

# **DE08TS Diesel Engine**

## **Disassembly & Assembly**

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**D100, D120, D150**

**D110S-5, D130S-5, D160S-5**



## Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

**Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.**

**Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.**

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "WARNING" as shown below.



The meaning of this safety alert symbol is as follows :

**Attention! Become Alert! Your Safety is Involved.**

The Message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

DOOSAN cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by DOOSAN is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product.

Obtain the complete and most current information before starting any job. DOOSAN dealers have the most current information available.



## Index

|                                      |    |
|--------------------------------------|----|
| Air Cleaner Assembly .....           | 24 |
| Air Cleaner Elements .....           | 25 |
| Air Compressor (if equipped) .....   | 72 |
| Alternator .....                     | 12 |
| Camshaft And Camshaft Bearing .....  | 61 |
| Connecting Rod Bearings .....        | 48 |
| Cooling Water Pipe .....             | 41 |
| Crankshaft.....                      | 69 |
| Crankshaft Pulley.....               | 63 |
| Cylinder Head .....                  | 49 |
| Cylinder Head Cover.....             | 34 |
| Cylinder Liners .....                | 57 |
| Electric Starting Motor.....         | 11 |
| Engine And Transmission .....        | 5  |
| Exhaust Manifold .....               | 33 |
| Fan Assembly .....                   | 26 |
| Fan Belts .....                      | 26 |
| Flywheel.....                        | 64 |
| Flywheel Housing.....                | 68 |
| Fuel Filter .....                    | 18 |
| Fuel Injection Lines .....           | 17 |
| Fuel Injection Nozzle Assembly ..... | 20 |
| Fuel Injection Pump .....            | 13 |
| Fuel Pump.....                       | 19 |
| Fuel Strainer .....                  | 18 |

|                                   |    |
|-----------------------------------|----|
| Intake Manifold.....              | 31 |
| Muffler .....                     | 22 |
| Oil Cooler .....                  | 39 |
| Oil Filter .....                  | 38 |
| Oil Pan .....                     | 34 |
| Oil Pump .....                    | 42 |
| Pistons .....                     | 53 |
| Radiator .....                    | 28 |
| Rocker Shaft .....                | 46 |
| Rocker Shaft And Push Rods .....  | 45 |
| Timing Gear Case.....             | 60 |
| Timing Gear Case Cover .....      | 58 |
| Timing Gears .....                | 58 |
| Water Pump .....                  | 35 |
| Water Temperature Regulator ..... | 27 |



### WARNING

Disconnect batteries before performance of any service work

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# Engine

## Remove Engine And Transmission A10999 & D40999 - 02

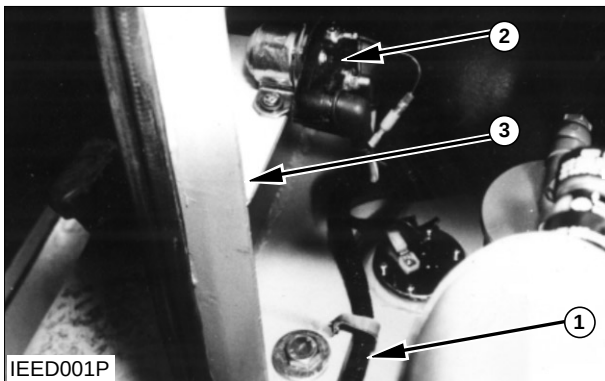
| Tools Needed | A |
|--------------|---|
| Link Bracket | 1 |

Start By :

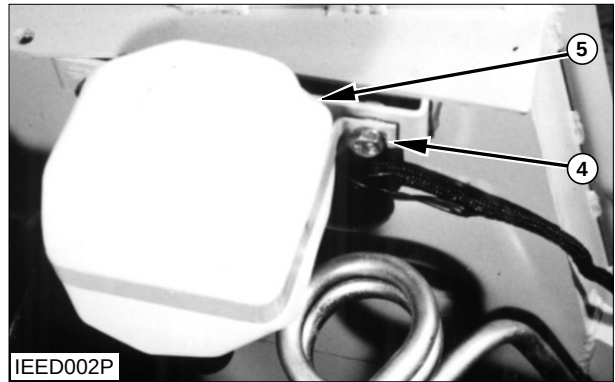
- a. Remove overhead guard.\*
- b. Remove floorplate.\*
- c. Remove hood.\*
- d. Remove air cleaner.
- e. Remove universal joint.\*

\* This operation is in the Vehicle Systems, Disassembly And Assembly Manual.

1. Drain the coolant from the radiator.



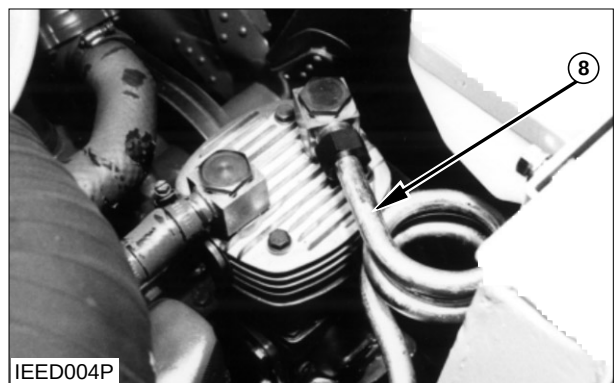
2. Remove engine harness assembly (1) from the clips of bonnet assembly (3).
3. Remove screws, washers and circuit breaker (2) from bonnet assembly (3).
4. Remove bolt and washer that hold bonnet assembly. Remove bonnet assembly (3) from the frame.



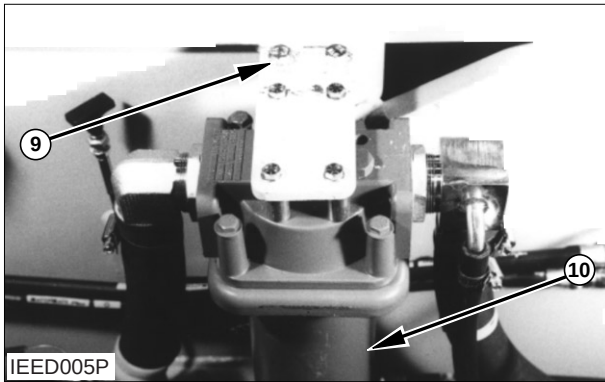
5. Remove bolts (4), washers and nuts that hold coolant reservoir on the frame. Set coolant reservoir (5) aside.



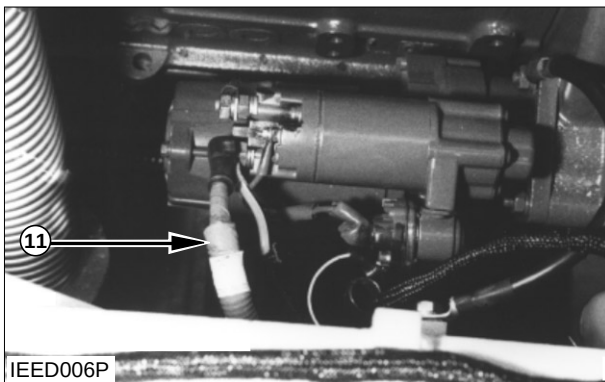
6. Disconnect two hoses (6) from the fuel tank.
7. Disconnect wiring harness (7) from fuel sender.



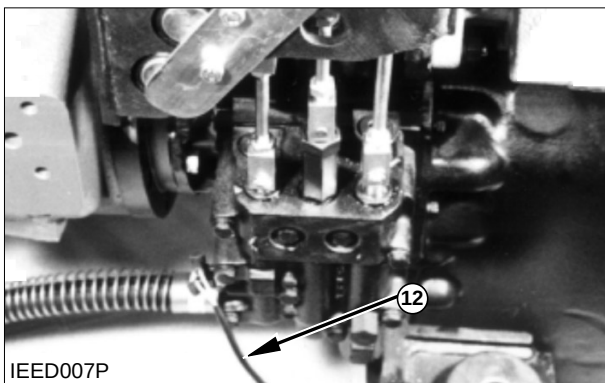
8. Remove tube (8) from the tube of air compressor (if equipped).



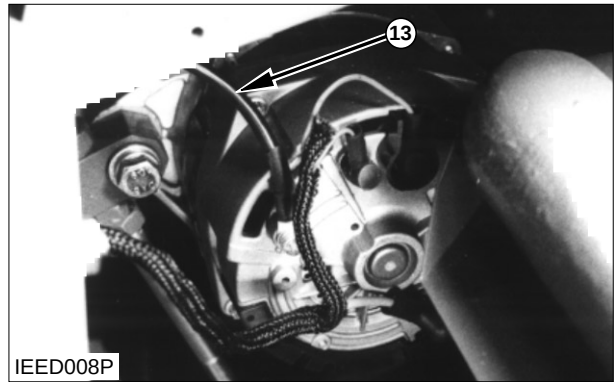
9. Remove two bolts washers (9) and hydraulic filter assembly (10). Set hydraulic filter assembly (10) aside.



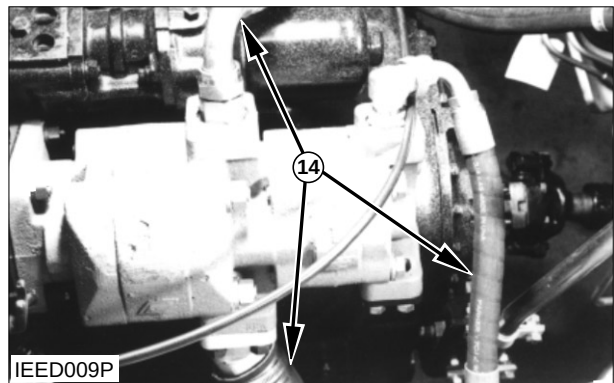
10. Disconnect battery cable (11) from the starting motor.



11. Disconnect transmission neutral switch connector (12).

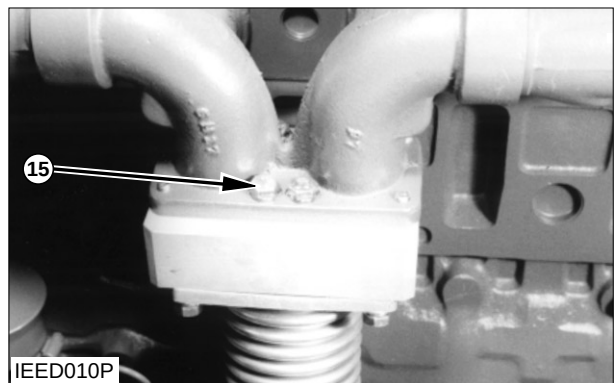


12. Disconnect ground cable (13) from the alternator.

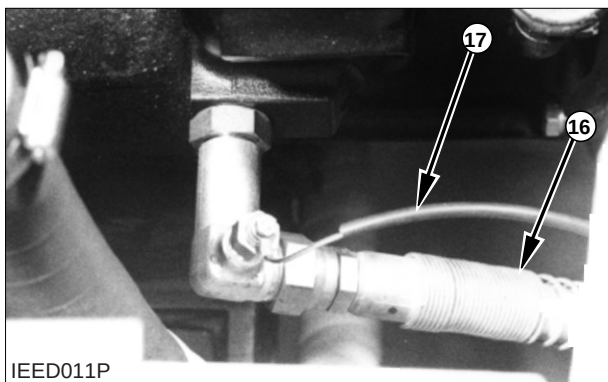


13. Disconnect three hoses (14) from the hydraulic pump.

**NOTE :** Plug and cap all hydraulic connectors and hoses to avoid debris and contamination from entering the system.

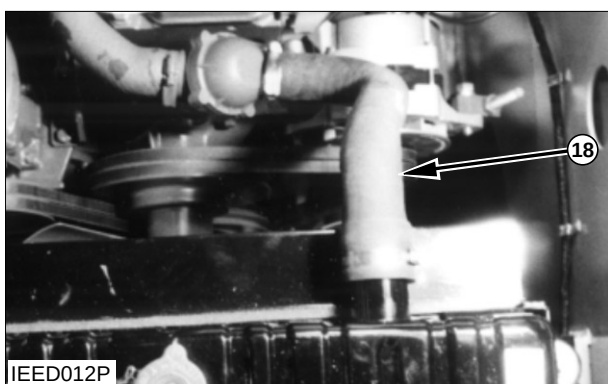


14. Remove bolts (15) and washers that hold the muffler expansion on exhaust manifold of the engine.

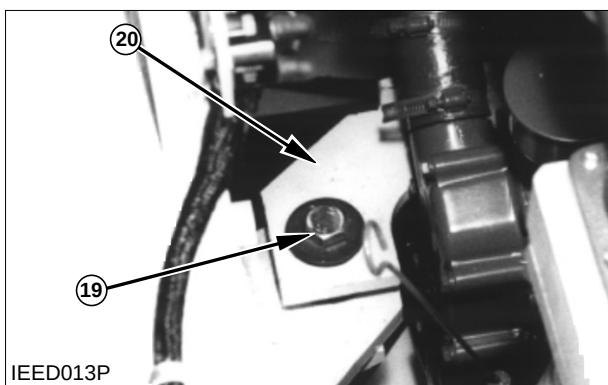


**15.** Disconnect two transmission cooling hoses (16) from the transmission.

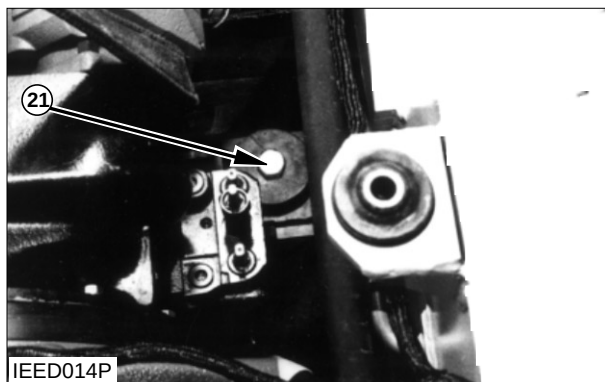
**16.** Disconnect transmission oil temperature switch wiring (17).



**17.** Disconnect two engine cooling hoses (18 ) from the engine.

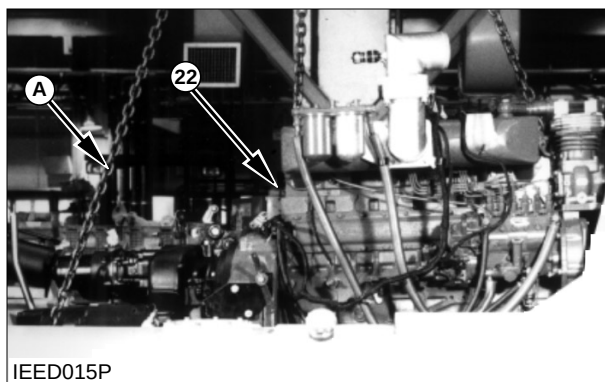


**18.** Remove bolts (19), washers, nuts from the two engine support (20), one on both side of the engine.



**19.** Remove bolts (21), washers and nuts from the two transmission support.

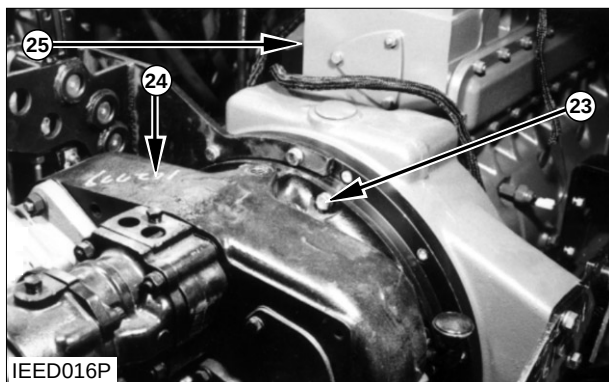
**NOTE :** At this point, make a final check to be sure all removals and disconnections have been made from the engine and the transmission.



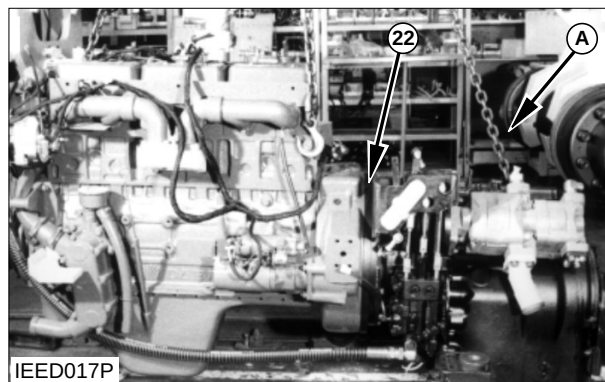
**20.** Install the tool (A) to the transmission. Fasten tool (A) to the engine and transmission as shown.

**21.** Remove engine and transmission (22) from the lift truck.

**22.** Put the engine and transmission on an acceptable engine stand. Remove tool (A).



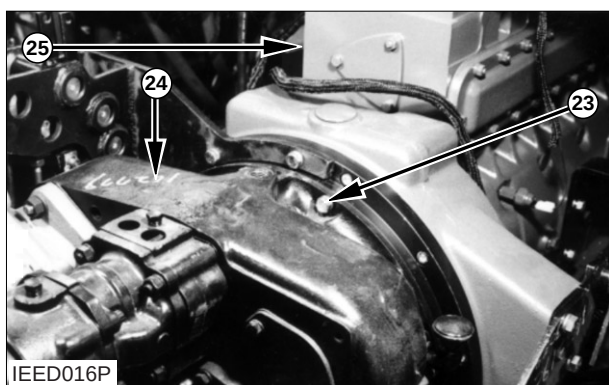
23. Support transmission (24) with fasten a strap and remove twenty bolts(23) and washers. Remove transmission (24) from engine (25).



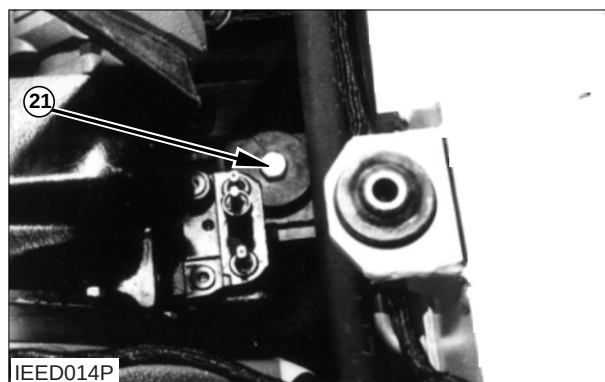
3. Install the tool (A) to the transmission.
4. Fasten tool (A) to engine and transmission (22) as shown.

## Install Engine And Transmission A10999 & C40999 - 03

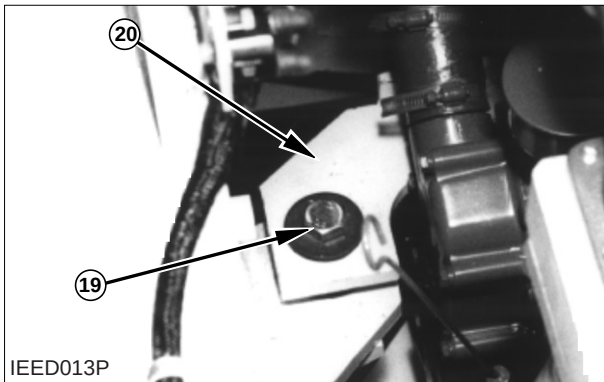
| Tools Needed | A | B |
|--------------|---|---|
| Link Bracket | 1 |   |
| Eye Bolt     |   | 1 |



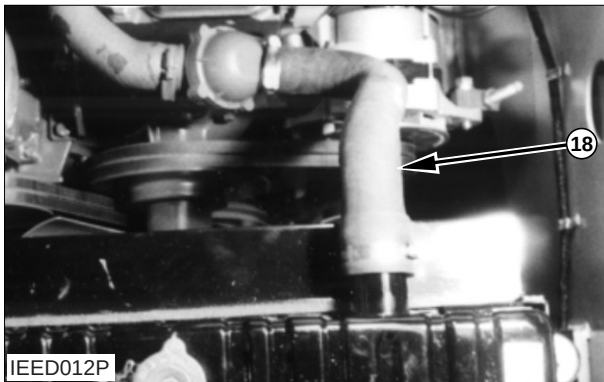
1. Put transmission (24) in position in engine (25).
2. Install bolts (23) and washers that hold transmission to the engine. Tighten bolts (23) to torque of  $55 \pm 10 \text{ N}\cdot\text{m}$  ( $40 \pm 7 \text{ lb}\cdot\text{ft}$ ).



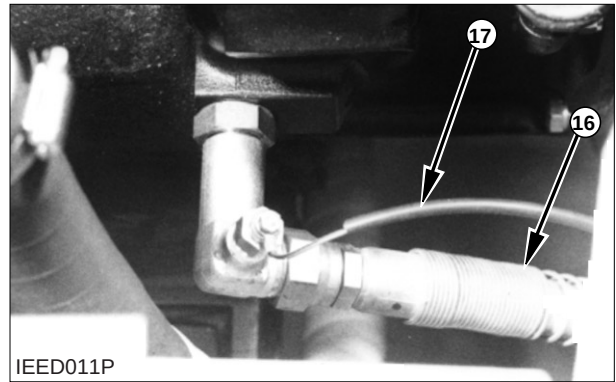
5. Put the engine and transmission in position on the lift truck. Make an alignment of supports with the frame.
6. Install bolts (21), washers and nuts that hold the transmission support to the frame. Tighten bolts (21) to a torque of  $730 \sim 800 \text{ N}\cdot\text{m}$  ( $540 \sim 590 \text{ lb}\cdot\text{ft}$ ).



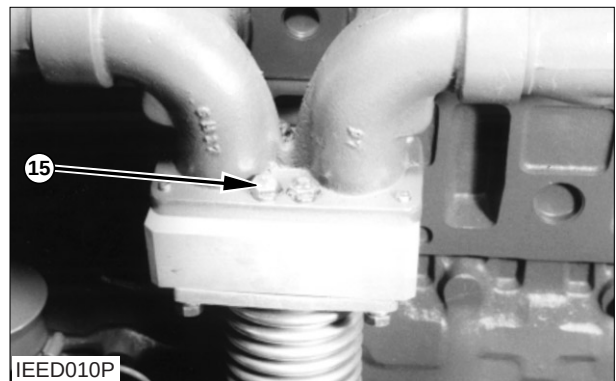
7. Install bolts (19), washers and nuts that hold engine support (20) to the frame. Tighten bolts (19) to a torque of **280 N•m (205 lb•ft)**.



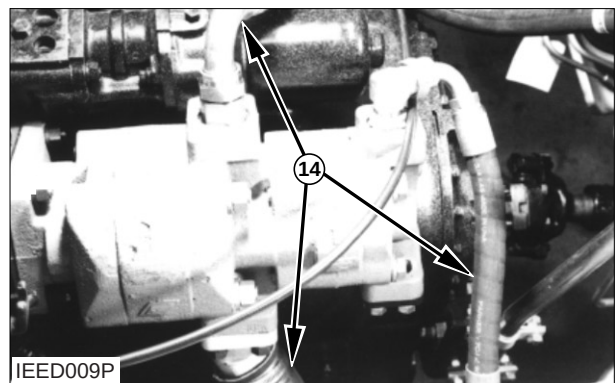
8. Connect two engine cooling hoses (18) and tighten the hose clamps.



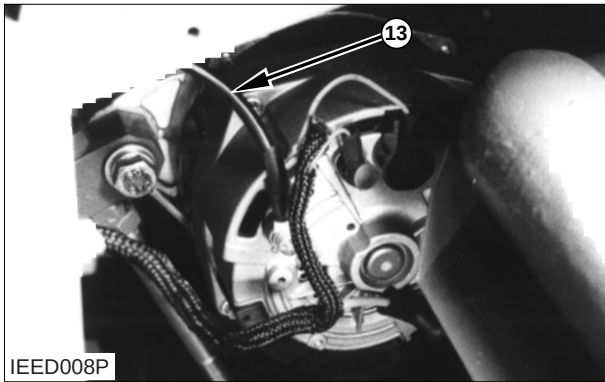
9. Connect two transmission cooling hoses (16) to transmission.
10. Connect transmission oil temperature switch connector (17).



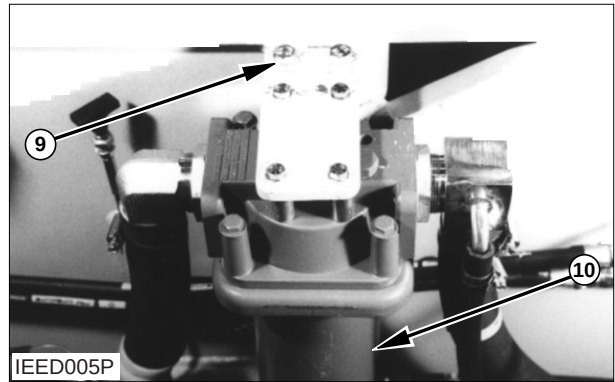
11. Install bolts (15) and washers that hold the muffler expansion to exhaust manifold of the engine.



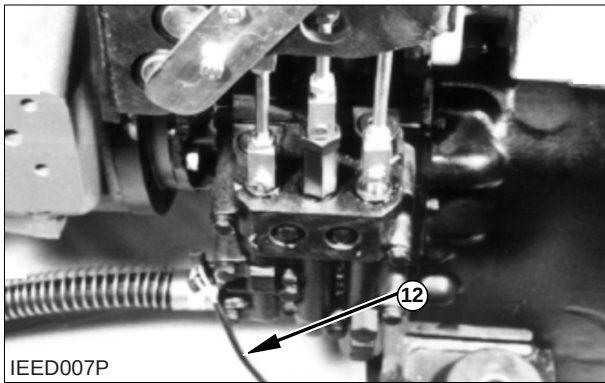
12. Connect three hydraulic hoses (14) to the hydraulic pump.



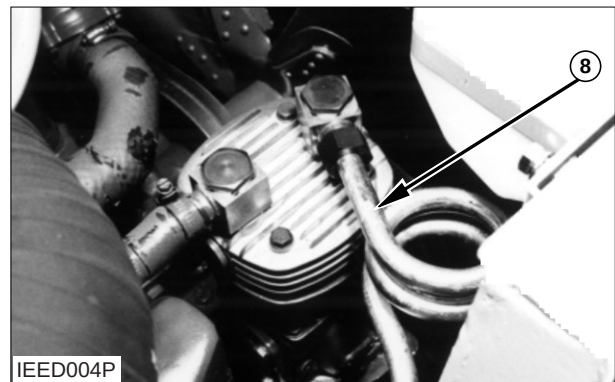
**13.** Connect ground cable (13) to the alternator.



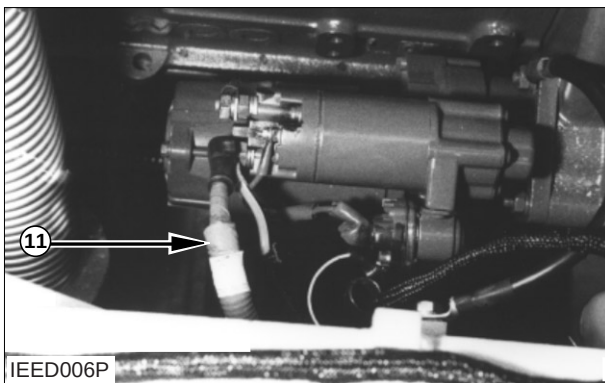
**16.** Put hydraulic filter assembly (10) in position on the frame. Install bolts (9) and washers.



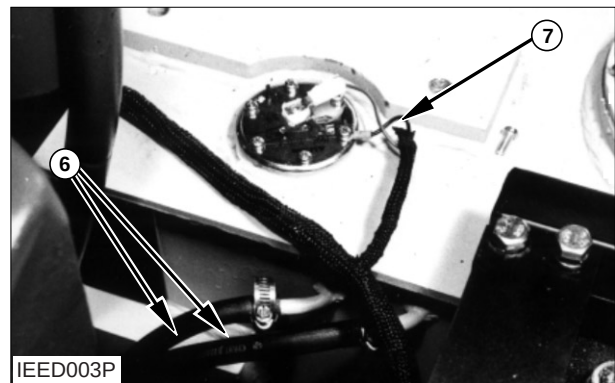
**14.** Connect transmission neutral switch connector (12).



**17.** Install tube (8) to the air compressor (if equipped).

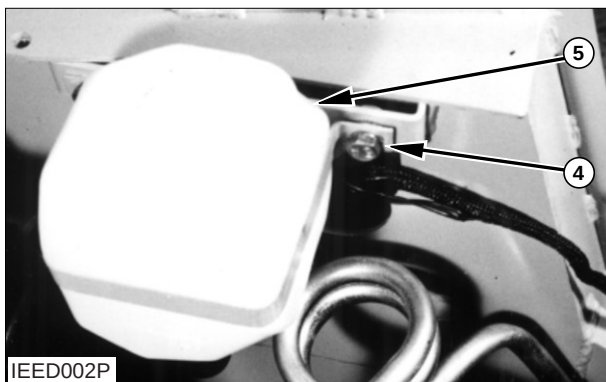


**15.** Connect battery cable(11) to the starting motor.

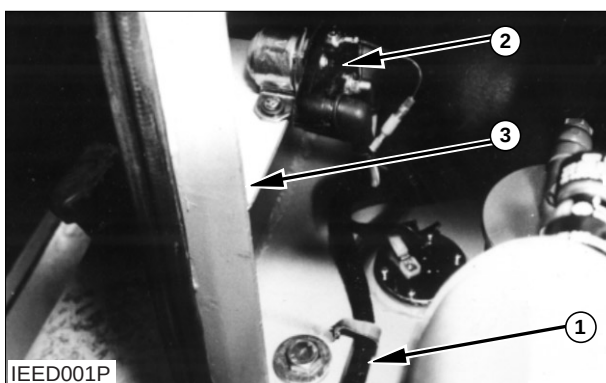


**18.** Connect wiring harness (7) to the fuel sender.

**19.** Connect two fuel hoses (6) and tighten the hose clamp.



20. Put the coolant reservoir with bracket (5) in position on the frame. Install bolts (4) and washers that hold coolant reservoir (5).



21. Put bonnet assembly (3) in position on the frame. Install the bolts and washers. Tighten the bolts to a torque of **200 N·m (150 lb·ft)**.
22. Install the screws and washers that hold circuit breaker (2).
23. Clear engine harness assembly (1).
24. Fill the cooling system. See the Maintenance Guide for the correct level.

End By :

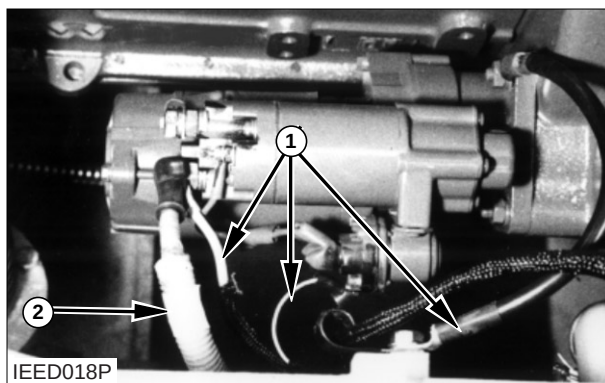
- a. Install universal joint.
- b. Install air cleaner.
- c. Install hood.
- d. Install floorplate.
- e. Install overhead guard.

## Electric Starting Motor

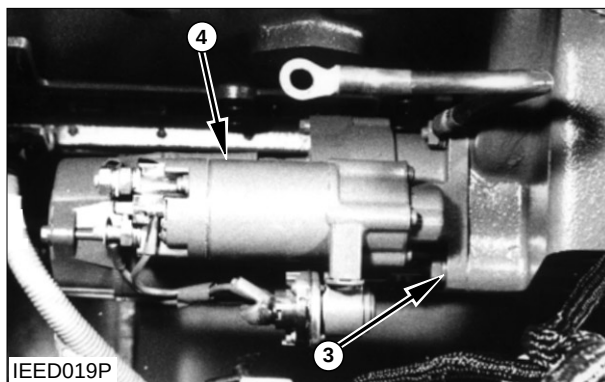
### Remove Electric Starting Motor A61564 - 02

#### **WARNING**

Disconnect the battery before the starting motor is removed

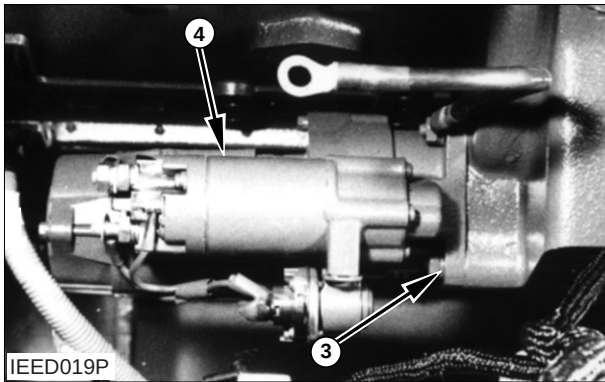


1. Put identification on the starting motor and solenoid wires. Disconnect wirings (1) and battery cable (2).

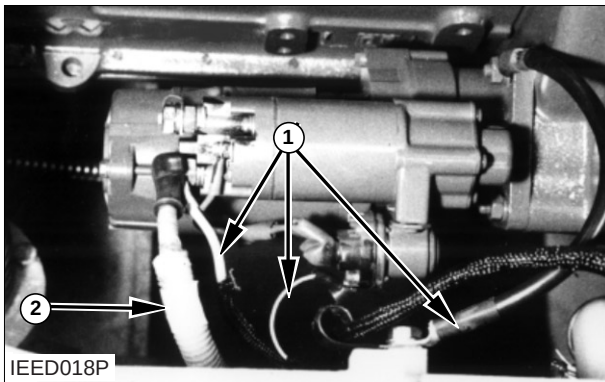


2. Remove mounting nuts (3) and then remove starting motor (4) from the lift truck.

## Install Electric Starting Motor A61564 - 03



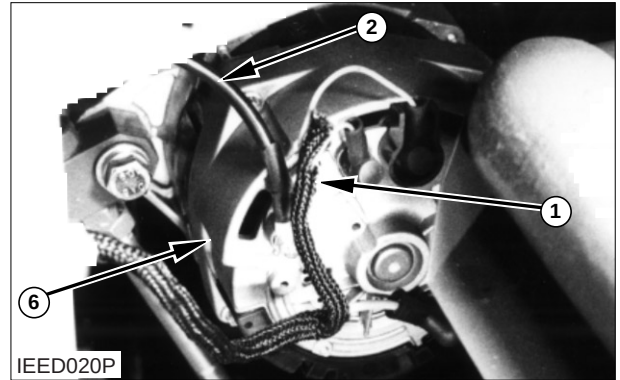
1. Put starting motor (4) in position on the flywheel housing and install nuts (3) that hold it.



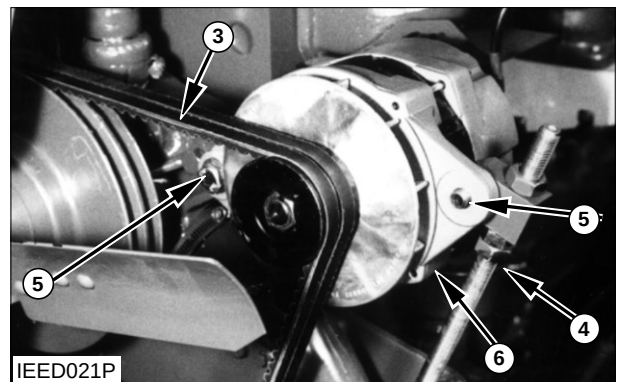
2. Connect wirings (2) to the starting motor and solenoid. Connect battery positive cable (1).

## Alternator

### Remove Alternator B31018 - 02

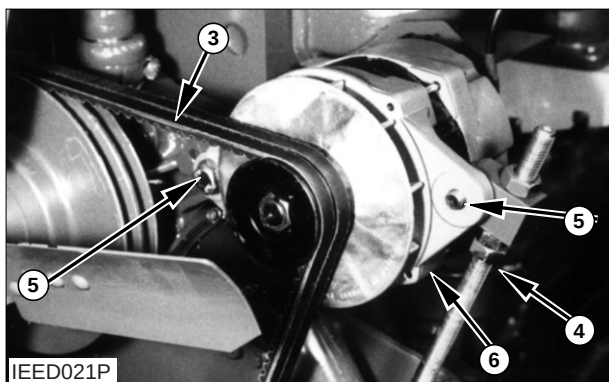


1. Put identification on all wires (1) and the disconnect them from alternator (6).
2. Disconnect ground cable (2) from alternator (6).

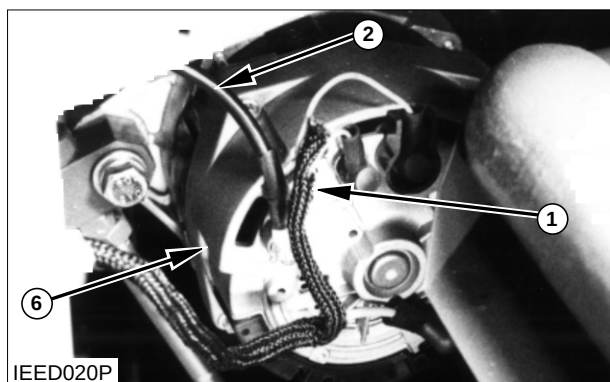


3. Loosen nuts (4) and then remove belt (3) from the alternator.
4. Remove bolts (5) from the alternator's bracket to remove alternator (6).

## Install Alternator B31018 - 03



1. Put alternator (6) in position on its bracket and install bolts (5) that hold it.
2. Install fan belt (3) on the alternator and tighten nuts (4).



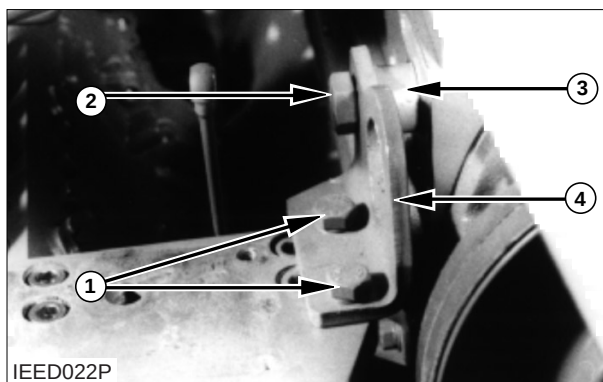
3. Connect all wires (1) to their respective positions.
4. Connect ground cable (2) to alternator (6).

## Fuel Injection Pump

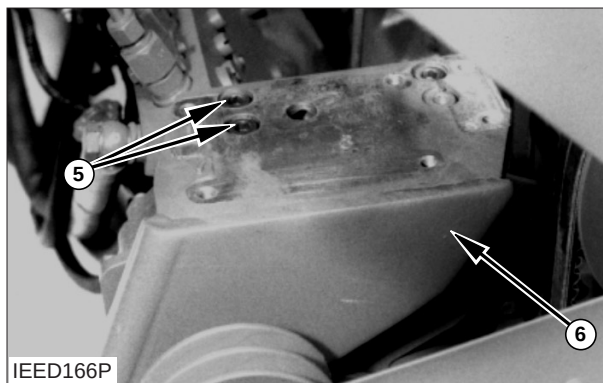
### Remove Fuel Injection Pump A25663 - 02

Start By :

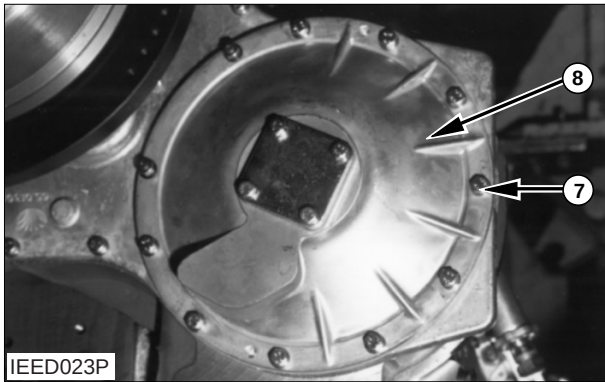
- a. Remove air compressor (if equipped).
- b. Remove intake manifold.



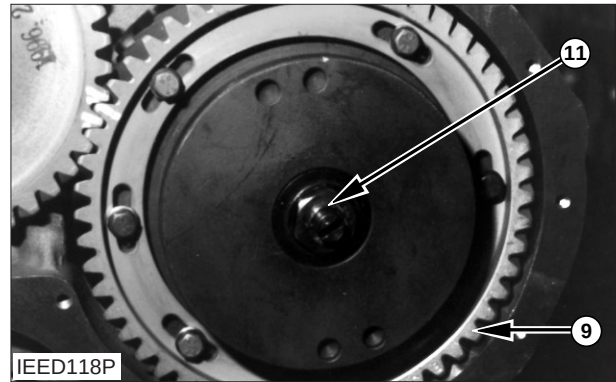
1. Remove two bolts (1) and washers.
2. Remove bolt (2), washers, spacer (3) and lifting bracket (4).



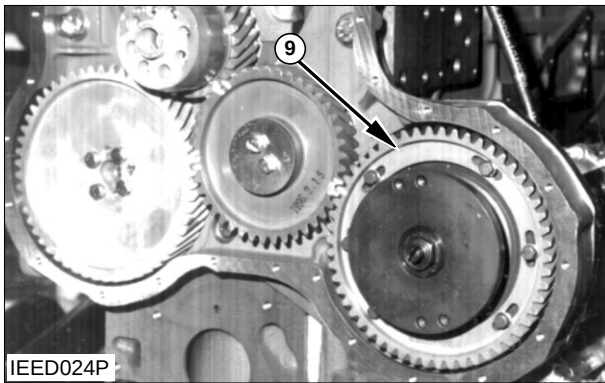
3. Remove bolts (5) and washers that hold the tension adjusting bracket on the timing gear case.
4. Remove the idle pulley and V-belt tension adjusting bracket assembly (6) and gasket. Discard the gasket.



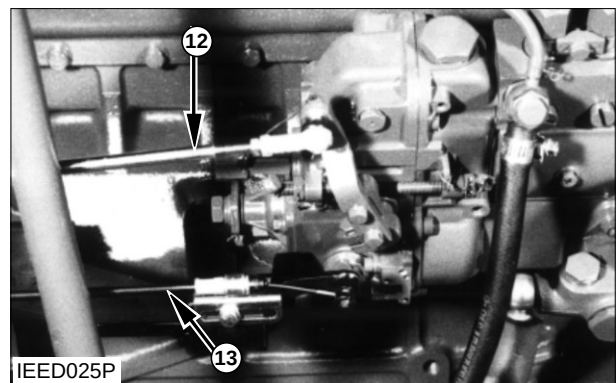
5. Remove bolts (7), washers and cover (8).



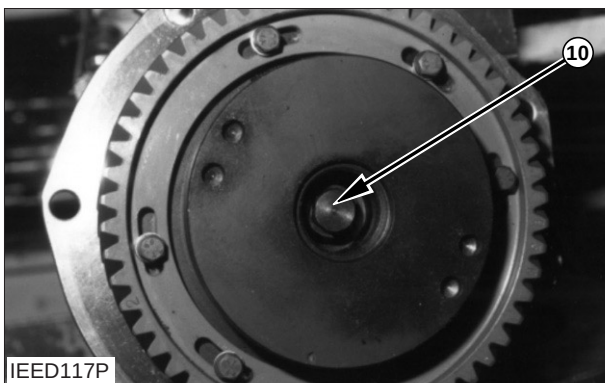
8. Remove nut (11) and injection pump coupling and gear (9) from the injection pump.



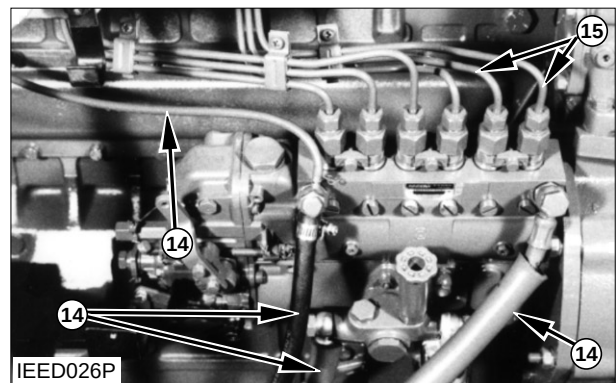
6. Make an alignment of the timing marks on fuel injection pump gear (9) and the idle gear or put a mark of identification on the gears for correct installation.



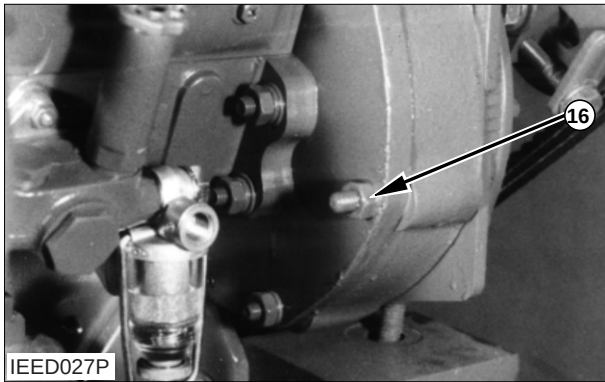
9. Disconnect accel rod (12) and engine stop cable (13).



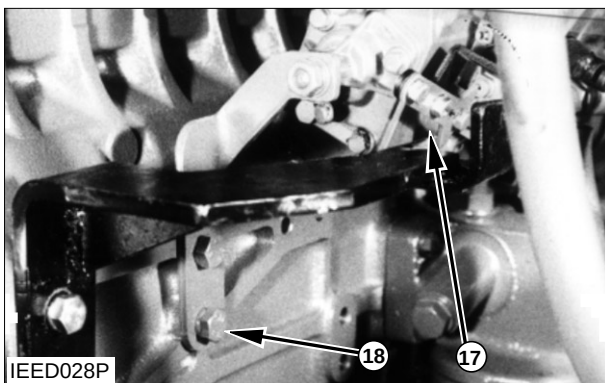
7. Remove nut (10) from the injection pump coupling.



10. Disconnect five hoses (14) and tubes (15) from the injection pump.

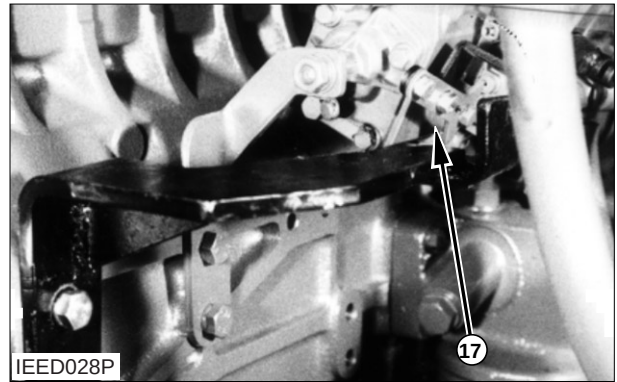


11. Remove four nuts (16) and washers that hold the injection pump in place. Remove the gasket and discard it.

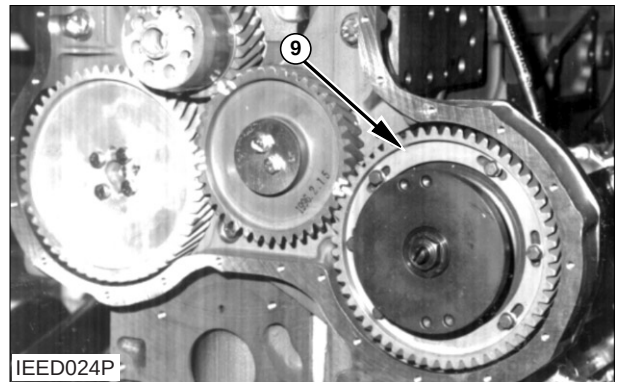


12. Support injection pump (17). Remove two bolts (18) and washers that hold injection pump (17) on the block. Remove injection pump (17).

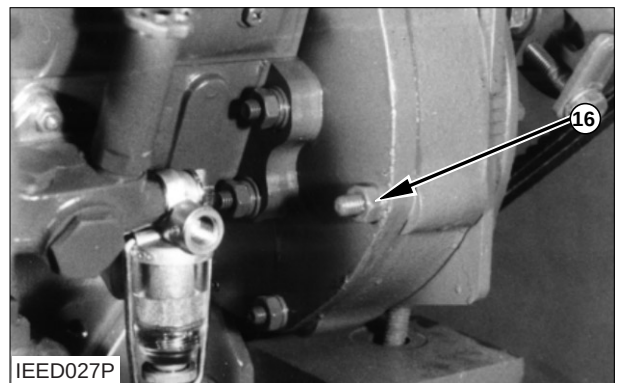
## Install Fuel Injection Pump A25663 - 03



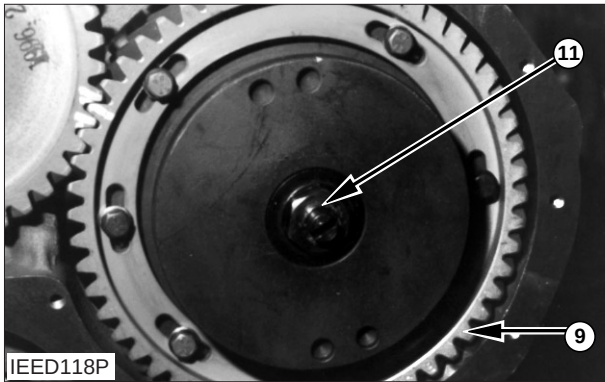
1. Install the new gasket in position on the timing gear case. Put fuel injection pump (17) in position on the timing gear case.



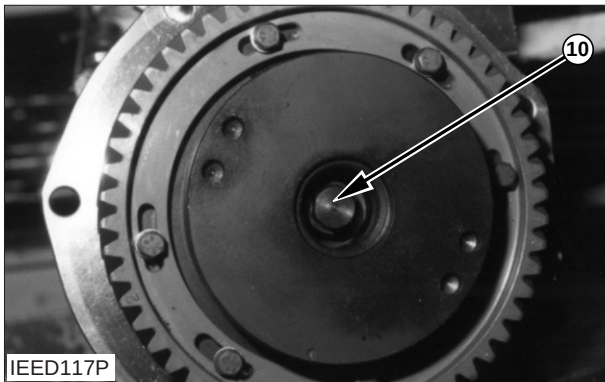
2. Make sure the timing marks or the marks that were put on the fuel injection pump gear (9) and the idle gear are in alignment.



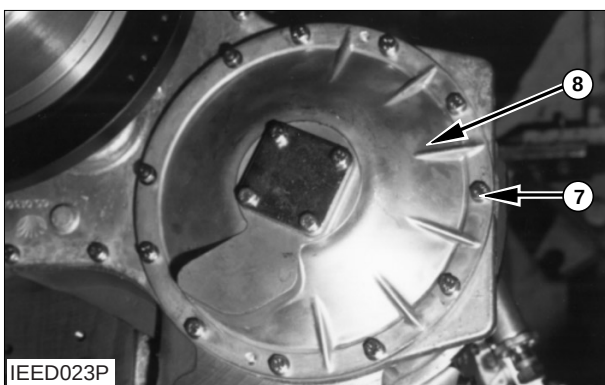
3. Install four nuts (16) and washers that hold the fuel injection pump on the timing gear case.



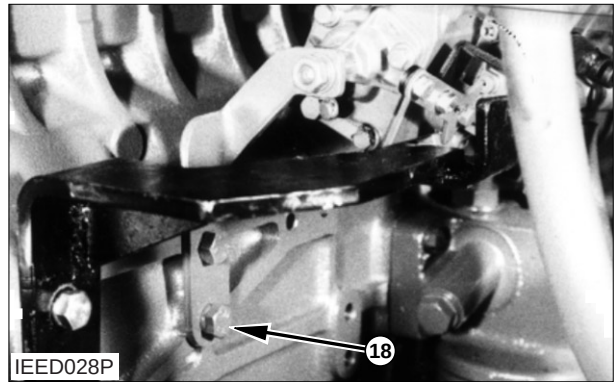
4. Put the fuel injection pump drive coupling and gear (9) in position. Make an alignment of the key and the groove (slot) in the coupling.
5. Install nut (11) that hold the injection pump drive coupling and gear (9) in place. Tighten nut (11) to a torque of **130 N•m (96 lb•ft)**.



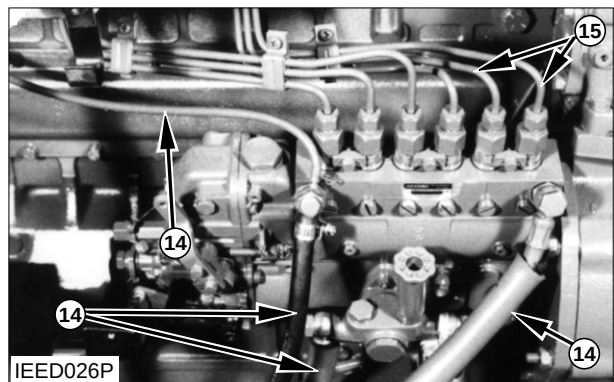
6. Install nut (10) into the injection pump coupling.



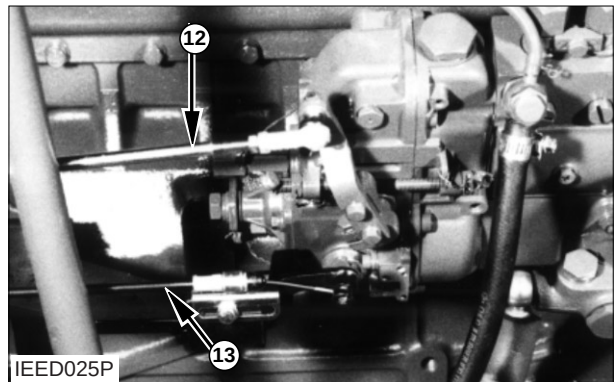
7. Install cover (8), bolts (7) and washers.



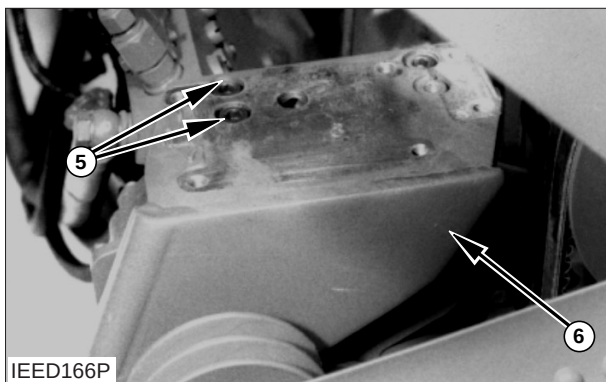
8. Install bolts (18) and washers that hold the injection pump on the block.



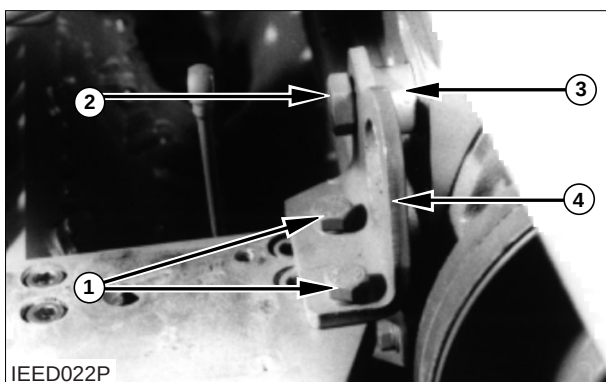
9. Connect three hoses (14) and tube (15) to the injection pump.



10. Connect accel cable (12) and engine stop cable (13) to the injection pump.



11. Install the new gasket on the timing gear case.
12. Put the idle pulley and V-belt tension adjusting bracket assembly (6) on the timing gear case and install bolts (5) and washers.



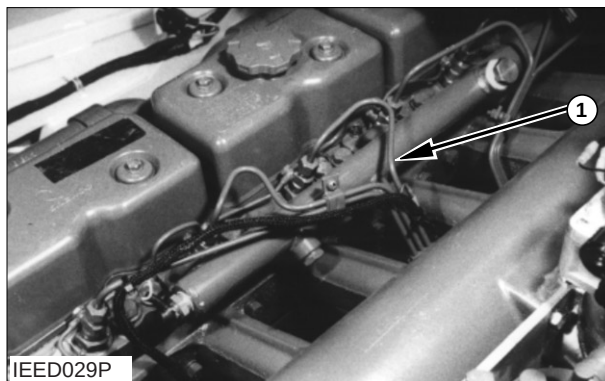
13. Install lifting bracket (4), spacer (3), washers and bolts (2) on the block.
14. Install two bolts (1) and washers.

End By :

- a. Install air compressor (if equipped).
- b. Install intake manifold.

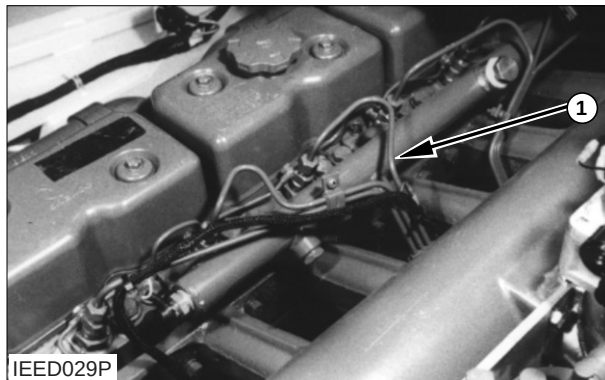
## Fuel Injection Lines

### Remove Fuel Injection Lines A23525 - 02



1. Disconnect fuel injection lines (1) from the fuel injection nozzle assemblies and the fuel injection pump.

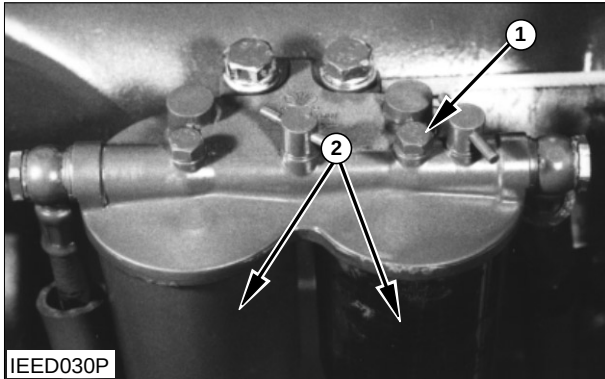
### Install Fuel Injection Lines A23525 - 03



2. Connect fuel injection lines (1) to the fuel injection pump and the fuel injection nozzle assemblies. Tighten the fuel line nuts to a torque of **16 to 20 N•m (12 to 15 lb•ft)**.

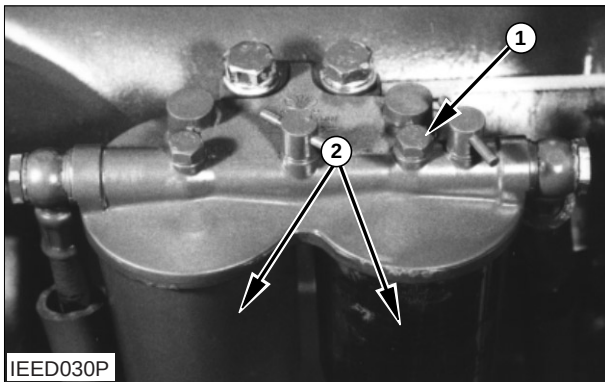
## Fuel Filter

### Remove Fuel Filter A21357SE - 02



1. Loosen bolt (1). Remove bowl (2).
2. Remove fuel filter.

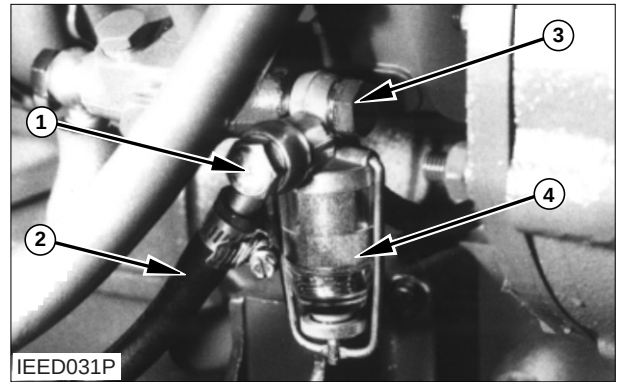
### Install Fuel Filter A21357SE - 03



1. Install a new gasket in the filter bowl.
2. Put a new fuel filter element in position.
3. Put filter bowl (2) in position and tighten bolt (1) that holds the bowl in position.

## Fuel Strainer

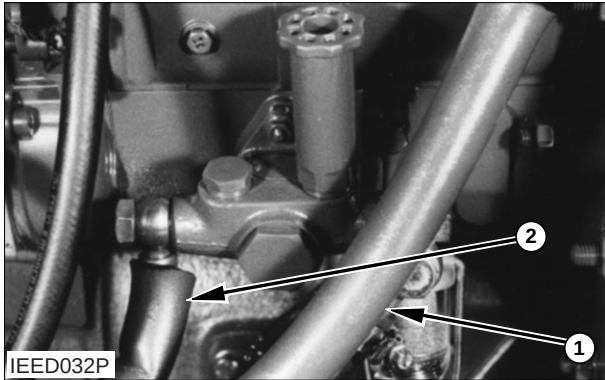
### Remove & Install Fuel Strainer A21357PR - 01



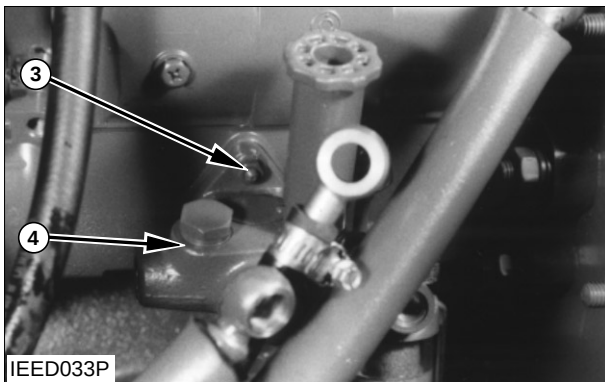
1. Remove bolt (1) and washers and disconnect fuel line (2) that connected the fuel tank.
2. Remove bolt (3), washers and fuel strainer (4) from the injection pump.
3. Install fuel strainer (4) in reverse order of removal.

## Fuel Pump

### Remove Fuel Pump A21663 - 02

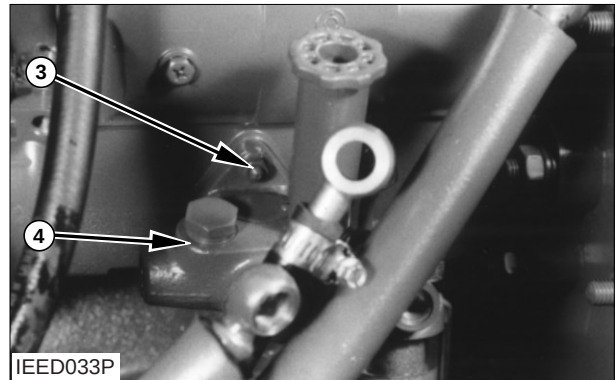


1. Disconnect fuel inlet line (1) and fuel outlet line (2) from the fuel pump.

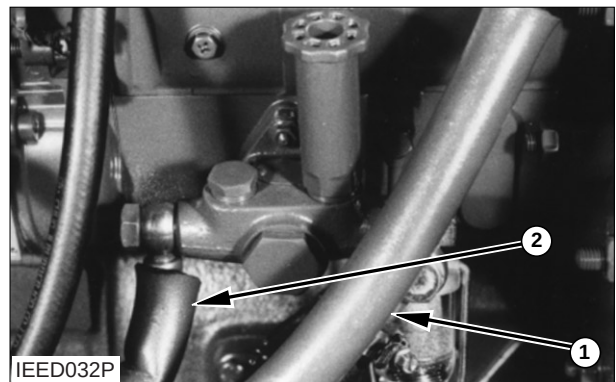


2. Remove three nuts (3) that hold fuel pump (4) to the injection pump. Remove fuel pump (4).

### Install Fuel Pump A21663 - 03



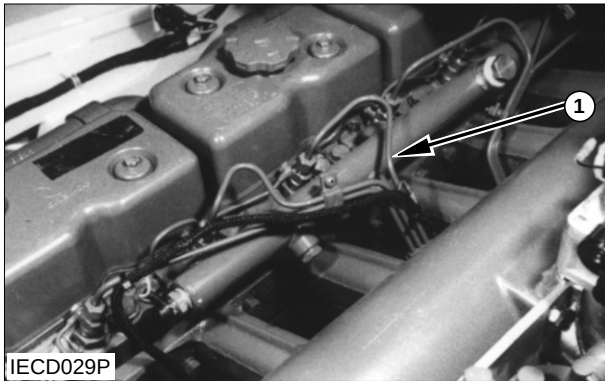
1. Put fuel pump (4) in position on the engine block with nuts (3) that hold it.



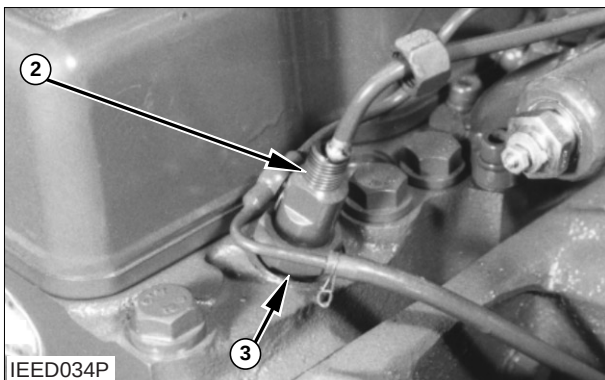
2. Connect fuel outlet line (2) and fuel inlet line (1) to the fuel pump.

## Fuel Injection Nozzle Assembly

### Remove Fuel Injection Nozzle Assembly A28999 - 02

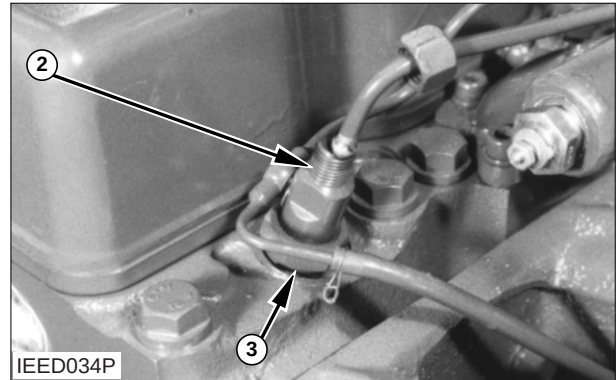


1. Disconnect fuel lines (1) from the fuel injection nozzles.

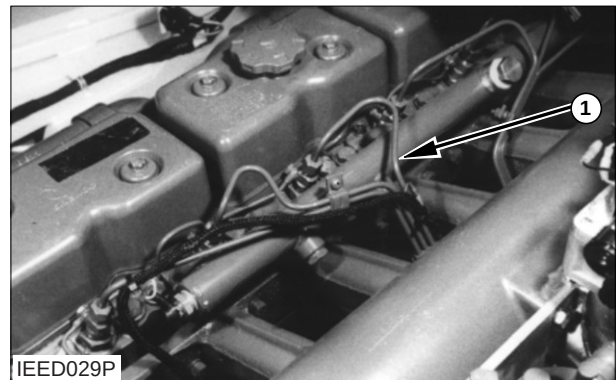


2. Remove nuts (3) and then remove fuel injection nozzles (2).
3. Remove the seals from the nozzle holders of the cylinder head and discard it.

### Install Fuel Injection Nozzle Assembly A28999 - 03



1. Install the new seal rings in the nozzle hole of the cylinder head.
2. Put fuel injection nozzles (2) in position. Install nuts (3) and tighten them to a torque of  $70 \pm 10 \text{ N}\cdot\text{m}$  ( $52 \pm 7 \text{ lb}\cdot\text{ft}$ ).

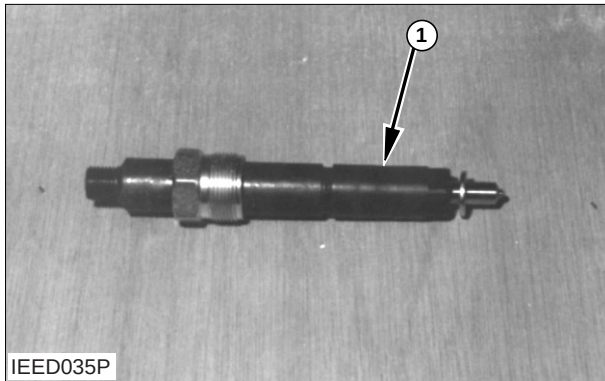


3. Connect fuel lines (1) to the injection nozzles and then tighten the nuts to a torque of  $30 \text{ N}\cdot\text{m}$  ( $22 \text{ lb}\cdot\text{ft}$ ).

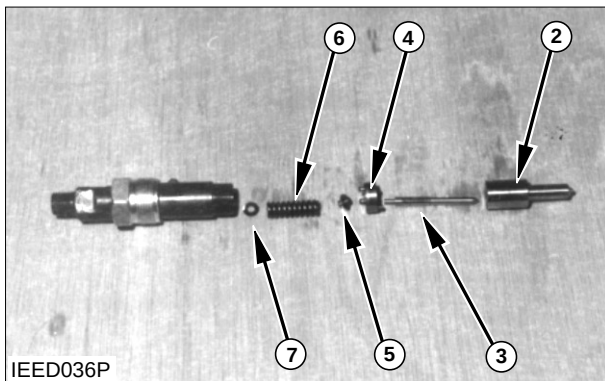
## Disassemble & Assemble Fuel Injection Nozzle Assembly A28999 - 06

Start By :

- a. Remove fuel injection nozzle assembly

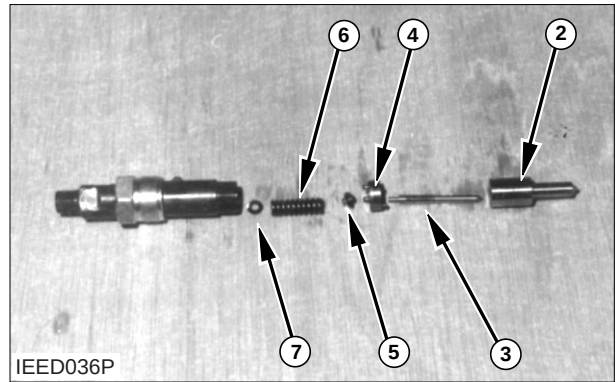


1. Remove union nut (1) from the nozzle assembly.

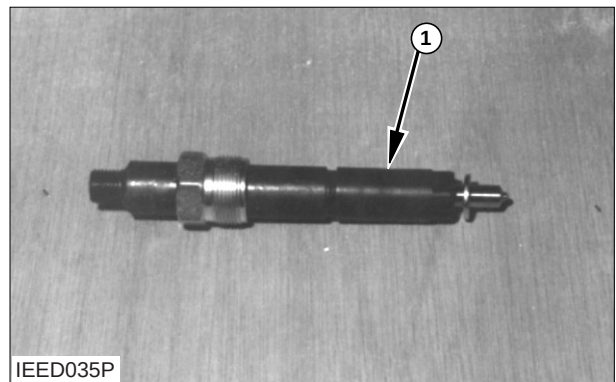


2. Remove fuel nozzle (2), needle valve (3), intermediate washer (4), guide (5), spring (6) and shims (7) from the nozzle holder.
3. Check all parts for damage. If damaged, use new parts for replacement.

**NOTE :** The following steps are for assembling the fuel injection nozzle assembly.



4. Install shims (7), spring (6), guide (5) and intermediate washer (4) to the nozzle holder.
5. Install needle valve (3) into fuel nozzle (2) and install the fuel nozzle.



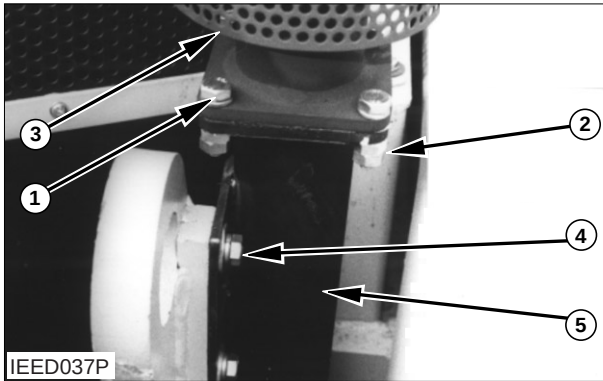
6. Install union nut (1) and tighten to a torque of  $70 \pm 10 \text{ N}\cdot\text{m}$  ( $52 \pm 7 \text{ lb}\cdot\text{ft}$ ).

End By :

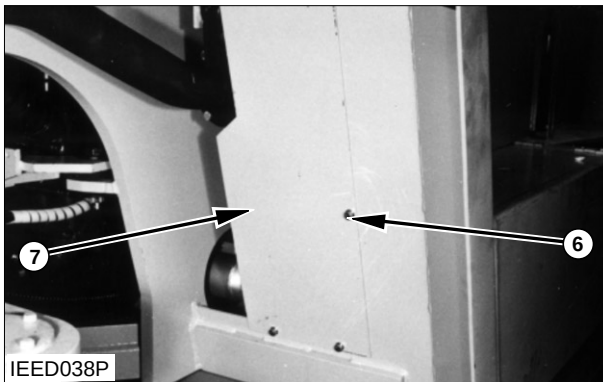
- a. Install fuel injection nozzle assembly.

## Muffler

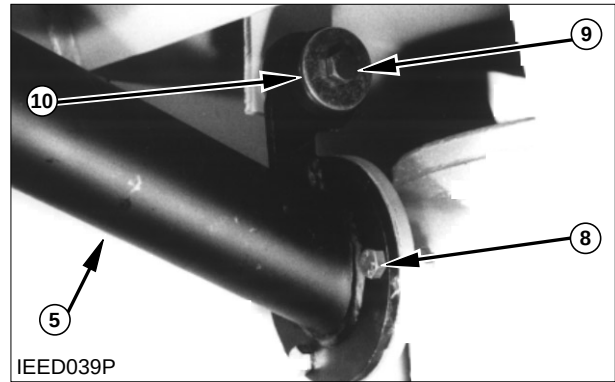
### Remove Muffler A32570 - 02



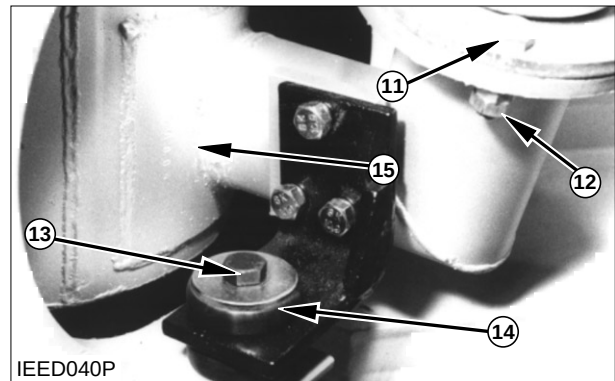
1. Remove four bolts (1), washers and nuts (2) that hold muffler tube assembly (3) on tube assembly (5).
2. Remove two bolts (4) and washers that hold tube assembly (5) on the frame.



3. Remove five bolts (6), washers and cover (7) from the frame.

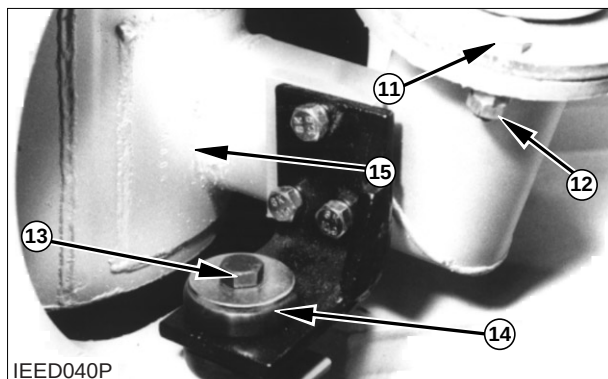


4. Remove three bolts (8), washers and nuts.
5. Support tube assembly (5) and remove bolt (9), washers, rubber mounts (10), shims and nuts that hold tube assembly (5) on the frame. Remove tube assembly (5).



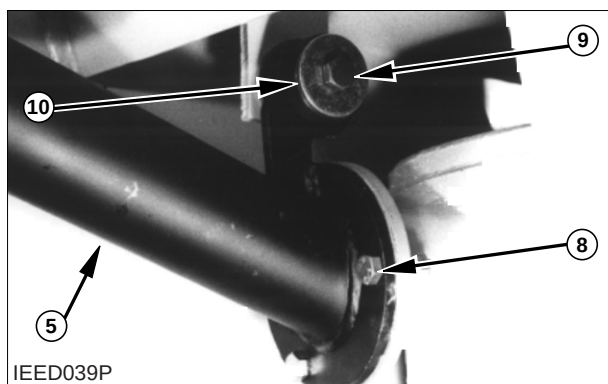
6. Remove three bolts (11), washers and nuts (12).
7. Remove bolt (13), washers, rubber mounts (14), shims and nuts that hold mount bracket of muffler assembly (15) on the frame. Remove muffler assembly (15).

## Install Muffler A32570 - 02



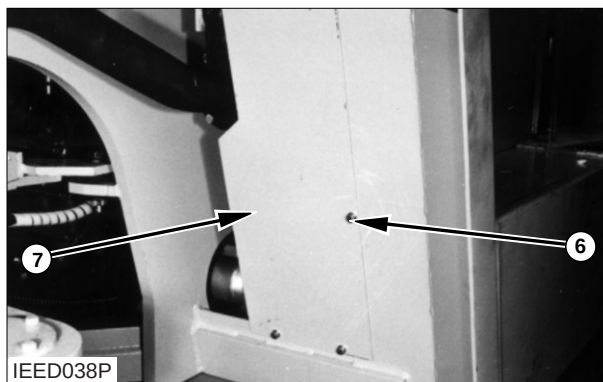
1. Put the muffler assembly (15) in position on the frame. Install bolt (13), washers, rubber mounts (14), shims and nuts that hold muffler assembly (15) on the frame. Tighten bolt (13) to a torque of **75~90 N•m (55 ~ 65 lb•ft)**.

2. Install three bolts (11), washers and nuts (12).

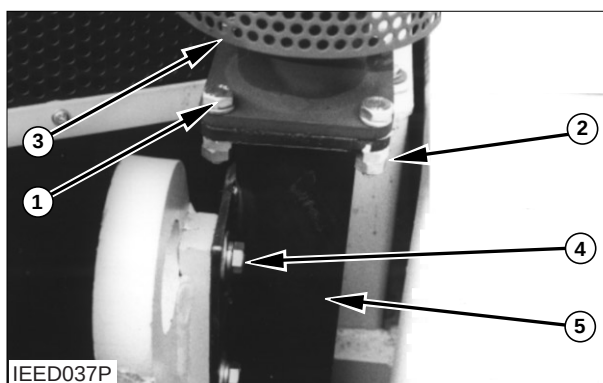


3. Put the tube assembly (5) in position in place. Install three bolts (8), washers and nuts.

4. Install bolt (9), washers, rubber mounts (10), shims and nuts that hold tube assembly (5) to the frame. Tighten bolt (9) to a torque of **75 ~ 90 N•m (55 ~ 65 lb•ft)**.



5. Install five bolts (6), washers and cover (7) to the frame.

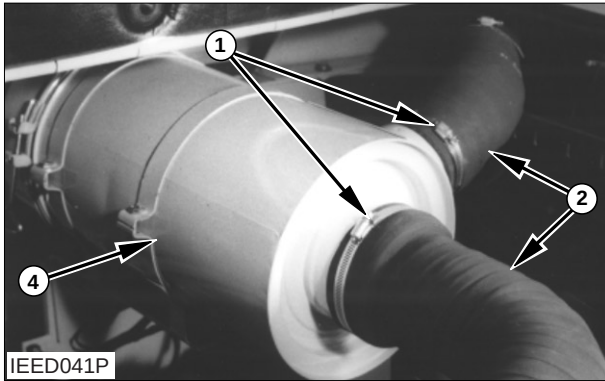


6. Install two bolts (4) and washers that hold tube assembly (5) on the frame.

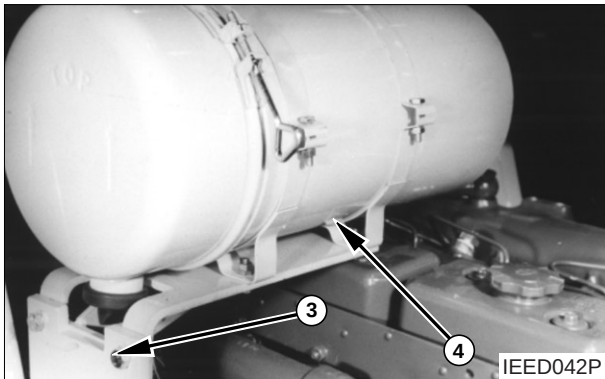
7. Put muffler tube assembly (3) in position on tube assembly (5). Install bolts (1), washers and nuts that hold muffler tube assembly (3).

## Air Cleaner Assembly

### Remove Air Cleaner Assembly A31999 - 02

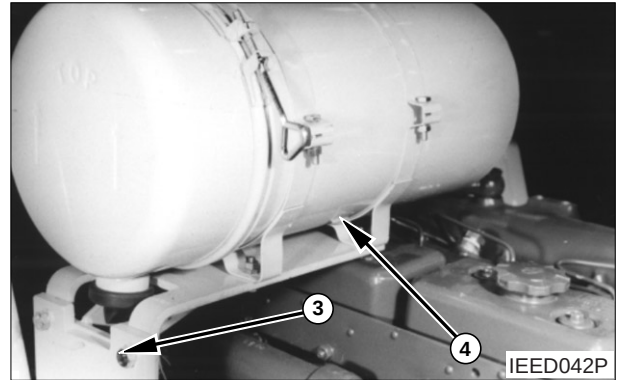


1. Loosen hose clamps (1) and disconnect hoses (2) from air cleaner (4).

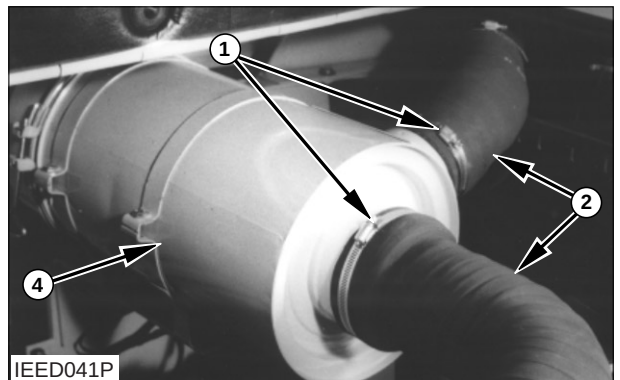


2. Remove bolts (3) and nuts, and then remove air cleaner assembly (4).

### Install Air Cleaner Assembly A31999 - 03



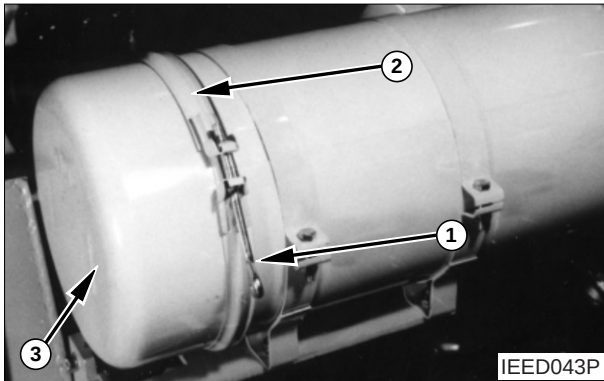
1. Put air cleaner assembly (4) in position and install bolts (3) and nuts that hold it. Tighten bolts (3) to a torque of **55 ~ 65 N·m (40 ~ 45 lb·ft)** with Loctite No. 242.



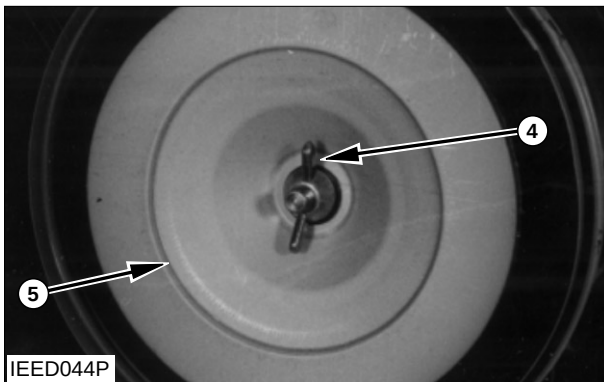
2. Install hoses (2) and tighten all hose clamps (1).

## Air Cleaner Elements

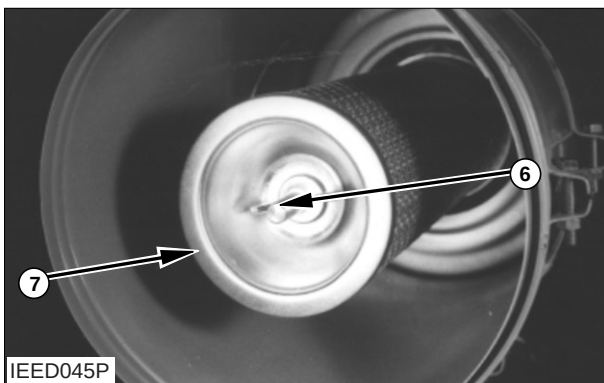
### Remove Air Cleaner Elements A31330 - 02



1. Loosen bolt (1) and remove clamp (2) and element cover (3)

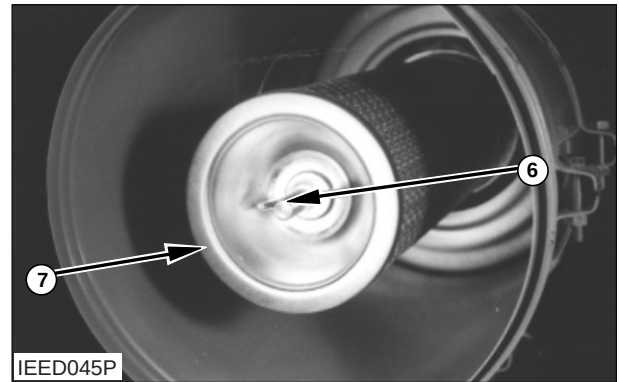


2. Remove nut (4) and outer filter element (5) from the cleaner assembly.

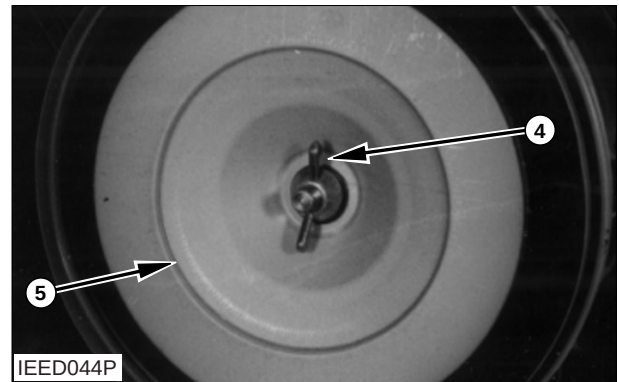


3. Remove nuts (6) and then remove inner filter element (7) from the cleaner assembly.

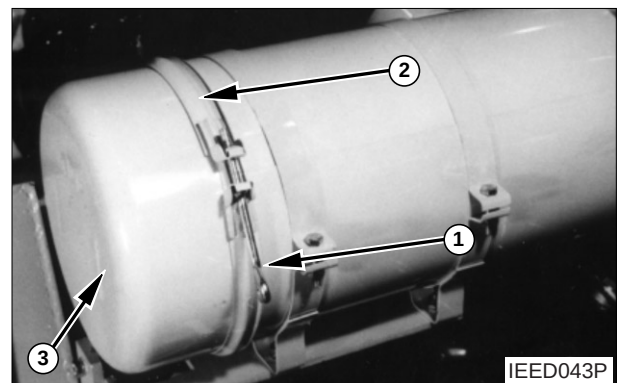
### Install Air Cleaner Elements A31330 - 03



1. Put inner element filter (7) in position inside the cleaner assembly and then install nut (6) that hold it.



2. Install outer filter element (5) in position and install nut (4) that hold it.



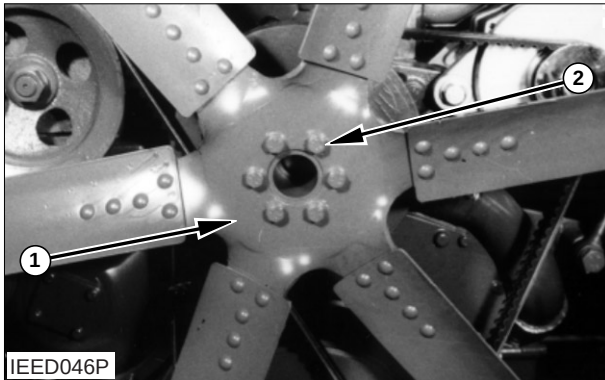
3. Install element cover (3) with the clamp (2) that hold it and tighten the bolt (1).

## Fan Assembly

### Remove Fan Assembly A51342 - 02

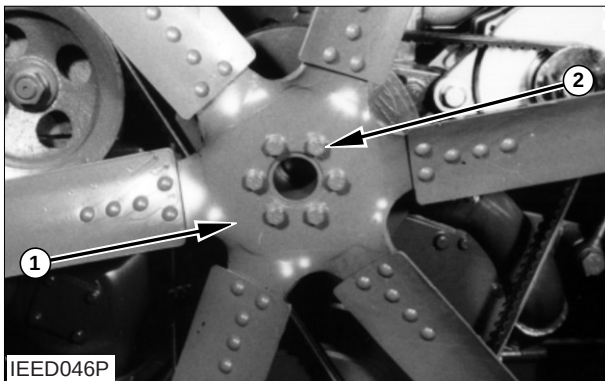
Start By :

- a. Remove radiator



1. Remove six bolts (2) and then remove fan assembly (1).

### Install Fan Assembly A51342-03

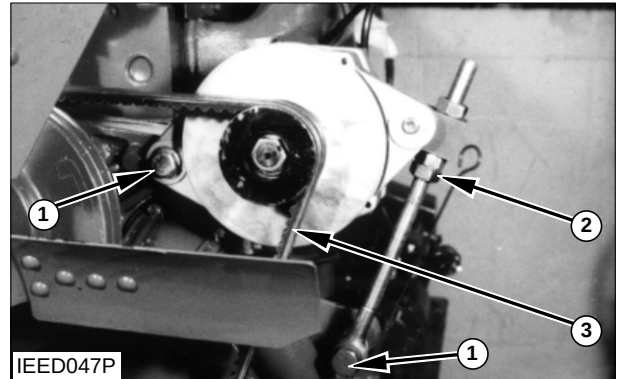


1. Put the fan assembly (1) in position and install the six bolts (2) that hold it.

End By :

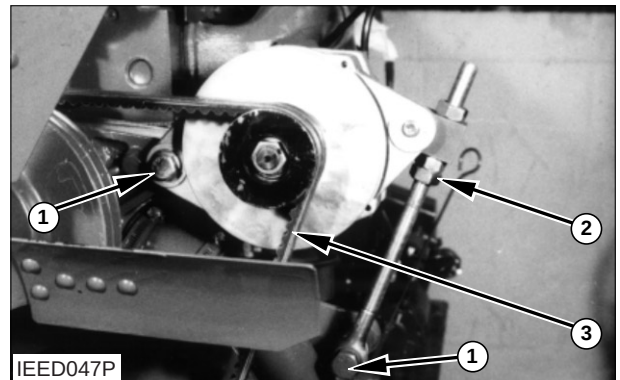
- a. Install radiator

### Remove Fan Belts A51087 - 02



1. Loosen bolts (1) and nuts (2) on the alternator bracket and idle pulley. Move the alternator in toward the engine. Remove belt (3).

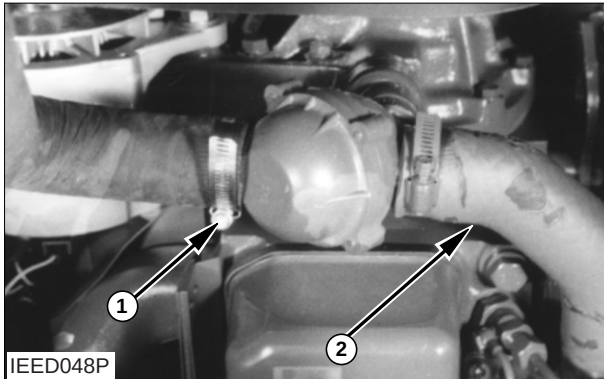
### Install Fan Belts A51087 - 03



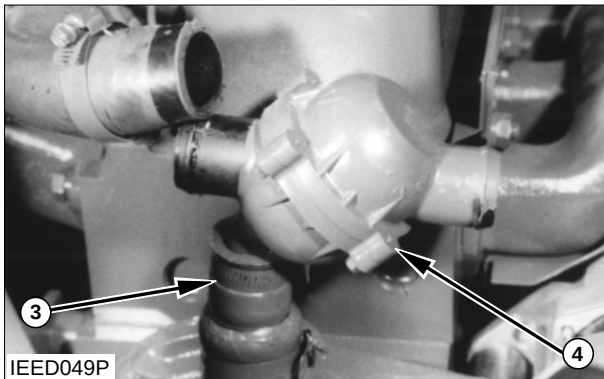
1. Put belt (3) in position on the pulleys. Move the alternator away from the engine to tighten the belt. Tighten bolts (1) and nuts (2). See Specifications for the correct belt tension.

## Water Temperature Regulator

### Remove Water Temperature Regulator A56581 - 02

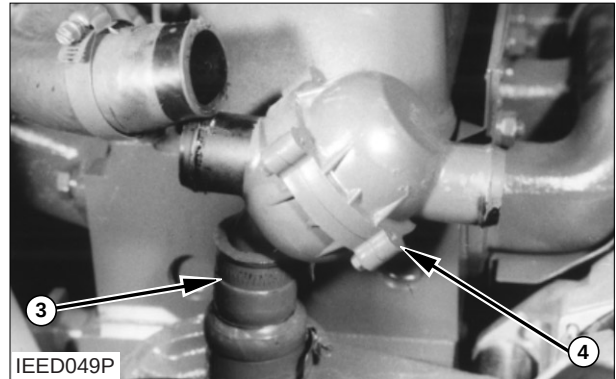


1. Drain the coolant below the level of the water temperature regulator.
2. Loosen clamps (1) to disconnect two hoses (2) from the regulator.

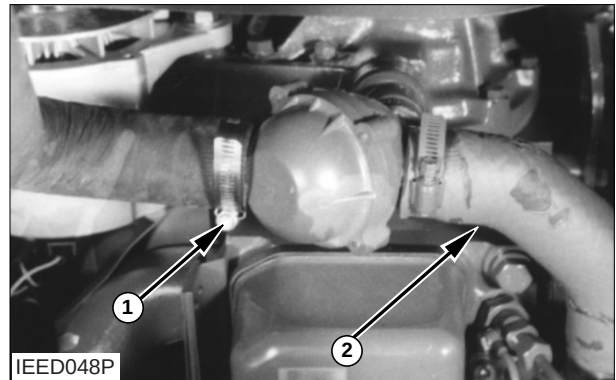


3. Loosen clamp (3) and remove water temperature regulator (4).

### Install Water Temperature Regulator A56581 - 03



1. Put water temperature regulator (4) in position as shown.



2. Put water temperature regulator (4) in place and connect hoses (2).
3. Tighten the hose clamps (1).
4. Fill the cooling system. See Maintenance Guide for the correct level.

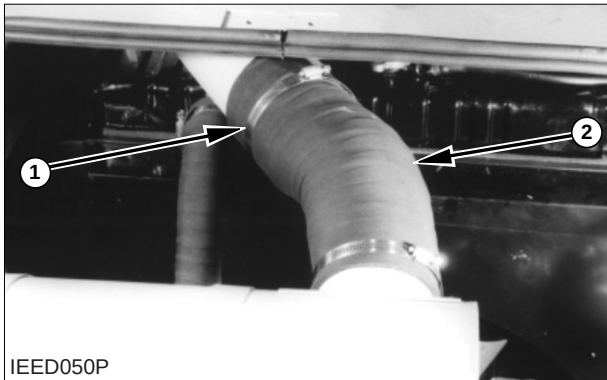
# Radiator

## Remove Radiator A52670 - 02

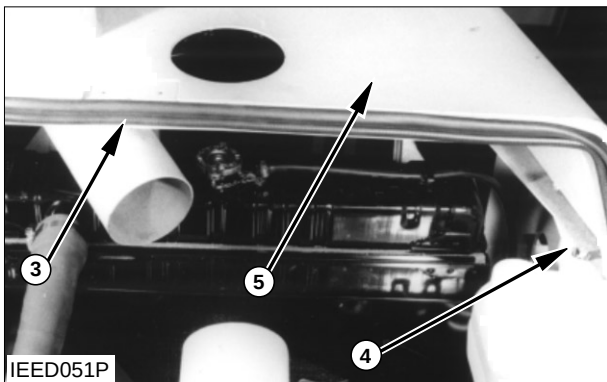
| Tools Needed | A |
|--------------|---|
| Link Bracket | 2 |

Start By :

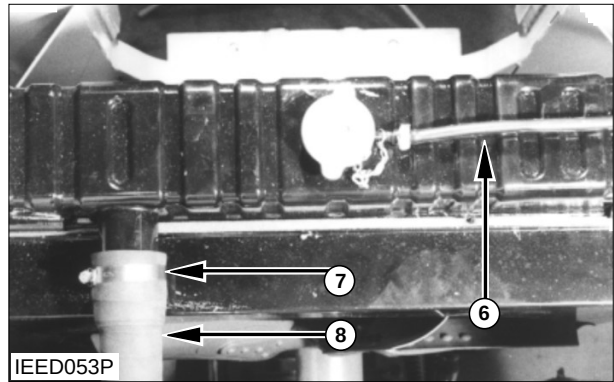
a. Remove hood



1. Drain the coolant from the radiator.
2. Loosen clamps (1) and remove air cleaner hose (2).



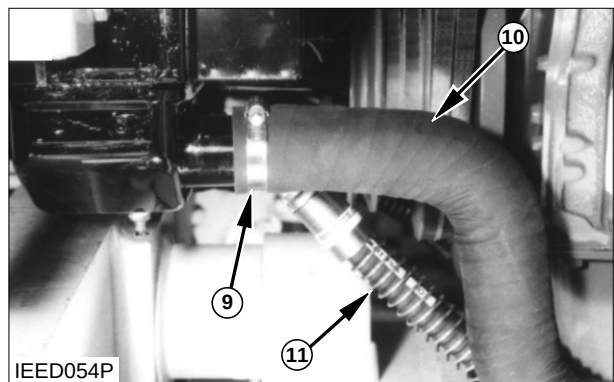
3. Remove strap (3) from top cover (5).
4. Remove four bolts (4) and washers that hold top cover (5) on the frame. Remove top cover (5) from the frame.



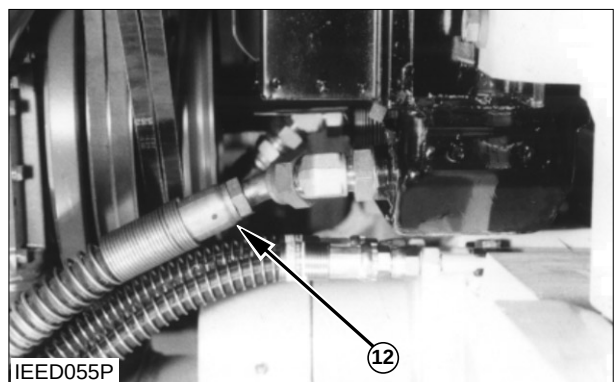
5. Disconnect over flow hose (6) from the radiator.
6. Loosen hose clamp (7) and disconnect top radiator hose (8).

### NOTICE

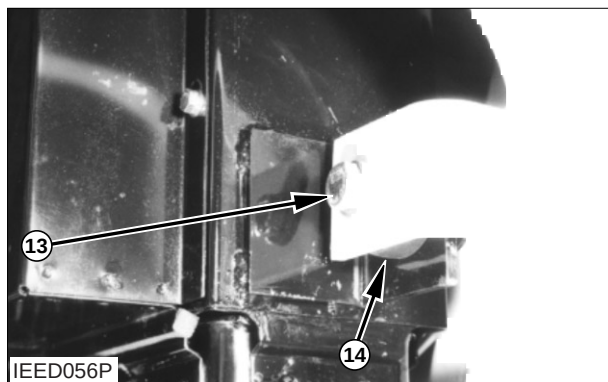
Plug and cap all cooling hoses to avoid debris from entering the system.



7. Loosen hose clamp (9) and disconnect hose (10).
8. Disconnect transmission cooling hose (11) from the radiator.

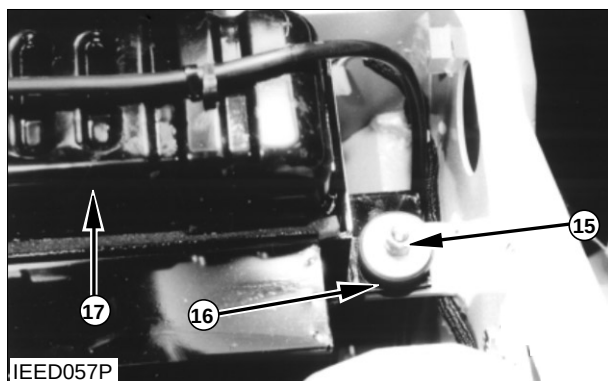


9. Disconnect transmission cooling hose (12) from the radiator.



10. Install tool (A) and fasten a hoist.

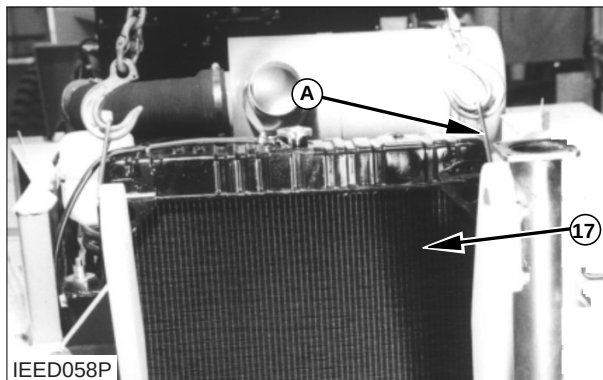
11. Remove bolts (13), washers, rubbers (14), shims and bolt that hold the radiator on the frame (both side).



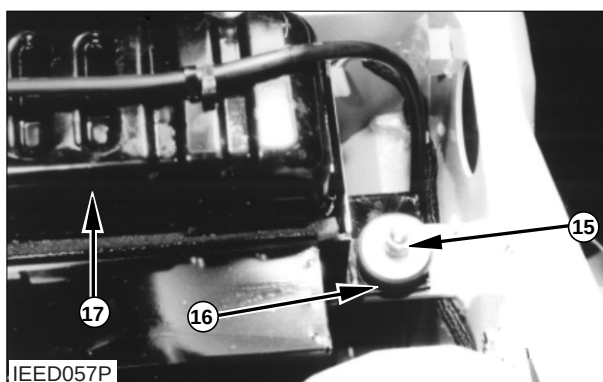
12. Remove nuts (15), washers, rubbers (16), shims and bolt that hold radiator (17) on the frame (both side). Remove radiator (17) from the lift truck.

## Install Radiator A52670 - 03

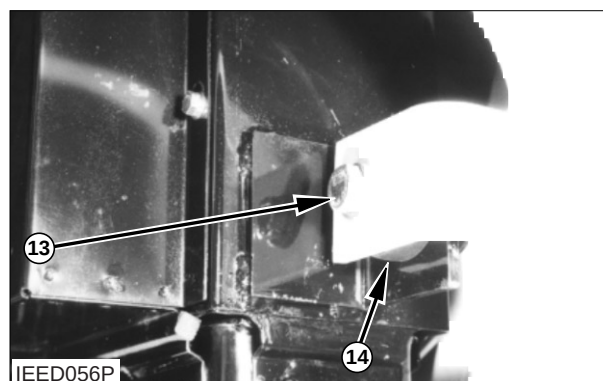
| Tools Needed | A |
|--------------|---|
| Link Bracket | 2 |



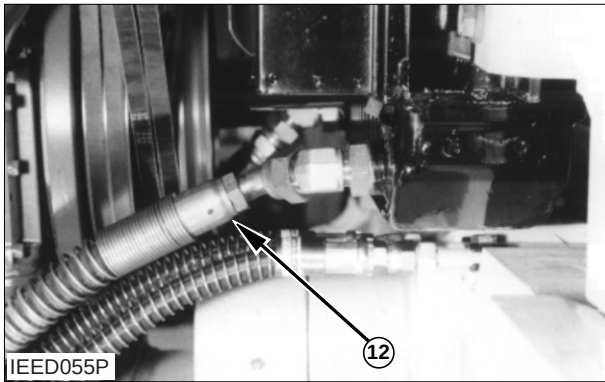
1. Install tool (A) and fasten a hoist as shown. Put radiator (17) in position on the lift truck.



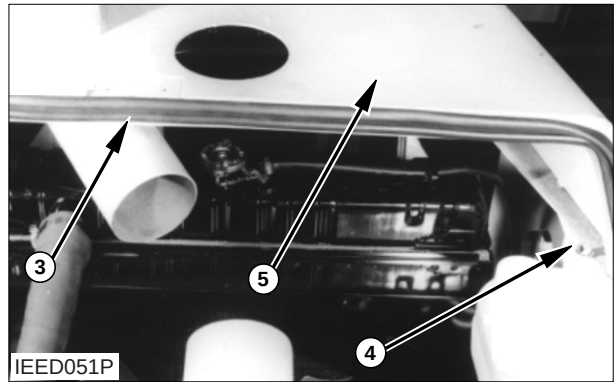
2. Install bolt, shims, rubbers (16), washers and nuts (15) that hold radiator (17) on the frame. Tighten nuts (15) and bolt to a torque of  $75 \sim 90 \text{ N}\cdot\text{m}$  ( $55 \sim 65 \text{ lb}\cdot\text{ft}$ ).



3. Install bolt, shims, rubbers (14), washers and nuts (13) that hold the radiator on the frame. Tighten nuts (13) and bolt to a torque of  $75 \sim 90 \text{ N}\cdot\text{m}$  ( $55 \sim 65 \text{ lb}\cdot\text{ft}$ ).

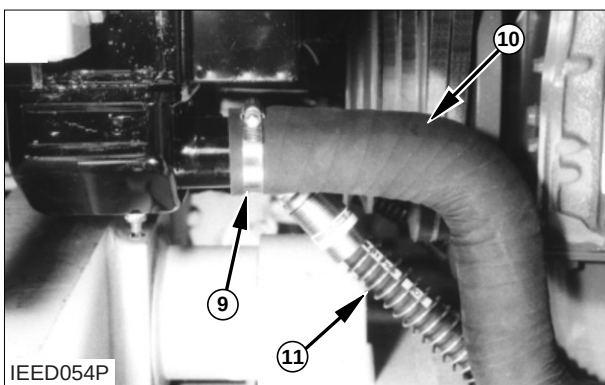


4. Connect transmission cooling hose (12) on the radiator.



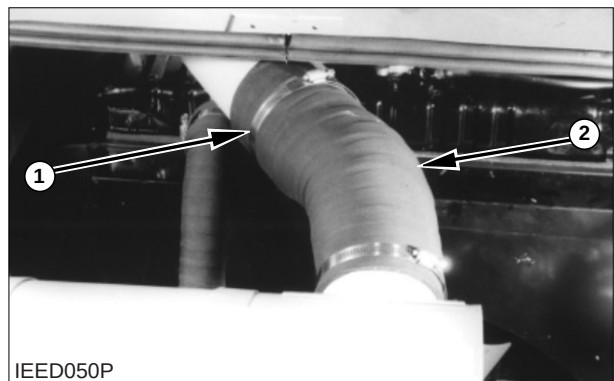
9. Put top cover (5) in position on the frame. Install bolts (4) and washers that hold top cover (5) on the frame.

10. Install strap (3).



5. Connect hose (10) on the radiator and tighten hose clamp (9).

6. Connect transmission cooling hose (11) on the frame.

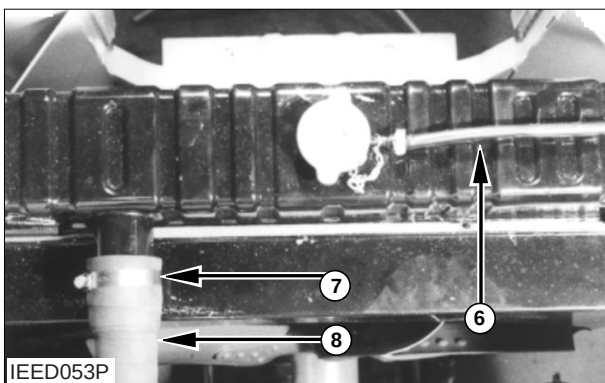


11. Install air cleaner hose (2) and tighten hose clamps (1).

12. Fill the cooling system. See the Maintenance Guide for the correct level.

End By :

- a. Install hood.



7. Connect top radiator hose (8) and tight hose clamp (7).

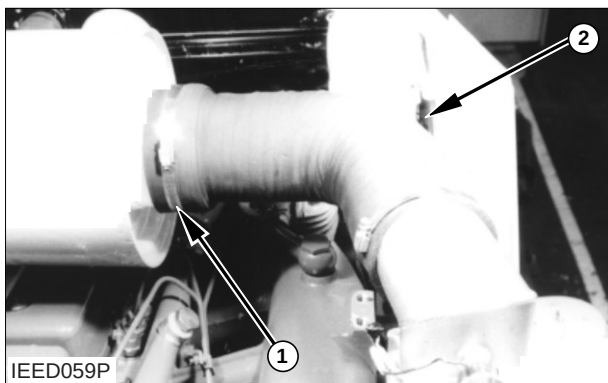
8. Connect radiator overflow hose (6).

## Intake Manifold

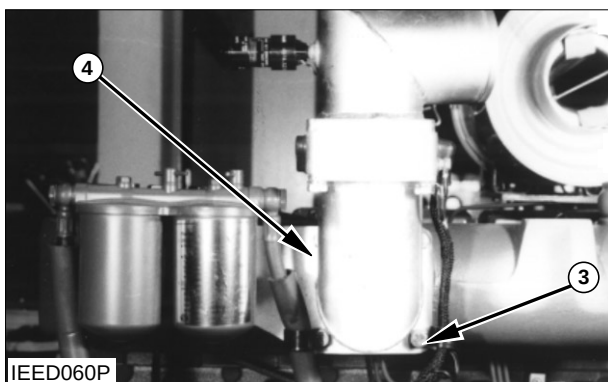
### Remove Intake Manifold A325491N - 02

Start By :

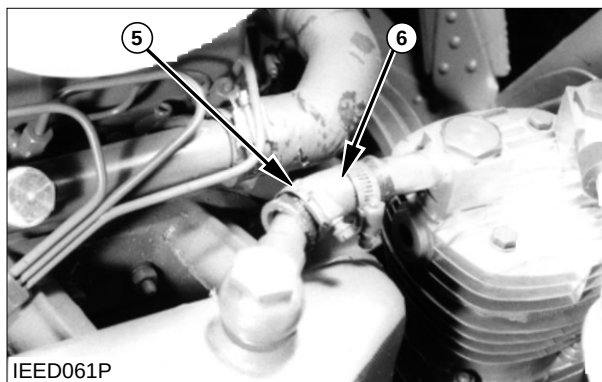
a. Remove hood



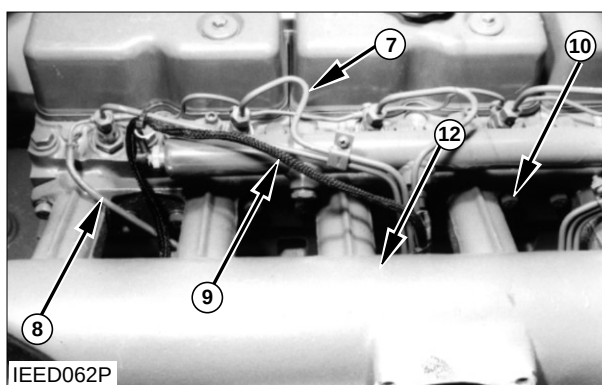
1. Loosen hose clamps (1) and remove air cleaner outlet hose (2).



2. Remove four bolts (3), washers and mount bracket and fuel filter assembly (4) from the intake manifold. Set the mount bracket and fuel filter assembly aside to the frame.



3. Loosen clamp (5) and disconnect hose (6) from the air compressor (if equipped).



4. Remove six nozzle pipes (7) and disconnect fuel return hose (8).

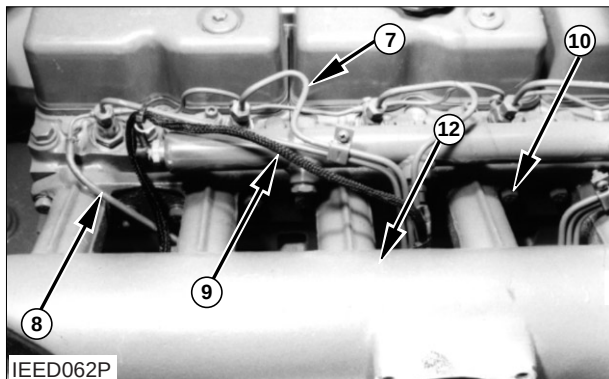
5. Disconnect cooling temperature harness (9) from the cooling water pipe.

6. Support intake manifold (12) with fasten a strap. Remove ten bolts (10), washers and two nuts that hold intake manifold (12) to the cylinder head.

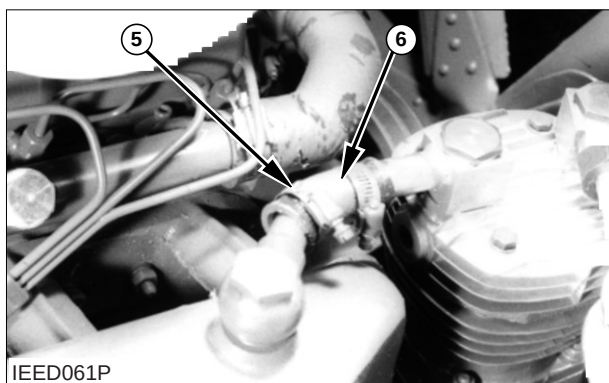
7. Remove intake manifold (12).

8. Remove the intake manifold gasket and discard it.

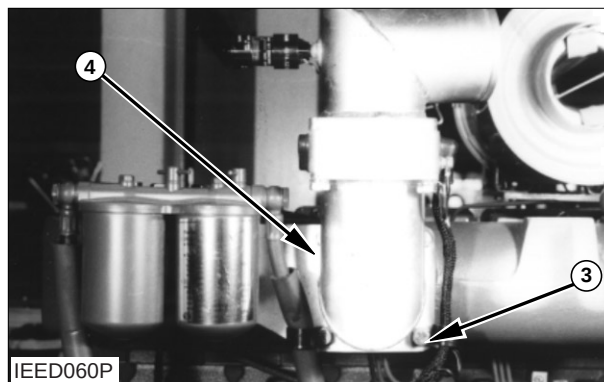
## Assemble Intake Manifold A325491N - 03



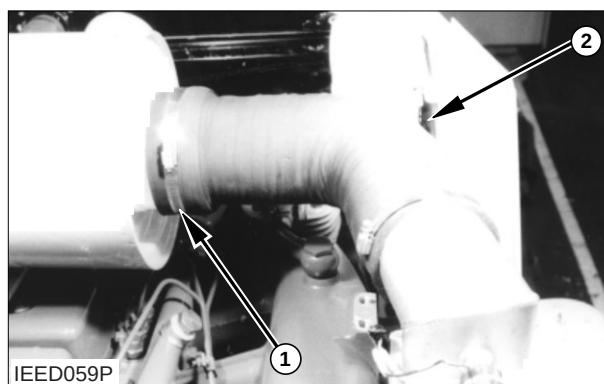
1. Install new intake manifold gasket on the cylinder head by aligning its openings with the intake port in the cylinder head.
2. Put the intake manifold (12) in position on the cylinder head. Install bolts (10), washers and nuts that hold intake manifold (12).
3. Connect fuel return hose (8) and install six nozzle pipes (7).
4. Connect cooling temperature harness (9).



5. Connect hose (6) to the air compressor (if equipped) and tighten clamp (5).



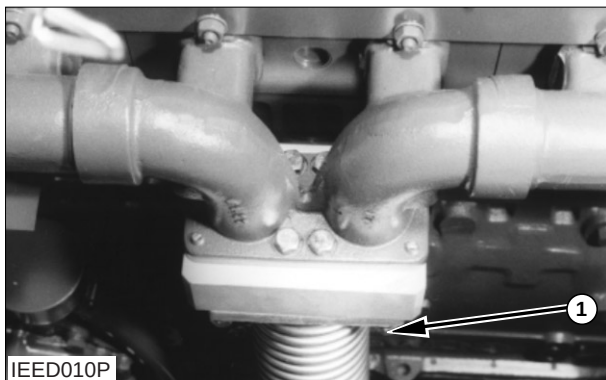
6. Put the mount bracket and fuel filter assembly (4) in position on the intake manifold. Install bolts (3) and washers that hold the mount bracket and fuel filter assembly (4).



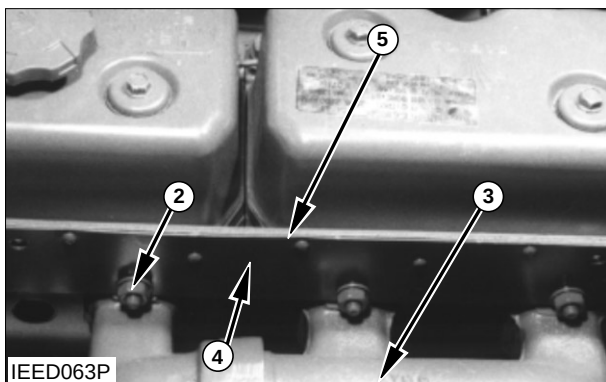
7. Install air cleaner outlet hose (2) and tighten hose clamps (1).

## Exhaust Manifold

### Remove Exhaust Manifold A32549ES - 02

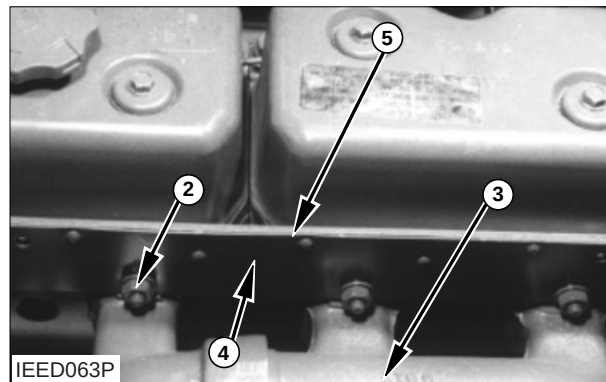


1. Remove four bolts (1) and washers from the exhaust manifold.

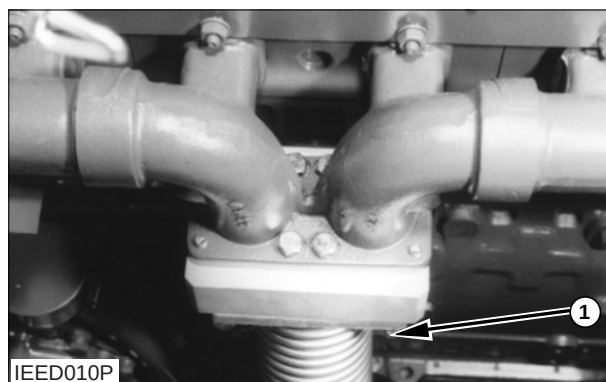


2. Remove twelve nuts (2) and washers that hold the exhaust manifold on the cylinder head. Remove exhaust manifold (3), heat screens (4) and gaskets from the cylinder head.

### Install Exhaust Manifold A32549EX - 03



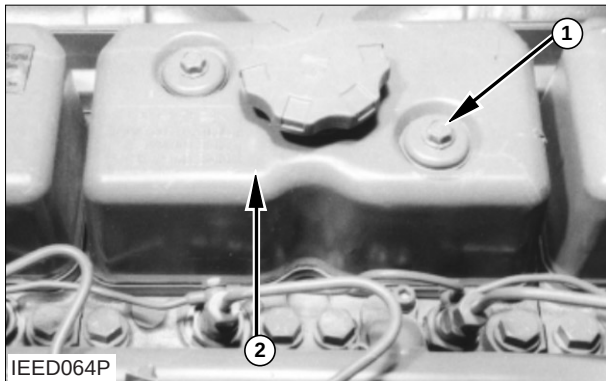
1. Check the seal ring on the jointing face of the exhaust manifold and replace it if needed.
2. Put the new gaskets, heat screens (4 and 5) and exhaust manifold (3) in position on the cylinder head. Install nuts (2) and washers that hold the exhaust manifold. Tighten nuts (2) to a torque of **45 N•m (33 lb•ft)**.



3. Install eight bolts (1) and washers.

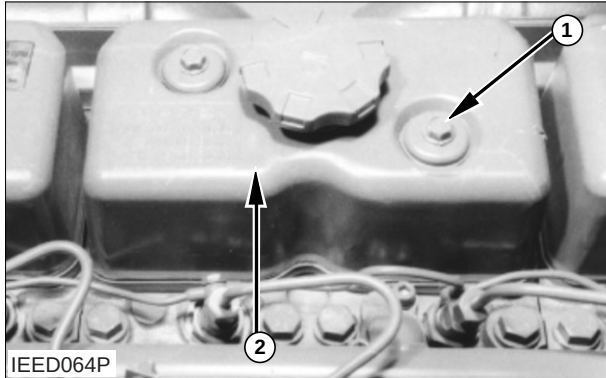
## Cylinder Head Cover

### Remove Cylinder Head Cover



1. Remove bolts (1) and washers that hold cylinder head cover (2) onto the cylinder head.
2. Remove cylinder head cover (2) with gasket. Inspect the cylinder head cover gasket for wear or damage and replace if required.

### Install Cylinder Head Cover

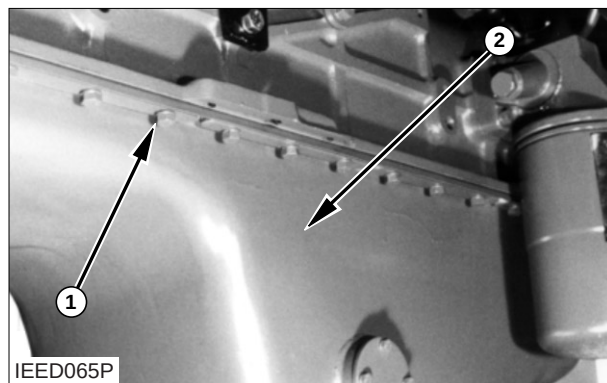


1. Fix the new gasket to the jointing face of cylinder head cover (2).
2. Position cylinder head cover (2) on the cylinder head, then install bolts (1) and tighten them torque to **20 N•m (15 lb•ft)**.

## Oil Pan

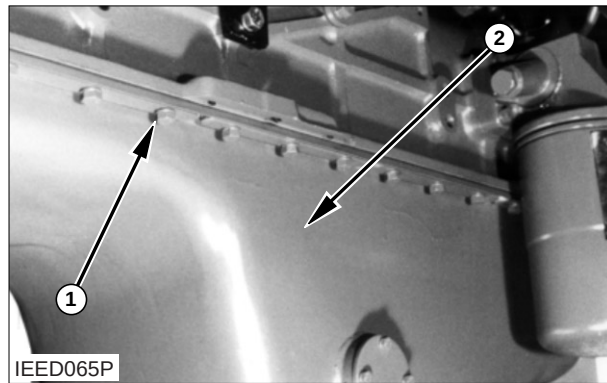
### Remove Oil Pan A43591-02

1. Put the lift truck in position up on the blocks.
2. Drain the oil from the oil pan (2).



3. Remove all bolts (1) and washers from around the oil pan and then remove oil pan (2) from the engine block. Check gasket for damage.

### Install Oil Pan A43591-03



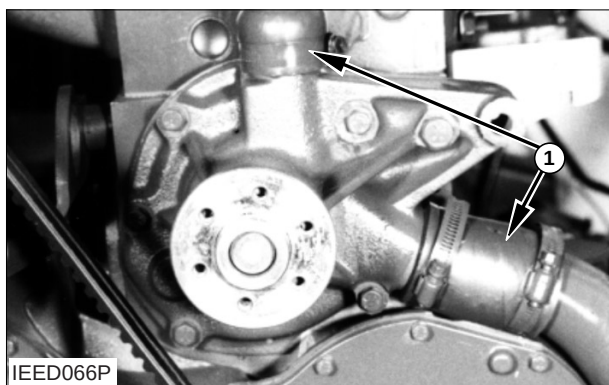
1. Remove the gasket residue on the fixing surface of the timing gear case, case cover and the cylinder block using a scraper.
2. Coat the new gasket fixing surface with silicon grease.
3. Put a new gasket in position on oil pan if necessary. Put oil pan (2) in position on the engine with bolts (1) and washers that hold it. Tighten the bolts (1) to a torque of **20 N•m (15 lb•ft)**.
4. Fill the engine with oil to the correct level. See the operation And Maintenance Manual for further information.
5. Remove the lift truck from the blocks.

## Water Pump

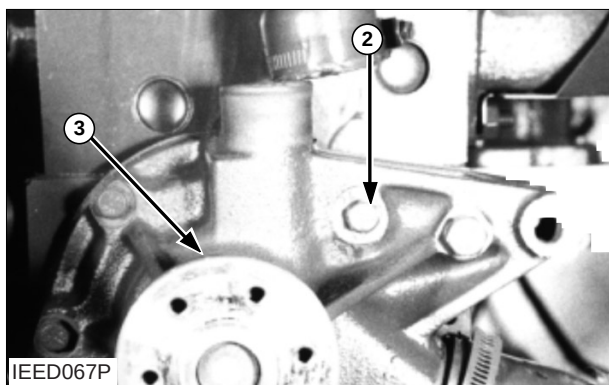
### Remove & Install Water Pump A53663-01

Start By :

- a. Remove fan assembly
- b. Remove radiator
- c. Remove alternator

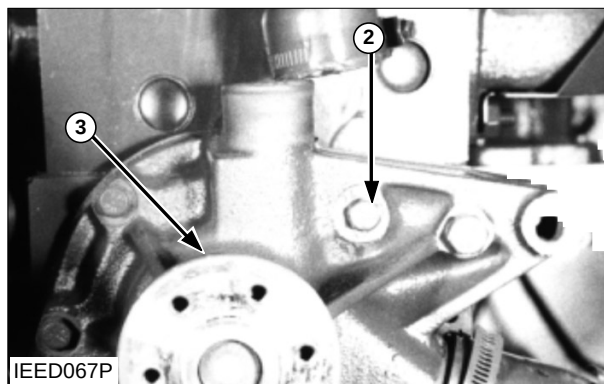


1. Remove hose (1) from the water pump.

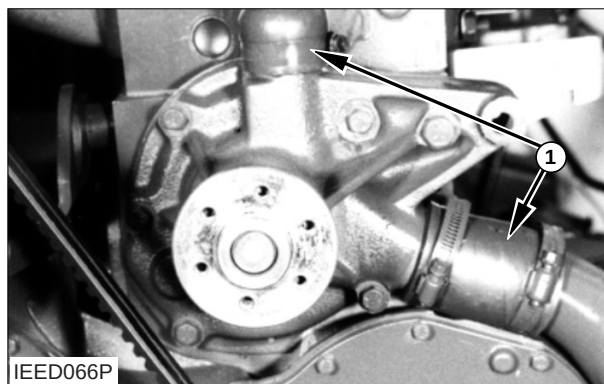


2. Remove six bolts (2) and washers that hold water pump (3) on the engine.
3. Remove water pump (3) from the engine.
4. Remove the gasket and discard it.

**NOTE :** Use the following steps to install the water pump.



5. Install the new gasket on the engine.
6. Put water pump (3) in position and install bolts (2) and washers that hold it. Tighten bolts (2) to a torque of **20 N • m (15 lb • ft)**.



7. Connect hose (1) to the water pump.

End By :

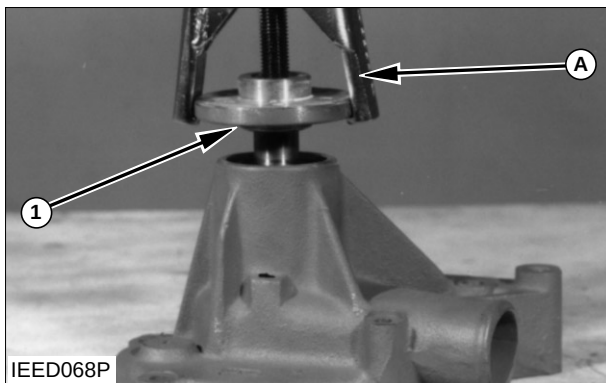
- a. Install fan assembly.
- b. Install alternator.
- c. Install radiator.

## Disassemble Water Pump A53663-07

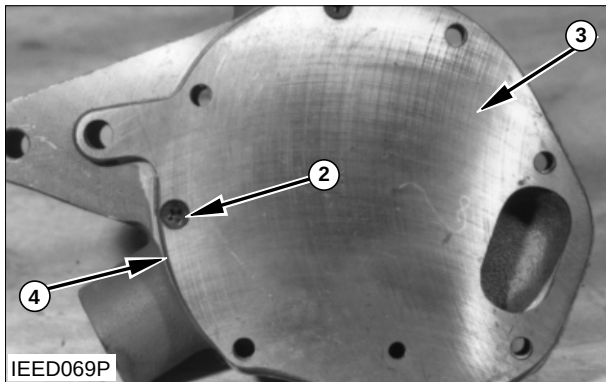
| Tools Needed | A | B | C |
|--------------|---|---|---|
| Gear Puller  | 1 |   |   |
| Pliers       |   | 1 |   |
| Drive Group  |   |   | 1 |

Start By :

### a. Remove water pump



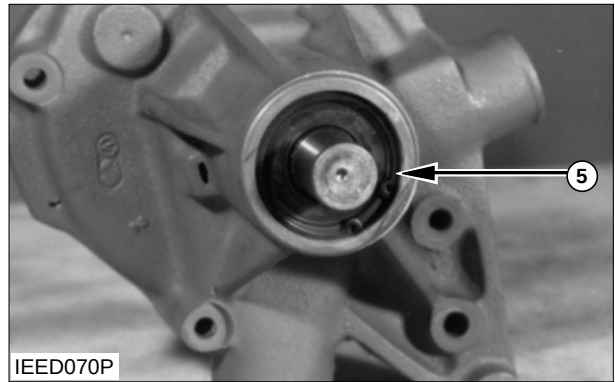
1. Remove flange (1) using tool (A).



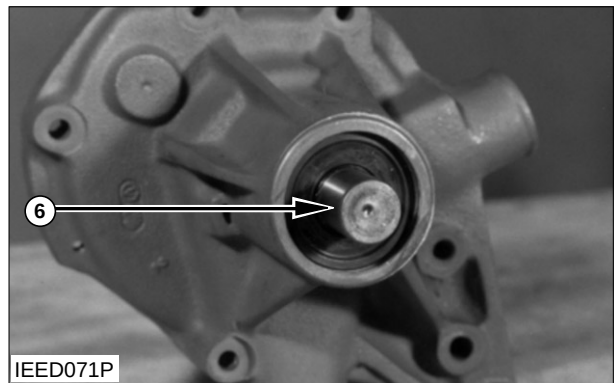
2. Remove three screws (2) that hold pump cover (3) on the pump housing.

**NOTE :** Before unscrewing the screws (2) slight impacts on them are necessary to loosen the loctite connection.

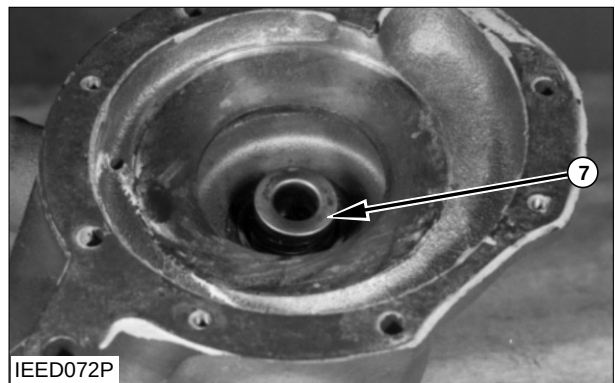
3. Remove pump cover (3) and gasket (4) and discard it.



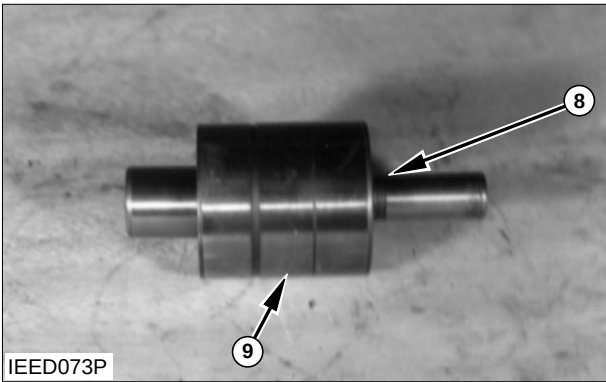
4. Remove snap ring (5) with tool (B).



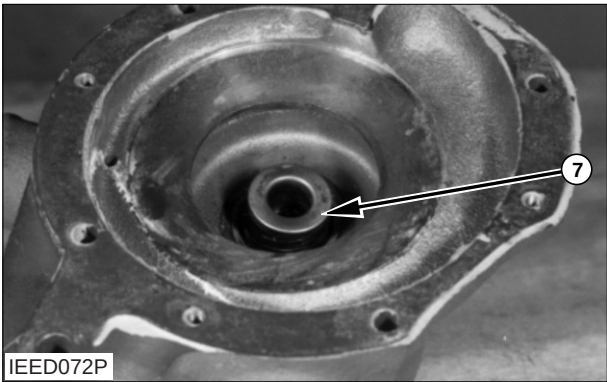
5. Put the water pump in position on a press. Install tool (C) and remove shaft assembly (6) from the impeller and the water pump housing.



6. Remove seals (7) from the water pump housing if they are damaged.



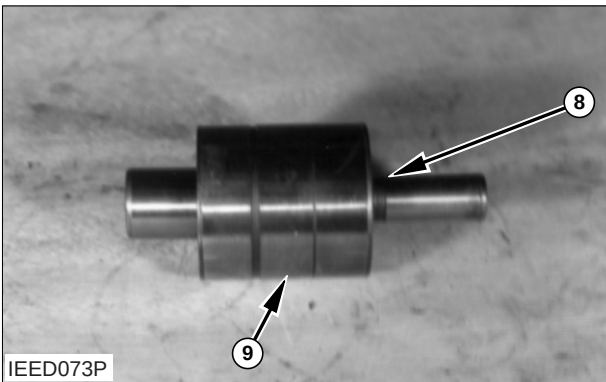
7. Put shaft assembly (8) in position in a press. Install Tool (A) to remove bearing (9) from the shaft.



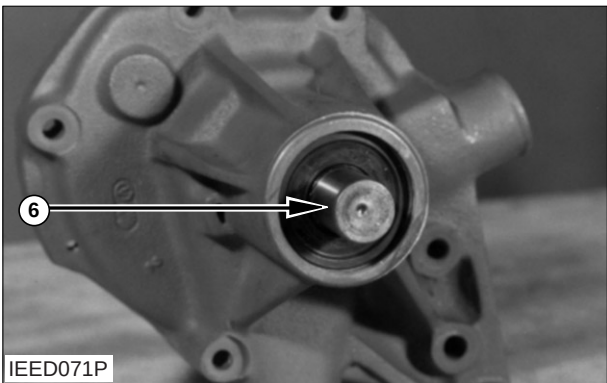
2. Install seal (7) in the housing.

Assemble Water Pump A53663

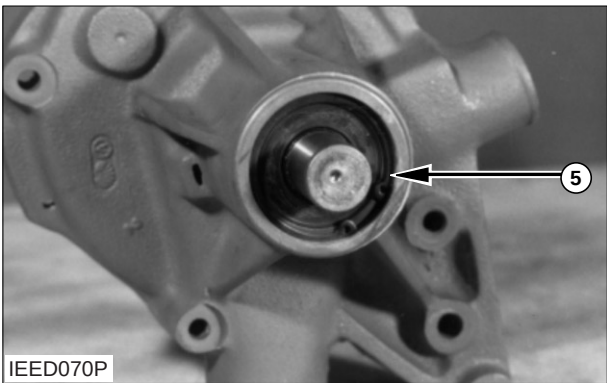
| Tools Needed | A | B |
|--------------|---|---|
| Pliers       | 1 |   |
| Drive Group  |   | 1 |



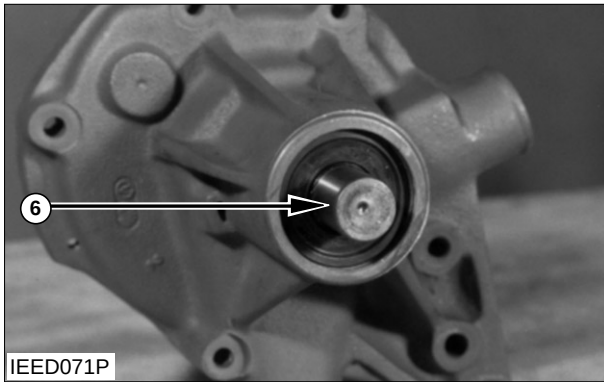
1. Put shaft bearing (9) in position in a press. Make sure there is support for the inner race of the bearing. Push shaft into bearing (9).



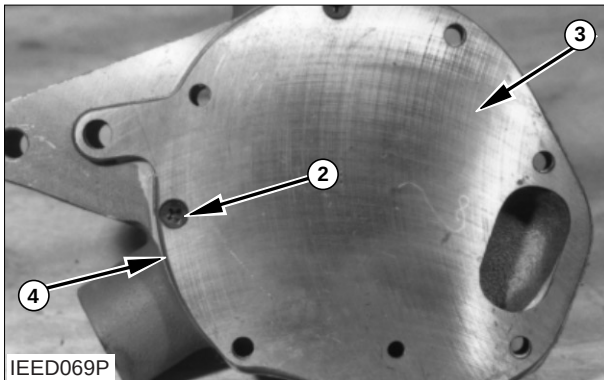
3. Put the water pump housing in position on a press and install shaft assembly (6) in the housing.



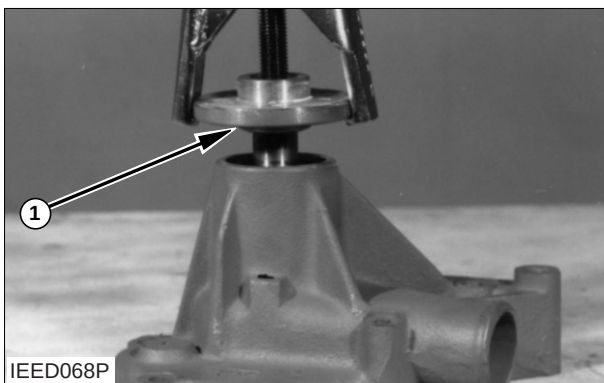
4. Install snap ring (5) over the bearings with tool (A).



5. Install impeller (10) on the shaft with tool (B) and a press. The clearance between the impeller blade and pump body have not to exceed **0.35 mm (.0138 in)**.



6. Install cover (3) and gasket (4) on the pump housing.
7. Install three screws (2) that hold cover (3). Tighten the screws (2) to a torque of **22 N • m (16 lb • ft)**.



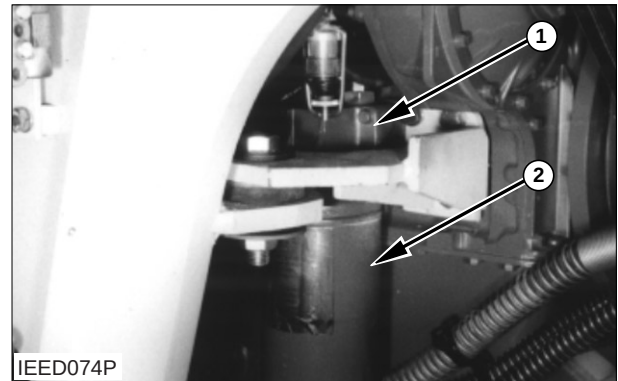
8. Install flange (1) on the shaft with tool (B) and a press.

End By :

- a. Install water pump.

## Oil Filter

### Remove & Install Oil Filter A42357-01



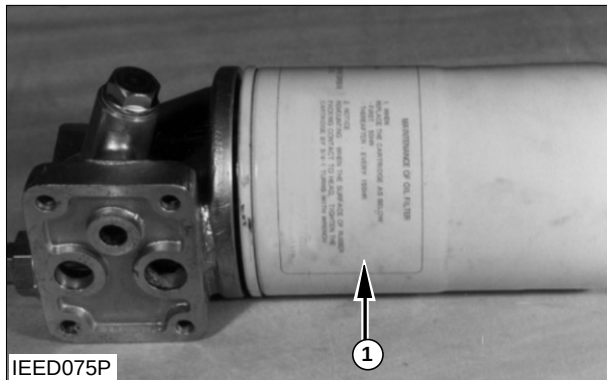
1. Remove four bolts (1) and washers that hold oil filter assembly (2) on the block.
2. Remove oil filter assembly (2) from the block.
3. Remove the gasket from the block and discard it.
4. Install the oil filter assembly (2) in reverse order of removal.

## Disassemble & Assemble Oil Filter A42357

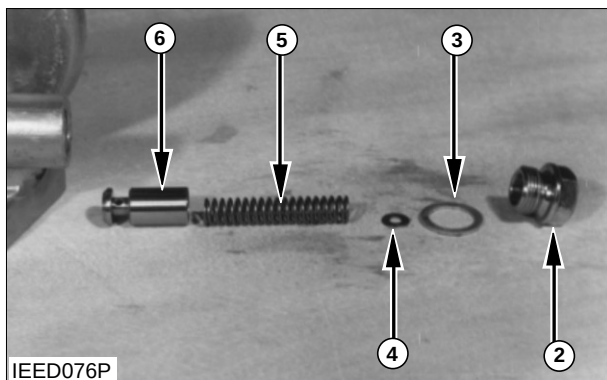
| Tools Needed  | A |
|---------------|---|
| Filter Wrench | 1 |

Start By :

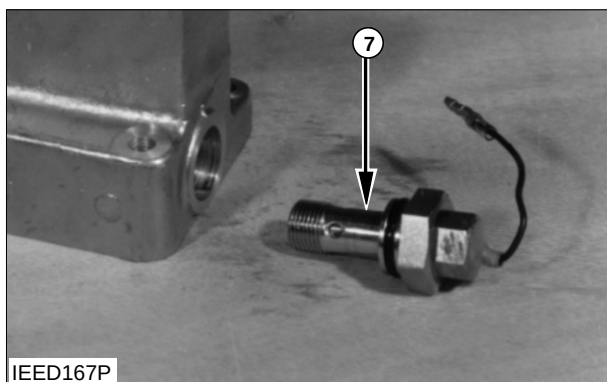
- a. Remove oil filter



1. Remove filter (1) on the filter head using tool (A).



2. Remove plug (2), seal ring (3), shim (4), spring (5) and valve plunger (6) from the filter head.



3. Remove relief valve assembly (7) with seal ring from the filter head.

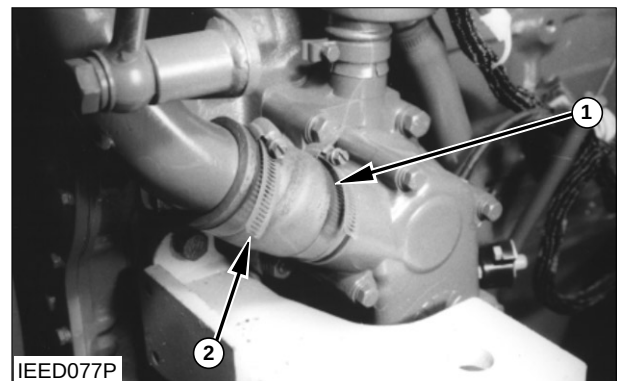
4. Assemble the oil filter assembly in reverse order of disassembly.

End By :

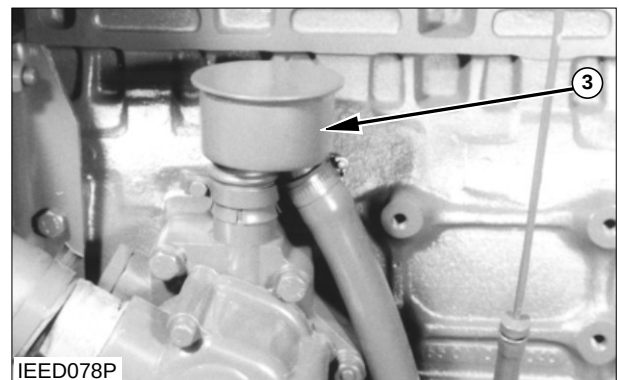
- a. Install oil filter.

## Oil Cooler

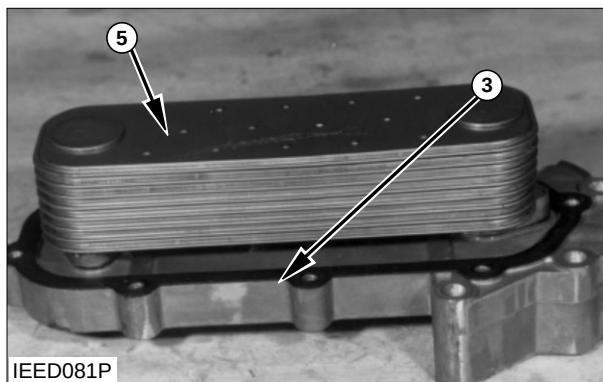
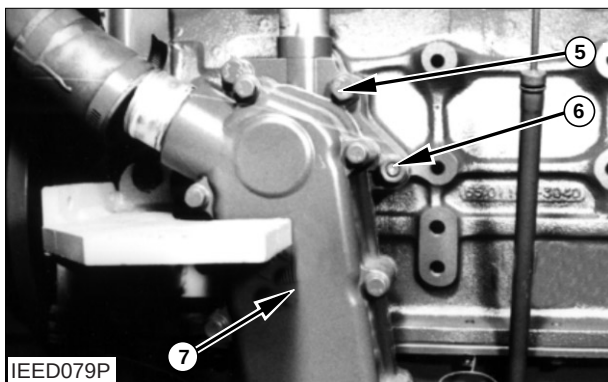
### Remove & Install Oil Cooler



1. Loosen clamps (1) and disconnect hoses (2) from the oil cooler.



2. Remove PCV valve (3) and O-ring from the cooler housing.

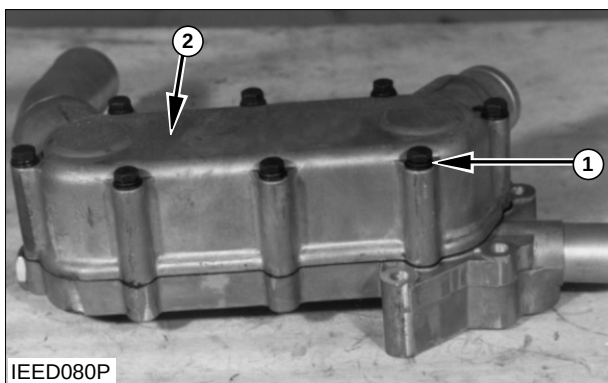


3. Remove two bolts (5), nuts (6) and washers that hold oil cooler (7) on the block.
4. Remove oil cooler assembly (7).
5. Remove the gasket from the block and discard it.
6. Install the oil cooler in reverse order of removal.

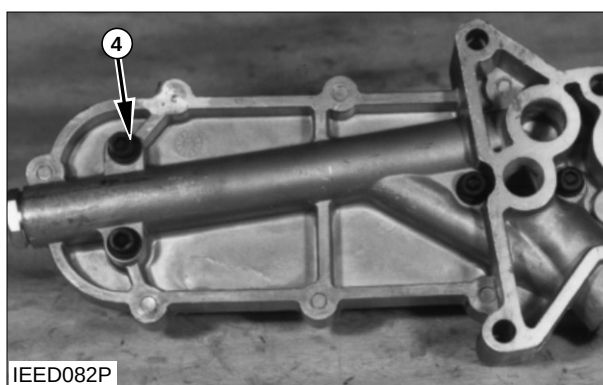
## Disassemble & Assemble Oil Cooler

Start By :

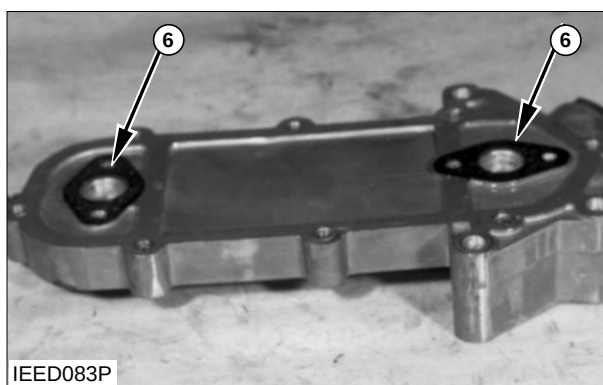
- a. Remove oil cooler



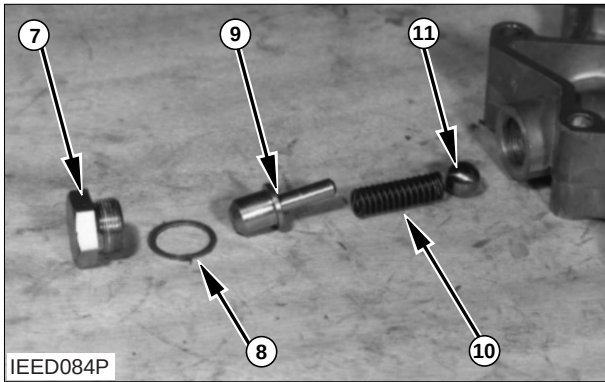
1. Remove eight bolts (1) and washers that hold cover (2) on the oil cooler housing.
2. Remove cover (2) from the oil cooler housing.



4. Remove four bolts (4) and washers that hold element in oil cooler housing.
5. Remove element (5) from oil cooler housing.



6. Remove two gaskets (6) from the oil cooler housing and discard it.



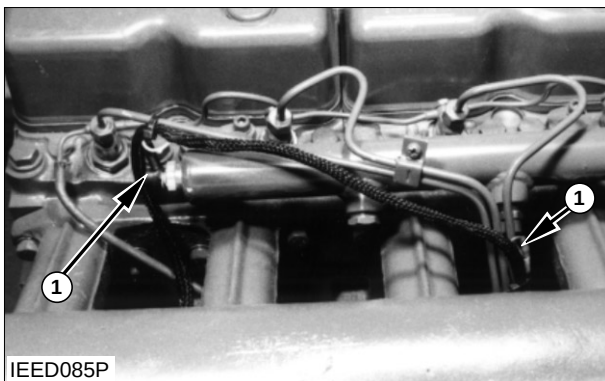
7. Remove plug (7), seal-ring (8), pin (9), spring (10) and ball (11) from the oil cooler housing.
8. Assemble the oil cooler in reverse order of disassembly.

End By :

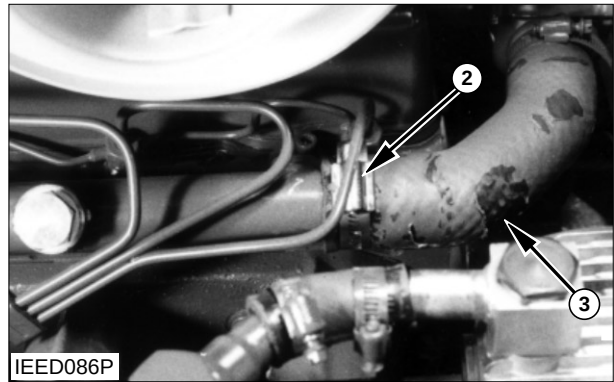
- a. Install oil cooler.

## Cooling Water Pipe

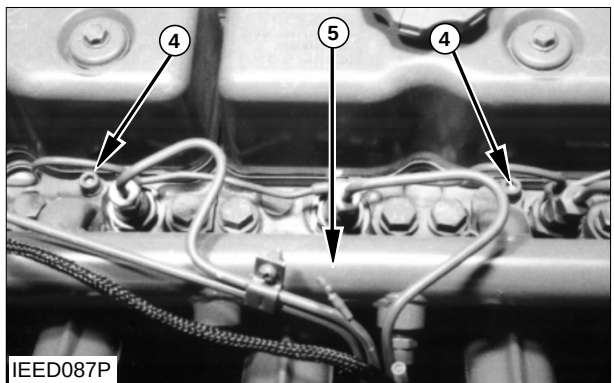
### Remove & Install Cooling Water Pipe



1. Disconnect two wirings (1) from the cooling water pipe.



2. Loosen clamp (2) and disconnect hose (3) from the cooling pipe.



3. Remove six bolts (4) and washers that hold cooling pipe (5) on the cylinder head.

**NOTE :** For purpose of reassembly, the torque for bolts (4) is **20 N•m (15 lb•ft)**.

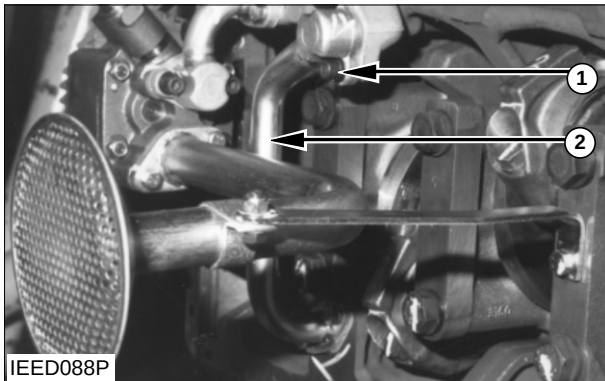
4. Remove cooling water pipe (5).
5. Remove gasket and discard it.
6. Install the cooling water pipe (5) in reverse order of removal.

## Oil Pump

### Remove Oil Pump A41663-02

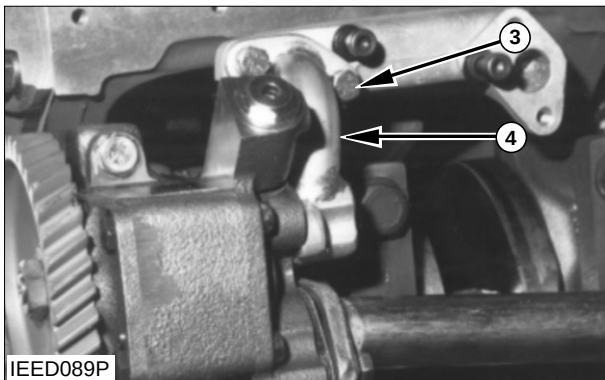
Start By :

a. Remove oil pan



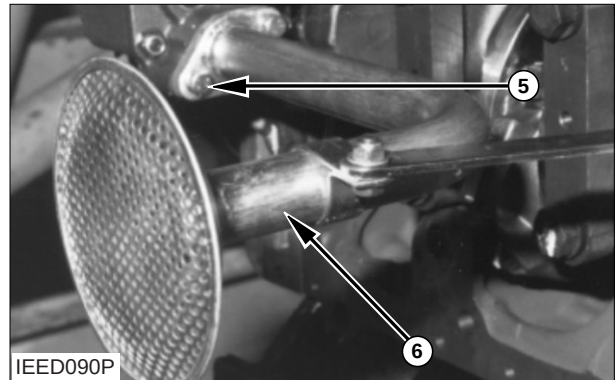
1. Remove bolts (1), washers and tube assembly (2).

2. Remove the gaskets and discard it.



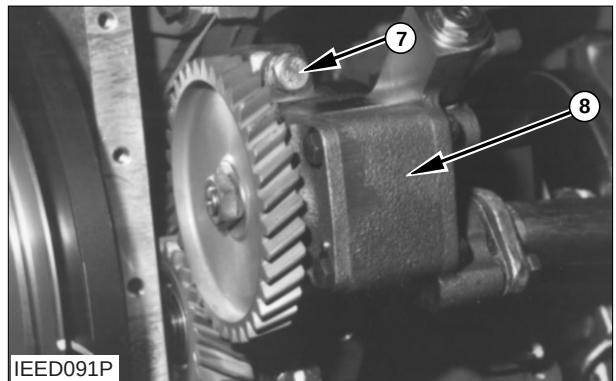
3. Remove bolts (3), washers and tube assembly (4).

4. Remove the gasket and discard it.



5. Remove bolts (5), washers and suction tube assembly (6).

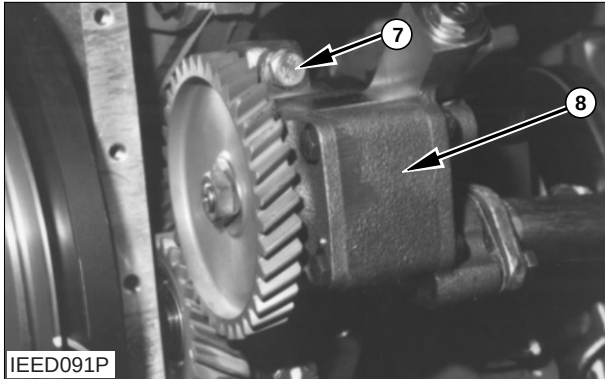
6. Remove the gasket and discard it



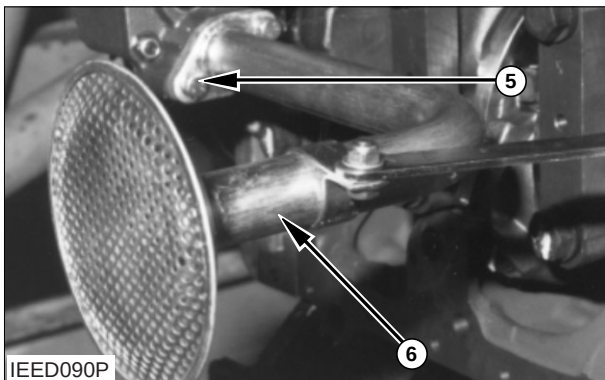
7. Remove two bolts (7) and washers that hold oil pump (8) in place.

8. Remove oil pump assembly (8) from the engine.

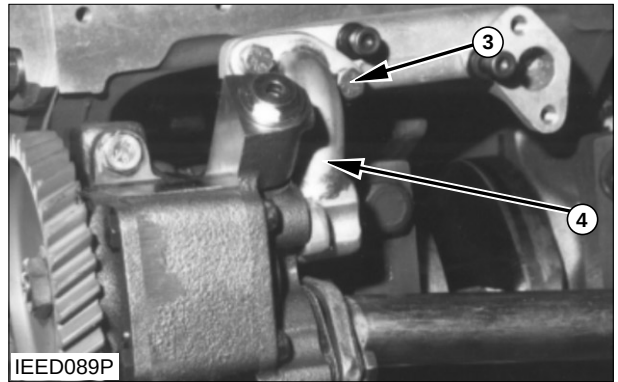
## Install Oil Pump A41663-03



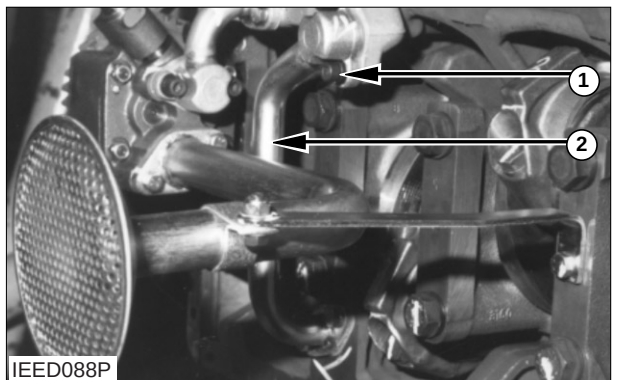
1. Put oil pump assembly (8) in position on No. 7 bearing cap, by tapping slightly with a plastic hammer.
2. Install bolts (7) and washers that hold the oil pump in place and tighten bolts (7) to a torque of **44 N•m (32 lb•ft)**.
3. Bend the lock washer towards bolt (7) to prevent from loosening.



4. Put suction tube assembly (6) in place and install new gasket, bolts (5) and washers that hold suction tube assembly (6).



5. Install new gasket on tube assembly (4).
6. Put tube assembly (4) in place and install bolts (3) and washers that hold tube assembly (4). Tighten bolts (3).



7. Install new gasket on tube assembly (2).
8. Put tube assembly (2) in place and install bolts (1) and washers that hold tube assembly (2). Tighten bolts (1).

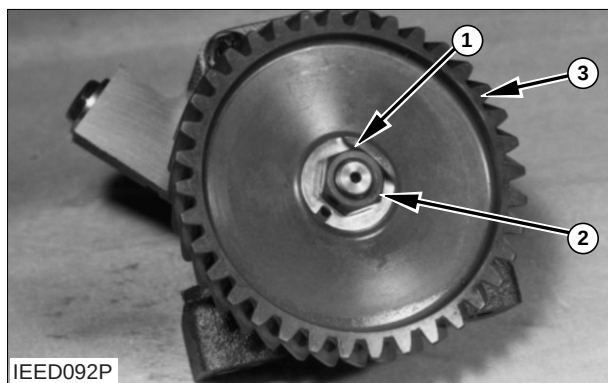
End By :

- a. Install oil pan.

## Disassemble & Assemble Oil Pump A41663-06

Start By :

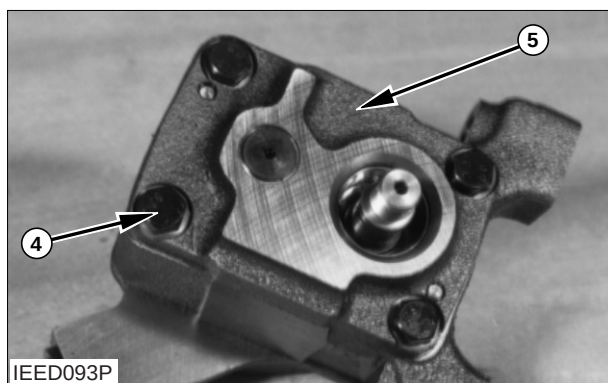
a. Remove oil pump



1. Bend washer (1) that lock nut (2) on the shaft of drive gear.
2. Remove washer (1), nut (2) and oil pump drive gear (3).

**NOTE :** For the purpose of reassembly, tighten nut (2) to a torque of **127 N • m (94 lb • ft)**.

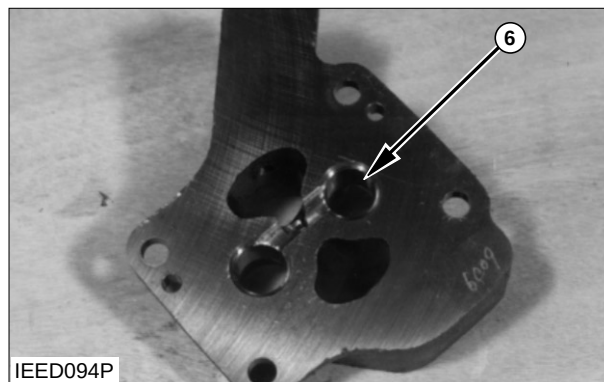
3. Remove wooden roof key from the shaft.



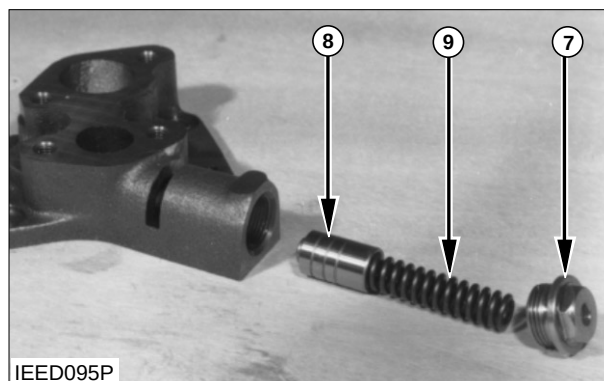
4. Remove four bolts (4) and nuts that hold rear cover (5) on the pump housing.

**NOTE :** For the purpose of reassembly, tighten bolts (4) and nuts to a torque of **22 N • m (16 lb • ft)**.

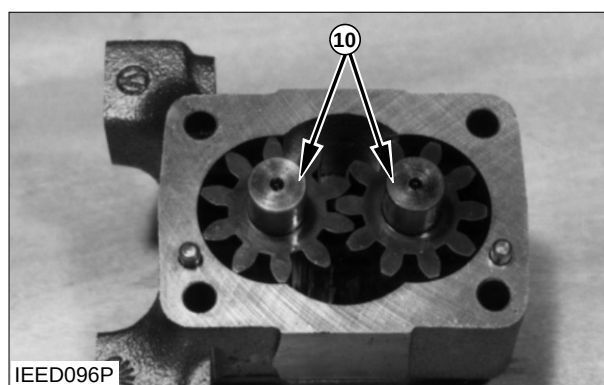
5. Remove rear cover (5).



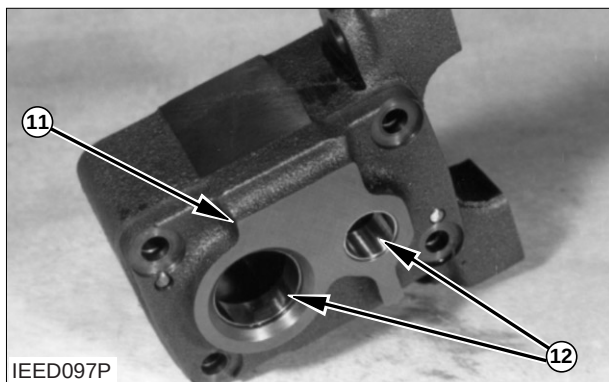
6. Check the conditions of bushing (6) in the rear cover. Replace with a new one if worn or damaged.



7. Remove plug (7), valve plunger (8) and spring (9) from the rear cover.



8. Remove two pump gears (10) from the pump housing.



**NOTE :** Mark front cover (11) for the purpose of reassembly.

9. Remove front cover (11) from the pump housing.
10. Check the conditions of bushings (12) in the front cover. Replace with new ones if worn or damaged.

**NOTE :** Assemble the oil pump in reverse order of removal.

End By :

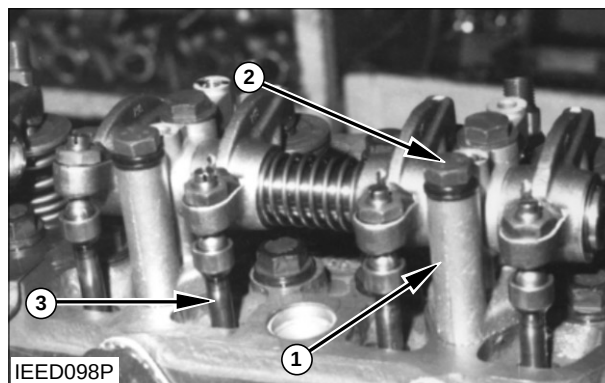
- a. Install oil pump.

## Rocker Shaft & Push Rods

### Remove Rocker Shaft & Push Rods A17744 & A17702-02

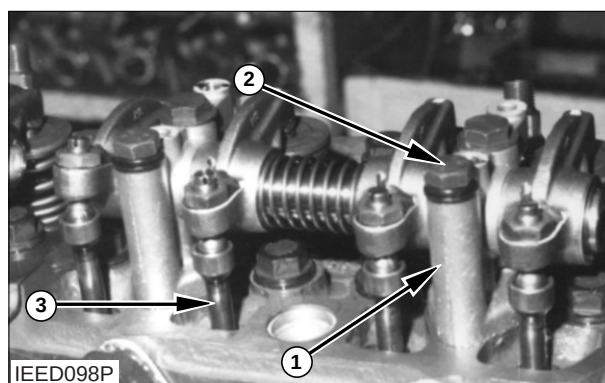
Start By :

- a. Remove head cover



1. Remove bolts (2) and washers from the rocker shaft assembly. Remove rocker shaft assembly (1) from the cylinder head.
2. Remove twelve push rods (3).

### Install Rocker Shaft & Push Rods A17744 & 17702-03



1. Install push-rods (3) coated with engine oil in the cylinder head.
2. Install rocker arm shaft assembly (1) and align the end of the rocker arm adjust screw with the push rod, then tighten bracket bolts (2).
3. Adjust valve clearance as following procedure ;

- a. Bring the TDC mark on the crankshaft pulley into alignment with the gear case by turning the crankshaft, then check the state of the rocker arms on No. 1 cylinder to see in which cylinder the piston is at the top dead center (TDC) on compression stroke.

**NOTE :** When both the intake and exhaust valve rocker arms are in free state, it indicates that the piston in that cylinder is at the top dead center on compression stroke.

- b. Perform valve clearance adjustment operation commencing with the valves on the cylinder in which the piston is at the top dead center on compression stroke. Insert a feeler gauge of specified thickness into the clearance between the valve stem end and rocker arm and adjust the clearance with the adjust screw. Fully tighten the rock nut when a correct adjustment is obtained.

| Valve clearance (Cold)<br>(mm) | Intake  | 0.3 |
|--------------------------------|---------|-----|
|                                | Exhaust | 0.3 |

- c. When adjustment of the valve on the No.1 cylinder is completed, turn the crankshaft one full turn and adjust the clearances of the valve on remaining cylinders.

|    | 1 |   | 2 |   | 3 |   | 4 |   | 5 |   | 6 |   |
|----|---|---|---|---|---|---|---|---|---|---|---|---|
|    | I | E | I | E | I | E | I | E | I | E | I | E |
| #1 | ○ | ○ | ○ |   |   | ○ | ○ |   |   | ○ |   |   |
| #6 |   |   |   | ⊙ | ⊙ |   |   | ⊙ | ⊙ |   | ⊙ | ⊙ |

I: Intake valve E : Exhaust valve.

**NOTE :** Adjust the clearance of the valves marked with '○' in the table when the piston in No. 1 cylinder is held at the top dead center on compression stroke. Conversely, adjust the clearance of the valves marked with '⊙' in the table when the piston in No. 6 cylinder is held at the top dead center on compression stroke.

End By :

- a. Install head cover.

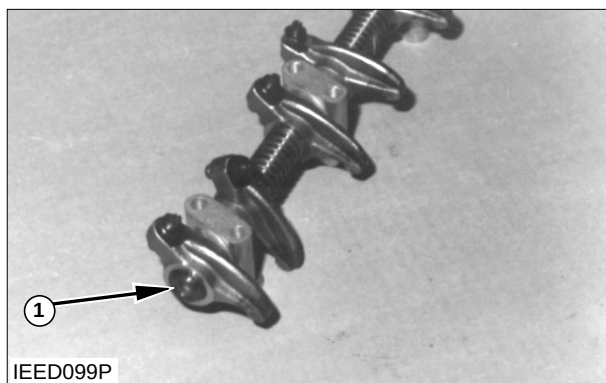
## Rocker Shaft

### Disassemble Rocker Shaft A17744-07

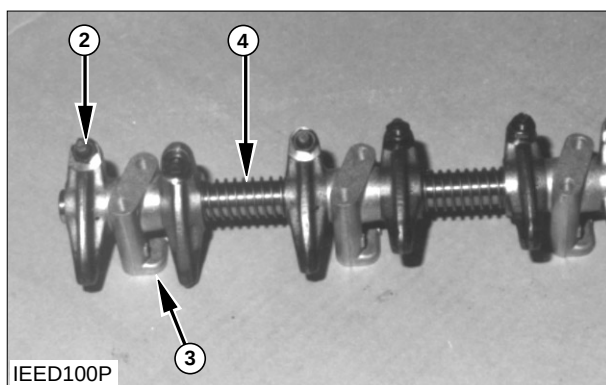
| Tools Needed | A |
|--------------|---|
| Drive Group  | 1 |

Start By :

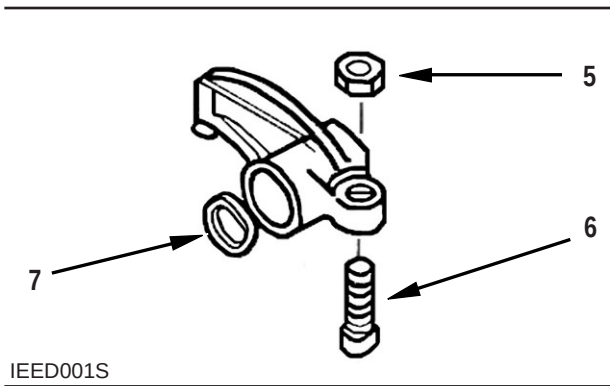
- a. Remove rocker shaft and push rods



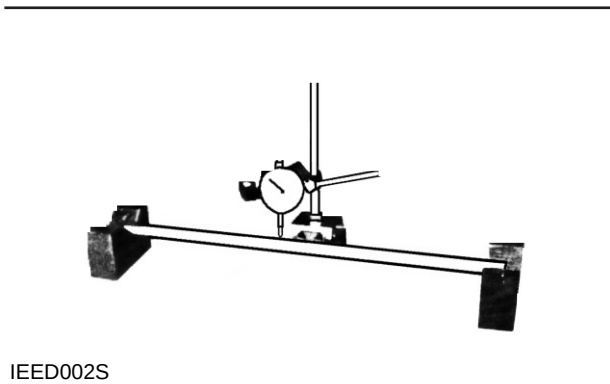
1. Remove circlip (1) and washer from both end of the rocker shaft.



2. Remove rocker arms (2), brackets (3) and springs (4) from both side of the rocker shaft.



3. Remove nut (5) and adjusting screw (6) from the rocker arm.
4. If a replacement is needed, remove bushing (7) with tool (A) and a press.

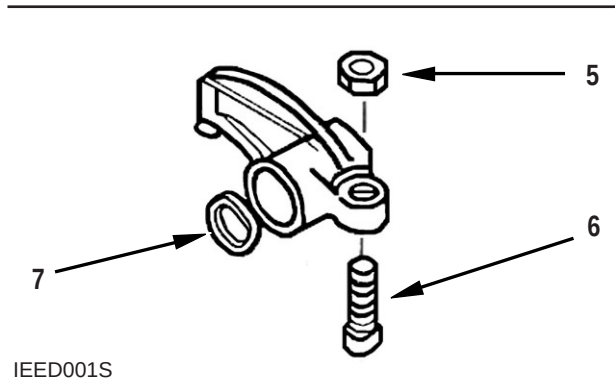


5. Support the rocker arm shaft on V-blocks at its ends and check the amount of run-out at the center part using a dial indicator. If a slight amount of run-out is noticeable, correct with a bench press without applying heat. Replace the rocker arm shaft if the amount of run-out is 0.3 mm (.012 in).
6. Measure the diameter of the rocker shaft at both of the rocker arm locations. The diameter must be **23.959 to 23.978 mm (.9432 to .9440 in).**

**NOTE :** The maximum permissible clearance between the rocker arm bearings and shaft is 0.25 mm (.0099 in.).

## Assemble Rocker Shaft A17744-08

| Tools Needed | A |
|--------------|---|
| Driver Group | 1 |



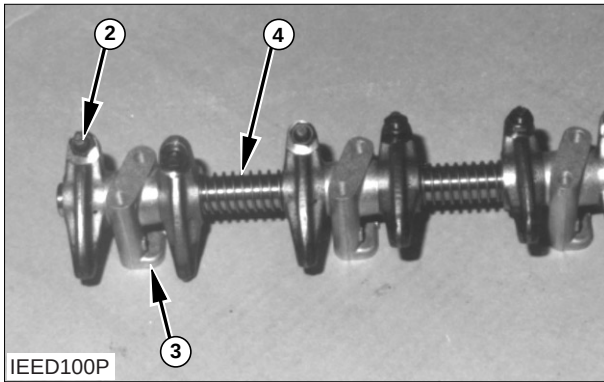
1. If replacement was needed, make an alignment of oil hole in the bushing with the oil hole in the rocker arm. Install new bushing (7) in the rocker arm with tool (A) and a press.

**NOTE :** Check the bore dimension of the bushing in the rocker arm after installation. It must be within the tolerance given in the specifications.

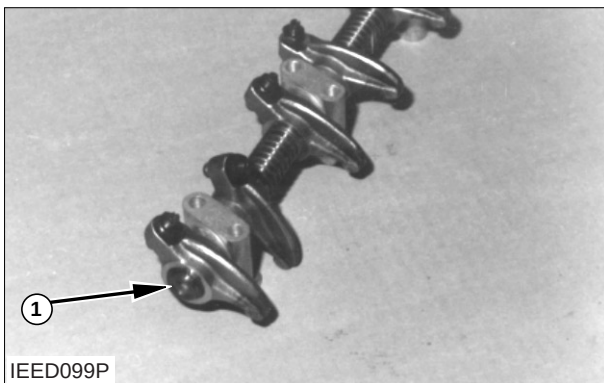
### NOTICE

Do not turn the adjusting screw too far into the rocker arms. Damage to the valve can be the result after the rocker shaft and push rods have been installed in the engine.

2. Install adjusting screw (6) and nut (5) in the rocker arm.



3. Install springs (4), brackets (3) and rocker arms (2) in their original positions.



4. Install washer and circlip (1) on both end of the rocker shaft.

End By :

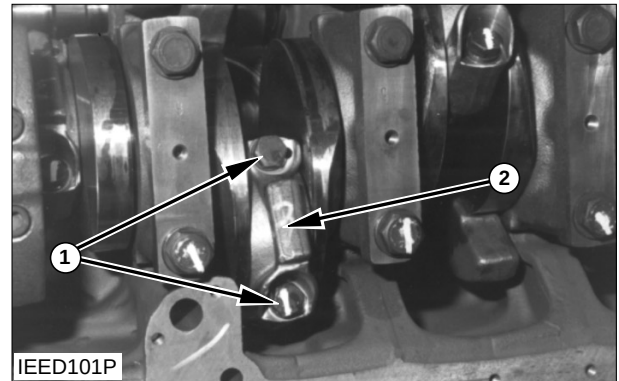
- a. Install rocker shaft and push rods.

## Connecting Rod Bearings

### Remove Connecting Rod Bearings A14078-02

Start By :

- a. Remove oil pump

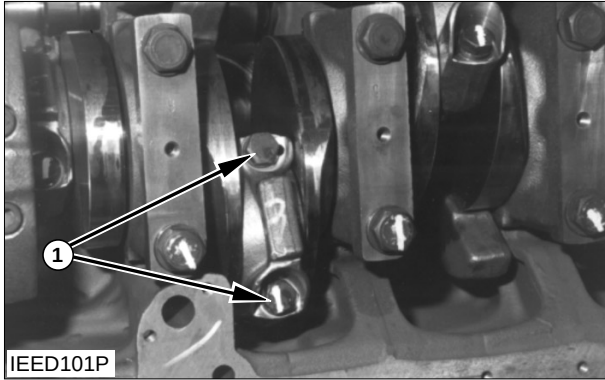


1. Remove two bolts (1). Remove connecting rod cap (2).

**NOTE :** Put identification on the bearings for correct installation.

2. Remove the lower bearing half from the cap.
3. Push the connecting rod away from the crankshaft and remove the upper bearing half.
4. Do Steps 1 through 4 for the other connecting rod bearings.

## Install Connecting Rod Bearings A14078-03



1. Make sure all parts are clean and free of all dirt and foreign material.
  2. Put clean engine oil on the bearings and the crankshaft journals.
- NOTE :** If the same bearings are used, install as per identification.
3. Put the upper bearing halves in position on the connecting rods. Make an alignment of the tabs on the bearings and the grooves (slots) in the connecting rods.
  4. Put the connecting rods in position on the crankshaft.
  5. Install the lower bearing halves on the caps. Make an alignment of the tabs on the bearings and the grooves (slots) in the caps.
- NOTE :** Make an alignment of the number on the cap with the correct number on the connecting rod.
6. Put clean engine oil on the connecting rod bolt threads. Install all bolt one of the connecting rod caps.
  7. Use Plastigage to check the bearing clearance of the connecting rods. Install connecting rod cap (1) and tighten the bolts to a torque of **180 N•m (133 lb•ft)**.
  8. Remove the connecting rod cap and measure the Plastigage. The bearing clearance for new rod bearings must be **0.035 to 0.075 mm (.0010 to .0029 in.)**.

9. Put the connecting rod cap in position and install the bolts. Tighten the nuts to a torque of **180 N•m (133 lb•ft)**.

**NOTE :** When installing undersize bearings, have the crankshaft journals and crankpins ground to size indicated in the below table :

| Bearing Size   | Outside diameter of crank journals after grinding (mm) | Outside diameter of crankpins after grinding (mm) |
|----------------|--------------------------------------------------------|---------------------------------------------------|
| Standard       | 83.966~83.988                                          | 70.971~70.990                                     |
| Undersize 0.25 | 83.716~83.738                                          | 70.721~70.740                                     |
| Undersize 0.50 | 83.466~83.488                                          | 70.471~70.490                                     |
| Undersize 0.75 | 83.216~83.238                                          | 70.221~70.240                                     |
| Undersize 1.00 | 82.966~82.988                                          | 69.971~69.990                                     |

10. Tighten main bearing cap bolts to a torque of **300 N•m (220 lb•ft)**.
11. Do steps 6 through 9 for the other connecting rod caps.

End By :

- a. Install oil pump.

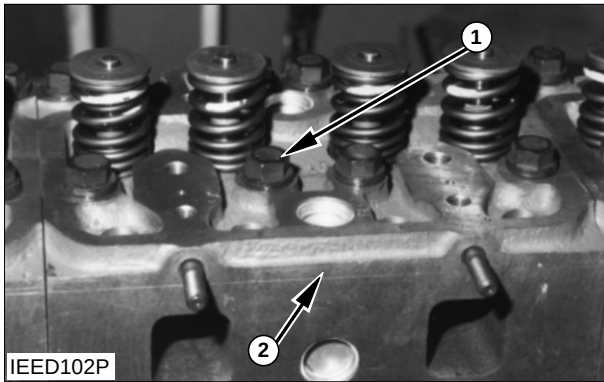
## Cylinder Head

### Remove Cylinder Head A17429-02

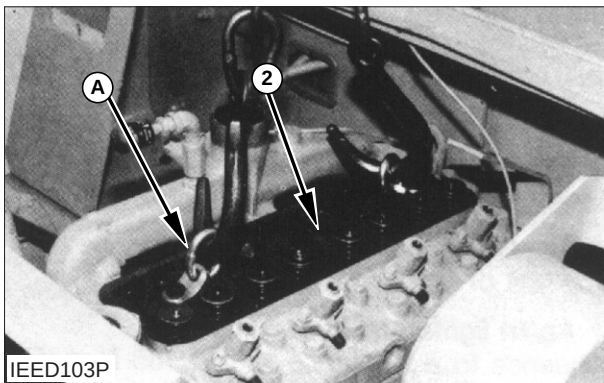
| Tools Needed | A |
|--------------|---|
| Link Bracket | 1 |

Start By :

- a. Remove air cleaner
- b. Remove intake manifold
- c. Remove exhaust manifold
- d. Remove cylinder head cover
- e. Remove rocker shaft and push rods

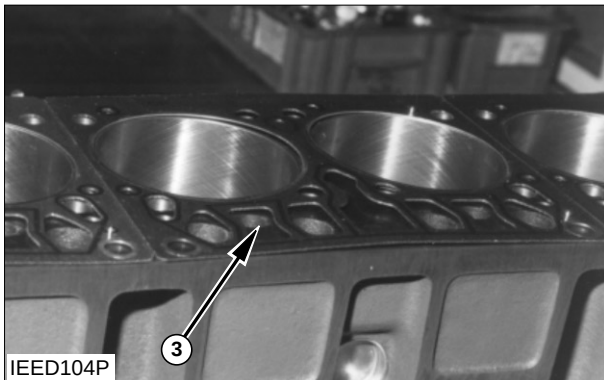


1. Remove bolts (1) that hold the cylinder head on the block.



Typical Example

2. Install tool (A) in the cylinder head, and then fasten a hoist. Remove cylinder head assemblies (2).

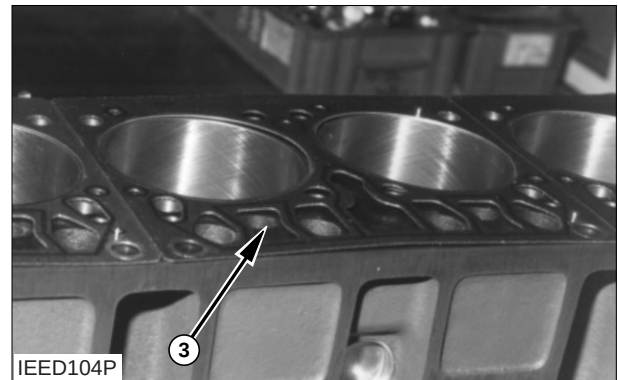


3. Remove cylinder head gasket (3) and discard it.

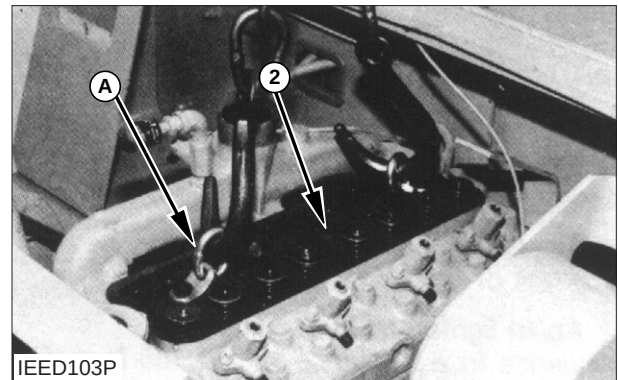
## Install Cylinder Head A17429-03

| Tools Needed | A |
|--------------|---|
| Link Bracket | 1 |

NOTE : Clean the bolt holes on the cylinder block with compressed air and thoroughly clean the upper face of the cylinder block.

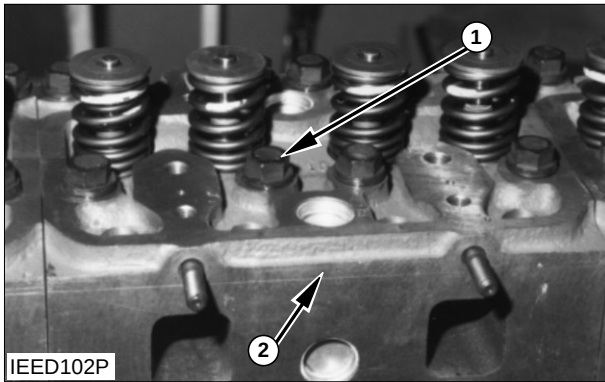


1. Install new cylinder head gasket (3) on the cylinder block by aligning the holes with the dowels.



Typical Example

2. Install tool (A) on the cylinder head. Fasten a hoist and put cylinder head (2) in position on the cylinder block.



3. Remove tool (A) and the hoist. Put engine oil on the bolt threads and then install bolts (1) that hold the cylinder head in place.
4. Tighten bolts (1) as follows :
  - a. Tighten all bolts in number sequence to a torque of **100 N•m (74 lb•ft)**.
  - b. Tighten all bolts in number sequence to a torque of **180 N•m (133 lb•ft)**.
  - c. Again tighten all bolts in number sequence to a torque of **220 N • m (163 lb • ft)**.

**NOTE :** After engine has run at normal temperature of operation for a very short time, tighten all bolts again to the final torque. Rocker shaft assembly has to be removed and valves have to be adjusted again.

End By :

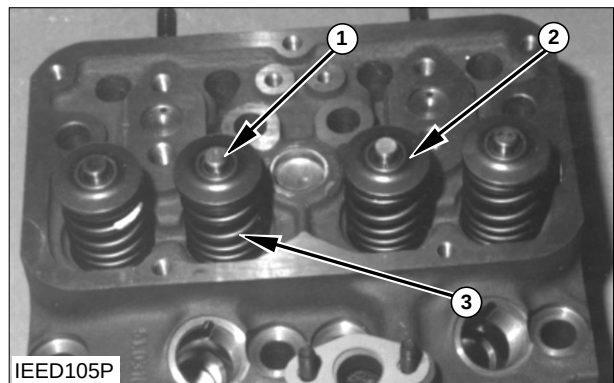
- a. Install rocker shaft and push rods.
- b. Install cylinder head cover.
- c. Install exhaust manifold.
- d. Install intake manifold.
- e. Install air cleaner.

## Disassemble Cylinder Head A17429-07

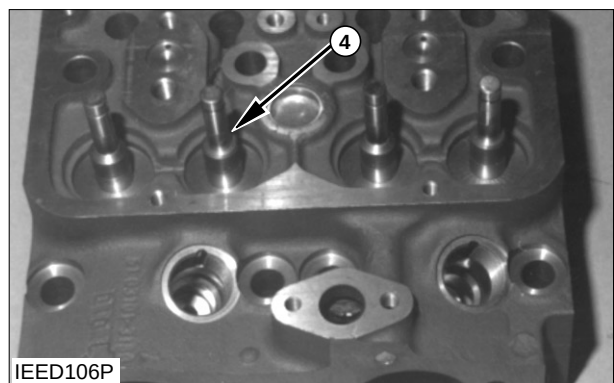
| Tools Needed            | A | B | C |
|-------------------------|---|---|---|
| Valve Spring Compressor | 1 |   |   |
| Valve Spring Tester     |   | 1 |   |
| Valve Guide Installer   |   |   | 1 |

Start By :

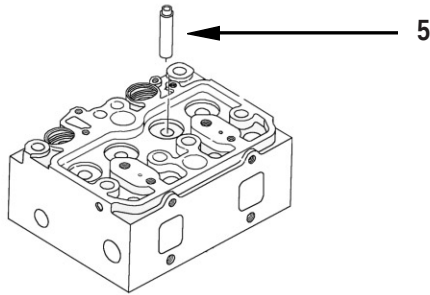
- a. Remove cylinder head



1. Apply cylinder number mark to the head of each valve.
2. Install tool (A) on the cylinder head.
3. Compress the valve springs and remove valve cotteners (1), spring retainer (2) and springs (3).

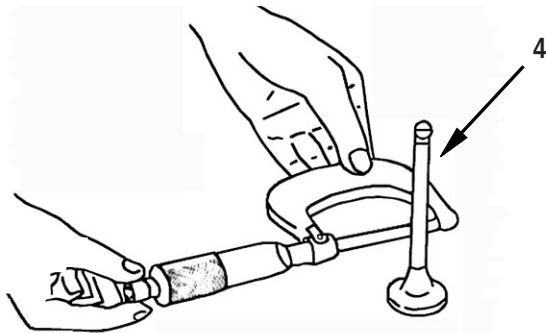


4. Remove valve (4), stem seal and spring seat.



IEED003S

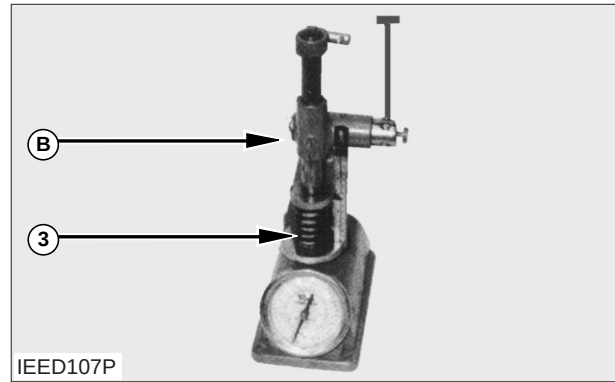
4. Remove valve guide (5) using tool (C).
5. Do steps 1 through 4 again for the remainder of the valves.
6. Carefully remove carbon from lower face of cylinder head to prevent scratching of valve seat faces.



IEED004S

7. Replace valve (4) with valve guide if reduction in diameter of the valve stem due to wear, is beyond the below specified limit.

| Description   | Nominal     | Limit for use |
|---------------|-------------|---------------|
| Intake Valve  | 8.95~8.97   | 8.93          |
| Exhaust Valve | 8.935~8.955 | 8.91          |



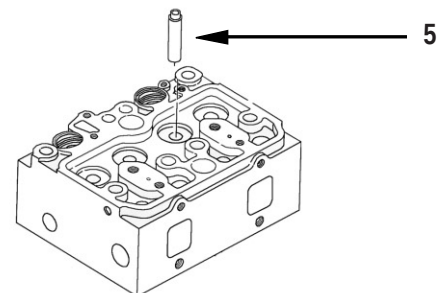
IEED107P

8. Check the spring force with tool (B) and replace springs (3) if measured valve is beyond the below limit.

| Description   |       | Spring Set Length(mm) | Nominal(kg) | Limit for Use(kg) |
|---------------|-------|-----------------------|-------------|-------------------|
| Intake Valve  |       | 41                    | 65.5~73.5   | 65.5              |
| Exhaust Valve | Outer | 41                    | 62.7~63.9   | 62.7              |
|               | Inner | 38                    | 27.2~30.0   | 27.2              |

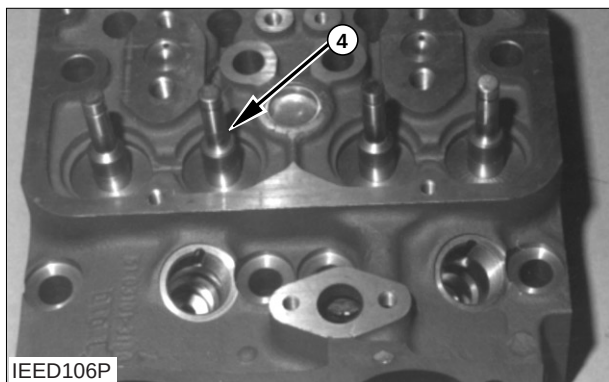
## Assemble Cylinder Head A17429-08

| Tools Needed          | A | B | C | D |
|-----------------------|---|---|---|---|
| Valve Compressor      | 1 |   |   |   |
| Valve Keeper Insertor |   | 1 |   |   |
| Valve Guide Installer |   |   | 1 |   |
| Stem Seal Installer   |   |   |   | 1 |

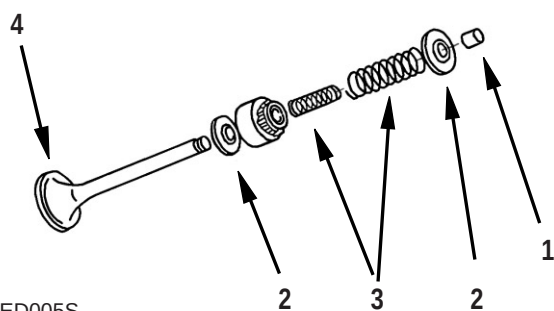


IEED003S

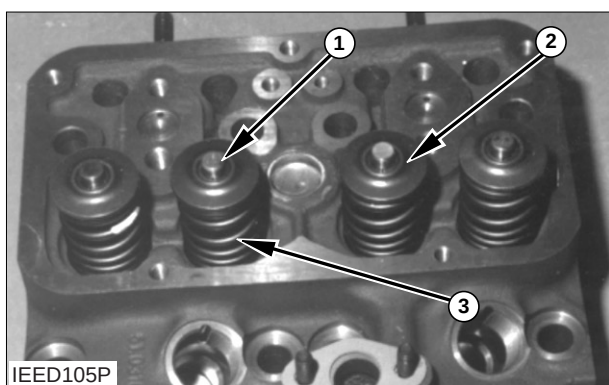
1. Install valve guide (5) with tool (C) in the cylinder head.



2. Press in new valve stem seal in valve guide using tool (D) if they were removed.
3. Put clean engine oil on the valve stems.
4. Install spring seat and valve (4) into the cylinder head.



IEED005S



5. Install springs (3) and spring retainer (2).

#### NOTICE

The close coil of spring (3) must be next to the head.

6. Use tool (A) and put springs (3) under compression. Use tool (B) and install valve cotters (1) that hold the springs (3) in place.

#### ⚠ WARNING

Valve cotters (1) can be thrown from valve (4) when tool (A) is released if they are not in their correct position on the valve stem.

7. Remove tool (A) and hit the top of the valve with a plastic hammer to be sure the locks are in their correct position on the valve.
8. Do steps 1 through 7 again for the remainder of the valves.

End By :

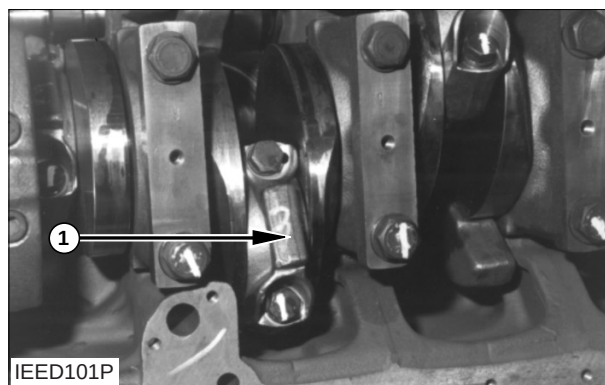
- a. Install cylinder head.

## Pistons

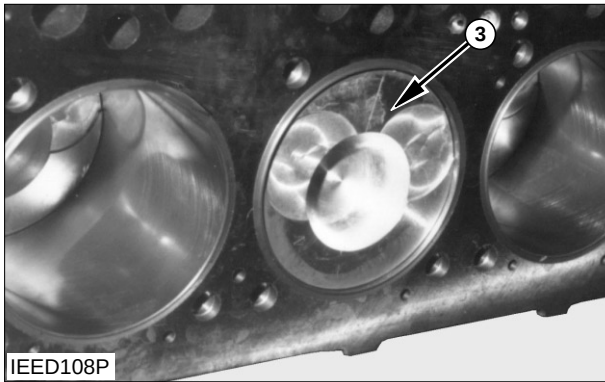
### Remove Pistons A14615-02

Start By :

- a. Remove cylinder head
- b. Remove oil pan plate
- c. remove oil pump



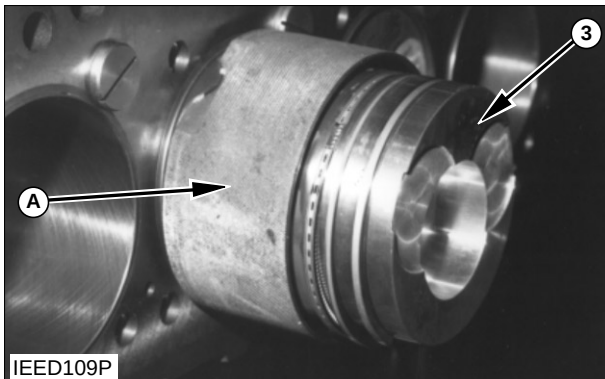
1. Remove the ring of carbon from the top inner surface of the cylinder liner.
2. Turn the crankshaft until the connecting rod bearing cap to be removed is at bottom center. Remove connecting rod bearing cap (1) from the connecting rod.



3. Push the piston and connecting rod away from the crankshaft until the piston rings are above the cylinder liner. Remove piston (3) and the connecting rod from the engine.
4. Do Steps 2 and 3 for the remainder of the pistons.

## Install Pistons A14615-03

| Tools Needed    | A |
|-----------------|---|
| Ring Compressor | 1 |

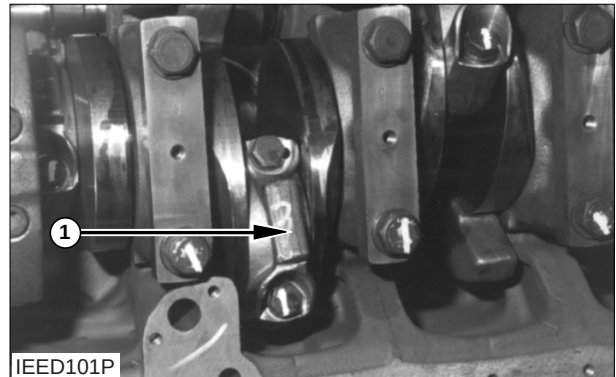


1. Turn the crankshaft until the bearing journal for the piston to be installed is at bottom center.
2. Put clean engine oil on the crankshaft journal and on the inside of the cylinder liner. Put clean engine oil on the piston rings and connecting rod bearings.
3. Move the rings on the piston until the ring openings are approximately 90° apart.

### NOTICE

Never install the ring compressor on the piston unless the cylinder liner is used as a guide. Damage to the piston rings can be the result.

4. Use tool (A) and put piston (3) and the connecting rod in the same cylinder from which it was removed. Make sure the identification "FRONT" on the piston is toward the front of the engine.



### NOTICE

When connecting rod caps are installed, make sure the number on the side of the cap is next to and respective with the number on the side of the connecting rod. The identification numbers must be opposite to the camshaft when the piston and connecting rod are installed.

5. Put connecting rod bearing cap (1) in position and install the nuts that hold it in place. Tighten the nuts to a torque of **180 N•m (133 lb•ft)**.
6. Follow the same above procedure for installation of the remainder of the pistons.

End By :

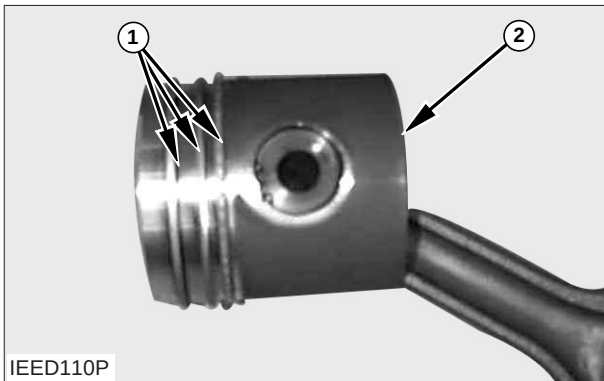
- a. Install oil pan plate.
- b. Install cylinder head.
- c. Install oil pump.

## Disassemble Pistons A14615-07

| Tools Needed | A | B | C |
|--------------|---|---|---|
| Pliers       | 1 |   |   |
| Pliers       |   | 1 |   |
| Drive Group  |   |   | 1 |

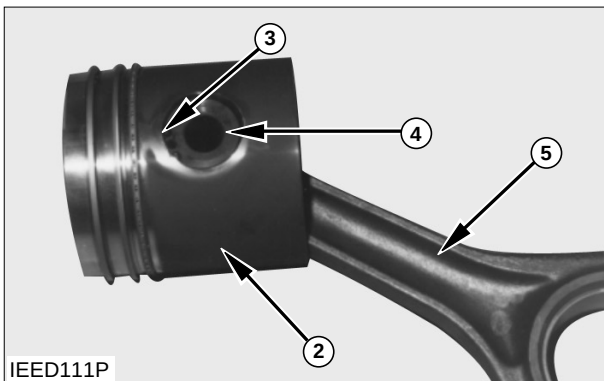
Start By :

### a. Remove piston



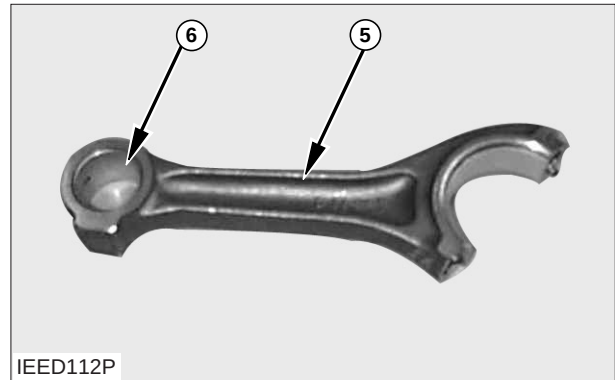
NOTE : Put identification on all parts for correct assembly.

#### 1. Remove rings (1) from piston (2) with tool (A).



#### 2. Remove retaining ring (3) from both side of the piston with tool (B).

#### 3. Remove pin (4) and connecting rod (5) from piston (2).

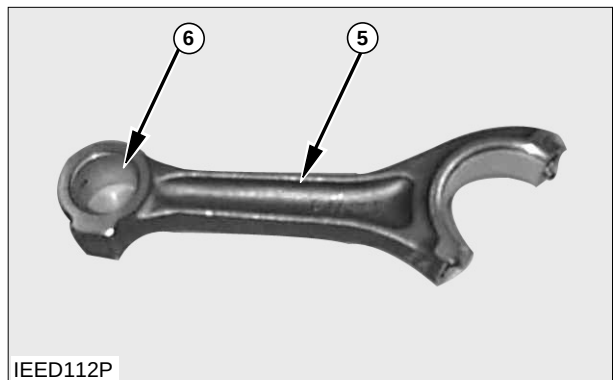


#### 4. Remove bushing (6) with tool group (C) from connecting rod (5).

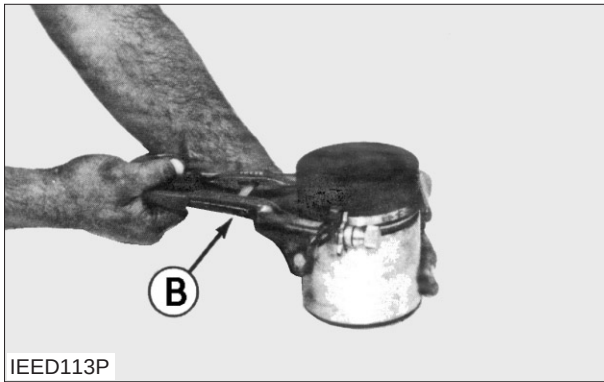
#### 5. See Specifications for use of the parts again.

## Assemble Pistons A14615-08

| Tools Needed               | A | B | C | D |
|----------------------------|---|---|---|---|
| Driver Group               | 1 |   |   |   |
| Piston Ring Groove Cleaner |   | 1 |   |   |
| Pliers                     |   |   | 1 |   |
| Pliers                     |   |   |   | 1 |



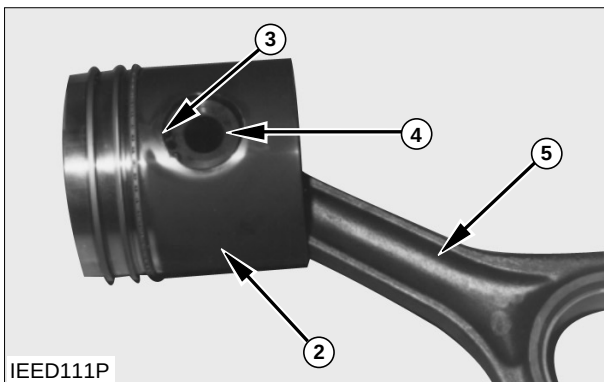
#### 1. Install the bushing in connecting rod (5) with tool group (A) and a press. Make the new bushing to the correct size with one. See SPECIFICATIONS.



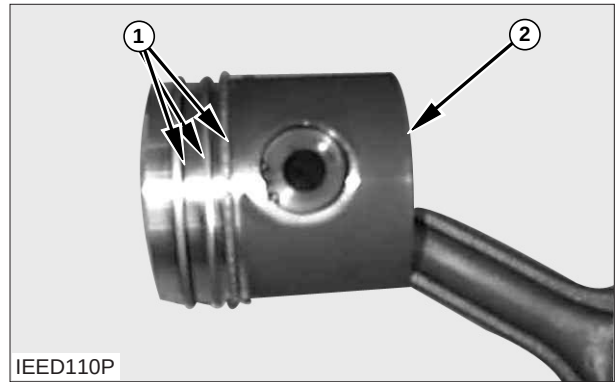
Typical Example

2. When the oil pistons are used, clean the piston grooves with tool (B) before the rings are installed.

**NOTE :** The concave area (the part that makes the curve to the inside) in the piston is toward one side of the piston. Install the piston on the connecting rod with the concave area toward the side which has the connecting rod and cap identification on it.



3. Slide connecting rod (5) inside the piston. Install pin (4) in the piston and the connecting rod.



4. Install a retaining ring (3) on both side of the piston (2) with tool (C).

5. Install rings (1) on the piston with tool (D).

**NOTE :** See Specifications for piston ring location.

End By :

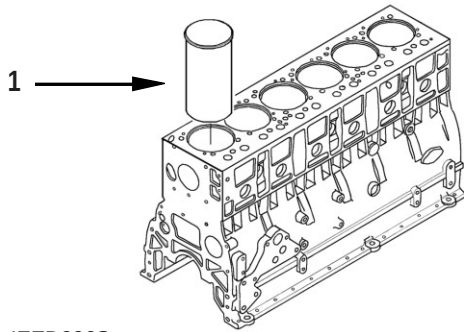
- a. Install pistons.

## Cylinder Liners

### Remove And Install Cylinder Liners A11552-01

Start By :

- a. Remove pistons
- b. Remove crankshaft



1. Pull out cylinder liner (1) using the cylinder liner extractor or by hand carefully so as not to damage the cylinder bore.
2. Do step 1 for the other cylinder liners.
3. Number cylinder liners (1) according to installed position.
4. Install the cylinder liners (1) in reverse order of removal.

End By :

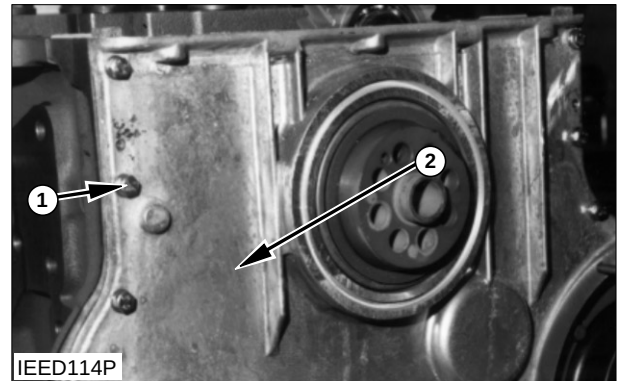
- a. Install pistons.
- b. Install crankshaft.

## Timing Gear Case Cover

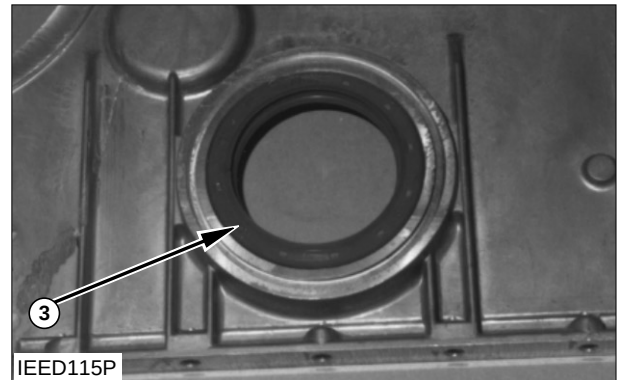
### Remove Timing Gear Case Cover A17198-02

Start By :

- a. Remove oil pan
- b. Remove crankshaft pulley



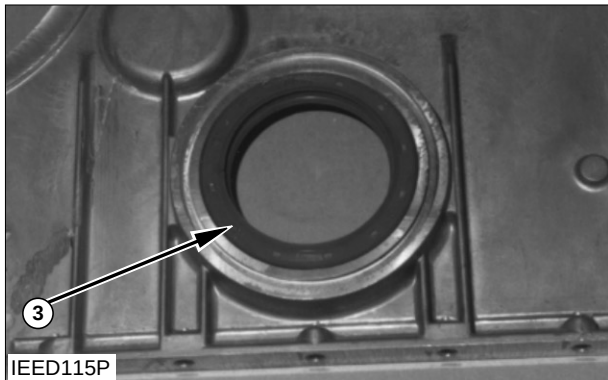
1. Remove bolts (1) and washers that hold timing gear case cover (2) to the timing gear case. Remove timing gear case cover (2) from the timing gear case.



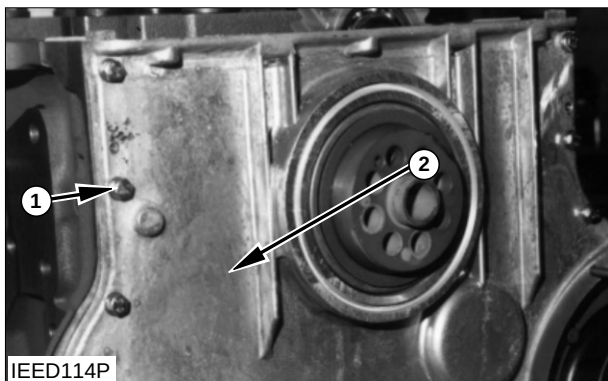
2. Remove lip type seal (3) from timing gear case cover (2).

## Install Timing Gear Case Cover A17198-03

| Tools Needed | A |
|--------------|---|
| Drive Group  | 1 |



1. Install lip type seal (3) with tool group (A) with the lip of the seal toward the inside of the timing gear case cover.



2. Make sure the gasket is in position between the timing gear case and cover.
3. Put the timing gear case cover (2) in position on the timing gear case and install bolts (1) that hold it to the case.

End By :

- a. Install crankshaft pulley.
- b. Install oil pan.

## Timing Gears

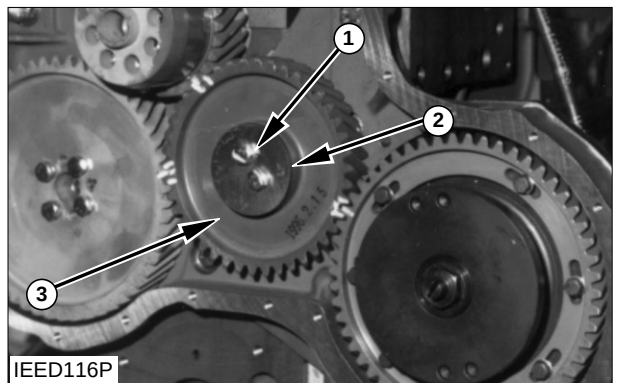
### Remove Timing Gears A16387-02

| Tools Needed | A |
|--------------|---|
| Puller Group | 1 |

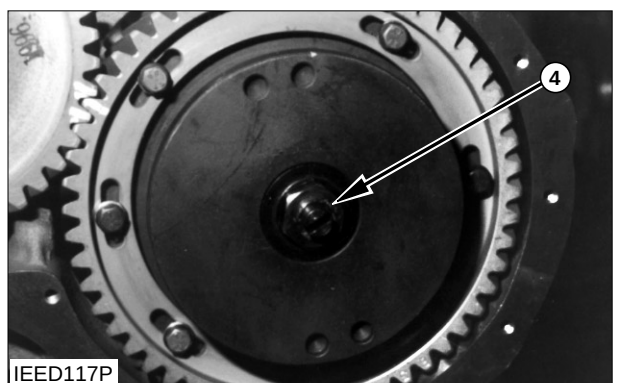
Start By :

- a. Remove timing gear case cover

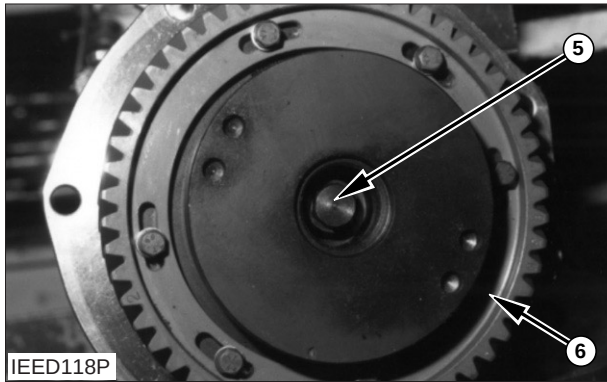
**NOTE :** Make an alignment of the timing marks on the fuel injection pump gear and idle gear, crankshaft gear and idle gear and camshaft gear and idle gear or put a mark of identification on the gears for correct installation.



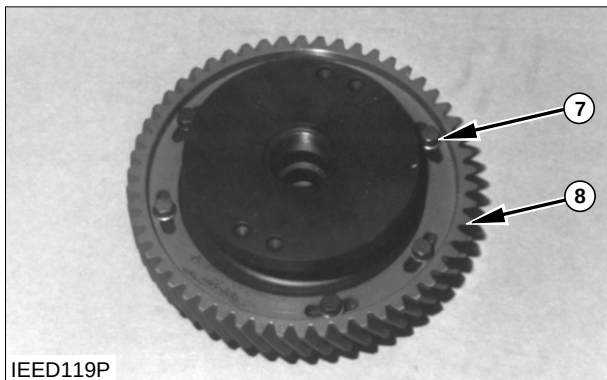
1. Remove bolts (1) and thrust washer (2). Remove idler gear (3). Remove the bushings from the inside gear if damaged.



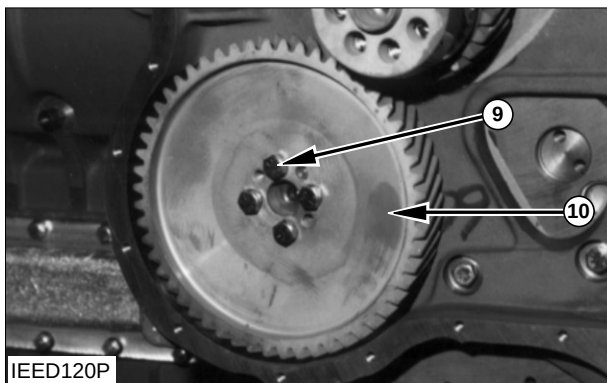
2. Remove nut (4) from injection pump coupling.



3. Remove nut (5) and injection pump coupling and gear (6) from injection pump.



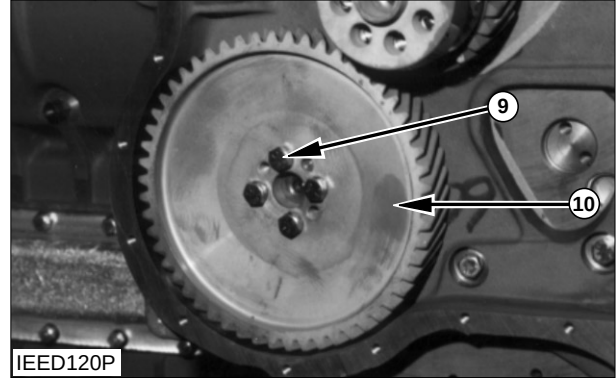
4. Remove six bolts (7) and washers that hold injection pump gear (8) in place and remove injection pump gear (8).



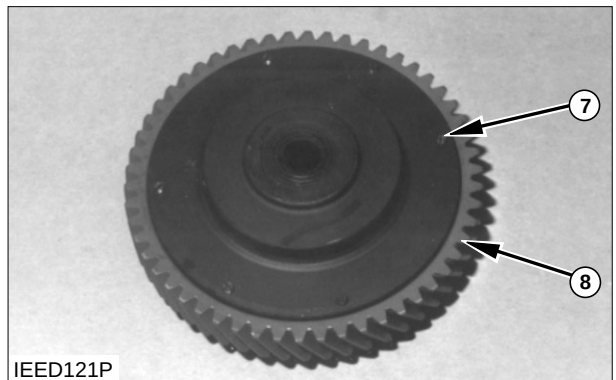
5. Remove four bolts (9), washers that hold camshaft gear in place.
6. Remove camshaft gear (10) from camshaft.

## Install Timing Gears A16387-03

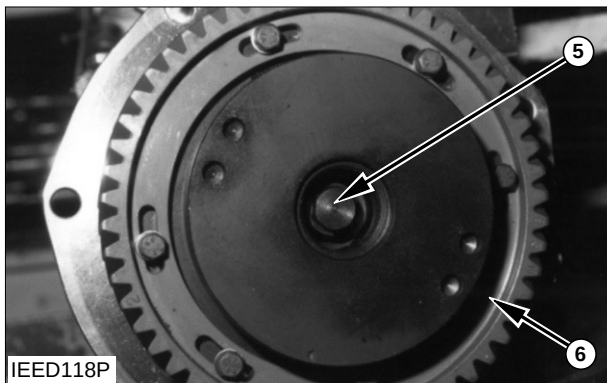
| Tools Needed   | A |
|----------------|---|
| Dial Indicator | 1 |



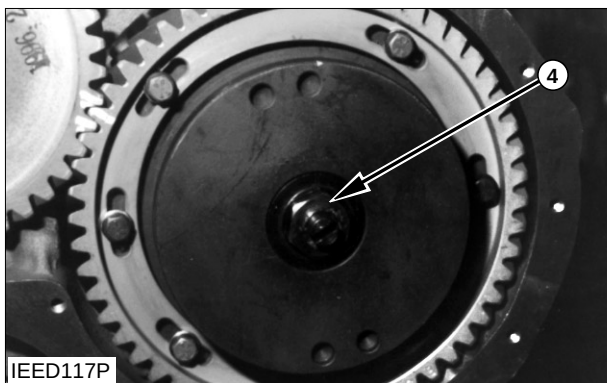
1. Put camshaft gear (10) in position on the camshaft and install washers and bolts (9). Tighten bolts (9) to a torque of **22 N•m (16 lb•ft)**.



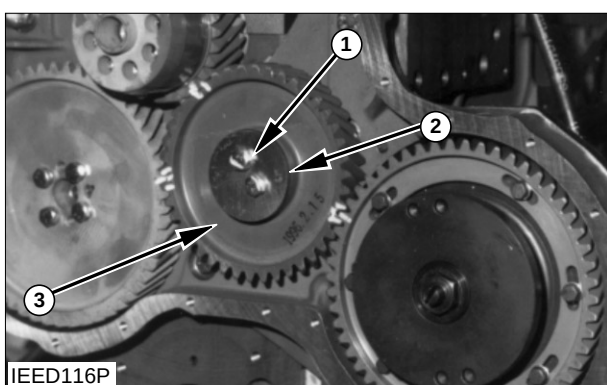
2. Put injection pump gear (8) in position on coupling and install washers and bolts (7).
3. Spread the end of bolts (7).



4. Put fuel injection pump drive coupling and gear (6) in position. Make an alignment of the key and the groove (slot) in the coupling.
5. Install nut (5) that hold the injection pump drive coupling and gear (6) in place. Tighten nut (5) to a torque of **130 N•m (96 lb•ft)**.



6. Install nut (4) into the injection pump coupling.



7. Put idler gear (3) in position on the idler gear pin, so that the marks on the idler gear are aligned with marks on the camshaft gear, crankshaft gear and the injection pump gear respectively.

8. Install thrust washer (2) and bolts (1) that hold the idler gear. Tighten the bolts to a torque of **40 N•m (30 lb•ft)**.
9. When installing the timing gears in position, check the amount of backlash between gears using tool (A). If the amount of backlash is beyond the specified value(below table) correct it.

|                                          | Backlash  |
|------------------------------------------|-----------|
| Camshaft gear and idler gear             | 0.16~0.28 |
| Crankshaft gear and idler gear           | 0.16~0.28 |
| Injection pump drive gear and idler gear | 0.16~0.28 |

End By :

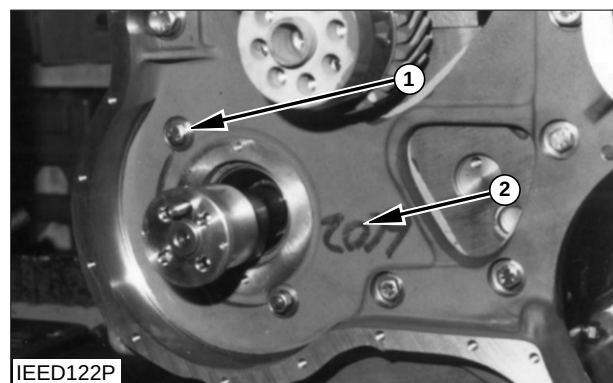
- a. Install timing gear case cover.

## Timing Gear Case

### Remove Timing Gear Case A17198-02

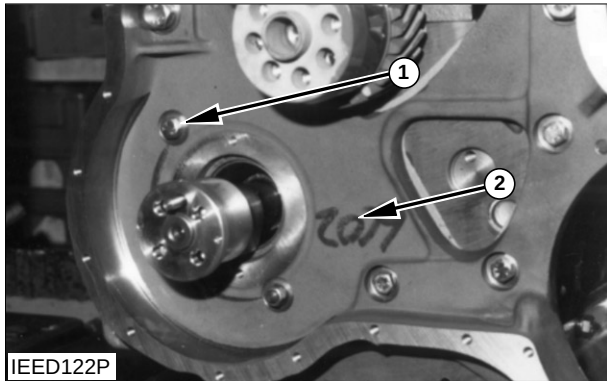
Start By :

- a. Remove timing gears
- b. Remove fuel injection pump
- c. Remove oil pan



1. Remove bolts (1) and then remove timing gear case (2) from the cylinder block.
2. Remove gasket from the timing gear case.

## Install Timing Gear Case A17198-03



1. Install a new gasket on the timing gear case.
2. Put timing gear case (2) in position on the cylinder block and install bolts (1) that hold it.

End By :

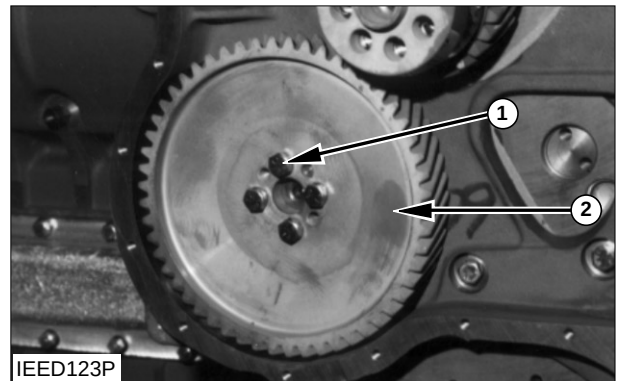
- a. Install oil pan.
- b. Install fuel injection pump.
- c. Install timing gears.

## Camshaft & Camshaft Bearing

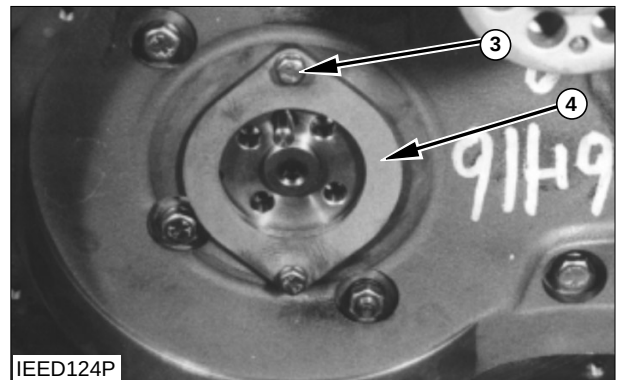
### Remove Camshaft & Camshaft Bearing A17174 & 17078 - 02

Start By :

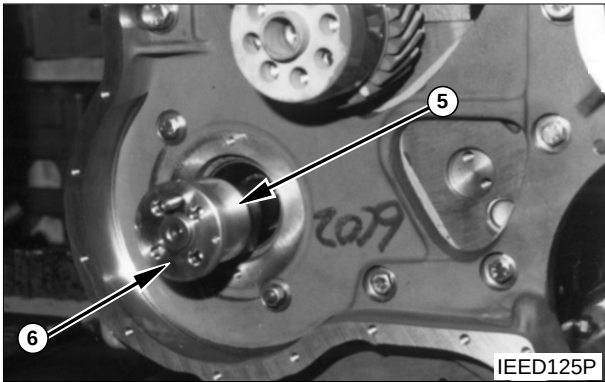
- a. Remove rocker shaft and push rods
- b. Remove timing gear cover



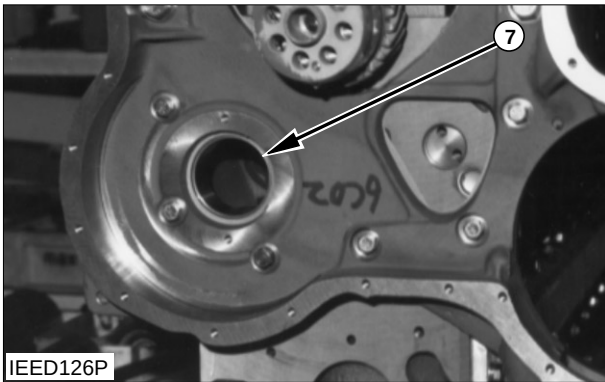
1. Remove four bolts (1), washers that hold camshaft gear (2) in place.
2. Remove camshaft gear (2) from the camshaft.



3. Remove bolts (3), washers and flange (4) from the camshaft.

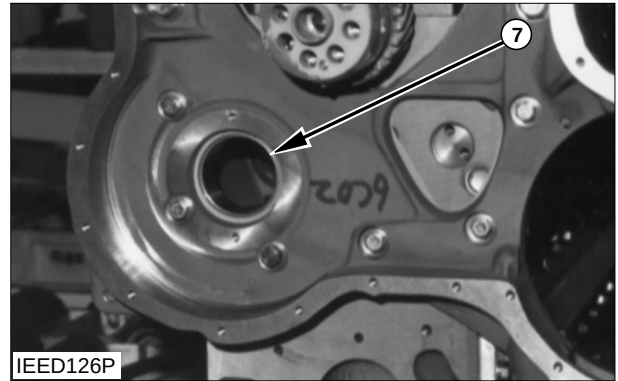


4. Remove camshaft assembly (5) by carefully sliding it out from the block. Do not force shaft as damage can occur to the camshaft bearings.
5. Check the conditions of thrust washer (6) and replace thrust washer (6) if needed.



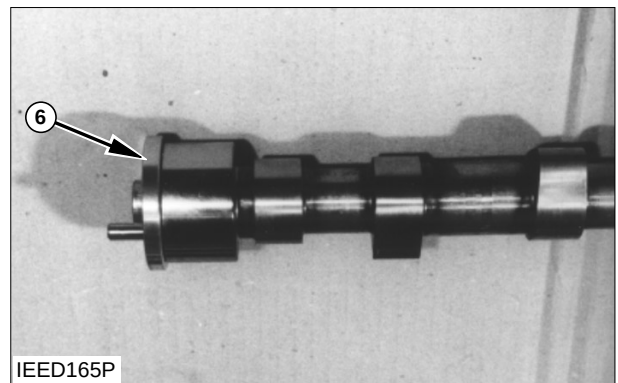
6. Remove camshaft bushes (7) from the block if necessary.

## Install Camshaft And Camshaft Bearing A17174 & A17078-03

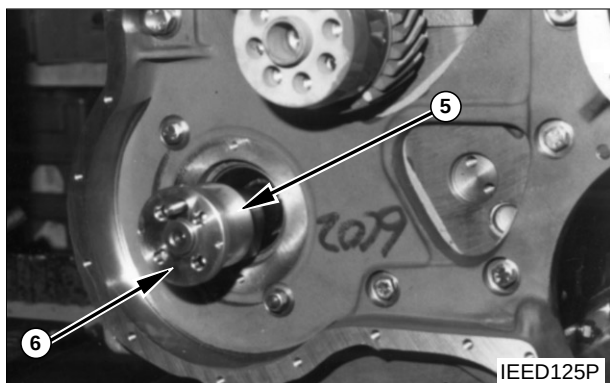


**NOTE :** Make an alignment of the oil holes in the bearing with the oil holes in the engine block.

1. Install a new bushes (7) in place in block if removed.

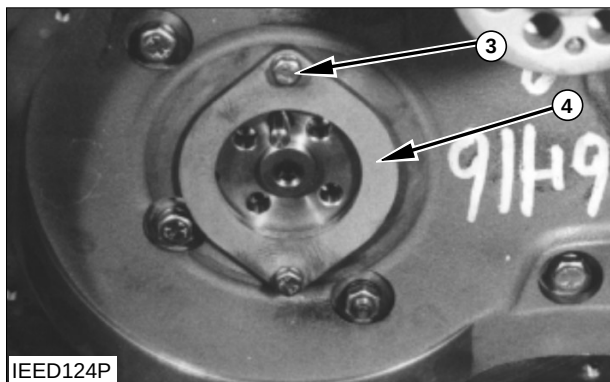


2. Install thrust washer (6). Make an alignment of the hole in the washer and the dowel in the camshaft.

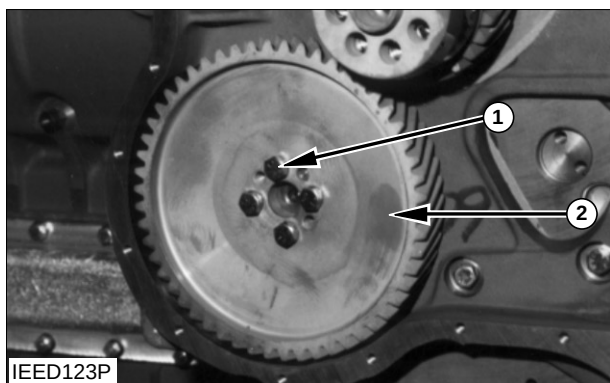


3. Clean engine oil to the cams and journals of the camshaft and the camshaft bushes, then install camshaft (5) in position in the cylinder block.

**NOTE :** When installing camshaft, exercise care not to scratch camshaft bearings.



4. Put flange (4) in place and install washers and bolts (3) that hold the flange.



5. Put camshaft gear (2) in position on the camshaft and install washers and bolt (1) that hold camshaft gear (2) in the camshaft.

End By :

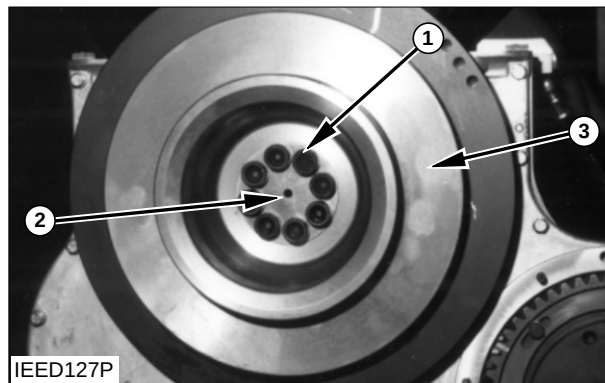
- a. Install timing gears.
- b. Install rocker shaft and push rods.

## Crankshaft Pulley

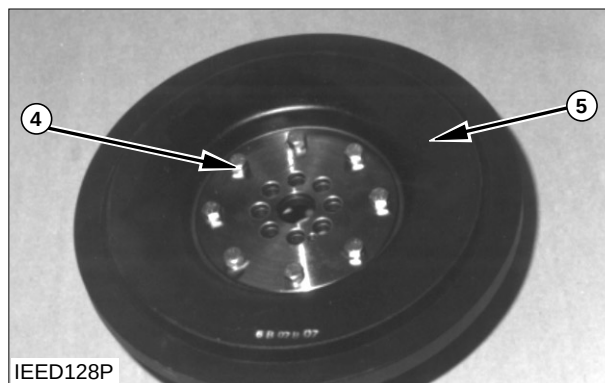
### Remove Crankshaft Pulley A12660-02

Start By :

- a. Remove fan belts

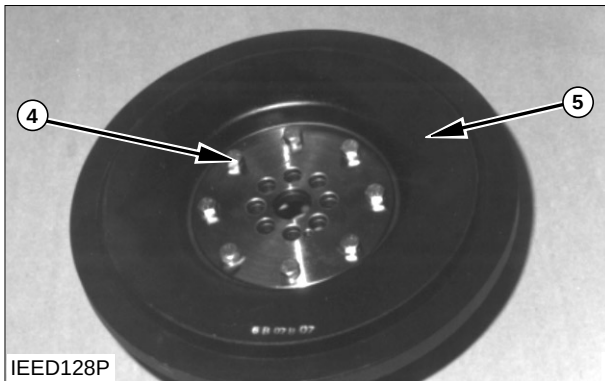


1. Remove eight bolts (1) and thrust washer (2) that hold crankshaft in place. Remove crankshaft pulley (3).

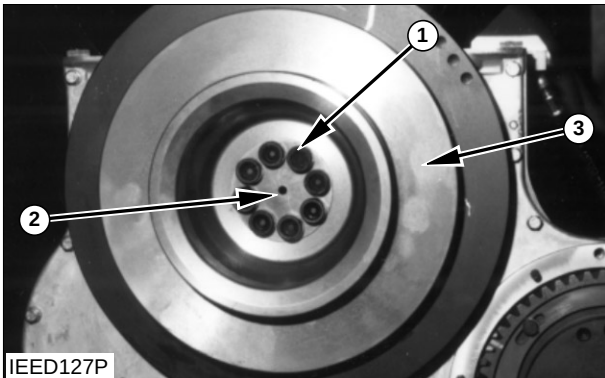


2. Remove eight bolts (4) and washers and separate the crankshaft pulley and vibration damper (5).

## Install Crankshaft Pulley A12660-03



1. Put vibration damper (5) in position on the crankshaft pulley. Install washers and bolts (4) that hold them.



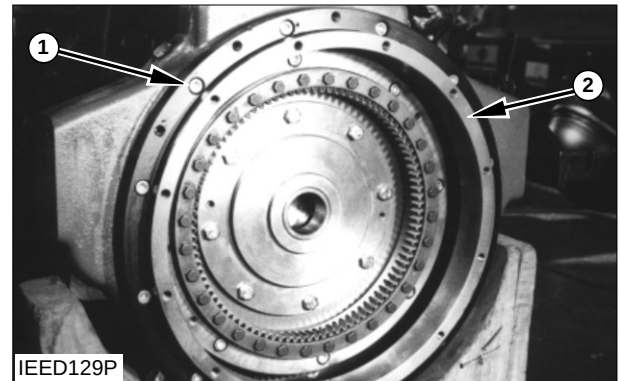
2. Put crankshaft pulley (3) in position on the crankshaft. Install thrust washer (2) and bolts (1) that hold crankshaft pulley. Tighten bolts (1) to a torque of **130 N•m (96 lb•ft)**.

## Flywheel

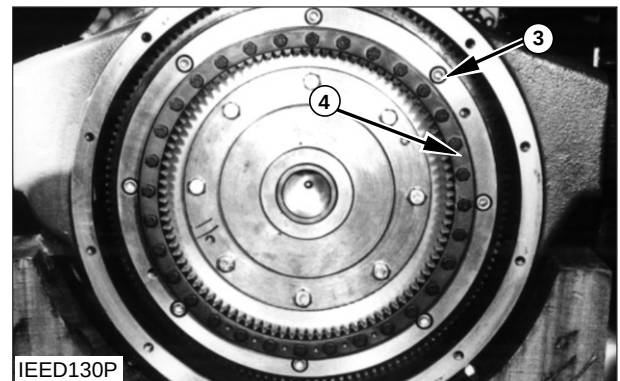
### Remove Flywheel

Start By :

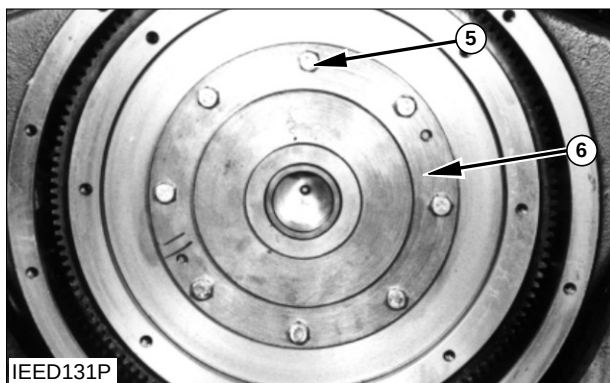
- a. Separation of engine and transmission



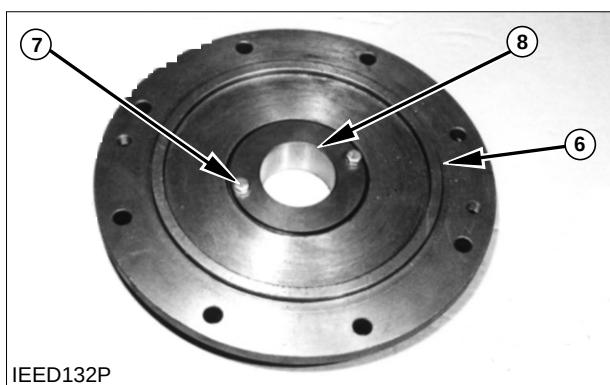
1. Remove bolts (1) that hold adapter (2) in place.
2. Remove adapter (2) from the flywheel housing.



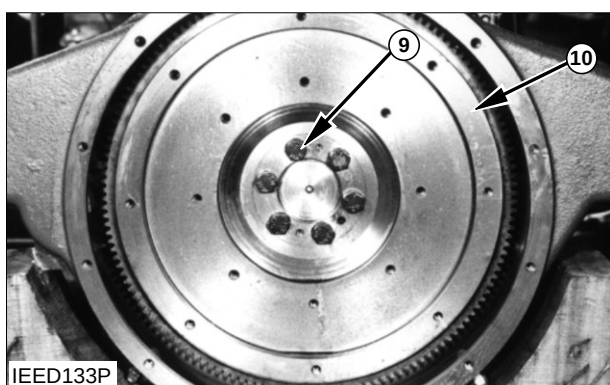
3. Remove eight bolts (3) and washers that hold adapter and ring gear assembly (4) on the flywheel.
4. Remove adapter and ring gear assembly (4) from the flywheel.



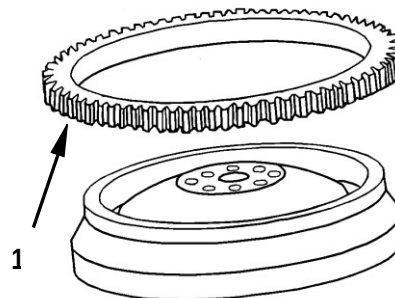
5. Remove bolts (5) and washers that hold adapter (6) on the flywheel.
6. Remove adapter (6) from the flywheel.



7. Remove two bolts (7) and washers that hold bushing on adapter (6).
8. Replace bushing (8) with new one if they was worn or damaged.



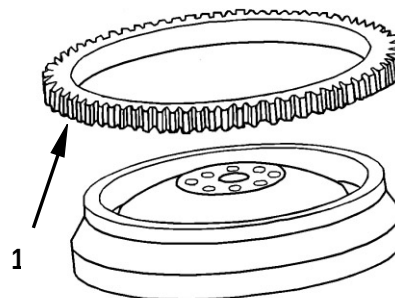
9. Remove two bolts opposite each other and install two M14x1.5 guide bolts in the flywheel.
10. Remove the remainder of bolts (9) and then remove flywheel (10).



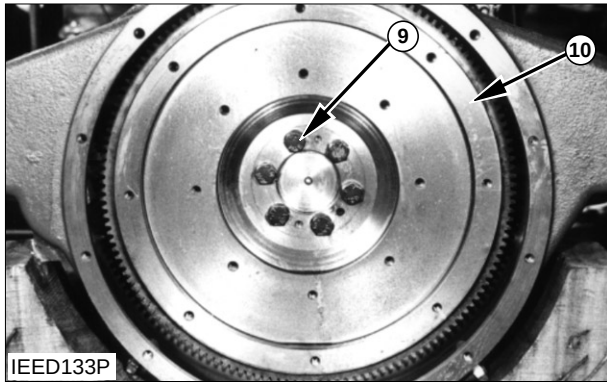
11. Remove flywheel ring gear (11) with a brass punch. If necessary, put a little heat on the flywheel ring gear.

## Install Flywheel A13366-03

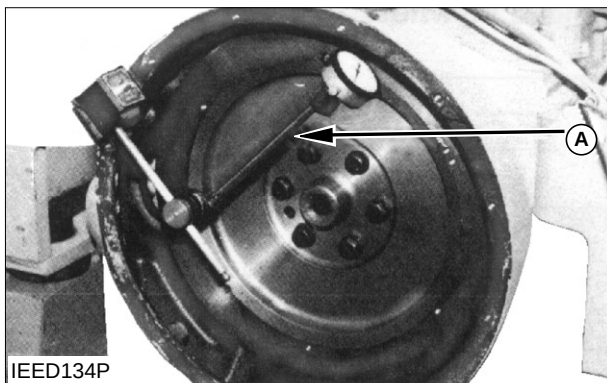
| Tools Needed         | A |
|----------------------|---|
| Dial Indicator Group | 1 |



1. Heat ring gear (11) to a maximum temperature of 246°C (475°F). Install the ring gear so the chamfer on the gear teeth is next to the starter pinion when the flywheel is installed.



2. Install two M14x1.5 guide bolts in opposite holes of the crankshaft flange.
3. Install enough bolts (9) with Loctite No.271 to hold flywheel (10) in position. Remove guide bolts.
4. Install remainder of bolts (9). Tighten bolts (9) to a torque of **180 N•m (133 lb•ft)**.



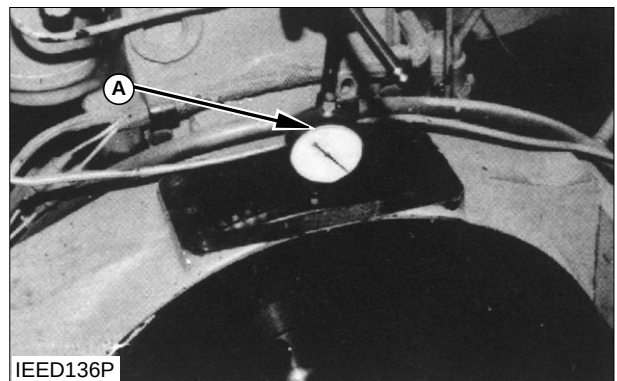
Typical Example

5. Check the flywheel face runout as follows:
  - a. Install tool group (A) as shown. Move the crankshaft the same way before the indicator is read so the crankshaft end clearance (movement) is always removed.
  - b. Set the dial indicator to read **0.0 mm (.000 in.)**.
  - c. Turn the flywheel and read the indicator every 90°
  - d. The difference between the lower and higher measurements taken at all four points must not be more than 0.20mm (.008in.) which is the maximum permissible face runout (axial eccentricity) of the flywheel.



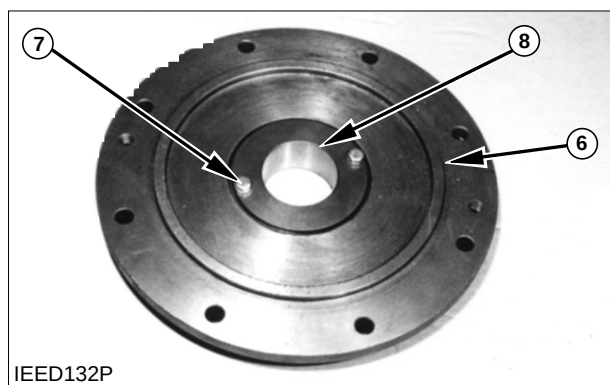
Typical Example

6. Check the pilot bore runout of the flywheel as follows:
  - a. Install tool group (A) as shown.
  - b. Set the dial indicator to read 0.0 mm (.000 in.).
  - c. Turn the flywheel and read the indicator at 90° intervals.
  - d. The difference between the lower and higher measurements taken at all four points must not be more than 0.30 mm (.012 in.) which is the maximum pilot bore runout (eccentricity) of the flywheel.

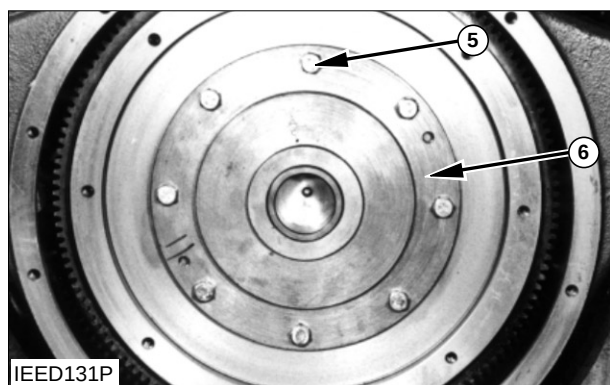


Typical Example

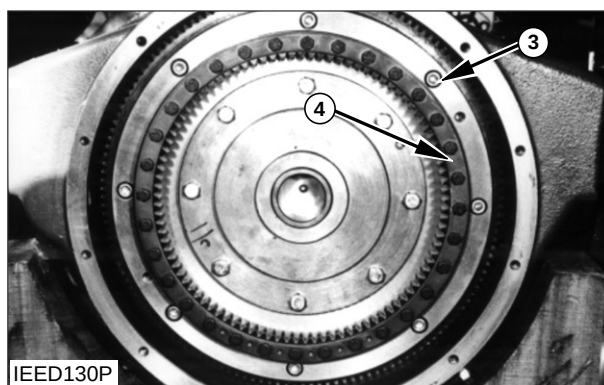
7. Check the outside diameter runout of the flywheel as follows:
  - a. Install tool group (A) at top dead center of the flywheel as shown. Mount the dial indicator to the flywheel housing or the engine block.
  - b. Set the dial indicator to read **0.0 mm (.000 in.)**.
  - c. Turn the flywheel and read the indicator every 90° .
  - d. The difference between the lower and higher measurements taken at all four points must not be more than 0.30 mm (.012 in.) which is the maximum permissible outside diameter runout (eccentricity) of the flywheel.



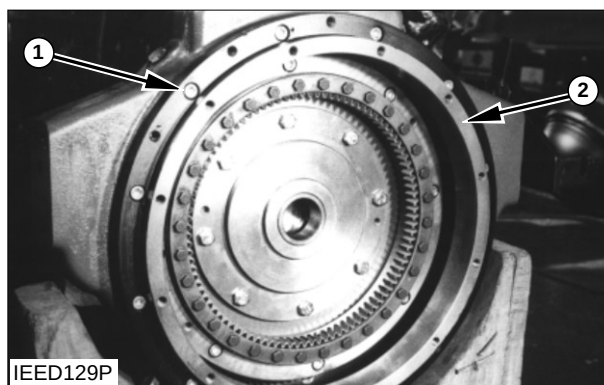
8. Install bushing (8) in position on adapter (6) and tighten bolts (7) to a torque of  $12 \pm 4 \text{ N} \cdot \text{m}$  ( $106 \pm 35 \text{ lb} \cdot \text{in}$ ).
9. Put the anti-seize compound (FEL-PRO C5-A) inside of bushing (8).



10. Put adapter (6) in position and install bolts (5) and washers that hold adapter (6) on the flywheel. Tighten bolts (5) to a torque of  $55 \pm 10 \text{ N} \cdot \text{m}$  ( $40 \pm 7 \text{ lb} \cdot \text{ft}$ ).



11. Put the adapter and ring gear assembly (4) in position and install bolts (3) and washers that hold adapter and ring gear assembly (4) on the flywheel. Tighten bolts (3) to a torque of  $55 \pm 10 \text{ N} \cdot \text{m}$  ( $40 \pm 7 \text{ lb} \cdot \text{ft}$ ).



12. Put adapter (2) in position and install bolts (1) that hold adapter (2) on the flywheel housing. Tighten bolts (1) to a torque of  $55 \pm 10 \text{ N} \cdot \text{m}$  ( $40 \pm 7 \text{ lb} \cdot \text{ft}$ ).

End By :

- a. Connection engine and transmission.

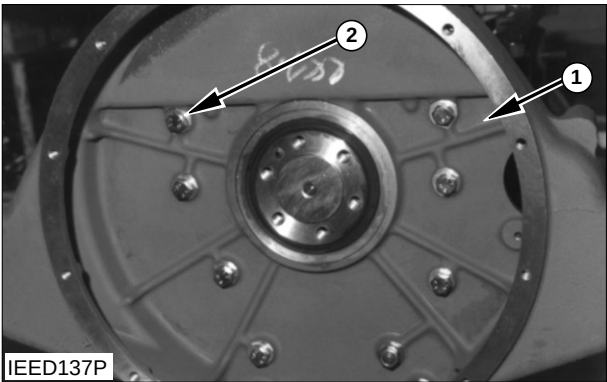
# Flywheel Housing

## Remove Flywheel Housing A11453-02

| Tools Needed | A |
|--------------|---|
| Link Bracket | 1 |

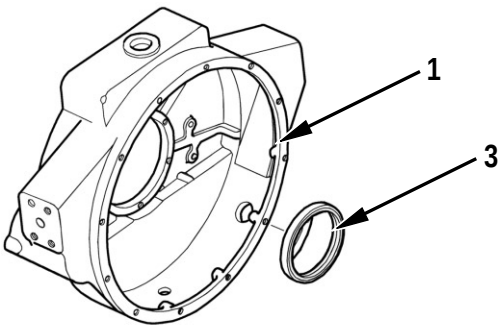
Start By :

- a. Remove flywheel
- b. Remove electric starting motor



1. Fasten tool (A) and a hoist to the flywheel housing. Remove bolts (2) to remove housing (1)

**NOTE :** Flywheel housing is put in a location with dowels.

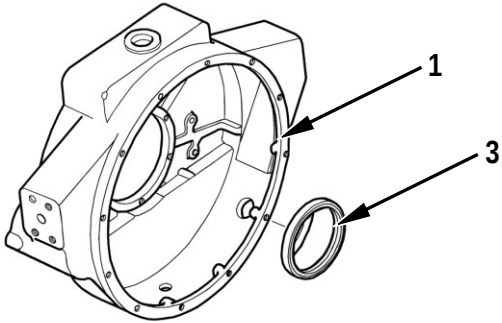


IEED008S

2. Remove lip type seal (3) from flywheel housing (1) and discard it.

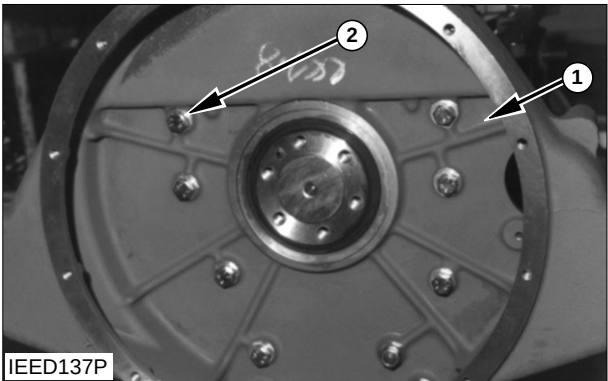
## Install Flywheel Housing A11453-03

| Tools Needed   | A | B |
|----------------|---|---|
| Link Bracket   | 1 |   |
| Seal Installer |   | 1 |



IEED008S

1. Install lip type seal (3) in flywheel housing (1) using tool (B).



2. Fasten tool (A) and a hoist to the flywheel housing.
3. Put flywheel housing (1) in position on the dowels. Install bolts (2) that hold it in position. Tighten bolts (2) to a torque of **80 N•m (60 lb•ft)**.

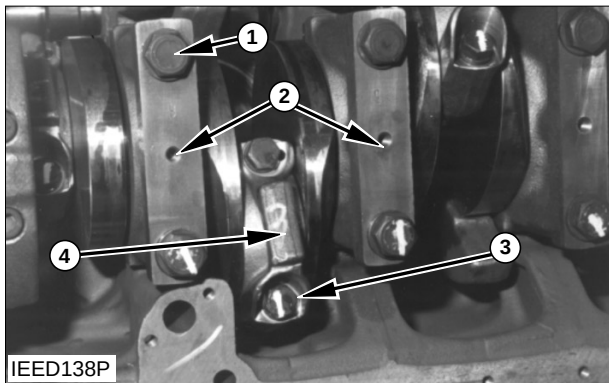
# Crankshaft

## Remove Crankshaft A12264-02

| Tools Needed              | A |
|---------------------------|---|
| Spuller Assembly          |   |
| Ratchet Box Wrench        |   |
| Bearing Puller Attachment |   |
| Step Plate                |   |

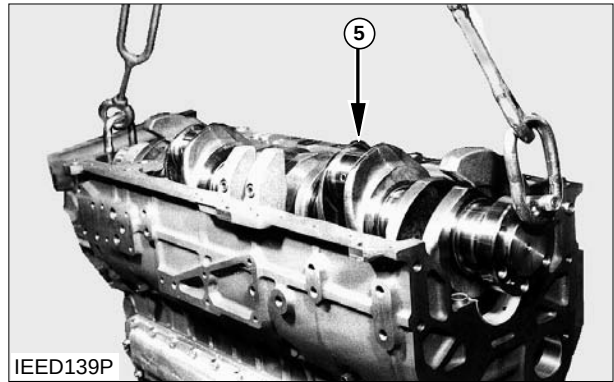
Start By :

- a. Remove oil pump
- b. Remove timing gear case
- c. Remove flywheel housing

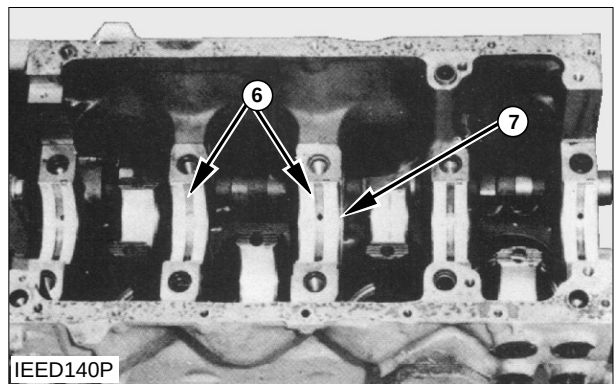


**NOTE :** Put identification on the main bearings and the thrust washers for correct installation if used again.

1. Remove bolts (1). Remove crankshaft main bearing caps (2). Remove the lower main bearing halves from the caps and the thrust washers from the outer main cap.
2. Remove bolts (3). Remove connecting rod caps (4).

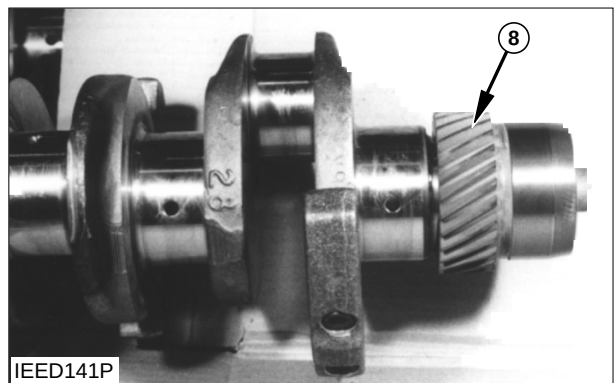


3. Fasten straps and a hoist to the crankshaft
4. Remove crankshaft (5).



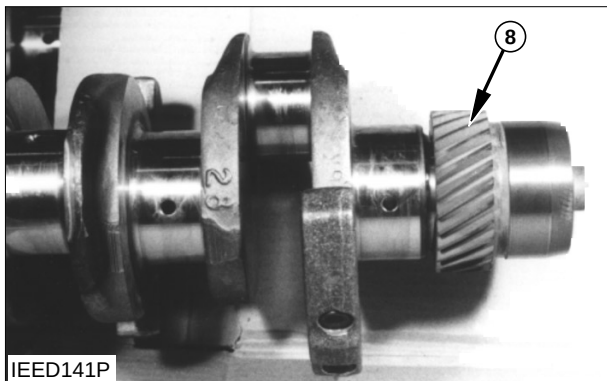
Typical Example

5. Remove upper main bearing halves (6).
6. Remove thrust washers (7) from the center main.

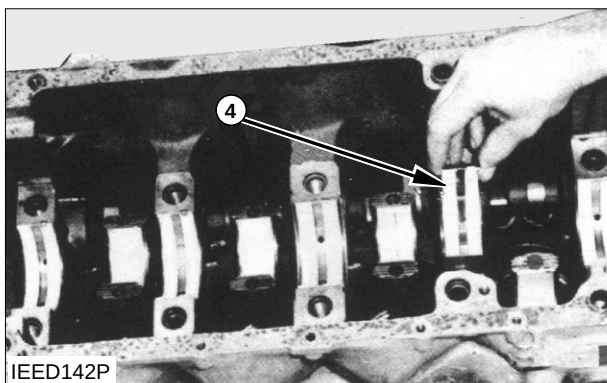


7. Remove gear (8) from the crankshaft with tool (A). Remove the dowel.

## Install Crankshaft A12264-03



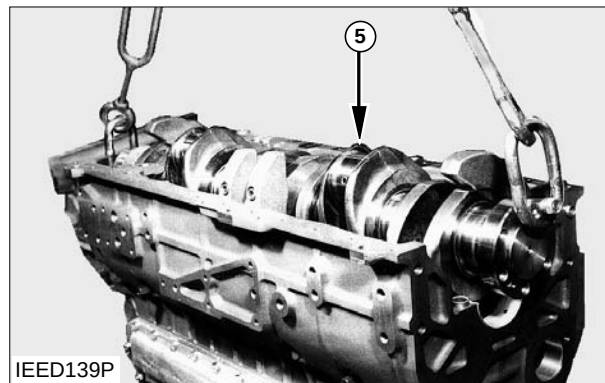
1. Check all parts for damage. If damaged, use new parts for replacement.
2. Make sure all parts are clean and free of dirt and foreign material.
3. Install dowel and gear (8) on the crankshaft.



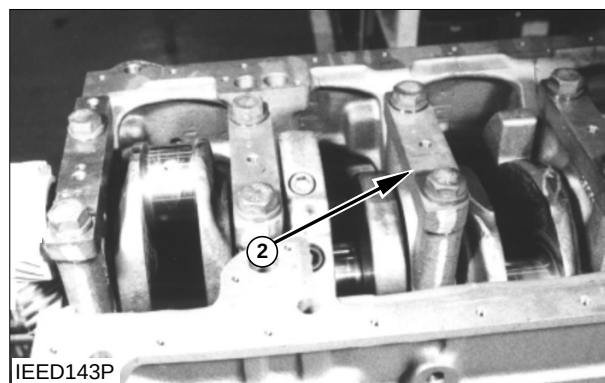
Typical Example

**NOTE :** Put clean engine oil on the crankshaft main journals, the main bearings and thrust washers. The upper main bearing halves have a long oil groove (slot). If the same bearings and thrust washers are used again, install as per identification.

4. Put upper main bearing halves (4) in position. The tabs on the bearings must be in alignment with the notches in the housing. Install the thrust washers in the center main housing. The steel side of the thrust washers must be next to or toward the engine block and the cap.



5. Fasten two straps and a hoist to crankshaft(5). Put the crankshaft in position. Remove the hoist and the straps.



Typical Example

6. Install lower main bearing halves (2) in the caps. The tabs on the bearings must be in alignment with the notches in the caps. Install the thrust washers in the center main cap.

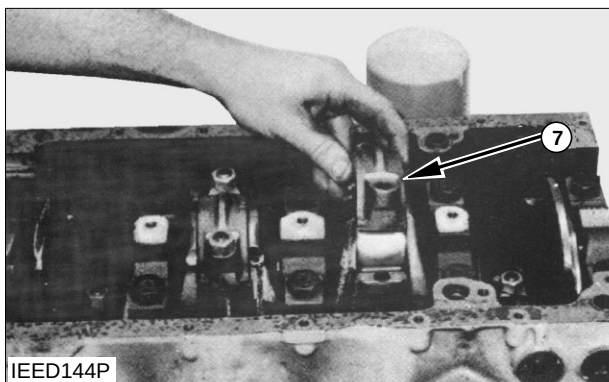
**NOTE :** The tabs of the lower main bearing halves must be on the same side as the tabs on the upper main bearing halves.

7. Install all bolt one of the main bearing caps as per identification.

**NOTE :** Do not turn the crankshaft as it will damage the plastigage.

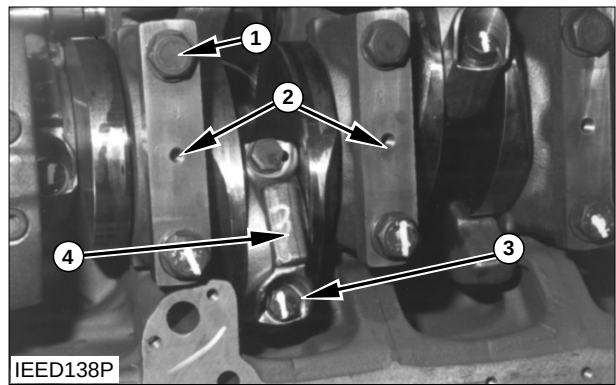
8. Put the plastigage in position on the lower main bearing half.

9. Put the bearing cap in position and tighten the bolts to a torque of **300 N•m (220 lb•ft)**.
10. Remove the main bearing cap and measure the Plastigage. The bearing clearance for new bearings must be **0.025 to 0.075 mm (.001 to .003 in.)**.
11. Put clean engine oil on the bearing and the crankshaft journal.
12. Install main bearing cap (2). Tighten the bolts to a torque of **300 N•m (220 lb•ft)**.
13. Do Steps 8 through 12 for the other main bearings.



Typical Example

14. Measure the crankshaft end play. The end play must be **0.15 to 0.325 mm (.006 to .013 in.)**.
15. Put clean engine oil on the connecting rod bolt threads. Install all bolt one of the connecting rod caps.
16. Use Plastigage to check the bearing clearance of the connecting rods. Install connecting rod cap (7) and tighten the to a torque of **180 N•m (133 lb•ft)**.



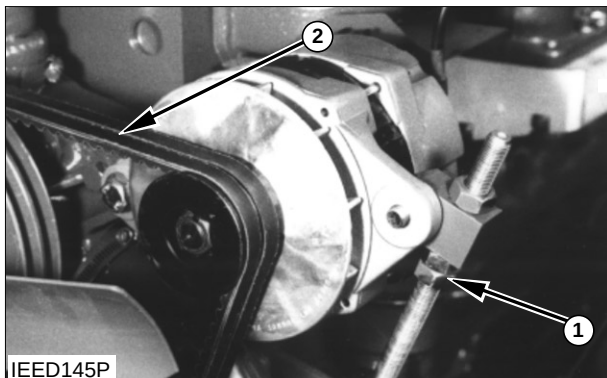
17. Remove the connecting rod cap and measure the Plastigage. The bearing clearance for new rod bearing must be **0.025 to 0.075 mm (.001 to .003 in.)**.
18. Put the connecting rod cap in position and install the nuts. Tighten the nuts to a torque of **180 N•m (133 lb•ft)**.
19. Do steps 16 through 18 for the other connecting rod caps.

End By :

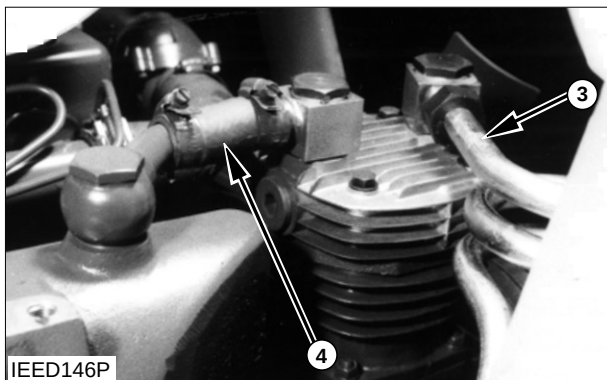
- a. Install flywheel housing.
- b. Install timing gear case.
- c. Install oil pump.

## Air Compressor (if equipped)

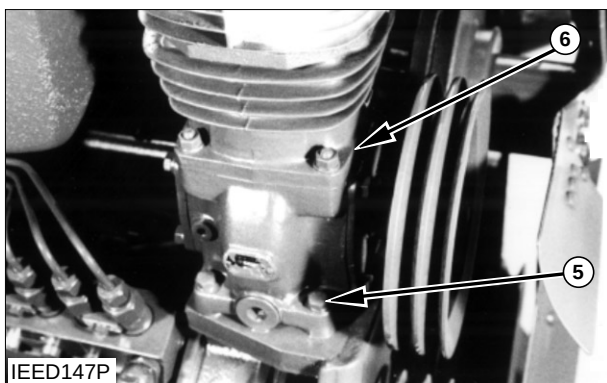
### Remove Air Compressor



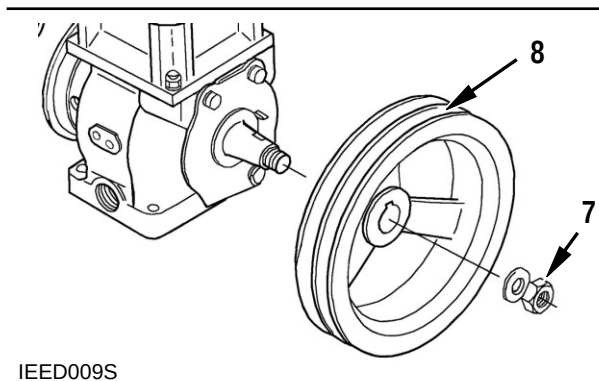
1. Loosen the tension adjusting bolts and nut (1) and nut attached on the idle pulley.
2. Take off V-belts (2).



3. Disconnect tube (3) from the air compressor.
4. Loosen clamp and disconnect hose (4).

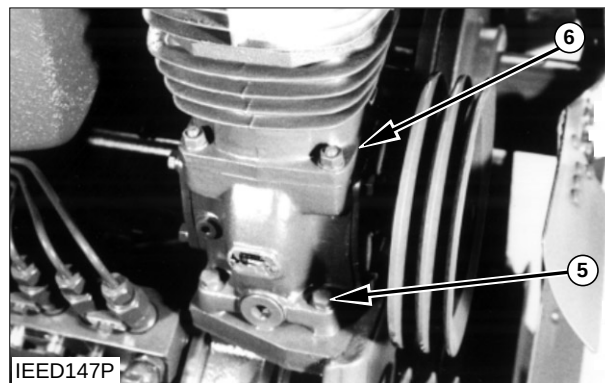


5. Remove four bolts (5) and washers that hold the air compressor assembly in place. Remove air compressor assembly (6).

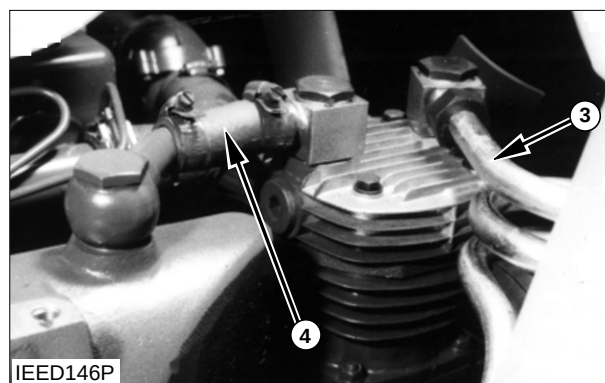


6. Remove nut (7), washer and pulley (8) from air compressor.

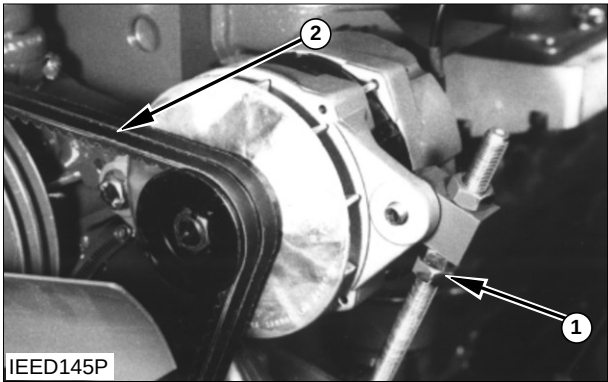
### Install Air Compressor



1. Put air compressor assembly (6) in position on the idle gear bracket.
2. Install bolts (5) and washers that hold it. Tighten bolts (5) to a torque of **22 N•m (16 lb•ft)**.



3. Connect oil supply tube (3) and air supply hose (4) on the air compressor. Tighten the hose clamp.



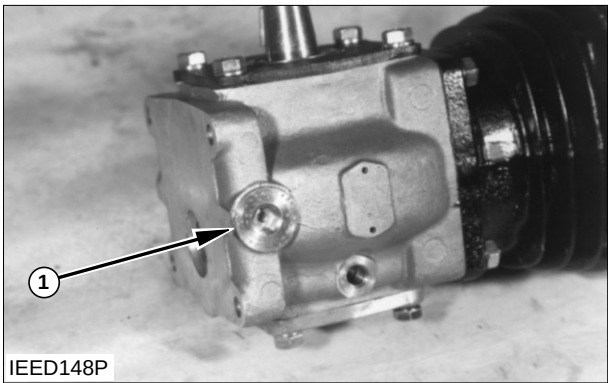
4. Assemble V-bolts (2) and adjust the tension of V-belt using tension adjusting bolt (1). Tighten tension adjusting bolts (1).

Disassemble Air Compressor

| Tools Needed   | A |
|----------------|---|
| Bearing Puller | 1 |

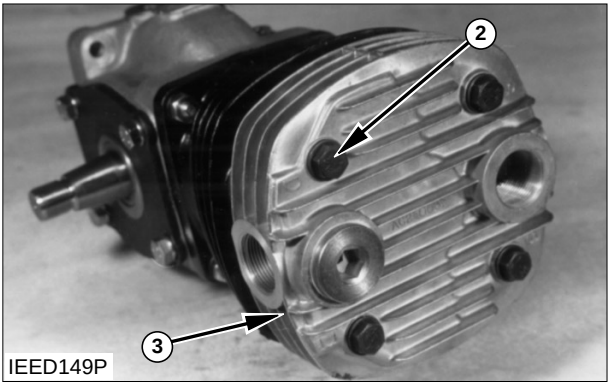
Start By :

a. Remove air compressor



1. Remove plug (1) and drain oil from the crankcase.

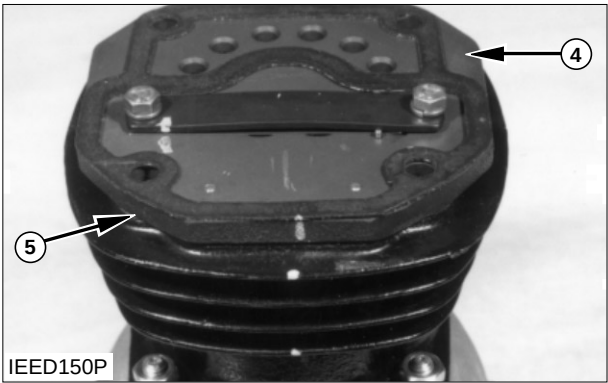
NOTE : For the purpose of reassembly, put Loctite No.572 on plug (1).



2. Remove four bolts (2) and washers that hold the cylinder head on the cylinder.

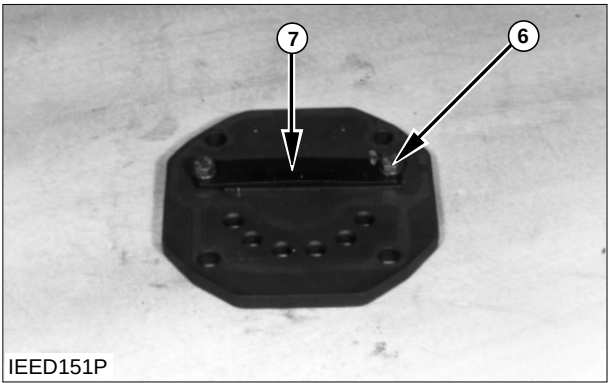
NOTE : For the purpose of reassembly, tighten bolts (2) to a torque of 25 ~ 31 N•m (19 ~ 23 lb•ft).

3. Remove cylinder head (3).

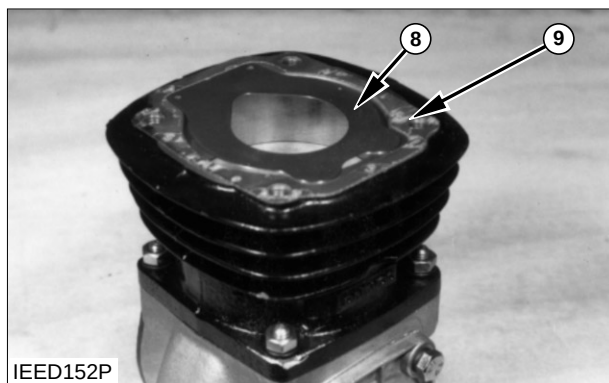


4. Remove gasket (4) and discard it.

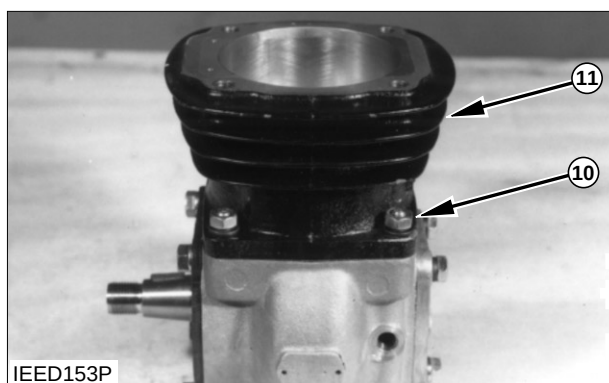
5. Remove seat plate assembly (5) from the cylinder.



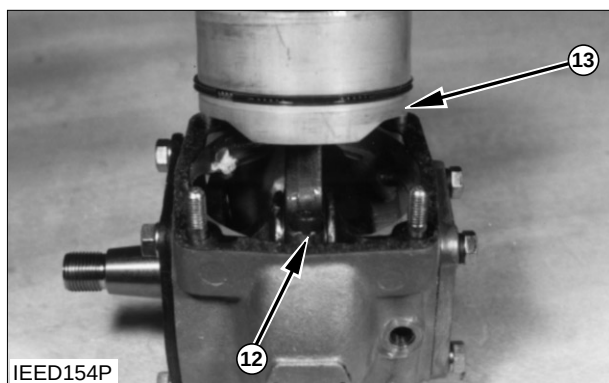
6. Remove two bolts (6), washers, pressure catcher (7) and disc if needed.



7. Remove suction disc (8).
8. Remove gasket (9) and discard it.

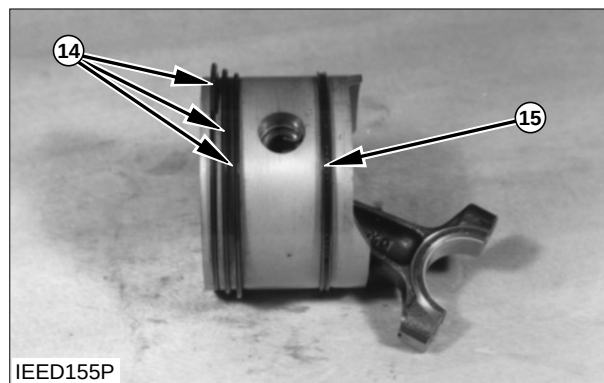


9. Remove four nuts (10) and washers that hold cylinder (11) on the crankcase.
- NOTE :** For the purpose of reassembly, tighten nuts (10) to a torque of  $17 \sim 21 \text{ N}\cdot\text{m}$  ( $150 \sim 186 \text{ lb}\cdot\text{ft}$ ).
10. Remove cylinder (11) from the crankcase.
  11. Remove gasket and discard it.



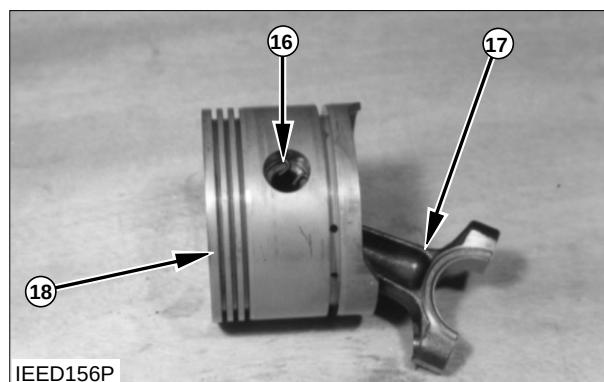
12. Remove two bolts (12) and separate piston and connecting rod assembly (13) from the crankshaft.

**NOTE :** For the purpose of reassembly, tighten bolts (12) to a torque of  $27 \sim 32 \text{ N}\cdot\text{m}$  ( $20 \sim 24 \text{ lb}\cdot\text{ft}$ )



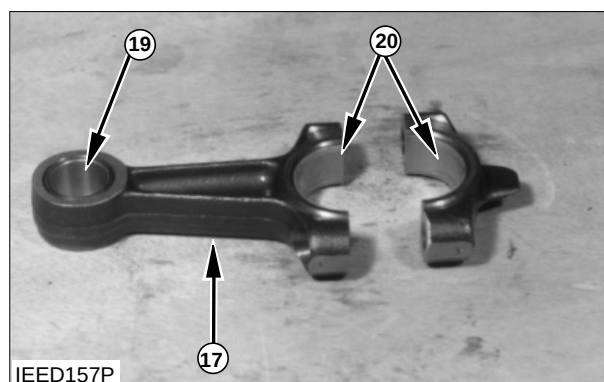
**NOTE :** Put identification on all parts for correct assembly.

13. Remove three oil rings (14) and wiping ring (15) using a piston ring expander.

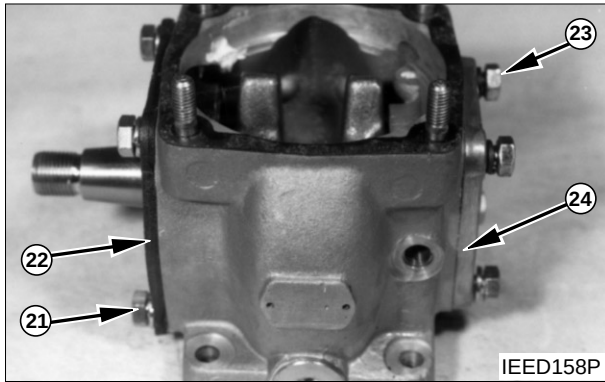


14. Remove piston pin (16) and snap rings from both side of the piston using snap ring plier.

15. Remove piston pin (16) and connecting rod (17) from piston (18).



16. Inspect bushings (19) and (20) in connecting rod (17). If the bushings has a large amount of wear, make a replacement of the bushing.

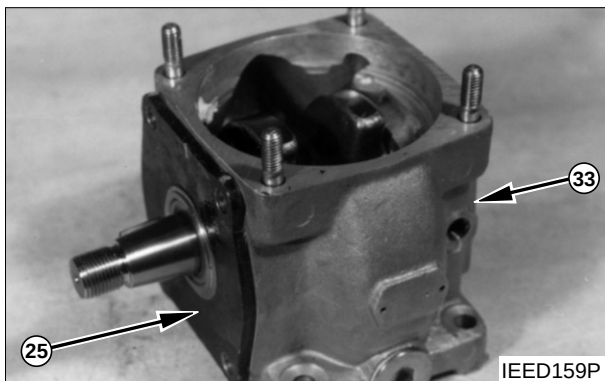


**17.** Remove four bolts (21) and washers that hold bearing cover (22) on the crankcase.

**NOTE :** For the purpose of reassembly, put Loctite No.572 on bolt thread and tighten bolts (21) to a torque of **17 ~ 21 N•m (150 ~ 186 lb•ft)**.

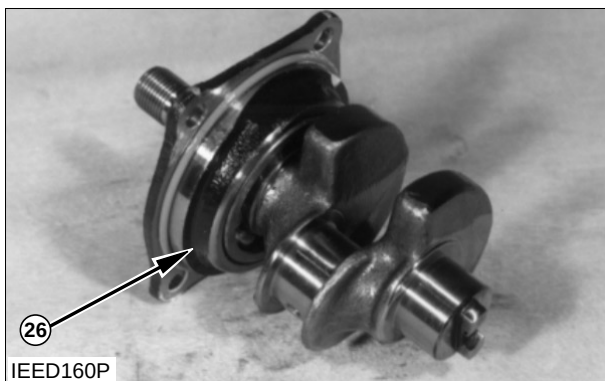
**18.** Remove four bolts (23), washers and end cover (24) from the crankcase.

**19.** Remove gasket and discard it.

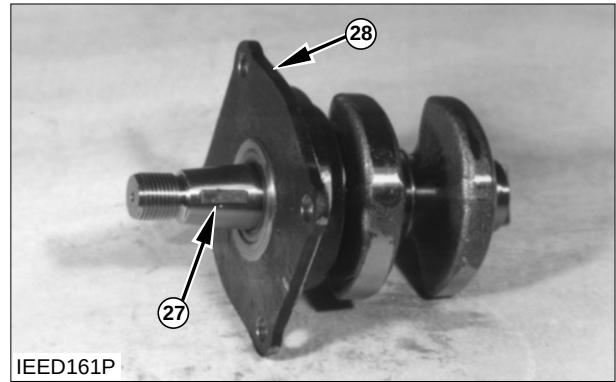


**20.** From rear of crankcase tap crankshaft from crankcase (33).

**21.** Remove the crankshaft assembly and bearing cover (25) as a unit.

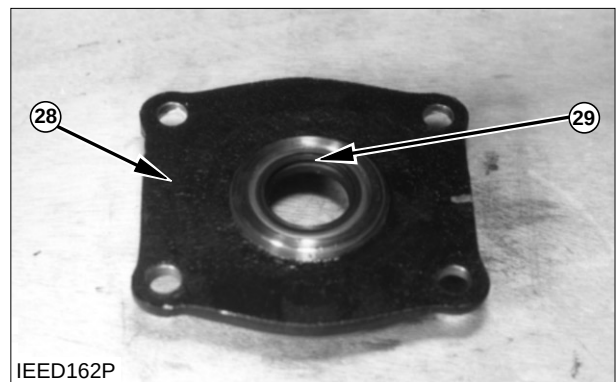


**22.** Remove O-ring (26) from the bearing cover.

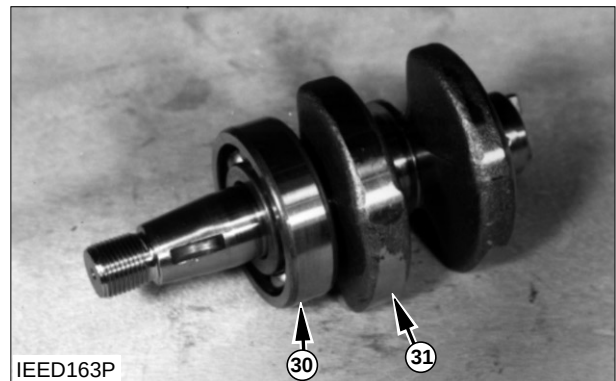


**23.** Remove woodruff key (27) from the crankshaft.

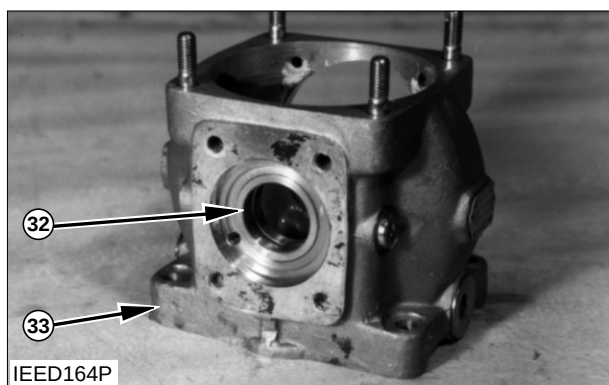
**24.** Remove bearing cover (28) using tool (A).



**25.** Remove oil seal (29) from bearing cover (28).



**26.** Remove bearing (30) from crankshaft (31).



**27.** Inspect bushing (32) in the crankcase (33). If the bushing has a large amount wear, replace with new one.

**28.** Assemble the air compressor assembly in reverse order of disassembly.

End By :

**a.** Install air compressor.