used)
G—Engine and Pump Controller (EPC)

TX,16,UU3985 –19–19SEP98–1/1

ENGINE SPEED LEARNING PROCEDURE

When the following components are repaired or replaced, or when engine speeds deviate from specification, the engine speed learning procedure must be performed.

- Engine
- Engine speed control cable
- Engine control motor and angle sensor
- Engine and pump controller
- Fast and slow idle stop screws

1. Stop engine. Ignition key OFF.

2. Disconnect the laptop computer from test connector.

   Wait for 5 seconds.

Continued on next page TX,05,GG2769 –19–18SEP98–1/2

NOTE: The three position switch, protected by an angle guard, is located just below and behind the computer test connector.

3. Push engine learning switch (C) up to the TOP position. The switch is a three-position switch. Make sure it is in the top position.
4. Turn key switch ON. Wait for 5 seconds.
5. Turn key switch OFF. Wait for 5 seconds.
6. Push engine learning switch to MIDDLE position.
7. Check engine speeds.

Engine Slow Idle—Specification

Speed .... 900 ± 25 rpm

Engine Auto-Idle—Specification

Speed .... 1200 ± 25 rpm

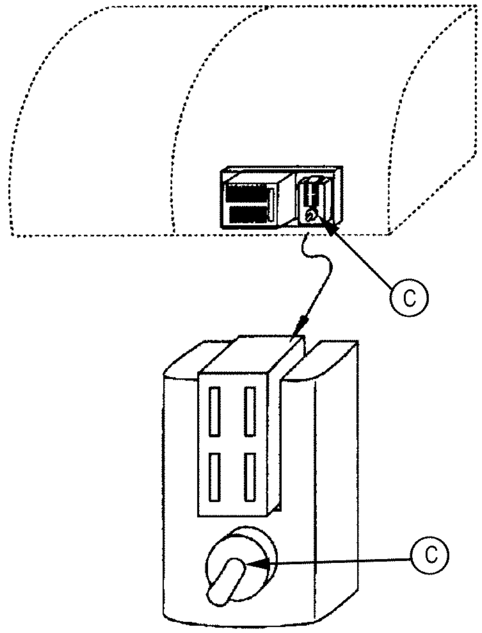
Engine E (Economy) Mode—Specification

Speed .... 1980 ± 25 rpm

Engine Fast Idle in Standard Mode—Specification

Speed .... 2180 ± 25 rpm

NOTE: The laptop computer with the excavator diagnostic software can be used to change the default speeds for slow idle, auto-idle, economy mode, and fast idle in standard mode. See Excavator Diagnostics Program Special Function—Engine Speed Adjustment in Group 9025-25.



T103674

T103674 –UN–11SEP96

A—Engine Learning Switch

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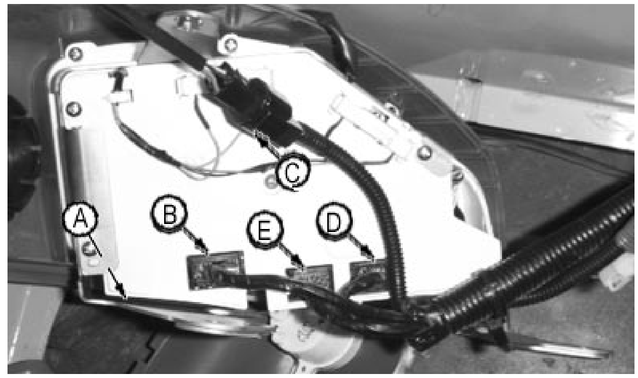
1675
5

TX,05,GG2769 –19–18SEP98–2/2

REMOVE AND INSTALL MONITOR CONTROLLER

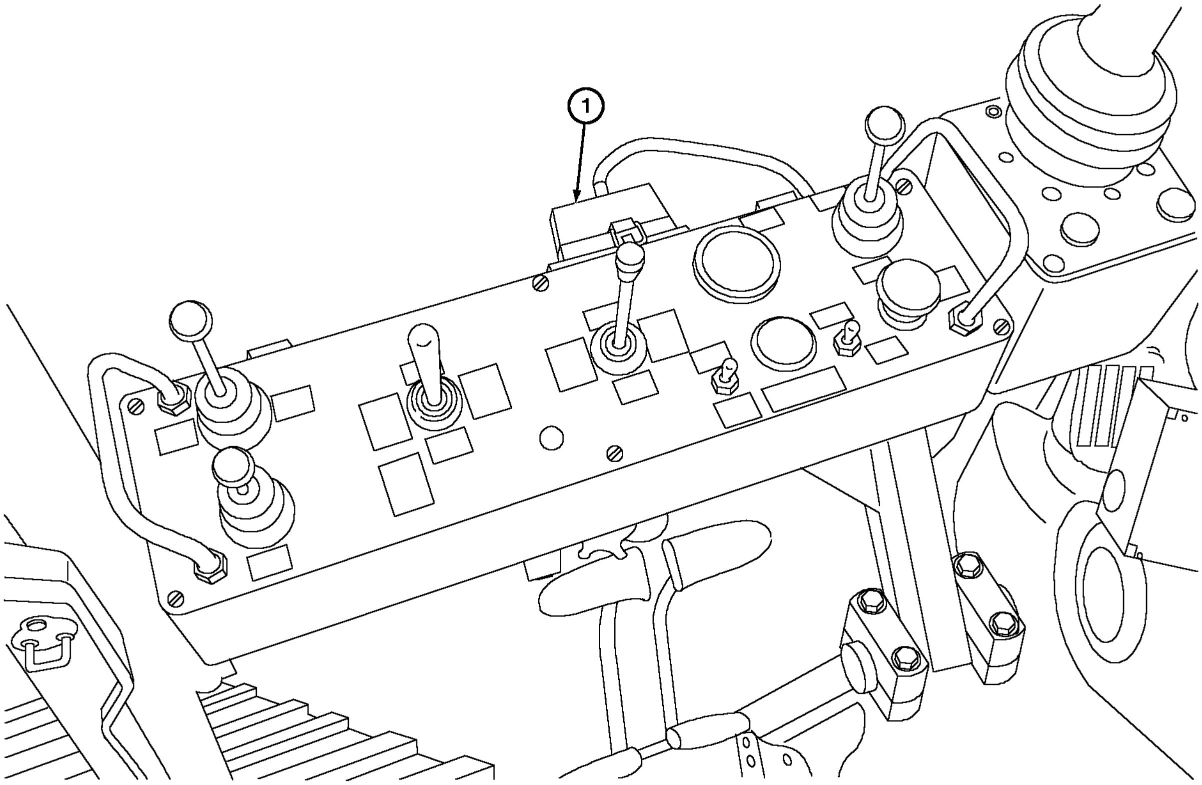


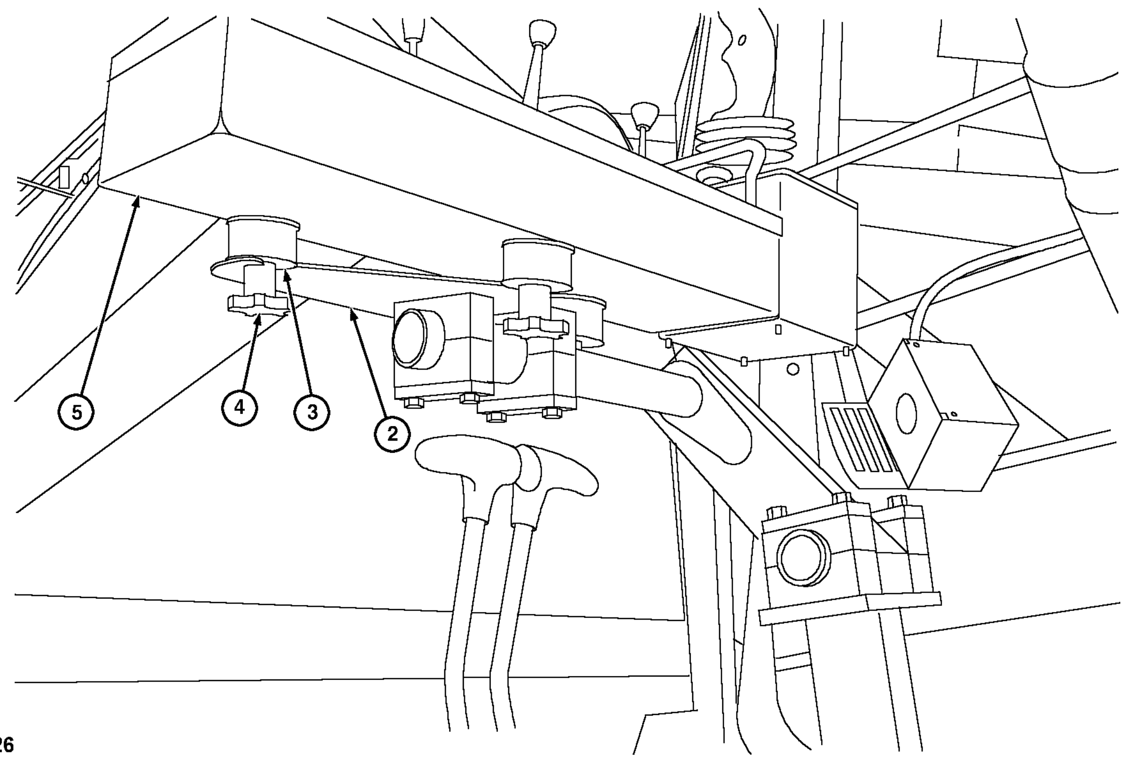
T105427B –UN–06MAR97

1. Disconnect battery ground cable.
2. Move seat forward and remove access cover.
3. Disconnect wiring harness connectors (C).
4. Remove screws (B) and monitor controller (A).
5. Install monitor controller and connect wiring harnesses.
6. Install cover and connect battery cable. Do engine speed recalibration. (See Engine and Pump Controller (EPC) in this group.)

TX,16,UU3323 –19–23JUN94–1/1

REMOVE AND INSTALL ROCKDRILL CONTROL CONSOLE





T121526

T121526 –UN–28OCT99

Continued on next page

CED,OUOE023,1 –19–27MAY99–1/2

System Controls

1—Harness Connector
2—Mounting Plate
3—Slots (3 used)
4—Hand Knobs (3 used)
5—Control Console

1. Disconnect harness connector (1) from control console (5).

2. Loosen three hand knobs (4).

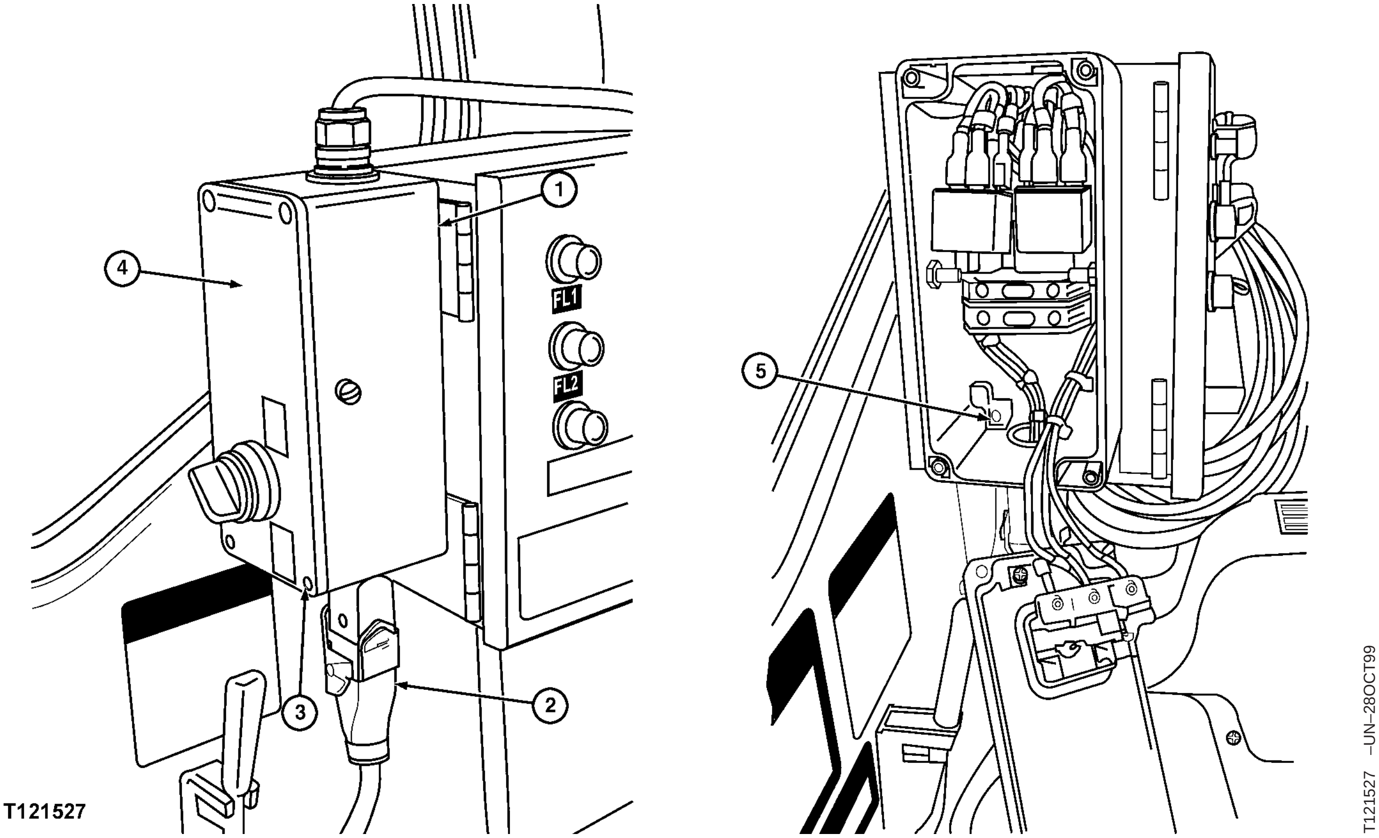
3. Remove control console (5) by sliding through slots (3) in mounting plate (2).

4. Install control console (5) by sliding through slots (3) in mounting plate (2) and tighten hand knobs (4).

5. Connect harness connector (1) to control console (5).

CED,OUOE023,1 –19–27MAY99–2/2

REMOVE AND INSTALL ROCK DRILL START—STOP SELECTOR CONTROL BOX

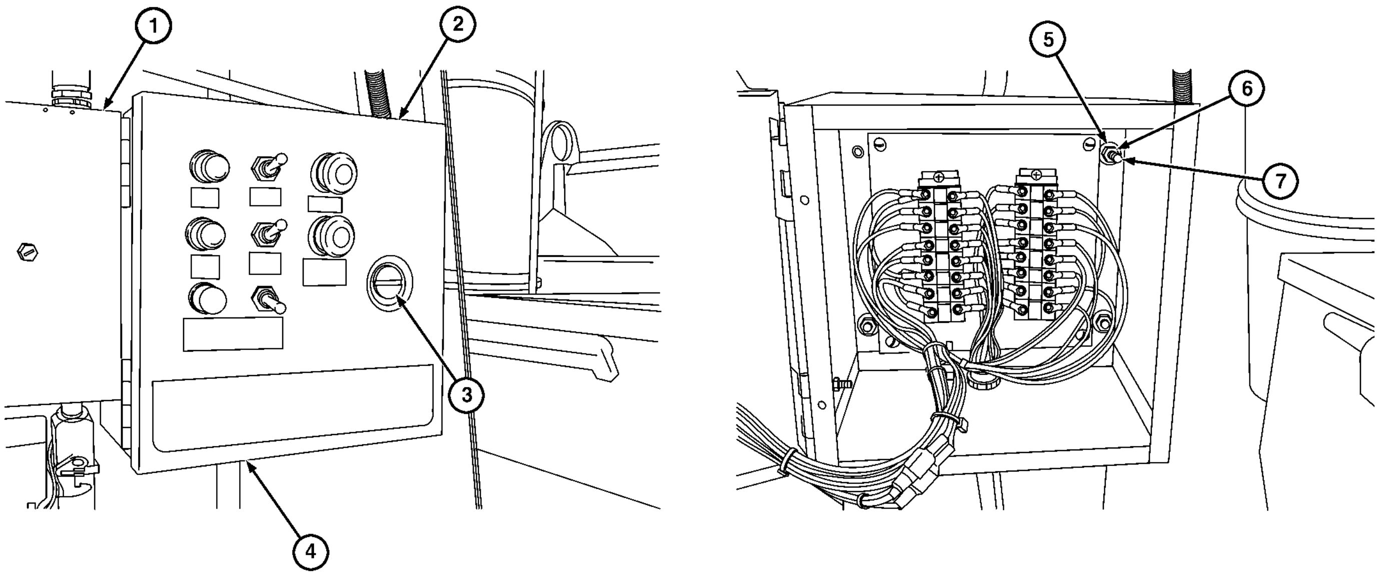


1—Start—stop selector control box
2—Harness Connector
3—Phillips Screw (4 used)
4—Cover
5—Phillips Screw (2 used)

1. Remove harness connector (2).
2. Remove Phillips screws (3) and remove cover (4).
3. Support start—stop selector control box and remove Phillips screws (5).
4. Install and tighten start—stop selector control box using Phillips screws (5).
5. Install and tighten cover (4) using Phillips screws (3).
6. Install harness connector (2).

CED,OUOE023,2 –19–27MAY99–1/1

REMOVE AND INSTALL COMPRESSOR REMOTE CONTROL PANEL



T121529

T121529 –UN–28OCT99

1—Control box
2—Control panel
3—Latch
4—Harness connector
5—Washers (3 used)
6—Nuts (3 used)
7—Studs (3 used)

1. Remove control box (1). (See Remove and Install Rock Drill Start—Stop Selector Control Box in this group).

2. Remove harness connector (4).

3. Turn latch (3) counterclockwise and open remote instrument control panel (2).

4. Support control panel (2), remove nuts (6) and washers (5).

5. Remove control panel (2).

6. Install control panel (2) onto studs (7).

7. Install washers (5) and tighten nuts (6).

8. Close remote instrument control panel (2) and turn latch (3) clockwise to lock.

9. Connect harness connector (4).

CED,OUOE023,3 –19–27MAY99–1/1

Group 1677
Starting Motors

GENERAL INFORMATION

IMPORTANT: Never operate starting motor longer than 30 seconds. Allow at least 2 minutes for cooling and battery recovery before operating again. Overheating caused by excessive operation will seriously damage starting motor.

RG,RG34710,2335 –19–15Mar97–1/1

TYPICAL STARTING CIRCUIT OPERATION

When wire from relay (A) is energized, current flows through both pull-in winding (C) and hold-in winding (D) to ground.

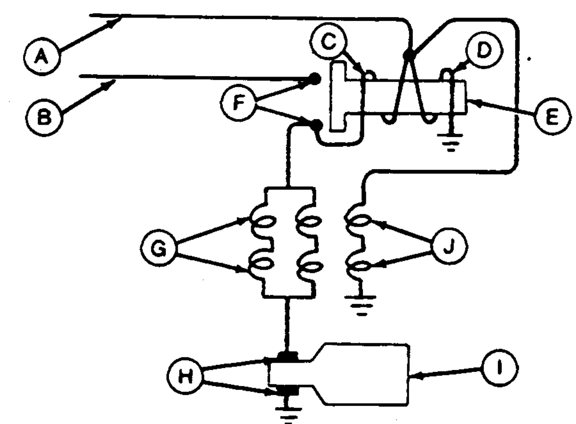
Current through windings engages solenoid plunger (E), which closes main contacts (F). When main contacts close, current through pull-in windings stops. Current continues through hold-in winding, keeping solenoid engaged and main contacts closed.

With main contacts closed, current flows from battery cable (B) to starting motor at a very high rate. Four heavy field windings (G) carry current to commutator brushes (H).

Light shunt windings (J) are wrapped together with two of the heavy field windings. Shunt windings are connected to solenoid switch terminal and directly to ground. They provide additional low speed torque to assist engine rotation and prevent overspeeding of motor.

From field windings, current flows through armature windings (I) to ground, making contact through commutator brushes (H).

Strong magnetic fields are set up by current flow through field windings and armature windings. Windings are arranged so that magnetic fields constantly repel each other, rotating armature.

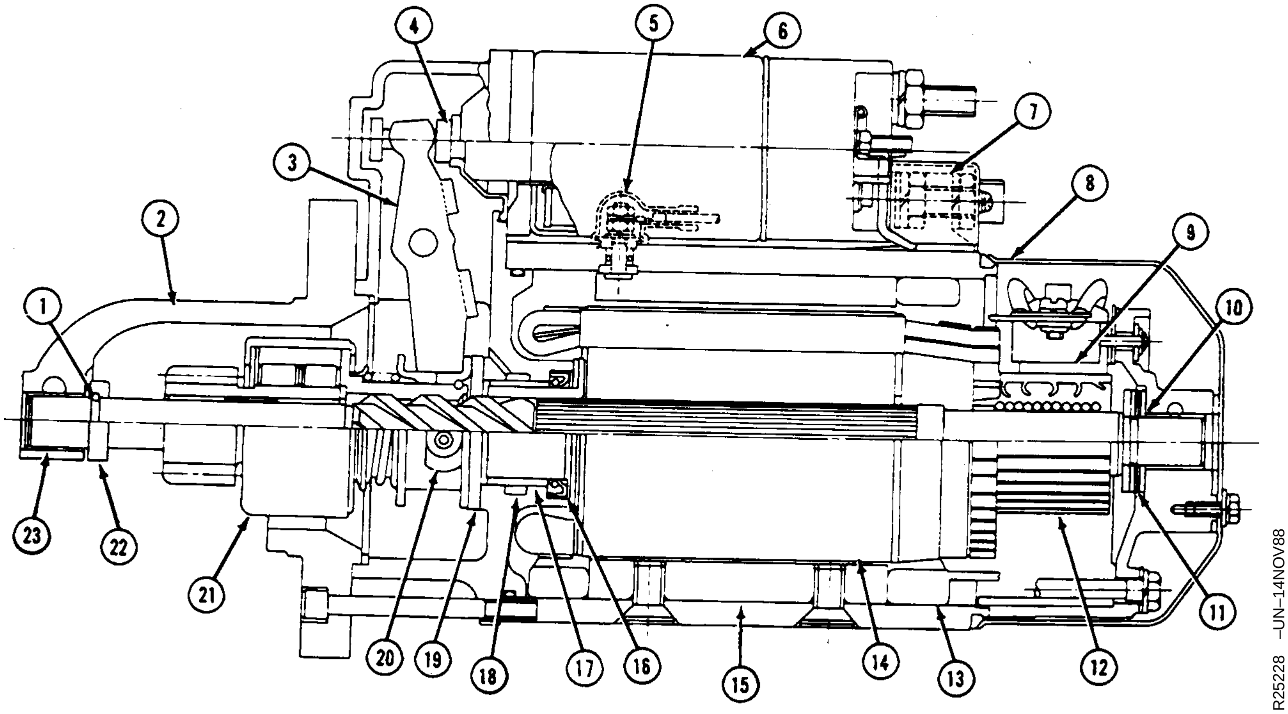


RG1313 –UN–20APR89

A—Wire From Relay
B—Cable from Battery
C—Pull-In Winding
D—Hold-In Winding
E—Solenoid Plunger
F—Main Contacts
G—Field Windings
H—Commutator Brushes
I—Armature
J—Shunt Windings

RG,RG34710,2336 –19–15Mar97–1/1

TYPICAL STARTING MOTOR OPERATION



1—Snap Ring	**7—Field Connector**	**13—Field Windings**	**19—Brake Washer**
2—Drive End Housing	**8—End Frame Cover**	**14—Armature**	**20—Wear Pads**
3—Shift Lever	**9—Brush**	**15—Pole Shoe**	**21—Overrunning Clutch**
4—Plunger	**10—Bushing**	**16—Oil Seal**	**22—Pinion Stop**
5—Shunt Field Terminal	**11—Thrust Washer**	**17—Bushing**	**23—Bushing**
6—Solenoid Assembly	**12—Commutator**	**18—Felt**	

When solenoid (6) engages, it pulls shift lever (3). Shift lever pushes overrunning clutch drive (21) to engage pinion in stater gear on flywheel. As armature (14) turns, it cranks engine.

When engine starters, overrunning clutch spins freely on shaft. This prevents overspeeding of armature by flywheel.

When key switch is released, current to solenoid hold-in winding is shut off. Current can feed through both pull-in and hold-in windings from main contacts, but direction of current is reversed in pull-in winding. The two windings cancel each other, and solenoid is released.

A spring pushes solenoid back to disengaged position. This opens main contacts and shuts off current to field windings and armature.

Shift lever retracts overrunning clutch drive, disengaging pinion from flywheel. Brake washer (19) slows armature to a stop.

RG,RG34710,2337 –19–15Mar97–1/1

Robert Bosch Starting Motor Repair

SPECIAL OR ESSENTIAL TOOLS

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

SERVICEGARD is a trademark of Deere & Company.

RG,RG34710,2338 –19–15Mar97–1/2

Digital Multimeter JT05791

Test electrical components for voltage, resistance, or current flow. It is especially good for measuring low voltage or high resistance circuits.

RW11274 –UN–12DEC88

RG,RG34710,2338 –19–15Mar97–2/2

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10
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ROBERT BOSCH STARTING MOTOR SPECIFICATIONS

				NO LOAD TEST		
John Deere Part No.	**Bosch Model No.**	**System Voltage**	**Rating kW**	**Volts**	**Amps (Max.)**	**Rpm kW**
AL110503	0 001 367 078	12	3.0	11.5	130	700080007000
AL110504	0 001 369 022	12	3.1	11.511.5	170	
AL41247	0 001 362 312	12	2.7		125	
AL62690	0 001 362 316	12	2.7	11.511.511.5	125	700080007000
AL62772	0 001 369 005	12	3.1		170	
AL78760	0 001 367 075	12	3.0		130	
AL81154	0 001 367 077	12	3.0	11.511.511.5	130	7000
RE30493	0 001 362 324	12	2.7		125	7000
RE65169	0 001 369 021	12	3.1		170	8000

Item	Specification
Minimum voltage of solenoid	8 volts
Testing armature for grounded circuit, voltage	40 volts a.c.
Testing field coils for grounded circuit, voltage	40 volts a.c.
Testing field coils for open windings, voltage	6—12 volts d.c.
Testing brush holder insulation for grounded circuit, voltage	40 volts a.c.
2.7 kW Starting Motor	
Minimum diameter of commutator (When turning down, armature shaft locating points are slightly off center.)	39.5 mm (1.555 in.)
Commutator out-of-roundness, max	0.03 mm (0.0012 in.)
Out-of-roundness of stack of armature plates, max	0.05 mm (0.002 in.)
Undercutting insulation after initial turn-down of commutator by approximately: (then finish-turn)	0.5—0.8 mm (0.02—0.03 in.)
Brush pressure (check with a spring scale)	26—28 N (5.7—6 lb)
Minimum brush length	7.5 mm (0.30 in.)
Armature end play	0.1—0.3 mm (0.004—0.012 in.)
Armature braking torque	0.45—0.75 N•m (4.0—6.6 in-lb)
Overrunning torque	0.40—0.55 N•m (3.5—4.8 in-lb)
3.0 and 3.1 kW Starting Motor	
Minimum diameter of commutator (important for turning down: Note: Armature shaft locating points are slightly off center)	42.5 mm (1.67 in.)
Commutator out-of roundness, max	0.03 mm (0.0012 in.)
Out-of roundness of stack of armature plates, max	0.05 mm (0.002 in.)
Undercutting insulation after initial turn-down of commutator by approximately: (then finish-turn)	0.5—0.8 mm (0.02—0.03 in.)
Minimum brush length	7.5 mm (0.30 in.)
Armature end play	0.1—0.3 mm (0.003—0.012 in.)
Armature braking torque	0.5—1.2 N•m (0.43—1.40 in-lb)
Overrunning torque	0.35—0.65 N•m (0.30—0.56 in-lb)

RG,RG34710,2339 –19–15Mar97–1/1

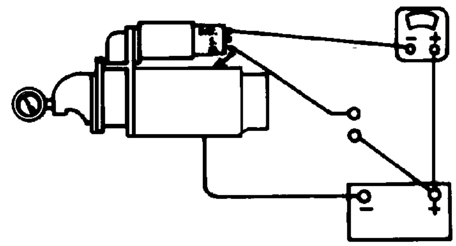
MAKE NO-LOAD TEST

1. Make connections as shown, and use an ammeter (A) capable of measuring several hundred amps.

2. Measure current draw in amps and compare with specifications given earlier in this group.

3. If speed and current draw are slightly low, connect a voltmeter between motor terminal and frame. Observe voltage during test. Voltage may be reduced because of high current draw on battery.

4. If speed or current draw is significantly different than specified, diagnose problem per chart which follows.



RG3897 RG3897 –UN–05DEC97

A—Ammeter
B—Battery
C—Starter Frame
D—Tachometer
E—Battery Terminal
F—Switch
G—Field Coil Connector

RG,RG34710,2340 –19–15Mar97–1/1

DIAGNOSING STARTING MOTOR MALFUNCTIONS

FAILS TO OPERATE, NO CURRENT DRAW

Open field circuit (all field windings)

Open armature windings

Defective brush contact with commutator

Open solenoid windings

Defective solenoid contacts

FAILS TO OPERATE, HIGH CURRENT DRAW

Grounded field windings or armature windings

Seized bearings

LOW SPEED, LOW CURRENT DRAW

High internal resistance

Defective brush contact with commutator

LOW SPEED, HIGH CURRENT DRAW

Low Speed, High Current Draw

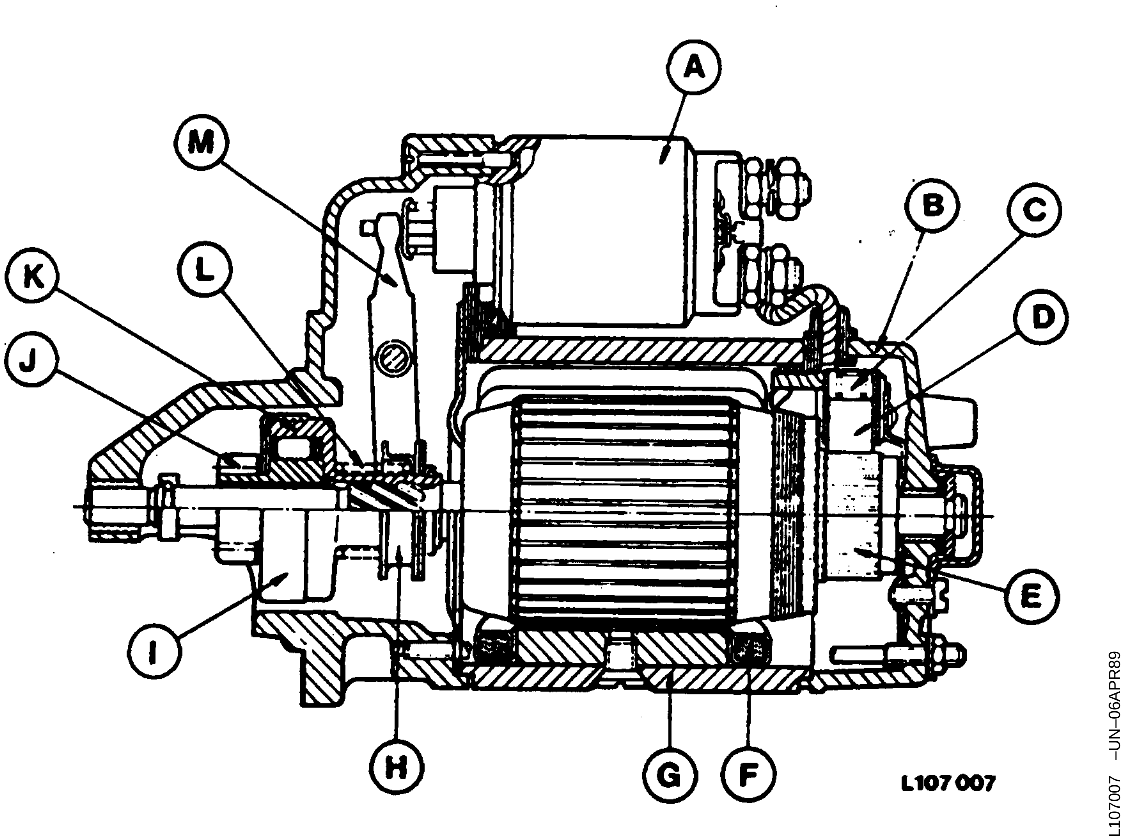
HIGH SPEED, HIGH CURRENT DRAW

Shorted field windings

NOTE: This test will not detect individual open-circuited field coils—the stator would have a slow cranking speed but would pass this test.

RG,RG34710,2341 –19–15Mar97–1/1

ROBERT BOSCH STARTING MOTOR



A—Solenoid Switch	**E—Commutator**	**I—Overrunning Clutch (Roller-Type)**	**L—Engaging Spring**
B—Commutator End Frame	**F—Field Winding**	**J—Pinion**	**M—Engaging Lever**
C—Compression Spring	**G—Field Frame**	**K—Drive Hub**	
D—Carbon Brush	**H—Guide Ring**		

RG,RG34710,2342 –19–15Mar97–1/1

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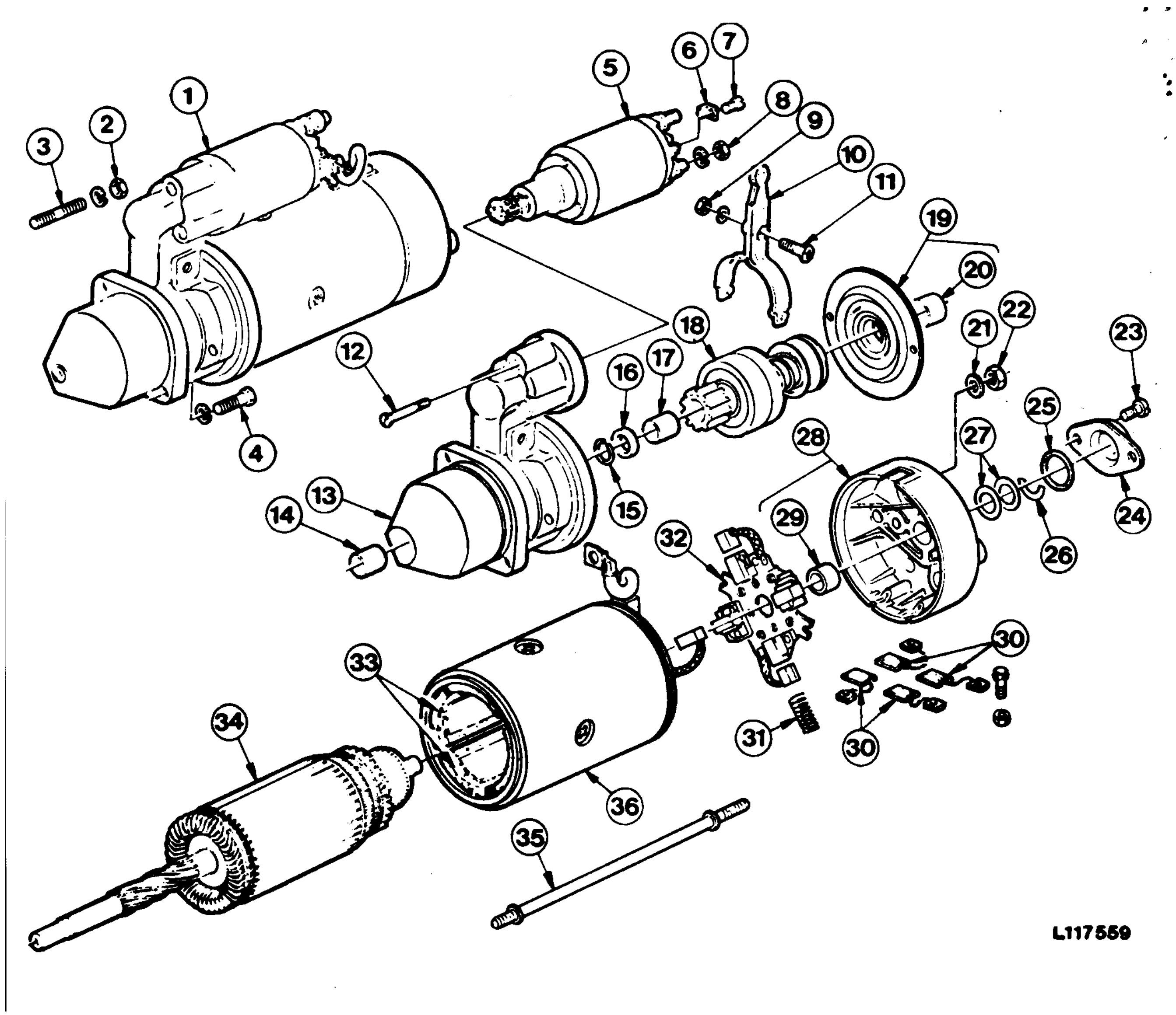
6

STARTING MOTOR, EXPLODED VIEW



L117559 –UN–02FEB89

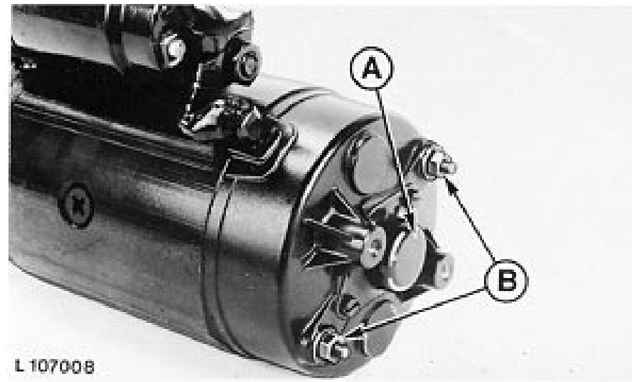
1—Starting Motor Assembly
2—Hex Nut
3—Stud
4—Cap Screw
5—Solenoid Switch
6—Securing Clip
7—Cylinder Head Screw
8—Hex Nuts (4 Used)
9—Hex Nut
10—Engaging Lever
11—Pivot Screw
12—Countersunk Screw (3 Used)
13—Drive End Frame Assembly
14—Bushing
15—Snap Ring
16—Stop Ring
17—Bushing
18—Drive With Pinion
19—Center Bearing
20—Bushing
21—Washer (2 Used)
22—Hex Nut (2 Used)
23—Cylinder Head Screw (2 Used)
24—Cover Cap
25—Rubber Ring
26—Fixing Washer
27—Shims
28—Commutator End Frame
29—Bushing
30—Carbon Brushes (Kit)
31—Compression Spring (4 Used)
32—Carbon Brush Plate
33—Winding
34—Armature
35—Stud (2 Used)
36—Field Frame

RG,RG34710,2343 –19–15Mar97–1/1

DISASSEMBLY

Unscrew cover cap (A) and remove fixing washer and shims. Be careful with rubber ring.

Remove hex nuts (B).



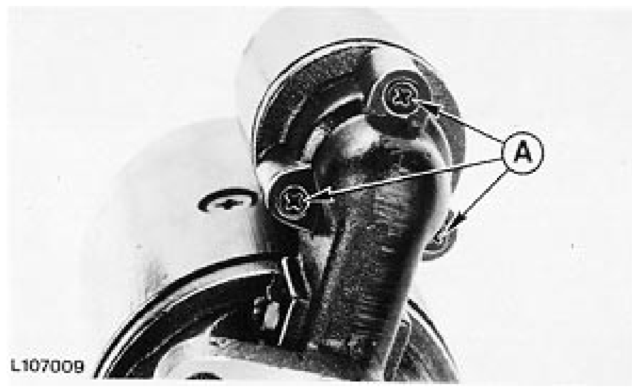
L107008 –UN–17JUL89

RG,RG34710,2344 –19–15Mar97–1/1

SOLENOID SWITCH—REMOVAL

Disconnect wiring connection from solenoid switch.

Remove attaching screws (A) and pull out solenoid switch with pinion head.



L107009 –UN–17JUL89

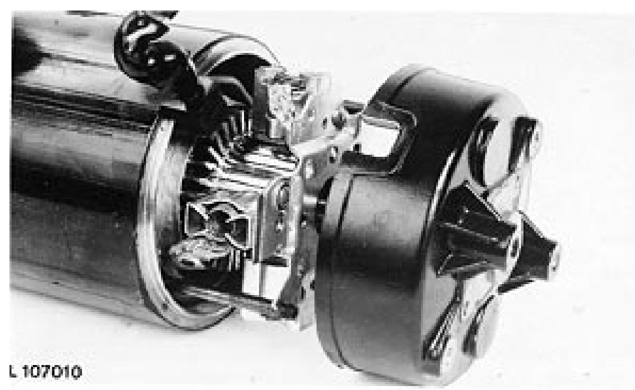
RG,RG34710,2345 –19–15Mar97–1/1

CARBON BRUSH PLATE—REMOVAL

Carefully remove commutator end frame as shown.

NOTE: *When removing commutator end frame the brush compression springs may spring out of the brush holders.*

Pull carbon brushes out of carbon brush plate and remove carbon brush plate from armature shaft.



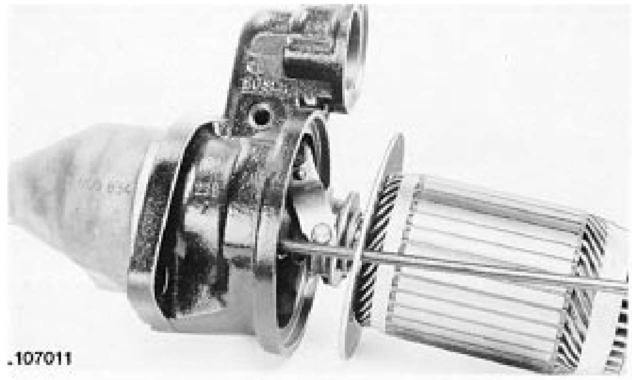
L107010 –UN–17JUL89

RG,RG34710,2346 –19–15Mar97–1/1

ARMATURE—REMOVAL

Carefully pull armature with drive end frame assembly from field frame (do not damage windings).

Remove engaging lever and armature jointly out of drive end frame assembly.



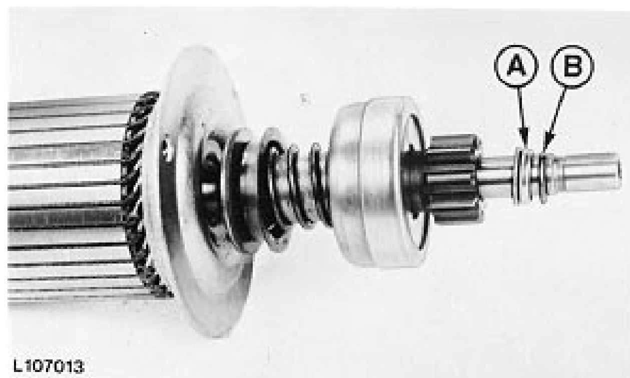
L107011 –UN–17JUL89

RG,RG34710,2347 –19–15Mar97–1/1

SNAP RING—REMOVAL

Drive back stop ring (A) and bend open snap ring (B).

Remove drive with pinion and center bearing from armature shaft.



L107013 –UN–17JUL89

RG,RG34710,2348 –19–15Mar97–1/1

CLEANING PARTS

Wash parts in solvent and dry with compressed air.

NOTE: Armature, windings and drive with pinion must not be placed in cleaning fluid.

Inspect all parts for wear and mechanical damage.

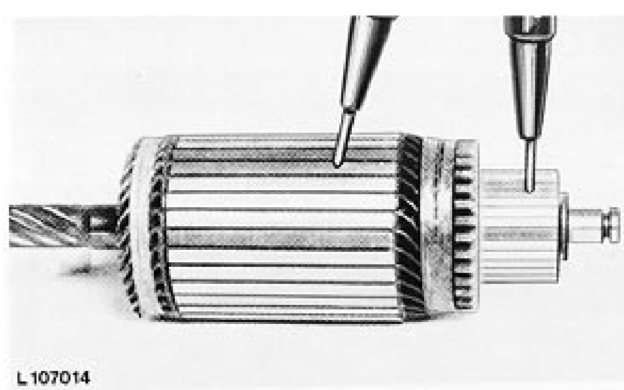
RG,RG34710,2349 –19–15Mar97–1/1

TESTING ARMATURE FOR GROUNDS

Set ohmmeter to read on highest scale.

Place one test lead on the armature core or shaft. Place other lead on commutator.

If the test meter indicator swings toward zero, the armature is grounded. Replace armature.



L107014 –UN–17JUL89

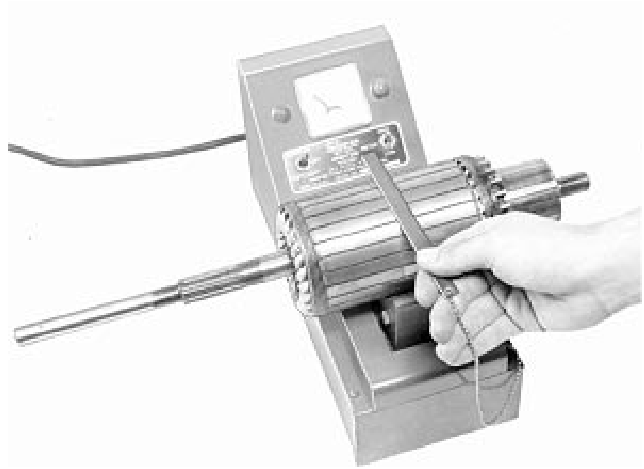
RG,RG34710,2350 –19–15Mar97–1/1

TESTING ARMATURE FOR SHORT CIRCUIT

Place armature in a growler and hold hacksaw blade above each slot while slowly rotating the armature.

If coil is shorted, the blade will be attracted to and repelled from the slot.

Short circuit most often occurs because of copper dust or filings between two commutator segments. Clean commutator segments to correct this short.



RG78074C1 –UN–09JAN90

RG,RG34710,2351 –19–15Mar97–1/1

TESTING ARMATURE FOR OPEN CIRCUIT

Set ohmmeter to read on lowest scale.

Place one test lead on commutator segment. Place other test lead on an adjacent segment. Repeat this operation for all segments by moving one lead at a time.

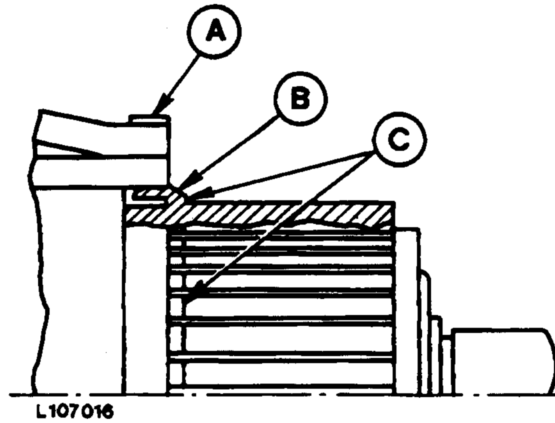
If the test meter indicator does not swing to zero and remains stationary, the armature coil between these two segments is open. Replace armature.

RG,RG34710,2352 –19–15Mar97–1/1

TURNING COMMUTATOR DOWN

Minimum diameter: 42.5 mm (1.67 in.)

After turning the commutator down, undercut its insulation by approximately. 0.5—0.8 mm (0.02—0.03 in.) with a commutator saw and then finish-turn.



L107016 –UN–06APR89

A—Solenoid Lug
B—Claw
C—Turn Down Only to Here

RG,RG34710,2353 –19–15Mar97–1/1

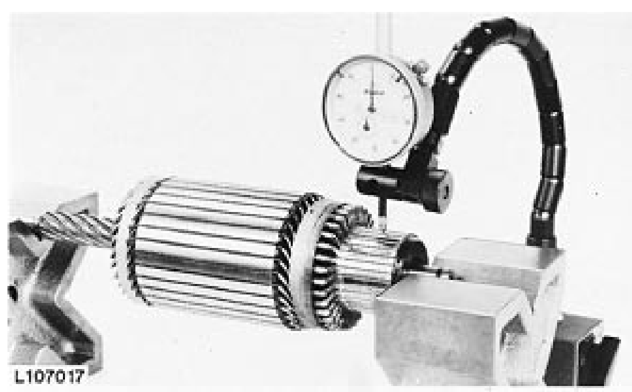
TESTING COMMUTATOR FOR OUT-OF-ROUNDNESS

Out of roundness:

Commutator, max: 0.03 mm (0.0012 in.)

Stack of armature plates, max: 0.05 mm (0.002 in.)

Check armature once again for grounds and short circuits.



L107017 –UN–17JUL89

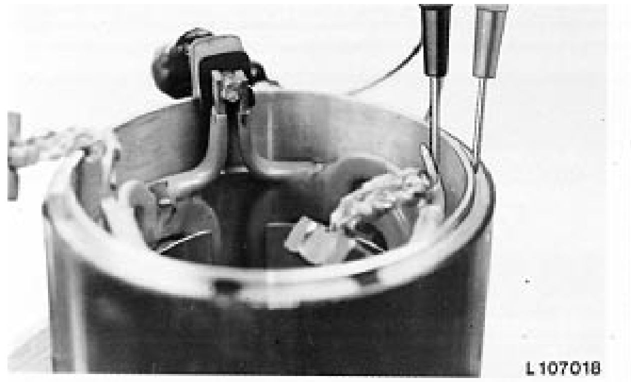
RG,RG34710,2354 –19–15Mar97–1/1

TESTING FIELD WINDING FOR GROUND CIRCUITS

Set ohmmeter to read on highest scale.

Place one test lead on a clean spot on field frame. Place other lead on brush lead.

If the ohmmeter indicator swings toward zero, a grounded circuit is indicated. Replace the field windings.

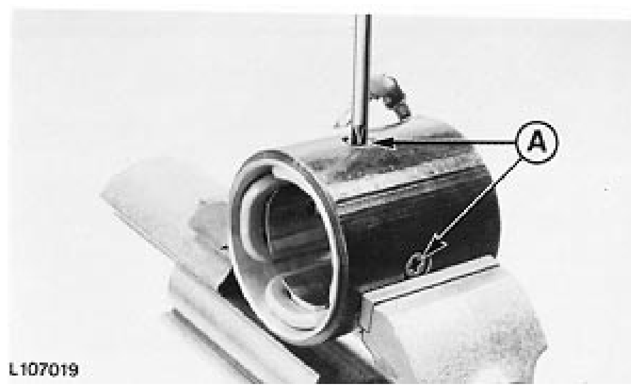


L107018 –UN–17JUL89

RG,RG34710,2355 –19–15Mar97–1/1

FIELD WINDING—REMOVAL

Mark position of pole shoes and winding ends and unscrew pole shoe screws (A).



L107019 –UN–17JUL89

RG,RG34710,2356 –19–15Mar97–1/1

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12

MAKE OPEN CIRCUIT TEST FOR FIELD WINDINGS

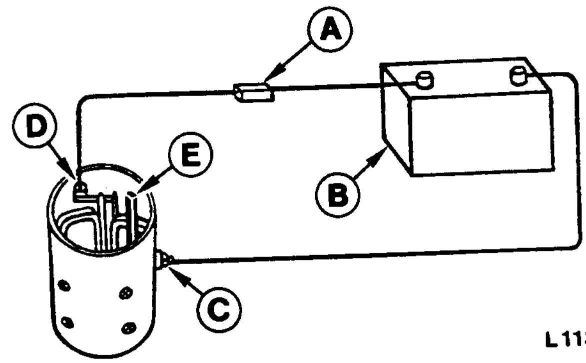
All four field windings are connected in parallel. Test each winding for an open circuit.

Connect a test battery (B) to field terminal (C) and either insulated brush lead (D), using a resistor (A) to limit current draw.

Use a hacksaw blade (E) to test winding for magnetism. If any winding is not magnetic, the winding is open circuited. Repair or replace windings.

NOTE: Because 1/4-ohm resistors capable of carrying several hundred watts are not widely available, a suggested alternative is to connect four 1-ohm resistors in parallel. Each resistor should be rated for at least 150 watts. A carbon pile can also be used. Limit current to 40—70 amps.

There is no suitable way to check field windings for short circuits. Winding resistance is too low to permit detection of a short circuit.



L113431 –UN–02FEB89

A—1/4-ohm Resistor
B—12-Volt Battery
C—Field Terminal
D—Insulated Brush Lead
E—Hacksaw Blade

RG,RG34710,2357 –19–15Mar97–1/1

LUBRICATION OF STARTING MOTOR (BEFORE AND DURING ASSEMBLY)

Lubrication Point	Lubrication Instructions
Bushings	Soak new bushings for at least 1/2 hour before installation.
Armature shaft	Coat drive and commutator end journals of shaft, splines and bearing surfaces of clutch drive with a light film of grease.
Shift Lever	Lubricate bearing surfaces and pivot bolts liberally with grease.
Solenoid switch	Coat inside of yoke and bolt threads with a light film of grease.

NOTE: Keep contacts free from grease.

RG,RG34710,2358 –19–15Mar97–1/1

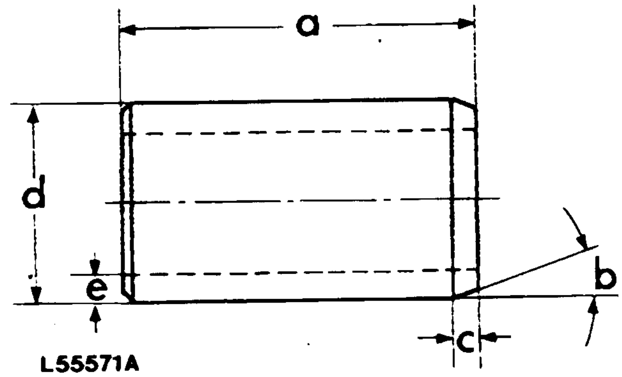
FIELD WINDING—INSTALLATION

Slightly warm windings and insert together with pole shoes into field frame. Insert pole shoe screws.

Press suitable mandrel (see illustration) between pole shoes.

Firmly tighten pole shoe screws and press out mandrel.

Check installed windings for shorted or open circuits.



L55571A –UN–09MAY89

A—85 mm (3.35 in.)
B—5° Chamfer
C—12—14 mm (0.47—0.55 in.)
D—75.80—75.85 mm (2.984—2.986 in.)
E—Wall Thickness 12—15 mm (0.47—0.59 in.)

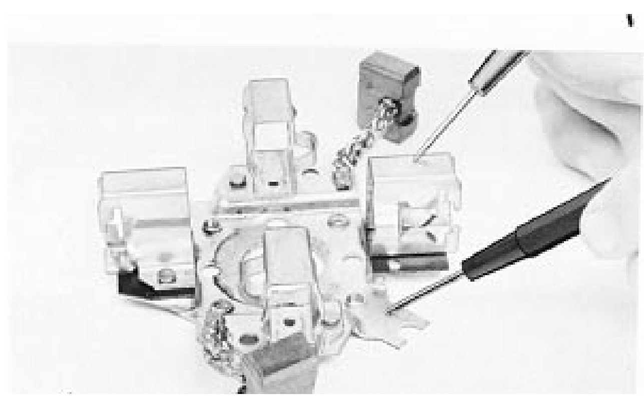
RG,RG34710,2359 –19–15MAR97–1/1

CHECKING CARBON BRUSH PLATE FOR GROUNDS

Set ohmmeter on its highest scale.

Place one test lead on commutator end frame. Place other lead on brush holder.

If needle swings toward zero, the positive brush holder is grounded and should be replaced.

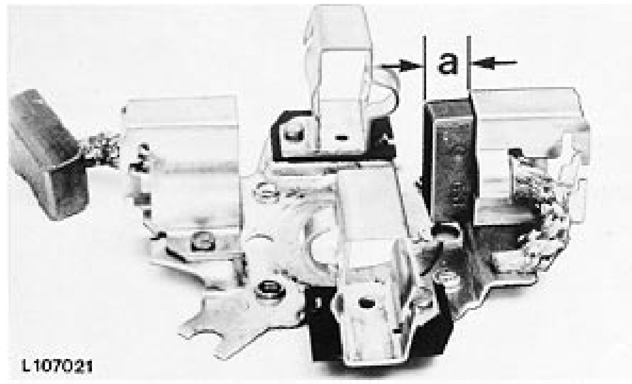


L107020 –UN–17JUL89

RG,RG34710,2360 –19–15MAR97–1/1

TESTING CARBON BRUSHES

The carbon brushes must move freely in their guides.



L107021 –UN–17JUL89

a—Minimum Length 7.5 mm (0.30 in.)

RG,RG34710,2361 –19–15Mar97–1/1

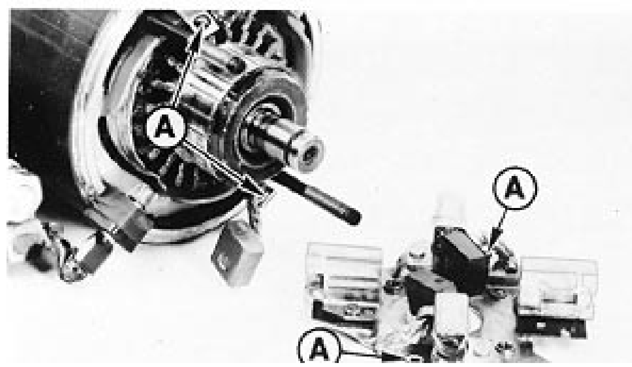
REPLACE CARBON BRUSHES

Cut off old brushes at end of brush strands.

Secure new brushes in bores (A).

Check for easy movement of carbon brushes in brush holders.

NOTE: Screws and hex nuts are included in the repair kit.



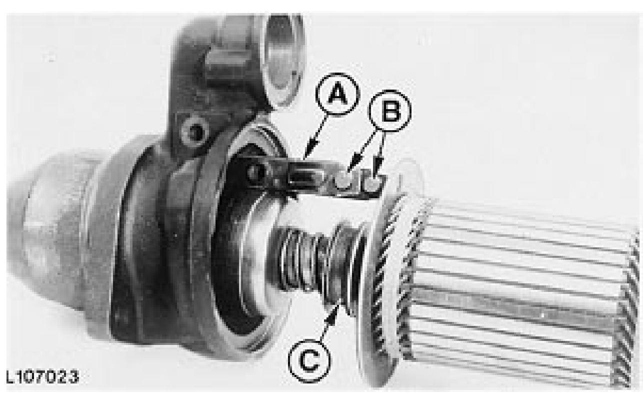
L117234 –UN–17JUL89

RG,RG34710,2362 –19–15Mar97–1/1

ENGAGING LEVER—INSTALLATION

Driving hub pins (B) of engaging lever (A) must engage in guide (C) of drive pinion.

Screw in studs and slide field frame over armature.

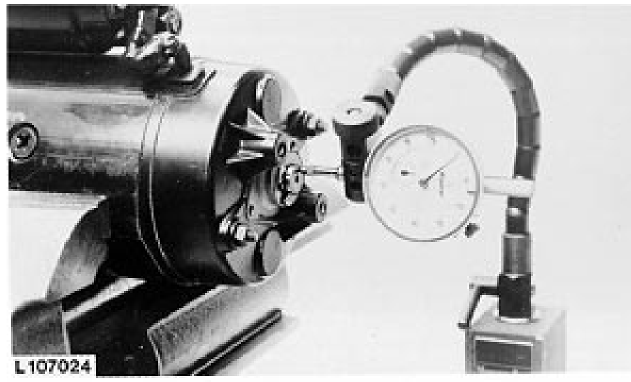


L107023 –UN–17JUL89

RG,RG34710,2363 –19–15Mar97–1/1

TESTING ARMATURE END PLAY

Check end play of armature using a dial indicator. End play should be 0.1—0.3 mm (0.004—0.012 in.)



L107024 –UN–17JUL89

RG,RG34710,2364 –19–15Mar97–1/1

INSTALLING STARTING MOTOR

Refer to machine technical manual for installing starting motor and adjusting belt tension.

RG,RG34710,2365 –19–15Mar97–1/1

BLANK

CHAPTER 17

SECTION 17

FRAME OR SUPPORTING STRUCTURE REPAIR

BLANK

Group 1740
Frame Installation

SPECIFICATIONS

Item	Measurement	Specification
Welding Repair of Major Structure:		
Weld Metal	Tensile Strength	482.6 mPa (70,000 psi)
	Yield Strength	413.7 mPa (60,000 psi)
	Elongation	22%
Structural Assembly	Preheat Temperature	38°C (100°F)
Ground Engaging Tool	Preheat Temperature	177°C (350°F)

CED,OUOE003,537 –19–15MAY98–1/1

WELDING ON MACHINE

IMPORTANT: Electrical current traveling from the welder through the machine electrical system may damage the machine electrical system, including battery, EPC controller. Disconnect battery ground cable and EPC electrical connectors before welding on the machine.

Before welding on the machine, follow the steps listed below to protect the machine electrical system.

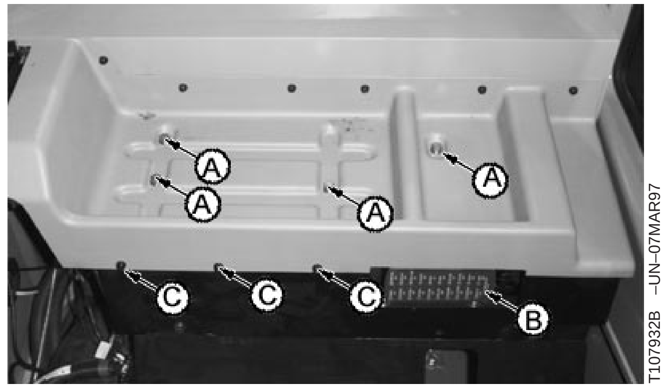
Continued on next page

TX,16,UU3588 –19–19SEP98–1/3

Frame Installation

1. Disconnect the battery ground and positive cables.

2. Inside the cab, remove four cap screws (A and C) and the fuse box cover (B) to remove the rear console cover.



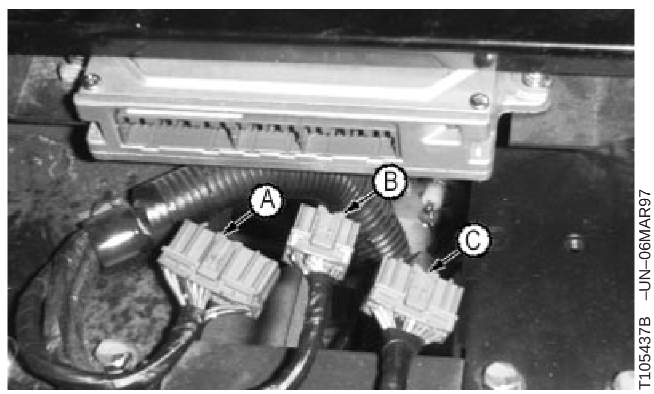
A—Cap Screws
B—Fuse Box Cover
C—Cap Screws

TX,16,UU3588 –19–19SEP98–2/3

3. Disconnect the engine and pump controller electrical connectors.

4. After the welding on machine is completed, install the connectors to the engine and pump controller and then connect the battery cables.

5. Do Engine Speed Learning Procedure. (See procedure in this group.)



A—Connector
B—Connector
C—Connector

TX,16,UU3588 –19–19SEP98–3/3

17
1740
2

WELDING REPAIR OF MAJOR STRUCTURE

CAUTION: 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.

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.

1. Remove paint before welding or heating.

IMPORTANT: Disconnect battery ground strap or turn battery disconnect switch to "OFF". Also disconnect the wiring harness connectors to the engine and pump controller.

Have only a qualified welder do this job. Connect welder ground clamp close to each weld area so electrical current does not pass through any bearings. Remove or protect all parts that can be damaged by heat or weld splatter.

2. Use one of the following weld processes:

- AWS-E-7018 covered electrode with shielded metal arc welding (SMAW) process.
- AWS-ER-70S-3 wire electrode with gas metal arc welding (GMAW) process.
- AWS-E70T-1 or E71T-1 wire electrode with flux core arc welding (FCAW) process.

Weld Metal—Specification

Tensile Strength	482.6 mPa (70,000 psi)
Yield Strength	413.7 mPa (60,000 psi)
Elongation	22%

IMPORTANT: Area to be repaired must be preheated to allow better weld penetration.

3. To repair weld metal failure, remove failed weld metal using arc or grinding equipment. Thoroughly clean area to be welded. Preheat structural assemblies to a minimum of 38°C (100°F). Preheat ground engaging tools (cutting edges, skid shoes, and teeth shanks) to 177°C (350°F).

   To repair base metal failure remove enough material to allow weld to penetrate to the bottom of crack. Preheat structural assemblies to a minimum of 38°C (100°F). Preheat ground engaging tools (cutting edges, skid shoes, and teeth shanks) to 177°C (350°F).

Structural Assembly—Specification

Preheat Temperature	38°C (100°F)

Ground Engaging Tool—Specification

Preheat Temperature	177°C (350°F)

Group 1749
Chassis Weights

SERVICE EQUIPMENT AND TOOLS

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

SERVICEGARD is a trademark of Deere & Company.

CED,OUOE003,1183 –19–19SEP98–1/3

Spreader Bar

To remove and install counterweight.

CED,OUOE003,1183 –19–19SEP98–2/3

Metric Lifting Eyebolt (2 used) JT05558 (M42-4.5)

To remove and install counterweight.

CED,OUOE003,1183 –19–19SEP98–3/3

SPECIFICATIONS

Item	Measurement	Specification
Counterweight:		
Counterweight	Weight	5100 kg (11,250 lb) approximate
Frame-to-Counterweight Cap Screw	Torque	1910 N•m (1410 lb-ft)

CED,OUOE003,1184 –19–19SEP98–1/1

REMOVE AND INSTALL COUNTERWEIGHT (MODEL 230LCR)

1. Park machine on level ground.

2. Remove two plastic caps from top of counterweight (D).

CAUTION: The approximate weight of counterweight is 5100 kg (11,250 lb).

The lifting capacity of a lifting eyebolt decreases as the lift angle increases from vertical. A spreader bar should be used to obtain, as close as possible, a vertical lift from eyebolts.

Counterweight—Specification

Weight.. 5100 kg (11,250 lb) approximate

3. Connect the counterweight to a hoist (A) using a spreader bar (B) and M42-4.5 metric lifting eyebolts (C) such as JT05558 Metric Lifting Eyebolt.

4. Remove cap screws and washers (E).

5. Remove counterweight.

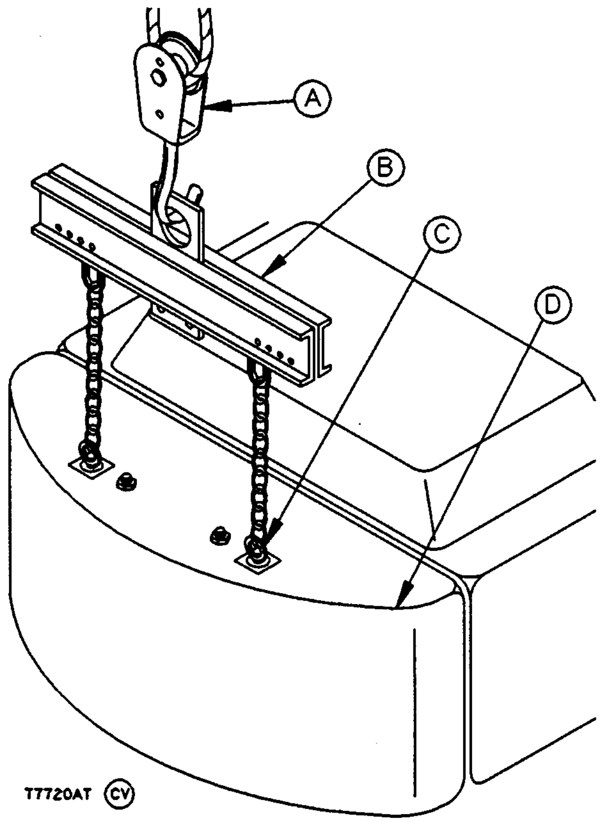
6. Install cap screws and washers. Tighten cap screws.

Frame-to-Counterweight Cap Screw—Specification

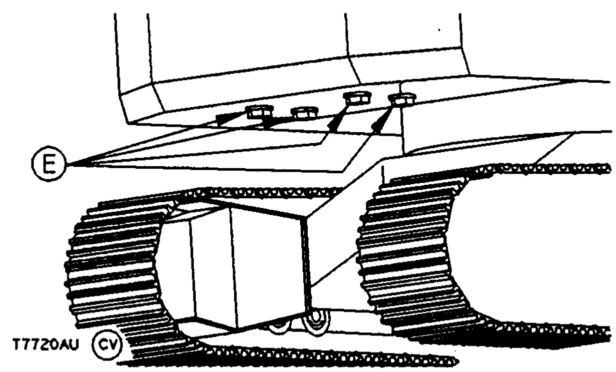
Torque .... 1910 N•m (1410 lb-ft)

7. Remove hoist, spreader bar, and eyebolts.

8. Install plastic caps.



T7720AT –UN–01MAY92



T7720AU –UN–01MAY92

A—Hoist
B—Spreader Bar
C—M42-4.5 Metric Lifting Eyebolt (2 used)
D—Counterweight
E—Cap Screw and Washer (4 used)

TX,17,UU3818 –19–04APR97–1/1

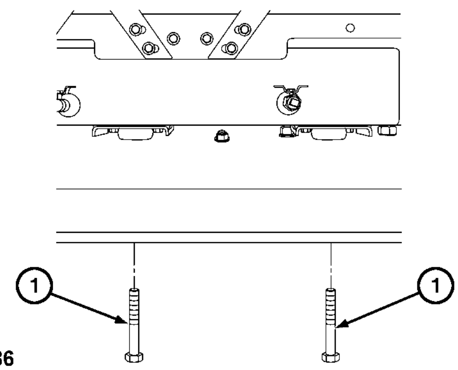
17
1749
2

REMOVE AND INSTALL COMPRESSOR (MODEL 230LCRD)

1. Disconnect battery cable at slave receptacle.
2. Disconnect coolant lines.
3. Attach suitable lifting device to the compressor unit.

CED,OUOE042,5062 –19–15APR99–1/2

4. Remove four cap screws (1).
5. Remove compressor unit from machine.
6. Replace or repair as necessary.
7. Install compressor unit on machine.
8. Install four cap screws (1).
9. Connect coolant lines.
10. Connect battery cable.



T121186

T121186 –UN–28OCT99

CED,OUOE042,5062 –19–15APR99–2/2

CHAPTER 18

SECTION 18

OPERATOR'S STATION REPAIR

BLANK

Group 1800
Operator's Station

SPECIFICATIONS

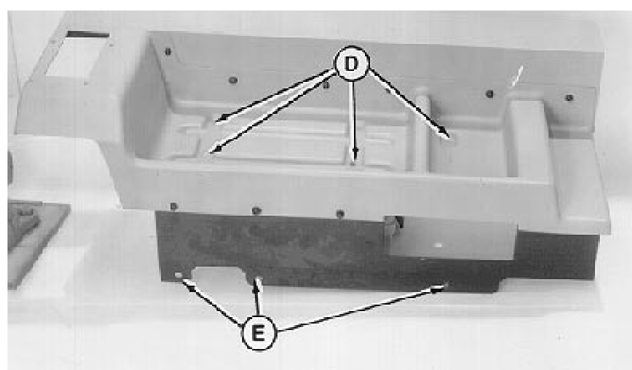
Item	Measurement	Specification
Cab:		
Cab	Weight	250 kg (550 lb) approximate
Rubber Mount-to-Frame Cap Screw	Torque	108 N•m (80 lb-ft)
Cab-to-Platform Cap Screw	Torque	64 N•m (47 lb-ft)
Cab and Platform-to-Rubber Mount Lock Nut	Torque	205 N•m (152 lb-ft)

CED,OUOE003,1185 –19–21SEP98–1/1

REMOVE AND INSTALL CAB

NOTE: It is not necessary to remove the seat to remove the cab.

1. Remove the four cap screws (D) and three screws (E) to remove the rear console cover behind the seat.
2. Disconnect battery ground cable.
3. Remove cab floor mat.



T105712 –UN–16DEC96

D—Cap Screw
E—Screws

Continued on next page TX,18,SB749 –19–21SEP98–1/6

4. Remove screws (A) to remove cover (B).

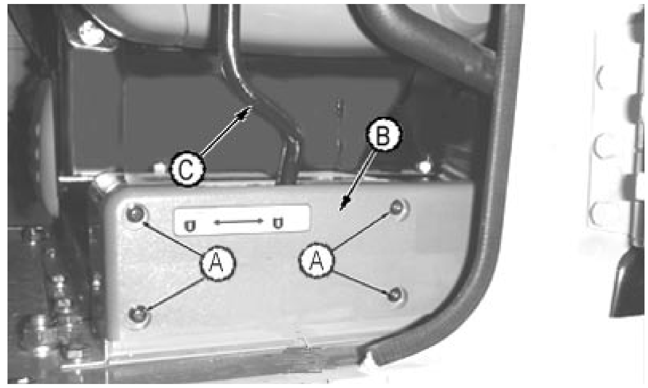
5. Remove spring pin (D) to remove pilot shut-off lever (C).

IMPORTANT: To avoid possible damage to switch panel during assembly, be sure to mark all corresponding bullet connector wiring leads before disassembly. Connecting bullet connectors to the wrong wiring leads will damage components in the switch panel.

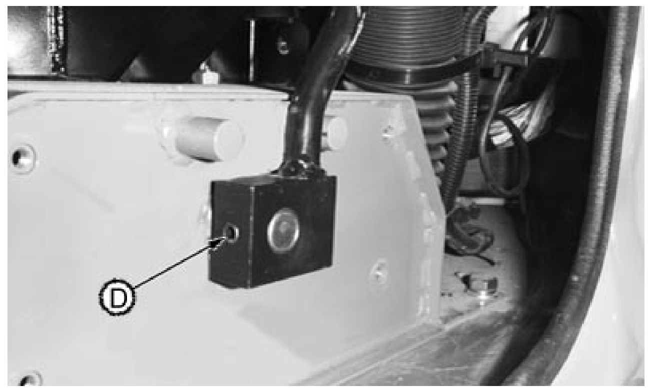
6. Disconnect all main wire harness connectors, radio speaker wires and radio antenna (if equipped), windshield wiper motor, dome light and bullet connectors as required.

7. Loosen and remove the fresh air intake cowl cap screws and remove cowl from inside rear wall of cab.

8. Disconnect windshield washer fluid tube from windshield washer pump located in the compartment behind the cab.



T105963B –UN–13JAN97



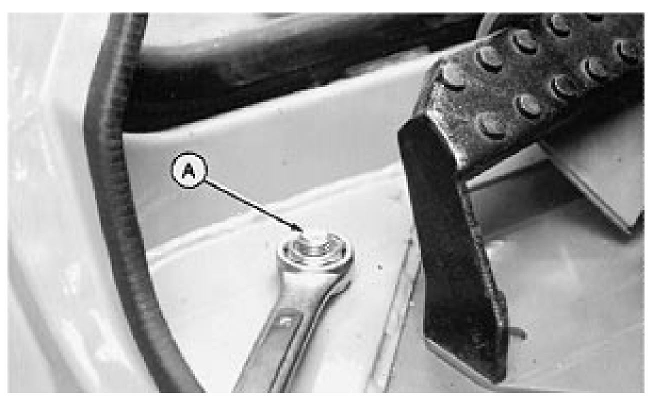
T105992B –UN–13JAN97

A—Screws
B—Cover
C—Pilot Shut-Off Lever
D—Spring Pin

TX,18,SB749 –19–21SEP98–2/6

9. Remove lock nuts (A) and washers located at the four inside corners of cab.

10. Remove the two cab-to-platform cap screws and washers from each of the four sides of cab.



T6585OE –UN–17OCT88

A—Lock Nut

Continued on next page

TX,18,SB749 –19–21SEP98–3/6

CAUTION: The approximate weight of cab is 250 kg (550 lb).

Cab—Specification

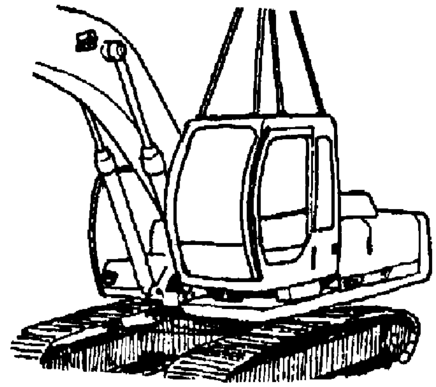
Weight.. 250 kg (550 lb) approximate

11. Connect cab to hoist, using lifting straps.

12. Slowly lift cab from platform.

    Move cab slightly forward as cab is being raised so front of cab can clear front of propel pedals.

T106453



T106453 –UN–15JAN97

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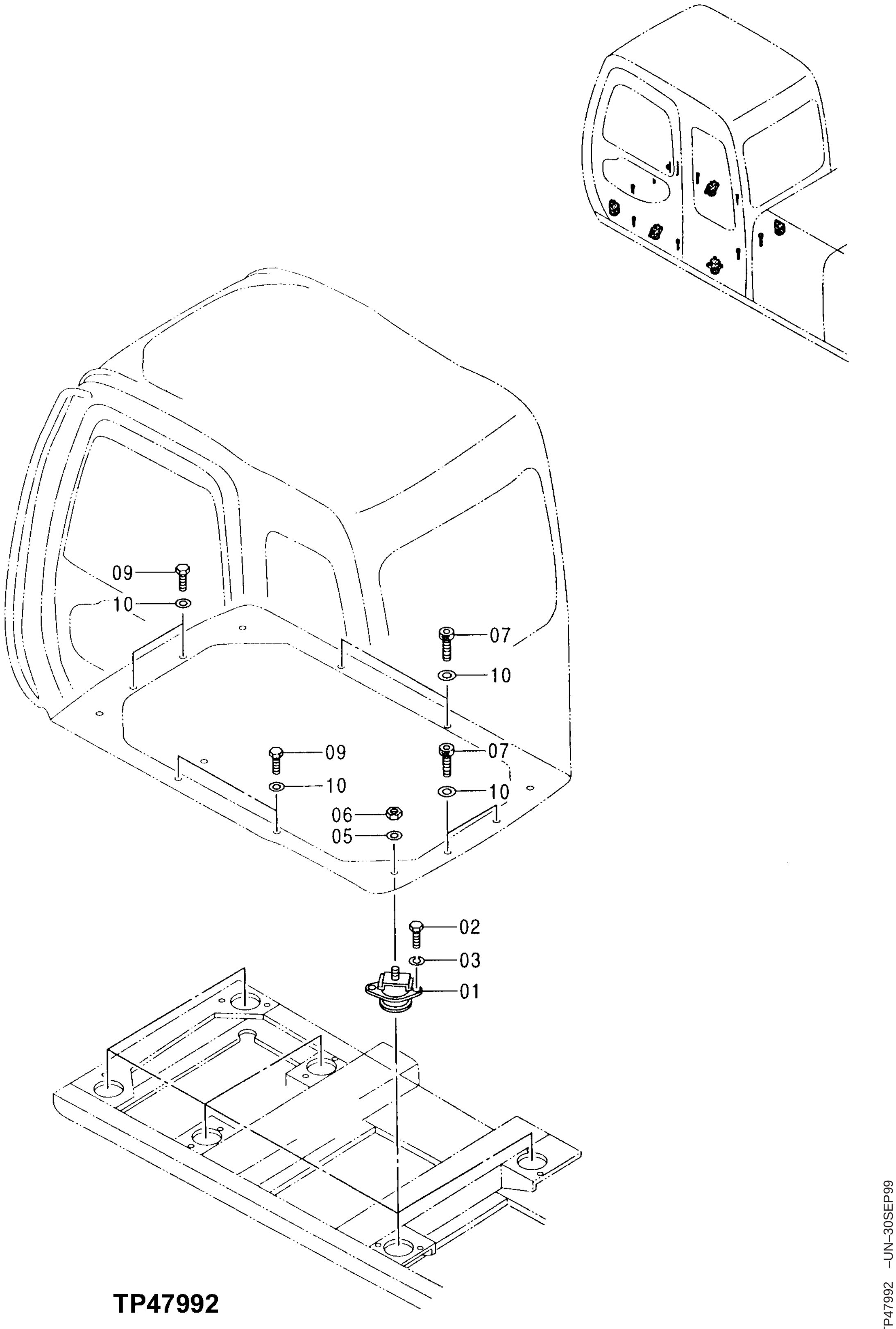
TX,18,SB749 –19–21SEP98–4/6

Operator's Station



1—Rubber Mount (6 used)
2—Cap Screw (12 used)
3—Lock Washer (12 used)
5—Washer (6 used)
6—Lock Nut
7—Cap Screw (4 used)
9—Cap Screw (4 used)
10—Washer (8 used)

Continued on next page

TX,18,SB749 –19–21SEP98–5/6

13. Repair or replace parts as necessary.

    Lift each corner of platform to remove and install rubber mounts (1).

    Tighten cap screw (2).

Rubber Mount-to-Frame Cap Screw—Specification

Torque.. 108 N•m (80 lb-ft)

14. Before installing cab, check that all lines and wiring harnesses are out of the way so they are not pinched when cab is installed.

15. Install the cap screws (9) with HEX HEAD at the front and left side of cab. Install cap screws (7) with SOCKET HEAD at the rear and right side.

    Tighten cap screws.

Cab-to-Platform Cap Screw—Specification

Torque.. 64 N•m (47 lb-ft)

Tighten lock nuts (6).

Cab and Platform-to-Rubber Mount Lock Nut—Specification

Torque.. 205 N•m (152 lb-ft)

TX,18,SB749 –19–21SEP98–6/6

Group 1810
Operator Enclosure

SERVICE EQUIPMENT AND TOOLS

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

SERVICEGARD is a trademark of Deere & Company.

CED,OUOE003,1190 –19–21SEP98–1/3

Insert Tool

To remove locking strip from molding and install windowpane.

CED,OUOE003,1190 –19–21SEP98–2/3

Weather Strip Installing Tool

To install locking strip.

CED,OUOE003,1190 –19–21SEP98–3/3

OTHER MATERIAL

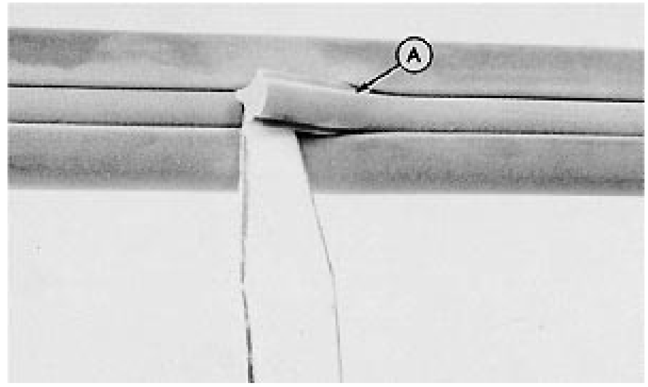
Number	Name	Use
TY21517 (U.S.) NA (Canadian) 454 (LOCTITE®)	Instant Gel Adhesive	Apply to frame channel of molding and cab floor.
AR54749 (U.S.)	Soap Lubricant	To aid in windowpane installation.

LOCTITE is a trademark of Loctite Corp.

CED,OUOE003,1191 –19–21SEP98–1/1

REMOVE AND INSTALL WINDOWPANE AND TWO PIECE MOLDING

1. Remove locking strip (A) from molding using insert tool.



A—Locking Strip

TX,18,SB750 –19–21SEP98–1/4

IMPORTANT: Use extreme care to avoid damaging the windowpane.

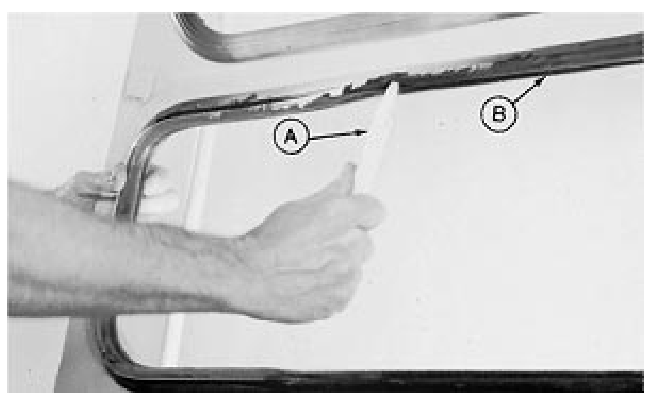
2. Carefully push out windowpane from molding.

3. Inspect molding for damage; replace if necessary.

TX,18,SB750 –19–21SEP98–2/4

4. Put instant gel adhesive in frame channel of molding (B). Install molding.

5. Install windowpane using insert tool (A) and a soap lubricant.



A—Tool
B—Frame Channel

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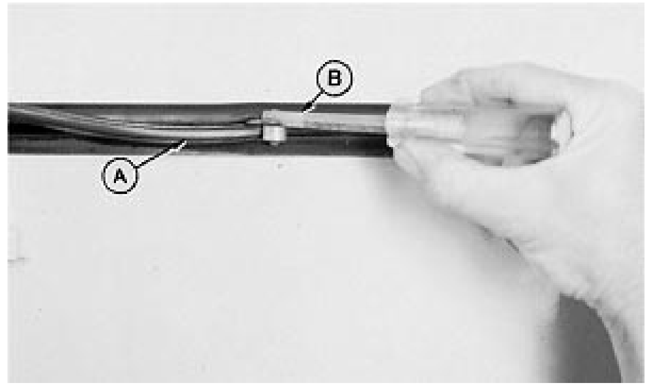
TX,18,SB750 –19–21SEP98–3/4

6. Install locking strip (A) using weather strip installing tool (B).



A—Locking Strip
B—Weather Strip Installing Tool

TX,18,SB750 –19–21SEP98–4/4

REMOVE AND INSTALL WINDOWPANE AND ONE PIECE MOLDING

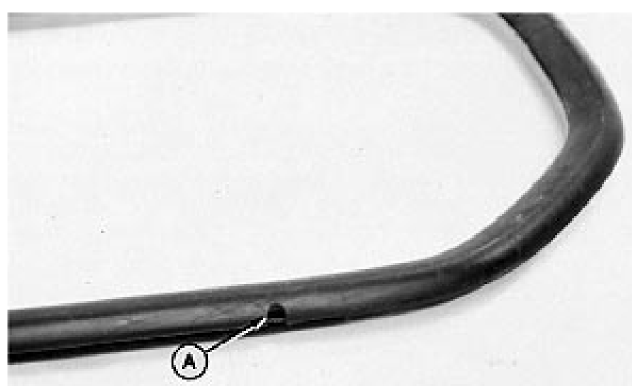
1. Lift inside of molding over cab frame and carefully push windowpane and molding out.

2. Remove molding from windowpane; replace if necessary.

TX,18,SB751 –19–10JAN97–1/2

3. Install molding on windowpane. Put drain notches (A) at bottom and towards outside of windowpane.

4. Install windowpane and molding. Lift inside of molding over cab frame.



A—Drain Notches

TX,18,SB751 –19–10JAN97–2/2

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3

REMOVE AND INSTALL SLIDING WINDOWS

1. Pull molding (D) from inside of window.

2. Cut the adhesive (E) between cab flange and window frame (B) using a putty knife.

IMPORTANT: Use extreme care to avoid damaging frame and windowpane. Remove window using two people; one to push window out, the other to keep window from falling.

3. Carefully push window frame from cab.

4. Lift frame slightly at the top-center to remove and install windowpanes.

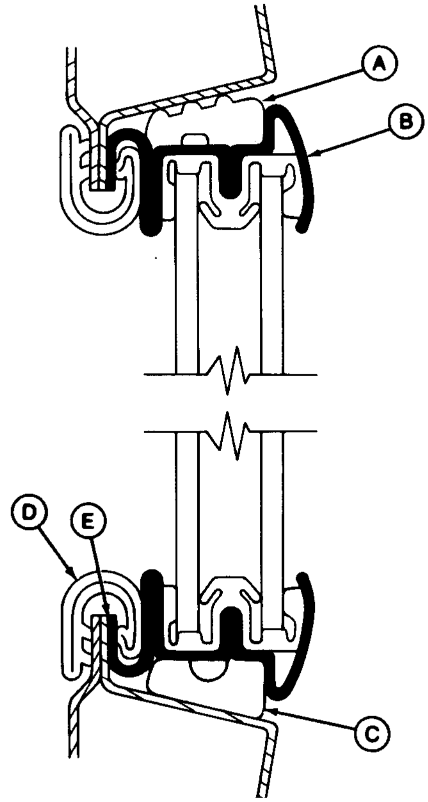
5. Apply instant gel adhesive to cab flange.

6. Install windows and frame with spacers (C) at the bottom and two on each end of frame.

7. Install three spacers (A) at top of frame.

8. Using water as a lubricant, push window frame tight against cab flange.

9. Install molding (D) around window and cab flange.

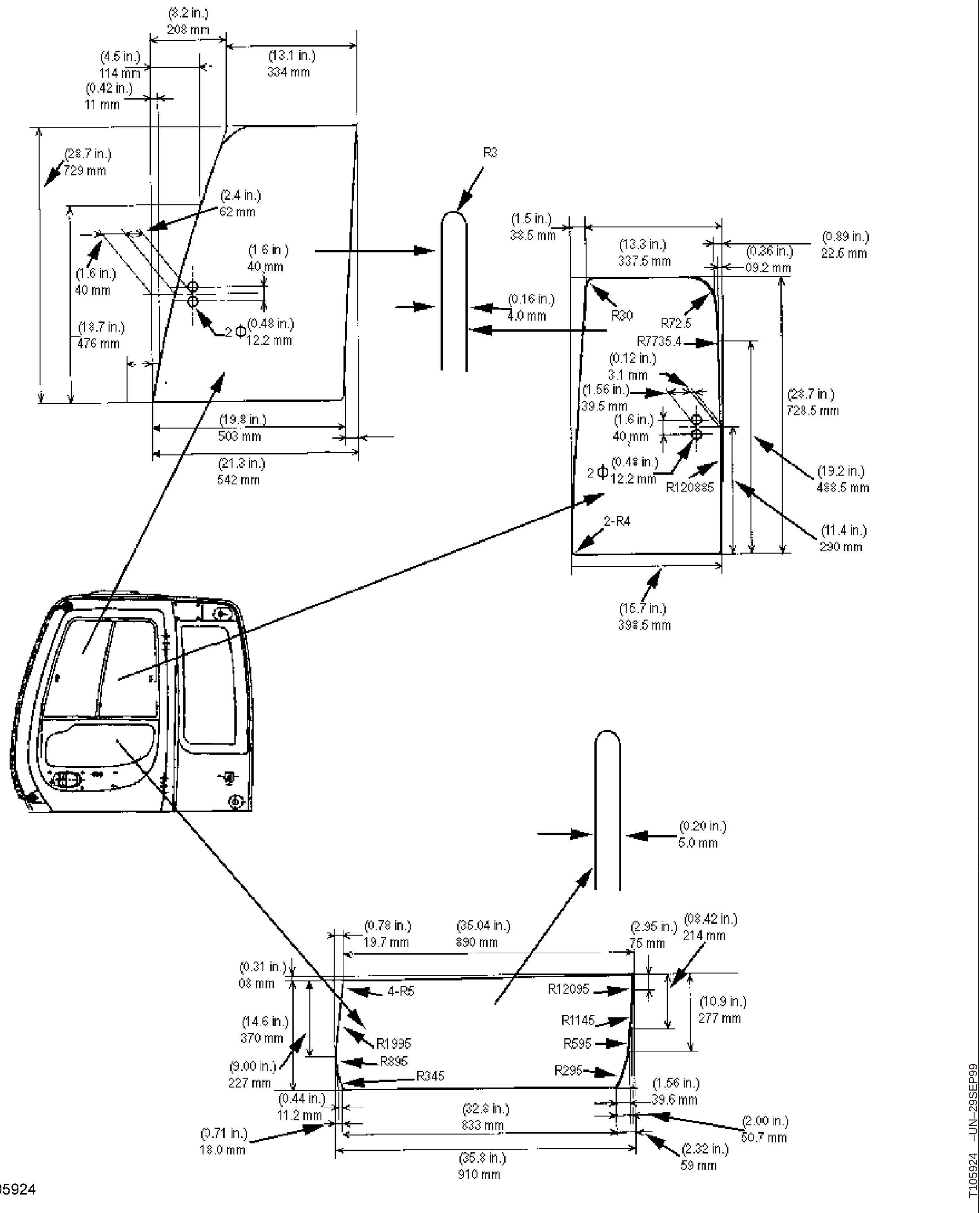


T6439TD –UN–05DEC89

A—Top Spacer (3 used)
B—Window Frame
C—Bottom and Side Spacer
D—Molding
E—Adhesive

TX,18,SB752 –19–10JAN97–1/1

WINDOWPANE DIMENSIONS



T105924

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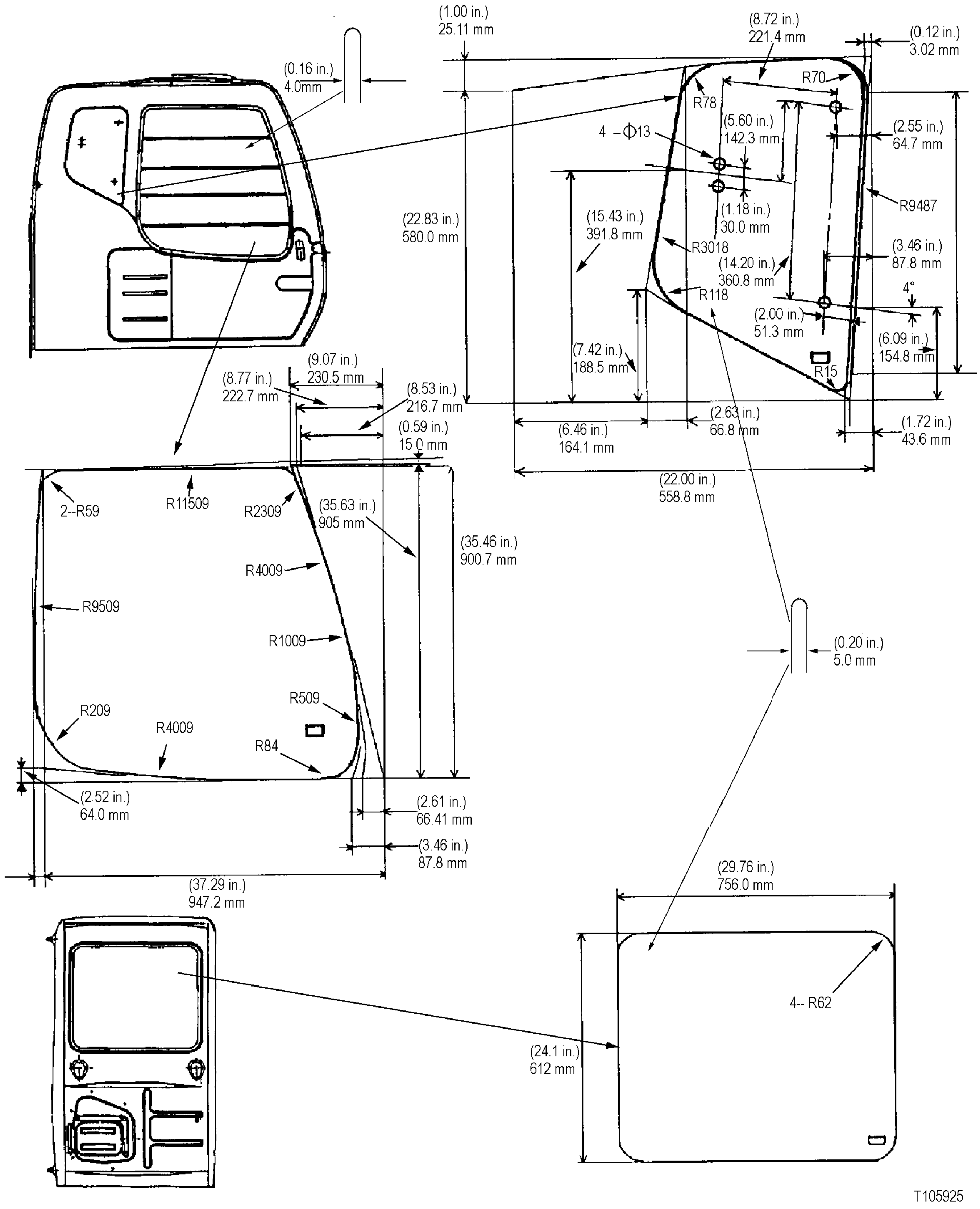
TX,18,SB753 –19–11JAN97–1/2



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7

TX,18,SB753 –19–11JAN97–2/2

Group 1821
Seat and Seat Belt

SPECIFICATIONS

Item	Measurement	Specification
Seat and Carrier	Weight	35 kg (75 lb) approximate

CED,OUOE003,550 –19–15MAY98–1/1

CHECK SEAT ADJUSTMENTS

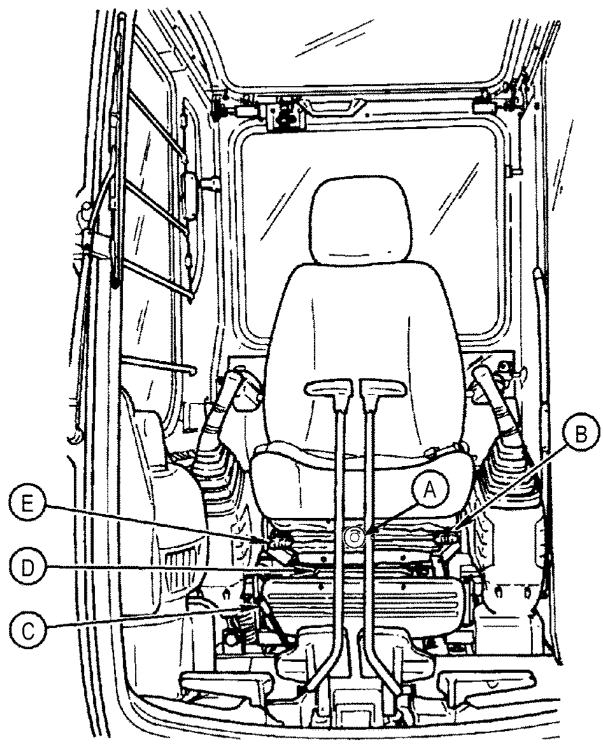
1. Turn weight adjustment knob (A) to adjust seat to weight of operator. Weight is displayed on knob.

2. Push seat height and angle adjustment lever (B) down while sitting on seat or while standing and pulling up on seat to obtain desired height. Release lever. Push down lever while sitting on seat to adjust seat to desired angle. Release lever.

3. Push console and seat fore-aft adjustment lever (C) down to adjust seat and both right and left consoles to desired distance from propel pedals and levers. Release lever to lock seat and consoles into position.

4. Pull seat fore-aft adjustment lever (D) up to unlock seat from both consoles. Slide the seat to desired distance from control levers. Release the lever.

5. Pull backrest adjustment lever (E) up to release backrest lock. Move backrest to desired position. Release the lever.



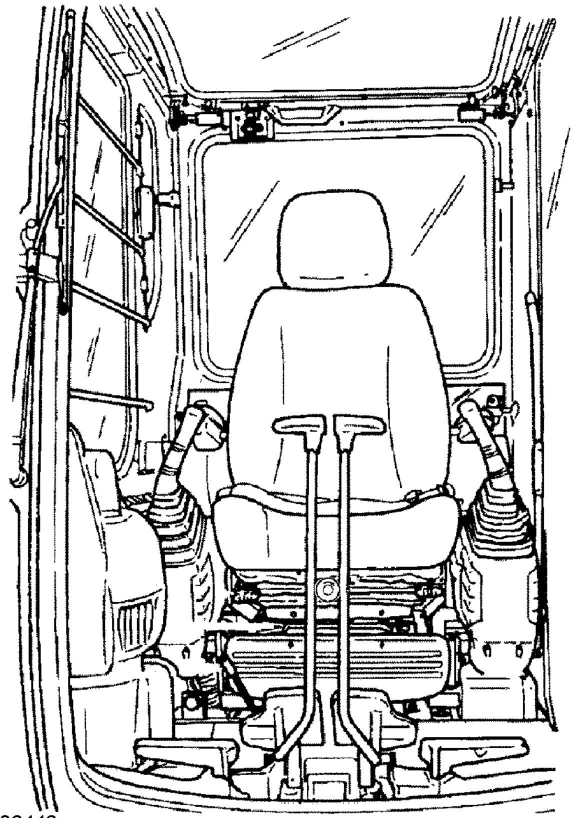
T102204 –UN–26JUL96

A—Weight Adjustment Knob
B—Seat Height and Angle Adjustment Lever
C—Console and Seat Fore-Aft Adjustment Lever
D—Seat Fore-Aft Adjustment Lever
E—Backrest Adjustment Lever

TX,18,SB754 –19–14JAN97–1/1

REMOVE AND INSTALL SEAT

1. Pull the seat and consoles as far forward as possible.



T106446

T106446 –UN–15JAN97

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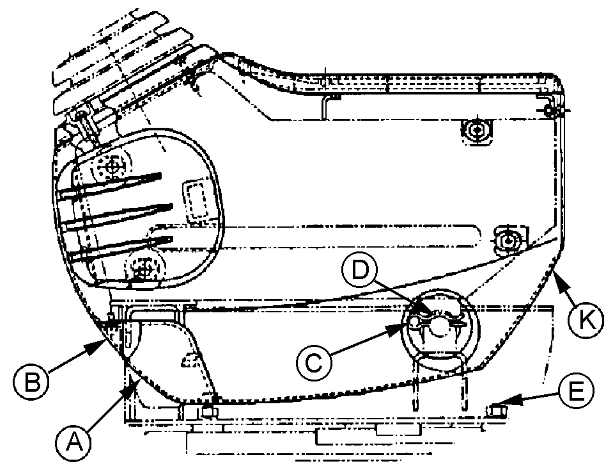
TX,18,SB755 –19–21SEP98–1/6

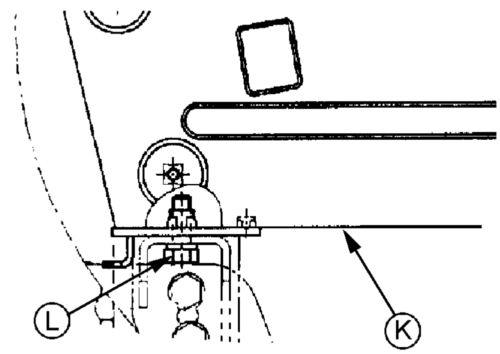
2. 3. Remove cap screws (L).
4. Tip the console up.
5. Remove a quick lock pin (C) to remove pin (D).

   Lay the console on cover behind the seat.
6. Remove nuts and washers (E).



T106445

Left Console Shown



T105912

A—Cover
B—Screw (2 used)
C—Quick Lock Pin
D—Pin
E—Nut and Washer (4 used)
K—Console
L—Cap Screw and Washer

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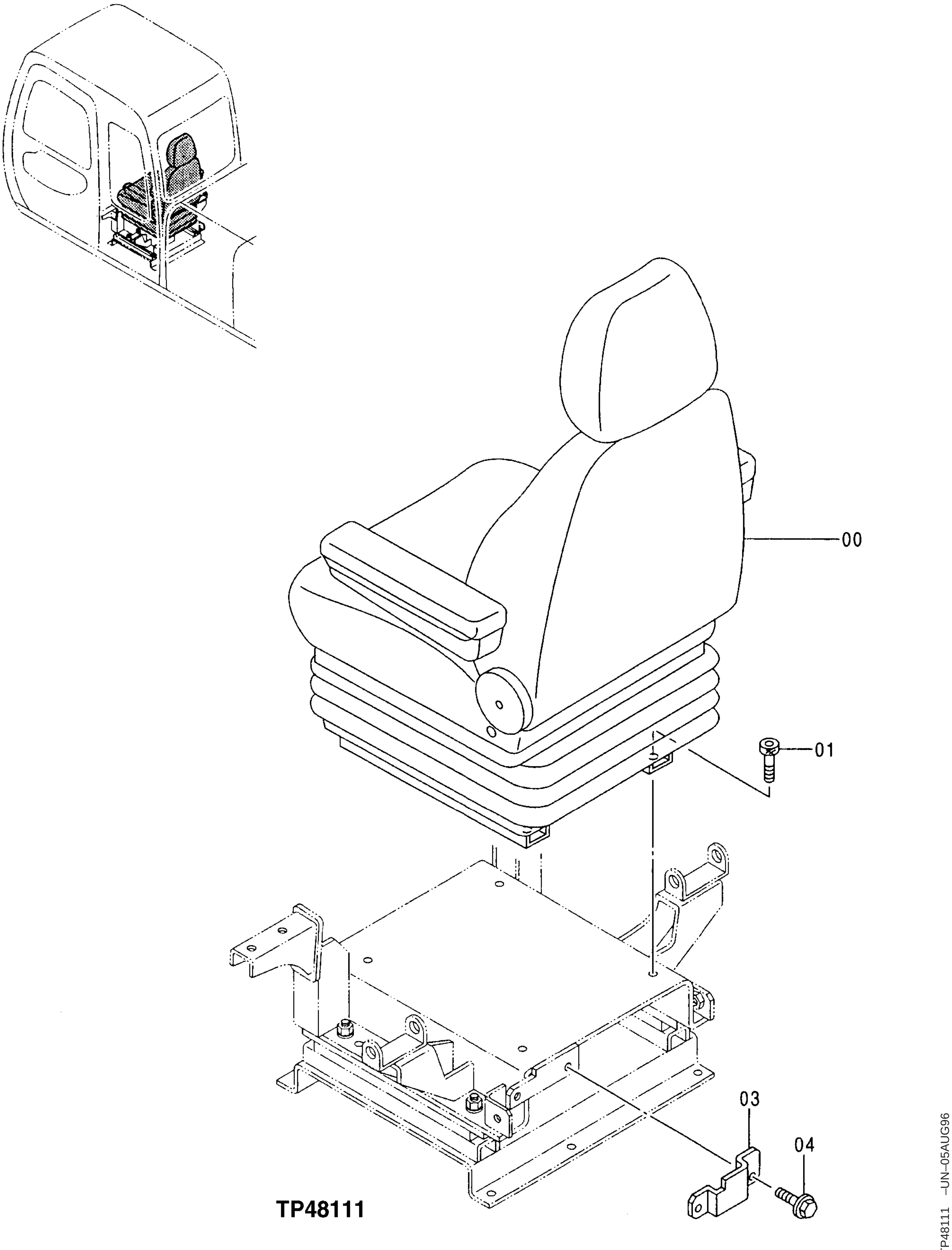
Seat and Seat Belt



TP48111

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TX,18,SB755 –19–21SEP98–3/6

18
1821
4

Seat and Seat Belt

0—Seat
1—Cap Screw (4 used)
3—Bracket
4—Cap Screw, Lock Washer and Washer (2 used)

CAUTION: The approximate weight of seat and carrier is 35 kg (75 lb).

Seat and Carrier—Specification

Weight.. 35 kg (75 lb) approximate

7. Remove the seat (0) and carrier.

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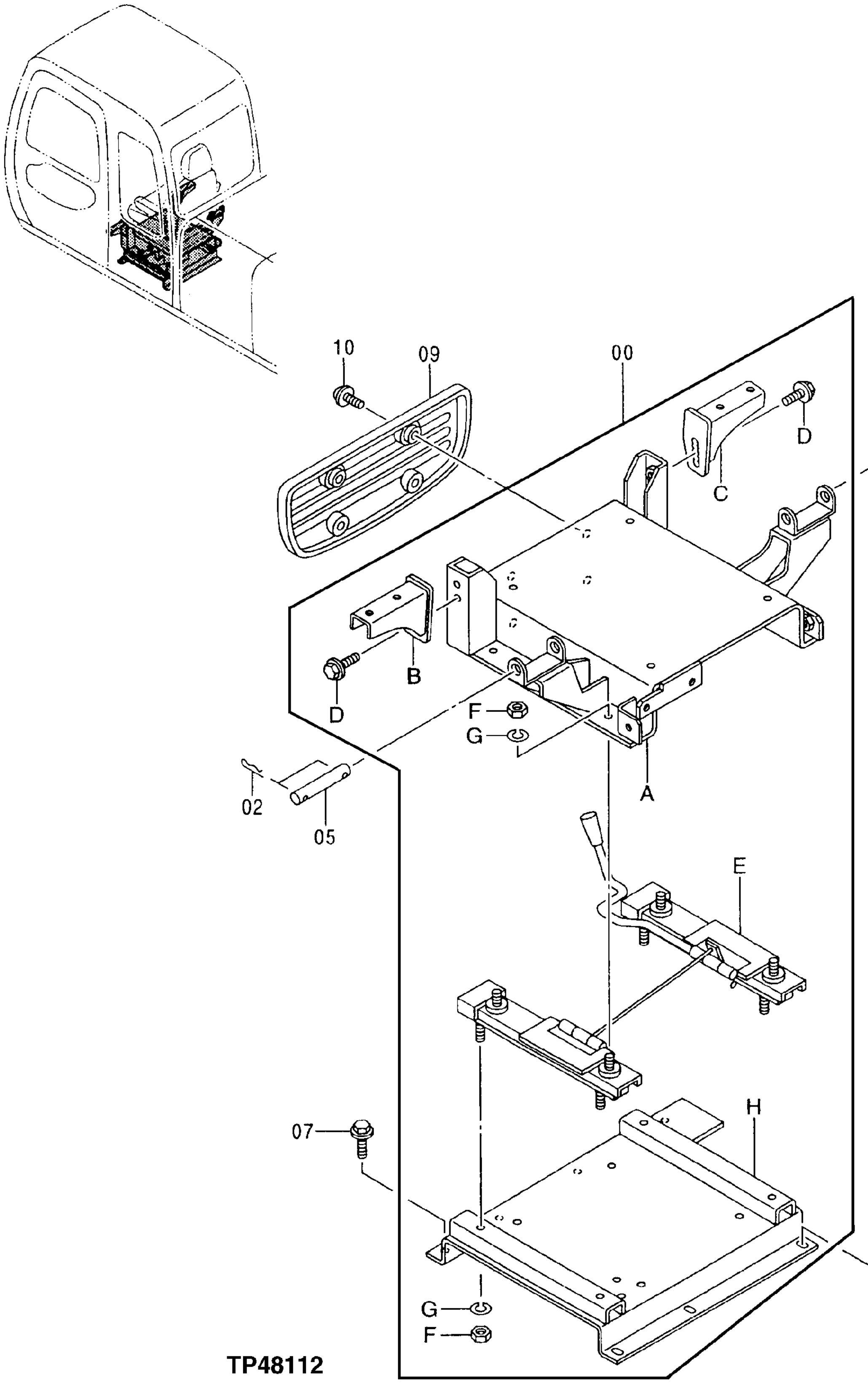
TX,18,SB755 –19–21SEP98–4/6

Seat and Seat Belt



TP48112

TP48112 –UN–07AUG96

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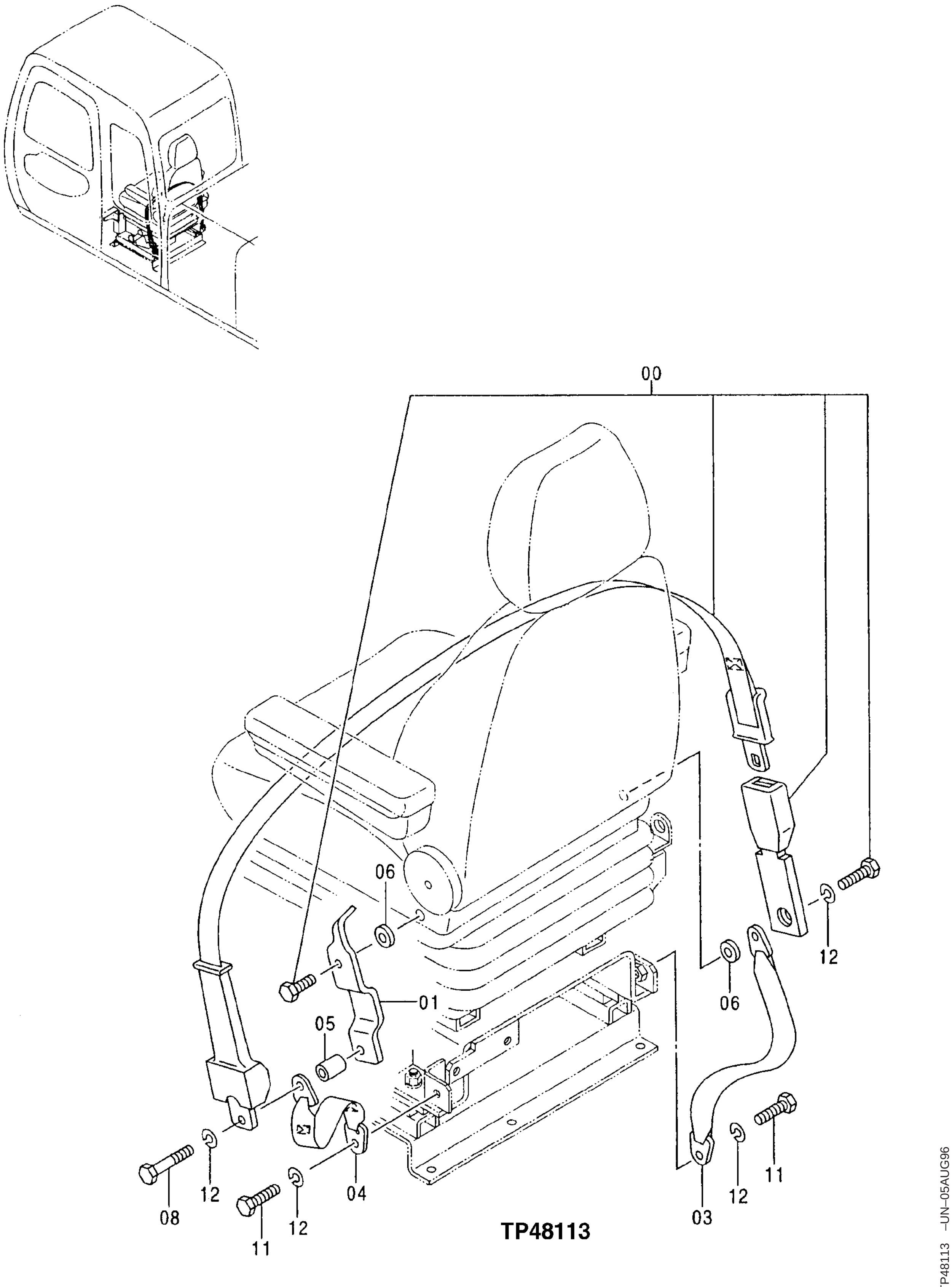
Seat and Seat Belt

0—Seat Stand
0A—Carrier
0B—Bracket
0C—Bracket
0D—Cap Screw, Lock Washer and Washer (4 used)
0E—Seat Slide
0F—Nut (8 used)
0G—Lock Washer (8 used)
0H—Seat Base
2—Quick Lock Pin (4 used)
3—Pin
4—Washer
5—Pin
7—Cap Screw, Lock Washer and Washer (4 used)
8—Cap Screw, Lock Washer and Washer (3 used)
9—Cover
10—Screw, Lock Washer and Washer (4 used)

8. Remove the seat base (0H) if replacement of seat slides (0E) is necessary.
9. Repair or replace parts as needed.

TX,18,SB755 –19–21SEP98–6/6

REMOVE AND INSTALL SEAT BELT



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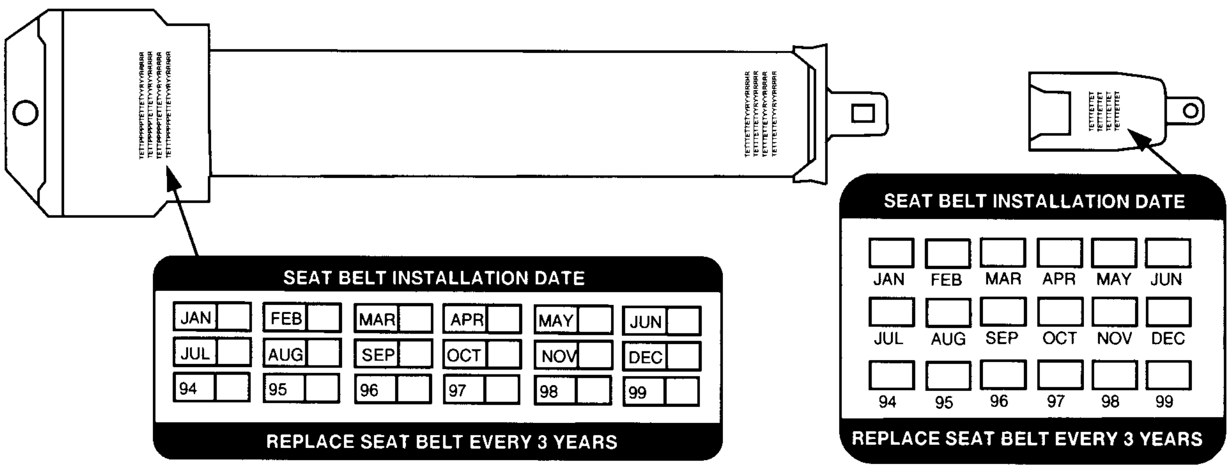
Seat and Seat Belt

0—Seat Belt
1—Bracket
3—Belt
4—Belt
5—Spacer (Sleeve)
6—Spacer (Sleeve) (2 used)
8—Cap Screw
11—Cap Screw (2 used)
12—Spring Washer (4 used)

TX,18,SB756 –19–14JAN97–2/2

INSPECT SEAT BELT



T8415AA –UN–09FEB95

Seat belt and mounting hardware must be inspected for wear or damage before operating the machine. Replace the belt or mounting hardware if worn or damaged.

Replace the complete seat belt assembly every three years regardless of appearance. A date label, to determine the age of the belt, is attached to each belt.

TX,18,SB757 –19–14JAN97–1/1

Group 1830
Heating and Air Conditioning

ESSENTIAL TOOLS

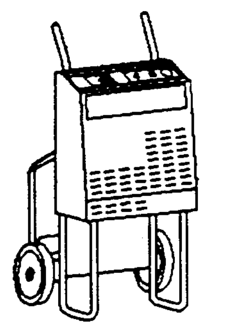
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or from the European Microfiche Tool Catalog (MTC).

SERVICEGARD is a trademark of Deere & Company.

CED,OUOE003,1194 –19–21SEP98–1/4

HFC134a Deluxe Recovery/Recycling and Charging Station . . . . JT02045[1]

Servicing air conditioning system using R134a refrigerant.



RW21613 –UN–17AUG92

[1]JT02046 and JT02050 HFC134a Recovery/Recyling Station can be substituted for the JT02045 Station.

CED,OUOE003,1194 –19–21SEP98–2/4

Vacuum Pump D05267ST

To evacuate air conditioning system.

CED,OUOE003,1194 –19–21SEP98–3/4

Schrader Valve Tool JT02130

To replace Schrader valve in compressor manifold on R134a A/C systems. To replace Schrader valve ports where high and low pressure switches are located in R134a A/C Systems.

CED,OUOE003,1194 –19–21SEP98–4/4

SERVICE EQUIPMENT AND TOOLS

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

SERVICEGARD is a trademark of Deere & Company.

CED,OUOE003,552 –19–15MAY98–1/3

Belt Tension Gauge

To check compressor belt tension.

CED,OUOE003,552 –19–15MAY98–2/3

Bench Mounted Holding Fixture D01006AA

Hold compressor during repair.

CED,OUOE003,552 –19–15MAY98–3/3

OTHER MATERIAL

Number	Name	Use
TY16134 (U.S.)	R134a Flushing Solvent	Flush R134a air conditioning system.
TY22025 (U.S.)	R134a Compressor Oil	Lubricate R134a air conditioning system.
TY15949 (12 oz) (U.S.)	R134a Refrigerant	Charge R134a air conditioning system.
TY15950 (15 lb) (U.S.)	R134a Refrigerant	Charge R134a air conditioning system.
TY15951 (30 lb) (U.S.)	R134a Refrigerant	Charge R134a air conditioning system.

CED,OUOE003,553 –19–15MAY98–1/1

SPECIFICATIONS

Item	Measurement	Specification
Air Conditioning Compressor:		
Air Conditioning Compressor Belt	Deflection	19 mm (0.75 in.) at 400 N (90 lb force)
Clutch Pulley and Clutch Hub	Flatness	0.3 mm (0.012 in.) maximum
Head-to-Compressor Cap Screw	Torque	26 N•m (19 ft-lb)
Pulley-to-Hub	Clearance	0.53—0.91 mm (0.021—0.036 in.)
Clutch Hub-to-Shaft Nut	Torque	16 N•m (12 ft-lb)

CED,OUOE003,1195 –19–21SEP98–1/1

PROPER R134A REFRIGERANT HANDLING

The U.S. Environmental Protection Agency prohibits discharge of any refrigerant into the atmosphere, and requires that refrigerant be recovered using the approved recovery equipment.

IMPORTANT: **To meet government standards relating to the use of refrigerants, R134a is used in the air conditioning system. Because it does not contain chlorine, R134a is not detrimental to the ozone in the atmosphere. However, it is illegal to discharge any refrigerant into the atmosphere. It must be recovered using the appropriate recovery stations.**

IMPORTANT: **Use correct refrigerant recovery, recycling and charging stations. DO NOT mix refrigerants, hoses, fittings, components or refrigerant oils.**

Recovery, recycling and charging stations for R12 and R134a refrigerants MUST NOT be interchanged. Systems containing R12 refrigerant use a different oil than systems using R134a. Certain seals are not compatible with both types of refrigerants.

TX,18,SB784 –19–13AUG96–1/1

R134A REFRIGERANT CAUTIONS

CAUTION: DO NOT allow liquid refrigerant to contact eyes or skin. Liquid refrigerant will freeze eyes or skin on contact. Wear goggles, gloves and protective clothing.

If liquid refrigerant contacts eyes or skin, DO NOT rub the area. Splash large amounts of COOL water on affected area. Go to a physician or hospital immediately for treatment.

DO NOT allow refrigerant to contact open flames or very hot surfaces such as electric welding arc, electric heating element and lighted smoking materials.

DO NOT heat refrigerant over 52°C (125°F) in a closed container. Heated refrigerant will develop high pressure which can burst the container.

Keep refrigerant containers away from heat sources. Store refrigerant in a cool place.

DO NOT handle damp refrigerant container with your bare hands. Skin may freeze to container. Wear gloves.

If skin freezes to container, pour COOL water over container to free the skin. Go to a physician or hospital immediately for treatment.

(R12 ONLY) Refrigerant exposed to high temperature forms phosgene gas. Inhaling toxic phosgene gas may result in serious illness or death. Phosgene gas has an odor like new mown hay or green corn. If you inhale phosgene gas, go to a physician or hospital immediately for treatment.

TX,18,SB785 –19–13AUG96–1/1

R134A COMPRESSOR OIL CHARGE CHECK

Remove compressor if R134a leakage was detected and repaired. See Remove and install Compressor in Repair Manual.

Drain oil from the compressor and record the amount. (See Compressor Oil Removal procedure in this group.)

NOTE: Drain oil and save if this is a new compressor.

If the oil drained from a compressor removed from operation is very black or the amount of oil is less than 6 mL (0.2 fl oz), perform the following:

1. Remove and discard the receiver-dryer.
2. Remove, clean, but do not disassemble the expansion valve.
3. Flush the complete system with TY16134 air conditioning flushing solvent.
4. If the compressor is serviceable, pour flushing solvent in the manifold ports and internally wash out the old oil.
5. Install a new receiver-dryer.
6. Install required amount of TY22025 refrigerant oil in the compressor. (See R134a Component Oil Charge procedure in this group.)
7. Connect all components, evacuate and charge the system.

TX,18,SB786 –19–13AUG96–1/1

R134A COMPRESSOR OIL REMOVAL

1. Remove compressor from machine. (See Remove and Install Compressor In This Group.)
2. Remove inlet/outlet manifold from compressor, and clutch dust cover.
3. Drain oil into graduated container while rotating compressor shaft.
4. Record measured oil and discard oil properly.
5. Install new oil. (See R134a Component Oil Charge in this group.)
6. Install compressor. See Remove and Install Compressor in this group.

TX,18,UU3821 –19–04APR97–1/1

R134A COMPONENT OIL CHARGE

CAUTION: All new compressors are charged with a mixture of nitrogen, R134a refrigerant and TY22025 (R134a) refrigerant oil. Wear safety goggles and discharge the compressor slowly to avoid possible injury.

Compressors can be divided into three categories when determining the correct oil charge for the system.

- New compressor from parts depot.
- Used compressor removed from operation.
- Compressor internally washed with flushing solvent.

Determining the amount of system oil charge prior to installation of compressor on a machine.

1. When the complete system, lines, and components were flushed add the correct amount of oil as described.

    - New compressor from parts depot contains the amount of new oil of 230 ± 20 mL (7.7 ± 0.7 fl oz). System requires an additional amount of new oil of 100 mL (3.4 fl oz) of new oil.
    - Used compressor removed from operation, oil drained, and flushed requires 330 ± 20 mL (11.1 ± 0.7 fl oz) of new oil.

2. When the complete system was not flushed add the correct amount of oil for the compressor plus amount of oil for each component that was serviced.

    - New compressor from parts depot, drain and return 45 mL (1.5 fl oz) of oil to the compressor. (See Compressor Oil Removal procedure in this group.)
    - Used compressor removed from operation and oil drained, (See Compressor Oil Removal procedure in this group.) Add 45 mL (1.5 fl oz) of new oil.
    - Used compressor removed from operation, oil drained, and flushed add 60 mL (2.0 fl oz) of new oil.

NOTE: Components listed below which have been removed, drained, or flushed, require the removal of the compressor to determine the correct oil charge. Use the following chart as a guide for adding oil to components:

Evaporator	130 mL (4.4 fl oz)
Condenser	65 mL (2.2 fl oz)
Receiver-Dryer	30 mL (1.0 fl oz)
Hoses	60 mL (2.0 fl oz)

NOTE: Hoses = 3 mL per 30 cm (0.1 fl oz per ft). Approximate total length equals 600 cm (20 ft).

If any section of hose is removed and flushed or replaced, measure the length of hose and use the formula to determine the correct amount of oil to be added.

CAUTION: DO NOT leave the system or R134a compressor oil containers open. This oil easily absorbs moisture. DO NOT spill R134a compressor oil on acrylic or ABS plastic. This oil will deteriorate these materials rapidly. Identify R134a oil containers and measures to eliminate accidental mixing of different oils.

TX,18,UU3822 –19–13AUG96–1/1

R134A REFRIGERANT RECOVERY, RECYCLING AND CHARGING STATION INSTALLATION PROCEDURE

CAUTION: Do not remove high pressure relief valve (B). Air conditioning system will discharge rapidly causing possible injury.

IMPORTANT: Use correct refrigerant recovery, recycling and charging stations. DO NOT mix refrigerant, hoses, fittings, components or refrigerant oils.

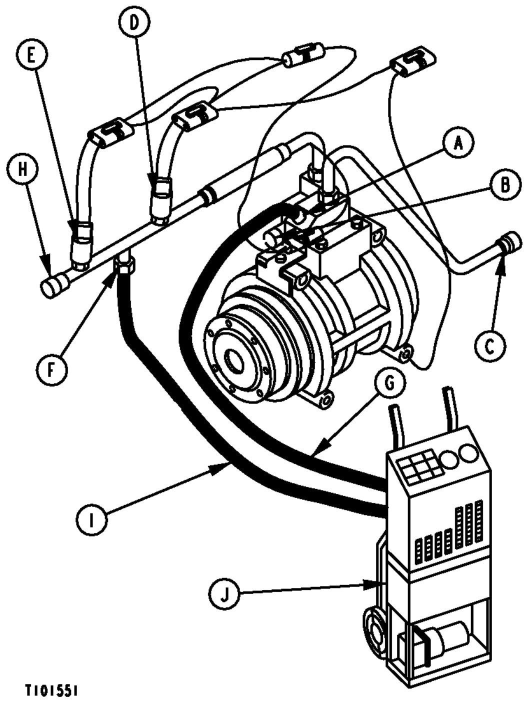
1. Close both high and low pressure valves on refrigerant recovery, recycling and charging station (J).

2. Remove cap from low pressure test port (A).

3. Connect low pressure blue hose (G) from refrigerant recovery, recycling and charging station (J) to low pressure test port (A) on compressor.

4. Connect high pressure red hose (I) to high pressure quick disconnect (F).

5. Follow the manufactures instructions when using the refrigerant recovery, recycling and charging station.



T101551 –UN–10SEP96

A—Low Pressure Test Port
B—High Pressure Relief Valve
C—Low Pressure Hose
D—Low Pressure Switch
E—High Pressure Switch
F—High Pressure Quick-Disconnect
G—Blue Hose
H—High Pressure Hose
I—Red Hose
J—Refrigerant Recovery/Recycling and Charging Station

TX,18,UU3823 –19–21SEP98–1/1

RECOVER R134A SYSTEM

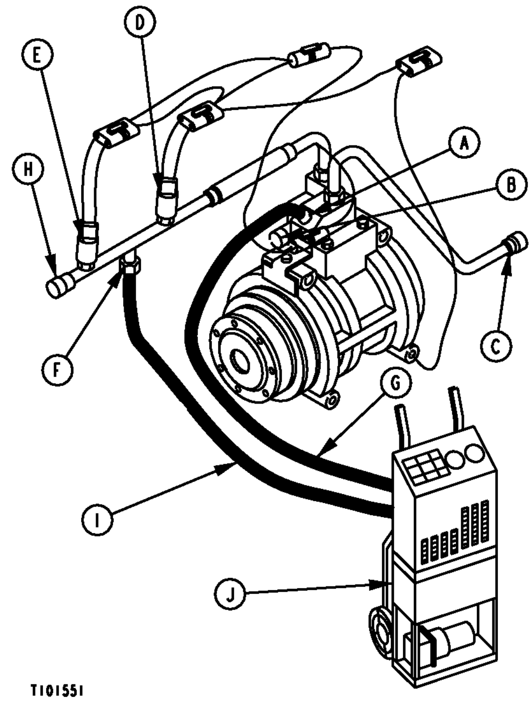
CAUTION: Do not remove high pressure relief valve (B). Air conditioning system will discharge rapidly causing possible injury.

IMPORTANT: Use correct refrigerant recovery, recycling and charging stations. DO NOT mix refrigerant, hoses, fittings, components or refrigerant oils.

NOTE: Run the air conditioning system for three minutes to help in the recovery process. Turn air conditioning system off before proceeding with recovery steps.

1. Connect refrigerant recovery, recycling and charging station. (See Charging Station Installation procedure in this group.)

2. Follow the manufacturer’s instructions when using the refrigerant recovery, recycling and charging station.



T101551 –UN–10SEP96

A—Low Pressure Test Port
B—High Pressure Relief Valve
C—Low Pressure Hose
D—Low Pressure Switch
E—High Pressure Switch
F—High Pressure Quick-Disconnect
G—Blue Hose
H—High Pressure Hose
I—Red Hose
J—Refrigerant Recovery/Recycling and Charging Station

TX,18,UU3824 –19–21SEP98–1/1

EVACUATE R134A SYSTEM

CAUTION: Do not remove high pressure relief valve (B). Air conditioning system will discharge rapidly causing possible injury.

IMPORTANT: Use correct refrigerant recovery, recycling and charging stations. DO NOT mix refrigerant, hoses, fittings, components or refrigerant oils.

Do not run compressor while evacuating.

1. Connect refrigerant recovery, recycling and charging station. (See installation procedure in this group.)

2. Open low and high pressure valves on refrigerant recovery, recycling and charging station.

3. Follow the manufacturer's instructions and evacuate the system.

4. Evacuate system until low pressure gauge registers 98 kPa (980 mbar) (29 in. Hg) vacuum.

   If 98 kPa (980 mbar) (29 in. Hg) vacuum cannot be obtained in 15 minutes, test the system for leaks. (See Leak Testing in Group 9031-25.) Correct all leaks as required.

NOTE: The vacuum specifications listed are for sea level conditions. Subtract 3.4 kPa (34 mbar) (1 in. Hg) from 98 kPa (980 mbar) (29 in. Hg) for each 300 m (1000 ft) elevation above sea level.

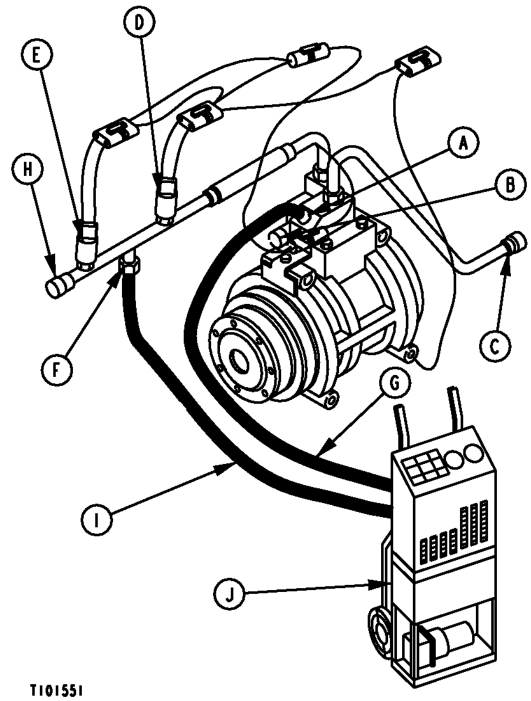
5. When vacuum is 98 kPa (980 mbar) (29 in. Hg), close low-side and high-side valves. Turn vacuum pump off.

6. If the vacuum decreases more than 3.4 kPa (34 mbar) (1 in. Hg) in 5 minutes, there is a leak in the system.

7. Repair leak.

8. Start to evacuate.

9. Open low-side and high-side valves.



T101551 –UN–10SEP96

A—Low Pressure Test Port
B—High Pressure Relief Valve
C—Low Pressure Hose
D—Low Pressure Switch
E—High Pressure Switch
F—High Pressure Quick-Disconnect
G—Blue Hose
H—High Pressure Hose
I—Red Hose
J—Refrigerant Recovery/Recycling and Charging Station

18
1830
9

Continued on next page TX,18,UU3825 –19–21SEP98–1/2

10. Continue to evacuate system for 30 minutes after 98 kPa (980 mbar) (29 in. Hg) vacuum is reached.

11. Close low-side and high-side valves. Stop evacuation.

12. Charge the system. (See procedure in this group.)

TX,18,UU3825 –19–21SEP98–2/2

CHARGE R134A SYSTEM

CAUTION: Do not remove high pressure relief valve (B). Air conditioning system will discharge rapidly causing possible injury.

IMPORTANT: Use correct refrigerant recovery, recycling and charging stations. DO NOT mix refrigerant, hoses, fittings, components or refrigerant oils.

1. Connect refrigerant recovery, recycling and charging station. (See Charging Station Installation Procedure in this group.)

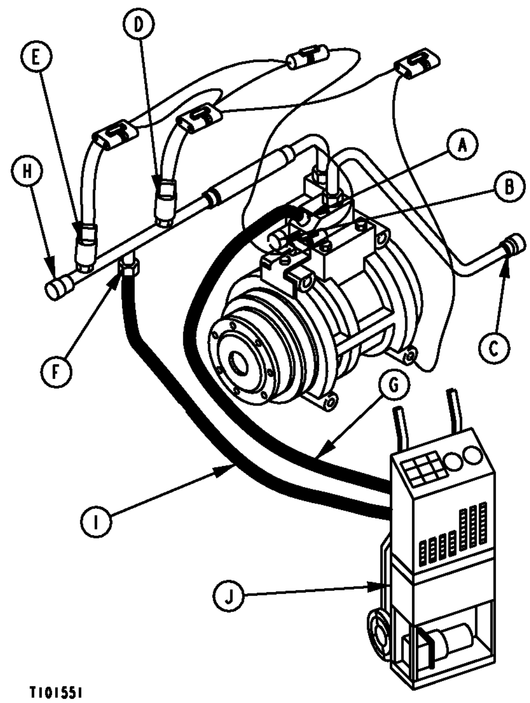
2. Evacuate the system. (See Evacuate Air Conditioning System Procedure in this group.)

NOTE: Before beginning to charge air conditioning system, the following conditions must exist: Engine STOPPED, the pump must be capable of pulling at least 28.6 in. Hg vacuum (sea level). Subtract 3.4 kPa (34 mbar) (1 in. Hg) from 98 kPa (980 mbar) (29 in. Hg) for each 300 m (1000 ft) elevation above sea level.

3. Follow the manufacturers instructions and charge the system.

4. Add refrigerant until system is charged with 2.43 kg (5.25 lb).

5. Do air conditioner checks and tests. (See procedures in Groups 9031-10 and 9031-25.)



T101551 –UN–10SEP96

A—Low Pressure Test Port
B—High Pressure Relief Valve
C—Low Pressure Hose
D—Low Pressure Switch
E—High Pressure Switch
F—High Pressure Quick-Disconnect
G—Blue Hose
H—High Pressure Hose
I—Red Hose
J—Refrigerant Recovery/Recycling and Charging Station

TX,18,UU3826 –19–21SEP98–1/1

CHECK AND ADJUST AIR CONDITIONING COMPRESSOR BELT TENSION

IMPORTANT: Never over tighten belt. Over tightening may cause belt cord damage and excessive load on bearings.

1. Run engine for five minutes. Stop the engine, then immediately check tension using a belt tension gauge. Measure strand tension or deflection at a point halfway between pulleys.

2. Belt must deflect 19 mm (0.75 in.) at 400 N (90 lb force). If not, allow belt to cool for 8—10 minutes.

Air Conditioning Compressor Belt—Specification

Deflection .... 19 mm (0.75 in.) at 400 N (90 lb force)

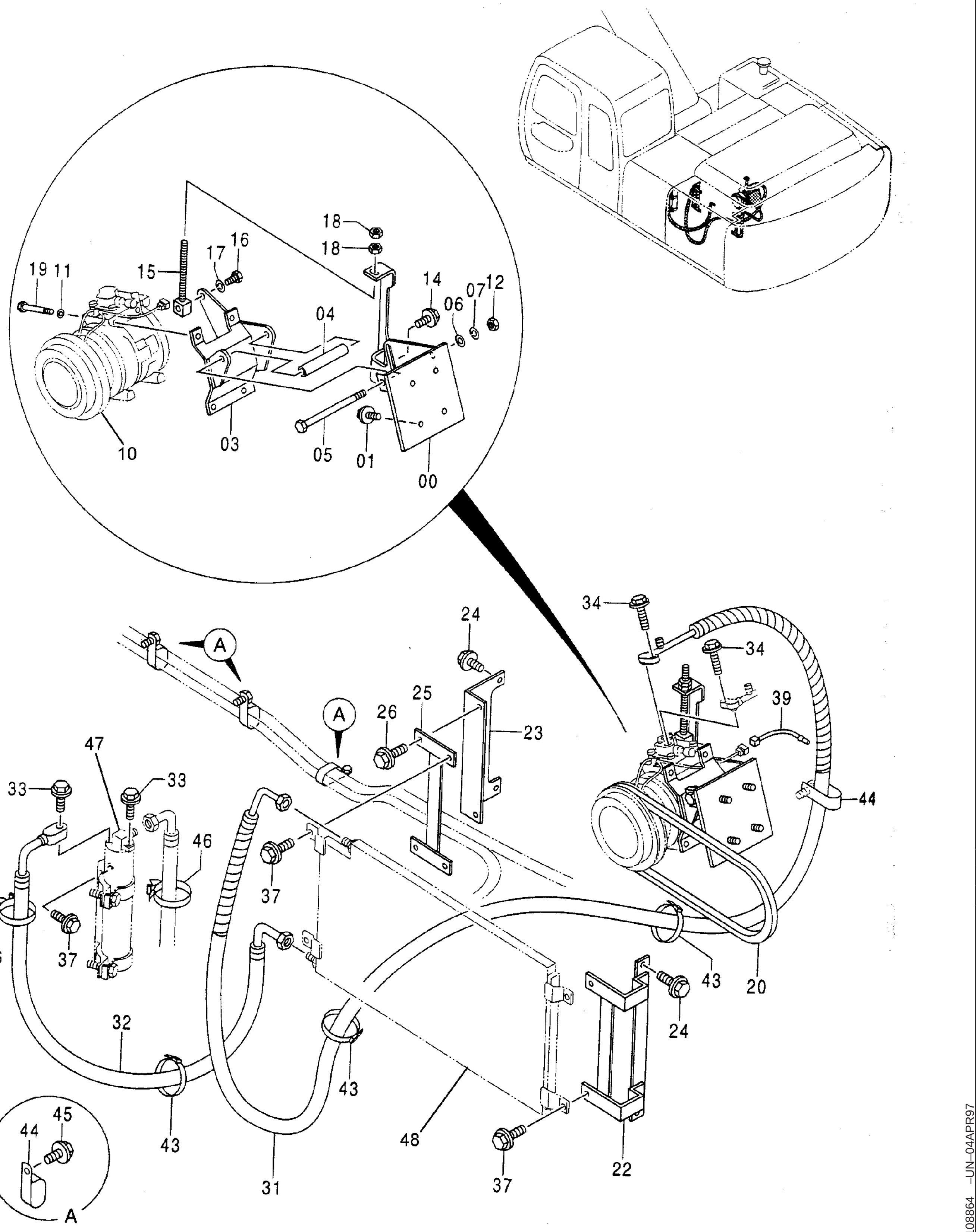
IMPORTANT: Force to adjust belt must be applied to front of compressor housing only to prevent damage to compressor.

3. Loosen compressor mounting cap screws. Apply force to front of compressor housing to tighten belt. Tighten cap screws.

4. Repeat Steps 1 and 2 to check belts.

TX,18,UU3827 –19–21SEP98–1/1

REMOVE AND INSTALL AIR CONDITIONING COMPRESSOR



T108864

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TX,18,UU3828 –19–10JAN97–1/2

00—Bracket	12—Nut	23—Bracket	39—Wiring Harness
01—Cap Screws	14—Cap Screw	24—Cap Screw	43—Clip
03—Bracket	15—Cap Screw	25—Bracket	44—Clip
04—Spacer	16—Cap Screw	26—Cap Screw	45—Cap Screw
05—Cap Screw	17—Lock Washer	31—Hose	46—Clip
06—Washer	18—Nut	32—Hose	47—Receiver Dryer
07—Lock Washer	19—Cap Screw	33—Cap Screw	48—Condenser
10—Compressor	20—Belt	34—Cap Screw	
11—Lock Washer	22—Bracket	37—Cap Screw	

1. Recover the refrigerant from the system. (See procedure in this group.)
2. Remove and install compressor (10). Install caps and plugs to close all open lines.

   Repair or replace compressor as necessary.
3. Evacuate and charge the system. (See procedures in this group.)
4. Adjust air conditioning compressor belt tension. (See procedure in this group.)

TX,18,UU3828 –19–10JAN97–2/2

DISASSEMBLE AND INSPECT AIR CONDITIONING COMPRESSOR

RW3654 –UN–23JAN89

1. Mount holding fixture in a bench vise and support compressor on holding fixture.

NOTE: *Mounting fixture can be made with two pieces of flat stock and two lengths of threaded rod.*

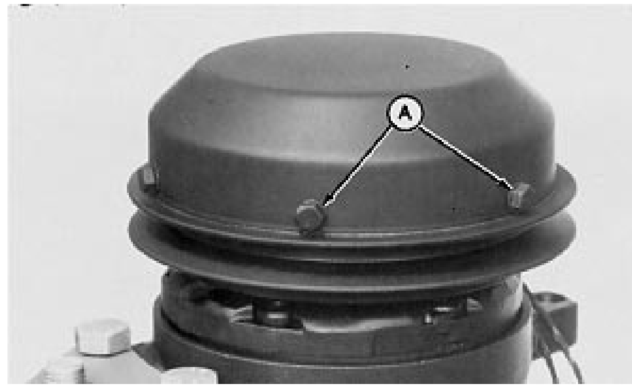
Weld one piece of stack perpendicular to other, drill two holes and install threaded rod as shown.

Compressor can also be mounted in pivoting D01006AA Bench Mounted Holding Fixture or similar holding device.

2. Put compressor in a bench holding fixture.

Continued on next page TX,18,UU3829 –19–21SEP98–1/26

3. Remove six dust cover cap screws (A) and remove cover.

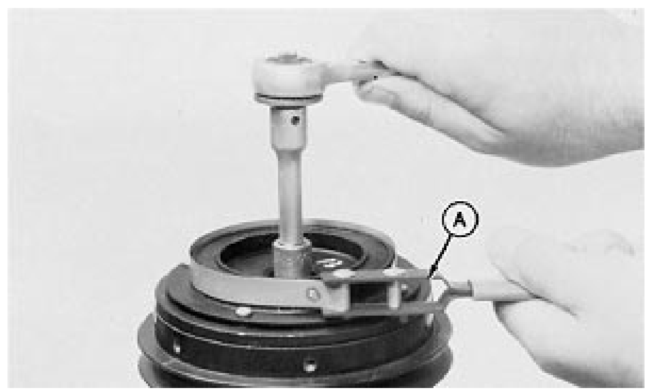


A—Cap Screws

TX,18,UU3829 –19–21SEP98–2/26

4. Hold clutch hub with clutch hub holding tool (A), and remove clutch hub retaining nut from shaft.

NOTE: If clutch drive plate slips on hub, drill a 1/4 in. hole through flanges of drive plate and hub. Insert a punch to hold clutch hub for removal of hub retaining nut.



A—Clutch Hub Holding Tool

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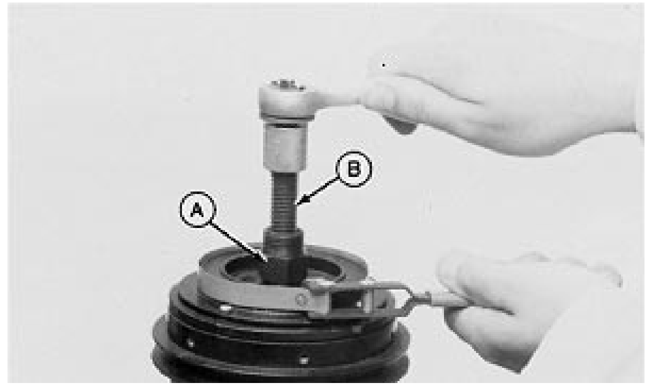
TX,18,UU3829 –19–21SEP98–3/26

5. Screw lower portion (A) clutch hub remover into hub.

6. Install forcing screw (B). Hold hub and tighten forcing screw until hub can be removed.

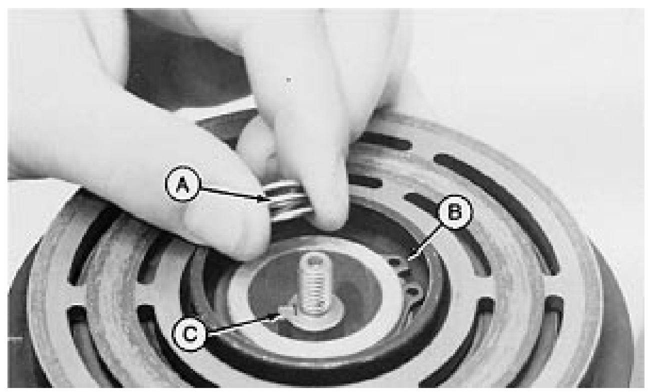


A—Lower Portion
B—Forcing Screw

TX,18,UU3829 –19–21SEP98–4/26

7. Remove shims (A) from shaft and note quantity. Save shims for reinstallation.

8. Remove and discard snap ring (B) and shaft key (C).



A—Shims
B—Snap Ring
C—Shaft Key

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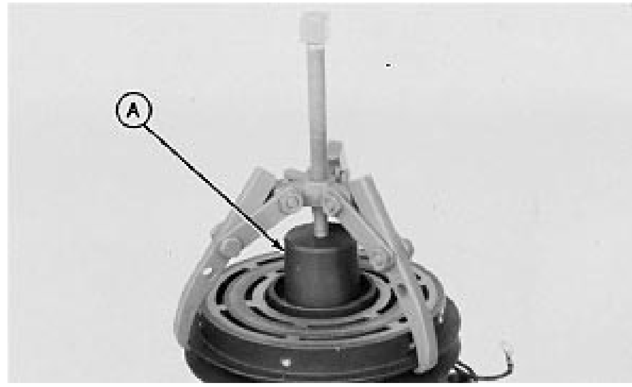
TX,18,UU3829 –19–21SEP98–5/26

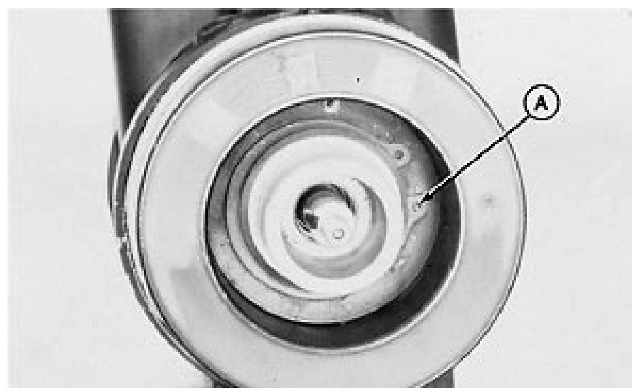
9. Install puller adapter (A) and use a suitable three jaw puller as shown to remove clutch pulley.



A—Puller Adapter

TX,18,UU3829 –19–21SEP98–6/26

10. Remove snap ring (A) and disconnect clutch field coil wire from compressor body. Remove clutch field coil.



A—Snap Ring

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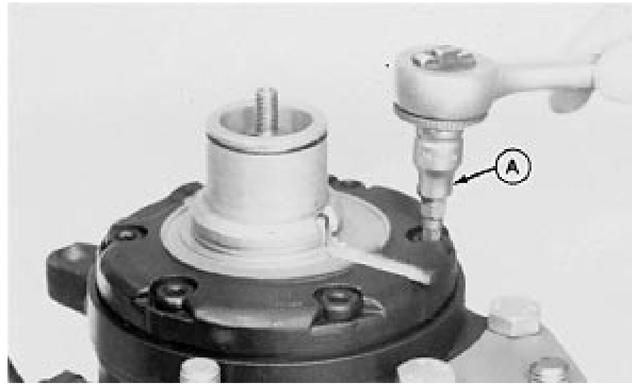
TX,18,UU3829 –19–21SEP98–7/26

11. Remove six through-bolts using special hex drive (A).

IMPORTANT: Do not remove through-bolts unless suction and discharge manifolds are in place and tight.

12. Carefully pry head from body using a screw driver. Pry only slightly around the circumference of the head. Repeat this procedure until head is removed.



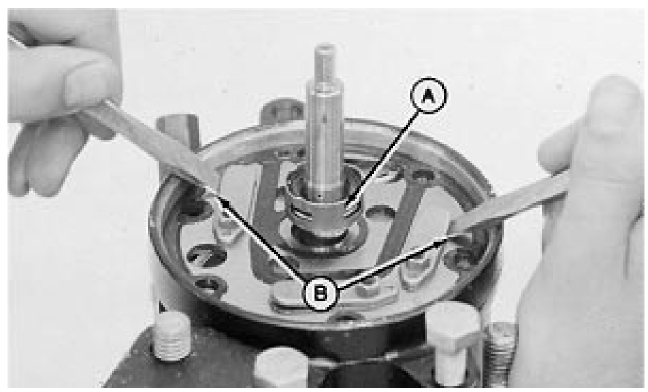
RW3661 –UN–23JAN89

A—Special Hex Drive

TX,18,UU3829 –19–21SEP98–8/26

13. Remove and discard shaft seal (A).

14. Use two screw drivers to remove discharge valve plate (B).



RW10908 –UN–07DEC88

A—Shaft Seal
B—Discharge Valve Plate

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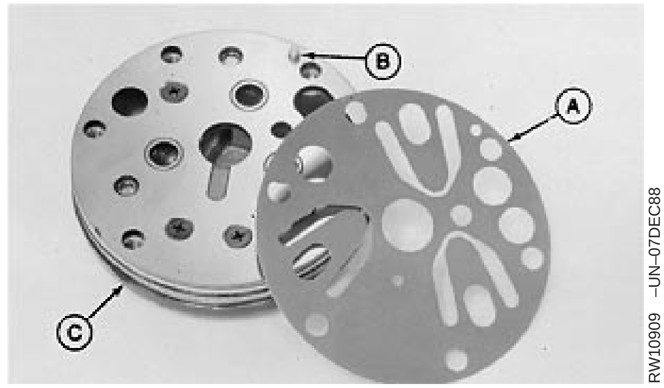
TX,18,UU3829 –19–21SEP98–9/26

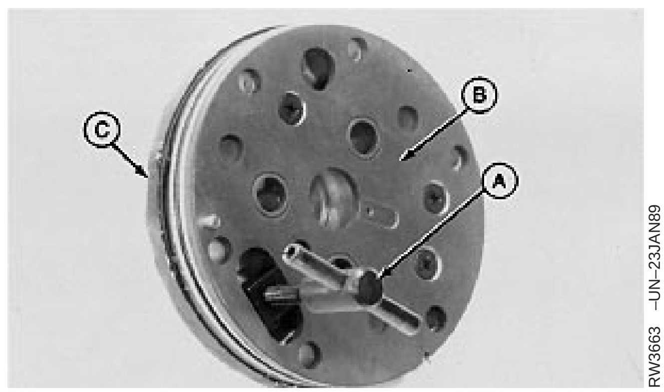
15. If shaft seal and valve plate remain with compressor head, carefully separate inlet reed valve (A) from valve plate (C). Do not lose locating dowel pin (B).



A—Inlet Reed Valve
B—Dowel Pin
C—Valve Plate

TX,18,UU3829 –19–21SEP98–10/26

16. Install valve plate remover (A) and carefully pull valve plate (B) from head (C).



A—Valve Plate Remover
B—Valve Plate
C—Head

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1830
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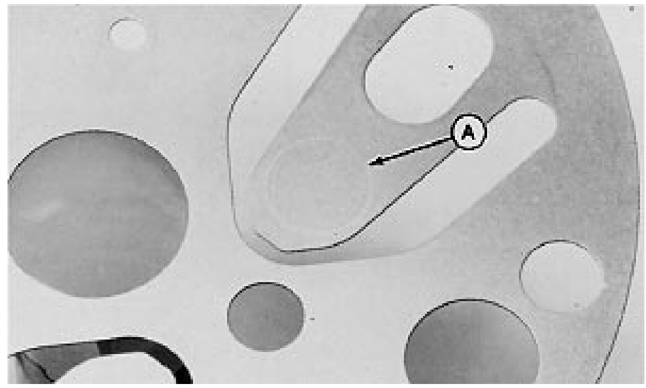
TX,18,UU3829 –19–21SEP98–11/26

17. Inspect valve plates side of inlet reed valves for a complete circular wear pattern (A).

18. If wear pattern has any voids in it, replace reed valve.



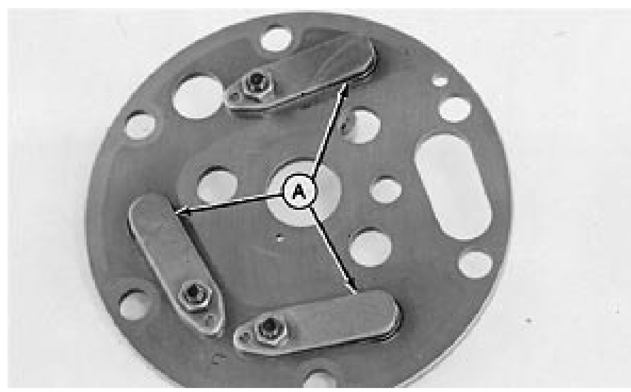
RW3665 –UN–23JAN89

A—Circular Wear Pattern

TX,18,UU3829 –19–21SEP98–12/26

19. Inspect discharge valves (A) for general condition. Valves should have slight pressure against valve plate.

20. Hold valve plate up to light and verify that valve is against its seat. If condition is doubtful, replace valve plate.



RW10001 –UN–07DEC88

A—Discharge Valves

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TX,18,UU3829 –19–21SEP98–13/26

21. Turn compressor over and remove rear head by prying on the small tabs cast into the head. Pry lightly around circumference of head.

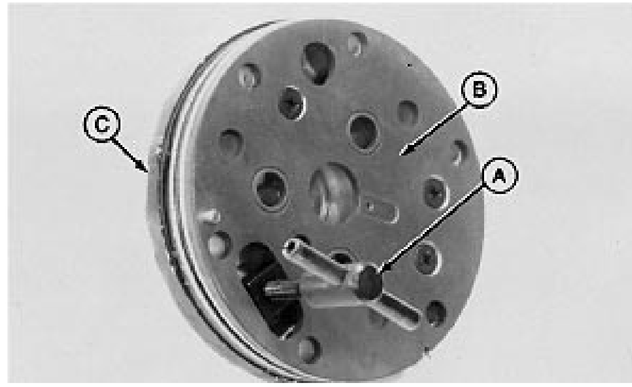
RW3668 –UN–23JAN89

Continued on next page

TX,18,UU3829 –19–21SEP98–14/26

22. Remove inlet reed valve from valve plate.

23. Install valve plate remover (A) and carefully pull valve plate (B) from head (C).



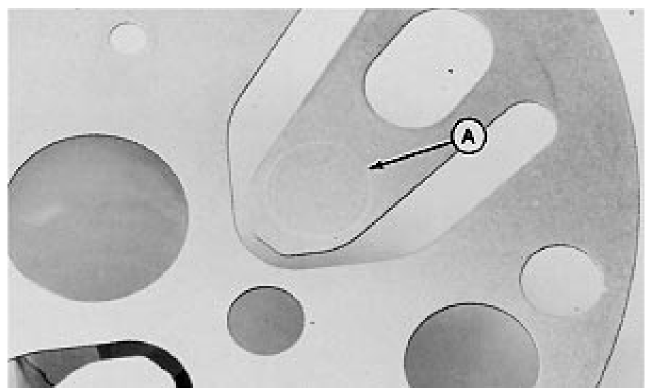
RW3663 –UN–23JAN89

A—Valve Plate Remover
B—Valve Plate
C—Head

TX,18,UU3829 –19–21SEP98–15/26

24. Inspect valve plate side of inlet reed valves for a complete circular wear pattern (A).

25. If wear pattern has any voids in it, replace reed valve.



RW3665 –UN–23JAN89

A—Circular Wear Pattern

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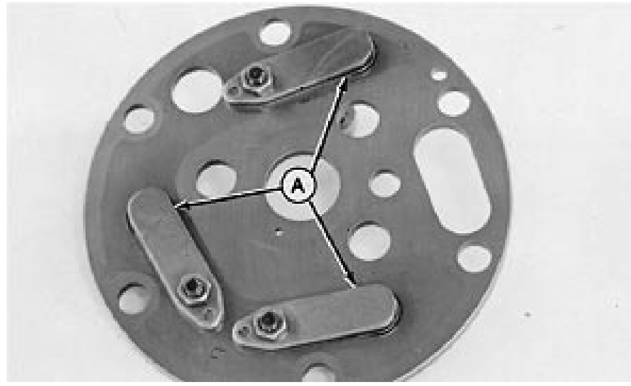
Continued on next page

TX,18,UU3829 –19–21SEP98–16/26

26. Inspect discharge valves (A) for general condition. Valves should have slight pressure against valve plate.

27. Hold valve plate up to light and verify that valve is against its seat. If condition is doubtful, replace valve plate.



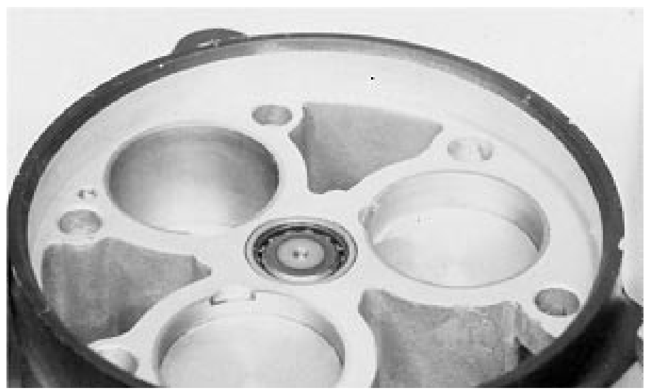
RW10001 –UN–07DEC88

A—Discharge Valves

TX,18,UU3829 –19–21SEP98–17/26

28. Inspect cylinders for scoring or excessive wear. If cylinders are scored or damaged, replace compressor.

NOTE: Some cylinder scuffing (light scratches) is normal.



RW3667 –UN–23JAN89

TX,18,UU3829 –19–21SEP98–18/26

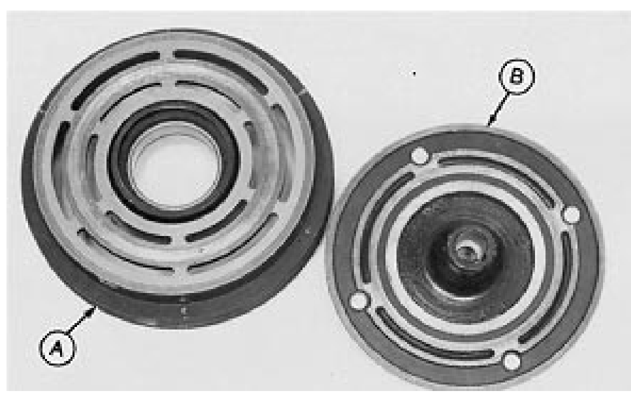
29. Inspect surfaces of clutch pulley (A) and clutch hub (B). If pulley is more than 0.3 mm (0.012 in.) from flat, replace pulley and clutch hub.

Clutch Pulley and Clutch Hub—Specification

Flatness .... 0.3 mm (0.012 in.) maximum

30. Rotate bearing in pulley. If pulley is rough or has evidence of loss of lube, replace bearing.

31. Clean as necessary.



RW3677 –UN–23JAN89

A—Clutch Pulley
B—Clutch Hub

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TX,18,UU3829 –19–21SEP98–19/26

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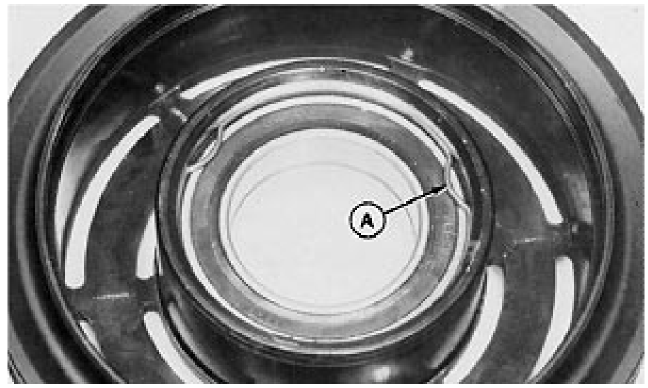
32. Remove retaining ring (A) from pulley bore.

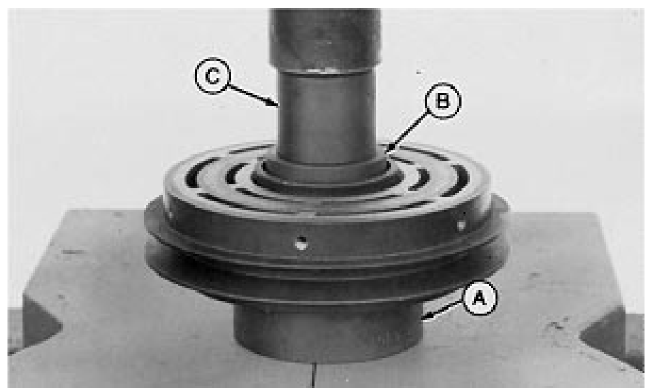


RW3670 –UN–23JAN89

A—Retaining Ring

TX,18,UU3829 –19–21SEP98–20/26

33. Put pulley on pulley support (A). Press bearing from pulley using bearing adapter (B) and puller adapter (C).



RW3671 –UN–23JAN89

A—Pulley Support
B—Bearing Adapter
C—Puller Adapter

18
1830
22

TX,18,UU3829 –19–21SEP98–21/26

34. Install dust shield, lip edge facing up, in pulley.

RW3672 –UN–23JAN89

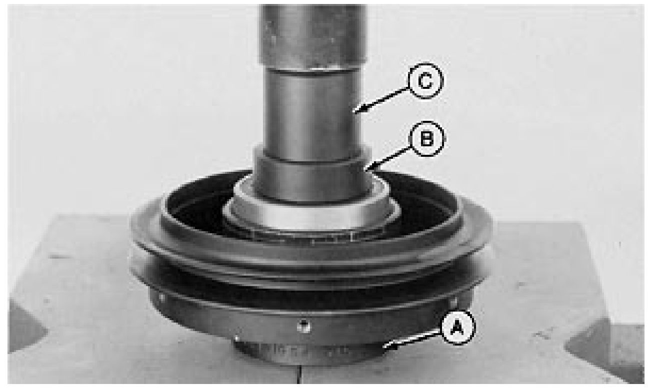
Continued on next page

TX,18,UU3829 –19–21SEP98–22/26

35. Put pulley on pulley bearing support (A). Make sure dust shield seats in support before putting bearing on pulley.

36. Press bearing into pulley until bearing bottoms on dust shield using a bearing adapter (B) and pulley adapter (C).

37. Install bearing retaining ring.

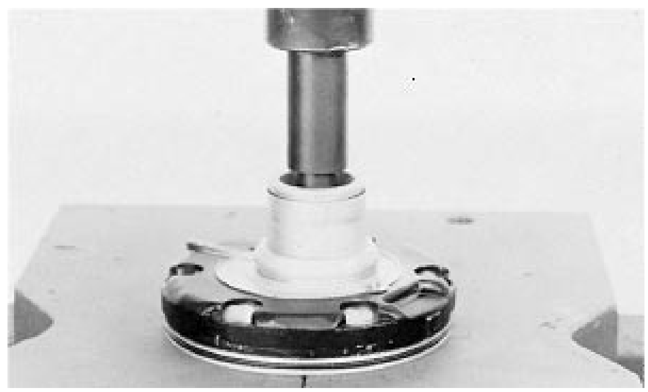


RW3673 –UN–23JAN89

A—Bearing Support
B—Bearing Adapter
C—Pulley Adapter

TX,18,UU3829 –19–21SEP98–23/26

38. Remove seat from head using a shaft seal seat remover.

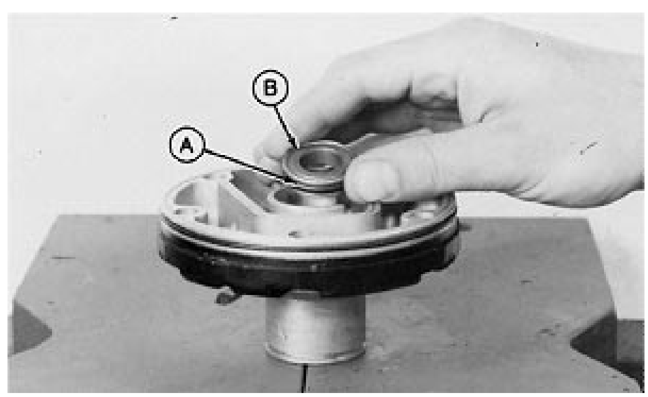


RW3674 –UN–23JAN89

TX,18,UU3829 –19–21SEP98–24/26

39. Apply a small amount of clean refrigerant oil to O-ring (A).

40. Install seal seat (B) in bore with grooved surface of seat facing up as shown.



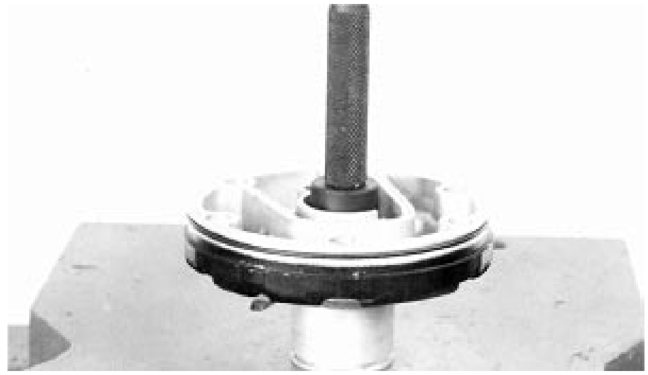
RW3675 –UN–23JAN89

A—O-Ring
B—Seal Seat

Continued on next page

TX,18,UU3829 –19–21SEP98–25/26

41. Press seal seat in head until seat bottoms in bore using shaft seal seat installer.


RW3676 –UN–23JAN89

TX,18,UU3829 –19–21SEP98–26/26

ASSEMBLE AIR CONDITIONING COMPRESSOR

1. Remove gaskets from both front and rear heads. Be sure all gasket material is removed. Wash all parts in clean solvent before assembly.

2. Place suction reed valve against compressor side of rear head. Install locating dowel pin to assure that reed valve and valve plate are properly indexed. Set in place in compressor.

3. Carefully install new head gasket. Be sure it is properly in place.

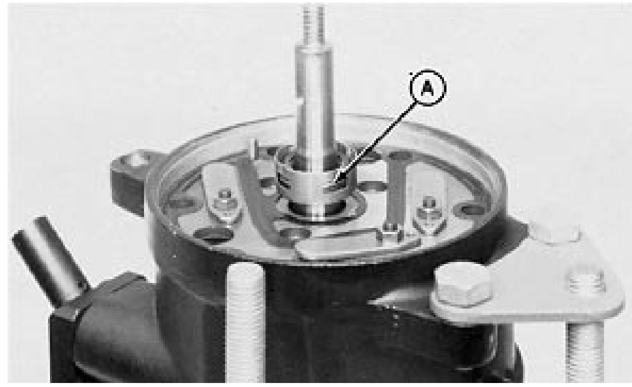
4. Carefully install rear head. Be sure locating dowel pin is correctly positioned in head. Lightly tap head into place.

5. Turn compressor over and install suction reed and valve plate. Install new head gasket.

Continued on next page TX,18,SB796 –19–21SEP98–1/6

IMPORTANT: Shaft seal is a two piece seal. Be sure they are properly installed or breakage will occur during assembly of front head.

6. Install new shaft seal (A) as shown. Be sure slotted rear side of seal engages with flats on compressor shaft.



A—Shaft Seal

TX,18,SB796 –19–21SEP98–2/6

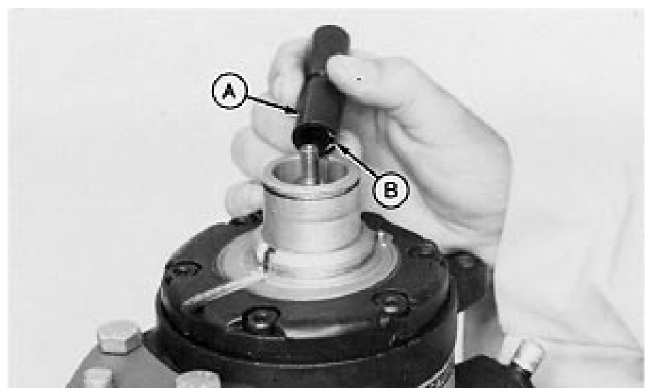
7. Align head with dowel pin and install head. Use six bolts to draw head down EVENLY, then tighten.

Head-to-Compressor Cap Screw—Specification

Torque .... 26 N•m (19 ft-lb)

8. Install new shaft key in key way. Position shaft key installer (A) with slotted area (B) over key.

9. Tap installer with a small hammer until key bottoms in key way.



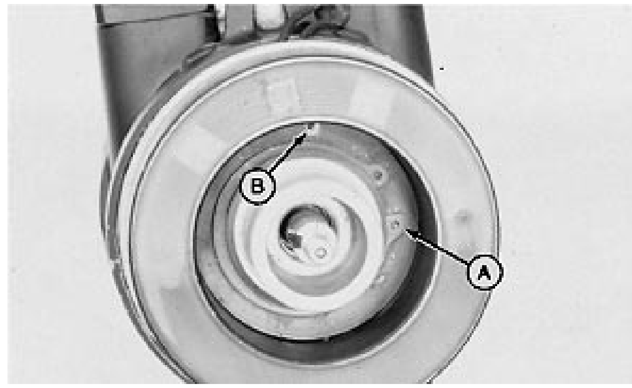
A—Shaft Key Installer
B—Slotted Area

Continued on next page

TX,18,SB796 –19–21SEP98–3/6

10. Align clutch coil with roll pin (B) in head and install coil. Install snap ring (A) with round edge facing upward.

11. Connect clutch coil wire to ground screw on compressor.



RW3679 –UN–23JAN89

A—Snap Ring
B—Roll Pin

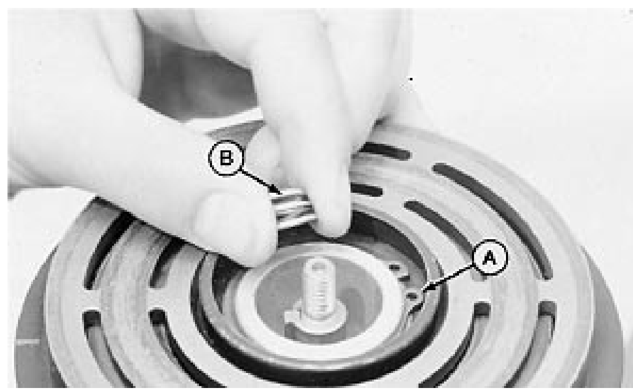
TX,18,SB796 –19–21SEP98–4/6

12. Install pulley. Slight tap may be needed to properly position pulley on shaft.

13. Install new snap ring (A) with rounded edge of snap ring facing upward. Install removed shims (B) on front head.

14. Align clutch head key way with key and install hub.

15. Tighten nut until clutch hub is tight against shims on compressor shaft shoulder.



RW3684 –UN–23JAN89

A—Snap Ring
B—Shims

Continued on next page

TX,18,SB796 –19–21SEP98–5/6

16. Check pulley-to-hub clearance in three equally spaced locations around hub using a feeler gauge.

Pulley-to-Hub—Specification

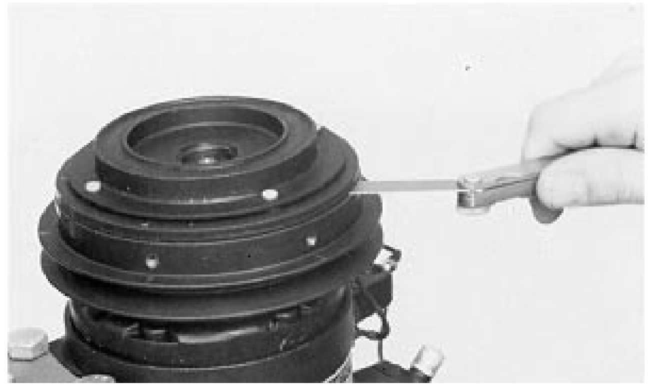
Clearance .... 0.53—0.91 mm (0.021—0.036 in.)

17. Turn pulley one-half turn (180°) and check clearance in three equally spaced locations. Remove or install shims as necessary for proper clearance.

18. Tighten clutch hub nut.

Clutch Hub-to-Shaft Nut—Specification

Torque .... 16 N•m (12 ft-lb)



RW3682 –UN–23JAN89

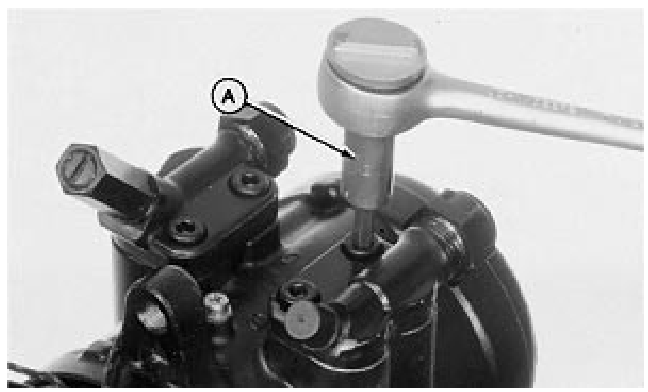
TX,18,SB796 –19–21SEP98–6/6

INSPECT AIR CONDITIONING COMPRESSOR MANIFOLDS

1. Recover the refrigerant from the system. (See procedure in this Group.)

IMPORTANT: Do not remove manifolds unless front and rear head cap screws are installed and tightened.

2. Remove cap screws using hex drive (A).
3. Inspect parting surfaces and O-rings.
4. Replace parts as necessary.
5. Install manifolds.
6. Evacuate and charge the system. (See procedures in this Group.)



RW4983 –UN–23JAN89

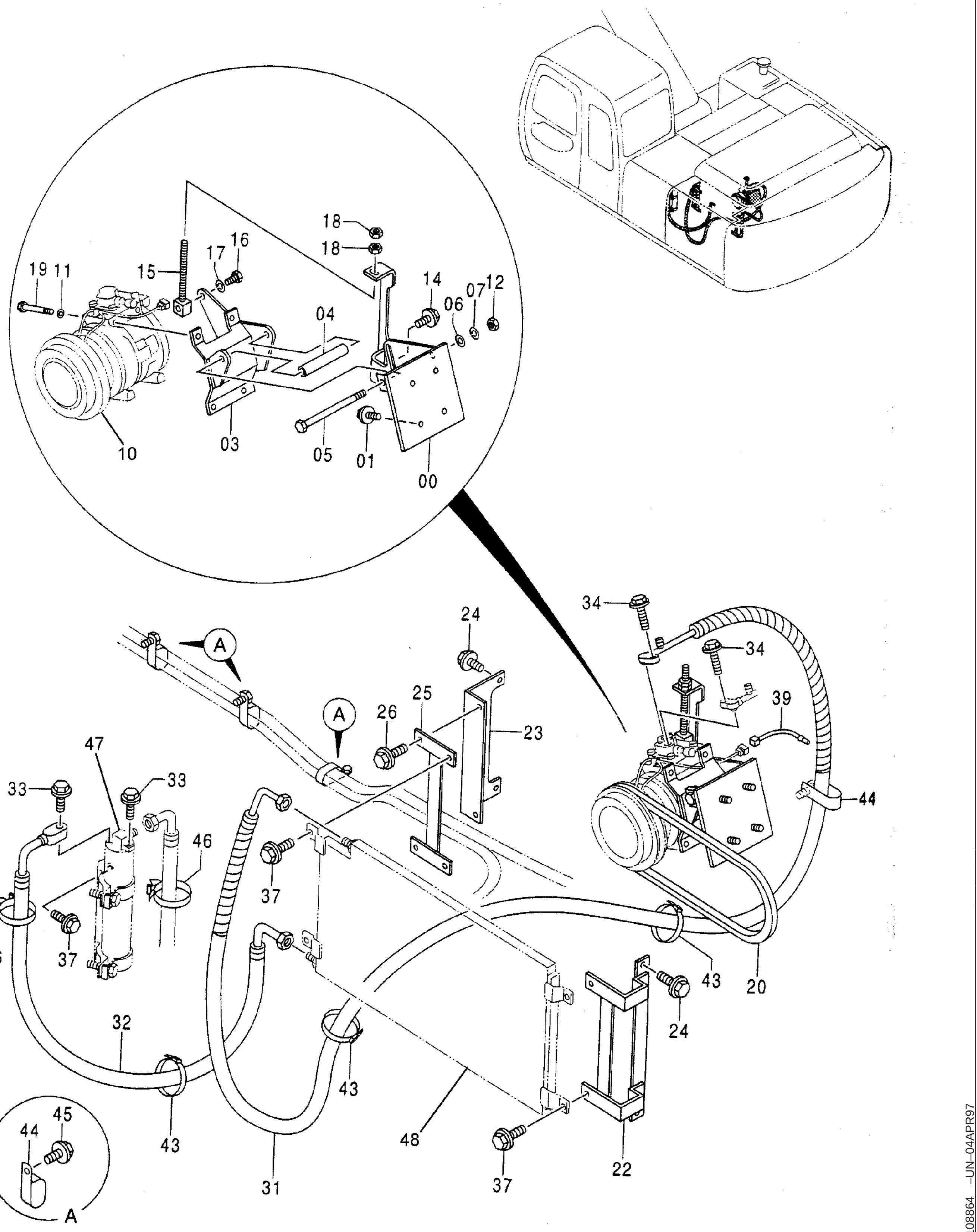
RW4984 –UN–23JAN89

A—Hex Drive

TX,18,SB797 –19–04APR97–1/1

18
1830
27

REMOVE AND INSTALL RECEIVER DRYER



T108864

Continued on next page TX,18,UU3830 –19–10JAN97–1/2

00—Bracket
01—Cap Screws
03—Bracket
04—Spacer
05—Cap Screw
06—Washer
07—Lock Washer
10—Compressor
11—Lock Washer
12—Nut
14—Cap Screw
15—Cap Screw
16—Cap Screw
17—Lock Washer
18—Nut
19—Cap Screw
20—Belt
22—Bracket
23—Bracket
24—Cap Screw
25—Bracket
26—Cap Screw
31—Hose
32—Hose
33—Cap Screw
34—Cap Screw
37—Cap Screw
39—Wiring Harness
43—Clip
44—Clip
45—Cap Screw
46—Clip
47—Receiver Dryer
48—Condenser

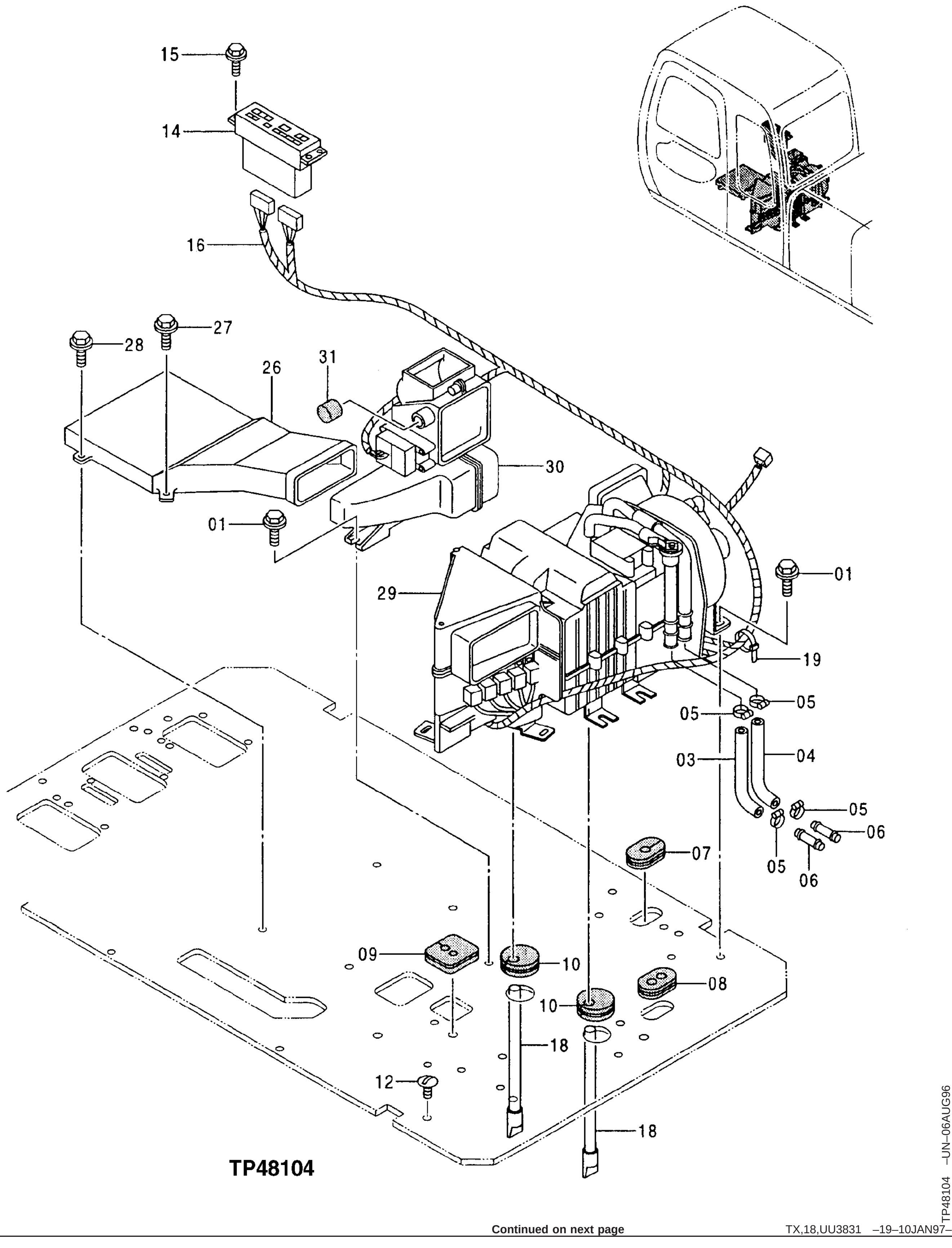
1. Recover the refrigerant from the system. (See procedure in this group.)

2. Remove and install receiver dryer (47).

3. Evacuate and charge the system. (See procedures in this group.)

TX,18,UU3830 –19–10JAN97–2/2

REMOVE AND INSTALL EVAPORATOR



TP48104

Continued on next page TX,18,UU3831 –19–10JAN97–1/2

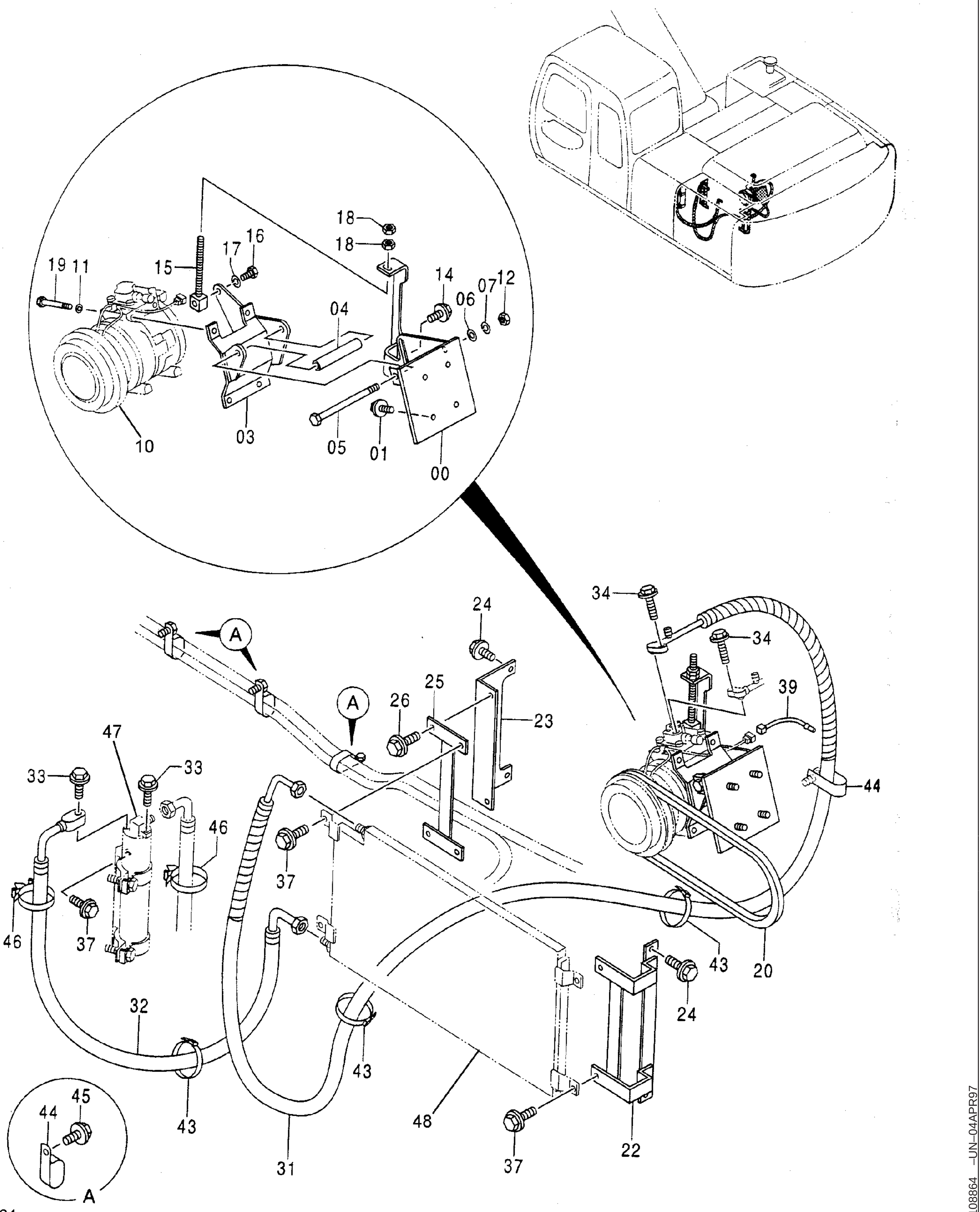
1—Cap Screw, Lock Washer, Washer (11 used)
3—Heater Hose
4—Heater Hose
5—Hose Clamp (4 used)
6—Tube (2 used)
7—Bushing
8—Grommet
9—Bushing
10—Grommet (2 used)
12—Plug (13 used)
14—Control
15—Screw (4 used)
16—Wiring Harness
18—Hose (2 used)
19—Tie Band (7 used)
26—Air Duct
27—Cap Screw, Lock Washer, Washer (2 used)
28—Cap Screw and Washer (2 used)
29—Air Conditioning Unit
30—Housing
31—Plug

NOTE: Evaporator is serviced as part of the air conditioning unit.

1. Recover the refrigerant from the system. (See procedure in this group.)
2. Remove and install air conditioning unit (29).
3. Evacuate and charge the system. (See procedures in this group.)

TX,18,UU3831 –19–10JAN97–2/2

REMOVE AND INSTALL CONDENSER



T108864

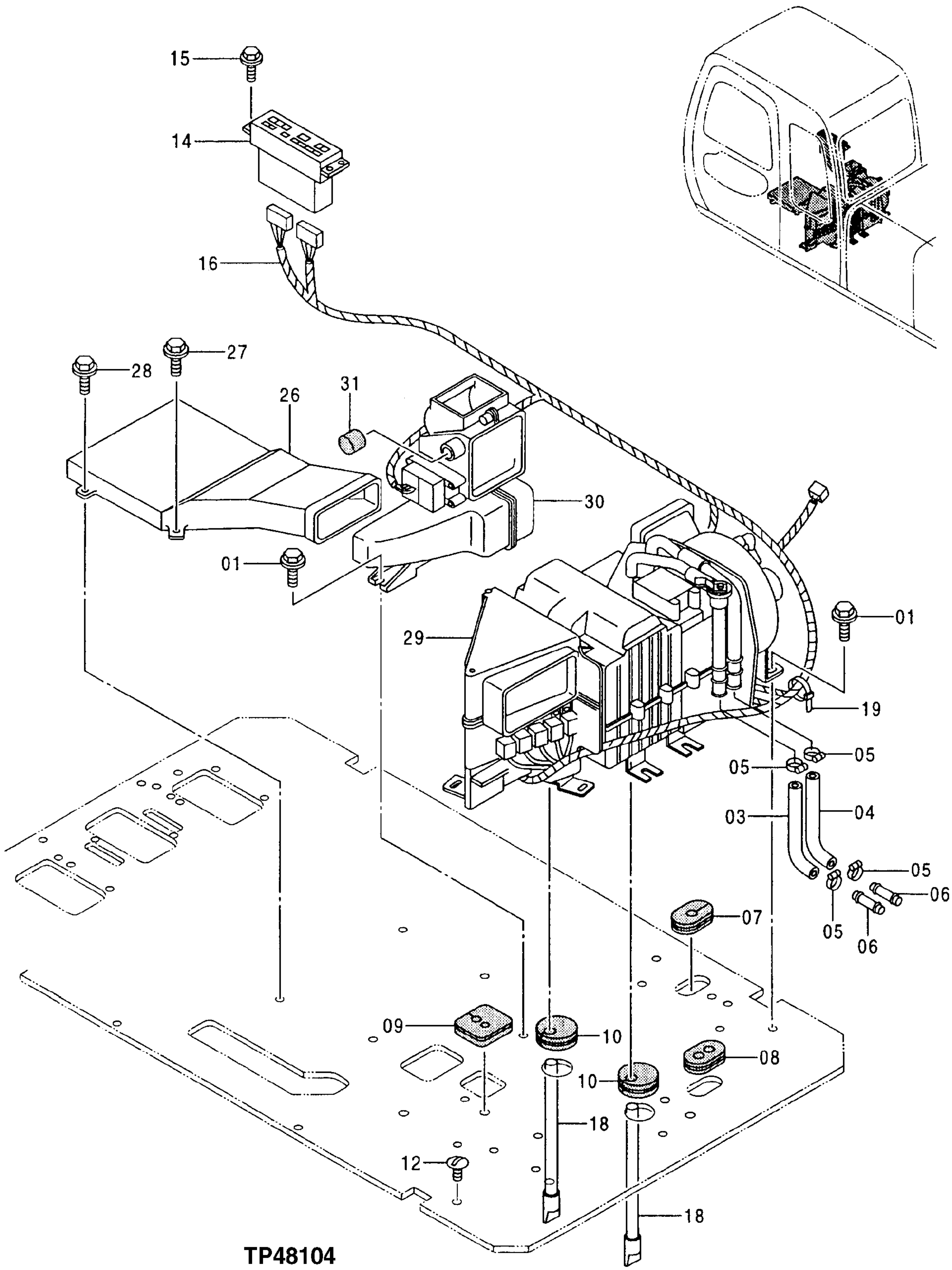
Continued on next page TX,18,UU3832 –19–10JAN97–1/2

00—Bracket	**12—Nut**	**23—Bracket**	**39—Wiring Harness**
01—Cap Screws	**14—Cap Screw**	**24—Cap Screw**	**43—Clip**
03—Bracket	**15—Cap Screw**	**25—Bracket**	**44—Clip**
04—Spacer	**16—Cap Screw**	**26—Cap Screw**	**45—Cap Screw**
05—Cap Screw	**17—Lock Washer**	**31—Hose**	**46—Clip**
06—Washer	**18—Nut**	**32—Hose**	**47—Receiver Dryer**
07—Lock Washer	**19—Cap Screw**	**33—Cap Screw**	**48—Condenser**
10—Compressor	**20—Belt**	**34—Cap Screw**	
11—Lock Washer	**22—Bracket**	**37—Cap Screw**	

1. Recover the refrigerant from the system. (See procedure in this group.)
2. Remove and install condenser (48) as shown.
3. Evacuate and charge the system. (See procedures in this group.)

TX,18,UU3832 –19–10JAN97–2/2

REMOVE AND INSTALL HEATER CORE—MACHINE WITH AIR CONDITIONING



TP48104

TP48104 –UN–06AUG96

Continued on next page TX,18,UU3833 –19–10JAN97–1/2

18
1830
34

1—Cap Screw, Lock Washer, Washer (11 used)
3—Heater Hose
4—Heater Hose
5—Hose Clamp (4 used)
6—Tube (2 used)
7—Bushing
8—Grommet
9—Bushing
10—Grommet (2 used)
12—Plug (13 used)
14—Control
15—Screw (4 used)
16—Wiring Harness
18—Hose (2 used)
19—Tie Band (7 used)
26—Air Duct
27—Cap Screw, Lock Washer, Washer (2 used)
28—Cap Screw and Washer (2 used)
29—Air Conditioning Unit
30—Housing
31—Plug

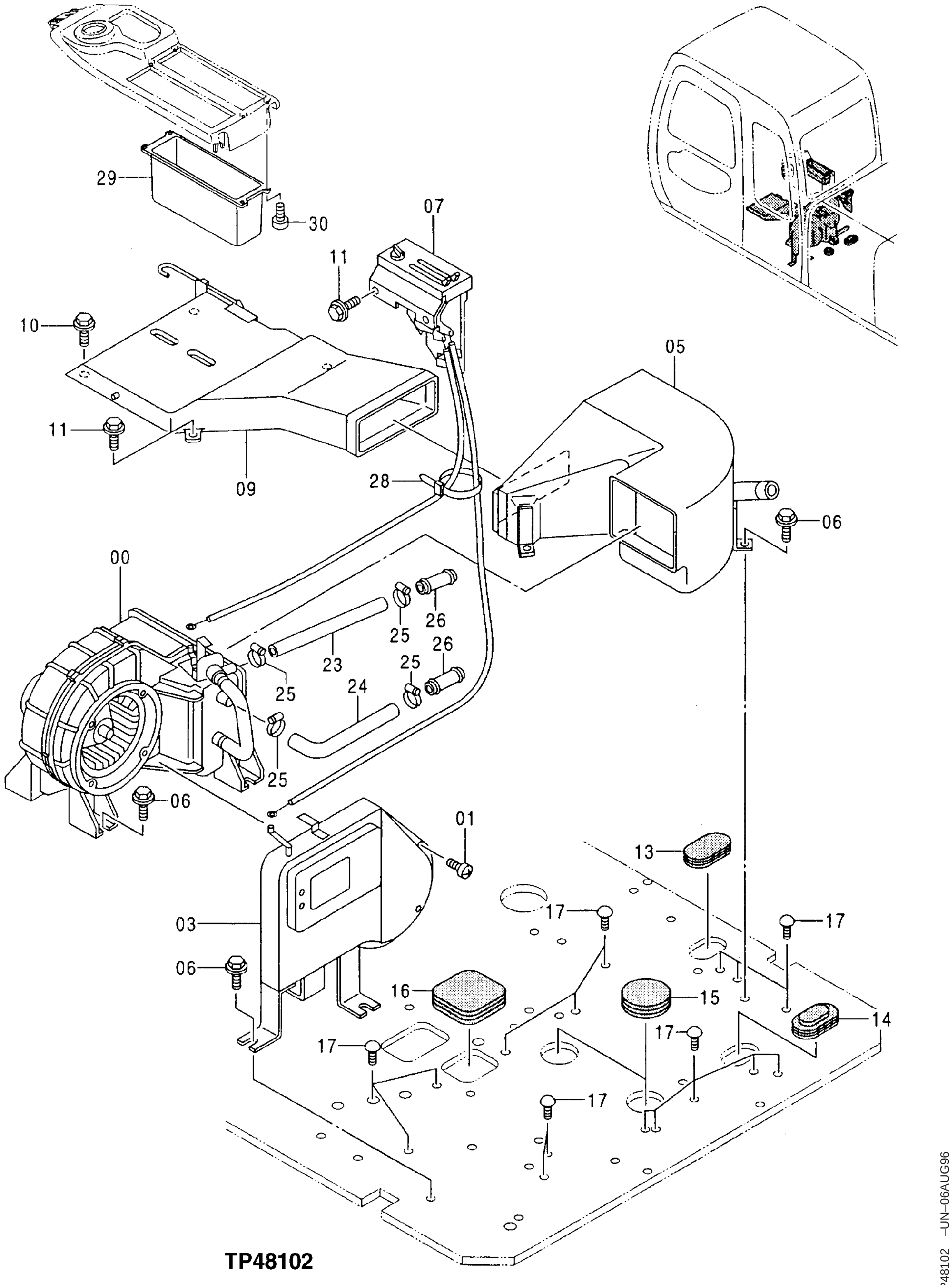
1. Recover the refrigerant from the system. (See procedure in this group.)

2. Remove and install air conditioning unit (29).

3. Evacuate and charge the system. (See procedures in this group.)

TX,18,UU3833 –19–10JAN97–2/2

REMOVE AND INSTALL HEATER CORE AND BLOWER MOTOR



TP48102

Continued on next page TX,18,UU3834 –19–10JAN97–1/3

0—Heater
1—Screw (3 used)
3—Support
5—Air Duct
6—Cap Screw, Lock Washer, Washer (10 used)
7—Control
9—Air Duct
10—Screw, With Washer (2 used)
11—Lock Washer, Cap Screw, Washer (4 used)
13—Grommet
14—Plug
15—Plug (2 used)
16—Plug
17—Plug (16 used)
23—Hose
24—Hose
25—Hose Clamp (4 used)
26—Tube (2 used)
28—Tie Band (3 used)
29—Tray
30—Screw (4 used)

TX,18,UU3834 –19–10JAN97–2/3

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

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

TS281 –UN–23AUG88

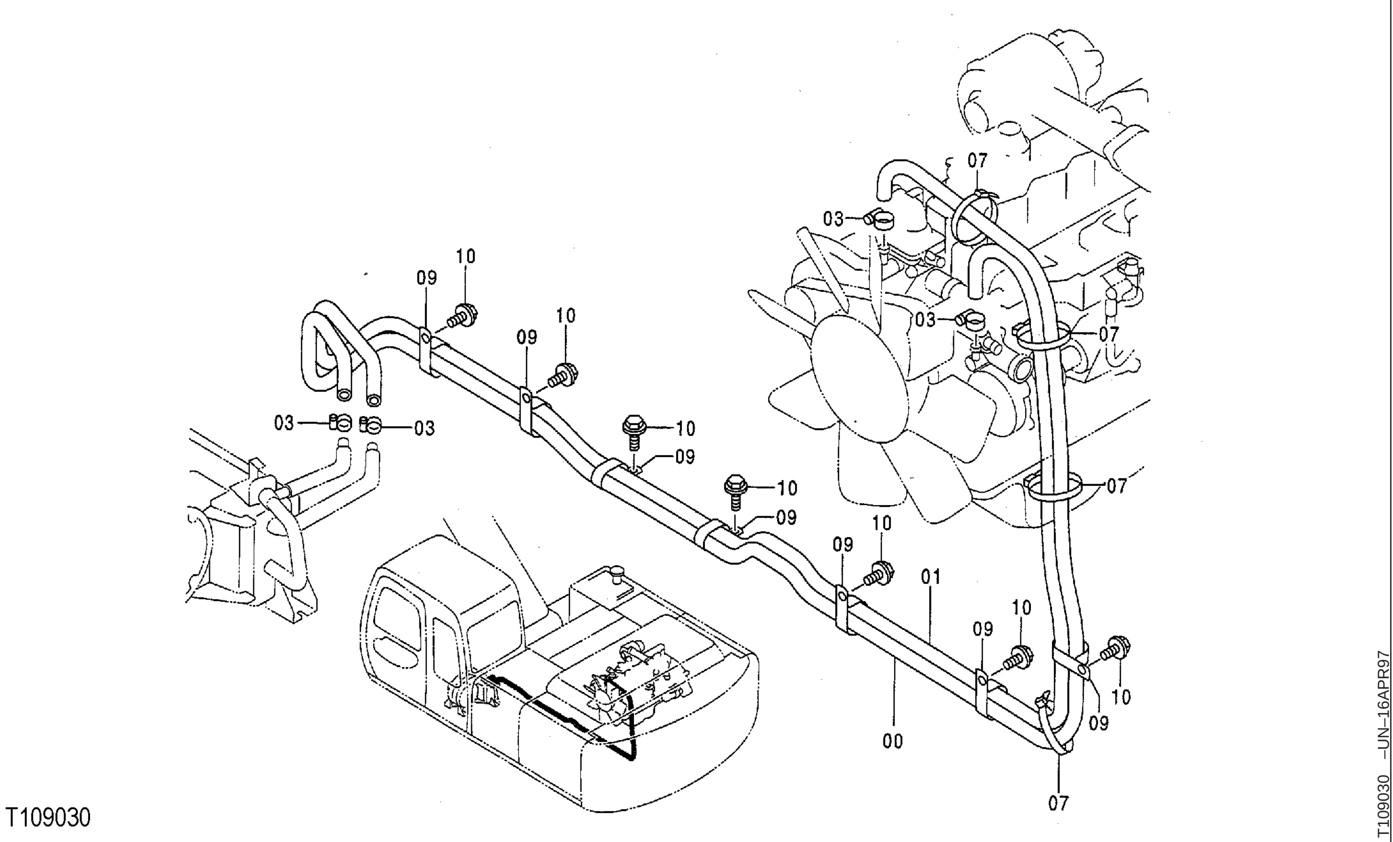
1. Close the shut-off valves on the engine or drain coolant from radiator. The approximate coolant system capacity is 22 L (6 gal).

2. Remove and install blower motor and heater core (0).

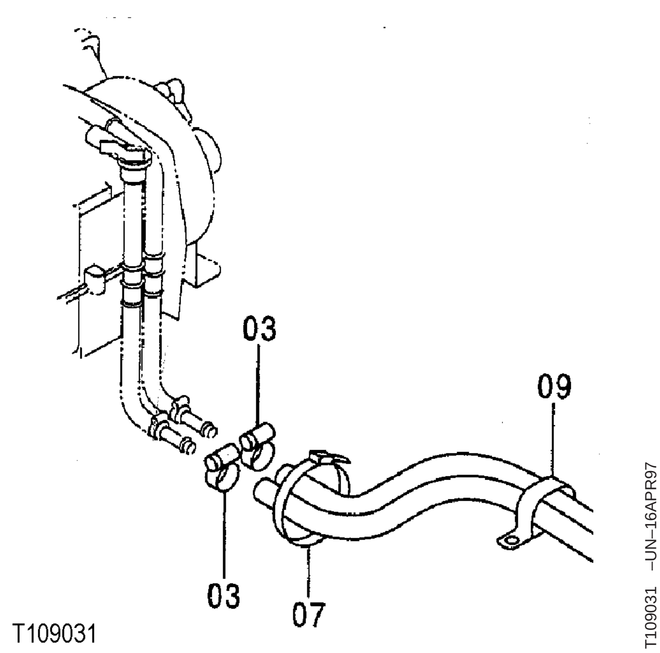
3. Tighten the hose clamps (25) until the hose just starts to deform around the clamp.

TX,18,UU3834 –19–10JAN97–3/3

REMOVE AND INSTALL HEATER HOSES



Heater Hoses without Air Conditioning



Heater Hose Connections w/Air Conditioning

00—Hose
01—Hose
03—Hose Clamp
07—Tie Band
09—Clip
10—Cap Screw

Continued on next page

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

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

TS281 –UN–23AUG88

1. Close the shut-off valves on the engine or drain coolant from radiator. The approximate coolant system capacity is 22 L (6 gal).

2. Tighten the hose clamps (03) until the hose just starts to deform around the clamp.

TX,18,UU3835 –19–15JAN97–2/2

BLANK

CHAPTER 19

SECTION 19

SHEET METAL AND STYLING REPAIR

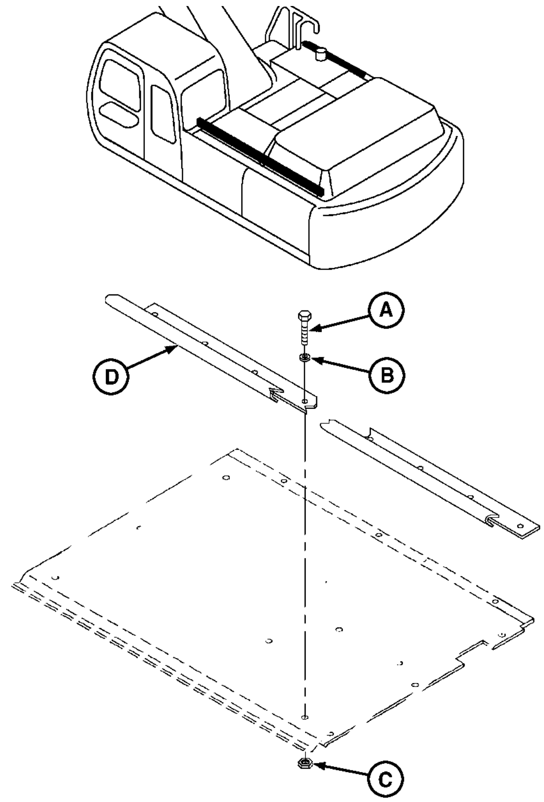
BLANK

Group 1910
Hand Rails

REMOVE AND INSTALL HAND RAILS

NOTE: Procedure is the same for both left and right hand rails; left hand rail is shown.

Remove cap screws (A), washers (B), nuts (C) and hand rail (D).



T125734

T125734 –UN–12NOV99

A—Cap Screw (6 used)
B—Washer (6 used)
C—Nut (6 used)
D—Hand Rail

CED,OUOE003,2 –19–12NOV99–1/1

Group 1919
Boom Cylinder Guard

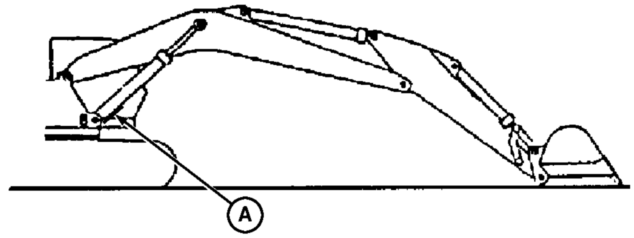
REMOVE AND INSTALL BOOM CYLINDER GUARD

1. Park machine on a firm, level surface.

2. Retract arm and bucket cylinders. Lower boom so bucket is on ground.

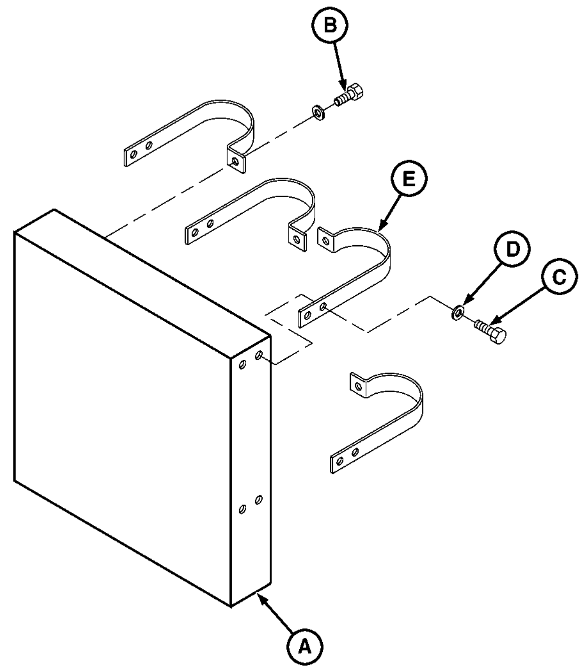
3. Stop engine.

4. Remove bolts (B and C), washers (D), clamps (E), and guard (A).



T125732

T125732 –UN–12NOV99



T125733

T125733 –UN–12NOV99

A—Boom Cylinder Guard
B—Bolt (4 used)
C—Bolt (8 used)
D—Washer (12 used)
E—Clamp (4 used)

CED,OUOE003,3 –19–12NOV99–1/1

18
1919
1

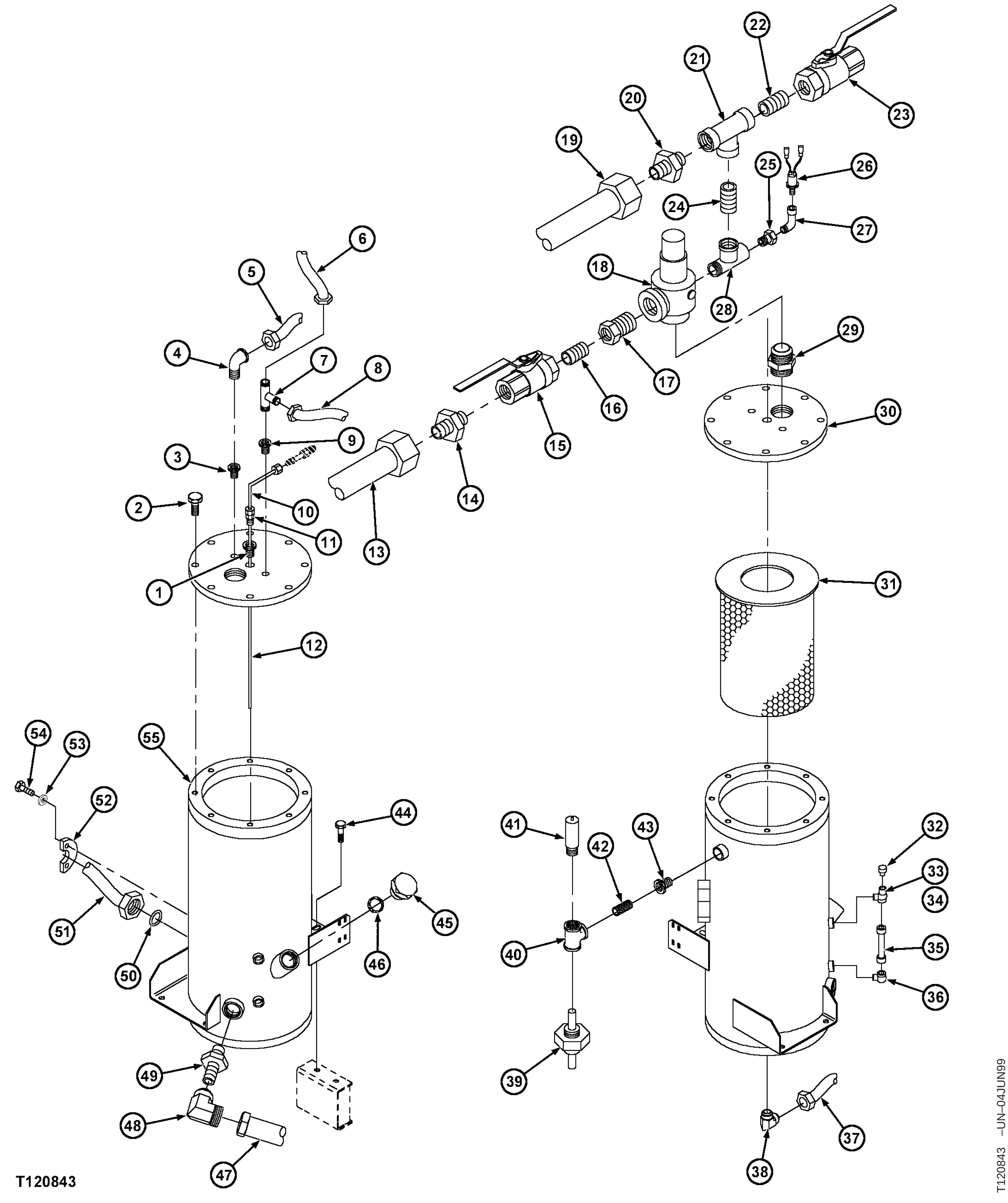
CHAPTER 20

SECTION 22

COMPRESSOR REPAIR

BLANK

SEPARATOR TANK



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Compressor

1—Bushing
2—Cap Screw (8 used)
3—Bushing
4—Elbow
5—Hose
6—Hose
7—Tee
8—Hose
9—Bushing
10—Lenz Tube
11—Fitting
12—Scavenge Tube
13—Hose
14—Connector
15—Ball Valve
16—Nipple
17—Bushing
18—Minimum Pressure Valve
19—Hose
20—Connector
21—Tee
22—Nipple
23—Ball Valve
24—Nipple
25—Bushing
26—Sensor
27—Street Elbow
28—Tee
29—Adapter
30—Cover
31—Element
32—Plug
33—Gasket (2 used)
34—Fitting
35—Sight Glass
36—Fitting
37—Hose
38—Elbow
39—Sensor
40—Street Tee
41—Safety Valve
42—Nipple
43—Bushing
44—Cap Screw (8 used)
45—Oil Fill Plug
46—O-Ring
47—Hose
48—Elbow
49—Connector
50—O-Ring
51—Hose
52—Flange Half (2 used)
53—Lock Washer (4 used)
54—Cap Screw (4 used)
55—Separator Tank

CAUTION: The approximate weight of the compressor is 1298 kg (2860 lb).

CED,OUOE039,7 –19–13APR99–2/2

REMOVE AND INSTALL SEPARATOR TANK

CAUTION: Before removing the separator tank, purge the system of all air pressure.

1. Disconnect hose (5) and remove elbow (4).
2. Disconnect fitting (11) and remove lenz tube (10).
3. Disconnect hose (6) and remove tee (7).
4. Disconnect hose (19).
5. Remove parts (20—28).
6. Disconnect hose (13) and remove parts (14—17).
7. Disconnect hose (47) and remove elbow (48) and connector (49).
8. Disconnect hose (37) and remove elbow (38).
9. Remove cap screws (54), lock washers (53), flange halves (52), hose (51), and O-ring (50).
10. Remove parts (32—36).
11. Remove parts (39—42).
12. Remove cap screws (44) and separator tank (55).
13. Repair and replace parts as necessary.
14. Install separator tank (55) and cap screws (44).
15. Install parts (39—42).
16. Install parts (32—36).
17. Install O-ring (50), hose (51), flange halves (52), lock washers (53), and cap screws (54).
18. Install elbow (38) and hose (37).
19. Install connector (49), elbow (48) and hose (47).
20. Install parts (14—17) and hose (13).
21. Install parts (20—28).
22. Install hose (19).
23. Install tee (7) and hose (6).
24. Install lenz tube (10) and fitting (11).
25. Install elbow (4) and hose (5).

CED,OUOE039,8 –19–13APR99–1/1

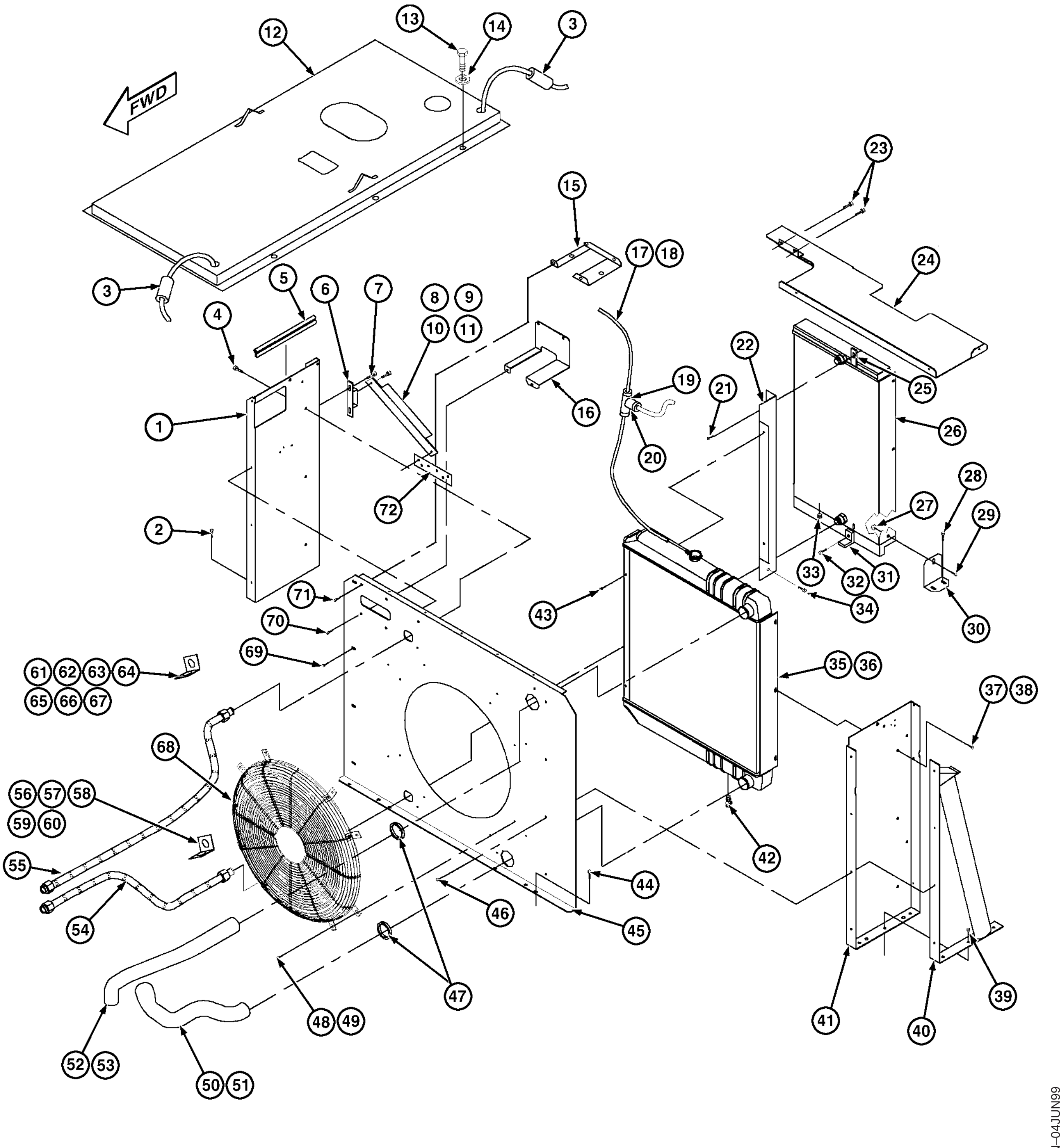
DISASSEMBLE AND ASSEMBLE SEPARATOR TANK

1. Remove bushings (1, 3, 9 and 43).
2. Remove minimum pressure valve (18) and adapter (29).
3. Remove oil fill plug (45) and O-ring (46).
4. Remove cap screws (2) and cover (30).
5. Remove scavenge tube (12) and element (31).
6. Repair and replace parts as necessary.
7. Install element (31) and scavenge tube (12).
8. Install cover (30) and cap screws (2).
9. Install O-ring (46) and oil fill plug (45).
10. Install adapter (29) and minimum pressure valve (18).
11. Install bushings (1, 3, 9, and 43).

CED,OUOE039,9 –19–13APR99–1/1

22
6

DISASSEMBLE AND ASSEMBLE COOLING SYSTEM



T120893

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1—Oil Cooler Side Support
2—Cap Screw (3 used)
3—Connector (2 used)
4—Cap Screw (3 used)
5—Seal Strip (2 used)
6—Mounting Bracket (2 used)
7—Cap Screw (4 used)
8—RH Cooler Support Brace (Shown)
9—LH Cooler Support Brace
10—Cap Screw (2 used)
11—Cap Screw (2 used)
12—Compressor Top Cover
13—Cap Screw (6 used)
14—Washer (6 used)
15—Top Bottle Support
16—Bottom Bottle Support
17—Overflow Hose
18—Clamp
19—Hose Clamp (3 used)
20—Tee
21—Cap Screw
22—Bracket
23—Cap Screw (5 used)
24—Top Cooler Guard
25—L-Bracket
26—Oil Cooler
27—Nut
28—Cap Screw
29—Cap Screw
30—L-Bracket
31—L-Bracket
32—Cap Screw
33—Plug
34—Cap Screw
35—Radiator
36—Radiator Cap
37—Cap Screw (3 used)
38—Washer (3 used)
39—Cap Screw (3 used)
40—Stiffener Bracket (2 used)
41—Radiator Side Support
42—Drain Cock
43—Plug (2 used)
44—Cap Screw
45—Fan Orifice Plate
46—Cap Screw (5 used)
47—Radiator Hose Grommet (2 used)
48—Cap Screw (8 used)
49—Washer (8 used)
50—Bottom Radiator Hose
51—Hose Clamp (2 used)
52—Top Radiator Hose
53—Hose Clamp (2 used)
54—Bottom Oil Cooler Hose
55—Top Oil Cooler Hose
56—Cap Screw
57—Oil Lube Bracket
58—Support Rubber Coated Clamp
59—Lock Nut (2 used)
60—Cap Screw (2 used)
61—Clamp Bracket (2 used)
62—Cap Screw
63—Nut
64—Support Rubber Coated Clamp
65—Lock Nut (2 used)
66—Washer (2 used)
67—Cap Screw (2 used)
68—Nut
69—Cap Screw (5 used)
70—Cap Screw (2 used)
71—Cap Screw (2 used)
72—Connecting Plate

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

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

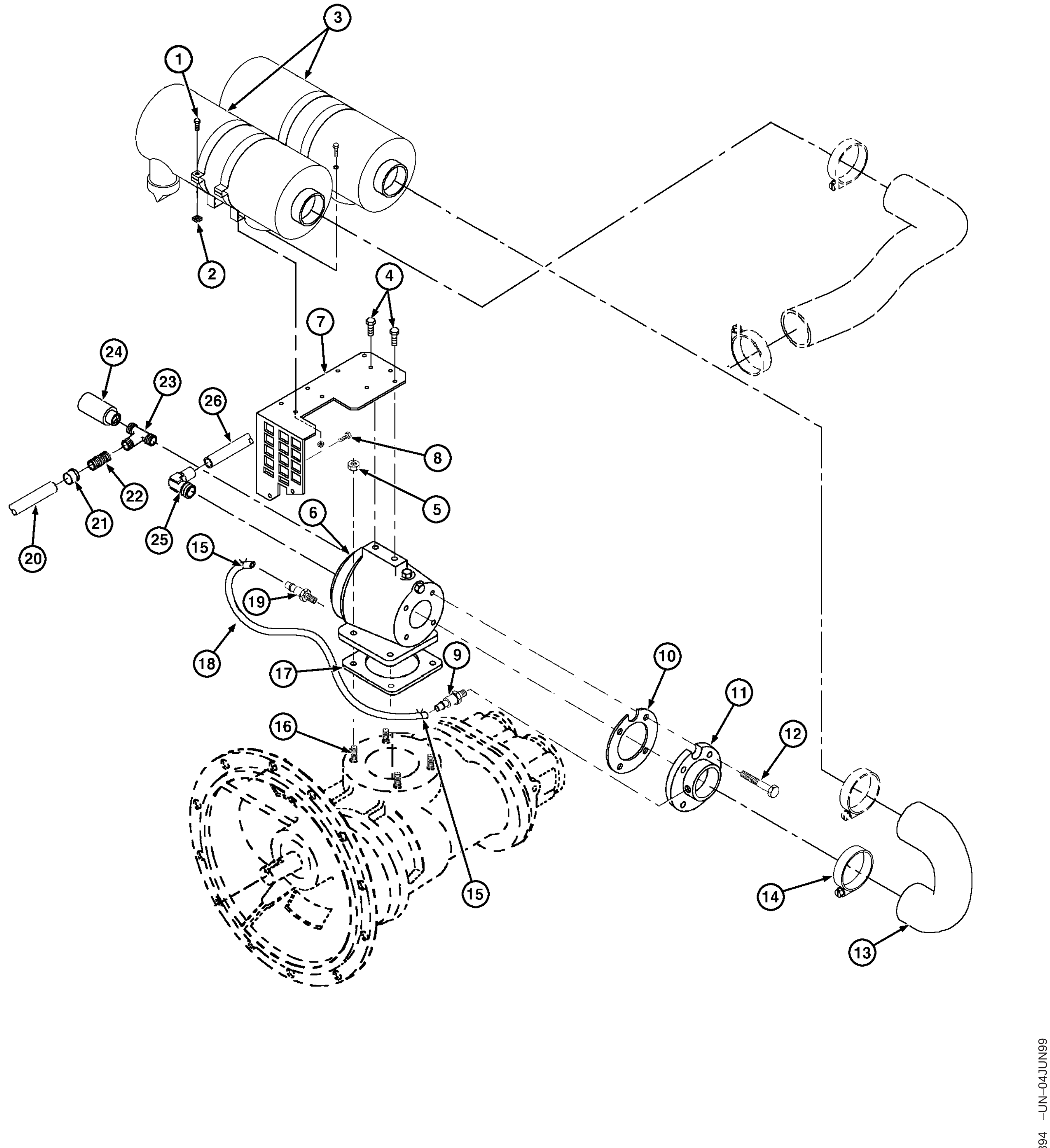
1. Drain coolant from radiator (35).
2. Drain hydraulic tank.
3. Remove plug (33) to drain hydraulic oil from oil cooler (26).
4. Disconnect connectors (3).
5. Remove cap screws (13) and washers (14).
6. Use a suitable lifting device and remove compressor top cover (12).
7. Remove cap screws (23) and remove top cooler guard (24).
8. Loosen clamp (18). Disconnect overflow hose (17).
9. Remove cap screws (71) and top bottle support (15).
10. Remove cap screw (70) and bottom support (16).
11. Remove parts (6—11 and 72).
12. Remove seal strips (5).
13. Disconnect bottom oil cooler hose (54) and remove top oil cooler hose (55).
14. Remove cap screws (4), cap screws (21, 28, 29, 31 and 34), nut (27), and oil cooler (26).
15. Loosen hose clamps (53) and upper radiator hose (52).
16. Loosen hose clamp (51) and remove lower radiator hose (50).
17. Remove cap screws (37) and radiator (35).
18. Remove radiator cap (36), drain cock (42) and plugs (43).

Continued on next page CED,OUOE039,1 –19–08MAR99–2/3

19. Remove radiator hose grommets (47).
20. Remove cap screws (2 and 69). Remove stiffener bracket (40) and oil cooler side support (1).
21. Remove cap screws (39 and 46). Remove stiffener bracket (40) and radiator side support (41).
22. Remove parts (56—60).
23. Remove parts (61—66).
24. Remove cap screws (48), washers (49) and fan guard (68).
25. Remove cap screws (44) and fan orifice plate (45).
26. Repair and replace parts as necessary.
27. Install fan orifice plate (45) and cap screws (44).
28. Install fan guard (68), washers (49) and cap screws (48).
29. Install parts (61—66).
30. Install parts (56—60).
31. Install radiator side support (41) and stiffener bracket (40). Install cap screws (39 and 46).
32. Install oil cooler side support (1) and stiffener bracket (40). Install cap screws (2 and 69).
33. Install radiator hose grommets (47).
34. Install plugs (43), drain cock (42) and radiator cap (36).
35. Install radiator (35) and cap screws (37).
36. Install lower radiator hose (50) and tighten hose clamp (51).
37. Install upper radiator hose (52) and tighten hose clamps (53).
38. Install oil cooler (26), cap screws (4), cap screws (21, 28, 29, 31 and 34), and nut (27).
39. Connect bottom oil cooler hose (54) and top oil cooler hose (55).
40. Install seal strips (5).
41. Install parts (6—11 and 72).
42. Install bottom support (16) and cap screw (70).
43. Install top bottle support (15) and cap screws (71).
44. Connect overflow hose (17). Tighten clamp (18).
45. Install top cooler guard (24) and cap screws (23).
46. Use a suitable lifting device and install top cover (12).
47. Install washers (14) and cap screws (13).
48. Connect connectors (3).
49. Install plug (33) to fill hydraulic oil to oil cooler (26).
50. Fill hydraulic tank.
51. Fill coolant to radiator (35).

CED,OUOE039,1 –19–08MAR99–3/3

REMOVE AND INSTALL UNLOADER VALVE ASSEMBLY



T120894

Continued on next page

Compressor

1—Cap Screw (4 used)
2—Nut (4 used)
3—Air Assembly Cleaner
4—Cap Screw (2 used)
5—Nut (4 used)
6—Unloader Assembly
7—Air Cleaner Bracket
8—Cap Screw (2 used)
9—Barbed Fitting
10—Gasket
11—Unloader Inlet
12—Cap Screw (4 used)
13—Hose
14—Clamp
15—Clamp (2 used)
16—Stud (4 used)
17—Gasket
18—Tubing
19—Adapter
20—Hose
21—Adapter
22—Nipple
23—Tee
24—Orifice Muffler
25—Adapter
26—Hose

CAUTION: Purge the system of all air pressure.

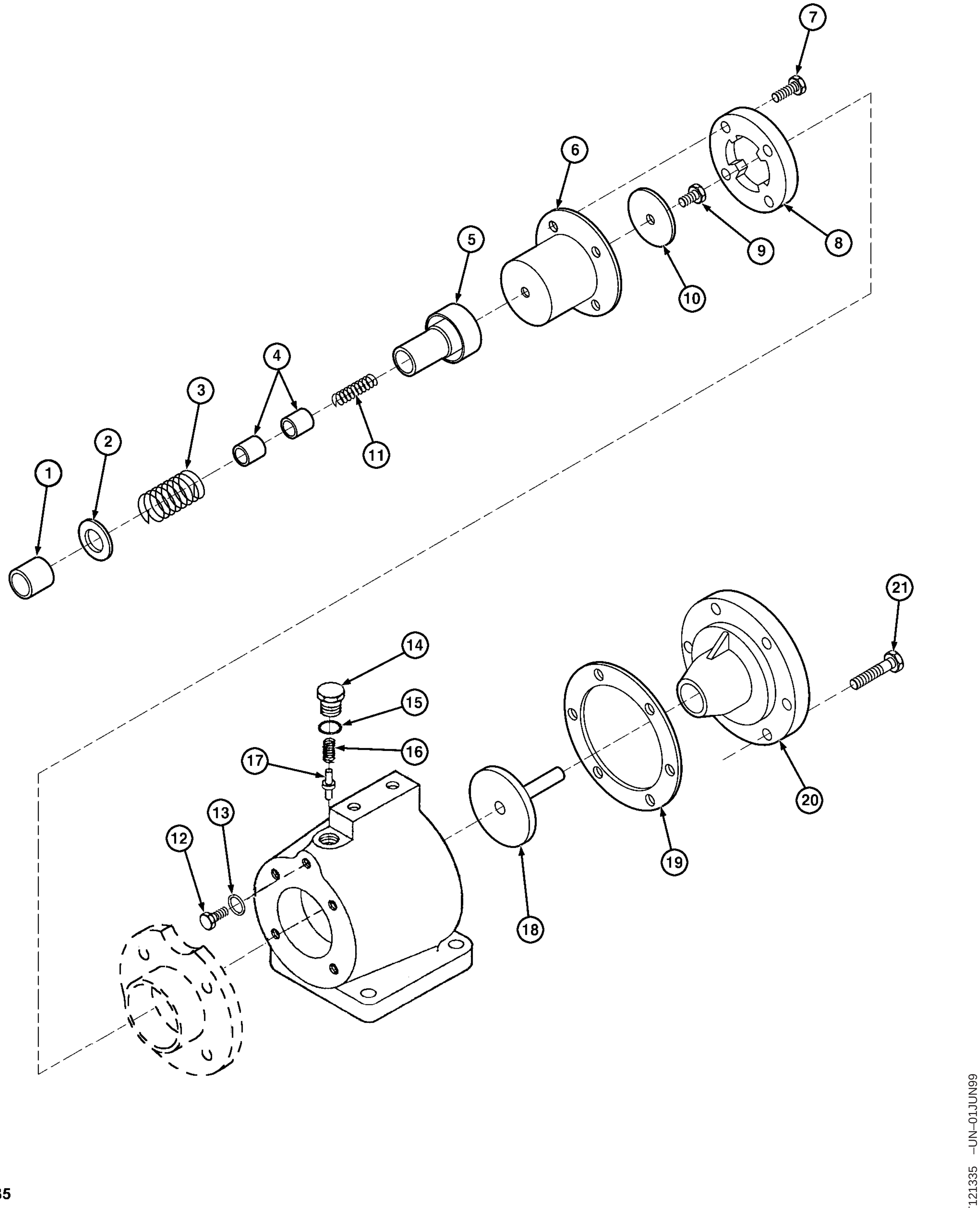
1. Loosen clamp (14) and disconnect hose (13).
2. Remove cap screws (1) and nuts (2). Set air assembly cleaner (3) aside.
3. Remove cap screws (4 and 8). Set air cleaner bracket (7) aside.
4. Loosen two clamps (15) and remove tubing (18).
5. Remove adapter (19) and barbed fitting (9).
6. Remove cap screws (12), unloader inlet (11) and gasket (10).
7. Disconnect hoses (20 and 26).
8. Remove parts (21—24).
9. Remove adapter (25).
10. Remove nuts (5) and unloader assembly (6).
11. Repair and replace parts as necessary.
12. Install gasket (17).
13. Install unloader assembly (6) and nuts (5).
14. Install adapter (25).
15. Install parts (21—24).
16. Connect hoses (20 and 26).
17. Install gasket (10), unloader inlet (11) and four cap screws (12).
18. Install barbed fitting (9) and adapter (19).
19. Install tubing (18) and tighten two clamps (15).
20. Install air cleaner bracket (7) on top of unloader valve assembly. Install cap screws (4 and 8).
21. Install air assembly cleaners (3), cap screws (1) and nuts (2).
22. Connect hose (13) and tighten clamp (14).

CED,OUOE039,19 –19–15APR99–2/2

22

12

DISASSEMBLE AND ASSEMBLE UNLOADER VALVE ASSEMBLY



T121335

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1—Housing Bushing
2—Washer
3—Piston Spring
4—Piston Bushing (2 used)
5—Piston Unloader
6—Diaphragm
7—Cap Screw (4 used)
8—Piston Cover
9—Cap Screw
10—Piston Washer
11—Spring
12—Plug
13—O-Ring
14—Plug
15—O-Ring
16—Pin Spring
17—Unloader Pin
18—Valve Plate
19—Piston Gasket
20—Piston Housing
21—Cap Screw (6 used)

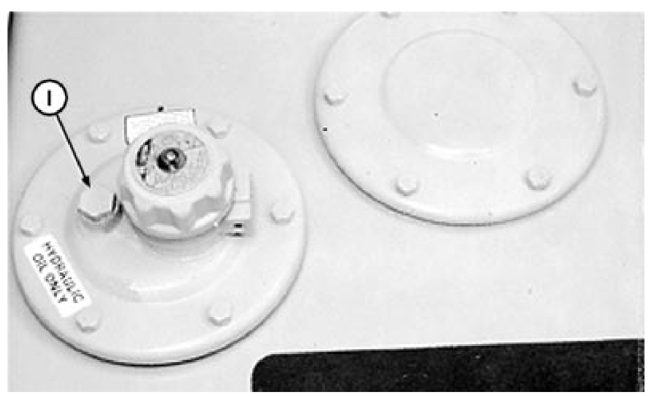
1. Remove plug (12) and O-ring (13).
2. Remove plug (14), O-ring (15), pin spring (16), and unloader pin (17).
3. Remove six cap screws (21), piston housing (20), piston gasket (19), and valve plate (18).
4. Remove four cap screws (7) and piston cover (8).
5. Remove parts (1—6, 9, 10, and 11).
6. Repair or replace parts as necessary.
7. Install parts (1—6, 9, 10, and 11)
8. Install piston cover (8) and four cap screws (7).
9. Install valve plate (18), piston gasket (19), piston housing (20), and six cap screws (21).
10. Install unloader pin (17), pin spring (16), O-ring (15), and plug (14).
11. Install O-ring (13) and plug (12).

CED,OUOE039,12 –19–15APR99–2/2

REMOVE AND INSTALL OIL TEMPERATURE BYPASS VALVE ASSEMBLY

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug.

1. Loosen vent plug (1) to release air pressure from hydraulic oil tank.

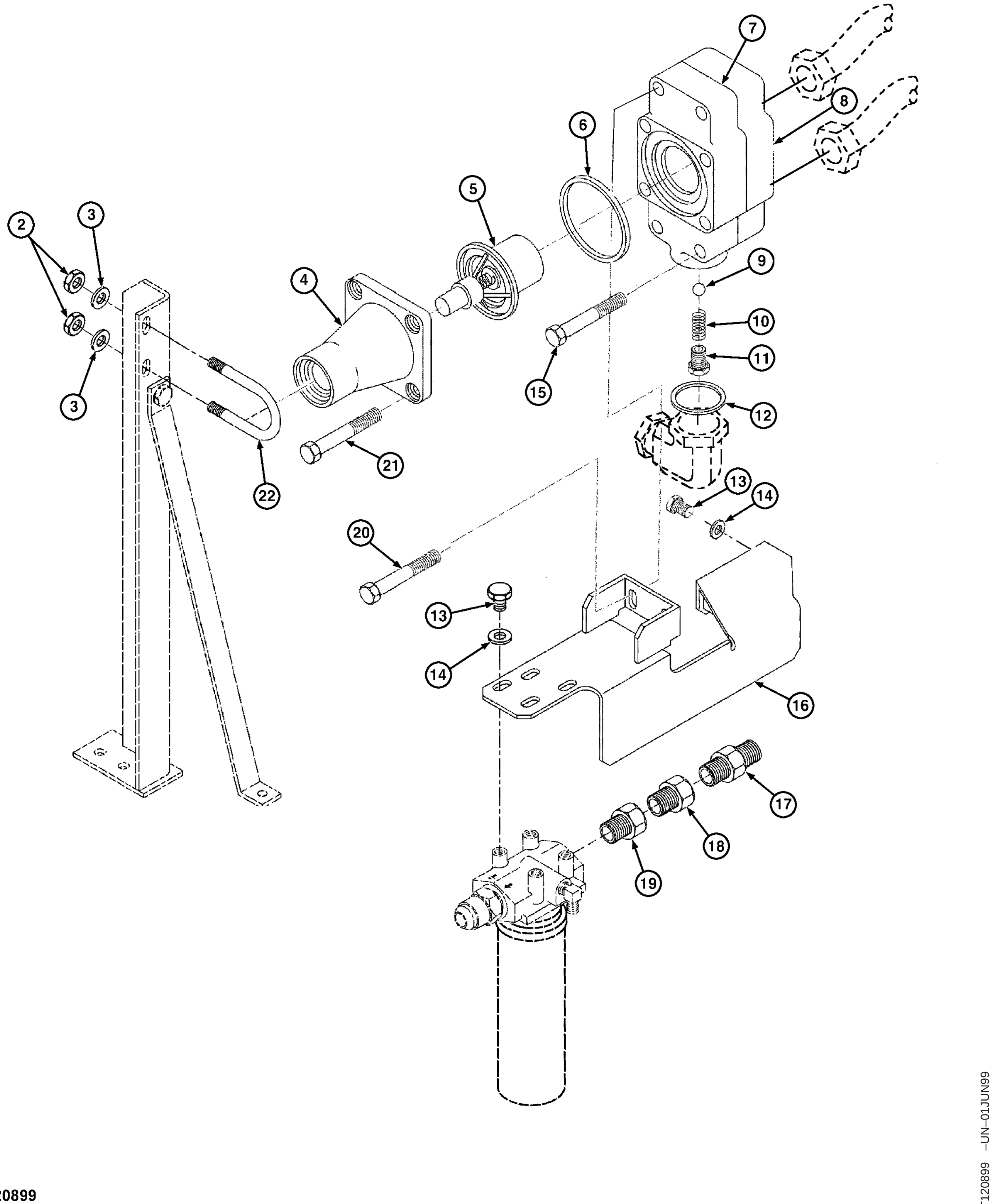


T121518 –UN–01JUN99

1—Vent Plug

Continued on next page CED,OUOE039,21 –19–16APR99–1/3

Compressor



T120899

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Compressor

2—Nut (2 used)	**7—Gasket**	**12—Seal**	**17—Connector**
3—Washer (2 used)	**8—Valve Assembly**	**13—Cap Screw (4 used)**	**18—Fitting Union**
4—Cover	**9—Ball**	**14—Washer (4 used)**	**19—Reducer**
5—Element	**10—Spring**	**15—Cap Screw (2 used)**	**20—Cap Screw (2 used)**
6—O-Ring	**11—Plug**	**16—Bracket**	**21—Cap Screw (2 used)**

2. Disconnect three hoses.

NOTE: Support assembly.

3. Remove cap screw (13 and 20), washers (14) and bracket (16).

4. Remove nuts (2), washers (3) and clamp (22).

5. Loosen parts (17—19).

6. Disconnect connector (17) from fitting union (18).

7. Remove connector (17) from cover (4).

8. Repair or replace parts as necessary.

9. Install reducer (19), fitting union (18) and connector (17).

10. Install clamp (22), washers (3) and nuts (2).

11. Install bracket (16), washers (14) and cap screws (13 and 20).

CED,OUOE039,21 –19–16APR99–3/3

22
16

DISASSEMBLE AND ASSEMBLE OIL TEMPERATURE BYPASS VALVE ASSEMBLY

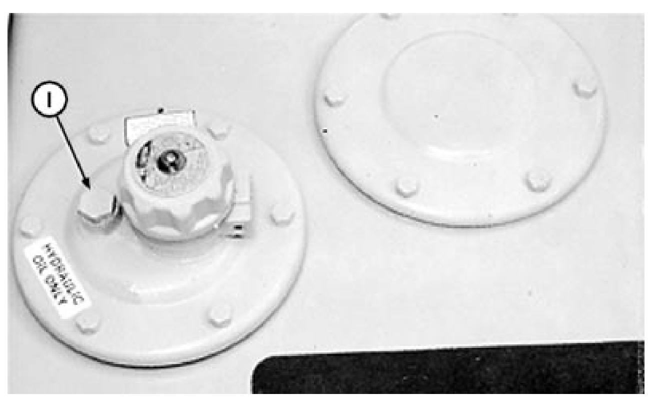
1. Remove parts (9—12).
2. Remove four cap screws (21) and remove cover (4).
3. Remove O-ring (6) and remove element (5).
4. Remove two cap screws (15)
5. Separate valve assembly (8) and remove gasket (7).
6. Repair or replace parts as necessary.
7. Install gasket (7) in between valve assembly bodies.
8. Install two cap screws (15).
9. Install O-ring (6) and element (5).
10. Install cover (4) and four cap screws (21).
11. Install parts (9—12).

CED,OUOE039,13 –19–15APR99–1/1

REMOVE AND INSTALL OIL FILTER ASSEMBLY

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug.

1. Loosen vent plug (1) to release air pressure from hydraulic oil tank.



T121518 –UN–01JUN99

1—Vent Plug

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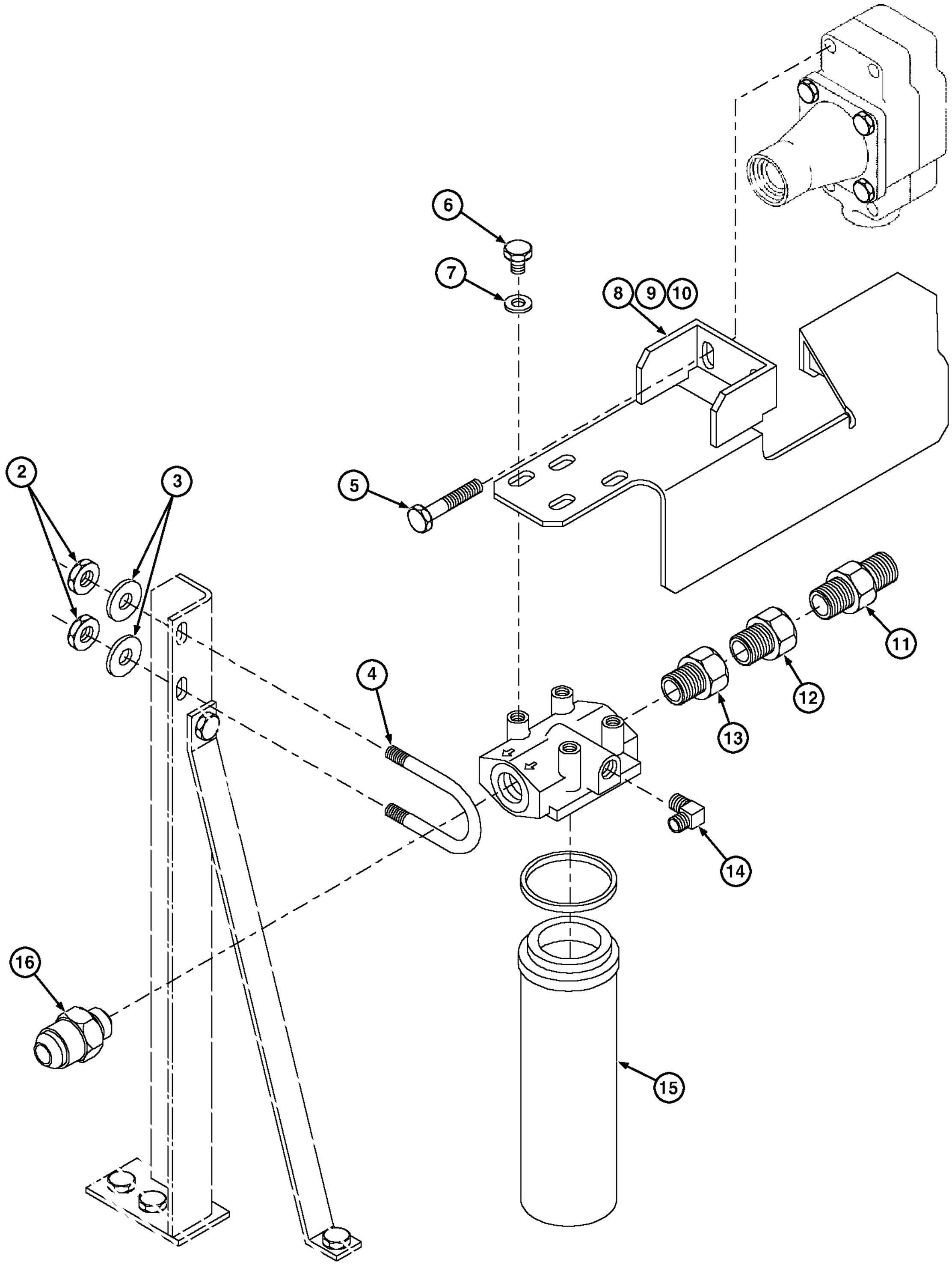
CED,OUOE039,22 –19–16APR99–1/3

Compressor



T120900

T120900 –UN–03JUN99

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CED,OUOE039,22 –19–16APR99–2/3

2—Nut (2 used)
3—Washer (2 used)
4—Clamp
5—Cap Screw (2 used)
6—Cap Screw (4 used)
7—Washer (4 used)
8—Oil Filter Bracket
9—Cap Screw (2 used)
10—Washer (2 used)
11—Connector
12—Reducer
13—Fitting Union
14—Elbow
15—Oil Filter Element
16—Adapter

2. Disconnect two hoses.

NOTE: Support assembly.

3. Remove cap screws (5 and 6), washers (7) and bracket (8).

4. Remove nuts (2), washers (3) and clamp (4).

5. Loosen parts (11, 12 and 13).

6. Disconnect fitting union (13) from connector (11).

7. Repair or replace parts as necessary.

8. Connect connector (11) to fitting union (13).

9. Tighten parts (11, 12 and 13).

10. Install clamp (4), washers (3) and nuts (2).

11. Install bracket (8), washers (7) and cap screws (5 and 6).

CED,OUOE039,22 –19–16APR99–3/3

DISASSEMBLE AND ASSEMBLE OIL FILTER ASSEMBLY

1. Remove reducer (12) and remove fitting union (13).

2. Remove elbow (14) and adapter (16).

3. Remove oil filter element (15).

4. Repair or replace parts as necessary.

5. Install the oil filter element (15).

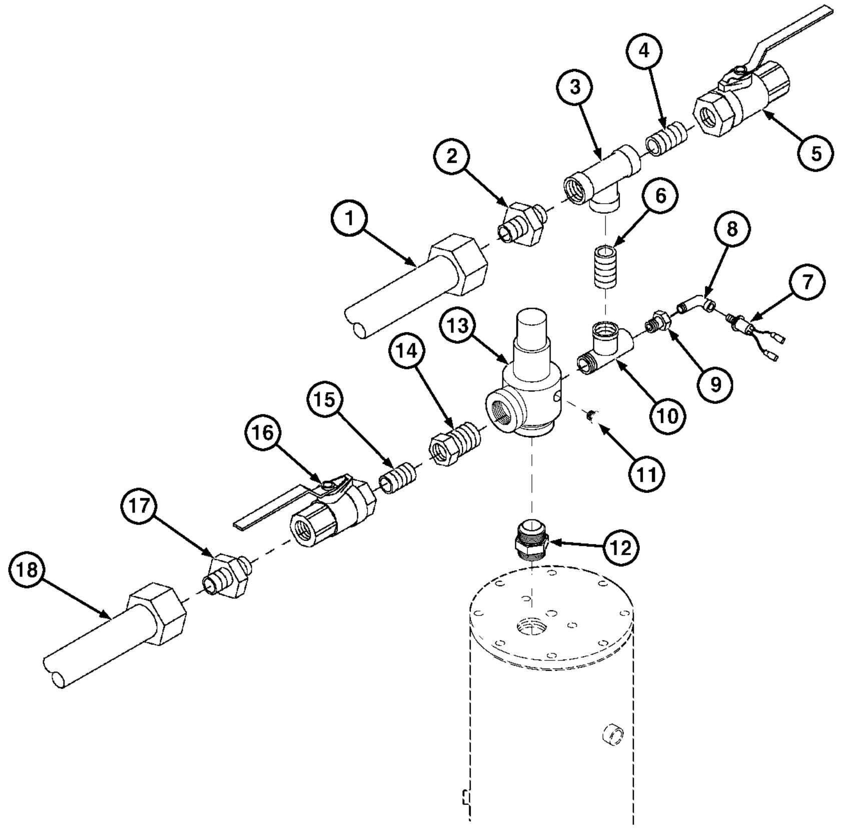
6. Install adapter (16) and elbow (14).

7. Install fitting union (13) and install reducer (12).

CED,OUOE039,20 –19–16APR99–1/1

22
20

REMOVE AND INSTALL MINIMUM PRESSURE VALVE



1—Hose	**6—Nipple**	**11—Plug**	**15—Nipple**
2—Connector	**7—Sensor**	**12—Connector**	**16—Ball Valve**
3—Tee	**8—Street Elbow**	**13—Minimum Pressure Valve**	**17—Adapter**
4—Nipple	**9—Bushing**	**14—Bushing**	**18—Hose**
5—Ball Valve	**10—Tee**		

CAUTION: Before removing the minimum pressure valve purge the system of all air pressure.

1. Disconnect hoses (1 and 18).
2. Remove connector (2), ball valve (5) and nipple (4).
3. Remove tee (3) and nipple (6).
4. Remove sensor (7), street elbow (8) and bushing (9).
5. Remove tee (10).
6. Remove plug (11).
7. Remove parts (14—17).
8. Remove minimum pressure valve (13) and remove connector (12).
9. Repair and replace parts as necessary.
10. Install connector (12) and minimum pressure valve (13).
11. Install parts (14—17).
12. Install plug (11).
13. Install tee (10).

Continued on next page CED,OUOE039,14 –19–15APR99–1/2

Compressor

14. Install bushing (9), street elbow (8) and sensor (7).

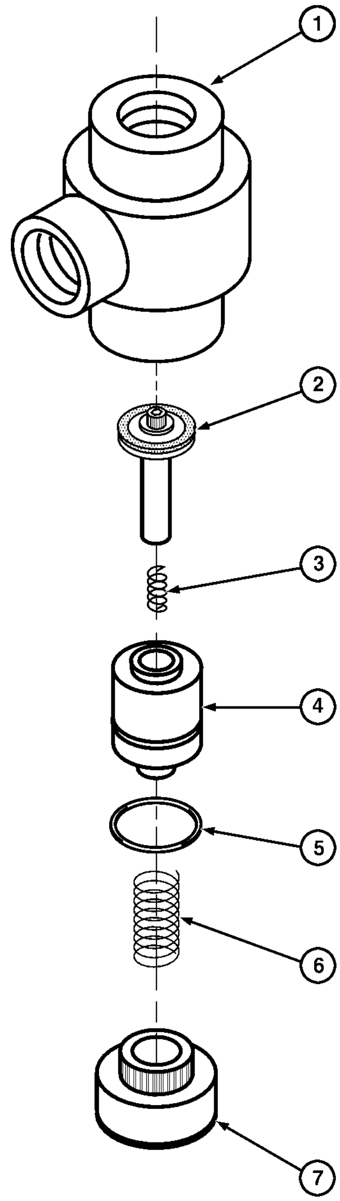
15. Install nipple (6) and tee (3).

16. Install nipple (4), ball valve (5) and connector (2).

17. Connect hoses (1 and 18).

CED,OUOE039,14 –19–15APR99–2/2

DISASSEMBLE AND ASSEMBLE MINIMUM PRESSURE VALVE



T120902

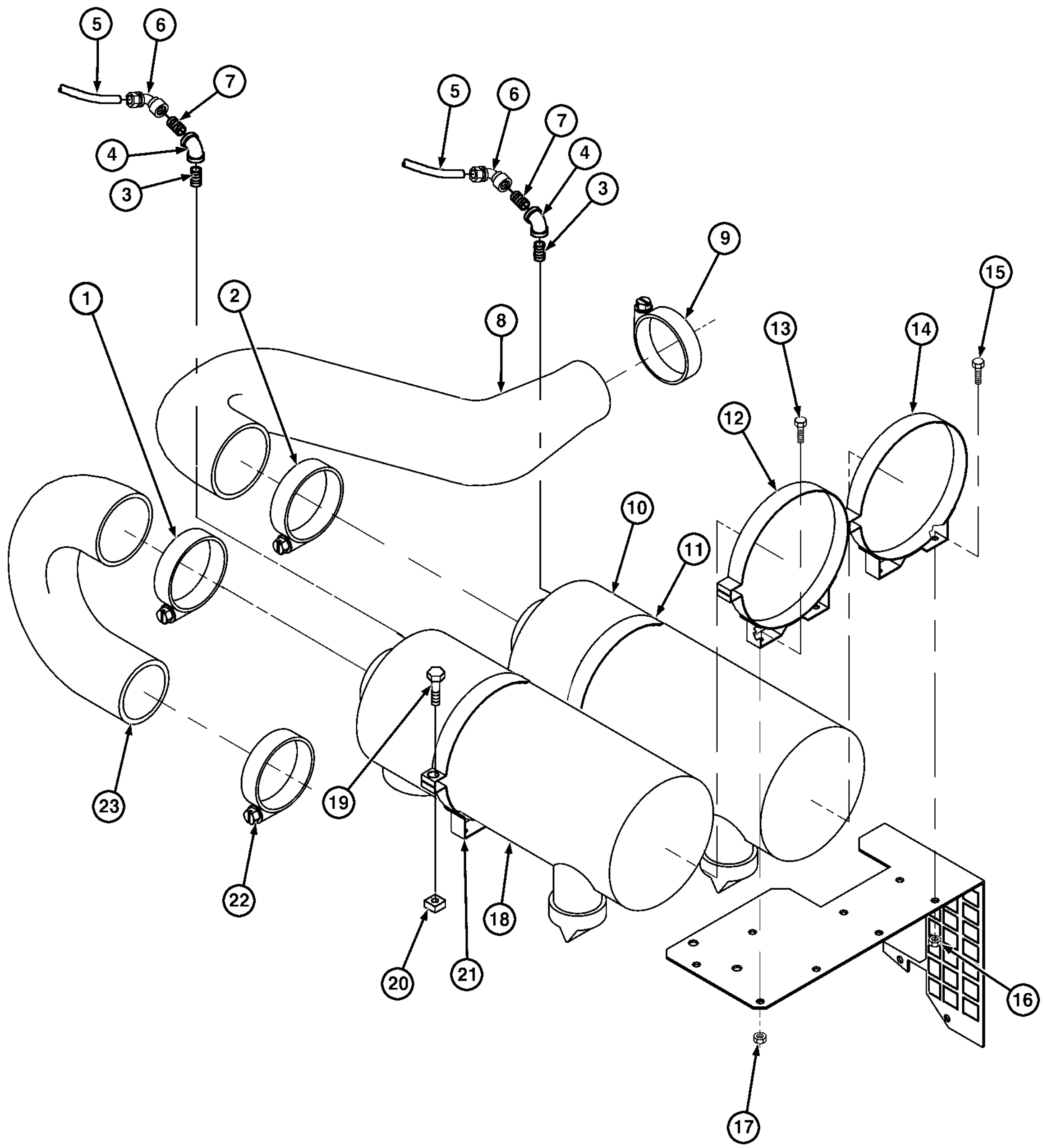
T120902 –UN–20APR99

1—Min Press Valve Body
2—CV Assembly
3—Spring
4—Piston
5—O-Ring
6—Spring
7—Cap

1. Remove parts (1—7).
2. Repair and replace parts as necessary.
3. Install parts (1—7).

CED,OUOE039,23 –19–16APR99–1/1

REMOVE AND INSTALL AIR INTAKE



T120903

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Compressor

1—Clamp
2—Clamp
3—Nipple (2 used)
4—Elbow (2 used)
5—Hose (2 used)
6—Adapter (2 used)
7—Nipple (2 used)
8—Engine Air Inlet Hose
9—Clamp
10—Air Assembly Cleaner
11—Mounting Band
12—Mounting Band
13—Cap Screw (4 used)
14—Mounting Band
15—Cap Screw (4 used)
16—Nut (4 used)
17—Nut (4 used)
18—Air Assembly Cleaner
19—Cap Screw (4 used)
20—Nut (4 used)
21—Mounting Band
22—Clamp
23—Elbow Air Hose

1. Loosen clamp (9 and 22).
2. Disconnect hoses (8 and 23).
3. Disconnect hoses (5).
4. Remove cap screws (13 and 15). Remove nuts (16 and 17).
5. Repair and replace parts as necessary.
6. Install cap screws (13 and 15) and nuts (16 and 17).
7. Connect hoses (5).
8. Connect hoses (8 and 23).
9. Tighten clamps (9 and 22).

CED,OUOE039,27 –19–16APR99–2/2

22

26

DISASSEMBLE AND ASSEMBLE AIR INTAKE

CAUTION: Before removing the minimum pressure valve purge valve of all air pressure

2. Loosen clamp (1) and remove elbow (23).

3. Loosen clamp (2) and remove air engine air inlet hose (8).

4. Remove adapters (6), nipples (7), elbow (4), and nipples (3).

5. Remove cap screws (19) and nuts (20).

6. Remove mounting bands (11, 12, 14, and 21).

7. Repair or replace parts as necessary.

8. Install mounting bands (11, 12, 14, and 21).

9. Install cap screws (19) and nuts (20).

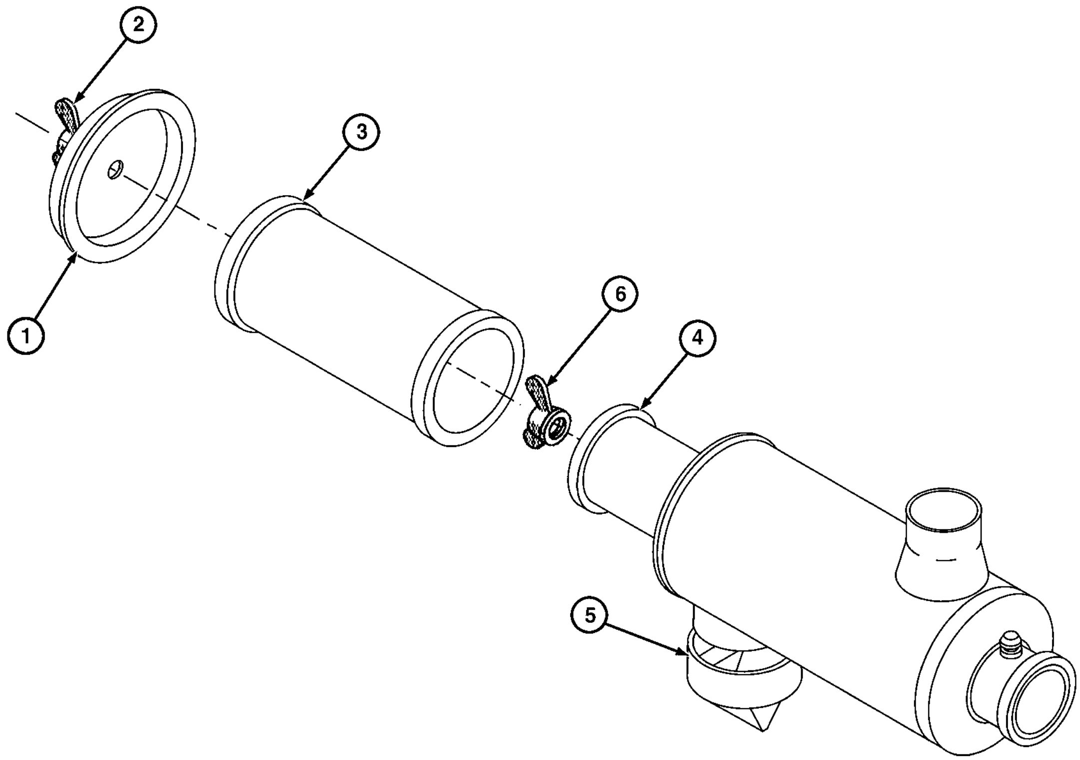
10. Install nipples (3), elbow (4), nipples (7), and adapters (6).

11. Install air engine air inlet hose (8). Tighten clamp (2).

12. Install elbow (23) and tighten clamp (1).

CED,OUOE039,15 –19–15APR99–1/1

DISASSEMBLE AND ASSEMBLE AIR CLEANER ASSEMBLY



T120904

1—Cover
2—Nut (2 used)
3—Element
4—Safety Element
5—Vacuator Valve
6—Nut

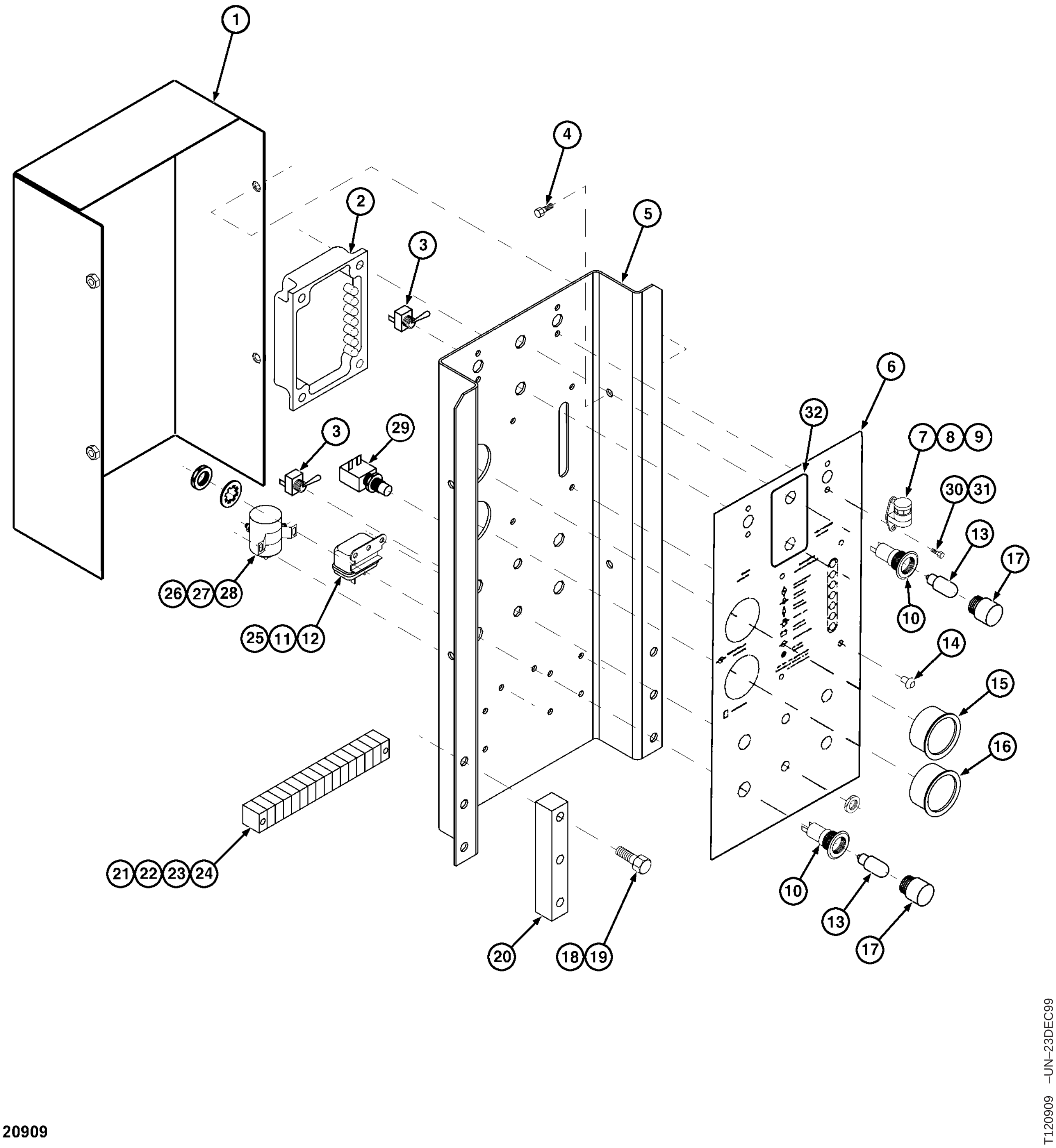
1. Loosen wing nut (2) and remove cover (1).
2. Remove element (3), nut (6) and safety element (4).
3. Remove vacuator valve (5).
4. Repair or replace parts as necessary.
5. Install vacuator valve (5).
6. Install safety element (4), nut (6) and element (3).
7. Install cover (1) and tighten wing nut (2).

CED,OUOE039,24 –19–16APR99–1/1

22

28

REMOVE AND INSTALL INSTRUMENT PANEL ASSEMBLY



T120909

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CED,OUOE039,25 –19–16APR99–1/2

Compressor

1—Panel Cover
2—Diagnostic Module
3—Toggle DPDT Switch (3 used)
4—Cap Screw (4 used)
5—Instrument Panel
6—Control Panel Decal
7—Restriction Indicator Flange (2 used)
8—Street Elbow (2 used)
9—Restriction Indicator (2 used)
10—Miniature Incadescent Indicator (3 used)
11—Cap Screw (6 used)
12—Nut (6 used)
13—Incandescent Bulb (3 used)
14—Rivet (4 used)
15—Discharge Pressure Gauge
16—Hourmeter
17—Lens
18—Cap Screw (6 used)
19—Nut (6 used)
20—Spacer (2 used)
21—Cap Screw (2 used)
22—Nut (2 used)
23—Strip Section Terminal (16 used)
24—Strip End Section Terminal
25—Relay (2 used)
26—Mag Switch Relay
27—Cap Screw (2 used)
28—Nut (2 used)
29—Push Button Spst Switch (2 used)
30—Cap Screw (2 used)
31—Nut (2 used)
32—Heater Decal

1. Remove cap screws (4), panel cover (1).
2. Label all hoses and electrical connections.
3. Disconnect all hoses and electrical connections.
4. Remove cap screws (18), nuts (19), spacers (20) and instrument panel (5).
5. Repair and replace parts as necessary.
6. Install instrument panel (5), spacers (20), cap screws (18) and nuts (19).
7. Connect all hoses and electrical connections.
8. Install panel cover (1) and cap screws (4).

CED,OUOE039,25 –19–16APR99–2/2

22

30

DISASSEMBLE AND ASSEMBLE INSTRUMENT PANEL ASSEMBLY

1. Remove parts (21—24).
2. Remove cap screws (27), nuts (28) and mag switch relay (26).
3. Remove push button spst switches (29).
4. Remove retaining nut on front of DPDT switches (3) and remove toggle DPDT switches (3).
5. Remove cap screws (11), nuts (12) and relay (25).
6. Remove rivets (14) and diagnostic module (2).
7. Remove cap screws (30), nuts (31), and restriction indicator flanges (7), street elbows (8) and restriction indicators (9).
8. Remove retaining nut and washer from back of miniature incandescent indicator (10).
9. Remove parts (10, 13, 17 and 32).
10. Remove retaining nuts from back of discharge pressure gauges (15) and hourmeter (16).
11. Remove discharge pressure gauges (15) and remove hourmeter (16).
12. Remove control panel decal (6).
13. Repair or replace parts as necessary.
14. Install control panel decal (6).
15. Install discharge pressure gauges (15) and install hourmeter (16).
16. Install retaining nuts to back of discharge pressure gauges (15) and hourmeter (16).
17. Install decal (32) and retaining nut and washer to back of miniature incadescent indicator (10).
18. Install parts (13 and 17).

Continued on next page

CED,OUOE039,16 –19–15APR99–1/2

19. Install restriction indicator flanges (7), street elbows (8) and restriction indicators (9), cap screws (30), and nuts (31).

20. Install diagnostic module (2) and rivets (14).

21. Install relay (25), cap screws (11) and nuts (12).

22. Install toggle DPDT switches (3) and retaining nut on front of dpdt switches (3).

23. Install push button spst switches (29).

24. Install mag switch relay (26), cap screws (27) and nuts (28).

25. Install parts (21—24).

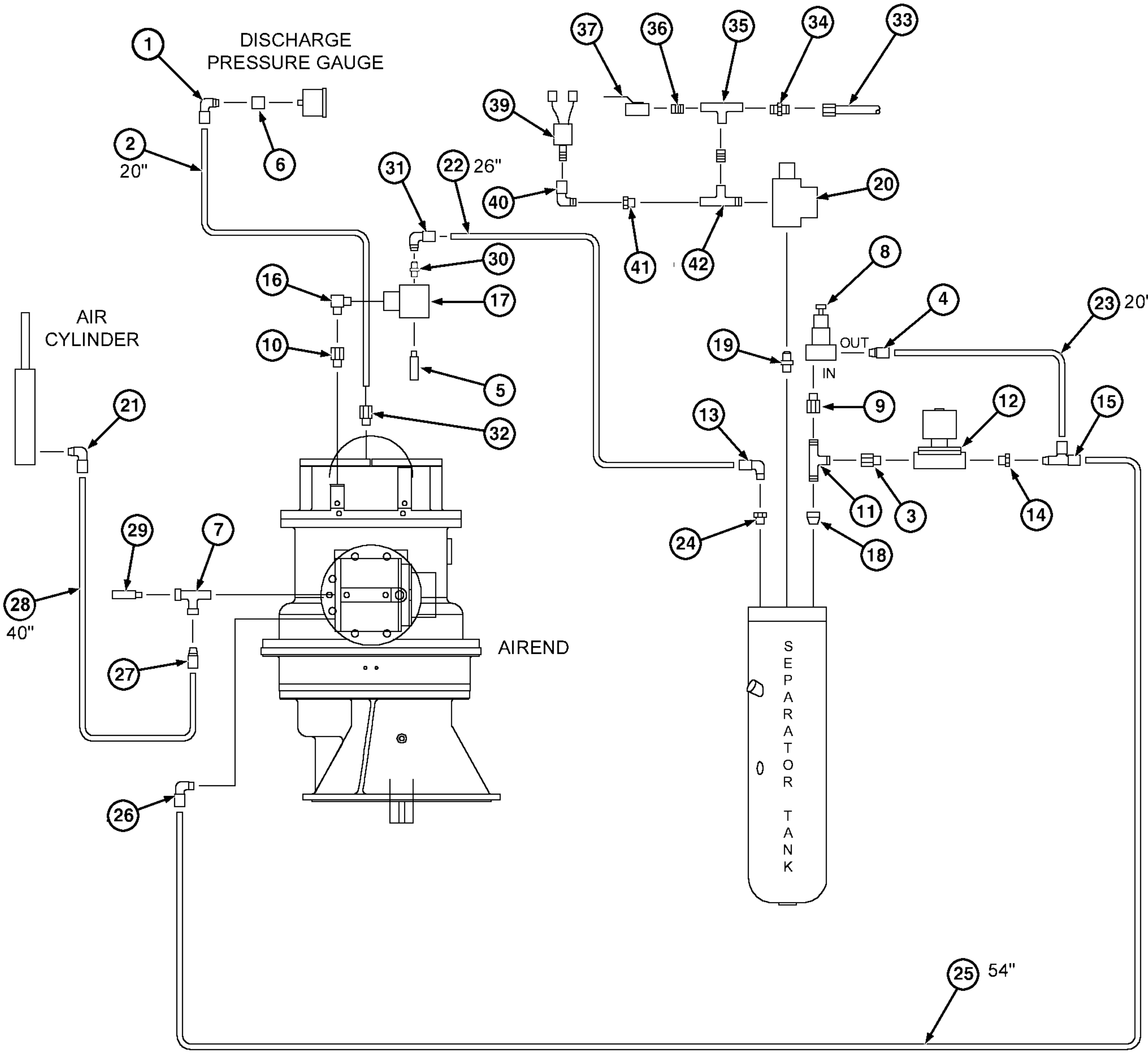
26. Install instrument panel (5), panel cover (1) and cap screws (4).

27. Install spacers (20), cap screws (18) and nuts (19).

CED,OUOE039,16 –19–15APR99–2/2

22
32

DISASSEMBLE AND ASSEMBLE AIR PIPING



T120905

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Compressor

1—Elbow	**11—Male Run Tee**	**21—Elbow**	**32—Connector**
2—Tubing	**12—Solenoid Valve**	**22—Tubing**	**33—Hose**
3—Swivel Nut Adapter	**13—Elbow**	**23—Tubing**	**34—Connector**
4—Connector	**14—Reducing Bushing**	**24—Reducing Bushing**	**35—Tee**
5—Orifice Muffler	**15—Tee**	**25—Tubing**	**36—Nipple**
6—Coupling	**16—Elbow**	**26—Elbow**	**37—Ball Valve**
7—Street Tee	**17—Blowdown Valve**	**37—Connector**	**38—Nipple**
8—Pressure Regulator Valve	**18—Reducing Bushing**	**28—Tubing**	**39—Sensor**
9—Swivel Nut Adapter	**19—Adapter**	**29—Orifice Muffler**	**40—Street Elbow**
10—Adapter	**20—Minimum Pressure Valve**	**30—Adapter**	**41—Bushing**
		31—Elbow	**42—Tee**

1. Remove cap screws and panel cover from instrument panel assembly.
2. Remove tubing (2).
3. Remove elbow (1) and coupling (6).
4. Remove connector (32).
5. Remove tubing (22).
6. Remove adapter (30) and elbow (31).
7. Remove elbow (13) and reducing bushing (24).
8. Remove orifice muffler (5), blowdown valve (17), elbow (16), and adapter (10).
9. Disconnect tubing (28) and remove elbow (21).
10. Remove connector (27), orifice muffler (29) and street tee (7).
11. Disconnect tubing (25) and remove elbow (26).
12. Disconnect tubing (23).
13. Remove tee (15), reducing bushing (14), solenoid valve (12), and swivel nut adapter (3).
14. Remove connector (4), pressure regulator valve (8), swivel nut adapter (9), male run tee (11), and reducing bushing (18).
15. Disconnect hose (33).
16. Remove connector (34), ball valve (37) and nipple (36).
17. Remove tee (35) and nipple (38).
18. Remove sensor (39), street elbow (40) and bushing (41).
19. Remove tee (42), minimum pressure valve (20) and adapter (19).
20. Repair or replace parts as necessary.
21. Install adapter (19), minimum pressure valve (20) and tee (42).
22. Install bushing (41), street elbow (40) and sensor (39).
23. Install nipple (38) and tee (35).
24. Install nipple (36), ball valve (37) and connector (34).
25. Connect hose (33).
26. Install reducing bushing (18), male run tee (11), swivel nut adapter (9), pressure regulator valve (8), and connector (4).
27. Install swivel nut adapter (3), solenoid valve (12), reducing bushing (14), and tee (15).
28. Connect tubing (23).

Continued on next page

Compressor

29. Install elbow (26) and connect tubing (25).

30. Install street tee (7), orifice muffler (29) and connector (27).

31. Install elbow (21) and connect tubing (28).

32. Install adapter (10), elbow (16), blowdown valve (17), and orifice muffler (5).

33. Install reducing bushing (24) and elbow (13).

34. Install elbow (31) and adapter (30).

35. Install tubing (22).

36. Install connector (32).

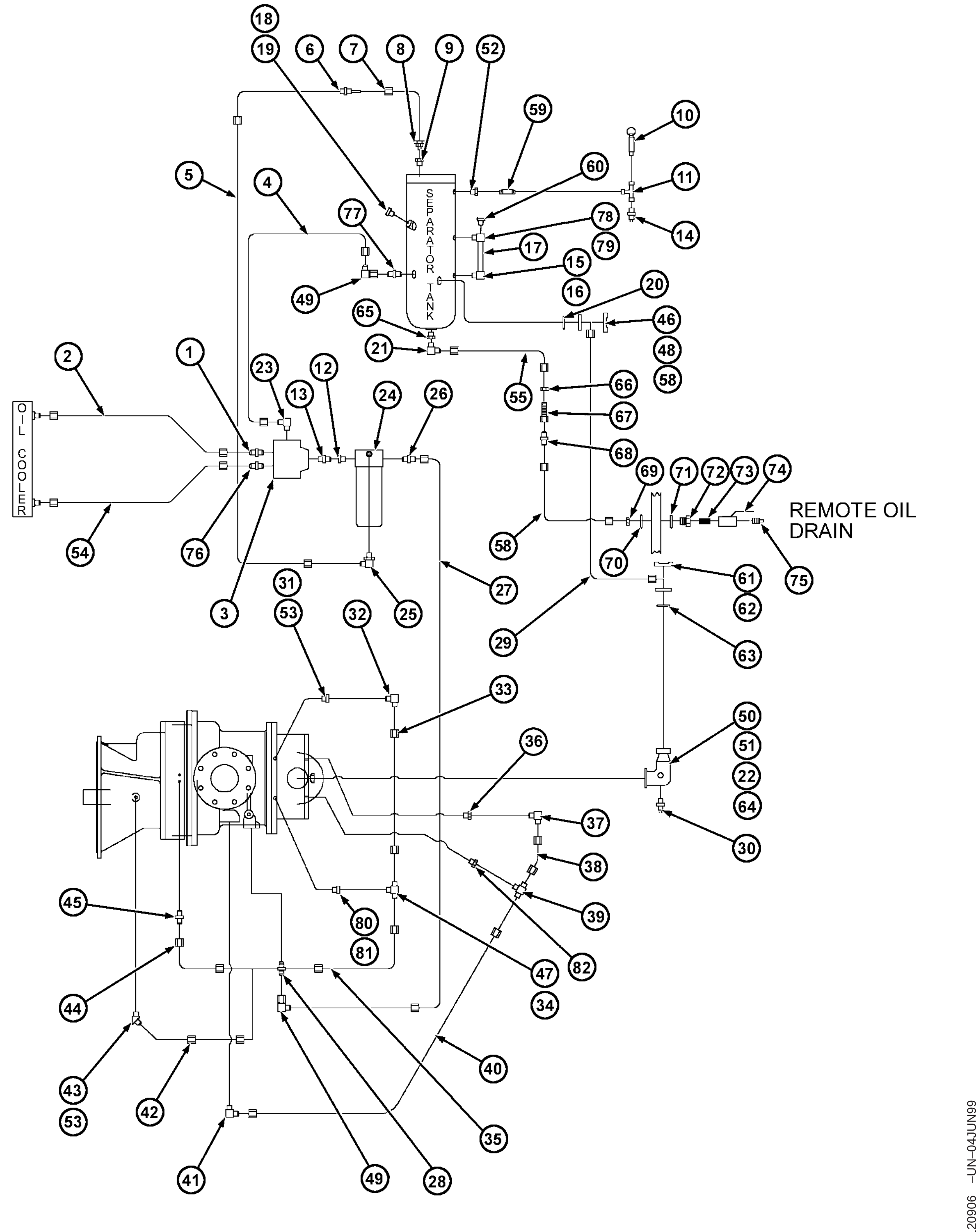
37. Install coupling (6) and elbow (1).

38. Install tubing (2).

39. Install instrument panel assembly and cap screws.

CED,OUOE039,17 –19–15APR99–3/3

DISASSEMBLE AND ASSEMBLE OIL PIPING



T120906

Continued on next page

Compressor

1—Connector
2—Hose Assembly
3—Oil Temperature Bypass Valve
4—Hose Assembly
5—Hose Assembly
6—Check Valve
7—Tube Scavenge Line
8—Lenz Fitting
9—Bushing
10—Safety Valve
11—Street Tee
12—Reducer
13—Union Fitting
14—Switch Shutdown
15—Sight Tube Fitting
16—Gasket
17—Sight Tube
18—Plug
19—O-Ring
20—O-Ring
21—Elbow
22—Cap Screw (4 used)
23—Elbow
24—Oil Filter
25—Elbow
26—Connector
27—Hose Assembly
28—Oil Manifold
29—Discharge Hose Assembly
30—Switch Shutdown
31—Expander
32—Elbow
33—Tube Assembly
34—Tee Branch
35—Tube Assembly
36—Expander
37—Elbow
38—Tube Assembly
39—Tee Branch
40—Tube Assembly
41—Elbow
42—Tube Assembly
43—Elbow
44—Tube Assembly
45—Connector
46—Flange Half (2 used)
47—O-Ring
48—Cap Screw (4 used)
49—Elbow
50—Gasket
51—Discharge Elbow
52—Bushing
53—O-Ring
54—Hose Assembly
55—Hose Assembly
56—Hose Assembly
57—Bulkhead Fitting
58—Lock Washer (4 used)
59—Nipple
60—Plug
61—Flange Half (2 used)
62—Cap Screw (4 used)
63—O-Ring
64—Washer (4 used)
65—Bushing
66—Nut
67—Fitting
68—Connector
69—Nut
70—Washer
71—Washer
72—Fitting
73—Nipple
74—Ball Valve
75—Plug
76—Connector
77—Connector
78—Sight Tube Fitting
79—Gasket
80—Expander
81—O-Ring
82—Expander

CAUTION: Before removing the oil piping purge system of all air pressure.

1. Remove hose assemblies (2 and 54).
2. Remove connectors (1 and 76).
3. Remove hose assembly (4).
4. Remove elbow (23), oil temperature bypass valve (3), union fitting (13), and reducer (12).
5. Remove elbow (49) and connector (77).
6. Remove hose assembly (5), elbow (25), check valve (6), tube scavenge line (7), lenz fitting (8), and bushing (9).
7. Remove hose assembly (27), connector (26) and elbow (49).
8. Remove oil filter (24).
9. Remove plug (18) and O-ring (19).
10. Remove safety valve (10), shutdown switch (14), tee (11), and bushing (52).
11. Remove parts (15—17, 60, 78 and 79).
12. Remove cap screws (48), lock washers (58), flange halves (46), and O-ring (20).
13. Remove cap screws (62), flange halves (61) and O-ring (63).
14. Remove discharge hose assembly (29).
15. Remove switch shutdown (30).
16. Remove cap screws (22), washers (64), discharge elbow (51), and gasket (50).
17. Remove hose assembly (55).
18. Remove elbow (21).
19. Remove hose assembly (56).
20. Remove nut (66), fitting (67) and connector (68).
21. Remove nut (69), washers (70 and 71), fittings (72), nipple (73), ball valve (74), and plug (75).

Continued on next page

Compressor

22

38

22. Remove tube assembly (33).
23. Remove elbow (32), expander (31) and O-ring (53).
24. Remove tube assembly (35).
25. Remove tee branch (34), O-ring (47), expander (80), and O-ring (81).
26. Remove tube assembly (38).
27. Remove elbow (37) and expander (36).
28. Remove tube assembly (40).
29. Remove tee branch (39) and expander (82).
30. Remove elbow (41).
31. Remove tube assembly (42).
32. Remove elbow (43) and O-ring (53).
33. Remove tube assembly (44).
34. Remove oil manifold (28).
35. Remove connector (45).
36. Repair or replace parts as necessary.
37. Install connector (45).
38. Install oil manifold (28).
39. Install tube assembly (44).
40. Install O-ring (53) and elbow (43).
41. Install tube assembly (42).
42. Install elbow (41).
43. Install expander (82) and tee branch (39).
44. Install tube assembly (40).
45. Install expander (36) and elbow (37).
46. Install tube assembly (38).
47. Install O-ring (81), expander (80), O-ring (47), and tee branch (34).
48. Install tube assembly (35).
49. Install O-ring (53), expander (31) and elbow (32).
50. Install tube assembly (33).
51. Install plug (75), ball valve (74), nipple (73), fittings (72), washers (70 and 71), and nut (69).
52. Install connector (68), fitting (67), nut (66).
53. Install hose assembly (56).
54. Install elbow (21).
55. Install hose assembly (55).
56. Install gasket (50), discharge elbow (51), washers (64), and cap screws (22).
57. Install shutdown switch (30).
58. Install discharge hose assembly (29).
59. Install O-ring (63), flange halves (61) and cap screws (62).
60. Install O-ring (20), flange halves (46), lock washers (58), and cap screws (48).
61. Install parts (15—17, 60, 78, and 79).
62. Install bushing (52), tee (11), shutdown switch (14), and safety valve (10).
63. Install O-ring (19) and plug (18).

Continued on next page

CED,OUOE039,18 –19–15APR99–3/4

64. Install oil filter (24).

65. Install elbow (49), connector (26) and hose assembly (27).

66. Install bushing (9), lenz fitting (8), tube scavenge line (7), check valve (6), elbow (25), and hose assembly (5).

67. Install connector (77) and elbow (49).

68. Install reducer (12), union fitting (13), oil temperature bypass valve (3), and elbow (23).

69. Install hose assembly (4).

70. Install connectors (1 and 76).

71. Install hose assemblies (2 and 54).

CED,OUOE039,18 –19–15APR99–4/4

CHAPTER 21

SECTION 33

EXCAVATOR REPAIR

BLANK

Group 3302
Buckets

SPECIFICATIONS

Item	Measurement	Specification
Bucket:		
Tooth Shank Preheat	Temperature	204—316°C (400—600°F)
Tooth Shank Fillet Weld	Size Distance	12.7 mm (0.5 in.) 25 ± 6 mm (0.98 ± 0.24 in.) from edge of cutting edge
Bucket	Weight	1138 kg (2500 lb) approximate
Bucket Pivot	End Play	As close to but not less than 0.5 mm (0.020 in.)

CED,OUOE003,1196 –19–21SEP98–1/1

REPLACE BUCKET TOOTH

T95784 –UN–10NOV88

CAUTION: Guard against injury from flying pieces of metal; wear goggles or safety glasses.

IMPORTANT: Hold the drift at an angle towards the bucket to avoid damaging the rubber pin lock.

1. Use a hammer and drift to drive out locking pin. Hold the drift at an angle toward the bucket.

NOTE: Alternate buckets may use different tooth assemblies.

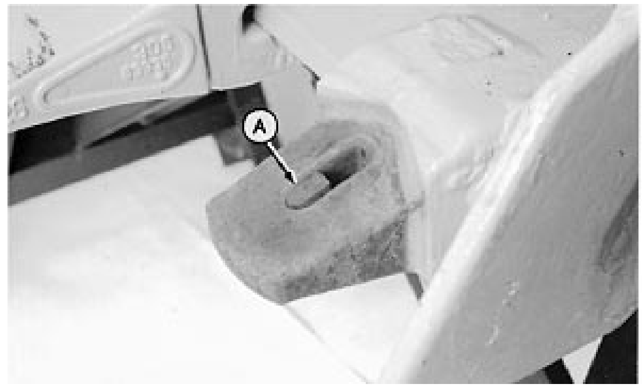
2. Remove tooth.

Continued on next page

TX,33,GG2393 –19–21SEP98–1/3

33
3302
1

3. Inspect rubber pin lock (A) for damage. Replace if necessary.
4. If rubber pin lock has moved, reposition in slot in adapter tooth shank.
5. Install the new tooth over the tooth shank.



T95785 –UN–10NOV88

A—Rubber Pin Lock

TX,33,GG2393 –19–21SEP98–2/3

6. Drive the locking pin into the hole fully.

NOTE: Check bucket teeth periodically so that wear does not extend to the bucket tooth shank.

T95786 –UN–10NOV88

TX,33,GG2393 –19–21SEP98–3/3

33
3302
2

REPLACE BUCKET TOOTH TIP—HEAVY-DUTY BUCKET

1. Clean tooth (A) and tooth tip (B).

2. Insert lock removal tool under U-shaped pin (C).

CAUTION: Avoid possible injury. Pin may fly after it is released from tooth tip. Keep a firm grip on pin to prevent injury.

3. Remove pin.

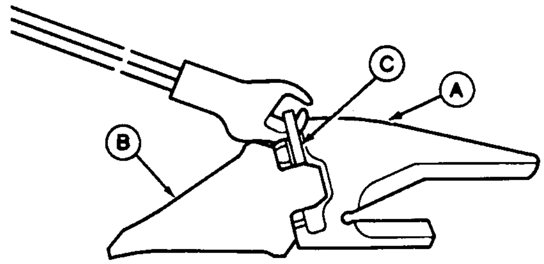
4. Turn tooth tip counterclockwise and pull it towards you to remove.

5. Clean tooth shank.

6. Replace U-shaped pin at same time you replace tooth tip.

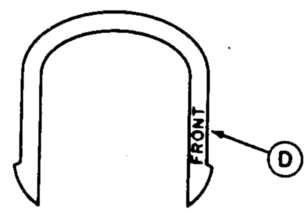
7. Insert tooth tip on shank turning tip clockwise.

8. Install U-shaped pin. Side of pin marked “FRONT” (D) must be toward tooth tip. Make sure pin is firmly engaged over tooth tip.



T6879EE

T6879EE –UN–06DEC88



T7527DO –UN–27JUN91

A—Tooth
B—Tooth Tip
C—Pin
D—“Front” Mark

TX,33,GG2395 –19–13DEC96–1/1

WELDING ON MACHINE

IMPORTANT: Electrical current traveling from the welder through the machine electrical system may damage the machine electrical system, including battery, EPC controller. Disconnect battery ground cable and EPC electrical connectors before welding on the machine.

Before welding on the machine, follow the steps listed below to protect the machine electrical system.

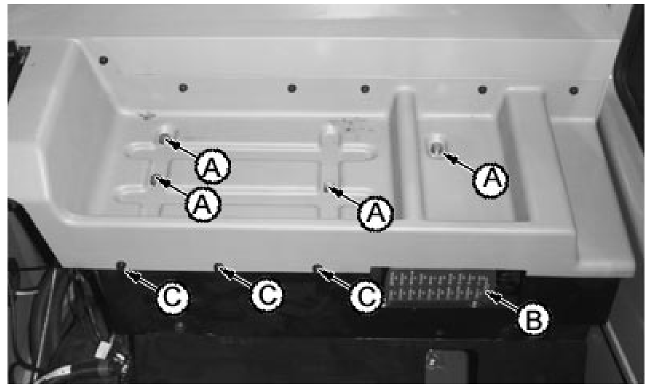
Continued on next page

TX,16,UU3588 –19–19SEP98–1/3

Buckets

1. Disconnect the battery ground and positive cables.

2. Inside the cab, remove four cap screws (A and C) and the fuse box cover (B) to remove the rear console cover.



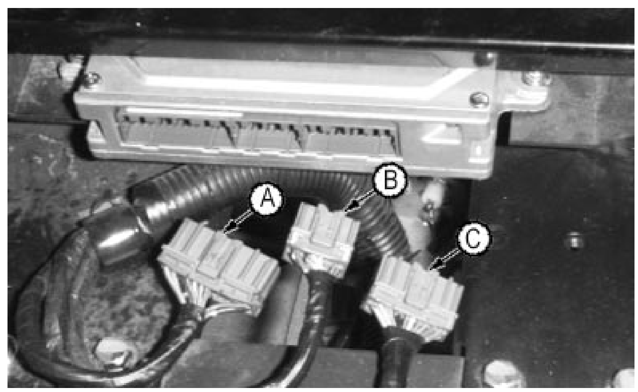
A—Cap Screws
B—Fuse Box Cover
C—Cap Screws

TX,16,UU3588 –19–19SEP98–2/3

3. Disconnect the engine and pump controller electrical connectors.

4. After the welding on machine is completed, install the connectors to the engine and pump controller and then connect the battery cables.

5. Do Engine Speed Learning Procedure. (See procedure in this group.)



A—Connector
B—Connector
C—Connector

TX,16,UU3588 –19–19SEP98–3/3

33
3302
4

REMOVE AND INSTALL TOOTH SHANK

IMPORTANT: Electrical current traveling from the welder through the machine's electrical system may damage the electrical system, including the battery, and the engine and pump controller. Before welding on the machine, the battery ground cable and wiring harness connectors to the engine and pump controller must be disconnected to protect the machine's electrical system.

1. Disconnect the battery ground strap and the wiring harness connectors to the engine and pump controller. (See Welding on Machine in this group.)

TX,33,GG2396 –19–21SEP98–1/5

2. Being careful not to cut into cutting edge, remove weld using a cutting torch or air arc equipment to remove shank.

3. Grind all surfaces smooth.

T92509 –UN–31OCT88

T92510 –UN–31OCT88

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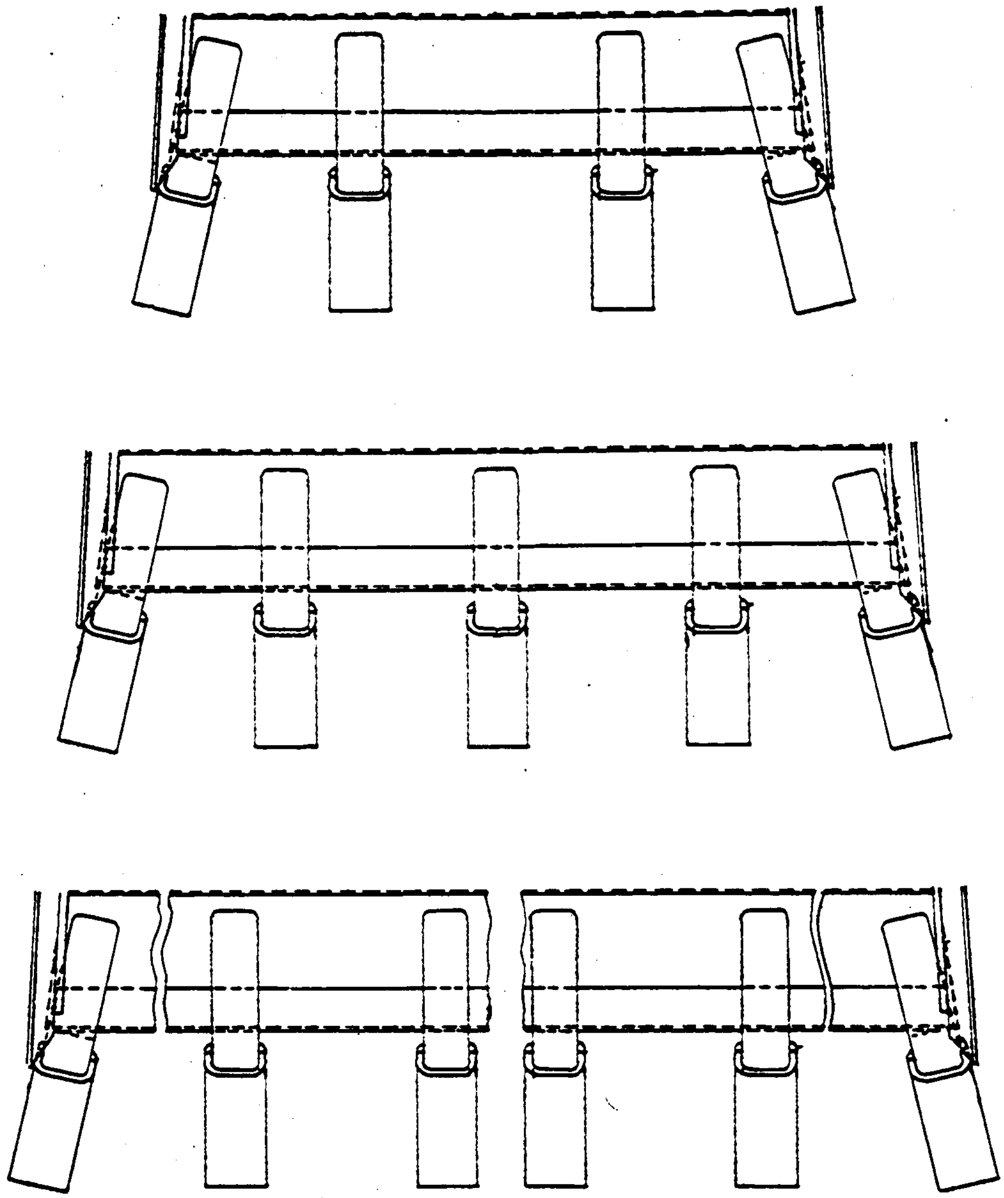
TX,33,GG2396 –19–21SEP98–2/5



T5985AQ —UN–31OCT89

IMPORTANT: Good welds are important. Have only a qualified welder do the welding. Before welding, clean all dirt and paint from weld area. Connect the welder ground clamp as close to each weld area as possible so electrical current does not pass through any bearings or bushings.

4. Before welding shank, remove the tooth tip so rubber pin lock is not damaged by the heat.

5. Install shank into corner so it is tight against the bevel edge and side of bucket.

   Install center shanks so they are tight against bevel edge and spaced equally across width of bucket.

6. Tack weld at the top rear center to hold it in position.

Continued on next page

TX,33,GG2396 –19–21SEP98–3/5

Buckets

Use E7018 electrodes for welding or Lincoln Electric Co. gasless flux core process electrode type NS3M. 3/32 or 1/8 in. rod may be used.

TX,33,GG2396 –19–21SEP98–4/5

7. Preheat shank and cutting edge to 204—316°C (400—600°F).

Tooth Shank Preheat—Specification

Temperature .... 204—316°C (400—600°F)

IMPORTANT: All weld beads must be continuous starting at rear center, around the corner and along the side for a good strong weld joint. DO NOT start or stop welding at a corner.

8. Weld shank to cutting edge using 12.7 mm (0.5 in.) fillet weld (1).

Tooth Shank Fillet Weld—Specification

Size... 12.7 mm (0.5 in.)

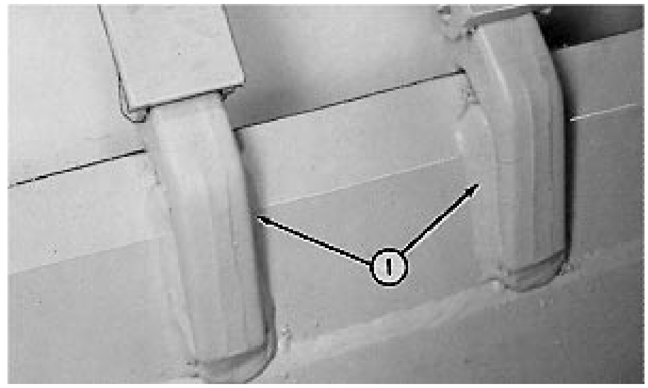
Starting at the rear center of shank, weld a continuous bead across end, around the corner, and along the side stopping 25 ± 6 mm (0.98 ± 0.24 in.) from edge of cutting edge.

Tooth Shank Fillet Weld—Specification

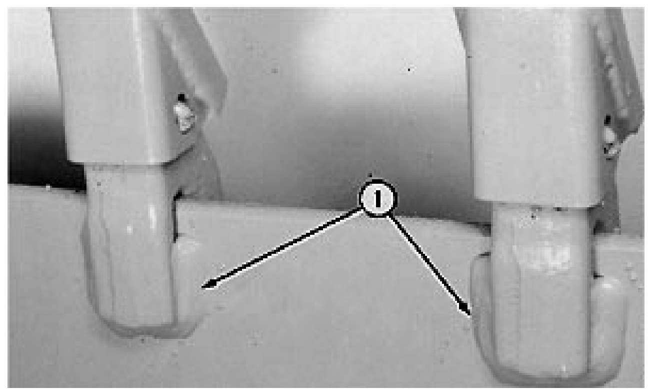
Distance... 25 ± 6 mm (0.98 ± 0.24 in.) from edge of cutting edge

Alternating from side to side, make as many passes as necessary to get the specified bead size.

9. Allow the weld area to cool slowly at room temperature.



T82798 –UN–31OCT88



T82799 –UN–31OCT88

1—Fillet Weld

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3302
7

TX,33,GG2396 –19–21SEP98–5/5

REPLACE WELDED CUTTING EDGE

IMPORTANT: Electrical current traveling from the welder through the machine's electrical system may damage the electrical system, including the battery, and the engine and pump controller. Before welding on the machine, the battery ground cable and wiring harness connectors to the engine and pump controller must be disconnected to protect the machine's electrical system.

1. Disconnect the battery ground strap and the wiring harness connectors to the engine and pump controller. (See Welding on Machine in this group.)

2. Perform welding in an environment with a minimum ambient temperature of 10°C (50°F).

3. Clean all joints to be welded of all foreign matter such as dirt, rust, mill scale, oil, etc. with grinders and/or solvents.

4. Use dry AWS-E7018 low hydrogen electrodes or either of the following equivalent low hydrogen wire feed electrodes: gas metal arc welding (CO_2 or argon CO_2) AWS-E70S6 or flux cored arc welding AWS-E70T1.

5. Preheat parts to be welded (both tack and final welds) to minimum of 204°C (400°F). PREHEAT TEMPERATURE MUST BE THROUGHOUT THE ENTIRE THICKNESS OF THE PARTS JOINED AND AT LEAST 51 mm (2 in.) BACK FROM THE JOINT. Maintain preheat throughout the entire welding operation. Tempilstiks should be used if possible.

6. Tack weld preheated plates starting at center of bucket and working towards the outside ends.

7. Final weld preheated plates starting at the center of front edge of bucket backing plate and working towards the outside ends.

   Repeat this operation at back edge of plates.

   Tack welds may be incorporated into the final weld, providing they have been made with electrodes that meet the requirements of the final welds and no cracking has occurred in the weld metal. Tack welds not meeting these requirements must be completely removed by grinding or air arc gouging just prior to making the final weld in that area.

8. Do not remove bucket from welding environment until weld metal temperature has dropped to the ambient temperature. Do not force cooling rate of weld metal.

TX,33,GG2397 –19–14DEC96–1/1

REPAIR CRACKED CUTTING EDGE

IMPORTANT: Electrical current traveling from the welder through the machine's electrical system may damage the electrical system, including the battery, and the engine and pump controller. Before welding on the machine, the battery ground cable and wiring harness connectors to the engine and pump controller must be disconnected to protect the machine's electrical system.

1. Disconnect the battery ground strap and the wiring harness connectors to the engine and pump controller. (See Welding on Machine in this group.)

2. For any crack in cutting edge, clean the area to find end of crack.

3. Drill a small hole at end of crack to prevent spreading.

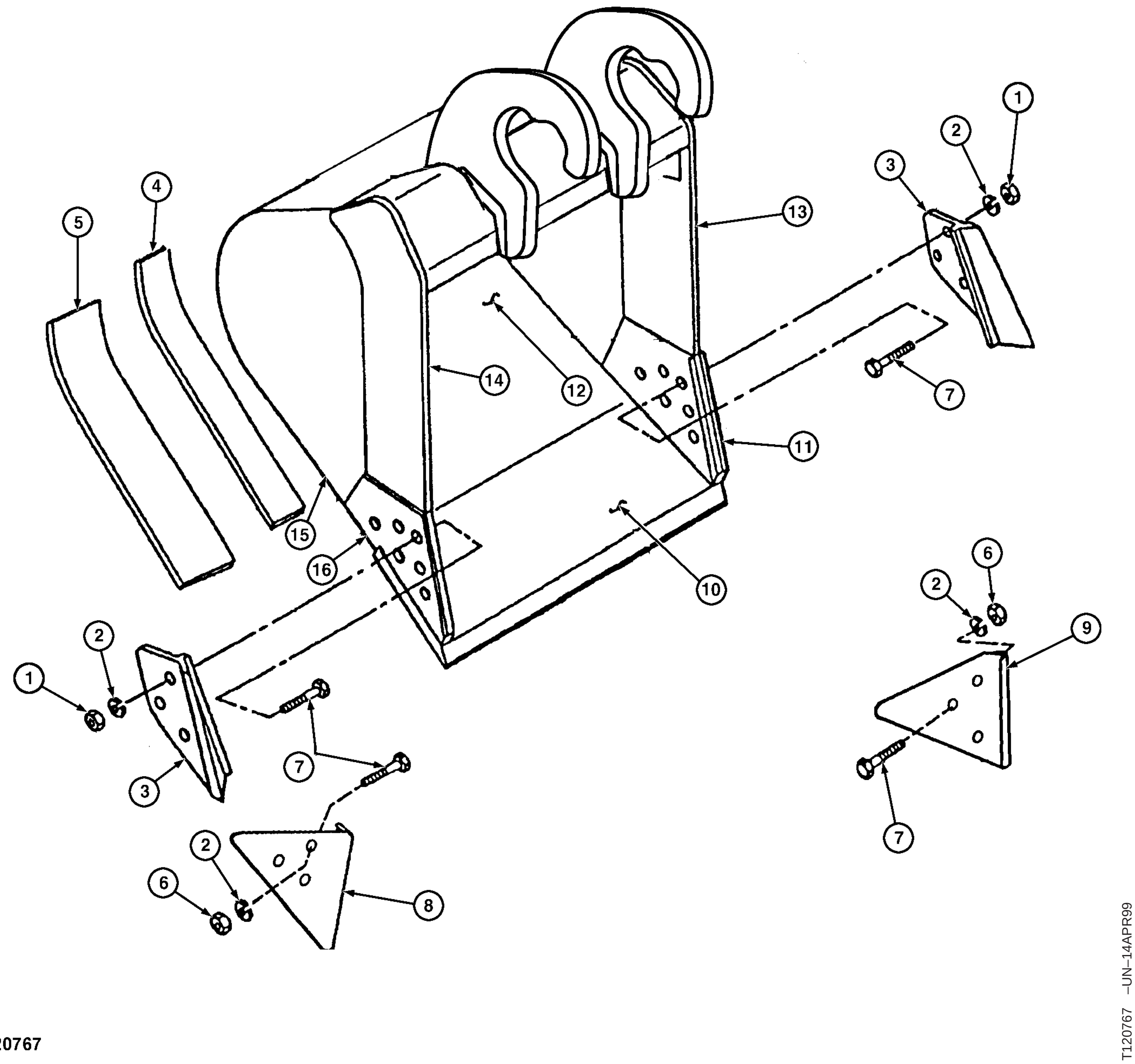
4. Grind a V-groove along crack on top and bottom of cutting edge.

5. Preheat the cracked area to approximately 149—260°C (300—500°F).

6. Fill the V-grooves with weld. Use E7018 electrodes. Extend the weld approximately 13 mm (0.5 in.) beyond end of crack.

TX,33,GG2398 –19–14DEC96–1/1

DISASSEMBLE AND ASSEMBLE BUCKET



T120767

1—Nut (6 used)
2—Lock Washer (6 used)
3—Cutting Edge
4—Inner Wear Bar
5—Outer Wear Bar (2 used)
6—Nut (6 used)
7—Lock Washer (3 used)
8—Wear Shroud
9—Wear Shroud
10—Cutting Edge
11—Insert Vertical Cutter
12—Moldboard
13—Upper Vertical Cutter
14—Upper Vertical Cutter
15—Plate
16—Insert Vertical Cutter

Inspect parts for wear or damage; replace as necessary.

To repair cracks, see Repair Cracked Cutting Edge in this group.

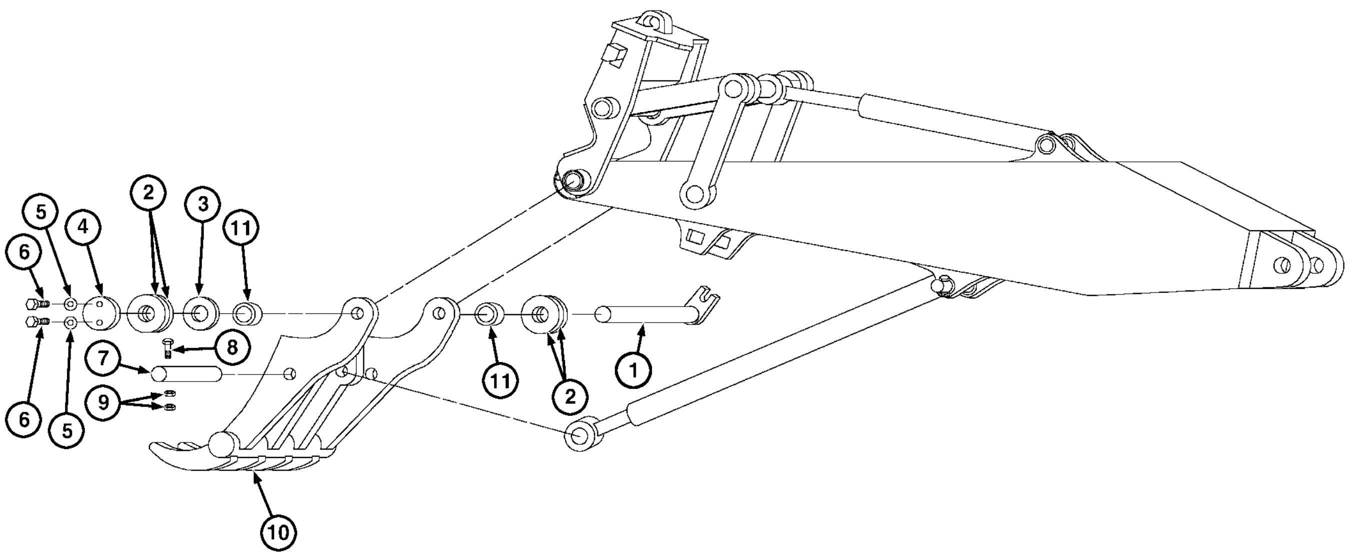
Continued on next page

Buckets

To replace cutting edges, see Replace Welded Cutting Edge in this group.

CED,OUOE042,56 –19–19MAR99–2/2

REMOVE AND INSTALL HYDRAULIC THUMB (MODEL 230LCR)



T120553

T120553 –UN–25MAR99

1—Pin
2—Shims (as required)
3—Spacer
4—Retaining Plate
5—Washers (2 used)
6—Cap Screws (2 used)
7—Pin
8—Cap Screw
9—Nuts (2 used)
10—Hydraulic Thumb
11—Bushing (2 used)

1. Position arm in the vertical position so that the bucket is pointing downward.

2. Connect the hydraulic thumb to a hoist using lifting straps.

CAUTION: The hydraulic thumb clamp weighs approximately 133 kg (675 lbs).

Hydraulic Thumb—Specification

Weight.. 133 kg (675 lbs) approximate

33
3302
12

3. Remove nuts (9) and cap screw (8) from the thumb cylinder pin (7).

4. Remove pin (7).

5. Remove two cap screws (6), washers (5), and retaining cap (4).

6. Remove pin (1).

7. Note the quantity and location of shims (2) and spacer (3) for assembly.

8. Using the hoist remove the thumb clamp (10).

9. Replace parts as necessary.

10. Using a hoist, position the suspended hydraulic thumb clamp (10) and align with the excavator arm and quick-disconnect mounting holes.

11. Install pin (1), spacer (3) and shims (2).

Continued on next page

CED,OUOE042,74 –19–08APR99–1/2

12. Check that a maximum clearance (see specification below) exists between any of the joint bearing faces. The clamp must be centered to the excavator arm. If not, reassemble and re-shim until centered.

Hydraulic Thumb—Specification

Clearance.. .060 inch

13. Install retaining cap (4), washers (5), and two cap screws (6).

14. Rest the clamp against the bucket. Align the hydraulic cylinder end to the clamp.

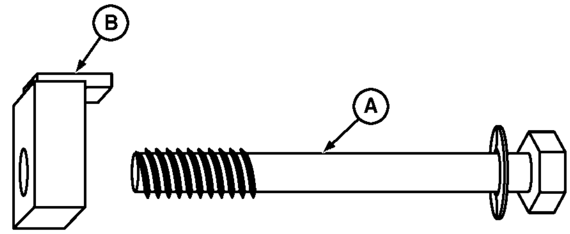
15. Install pin (7) and cap screw (8) and nuts (9).

CED,OUOE042,74 –19–08APR99–2/2

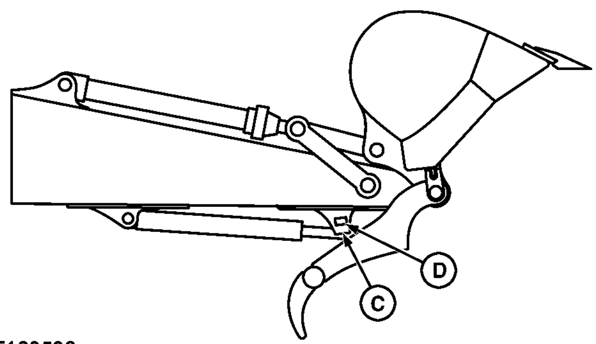
HYDRAULIC THUMB LOCK-UP PROCEDURE

The cap screws-washerhook assembly allows the hydraulic thumb to be bolted in the stored position. This will allow the thumb hydraulic cylinder lines to be disconnected. It also allows for the lock-up of the thumb for transporting the machine.

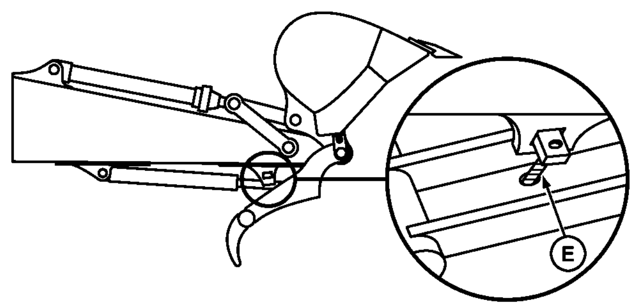
1. Retract the arm to the horizontal position and rest on the ground.
2. Position the hydraulic thumb against the clamp rest (C).
3. Shut the engine off.
4. Place the hook block (B) through the clamp rest (C).
5. Install cap screw (A) through the clamp arm faceplate hole. Thread the cap screw in the hole in the hook block (E).
6. Tighten the cap screw.



T120601



T120598



T120607

A—Cap Screw
B—Hook Block
C—Clamp Rest
D—Clamp Rest Hole
E—Lock-Up Assembly

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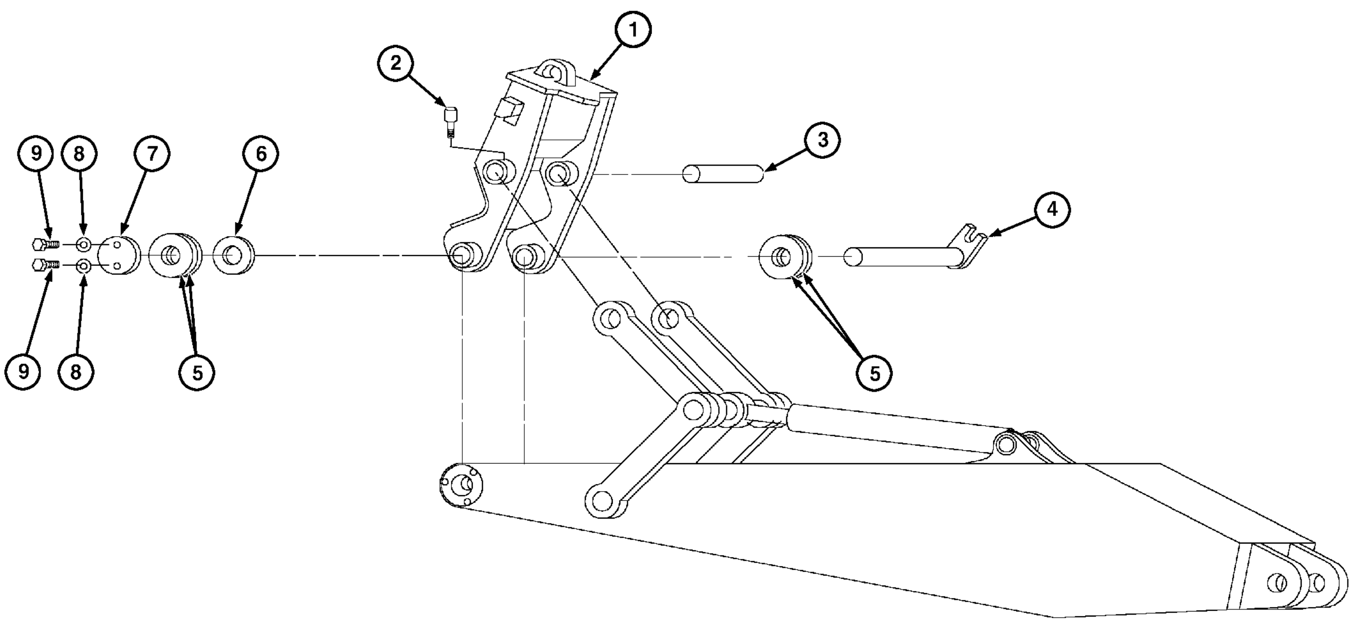
3302
14

CED,OUOE042,5063 –19–15APR99–1/1

REMOVE AND INSTALL QUICK-DISCONNECT HITCH (MODEL 230LCRD)



T121189

1—Quick-Disconnect Hitch	**4—Pin**	**7—Retaining Plate**
2—Cap Screw	**5—Shims (use as required)**	**8—Lock washer (2 used)**
3—Pin	**6—Spacer**	**9—Cap Screws (2 used)**

1. Park machine on a firm, level surface.

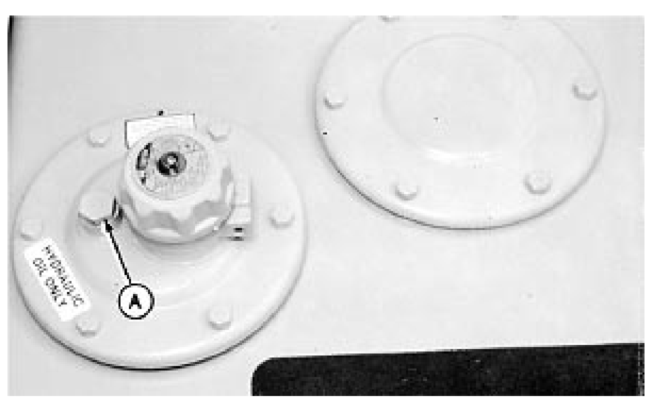
CAUTION: The approximate weight of the quick-disconnect hitch is 384 kg (846 lb).

2. Remove attachment from quick-disconnect hitch.

CED,OUOE042,5068 –19–16APR99–1/3

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

3. Loosen vent plug (A) to release air pressure from hydraulic tank.



Continued on next page CED,OUOE042,5068 –19–16APR99–2/3

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3302
15

4. Slowly loosen hydraulic lines (A) and disconnect.

5. Remove cap screws (2) from left side of pin (3).

6. Remove pin (3).

7. Remove cap screws (9), washers (8), and retaining plate (7) from pin (4).

8. Remove pin (4). Take note of location and quantity of any shims.

9. Raise arm to separate from the quick-disconnect hitch (1).

10. Replace parts as necessary.

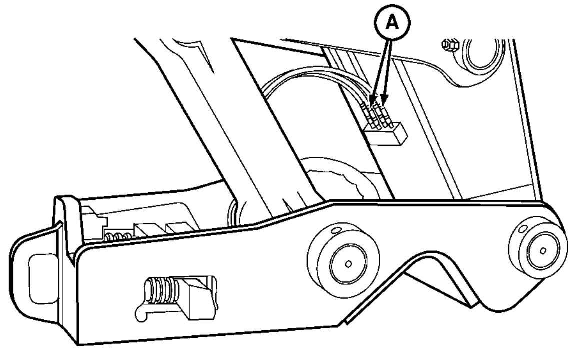
11. Position arm into the quick-disconnect hitch. Align the pin bores.

12. Install pin (4), shims (5) and spacer (6).

13. Install retaining plate (7), cap screws (9) and lockwashers (5).

14. Install pin (3) and set screw (2).

15. Install hydraulic lines (A).



A—Hydraulic Lines (2)

CED,OUOE042,5068 –19–16APR99–3/3

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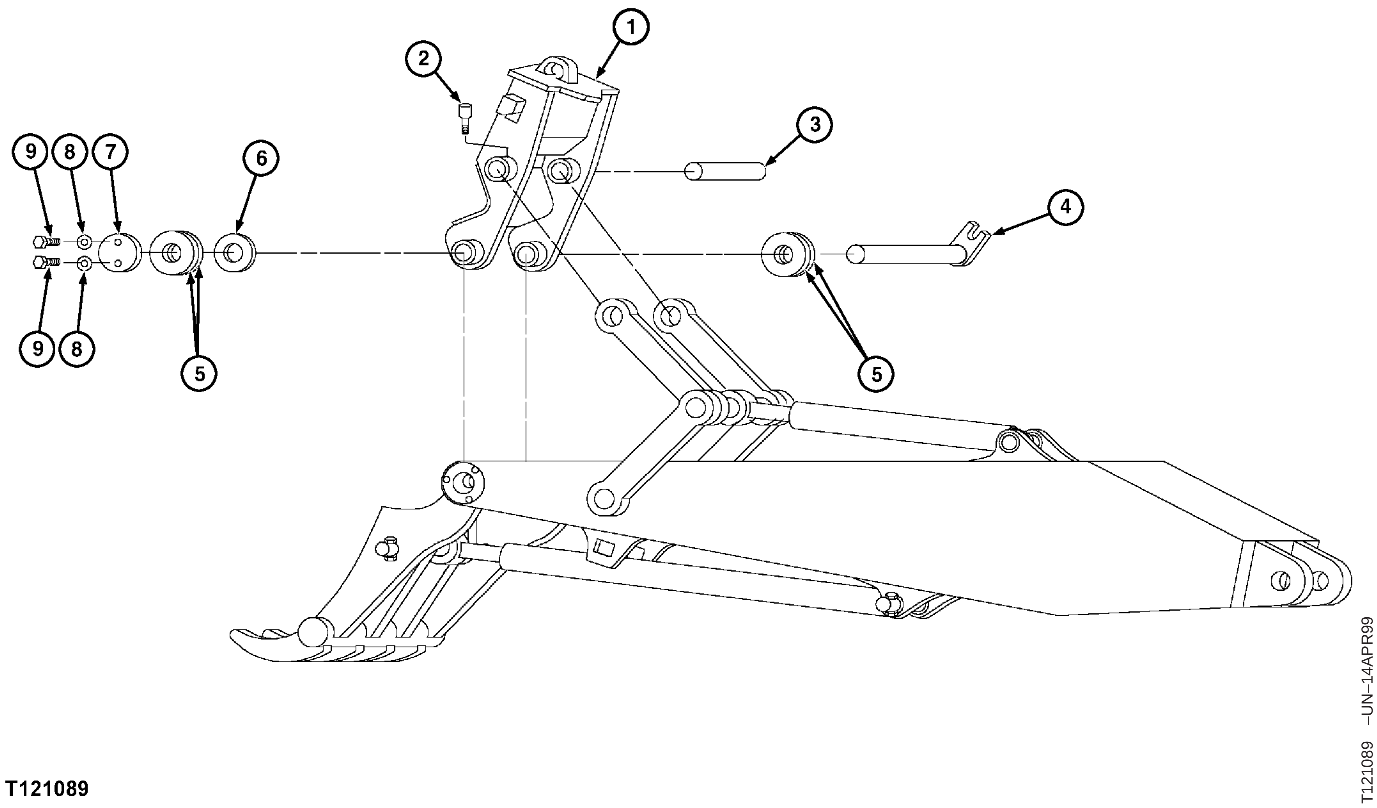
3302
16

REMOVE AND INSTALL QUICK-DISCONNECT HITCH (MODEL 230LCR)



1—Quick-Disconnect Hitch
2—Cap Screw
3—Pin
4—Pin
5—Shims (use as required)
6—Spacer
7—Retaining Plate
8—Lock washer (2 used)
9—Cap Screws (2 used)

1. Park machine on a firm, level surface.

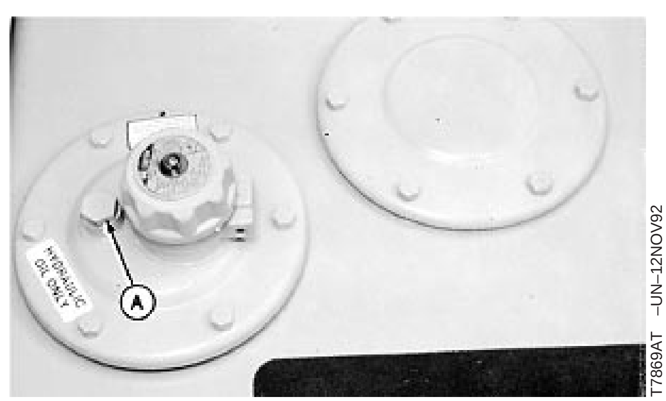
CAUTION: The approximate weight of the quick-disconnect hitch is 384 kg (846 lb).

2. Remove attachment from quick-disconnect hitch.
3. Lock up the hydraulic thumb. (See Hydraulic Thumb Lock-Up procedure in this group.)

CED,OUOE042,76 –19–08APR99–1/3

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

4. Loosen vent plug (A) to release air pressure from hydraulic tank.



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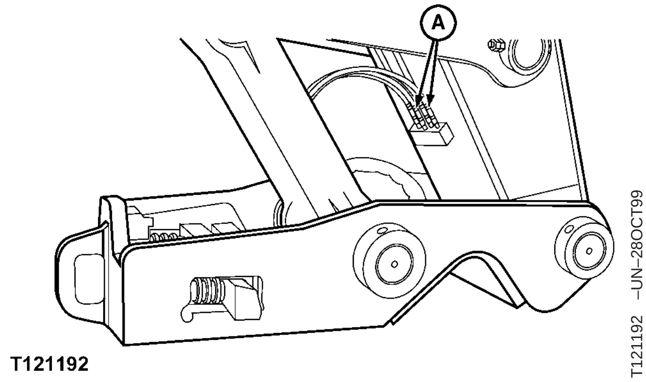
CED,OUOE042,76 –19–08APR99–2/3

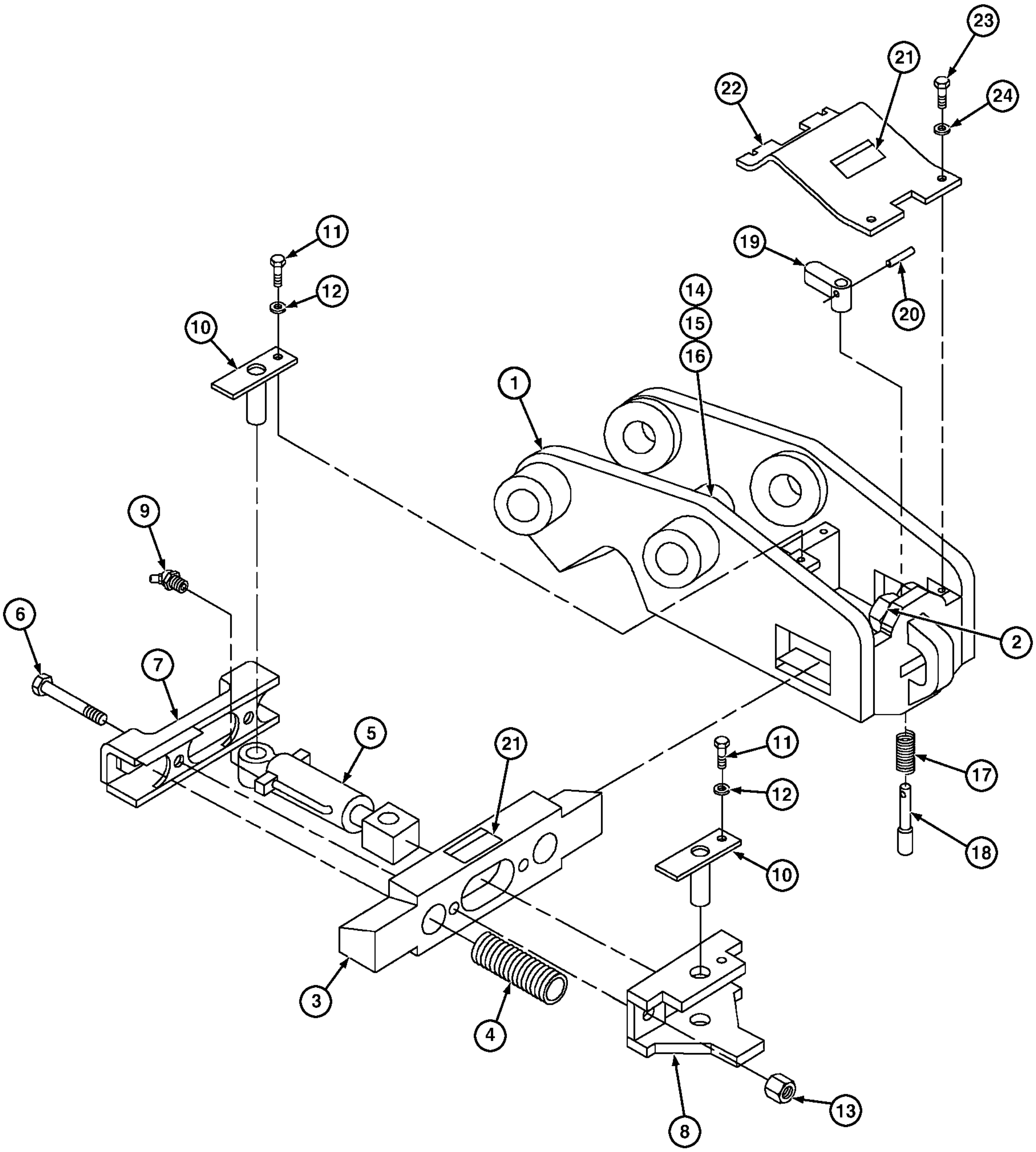
5. Slowly loosen hydraulic lines (A) and disconnect.
6. Remove cap screw (2) from left side of pin (3).
7. Remove pin (3).
8. Remove cap screws (9), washers (8), and retaining plate (7) from pin (4).
9. Remove pin (4). Take note of location and quantity of any shims.
10. Raise arm to separate from the quick-disconnect hitch (1).
11. Replace parts as necessary.
12. Position arm into the quick-disconnect hitch. Align the pin bores.
13. Install pin (4), shims (5) and spacer (6).
14. Install retaining plate (7), cap screws (9) and lockwashers (5).
15. Install pin (3) and cap screw (2).
16. Install hydraulic lines (A).



A—Hydraulic Lines (2)

CED,OUOE042,76 –19–08APR99–3/3

DISASSEMBLE QUICK-DISCONNECT HITCH



T120511

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1—Quick-Latch Frame Assembly
2—Grease Fitting
3—Wedge Bar
4—Spring
5—Hydraulic Cylinder
6—Cap Screw (2 used)
7—Spring Mounting Bracket
8—Cylinder Mounting Bracket
9—Elbow
10—Pin Assembly
11—Cap Screw (2 used)
12—Lock Washer (2 used)
13—Nut (2 used)
14—Hose Clamp
15—Cover Plate
16—Cap Screw
17—Spring
18—Pin
19—Handle Assembly
20—Roll Pin
21—Decal
22—Cover
23—Cap Screw (4 used)
24—Lock Washer (4 used)

IMPORTANT: The quick-disconnect hitch must be in latch mode.

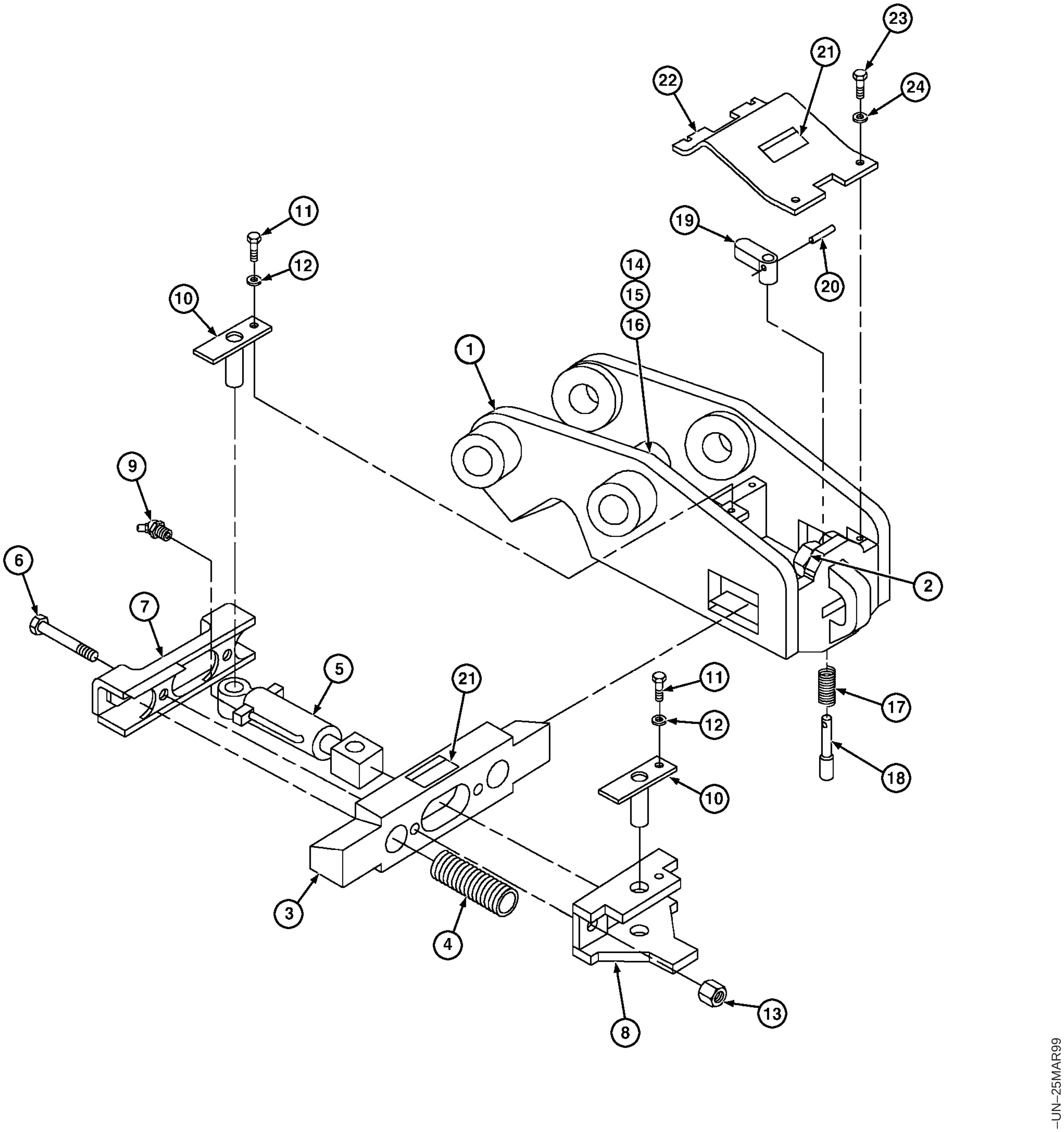
1. Remove cap screws (23), washers (24) and cover (22).
2. Remove cap screw (16), cover plate (15) and hose clamp (14).
3. Slowly remove cap screws (6) and nuts (13) to release tension of springs (4).
4. Remove cylinder rod mounting bracket (8), wedge bar (3) and spring mounting bracket (7).
5. Remove hydraulic cylinder (5).
6. Block up pin (18) with a shim through slot in the back plate of frame.
7. Remove roll pin (20) and handle (19).

CAUTION: Assembly is under spring tension. Remove shim carefully.

8. Slowly remove blocking shim, and remove pin (18) and spring (17).

CED,OUOE042,5070 –19–16APR99–2/2

ASSEMBLE QUICK-DISCONNECT HITCH



T120511

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Buckets

1—Quick-Latch Frame Assembly	**7—Spring Mounting Bracket**	**12—Lock Washer (2 used)**	**19—Handle Assembly**
2—Grease Fitting	**8—Cylinder Mounting Bracket**	**13—Nut (2 used)**	**20—Roll Pin**
3—Wedge Bar	**9—Elbow**	**14—Hose Clamp**	**21—Decal**
4—Spring	**10—Pin Assembly**	**15—Cover Plate**	**22—Cover**
5—Hydraulic Cylinder	**11—Cap Screw (2 used)**	**16—Cap Screw**	**23—Cap Screw (4 used)**
6—Cap Screw (2 used)		**17—Spring**	**24—Lock Washer (4 used)**
		18—Pin	

1. Rotate wedge bar (3) 90 degrees and slide it into the latch frame (1). The wedge taper should be on the top and angled down toward the link pin when the wedge bar is routed back to its upright position.

2. Tilt the top of wedge bar back about 30 degrees. Slide the two compression springs (4) into the holes in the wedge bar.

3. While the wedge bar is still tilted up, slide the hydraulic cylinder (5) into the center hole of the wedge bar. Slide the cylinder inward rod first and with the rod port on the right hand side.

4. Install the two cap screws (6) into the spring mounting bracket (7) and place the bracket on the end of the two compression springs (4). Rotate the all the parts downward into the latch frame (1).

5. Install the two 45 degree elbows (9) with the ends oriented downwards.

6. Install the cylinder rod mounting bracket (8) in the frame on the rearward side of the wedge. Install nuts (13).

7. Route the two hydraulic lines through the holes in the latch frame cross member. Connect the lines to the elbows (9).

8. Assemble hydraulic cylinder base side pin (10) and rod side pin (10) with mounting hardware (11) and (12). Torque cap screws to 45 lb-ft. Tighten nuts (13).

Side Pin Cap Screw—Specification

Torque.. 45 lb-ft

9. Slide the two cap screws (6) through the wedge bar (3) and rod eye mounting bracket (8). Install the two nuts (13) and tighten to 200 lb-ft. This will draw the cylinder rod eye mounting bracket, wedge bar, and spring mounting bracket together. This will also apply a spring pre-load to the wedge bar.

Wedge Bar Nuts—Specification

Torque.. 200 lb-ft

10. Route the hydraulic lines so they clear the arm link. Anchor the lines with hose clamp (14) and mounting hardware (15) and (16).

11. Install cover (22) to the quick-disconnect hitch with cap screws (23) and lock washers (24). Torque the cap screws (24) to 80 lb-ft.

Cover Cap Screws—Specification

Torque.. 80 lb-ft

33
3302
23

CED,OUOE042,5072 –19–16APR99–2/2

SERVICE EQUIPMENT AND TOOLS

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

SERVICEGARD is a trademark of Deere & Company.

CED,OUOE003,556 –19–18MAY98–1/4

Floor Stand

To support load of boom and boom cylinder.

CED,OUOE003,556 –19–18MAY98–2/4

Bushing, Bearing and Seal Driver Set

Use with puller set to remove and install bushings in boom and arm.

CED,OUOE003,556 –19–18MAY98–3/4

17-1/2 and 30 Ton Puller Set

To remove and install bushings in boom and arm.

CED,OUOE003,556 –19–18MAY98–4/4

OTHER MATERIAL

Number	Name	Use
TY6347 (U.S.)	Multi-Purpose Grease	To provide a light lubrication between pivot joints.

CED,OUOE003,557 –19–18MAY98–1/1

Frames

SPECIFICATIONS

Item	Measurement	Specification
Boom:		
Boom Cylinder	Weight	220 kg (485 lb) approximate
Boom	Weight	1550 kg (3418 lb) approximate
Arm Cylinder	Weight	290 kg (640 lb) approximate
Boom-to-Frame Pin Nut	Torque	540 N•m (400 lb-ft) (tighten nut against nut, not the retainer)
Boom Cylinder Head End-to-Frame Joint Pin	OD OD	90.0 mm (3.54 in.) nominal 89.0 mm (3.50 in.) limit of use
Boom Cylinder Head End-to-Frame Joint Bushing	ID ID	90.0 mm (3.54 in.) nominal 91.5 mm (3.60 in.) limit of use
Boom Cylinder Head End-to-Frame Joint Boss	ID ID	90.0 mm (3.54 in.) nominal 91.5 mm (3.60 in.) limit of use
Boom Cylinder Rod End-to-Boom Joint Pin	OD OD	90.0 mm (3.54 in.) nominal 89.0 mm (3.50 in.) limit of use
Boom Cylinder Rod End-to-Boom Joint Bushing	ID ID	90.0 mm (3.54 in.) nominal 91.5 mm (3.60 in.) limit of use
Boom-to-Frame Joint Pin	OD OD	100.0 mm (3.94 in.) nominal 99.0 mm (3.99 in.) limit of use
Boom-to-Frame Joint Bushing	ID ID	100.0 mm (3.94 in.) nominal 101.5 mm (4.00 in.) limit of use
Boom-to-Arm Joint Pin	OD OD	90.0 mm (3.54 in.) nominal 89.0 mm (3.50 in.) limit of use
Boom-to-Arm Joint Bushing	ID ID	90.0 mm (3.54 in.) nominal 91.5 mm (3.60 in.) limit of use

33
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CED,OUOE003,1212 –19–23SEP98–1/3

Frames

Item	Measurement	Specification
Arm:		
Standard Arm	Weight	754 kg (1663 lb) approximate
Bucket Cylinder	Weight	190 kg (420 lb) approximate
Arm Cylinder Head End-to-Boom Joint Pin	OD OD	80.0 mm (3.15 in.) nominal 79.0 mm (3.11 in.) limit of use
Arm Cylinder Head End-to-Boom Joint Bushing	ID ID	80.0 mm (3.15 in.) nominal 81.5 mm (3.21 in.) limit of use
Arm Cylinder Head End-to-Boom Joint Boss	ID ID	80.0 mm (3.15 in.) nominal 81.5 mm (3.21 in.) limit of use
Arm Cylinder Rod End-to-Arm Joint Pin	OD OD	80.0 mm (3.15 in.) nominal 79.0 mm (3.11 in.) limit of use
Arm Cylinder Rod End-to-Arm Joint Bushing	ID ID	80.0 mm (3.15 in.) nominal 81.5 mm (3.21 in.) limit of use
Arm Cylinder Rod End-to-Arm Joint Boss	ID ID	80.0 mm (3.15 in.) nominal 81.5 mm (3.21 in.) limit of use
Bucket:		
Bucket Cylinder Head End-to-Arm Joint Pin	OD OD	80.0 mm (3.15 in.) nominal 79.0 mm (3.11 in.) limit of use
Bucket Cylinder Head End-to-Arm Joint Bushing	ID ID	80.0 mm (3.15 in.) nominal 81.5 mm (3.21 in.) limit of use
Bucket Cylinder Head End-to-Arm Joint Boss	ID ID	80.0 mm (3.15 in.) nominal 81.5 mm (3.21 in.) limit of use

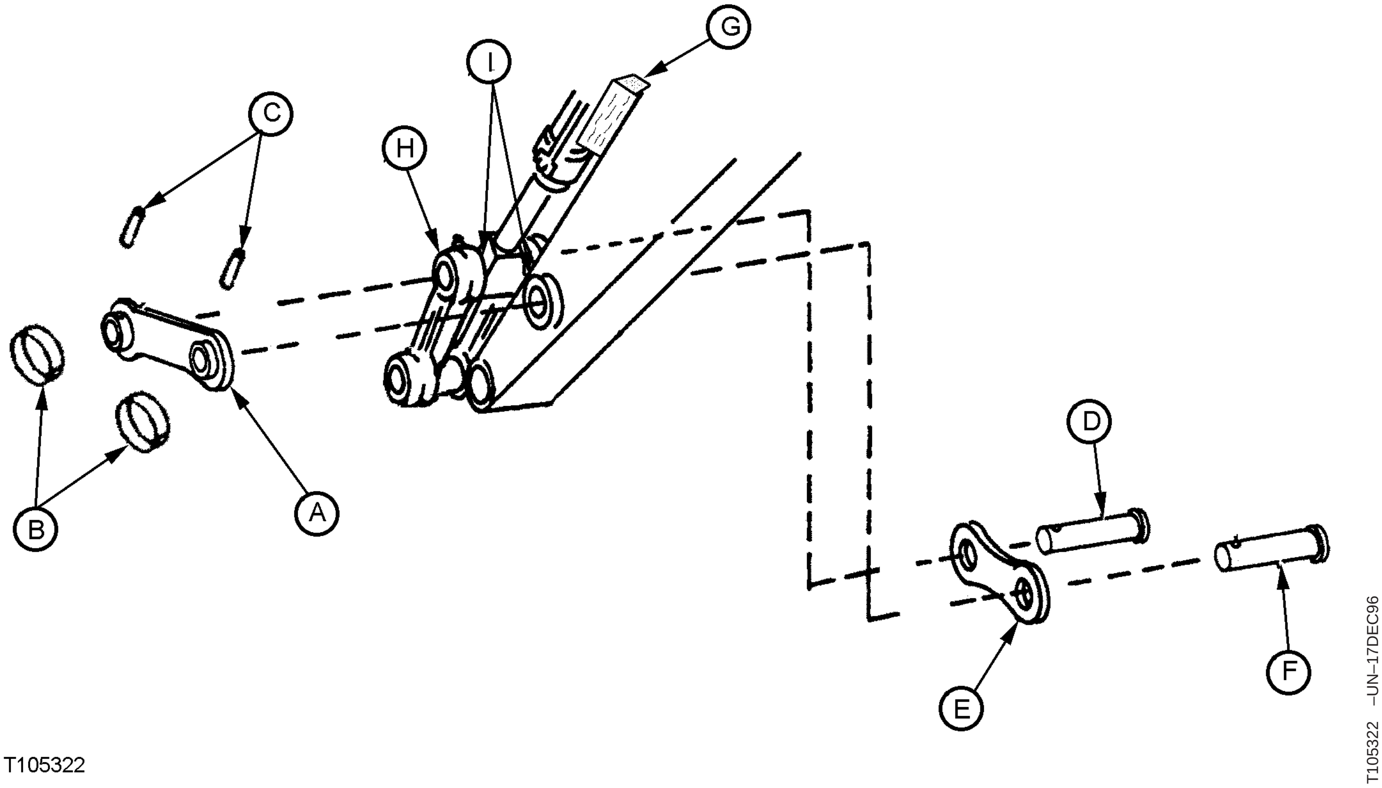
Continued on next page CED,OUOE003,1212 –19–23SEP98–2/3

Frames

Item	Measurement	Specification
Bucket Cylinder Rod End-to-Side and Center Links Joint Pin	OD OD	90.0 mm (3.54 in.) nominal 89.0 mm (3.50 in.) limit of use
Bucket Cylinder Rod End-to-Side and Center Links Joint Bushings	ID ID	90.0 mm (3.54 in.) nominal 91.5 mm (3.60 in.) limit of use
Side Links-to-Arm Joint Pin	OD OD	80.0 mm (3.15 in.) nominal 79.0 mm (3.11 in.) limit of use
Side Links-to-Arm Joint Bushing	ID ID	80.0 mm (3.15 in.) nominal 81.5 mm (3.21 in.) limit of use
Center Link-to-Bucket Joint Pin	OD OD	90.0 mm (3.54 in.) nominal 89.0 mm (3.50 in.) limit of use
Center Link-to-Bucket Joint Bushing	ID ID	90.0 mm (3.54 in.) nominal 91.5 mm (3.60 in.) limit of use
Bucket-to-Arm Joint Pin	OD OD	90.0 mm (3.54 in.) nominal 89.0 mm (3.50 in.) limit of use
Bucket-to-Arm Joint Bushing	ID ID	90.0 mm (3.54 in.) nominal 91.5 mm (3.60 in.) limit of use

CED,OUOE003,1212 –19–23SEP98–3/3

REMOVE AND INSTALL BUCKET LINKS



A—Left Side Link
B—Retainer Ring (2 used)
C—Pin (2 used)
D—Links-to-Bucket Cylinder Pin
E—Right Side Link
F—Links-to-Arm Pin
G—Wooden Block
H—Center Link
I—Washer (As Required)

NOTE: Removal of bucket is not necessary for the removal of just the bucket links. Remove the bucket if the arm is also being removed. (See Remove and Install Bucket in Group 3302.)

1. Connect center link (H) to a hoist using a lifting strap. Put a wooden block (G) between the bucket cylinder and arm to hold cylinder up when links-to-bucket cylinder pin (D) is removed.

2. Remove the retainer rings (B) and pins (C).

   As links-to-bucket cylinder pin (D) is removed, lower the left (A) and right (E) side links to the ground.

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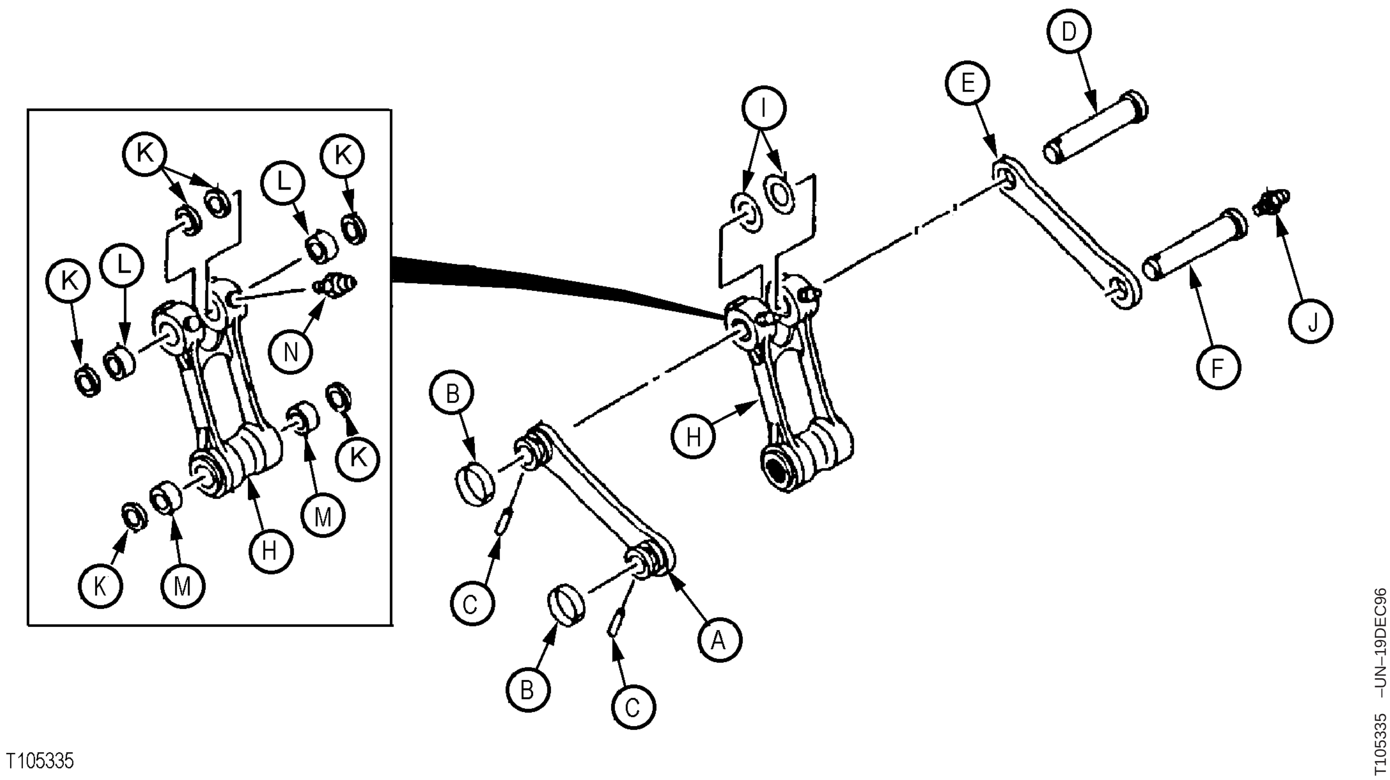
TX,33,UU3773 –19–16DEC96–1/2

Frames



A—Left Side Link
B—Retainer Ring (2 used)
C—Pin (2 used)
D—Links-to-Bucket Cylinder Pin
E—Right Side Link
F—Links-to-Arm Pin
H—Center Link
I—Washer (As Required)
J—Lubrication Fitting (2 used)
K—Dust Seal (6 used)
L—Bushing (2 used)
M—Bushing (2 used)

3. Inspect the bushings (L and M) and dust seals (K). (See Inspect Arm and Boom Pins and Bushings in this group.)

   Replace parts as necessary.

4. Before installing pins, align the pin bores so as not to damage the dust seal when pins are installed.

5. Apply grease to all lubrication fittings.

TX,33,UU3773 –19–16DEC96–2/2

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REMOVE AND INSTALL ARM

1. Remove the bucket. (See Remove and Install Bucket in Group 3302.)

2. Retract arm cylinder.

3. Put a floor stand under end of boom so load is on boom, not on arm cylinder.

   Extend arm cylinder just enough to put end of arm on the ground.

4. Stop the engine.

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

5. Loosen vent plug to release pressure from hydraulic oil tank.

NOTE: Arm can also be removed with bucket cylinder and links installed.

6. Remove bucket cylinder and links. (See procedure in this group and Group 3360.)

Continued on next page TX,33,UU3774 –19–21SEP98–1/2

CAUTION: The approximate weight of standard arm is 754 kg (1663 lb).

The approximate weight of bucket cylinder is 190 kg (420 lb).

Standard Arm—Specification

Weight.. 754 kg (1663 lb) approximate

Bucket Cylinder—Specification

Weight.. 190 kg (420 lb) approximate

7. Remove arm without bucket cylinder or with bucket cylinder installed. Bucket end of arm is the heavy end when hoist is connected to mounting bracket for bucket cylinder.

   Put a wooden block between the arm cylinder and boom to hold cylinder up when arm-to-arm cylinder pin (F) is removed.

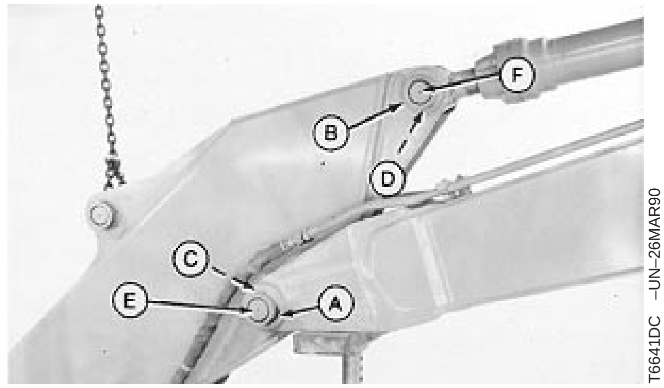
8. Inspect the bushings and dust seals. (See Inspect Arm and Boom Pins and Bushings in this group.)

   Repair or replace parts as necessary. (See Remove and Install Bushings and Seals in this group.)

9. Install washer equally on each side of arm to get the minimal amount of clearance between boom and arm. There must be some clearance between boom and arm.

10. Before installing pins, align the pin bores so as not to damage the dust seal when pins are installed.

11. Apply grease to all lubrication fitting.



Arm-to-Boom Pivot

Arm With Bucket Cylinder

A—Retainer Ring
B—Retainer Ring
C—Pin
D—Pin
E—Arm-to-Boom Pin
F—Arm-to-Arm Cylinder Pin

REMOVE AND INSTALL BOOM

1. Remove bucket and arm. (See procedures in Group 3302 and in this group.)

2. Lower boom to the ground.

3. Stop the engine.

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

4. Loosen vent plug to release air pressure from hydraulic oil tank.

5. Remove arm cylinder only if necessary to repair boom. (See Remove and Install Arm Cylinder in Group 3360.)

6. Disconnect wiring harness and lubrication lines.

   Disconnect arm and bucket lines at frame end of boom.

Continued on next page TX,33,UU3775 –19–21SEP98–1/5

CAUTION: The approximate weight of a boom cylinder is 220 kg (485 lb).

Boom Cylinder—Specification

Weight.. 220 kg (485 lb) approximate

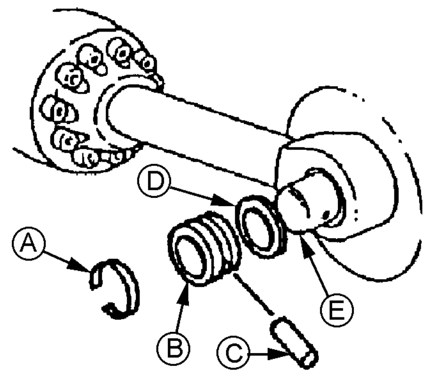
7. Attach a boom cylinder (F) to hoist using a lifting strap.

8. Remove retainer rings (A), pins (C), retainers (B) and shims (D).

9. Push boom cylinder-to-boom pin (E) into the boom.

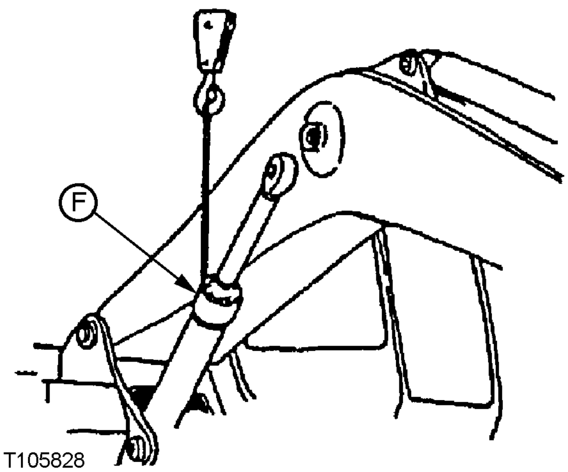
   Lower boom cylinder (F) on a floor stand.

   Repeat procedure for the second boom cylinder



T105734

T105734 –UN–30DEC96



T105828

T105828 –UN–30DEC96

A—Retainer Ring (2 used)
B—Retainer (2 used)
C—Pin (2 used)
D—Shim (As Required)
E—Boom Cylinder-to-Boom Pin
F—Boom Cylinder (2 used)

Continued on next page

TX,33,UU3775 –19–21SEP98–2/5

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10

CAUTION: The approximate weight of boom is 1550 kg (3418 lb).

The approximate weight of arm cylinder is 290 kg (640 lb).

Boom—Specification

Weight.. 1550 kg (3418 lb) approximate

Arm Cylinder—Specification

Weight.. 290 kg (640 lb) approximate

10. Attach boom to hoist. Use a protective covering to prevent damage to pin if a chain is used.

    The arm end of boom is the heavy end with arm cylinder installed, The frame end is the heavy end when the arm cylinder is removed.

T6626JW –UN–31OCT88

Continued on next page TX,33,UU3775 –19–21SEP98–3/5

11. Remove nuts (C) and cap screws (A).

12. Remove pin (D) using a slide hammer and adapter. Remove any washers (B) between frame and boom.

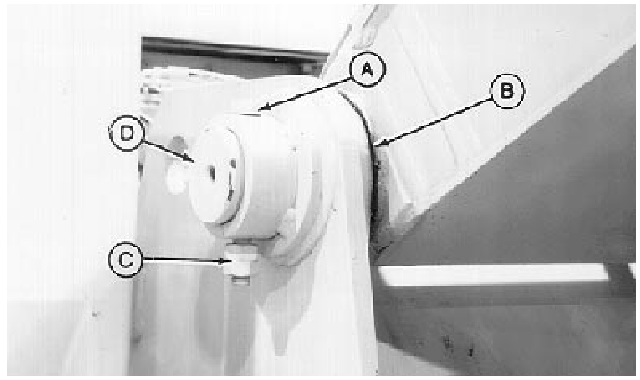
13. Inspect the bushings and dust seals. (See Inspect Arm and Boom Pins and Bushings in this group.)

    Repair or replace parts as necessary. (See Remove and Install Bushings and Seals in this group.)

14. Install washer (B) equally on each side of boom to get the minimal amount of clearance between boom and frame. There must be some clearance between boom and frame.

15. Before installing pin (D), align the pin bores so as not to damage the dust seal when pin is installed.

    Tighten the nuts (C) against each other (not against the retainer). Cap screw (A) must be free to turn in hole.



T105736 –UN–17DEC96

Boom-to-Frame Pin Nut—Specification

Torque .... 540 N•m (400 lb-ft) (tighten nut against nut, not the retainer)

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TX,33,UU3775 –19–21SEP98–4/5

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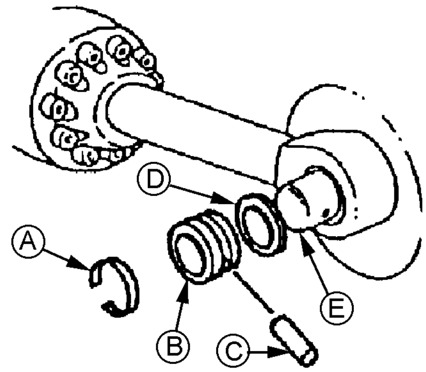
12

16. Install boom cylinders to boom.

    Install shims (D) equally on each side to get the minimum amount of clearance between boom and cylinder rod end. There must be some clearance between boom and cylinder rod end.

17. Apply grease to all lubrication fitting.



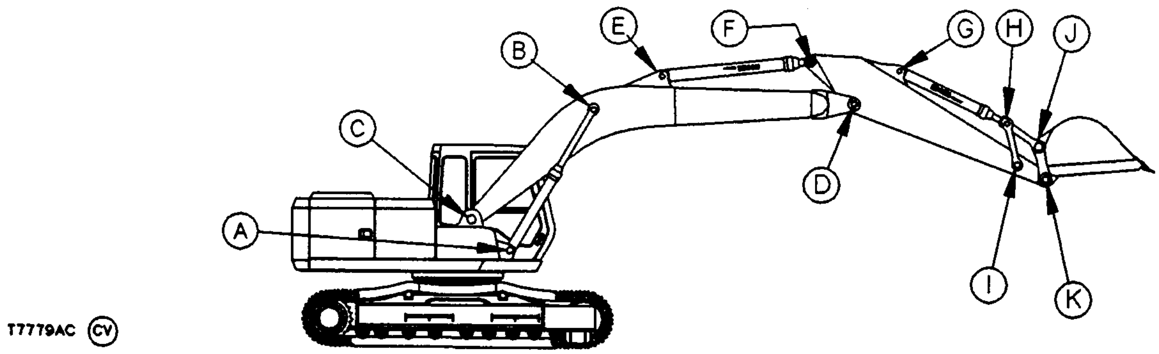
T105734

T105734 –UN–30DEC96

A—Retainer Ring (2 used)
B—Retainer (2 used)
C—Pin (2 used)
D—Shim (As Required)
E—Boom Cylinder-to-Boom Pin

TX,33,UU3775 –19–21SEP98–5/5

INSPECT BOOM, ARM, AND BUCKET PINS, BUSHINGS AND BOSSES



T7779AC –UN–11JUN92

A—Boom Cylinder Head End-to-Frame Joint
B—Boom Cylinder Rod End-to-Boom Joint
C—Boom-to-Frame Joint
D—Boom-to-Arm Joint
E—Arm Cylinder Head End-to-Boom Joint
F—Arm Cylinder Rod End-to-Arm Joint
G—Bucket Cylinder Head End-to-Arm Joint
H—Bucket Cylinder Rod End-to-Side and Center Links Joint
I—Side Links-to-Arm Joint
J—Center Link-to-Bucket Joint
K—Bucket-to-Arm Joint

Boom Cylinder Head End-to-Frame Joint Pin—Specification

OD.. 90.0 mm (3.54 in.) nominal
OD... 89.0 mm (3.50 in.) limit of use

Boom Cylinder Head End-to-Frame Joint Bushing—Specification

ID .... 90.0 mm (3.54 in.) nominal
ID .... 91.5 mm (3.60 in.) limit of use

Boom Cylinder Head End-to-Frame Joint Boss—Specification

ID .... 90.0 mm (3.54 in.) nominal
ID .... 91.5 mm (3.60 in.) limit of use

Boom Cylinder Rod End-to-Boom Joint Pin—Specification

OD.. 90.0 mm (3.54 in.) nominal
OD... 89.0 mm (3.50 in.) limit of use

Boom Cylinder Rod End-to-Boom Joint Bushing—Specification

ID .... 90.0 mm (3.54 in.) nominal
ID .... 91.5 mm (3.60 in.) limit of use

Boom-to-Frame Joint Pin—Specification

OD.. 100.0 mm (3.94 in.) nominal
OD... 99.0 mm (3.99 in.) limit of use

Boom-to-Frame Joint Bushing—Specification

ID .... 100.0 mm (3.94 in.) nominal
ID .... 101.5 mm (4.00 in.) limit of use

Boom-to-Arm Joint Pin—Specification

OD.. 90.0 mm (3.54 in.) nominal
OD... 89.0 mm (3.50 in.) limit of use

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14

Continued on next page CED,TX08227,3209 –19–17AUG98–1/3

Boom-to-Arm Joint Bushing—Specification

ID .... 90.0 mm (3.54 in.) nominal
ID .... 91.5 mm (3.60 in.) limit of use

Arm Cylinder Head End-to-Boom Joint Pin—Specification

OD... 80.0 mm (3.15 in.) nominal
OD.. 79.0 mm (3.11 in.) limit of use

Arm Cylinder Head End-to-Boom Joint Bushing—Specification

ID .... 80.0 mm (3.15 in.) nominal
ID .... 81.5 mm (3.21 in.) limit of use

Arm Cylinder Head End-to-Boom Joint Boss—Specification

ID .... 80.0 mm (3.15 in.) nominal
ID .... 81.5 mm (3.21 in.) limit of use

Arm Cylinder Rod End-to-Arm Joint Pin—Specification

OD... 80.0 mm (3.15 in.) nominal
OD.. 79.0 mm (3.11 in.) limit of use

Arm Cylinder Rod End-to-Arm Joint Bushing—Specification

ID .... 80.0 mm (3.15 in.) nominal
ID .... 81.5 mm (3.21 in.) limit of use

Arm Cylinder Rod End-to-Arm Joint Boss—Specification

ID .... 80.0 mm (3.15 in.) nominal
ID .... 81.5 mm (3.21 in.) limit of use

Bucket Cylinder Head End-to-Arm Joint Pin—Specification

OD... 80.0 mm (3.15 in.) nominal
OD.. 79.0 mm (3.11 in.) limit of use

Bucket Cylinder Head End-to-Arm Joint Bushing—Specification

ID .... 80.0 mm (3.15 in.) nominal
ID .... 81.5 mm (3.21 in.) limit of use

Bucket Cylinder Head End-to-Arm Joint Boss—Specification

ID .... 80.0 mm (3.15 in.) nominal
ID .... 81.5 mm (3.21 in.) limit of use

Bucket Cylinder Rod End-to-Side and Center Links Joint Pin—Specification

OD... 90.0 mm (3.54 in.) nominal
OD.. 89.0 mm (3.50 in.) limit of use

Bucket Cylinder Rod End-to-Side and Center Links Joint Bushings—Specification

ID .... 90.0 mm (3.54 in.) nominal
ID .... 91.5 mm (3.60 in.) limit of use

Side Links-to-Arm Joint Pin—Specification

OD... 80.0 mm (3.15 in.) nominal
OD.. 79.0 mm (3.11 in.) limit of use

Side Links-to-Arm Joint Bushing—Specification

ID .... 80.0 mm (3.15 in.) nominal
ID .... 81.5 mm (3.21 in.) limit of use

Center Link-to-Bucket Joint Pin—Specification

OD... 90.0 mm (3.54 in.) nominal
OD.. 89.0 mm (3.50 in.) limit of use

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15

Continued on next page CED,TX08227,3209 –19–17AUG98–2/3

Frames

Center Link-to-Bucket Joint Bushing—Specification

ID .... 90.0 mm (3.54 in.) nominal
ID .... 91.5 mm (3.60 in.) limit of use

Bucket-to-Arm Joint Pin—Specification

OD... 90.0 mm (3.54 in.) nominal
OD.. 89.0 mm (3.50 in.) limit of use

Bucket-to-Arm Joint Bushing—Specification

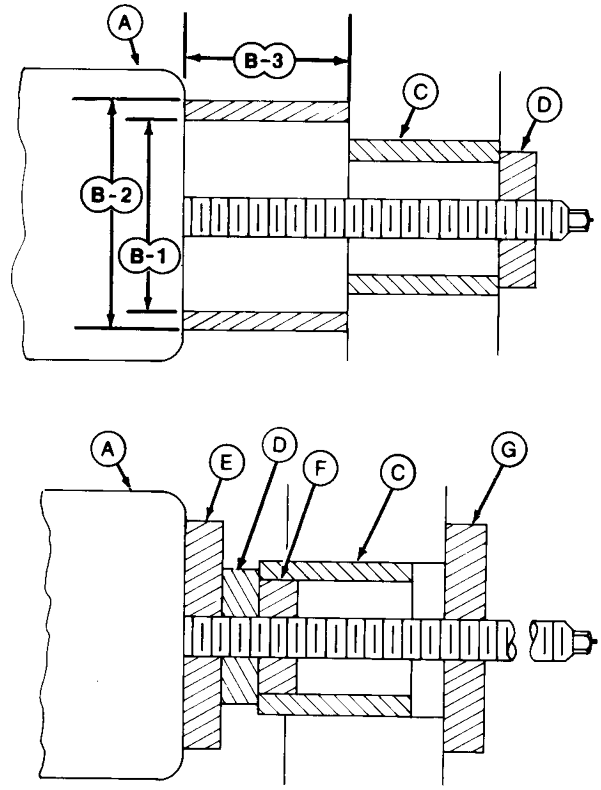
ID .... 90.0 mm (3.54 in.) nominal
ID .... 91.5 mm (3.60 in.) limit of use

CED,TX08227,3209 –19–17AUG98–3/3

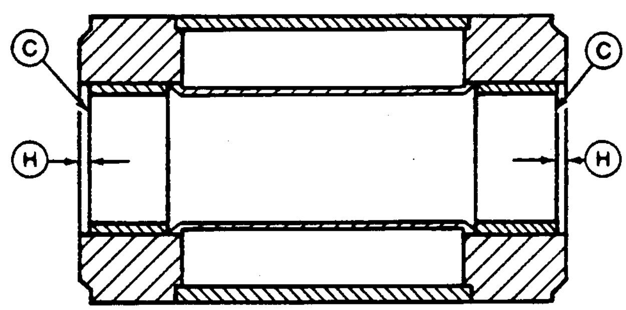
REMOVE AND INSTALL BUSHINGS AND SEALS

NOTE: Bushing can also be removed by welding three to five weld beads on the inside of bushing. Bushing will shrink enough to permit removal using a hammer.

1. Remove and install bushings (C) and dust seals using bushing, bearing, and seal driver set.
2. Install bushings with lubrication hole in alignment with lubrication passage in pivot.
3. Install bushing to a depth equal to the thickness of dust seal (H)
4. Install dust seals with lip towards the outside of component.



T95237 –UN–01NOV88



T6641CW –UN–31OCT88

A—Hydraulic Ram
B1—Pipe-Minimum ID to Clear Bushing OD
B2—Pipe-Maximum OD
B3—Pipe-Length of Bushing
C—Bushing
D—Disks
E—Bushing Stop (Disk)
F—Pilot (Disk)
G—Ram Stop (Disk)
H—Thickness of Dust Seal

33
3340
17

TX,33,UU3777 –19–25NOV96–1/1

Group 3360
Hydraulic System

ESSENTIAL TOOLS

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

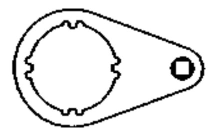
SERVICEGARD is a trademark of Deere & Company.

CED,OUOE003,1207 –19–22SEP98–1/3

T7782AH –UN–19JUN92

Spanner Wrench. JDG769

To remove and install bearing nut from drive shaft for propel motor or hydraulic pump.



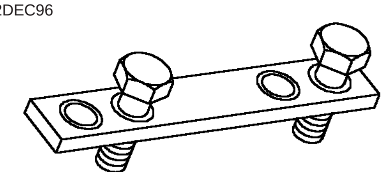
T7782AH (CV)

CED,OUOE003,1207 –19–22SEP98–2/3

T105612 –UN–12DEC96

Aligning Bar (Pump Timing Tool) JDG1054

To time the front and rear pump drive shafts for installation of drive and driven gears.



T105612

CED,OUOE003,1207 –19–22SEP98–3/3

SERVICE EQUIPMENT AND TOOLS

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

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CED,OUOE003,1208 –19–22SEP98–1/18

4 mm Hex Key Wrench

To loosen boom manual lower screw.

CED,OUOE003,1208 –19–22SEP98–2/18

Portable Filter Caddy

To clean contamination from the hydraulic system after a hydraulic component failure.

CED,OUOE003,1208 –19–22SEP98–3/18

3658 mm (12 ft) x 3/4 in. ID 100R1 Hose with 3/4 M NPT Ends (2 used)

To connect to the portable filter caddy.

CED,OUOE003,1208 –19–22SEP98–4/18

Metric Lifting Eyebolt (3 used) JT05550 (M12-1.75)

Used to remove hydraulic pump.

Continued on next page

CED,OUOE003,1208 –19–22SEP98–5/18

Two Temperature Heat Gun JT07010

To heat the pump housing for installation of drive shafts and bearings.

CED,OUOE003,1208 –19–22SEP98–6/18

6 mm Hex Key Wrench

To tighten hydraulic pump and drive gearbox servo piston-to-pin set screw.

CED,OUOE003,1208 –19–22SEP98–7/18

M8-1.25 Nut

To remove flow sense spool and sleeve from housing.

CED,OUOE003,1208 –19–22SEP98–8/18

M5-0.8 Cap Screw

To remove spacer from housing.

CED,OUOE003,1208 –19–22SEP98–9/18

M6-1.0 Cap Screw

To remove spacer from housing.

CED,OUOE003,1208 –19–22SEP98–10/18

Floor Stand

To support load of boom and boom cylinder.

Continued on next page CED,OUOE003,1208 –19–22SEP98–11/18

Cylinder Service Stand JT30043

To disassemble and assemble hydraulic cylinders.

CED,OUOE003,1208 –19–22SEP98–12/18

Hex Piston Nut Wrench JT30043-30

To remove and install rod-to-piston nut.

CED,OUOE003,1208 –19–22SEP98–13/18

Bushing, Bearing, and Seal Driver Set

To remove and install seals and bushings.

CED,OUOE003,1208 –19–22SEP98–14/18

Installer JDG841

To expand cap seal as it is pushed on the bucket cylinder piston.

CED,OUOE003,1208 –19–22SEP98–15/18

Installer JDG917

To expand cap seal as it is pushed on the boom cylinder piston.

Continued on next page CED,OUOE003,1208 –19–22SEP98–16/18

Installer JDG918

To expand cap seal as it is pushed on the arm cylinder piston.

CED,OUOE003,1208 –19–22SEP98–17/18

Pusher . . . . .JDG840-6 and JDG901-3

To push cap seal on cylinder pistons.

CED,OUOE003,1208 –19–22SEP98–18/18

OTHER MATERIAL

Number	Name	Use
TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®)	Pipe Sealant	Apply to drain plug for pump drive gearbox.
TY6347 (U.S.)	Multi-Purpose Grease	Apply to lips of oil seals. Apply to backup rings and O-rings. Apply to ends of pushers and U-joint.
T43512 (U.S.) TY9473 (Canadian) 242 (LOCTITE®)	Thread Lock and Sealer (Medium Strength)	Apply to threads of feedback link dowel pins in front and rear pump valve plates. Apply to threads of pin-to-servo piston set screw. Apply to threads of set screws in dampener drive hub. Apply to threads of U-joint in dig function pilot controller.
T43514 (U.S.) TY9475 (Canadian) 277 (LOCTITE®)	Plastic Gasket	Apply to mounting surface for pilot pump on pump drive gearbox.
T43513 (U.S.) TY9474 (Canadian) 271 (LOCTITE®)	Thread Lock and Sealer (High Strength)	Apply to threads of boom regenerative valve plugs in boom spool.

LOCTITE is a trademark of Loctite Corp.

CED,OUOE003,561 –19–18MAY98–1/1

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SPECIFICATIONS

Item	Measurement	Specification
Lower Boom (with Engine Stopped):		
Boom Manual Lower Screw	Torque	6.9 N•m (60 lb-in.)
Boom Manual Lower Screw-to-Housing Nut	Torque	13 N•m (115 lb-in.)
Hydraulic Oil Cleanup Procedure:		
Hydraulic Oil Tank Filtering	Capacity Time	148 L (30 gal) approximate 13 minutes approximate
Hydraulic System Filtering	Capacity Time	270 L (71 gal) approximate 43 minutes approximate
Hydraulic Pump and Drive Gearbox:		
Hydraulic Pump and Drive Gearbox	Weight	170 kg (375 lb) approximate
Pump Drive Gearbox-to-Flywheel Housing Cap Screw	Torque	49 N•m (36 lb-ft)
Pump Drive and Driven Gear	Backlash Backlash	0.68 mm (0.027 in.) nominal 1.50 mm (0.059 in.) limit of use
Cylinder Head	Weight	30 kg (66 lb) approximate
Rear Pump Drive Shaft Oil Seal Contact Surface	OD OD OD OD	45 mm (1.77 in.) nominal 44.8 mm (1.76 in.) limit of use 55 mm (2.17 in.) nominal 54.8 mm (2.16 in.) limit of use
Front Pump Drive Shaft Oil Seal Contact Surface	OD OD	55 mm (2.17 in.) nominal 54.8 mm (2.16 in.) limit of use
Piston-to-Drive Shaft Socket	Play Play	0.058 mm (0.0023 in.) nominal 0.400 mm (0.0157 in.) limit of use

33
3360
7

Continued on next page CED,OUOE003,1209 –19–22SEP98–1/10

Item	Measurement	Specification
Cylinder Block Bore-to-Piston	Clearance Clearance	0.043 mm (0.0032 in.) nominal 0.080 mm (0.0032 in.) limit of use
Piston-to-Connecting Rod	Play Play	0.150 mm (0.0059 in.) nominal 0.400 mm (0.0157 in.) limit of use
Servo Piston-to-Cylinder Head Bore	Clearance Clearance	0.079 mm (0.0033 in.) nominal 0.200 mm (0.0078 in.) limit of use
Servo Piston Pin-to-Valve Plate Bore	Clearance Clearance	0.051 mm (0.0020 in.) nominal 0.300 mm (0.0118 in.) limit of use
Roller Bearing Heat	Temperature	50—80°C (122—176°F)
Pump Drive Shaft Bearing Nut	Rolling Drag Torque	2.16 ± 0.49 N•m (19 ± 4 lb-in.)
Pump Housing Heat	Temperature	50—80°C (122—176°F)
Special Plug-to-Pump Housing Special Fitting	Torque	34 N•m (300 lb-in.)
Dowel Pin-to-Front and Rear Pump Valve Plate	Torque	9.8 N•m (86 lb-in.)
Servo Piston-to-Pin Set Screw	Torque	34 N•m (300 lb-in.)
Stop and Cover-to-Cylinder Head Cap Screw	Torque	19.5 N•m (180 lb-in.)
Cylinder Head-to-Pump Housing Cap Screw	Torque	108 N•m (80 lb-ft)
Regulator-to-Pump Housing Cap Screw	Torque	49 N•m (36 lb-ft)
Pump Pressure Sensor-to-Pump Housing	Torque	98 N•m (72 lb-ft)
Pump Housing-to-Gearbox Cap Screw	Torque	147 N•m (109 lb-ft)
Pilot Pump-to-Gearbox Cap Screw	Torque	49 N•m (36 lb-ft)

Continued on next page CED,OUOE003,1209 –19–22SEP98–2/10

Item	Measurement	Specification
Dampener Drive Hub-to-Rear Pump Drive Shaft Set Screw	Torque	108 N•m (80 lb-ft)
Front and Rear Pump Regulator:		
End Plate and Cover-to-Housing Cap Screw	Torque	19.8 N•m (180 lb-in.)
Housing-to-Pump Housing Cap Screw	Torque	49 N•m (36 lb-ft)
Air Bleed Plug-to-Housing	Torque	78 N•m (58 lb-ft)
Pilot Pump:		
Pump-to-Drive Gearbox Cap Screw	Torque	49 N•m (36 lb-ft)
Cover-to-Flange Cap Screw	Torque	41 N•m (31 lb-ft)
Pilot Pressure Regulating Valve and Filter:		
Housing-to-Filter Head Cap Screw	Torque	20 N•m (175 lb-in.)
Pilot Filter Element Housing-to-Filter Head	Torque	25 N•m (220 lb-in.)
Filter Head-to-Support Cap Screw	Torque	49 N•m (36 lb-ft)
Plug-to-Housing	Torque	49 N•m (36 lb-ft)
Pilot Shut-Off Valve:		
Housing-to-Cab Platform Cap Screw	Torque	49 N•m (36 lb-ft)
Linkage Adjustment	Clearance	1.5 ± 0.5 mm (0.06 ± 0.02 in.) between lever and cap screw
Proportional Solenoid Valve:		
Valve Housing-to-Solenoid Valve Manifold Cap Screw	Torque	3 N•m (24 lb-in.)

Continued on next page

Hydraulic System

Item	Measurement	Specification
Dig Function Pilot Controller:		
Bottom Plate-to-Housing Cap Screw	Torque	49 N•m (36 lb-ft)
U-Joint-to-Housing	Torque	24 N•m (216 lb-in.)
Cam-to-Pushers	Clearance	0—0.20 mm (0—0.008 in.)
Coupling-to-Cam and U-Joint	Torque	78 N•m (58 lb-ft)
Propel Pilot Controller:		
Controller-to-Cab Platform Cap Screw	Torque	49 N•m (36 lb-ft)
Propel Pedal-to-Lever Cap Screw	Torque	49 N•m (36 lb-ft)
Holder-to-Housing Cap Screw	Torque	49 N•m (36 lb-ft)
Plug-to-Housing	Torque	34 N•m (25 lb-ft)
Flow Regulator Valve:		
Arm In Plunger Orifice	Size	3.2 mm (0.126 in.)
Boom Up Plunger Orifice	Size	2.5 mm (0.098 in.)
3/8 in. Plug for Plunger-to-Housing	Torque	49 N•m (36 lb-ft)
Check Valve-to-Housing Plug	Torque	10 N•m (86 lb-in.)
Orifice-to-Housing	Torque	10 N•m (86 lb-in.)
Control Valve:		
Control Valve	Weight	240 kg (530 lb) approximate
Mounting Bracket-to-Valve Housing Cap Screw	Torque	205 N•m (150 lb-ft)
Split Flange Fitting-to-Housing M10 Cap Screw	Torque	64 N•m (47 lb-ft)

Continued on next page

CED,OUOE003,1209 –19–22SEP98–4/10

Item	Measurement	Specification
Split Flange Fitting-to-Housing M12 Cap Screw	Torque	108 N•m (80 lb-ft)
Pump Control Valve-to-Housing Plug	Torque	84 N•m (62 lb-ft)
Pilot Plate-to-Housing Cap Screw	Torque	78 N•m (58 lb-ft)
Plug-to-Propel Flow Control Valve Pilot Plate	Torque	98 N•m (72 lb-ft)
Circuit Relief and Anti-Cavitation Valve-to-Housing	Torque	83 N•m (61 lb-ft)
System Relief Valve 27 mm Nut	Torque	64 N•m (47 lb-ft)
System Relief Valve 32 mm Nut	Torque	83 N•m (61 lb-ft)
System Relief Valve-to-Housing	Torque	83 N•m (61 lb-ft)
Arm In Reduced Leakage Valve-to-Housing Cap Screw	Torque	78 N•m (58 lb-ft)
Plug-to-Arm In Reduced Leakage Valve	Torque	29 N•m (255 lb-in.)
Spacer-to-Arm Regenerative Valve Spool	Torque	18.6 N•m (165 lb-in.)
Special Cap Screw-to-Control Valve Spool	Torque	15 N•m (133 lb-in.)
Pilot Cap-to-Control Valve Housing Cap Screw	Torque	78 N•m (58 lb-ft)
Plug-to-Front Pump Control Valve	Torque	84 N•m (62 lb-ft)
Plug-to-Bucket Flow Control Valve Poppet	Torque	39 N•m (348 lb-in.)
Bucket Flow Control Valve Housing-to-Control Valve Housing Cap Screw	Torque	78 N•m (58 lb-ft)

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3360
11

Continued on next page CED,OUOE003,1209 –19–22SEP98–5/10

Item	Measurement	Specification
Pilot Valve-to-Bucket Flow Control Valve Housing Plug	Torque	71 N•m (52 lb-ft)
Flow Combiner Valve Spool-to-Control Valve Housing Plug	Torque	157 N•m (116 lb-ft)
Pilot Pressure Inlet Fitting and Filter-to-Control Valve Housing	Torque	76 N•m (56 lb-ft)
Circuit Relief and Anti-Cavitation Valve-to-Housing	Torque	83 N•m (62 lb-ft)
Boom Regenerative Valve-to-Control Valve Spool Plug	Torque	15 N•m (130 lb-in.)
Boom Reduced Leakage Valve Housing-to-Housing Cap Screw	Torque	78 N•m (58 lb-ft)
Spool-to-Boom Reduced Leakage Valve Housing Plug	Torque	29 N•m (255 lb-in.)
Boom Manual Lower Screw-to-Housing	Torque	6.9 N•m (60 lb-in.)
Boom Manual Lower Screw-to-Housing Lock Nut	Torque	13 N•m (115 lb-in.)
Special Cap Screw-to-Control Valve Spool	Torque	15 N•m (133 lb-in.)
Pilot Cap-to-Housing Cap Screw	Torque	78 N•m (58 lb-ft)
System Relief Valve Isolation Check Valve Cover-to-Control Valve Housing Cap Screw	Torque	61 N•m (45 lb-ft)
Flow Combiner Valve Check Valve-to-Control Valve Housing Cap Screw	Torque	61 N•m (45 lb-ft)
Propel Flow Control Valve and Orifice Fitting	Torque	76 N•m (56 lb-ft)

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12

Continued on next page

CED,OUOE003,1209 –19–22SEP98–6/10

Hydraulic System

Item	Measurement	Specification
Front and Rear Pump Control Valve-to-Control Valve Housing Fitting	Torque	34 N•m (25 lb-ft)
System Relief Valve:		
System Relief Valve 27 mm Nut	Torque	64 N•m (47 lb-ft)
System Relief Valve 32 mm Nut	Torque	83 N•m (61 lb-ft)
System Relief Valve Cartridge-to-Housing	Torque	83 N•m (61 lb-ft)
Circuit Relief and Anti-Cavitation Valve:		
Adjusting Screw-to-Plug Nut	Torque	29.5 N•m (264 lb-in.)
Circuit Relief and Anti-Cavitation Valve-to-Housing	Torque	83 N•m (62 lb-ft)
Hydraulic Oil Tank:		
Hydraulic Oil Tank	Weight	147 kg (325 lb) approximate
Frame-to-Oil Tank Cap Screw	Torque	205 N•m (152 lb-ft)
Return Line-to-Oil Tank Coupling Nut	Torque	10.3—12.4 N•m (91—110 lb-in.)
Oil Tank Elbow-to-Suction Line T-Bolt Type Clamp	Torque	4.4 N•m (40 lb-in.)
Oil Tank Elbow-to-Suction Line Worm Gear Type Clamp	Torque	5.9—6.9 N•m (52—61 lb-in.)
Cover-to-Hydraulic Oil Tank Cap Screw	Torque	49 N•m (36 lb-ft)
Rod and Suction Strainer	Length	683 mm (26.9 in.)
Rod-to-Suction Strainer Nut	Torque	17 N•m (153 lb-in.)

Continued on next page

CED,OUOE003,1209 –19–22SEP98–7/10

Hydraulic System

Item	Measurement	Specification
Return Filter and Bypass Valve:		
Filter Bypass Valve-to-Cover Cap Screw	Torque	49 N•m (36 lb-ft)
Suction Filter:		
Rod and Suction Strainer	Length	683 mm (26.9 in.)
Rod-to-Suction Strainer Nut	Torque	17 N•m (153 lb-in.)
Cover-to-Oil Tank Cap Screw	Torque	49 N•m (36 lb-ft)
Swing Motor Make-Up Oil Restriction Valve:		
Oil Cooler-to-Hydraulic Oil Tank Return Line Coupling Nut	Torque	10.3—12.4 N•m (91—110 lb-in.)
Oil Cooler Bypass Valve:		
Control Valve-to-Hydraulic Oil Tank Return Line Coupling Nut	Torque	10.3—12.4 N•m (91—110 lb-in.)
Oil Cooler:		
Radiator and Oil Cooler	Weight	65 kg (140 lb) approximate
Line-to-Oil Cooler Coupling Nut	Torque	10.3—12.4 N•m (91—110 lb-in.)
Upper and Lower Radiator Hose-to-Radiator Worm Gear Type Clamp	Torque	5.9—6.9 N•m (52—61 lb-in.)
Boom Cylinder:		
Boom Cylinder	Weight	220 kg (485 lb) approximate
Boom Cylinder Piston-to-Rod Nut	Torque	4780 N•m (3525 lb-ft)
Boom Cylinder Head End and Rod End Bushing	ID ID	90.0 mm (3.54 in.) nominal 91.5 mm (3.60 in.) limit of use

Continued on next page

Item	Measurement	Specification
Boom Rod	Curvature	0.5 mm per 1 m (0.020 in. per 3.25 ft)
Boom Rod Allowable Scratch	Depth	0.1 mm (0.004 in.) (enough to detect by a fingernail)
Boom Rod	OD	90 ± 0.03 mm (3.543 ± 0.001 in.)
Boom Cylinder Piston-to-Rod Nut	Torque	4780 N•m (3525 lb-ft)
Boom Cylinder Nut-to-Rod Set Screw	Torque	57 N•m (42 lb-ft)
Boom Cylinder Rod Guide-to-Barrel Cap Screw	Torque	265 N•m (195 lb-ft)
Arm Cylinder:		
Arm Cylinder	Weight	290 kg (640 lb) approximate
Arm Cylinder Piston-to-Rod Nut	Torque	9460 N•m (6980 lb-ft)
Arm Cylinder Head End or Rod End Bushing	ID ID	80.0 mm (3.15 in.) nominal 81.5 mm (3.21 in.) limit of use
Arm Rod	Curvature	0.5 mm per 1 m (0.020 in. per 3.25 ft)
Arm Rod Allowable Scratch	Depth	0.1 mm (0.004 in.) (enough to detect by a fingernail)
Arm Rod	OD	100 ± 0.03 mm (3.937 ± 0.001 in.)
Arm Cylinder Piston-to-Rod Nut	Torque	9460 N•m (6980 lb-ft)
Arm Cylinder Nut-to-Rod Set Screw	Torque	57 N•m (42 lb-ft)
Arm Cylinder Rod Guide-to-Barrel Cap Screw	Torque	365 N•m (270 lb-ft)

Continued on next page

Hydraulic System

Item	Measurement	Specification
Bucket Cylinder:		
Bucket Cylinder	Weight	190 kg (420 lb) approximate
Bucket Cylinder Piston-to-Rod Nut	Torque	5640 N•m (4160 lb-ft)
Bucket Cylinder Head End Bushing	ID ID	80.0 mm (3.15 in.) nominal 81.5 mm (3.21 in.) limit of use
Bucket Cylinder Rod End Bushing	ID ID	90.0 mm (3.54 in.) nominal 91.5 mm (3.60 in.) limit of use
Bucket Rod	Curvature	0.5 mm per 1 m (0.020 in. per 3.25 ft)
Bucket Rod Allowable Scratch	Depth	0.1 mm (0.004 in.) (enough to detect by a fingernail)
Bucket Rod	OD	85 ± 0.03 mm (3.346 ± 0.001 in.)
Bucket Cylinder Piston-to-Rod Nut	Torque	5640 N•m (4160 lb-ft)
Bucket Cylinder Nut-to-Rod Set Screw	Torque	57 N•m (42 lb-ft)
Bucket Cylinder Rod Guide-to-Barrel Cap Screw	Torque	170 N•m (125 lb-ft)

CED,OUOE003,1209 –19–22SEP98–10/10

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16

CONTROL LEVER PATTERN CONVERSION

To change your machine pilot control levers from the standard pattern to a John Deere pattern:

1. Lower bucket to the ground.

2. Turn auto-idle switch off. Run engine with engine rpm dial at 1/3 position without load for 2 minutes.

3. Turn engine rpm dial to slow idle position. Turn key switch to OFF to stop engine. Remove key from switch.

4. Pull pilot control shut-off lever to LOCK position.

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

5. Release air pressure from hydraulic oil tank by loosing vent plug.

6. Open door on storage compartment behind cab.

7. Remove cover above flow regulator valve.

TX,15,GG2237 –19–07SEP96–1/2

NOTE: Do not use manufacturer's identification tags or markings on line ends to identify lines for this conversion procedure. The conversion must be done on the front (cab side) of flow regulator valve.

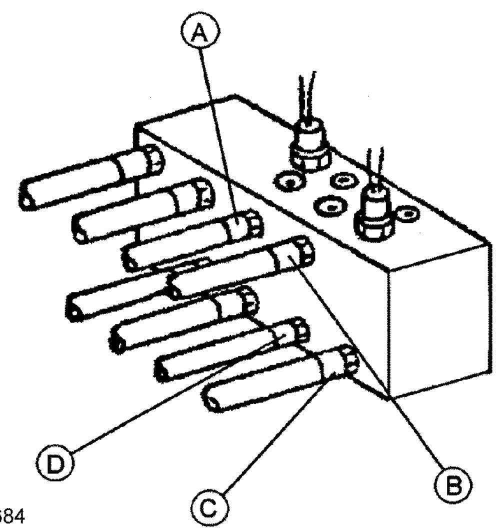
8. Hoses are switched in a X pattern.

   Switch hose (A) with hose (C).

   Switch hose (B) with hose (D).

CAUTION: Prevent injury from unexpected control lever function. Install new decals on control consoles.

9. Install new decals (black on yellow) on control consoles near the base of control levers. Decals are enclosed in Operator's Manual package. Additional decals are available through parts.



T102684

T102684 –UN–07AUG96

A—Hose
B—Hose
C—Hose
D—Hose

TX,15,GG2237 –19–07SEP96–2/2

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HYDRAULIC SYSTEM WARM-UP PROCEDURE

SPECIFICATIONS	
Hydraulic System Warm-Up Oil Temperature	50 ± 5°C (120 ± 10°F)

SERVICE EQUIPMENT AND TOOLS
JT05800 Digital Thermometer

IMPORTANT: If the machine temperature is below -18 degrees C (0°F), start the engine with the speed control in the idle position. If the unit has been prepared for arctic operation with the MIL-L-46167 hydraulic oil, the suction strainer in the hydraulic tank should also have been changed to the coarser strainer for use in arctic conditions. Failure to do this could cause the hydraulic pump to cavitate which can cause pump failure. Operate engine at idle speed for at least 10 minutes before increasing the speed to half. Cover the radiator and oil cooler debris screens to restrict the air flow for faster warmup.

Below -18°C (0°F) an extended warm-up period may be necessary. Hydraulic function will move slowly and lubrication of parts may not be adequate with cold oil. Do not attempt normal machine operation until hydraulic functions move at or close to normal cycle times.

Hydraulic System Warm-Up Oil—Specification

Temperature .... 50 ± 5°C (120 ± 10°F)

Operate functions slowly and avoid sudden movements until engine and hydraulic oils are thoroughly warmed. Operate a function by moving it a short distance in each direction. Continue operating the function increasing the distance traveled in each cycle until full stroke is reached.

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18

For faster warm-up, restrict air flow through oil cooler using cardboard or other similar material. Use correct viscosity oil to minimize warm-up period. (See Hydraulic Oil in Group 9000-04.)

1. Connect digital thermometer. Install temperature probe on hydraulic oil tank-to-pump inlet line. (See JT05800 Digital Thermometer Installation in this group.)

CAUTION: Avoid possible serious injury from machine movement during warm-up procedure. Clear the area of all bystanders before doing the warm-up procedure.

2. Clear the area of all bystanders to allow for machine movement.

3. Start engine. Run engine at 1/2 speed for approximately 5 minutes before operating any functions. Do not run engine at fast or slow idle.

4. Check that work mode is in Dig Mode and power mode is in Standard Mode (no buttons pushed down, indicator lights off). Push auto-idle switch to turn off auto-idle function (auto-idle indicator off).

5. Slowly turn upperstructure so boom is to the side.

CAUTION: Avoid possible serious injury from machine sliding backwards. Keep angle between boom and arm at 90—110°

6. Keeping the angle between boom and arm at 90—110°, lower boom to raise one track off the ground.

7. Operate propel function for approximately 5 minute.

8. Once oil temperature is above -18°C (0°F), increase engine speed to fast idle.

Continued on next page TX,25,GG2232 –19–13AUG98–1/2

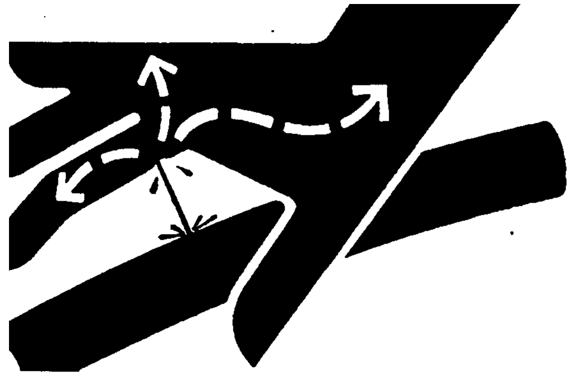
IMPORTANT: Holding a function over relief for more than 10 seconds can cause damage from hot spots in the control valve.

9. Operate the propel function (side with track off the ground). Also operate the bucket curl function over relief for 10 seconds and then stop for 5 seconds. Repeat the cycle until oil is heated to specifications.

10. Stop periodically and operate all hydraulic functions to distribute the heated oil.

TX,25,GG2232 –19–13AUG98–2/2

LOWER BOOM WITH ENGINE STOPPED (USING BOOM CYLINDER LOAD LOWERING VALVE)



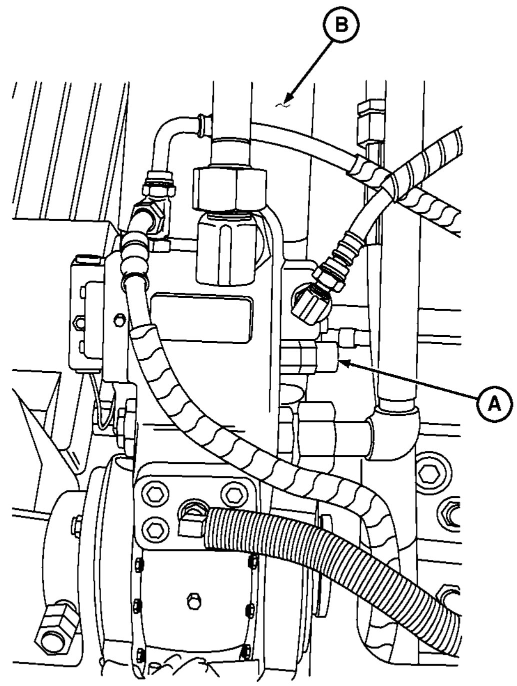
When an engine stops during operation, the boom cannot be lowered using the pilot controller because there is no pilot pressure oil to move the boom valve spool or to unlatch the boom load lowering valves.

CAUTION: Prevent possible injury from unexpected machine movement. Clear all persons from the area before lowering the boom with the engine stopped.

To avoid injury from escaping fluid under pressure, stop engine and relieve the pressure in the system before disconnecting or connecting hydraulic or other lines. Tighten all connections before applying pressure.

1. Loosen jam nut on relief valve (A). Back off relief valve set screw, counting number of turns, until boom starts to lower slowly.

2. After bucket is on ground, reset relief valve (A) by turning set screw clockwise the same number of turns noted in step 1 and lock jam nut.



T127544

A—Relief Valve
B—Boom Cylinder

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3360
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CED,OUOEBAS,5 –19–21JAN00–1/1

LOWER BOOM WITH ENGINE STOPPED (WHEN NOT EQUIPPED WITH BOOM CYLINDER LOAD LOWERING VALVE)

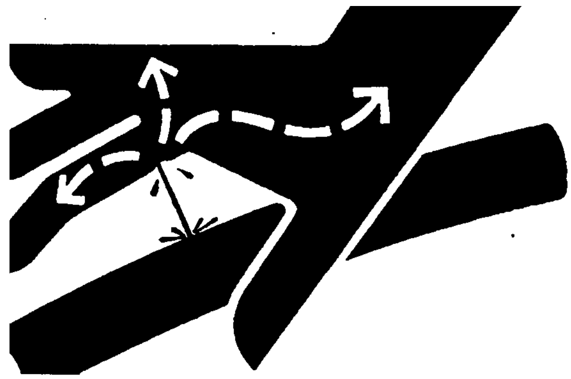
When an engine stops during operation, the boom cannot be lowered using the pilot controller because there is no pilot pressure oil to move the boom valve spool.

CAUTION: Prevent possible injury from unexpected machine movement. Clear all persons from the area before lowering the boom with the engine stopped.

1. Remove the control valve access cover.

Continued on next page CED,OUOEBAS,10 –19–25JAN00–1/2

CAUTION: To avoid injury from escaping fluid under pressure, never loosen screw more than two turns as screw may come out. Tighten screw and nut before applying pressure.


X9811 –UN–23AUG88

2. Loosen the small nut (B) on the boom reduced leakage valve housing (C).

   Slowly loosen boom manual lower screw (A) 1/2 turn using a 4 mm hex key wrench. The boom will start to lower.

   The boom lowering speed can be increased somewhat by loosening screw an additional 1-1/2 turns. Never loosen screw more than two turns.

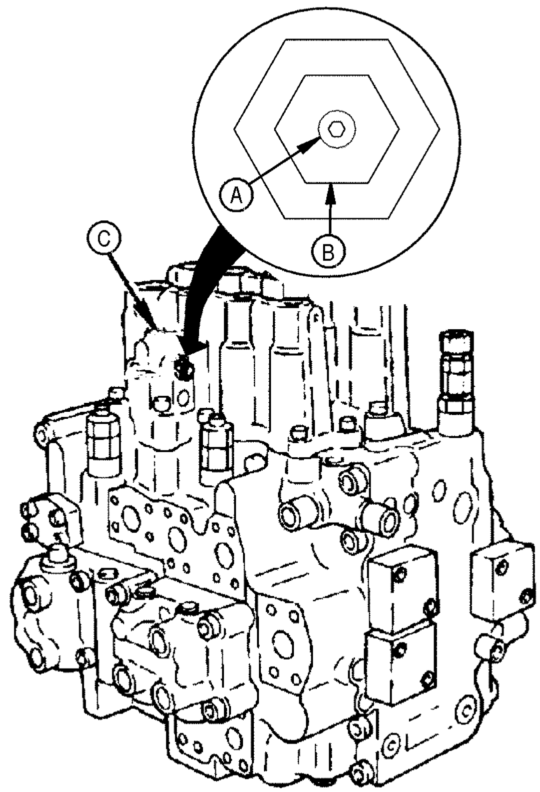
3. After the bucket is lowered to the ground, tighten the screw to specification, and then the nut.

Boom Manual Lower Screw—Specification

Torque .... 6.9 N•m (60 lb-in.)

Boom Manual Lower Screw-to-Housing Nut—Specification

Torque .... 13 N•m (115 lb-in.)



T102664 –UN–07AUG96

Boom Manual Lower Screw

A—Boom Manual Lower Screw
B—Small Nut
C—Boom Reduced Leakage Valve Housing

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CED,OUOE003,1198 –19–21SEP98–2/2

HYDRAULIC OIL CLEANUP PROCEDURE USING PORTABLE FILTER CADDY

1. Install new return filter elements.

NOTE: For a failure that creates a lot of debris, remove access cover from hydraulic tank. Drain hydraulic tank. Connect filter caddy suction line to drain port. Add a minimum of 19 L (5 gal) of oil to reservoir. Operate filter caddy and wash out the hydraulic tank.

IMPORTANT: The minimum inside diameter for a connector is 13 mm (1/2 in.) to prevent cavitation of filter caddy pump.

2. Put filter caddy suction and discharge wands into hydraulic tank filler hole so ends are as far apart as possible to obtain a thorough cleaning of oil.

3. Start the filter caddy. Check to be sure oil is flowing through the filters.

   Operate filter caddy until all the oil in hydraulic tank has been circulated through the filter a minimum of four times.

Hydraulic Oil Tank Filtering—Specification

Capacity	148 L (30 gal) approximate
Time	13 minutes approximate

NOTE: Filtering time for hydraulic tank is 0.089 minute x number of liters (0.33 minutes x number of gallons).

4. Leave filter caddy operating for the next step.

5. Start the engine and run it at fast idle.

IMPORTANT: For the most effective results, cleaning procedure must start with the smallest capacity circuit then proceed to the next larger capacity circuit.

6. Starting with the smallest capacity circuit, operate each function through a complete cycle.

   Repeat procedure until the total system capacity has circulated through filter caddy seven times. Each function must go through a minimum of three complete cycles for a thorough cleaning of oil.

Hydraulic System Filtering—Specification

Capacity	270 L (71 gal) approximate
Time	43 minutes approximate

NOTE: Filtering time for complete hydraulic system is 0.158 minute x number of liters (0.6 minute x number of gallons). Filtering time for machines with auxiliary hydraulic functions must be increased because system capacity is larger.

7. Stop the engine. Remove the filter caddy.

8. Install new return filter elements.

9. Check oil level in hydraulic tank, add oil if necessary. (See Hydraulic Oil in Group 0004.)

TX,33,UU3780 –19–21SEP98–1/1

REMOVE AND INSTALL HYDRAULIC PUMP AND DRIVE GEARBOX

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

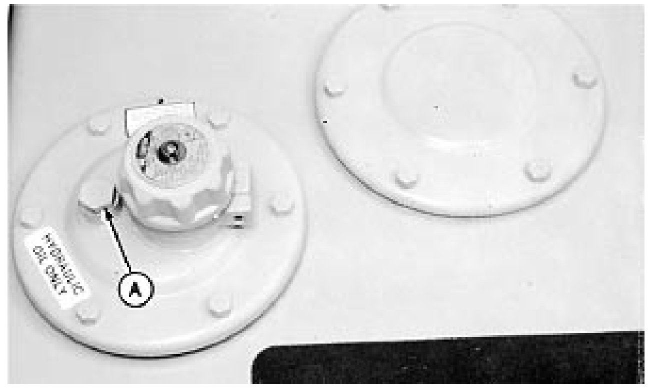
1. Loosen vent plug (A) to release air pressure in hydraulic oil tank.

2. Drain hydraulic oil tank. Approximate oil capacity is 148 L (39 gal).

3. Drain pump drive gearbox. Approximate oil capacity is 1.0 L (1.1 qt).

4. Remove the hood. Remove the hood support and covers.

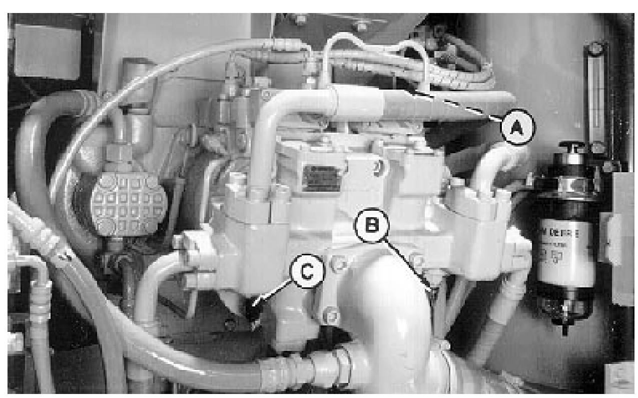
5. Remove the muffler and muffler bracket.



A—Vent Plug

TX,33,UU3781 –19–21SEP98–1/4

6. Disconnect wiring harness connectors from engine speed sensor (A) and pump pressure sensors (B and C). Remove wiring harness clamps from pump housing.



A—Engine Speed Sensor
B—Front Pump Pressure Sensor
C—Rear Pump Pressure Sensor

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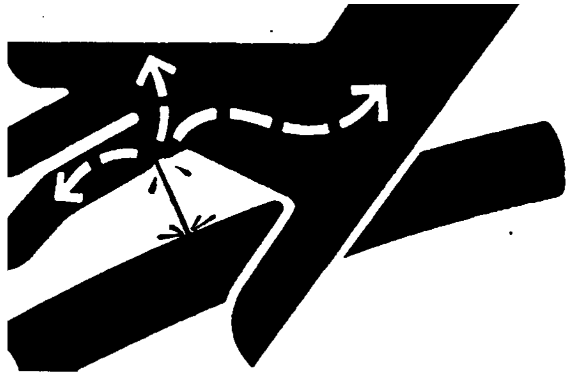
TX,33,UU3781 –19–21SEP98–2/4

CAUTION: To avoid injury from escaping fluid under pressure, stop engine, and relieve the pressure in the system before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.



X9811 –UN–23AUG88

7. Disconnect lines (D, E and G—N).

CAUTION: The approximate weight of hydraulic pump and drive gearbox is 170 kg (375 lb).

Hydraulic Pump and Drive Gearbox—Specification

Weight... 170 kg (375 lb) approximate

8. Install M12-1.75 metric lifting eyebolts, such as JT05550 Metric Lifting Eyebolts, in tapped holes in air bleed plugs (F) and pump drive gearbox housing. Connect a hoist to eyebolts using lifting straps.

9. Remove pump drive gearbox-to-flywheel cap screw to remove pump. Repair or replace pump.

10. Tighten pump drive gearbox-to-flywheel cap screw.

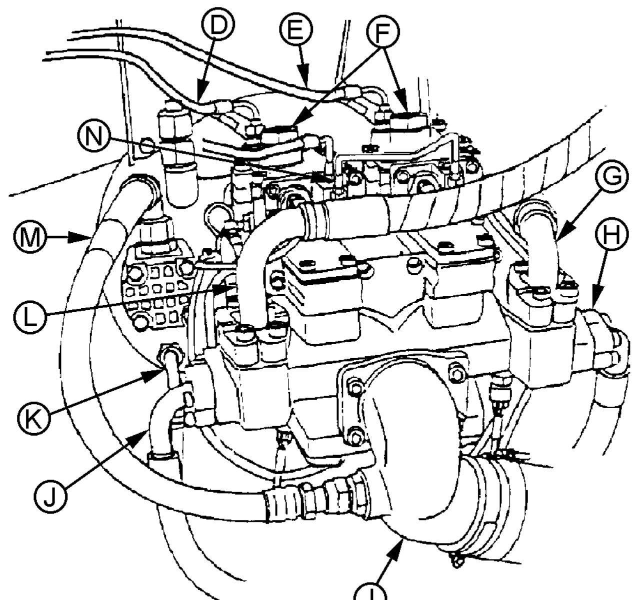
Pump Drive Gearbox-to-Flywheel Housing Cap Screw—Specification

Torque .... 49 N•m (36 lb-ft)

IMPORTANT: Hydraulic pump and drive gearbox will be damaged if not filled with oil before starting engine. Procedure must be performed whenever a new pump or gearbox is installed or oil has been drained from the pump, gearbox or hydraulic oil tank.

11. Fill pump housing and pump drive gearbox with oil. (See Hydraulic Pump and Drive Gearbox Start-Up Procedure in this group.)

    Apply pipe sealant to drain plug threads.



T105620

T105620 –UN–11DEC96

D—Regulator-to-Rear Pump Control Valve Line
E—Regulator-to-Front Pump Control Valve Line
F—Air Bleed Plugs
G—Front Pump Outlet-to-Right Control Valve Line
H—Attenuator Line
I—Inlet-to-Hydraulic Oil Tank Line
J—Attenuator Line
K—Pilot Pump Outlet-to-Pilot Filter Line
L—Rear Pump Outlet-to-Left Control Valve
M—Pilot Pump Inlet Line
N—Regulator-to-Speed Sensing Solenoid Valve Line

Continued on next page

TX,33,UU3781 –19–21SEP98–3/4

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12. Check pump regulator adjustments. (See Hydraulic Pump Regulator Test and Adjustments in Group 9025-25.)

TX,33,UU3781 –19–21SEP98–4/4

HYDRAULIC PUMP AND DRIVE GEARBOX START-UP PROCEDURE

IMPORTANT: Hydraulic pump and drive gearbox will be damaged if not filled with oil before starting engine. Procedure must be performed whenever a new pump or gearbox is installed or oil has been drained from the pump, gearbox or hydraulic oil tank.

Procedure is to ensure the pumps and gearbox are filled with oil and air is bled from suction side of pumps to prevent cavitation.

1. Remove air bleed plugs (C) from the top of pump regulators to allow housing to fill with oil from the hydraulic oil tank and to let air escape.

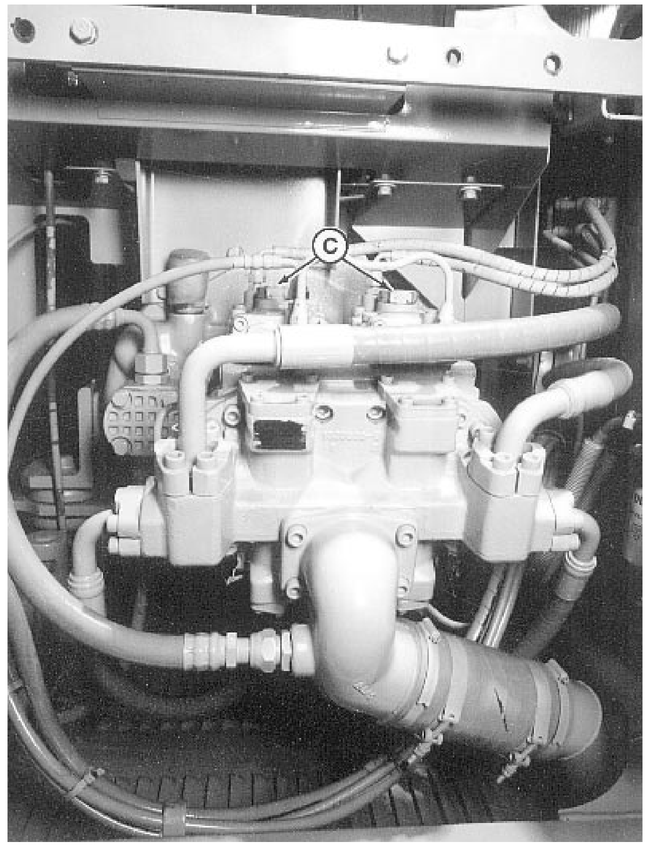
2. When pump housing is full of oil, install plugs.

3. As necessary, add oil to hydraulic oil tank until it is between marks on sight glass. (See Hydraulic Oil in Group 0004.) Tighten tank cap. Tighten vent plug.

4. Start engine and run at slow idle. Slowly raise boom to full height and then lower to pressurize hydraulic oil tank.

5. Purge air from the hydraulic system by slowly operating each function through three cycles. Air in pilot circuits are purged automatically.

6. Fill pump drive gearbox with oil through filler pipe (B) so level is above “H” mark on dipstick (A). (See Diesel Engine and Pump Gearbox Oils in Group 0004.)



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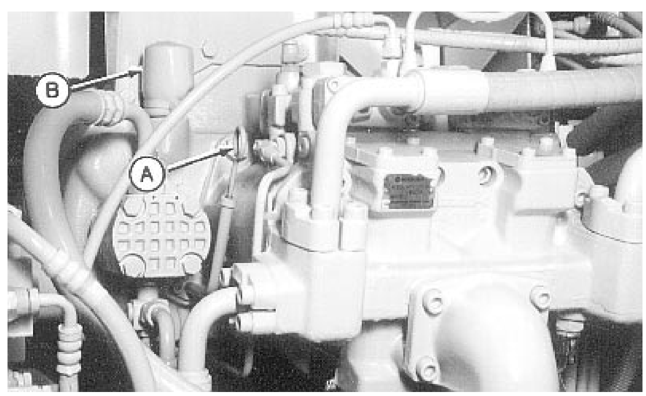
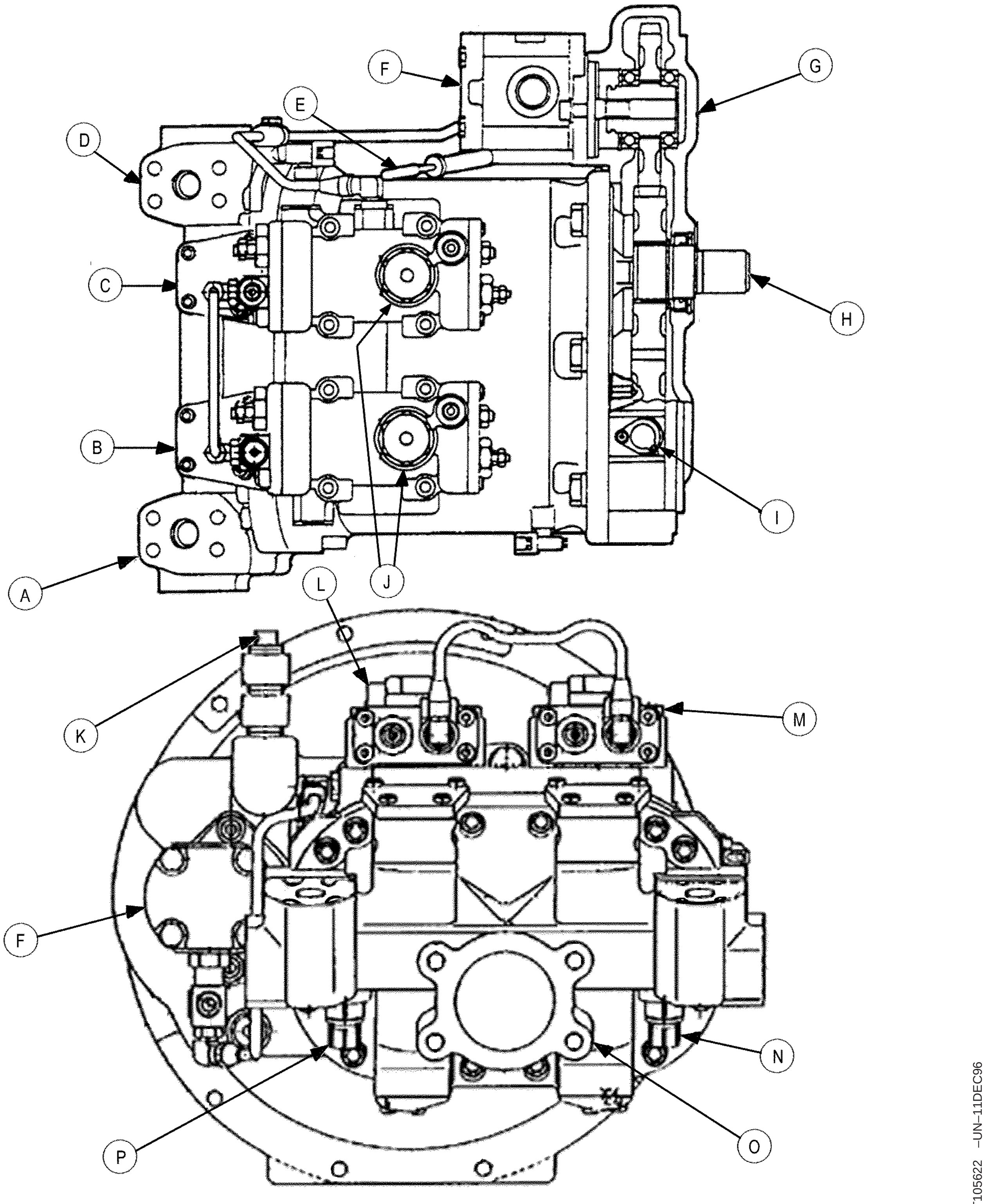


T101493 –UN–15JUL96

A—Dipstick
B—Filler Pipe
C—Air Bleed Plugs

TX,33,UU3782 –19–21SEP98–1/1

DISASSEMBLE HYDRAULIC PUMP AND DRIVE GEARBOX



T105622

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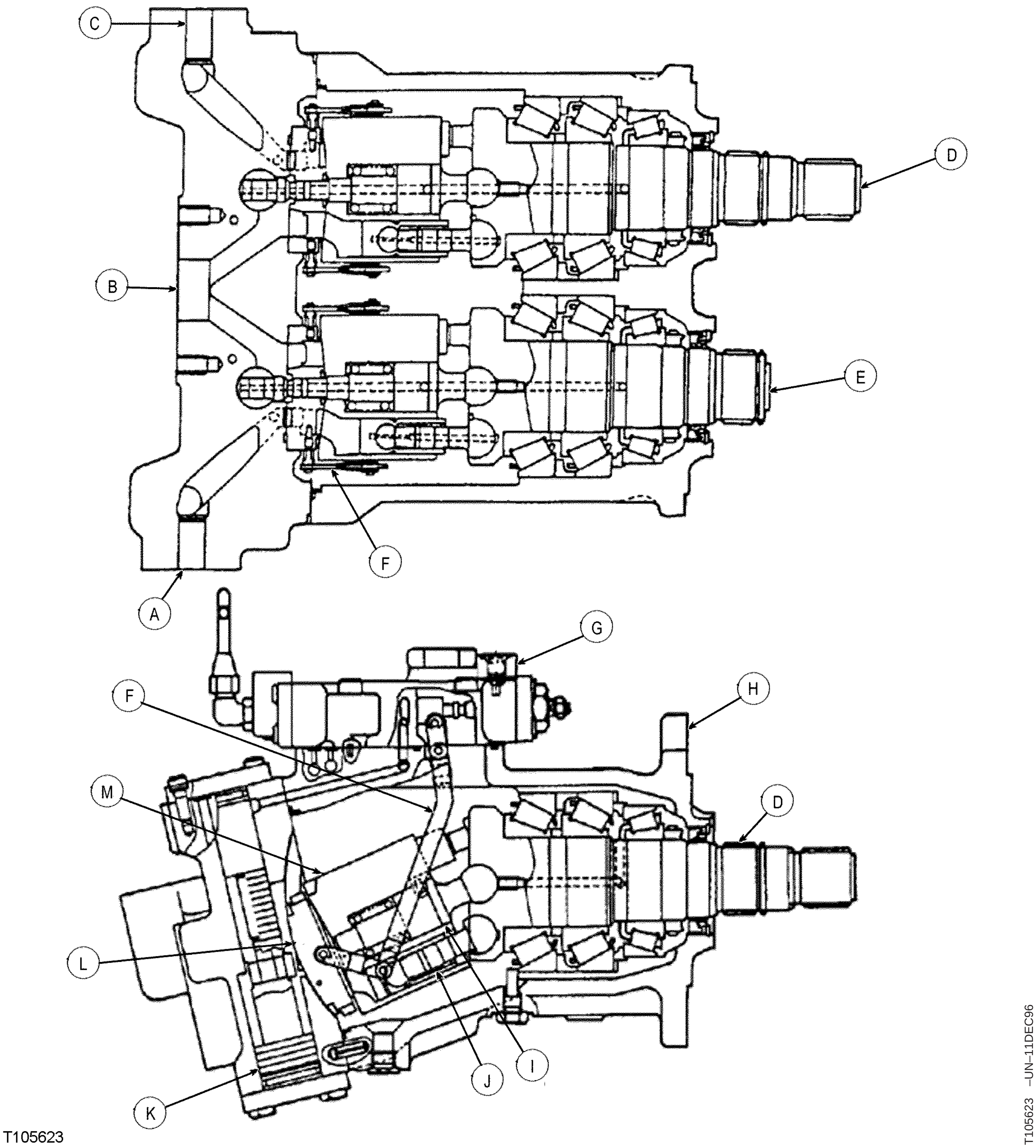
A—Front Pump Discharge Port
B—Front Pump
C—Rear Pump
D—Rear Pump Discharge Port
E—Dipstick
F—Pilot Pump
G—Pump Drive Gearbox
H—Rear Pump Drive Shaft
I—Engine Speed Sensor
J—Air Bleed Plug (2 used)
K—Fill Plug and Breather
L—Rear Pump Regulator
M—Front Pump Regulator
N—Front Pump Pressure Sensor
O—Pump Inlet Port
P—Rear Pump Pressure Sensor

Continued on next page TX,33,UU3783 –19–21SEP98–2/17



A—Front Pump Discharge Port
B—Pump Inlet Port
C—Rear Pump Discharge Port
D—Rear Pump Drive Shaft
E—Front Pump Drive Shaft
F—Feedback Link
G—Pump Regulator
H—Pump Housing
I—Center Shaft
J—Piston
K—Servo Piston
L—Valve Plate
M—Cylinder Block

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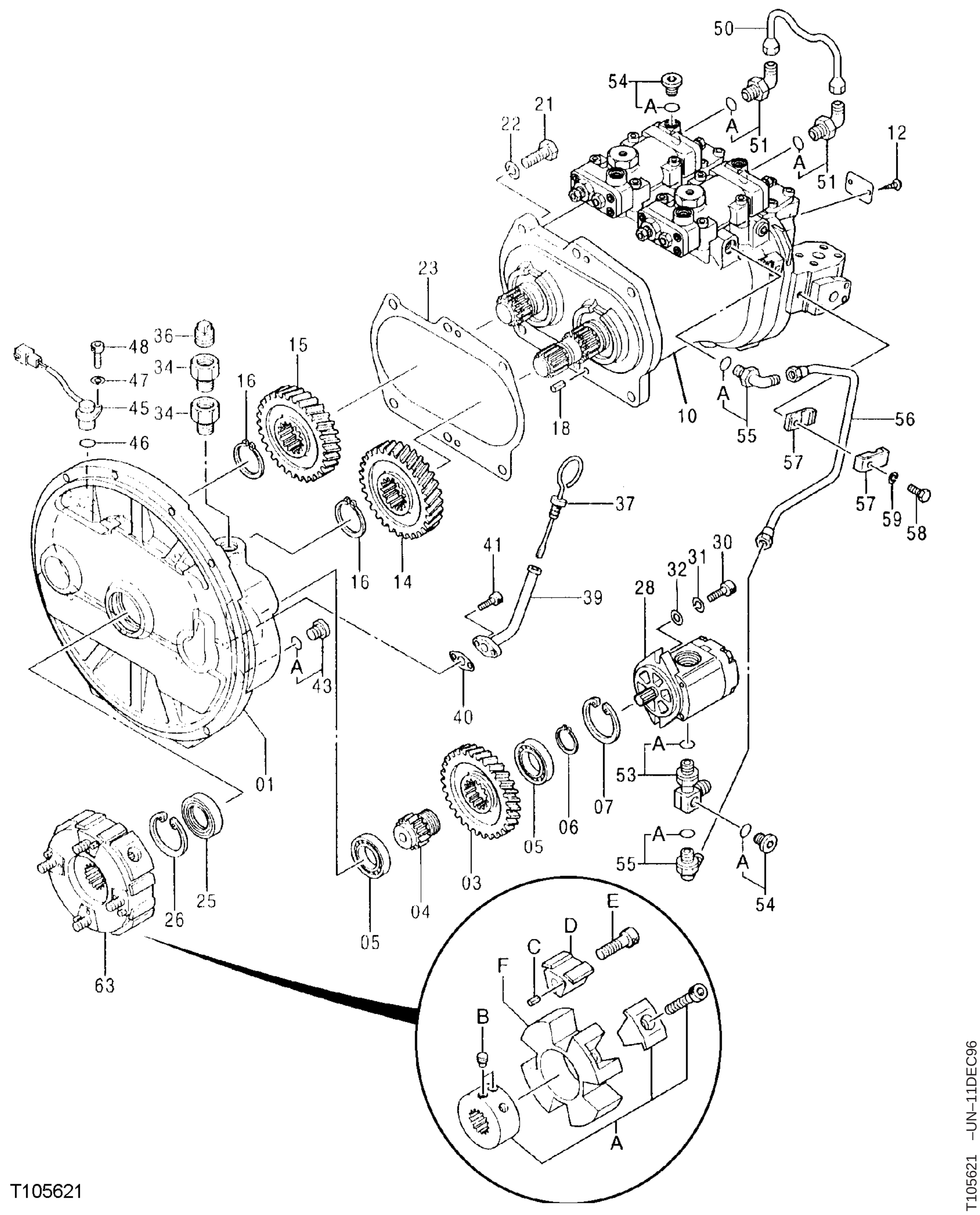
TX,33,UU3783 –19–21SEP98–3/17

Hydraulic System



T105621

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TX,33,UU3783 –19–21SEP98–4/17

1—Pump Drive Gearbox Case
3—Pilot Pump Drive Gear
4—Pilot Pump Drive Shaft
5—Ball Bearing (2 used)
6—Snap Ring
7—Snap Ring
10—Pump Housing
12—Screw (2 used)
14—Front Pump Driven Gear
15—Rear Pump Drive Gear
16—Snap Ring (2 used)
18—Spring Pin (2 used)
21—Cap Screw (6 used)
22—Lock Washer (6 used)
23—Gasket
25—Oil Seal
26—Snap Ring
28—Pilot Pump
30—Cap Screw (2 used)
31—Lock Washer (2 used)
32—Washer (2 used)
34—Adapter (2 used)
36—Plug and Breather
37—Dipstick
39—Dipstick Tube
40—Gasket
41—Cap Screw (2 used)
43—Drain Plug
43A—O-Ring
45—Engine Speed Sensor
46—O-Ring
47—Washer
48—Cap Screw
50—Oil Line
51—Fitting (2 used)
51A—O-Ring (2 used)
53—Adapter
53A—O-Ring
54—Plug
54A—O-Ring
55—Fitting (2 used)
55A—O-Ring (2 used)
56—Oil Line
57—Clamp (2 used)
58—Cap Screw
59—Lock Washer
63—Dampener Drive
63A—Hub
63B—Set Screw (2 used)
63C—Spring Pin (4 used)
63D—Insert (4 used)
63E—Cap Screw (4 used)
63F—Flex Coupling, Insert, Cap Screw and Hub

CAUTION: The approximate weight of hydraulic pump and drive gearbox is 170 kg (375 lb).

Hydraulic Pump and Drive Gearbox—Specification

Weight.. 170 kg (375 lb) approximate

1. Remove the engine speed sensor (45).
2. Loosen set screws (63B). Remove hub (63A).
3. Remove oil lines (50 and 56) and dipstick tube (39).
4. Remove pilot pump (28).
5. Remove cap screw (21) and lock washer (22) to remove pump (10) from pump drive gearbox case (1).

Continued on next page

TX,33,UU3783 –19–21SEP98–5/17

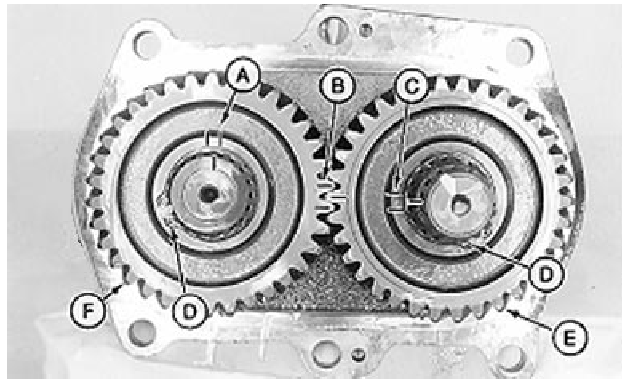
6. To aid assembly, make timing marks on drive gear (E), drive shafts (A and C), and driven gear (14). The gears are not interchangeable.

   Measure the amount of backlash between gears.

Pump Drive and Driven Gear—Specification

Backlash .... 0.68 mm (0.027 in.) nominal
Backlash .... 1.50 mm (0.059 in.) limit of use

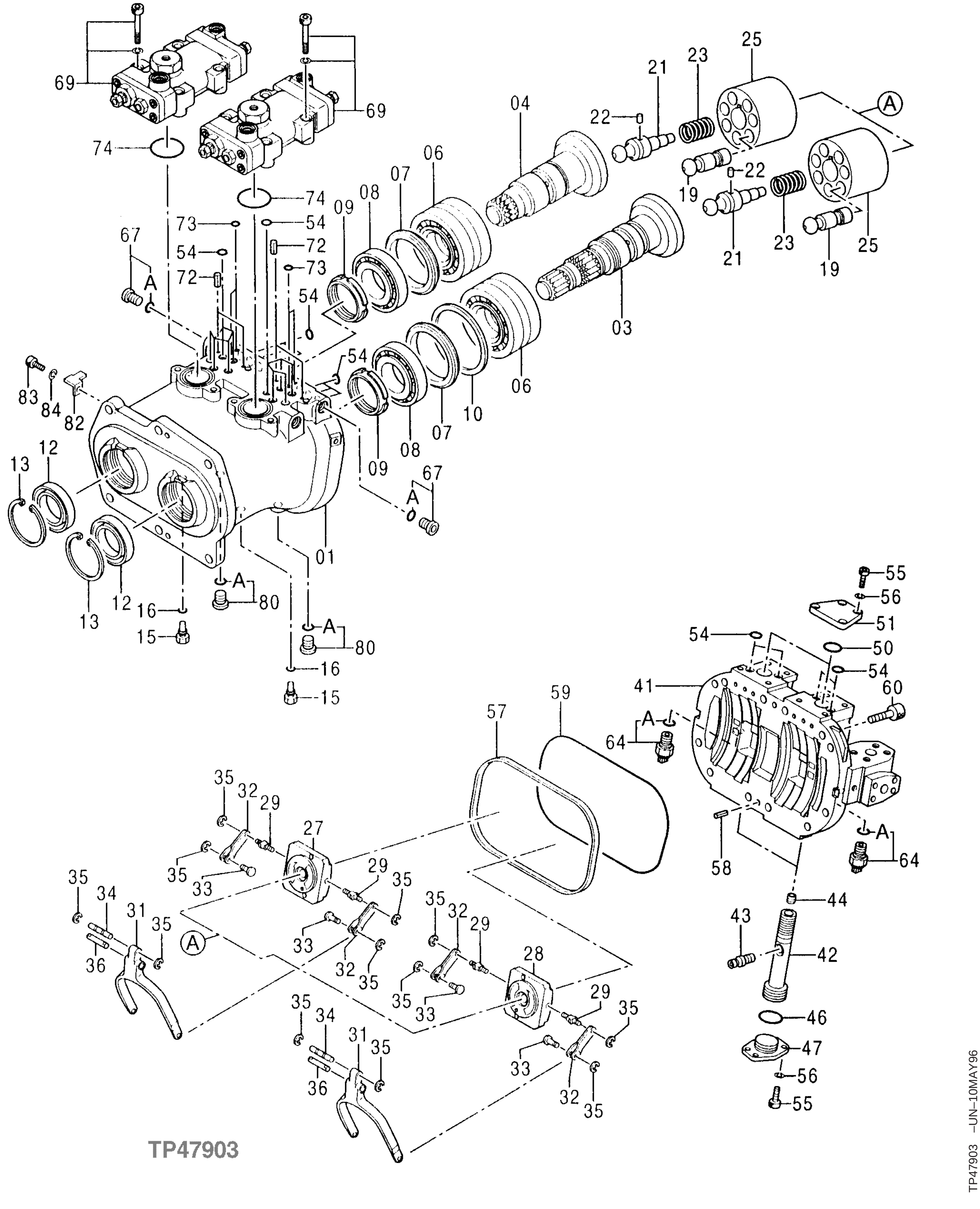
Remove snap rings (16) to remove gears.



T105624 –UN–11DEC96

A—Front Pump Drive Shaft-to-Driven Gear Timing Mark
B—Driven Gear-to-Drive Gear Timing Mark
C—Rear Pump Drive Shaft-to-Drive Gear Timing Mark
D—Snap Ring (2 used)
E—Drive Gear
F—Driven Gear

Continued on next page TX,33,UU3783 –19–21SEP98–6/17



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1—Pump Housing	22—Pin (2 used)	41—Cylinder Head (Cover)	64—Pump Pressure Sensor (2 used)
3—Rear Pump Drive Shaft	23—Spring (2 used)	42—Servo Piston (2 used)	64A—O-Ring (2 used)
4—Front Pump Drive Shaft	25—Cylinder Block (Rotor) (2 used)	43—Pin (2 used)	67—Plug (Fitting) (2 used)
6—Roller Bearing (2 used)	27—Front Pump Valve Plate	44—Set Screw (2 used)	67A—O-Ring (2 used)
7—Ring (2 used)	28—Rear Pump Valve Plate	46—O-Ring (2 used)	69—Pump Regulator (2 used)
8—Roller Bearing (2 used)	29—Dowel Pin (4 used)	47—Stop (2 used)	72—Spring Pin (4 used)
9—Bearing Nut (2 used)	31—Feedback Link (2 used)	50—O-Ring (2 used)	73—O-Ring (4 used)
10—Ring (Rear Pump Drive Shaft Only)	32—Lever (4 used)	51—Cover (2 used)	74—O-Ring (2 used)
12—Oil Seal (2 used)	33—Dowel Pin (4 used)	54—O-Ring (20 used)	80—Plug (Fitting) (2 used)
13—Snap Ring (2 used)	34—Dowel Pin (2 used)	55—Cap Screw (16 used)	80A—O-Ring
15—Special Fitting (2 used)	35—Snap Ring (12 used)	56—Lock Washer (16 used)	82—Bracket
16—O-Ring (2 used)	36—Dowel Pin (2 used)	57—Backup Ring	83—Cap Screw
19—Piston (14 used)		58—Spring Pin (2 used)	84—Lock Washer
21—Center Shaft (2 used)		59—O-Ring	
		60—Cap Screw (12 used)	

7. Remove pump pressure sensors (64).

8. Remove pump regulators (69). (See Disassemble and Assemble Hydraulic Pump Regulator in this group.)

CAUTION: The approximate weight of cylinder head is 30 kg (66 lb).

Cylinder Head—Specification

Weight.. 30 kg (66 lb) approximate

IMPORTANT: The front and rear pump valve plates (27 and 28) may stick to cylinder head (41) when head is removed. The valve plates are connected to the feedback linkage and must remain on the cylinder blocks (25). The valve plates and end of cylinder blocks are made with highly machined surfaces and can be damaged.

9. Remove cap screws (60). Checking that valve plates (27 and 28) remain on the cylinder blocks, carefully remove cylinder head (41).

10. Remove servo pistons (42) only if replacement is necessary.

    Heat the set screw (44) to loosen the thread lock and sealer (medium strength). Remove set screw using a 6 mm hex key wrench. Remove pin (43).

11. Remove snap rings (35) and pins (33) to disconnect feedback linkage.

IMPORTANT: The front pump (27) and rear pump (28) valve plates are not interchangeable. Take notice of the location and position of ports in plate. The inlet port in valve plate is located towards the center and top of pump housing.

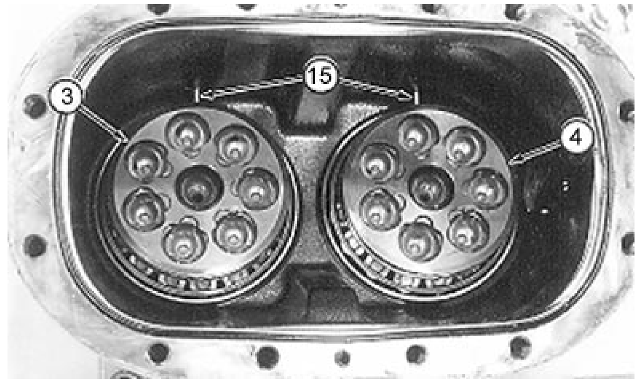
12. Remove the front pump (27) and rear pump (28) valve plates. Protect machined surfaces of plates from damage.

13. Remove cylinder blocks (25).

14. Remove the pistons (19) by tipping piston towards center of shaft and lifting up.

Continued on next page TX,33,UU3783 –19–21SEP98–8/17

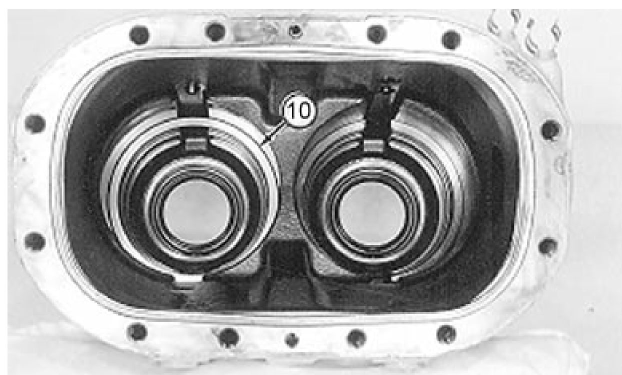
15. Remove special fittings (15) before removing front (4) and rear (3) pump drive shafts



3—Rear Pump Drive Shaft
4—Front Pump Drive Shaft
15—Special Fitting

TX,33,UU3783 –19–21SEP98–9/17

16. Remove spacer ring (10) for rear pump drive shaft from bore.



10—Spacer Ring

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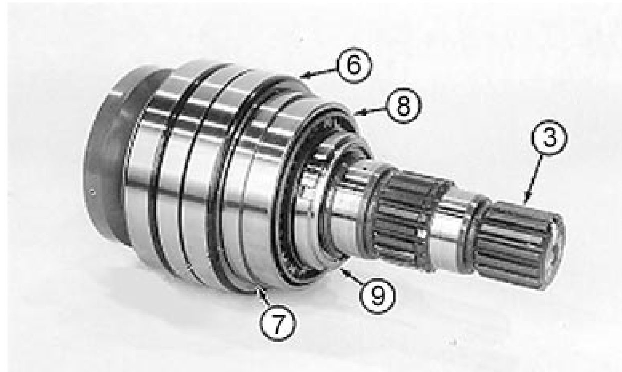
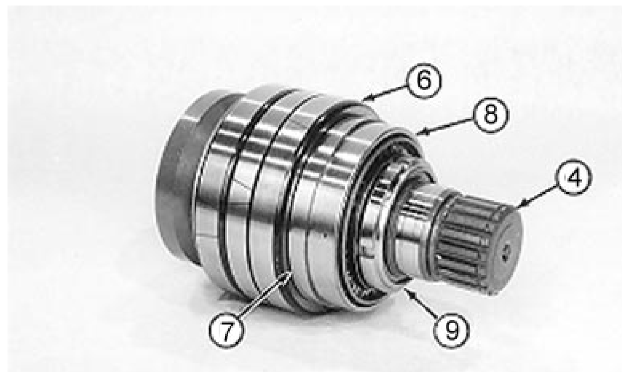
TX,33,UU3783 –19–21SEP98–10/17

17. Remove bearing nut (9) using the JDG769 Spanner Wrench.

18. Remove roller bearings (6 and 8) using a knife edge puller and a press.



Front Pump Drive Shaft



Rear Pump Drive Shaft

3—Front Pump Drive Shaft
4—Rear Pump Drive Shaft
6—Roller Bearing
7— Spacer Ring
8—Roller Bearing
9—Bearing Nut

Continued on next page TX,33,UU3783 –19–21SEP98–11/17

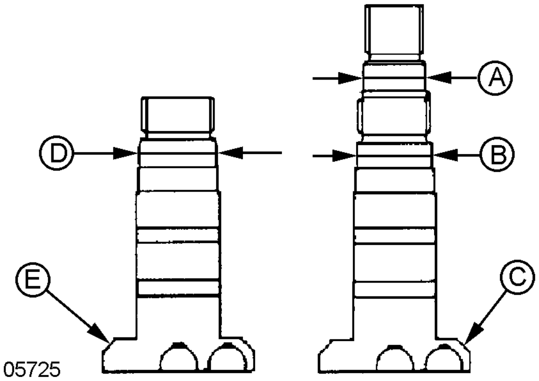
19. Measure diameter of oil seal contact surfaces (A, B, and D) on front (E) and rear (C) pump drive shaft.

Rear Pump Drive Shaft Oil Seal Contact Surface—Specification

OD .... 45 mm (1.77 in.) nominal
OD .... 44.8 mm (1.76 in.) limit of use
OD .... 55 mm (2.17 in.) nominal
OD .... 54.8 mm (2.16 in.) limit of use

Front Pump Drive Shaft Oil Seal Contact Surface—Specification

OD .... 55 mm (2.17 in.) nominal
OD .... 54.8 mm (2.16 in.) limit of use



T105725

T105725 –UN–09JAN97

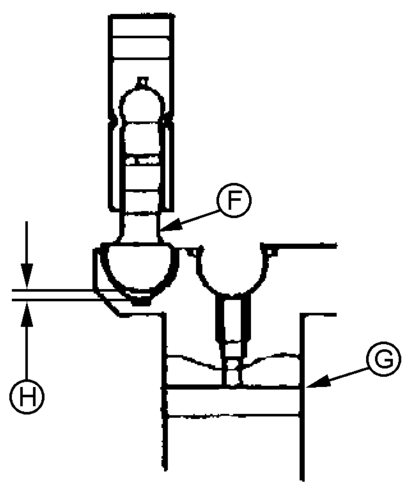
A—Oil Seal Contact Surface
B—Oil Seal Contact Surface
C—Rear Pump Drive Shaft
D—Oil Seal Contact Surface
E—Front Pump Drive Shaft

TX,33,UU3783 –19–21SEP98–12/17

20. Measure clearance (H) between the piston connecting rod (F) and socket in front and rear drive shafts (G).

Piston-to-Drive Shaft Socket—Specification

Play.. 0.058 mm (0.0023 in.) nominal
Play.. 0.400 mm (0.0157 in.) limit of use



T105726

T105726 –UN–09JAN97

F—Connecting Rod
G—Rear Drive Shaft
H—Play

Continued on next page

TX,33,UU3783 –19–21SEP98–13/17

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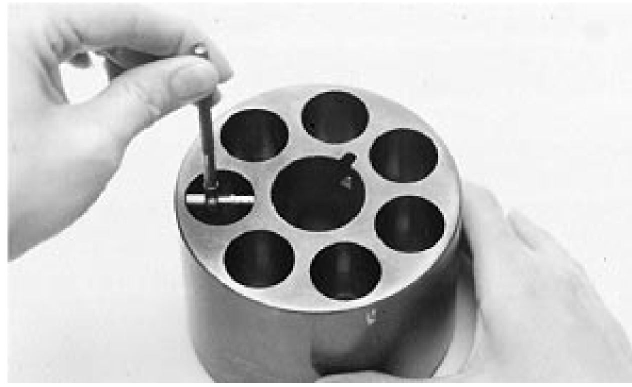
21. Measure ID of cylinder block piston bore. Measure OD of piston. Subtract the OD from the ID for clearance.

Cylinder Block Bore-to-Piston—Specification

Clearance .... 0.043 mm (0.0032 in.) nominal
Clearance .... 0.080 mm (0.0032 in.) limit of use



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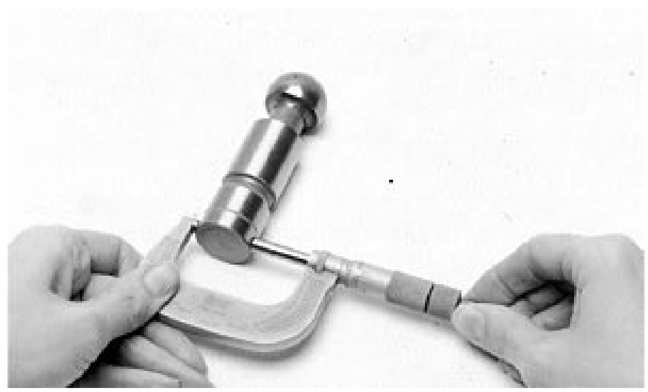


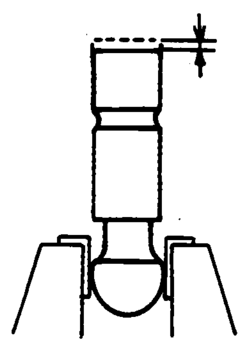
T6557EN —UN—18OCT88

TX,33,UU3783 –19–21SEP98–14/17

22. Clamp the connecting rod end of a piston in a vise with soft-jaw faces. Measure play between connecting rod and piston.

Piston-to-Connecting Rod—Specification

Play.. 0.150 mm (0.0059 in.) nominal
Play... 0.400 mm (0.0157 in.) limit of use



T6557EK —UN—18OCT88

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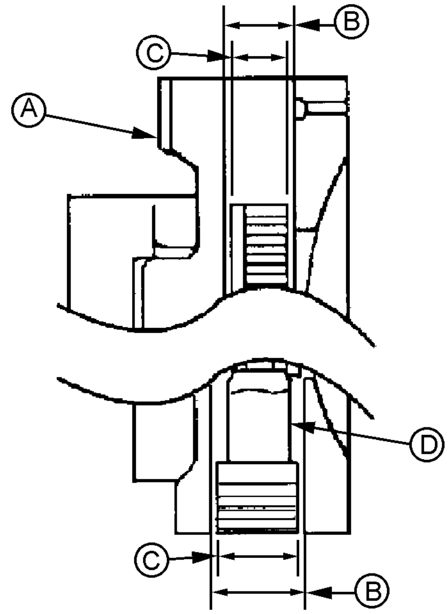
TX,33,UU3783 –19–21SEP98–15/17

23. Measure OD (C) of small and large end of servo piston (D). Measure ID (B) of small and large end of bore in cylinder head (A). Subtract the OD from the ID for clearances.

Servo Piston-to-Cylinder Head Bore—Specification

Clearance .... 0.079 mm (0.0033 in.) nominal
Clearance .... 0.200 mm (0.0078 in.) limit of use



T105727

T105727 –UN–19DEC96

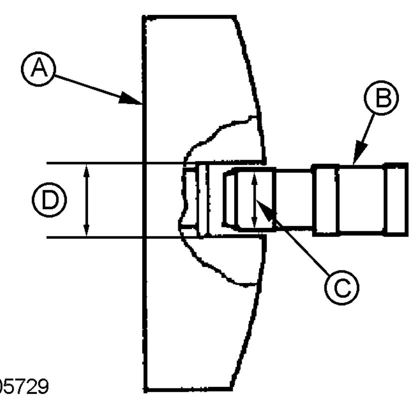
A—Cylinder Head
B—ID
C—OD
D—Servo Piston

TX,33,UU3783 –19–21SEP98–16/17

24. Measure OD (C) of servo piston pin (B). Measure ID (D) of bore in valve plate (A). Subtract the OD from the ID for the clearance.

Servo Piston Pin-to-Valve Plate Bore—Specification

Clearance .... 0.051 mm (0.0020 in.) nominal
Clearance .... 0.300 mm (0.0118 in.) limit of use



T105729

T105729 –UN–09JAN97

A—Valve Plate Bore
B—Servo Piston Pin
C—OD
D—ID

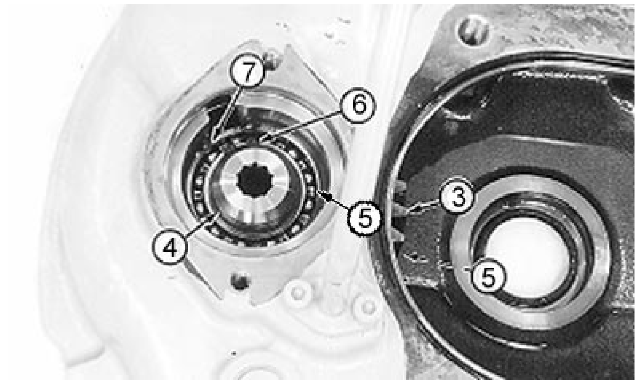
TX,33,UU3783 –19–21SEP98–17/17

DISASSEMBLE AND ASSEMBLE PILOT PUMP DRIVE SHAFT AND GEAR

1. Remove snap ring (A).

2. Remove pilot pump drive shaft (E) and upper ball bearing (D) using a blind-hole puller or an internal pullers. Ball bearings are a press fit in the drive shaft and in the housing.

3. Remove pilot pump drive gear (C) through opening for hydraulic pump.



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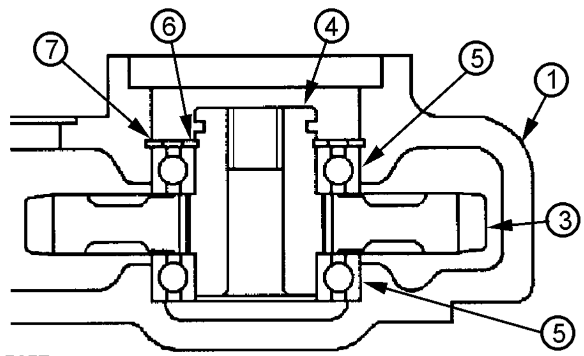
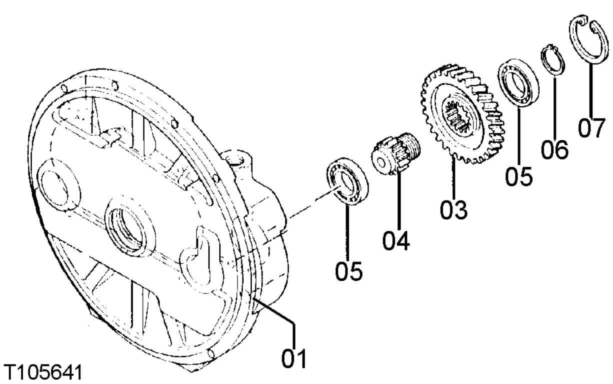


T105657

T105657 –UN–12DEC96



T105641

T105641 –UN–12DEC96

1—Pump Drive Gearbox Case
3—Pilot Pump Drive Gear
4—Pilot Pump Drive Shaft
5—Ball Bearing (2 used)
6—Snap Ring
7—Snap Ring

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3360
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TX,33,UU3783 –19–07DEC96–1/1

ASSEMBLE HYDRAULIC PUMP AND DRIVE GEARBOX

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

1. Heat roller bearings (6 and 8).

Roller Bearing Heat—Specification

Temperature .... 50—80°C (122—176°F)

2. Apply oil to bearing. Push roller bearing (6) on drive shaft so inner race is tight against shoulder.

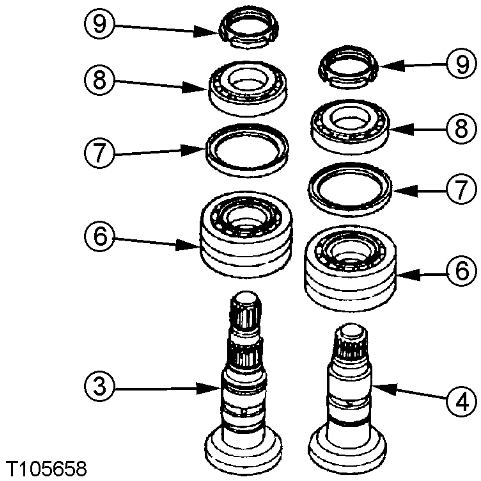
3. Install spacer ring (7) and roller bearing (8).

4. Apply oil to threads of bearing nut (9).

5. Tighten bearing nut using JDG769 Spanner Wrench.

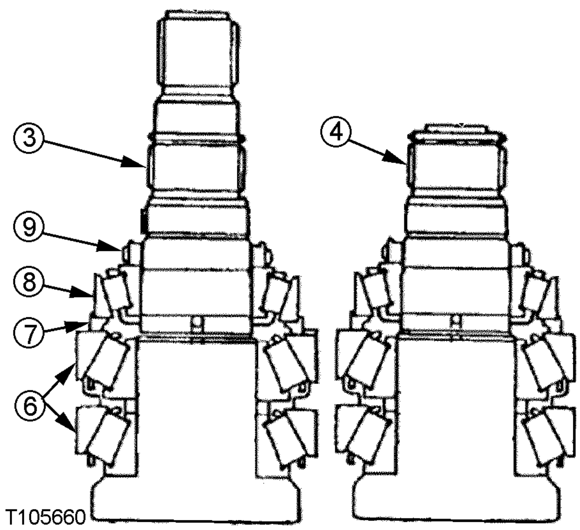
Pump Drive Shaft Bearing Nut—Specification

Rolling Drag Torque .... 2.16 ± 0.49 N•m (19 ± 4 lb-in.)



T105658

T105658 –UN–12DEC96



T105660

T105660 –UN–12DEC96

3—Front Pump Drive Shaft
4—Rear Pump Drive Shaft
6—Roller Bearing
7— Spacer Ring
8—Roller Bearing
9—Bearing Nut

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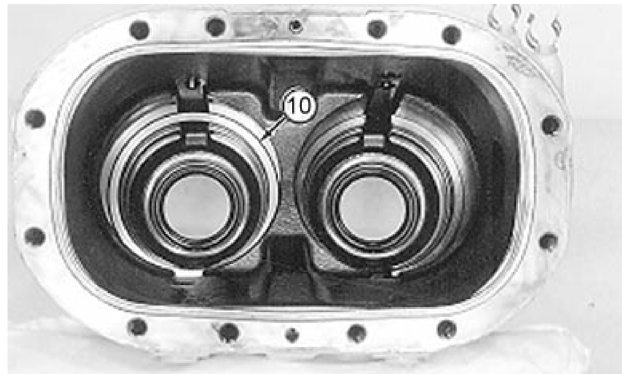
TX,33,UU3784 –19–21SEP98–1/9

6. Install spacer ring (10) into housing bore for rear pump drive shaft.



10—Spacer Ring

TX,33,UU3784 –19–21SEP98–2/9

7. To help installation of drive shafts (3 and 4), heat pump housing using a heat gun such as the JT07010 Two Temperature Heat Gun.

Pump Housing Heat—Specification

Temperature .... 50—80°C (122—176°F)

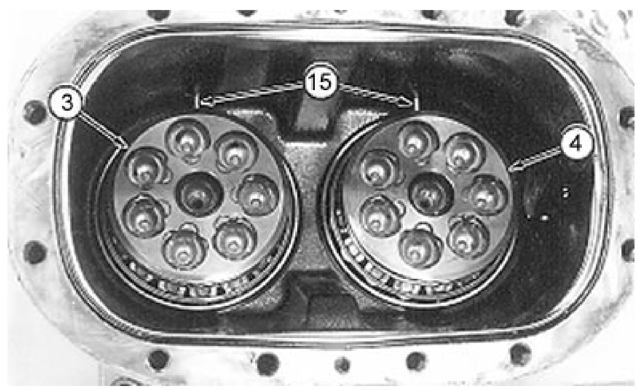
8. Apply a film of oil to outer race of bearings. Install the drive shafts.

9. Install and tighten special fittings (15).

Special Plug-to-Pump Housing Special Fitting—Specification

Torque .... 34 N•m (300 lb-in.)

10. Apply grease to lips of oil seals. Install oil seals with lip (spring side) towards inside of housing. Install snap rings.



3—Drive Shaft
4—Drive Shaft
15—Special Fitting

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TX,33,UU3784 –19–21SEP98–3/9

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11. For original parts, install drive (E) and driven (F) gears on shafts so timing marks (A, B, and C) are aligned.

    For new parts, install the JDG1054 Aligning Bar on the socket (I and J) end of drive shafts.

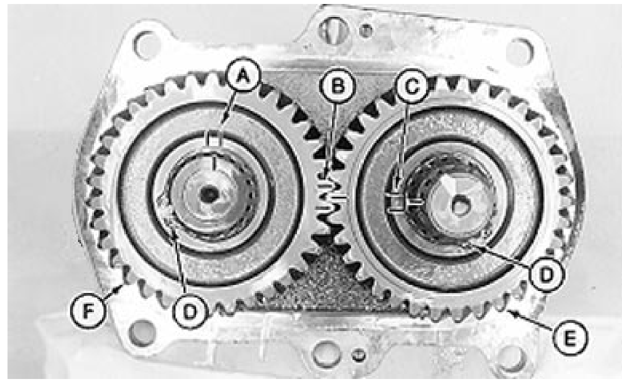
    Install aligning bar so end marked “Long Shaft Side” is to the rear pump drive shaft (H). Turn shafts so socket alignment dowels (L and M) engage a socket in drive shafts. The socket for front pump drive shaft is slightly below the centerline of socket for rear pump drive shaft when shafts are timed correctly.

    Install cap screws (N) to hold bar in position.

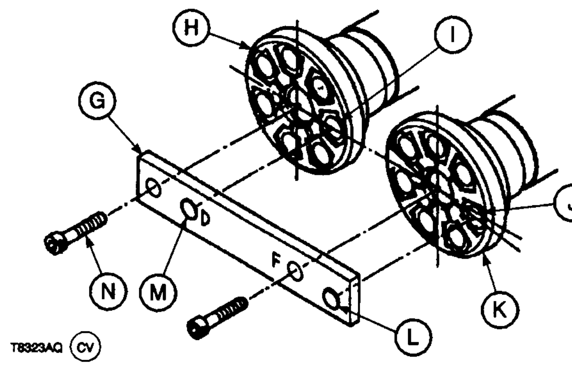
12. From the splined end of shafts, turn shafts to the left to remove any play between socket alignment dowels and sockets.

13. Install gear on the rear pump drive shaft. Install the snap ring.

    Install gear on front pump drive shaft. As necessary, turn shaft slightly or turn gear to another position so teeth on gears engage. Install snap ring.



T105624 –UN–11DEC96



T8323AQ –UN–04OCT94

A—Front Pump Drive Shaft-to-Driven Gear Timing Mark
B—Driven Gear-to-Drive Gear Timing Mark
C—Rear Pump Drive Shaft-to-Drive Gear Timing Mark
D—Snap Ring (2 used)
E—Drive Gear
F—Driven Gear
G—JDG1054 Aligning Bar (Pump Timing Tool)
H—Rear Pump Drive Shaft
I—Socket
J—Socket
K—Front Pump Drive Shaft
L—Socket Alignment Dowel
M—Socket Alignment Dowel
N—M8-1.25 Cap Screw (2 used)

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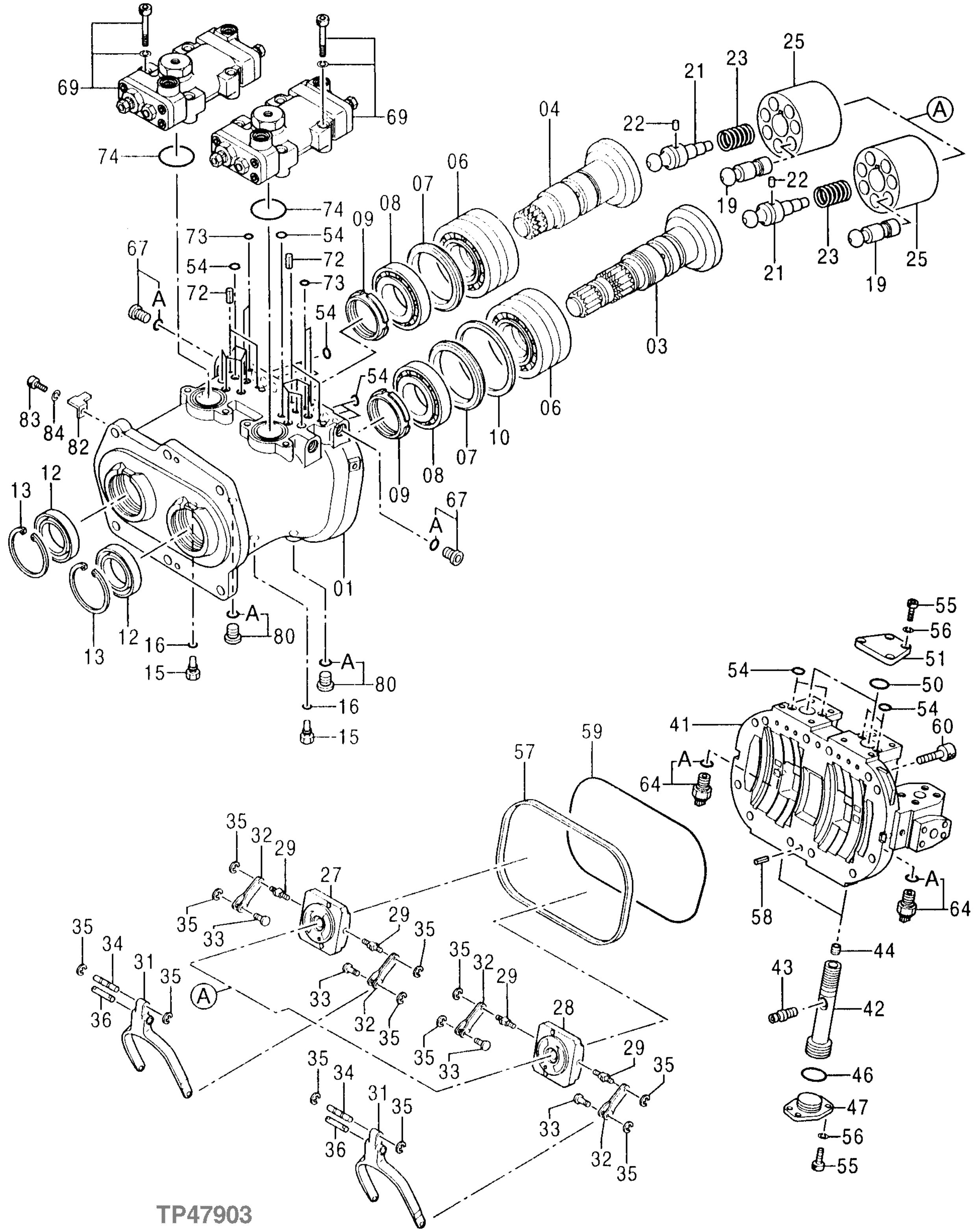

TP47903 –UN–10MAY96

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TX,33,UU3784 –19–21SEP98–5/9

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1—Pump Housing
3—Rear Pump Drive Shaft
4—Front Pump Drive Shaft
6—Roller Bearing (2 used)
7—Ring (2 used)
8—Roller Bearing (2 used)
9—Bearing Nut (2 used)
10—Ring (Rear Pump Drive Shaft Only)
12—Oil Seal (2 used)
13—Snap Ring (2 used)
15—Special Fitting (2 used)
16—O-Ring (2 used)
19—Piston (14 used)
21—Center Shaft (2 used)
22—Pin (2 used)
23—Spring (2 used)
25—Cylinder Block (Rotor) (2 used)
27—Front Pump Valve Plate
28—Rear Pump Valve Plate
29—Dowel Pin (4 used)
31—Feedback Link (2 used)
32—Lever (4 used)
33—Dowel Pin (4 used)
34—Dowel Pin (2 used)
35—Snap Ring (12 used)
36—Dowel Pin (2 used)
41—Cylinder Head (Cover)
42—Servo Piston (2 used)
43—Pin (2 used)
44—Set Screw (2 used)
46—O-Ring (2 used)
47—Stop (2 used)
50—O-Ring (2 used)
51—Cover (2 used)
54—O-Ring (20 used)
55—Cap Screw (16 used)
56—Lock Washer (16 used)
57—Backup Ring
58—Spring Pin (2 used)
59—O-Ring
60—Cap Screw (12 used)
64—Pump Pressure Sensor (2 used)
64A—O-Ring (2 used)
67—Plug (Fitting) (2 used)
67A—O-Ring (2 used)
69—Pump Regulator (2 used)
72—Spring Pin (4 used)
73—O-Ring (4 used)
74—O-Ring (2 used)
80—Plug (Fitting) (2 used)
80A—O-Ring
82—Bracket
83—Cap Screw
84—Lock Washer

14. Apply oil to center shaft (21), pistons (19) and cylinder blocks (25). Use petroleum jelly to hold pin (22) in hole in center shaft.

15. Install cylinder block so pin engages slot in cylinder block.

16. Apply thread lock and sealer (medium strength) to threads of dowel pins (29). Tighten dowel pins into front pump (27) and rear pump (28) valve plates.

Dowel Pin-to-Front and Rear Pump Valve Plate—Specification

Torque.. 9.8 N•m (86 lb-in.)

IMPORTANT: The front pump (27) and rear pump (28) valve plates are not interchangeable. The inlet port in valve plate is located towards the center and top of pump housing.

17. Apply oil to valve plates.

    Install valve plates so inlet port is towards the center and top of pump housing.

    Connect levers (32) for feedback linkage to valve plates.

18. Install servo pistons (42) and pins (43).

    Apply thread lock and sealer (medium strength) to threads of set screw (44).

    Tighten set screw (44) using a 6 mm hex key wrench.

Servo Piston-to-Pin Set Screw—Specification

Torque.. 34 N•m (300 lb-in.)

Tighten cap screws (55) for stop (47) and cover (51).

Stop and Cover-to-Cylinder Head Cap Screw—Specification

Torque.. 19.5 N•m (180 lb-in.)

19. Install cylinder head (41) checking to be sure that pins engage middle hole in valves plates.

    Tighten cap screws (60).

Cylinder Head-to-Pump Housing Cap Screw—Specification

Torque.. 108 N•m (80 lb-ft)

20. Remove air bleed plugs from pump regulators (69).

    Install regulators making sure groove in remote control sleeve and load sleeve engage dowel pin (34) in feedback link (31). Check through hole that groove in sleeves engage dowel pin.

Continued on next page

Tighten cap screws.

Regulator-to-Pump Housing Cap Screw—Specification

Torque.. 49 N•m (36 lb-ft)

21. Tighten pump pressure sensors (64).

Pump Pressure Sensor-to-Pump Housing—Specification

Torque.. 98 N•m (72 lb-ft)

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TX,33,UU3784 –19–21SEP98–7/9

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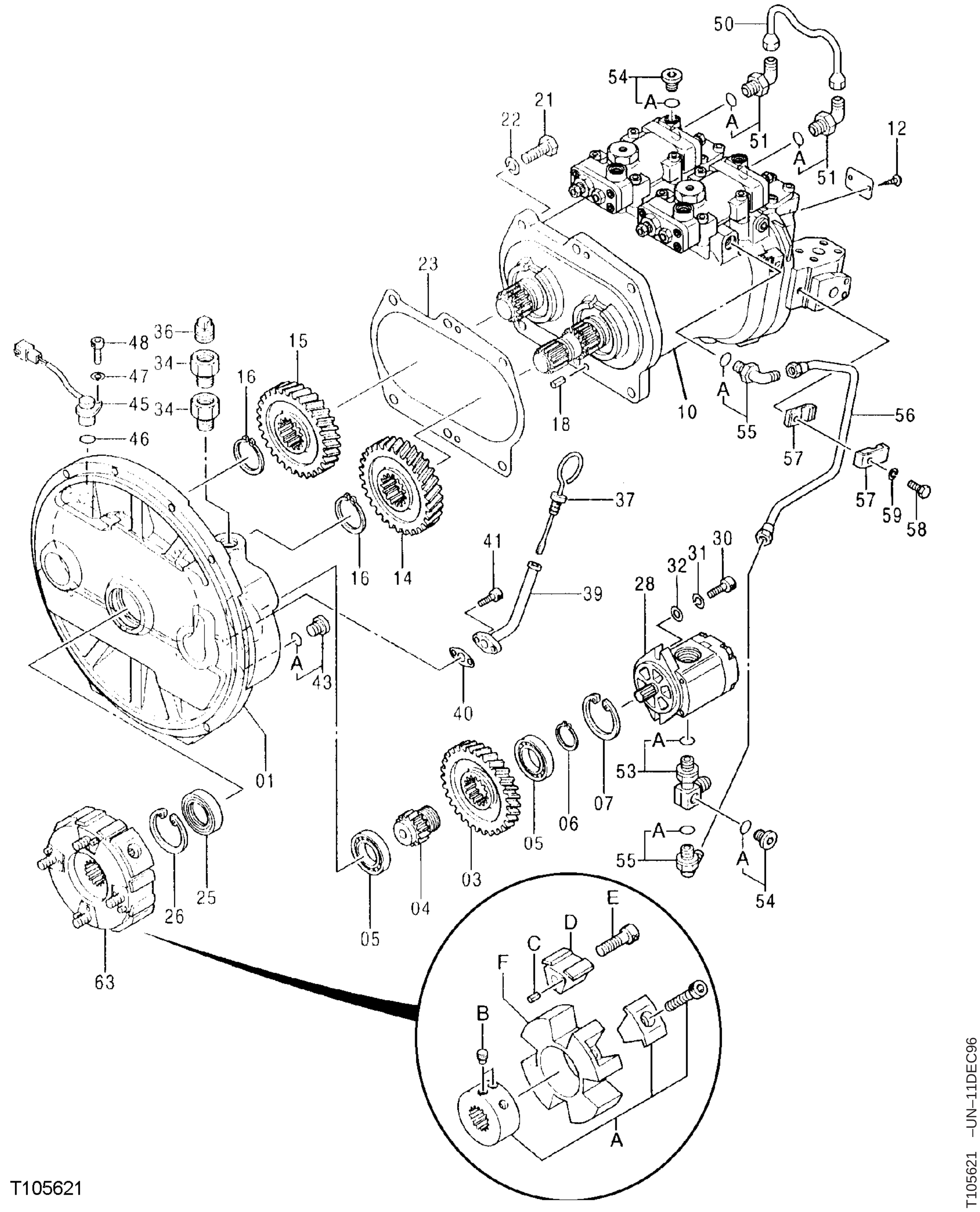

T105621

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1—Pump Drive Gearbox Case
3—Pilot Pump Drive Gear
4—Pilot Pump Drive Shaft
5—Ball Bearing (2 used)
6—Snap Ring
7—Snap Ring
10—Pump Housing
12—Screw (2 used)
14—Front Pump Driven Gear
15—Rear Pump Drive Gear
16—Snap Ring (2 used)
18—Spring Pin (2 used)
21—Cap Screw (6 used)
22—Lock Washer (6 used)
23—Gasket
25—Oil Seal
26—Snap Ring
28—Pilot Pump
30—Cap Screw (2 used)
31—Lock Washer (2 used)
32—Washer (2 used)
34—Adapter (2 used)
36—Plug and Breather
37—Dipstick
39—Dipstick Tube
40—Gasket
41—Cap Screw (2 used)
43—Drain Plug
43A—O-Ring
45—Engine Speed Sensor
46—O-Ring
47—Washer
48—Cap Screw
50—Oil Line
51—Fitting (2 used)
51A—O-Ring (2 used)
53—Adapter
53A—O-Ring
54—Plug
54A—O-Ring
55—Fitting (2 used)
55A—O-Ring (2 used)
56—Oil Line
57—Clamp (2 used)
58—Cap Screw
59—Lock Washer
63—Dampener Drive
63A—Hub
63B—Set Screw (2 used)
63C—Spring Pin (4 used)
63D—Insert (4 used)
63E—Cap Screw (4 used)
63F—Flex Coupling, Insert, Cap Screw and Hub

CAUTION: The approximate weight of hydraulic pump and drive gearbox is 170 kg (365 lb).

Hydraulic Pump and Drive Gearbox—Specification

Weight.. 170 kg (365 lb) approximate

22. Tighten pump housing-to-gearbox housing cap screws (21).

Pump Housing-to-Gearbox Cap Screw—Specification

Torque.. 147 N•m (109 lb-ft)

23. Apply plastic gasket to mounting surface for pilot pump (28).

    Tighten cap screws (30).

Pilot Pump-to-Gearbox Cap Screw—Specification

Torque.. 49 N•m (36 lb-ft)

24. Apply grease to lips of oil seal (25). Install oil seal with lip (spring side) towards inside of housing.

25. Apply thread lock and sealer (medium strength) to threads of set screws (63B) in dampener drive hub.

    Tighten set screws. (For assembly of dampener drive, see Remove and Install Dampener Drive in Group 0752.)

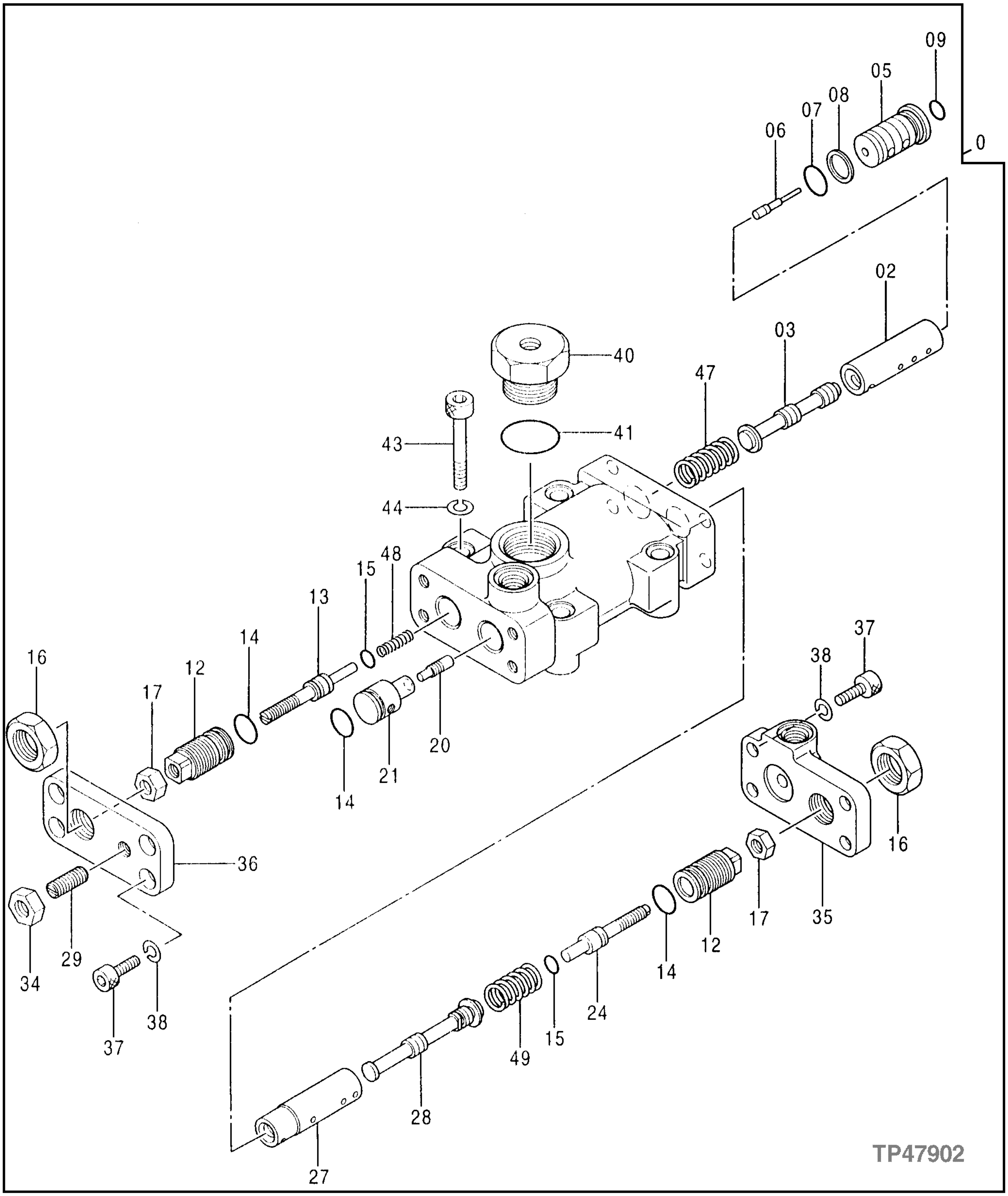
Dampener Drive Hub-to-Rear Pump Drive Shaft Set Screw—Specification

Torque.. 108 N•m (80 lb-ft)

26. Fill pump and pump drive gearbox with oil. (See Hydraulic Pump and Drive Gearbox Start-Up Procedure in this group.)

TX,33,UU3784 –19–21SEP98–9/9

DISASSEMBLE AND ASSEMBLE HYDRAULIC PUMP REGULATOR



TP47902 –UN–10MAY96

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0—Pump Regulator
2—Load Sleeve
3—Load Spool
5—Cylinder
6—Load Piston
7—O-Ring
8—Backup Ring
9—O-Ring
12—Load Adjusting Cartridge (Stop)
—Flow Adjusting Cartridge (Stop)
13—Load Adjusting Screw (Stop)
14—O-Ring (3 used)
15—O-Ring (2 used)
16—Nut (2 used)
17—Nut (2 used)
20—Piston
21—Cylinder
24—Maximum Flow Adjusting Screw (Stop)
27—Remote Control Sleeve
28—Remote Control Spool
29—Minimum Flow Adjusting Screw
34—Nut
35—End Plate
36—Cover
37—Cap Screw (8 used)
38—Lock Washer (8 used)
40—Air Bleed Plug
41—O-Ring
43—Cap Screw (4 used)
44—Lock Washer (4 used)
47—Outer Spring
48—Inner Spring
49—Spring

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug to release air pressure in hydraulic oil tank
2. Pull a vacuum in hydraulic oil tank using a vacuum pump or drain hydraulic oil tank. Approximate oil capacity is 148 L (39 gal).
3. Remove cap screw (43) to remove pump regulator (0).

IMPORTANT: Removal of adjusting screws (13, 24 and 29) and cartridges (12) from end plate (35) and cover (36) will required the adjustment of pump regulators. Only remove parts from end plate and cover if replacement is necessary.

4. Remove the end plate (35) and cover (36) with the adjusting screws and cartridges installed.
5. Repair or replace parts as necessary.
6. Install end plate.
7. Tighten cap screws (37).

End Plate and Cover-to-Housing Cap Screw—Specification

Torque.. 19.8 N•m (180 lb-in.)

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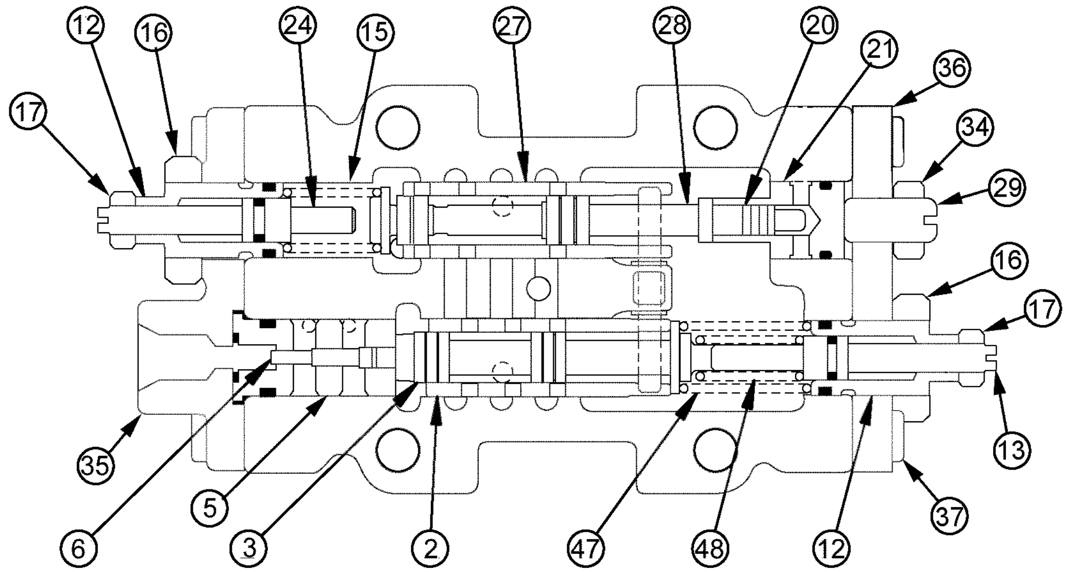


2—Load Sleeve
3—Load Spool
5—Cylinder
6—Load Piston
12—Load Adjusting Cartridge (Stop)
—Flow Adjusting Cartridge (Stop)
13—Load Adjusting Screw (Stop)
16—Nut (2 used)
17—Nut (2 used)
20—Piston
21—Cylinder
24—Maximum Flow Adjusting Screw (Stop)
27—Remote Control Sleeve
28—Remote Control Spool
29—Minimum Flow Adjusting Screw
34—Nut
35—End Plate
36—Cover
37—Cap Screw (8 used)
47—Outer Spring
48—Inner Spring

8. Remove air bleed plugs from pump regulators. Install regulators making sure groove in remote control sleeve (27) and load sleeve (2) engage dowel pin in feedback link. Check through hole that groove in sleeves engage dowel pin.

   Tighten cap screws.

Housing-to-Pump Housing Cap Screw—Specification

Torque... 49 N•m (36 lb-ft)

Tighten the large air bleed plug (located on top of regulator housing).

Air Bleed Plug-to-Housing—Specification

Torque... 78 N•m (58 lb-ft)

IMPORTANT: Hydraulic pump will be damaged if not filled with oil before starting engine. Procedure must be performed whenever a new pump installed or oil has been drained from the pump or hydraulic oil tank.

9. Fill pump housing with oil. (See Hydraulic Pump and Drive Gearbox Start-Up Procedure in this group.)

10. Check pump regulator adjustments. (See Hydraulic Pump Regulator Test and Adjustments in Group 9025-25.)

REMOVE AND INSTALL PILOT PUMP

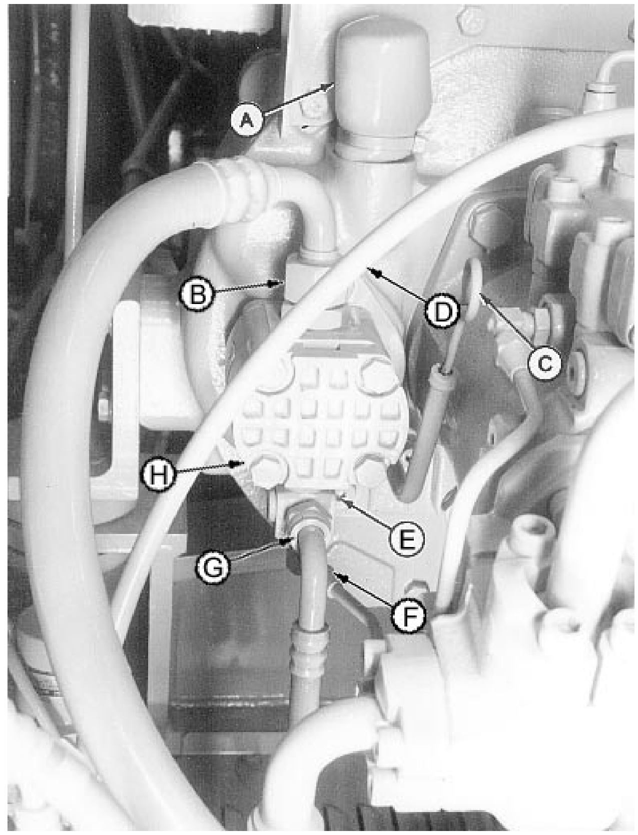
CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug to release air pressure in hydraulic oil tank.
2. Remove drain plug (E) to drain pump drive gearbox. Approximate oil capacity is 1.0 L (1.1 qt).
3. Pull a vacuum in hydraulic oil tank using a vacuum pump or drain hydraulic oil tank. Approximate oil capacity is 148 L (39 gal).
4. Disconnect lines (B, F and G).
5. Remove cap screws (D) to remove pilot pump (F).
6. Replace parts as necessary. (See Disassemble and Assemble Pilot Pump in this group.)
7. Apply plastic gasket to mounting surface for pilot pump.
8. Tighten cap screw.

Pump-to-Drive Gearbox Cap Screw—Specification

Torque .... 49 N•m (36 lb-ft)

9. Connect lines.
10. Fill pump drive gearbox with oil through filler pipe (A) so level is above “H” mark on dipstick (C). (See Diesel Engine and Pump Gearbox Oils in Group 0004.)



T105711 –UN–19DEC96

A—Filler Pipe
B—Pilot Pump Inlet-to-Hydraulic Oil Tank Line
C—Dipstick
D—Cap Screw, Washer and Lock Washer (2 used)
E—Drain Plug
F—Pilot Pump Outlet-to-Hydraulic Pump Line
G—Pilot Pump Outlet-to-Pilot Filter Line
H—Pilot Pump

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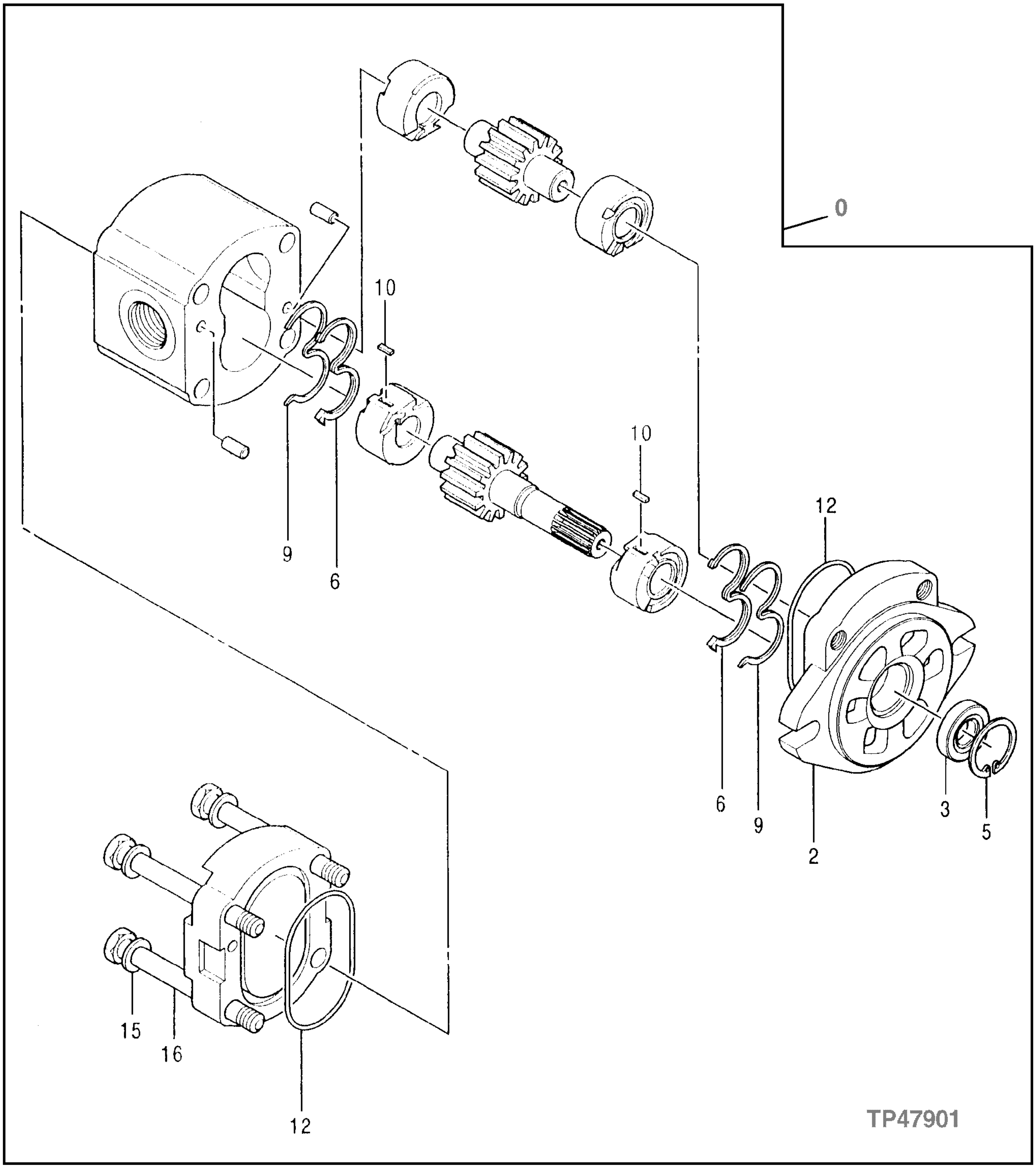
TX,33,UU3786 –19–21SEP98–1/1

DISASSEMBLE AND ASSEMBLE PILOT PUMP



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TX,33,UU3787 –19–21SEP98–1/3

0—Pilot Pump
2—Flange
3—Oil Seal
5—Snap Ring
6—Seal (2 used)
9—Backup Retainer (2 used)
10—Key (2 used)
12—O-Ring (2 used)
15—Washer (4 used)
16—Cap Screw and Washer (4 used)

1. Remove cap screws (16) to remove end plate and flange (2) from housing.

TX,33,UU3787 –19–21SEP98–2/3

2. Remove drive (A), driven (C) gears, bushings (D) and keys (B).

3. Check bushings (D). If inside diameter and surface toward gear are rough or worn, replace pump.

4. Check gears (A and C) and housing. If gear teeth, shaft, and inside of housing is rough or worn, replace pump.

IMPORTANT: Apply clean hydraulic oil to all parts. Pump failure can result if pump is assembled dry.

5. Apply clean hydraulic oil to all parts.

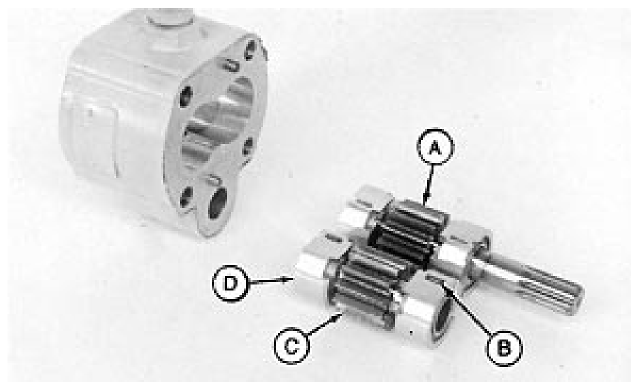
6. Apply grease to lip of oil seal. Install oil seal with lip (spring side) towards inside of housing.

7. Tighten cap screws.

Cover-to-Flange Cap Screw—Specification

Torque .... 41 N•m (31 lb-ft)

8. Do Pilot Pressure Regulating Valve Test and Adjustment to check pressure setting. (See procedure in Group 9025-25.)



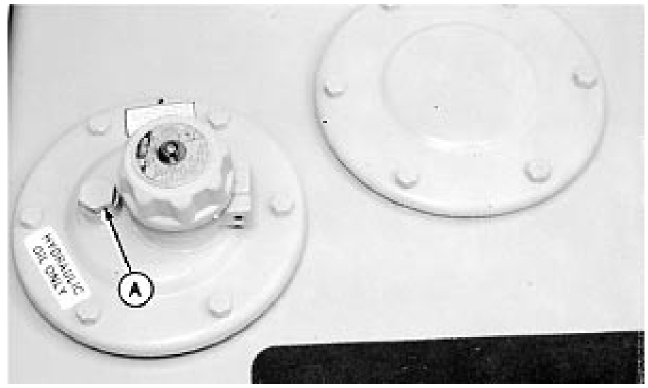
A—Drive Gear
B—Keys
C—Driven Gear
D—Bushing

TX,33,UU3787 –19–21SEP98–3/3

REMOVE AND INSTALL PILOT PRESSURE REGULATING VALVE AND FILTER

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to release air pressure in hydraulic oil tank.



A—Vent Plug

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2. Disconnect lines (A—D).

3. Remove cap screws (H) to remove pilot pressure regulating valve and pilot filter.

4. Replace parts as necessary.

5. Install cap screws (J).

Housing-to-Filter Head Cap Screw—Specification

Torque .... 20 N•m (175 lb-in.)

6. Install new pilot filter element.

Pilot Filter Element Housing-to-Filter Head—Specification

Torque .... 25 N•m (220 lb-in.)

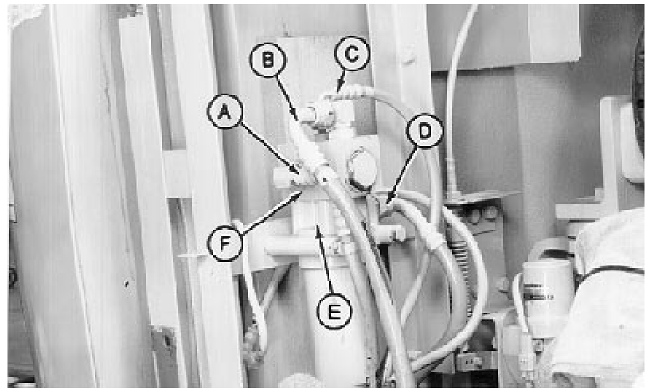
7. Install cap screws (H).

Filter Head-to-Support Cap Screw—Specification

Torque .... 49 N•m (36 lb-ft)

8. Connect lines.

9. Do Pilot Pressure Regulating Valve Test and Adjustment to check pressure setting. (See procedure in Group 9025-25.)



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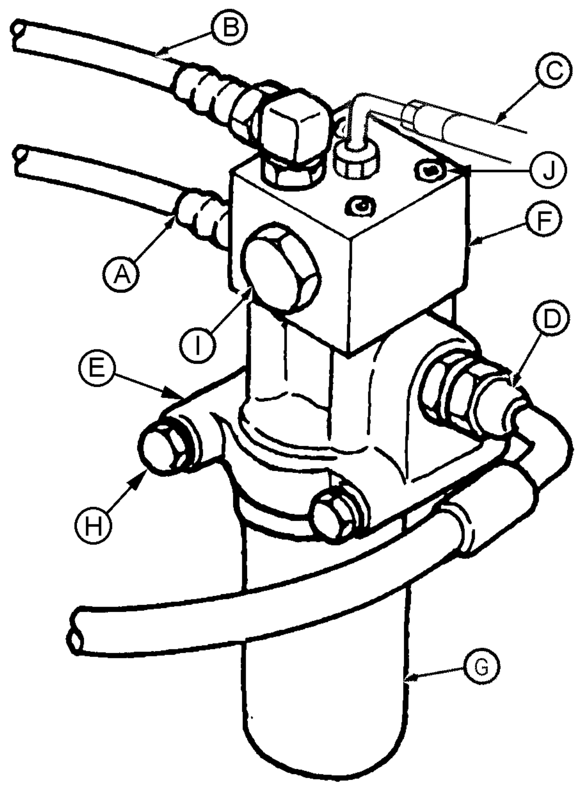

T105738

T105738 –UN–19DEC96

A—To Pilot Shut-Off Valve Line
B—To Hydraulic Oil Tank Return Manifold Line
C—To Right Control Valve Line
D—From Pilot Pump Line
E—Filter Head
F—Pilot Pressure Regulating Valve Housing
G—Pilot Filter
H—Cap Screw and Lock Washer (2 used)
I—Plug
J—Cap Screw (4 used)

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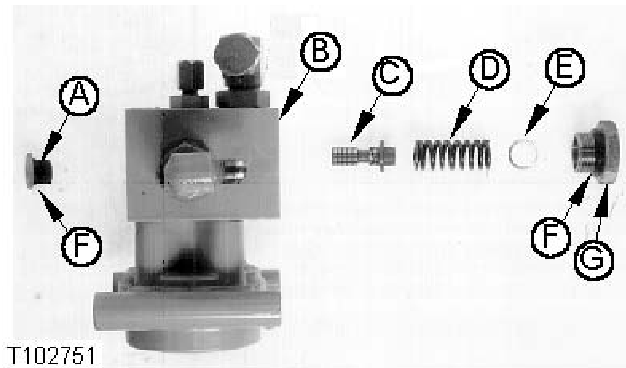
TX,33,GG2389 –19–21SEP98–2/2

DISASSEMBLE AND ASSEMBLE PILOT PRESSURE REGULATING VALVE AND FILTER

1. Remove plugs (A and G).
2. Push piston (C) and spring (D) to the right to remove.
3. Inspect and clean parts.
4. Check that poppet (C) slides smoothly in pilot pressure regulating valve housing (B).
5. Tighten plugs (A and G).

Plug-to-Housing—Specification

Torque .... 49 N•m (36 lb-ft)



T102751 –UN–02AUG96

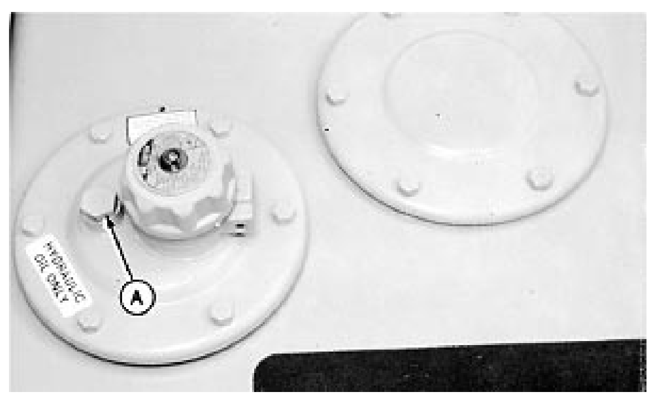
A—Plug
B—Pilot Pressure Regulating Valve Housing
C—Poppet
D—Spring
E—Shim (As Required)
F—O-Ring
G—Plug

TX,33,UU3999 –19–21SEP98–1/1

REMOVE AND INSTALL PILOT SHUT-OFF VALVE

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to release air pressure in hydraulic oil tank.



T7869AT –UN–12NOV92

A—Vent Plug

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Continued on next page TX,33,UU3789 –19–21SEP98–1/2

2. Turn upperstructure 90° to tracks.

3. Remove cover under storage compartment behind cab.

4. Disconnect pilot shut-off valve linkage (K).

5. Mark lines for to aid assembly.

   Disconnect lines (A—I).

6. Remove cap screws (J) to remove pilot shut-off valve.

7. Repair or replace valve as necessary.

8. Install valve. Tighten cap screws.

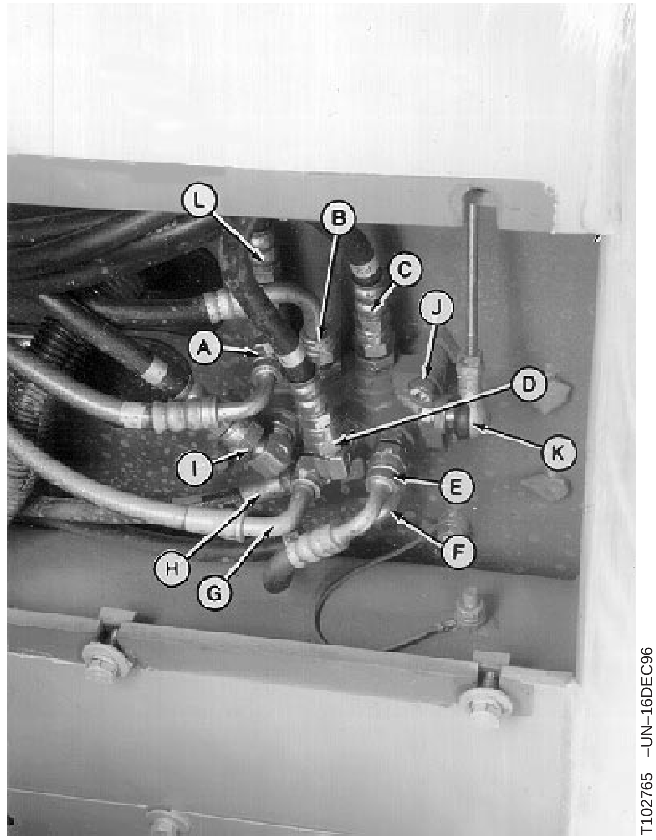
Housing-to-Cab Platform Cap Screw—Specification

Torque .... 49 N•m (36 lb-ft)

9. Connect lines.

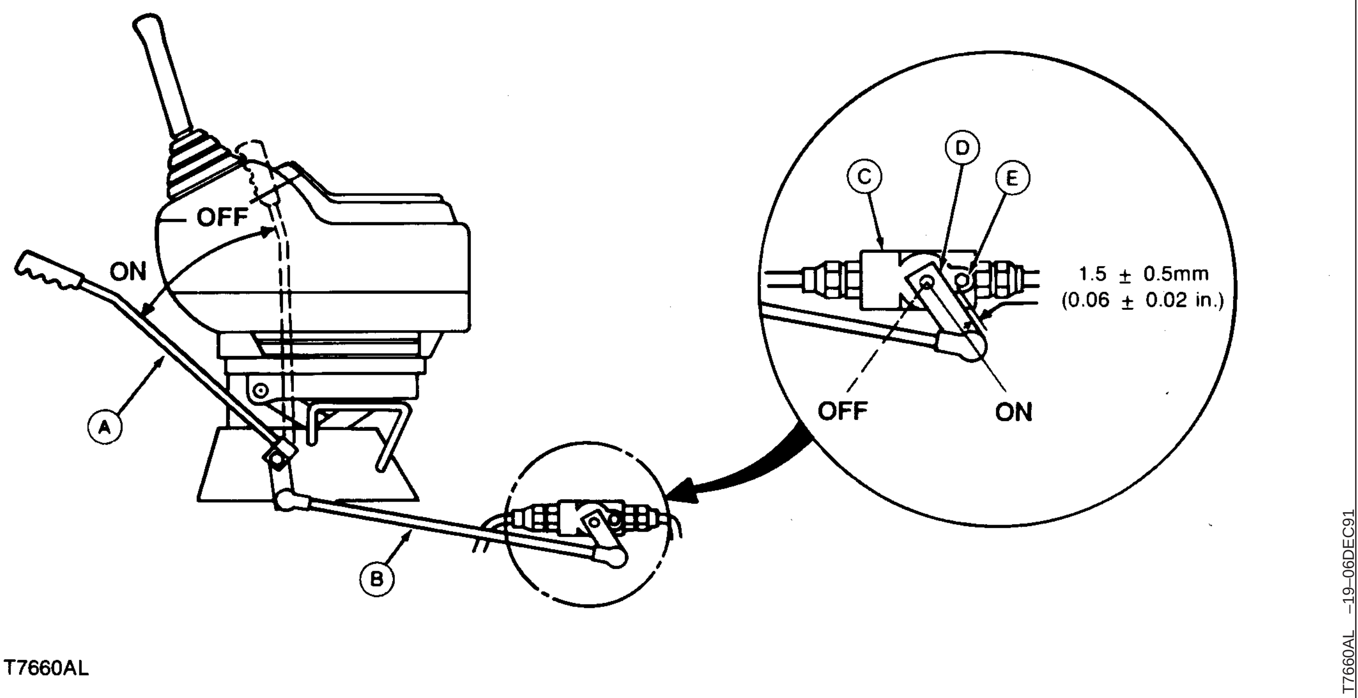
10. Connect linkage.

    Check pilot shut-off valve linkage adjustment. (See Pilot Shut-Off Valve Linkage Adjustment Procedure in this group.)



A—To Right Pilot Controller P Port
B—To Propel Pilot Controller P Port
C—To Left Pilot Controller P Port
D—From Left Pilot Controller T Port
E—To Flow Regulator Valve
F—From Pilot Pressure Regulating Valve
G—From Propel Pilot Controller T Port
H—To Solenoid Valve Manifold DP Port
I—From Right Pilot Controller T Port
J—Cap Screw (2 used)
K—Pilot Shut-Off Valve Linkage
L—To Solenoid Valve Manifold PF Port

PILOT SHUT-OFF VALVE LINKAGE ADJUSTMENT



A—Pilot Shut-Off Lever
B—Rod
C—Valve
D—Lever
E—Cap Screw

1. Stop engine.

2. Remove cover underneath operator's station.

3. Push pilot shut-off lever (A) forward to the ON position. Check that lever is against the front stop.

4. Adjust ball joints on rod (B) to get the specified clearance between valve lever (D) and head of cap screw (E).

Linkage Adjustment—Specification

Clearance.. 1.5 ± 0.5 mm (0.06 ± 0.02 in.) between lever and cap screw

5. Pull pilot shut-off lever to the OFF position. Check that lever is against the rear stop.

CAUTION: Machine may move if adjustment is incorrect. Before checking pilot shut-off lever adjustment, make sure the area around machine is clear.

6. Start the engine. Run engine at slow idle. Actuate the hydraulic functions. Hydraulic functions must not move with the pilot shut-off lever in the OFF position. If hydraulic functions move, repeat adjustment procedure.

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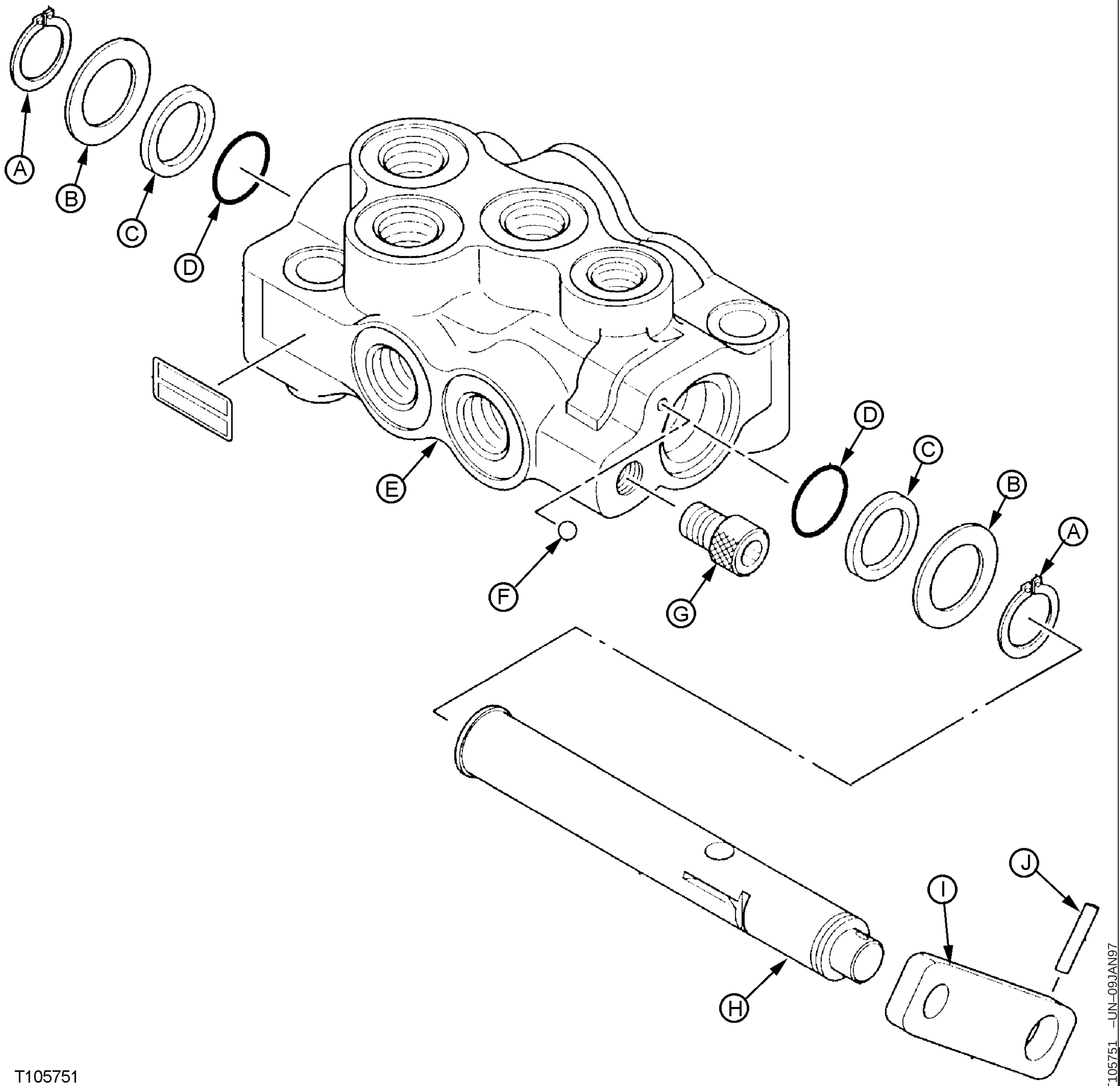
TX,33,UU3790 –19–21SEP98–1/1

DISASSEMBLE AND ASSEMBLE PILOT SHUT-OFF VALVE



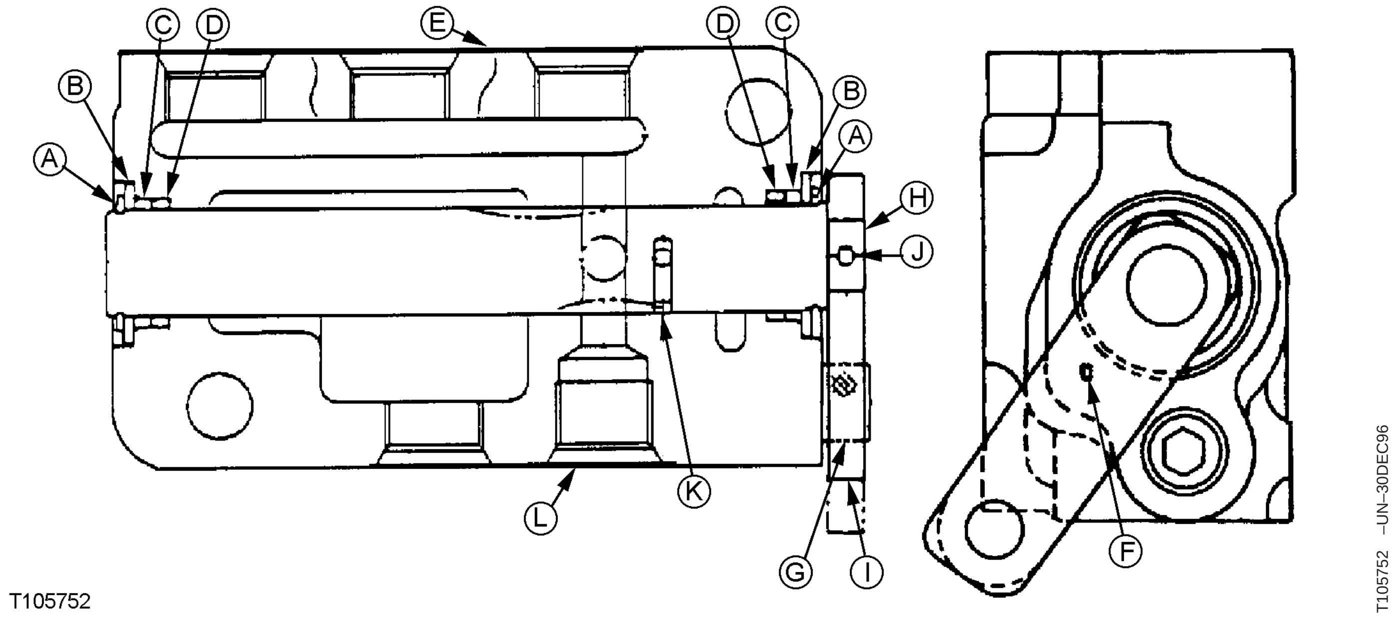
T105751

A—Snap Ring (2 used)	**D—O-Ring (2 used)**	**G—Cap Screw (Lever Stop)**	**J—Spring Pin**
B—Washer (2 used)	**E—Housing**	**H—Spool**	
C—Backup Ring (2 used)	**F—Steel Ball**	**I—Lever**	

1. Make a mark on spool (H) and lever (I) with respect to housing (E) to aid assembly.

Continued on next page

TX,33,UU3791 –19–11JAN96–1/2



A—Snap Ring (2 used)
B—Washer (2 used)
C—Backup Ring (2 used)
D—O-Ring (2 used)
E—Housing
F—Steel Ball
G—Cap Screw (Lever Stop)
H—Spool
I—Lever
J—Spring Pin
K—Slot
L—Inlet Port

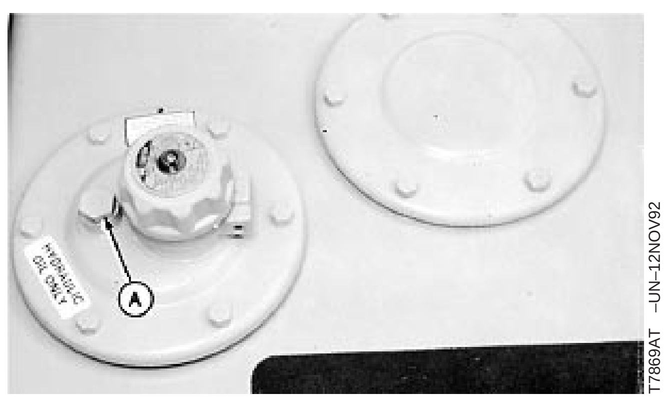
2. Remove snap ring (A) to remove parts (B—D and H).
3. Inspect and replace parts as necessary.
4. Apply grease to backup rings (C) and O-rings (D). Apply clean oil to spool (H).
5. Install spool (H) so slot (K) is towards the inlet port (L).
6. Install parts (A—D).
7. Install lever (I) and spring pin (J).

TX,33,UU3791 –19–11JAN96–2/2

REMOVE AND INSTALL PROPORTIONAL SOLENOID VALVE MANIFOLD

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to relieve hydraulic pressure in reservoir.



A—Vent Plug

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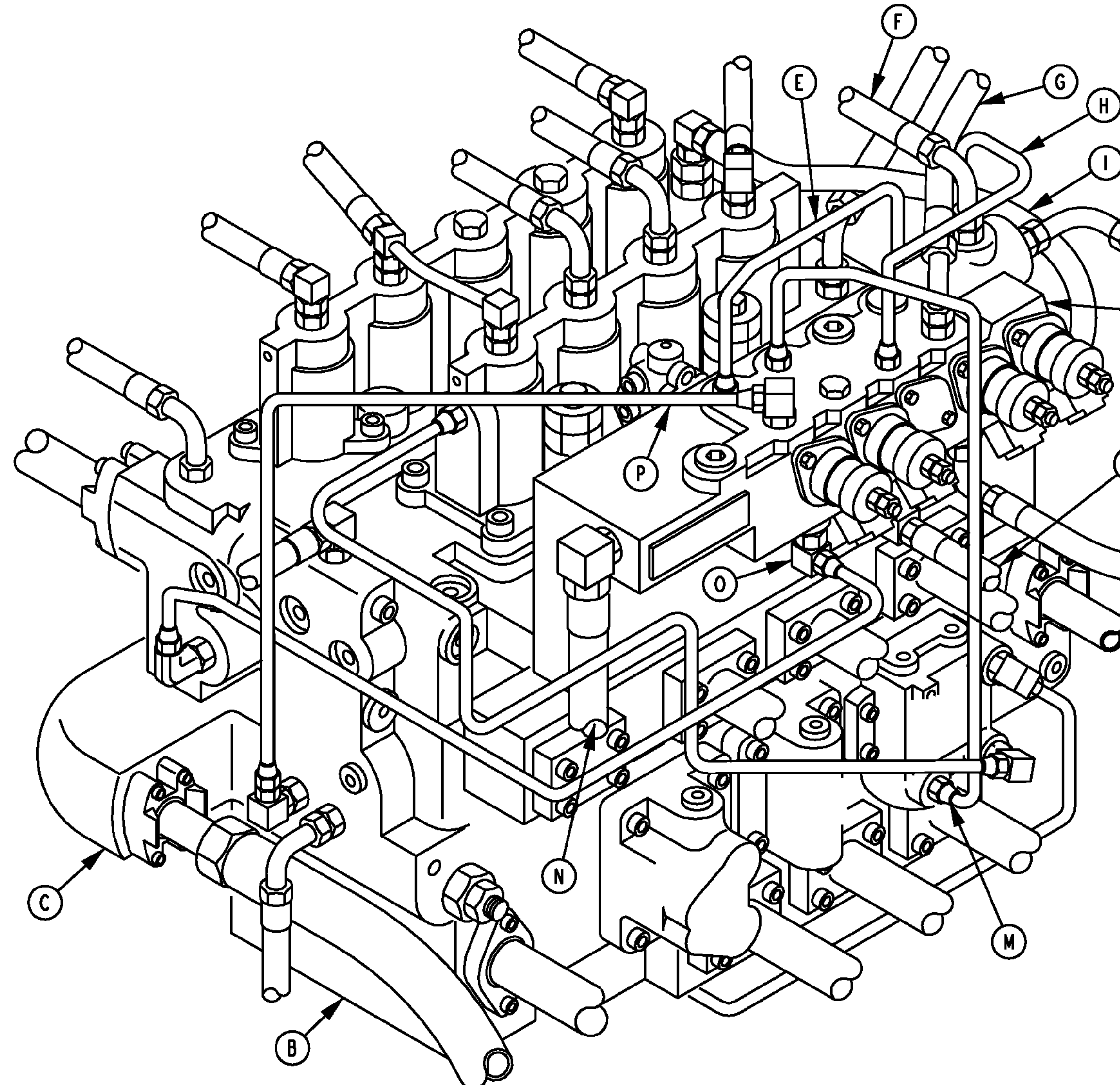
Continued on next page TX,33,UU3792 –19–17DEC96–1/3



Right Rear

B—Right Control Valve—4-Spool
C—Left Control Valve—5-Spool
D—Proportional Solenoid Valve Manifold
E—From Propel Flow Control Valve
F—To Flow Regulator Valve
G—To Swing Motor Park Brake Release Valve Top Port
H—To Rear Pump Control Valve
I—To Power Boost Port in System Relief Valve
J—To Hydraulic Oil Tank
K—To Propel Motor Speed Change Valve
L—To Front and Rear Pump Regulating Valve Speed Sensing Port
M—From Bucket Flow Control Valve
N—From Pilot Shut-Off Valve
O—To Arm Regenerative Valve
P—To Front Pump Control Valve

NOTE: The individual proportional solenoid valves can be removed with manifold on the machine.

2. Disconnect lines (E—P).

Continued on next page

3. Disconnect wiring harness connectors at each solenoid valve (Q—T).

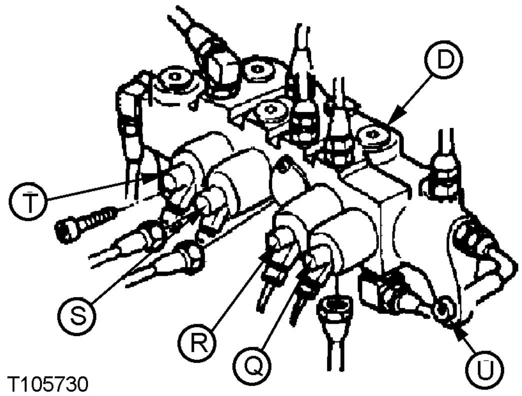
4. Remove cap screws (U) to remove proportional solenoid valve manifold (D). Repair or replace part as necessary.

5. Install solenoid valve manifold

6. Connect wiring harness connectors.

7. Connect lines.

8. Check pressure setting of proportional solenoid valves. (See Proportional Solenoid Valve Test and Adjustment in Group 9025-25.)



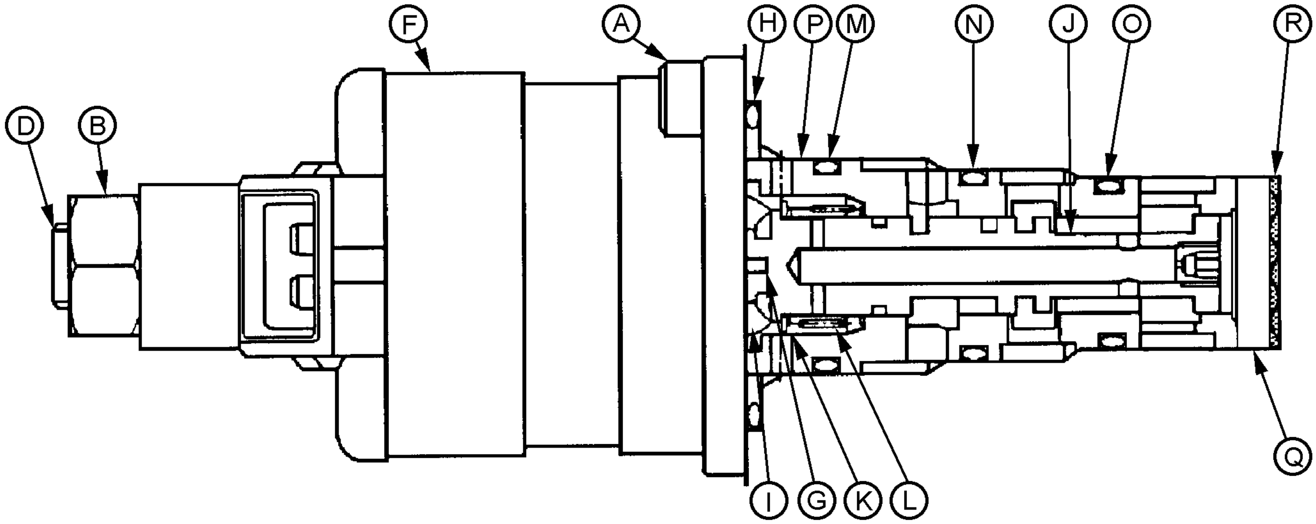
T105730

T105730 –UN–30DEC96

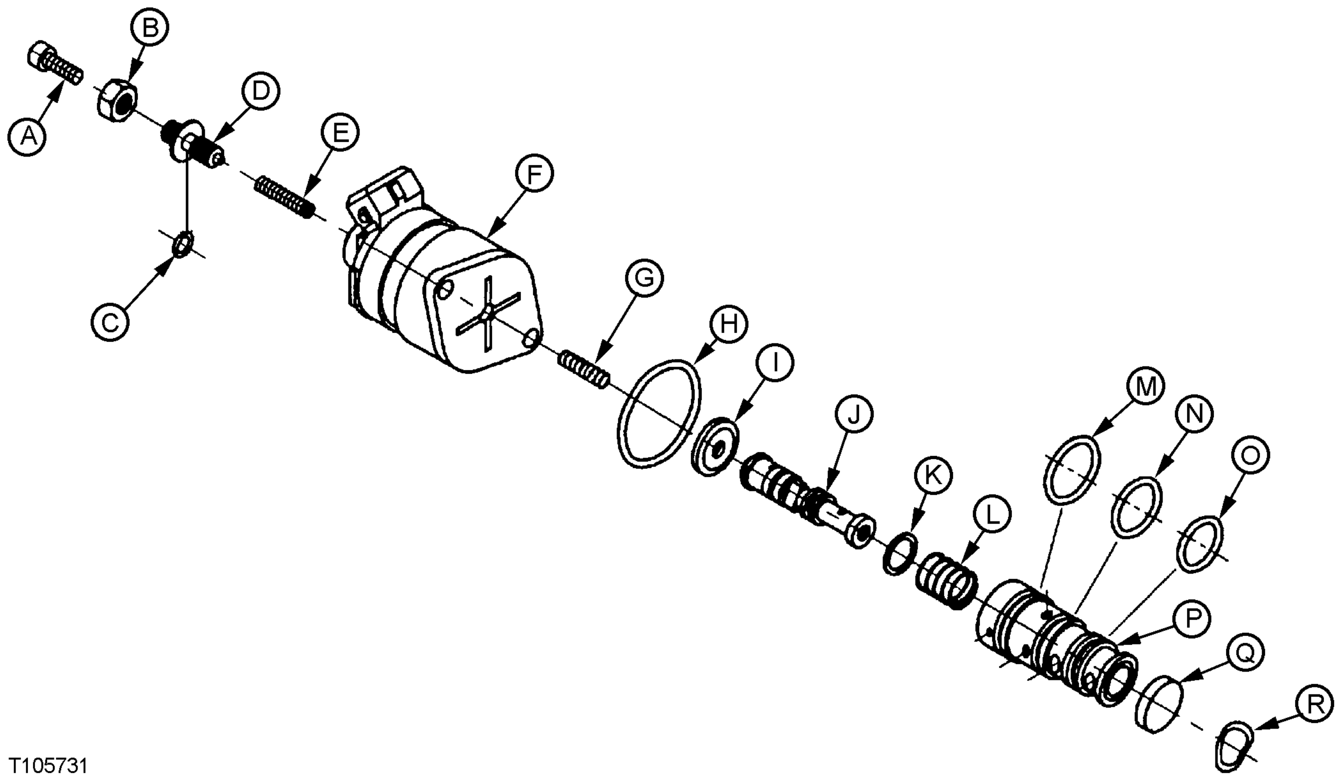
D—Proportional Solenoid Valve Manifold
Q—Power Boost Solenoid Valve (BLU/BLK and BLU/RED Wiring Leads
R—Propel Speed Change Solenoid Valve (LGRN/RED and LGRN/BLK Wiring Leads)
S—Speed Sensing Solenoid Valve (RED/YEL and RED/WHT Wiring Leads)
T—Arm Regenerative Solenoid Valve (BLU/WHT and BLU/ORN Wiring Leads)
U—Cap Screw (2 used)

TX,33,UU3792 –19–17DEC96–3/3

DISASSEMBLE AND ASSEMBLE PROPORTIONAL SOLENOID VALVE



T105732



T105731

A—Cap Screw (4 used)
B—Lock Nut
C—O-Ring
D—Adjusting Screw
E—Spring
F—Solenoid Coil
G—Spring
H—O-Ring
I—Diaphragm
J—Spool
K—Washer
L—Spring
M—O-Ring
N—O-Ring
O—O-Ring
P—Sleeve
Q—Plate
R—Washer

Continued on next page

TX,33,UU3793 –19–21SEP98–1/5

1. Keep the parts for each solenoid valve together.

   When removing the solenoid coil (F), do not lose spring (G).

   Only remove the lock nut (B) and adjusting screw (D) if replacement of O-ring (C) is necessary.

   Pressure setting of proportional solenoid valve will need to be adjusted. (See Proportional Solenoid Valve Test and Adjustment in Group 9025-25.)

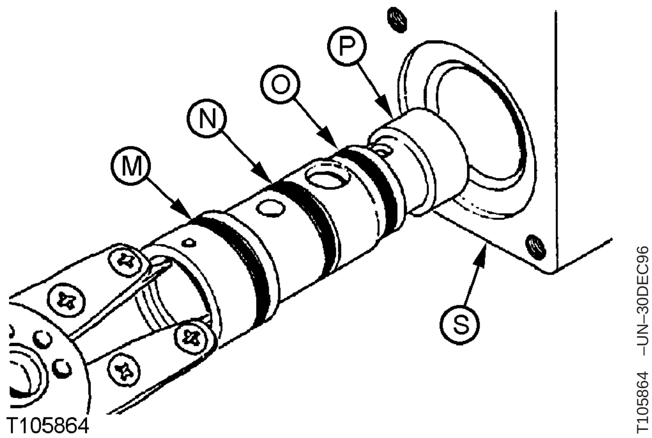
2. Repair or replace parts as necessary.

3. Install washer (R) and plate (Q).

TX,33,UU3793 –19–21SEP98–2/5

4. Apply clean oil to sleeve (P) and O-rings (M, N and O).

5. Install sleeve so ports align with ports in manifold (S).



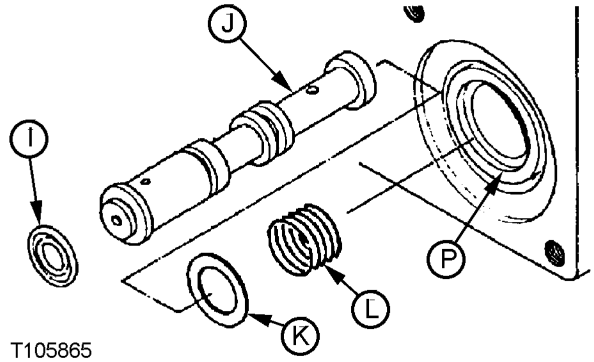
M—O-Ring
N—O-Ring
O—O-Ring
P—Sleeve
S—Manifold

Continued on next page TX,33,UU3793 –19–21SEP98–3/5

6. Apply clean oil to spool (J).

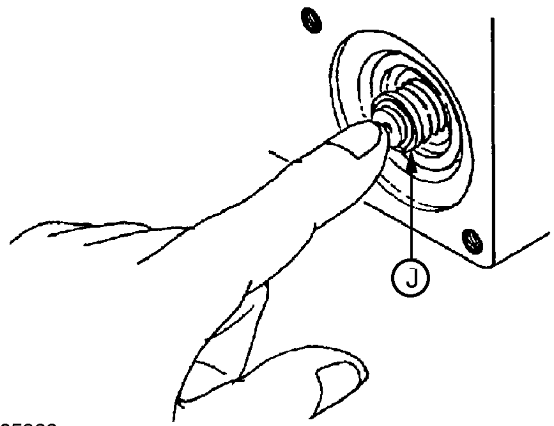
7. Install washer (K) and spring (L) on spool. Install spool.

   After installing spool, push spool against spring to check that spool slides smoothly in sleeve.



T105865

T105865 –UN–30DEC96



T105866

T105866 –UN–30DEC96

I—Diaphragm
J—Spool
K—Washer
L—Spring
P—Sleeve

Continued on next page

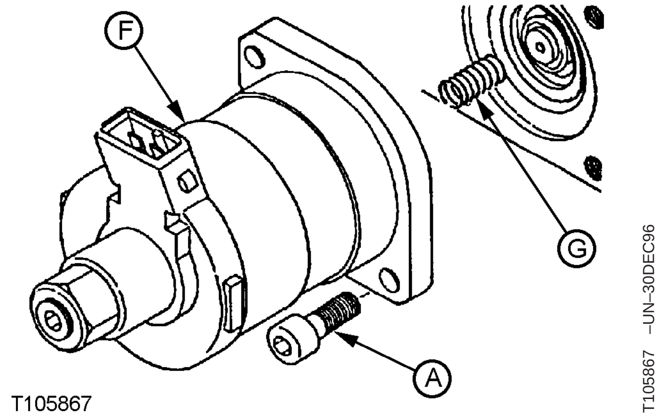
TX,33,UU3793 –19–21SEP98–4/5

8. Check to be sure spring (G) remains in position when installing solenoid coil (F).

9. Tighten cap screws (A).

Valve Housing-to-Solenoid Valve Manifold Cap Screw—Specification

Torque .... 3 N•m (24 lb-in.)



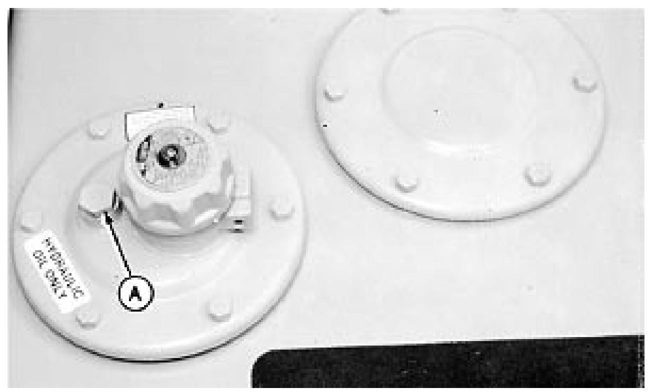
A—Cap Screw
F—Solenoid Coil
G—Spring

TX,33,UU3793 –19–21SEP98–5/5

REMOVE AND INSTALL DIG FUNCTION PILOT CONTROLLER

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to release air pressure from hydraulic oil tank.

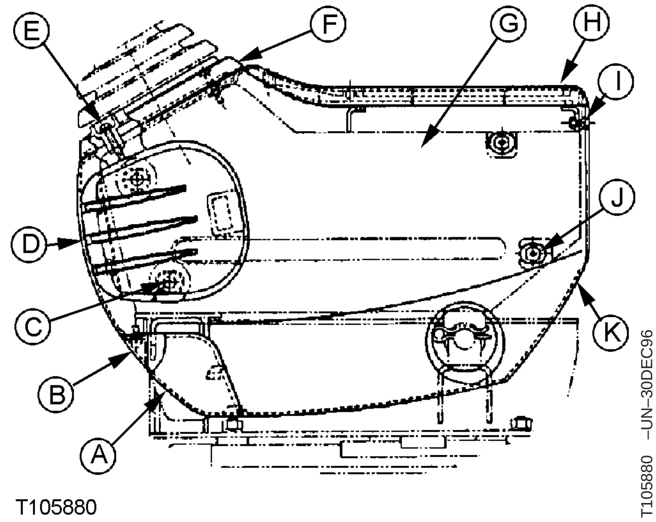


A—Vent Plug

Continued on next page TX,33,UU4000 –19–21SEP98–1/5

2. Remove cover (D) by pulling at front edge.

3. Remove all covers (A, G and H) and boot (F) from the console (K).



T105880

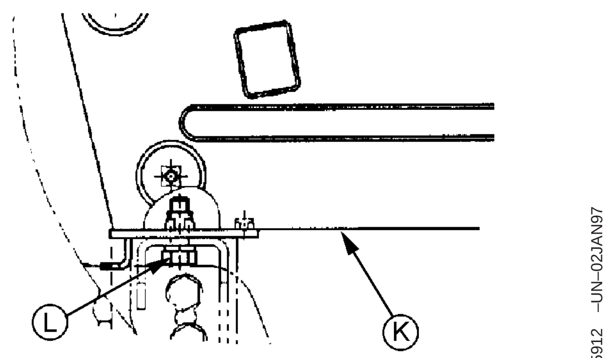
Left Console Shown

A—Cover
B—Screw (2 used)
C—Screw (2 used)
D—Cover
E—Screw (4 used)
F—Boot
G—Cover
H—Cover
I—Screw (4 used)
J—Screw (2 used)
K—Console

TX,33,UU4000 –19–21SEP98–2/5

4. Pull the seat and consoles as far forward as possible.

5. Remove cap screws (L) so the console (K) can be tipped back.



T105912

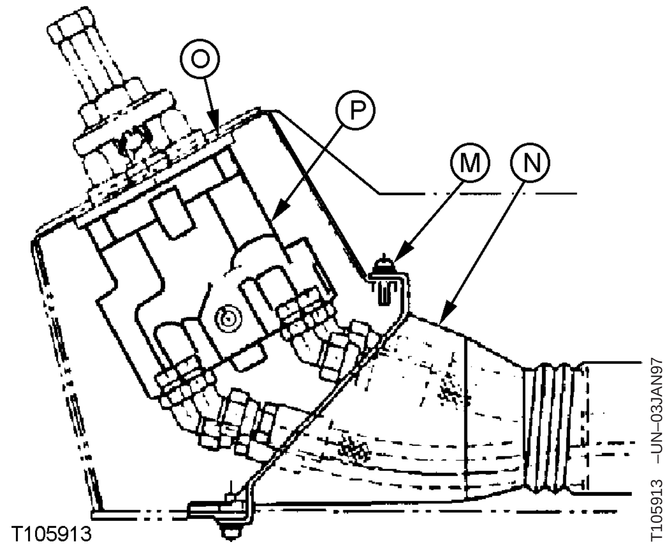
K—Console
L—Cap Screw

Continued on next page

TX,33,UU4000 –19–21SEP98–3/5

6. Remove screws (M) to disconnect hose boot (N) from console.

7. Remove cap screws (O) to remove pilot controller (P) from console.



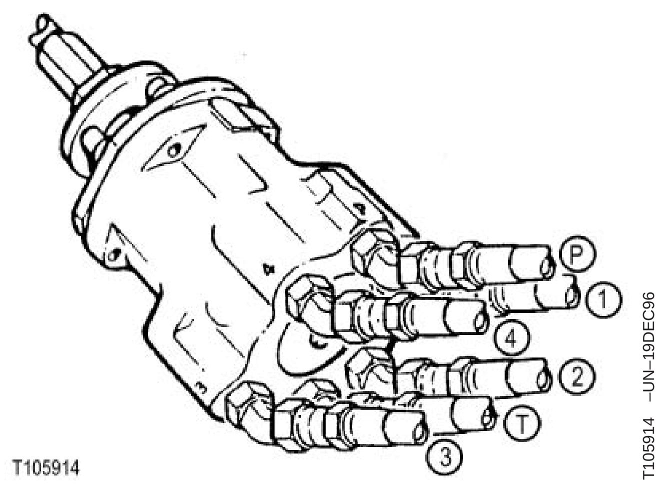
M—Screws
N—Hose Boot
O—Cap Screw
P—Pilot Controller

TX,33,UU4000 –19–21SEP98–4/5

8. Disconnect lines (P, T and 1—4) from pilot controller. Identify the lines by the numbers and letters stamped on the controller housing.

   Install caps and plugs to close all openings.

9. After pilot controller is installed, check the operation of all functions to be sure they operate as shown on the decal on console.

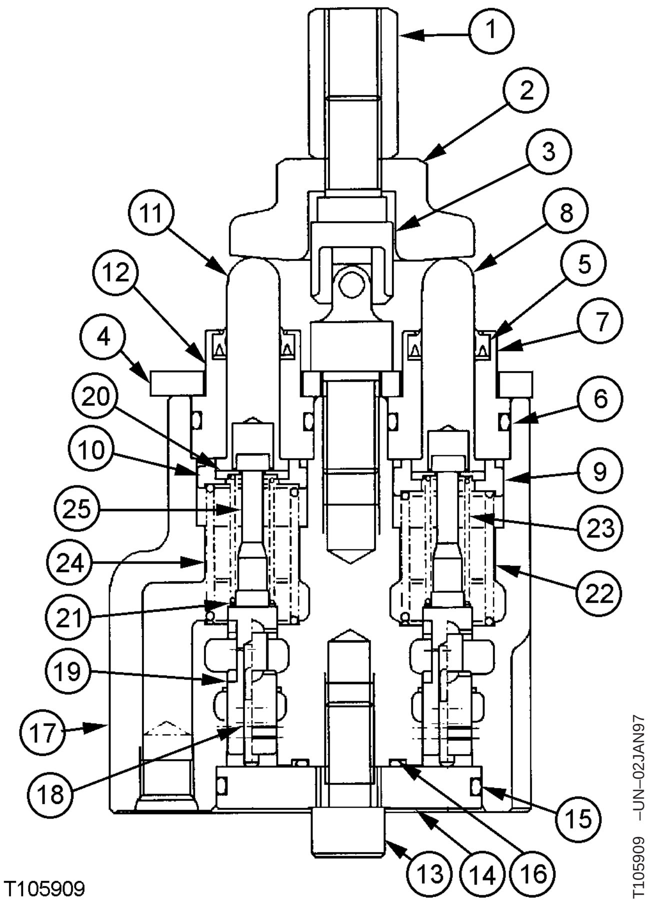


P—Hydraulic Line
T—Hydraulic Line
1—Hydraulic Line
2—Hydraulic Line
3—Hydraulic Line
4—Hydraulic Line

TX,33,UU4000 –19–21SEP98–5/5

DISASSEMBLE AND ASSEMBLE DIG FUNCTION PILOT CONTROLLER

1. Remove coupling (1) and cam (2).

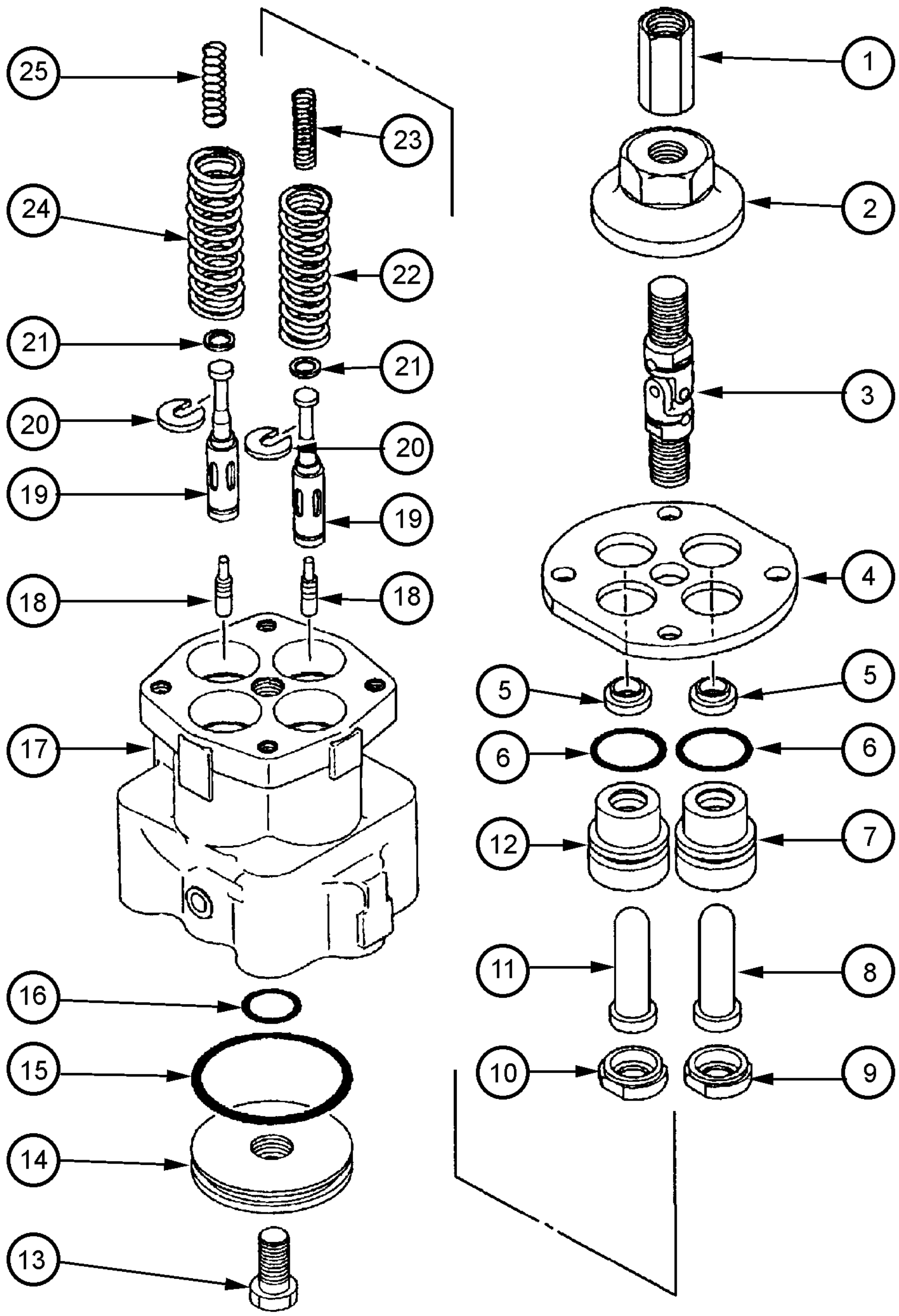


T105909

1—Coupling
2—Cam
3—U-Joint
4—Plate
5—Oil Seal (4 used)
6—O-Ring (4 used)
7—Bushing (2 used)
8—Pusher (2 used)
9—Spring Guide (2 used)
10—Spring Guide (2 used)
11—Pusher (2 used)
12—Bushing (2 used)
13—Cap Screw
14—Plate
15—O-Ring
16—Seal
17—Housing
18—Piston (4 used)
19—Spool (4 used)
20—Spacer (Retainer) (4 used)
21—Shim (20 used)
22—Return Spring (2 used)
23—Balance Spring (2 used)
24—Return Spring (2 used)
25—Balance Spring (2 used)

Continued on next page

TX,33,GG2416 –19–21SEP98–1/3



1—Coupling
2—Cam
3—U-Joint
4—Plate
5—Oil Seal (4 used)
6—O-Ring (4 used)
7—Bushing (2 used)
8—Pusher (2 used)
9—Spring Guide (2 used)
10—Spring Guide (2 used)
11—Pusher (2 used)
12—Bushing (2 used)
13—Cap Screw
14—Plate
15—O-Ring
16—Seal
17—Housing
18—Piston (4 used)
19—Spool (4 used)
20—Spacer (Retainer) (4 used)
21—Shim (20 used)
22—Return Spring (2 used)
23—Balance Spring (2 used)
24—Return Spring (2 used)
25—Balance Spring (2 used)

Continued on next page

TX,33,GG2416 –19–21SEP98–2/3

IMPORTANT: The housing (17) and spools (19) are replaced as an assembly because the spools are select fitted to bores in housing.

Some of the parts from ports 1 and 3 are different than parts from ports 2 and 4. Parts for each port must be kept together and installed into the same port from which it was removed. The port numbers are stamped on the housing.

2. Temporarily install M8-1.25 cap screws to hold the plate (4) on housing.

   Remove the U-joint (3).

3. Remove cap screw (13).

   Pull plate (14) from housing using an M16-2.0 cap screw.

4. Remove pistons (18). These pistons must be removed FIRST and installed LAST.

5. Slowly loosen the cap screws to release the spring force of return springs on plate.

6. Remove parts from housing. Remember to keep the parts removed from each port together. Identify each group of parts by the port numbers stamped on the housing.

7. Repair or replace parts as necessary.

8. Install the same number of shims (21) on each spool (19) as were removed.

   Push the balance spring (23 and 25) down and then install the spacer (retainer) (20) so the recess side is against the spring.

9. Apply grease to oil seals (5).

10. Install the parts into housing.

    Temporarily install M8-1.25 cap screws to hold the plate (4) on housing.

11. Install the pistons (18), small end first, into the spools

12. Install plate (14). Tighten cap screw (13).

Bottom Plate-to-Housing Cap Screw—Specification

Torque.. 49 N•m (36 lb-ft)

13. Apply thread lock and sealer (medium strength) to threads on one end of U-joint (3).

    Tighten U-joint into housing.

U-Joint-to-Housing—Specification

Torque.. 24 N•m (216 lb-in.)

Remove the temporarily installed cap screws.

14. Apply grease to the end of each pusher (8 and 11) and to the joint of U-joint.

15. Install cam on U-joint. Adjust clearance between pushers and cam.

Cam-to-Pushers—Specification

Clearance.. 0—0.20 mm (0—0.008 in.)

While holding cam (2), tighten coupling (1).

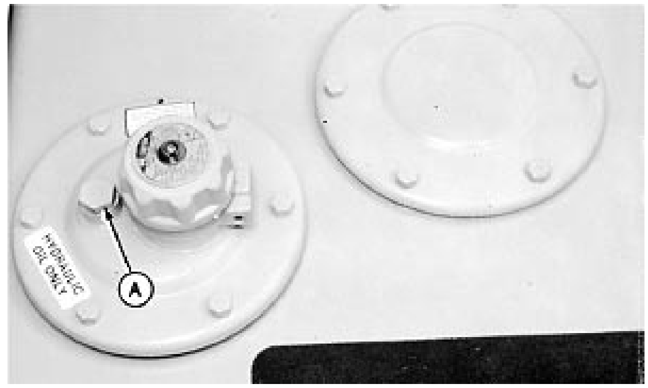
Coupling-to-Cam and U-Joint—Specification

Torque... 78 N•m (58 lb-ft)

REMOVE AND INSTALL PROPEL PILOT CONTROLLER

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to release air pressure from hydraulic oil tank.



A—Vent Plug

Continued on next page TX,33,GG2557 –19–21SEP98–1/2

2. Disconnect lines (C—H). Install plugs and caps.

3. Remove cap screws to remove pedals (K), levers, and damper brackets.

4. Remove cap screws (I) to remove propel pilot controller (J).

5. Repair or replace parts as necessary.

6. Tighten valve mounting cap screws (I).

Controller-to-Cab Platform Cap Screw—Specification

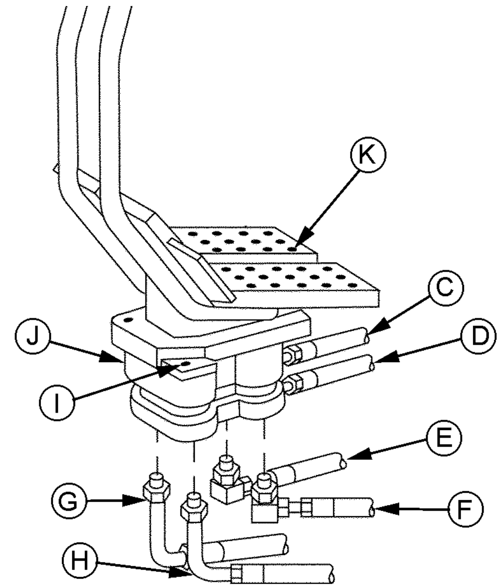
Torque .... 49 N•m (36 lb-ft)

7. Tighten pedal-to-lever cap screws.

Propel Pedal-to-Lever Cap Screw—Specification

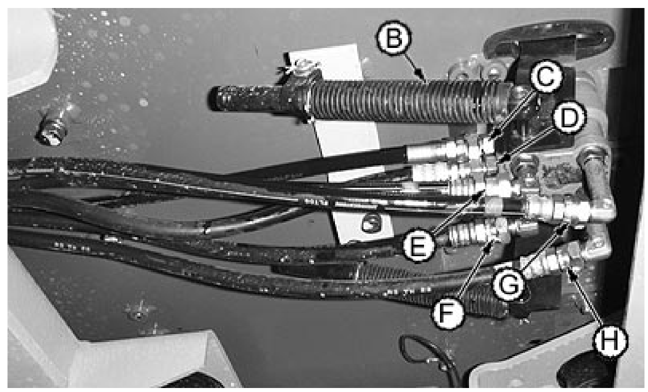
Torque .... 49 N•m (36 lb-ft)

8. After propel pilot controller is installed, check the operation of all functions to be sure they operate correctly.



T108085

T108085 –UN–11MAR97



T108073B –UN–11MAR97

B—Propel Pedal Dampener
C—To Pilot Shut-Off Valve
D—From Pilot Shut-Off Valve
E—To Right Propel Reverse Top Pilot Cap
F—To Left Propel Reverse Top Pilot Cap
G—To Right Propel Forward Bottom Pilot Cap
H—To Left Propel Forward Bottom Pilot Cap
I—Cap Screw (2 used)
J—Propel Pilot Controller
K—Pedal, Lever and Bracket

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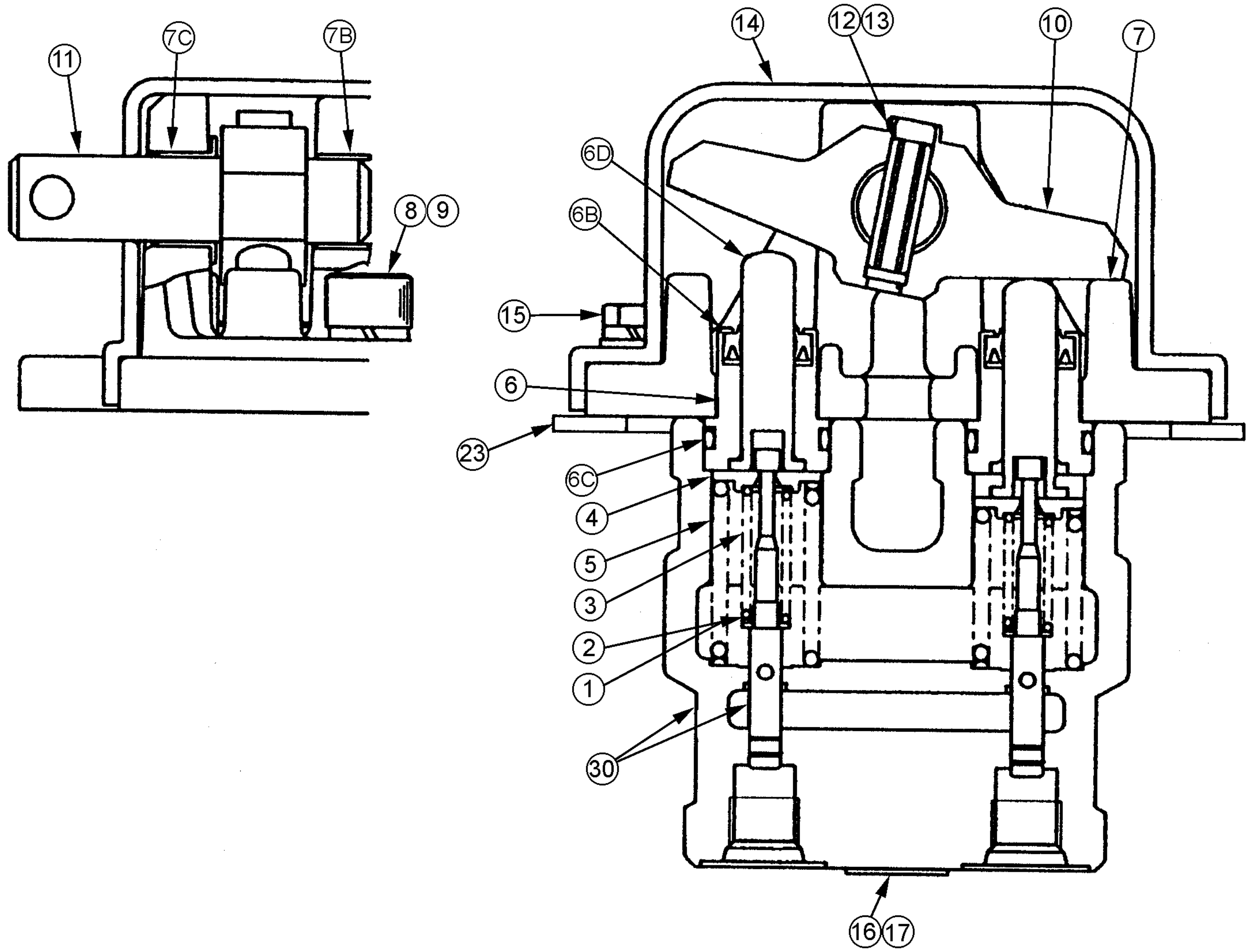
TX,33,GG2557 –19–21SEP98–2/2

DISASSEMBLE AND ASSEMBLE PROPEL PILOT CONTROLLER



0—Propel Pilot Controller
1—Spacer (4 used)
2—Shim (12 used)
3—Balance Spring (4 used)
4—Spring Guide (4 used)
5—Return Spring (4 used)
6—Plunger (4 used)
6B—Seal (4 used)
6C—O-Ring (4 used)
6D—Plunger (4 used)
7—Holder
7B—Bushing (2 used)
7C—Bushing (2 used)
8—Cap Screw (2 used)
9—Lock Washer (2 used)
10—Cam (2 used)
11—Pin (2 used)
11A—Bushing (4 used)
12—Spring Pin (2 used)
13—Spring Pin (2 used)
14—Cover
15—Cap Screw, Lock Washer, Washer (2 used)
16—Plug
17—O-Ring
23—Plate
30—Housing and Spools

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3360
78

IMPORTANT: The housing and spools (30) are replace as an assembly because the spools are select fitted to bores in housing. Spools must be installed into the same ports from which they were removed.

1. Remove cover (14).

2. Slowly loosen the cap screws (8) to release the spring force of balance spring (3) and return springs (5) on holder (7).

Continued on next page

TX,33,GG2558 –19–21SEP98–1/4

3. Remove the cams (10) only if replacement of parts is necessary.

   To remove, drive the inner spring pin (13) out first. Then drive the outer spring pin (12) out through the top of cam. The outer spring pin is against a shoulder at bottom of cam. After spring pins are installed, bend part of flange over pins to prevent then from coming out.

4. Remove parts from housing. Remember to keep the parts removed from each port together. Identify each group of parts by the port numbers stamped on housing. Take note of the number of spacers (1) and shims (2) on each spool.

5. Remove plug (16).

6. Repair or replace parts as necessary.

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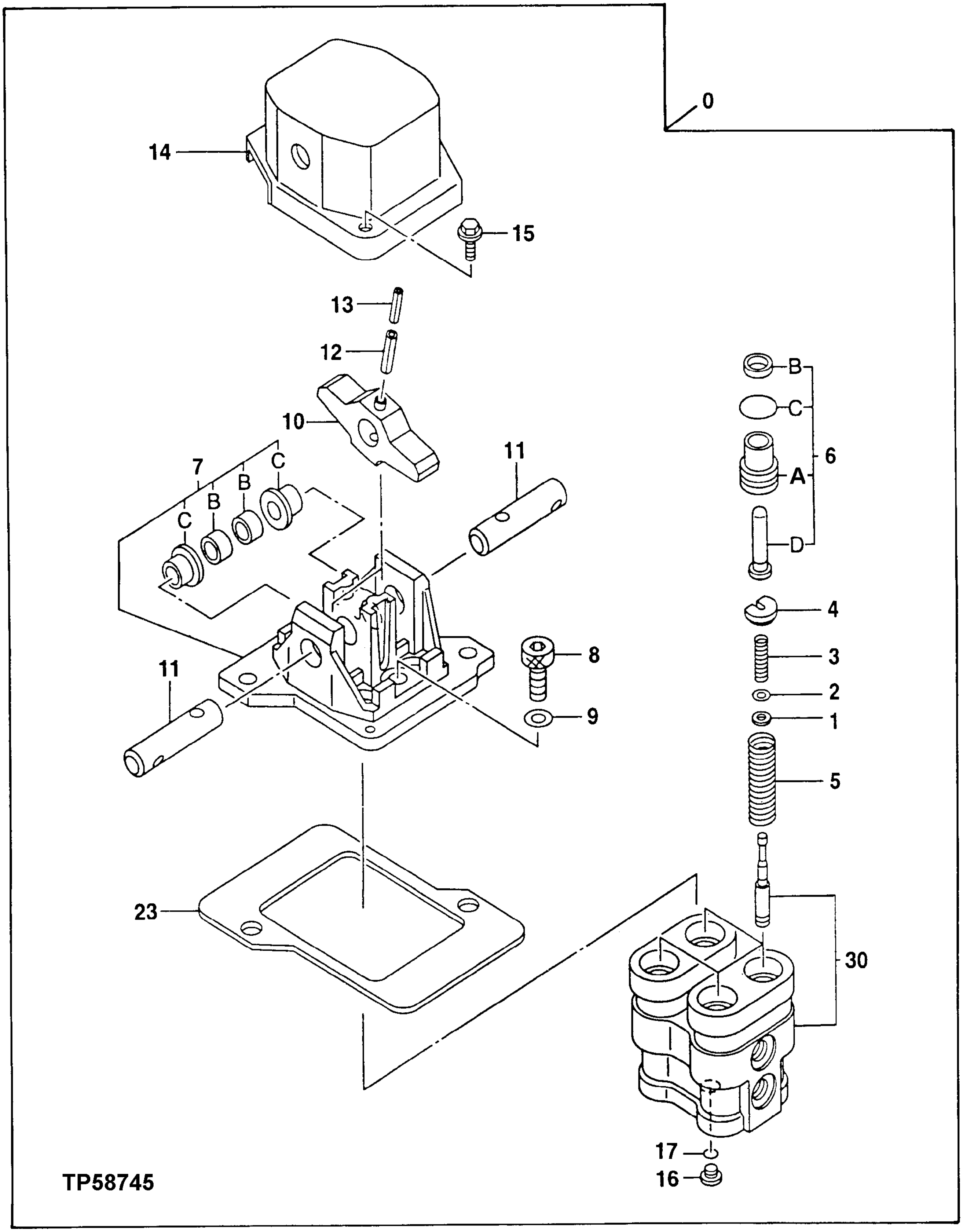

TP54575 –UN–05AUG97

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TX,33,GG2558 –19–21SEP98–3/4

33
3360
80

0—Propel Pilot Controller
1—Spacer (4 used)
2—Shim (12 used)
3—Balance Spring (4 used)
4—Spring Guide (4 used)
5—Return Spring (4 used)
6—Plunger (4 used)
6B—Seal (4 used)
6C—O-Ring (4 used)
6D—Plunger (4 used)
7—Holder
7B—Bushing (2 used)
7C—Bushing (2 used)
8—Cap Screw (2 used)
9—Lock Washer (2 used)
10—Cam (2 used)
11—Pin (2 used)
11A—Bushing (4 used)
12—Spring Pin (2 used)
13—Spring Pin (2 used)
14—Cover
15—Cap Screw, Lock Washer, and Washer (2 used)
16—Plug
17—O-Ring
23—Plate
30—Housing and Spools

7. Install the same number of spacers (1) and shims (2) on each spool as were removed.

   Push the balance spring (3) down and then install the spring guide (4) so the concave side is against the spring.

8. Apply grease to oil seals (6B) and O-rings (6C).

9. Install the parts into housing. Remember to install the spools into the same ports from which they were removed.

   Slowly push holder down to compress springs and push parts into housing.

   Tighten hex head cap screws (8).

Holder-to-Housing Cap Screw—Specification

Torque.. 49 N•m (36 lb-ft)

10. Tighten plug (16).

Plug-to-Housing—Specification

Torque.. 34 N•m (25 lb-ft)

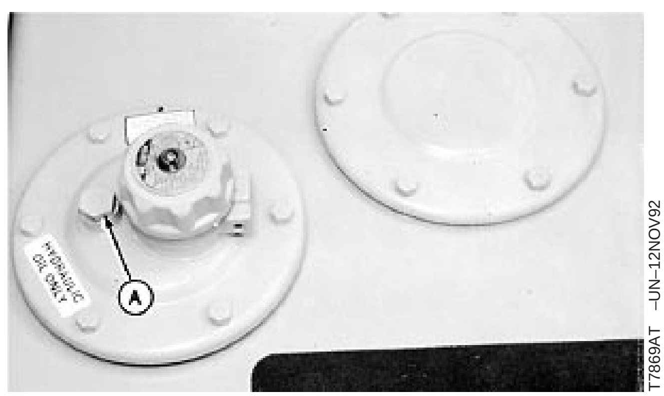
11. Apply grease to the end of plungers (6D).

TX,33,GG2558 –19–21SEP98–4/4

REMOVE AND INSTALL FLOW REGULATOR VALVE

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to release air pressure from hydraulic oil tank.

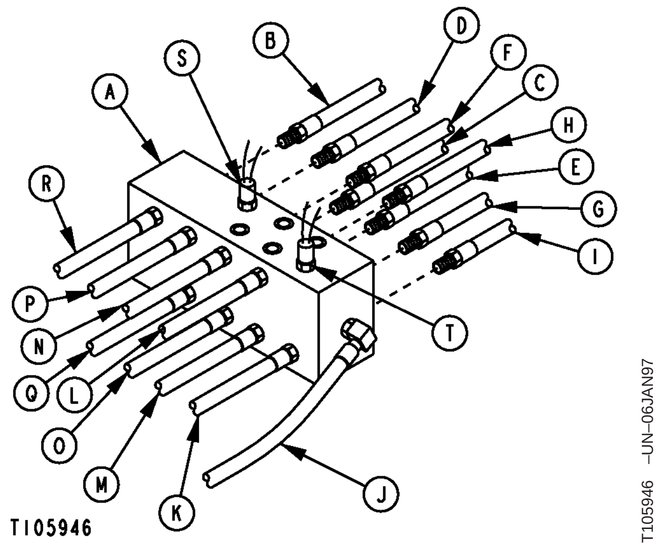


A—Vent Plug

Continued on next page

TX,33,UU3798 –19–21SEP98–1/2

2. After lines are connected to flow regulator valve, check the operation of all functions to be sure they operate as shown on the decal on console.



SAE Pattern Shown

A—Flow Regulator Valve
B—To Swing Left, Bottom Pilot Cap
C—To Swing Right Top Pilot Cap
D—To Bucket Dump Bottom Pilot Cap
E—To Bucket Load Top Pilot Cap
F—To Boom Up Bottom Pilot Cap
G—To Boom Down Top Pilot Cap
H—To Arm Out Bottom Pilot Cap
I—To Arm In Top Pilot Cap
J—From Pilot Shut-Off Valve
K—From Port 1 Left Pilot Controller
L—From Port 3 Left Pilot Controller
M—From Port 2 Right Pilot Controller
N—From Port 4 Right Pilot Controller
O—From Port 3 Right Pilot Controller
P—From Port 4 Right Pilot Controller
Q—From Port 2 Left Pilot Controller
R—From Port 4 Left Pilot Controller
S—Boom Up Pilot Pressure Switch
T—Arm In Pilot Pressure Sensor

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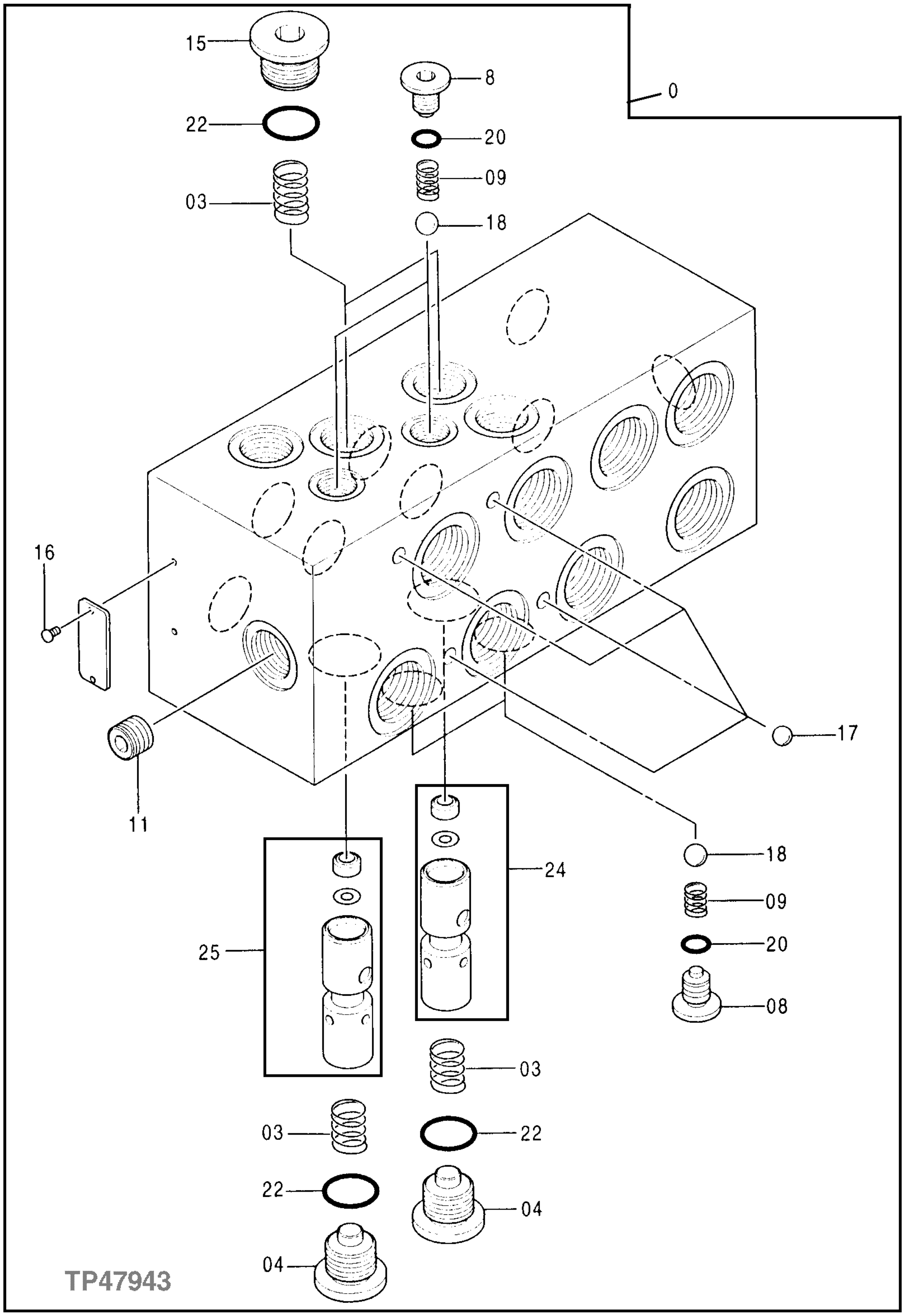
TX,33,UU3798 –19–21SEP98–2/2

DISASSEMBLE AND ASSEMBLE FLOW REGULATOR VALVE



TP47943 –UN–22MAY96

0—Flow Regulator Valve
3—Spring (4 used)
4—Plug (2 used)
8—Plug (4 used)
9—Spring (4 used)
11—Orifice
15—Plug (2 used)
16—Screw
17—Ball (4 used)
18—Ball (4 used)
20—O-Ring (4 used)
22—O-Ring (4 used)
24—Plunger (Spool, Orifice and Ring)
25—Plunger (Spool, Orifice and Ring)

Continued on next page

TX,33,UU3799 –19–21SEP98–1/2

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83

IMPORTANT: The orifice size in the plungers (24 and 25) are a different size. Plungers with the correct size orifice must be install into the same bore from which they were removed for proper operation.

1. Check that plungers (24 and 25) slide smoothly in bore. Check that orifice in plungers are clean.

   Orifice size for plunger (25) in the arm in circuit is 3.2 mm (0.126 in.). Orifice size for plunger (24) in the boom up circuit is 2.5 mm (0.098 in.).

Arm In Plunger Orifice—Specification

Size .... 3.2 mm (0.126 in.)

Boom Up Plunger Orifice—Specification

Size .... 2.5 mm (0.098 in.)

Tighten spool assembly bottom plug (4).

3/8 in. Plug for Plunger-to-Housing—Specification

Torque .... 49 N•m (36 lb-ft)

2. Check seats in housing for check valve balls (18). Tighten plug (8).

Check Valve-to-Housing Plug—Specification

Torque .... 10 N•m (86 lb-in.)

3. Check that orifice (11) is clean. Tighten orifice.

Orifice-to-Housing—Specification

Torque .... 10 N•m (86 lb-in.)

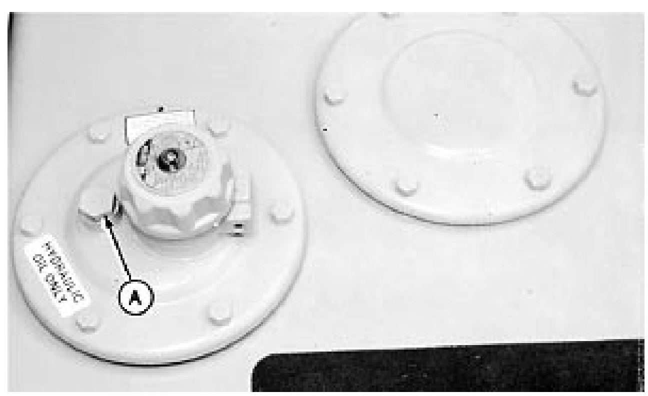
TX,33,UU3799 –19–21SEP98–2/2

REMOVE AND INSTALL CONTROL VALVE

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to release air pressure from hydraulic oil tank.

2. Pull a vacuum in hydraulic oil tank using a vacuum pump or drain hydraulic oil tank. Approximate oil capacity is 130 L (35 gal).



T7869AT –UN–12NOV92

A—Vent Plug

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TX,33,UU4002 –19–21SEP98–1/8

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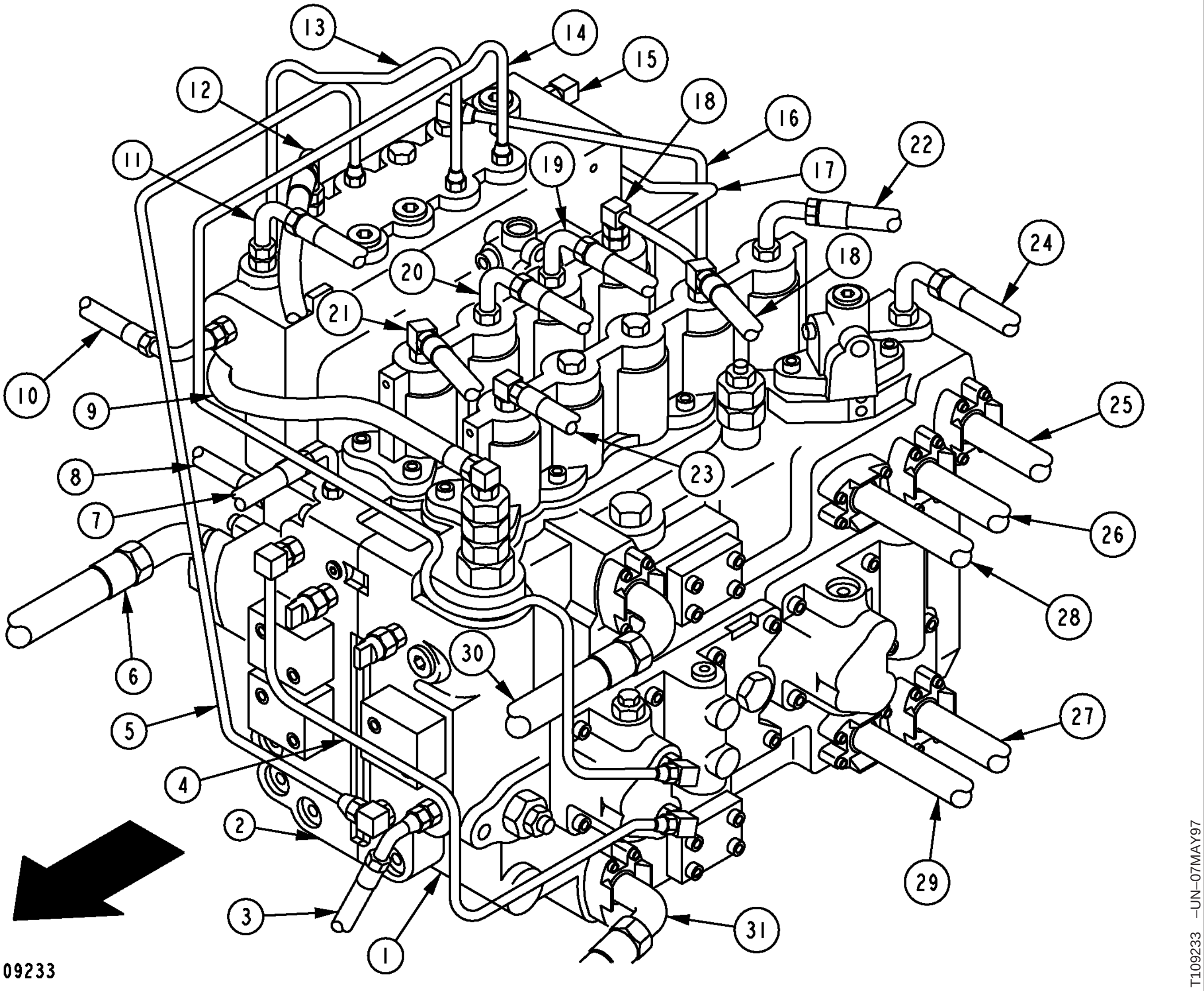
3360
84

Hydraulic System



Left Front

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33
3360
86

1—Left Control Valve (5-Spool)
2—Right Control Valve (4-Spool)
3—To Rear Pump Control Valve Pressure Sensor and Rear Pump Regulator
4—Pilot Pressure Signal To Propel Flow Control Valve
5—To Rear Pump Control Valve
6—Inlet Flow From Front Pump
7—Pilot Pressure Signal To Swing Motor Park Brake Release Valve—Bottom Port
8—Pilot Pressure From Pilot Pressure Regulating Valve
9—Power Boost Solenoid Valve to System Relief Valve
10—Return to Hydraulic Tank
11—Return From Pilot Shut-Off Valve
12—Pilot Pressure To Swing Motor Park Brake Release Valve—Top Port
13—Return From Bucket Flow Control Valve To Solenoid Valve Manifold
14—Return From Propel Flow Control Valve To Solenoid Valve Manifold
15—Pilot Pressure From Pilot Shut-Off Valve to Solenoid Valve Manifold
16—Pilot Pressure to Front Pump Control Valve
17—Arm In Pilot To Bucket Flow Control Valve—Front Bottom Port
18—Arm In Pilot From Left Pilot Controller—SAE Pattern
19—Boom Down Pilot From Right Pilot Controller—SAE Pattern
20—Bucket Load Pilot From Right Pilot Controller
21—Right Propel Reverse Pilot From Propel Pilot Controller
22—Swing Right Pilot From Left Pilot Controller
23—Left Propel Reverse Pilot From Propel Pilot Controller
24—To Swing Motor Make-Up Oil Port
25—To Hydraulic Oil Cooler
26—To Swing Motor Front Port—Left Swing
27—To Swing Motor Rear Port—Right Swing
28—To Arm Cylinder Rod End—Arm Out
29—To Arm Cylinder Head End—Arm In
30—Left Propel Forward To Rotary Manifold Left Front Port
31—Left Propel Reverse To Rotary Manifold Left Rear Port

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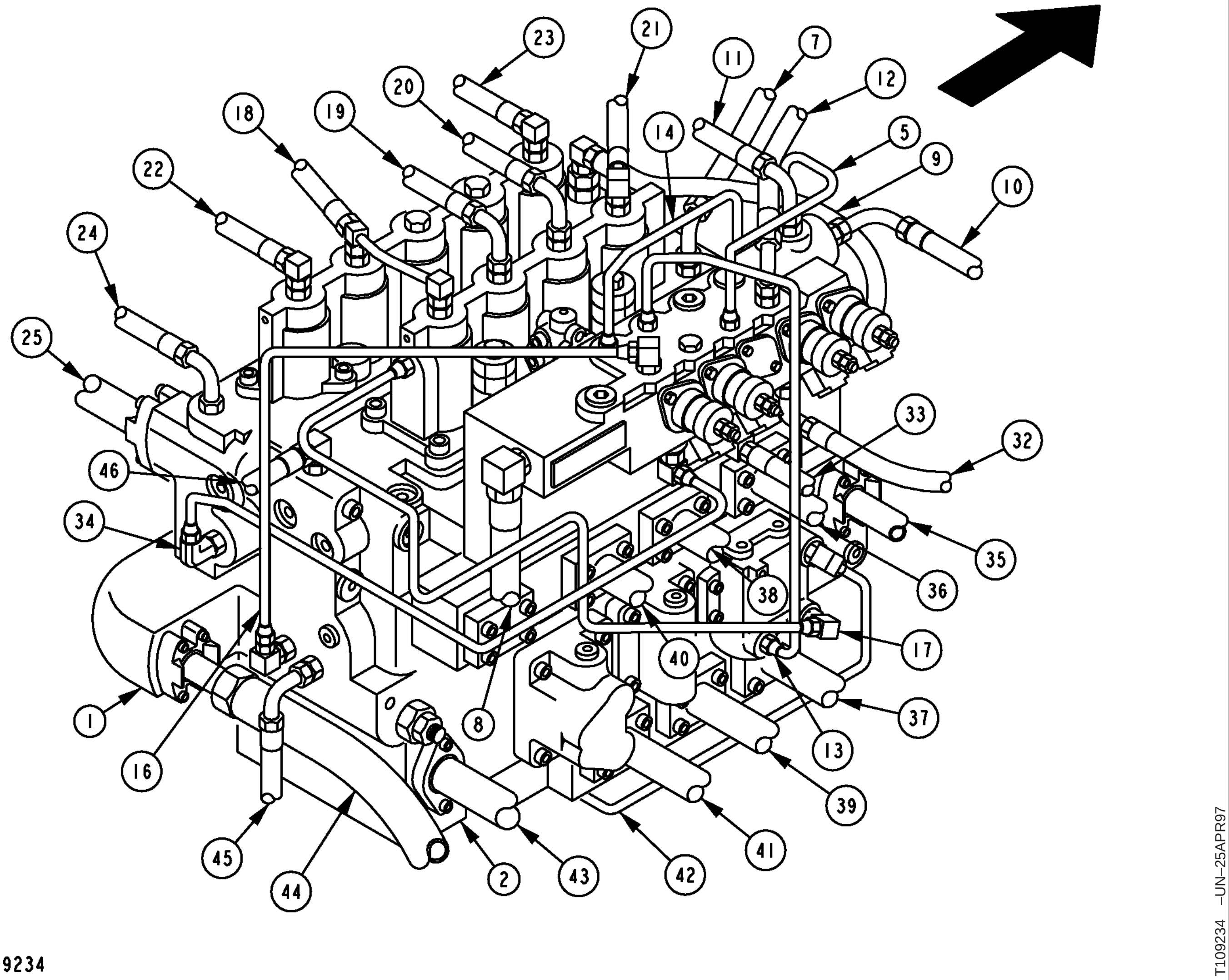
TX,33,UU4002 –19–21SEP98–3/8

33
3360
87

Hydraulic System



Right Rear

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1—Left Control Valve—5-Spool
2—Right Control Valve—4-Spool
5—To Rear Pump Control Valve
7—To Swing Motor Park Brake Release Valve—Bottom Port
9—Power Boost Solenoid Valve to System Relief Valve
10—Return to Hydraulic Tank
11—Return From Pilot Shut-Off Valve
12—Pilot Pressure Signal To Swing Motor Park Brake Release Valve—Top Port
13—Return From Bucket Flow Control Valve To Solenoid Valve Manifold
14—Return From Propel Flow Control Valve To Solenoid Valve Manifold
15—Pilot Pressure From Pilot Shut-Off Valve to Solenoid Valve Manifold
16—Pilot Pressure to Front Pump Control Valve
17—Arm In Pilot To Bucket Flow Control Valve—Front Bottom Port
18—Arm In Pilot From Left Pilot Controller—SAE Pattern
19—Boom Down Pilot From Right Pilot Controller—SAE Pattern
20—Bucket Curl Pilot From Right Pilot Controller
21—Right Propel Reverse Pilot From Propel Pilot Controller
22—Swing Right Pilot From Left Pilot Controller
23—Left Propel Reverse Pilot From Propel Pilot Controller
24—To Swing Motor Make-Up Oil Port
25—To Hydraulic Oil Cooler
32—To Propel Motor Speed Change Valve
33—Speed Sensing Solenoid Valve To Front and Rear Pump Regulator Speed Sensing Port
34—Arm Regenerative Solenoid Valve To Arm Regenerative Valve
35—Supply Oil From Front Pump
36—Right Propel Forward To Rotary Manifold Right Front Port
37—Right Propel Reverse To Rotary Manifold Right Rear Port
38—To Bucket Cylinder Rod End—Bucket Dump
39—To Bucket Cylinder Head End—Bucket Curl
40—To Boom Cylinder Head End—Boom Up
41—To Boom Cylinder Rod End—Boom Down
42—Pilot Pressure From Boom Up Pilot Cap To Bucket Flow Control Valve
43—Return To Hydraulic Tank
44—Supply Oil From Rear Pump
45—To Front Pump Control Valve Pressure Sensor and Front Pump Regulator
46—Return From Front Pump Control Valve and Warm-Up Circuit To Hydraulic Tank

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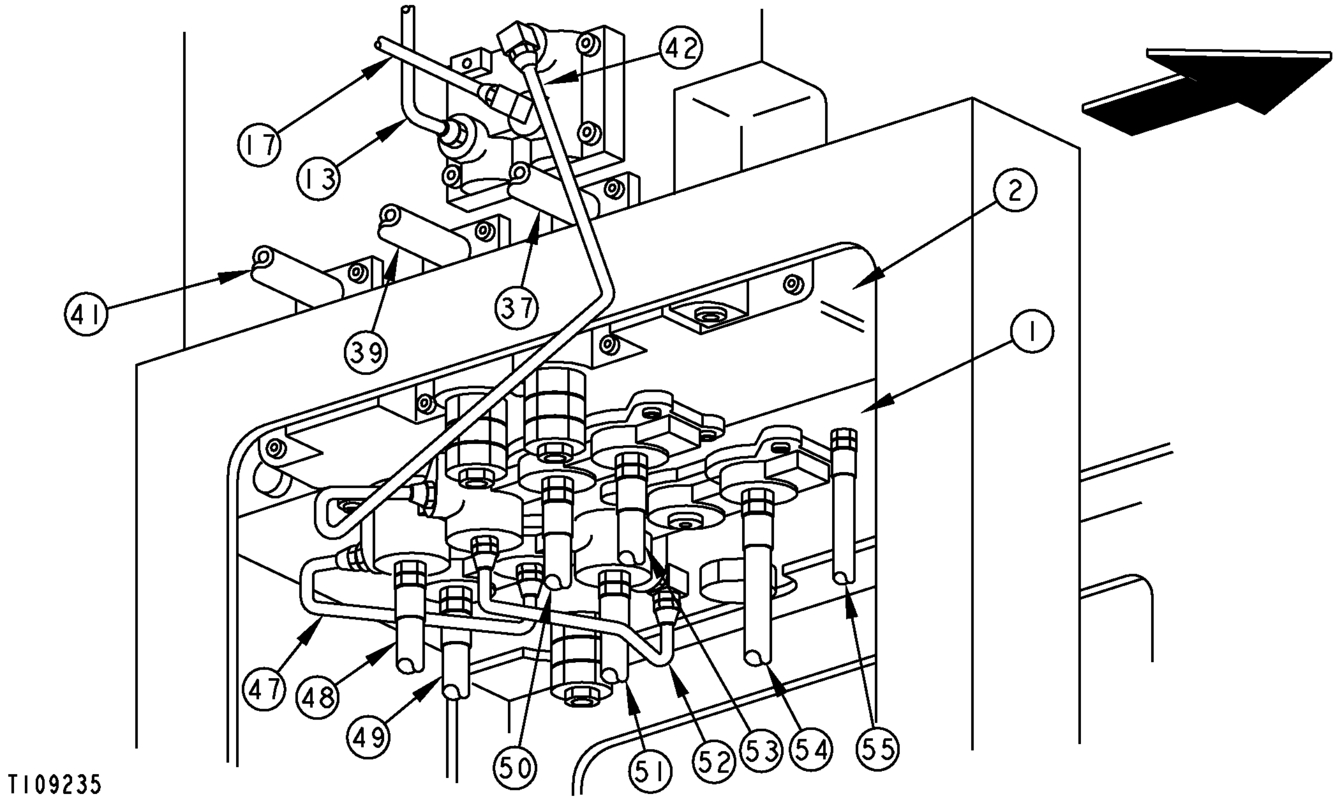


T109235 –UN–08MAY97

Bottom

1—Left Control Valve—5-Spool
2—Right Control Valve—4-Spool
13—Return From Bucket Flow Control Valve To Solenoid Valve Manifold
17—Arm In Pilot To Bucket Flow Control Valve—Front Bottom Port
37—Right Propel Reverse To Rotary Manifold Right Rear Port
39—To Bucket Cylinder Head End—Bucket Curl
41—To Boom Cylinder Rod End—Boom Down
42—Bucket Flow Control Valve Front Top Port To Right Side Boom Up Pilot Cap
47—Arm II To Arm I Pilot—Arm Out
48—Arm Out Pilot From Left Pilot Controller—SAE Pattern
49—Swing Left Pilot From Left Pilot Controller
50—Bucket Dump Pilot From Right Pilot Controller
51—Boom Up Pilot From Right Pilot Controller—SAE Pattern
52—Boom II To Boom I Pilot—Boom Up
53—Right Propel Forward Pilot From Propel Pilot Controller
54—Left Propel Forward Pilot From Propel Pilot Controller
55—To Hydraulic Tank—Return From Rear Pump Control Valve

CAUTION: To avoid injury from escaping fluid under pressure, stop engine, and relieve the pressure in the system before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

3. Disconnect the lines (3—55). Install caps and plugs.

   Disconnect wiring harness connectors from propel pressure switch, dig pressure switch, and the four proportional solenoid valves.

33
3360
90

Continued on next page

TX,33,UU4002 –19–21SEP98–6/8

CAUTION: The approximate weight of control valve is 240 kg (530 lb).

Control Valve—Specification

Weight.. 240 kg (530 lb) approximate

4. Remove cap screw (C) and lock washer (B) to remove control valve (A).

5. Repair or replace parts as necessary.

6. Tighten cap screws (C).

Mounting Bracket-to-Valve Housing Cap Screw—Specification

Torque .... 205 N•m (150 lb-ft)

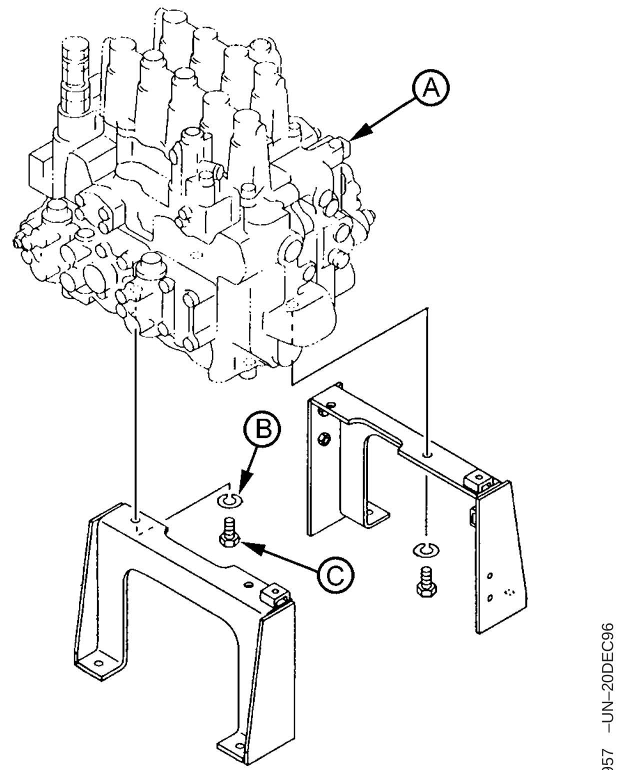
7. Tighten the split flange fitting-to-housing M10 and M12 cap screws.

Split Flange Fitting-to-Housing M10 Cap Screw—Specification

Torque .... 64 N•m (47 lb-ft)

Split Flange Fitting-to-Housing M12 Cap Screw—Specification

Torque .... 108 N•m (80 lb-ft)



T105957

A—Control Valve
B—Lock Washer
C—Cap Screw

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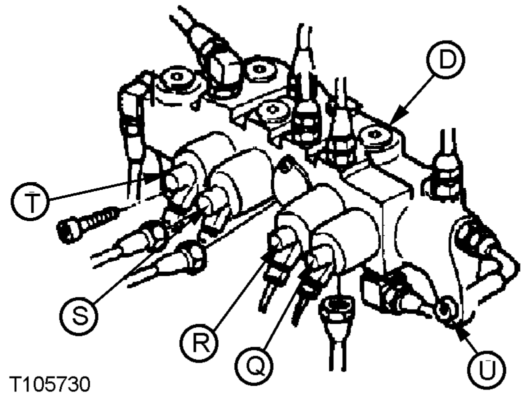
TX,33,UU4002 –19–21SEP98–7/8

8. Connect wiring harness connectors to solenoid valves (Q—T).

   Connect wiring harness connectors to dig and propel pressure switches.

9. Check oil level in the hydraulic tank. Add oil as necessary. (See Hydraulic Oil in Group 0004.)

10. Do Hydraulic Pump Start-Up Procedure. (See Hydraulic Pump Start-Up Procedure in this group.)



T105730

D—Proportional Solenoid Valve Manifold
Q—Power Boost Solenoid Valve (BLU/BLK and BLU/RED Wiring Leads
R—Propel Speed Change Solenoid Valve (LGRN/RED and LGRN/BLK Wiring Leads)
S—Speed Sensing Solenoid Valve (RED/YEL and RED/WHT Wiring Leads)
T—Arm Regenerative Solenoid Valve (BLU/WHT and BLU/ORN Wiring Leads)
U—Cap Screw (2 used)

TX,33,UU4002 –19–21SEP98–8/8

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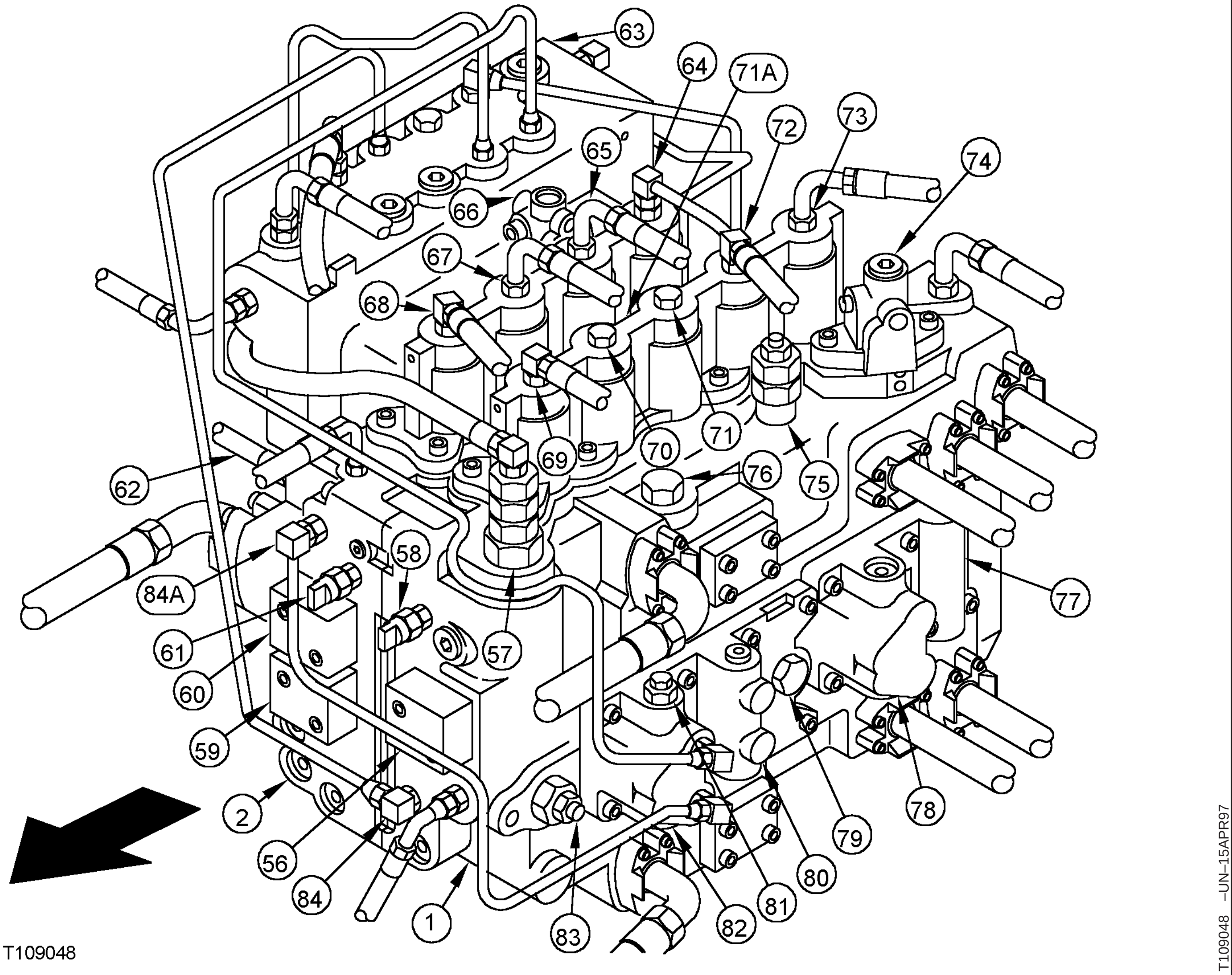
3360
92

DISASSEMBLE AND ASSEMBLE CONTROL VALVE



Left Front

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TX,33,UU4003 –19–21SEP98–1/17

33
3360
94

1—Left Control Valve—5-Spool
2—Right Control Valve—4-Spool
56—Check Valve and Orifice, Signal to Propel Flow Control Valve
57—System Relief Valve
58—Dig Pressure Switch
59—System Relief Valve Isolation Check Valve
60—System Relief Valve Isolation Check Valve
61—Propel Pressure Switch
62—Pilot Pressure Inlet Filter
63—Solenoid Valve Manifold
64—Arm II Valve
65—Boom I Valve
66—Boom Reduced Leakage Valve
67—Bucket Valve
68—Right Propel Valve
69—Left Propel Valve
70—Auxiliary Valve
71—Boom II Valve
71A—Propel-Boom Down Selector Valve
72—Arm I Valve
73—Swing Valve
74—Arm Reduced Leakage Valve
75—Arm Circuit Relief and Anti-Cavitation Valve
76—Plug
77—Swing Lift Check Valve
78—Arm I Power and Neutral Passage Lift Check Valves and Restriction Orifice
79—Boom II Power Passage Lift Check Valve
80—Auxiliary Power Passage Lift Check Valve
81—Propel Flow Control Valve
82—Propel Power and Neutral Passage Lift Check Valves
83—Rear Pump Control Valve
84—Filter and Orifice for Pilot Pressure to Rear Pump Control Valve
84A—Check Valve and Orifice for Propel Flow Control Valve

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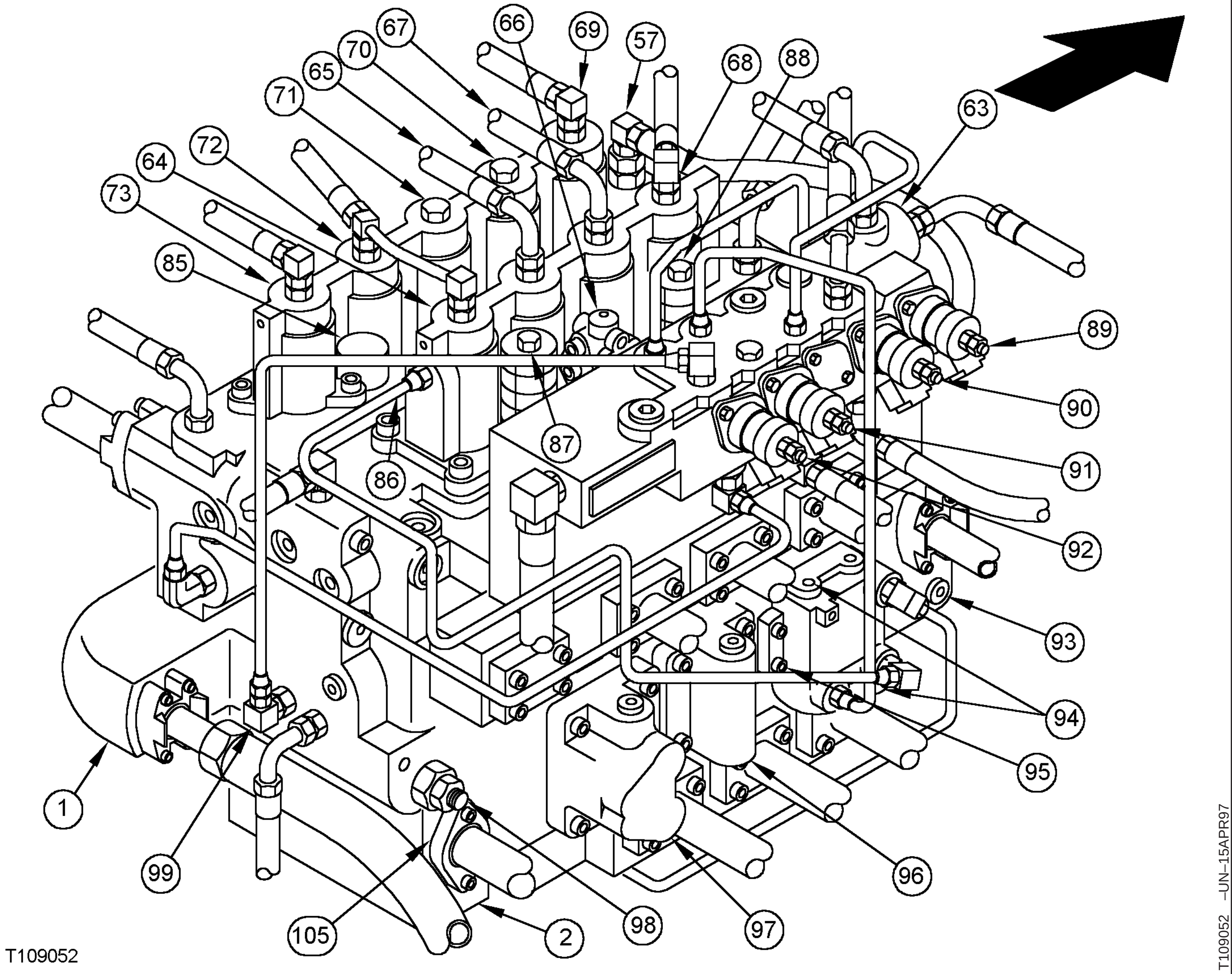
TX,33,UU4003 –19–21SEP98–2/17

33
3360
95



Right Rear

1—Left Control Valve—5-Spool
2—Right Control Valve—4-Spool
57—System Relief Valve
63—Solenoid Valve Manifold
64—Arm II Valve
65—Boom I Valve
66—Boom Reduced Leakage Valve
67—Bucket Valve
68—Right Propel Valve
69—Left Propel Valve
70—Auxiliary Valve
71—Boom II Valve
72—Arm I Valve
73—Swing Valve
85—Arm Regenerative Valve
86—Arm II to Arm I Neutral Passage Check Valve
87—Boom Up Circuit Relief Valve
88—Bucket Dump Circuit Relief Valve
89—Power Boost Solenoid Valve
90—Propel Speed Change Solenoid Valve
91—Speed Sensing Solenoid Valve
92—Arm Regenerative Solenoid Valve
93—Flow Combiner Valve
94—Bucket Flow Control Valve
95—Bucket Check Valve (Lift Check)
96—Boom I Power and Neutral Passage Check Valves (Lift Checks)
97—Arm II Power and Neutral Passage Check Valves and Restriction Orifice
98—Front Pump Control Valve
99—Filter and Orifice for Pilot Pressure to Front Pump Control Valve
105—Oil Cooler bypass Valve

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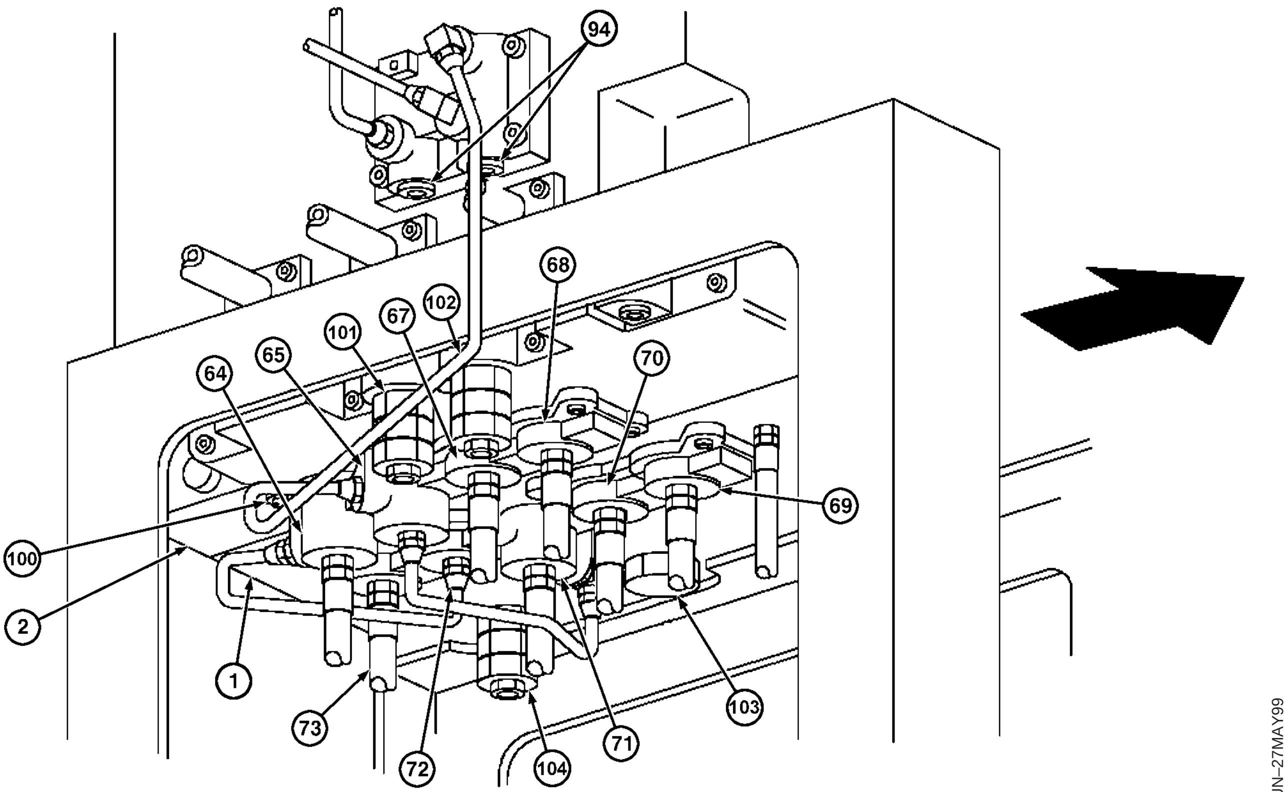

T120890

Bottom

1—Left Control Valve—5-Spool
2—Right Control Valve—4-Spool
64—Arm II Valve
65—Boom I Valve
67—Bucket Valve
68—Right Propel Valve
69—Left Propel Valve
70—Auxiliary Valve
71—Boom II Valve
72—Arm I Valve
73—Swing Valve
94—Bucket Flow Control Valve
100—Arm Regenerative Circuit Check Valve
101—Bucket Load Circuit Relief and Anti-Cavitation Valve
102—Boom Down Circuit Relief and Anti-Cavitation Valve
103—Plug
104—Arm In Circuit Relief and Anti-Cavitation Valve

1. Use the three previous illustrations to locate individual components on the assembled control valve.

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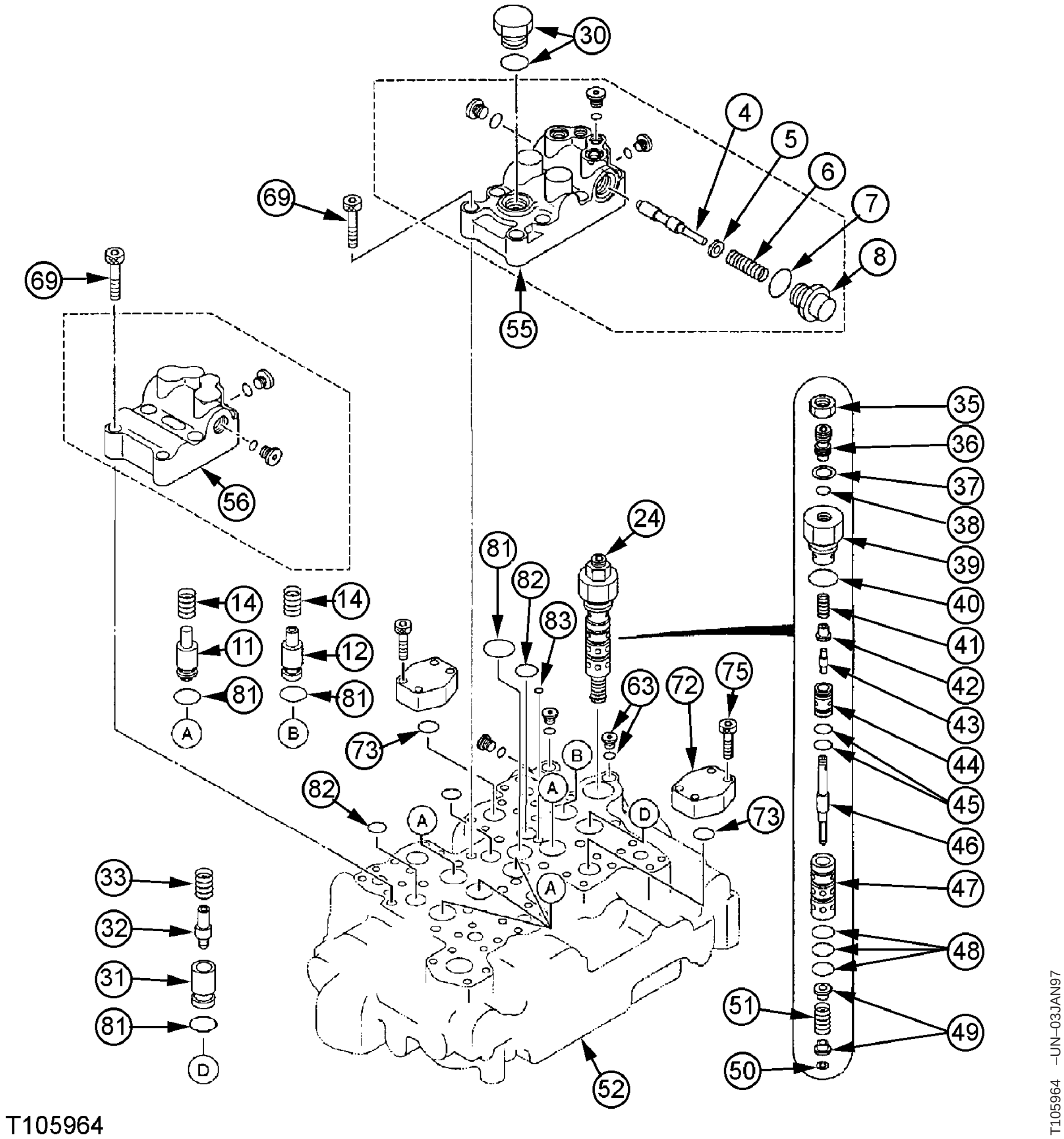

Left Control Valve—5-Spool

4—Propel Flow Control Valve Spool
5—Seat
6—Spring
7—O-Ring
8—Plug
11—Check Valve Poppet
12—Check Valve Poppet
14—Spring (6 used)
24—Rear Pump Control Valve
30—Plug and O-Ring
31—Sleeve
32—Check Valve Poppet
33—Spring
35—Lock Nut
36—Adjusting Screw
37—Washer
38—O-Ring
39—Plug
40—O-Ring
41—Relief Valve Spring
42—Spring Seat
43—Relief Valve Spool
44—Sleeve
45—O-Ring (2 used)
46—Flow Sense Spool
47—Sleeve
48—O-Ring (3 used)
49—Spring Seat (2 used)
50—Snap Ring
51—Flow Sense Spring
52—Housing—5-Spool
55—Pilot Plate
56—Pilot Plate
63—Plug and O-Ring (3 used)
69—Cap Screw (14 used)
72—Cap (2 used)
73—O-Ring (2 used)
75—Cap Screw (8 used)
81—O-Ring (8 used)
82—O-Ring (3 used)
83—O-Ring

33
3360
98

Continued on next page

NOTE: It is not always necessary to remove the control valve to remove individual components.

The letters, A—D, are used in the illustration to indicate the location of parts in housing.

2. **Rear pump control valve (24):** Disassemble valve for cleaning and inspections only. Valve is serviced as an assembly. Valve is set at the factory so adjustment in the field should not be necessary. If disassembly of lock nut (35) and adjusting screw (36) from plug (39) is necessary, check valve pressure setting after assembly. (See Pump Control Valve Test in Group 9025-25.)

   Pull flow sense spool (46) and sleeve (47) from housing (52) using a M8-1.25 nut on threaded end of spool.

   Tighten plug (39).

Pump Control Valve-to-Housing Plug—Specification

Torque.. 84 N•m (62 lb-ft)

3. Tighten cap screws (69).

Pilot Plate-to-Housing Cap Screw—Specification

Torque.. 78 N•m (58 lb-ft)

4. Tighten plug (8).

Plug-to-Propel Flow Control Valve Pilot Plate—Specification

Torque.. 98 N•m (72 lb-ft)

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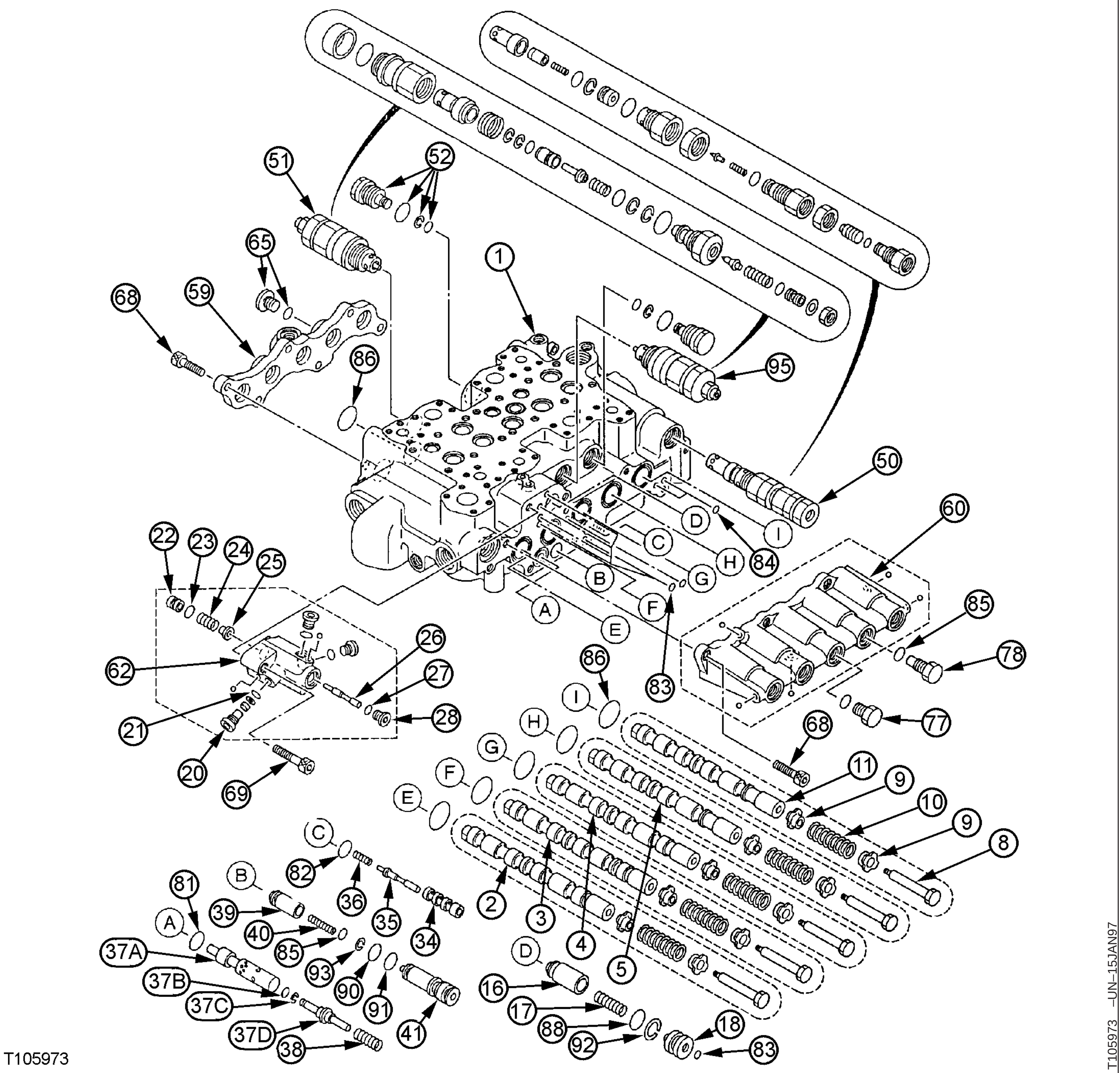

T105973

Left Control Valve—5-Spool

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TX,33,UU4003 –19–21SEP98–7/17

1—Housing—5-Spool
2—Swing Spool
3—Arm I Spool
4—Boom II Spool
5—Auxiliary Spool
8—Special Cap Screw (5 used)
9—Spring Seat (10 used)
10—Spring
11—Left Propel Spool
16—Arm Reduced Leakage Check Valve Poppet
17—Spring
18—Spacer
20—Plug
21—O-Ring
22—Spacer
23—O-Ring
24—Spring
25—Spring Seat
26—Reduced Leakage Valve Spool
27—O-Ring
28—Plug
34—Sleeve
35—Propel-Boom Down Selector Spool
36—Spring
37A—Arm Regenerative Valve Spool
37B—O-Ring
37C—Backup Ring
37D—Spacer
38—Spring
39—Check Valve Poppet
40—Spring
41—Spacer
50—System Relief Valve
51—Arm In Circuit Relief and Anti-Cavitation Valve
52—Plug, O-Ring, Backup Ring and O-Ring (2 used)
59—Bottom Pilot Cap
60—Top Pilot Cap
62—Arm In Reduced Leakage Valve Housing
65—Plug and O-Ring
68—Cap Screw (12 used)
69—Cap Screw (2 used)
77—Plug
78—Plug
81—O-Ring
82—O-Ring
83—O-Ring (6 used)
84—O-Ring (3 used)
85—O-Ring (3 used)
86—O-Ring (10 used)
88—O-Ring
90—O-Ring
91—O-Ring
92—Backup Ring
93—Backup Ring
95—Arm Out Circuit Relief and Anti-Cavitation Valve

IMPORTANT: The spools (11, and 14—17) are select fitted to bores in housing and are a different design for each function. Spools must be installed into the same bores from which they were removed for proper operation of machine.

NOTE: The letters, A—I, are used in the illustration to indicate the location of parts in housing.

5. **Circuit relief and anti-cavitation valve (51 and 95):** Disassemble valves for cleaning and inspection only. Valves are serviced as assemblies.

   Tighten valves into housing.

Circuit Relief and Anti-Cavitation Valve-to-Housing—Specification

Torque.. 83 N•m (61 lb-ft)

Check and adjust pressure setting. (See Circuit Relief Valve Test and Adjustment in Group 9025-25.)

6. **System relief valve (50):** Disassemble valve for cleaning and inspection only. Valve is serviced as an assembly.

   Tighten top nut.

System Relief Valve 27 mm Nut—Specification

Torque.. 64 N•m (47 lb-ft)

Tighten bottom nut.

System Relief Valve 32 mm Nut—Specification

Torque.. 83 N•m (61 lb-ft)

Tighten valve into housing.

System Relief Valve-to-Housing—Specification

Torque.. 83 N•m (61 lb-ft)

Check and adjust pressure setting for system relief valve and power boost after assembly. (See System Relief and Power Boost Valve Test and Adjustment in Group 9025-25.)

7. **Arm in reduced leakage valve:** Spring (24) may force spacer (22) out of housing (62).

   Pull spacer (18) from housing (1) using a M5-0.8 cap screw.

   Tighten cap screws (69).

Continued on next page

Arm In Reduced Leakage Valve-to-Housing Cap Screw—Specification

Torque.. 78 N•m (58 lb-ft)

Tighten plug (28).

Plug-to-Arm In Reduced Leakage Valve—Specification

Torque.. 29 N•m (255 lb-in.)

8. **Arm regenerative valve (37A—38):** Heat spacer (37D) and spool (37A) using a heat gun to breakdown the high strength thread lock and sealer.

   Apply high strength thread lock and sealer to threads of spacer (37D).

   Tighten spacer into spool. Hold spool in a vise using wooden blocks to protect the spool.

Spacer-to-Arm Regenerative Valve Spool—Specification

Torque... 18.6 N•m (165 lb-in.)

9. **Arm II to arm I neutral passage check valve (39):** Pull spacer (41) out of housing (1) using a M6-1.0 cap screw.

10. **Valve spools (2—5 and 11):** Tighten special cap screws (8).

Special Cap Screw-to-Control Valve Spool—Specification

Torque.. 15 N•m (133 lb-in.)

Hold the spool in a vise by the chamfered end.

Tighten pilot cap-to-housing cap screws (1).

Pilot Cap-to-Control Valve Housing Cap Screw—Specification

Torque.. 78 N•m (58 lb-ft)

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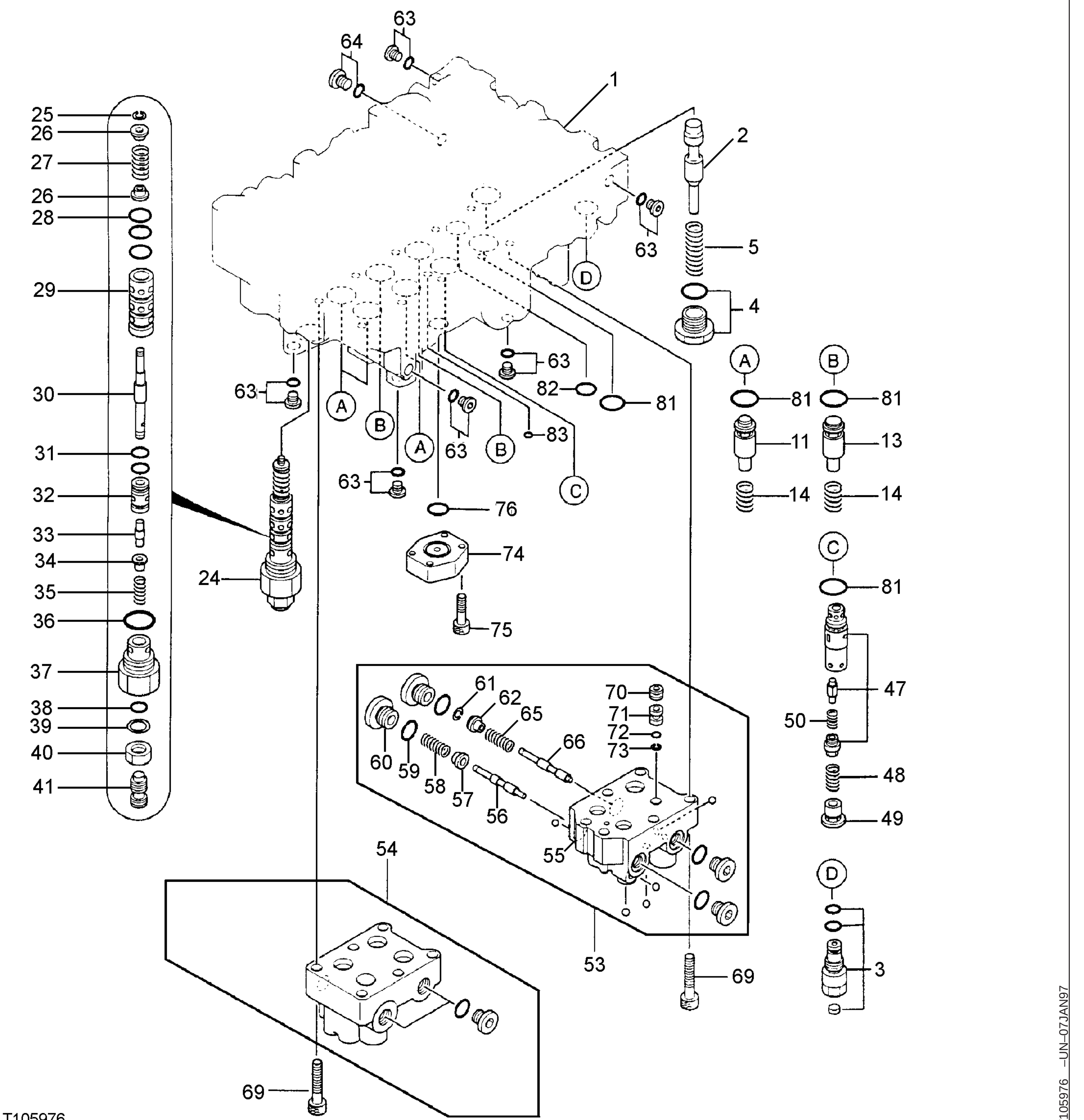
TX,33,UU4003 –19–21SEP98–9/17



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Right Control Valve—4-Spool

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TX,33,UU4003 –19–21SEP98–10/17

1—Housing—4-Spool
2—Flow Combiner Valve Spool
3—Pilot Pressure Inlet Fitting, Filter and O-Rings
4—Plug and O-Ring
5—Spring
11—Check Valve Poppet (3 used)
13—Check Valve Poppet (2 used)
14—Spring (5 used)
24—Front Pump Control Valve
25—Snap Ring
26—Spring Seat (2 used)
27—Spring
28—O-Ring
29—Sleeve
30—Load Sense Valve Spool
31—O-Ring
32—Sleeve
33—Relief Valve Spool
34—Spring Seat
35—Spring
36—O-Ring
37—Plug
38—O-Ring
39—Washer
40—Lock Nut
41—Adjusting Screw
47—Bucket Flow Control Valve Poppet
48—Spring
49—Spacer
50—Spring
53—Bucket Flow Control Valve
54—Housing
55—Bucket Flow Control Valve Housing
56—Bucket Flow Control Valve Pilot Spool
57—Spring Seat
58—Spring
59—O-Ring
60—Plug (2 used)
61—Snap Ring
62—Spring Seat
63—Plug and O-Ring (6 used)
64—Plug and O-Ring
65—Spring
66—Bucket Flow Control Valve Pilot Spool
69—Cap Screw (12 used)
70—Pipe Plug
71—Plug
72—O-Ring
73—Backup Ring
74—Cover
75—Cap Screw (4 used)
76—O-Ring
81—O-Ring (7 used)
82—O-Ring
83—O-Ring

NOTE: The letters, A—E, are used in the illustration to indicate the location of parts in housing.

11. **Front pump control valve (24):** Disassemble valve for cleaning and inspections only. Valve is serviced as an assembly. Valve is set at the factory so adjustment in the field should not be necessary. If disassembly of lock nut (40) and adjusting screw (41) from plug (37) is necessary, check valve pressure setting after assembly. (See Pump Control Valve Test in Group 9025-25.)

    Pull flow sense spool (30) and sleeve (29) from housing using a M8-1.25 nut on threaded end of spool.

    Tighten plug (37).

Plug-to-Front Pump Control Valve—Specification

Torque... 84 N•m (62 lb-ft)

12. **Bucket flow control valve (47 and 53):** Tighten plug into poppet (47).

Plug-to-Bucket Flow Control Valve Poppet—Specification

Torque... 39 N•m (348 lb-in.)

Tighten housing-to-control valve housing cap screws (69).

Bucket Flow Control Valve Housing-to-Control Valve Housing Cap Screw—Specification

Torque.. 78 N•m (58 lb-ft)

Tighten plugs (60) into housing.

Pilot Valve-to-Bucket Flow Control Valve Housing Plug—Specification

Torque.. 71 N•m (52 lb-ft)

13. **Flow combiner valve (2):** Tighten plug (4) into housing.

Flow Combiner Valve Spool-to-Control Valve Housing Plug—Specification

Torque.. 157 N•m (116 lb-ft)

14. **Pilot pressure inlet fitting and filter (3):** Tighten fitting into housing.

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105

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TX,33,UU4003 –19–21SEP98–11/17

Pilot Pressure Inlet Fitting and Filter-to-Control Valve Housing—Specification

Torque... 76 N•m (56 lb-ft)

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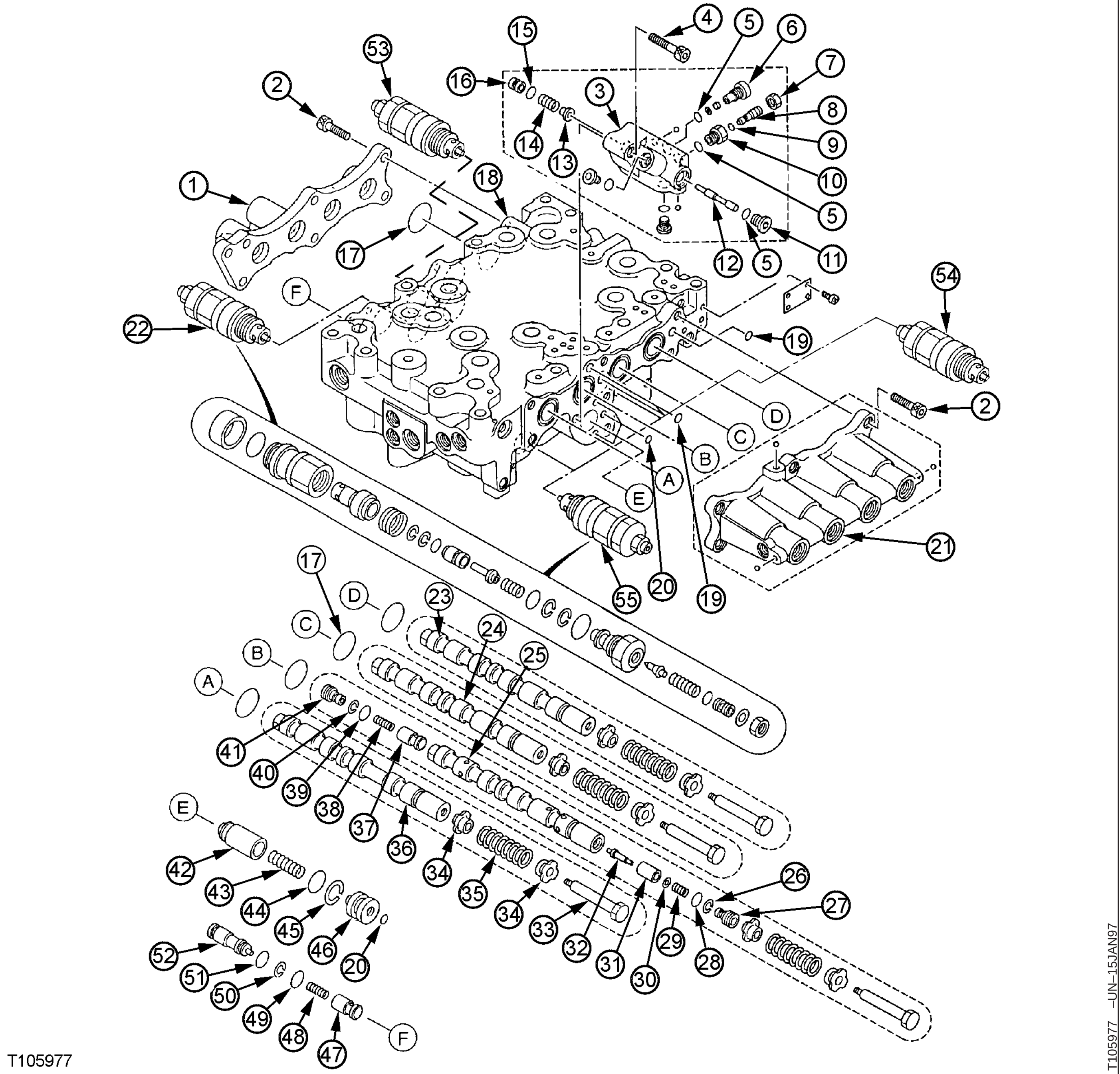

Right Control Valve—4-Spool

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1—Pilot Cap
2—Cap Screw (14 used)
3—Boom Reduced Leakage Valve Housing
4—Cap Screw (2 used)
5—O-Ring
6—Plug
7—Lock Nut
8—Boom Manual Lower Screw
9—O-Ring
10—Plug
11—Plug
12—Spool
13—Spring Seat
14—Spring
15—O-Ring
16—Spacer
17—O-Ring
18—Housing—4-Spool
19—O-Ring (3 used)
20—O-Ring (4 used)
21—Pilot Cap
22—Boom Down Circuit Relief and Anti-Cavitation Valve
23—Right Propel Spool
24—Bucket Spool
25—Boom I Spool
26—Backup Ring
27—Plug
28—O-Ring
29—Spring
30—Washer
31—Sleeve
32—Boom Down Regenerative Valve Poppet
33—Special Cap Screw (4 used)
34—Spring Seat (8 used)
35—Spring (4 used)
36—Arm II Spool
37—Poppet
38—Spring
39—O-Ring
40—Backup Ring
41—Plug
42—Boom Reduced Leakage Check Valve Poppet
43—Spring
44—O-Ring
45—Backup Ring
46—Spacer
47—Arm Regenerative Check Valve Poppet
48—Spring
49—O-Ring
50—Backup Ring
51—O-Ring
52—Spacer
53—Bucket Curl Circuit Relief and Anti-Cavitation Valve
54—Bucket Dump Circuit Relief and Anti-Cavitation Valve
55—Boom Up Circuit Relief and Anti-Cavitation Valve

IMPORTANT: Spools (23—25 and 36) are select fitted to bores in housing and are a different design for each function. Spools must be installed into the same bores from which they were removed for proper operation.

NOTE: The letters, A—F, are used in the illustration to indicate the location of parts in housing.

15. **Circuit relief and anti-cavitation valve (22, 53, 54 and 55):** Disassemble valves for cleaning and inspection only. Valves are serviced as assemblies.

    Tighten valve into housing.

Circuit Relief and Anti-Cavitation Valve-to-Housing—Specification

Torque... 83 N•m (62 lb-ft)

Check and adjust pressure setting after assembly. (See Circuit Relief Valve Test and Adjustment in Group 9025-25.)

16. **Boom regenerative valve:** Heat plugs (27 and 41) in boom I spool (25) using a heat gun to breakdown the high strength thread lock and sealer. Hold spool in a vise using wooden blocks to protect it.

    Apply thread lock and sealer (high strength) to threads of plugs (27 and 41). Tighten plugs. Hold spool in a vise using wooden blocks to protect it.

Boom Regenerative Valve-to-Control Valve Spool Plug—Specification

Torque.. 15 N•m (130 lb-in.)

17. **Boom reduced leakage valve:** Pull spacer (46) from housing using a M5-0.8 cap screw.

    Tighten reduced leakage valve housing-to-housing cap screws.

Boom Reduced Leakage Valve Housing-to-Housing Cap Screw—Specification

Torque... 78 N•m (58 lb-ft)

Tighten plug (11) into housing.

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3360
109

Continued on next page

Spool-to-Boom Reduced Leakage Valve Housing Plug—Specification

Torque.. 29 N•m (255 lb-in.)

Tighten boom manual lower screw (8). Hold screw and tighten lock nut (7).

Boom Manual Lower Screw-to-Housing—Specification

Torque... 6.9 N•m (60 lb-in.)

Boom Manual Lower Screw-to-Housing Lock Nut—Specification

Torque.. 13 N•m (115 lb-in.)

18. **Arm regenerative check valve poppet (47):** Pull spacer (52) from housing using a M6-1.0 cap screws.

19. **Valve spools (23—25 and 36):** Tighten special cap screws (33).

Special Cap Screw-to-Control Valve Spool—Specification

Torque.. 15 N•m (133 lb-in.)

Hold spool in a vise by the chamfered end.

Tighten pilot cap-to-housing cap screws (2).

Pilot Cap-to-Housing Cap Screw—Specification

Torque... 78 N•m (58 lb-ft)

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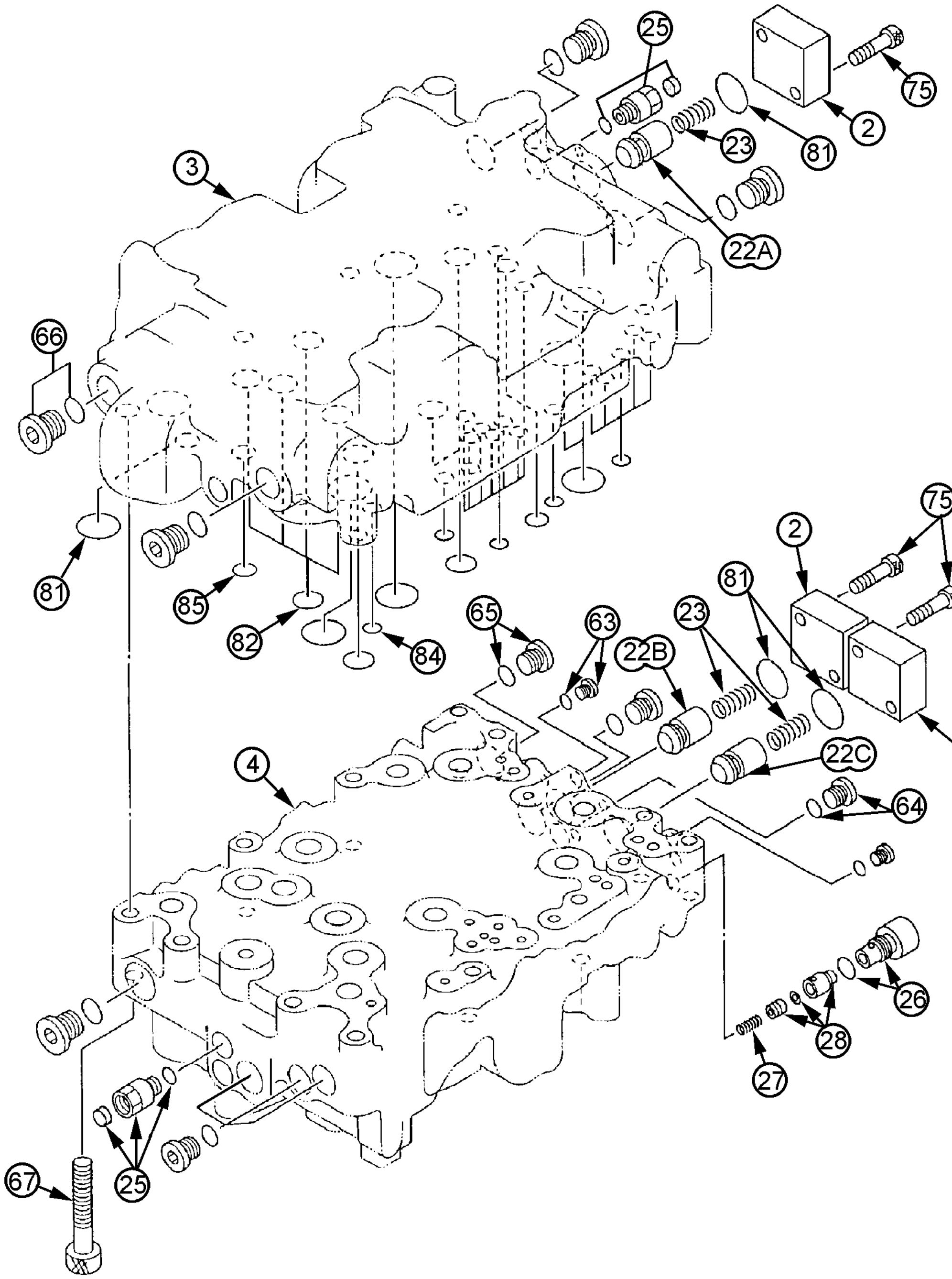

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T105978 –UN–09JAN97

2—Cover (3 used)
3—Left Control Valve—5-Spool
4—Right Control Valve—4—Spool
22A—System Relief Valve Isolation Check Valve Poppet
22B—Flow Combiner Valve Check Valve Poppet
22C—System Relief Valve Isolation Check Valve Poppet
23—Spring (3 used)
25—Fitting with orifice, O-Ring and Filter (2 used)
26—Fitting and O-Ring
27—Spring
28—Filter, Orifice and Check Valve Poppet Propel Flow Control Valve
63—Plug and O-Ring (2 used)
64—Plug and O-Ring
65—Plug and O-Ring (5 used)
66—Plug and O-Ring (5 used)
67—Cap Screw (12 used)
75—Cap Screw (6 used)
81—O-Ring (8 used)
82—O-Ring (7 used)
84—O-Ring (16 used)
85—O-Ring (2 used)

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TX,33,UU4003 –19–21SEP98–16/17

20. **System relief valve isolation check valve poppet (22A and 22C):** Tighten cap screws.

System Relief Valve Isolation Check Valve Cover-to-Control Valve Housing Cap Screw—Specification

Torque... 61 N•m (45 lb-ft)

21. **Flow combiner valve check valve poppet (22B):** Tighten cap screws (75).

Flow Combiner Valve Check Valve-to-Control Valve Housing Cap Screw—Specification

Torque... 61 N•m (45 lb-ft)

22. **Check valve and orifice (28) for propel flow control valve:** Tighten fitting (26).

Propel Flow Control Valve and Orifice Fitting—Specification

Torque... 76 N•m (56 lb-ft)

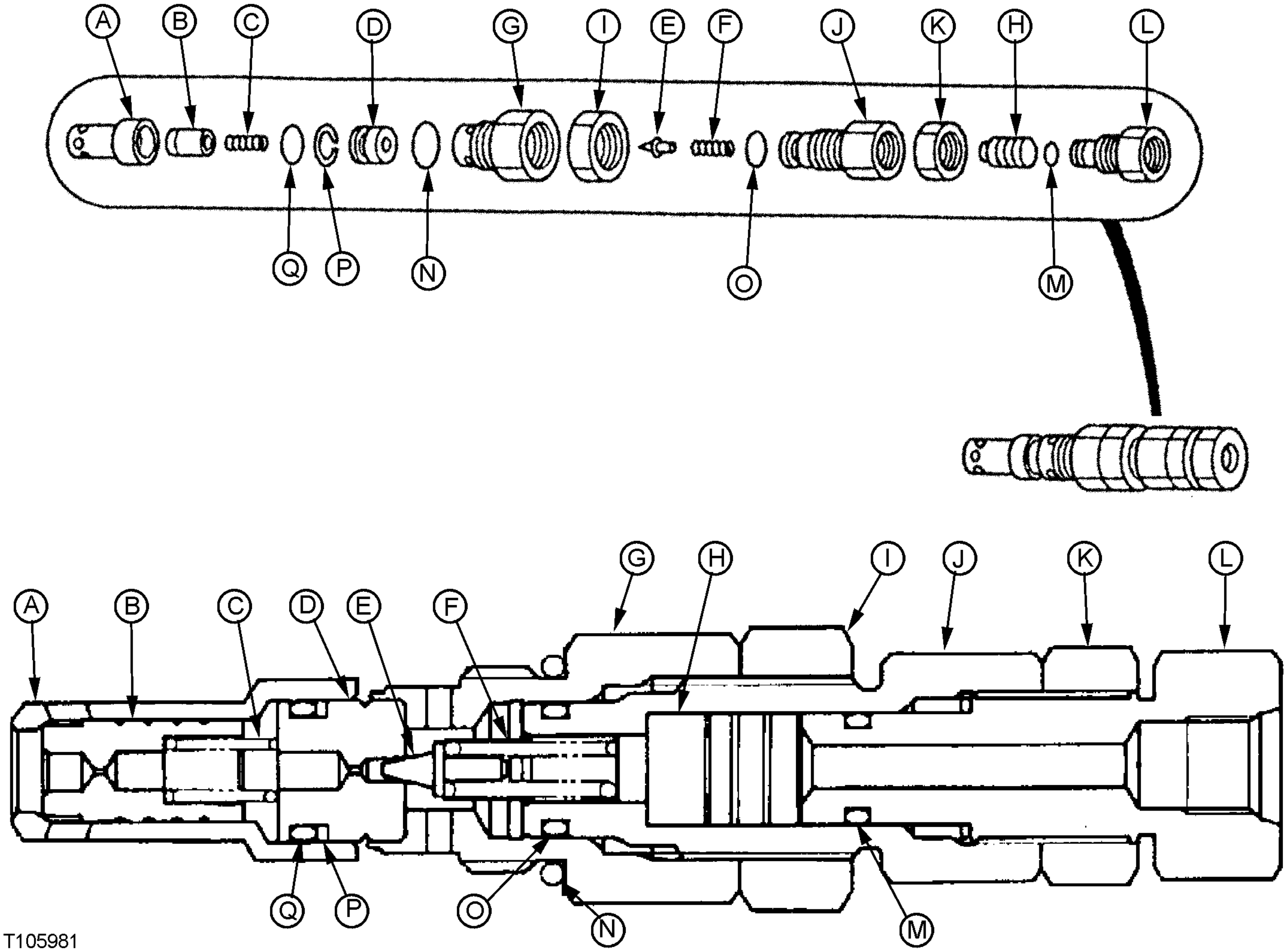
23. **Fitting with orifice, O-ring and filter (25) for front and rear pump control valves:** Tighten fitting.

Front and Rear Pump Control Valve-to-Control Valve Housing Fitting—Specification

Torque... 34 N•m (25 lb-ft)

TX,33,UU4003 –19–21SEP98–17/17

DISASSEMBLE AND ASSEMBLE SYSTEM RELIEF VALVE



A—Main Poppet Seat	**F—Pilot Poppet Spring**	**K—27 mm Nut**	**P—Backup Ring**
B—Main Poppet	**G—Cartridge**	**L—First Adjusting Plug**	**Q—O-Ring**
C—Main Poppet Spring	**H—Piston**	**M—O-Ring**	
D—Pilot Poppet Seat	**I—32 mm Nut**	**N—O-Ring**	
E—Pilot Poppet	**J—Second Adjusting Plug**	**O—O-Ring**	

1. Disassemble valve for cleaning and inspection only. Valve is serviced as an assembly.

2. Tighten 27 mm nut (K).

System Relief Valve 27 mm Nut—Specification

Torque.. 64 N•m (47 lb-ft)

Tighten 32 mm nut (I).

System Relief Valve 32 mm Nut—Specification

Torque.. 83 N•m (61 lb-ft)

Tighten valve cartridge (G) into housing.

System Relief Valve Cartridge-to-Housing—Specification

Torque.. 83 N•m (61 lb-ft)

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3360
113

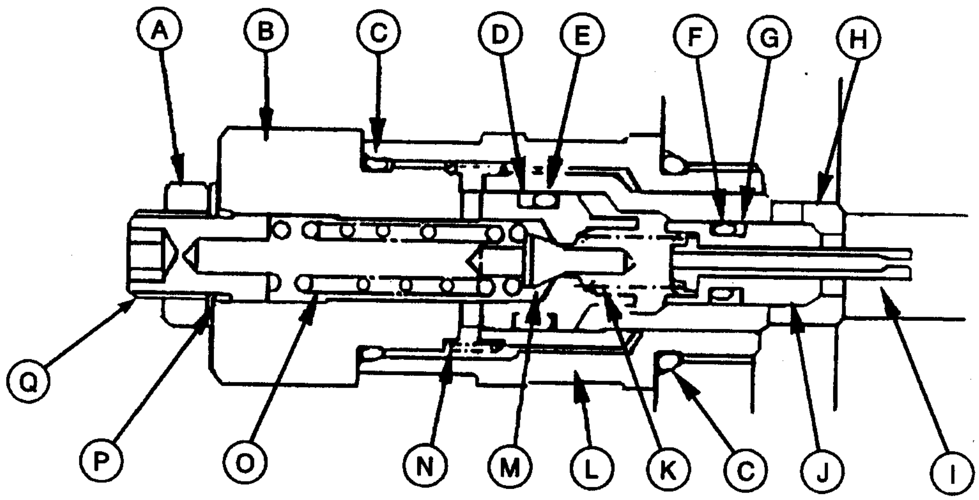
Continued on next page

TX,33,UU3802 –19–21SEP98–1/2

3. Check and adjust pressure setting for system relief valve and power boost. (See System Relief and Power Boost Valve Test and Adjustment in Group 9025-25.)

TX,33,UU3802 –19–21SEP98–2/2

DISASSEMBLE AND ASSEMBLE CIRCUIT RELIEF AND ANTI-CAVITATION VALVE



A—Nut
B—Plug
C—O-Ring (2 used)
D—Backup Ring
E—O-Ring
F—O-Ring
G—Backup Ring
H—Anti-Cavitation Sleeve
I—Piston
J—Main Poppet
K—Piston and Main Poppet Spring
L—Cartridge
M—Pilot Poppet
N—Anti-Cavitation Sleeve Spring
O—Pilot Poppet Spring
P—O-Ring
Q—Adjusting Screw

1. Disassemble valves for cleaning and inspection only. Valves are serviced as assemblies.

2. Tighten nut (A).

Adjusting Screw-to-Plug Nut—Specification

Torque.. 29.5 N•m (264 lb-in.)

Tighten valve into housing.

Circuit Relief and Anti-Cavitation Valve-to-Housing—Specification

Torque.. 83 N•m (62 lb-ft)

3. Check and adjust pressure setting. (See Circuit Relief Valve Test and Adjustment in Group 9025-25.)

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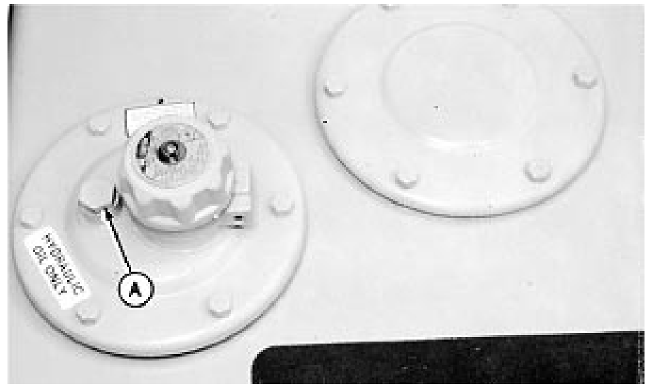
TX,33,UU3803 –19–21SEP98–1/1

REMOVE AND INSTALL HYDRAULIC OIL TANK



A—Vent Plug

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to release air pressure in hydraulic oil tank.

2. Remove covers from the bottom and side of hydraulic oil tank.

NOTE: It is not necessary to drain and remove the hydraulic oil tank if only the return filter element is being removed. (See procedures in this group.)

3. Drain hydraulic oil tank. Approximate oil capacity is 148 L (39 gal).

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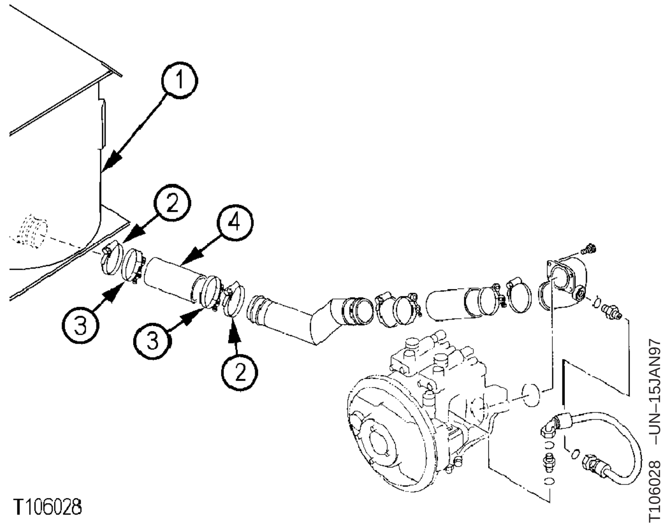
TX,33,UU3804 –19–21SEP98–1/6

4. Loosen hose clamps (2 and 3) at the bottom of hydraulic oil tank (1).

   Slide hose (4) off elbow.



1—Hydraulic Oil Tank
2—Hose Clamps
3—Hose Clamps
4—Hose

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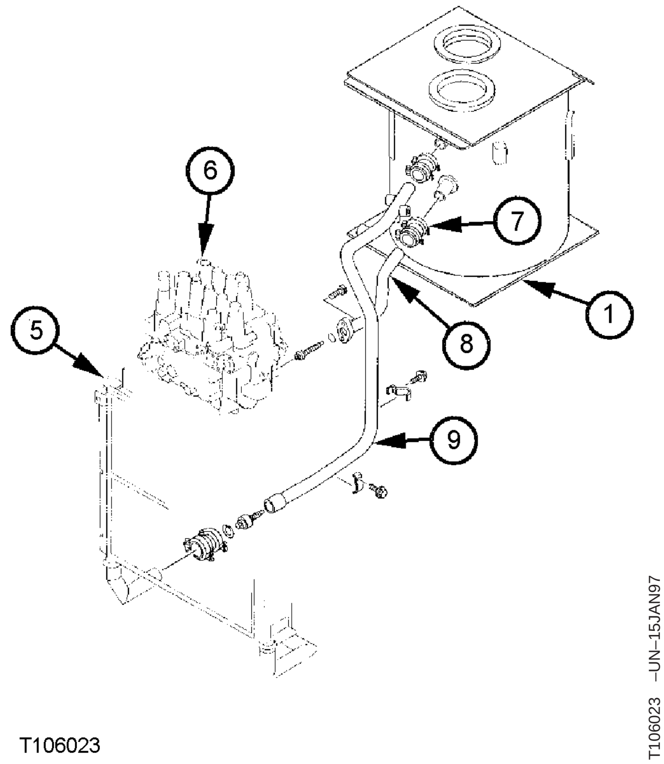
5. Loosen nuts on couplings (7). Slide couplings onto return lines (8 and 9).

   Install caps and plugs.



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1—Hydraulic Oil Tank
5—Oil Cooler
6—Control Valve
7—Coupling (2 used)
8—Control Valve-to-Hydraulic Oil Tank Return Line
9—Oil Cooler-to-Hydraulic Oil Tank Return Line

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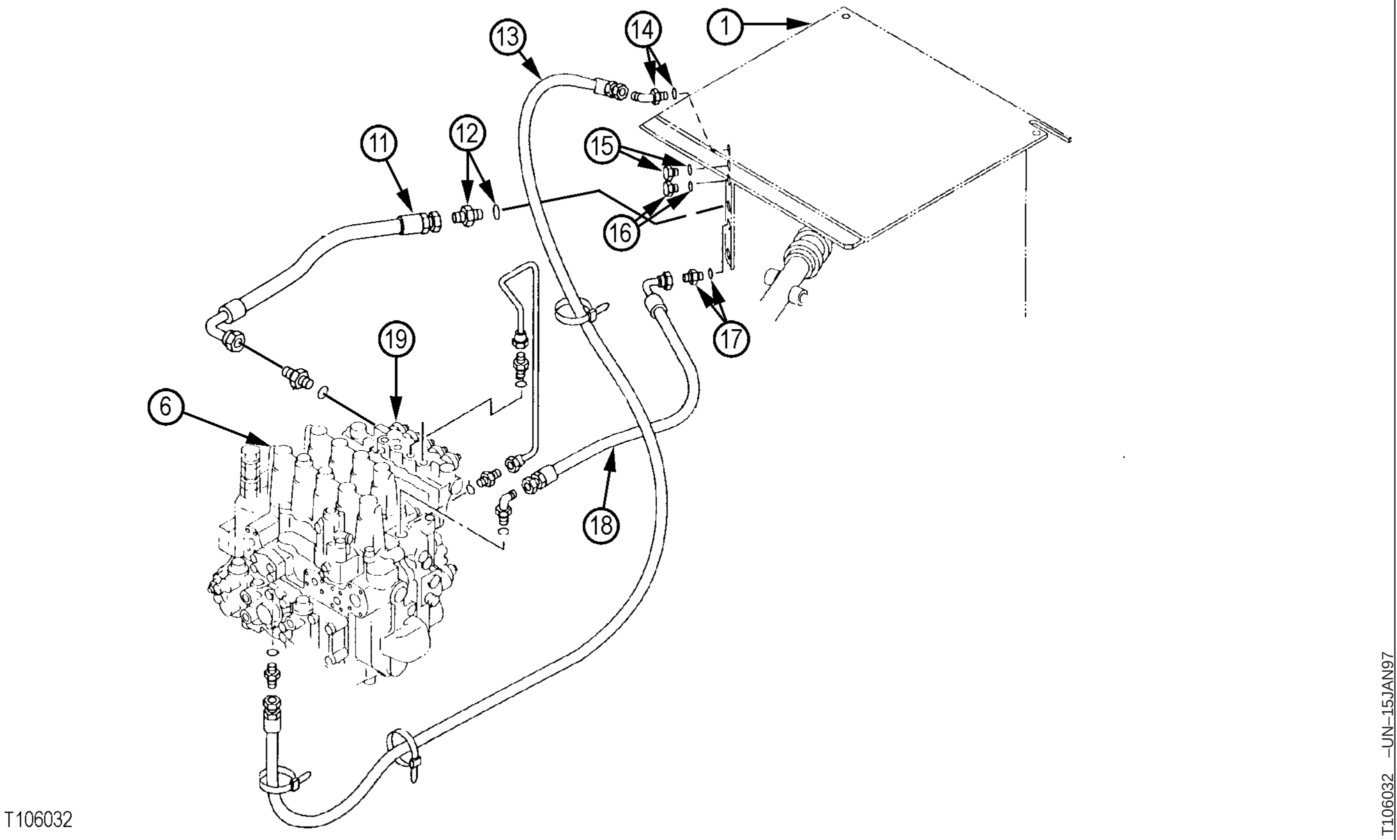

1—Hydraulic Oil Tank
6—Control Valve
11—Solenoid Valve Manifold Pilot Return Line
12—Fitting and O-Ring
13—Rear Pump Control Valve Pilot Return Line
14—Elbow and O-Ring
15—Plug and O-Ring
16—Plug and O-Ring
17—Fitting and O-Ring
18—Front Pump Control Valve Pilot Return Line
19—Solenoid Valve Manifold

6. Disconnect lines (11, 13 and 18). Install caps and plugs.

7. Disconnect wiring harness for hydraulic oil level switch.

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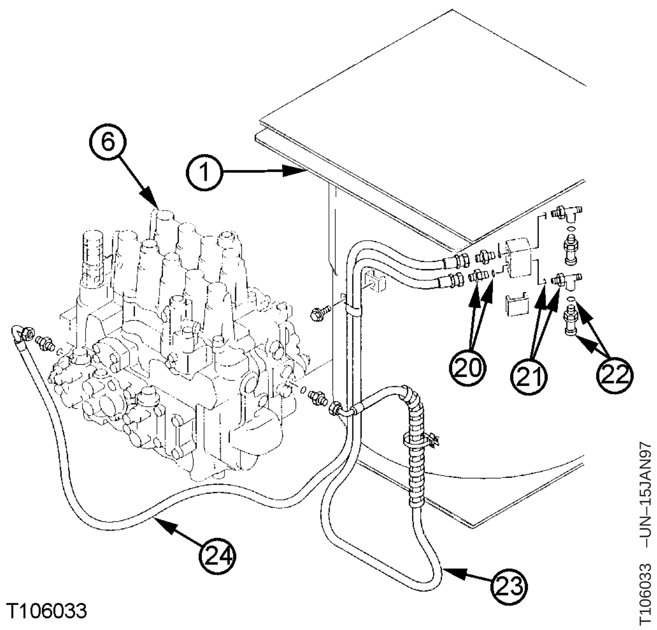
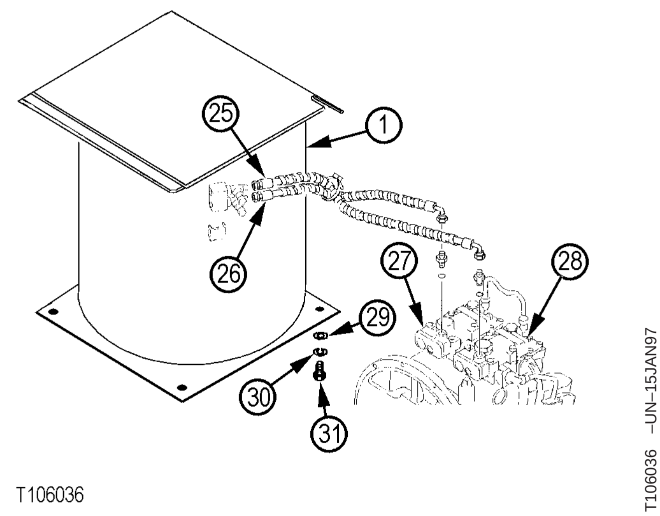
TX,33,UU3804 –19–21SEP98–4/6





1—Hydraulic Oil Tank
6—Control Valve
20—Fitting and O-Ring (2 used)
21—Tee and O-Ring (2 used)
22—Pump Control Pressure Sensor and O-Ring (2 used)
23—Front Pump Control Valve-to-Bulkhead Pilot Line
24—Rear Pump Control Valve-to-Bulkhead Pilot Line
25—Bulkhead-to-Rear Pump Regulator Pilot Line
26—Bulkhead-to-Front Pump Regulator Pilot Line
27—Front Pump Regulator
28—Rear Pump Regulator
29—Washer (4 used)
30—Lock Washer (4 used)
31—Cap Screw (4 used)

8. Disconnect lines (23, 24, 25 and 26) at bulkhead. Install caps and plugs.

9. Disconnect wiring harness connectors from pump control pressure sensors (22) and hydraulic oil level switch.

10. Remove cap screws (31), lock washers (30) and washers (29).

CAUTION: The approximate weight of hydraulic oil tank is 147 kg (325 lb).

Hydraulic Oil Tank—Specification

Weight.. 147 kg (325 lb) approximate

11. Remove hydraulic oil tank using a hoist and lifting straps.

12. Repair or replace parts as necessary.

13. Install hydraulic oil tank.

Frame-to-Oil Tank Cap Screw—Specification

Torque.. 205 N•m (152 lb-ft)

Return Line-to-Oil Tank Coupling Nut—Specification

Torque.. 10.3—12.4 N•m (91—110 lb-in.)

Oil Tank Elbow-to-Suction Line T-Bolt Type Clamp—Specification

Torque.. 4.4 N•m (40 lb-in.)

Continued on next page

TX,33,UU3804 –19–21SEP98–5/6

Oil Tank Elbow-to-Suction Line Worm Gear Type Clamp—Specification

Torque.. 5.9—6.9 N•m (52—61 lb-in.)

14. Connect wiring harness connectors.

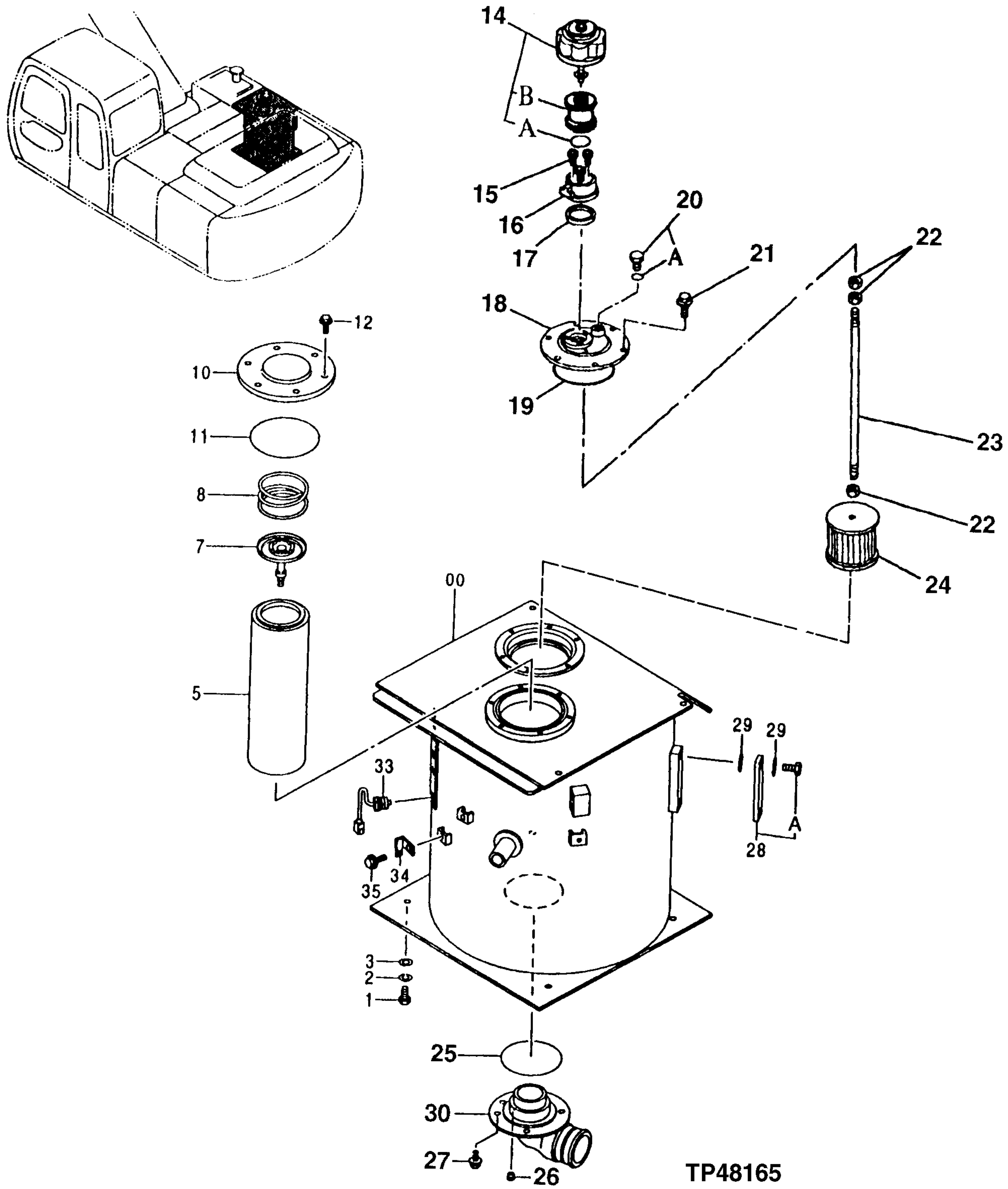
15. Add hydraulic oil to tank until it is between marks on sight glass. (See Hydraulic Oil in Group 0004.)

IMPORTANT: Hydraulic pump will be damaged if not filled with oil before starting. Procedure must be performed to fill pump housing whenever oil has been drained from the pump or hydraulic oil tank.

16. Do the Hydraulic Pump Start-Up Procedure. (See Hydraulic Pump Start-Up Procedure in this group.)

TX,33,UU3804 –19–21SEP98–6/6

DISASSEMBLE AND ASSEMBLE HYDRAULIC OIL TANK



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122

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TX,33,UU4004 –19–03APR98–1/2

0—Hydraulic Oil Tank
1—Cap Screw (4 used)
2—Lock Washer (4 used)
3—Washer (4 used)
5—Return Filter Element
7—Filter Bypass Valve
8—Spring
10—Cover
11—O-Ring
12—Cap Screw and Lock Washer (6 used)
14—Cap and Relief Valve
14A—O-Ring
14B—Breather Filter
15—Cap Screw (3 used)
16—Base (Housing)
17—Packing
18—Cover
19—O-Ring
20—Vent Plug
20A—O-Ring
21—Cap Screw and Lock Washer (6 used)
22—Nut (3 used)
23—Rod
24—Suction Strainer
25—O-Ring
26—Drain Plug
27—Cap Screw and Lock Washer (5 used)
28—Level Gauge
28A—Fitting (2 used)
29—Washer (Seal) (4 used)
30—Elbow
33—Hydraulic Oil Level Switch
34—Bracket
35—Cap Screw and Lock Washer

NOTE: It is not necessary to drain and remove the hydraulic oil tank (0) if only the return filter element (5) is being removed. (See procedures in this group.)

1. Tighten cap screws (12, 21 and 27).

Cover-to-Hydraulic Oil Tank Cap Screw—Specification

Torque... 49 N•m (36 lb-ft)

2. Adjust the length of rod (23) and suction strainer (24).

Rod and Suction Strainer—Specification

Length... 683 mm (26.9 in.)

Tighten nut (22).

Rod-to-Suction Strainer Nut—Specification

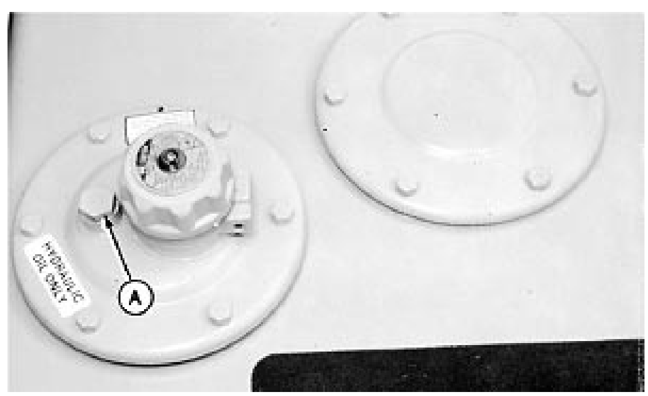
Torque.. 17 N•m (153 lb-in.)

TX,33,UU4004 –19–03APR98–2/2

REMOVE AND INSTALL RETURN FILTER AND BYPASS VALVE

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to release air pressure from hydraulic oil tank.



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A—Vent Plug

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123

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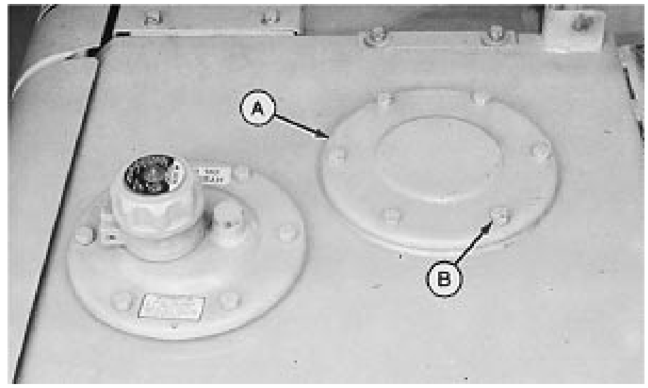
2. Hold down cover (A) against light spring (D) force when removing the last two cap screws (B).

3. Remove the spring (D), filter bypass valve (E) and return filter element (F).

4. Inspect element for metal particles and debris. Check for metal particles and debris at the bottom of filter case. Excessive amounts of brass and steel particles can indicate a hydraulic pump, motor or valve malfunction, or a malfunction in process. A rubber type of material can indicate a cylinder packing problem.

   As necessary, drain the hydraulic oil tank and clean the filter case and tank. Approximate oil capacity is 130 L (35 gal).



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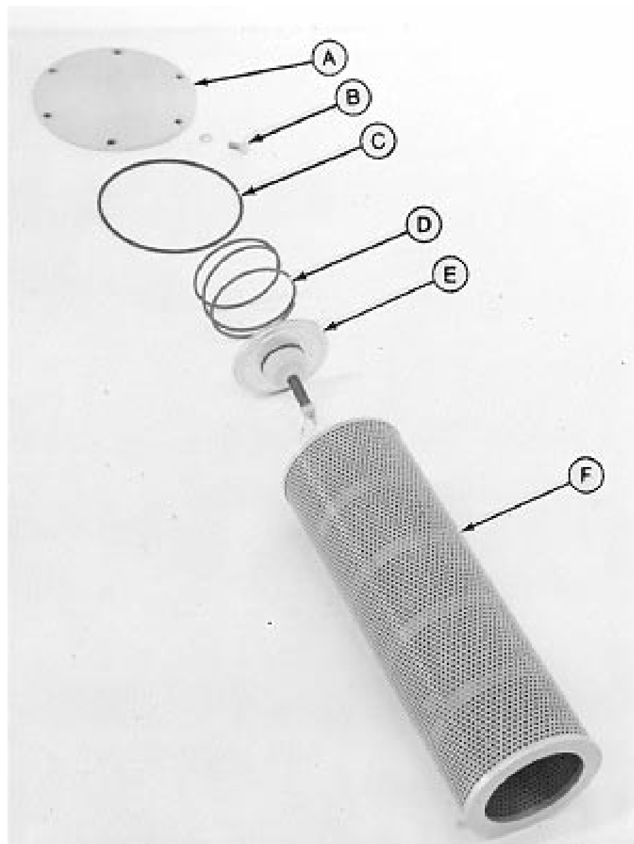

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A—Cover
B—Cap Screw and Lock Washer (6 used)
C—O-Ring
D—Spring
E—Filter Bypass Valve
F—Return Filter Element

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124

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TX,33,UU3806 –19–21SEP98–2/3

5. Install element (D) making sure it is pushed down on its seat at bottom of case.

6. Install filter bypass valve (E), spring (C), O-ring (F), cover (A) and cap screws (B).

   Tighten cap screws.

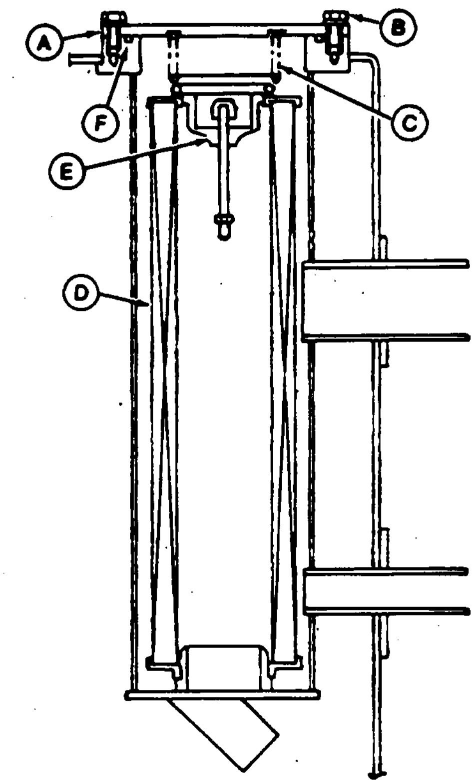
Filter Bypass Valve-to-Cover Cap Screw—Specification

Torque .... 49 N•m (36 lb-ft)

7. Add hydraulic oil as necessary. (See Hydraulic Oil in Group 0004.)

IMPORTANT: Hydraulic pump will be damaged if not filled with oil before starting. Procedure must be performed to fill pump housing whenever oil has been drained from the pump or hydraulic oil tank.

8. If hydraulic oil tank was drained, do the Hydraulic Pump Start-Up Procedure. (See procedure in this group.)



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A—Cover
B—Cap Screw
C—Spring
D—Element
E—Filter Bypass Valve
F—O-Ring

TX,33,UU3806 –19–21SEP98–3/3

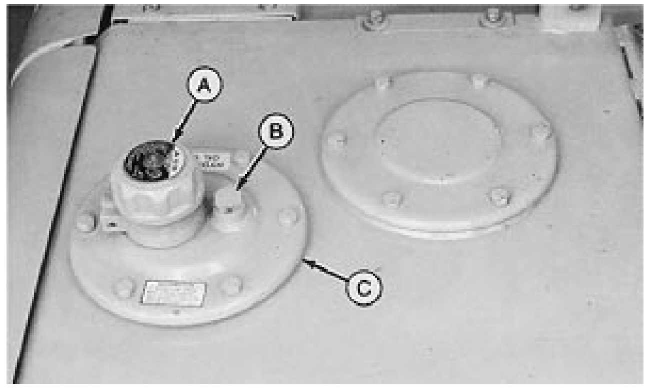
REMOVE AND INSTALL SUCTION STRAINER

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (B) to release air pressure in hydraulic oil tank.

2. Drain hydraulic oil tank. Approximate oil capacity is 148 L (39 gal).

3. Remove the filler cap (A) and cover (C).



A—Filler Cap
B—Vent Plug
C—Cover

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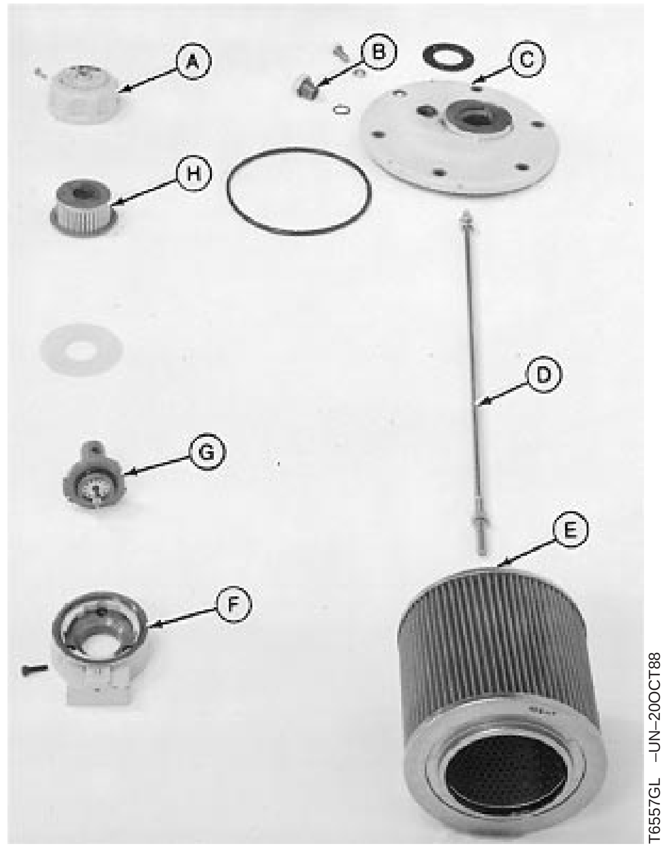
TX,33,GG2428 –19–13MAY98–1/4

4. Remove parts (D—H).

   Replace parts as necessary.



A—Filler Cap
B—Vent Plug
C—Cover
D—Rod and Nuts
E—Suction Strainer
F—Housing
G—Relief Valve
H—Filter

Continued on next page

TX,33,GG2428 –19–13MAY98–2/4

IMPORTANT: To ensure suction strainer is held in position on suction tube, the rod and suction strainer must be adjusted to the correct length.

5. Adjust the length (A) of rod and strainer.

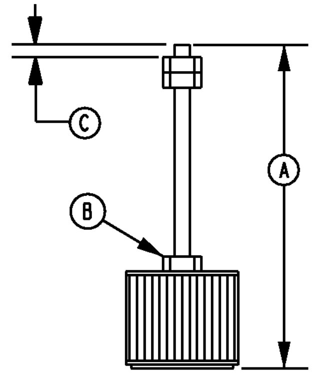
Rod and Suction Strainer—Specification

Length... 683 mm (26.9 in.)

Tighten nut (B).

Rod-to-Suction Strainer Nut—Specification

Torque .... 17 N•m (153 lb-in.)



T108541 –UN–24MAR97

A—683 mm (26.9 in.)
B—Nut
C—20 mm (0.78 in.)

Continued on next page

TX,33,GG2428 –19–13MAY98–3/4

6. Install suction strainer and rod (D and E) making sure it is pushed down on suction tube at bottom of oil tank.

7. Install cover (C). Make sure rod is through hole in cover.

   Tighten cap screws.

Cover-to-Oil Tank Cap Screw—Specification

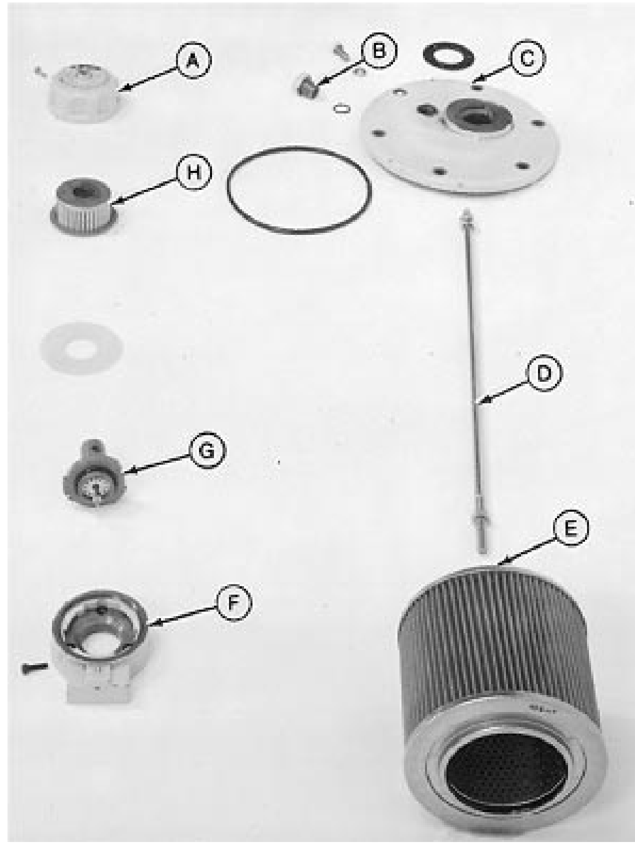
Torque .... 49 N•m (36 lb-ft)

Install parts (A, B, and F—H).

8. Add hydraulic oil to tank until it is between marks on sight glass. (See Hydraulic Oil in Group 0004.)

IMPORTANT: Hydraulic pump will be damaged if not filled with oil before starting. Procedure must be performed to fill pump housing whenever oil has been drained from the pump or hydraulic oil tank.

9. Do the Hydraulic Pump Start-Up Procedure. (See procedure in this group.)



T6557GL –UN–20OCT88

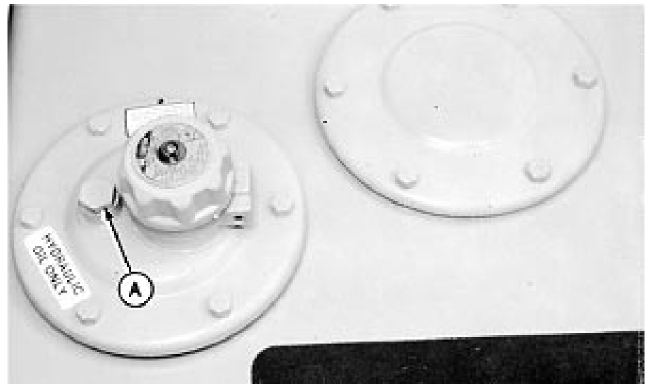
A—Filler Cap
B—Vent Plug
C—Cover
D—Rod and Nuts
E—Suction Strainer
F—Housing
G—Relief Valve
H—Filter

TX,33,GG2428 –19–13MAY98–4/4

DISASSEMBLE AND ASSEMBLE HYDRAULIC OIL TANK RELIEF VALVE AND BREATHER FILTER CAP

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to release air pressure in hydraulic tank.



T7869AT –UN–12NOV92

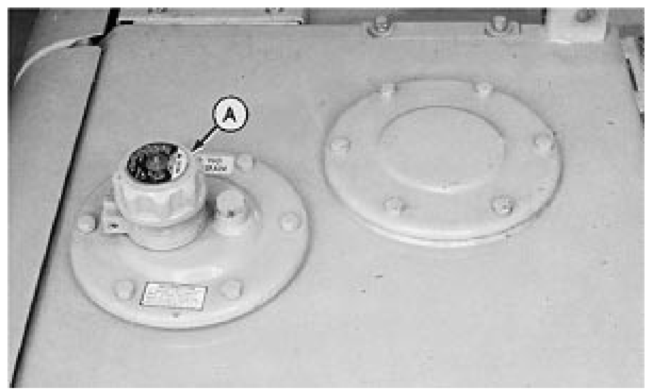
A—Vent Plug

TX,33,UU3807 –19–21SEP98–1/2

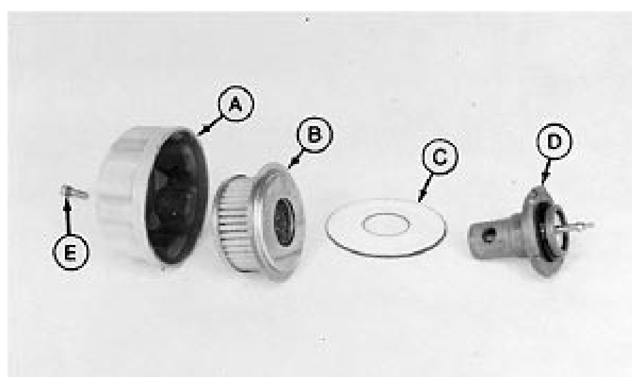
2. Insert a 4 mm hex key wrench in base and turn to release locking pin. Remove cap (A).

3. Remove cap screw (E). Remove parts (B—D).

   Replace parts as necessary.



T7995AN –UN–04MAY93



T7995AX –UN–04MAY93

A—Cap
B—Breather Filter
C—Seal
D—Relief Valve
E—Cap Screw (3 used)

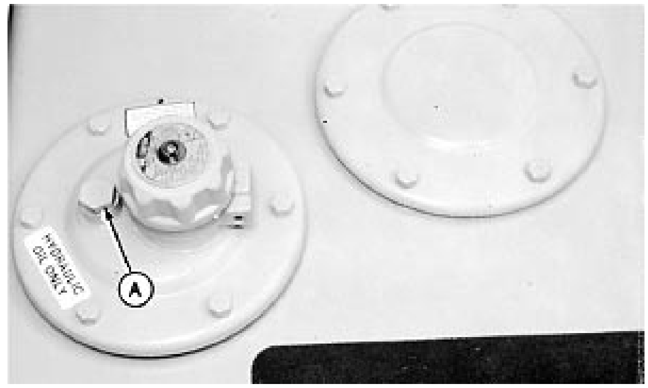
TX,33,UU3807 –19–21SEP98–2/2

REMOVE AND INSTALL SWING MOTOR MAKE-UP OIL RESTRICTION VALVE

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to release air pressure from hydraulic oil tank.

2. Pull a vacuum in hydraulic oil tank using a vacuum pump or drain hydraulic oil tank. Approximate oil capacity is 148 L (39 gal).



T7869AT –UN–12NOV92

A—Vent Plug

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TX,33,UU3808 –19–21SEP98–1/3

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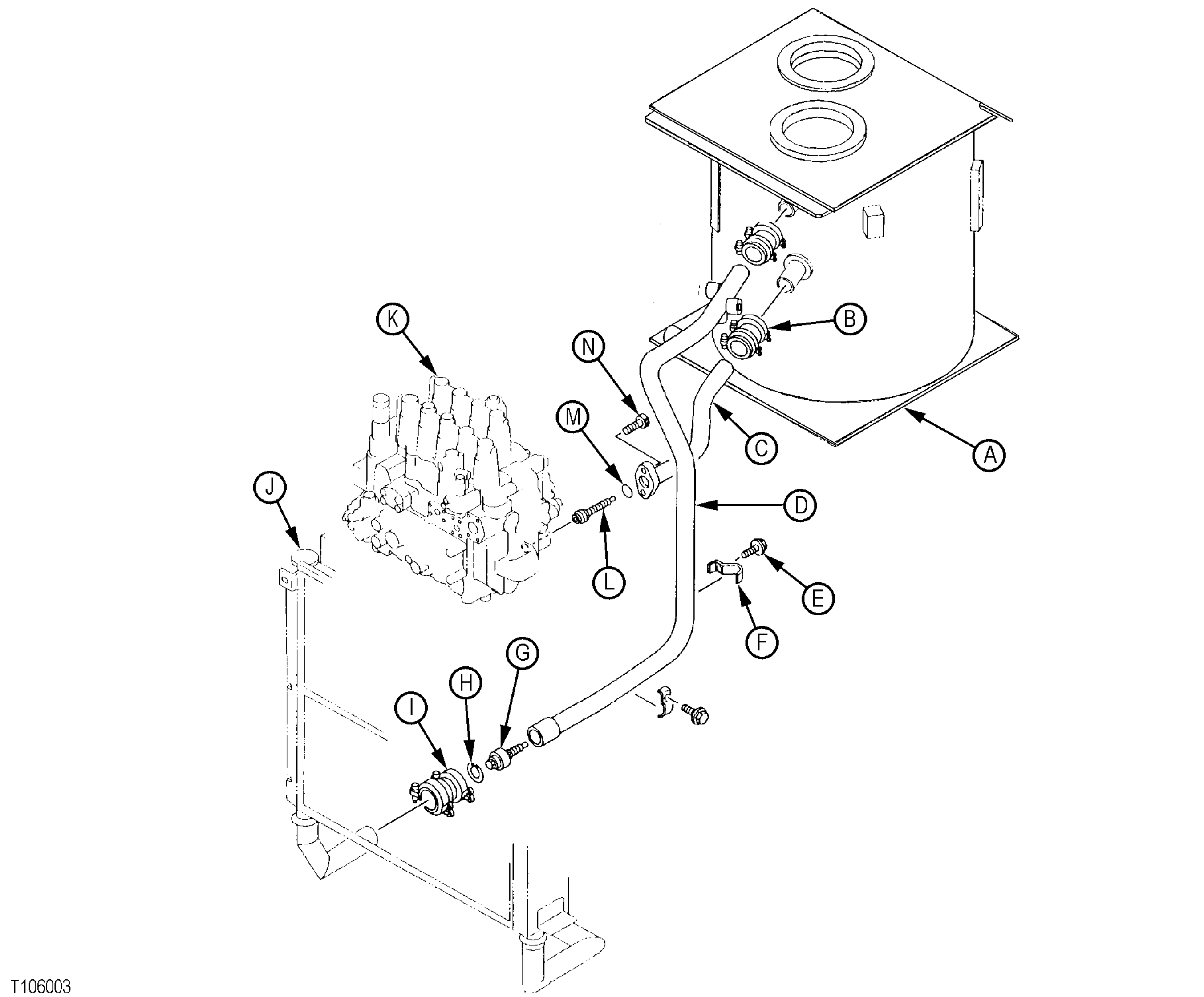
131



A—Hydraulic Oil Tank
B—Coupling (2 used)
C—Control Valve-to-Hydraulic Oil Tank Return Line
D—Oil Cooler-to-Hydraulic Oil Tank Return Line
E—Cap Screw and Lock Washer (2 used)
F—Clamp (2 used)
G—Swing Motor Make-Up Oil Restriction Valve
H—Snap Ring
I—Coupling
J—Oil Cooler
K—Control Valve
L—Oil Cooler Bypass Valve
M—O-Ring
N—Cap Screw (2 used)

33
3360
132

3. Loosen nuts on coupling (I). Slide coupling onto oil cooler-to-hydraulic oil tank return line (D).

   Repair or replace swing motor make-up oil restriction valve (G) and snap ring (H).

4. Tighten nuts on coupling.

Oil Cooler-to-Hydraulic Oil Tank Return Line Coupling Nut—Specification

Torque... 10.3—12.4 N•m (91—110 lb-in.)

Continued on next page

TX,33,UU3808 –19–21SEP98–2/3

5. Check oil level in hydraulic oil tank. Add oil as necessary. (See Hydraulic Oil in Group 0004.)

IMPORTANT: Hydraulic pump will be damaged if not filled with oil before starting. Procedure must be performed to fill pump housing whenever oil has been drained from the pump or hydraulic oil tank.

6. Do the Hydraulic Pump Start-Up Procedure. (See procedure in this group.)

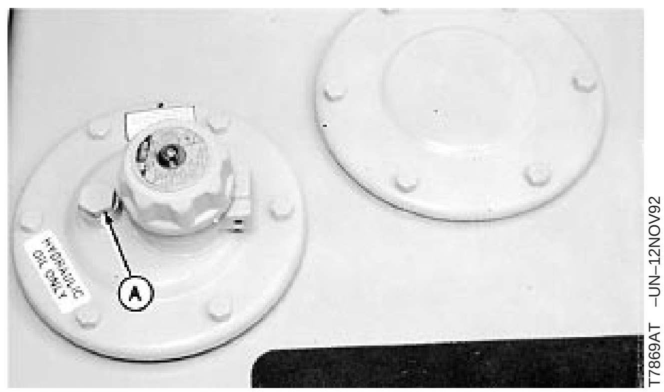
TX,33,UU3808 –19–21SEP98–3/3

REMOVE AND INSTALL OIL COOLER BYPASS VALVE

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to release air pressure from hydraulic oil tank.

2. Pull a vacuum in hydraulic oil tank using a vacuum pump or drain hydraulic oil tank. Approximate oil capacity is 148 L (39 gal).



A—Vent Plug

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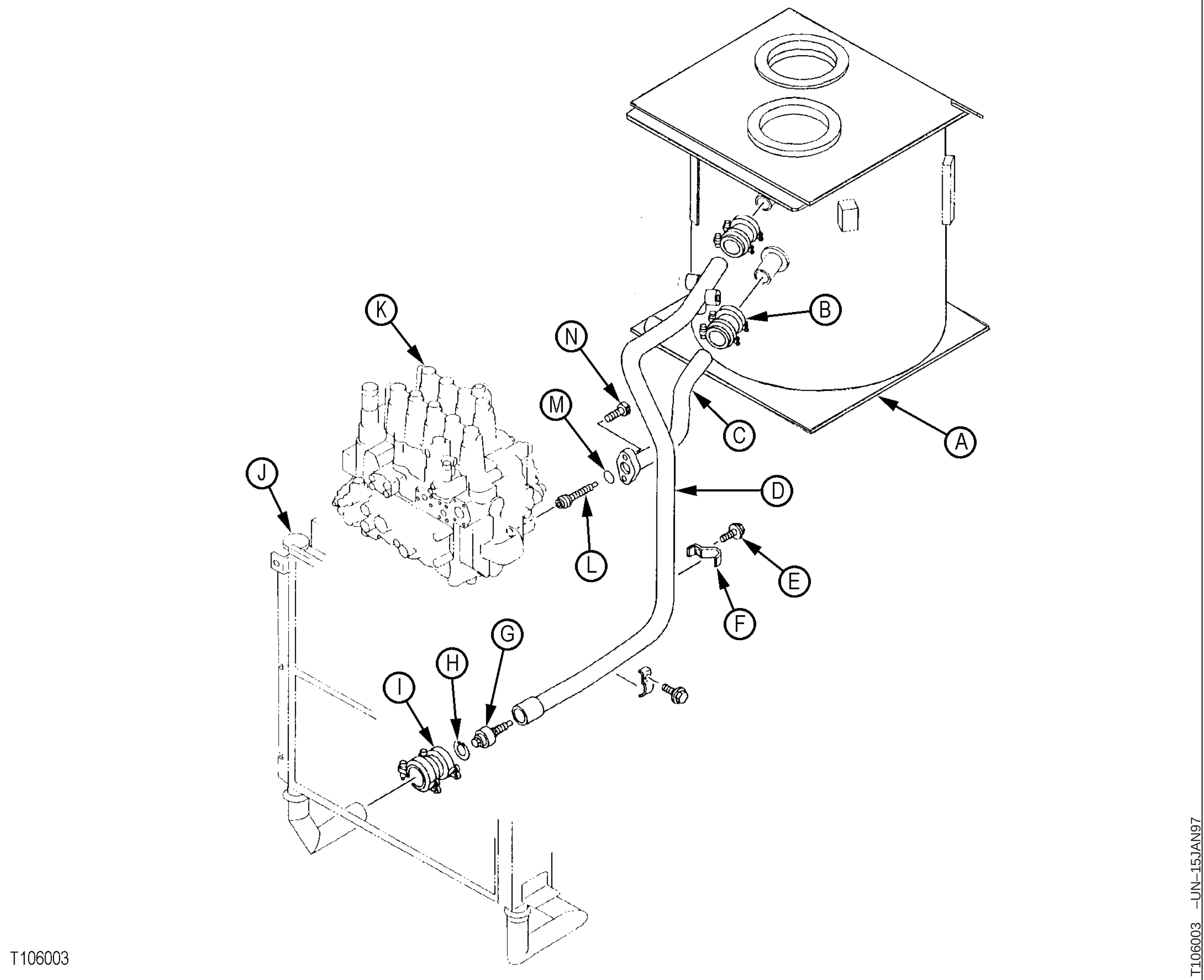


A—Hydraulic Oil Tank
B—Coupling (2 used)
C—Control Valve-to-Hydraulic Oil Tank Return Line
D—Oil Cooler-to-Hydraulic Oil Tank Return Line
E—Cap Screw and Lock Washer (2 used)
F—Clamp (2 used)
G—Swing Motor Make-Up Oil Restriction Valve
H—Snap Ring
I—Coupling
J—Oil Cooler
K—Control Valve
L—Oil Cooler Bypass Valve
M—O-Ring
N—Cap Screw (2 used)

33
3360
134

3. Loosen nuts on coupling (B). Slide coupling onto the control valve-to-hydraulic oil tank return line (C). Remove cap screws (N) to remove line.

   Repair or replace oil cooler bypass valve (L).

4. Tighten nuts on coupling.

Control Valve-to-Hydraulic Oil Tank Return Line Coupling

Nut—Specification

Torque.. 10.3—12.4 N•m (91—110 lb-in.)

5. Check oil level in hydraulic oil tank. Add oil as necessary. (See Hydraulic Oil in Group 0004.)

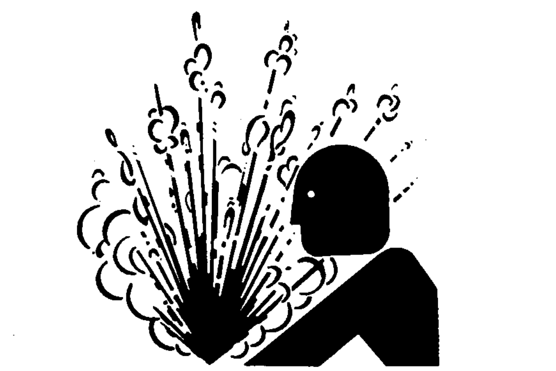
Continued on next page CED,OUOE003,1201 –19–21SEP98–2/3

IMPORTANT: Hydraulic pump will be damaged if not filled with oil before starting. Procedure must be performed to fill pump housing whenever oil has been drained from the pump or hydraulic oil tank.

6. Do the Hydraulic Pump Start-Up Procedure. (See Hydraulic Pump Start-Up Procedure in this group.)

CED,OUOE003,1201 –19–21SEP98–3/3

REMOVE AND INSTALL OIL COOLER



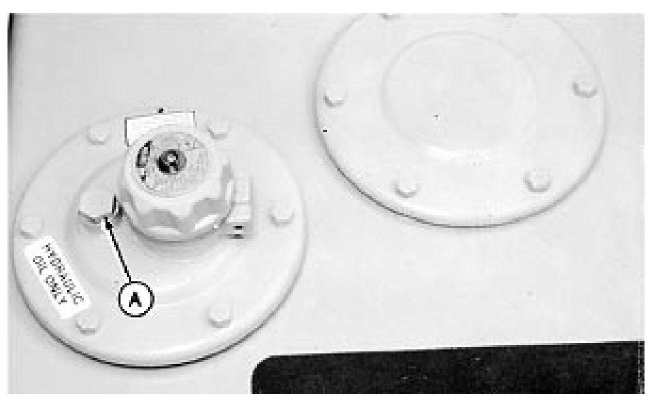
TS281 –UN–23AUG88

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

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

1. Drain coolant from radiator. Approximate capacity is 22.0 L (6 gal).

TX,33,UU3809 –19–21SEP98–1/6



T7869AT –UN–12NOV92

A—Vent Plug

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

2. Loosen vent plug (A) to release air pressure from hydraulic oil tank.

Continued on next page

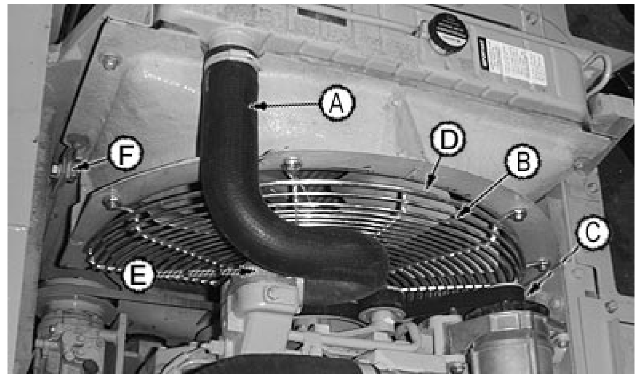
TX,33,UU3809 –19–21SEP98–2/6

3. Remove parts (A—E).

4. Pull a vacuum in hydraulic oil tank using a vacuum pump or drain hydraulic oil tank. Approximate oil capacity is 148 L (39 gal).

5. Remove cover under the radiator and oil cooler.

6. For machines with air conditioning, remove cap screws and lay the condenser on the battery cover.



T105161B –UN–19NOV96

CAUTION: The approximate weight of radiator and oil cooler is 65 kg (140 lb).

Radiator and Oil Cooler—Specification

Weight.. 65 kg (140 lb) approximate

7. Connect a hoist to lifting eyes on radiator.

8. Disconnect upper radiator hose (A).

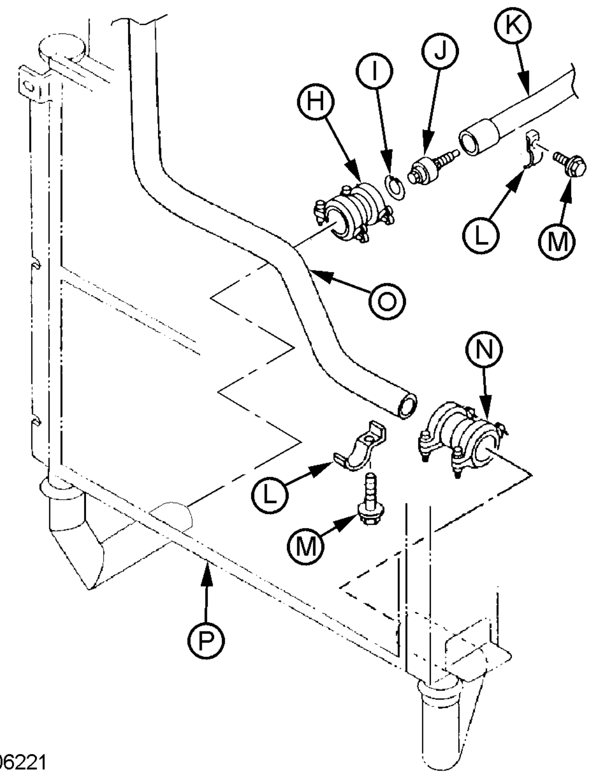
   Remove fan guard (B), fan (D) and fan spacer (E).

   Remove cap screws from radiator braces (F).

9. Disconnect lower radiator hose (C).

   Remove cap screws (M) and clamps (L).

   Loosen nuts on couplings (H and N). Slide couplings onto the lines (K and O). Install cap and plugs.



T106221

T106221 –UN–16JAN97

A—Upper Radiator Hose
B—Fan Guard
C—Lower Radiator Hose
D—Fan
E—Fan Spacer
F—Radiator Braces (2 used)
G—Frame-to-Radiator Bracket Cap Screw (4 used)
H—Coupling
I—Snap Ring
J—Swing Motor Make-Up Oil Restriction Valve
K—Oil Cooler-to-Hydraulic Oil Tank Return Line
L—Clamp (2 used)
M—Cap Screw and Lock Washer (2 used)
N—Coupling
O—Control Valve-to-Oil Cooler Line
P—Oil Cooler

Continued on next page

TX,33,UU3809 –19–21SEP98–3/6

10. Remove the frame-to-radiator bracket cap screws (G).

11. Carefully remove radiator and oil cooler.

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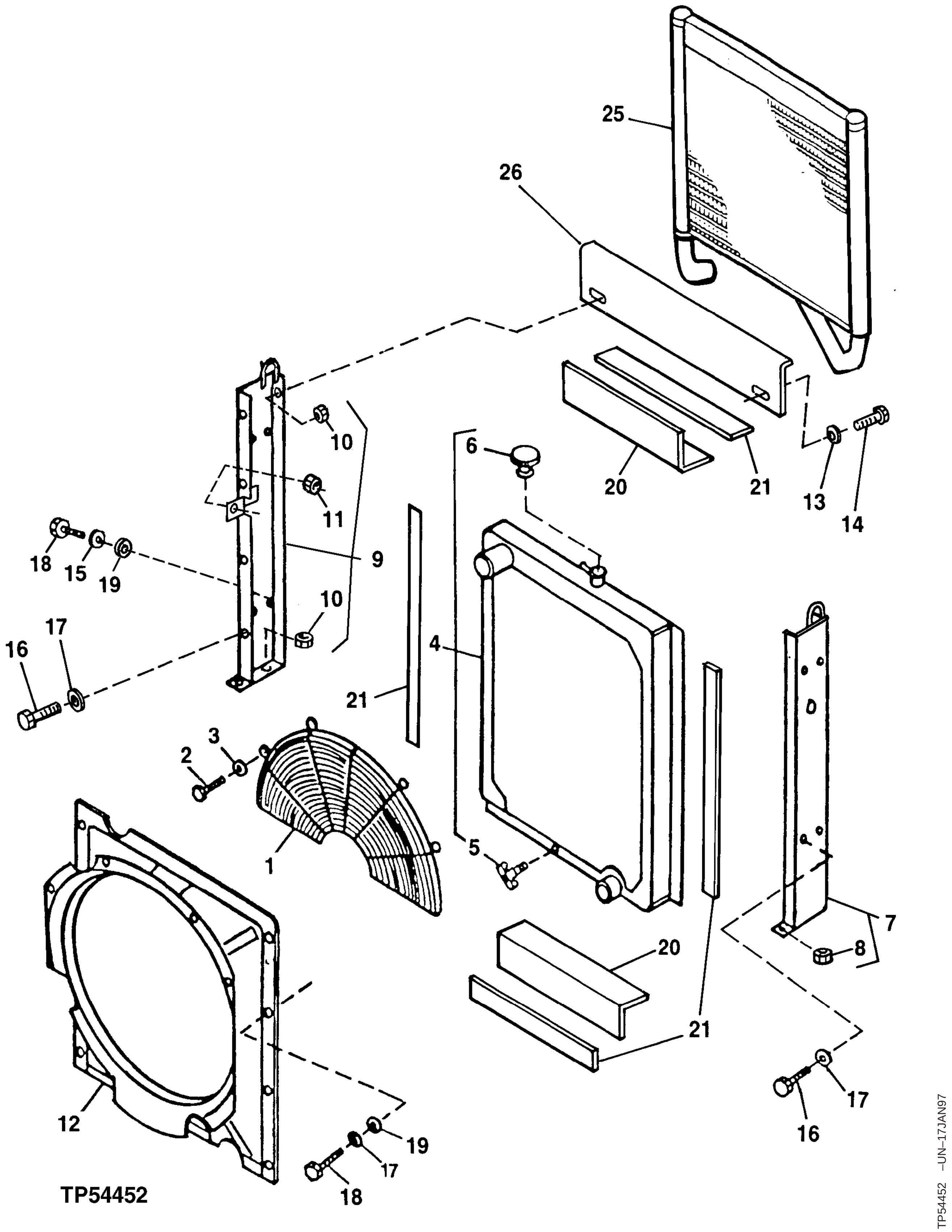

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1—Fan Guard	**7—Radiator Support**	**13—Washer (2 used)**	**19—Washer (20 used)**
2—Cap Screw (4 used)	**8—Nut (2 used)**	**14—Cap Screw (2 used)**	**20—Baffle (2 used)**
3—Washer (4 used)	**9—Radiator Support**	**15—Lock Washer (6 used)**	**21—Baffle**
4—Radiator	**10—Nut (2 used)**	**16—Cap Screw (8 used)**	**25—Oil Cooler**
5—Drain Valve	**11—Nut**	**17—Washer (16 used)**	**26—Bracket**
6—Radiator Cap	**12—Shroud**	**18—Cap Screw (20 used)**	

12. Repair or replace oil cooler.

13. Tighten nuts on couplings for oil cooler lines.

Line-to-Oil Cooler Coupling Nut—Specification

Torque.. 10.3—12.4 N•m (91—110 lb-in.)

Tighten worm gear type clamps on upper and lower radiator hoses.

Upper and Lower Radiator Hose-to-Radiator Worm Gear Type Clamp—Specification

Torque.. 5.9—6.9 N•m (52—61 lb-in.)

14. Check oil level in hydraulic oil tank. Add oil as necessary. (See Hydraulic Oil in Group 0004.)

IMPORTANT: Hydraulic pump will be damaged if not filled with oil before starting. Procedure must be performed to fill pump housing whenever oil has been drained from the pump or hydraulic oil tank.

15. Do the Hydraulic Pump Start-Up Procedure. (See Hydraulic Pump Start-Up Procedure in this group.)

TX,33,UU3809 –19–21SEP98–6/6

230 REMOVE AND INSTALL LEFT BOOM CYLINDER CONTROLLED LOAD LOWERING VALVE

1. Park machine on a firm , level surface.

Continued on next page

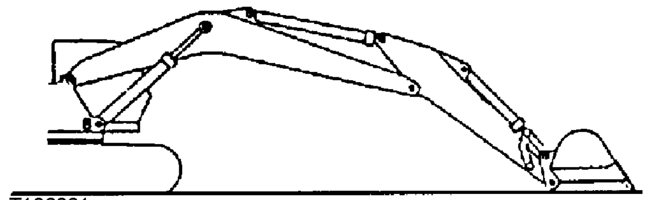
CED,OUOE020,34 –19–14MAR99–1/3

2. Retract arm and bucket cylinders. Lower boom so bucket is on ground.

3. Stop engine.

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

4. Loosen vent plug to release air pressure from hydraulic oil tank.



T106031 –UN–10JAN97

Continued on next page CED,OUOE020,34 –19–14MAR99–2/3

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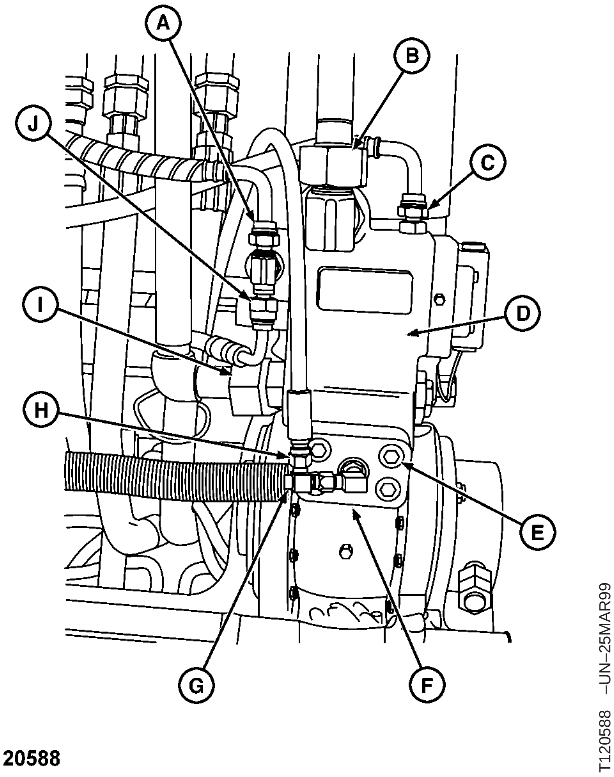
140

5. Disconnect pipes (B and I).

6. Disconnect hoses (A, C, G, H and J).

7. Remove four cap screws (E), flange (F) and valve (D). Replace parts as necessary.



T120588

Left Side Valve

A—Hose
B—Pipe
C—Hose
D—Valve
E—Cap Screw (4 used)
F—Flange
G—Hose
H—Hose
I—Pipe
J—Hose

CED,OUOE020,34 –19–14MAR99–3/3

230 REMOVE AND INSTALL RIGHT BOOM CYLINDER CONTROLLED LOAD LOWERING VALVE

1. Park machine on a firm , level surface.

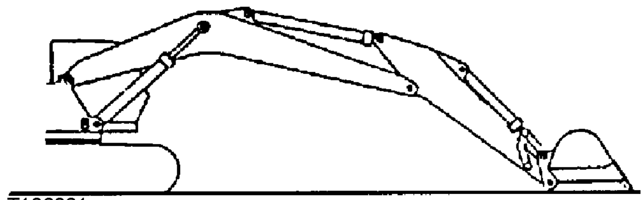
Continued on next page CED,OUOE020,35 –19–14MAR99–1/3

2. Retract arm and bucket cylinders. Lower boom so bucket is on ground.

3. Stop engine.

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

4. Loosen vent plug to release air pressure from hydraulic oil tank.



T106031 –UN–10JAN97

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CED,OUOE020,35 –19–14MAR99–2/3

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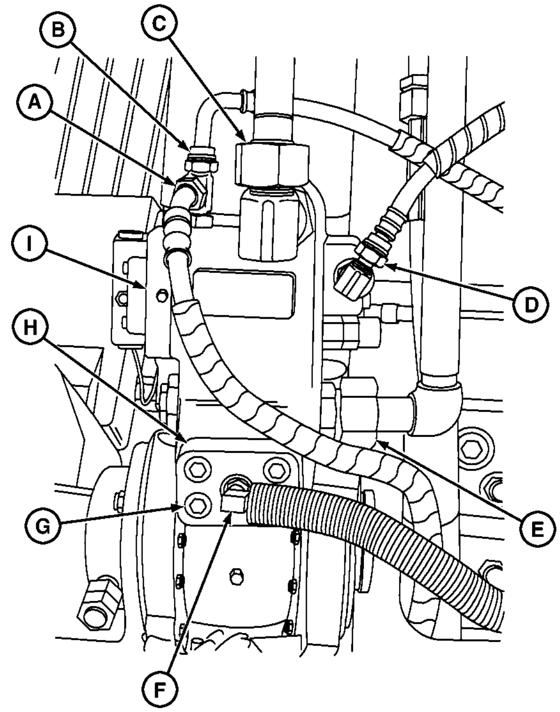
5. Disconnect pipes (C and E).

6. Disconnect hoses (A, B, D and F).

7. Remove four cap screws (G), flange (H) and valve (I). Replace parts as necessary.



T120589

Right Side Valve

A—Hose
B—Hose
C—Pipe
D—Hose
E—Pipe
F—Hose
G—Cap Screw (4 used)
H—Flange
I—Valve

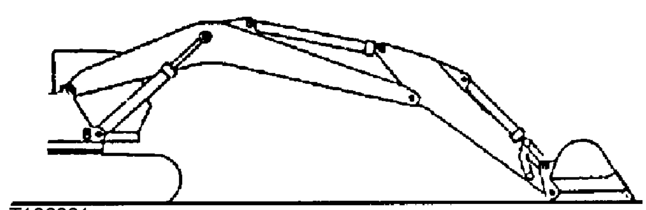
CED,OUOE020,35 –19–14MAR99–3/3

REMOVE AND INSTALL BOOM CYLINDER

NOTE: Procedure is the same for both left and right boom cylinders; right boom cylinder is shown.

1. Retract arm and bucket cylinders. Lower boom so bucket in on the ground.

   Stop the engine.



T106031

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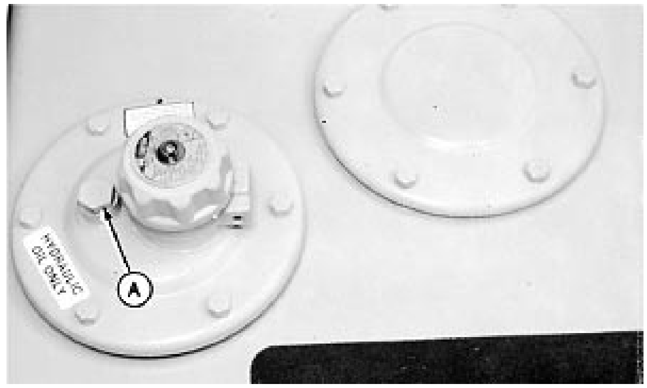
TX,33,UU3810 –19–22SEP98–1/5

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

2. Loosen vent plug (A) to release air pressure from hydraulic oil tank.



A—Vent Plug

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TX,33,UU3810 –19–22SEP98–2/5

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144

3. Disconnect lubricant line at rod end of cylinder.

CAUTION: The approximate weight of boom cylinder is 220 kg (485 lb).

Boom Cylinder—Specification

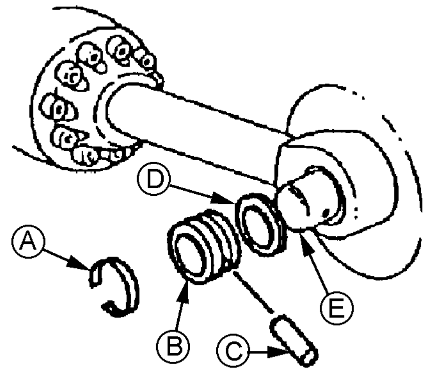
Weight.. 220 kg (485 lb) approximate

4. Connect boom cylinder (F) to hoist using a lifting strap.

5. Remove retainer ring (A), pin (C), retainer (B) and shims (D). Take notice of location of shim for assembly.

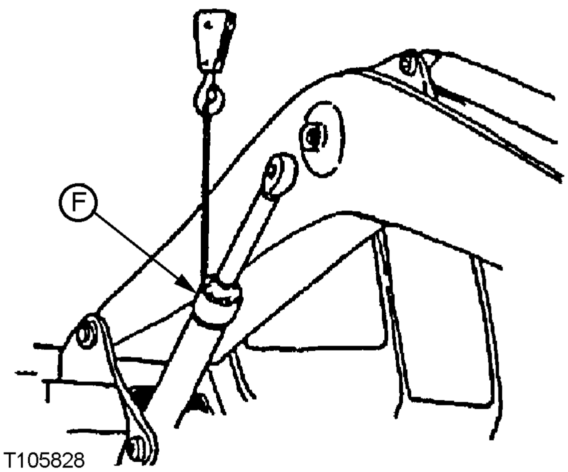
6. Push boom cylinder-to-boom pin (E) into the boom.

   Lower boom cylinder (F) onto a floor stand.



T105734

T105734 –UN–30DEC96



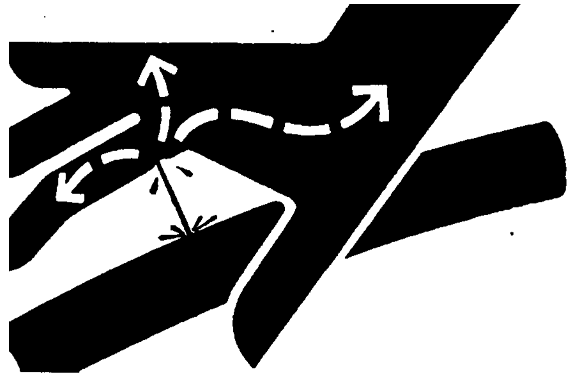
T105828

T105828 –UN–30DEC96

A—Retainer Ring
B—Retainer
C—Pin
D—Shim (as required)
E—Boom Cylinder-to-Boom Pin
F—Boom Cylinder

Continued on next page

TX,33,UU3810 –19–22SEP98–3/5


X9811 –UN–23AUG88

CAUTION: To avoid injury from escaping fluid under pressure, stop engine, and relieve the pressure in the system before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

7. Disconnect lines (G) from cylinder.

8. Take notice of washer (J) locations for assembly.

   Remove parts (H—K) to remove cylinder.

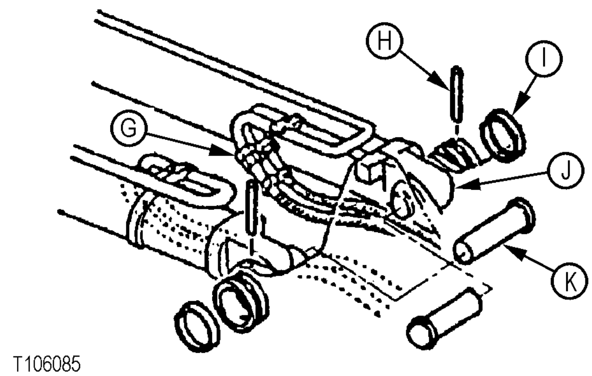
9. Repair or replace cylinder.

10. Install washers (J) equally on each side of cylinder head end to get the minimum amount of clearance in joint.

11. Align pin bores so dust seals are not damaged as boom cylinder-to-frame pin (K) is installed.

    Install pin (H) and retainer ring (I).

12. Connect the lines (G).



T106085 –UN–09JAN97

G—Rod End-to-Boom Section Bottom Port Line
—Head End-to-Boom Section Top Port Line
H—Pin
I—Retainer Ring
J—Washer (As Required)
K—Boom Cylinder-to-Frame Pin

Continued on next page TX,33,UU3810 –19–22SEP98–4/5

IMPORTANT: Trapped air suddenly compressed in a cylinder is heated and ignites the oil used for assembly causing cap seal and ring damage. Start with cylinder rod retraced and the rod end filled with clean oil. Connect the cylinder head end and lines. Operate function to slowly extend rod. Procedure will eliminate most of the air and reduce the possibility of damage.

13. Start the engine.

    Slowly extend boom cylinder (F) to align pin bores so dust seals are not damaged as cylinder-to-boom pin (E) is installed.

14. Install shims (D) to get the minimum amount of clearance between boom and cylinder rod end.

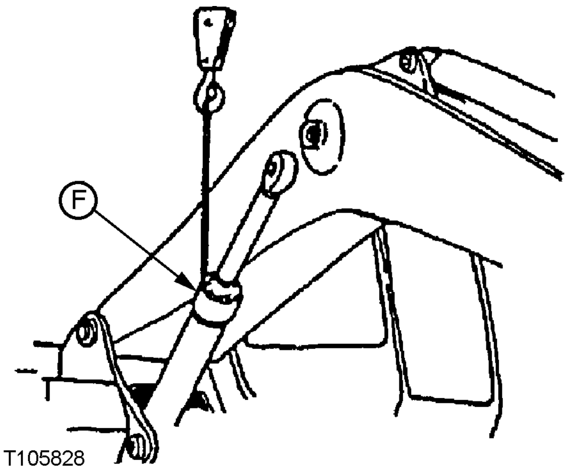
    Install retainer (B), pin (C) and retainer ring (A).

15. Connect lubricant line.

    Lubricate all pivot joints. (See Track Adjuster, Working Tool Pivot, Swing Bearing, and Swing Bearing Gear Grease in Group 0004.)

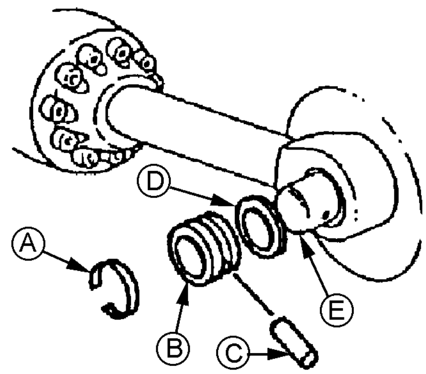
16. Bleed air from cylinder.(See Hydraulic Cylinder Bleed Procedure in this group.)

17. Check oil level in hydraulic oil tank. Add oil as necessary. (See Hydraulic Oil in Group 0004.)



T105828

T105828 –UN–30DEC96



T105734

T105734 –UN–30DEC96

A—Retainer Ring
B—Retainer
C—Pin
D—Shim (As Required)
E—Boom Cylinder-to-Boom Pin
F—Boom Cylinder

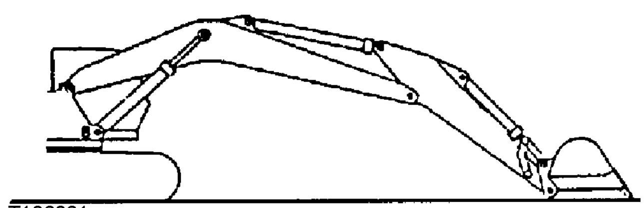
TX,33,UU3810 –19–22SEP98–5/5

REMOVE AND INSTALL ARM CYLINDER

1. Park machine on a firm, level surface.

   Retract arm and bucket cylinders. Lower boom so bucket in on the ground.

   Stop the engine.



T106031

T106031 –UN–10JAN97

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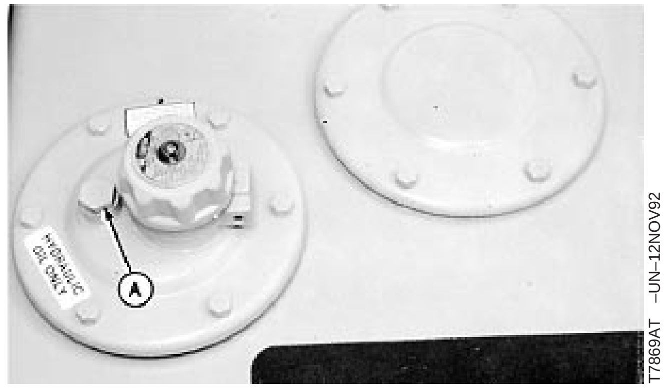
TX,33,UU3811 –19–22SEP98–1/5

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

2. Loosen vent plug (A) to release air pressure from hydraulic oil tank.



A—Vent Plug

TX,33,UU3811 –19–22SEP98–2/5

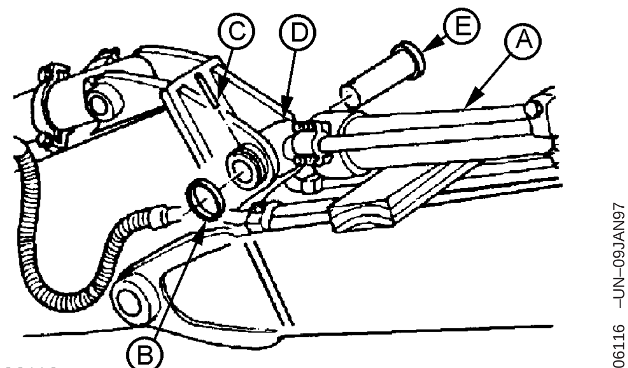
CAUTION: The approximate weight of arm cylinder is 290 kg (640 lb).

Arm Cylinder—Specification

Weight... 290 kg (640 lb) approximate

3. Connect arm cylinder (A) to a hoist using lifting straps.
4. Remove retainer ring (B) and pin (C).
5. Take notice of washer (D) locations for assembly.

   Remove arm cylinder-to-arm pin (E).

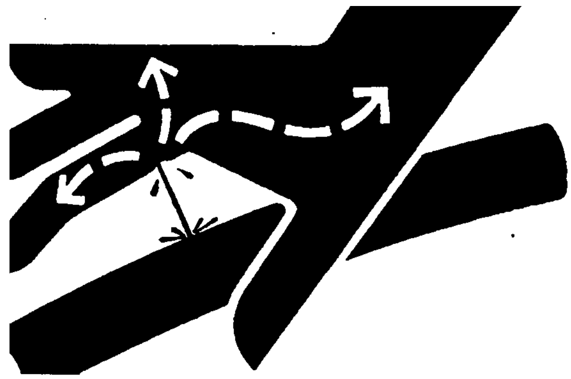


A—Arm Cylinder
B—Retainer Ring
C—Pin
D—Washer (As Required)
E—Arm Cylinder-to-Arm Pin

33
3360
148

Continued on next page TX,33,UU3811 –19–22SEP98–3/5

CAUTION: To avoid injury from escaping fluid under pressure, stop engine, and relieve the pressure in the system before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.



6. Disconnect hydraulic lines (F) and lubricant line (G).

7. Remove parts (H—K) to remove arm cylinder (A). Take notice of location of washers (I) for assembly.

8. Repair or replace cylinder.

9. Install washers (I) equally on each side of cylinder head and rod ends to get the minimum amount of clearance in joints.

10. Align pin bores so dust seals are not damaged as arm cylinder-to-boom pin (J) is installed.

    Install pin (H) and retainer ring (K).

11. Connect lubricant line (G) and hydraulic lines (F).

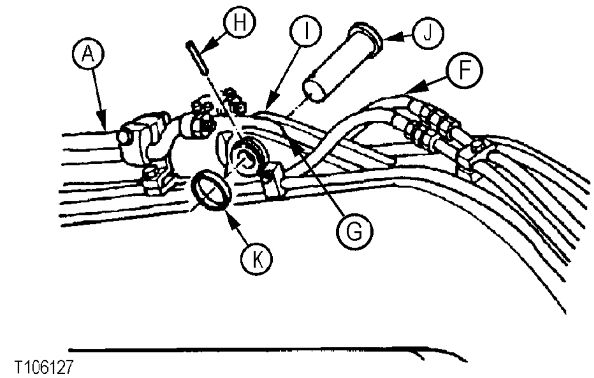
IMPORTANT: Trapped air suddenly compressed in a cylinder is heated and ignites the oil used for assembly causing cap seal and ring damage. Start with cylinder rod retracted and the rod end filled with clean oil. Connect the cylinder head end and lines. Operate function to slowly extend cylinder rod. Procedure will eliminate most of the air and reduce the possibility of cap seal and ring damage.

12. Start the engine.

    Slowly extend cylinder to align pin bores so dust seals are not damaged as arm cylinder-to-arm pin is installed.

    Install pin and retainer ring.

13. Lubricate all pivot joints. (See Track Adjuster, Working Tool Pivot, Swing Bearing, and Swing Bearing Gear Grease in Group 0004.)



A—Arm Cylinder
F—Arm Cylinder Head End-to-Arm Section Bottom Port Line
—Arm Cylinder Rod End-to-Arm Section Top Port Line
G—Lubricant Line
H—Pin
I—Washer (As Required)
J—Arm Cylinder-to-Boom Pin
K—Retainer Ring

33
3360
149

Continued on next page

14. Bleed air from cylinder. (See procedure in this group.)

15. Check oil level in hydraulic oil tank. Add oil as necessary. (See Hydraulic Oil in Group 0004.)

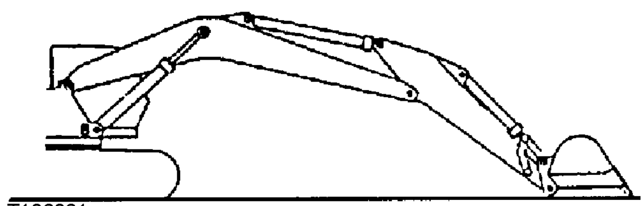
TX,33,UU3811 –19–22SEP98–5/5

REMOVE AND INSTALL BUCKET CYLINDER

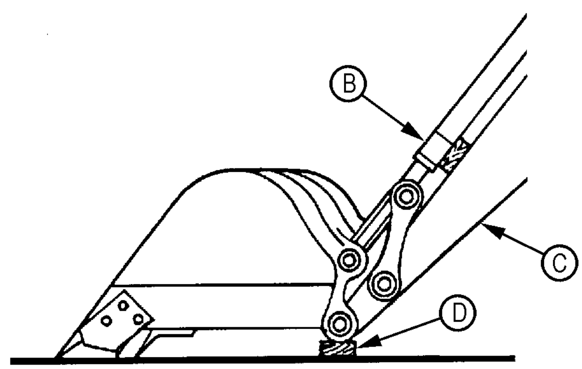
1. Park machine on a firm, level surface.

2. Retract arm and bucket (B) cylinders. Lower boom so bucket in on the ground and end of arm (C) is on a wooden block (D).

3. Stop the engine.



T106031 –UN–10JAN97



T106135 –UN–09JAN97

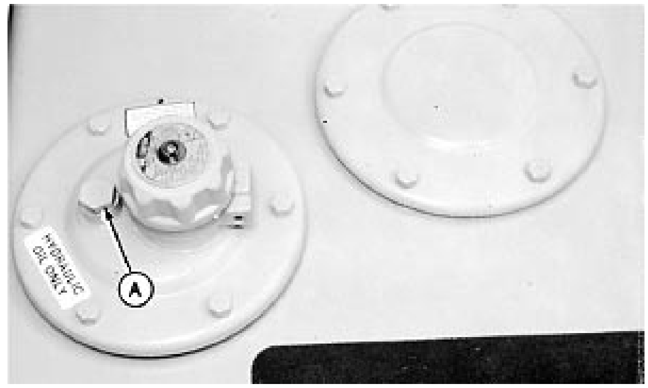
B—Bucket Cylinder
C—Arm
D—Wooden Block

Continued on next page

TX,33,UU3812 –19–22SEP98–1/5

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

4. Loosen vent plug (A) to release hydraulic pressure in reservoir.



T7869AT –UN–12NOV92

A—Vent Plug

Continued on next page

TX,33,UU3812 –19–22SEP98–2/5

CAUTION: To avoid injury from escaping fluid under pressure, stop engine, and relieve the pressure in the system before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

5. Disconnect hydraulic lines (H).

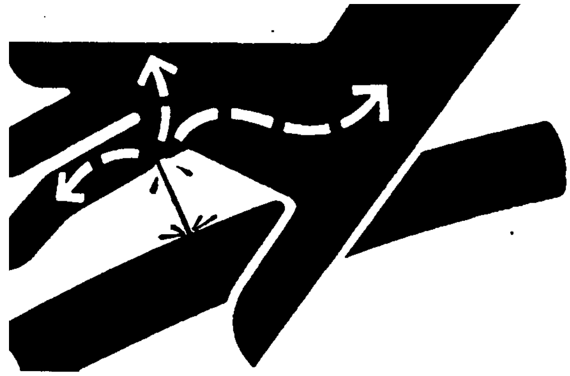
6. Connect center link to a hoist using a lifting strap.

7. Put a wooden block between bucket cylinder and arm to hold cylinder up when side and center links-to-bucket cylinder pin (I) is removed.

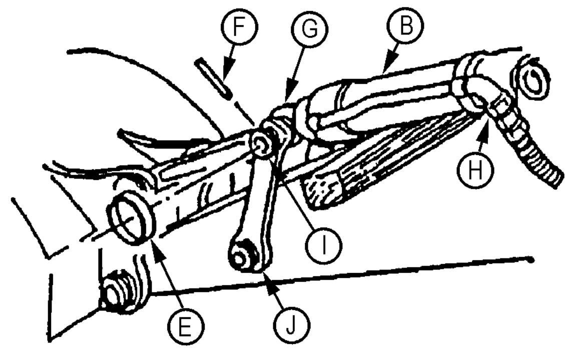
8. Remove retainer ring (E) and pin (F).

9. As side and center links-to-bucket cylinder pin is removed, lower links to the ground.

   Take notice of washer (G) locations for assembly.

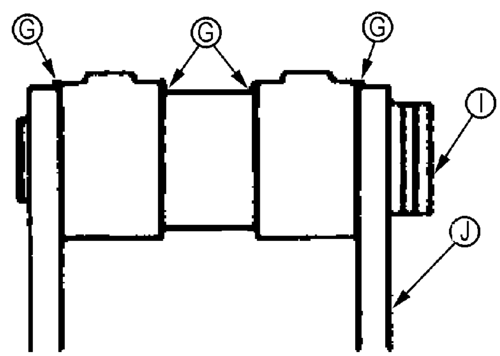


X9811 –UN–23AUG88



T106136

T106136 –UN–09JAN97



T106137

T106137 –UN–09JAN97

B—Bucket Cylinder
E—Retainer Ring
F—Pin
G—Washer (As Required)
H—Bucket Cylinder Rod End-to-Bucket Section Top Port Line
—Bucket Cylinder Head End-to-Bucket Section Bottom Port Line
I—Side and Center Links-to-Bucket Cylinder Pin
J—Side Link

Continued on next page

TX,33,UU3812 –19–22SEP98–3/5

CAUTION: The approximate weight of bucket cylinder is 190 kg (420 lb).

Bucket Cylinder—Specification

Weight.. 190 kg (420 lb) approximate

10. Connect bucket cylinder (B) to hoist using a lifting strap.

11. Remove retainer ring (K) and pin (L).

12. Take notice of washer (M) locations for assembly.

    Remove bucket cylinder-to-arm pin (N). Remove cylinder.

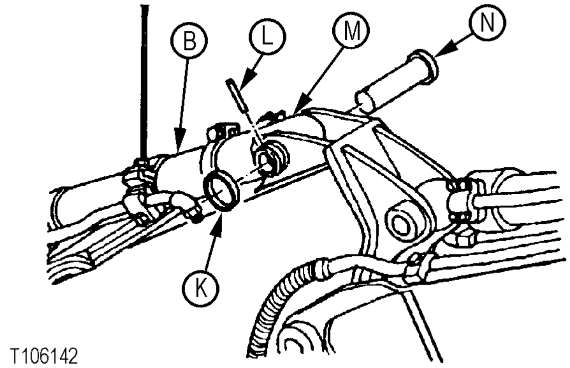
13. Repair or replace cylinder.

14. Install washers equally on each side of bucket cylinder head end to get the minimum amount of clearance in joint.

15. Align pin bores so dust seals are not damaged as bucket cylinder-to-arm pin is installed.

    Install pin and retainer ring.

16. Connect the hydraulic lines.



T106142 –UN–09JAN97

B—Bucket Cylinder
K—Retainer Ring
L—Pin
M—Washer (As Required)
N—Bucket Cylinder-to-Arm Pin

Continued on next page

TX,33,UU3812 –19–22SEP98–4/5

IMPORTANT: Trapped air suddenly compressed in a cylinder is heated and ignites the oil used for assembly causing cap seal and ring damage. Start with cylinder rod retraced and the rod end filled with clean oil. Connect the cylinder head end and lines. Operate function to slowly extend rod. Procedure will eliminate most of the air and reduce the possibility of damage.

17. Start the engine.

    Slowly extend bucket cylinder (B) to align pin bores so dust seals are not damaged as bucket cylinder-to-side and center links pin (I) is installed.

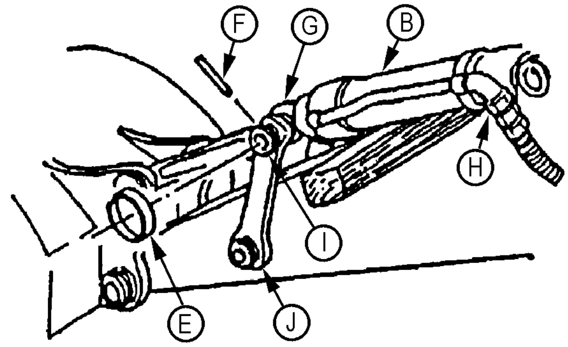
18. Install washers (G) equally on each side of cylinder rod end and side links to get the minimum amount of clearance in joint.

    Install pin (F) and retainer ring (E).

19. Lubricate all pivot joints. (See Track Adjuster, Working Tool Pivot, Swing Bearing, and Swing Bearing Gear Grease in Group 0004.)

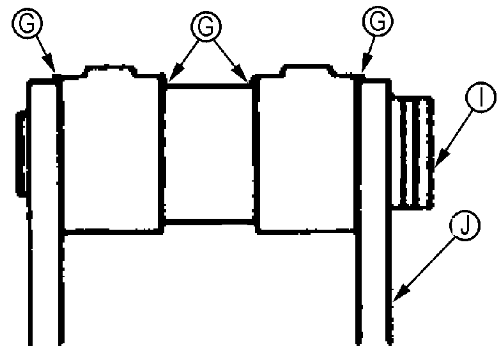
20. Bleed air from cylinder. (See procedure in this group.)

21. Check oil level in hydraulic oil tank. Add oil as necessary. (See Hydraulic Oil in Group 0004.)



T106136

T106136 –UN–09JAN97



T106137

T106137 –UN–09JAN97

B—Bucket Cylinder
E—Retainer Ring
F—Pin
G—Washer (As Required)
H—Bucket Cylinder Rod End-to-Bucket Section Top Port Line
—Bucket Cylinder Head End-to-Bucket Section Bottom Port Line
I—Side and Center Links-to-Bucket Cylinder Pin
J—Side Link

TX,33,UU3812 –19–22SEP98–5/5

33
3360
154

HYDRAULIC CYLINDER BLEED PROCEDURE

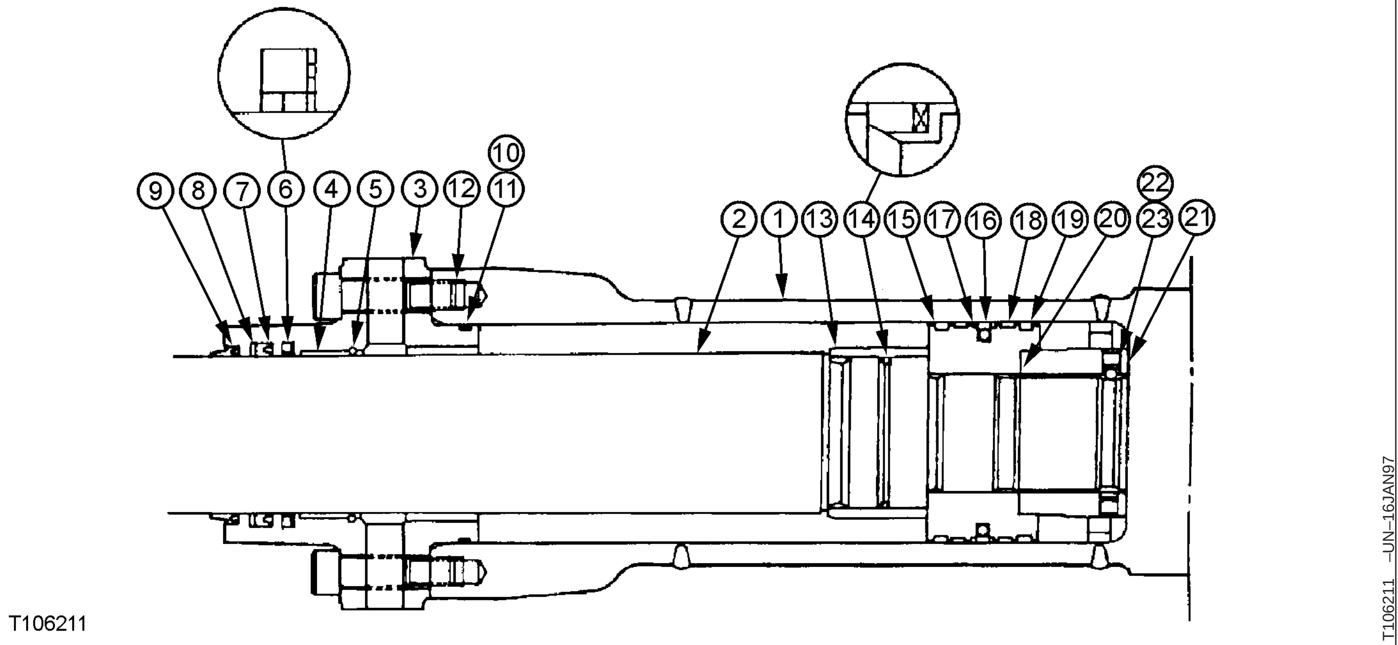
IMPORTANT: Trapped air suddenly compressed in a cylinder is heated and ignites the oil used for assembly causing cap seal and ring damage. Start with cylinder rod retraced and the rod end filled with clean oil. Connect the cylinder head end and lines. Operate function to slowly extend rod. Procedure will eliminate most of the air and reduce the possibility of damage.

NOTE: Bleed air at initial start-up, whenever major repairs or maintenance (oil change) is done on hydraulic system, or when machine has been in storage for a period of time.

1. Run engine at slow idle.
2. Slowly operate function to move cylinder to the most horizontal position possible.
3. Slowly extend and retract cylinder several times to approximately 100 mm (4 in.) from end of stroke.
4. Operate cylinder several times to full stroke.

TX,33,GG2374 –19–06DEC96–1/1

DISASSEMBLE BOOM, ARM OR BUCKET CYLINDER

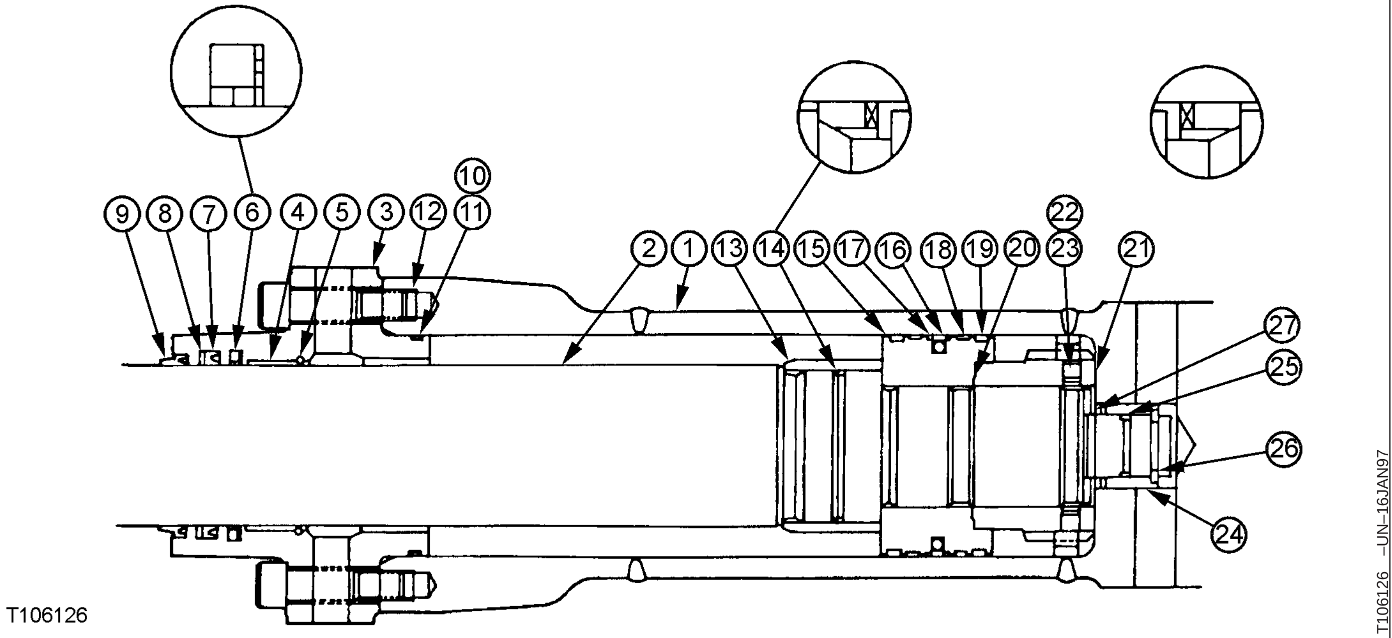


Boom Cylinder

1—Cylinder Barrel and Bushing
2—Rod and Bushing
3—Rod Guide
4—Wear Ring
5—Snap Ring
6—Buffer Ring Seal
7—U-Cup Seal
8—Backup Ring
9—Wiper Seal
10—O-Ring
11—Backup Ring
12—Cap Screw (12 used)
13—Cushion
14—Cushion Seal
15—Piston
16—Cap Seal and O-Ring
17—Backup Ring (2 used)
18—Buffer Seal (2 used)
19—Wear Ring
20—Shim
21—Nut
22—Set Screw
23—Steel Ball

Continued on next page TX,33,UU3813 –19–22SEP98–1/11

33
3360
156

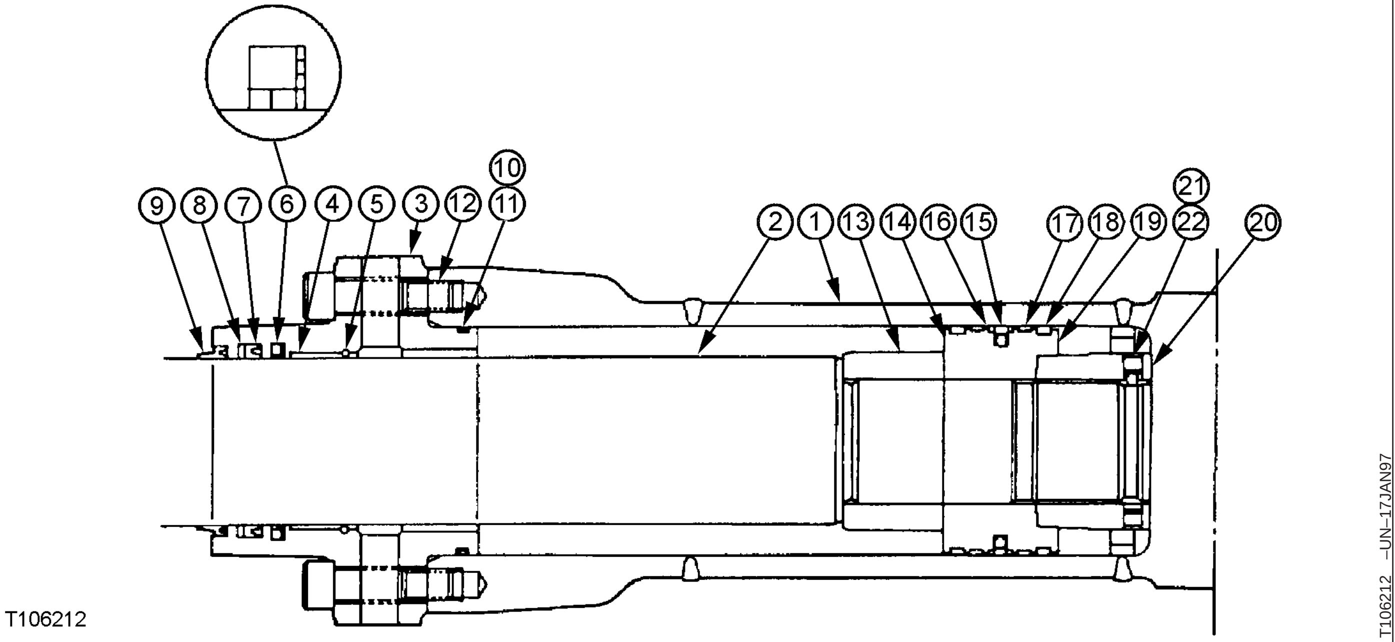


Arm Cylinder

1—Cylinder Barrel and Bushing
2—Rod and Bushing
3—Rod Guide
4—Wear Ring
5—Snap Ring
6—Buffer Ring Seal
7—U-Cup Seal
8—Backup Ring
9—Wiper Seal
10—O-Ring
11—Backup Ring
12—Cap Screw (12 used)
13—Cushion
14—Cushion Seal
15—Piston
16—Cap Seal and O-Ring
17—Backup Ring (2 used)
18—Buffer Seal (2 used)
19—Wear Ring
20—Shim
21—Nut
22—Set Screw
23—Steel Ball
24—Cushion
25—Cushion Seal
26—Retainer Ring
27—Ring

Continued on next page

TX,33,UU3813 –19–22SEP98–2/11



Bucket Cylinder

1—Cylinder Barrel and Bushing
2—Rod and Bushing
3—Rod Guide
4—Wear Ring
5—Snap Ring
6—Buffer Ring Seal
7—U-Cup Seal
8—Backup Ring
9—Wiper Seal
10—O-Ring
11—Backup Ring
12—Cap Screw (12 used)
13—Cushion
14—Piston
15—Cap Seal and O-Ring
16—Backup Ring (2 used)
17—Buffer Seal (2 used)
18—Wear Ring
19—Shim
20—Nut
21—Set Screw
22—Steel Ball

Continued on next page TX,33,UU3813 –19–22SEP98–3/11

CAUTION: The approximate weight of boom cylinder is 220 kg (485 lb).

The approximate weight of arm cylinder is 290 kg (640 lb).

The approximate weight of bucket cylinder is 190 kg (420 lb).

Boom Cylinder—Specification

Weight... 220 kg (485 lb) approximate

Arm Cylinder—Specification

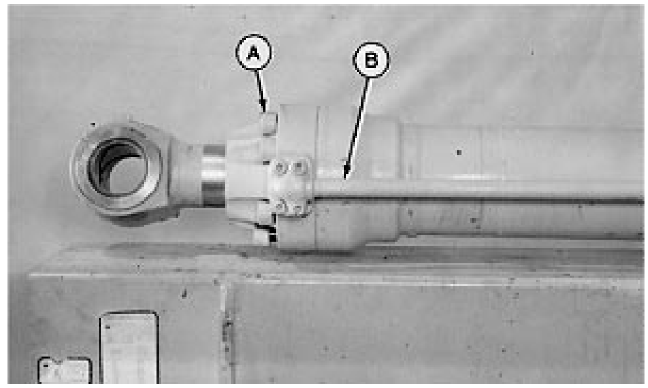
Weight... 290 kg (640 lb) approximate

Bucket Cylinder:—Specification

Weight... 190 kg (420 lb) approximate

NOTE: Disassemble procedure is the same for all cylinders except as noted. Disassembly of cylinder is shown using the JT30043 Cylinder Service Stand.

1. Fasten head end of cylinder to cylinder service stand.
2. Remove line (B).
3. Pull rod out so piston is against rod guide.
4. Connect rod to a hoist using a lifting strap.
5. Remove cap screws (A).
6. Pull rod, rod guide and piston from barrel.



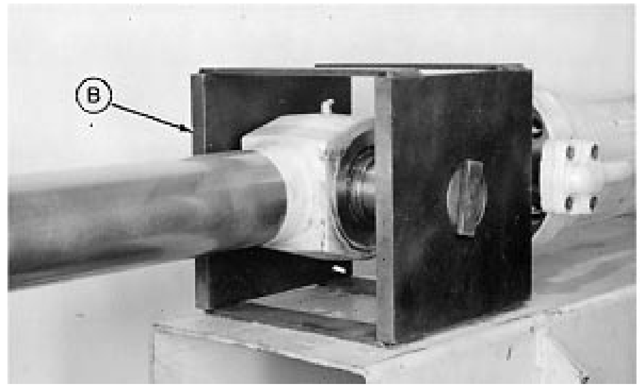
T6557HI –UN–27OCT88

A—Cap Screw
B—Line

33
3360
159

Continued on next page TX,33,UU3813 –19–22SEP98–4/11

7. Install rod eye in sliding housing (B). Install housing in the cylinder service stand.



B—Housing

TX,33,UU3813 –19–22SEP98–5/11

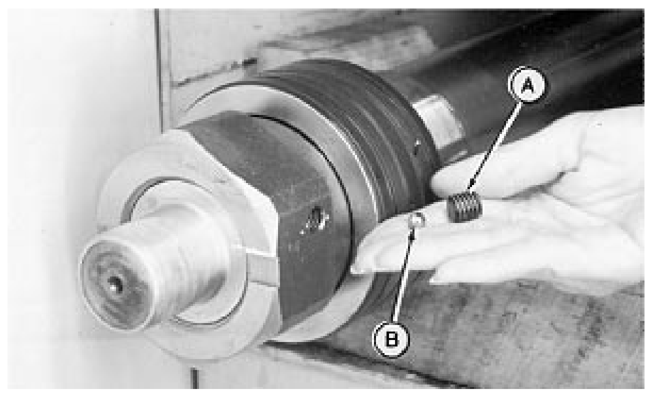
8. Remove the staked material from set screw (A) hole using a small air grinder or a drill and bit.

9. Remove set screw (A). Remove the steel ball (B).

IMPORTANT: To avoid damaging the tapped hole for set screw, the cap screw in the JT30043-30 Hex Piston Nut Wrench must be tightened against a side of the nut without the tapped hole.

To avoid gouging side of nut, install a piece of steel flat stock between nut and cap screw.

10. Install JT30043-30 Hex Piston Nut Wrench so cap screw is tight against a side of nut (B) without the tapped hole.



A—Set Screw
B—Steel Ball

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TX,33,UU3813 –19–22SEP98–6/11

Install a 38 x 51 x 6.4 mm (1.5 x 2.0 x 0.25 in.) piece of steel flat stock between nut and cap screw. Tighten cap screw.

11. Loosen the nut (B).

Boom Cylinder Piston-to-Rod Nut—Specification

Torque .... 4780 N•m (3525 lb-ft)

Arm Cylinder Piston-to-Rod Nut—Specification

Torque .... 9460 N•m (6980 lb-ft)

Bucket Cylinder Piston-to-Rod Nut—Specification

Torque .... 5640 N•m (4160 lb-ft)

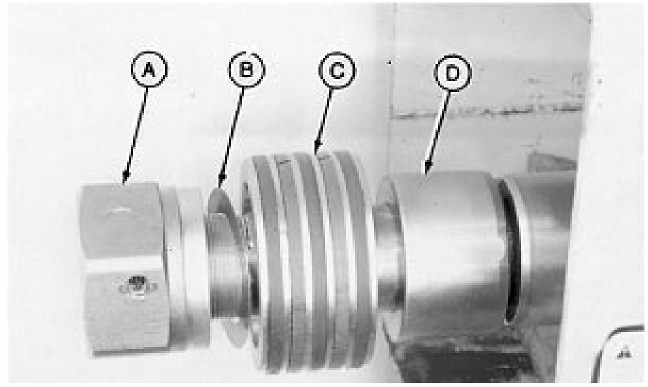
B—Nut

Continued on next page

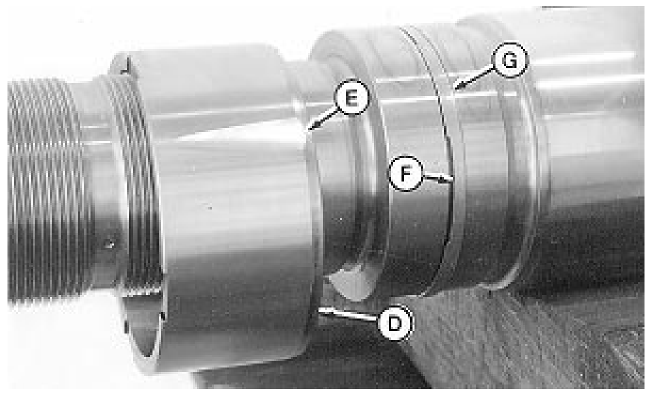
TX,33,UU3813 –19–22SEP98–7/11

12. Remove nut (A), shim (B), piston (C), and cushion (D).

    Take notice of the direction of flat face (E) on cushion and notches (G) in cushion seal and cushion for assembly. For bucket cylinder, no cushion seal is used.



T6585XK –UN–27OCT88



T8286BL –UN–16JUL94

A—Nut
B—Shim
C—Piston
D—Cushion
E—Flat Face
F—Notch
G—Cushion Seal

Continued on next page

TX,33,UU3813 –19–22SEP98–8/11

13. For arm cylinder, remove ring (A) using a punch and a hammer.

    Push cushion (C) against shoulder.

    Remove retainer ring (B). Remove cushion.

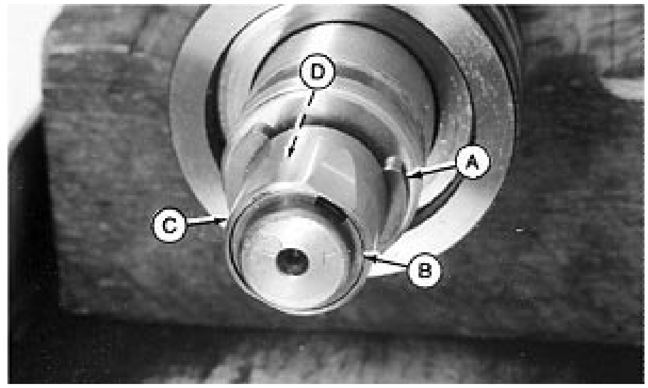
    Take notice of the direction of flat face on cushion and notches in cushion seal for assembly.

    Remove cushion seal (D).

14. Remove the rod guide.

    Remove parts from rod guide and piston.

    Inspect the piston, inside the rod guide and barrel for wear, scratches and nicks that may cut or damage a seal or wear ring.



Arm Cylinder Rod End Cushion

A—Ring
B—Retainer Ring
C—Cushion
D—Cushion Seal

Continued on next page TX,33,UU3813 –19–22SEP98–9/11

15. Inspect dust seals (A) and bushing (B) for wear or damage, replace as necessary. (See Remove and Install Bushing and Seals in Group 3340.)

Boom Cylinder Head End and Rod End Bushing—Specification

ID .... 90.0 mm (3.54 in.) nominal
ID .... 91.5 mm (3.60 in.) limit of use

Arm Cylinder Head End or Rod End Bushing—Specification

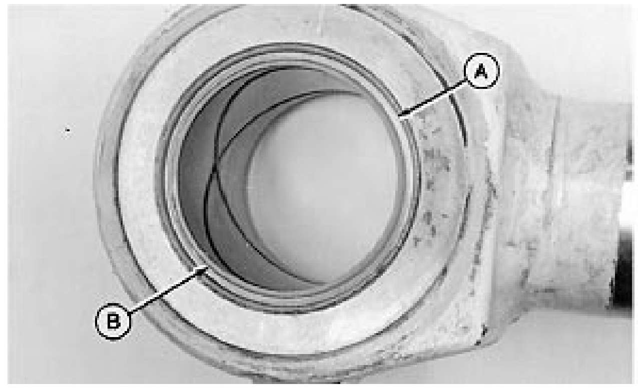
ID .... 80.0 mm (3.15 in.) nominal
ID .... 81.5 mm (3.21 in.) limit of use

Bucket Cylinder Head End Bushing—Specification

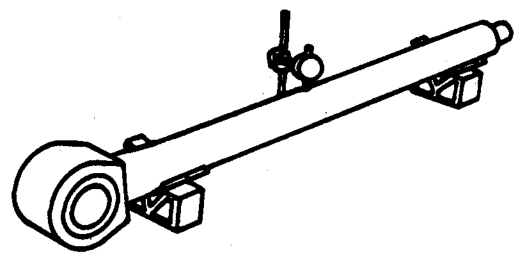
ID .... 80.0 mm (3.15 in.) nominal
ID .... 81.5 mm (3.21 in.) limit of use

Bucket Cylinder Rod End Bushing—Specification

ID .... 90.0 mm (3.54 in.) nominal
ID .... 91.5 mm (3.60 in.) limit of use



T6557HR –UN–27OCT88



T6585XG –UN–27OCT88

A—Dust Seal
B—Bushing

16. Check for rod curvature.

Put rod on V-blocks. Measure for rod curvature using a dial indicator.

Boom Rod—Specification

Curvature .... 0.5 mm per 1 m (0.020 in. per 3.25 ft)

Arm Rod—Specification

Curvature .... 0.5 mm per 1 m (0.020 in. per 3.25 ft)

Bucket Rod—Specification

Curvature .... 0.5 mm per 1 m (0.020 in. per 3.25 ft)

17. Inspect rod surface for scratches or wear.

Boom Rod Allowable Scratch—Specification

Depth .... 0.1 mm (0.004 in.) (enough to detect by a fingernail)

Boom Rod—Specification

OD .... 90 ± 0.03 mm (3.543 ± 0.001 in.)

Continued on next page

TX,33,UU3813 –19–22SEP98–10/11

Arm Rod Allowable Scratch—Specification

Depth .... 0.1 mm (0.004 in.) (enough to detect by a fingernail)

Arm Rod—Specification

OD .... 100 ± 0.03 mm (3.937 ± 0.001 in.)

Bucket Rod Allowable Scratch—Specification

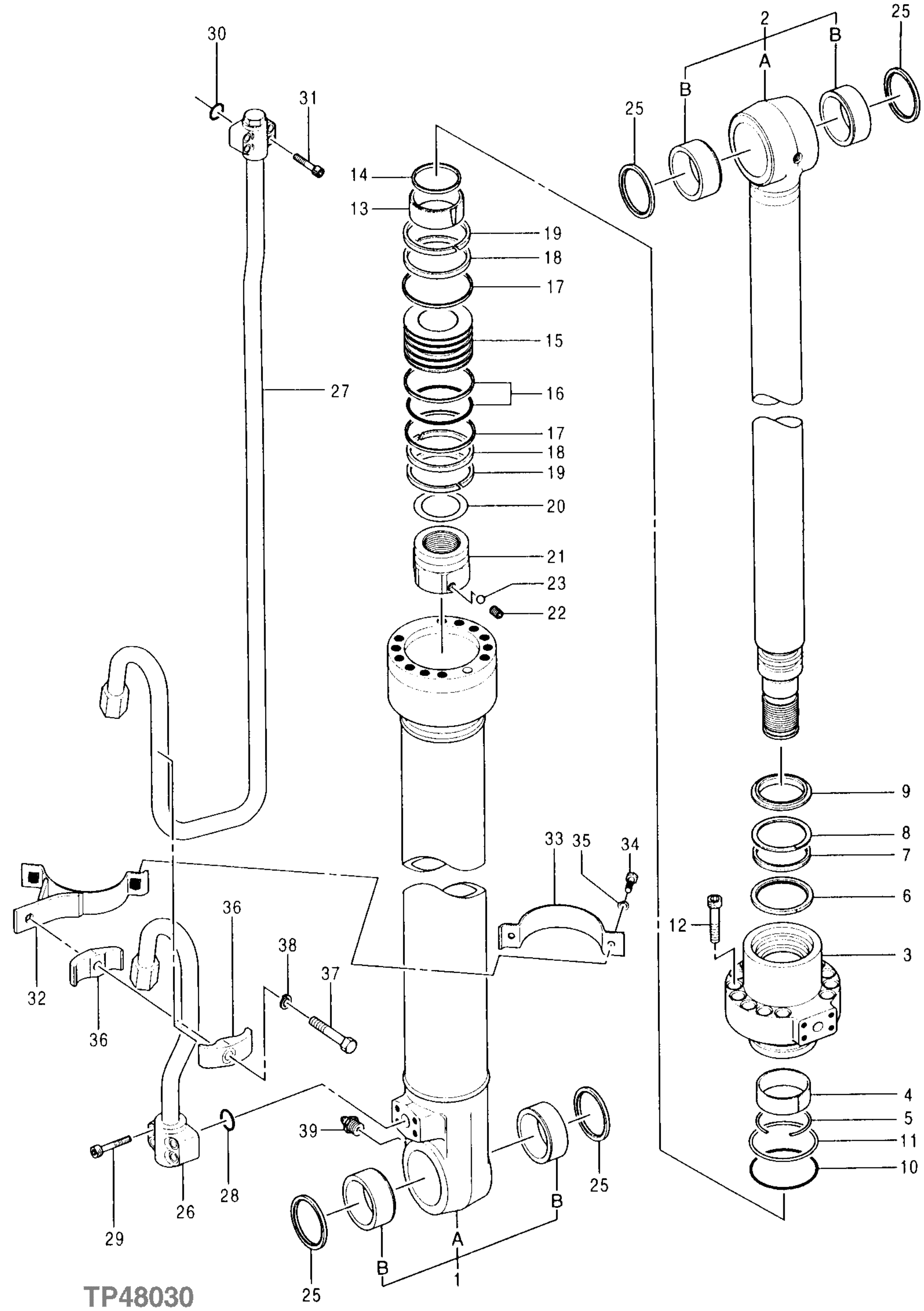
Depth .... 0.1 mm (0.004 in.) (enough to detect by a fingernail)

Bucket Rod—Specification

OD .... 85 ± 0.03 mm (3.346 ± 0.001 in.)

TX,33,UU3813 –19–22SEP98–11/11

ASSEMBLE BOOM, ARM OR BUCKET CYLINDER



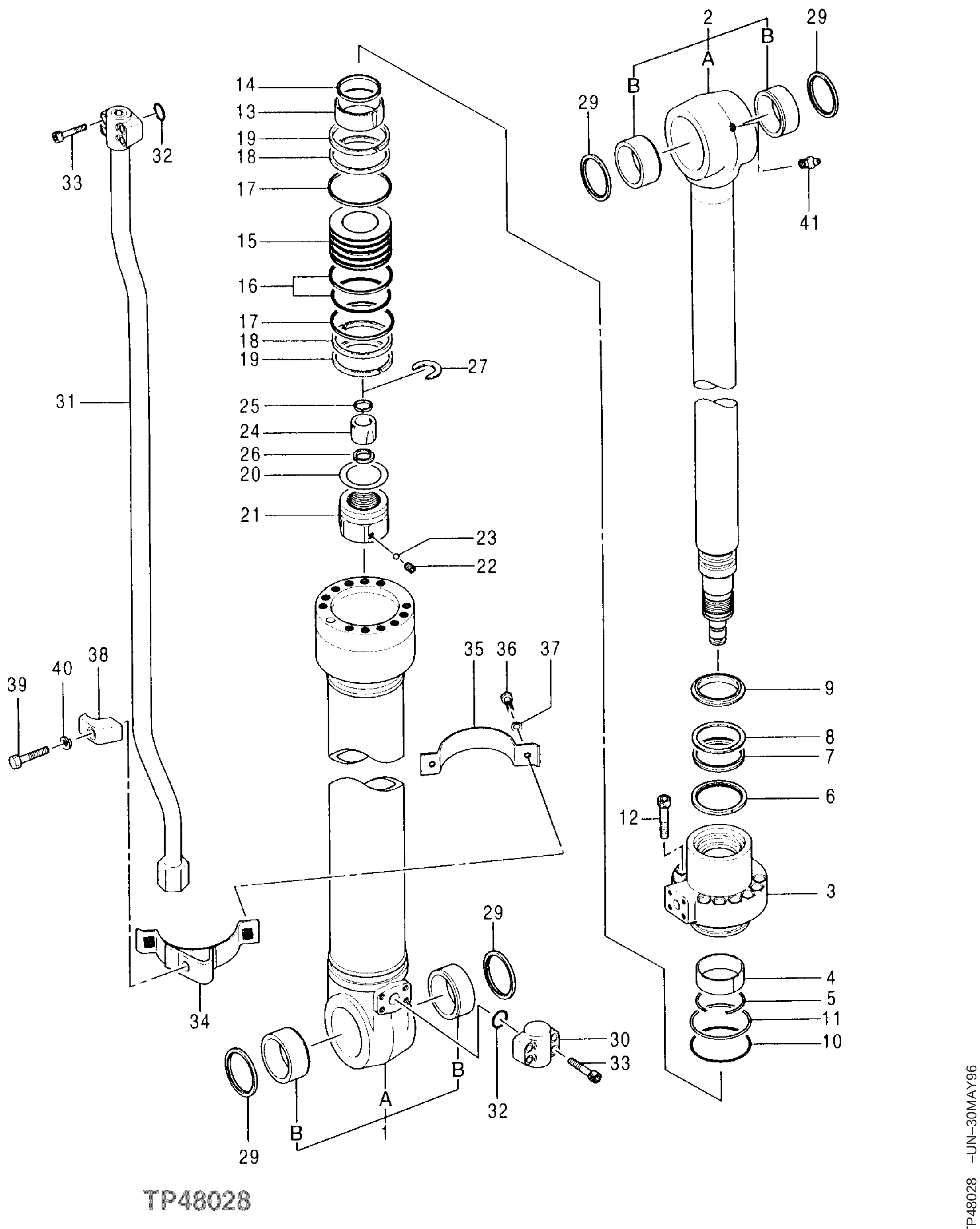
TP48030 –UN–30MAY96

Boom Cylinder

Continued on next page TX,33,UU3814 –19–07JAN97–1/17

1—Cylinder Barrel and Bushing
1A—Cylinder Barrel
1B—Bushing (2 used)
2—Rod and Bushing
2A—Rod
2B—Bushing (2 used)
3—Rod Guide
4—Wear Ring
5—Snap Ring
6—Buffer Ring Seal
7—U-Cup Seal
8—Backup Ring
9—Wiper Seal
10—O-Ring
11—Backup Ring
12—Cap Screw (12 used)
13—Cushion
14—Cushion Seal
15—Piston
16—Cap Seal and O-Ring
17—Backup Ring (2 used)
18—Buffer Seal (2 used)
19—Wear Ring
20—Shim
21—Nut
22—Set Screw
23—Steel Ball
25—Dust Seal (4 used)
26—Head End Line
27—Rod End Line
28—O-Ring
29—Cap Screw (4 used)
30—O-Ring
31—Cap Screw (4 used)
32—Clamp
33—Clamp
34—Cap Screw (2 used)
35—Lock Washer (2 used)
36—Half Clamp (2 used)
37—Cap Screw
38—Lock Washer
39—Lubrication Fitting

Continued on next page TX,33,UU3814 –19–07JAN97–2/17



Arm Cylinder

Continued on next page TX,33,UU3814 –19–07JAN97–3/17

1—Cylinder Barrel and Bushing
1A—Cylinder Barrel
1B—Bushing (2 used)
2—Rod and Bushing
2A—Rod
2B—Bushing (2 used)
3—Rod Guide
4—Wear Ring
5—Snap Ring
6—Buffer Ring Seal
7—U-Cup Seal
8—Backup Ring
9—Wiper Seal
10—O-Ring
11—Backup Ring
12—Cap Screw (12 used)
13—Cushion
14—Cushion Seal
15—Piston
16—Cap Seal and O-Ring
17—Backup Ring (2 used)
18—Buffer Seal (2 used)
19—Wear Ring
20—Shim
21—Nut
22—Set Screw
23—Steel Ball
24—Cushion
25—Cushion Seal
26—Retainer Ring
27—Ring
29—Dust Seal (4 used)
30—Head End Adapter
31—Rod End Line
32—O-Ring (2 used)
33—Cap Screw (8 used)
34—Clamp
35—Clamp
36—Cap Screw (2 used)
37—Lock Washer (2 used)
38—Clamp
39—Cap Screw
40—Lock Washer
41—Lubrication Fitting

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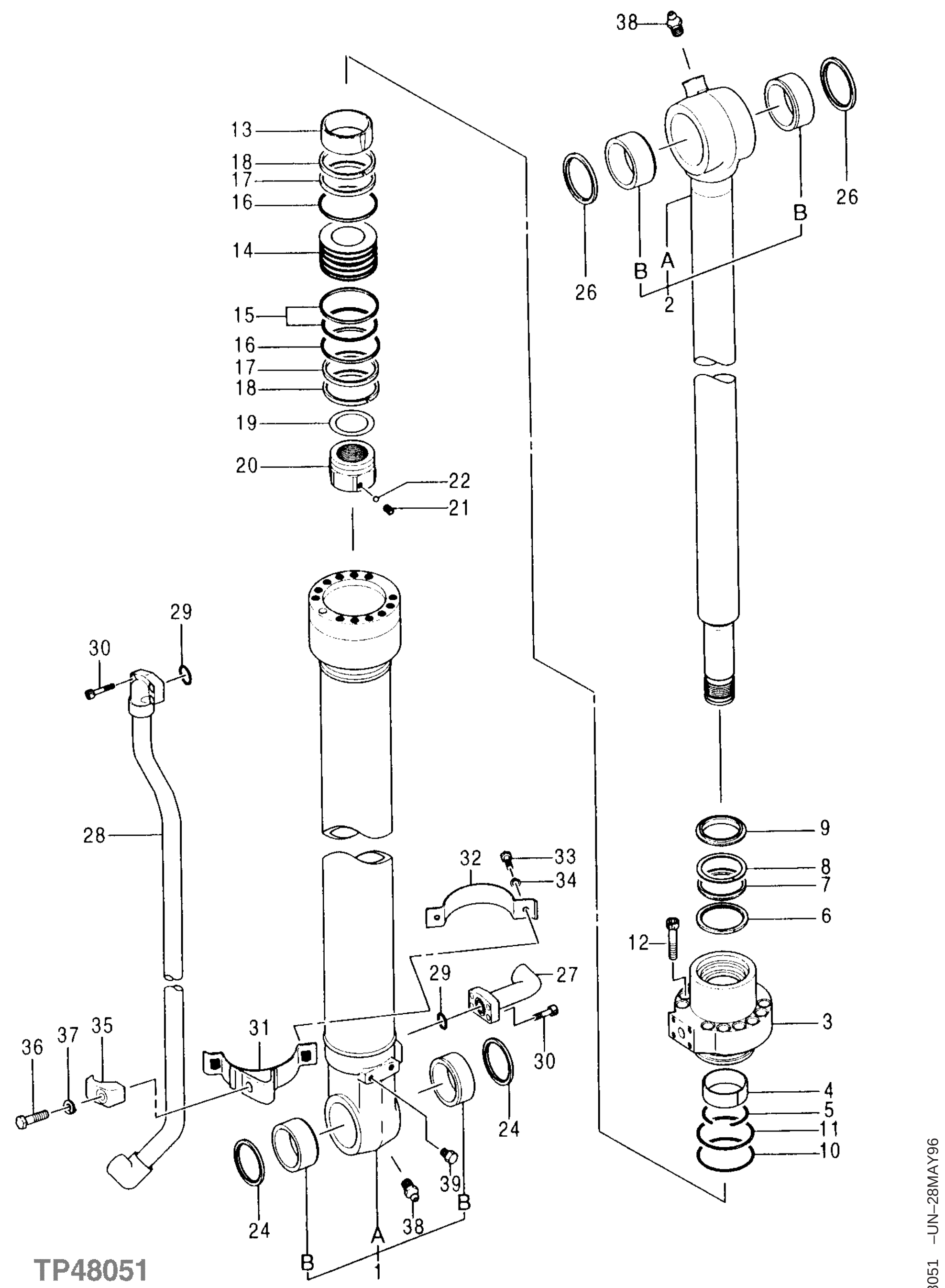
TX,33,UU3814 –19–07JAN97–4/17



Bucket Cylinder

Continued on next page TX,33,UU3814 –19–07JAN97–5/17

1—Cylinder Barrel and Bushing
1A—Cylinder Barrel
1B—Bushing (2 used)
2—Rod and Bushing
2A—Rod
2B—Bushing (2 used)
3—Rod Guide
4—Wear Ring
5—Snap Ring
6—Buffer Ring Seal
7—U-Cup Seal
8—Backup Ring
9—Wiper Seal
10—O-Ring
11—Backup Ring
12—Cap Screw (12 used)
13—Cushion
14—Piston
15—Cap Seal and O-Ring
16—Backup Ring (2 used)
17—Buffer Seal (2 used)
18—Wear Ring
19—Shim
20—Nut
21—Set Screw
22—Steel Ball
24—Dust Seal (2 used)
26—Dust Seal (2 used)
27—Elbow Fitting
28—Rod End Line
29—O-Ring (2 used)
30—Cap Screw (8 used)
31—Clamp
32—Clamp
33—Cap Screw (2 used)
34—Lock Washer (2 used)
35—Clamp
36—Cap Screw
37—Lock Washer
38—Lubrication Fitting

NOTE: Use a cylinder repair kit when assembling a rebuildable cylinder.

The left and right boom cylinders are the same except for the head (26) and rod (27) end lines, and clamps (32 and 33).

1. Install bushing (1B and 2B) to a depth equal to the thickness of dust seals.

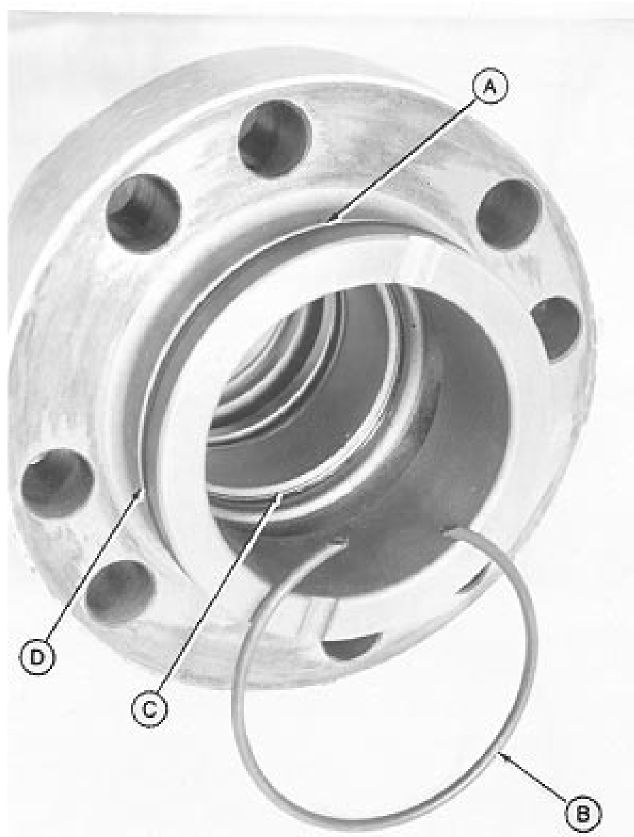
2. Install dust seals tight against bushing with seal lip outward. (See Remove and Install Bushings and Seals in Group 3340.)

Continued on next page TX,33,UU3814 –19–07JAN97–6/17

3. Push wear ring (C) to bottom of bore using a driver disk and a press.

4. Install the snap ring (B).

5. Install backup ring (A) and O-ring (D).



T6585XN –UN–27OCT88

A—Backup Ring
B—Snap Ring
C—Wear Ring
D—O-Ring

Continued on next page

TX,33,UU3814 –19–07JAN97–7/17

6. Install buffer ring seal (I) with notched side towards wear ring (B)

   Install black buffer ring (D) with notched side (C) towards the wear ring.

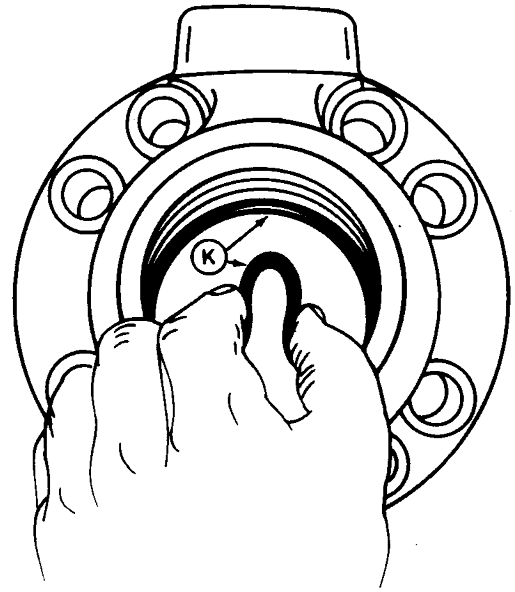
   Install green buffer ring (E).

7. Install U-cup seal (F) with lip towards wear ring (B) using the bending method (K)

   Install backup ring (G).

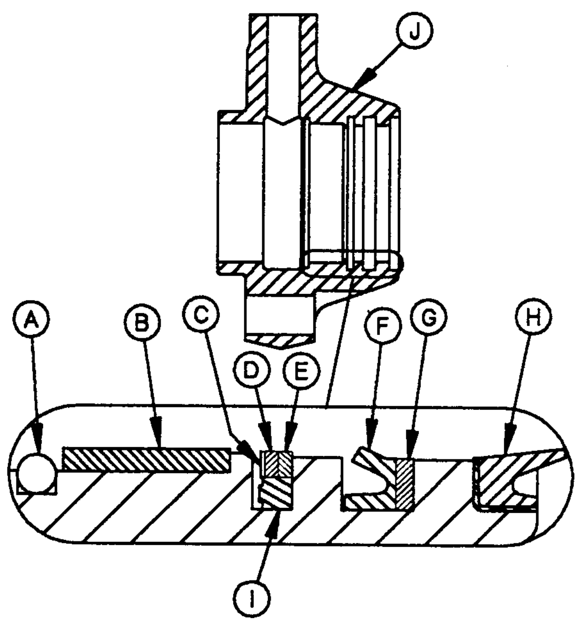
8. Install wiper seal (H) so lip is towards outside of cylinder.

9. Install rod guide (J) on the rod.



T7963AK

T7963AK –UN–01APR93



T7623AF

T7623AF –UN–22OCT91

A—Snap Ring
B—Wear Ring
C—Notched Side
D—Black Buffer Ring
E—Green Buffer Ring
F—U-Cup Seal
G—Backup Ring
H—Wiper Seal
I—Buffer Ring Seal
J—Rod Guide
K—Bending Method Seal Installation

Continued on next page

TX,33,UU3814 –19–07JAN97–8/17

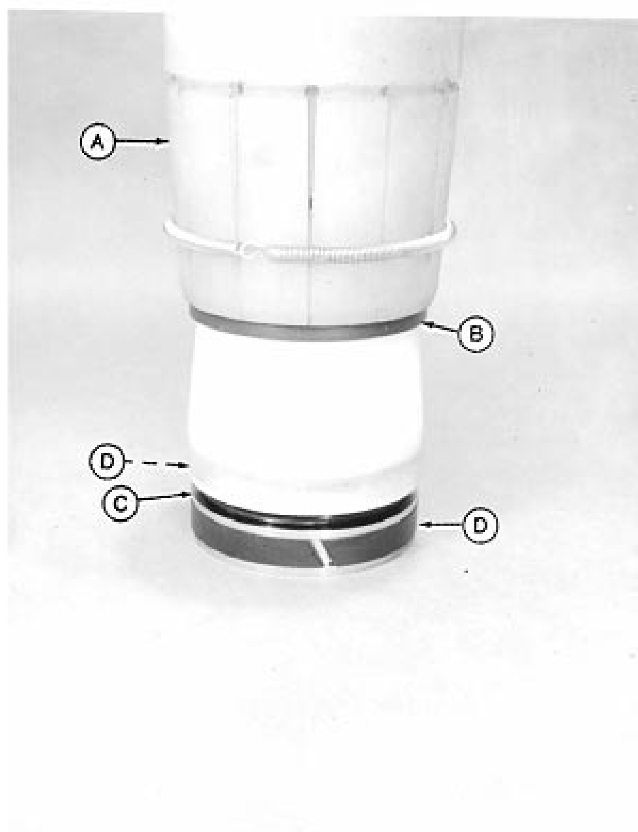
33
3360
173

10. Install O-ring (C) into the middle groove of piston.

11. Install the buffer seals (D). The buffer seal in groove above helps support the thin section of installer. The buffer seal below keeps the cap seal from going into that groove if pushed too far.

12. Install the correct installer on the boom, arm or bucket piston. Apply clean oil to installer.

13. Push the cap seal (B) down the installer and into the middle groove over the O-ring (C) using the correct size pusher (A).



T7964AQ –UN–18MAR93

A—JDG8406 Pusher
—JDG9013 Pusher
—JDG841 Installer For Bucket
—JDG917 Installer For Boom
—JDG918 Installer For Arm
B—Cap Seal
C—O-Ring
D—Wear Ring

Continued on next page TX,33,UU3814 –19–07JAN97–9/17

14. Check the cap seal, seal must fit tight against O-ring and not turn. If seal can be turned, it has been stretched too much and can be damaged during assembly into cylinder barrel.

15. For a cap seal that has been stretched too much, shrink it to its original size using a ring compressor or a plastic tie band and hose clamp.

    When using a ring compressor, put a piece of shim stock between cap seal and compressor at the joint so it does not damage seal.

    When using a plastic tie band and hose clamp, grind a taper on one end of tie band. Install tie band with the taper against cap seal. Before tightening the hose clamp, check to be sure tie band is under hose clamp all around piston.

T6396AC –UN–27OCT88

TX,33,UU3814 –19–07JAN97–10/17

16. Install a backup ring (C) on each side of cap seal.

17. Install the buffer seals (B) and wear rings (A).

    Turn the seals and rings so the slits are 180° from each other

T6557HV –UN–27OCT88

A—Wear Ring
B—Buffer Seal
C—Backup Ring

Continued on next page

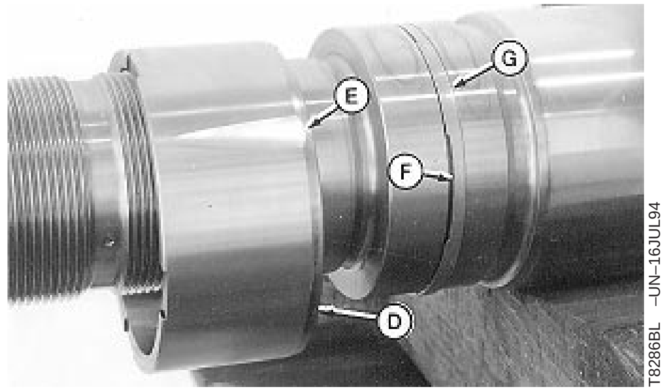
TX,33,UU3814 –19–07JAN97–11/17

NOTE: For bucket cylinder, no cushion seal is used under the cushion.

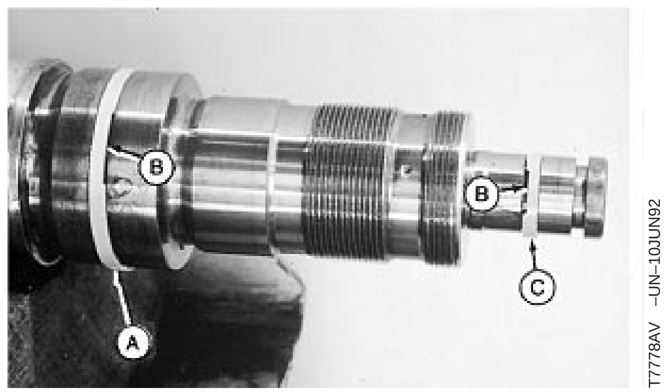
18. For boom cylinder, install cushion seal (G) so notches (F) are towards the piston and threaded section of rod.

    For arm cylinder, install cushion seals (A and C) so notches (B) are towards the piston and threaded section of rod.

19. Install cushion (D) so wide end of flat face (E) is towards the rod guide and narrow end is towards the piston.



Boom Cylinder Rod



Arm Cylinder Rod

A—Cushion Seal
B—Notch
C—Cushion Seal
D—Cushion
E—Flat Face
F—Notch
G—Cushion Seal

Continued on next page

TX,33,UU3814 –19–07JAN97–12/17

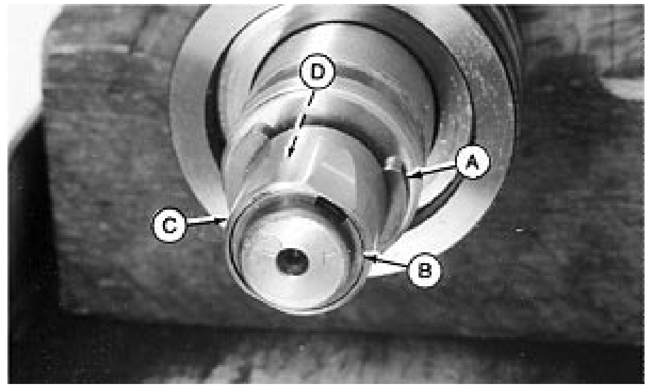
33
3360
176

20. For arm cylinder, install cushion (C) so wide end of flat face is towards the end of rod and narrow end is towards the piston.

    Install retainer ring in groove.

    Pull cushion out against retainer ring.

    Install ring (A).



Arm Cylinder Rod Cushion

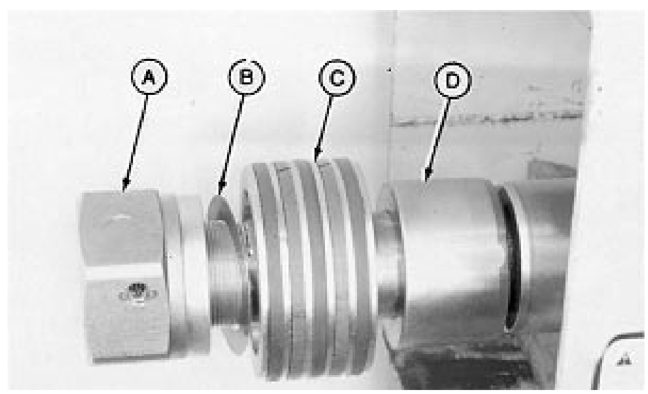
A—Ring
B—Retainer Ring
C—Cushion
D—Cushion Seal

TX,33,UU3814 –19–07JAN97–13/17

21. Install piston (C) so flat side is against the cushion (D) nut (A).

22. Install shim (B).

23. Install nut (A).



A—Nut
B—Shim
C—Piston
D—Cushion

Continued on next page

TX,33,UU3814 –19–07JAN97–14/17

IMPORTANT: To avoid damaging the tapped hole for set screw, the cap screw in the JT30043-30 Hex Piston Nut Wrench must be tightened against a side of the nut without the tapped hole.

To avoid gouging side of nut, install a piece of steel flat stock between nut and cap screw.

24. Tighten nut using the JT30043-30 Hex Piston Nut Wrench. Install wrench so cap screw is tighten against a side of nut (B) without the tapped hole.

    Install a 38 x 51 x 6.4 mm (1.5 x 2.0 x 0.25 in.) piece of steel flat stock between nut and cap screw. Tighten cap screw.

Boom Cylinder Piston-to-Rod Nut—Specification

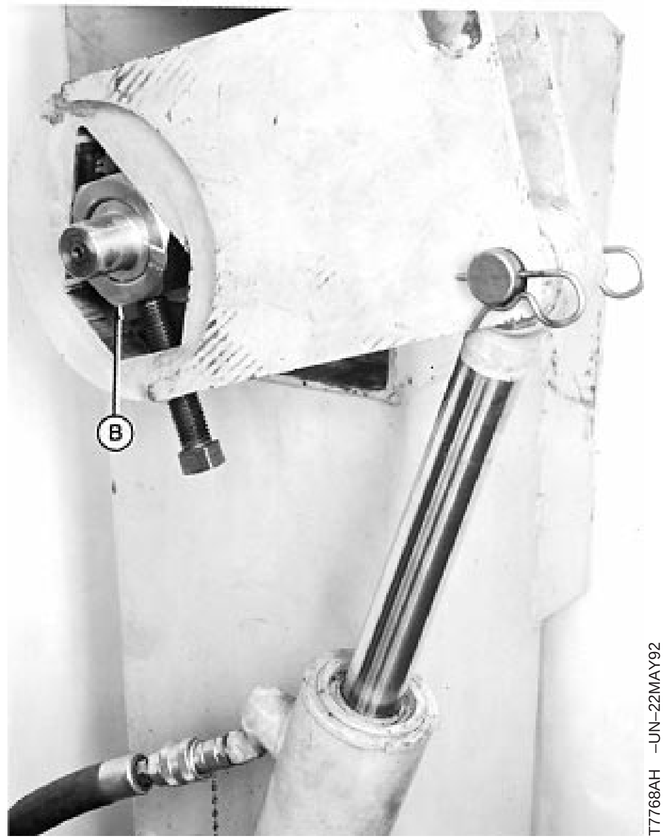
Torque .... 4780 N•m (3525 lb-ft)

Arm Cylinder Piston-to-Rod Nut—Specification

Torque .... 9460 N•m (6980 lb-ft)

Bucket Cylinder Piston-to-Rod Nut—Specification

Torque .... 5640 N•m (4160 lb-ft)



B—Nut

Continued on next page TX,33,UU3814 –19–07JAN97–15/17

33
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178

25. Install steel ball (B).

    If indentation for steel ball in rod is not aligned with tapped hole, make a new indentation using a drill and a 10 mm bit or by striking the steel ball using a hammer and punch.

26. Tighten set screw (A).

Boom Cylinder Nut-to-Rod Set Screw—Specification

Torque .... 57 N•m (42 lb-ft)

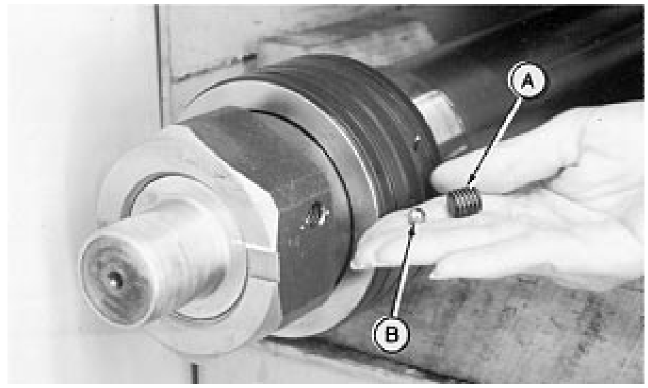
Arm Cylinder Nut-to-Rod Set Screw—Specification

Torque .... 57 N•m (42 lb-ft)

Bucket Cylinder Nut-to-Rod Set Screw—Specification

Torque .... 57 N•m (42 lb-ft)

27. Stake set screw in two places 90° from previous stake marks.



T6585XI –UN–27OCT88

A—Set Screw
B—Steel Ball

TX,33,UU3814 –19–07JAN97–16/17

28. Apply clean oil to piston and seals. Attach a hoist to rod using a lifting strap. Carefully install piston, rod and rod guide into barrel.

29. Tighten cap screws (A).

Boom Cylinder Rod Guide-to-Barrel Cap Screw—Specification

Torque .... 265 N•m (195 lb-ft)

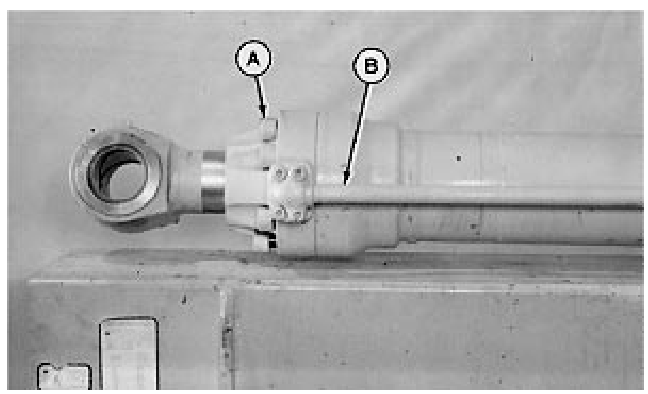
Arm Cylinder Rod Guide-to-Barrel Cap Screw—Specification

Torque .... 365 N•m (270 lb-ft)

Bucket Cylinder Rod Guide-to-Barrel Cap Screw—Specification

Torque .... 170 N•m (125 lb-ft)

30. Install the lines (B).



T6557HI –UN–27OCT88

A—Cap Screw
B—Lines

TX,33,UU3814 –19–07JAN97–17/17

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179

REMOVE AND INSTALL HYDRAULIC THUMB CYLINDER

1. Park machine on a firm, level surface.

2. Remove bucket from quick-disconnect hitch.

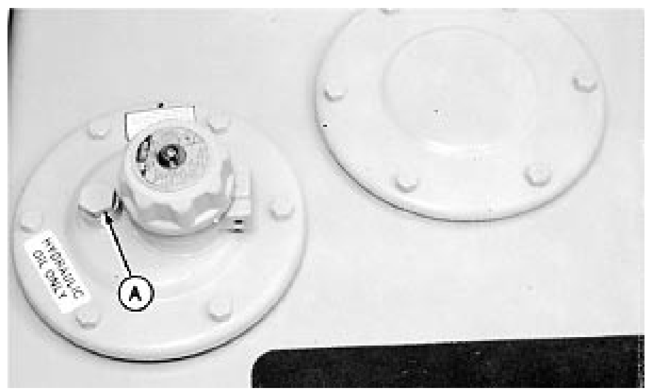
3. Extend hydraulic thumb. Retract arm and lower to ground. Support hydraulic thumb on stand.

4. Stop engine.

CED,OUOE042,81 –19–09APR99–1/3

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

5. Loosen vent plug (A) to release hydraulic pressure in reservoir.



T7869AT –UN–12NOV92

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CED,OUOE042,81 –19–09APR99–2/3

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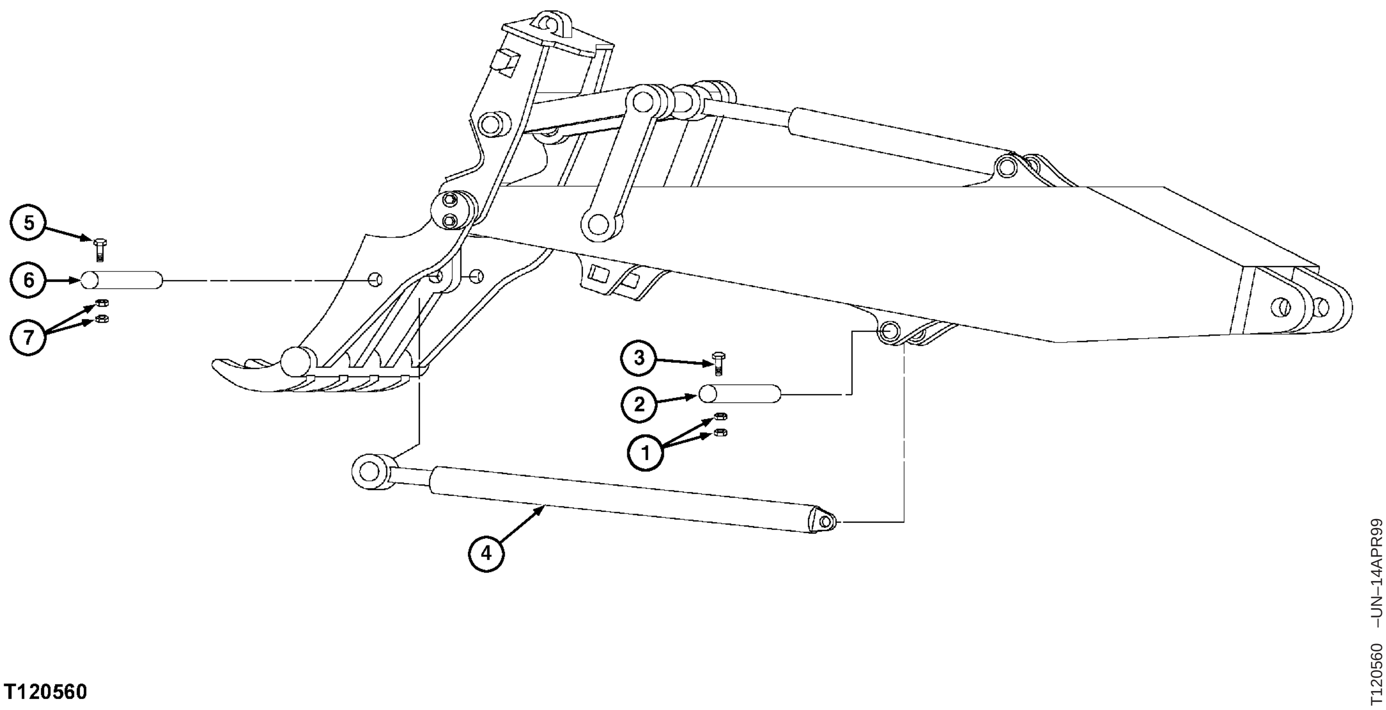
180



T120560

6. Disconnect hydraulic lines from hydraulic thumb cylinder.

7. Remove nuts (7) and pin (5).

8. Support cylinder (4).

9. Remove nuts (1) and cap screw (3).

10. Remove pins (2 and 6).

CAUTION: The approximate weight of the hydraulic cylinder is 306 kg (293 lb).

11. Remove cylinder (4).

12. Repair or replace cylinder.

13. Raise cylinder (4) into place on arm.

14. Install pins (2 and 6).

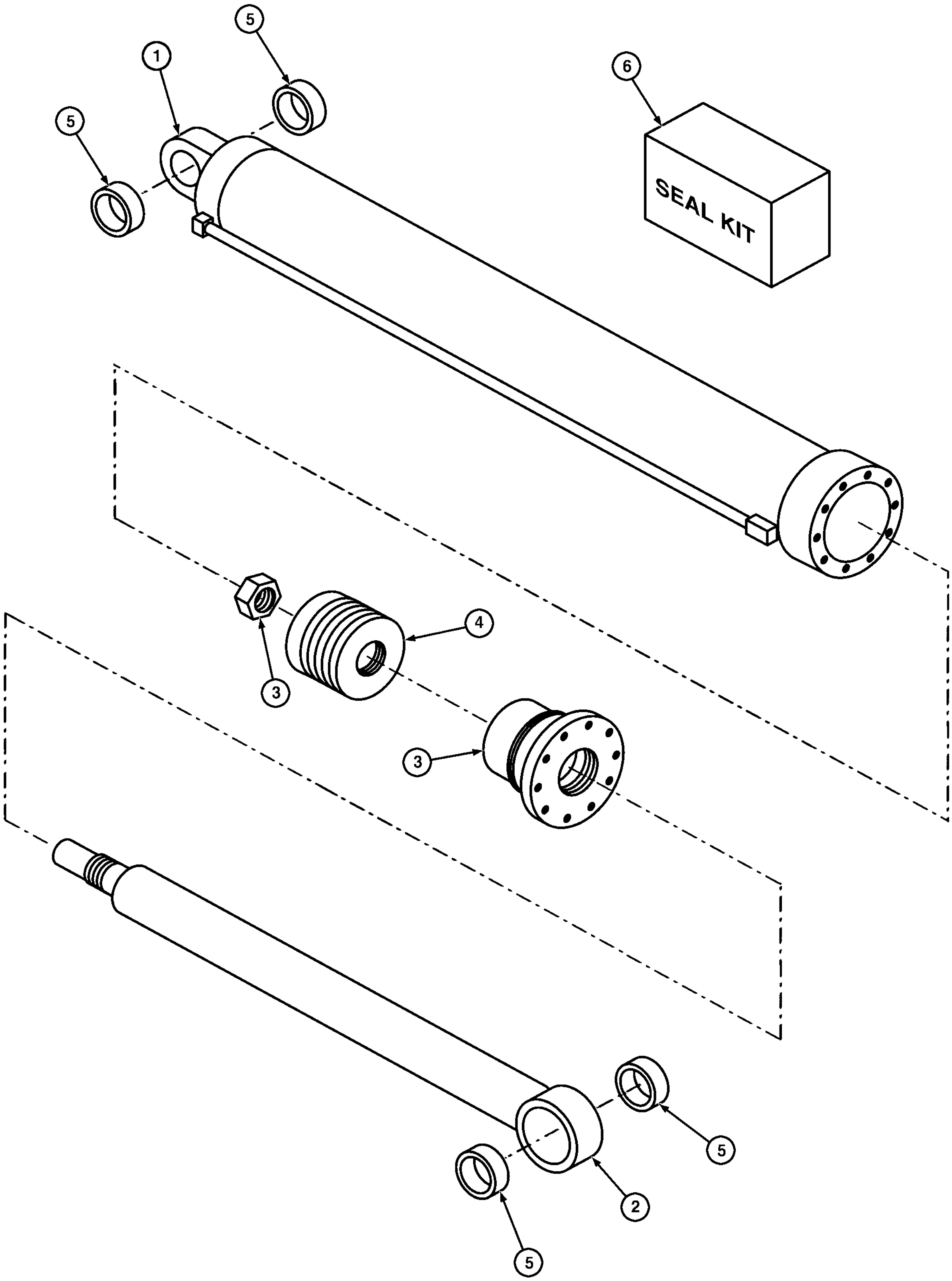
15. Install cap screws (3), nuts (1), cap screws (5) and nuts (7).

16. Connect hydraulic lines to cylinder.

17. Bleed air from cylinder. (See procedure in this group.)

18. Check oil level in hydraulic oil tank. Add oil as necessary. (See Hydraulic Oil in Group 0004.)

DISASSEMBLE AND ASSEMBLE HYDRAULIC THUMB CYLINDER



T120523

T120523 –UN–25MAR99

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AG,OUOE042,44 –19–16MAR99–1/2

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3360
182

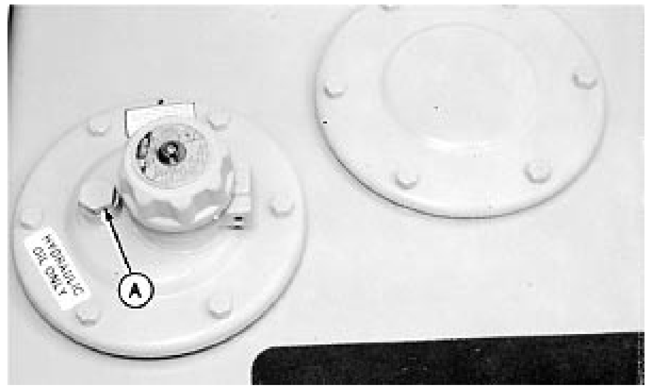
1—Barrel Assembly
2—Rod Assembly
3—Rod Bearing Assembly
4—Piston Assembly
5—Bushing
6—Seal Kit

AG,OUOE042,44 –19–16MAR99–2/2

REMOVE AND INSTALL HYDRAULIC HOSE REEL

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

1. Loosen vent plug (A) to release hydraulic pressure in reservoir.



T7869AT –UN–12NOV92

A—Vent Plug

Continued on next page

CED,OUOE042,79 –19–09APR99–1/2

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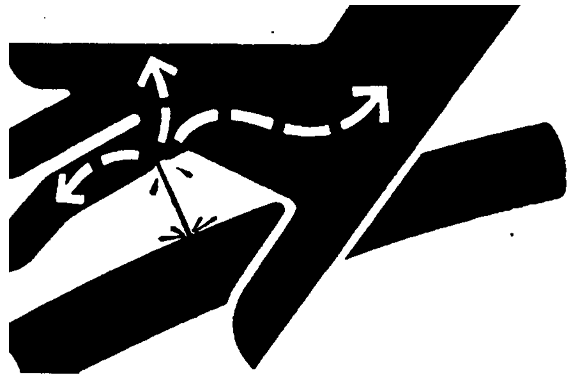
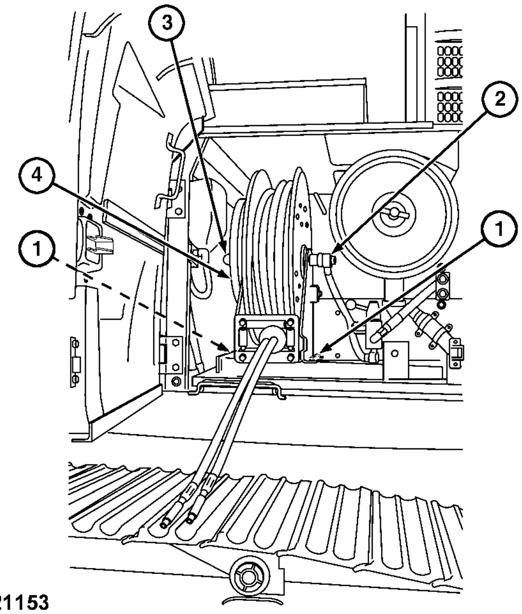
3360
183

CAUTION: To avoid injury from escaping fluid under pressure, stop engine, and relieve the pressure in the system before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.



X9811 –UN–23AUG88

2. Disconnect hydraulic line (2) from hose reel fitting.
3. Remove four cap screws (1) and slide hose reel outward.
4. Disconnect hydraulic line (3) from hose reel fitting.
5. Remove hose reel (4) from machine.
6. Replace parts as necessary.
7. Install hose reel (4) partially in place and connect hydraulic line (3) to hose reel fitting and tighten.
8. Install hose reel fully in place and install four cap screws (1) and tighten.
9. Connect hydraulic line (1) to hose reel fitting and tighten.



T121153 –UN–07JUN99

CED,OUOE042,79 –19–09APR99–2/2

CHAPTER 22

SECTION 43

SWING OR PIVOTING SYSTEM REPAIR

BLANK

Group 4350
Mechanical Drive Elements

SERVICE EQUIPMENT AND TOOLS

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

SERVICEGARD is a trademark of Deere & Company.

CED,OUOE003,1213 –19–23SEP98–1/10

Lifting Bracket JT01748

To remove and install swing bearing.

CED,OUOE003,1213 –19–23SEP98–2/10

Barrel Support . . . . DFT1089[1]

Use with bridge planks, hardwood blocks, and a wide flange beam to support the upperstructure.

[1]Fabricated tool, dealer made. (See Section 99 for instructions to make tool.)

CED,OUOE003,1213 –19–23SEP98–3/10

Bridge Planks

Use with barrel supports to support upperstructure.

CED,OUOE003,1213 –19–23SEP98–4/10

Wide Flange Beam . . . 3.7 m (12 ft) Length of W8 x 28 lb

Use with barrel supports to support upperstructure.

CED,OUOE003,1213 –19–23SEP98–5/10

Chain . . . . 13 mm (1/2 in.)

To secure the boom.

Continued on next page

CED,OUOE003,1213 –19–23SEP98–6/10

Mechanical Drive Elements

Chain Binder

To remove slack from chain.

CED,OUOE003,1213 –19–23SEP98–7/10

Service Jack 18-t (20-Ton)

Placed under each end of undercarriage to support upperstructure.

CED,OUOE003,1213 –19–23SEP98–8/10

Guide Pin . . . . DFT1144[1]

To align cap screw holes in swing bearing with holes in main frame.

[1]*Fabricated tool, dealer made. (See Section 99 for instructions to make tool.)*

CED,OUOE003,1213 –19–23SEP98–9/10

M10-1.25 Cap Screw

To remove loading plug from swing bearing.

CED,OUOE003,1213 –19–23SEP98–10/10

43
4350
2

OTHER MATERIAL

Number	Name	Use
T43513 (U.S.) TY9474 (Canadian) 271 (LOCTITE®)	Thread Lock and Sealer (High Strength)	Apply to seal bore and threads of sprocket cap screws.
TY16285 (U.S.) TY9485 (Canadian) 7649 (LOCTITE®)	Cure Primer	To clean and cure surfaces prior to application of adhesives or sealants.
TY9375 (U.S.) TY9480 (Canadian) 592 (LOCTITE®)	Pipe Sealant	Apply to swing gearbox cover.
TY2098 (U.S.)	Multi-Purpose Grease	To lubricate swing bearing.
TY21517 (U.S.) NA (Canadian) 454 (LOCTITE®)	Instant Gel Adhesive	To bond upper and lower seal to swing bearing.

LOCTITE is a trademark of Loctite Corp.

CED,OUOE003,565 –19–18MAY98–1/1

43
4350
3

SPECIFICATIONS

Item	Measurement	Specification
Swing Gearbox:		
Swing Motor, Brake, and Gearbox	Weight	330 kg (730 lb) approximate
Gearbox-to-Frame Cap Screw	Torque	540 N•m (406 lb-ft)
Swing Motor and Brake	Weight	60 kg (132 lb) approximate
Output Shaft Cover-to-Gearbox Cap Screw	Torque	88 N•m (65 lb-ft)
Ring Gear-to-Housing Cap Screw	Torque	206 N•m (152 lb-ft)
Swing Motor-to-Ring Gear Cap Screw	Torque	88 N•m (65 lb-ft)
Upperstructure:		
Machine Without Tracks	Weight	20 329 kg (44,818 lb)
Floor-to-Bottom of Main Frame Clearance	Height Height	1.4 m (55 in.) minimum 1.45 m (57 in.) maximum
Undercarriage Without Tracks	Weight	4717 kg (10,400 lb) approximate
Swing Bearing-to-Upperstructure Cap Screw	Torque	640 N•m (470 lb-ft)
Swing Bearing:		
Swing Bearing	Weight	331 kg (730 lb) approximate
Undercarriage-to-Swing Bearing Cap Screw	Torque	740 N•m (540 lb-ft)

CED,OUOE003,1214 –19–23SEP98–1/1

43
4350
4

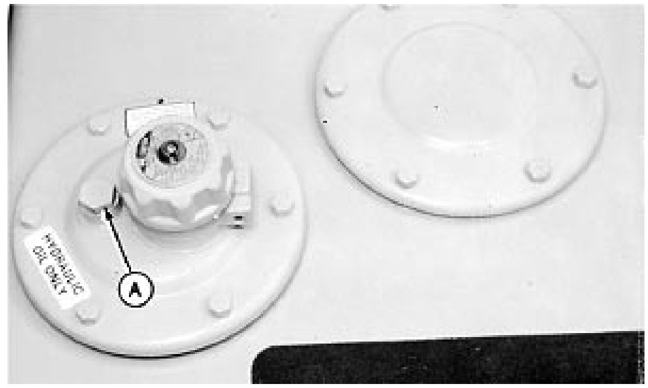
REMOVE AND INSTALL SWING GEARBOX

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

NOTE: Swing motor may be removed separately.

1. Loosen vent plug (A) to release air pressure form hydraulic oil tank.

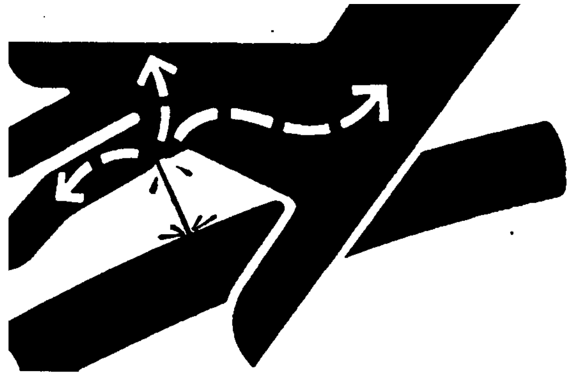
2. Pull a vacuum in hydraulic oil tank using a vacuum pump or drain hydraulic oil tank. Approximate capacity is 148 L (39 gal).



A—Vent Plug

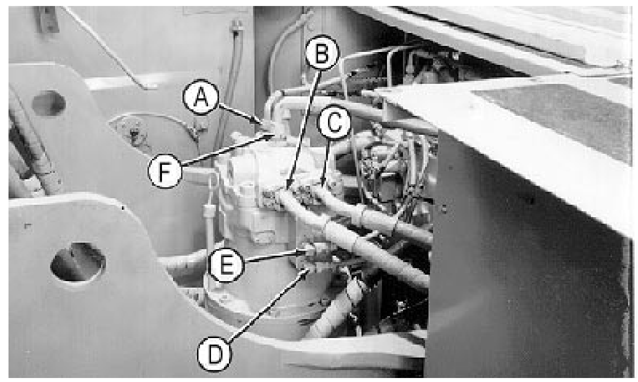
Continued on next page TX,43,UU3741 –19–23SEP98–1/3

CAUTION: To avoid injury from escaping fluid under pressure, stop engine, and relieve the pressure in the system before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

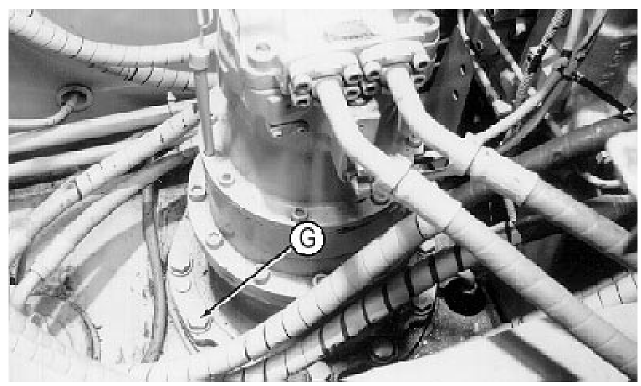


X9811 –UN–23AUG88

3. Disconnect lines (A—F).



T105899 –UN–19DEC96



T105900 –UN–19DEC96

A—Motor Drain-to-Hydraulic Oil Tank
B—To Swing Valve Section (Top)
C—To Swing Valve Section (Bottom)
D—To Control Valve (Pilot Oil)
E—To Solenoid Valve Manifold
F—To Control Valve
G—Cap Screw (12 used)

Continued on next page

TX,43,UU3741 –19–23SEP98–2/3

43
4350
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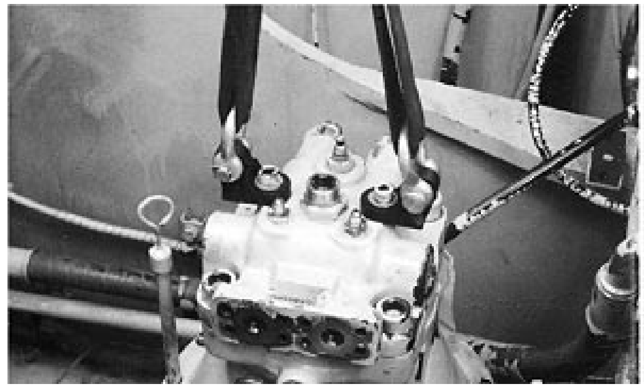

T7685NL –UN–07MAY92

CAUTION: The approximate weight of swing motor, brake, and gearbox is 330 kg (730 lb).

Swing Motor, Brake, and Gearbox—Specification

Weight... 330 kg (730 lb) approximate

4. Remove cap screws (G). Remove swing motor and gearbox using lifting brackets, such as JT01748 Lifting Brackets, and hoist.

5. Tighten cap screws (G).

Gearbox-to-Frame Cap Screw—Specification

Torque .... 540 N•m (406 lb-ft)

6. Connect lines (A—F).

7. Do swing gearbox start-up procedure.(See Swing Gearbox Start-Up Procedure in this group.) Do swing motor and brake start-up procedure. (See procedures in Group 4360.)

TX,43,UU3741 –19–23SEP98–3/3

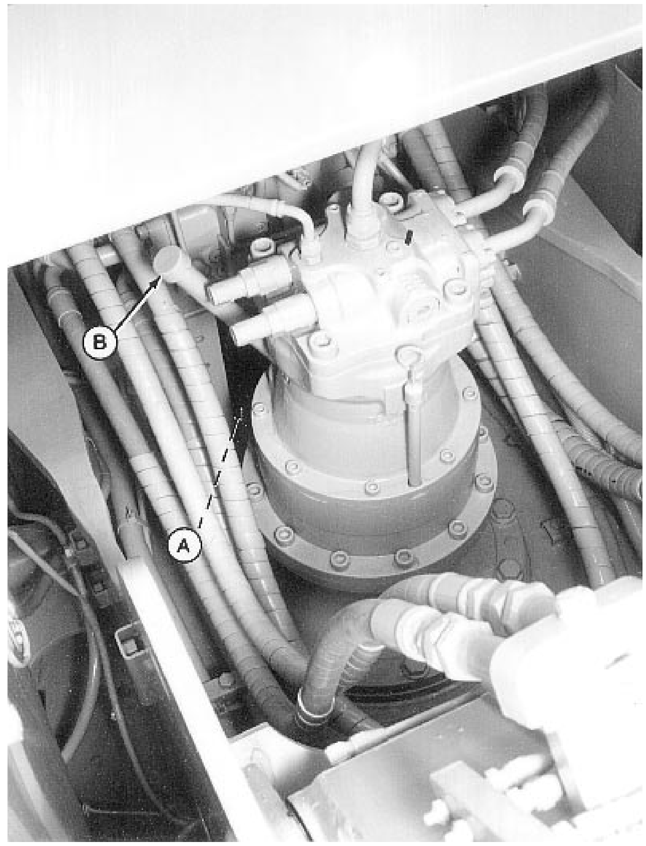
SWING GEARBOX START-UP PROCEDURE

IMPORTANT: Swing gearbox will be damaged if not filled with oil before operating swing function. Procedure must be performed whenever a new swing gearbox is installed or oil has been drained from the gearbox.

1. Check that drain line (A) plug is installed.

2. Remove fill cap (B). Add oil. (See Swing Gearbox and Propel Gearbox Oils in Group 0004.)

3. Install fill cap. Check oil level on dipstick.

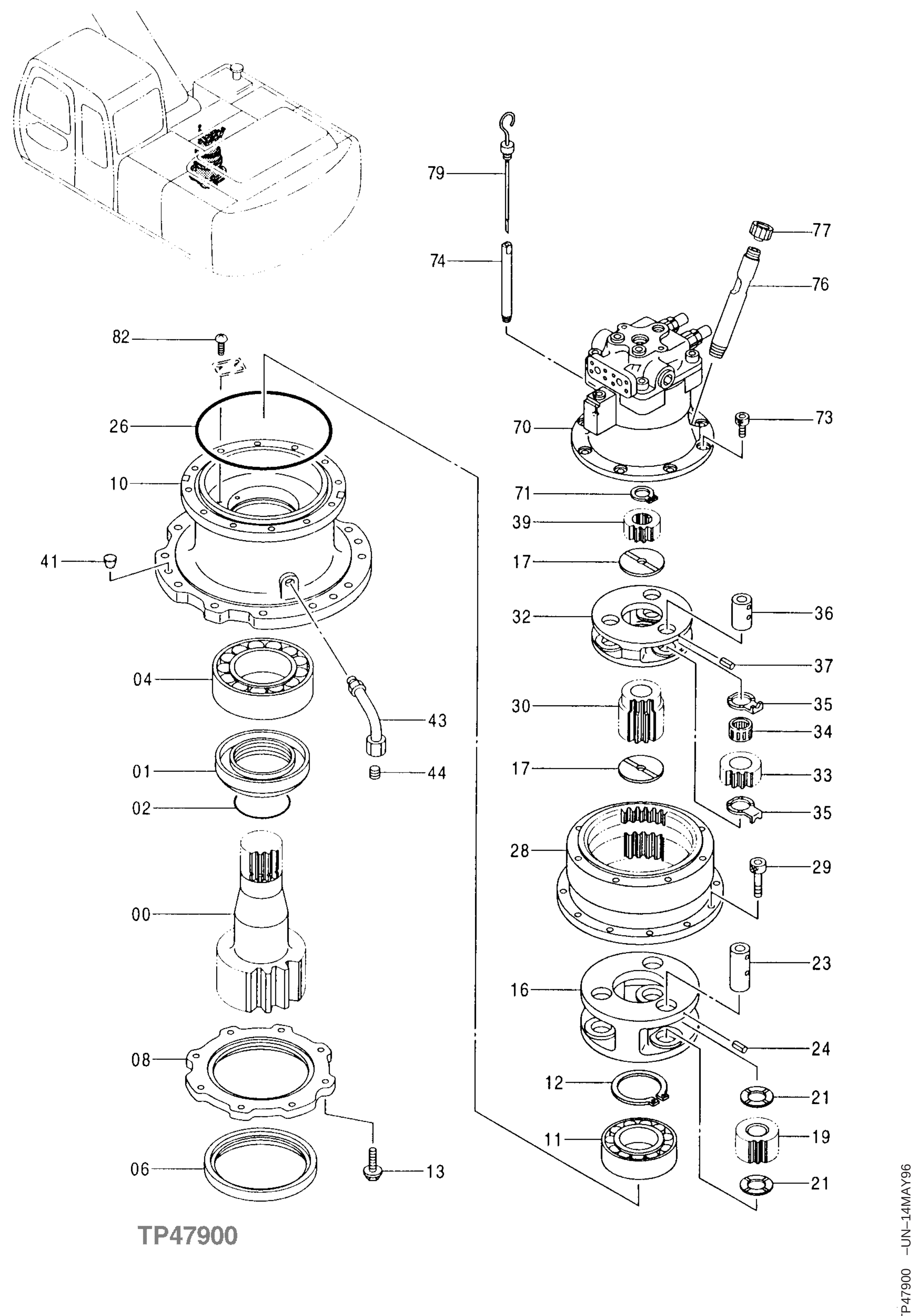


T102305 –UN–30JUL96

A—Drain Line
B—Fill Cap

TX,43,UU3742 –19–23SEP98–1/1

DISASSEMBLE AND ASSEMBLE SWING GEARBOX



Continued on next page TX,43,UU3660 –19–23SEP98–1/18

Mechanical Drive Elements

0—Shaft
1—Sleeve
2—O-Ring
4—Roller Bearing
6—Seal
8—Cover
10—Housing
11—Roller Bearing
12—Snap Ring
13—Cap Screw
16—Planet Pinion Carrier
17—Plate
19—Gear
21—Plate
23—Pin
24—Spring Pin
26—O-Ring
28—Ring Gear
29—Screw
30—Sun Gear
32—Planet Pinion Carrier
33—Gear
34—Needle Bearing
35—Plate
36—Pin
37—Spring Pin
39—Sun Gear
41—Plug
43—Oil Line
44—Fitting Plug
70—Motor
71—Snap Ring
73—Screw
74—Pipe
76—Pipe
77—Cap
79—Gauge
82—Screw

TX,43,UU3660 –19–23SEP98–2/18

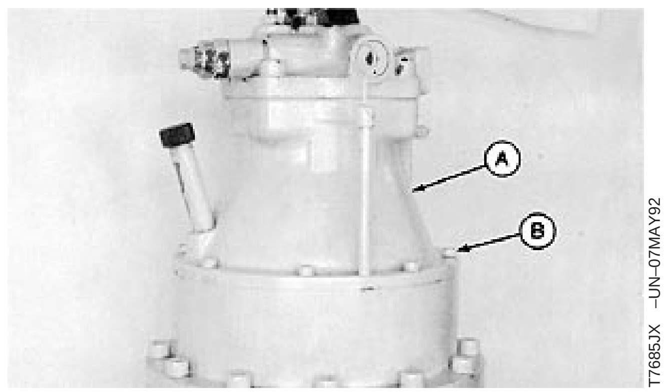
1. Drain swing gearbox oil. Approximate capacity 13.2 L (14 qt).

CAUTION: The approximate weight of swing motor and brake is 60 kg (132 lb).

Swing Motor and Brake—Specification

Weight.. 60 kg (132 lb) approximate

2. Remove cap screws (B). Remove swing motor and brake (A).



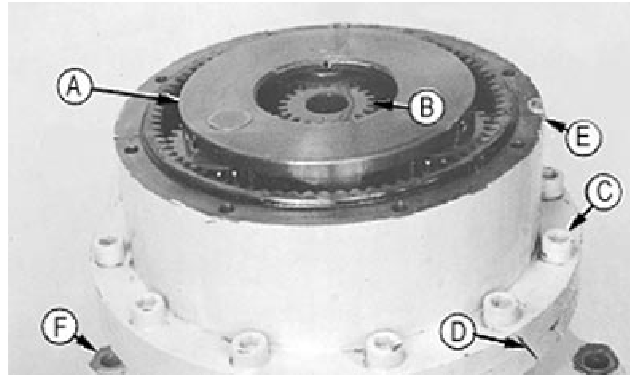
A—Swing Motor and Brake
B—Cap Screw

Continued on next page

TX,43,UU3660 –19–23SEP98–3/18

3. Make alignment mark (D) on ring gear (E) and housing (F) for assembly.

4. Remove parts (A—C). Remove ring gear.

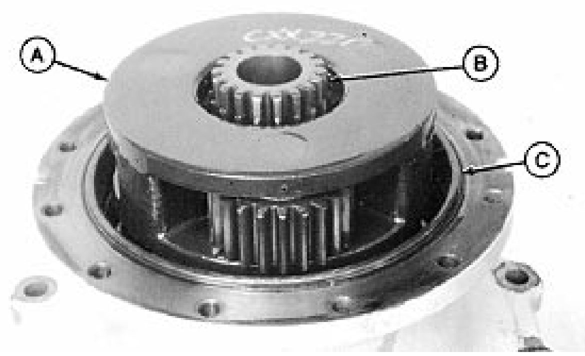


T105911 –UN–19DEC96

A—First Planet Pinion Carrier
B—First Planet Sun Gear
C—Cap Screw (12 used)
D—Alignment Mark
E—Ring Gear
F—Housing

TX,43,UU3660 –19–23SEP98–4/18

5. Remove parts (A—C).



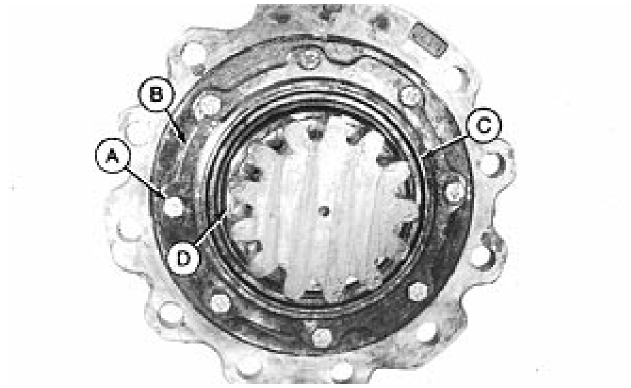
T7685JZ –UN–07MAY92

A—Second Planet Pinion Carrier
B—Second Planet Sun Gear
C—O-Ring

Continued on next page

TX,43,UU3660 –19–23SEP98–5/18

6. Remove parts (A—D).



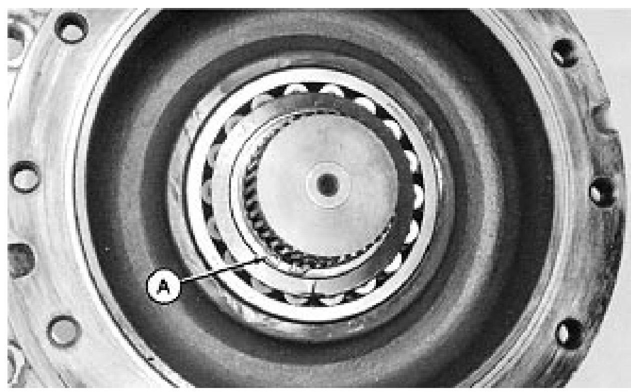
T7685DB –UN–22JUN92

A—Cap Screw (8 used)
B—Cover and O-Ring
C—Seal
D—Sleeve and O-Ring

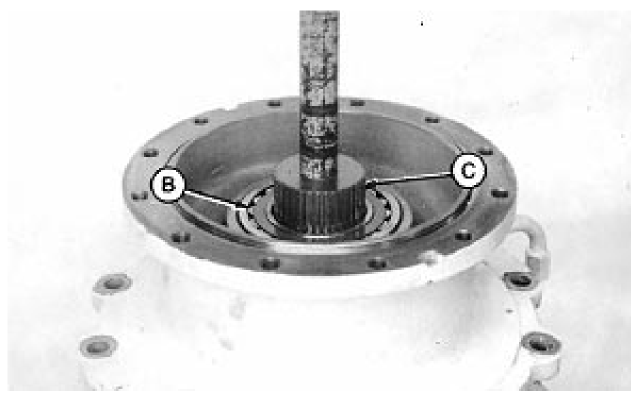
TX,43,UU3660 –19–23SEP98–6/18

7. Remove snap ring (A)

8. Remove output shaft (C) using a press. Remove roller bearing (B).



T7685KB –UN–07MAY92



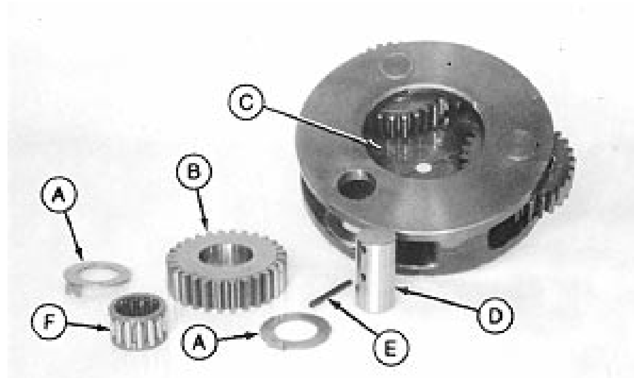
T7685KC –UN–07MAY92

A—Snap Ring
B—Roller Bearing
C—Output Shaft

Continued on next page TX,43,UU3660 –19–23SEP98–7/18

9. Remove spring pin (E).

10. Remove parts (A—D, and F).



T7685KD –UN–07MAY92

A—Plate (6 used)
B—First Planet Gear (3 used)
C—Plate
D—Pin (3 used)
E—Spring Pin (3 used)
F—Needle Bearing (3 used)

TX,43,UU3660 –19–23SEP98–8/18

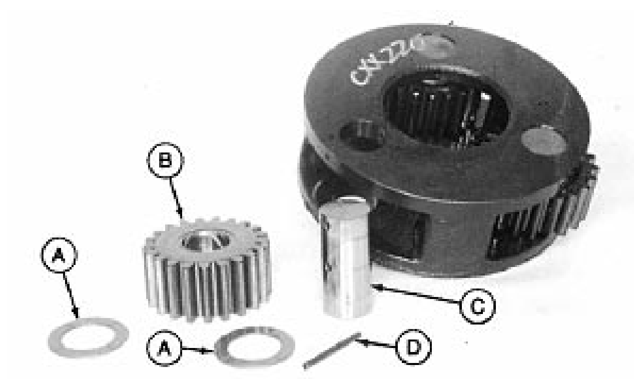
11. Remove spring pin (D).

12. Remove parts (A—C)

13. Replace parts as necessary.

14. Install plate (A), groove side up.

15. Install parts (B and C).



T7685KF –UN–07MAY92

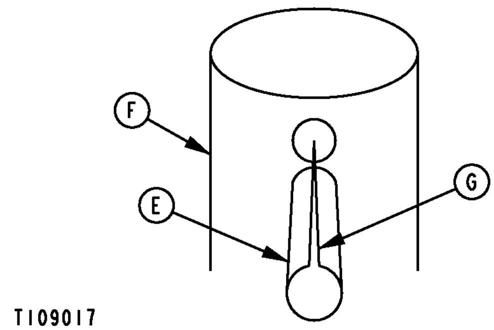
A—Plate (6 used)
B—Second Planet Gear (3 used)
C—Pin (3 used)
D—Spring Pin (3 used)
E—Plate

43
4350
14

Continued on next page

TX,43,UU3660 –19–23SEP98–9/18

16. Install spring pin (E) with slit (G) towards end of pin (F).

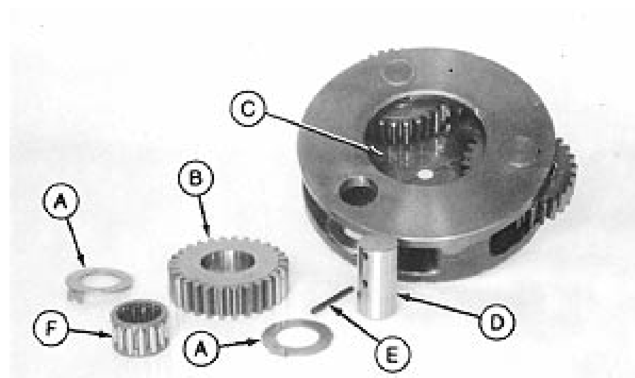


T109017 –UN–17APR97

E—Spring Pin
F—Pin
G—Slit

TX,43,UU3660 –19–23SEP98–10/18

17. Install parts (A—D and F).



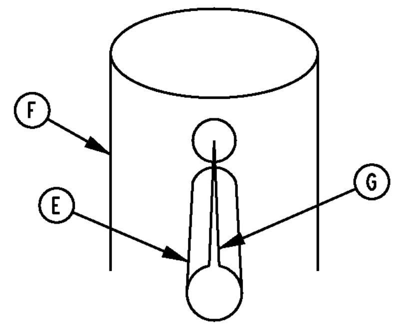
T7685KD –UN–07MAY92

A—Plate (6 used)
B—First Planet Gear (3 used)
C—Plate
D—Pin (3 used)
E—Spring Pin (3 used)
F—Needle Bearing (3 used)

Continued on next page

TX,43,UU3660 –19–23SEP98–11/18

18. Install spring pin (E) with slit (G) towards end of pin (F).



T109017 –UN–17APR97

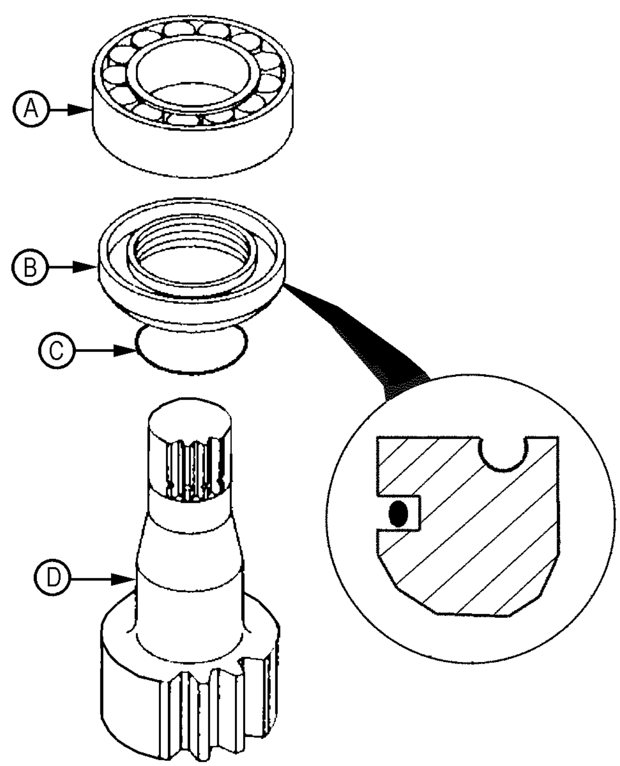
E—Spring Pin
F—Pin
G—Slit

TX,43,UU3660 –19–23SEP98–12/18

19. Install wear sleeve (B) flush against gear on shaft (D) as shown.

20. Install O-ring (C) on sleeve.

21. Install bearing (A) on shaft (D).



T105952

T105952 –UN–20DEC96

A—Bearing
B—Wear Sleeve
C—O-Ring
D—Shaft

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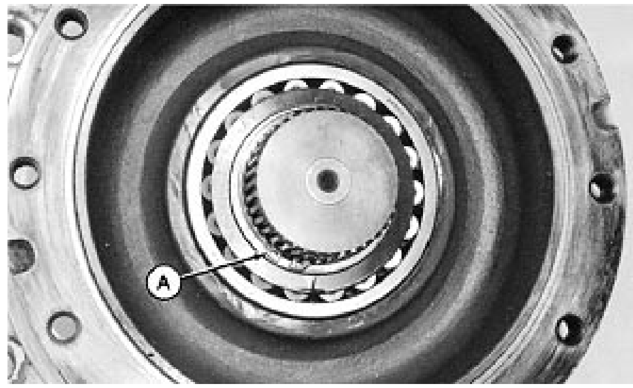
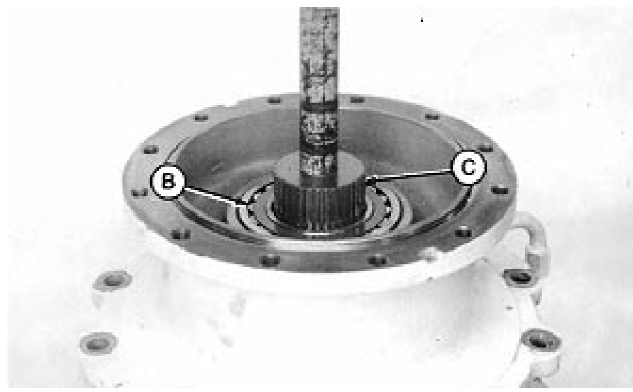
TX,43,UU3660 –19–23SEP98–13/18

22. Install roller bearing (B) and shaft (C).

23. Install snap ring (A).





A—Snap Ring
B—Roller Bearing
C—Shaft

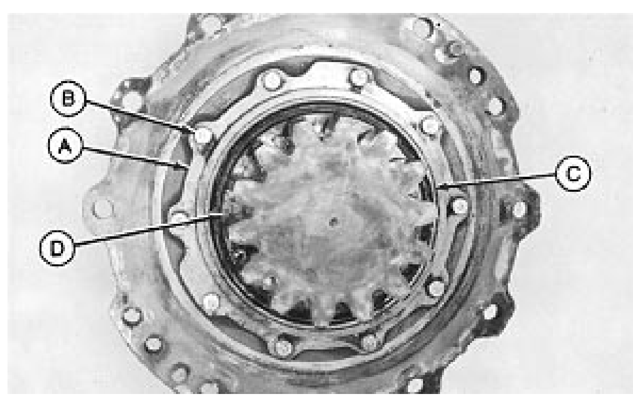
TX,43,UU3660 –19–23SEP98–14/18

24. Place swing gearbox in a vertical position with output shaft facing up. Apply thread lock and sealer to the seal bore. Install seal (C) into cover (A).

25. Clean surface of cover (A) using cure primer. Apply pipe sealant to cover. Apply grease to lips of seal (C). Install cover (A) by turning cover back and forth while pushing down. Make sure seal lips are not rolled over by using a blunt flat tip screwdriver to lift lips. Make sure screwdriver tip has no burrs or sharp edges. Tighten cap screws (B).

Output Shaft Cover-to-Gearbox Cap Screw—Specification

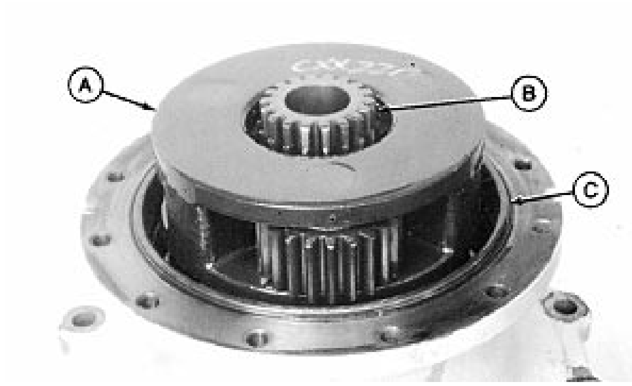
Torque .... 88 N•m (65 lb-ft)



A—Cover
B—Cap Screw (8 used)
C—Seal
D—Shaft

Continued on next page TX,43,UU3660 –19–23SEP98–15/18

26. Turn gearbox onto output shaft. Install parts (A—C).



A—Second Planet Pinion Gear
B—Second Sun Gear
C—O-Ring

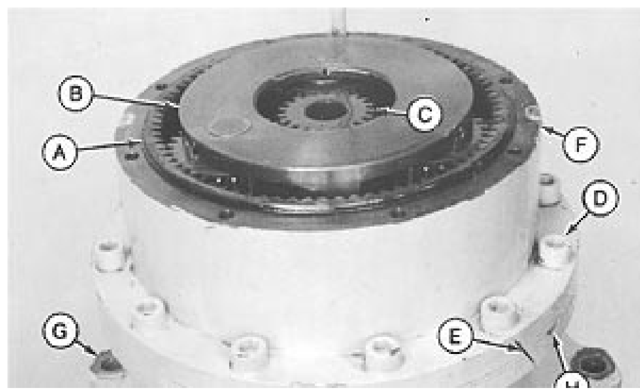
TX,43,UU3660 –19–23SEP98–16/18

27. Install ring gear (F) aligning marks on housing (G). Tighten cap screws (D).

Ring Gear-to-Housing Cap Screw—Specification

Torque .... 206 N•m (152 lb-ft)

28. Install parts (A—C). Install first sun gear (C), stepped side down.



A—O-Ring
B—First Planet Pinion Gear
C—First Sun Gear
D—Cap Screw (12 used)
E—Alignment Mark
F—Ring Gear
G—Housing

Continued on next page TX,43,UU3660 –19–23SEP98–17/18

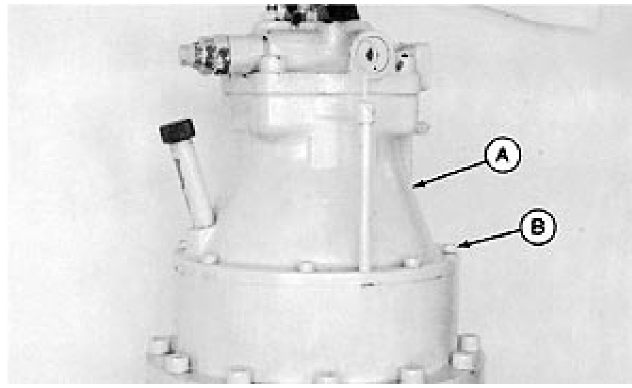
29. Install swing motor and brake (A). Tighten cap screws (B).

Swing Motor-to-Ring Gear Cap Screw—Specification

Torque .... 88 N•m (65 lb-ft)

30. Install drain pipe.

31. Add gear oil. (See Swing Gearbox and Propel Gearbox Oils in Group 0004.)



T7685JX –UN–07MAY92

A—Swing Motor and Brake
B—Cap Screw

TX,43,UU3660 –19–23SEP98–18/18

REMOVE UPPERSTRUCTURE

NOTE: Procedure requires two technicians. The cement floor must be a minimum of 102 mm (4 in.) thick. Area must be large enough so the upperstructure can be turned 180° with the angle between boom and arm at 90—100° and the tracks laid out flat on the floor.

1. Clean the machine thoroughly.

Continued on next page

TX,43,UU3743 –19–23SEP98–1/8

43
4350
19

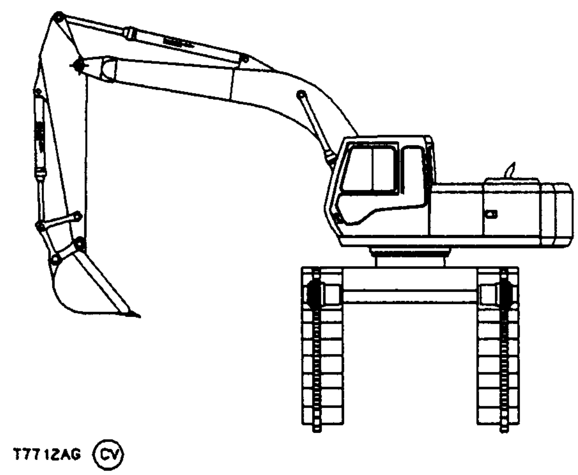
CAUTION: Keep the angle between boom and arm at 90—100° to prevent machine from sliding backwards.

2. Park machine with boom to the left side (cab side toward sprocket) of undercarriage.

3. Disconnect tracks and lay out flat on the floor to the sprocket end of undercarriage. (See Remove Track Shoes and Remove Track procedures in Group 0130.)

NOTE: To make removal of main frame-to-swing bearing cap screws easier after machine is raised into position, loosen the cap screws one turn at this time.

4. Turn upperstructure and raise the right side of machine, using boom down function.



T7712AG –UN–24FEB92

Continued on next page TX,43,UU3743 –19–23SEP98–2/8

CAUTION: The approximate weight of machine without tracks is 20 329 kg (44,818 lb).

Machine Without Tracks—Specification

Weight.. 20 329 kg (44,818 lb)

5. Put 254 mm (10 in.) high hardwood blocks (B), between lower track rollers (A) and track chain (C).

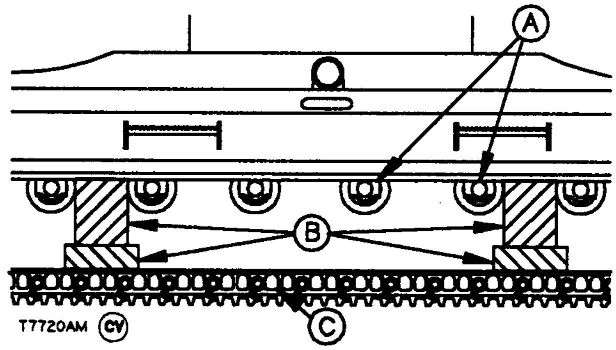
6. Turn upperstructure back to left side so it is perpendicular (90°) to track.

7. Put two DFT1089 Barrel Supports (G) under the counterweight (D). (See Section 99 for instructions to make barrel supports.)

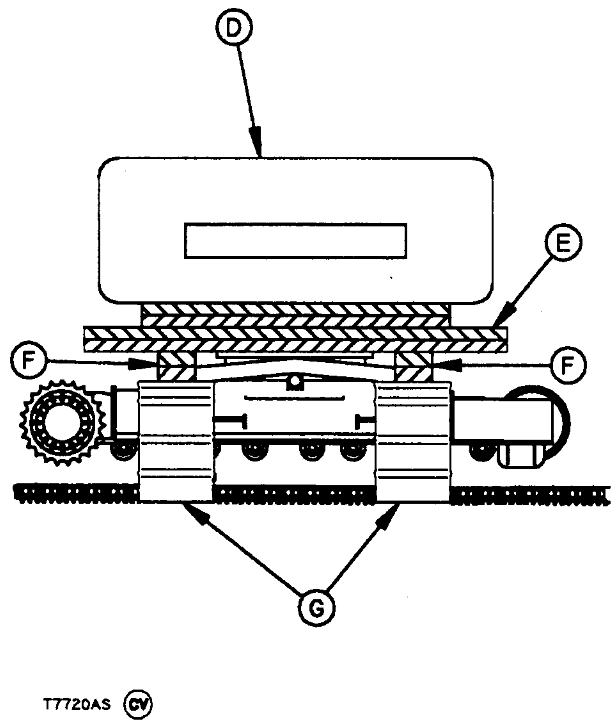
   To provide enough clearance, use bridge planks (E) and hardwood blocks (F) to raise the height of supports and planks to 1.4 m (55 in.). This height is the approximate minimum clearance needed to clear the bottom of rotary manifold. Do not put blocks under cap screw heads. Keep the height below the maximum.

Floor-to-Bottom of Main Frame Clearance—Specification

Height .... 1.4 m (55 in.) minimum
Height .... 1.45 m (57 in.) maximum



T7720AM –UN–07MAY92



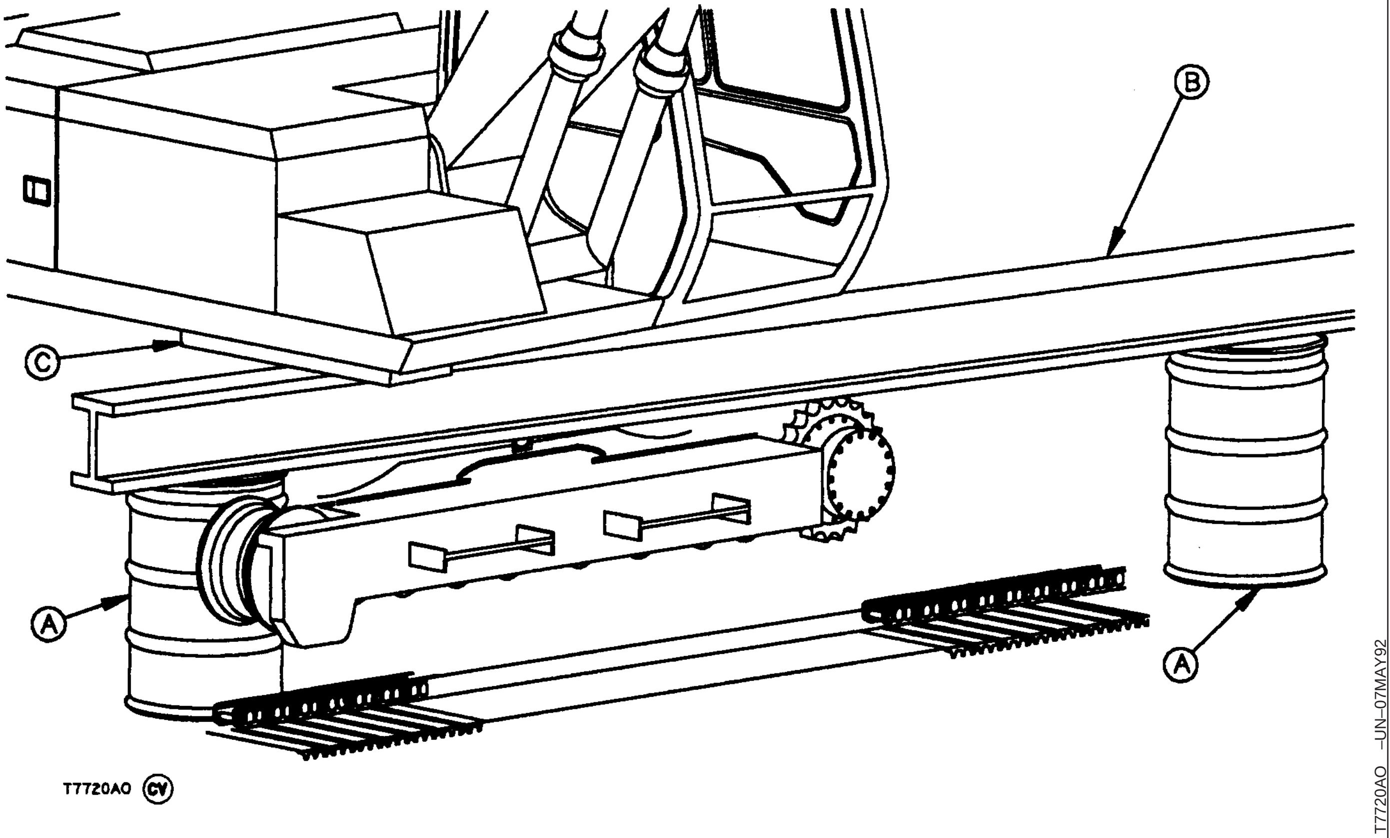
T7720AS –UN–07MAY92

A—Lower Track Roller
B—Hardwood Block (As Required)
C—Track Chain
D—Counterweight
E—Bridge Plank (As Required)
F—Hardwood Block (As Required)
G—DFT1089 Barrel Support (2 used)

43
4350
21

Continued on next page

TX,43,UU3743 –19–23SEP98–3/8



A—DFT1089 Barrel Support (2 used)
B—3.7 m (12 ft) Length of W8 x 28 lb Wide Flange Beam
C—Hardwood Block (Use as Required)

8. Slowly raise left side, using boom down function, until machine is level.

9. Put DFT1089 Barrel Supports (A) and a 3.7 m (12 ft) length of W8 x 28 lb Wide Flange Beam (B) under main frame at right boom cylinder and right corner of cab.

   For maximum support, the barrel supports must be positioned so the beam is under the main frame and corner of cab as far as possible.

   Install hardwood blocks (C) as needed to make up for any unevenness.

10. Lower machine so main frame and corner of cab is on the beam.

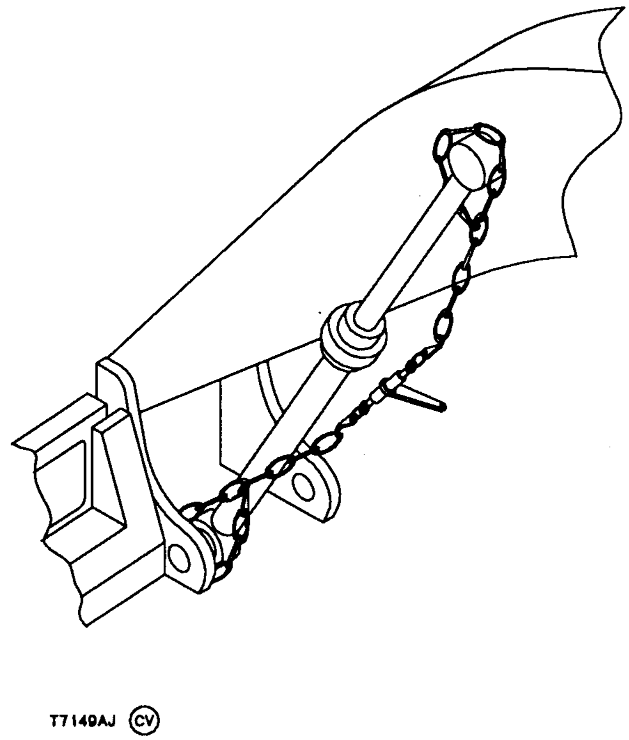
    Check that bottom of main frame is 1.4 m (55 in.) off the floor and level. Keep height to a maximum of 1.45 m (57 in.).

Continued on next page

TX,43,UU3743 –19–23SEP98–4/8

11. Install a 13 mm (1/2 in.) chain around boom cylinder head end boss on frame and rod end boss on boom. Tighten chain just enough to remove the slack using a chain binder.

12. Disconnect the negative battery cables.

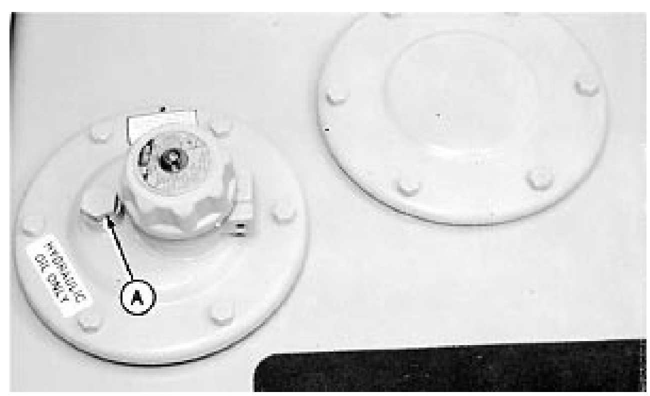


T7149AJ –UN–05OCT89

TX,43,UU3743 –19–23SEP98–5/8

CAUTION: The hydraulic oil tank is pressurized. High pressure release of oil from pressurized system can cause serious burns or penetrating injury. Release pressure from tank by loosening vent plug. It is not necessary to remove vent plug.

13. Loosen vent plug (A) to relieve hydraulic oil tank pressure.



T7869AT –UN–12NOV92

A—Vent Plug

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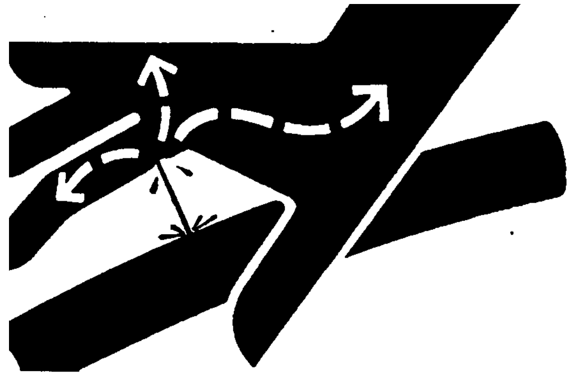
TX,43,UU3743 –19–23SEP98–6/8

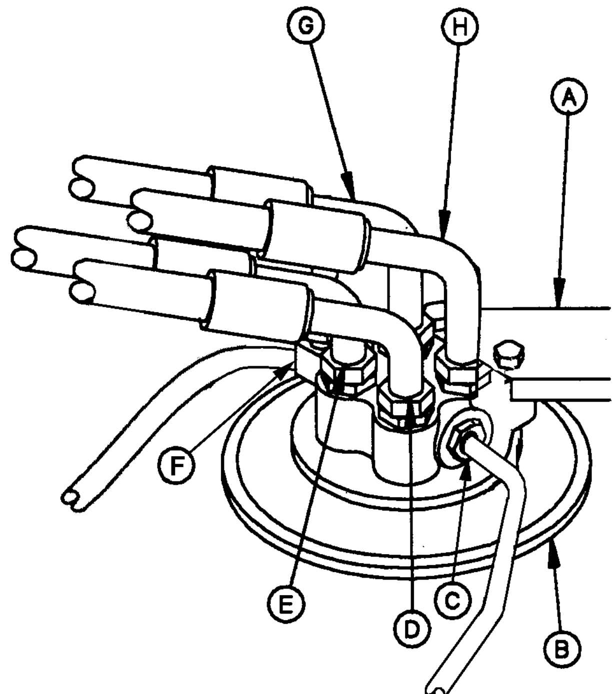


CAUTION: To avoid injury from escaping fluid under pressure, stop engine, and relieve the pressure in the system before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

14. Disconnect lines (C—H). Remove fittings for more clearance between rotary manifold and upperstructure.

15. Remove stop (A).

16. Remove cover (B).



T105974

A—Stop
B—Cover
C—P1-to-Proportional Solenoid Valve SH Port Line
D—Port 2-to-Right Propel Section Bottom Port (Reverse) Line
E—Port 4-to-Left Propel Section Bottom Port (Reverse) Line
F—Port D-to-Return Manifold
G—Port 3-to-Left Propel Section Top Port (Forward) Line
H—Port 1-to-Right Propel Section Top Port (Forward) Line

Continued on next page

TX,43,UU3743 –19–23SEP98–7/8

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4350
24

CAUTION: The approximate weight of undercarriage without tracks is 4717 kg (10,400 lb).

Undercarriage Without Tracks—Specification

Weight.. 4717 kg (10,400 lb) approximate

17. Put an 18-t (20-ton) service jack under each end of undercarriage. Use hardwood blocks is necessary.

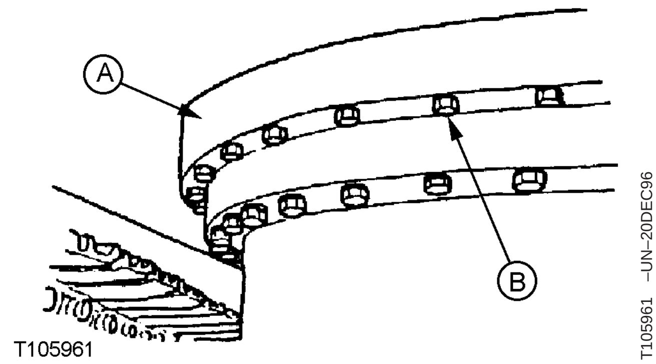
18. Remove cap screws (B) from swing bearing (A).

19. Slowly lower undercarriage onto track chain.

20. Lift sprocket end of undercarriage so sprocket clears track chain.

21. Pull undercarriage out from under the upperstructure.

22. Remove swing bearing. (See procedure in this group.)



A—Swing Bearing
B—Cap Screw (31 used)

TX,43,UU3743 –19–23SEP98–8/8

INSTALL UPPERSTRUCTURE

1. Push undercarriage under upperstructure.

2. Install DFT1144 Guide Pins to help align holes in swing bearing (A) with holes in main frame. (See Section 99 for instructions to make tool.)

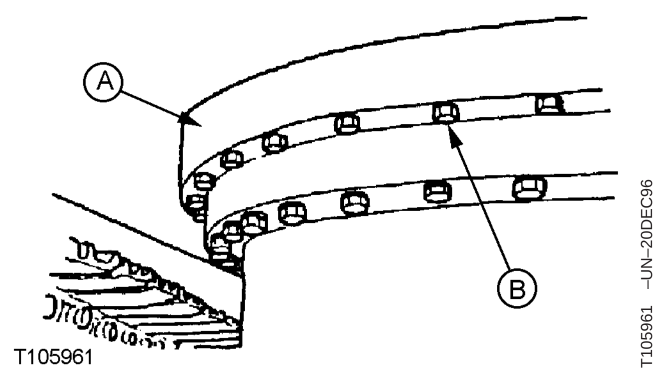
3. Raise undercarriage into position using two 18-t (20-ton) service jacks. It may be necessary to turn swing bearing inner race to align teeth on swing motor pinion shaft.

4. Install cap screws (B). Tighten cap screws.

Swing Bearing-to-Upperstructure Cap Screw—Specification

Torque .... 640 N•m (470 lb-ft)

If all cap screws are not accessible, tighten them after the machine has been lowered and supports have been removed.



A—Swing Bearing
B—Cap Screw (31 used)

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4350
25

Continued on next page

TX,43,UU3744 –19–23SEP98–1/4

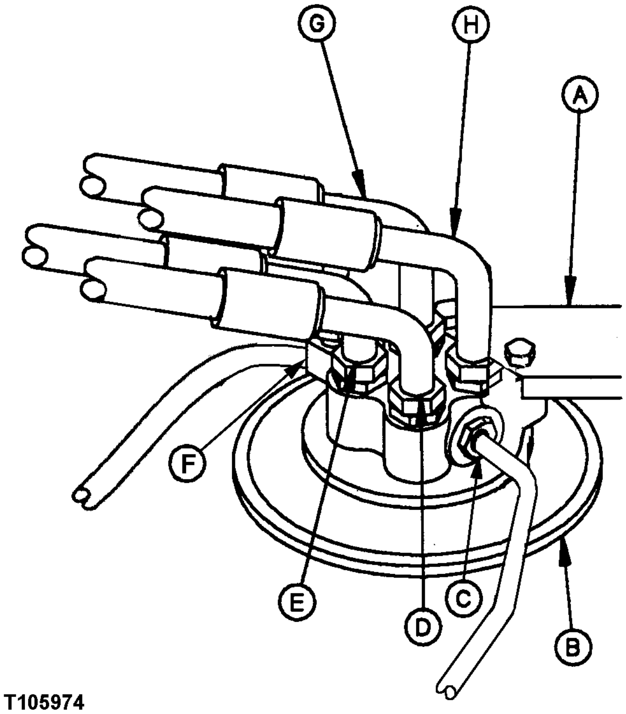
5. Install cover (B).

6. Install stop (A).

7. Connect lines (C—H).

8. Connect negative battery cables.

9. Remove chain from boom cylinder.



T105974

A—Stop
B—Cover
C—P1-to-Proportional Solenoid Valve SH Port Line
D—Port 2-to-Right Propel Section Bottom Port Reverse Line
E—Port 4-to-Left Propel Section Bottom Port Reverse Line
F—Port D-to-Return Manifold
G—Port 3-to-Left Propel Section Top Port Forward Line
H—Port 1-to-Right Propel Section Top Port Forward Line

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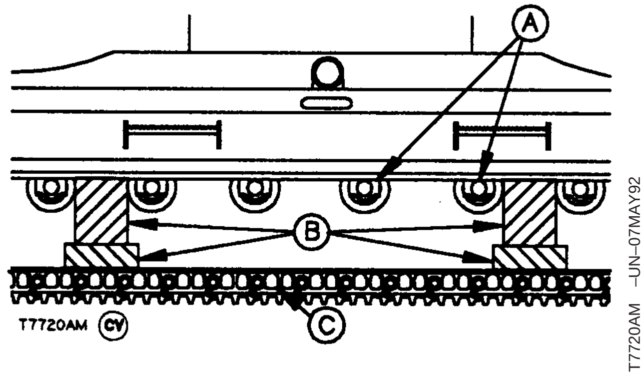
TX,43,UU3744 –19–23SEP98–2/4

10. Put hardwood blocks (B) between lower track rollers (A) and track chain (C) on the counterweight side.



A—Lower Track Roller
B—Hardwood Blocks
C—Track Chain

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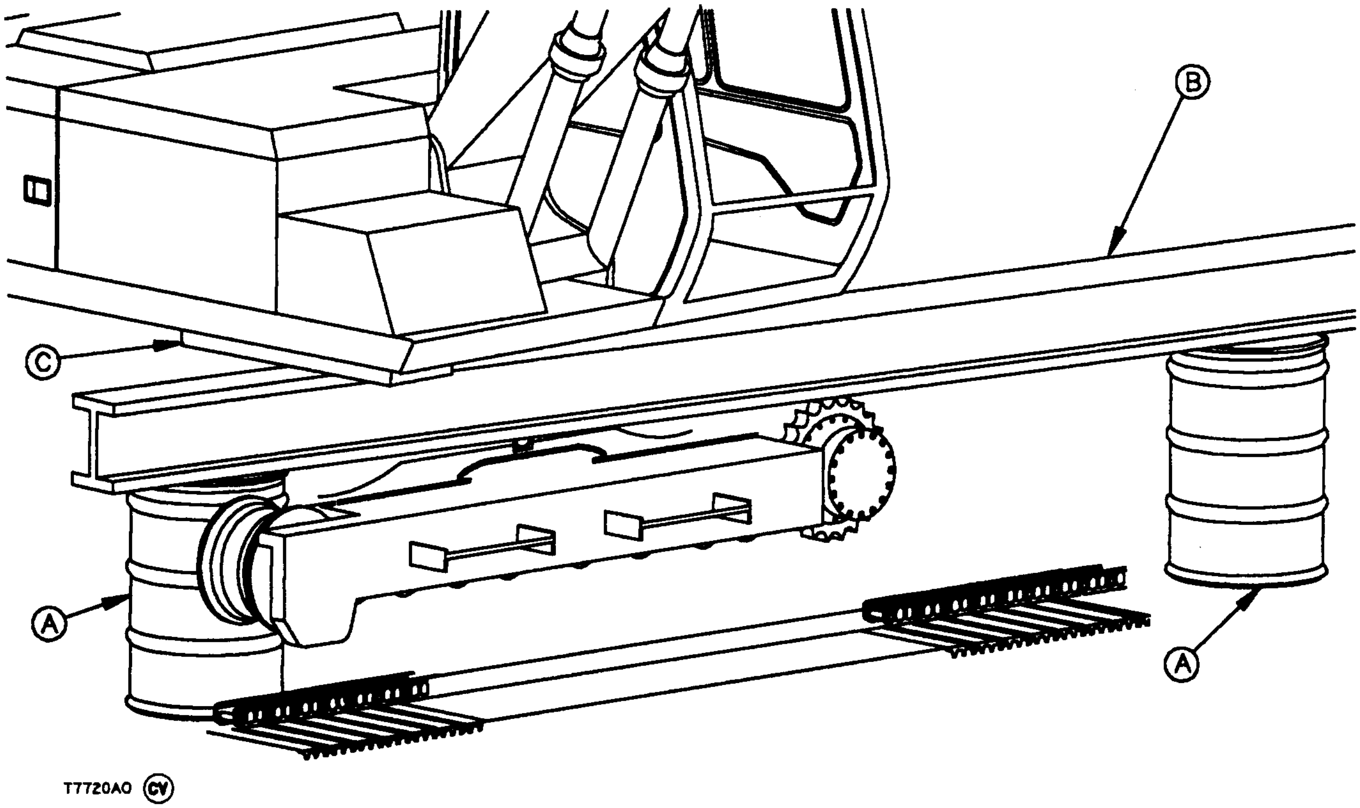


A—DFT1089 Barrel Support (2 used)
B—3.7 m (12 ft) Length of W8 x 28 lb Wide Flange Beam
C—Hardwood Block (Use as Required)

11. Raise machine just enough to remove the hardwood blocks (C), wide flange beam (B), and barrel supports (A).

12. Lower machine so lower track rollers and front idler are on track chain.

13. Remove bridge planks and barrel supports from other side.

14. Turn upperstructure to other side and raise machine just enough to remove hardwood blocks between roller and track chain.

15. Lower machine so lower track rollers and front idler are on the track chain.

16. Tighten any of the swing bearing-to-main frame cap screws that could not be tightened.

17. Install track chains.

18. Adjust track sag. (See Adjust Track Sag Procedure in Group 0130.)

REMOVE AND INSTALL SWING BEARING

1. Remove upperstructure. (See Remove Upperstructure procedure in this group.)

CAUTION: The approximate weight of swing bearing is 331 kg (730 lb).

Swing Bearing—Specification

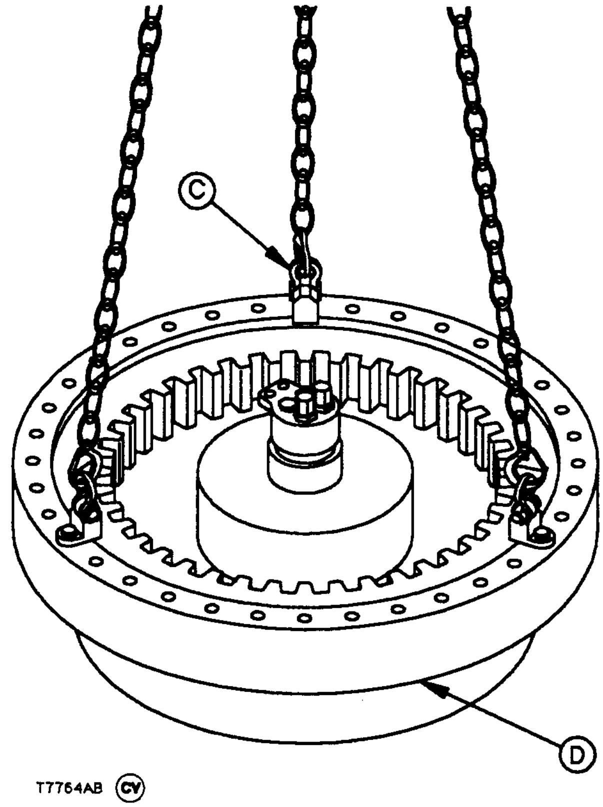
Weight.. 331 kg (730 lb) approximate

2. Connect swing bearing to a hoist using lifting brackets (C) such as JT01748 Lifting Brackets.

3. Remove cap screws and lock washer (D). Remove bearing.

4. Replace upper and lower seals, steel balls and ball supports as necessary. (See Replace Seal procedures in this group.)

5. Clean mating surfaces of swing bearing, upperstructure, and undercarriage.



T7764AB –UN–07MAY92

C—Lifting Brackets
D—Cap Screw and Lock Washer

Continued on next page TX,43,UU4005 –19–23SEP98–1/2

IMPORTANT: The tooth marked with the letter “G” or “S” or equivalent is the starting and stopping point for the hardening process. The tooth and the bearing loading plug must be installed on the right side of the machine so the use of that part of the swing bearing is minimized.

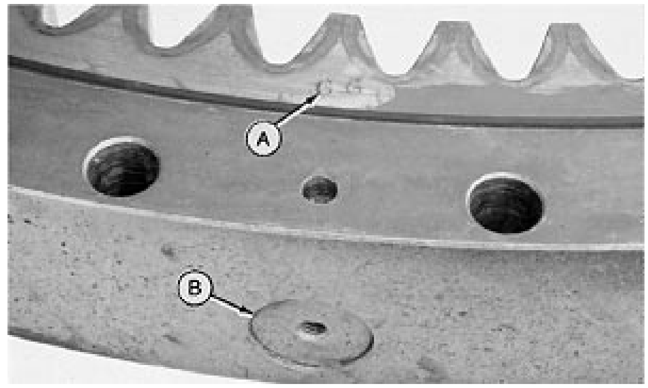
6. Install swing bearing on undercarriage so the tooth (A) marked “G” or “S” or equivalent and bearing loading plug (B) is to the right side of machine.

7. Install cap screws and lock washer. Tighten cap screws.

Undercarriage-to-Swing Bearing Cap Screw—Specification

Torque .... 740 N•m (540 lb-ft)

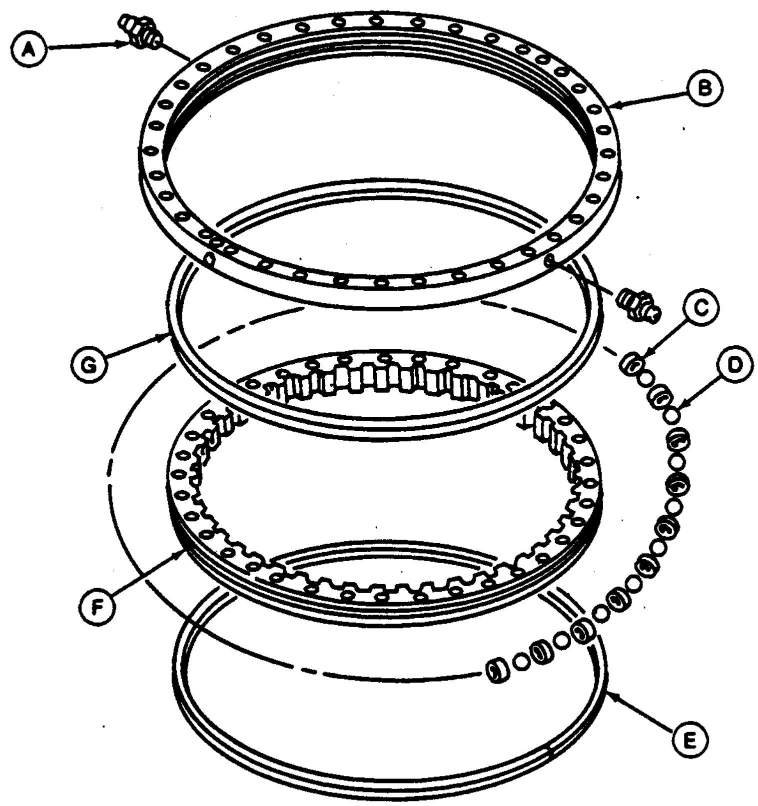
8. Apply multi-purpose EP grease to swing bearing teeth and pinion shaft. (See Track Adjuster, Working Tool Pivot, Swing Bearing, and Swing Bearing Gear Grease in Group 0004.)



A—Tooth
B—Loading Plug

TX,43,UU4005 –19–23SEP98–2/2

DISASSEMBLE AND ASSEMBLE SWING BEARING



A—Lubrication Fitting (2 used)
B—Outer Race
C—Spacer—Thin Center Section (82 used)
—Spacer—Thick Center Section (8 used)
D—Steel Ball (90 used)
E—Lower Seal
F—Inner Race
G—Upper Seal

1. Install new upper and lower seals (E and G) if torn or damaged. (See procedure in this group.)

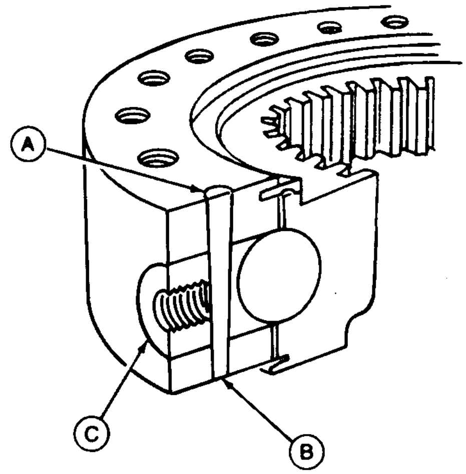
Continued on next page TX,43,UU3664 –19–23SEP98–1/4

43
4350
31

2. Grind tack weld (A) off top of taper pin (B).

3. Drive taper pin out from the bottom side of bearing.

4. Remove loading plug (C) using an M10-1.25 cap screw.



A—Tack Weld
B—Taper Pin

Continued on next page

TX,43,UU3664 –19–23SEP98–2/4

43
4350
32

5. Remove steel balls (A) using a magnet.

6. Remove spacers (B) using a length of wire.

NOTE: Some spacers have a thicker center section. The thick center section spacers are used to remove excess play caused by a tolerance build up between balls and spacers.

7. Turn inner race to remove remaining steel balls and spacers.

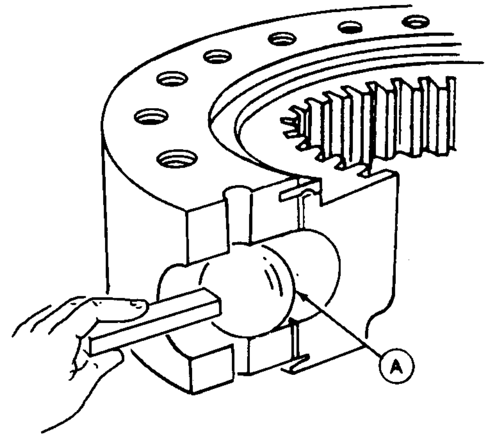
8. Lift outer race off inner race.

9. Install the spacers (B) and steel balls (A).

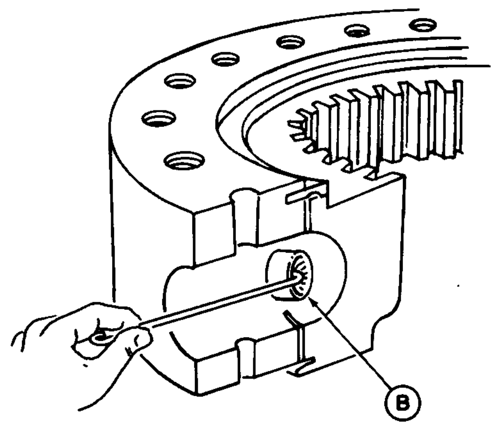
   Install the same number of thick and thin center section spacers as were removed.

   Turn inner race as needed to install spacers and steel balls.

   As needed, replace a thin center section spacer with a thick center section spacer to remove any excess play between spacers and steel balls.



T6876FK –UN–07MAY92



T7763AB –UN–07MAY92

A—Steel Ball
B—Spacer

Continued on next page

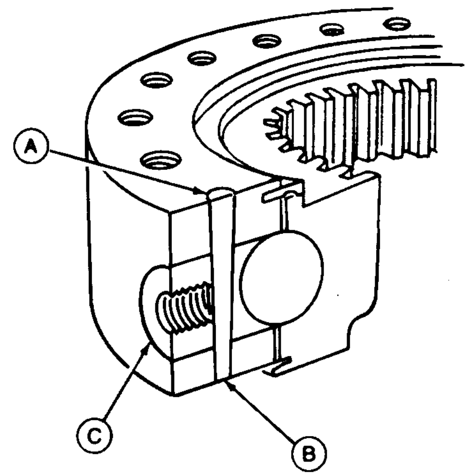
TX,43,UU3664 –19–23SEP98–3/4

10. Install loading plug (C).

11. Install taper pin (B) even with top of swing bearing.

12. Tack weld pin (A) to swing bearing.

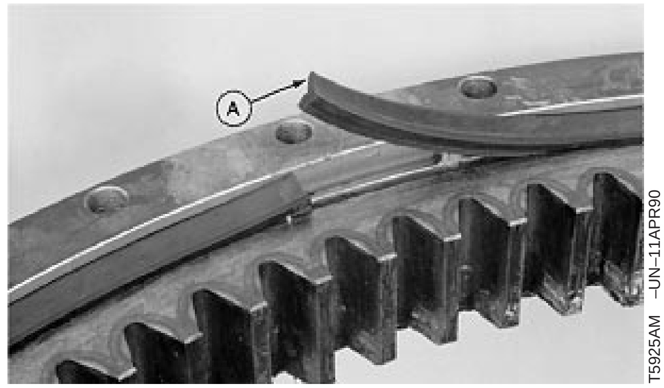
13. Add grease to swing bearing through lubrication fittings. (See Track Adjuster, Working Tool Pivot, Swing Bearing, and Swing Bearing Gear Grease in Group 0004.)



A—Tack Weld
B—Taper Pin
C—Loading Plug

TX,43,UU3664 –19–23SEP98–4/4

INSTALL SWING BEARING UPPER SEAL



A—Seal

1. Remove upperstructure. (See Remove Upperstructure Procedure in this group.)

2. Remove old seal (A).

3. Scrape old adhesive from seal groove.

   Thoroughly clean seal groove and new seal using cure primer.

4. Apply instant gel adhesive sparingly to seal groove.

5. Install seal with lip against inner bearing race.

   Start about 76 mm (3 in.) from end of seal using a blunt instrument to force seal into groove. Push seal in direction of portion already installed to avoid stretching seal.

6. Before bringing ends of seal together, cut off excess length.

7. Apply adhesive to both ends of seal. Push ends into seal groove making sure they come together.

IMPORTANT: To avoid pulling seal out of groove, adhesive must cure for at least 24 hours before using swing function.

8. Let adhesive cure for at least 24 hours before using swing function.

TX,43,UU3665 –19–23SEP98–1/1

INSTALL SWING BEARING LOWER SEAL

NOTE: Part of swing bearing shown cut away to show lower seal in groove.

1. Remove old seal (A).

2. Scrape old adhesive from seal groove (B).

   Thoroughly clean seal groove and new seal using cure primer.

3. Apply instant gel adhesive sparingly to seal groove.

4. Install seal with seal lip against outer race.

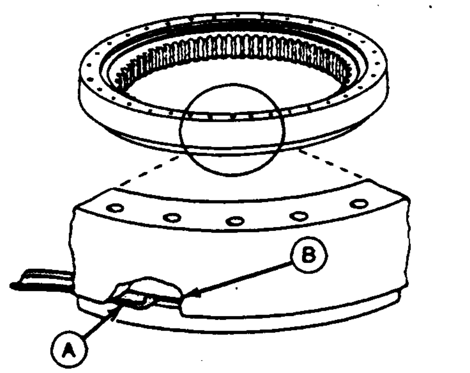
   Start about 76 mm (3 in.) from end of seal using a blunt instrument to force seal into groove. Push seal in direction of portion already installed to avoid stretching seal.

5. Before bringing ends of seal together, cut off excess length.

6. Apply adhesive to both ends of seal. Push ends into seal groove making sure they come together.

IMPORTANT: To avoid pulling seal out of groove, adhesive must cure for at least 24 hours before using swing function.

7. Let adhesive cure for at least 24 hours before using swing function.



A—Seal
B—Seal Groove

TX,43,UU3666 –19–23SEP98–1/1

Group 4360
Hydraulic System

SPECIFICATIONS

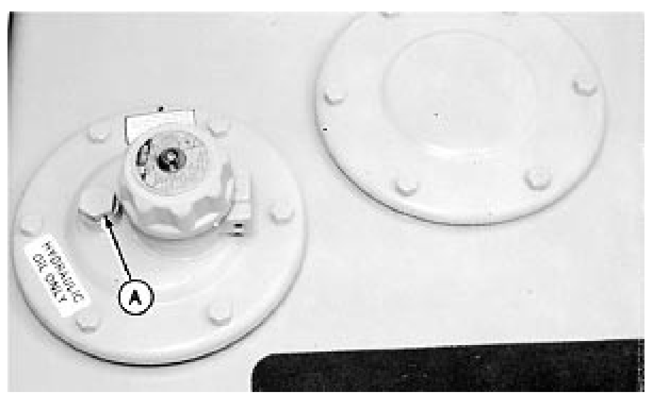
Item	Measurement	Specification
Swing Motor and Park Brake:		
Swing Motor and Brake	Weight	60 kg (132 lb) approximate
Motor-to-Gearbox Cap Screw	Torque	88 N•m (65 lb-ft)
Valve Housing-to-Motor Housing Cap Screw	Torque	430 N•m (320 lb-ft)
Swing Motor Make-Up and Crossover Relief Valves:		
Make-Up Valve Plug-to-Housing	Torque	330 N•m (245 lb-ft)
Crossover Relief Valve-to-Housing	Torque	176 N•m (130 lb-ft)

CED,OUOE003,1218 –19–23SEP98–1/1

REMOVE AND INSTALL SWING MOTOR AND PARK BRAKE

1. Remove vent plug (A) to release air pressure from hydraulic oil tank.

2. Pull a vacuum in hydraulic oil tank or drain hydraulic oil tank. Approximate oil capacity is 148 L (39 gal).

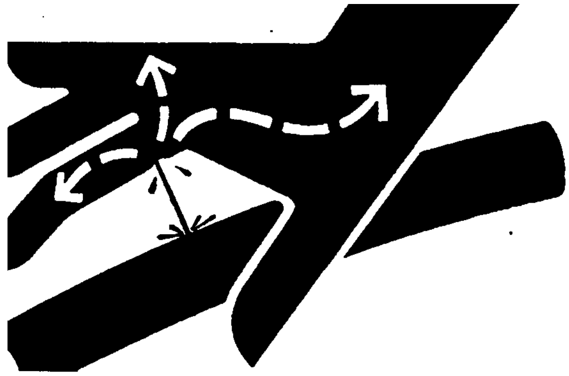


A—Vent Plug

Continued on next page

TX,43,UU3746 –19–23SEP98–1/2

CAUTION: To avoid injury from escaping fluid under pressure, stop engine, and relieve the pressure in the system before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.



X9811 –UN–23AUG88

3. Disconnect lines (A—F).

CAUTION: The approximate weight of swing motor and brake is 60 kg (132 lb).

Swing Motor and Brake—Specification

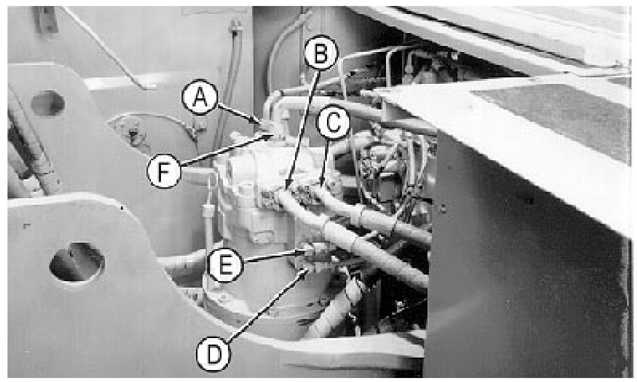
Weight.. 60 kg (132 lb) approximate

4. Remove cap screws (G). Remove swing motor and brake.
5. Replace parts as necessary.
6. Install swing motor and brake. Tighten cap screws.

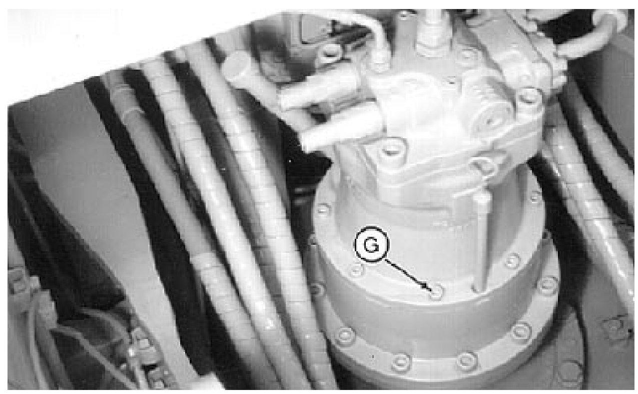
Motor-to-Gearbox Cap Screw—Specification

Torque .... 88 N•m (65 lb-ft)

7. Connect lines.
8. Do swing motor and brake start-up procedure. (See Swing Motor and Park Brake Start-Up Procedure in this group.)



T105899 –UN–19DEC96



T105990 –UN–09JAN97

A—Motor Drain-to-Hydraulic Oil Tank
B—To Swing Valve Section (Top)
C—To Swing Valve Section (Bottom)
D—To Control Valve (Pictorial)
E—To Solenoid Valve Manifold
F—To Control Valve
G—Cap Screw (8 used)

TX,43,UU3746 –19–23SEP98–2/2

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2

SWING MOTOR AND PARK BRAKE START-UP PROCEDURE

IMPORTANT: Swing motor will be damaged if not filled with oil before operating swing function. Procedure must be performed whenever a new swing motor is installed or oil has been drained from the motor.

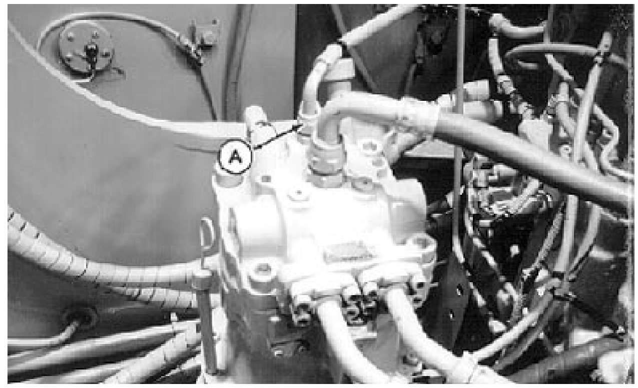
Procedure is to ensure the swing motor is filled with oil.

1. Disconnect swing motor drain line (A).

2. Fill motor with hydraulic oil through drain port until oil reaches the level of drain port.

NOTE: Air must be allowed to escape from the swing motor while filling.

3. Connect drain line.

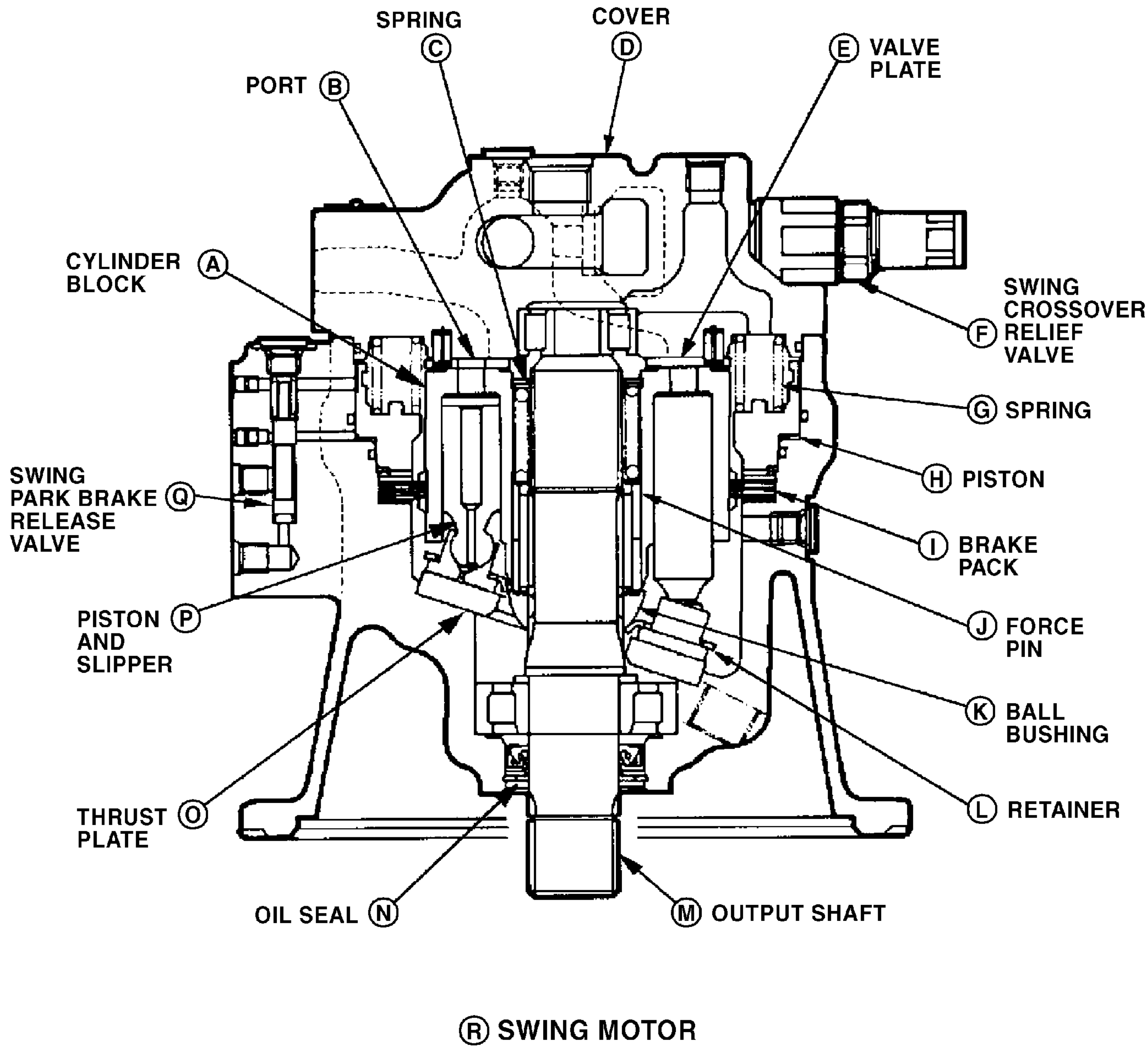


T105991 –UN–09JAN97

A—Swing Motor-to-Hydraulic Oil Tank Drain Line

TX,43,SB533 –19–23SEP98–1/1

DISASSEMBLE SWING MOTOR AND PARK BRAKE



T103087

T103087 –19–12SEP96

A—Cylinder Block
B—Port
C—Spring
D—Valve Housing and Cover
E—Valve Plate
F—Swing Motor Crossover Relief Valve
G—Spring (18 used)
H—Piston
I—Brake Pack
J—Force Pin (12 used)
K—Ball Bushing
L—Retainer
M—Output Shaft
N—Oil Seal
O—Thrust Plate
P—Piston and Slipper (9 used)
Q—Swing Park Brake Release Valve
R—Swing Motor

Continued on next page

1. Remove drain plug. Drain oil. Approximate oil capacity is 2 L (2.1 qt).

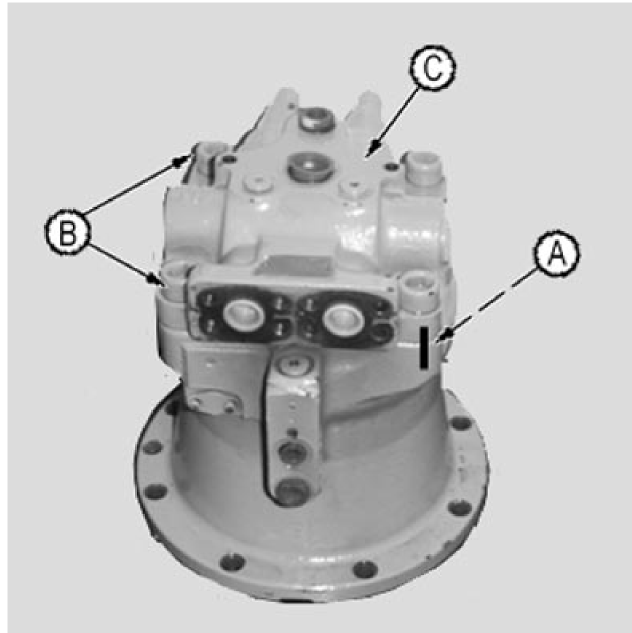
2. Make alignment mark (A) on swing motor valve housing and cover to motor housing for assembly.

CAUTION: Swing motor valve housing and cover is under spring pressure. Remove cap screws evenly to release spring force.

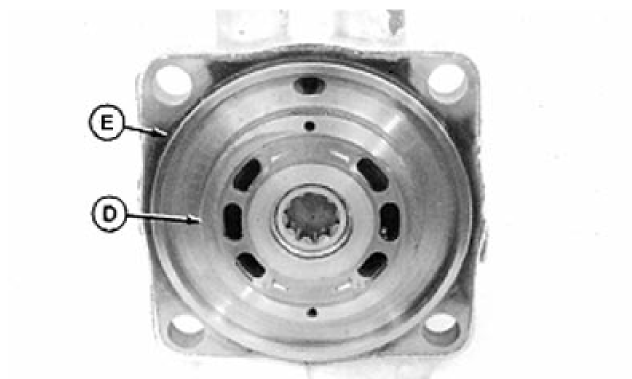
3. Remove cap screws (B) evenly. Remove valve housing and cover (C).

IMPORTANT: Valve plate (D) may remain on valve housing and cover or stay with cylinder block. Be careful not to damage valve plate.

4. Remove parts (D and E).



T106131B –UN–09JAN97



T106109 –UN–09JAN97

A—Alignment Mark
B—Cap Screw (4 used)
C—Valve Housing and Cover
D—Valve Plate
E—O-Ring

Continued on next page TX,43,UU3747 –19–23SEP98–2/6

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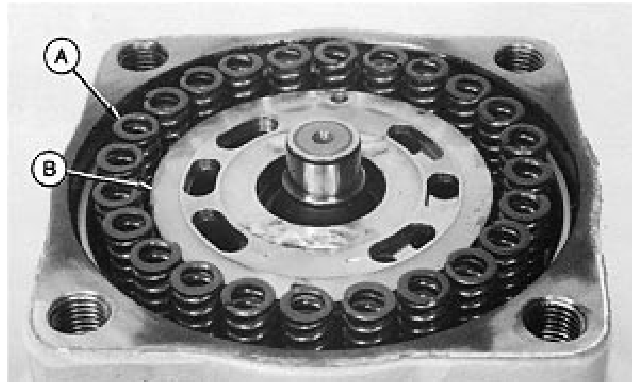
5

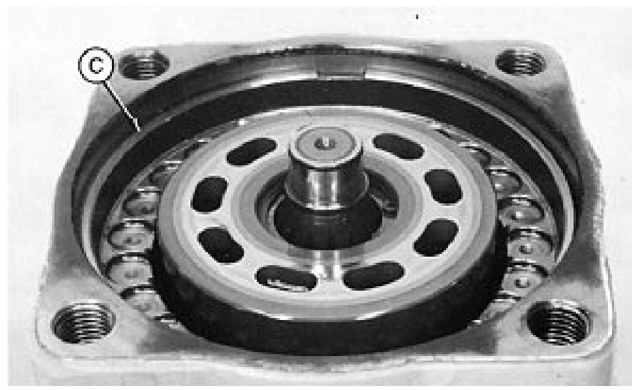
5. Remove valve plate (B) if not removed.

6. Remove brake springs (A).

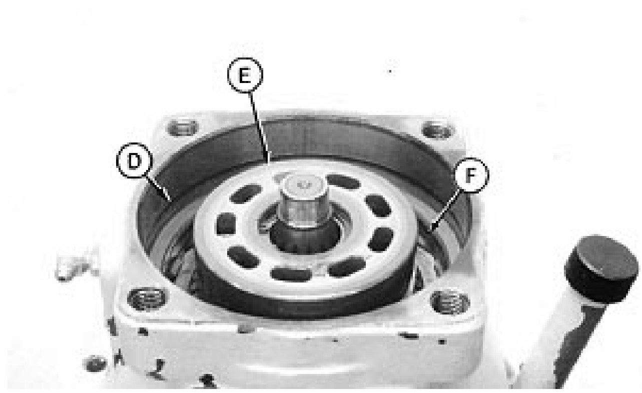
7. Remove parts (C—F).



T7685KJ –UN–07MAY92



T7685KK –UN–07MAY92



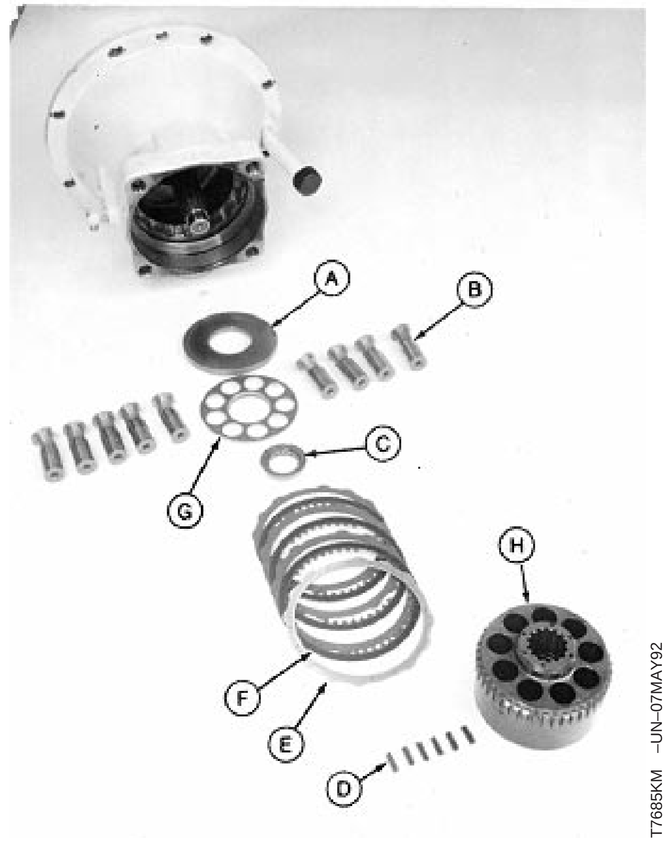
T7685KL –UN–07MAY92

A—Brake Spring (18 used)
B—Valve Plate
C—Brake Piston
D—O-Ring
E—Cylinder Block
F—O-Ring

Continued on next page

TX,43,UU3747 –19–23SEP98–3/6

8. Remove parts (A—G).



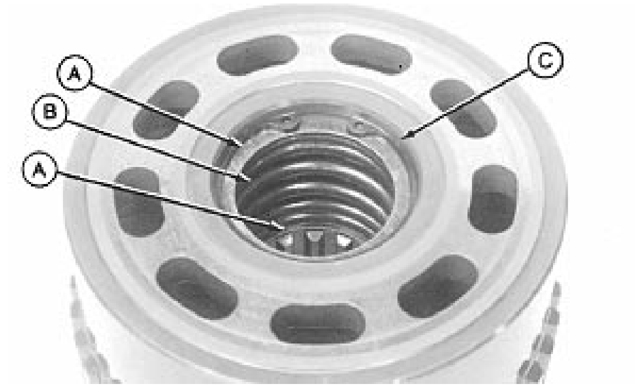
A—Thrust Plate
B—Piston (9 used)
C—Ball Bushing and Spacer
D—Force Pin (12 used)
E—Separator Plate (4 used)
F—Disk (3 used)
G—Retainer
H—Cylinder Block

Continued on next page TX,43,UU3747 –19–23SEP98–4/6

CAUTION: Spring (B) is under pressure. Remove spring load from snap ring before removing it.

9. Push spacer (A) and spring (B) down using a disk and a press. Remove snap ring (C).

10. Remove spacers and spring.



A—Spacer (2 used)
B—Spring
C—Snap Ring

Continued on next page

TX,43,UU3747 –19–23SEP98–5/6

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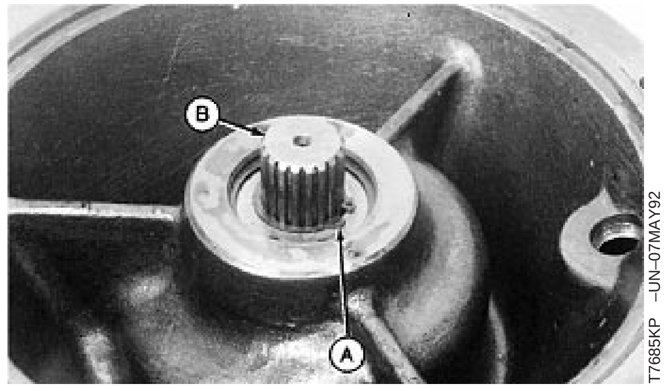
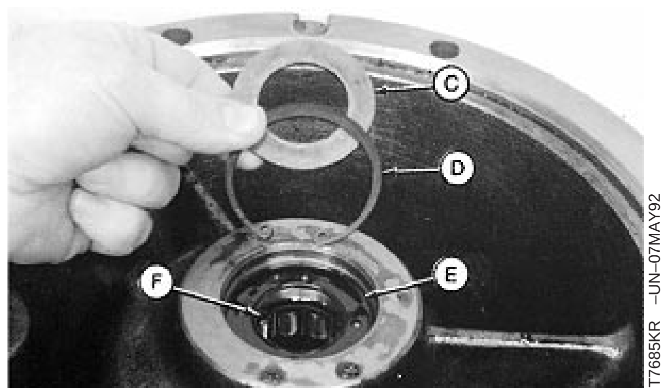
8

11. Remove snap ring (A).

12. Remove output shaft (B).

13. Remove parts (C—F).

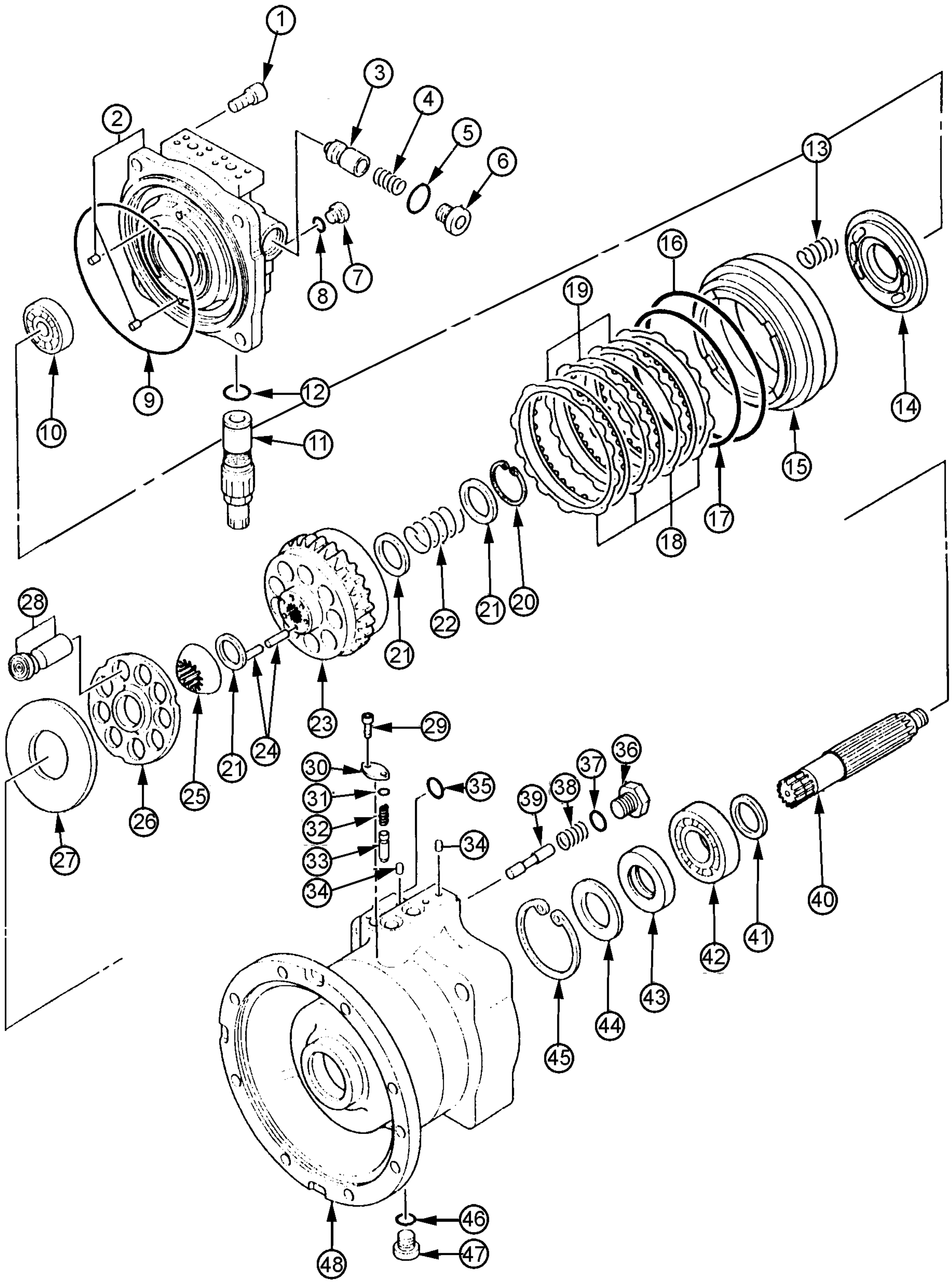




A—Snap Ring
B—Output Shaft
C—Seal Cover
D—Snap Ring
E—Oil Seal
F—Roller Bearing

TX,43,UU3747 –19–23SEP98–6/6

ASSEMBLE SWING MOTOR AND PARK BRAKE



T106201

T106201 –UN–09JAN97

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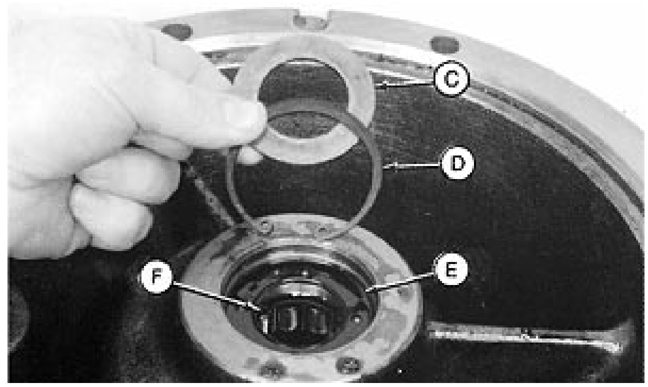
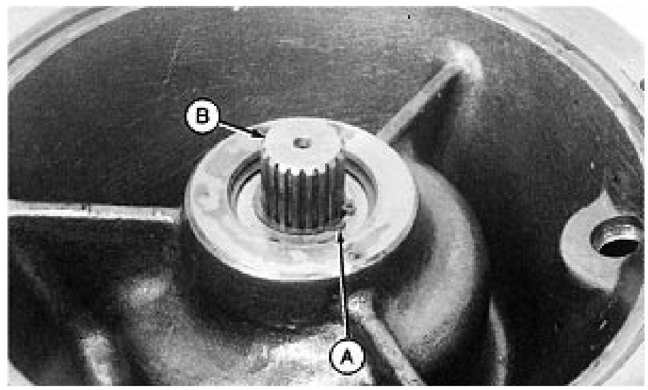
1—Cap Screw (4 used)
2—Valve Housing and Cover
3—Make-Up Valve Poppet (2 used)
4—Spring (2 used)
5—O-Ring (2 used)
6—Plug (2 used)
7—Plug (2 used)
8—O-Ring (2 used)
9—O-Ring
10—Bearing
11—Crossover Relief Valve (2 used)
12—O-Ring (2 used)
13—Spring (18 used)
14—Valve Plate
15—Piston
16—O-Ring
17—O-Ring
18—Plate (4 used)
19—Disk (3 used)
20—Snap Ring
21—Spacer (3 used)
22—Spring
23—Cylinder Block
24—Force Pin (12 used)
25—Ball Bushing
26—Retainer
27—Thrust Plate
28—Piston and Slipper (9 used)
29—Cap Screw (2 used)
30—Plate
31—O-Ring
32—Spring
33—Check Valve and Orifice (Plunger)
34—Pipe Plug (3 used)
35—O-Ring
36—Plug
37—O-Ring
38—Spring
39—Swing Park Brake Release Spool
40—Output Shaft
41—Spacer
42—Bearing
43—Seal
44—Retainer
45—Snap Ring
46—O-Ring
47—Plug
48—Housing

Continued on next page TX,43,UU3748 –19–23SEP98–2/7

1. Install parts (C—F).
2. Install shaft (B). Install snap ring (A).



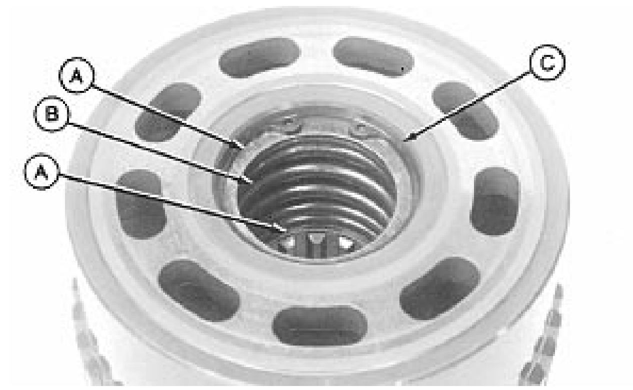


A—Snap Ring
B—Output Shaft
C—Seal Cover
D—Snap Ring
E—Oil Seal
F—Roller Bearing

Continued on next page TX,43,UU3748 –19–23SEP98–3/7

3. Install spacer (A), spring (B), and spacer.

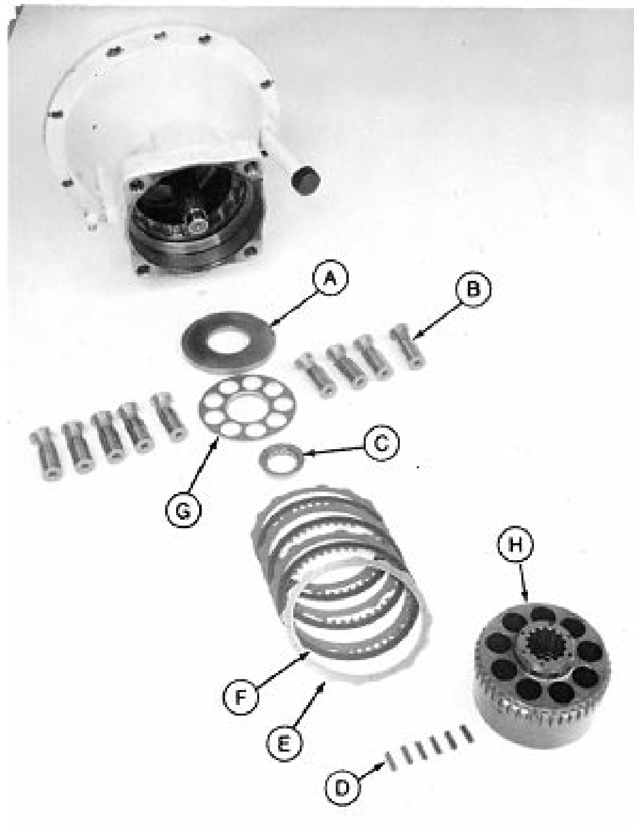
   Compress the spacer and spring using a disk and press. Install the snap ring (C).



A—Spacer (2 used)
B—Spring
C—Snap Ring

Continued on next page TX,43,UU3748 –19–23SEP98–4/7

4. Install parts (A—H).

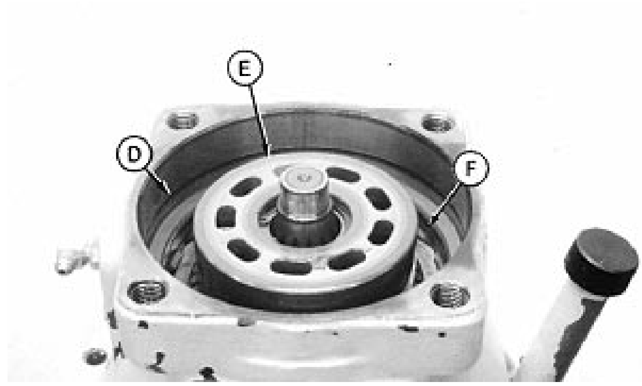


T7685KM –UN–07MAY92

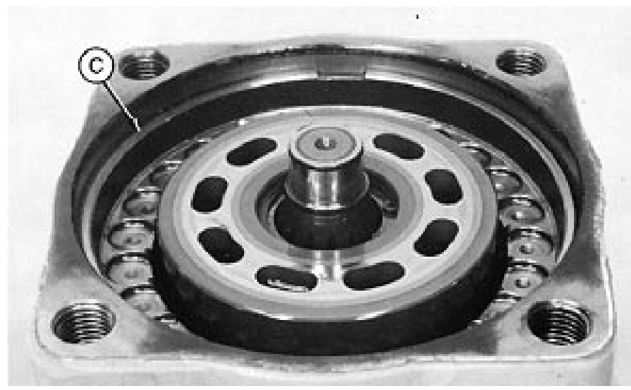
A—Thrust Plate
B—Piston (9 used)
C—Ball Bushing and Spacer
D—Force Pin (12 used)
E—Separator Plate (4 used)
F—Disk (3 used)
G—Retainer
H—Cylinder Block

Continued on next page TX,43,UU3748 –19–23SEP98–5/7

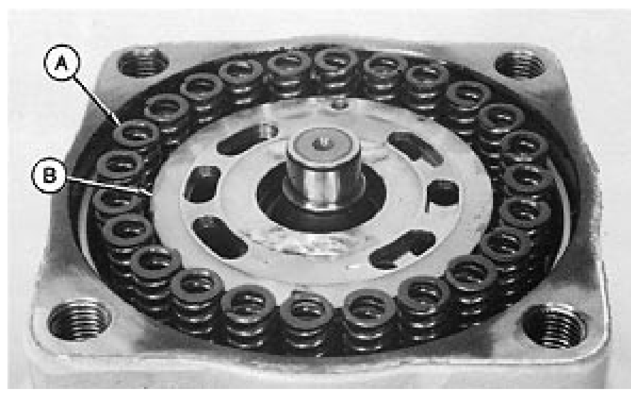
5. Install parts (A—F).



T7685KL –UN–07MAY92



T7685KK –UN–07MAY92



T7685KJ –UN–07MAY92

A—Brake Spring (18 used)
B—Valve Plate
C—Brake Piston
D—O-Ring
E—Cylinder Block
F—O-Ring

Continued on next page

TX,43,UU3748 –19–23SEP98–6/7

6. Install O-ring (E) and valve plate (D).

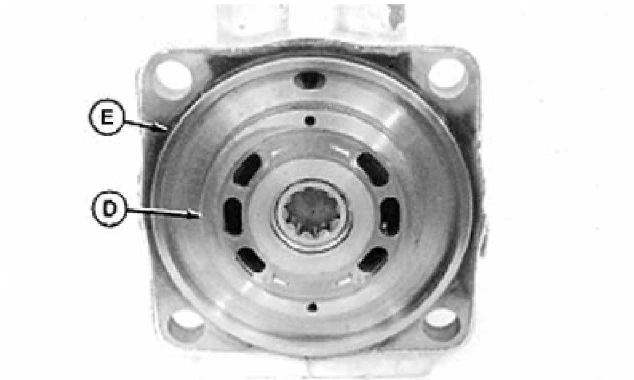
7. Install swing motor valve housing and cover (C) so work ports are towards the park brake release valve side of motor housing.

   Tighten cap screws (B).

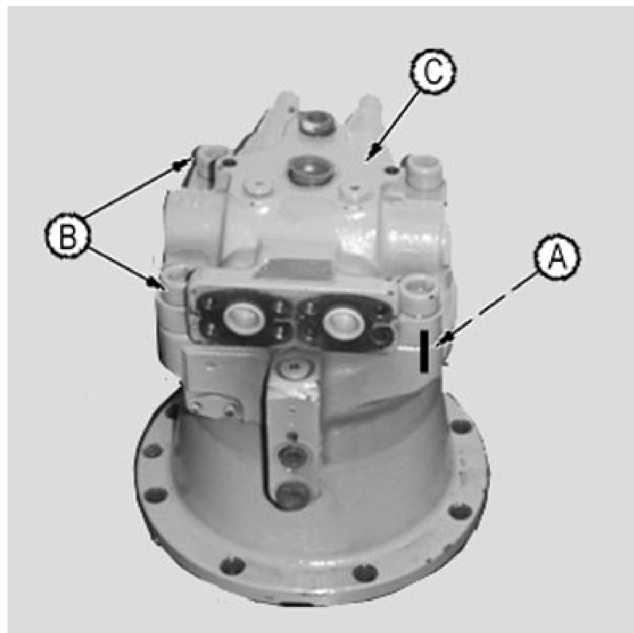
Valve Housing-to-Motor Housing Cap Screw—Specification

Torque .... 430 N•m (320 lb-ft)

8. Add oil. (See Hydraulic Oil in Group 0004.)



T106109 –UN–09JAN97

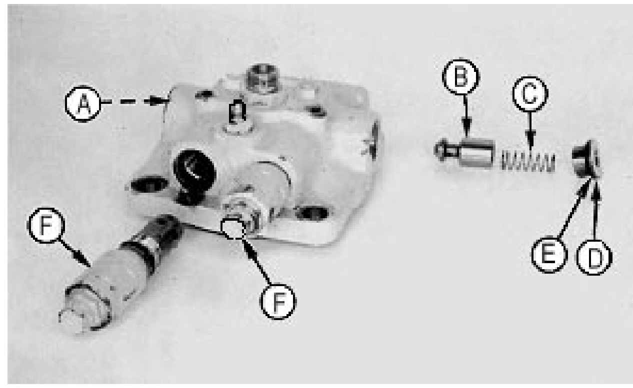


T106131B –UN–09JAN97

A—Alignment Mark
B—Cap Screw
C—Valve Housing and Cover
D—Valve Plate
E—O-Ring

TX,43,UU3748 –19–23SEP98–7/7

DISASSEMBLE AND ASSEMBLE SWING MOTOR MAKE-UP AND CROSSOVER RELIEF VALVES



A—Make-Up Valve (2 used)
B—Poppet
C—Spring
D—Plug
E—O-Ring
F—Crossover Relief Valve (2 used)

1. Disassemble make-up valves (A); remove parts (B—E).
2. Remove crossover relief valves (F).
3. Replace parts as necessary.
4. Install parts (B—E). Tighten plug (D).

Make-Up Valve Plug-to-Housing—Specification

Torque .... 330 N•m (245 lb-ft)

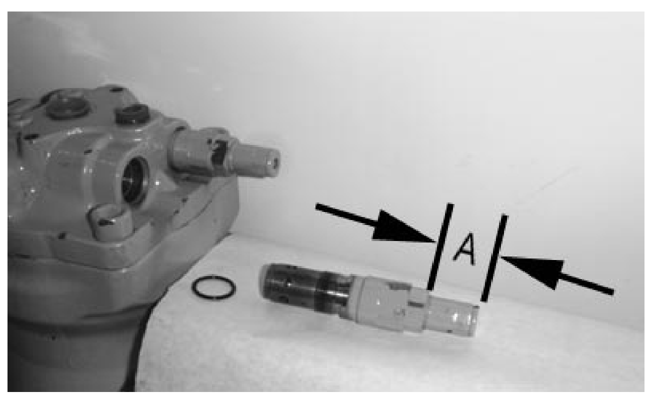
5. Install crossover relief valves (F). Tighten valves.

Crossover Relief Valve-to-Housing—Specification

Torque .... 176 N•m (130 lb-ft)

TX,43,UU3749 –19–23SEP98–1/3

6. Take dimension (A) and record for assembly.



A—Dimension

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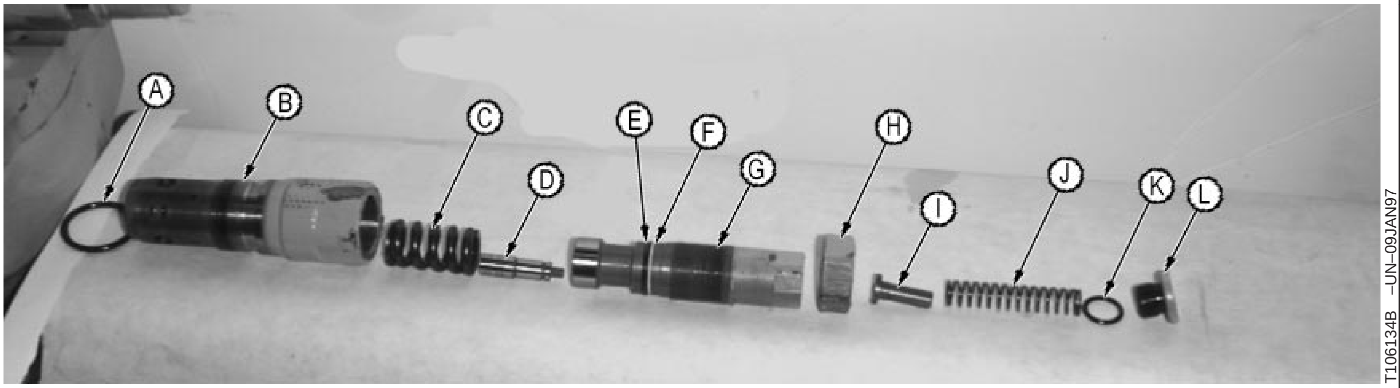
TX,43,UU3749 –19–23SEP98–2/3



A—O-Ring	**D—Spool**	**G—Adjusting Plug**	**J—Spring**
B—Body	**E—O-Ring**	**H—Nut**	**K—O-Ring**
C—Spring	**F—Backup Ring**	**I—Spring Guide**	**L—Plug**

IMPORTANT: Disassembly of relief valve is shown for convenience of cleaning. Service parts are not available. The relief valve must be replaced.

7. Disassemble crossover relief valve (A—L).

8. Clean and inspect parts.

9. Replace relief valve if any part is damaged or worn.

IMPORTANT: Make sure the poppet in body (B) slides into the bore in adjusting plug (G) while assembling. Failure to do so will force the plug out the end of body (B).

10. Assemble relief valve (A—L).

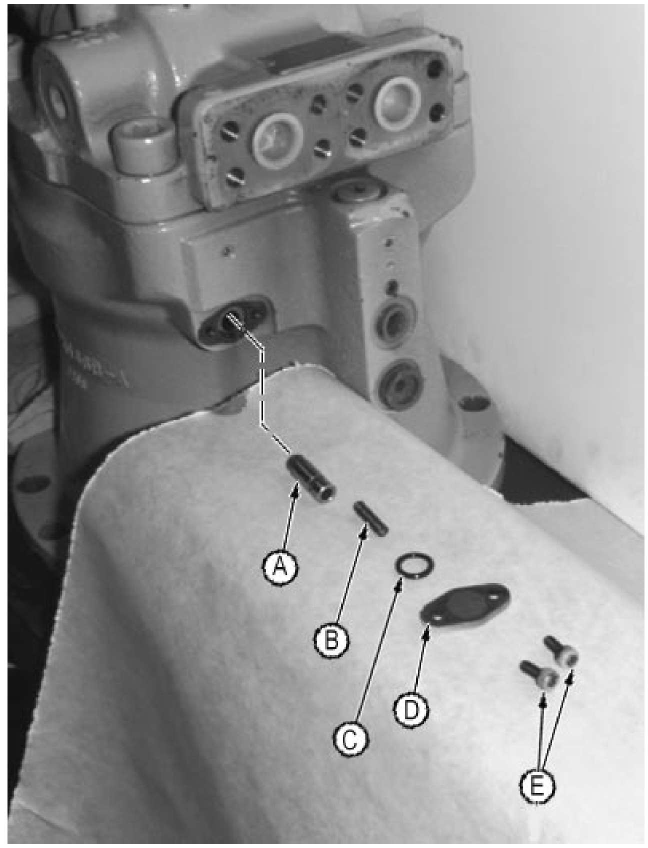
11. Adjust plug (G) to original dimension.

12. Check swing crossover relief valve pressure settings. (See Swing Motor Crossover Relief Valve Test and Adjustment Procedure in Group 9025-25.)

TX,43,UU3749 –19–23SEP98–3/3

REMOVE AND INSTALL SWING PARK BRAKE ORIFICE AND CHECK VALVE

1. Remove cap screws (E).
2. Remove cover (D) and O-ring (C).
3. Remove spool (A) and spring (B).
4. Clean and inspect parts. Replace as necessary.
5. Install parts (A—E).



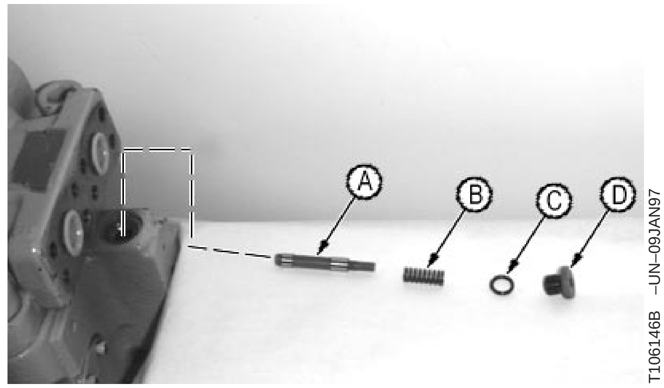
T106145B –UN–09JAN97

A—Spool
B—Spring
C—O-Ring
D—Cover
E—Cap Screw (2 used)

TX,43,UU3750 –19–08JAN97–1/1

REMOVE AND INSTALL SWING PARK BRAKE RELEASE VALVE

1. Remove plug (D).
2. Remove spring (B).
3. Remove spool (A). A magnet may be required.
4. Inspect parts. Replace if necessary.
5. Install parts (A—D).



A—Spool
B—Spring
C—O-Ring
D—Plug

TX,43,UU3751 –19–08JAN97–1/1

BLANK

CHAPTER 23

SECTION 44

ROCK DRILL REPAIR

BLANK

SERVICE EQUIPMENT AND TOOLS

NOTE: Order tools according to information given in the U.S. SERVICEGARD catalog or from the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier.

CED,OUOE019,1 –19–09MAR99–1/30

Clamping Assembly 59829

To secure hydraulic drifter during maintenance.

CED,OUOE019,1 –19–09MAR99–2/30

Spanner 66223

To loosen and tighten inflating screw in cover of accumulators.

CED,OUOE019,1 –19–09MAR99–3/30

Special Socket 95372

To remove and install cover, and plug of accumulators.

CED,OUOE019,1 –19–09MAR99–4/30

Dismounting-Mounting Tools 77796

To separate thrust housing from motor body.

CED,OUOE019,1 –19–09MAR99–5/30

Flange 59831

To remove and install cover in motor body.

Continued on next page CED,OUOE019,1 –19–09MAR99–6/30

Rock Drill

Gear Locking Tool. 76173

To secure shaft when removing and installing connected motor body parts.

CED,OUOE019,1 –19–09MAR99–7/30

Mandrel. 60482

To drive out motor body parts.

CED,OUOE019,1 –19–09MAR99–8/30

Threaded Ring 77794

To remove and install guiding ring in front guide.

CED,OUOE019,1 –19–09MAR99–9/30

Segment Assembly 77795

To remove and install guiding ring in front guide and motor body.

CED,OUOE019,1 –19–09MAR99–10/30

Socket Head Screw. 8861

To remove and install guiding ring in front guide and motor body.

Continued on next page

CED,OUOE019,1 –19–09MAR99–11/30

Rock Drill

Centering Ring 77793

To remove and install guiding ring in front guide.

CED,OUOE019,1 –19–09MAR99–12/30

Bronze Ring Driving Tool 60494

To remove and install guiding ring in front guide.

CED,OUOE019,1 –19–09MAR99–13/30

Threaded Ring 60485

To remove and install guiding ring in motor body.

CED,OUOE019,1 –19–09MAR99–14/30

Centering Ring 60480

To remove and install guiding ring in motor body.

CED,OUOE019,1 –19–09MAR99–15/30

Segment Assembly 60492

To remove and install guiding ring in motor body.

CED,OUOE019,1 –19–09MAR99–16/30

Bronze Ring Driving Tool 60483

To remove and install guiding ring in motor body.

CED,OUOE019,1 –19–09MAR99–17/30

Shouldered Pin. 59828

To install needle bearings.

CED,OUOE019,1 –19–09MAR99–18/30

Lip Seal Mounting Tool. 73125

To install lip seals.

Continued on next page

CED,OUOE019,1 –19–09MAR99–19/30

Rock Drill

44
9506
4

Nitrogen Inflation Kit 95234

To supply nitrogen to accumulators.

CED,OUOE019,1 –19–09MAR99–20/30

Inflation Tool 95233

To supply nitrogen to accumulators.

CED,OUOE019,1 –19–09MAR99–21/30

Nitrogen Bottle Pressure Reducer. 41544

To supply nitrogen to accumulators.

CED,OUOE019,1 –19–09MAR99–22/30

Nitrogen Bottle 48429

To supply nitrogen to accumulators.

CED,OUOE019,1 –19–09MAR99–23/30

Sling

To lift hydraulic drifter.

CED,OUOE019,1 –19–09MAR99–24/30

Hydraulic Press

To remove and install parts.

CED,OUOE019,1 –19–09MAR99–25/30

Plastic Rod . . . . 1.38 dia by 9.84 inches long

To remove tight rings.

CED,OUOE019,1 –19–09MAR99–26/30

Plastic Hammer

To drive out parts in motor body.

Continued on next page CED,OUOE019,1 –19–09MAR99–27/30

44
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Plastic Sledge Hammer

To drive accumulators.

CED,OUOE019,1 –19–09MAR99–28/30

Torque Wrench. . . . . 10-1050 ftlbs

To install attaching parts.

CED,OUOE019,1 –19–09MAR99–29/30

Cartridge Mounting Tool

To install cartridge.

CED,OUOE019,1 –19–09MAR99–30/30

OTHER MATERIAL

Number	Name	Use
	Grease	Apply to tight seals and face seal at installation.
	Hydraulic Fluid	Apply to accumulator parts at installation.
	Silicone Grease	Apply to internal face of diaphragm of accumulators at installation.

CED,OUOE019,2 –19–09MAR99–1/1

TORQUE SPECIFICATIONS

Be very careful not to mix metric with US fasteners.

METRIC THREADS

Tightening torque depends of the grade of the screw. All the hexagonal head screws are of 8.8 class; most of socket head screw are of 12.9 class.

The screw class is stamped on the head.

Class 8.8

Dia	Wrench (mm)	Allen key (mm)	Torque (N.m)
M5	8	4	6
M6	10	5	10
M8	13	6	24
M10	17	8	47
M12	19	10	81
M16	24	14	195
M20	30	17	370
M24	36	19	640
M30	46	22	1270
M36	55	27	2260

Class 12.9

Dia	Wrench (mm)	Allen key (mm)	Torque (N.m)
M5	8	4	10
M6	10	5	17
M8	13	6	40
M10	17	8	80
M12	19	10	135
M16	24	14	330
M20	30	17	620
M24	36	19	1100
M30	46	22	2000
M36	55	27	3800

UNC THREADS

Dia	Wrench (mm)	Allen key (mm)	Torque (N.m)
1/2“	3/4”	3/8”	65
5/8”	15/16”	1/2”	150
3/4”	1” 1/8	9/16”	280
1”	1” 5/16	7/8”	650

UNF THREADS

Dia	Wrench (mm)	Allen key (mm)	Torque (N.m)
1/2“	3/4”	3/8”	80
5/8”	15/16”	1/2”	150
3/4”	1” 1/8	9/16”	300
1”	1” 5/16	7/8”	750

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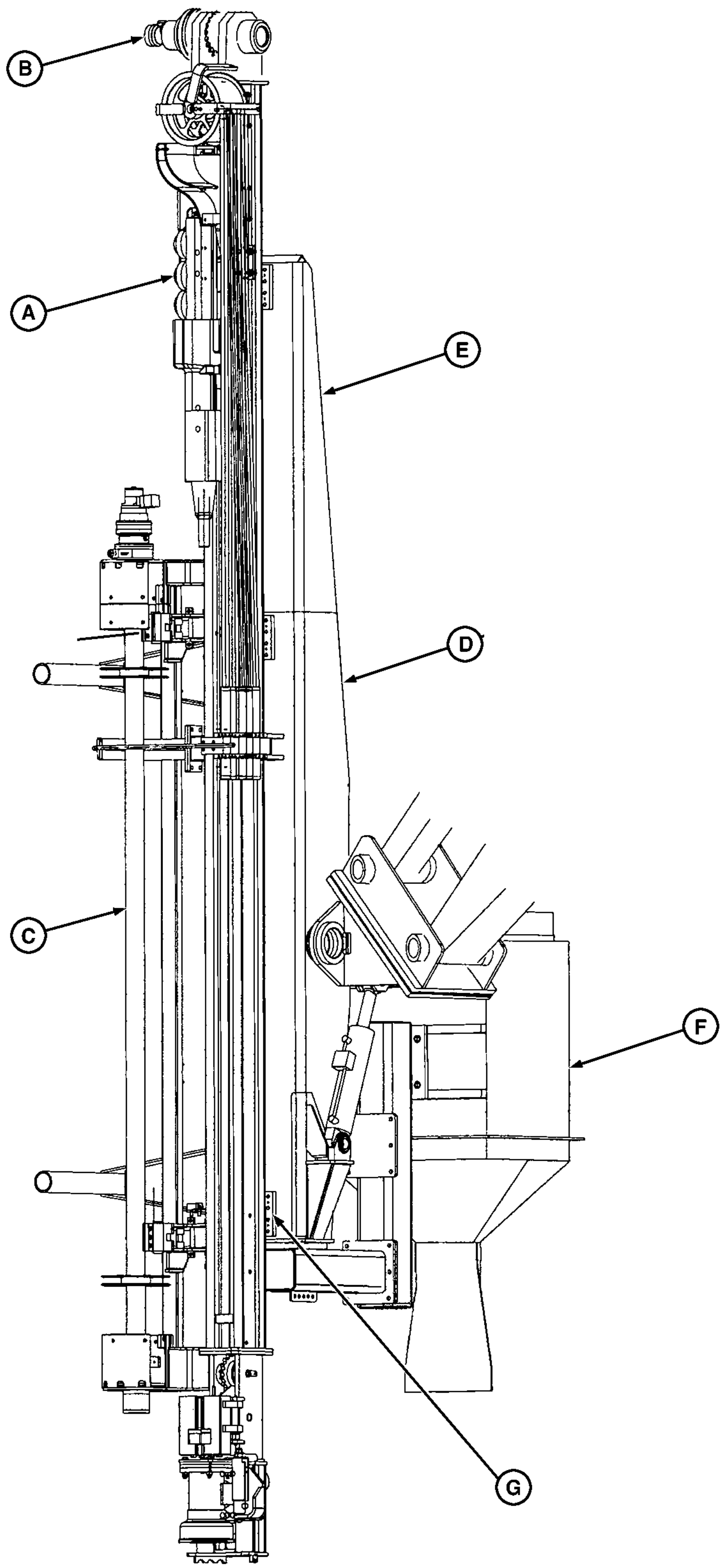
DISASSEMBLE ROCK DRILL



T120823

T120823 –UN–01JUN99

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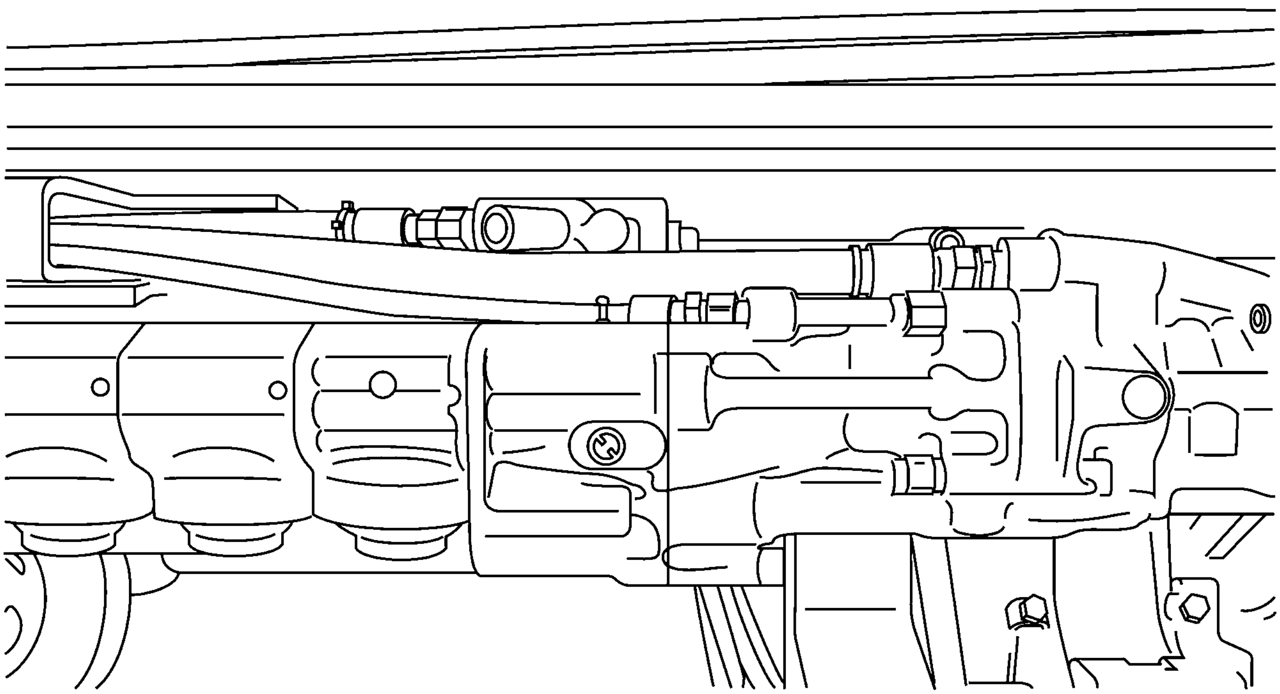
CED,OUOE019,4 –19–09MAR99–1/23

Rock Drill

A— Hydraulic Drifter
B—GCX 14/12 Feed
C—Rod Changer
D—Cradle and Articulation
E—Electro-Hydraulic Equipment
F—Dust Collector
G—Hydraulic Drifter Control

1. If connected, remove drill rod and coupling.
2. Disconnect one electrical cable, one grease hose, one air hose, and three hydraulic hoses from the excavator.
3. Unhitch the rock drill from the excavator.

CED,OUOE019,4 –19–09MAR99–2/23



T121448

T121448 –UN–01JUN99

4. Remove seven hydraulic hoses from the hydraulic drifter.

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CED,OUOE019,4 –19–09MAR99–3/23

Rock Drill

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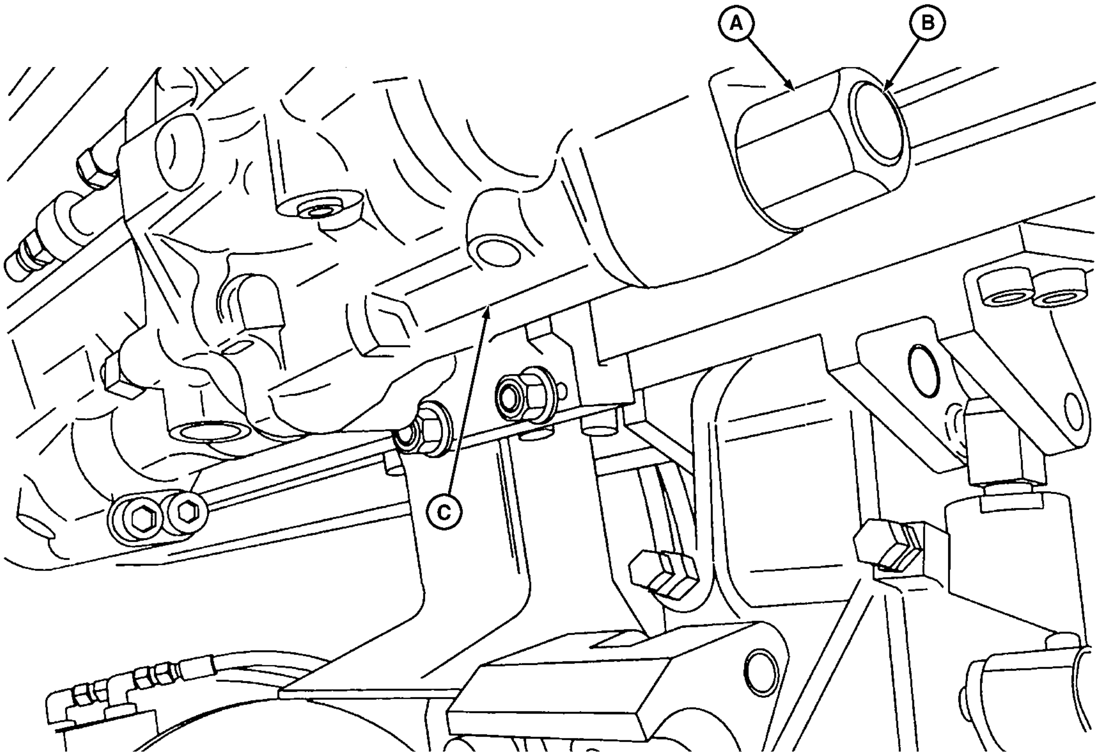


T121449

A—Nut (4 used) **B—Shaft (2 used)** **C—Hydraulic Drifter**

5. Remove four nuts (A) from ends of two shafts (B).

CAUTION: The approximate weight of hydraulic drifter is 2700 kg (5948 lb).

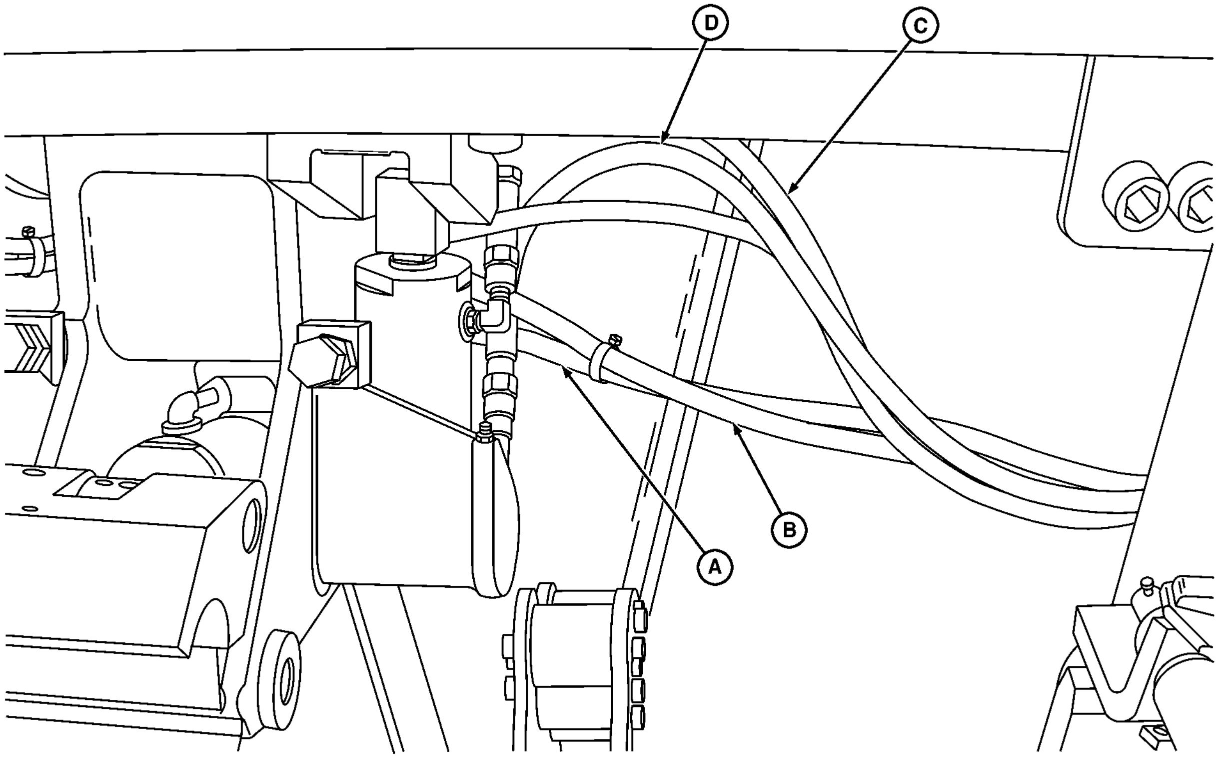
Hydraulic Drifter—Specification

Weight.. 2700 kg (5948 lb)

6. Support hydraulic drifter (C) with sling and slide shafts (B) out of mounting sleeves.

7. Remove hydraulic drifter (C).

Continued on next page CED,OUOE019,4 –19–09MAR99–4/23



T121450

A—Hydraulic Hose **B—Hydraulic Hose** **C—Hydraulic Hose** **D—Hydraulic Hose**

8. Remove four hydraulic hoses (A through D).

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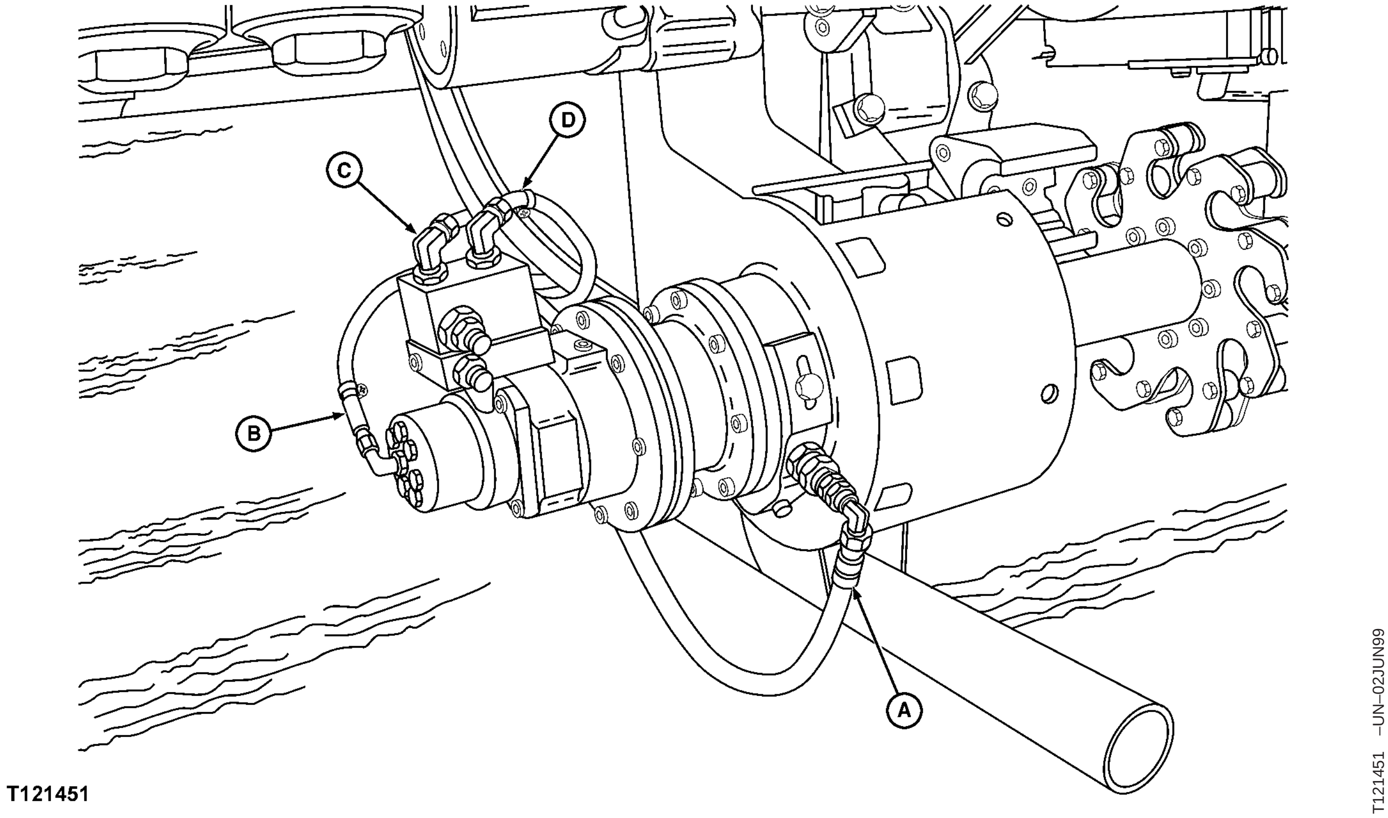
Rock Drill



A—Hydraulic Hose **B—Hydraulic Hose** **C—Hydraulic Hose** **D—Hydraulic Hose**

9. Remove four hydraulic hoses (A through D).

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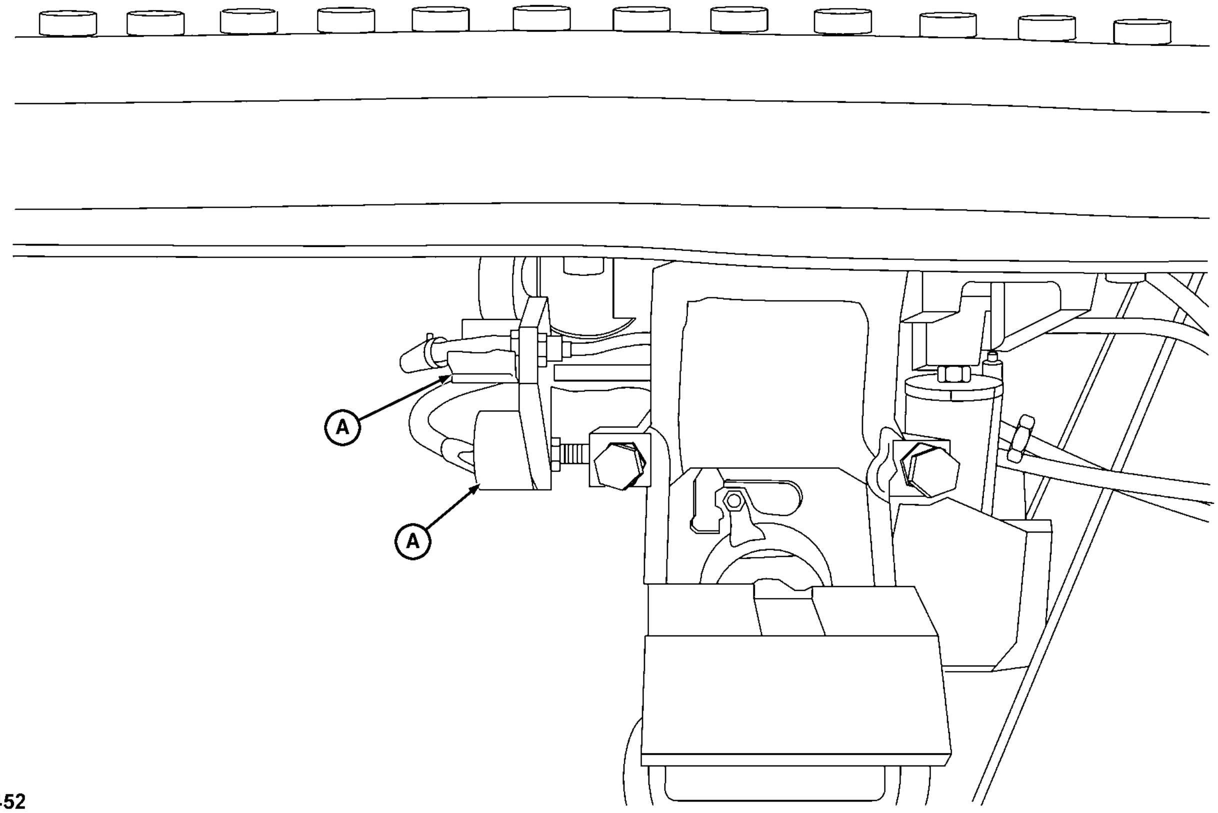

T121452

A—Sensor (2 used)

10. Remove two sensors (A).

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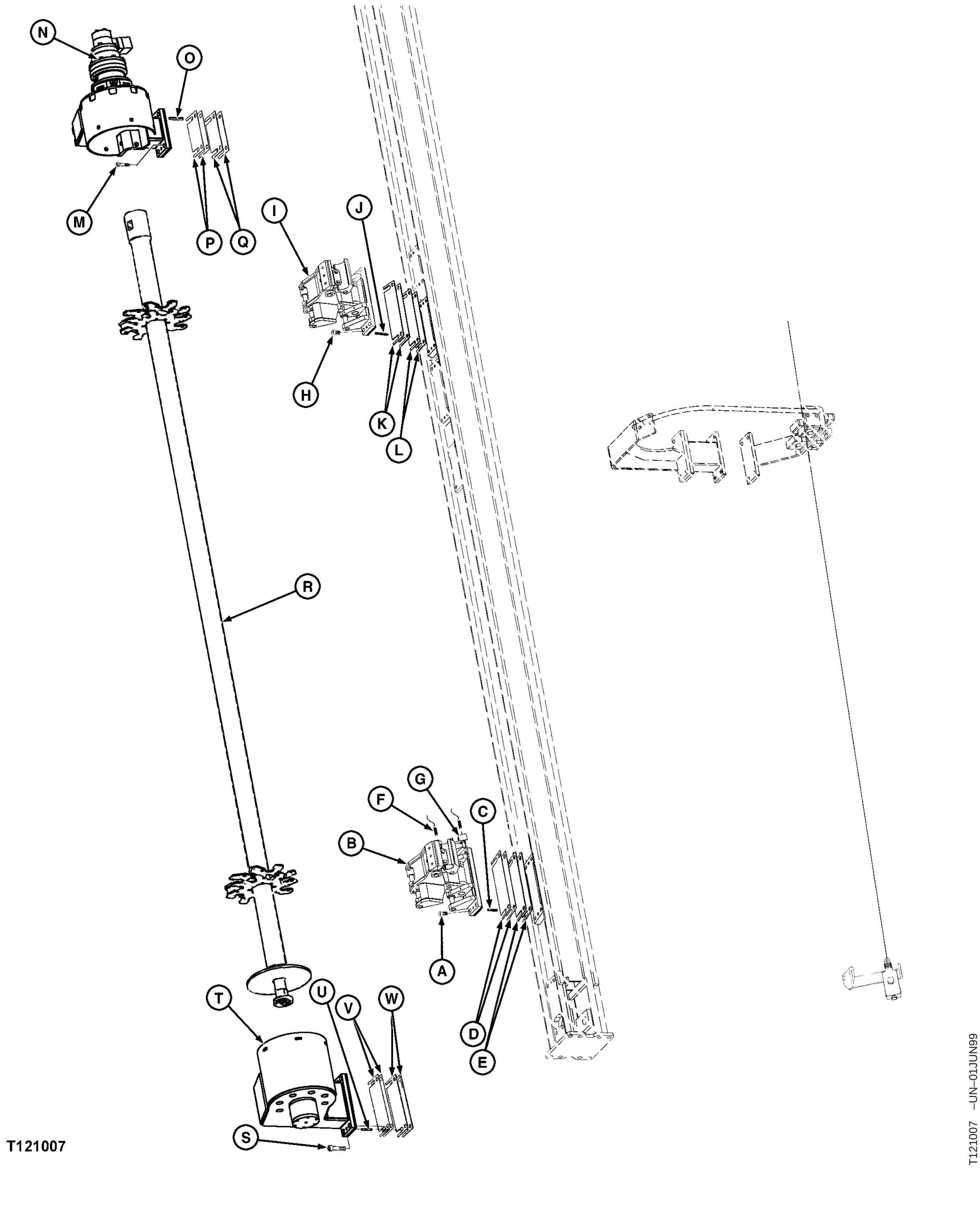
Rock Drill



Continued on next page CED,OUOE019,4 –19–09MAR99–8/23

A—Screw (4 used)
B—Lower Clamp Support
C—Elastic Pin (2 used)
D—Shim (2 used)
E—Shim (2 used)
F—Stud
G—Detector Support
H—Screw (4 used)
I—Upper Clamp Support
J—Elastic Pin (2 used)
K—Shim (2 used)
L—Shim (2 used)
M—Screw (4 used)
N—Brake Reducer Motor
O—Elastic Pin (2 used)
P—Shim (2 used)
Q—Shim (2 used)
R—Central Tube
S—Screw (4 used)
T—Lower Support
U—Elastic Pin (2 used)
V—Shim (2 used)
W—Shim (2 used)

11. Remove four screws (A), lower clamp support (B), two elastic pins (C), two shims (D), and two shims (E).

12. Remove stud (F), and detector support (G).

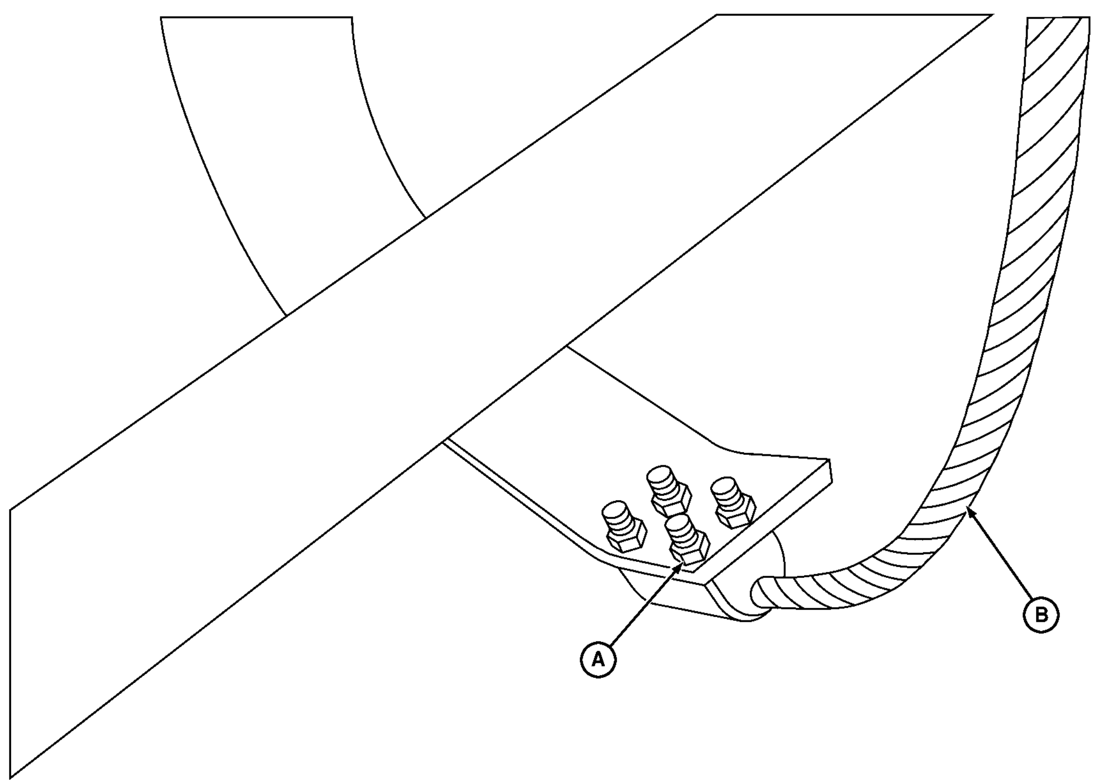
13. Remove four screws (H), upper clamp support (I), two elastic pins (J), two shims (K), and two shims (L).

14. Remove four screws (M), brake reducer motor (N), two elastic pins (O), two shims (P), and two shims (Q).

15. Remove central tube (R).

16. Remove four screws (S), lower support (T), two elastic pins (U), two shims (V), and two shims (W).

CED,OUOE019,4 –19–09MAR99–9/23



T121453

T121453 –UN–01JUN99

A—Nut (4 used)
B—Cable

17. Remove four nuts (A) and disconnect cable (B).

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CED,OUOE019,4 –19–09MAR99–10/23

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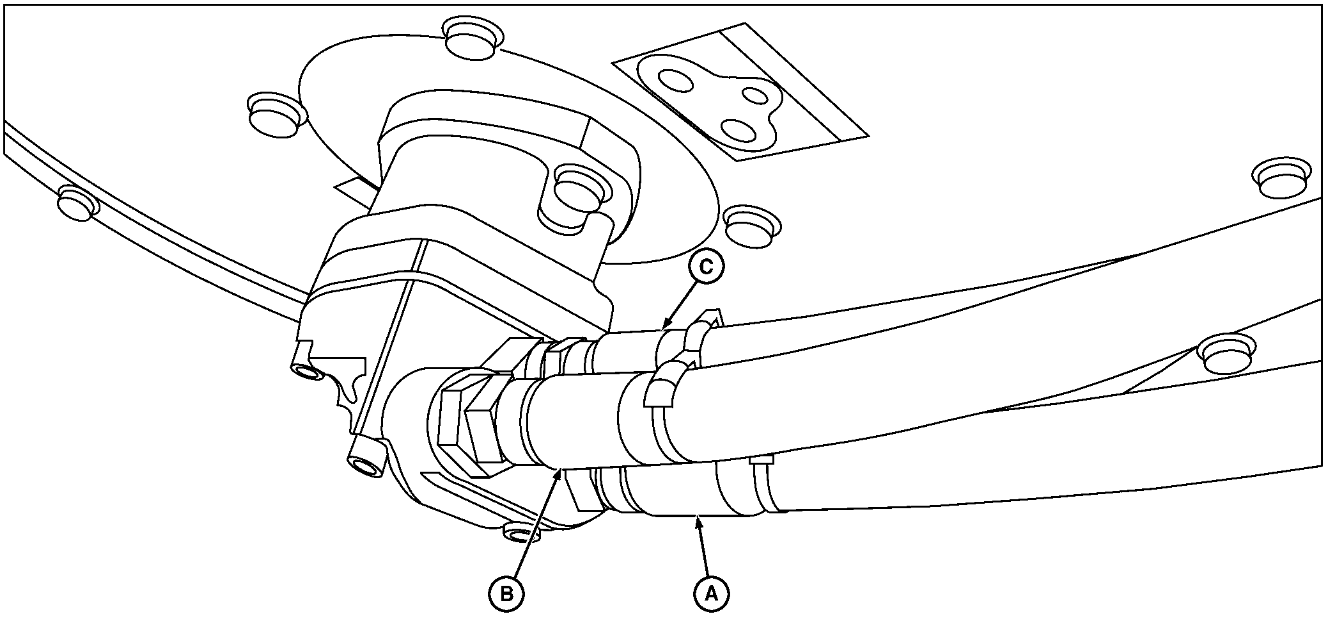

T121454

A—Hydraulic Hose B—Hydraulic Hose C—Hydraulic Hose

18. Remove three hydraulic hoses (A, B, and C).

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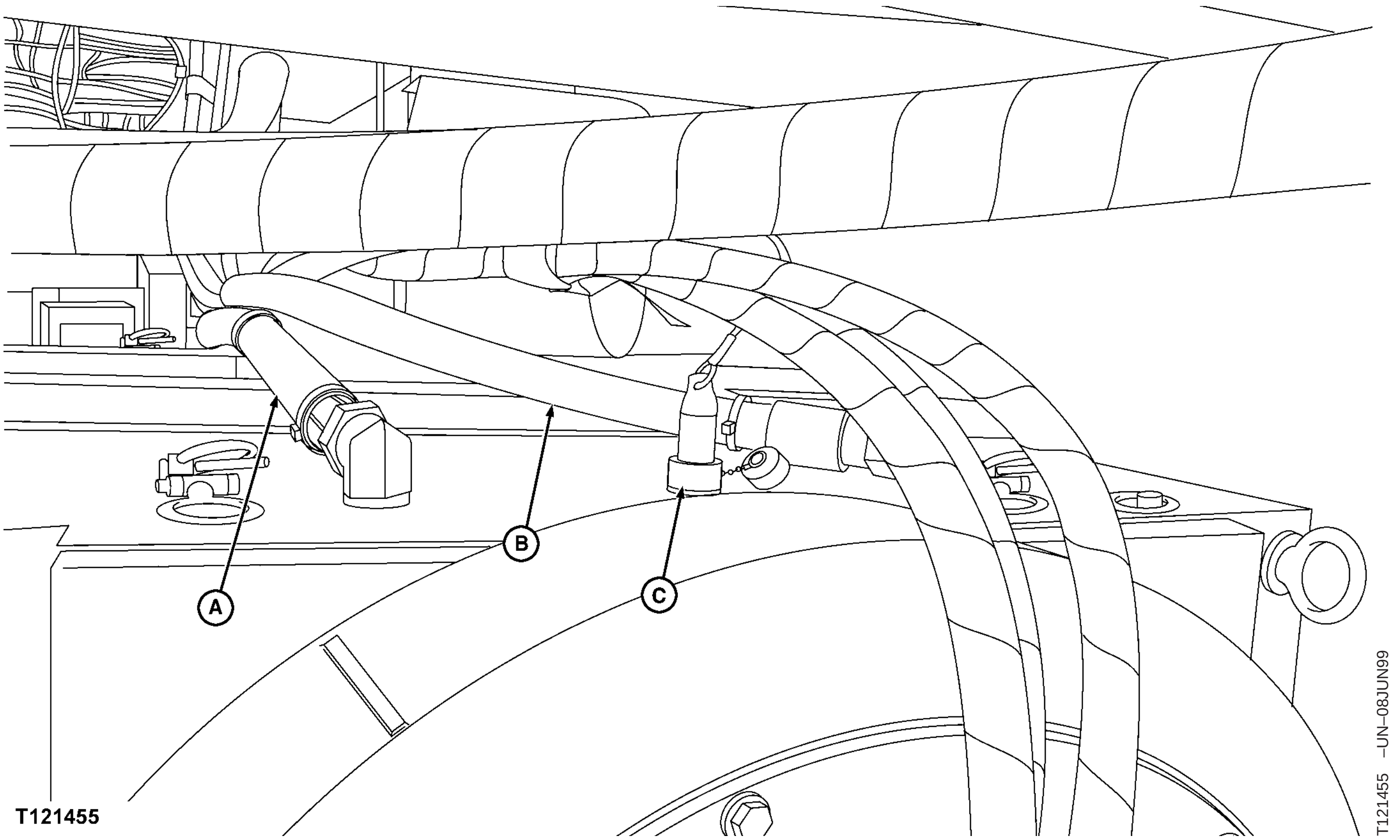

A—Air Line **B—Air Line** **C—Harness Connector**

19. Remove two air lines (A and B).

20. Remove harness connector (C).

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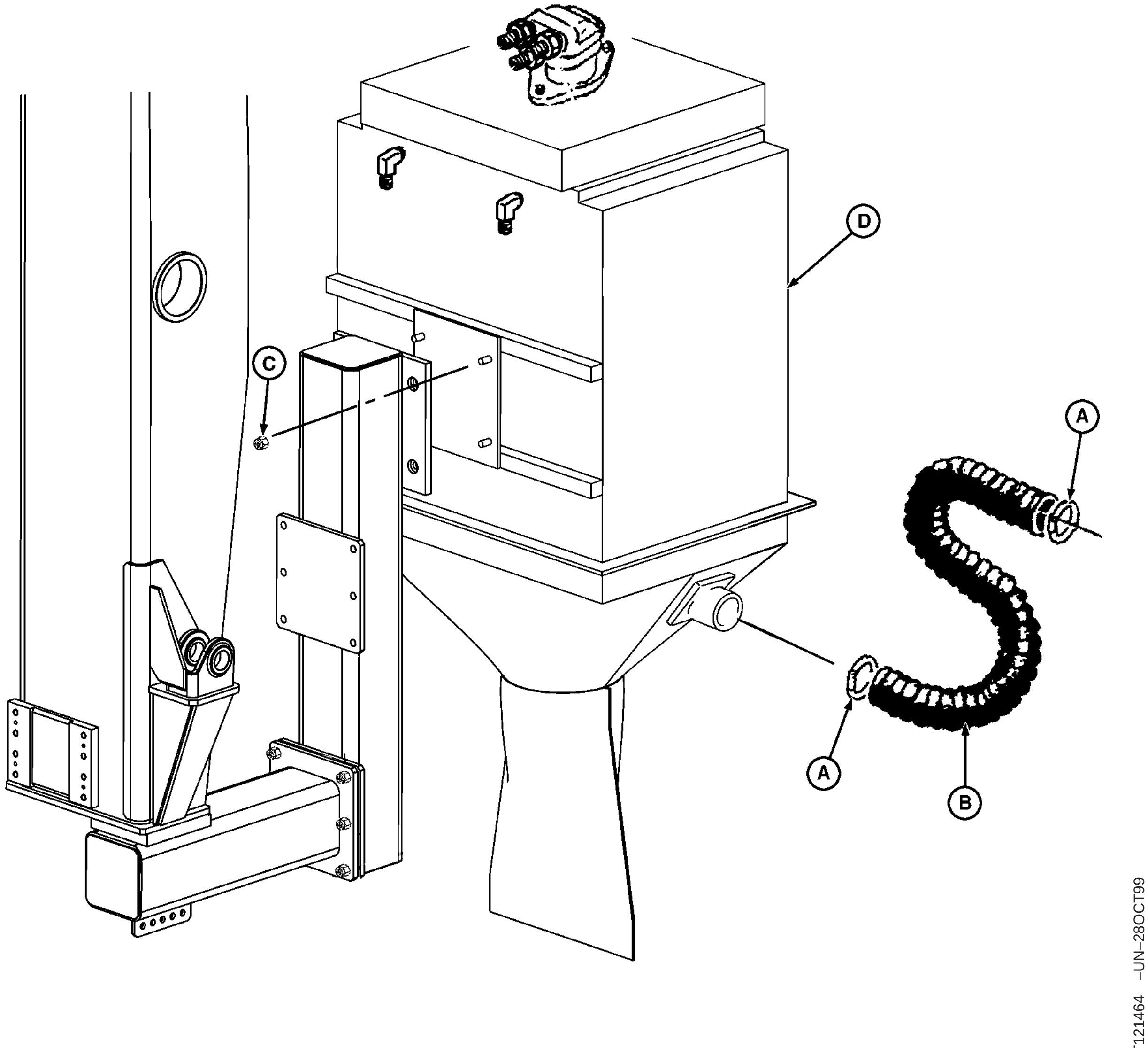

T121464

A—Clamp (2 used) B—Suction Hose C—Nut (4 used) D—Dust Collector

21. Remove two clamps (A) and suction hose (B).

22. Remove four nuts (C) and dust collector (D).

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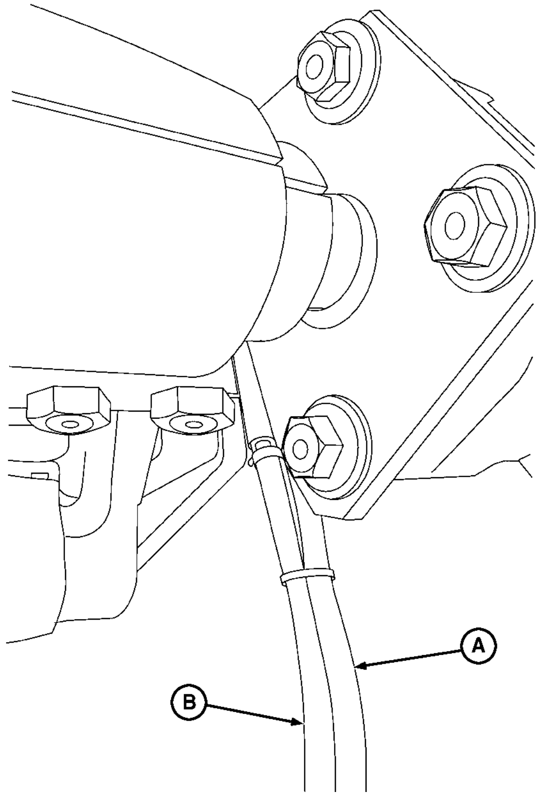
CED,OUOE019,4 –19–09MAR99–13/23

Rock Drill



A—Hydraulic Hose **B—Hydraulic Hose**

23. Remove hydraulic hoses (A and B).

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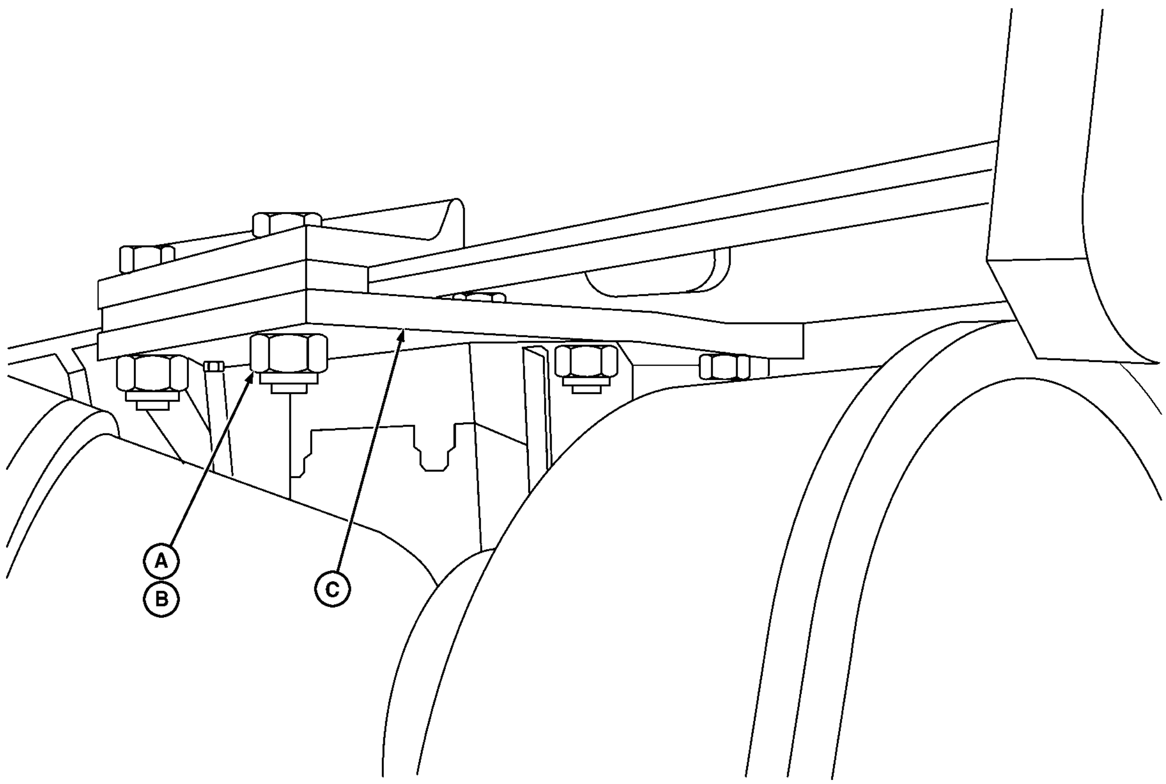
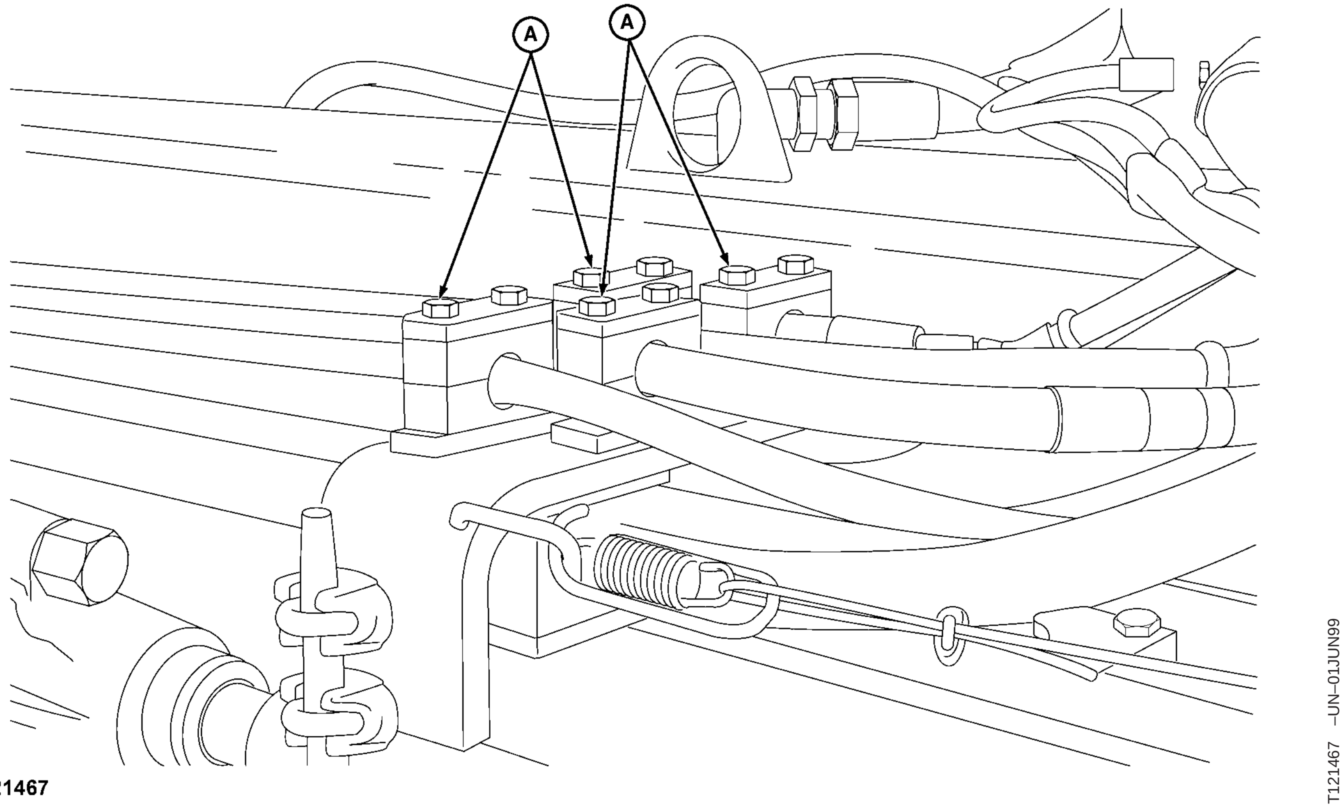


A—Bolt (5 used) **B—Nut (5 used)** **C—Bit Cover**

24. Remove five bolts (A), nuts (B), and bit cover (C).

Continued on next page CED,OUOE019,4 –19–09MAR99–15/23



A—Clamp (4 used)

25. Remove four clamps (A).

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Rock Drill

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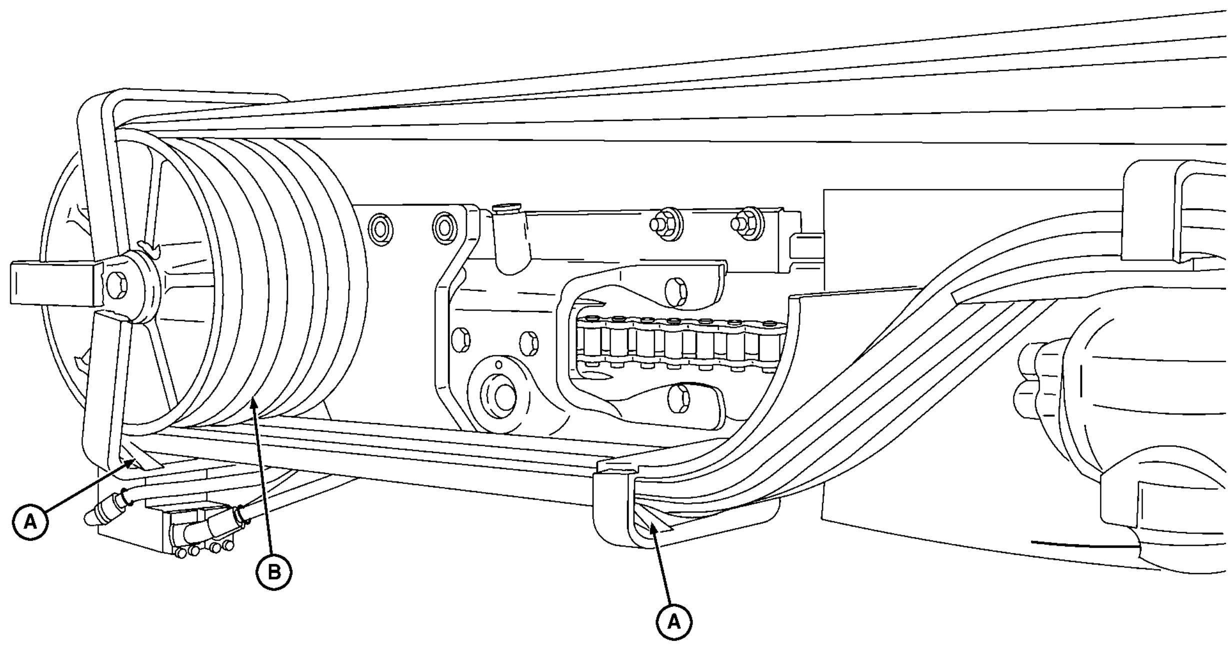

T121470

A—Guide (2 used) **B—Hydraulic Hose**

26. Remove two guides (A).

27. Remove hydraulic hose (B).

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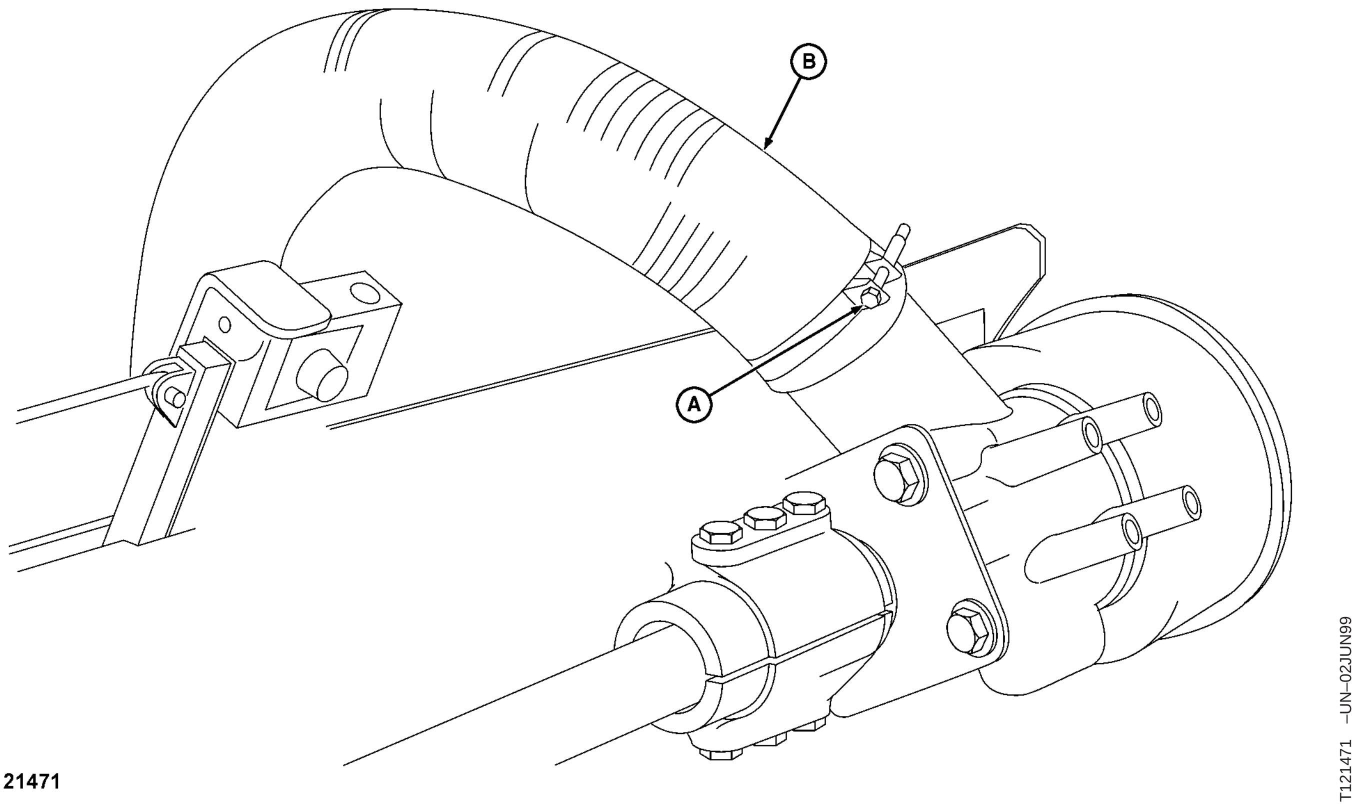
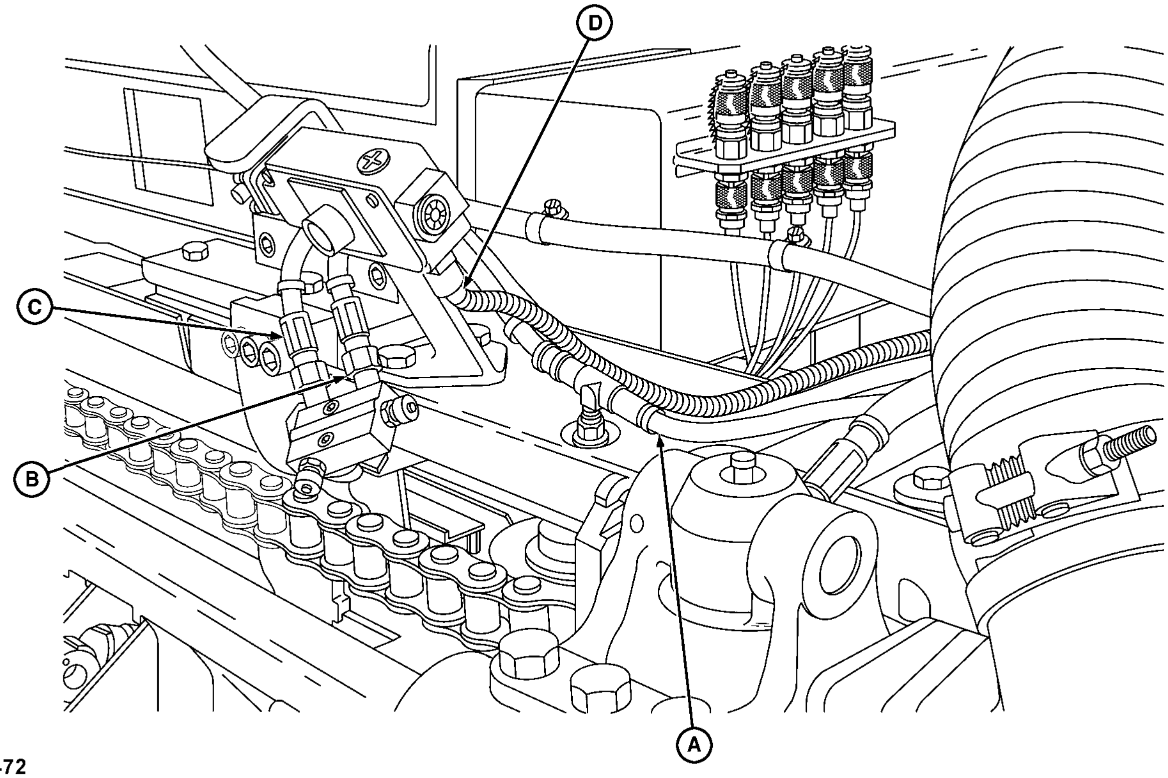


A—Clamp **B—Vacuum Hose**

28. Remove clamp (A), and vacuum hose (B).

Continued on next page CED,OUOE019,4 –19–09MAR99–18/23



T121472

A—Hydraulic Hose
B—Hydraulic Hose
C—Hydraulic Hose
D—Emergency Stop Switch Harness

29. Remove hydraulic hoses (A through C).

30. Remove emergency stop switch harness (D).

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CED,OUOE019,4 –19–09MAR99–19/23

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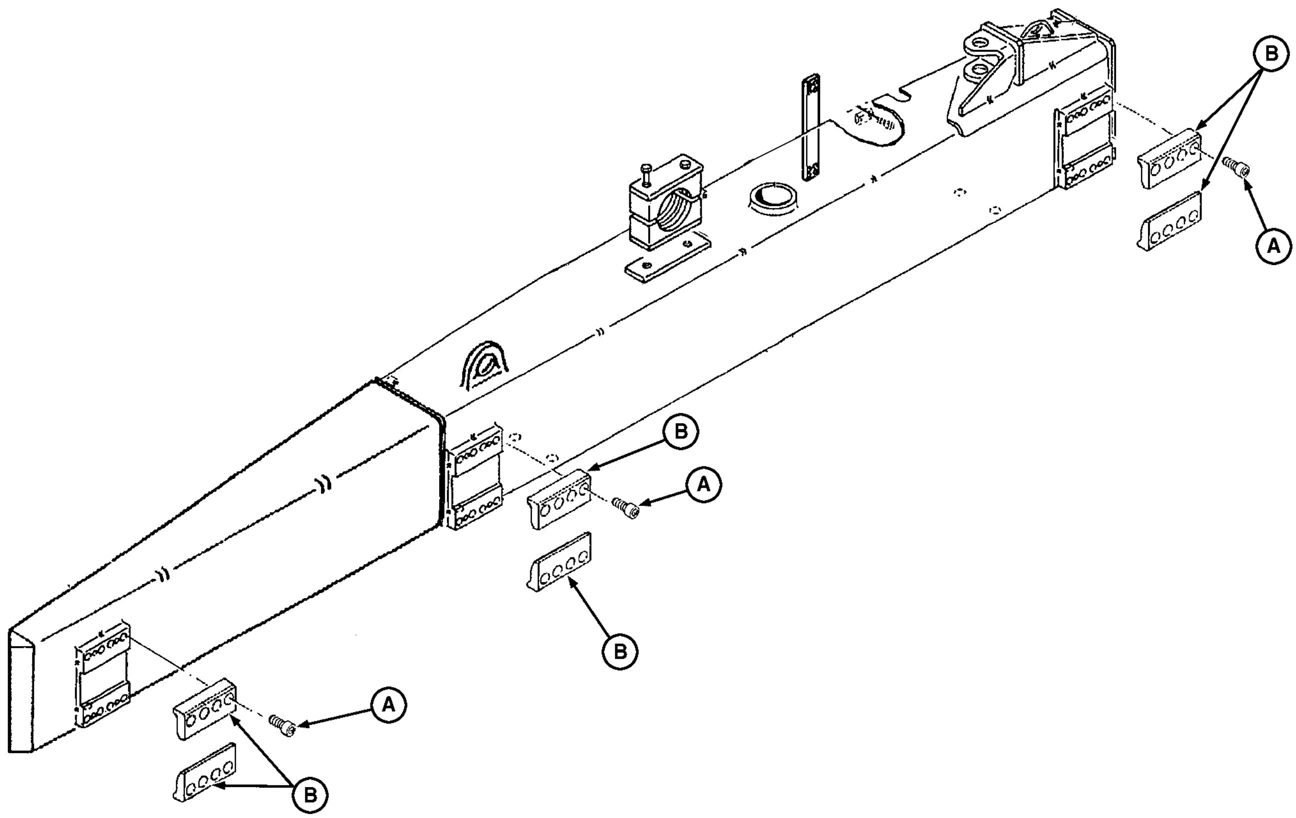

T121473

T121473 –UN–28OCT99

A—Screw (24 used) **B—Clamp (6 used)**

31. Remove 24 screws (A) and six clamps (B).

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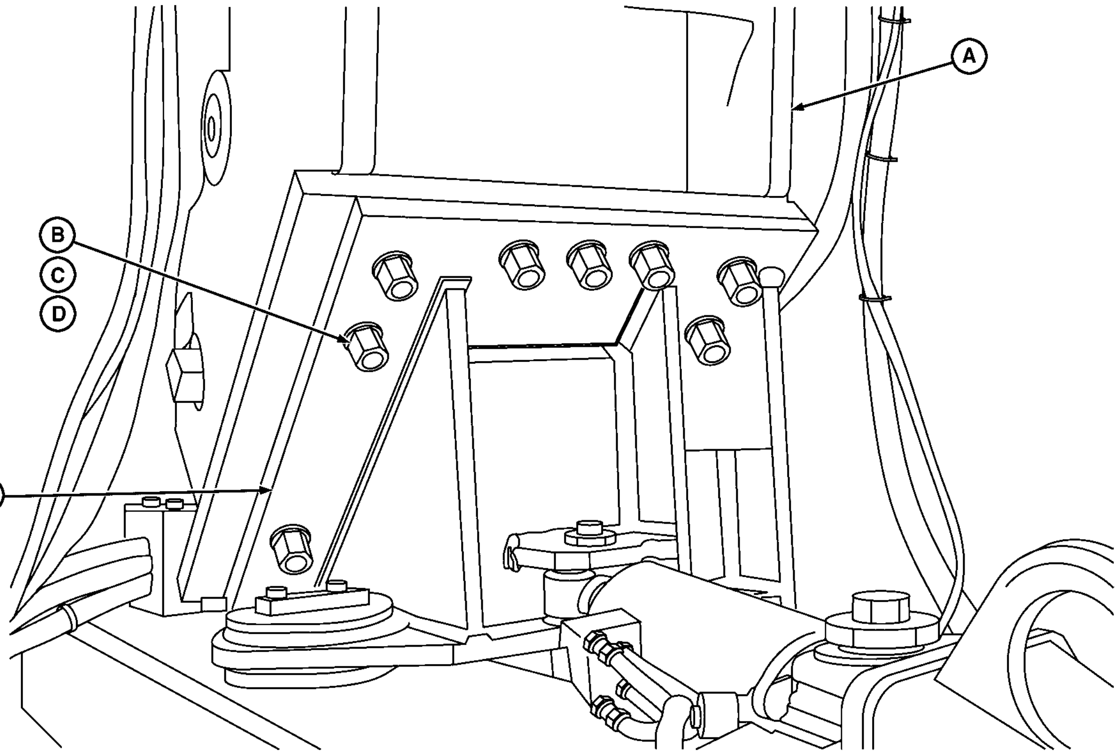


A—Hitch Adapter
B—Screw (14 used)
C—Washer (28 used)
D—Nut (14 used)
E—Cradle and Articulator Assembly

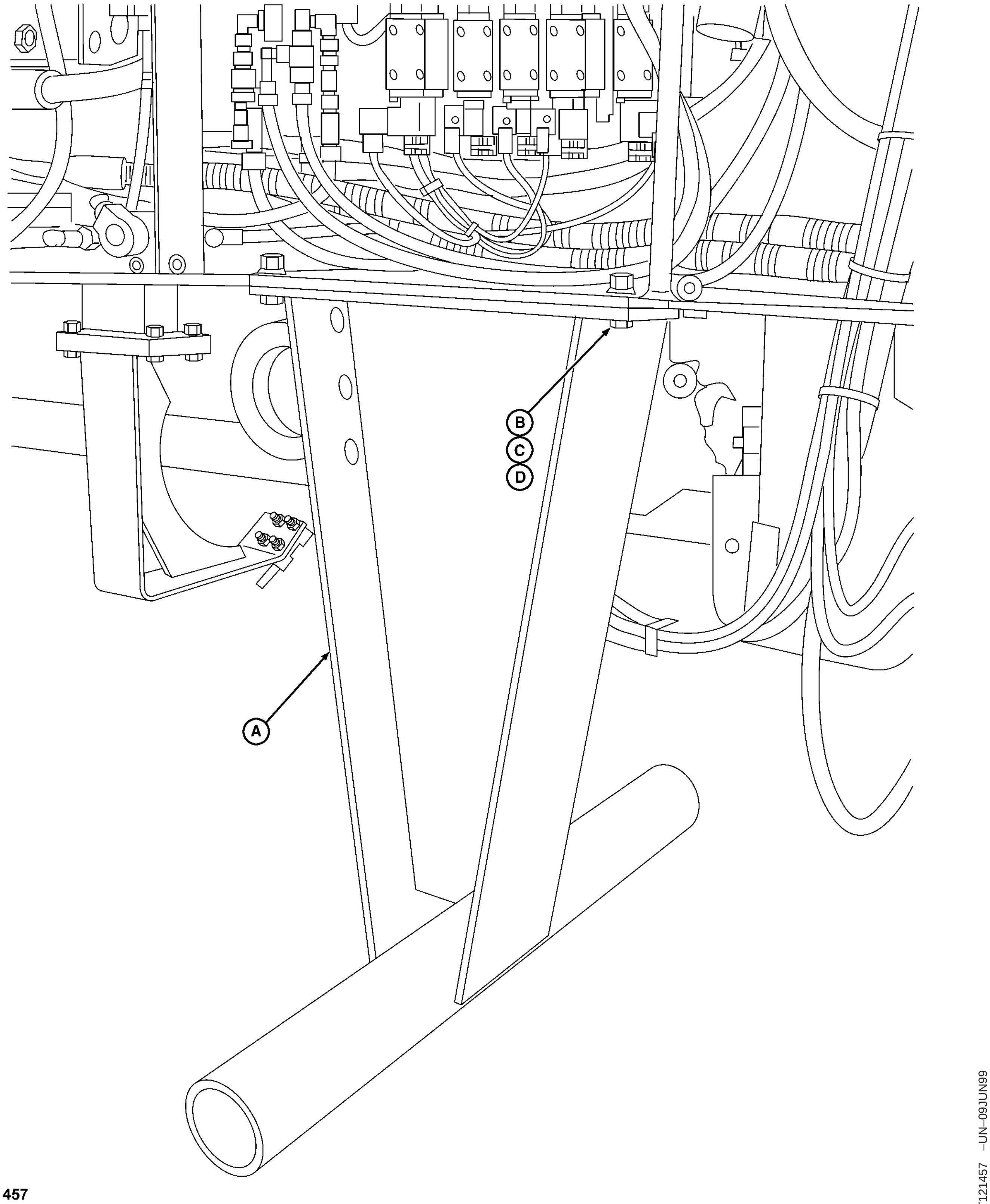
32. Attach a lifting device to hitch adapter (A).

33. Remove 14 screws (B), 28 washers (C), and 14 nuts (D).

34. Remove hitch adapter (A) from cradle and articulator assembly (E).

Continued on next page CED,OUOE019,4 –19–09MAR99–21/23

Rock Drill



T121457

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Rock Drill

A—Cradle and Articulator Assembly
B—Bolt (8 used)
C—Washer (8 used)
D—Nut (8 used)
E—Support Leg (2 used)

35. Support cradle and articulator assembly (A) and remove four bolts (B), washers (C), and nuts (D) from each support leg (E).

36. Remove both support legs (E).

CED,OUOE019,4 –19–09MAR99–23/23

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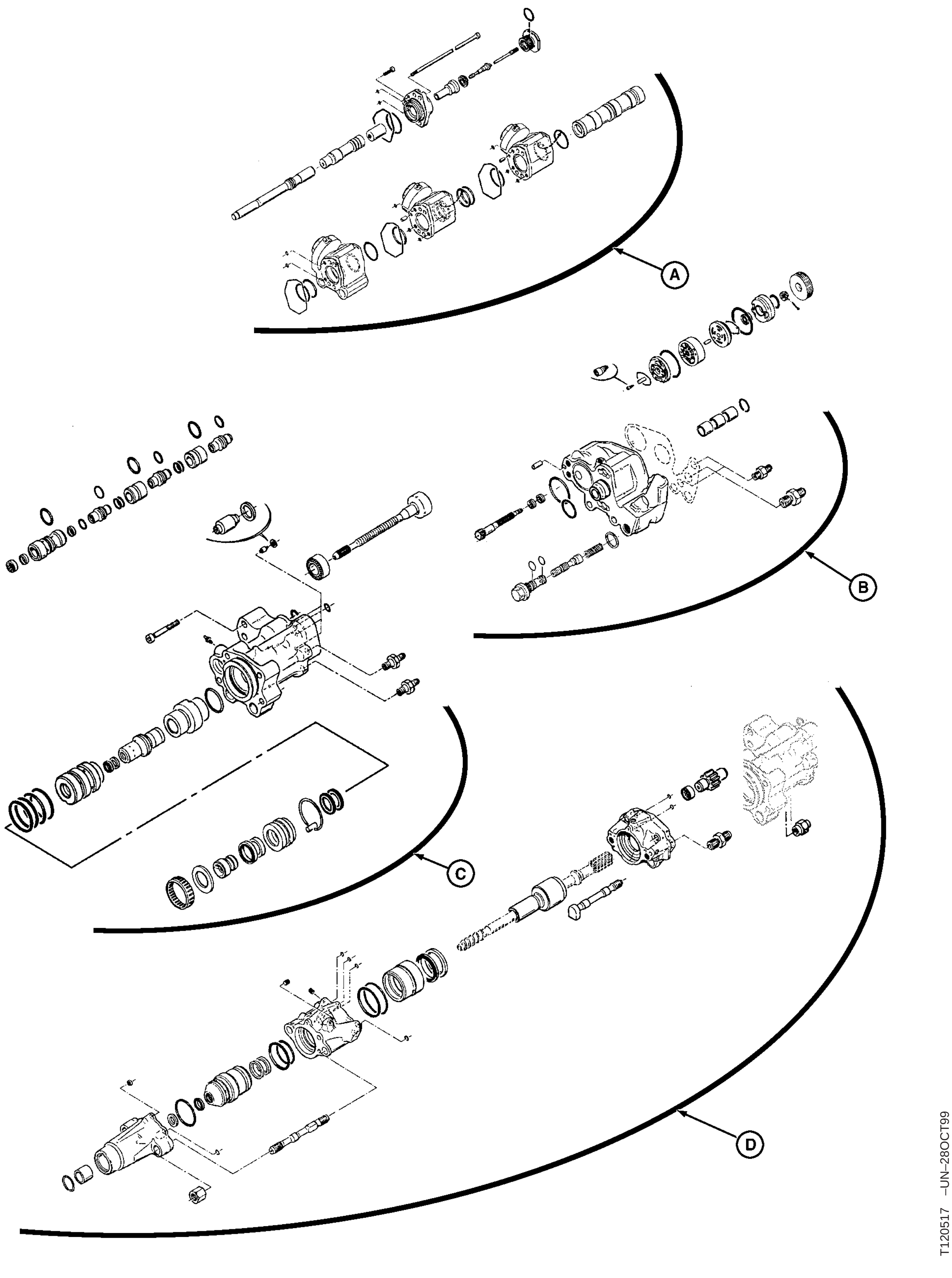
DISASSEMBLE AND ASSEMBLE HYDRAULIC DRIFTER



T120517

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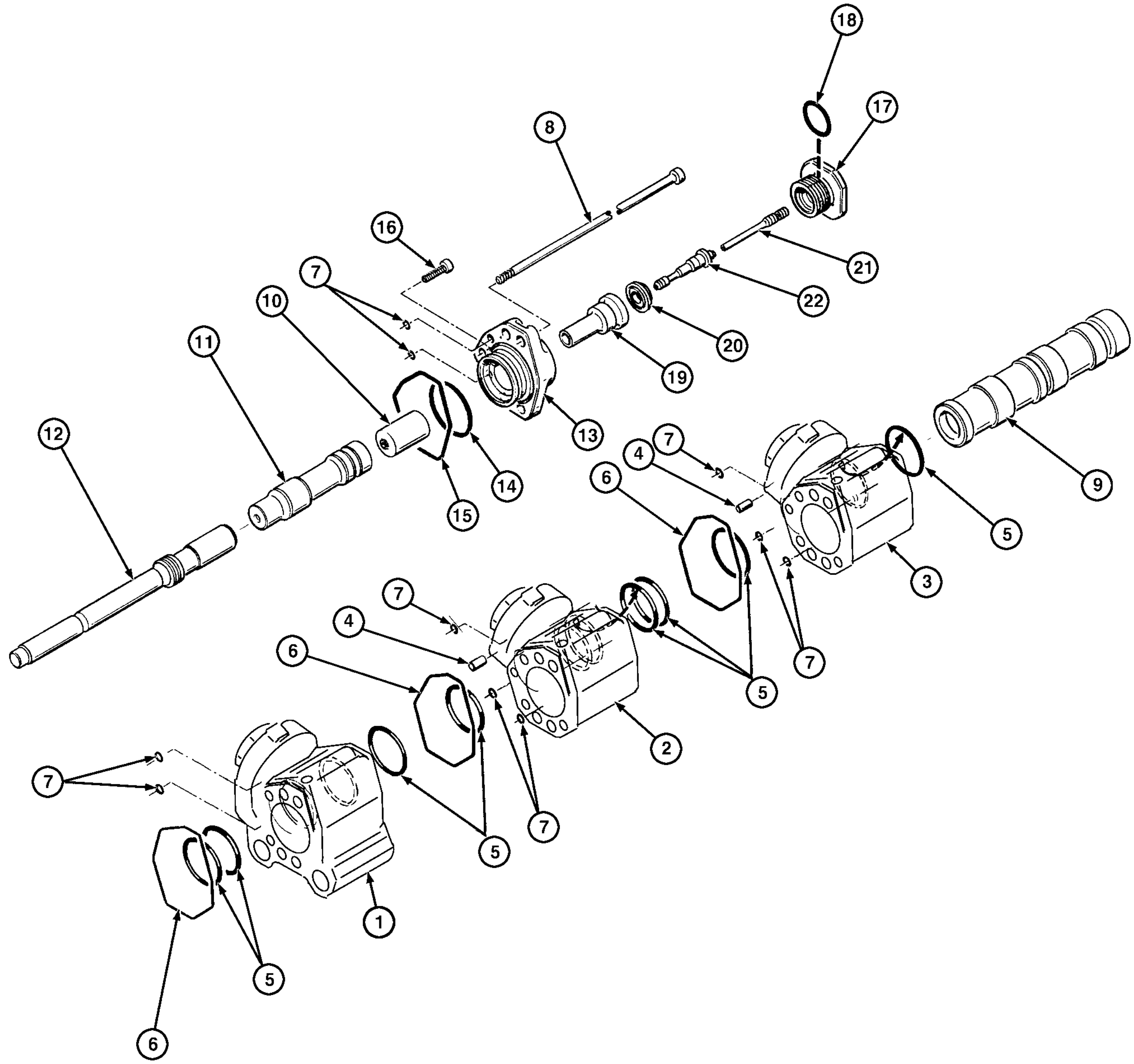

DETAIL A

T120518

T120518 –UN–13APR99

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Rock Drill

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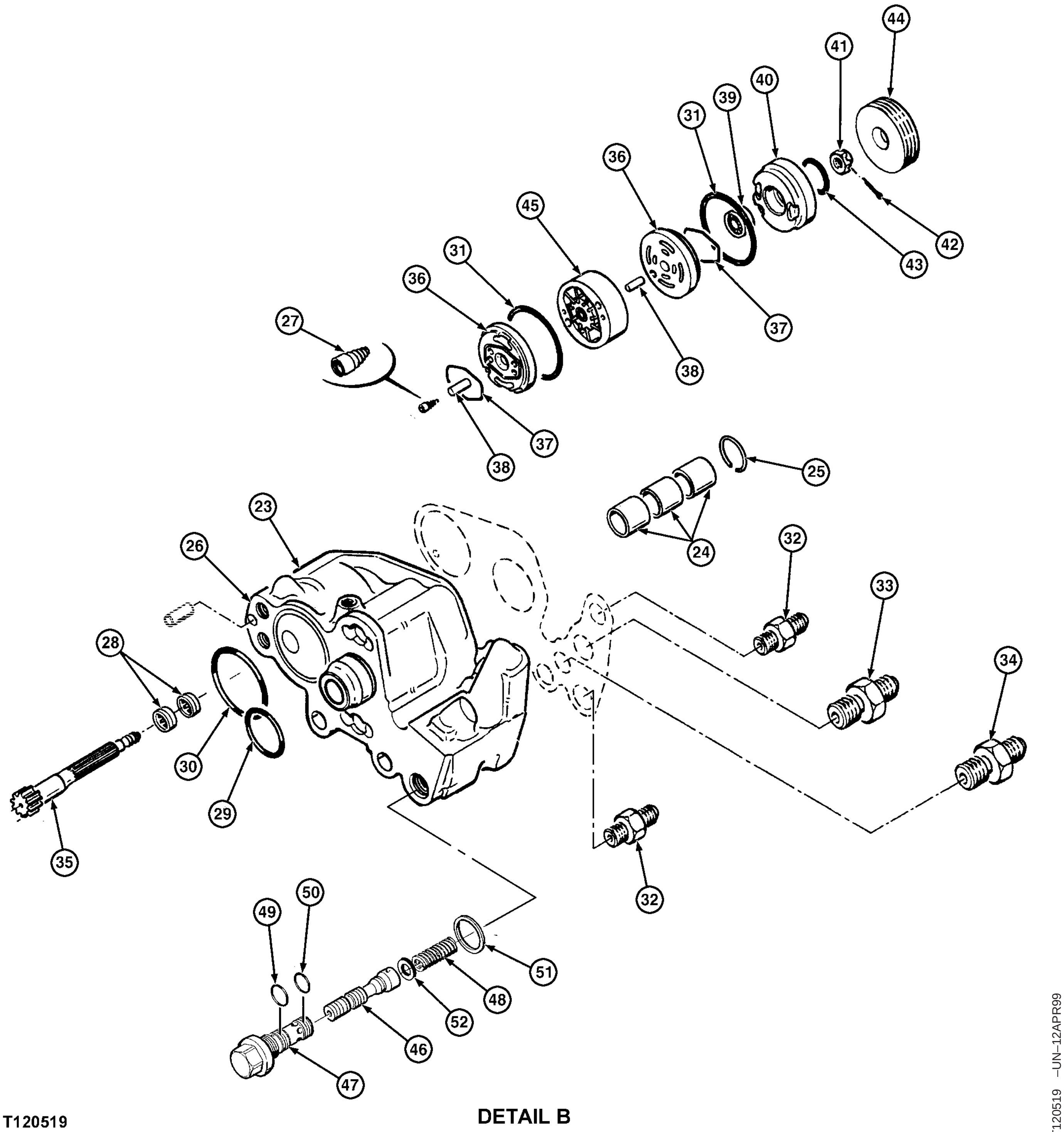

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CED,OUOE019,5 –19–09MAR99–3/20

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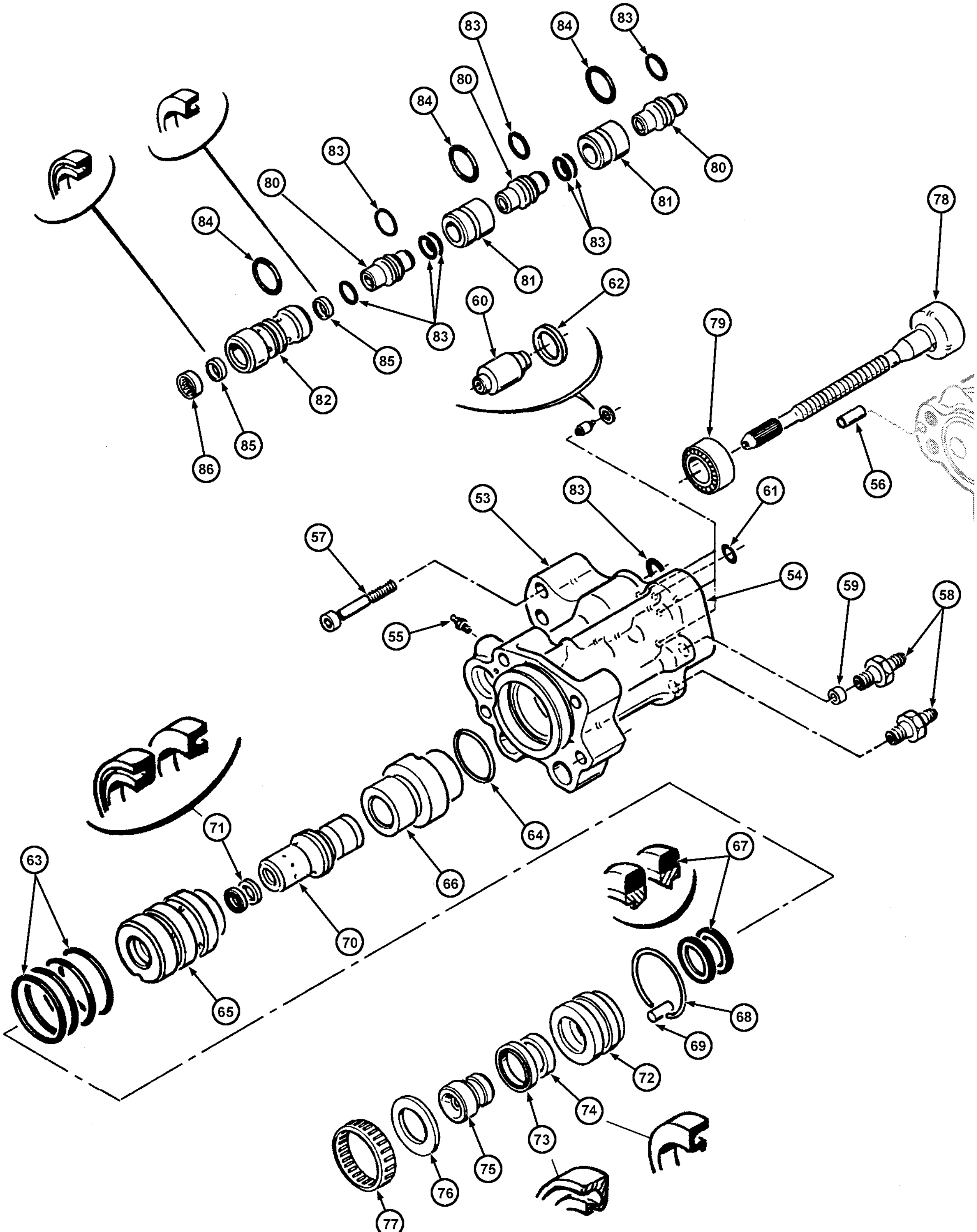

T120520

DETAIL C

T120520 –UN–13APR99

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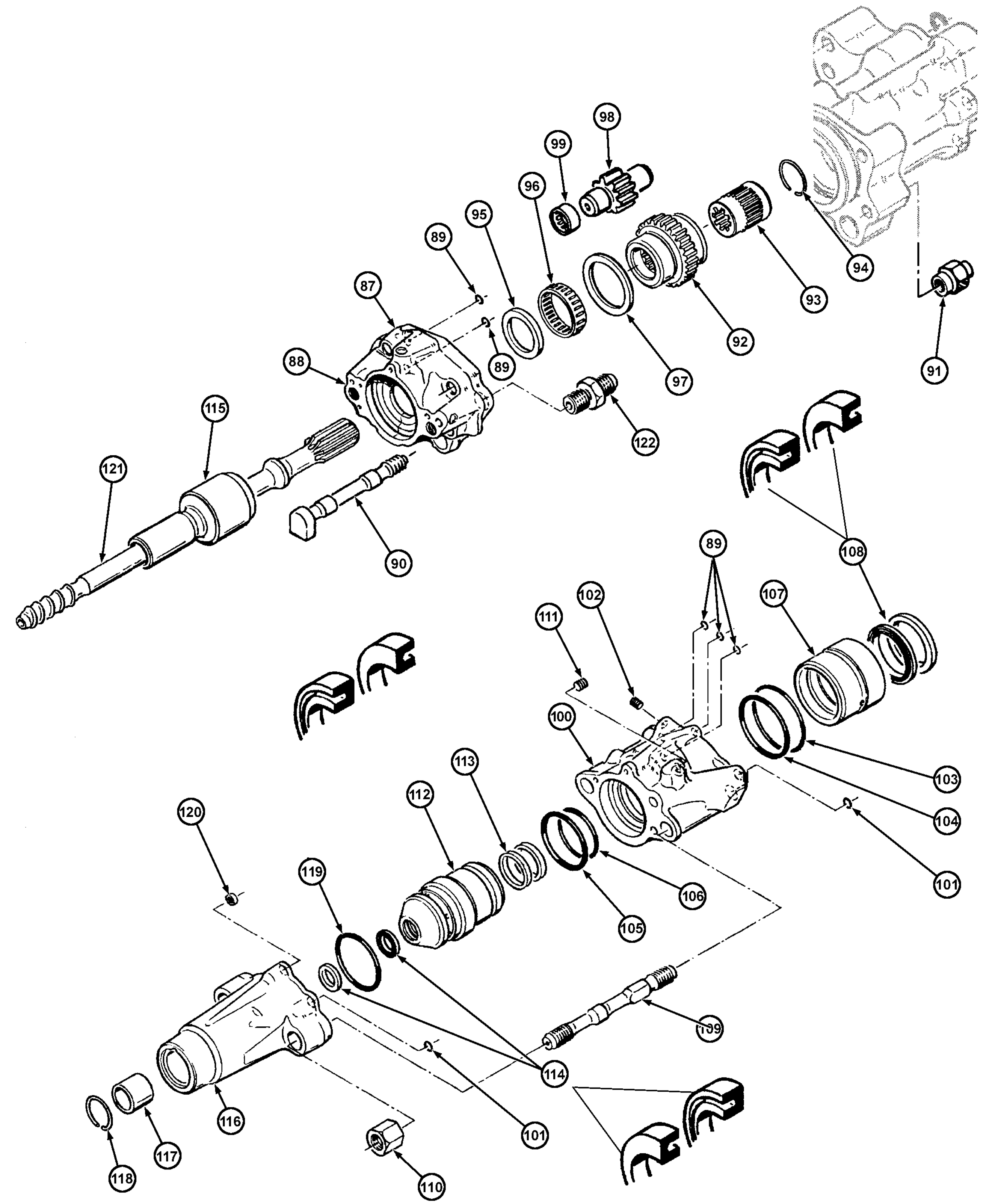
CED,OUOE019,5 –19–09MAR99–4/20

Rock Drill



T120521

DETAIL D

T120521 –UN–13APR99

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Rock Drill

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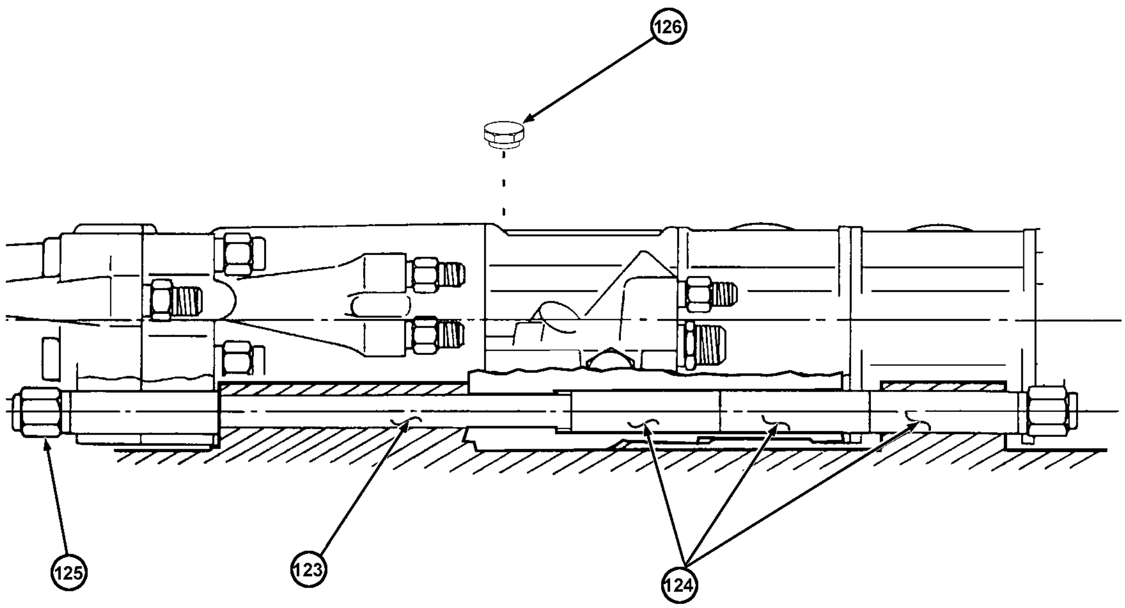

T120522

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CED,OUOE019,5 –19–09MAR99–6/20

1—LP Accumulator
2—HP Accumulator-Central
3—HP Accumulator
4—Pin (2 used)
5—O-Ring (8 used)
6—O-Ring (3 used)
7—Tight Seal (10 used)
8—Screw (4 used)
9—Cylinder
10—Distributor
11—Thrust Piston
12—Piston
13—Cover
14—O-Ring
15—O-Ring
16—Screw
17—Plug
18—O-Ring
19—Cover
20—Valve
21—Push Rod
22—Lining
23—Motor Body
24—Guiding Ring (3 used)
25—Snap Ring
26—Helicoil (2 used)
27—Spring
28—Needle Bearing (2 used)
29—O-Ring
30—O-Ring
31—O-Ring (2 used)
32—Adapter (2 used)
33—Adapter
34—Adapter
35—Shaft
36—Plate (2 used)
37—O-Ring (2 used)
38—Pin (2 used)
39—Ball Bearing
40—Plate
41—Nut
42—Pin
43—O-Ring
44—Cover
45—Cartridge (Type 055)
46—Slider
47—Lining
48—Spring
49—O-Ring
50—O-Ring
51—BS Ring
52—Adjusting Shim (As Required)
53—Thrust Housing
54—Helicoil (4 used)
55—Oiler
56—Pin
57—Screw (2 used)
58—Adapter
59—Restrictor
60—Valve (3 used)
61—Face Seal
62—Tight Seal (3 used)
63—O-Ring (4 used)
64—O-Ring
65—Front Lining
66—Rear Lining
67—Composite Seal (2 used)
68—Snap Ring
69—Pin
70—Hydraulic Stop Piston
71—Seal (2 used)
72—Guide
73—Centering Part
74—Centering Part
75—Shank Stop
76—Ring
77—Needle Bearing
78—Shaft
79—Ball Bearing
80—Tight Ring (3 used)
81—Tight Ring (2 used)
82—Tight Ring
83—O-Ring (9 used)
84—O-Ring (3 used)
85—Seal (2 used)
86—Needle Bearing
87—Housing
88—Helicoil (2 used)
89—O-Ring (5 used)
90—Screw
91—Nut (4 used)
92—Gear
93—Splined Nut
94—Snap Ring
95—Ring
96—Needle Bearing
97—Ring
98—Gear
99—Needle Bearing
100—Housing
101—Tight Seal (2 used)
102—Plug
103—O-Ring
104—O-Ring
105—O-Ring
106—O-Ring
107—Rear Lining
108—Seal (2 used)
109—Gudgeon (2 used)
110—Nut (2 used)
111—Plug
112—Front Lining
113—Lip Seal (2 used)
114—Lip Seal (2 used)
115—Retainer
116—Front Guide
117—Guiding Ring
118—Snap Ring
119—O-Ring
120—Seal
121—Shank
122—Adapter
123—Gudgeon (2 used)
124—Ring (8 used)
125—Nut (4 used)
126—Plug

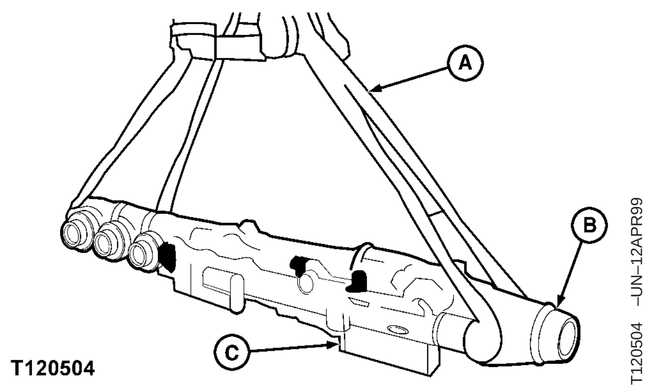
CED,OUOE019,5 –19–09MAR99–7/20

CAUTION: The approximate weight of hydraulic drifter is 2700 kg (5948 lb).

Hydraulic Drifter—Specification

Weight.. 2700 kg (5948 lb)

1. Using a sling (A) lift hydraulic drifter (B) and place it on clamping assembly, 59829 (C).



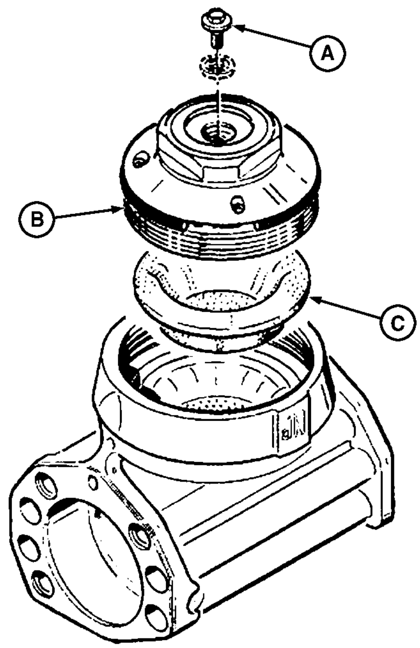
A—Sling
B—Hydraulic Drifter
C—Clamping Assembly

Continued on next page CED,OUOE019,5 –19–09MAR99–8/20

44
9506
38

2. Using spanner, 66223 in accumulator nitrogen inflation kit, drain nitrogen off by unscrewing inflating screw (A).

3. Using special socket, 95372 and wrench with a 1-inch square driver, remove cover (B).



T120508

A—Inflating Screw
B—Cover
C—Diaphragm

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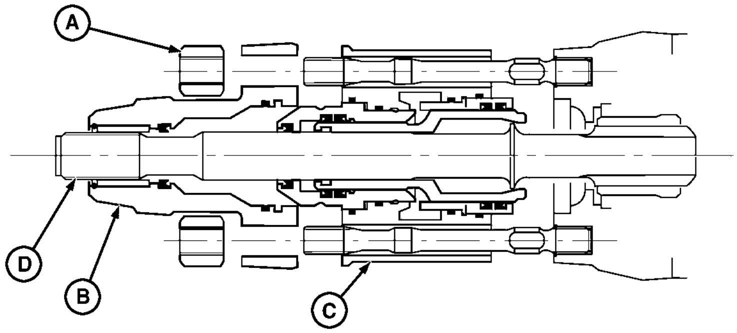
CED,OUOE019,5 –19–09MAR99–9/20



A—Nut (2 used) **B—Front Guide** **C—Front Housing** **D—Shank**

4. Remove two nuts (A).

5. Remove front guide (B).

6. Remove front housing (C).

7. Remove and discard all O-rings and lip seals from front guide (B) and front housing (C).

8. Remove shank (D).

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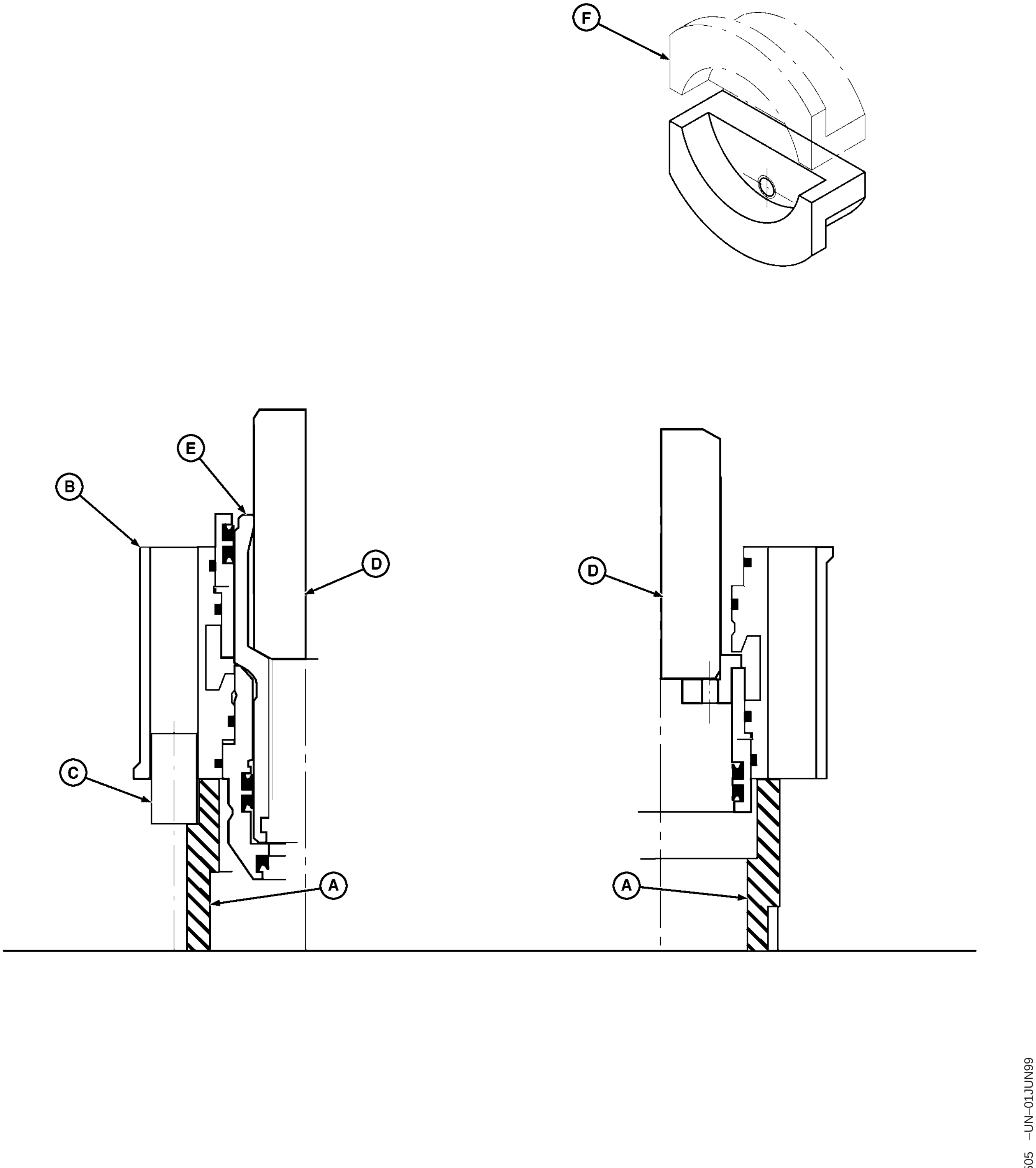
Rock Drill



T120505

A—Clamping Assembly
B—Front Housing
C—Locating Pin (2 used)
D—Spacer
E—Retainer
F—Half Shell (2 used)

Continued on next page

CED,OUOE019,5 –19–09MAR99–11/20

NOTE: Front and rear linings must be extracted by using an hydraulic press and special tools.

10. Place clamping assembly, 59829 (A) on hydraulic press block.

11. Place the front housing (B) on the clamping assembly, 59829 (A).

12. Insert two locating pins (C) in the rear of the front housing (B). Adjust the position of the front housing so that the pins drop into place.

13. Insert spacer (D) in retainer (E).

14. Press Spacer (D) to pull front lining out.

15. Turn clamping assembly, 59829 (A) upside down.

16. Place front housing (B) on clamping assembly, 59829 (A).

17. Using a handling screw (100 mm long), insert the two half shells (F).

18. Turn spacer (D) upside down and insert two half shells.

19. Press spacer (D) to pull rear lining out.

20. Remove and discard all O-rings and lip seals from front housing (B).

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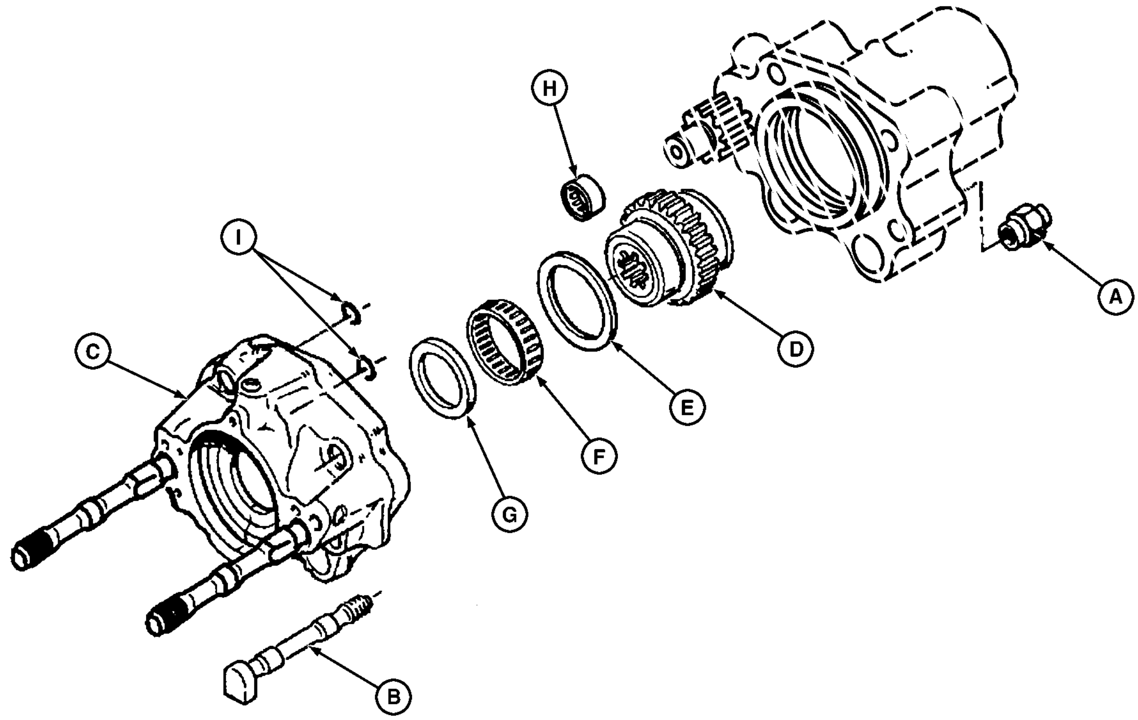

A—Nut (4 used)
B—Screw (4 used)
C—Housing
D—Gear
E—Bronze Ring
F—Needle Bearing
G—Bronze Ring
H—Needle Bearing
I—O-Ring (2 used)

21. Remove four nuts (A) and screws (B).

22. Remove housing (C).

23. Remove gear (D), bronze rings (E and G), and needle bearings (F and H).

24. Remove and discard two O-rings (I).

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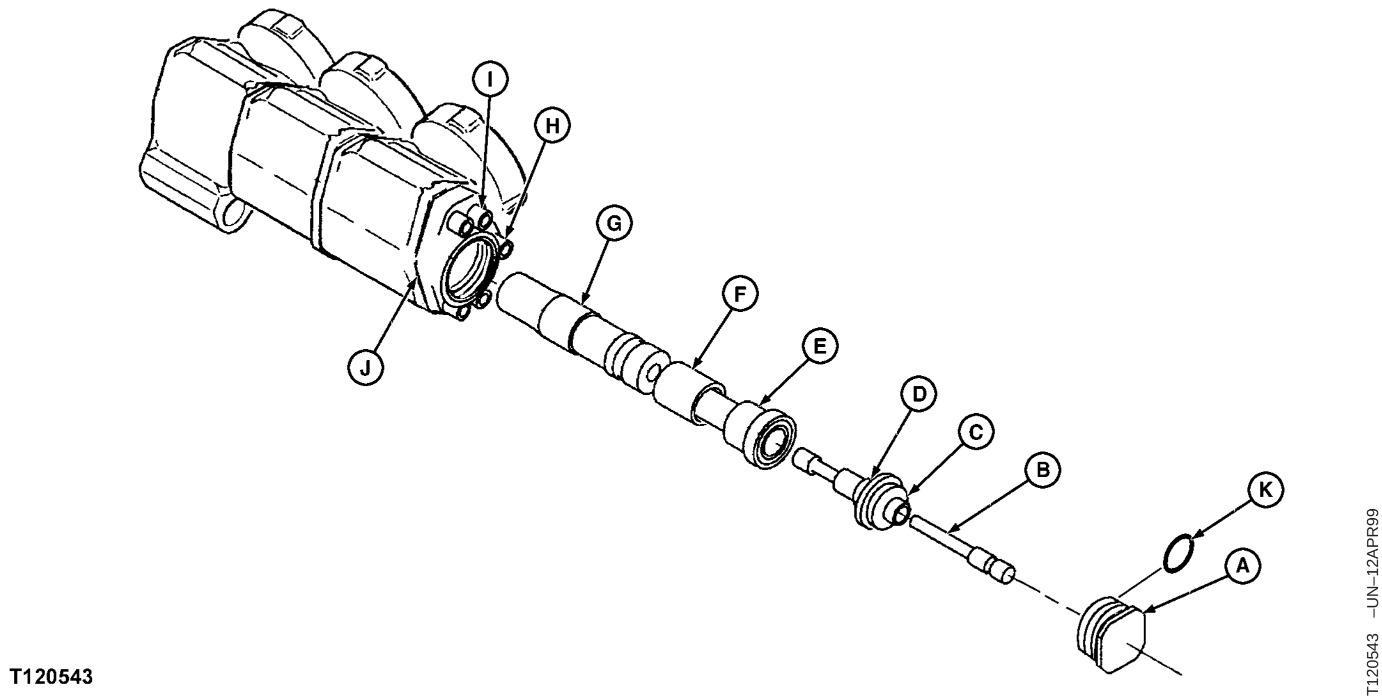
9506
43



A—Plug
B—Push Rod
C—Lining
D—Valve
E—Cover
F—Distributor
G—Thrust Piston
H—Screw
I—Tie Rod (4 used)
J—Cover
K—O-Ring

25. Using special socket, 95372 and a wrench with a 1-inch square driver, remove plug (A).

26. Remove and discard O-ring (K).

27. Remove push rod (B), lining (C), and valve (D).

28. Remove cover (E), distributor (F), and thrust piston (G).

29. Remove screw (H).

30. Remove four tie rods (I).

31. Remove cover (J).

Continued on next page CED,OUOE019,5 –19–09MAR99–14/20

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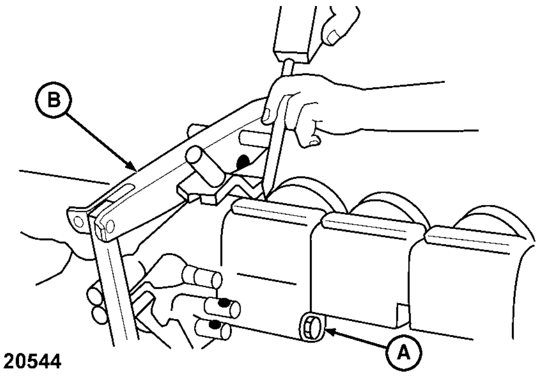
32. Loosen the accumulator block by prying with a chisel and hammer between LP accumulator (A) and motor body (B)

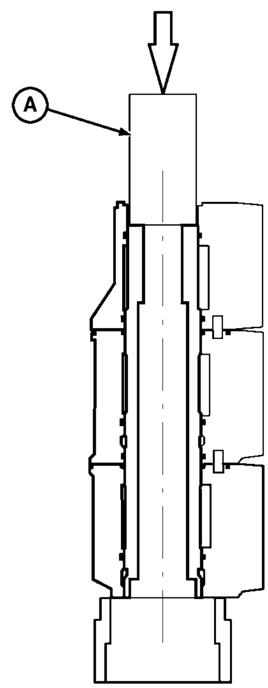


T120544

A—LP Accumulator
B—Motor Body

CED,OUOE019,5 –19–09MAR99–15/20

33. If required, remove cylinder (A) with a hydraulic press.



T120545

A—Cylinder

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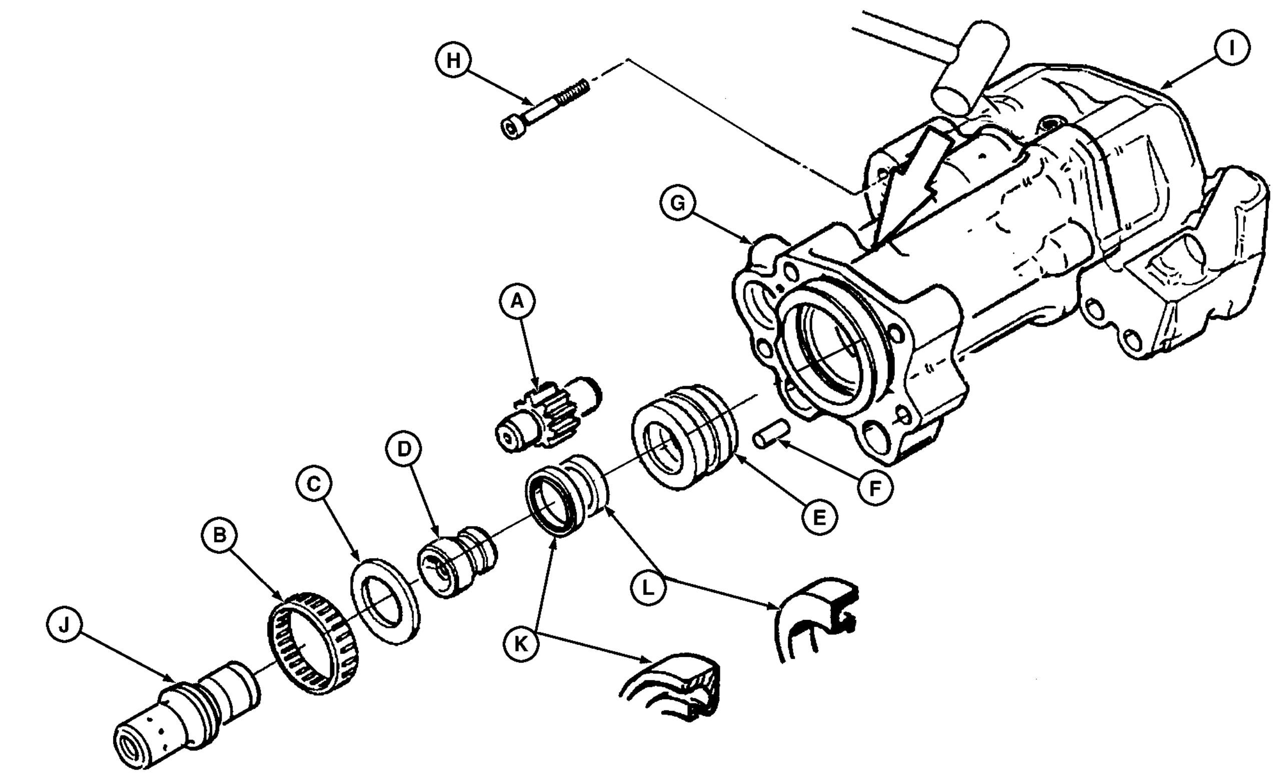
CED,OUOE019,5 –19–09MAR99–16/20



A—Gear
B—Needle Bearing
C—Bronze Ring
D—Shank Stop
E—Guide
F—Pin
G—Thrust Housing
H—Screw (2 used)
I—Motor Body
J—Hydraulic Stop Piston
K—Centering Part
L—Centering Part

34. Remove gear (A).

35. Remove needle bearing (B), bronze ring (C), shank stop (D), and guide (E).

36. Remove centering parts (K and L) from shank stop (D).

37. Remove pin (F).

38. Remove two screws (H).

CAUTION: Ensure hydraulic stop piston is in position before separating thrust housing from hydraulic stop body. This will prevent the hydraulic stop body from falling when extracted.

39. Using dismounting-mounting tools, 77796 separate thrust housing (G) from motor body (I).

40. Remove thrust housing (G).

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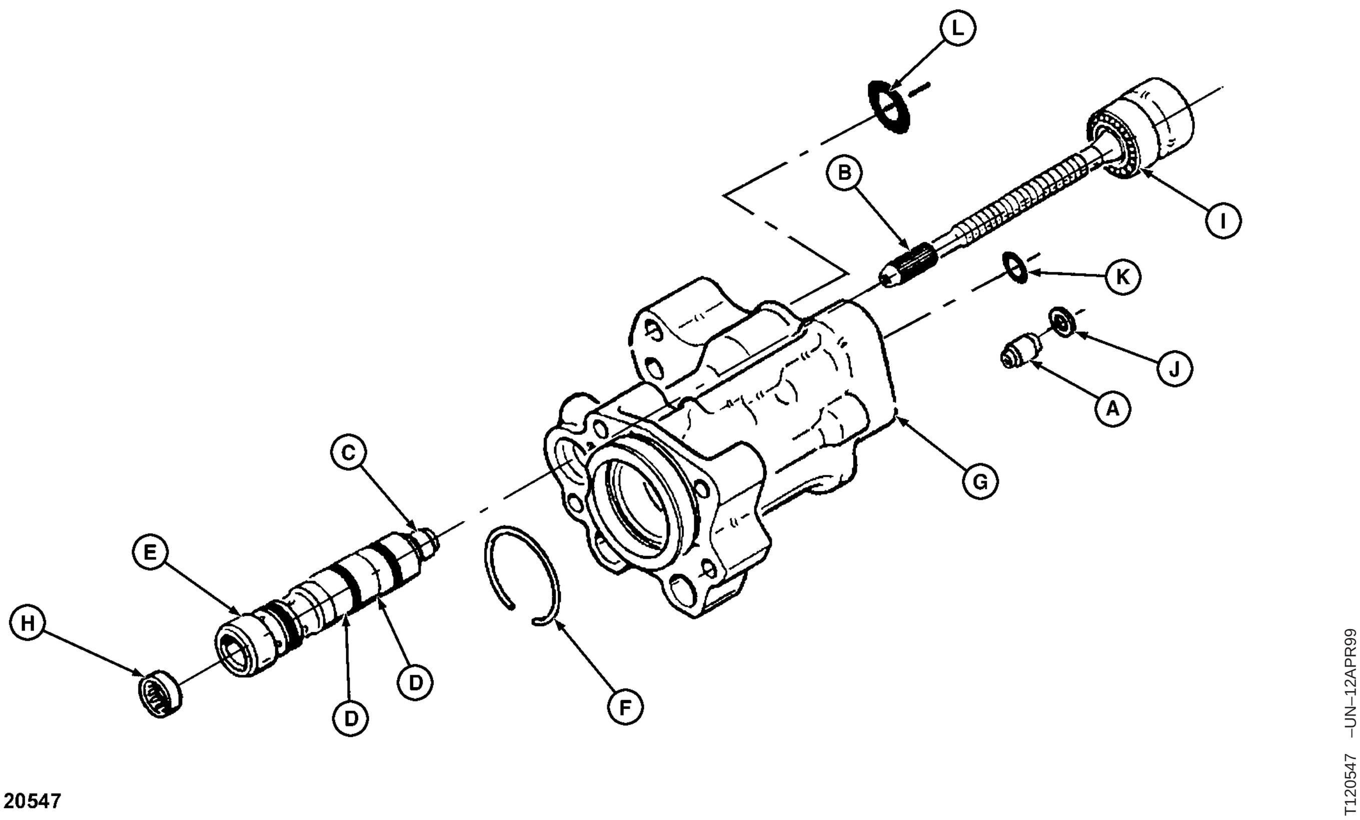

T120547

A—Valve (3 used)
B—Drive Shaft
C—Tight Ring
D—Tight Ring (2 used)
E—Tight Ring
F—Ring
G—Thrust Housing
H—Needle Bearing
I—Ball Bearing
J—Tight Seal (3 used)
K—Face Seal
L—O-Ring

41. Remove three valves (A) and tight seals (J). Discard the tight seals.

42. Remove drive shaft (B).

43. Remove ball bearing (I) from drive shaft (B).

44. Pull out tight rings (C, D, and E) using a plastic rod (1.38 dia by 9.84 inches long) inserted through the rear of thrust housing (G).

45. Remove and discard all O-rings and seals from the tight rings (C, D, and F).

46. Remove ring (F) with a screwdriver. Ensure that ring is not damaged during the removal.

47. Remove needle bearing (H).

48. Remove and discard O-ring (L).

49. Remove and discard face seal (K).

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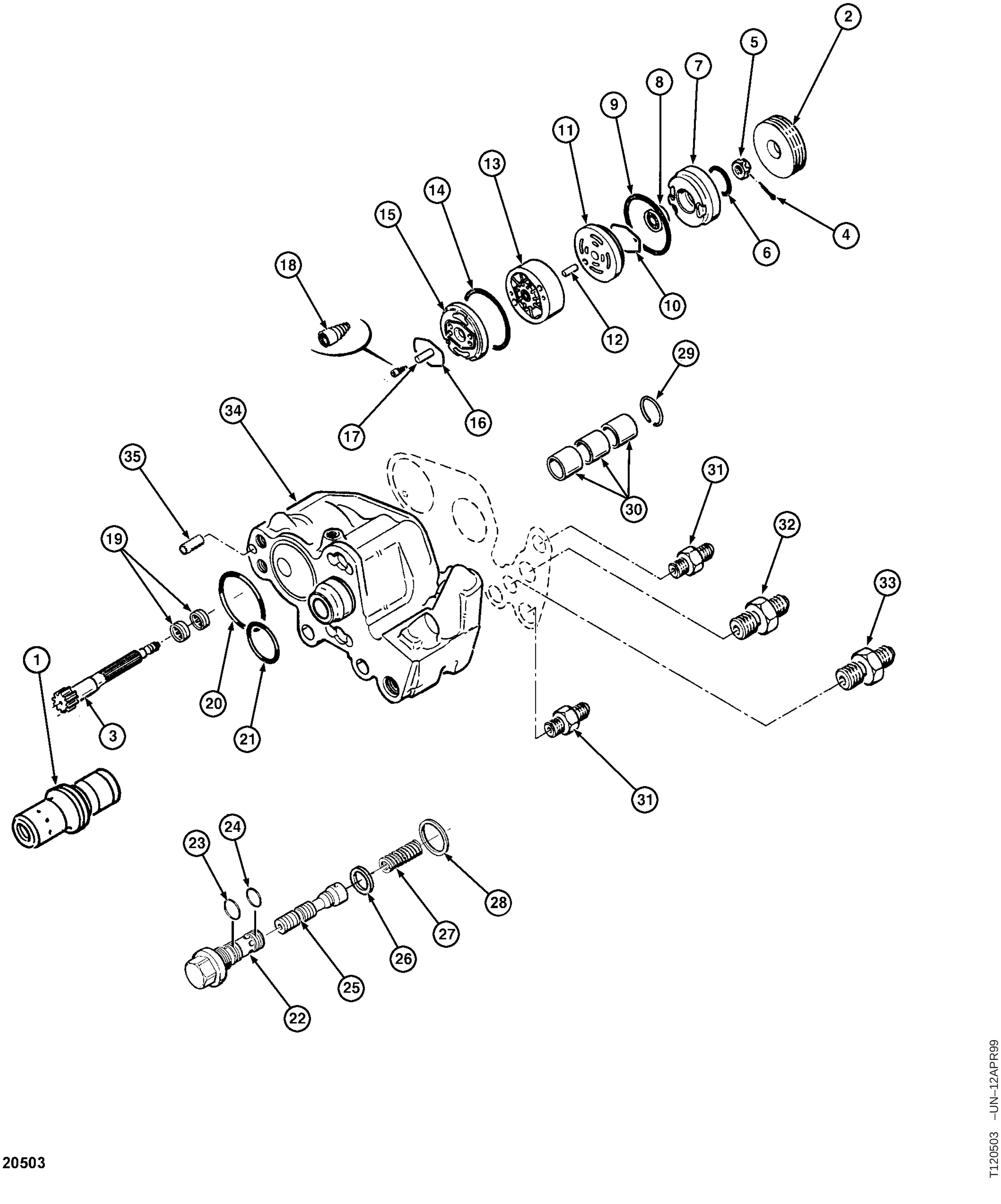
CED,OUOE019,5 –19–09MAR99–18/20

Rock Drill



T120503

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1—Hydraulic Stop Piston
2—Cover
3—Shaft
4—Pin
5—Nut
6—O-Ring
7—Plate
8—Ball Bearing
9—O-Ring
10—O-Ring
11—Plate
12—Pin
13—Cartridge (Type 055)
14—O-Ring
15—Plate
16—O-Ring
17—Pin
18—Spring
19—Needle Bearing (2 used)
20—O-Ring
21—O-Ring
22—Lining
23—O-Ring
24—O-Ring
25—Slider
26—Adjusting Shim (As Required)
27—Spring
28—BS Ring
29—Snap Ring
30—Guiding Ring (3 used)
31—Adapter (2 used)
32—Adapter
33—Adapter
34—Motor Body
35—Pin

50. Remove hydraulic stop piston (1).

51. Using flange, 59831, and two screws, remove cover (2).

52. Lock shaft (3) with gear locking tool 76173.

53. Remove pin (4).

54. Drive out shaft (3) using a small plastic hammer.

NOTE: Use a plastic hammer and mandrel, 60482 to drive out the remaining parts.

55. Remove O-ring (6), plate (7), ball bearing (8), and O-ring (9). Discard the O-rings.

56. Remove O-ring (10), plate (11), pin (12), and cartridge (13). Discard the O-ring.

57. Remove O-ring (14), plate (15), O-ring (16), pin (17), and spring (18). Discard the O-rings.

58. Remove two needle bearings (19).

59. Remove and discard O-rings (20 and 21).

60. Remove lining (22), O-rings (23 and 24), slider (25), adjusting shim (26), spring (27), and BS ring (28). Discard the O-rings.

61. Remove snap ring (29), and three guiding rings (30).

62. Remove adapters (31, 32, and 33).

63. Inspect, repair or replace parts as necessary.

CED,OUOE019,5 –19–09MAR99–20/20

44
9506
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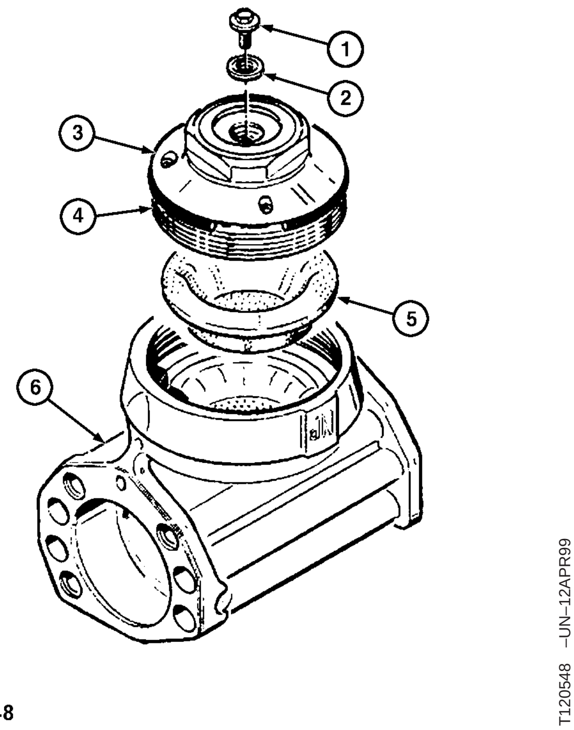
DISASSEMBLE AND ASSEMBLE HP ACCUMULATOR-CENTRAL

1. Remove inflating screw (1) and BS ring (2).
2. Remove O-ring (3) and cover (4). Discard O-ring.
3. Remove diaphragm (5).
4. Inspect, repair or replace parts as necessary.
5. Apply silicone grease to the internal face of diaphragm (5) and install the diaphragm.
6. Install new O-ring (3) and cover (4). Tighten the cover using a torque wrench and special socket, 95372.

Cover—Specification

Torque .... 1400 N•m (1030 ft-lb)

Install BS ring (2) and inflating screw (1).



T120548

1—Inflating Screw
2—BS Ring
3—O-Ring
4—Cover
5—Diaphragm
6—Accumulator Body

CED,OUOE019,6 –19–11MAR99–1/1

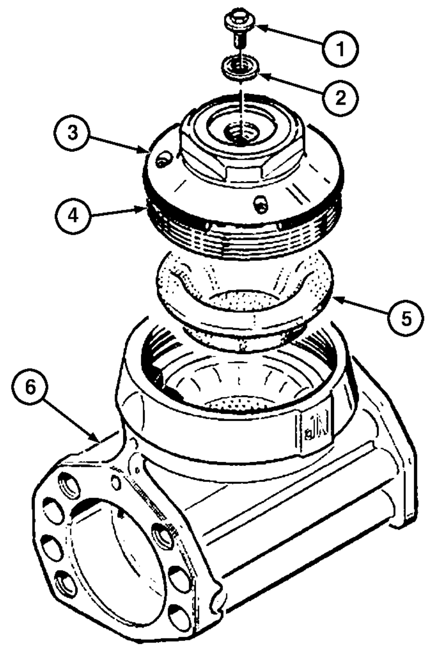
DISASSEMBLE AND ASSEMBLE HP ACCUMULATOR

1. Remove inflating screw (1) and BS ring (2).
2. Remove O-ring (3) and cover (4). Discard O-ring.
3. Remove diaphragm (5).
4. Inspect, repair or replace parts as necessary.
5. Apply silicone grease to the internal face of diaphragm (5) and install the diaphragm.
6. Install new O-ring (3) and cover (4). Tighten the cover using a torque wrench and special socket, 95372.

Cover—Specification

Torque .... 1400 N•m (1030 ft-lb)

7. Install BS ring (2) and inflating screw (1).



T120549 –UN–12APR99

T120549

1—Inflating Screw
2—BS Ring
3—O-Ring
4—Cover
5—Diaphragm
6—Accumulator Body

CED,OUOE019,7 –19–11MAR99–1/1

44
9506
52

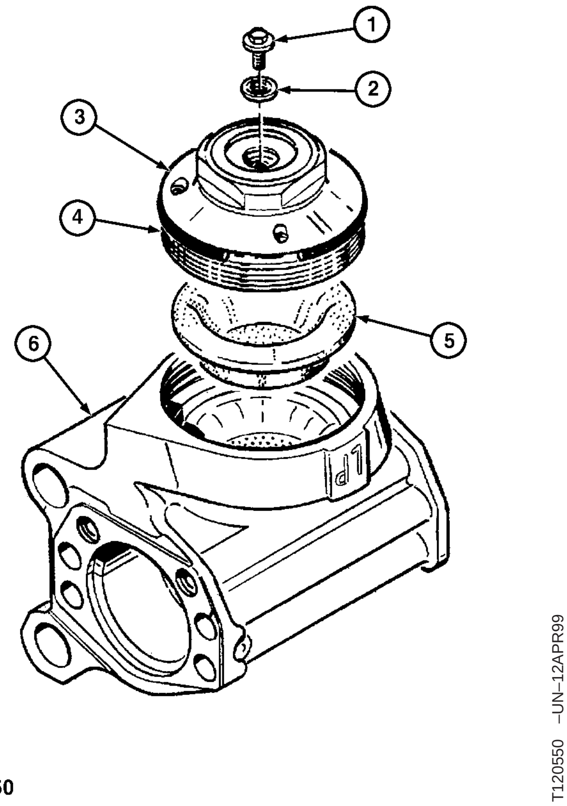
DISASSEMBLE AND ASSEMBLE LP ACCUMULATOR

1. Remove inflating screw (1) and BS ring (2).
2. Remove O-ring (3) and cover (4). Discard O-ring.
3. Remove diaphragm (5).
4. Inspect, repair or replace parts as necessary.
5. Apply silicone grease to the internal face of diaphragm (5) and install the diaphragm.
6. Install new O-ring (3) and cover (4). Tighten the cover using a torque wrench and special socket, 95372.

Cover—Specification

Torque .... 1400 N•m (1030 ft-lb)

7. Install BS ring (2) and inflating screw (1).



T120550

1—Inflating Screw
2—BS Ring
3—O-Ring
4—Cover
5—Diaphragm
6—Accumulator Body

CED,OUOE019,9 –19–11MAR99–1/1

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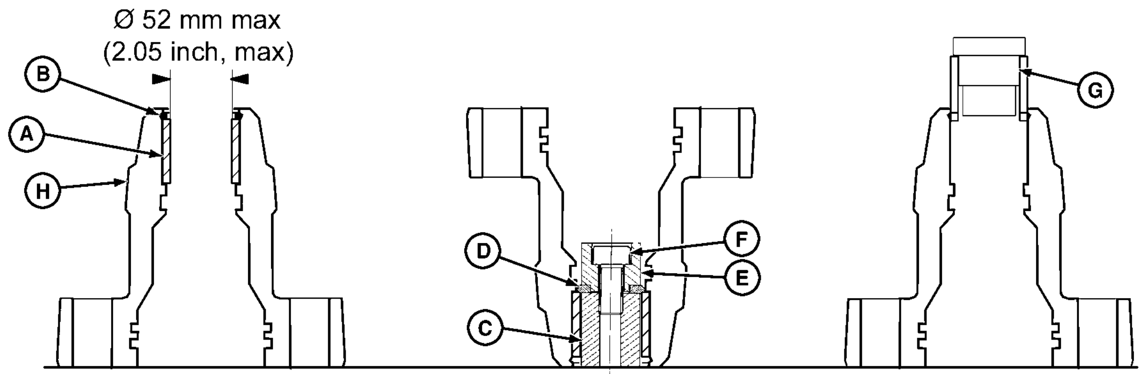
9506
53

INSPECTION HYDRAULIC DRIFTER



A—Guiding Ring
B—Snap Ring
C—Threaded Ring
D—Segment Assembly (2 used)
E—Centering Ring
F—Socket Head Screw
G—Bronze Ring Driving Tool
H—Front Guide

1. Inspect ovalization of guiding ring (A), replace if opening is above 2.05 inches.
2. If required, replace guiding ring (A) as follows:
3. Remove snap ring (B) with a screwdriver.
4. Install threaded ring, 77794 (C), two segment assemblies, 77795 (D), centering ring, 77793 (E), and socket head screw, 8861 (F) in the front guide (H).
5. Secure all parts together by tightening socket head screw, 8861 (F).
6. Remove worn guiding ring (A) using a hydraulic press.
7. Install new guiding ring (A) in front guide (H) using bronze ring driving tool, 60494 (G) with a hydraulic press.
8. Install a new snap ring (B).

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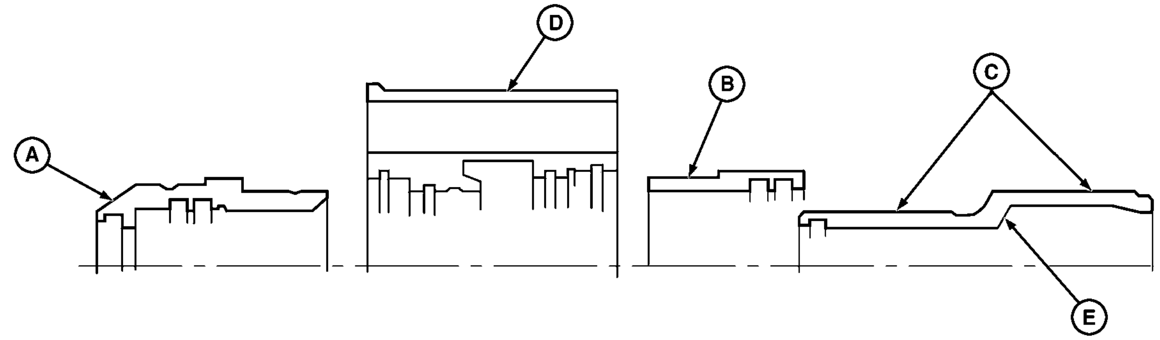
9506
54



T120600

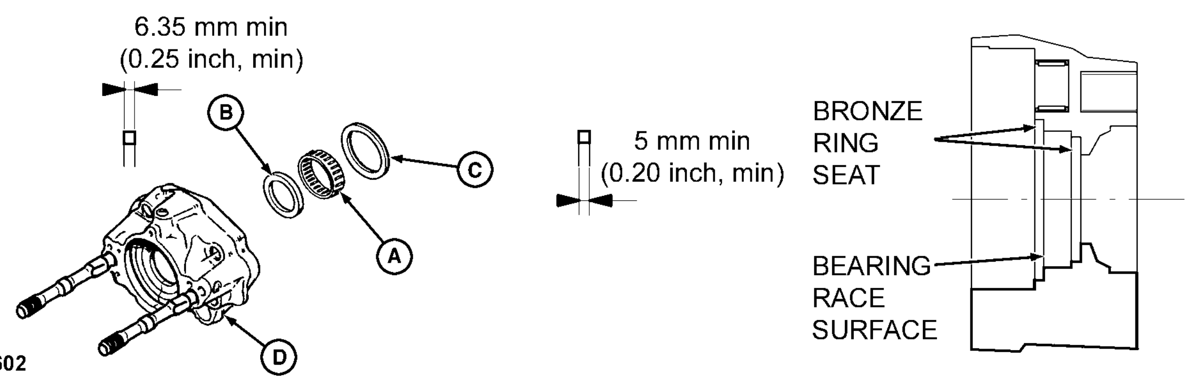
A—Front Lining
B—Rear Lining
C—Retainer
D—Housing
E—Shank

9. Inspect internal surfaces and outside diameters of front lining (A), rear lining (B), and retainer (C) for marks.

10. If necessary, remove serious marks only with fine hand stone or sand paper. Replace parts if marks are too deep.

11. Inspect retainer (C) for pitting or deformation where the internal area makes contact with shank (E). There shall be no pitting or deformation.

CED,OUOE019,9 –19–12MAR99–2/34



T120602

A—Needle Bearing
B—Ring
C—Ring
D—Housing

12. Inspect bearing race and bronze ring seat surfaces for pitting or rust. There shall be no pitting or rust.

13. Inspect thickness of ring (B). Thickness shall not be less than 0.250 inch.

14. Inspect thickness of ring (C). Thickness shall not be less than 0.20 inch.

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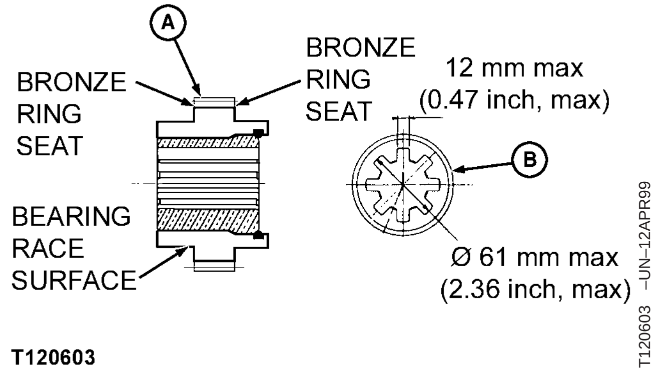
CED,OUOE019,9 –19–12MAR99–3/34

15. Inspect bearing race and bronze ring seat surfaces for pitting or rust. There shall be no pitting or rust.

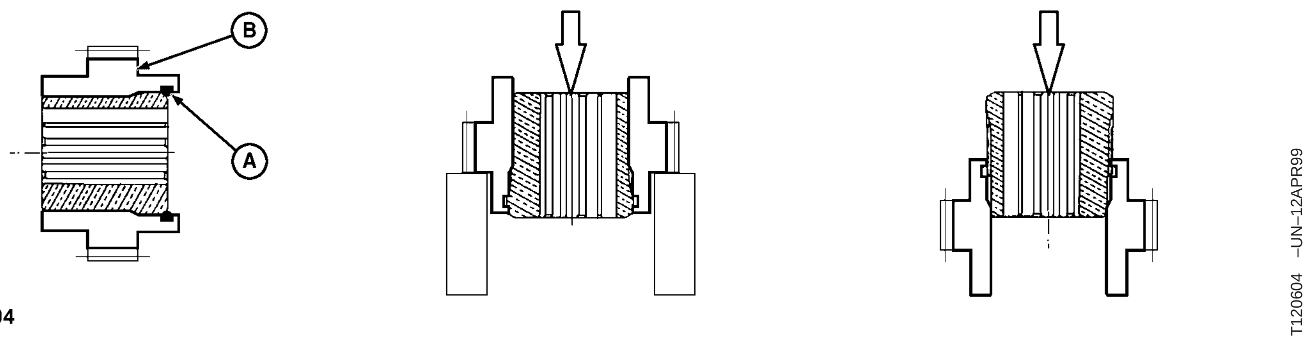
16. Inspect splines of splined nut (B). The teeth shall be 0.47 inch and 2.36 inch maximum.



T120603

A—Gear
B—Splined Nut

CED,OUOE019,9 –19–12MAR99–4/34



T120604

A—Splined Nut B—Snap Ring

17. If required, remove splined nut (A) as follows:

18. Remove snap ring (B).

19. Remove splined nut (A) using an hydraulic press.

20. Install new splined nut (A) using an hydraulic press.

21. Install new snap ring (B).

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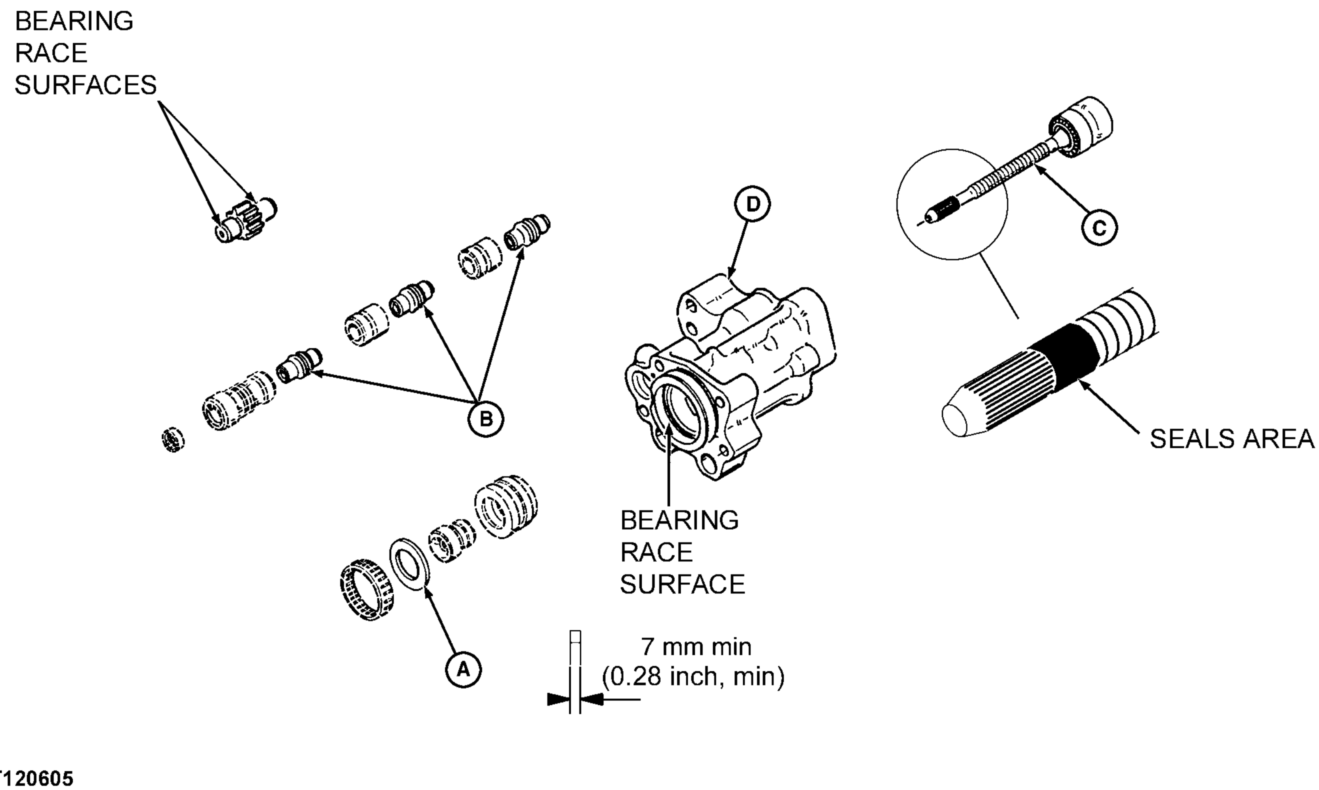
44
9506
56



A—Ring B—Tight Ring (3 used) C—Shaft D—Thrust Housing

22. Inspect bearing race surface for pitting or rust. There shall be no pitting or rust.

23. Inspect thickness of ring (A). The thickness shall be 0.28 inch minimum.

24. Inspect internal diameter of three tight rings (B). There shall be no scratches.

25. Inspect sealing part of shaft (C) for scratches. There shall be no scratches.

26. Inspect seals area on shaft (C). Only a perfect surface is acceptable.

27. Inspect bearing race surfaces for pitting or rust. There shall be no pitting or rust.

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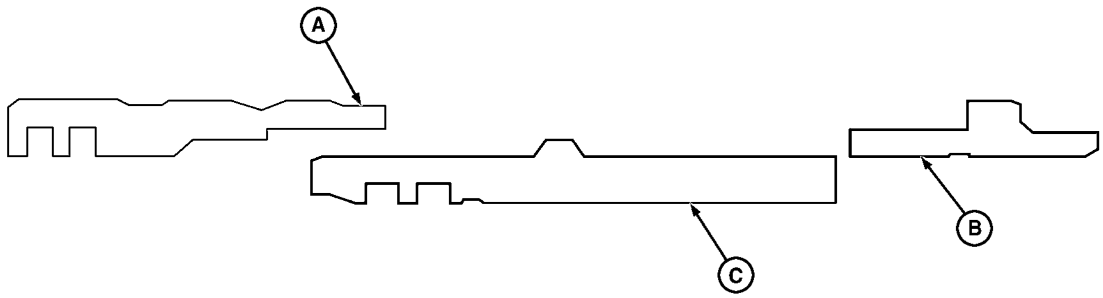
57



T120606

A—Front Lining **B—Rear Lining** **C—Hydraulic Stop Piston**

28. Inspect internal surfaces of front lining (A) and rear lining (B) for marks. If necessary, remove serious marks only with fine hand stone or sand paper. Replace parts if marks are too deep.

29. Inspect outside diameter and boring surfaces of hydraulic stop piston (C) for marks. If necessary, remove serious marks only with fine hand stone or sand paper. Replace part if marks are too deep.

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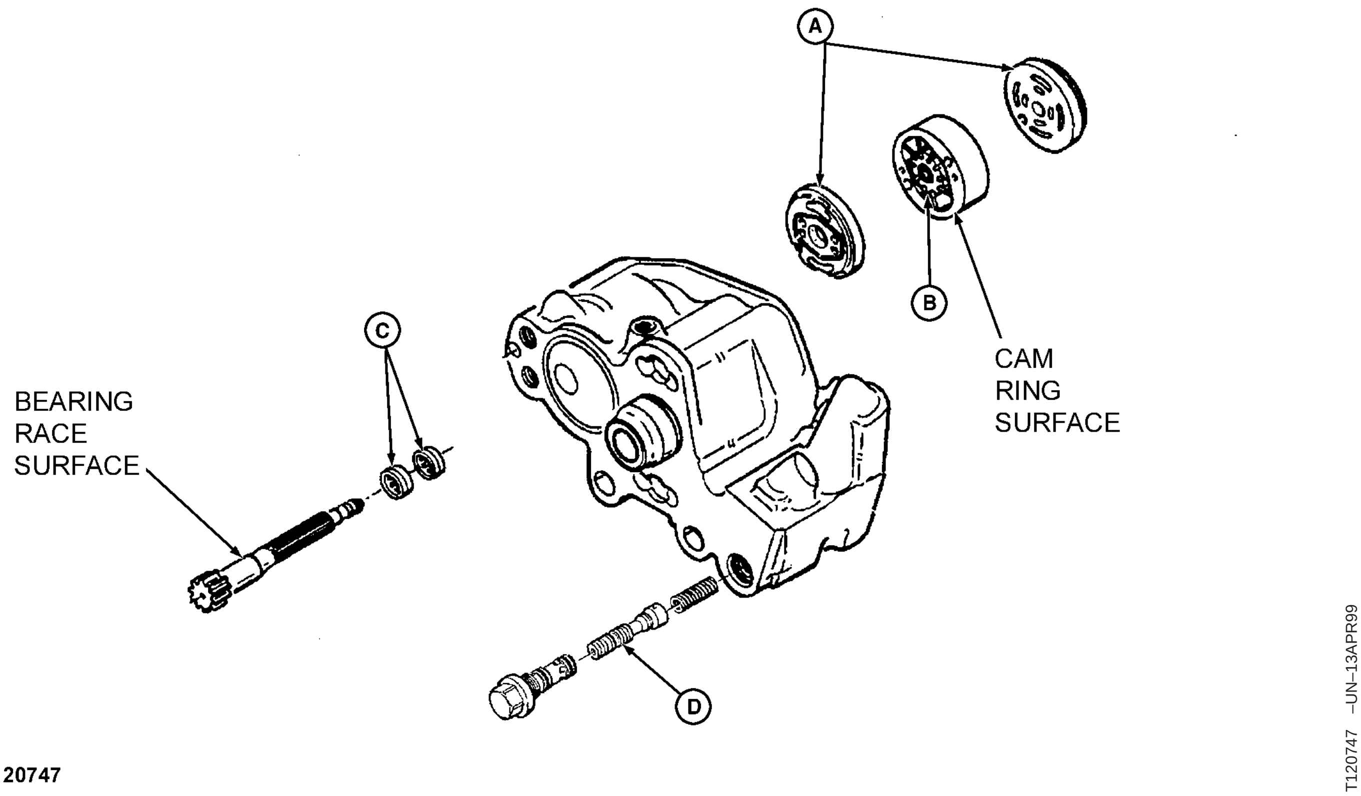

T120747

A—Plate (2 used)
B—Cartridge
C—Needle Bearings (2 used)
D—Slider

30. Inspect bearing race surface for pitting or rust. There shall be no pitting or rust.

31. Inspect two plates (A) for scratches and black coating condition. There shall be no scratches. Replace plate if black coating has disappeared.

32. Inspect cartridge (B) for scratches on vanes and wear of cam ring. There shall be no scratches on vanes or wear of cam ring.

33. Replace needle bearings (C) using shouldered pin, 59828.

34. Inspect slider (D) for scratches. There shall be no scratches.

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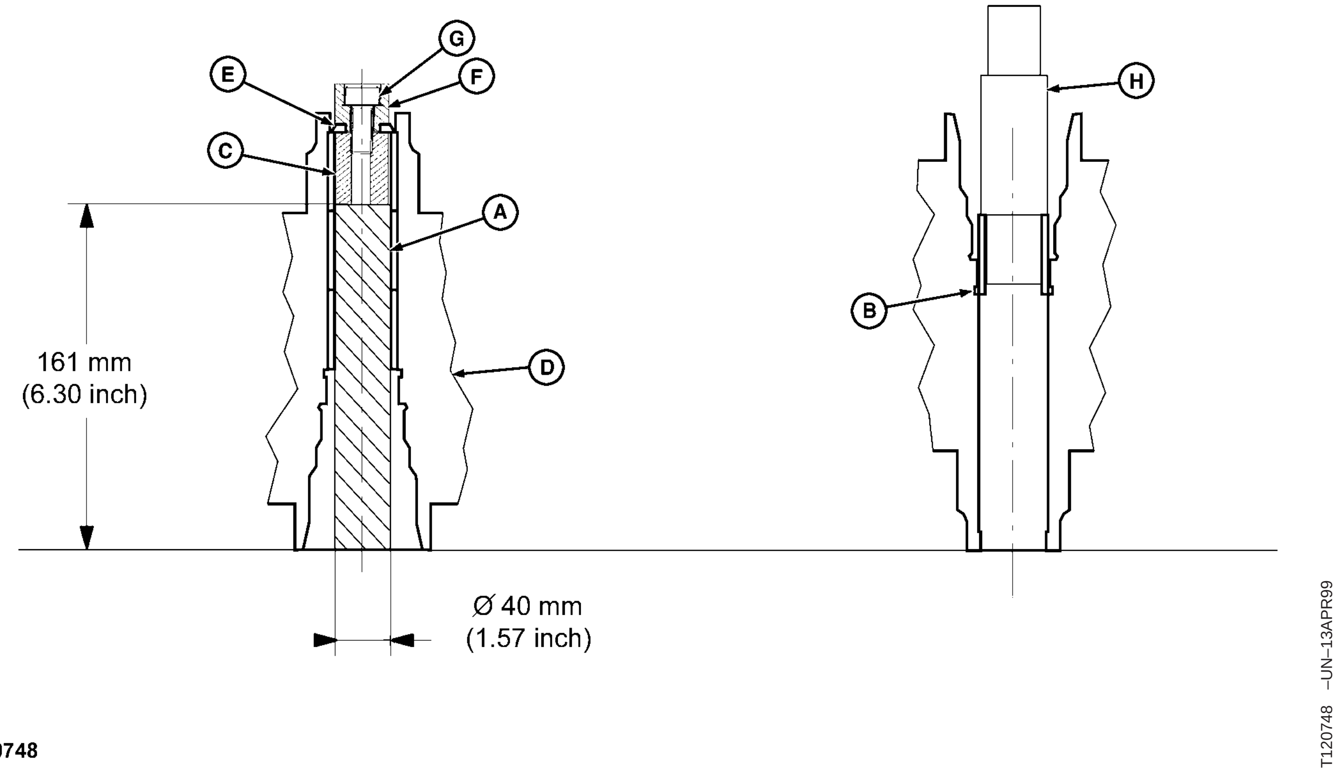

T120748

A—Guiding Ring (3 used)
B—Snap Ring
C—Threaded Ring
D—Motor Body
E—Segment Assembly (2 used)
F—Centering Ring
G—Socket Head Screw
H—Bronze Ring Driving Tool

35. Inspect opening of guiding ring (A). Replace if opening is above 1.57 inches.

36. If required replace guiding ring (A) as follows:

37. Remove snap ring (B) with a screwdriver.

38. Install threaded ring, 60485 (C), two segment assemblies, 77795 (E), centering ring, 60480 (F), and socket head screw, 8861 (G) in the motor body (D).

39. Secure all parts together by tightening socket head screw, 8861 (G).

40. Extract worn guiding ring (A) approximately 0.28 inch using an hydraulic press.

41. Replace two segment assemblies, 77795 (E) with segment assembly 60492.

42. Remove guiding rings (A).

43. Install new guiding rings (A) using bronze ring driving tool, 60483 (H) with an hydraulic press.

44. Install a new snap ring (B).

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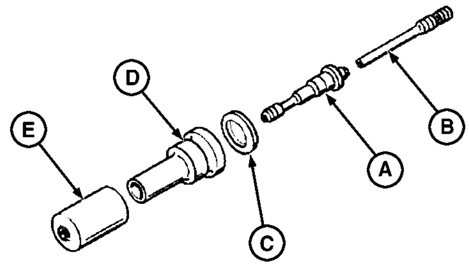
44
9506
60

45. Inspect lining (A) and push rod (B) for scratches or cavitation marks. There shall be no scratches or cavitation marks.

46. Inspect condition of valve (C). There shall be no marks.

47. Inspect condition of cover (D). There shall be no marks or scratches.

48. Inspect condition of distributor (E). There shall be no marks or scratches.



T120749

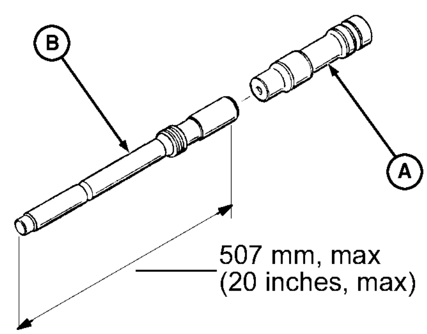
T120749 –UN–13APR99

A—Lining
B—Push Rod
C—Valve
D—Cover
E—Distributor

CED,OUOE019,9 –19–12MAR99–10/34

49. Inspect thrust piston (A) and cylinder (B) for marks. If necessary, remove serious marks only with fine hand stone or sand paper. Replace part if marks are too deep.

50. Inspect overall length of thrust piston (B). The overall length shall be 20 inches maximum.



T120750

T120750 –UN–13APR99

A—Thrust Piston
B—Cylinder

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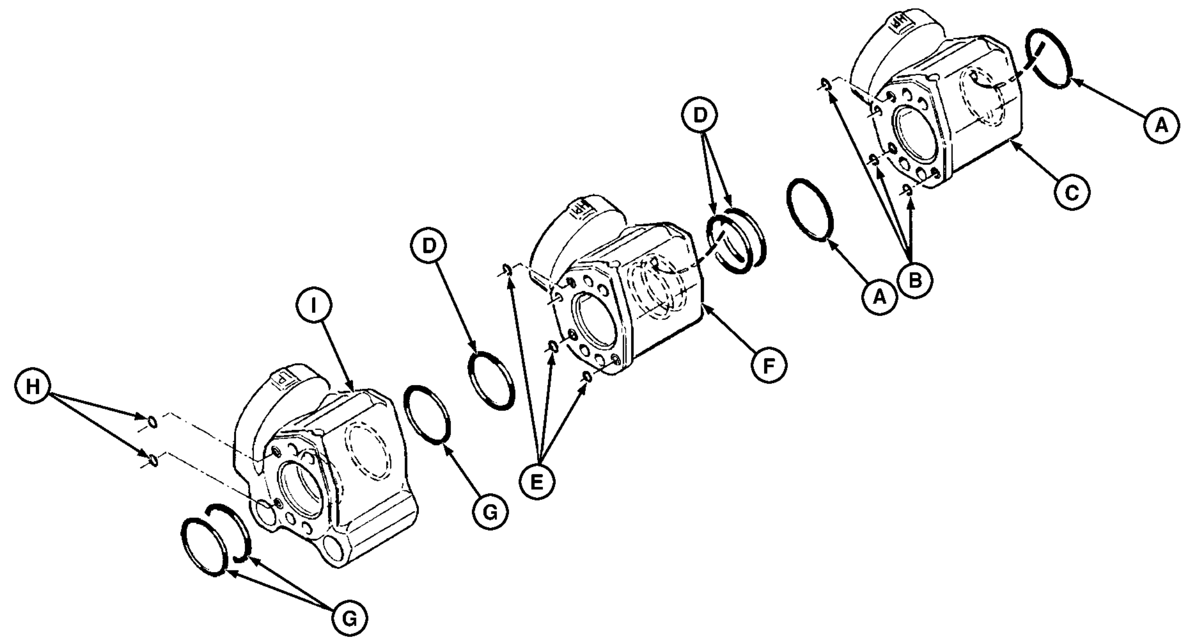


T120751

A—O-Ring (2 used)
B—Tight Seal (3 used)
C—HP Accumulator
D—O-Ring (3 used)
E—Tight Seal (3 used)
F—HP Accumulator-Central
G—O-Ring (3 used)
H—Tight Seal (2 used)
I—LP Accumulator

51. Install two new O-rings (A) and three tight seals (B).

NOTE: Clean all parts and apply a layer of hydraulic fluid at the time they are installed.

52. Install three new O-rings (D) and three tight seals (E).

53. Install three rings (G) and two tight seals (H).

Continued on next page CED,OUOE019,9 –19–12MAR99–12/34

44
9506
62

54. Secure cylinder (A) in a vertical position.

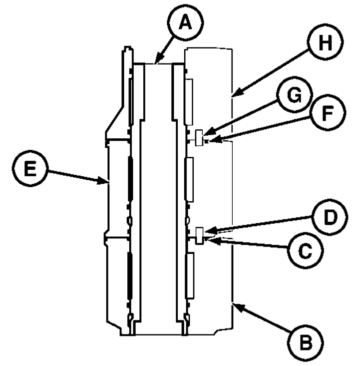
55. Install HP accumulator (B). Drive it to the end position using a plastic sledge hammer.

56. Install O-ring (C) and pin (D).

57. Install HP accumulator (E). Drive it into position using a plastic sledge hammer.

58. Install O-ring (F) and pin (G).

59. Install LP accumulator (H). Drive it into position using a plastic sledge hammer.



T120752

T120752 –UN–13APR99

A—Cylinder
B—HP Accumulator
C—O-Ring
D—Pin
E—HP Accumulator-Central
F—O-Ring
G—Pin
H—LP Accumulator

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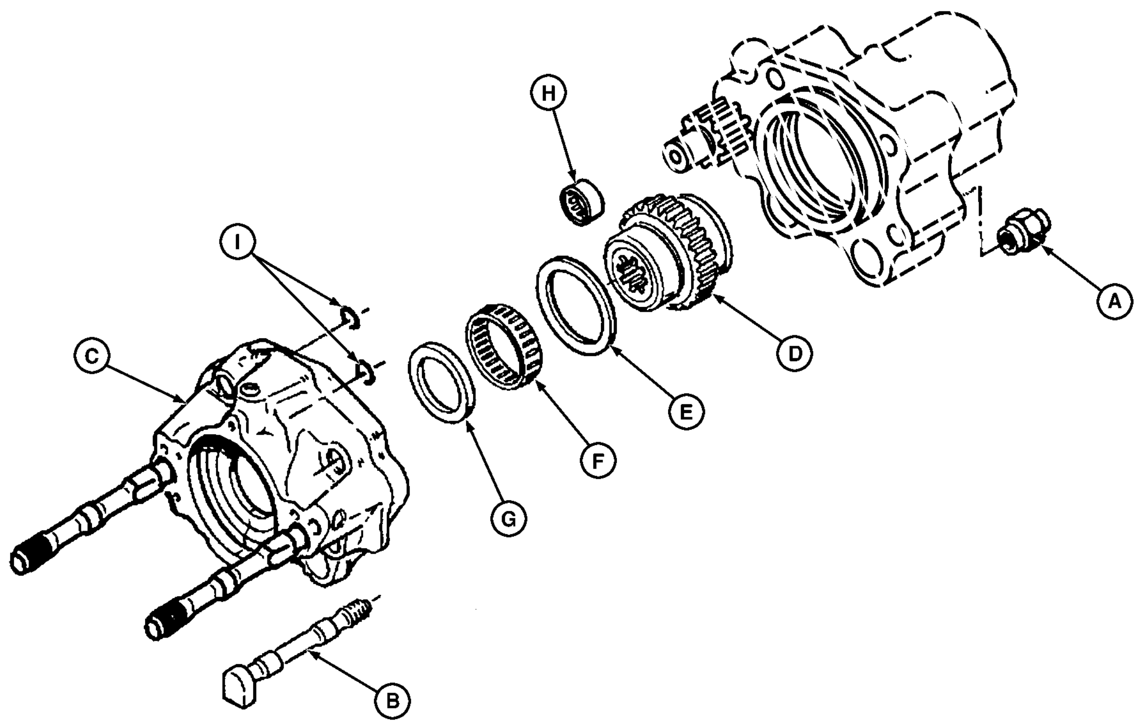
CED,OUOE019,9 –19–12MAR99–13/34



T120542

T120542 –UN–13APR99

A—Nut (4 used)
B—Screw (4 used)
C—Housing
D—Gear
E—Bronze Ring
F—Needle Bearing
G—Bronze Ring
H—Needle Bearing
I—O-Ring (2 used)

60. Install needle bearing (F), bronze rings (E and G), and gear (D). Use shouldered pin, 59828 to install the needle bearing.

61. Install needle bearing (H).

62. Install two new O-rings (I).

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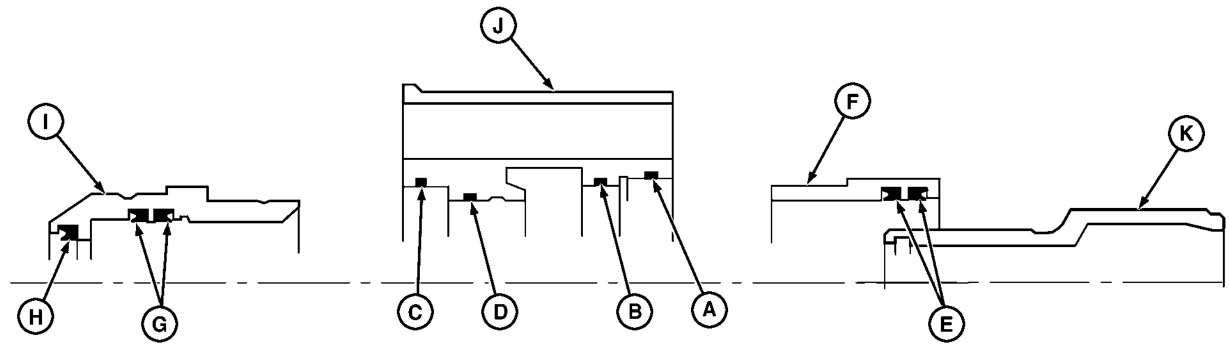
9506
64



T120753 –UN–13APR99

T120753

A—O-Ring
B—O-Ring
C—O-Ring
D—O-Ring
E—Lip Seal (2 used)
F—Rear Lining
G—Lip Seal (2 used)
H—Lip Seal
I—Front Lining
J—Front Housing
K—Retainer

63. Install O-rings (A, B, C, and D).

64. Using lip seal mounting tool, 73125, install two lip seals (E).

65. Using lip seal mounting tool, 73125, install two lip seals (G), and lip seal (H).

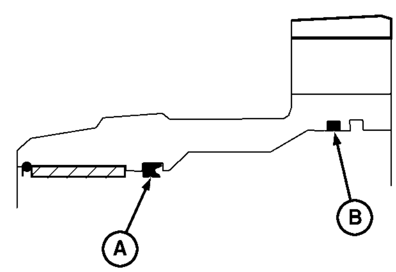
66. Install rear lining (F) and front lining (I) with a hydraulic press.

67. Install retainer (K).

CED,OUOE019,9 –19–12MAR99–15/34

68. Using lip seal mounting tool, 73125 (A), install lip seal (A).

69. Install O-ring (B).



T120754 –UN–13APR99

T120754

A—Lip Seal
B—O-Ring

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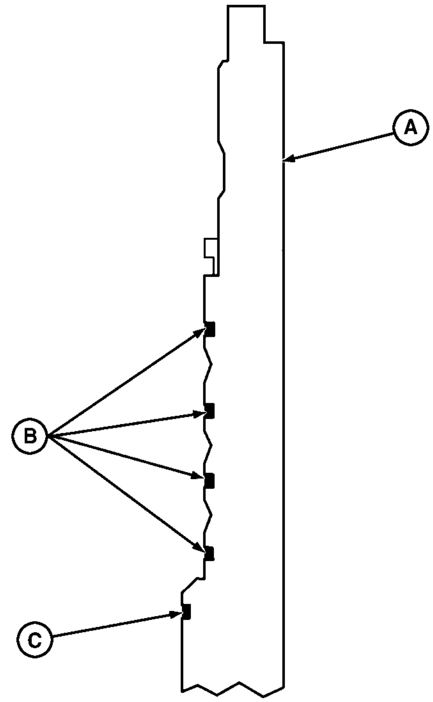
CED,OUOE019,9 –19–12MAR99–16/34

70. Place thrust housing (A) in a vertical position and install four O-rings (B) and O-ring (C).

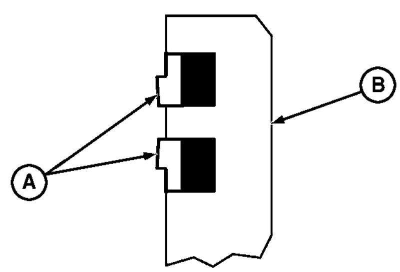


T120755

A—Thrust Housing
B—O-Ring (4 used)
C—O-Ring

CED,OUOE019,9 –19–12MAR99–17/34

71. Install two composite seals (A) in front lining (B). Ensure position of composite seals is correct.



T120756

A—Composite Seal (2 used)
B—Front Lining

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CED,OUOE019,9 –19–12MAR99–18/34

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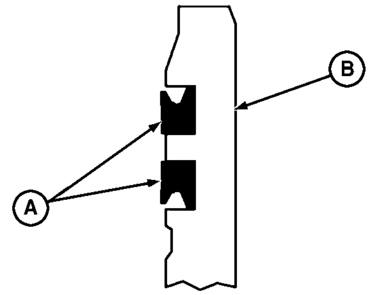
9506
66

72. Install two lip seals (A) in hydraulic stop piston (B) with lip seal mounting tool, 73125.



T120757

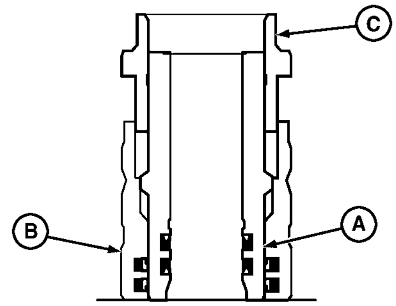
A—Lip Seal (2 used)
B—Hydraulic Stop Piston

CED,OUOE019,9 –19–12MAR99–19/34

73. Install hydraulic stop piston (A) in front lining (B).

74. Place rear lining (C) on hydraulic stop piston (A).

75. Drive rear lining (C) in position with a hydraulic press.



T120758

A—Hydraulic Stop Piston
B—Front Lining
C—Rear Lining

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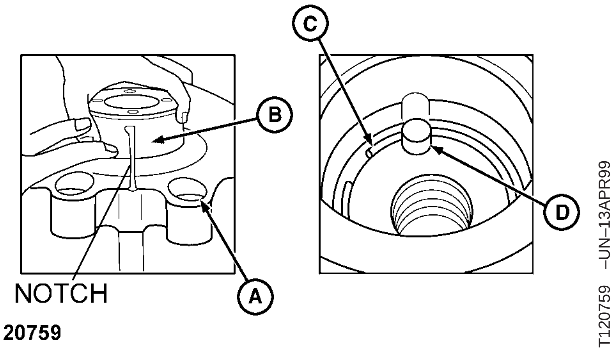
76. Mark the position of the internal notch of the thrust housing (A).

77. Install hydraulic stop piston (B) with attached components in thrust housing (A). Ensure that notch is aligned with the mark.

78. Drive the hydraulic stop piston (B) with attached components in the thrust housing (A) with a hydraulic press.

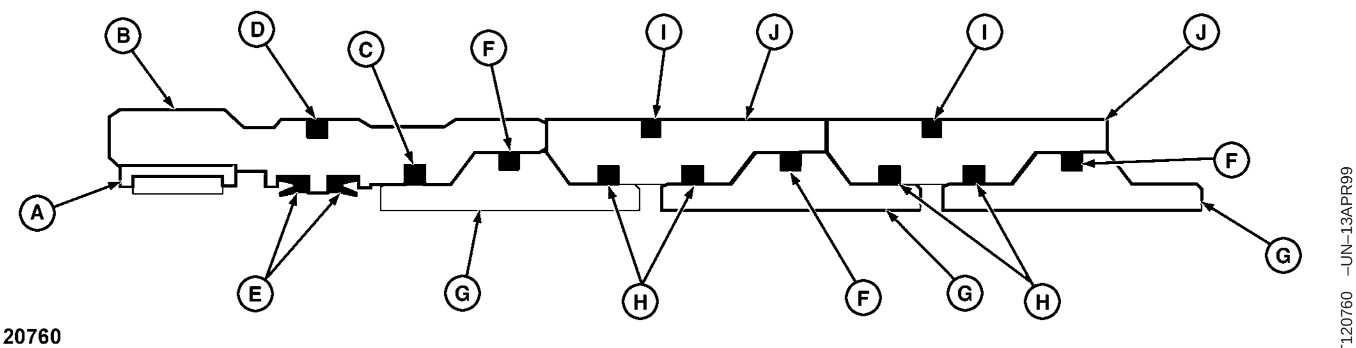
79. Install snap ring (C) and pin (D).



T120759

A—Thrust Housing
B—Hydraulic Stop Piston
C—Snap Ring
D—Pin

CED,OUOE019,9 –19–12MAR99–21/34



T120760

A—Needle Bearing
B—Tight Ring
C—O-Ring
D—O-Ring
E—Seal (2 used)
F—O-Ring
G—Tight Ring (3 used)
H—O-Ring (4 used)
I—O-Ring (2 used)
J—Tight Ring (2 used)

80. Using shouldered pin, 59828, install needle bearing (A).

81. Install new O-rings (C and D) and two new seals (E) on tight ring (B).

82. Install one new O-ring (F) in each of three tight rings (G).

83. Install two new O-rings (H) and new O-ring (I) in each of two tight rings (J).

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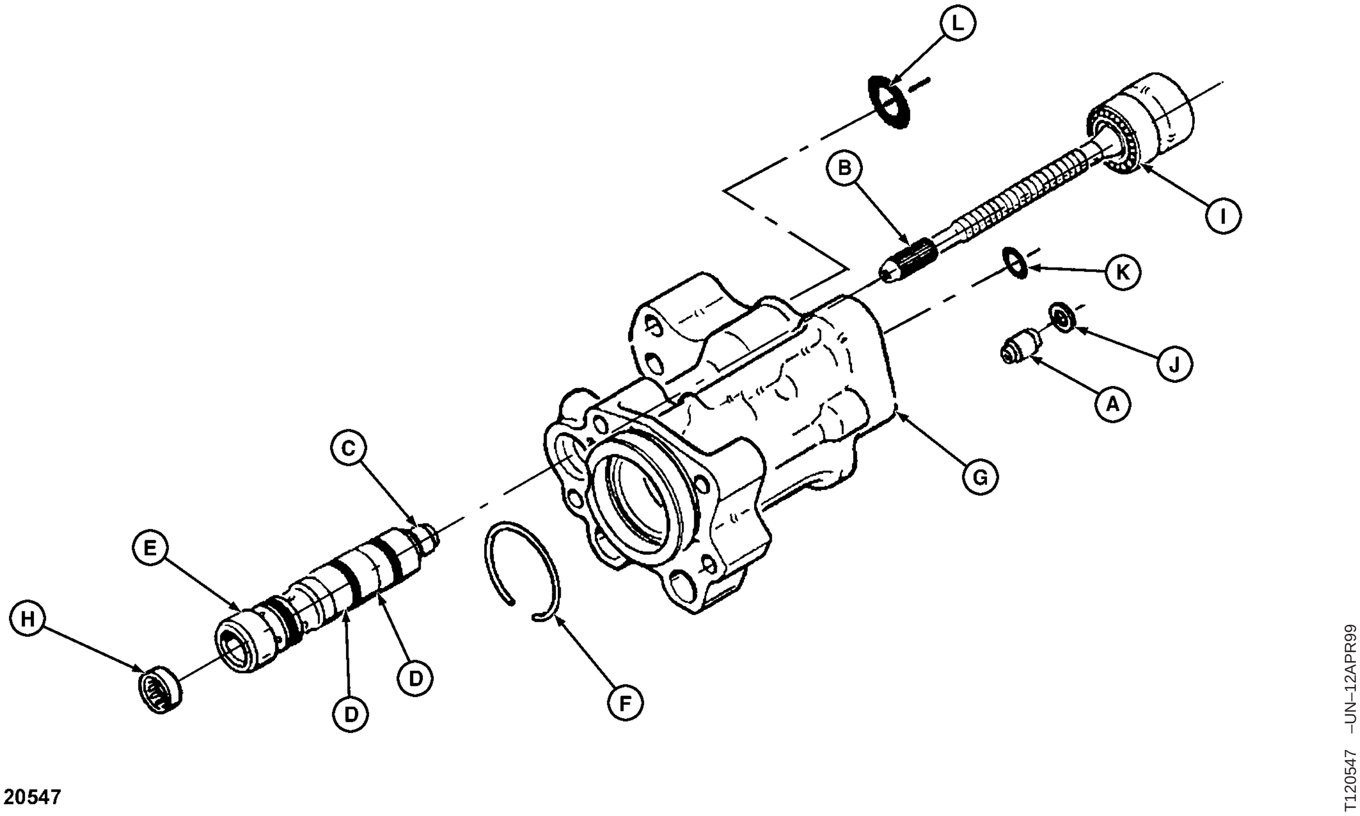

T120547

A—Valve (3 used)	**D—Tight Ring (2 used)**	**G—Thrust Housing**	**J—Tight Seal (3 used)**
B—Drive Shaft	**E—Tight Ring**	**H—Needle Bearing**	**K—Face Seal**
C—Tight Ring	**F—Ring**	**I—Ball Bearing**	**L—O-Ring**

84. Install tight rings (C, D, and E) with the attached components.

85. Install new O-ring (L).

86. Install ball bearing (I) on drive shaft (B).

87. Install drive shaft (B).

88. Install three valves (A).

89. Apply grease to three tight seals (J) and face seal (K), and install in thrust housing (G).

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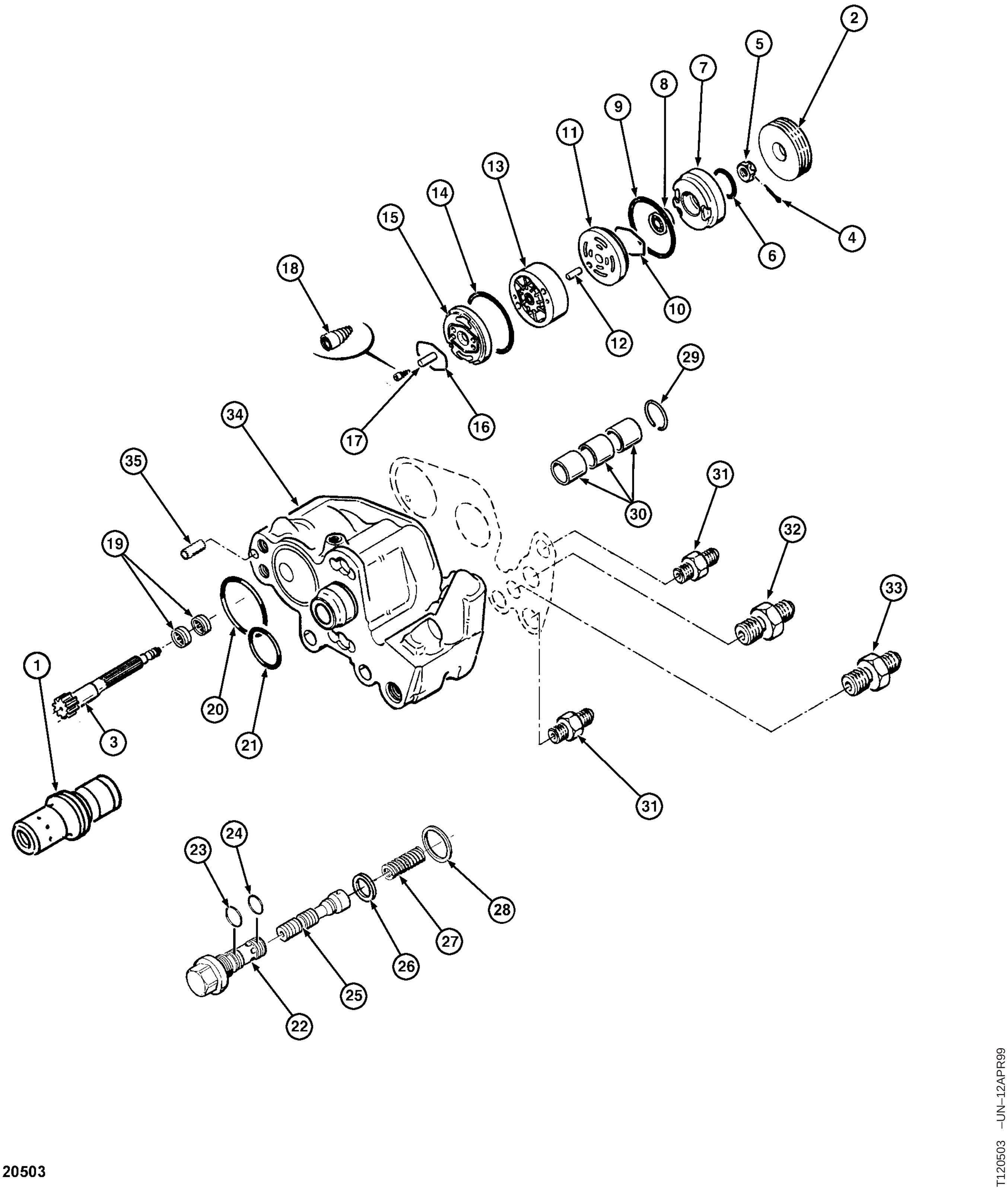

T120503

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Rock Drill

1—Hydraulic Stop Piston
2—Cover
3—Shaft
4—Pin
5—Nut
6—O-Ring
7—Plate
8—Ball Bearing
9—O-Ring
10—O-Ring
11—Plate
12—Pin
13—Cartridge (Type 055)
14—O-Ring
15—Plate
16—O-Ring
17—Pin
18—Spring
19—Needle Bearing (2 used)
20—O-Ring
21—O-Ring
22—Lining
23—O-Ring
24—O-Ring
25—Slider
26—Adjusting Shim (As Required)
27—Spring
28—BS Ring
29—Snap Ring
30—Guiding Ring (3 used)
31—Adapter (2 used)
32—Adapter
33—Adapter
34—Motor Body
35—Pin

90. Secure motor body (34) on clamping assembly, 59829.

91. Using shouldered pin, 59828, install two needle bearings (19).

92. Install new O-rings (23 and 24), and BS ring (28) on lining (22).

93. Install spring (27), slider (25), and lining (22).

Lining—Specification

Torque.. 300 N•m (220 ft-lb)

94. Install new O-rings (10 and 16) on plate (11 and 15).

95. Install pin (17) in plate (15).

96. Install spring (18).

97. Install plate (15). Rotate the plate until pin (17) enters motor body (34) against spring (18).

98. Install new O-ring (14).

99. Using a cartridge mounting tool, install cartridge (13). Rotate the cartridge until it is locked by pin (16).

100. Using a plastic rod, push cartridge (13) over O-ring (14).

101. Install pin (12), plate (11), and new O-rings (9 and 10).

102. Install ball bearing (8) in plate (7).

103. Install plate (7).

104. Install cover (2).

105. Install shaft (3).

106. Remove cover (2).

107. Install pin (35).

108. Lock shaft (3) in place with gear locking tool, 76173.

109. Install nut (5) and pin (4).

110. Install new O-ring (6).

111. Apply silicone sealing on last threads of cover (2) and install the cover.

112. Install flange, 59831 and two screws on cover (2).

113. Using a torque wrench, tighten cover (2). Ensure that the edge of the cover does not protrude beyond the edge of the motor body (34).

Cover—Specification

Torque.. 600 N•m (440 ft-lb)

114. Install adapters (31, 32, and 33).

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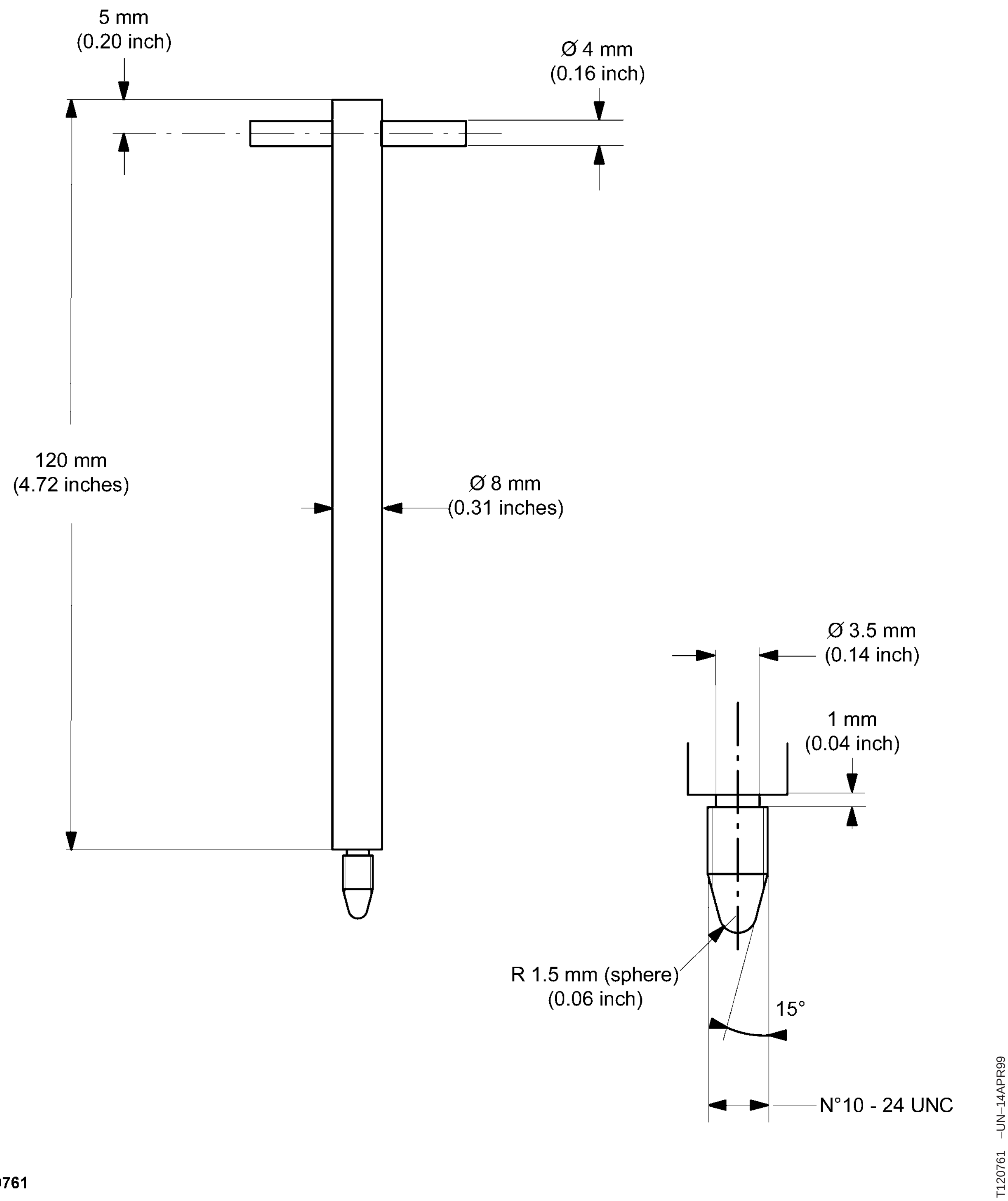
Rock Drill



T120761

Cartridge Mounting Tool

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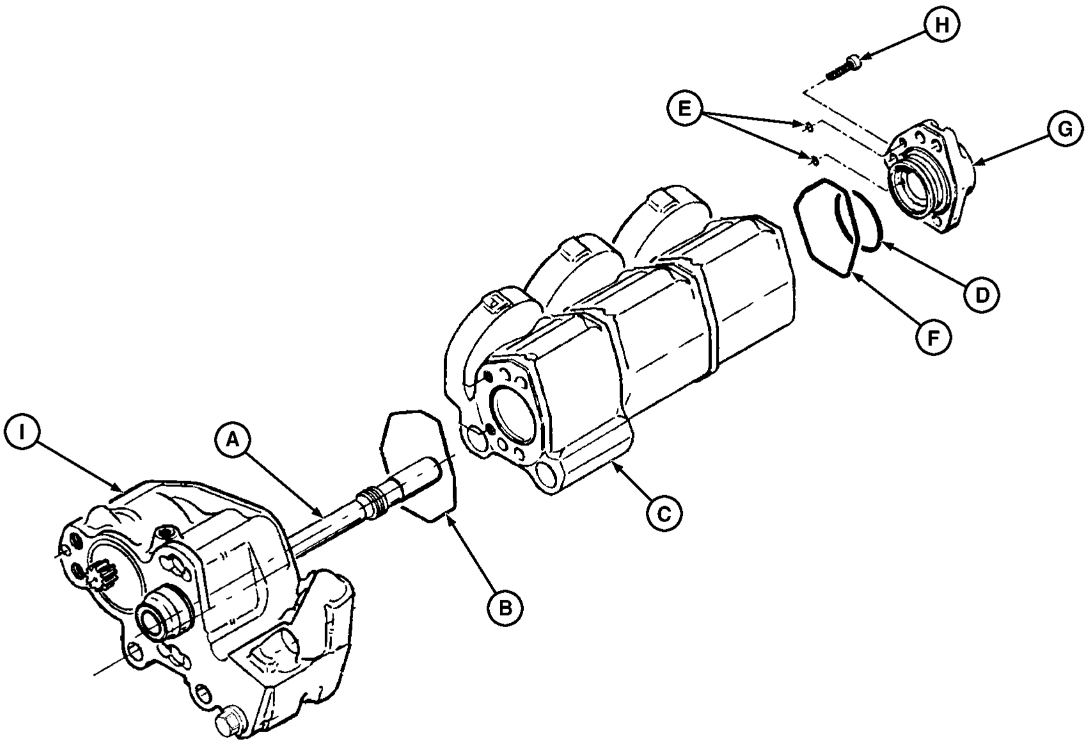
115. Install three guiding rings (30), and snap ring (29).

CED,OUOE019,9 –19–12MAR99–27/34



T120762

T120762 –UN–13APR99

A—Piston
B—O-Ring
C—LP Accumulator
D—O-Ring
E—Tight Ring (2 used)
F—O-Ring
G—Cover
H—Screw
I—Motor Body

116. Install piston (A).

117. Install new O-ring (B) in LP accumulator (C).

118. Install new O-ring (D), two tight rings (E), and new O-ring (F) on cover (G).

119. Install cover (G) and secure with screw (H).

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CED,OUOE019,9 –19–12MAR99–28/34

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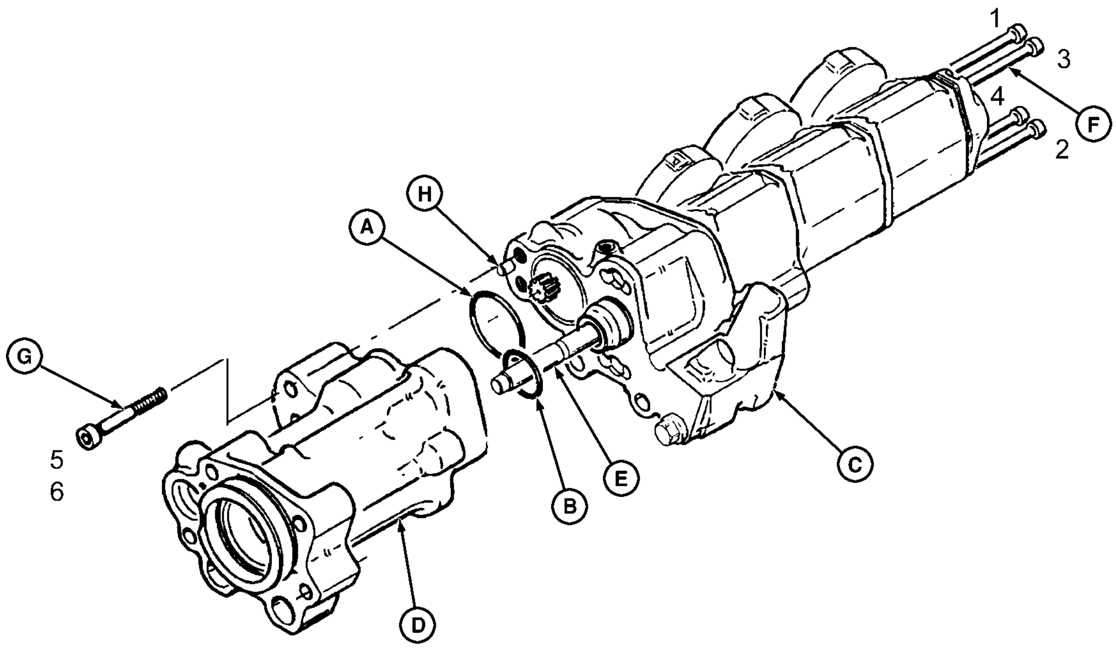
9506
74



T120763

A—O-Ring
B—O-Ring
C—Motor Body
D—Thrust Housing
E—Piston
F—Screw (4 used)
G—Screw (2 used)
H—Pin

120. Install new O-rings (A and B) on the motor body (C).

121. Verify pin (H) is installed in proper position.

122. Install thrust housing (D) over piston (E).

123. Install four screws (F) and two screws (G). Gradually tighten the six screws in the indicated sequence to pull thrust housing (D) in position.

Screws—Specification

Torque.. 300 N•m (220 ft-lb)

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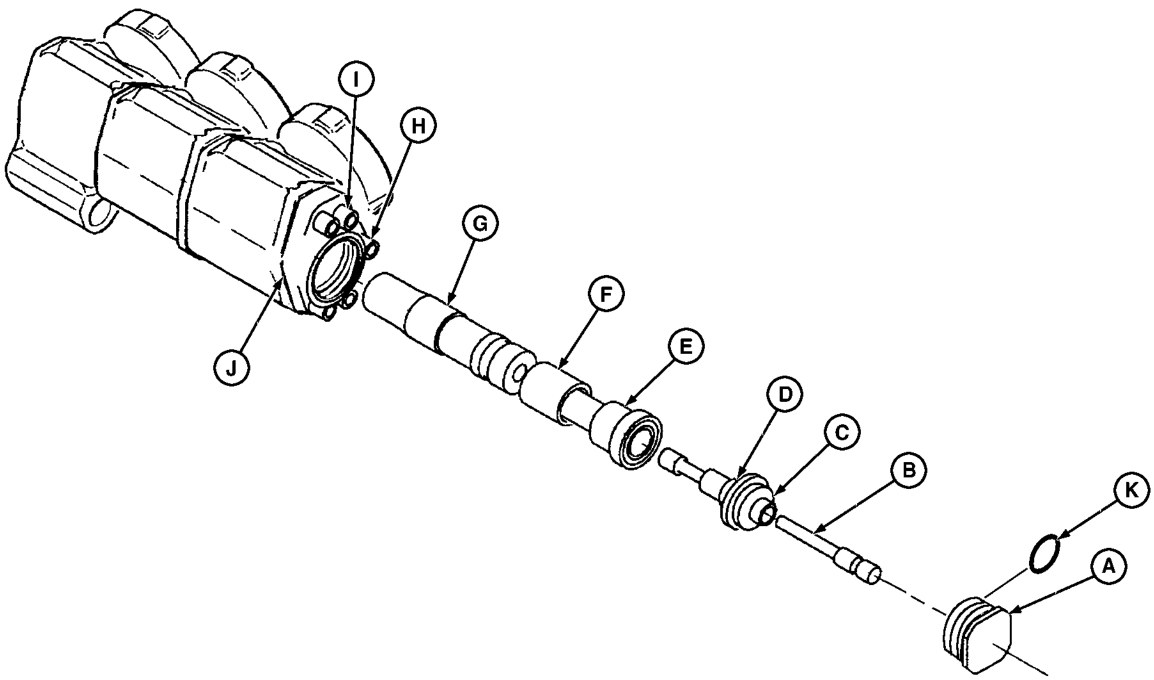

T120543

A—Plug
B—Push Rod
C—Lining
D—Valve
E—Cover
F—Distributor
G—Thrust Piston
H—Screw
I—Tie Rod (4 used)
J—Cover
K—O-Ring

124. Install thrust piston (G), distributor (F), cover (E), valve (D), lining (C), and push rod (B).

125. Install new O-ring (K) on plug (A).

126. Install plug (A). Tighten the plug with torque wrench and special socket, 95372.

Plug—Specification

Torque.. 300 N•m (220 ft-lb)

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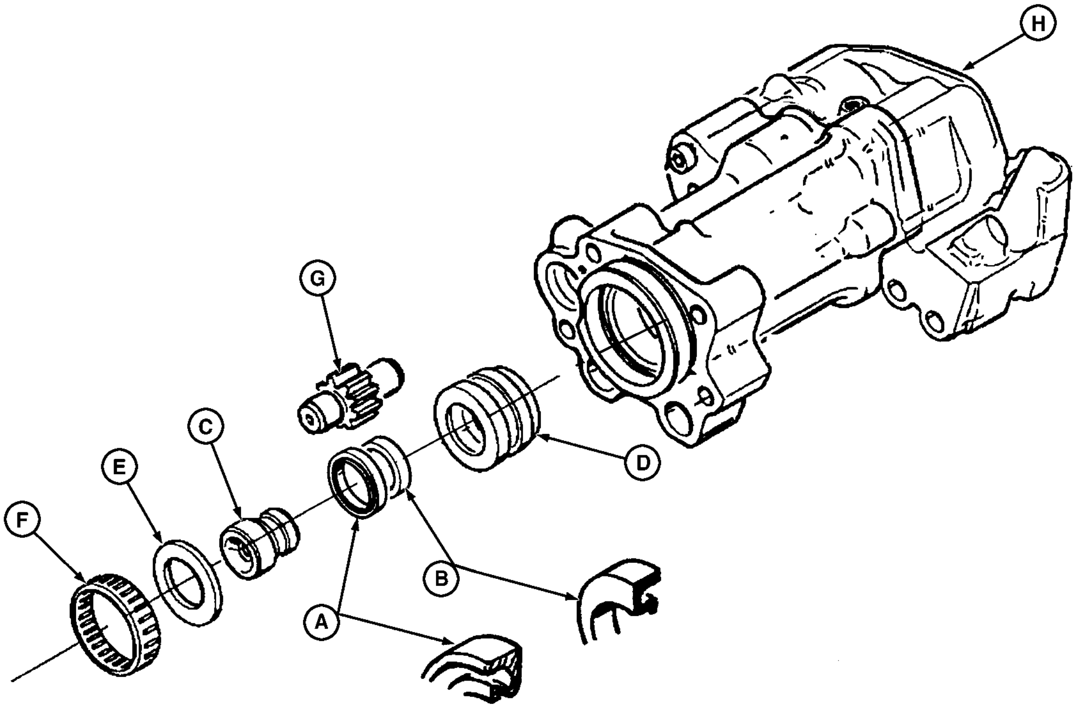
76



T120764

A—Centering Part	**C—Shank Stop**	**E—Ring**	**G—Gear**
B—Centering Part	**D—Guide**	**F—Needle Bearing**	**H—Thrust Housing**

127. Install centering parts (A and B) in shank stop (C).

128. Install guide (D), shank stop (C), ring (E), and needle bearing (F).

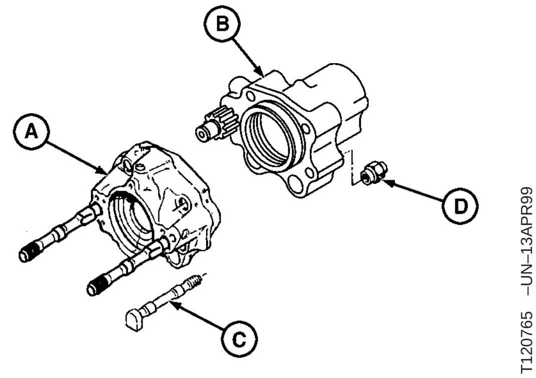
129. Install gear (G).

Continued on next page CED,OUOE019,9 –19–12MAR99–31/34

130. Install front part housing (A) and secure with four screws (C) and Nuts (D).

Nut—Specification

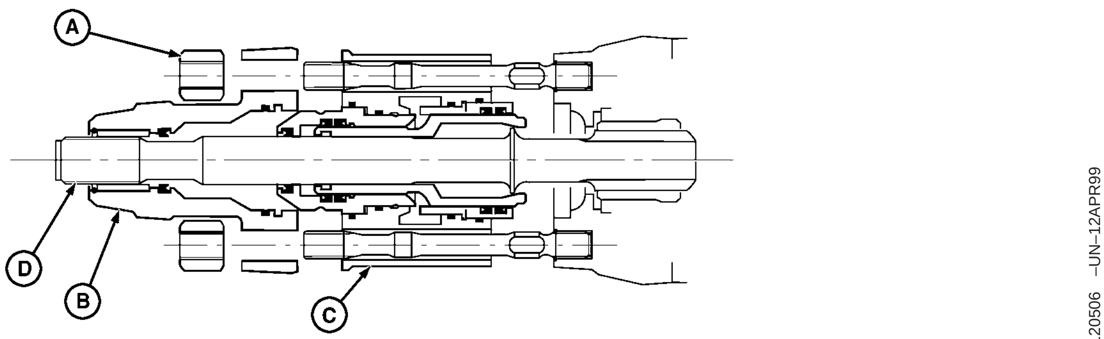
Torque .... 300 N•m (220 ft-lb)



T120765

A—Front Part Housing
B—Thrust Housing
C—Screw (4 used)
D—Nut (4 used)

CED,OUOE019,9 –19–12MAR99–32/34



T120506

A—Nut (2 used) **B—Front Guide** **C—Front Housing** **D—Shank**

131. Install shank (D).

132. Install front housing (C).

133. Install front guide (B).

134. Install two nuts (A).

Nut—Specification

Torque.. 650 N•m (470 ft-lb)

Continued on next page

CED,OUOE019,9 –19–12MAR99–33/34

44
9506
78

135. Install inflation tool, 95233 of accumulator nitrogen inflation kit, 95234 on cover (A).

136. Ensure key (B) is engaged on inflating screw head on cover (A).

137. Tighten fixing screws.

138. Fully tighten setting screw (C).

139. Turn drain cock (D) off.

140. Connect the flange to the nitrogen bottle pressure reducer, 41544.

141. Open nitrogen bottle, 48429 and set pressure reducer, 41544 to the required pressure: 4 bar for LP accumulator; 40 bar for HP accumulators.

142. Fill up accumulator by loosening key (A).

143. Tighten key (A) after pressure is stabilized.

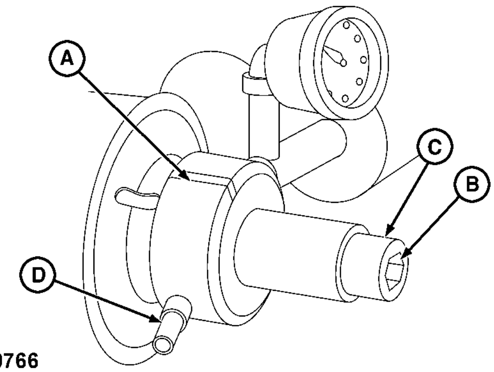
144. Close nitrogen bottle, 48429 and turn drain cock (D) to off to relieve pressure from inflation tool, 95233.

145. Remove inflation tool, 95233.

146. Tighten inflating screw in cover (A) with spanner, 66223.

Inflating Screw—Specification

Torque .... 22 N•m (16 ft-lb)



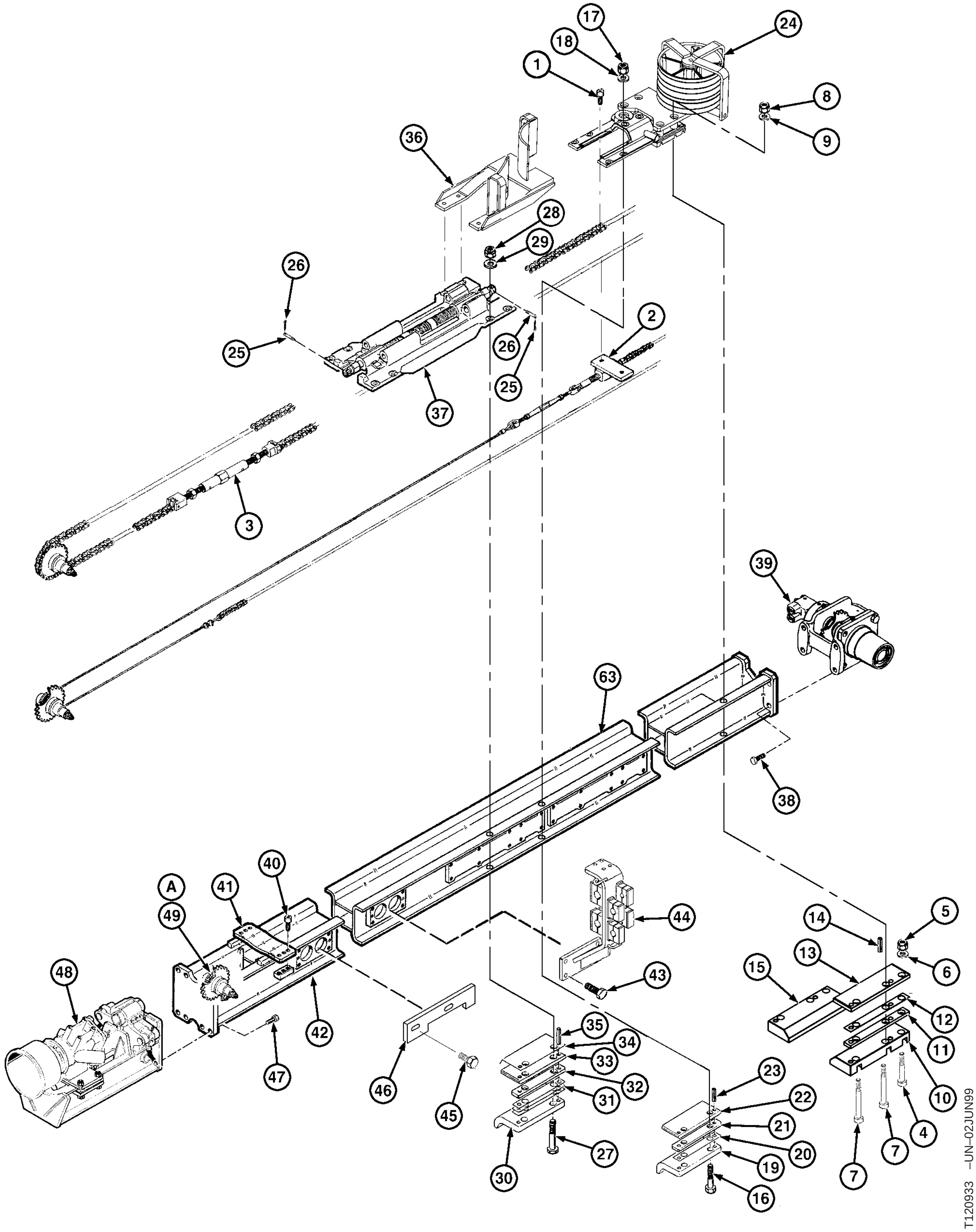
T120766

T120766 –UN–13APR99

A—Cover
B—Key
C—Setting Screw
D—Drain Cock

CED,OUOE019,9 –19–12MAR99–34/34

DISASSEMBLE AND ASSEMBLE GCX 14/12 FEED



T120933

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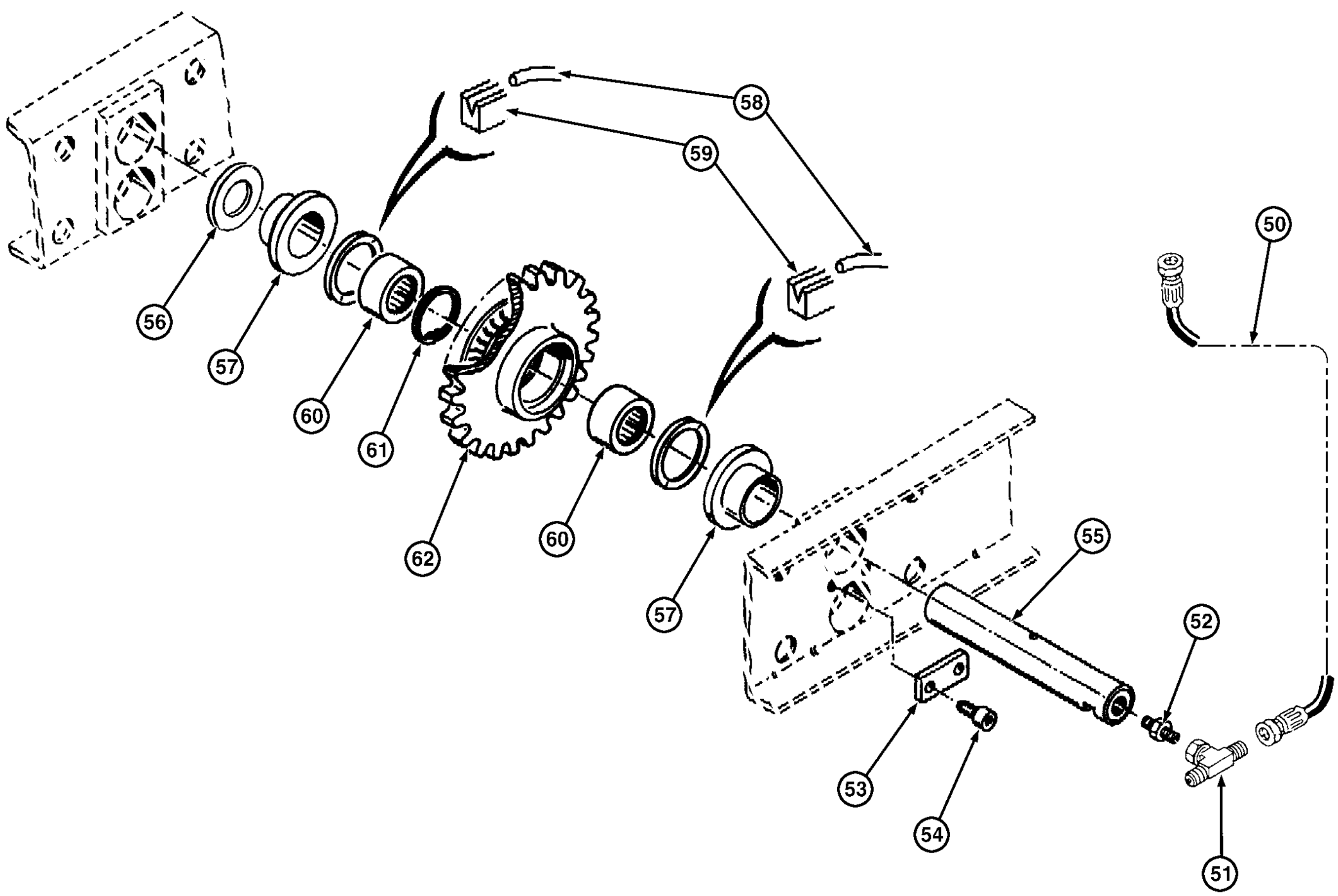

DETAIL A

T120934

T120934 –UN–01JUN99

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Rock Drill

1—Screw (2 used)
2—Winder Cradle Chains and Chains Fastener
3—Drifter Cradle Chains and Chains Fastener
4—Screw (2 used)
5—Locknut (2 used)
6—Washer (2 used)
7—Screw (4 used)
8—Nut (4 used)
9—Washer (4 used)
10—Left Slipper
11—Shim (2 used)
12—Shim (4 used)
13—Wearing Plate (2 used)
14—Elastic Pin (4 used)
15—Right Slipper
16—Screw (4 used)
17—Locknut (4 used)
18—Washer (4 used)
19—Slipper (2 used)
20—Adjusting Shim (4 used)
21—Spacer (2 used)
22—Wearing Plate (2 used)
23—Elastic Pin (4 used)
24—Hoses Reel
25—Pin (2 used)
26—Chain Axle (2 used)
27—Screw (8 used)
28—Locknut (8 used)
29—Washer (8 used)
30—Slipper (4 used)
31—Adjusting Shim (12 used)
32—Spacer (4 used)
33—Wearing Plate (4 used)
34—Adjusting Shim (4 used)
35—Elastic Pin (8 used)
36—Hose Guide
37—Drill Mounting Assembly
38—Screw (4 used)
39—Brake-Motor-Reducer
40—Screw (6 used)
41—Front Thrust
42—Flange (2 used)
43—Screw (4 used)
44—Hoses Holder
45—Screw (2 used)
46—Plate
47—Screw (8 used)
48—Front Part
49—Roller
50—Hose
51—Tee
52—Adapter
53—Stop Plate
54—Screw (2 used)
55—Pin
56—Adjusting Shim
57—Ring (2 used)
58—Ring (2 used)
59—Seal (2 used)
60—Needle Bearing (2 used)
61—Snap Ring
62—Chain Wheel
63—Bare Box

1. Remove two screws (1).
2. Remove two screws (4), locknuts (5), washers (6), four screws (7), nuts (8), and washers (9).
3. Remove left slipper (10), two shims (11), four shims (12), two wearing plates (13), four elastic pins (14), and right slipper (15).
4. Remove four screws (16), nuts (17), washers (18), two slippers (19), four adjusting shims (20), two spacers (21), two wearing plates (22), and four elastic pins (23).
5. Remove hoses reel (24).
6. Remove two pins (25), and two chain axles (26).
7. Remove eight screws (27), locknuts (28), and washers (29).
8. Remove four slippers (30), twelve adjusting shims (31), four spacers (32), four wearing plates (33), four adjusting shims (34), eight elastic pins (35), and hose guide (36).
9. Remove drill mounting assembly (37).
10. Remove four screws (38) and brake-motor-reducer (39).
11. Remove six screws (40), front thrust (41), and two flanges (42).
12. Remove four screws (43) and hoses holder (44).
13. Remove two screws (45) and plate (46).
14. Remove eight screws (47) and front part (48).
15. Remove roller (49).
16. Remove hose (50).
17. Remove tee (51) and adapter (52.
18. Remove two screws (54) and stop plate (53).
19. Gradually extract pin (55) to allow parts to be removed from the pin.
20. Remove adjusting shim (56), two rings (57), two rings (58), two seals (59), two needle bearings (60), snap ring (61), and chain wheel (62). Discard rings (58), and seals (59).
21. Remove pin (55).
22. Inspect, repair or replace parts as necessary.

Continued on next page

Rock Drill

44
9506
82

23. Install pin (55).

24. Install two new rings (58), two new seals (59), chain wheel (62), snap ring (61), two needle bearings (60), two rings (57), and adjusting shim (56).

25. Install stop plate (53), and two screws (54).

26. Install adapter (52), and tee (51).

27. Install hose (50).

28. Install roller (49).

29. Install front part (48), and eight screws (47).

30. Install plate (46) and two screws (45).

31. Install hoses holder (44), and four screws (43).

32. Install two flanges (42), front thrust (41), and six screws (40).

33. Install brake-motor reducer (39), and four screws (38).

34. Install drill mounting assembly (37).

35. Install hose guide (36).

36. Install four slippers (30), twelve adjusting shims (31), four spacers (32), four wearing plates (33), four adjusting shims (34), and eight elastic pins (35).

37. Install eight screws (27), locknuts (28), and washers (29).

38. Install two chain axles (26), and two pins (25).

39. Install hoses reel (24).

40. Install four elastic pins (23).

41. Install two wearing plates (22), two spacers (21), four adjusting shims (20), two slippers (19), four screws (16), nuts (17), and washers (18).

42. Install right slipper (15), four elastic pins (14), two wearing plates (13), four shims (12), two shims (11), and left slipper (10).

43. Install four screws (7), nuts (8), washers (9), two screws (4), locknuts (5), and washers (6).

44. Install two screws (1).

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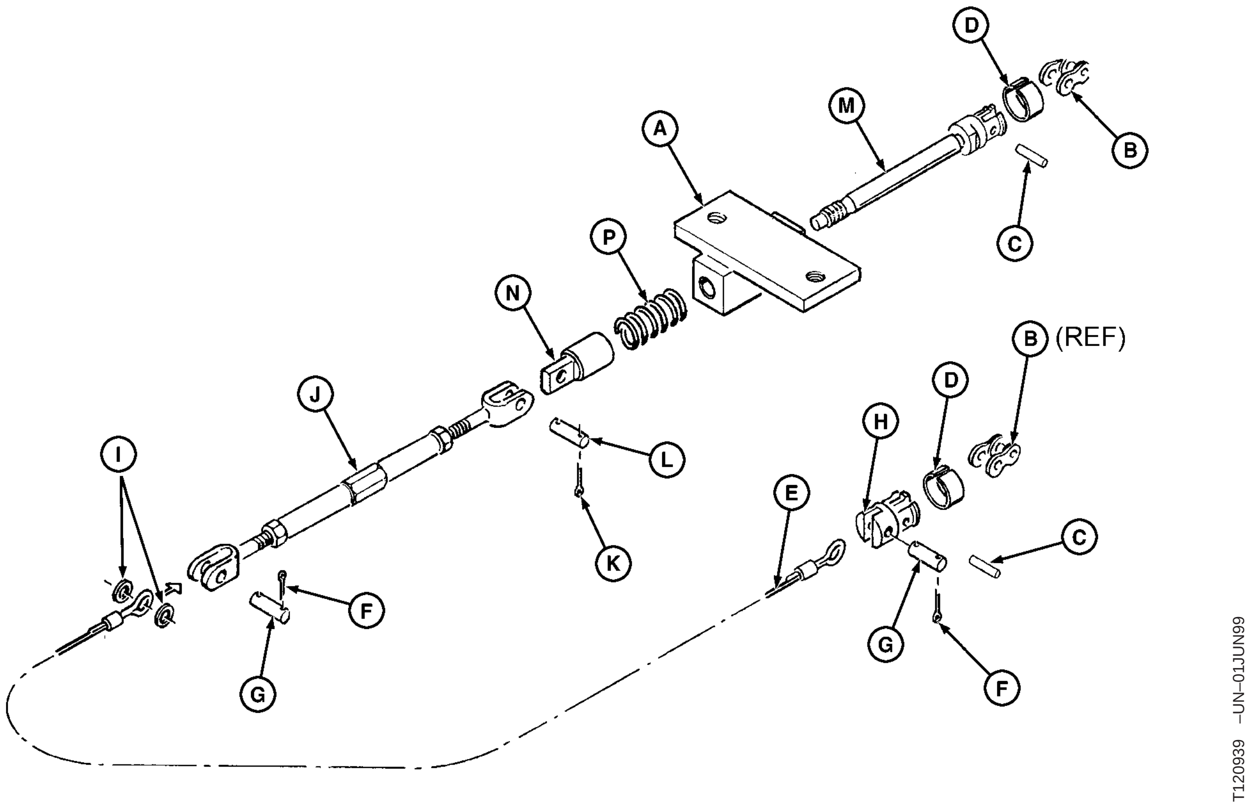
CED,OUOE019,11 –19–23MAR99–4/22



T120939

A—Chain Fastener
B—Chain
C—Pin (2 used)
D—Retaining Ring (2 used)
E—Cable
F—Pin (2 used)
G—Pin (2 used)
H—Attachment
I—Washer (2 used)
J—Tension Piece
K—Pin
L—Pin
M—Attachment
N—Attachment
P—Spring

45. Remove two pins (C), chain (B), and two retaining rings (D).

46. Remove two pins (F), two pins (G), cable (E), two washers (I), and attachment (H).

47. Remove pins (K and L), and tension piece (J).

48. Remove attachments (M and N), and spring (P).

49. Inspect, repair or replace parts as necessary.

50. Install spring (P), and attachments (M and N).

51. Install tension piece (J), and pins (L and K).

52. Install cable (E), two pins (F), two pins (G), two washers (I), and attachment (H).

53. Install chain (B), two retaining rings (D), and two pins (C).

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CED,OUOE019,11 –19–23MAR99–5/22

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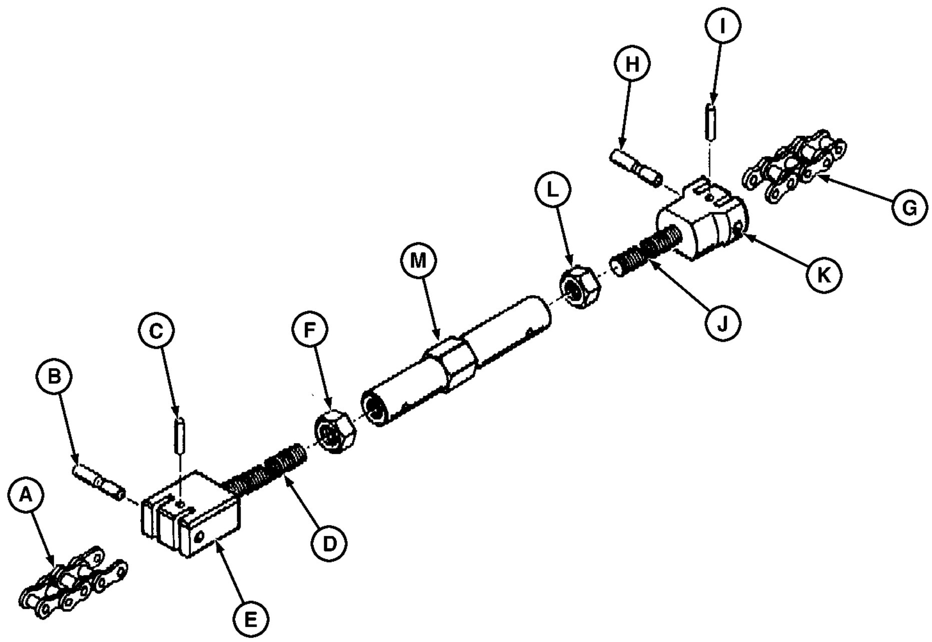

T120940

A—Front Chain
B—Chain Axle
C—Pin
D—Gudgeon
E—Chain Fastener
F—Nut
G—Rear chain
H—Chain Axle
I—Pin
J—Gudgeon
K—Chain Fastener
L—Nut
M—Adjuster

54. Remove pin (C), chain axle (B), and front chain (A).

55. Remove gudgeon (D), chain fastener (E), and nut (F).

56. Remove pin (I), chain axle (H) and rear chain (G).

57. Remove gudgeon (J), chain fastener (K), and nut (L).

58. Inspect, repair or replace parts as necessary.

59. Install nut (L), chain fastener (K), and gudgeon (J).

60. Install rear chain (G), chain axle (H), and pin (I).

61. Install nut (F), gudgeon (D), and chain fastener (E).

62. Install front chain (A), chain axle (B), and pin (C).

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CED,OUOE019,11 –19–23MAR99–6/22

Rock Drill

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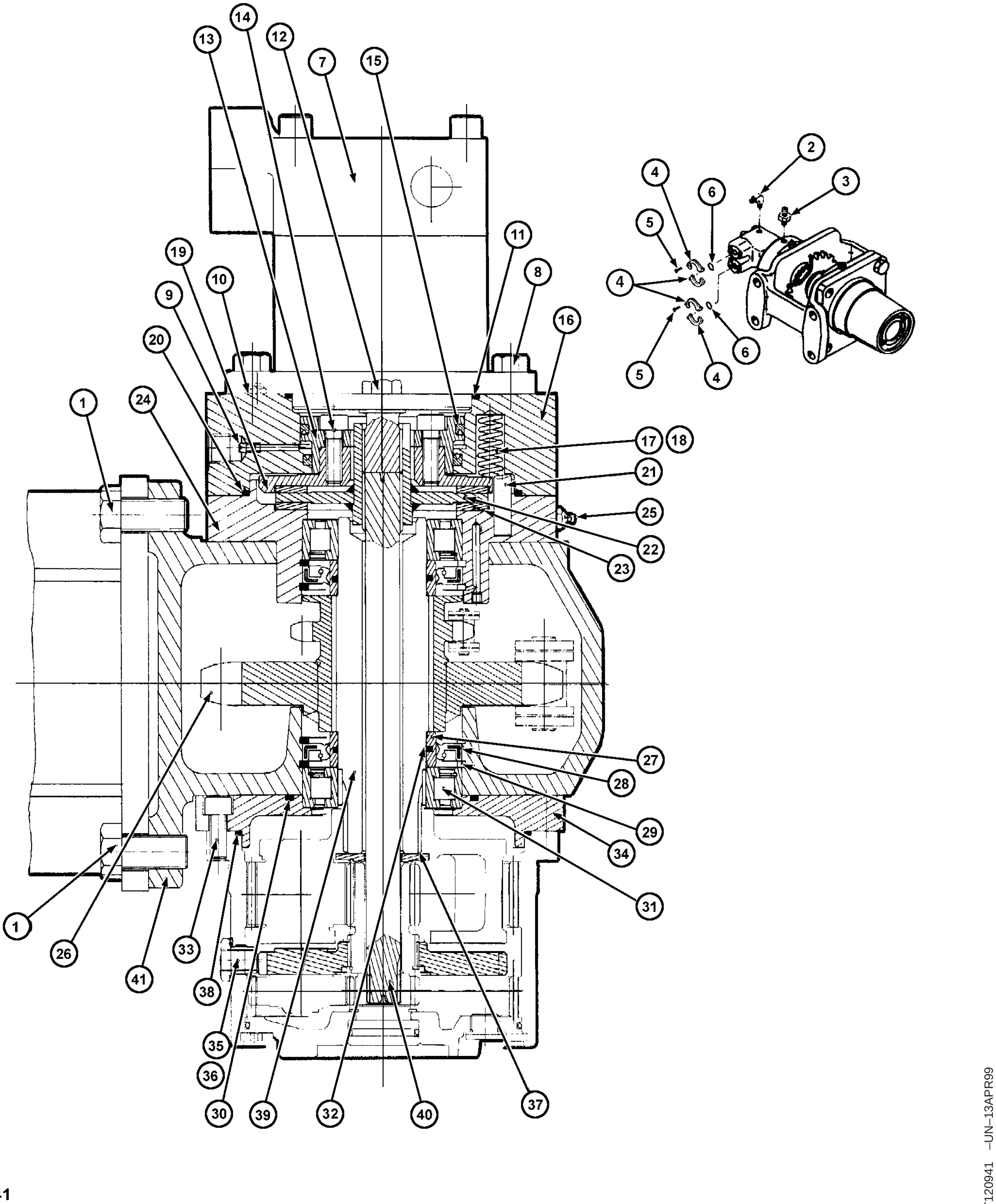

T120941

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Rock Drill

1—Screw (4 used)
2—Adapter
3—Adapter
4—Half-Flange (4 used)
5—Screw (8 used)
6—O-Ring (2 used)
7—Hydraulic Motor
8—Screw (2 used)
9—Oil Restricter
10—Relief Valve
11—O-Ring
12—Screw (4 used)
13—Piston
14—Screw (6 used)
15—Lip Seal (2 used)
16—Cylinder Body
17—Spring (6 used)
18—Spring (6 used)
19—Pressure Disc
20—O-Ring
21—Pin (2 used)
22—Brake Disc
23—Disc
24—Bearing Holder
25—Oiler (2 used)
26—Chain Wheel
27—Ring (2 used)
28—Seal (2 used)
29—Circlips (4 used)
30—O-Ring
31—Bearing
32—O-Ring
33—Screw (12 used)
34—Spacer
35—Plug (2 used)
36—Tight Ring (2 used)
37—Reducer
38—O-Ring
39—Shaft
40—Driving Shaft
41—Support

63. Remove four screws (1).

64. Remove adapter (2).

65. Remove adapter (3).

66. Remove eight screws (5) and four half-flanges (4).

67. Remove and discard two O-rings (6).

68. Remove two screws (8) and hydraulic motor (7).

69. Remove oil restrictor (9).

70. Remove relief valve (10).

71. Remove and discard O-ring (11).

72. Remove four screws (12).

73. Remove six screws (14), and piston (13).

74. Remove and discard two lip seals (15).

75. Remove cylinder body (16).

76. Remove springs (17 and 18).

77. Remove pressure disc (19).

78. Remove and discard O-ring (20).

79. Remove two pins (21).

80. Remove brake disc (22), and disc (23).

81. Remove bearing holder (24).

82. Remove two oilers (25).

83. Remove chain wheel (26).

84. Remove two rings (27), two seals (28), four circlips (29), O-ring (32), and bearing (31). Discard the seals and o-ring.

85. Remove and discard O-ring (30).

86. Remove twelve screws (33) and spacer (34).

87. Remove and discard O-ring (38).

88. Remove two plugs (35), and two tight rings (36).

89. Remove reducer (37).

90. Remove shaft (39), and driving shaft (40).

91. Inspect, repair or replace parts as necessary.

92. Install shaft (39), and driving shaft (40).

93. Install reducer (37).

94. Install two tight rings (36), and two plugs (35).

95. Install new O-ring (38).

96. Install spacer (34), and twelve screws (33).

97. Install new O-ring (30).

Continued on next page CED,OUOE019,11 –19–23MAR99–8/22

Rock Drill

98. Install bearing (31), new O-ring (32), four circlips (29), two new seals (28), and two rings (27).

99. Install chain wheel (26).

100. Install two oilers (25).

101. Install bearing holder (24).

102. Install disc (23), and brake disc (22).

103. Install two pins (21).

104. Install new O-ring (20).

105. Install pressure disc (19).

106. Install springs (17 and 18).

107. Install cylinder body (16).

108. Install two new lip seals (15).

109. Install piston (13) and six screws (14).

110. Install four screws (12).

111. Install new O-ring (11).

112. Install relief valve (10).

113. Install oil restrictor (9).

114. Install hydraulic motor (7), and two screws (8).

115. Install two new O-rings (6).

116. Install four half-flanges (4), and eight screws (5).

117. Install adapter (3).

118. Install adapter (2).

119. Install four screws (1).

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CED,OUOE019,11 –19–23MAR99–9/22

Rock Drill

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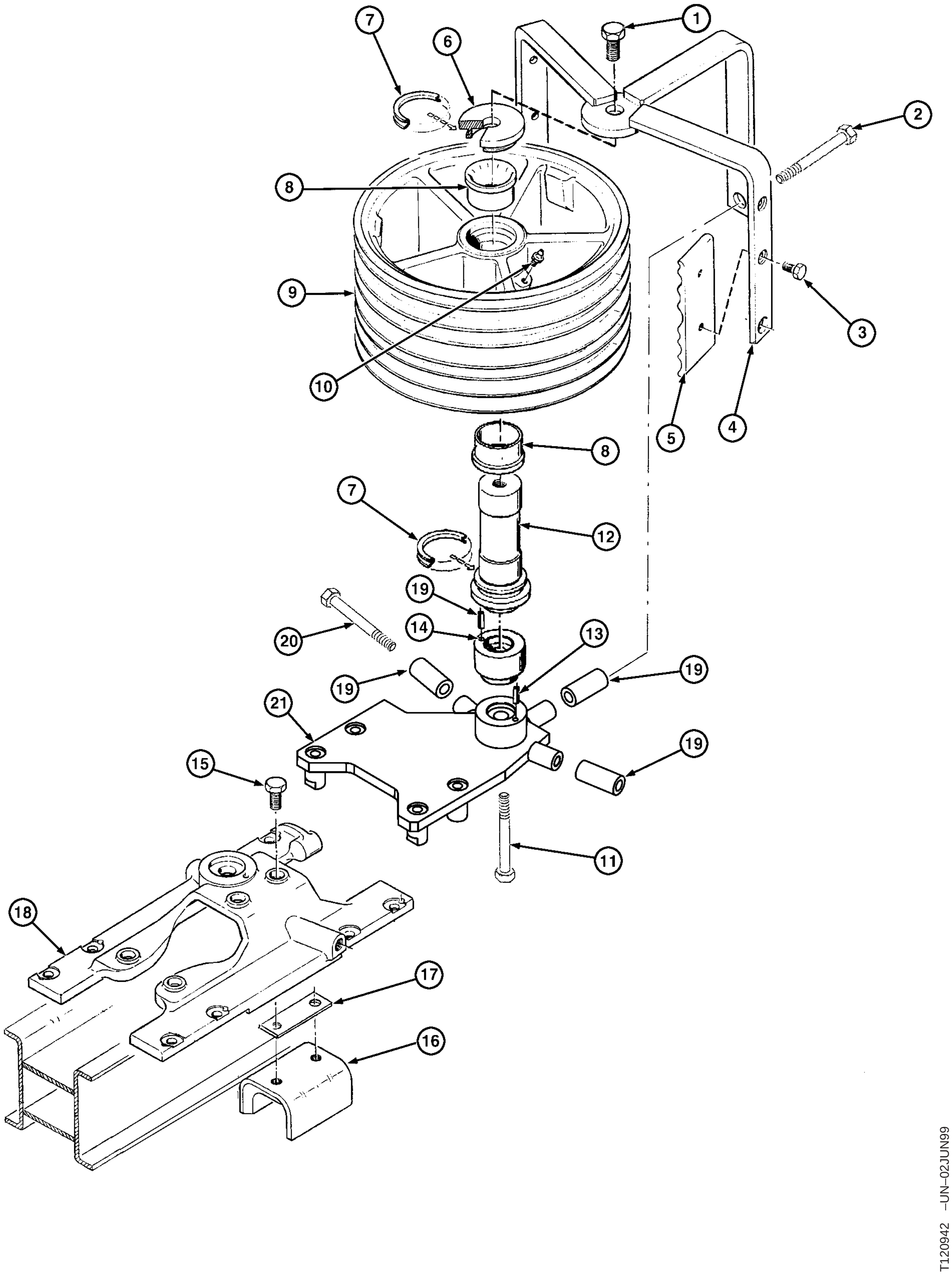

T120942

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1—Screw
2—Bolt
3—Screw (4 used)
4—Shield
5—Hoses Guide (2 used)
6—Ring
7—Joint (2 used)
8—Ring (2 used)
9—Pulley
10—Oiler
11—Screw
12—Shaft
13—Elastic Pin (2 used)
14—Spacer
15—Screw (2 used)
16—Chain Guide
17—Shim
18—Hoses Winder Cradle
19—Spacer Ring (3 used)
20—Screw (3 used)
21—Cradle Spacer

120. Remove screw (1).

121. Remove bolt (2).

122. Remove four screws (3).

123. Remove shield (4).

124. Remove two hoses guides (5).

125. Remove screw (11).

126. Remove ring (6), two joints (7), two rings (8), pulley (9), two elastic pins (13), spacer (14), and shaft (12).

127. Remove oiler (10).

128. Remove two screws (15), chain guide (16), shim (17), and hoses winder cradle (18).

129. Remove three screws (20), and spacer rings (19).

130. Inspect, repair or replace parts as necessary.

131. Install three spacer rings (19), and screws (20).

132. Install chain guide (16), shim (17), two screws (15), and hoses winder cradle (18).

133. Install oiler (10).

134. Install shaft (12), spacer (14), two elastic pins (13), pulley (9), two rings (8), two joints (7), and ring (6).

135. Install screw (11).

136. Install two hoses guides (5).

137. Install shield (4).

138. Install four screws (3).

139. Install bolt (2).

140. Install screw (1).

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Rock Drill

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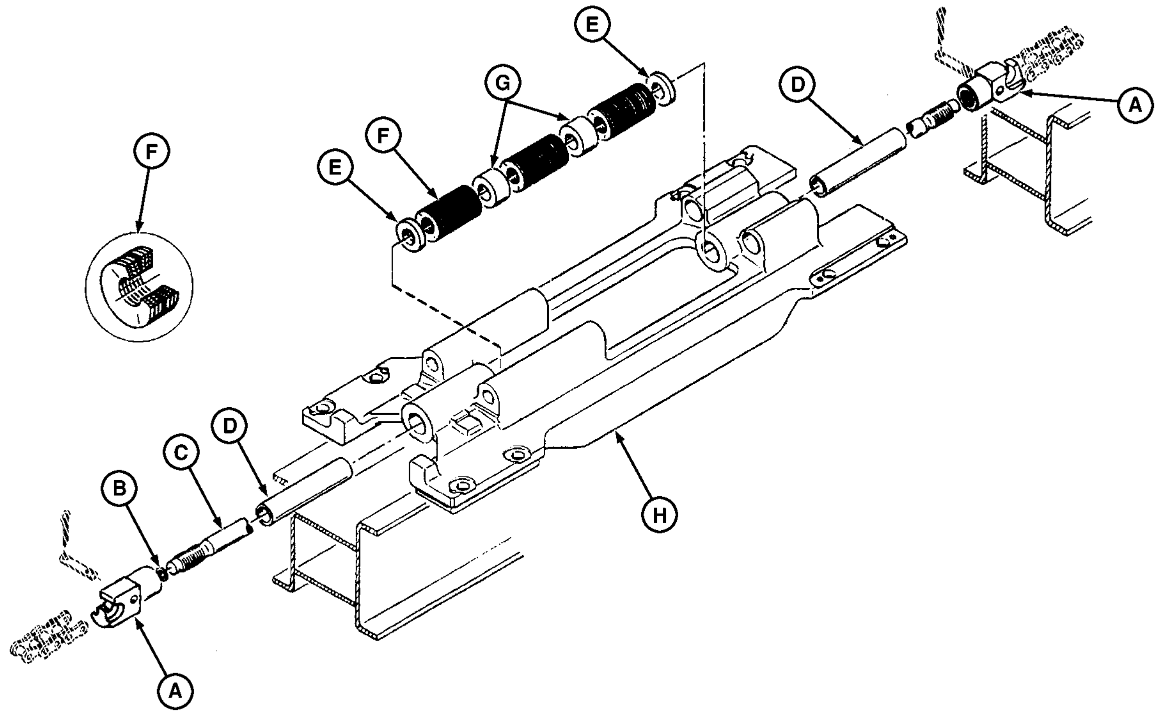

A—Chain Fastener (2 used)
B—Adjusting Ring (3 used)
C—Gudgeon
D—Ring (2 used)
E—Ring (2 used)
F—Spring Washer (18 used in sets of 6)
G—Ring (2 used)
H—Cradle

141. Remove two chain fasteners (A).

142. Remove three adjusting rings (B), gudgeon (C), and two rings (D).

143. Remove two rings (E), eighteen spring washers (F), and two rings (G).

144. Inspect, repair or replace parts as necessary.

145. Install two rings (E), eighteen spring washers (F) (in sets of six), and two rings (G).

146. Install three adjusting rings (B), gudgeon (C), and two rings (D).

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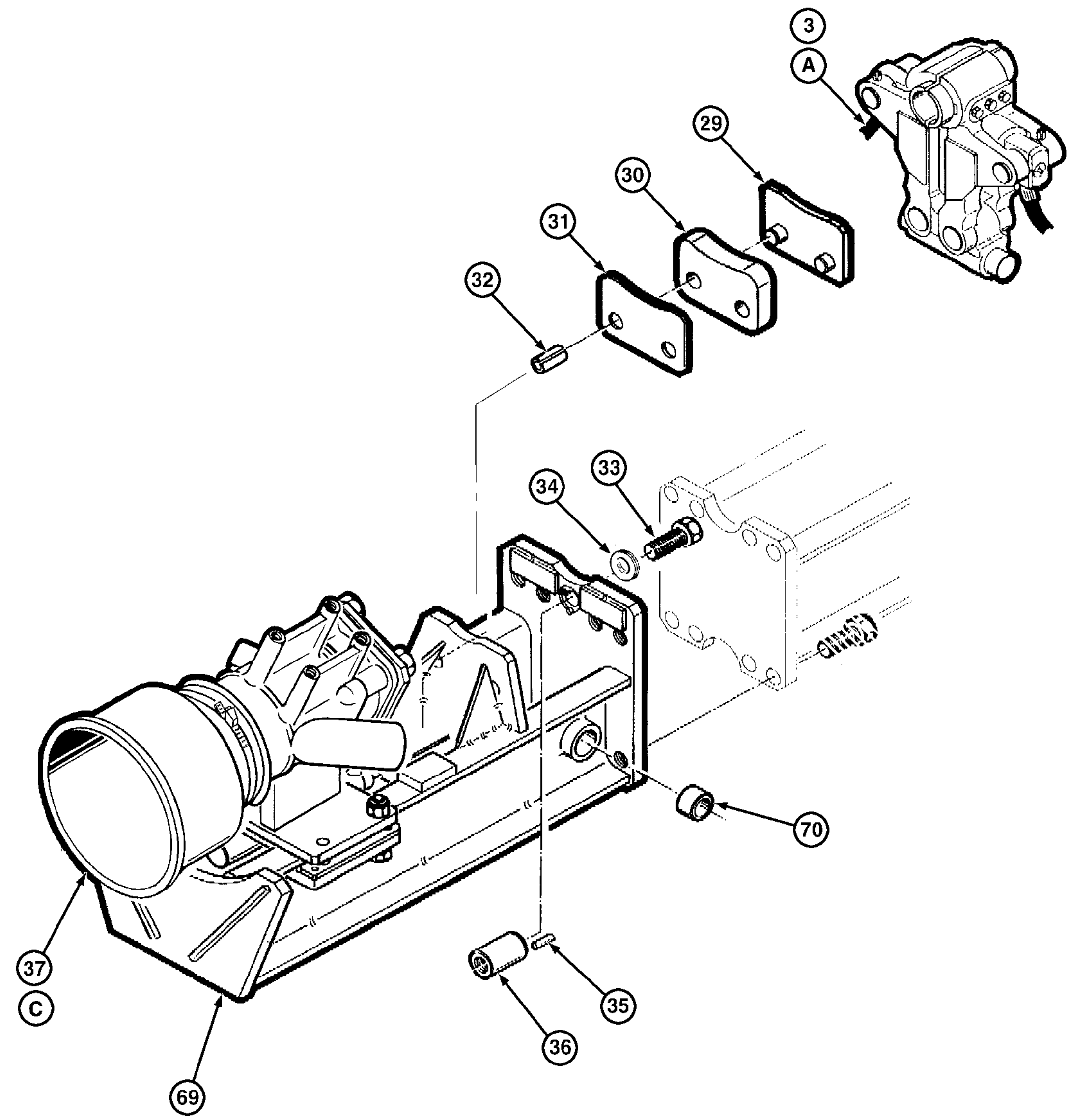
Rock Drill



T120944

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147. Install two chain fasteners (A).

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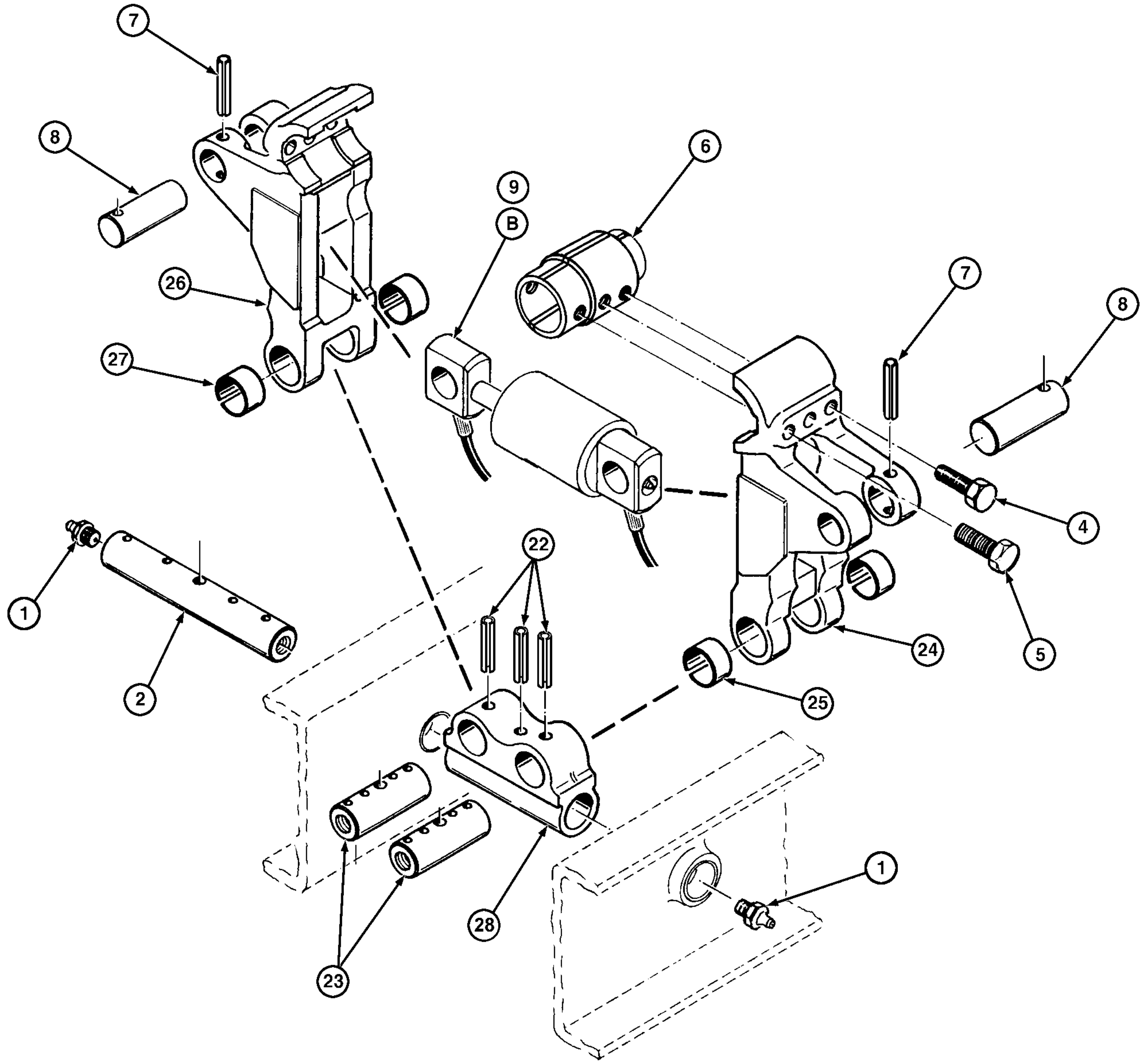
Rock Drill



DETAIL A

T120945

T120945 –UN–13APR99

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Rock Drill

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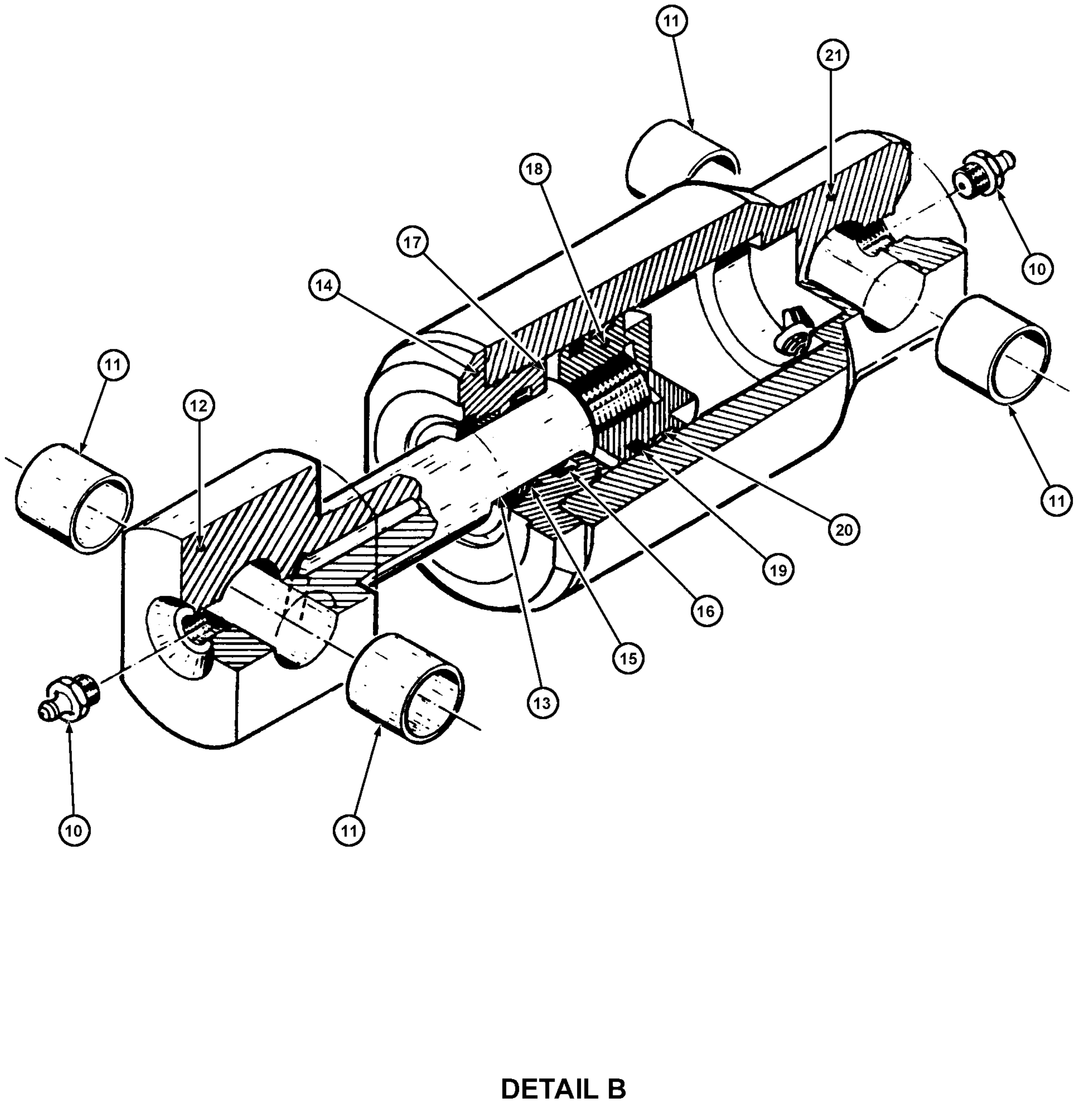

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T120946 –UN–13APR99

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CED,OUOE019,11 –19–23MAR99–16/22

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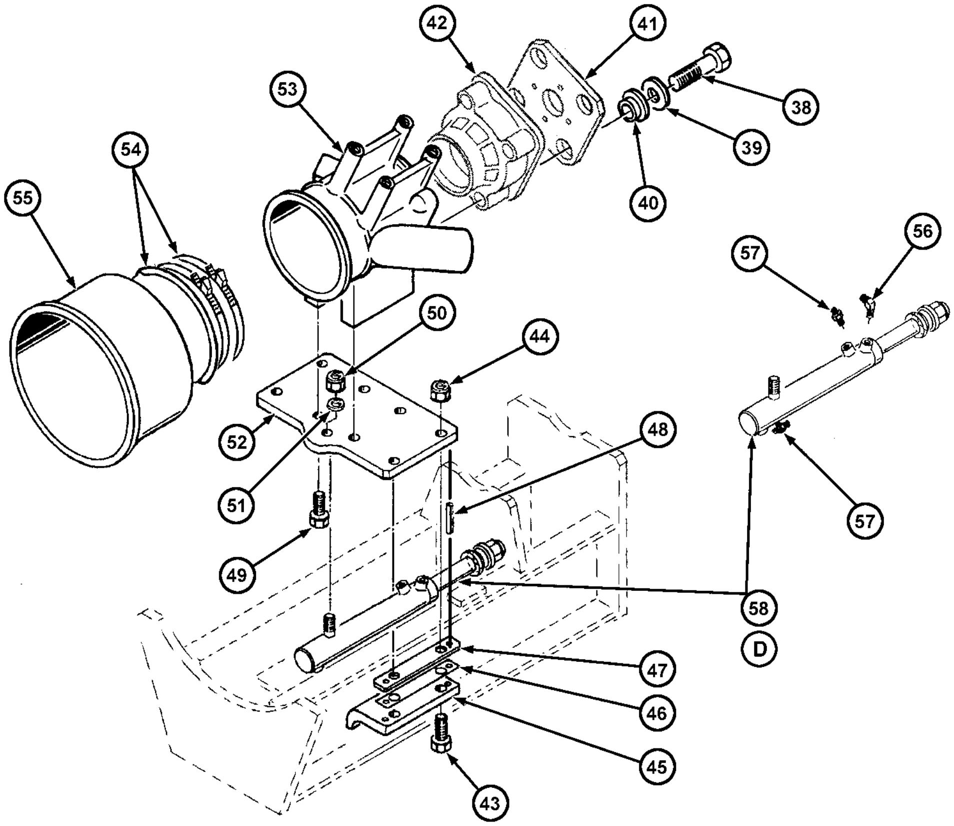
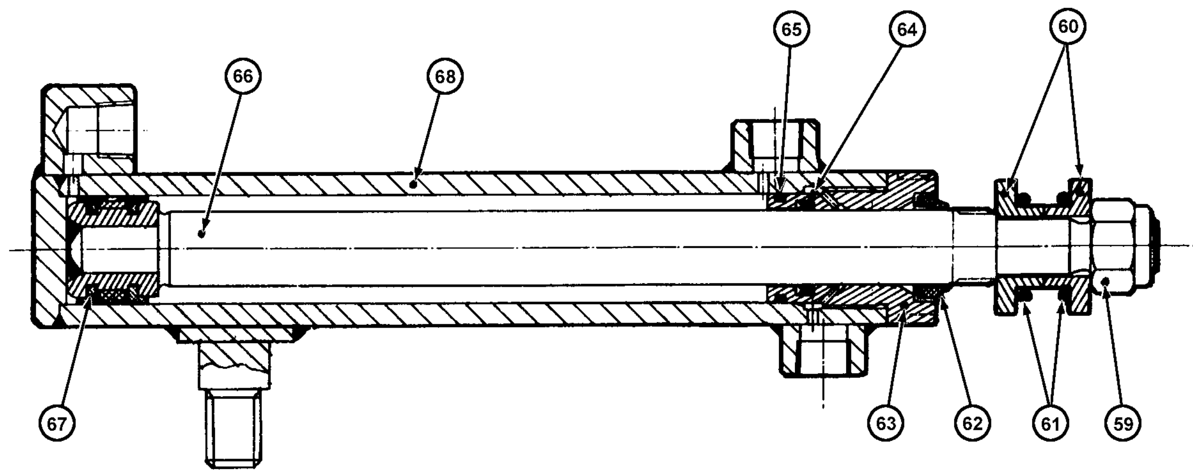


DETAIL C



DETAIL D

T120947

T120947 –UN–13APR99

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1—Oiler (2 used)
2—Pin
3—Hydraulic Centralizer
4—Screw (4 used)
5—Screw (2 used)
6—Centralizer Half-Shell
7—Elastic Pin (2 used)
8—Pin (2 used)
9—Cylinder
10—Oiler (2 used)
11—Self-Lubricating Ring (4 used)
12—Cylinder Rod
13—Scraper Seal
14—Guide
15—Self-Lubricating Ring
16—Rod Seal
17—O-Ring
18—Piston
19—Piston Seal
20—Guide Ring
21—Cylinder Body
22—Elastic Pin (3 used)
23—Pin (2 used)
24—Left Centralizer
25—Ring (2 used)
26—Right Centralizer
27—Ring (2 used)
28—Articulation Block
29—Plate
30—Shock Absorber
31—Shim
32—Pin (2 used)
33—Screw
34—Lock Washer
35—Pin
36—Centering Pin
37—Dust Hood
38—Screw (4 used)
39—Washer (4 used)
40—Ring (4 used)
41—Diaphragm
42—Centering Part
43—Screw (4 used)
44—Locknut (4 used)
45—Slipper (2 used)
46—Adjusting Shim (6 used)
47—Spacer (2 used)
48—Pin (4 used)
49—Screw (4 used)
50—Locknut
51—Ring
52—Support
53—Dust Hood
54—Band
55—Skirt
56—Adapter
57—Adapter (2 used)
58—Hydraulic Cylinder
59—Locknut
60—Ring (2 used)
61—O-Ring (2 used)
62—Scraper Seal
63—Guide
64—Rod Seal
65—O-Ring
66—Cylinder Rod
67—Piston Seal
68—Cylinder Body
69—Support
70—Self-Lubricating Ring (2 used)

148. Remove two oilers (1).

149. Remove pin (2).

150. Remove hydraulic centralizer (3).

151. Remove four screws (4).

152. Remove two screws (5).

153. Remove centralizer half-shell (6).

154. Remove two elastic pins (7).

155. Remove two pins (8).

156. Remove cylinder (9).

157. Remove two oilers (10).

158. Remove and discard four self-lubricating rings (11).

159. Remove cylinder rod (12).

160. Remove and discard scraper seal (13).

161. Remove guide (14).

162. Remove and discard self-lubricating ring (15).

163. Remove rod seal (16), O-ring (17), piston (18), piston seal (19), and guide ring (20). Discard the O-ring.

164. Remove three elastic pins (22).

165. Remove two pins (23).

166. Remove left centralizer (24) and two rings (25).

167. Remove right centralizer (26) and two rings (27).

168. Remove articulation block (28).

169. Remove plate (29), two pins (32), shock absorber (30), and shim (31).

170. Remove screw (33), lock washer (34), pin (35), and centering pin (36).

171. Remove four screws (38), washers (39), rings (40), diaphragm (41), and centering part (42).

172. Remove four screws (43), locknuts (44), two slippers (45), six adjusting shims (46), two spacers (47), and four pins (48).

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CED,OUOE019,11 –19–23MAR99–18/22

Rock Drill

173. Remove four screws (49).

174. Remove locknut (50), ring (51), and support (52).

175. Remove dust hood (53), band (54), and skirt (55).

176. Remove adapter (56).

177. Remove two adapters (57).

178. Remove hydraulic cylinder (58).

179. Remove locknut (59).

180. Remove two rings (60), and two O-rings (61). Discard the O-rings.

181. Remove cylinder rod (66), scraper seal (62), guide (63), rod seal (64), O-ring (65), and piston seal (67). Discard the O-ring.

182. Remove two self-lubricating rings (70).

183. Inspect, repair or replace parts as necessary.

184. Install two self-lubricating rings (70).

185. Install piston seal (67),

186. Install new O-ring (65), rod seal (64), guide (63), scraper seal (62), and cylinder rod (66).

187. Install two new O-rings (61), and two rings (60)

188. Install locknut (59).

189. Install hydraulic cylinder (58).

190. Install two adapters (57).

191. Install adapter (56).

192. Install skirt (55), band (54), and dust hood (53).

193. Install support (52), ring (51), and locknut (50).

194. Install four screws (49).

195. Install two spacers (47), six adjusting shims (46), four pins (48), two slippers (45), four screws (43), and locknuts (44).

196. Install centering part (42), diaphragm (41), four screws (38), washers (39), and rings (40).

197. Install pin (35), centering pin (36), screw (33), and lock washer (34).

198. Install shock absorber (30), shim (31), two pins (32), and plate (29).

199. Install articulation block (28).

200. Install two rings (27), and right centralizer (26).

201. Install two rings (25), and left centralizer (24).

202. Install two pins (23), and three elastic pins (22).

203. Install guide ring (20), piston seal (19), piston (18), new O-ring (17), and rod seal (16).

204. Install new self-lubricating ring (15).

205. Install guide (14).

206. Install scraper seal (13).

207. Install cylinder rod (12).

208. Install four new self-lubricating rings (11).

209. Install two oilers (10).

210. Install cylinder (9).

211. Install two pins (8).

212. Install two elastic pins (7).

213. Install centralizer half-shell (6).

Continued on next page

214. Install two screws (5).

215. Install four screws (4).

216. Install hydraulic centralizer (3).

217. Install pin (2).

218. Install two oilers (1).

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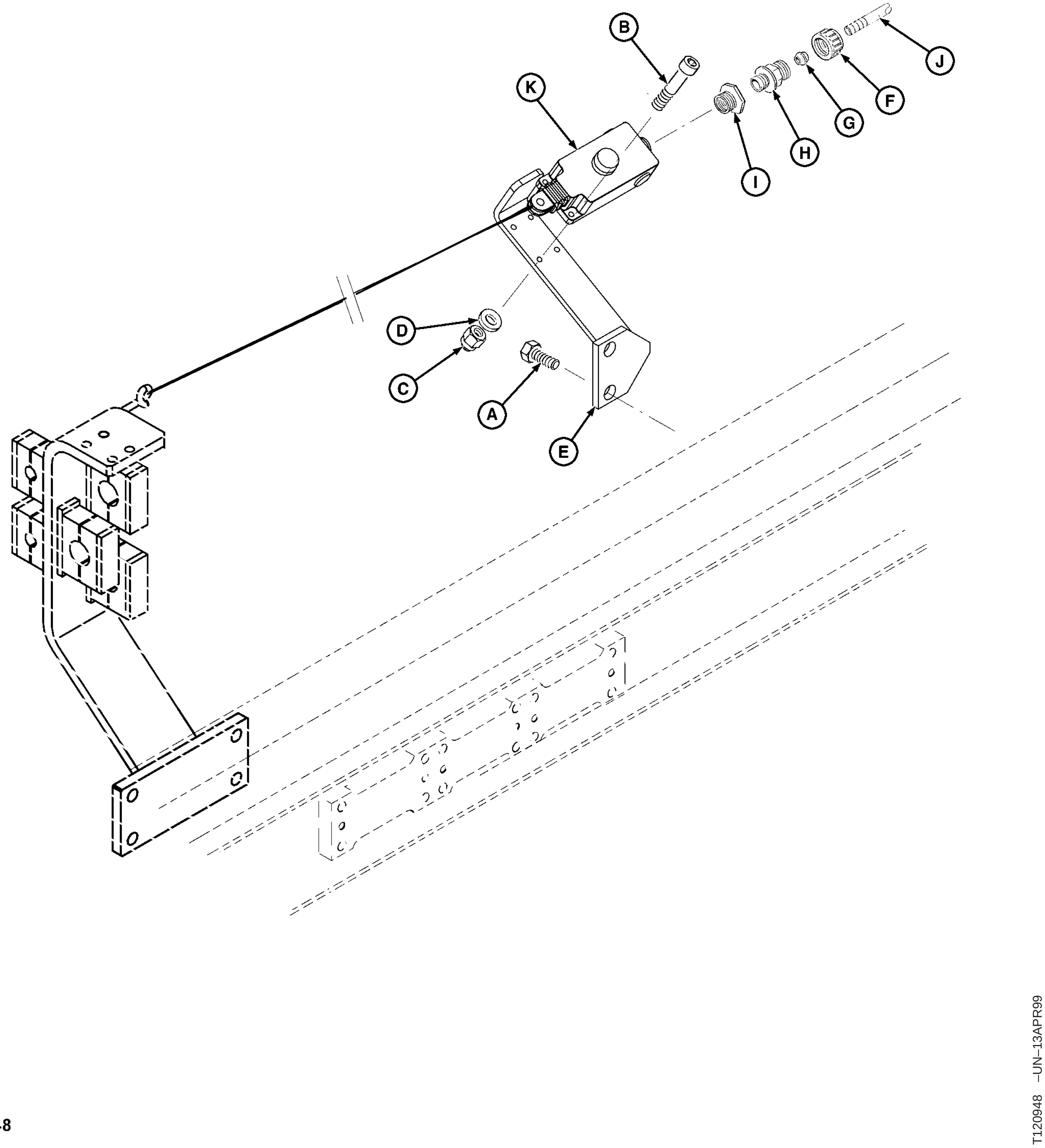
Rock Drill



T120948

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Rock Drill

A—Screw (2 used)
B—Screw (2 used)
C—Locknut (2 used)
D—Washer (2 used)
E—Detector Support
F—End Piece
G—End Piece
H—End Piece
I—Gland Plug Reducer
J—Cover
K—Emergency Stop

219. Remove two screws (A).

220. Remove two screws (B), locknuts (C), and washers (D).

221. Remove detector support (E).

222. Remove end pieces (F, G and H), gland plug reducer (I), and cover (J).

223. Inspect, repair or replace parts as necessary.

224. Install cover (J), gland plug reducer (I), and end pieces (F, G, and H).

225. Install detector support (E).

226. Install two screws (B), locknuts (C), and washers (D).

227. Install two screws (A).

CED,OUOE019,11 –19–23MAR99–22/22

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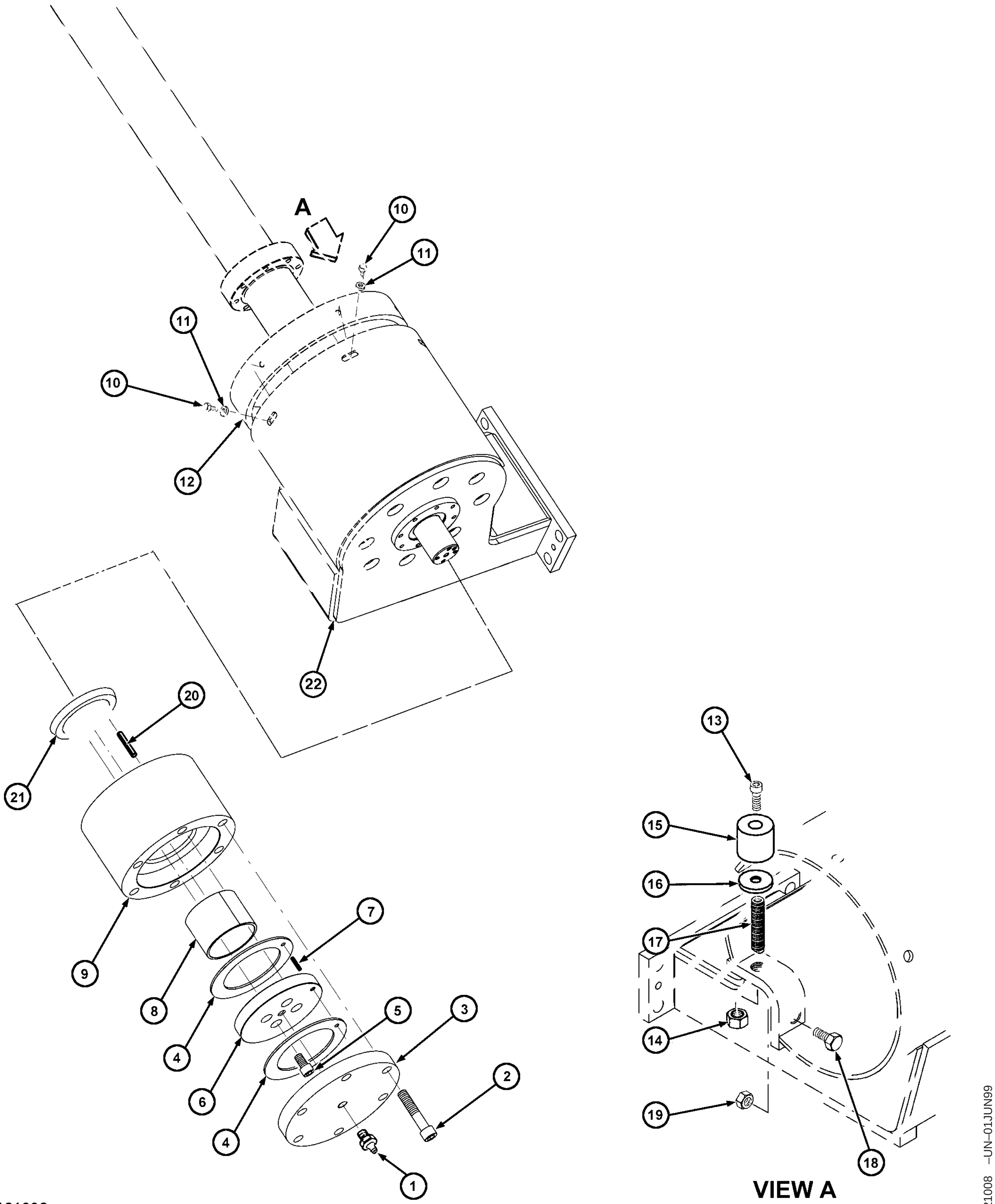
104

DISASSEMBLE AND ASSEMBLE ROD CHANGER



T121008

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Rock Drill

1—Oiler
2—Screw (2 used)
3—Stop Washer
4—Self-Lubricating Ring (2 used)
5—Screw (4 used)
6—Stop Washer
7—Elastic Pin
8—Self-Lubricating Ring
9—Bearing
10—Screw (5 used)
11—Washer (5 used)
12—Spacer
13—Screw
14—Special Nut
15—Shock Absorber
16—Washer
17—Threaded Rod
18—Screw
19—Special Nut
20—Pin
21—Scraper Joint
22—Lower Support

1. Remove oiler (1).
2. Remove six screws (2), and stop washer (3).
3. Remove four screws (5), stop washer (6), elastic pin (7), and two self-lubricating rings (4).
4. Remove self-lubricating ring (8), and bearing (9).
5. Remove five screws (10), washers (11), and spacer (12).
6. Remove screw (13), special nut (14), shock absorber (15), washer (16), and threaded rod (17).
7. Remove screw (18), and nut (19).
8. Remove pin (20), and scraper joint (21).
9. Inspect, repair or replace parts as necessary.
10. Install scraper joint (21), and pin (20).
11. Install screw (18), and nut (19).
12. Install threaded rod (17), washer (16), shock absorber (15), special nut (14), and screw (13).
13. Install spacer (12), five screws (10), and washers (11).
14. Install bearing (9), and self-lubricating ring (8).
15. Install two self-lubricating rings (4), elastic pin (7), stop washer (6), and four screws (5).
16. Install stop washer (3), and six screws (2).
17. Install oiler (1).

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CED,OUOE019,14 –19–30MAR99–2/13

Rock Drill

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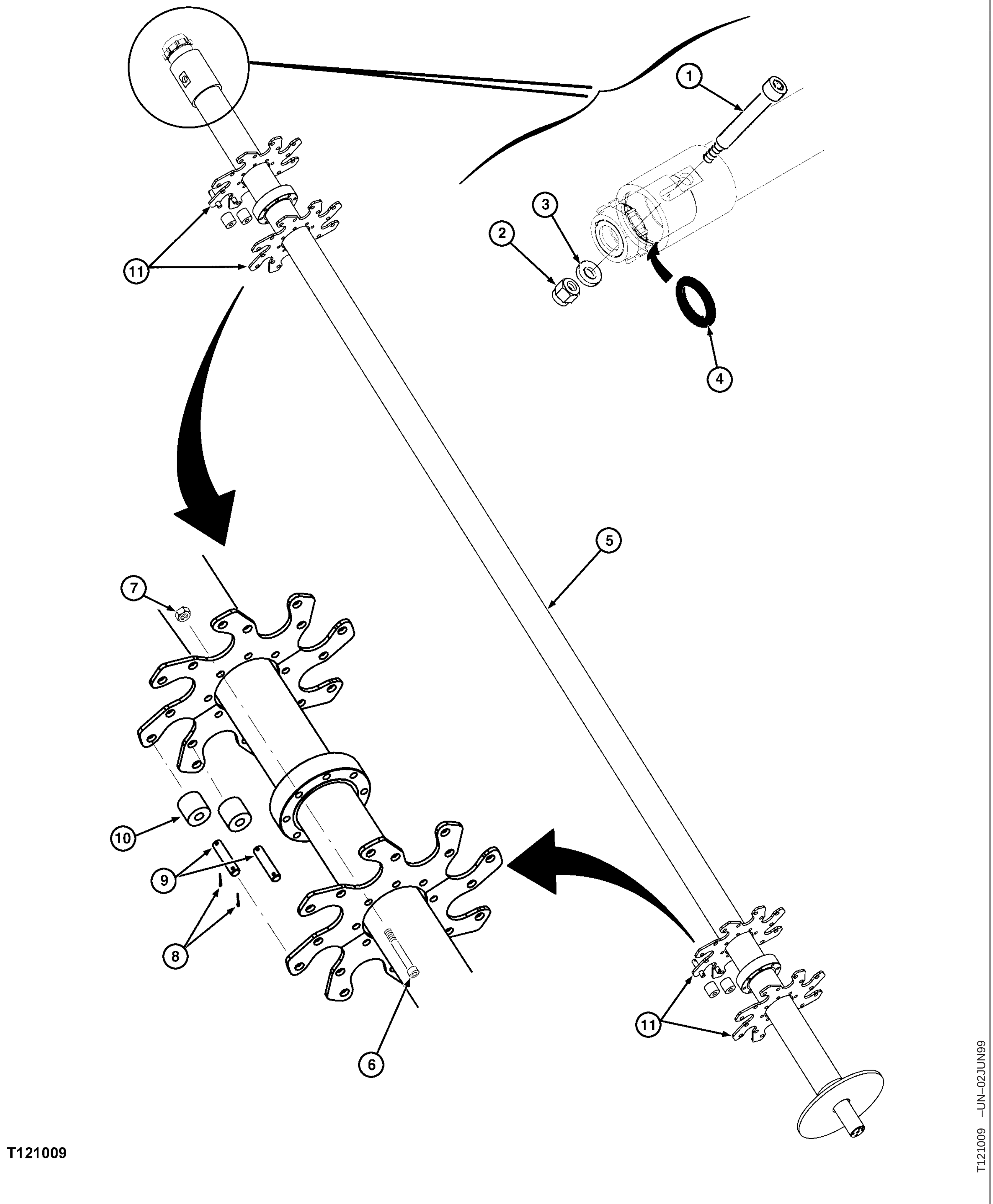

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CED,OUOE019,14 –19–30MAR99–3/13

Rock Drill

1—Threaded Pin
2—Locknut
3—Washer
4—O-Ring
5—Central Tube
6—Screw (16 used)
7—Locknut (16 used)
8—Pin (56 used)
9—Pin (28 used)
10—Shock Absorber (28 used)
11—Separator (4 used)

18. Remove threaded pin (1), locknut (2), washer (3), and O-ring (4). Discard the O-ring.

19. Remove central tube (5).

20. Remove 16 screws (6), and locknuts (7),

21. Remove 56 pins (8), 28 pins (9), and 28 shock absorbers (10).

22. Remove four separators (11).

23. Inspect, repair or replace parts as necessary.

24. Install four separators (11).

25. Install 28 shock absorbers (10), 28 pins (9), and 56 pins (8).

26. Install 16 screws (6), and locknuts (7).

27. Install central tube (5).

28. Install new O-ring (4), threaded pin (1), locknut (2), and washer (3).

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Rock Drill

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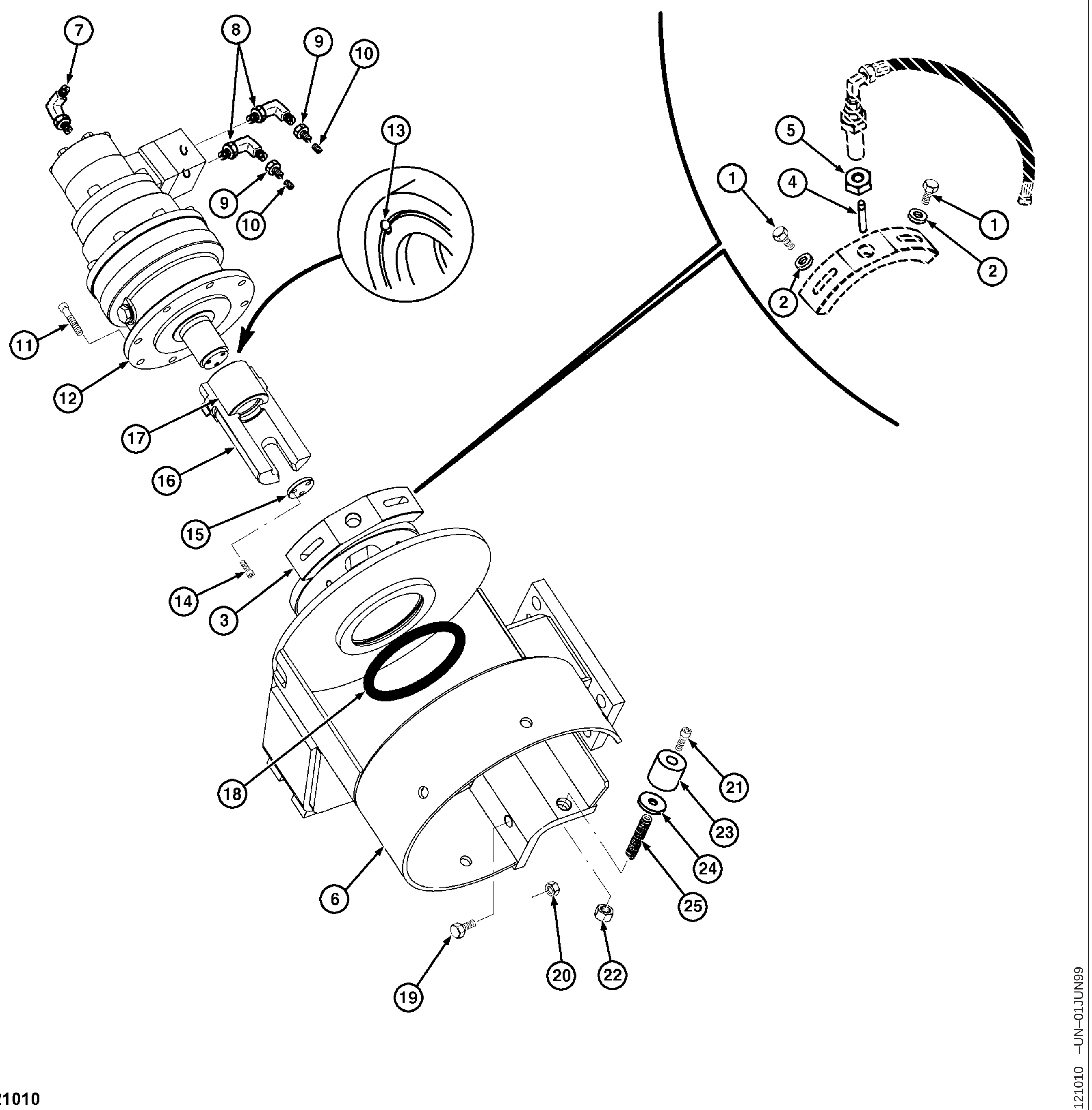
108



T121010

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Rock Drill

1—Screw (2 used)
2—Washer (2 used)
3—Detector Support
4—Stud
5—Special Nut
6—Upper Support
7—Adapter
8—Adapter (2 used)
9—Adapter (2 used)
10—Oil Restrictor (2 used)
11—Screw (8 used)
12—Brake Reducer Motor
13—Screw
14—Screw (3 used)
15—Washer
16—Sleeve
17—Grooved Sleeve
18—O-Ring
19—Screw
20—Special Nut
21—Screw
22—Special Nut
23—Shock Absorber
24—Washer
25—Threaded Rod
26—Upper Support

29. Remove two screws (1), washers (2), and detector support (3).
30. Remove stud (4), and special nut (5).
31. Remove adapter (7).
32. Remove two adapters (8), two adapters (9), and two oil restrictors (10).
33. Remove eight screws (11), and brake reducer motor (12).
34. Remove screw (13).
35. Remove three screws (14), and washer (15).
36. Remove sleeve (16), and grooved sleeve (17)
37. Remove and discard O-ring (18).
38. Remove screw (19), and special nut (20).
39. Remove screw (21), special nut (22), shock absorber (23), washer (24), and threaded rod (25).
40. Inspect, repair or replace parts as necessary.
41. Install threaded rod (25), washer (24), shock absorber (23), special nut (22), and screw (21).
42. Install special nut (20), and screw (19).
43. Install new O-ring (18).
44. Install grooved sleeve (17), and sleeve (16).
45. Install washer (15), and three screws (14).
46. Install screw (13).
47. Install brake reducer motor (12), and eight screws (11).
48. Install two oil restrictors (10), two adapters (9), and two adapters (8).
49. Install adapter (7).
50. Install stud (4), and special nut (5).

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Rock Drill

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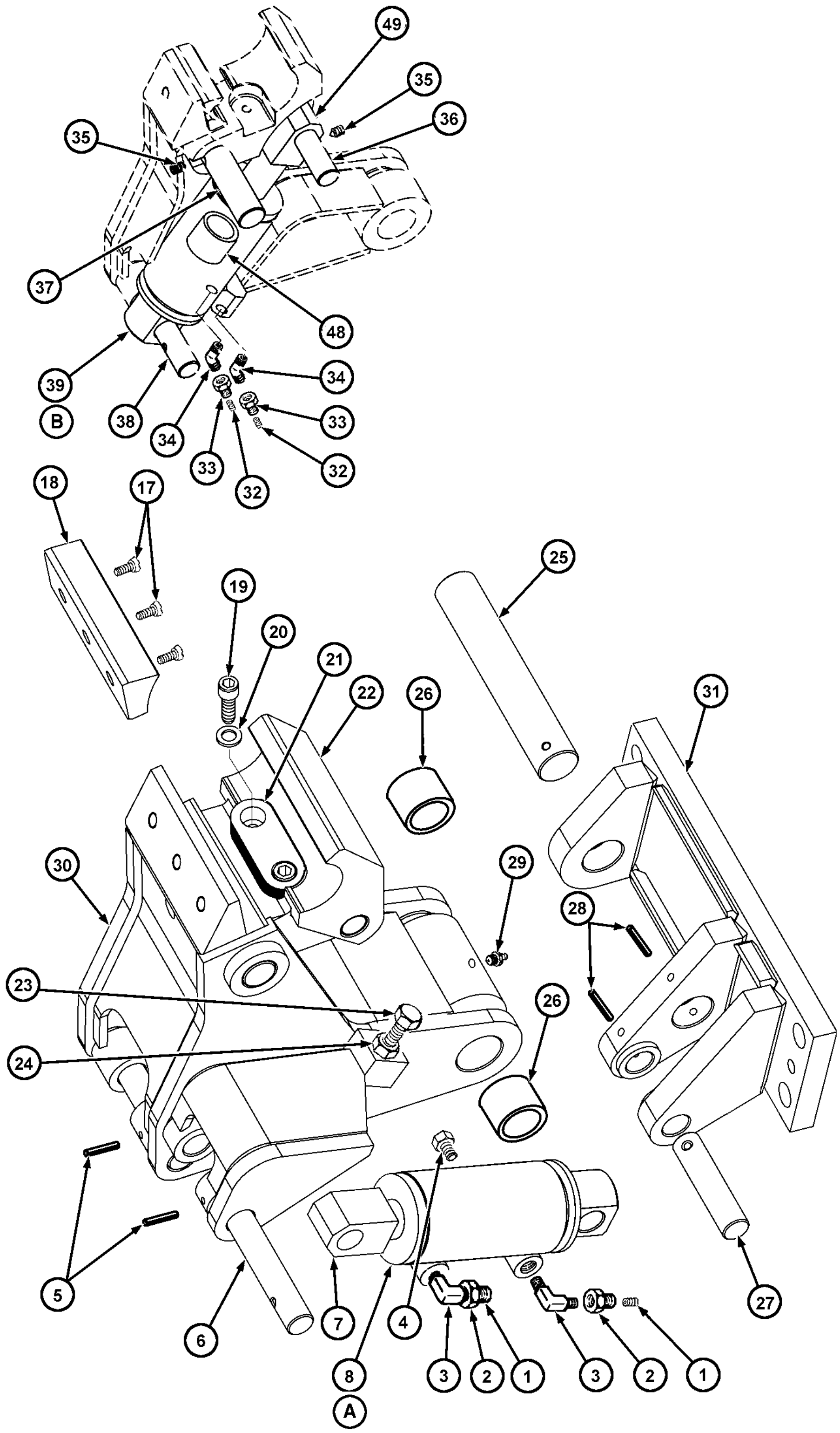

T121014

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Rock Drill

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51. Install detector support (3), two screws (1), and washers (2).

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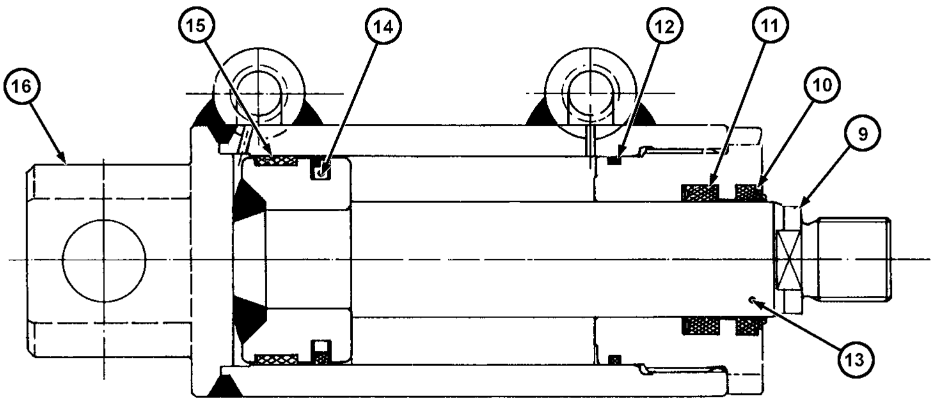
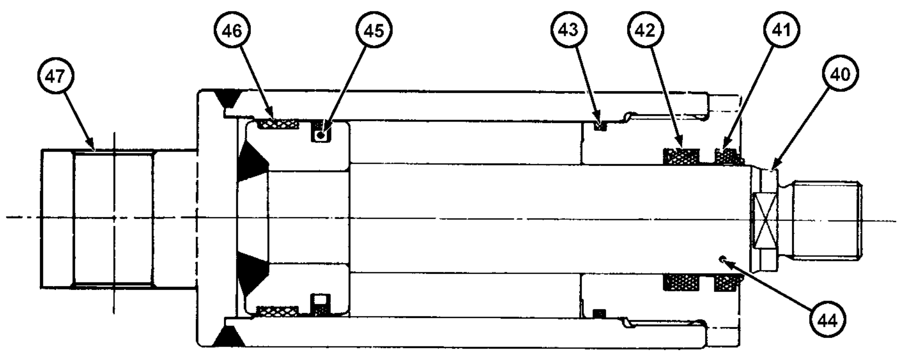


DETAIL A



DETAIL B

T121013

T121013 –UN–01JUN99

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CED,OUOE019,14 –19–30MAR99–9/13

Rock Drill

1—Oil Restrictor (2 used)
2—Oil Restrictor Adapter (2 used)
3—Adapter (2 used)
4—Plug (2 used)
5—Elastic Pin (2 used)
6—Pin
7—Attachment Cylinder
8—Hydraulic Cylinder
9—Rod
10—Scraper Joint
11—Rod Seal
12—O-Ring
13—Lining
14—Piston Joint
15—Guiding Ring
16—Body
17—Screw (3 used)
18—Rod Jaw
19—Screw (2 used)
20—Washer (2 used)
21—Block
22—Rod Clamp
23—Screw (2 used)
24—Nut (2 used)
25—Pin
26—Self-Lubricating Ring (2 used)
27—Pin
28—Elastic Pin (2 used)
29—Oiler
30—Clamp Support
31—Clamp Support
32—Oil Restrictor (2 used) (used only on upper clamp support)
33—Oil Restrictor Adapter (2 used) (used only on upper clamp support)
34—Adapter (2 used)
35—Screw (2 used)
36—Pin
37—Pin
38—Pin
39—Hydraulic Cylinder
40—Rod
41—Scraper Joint
42—Rod Seal
43—O-Ring
44—Lining
45—Piston Joint
46—Guiding Ring
47—Body
48—Spring
49—Attachment Cylinder

52. Remove two oil restrictors (1), two oil restrictor adapters (2), and two adapters (3).

53. Remove two plugs (4).

54. Remove two elastic pins (5), and two pins (6).

55. Remove attachment cylinder (7), and hydraulic cylinder (8).

56. Remove rod (9).

57. Remove scraper joint (10), rod seal (11), O-ring (12), lining (13), piston joint (14), and guiding ring (15). Discard the O-ring.

58. Remove three screws (17), and rod jaw (18).

59. Remove two screws (19), washers (20), block (21), and rod clamp (22).

60. Remove two screws (23), and nuts (24).

61. Remove pin (25), two elastic pins (28), and two self-lubricating rings (26).

62. Remove pin (27).

63. Remove oiler (29).

64. Remove clamp support (30).

65. Remove two oil restrictors (32), and two oil restrictor adapters (33) (used only on upper clamp support).

66. Remove two adapters (34).

67. Remove two screws (35), and pins (36 and 37).

68. Remove pin (38).

69. Remove hydraulic cylinder (39).

70. Remove rod (40).

71. Remove scraper joint (41), rod seal (42), O-ring (43), lining (44), piston joint (45), and guiding ring (46). Discard the O-ring.

72. Remove spring (48).

73. Remove attachment cylinder (49).

74. Inspect, repair or replace parts as necessary.

75. Install attachment cylinder (49).

76. Install spring (48).

77. Install guiding ring (46), piston joint (45), lining (44), new O-ring (43), rod seal (42), and scraper joint (41).

78. Install rod (40).

79. Install hydraulic cylinder (39).

Continued on next page CED,OUOE019,14 –19–30MAR99–10/13

80. Install pin (38).

81. Install pins (36 and 37), and two screws (35).

82. Install two adapters (34).

83. Install two oil restrictor adapters (33), and two oil restrictors (32) (used only on upper clamp support).

84. Install clamp support (30).

85. Install oiler (29).

86. Install two self-lubricating rings (26), and pin (27).

87. Install pin (25), and two elastic pins (28).

88. Install two screws (23), and nuts (24).

89. Install rod clamp (22), block (21), two screws (19), and washers (20).

90. Install rod jaw (18), and three screws (17).

91. Install guiding ring (15), piston joint (14), lining (13), new O-ring (12), rod seal (11), and scraper joint (10).

92. Install rod (9).

93. Install hydraulic cylinder (8), and attachment cylinder (7).

94. Install pin (6), and two elastic pins (5).

95. Install two plugs (4).

96. Install two adapters (3), two oil restrictors (1), and two oil restrictor adapters (2).

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CED,OUOE019,14 –19–30MAR99–11/13

Rock Drill

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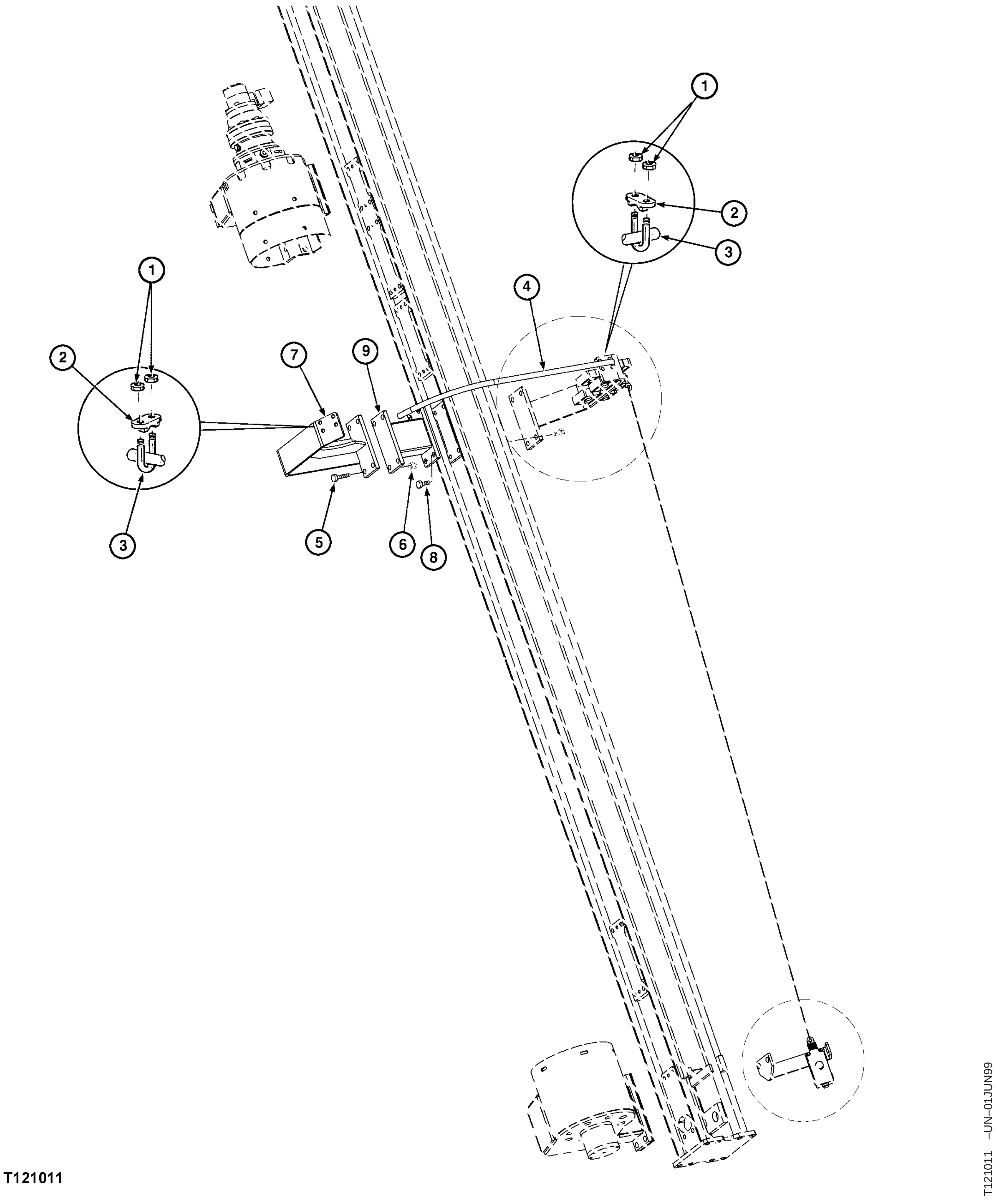

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CED,OUOE019,14 –19–30MAR99–12/13

Rock Drill

1—Nut (4 used)	**4—Cable**	**7—Support**
2—Base (2 used)	**5—Screw (4 used)**	**8—Screw (4 used)**
3—Cable Clip (2 used)	**6—Locknut (4 used)**	**9—Spacer Support**

97. Remove four nuts (1), two bases (2), and two cable clips (3).

98. Remove cable (4).

99. Remove four screws (5), locknuts (6), and support (7).

100. Remove four screws (8), and spacer support (9).

101. Inspect, repair or replace parts as necessary.

102. Install spacer support (9), and four screws (8).

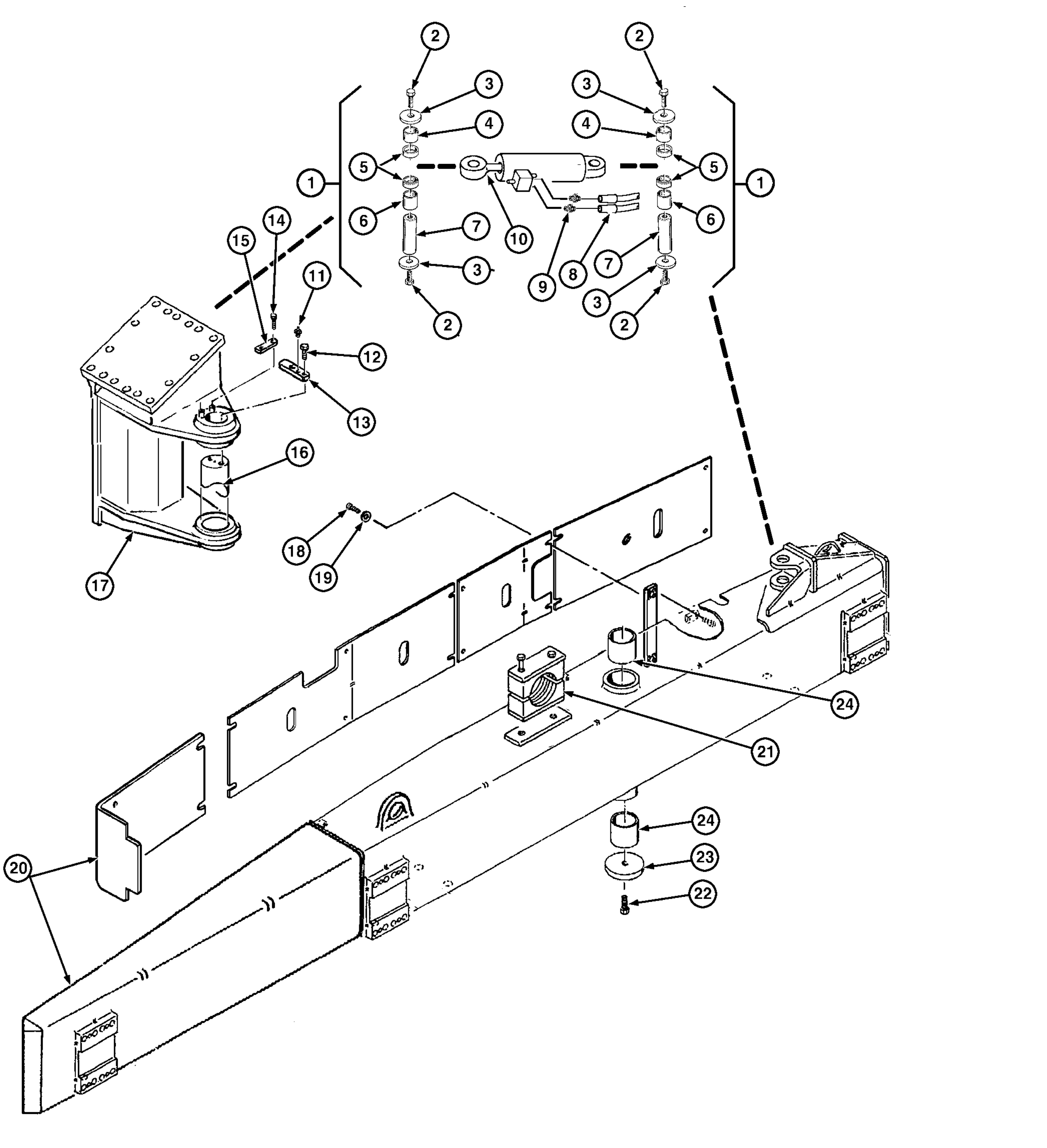
103. Install support (7), four screws (5), and locknuts (6).

104. Install cable (4).

105. Install two cable clips (3), two bases (2), and four nuts (1).

CED,OUOE019,14 –19–30MAR99–13/13

DISASSEMBLE AND ASSEMBLE CRADLE AND ARTICULATION



T121023

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CED,OUOE019,17 –19–01APR99–1/2

Rock Drill

1—Cylinder Attachment (2 used)
2—Screw (4 used)
3—Washer (4 used)
4—Ring (2 used)
5—Swivel Ring (4 used)
6—Ring (2 used)
7—Swivel Pin (2 used)
8—Hose (2 used)
9—Adapter (2 used)
10—Cross-Tilting Cylinder
11—Grease Fitting
12—Screw (2 used)
13—Bar
14—Screw (2 used)
15—Bar
16—Pin
17—Articulator
18—Screw (18 used)
19—Washer (18 used)
20—Feed Cradle
21—Hoses Support
22—Screw
23—Cover
24—Self-Lubricating Ring (2 used)

1. Remove two screws (2) from one cylinder attachment (1).
2. Remove two washers (3), ring (4), two swivel rings (5), ring (6), and swivel pin (7).
3. Repeat two previous steps for remaining cylinder attachment (1).
4. Remove two hoses (8).
5. Remover two adapters (9).
6. Remove cross-tilting cylinder (10).
7. Remove grease fitting (11).
8. Support articulator (17) with lifting device and remove two screws (14), and bar (15).
9. Support pin (16) with a jack and remove two screws (12), and bar (13).
10. Lower pin (16) on the jack and remove articulator (17).
11. Remove eighteen screws (18), washers (19), and sides of feed cradle (20).
12. Remove hoses on hoses support (21) and remove the hoses support.
13. Remove screw (22), cover (23), and two self-lubricating rings (24).
14. Inspect, repair or replace parts as necessary.
15. Install two self-lubricating rings (24), cover (23), and screw (22).
16. Install hoses and hoses support (21).
17. Install sides of feed cradle (20), eighteen screws (18), and washers (19).
18. Install articulator (17).
19. Raise pin (16) on a jack.
20. Install bar (13), and two screws (12).
21. Support pin (16) with a jack and install bar (15), and two screws (14).
22. Install grease fitting (11).
23. Install cross-tilting cylinder (10).
24. Install two adapters (9).
25. Install two hoses (8).
26. Install swivel pin (7), ring (6), two swivel rings (5), ring (4), two washers (3), and two screws (2) for each of two cylinder attachments (1).

CED,OUOE019,17 –19–01APR99–2/2

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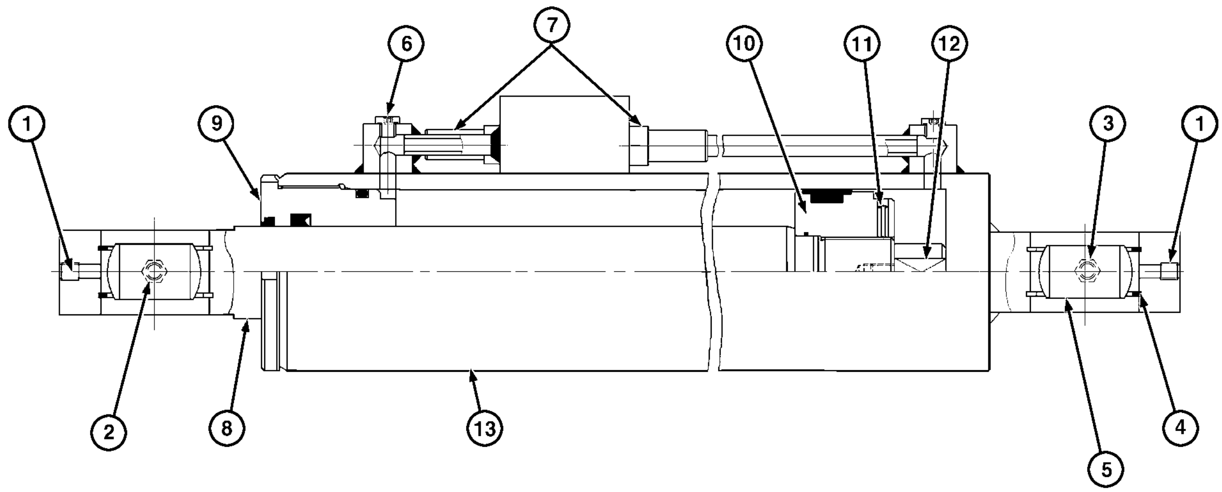
DISASSEMBLE AND ASSEMBLE CROSS-TILTING CYLINDER



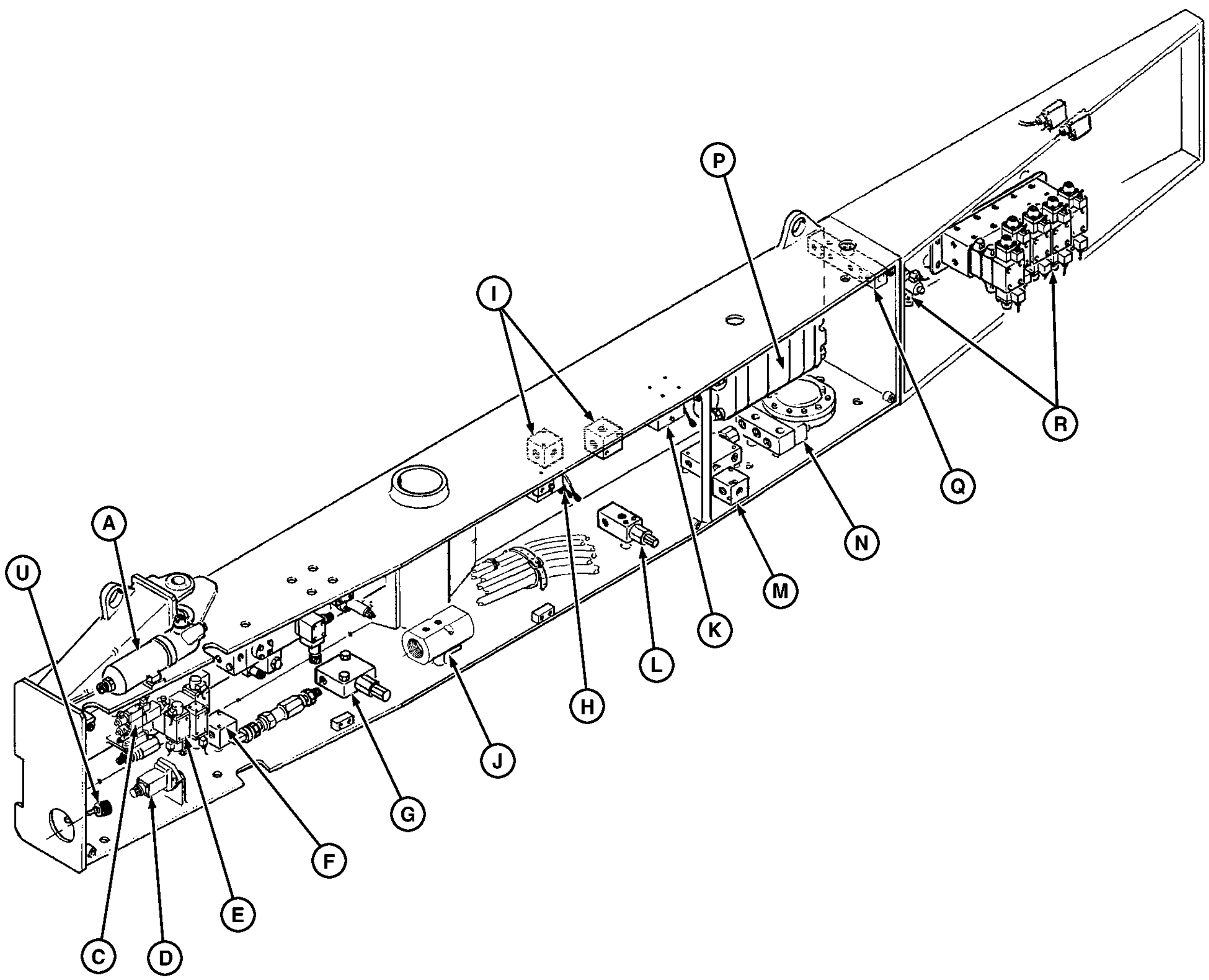
T121024

1—Screw (2 used)
2—Grease Fitting
3—Grease Fitting
4—Snap Ring (4 used)
5—Swivel (2 used)
6—Plug (2 used)
7—Hydraulic Valve (2 used)
8—Rod
9—Lining
10—Piston
11—Screw
12—Rod Stop
13—Cylinder

1. Remove two screws (1).
2. Remove grease fitting (2).
3. Remove grease fitting (3).
4. Remove four snap rings (4), and two swivels (5).
5. Remove two plugs (6).
6. Remove two hydraulic valves (7).
7. Remove rod (8), lining (9), piston (10), screw (11), and rod stop (12).
8. Inspect, repair or replace parts as necessary.
9. Install rod stop (12), screw (11), piston (10), lining (9), and rod (8).
10. Install two hydraulic valves (7).
11. Install two plugs (6).
12. Install two swivels (5), and four snap rings (4).
13. Install grease fitting (3).
14. Install grease fitting (2).
15. Install two screws (1).

CED,OUOE019,23 –19–26MAY99–1/1

DISASSEMBLE AND ASSEMBLE ELECTRO-HYDRAULIC EQUIPMENT



T121045

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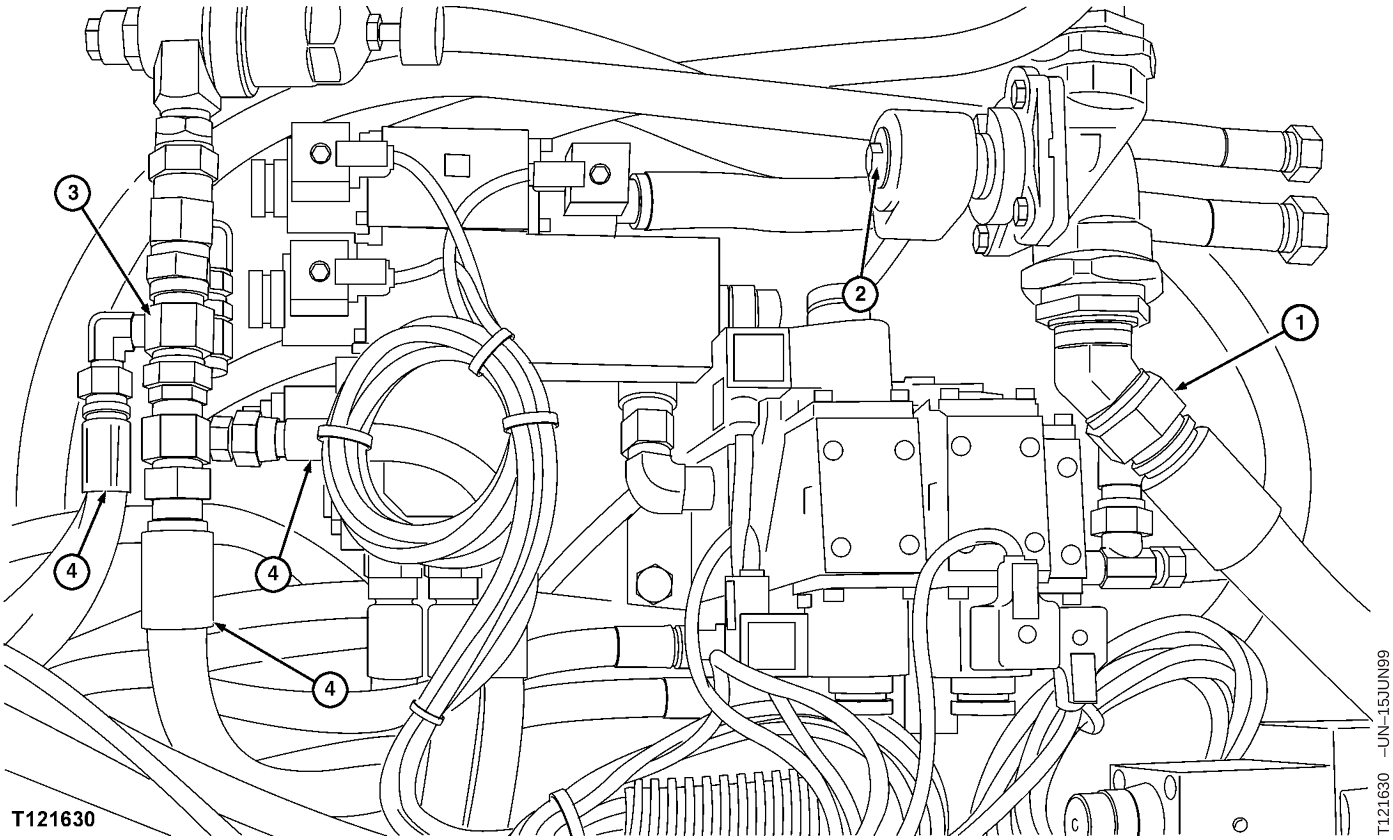
Rock Drill



1—Hose **2—Electrical Connector** **3—Fitting** **4—Hose (3 used)**

1. Remove hose (1).
2. Remove electrical connector (2).
3. Remove fitting (3).
4. Remove three hoses (4).

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Rock Drill

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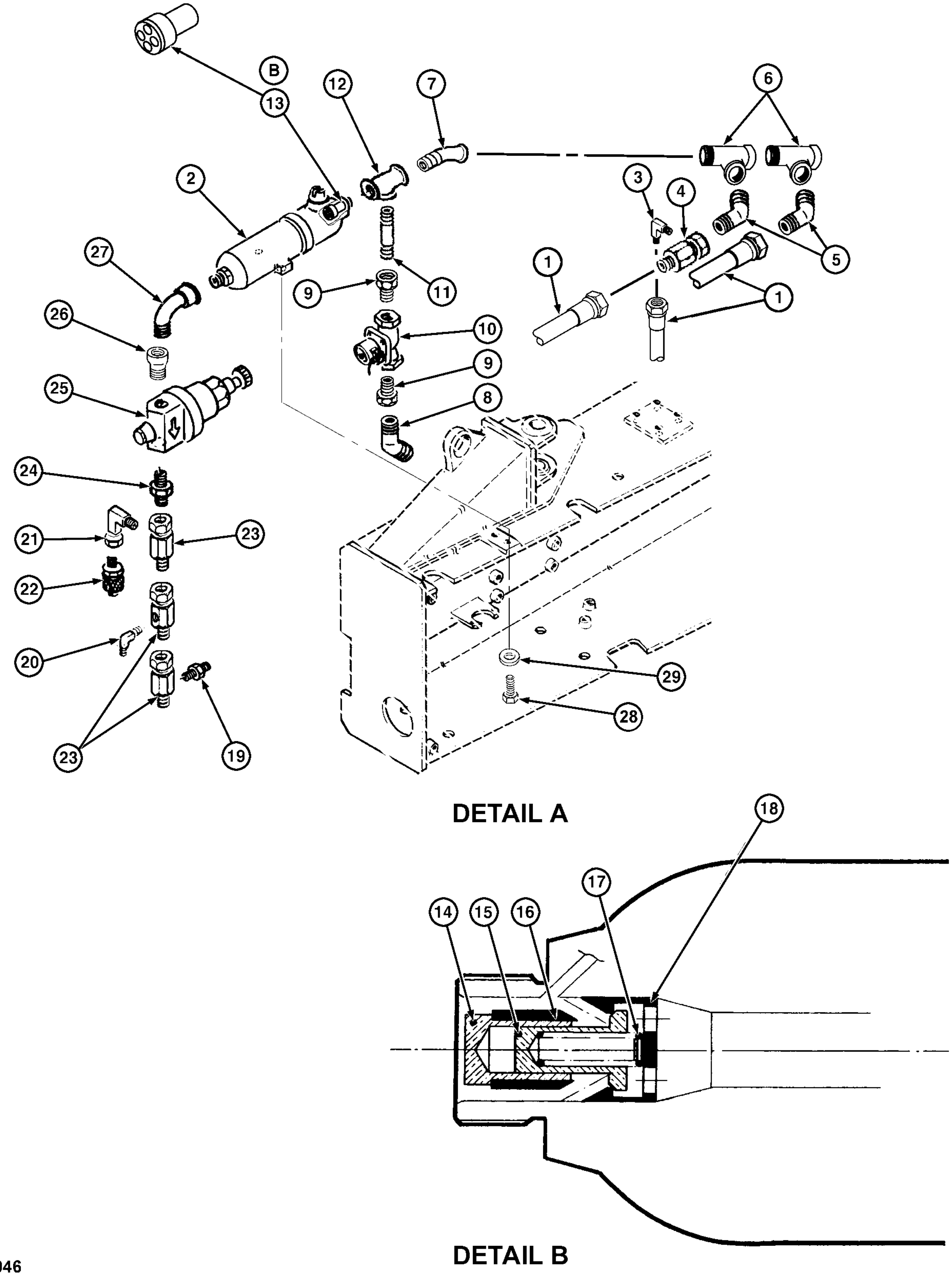

T121046

T121046 –UN–22JUN99

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1—Hose (3 used)
2—Atomizer Lubricator
3—Adapter
4—Tee
5—Adapter (2 used)
6—Tee (2 used)
7—Bent Adapter
8—Adapter
9—Adapter (2 used)
10—Electro-Valve
11—Sleeve
12—Tee
13—Check Valve
14—Guide Valve
15—Valve
16—Seat Valve
17—Spring
18—Thrust
19—Adapter
20—Adapter
21—Adapter
22—Pressure Socket
23—Tee (3 used)
24—Adapter
25—Reducer
26—Sleeve
27—Bent Adapter
28—Screw (2 used)
29—Washer (2 used)

5. Remove three hoses (1)

6. Remove adapter (3), tee (4), two adapters (5), and two tees (6).

7. Remove bent adapter (7).

8. Remove two screws (28), washers (29), and atomizer lubricator (2).

9. Remove adapter (8), two adapters (9), electro-valve (10), sleeve (11), and tee (12).

10. Remove check valve (13)

11. Remove adapter (24), reducer (25), sleeve (26), and bent adapter (27).

12. Remove adapters (19, 20, and 21), pressure socket (22), and three tees (23).

13. Remove guide valve (14), valve (15), seat valve (16), spring (17), and thrust (18).

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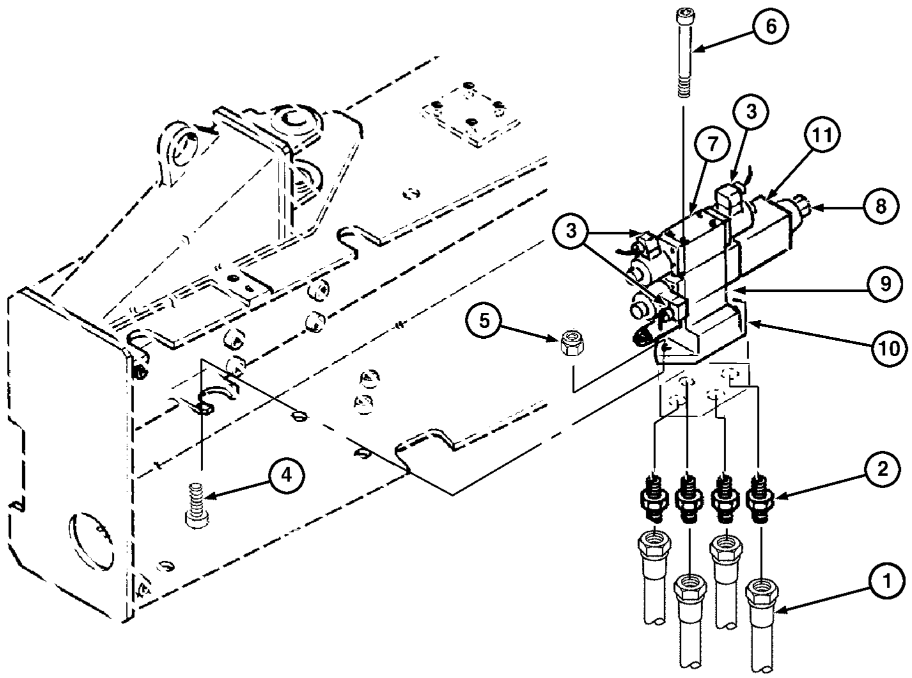

1—Hose (4 used)	**4—Screw (2 used)**	**7—Electro-Valve**	**10—Base Plate**
2—Adapter (4 used)	**5—Locknut (2 used)**	**8—Flow Governor**	**11—Flow Control Assembly**
3—Connector (3 used)	**6—Screw (4 used)**	**9—Pressure Limiter**	

14. Remove four hoses (1).

15. Remove four adapters (2).

16. Remove three connectors (3) with a small screwdriver.

17. Remove two screws (4), locknuts (5), and flow control assembly (11).

18. Remove four screws (6) and separate electro-valve (7), flow governor (8), pressure limiter (9), and base plate (10).

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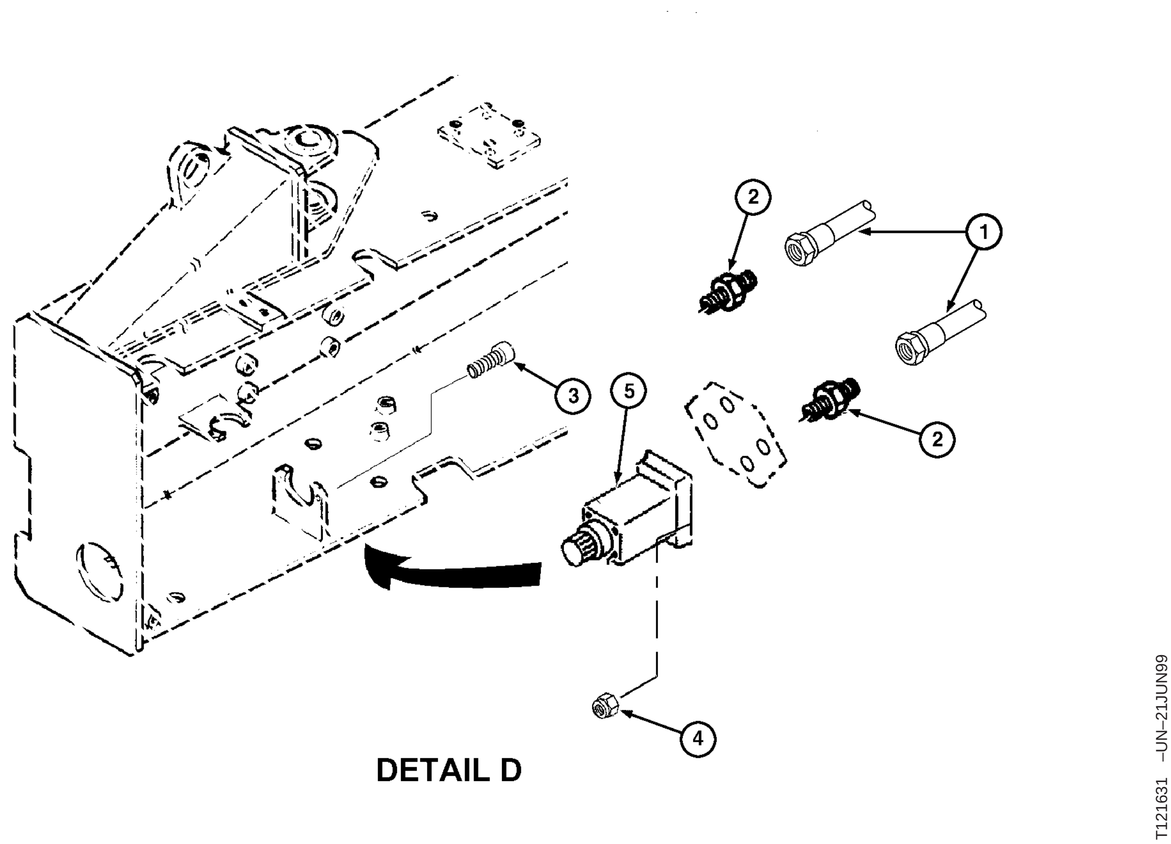

1—Hose (2 used)
2—Adapter (2 used)
3—Screw (2 used)
4—Locknut (2 used)
5—Flow Governor

19. Remove two hoses (1).

20. Remove two adapters (2).

21. Remove two screws (3), locknuts (4), and flow governor (5).

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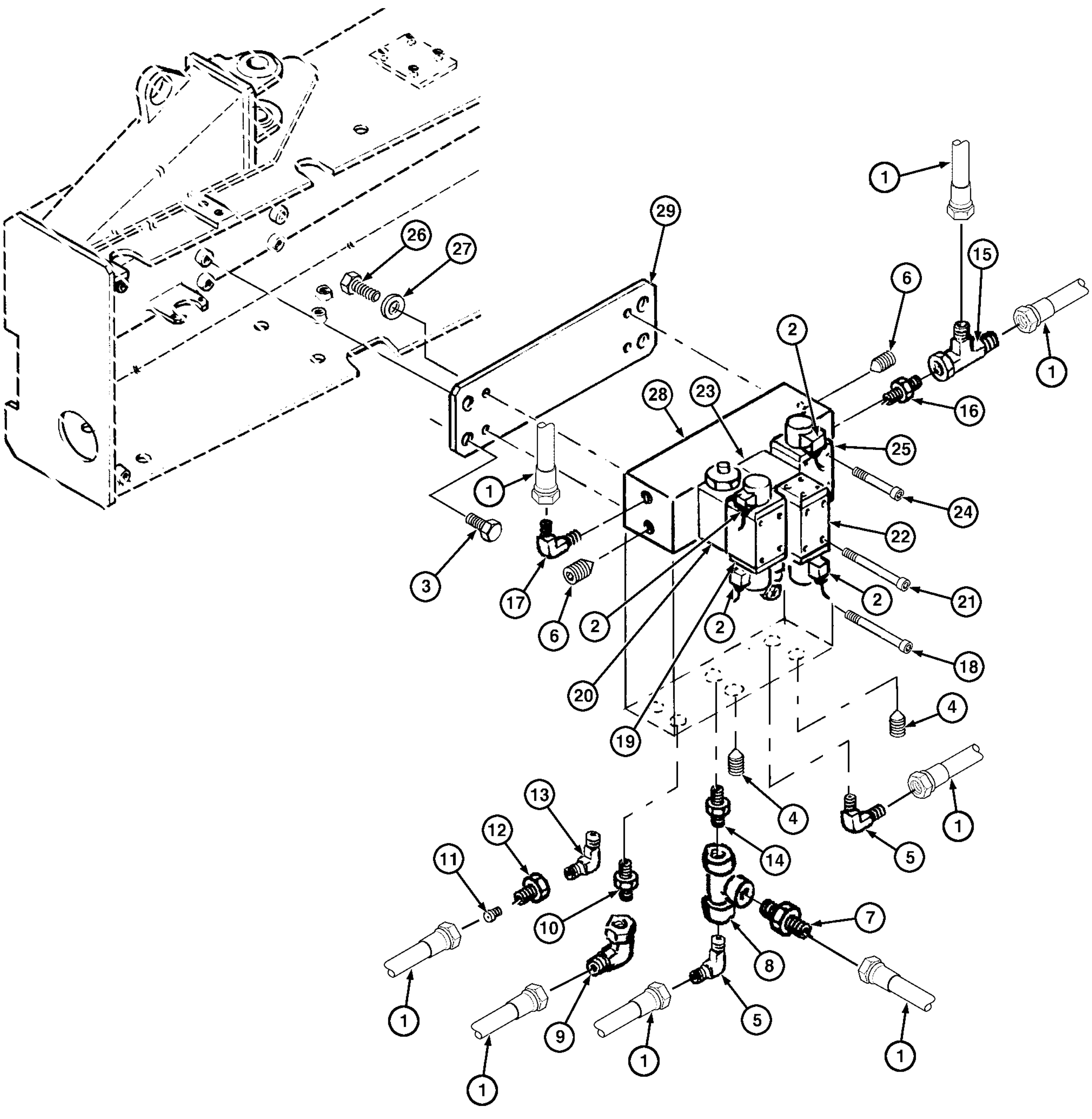
Rock Drill



DETAIL E

T121048

T121048 –UN–22JUN99

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1—Hose (8)
2—Electrical Connector (4 used)
3—Screw (4 used)
4—Plug (2 used)
5—Adapter (2 used)
6—Plug (2 used)
7—Adapter
8—Tee
9—Adapter
10—Adapter
11—Oil Restrictor
12—Restrictor Adapter
13—Adapter
14—Adapter
15—Tee
16—Adapter
17—Adapter
18—Screw (4 used)
19—Solenoid Valve
20—Pressure Limiter
21—Screw (4 used)
22—Solenoid Valve
23—Sequence Valve
24—Screw (4 used)
25—Solenoid Valve
26—Screw (4 used)
27—Washer (4 used)
28—Bar
29—Base Plate

22. Remove eight hoses (1).

23. Remove four electrical connectors (2).

24. Remove four screws (3).

25. Remove two plugs (4), two adapters (5), two plugs (6), adapter (7), and tee (8).

26. Remove adapters (9 and 10).

27. Remove oil restrictor (11), restrictor adapter (12), and adapters (13 and 14).

28. Remove tee (15) and adapters (16 and 17).

29. Remove four screws (18), solenoid valve (19), and pressure limiter (20).

30. Remove four screws (21), solenoid valve (22), and sequence valve (23).

31. Remove four screws (24) and solenoid valve (25).

32. Remove four screws (26), washers (27), bar (28), and base plate (29).

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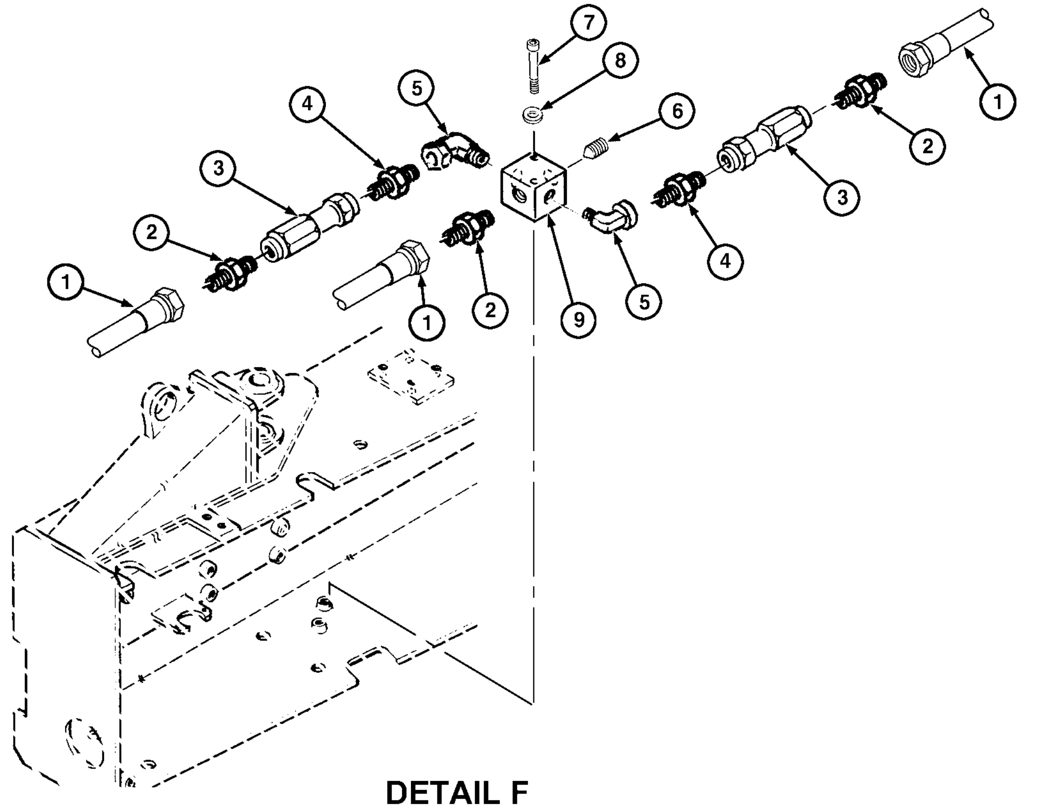

T121049

1—Hose (3 used)
2—Adapter (3 used)
3—Check Valve (2 used)
4—Adapter (2 used)
5—Adapter (2 used)
6—Plug
7—Screw (2 used)
8—Washer (2 used)
9—Connector

33. Remove three hoses (1).

34. Remove three adapters (2), two check valves (3), two adapters (4), and two adapters (5).

35. Remove plug (6).

36. Remove two screws (7), washers (8), and connector (9).

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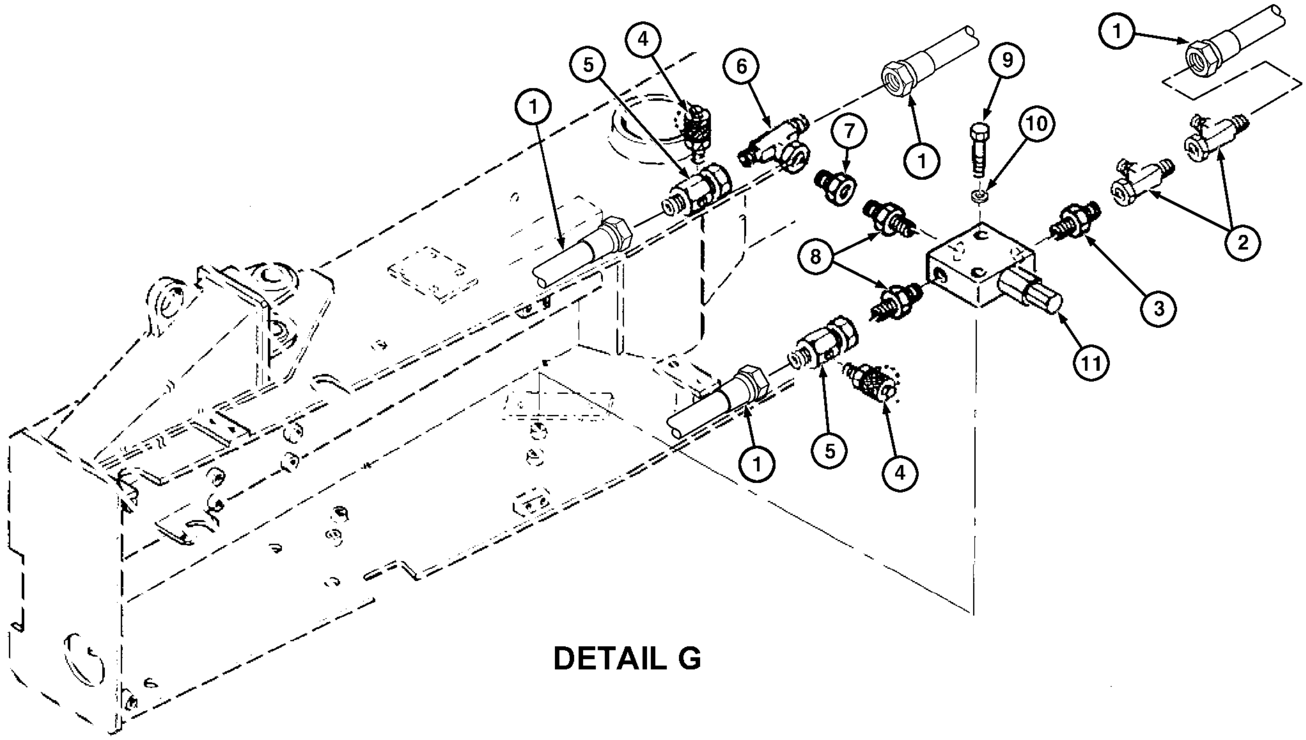
CED,OUOE019,18 –19–01APR99–9/49



T121632

1—Hose (4 used)
2—Tee (2 used)
3—Adapter
4—Pressure Socket (2 used)
5—Tee (2 used)
6—Tee
7—Restrictor Adapter
8—Adapter (2 used)
9—Screw (2 used)
10—Washer (2 used)
11—Sequence Valve

37. Remove four hoses (1).

38. Remove two tees (2), and adapter (3).

39. Remove two pressure sockets (4), two tees (5), tee (6), restrictor adapter (7), and two adapters (8).

40. Remove two screws (9), washers (10), and sequence valve (11).

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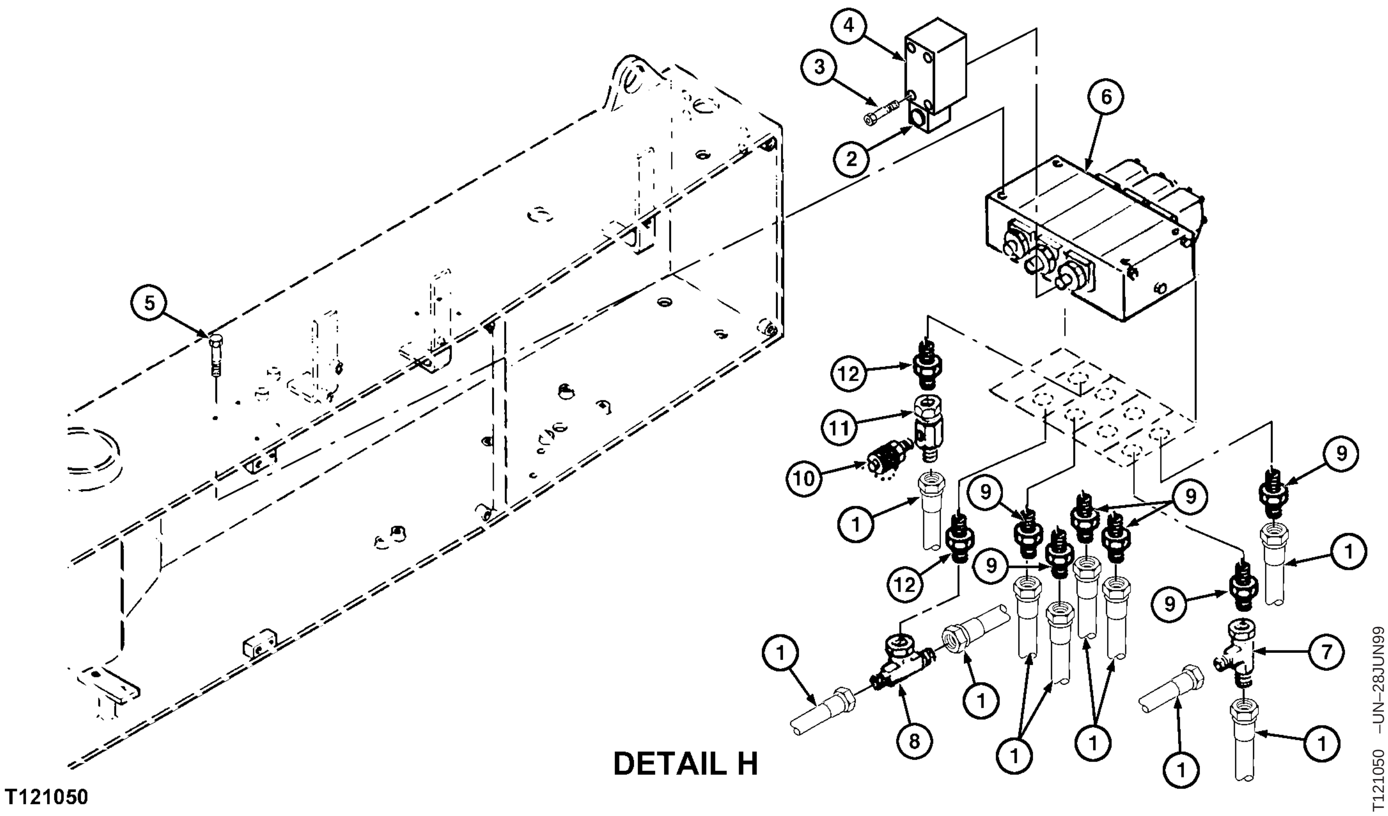

1—Hose (10 used)
2—Solenoid Connector (3 used)
3—Screw (3 used)
4—Solenoid (3 used)
5—Screw (4 used)
6—Solenoid Valve
7—Tee
8—Tee
9—Adapter (6 used)
10—Pressure Socket
11—Tee
12—Adapter (2 used)

41. Remove ten hoses (1).

42. Remove three solenoid connectors (2).

43. Remove three screws (3) and three solenoids (4).

44. Remove four bolts (5) and solenoid valve (6).

45. Remove tees (7 and 8), six adapters (9), pressure socket (10), tee (11), and two adapters (12).

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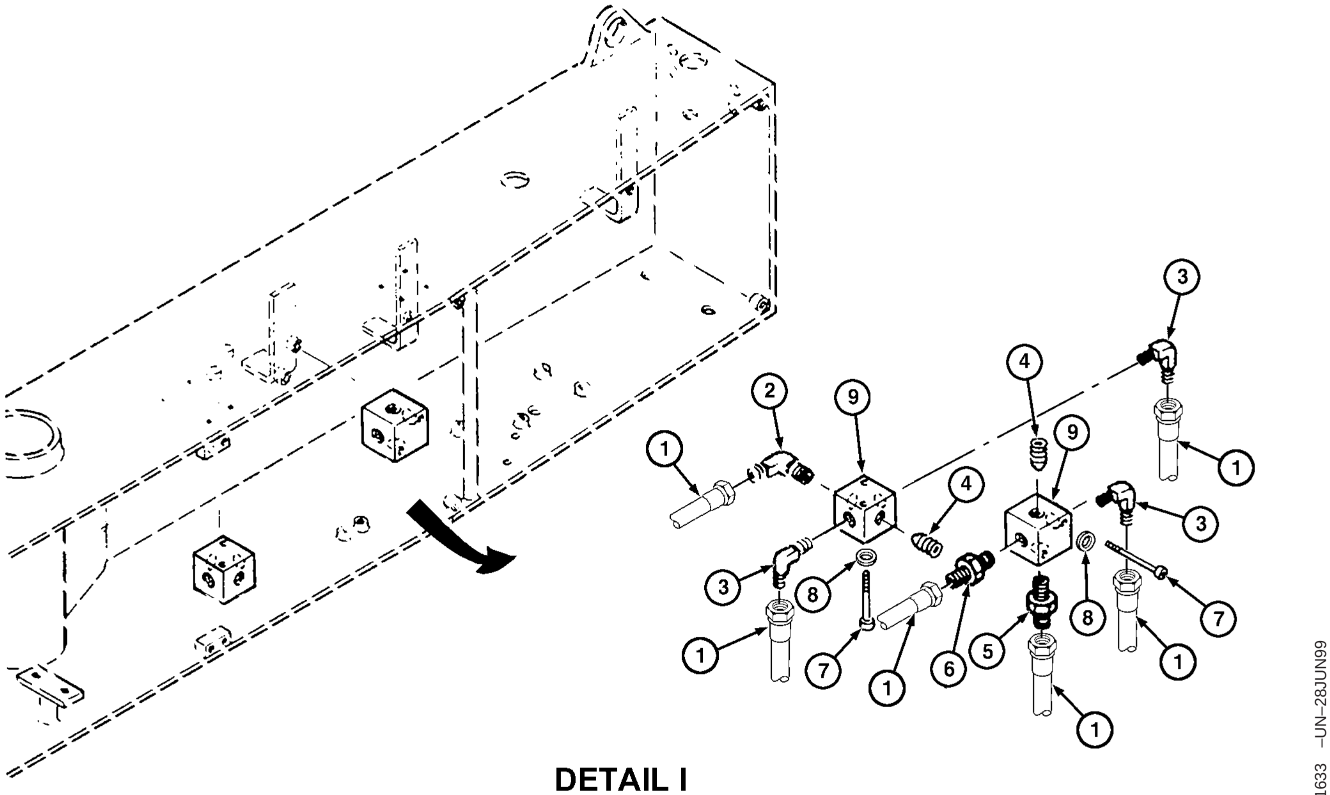

T121633

1—Hose (6 used)
2—Adapter
3—Adapter (3 used)
4—Plug (2 used)
5—Adapter
6—Adapter
7—Screw (4 used)
8—Washer (4 used)
9—Connector (2 used)

46. Remove six hoses (1).

47. Remove adapter (2) and three adapters (3).

48. Remove two plugs (4).

49. Remove adapters (5 and 6).

50. Remove four screws (7), washers (8), and two connectors (9).

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CED,OUOE019,18 –19–01APR99–12/49

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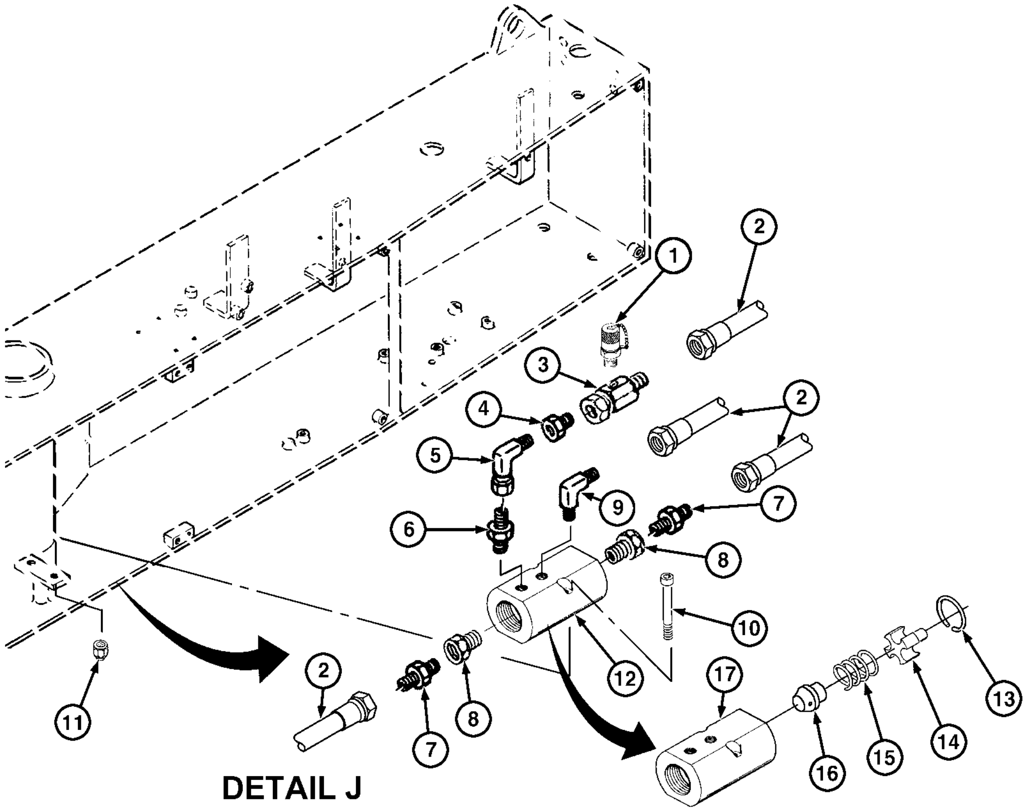

1—Pressure Sensor Switch
2—Hose (4 used)
3—Adapter
4—Restrictor Adapter
5—Adapter
6—Adapter
7—Adapter (2 used)
8—Nipple (2 used)
9—Adapter
10—Screw (2 used)
11—Locknut (2 used)
12—Air Flow Detector
13—Rush
14—Valve Guide
15—Spring
16—Valve
17—Valve Seat

51. Tag and disconnect two wires from pressure sensor switch (1).

52. Remove pressure sensor switch (1).

53. Remove four hoses (2).

54. Remove adapter (3), restrictor adapter (4), and adapters (5 and 6).

55. Remove two adapters (7), two nipples (8), and adapter (9).

56. Remove two screws (10), locknuts (11), and air flow detector (12).

57. Remove rush (13), valve guide (14), spring (15), and valve (16).

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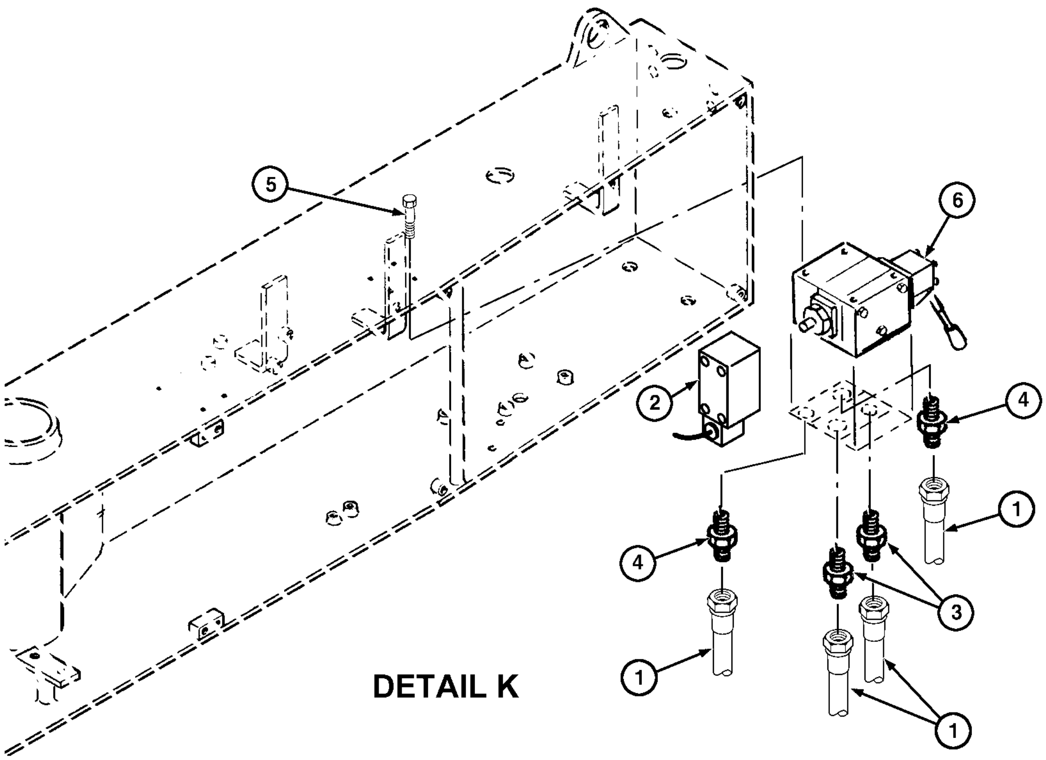

T121634

T121634 –UN–22JUN99

1—Hose (4 used)
2—Solenoid Connector
3—Adapter (2 used)
4—Adapter (2 used)
5—Screw (4 used)
6—Solenoid Valve

58. Remove four hoses (1).

59. Remove solenoid connector (2).

60. Remove two adapters (3) and two adapters (4).

61. Remove four screws (5) and solenoid valve (6).

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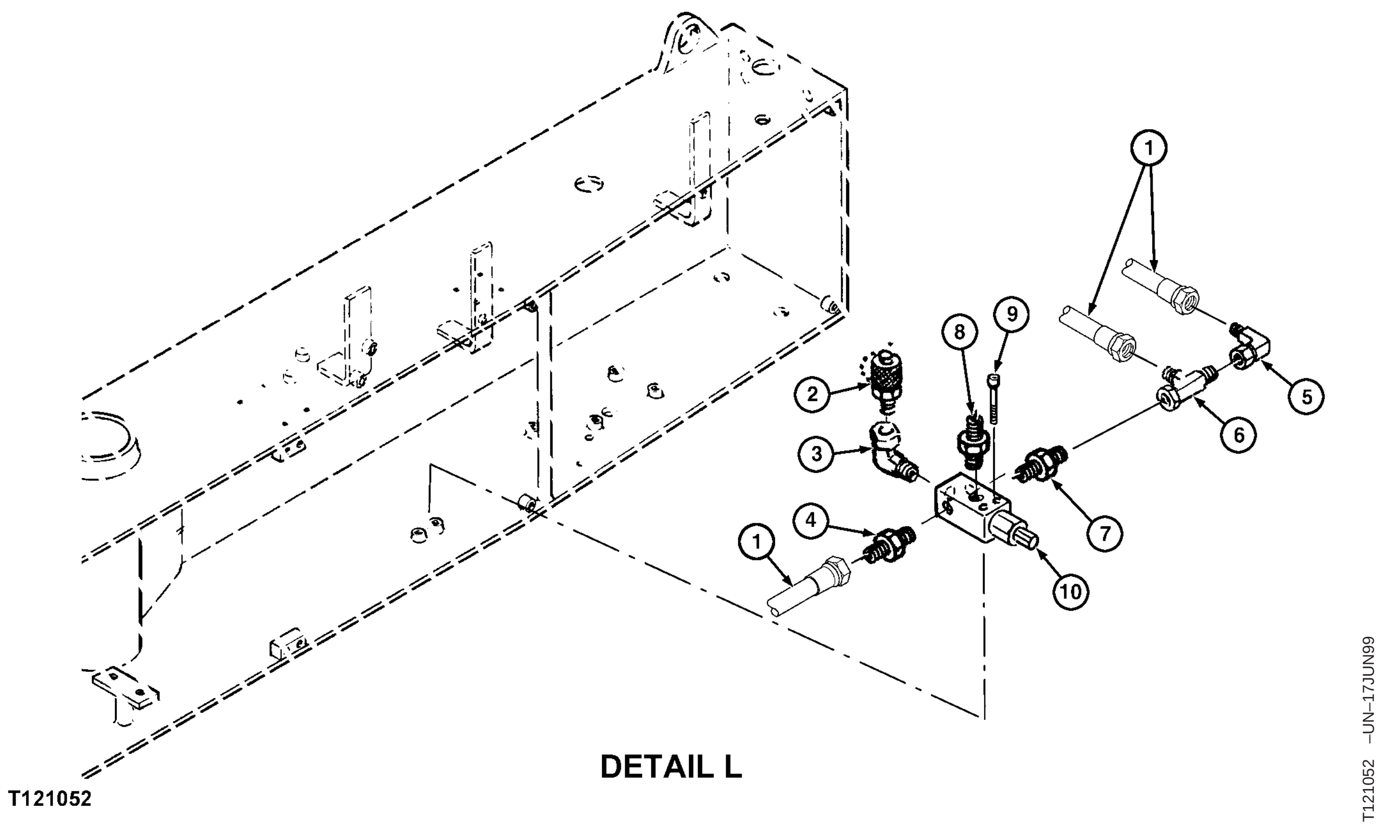
CED,OUOE019,18 –19–01APR99–14/49



1—Hose (3 used)	**4—Adapter**	**7—Adapter**	**10—Pressure Limiter**
2—Pressure Socket	**5—Adapter**	**8—Adapter**	
3—Adapter	**6—Tee**	**9—Screw (2 used)**	

62. Remove three hoses (1).

63. Remove pressure socket (2), adapters (3, 4, 5, 7, and 8), and tee (6).

64. Remove two screws (9) and pressure limiter (10).

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CED,OUOE019,18 –19–01APR99–15/49

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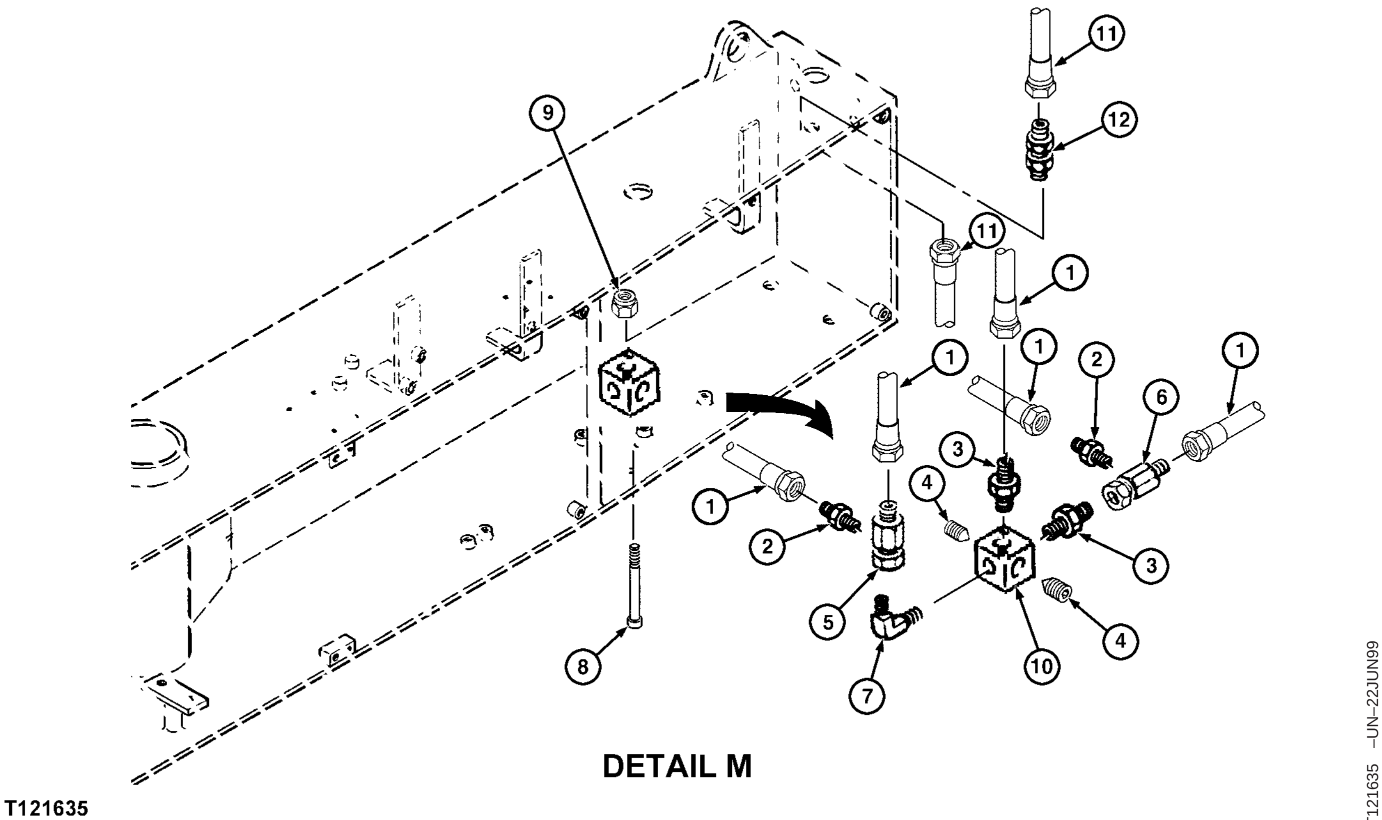

1—Hose (5 used)	**4—Plug (2 used)**	**7—Adapter**	**10—Connector**
2—Adapter (2 used)	**5—Tee**	**8—Screw (2 used)**	**11—Hose (2 used)**
3—Adapter (2 used)	**6—Tee**	**9—Locknut (2 used)**	**12—Fitting**

65. Remove four hoses (1).

66. Remove two adapters (2), two adapters (3), and plugs (4).

67. Remove tees (5 and 6) and adapter (7).

68. Remove two screws (8), locknuts (9), and connector (10).

69. Remove two hoses (11).

70. Remove fitting (12).

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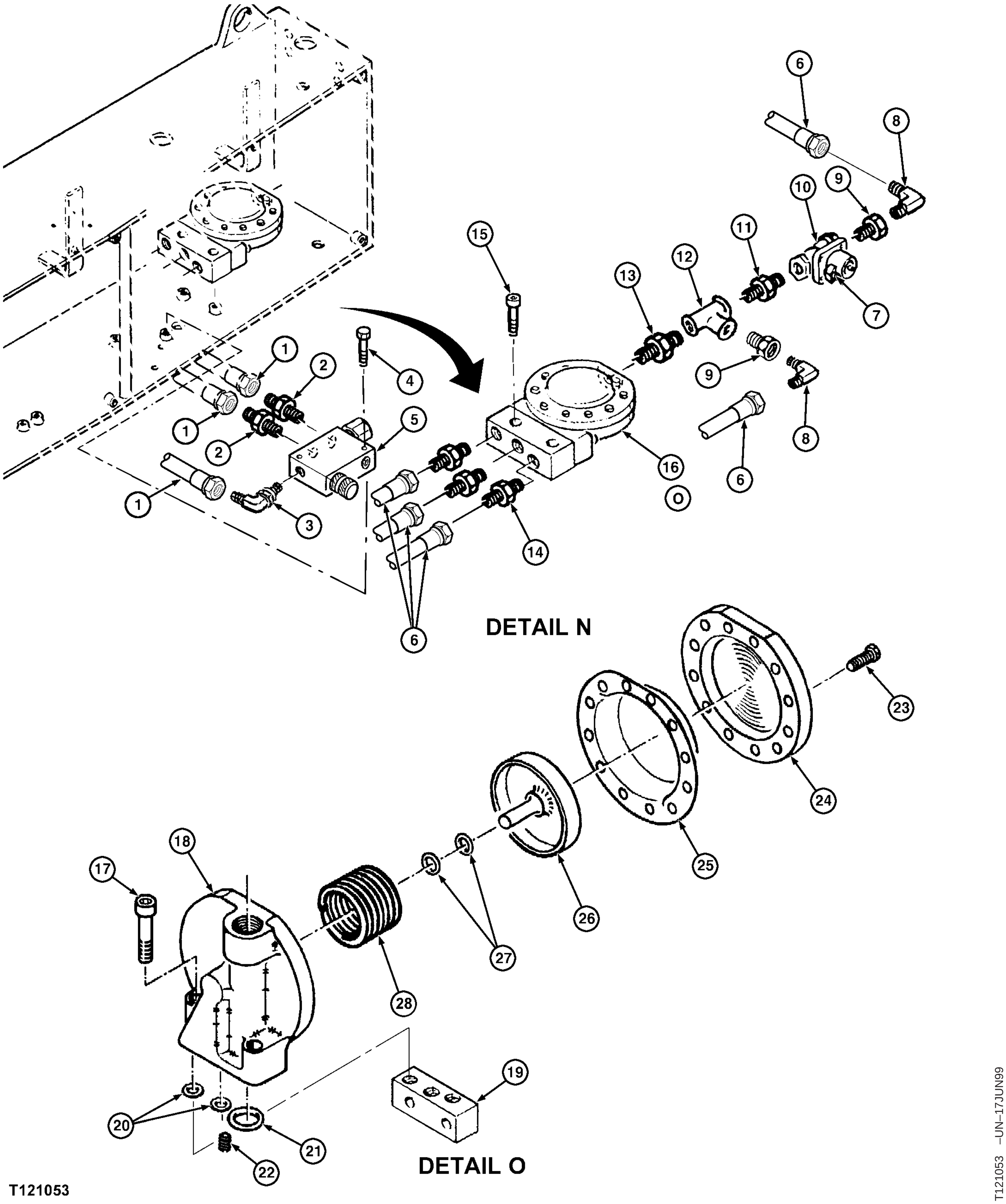
Rock Drill



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Rock Drill

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139

1—Hose (3 used)	**8—Adapter (2 used)**	**15—Screw (2 used)**	**22—Oil Restrictor**
2—Adapter (2 used)	**9—Adapter (2 used)**	**16—Valve**	**23—Screw (12 used)**
3—Adapter	**10—Soleniod Valve**	**17—Screw (2 used)**	**24—Case**
4—Screw (2 used)	**11—Adapter**	**18—Complete Housing**	**25—Diaphragm**
5—Divider	**12—Tee**	**19—Base Plate**	**26—Piston**
6—Hose (5 used)	**13—Adapter**	**20—O-Ring (2 used)**	**27—O-Ring (2 used)**
7—Soleniod Harness	**14—Adapter (3 used)**	**21—O-Ring**	**28—Spring**

71. Remove three hoses (1).

72. Remove two adapters (2) and adapter (3).

73. Remove two screws (4) and divider (5).

74. Remove five hoses (6).

75. Remove solenoid harness (7).

76. Remove two adapters (8), two adapters (9), solenoid valve (10), adapter (11), tee (12), and adapter (13).

77. Remove three adapters (14).

78. Remove two screws (15) and valve (16).

79. Remove two screws (17), complete housing (18), and base plate (19).

80. Remove two O-rings (20), O-ring (21), and oil restrictor (22). Discard the O-rings.

81. Remove twelve screws (23), case (24), diaphragm (25), piston (26), two O-rings (27), and spring (28). Discard the O-rings.

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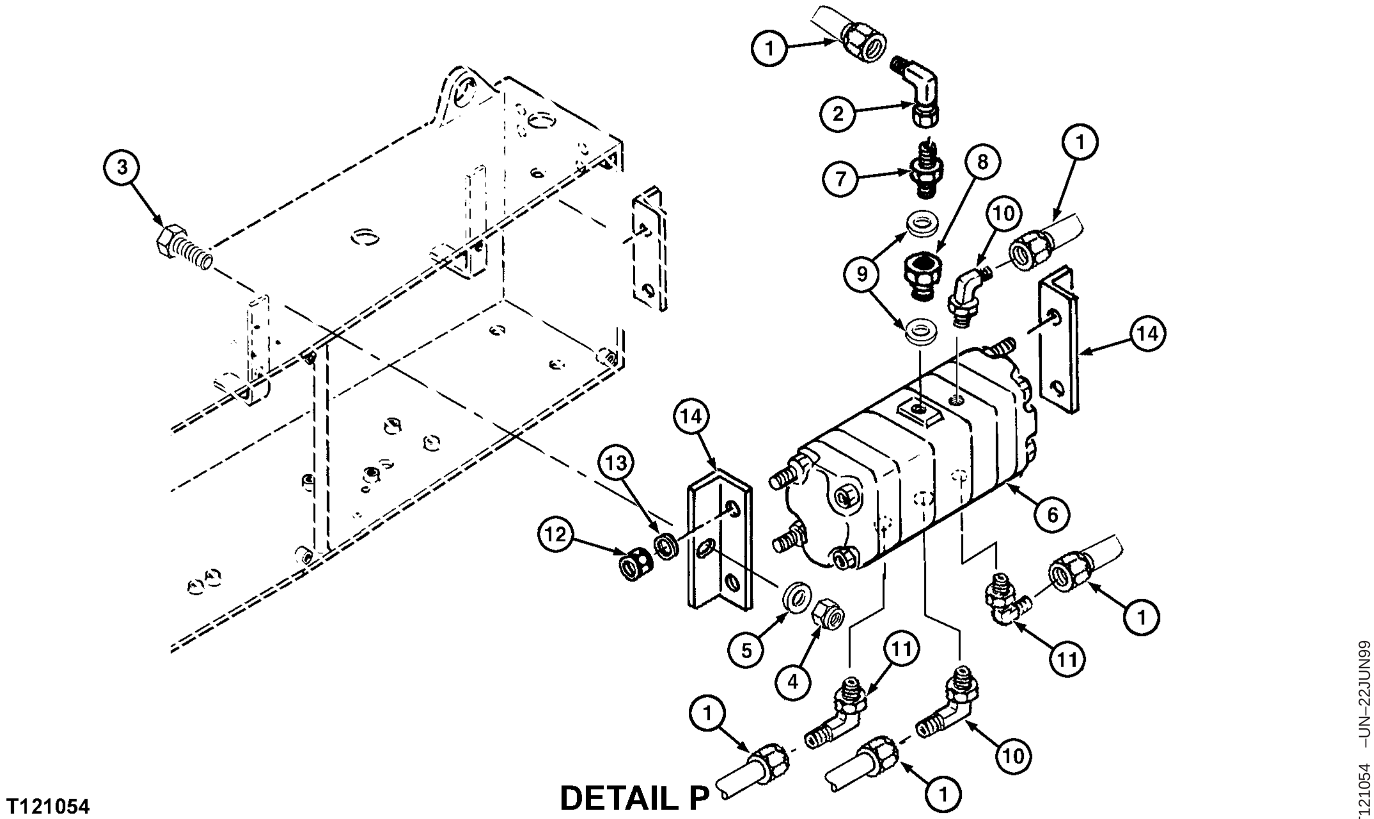
Rock Drill



1—Hose (5 used)
2—Adapter
3—Screw (2 used)
4—Locknut (2 used)
5—Washer (2 used)
6—Flow Divider
7—Adapter
8—Adapter
9—BS Ring (2 used)
10—Adapter (2 used)
11—Adapter (2 used)
12—Nut (4 used)
13—Washer (4 used)
14—Iron Corner (2 used)

82. Remove five hoses (1).

83. Remove adapter (2).

84. Remove two screws (3), locknuts (4), washers (5), and flow divider (6).

85. Remove adapters (7 and 8) and two BS rings (9).

86. Remove two adapters (10) and two adapters (11).

87. Remove four nuts (12), washers (13), and two iron corners (14).

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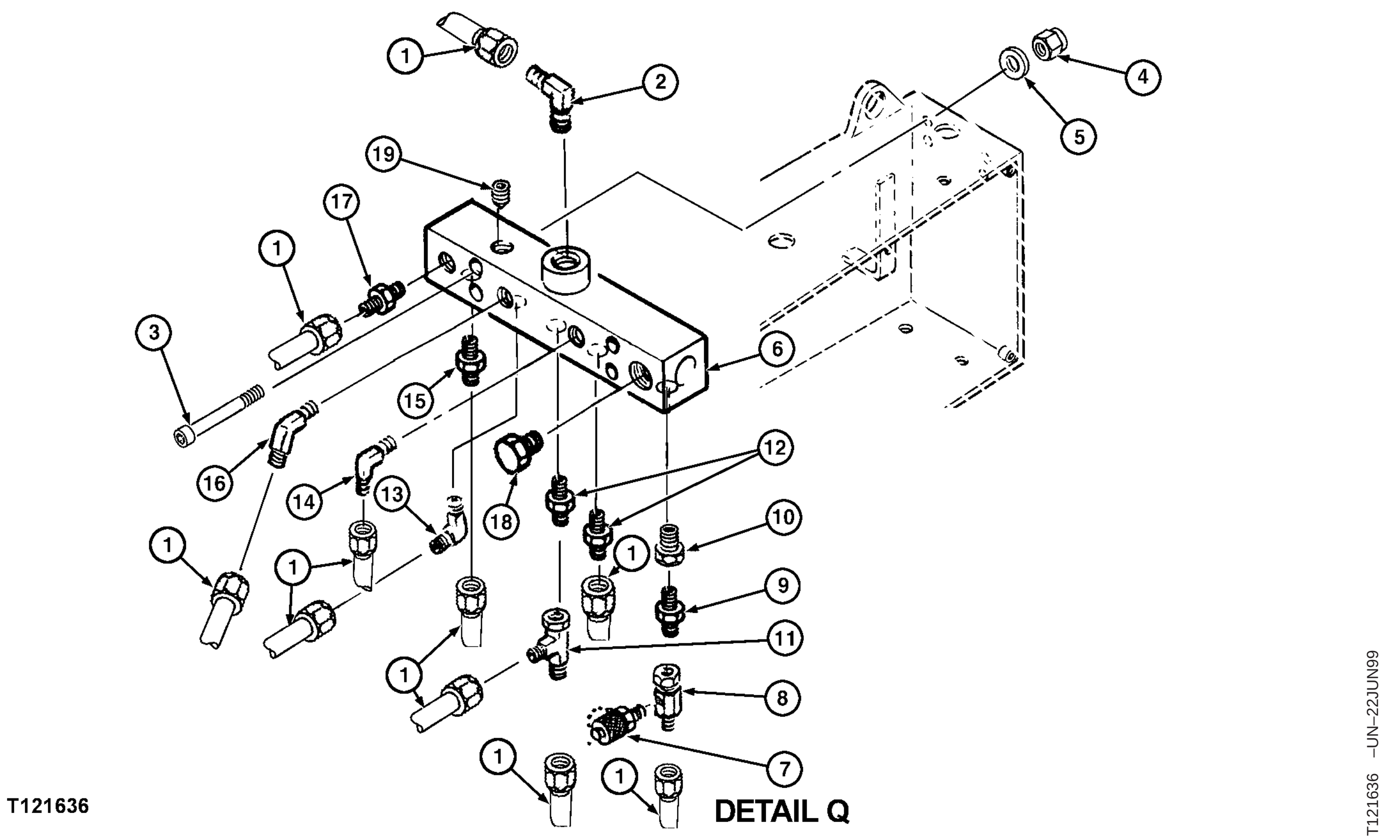
CED,OUOE019,18 –19–01APR99–19/49



1—Hose
2—Adapter
3—Screw (4 used)
4—Locknut (4 used)
5—Washer (4 used)
6—Connector
7—Pressure Socket
8—Tee
9—Adapter
10—Adapter
11—Tee
12—Adapter (2 used)
13—Adapter
14—Adapter
15—Adapter
16—Adapter
17—Adapter
18—Plug
19—Plug

88. Remove ten hoses (1).

89. Remove adapter (2).

90. Remove four screws (3), locknuts (4), washers (5), and connector (6).

91. Remove pressure socket (7), tee (8), and adapters (9 and 10).

92. Remove tee (11), and two adapters (12).

93. Remove adapters (13 through 17).

94. Remove plugs (18 and 19).

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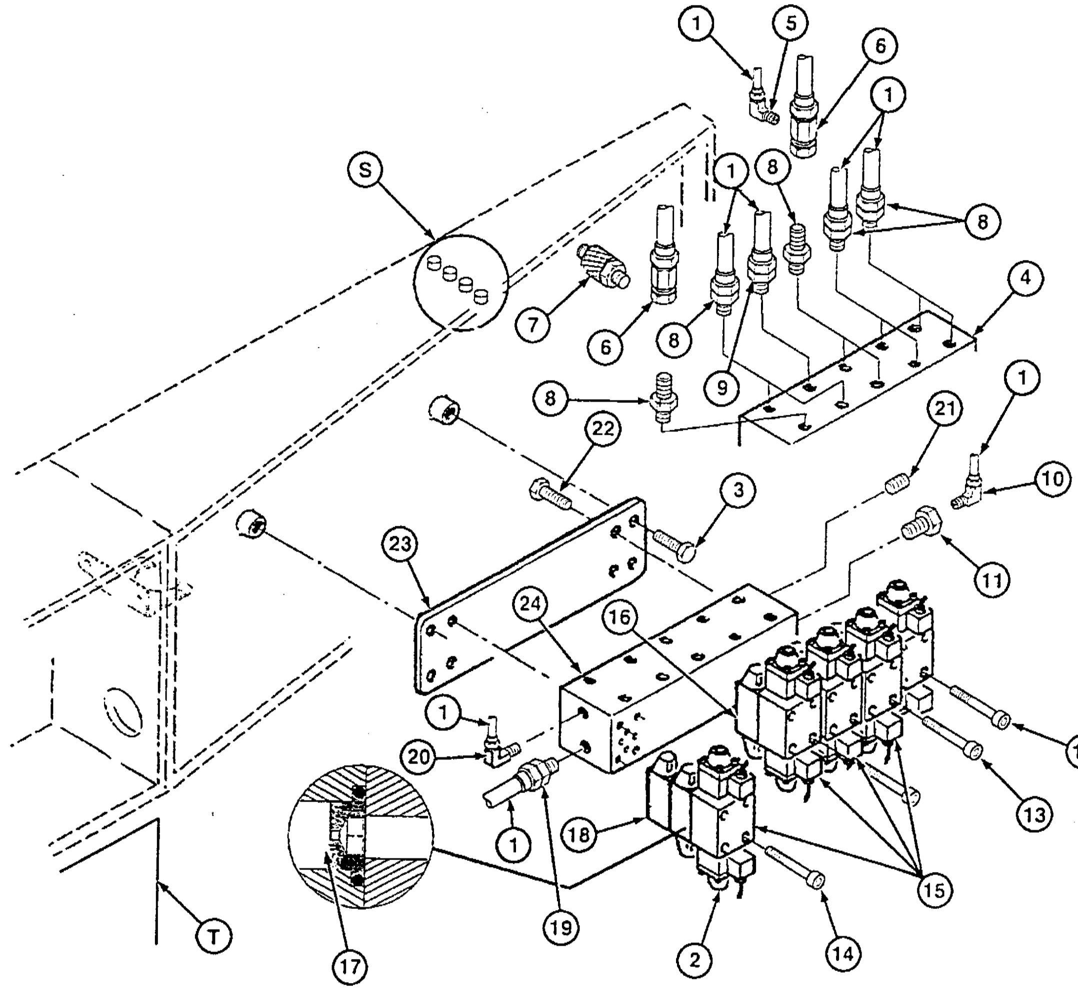
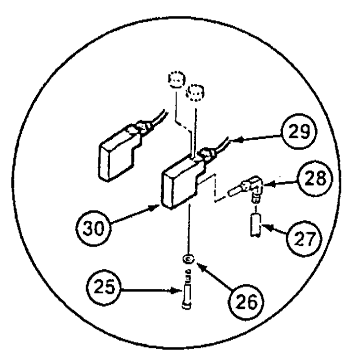
44
9506
142



DETAIL R



DETAIL S

T121055

T121055 -UN-19APR99

Continued on next page

1—Hose (10 used)
2—Harness Connector (8 used)
3—Screw (4 used)
4—Valve Assembly
5—Adapter (2 used)
6—Tee (2 used)
7—Pressure Socket
8—Adapter (9 used)
9—Plug
10—Adapter
11—Reducer
12—Screw (4 used)
13—Screw (12 used)
14—Screw (4 used)
15—Electro-Valve (5 used)
16—Check Valve (4 used)
17—Oil Restrictor
18—Pressure Limiter
19—Adapter
20—Adapter
21—Plug
22—Screw (4 used)
23—Plate
24—Connector
25—Screw (4 used)
26—Washer (4 used)
27—Hose (2 used)
28—Adapter (2 used)
29—Harness Connector (2 used)
30—Manostat (2 used)

95. Remove ten hoses (1).

96. Remove eight harness connectors (2).

97. Remove four screws (3) and valve assembly (4).

98. Remove two adapters (5), two tees (6), pressure socket (7), nine adapters (8), and plug (9).

99. Remove adapter (10) and reducer (11).

100. Remove four screws (12), twelve screws (13), and four screws (14).

101. Remove five electro-valves (15), four check valves (16), oil restrictor (17), and pressure limiter (18).

102. Remove adapters (19 and 20) and plug (21).

103. Remove four screws (22), plate (23), and connector (24).

104. Remove two hoses (27).

105. Remove two harness connectors (29).

106. Remove four screws (25), washers (26), and two manostats (30).

107. Remove two adapters (28).

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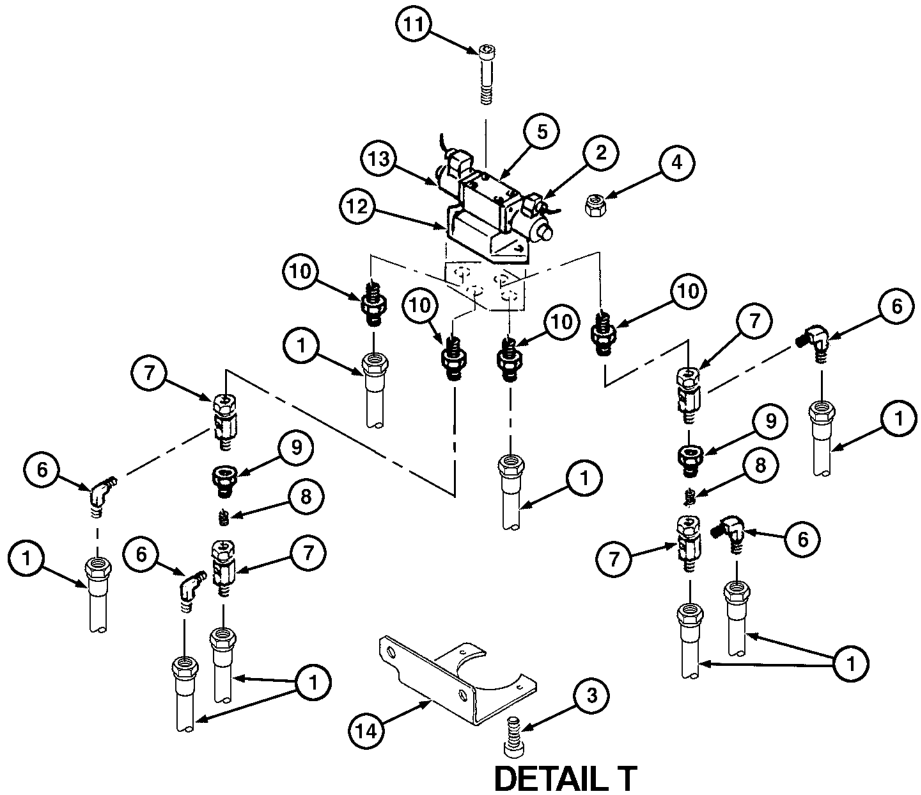
144



T121637 –UN–22JUN99

1—Hose (8 used)
2—Harness Connector (2 used)
3—Screw (2 used)
4—Locknut (2 used)
5—Valve Assembly
6—Adapter (4 used)
7—Tee (4 used)
8—Oil Restrictor (2 used)
9—Adapter (2 used)
10—Adapter (4 used)
11—Screw (4 used)
12—Base Plate
13—Electro-Valve
14—Support

108. Remove eight hoses (1).

109. Remove two harness connectors (2).

110. Remove two screws (3), locknuts (4), valve assembly (5), and support (14).

111. Remove four adapters (6), four tees (7), two oil restrictors (8), two adapters (9), and four adapters (10).

112. Remove four screws (11), base plate (12), and electro-valve (13).

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CED,OUOE019,18 –19–01APR99–23/49

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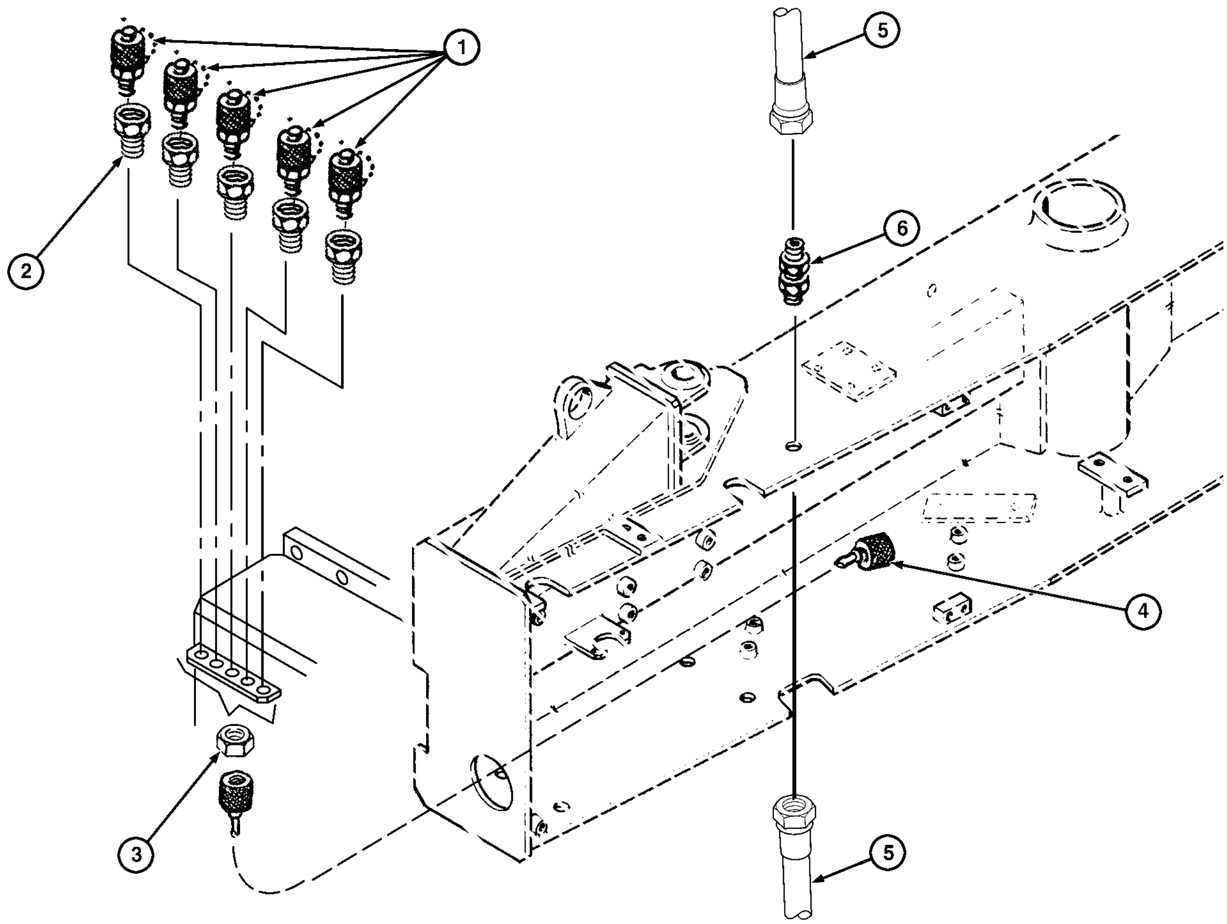
9506
146



DETAIL U

T121056

T121056 –UN–17JUN99

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Rock Drill

1—Pressure Socket (5 used)
2—Adapter (5 used)
3—Nut (5 used)
4—Pressure Socket Hose (5 used)
5—Hose (2 used)
6—Fitting

44
9506
147

113. Remove five pressure sockets (1), five adapters (2), five nuts (3), and five pressure socket hoses (4).

114. Remove two hoses (5).

115. Remove fitting (6).

116. Inspect, repair or replace parts as necessary.

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CED,OUOE019,18 –19–01APR99–25/49

Rock Drill

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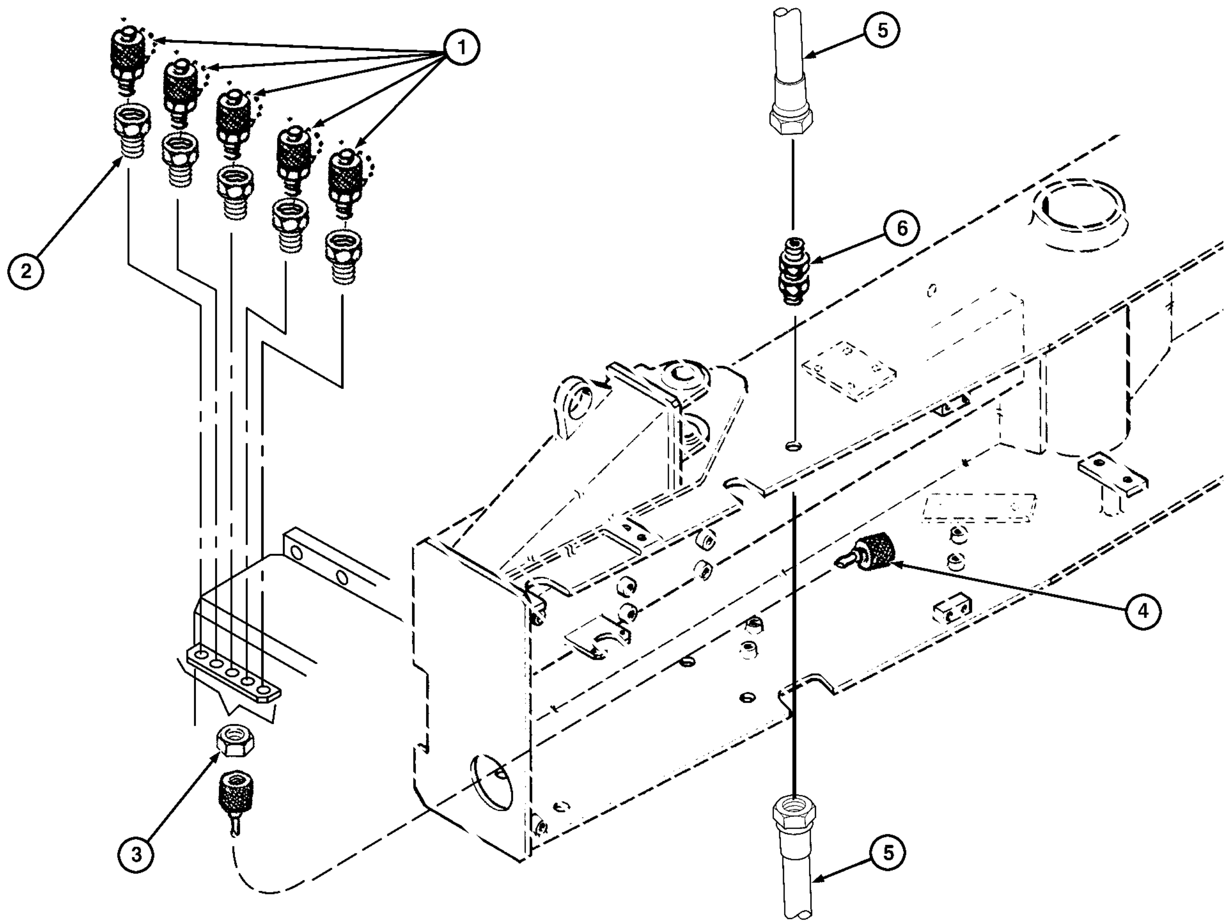
148



DETAIL U

T121056

T121056 –UN–17JUN99

Continued on next page

CED,OUOE019,18 –19–01APR99–26/49

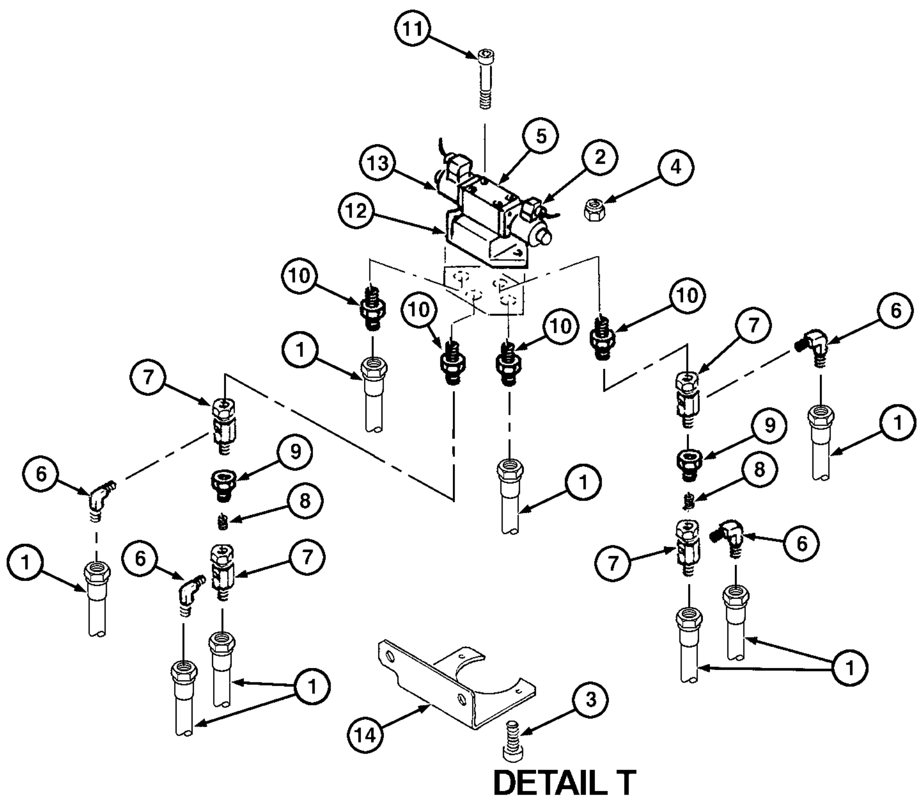
1—Pressure Socket (5 used)
2—Adapter (5 used)
3—Nut (5 used)
4—Pressure Socket Hose (5 used)
5—Hose (2 used)
6—Fitting

117. Install fitting (6).

118. Install two hoses (5).

119. Install five pressure socket hoses (4), five nuts (3), five adapters (2), and five pressure sockets (1).

CED,OUOE019,18 –19–01APR99–27/49



T121637

T121637 –UN–22JUN99

1—Hose (8 used)
2—Harness Connector (2 used)
3—Screw (2 used)
4—Locknut (2 used)
5—Valve Assembly
6—Adapter (4 used)
7—Tee (4 used)
8—Oil Restrictor (2 used)
9—Adapter (2 used)
10—Adapter (4 used)
11—Screw (4 used)
12—Base Plate
13—Electro-Valve
14—Support

120. Install electro-valve (13), base plate (12), and four screws (11).

121. Install four adapters (10), four tees (7), four adapters (6), two adapters (9), and oil two restrictors (8).

122. Install valve assembly (5), support (14), two screws (3), and locknuts (4).

123. Install two harness connectors (2).

124. Install eight hoses (1).

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CED,OUOE019,18 –19–01APR99–28/49

Rock Drill

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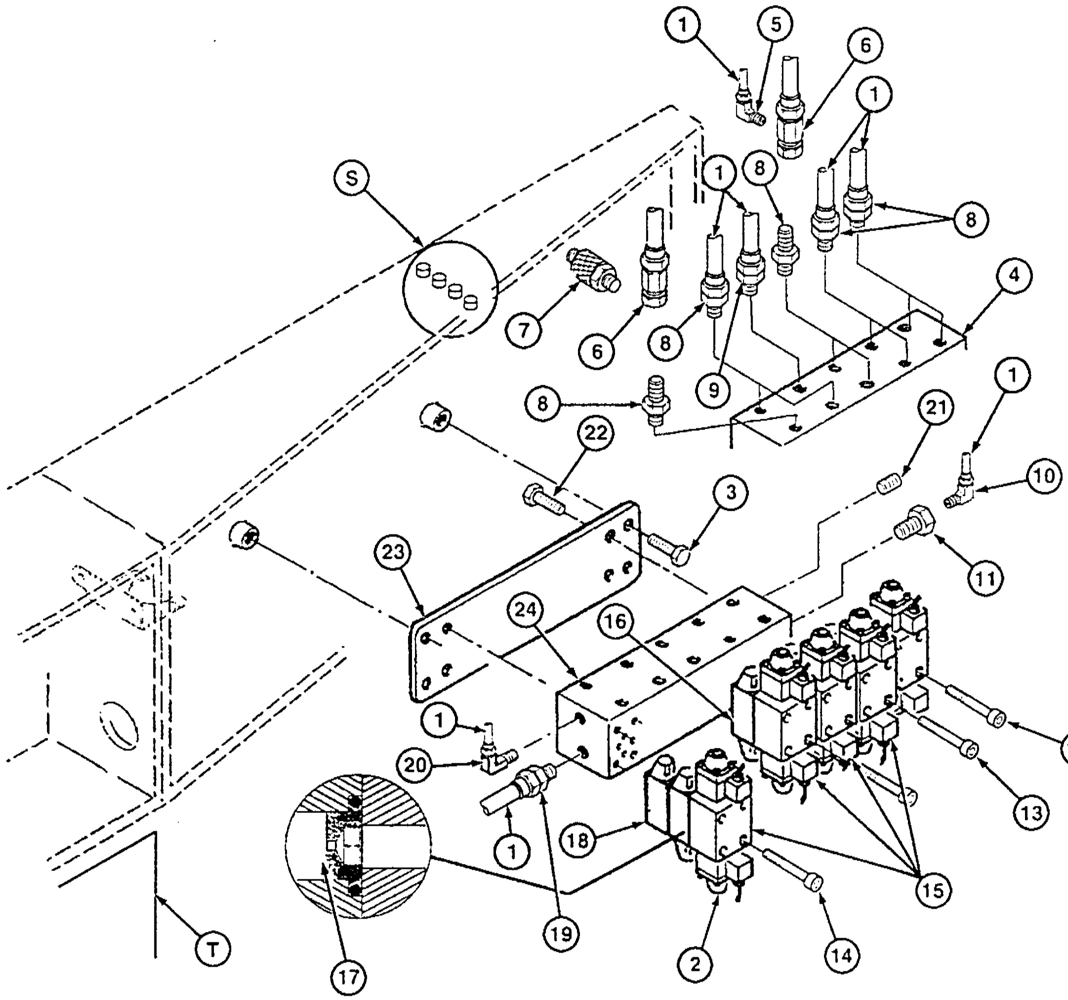
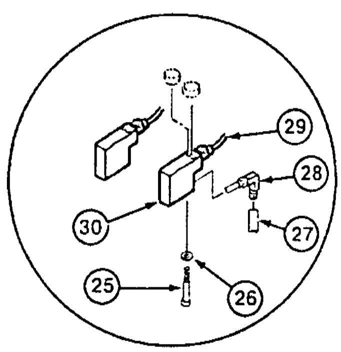
150



DETAIL R



DETAIL S

T121055 -UN-19APR99

T121055

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151

1—Hose (10 used)
2—Harness Connector (8 used)
3—Screw (4 used)
4—Valve Assembly
5—Adapter (2 used)
6—Tee (2 used)
7—Pressure Socket
8—Adapter (9 used)
9—Plug
10—Adapter
11—Reducer
12—Screw (4 used)
13—Screw (12 used)
14—Screw (4 used)
15—Electro-Valve (5 used)
16—Check Valve (4 used)
17—Oil Restrictor
18—Pressure Limiter
19—Adapter
20—Adapter
21—Plug
22—Screw (4 used)
23—Plate
24—Connector
25—Screw (4 used)
26—Washer (4 used)
27—Hose (2 used)
28—Adapter (2 used)
29—Harness Connector (2 used)
30—Manostat (2 used)

125. Install two adapters (28).

126. Install two manostats (30), four screws (25), and washers (26).

127. Install two harness connectors (29).

128. Install two hoses (27).

129. Install connector (24), plate (23), and four screws (22).

130. Install plug (21) and adapters (19 and 20).

131. Install pressure limiter (18), oil restrictor (17), four check valves (16), and five electro-valves (15).

132. Install four screws (14), twelve screws (13), and four screws (12).

133. Install reducer (11) and adapter (10).

134. Install plug (9), nine adapters (8), pressure socket (7), two tees (6), and two adapters (5).

135. Install valve assembly (4) and four screws (3).

136. Install eight harness connectors (2).

137. Install ten hoses (1).

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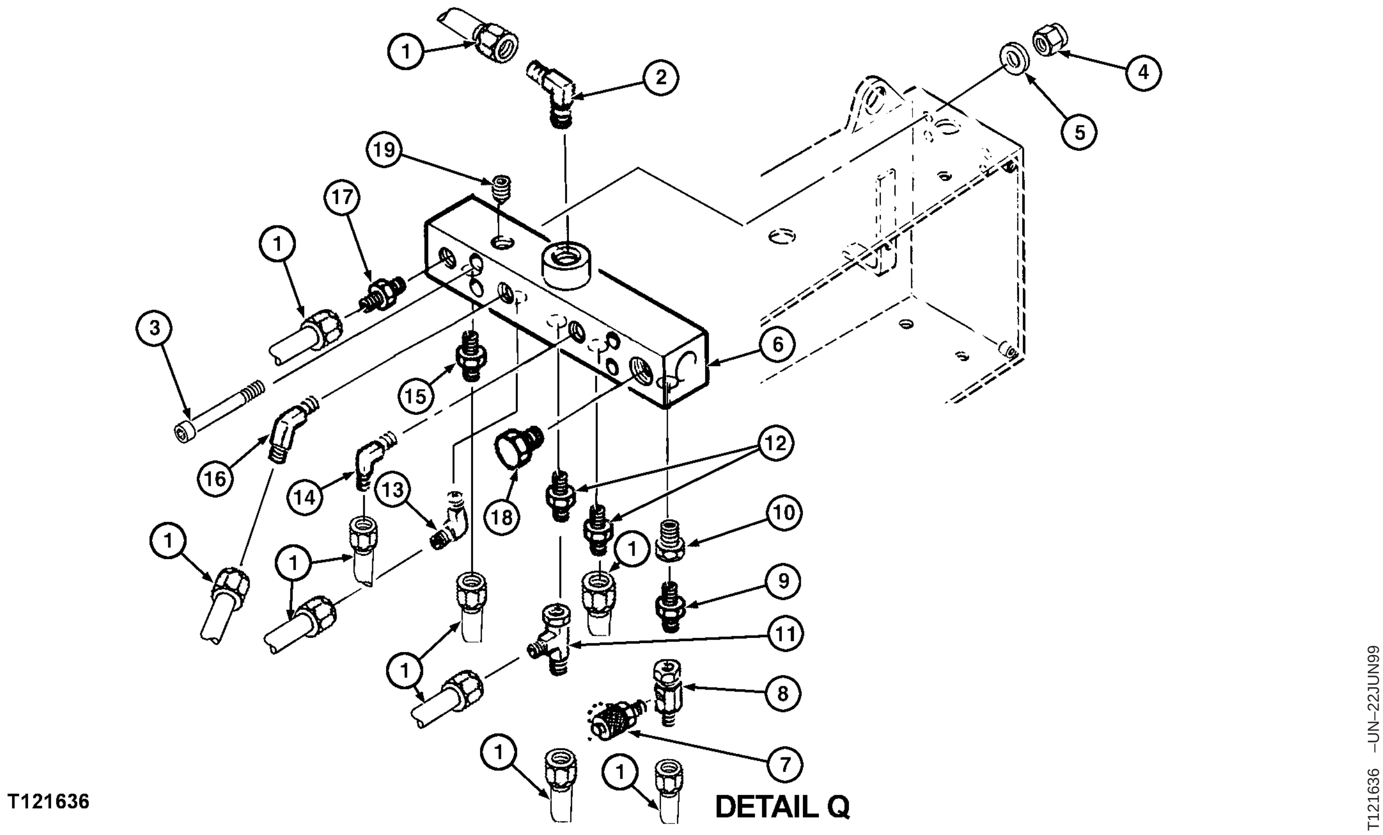
CED,OUOE019,18 –19–01APR99–30/49

Rock Drill



1—Hose	**6—Connector**	**11—Tee**	**16—Adapter**
2—Adapter	**7—Pressure Socket**	**12—Adapter (2 used)**	**17—Adapter**
3—Screw (4 used)	**8—Tee**	**13—Adapter**	**18—Plug**
4—Locknut (4 used)	**9—Adapter**	**14—Adapter**	**19—Plug**
5—Washer (4 used)	**10—Adapter**	**15—Adapter**	

138. Install plugs (18 and 19).

139. Install adapters (13—17).

140. Install two adapters (12) and tee (11).

141. Install adapters (9 and 10), tee (8), and pressure socket (7).

142. Install connector (6), four screws (3), locknuts (4), and washers (5).

143. Install adapters (2).

144. Install ten hoses (1).

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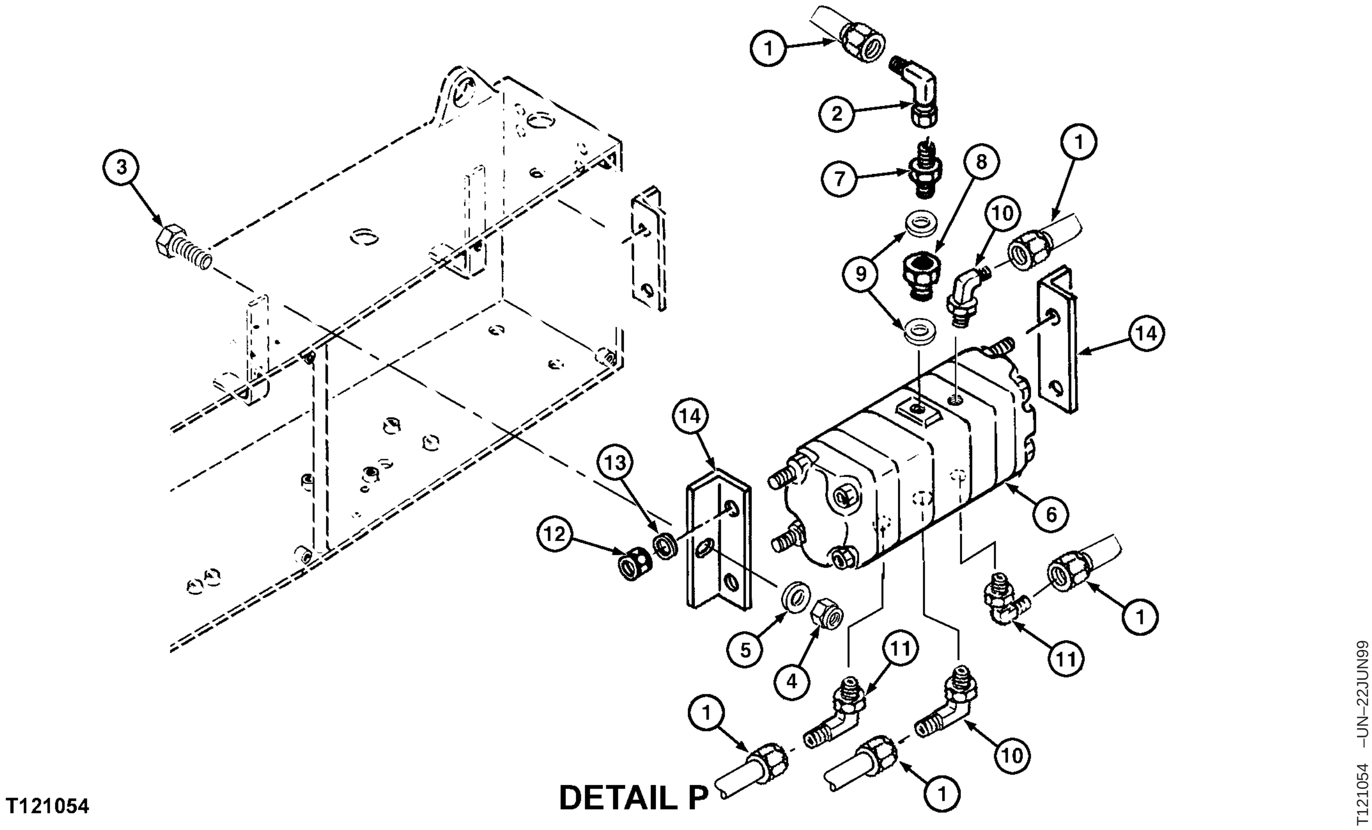
CED,OUOE019,18 –19–01APR99–31/49

Rock Drill



1—Hose (5 used)
2—Adapter
3—Screw (2 used)
4—Locknut (2 used)
5—Washer (2 used)
6—Flow Divider
7—Adapter
8—Adapter
9—BS Ring (2 used)
10—Adapter (2 used)
11—Adapter (2 used)
12—Nut (4 used)
13—Washer (4 used)
14—Iron Corner (2 used)

145. Install two iron corners (14), four nuts (12), and washers (13).

146. Install two adapters (10) and two adapters (11).

147. Install two BS rings (9) and adapters (7 and 8).

148. Install flow divider (6), two screws (3), locknuts (4), and washers (5).

149. Install adapter (2).

150. Install five hoses (1).

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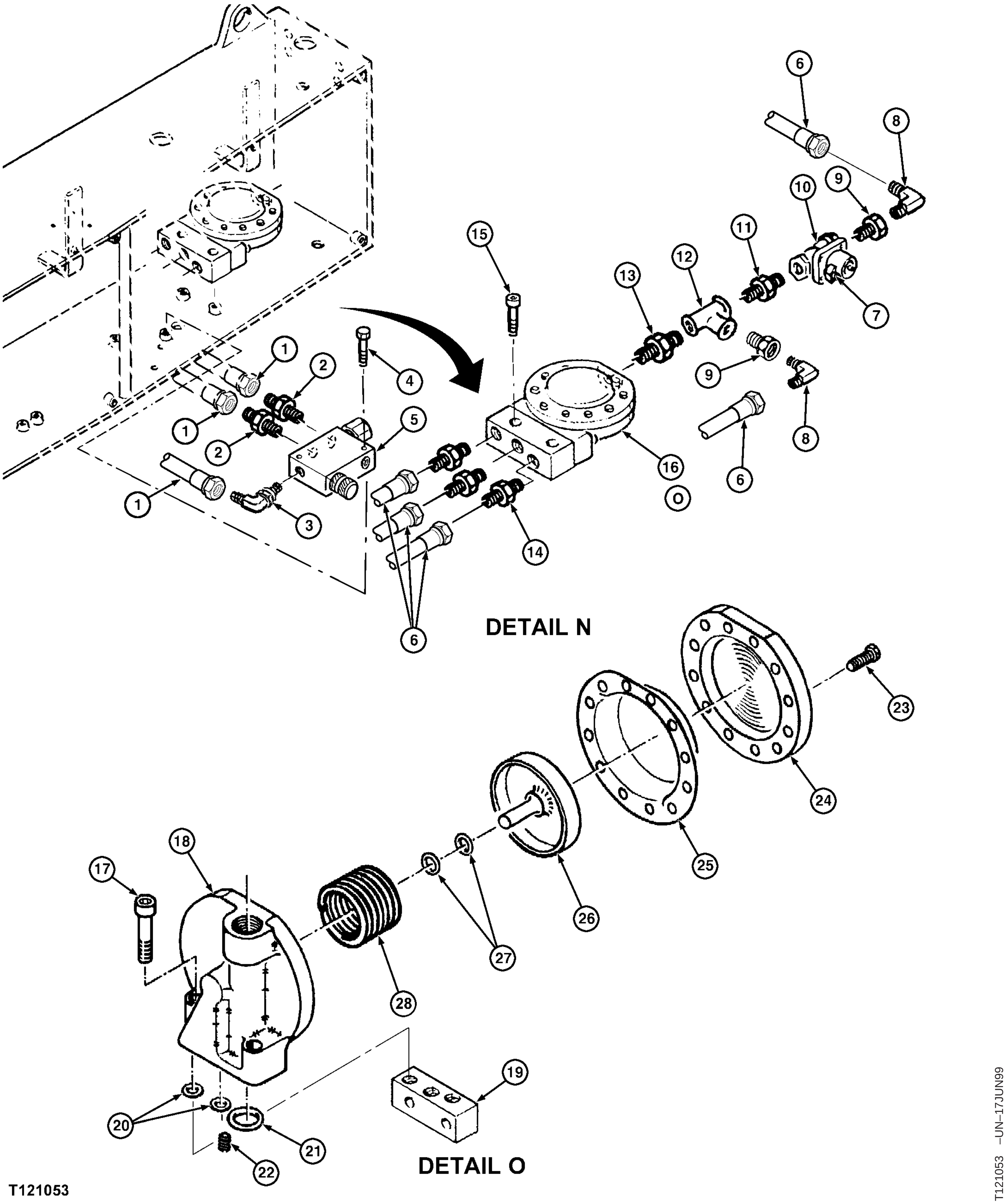
Rock Drill



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1—Hose (3 used)
2—Adapter (2 used)
3—Adapter
4—Screw (2 used)
5—Divider
6—Hose (5 used)
7—Soleniod Harness
8—Adapter (2 used)
9—Adapter (2 used)
10—Soleniod Valve
11—Adapter
12—Tee
13—Adapter
14—Adapter (3 used)
15—Screw (2 used)
16—Valve
17—Screw (2 used)
18—Complete Housing
19—Base Plate
20—O-Ring (2 used)
21—O-Ring
22—Oil Restrictor
23—Screw (12 used)
24—Case
25—Diaphragm
26—Piston
27—O-Ring (2 used)
28—Spring

151. Install spring (28), new O-rings (27), piston (26), diaphragm (25), case (24), and twelve screws (23).

152. Install oil restrictor (22), two new O-rings (20), and O-ring (21).

153. Install complete housing (18), two screws (17), and base plate (19).

154. Install valve (16) and two screws (15).

155. Install three adapters (14).

156. Install adapter (13), tee (12), adapter (11), solenoid valve (10), two adapters (9), and two adapters (8).

157. Install solenoid harness (7).

158. Install five hoses (6).

159. Install divider (5) and two screws (4).

160. Install adapter (3) and two adapters (2).

161. Install three hoses (1).

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Rock Drill

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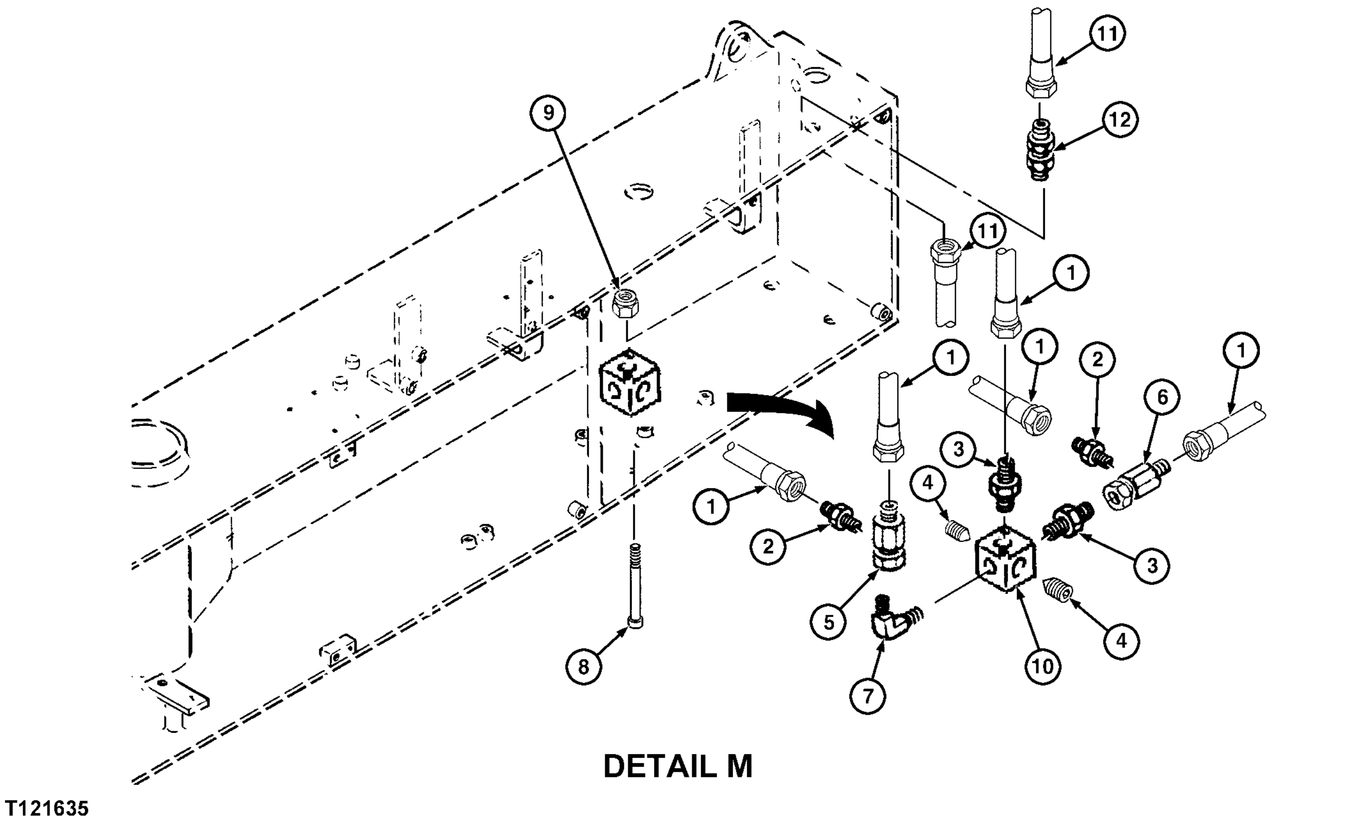
9506
156



1—Hose (4 used)
2—Adapter (2 used)
3—Adapter (2 used)
4—Plug (2 used)
5—Tee
6—Tee
7—Adapter
8—Screw (2 used)
9—Locknut (2 used)
10—Connector
11—Hose (2 used)
12—Fitting

162. Install fitting (12).

163. Install two hoses (11).

164. Install connector (10), two screws (8), and locknuts (9).

165. Install adapter (7) and tees (5 and 6).

166. Install two plugs (4), two adapters (3), and two adapters (2).

167. Install four hoses (1).

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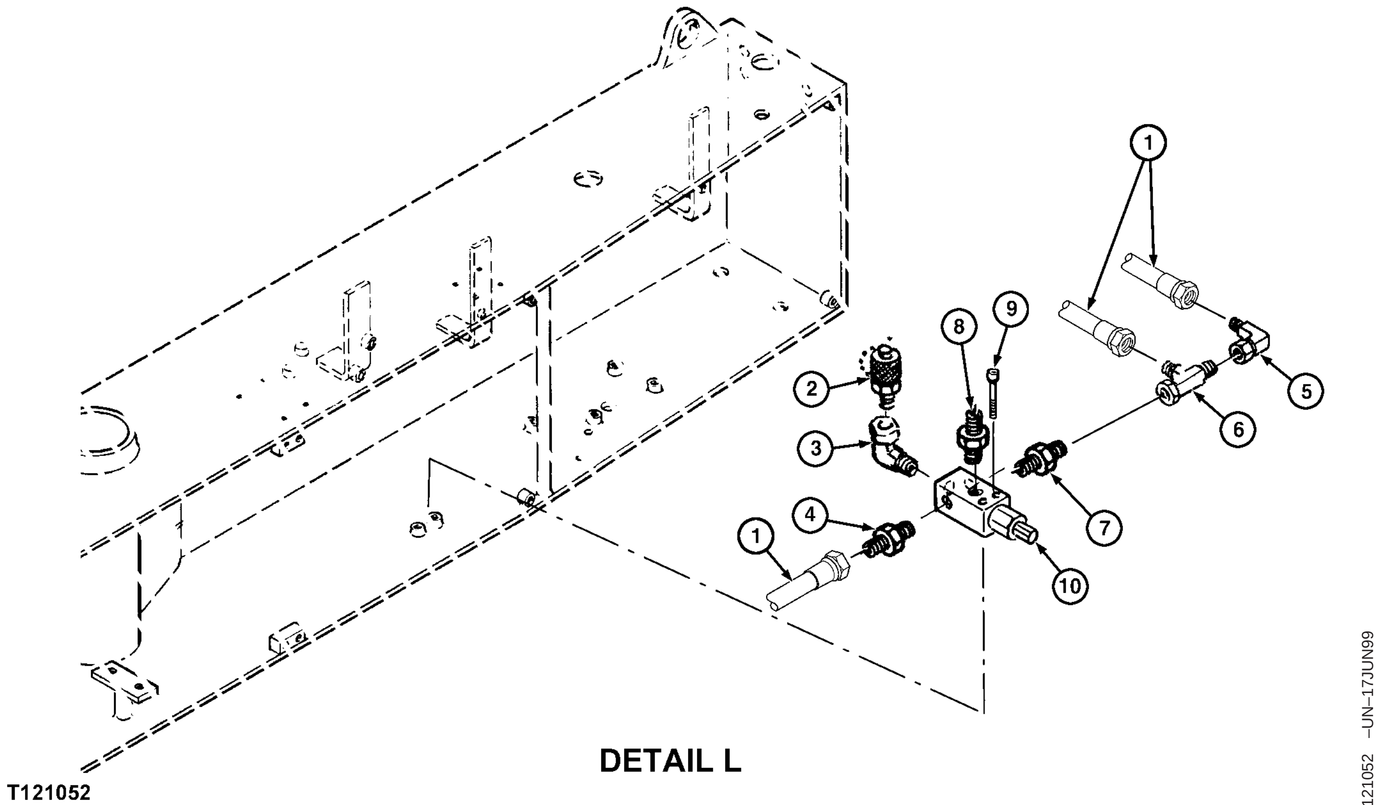
Rock Drill



1—Hose (3 used)
2—Pressure Socket
3—Adapter
4—Adapter
5—Adapter
6—Tee
7—Adapter
8—Adapter
9—Screw (2 used)
10—Pressure Limiter

168. Install pressure limiter (10) and two screws (9).

169. Install tee (6), adapters (3, 4, 5, 7, and 8), and pressure socket (2).

170. Install three hoses (1).

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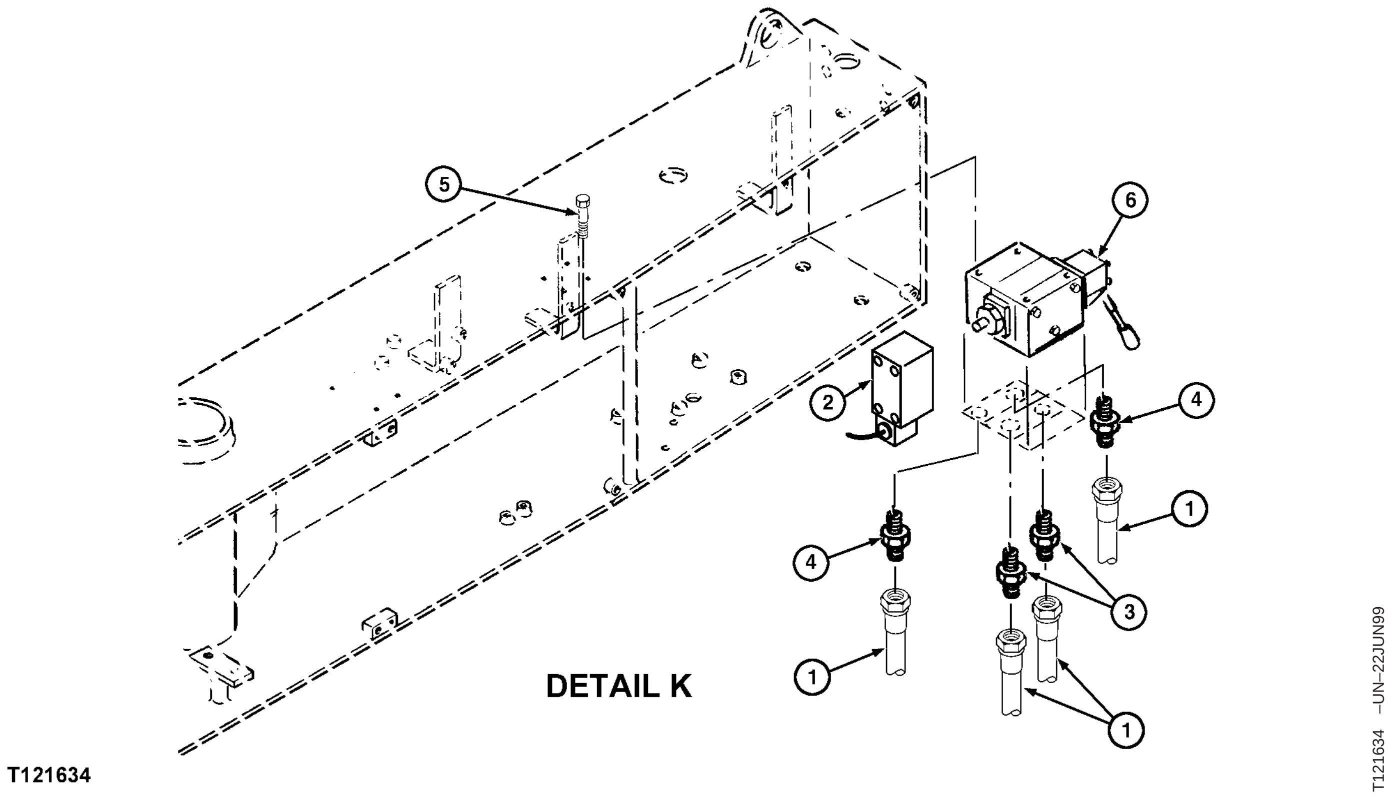
CED,OUOE019,18 –19–01APR99–36/49



1—Hose (4 used)
2—Solenoid Connector
3—Adapter (2 used)
4—Adapter (2 used)
5—Screw (4 used)
6—Solenoid Valve

171. Install solenoid valve (6) and four screws (5).

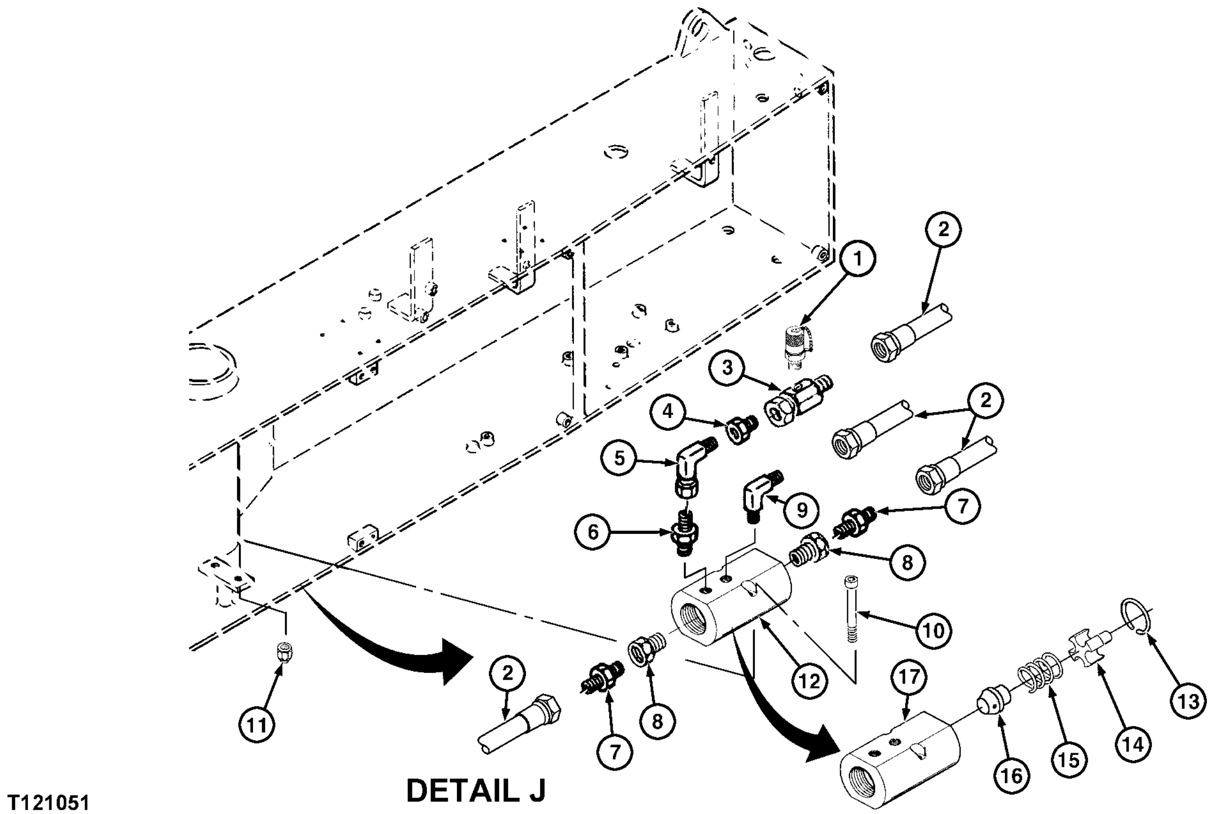
172. Install two adapters (4) and two adapters (3).

173. Install solenoid connector (2).

174. Install four hoses (1).

Continued on next page

44
9506
159



1—Pressure Sensor Switch
2—Hose (4 used)
3—Adapter
4—Restrictor Adapter
5—Adapter
6—Adapter
7—Adapter (2 used)
8—Nipple (2 used)
9—Adapter
10—Screw (2 used)
11—Locknut (2 used)
12—Air Flow Detector
13—Rush
14—Valve Guide
15—Spring
16—Valve
17—Valve Seat

175. Install valve (16), spring (15), valve guide (14), and rush (13).

176. Install air flow detector (12), two screws (10), and locknuts (11).

177. Install adapter (9), two nipples (8), and two adapters (7).

178. Install adapters (5 and 6), restrictor adapter (4), and adapter (3).

179. Install four hoses (2).

180. Install pressure sensor switch (1),

181. Remove tags and connect wires to pressure sensor switch (1).

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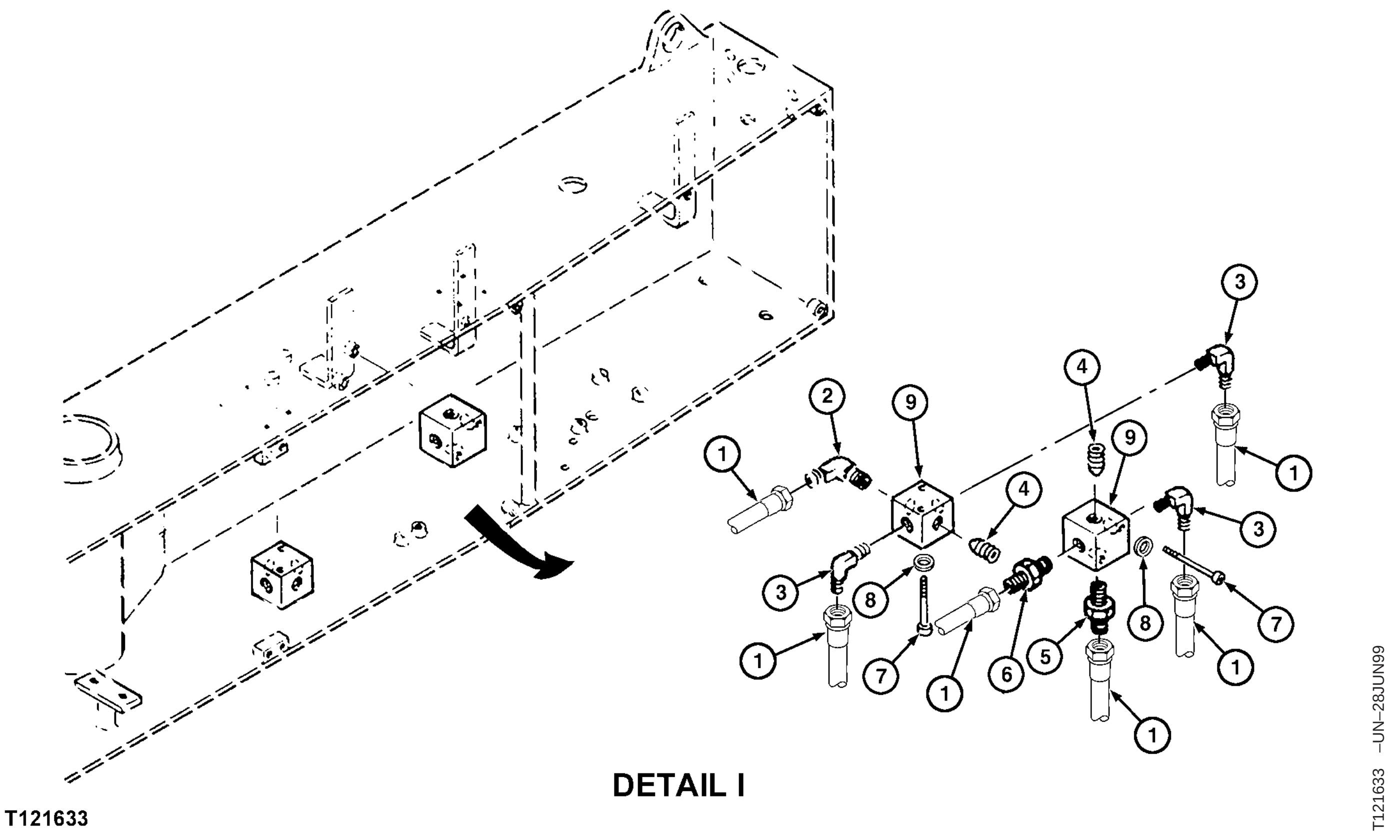

1—Hose (6 used)
2—Adapter
3—Adapter (3 used)
4—Plug (2 used)
5—Adapter
6—Adapter
7—Screw (4 used)
8—Washer (4 used)
9—Connector (2 used)

182. Install two connectors (9), four screws (7), and washers (8).

183. Install adapters (5 and 6).

184. Install two plugs (4).

185. Install three adapters (3) and adapter (2).

186. Install six hoses (1).

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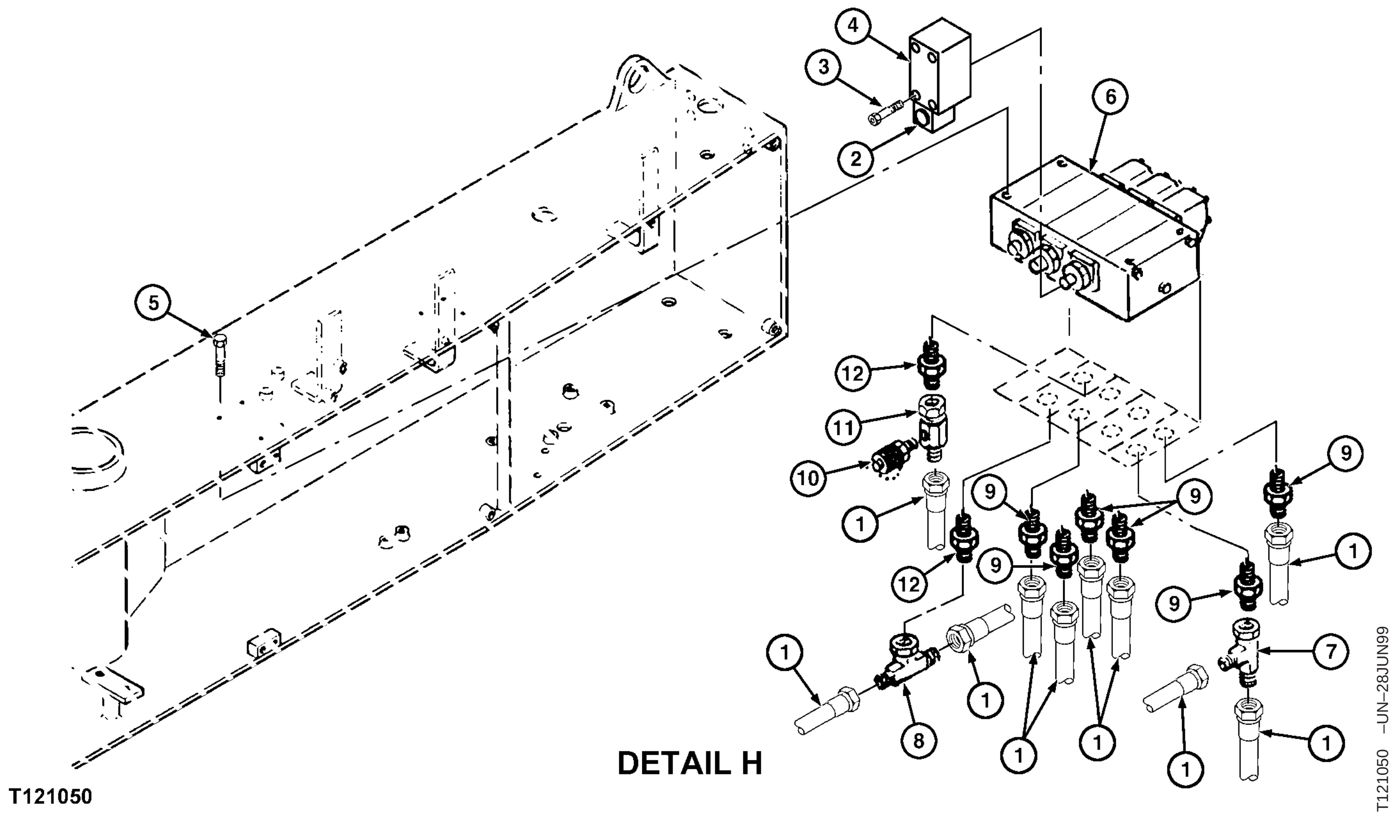
Rock Drill



1—Hose (10 used)
2—Solenoid Connector (3 used)
3—Screw (3 used)
4—Solenoid (3 used)
5—Screw (4 used)
6—Solenoid Valve
7—Tee
8—Tee
9—Adapter (6 used)
10—Pressure Socket
11—Tee
12—Adapter (2 used)

187. Install two adapters (12), tee (11), pressure socket (10), six adapters (9), and tees (7 and 8).

188. Install solenoid valve (6) and four bolts (5).

189. Install three solenoids (4) and three screws (3).

190. Install three solenoid connectors (2).

191. Install ten hoses (1).

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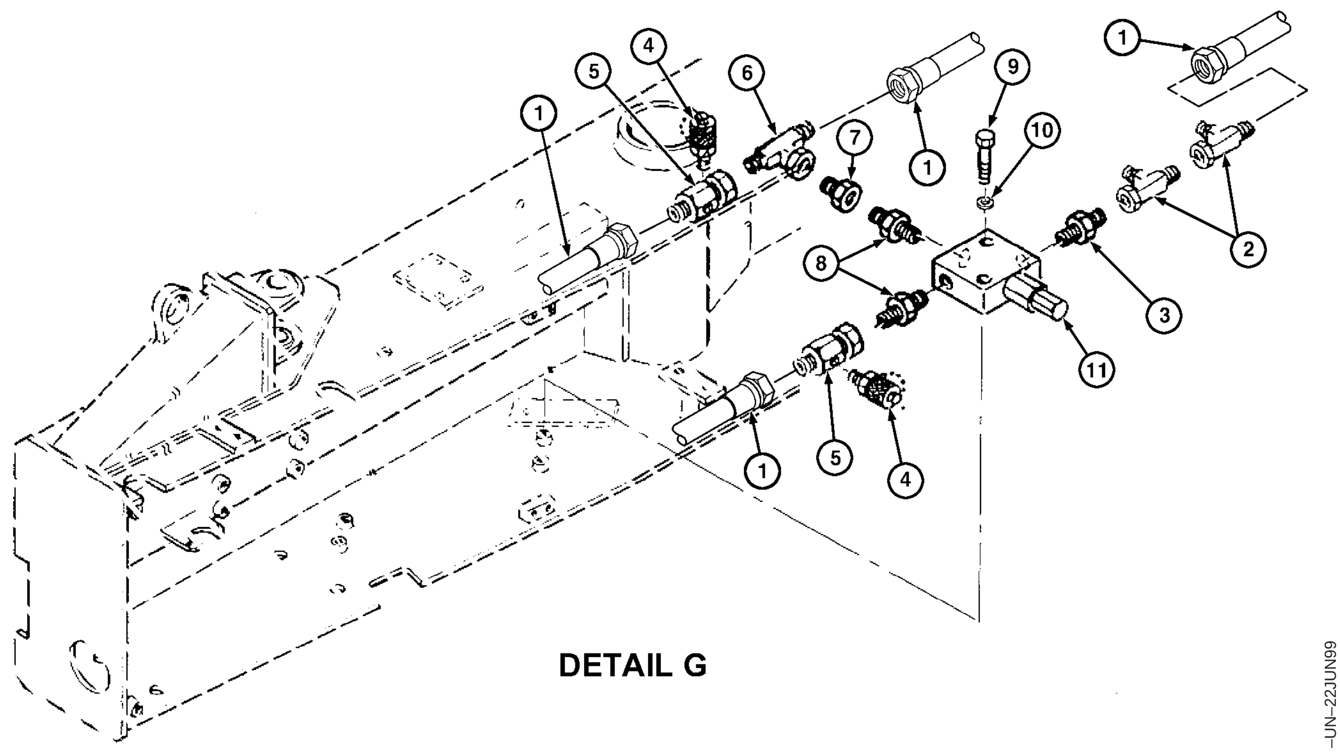

T121632

1—Hose (4 used)
2—Tee (2 used)
3—Adapter
4—Pressure Socket (2 used)
5—Tee (2 used)
6—Tee
7—Restrictor Adapter
8—Adapter (2 used)
9—Screw (2 used)
10—Washer (2 used)
11—Sequence Valve

192. Install sequence valve (11), two screws (9), and washers (10).

193. Install two adapters (8), restrictor adapter (7), tee (6), two tees (5), and two pressure sockets (4).

194. Install adapter (3) and two tees (2).

195. Install four hoses (1).

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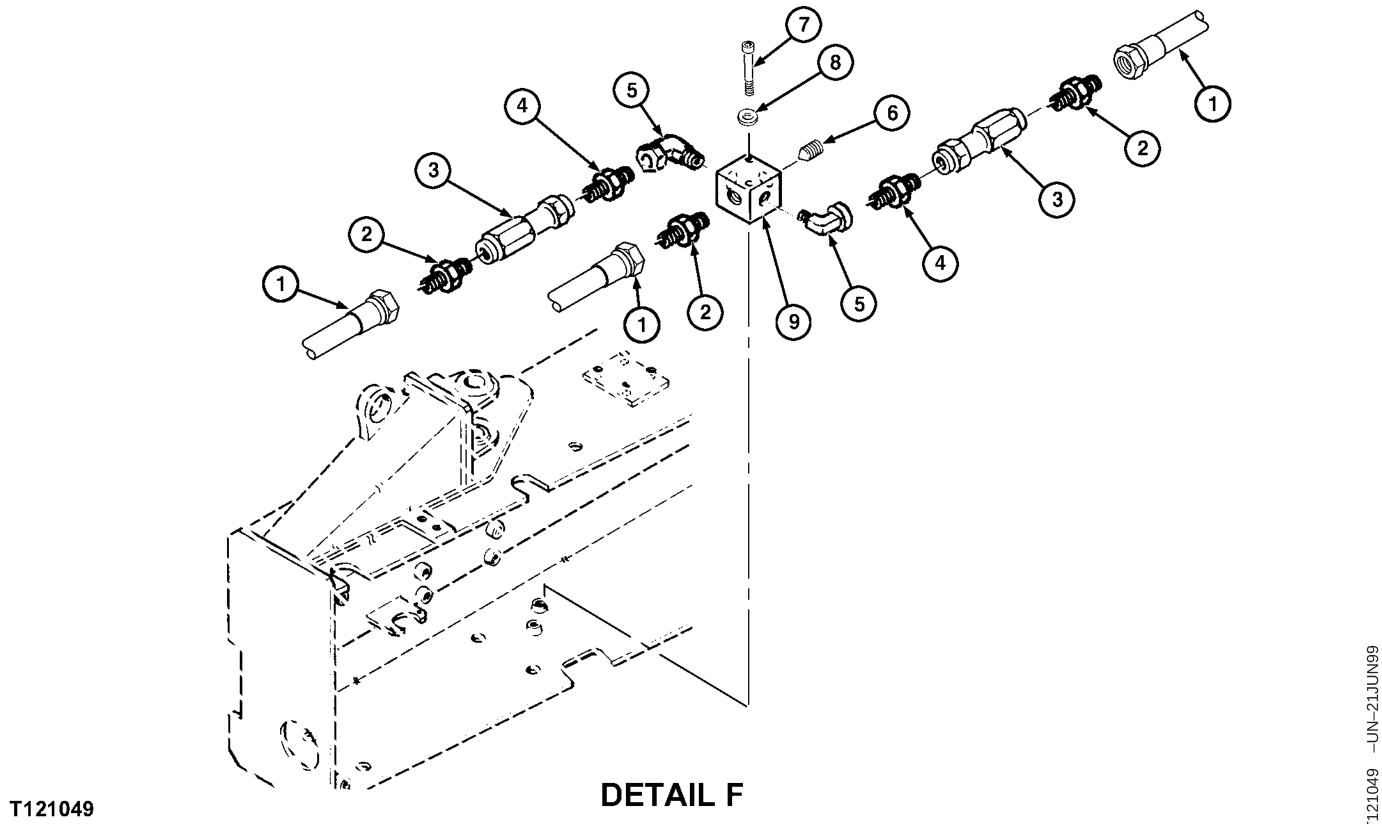

1—Hose (3 used)
2—Adapter (3 used)
3—Check Valve (2 used)
4—Adapter (2 used)
5—Adapter (2 used)
6—Plug
7—Screw (2 used)
8—Washer (2 used)
9—Connector

196. Install connector (9), two screws (7), and washers (8).

197. Install plug (6).

198. Install two adapters (5), two adapters (4), two check valves (3), and three adapters (2).

199. Install three hoses (1).

Continued on next page CED,OUOE019,18 –19–01APR99–42/49

Rock Drill

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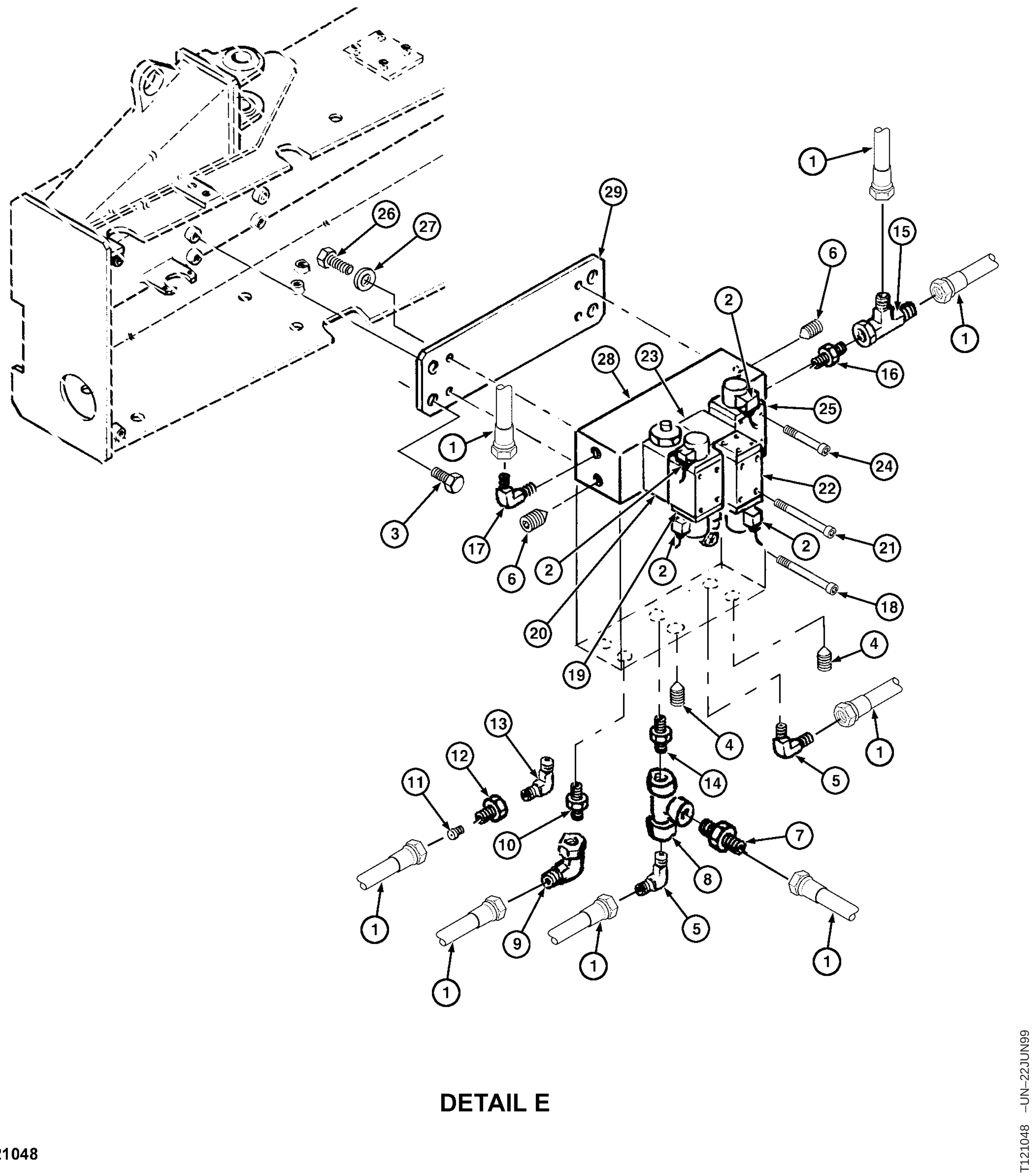
164



DETAIL E

T121048

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1—Hose (8)
2—Electrical Connector (4 used)
3—Screw (4 used)
4—Plug (2 used)
5—Adapter (2 used)
6—Plug (2 used)
7—Adapter
8—Tee
9—Adapter
10—Adapter
11—Oil Restrictor
12—Restrictor Adapter
13—Adapter
14—Adapter
15—Tee
16—Adapter
17—Adapter
18—Screw (4 used)
19—Solenoid Valve
20—Pressure Limiter
21—Screw (4 used)
22—Solenoid Valve
23—Sequence Valve
24—Screw (4 used)
25—Solenoid Valve
26—Screw (4 used)
27—Washer (4 used)
28—Bar
29—Base Plate

200. Install base plate (29), bar (28), four screws (26), and washers (27).

201. Install solenoid valve (25) and four screws (24).

202. Install sequence valve (23), solenoid valve (22), and four screws (21).

203. Install pressure limiter (20), solenoid valve (19), and four screws (18).

204. Install adapters (16 and 17) and tee (15).

205. Install adapters (13 and 14), restrictor adapter (12), and oil restrictor (11).

206. Install adapters (9 and 10).

207. Install tee (8), adapter (7), two plugs (6), two adapters (5), and two plugs (4).

208. Install four screws (3).

209. Install four electrical connectors (2).

210. Install eight hoses (1).

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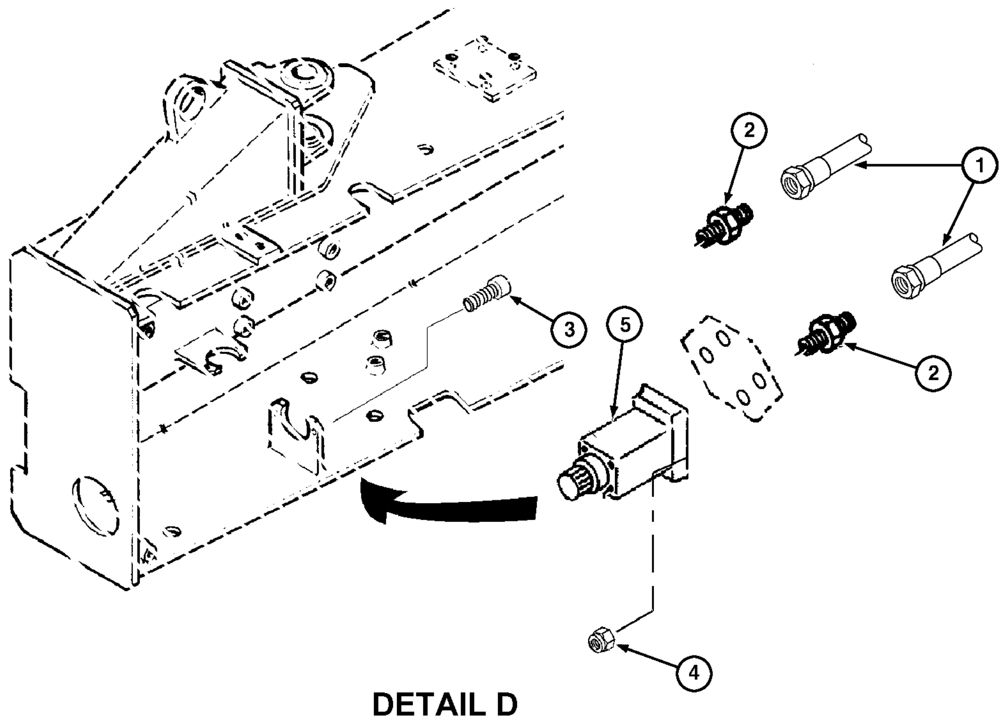
166



1—Hose (2 used)
2—Adapter (2 used)
3—Screw (2 used)
4—Locknut (2 used)
5—Flow Governor

211. Install flow governor (5), two screws (3), and locknuts (4).

212. Install two adapters (2).

213. Install two hoses (1).

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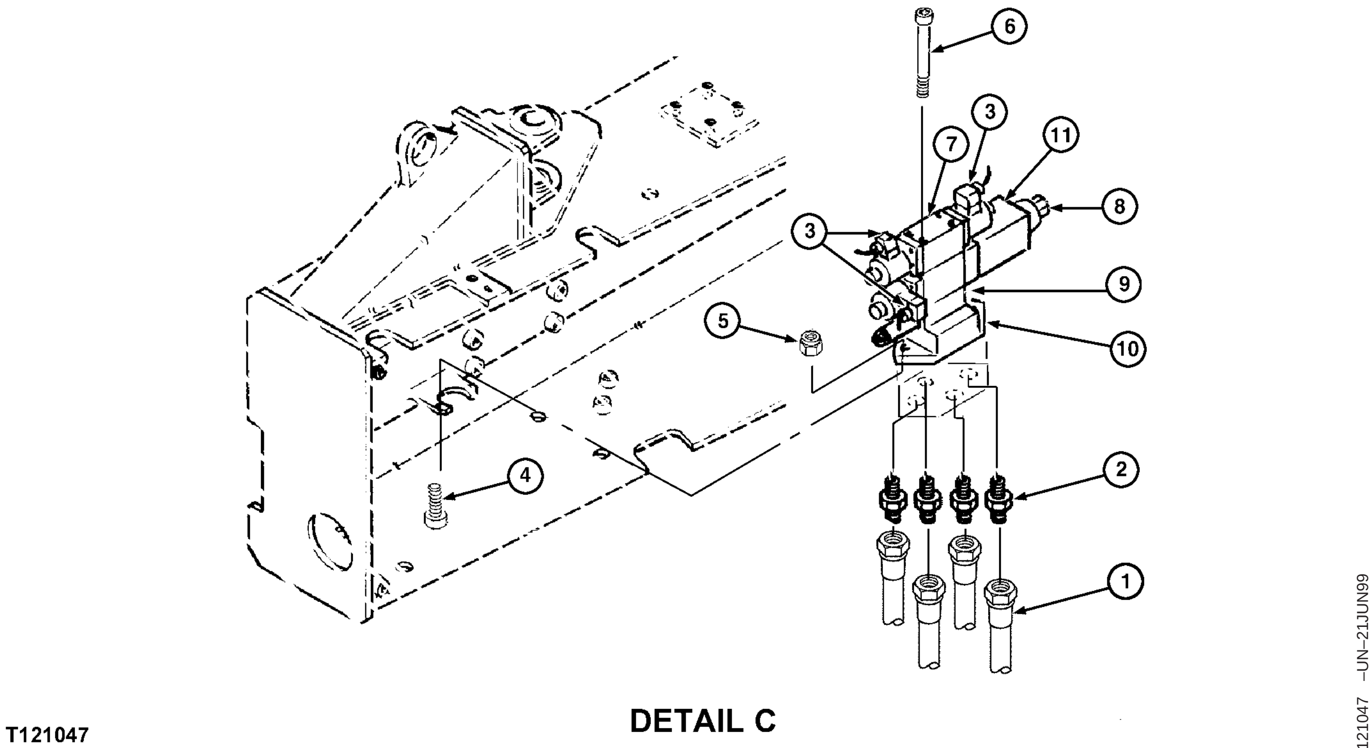
167



1—Hose (4 used)	**4—Screw (2 used)**	**7—Electro-Valve**	**10—Base Plate**
2—Adapter (4 used)	**5—Locknut (2 used)**	**8—Flow Governor**	**11—Flow Control Assembly**
3—Connector (3 used)	**6—Screw (4 used)**	**9—Pressure Limiter**	

214. Install base plate (10), pressure limiter (9), flow governor (8), electro-valve (7), and four screws (6).

215. Install flow control assembly (11), two screws (4), and locknuts (5).

216. Install three connectors (3).

217. Install four adapters (2).

218. Install four hoses (1).

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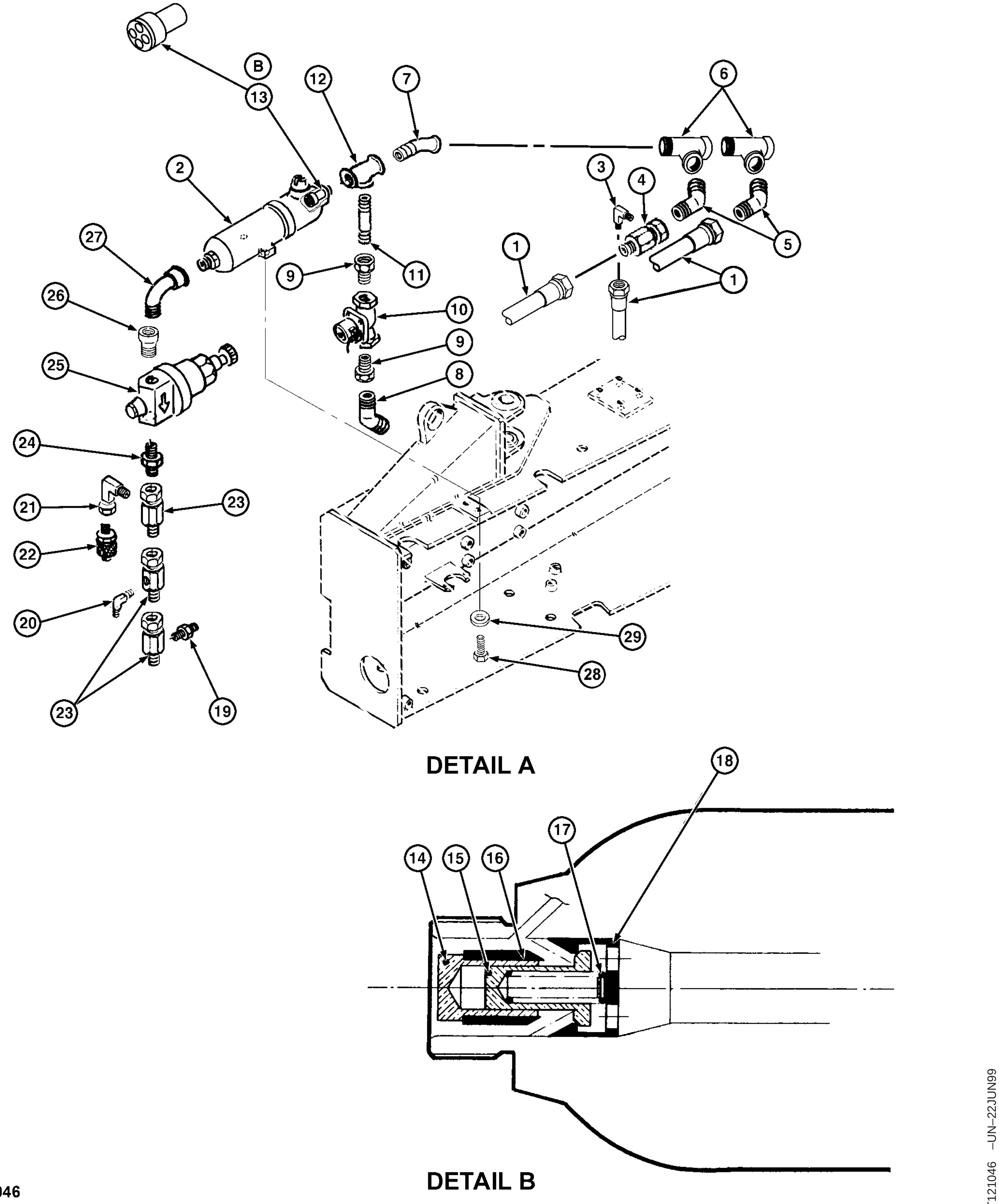
CED,OUOE019,18 –19–01APR99–46/49

Rock Drill



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Rock Drill

1—Hose (3 used)
2—Atomizer Lubricator
3—Adapter
4—Tee
5—Adapter (2 used)
6—Tee (2 used)
7—Bent Adapter
8—Adapter
9—Adapter (2 used)
10—Electro-Valve
11—Sleeve
12—Tee
13—Check Valve
14—Guide Valve
15—Valve
16—Seat Valve
17—Spring
18—Thrust
19—Adapter
20—Adapter
21—Adapter
22—Pressure Socket
23—Tee (3 used)
24—Adapter
25—Reducer
26—Sleeve
27—Bent Adapter
28—Screw (2 used)
29—Washer (2 used)

219. Install atomizer lubricator (2), two screws (28), and washers (29).

220. Install bent adapter (27), sleeve (26), reducer (25), and adapter (24).

221. Install three tees (23), pressure socket (22), and adapters (19, 20, and 21).

222. Install thrust (18), spring (17), seat valve (16), valve (15), and guide valve (14).

223. Install check valve (13).

224. Install tee (12), sleeve (11), electro-valve (10), two adapters (9), and adapter (8).

225. Install bent adapter (7).

226. Install two tees (6), two adapters (5), tee (4), and adapter (3).

227. Install three hoses (1).

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Rock Drill

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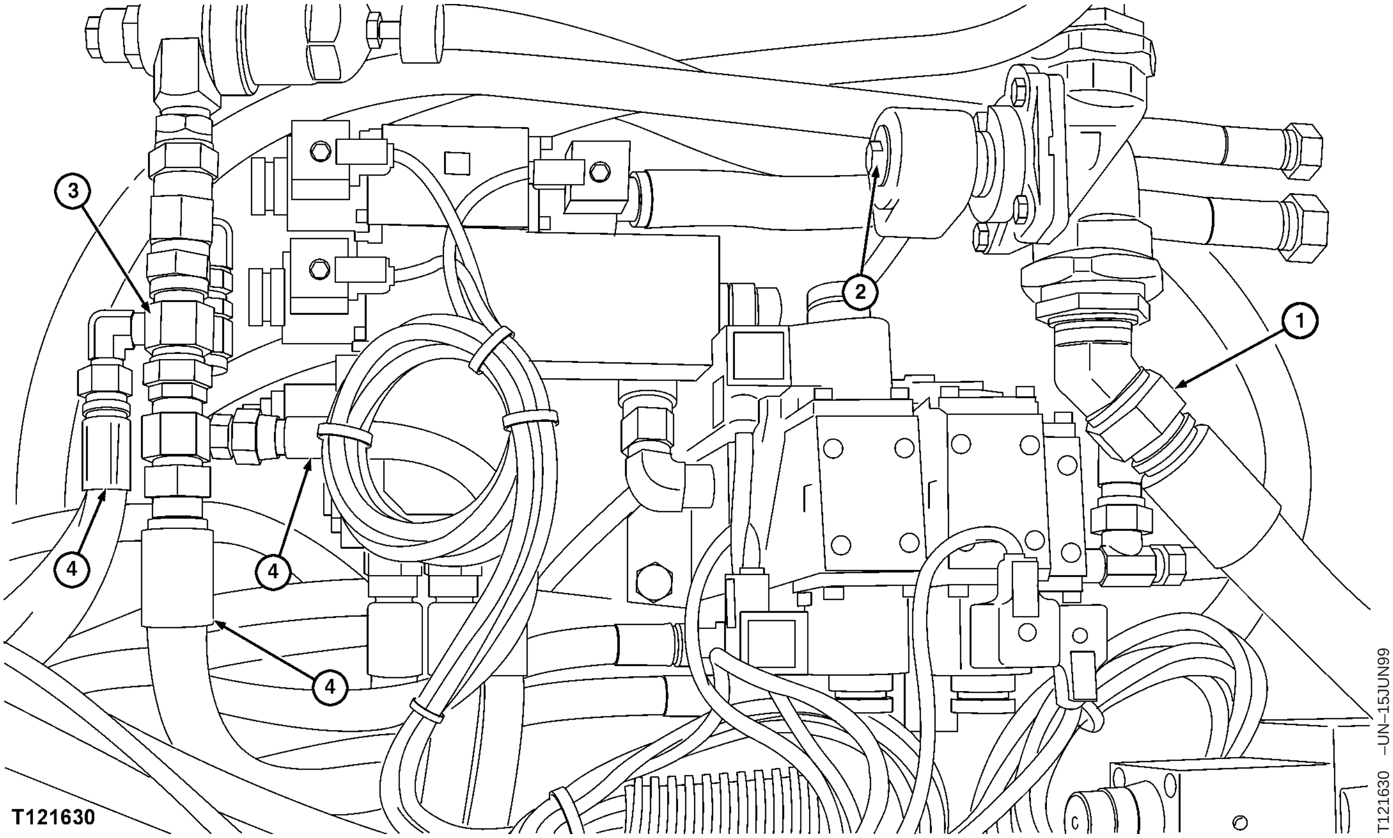
9506
170



1—Hose **2—Electrical Connector** **3—Fitting** **4—Hose (3 used)**

228. Install three hoses (4).

229. Install fitting (3).

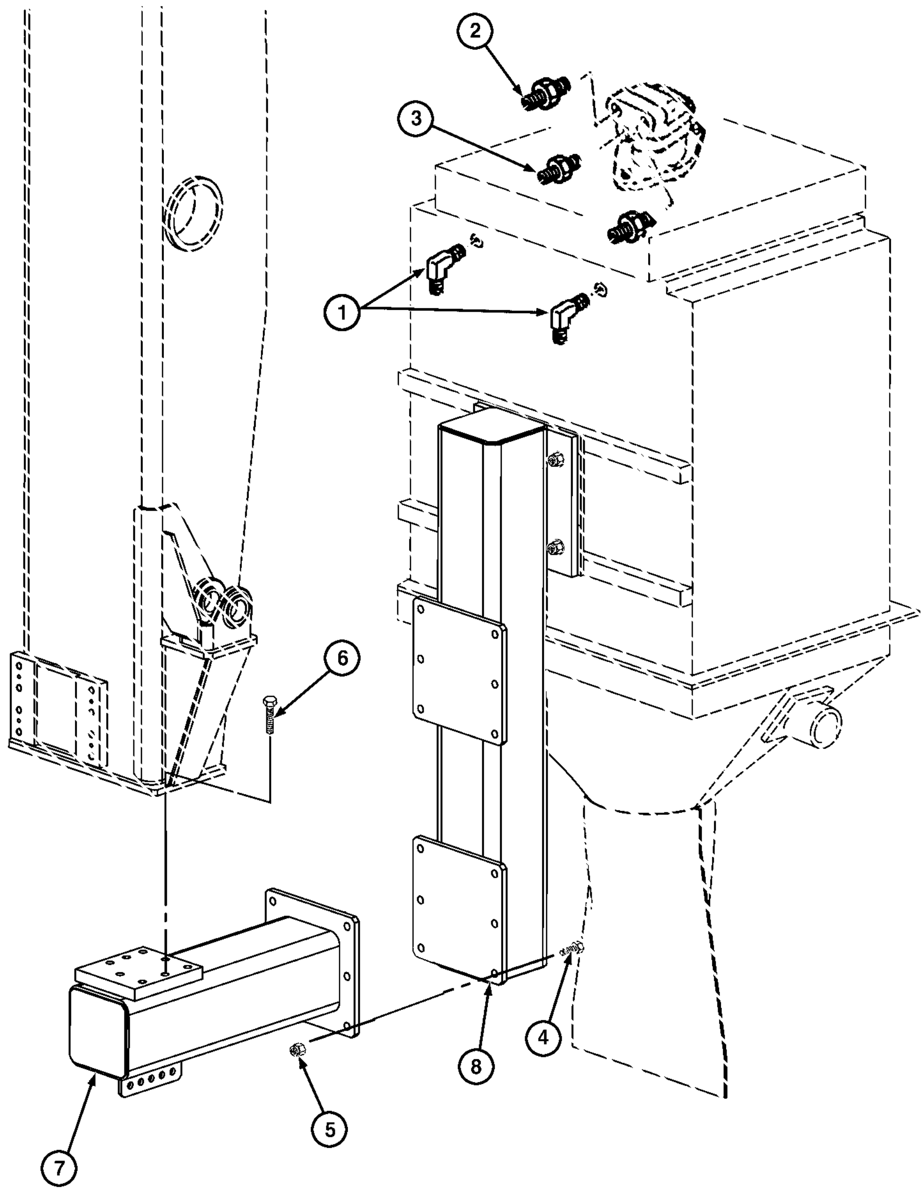
230. Install electrical connector (2).

231. Install hose (1).

CED,OUOE019,18 –19–01APR99–49/49

44
9506
172

DISASSEMBLE AND ASSEMBLE DUST COLLECTOR



T121076

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CED,OUOE019,19 –19–06APR99–1/5

Rock Drill

44
9506
173

1—Adapter (2 used)
2—Adapter (2 used)
3—Adapter
4—Screw (6 used)
5—Locknut (6 used)
6—Screw (8 used)
7—Support
8—Support

1. Remove adapters (1, 2, and 3).

2. Remove six screws (4), locknuts (5), eight screws (6), and supports (7 and 8).

3. Inspect, repair or replace parts as necessary.

4. Install supports (7 and 8), eight screws (6), six screws (4), and locknuts (5).

5. Install adapter (1, 2, and 3).

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Rock Drill

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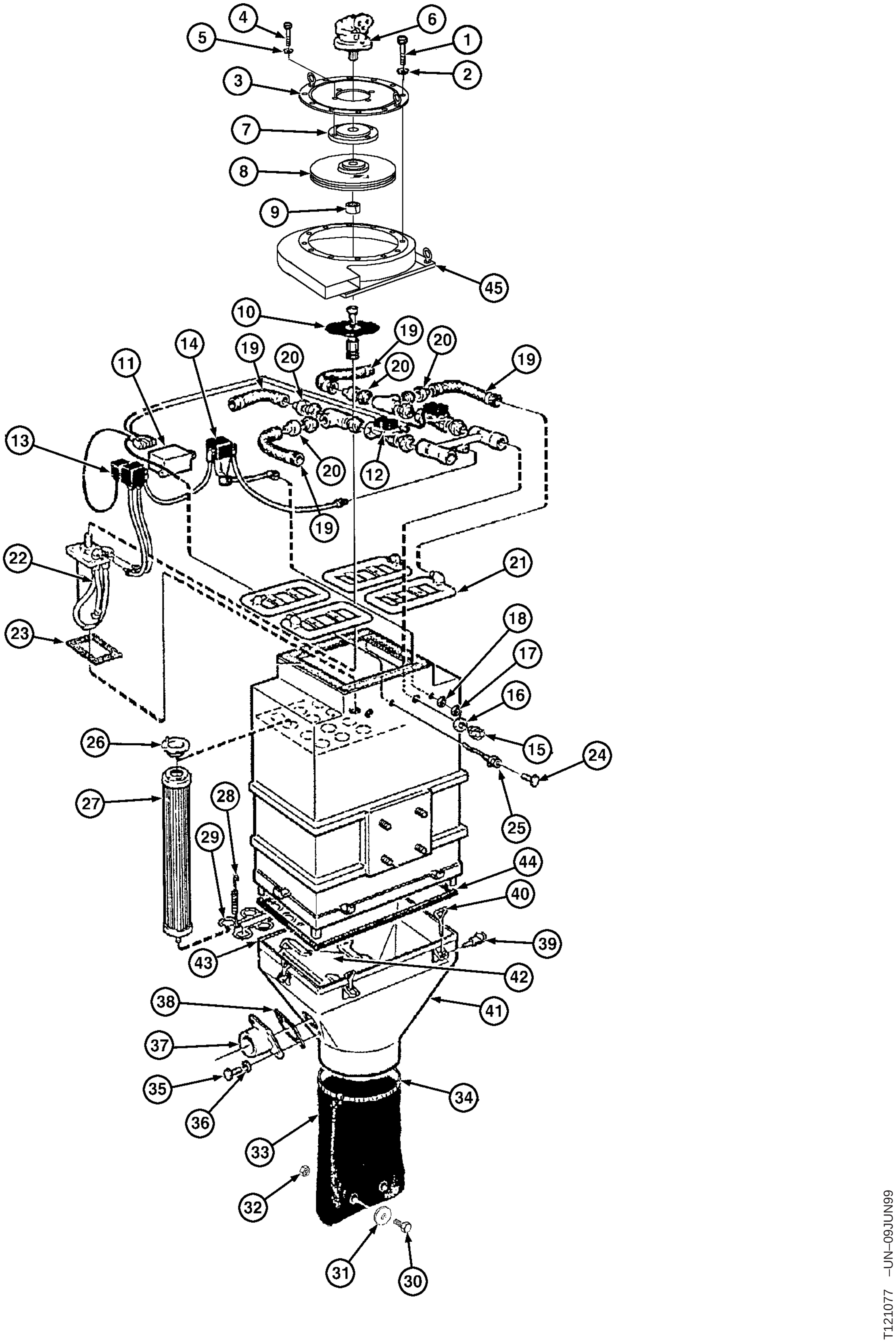
9506
174



T121077

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CED,OUOE019,19 –19–06APR99–3/5

44
9506
175

1—Screw (10 used)
2—Washer (10 used)
3—Fan Top
4—Screw (4 used)
5—Washer (4 used)
6—Hydraulic Motor
7—Flange
8—Wheel
9—Sleeve
10—Valve
11—Pressure Retarder
12—Electro-Distributor
13—Electro-Distributor
14—Draining Filter Hose
15—Half-Coupling (2 used)
16—Washer
17—Nut
18—Washer
19—Hose (4 used)
20—Fitting (4 used)
21—Cleaning Manifold
22—Pneumatic Cylinder
23—Spacer
24—Screw (2 used)
25—Connector
26—Filter Plug (24 used)
27—Filter Assembly (24 used)
28—Spring (2 used)
29—Filter Separating Grid
30—Screw (2 used)
31—Washer (4 used)
32—Locknut (2 used)
33—Rubber Sleeve
34—Collar Clamp
35—Screw (4 used)
36—Washer (4 used)
37—Suction Nozzle
38—Gasket
39—Pin (6 used)
40—Hook (6 used)
41—Hopper
42—Rock Blocker
43—Rubber Profile
44—Rubber Profile
45—Fan Housing

6. Remove ten screws (1), washers (2), and fan top (3).

7. Remove four screws (4), washers (5), hydraulic motor (6), flange (7), wheel (8), and sleeve (9).

8. Remove valve (10).

9. Remove pressure retarder (11).

10. Remove electro-distributors (12 and 13).

11. Remove nut (17), washer (18), and draining filter hose (14).

12. Remove two half-couplings (15) and washers (16).

13. Remove four hoses (19) and fittings (20).

14. Remove cleaning manifold (21).

15. Remove pneumatic cylinder (22) and spacer (23).

16. Remove two screws (24) and connector (25).

17. Remove twenty four filter plugs (26) and twenty four filter assemblies (27).

18. Remove two springs (28) and filter separating grid (29).

19. Remove two screws (30), four washers (31), two locknuts (32), rubber sleeve (33), and collar clamp (34).

20. Remove four screws (35), washers (36), suction nozzle (37), and gasket (38).

21. Unhook two safety chains and remove six pins (39), hooks (40), and hopper (41).

22. Remove rock blocker (42).

23. Remove rubber profiles (43 and 44).

24. Remove fan housing (45).

25. Inspect, repair or replace parts as necessary.

26. Install fan housing (45).

27. Install rubber profiles (43 and 44).

28. Install rock blocker (42).

29. Install hopper (41), six hooks (40), and six pins (39).

30. Hook up two safety chains.

31. Install gasket (38), suction nozzle (37), four screws (35), and washers (36).

32. Install collar clamp (34), rubber sleeve (33), two screws (30), four washers (31), and two locknuts (32).

33. Install filter separating grid (29) and two springs (28).

Continued on next page

CED,OUOE019,19 –19–06APR99–4/5

Rock Drill

34. Install twenty four filter assemblies (27) and twenty four filter plugs (26).

35. Install connector (25) and two screws (24).

36. Install spacer (23) and pneumatic cylinder (22).

37. Install cleaning manifold (21).

38. Install four fittings (20) and hoses (19).

39. Install two half-couplings (15) and washers (16).

40. Install draining filter hose (14), nut (17), and washer (18).

41. Install electro-distributors (12 and 13).

42. Install pressure retarder (11).

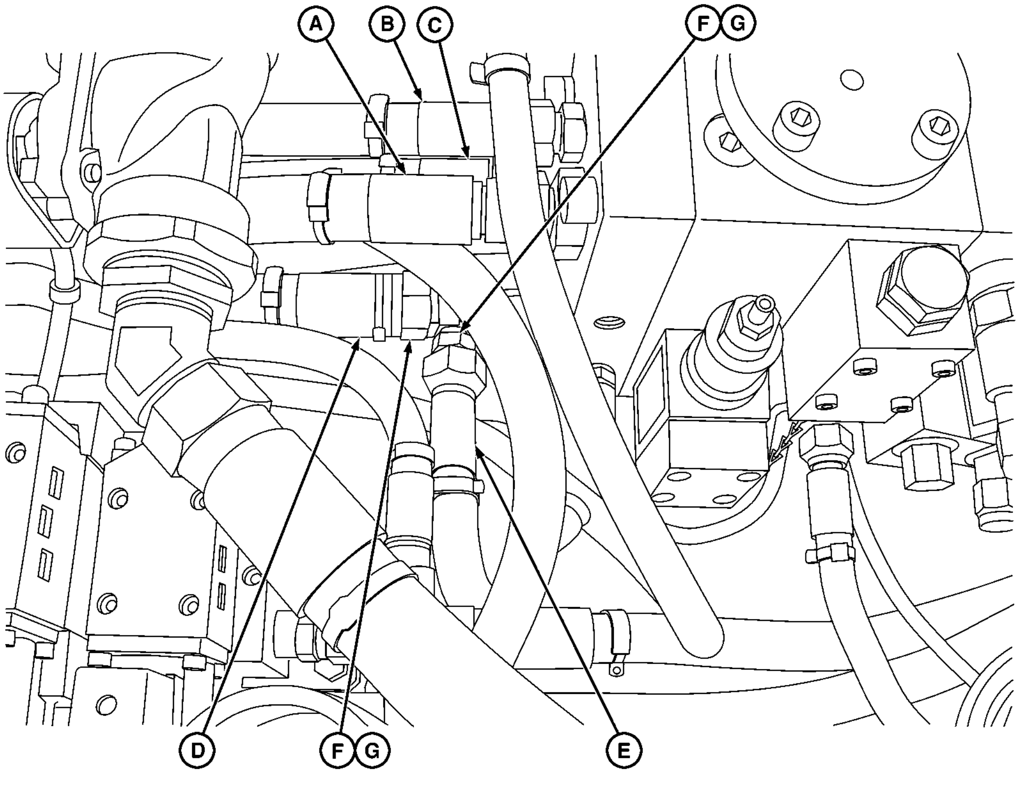
43. Install valve (10).

44. Install hydraulic motor (6), sleeve (9), wheel (8), flange (7), four screws (4), and washers (5).

45. Install fan top (3), ten screws (1), and washers (2).

CED,OUOE019,19 –19–06APR99–5/5

DISASSEMBLE AND ASSEMBLE HYDRAULIC DRIFTER CONTROL



A—Hydraulic Hose
B—Hydraulic Hose
C—Hydraulic Hose
D—Hydraulic Hose
E—Hydraulic Hose
F—Screw (4 used)
G—Brace

1. Tag and disconnect hydraulic hoses (A through E).

2. Remove four screws (F) and brace (G).

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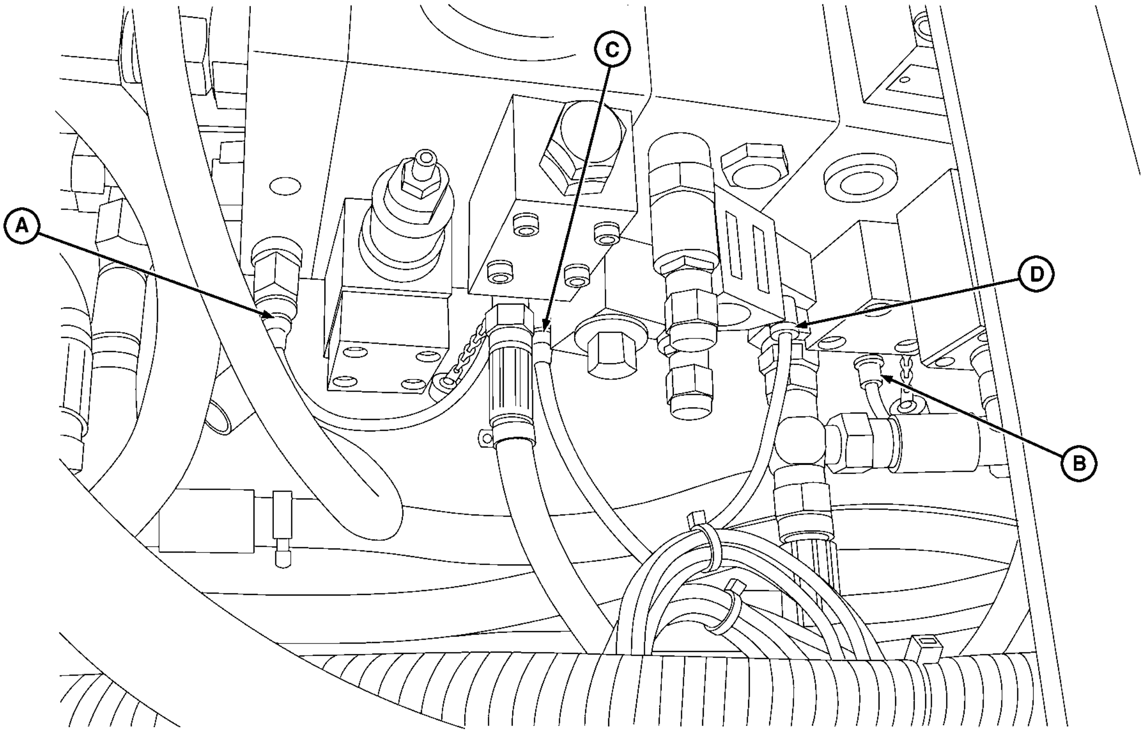
Rock Drill

44
9506
178



T121459

A—Hydraulic Hose
B—Hydraulic Hose
C—Connector
D—Connector

3. Tag and disconnect hydraulic hoses (A and B).

4. Disconnect connectors (C and D).

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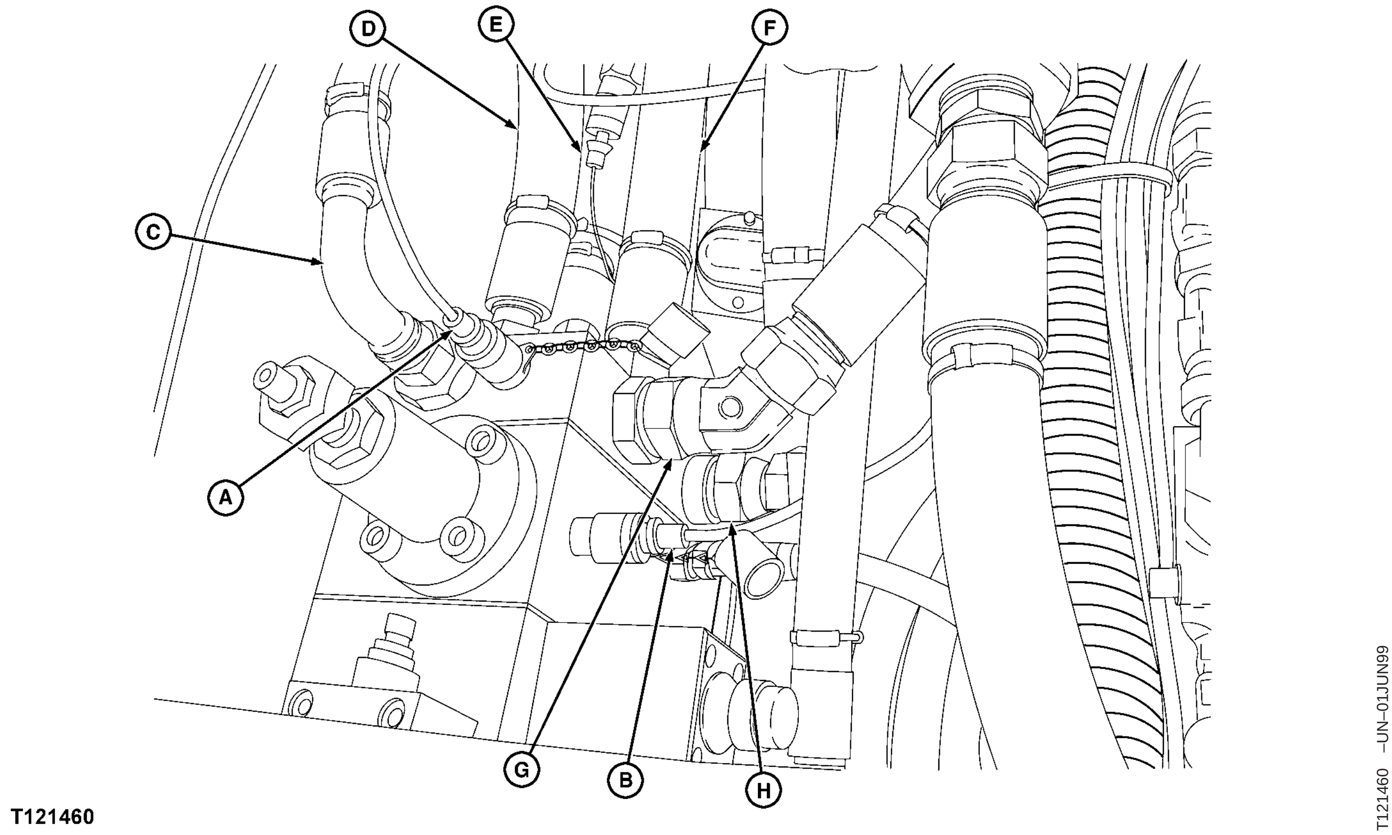
CED,OUOE019,20 –19–07APR99–2/20



A—Hydraulic Hose
B—Hydraulic Hose
C—Hydraulic Hose
D—Hydraulic Hose
E—Hydraulic Hose
F—Hydraulic Hose
G—Hydraulic Hose
H—Hydraulic Hose

5. Tag and disconnect hydraulic hoses (A through H).

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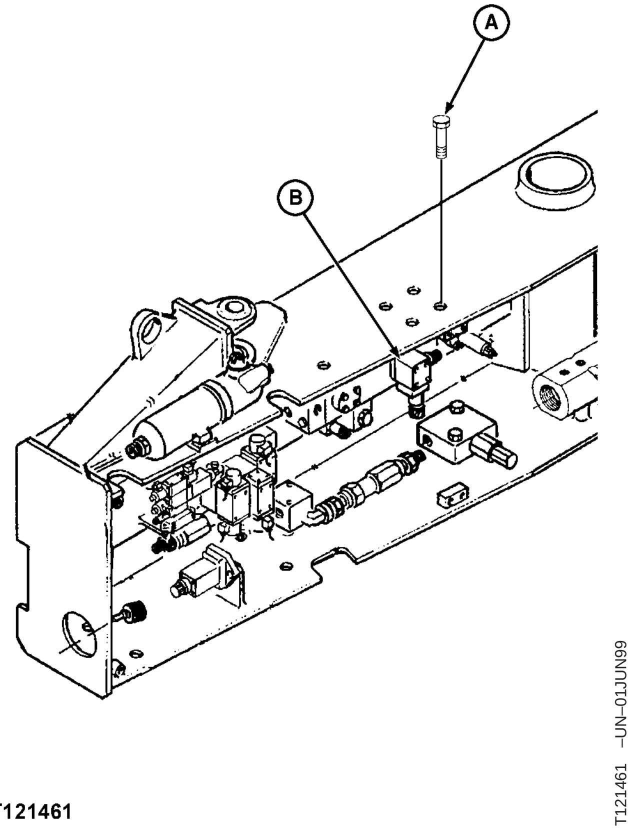
6. Remove four screws (A) and hydraulic drifter control (B).



T121461

A—Screw (4 used)
B—Hydraulic Drifter Control

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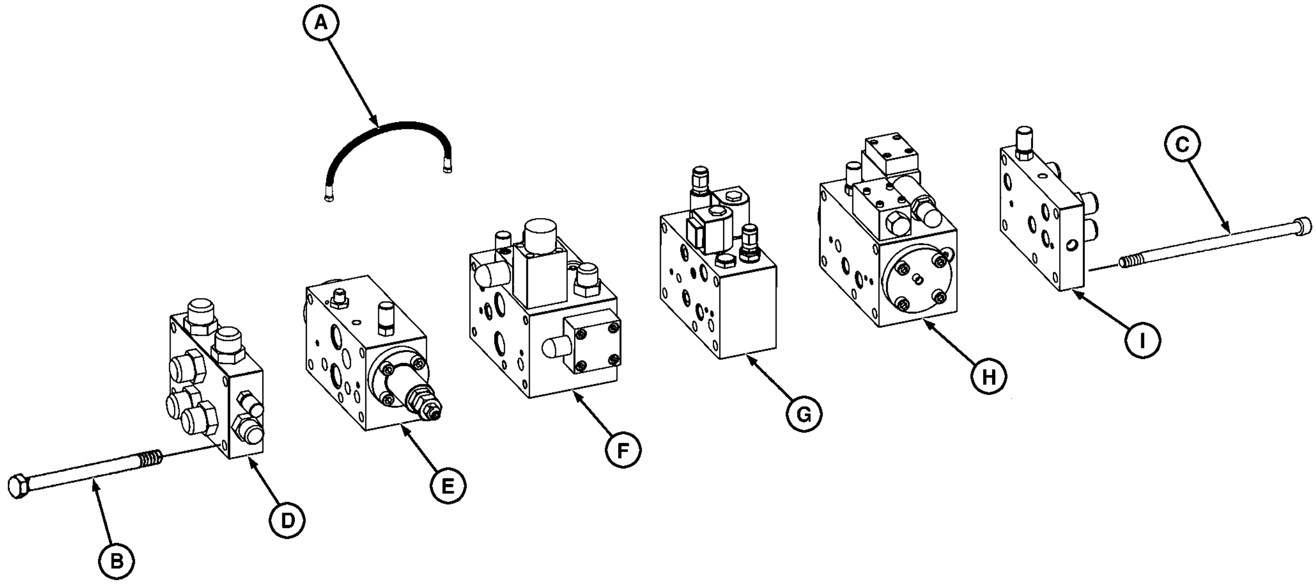

T121098

T121098 –UN–28OCT99

A—Hose
B—Screw (5 used)
C—Screw (5 used)
D—Percussion Inlet Plate
E—Percussion Power Regulator
F—Central Part
G—Synchronizer
H—Feed Flow Regulator
I—Feed Inlet Plate

1. Remove hose (A).
2. Remove five screws (B) and five screws (C).
3. Separate percussion inlet plate (D).
4. Separate percussion power regulator (E).
5. Separate central part (F).
6. Separate sychronizer (G).
7. Separate feed flow regulator (H).
8. Remove feed inlet plate (I).

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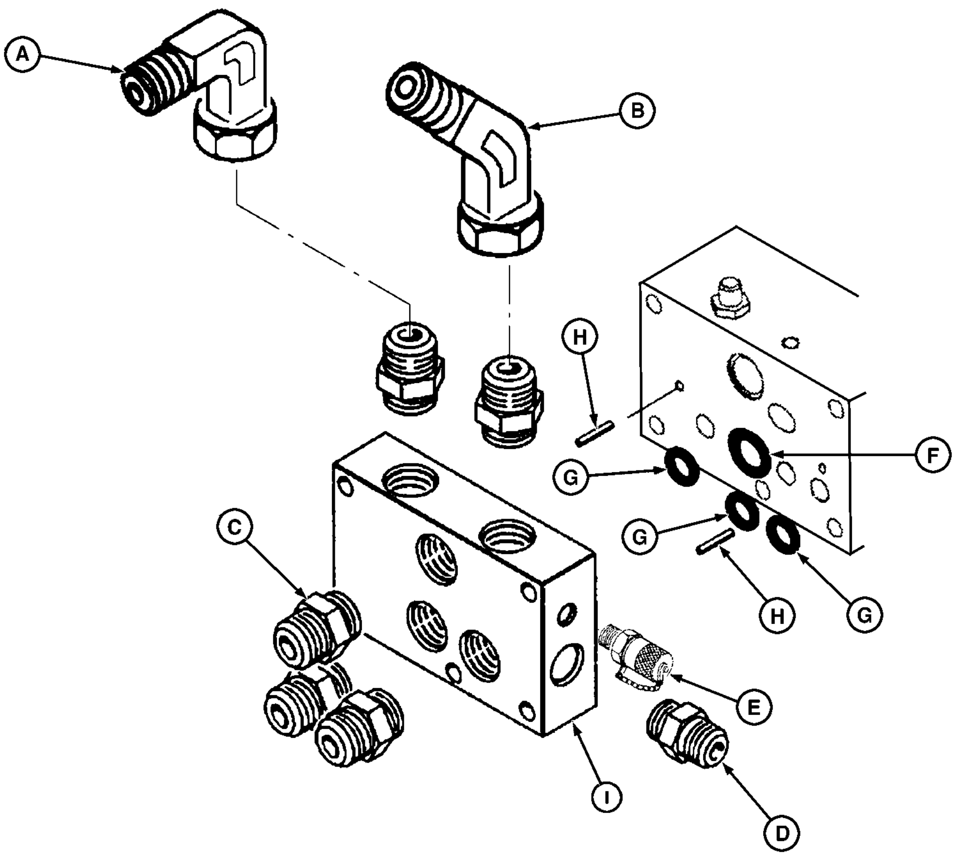
44
9506
182



T121099

T121099 –UN–28OCT99

A—Adapter
B—Adapter
C—Adapter (5 used)
D—Adapter
E—Pressure Socket
F—O-Ring
G—O-Ring (3 used)
H—Elastic Pin (2 used)
I—Plate

9. Remove adapters (A, B, C, and D).

10. Remove pressure socket (E).

11. Remove and discard O-rings (F and G).

12. Remove two elastic pins (H).

13. Inspect, repair or replace parts as necessary.

14. Install two elastic pins (H).

15. Install new O-rings (F and G).

16. Install pressure socket (E).

17. Install adapters (A, B, C, and D).

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CED,OUOE019,20 –19–07APR99–6/20

Rock Drill

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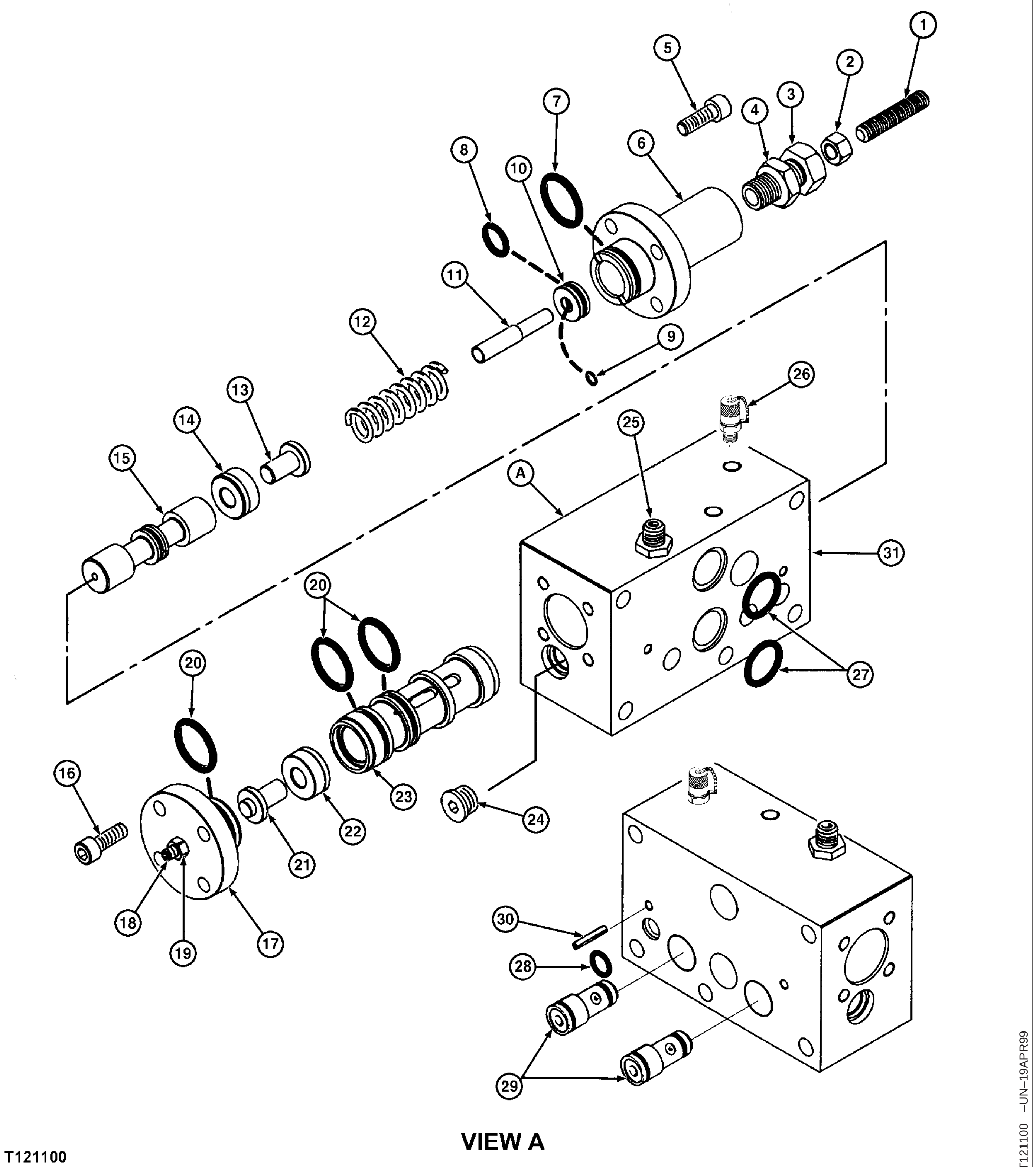
9506
184



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Rock Drill

1—Screw	**9—O-Ring**	**17—Cover**	**25—Adapter**
2—Nut	**10—Guide**	**18—Screw**	**26—Pressure Socket**
3—Screw	**11—Stop**	**19—Nut**	**27—O-Ring (2 used)**
4—Nut	**12—Spring**	**20—O-Ring (3 used)**	**28—O-Ring**
5—Screw (4 used)	**13—Tappet**	**21—Tappet**	**29—Valve (2 used)**
6—Cover	**14—Guide**	**22—Guide**	**30—Elastic Pin**
7—O-Ring	**15—Slide**	**23—Liner**	**31—Housing**
8—O-Ring	**16—Screw (4 used)**	**24—Threaded Plug**	

18. Remove screw (1), nut (2), screw (3), and nut (4).

19. Remove four screws (5) and cover (6).

20. Remove and discard O-ring (7).

21. Remove guide (10) and O-rings (8 and 9). Discard the O-rings.

22. Remove stop (11), spring (12), tappet (13), guide (14), and slide (15).

23. Remove four screws (16) and cover (17).

24. Remove screw (18), nut (19), and O-ring (20). Discard the O-ring.

25. Remove tappet (21), guide (22), liner (23), and two O-rings (20). Discard the O-rings.

26. Remove threaded plug (24).

27. Remove adapter (25).

28. Remove pressure socket (26).

29. Remove and discard two O-rings (27) and O-ring (28).

30. Remove two valves (29).

31. Remove elastic pin (30).

32. Inspect, repair or replace parts as necessary.

33. Install elastic pin (30).

34. Install two valves (29).

35. Install new O-ring (28) and two new O-rings (27).

36. Install pressure socket (26).

37. Install adapter (25).

38. Install threaded plug (24).

39. Install two new O-rings (20), liner (23), guide (22), and tappet (21).

40. Install new O-ring (20), screw (18), and nut (19).

41. Install cover (17) and four screws (16).

42. Install slide (15), guide (14), tappet (13), spring (12), and stop (11).

43. Install new O-rings (8 and 9) and guide (10).

44. Install new O-ring (7).

45. Install cover (6) and four screws (5).

46. Install nut (4), screw (3), nut (2), and screw (1).

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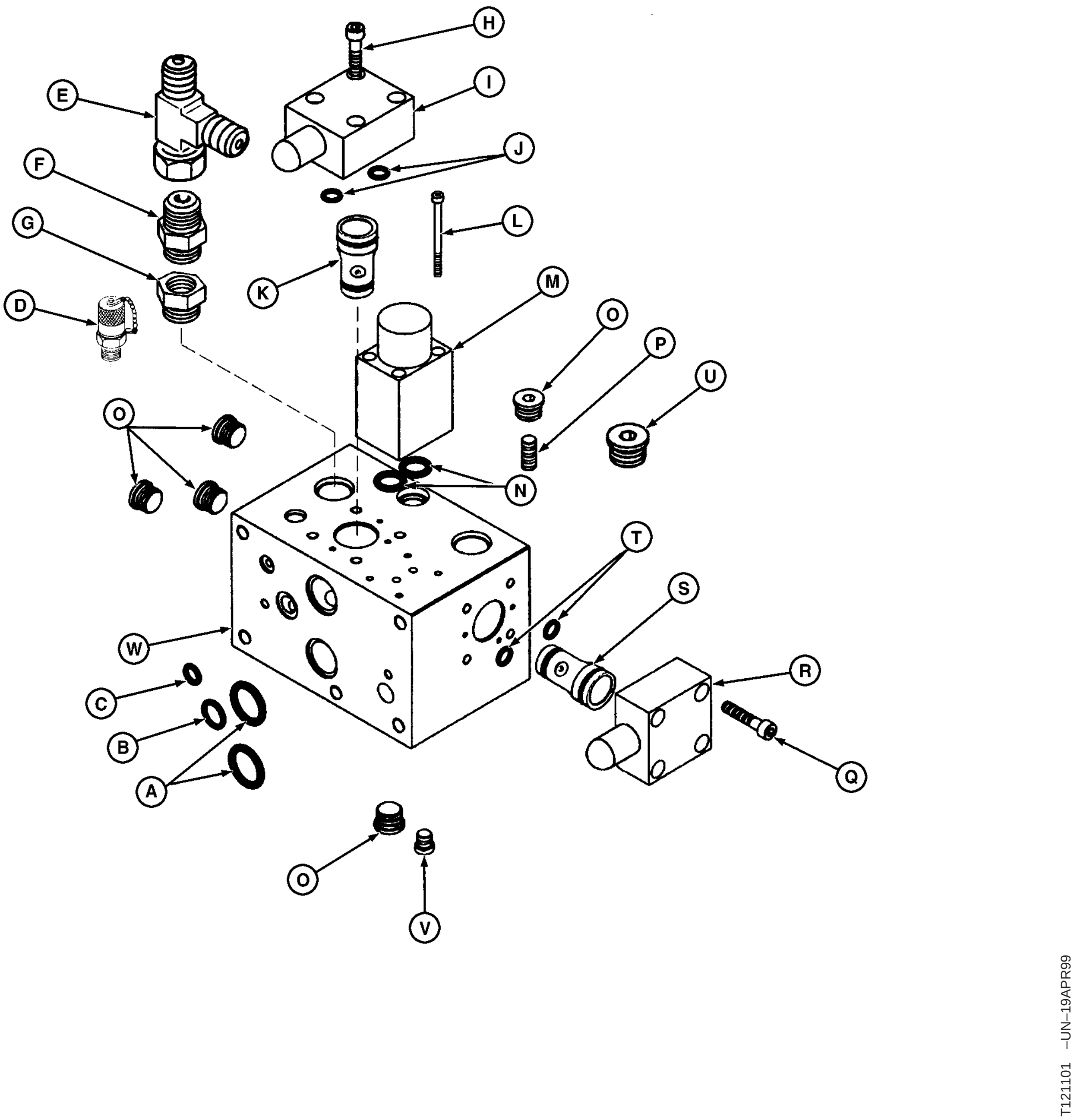
CED,OUOE019,20 –19–07APR99–8/20

Rock Drill

44
9506
186



T121101

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CED,OUOE019,20 –19–07APR99–9/20

A—O-Ring (2 used)
B—O-Ring (3 used)
C—O-Ring (3 used)
D—Pressure Socket
E—Tee
F—Adapter
G—Adapter
H—Screw (4 used)
I—Pressure Limiter
J—O-Ring (2 used)
K—Pressure Limiter
L—Screw (4 used)
M—Flow reguator
N—O-Ring (2 used)
O—Threaded Plug (5 used)
P—Screw
Q—Screw (4 used)
R—Pressure Limiter
S—Pressure Limiter
T—O-Ring (2 used)
U—Threaded Plug
V—Threaded Plug
W—Plate

47. Remove and discard two O-rings (A), three O-rings (B), and three O-rings (C).

48. Remove pressure socket (D).

49. Remove tee (E) and adapters (F and G).

50. Remove four screws (H), pressure limiter (I), two O-rings (J), and pressure limiter (K). Discard the O-rings.

51. Remove four screws (L), flow regulator (M), and two O-rings (N). Discard the O-rings

52. Remove five threaded plugs (O).

53. Remove screw (P).

54. Remove four screws (Q), pressure limiters (R and S), and two O-rings (T). Discard the O-rings.

55. Remove threaded plugs (U and V).

56. Inspect, repair or replace parts as necessary.

57. Install threaded plugs (U and V).

58. Install two new O-rings (T), pressure limiters (R and S), and four screws (Q).

59. Install screw (P).

60. Install five threaded plugs (O).

61. Install two new O-rings (N), flow regulator (M), and four screws (L).

62. Install pressure limiter (K), two new O-rings (J), pressure limiter (I), and four screws (H).

63. Install adapters (F and G) and tee (E).

64. Install pressure socket (D).

65. Install three new O-rings (C), three new O-rings (B), and two new O-rings (A).

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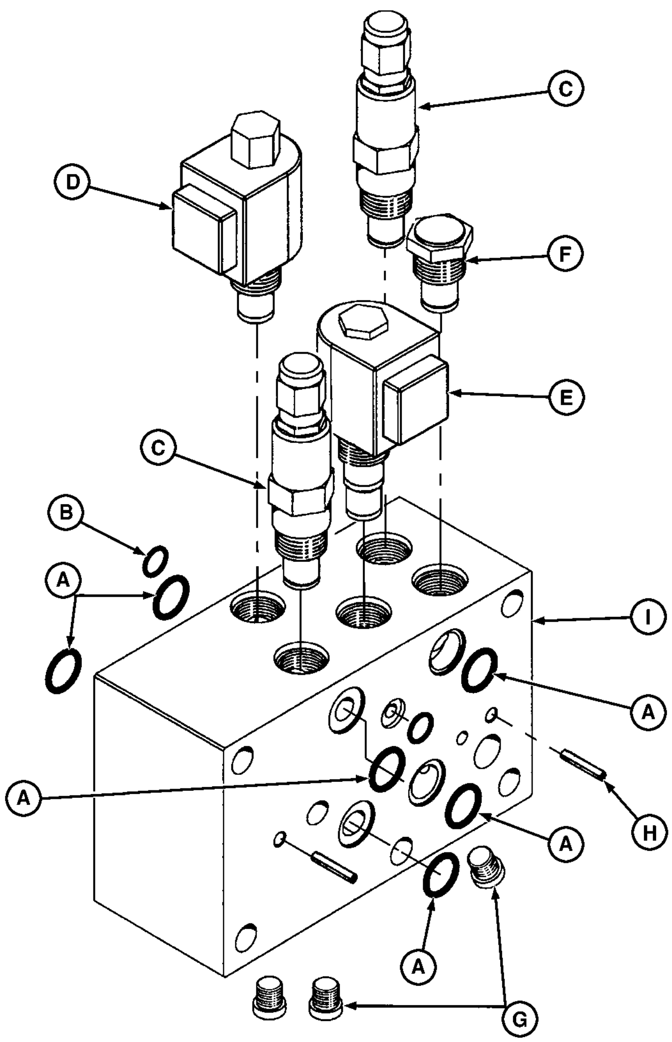
44
9506
188

Rock Drill



T121102

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CED,OUOE019,20 –19–07APR99–11/20

Rock Drill

44
9506
189

A—O-Ring (6 used)
B—O-Ring (2 used)
C—Flow Regulator (2 used)
D—Solenoid
E—Solenoid
F—Check Valve
G—Threaded Plug (3 used)
H—Elastic Pin (2 used)
I—Housing

66. Remove and discard six O-rings (A) and two O-rings (B).

67. Remove two flow regulators (C).

68. Remove solenoids (D and E).

69. Remove check valve (F).

70. Remove three threaded plugs (G).

71. Remove two elastic pins (H).

72. Inspect, repair or replace parts as nesessary.

73. Install two elastic pins (H).

74. Install three threaded plugs (G).

75. Install check valve (F).

76. Install solenoids (D and E).

77. Install two flow indicators (C).

78. Install two new O-rings (B) and six new O-rings (A).

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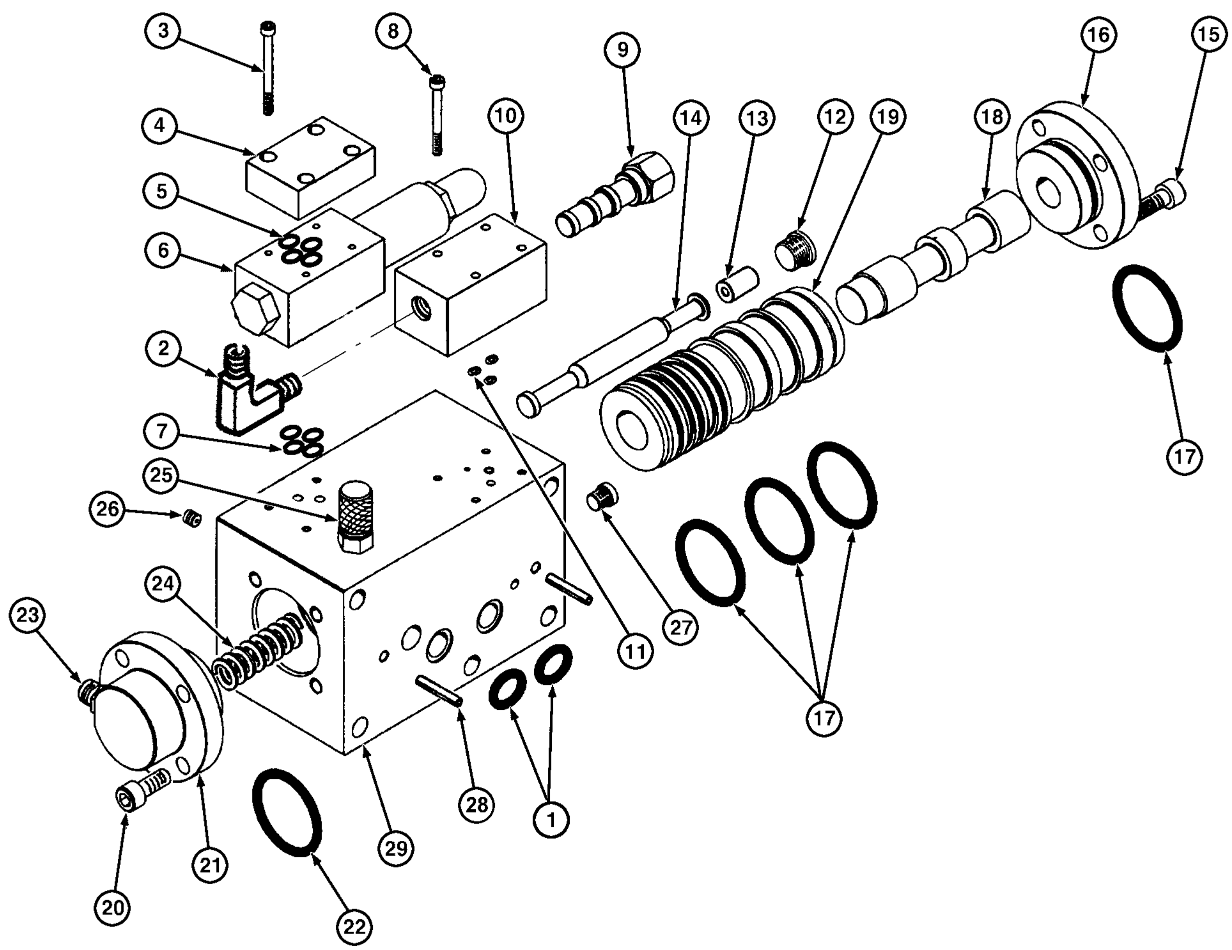
Rock Drill



T121103

T121103 –UN–28OCT99

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1—O-Ring (2 used)	**9—Hydraulic Distributor**	**17—O-Ring (4 used)**	**25—Pressure socket**
2—Adapter	**10—Distributor Body**	**18—Spool**	**26—Oil Restrictor**
3—Screw (4 used)	**11—O-ring (3 used)**	**19—Liner**	**27—Threaded Plug**
4—Locking Plate	**12—Threaded Plug**	**20—Screw (4 used)**	**28—Elastic Pin (2 used)**
5—O-Ring (4 used)	**13—Ring**	**21—Cover**	**29—Housing**
6—Pressure Reducer	**14—Oil Restrictor**	**22—O-ring**	
7—O-Ring (4 used)	**15—Screw (4 used)**	**23—Adapter**	
8—Screw (4 used)	**16—Cover**	**24—Spring**	

79. Remove and discard two O-rings (1).

80. Remove adapter (2).

81. Remove four screws (3), locking plate (4), four O-rings (5), pressure reducer (6), and four O-rings (7). Discard the O-rings.

82. Remove four screws (8), hydraulic distributor (9), distributor body (10), and three O-rings (11). Discard the O-rings.

83. Remove threaded plug (12), ring (13), and oil restrictor (14).

84. Remove four screws (15), cover (16), and O-ring (17). Discard the O-ring.

85. Remove spool (18), liner (19), and three O-rings (17). Discard the O-rings.

86. Remove four screws (20), cover (21), O-ring (22), adapter (23), and spring (24). Discard the O-ring.

87. Remove pressure socket (25).

88. Remove oil restrictor (26).

89. Remove threaded plug (27).

90. Remove two elastic pins (28).

91. Inspect, repair or replace parts as necessary.

92. Install two elastic pins (28).

93. Install threaded plug (27).

94. Install oil restrictor (26).

95. Install pressure socket (25).

96. Install spring (24), adapter (23), new O-ring (22), cover (21), and four screws (20).

97. Install three new O-rings (17), liner (19), and spool (18).

98. Install new O-ring (17), cover (16), and four screws (15).

99. Install oil restrictor (14), ring (13), and threaded plug (12).

100. Install three new oil rings (11), distributor body (10), hydraulic distributor (9), and four screws (8).

101. Install four new O-rings (7), pressure reducer (6), four new O-rings (5), locking plate (4), and four screws (3).

102. Install adapter (2).

103. Install two new O-rings (1).

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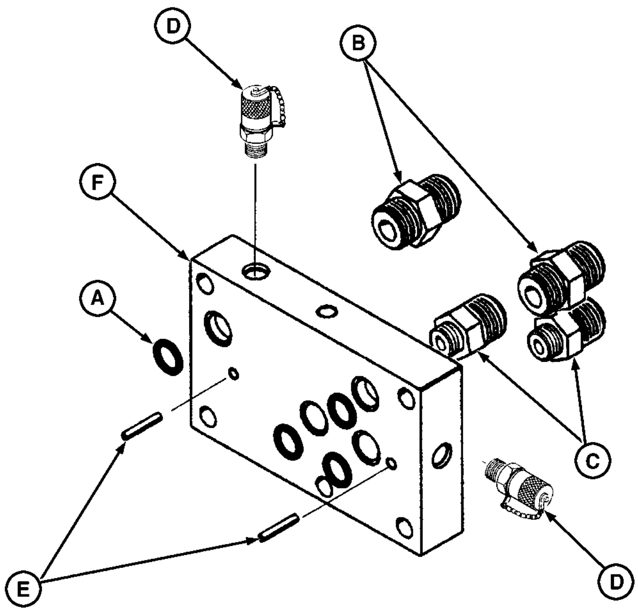
9506
192



T121104

A—O-Ring (4 used)
B—Nipple (2 used)
C—Nipple (2 used)
D—Pressure Socket (2 used)
E—Elastic Pin (2 used)
F—Plate

104. Remove and discard four O-rings (A).

105. Remove two nipples (B) and two nipples (C).

106. Remove two pressure sockets (D).

107. Remove two elastic pins (E).

108. Inspect, repair or replace parts as necessary.

109. Install two elastic pins (E).

110. Install two pressure sockets (D).

111. Install two nipples (B) and two nipples (C).

112. Install four new O-rings (A).

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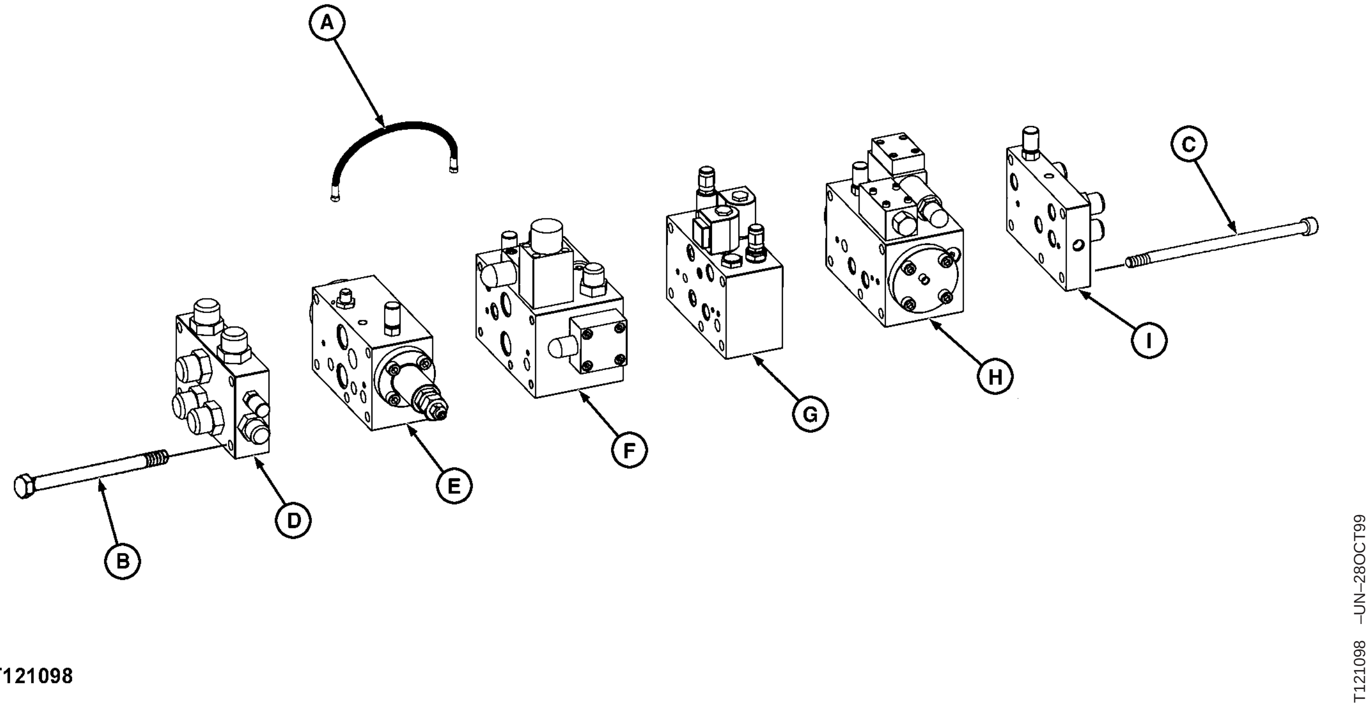

T121098

A—Hose
B—Screw (5 used)
C—Screw (5 used)
D—Percussion Inlet Plate
E—Percussion Power Regulator
F—Central Part
G—Synchronizer
H—Feed Flow Regulator
I—Feed Inlet Plate

113. Install feed inlet plate (I).

114. Install feed flow regulator (H).

115. Install synchronizer (G).

116. Install central part (F).

117. Install percussion power regulator (E).

118. Install percussion inlet plate (D).

119. Install five screws (C) and five screws (B).

120. Install hose (A).

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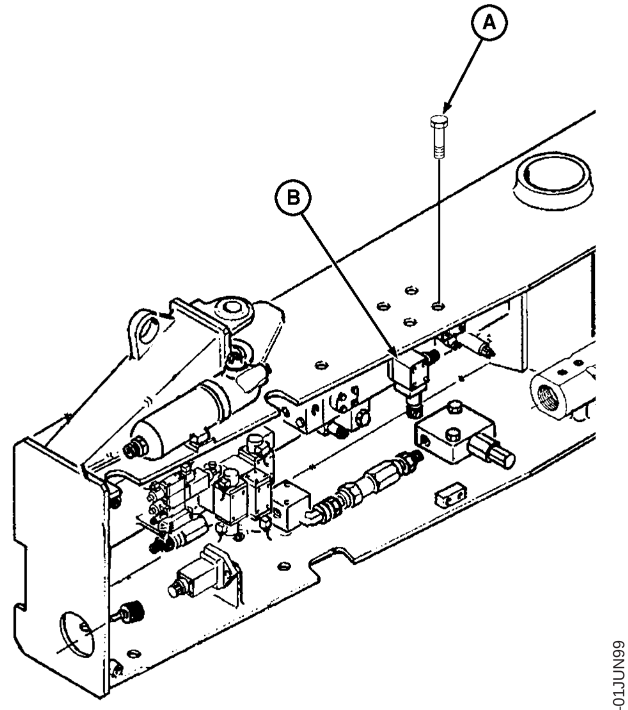
CED,OUOE019,20 –19–07APR99–16/20

44
9506
194

121. Install hydraulic drifter control (B) and four screws (C).



T121461

A—Screw (4 used)
B—Hydraulic Drifter Control

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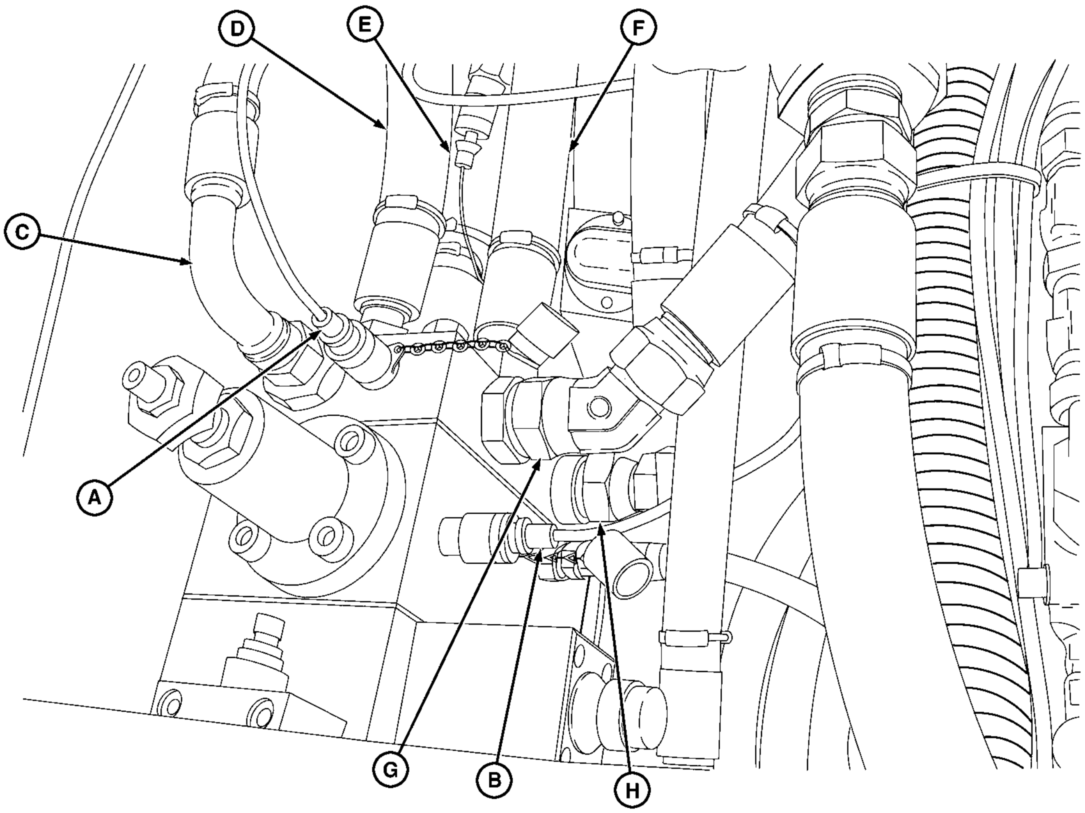

A—Hydraulic Hose
B—Hydraulic Hose
C—Hydraulic Hose
D—Hydraulic Hose
E—Hydraulic Hose
F—Hydraulic Hose
G—Hydraulic Hose
H—Hydraulic Hose

122. Remove tags and connect hydraulic hoses (A through H).

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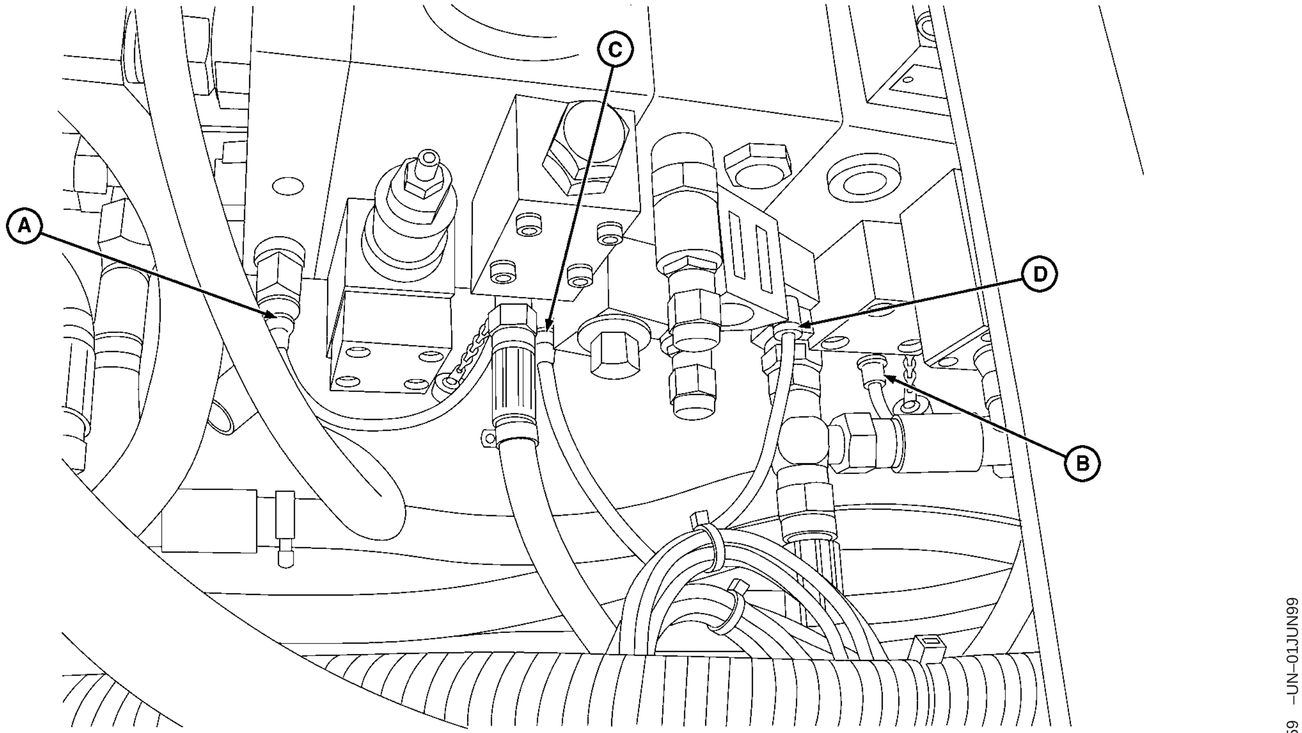
CED,OUOE019,20 –19–07APR99–18/20

Rock Drill



T121459

A—Hydraulic Hose B—Hydraulic Hose C—Connector D—Connector

123. Install connectors (C and D).

124. Remove tags and connect hydraulic hoses (A and B).

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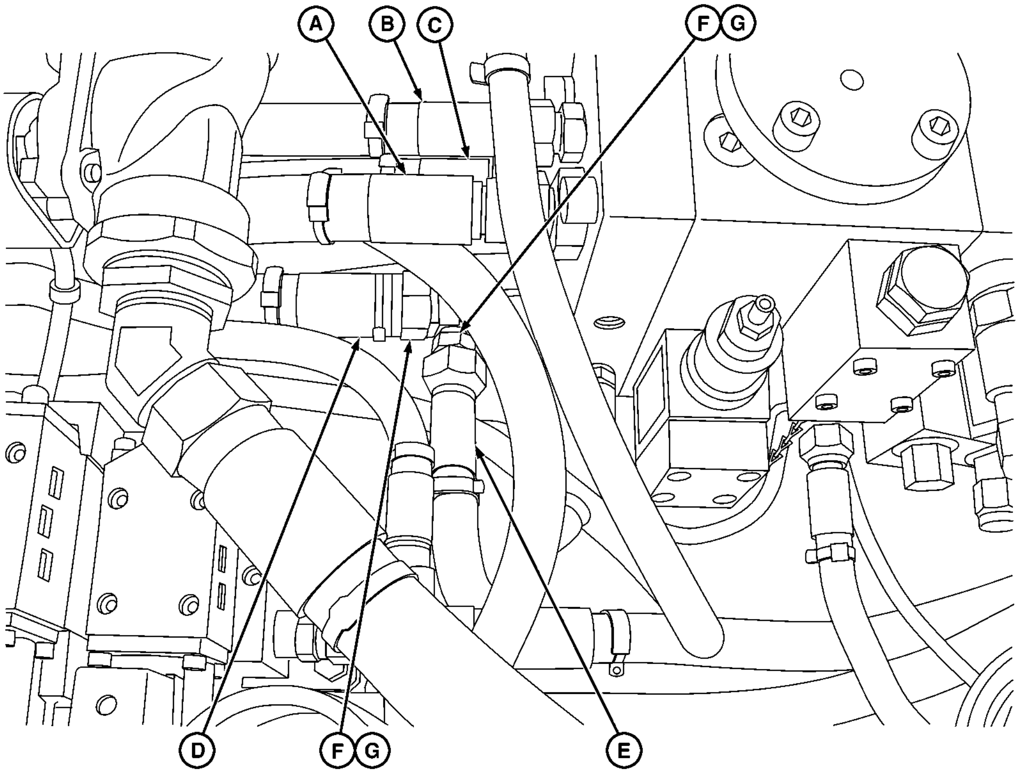
Rock Drill



T121458

T121458 –UN–08JUN99

A—Hydraulic Hose
B—Hydraulic Hose
C—Hydraulic Hose
D—Hydraulic Hose
E—Hydraulic Hose
F—Brace
G—Screw (4 used)

125. Install brace (F), and four screws (G).

126. Remove tags and connect hydraulic hoses (A through E).

CED,OUOE019,20 –19–07APR99–20/20

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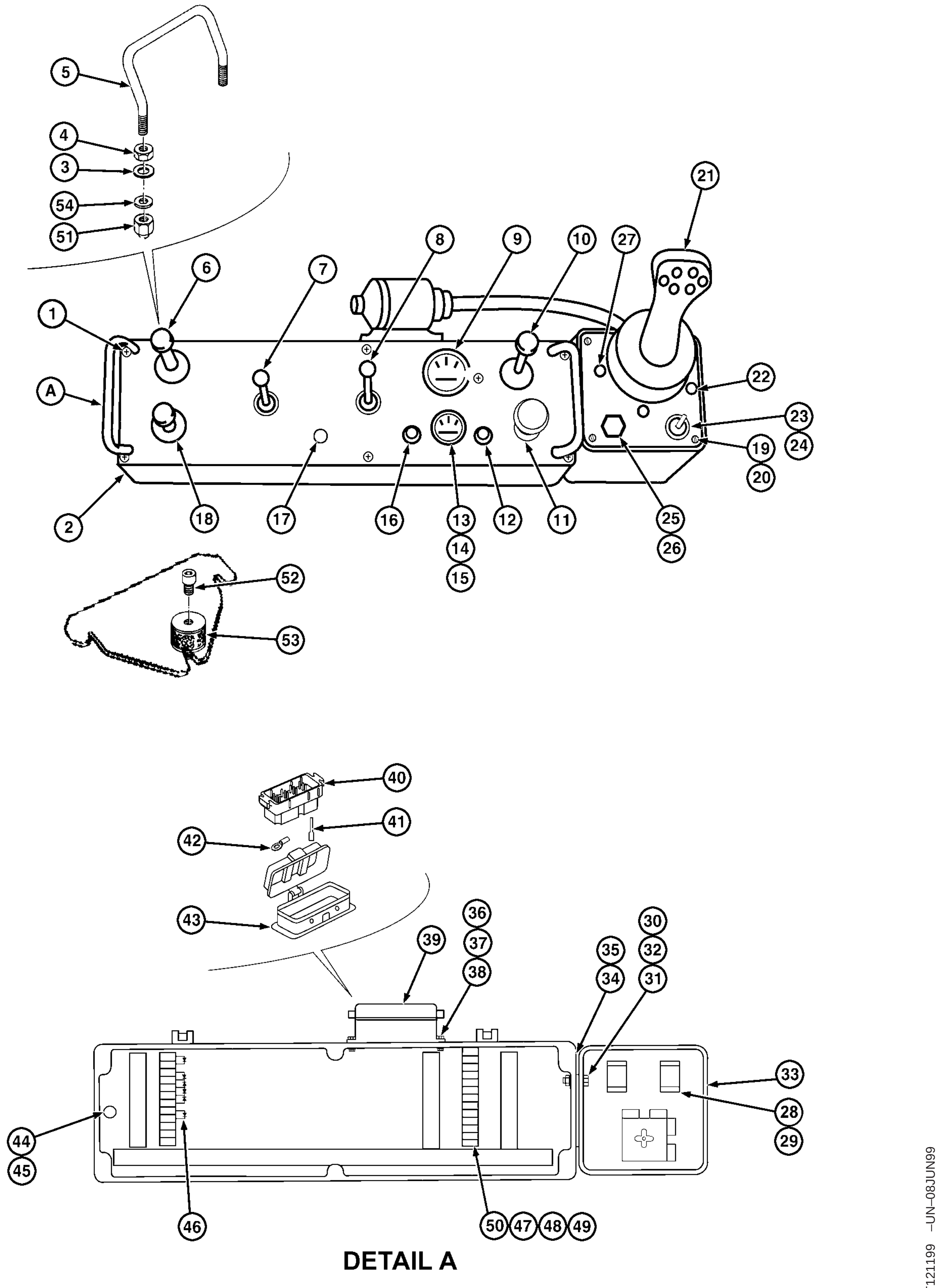
198

DISASSEMBLE AND ASSEMBLE REMOTE CONTROL ASSEMBLY



T121199

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1—Screw (6 used)
2—Control Panel
3—Ring (4 used)
4—Nut (4 used)
5—Handle (2 used)
6—Electric Manipulator
7—Electric Manipulator
8—Electric Manipulator
9—Hour Meter
10—Electric Manipulator
11—Push-Button Switch
12—Switch
13—Push-Button Switch
14—Push-Button Switch
15—Cap
16—Electric Manipulator
17—Plug
18—Electric Manipulator
19—Screw (4 used)
20—Nut (4 used)
21—Electric Manipulator
22—Screw (4 used)
23—Button-Head Switch
24—Body
25—Light
26—Lamp
27—Signal Plate
28—Block
29—Block
30—Screw (4 used)
31—Washer (10 used)
32—Nut (6 used)
33—Electric Box
34—Counter Plate
35—Screw (2 used)
36—Screw (4 used)
37—Washer (4 used)
38—Nut (4 used)
39—Jack Plug
40—Housing
41—Pin (40 used)
42—Thimble
43—Base
44—Screw (2 used)
45—Ring (2 used)
46—Diode (7 used)
47—Screw (4 used)
48—Washer (4 used)
49—Nut (4 used)
50—Strip (3 used)
51—Nut (4 used)
52—Screw (3 used)
53—Suspension (3 used)
54—BS Ring (4 used)

1. Remove six screws (1) and swing control panel (2) up to gain access to parts.

NOTE: Disassemble the remote control panel only to the extent necessary to inspect, or replace parts. To facilitate assembly tag all wires prior to removal, and cover all exposed wires with tape.

2. If required, remove switch (12), and electric manipulators (6, 7, 16, and 18) as indicated in the following steps:

   a. If applicable, remove rubber boot.

   b. Unscrew mounting ring on outside of panel and remove part.

3. If required, remove hour meter (9) by removing two mounting nuts on inside of panel.

4. If required, remove push-button switches (11, 13, and 14) as indicated in the following steps:

   a. If applicable, remove cap (15).

   b. Remove terminal block and two screws.

5. If required, remove light (25) as indicated in the following steps:

   a. Unscrew lens.

   b. Loosen two tension screws from inside of panel.

   c. Twist lens to unlock and separate lens from lamp body

   d. Remove lamp (26) by pushing in and rotating counterclockwise.

6. If required, remove button-head switch (23) as indicated in the following steps:

   a. Loosen two tension screws from inside of panel.

   b. Twist lens to unlock and separate lens from lamp body.

7. If required, remove electric manipulator (21) by removing four Allen head screws and pulling the electric manipulator out of panel.

8. Remove four nuts (51), BS rings (54), nuts (4), and two handles (5).

9. Remove three screws (52) and suspensions (53).

10. Inspect, repair or replace parts as necessary.

Continued on next page

Rock Drill

44
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200

NOTE: When installing electrical type items, do not remove the tape from the wire ends until the connection is made, and remove the tags from the wires after the connection is made.

11. Install three suspensions (53) and screws (52).

12. Install two handles (5), four nuts (51), BS rings (54), rings (3), and nuts (4).

13. If removed, install electric manipulator (21) in the panel and secure four Allen head screws.

14. If removed, install button-head switch (23) as indicated in the following steps:

    a. Assemble lens to lamp body.

    b. Install button-head switch (23) and secure with two tension screws inside of panel.

15. If removed, install light (25) as indicated in the following steps:

    a. Install lamp (26) by pushing in and rotating clockwise.

    b. Assemble lens to lamp body.

16. Install light (25), and secure with two tension screws inside of panel.

17. Secure lens.

18. If removed, install push-button switches (11, 13, and 14) as indicated in the following steps:

    a. Install terminal block and two screws.

    b. If applicable, install cap (15).

19. If removed, install hour meter (9) by installing two mounting nuts on inside of panel.

20. If removed, install switch (12), and electric manipulators (6, 7, 16, and 18) as indicated in the following steps:

    a. Install part and secure with mounting ring on outside of panel.

    b. If applicable, install rubber boot.

21. Lower control panel (2) and install six screws (1).

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CED,OUOE019,21 –19–09APR99–3/5

Rock Drill

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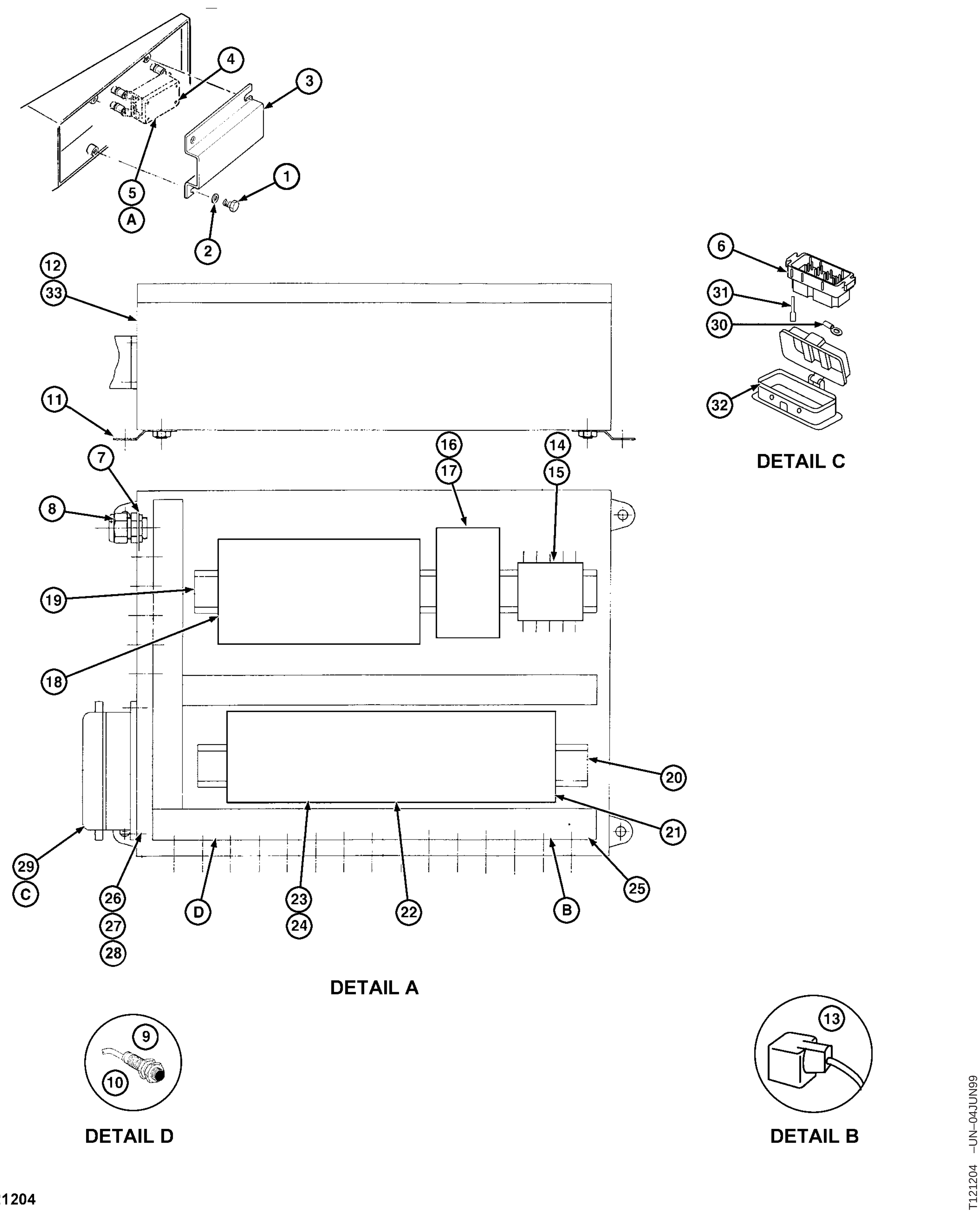
202



T121204

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Rock Drill

1—Screw (4 used)	**10—Switch (2 used)**	**19—Profile**	**28—Nut (4 used)**
2—Washer (4 used)	**11—Fixation Assembly**	**20—Profile**	**29—Jack Plug**
3—Protecting Plate	**12—Fixing Plate**	**21—Locking Plate**	**30—Thimble**
4—Screw (4 used)	**13—Connector (21 used)**	**22—Diode**	**31—Pin (40 used)**
5—Panel	**14—Fuse (5 used)**	**23—Terminal (60 used)**	**32—Base**
6—Housing	**15—Fuse Support**	**24—Shunt (9 used)**	**33—Box**
7—Plug (40 used)	**16—Relay (9 used)**	**25—Protective Cover**	
8—Packer (34 used)	**17—Shunt (8 used)**	**26—Screw (4 used)**	
9—Switch	**18—PLC**	**27—Washer (4 used)**	

22. *NOTE: Disassemble the PLC box only to the extent nesessary to inspect, or replace parts. To facilitate assembly tag all wires prior to removal, and cover all exposed wires with tape.*

23. Remove four screws (1), washers (2), and protecting plate (3).

24. Remove four screws (4).

25. Tilt panel (5) out of box (33).

26. Slide profiles (19 and 20) as necessary to gain access to parts to be removed.

27. Inspect, repair or replace parts as necessary.

NOTE: When installing electrical type items, do not remove the tape from the wire ends until the connection is made, and remove the tags from the wires after the connection is made.

28. Slide profiles (19 and 20) as necessary to gain access to parts to be installed.

29. Secure panel (5) and install four screws (4).

30. Install protecting plate (3), four screws (1), and washers (2).

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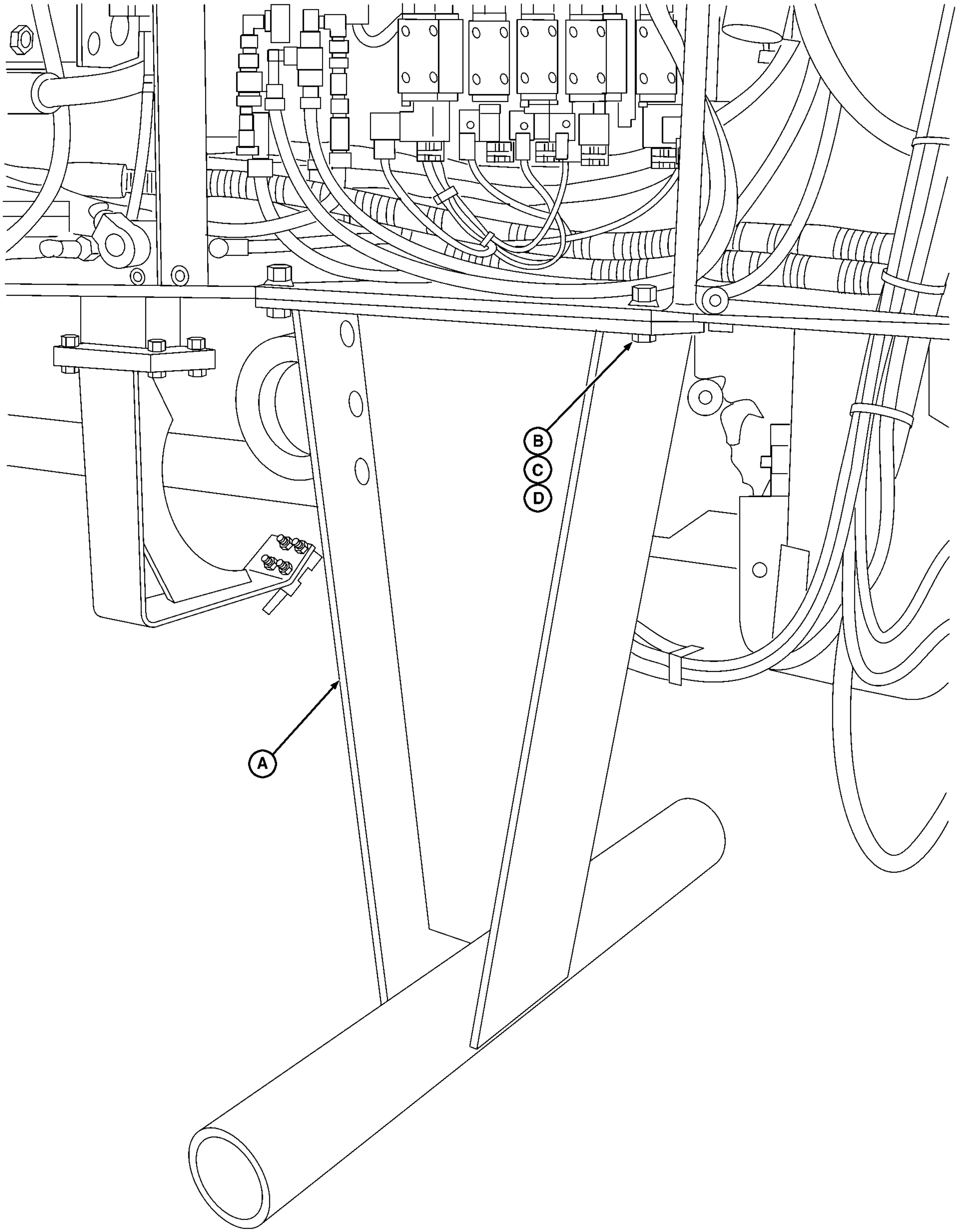
ASSEMBLE ROCK DRILL



T121457

T121457 –UN–09JUN99

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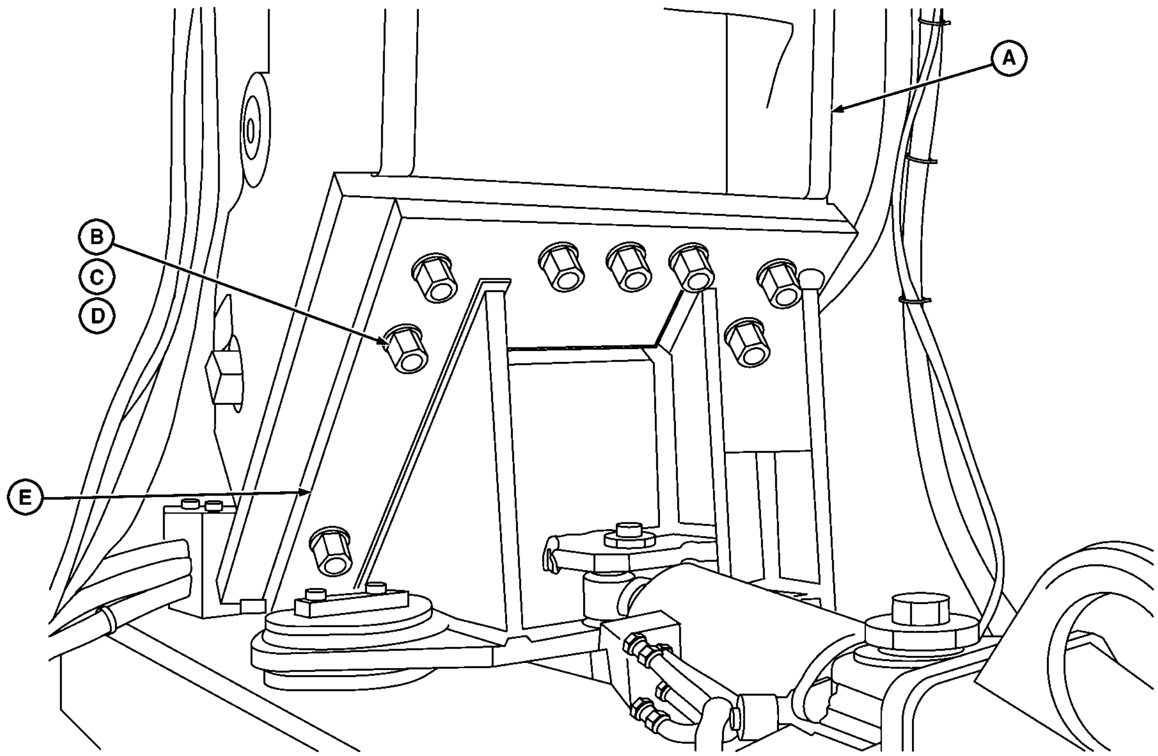
Rock Drill

A—Cradle and Articulator
B—Bolt (8 used)
C—Washer (8 used)
D—Nut (8 used)
E—Support (2 used)

1. Support cradle and articulator assembly (A).

2. Install two support legs (E), eight bolts (B), washers (C), and nuts (D).

CED,OUOE019,15 –19–01APR99–2/21



T121456

T121456 –UN–02JUN99

A—Hitch Adapter
B—Screw (14 used)
C—Washer (28 used)
D—Nut (14 used)
E—Cradle and Articulator Assembly

3. Install hitch adapter (A) on cradle and articulator assembly (E).

4. Install 14 screws (B), 28 washers (C), and 14 nuts (D).

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CED,OUOE019,15 –19–01APR99–3/21

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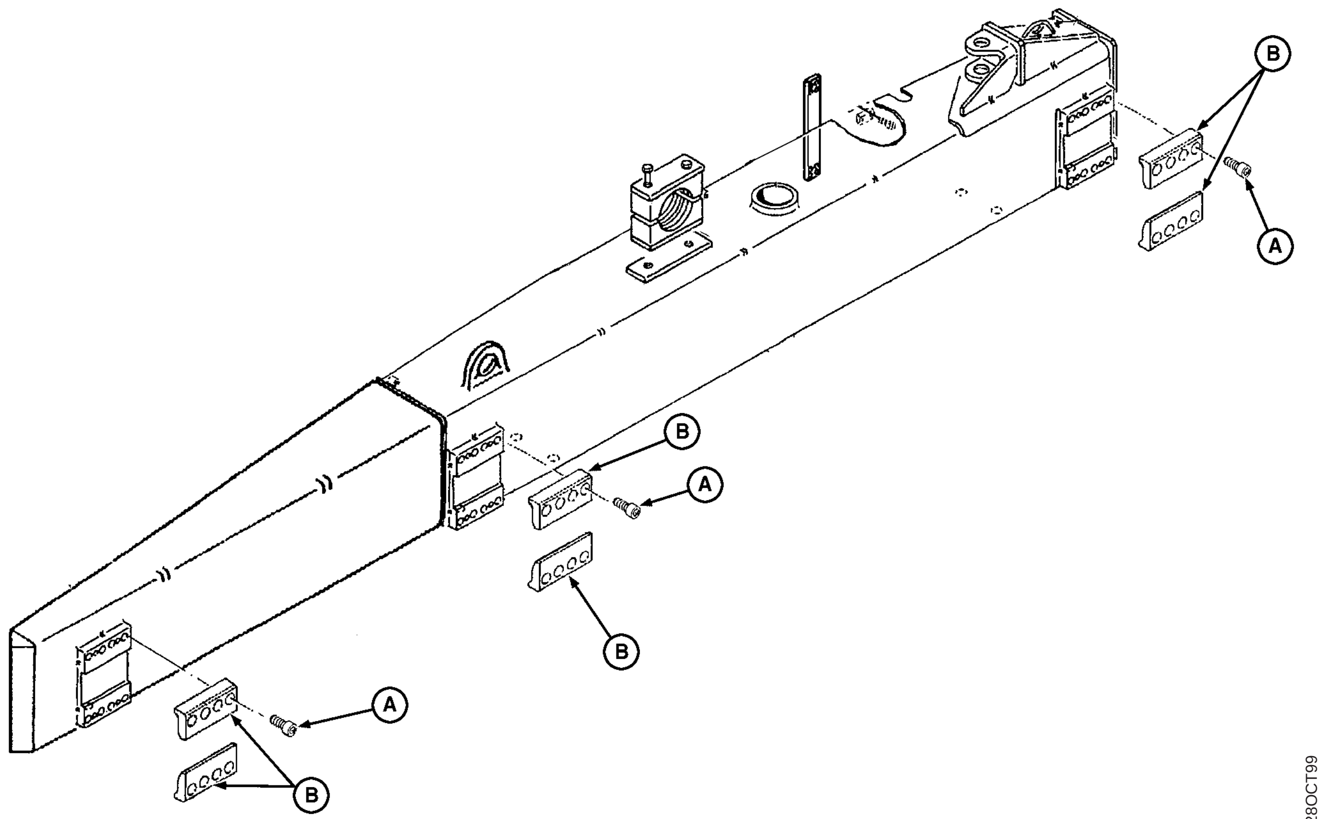
206



T121473

A—Screw (24 used) **B—Clamp (6 used)**

5. Install six clamps (B) and 24 screws (A).

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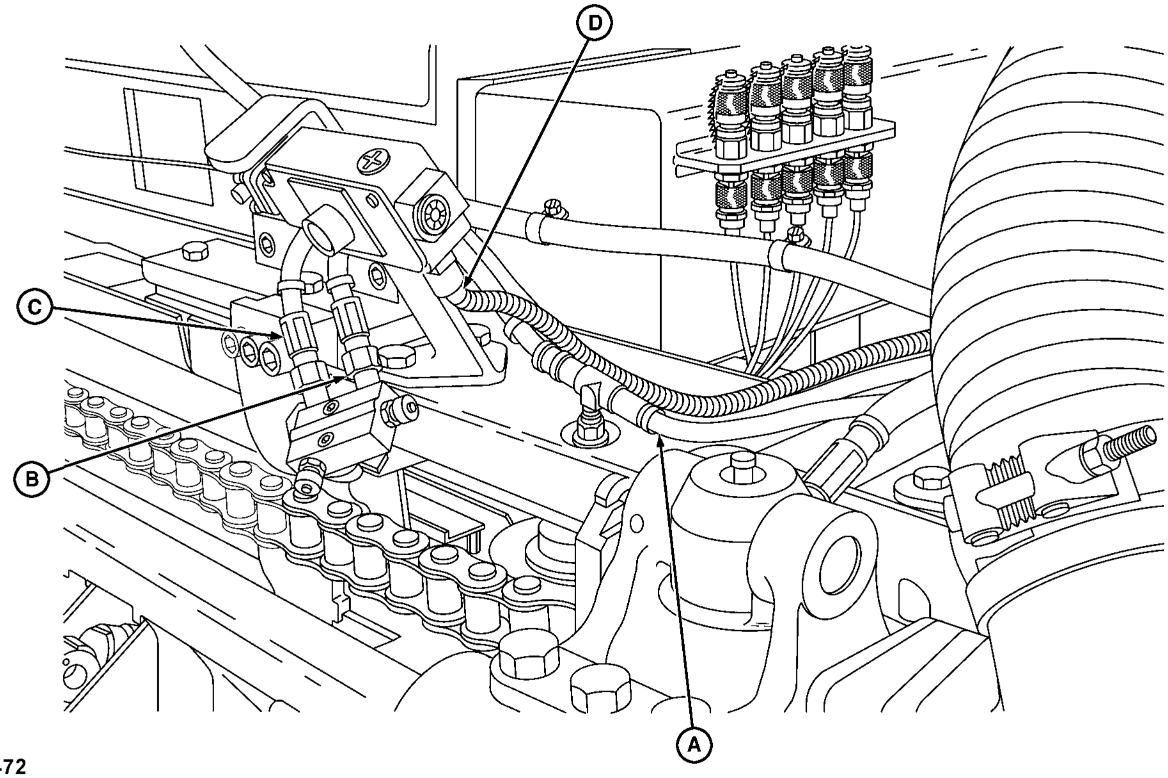

A—Hydraulic Hose
B—Hydraulic Hose
C—Hydraulic Hose
D—Emergency Stop Switch Harness

6. Install emergency stop switch harness (D).

7. Install hydraulic hoses (A through C).

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44
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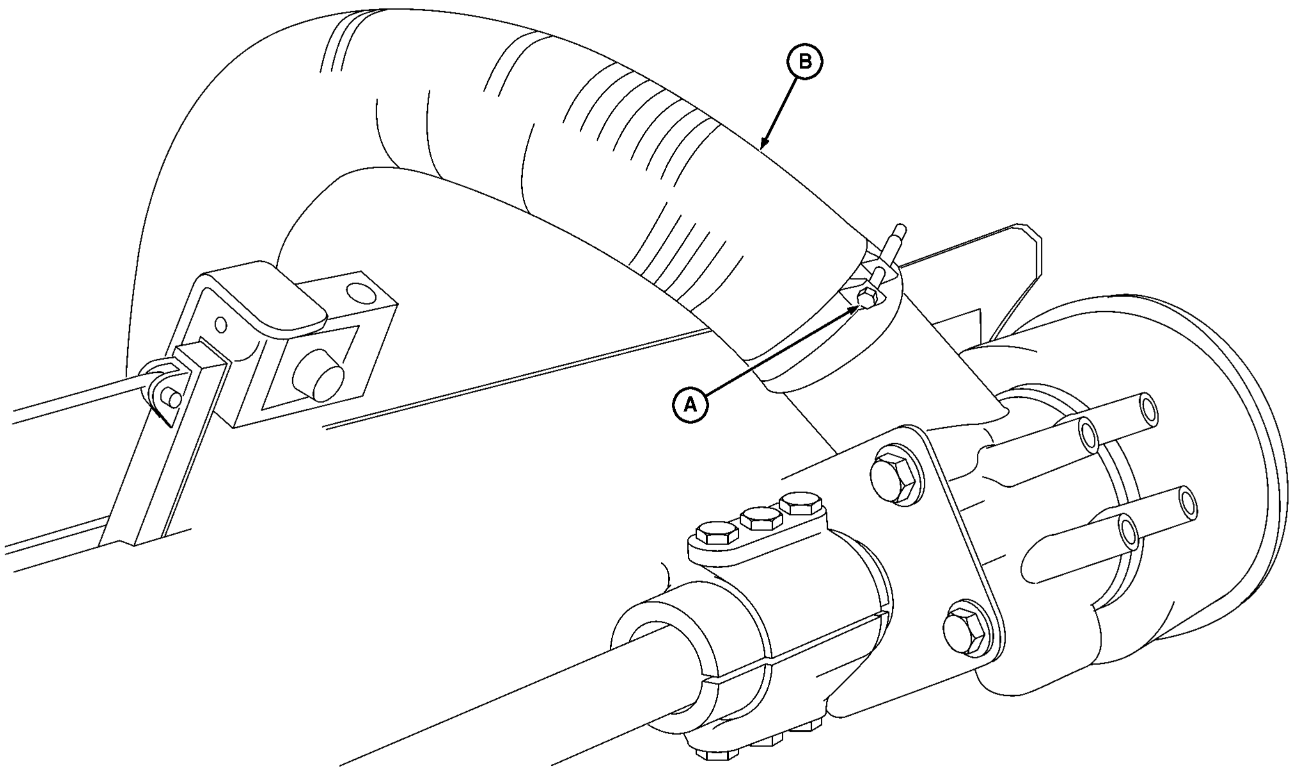
208



T121471

A—Clamp **B—Vacuum**

8. Install vacuum hose (B), and clamp (A).

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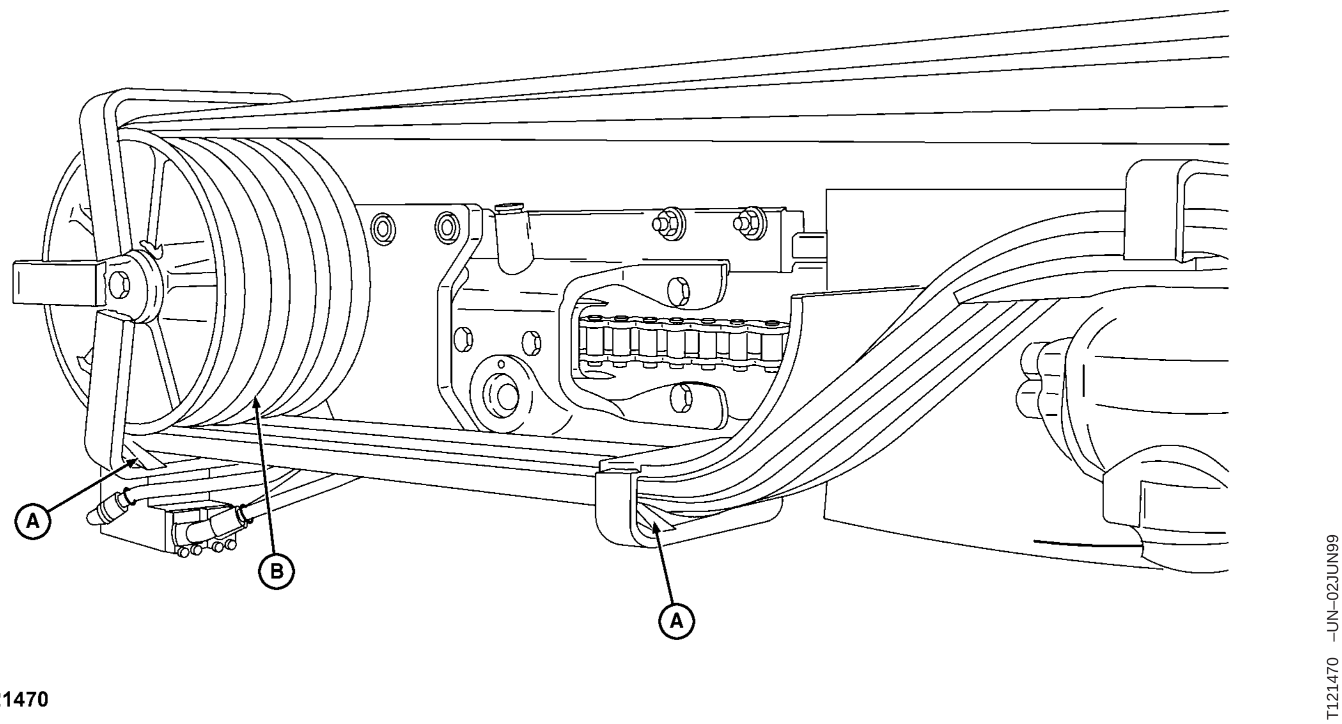

A—Guide (2 used) **B—Hydraulic Hose**

9. Install hydraulic hose (B).

10. Install two guides (A).

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Rock Drill

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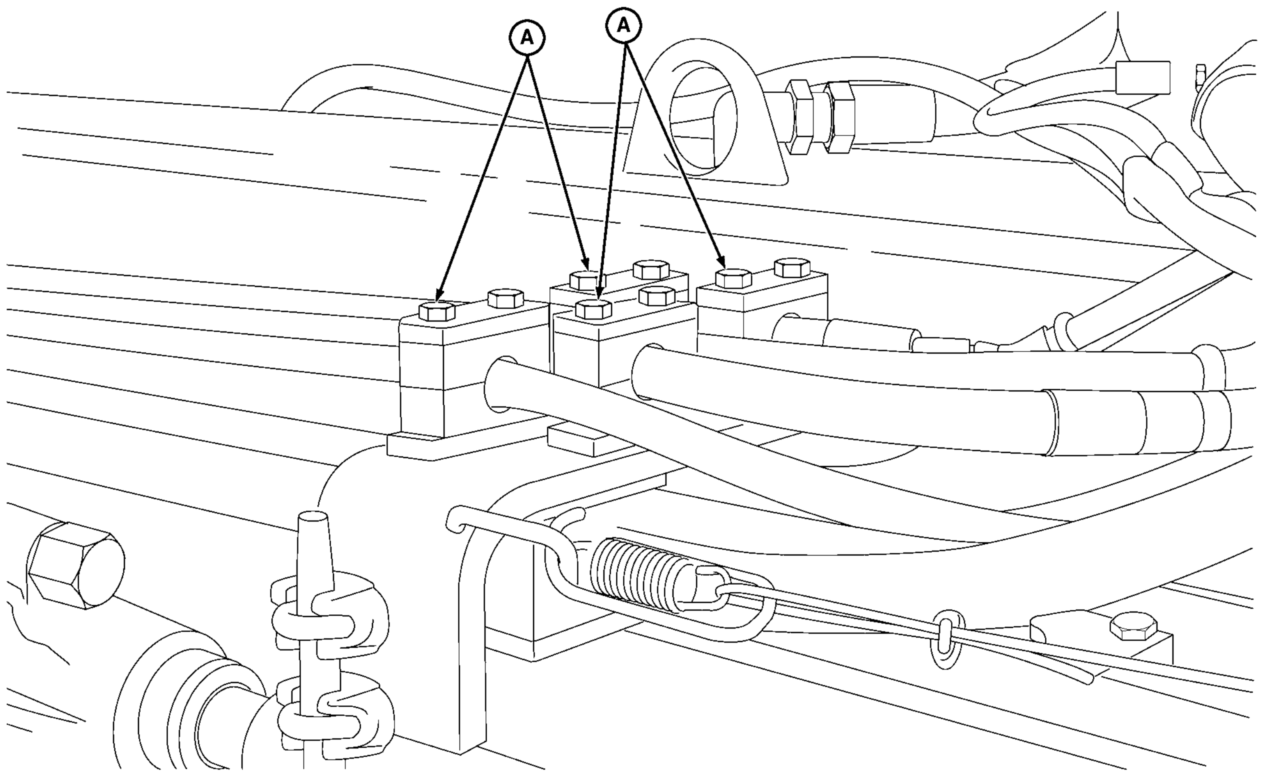
210



T121467

A—Clamp (4 used)

11. Install four clamps (A).

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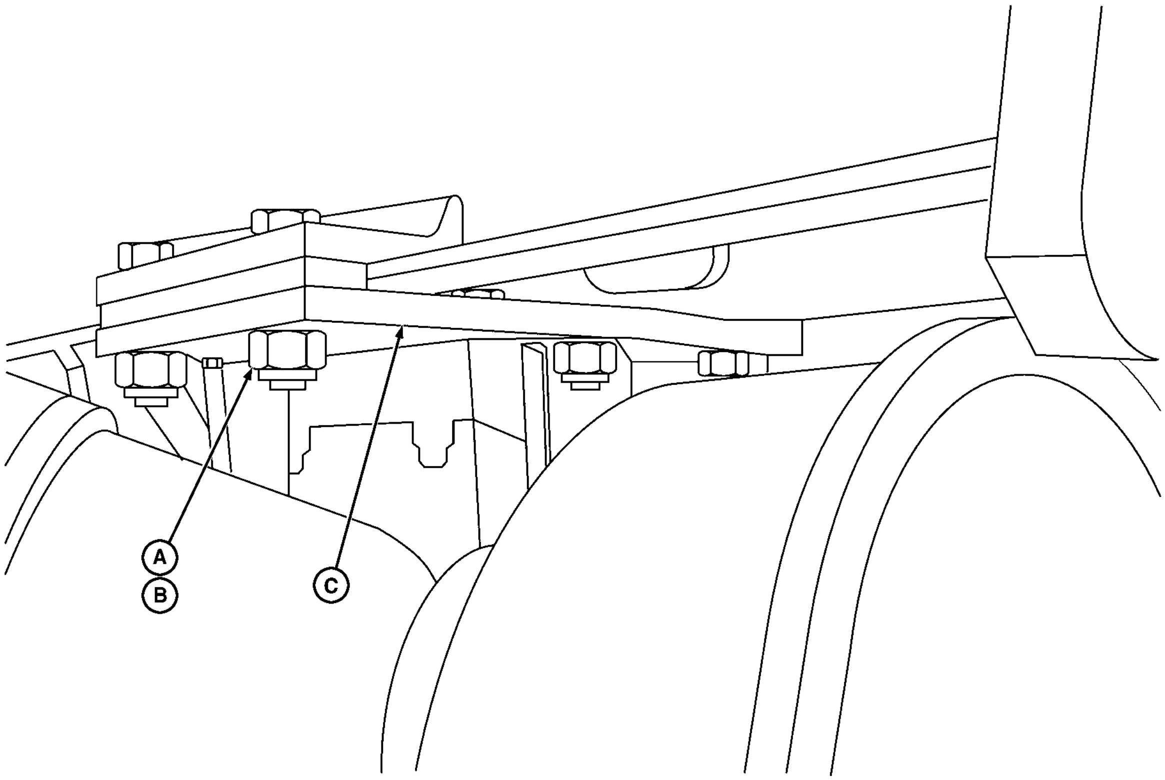

T121466

A—Bolt (5 used) **B—Nut (5 used)** **C—Bit Cover**

12. Install bit cover (C), five bolts (A), and nuts (B).

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Rock Drill

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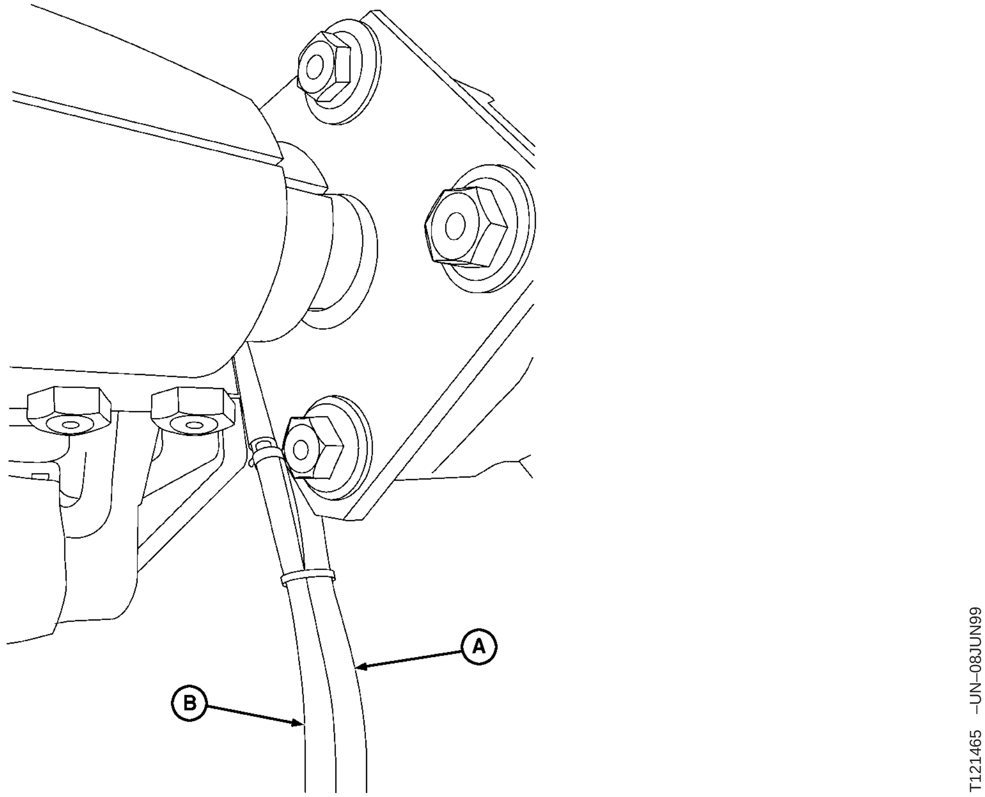
212



T121465

A—Hydraulic Hose **B—Hydraulic Hose**

13. Install hydraulic hoses (A and B).

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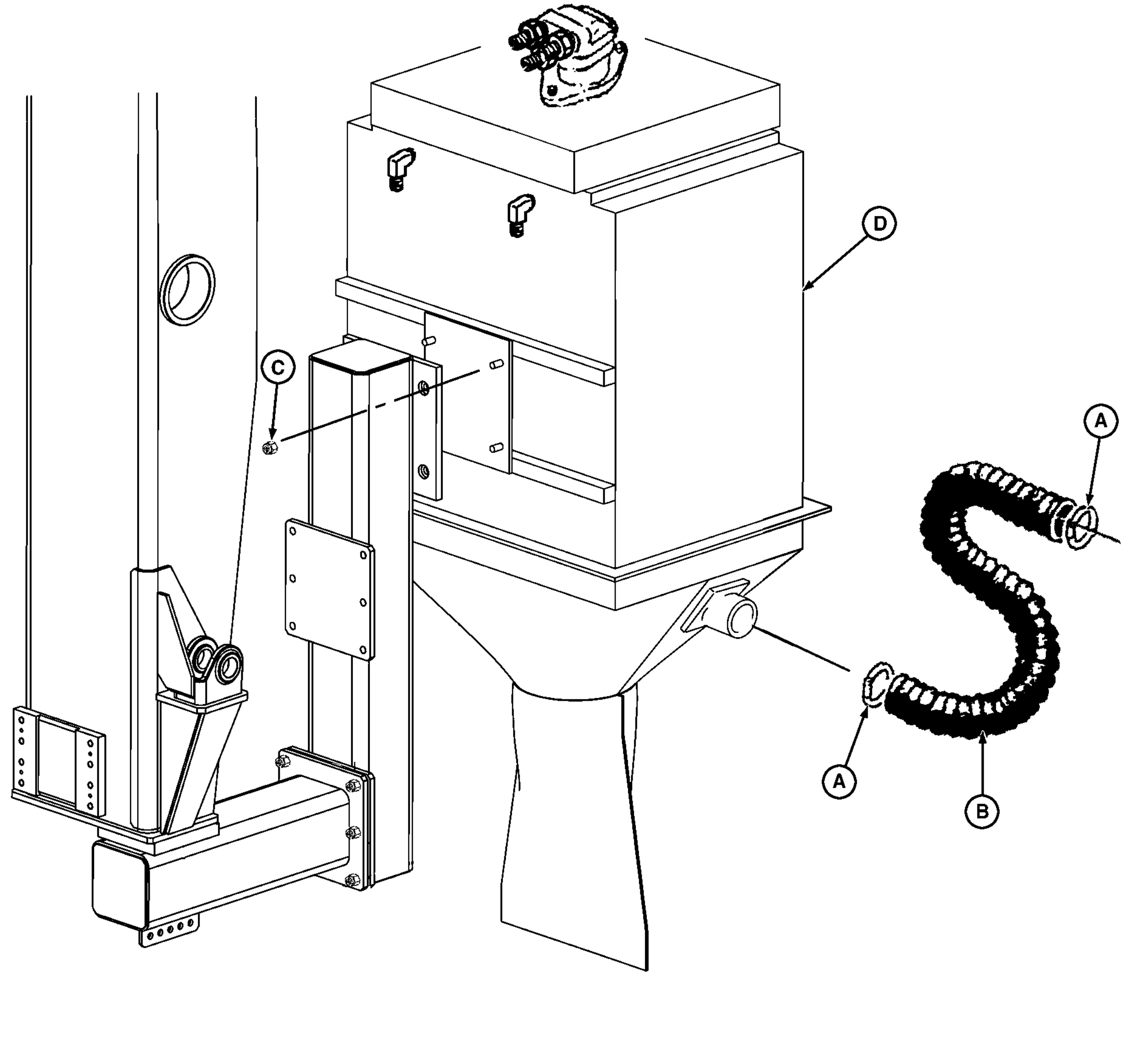
213



T121464

A—Clamp (2 used) **B—Suction Hose** **C—Nut (4 used)** **D—Dust Collector**

14. Install dust collector (D) and four nuts (C).

15. Install suction hose (B) and two clamps (A).

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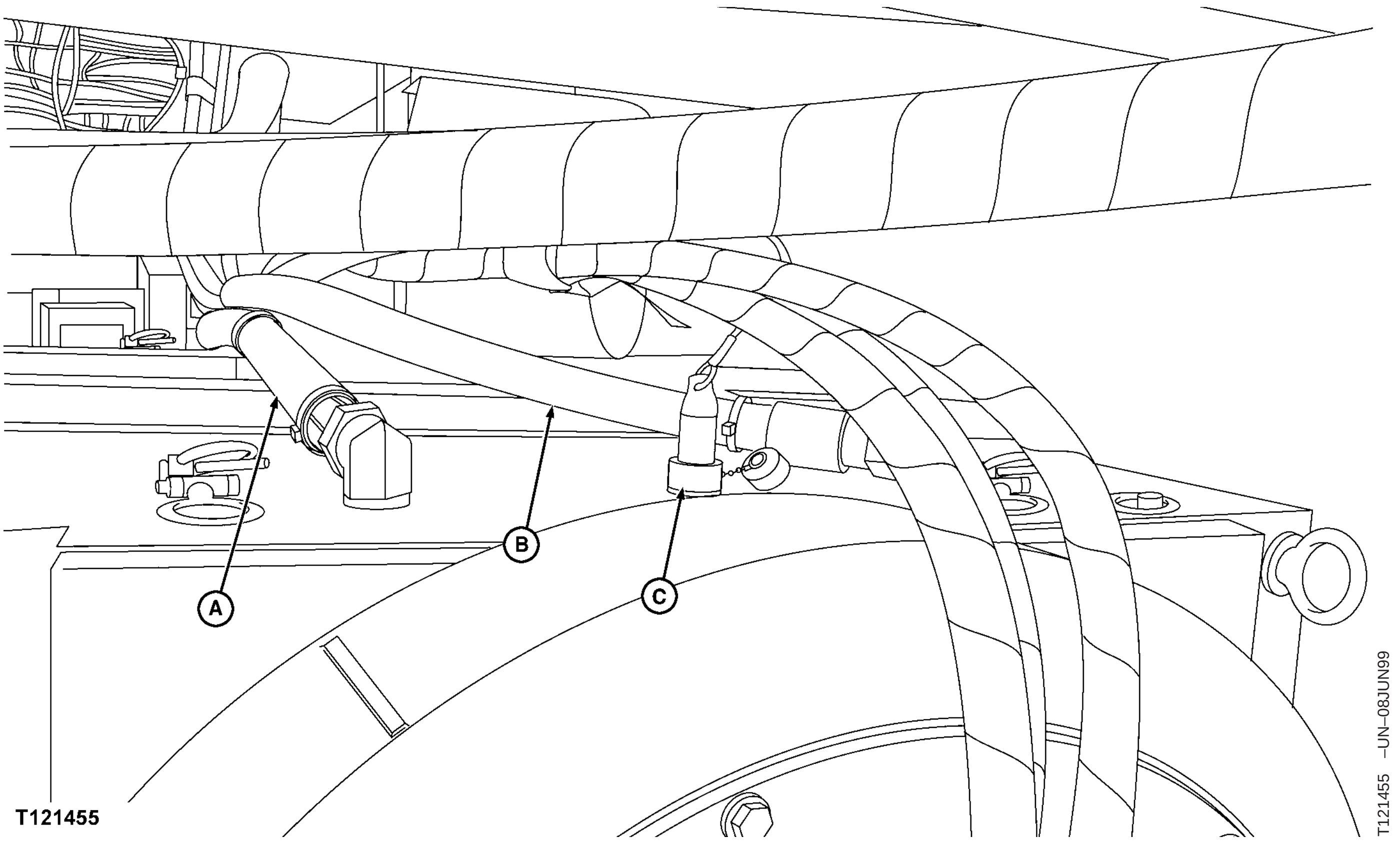
214



A—Air Line **B—Air Line** **C—Harness Connector**

16. Install harness connector (C).

17. Install two air lines (A and B).

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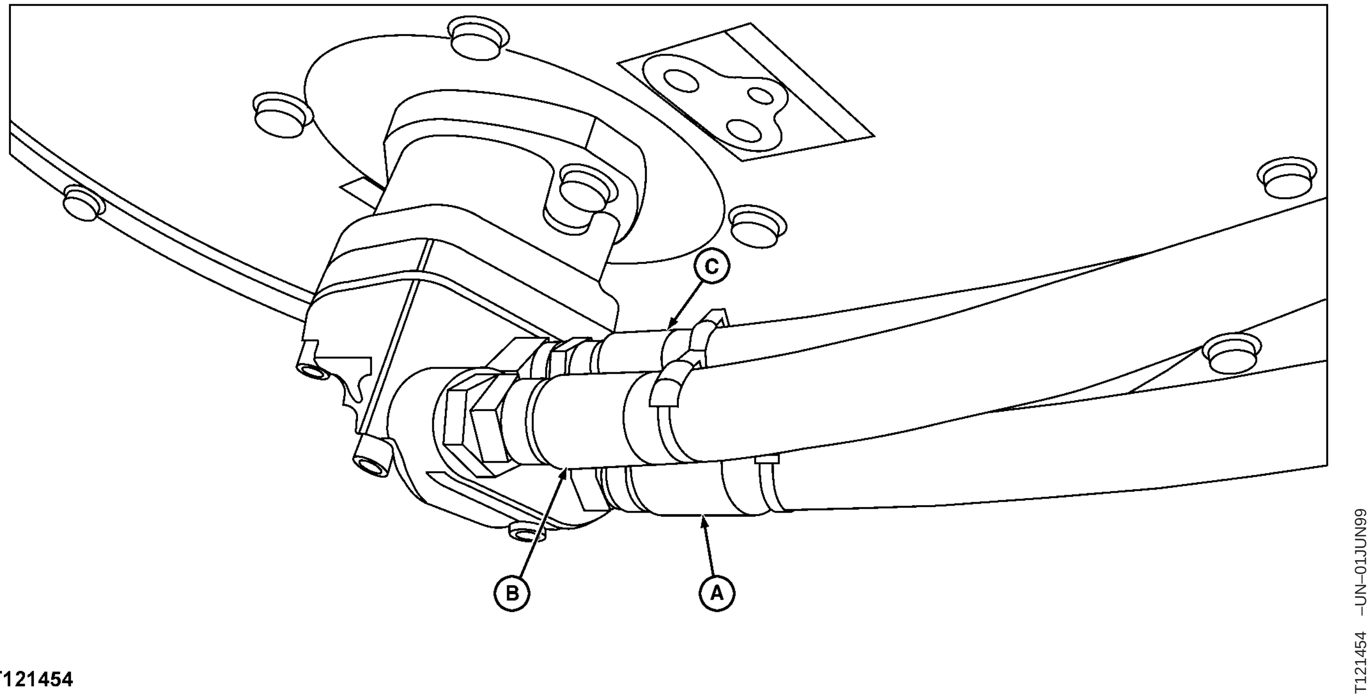
Rock Drill



T121454

A—Hydraulic Hose **B—Hydraulic Hose** **C—Hydraulic Hose**

18. Install three hydraulic hoses (A, B, and C).

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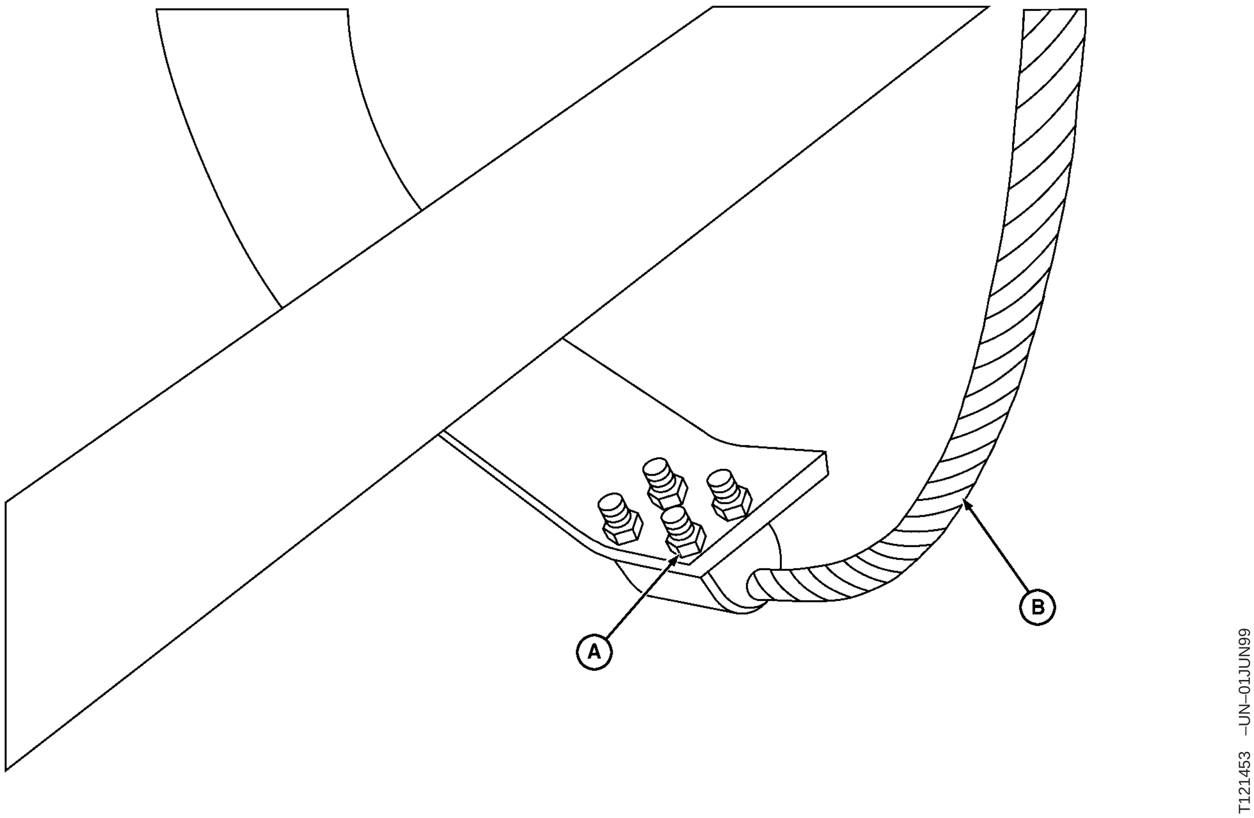

T121453

A—Nut (4 used) **B—Cable**

19. Connect cable (B) and install four nuts (A).

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Rock Drill

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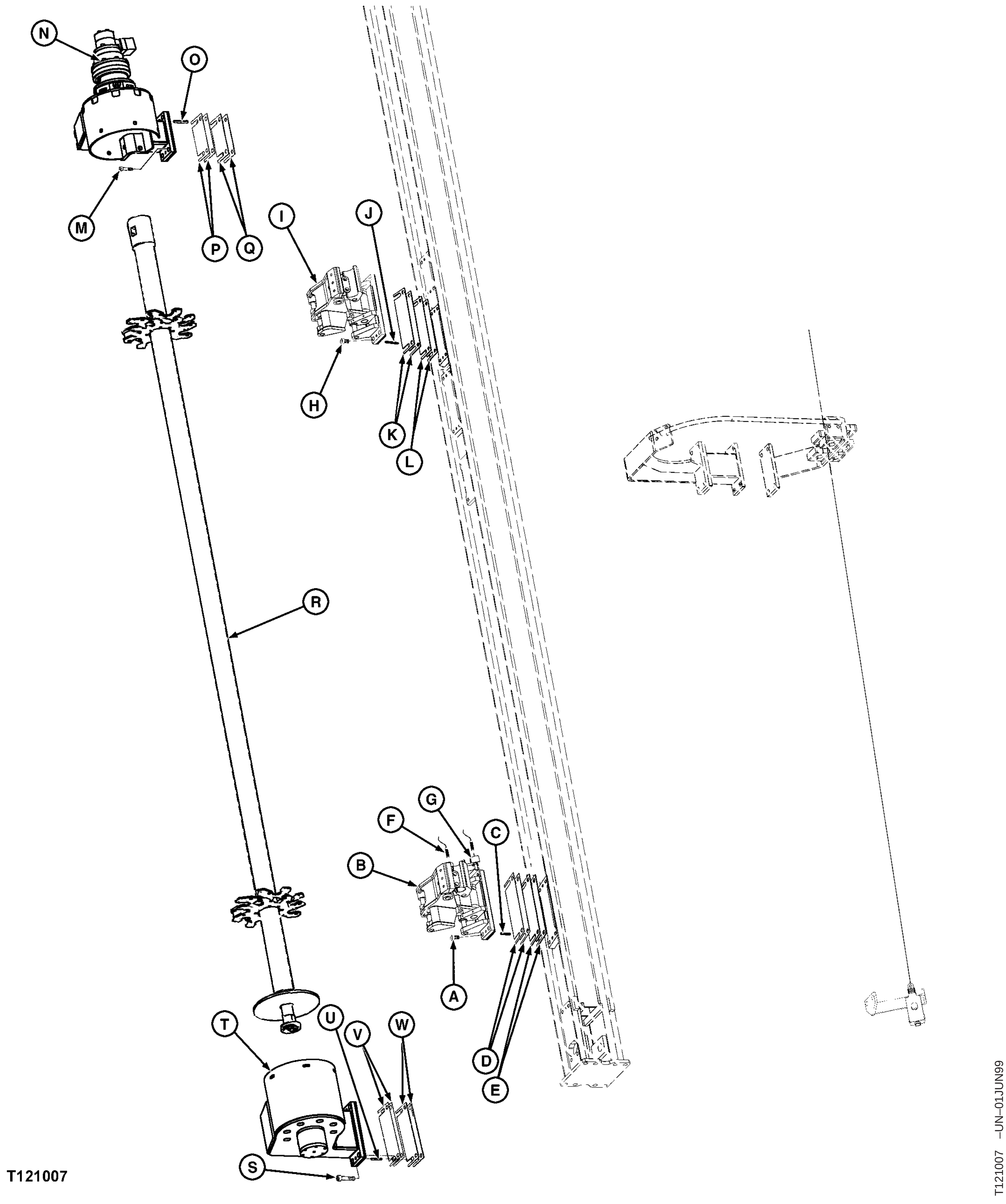
218



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A—Screw (4 used)
B—Lower Clamp Support
C—Elastic Pin (2 used)
D—Shim (2 used)
E—Shim (2 used)
F—Stud
G—Detector Support
H—Screw (4 used)
I—Upper Clamp Support
J—Elastic Pin (2 used)
K—Shim (2 used)
L—Shim (2 used)
M—Screw (4 used)
N—Brake Reducer Motor
O—Elastic Pin (2 used)
P—Shim (2 used)
Q—Shim (2 used)
R—Central Tube
S—Screw (4 used)
T—Lower Support
U—Elastic Pin (2 used)
V—Shim (2 used)
W—Shim (2 used)

20. Install four screws (S), lower support (T), two elastic pins (U), two shims (V), and two shims (W).

21. Install central tube (R).

22. Install four screws (M), brake reducer motor (N), two elastic pins (O), two shims (P), and two shims (Q).

23. Install four screws (H), upper clamp support (I), two elastic pins (J), two shims (K), and two shims (L).

24. Install stud (F) and detector support (G).

25. Install four screws (A), lower clamp support (B), two elastic pins (C), two shims (D), and two shims (E).

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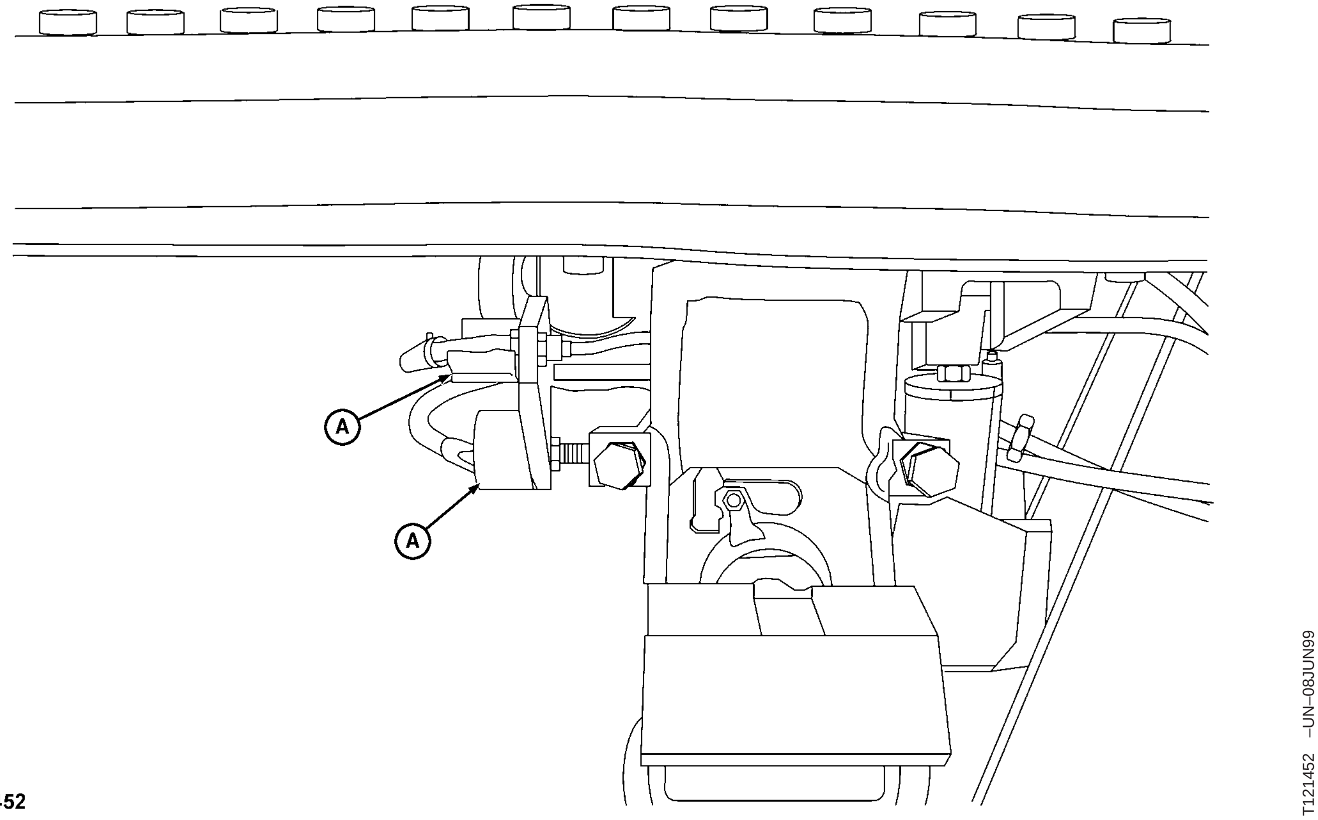

T121452

A—Sensor (2 used)

26. Install two sensors (A).

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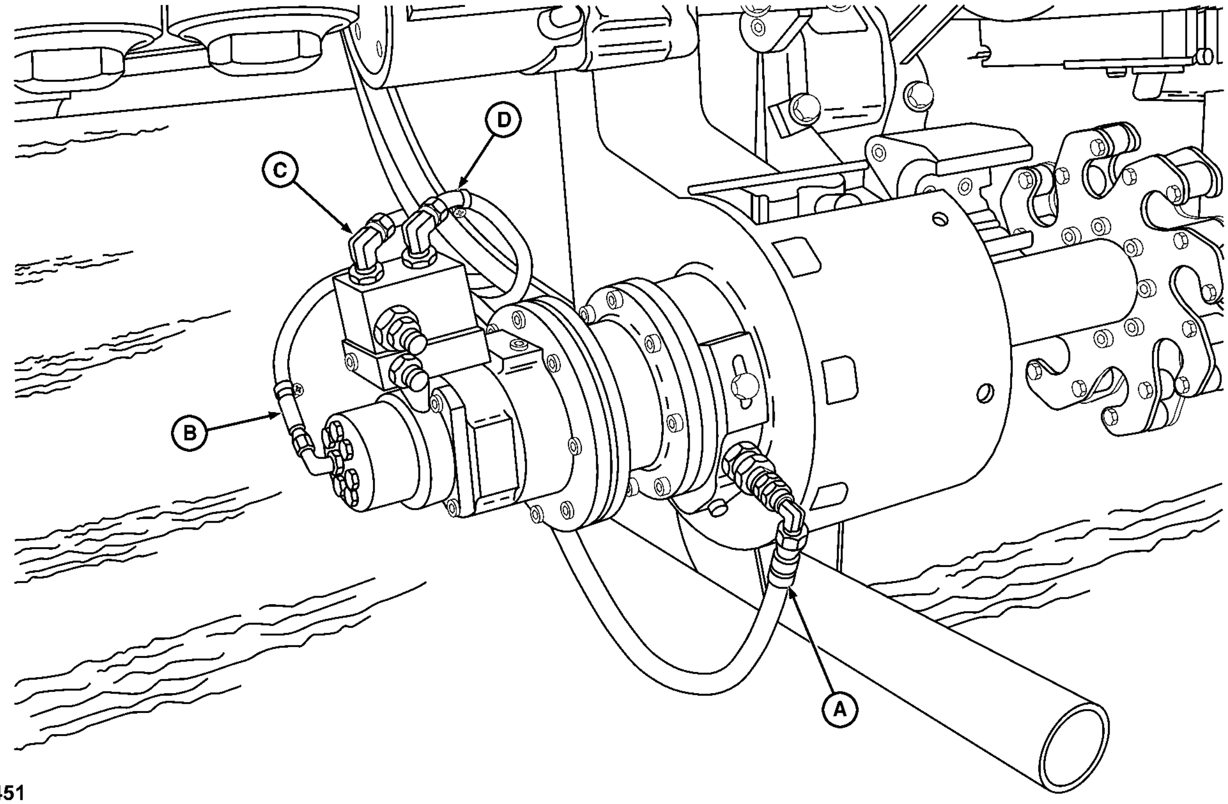

A—Hydraulic Hose B—Hydraulic Hose C—Hydraulic Hose D—Hydraulic Hose

27. Install four hydraulic hoses (A through D).

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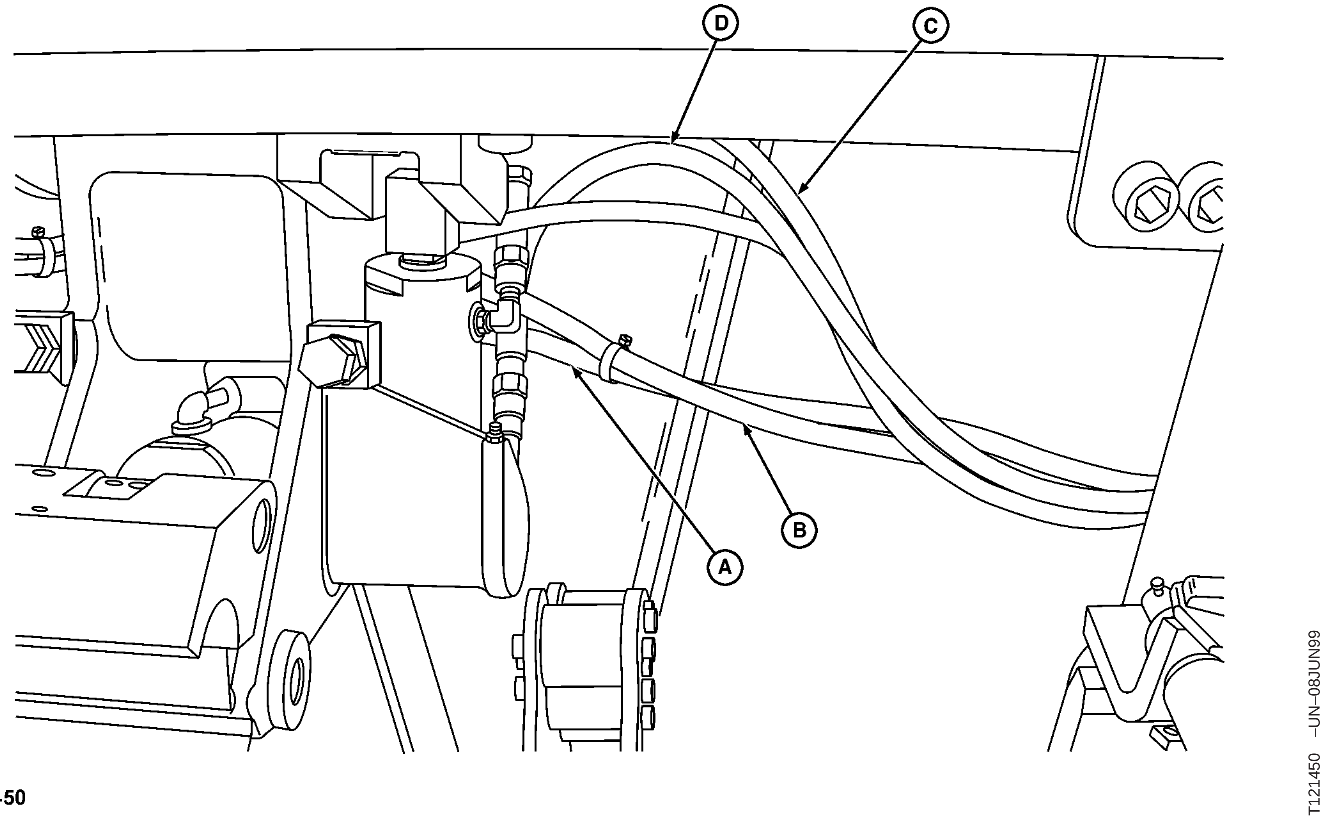
222



T121450

A—Hydraulic Hose B—Hydraulic Hose C—Hydraulic Hose D—Hydraulic Hose

28. Install four hydraulic hoses (A through D).

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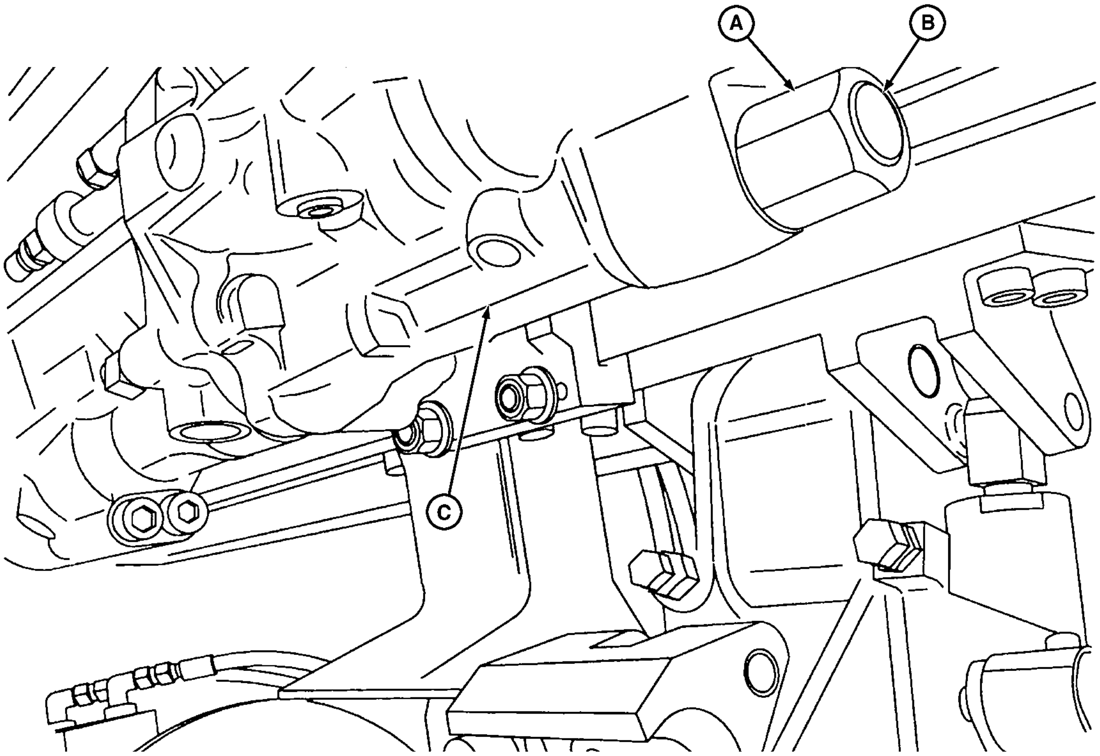

T121449

A—Nut (4 used) **B—Shaft (2 used)** **C—Hydraulic Drifter**

CAUTION: The approximate weight of hydraulic drifter is 2700 kg (5948 lb).

Hydraulic Drifter—Specification

Weight.. 2700 kg (5948 lb)

29. Support hydraulic drifter (C) with sling and slide shafts (B) into mounting sleeves.

30. Install four nuts (A) on ends of two shafts (B).

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Rock Drill

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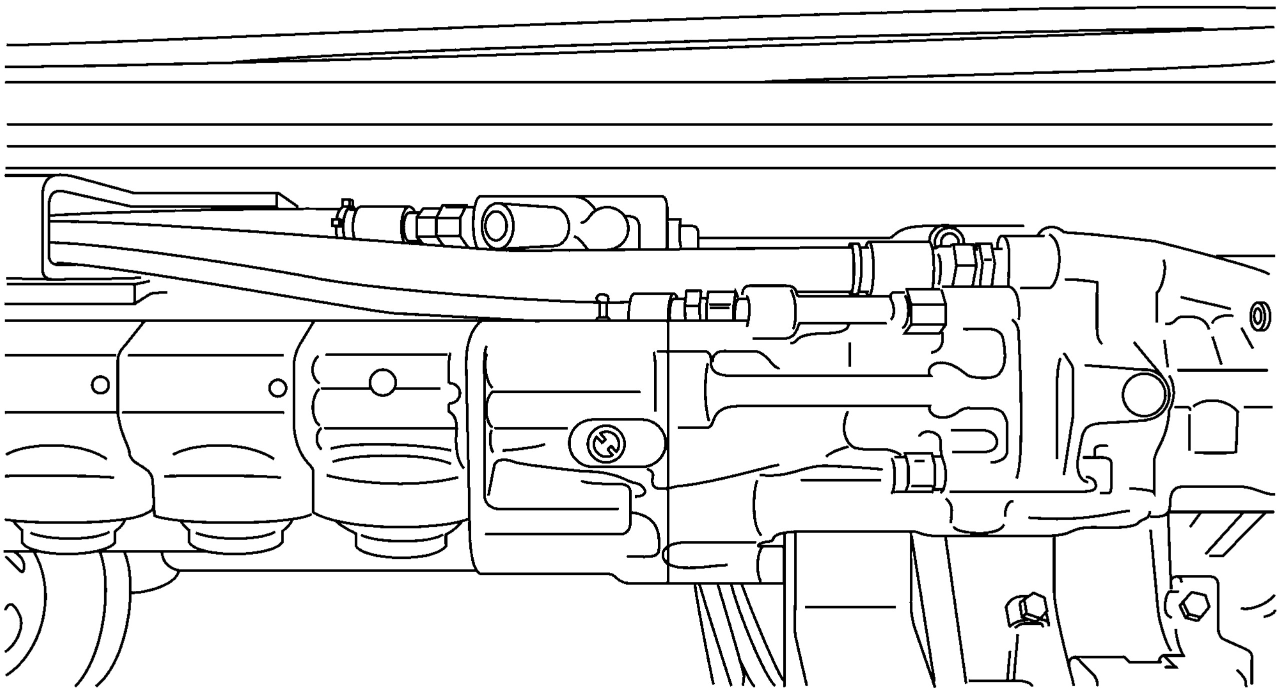
224



T121448

T121448 –UN–01JUN99

31. Install seven hydraulic hoses on the hydraulic drifter.

CED,OUOE019,15 –19–01APR99–21/21

BLANK

CHAPTER 24

SECTION 99

DEALER FABRICATED TOOLS

BLANK

Group 9900
Dealer Fabricated Tools

ST4920 TRACK RECOIL SPRING DISASSEMBLY AND ASSEMBLY TOOL

NOTE: It is recommended that DFT1087 Track Recoil Spring Disassembly and Assembly Guard Tool be used with track recoil spring disassembly and assembly tool.

Dimensions given are metric.

Tool is the same as used on other machines except the holder (C). For each track adjuster use the holder with the correct size hole for the nut on that track adjuster.

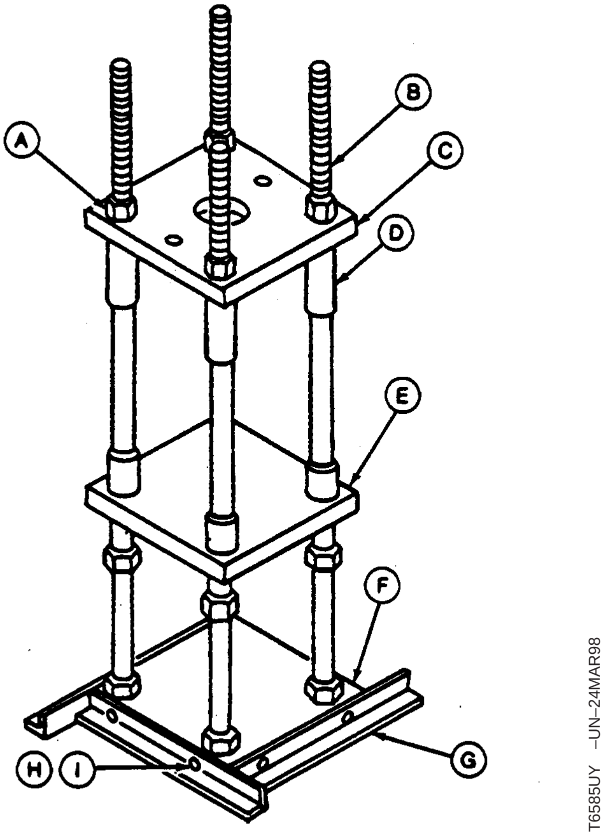
Track Recoil Spring Disassembly and Assembly Tool (compression tool) is used with hydraulic jack to compress recoil spring in track adjuster repair.

Material required:

- 1020 HR Steel for Holder (C), Supporting Plate (E), Base Plate (F), and Base (G).
- "D" Grade (SAE Grade 5) for Eyebolts (D), Nuts (A), and Cap Screws (H).
- "F" Grade (SAE Grade 8) for Studs (B).

Print Numbers:

- A-ST4050 Nut
- B-ST4045 Bolt
- C-ST4035 Holder (Plate)
- C-ST4036 Holder (Plate)
- C-ST4037 Holder (Plate)
- D-ST4047 Eyebolt
- E-ST4040 Supporting Base
- F-ST4042 Base Plate
- G-ST4041 Base
- H-ST4046 Cap Screw
- I-ST4049 Lock Washer



A—Nut (12 used)
B—Stud (4 used)
C—Holder
D—Eyebolt (2 used)
E—Supporting Plate
F—Base Plate
G—Base (4 used)
H—Cap Screw (4 used)
I—Lock Washer (8 used)

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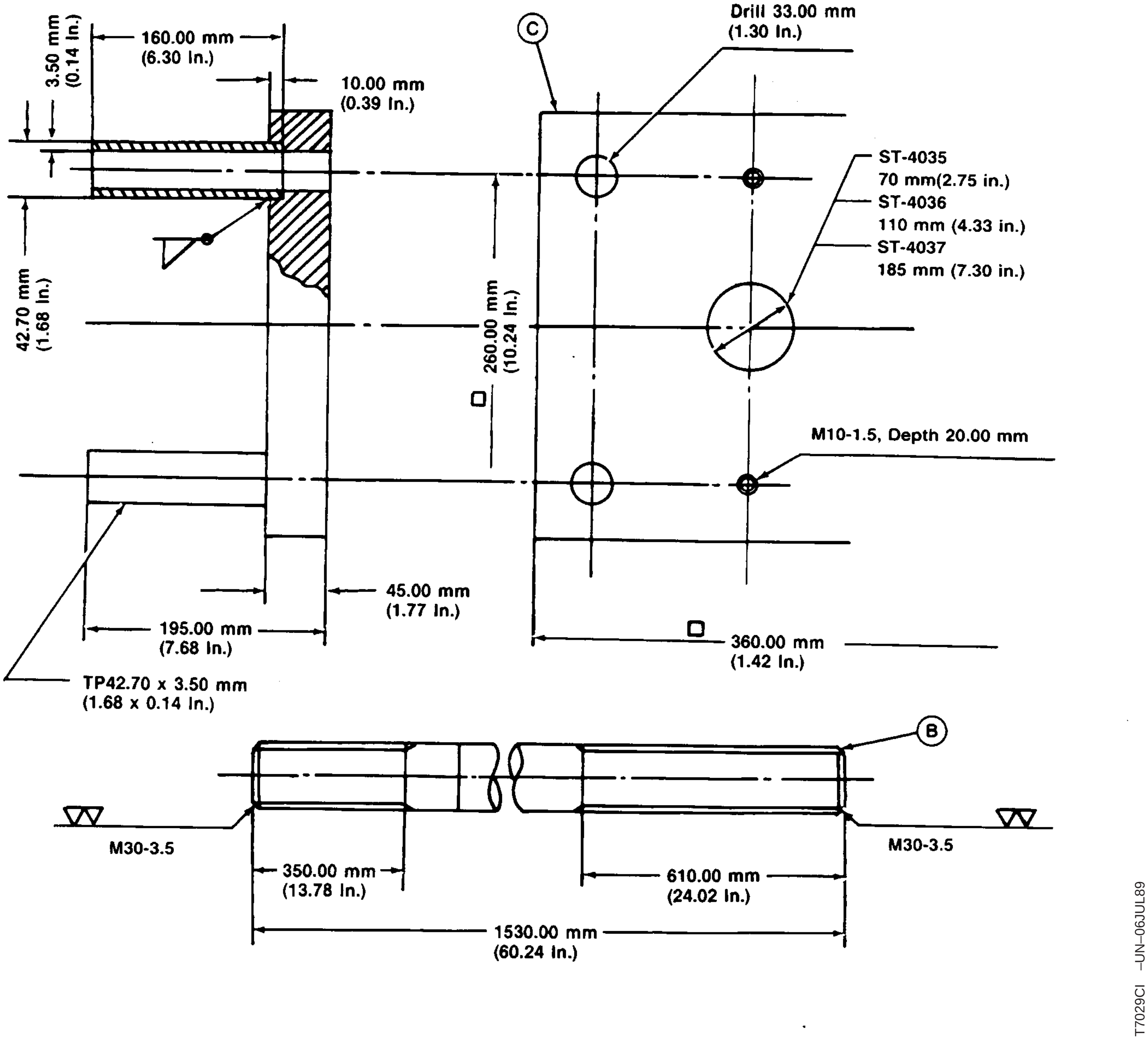
Dealer Fabricated Tools



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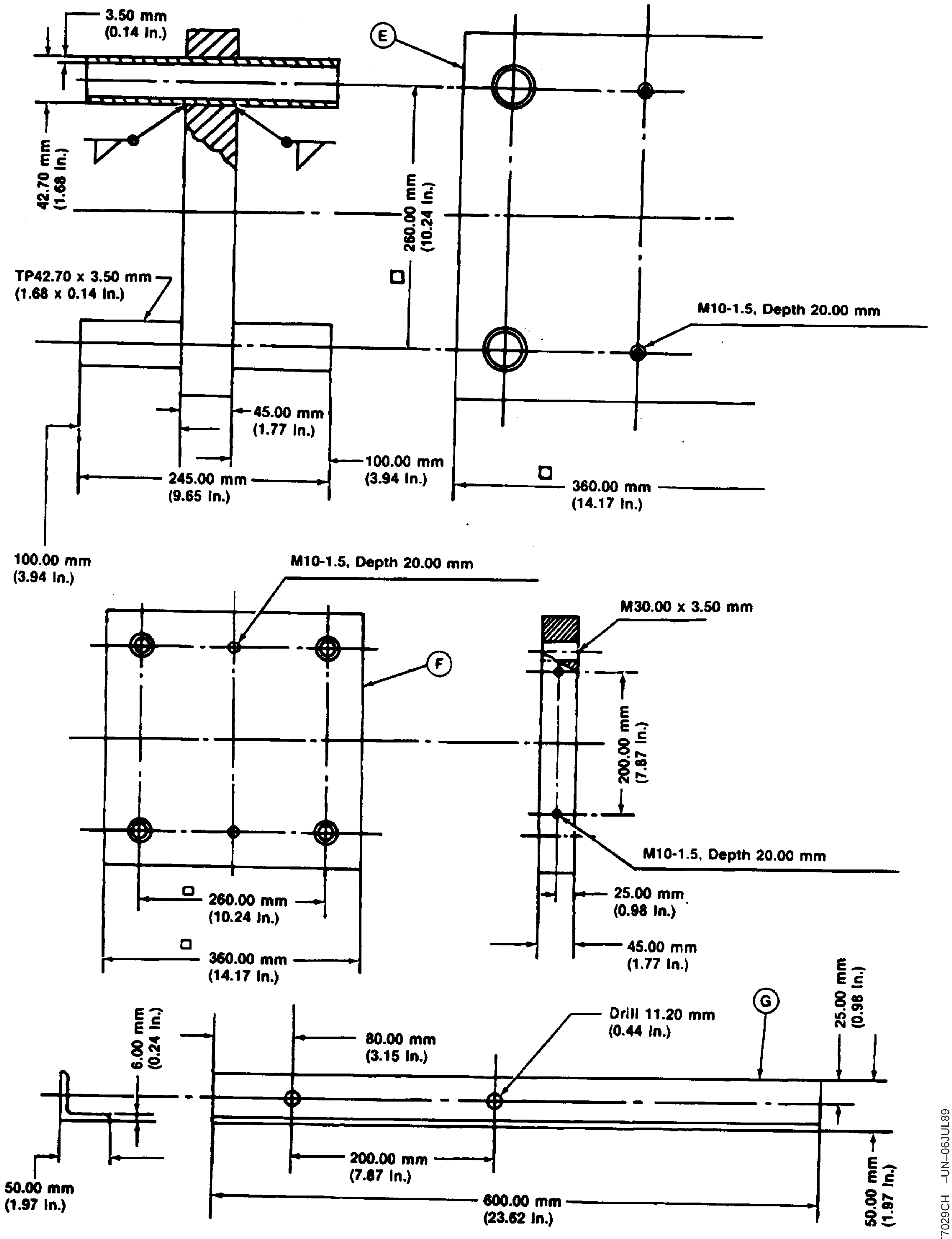
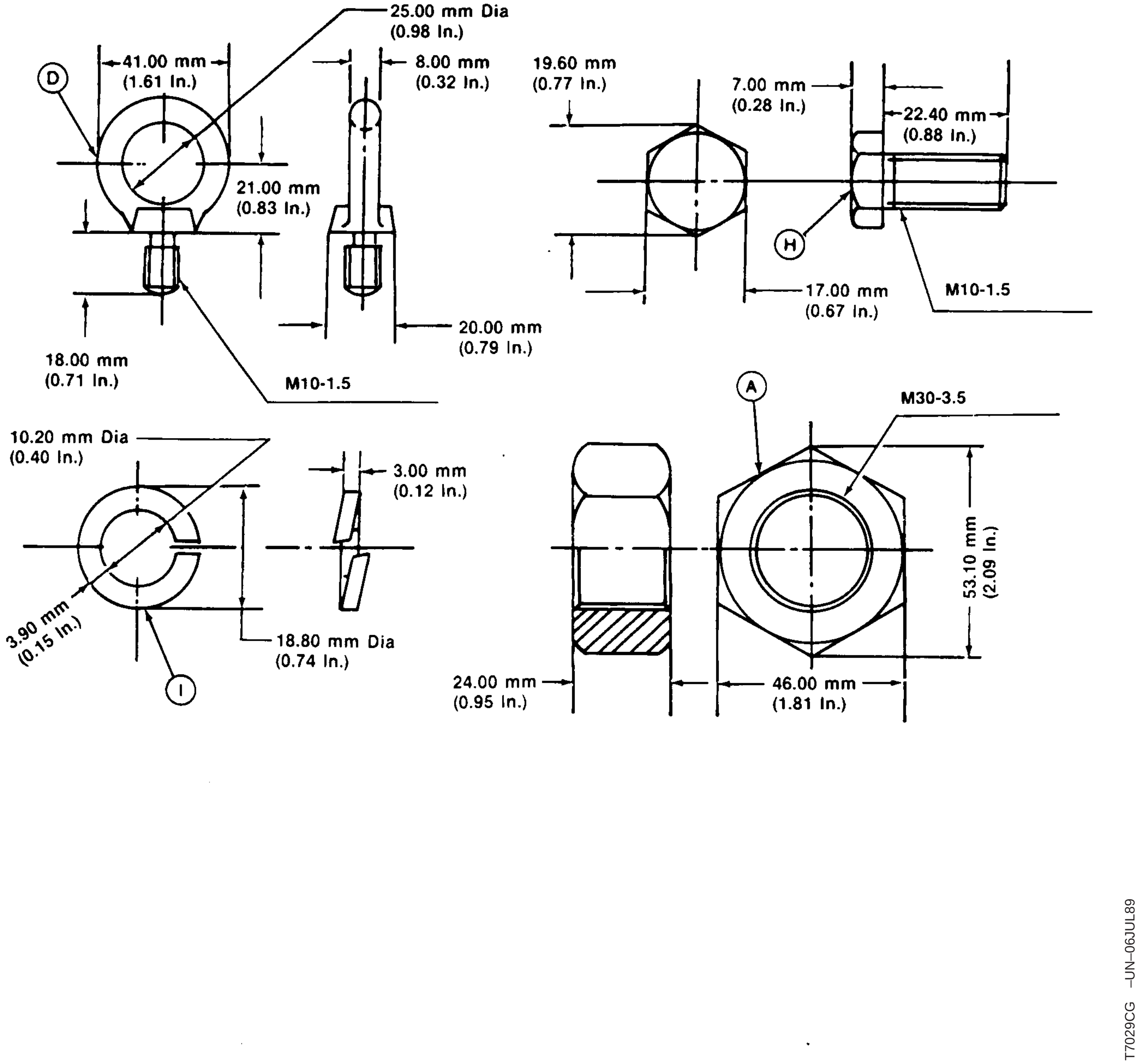


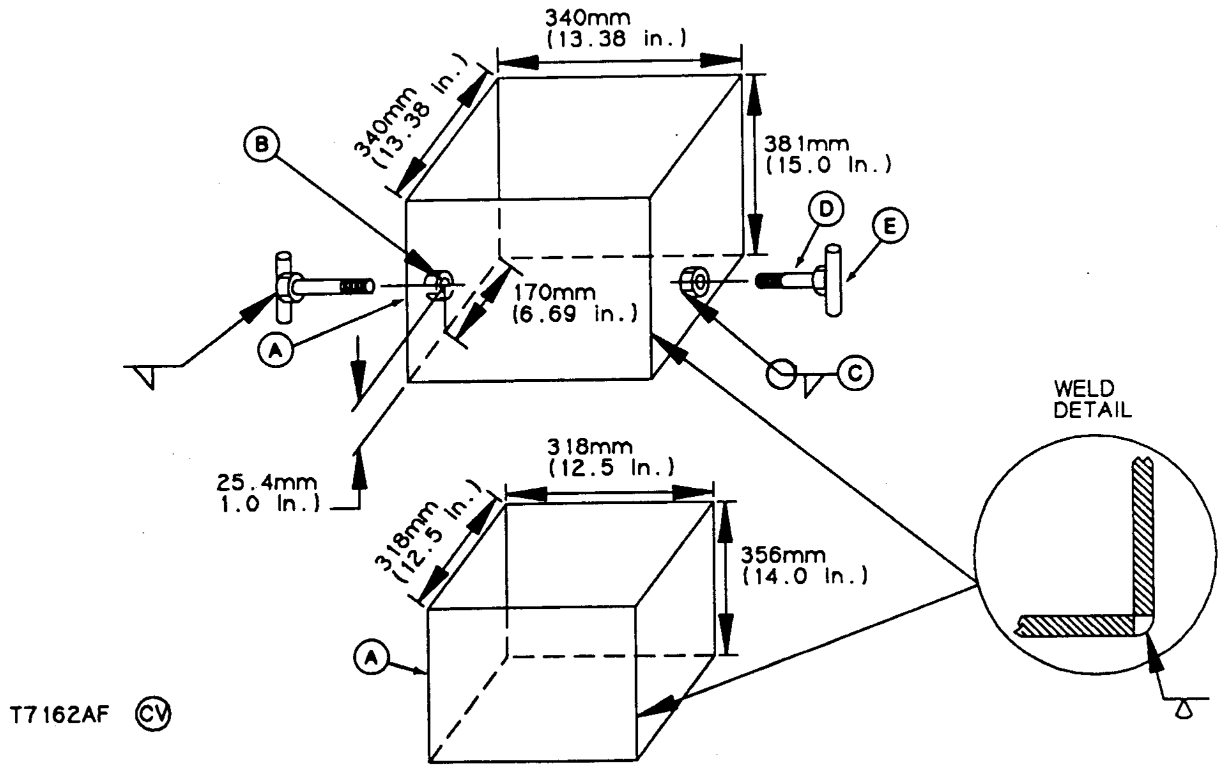
Continued on next page TX,99,SB548 –19–08JAN97–3/4

Dealer Fabricated Tools



TX,99,SB548 –19–08JAN97–4/4

DFT1087 TRACK RECOIL SPRING DISASSEMBLY AND ASSEMBLY GUARD TOOL



T7162AF –UN–17OCT89

A—3/16 in. 1020 CR Steel Plate
B—9/16 in. Hole (2 places)
C—1/2 in. Nut (2 used)
D—1/2 x 2 in. Cap Screw (2 used)
E—1/2 x 3 in. Steel Round Stock (2 used)

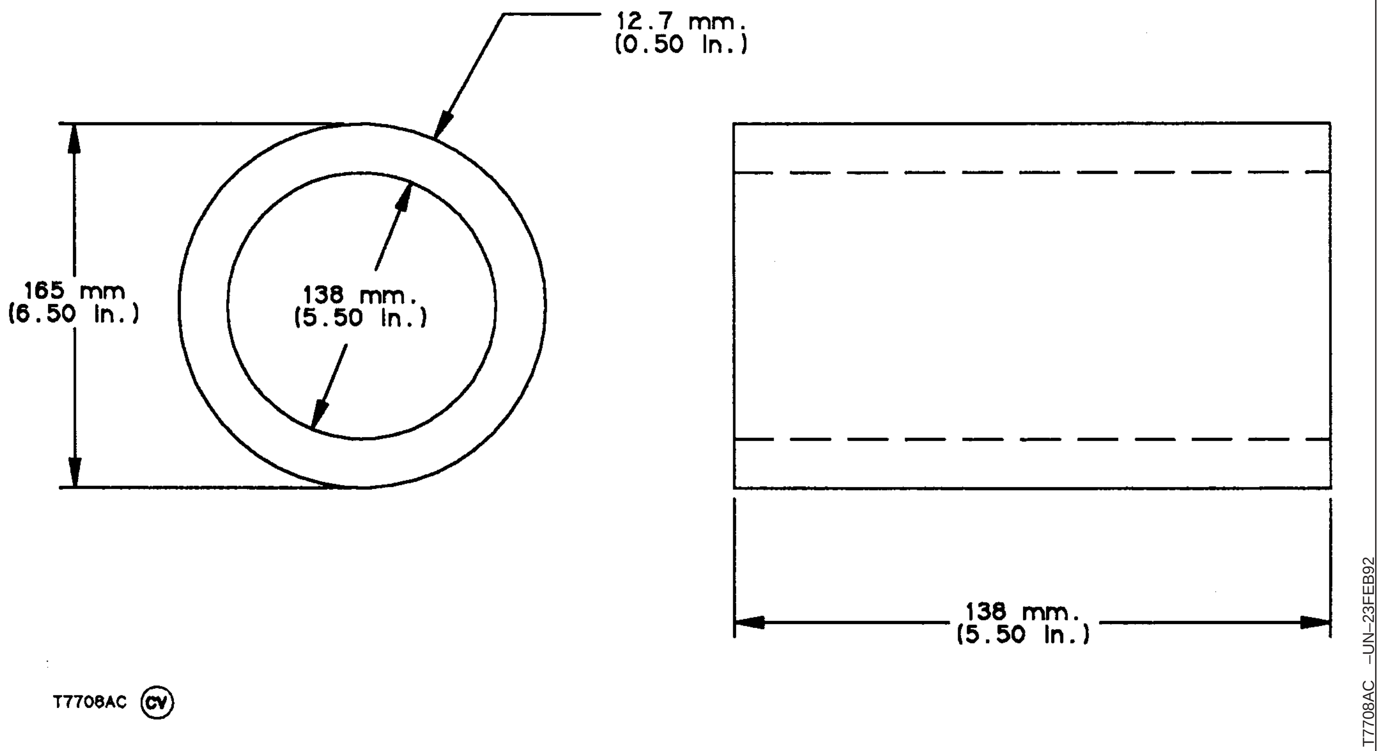
Track Disassembly and Assembly Guard Tool is used with ST4920 Track Recoil Spring Disassembly and Assembly Tool.

Material required:

- 3/16 in. 1020 CR Steel Plate (A)
- 9/16 in. Hole (2 places) (B)
- 1/2 in. Nut (2 used) (C)
- 1/2 x 2 in. Cap Screw (D) (2 used)
- 1/2 x 3 in. Steel Round Stock (E) (2 used)

TX,99,SB542 –19–08JAN97–1/1

DFT1110 SPACER



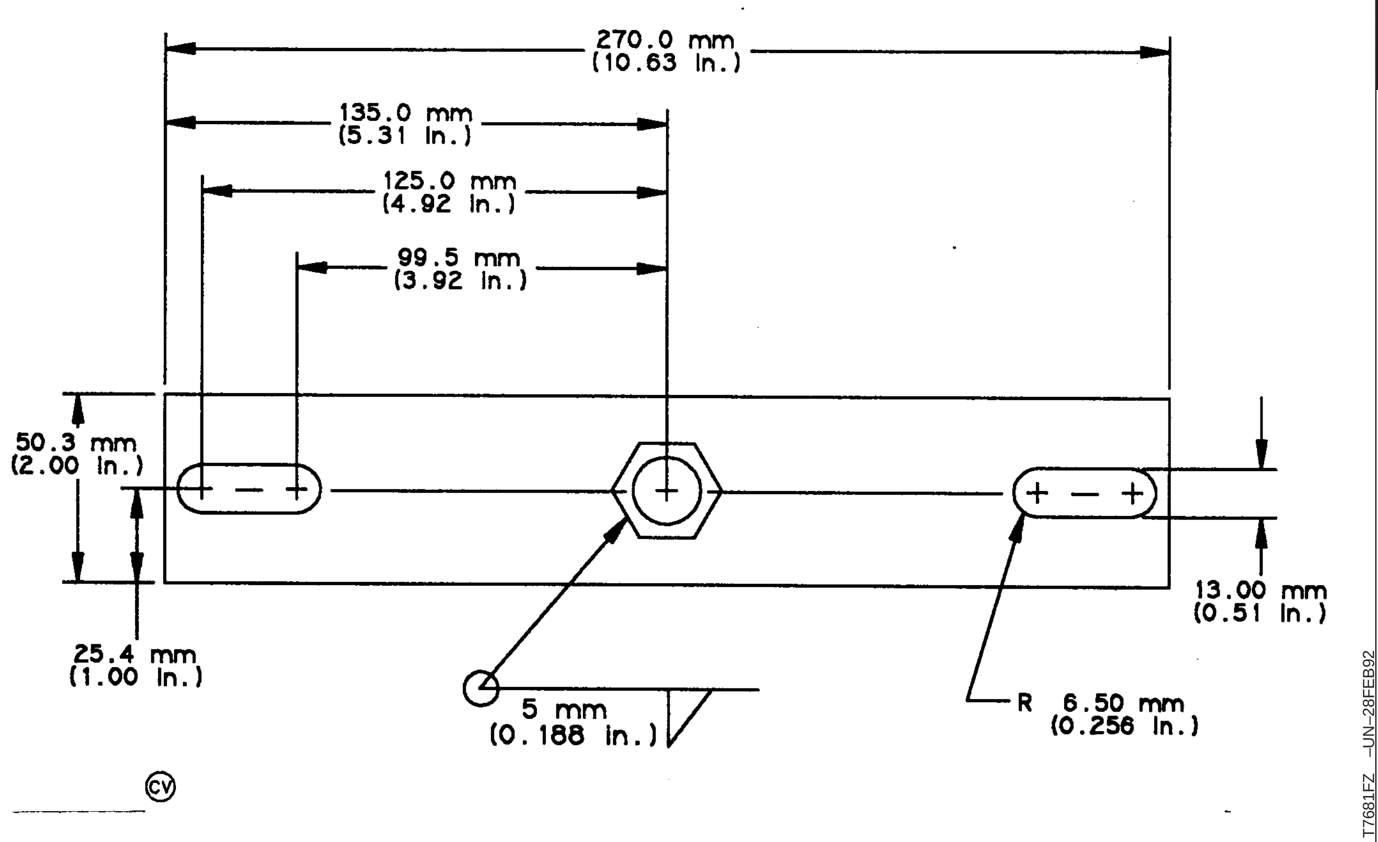
Spacer is used with ST4920 Track Recoil Spring Disassembly and Assembly Tool. Spacer is installed on the bottom plate so force is applied to spring flange on cylinder and not to the piston.

Cut the ends of spacer so they are parallel to each other.

Material required is 165 x 138 x 138 mm (6.50 x 5.50 x 5.50 in.) Heavy Wall Steel Pipe.

TX,99,SB549 –19–08JAN97–1/1

DFT1036A PROPEL GEARBOX NUT WRENCH



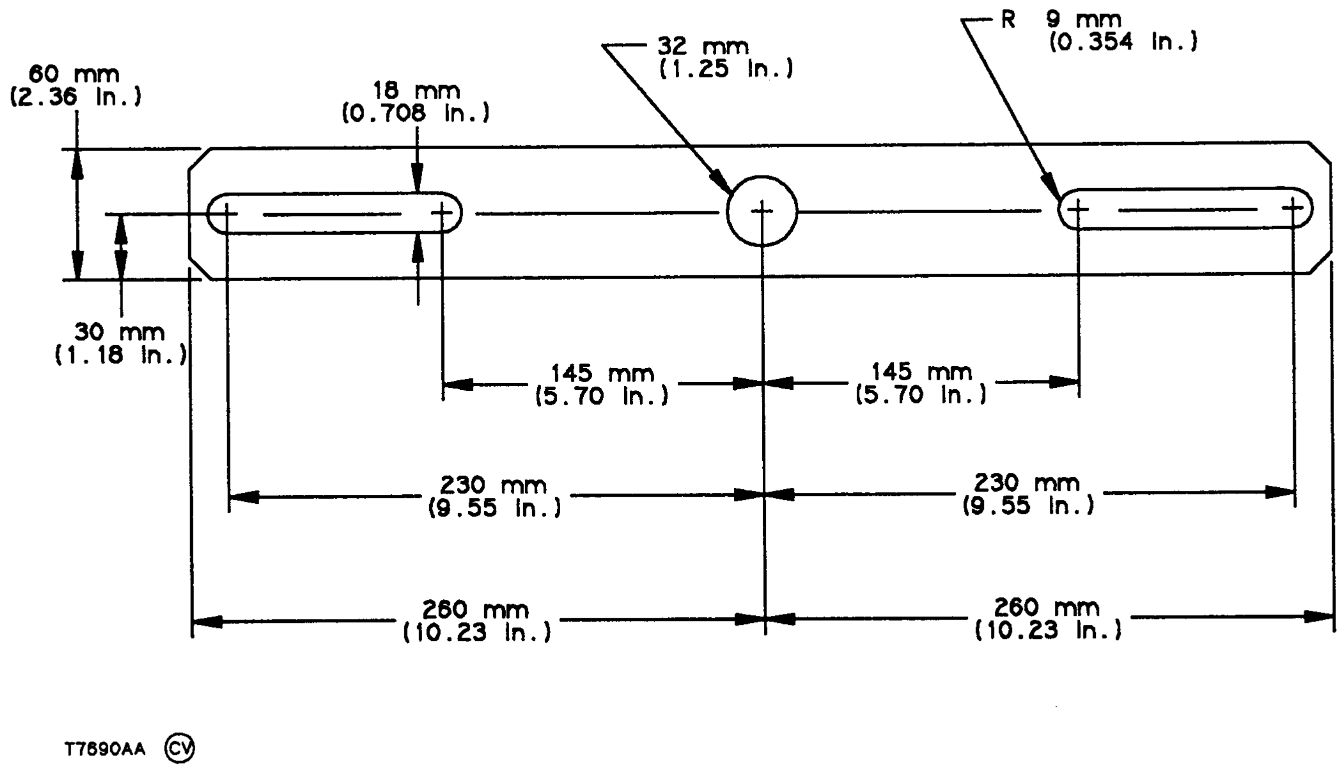
Propel Gearbox Nut Wrench is used to remove and install the hub-to-housing nut in the propel gearbox.

Material required:

- 16 mm (5/8 in.) flat bar stock
- M24 (1 in.) nut
- M10-1.5 x 60 mm cap screw (2 used)
- M10-1.5 nut (2 used)

TX,99,SB544 –19–08JAN97–1/1

DFT1109 HOLDING BAR



T7690AA –UN–27FEB92

Holding Bar is used with the DFT1036A Propel Gearbox Nut Wrench as a guide when loosening the hub-to-housing nut in the propel gearbox.

Material required is 16 mm (5/8 in.) flat bar stock.

TX,99,SB550 –19–08JAN97–1/1

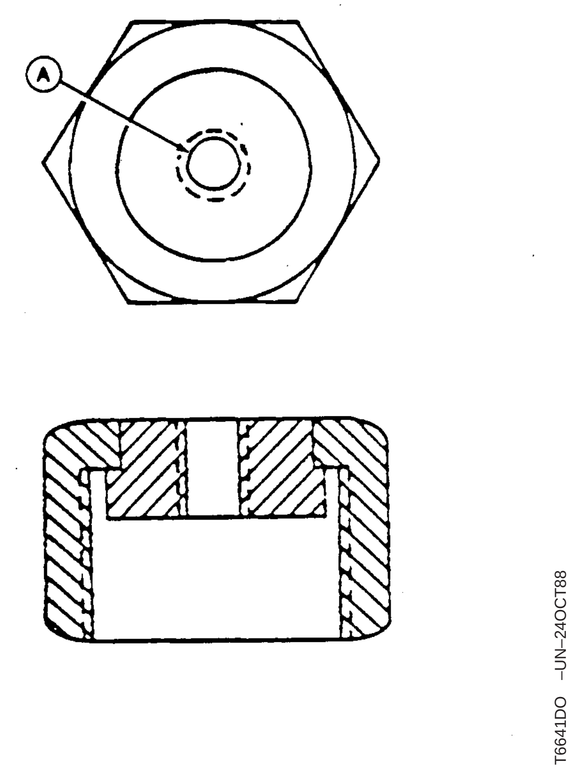
ROTARY MANIFOLD LIFTING TOOL

Tool is used to remove and install rotary manifold.

Drill and tap disk in fitting cap to M8-1.25 mm threads (A).

Material required:

- 38H1416 Cap (—12)
- M8-1.25 Lifting Eyebolt such as JT05548 Metric Lifting Eyebolt



A—Threads

TX,99,SB546 –19–08JAN97–1/1

DFT1089 BARREL SUPPORT

Barrel supports are used to support the upperstructure when removing the undercarriage.

CAUTION: Cutting tops off barrels that contained flammable or explosive material can cause serious injury or death.

Material required:

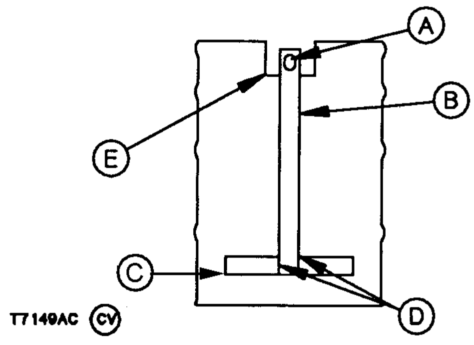
- Clean metal 55 gallon barrels of equal height with lids removed. (Must be 34.5—35.5 in. height x 24 in. wide.)
- 1/2 x 4 x 24 in. 1020 CR Plate
- 1/2 x 4 x 12 in. 1020 CR Plate
- One empty 3 lb coffee can or equivalent
- Highway Cement (9 bag mix). Mix extra dry to aid curing time.

Insert hook assembly into barrel before cement is set. Hold assembly in position, using a steel plate or wire, until cement begins to cure.

Level off cement with top of barrels.

Cement must cure for a minimum of ten days.

The approximate weight of each barrel support is 545 kg (1200 lb). The approximate support capacity of each barrel support is 385 560 kg (850,000 lb).



T7149AC –UN–09JAN97

A—2 x 4 in. Slotted Hole, Recessed
B—1/2 x 4 x 24 in. 1020 CR Plate
C—1/2 x 4 x 12 in. 1020 CR Plate
D—1/4 in. Fillet Weld
E—One Empty 3 lb Coffee Can or Equivalent

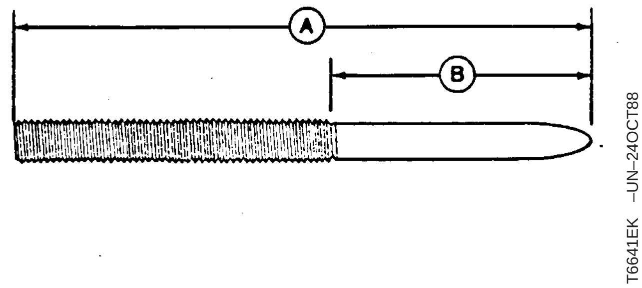
TX,99,SB551 –19–08JAN97–1/1

DFT1144 GUIDE PIN

Guide pin is used to align cap screw holes in swing bearing and upperstructure.

Remove threads for a distance (B) and then grind a taper on same end.

Material required is M20-2.5 x 230 mm (9 in.) Threaded Rod.

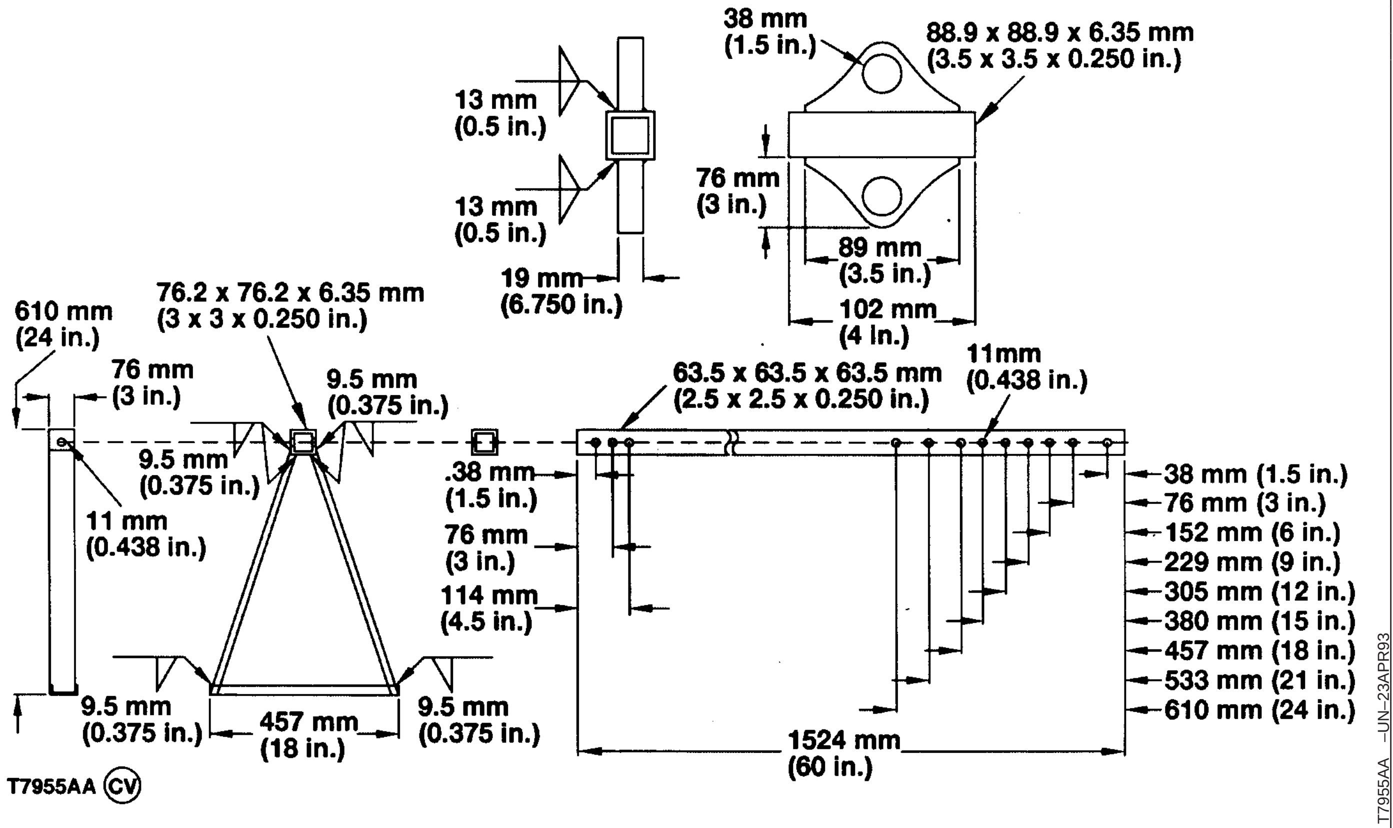


A—230 mm (9 in.)
B—100 mm (4 in.)

TX,99,SB552 –19–08JAN97–1/1

99
9900
12

DFT1119 PUMP SUPPORT



Pump support is used with a hand hoist to support a pump(s) when an engine is removed.

Two end stands are needed.

Drill the holes through the square steel tubing so they are centered.

Material required:

- C3 x 5 Steel Channel
- 88.9 x 88.9 x 6.35 mm (3.5 x 3.5 x 0.250 in.) Square Steel Tubing
- 76.2 x 76.2 x 6.35 mm (3 x 3 x 0.250 in.) Square Steel Tubing
- 63.5 x 63.5 x 6.35 mm (2.5 x 2.5 x 0.250 in.) Square Steel Tubing
- 19 mm (3/4 in.) Flat Bar Stock
- M10 x 89 mm or 3/8 x 3-1/2 in. D Grade (SAE Grade 5) Cap Screw (2 used)
- M10 or 3/8 in. D Grade (SAE Grade 5) Nut (2 used)

TX,99,SB553 –19–08JAN97–1/1

APPENDIX A
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

A-1. GENERAL

Preventive Maintenance Checks and Services (PMCS) are performed to keep the Hydraulic Excavator in operating condition. The checks are used to find, correct, or report problems. Pay attention to WARNING and CAUTION statements. A WARNING means someone could be hurt. A CAUTION means equipment could be damaged.

Once a week do Weekly PMCS. If Hydraulic Excavator has not been operated in a week, also do Before PMCS at the same time.

Do Monthly PMCS once a month. If Hydraulic Excavator has not been operated in a month, also do After PMCS at the same time.

If you are operating the Hydraulic Excavator for the first time, do your Weekly and Monthly PMCS the first time you do your Before PMCS.

If you find something wrong when performing PMCS, fix it if you can using troubleshooting procedures and/or maintenance procedures.

The right-hand column of the PMCS table lists conditions that make the Hydraulic Excavator not fully mission capable. Write up items not fixed on DA Form 2404 for direct support maintenance. For further information on how to use this form, see DA PAM 738-750.

A-2. LEAKAGE DEFINITION

CAUTION: Equipment operation is allowable with minor leakages (Class I or II) except for fuel leaks. Of course, consideration must be given to the fluid capacity of the item or system being checked. When in doubt, ask your supervisor.

When operating with Class I or II leaks, continue to check fluid levels as required in the PMCS.

Class III leaks should be reported immediately to your supervisor.

It is necessary to know how fluid leakage affects the status of the Hydraulic Excavator. The following are definitions of the classes of leakage an operator or crewmember needs to know to be able to determine the condition of the leak. Learn and then be familiar with them, and REMEMBER-WHEN IN DOUBT, ASK YOUR SUPERVISOR.

Leakage Definitions for Unit PMCS:

CLASS I-Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.

CLASS II-Leakage of fluid great enough to form drops but not enough to cause drops to drip from item being checked.

CLASS III-Leakage of fluid great enough to form drops that fall from the item being checked.

A-3. INSPECTION

Look for signs of a problem or trouble. Senses help here. You can feel, smell, hear, or see many problems. Be alert when on the Hydraulic Excavator.

Inspect to see if items are in good condition. Are they correctly assembled, stowed, secured, excessively worn, leaking, corroded, or properly lubricated? Correct any problems found or notify direct support maintenance.

There are some common items to check all over the Hydraulic Excavator. These include the following:

1. Bolts, clamps, nuts, and screws: Continuously check for looseness. Look for chipped paint, bare metal, rust, or corrosion around bolt and screw heads and nuts. Tighten them when you find them loose. If tools are not available, notify direct support maintenance.

2. Welds: Many items on the Hydraulic Excavator are welded. To check these welds, look for chipped paint, rust, corrosion, or gaps. When these conditions exist, notify direct support maintenance on DA Form 2404.

3. Electrical wires, connectors, and harnesses: Tighten loose connectors. Look for cracked or broken insulation, bare wires, and broken connectors. If any are found, notify direct support maintenance.

4. Hoses and fluid lines: Look for wear, damage, and leaks, and make sure clamps and fittings are tight. Wet spots mean a leak. A stain by a fitting or connector can also mean a leak. When you find a leak, notify direct support maintenance.

A-4. LUBRICATION SERVICE INTERVALS-NORMAL CONDITIONS

For safer, more trouble-free operations, make sure that the Hydraulic Excavator is serviced in accordance with the proper lubrication and service intervals specified in the PMCS.

A-5. LUBRICATION SERVICE INTERVALS-UNUSUAL CONDITIONS

The Hydraulic Excavator will require extra service and care when you operate under unusual conditions. High or low temperatures, long periods of hard use, or continued use, in sand, water, mud, or snow will break down the lubricant requiring you to add or change lubricant more often.

A-6. AOAP SAMPLING

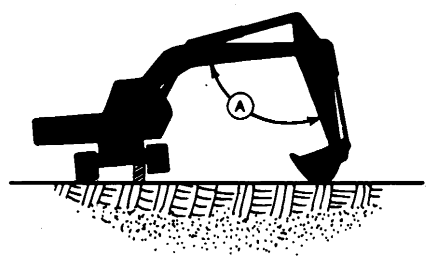
Engine oil must be sampled at 50 hours of operation or 90 days, and hydraulic oil must be sampled once a year as prescribed by DA PAM 738-750, Functional Users Guide for The Army Maintenance Management System (TAMMS). For equipment under manufacturer’s warranty, hard-time oil service intervals shall be followed. Intervals shall be shortened if lubricants are known to be contaminated, or if operation is under adverse conditions (such as longer-than-usual operating hours, extended idling periods, extreme dust).

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		WARNING: Always remember the CAUTIONS, WARNINGS, and NOTES before operating this machine and prior to PMCS.	
		PREPARE MACHINE FOR MAINTENANCE	
		Before performing PMCS and before leaving the operator's seat, park the machine as described below unless another position is specified in the procedure.	
		(1) Park machine on a level surface.	
		(2) Lower bucket to the ground.	
		(3) Turn auto-idle switch off.	
		CAUTION: Turbocharger may be damaged if engine is not properly shut down.	
		(4) Run engine with engine rpm dial at 1/3 position without load for 2 minutes.	
		(5) Move engine rpm dial to slow idle position.	
		(6) Turn key switch to OFF. Remove key from switch.	
		(7) Pull pilot control shut-off lever to locked position.	
1	*As Required	Check Track Sag	
		(1) Swing upperstructure 90 degrees and lower bucket to raise track off ground.	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:

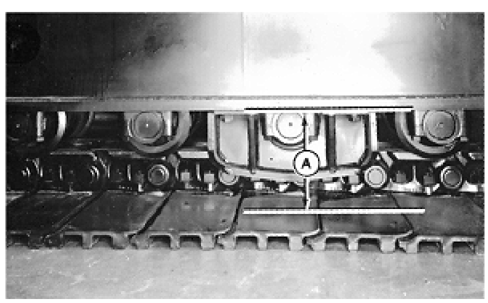


(2) Keep the angle (A) between 90—110 degrees and position bucket's round side on the ground.

WARNING: Prevent possible injury from unexpected machine movement. Place blocks under frame to support machine while measuring track sag.

(3) Place blocks under machine to support machine.

(4) Rotate track forward two full rotations and then in reverse two full rotations.

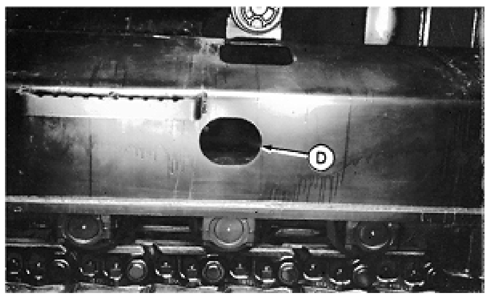
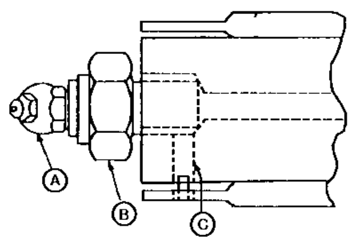


(5) Measure the distance (A) at middle track roller from bottom of track frame to top surface of track shoe.

TRACK SAG SPECIFICATIONS

Normal Ground Conditions	300—335 mm (11-13/16—13-3/16 in.)

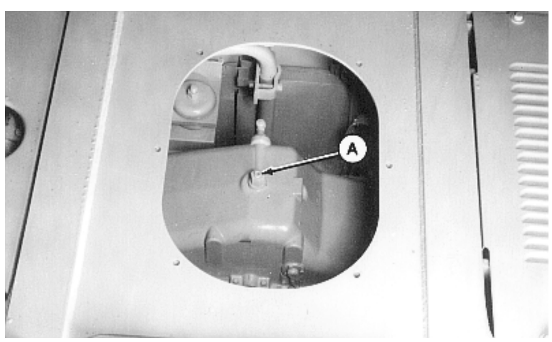
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
2	*As Required	Adjust Track Sag	
		CAUTION: Prevent possible damage to track components. DO NOT use the grease fitting on the track-adjusting cylinder for lubrication. Use this fitting ONLY for track adjustment.	
			
			
		(1) To tighten track, connect grease gun to grease fitting (A) (located through access hole [D]) in track frame. Add grease until sag is within specifications (see Fuels and Lubricants, Chapter 1).	
		WARNING: Prevent possible injury from high-pressure grease. Do not remove grease fitting (A) from nut (B).	
		(2) To loosen track, slowly turn nut (B) counter-clockwise; grease will escape through the bleed hole (C).	
		(3) When track sag is within specifications, torque nut (B) to 147 N•m (108 lb-ft).	Cannot adjust track sag
		TRACK SAG SPECIFICATIONS Normal Ground Conditions 300—335 mm (11-13/16—13-3/16 in.)	

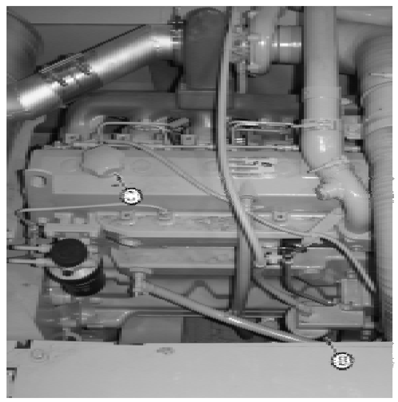
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
3	Monthly	Clean Quick-Disconnect Hitch Cavity and Grease Safety Lock Pin (1) Remove quick-disconnect hitch cover by removing four cap screws and washers. (2) Clean dirt and debris from quick-disconnect hitch cavity. (3) Apply grease to safety lock pin tube until grease is visible at ends of tube (see Fuels and Lubricants, Chapter 1). (4) Install hitch cover.	
4	Monthly	Check Quick-Disconnect Hitch for Loose Bolts and Nuts (1) Ensure that all bolts are within proper torque specifications.	
5	Monthly	Check Arctic Starter Glow Pin (1) Check glow pin for wear or damage. Replace if necessary.	
6	Monthly	Check Arctic Starter Coolant Hoses and Clamps (1) Check coolant hoses for wear, cracking, or leaks. Replace if necessary. (2) Check clamp tightness and for wear or damage. Replace if necessary.	Any Class III leak evident
7	Monthly	Check All Arctic Starter Electrical Lines and Connections (1) Visually check all electrical lines and connections for corrosion. Replace if necessary.	
8	Monthly	Change Engine Oil and Replace Filter **NOTE: If fuel sulfur content exceeds 0.5 percent, change the engine oil at 1/2 the normal interval.** **NOTE: If the engine has not run 250 hours before the season changes, change oil.** (1) Run engine to warm oil.	

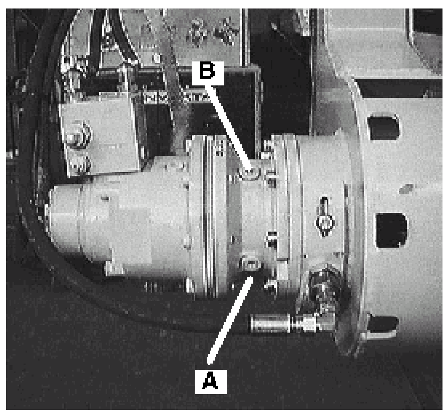
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		(2) Park machine on level surface. (3) Lower bucket to the ground. (4) Turn auto-idle switch off. **CAUTION: Turbocharger may be damaged if engine is not properly shut down.** (5) Run engine with engine rpm dial at 1/3 position without load for 2 minutes. (6) Move engine rpm dial to slow idle. (7) Turn key switch to OFF. Remove key from switch. (8) Attach a “Do Not Operate” tag on the right control lever. (9) Pull pilot control shut-off lever to locked position.  (10) Remove cover from under the engine. Remove drain plug (A) from bottom of engine oil pan, or open drain valve on side of engine oil pan. Allow oil to drain into a container. Dispose of waste properly.	

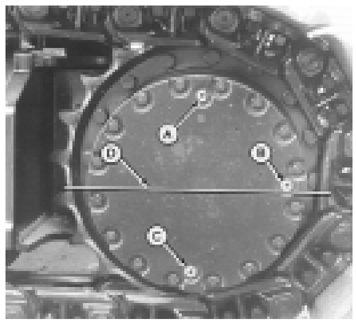
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		(11) Turn filter (B) counterclockwise to remove. Clean mounting surface on base.	
		(12) Apply a thin film of oil to rubber gasket of new filter.	
			
		(13) Install new filter. Turn filter clockwise by hand until gasket touches mounting surface.	
		(14) Tighten filter 1/2—3/4 turns more.	
		(15) Install drain plug or close drain valve.	
		(16) Remove fill cap (C).	
		(17) Fill engine with oil (see Fuels and Lubricants, Chapter 13).	
		SPECIFICATION Oil Capacity With Filter Change 19 L (20 qt)	
		(18) Install fill cap.	
		(19) Start engine.	
		NOTE: Engine oil pressure indicator on monitor must go out within 15—20 seconds. If not, stop the engine immediately and find the cause.	
		(20) Stop engine. Check oil level.	
		(21) Check for any leakage at filter. If so, tighten filter just enough to stop leakage and repeat steps 19 through 21.	

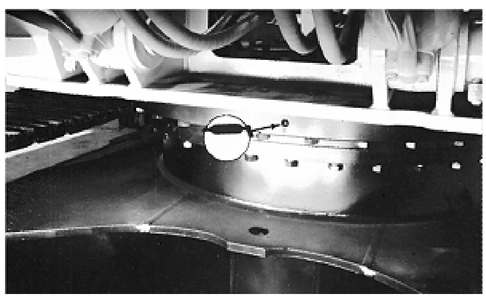
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		(22) Install cover from under the engine.	
9	Monthly	Change Rod Changer Reducer Oil on Rock Drill (Model 230LCRD Only) **NOTE: Change rod changer reducer oil at 150 hours if it is the first time the oil is being changed. Change guide reducer oil annually (2000 hours) afterwards.** (1) Lower rock drill attachment to rest position.  (2) Remove plugs (A) and (B). Drain oil. (3) Install plug (A). (4) Fill reducer with oil (see Fuels and Lubricants, Chapter 1). **SPECIFICATION** Rod Changer Reducer 0.3 L (0.27 qt)	
10	Quarterly	Check Rock Drill Drifter Accumulator Charge (Model 230LCRD Only)	

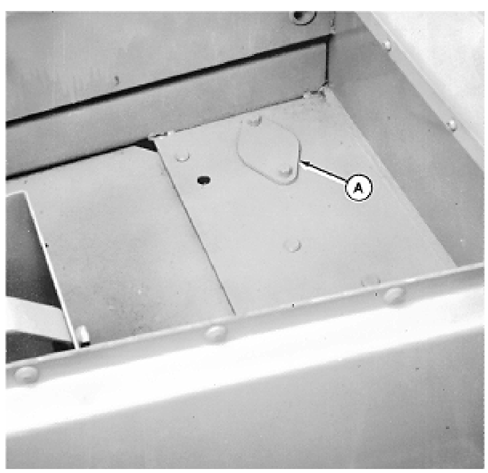
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
11	Quarterly	Check Propel Gearbox Oil  (1) Park machine on level ground rotating propel gearbox until bottom of the oil level check plug (B) is even with the horizontal centerline (D). (2) Lower boom to the ground. (3) Turn auto-idle switch off. (4) Run engine with engine rpm dial at 1/3 position without load for 2 minutes. **CAUTION: Turbocharger may be damaged if engine is not properly shut down.** (5) Move engine rpm dial to slow idle and turn key switch to OFF. Remove key switch. (6) Attach a “Do Not Operate” tag on the right control lever. (7) Pull pilot control shut-off lever to locked position. **WARNING: High-pressure release of fluids from pressurized system can cause serious burns. Wait for propel gearbox oil to cool. Keep body and face away from check plug. Gradually loosen check plug to release pressure.** (8) After propel gearbox has cooled, slowly loosen check plug (B) to release pressure. (9) Remove check plug (B). Oil must be to bottom of hole. (10) If necessary, remove fill plug (A).	

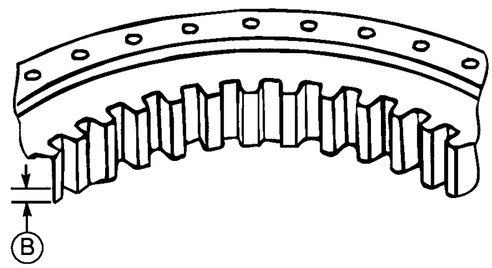
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		(11) Add oil until oil flows out of level check plug hole (see Fuels and Lubricants, Chapter 1). (12) Wrap threads of check plug and fill plug with sealing-type tape. Install plugs. Tighten plugs to 49 N•m (430 lb-in.). (13) Change oil of second propel gearbox.	
12	Quarterly	Grease Swing Bearing **WARNING: Prevent possible injury from unexpected machine movement if another person moves controls. One person must do lubricating of swing bearing and rotating the upperstructure. Before you lubricate swing bearing, clear area of all personnel.**  (1) Park machine on level surface. (2) Lower bucket to the ground. (3) Turn auto-idle switch off. **CAUTION: Turbocharger may be damaged if engine is not properly shut down.** (4) Run engine with engine rpm dial at 1/3 position without load for 2 minutes. (5) Move engine rpm dial to slow idle position. (6) Turn key switch to OFF position. Remove key from switch. (7) Attach a “Do Not Operate” tag on the right control lever.	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		(8) Pull pilot control shut-off lever to locked position. (9) Lubricate swing bearing with 10 shots of grease at both grease fittings. (10) Start engine. Raise bucket several inches off the ground and rotate the upperstructure 45 degrees. (11) Repeat steps 2 through 9 three times. **NOTE: It is not necessary to start the engine the last time.**	
13	Quarterly	Grease Swing Bearing Gear **WARNING: Prevent possible injury from unexpected machine movement if another person moves controls. One person must do lubricating of swing bearing gear and rotating the upperstructure. Before you lubricate swing bearing gear clear area of all personnel.**  (1) Use a wrench to remove access cover (A) to swing gear.	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

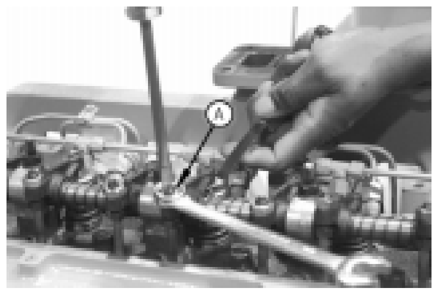
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		 B (2) Check grease: a. Grease must be 13—25 mm (1/2—1in.) (B) deep. Measured from the bottom of the swing gear. b. The grease must be free of contamination by dirt and water. If the grease is contaminated, remove grease and replace with clean grease (see Fuels and Lubricants, Chapter 1). **NOTE: If water or mud is found in swing gear area, refer to “Operating in Water and Mud” in the Operating the Machine section.** (3) Add grease as required (approximately 0.113 kg [1/4 lb] every 90°). **CAUTION: Excessive grease can damage the swing gearbox seal.** (4) Remove excessive grease that extrudes over the top of the swing drive pinion. (5) Install access cover.	

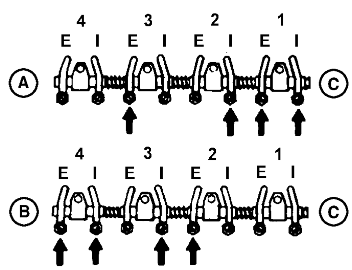
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
14	Quarterly	Inspect Air Intake Hoses	
			
		(1) Inspect hoses (A) for cracks and leaks. If hoses have cracks or leaks, replace as necessary.	Any damage that would prevent operation
		(2) Tighten clamps.	
		NOTE: Items 15 through 21 are applicable to Model 230LCRD only.	
15	Quarterly	Clean Exterior of Compressor Oil Cooler and Engine Radiator	
		(1) Remove two bolts and open compressor right side access door.	
		(2) Check radiator for damage and remove any debris from radiator screen.	Any damage that would prevent operation
		(3) Clean exterior of oil cooler.	
		NOTE: Ensure that access door is closed securely after inspection is complete.	
16	Quarterly	Check Compressor for Loose or Missing Bolts, Clamps, Nuts, and Screws	Loose or missing hardware
17	Quarterly	Check Compressor Air Cleaner Elements	
		(1) Inspect elements for damage or dirt. Replace as necessary.	
18	Quarterly	Replace Engine Oil and Filter of Compressor (Refer to Fuels and Lubricants, Chapter 1.)	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
19	Quarterly	Check Valve Lash of Compressor Engine (Refer to Annually – Check and Adjust Engine Valve Lash)	
20	Quarterly	Adjust Valve Clearances (4-Cylinder Engine)	





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

A - No. 1 TDC compression stroke
B - No. 1 TDC exhaust stroke
C - Fan end of engine

(1) Adjust No. 1 and 3 exhaust valves and No. 1 and 2 intake valves.

VALVE CLEARANCE SPECIFICATIONS

Exhaust Valves (E)	0.46 mm (0.018 in.)
Intake Valves (I)	0.36 mm (0.014 in.)

(2) Rotate engine 360° and repeat step 1 for the remaining intake and exhaust valves.

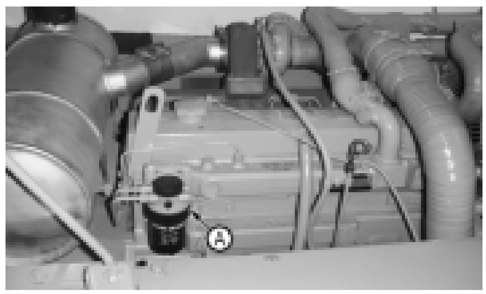
(3) Tighten jam nut to 27 N•m (20 lb-ft).

(4) Clean cylinder head and rocker arm cover mating surfaces.

(5) Install rocker arm gasket. Do not use sealant on gasket.

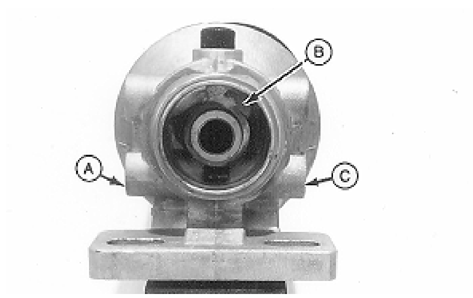
(6) Install rocker arm cover. Tighten screws to 35 N•m (26 lb-ft). Do not overtighten cap screws.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		(7) Remove turning tool and timing pin. (8) Install parts. Center muffler to turbocharger inlet tube before fastening muffler into place.	
21	Quarterly	Check Crankcase Breather of Compressor Engine	
22	Quarterly	Replace Final Fuel Filter  (1) Turn retaining ring (A) clockwise to remove filter. Allow sediment to drain into a container. Dispose of waste properly. (2) Clean filter base. (3) Install new filter. (4) Bleed fuel system. (Refer to Bleed Fuel System in the Engine Auxiliary System Repair chapter.)	
23	Quarterly	Replace Primary Fuel Filter (Water Separator)  (1) Turn retaining ring (A) counterclockwise to remove filter (B). Allow sediment to drain into a container. Dispose of waste properly. (2) Turn sediment bowl (C) counterclockwise to remove from assembly. Clean bowl.	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		(3) Remove hand primer from fuel filter base. Disassemble hand primer assembly.	



ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		(4) Remove fuel inlet line (A) and plug (C). (5) Flush any debris from filter base. (6) Install fuel inlet plug and fuel inlet line. (7) Assemble primer assembly and install onto fuel filter base. (8) Install new filter. (Follow instructions on filter.) (9) Install sediment bowl. (10) Bleed fuel system. (Refer to Bleed Fuel System in the Engine Auxiliary System Repair chapter.)	
24	Quarterly	Replace Hydraulic Oil Filter (1) Park machine on level surface. (2) Position machine with arm cylinder fully retracted and bucket cylinder fully extended.	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:

(3) Lower bucket to the ground.

(4) Turn auto-idle switch off.

CAUTION: Turbocharger may be damaged if engine is not properly shut down.

(5) Run engine with rpm dial at 1/3 position without load for 2 minutes.

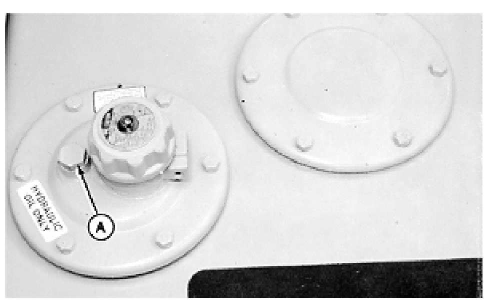
(6) Move engine rpm dial to slow idle position.

(7) Turn key switch to OFF. Remove key from switch.

(8) Attach a "Do Not Operate" tag on the right control lever.

(9) Pull pilot control shut-off lever to locked position.

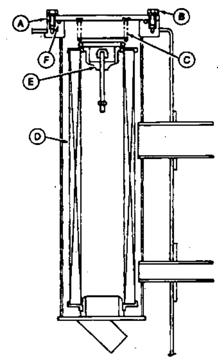
WARNING: High-pressure release of oil from pressurized system can cause serious burns or penetrating injury. The hydraulic tank is pressurized. Do not remove vent plug (A). Release pressure by loosening vent plug.



(10) Loosen vent plug (A) to release hydraulic pressure.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:



(11) Hold down filter cover (A) against light spring load when removing the last two cap screws.

(12) Remove spring (C), valve (E), and element (D).

(13) Remove filter case and discard element and O-ring (F).

WARNING: Prevent possible injury from flying chips if compressed air is more than 210 kPa (2.1 bar) (30 psi). Reduce compressed air to less than 210 kPa (2.1 bar) (30 psi) when using for cleaning purposes. Clean area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

NOTE: Remove element and inspect for metal particles and debris in bottom of filter case. Excessive amounts of brass and steel particles can indicate a hydraulic pump, motor, or valve malfunction, or a malfunction in progress. A rubber type of material can indicate cylinder-packing problem.

(14) Clean filter case with diesel fuel and dry with compressed air.

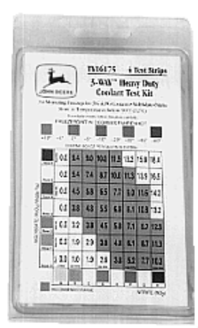
(15) Install filter case, valve (E), and spring (C) in reservoir.

(16) Install filter cover (A) and tighten cap screws (B).

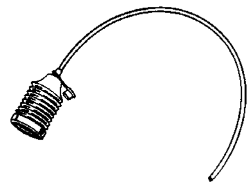
FILTER COVER SPECIFICATIONS

Cap Screws, Cover	49 N•m (36 lb-ft)

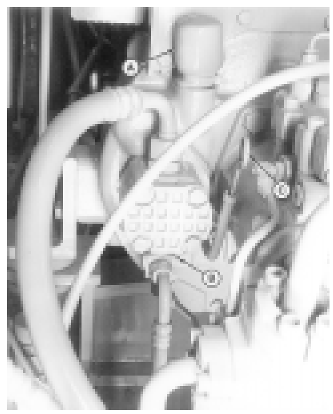
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		(17) Tighten vent plug.	
25	Quarterly	Check Coolant Conditioner  **WARNING: Explosive release of fluids from pressurized cooling system can cause serious burns.** Remove filler cap only when engine is cold or when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely. **CAUTION: John Deere Liquid Conditioner does not protect against freezing. Coolant conditioner prevents rust, scale, and liner cavitation.** **NOTE: Check coolant every 500 hours or 3 months, or when replacing 1/3 or more coolant. Add coolant conditioner as necessary.** (1) Turn cap slowly to release pressure and remove cap. Test coolant solution using one of the following methods.  • **3-Way Heavy-Duty Coolant Test Kit (TY161775)** Coolant test strips provide an effective method to check freeze point and additive levels of engine coolant. Follow instructions on kit.	

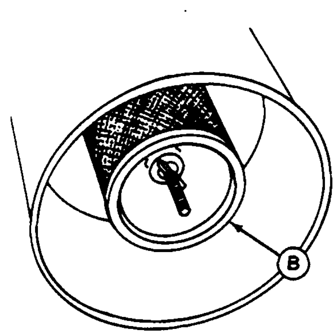
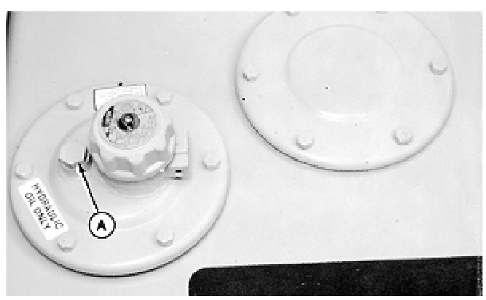
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		 • **Coolscan Plus®** For a more thorough evaluation of coolant, perform Coolscan Plus® analysis. (2) Add TY16004 John Deere Coolant Conditioner or equivalent non-chromate conditioner/rust inhibitor, following instructions on container. **COOLING SYSTEM SPECIFICATION** Cooling System Capacity Approx. 22 L (6 gal)	
26	Quarterly	Check Batteries (Refer to Check Battery Electrolyte Level and Terminals in the Electrical System Repair chapter.)	
27	Semiannually	Change Swing Gearbox Oil  (1) Remove plug (A) to drain oil into a container. Dispose of waste oil properly. (2) Install plug. (3) Remove filler cap (B) and add oil (see Fuels and Lubricants, Chapter 1). **SPECIFICATION** Swing Gearbox Oil Capacity 13 L (14 qt)	

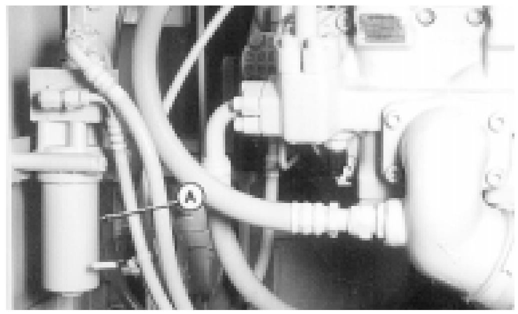
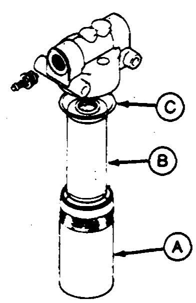
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		(4) Install filler cap. (5) Check oil level on dipstick.	
28	Semiannually	Change Pump Drive Gearbox Oil  (1) Remove filler plug (A). (2) Remove drain plug (B). Allow oil to drain into a container. Dispose of waste oil properly. (3) Apply Liquid TEFLON® Pipe Thread Sealant to drain plug. Install plug. (4) Add oil (see Fuels and Lubricants, Chapter 1). **SPECIFICATION** Pump Gearbox Capacity 1.0 L (1.1 qt) (5) Pull dipstick (C) and check oil level. Oil level must be approximately halfway below “H” (level) mark. (6) Install filler plug and dipstick.	
29	Semiannually	Change Secondary Air Cleaner Element (1) Open front service door. (2) Loosen wing nut to remove cover and primary element. Clean primary element or replace if damaged.	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		 (3) Remove inner wing nut and secondary element (B). (4) Install new secondary element and primary element, making sure that the secondary element is centered in canister. (5) Install cover.	
30	Semiannually	Change Pilot Control Oil Filter  **WARNING: High-pressure release of oil from pressurized system can cause serious burns or penetrating injury. The hydraulic tank is pressurized. Do not remove vent plug (A). Release pressure by loosening vent plug.** (1) Loosen vent plug (A) to relieve air pressure.	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
			
		(2) Remove filter case (A).	
			
		(3) Unscrew filter element (B).	
		(4) Remove O-ring (C).	
		(5) Install new O-ring and filter element.	
		(6) Install filter case (A).	
		SPECIFICATION Filter Case Torque 20—30 N•m (15—22 lb-ft)	
		(7) Tighten vent plug.	
31	Semiannually	Drain Fuel Tank	
32	Semiannually	Inspect Fan Belts	Belt is excessively worn or damaged
		(1) Check belts regularly for wear, especially for cracks at the bottom of grooves and for frayed edges.	

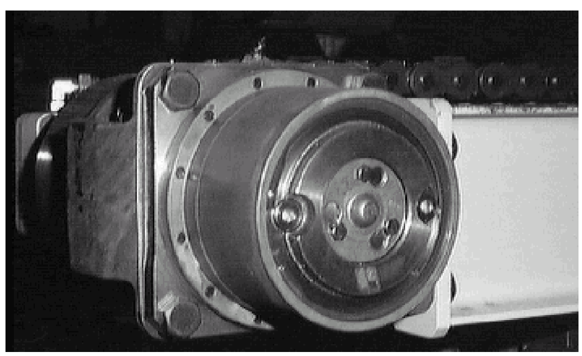
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
33	Semiannually	Replace Air Cleaner Dust Valve	Dust valve is missing or damaged

NOTE: A missing, damaged, or hardened dust valve will cause the air filter elements to be ineffective.

NOTE: Items 34 through 41 are applicable to Model 230LCRD only.

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	EQUIPMENT IS NOT READY/AVAILABLE IF:
34	Semiannually	Change Guide Reducer Oil on Rock Drill	



(1) Lower rock drill attachment to rest position.

(2) Unscrew top filling plug.

(3) Use a syringe to remove old oil.

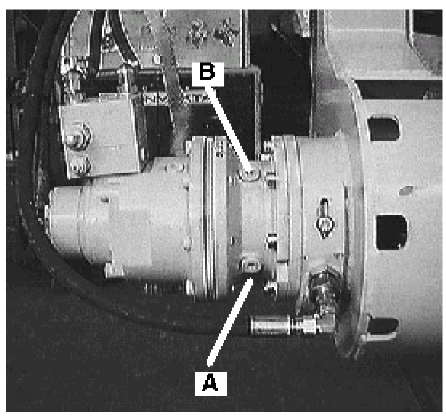
(4) Fill reducer with new oil (see Fuels and Lubricants, Chapter 1).

SPECIFICATION

Reducer Capacity	0.5 L (0.45 qt)

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
35	Semiannually	Lubricate Compressor Governor	
36	Semiannually	Replace Compressor Fuel/Water Element	
37	Semiannually	Replace Compressor Oil	
38	Annually	Check Compressor Shutdown Switch (See Automatic Shutdown System)	
39	Annually	Clean Compressor Scavenger Orifice and Related Parts (See Scavenge Line)	
40	Annually	Replace Compressor Oil Separator Element (See Oil Separator Element)	
41	Annually	Change Rod Changer Reducer Oil on Rock Drill	



(1) Lower rock drill attachment to rest position.

(2) Remove plugs (A) and (B). Drain oil.

(3) Install plug (A).

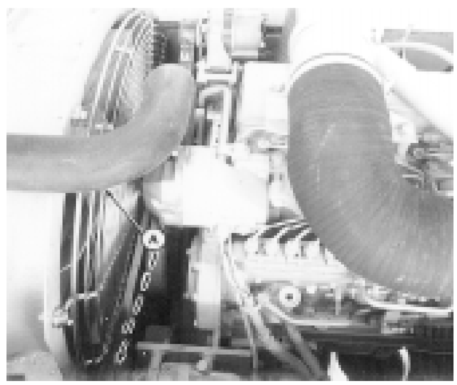
(4) Fill reducer with oil (see Fuels and Lubricants, Chapter 1).

SPECIFICATION

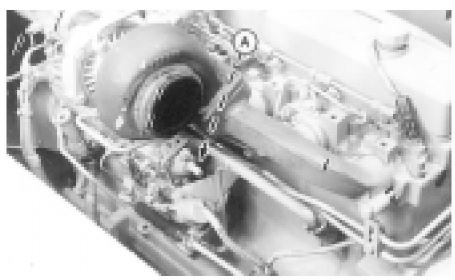
Rod Changer Reducer	0.3 L (0.27 qt)

(5) Install plug (B).

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
42	Annually	Drain Cooling System Replace Cooling System Coolant Drain and flush cooling systems of excavator engine and compressor engine (Model 230LCRD) using commercial products. Replace thermostats and radiator caps, and refill with new coolant. 	
		(1) Check coolant hoses (A) for cracks and leaks. Replace if necessary.	Any Class III leak evident
		(2) Tighten clamps.	
		(3) Check radiators and oil cooler for dirt, grease, leaks, and loose or broken mountings. Clean radiators and oil cooler fins.	Any Class III leak evident
		WARNING: Prevent possible injury from hot spraying water. DO NOT remove radiator cap unless engine is cool. Then turn cap slowly to the stop.	
		(4) Release air to relieve pressure. Remove filler cap.	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		 (5) Turn radiator petcock (A) counterclockwise to open valve. Allow coolant to drain into a container. Dispose of waste properly. **COOLING SYSTEM SPECIFICATION** Cooling Capacity Approx. 22 L (6 gal)  (6) Turn engine block drain cock (A) counter-clockwise to drain engine block. Drain coolant into a container. Dispose of waste properly.	
43	Annually	Perform Cooling System Fill and Deaeration Procedure **COOLING SYSTEM SPECIFICATION** Cooling Capacity Approx. 22 L (6 gal) **CAUTION: Use only permanent-type low silicate ethylene glycol base antifreeze in coolant solution. Other types of antifreeze may cause damage to cylinder seals.** **FREEZING TEMPERATURES**: Fill with permanent-type low silicate ethylene glycol base antifreeze (without stop-leak additive) and clean, soft water.	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

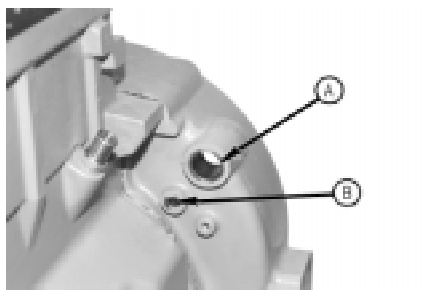
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		FILL	
		Fill radiators to the bottom of the radiator fill necks.	
		Fill the recovery tank to FULL mark.	
		DEAERATION	
		The cooling system requires several warm-up and cool down cycles to deaerate. It will NOT deaerate during normal operation. Only during warm-up and cool down cycles will the system deaerate.	
		(1) Start engine. Run engine until coolant reaches a warm temperature.	
		(2) Stop engine. Allow coolant to cool.	
		(3) Check coolant level at recovery tank.	
		(4) Repeat steps 1 through 3 until recovery tank is repeatedly at the same level (stabilized).	
		NOTE: The level of the coolant in the cooling system MUST BE repeatedly checked after all drain and refill procedures to ensure that all air is out of the system which allows the coolant to stabilize. Check coolant level only when the engine is cold.	
		(5) If necessary, fill recovery tank to FULL mark.	
		(6) Install recovery tank and radiator caps.	
44	Annually	Check and Adjust Engine Valve Lash (Clearance)	
		CAUTION: Valve clearance MUST BE checked and adjusted with engine COLD.	
		CAUTION: Prevent accidental starting of engine while performing valve adjustments. Always disconnect NEGATIVE (-) battery terminal.	
		(1) Remove rocker arm cover and engine crankcase ventilation tube. Clean tube with solvent or diesel fuel. Inspect rocker arm O-ring.	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:

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

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



(2) Remove plug (A). Install JDG 820 Flywheel Turning Tool. Remove cap screw (B). Install JDE-81-4 Timing Pin.

(3) Turn flywheel until timing pin goes into flywheel.

(4) Using engine rotation tool, rotate engine flywheel in running direction (clockwise viewed from front) until No. 1 cylinder is at “TDC” Compression stroke.

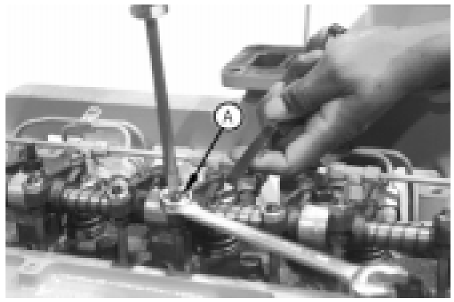
If No. 1 cylinder rocker arms are loose, the engine is at No. 1 “TDC” Compression. If No. 1 cylinder rocker arms are not loose, rotate engine one full revolution (360°) to No. 1 “TDC” Compression.

To change piston position, remove timing pin and rotate flywheel.

(5) Check and adjust valve clearance to specifications as directed in following procedures.

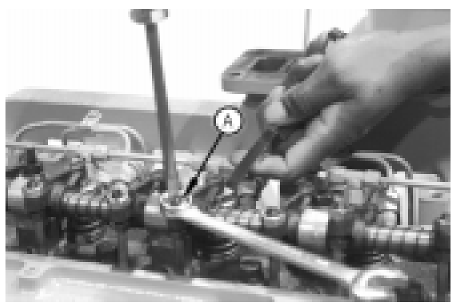
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

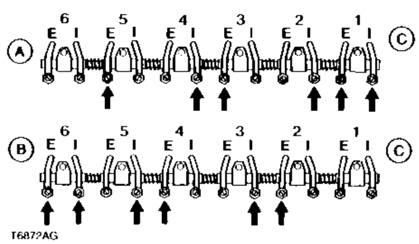
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:



(6) Loosen jam nut (A) and adjust clearance with a screwdriver, as shown.

45	Annually	Adjust Valve Clearances (6-Cylinder Engine)	





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

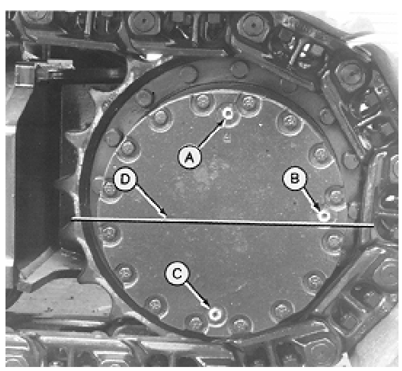
A - No. 1 TDC compression stroke
B - No. 1 TDC exhaust stroke
C - Fan end of engine

(1) Adjust No. 1, 3, and 5 exhaust valves and No. 1, 2, and 4 intake valves.

VALVE CLEARANCE SPECIFICATIONS

Exhaust Valves (E)	0.46 mm (0.018 in.)
Intake Valves (I)	0.36 mm (0.014 in.)

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		(2) Rotate engine 360° and repeat step 1 for the remaining intake and exhaust valves. (3) Tighten jam nut to 27 N•m (20 lb-ft). (4) Clean cylinder head and rocker arm cover mating surfaces. (5) Install rocker arm gasket. Do not use sealant on gasket. (6) Install rocker arm cover. Tighten screws to 35 N•m (26 lb-ft). Do not overtighten cap screws. (7) Remove turning tool and timing pin. (8) Install parts. Center muffler to turbocharger inlet tube before fastening muffler into place.	
46	Annually	Change Propel Gearbox Oil  (1) Park machine on level ground rotating propel gearbox until bottom of the oil level check plug (B) is even with the horizontal centerline (D). (2) Lower boom to the ground. (3) Turn auto-idle switch off. (4) Run engine with engine rpm dial at 1/3 position without load for 2 minutes. **CAUTION: Turbocharger may be damaged if engine is not properly shut down.**	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
		(5) Move engine rpm dial to slow idle and turn key switch to OFF. Remove key switch. (6) Attach a “Do Not Operate” tag on the right control lever. (7) Pull pilot control shut-off lever to locked position. **WARNING: High-pressure release of fluids from pressurized system can cause serious burns. Wait for propel gearbox oil to cool. Keep body and face away from check plug. Gradually loosen check plug to release pressure.** (8) After propel gearbox has cooled, slowly loosen check plug (B) to release pressure. (9) Remove drain plug (C). Allow oil to drain into a container. Dispose of waste properly. **SPECIFICATION** Propel Gearbox Oil Capacity Approx. 6 L (6.5 qt) (each) (10) Wrap threads of drain plug with a sealing-type tape. Install plug. Tighten to 49 N•m (430 lb-in.). (11) Remove fill plug (A). (12) Add oil until oil flows out of level check plug hole (see Fuels and Lubricants, Chapter 1). (13) Wrap threads of check plug and fill plug with sealing-type tape. Install plugs. Tighten plugs to 49 N•m (430 lb-in.). (14) Change oil of second propel gearbox.	

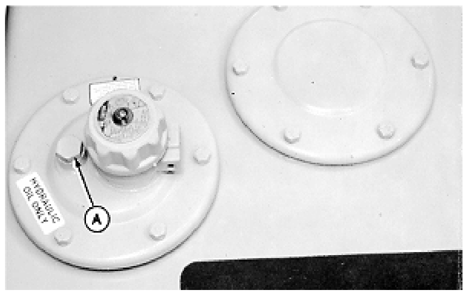
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
47	Annually	Change Hydraulic Oil **CAUTION: DO NOT run engine without oil in the tank.**  (1) Park machine on level surface. (2) Position machine with arm cylinder fully retracted and bucket cylinder fully extended. (3) Lower bucket to the ground. (4) Turn auto-idle switch off. **CAUTION: Turbocharger may be damaged if engine is not properly shut down.** (5) Run engine with rpm dial at 1/3 position without load for 2 minutes. (6) Move engine rpm dial to slow idle position. (7) Turn key switch to OFF. Remove key from switch. (8) Attach a “Do Not Operate” tag on the right control lever. (9) Pull pilot control shut-off lever to locked position.	

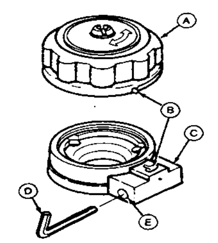
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:

WARNING: High-pressure release of oil from pressurized system can cause serious burns or penetrating injury. The hydraulic tank is pressurized. Do not remove vent plug (A). Release pressure by loosening vent plug.

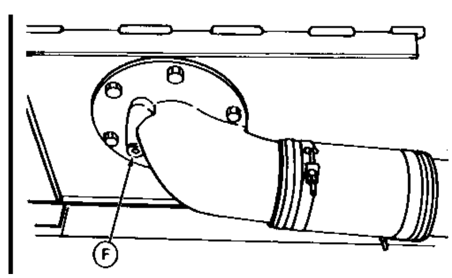


(10) Loosen vent plug (A) to release hydraulic pressure.



(11) Insert 4 mm (0.15 in.) Allen wrench (D) into hole (E) and turn counterclockwise.

(12) Slowly turn cap (A) counterclockwise and remove.



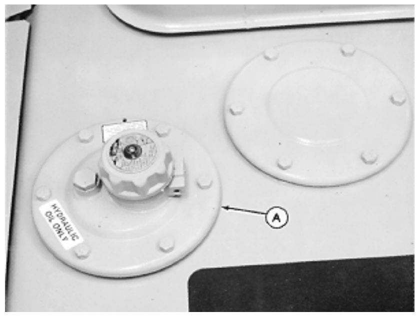
(13) Remove drain plug (F). Allow oil to drain into a container. Dispose of waste properly.

SPECIFICATION

Hydraulic Tank Oil Capacity 148 L (39 gal)

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:

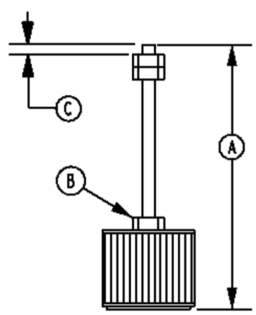


(14) Remove cover (A) with suction filter.

(15) Clean inside of tank and suction filter.

(16) Change hydraulic oil filter. (Refer to Quarterly services.)

(17) Change pilot control oil filter. (Refer to Semi-Annual services.)



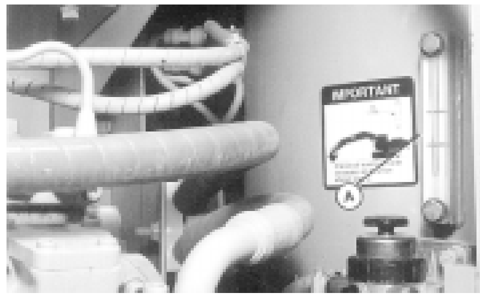
(18) Install suction screen with cover. Suction screen must seal against outlet pipe in bottom of tank. If necessary, loosen nut (B) to adjust rod length.

SPECIFICATIONS

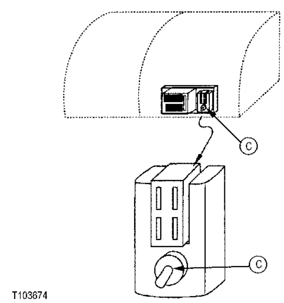
Suction Screen Rod Length (A)	670 mm (26.4 in.)
Suction Screen Rod Torque	17 N•m (12.5 lb-ft)
Top of Rod to Top of Rod Nut (C)	20 mm (0.8 in.)
Cover Cap Screw Torque	49 N•m (36 lb-ft)

(19) Install tank drain plug and bottom guard.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
			
		(20) Add oil until it is between marks on sight glass (A) (see Fuels and Lubricants, Chapter 1).	
		CAUTION: If the hydraulic pump is not filled with oil, it will be damaged when the engine is started.	
			
		(21) Remove air bleed plugs (C) from hydraulic pump until oil flows from bleed lines.	
		(22) Install air bleed plugs in hydraulic pump.	
		(23) Install cap.	
48	Annually	Engine Crankcase Ventilation Tube	Tube is clogged
			
		Clean the engine ventilation tube (A) when you measure and adjust engine valve clearance (lash).	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
49	Annually	Check Engine Speeds (1) Warm engine to normal operating temperature. (2) Connect a tachometer to check engine speeds. (3) Turn engine rpm dial to slow idle to check slow idle speed. (4) Turn engine rpm dial to fast idle to check fast idle speed. **SPECIFICATIONS** Slow Idle 900 ± 25 rpm Fast Idle in Standard Mode 2180 ± 25 rpm	
50	Annually	Perform Engine Speed Learning Procedure  (1) Stop engine. (2) Push engine learning switch (C) up to top position. Make sure that it is in the top position. (3) Turn key switch ON. Wait 5 seconds. (4) Turn key switch OFF. Wait 5 seconds. (5) Push engine learning switch to middle position. (6) Check engine speeds. **SPECIFICATIONS** Slow Idle 900 ± 25 rpm Auto Idle 1200 ± 25 rpm E (Economy) Mode 1980 ± 25 rpm Fast Idle in Standard Mode 2180 ± 25 rpm **NOTE: If engine RPM is not to specifications, contact direct support maintenance.**	

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR HYDRAULIC EXCAVATOR 230LCR/230LCRD

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED PROCEDURE: DO THE PMCS AND HAVE ITEM REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
51	Every 3 Years	Replace Seat Belt (1) Replace the complete seat belt assembly regardless of appearance. A date label, to determine the age of the belt, is attached to each belt.	
52	Every 1000 Meters (3281 Feet) Drilled	Rock Drill Drifter (1) Check rock drill drifter shank and flushing nozzle bronze bushing for wear/damage. (For procedures and specifications, refer to Drifter maintenance in this manual.)	Excessive wear of bushing or damage to spline shank

BLANK

APPENDIX B
MAINTENANCE ALLOCATION CHART
FOR HYDRAULIC EXCAVATOR 230LCR AND 230LCRD

Section I. INTRODUCTION

B-1. GENERAL

This Maintenance Allocation Chart (MAC) designates responsibility for performance of maintenance repair functions at specified levels.

a. Section I. INTRODUCTION. This is a general explanation and definition of terms.

b. Section II. MAINTENANCE ALLOCATION CHART. This listing shows the maintenance level responsible and estimated work measurement time for specific functions.

c. Section III. TOOLS AND TEST EQUIPMENT REQUIREMENTS. This section lists common tool sets and the special tools, test, and support equipment required for each maintenance function shown in Section II.

d. Section IV. REMARKS. This lists the remarks referenced in Section II.

B-2. EXPLANATION OF COLUMNS IN SECTION II

a. Column (1) – Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column (2) – Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column (3) – Maintenance Function. Column 3 lists the functions to be performed on the item listed in Column 2. (For a detailed explanation of these functions refer to “Maintenance Functions” outlined below.

d. Column (4) – Maintenance Level. Column 4 specifies, by the listing of a “work time” figure in the appropriate subcolumn(s), the level of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated level of maintenance. If the number or level of the tasks within the listed maintenance function vary at different maintenance levels, appropriate work time figures will be shown for each level. The number of man-hours specified by the work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the MAC. This figure does not include any time for performance of preliminary tasks listed elsewhere in the MAC; e.g., removal of engine under repair of fuel pump, when the engine is listed separately in the MAC. The symbol designations for the various maintenance categories remain as follows:

C – Operator/Crew
O – Unit Maintenance
F – Direct Support Maintenance
H – General Support Maintenance
D – Depot Maintenance

e. Column (5) – Tools and Equipment. Column 5 specifies, by code those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated functions.

f. Column (6) – Remarks. Column 6 references any amplifying remarks.

B-3. MAINTENANCE FUNCTIONS DEFINED

a. Inspect. To closely and critically examine (e,g., sight, sound, or feel) an item to detect errors, flaws, wear, etc., and to determine its condition and serviceability by comparing its physical mechanical/electrical characteristics within established standards.

b. Test. To verify serviceability and detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition: i.e. to clean (decontaminate), to preserve, to drain, to paint or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Consists of comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part. or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. Replace. The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, or replace) or other maintenance actions (welding, grinding, riveting, straightening, facing remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is the normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to a like-new condition.

B-4. EXPLANATION OF COLUMNS IN SECTION III

a. Column (1) – Tool or Test Equipment Reference Code. The tool or test equipment reference code correlates with a code in Column 5 of the MAC.

b. Column (2) – Maintenance Level. The lowest level of maintenance authorized to use the tool or test equipment.

c. Column (3) – Nomenclature. Name or identification of the tool or test equipment.

d. Column (4) – National/NATO Stock Number. The NSN/NATO Stock Number of the tool or test equipment.

e. Column (5) – Tool Number. The manufacturer's part number, model number, or type number.

B-5. EXPLANATION OF COLUMNS IN SECTION IV

a. Column (1) – Reference Code. The code recorded in Column 6 of the MAC.

b. Column (2) – Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC.

B-6. JOHN DEERE FUNCTIONAL GROUP CODING

The MAC is arranged in accordance with the following John Deere functional group coding:

01 Tracks
02 Axles and Suspension Systems
04 Engine
05 Engine Auxiliary Systems
16 Electrical System
17 Frame, Chassis or Supporting Structure
18 Operator's Station
20 Safety and Convenience
21 Main Hydraulic System
22 Pneumatic Systems
33 Excavator
43 Swing or Pivoting System
44 Cutting Mechanisms

Section II. MAINTENANCE ALLOCATION CHART FOR 230LCR AND 230LCRD

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
01	TRACKS								
0130	Track System	Inspect	0.5	0.5				2	
		Service	2.0	2.0					
		Adjust	0.5	0.5					
		Repair			6.0			1	
	Track Adjuster Cylinder	Replace			2.0			1, 4	
		Repair			3.0			1, 4	B
	Track Adjuster and Recoil Spring	Replace			1.8				
		Repair			3.0			1, 4	B
0132	Track Chain	Inspect	0.5						
		Test			0.5				
		Replace			7.8			1	
		Repair			11.8			1	B
	Track Shoe	Inspect	0.5						
		Test			0.5				
		Replace			7.8			1	
0133	Front Idler	Test			1.0			3	
		Replace			1.4			1	
		Repair			4.0			1	A
	Track Carrier Roller	Inspect			0.5				
		Test			0.5				
		Replace			0.5			1	
		Repair			12.3			1	
	Track Roller	Inspect		0.5					
		Test		0.5					
		Replace			7.8			1	
		Repair			8.0			1	A
02	AXLES AND SUSPENSION SYSTEMS								
0250	Axle Shaft, Bearings, and Reduction Gears	Inspect			0.5				
		Replace				7.0		1	
		Repair				15.0		1	

Section II. MAINTENANCE ALLOCATION CHART FOR 230LCR AND 230LCRD (Cont'd)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
	Propel Gearbox	Inspect		0.5					
		Service		1.0					
		Replace			13.3			1	
		Repair				14.8		1	
0260	Hydraulic System								
	Rotary Manifold	Test		0.5				1	
		Replace			2.0			1	
		Repair			2.4			1	
0262	Propel Motor Brake Valve Housing	Test		0.5					
		Replace			2.0			1	
		Repair			1.5			1	
0267	Propel Motor and Brake	Replace			2.0			1	
		Repair			1.5			1	
04	ENGINE (4.5L and 6.8L)								
0400	Engine	Inspect	0.2	1.0					
		Test		2.5					
		Service	0.2	1.2					
		Adjust		1.0					
		Replace			6.1			1, 5, 6, 28, 33	
		Repair				16.0		1, 5, 6, 28, 33, 64, 65	D
		Overhaul					36.5	1	E
0401	Crankshaft, Main Bearings and Flywheel	Inspect				0.5			
		Replace				13.0		1, 7, 54, 60, 62, 14-31	
0402	Rocker Arm Shaft Assembly	Inspect			0.5				
		Replace			8.0			1	
	Camshaft, Balancer Shafts and Timing Gear Train	Inspect				0.5			
		Replace				11.6		1, 6, 32, 33	

Section II. MAINTENANCE ALLOCATION CHART FOR 230LCR AND 230LCRD (Cont'd)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0404	Cylinder Block Liners, Pistons and Rods	Inspect				0.5			
		Replace				24.8		1	
		Repair				6.9		1	
0407	Engine Oiling System	Inspect		1.0	1.0				
		Service	0.3	0.5					
	Engine Oil Pump	Inspect			3.0				
		Replace			3.0			1	
		Repair			3.3			1	
	Engine Oil Filter Base	Inspect		0.1					
		Replace		0.3				1	
	Engine Oil Filter Element	Replace		0.5				1	
	Oil Bypass Valve	Inspect		0.5					
		Replace		1.0				1	E
	Pressure Regulating Valve	Inspect		0.5					
		Replace		1.0				1	
0409	Cylinder Head and Valves	Inspect			0.5				
		Adjust			2.0				
		Replace			7.0			1, 57-59	
		Repair			6.8			1, 57-59	
0410	Exhaust Manifold	Replace			1.6			1	
0413	Fuel Injection System	Service			1.0				
	Fuel Supply Pump	Inspect	0.1	0.5					
		Test		0.3					
		Replace		1.0				1	
	Fuel Injection Pump	Replace			2.0			1, 8, 56, 61	
		Repair					4.0	1, 8, 56, 61	
	Fuel Injection Nozzle	Inspect		0.5					
		Test			0.5			1	F
		Replace				1.0		1, 34, 35	
		Repair				0.6		1, 34, 35, 51, 52	

Section II. MAINTENANCE ALLOCATION CHART FOR 230LCR AND 230LCRD (Cont'd)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0414	Air Intake System	Inspect	0.5	0.5					
		Test		0.3				1	
0416	Turbocharger	Inspect	0.5	0.5					
		Replace			1.5			1	
0417	Water Pump Assembly	Inspect		0.5					
		Replace		2.2				1	
		Repair			1.8			1, 53	
0418	Water Manifold/ Thermostat and Thermostat Cover	Test		0.3					
		Replace		0.9				1	
0419	Engine Oil Cooler	Inspect	0.2	0.5					
		Replace			1.0			1	
0420	Fuel Filter/Water Separator	Service	0.5	0.5					
		Replace		1.6				1	
0429	Belt Tensioner	Inspect	0.5	0.5					
		Adjust			1.0				
		Replace		0.6				1	
	Fan Drive Assembly	Inspect		0.5					
		Adjust			1.0				
		Replace			1.7			1	
0433	Engine Flywheel	Inspect			0.5				
		Replace			3.3			1	
		Repair			8.0			1	
05	ENGINE AUXILIARY SYSTEMS								
0505B	Cold Weather Starting Aid	Inspect		0.5					
		Replace			1.5			1	
		Repair			2.5			1	
	Engine Coolant Heater	Inspect	0.5	0.5					
		Replace			1.0			1	
		Repair			1.0			1	
0510	Cooling System	Inspect	0.2	0.5					
		Service	0.2	2.0					

Section II. MAINTENANCE ALLOCATION CHART FOR 230LCR AND 230LCRD (Cont'd)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0511	Radiator, Hydraulic Oil Cooler and Fan Shroud	Inspect	0.2	0.2					
		Test		0.5					
		Service		1.0				1	
		Replace			2.6			1	
0515	Speed Controls	Inspect		0.5					
		Adjust		0.2				1	
		Replace			0.6			1	
	Engine Control Motor and Sensor	Adjust		0.5				1	
		Replace			0.5			1	
	Fuel Shut-Off Solenoid Linkage	Inspect		0.5					
		Adjust		0.5				1	
		Replace			1.0			1	
0521	Air Intake Hoses	Inspect	0.1	0.5					
		Replace		0.2				1	
	Air Cleaner	Inspect	0.3	0.3					
		Service	1.0	1.0					
		Replace		1.0				1	
0560	External Fuel Supply System	Inspect	0.3	0.3					
		Service	0.3						
		Replace			1.8			1	
		Repair			1.0			1	
	Primary Fuel Filter (Water Separator)	Inspect	0.1	0.1					
		Service	0.1	0.1				1	
		Replace		0.6				1	
	Final Fuel Filter	Inspect	0.1	0.1					
		Replace	0.6	0.6				1	
16	ELECTRICAL SYSTEM								
1671	Batteries, Support, and Cables	Inspect	0.1	0.5					
		Test		0.5					
		Service		0.5					
		Replace		0.6				1	

Section II. MAINTENANCE ALLOCATION CHART FOR 230LCR AND 230LCRD (Cont'd)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
1672	Alternator, Regulator, and Charging System Wiring	Inspect		0.2					
		Replace		0.6				1	
		Repair			1.7			1	
	Robert Bosch Alternators	Inspect		0.5					
		Test		0.5					
		Replace		0.5				1	
		Repair			2.4			1	
1674	Wiring Harness and Switches	Inspect		0.5					
		Replace			24.0			1	
		Repair			1.0			1	
	Travel Alarm	Adjust		0.5				1	
		Replace		1.0				1	
1675	System Controls	Inspect		0.5					
		Replace			1.2			1	
1677	Robert Bosch Starting Motors	Inspect		0.5					
		Test		0.5					
		Replace		0.5				1	
		Repair			2.4			1	
17	FRAME OR SUPPORTING STRUCTURE								
1740	Frame Installation	Repair			8.0			1	
1749	Chassis Weights	Inspect		1.0					
		Replace			0.8			1, 12	
18	OPERATOR'S STATION								
1801B	Rifle Rack	Inspect	0.1	0.1					
		Replace		0.5				1	
		Repair			0.5			1	
1810	Operator Enclosure	Replace			6.0			1	
		Repair			0.5			1	

Section II. MAINTENANCE ALLOCATION CHART FOR 230LCR AND 230LCRD (Cont'd)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
1821	Seat and Seat Belt								
	Seat	Adjust	0.2						
		Replace		1.3				1	
	Seat Belt	Inspect	0.2	0.2					
		Replace		0.4				1	
1830	Heating and Air Conditioning	Inspect		0.5					
		Replace			2.5			1	
		Repair			3.8			1	
1831	Heater, Hoses and Controls	Inspect	0.1	0.3					
		Replace			2.0			1	
		Repair			1.0			1	
1832	Air Conditioning Compressor System	Inspect		0.5					
		Test		1.0					
		Adjust			0.3			1	
		Replace			2.0			1	
		Repair				1.0		1	
20	SAFETY AND CONVENIENCE								
2004	Overload Alarm	Inspect	0.1	0.5					
		Replace		1.0				1	
21	MAIN HYDRAULIC SYSTEM								
2163A	Hydraulic Quick Couplers For Auxiliary Lines (Model 230LCRD Only)	Inspect	0.1	0.5					
		Replace		0.5				1	
		Repair			1.0			1	
2163B	Hydraulic Quick Couplers For Rock Drill (Model 230LCRD Only)	Inspect	0.1	0.5					
		Replace		0.5				1	
		Repair			1.0			1	

Section II. MAINTENANCE ALLOCATION CHART FOR 230LCR AND 230LCRD (Cont'd)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
22	PNEUMATIC SYSTEMS								
2200	Compressor (Model 230LCRD Only)	Inspect	0.2	1.0					
		Service	0.3	1.0					
		Replace			1.0				
		Repair			2.0				
	Instrument Control Panel Assembly	Inspect		0.5					
		Replace			1.0			1	
		Repair			1.0			1	
	Unloader Valve Assembly	Inspect		0.5					
		Replace		1.0				1	
		Repair			2.0			1	
	Oil Temperature Bypass Valve Assembly	Inspect		0.5					
		Replace		1.0				1	
		Repair			1.0			1	
	Minimum-Pressure Valve Assembly	Inspect		0.5					
		Replace		1.0				1	
		Repair			1.0			1	
2263	Air Intake System	Inspect	0.3	0.5					
		Replace		1.0				1	
		Repair			1.0			1	
2264	Separator Tank	Inspect		0.5					
		Replace		1.0				1	
		Repair			1.0			1	
	Oil Filter Assembly	Inspect		0.5					
		Replace		1.0				1	
		Repair			1.0			1	
33	EXCAVATOR								
3301	Quick-Disconnect Hitch	Inspect	0.3	0.5					
		Replace		0.5				1	
		Repair			1.0			1	
3302	Buckets	Inspect	0.5	0.5					
		Replace		0.8				1	
		Repair			2.0			1	

Section II. MAINTENANCE ALLOCATION CHART FOR 230LCR AND 230LCRD (Cont'd)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
3340	Frames	Repair				1.0		1	
3344	Boom	Inspect Replace	0.3	0.5	 2.0			 1	
3346	Arm	Inspect Replace	0.3	0.5	 1.5			 1	
3360	Hydraulic System	Inspect Service	0.5	 1.0					
	Pilot Pump Drive Shaft and Gear	Repair			1.0			1	
	Dig Function Pilot Controller	Replace Repair			0.5 1.0			1 1	
	Propel Pilot Controller	Replace Repair			1.0 1.0			1 1	
3361	Hydraulic Pump and Drive Gearbox	Inspect Service Replace Repair		0.5 0.5	 0.5 1.0			 1 1	
	Pilot Pump	Replace Repair			1.0 1.5			1 1	
3362	Pilot Pressure Regulating Valve and Filter	Replace Repair		1.0	1.0 0.5			1 1	
	Pilot Shut-Off Valve	Adjust Replace Repair		0.5	 1.0 1.0			 1 1	
	Proportional Solenoid Valve	Repair			1.0			1	
	Flow Regulator Valve	Replace Repair			0.5 1.0			1 1	
	Control Valve	Replace Repair			1.0 1.0			1 1	

Section II. MAINTENANCE ALLOCATION CHART FOR 230LCR AND 230LCRD (Cont'd)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
	System Relief Valve	Repair			1.0			1	
	Circuit Relief and Anti-Cavitation Valve	Repair			1.0			1	
	Hydraulic Oil Tank Relief Valve and Breather Filter Cap	Service	0.3	0.3					
		Repair			1.0			1	
3364	Hydraulic Oil Tank	Inspect	0.1	0.3					
		Service	0.5	0.5					
		Replace		1.0				1	
		Repair			1.0			1	
3365	Boom, Arm or Bucket Cylinder	Service	0.3	1.0					
		Replace			1.8			1, 13	
		Repair			2.0			1, 13	
3370	Hydraulic Thumb (Model 230LCR Only)	Inspect	0.3	0.5					
		Service	0.3	0.5					
		Replace		1.0				1	
		Repair			1.0			1	
	Hydraulic Cylinder Assembly	Inspect	0.2	0.5					
		Service	0.5						
		Replace		1.0				1	
		Repair			1.0			1	
43	SWING OR PIVOTING SYSTEM								
4350	Mechanical Drive Elements	Replace			1.0			1	
		Repair			1.0			1	
4351	Swing Gearbox	Inspect		0.5					
		Service		1.0					
		Replace			1.0			1	
		Repair			1.0			1	
4353	Swing Bearing	Inspect		0.5					
		Service		1.0					
		Replace			1.0			1	
		Repair			1.0			1	

Section II. MAINTENANCE ALLOCATION CHART FOR 230LCR AND 230LCRD (Cont'd)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
4360	Hydraulic System	Inspect			0.5				
		Replace			1.0			1	
		Repair			1.0			1	
4367	Swing Motor and Park Brake	Inspect		0.5					
		Replace			3.6			1	
		Repair			6.0			1	
	Swing Motor Make-Up and Crossover Relief Valves	Repair			1.0			1	
44	CUTTING MECHANISMS								
4400	Rock Drill (Model 230LCRD Only)	Inspect	0.5	0.5					
		Service	1.0	1.0					
		Adjust		1.0				1	
		Replace		1.6				1	
		Repair			3.8			1	
	Hydraulic Drifter	Inspect	0.5	0.5					
		Replace		1.5				1, 38-50	
		Repair			2.5			1, 38-50	
	Hydraulic Drifter Control	Repair			2.5			1	
	HP Accumulator	Service		0.5					
		Repair			2.5			1, 36-38 69-72	
	LP Accumulator	Service		0.5					
		Repair			2.5			1, 36-38 69-72	
	GCX 14/12 Feed	Repair			2.5			1	
	Rod Changer	Service	1.0	1.0					
		Repair			2.5			1	
	Cradle and Articulation	Repair			2.5			1	

Section II. MAINTENANCE ALLOCATION CHART FOR 230LCR AND 230LCRD (Cont'd)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL UNIT C	UNIT O	DIRECT SUPPORT F	GENERAL SUPPORT H	DEPOT D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
	Cross-Tilting Cylinder	Repair			1.5			1	
	Electro-Hydraulic Equipment	Repair			2.5			1	
	Dust Collector	Inspect	0.5						
		Service	0.3	1.0					
		Replace			1.5			1	
		Repair			2.5			1	
	Remote Control Assembly	Repair			2.5			1	

Section III. TOOLS AND TEST EQUIPMENT REQUIREMENTS FOR 230LCR AND 230LCRD

(1) TOOL OR TEST EQUIPMENT REFERENCE CODE	(2) MAINTENANCE LEVEL	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
1	O, F, H	Tool Kit, General Mechanic's SC5180-90-N26	5180-00-177-7033	
	O	Shop Equipment, Automotive Maintenance and Repair: Organizational Maintenance, Common No. 1 SC4910-95-A74	4910-00-754-0654	
	O	Shop Equipment, Automotive Maintenance and Repair: Organizational Maintenance, Supplemental No. 1 SC4910-95-A73	4910-00-754-0653	
	F, H	Tool Kit, Automotive Fuel and Electrical System Repair SC5180-95-CL-B08	5810-00-754-0655	
	F, H	Shop Equipment, General Purpose Repair, Semi-Trailer Mounted SC4940-95-B02	4940-00-287-4894	
	O, F, H	Tool Kit, General Mechanic's SC5180-90-N05	5180-00-699-5273	
	O	Shop Equipment, Organizational Repair, Light, Truck-Mounted SC4940-95-B03	4940-00-284-9516	
	F, H	Shop Equipment, Welding SC4540-95-CL-B19		
2	F, H	Tool Kit, Undercarriage Inspection Service		JT05518A
3	F, H	Leak Detector Kit, Rubber Stopper		D05361ST
4	F, H	Spring, Track Recoil		ST4920
5	F, H	Lifting Sling	4910-01-243-5558	JDG23
6	F, H	Flywheel Turning Tool		JD820
7	F, H	Timing Pin (Used with JDE81-1)	5315-01-321-6068	JDE81-4
8	F, H	Injection Pump Timing Pin		JDG886

Section III. TOOLS AND TEST EQUIPMENT REQUIREMENTS FOR 230LCR AND 230LCRD (Cont'd)

(1) TOOL OR TEST EQUIPMENT REFERENCE CODE	(2) MAINTENANCE LEVEL	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
9	F, H	Recovery/Recycling and Charging Station		JT02045
10	F, H	Vacuum Pump		D05267ST
11	F, H	Schrader Valve Tool		JT02130
12	F, H	Metric Lifting Eyebolt		JT0550
13	F, H	Cylinder Service Stand		JT30043
14	F, H	Vibration Damper Puller Set		JDG410
15	F, H	Crankshaft Pulley Puller		KJD10206
16	F, H	Seal and Wear Sleeve Remover		JDG698
17	F, H	Crankshaft Seal Puller Adapter		JDG719
18	F, H	Seal Installer		JDG720A
19	F, H	Hub Puller Kit		JDG721
20	F, H	Front Wear Sleeve Puller		JDG992-1
21	F, H	Thread Protector		JDG787
22	F, H	Rear Wear Sleeve Puller Kit		JDG790
23	F, H	Main Bearing Cap Puller/Installer		JDG1069
24	F, H	Magnetic Follower Holder Kit		D15001NU
25	F, H	Front Wear Sleeve Puller		JDG992-2
26	F, H	Rear Crankshaft Oil Seal/Wear Sleeve Puller		JDG645E
27	F, H	Crankshaft Rear Oil Seal/Sleeve Installer Tool	5120-01-384-4147	JT30040B or KCD10002
28	F, H	Crankshaft Gear and Front Oil Seal Installer		JD954
29	F, H	Bushing, Bearing and Seal Driver Set		D01045AA
30	F, H	Pulling Attachment		D01218AA

Section III. TOOLS AND TEST EQUIPMENT REQUIREMENTS FOR 230LCR AND 230LCRD (Cont'd)

(1) TOOL OR TEST EQUIPMENT REFERENCE CODE	(2) MAINTENANCE LEVEL	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
31	F, H	Push Puller		D01200AA
32	F, H	Camshaft Bushing Service Set		JDG739B
33	F, H	Engine Turning Tool		JDE83
34	F, H	Injection Nozzle Puller Set		JDE38B
35	F, H	Adapter and Slide Handle		JDG716
36	F, H	Clamping Assembly		59829
37	F, H	Accumulator Nitrogen Inflation Kit		95234
38	F, H	Special Socket		95372
39	F, H	Tools Dismounting/Mounting		77796
40	F, H	Flange		59831
41	F, H	Gear Locking Tool		76173
42	F, H	Threaded Ring		77794
43	F, H	Segment Assembly		77795
44	F, H	Centering Ring		77793
45	F, H	Socket Head Screw		8861
46	F, H	Bronze Ring Driving Tool		60494
47	F, H	Shouldered Pin		59828
48	F, H	Threaded Ring		60485
49	F, H	Centering Ring		60480
50	F, H	Lip Seal Mounting Tool		73125
51	F, H	Injection Nozzle Seal Tool		JD258
52	F, H	Injector Nozzle Bore Reamer		JDE39
53	F, H	Water Pump Bearing Driver		JDE74
54	F, H	Engine Rotation Tool	5120-01-335-5827	JDE81-1

Section III. TOOLS AND TEST EQUIPMENT REQUIREMENTS FOR 230LCR AND 230LCRD (Cont'd)

(1) TOOL OR TEST EQUIPMENT REFERENCE CODE	(2) MAINTENANCE LEVEL	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
55	F, H	Liner and Piston Height Gage		JDG451
56	F, H	Injector Pump Gear Puller (use with DB4 pump)		JDG670A
57	F, H	Valve Seat Insert Installer Adapter	5120-01-393-3892	JDG675
58	F, H	Valve Seat Pilot Driver	5120-01-393-1254	JDG676
59	F, H	Valve Stem Seal Installer		JDG678
60	F, H	Rear Crankshaft Oil Seal/Wear Sleeve Removal Tool		JDG22
61	F, H	Aligning Bar (Pump Timing Tool)		JDG1054
62	F, H	Crankshaft Gear/Front Oil Seal Installer		JDG954A
63	F, H	Dipstick Tube Installer		JDG965
64	F, H	Adapter, Engine Stand		JT07268
65	F, H	Special Adapter, Engine Stand		D05226ST
66	F, H	Cable, Excavator to Computer		JT07273
67	F, H	Software (Disk)		JT07274
68	F, H	Test Harness, Wiper		JT07275
69	F, H	Adapter, Fitting		DGA20-1/4NPT
70	F, H	Inflation Tool, Adapter		95233
71	F, H	Spanner Wrench		66223
72	F, H	Accumulator Charging Device		59832

Section IV. REMARKS

(1) REFERENCE CODE	(2) REMARKS
A	Measure for wear and test for oil leakage.
B	Make tool ST4920.
C	Measure for wear.
D	Engine weight is approximately 2100 lbs.
E	Requires removal of engine.
F	Test nozzle prior to disassembly to determine if nozzle can be reused.
G	Test consists of pressure check.

APPENDIX C
REFERENCES

C-1. SCOPE

This appendix lists forms, field manuals, technical manuals, and other publications either referenced in this manual or which apply to the operation and maintenance of the Hydraulic Excavator. Web sites which may be useful are also included in this appendix.

C-2. DEPARTMENT OF THE ARMY PAMPHLETS

Consolidated Index of Army Publications and Blank Forms	DA Pam 25-30
Using Unit Supply System (Manual Procedures)	DA Pam 710-2-1
Functional Users Manual for The Army Maintenance Management System (TAMMS)	DA Pam 738-750

C-3. FORMS

Recommended Changes to Publications and Blank Forms	DA Form 2028
Recommended Changes to Equipment Technical Publications	DA Form 2028-2
Organizational Control Record for Equipment	DA Form 2401
Equipment Inspection and Maintenance Worksheet	DA Form 2404
Equipment Inspection and Maintenance Worksheet (Electronic)	DA Form 5988E
Maintenance Request	DA Form 2407
Preventive Maintenance Schedule and Record	DD Form 314
Product Quality Deficiency Report (NSN 7540-00-105-0078)	SF 368

C-4. FIELD MANUALS

NBC Contamination Avoidance	FM 3-3
NBC Protection	FM 3-4
NBC Decontamination	FM 3-5
NBC Handbook	FM 3-7
Camouflage	FM 20-3
Operation and Maintenance of Ordnance Materiel in Extreme Cold Weather (0° to -65°F)	FM 9-207

Recovery and Battlefield Damage Assessment and Repair	FM 9-43-2
Soldier's Manual for First Aid	FM 21-11
Basic Cold Weather Manual	FM 31-70
Northern Operations	FM 31-71
Army Motor Transport Units and Operators	FM 55-30
Desert Operations (How to Fight)	FM 90-3
Operational Symbols	FM 101-5-1

C-5. SUPPLY BULLETIN

Storage Serviceability Standard – Tracked Vehicles, Wheeled Vehicles, and Component Parts	SB 740-98-1

C-6. TECHNICAL BULLETINS

Equipment Improvement Report and Maintenance Digest (US Army Tank-Automotive Command) Tank-Automotive Equipment	TB 43-001-39-Series
Color, Marking, and Camouflage Painting of Military Vehicles, Construction Equipment, and Materiels Handling Equipment	TB 43-0209
Maintenance in the Desert	TB 43-0239
Use of Antifreeze and Cleaning Compounds in Engine Cooling Systems	TB 750-651
Inspection, Use and Tightening of Metal Fasteners Used on Tank-Automotive Equipment	TB 43-0218

C-7. TECHNICAL MANUALS

Operator's Manual, Hydraulic Excavator, John Deere Model 230LCR/230LCRD	TM 5-3805-280-10
Unit Maintenance, Direct Support and General Support Maintenance With Parts List, Hydraulic Excavator, John Deere Model 230LCR/230LCRD	TM 5-3805-280-24P
Chemical, Biological, and Radiological (CBR) Decontamination	TM 3-220
Inspection, Care, and Maintenance of Antifriction Bearings	TM 9-214
Care and Use of Hand Tools and Measuring Tools	TM 9-243
Materials Used for Cleaning, Preserving, Abrading, and Cementing Ordnance Materiel and Related Items Including Chemicals	TM 9-247
Tool Outfit Hydraulic System Test and Repair Unit (HYSTRU)	TM 9-4940-468-13

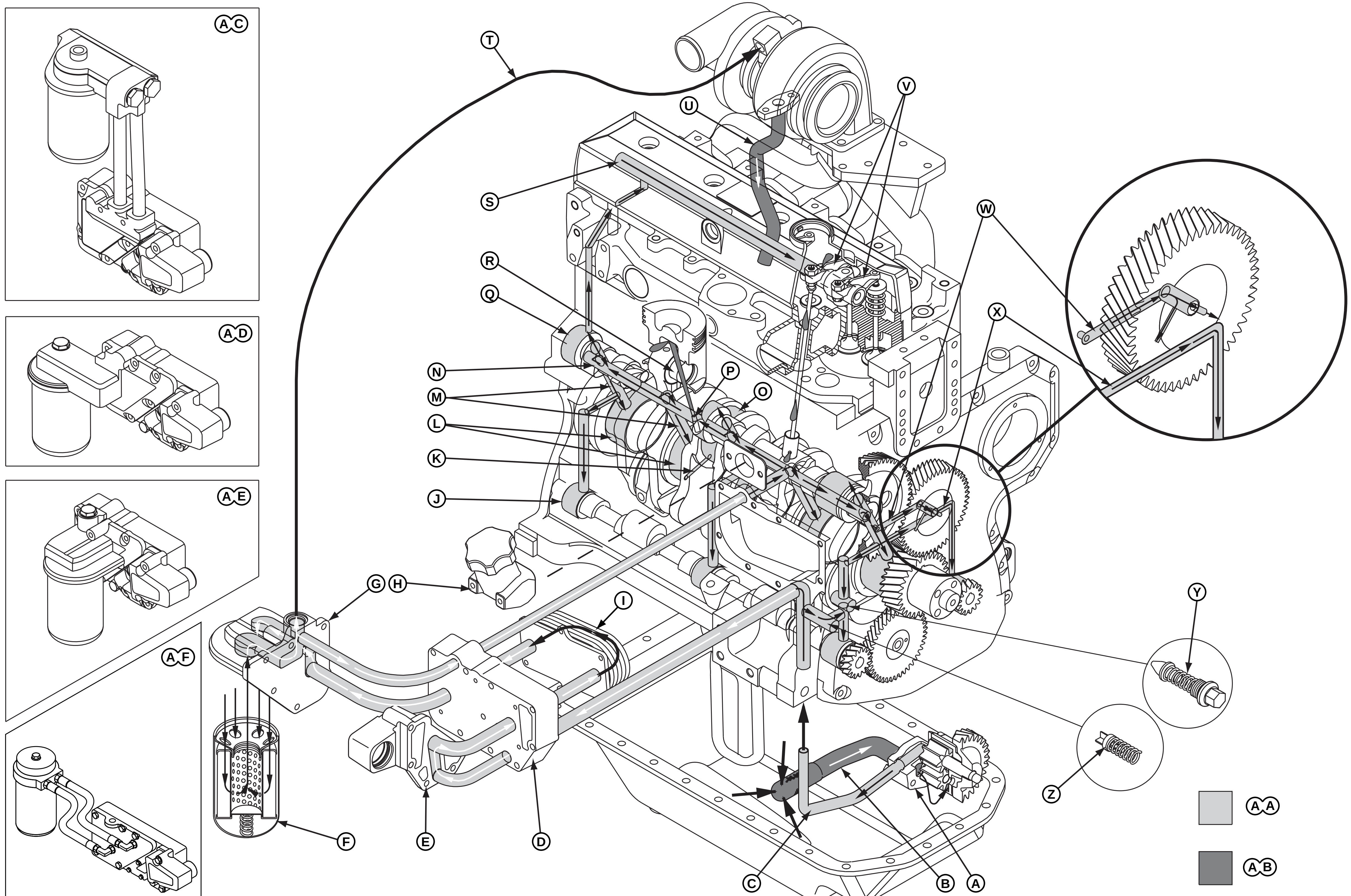
Operator, Unit, Direct Support, and General Support Maintenance Manual for Lead Storage Batteries	TM 9-6140-200-14
Preparing Hazardous Materials for Military Air Shipments	TM 38-250
Principals of Automotive Vehicles	TM 9-8000
Painting Instructions for Field Use	TM 43-0139
Procedures for Destruction of Tank-Automotive Equipment to Prevent Enemy Use	TM 750-244-6

C-8. OTHER PUBLICATIONS

Army Logistics Readiness and Sustainability	AR 700-138
Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic Items)	CTA 50-970
Abbreviations and Acronyms	ASME Y14.38M

C-9. WEB SITES

Military Traffic Management Command (MTMC)	http://www.tea.army.mil
Logistical Support Activity (LOGSA)	http://www.logsa.army.mil
US Army Tank-Automotive and Armaments Command (TACOM)	http://www.tacom.army.mil



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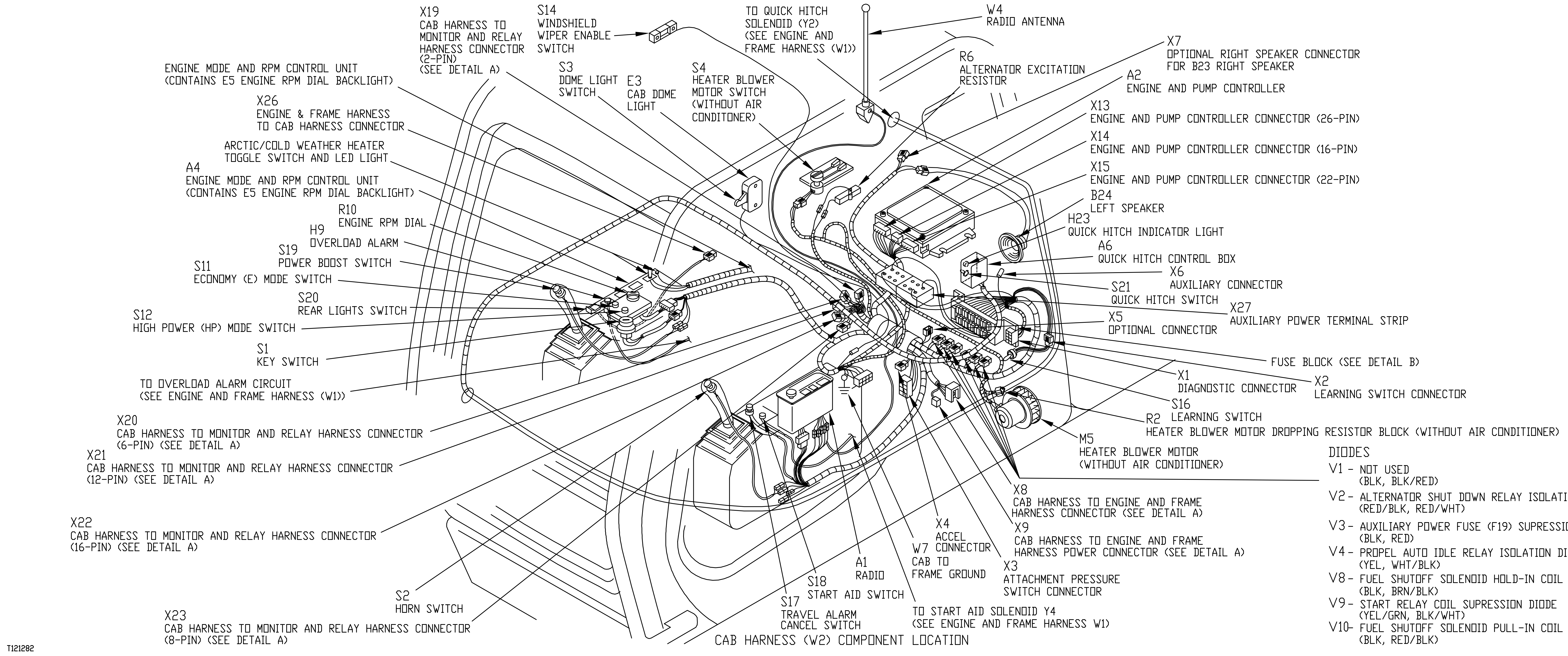
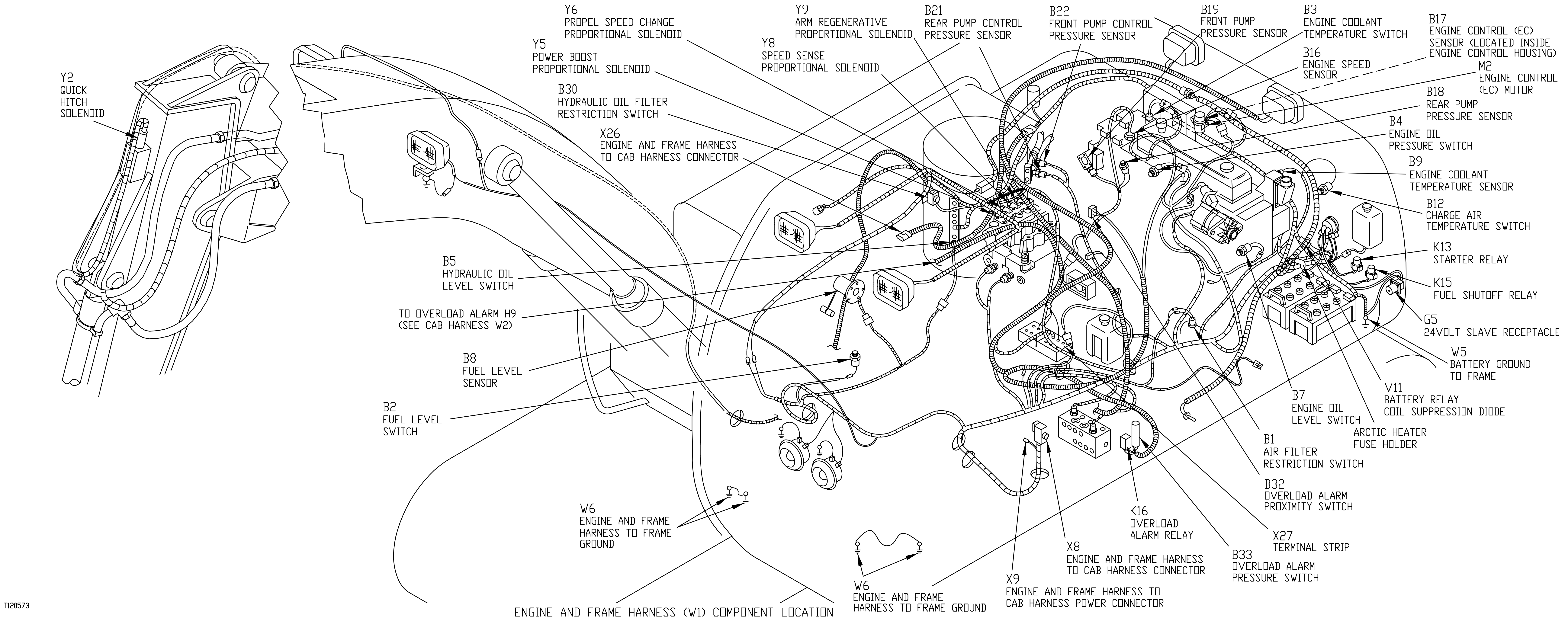


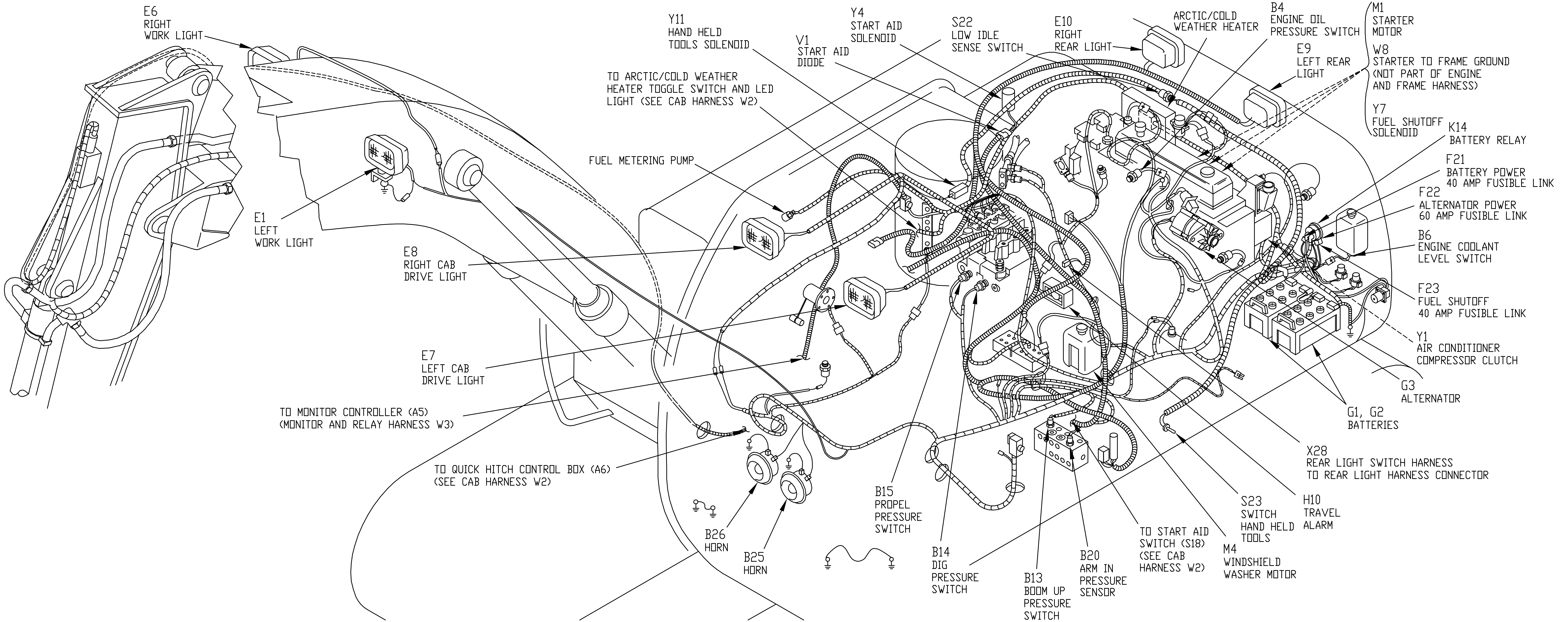
CAB HARNESS (W2) COMPONENT LOCATION

DIODES

- V1 - NOT USED (BLK, BLK/RED)
- V2 - ALTERNATOR SHUT DOWN RELAY ISOLATION DIODE (RED/BLK, RED/WHT)
- V3 - AUXILIARY POWER FUSE (F19) SUPRESSION DIODE (BLK, RED)
- V4 - PROPEL AUTO IDLE RELAY ISOLATION DIODE (YEL, WHT/BLK)
- V8 - FUEL SHUTOFF SOLENOID HOLD-IN COIL SUPPRESSION DIODE (BLK, BRN/BLK)
- V9 - START RELAY COIL SUPRESSION DIODE (YEL/GRN, BLK/WHT)
- V10 - FUEL SHUTOFF SOLENOID PULL-IN COIL SUPRESSION DIODE (BLK, RED/BLK)



ENGINE AND FRAME HARNESS (W1) COMPONENT LOCATION



ENGINE AND FRAME HARNESS (W1) COMPONENT LOCATION (CONTINUED)

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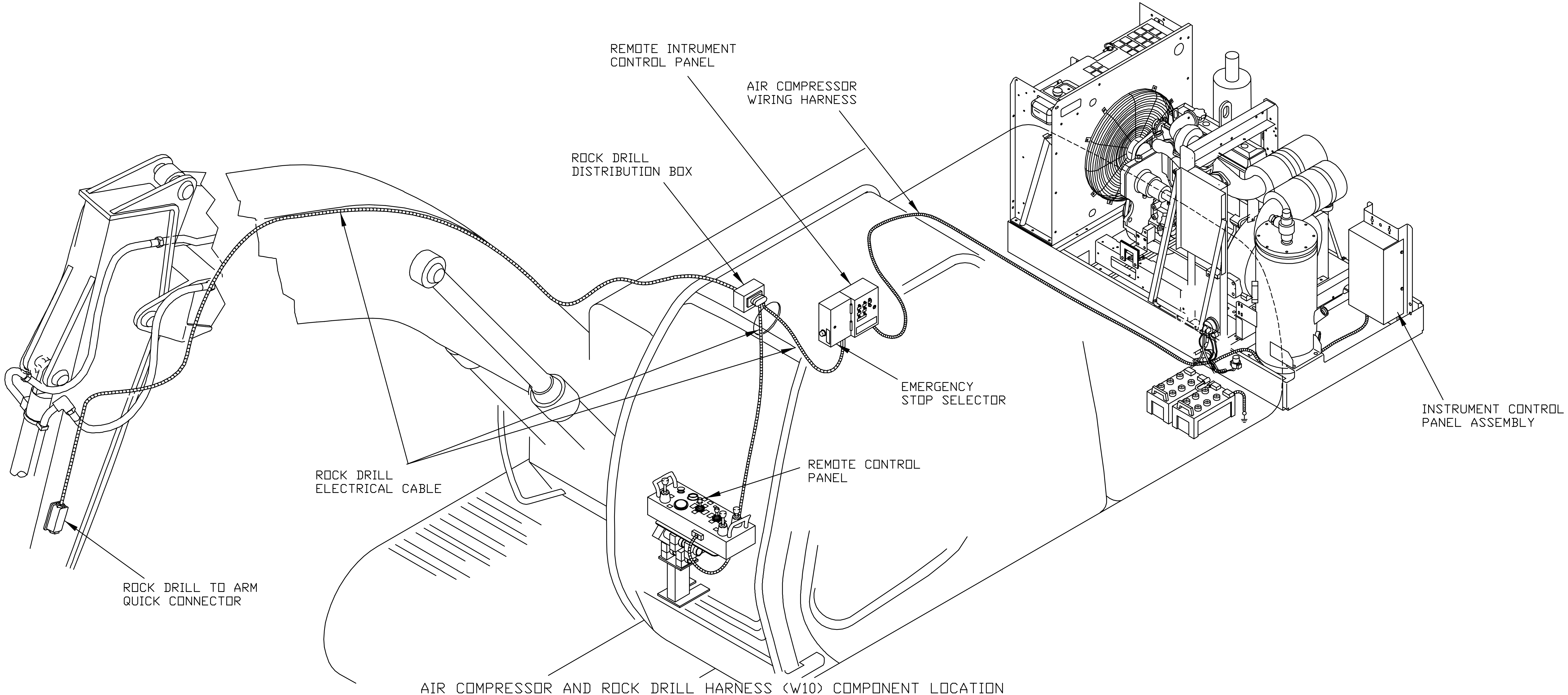


AIR COMPRESSOR AND ROCK DRILL HARNESS (W10) COMPONENT LOCATION

T121476

BLANK

By order of the Secretary of the Army:

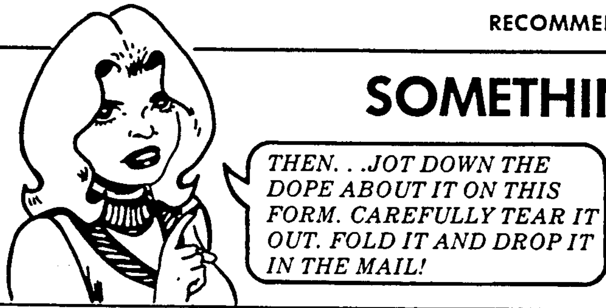
ERIC K. SHINSEKI
General United States Army
Chief of Staff

Official:

JOEL B. HUDSON
Administrative Assistant to the
Secretary of the Army
9930503

Distribution: To be distributed in accordance with Initial Distribution Number (IDN) 256561, requirements for TM 5-3805-280-24-2.

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS



SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)
Your mailing address

DATE SENT Date you fill out this form

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM 5-2350-262-34	Date of TM	M9 DS/GS MAINTENANCE MANUAL

BE EXACT . . PIN-POINT WHERE IT IS: PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.	IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
2-2				Fuel tank removal and installation is now a DS/GS task. Delete this task from the unit maintenance list.
4-185	B			There are three clamps securing air cleaner duct, not the two as shown. Suggest changing text and art to show three clamps.
B-5		1		Roadwheel jack does not have an NSN or P/N listed and cannot be found on AMDF. Request correct NSN and P/N be furnished.

SAMPLE

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBERS	SIGN HERE:
Joe Doe, SFC 555-1212	Joe Doe, Sfc

DA FORM 1 JUL 79 2028-2 PREVIOUS EDITIONS ARE OBSOLETE.

P.S.—IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

SAMPLE

FILL IN YOUR UNIT'S ADDRESS

FOLD BACK

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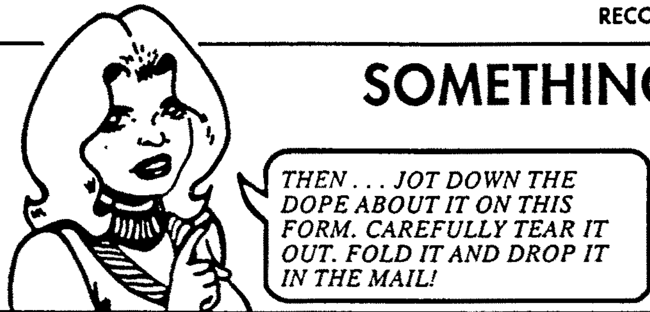
Commander
U.S. Army Tank-automotive and Armaments Command
ATTN: AMSTA-AC-NML
Rock Island, IL 61299-7630

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS



SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM 5-3805-280-24-2		Hydraulic Excavator 230LCR/230LCRD UNIT, DS, GS Maintenance Manual

BE EXACT. . .PIN-POINT WHERE IT IS				IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.	

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PREVIOUS EDITIONS ARE OBSOLETE.

P.S.—IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

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THE METRIC SYSTEM AND EQUIVALENTS

'NEAR MEASURE

. Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

'EIGHTS

Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

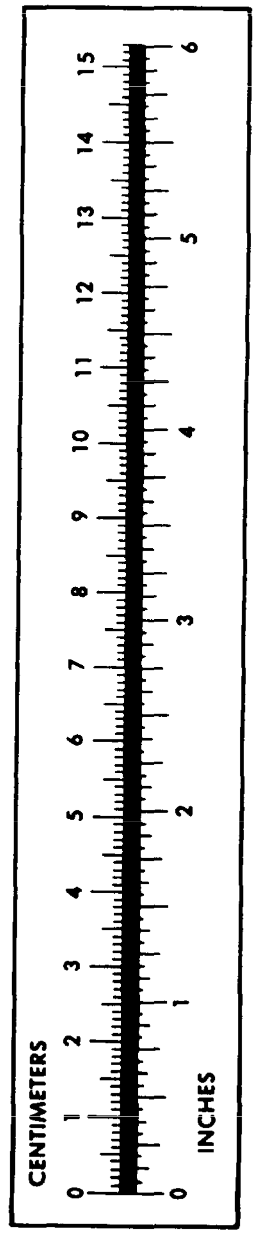
TEMPERATURE

5/9(°F - 32) = °C
212° Fahrenheit is evuivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5C° + 32 =°F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
ıts	Liters	0.473
arts	Liters	0.946
allons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
'ers	Gallons	0.264
.ms	Ounces	0.035
.ograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
'lometers per Liter	Miles per Gallon	2.354
›meters per Hour	Miles per Hour	0.621



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