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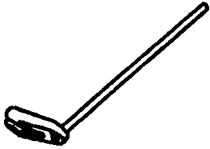

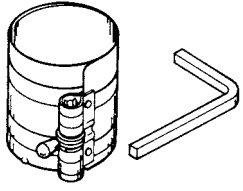
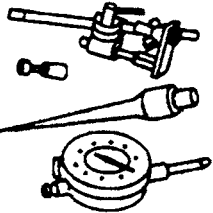
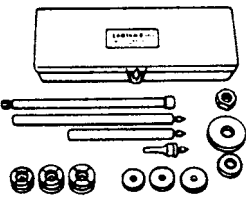
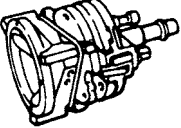
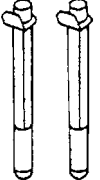

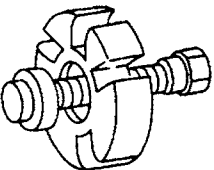
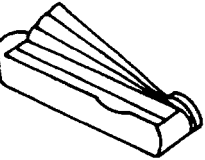
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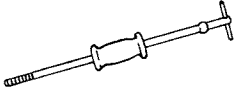
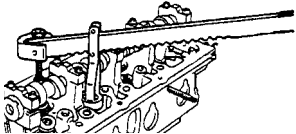
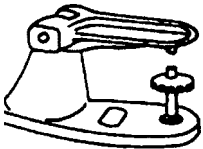
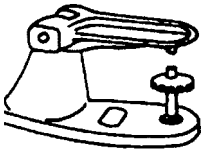
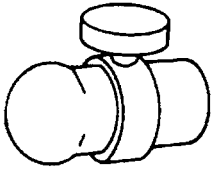
**NOTE:** For engine diagnosis, refer to Section 01.

GENERAL INFORMATION

Special Tools

	<p>Valve Spring Compressor T81P-6513-A or Equivalent</p>		<p>Seal Remover T92C-6700-CH or Equivalent</p>
	<p>Piston Ring Compressor D81L-6002-C or Equivalent</p>		<p>Dial Indicator with Bracketry TOOL-4201-C or Equivalent</p>
	<p>Camshaft Bearing Set T65L-6250-A or Equivalent</p>		<p>Cylinder Ridge Reamer T64L-6011-EA or Equivalent</p>
	<p>Connecting Rod Guide Tool T93P-6136-A or Equivalent</p>		<p>Vibration Damper Remover Adapter T82L-6316-B or Equivalent</p>
	<p>Crankshaft Damper Remover T58P-6316-D or Equivalent</p>		<p>Feeler Gauge D81L-4201-A or Equivalent</p>

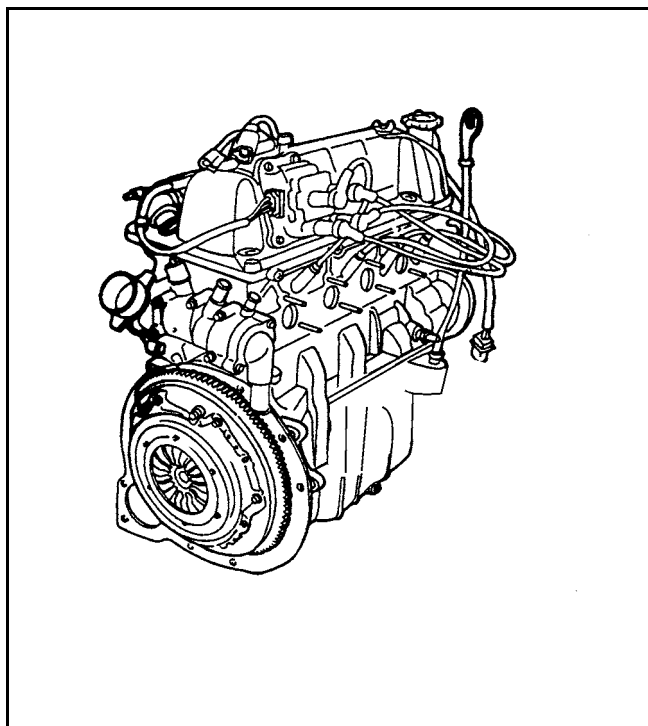
Special Tools

 <p>FPP10000</p>	<p>Impact Slide Hammer T50T-100-A or Equivalent</p>		<p>Valve Seal Tool 21-024 or Equivalent</p>
 <p>FPP10035</p>	<p>Pound/Inch Torque Wrench Purchase from Local Tool Dealer</p>		<p>Extra space</p>
 <p>FPP10035</p>	<p>Spring Tester 303-006 or TOOL-6513-DD or Equivalent</p>		<p>Extra space</p>
 <p>FPP10034</p>	<p>Valve Clearance Measuring Tool 100-002 or TOOL-6505-E or Equivalent</p>		<p>Extra space</p>
	<p>Spring Testing Fixture 21-024 or Equivalent</p>		<p>Extra space</p>

## Description

The 1.6L 4 cylinder Zetec Rocam engine has been developed with the highest technology. Its main characteristics are:

- electronic controlled multipoint sequential injection
- roller finger follower camshaft
- intake manifold made of aluminum
- high resistance aluminum cylinder head
- steel oil pan.



## Fuel System

The electronic fuel injection (EFI) system is electronically controlled by an ECM module which carefully controls fuel-air mixture along with spark timing, depending on information received from various sensors.

## Intake Manifold

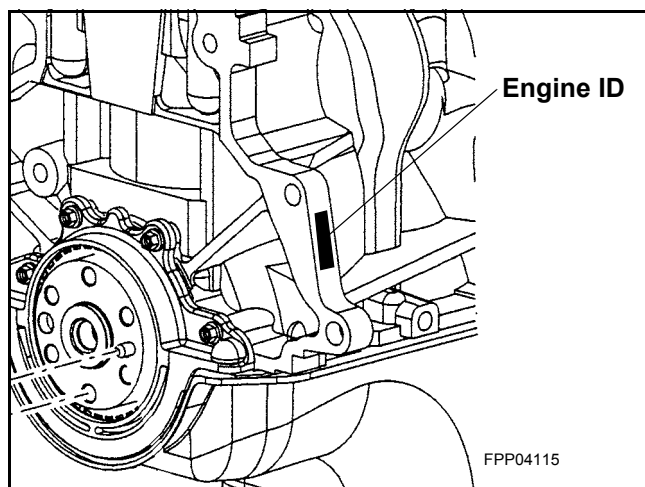
The intake manifold is made of aluminum. It consists of two pieces.

## Cylinder Head

The Zetec Rocam engine cylinder head is entirely made of aluminum which improves the thermal characteristics and reduces weight. The assembly is attached using a multi layer steel gasket and 12 bolts.

## Oil Pan

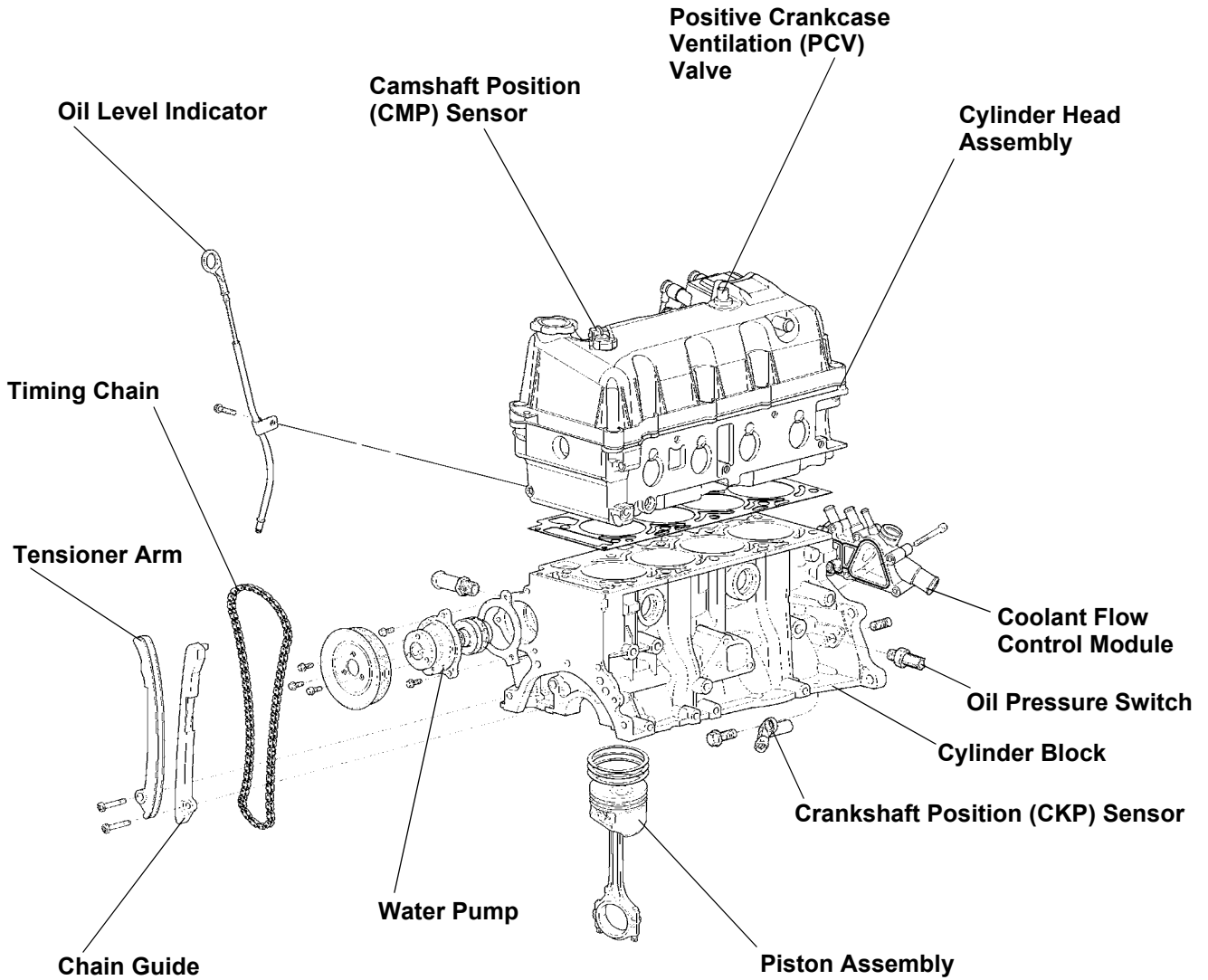
The Zetec Rocam engine oil pan is made of steel. The gasket must always be replaced whenever the oil pan is removed.



## Engine Identification Number

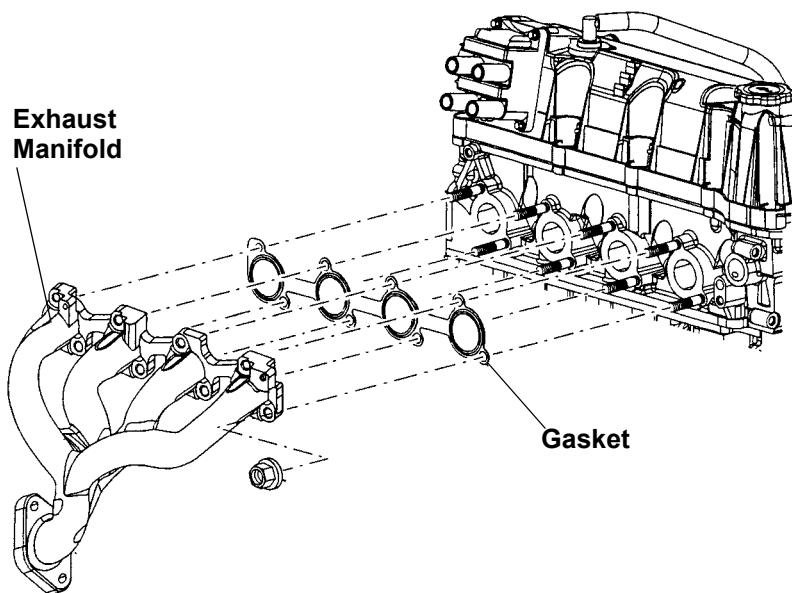
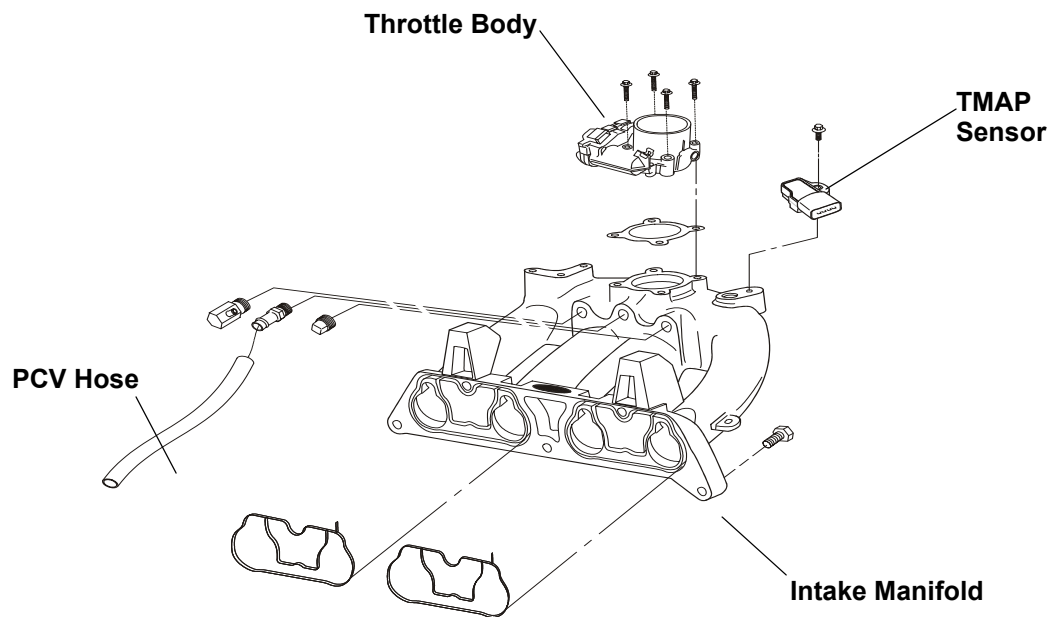
The engine identification number is marked on the right side of the cylinder block as shown.

Component Location

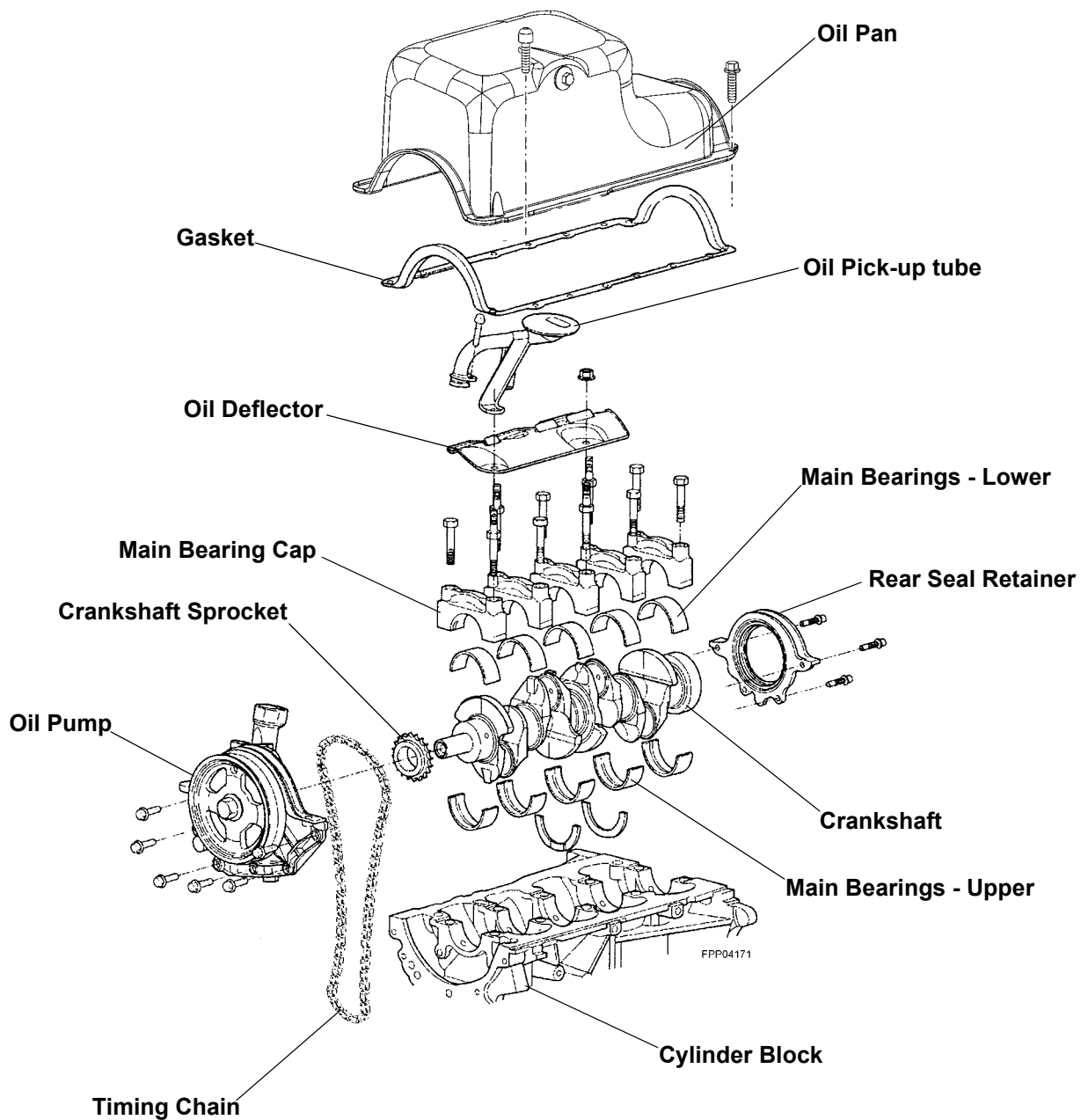


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Component Location

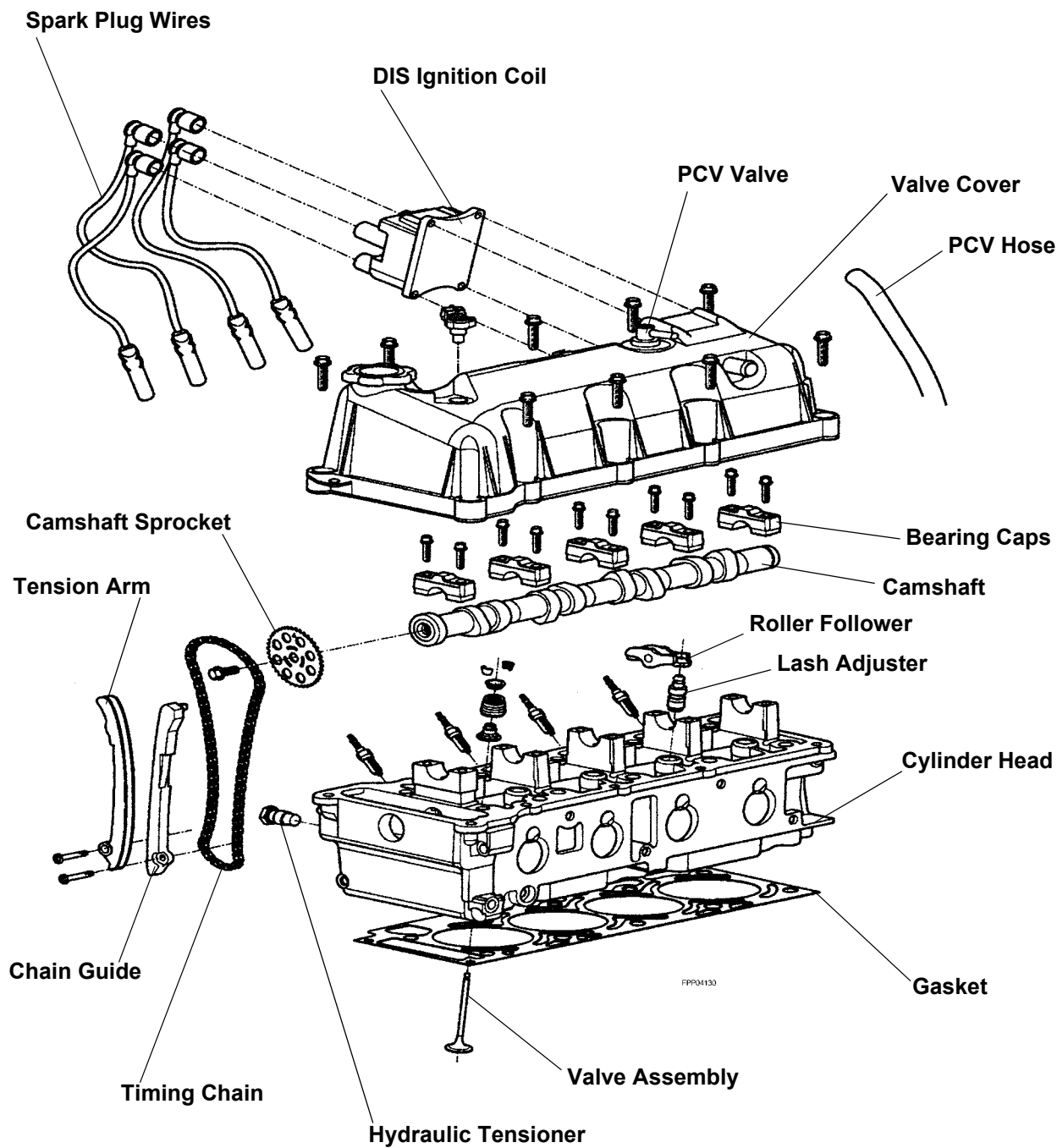


Component Location





Component Location

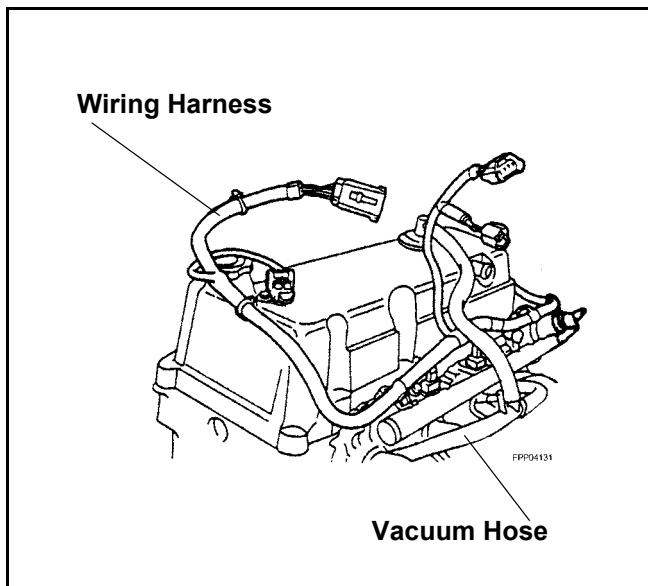


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## ENGINE REPAIR

### Valve Cover - Removal

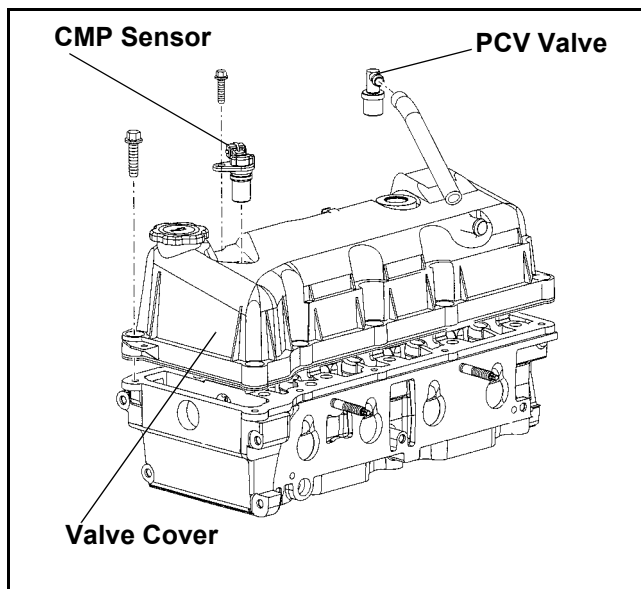
1. Remove any necessary wiring and vacuum hoses. Mark connections and routing as necessary to assure they are returned as they were removed.



- 2.
- 3.
4. Remove DIS coil and set aside - refer to Section 03.
5. Remove bolts.
6. Remove valve cover and gasket.

### Valve Cover - Installation

1. Contact surfaces must be clean and free of oil.
2. Install a new gasket and valve cover.

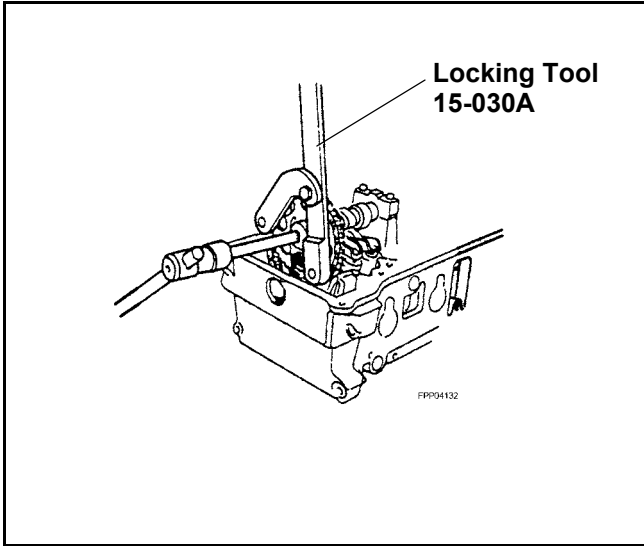


3. Install bolts. Tighten to 7 lb.ft. (9 Nm). (?any sequence ?).
4. Install DIS coil - refer to Section 03.
- 5.
- 6.
7. Reconnect any wiring and vacuum hoses removed.

### Camshaft- Removal

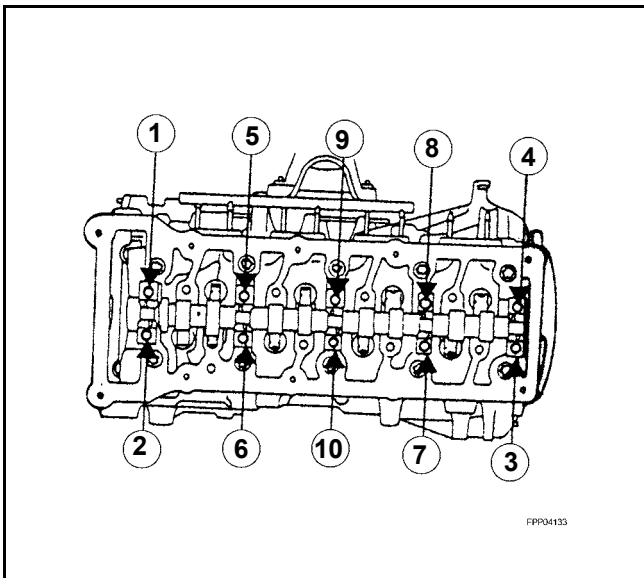
**NOTE:** Store components to ensure assembly in the same order as they were removed.

1. Remove valve cover -- Refer to "Valve Cover - Removal" on page 10.
2. Using tool 15-030A to lock camshaft sprocket, remove bolt.

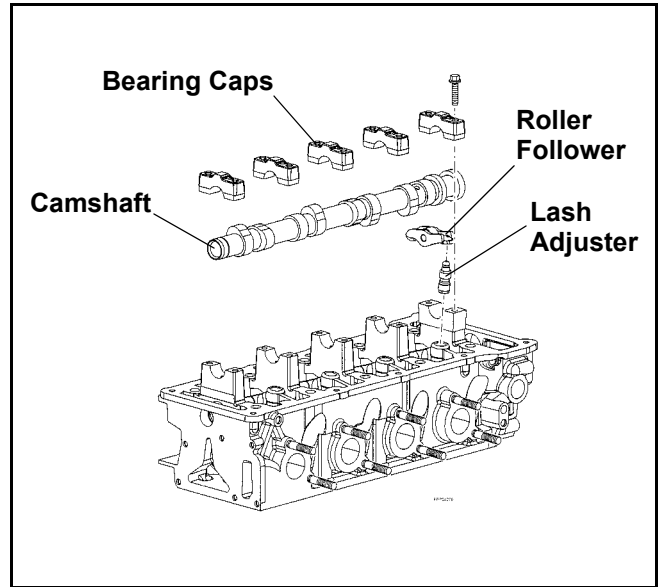


**CAUTION:** During camshaft removal, the camshaft sprocket and chain must remain engaged and the chain tensioned in order to keep timing links aligned. If chain is allowed to slacken or disengage with sprocket, the oil pump will have to be removed, and the timing chain realigned - refer to timing chain assembly xxx.

3. Separate camshaft sprocket and chain from camshaft while maintaining tension on the chain.
4. Remove bolts and camshaft bearing caps evenly in the sequence shown.



5. Remove camshaft, lower bearings, roller followers and lash adjusters.



6. ?

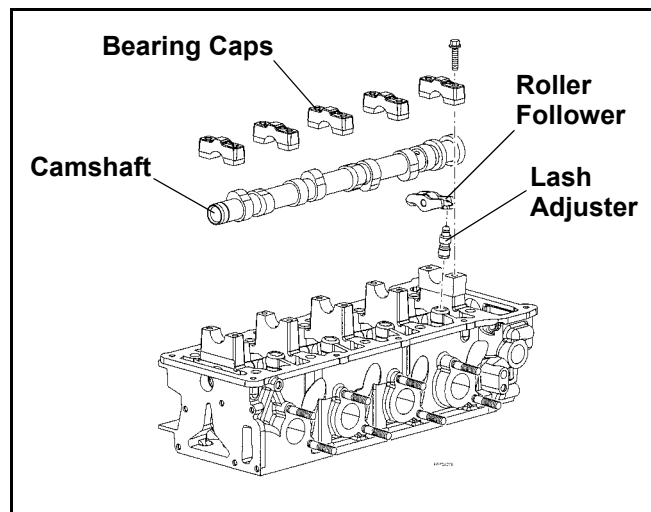
7. ?

Refer to Section 01 for camshaft and bearing service.

## Camshaft - Installation

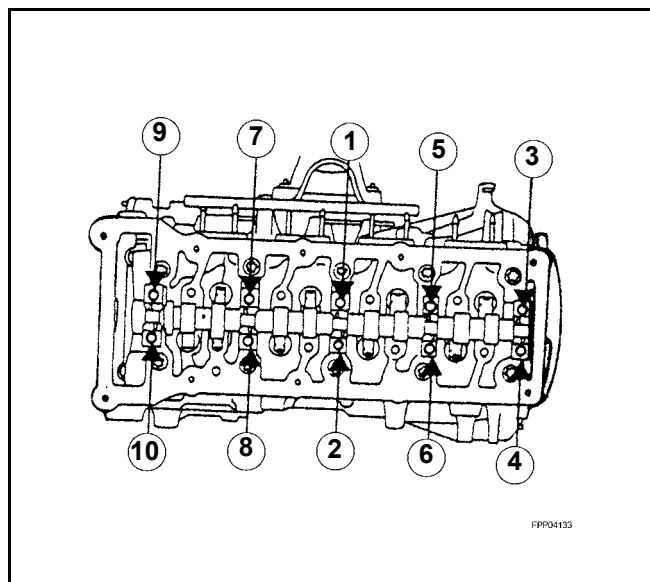
**NOTE:** All components must be clean and assembled in the same positions as removed. Lubricate contact surfaces with clean engine oil.

- 1.
- 2.
3. Install lash adjusters.
4. Install roller followers.



**NOTE:** The chamfer on the camshaft bearing caps must be facing the chain housing. Rotate camshaft so keyway will align with sprocket.

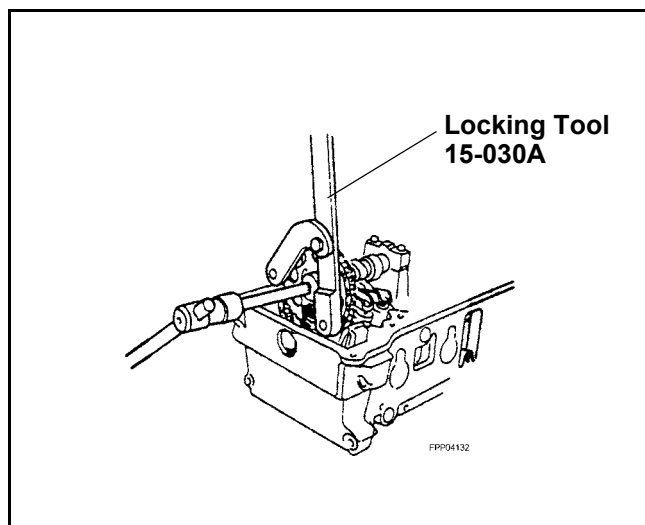
5. Carefully install camshaft, bearings, caps and bolts finger tight.
6. Tighten bolts in the sequence shown in 3 steps to 6-7 lb.ft. (8-10 Nm).



7. Install camshaft sprocket with chain onto camshaft while maintaining tension on the chain.

**CAUTION:** The camshaft sprocket and chain must remain engaged and the chain tensioned in order to keep timing links aligned. If chain is allowed to slacken or disengage with sprocket, the oil pump will have to be removed, and the timing chain realigned - refer to timing chain assembly xxx.

8. Using tool 15-030A, install bolt and tighten to 52-59 lb.ft. (70-80 Nm).



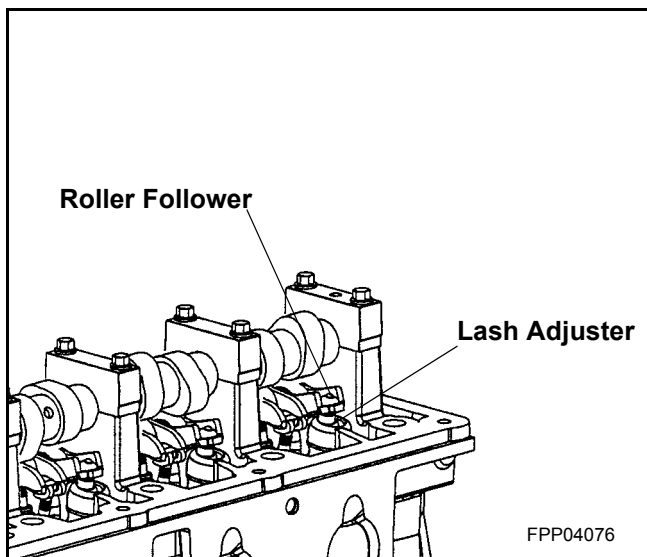
9. Install valve cover -- Refer to "Valve Cover - Installation" on page 10.

## Valve Stem Seal - Removal

**NOTE:** If the valve or valve seat has not been damaged, the valve spring, seal, retainer or keys may be replaced by holding the affected valve closed using compressed air.

Use an appropriate air line tool installed in the spark plug hole. A minimum of 965 kPa (140 psi) line pressure is required. If air pressure does not hold the valve shut, the valve is damaged or burned and the cylinder head must be removed and serviced.

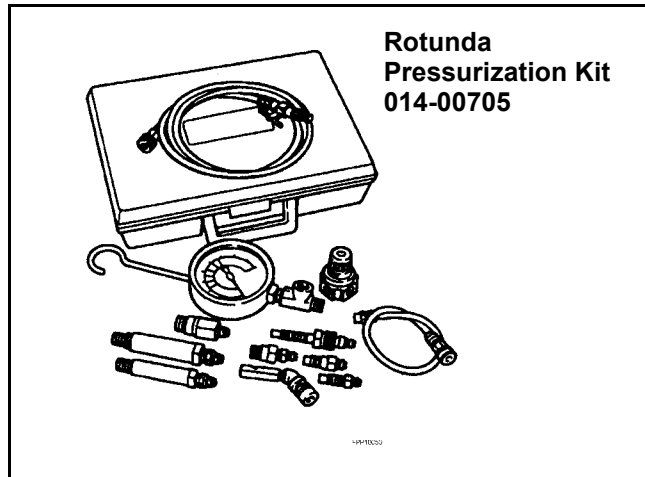
1. Remove valve cover -- Refer to "Valve Cover - Removal" on page 10.
2. Rotate the camshaft so the roller follower for the valve to be serviced is on the heel of the cam.
3. Using a suitable valve spring compressor tool, compress and hold down the valve spring. Slide out the roller follower over the lash adjuster.



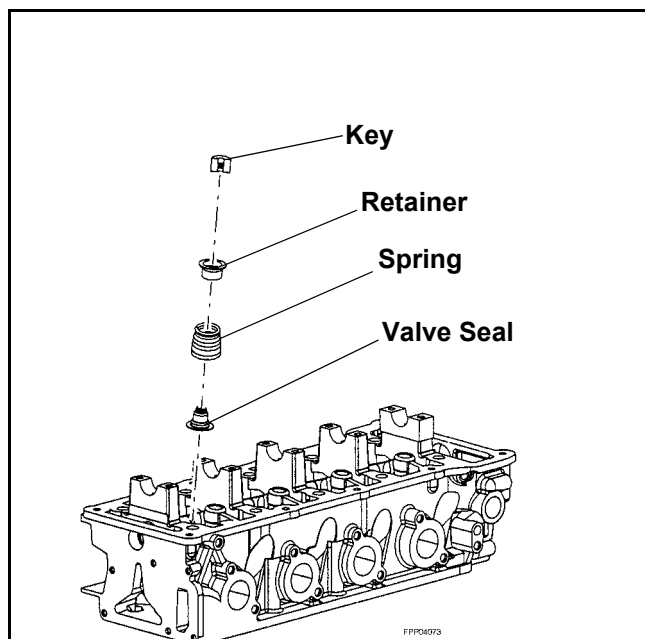
4. Replace spark plug for cylinder being serviced with an air line adapter. Mark location so spark plug is returned to the same cylinder.

**CAUTION:** The crankshaft may rotate when air pressure is applied. Remove all objects from fan area such as lights, extension cords, etc.

5. Turn on air supply and pressurize cylinder. Air pressure may rotate the crankshaft until the piston reaches the bottom of the stroke.



6. Using a suitable valve spring compressor, compress the valve spring and remove the keys and retainer. Remove and discard the stem seal.



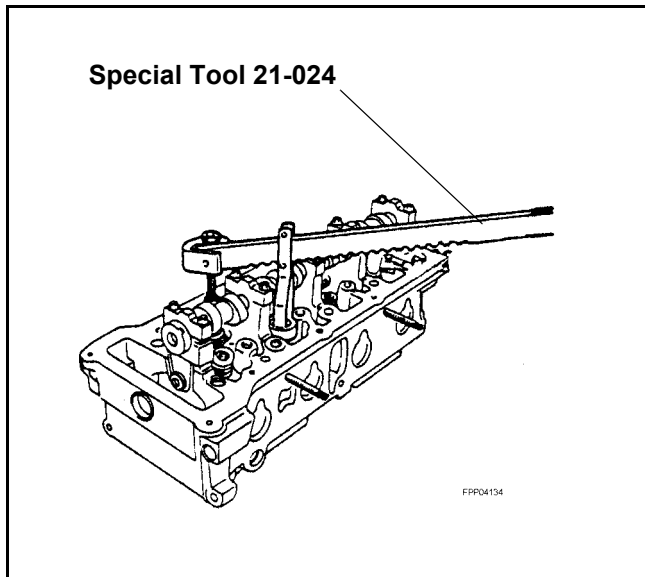
7. If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve(s) to drop into the cylinder. Wrap a rubber band, tape or string around the end of the valve stem in such a way to prevent the valve from falling in and to allow enough travel to check the valve for binds.
8. Inspect the valve stem for damage. Rotate the valve and check the stem tip for eccentric movement. Move the valve up and down through normal travel in the valve guide and check the stem for any binding. If the valve has been damaged, it will be necessary to remove the cylinder head as outlined in this section.

## Valve Stem Seal - Installation

**NOTE:** All components must be clean and assembled in the same positions as removed. Lubricate contact surfaces with clean engine oil.

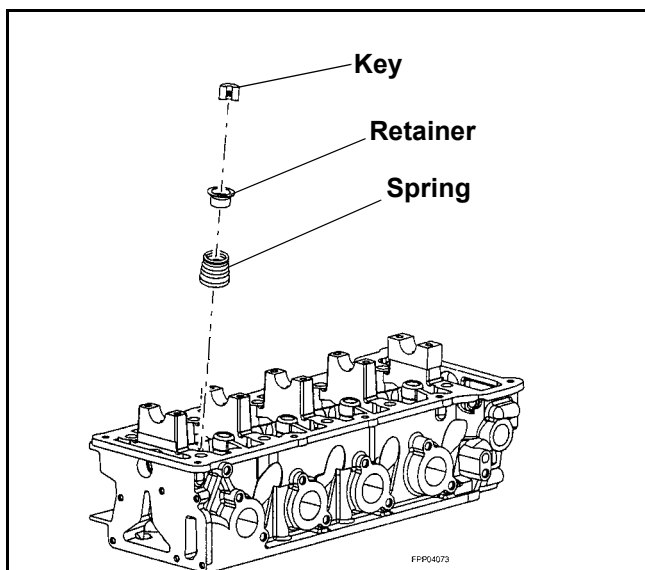
**CAUTION:** Valve stem seal can be cut by grooves in valve stem. A damaged seal will leak causing oil burning and valve fouling.

1. Carefully slide oil seal over valve stem.
2. Install new valve seal using special tool 21-024 (optional T95P-6565A) ??protective cap??.

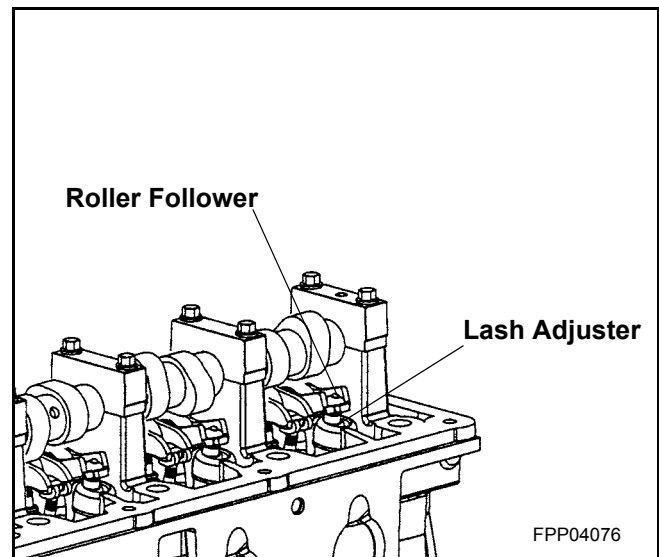


**NOTE:** Apply a small amount of Ford Multi-purpose Grease D0A2-19584-AA, or equivalent, meeting Ford specification ESR-M1C159-A to valve spring retainer key to hold in place during installation.

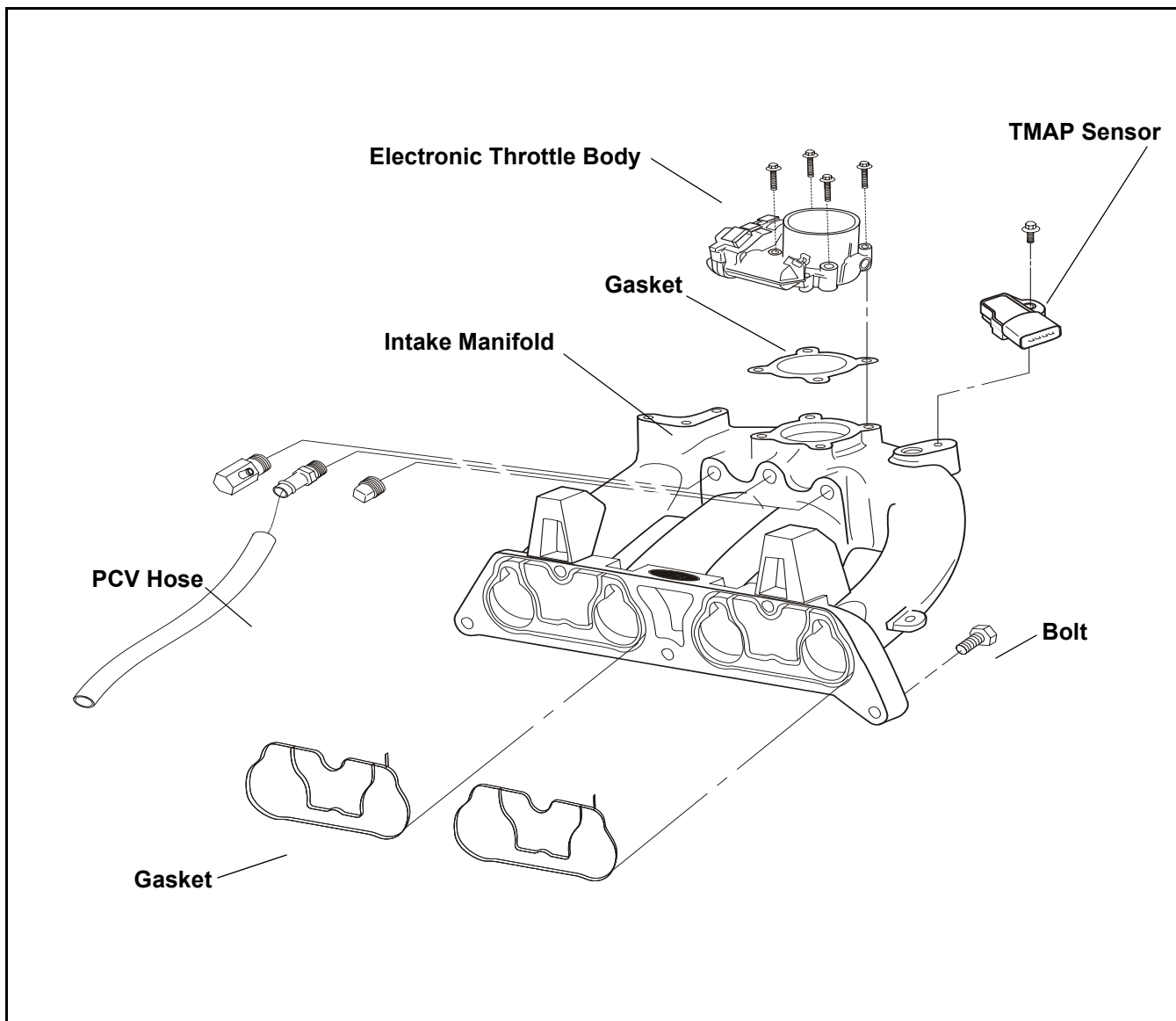
3. With cylinder pressurized and using a suitable spring compressor tool, install valve spring, retainer and locks.



4. Release air pressure and remove air adapter. Install spark plug in proper cylinder.
5. Grease contact surfaces of roller follower with Ford Multi-purpose Grease D0AZ-19584-AA, or equivalent, meeting Ford specification ESR-M1C159-A.
6. Using spring compressor, compress and hold down the valve and spring. Slide the roller finger follower into place over valve and lash adjuster. Release spring.



7. Install valve cover -- Refer to "Valve Cover - Installation" on page 10.



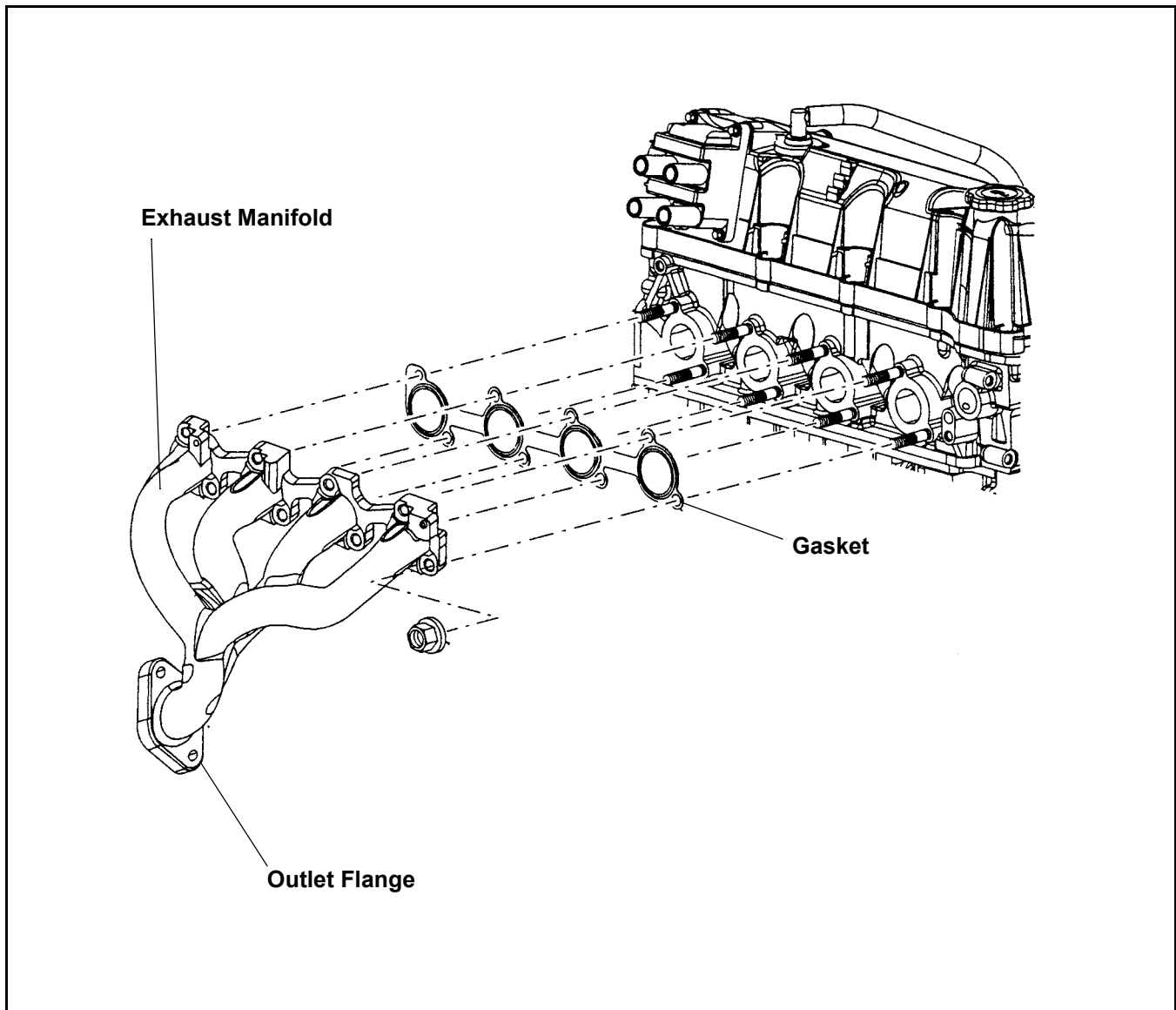
### Intake Manifold - Removal

1. Remove any necessary wiring and vacuum hoses. Mark connections and routing as necessary to assure they are returned as they were removed.
2. Relieve fuel pressure.
3. Disconnect fuel lines from fuel rail.
4. Disconnect air intake tube.
- 5.
- 6.
7. Remove bolts, nuts and intake manifold assembly.

### Intake Manifold - Installation

**NOTE:** All contact surfaces must be clean and free from any old gasket material.

1. Install a new gasket and intake manifold assembly.
2. Install bolts and nuts. Tighten to 6 lb.ft. (8 Nm).
- 3.
- 4.
5. Connect air intake tube.
6. Connect fuel lines to fuel rail.
7. Install any wiring and vacuum hoses that were removed. Connect and route as they were removed.



### Exhaust Manifold - Removal

1. Remove any necessary wiring and vacuum hoses. Mark connections and routing as necessary to assure they are returned as they were removed.
2. Disconnect exhaust at outlet flange.
- 3.
- 4.
5. Remove nuts, exhaust manifold and gasket.

### Exhaust Manifold - Installation

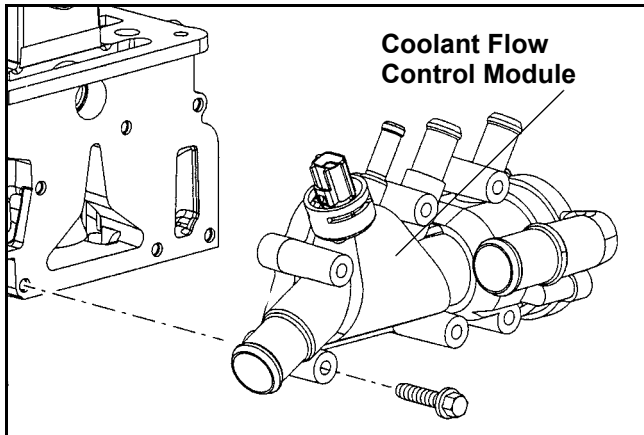
**NOTE:** All contact surfaces must be clean and free from any old gasket material.

1. Install a new gasket and exhaust manifold.
2. Install nuts. Tighten to 11 lb.ft. (15 Nm).
- 3.
- 4.
5. Connect exhaust at outlet flange.
6. Tighten flange nuts to xx lb.ft. (xx Nm).
7. Install any wiring and vacuum hoses that were removed. Connect and route as they were removed.

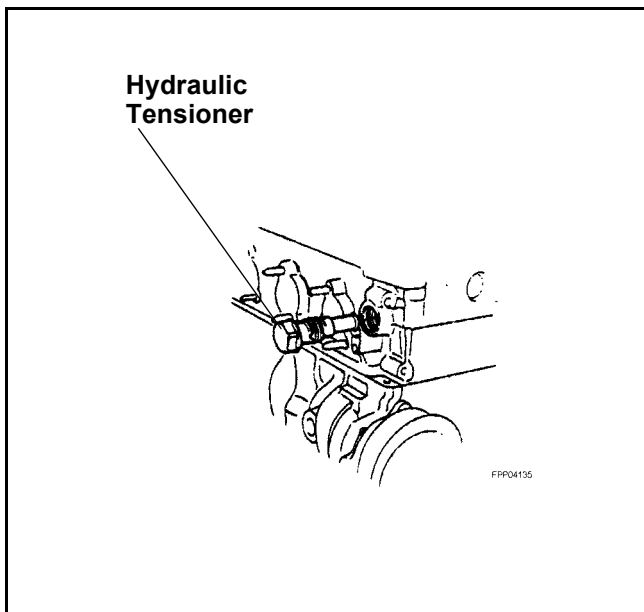


## Cylinder Head - Removal

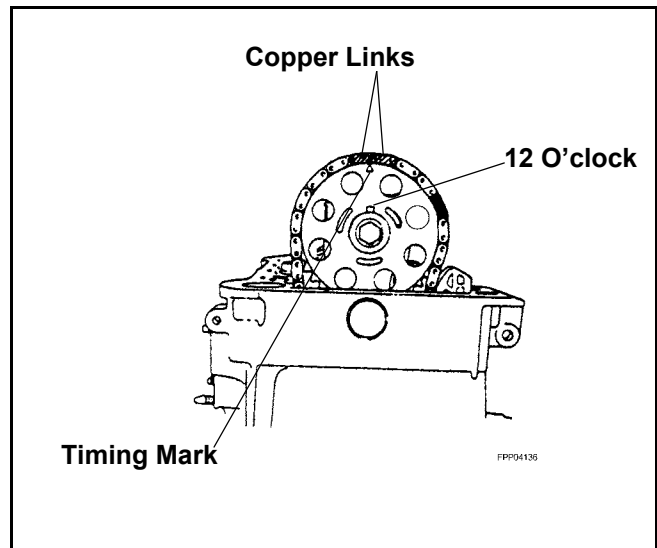
1. Drain engine oil - refer to Operator Handbook.
2. Drain engine coolant - refer to Section 05.
3. Remove any necessary wiring and vacuum hoses. Mark connections and routing as necessary to assure they are returned as they were removed.
4. Remove valve cover -- Refer to "Valve Cover - Removal" on page 10.
5. Remove spark plugs and wires.
6. Remove the coolant flow control module - refer to Section 05.



7. Remove bolts and nuts holding intake manifold to cylinder head. Move aside.
8. Remove heat shield ??.
9. Remove nuts at exhaust manifold. Move aside.
10. Remove oil level indicator tube bolt at cylinder head.
11. Remove timing chain hydraulic tensioner.



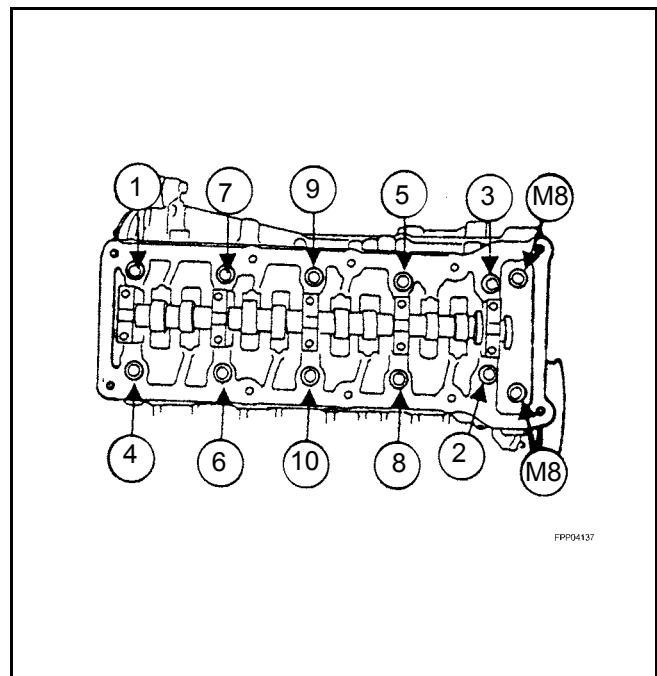
12. Rotate camshaft sprocket using tool 15-030A until the 2 copper links on timing chain are at 12 o'clock.



13. Using tool 15-030A to lock camshaft sprocket, remove bolt.

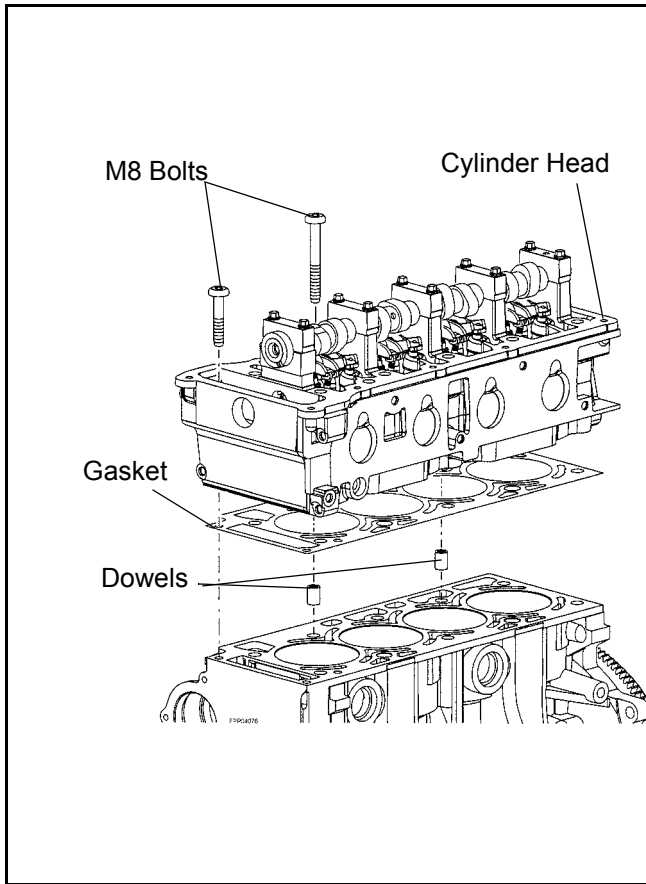
**CAUTION:** During cylinder head removal, the timing chain must be held up with a wire with constant tension in order to keep timing links aligned at crankshaft. If chain is allowed to slacken or disengage with sprocket, the oil pump will have to be removed, and the timing chain realigned - refer to timing chain assembly xxx.

14. Remove camshaft sprocket from chain while maintaining tension on the chain using a wire.
15. Remove the M11 cylinder head bolts in 3 phases in the sequence shown.

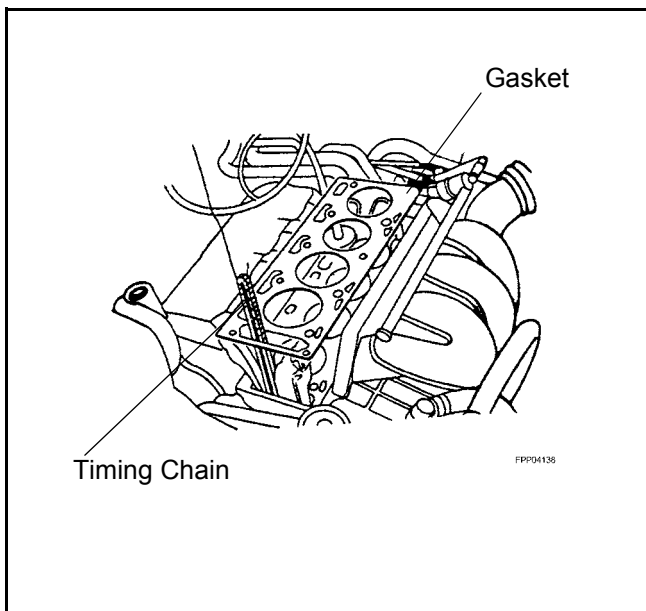


**CAUTION: Be careful to avoid the bolts falling into the timing chain compartment.**

16. Remove 2 M8 bolts, cylinder head and gasket.



17. Carefully remove cylinder head and gasket while maintaining tension on timing chain.



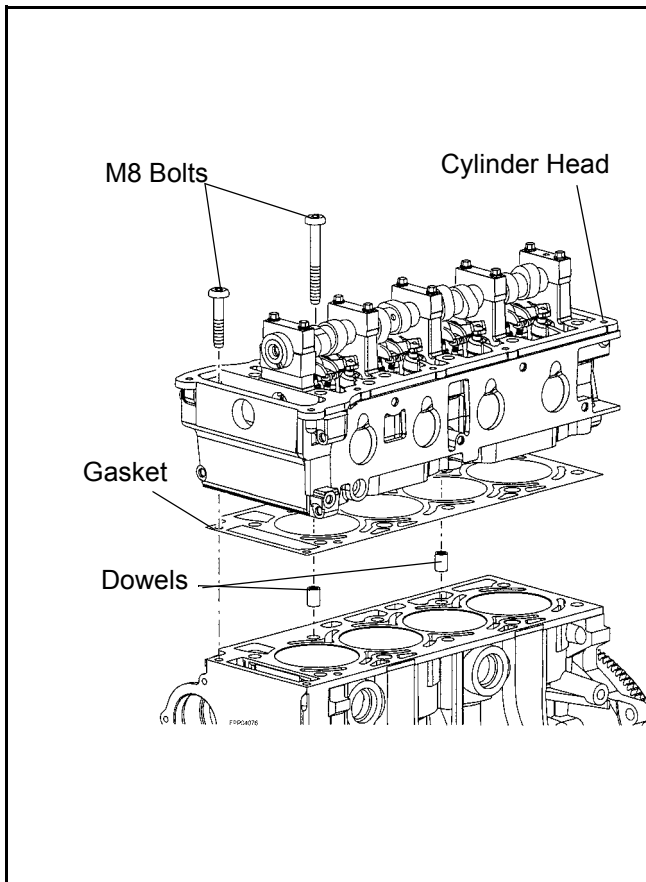
## Cylinder Head - Installation

**NOTE:** The contact surface of the cylinder head and block must be clean and free of oil. Use new cylinder head bolts and lubricate the threads.

1. Rotate crankshaft so all pistons are **below** top dead center (TDC).

**CAUTION:** During cylinder head installation, the timing chain must be held up with a wire with constant tension in order to keep timing links aligned at crankshaft. If chain is allowed to slacken or disengage with sprocket, the oil pump will have to be removed, and the timing chain realigned - refer to timing chain assembly xxx.

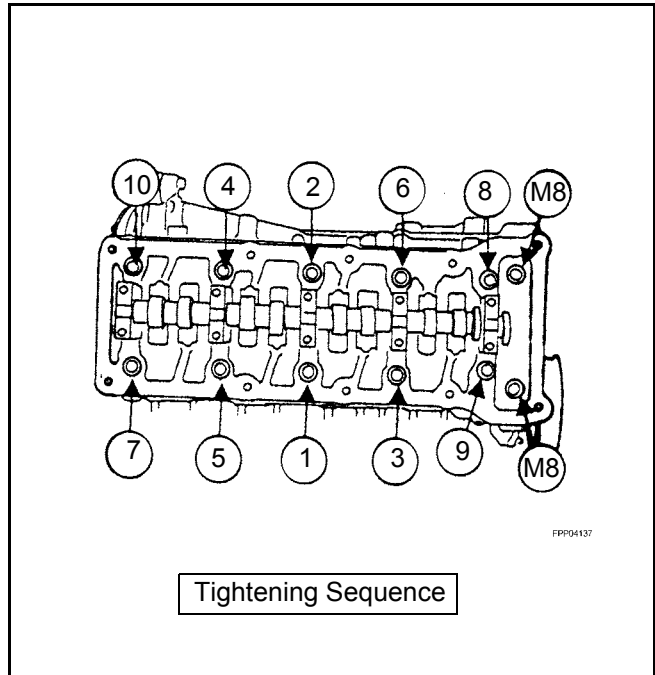
2. Carefully install dowels, a new gasket and cylinder head to the engine block while maintaining tension on the timing chain.



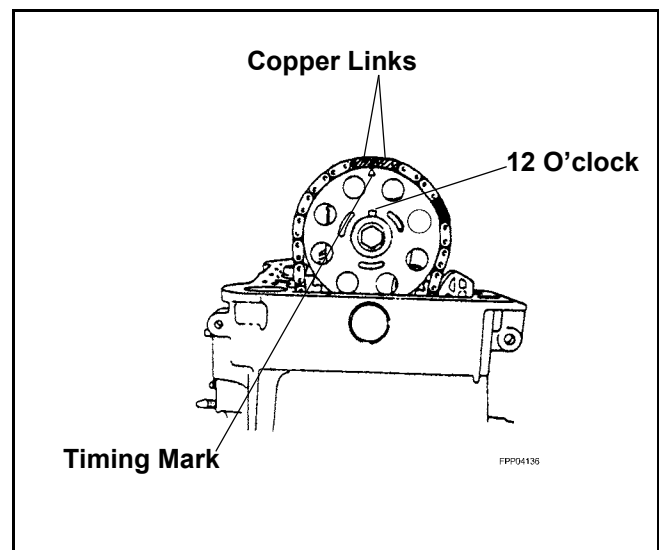
**CAUTION:** Be careful to avoid the bolts falling into the timing chain compartment.

3. Install new bolts using the sequence shown in the following 3 steps:

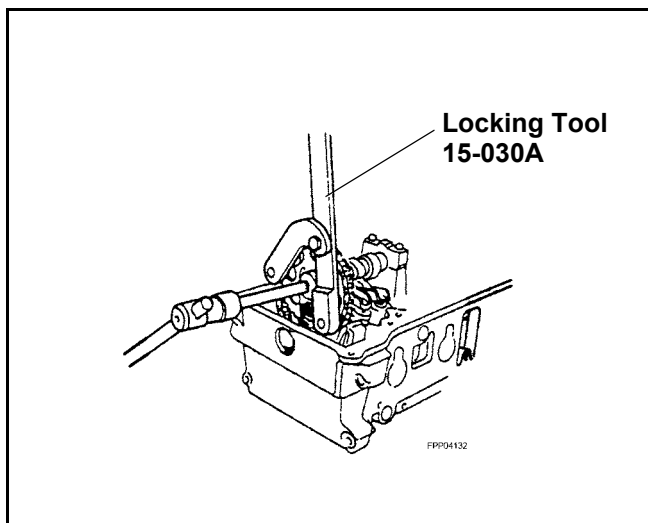
- Step 1 - tighten M11 bolts to 29.5 lb.ft. (40 Nm)
- Step 2 - tighten M8 bolts to 11 lb.ft. (15 Nm) + 45°
- Step 3 - tighten M11 bolts additional 120°



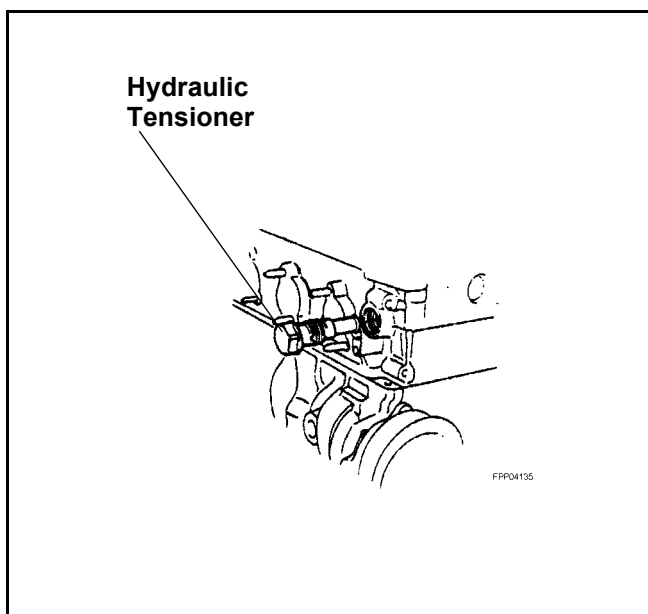
4. Carefully install sprocket into timing chain aligning timing mark with 2 copper links.



5. Using tool 15-030A, install camshaft sprocket bolt. Tighten to 92 lb.ft. (125 Nm).

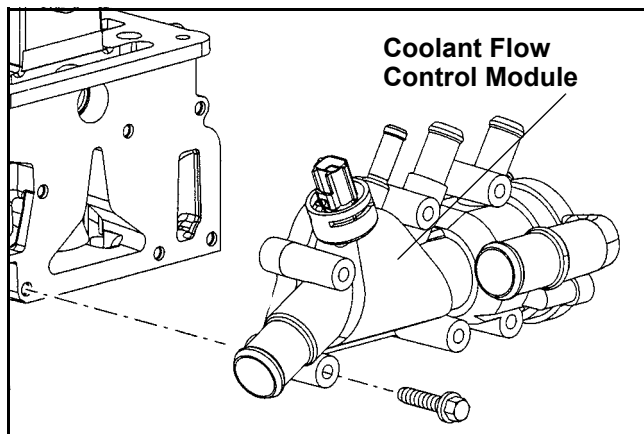


6. Install hydraulic tensioner and tighten to 30 lb.ft. (40 Nm).



7. Install oil level indicator bolt. Tighten to 15 lb.ft. (20 Nm).
8. Install exhaust manifold and nuts. Tighten nuts to 11 lb.ft. (15 Nm).
9. Install heat shield ??.
10. Install bolts and nuts holding intake manifold to cylinder head. Tighten to nuts and bolts to 13 lb.ft. (18 Nm).

11. Install the coolant flow control module - refer to Section 05.

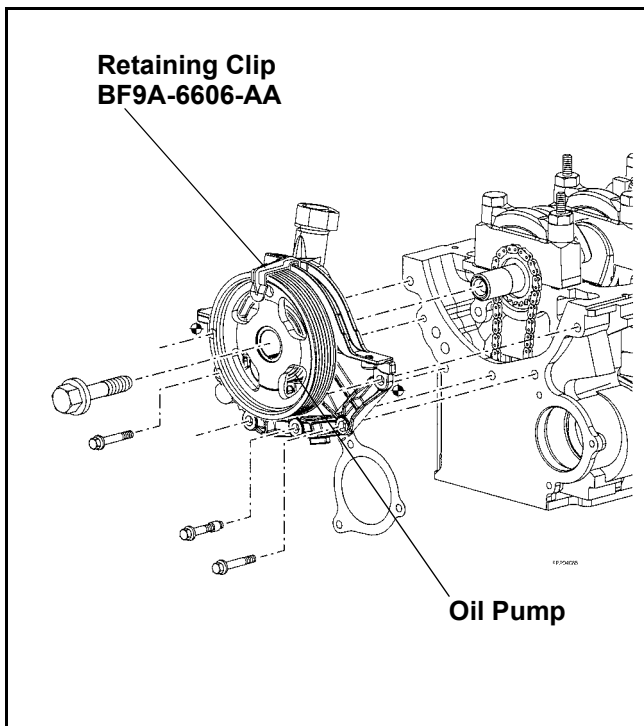


12. Install spark plugs and wires - refer to Section 03.
13. Install valve cover -- Refer to "Valve Cover - Removal" on page 10.
14. Install and route any wiring and vacuum hoses removed.
15. Fill engine with correct type and quantity of coolant - refer to Section 05.
16. Fill engine with correct type and quantity of engine oil - refer to Operator Handbook.

## Oil Pump - Removal

**CAUTION:** The oil pump, pulley and sealer are provided as an assembly kept together by a clip (no. BF9A-6606-AA). Do not remove clip until oil pump is installed. If pulley is pushed out of the oil pump prior to oil pump installation, it will have to be repaired or replaced.

1. Remove drive belt - refer to xx.
- 2.
3. Remove water pump - refer to Section 05.
4. Insert retaining clip # BF9A-6606-AA between crankshaft pulley and oil pump to prevent pulley axial movement.



5. Remove crankshaft pulley bolt.

**NOTE:** Identify oil pump bolts so they may be returned to their original positions.

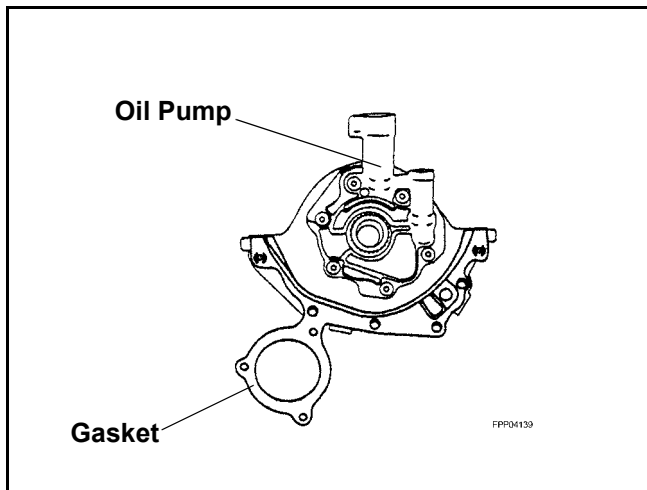
6. Remove 6 oil pump bolts, oil pump and gasket.

## Oil Pump - Installation

**NOTE:** Contact surfaces of the oil pump and block must be clean and free of oil.

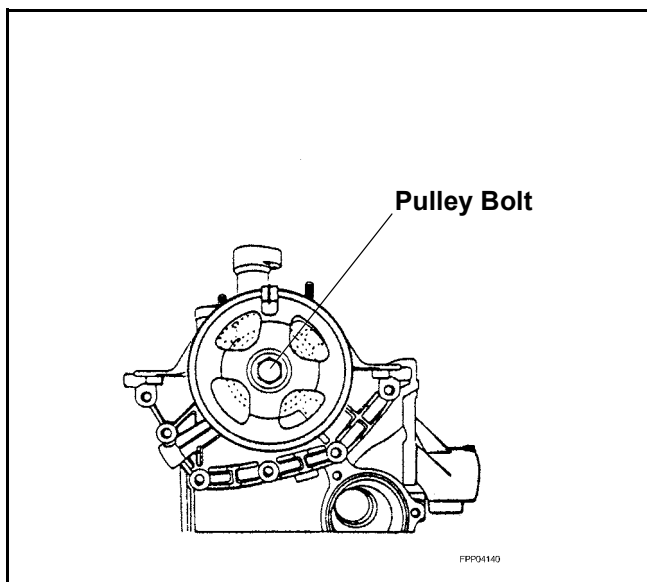
**CAUTION:** The oil pump, pulley and sealer are provided as an assembly kept together by a clip (no. BF9A-6606-AA). Do not remove clip until oil pump is installed. If pulley is pushed out of the oil pump prior to oil pump installation, it will have to be repaired or replaced.

1. Assemble gasket onto oil pump housing guiding it with 2 outer bolts.



**CAUTION:** Do not apply oil to shaft or seal. Sealing lip along with all contact surfaces must be free of oil.

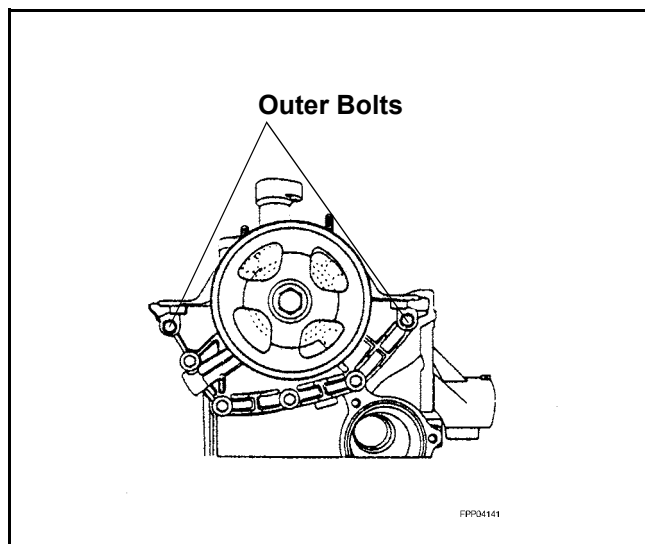
2. Place oil pump and gasket onto crankshaft.
3. Install pulley bolt and tighten to 92 lb.ft. (125 Nm).



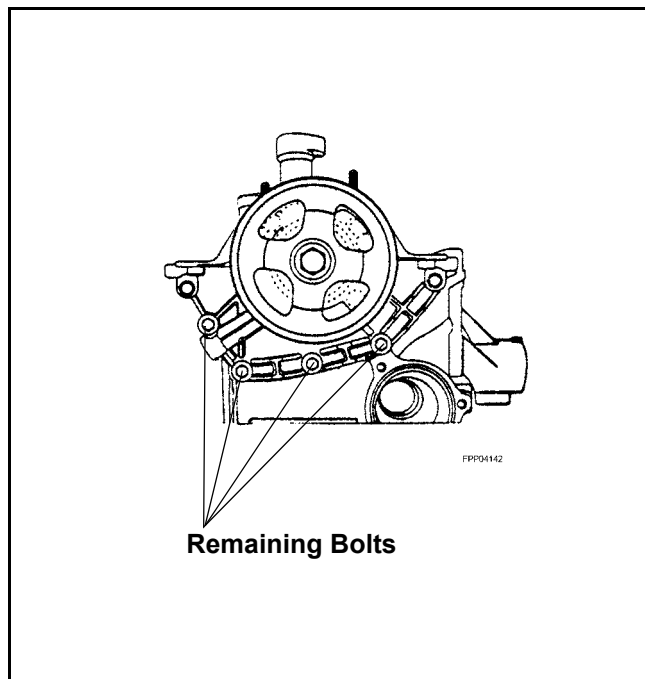
4. Remove clip.
5. Install oil pump housing bolts finger tight.

**CAUTION:** The oil pump housing must be positioned during tightening of the oil pump housing bolts, so that the sealing flange of the oil pump housing is within  $\pm 0.008$  in. (0.20 mm) of the block bottom sealing flanges.

6. Tighten 2 outer oil pump housing bolts to 15 lb.ft. (20 Nm).

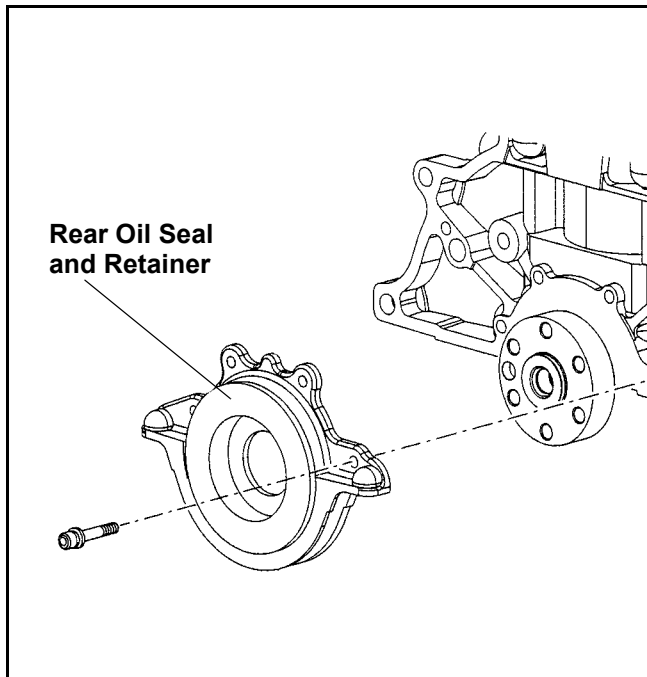


7. Tighten remaining oil pump housing bolts to 15 lb.ft. (20 Nm).



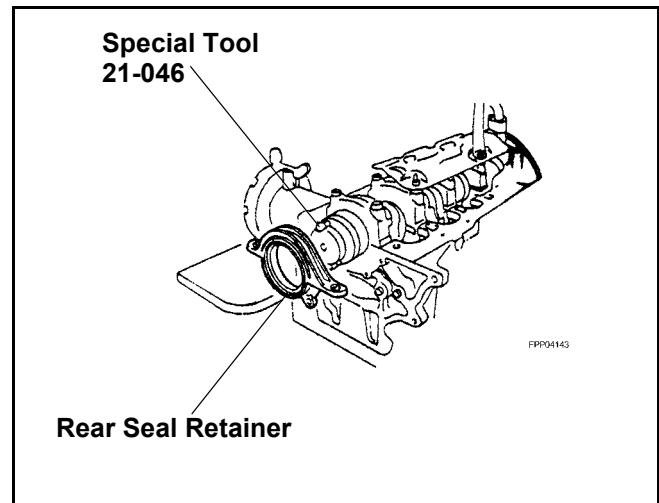
### Crankshaft Rear Oil Seal - Removal

1. Remove flywheel - refer to xx.
2. ??Remove oil pan - refer to xx.??
3. Remove bolts and rear oil seal retainer.



### Crankshaft Rear Oil Seal - Installation

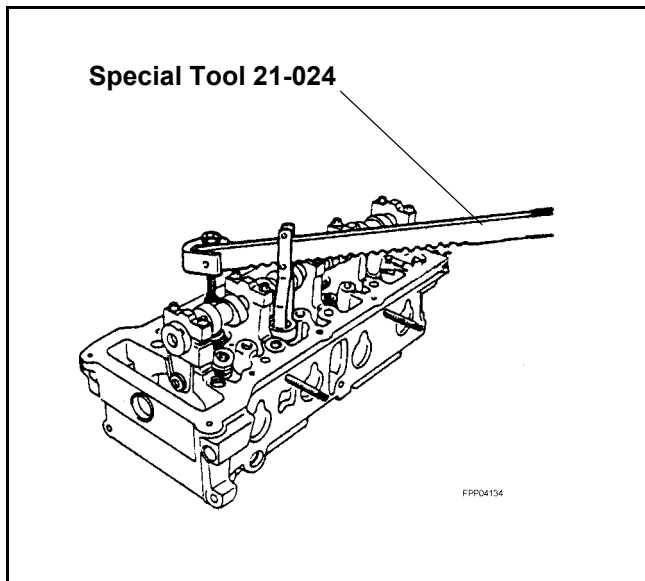
1. Install new rear seal and retainer using tool 21-046.



2. ??Install oil pan - refer to xx.??
3. Install flywheel - refer to xx.

### Camshaft Follower / Hydraulic Lash Adjuster - Removal

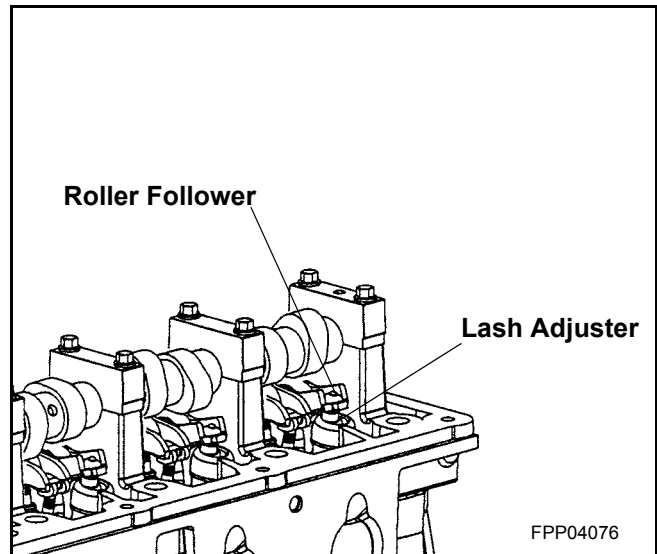
1. Remove valve cover -- Refer to "Valve Cover - Removal" on page 10.
2. Rotate the camshaft so the roller follower for the valve to be serviced is on the heel of the cam.
3. Using a suitable valve spring compressor tool, compress and hold down the valve spring. Slide out the roller follower over the lash adjuster.



4. Lift out the hydraulic lash adjuster.

### Camshaft Follower / Hydraulic Lash Adjuster - Installation

**NOTE:** All components must be kept clean and lubricated with clean engine oil.

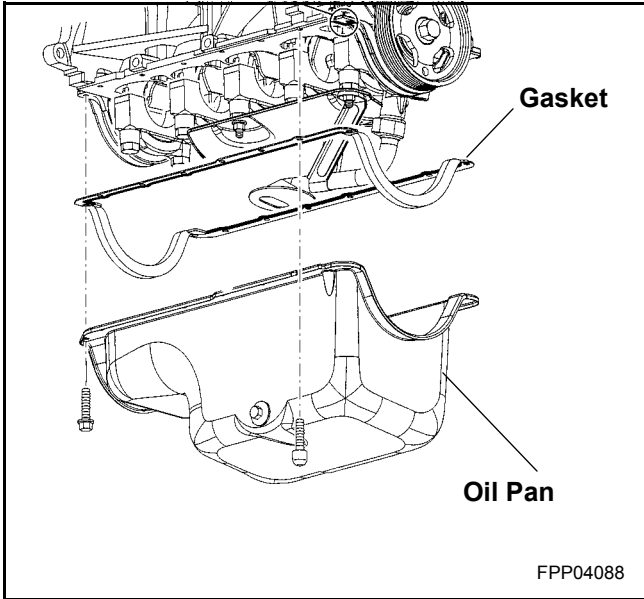


1. Rotate the camshaft so the roller follower for the valve to be serviced is on the heel of the cam.
2. Install the hydraulic lash adjuster.
3. Using a suitable valve spring compressor tool, compress and hold down the valve spring. Slide in the roller follower over the lash adjuster.
4. Install valve cover -- Refer to "Valve Cover - Removal" on page 10.



### Oil Pan - Removal

1. Remove bolts.
2. Remove oil pan.

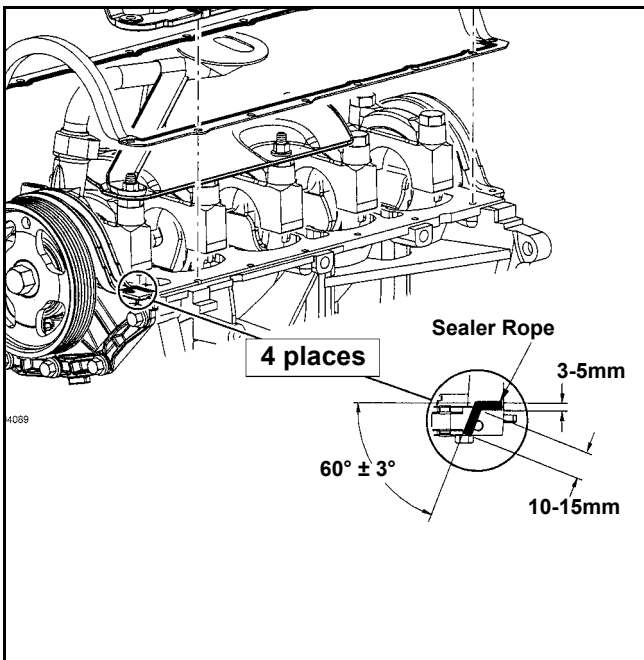


3. Remove all gasket material from pan.
- CAUTION:** Be careful not to contact surfaces.

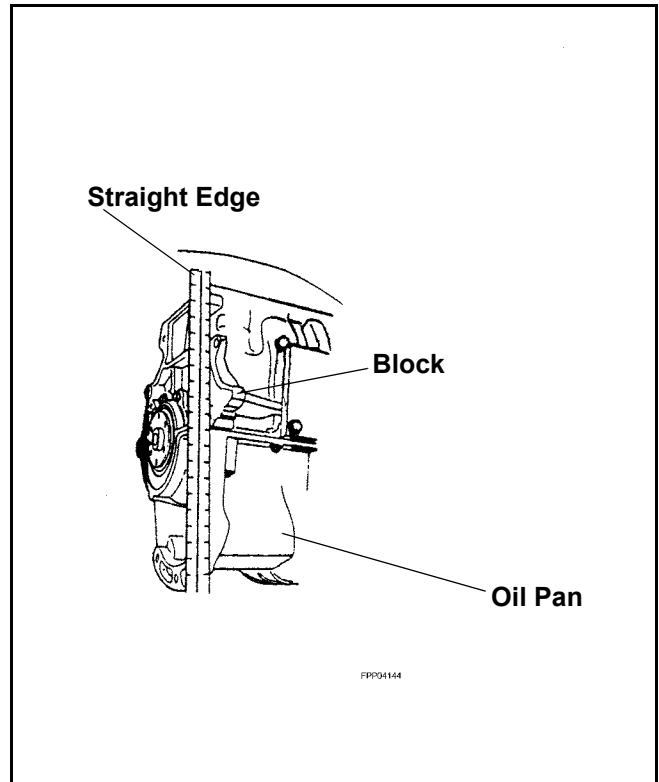
### Oil Pan - Installation

**CAUTION:** The contact surfaces of oil pan, gasket and block must be free of oil. Do not wait more than 5 minutes to install the oil pan gasket after sealer has been applied.

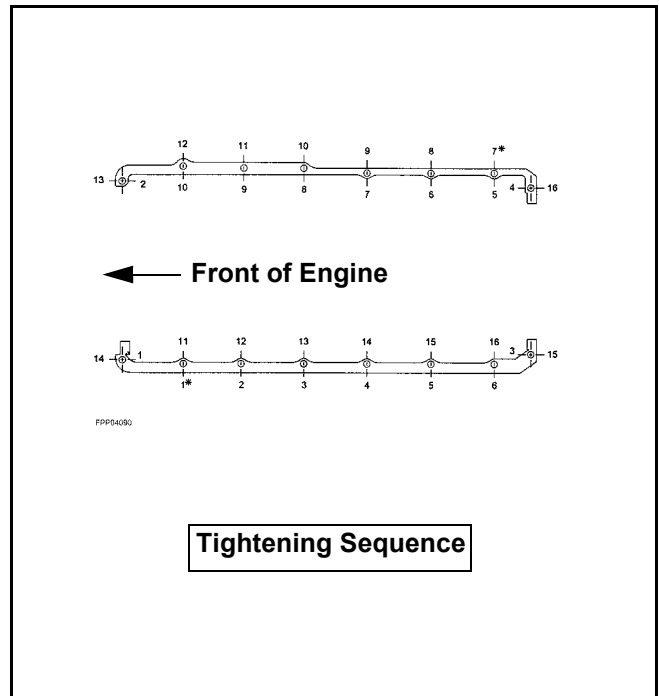
1. Apply WSEM-A4 sealer (Loctite 5910) to the 4 positions as shown.

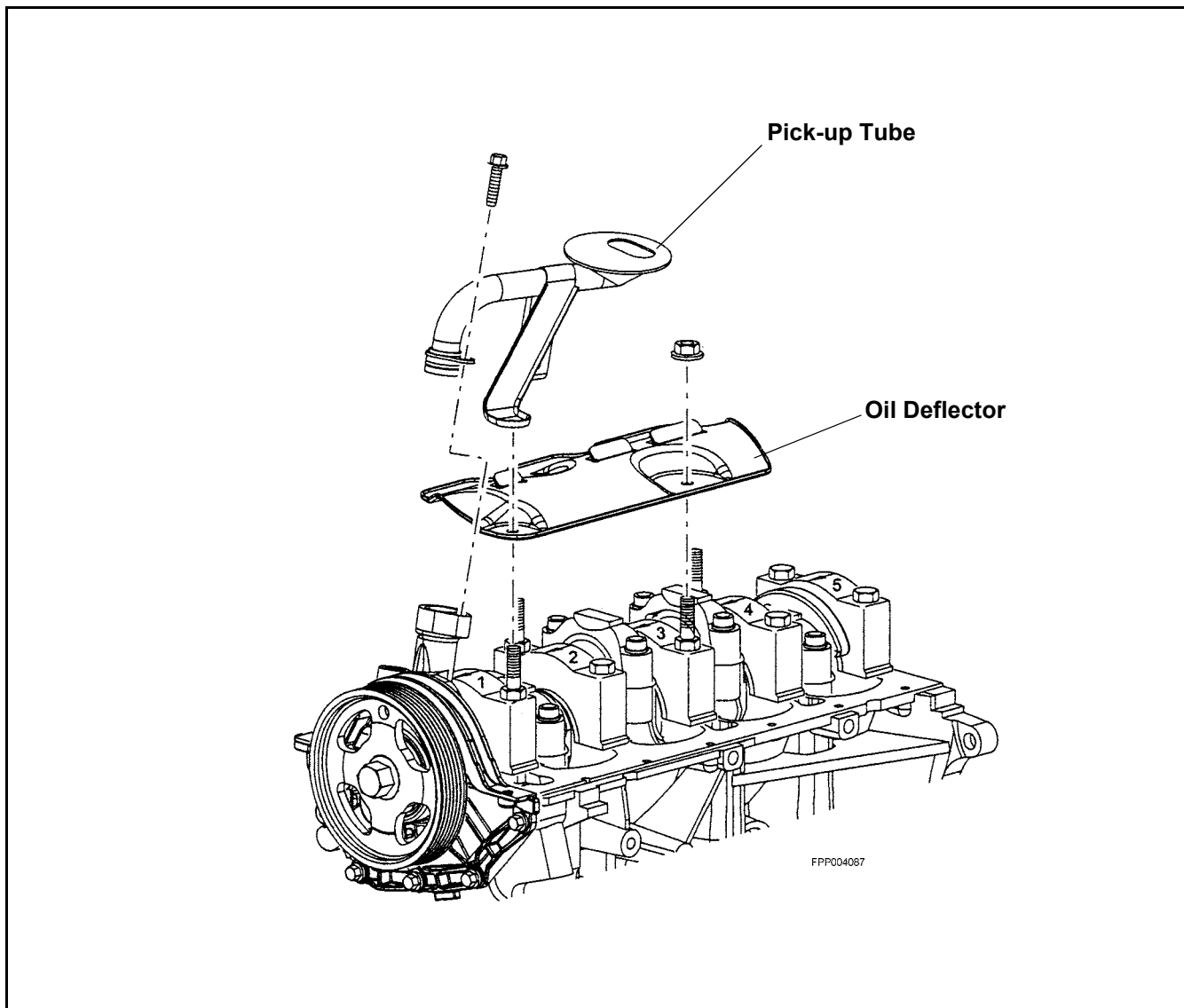


2. Install the oil pan and bolts finger tight.
3. Align oil pan with rear portion of engine block.



4. Tighten oil pan bolts in 3 steps in the sequence shown:
  - enough for gasket settlement
  - 5 lb.ft. (7 Nm)
  - 7 lb.ft. (10 Nm)





### Pick-up Tube / Deflector - Removal

- 1.
- 2.
3. Remove oil pan -- Refer to "Oil Pump - Removal" on page 21.
4. Remove 4 nuts and 1 bolt.
5. Remove pick-up tube.
6. Remove oil deflector.

### Pick-up Tube / Deflector - Installation

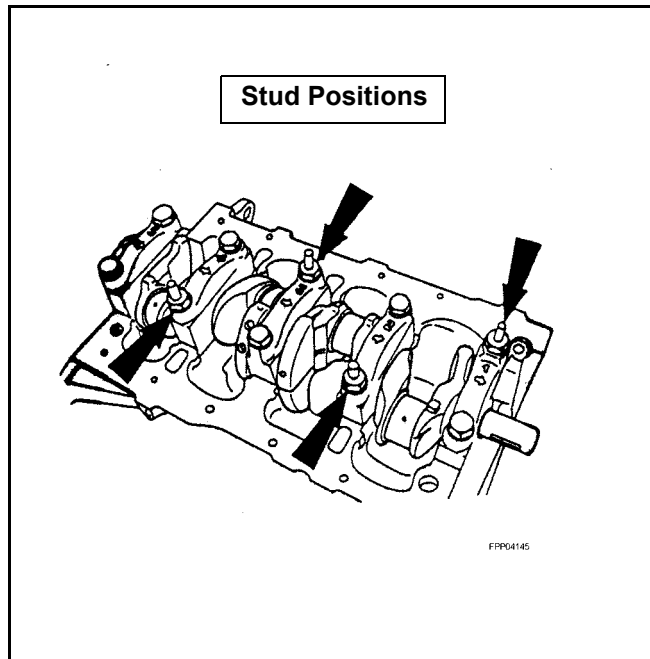
1. Install oil deflector.
2. Install pick-up tube.
3. Install 4 nuts and tighten to 14 lb.ft. (19 Nm).
4. Install bolt and tighten to 7 lb.ft. (9.5 Nm).
5. Install oil pan -- Refer to "Oil Pump - Installation" on page 22.
- 6.
- 7.

## Crankshaft Main Bearings - Removal

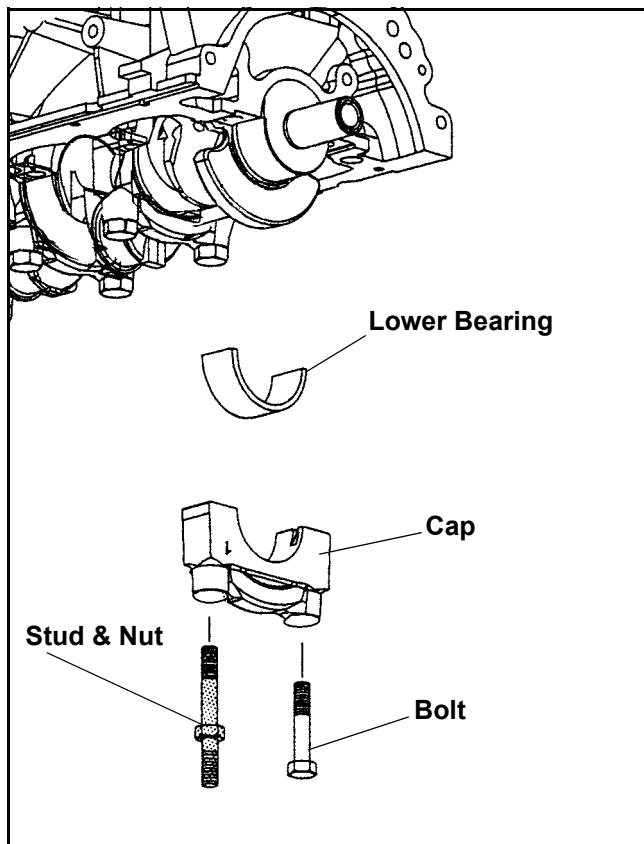
**NOTE:** To check bearing clearances or to select new bearings, refer to Section 01.

1. Remove oil pan -- Refer to "Oil Pan - Removal" on page 25.
2. Remove pick-up tube & deflector -- Refer to "Pick-up Tube / Deflector - Removal" on page 26.

**NOTE:** Replace one bearing at a time, leaving the other bearings securely fastened. Note location of studs for deflector installation.



3. Remove first main bearing cap bolts.
4. Remove cap and lower bearing.
5. Press on end of upper bearing without tang to start it out.
6. Rotate bearing out from between crankshaft and cylinder block.



## Crankshaft Main Bearings - Installation

**NOTE:** All components must be clean and dried with compressed air or a lint free cloth. Lubricate bearing to crankshaft contact surfaces with clean engine oil.

1. Place upper bearing on crankshaft and rotate into place. Oil holes must align.
2. Place lower bearing into cap.

**NOTE:** Main bearing cap arrow must point to the front of the engine.

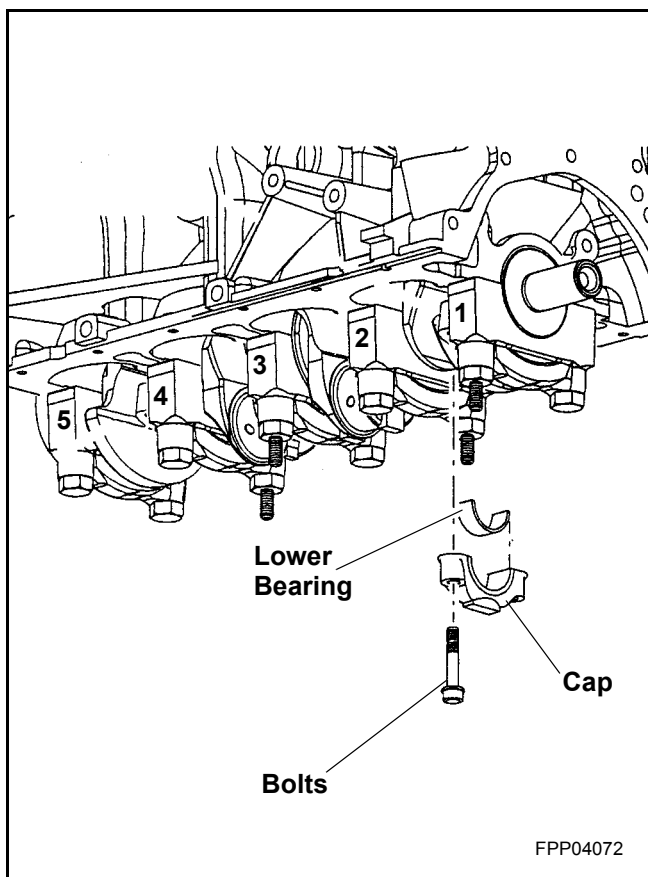
3. Install bearing cap.

**CAUTION: Use new main bearing cap bolts.**

4. Lightly oil new main bearing bolts or studs and install in same positions as removed. Alternately tighten in 3 steps to 70 lb.ft. (95 Nm).
5. Check crankshaft end play as outlined in Section 01.
6. Install pick-up tube and deflector -- Refer to "Pick-up Tube / Deflector - Installation" on page 26.
7. Install oil pan -- Refer to "Oil Pan - Installation" on page 25.

### Connecting Rod Bearings - Removal

1. Remove oil pan -- Refer to "Oil Pan - Removal" on page 25.
2. Remove pick-up tube and deflector -- Refer to "Pick-up Tube / Deflector - Removal" on page 26.
3. Remove spark plug for cylinder being serviced.
4. Rotate crankshaft until connecting rod and bearing to be serviced is placed at the bottom of its stroke.
5. Remove two connecting rod nuts.
6. Remove connecting rod cap with lower bearing.



7. Push piston and connecting rod assembly up into bore.
8. Remove upper bearing from connecting rod.

**NOTE:** For bearing service refer to Section 01.

### Connecting Rod Bearings - Installation

**NOTE:** Make sure bearing bore of connecting rod and cap and bearing journal are clean. Lubricate wear surfaces with clean engine oil.

1. Insert upper bearing into connecting rod.
2. Insert lower bearing into cap.

**CAUTION:** Do not scratch journal with connecting rod bolts.

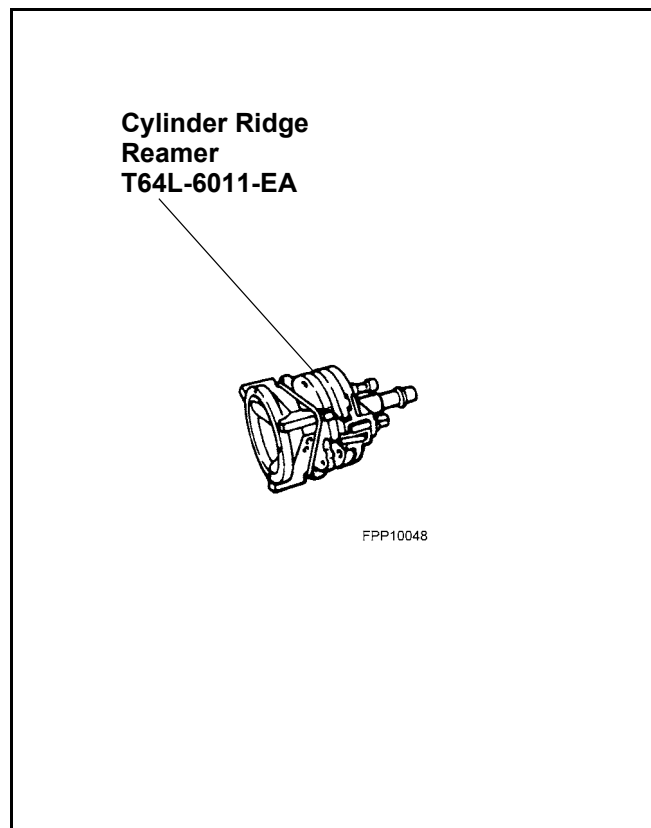
3. Install cap and bolts. Tighten bolts in 2 steps:
  - Step 1 - 9 lb.ft. (12.5 Nm)
  - Step 2 - 22 lb.ft. (30 Nm) (41-94°???)
4. Install deflector and pick-up tube -- Refer to "Pick-up Tube / Deflector - Installation" on page 26.
5. Install oil pan -- Refer to "Oil Pan - Installation" on page 25.

## Piston - Removal

1. Remove oil pan -- Refer to "Oil Pan - Removal" on page 25.
2. Remove pick-up tube and deflector -- Refer to "Pick-up Tube / Deflector - Removal" on page 26.
3. Remove cylinder head assembly -- Refer to "Cylinder Head - Removal" on page 17.

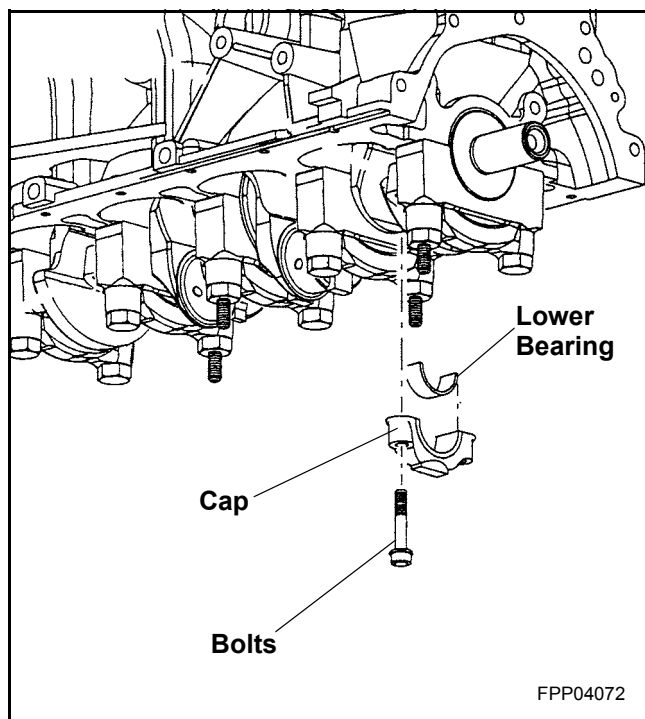
**CAUTION: Never cut into the ring travel area in excess of 0.8mm (1/32 inch) when removing ridges.**

4. Turn crankshaft until piston to be removed is at the bottom of its travel and place a cloth on the piston head to collect the cuttings.
5. Remove any ridge and/or deposits from the upper end of the cylinder bores using a ridge cutter. follow the instructions furnished by the tool manufacturer.



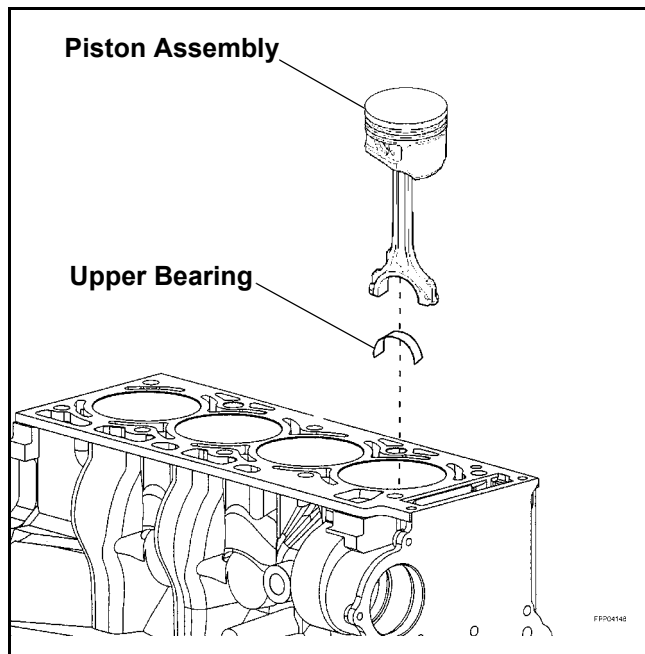
**NOTE:** Make sure all caps are marked so that they can be installed in their original positions.

6. Remove 2 bolts, connecting rod cap and lower bearing.



**CAUTION: Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.**

7. Push piston assembly out the top of the cylinder with the handle end of a hammer.



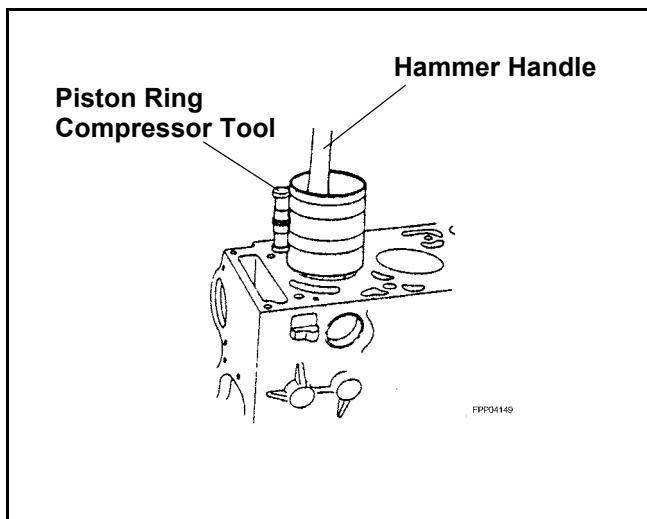
8. Remove upper bearing from connecting rod.

**NOTE:** For piston and bearing service - refer to Section 01.

## Piston - Installation

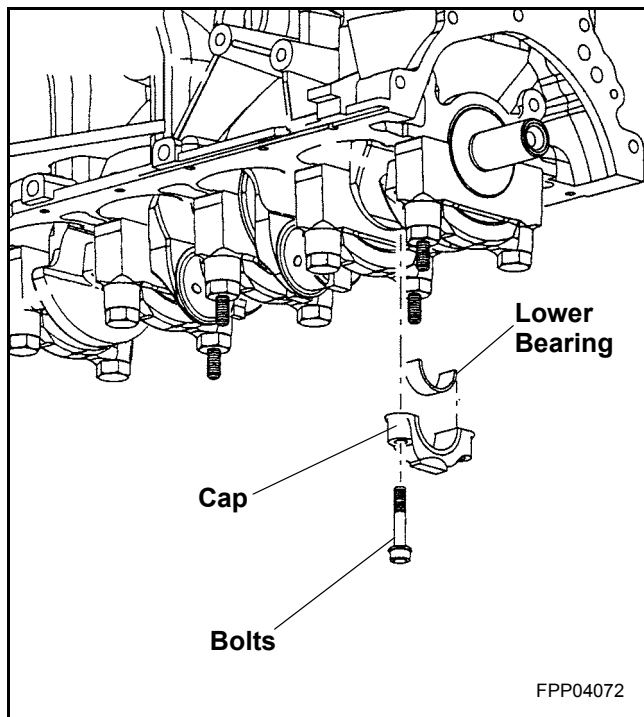
**NOTE:** Crankshaft journal should be at its lowest point. All components should be clean and dried with compressed air or a lint free cloth.

1. Set piston ring gaps as follows:
  - lower oil ring gap aligned with piston pin.
  - center ring gap at 90° from the oil ring gap.
  - top ring gap at 180° from the oil ring gap.
2. Lubricate piston, bearing wear surface, crankshaft journal and cylinder wall with clean engine oil.
3. Carefully install pistons with bearings into cylinder bores using a piston ring compressor and a hammer handle. Avoid damage to the crankshaft bearing journals. The arrow of the piston must point to the front of the engine. The connecting rod has the cylinder number identified in the base.



**CAUTION:** Use new connecting rod cap bolts and lubricate threads with clean engine oil.

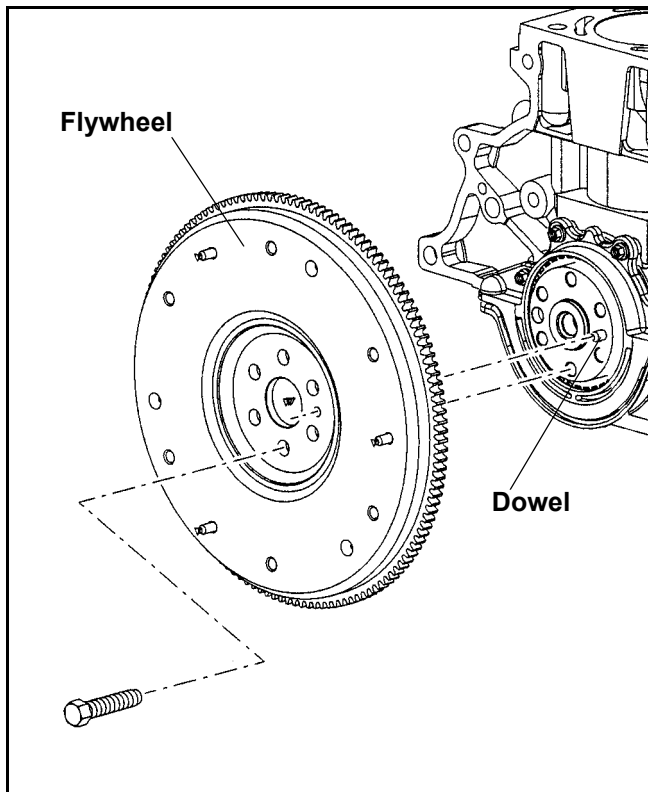
4. Install connecting rod caps with bearings (lubricate wear surface) and tighten bolts in 2 steps:
  - Step 1 - 9 lb.ft. (12.5 Nm)
  - Step 2 - 22 lb.ft. (30 Nm) (41-94°???)



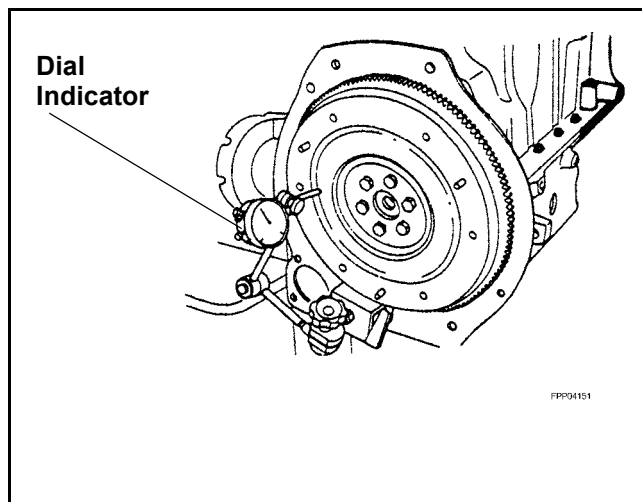
5. ??Check connecting rod side clearance??.
6. Install cylinder head assembly -- Refer to "Cylinder Head - Installation" on page 19.
7. Install pick-up tube and deflector -- Refer to "Pick-up Tube / Deflector - Installation" on page 26.
8. Install oil pan -- Refer to "Oil Pan - Installation" on page 25.

### Flywheel - Removal

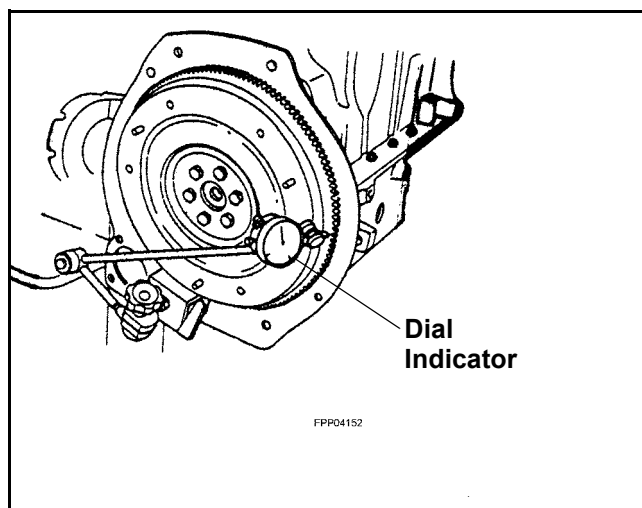
1. Remove bolts.
2. Remove flywheel.
- 3.
- 4.



3. Check flywheel runout at clutch disc surface:
  - maximum runout 0.005 in. (0.13 mm)

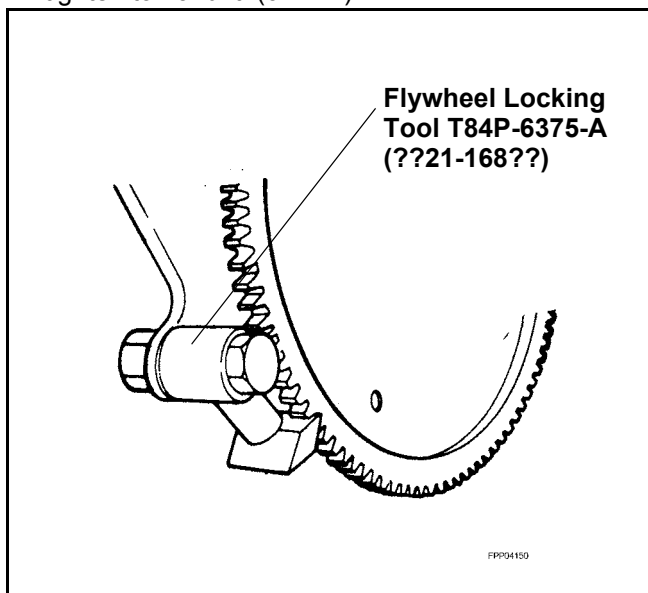


4. Check flywheel runout at gear surface:
  - maximum runout 0.024 in. (0.6 mm)



### Flywheel - Installation

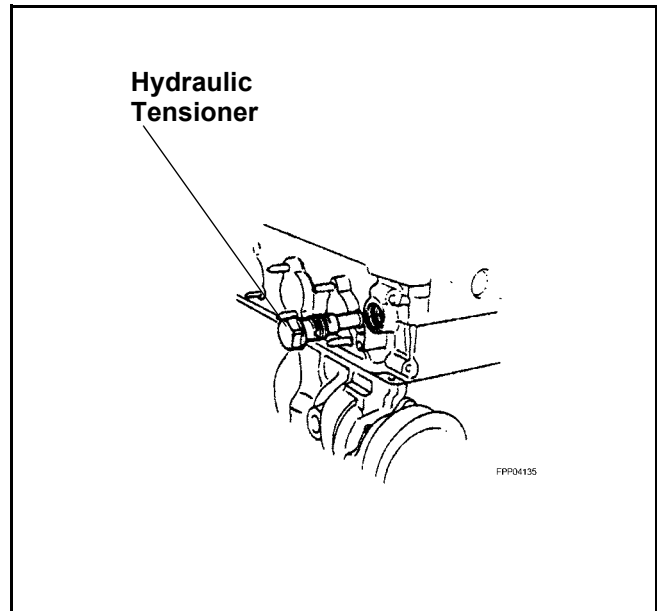
1. Install flywheel using special locking tool 21-168.
2. Lubricate bolt threads with clean engine oil and tighten to 49 lb.ft. (67 Nm).



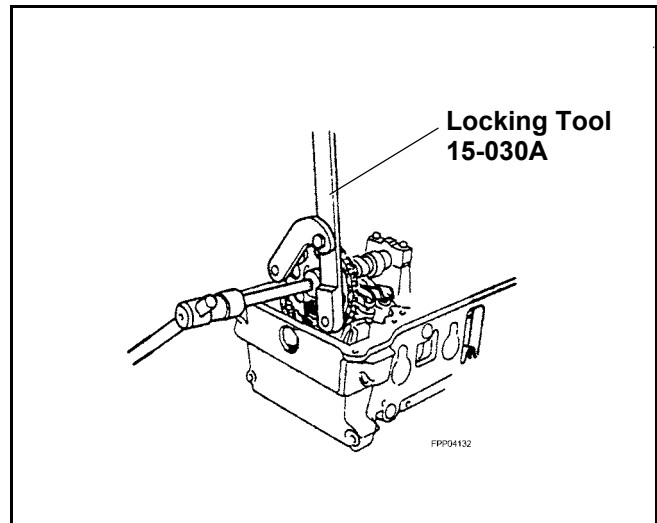
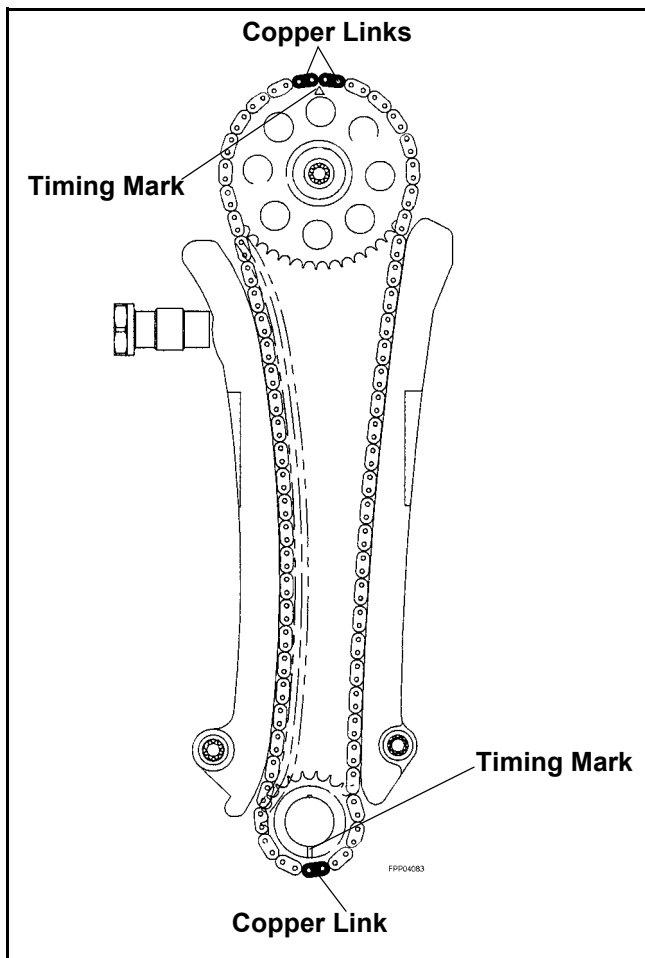
### Timing Chain and Sprockets - Removal

- 1.
- 2.
- 3.
4. Remove oil pump assembly -- Refer to "Oil Pump - Removal" on page 21.
5. Remove valve cover -- Refer to "Valve Cover - Removal" on page 10.
6. oil pan, water pump, ???
7. Check to see if coppered links on the timing chain are still visible. If not, identify them as follows:
  - Turn engine until timing mark on camshaft sprocket is at 12 o'clock.
  - Mark the two chain links left and right of that timing mark.
  - Mark the single chain link that is positioned on the crankshaft sprocket timing mark.

8. Remove the hydraulic tensioner.

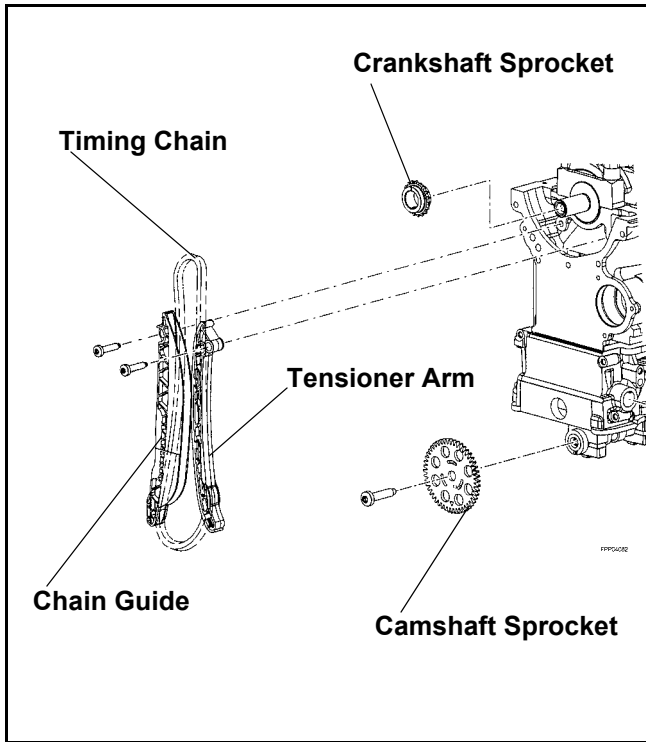


9. Using tool 15-030A to lock camshaft sprocket, remove bolt and camshaft sprocket.

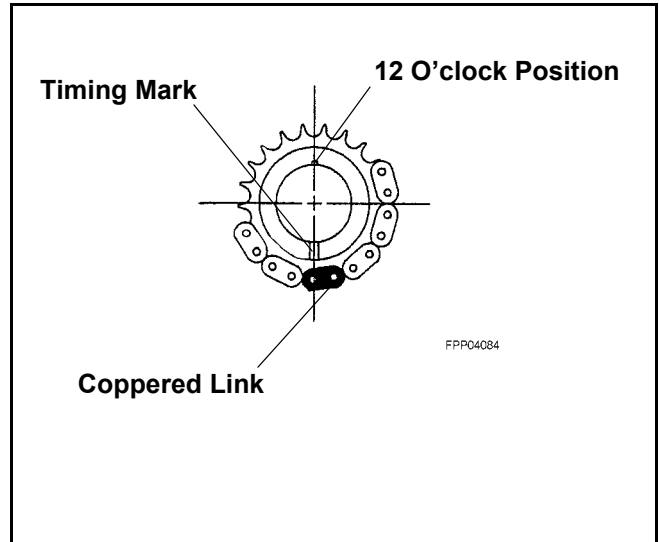




10. Remove timing chain and crankshaft sprocket.
11. Remove tensioner arm and chain guide if necessary.



2. Install crankshaft sprocket with key at 12 o'clock position.
3. Assemble drive chain through chain housing cavity from top of engine and onto crankshaft sprocket. Align timing mark with coppered link on drive chain.

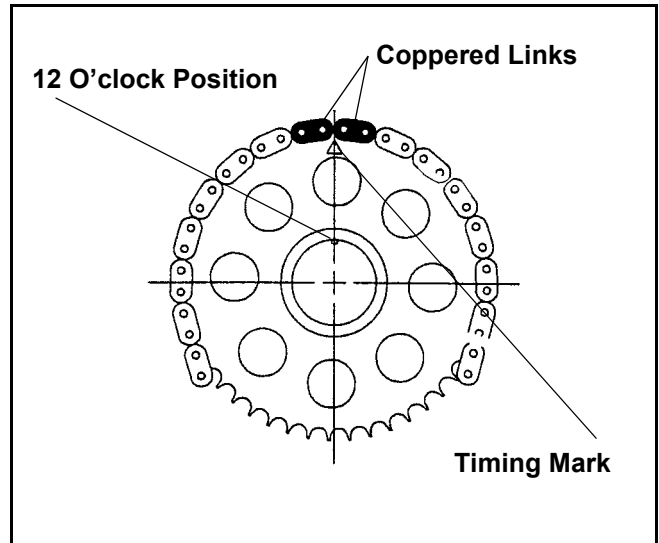
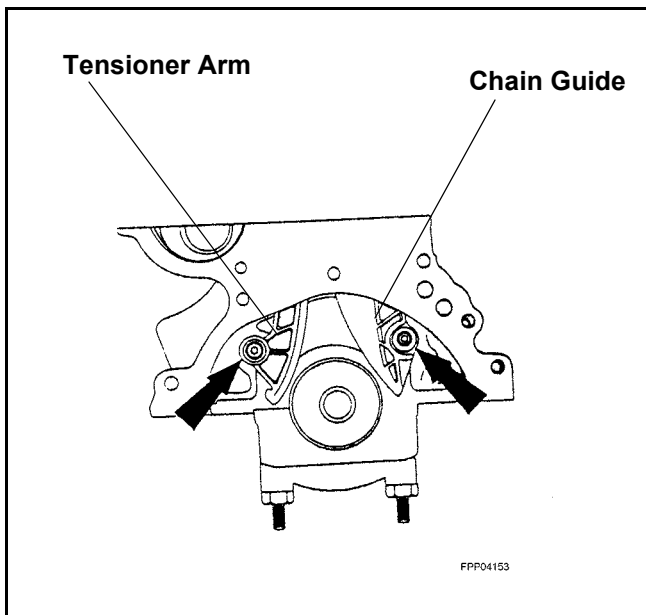


4. Insert camshaft sprocket into chain and assemble to camshaft. Position camshaft key at 12 o'clock and align timing mark between 2 coppered links on drive chain.

### Timing Chain and Sprockets - Installation

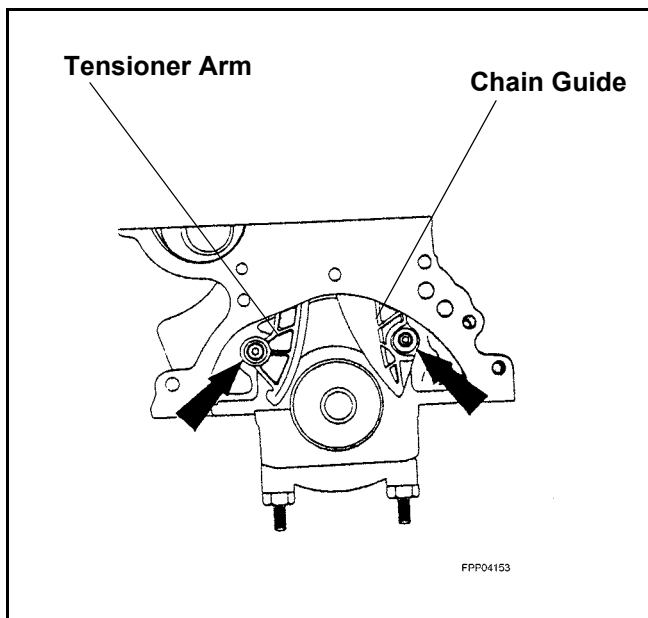
**NOTE:** All components must be clean and dried with compressed air or a lint free cloth. Lubricate with clean engine oil.

1. Install the (if removed) chain guide and the tensioner arm from the top of the engine. Install bolts finger tight.

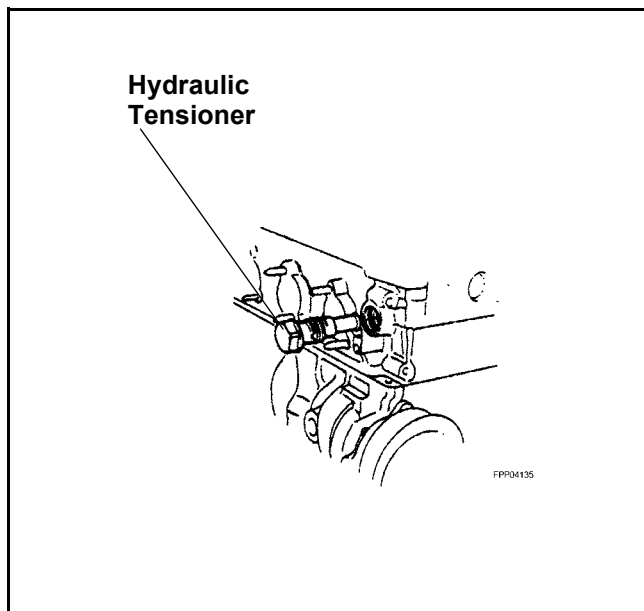


5. Install camshaft sprocket bolt and hydraulic tensioner finger tight.

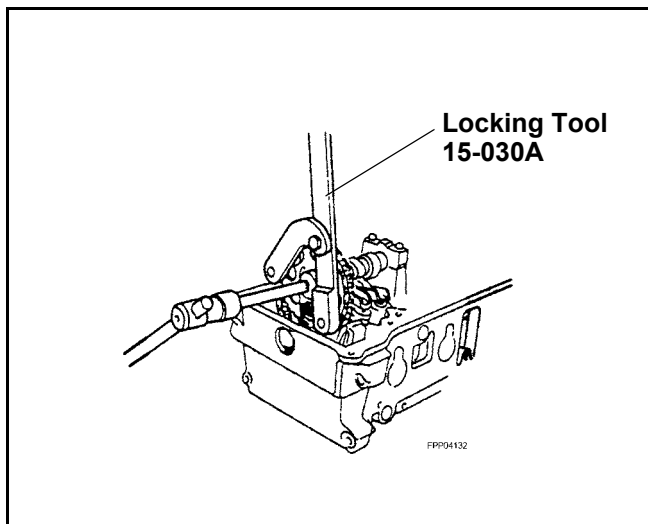
6. Tighten guide and tensioner arm bolts to 18-21 lb.ft. (24-28 Nm).



8. Tighten hydraulic tensioner to 27-32 lb.ft. (36-44 Nm).



7. Using ?? locking tool ??, tighten camshaft sprocket bolt to 52-59 lb.ft. (70-80 Nm).



9. oil pan, water pump, ???

10. Install valve cover -- Refer to "Valve Cover - Installation" on page 10.

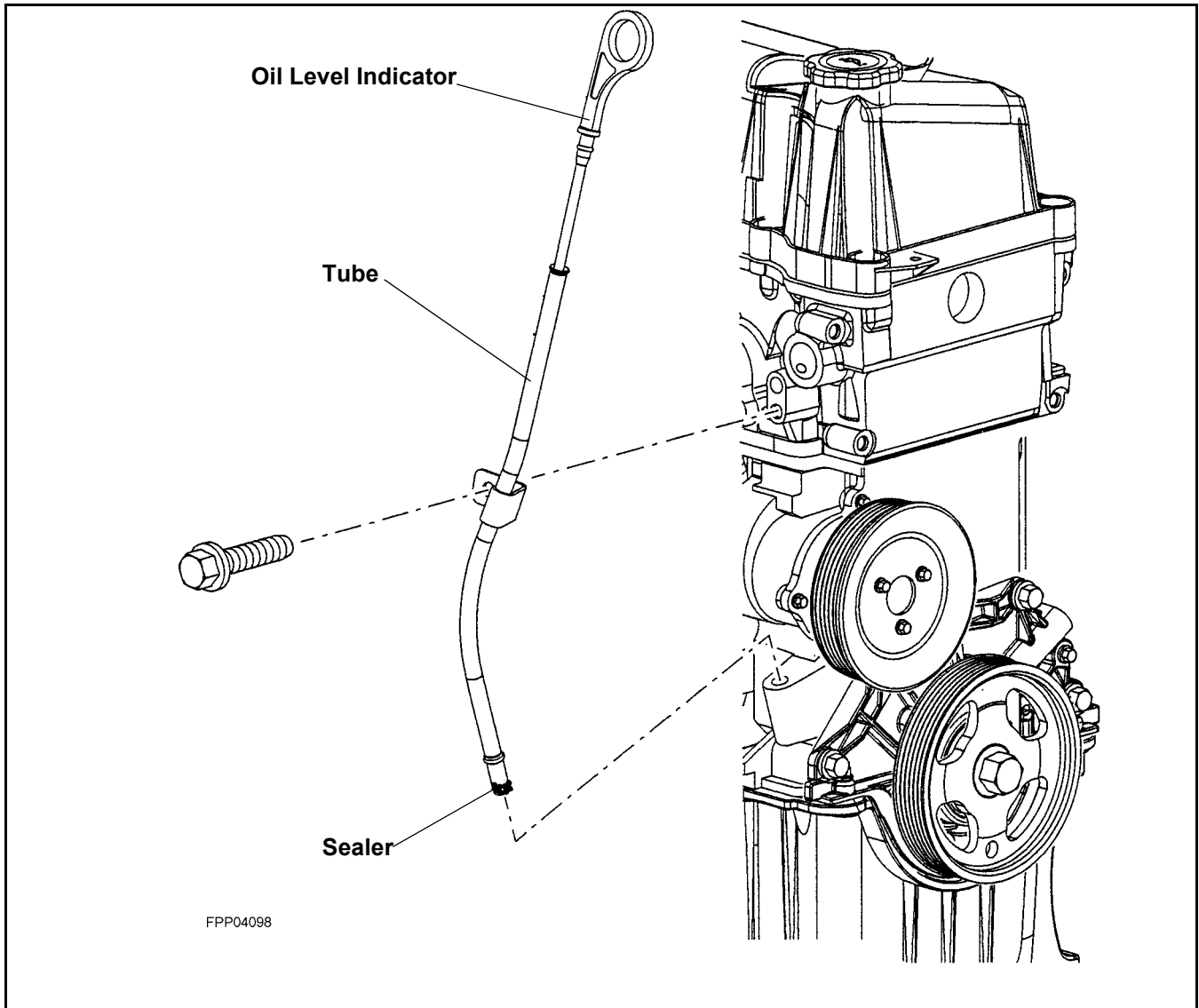
11. Install oil pump assembly -- Refer to "Oil Pump - Installation" on page 22.

12.

13.

14.

15.

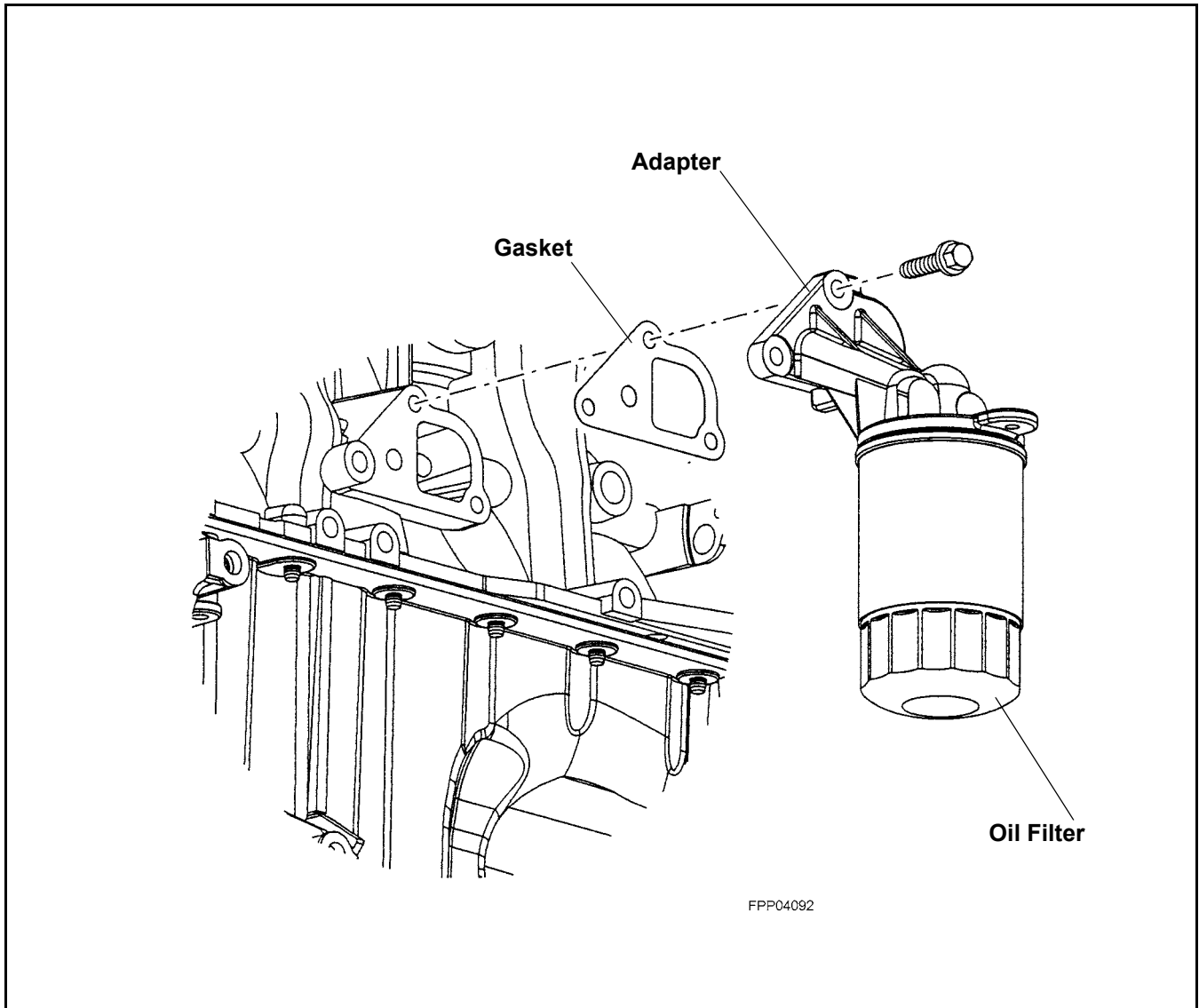


### Oil Level Indicator - Removal

- 1.
2. Remove bolt.
3. Remove oil level indicator & tube.

### Oil Level Indicator - Installation

1. Apply sealer WSK-M2G 349-A4 (Loctite 648) to lower end of oil level indicator tube.
2. Install tube immediately into bore.
3. Install bolt and tighten to 15 lb.ft. (20 Nm).
- 4.



### Oil Filter and Adapter - Removal

**NOTE:** Place oil drain pan under oil filter to catch oil drainage.

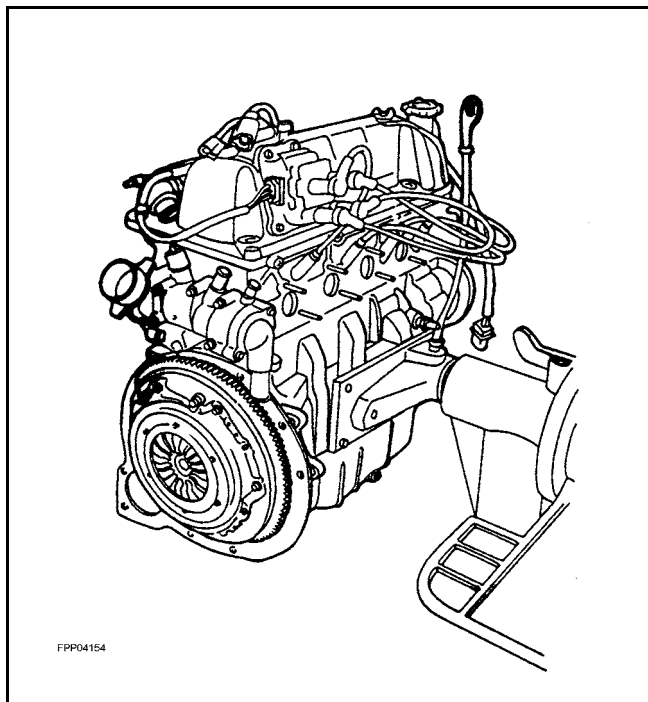
- 1.
2. Remove oil filter.
3. Remove 3 bolts.
4. Remove adapter and gasket.

### Oil Filter and Adapter - Installation

1. Install a new gasket.
2. Lubricate oil seal on a new filter and install to adapter. Tighten 1 1/2 to 1 3/4 turns after first contact.
3. Install filter/adapter to block.
4. Install 3 bolts and tighten to 15 lb.ft. (20 Nm).
- 5.

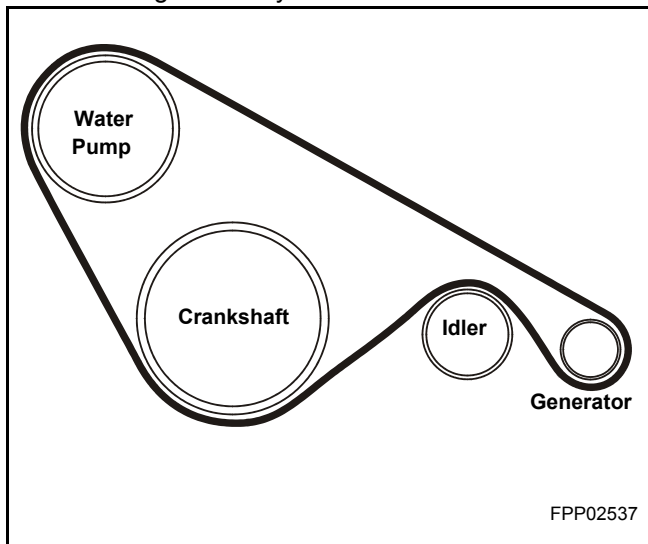
## DISASSEMBLY

1. Install engine on an engine stand.

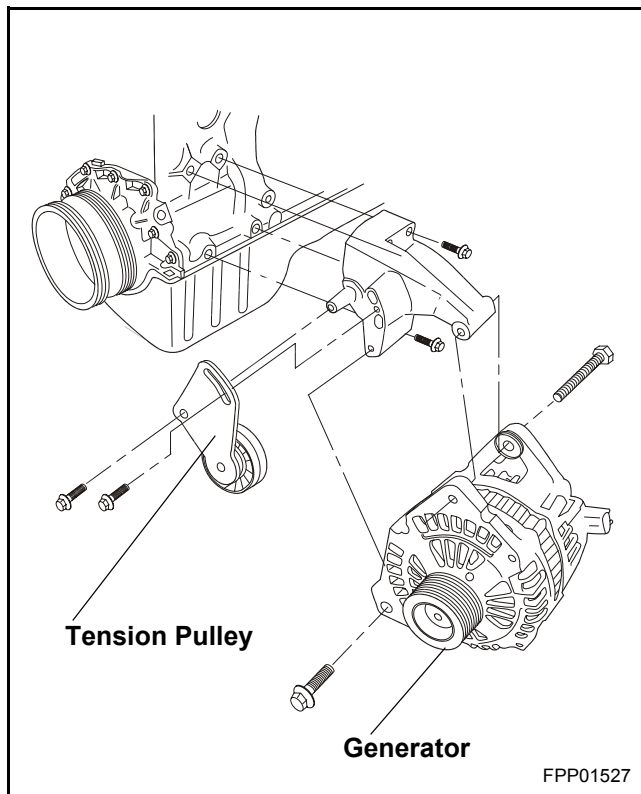


2. Drain the engine oil.

**NOTE:** Record drive belt routing and direction of travel for use during assembly.

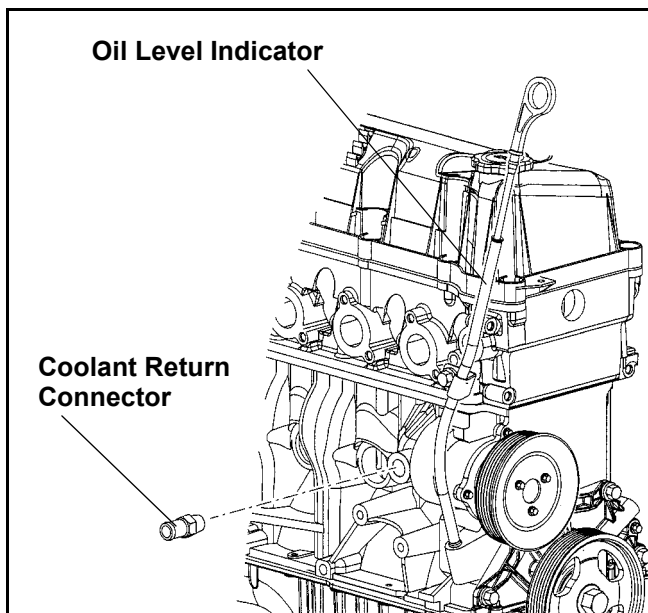


3. Loosen the tensioner pulley and remove the drive belt.



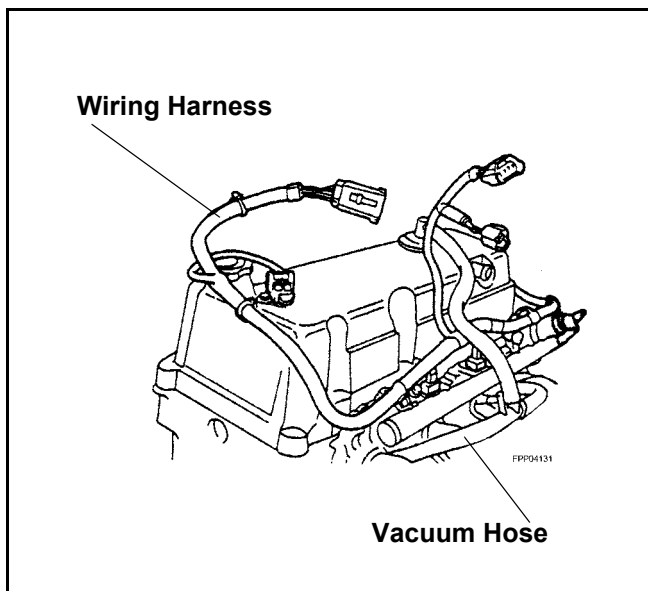
4. Disconnect wiring at generator.
5. Remove the generator.
6. Remove the generator support.

- 7. Remove oil level indicator tube.
- 8. Remove the ?return connector?.

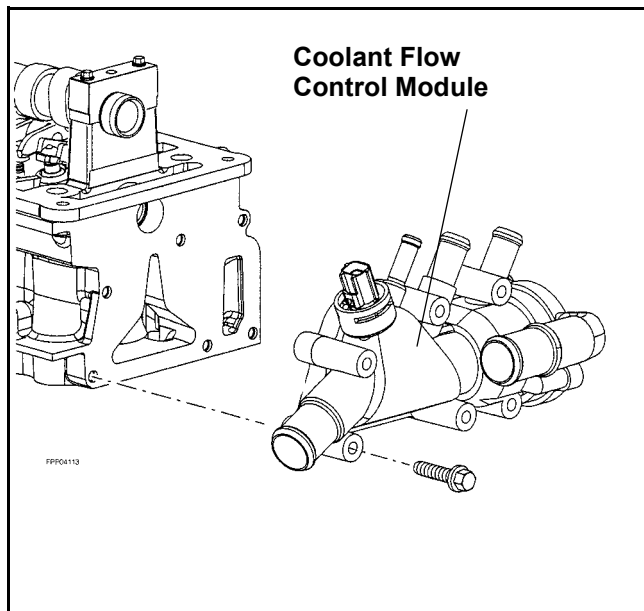


**NOTE:** Record routing of wiring harnesses and vacuum tubes so they may be returned to their original positions during assembly.

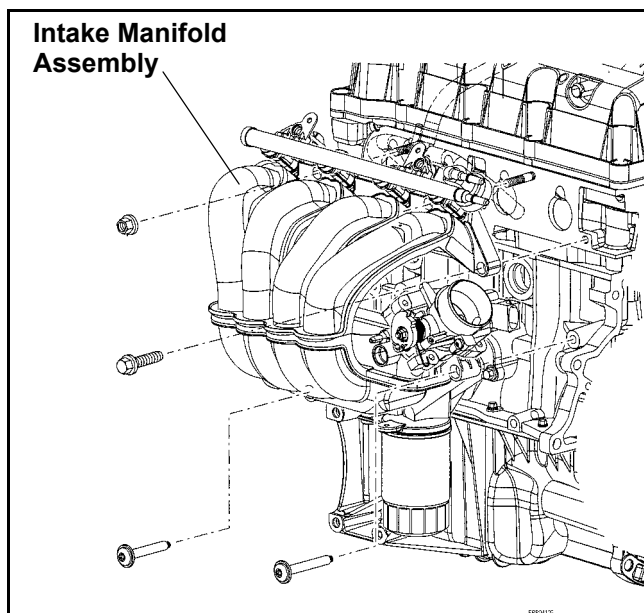
- 9. Remove any vacuum hoses and wiring.



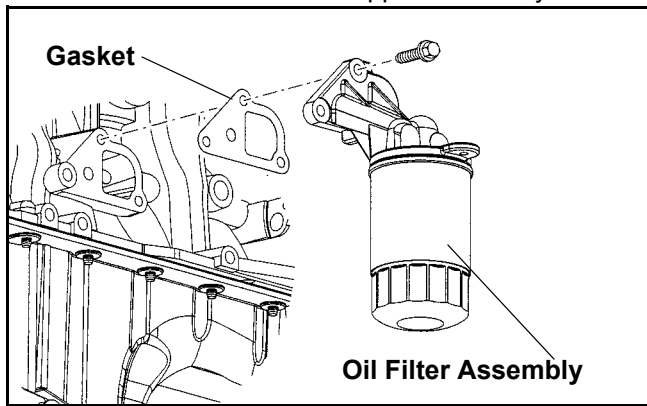
- 10. Remove the coolant flow control module.



- 11. Remove the intake manifold assembly.

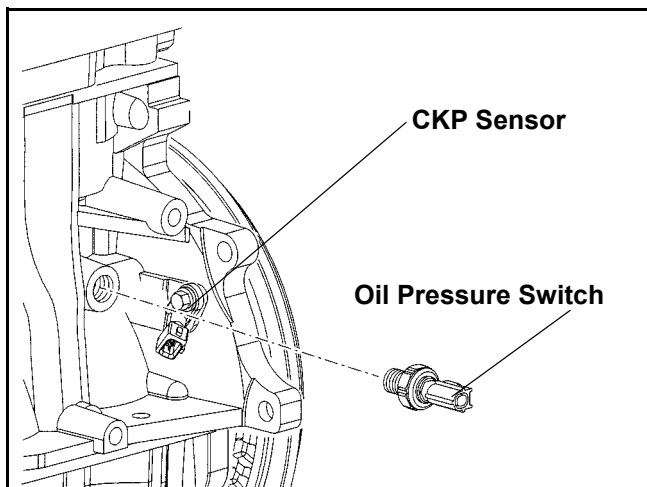


12. Remove the oil filter and support assembly.

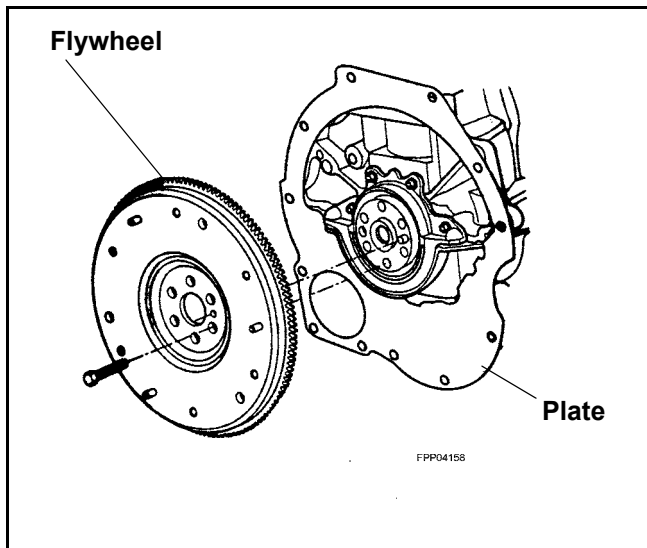


13. Remove oil pressure switch.

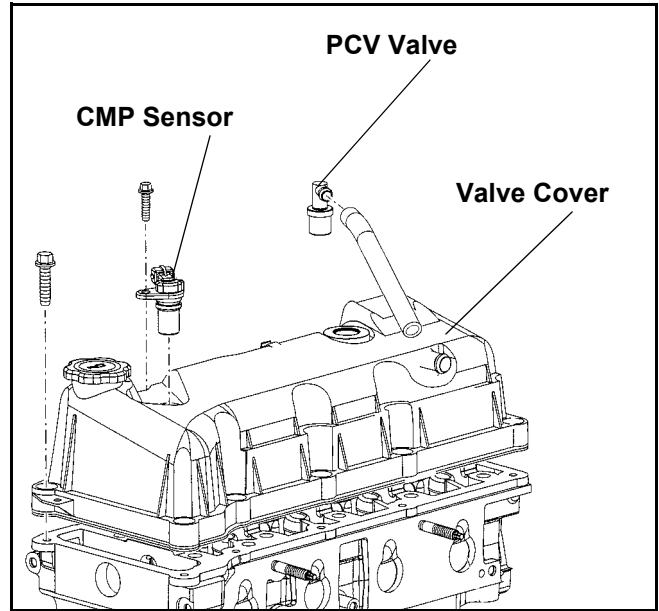
14. Remove crankshaft position (CKP) sensor.



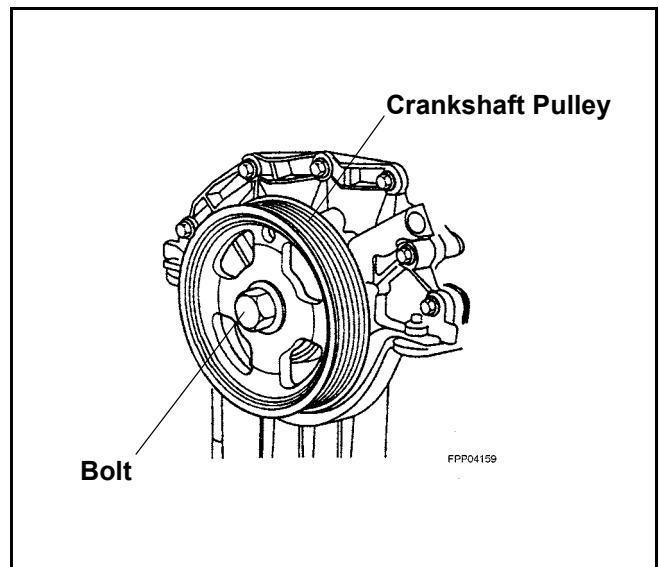
15. Remove the flywheel and flywheel plate.



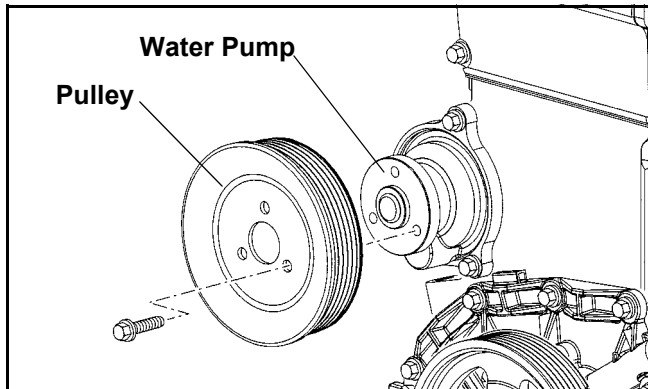
16. Remove the valve cover assembly.



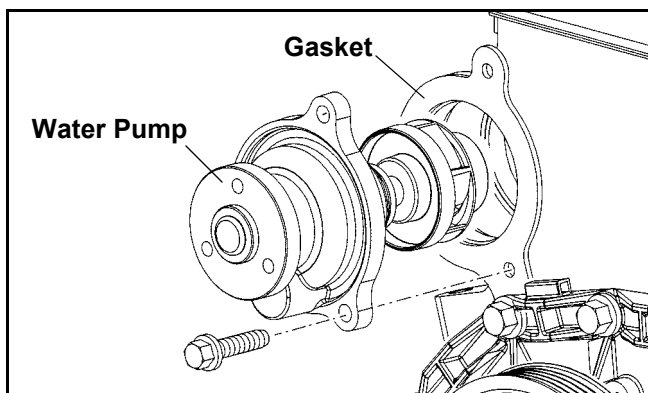
17. Loosen the crankshaft pulley bolt.



18. Remove 3 bolts and the water pump pulley.

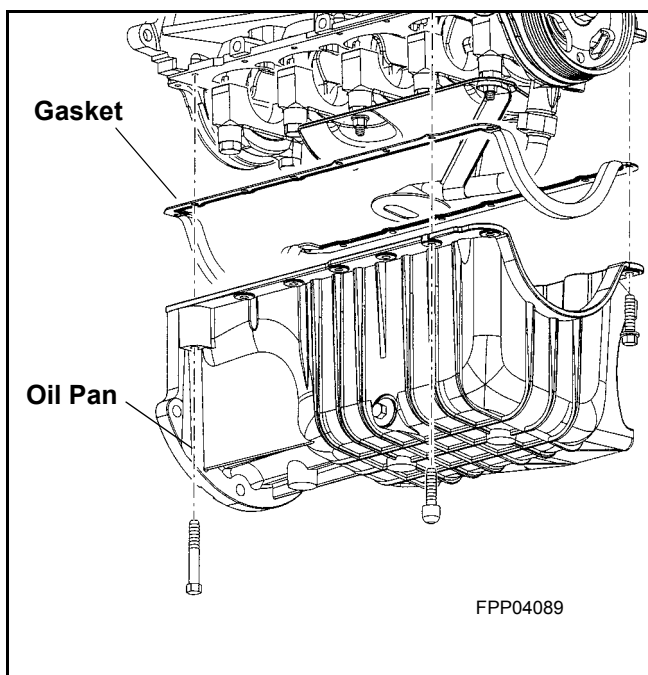


19. Remove 3 bolts, water pump and gasket.



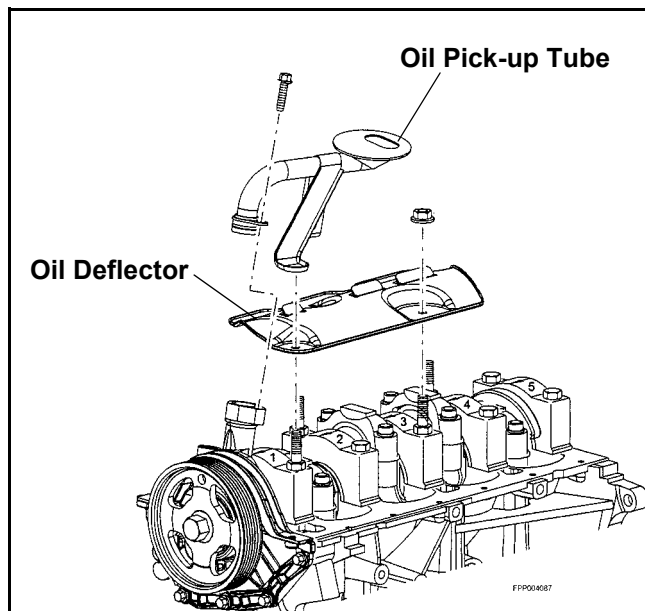
**NOTE:** When removing oil pan, always keep the engine in its normal upright position to avoid contamination.

20. Remove bolts, gasket and oil pan.



21. Turn the engine over 180°.

22. Remove 4 nuts, 1 bolt, oil pick-up tube and oil deflector.

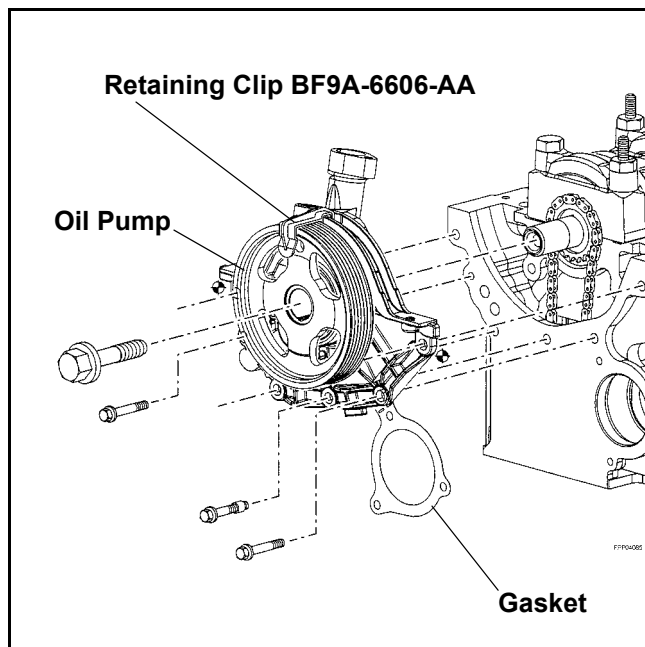


23. Insert retaining clip # BF9A-6606-AA between crankshaft pulley and oil pump to prevent pulley axial movement.

24. Remove crankshaft pulley bolt.

**NOTE:** Identify oil pump bolts so they may be returned to their original positions.

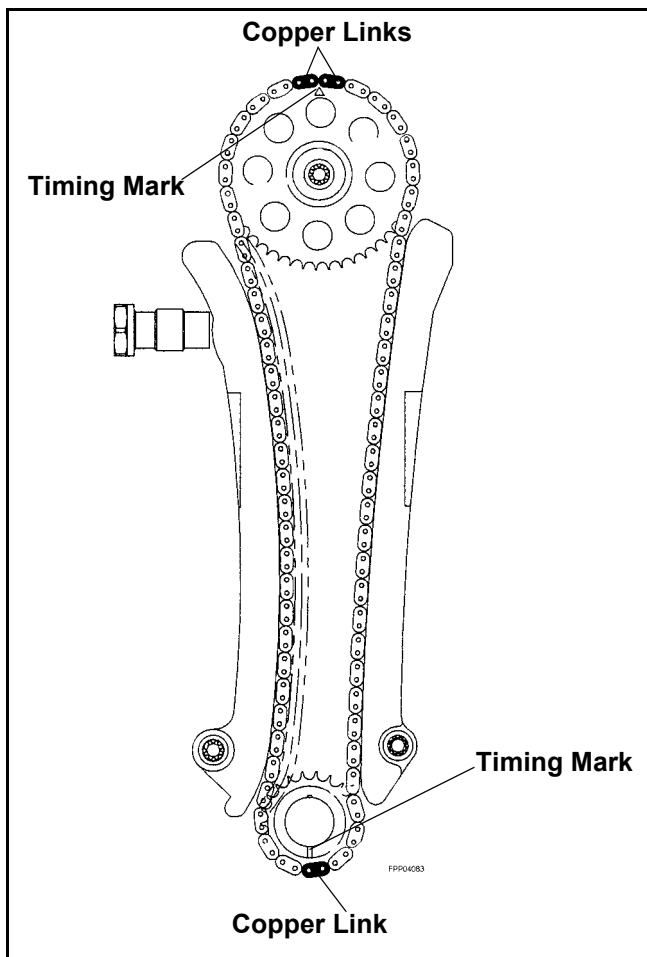
25. Remove 6 oil pump bolts, and oil pump.



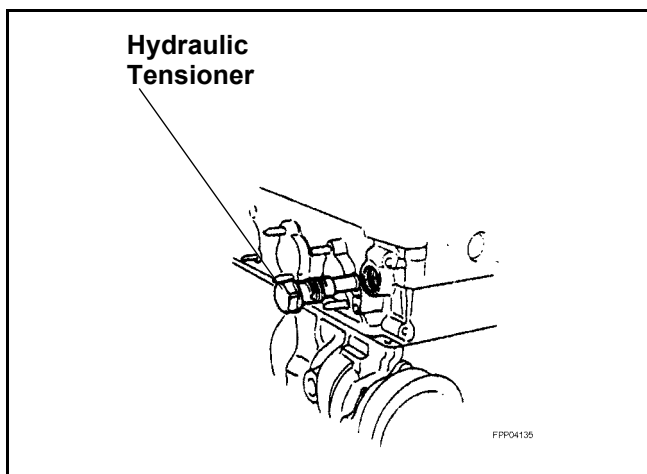


26. Check to see if coppered links on the timing chain are still visible. If not, identify them as follows:

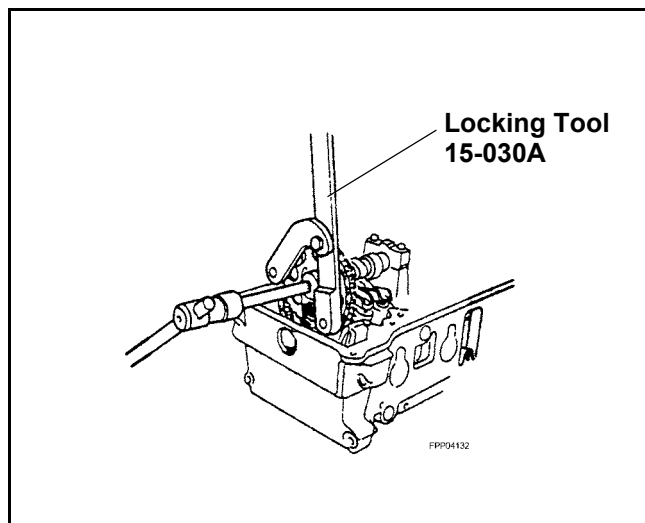
- Turn engine until timing mark on camshaft sprocket is at 12 o'clock.
- Mark the two chain links left and right of that timing mark.
- Mark the single chain link that is positioned on the crankshaft sprocket timing mark.



27. Remove the hydraulic tensioner.

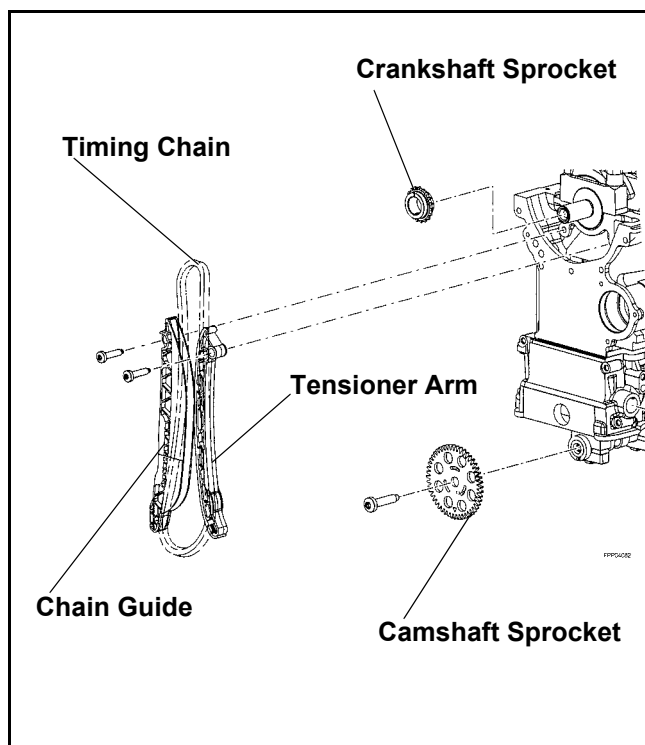


28. Using tool 15-030A to lock camshaft sprocket, remove bolt and camshaft sprocket.



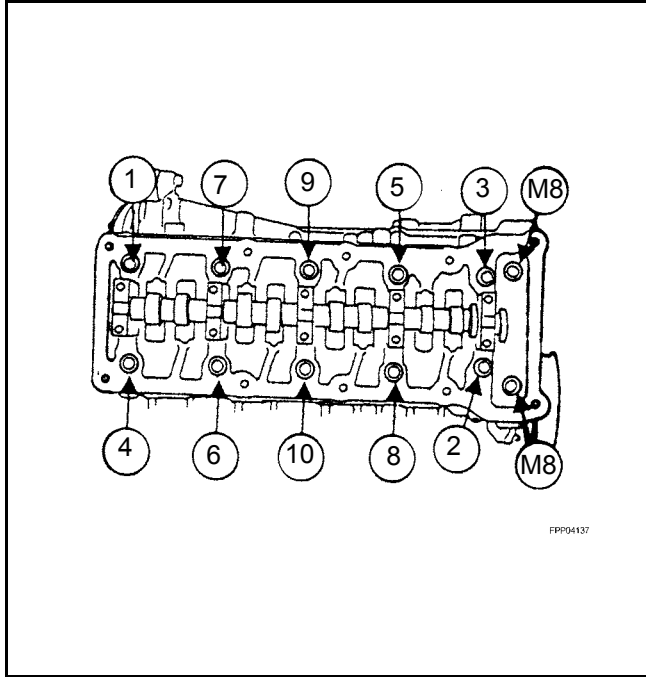
29. Remove timing chain and crankshaft sprocket.

30. Remove tensioner arm and chain guide.

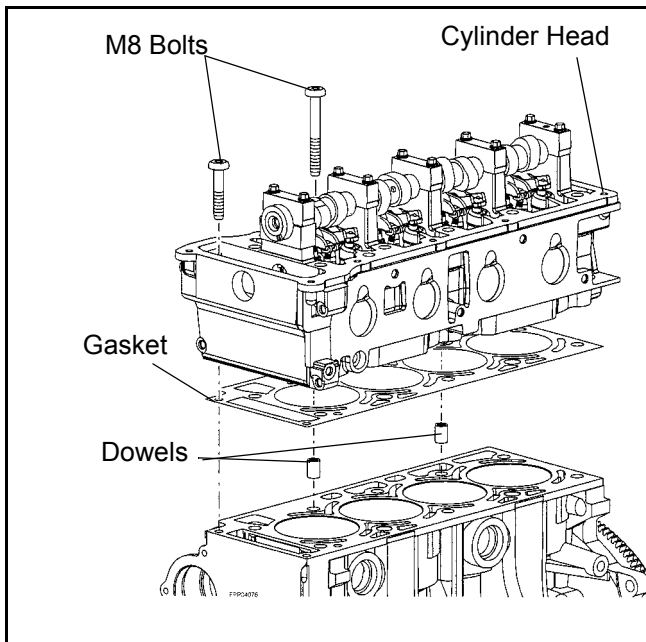


**CAUTION:** Keep cylinder head in the vertical position during removal to avoid warping and damage to the sealing surfaces.

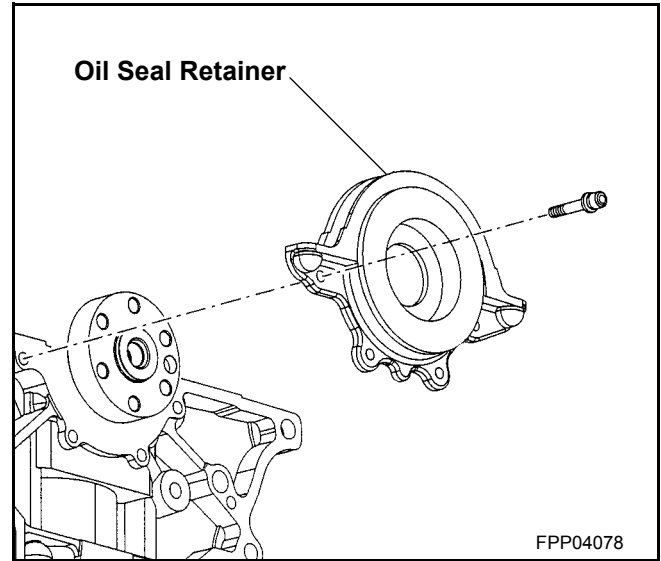
31. Remove the M11 cylinder head bolts in 3 phases in the sequence shown.



32. Remove 2 M8 bolts, cylinder head and gasket.

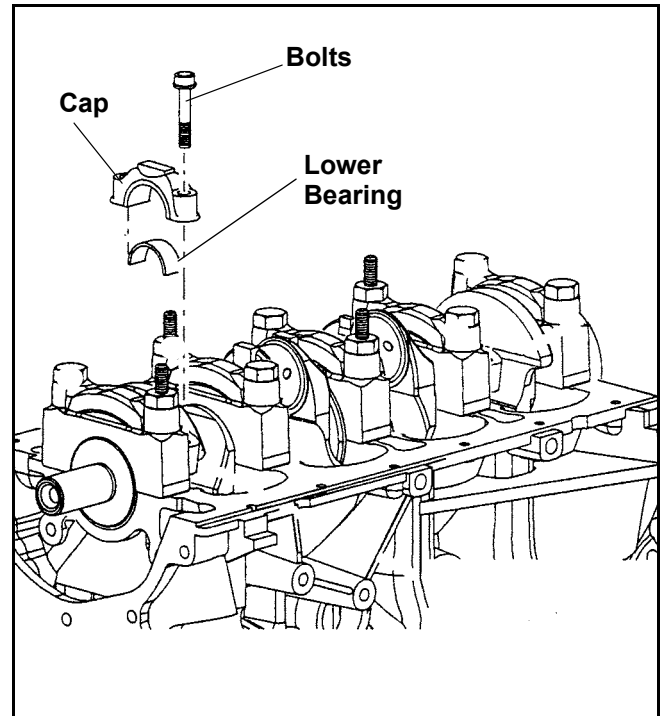


33. Remove crankshaft rear seal retainer.



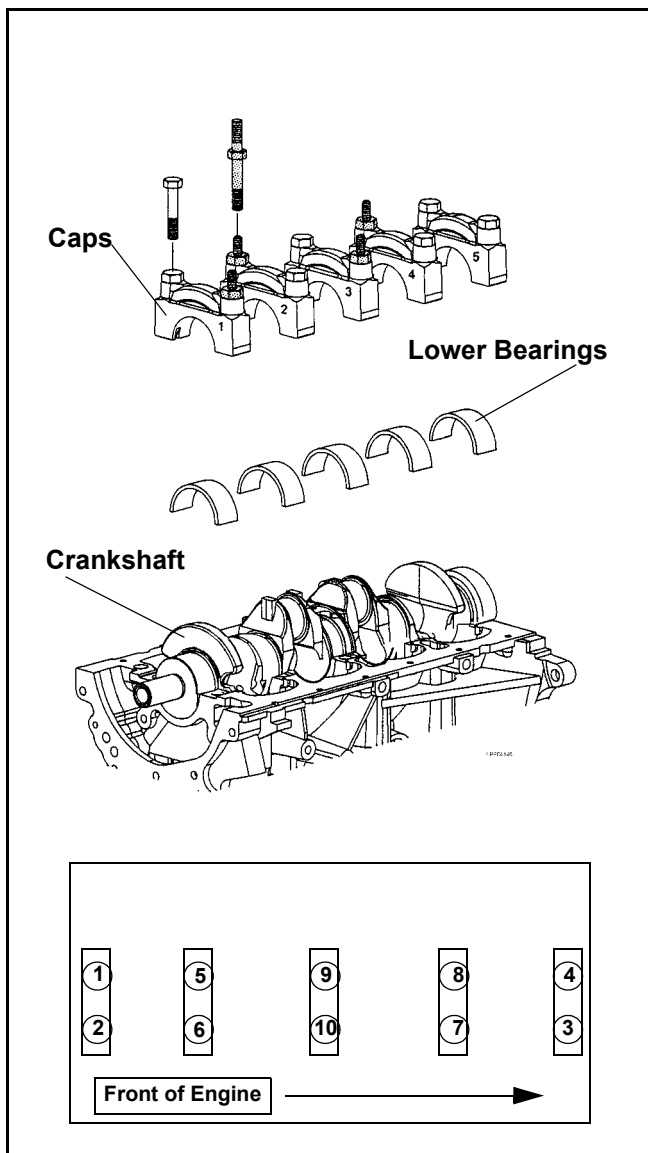
**NOTE:** Mark piston and cap so they may be returned to their original positions.

34. Remove 2 bolts, lower connecting rod bearing and cap. Push piston assembly out of the engine block. Repeat for other three cylinders.

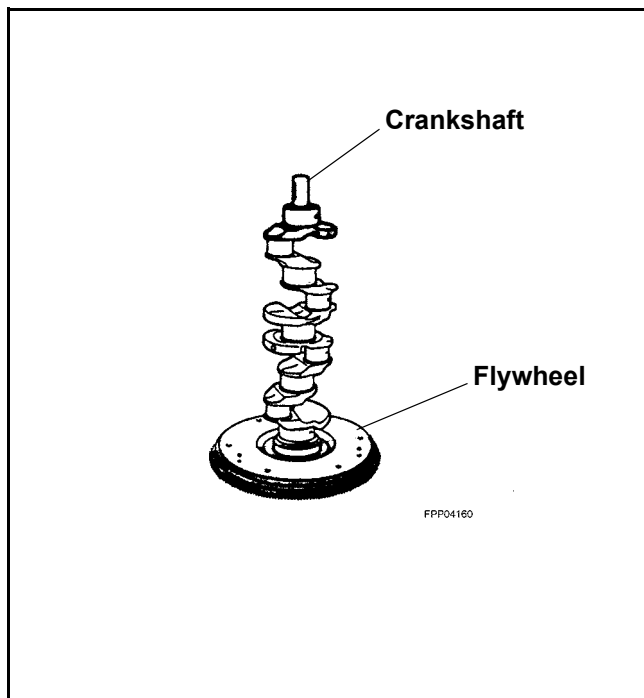


**NOTE:** Keep caps and bearings in order so they may be returned to their original positions.

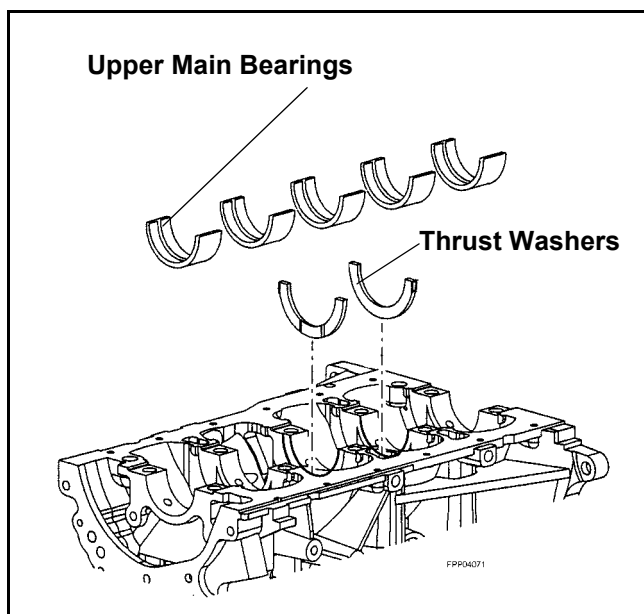
35. Remove bolts, caps and crankshaft lower main bearings in the sequence shown.



36. Carefully remove the crankshaft and install it vertically on the flywheel to avoid warp running-out.



37. Remove the 5 upper main bearings and the 2 thrust washers.



## SUBASSEMBLIES

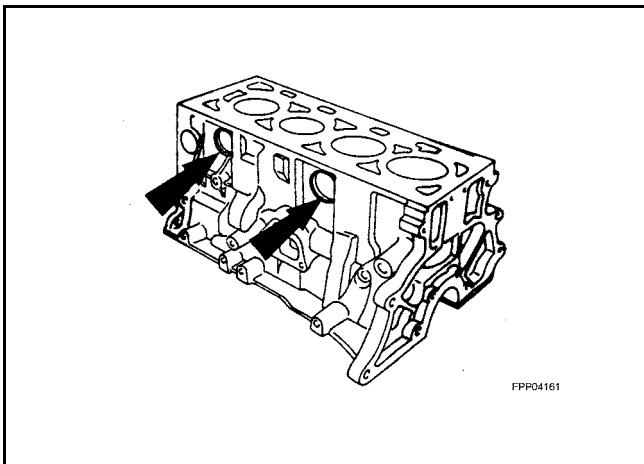
Clean crankcase and all subassemblies of all foreign material. Scrape or wire brush RTV sealant from mating surfaces. Surfaces must be kept oil free for good adhesion of fresh RTV seal (during reassembly).

**NOTE:** For cleaning and service information on crankcase, cylinder head, camshaft, crankshaft and bearings, Refer to Section 01.

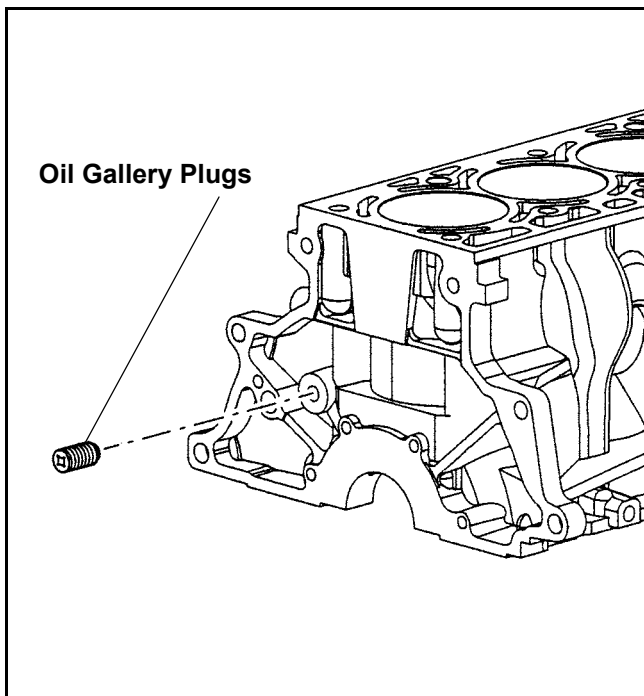
Discard gaskets and O-Rings and replace with new ones unless otherwise instructed.

### Cylinder Block

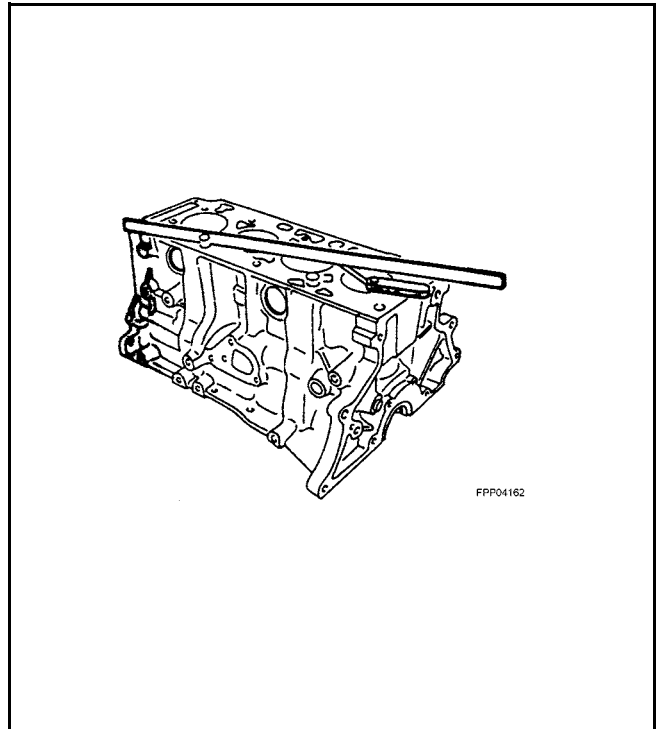
1. Remove the core plugs, if necessary.



2. Remove oil gallery plugs.



3. Check the engine block for warpage, cracks or any other damage.

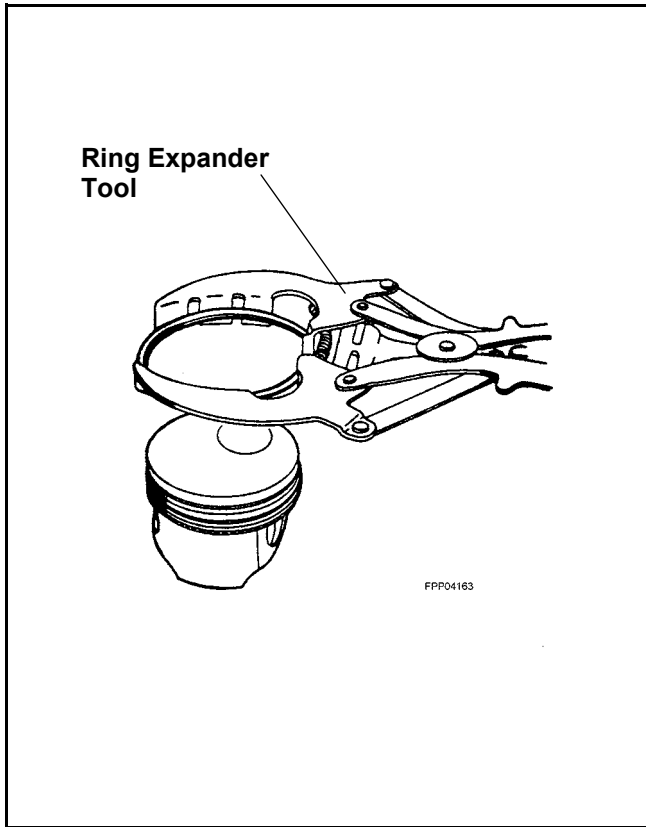


4. Coolant and oil galleries must be free of dirt and deposits.
5. Refer to Section 01 for cleaning & servicing cylinder block and core plug installation.
6. Reinstall oil gallery plugs.

### Piston - Disassembly

**NOTE:** Store components to ensure assembly with the same rod and installation in the same cylinders from which they were removed. Refer to Section 01 for piston inspection and servicing.

1. Remove the connecting rod bearing from the connecting rod and cap.
2. Remove the piston rings using a suitable piston ring expander.

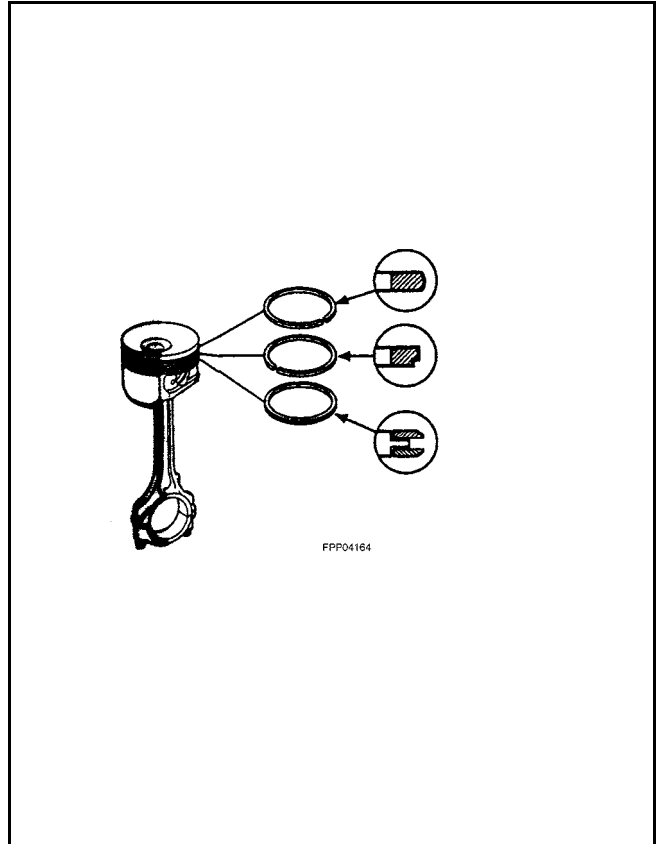


3. Remove piston pin????????????????????????????
- 4.

### Piston - Assembly

**NOTE:** Apply a light coat of clean engine oil contact surfaces.

1. Assemble piston to connecting rod using ??????????
2. Install piston rings using a suitable piston ring expander.



**NOTE:** Check piston ring end gap and side clearance - refer to Section 01.

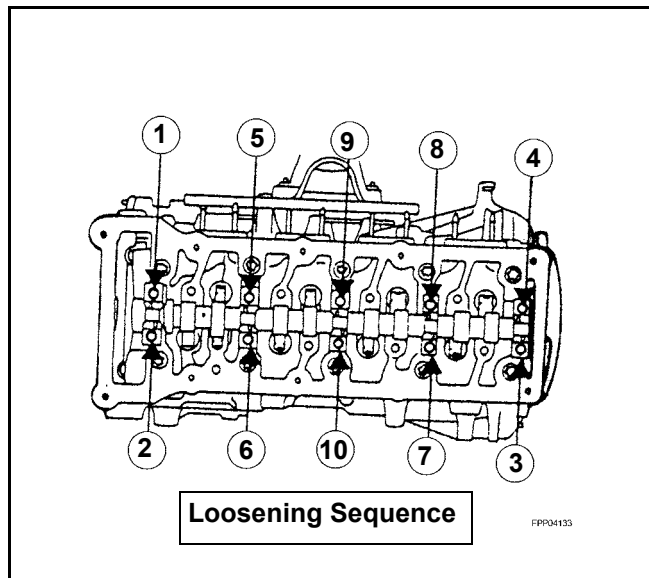
3. Install bearings into connecting rods and caps. Make sure lock slots align.

**CAUTION:** Make sure bearings and connecting rod bore are clean. foreign material under the inserts will distort the bearing and cause a failure.

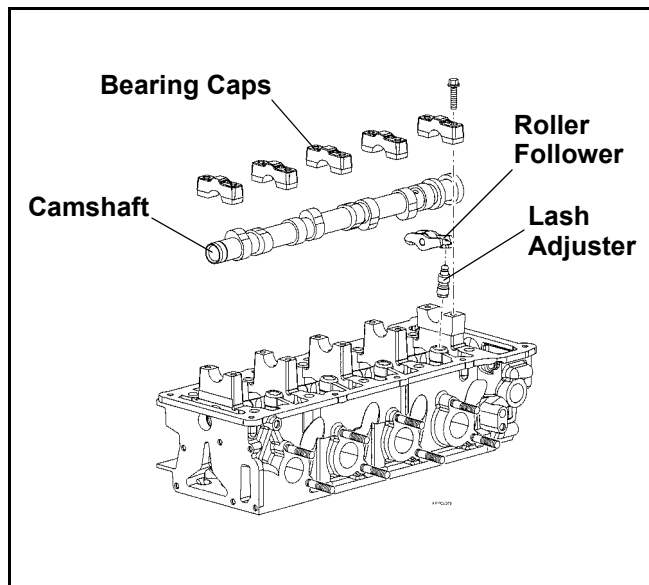
## Cylinder Head - Disassembly

**NOTE:** Store components to ensure assembly in the same order as they were removed.

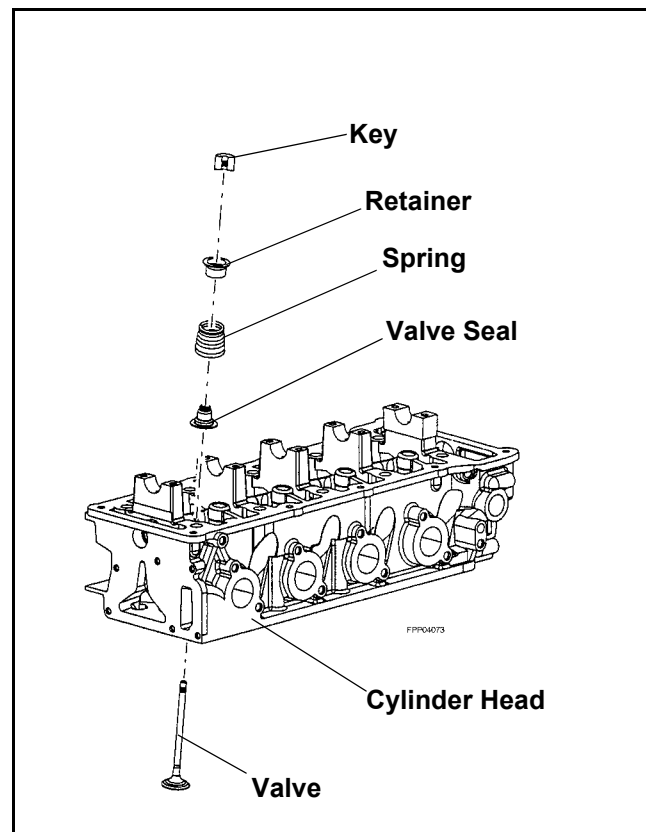
1. Remove bolts and camshaft bearing caps evenly in the sequence shown.



2. Remove camshaft.
3. Remove roller followers.
4. Remove lash adjusters.
5. Remove spark plugs.



6. Remove all valve components using a suitable valve spring compressor.



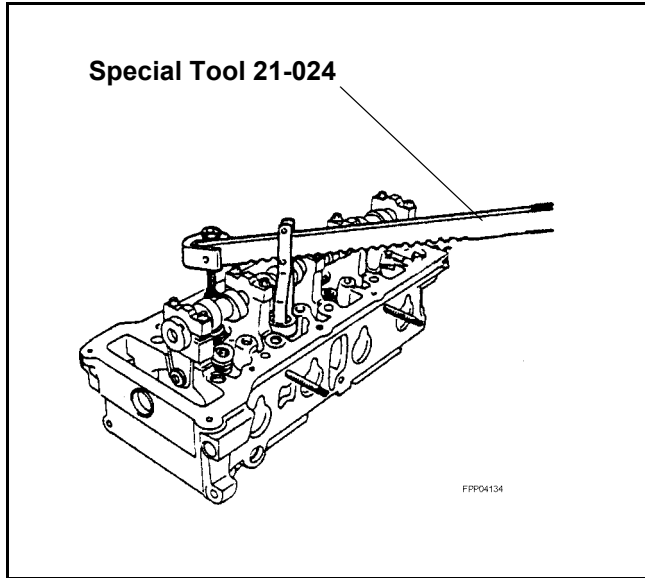
Refer to Section 01 for:

- servicing valve components, valve guide and valve seat.
- camshaft and bearing service.
- cylinder head cleaning and inspection.

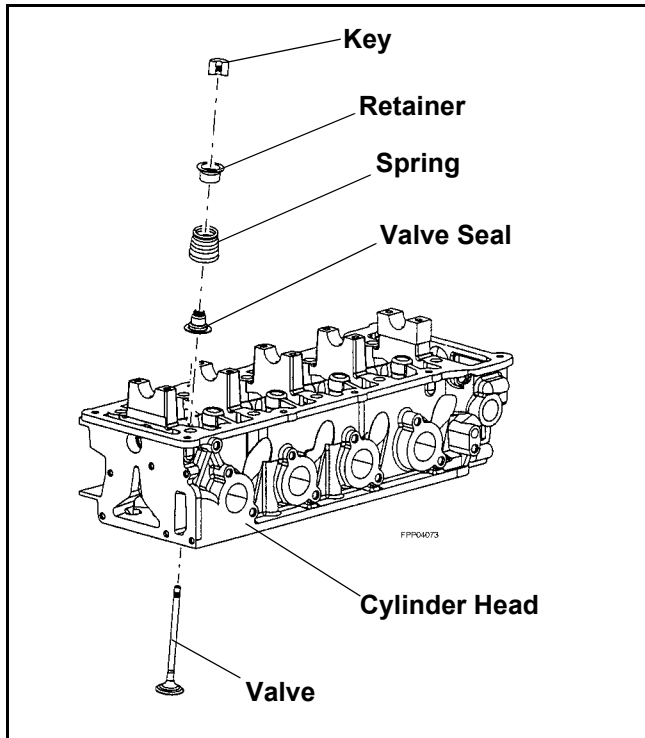
### Cylinder Head - Assembly

**NOTE:** All components must be clean and assembled in the same positions as removed. Lubricate contact surfaces with clean engine oil.

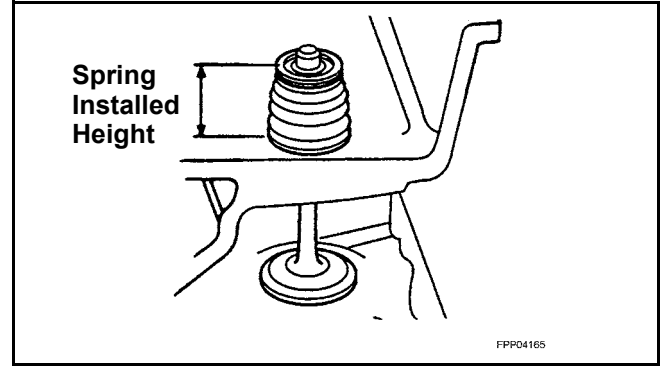
1. Check that valves move freely in valve guides.
2. Install intake and exhaust valves.
3. Install new valve seals using special tool 21-024 (optional T95P-6565A).



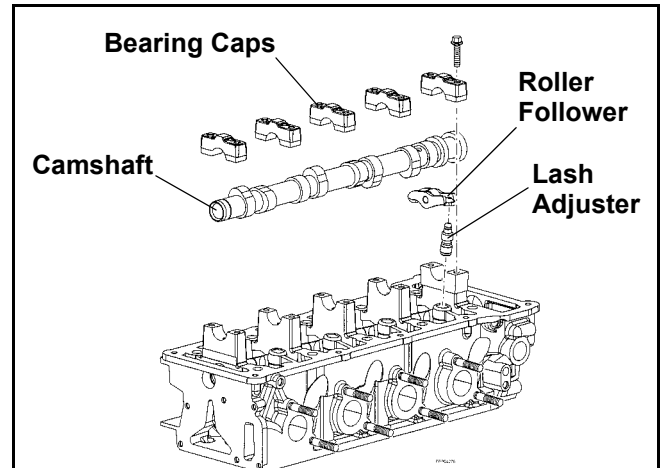
4. Using a suitable spring compressor tool, install valve springs, retainers and locks.



5. Check that spring installed height is  $35.2 \pm 1$ mm.



6. Install lash adjusters.



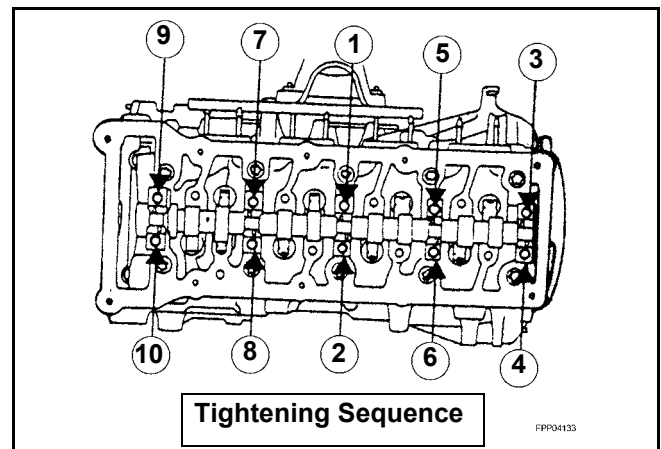
7. Install roller followers.

**NOTE:** The chamfer on the camshaft bearing caps must be facing the chain housing.

8. Carefully install camshaft bearings, camshaft and bearing caps with bolts finger tight.

**NOTE:** Rotate camshaft so key is at 12 O'clock position.

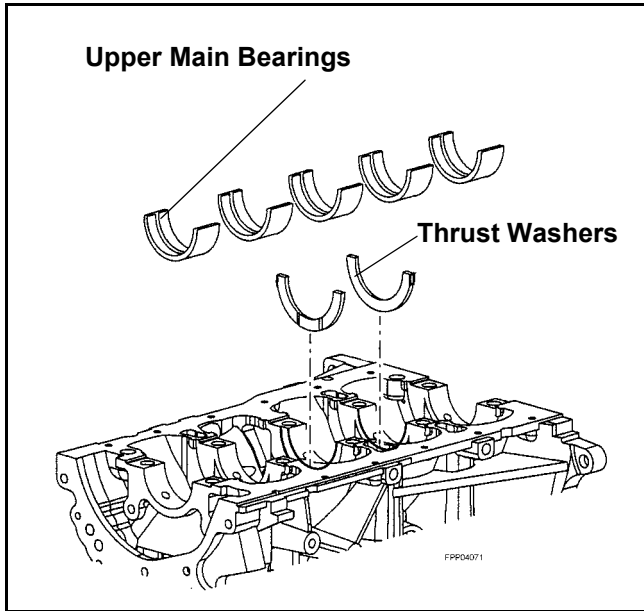
9. Tighten bolts in the sequence shown in 3 steps to 6-7 lb.ft. (8-10 Nm).



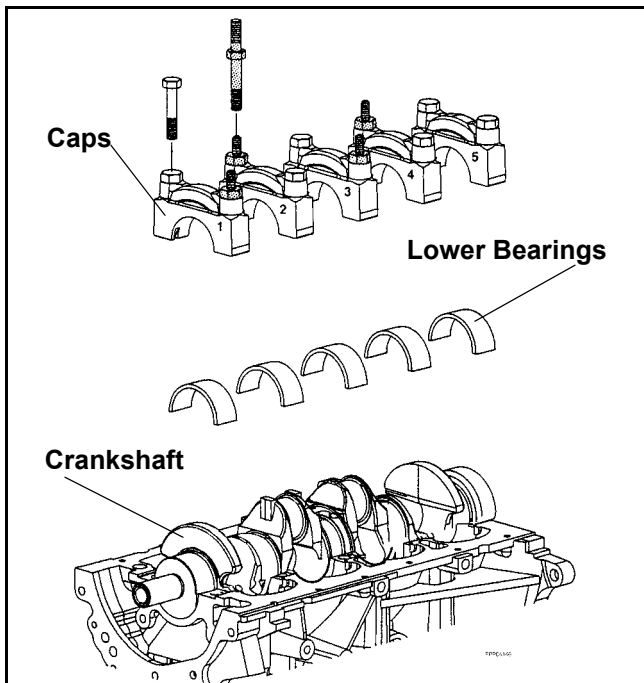
**ASSEMBLY**

**NOTE:** All components must be clean and dried with compressed air or a lint free cloth. For information on bearings & piston inspection and selection - Refer to Section 01.

1. Install upper main bearings and thrust washers to cylinder block. Lubricate the wear surfaces with clean engine oil. Make sure oil holes align.



2. Carefully install the crankshaft onto the upper bearings.
3. Assemble the lower main bearings into caps. Lubricate the wear surfaces and the bolt threads with clean engine oil.

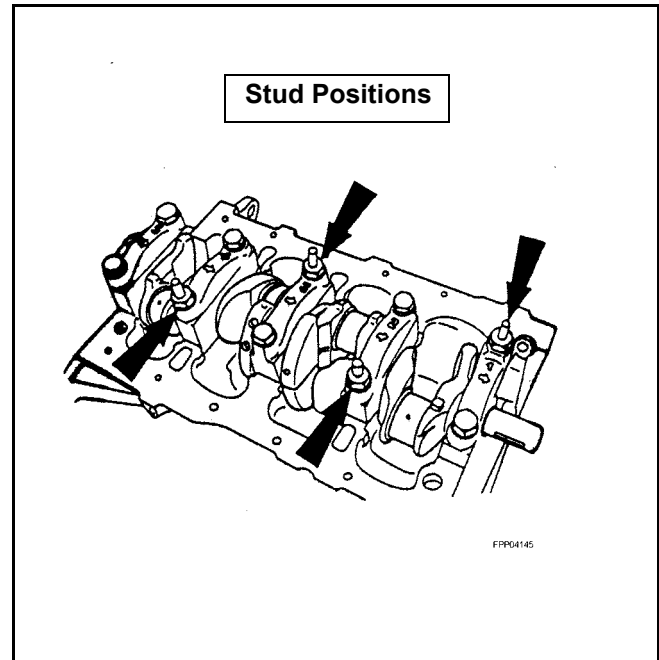


**NOTE:** The main bearing caps are numbered and must be assembled to corresponding numbers. The arrow on the main bearing caps must point to the front of the engine.

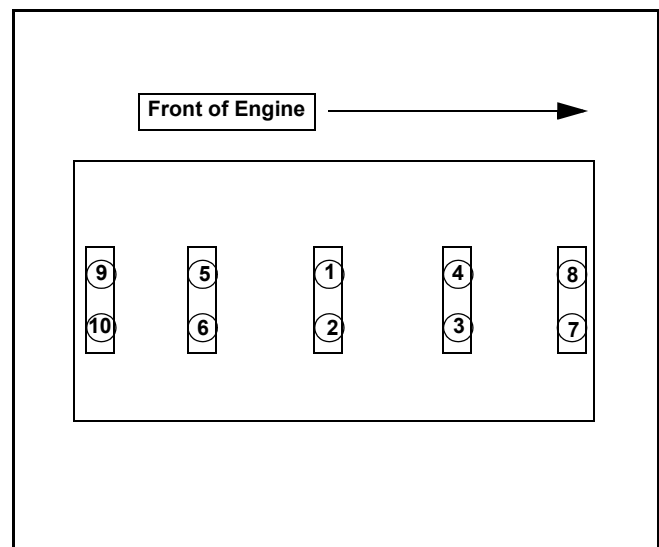
**CAUTION:** Use new main bearing cap bolts.

4. Install main bearing caps in the same positions as removed.

**NOTE:** Check the position of studs as shown.



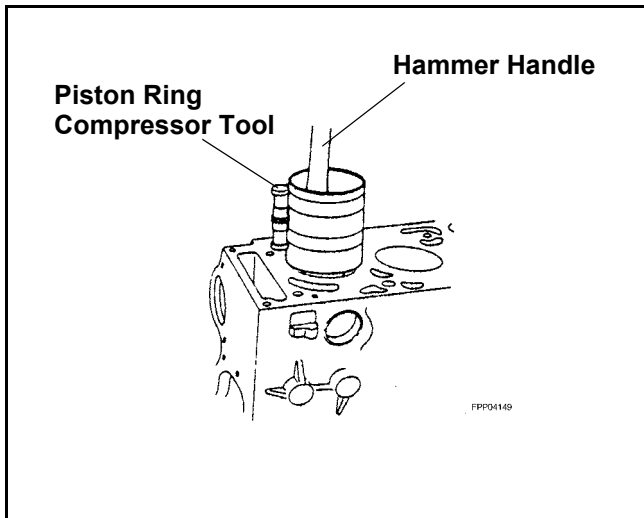
5. Tighten main bearing cap bolts/studs in sequence shown and in three steps to 70 lb.ft. (95 Nm).



**NOTE:** Check crankshaft end play as outlined in Section 01.

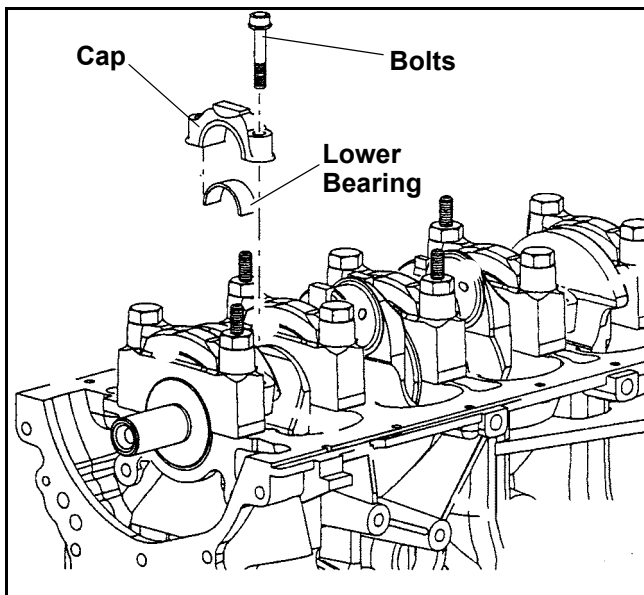


6. Set piston ring gaps as follows:
  - lower oil ring gap aligned with piston pin.
  - center ring gap at 90° from the oil ring gap.
  - top ring gap at 180° from the oil ring gap.
7. Lubricate piston, bearing wear surface, crankshaft journal and cylinder wall with clean engine oil.
8. Carefully install pistons with bearings into cylinder bores using a piston ring compressor and a hammer handle. Avoid damage to the crankshaft bearing journals. The arrow of the piston must point to the front of the engine. The connecting rod has the cylinder number identified in the base.

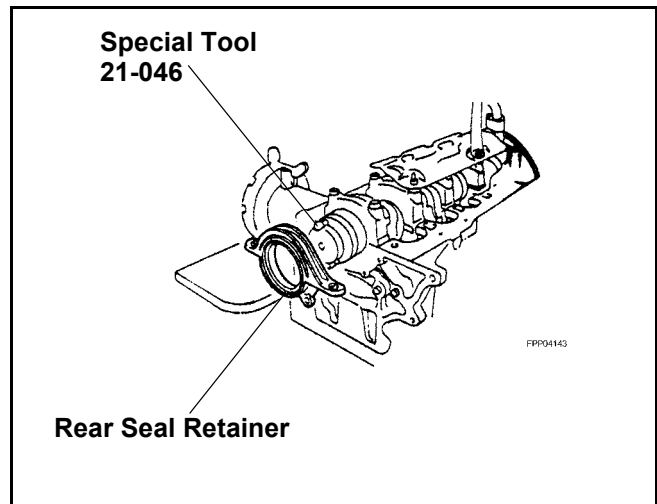


**CAUTION:** Use new connecting rod cap bolts and lubricate threads with clean engine oil.

9. Install connecting rod caps with bearings (lubricate wear surface) and tighten bolts in 2 steps:
  - Step 1 - 9 lb.ft. (12.5 Nm)
  - Step 2 - 22 lb.ft. (30 Nm) (41-94°???)



10. Install a new rear seal and retainer using tool 21-046.

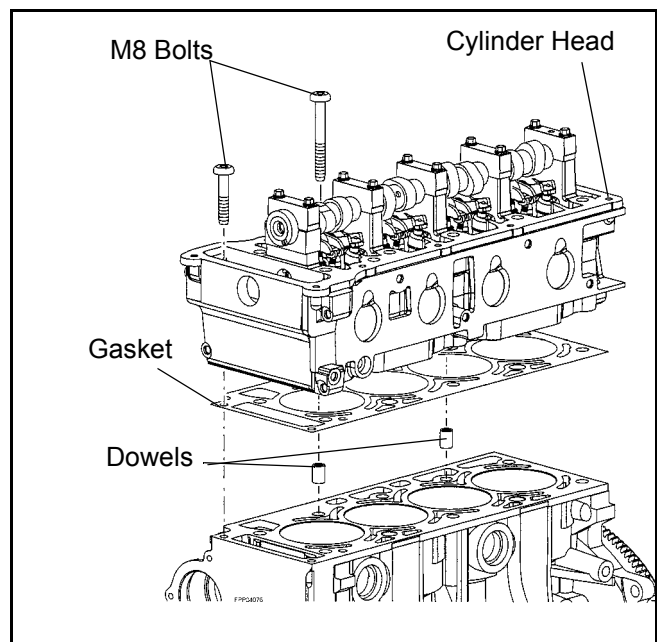


**NOTE:** Rear seal retainer comes on a plastic sleeve. Link plastic sleeve to crankshaft (?? 34mm ??) and push retainer to crankshaft. Plastic pins at rear side of retainer must fit to corresponding block bores. Remove plastic sleeve when done.

11. Turn engine 180° to prepare for cylinder head installation.

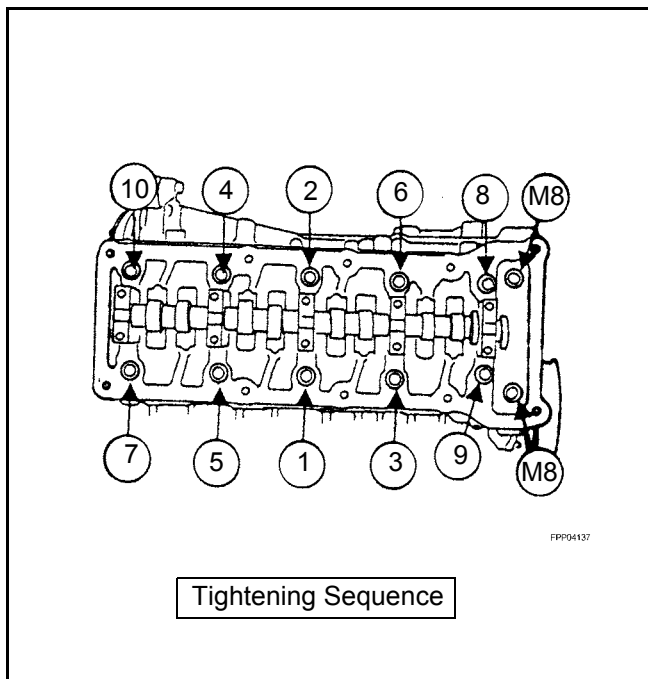
**NOTE:** The contact surface of the cylinder head and block must be clean and free of oil. Use new cylinder head bolts and lubricate the threads.

12. Rotate crankshaft so all pistons are **below** top dead center (TDC).
13. Install dowels and new cylinder head gasket to the engine block.
14. Carefully install the cylinder head onto the gasket.

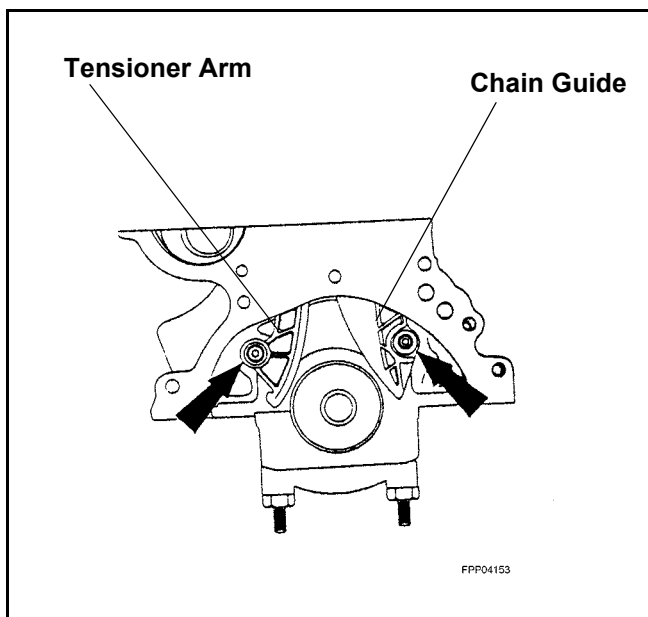


15. Install new bolts using the sequence shown in the following 3 steps:

- Step 1 - tighten M11 bolts to 29.5 lb.ft. (40 Nm)
- Step 2 - tighten M8 bolts to 11 lb.ft. (15 Nm) + 45°
- Step 3 - tighten M11 bolts additional 120°

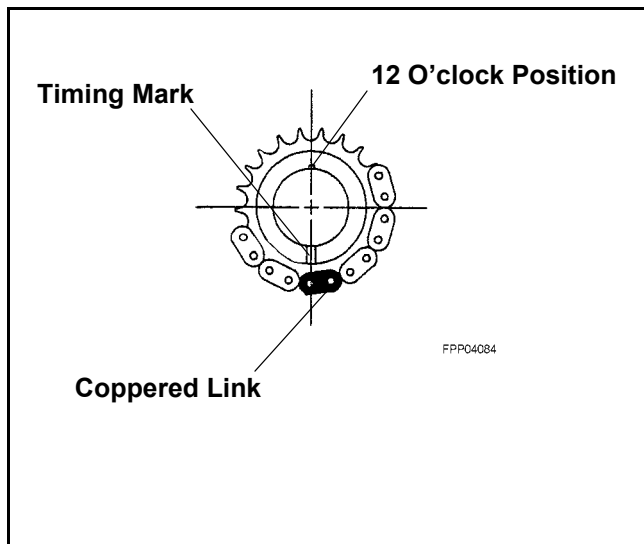


16. Install the chain guide and the tensioner arm from the top of the engine. Install bolts finger tight.

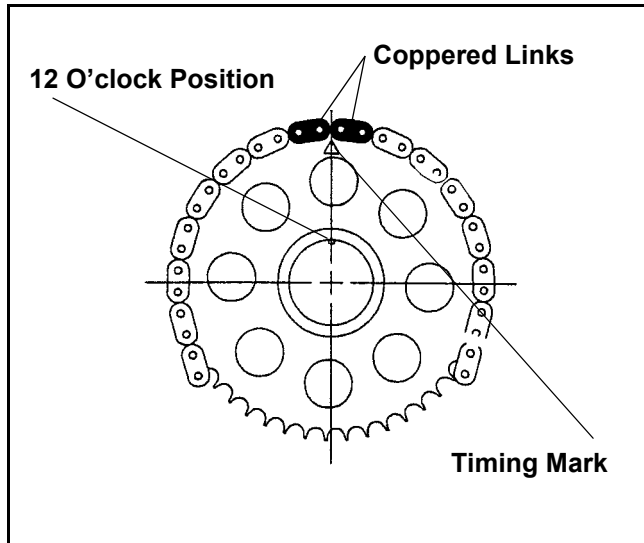


17. Install crankshaft sprocket with key at 12 o'clock position.

18. Assemble drive chain through chain housing cavity from top of engine and onto crankshaft sprocket. Align timing mark with coppered link on drive chain.

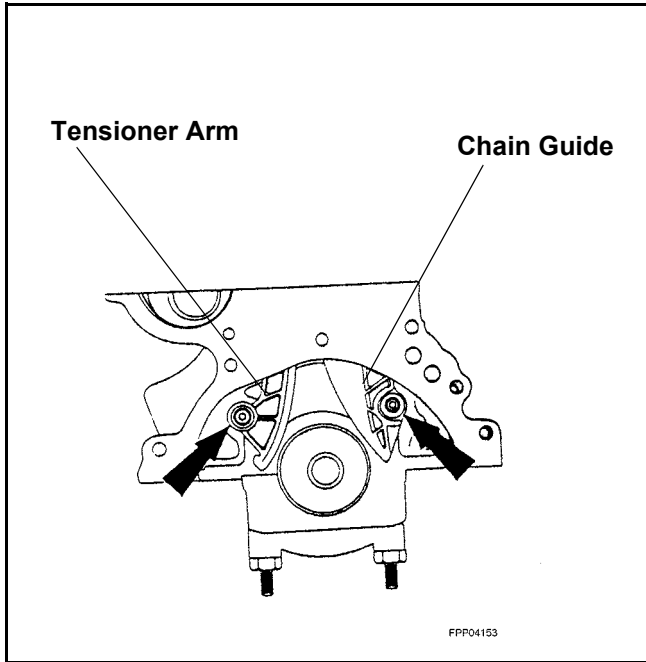


19. Insert camshaft sprocket into chain and assemble to camshaft. Position camshaft key at 12 o'clock and align timing mark between 2 coppered links on drive chain.

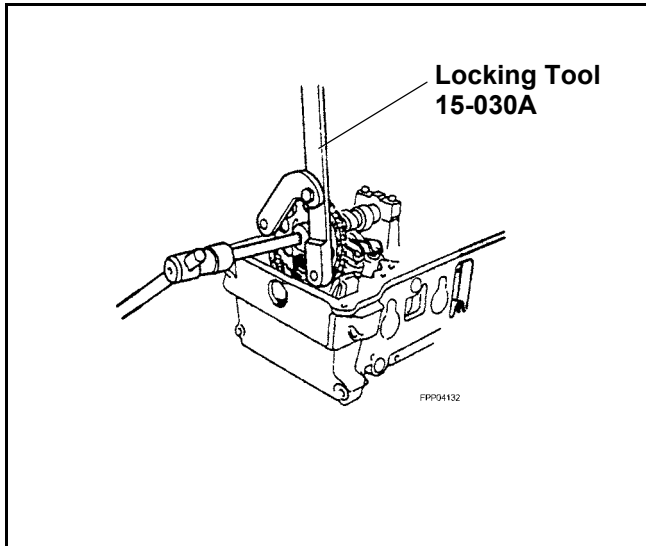


20. Install camshaft sprocket bolt and hydraulic tensioner finger tight.

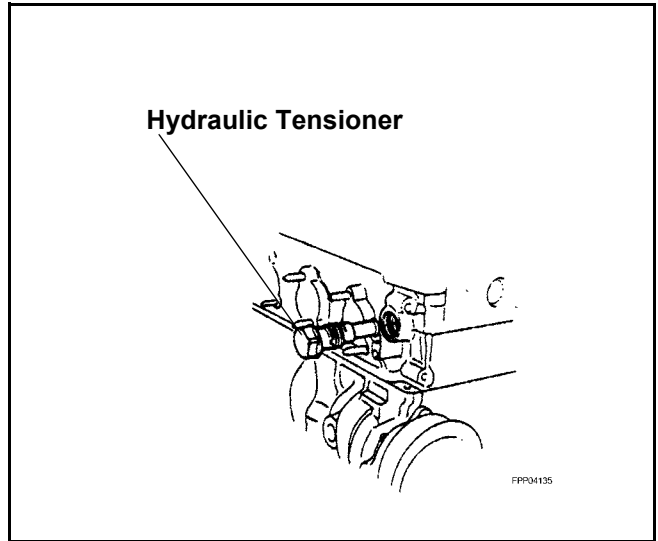
21. Tighten guide and tensioner arm bolts to 18-21 lb.ft. (24-28 Nm).



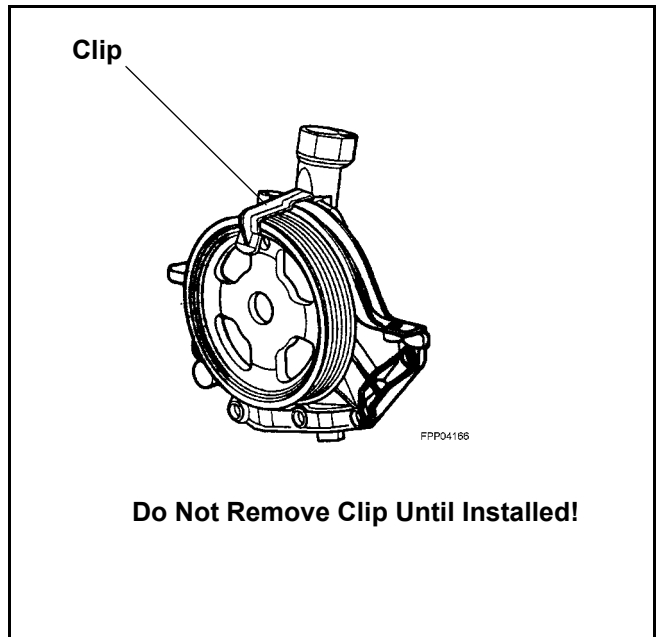
22. Using locking tool, tighten camshaft sprocket bolt to 52-59 lb.ft. (70-80 Nm).



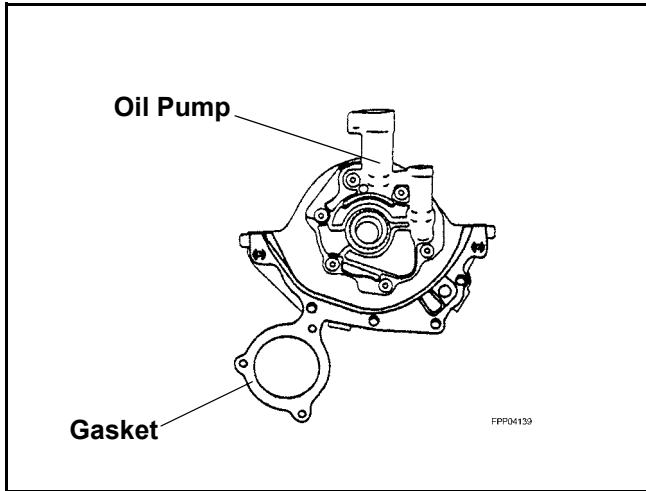
23. Tighten hydraulic tensioner to 27-32 lb.ft. (36-44 Nm).



**CAUTION:** The oil pump, pulley and sealer are provided as an assembly kept together by a clip (no. BF9A-6606-AA). Do not remove clip until oil pump is installed. If pulley is pushed out of the oil pump prior to oil pump installation, it will have to be ??repaired?? or replaced. (?can this pump be rebuilt?)



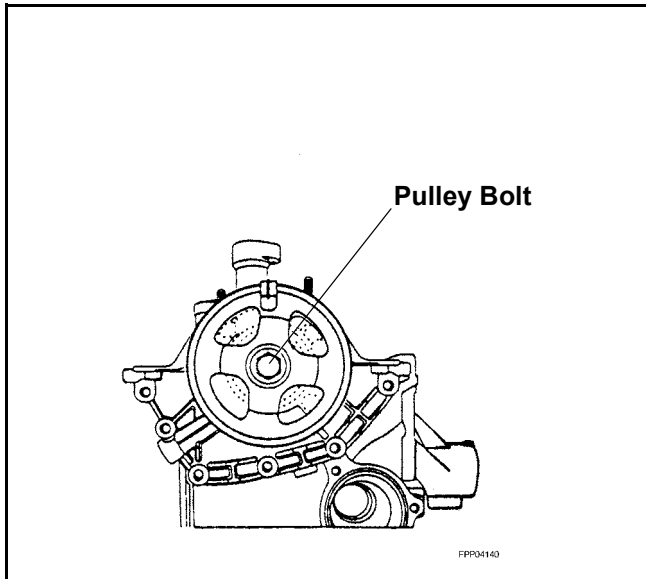
24. Assemble gasket onto oil pump housing guiding it with 2 outer bolts.



**CAUTION: Do not apply oil to shaft or seal. Sealing lip along with all contact surfaces must be free of oil.**

25. Place oil pump and gasket onto crankshaft.

26. Install pulley bolt and tighten to 92 lb.ft. (125 Nm).

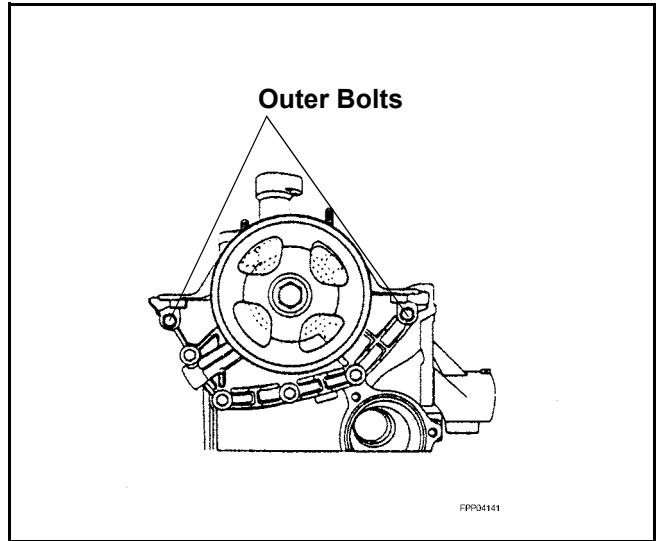


27. Remove clip.

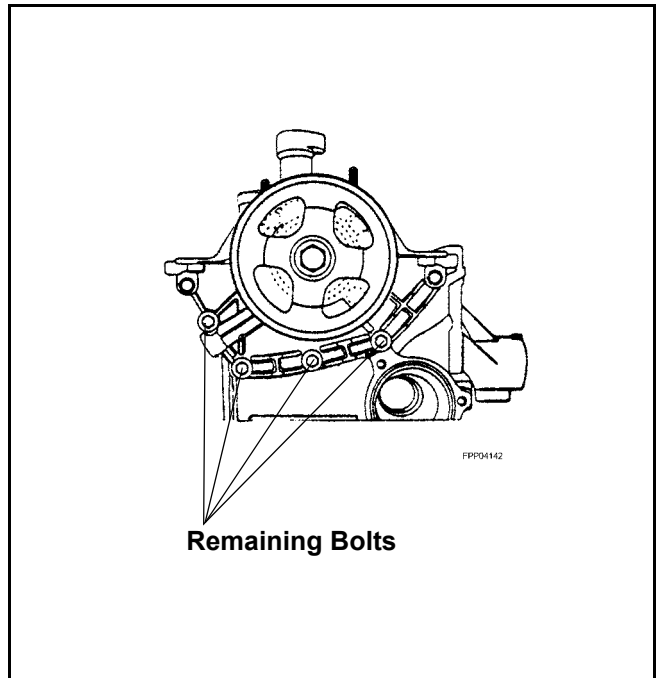
28. Install oil pump housing bolts finger tight.

**CAUTION: The oil pump housing must be positioned during tightening of the oil pump housing bolts, so that the sealing flange of the oil pump housing is within  $\pm 0.008$  in. (0.20 mm) of the block bottom sealing flanges.**

29. Tighten 2 outer oil pump housing bolts to 15 lb.ft. (20 Nm).

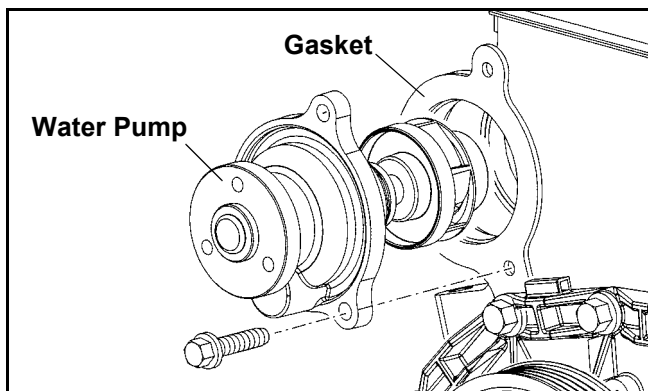


30. Tighten remaining oil pump housing bolts to 15 lb.ft. (20 Nm).



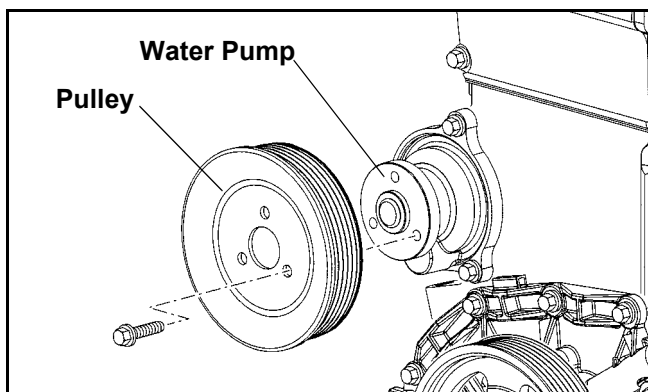
31. Install water pump.

32. Install bolts and tighten to 7 lb.ft. (10 Nm).



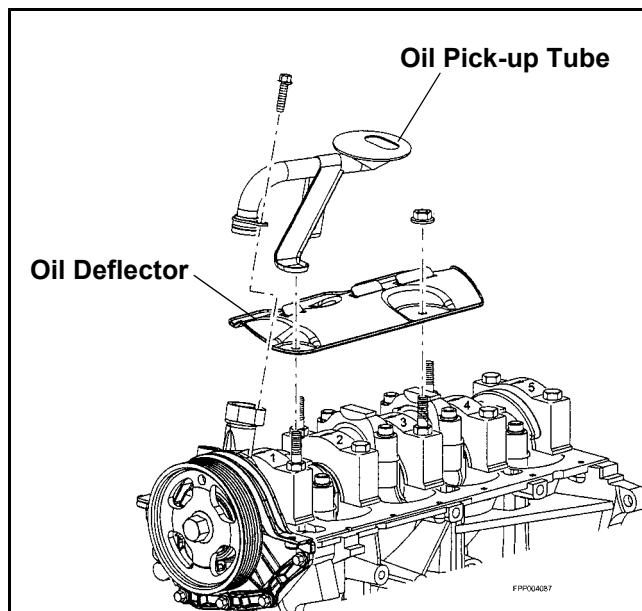
33. Install water pump pulley.

34. Install bolts and tighten to 9 lb.ft. (12 Nm).



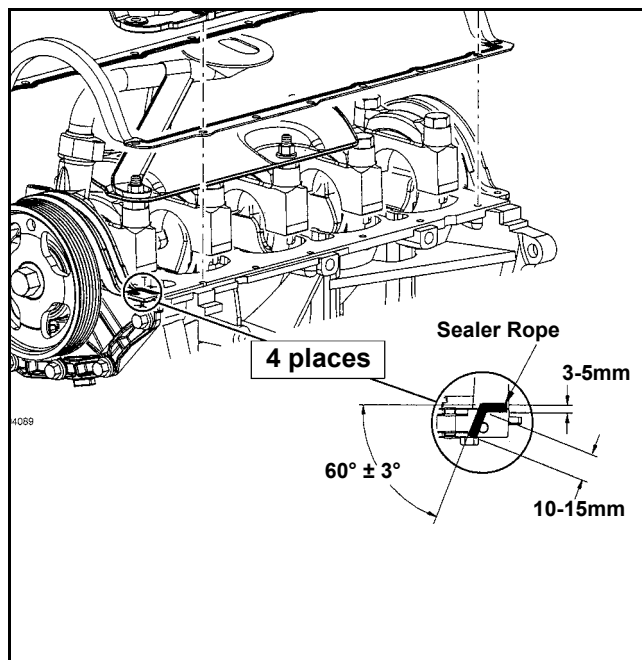
35. Install oil deflector.

36. Install oil pick-up tube.



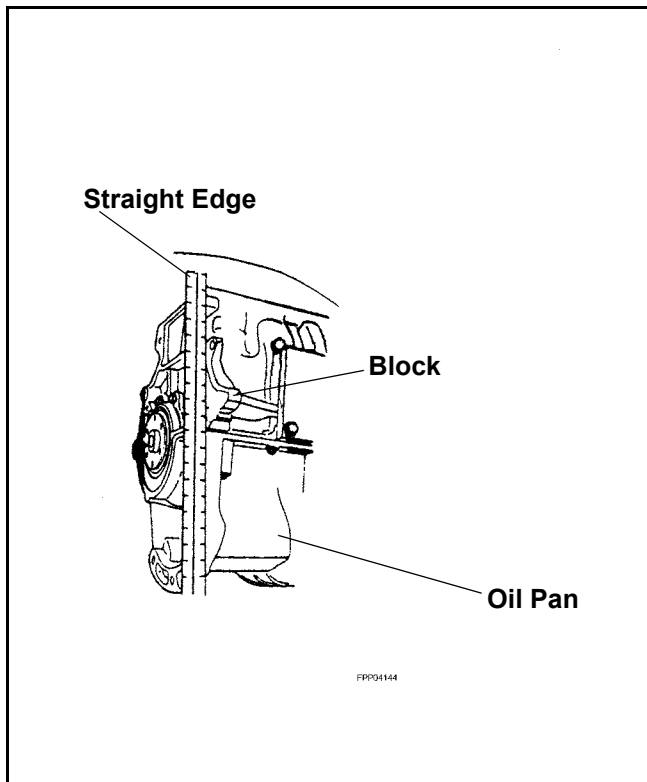
37. Tighten nuts to 14 lb.ft. (19 Nm). Tighten bolt to 7 lb.ft. (9.5 Nm).

38. Apply WSEM-A4 sealer (Loctite 5910) to the 4 positions as shown.

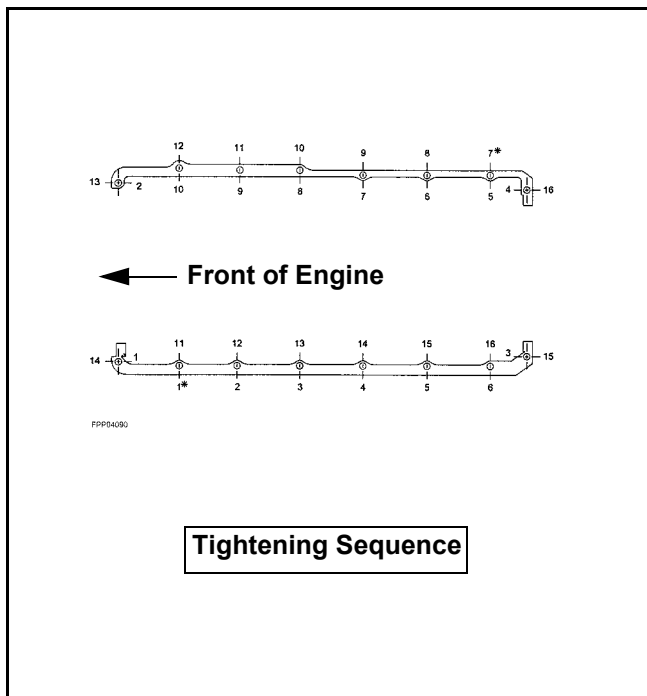


**CAUTION:** The contact surfaces of oil pan, gasket and block must be free of oil. Do not wait more than 5 minutes to install the oil pan gasket after sealer has been applied.

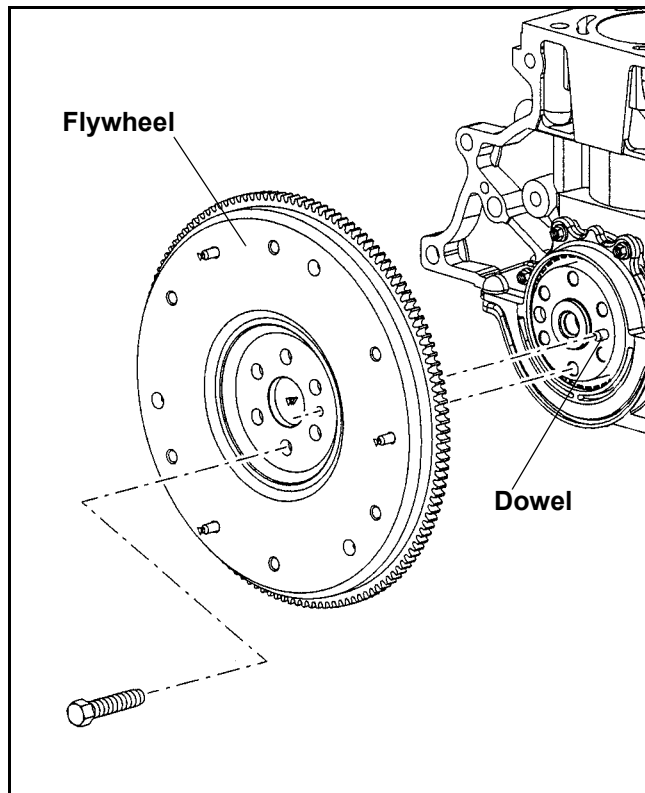
39. Install the oil pan and bolts finger tight.  
 40. Align oil pan with rear portion of engine block.



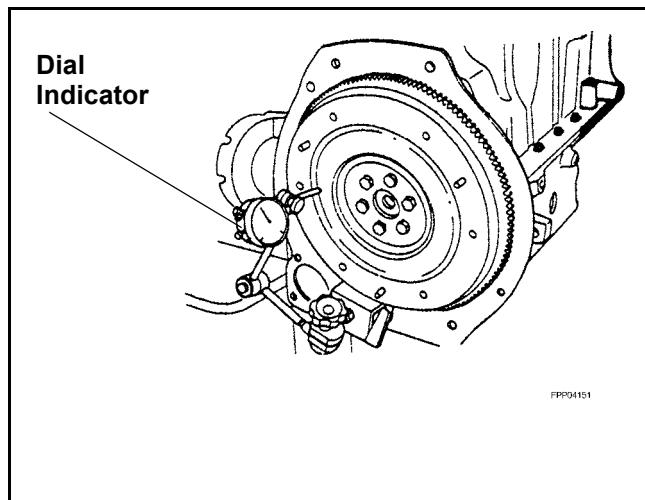
41. Tighten oil pan bolts in 3 steps in the sequence shown:
- enough for gasket settlement
  - 5 lb.ft. (7 Nm)
  - 7 lb.ft. (10 Nm)



42. Install the oil pan drain plug. Tighten to 18 lb.ft. (25 Nm).  
 43. Install flywheel using special locking tool 21-168.

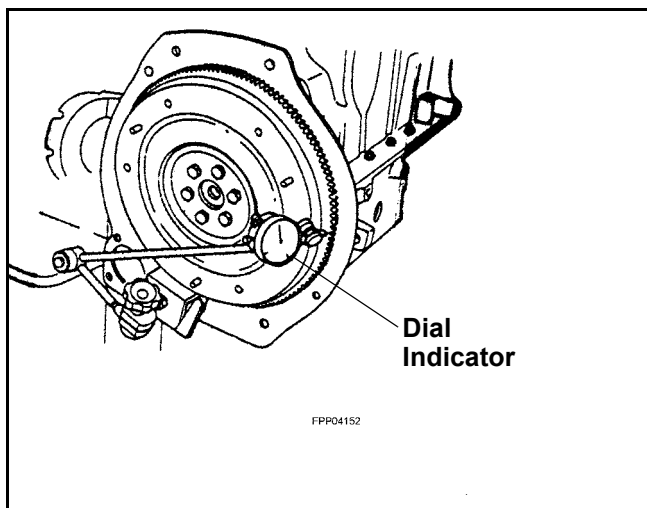


44. Lubricate bolt threads with clean engine oil and tighten to 49 lb.ft. (67 Nm).  
 45. Check flywheel runout at clutch disc surface:
- maximum runout 0.005 in. (0.13 mm)

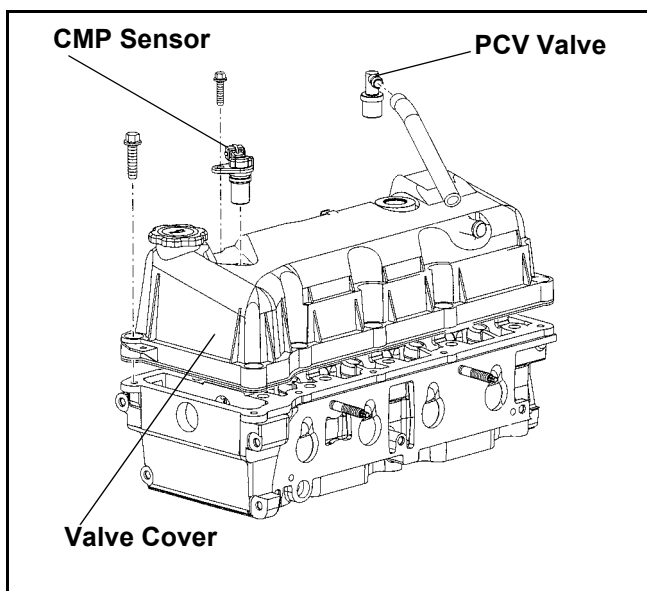


46. Check flywheel runout at gear surface:

- maximum runout 0.024 in. (0.6 mm)



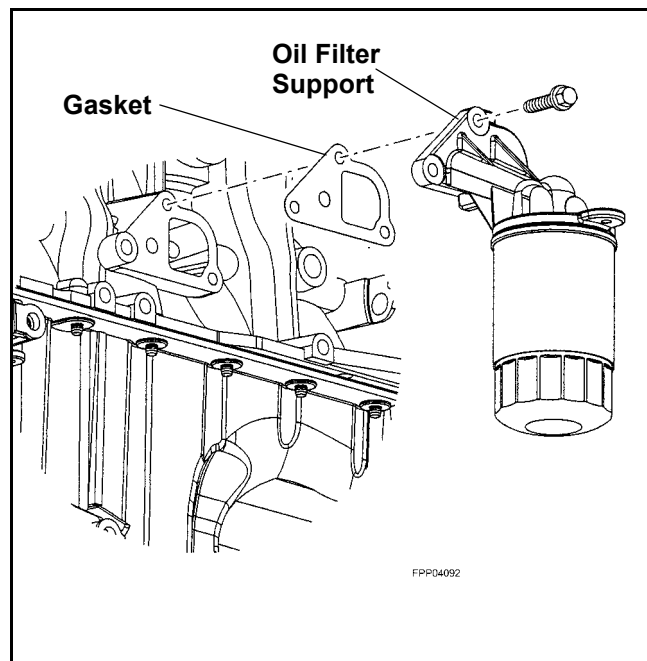
47. Install valve cover and gasket. Tighten bolts to 7 lb.ft. (9 Nm).



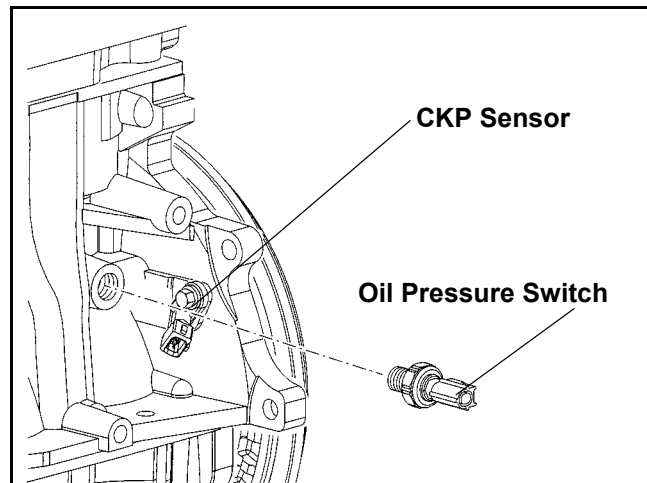
48. Apply grease WSD-M13P8-A1 (? kluberpaste? HEL46-450 ? anti-seize? ) or equivalent to spark plug threads.

49. Install spark plugs and tighten to 10-13 lb.ft. (13-17 Nm).

50. Install oil filter support with new filter. Tighten bolts to 15 lb.ft. (20 Nm).

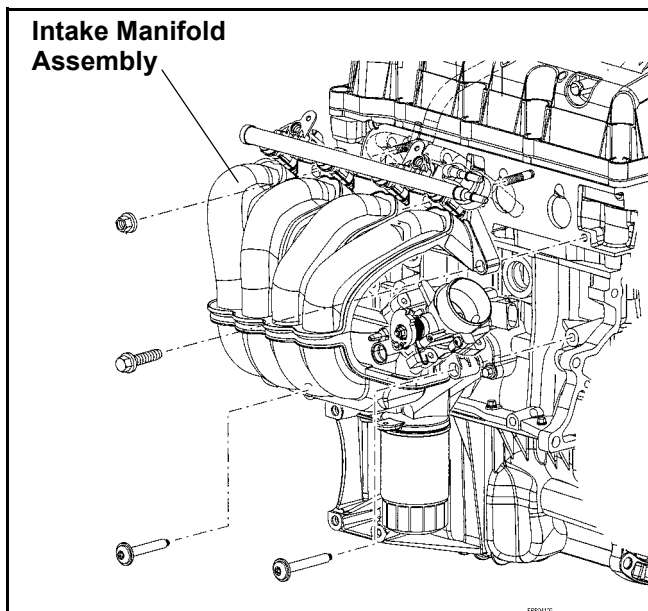


51. Install oil pressure switch and tighten to 15 lb.ft. (20 Nm).

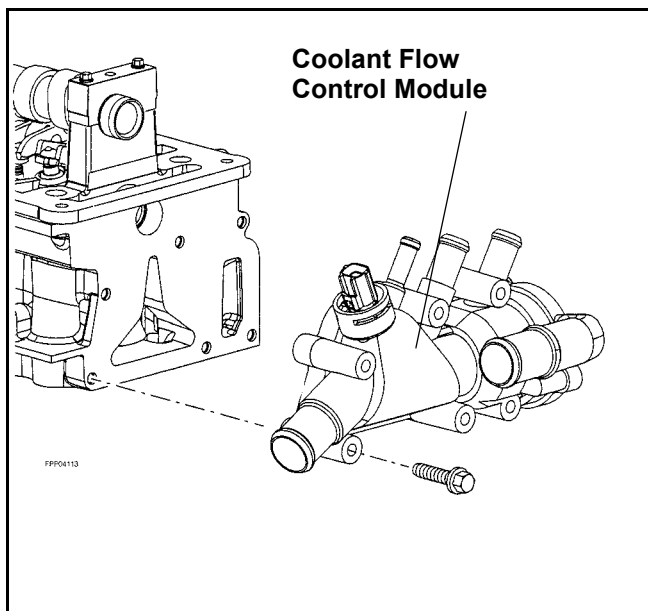


52. Install crankshaft position sensor and tighten to 3 lb.ft. (4 Nm).

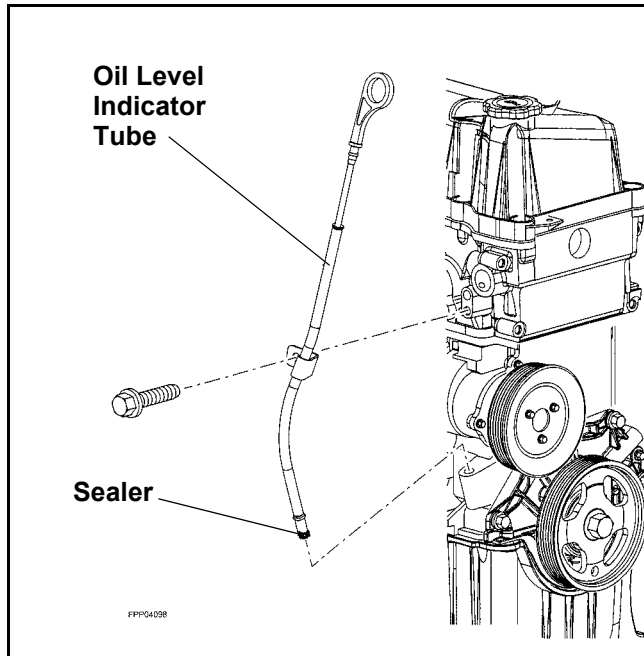
53. Install intake manifold and gasket. Tighten bolts and nuts to 6 lb.ft. (8 Nm).



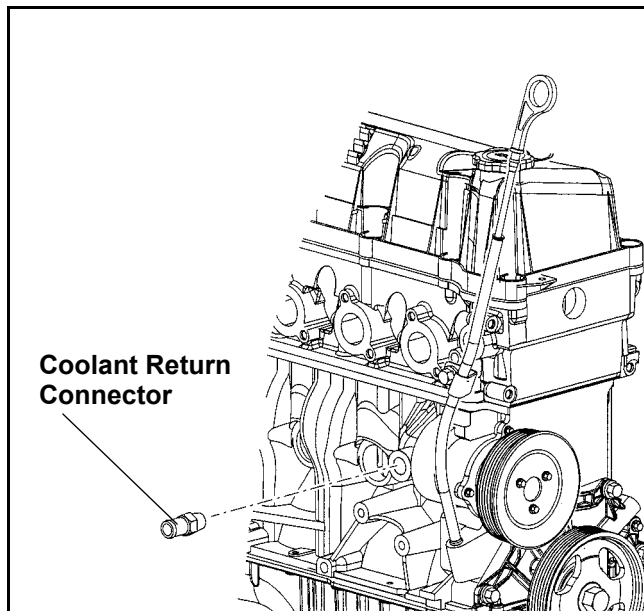
54. Install coolant flow control module and gasket. Tighten bolts to 7 lb.ft. (10 Nm).



55. Apply sealer WSK-M2G 349-A4 (Loctite 648) to lower end of oil level indicator tube. Install immediately and tighten bolt to 15 lb.ft. (20 Nm).

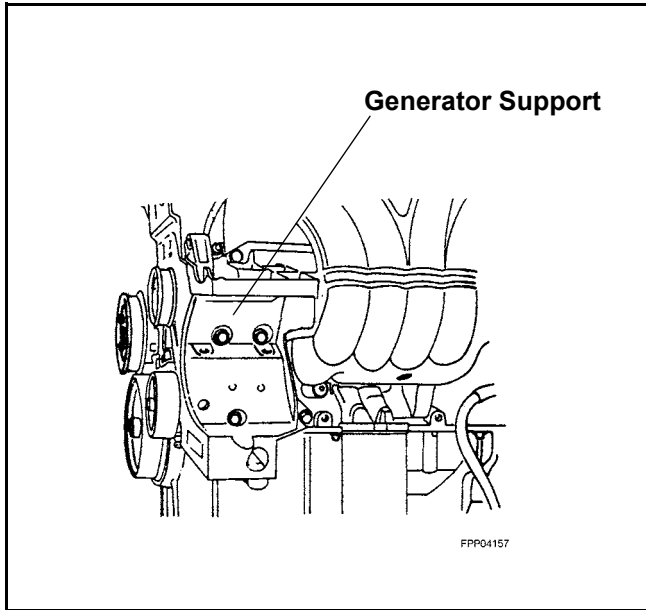


56. Apply sealer WSK-M2G 349-A7 (Loctite 243) to threads of coolant return connector. Install and tighten to 15 lb.ft. (20 Nm).

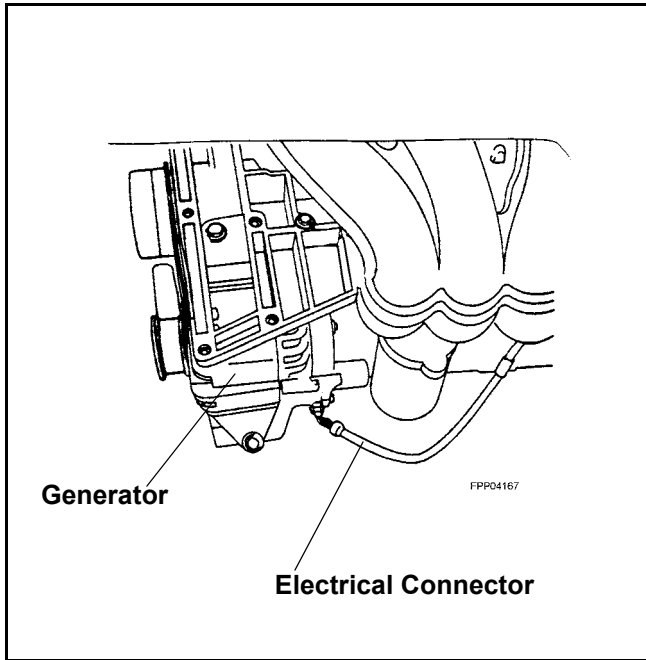




57. Install generator support. Tighten bolts to? lb.ft. (? Nm).

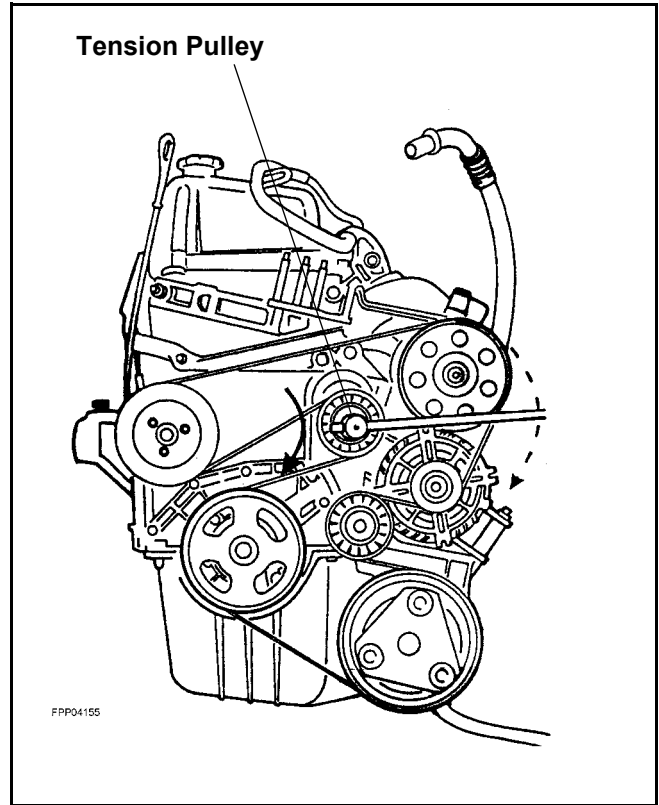


58. Install generator and electrical connectors. Tighten bolts to? lb.ft. (? Nm).

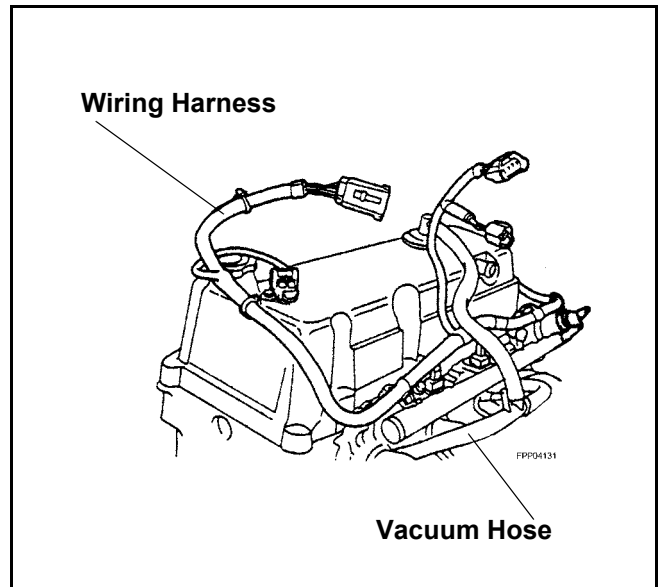


**NOTE:** Drive belt must be installed in the same direction of rotation as when removed.

59. Pry tensioner pulley as shown and install drive belt.



60. Install engine wiring and vacuum hoses.



61. Fill engine with clean engine oil of the correct type and quantity.

**NOTE:** Ford Power Products industrial engines are designed to perform with engine oils that are licensed by the American Petroleum Institute (API) and oils carrying the most current API classification should be used.

**SPECIFICATIONS**

<b>GENERAL SPECIFICATIONS</b>	
Engine Type:	4 cylinder, 4 stroke spark ignition 90° Overhead Valve (OHV) chain driven, overhead camshaft operating the valves via roller cam followers.
Liter/CID:	1.6 / 97.5
Bore: mm (inch)	82.070 mm (3.23 in.)
Stroke: mm (inch)	75.480 mm (2.97 in.)
Number of cylinders:	4
Compression Ratio:	9.5 : 1

<b>FUEL SYSTEM</b>	
LPG Type: Fuel Specification:	Liquefied Petroleum Gas EN589 (European) (USA)
NG Type: Fuel Specification:	Natural Gas 38.7 MJ/m <sup>3</sup> (UK) 39.0 MJ/m <sup>3</sup> (USA)
GAS Type: Fuel Specification:	Gasoline (petrol) Electronic Fuel Injection Unleaded 87 or 89 Octane (Gasoline blends not to exceed 10% Ethanol by volume Octane Index of 87 or 89).
Fuel Pump Pressure Normal: Max:	(Part #ZU1L-9350-AA) 40 psi ?? psi

<b>LUBRICATION SYSTEM</b>	
Max. Oil Pressure:	Hot@2500 rpm: 275.79 - 413.69 kPa (40-60 psi)
Oil Type:	SAE 5W30 WSS-M2C205-A (API classification: SJ)
Service Oil fill capacity (including filter):	4.2 Liter (4.44 quarts)
Oil filter Type:	X56E-6714-D1A

<b>COOLING SYSTEM</b>	
Thermostat:	Type: Wax element Commences opening: 82.2°C (180°F) Fully open:94.5°C (202°F)
Coolant	50% Motorcraft Super Plus 2000 plus 50% clear water Ford Specification: WSS-M97B44-D or ESE-M97B44-A

<b>ELECTRICAL SYSTEM</b>	
Polarity:	Negative to earth (ground)
Generator Drive Belt Tension (8K Poly Belt):	Tension is within specification if the tensioner is within the indicator markings

<b>IGNITION</b>	
Spark Plug	Ford Part Number: XS6F-12405-A1A (NGK TR6B-10) Gap: 0.95 - 1.05 mm
Firing Order	1-3-4-2

<b>CRANKSHAFT</b>	
Main journal-standard diameter	2.243 - 2.244 (56.980 - 57.000 mm)
Main journal-undersize diameter	2.233 - 2.234 (56.726 - 56.746)
Width-main journal bearing shell	
Pin Journal standard	

ITEM	Nm	FT. LB.	LB. IN.
Oil Pan Drain Plug	25	18	221.3
Spark Plugs	13-17	9.6-12.5	115-150.5
Oil Filter	11-15	8-11	97.4-132.7