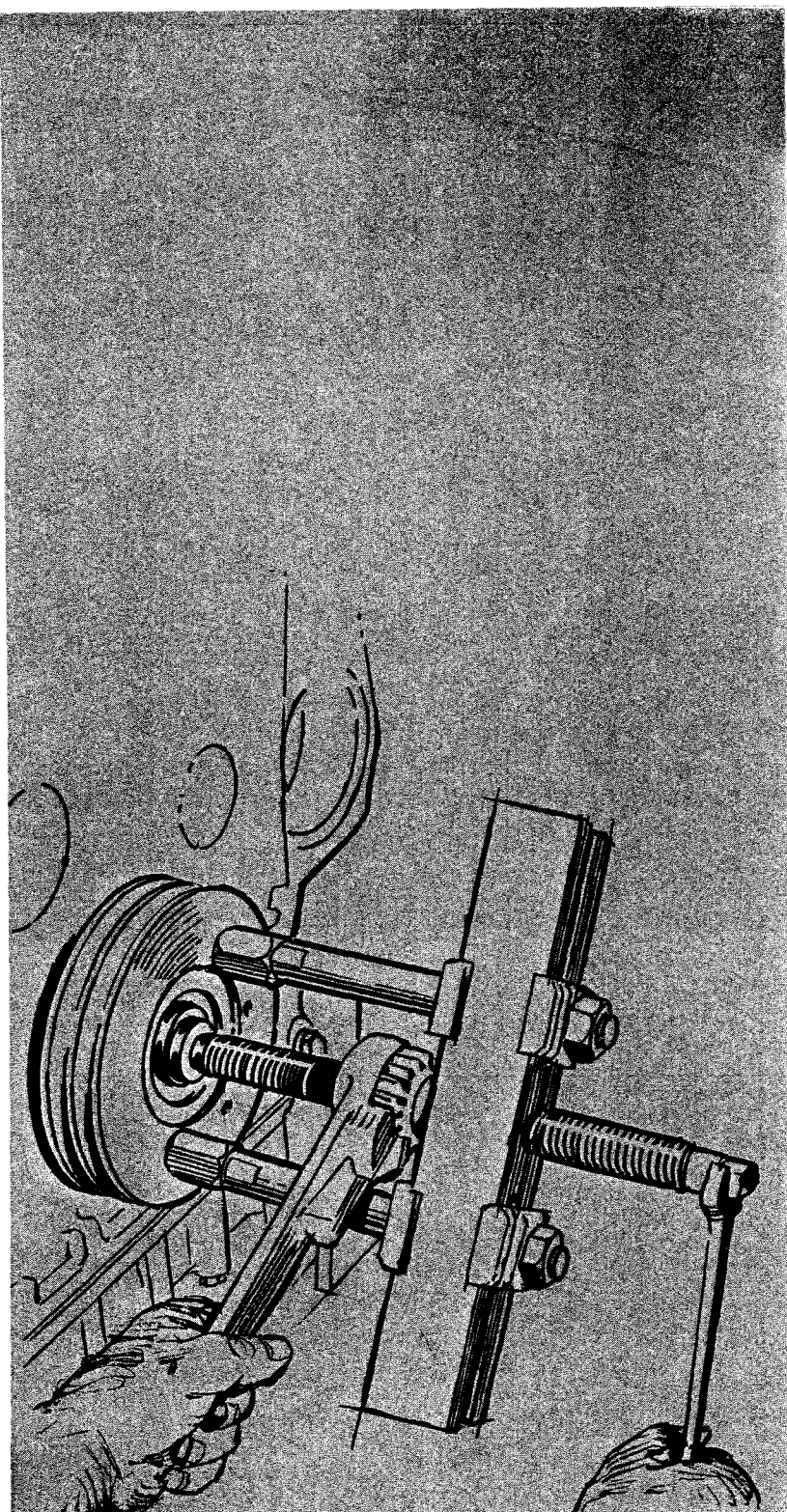




SERVICE MANUAL

DISASSEMBLY AND ASSEMBLY 950 ENGINE

INTRODUCTION

This publication has instructions and procedures for the subject on the front cover. The information, specifications, and illustrations in this publication are on the basis of information that was current at the time this issue was written.

The "Alphabetical Index" is a list of all components and service operations in this manual section. It gives page numbers and also the operations numbers as found in the "Service Index".

The "Service Index" is a list of all component operations found in this manual section. All operations in the column "Component Operation" are removal and installation instructions, unless other descriptions are given for the operation. The arrangement of the components in this list is by location on the machine or engine. The column "Other Needed Operations" gives the number of all other component operations that are necessary to do the respective job.

Correct operation, maintenance, test and repair procedures will give this product a long service life. Before starting a test, repair or rebuild job, the serviceman must read the respective sections of the Service Manual, and know all the components he will work on.

Your safety, and the safety of others, is at all times very important. When you see this symbol  or this symbol  in the manual, you must know that caution is needed for the procedure next to it. The symbols are warnings. To work safely, you must understand the job you do. Read all instructions to know what is safe and what is not safe.

It is very important to know the weight of parts. Do not lift heavy parts by hand. Use a hoist. Make sure heavy parts have a good stability on the ground. A sudden fall can cause an accident. When lifting part of a machine, make sure the machine has blocks at front and rear. Never let the machine hang on a hoist, put blocks or stands under the weight.

When using a hoist, follow the recommendation in the manual. Use correct lift tools as shown in illustrations to get the correct balance of the component you lift. This makes your work safer at all times.

Make reference to GENERAL INSTRUCTIONS.

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**ALWAYS INSTALL LIFT ARM SUPPORT
BEFORE WORKING UNDER RAISED
LIFT ARMS OR BUCKET**



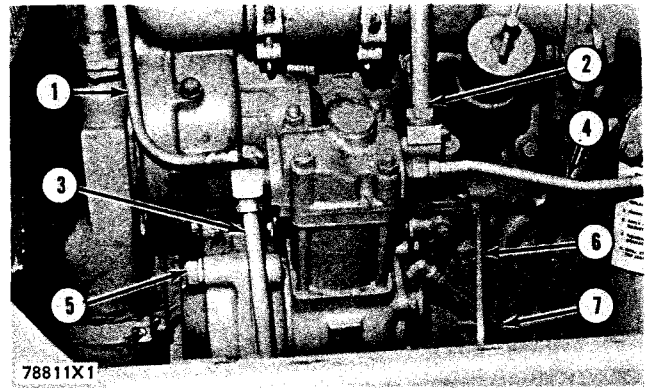
**DISCONNECT BATTERIES BEFORE
PERFORMING SERVICE WORK**

AIR COMPRESSOR

REMOVE AIR COMPRESSOR

11-1065

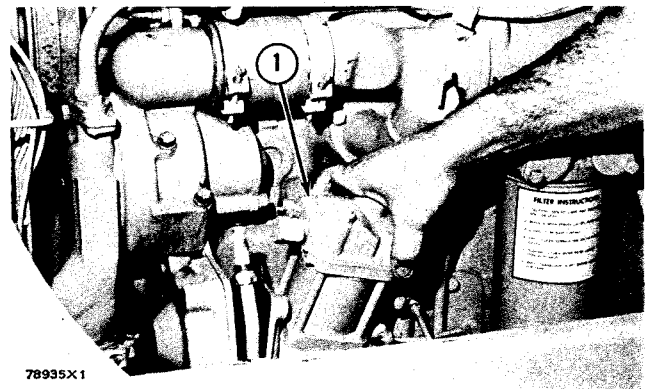
1. Remove the coolant from the cooling system.
2. Open right side door of hood.
3. Remove air inlet line (2) from air compressor.
4. Disconnect outlet line (3) from air compressor.
5. Remove water lines (1) and (4).
6. Remove line (6) from air compressor governor.
7. Remove lubrication line (7) from air compressor.
8. Remove air compressor bolts (5).
9. Remove the air compressor. Weight is 35 lbs. (15.9 kg).



INSTALL AIR COMPRESSOR

12-1065

1. Put compressor (1) in position on the engine and install the bolts that hold it to the engine.
2. Connect the lubrication line for the air compressor.
3. Connect line to air compressor governor.
4. Install water lines on air compressor.
5. Connect air outlet line to the air compressor.
6. Connect air inlet line to compressor.
7. Close right side door of hood.
8. Fill the cooling system to the correct level.



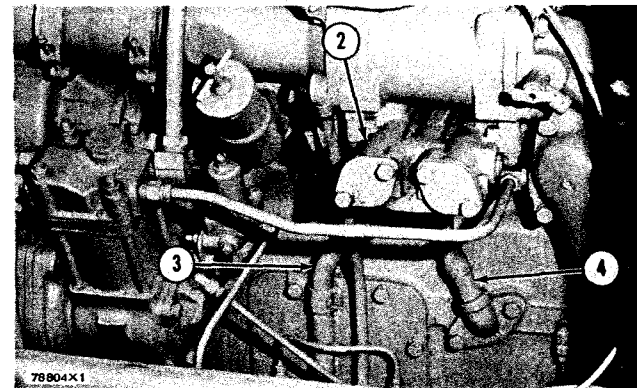
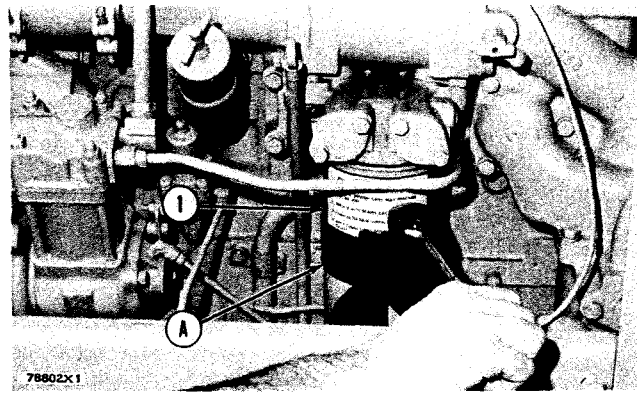
OIL FILTER BASE

REMOVE OIL FILTER BASE

11-1306

Tool Needed		A
2P8250	Strap Wrench	1

1. Open right side door of hood.
2. Remove oil filter (1) with wrench (A).
3. Remove oil filter outlet line (4).
4. Remove oil filter inlet line (3).
5. Remove the four bolts that hold the base to the oil cooler.
6. Remove the oil filter base (2).

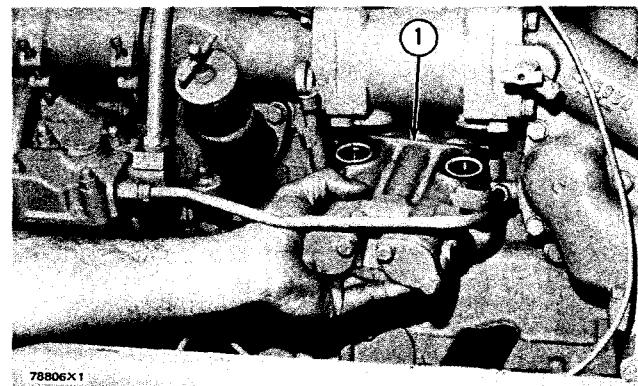


INSTALL OIL FILTER BASE

12-1306

Tool Needed		A
2P8250	Strap Wrench	1

1. Put the oil filter base (1) in position on engine and install bolts that hold it to the cooler.
2. Put lubricant on O-ring seals. Install the inlet and outlet lines for the oil filter base.
3. Install the oil filter with wrench (A).
4. Close right side door of hood.



OIL FILTER BASE

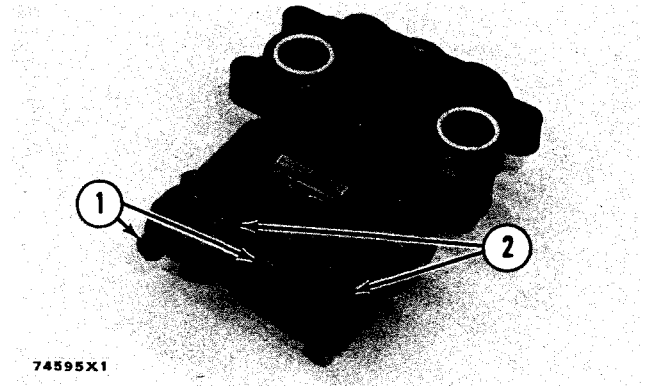
DISASSEMBLE OIL FILTER BASE 15-1306

start by:

a) remove oil filter base

1. Remove the bolts (1) and covers (2) for the bypass valves.

2. Remove the springs and plungers.



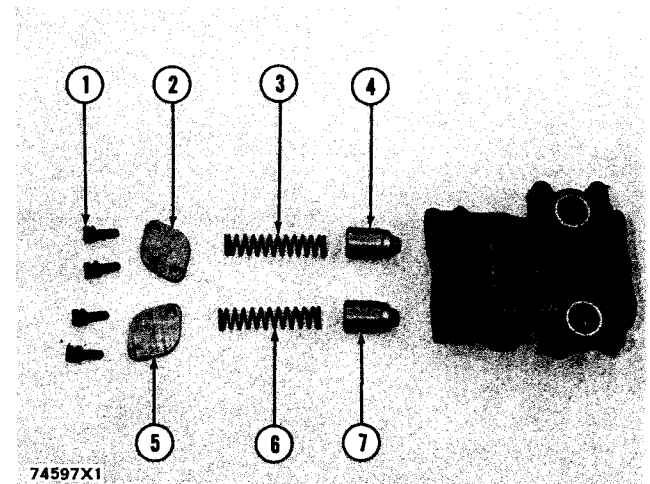
ASSEMBLE OIL FILTER BASE 16-1306

1. Install plunger (4), spring (3), cover (2) and bolts (1) of bypass valve for oil cooler in oil filter base.

2. Install plunger (7), spring (6), cover (5) and bolts of bypass valve for oil filter in oil filter base.

end by:

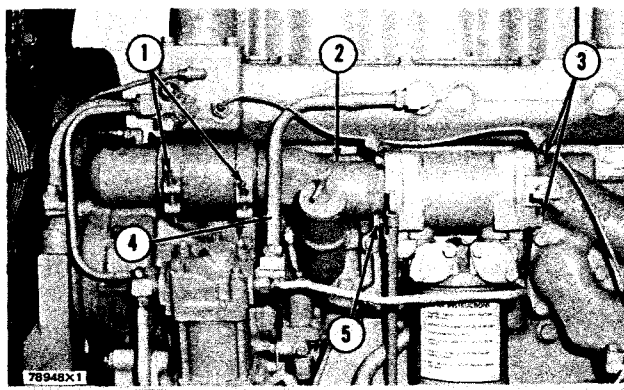
a) install oil filter base



ENGINE OIL COOLER

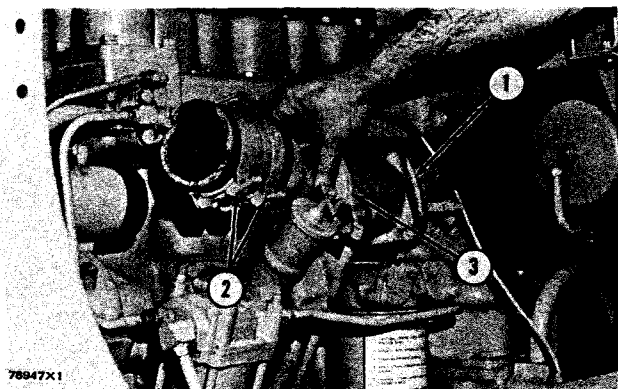
REMOVE ENGINE OIL COOLER 11-1378

1. Open right side door of hood.
2. Remove coolant from cooling system.
3. Loosen hose clamps (1).
4. Remove air inlet line (4) from air compressor.
5. Remove the bolt (5) from the gauge tube for oil level.
6. Remove bolts (3) that hold the oil cooler.
7. Remove bolts from oil filter base.
8. Remove the oil cooler for the engine.
9. Remove the bonnet (2) from the oil cooler.



INSTALL ENGINE OIL COOLER 12-1378

1. Install the bonnet (3) on the oil cooler.
2. Put the oil cooler (1) in position and install bolts.
3. Install bolt in the gauge tube for oil level.
4. Install the air inlet line on the air compressor.
5. Tighten hose clamps (2).
6. Fill the engine cooling system to correct level.
7. Start engine and check for leaks.
8. Close right side door of hood.

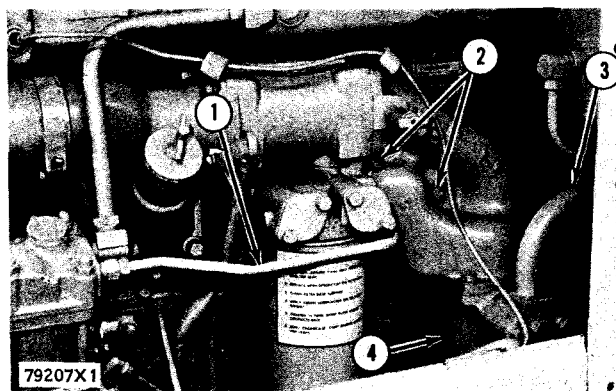


TORQUE CONVERTER OIL COOLER, WATER PUMP

REMOVE TORQUE CONVERTER OIL COOLER

11-1375

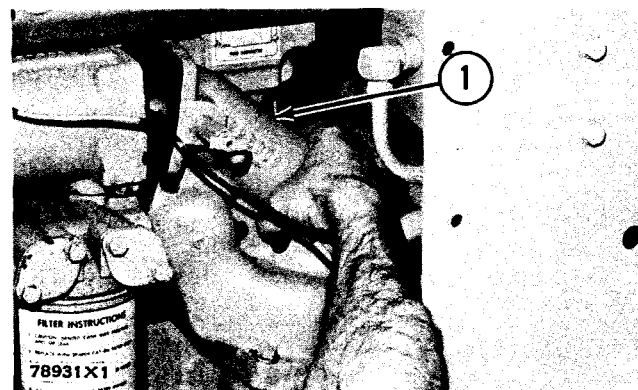
1. Open right side door of hood.
2. Remove coolant from the cooling system.
3. Disconnect inlet line (3) and outlet line from oil cooler.
4. Remove compressor water line (1).
5. Remove bolts (2). Remove oil cooler (4) for torque converter. Weight is 34 lb. (15.5 kg).
6. Remove bonnets from the oil cooler.



INSTALL TORQUE CONVERTER OIL COOLER

12-1375

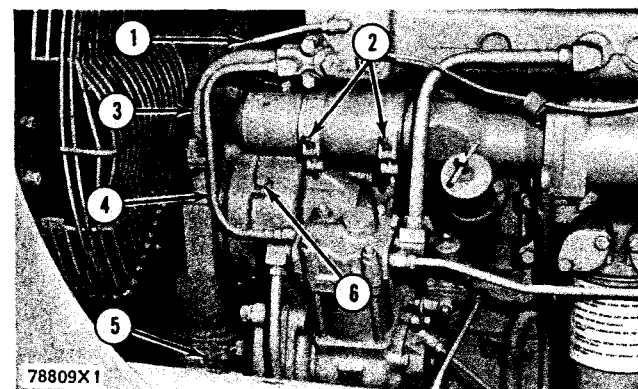
1. Install the bonnets (1) on the oil cooler. Put the oil cooler in position on engine and install all bolts.
2. Connect the inlet and outlet oil lines to the cooler.
3. Install water line for compressor.
4. Fill the cooling system to the correct level.
5. Close right side door of hood.



REMOVE WATER PUMP

11-1361

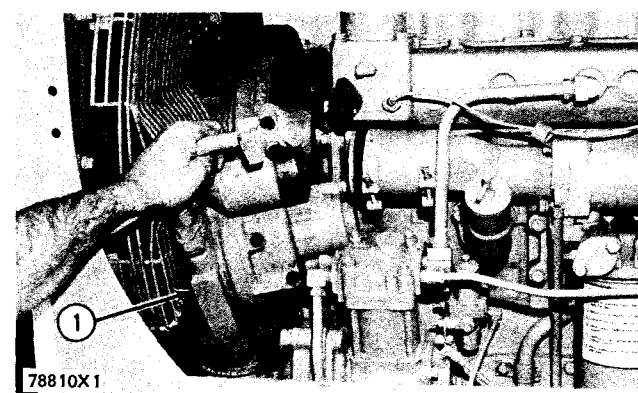
1. Open right side door of hood.
2. Remove coolant from the cooling system.
3. Remove lines (1) and (4). Disconnect line (3) from cylinder head.
4. Loosen hose clamps (2) and (5). Slide hose on the engine oil cooler bonnet.
5. Remove bolts (6) from water pump. Remove water pump.



INSTALL WATER PUMP

12-1361

1. Put the water pump (1) in position on the engine and install bolts.
2. Put the hoses in position and tighten the clamps.
3. Install all lines on cylinder head and air compressor.
4. Fill the cooling system to correct level.
5. Close right side door of hood.



WATER PUMP

DISASSEMBLE WATER PUMP

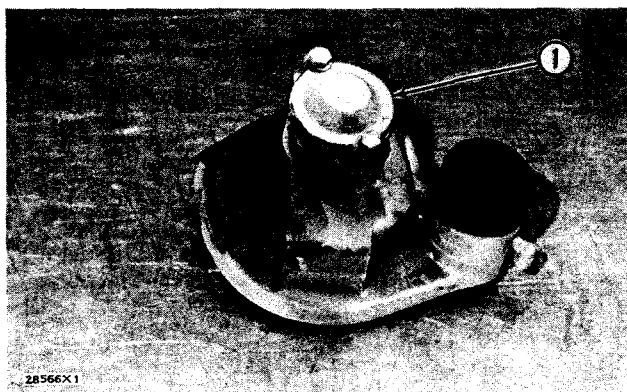
15-1361

start by:

a) remove water pump

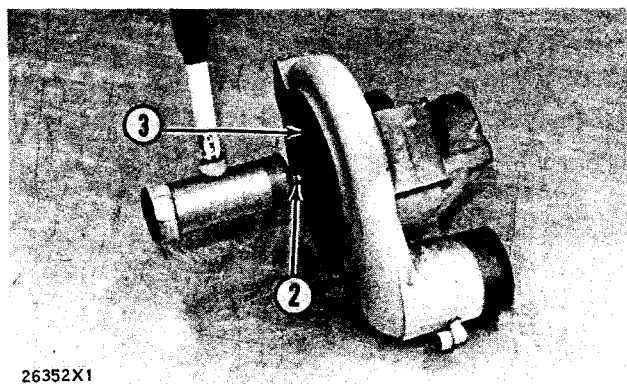
1. Remove the water inlet cover from the water pump.

2. Remove cover (1).



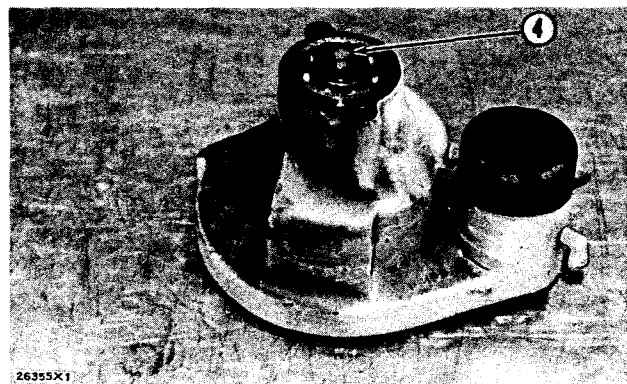
3. Loosen bolt (2) .25 in. (6.35 mm). Hit the bolt with a soft hammer to remove the impeller from the shaft. Remove the bolt, washer, and impeller (3).

4. Remove the seal and ring from the impeller.



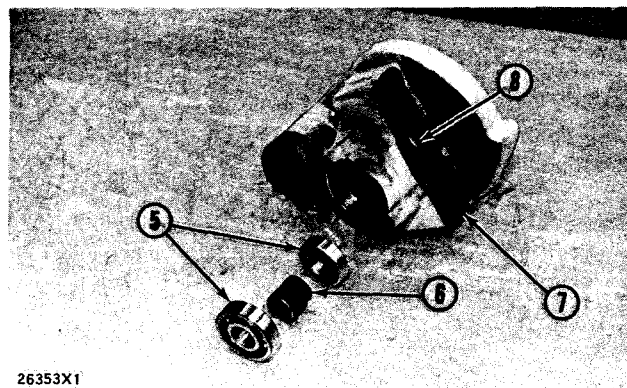
5. Remove bolt (4) and washer from shaft.

6. Remove the shaft and seal out of the impeller end of the water pump housing.



7. Remove drive gear of water pump from housing.

8. Remove the bearings (5) and spacer (6) from housing (7).



9. Remove the seal (8) from housing.

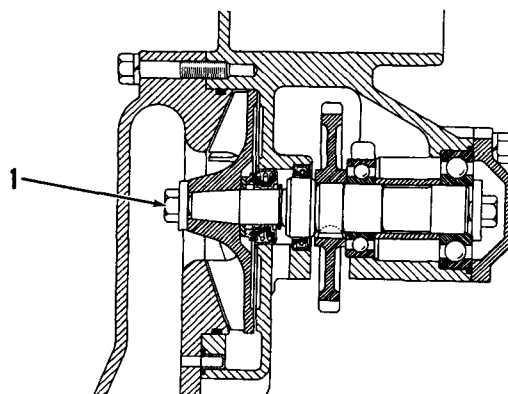
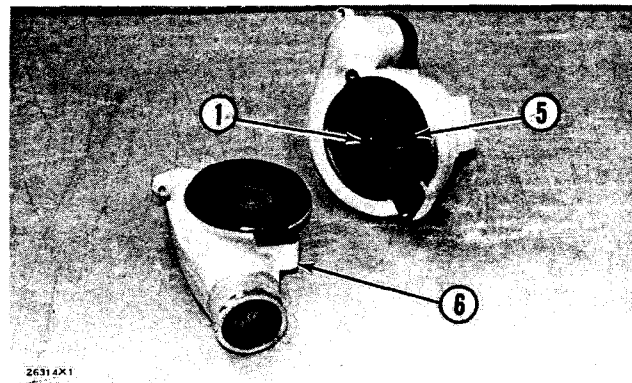
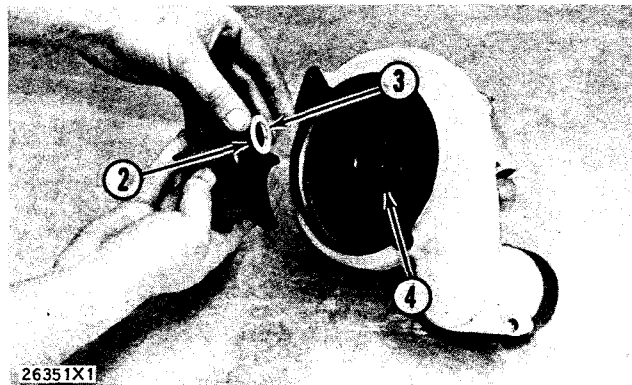
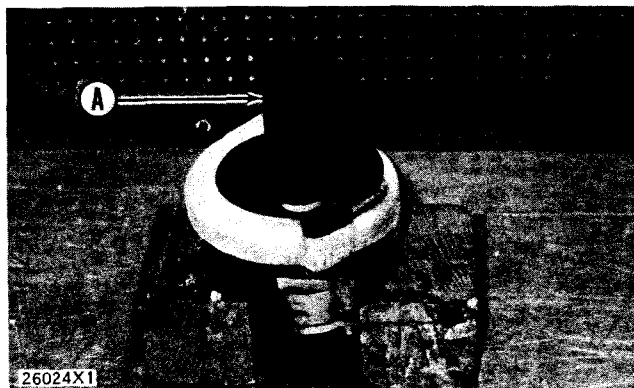
WATER PUMP

ASSEMBLE WATER PUMP

16-1361

Tools Needed		A
9S8096	Seal Installer	1

1. Install the seal in water pump housing with the lip of seal toward the bearing end of housing. Put clean SAE 30 engine oil on lip of seal.
 2. Put the drive gear in position in the housing and install the shaft with key on shaft in alignment with groove in drive gear.
 3. Put clean SAE 30 engine oil on the bearings. Install the bearings and spacer in the pump housing. Install the bolt and washer.
 4. Install cover.
 5. Install the seal (4) in housing with tool (A).
 6. Install the seal (2) and ring (3) in the impeller with the shiny surface of ring toward the seal (4).
 7. Put the impeller (5) in position on the shaft, and install bolt and washer. Turn bolt (1) to a torque of 38 ± 1 lb.ft. (3.9 ± 0.1 mkg).
 8. Install the water inlet cover (6).
- end by:
- a) install water pump

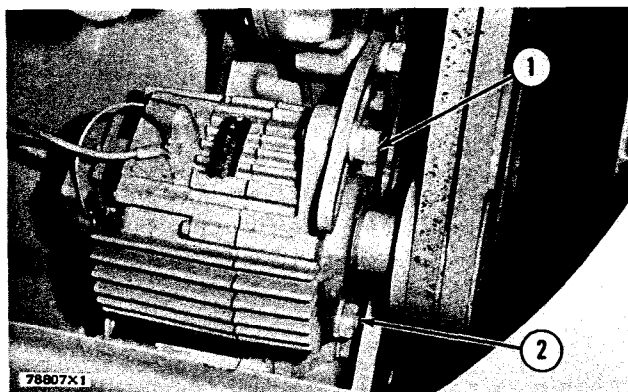


ALTERNATOR, FUEL BYPASS VALVE

REMOVE ALTERNATOR

11-1405

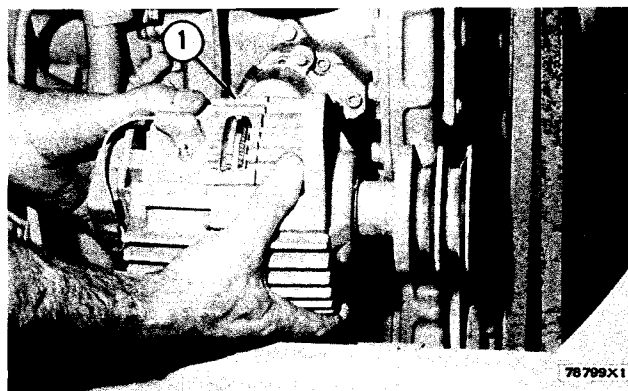
1. Open left side door of hood.
2. Loosen alternator bolts (1). Remove the alternator drive belts from the alternator pulley.
3. Remove wires from alternator.
4. Remove the alternator bolts (1) and (2). Remove the alternator.



INSTALL ALTERNATOR

12-1405

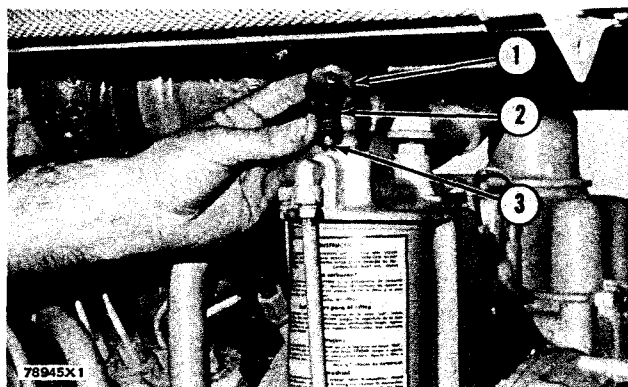
1. Put the alternator (1) in position on the engine, and install the bolts that hold it to the engine.
2. Put the alternator drive belts in position on the pulley and make adjustment to the belt tension. Correct belt adjustment for used belts is 7/8 in. (22 mm) of movement and for new belts 3/4 in. (19 mm) of movement.
3. Install wires on the alternator.
4. Close left side door of hood.



REMOVE AND INSTALL FUEL BYPASS VALVE

10-1284

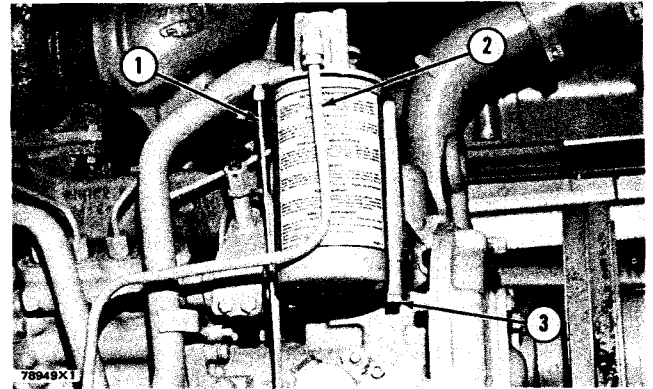
1. Remove cover (1), spring (2) and plunger (3).
2. Inspect plunger and seat in housing.
3. Install plunger, spring and cover.



FUEL FILTER BASE, FUEL TRANSFER PUMP

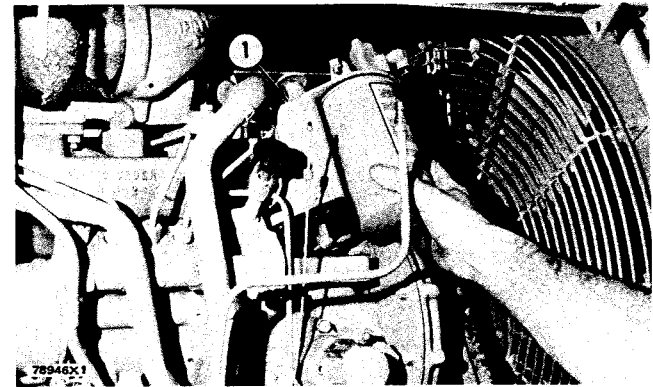
REMOVE FUEL FILTER BASE 11-1262

1. Open left side door of hood.
2. Disconnect lines (1) and (2) from fuel filter base.
3. Remove six bolts (3) from fuel filter base.
4. Remove fuel filter base and filter as a unit.
5. Remove filter from base.



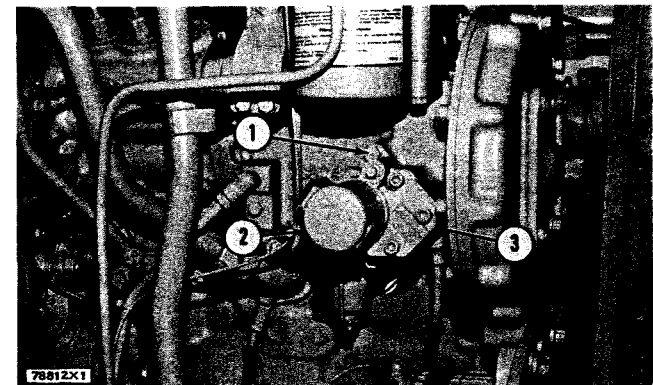
INSTALL FUEL FILTER BASE 12-1262

1. Put the fuel filter base (1) and filter in position on the engine. Install six bolts in the base.
2. Connect lines to fuel filter base.
3. Close left side door of hood.



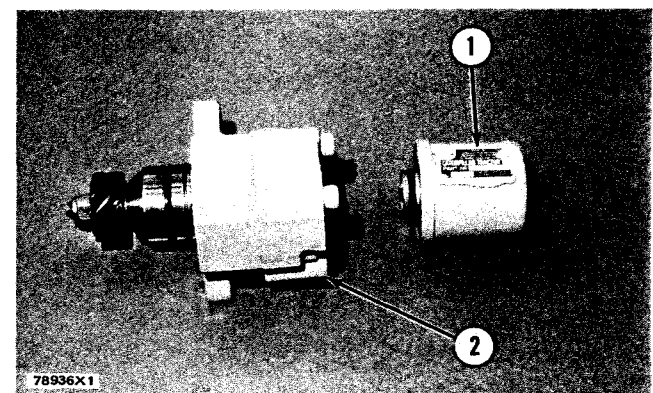
REMOVE FUEL TRANSFER PUMP 11-1256

1. Open left side door of hood.
2. Remove bolts (1).
3. Remove fuel transfer pump (3).
4. Remove service meter (2) from fuel transfer pump.



INSTALL FUEL TRANSFER PUMP 12-1256

1. Install service meter (1) on fuel transfer pump (2).
2. Put the fuel transfer pump in position on the engine and install the bolts that hold it on the engine.
3. Close left side door of hood.



FUEL TRANSFER PUMP

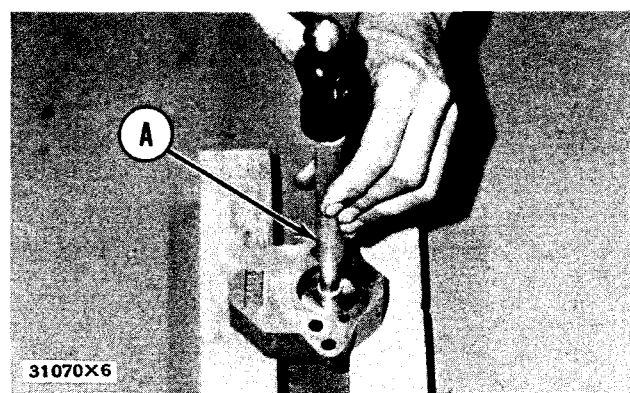
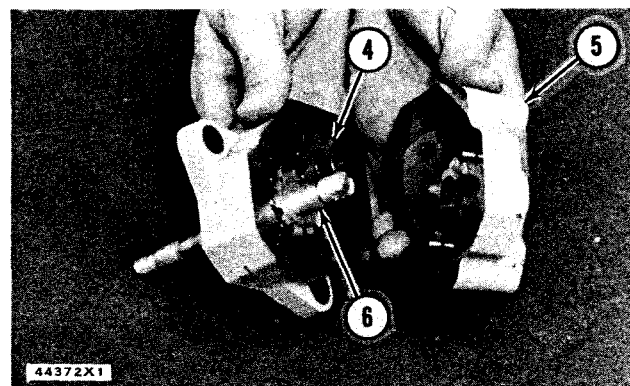
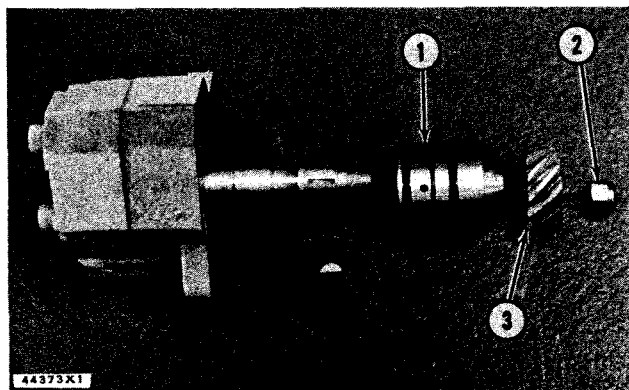
DISASSEMBLE FUEL TRANSFER PUMP

15-1256

Tools Needed			A
1P529	Handle	1	
1P528	Extension Tube	1	
1P457	Drive Plate	1	
1P454	Drive Plate	1	

start by:

- a) remove fuel transfer pump
 1. Remove nut (2), gear (3), and key.
 2. Remove the cage (1).
 3. Remove the O-ring seals from the cage.
 4. Remove the bearing and seals from cage with tooling (A).
 5. Remove the cover (5).
- CAUTION:** Be careful not to cause damage to surfaces of cover and pump body that fit together.
6. Remove the seal from the cover.
 7. Remove the gear (4), and the gear and shaft (6) from pump body.
 8. Remove the bearing from pump body with tooling (A).



FUEL TRANSFER PUMP

ASSEMBLE FUEL TRANSFER PUMP 16-1256

Tools Needed		A	B
1P529	Handle	1	1
1P459	Drive Plate	1	
1P454	Drive Plate	1	1
1P462	Drive Plate		1

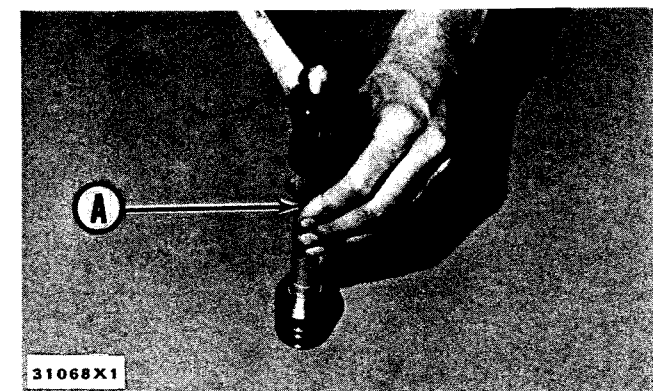
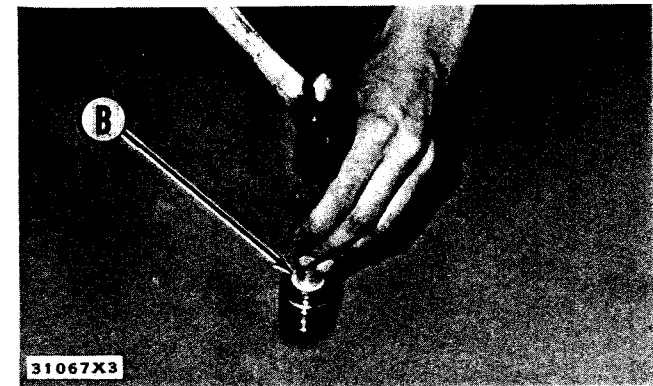
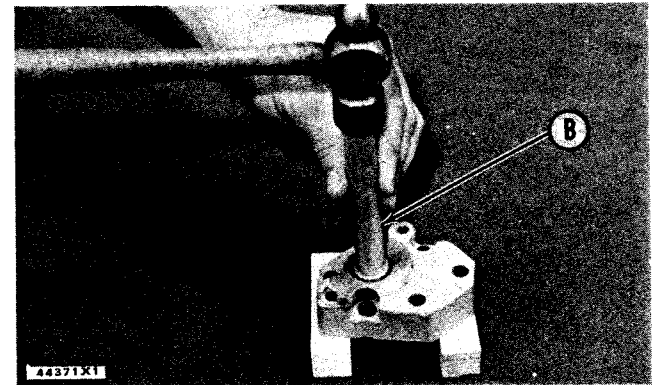
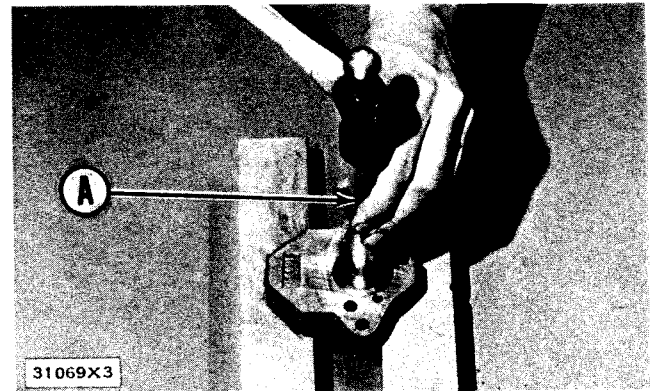
1. Clean all parts before assembling pump.
2. Install the bearing in pump body with tooling (A).
3. Put the gear and shaft in position in body.
4. Install the seal in the cover with tooling (B).
5. Put a small amount of 8S6747 Permatex Aviation Type form a gasket on surface of body.

CAUTION: Do not let Permatex enter pump.

6. Install the cover on pump body.

NOTE: After tightening bolts of the cover, the gear and shaft must turn freely.

7. Install the seals in the cage with tooling (B). Install the inside seal with lip of seal toward pump drive gear. Install the outside seal with lip near pump body.
8. Install the bearing in the cage with tooling (A).
9. Install the O-ring seals on cage.
10. Put clean SAE 30 engine oil on seals.
11. Put the cage in position on the gear and shaft.
12. Install the key, gear, and nut. Turn the nut to a torque of 22 ± 5 lb. ft. (3.0 ± 0.7 mkg). end by:
 - a) install fuel transfer pump.

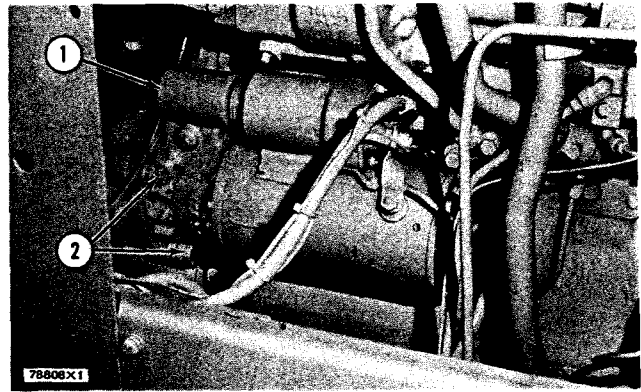


STARTER, FUEL INJECTION PUMP HOUSING AND GOVERNOR

REMOVE STARTER

11-1453

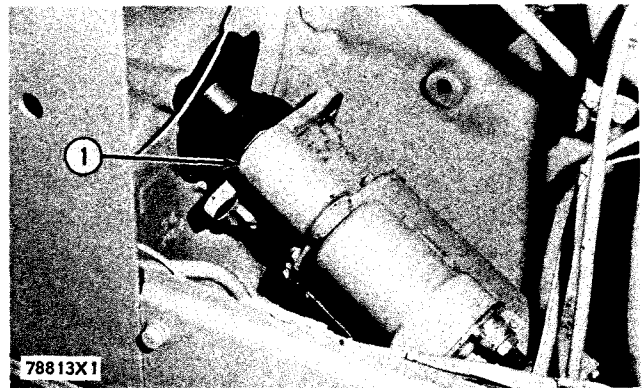
1. Open left side door of hood.
2. Put identification on wires and remove all wires from starter (1).
3. Remove three starter bolts (2). Remove starter. Weight is 60 lbs. (27 kg).



INSTALL STARTER

12-1453

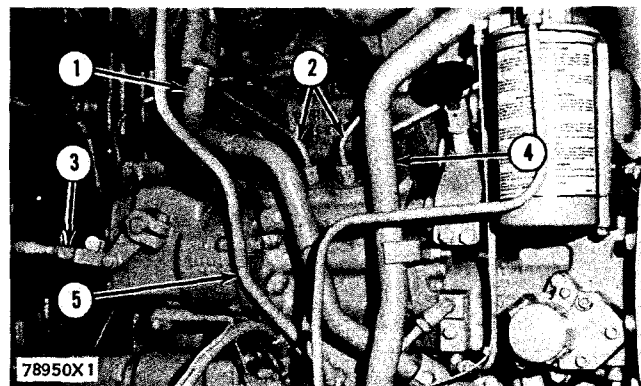
1. Put starter (1) in position on engine. Install the bolts that hold it to the engine.
2. Install all wires on starter.
3. Close left side door of hood.



REMOVE FUEL INJECTION PUMP HOUSING AND GOVERNOR AS A UNIT

11-1286

1. Open left side door of hood.
2. Remove lubrication supply line (5) and return line (1) from the turbocharger.
3. Disconnect throttle linkage (3) from governor.
4. Disconnect fuel injection lines (2). Put a cap on all openings.
5. Remove breather tube (4).
6. Remove all bolts that hold fuel injection pump housing to the accessory drive housing and bracket.
7. Remove the governor and fuel injection pump housing as a unit. Weight is 40 lb. (18 kg).



FUEL INJECTION PUMP HOUSING AND GOVERNOR

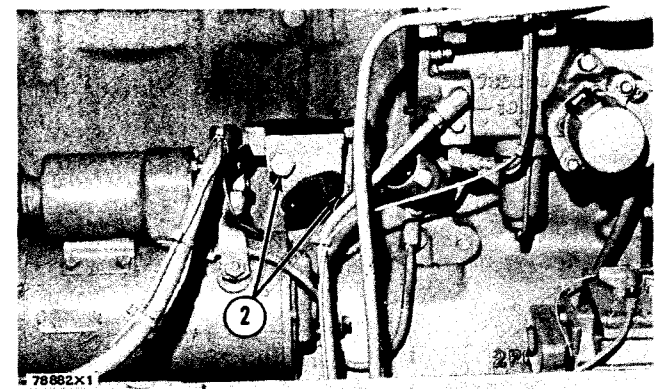
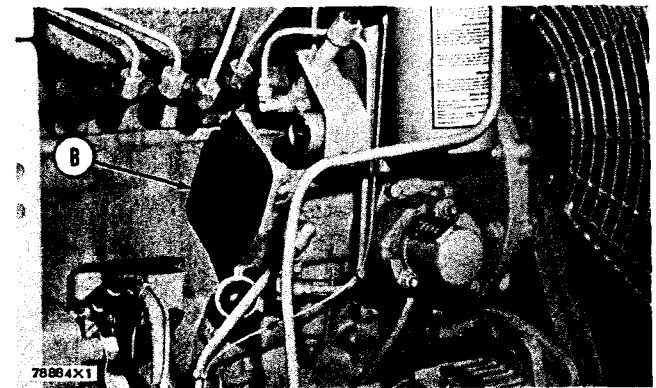
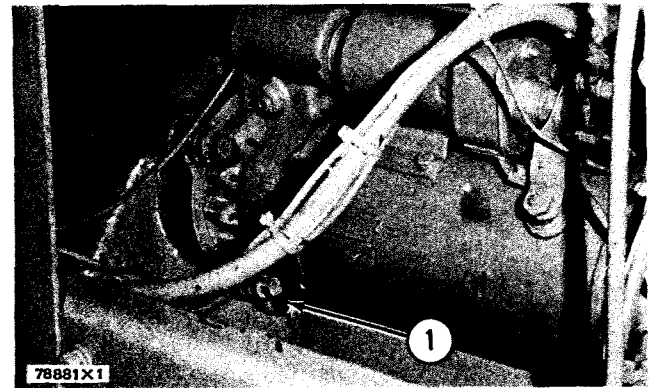
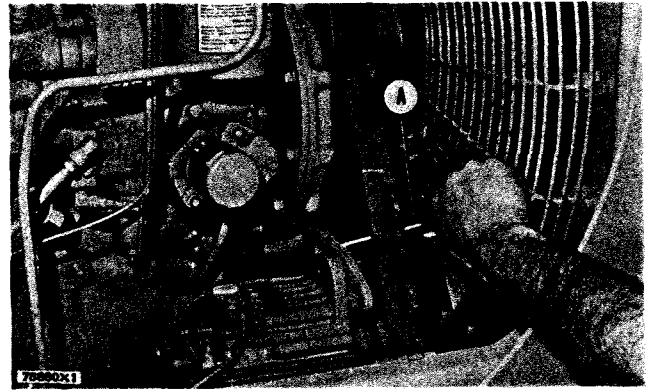
INSTALL FUEL INJECTION PUMP HOUSING AND GOVERNOR AS A UNIT 12-1286

Tools Needed		A	B
8S2292	Engine Turning Tool	1	
8S5417	Timing Fixture Plate		1

1. Remove crankcase breather from valve cover.
2. Remove timing plug from the flywheel housing.
3. Put tool (A) in position on crankshaft pulley. Turn crankshaft clockwise as seen from the front of the engine (rear of machine) until a 3/8"-16NC bolt (1), 2 1/2 in. long can be installed in the flywheel through the timing hole.

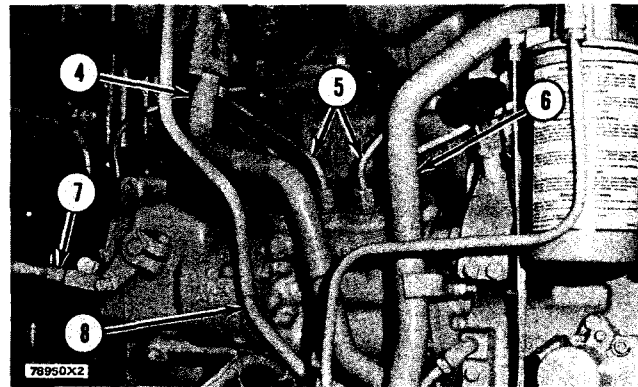
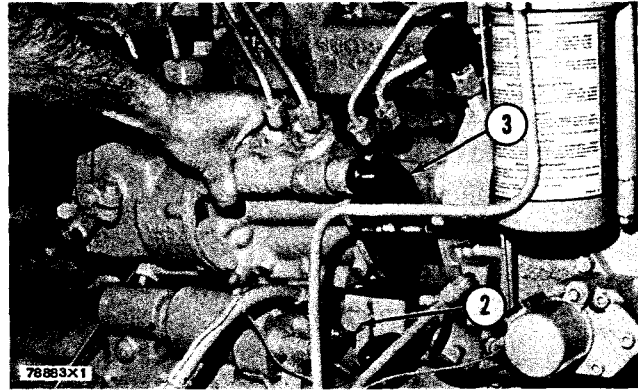
NOTE: If the timing hole in the flywheel is turned too far, do not turn the crankshaft back. Turn the crankshaft a full 360°.

4. When No. 1 piston is at top center compression position, the intake and exhaust rocker arms for No. 1 cylinder can be moved through the breather hole in the valve cover.
5. If the rocker arm can not be moved, remove the timing bolt and turn the crankshaft 360° and install the timing bolt again.
6. Install tool (B) on the rear face of the accessory drive housing. Install the plate with the dowels in the accessory drive housing in alignment with the dowel holes in the plate. If the timing fixture plate can not be installed, see TIMING ACCESSORY DRIVE SHAFT in TESTING AND ADJUSTING.
7. Loosen bolts (2) to prevent damage to the O-ring seals.



FUEL INJECTION PUMP HOUSING AND GOVERNOR

8. Put the fuel injection pump housing (3) and governor in position on the engine. Install all bolts that hold it to the accessory drive housing and bracket. Tighten the bolts (2) for the bracket.
9. Install the crankcase breather and tube (6).
10. Install the turbocharger lubrication supply line (8) and return line (4).
11. Connect the linkage (7) to the governor.
12. Remove the timing bolt and install the plug.
13. Remove the caps and connect the fuel injection lines (5). Tighten the nuts of the fuel injection lines to a torque of 30 ± 5 lb. ft. (4.1 ± 0.7 mkg).
14. Close left side door of hood.

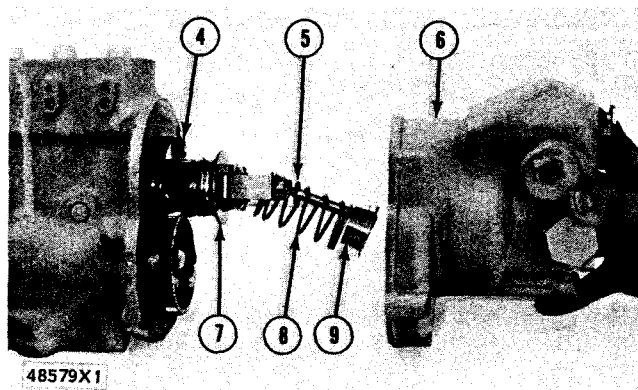
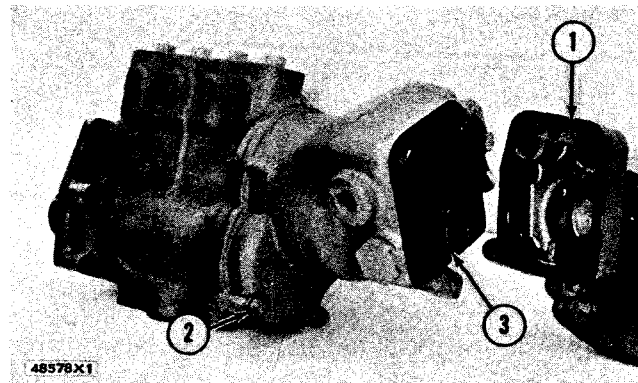


SEPARATION OF GOVERNOR FROM FUEL INJECTION PUMP HOUSING

start by:

- a) remove fuel injection pump housing and governor as a unit

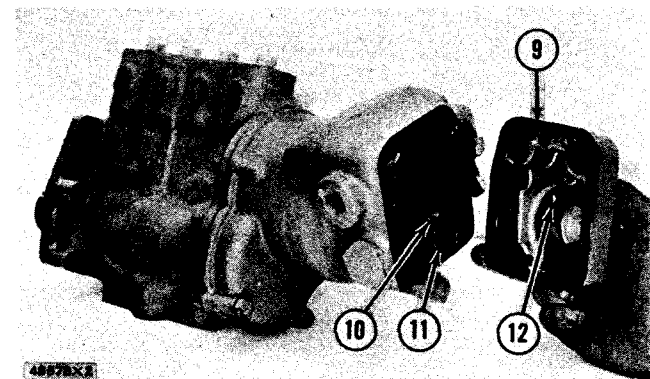
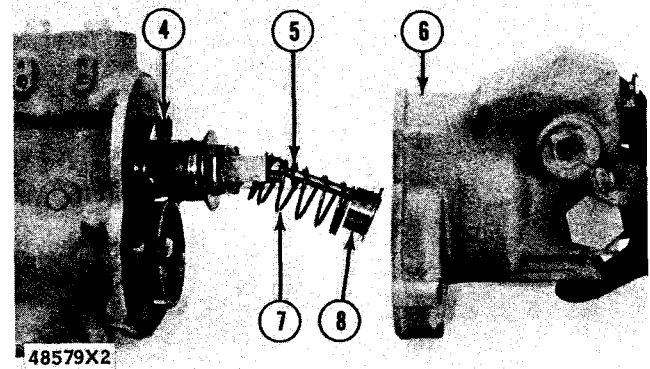
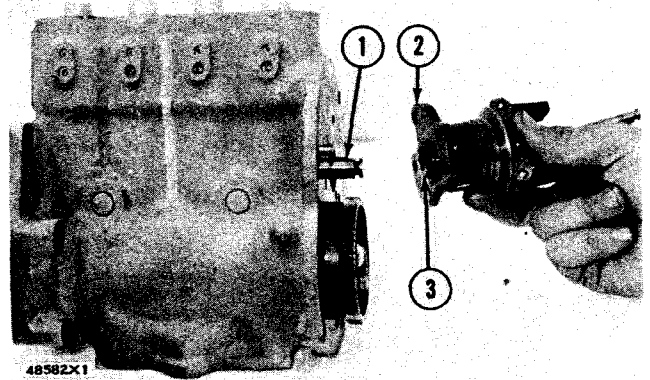
1. Remove cover (1).
2. Remove stop collar (3), collar and spring.
3. Remove mounting bolts (2).
4. Remove the governor housing (6).
5. Remove the seat (9) and spring (8). Remove spring (5) from the bolt.
6. Remove the three mounting bolts (4) and lock.
7. Pull the cylinder and weight (7) out to clear locating dowels. Slide it to the side and remove it from the rack.



FUEL INJECTION PUMP HOUSING AND GOVERNOR

CONNECTION OF GOVERNOR TO FUEL INJECTION PUMP HOUSING

1. Put the cylinder and weight (2) in position on the fuel injection pump housing so that piston (3) fits in the groove in the rack (1).
2. Push the cylinder and weight onto the locating dowels.
3. Install the three bolts (4) and lock.
4. Install the spring (5) on bolt so the inside diameter of spring (5) contacts the guide in governor housing (6).
5. Put seat (8) and governor spring (7) in position and install the governor housing (6) on the fuel injection pump housing.
6. Install spring, collar and rack stop collar (11) on bolt.
7. Install the rack stop collar screw (10).
8. Put the idle screw cover (9) in position on the governor housing so that dowel (12) in housing fits opening in rack stop collar (11).
9. Install the bolts in the idle screw cover.
 - a) install fuel injection pump housing and governor as a unit
 - b) make rack setting and governor adjustment (See FUEL RACK SETTING AND GOVERNOR ADJUSTMENTS in TESTING AND ADJUSTING)



GOVERNOR

DISASSEMBLE GOVERNOR

15-1264

start by:

a) separation of governor from fuel injection pump housing

1. Remove the seat retaining ring (1) and pin (2).

2. Remove the seat (3), bolt (4), washers (5), and spring (6).

3. Remove the sleeve and bearing from the cylinder and weight unit.

4. Remove the retaining ring (7) and sleeve (8).

5. Remove bearing (9) and races (10) from sleeve (8).

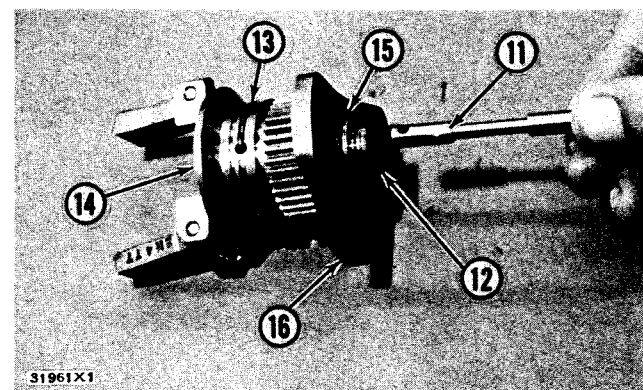
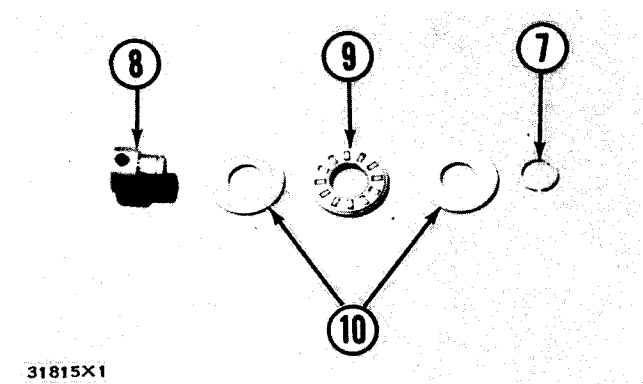
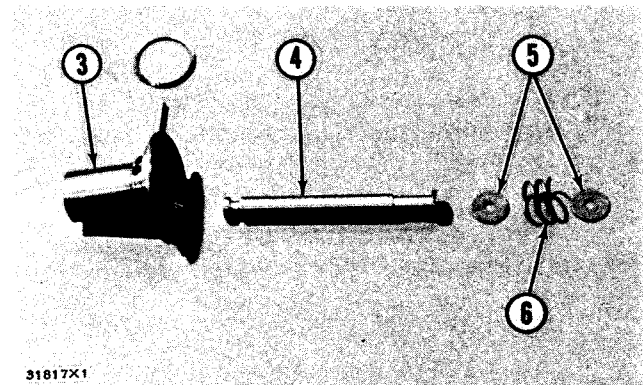
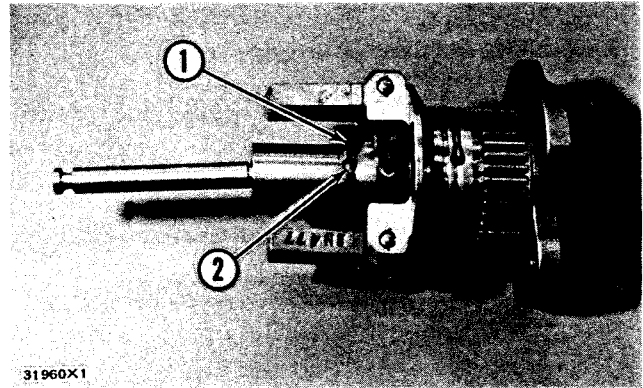
6. Remove the valve (11) from piston (12).

7. Remove retaining ring (13).

8. Remove the weight unit (14).

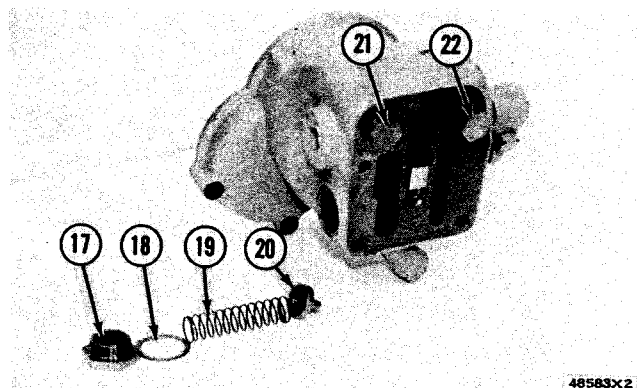
9. Remove piston (12) and sleeve (15) from the cylinder (16).

10. Remove the O-ring seal from the sleeve (15).



GOVERNOR

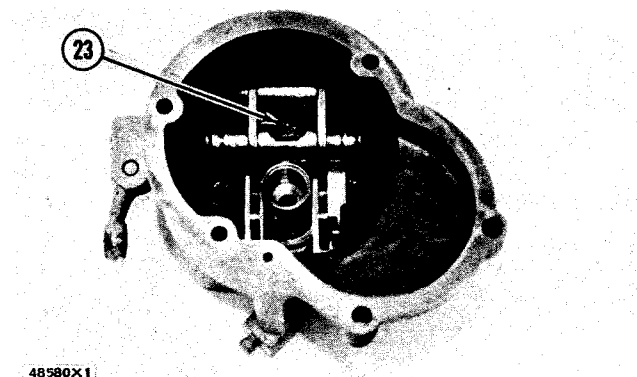
11. Remove the speed limiter plug (17), gasket (18), spring (19), and plunger (20) from the governor housing.



12. Remove the high idle screw (22) and low idle screw (21).

13. Remove the retaining bolt (23) and lock.

14. Remove the shaft and lever from governor housing.



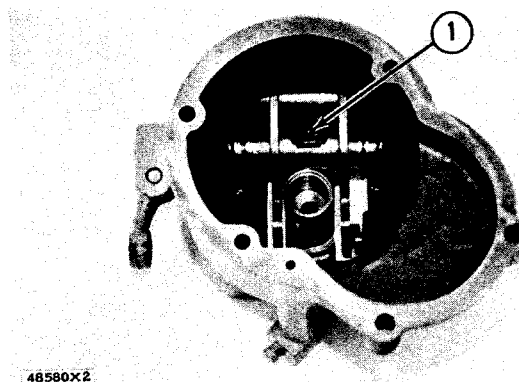
15. Remove the seal, plug, and two bearings from the governor housing.

GOVERNOR

ASSEMBLE GOVERNOR

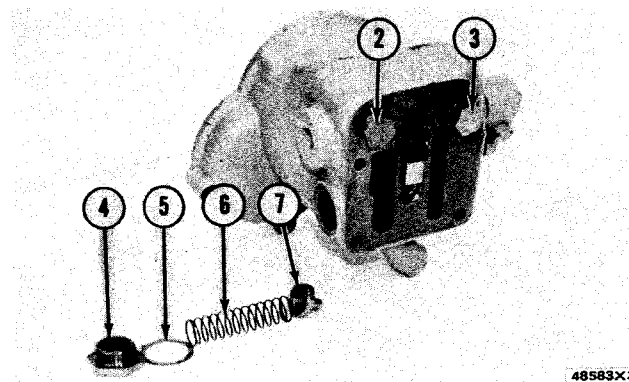
16-1264

1. Install two bearings, plug, and seal in the governor housing with the lip of seal to inside.



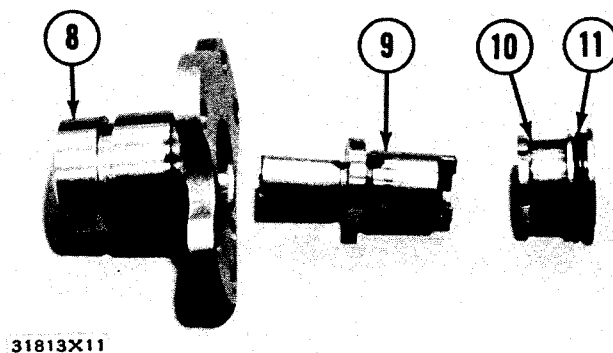
2. Put the lever and shaft in position in the governor housing. Install the retaining bolt (1) and lock.

3. Install the high idle screw (3) and low idle screw (2) in the governor housing.

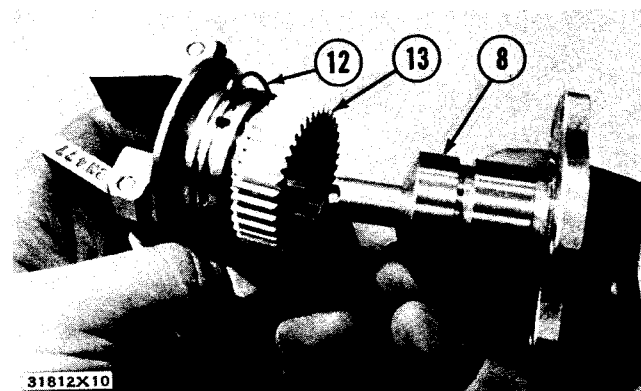


4. Install the speed limiter plug (4), gasket (5), spring (6), and plunger (7) in the governor housing.

5. Install the O-ring seal (11) on sleeve (10).



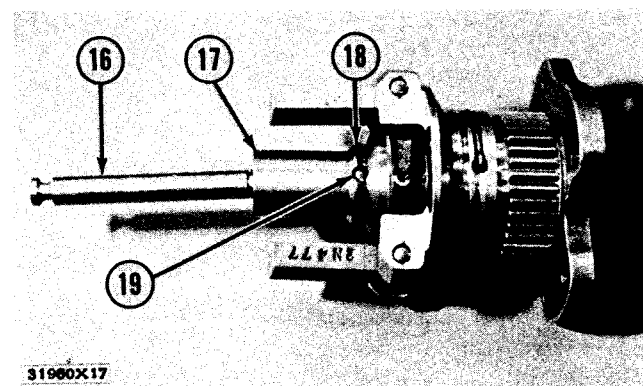
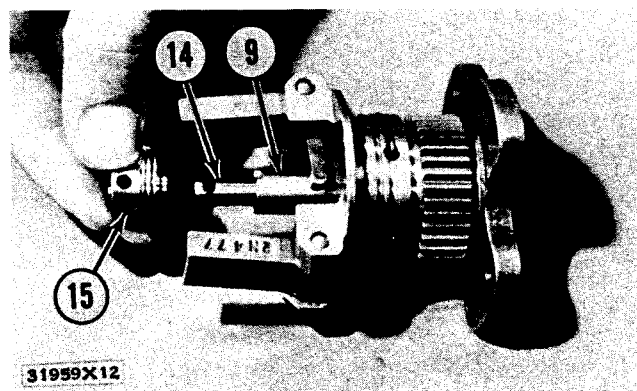
6. Install piston (9) and sleeve (10) in the cylinder (8).



7. Put the weight unit (13) in position on cylinder (8), and install retaining ring (12).

GOVERNOR

8. Install the valve (14) in piston (9).
 9. Install the bearing and races in sleeve. Install ring. Install the sleeve and bearing (15) on valve (14).
 10. Put the seat (17), bolt (16), washers and spring in position on the valve (14). Install the retaining pin (19) and ring (18).
- end by:
- a) connection of governor to fuel injection pump housing
 - b) install fuel injection pump housing and governor as a unit
 - c) make rack setting and governor adjustment (See FUEL RACK SETTING AND GOVERNOR ADJUSTMENTS in TESTING AND ADJUSTING)



FUEL INJECTION PUMP HOUSING

DISASSEMBLE FUEL INJECTION PUMP HOUSING 15-1253

Tools Needed		A	B	C
8S4613	Wrench	1		
8S2244	Extractor		1	
8S2241	Camshaft Brg. Installation & Removal Tool Group			1

start by:

- a) separation of governor from fuel injection pump housing

1. Remove the fuel injection pumps as follows:

- a) Remove the protection cap and washer (1).
- b) Install tool (A) and remove bushing (2) from housing.
- c) Remove the seal (3).
- d) Install tool (B).
- e) Lift the fuel injection pump out of the housing.
- f) Remove the spacer (4). Keep the spacers (4) and pumps together, and put a mark on them as to their location in the fuel injection pump housing.

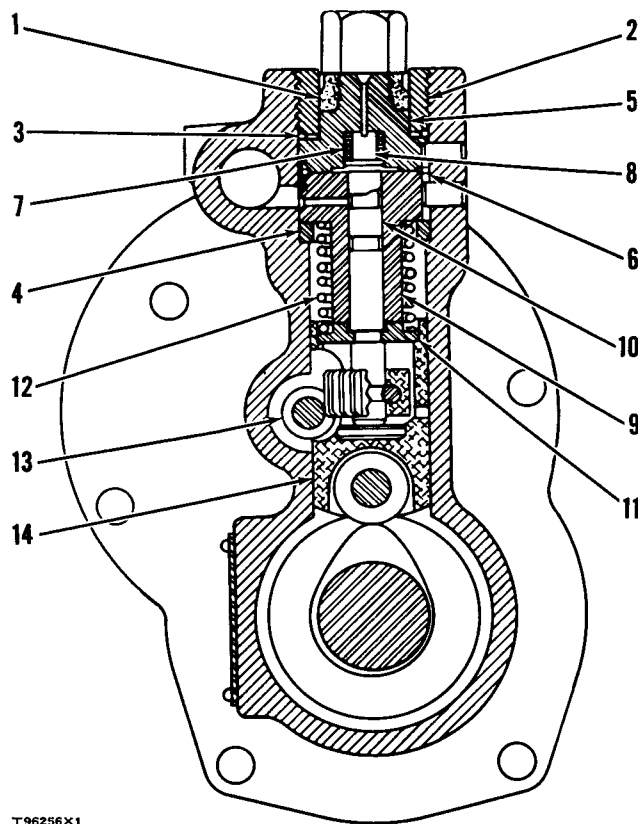
2. Disassemble the fuel injection pump as follows:

- a) Remove the bonnet (5), ring (6), spring (7), and check valve (8) from the barrel (9).
- b) Remove the plunger (10), washer (11), and spring (12) from the barrel (9).

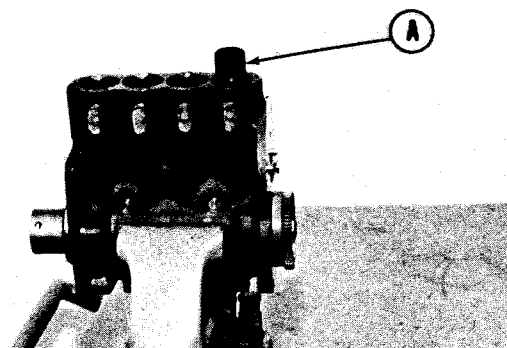
CAUTION: During disassembly and assembly of fuel injection pumps, do not cause damage to plunger surfaces. The barrel and plunger are exactly fitted, and the parts can not be changed with other barrels or plungers.

3. Remove the rack (13).

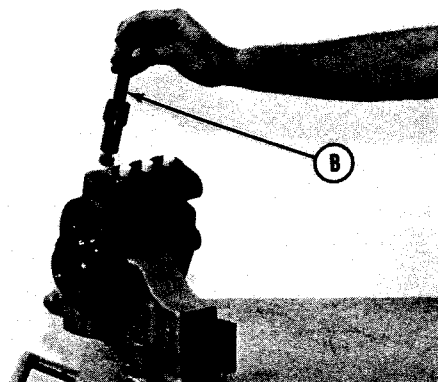
4. Remove the lifters (14). Put identification on the lifters and keep them together with their respective pump and spacers.



T96256X1



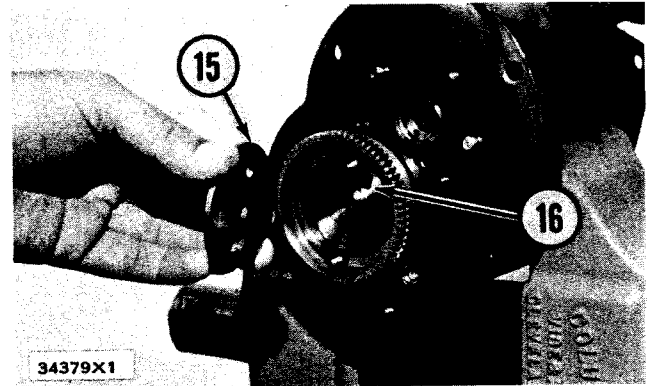
35004X1



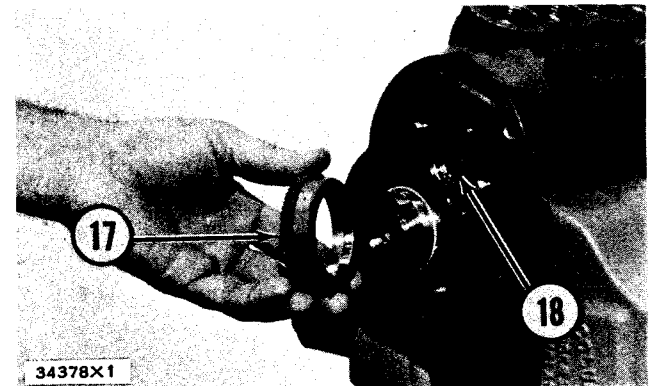
34377X1

FUEL INJECTION PUMP HOUSING

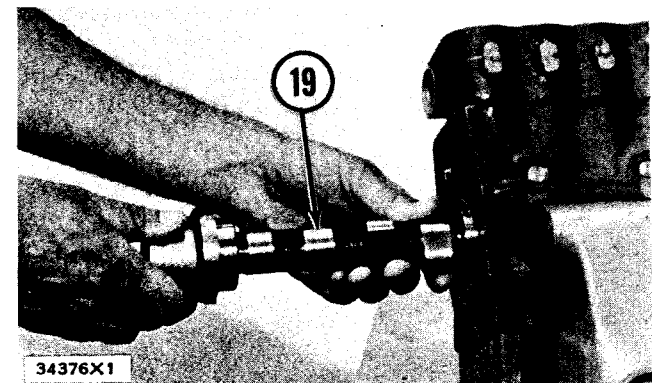
5. Remove the camshaft plate (15), bolt and lock.



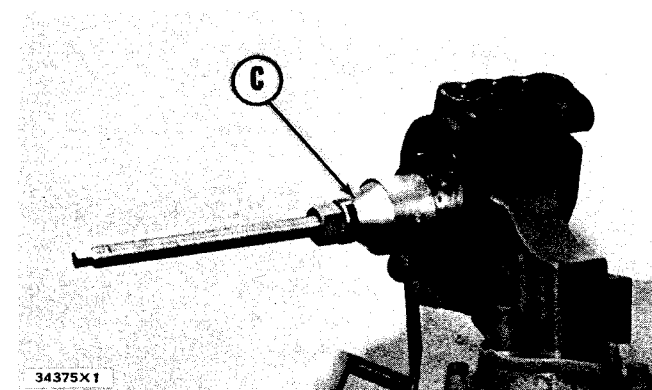
6. Remove the spring (16) and the gear (17) from the camshaft.



7. Remove the camshaft (19).



8. Remove the camshaft bearings from the fuel injection pump housing with tool (C).



9. Remove the two bearings (18) from the fuel injection pump housing.

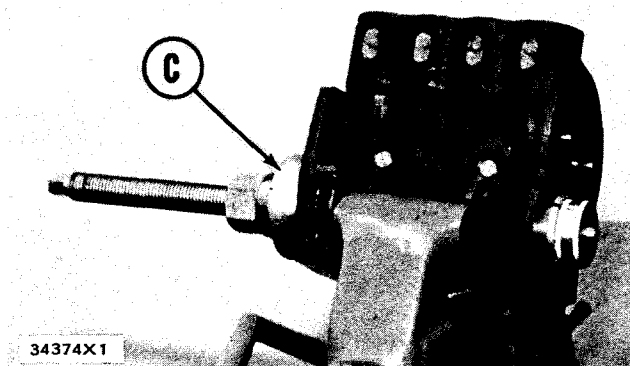
FUEL INJECTION PUMP HOUSING

ASSEMBLE FUEL INJECTION PUMP HOUSING

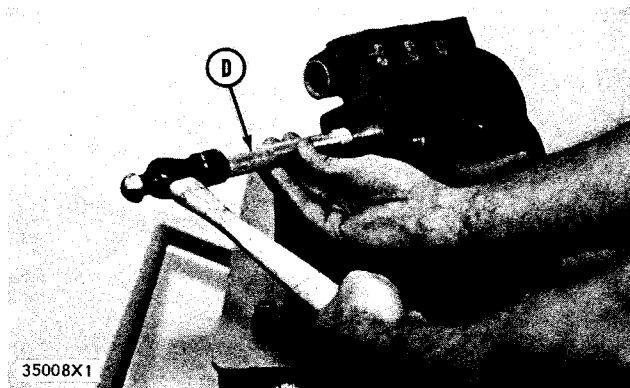
16-1253

Tools Needed		A	B	C	D	E
8S4613	Wrench	1				
8S2244	Extractor		1			
8S2241	Camshaft Brg. Installation & Removal Tool Group			1		
1P529	Handle				1	
1P460	Drive Plate				1	
1P455	Drive Plate				1	
7S7113	Rack Setting Gauge					1
FT960	Fuel Injection Pump Installation Tool Group					1

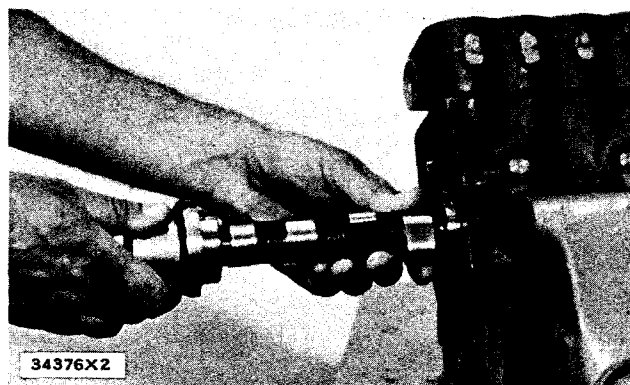
1. Install the camshaft bearings in the fuel injection pump housing with tool (C). Install the bearing in governor end of housing so the lubrication hole in the bearing is in alignment with lubrication hole in housing. Install the camshaft bearings even with outside ends of fuel injection pump housing.



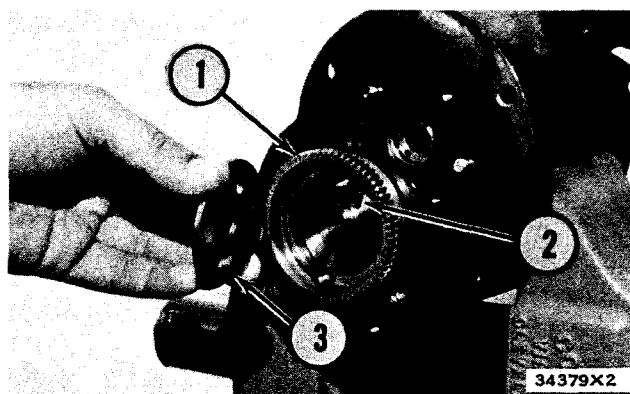
2. Install the two rack bearings in the fuel injection pump housing with tooling (D). Install the bearing in governor end of housing so it will be $.195 \pm .005$ in. (4.953 ± 0.127 mm) lower than face of housing. Install the rack bearing in accessory drive end of housing so it will be even with face of fuel injection pump housing.



3. Put clean SAE 30 engine oil on camshaft. Install the camshaft in fuel injection pump housing.



4. Put the governor drive gear (1) and spring (2) in position on the camshaft. Install the camshaft plate (3), bolt, and lock.

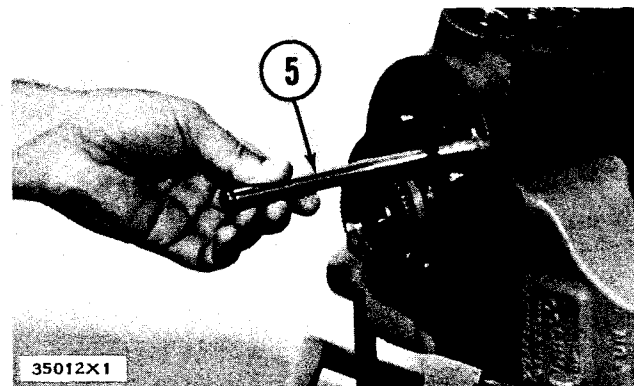


FUEL INJECTION PUMP HOUSING

5. Install the lifters (4) in their positions in housing. Put clean SAE 30 engine oil on the rack. Install the rack (5) in fuel injection pump housing with the opening in rack near the governor end of housing.

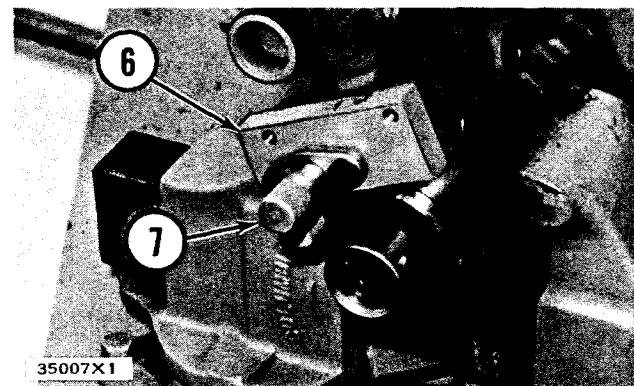


6. Install the spacers in their respective positions in housing. When installing new lifters and pumps, it is necessary to make adjustment of the fuel pump timing. See FUEL INJECTION PUMP TIMING DIMENSIONS SETTING, OFF ENGINE in TESTING AND ADJUSTING.

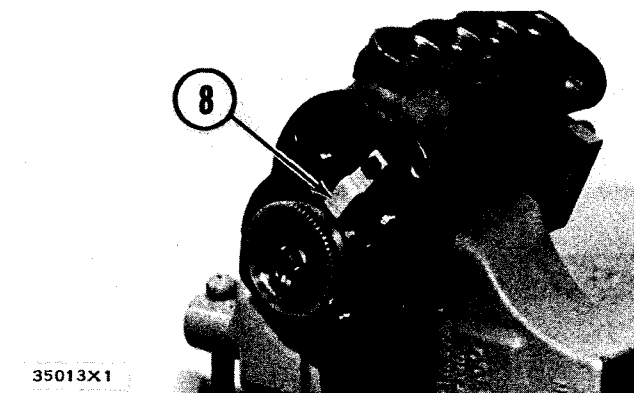


7. Assemble the fuel injection pumps as follows:
 - a) Put clean fuel oil on all parts.
 - b) Install the spring, washer, and plunger in the barrel.
 - c) Install the spring, check valve, bonnet, and ring on the barrel.

CAUTION: Do not install fuel injection pumps until the rack has been put in the center position.



8. Put the rack in the center position with tooling (E) as follows:
 - a) Install location fixture (6) on the fuel injection pump housing.
 - b) Install the gauge (7). Move the gauge (7) to zero. Push the rack (5) against the gauge.
 - c) Install the clamp (8) on pump housing as illustrated. This will keep the rack in the center while installing the fuel injection pumps.



FUEL INJECTION PUMP HOUSING

9. With the rack in the center, install the fuel injection pumps as follows:

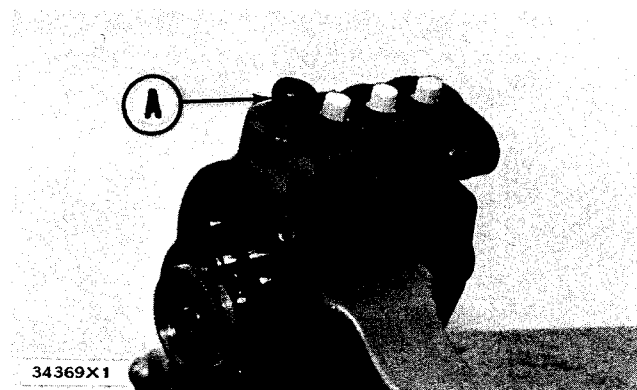
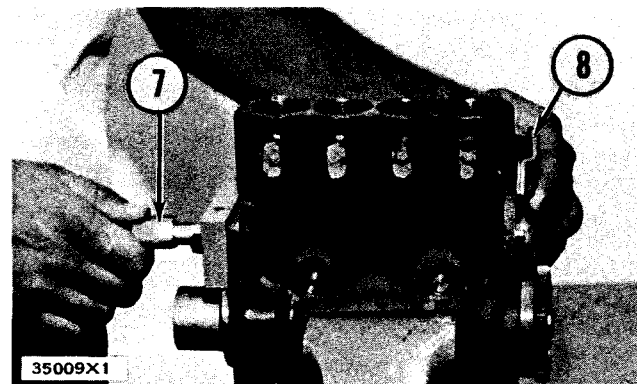
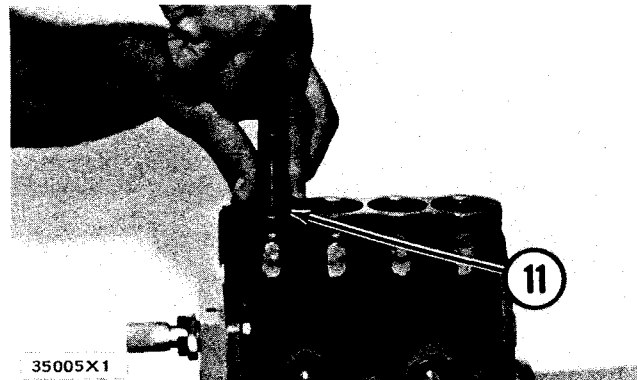
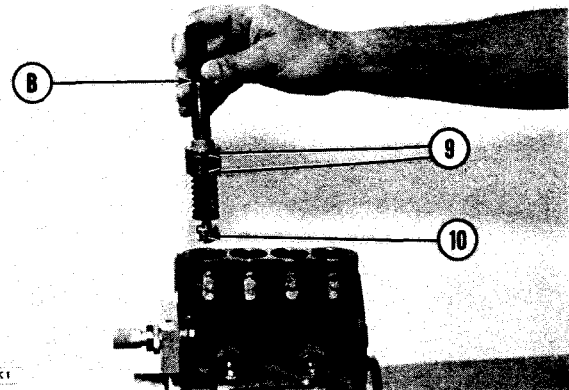
- a) Turn the camshaft until lobe of camshaft is down for pump being installed.
- b) Install the tool (B) on pump.
- c) Put the grooves (9) in bonnet and barrel in alignment with the groove (10) in pump gear. The groove must be in alignment with the center of these grooves. Put the pump in position so notches are in alignment with the guide pins in housing bore. Install the pump in its correct position in housing.
- d) Install the seal and bushing (11). Push down on tool (B), and tighten bushing by hand until the bushing is even with top of housing. If installation of the bushing cannot be made this far by hand, remove it. Remove pump, put components in alignment again and install the bushing again.

CAUTION: If installation of pump is correct, bushing can be tightened by hand until it is even with face of pump housing.

- e) After installation of each pump, check the rack travel as follows: Move the clamp (8) away from the end of rack. Check rack travel with gauge (7). If installation of the pump gear has been correct respective to rack, total rack travel must be .800 in. (20.32 mm). If you can not get total rack travel, remove the pump, put components in alignment again and again install pump.
- f) Remove the tool (B) and tool (E). Install tool (A) and turn retaining bushing to a torque of 150 ± 10 lb. ft. (20.7 ± 1.4 mkg). Remove tool (A). Install the washers and protection caps for fuel injection pumps.

end by:

- a) connection of governor to fuel injection pump housing

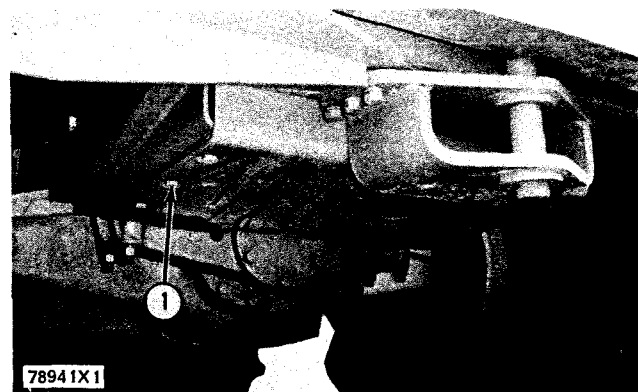


AIR TANK GUARD, AIR TANK

REMOVE AIR TANK GUARD 11-7150

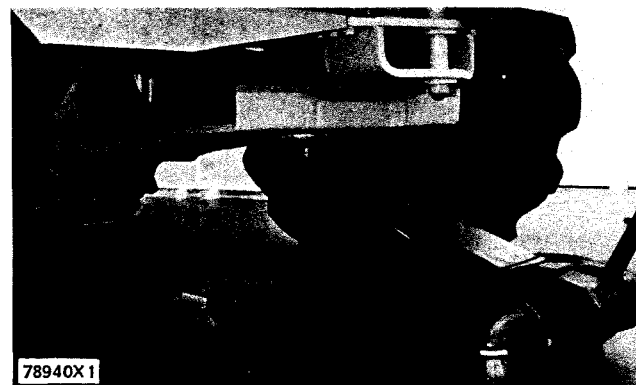
1. Put a floor jack into position under the air tank guard.
2. Remove the bolts (1) that hold guard to frame.
3. Remove air tank guard. Weight is 80 lb. (36 kg).

NOTE: Guard shown is for a 950 Tree Harvester.



INSTALL AIR TANK GUARD 12-7150

1. Put the guard for air tank on the floor jack.
2. Lift the guard into position.
3. Install bolts.

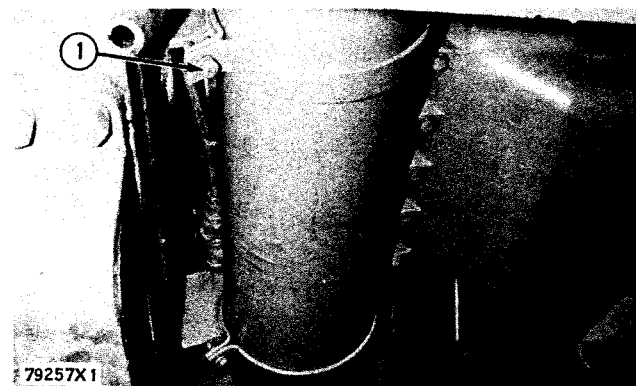


REMOVE AIR TANK 11-4272

start by:

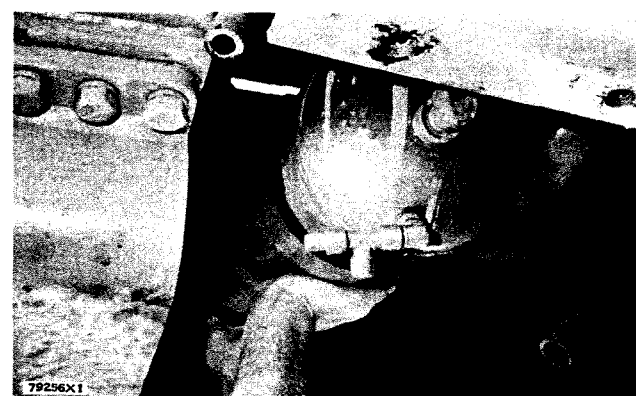
- a) remove air tank guard

1. Open valve on tank and release air pressure.
2. Disconnect air lines and governor sensing line from tank.
3. Remove tank bolts (1) from straps.
4. Remove the air tank.



INSTALL AIR TANK 12-4272

1. Put the air tank into position on machine.
 2. Install bolts in the straps.
 3. Connect the air lines to the tank.
- end by:
- a) install air tank guard



OIL PAN, OIL PAN PLATE

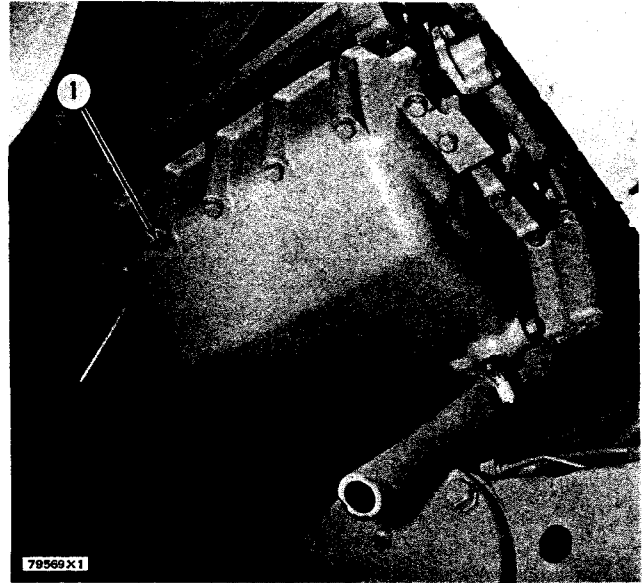
REMOVE OIL PAN

11-1302

start by:

a) remove air tank

1. Remove oil from crankcase.
2. Remove oil level gauge.
3. Remove bolts (1) from oil pan. Remove oil pan. Weight is 45 lb. (21 kg).



INSTALL OIL PAN

12-1302

1. Put the oil pan (1) in position on engine and install bolts.
2. Install oil level gauge.
3. Fill crankcase to correct level.

end by:

a) install air tank

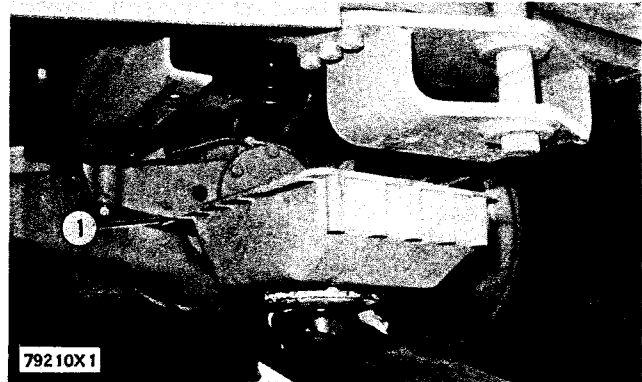
REMOVE OIL PAN PLATE

11-1303

start by:

a) remove oil pan

1. Remove suction bell (1).
2. Disconnect suction tube from oil pump.
3. Remove bolts (2) from oil pan plate.
4. Remove oil pan plate.



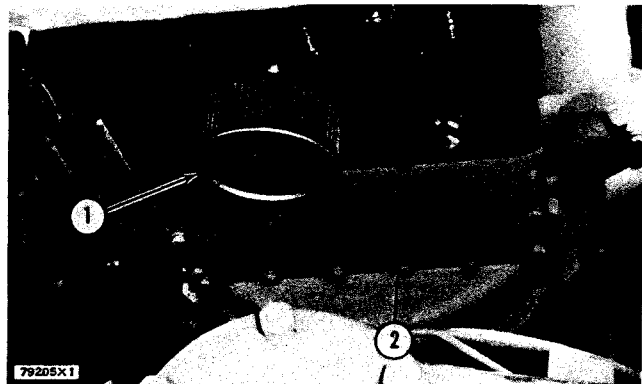
INSTALL OIL PAN PLATE

12-1303

1. Put the oil pan plate in position on engine and install bolts.
2. Connect suction tube to oil pump.
3. Install suction bell.

end by:

a) install oil pan



OIL PUMP

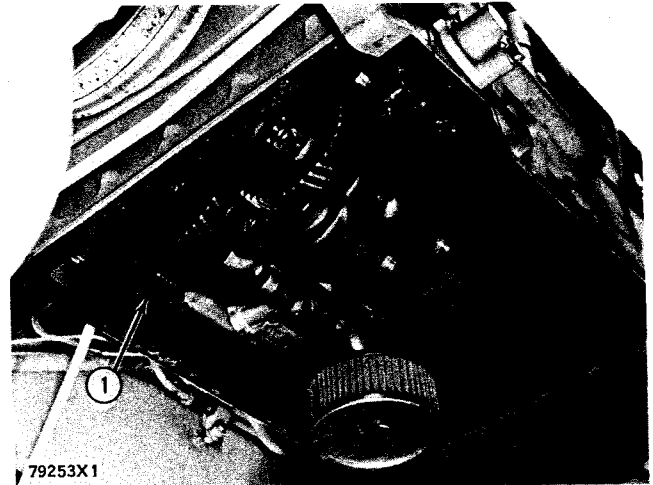
REMOVE OIL PUMP

11-1304

start by:

a) remove oil pan

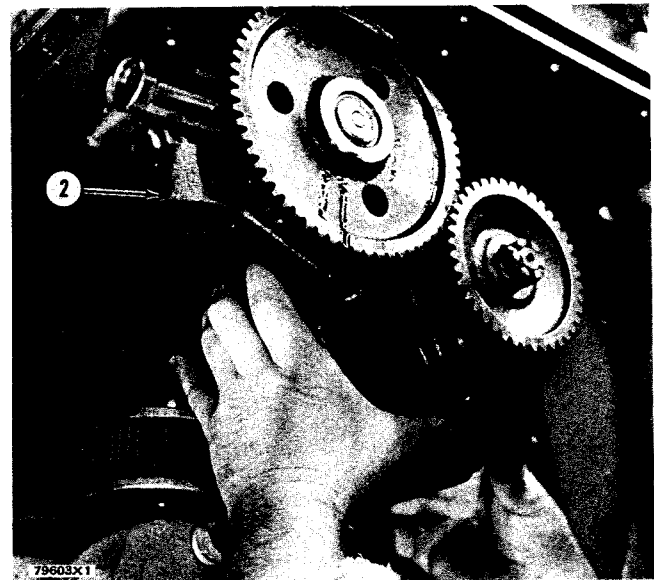
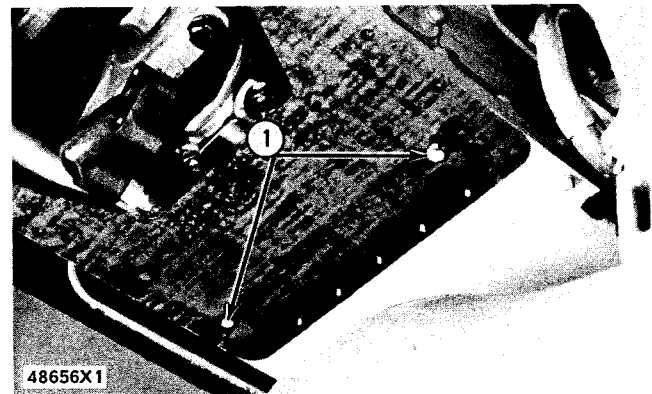
1. Remove the bolts that hold the suction tube to the oil pump.
2. Remove bolts (1) and locks from pump.
3. Remove the oil pump. Weight is 35 lb. (16 kg).



INSTALL OIL PUMP

12-1304

1. Put No. 1 piston on top center compression stroke. See LOCATING (FINDING) TOP CENTER COMPRESSION POSITION FOR NO. 1 PISTON IN TESTING AND ADJUSTING.
2. Turn both balancer shafts so the flat part is away from the oil pan plate. Install two, 3/8"-16NC bolts (1) 1 1/2" long so they fit in countersunk holes in the balancer shafts. This prevents shaft movement. Do not tighten the bolts against the bottom of countersunk holes in the shaft.
3. Put the oil pump (2) in position on the engine block and install the locks and bolts that fasten it to the engine.
4. Remove bolts (1) and check to see that the balancers are in correct time. Balancer timing is correct when holes in balancers are in alignment with holes in oil pan plate and No. 1 piston is at top center compression.
5. Install the suction tube on the oil pump.
end by:
a) install oil pan



OIL PUMP

DISASSEMBLE OIL PUMP

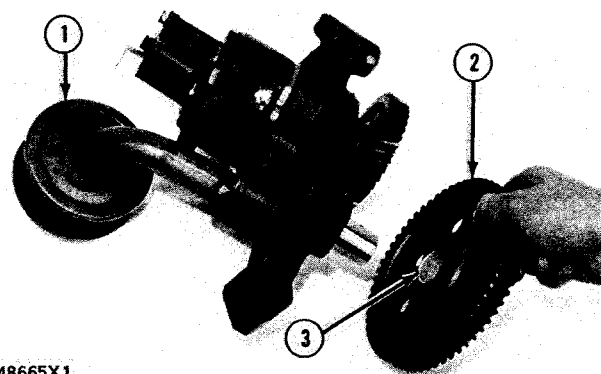
15-1304

Tools Needed		A	B	C
1P529	Handle	1	1	
1P468	Drive Plate	1		
1P465	Drive Plate	1		
1P462	Drive Plate		1	
1P461	Drive Plate		1	
8B7560	Step Plate			1
1P2320	Puller Assembly (8H695)			1

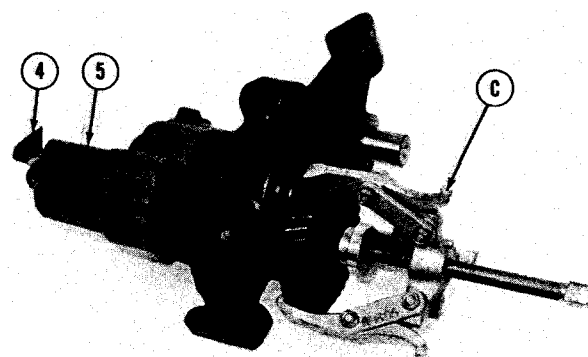
start by:

a) remove oil pump

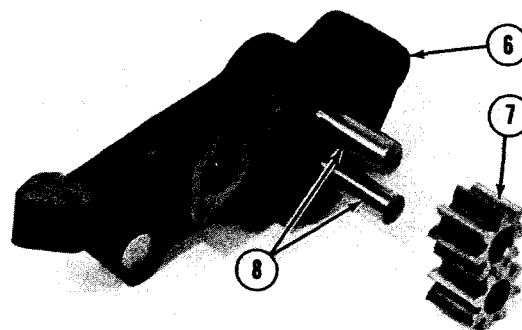
1. Remove the idler gear (2). Remove the bearing (3) from gear with tooling (A).
2. Remove the suction bell (1).
3. Remove the nut, washer and cotter pin from drive gear of the oil pump. Remove drive gear from shaft with tooling (C). Remove key from shaft.
4. Remove cover (4), spring, and plunger.
5. Remove the oil pump body (5).
6. Remove the oil pump gears (7).
7. Remove the spacer (6).
8. Remove the two shafts (8) and gears.
9. Remove the bearings from the two pump bodies with tooling (B).



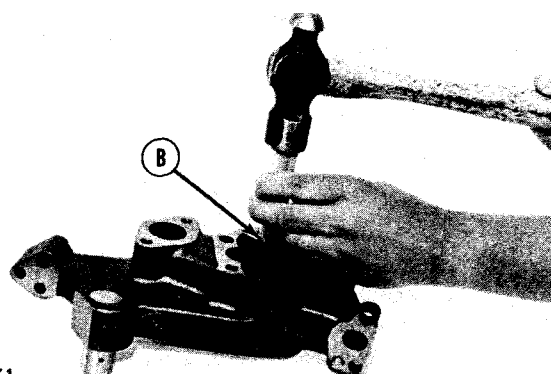
48665X1



48666X1



48664X1



48662X1

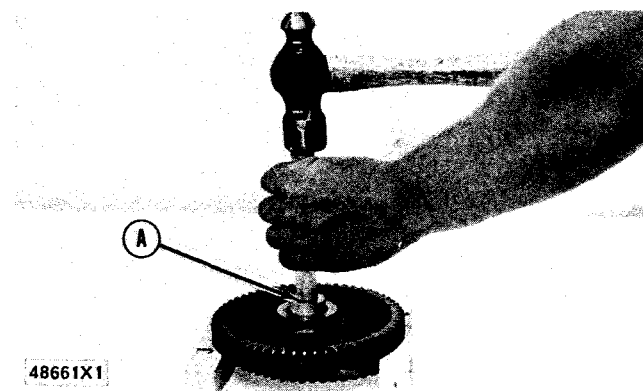
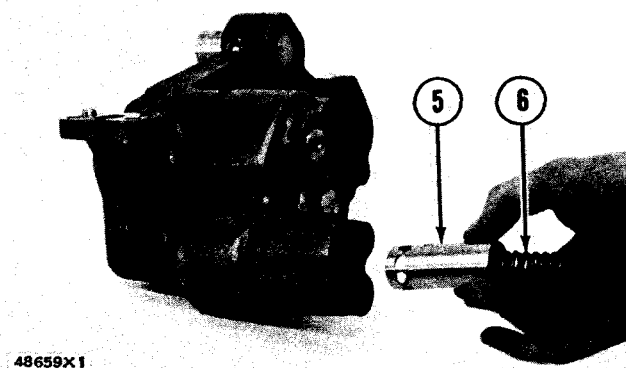
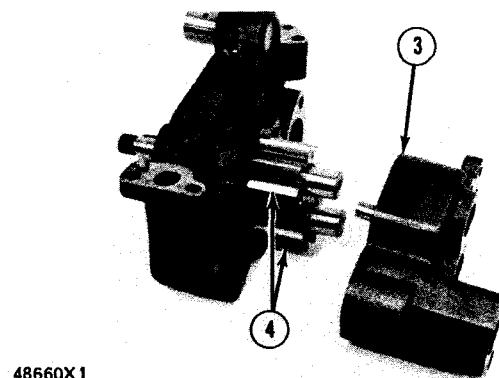
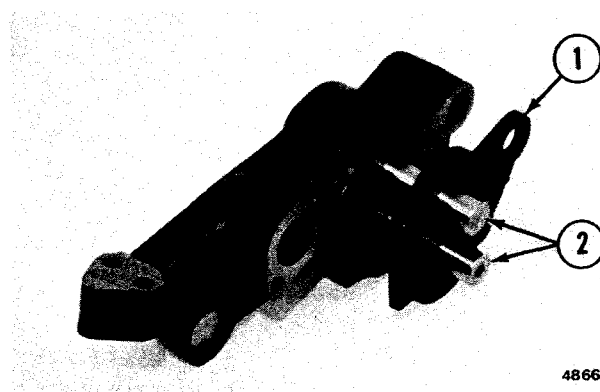
OIL PUMP

ASSEMBLE OIL PUMP

16-1304

Tools Needed		A	B
1P529	Handle	1	1
1P465	Drive Plate	1	
1P468	Drive Plate	1	
1P461	Drive Plate		1
1P462	Drive Plate		1

1. Install the bearings in the two bodies with tooling (B).
 2. Put clean SAE 30 oil on the shafts (2) and gears and install them in oil pump body.
 3. Install spacer (1).
 4. Put clean SAE 30 oil on the oil pump gears (4). Install the keys in the shafts (2). Install the oil pump gears (4).
 5. Install the oil pump body (3).
 6. Install the plunger (5) and spring (6) in the body. Install cover.
 7. Put the oil pump drive gear in position on the shaft and install nut and washer. Tighten nut to a torque of 60 lb. ft. (8.3 mkg) and added amount necessary to put cotter pin hole in alignment. Install the cotter pin.
 8. Install the suction bell.
 9. Install the bearing in oil pump idler gear with tooling (A). Install the idler gear on the oil pump.
- end by:
- a) install oil pump



CONNECTING ROD BEARINGS

REMOVE AND INSTALL CONNECTING ROD BEARINGS

10-1219

Tool Needed		A
5B1161	Wire	*

start by:

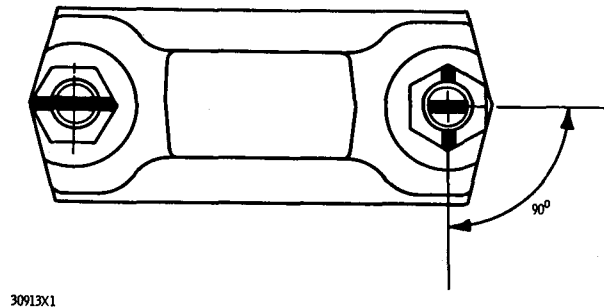
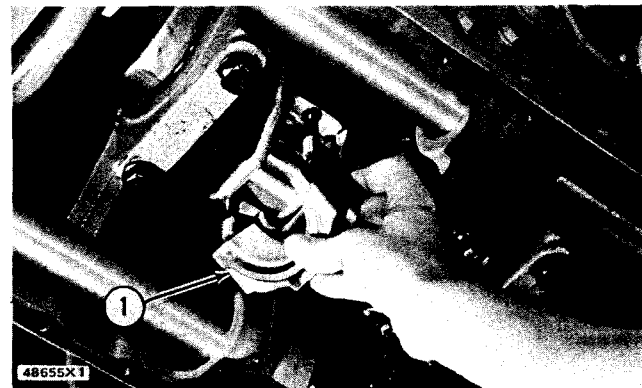
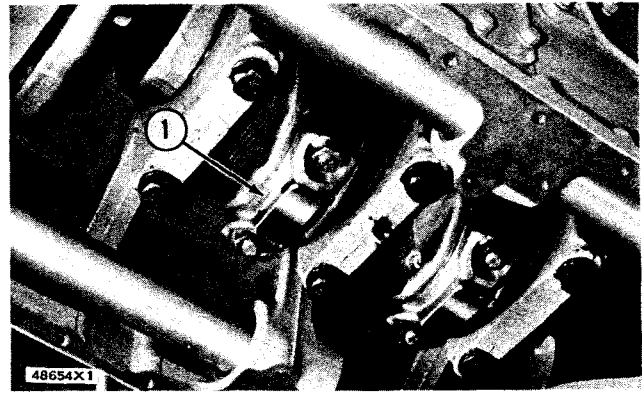
- remove oil pump
 - remove oil pan plate
- Turn the crankshaft until two pistons are at bottom center. Remove the connecting rod caps (1) from these connecting rods. Remove the lower half of bearings from the caps.
 - Push the connecting rods away from the crankshaft, and remove upper half of bearings.
 - At installation, clean the surfaces where the bearings fit, and install upper half of new bearings in the rods. Put clean SAE 30 oil on the bearings and crankshaft journals. Put the connecting rods in position on the crankshaft.
 - Clean the surfaces where the bearings fit and install lower half of new bearings in caps. Put clean SAE 30 oil on the bearings.
 - Put clean SAE 30 oil on the threads of all bolts.
 - Check the bearing clearance with wire (A). Put the caps (1) in position on the connecting rods and install nuts on the bolts. Turn both nuts to a torque of 30 ± 3 lb. ft. (4.1 ± 0.4 mkg). Put a mark on the nut and on the end of each bolts, and turn both nuts 90° more.
 - Remove the rod cap, and measure thickness of wire. Rod bearing clearance should be .0020 to .0075 in. (0.050 to 19.050 mm). Maximum permissible clearance is .010 in. (0.25 mm).
 - Put the caps in position on the connecting rods and install nuts on the bolts. Turn both nuts to a torque of 30 ± 3 lb.ft. (4.1 ± 0.4 mkg). Put a marks on the nut and on the end of each bolt, and turn both nuts 90° more.

CAUTION: When installing connecting rod cap, be sure that the number on side of cap is near to and respective to the number on side of connecting rod.

- Do Steps 1 through 6 again for other connecting rod bearings.

end by:

- install oil pan plate
- install oil pump



CRANKSHAFT MAIN BEARINGS

REMOVE AND INSTALL CRANKSHAFT MAIN BEARINGS

10-1203

Tools Needed		A	B	C
2P5518	Main Bearing Removal Tool	1		
5B1161	Wire		*	
8S2328	Dial Test Indicator Group			1

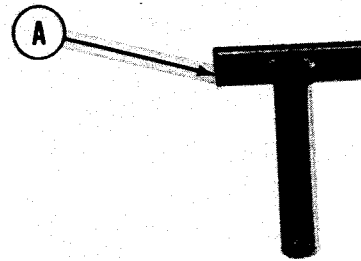
start by:

- a) remove oil pump
- b) remove oil pan plate

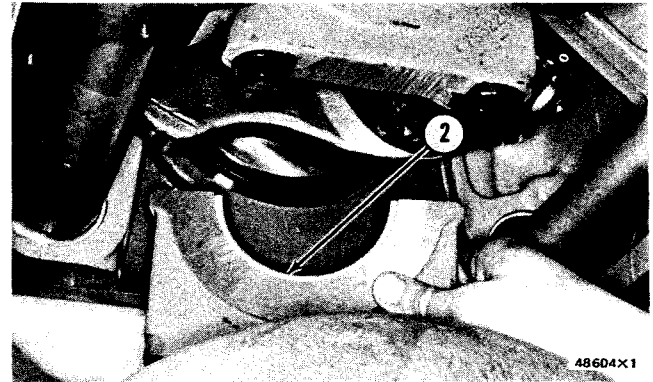
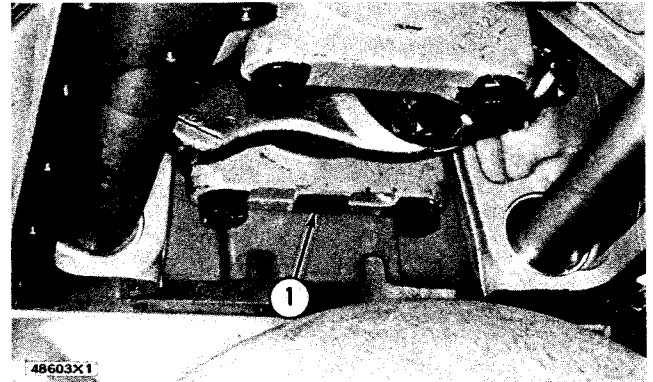
1. Remove the No. 1, 3, and 5 main bearing caps (1) of the crankshaft.
2. Remove the upper halves of main bearings by turning the crankshaft and moving the bearing out of cylinder block with tool (A). Remove lower halves (2) of main bearings from caps.
3. Put clean SAE 30 oil on upper halves of main bearings. Put upper halves of main bearings into place with tool (A).
4. Clean the main bearing caps, and install lower halves of bearings in caps.
5. Check the bearing clearance using wire (B). Install caps and turn bolts to a torque of 30 ± 3 lb. ft. (4.1 ± 0.4 mkg). Put a mark on both bolt heads and bearing caps, then turn each bolt 90° more. Remove the bearing caps, and measure thickness of wire. Main bearing clearance should be .0030 to .0059 in. (0.076 to 0.150 mm).
6. Put clean SAE 30 oil on threads of cap bolts, face of washers, and lower halves of main bearings. Put the caps (1) in position on engine with number on cap in direction of respective number on pan face on left side of cylinder block. Install bolts and washers. Turn both bolts to a torque of 30 ± 3 lb. ft. (4.1 ± 0.4 mkg). Put a mark on both bolt heads and bearing caps, then turn both bolts 90° more.
7. Remove the No. 2 and 4 main bearing caps. Remove the crankshaft thrust bearings. Put clean SAE 30 oil on the new thrust bearings and install them in cylinder block with groove in bearing against crankshaft.
8. Do Step 2 through Step 6 for remaining bearings. Check crankshaft end play with indicator group (C). End play must be .0025 to .0145 in. (0.064 to 0.368 mm). Maximum permissible end play is .025 in. (0.64 mm).

end by:

- a) install oil pan plate
- b) install oil pump



58763X1

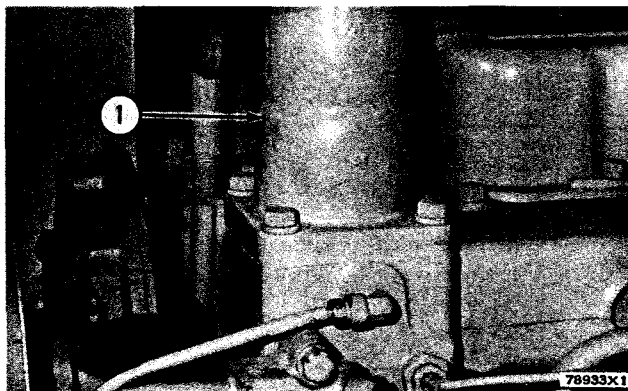


WATER TEMPERATURE REGULATOR, HOOD

REMOVE WATER TEMPERATURE REGULATOR

11-1355

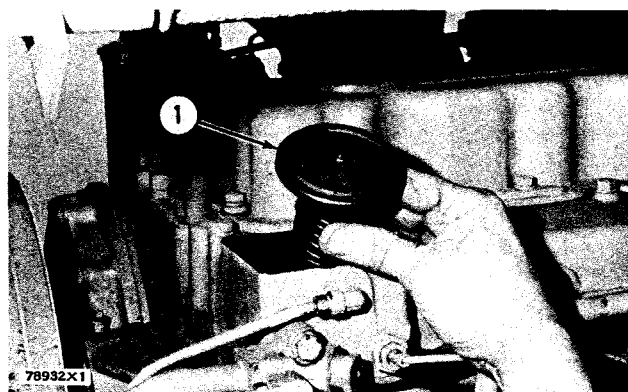
1. Open left side door of hood.
2. Remove coolant from cooling system.
3. Remove water pipe (1).
4. Remove water temperature regulator from cylinder head.



INSTALL WATER TEMPERATURE REGULATOR

12-1355

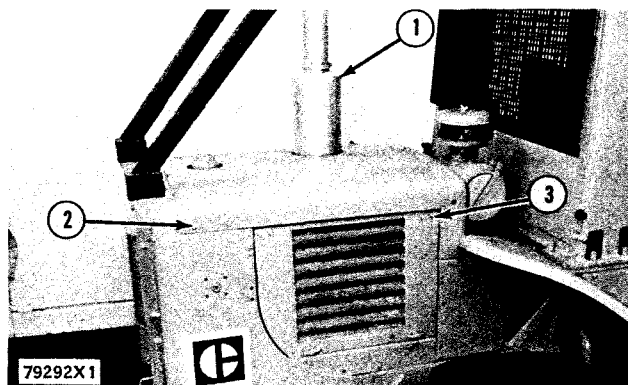
1. Put water temperature regulator (1) in position in the cylinder head.
2. Put water pipe in position over water temperature regulator and install four bolts in pipe.
3. Tighten clamps at top of water pipe.
4. Fill cooling system to correct level.
5. Close left side door of hood.



REMOVE HOOD

11-7251

1. Remove muffler (1).
2. Remove bolts (2) from hood. Remove hood. Weight is 48 lb. (22 kg).
3. Remove bolts (3) from brackets. Remove brackets and side doors.

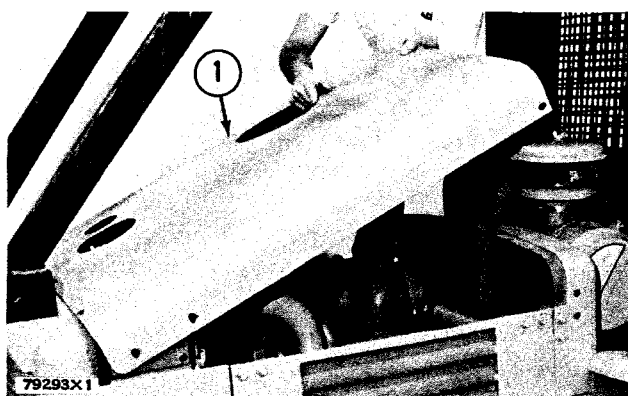


TREE HARVESTER SHOWN

INSTALL HOOD

12-7251

1. Put side doors in position and install brackets and bolts.
2. Install hood (1) and bolts.
3. Install muffler.



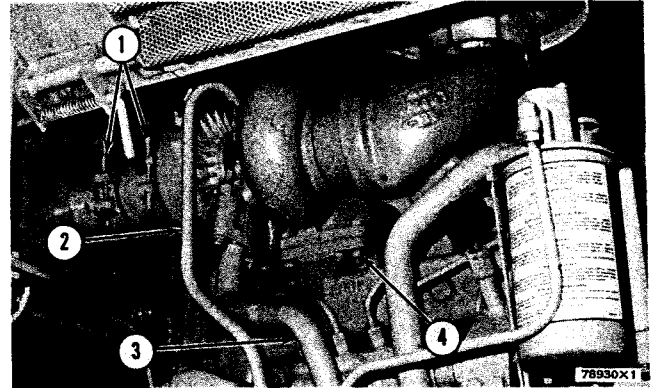
TREE HARVESTER SHOWN

TURBOCHARGER

REMOVE TURBOCHARGER

11-1052

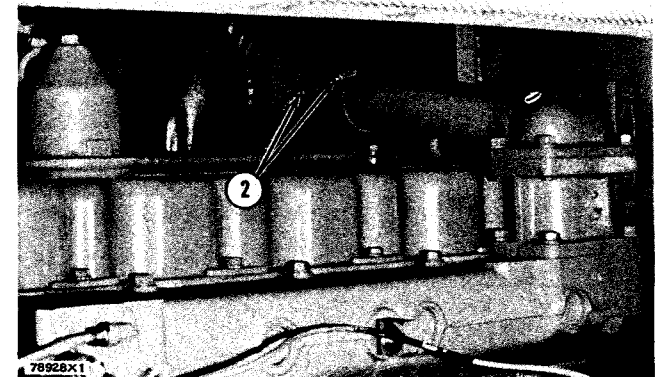
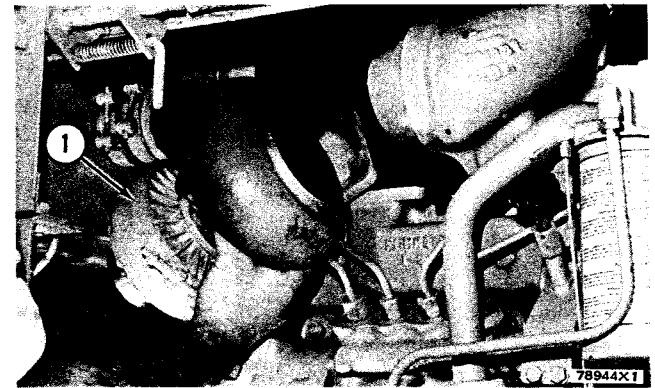
1. Open both side doors of hood.
2. Loosen hose clamps (1) and slide hose toward air cleaner.
3. Remove oil supply line (2) and return line (3) from turbocharger.
4. Loosen hose clamps on outlet hose and slide hose toward intake manifold.
5. Remove bolts (4) from turbocharger and remove turbocharger.



INSTALL TURBOCHARGER

12-1052

1. Put 9 M3710 Anti-Seize Compound on threads of turbocharger bolts.
2. Put the turbocharger (1) in position on exhaust manifold and install bolts.
3. Tighten turbocharger bolts to a torque of 40 ± 4 lb. ft. (5.5 ± 0.7 mkg).
4. Put inlet and outlet hoses into position on turbocharger. Tighten hose clamps (2). Tighten the hose clamps on the intake manifold.
5. Install oil supply line and return line on turbocharger.
6. Close both side doors of hood.



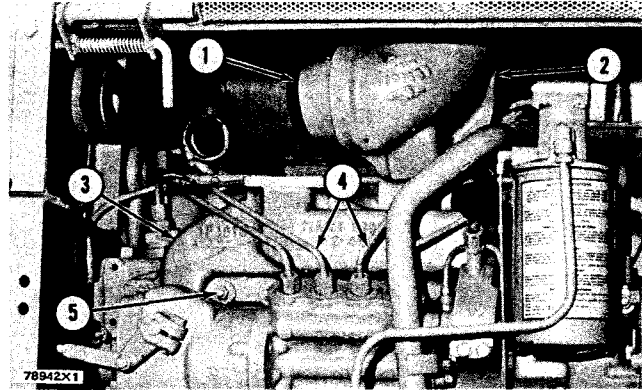
EXHAUST MANIFOLD, AIR CLEANER HOUSING

REMOVE EXHAUST MANIFOLD 11-1059

start by:

a) remove turbocharger

1. Remove coupling (1), elbow (2) and muffler as a unit.
2. Remove all fuel injection lines (4). Put covers over all fuel openings.
3. Remove nuts (5) and washers from studs. Remove exhaust manifold (3).

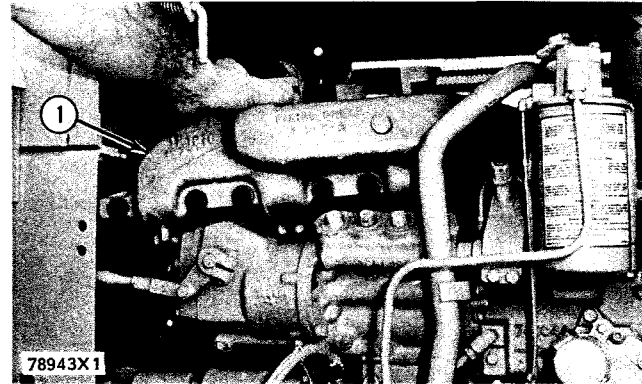


INSTALL EXHAUST MANIFOLD 12-1059

1. Put 9M3710 Anti-Seize Compound on manifold studs and bolts. Put manifold (1) on studs and install washer and nuts.
2. Remove covers from all fuel openings. Install fuel injection lines and tighten nuts to a torque of 30 ± 5 lb. ft. (4.1 ± 0.7 mkg).
3. Install muffler, elbow and coupling as a unit.

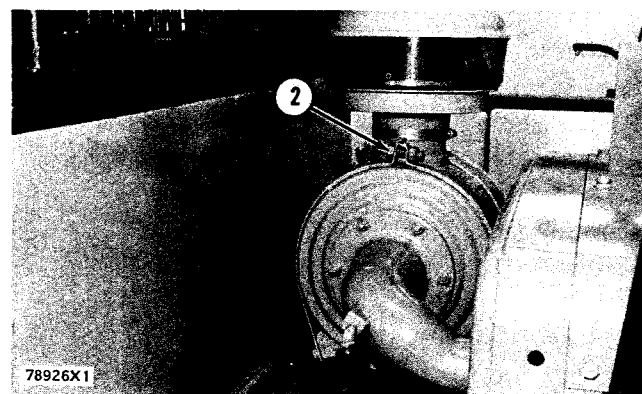
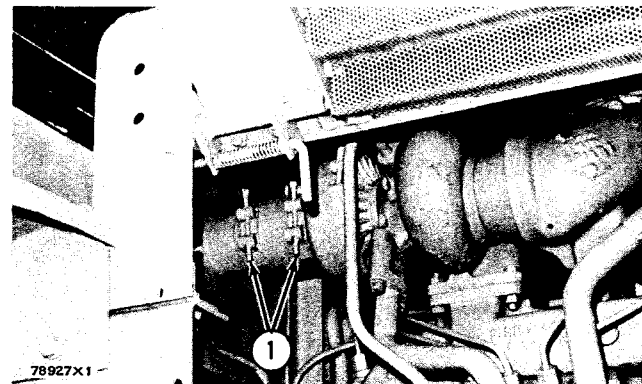
end by:

a) install turbocharger



REMOVE AIR CLEANER HOUSING 11-1051

1. Open left side door of hood.
2. Loosen hose clamps (1).
3. Remove two straps (2) that hold the air cleaner housing to the bracket.
4. Remove air cleaner housing.

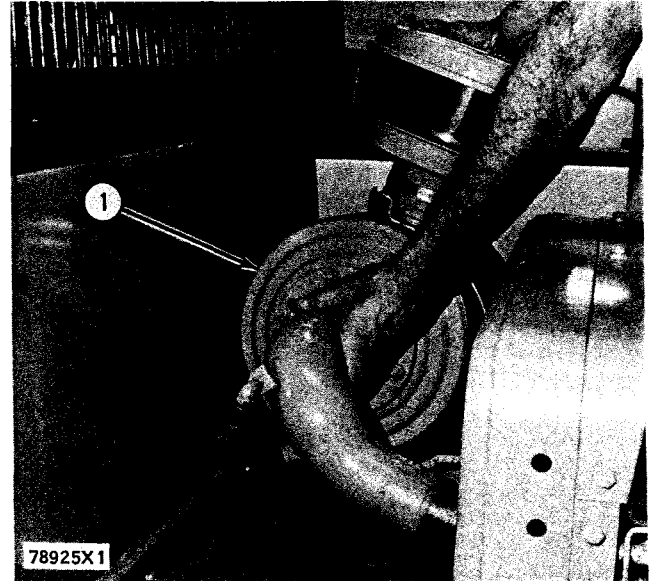


TREE HARVESTER SHOWN

AIR CLEANER HOUSING, FUEL INJECTION VALVES

INSTALL AIR CLEANER HOUSING 12-1051

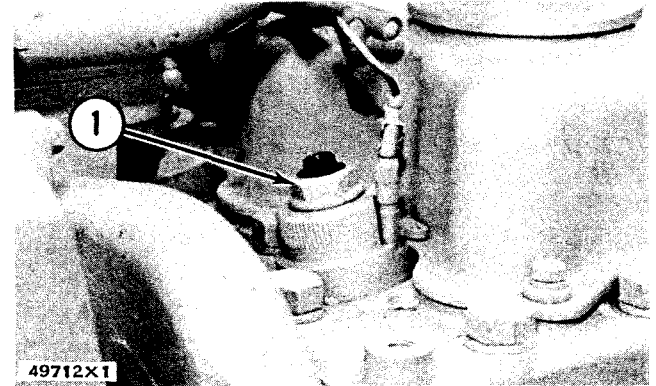
1. Put air cleaner housing (1) in position on bracket and install the two straps that hold it to the bracket.
2. Tighten hose clamps on the air outlet pipe.
3. Close left side door of hood.



TREE HARVESTER SHOWN

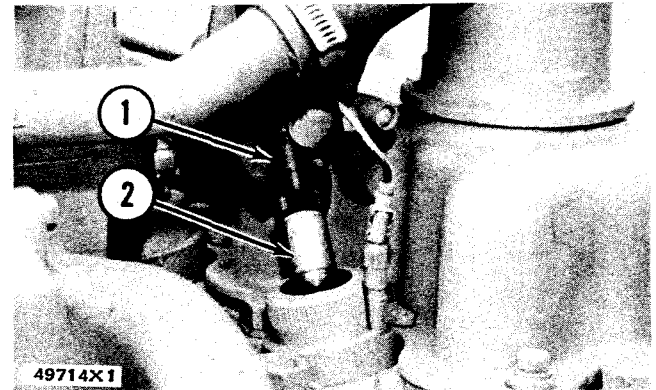
REMOVE FUEL INJECTION VALVES 11-1254

1. Open right and left side doors of hood.
2. Remove the fuel injection lines. Put covers over the openings.
3. Remove fuel injection valve nut (1).
4. Remove fuel injection valve.
5. Remove fuel injection valve from body.



INSTALL FUEL INJECTION VALVES 12-1254

1. Install the fuel injection valve (2) hand tight on body (1).
2. Install the fuel injection valve in the pre-combustion chamber.
3. Install the nut for the fuel injection valve. Tighten the nut to a torque of 105 ± 5 lb. ft. (14.5 ± 0.7 mkg).
4. Remove covers from openings and install fuel injection lines. Tighten nuts on lines to a torque of 30 ± 5 lb. ft. (4.1 ± 0.7 mkg).
5. Close right and left side doors of hood.



PRECOMBUSTION CHAMBERS

REMOVE PRECOMBUSTION CHAMBERS

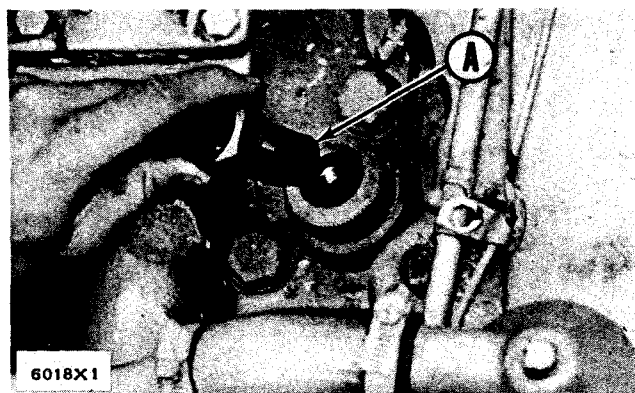
11-1106

Tools Needed		A
5F8353	Wrench	1

start by:

a) remove fuel injection valves

1. Remove coolant from cooling system.
2. Remove the glow plugs.
3. Remove precombustion chambers with tool (A).



INSTALL PRECOMBUSTION CHAMBERS

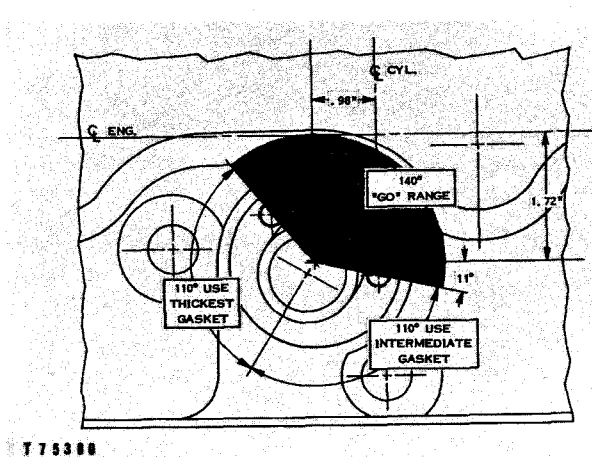
12-1106

Tools Needed		A
5F8353	Wrench	1

1. Install new O-ring seal on precombustion chamber.
2. Put 9M3710 Anti-Seize Compound on the precombustion chamber threads.
3. Install the thinner gasket on the precombustion chamber.
4. Put liquid soap on both the bore in the head and the rubber ring. Install the precombustion chamber in the cylinder head. Tighten chamber to a torque of 150 ± 10 lb. ft. (20.7 ± 1.4 mkg), with tool (A).
5. If the glow plug opening is not in the "GO" range position, remove precombustion chamber and install a new gasket as shown in illustration.
6. Put 9M3710 Anti-Seize Compound on the threads of the glow plug.
7. Install the glow plugs in the precombustion chambers. Tighten glow plugs to a torque of 120 ± 24 lb. in. (138.4 ± 27.7 cm.kg).
8. Fill cooling system to the correct level.

end by:

a) install fuel injection valves

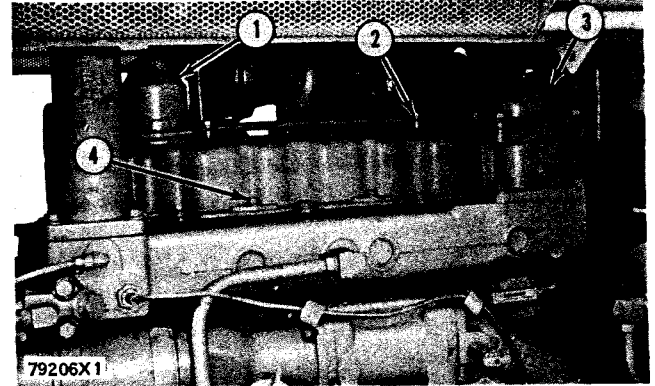


VALVE COVER, ROCKER SHAFT AND PUSH RODS

REMOVE VALVE COVER

11-1107

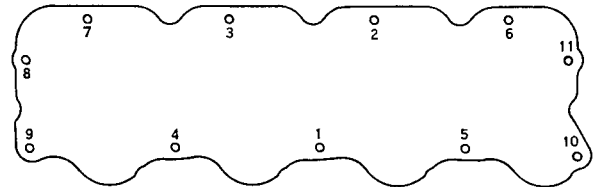
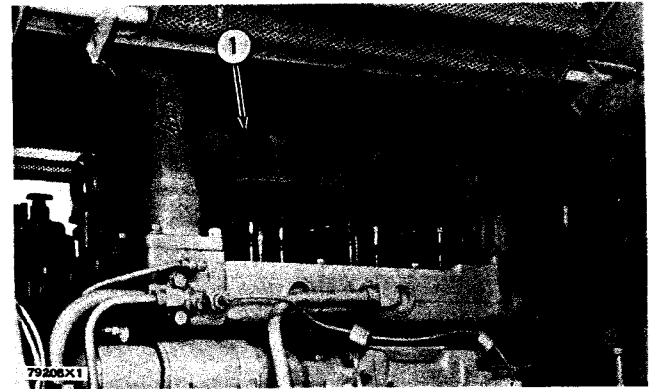
1. Open right side door of hood.
2. Remove bolts (2) that hold glow plug wire to valve cover. Put the wire to one side.
3. Remove elbow (3) for air inlet.
4. Remove breather (1).
5. Remove bolts (4) from valve cover. Remove valve cover.



INSTALL VALVE COVER

12-1107

1. Install a new gasket for the valve cover if needed. Put 5H2471 Cement on the gasket and on valve cover when installing a new gasket.
2. Put the valve cover (1) into position on engine. Install the bolts. Tighten bolts to 96 ± 24 lb. in. (111 ± 27.7 cm.kg) in number order shown.
3. Install breather.
4. Install elbow for air inlet.
5. Install glow plugs wire on valve cover.
6. Close right side door of hood.



T98226

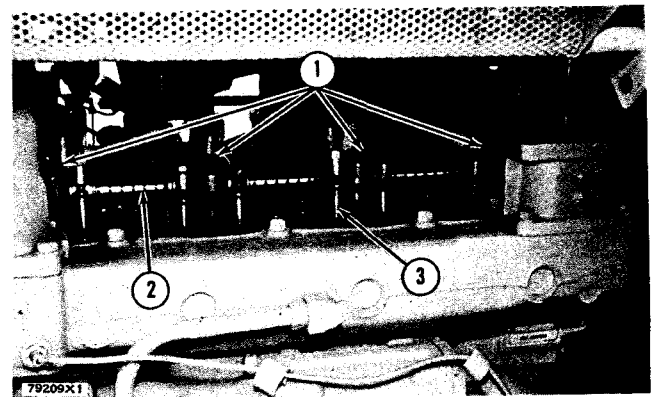
REMOVE ROCKER SHAFT AND PUSH RODS

11-1102 & 1208

start by:

a) remove valve cover

1. Remove the four rocker shaft bolts (1).
2. Remove the rocker shaft (2) and push rods (3).



ROCKER SHAFT AND PUSH RODS

INSTALL ROCKER SHAFT AND PUSH RODS 12-1102 & 1108

1. Install the push rods (2).
2. Put 9M3710 Anti-Seize Compound on threads of rocker shaft bolts.
3. Put the rocker shaft (1) in position on the engine. Install the bolts and washers. Tighten all the bolts 3, 4, 5, and 6 in number sequence to a torque of 115 lb. ft. (15.9 mkg). Tighten all the bolts again in number sequence to a torque of 175 ± 5 lb. ft. (24.2 ± 0.7 mkg). Last, tighten again (hand turn only) in number sequence to a torque of 175 ± 5 lb. ft. (24.2 ± 0.7 mkg).
4. Make adjustments until the intake valve clearance is .015 in. (0.38 mm) and exhaust valve clearance is .025 in. (0.64 mm).

end by:

- a) install valve cover

DISASSEMBLE ROCKER SHAFT 15-1102

Tools Needed		A
1P529	Handle	1
1P460	Drive Plate	1

start by:

- a) remove rocker shaft and push rods

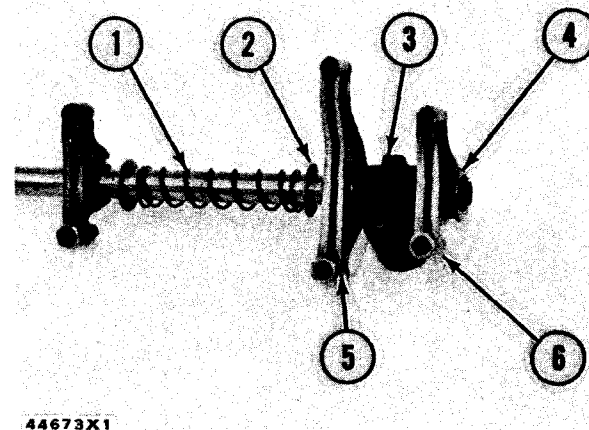
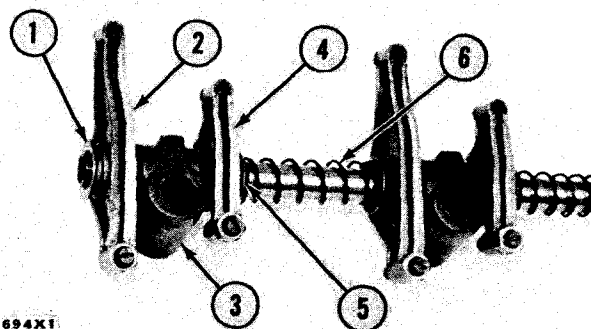
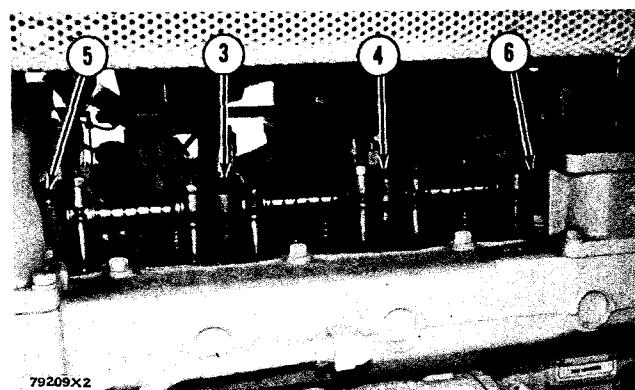
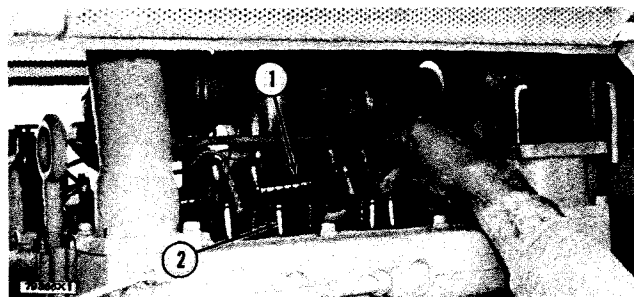
1. Remove ring, washer and spring (1).
2. Remove rocker (2), bracket (3), rocker (4), washer (5) and spring (6).
3. Disassemble remainder of rocker shaft in the same way.
4. Remove bearings from rocker arms with tooling (A).

ASSEMBLE ROCKER SHAFT 16-1102

1. Install ring, washer and spring (4).
2. Install rocker (6), bracket (3), rocker (5), washer (2) and spring (1).
3. Assemble the remainder of the rocker shaft in the same way. Put lubrication on all components after assembly.

end by:

- a) install rocker shaft and push rods



VALVE LIFTERS

REMOVE VALVE LIFTERS

11-1209

start by:

a) remove rocker shaft and push rods

1. Remove the valve lifters (2) with magnet (1).
2. Put an identification on each lifter for installation purpose.

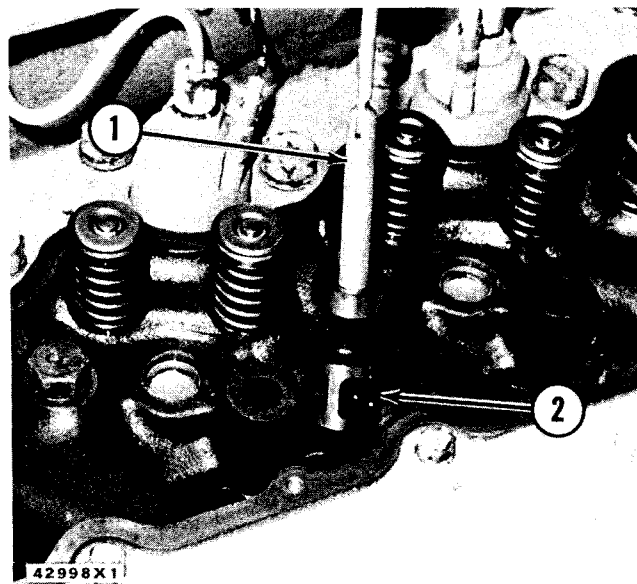
INSTALL VALVE LIFTERS

12-1209

1. Put clean SAE 30 engine oil on the valve lifters and the camshaft lobes.
2. Install the valve lifters in their original positions in the cylinder block.

end by:

a) install rocker shaft and push rods



CYLINDER HEAD

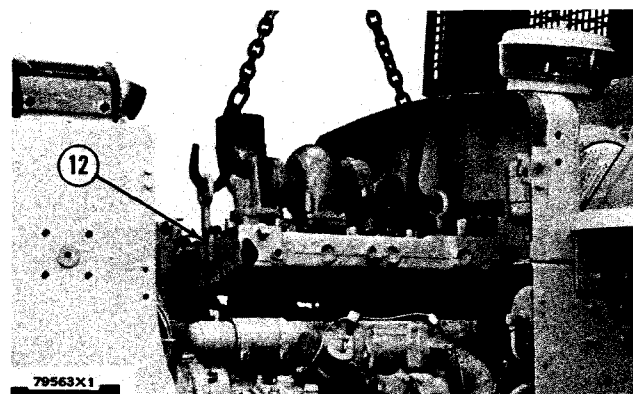
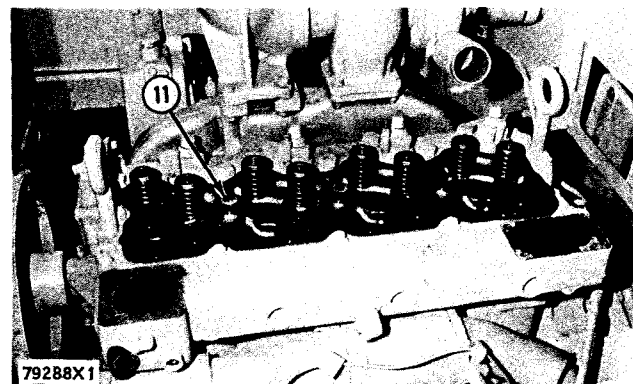
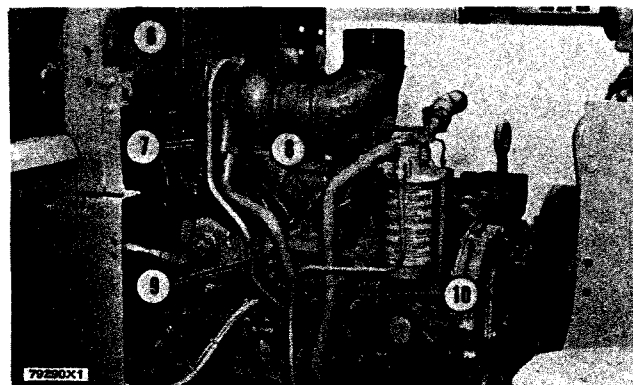
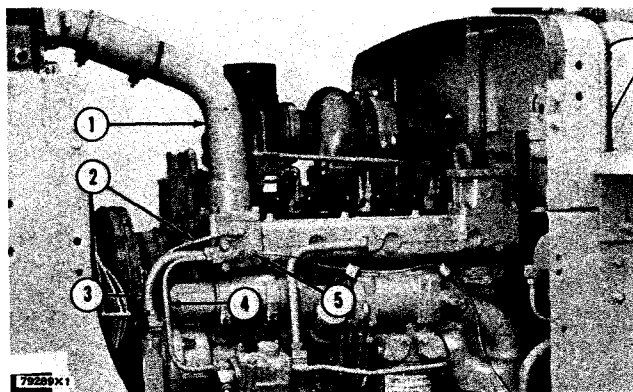
REMOVE CYLINDER HEAD

11-1100

start by:

- a) remove hood
- b) remove rocker shaft and push rods

1. Remove coolant from engine.
2. Remove air inlet pipe from cylinder head.
3. Disconnect wires from glow plugs and put them to one side.
4. Remove water elbow (1), regulator, and hose.
5. Disconnect line (5) for water temperature.
6. Remove water line (4) between air compressor and cylinder head.
7. Remove lines (2) and (3) for the water pump.
8. Remove air inlet line for air compressor.
9. Remove tube (10) for breather.
10. Remove fuel injection lines (8) and put covers on openings.
11. Remove supply line (7) for turbocharger.
12. Disconnect return line (9) from turbocharger.
13. Loosen hose clamps (6) and slide hose toward air cleaner.
14. Remove all cylinder head bolts (11) except five. Five bolts must be removed with head.
15. Remove the cylinder head (12). Weight is 200 lb. (91 kg).
16. Remove the exhaust manifold and turbocharger as a unit from the cylinder head.



TREE HARVESTER SHOWN

CYLINDER HEAD

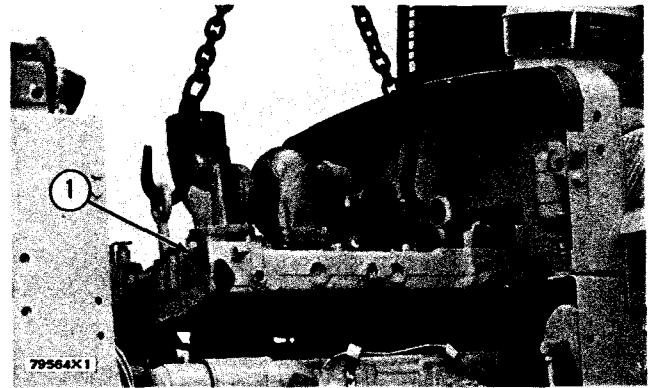
INSTALL CYLINDER HEAD

12-1100

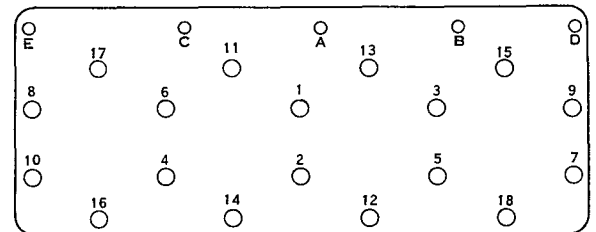
1. Install exhaust manifold and turbocharger as a unit on the cylinder head.
2. Install a new, dry cylinder head gasket.
3. Put cylinder head (1) in position with a hoist. Install the push rods. Put the rocker shaft in position on the cylinder head. Be sure dowels are in alignment on the rocker shaft.
4. Put 9M3710 Anti-Seize Compound on the threads of cylinder head and rocker shaft bolts. Install the bolts and washers, and tighten bolts in the following step sequence:

- Step 1 Tighten all bolts in numbered sequence to a torque of 115 lb. ft. (15.9 mkg).
- Step 2 Tighten all bolts in numbered sequence to a torque of 175 ± 5 lb. ft. (24.2 ± 0.7 mkg) again.
- Step 3 Tighten all bolts in numbered sequence (hand turn only) to a torque of 175 ± 5 lb. ft. (24.2 ± 0.7 mkg) again.
- Step 4 Tighten all bolts in lettered sequence to a torque of 22 lb. ft. (3.0 mkg).
- Step 5 Tighten all bolts in lettered sequence to a torque of 32 ± 5 lb. ft. (4.4 ± 0.7 mkg).
- Step 6 Tighten all bolts (hand turn only) in lettered sequence to a torque of 32 ± 5 lb. ft. (4.4 ± 0.7 mkg) again.

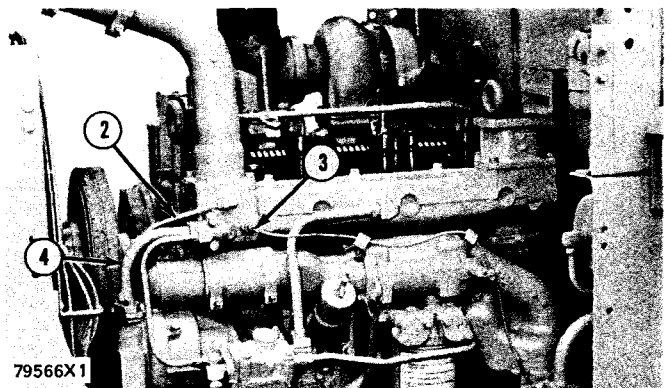
5. Make adjustments to the intake valve clearance is .015 in. (0.38 mm) and the exhaust valve clearance is .025 in. (0.64 mm).
6. Remove the covers from the fuel openings. Install fuel injection lines. Tighten nuts for fuel injection lines to a torque of 30 ± 5 lb. ft. (4.1 ± 0.7 mkg).
7. Install supply line and connect return line to turbocharger.
8. Install tube for breather.
9. Install lines (2) and (4) for water pump.
10. Install water line and air line for air compressor.
11. Connect line (3) for water temperature.
12. Install air pipe between head and air cleaner.



TREE HARVESTER SHOWN



T98228



79566X1

13. Put hose in position between air cleaner and turbocharger and tighten clamps.
 14. Install regulator, water elbow and base.
 15. Connect glow plug wires.
- end by:
- a) install valve cover
 - b) install hood

PISTONS

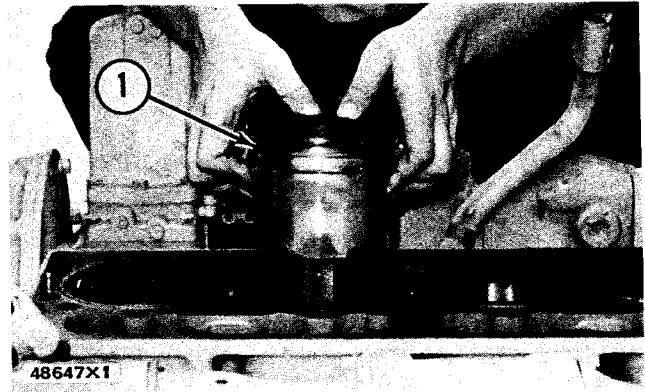
REMOVE PISTONS

11-1214

start by:

- a) remove cylinder head
- b) remove oil pump
- c) remove oil pan plate

1. Remove the carbon from the top inner surface of the cylinder liners.
2. Turn the crankshaft until two pistons are at bottom center.
3. Remove the caps from the connecting rods for these two pistons. Put tape or a piece of rubber hose over rod bolt threads to keep threads from causing damage to crankshaft when removing rod and piston. Push the piston up until the piston rings are above the cylinder liner.
4. Remove the two pistons (1) and connecting rods.
5. Do Steps 2 through 4 for remainder of pistons.



PISTONS

INSTALL PISTONS

12-1214

Tools Needed		A
7S9417	Ring Compressor	1

1. Put clean engine oil on crankshaft bearing journals and on inside of cylinder liners. Put clean engine oil on the piston rings and on the bearings of connecting rods.
2. Put compressor (A) in position on cylinder liner. Put piston and connecting rod into position in compressor (A) with "V" mark on piston in alignment with "V" mark on block.

CAUTION: Never install ring compressor on piston without using the liner as a guide, or damage to the piston rings can result.

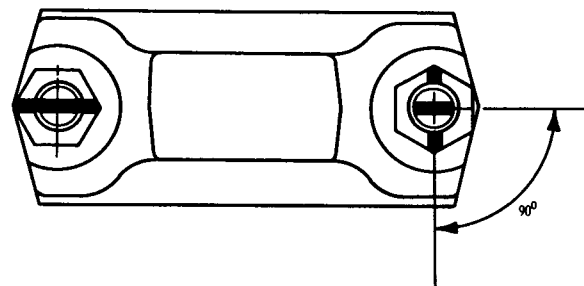
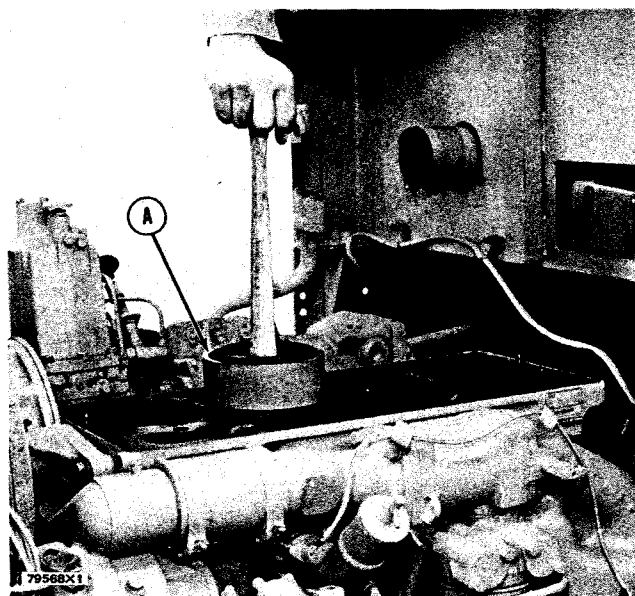
3. Push the piston into place while putting the connecting rod into position on crankshaft.
4. Put clean engine oil on threads of bolts for caps of connecting rods.
5. Put the caps on connecting rods, and install the nuts. Tighten both nuts to 30 ± 3 lb. ft. (4.1 ± 0.4 mkg). Put a mark on each nut and on end of each bolt. Turn the nuts an additional 90° from marks.

CAUTION: When installing caps of connecting rods be sure the number marked on side of cap is next to and the same as the number marked on side of rod.

6. Turn crankshaft until the next two bearing journals are at bottom center.
7. Use the above procedure for installation of the remainder of pistons.

end by:

- a) install oil pan plate
- b) install oil pump
- c) install cylinder head



30913X1

PISTONS

DISASSEMBLE PISTONS

15-1214

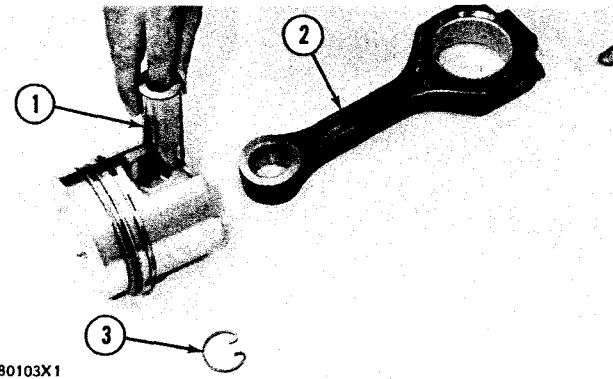
Tools Needed		A
7S9470	Ring Expander	1

start by:

- a) remove pistons



1. Remove rings from piston with tool (A).



2. Remove snap ring (3), piston pin (1) and connecting rod (2) from piston.

ASSEMBLE PISTONS

16-1214

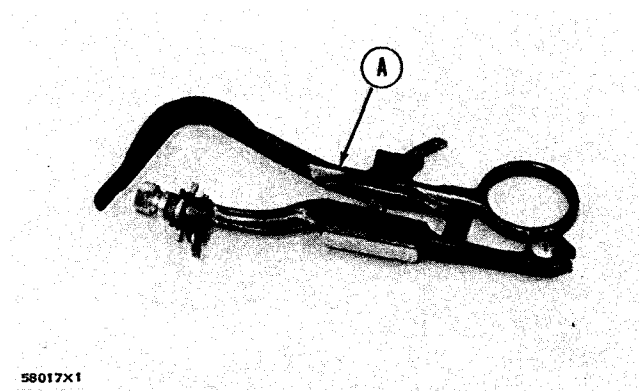
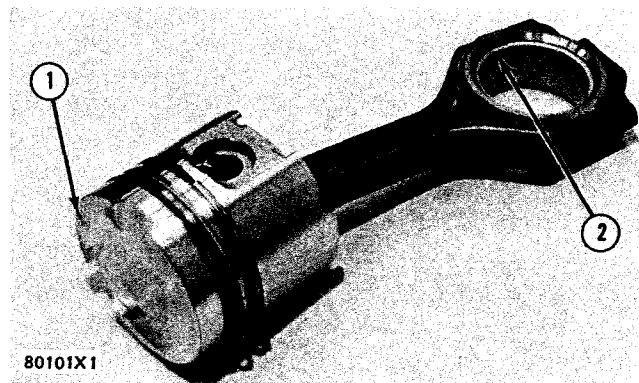
Tools Needed		A	B
8S2304	Pistons Ring Groove Cleaner	1	
7S9470	Ring Expander		1

NOTE: If rod pin bearing is replaced, use a pin boring machine to make the bearing the correct size.

1. Install rod on piston with bearing tab groove (2) and number identification on the same side as the "V" mark (1) on top of piston.
2. Install piston pin and snap rings.
3. When the old pistons are used, clean the piston grooves with tool (A) before installing new rings.
4. Install rings on piston with tool (B). The ring openings must be 90° apart.

end by:

- a) install pistons



CYLINDER LINERS

REMOVE CYLINDER LINERS

11-1216

Tools Needed		A
1P2399	Cylinder Liner Removal Group	1
1P2394	Plate	1

start by:

a) remove pistons

1. Check to be sure that all coolant has been removed from the cylinder block.
2. Cover the crankshaft bearing journals before removing cylinder liners.
3. Remove the cylinder liner with tooling (A).

INSTALL CYLINDER LINERS

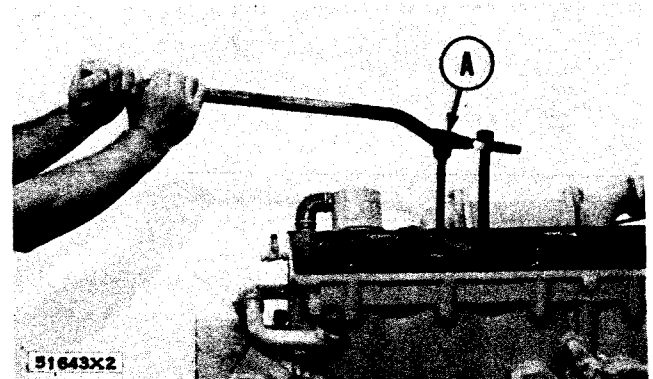
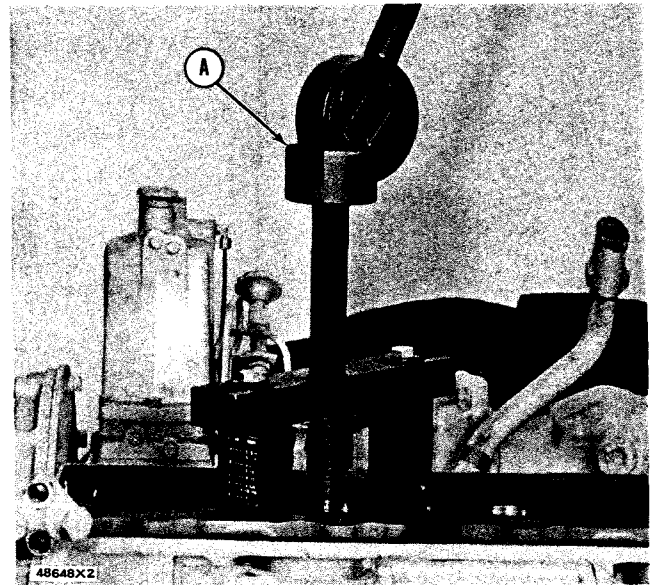
12-1216

Tools Needed		A	B	C
2P8260	Liner Installer Group	1		
1P2394	Plate		1	
8B7548	Push Puller Bar		1	
3H465	Plate		2	
1P5510	Liner Projection Tool Group			1

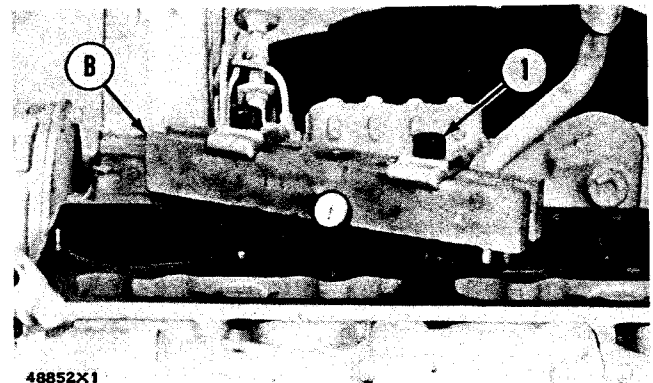
1. Clean the cylinder liners and block.
2. Install new O-ring seals on the liners.
3. Put liquid soap on the O-ring seals and in the bore of the cylinder block.
4. Put the cylinder liner in position in the cylinder block. Push the cylinder liner into the cylinder block with tool group (A).
5. Hold the cylinder liner in position with tooling (B) and two 5/8"-11NC bolts (1) 4 1/2 in. long. Tighten the bolts evenly to 50 lb. ft. (7 mkg).
6. Check the liner projection with tool group (C) at four locations around liner.
7. Projection must be .0020 to .0056 in. (0.051 to 0.142 mm). Measurements on same liner must not be different by more than .001 in. (0.03 mm). Average measurements between liners next to each other must not be different by more than .001 in. (0.03 mm).

end by:

a) install pistons



TYPICAL EXAMPLE

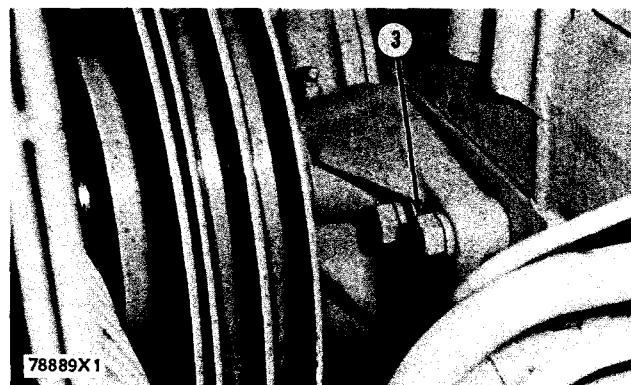
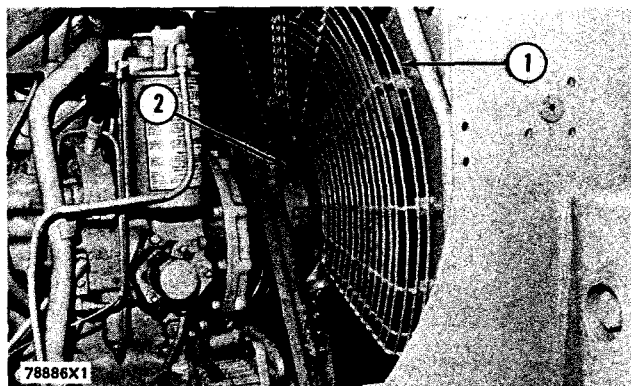


FAN AND FAN DRIVE

REMOVE FAN AND FAN DRIVE

11-1356 & 1359

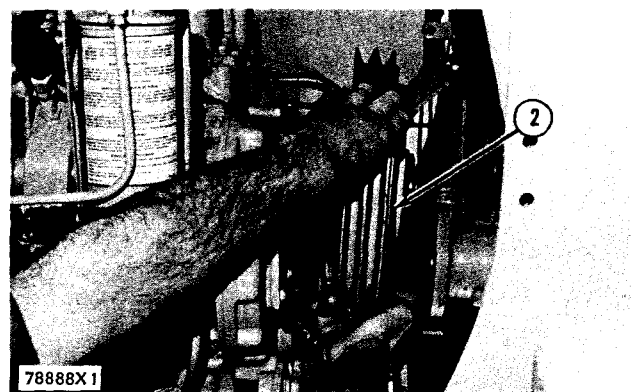
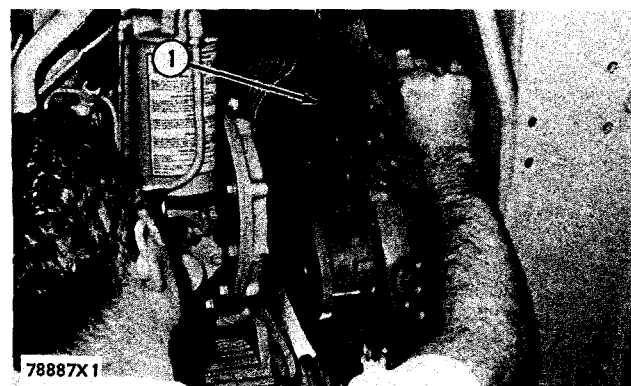
1. Open both side doors of hood.
2. Remove left fan guard (1).
3. Loosen tension on fan belts.
4. Remove adapter (2) from fan drive and put adapter and fan as a unit against radiator core.
5. Remove four bolts (3) from fan drive.
6. Remove the fan drive. Weight is 35 lb. (16 kg).
7. Remove the adapter from the fan.



INSTALL FAN AND FAN DRIVE

12-1356 & 1359

1. Install adapter on fan.
2. Put the adapter and fan (1) as a unit against radiator core.
3. Put the fan drive (2) in position on the engine and install the four bolts that hold it to the engine.
4. Install the adapter and fan as a unit on the fan drive.
5. Install the drive belts and make adjustment of the belt tension. See LUBRICATION AND MAINTENANCE GUIDE for adjustment.
6. Install the left fan guard.
7. Put multipurpose grease in fan drive for lubrication.
8. Close both side doors of hood.



FAN DRIVE

DISASSEMBLE FAN DRIVE

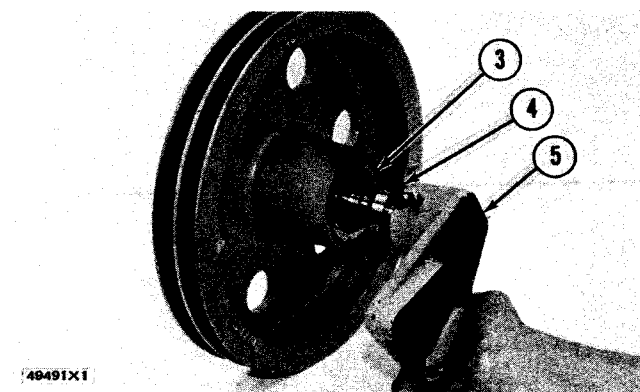
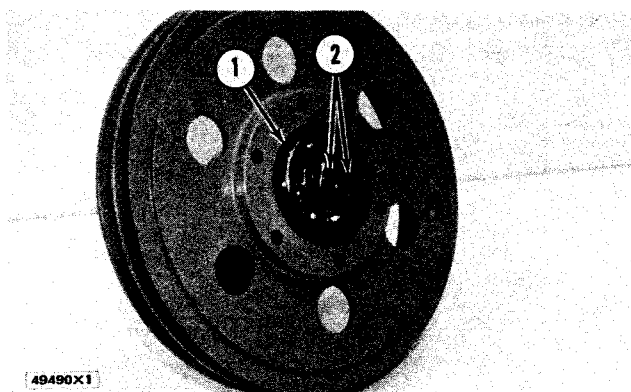
15—1359

Tools Needed		A
1P492	Drive Plate	1
1P529	Handle	1

start by:

a) remove fan and fan drive

1. Remove O-ring seal (1).
2. Remove retaining bolts (2), lock, and washer.
3. Remove bracket (5) from pulley. Remove spacer (4) from bracket.
4. Remove bearings and spacer from pulley.
5. Remove seal (3) from pulley with tooling (A).

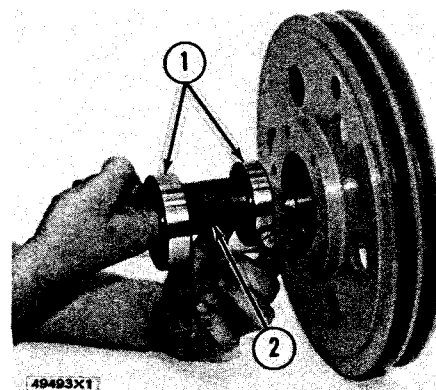
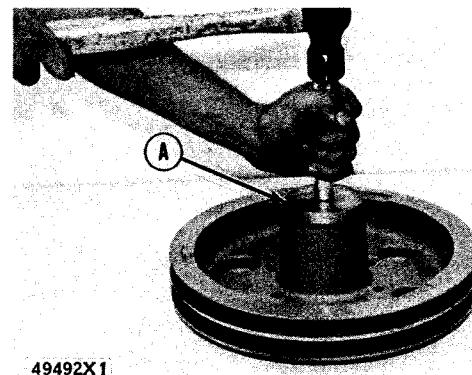


ASSEMBLE FAN DRIVE

16—1359

Tools Needed		A
1P496	Drive Plate	1
1P529	Handle	1

1. Put multipurpose grease on lip of seal.
 2. Install seal in pulley with tooling (A). Install seal with lip out. Install bearings (1) and spacer (2) in pulley.
 3. Install spacer on bracket and put bracket in position in pulley.
 4. Install washer, lock and bolts. Make a bend in the lock.
 5. Install O-ring seal over bearing.
- end by:
- a) install fan and fan drive



RADIATOR AND GUARD

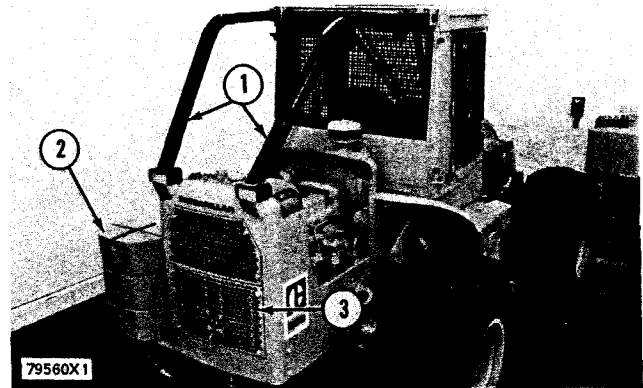
REMOVE RADIATOR AND GUARD AS A UNIT

11-1381

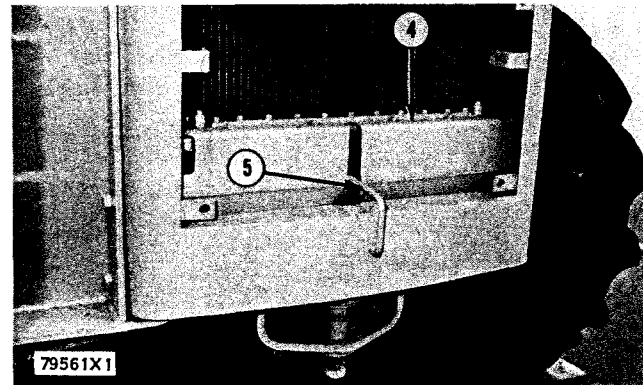
start by:

a) remove hood

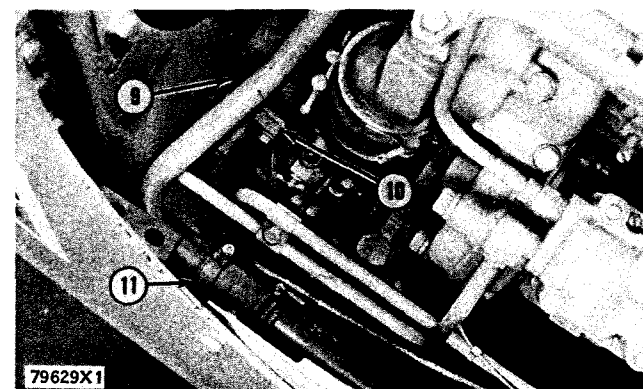
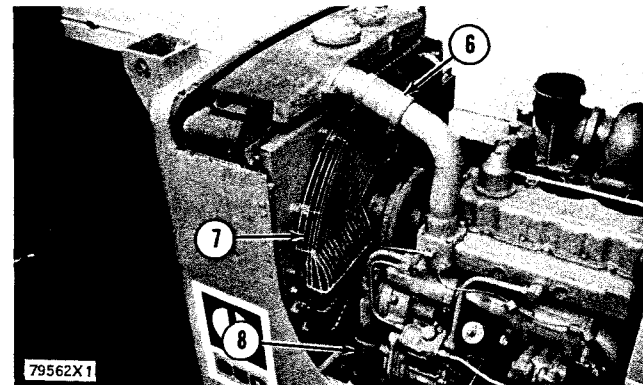
1. Remove coolant from cooling system.
2. Remove six counterweights (2). Weight is 332 lb. (150.5 kg) each. (Tree Harvester only).
3. Remove sweeps (1). (Tree Harvester only).
4. Remove radiator lower guard (3).
5. Remove plate (4) and hitch pin (5).
6. Remove right and left fan guards (7) as a unit.
7. Loosen hose clamps and slide upper hose (6) toward engine.
8. Loosen hose clamps and slide lower hose (8) up toward water pump.
9. Remove adapter (10) from lower water pipe (9).
10. Loosen hose clamps on hoses (11) for hydraulic oil cooler and slide hoses back on to pipe.
11. Remove the two bolts from side panels.
12. Remove two bolts from the upper radiator tank and install two 1/2"-13NC forged eyebolts.
13. Connect a hoist and remove bolts from guard. Slide radiator and guard away from fan.
14. Remove the radiator and guard. Weight is 600 lb. (295 kg).



TREE HARVESTER SHOWN



TREE HARVESTER SHOWN

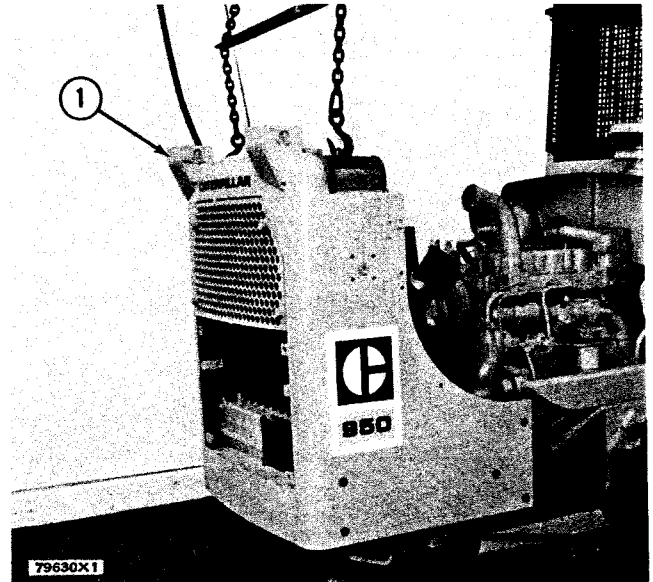


RADIATOR AND GUARD

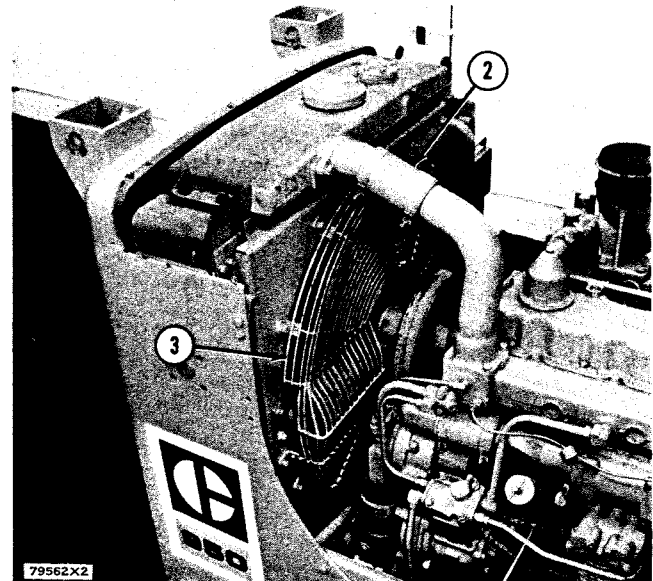
INSTALL RADIATOR AND GUARD AS A UNIT

12-1381

1. Put the radiator and guard (1) in position on the frame and install the bolts that hold the guard to the frame.
2. Remove the eyebolts and install the two bolts that hold the upper radiator tank to the guard.
3. Install bolts in side panels.
4. Connect the hoses for the hydraulic oil cooler.
5. Install the adapter on the lower water pipe.
6. Connect upper hose (2) and lower hose for the radiator.
7. Install right and left fan guards (3).
8. Install hitch pin and plate.
9. Install lower guard for radiator.
10. Install sweeps. (Tree Harvester only).
11. Install six counterweights. (Tree Harvester only).
12. Fill cooling system to correct level.
end by:
a) install hood



TREE HARVESTER SHOWN



RADIATOR CORE, HYDRAULIC OIL COOLER

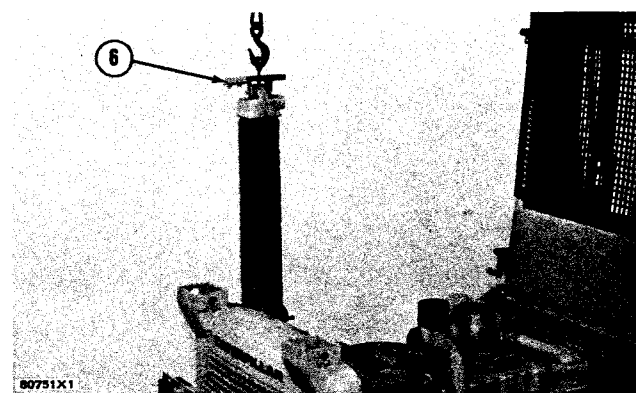
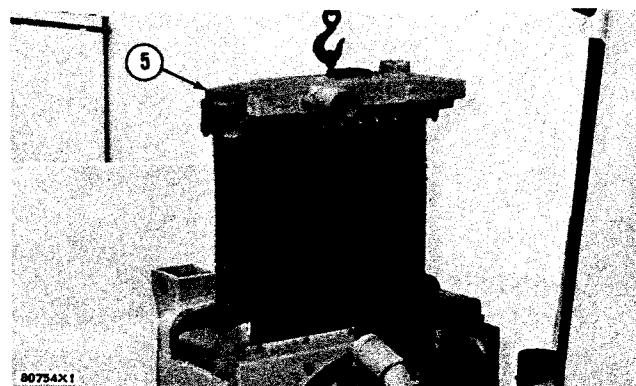
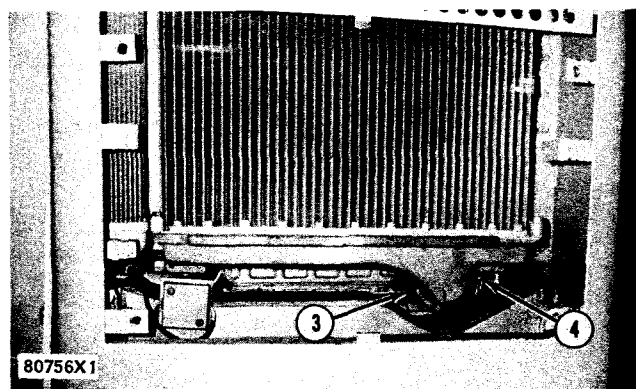
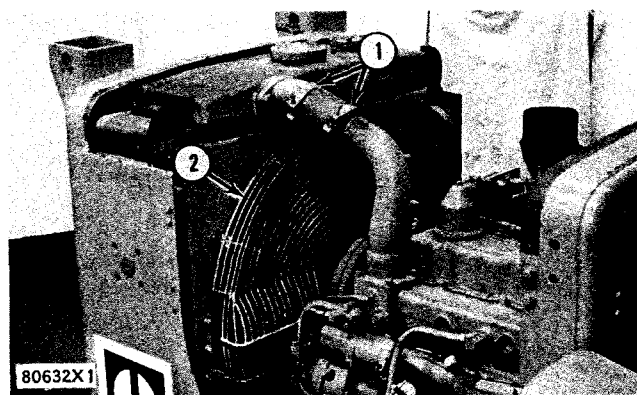
REMOVE RADIATOR CORE AND HYDRAULIC OIL COOLER 11-1353 & 1374

start by:

- a) remove hood
- b) remove air tank

1. Remove coolant from cooling system.
2. Remove fan guards (2) as a unit. Remove upper right fan shield.
3. Loosen hose clamps (1) and slide the hose down on to the elbow.
4. Loosen hose clamps on lower hose.
5. Remove radiator lower guard.
6. Remove the two plates from bottom of radiator. Remove hitch pin.
7. Disconnect water pipe (3) from bottom of radiator.
8. Remove bolts (4) from bottom mounts of radiator and cooler.
9. Remove bolts that hold cooler and upper radiator tank to the guard.
10. Install a 1/2"—13NC forged eyebolt in top tank and connect a hoist.
11. Remove the radiator core (5). Weight is 250 lb. (113 kg).
12. Install 1/2"—13NC forged eyebolt in top of cooler.
13. Disconnect top and bottom lines from cooler.
14. Remove oil cooler. Weight is 40 lb. (18 kg).

NOTE: Hydraulic oil cooler shown is for a 950 Tree Harvester.

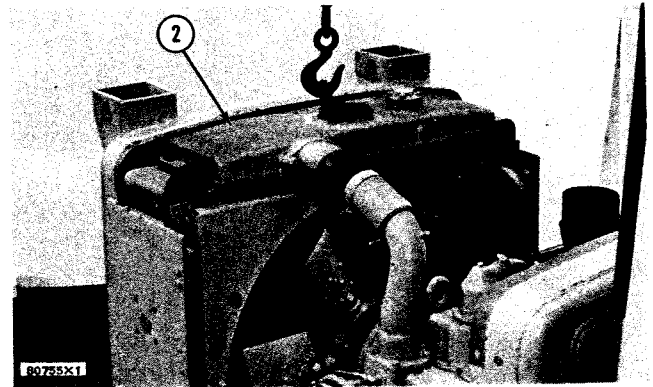
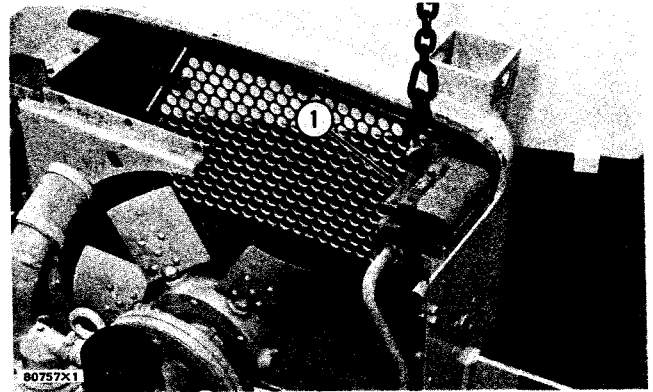


TREE HARVESTER SHOWN

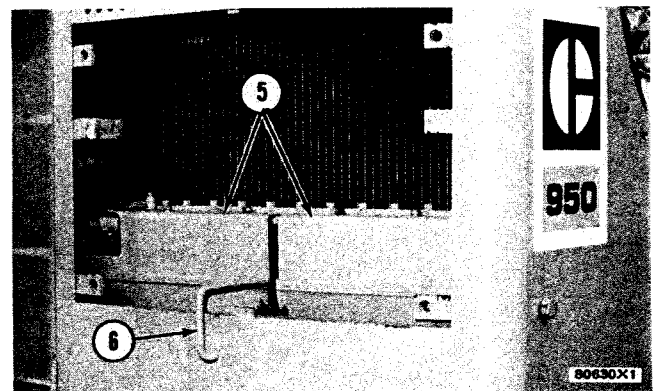
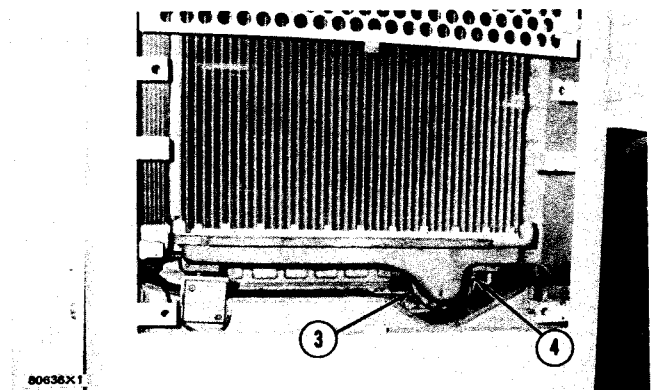
RADIATOR CORE, HYDRAULIC OIL COOLER

INSTALL RADIATOR CORE AND HYDRAULIC OIL COOLER 12-1353 & 1374

1. Connect a hoist and put cooler (1) into position in machine.
2. Connect top and bottom lines to cooler.
3. Connect a hoist and put radiator core (2) into position in machine.
4. Install bolts (4) in the radiator and cooler bottom mounts.
5. Install bolts that hold cooler and upper radiator tank to the guard.
6. Connect water pipe (3) to bottom of radiator.
7. Install hitch pin (6) and two bottom plates (5).
8. Install radiator bottom guard.
9. Tighten clamps on lower water hose.
10. Put top hose in position and tighten clamps.
11. Install fan guards and upper right shield.
12. Fill cooling system to correct level.
end by:
a) install hood
b) install air tank



TREE HARVESTER SHOWN



CRANKSHAFT PULLEY

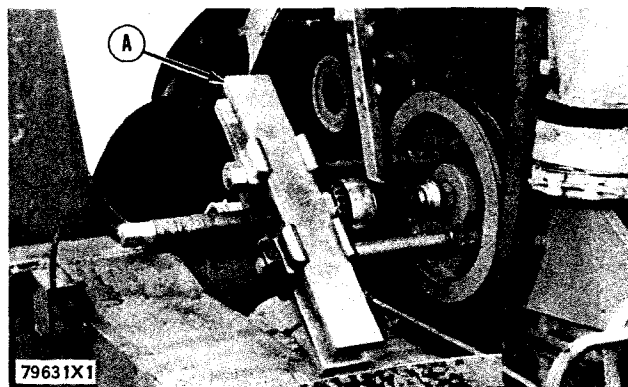
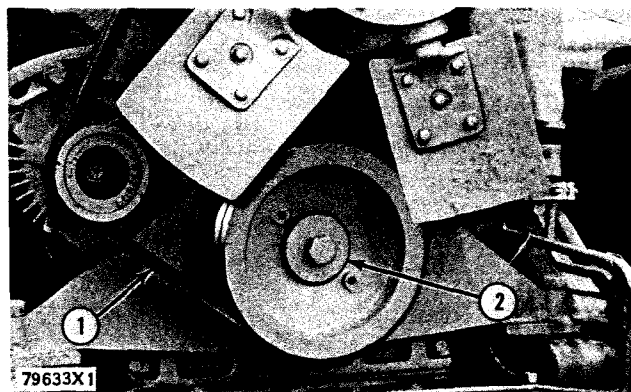
REMOVE CRANKSHAFT PULLEY 11-1155

Tools Needed			A
8B7548	Push Puller Assembly	1	
8H684	Ratchet Box Wrench	1	
8B7557	Adapter	2	
8B7550	Leg	2	
8B7560	Step Plate	1	

start by:

a) remove radiator core and guard

1. Turn fan and fan blades to give clearance for access to crankshaft pulley.
2. Loosen fan belts (1). Install a spacer between washer (2) and crankshaft to get about 1/8 inch (3 mm) clearance between washer and pulley.
3. Install tooling (A) and loosen the pulley from the crankshaft.
4. Remove tooling (A).
5. Remove bolt, washer, spacer and crankshaft pulley.

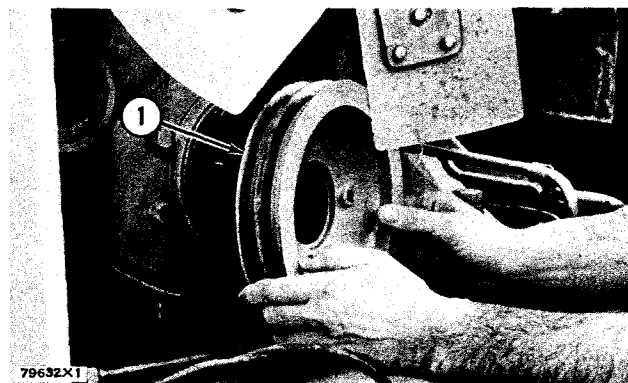


INSTALL CRANKSHAFT PULLEY 12-1155

1. Install the crankshaft pulley (1), washer and bolt.
2. Tighten the bolt to a torque of 230 ± 20 lb. ft. (31.8 ± 2.8 mkg).
3. Hit the bolt with a hammer. Tighten the bolt again to a torque of 230 ± 20 lb. ft. (31.8 ± 2.8 mkg).
4. Tighten fan belts. The correct belt adjustment for used belts is 7/8 in. (22 mm) of movement and for new belts 3/4 in. (19 mm) of movement.

end by:

a) install radiator core and guard



CRANKSHAFT FRONT SEAL

REMOVE CRANKSHAFT FRONT SEAL

11-1160

Tools Needed		A
1P3075	Seal Puller Group	1

start by:

a) remove crankshaft pulley

1. Remove the front seal with tool group (A).

INSTALL CRANKSHAFT FRONT SEAL

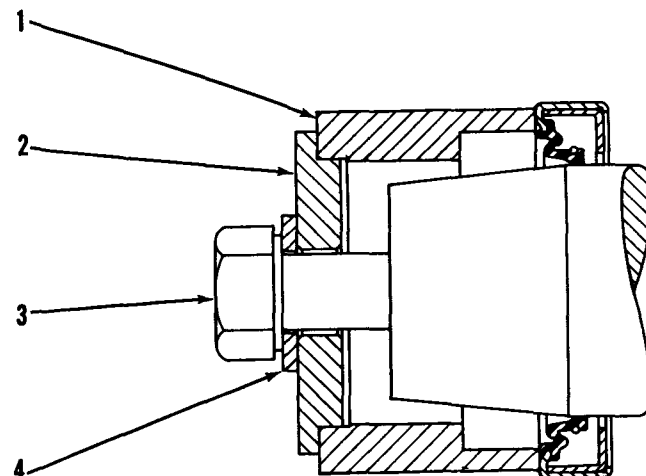
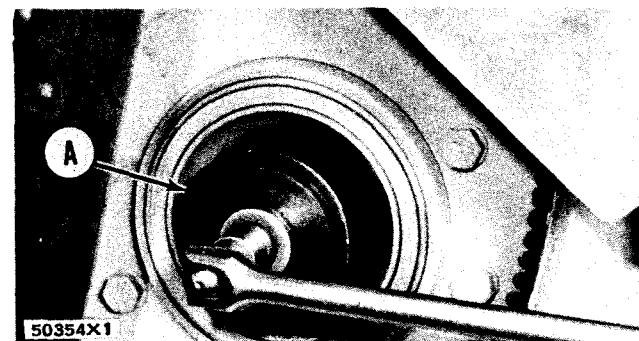
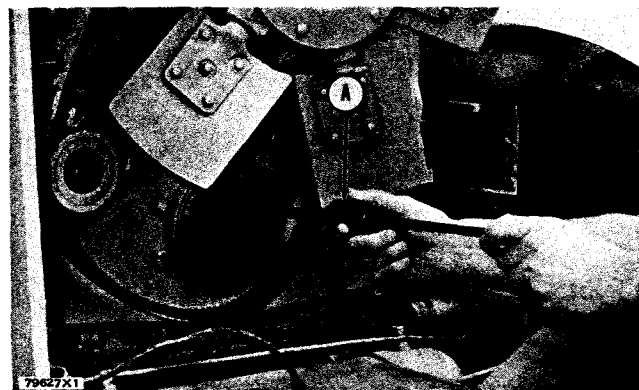
12-1160

Tools Needed		A
9S8878	Seal Installer Ring	1
9S8879	Pusher Plate	1
6B5310	Bolt	1
4B4283	Washer	1

1. Install the crankshaft front seal with tooling (A) as follows.
2. Put clean engine oil on the lip of seal and on outside diameter of crankshaft.
3. Put 7F2770 Cement on the outside diameter of seal.
4. Put the seal in position on crankshaft with lip of seal toward the oil being sealed.
5. Put the seal installer ring (1) and pusher plate (2) in position on crankshaft.
6. Install the bolt (3) and washer (4).
7. Tighten bolt (3) until the seal is against the bottom of bore in cover of timing gears.
8. Remove tooling (A).

end by:

a) install crankshaft pulley



28974X1

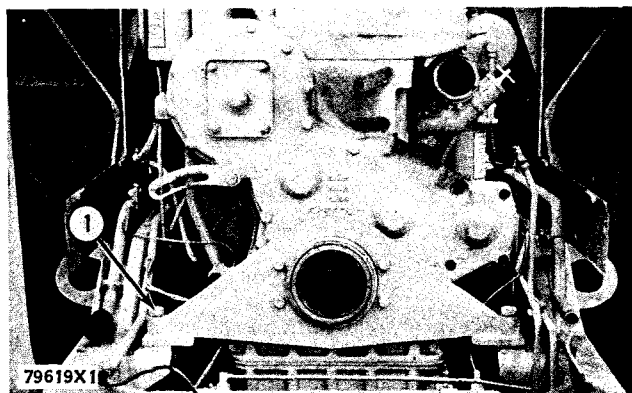
TIMING GEAR COVER

REMOVE TIMING GEAR COVER 11-1116

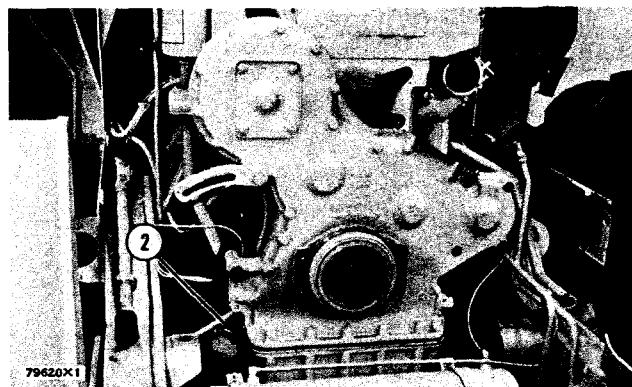
start by:

- a) remove front bottom guard
- b) remove crankshaft pulley
- c) remove fan and fan drive
- d) remove alternator
- e) remove air compressor
- f) remove water pump

1. Remove bolt from oil gauge tube.

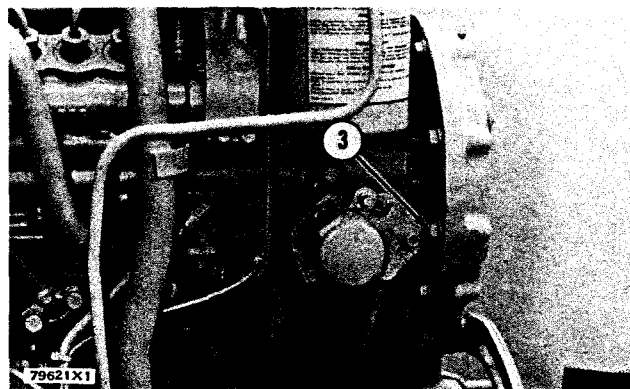


2. Remove bolts that hold the oil pan to the timing gear cover and loosen the bolts that hold the oil pan and plate to the cylinder block.



3. Remove bolts (1) from front support.

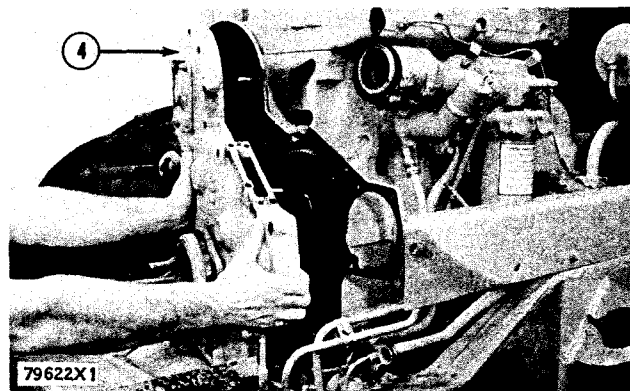
4. Install spacers (2) between the cylinder block and the oil pan plate. Put jacks under each side of the oil pan flange in line with the spacers to support weight of the engine. Remove the front support.



CAUTION: Do not hold engine up by putting blocks under oil pan. Damage to the oil pan can result.

5. Remove the bolts and nuts that hold the cover to block and plate of timing gears except bolt (3).

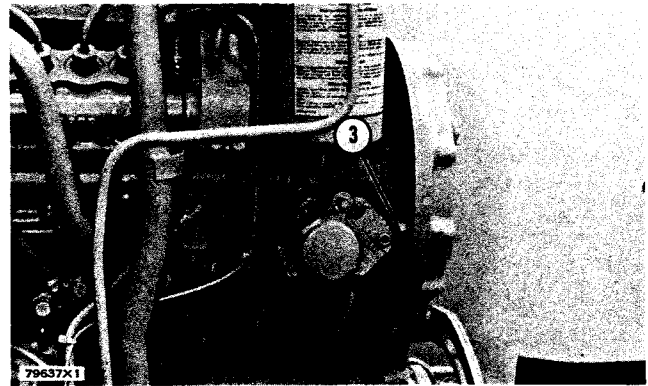
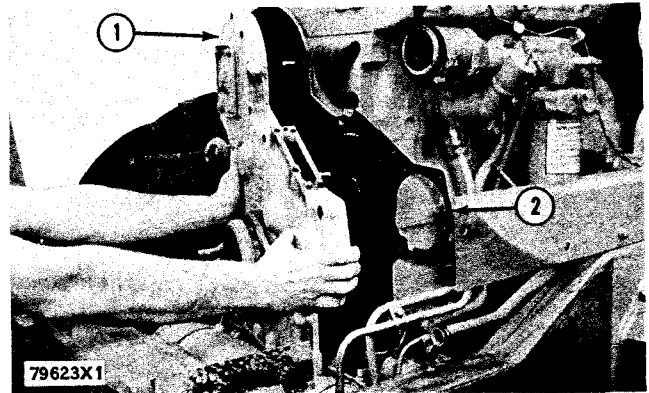
6. Remove bolt (3) while removing timing cover (4). Weight is 50 lb. (22.6 kg).



TIMING GEAR COVER

INSTALL TIMING GEAR COVER 12-1166

1. Install a new gasket on the timing gear plate (2) and cut the gasket even with the bottom face of the cylinder block. Use 5H2471 Gasket Cement where the gasket for the timing gear cover makes contact with the gasket for the oil pan plate.
2. Install the timing gear cover (1) with a hoist while tightening bolt (3).
3. Install all bolts and nuts on timing gear cover.
4. Install the front support.
5. Lower the engine on to the frame and install the two bolts and nuts in front support.
6. Remove the spacers between the cylinder block and the oil pan plate.
7. Install and tighten all bolts of oil pan and plate.
8. Install the bolt in gauge tube.
end by:
 - a) install water pump
 - b) install air compressor
 - c) install alternator
 - d) install fan and fan drive
 - e) install crankshaft pulley
 - f) install front bottom guard



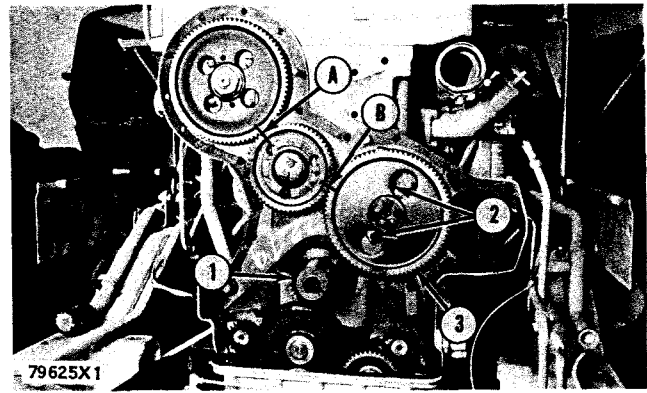
CAMSHAFT

REMOVE CAMSHAFT

11-1210

start by:

- a) remove valve lifters
 - b) remove timing gear cover
1. Turn the crankshaft until the "C" mark on the crankshaft gear (1) is in alignment with "C" mark on the camshaft gear (3).
 2. Put a mark on the teeth of the accessory drive gear and idler gear at location (A). Put a mark on the teeth of idler gear and camshaft gear at location (B). The timing of the fuel injection pump will be correct if the gear teeth are marked.
 3. Remove the camshaft bolts (2), lock, and thrust washer.
 4. Pull the camshaft out of the cylinder block.
 5. Remove bolts and lock from camshaft gear. Remove gear from camshaft.



INSTALL CAMSHAFT

12-1210

1. Put gear in position on camshaft and install lock and bolts.

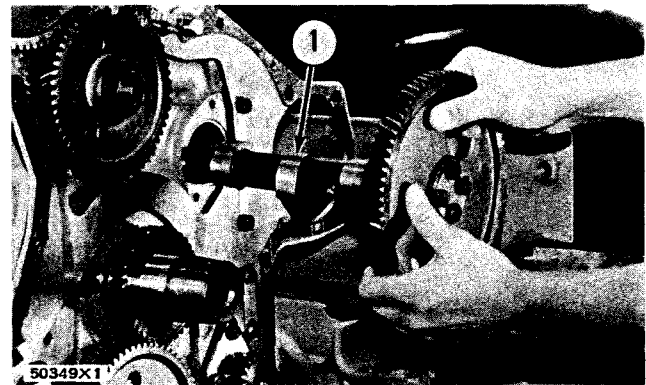
NOTE: On later engines there will not be a lock on bolts for camshaft gear.

2. Put clean SAE 30 lubricant on cams and bearing journals of the camshaft.
3. Install the camshaft (1) in the block with timing marks on the accessory drive gear, idler gear, camshaft gear, and crankshaft gear in alignment.
4. Put the thrust washer in position and install the bolts and locks.

NOTE: If a replacement has been installed for any of the four above timing gears, it will be necessary to put the shaft of accessory drive in time. See REMOVE AND INSTALL FUEL INJECTION PUMP HOUSING AND GOVERNOR AS A UNIT.

end by:

- a) install timing gear cover
- b) install valve lifters



TYPICAL EXAMPLE

ACCESSORY DRIVE HOUSING AND SHAFT

REMOVE ACCESSORY DRIVE HOUSING AND SHAFT

11-1207 & 1229

Tools Needed		A	B
8S2264	Puller Group	1	
8S8375	Sleeve	1	
3/8"			
-24NF	Bolts 3 1/2" long	2	
3/8"	Flat Washers	2	
8B7561	Step Plate	1	
1P2320	Puller Assembly		1

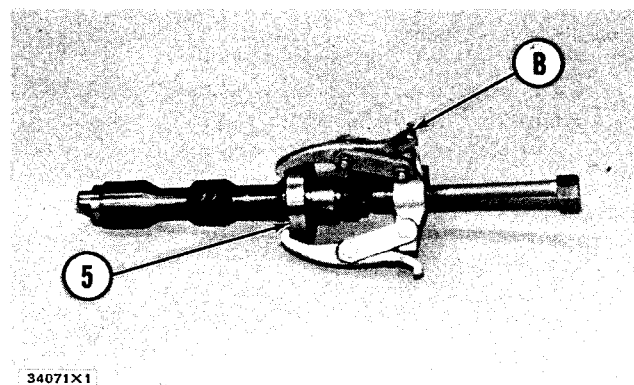
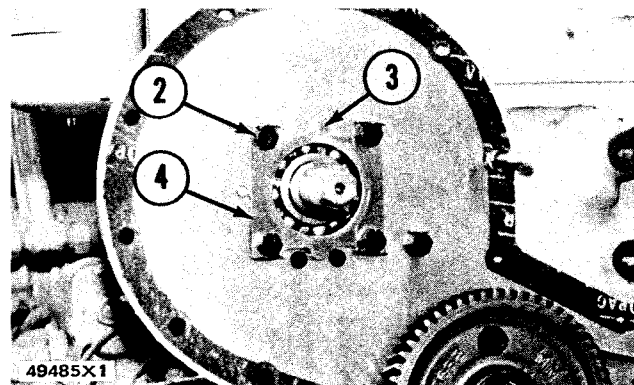
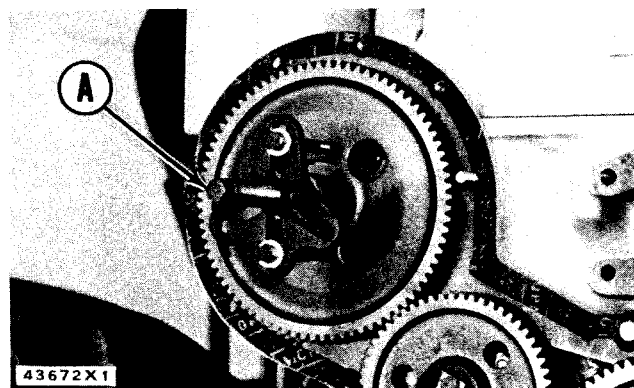
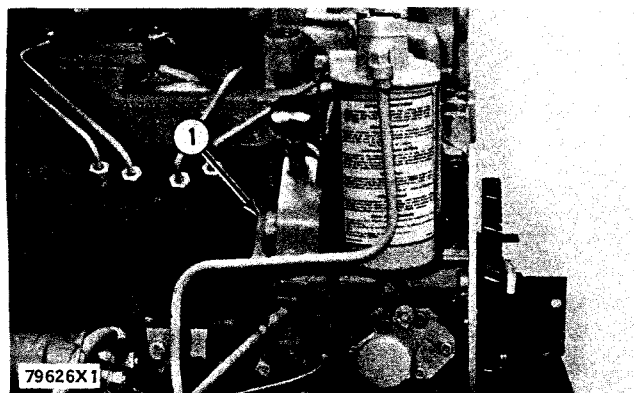
start by:

- a) remove timing gear cover
 - b) remove fuel injection pump housing and governor
1. Remove all lines from the accessory drive housing (1) and fuel filter base.
 2. Remove nut and washer from accessory drive shaft.
 3. Remove the accessory drive gear with tooling (A). Remove sleeve from shaft.



WARNING: Hold puller with hand to prevent injury when gear is removed from shaft.

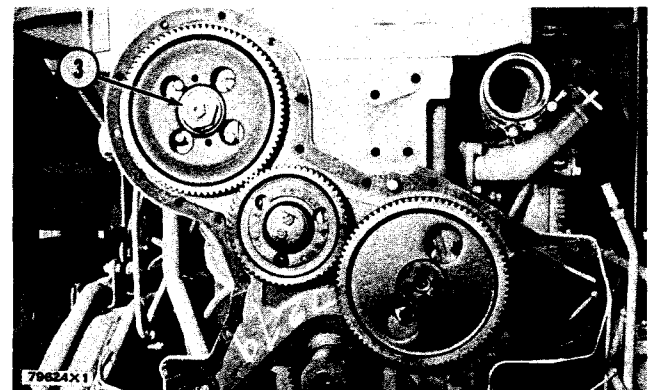
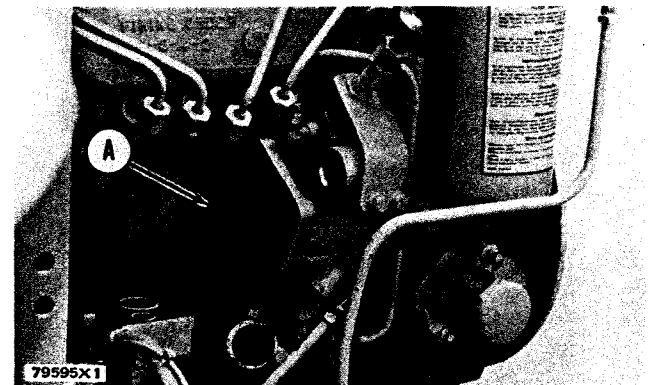
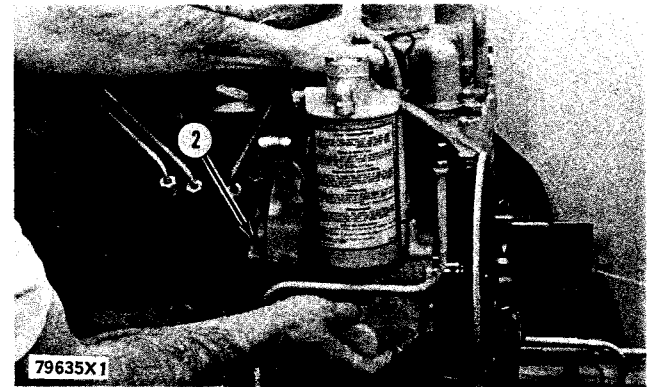
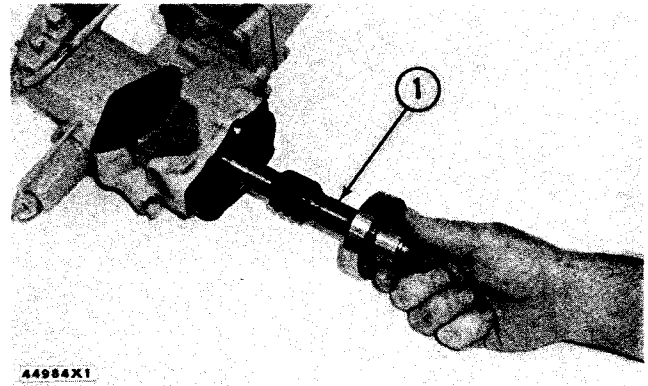
4. Remove bolts (2), locks (4) and retainer (3) that fasten the accessory drive housing to the plate.
5. Remove the accessory drive housing.
6. Remove fuel transfer pump.
7. Remove the accessory drive shaft from the housing.
8. Remove bearing (5) from shaft with tool (B).



ACCESSORY DRIVE HOUSING AND SHAFT

INSTALL ACCESSORY DRIVE HOUSING AND SHAFT 12-1207 & 1229

1. Heat the bearing for the accessory drive shaft in 300°F (149°C) oil and install the bearing on the shaft.
2. Install the accessory drive shaft (1) and bearing in the housing.
3. Install the fuel transfer pump.
4. Install the accessory drive housing (2).
5. Install the retainer, locks and bolts.
6. Turn the accessory drive shaft until tool (A) can be installed.
7. Install the sleeve, gear, washer and nut for the accessory drive shaft. Tighten nut (3) to 100 ± 10 lb. ft. (13.8 ± 1.4 mkg).
8. Connect the fuel lines.



TIMING GEARS AND PLATE

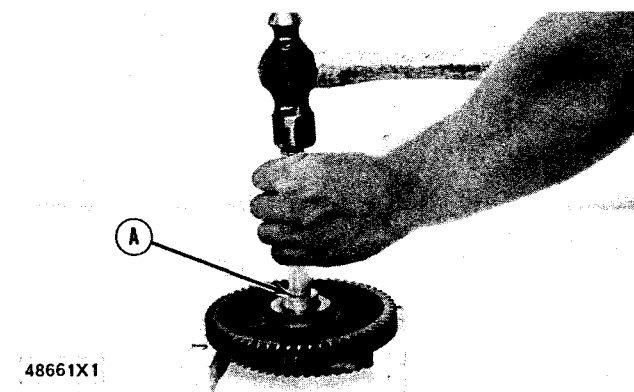
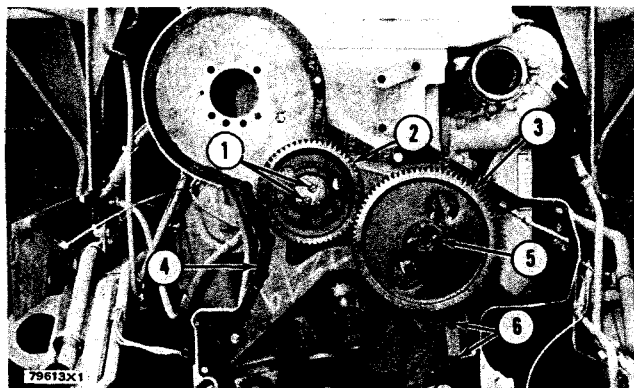
REMOVE TIMING GEARS AND PLATE

11-1206 & 1162

Tools Needed			A
1P529	Handle		1
1P472	Drive Plate		1
1P469	Drive Plate		1

start by:

- a) remove accessory drive housing and shaft
1. Remove bolts (1), lock and washer. Remove idler gear (2).
2. Remove bolts (5) and lock. Remove the camshaft drive gear (3).
3. Remove the bearing from idler gear with tooling (A).
4. Remove all bolts (6) and locks from the timing gear plate. Remove timing gear plate (4).



INSTALL TIMING GEARS AND PLATE

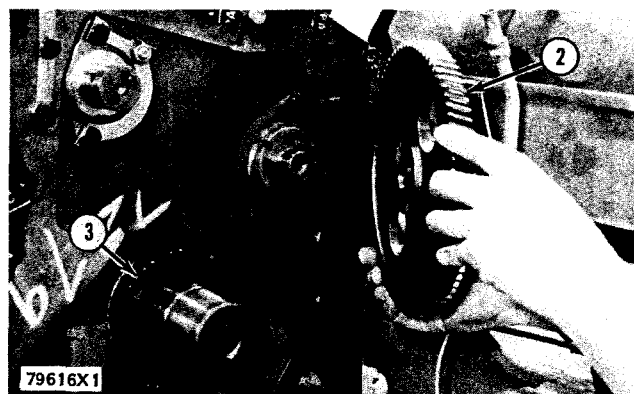
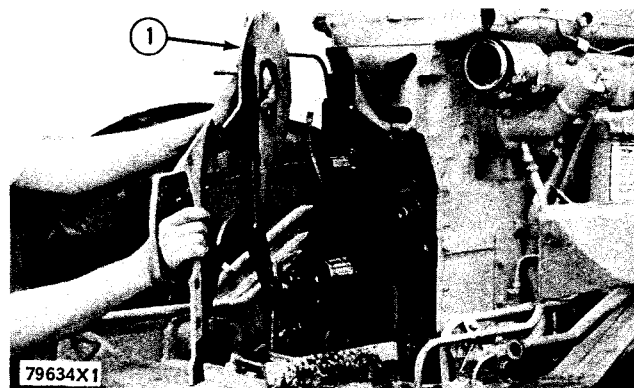
12-1206 & 1162

Tools Needed			A
1P475	Drive Plate		1
1P529	Handle		1
1P469	Drive Plate		1

1. Install a new gasket for housing of accessory drive. Install a new gasket for plate of timing gears. Cut the gasket for the plate of timing gears even with bottom of cylinder block. Put 5H2471 Gasket Cement on cut edge of gasket.
2. Put the plate (1) of timing gears in position on the engine. Install the bolts and locks that hold the plate to the cylinder block.
3. Install the camshaft gear (2) with timing mark on camshaft in alignment with the timing mark on crankshaft gear (3). Install the bolts and lock that hold the gear.
4. Install the bearing in the idler gear with tooling (A). Install the idler gear, washer, lock and bolts.

end by:

- a) install accessory drive housing and shaft



BALANCER SHAFTS, TRANSMISSION BOTTOM GUARD

REMOVE BALANCER SHAFTS

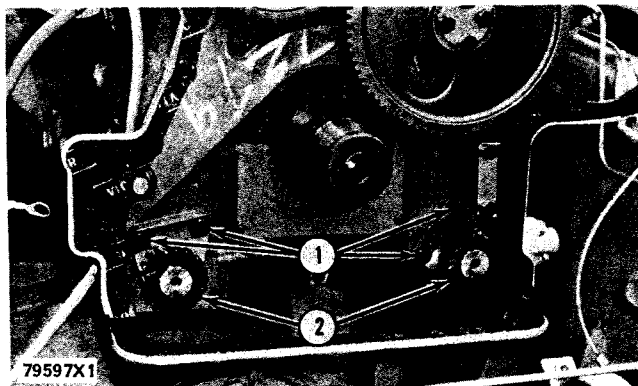
11-1220

start by:

- a) remove timing gear cover
- b) remove oil pump

1. Remove bolts (1), locks and plates.

2. Remove balancers (2).



INSTALL BALANCER SHAFTS

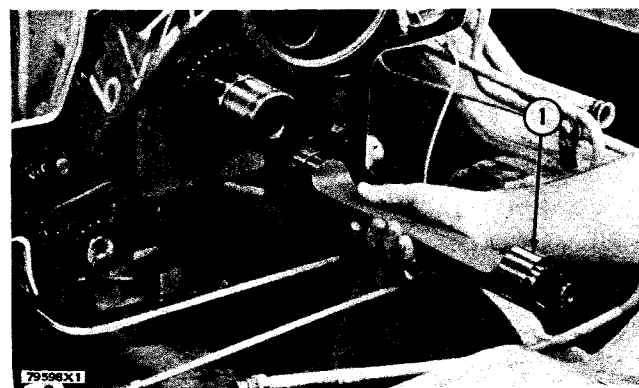
12-1220

1. Put the balancer shaft (1) into position and install the plates, locks and bolts.

NOTE: Balancer shafts must be correctly in time. See, INSTALL OIL PUMP.

end by:

- a) install oil pump
- b) install timing gear cover

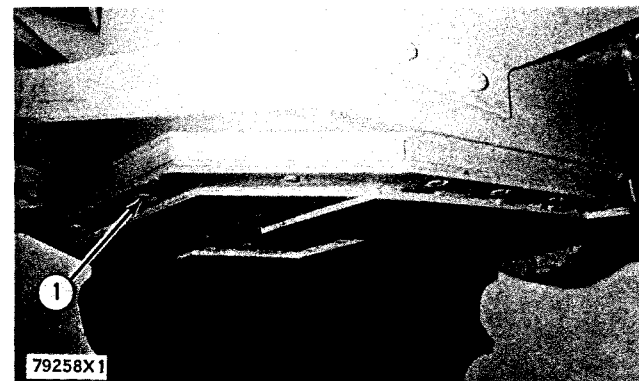


REMOVE TRANSMISSION BOTTOM GUARD

11-7150

1. Put a floor jack into position under transmission guard.
2. Remove bolts (1) that hold guard to frame.
3. Remove the transmission guard. Weight is 400 lb. (181 kg).

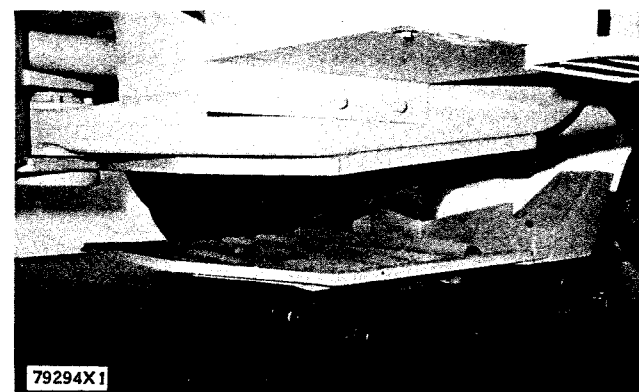
NOTE: Guard shown is for a 950 Tree Harvester.



INSTALL TRANSMISSION BOTTOM GUARD

12-7150

1. Put the guard for the transmission on a floor jack.
2. Lift the guard into position.
3. Install the bolts and tighten to a torque of 110 ± 10 lb. ft. (15.1 ± 1.38 mkg).



ENGINE

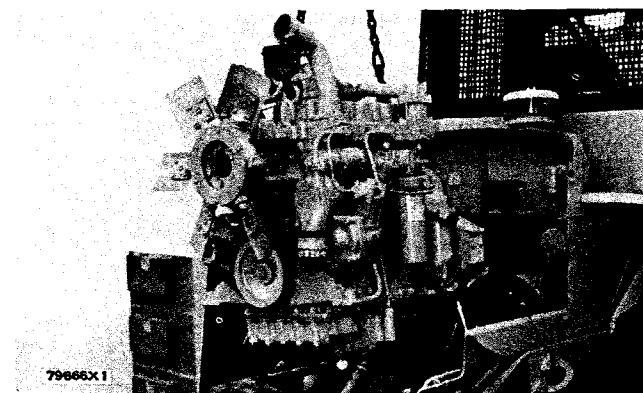
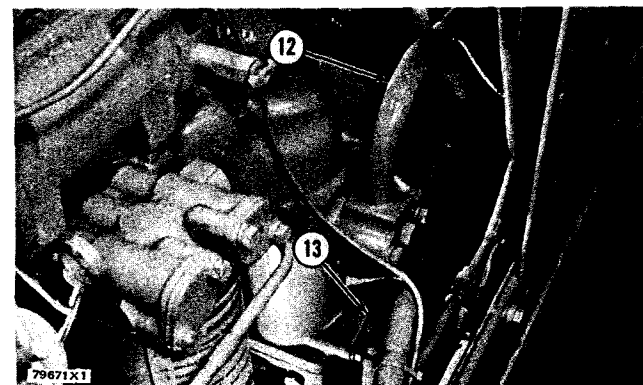
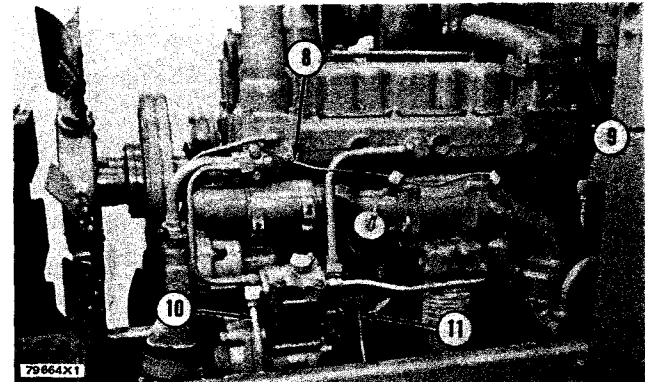
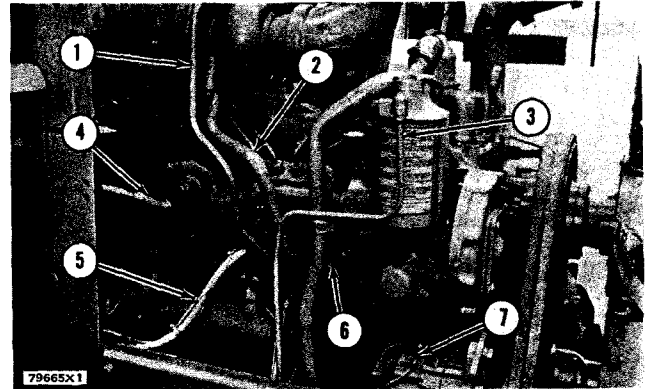
REMOVE ENGINE

11-1000

start by:

- a) remove radiator and guard
- b) remove transmission guard
- c) remove air tank

1. Disconnect battery cables from battery.
2. Disconnect control rod (4) from governor.
3. Disconnect wires (5) and (7) from starter and alternator and put identification on each wire.
4. Remove line (1) and disconnect line (2) from turbocharger.
5. Disconnect wire for glow plugs.
6. Disconnect fuel lines (3) and (6) from the base of fuel filter and housing of accessory drive. Disconnect the gauge line for fuel pressure from the fuel filter base.
7. Disconnect the gauge line for oil pressure from the rear of engine.
8. Disconnect the gauge line (8) for water temperature.
9. Disconnect the air outlet line (10). Remove governor line (11) from the air compressor.
10. Loosen the hose clamps on inlet pipe for turbocharger. Remove bolts from bracket (9) for the air cleaner. Move the air cleaner toward the canopy.
11. Remove the bolts that hold the front support to the frame.
12. Disconnect the bottom line (13) and remove the top line (12) from cooler for the torque converter.
13. Connect a hoist and remove the bolts that hold the housing of torque converter to the flywheel housing.
14. Remove engine. Weight is 1500 lb. (680 kg).



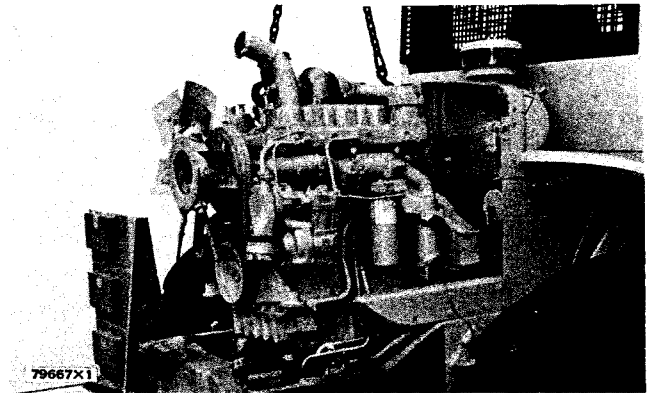
TREE HARVESTER SHOWN

ENGINE

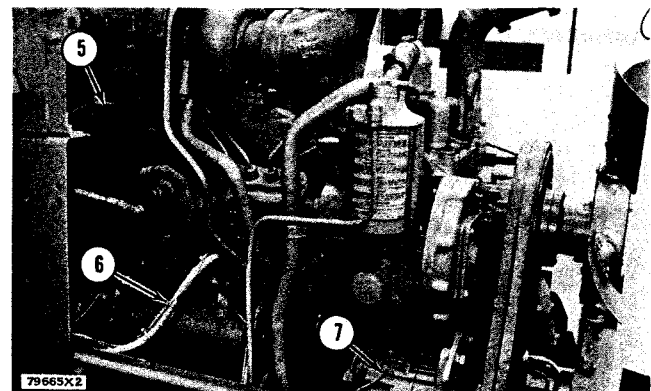
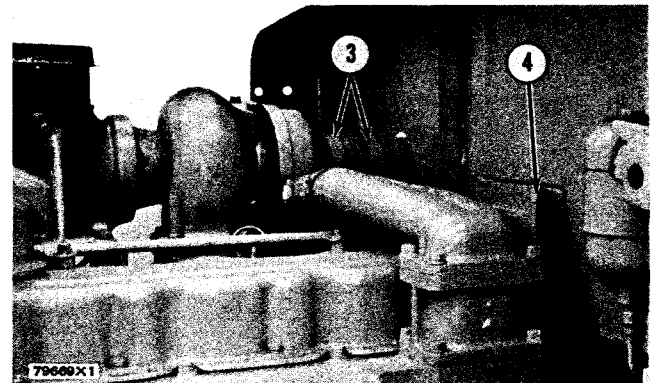
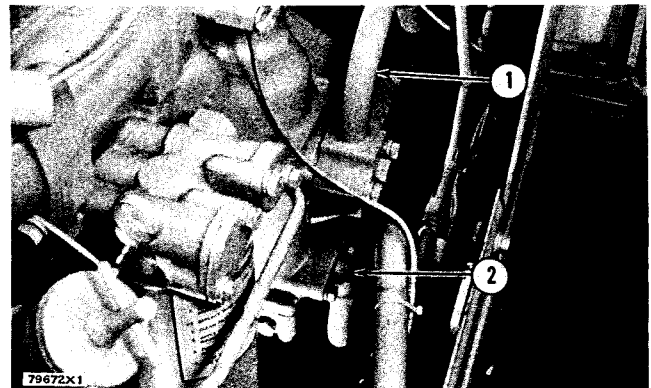
INSTALL ENGINE

12-1000

1. Connect a hoist and put the engine into position in the machine. Turn the crankshaft if necessary to put flywheel gear in alignment with gear of torque converter.
2. Install the bolts that hold the engine to the torque converter. Install the bolts and nuts in front support of engine.
3. Connect the bottom line (2) and install the top line (1) to cooler for the torque converter.
4. Put the air cleaner in position and install bolts in bracket (4). Tighten clamps (3) on hose.
5. Connect air lines to air compressor.
6. Connect the gauge line for water temperature.
7. Connect the gauge line for oil pressure to rear of engine.
8. Connect fuel lines to base of fuel filter and housing of accessory drive.
9. Connect wire (5) for glow plugs.
10. Connect wire (6) to starter and wire (7) to alternator.
11. Connect control rod to governor.
12. Connect oil lines to turbocharger.
13. Connect battery cables to the battery.
end by:
 - a) install air tank
 - b) install transmission guard
 - c) install radiator and guard



TREE HARVESTER SHOWN



FLYWHEEL, CRANKSHAFT REAR SEAL

REMOVE FLYWHEEL

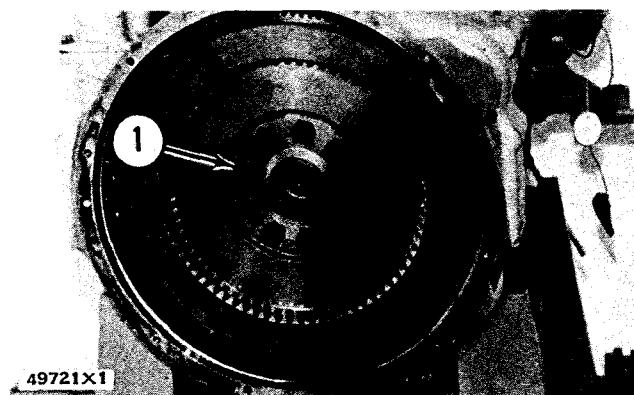
11-1156

Tools Needed		A
FT120	Lifting Bracket	1

start by:

a) remove engine

1. Make a mark on the flywheel and crankshaft at the same location.
2. Remove two bolts from flywheel and install two 5/8"-18NF guide bolts in flywheel. Remove all bolts (1) from flywheel.
3. Remove flywheel with tool (A). The flywheel weight is 65 lbs. (30 kg).



INSTALL FLYWHEEL

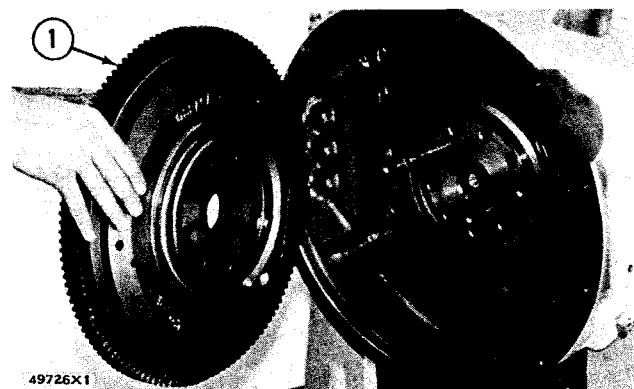
12-1156

Tools Needed		A
FT120	Lifting Bracket	1

1. Install two 5/8"-18NF guide bolts in crankshaft.
2. Install tool (A) and a hoist, put the flywheel (1) in position with mark on flywheel and mark on crankshaft in alignment.
3. Install all the bolts in the flywheel except two. Remove the guide bolts and install two bolts.

end by:

a) install engine



REMOVE CRANKSHAFT REAR SEAL

11-1161

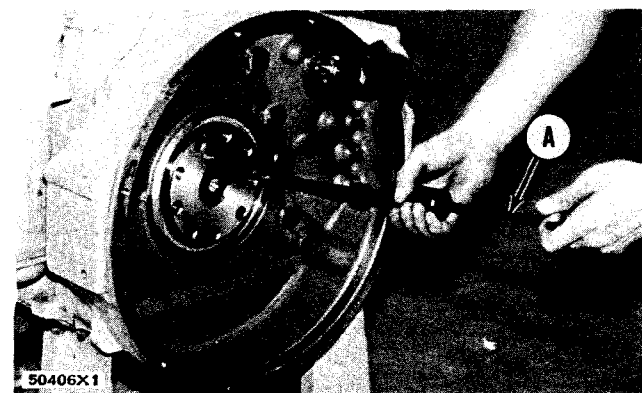
Tools Needed		A
1P3075	Seal Puller Group	1

start by:

a) remove engine

b) remove flywheel

1. Remove the crankshaft rear seal with tool (A).



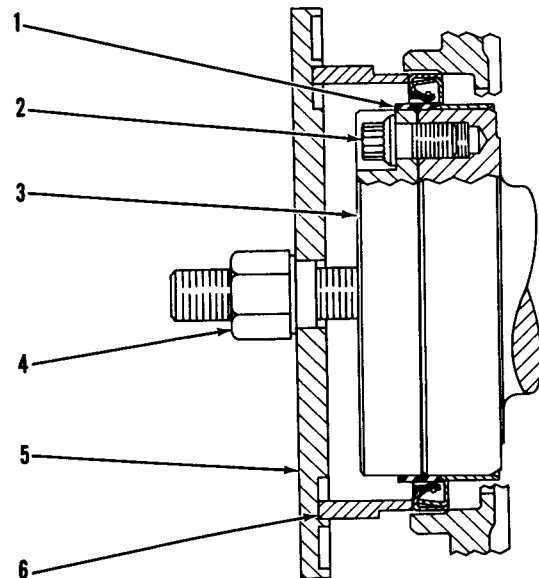
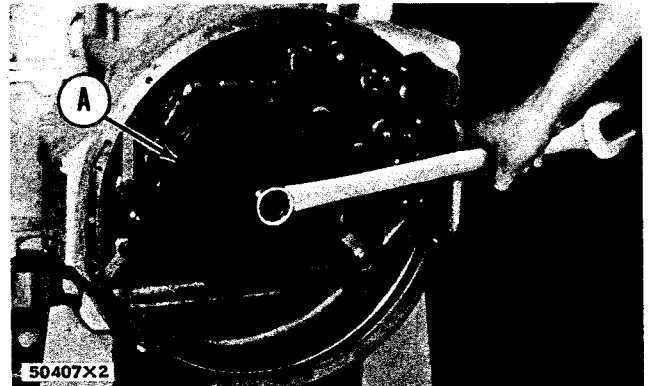
CRANKSHAFT REAR SEAL

INSTALL CRANKSHAFT REAR SEAL

12-1161

Tools Needed		A
9S8543	Seal Installer Ring	1
9S8548	Seal Pilot	1
9S8858	Nut	1
9S8864	Pusher Plate	1
9S8871	Locator Assembly	1
9S8890	Screw	3

1. Install the crankshaft rear seal with tooling (A) as follows:
 - a) Install locator (3) and screws (2) on the crankshaft.
 - b) Put clean SAE 30 lubricant on lip of seal and seal pilot (1). Put the seal on the seal pilot. Install seal and seal pilot (1) on locator (3) and crankshaft with lip of seal toward engine block.
 - c) Put the seal installer ring (6) and pusher plate (5) in position on the stud of the locator (3) and install nut (4).
 - d) Tighten nut (4) until the seal makes contact with the bottom.
- end by:
- a) install flywheel
 - b) install engine



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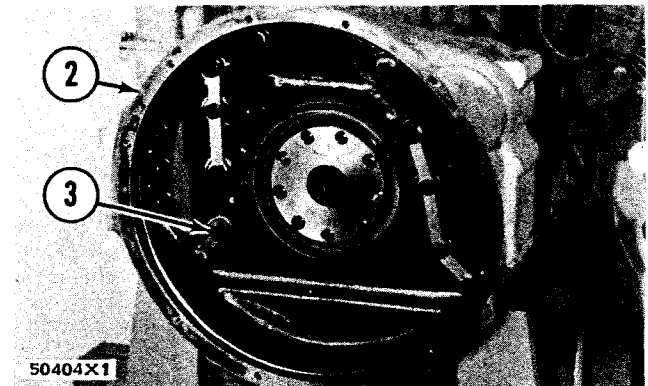
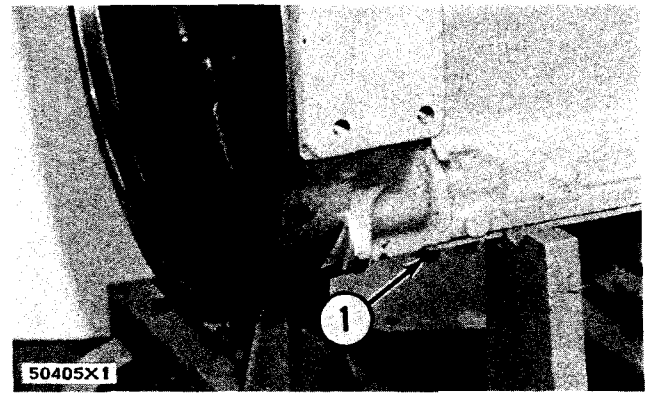
FLYWHEEL HOUSING

REMOVE FLYWHEEL HOUSING 11-1157

start by:

- a) remove engine
- b) remove flywheel
- c) remove starter

1. Remove bolts (1) from bottom of flywheel housing. Loosen all bolts in the oil pan plate.
2. Put a spacer between oil pan plate and engine block at the flywheel housing.
3. Install two 1/2"-13NC forged eyebolts in the flywheel housing and connect a hoist to flywheel housing.
4. Remove bolts (3) and locks.
5. Remove flywheel housing (2). Weight is 95 lbs. (43 kg).

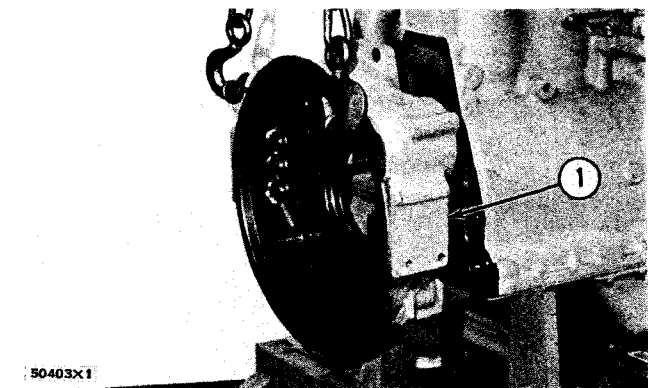


INSTALL FLYWHEEL HOUSING 12-1157

1. Install a new gasket on flywheel housing.
2. Install two 1/2"-13NC guide bolts in engine block.
3. Put flywheel housing (1) in position on guide bolts with a hoist. Install bolts and locks on inside of flywheel housing.
4. Remove spacers and install bolts in bottom of flywheel housing. Tighten all bolts in oil pan plate.

end by:

- a) install starter
- b) install flywheel
- c) install engine



CAMSHAFT BEARINGS

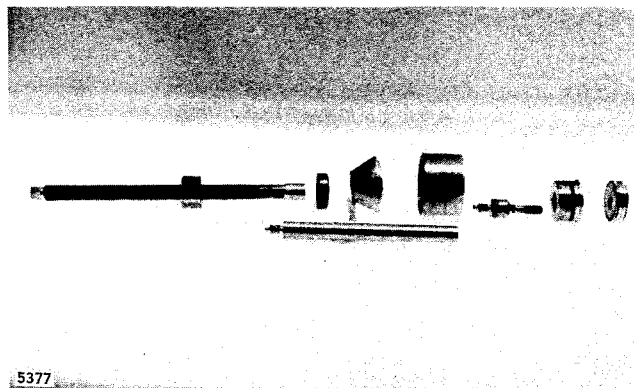
REMOVE CAMSHAFT BEARINGS 11-1211

Tools Needed		A
8S2241	Camshaft Bearing Tool Group	1

start by:

- a) remove engine
- b) remove flywheel housing
- c) remove camshaft

1. Remove the camshaft bearings starting with the front bearing with tool group (A).



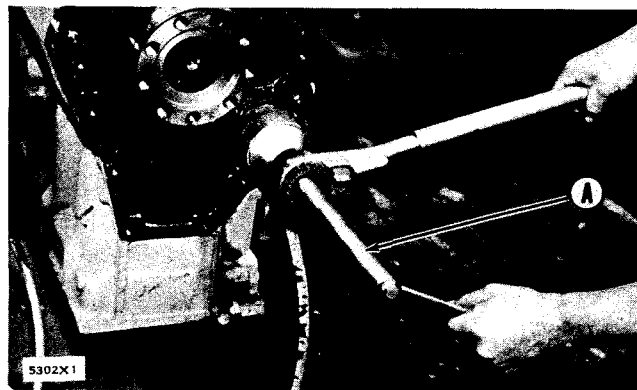
INSTALL CAMSHAFT BEARINGS 12-1211

Tools Needed		A
8S2241	Camshaft Bearing Tool Group	1

1. Install the camshaft bearings in the cylinder block starting with the front bearing. Install bearings with tool group (A). Install the bearings with the oil hole in alignment with the oil hole in the cylinder block.
2. The front and rear bearings after installation are to be .06 in. (1.5 mm) inside the ends of the cylinder block.

end by:

- a) install camshaft
- b) install flywheel housing
- c) install engine



CRANKSHAFT

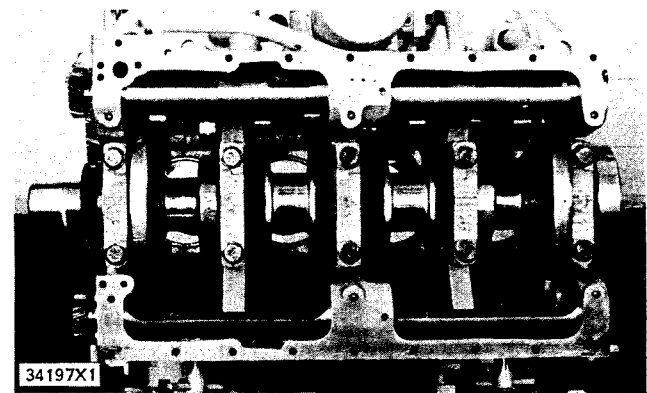
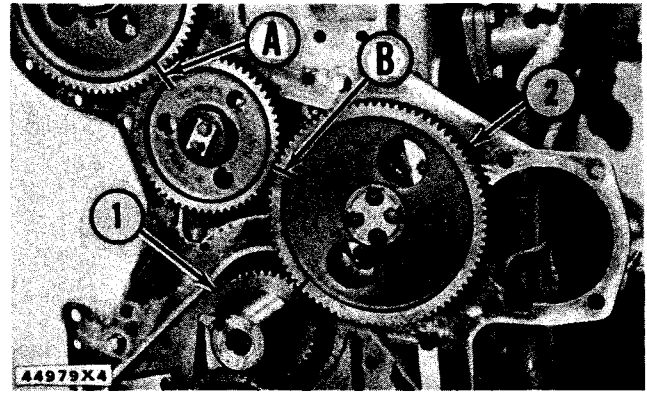
REMOVE CRANKSHAFT

11-1202

start by:

- a) remove engine
- b) remove flywheel housing
- c) remove timing gear cover
- d) remove pistons

1. Turn the crankshaft until the timing mark on the crankshaft gear (1) is in alignment with the timing mark on the camshaft gear (2).
2. Make a mark on the teeth of the accessory drive gear and the idler gear in their engaged position at location (A). Mark the engaged teeth of idler gear and camshaft gear at location (B). This will aid in the correct timing of the camshaft for the fuel injection pump during crankshaft installation.
3. Fasten a hoist to the crankshaft.
4. Remove the caps for the main bearings.
5. Remove the crankshaft. Weight is 145 lb. (66 kg).
6. Remove the crankshaft main bearings from the cylinder block and from the caps.

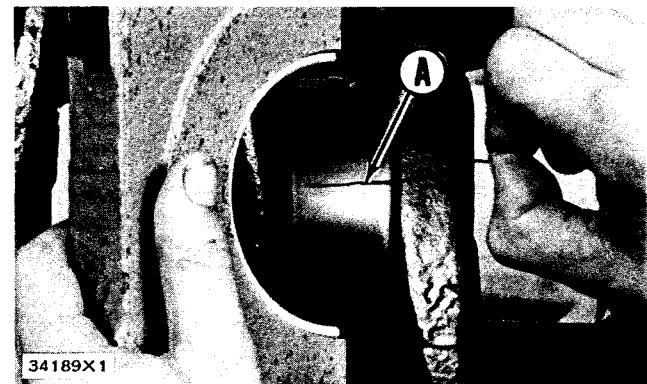


INSTALL CRANKSHAFT

12-1202

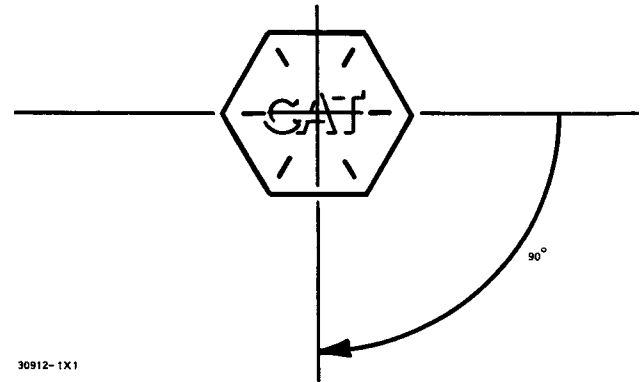
Tools Needed		A	B
5B1161	Wire	*	
8S2328	Indicator Group		1

1. Clean the surfaces on the cylinder block for the bearings. Install the upper halves of the main bearings in the block. Put clean oil on the bearings.
2. Put the crankshaft in the block with a hoist. Be sure all timing marks are in alignment.
3. Clean the main bearing caps. Install the lower halves of the main bearings in caps.
4. Check the main bearing clearance with wire (A). Install the caps in their correct places. Be sure the number on the cap is toward the number on the pan surface on the left side of the block.



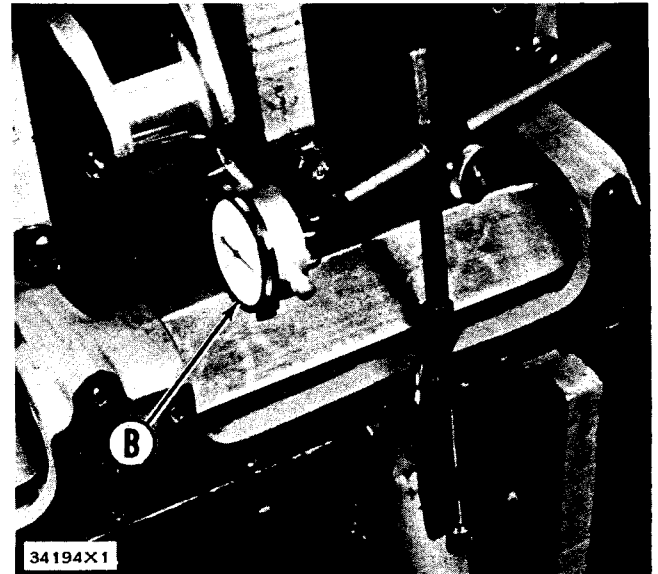
CRANKSHAFT

5. Put clean oil on the threads of the bolts and on the faces of the washers that hold the main bearing caps. Install the bolts and washers. Tighten both bolts to 30 ± 3 lb. ft. (4.1 ± 0.4 mkg). Put a mark on the bolt heads and bearing caps. Tighten the bolts 90° from the mark as shown. Remove bearing caps and measure the thickness of the wire (A). Main bearing clearance (wire thickness) must be .0030 to .0059 in. (0.076 to 0.150 mm). Maximum permissible clearance is .010 in. (0.25 mm).



30912-1X1

6. Put clean oil on the lower halves of main bearings. Install the caps in their correct places. Install the bolts and washers. Tighten to 30 ± 3 lb. ft. (4.1 ± 0.4 mkg). Put marks on bolt heads and caps. Tighten each bolt 90° from the mark.

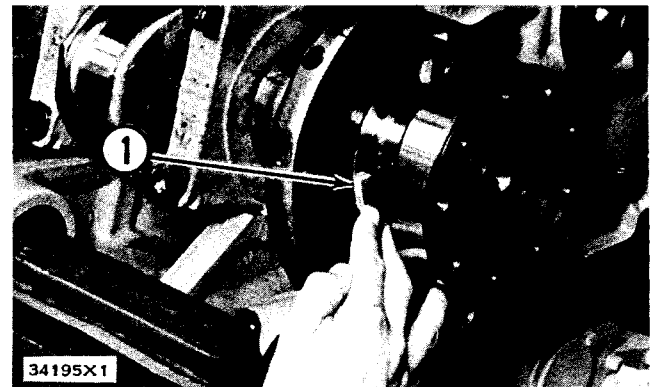


7. Check the crankshaft end clearance with tool group (B). End clearance is controlled by the thrust bearing (1) on the rear main. End clearance must be .0025 to .0145 in. (0.064 to 0.368 mm). Maximum permissible end clearance is .025 in. (0.64 mm).

8. If the accessory drive gear, idler gear, camshaft gear or crankshaft gear has been removed or replaced it is necessary to put the accessory drive shaft into correct timing after the engine is assembled. See REMOVE AND INSTALL FUEL INJECTION PUMP HOUSING AND GOVERNOR AS A UNIT.

end by:

- a) install pistons
- b) install timing gear cover
- c) install flywheel housing
- d) install engine



BALANCER SHAFT BEARINGS

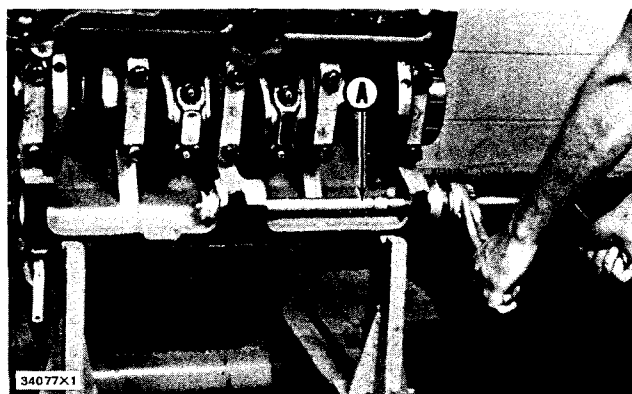
REMOVE BALANCER SHAFT BEARINGS

11-1224

Tools Needed		A
8S2241	Camshaft Bearing Tool Group	1

start by:

- a) remove oil pan plate
 - b) remove balancer shafts
 - c) remove flywheel housing
1. Remove the bearings for the balancer shaft with tool group (A). Remove the front bearing first.



INSTALL BALANCER SHAFT BEARINGS

12-1224

Tools Needed		A
8S2241	Camshaft Bearing Tool Group	1

1. Install the balancer shaft bearings in the cylinder block with tool group (A). Install the front bearing first. Make sure the oil holes in the bearings are in alignment with the oil holes in the cylinder block.
 2. The front and rear bearings are to be $.03 \pm .02$ in. (0.76 ± 0.5 mm) inside the ends of the block after installation.
- end by:
- a) install balancer shafts
 - b) install flywheel housing
 - c) install oil pan plate

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