Chapter 2 Part B
V6 engine

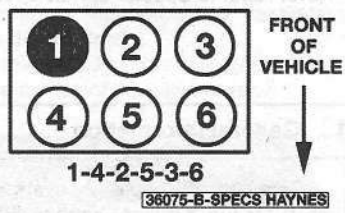
Contents

	Section
Camshafts, hydraulic lash adjusters and rocker arms - removal, inspection and installation	10
Crankshaft pulley and front oil seal - removal and installation	7
Cylinder heads - removal and installation	11
Driveplate - removal and installation	15
Engine front cover - removal and installation	8
Engine mounts - inspection and replacement	16
Exhaust manifolds - removal and installation	6
General information	1
Intake manifold - removal and installation	5
Oil pan - removal and installation	12
Oil pump - removal, inspection and installation	13
Rear main oil seal - replacement	14
Repair operations possible with the engine in the vehicle	2
Timing chains, tensioners, and chain guides - removal inspection, and installation	9
Top Dead Center (TDC) for number one piston - locating	3
Valve covers - removal and installation	4

Specifications

General

Engine type	Single overhead cam (SOHC) V6
Displacement	182 cubic inches (3.0 liters)
Engine VIN code	1
Bore	3.50 inches (89.0 mm)
Stroke	3.13 inches (79.5 mm)
Compression ratio	10:1
Compression	See Chapter 2C
Firing order	1-4-2-5-3-6
Oil pressure	See Chapter 2C



Cylinder location diagram - V6 engine

Camshafts

Lobe lift (intake and exhaust)	0.188 inch (4.79 mm)
Journal diameter	1.060 to 1.061 inches (26.936 to 26.962 mm)
Bearing inside diameter	1.062 to 1.063 inches (26.987 to 27.012 mm)
Journal-to-bearing oil clearance	
Standard	0.001 to 0.003 inch (0.025 to 0.076 mm)
Service limit	0.0047 (0.121 mm)
Endplay	
Standard	0.001 to 0.0064 inch (0.025 to 0.165 mm)
Service limit	0.0075 inch (0.190 mm)

Hydraulic lash adjuster

Diameter	0.6290 to 0.6294 inch (15.988 to 16.000 mm)
Lash adjuster-to-bore clearance	
Standard	0.0007 to 0.0027 inch (0.018 to 0.069 mm)
Minimum	0.0006 inch (0.016 mm)

Warpage limits

Head gasket surface warpage limit	0.005 inch (0.120 mm)

Torque specifications

	Ft-lbs (unless otherwise indicated)	Nm
Air conditioning compressor bolts	18	25
Air conditioning compressor bracket nuts		
Step 1	18	25
Step 2	Tighten an additional 90-degrees	
Camshaft bearing cap bolts	89 in-lbs	10
Camshaft oil seal retainer bolts	89 in-lbs	10
Crankshaft pulley bolt		
Step 1	86	120
Step 2	Loosen 360-degrees	
Step 3	37	50
Step 4	Tighten an additional 90-degrees	
Cylinder head bolts **(in sequence - see illustration 11.21a)**		
Step 1	30	40
Step 2	Tighten an additional 90-degrees	
Step 3	Loosen one full turn (360-degrees)	
Step 4	30	40
Step 5	Tighten an additional 90-degrees	
Step 6	Tighten an additional 90-degrees	
Drivebelt tensioner bolt	18	25
Driveplate-to-crankshaft bolts	59	80
Engine access cover	53 in-lbs	6
Engine front cover bolts **(in sequence - see illustration 8.23)**	18	25
Exhaust manifold nuts	15	20
Intake manifold assembly **(in sequence - see illustrations 5.17 and 5.33)**		
Upper intake manifold bolts	89 in-lbs	10
Lower intake manifold bolts	89 in-lbs	10
Oil pan bolts	18	25
Oil pan-to-transaxle bolts	30	40
Oil pump screen cover and tube bolts	89 in-lbs	10
Oil pump screen cover and tube nut		
Step 1	44 in-lbs	5
Step 2	Tighten an additional 45-degrees	
Oil pump-to-engine block bolts	89 in-lbs	10
Oil pan baffle bolts		
Step 1	44 in-lbs	5
Step 2	Tighten an additional 45-degrees	
Timing chain guide bolts	18	25
Timing chain tensioner bolts	18	25
Valve cover bolts **(in sequence - see illustrations 4.15 and 4.27)**	89 in-lbs	10

* **Note:** *Refer to Chapter 2, Part C for additional torque specifications.*

1 General information

This part of Chapter 2 covers in-vehicle repairs for the 3.0 liter Overhead Camshaft (OHC) V6 Duratec engine. This version of the 3.0L V6 engine features an aluminum engine block and aluminum cylinder heads with dual overhead camshafts and four valves per cylinder.

All information on engine removal and installation, as well as general overhaul procedures, is in Part C of Chapter 2.

The following repair procedures are based on the assumption that the engine is installed in the vehicle. If the engine has been removed and mounted on a stand, many of the Steps in this part of Chapter 2 will not apply.

In this chapter, "left" and "right" are used to describe locations on the engine. These directions are in relation to the vehicle overall from the position of sitting in the driver's seat. So, "left" means the driver's side, and "right" means the passenger's side of the vehicle.

2 Repair operations possible with the engine in the vehicle

Many major repairs can be done without removing the engine from the vehicle. Clean the engine compartment and the exterior of the engine with a pressure washer or degreaser solvent before doing any work. Cleaning the engine and engine compartment will make repairs easier and help to keep dirt out of the engine.

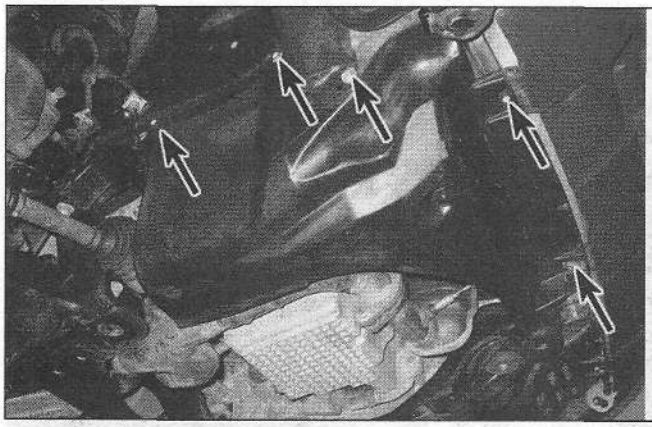
It may help to remove the hood for better access to the engine. (Refer to Chapter 11, if necessary.)

If the engine has vacuum, exhaust, oil, or coolant leaks that indicate the need for gasket replacement, repairs can usually be done with the engine in the vehicle. The intake and exhaust manifold gaskets, the timing chain cover gasket, the oil pan gasket, crankshaft oil seals, and cylinder head gaskets are all accessible with the engine in the vehicle.

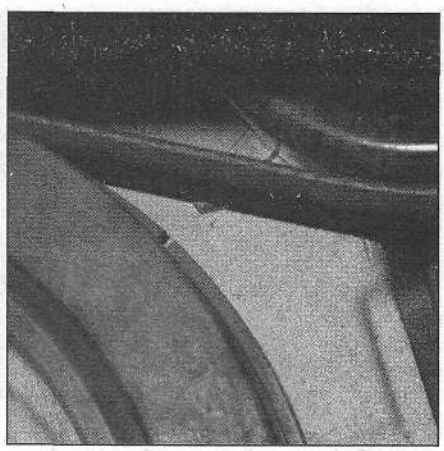
Exterior engine components, such as the intake and exhaust manifolds, the oil pan, the water pump, the starter motor, the alternator, and many fuel system components also can be serviced with the engine installed.

Because the cylinder heads can be removed without pulling the engine, valve train components can be serviced with the engine in the vehicle. The timing chain and sprockets also can be replaced without removing the engine, although clearance is very limited.

In some cases - caused by a lack of equipment - pistons, piston rings, connecting rods, and rod bearings can be replaced with



3.6a Remove the inner fender splash shield mounting bolts



3.6b To position the number 1 piston at TDC, position the crankshaft pulley keyway at 11 o'clock and align the mark on the pulley with the mark on the engine front cover

the engine in the vehicle. This is not recommended, however, because of the cleaning and preparation that must be done to the parts involved.

3 Top Dead Center (TDC) for number one piston - locating

Refer to illustrations 3.6a and 3.6b

Note: *Although this engine does not have a distributor, timing marks on the crankshaft pulley and a stationary pointer on the engine front cover will help you to locate Top Dead Center (TDC) for cylinders 1 and 5.*

1 Top Dead Center (TDC) is the highest point in the cylinder that each piston reaches as it travels upward when the crankshaft turns. Each piston reaches TDC on the compression stroke and on the exhaust stroke, but TDC usually refers to piston position on the compression stroke.

2 Positioning one or more pistons at TDC is an essential part of many procedures such as rocker arm removal, valve adjustment, and timing chain replacement.

3 To place any piston at TDC, turn the crankshaft using one of the methods described below. When you look at the front of the engine (right side of the engine compartment), crankshaft rotation is clockwise. **Warning:** *Before using any of the following methods to turn the crankshaft, be sure the transaxle is in Park. Also disconnect the ignition wiring harness connector from the side of the coil pack assembly.*

a) *The best way to turn the crankshaft is to use a socket and breaker bar on the crankshaft pulley bolt on the front of the crankshaft.*

b) *You also can use a remote starter switch connected to the S (switch) and B (battery) terminals of the starter relay. Operate the remote switch in short intervals until the piston is close to TDC. Then use a socket and breaker bar for the final rotation to TDC.*

c) *If an assistant is available to operate the ignition switch in short intervals, you can rotate the crankshaft until the piston is close to TDC. Then use a socket and breaker bar for the final rotation to TDC.*

4 Remove the spark plug from number 1 cylinder and install a compression gauge in its place (see Chapter 5).

5 Rotate the crankshaft by one of the methods described in Step 3, until a compression reading is indicated on the gauge. The piston should be approaching TDC.

6 Continue turning the crankshaft with a socket and breaker bar until the notch in the crankshaft pulley is aligned with the TDC mark on the front cover **(see illustrations)**. At this point, the number one cylinder is at TDC on the compression stroke. If the marks aligned but there was no compression, the piston was on the exhaust stroke. Continue rotating the engine until compression is indicated.

7 If you go past TDC, rotate the engine backwards (counterclockwise) until the timing marks indicate that the piston is before TDC. Then rotate the crankshaft clockwise until the marks align. Final rotation should always be clockwise to remove slack from the timing chains and ensure that the piston is truly at TDC.

8 After the number one piston is at TDC on the compression stroke, TDC for any of the remaining cylinders can be located by turning the crankshaft and following the firing order (refer to the Specifications). Divide the crankshaft pulley into three equal sections with chalk marks at three points, each indicating 120-degrees of crankshaft rotation. For example, rotating the engine 120-degrees past TDC for number 1 piston will place the engine at TDC for cylinder number 4. Refer to the firing order for the remaining cylinder numbers.

4 Valve covers - removal and installation

Refer to illustration 4.1

1 Remove the engine access cover **(see illustration)**.

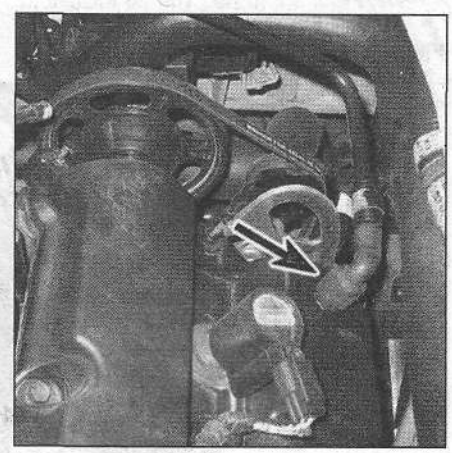
Front (left-side) valve cover

Refer to illustrations 4.2, 4.8a, 4.8b, 4.10, 4.11a and 4.11b

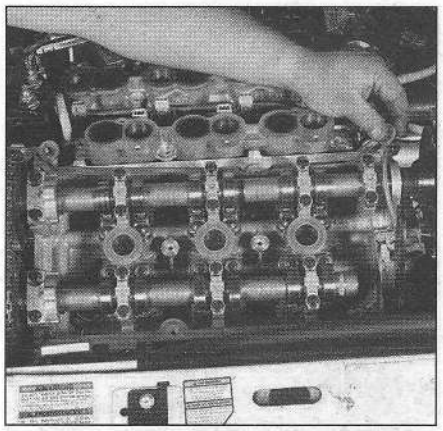
2 Disconnect the crankcase ventilation tube **(see illustration)**.

3 Remove the ignition coils (see Chapter 5) from the top of the valve cover.

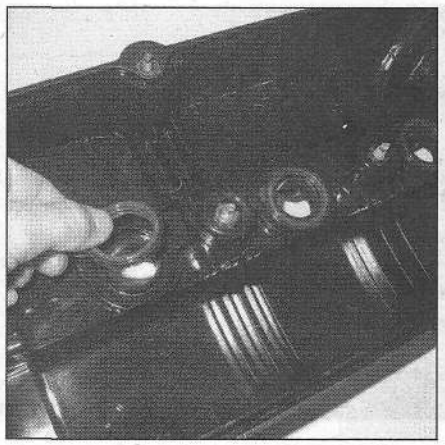
4.1 Remove the engine access cover mounting nuts



4.2 Disconnect the crankcase ventilation tube from the front valve cover

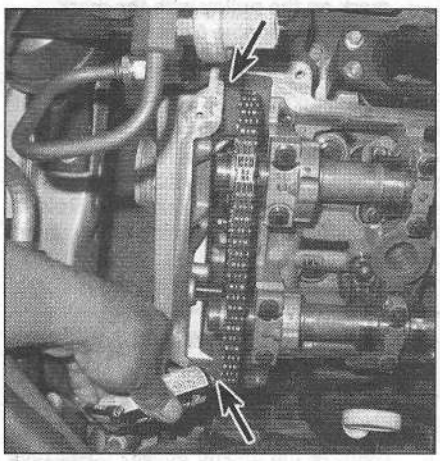


4.8a Remove and discard the old valve cover gasket - it must be replaced during assembly to prevent leakage

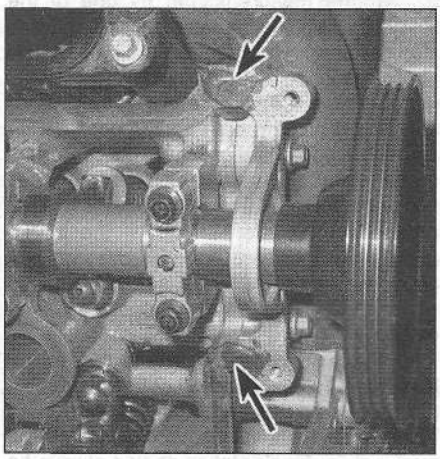


4.8b Remove and discard the spark plug tube seals from the valve cover

4.10 Press the new gasket into the groove in the valve cover, making sure it isn't twisted



4.11a Apply a 5/16-inch bead of RTV sealant to the seams of the engine front cover/cylinder head . . .



4.11b . . . and the camshaft seal retainer/ cylinder head

4 Disconnect the wiring harness from the valve cover and position it off to the side.

5 Remove the engine lifting brackets.

6 Remove the bolt from the power steering pump hose bracket and position the hose off to the side.

7 Loosen the valve cover bolts gradually and evenly until all are loose. Follow the reverse of the tightening sequence **(see illustration 4.15)**. Remove the valve cover fasteners and lift the valve cover off the engine.

8 Remove and discard the valve cover gaskets and spark plug tube seals **(see illustrations)**. Install new gaskets and seals during reassembly.

9 Inspect the valve cover and cylinder head sealing surfaces for nicks or other damage. Clean the sealing surfaces with clean solvent and a shop towel.

10 Install a new valve cover gasket, making sure the gasket is properly seated in the groove **(see illustration)**. Also install new spark plug tube seals.

11 Apply a 5/16-inch bead of RTV sealant at the locations shown **(see illustrations)**.

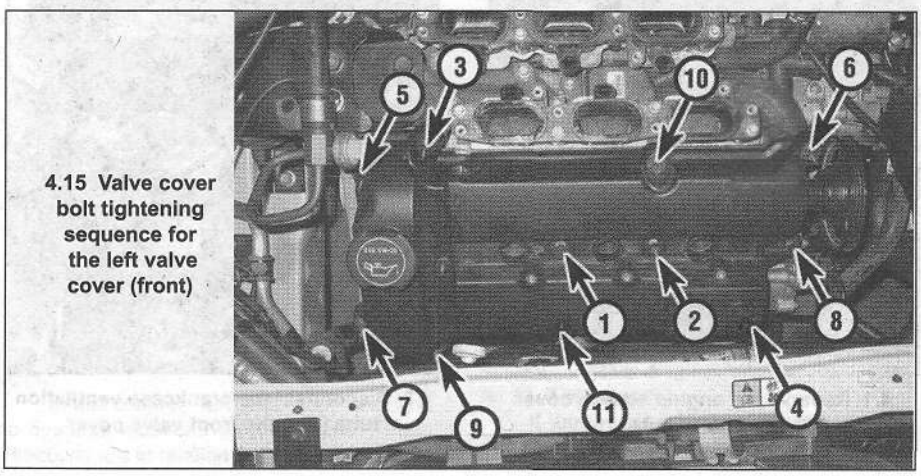
12 Lower the valve cover into position, making sure that the gaskets stay in place. Install the cover fasteners and tighten them gradually and evenly to the torque listed in this Chapter's Specifications.

13 Reconnect the wiring harness to the bracket studs.

14 Reconnect the crankcase ventilation tube to the valve cover.

15 Tighten the valve cover bolts to the torque listed in this Chapter's Specifications. Follow the correct torque sequence **(see illustration)**.

16 The remaining installation is the reverse of removal.



4.15 Valve cover bolt tightening sequence for the left valve cover (front)

Rear (right-side) valve cover

Refer to illustration 4.27

17 Remove the upper intake manifold (see Section 5).

18 Remove the ignition coils (see Chapter 5) from the top of the valve cover.

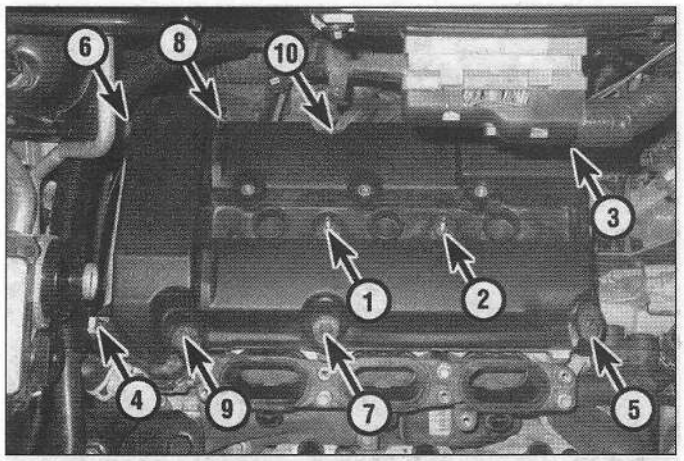
19 Remove the oxygen sensor wiring harness cover and position the oxygen sensor connectors and the wiring harness off to the side.

20 Remove the radio/ignition interference capacitor from the base of the alternator.

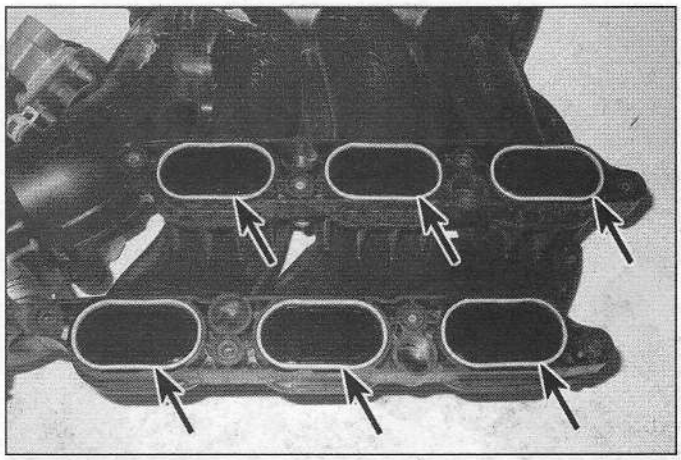
21 Disconnect the crankcase ventilation tube.

22 Loosen the valve cover fasteners gradually and evenly, until all fasteners are loose. Follow the reverse of the tightening sequence **(see illustration 4.27)**. Then, unscrew and remove the fasteners. Lift the valve cover off the cylinder head.

23 Remove and discard the valve cover gaskets and spark plug tube seals **(see illustrations 4.8a and 4.8b)**. Install new gaskets and seals during reassembly.



4.27 Valve cover bolt tightening sequence for the right valve cover (rear)



5.14 Remove the gaskets from the upper intake manifold

24 Inspect the valve cover and cylinder head sealing surfaces for nicks or other damage. Clean the sealing surfaces with clean solvent and a shop towel.

25 Install a new valve cover gasket, making sure the gasket is properly seated in the groove **(see illustration 4.10)**. Also install new spark plug tube seals.

26 Apply a 5/16-inch bead of RTV sealant to the two locations where the valve cover contacts the cylinder head **(see illustration 4.11a)**.

27 Install the valve cover fasteners and tighten them gradually and evenly to the torque listed in this Chapter's Specifications. Follow the correct torque sequence **(see illustration)**.

28 Reinstall all wiring harnesses and brackets.

29 Reinstall the ignition coils (see Chapter 5).

30 Install the upper intake manifold (see Section 5).

31 The remaining installation is the reverse of removal.

5 Intake manifold - removal and installation

Upper intake manifold

Removal

Refer to illustration 5.14

1 Disconnect the cable from the negative battery terminal (see Chapter 5).

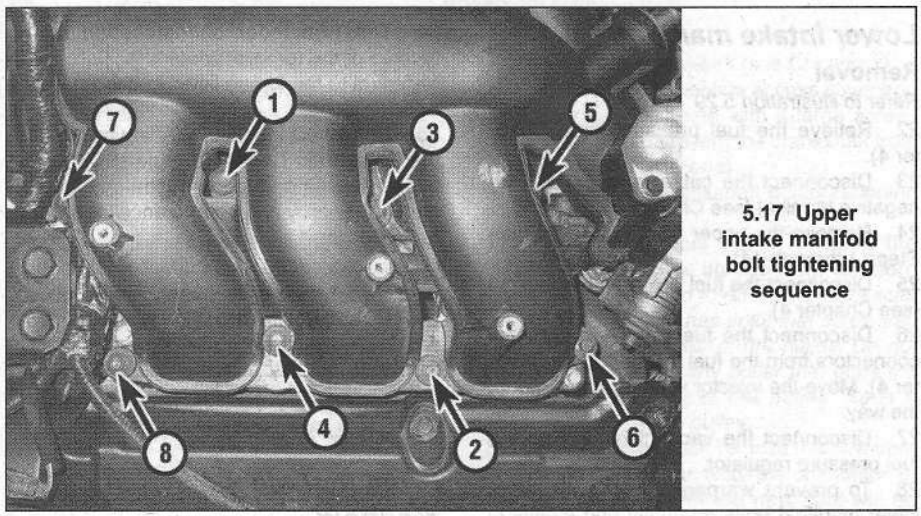
2 Remove the air filter housing intake duct (see Chapter 4).

3 Remove the engine access cover **(see illustration 4.1)**.

4 Disconnect the accelerator cable and the cruise control cable, if equipped (see Chapter 4).

5 Disconnect the throttle position sensor (TPS) and the idle air control (IAC) valve connectors (see Chapter 4).

6 Disconnect the EGR valve vacuum hose and the EGR pipe (see Chapter 6).



5.17 Upper intake manifold bolt tightening sequence

7 Disconnect the EGR valve vacuum regulator solenoid connector (see Chapter 6).

8 Disconnect the vapor management valve (see Chapter 6).

9 Disconnect the vacuum lines and electrical connectors from the upper intake manifold. Be sure to mark them with tape to insure correct reassembly.

10 Disconnect the power steering pressure sensor from the power steering pump.

11 Remove the transaxle vent hose bracket and position the hose off to the side.

12 Remove the wire harness bracket nut and position the wiring harness off to the side.

13 Loosen the upper intake manifold bolts. Follow the opposite of the tightening sequence **(see illustration 5.17)**.

14 Remove and discard the upper intake manifold gaskets **(see illustration)**.

Installation

Refer to illustration 5.17

Caution: *Be very careful when scraping on aluminum engine parts. Aluminum is soft and gouges easily. Severely gouged parts may require replacement.*

15 If the gasket was leaking, check the mating surfaces for warpage. Check carefully around the mounting points of components such as the IAC valve and the EGR pipe. Replace the manifold if it is cracked or badly warped.

16 Install new gaskets. If the mating surfaces are clean and flat, a new gasket will ensure the joint is sealed. Don't use any kind of sealant on any part of the fuel system or intake manifold.

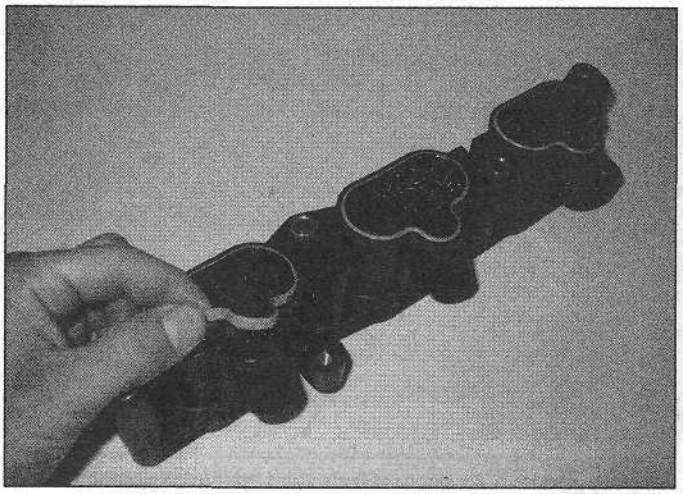
17 Locate the upper manifold on the lower manifold and install the fasteners. Tighten the fasteners in three or four steps in the sequence shown **(see illustration)** to the torque listed in this Chapter's Specifications.

18 Install the remaining parts in the reverse order of removal.

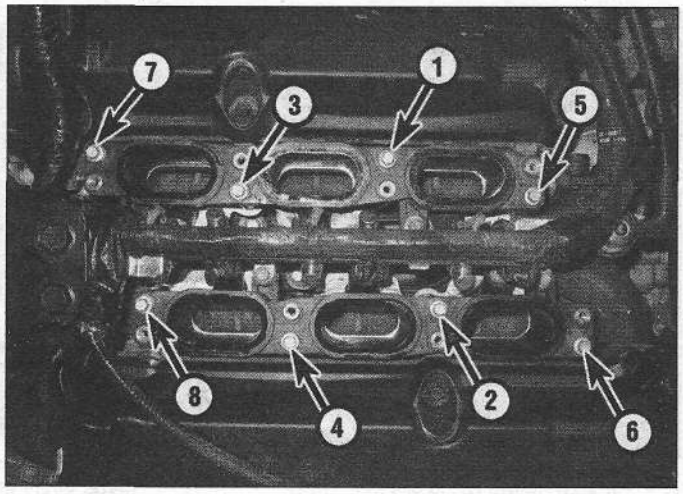
19 Before starting the engine, check the accelerator cable for correct adjustment and the throttle linkage for smooth operation.

20 Reconnect the battery. After you're done, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Chapter 5, Section 1).

21 When the engine is fully warm, check for fuel and vacuum leaks. Road test the vehicle and check for proper operation of all components.



5.29 Remove the gaskets from the lower intake manifold



5.33 Lower intake manifold bolt tightening sequence

Lower intake manifold

Removal

Refer to illustration 5.29

22 Relieve the fuel pressure (see Chapter 4).

23 Disconnect the cable from the battery negative terminal (see Chapter 5).

24 Remove the upper intake manifold (see Steps 1 through 14).

25 Disconnect the fuel line from the fuel rail (see Chapter 4).

26 Disconnect the fuel injection electrical connectors from the fuel injectors (see Chapter 4). Move the injector wiring harness out of the way.

27 Disconnect the vacuum hose from the fuel pressure regulator.

28 To prevent warpage, loosen the eight lower manifold bolts gradually and evenly in the reverse of the tightening sequence until all are loose **(see illustration 5.33)**. Then, remove the bolts.

29 Lift the lower intake manifold off the engine. Remove and discard the manifold gaskets **(see illustration)**.

30 Carefully clean all gasket material from the manifold and cylinder head mating surfaces. Don't nick, scratch or gouge the sealing surfaces. **Caution:** *Be very careful when scraping on aluminum engine parts. Aluminum is soft and gouges easily. Severely gouged parts may require replacement.* Inspect all parts for cracks or other damage. If the manifold gaskets were leaking, check the mating surfaces for warpage.

Installation

Refer to illustration 5.33

31 Install new lower intake manifold gaskets on the cylinder heads.

32 Place the lower manifold into position on the cylinder heads. Make sure the gaskets are not dislodged.

33 Install the lower manifold bolts. Tighten the bolts gradually and evenly, in the sequence shown **(see illustration)**, to the torque listed in this Chapter's Specifications.

34 The remainder of installation is the reverse of the removal procedure. Tighten the fasteners to the torque listed in this Chapter's Specifications.

35 Reconnect the battery. After you're done, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Chapter 5, Section 1).

6 Exhaust manifolds - removal and installation

Warning: *Allow the engine to cool completely before beginning this procedure.*

Front (left-side) exhaust manifold

Refer to illustration 6.7

Warning: *The engine and exhaust system must be completely cool before performing this procedure.*

1 Disconnect the cable from the negative battery terminal (see Chapter 5).

2 Disconnect the electrical connector for the oxygen sensor and the catalytic converter monitor (see Chapter 6).

3 Loosen the right front wheel lug nuts, then raise the front of the vehicle and support it securely on jackstands. Remove the wheel, then remove the fender splash shield.

4 Remove the exhaust crossover pipe (see Chapter 4).

5 Remove the drivebelt (see Chapter 1).

6 Remove the air conditioning compressor bolts and position the compressor off to the side. Do not disconnect the refrigerant lines from the compressor.

7 Remove the six nuts securing the exhaust manifold **(see illustration)**. Remove and discard the manifold gasket.

8 Using a scraper, remove all old gasket material and carbon deposits from the manifold and cylinder head mating surfaces. **Caution:** *Be very careful when scraping on aluminum engine parts. Aluminum is soft and gouges easily. Severely gouged parts may require replacement.* If the gasket was leaking, check the manifold for warpage and have it resurfaced if necessary.

9 Install a new manifold gasket over the cylinder head studs. Lightly oil the stud threads with clean engine oil before installation. Install the manifold and the nuts.

10 Tighten the nuts in three or four steps, in a spiral pattern starting with the center fasteners, to the torque listed in this Chapter's Specifications.

11 The remainder of installation is the reverse of the removal procedure.

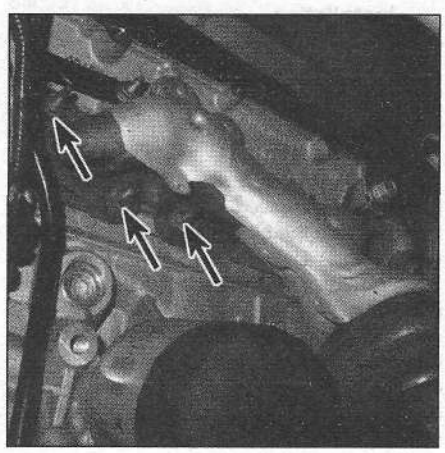
12 Start and run the engine and check for exhaust leaks. The Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Chapter 5, Section 1).

Rear (right-side) exhaust manifold

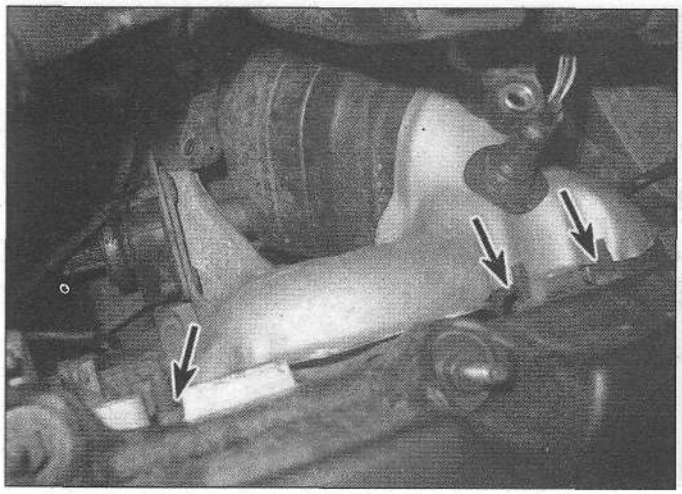
Refer to illustration 6.18

13 Disconnect the cable from the negative battery terminal (see Chapter 5).

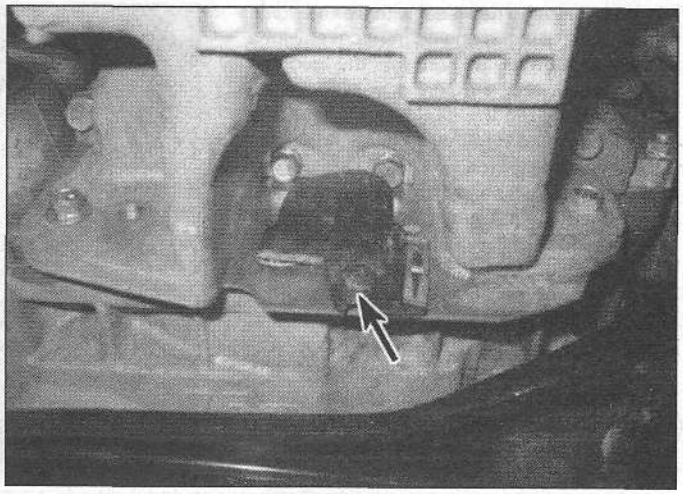
14 Remove the EGR pipe from the exhaust



6.7 Remove the front exhaust manifold mounting nuts - three nuts hidden from view



6.18 The rear exhaust manifold mounting nuts are difficult to access (not all are visible here)



7.5a To keep the crankshaft from turning, remove the driveplate access cover . . .

manifold (see Chapter 6).
15 Remove the alternator (see Chapter 5).
16 Remove the oxygen sensor (see Chapter 6).
17 Remove the nuts from the exhaust manifold flange and separate the crossover pipe from the manifold (see Chapter 4).
18 Remove the six exhaust manifold mounting nuts and remove the manifold from the engine **(see illustration)**. Remove and discard the manifold gasket.
19 Using a scraper, remove all gasket material and carbon deposits from the exhaust manifold and cylinder head mating surfaces. **Caution:** *Be very careful when scraping on aluminum engine parts. Aluminum is soft and gouges easily. Severely gouged parts may require replacement.* If the gasket was leaking, check the manifold for warpage and have it resurfaced if necessary.
20 Install a new manifold gasket over the cylinder head studs. Lightly oil the stud threads with clean engine oil before installation. Install the manifold and the nuts.
21 Tighten the nuts in three or four steps, in a spiral pattern starting with the center fasteners, to the torque listed in this Chapter's Specifications.
22 Complete the installation by reversing the removal procedure.
23 Start and run the engine and check for exhaust leaks. The Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Chapter 5, Section 1).

7 Crankshaft pulley and front oil seal - removal and installation

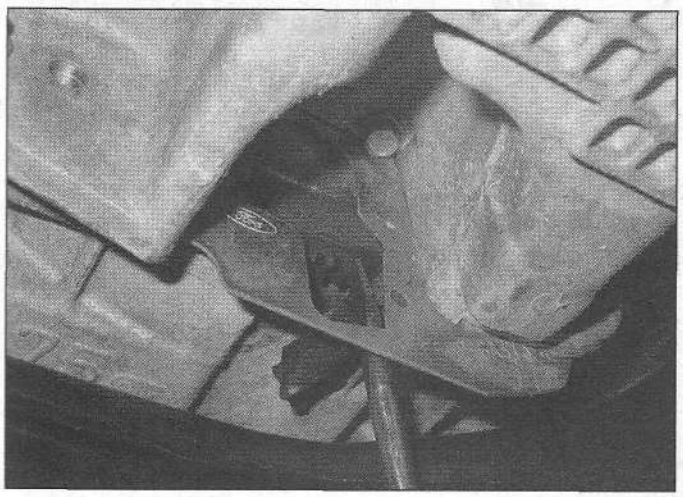
Removal

Refer to illustrations 7.5a, 7.5b and 7.7

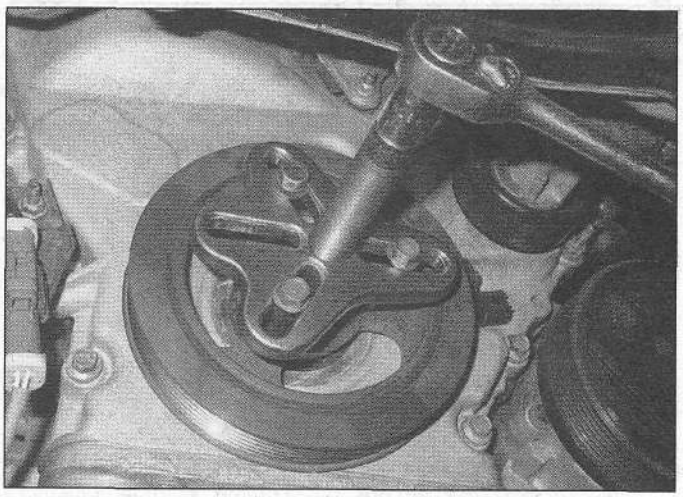
1 Disconnect the cable from the negative battery terminal (see Chapter 5).
2 Loosen the right front wheel lug nuts. Raise the front of the vehicle and support it securely on jackstands, then remove the wheel.
3 Remove the fender splash shield.
4 Remove the drivebelt (see Chapter 1).
5 Remove the driveplate access cover and hold the ring gear teeth with a large screwdriver or prybar to prevent the crankshaft from turning **(see illustrations)**.
6 Remove the crankshaft pulley retaining bolt.
7 Using a suitable puller, remove the crankshaft pulley **(see illustration)**. **Caution:** *Use a puller designed to remove a crankshaft pulley. Such a puller has bolts that screw into the holes in the center of the pulley. Do not use a gear puller or any puller that grips the outer circumference of the pulley. Such a puller will destroy the pulley.*
8 Using a seal puller, remove the seal from the engine front cover. Note the orientation of the sealing lip so that the new seal will be installed in the same direction.

Installation

9 Inspect the front cover and the pulley seal surface for nicks, burrs, or other roughness that could damage the new seal. Correct as necessary.



7.5b . . . engage the ring gear teeth with a large screwdriver or prybar



7.7 Remove the crankshaft pulley with a bolt-type puller

10 Lubricate the new seal with clean engine oil and install it in the engine front cover with a suitable seal driver. Be sure that the lip of the seal faces inward. If a seal driver is unavailable, carefully tap the seal into place with a large socket and hammer until it's flush with the front cover surface.

11 Apply RTV sealant to the keyway and inner bore of the pulley and lubricate the outer sealing surface of the pulley with clean engine oil. Then align the pulley keyway with the crankshaft key and install the pulley with a suitable pulley installation tool (available at auto parts stores). If such a tool is unavailable, start the pulley onto the crankshaft with a soft-faced mallet and finish the installation by tightening the retaining bolt. Tighten the bolt to the torque listed in this Chapter's Specifications.

12 Reinstall the remaining parts in the reverse order of removal. Tighten the wheel lug nuts to the torque listed in the Chapter 1 Specifications.

13 Reconnect the battery, then start the engine and check for oil leaks.

14 The Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Chapter 5, Section 1).

8 Engine front cover - removal and installation

Warning: *Wait until the engine is completely cool before beginning this procedure.*

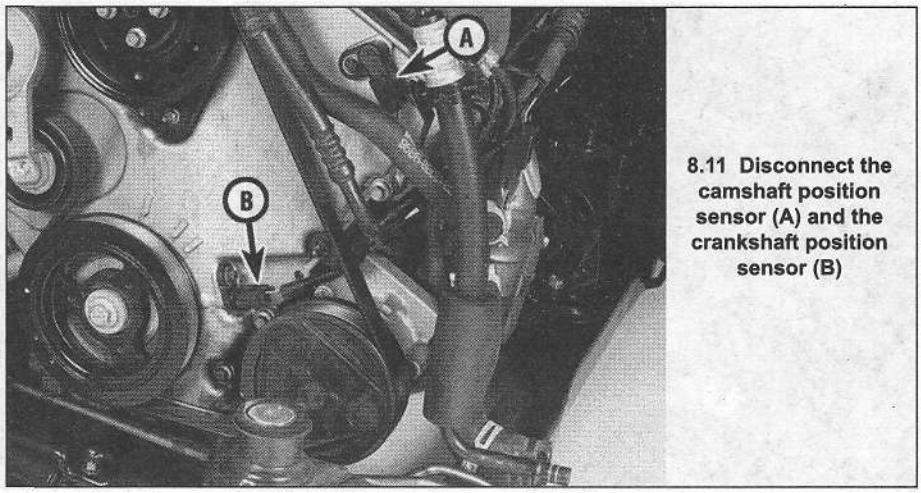
Note: *Because of a lack of clearance, this procedure is very difficult with the engine installed in the vehicle. If major engine work is being performed, it may be easier to remove the engine from the vehicle* (see Chapter 2C).

Removal

Refer to illustrations 8.11, 8.15 and 8.16

1 Disconnect the cable from the negative battery terminal (see Chapter 5).

2 Loosen the right front wheel lug nuts. Raise the front of the vehicle and support it securely on jackstands, then remove the wheel.



8.11 Disconnect the camshaft position sensor (A) and the crankshaft position sensor (B)

3 Drain the engine oil (see Chapter 1).

4 Remove the drivebelt (see Chapter 1).

5 Remove the drivebelt tensioner from the front cover.

6 Remove the valve covers (see Section 4).

7 Remove the alternator and alternator mounting bracket (see Chapter 5).

8 Remove the crankshaft pulley (see Section 7).

9 Drain the cooling system (see Chapter 1) and remove the coolant expansion tank (see Chapter 3).

10 Remove the power steering pump (see Chapter 10).

11 Disconnect the crankshaft position sensor **(see illustration)**.

12 Disconnect the camshaft position sensor (see Chapter 6).

13 Remove the oil pan (see Section 12).

14 If necessary, loosen the air conditioning compressor mounting bolts and move the compressor aside as required for access to the engine cover. **Warning:** *The air conditioning system is under high pressure. Do not disconnect the hoses from the compressor.* Remove or disconnect any remaining wires, hoses, clamps, or brackets that will interfere with engine cover removal.

15 Loosen the engine cover fasteners gradually and evenly; then remove the fasteners **(see illustration)**. **Note:** *Draw a sketch of the engine cover and cover fasteners. Identify the location of all stud bolts for installation in their original locations.*

16 Remove the front cover **(see illustration)**.

17 Remove and discard the cover-to-cylinder block gaskets.

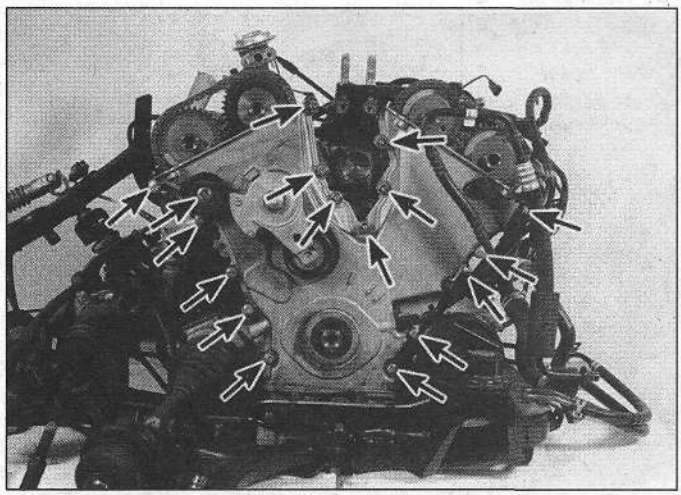
Installation

Refer to illustrations 8.20 and 8.23

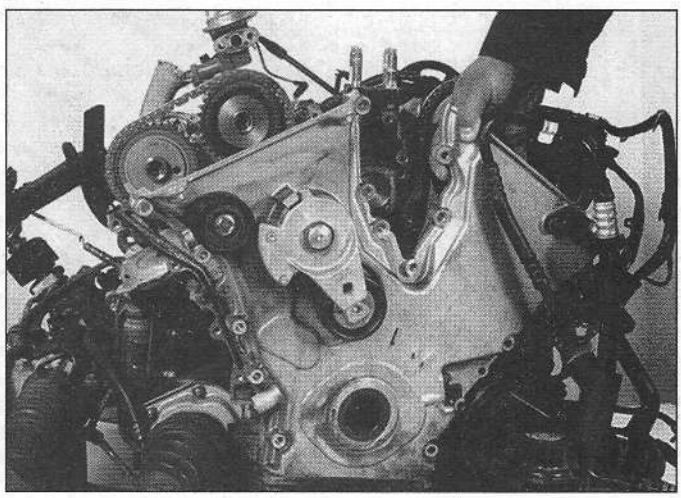
18 Inspect and clean all sealing surfaces of the engine front cover and the block. **Caution:** *Be very careful when scraping on aluminum engine parts. Aluminum is soft and gouges easily. Severely gouged parts may require replacement.*

19 If necessary, replace the crankshaft seal in the front cover.

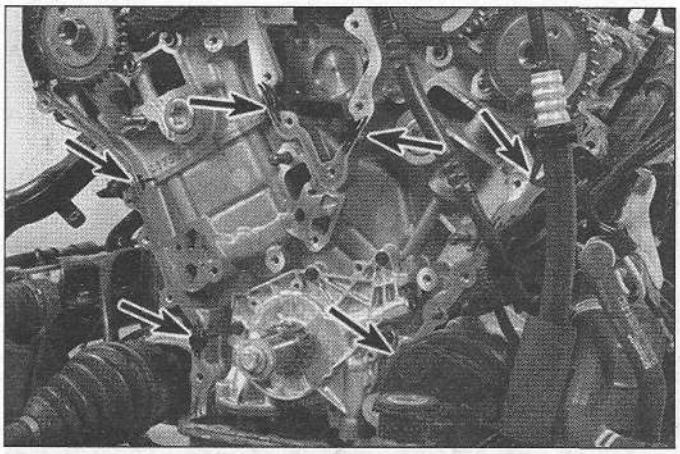
20 Apply a bead of RTV sealant approximately 1/8-inch wide at the locations shown **(see illustration)**.



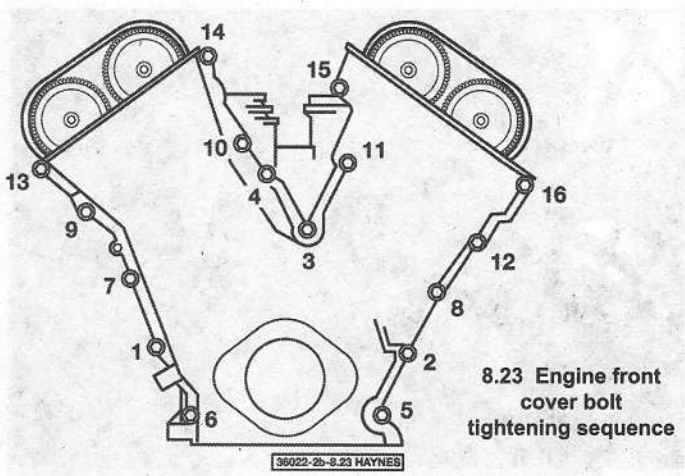
8.15 Remove the cover fasteners - note the locations of all studs and bolts for installation reference



8.16 Lift off the front cover



8.20 Apply a bead of RTV sealant at the locations shown



8.23 Engine front cover bolt tightening sequence

21 Install a new front cover gasket on the engine block. Make sure the gasket fits over the alignment dowels.

22 Install the front cover and cover fasteners. Make sure the fasteners are in their original locations. Tighten the fasteners by hand until the cover is contacting the block and cylinder heads around its entire periphery.

23 Following the correct sequence **(see illustration)**, tighten the bolts to the torque listed in this Chapter's Specifications.

24 Install the drivebelt and tensioner. Tighten the tensioner pulley to the torque listed in this Chapter's Specifications.

25 Install the oil pan (see Section 12).

26 Install the crankshaft pulley (see Section 7).

27 Connect the wiring harness connectors to the camshaft and crankshaft position sensors.

28 Install the power steering pump and hoses (see Chapter 10).

29 Reinstall the remaining parts in the reverse order of removal.

30 Fill the crankcase with the recommended oil (see Chapter 1). Fill the power steering reservoir with the correct fluid and refill the cooling system.

31 Reconnect the battery, then start the engine and check for leaks. The Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Chapter 5, Section 1).

9 Timing chains, tensioners, and chain guides - removal, inspection, and installation

Note: *Because of a lack of clearance, this procedure is very difficult with the engine installed in the vehicle. If major engine work is being performed, it may be easier to remove the engine from the vehicle* (see Chapter 2C).

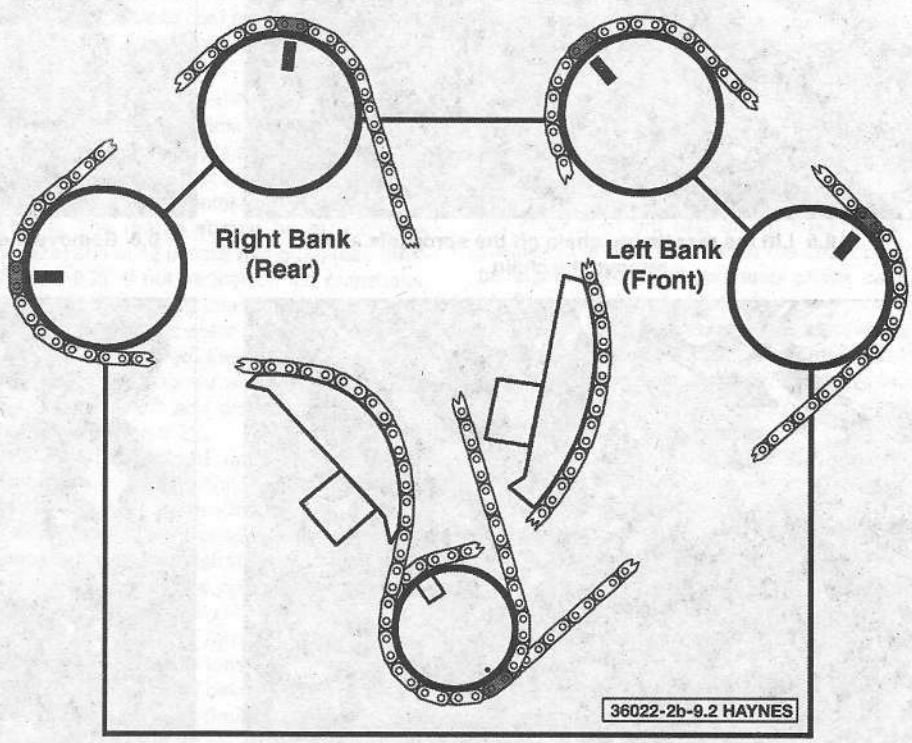
Removal

Refer to illustrations 9.2, 9.4a, 9.4b, 9.5, 9.6, 9.7, 9.8a, 9.8b and 9.10.

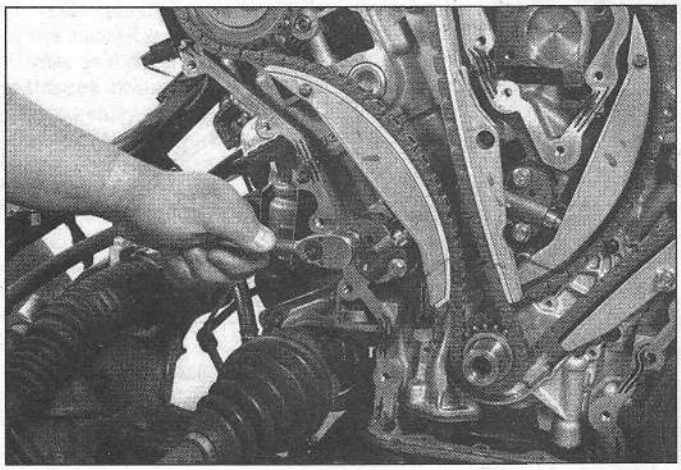
1 Remove the engine front cover (see Section 8). Slide the crankshaft position sensor trigger wheel off the crankshaft. **Caution:** *The pulse (trigger) wheel cannot be interchanged with another engine. Note the exact position of the pulse wheel to insure correct reassembly.* Remove the spark plugs (see Chapter 1).

2 Install the crankshaft pulley retaining bolt, then use a wrench on the bolt to turn the crankshaft clockwise and place the crankshaft keyway at the 11 o'clock position. TDC number 1 is the starting position and the ending position for this procedure. Verify TDC by observing the index marks on the front of the camshaft sprockets. If the number 1 cylinder is at TDC, the index mark on the front (left) bank exhaust camshaft will be directly UP (12 o'clock) in relation to the cylinder head surface and the intake camshaft index mark will be horizontal (9 o'clock) to the cylinder head **(see illustration)**. If not, turn the crankshaft exactly one full turn and again position the crankshaft keyway at 11 o'clock. **Caution:** *Turning the crankshaft counterclockwise can cause the timing chains to bind and damage the chains, sprockets and tensioners. Turn the crankshaft only clockwise.*

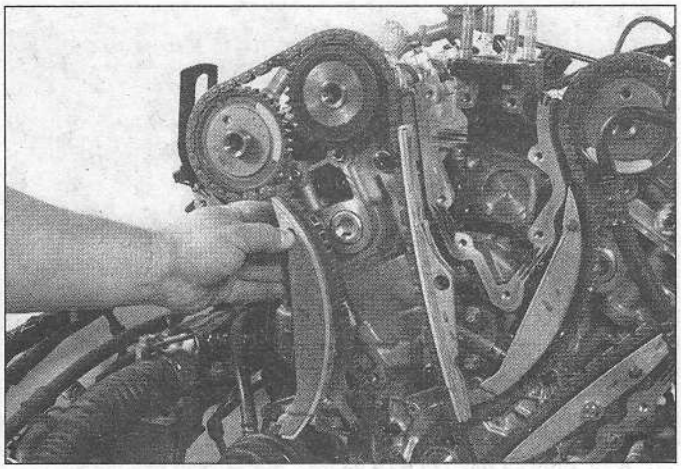
3 Recheck the marks on the sprockets. If they are aligned and the keyway is at 11 o'clock, the number 1 cylinder is at TDC on the compression stroke. Continue to turn the crankshaft clockwise until the keyway is at the 3 o'clock position, which will set the camshafts on the rear cylinder head in their "neutral" position.



9.2 Positions of the camshaft sprocket timing marks and the crankshaft keyway with the engine set at TDC for the number one piston



9.4a Remove the bolts securing the rear timing chain tensioner and remove the tensioner . . .



9.4b . . . then slide the tensioner arm off its pivot

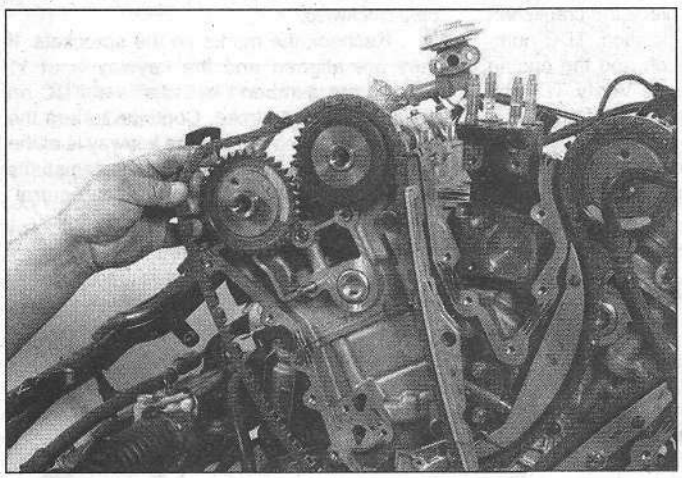
4 Remove the two bolts securing the timing chain tensioner for the rear chain. Remove the tensioner, then remove the tensioner arm **(see illustrations)**. Mark all parts that will be reused so they can be reinstalled in their original locations.

5 Lift the rear timing chain from the sprockets and remove the chain **(see illustration)**.

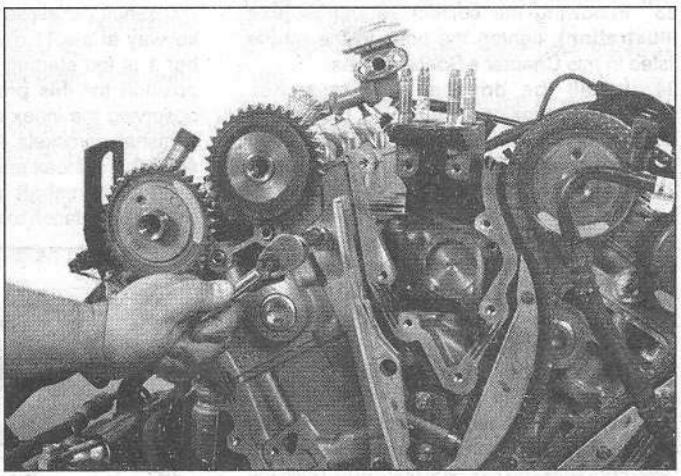
6 Remove the bolts securing the rear chain guide and remove the guide **(see illustration)**.

7 Slide the sprocket for the rear timing chain off the crankshaft **(see illustration)**.

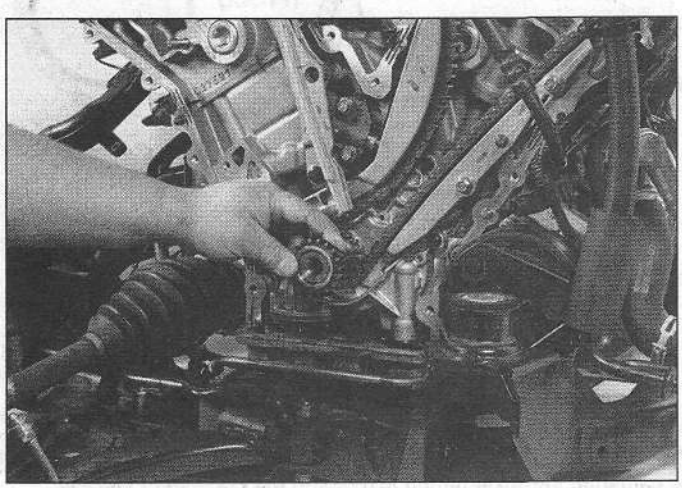
8 Rotate the crankshaft 600-degrees (1-2/3 turns) clockwise, until the keyway is in the 11 o'clock position, setting the camshafts in the front cylinder head in their neutral position. Remove the front timing chain tensioner



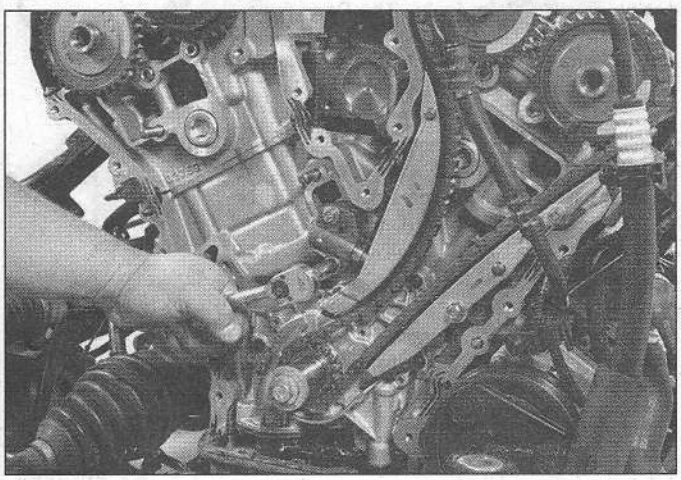
9.5 Lift the rear timing chain off the sprockets and remove the chain



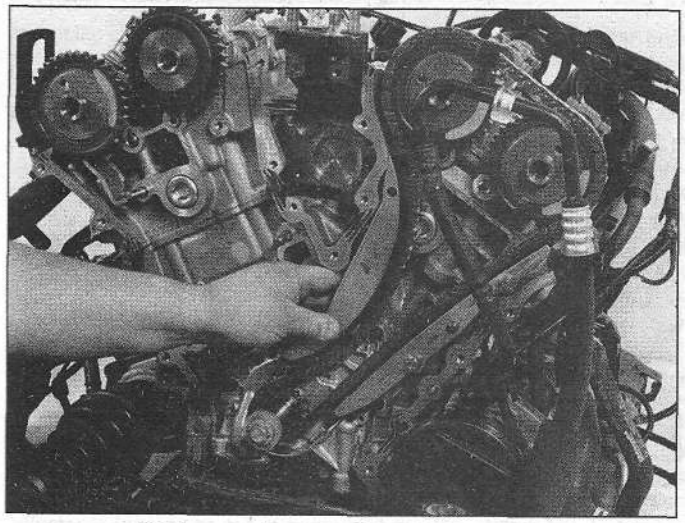
9.6 Remove the bolts securing the rear timing chain guide, then remove the guide



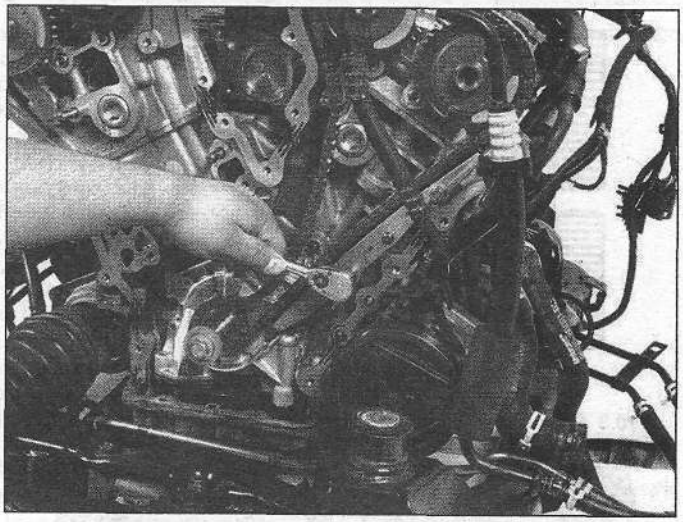
9.7 Remove the rear timing chain sprocket from the crankshaft



9.8a Remove the bolts that secure the front timing chain tensioner, then remove the tensioner . . .



9.8b . . . and remove the tensioner arm



9.10 Remove the bolts securing the front timing chain guide and remove the guide

mounting bolts. Remove the tensioner and tensioner arm **(see illustrations)**.

9 Lift the front timing chain off the sprockets and remove the chain.

10 Remove the chain guide mounting bolts and remove the front chain guide **(see illustration)**. If necessary, slide the crankshaft sprocket for the front timing chain off the crankshaft.

Inspection

Note: *Do not mix parts from the front and rear timing chains and tensioners. Keep the parts separate.*

11 Clean all parts with clean solvent. Dry with compressed air, if available.

12 Inspect the chain tensioners and tensioner arms for excessive wear or other damage.

13 Inspect the timing chain guides for deep grooves, excessive wear, or other damage.

14 Inspect the timing chain for excessive wear or damage.

15 Inspect the camshaft and crankshaft sprockets for chipped or broken teeth, excessive wear, or damage.

16 Replace any component that is in questionable condition.

Installation

Refer to illustration 9.32

17 The timing chain tensioners must be fully compressed and locked in place before chain installation. To prepare the chain tensioners for installation:

a) *Insert a small screwdriver into the access hole in the tensioner and release the pawl mechanism.*
b) *Compress the plunger into the tensioner housing until the plunger tip is below the plate on the pawl.*
c) *Hold the plunger in the compressed position and rotate the plunger one-half turn so the plunger can be removed. Remove the plunger and plunger spring.*
d) *Drain the oil from the tensioner housing and plunger.*
e) *Lubricate the tensioner housing, spring and plunger with clean engine oil. Insert the plunger spring into the tensioner housing. Install the plunger into the housing and push it in until fully compressed. Then, turn the plunger 180-degrees and use a small screwdriver to push back the pawl mechanism into contact with the plunger.*
f) *With the plunger compressed, insert a 1/16-inch drill bit or a straightened paper clip into the small hole above the pawl mechanism to hold the plunger in place.*
g) *Repeat this procedure for the other tensioner.*

18 If removed, install the crankshaft sprocket for the front timing chain. Make sure the crankshaft keyway is still at 11 o'clock.

19 Look at the index marks on the sprockets of the front bank intake and exhaust camshafts. The marks should be at 9 o'clock (intake) and at 12 o'clock (exhaust) **(see illustration 9.2)**. If not, reposition the camshafts. **Caution:** *The timing chains have three links that are a different color than the rest of the links. When installed, the colored links on the chain must be aligned with the index marks on the camshaft and crankshaft sprockets* **(see illustration 9.2)**.

20 Install the front timing chain guide. Tighten the mounting bolts to the torque listed in this Chapter's Specifications.

21 Install the front timing chain around the camshaft and crankshaft sprockets. Make sure the index marks on the sprockets are aligned and the colored links of the chain.

22 Install the front tensioner arm over its pivot dowel. Seat the tensioner arm firmly on the cylinder head and block.

23 Install the front timing chain tensioner assembly **(see illustrations 9.8a and 9.8b)**. Be sure the tensioner plunger is fully compressed and locked in place. Tighten the tensioner mounting bolts to the torque listed in this Chapter's Specifications. Verify that the colored links of the timing chain are aligned with the index marks on the camshaft and crankshaft sprockets, and the crankshaft keyway is at 11 o'clock. If not, remove the timing chain and repeat the installation procedure.

24 Install the crankshaft sprocket for the rear timing chain on the crankshaft **(see illustration 9.7)**.

25 Rotate the crankshaft clockwise until the crankshaft keyway is in the 3 o'clock position. This will correctly position the pistons for installation of the rear timing chain.

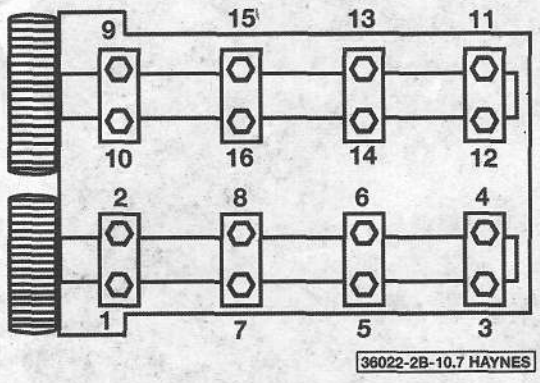
26 Install the rear timing chain guide. Tighten the mounting bolts to the torque listed in this Chapter's Specifications.

27 Double-check the position of the rear camshafts so the index marks on the sprockets are at (approximately) 3 o'clock (intake) and at 12 o'clock (exhaust). **Caution:** *The timing chains have three links that are a different color than the rest of the links. When installed, the colored links on the chain must be aligned with the index marks on the camshaft and crankshaft sprockets.*

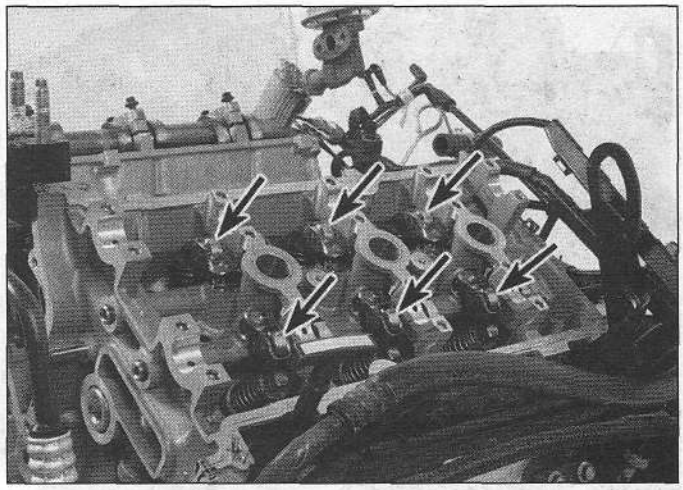
28 Install the rear timing chain around the camshaft and crankshaft sprockets. Make sure the colored links of the chain are aligned with the index marks on the front of the camshaft and crankshaft sprockets.

29 Install the rear tensioner arm over its pivot dowel. Seat the tensioner arm firmly on the cylinder head and block.

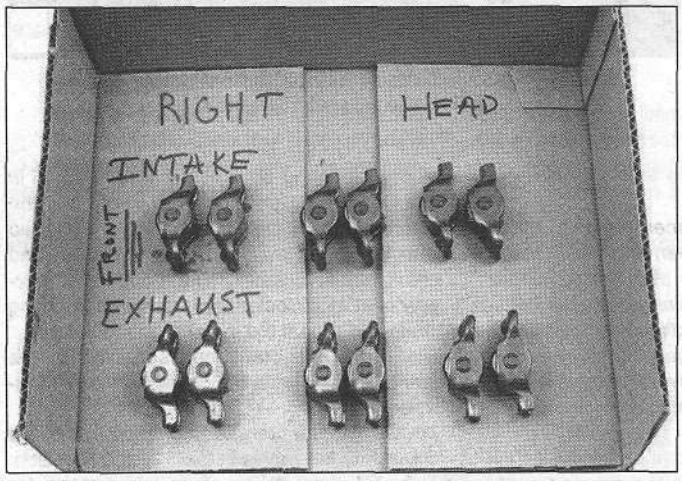
30 Install the rear timing chain tensioner **(see illustrations 9.4a and 9.4b)**. Be sure the tensioner plunger is fully compressed and locked in place. Tighten the tensioner mounting bolts to specification. Verify that the colored links of the timing chain are aligned with the index marks on the camshaft and crankshaft sprockets, and the crankshaft keyway is at 3 o'clock. If not, remove the timing chain and repeat the installation procedure.



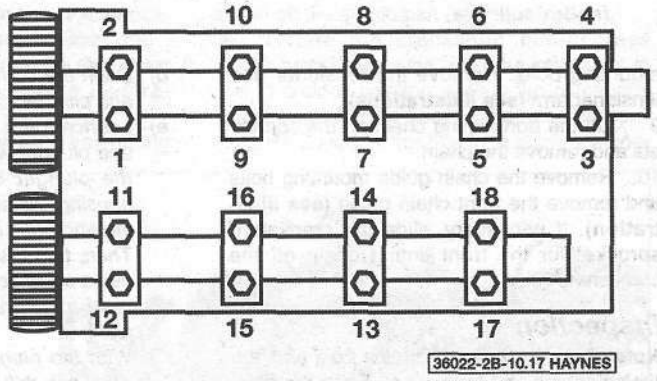
10.3 Rear bank camshaft bearing cap loosening sequence



10.5 Remove the rocker arms



10.6 Place all the parts in a container so they can be separated and identified for installation in their original locations



10.10 Front bank camshaft bearing cap loosening sequence

31 Remove the drill bits or wires (locking pins) from the timing chain tensioners.

32 Rotate the crankshaft counterclockwise back to the 11 o'clock position (the Number 1 TDC position). Verify the timing marks on the camshafts sprockets and the crankshaft sprocket with the colored links **(see illustration 9.2)**.

33 Install the crankshaft position sensor pulse (trigger) wheel on the crankshaft. **Caution:** *Make sure the pulse wheel is installed with the crankshaft key in the slot marked "20-25-34Y-30M."*

34 Rotate the engine by hand and verify that there is no binding. If any resistance is felt, STOP; double-check your work and find out why.

35 Install the engine front cover (see Section 8).

36 Reinstall the remaining parts in the reverse order of removal.

37 Fill the crankcase with the recommended oil (see Chapter 1). Fill the power steering reservoir with the correct fluid and refill the cooling system.

38 Reconnect the battery, then start the engine and check for leaks.The Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Chapter 5, Section 1).

10 Camshafts, hydraulic lash adjusters and rocker arms - removal inspection, and installation

Removal

Refer to illustrations 10.3, 10.5, 10.6 and 10.10

1 Remove the timing chains (see Section 9). **Note:** *If you're only removing the camshafts from the rear bank cylinder head, you only have to remove the rear timing chain. If you're removing the camshafts from the front bank cylinder head, both timing chains will have to be removed.*

Rear bank cylinder head

2 Note the location of each camshaft cap. Use a marker on each cap or notes on paper or cardboard if they're not marked. Do not mix any of the camshaft caps.

3 Following the sequence shown **(see illustration)**, gradually loosen the bolts that secure the camshaft bearing caps to the cylinder head, then remove the camshaft caps. It may be necessary to tap the caps lightly with a soft-faced mallet to loosen them from the locating dowels. **Caution:** *The camshaft bearing caps and cylinder heads are numbered to identify the locations of the caps. The caps must be installed in their original locations. Keep all parts from each camshaft together; never mix parts from one camshaft with those for another.*

4 Mark the intake and exhaust camshafts to prevent reinstalling them in the wrong locations, then lift the camshafts straight up and out of the cylinder head.

5 Mark the positions of the rocker arms so they can be reinstalled in their original locations, then remove the rocker arms **(see illustration)**.

6 Place the rocker arms in a suitable container so they can be separated and identified **(see illustration)**.

7 Lift the hydraulic lash adjusters from their bores in the cylinder head. Identify and separate the adjusters so they can be reinstalled in their original locations.

Front bank cylinder head

8 To place the front bank camshafts in the neutral position turn the crankshaft 1-2/3 turns (clockwise) until the crankshaft keyway is at 11 o'clock **(see illustration 9.2)**.

9 Remove the timing chain for the front cylinder bank (see Section 9). Also remove the oil seal retainer from the rear of

the intake camshaft.

10 Repeat Steps 3 to 7 to remove the front (left side) camshafts, rocker arms and lash adjusters. Be sure to loosen the bearing caps on the front camshafts in the sequence shown **(see illustration)**.

Inspection

Refer to illustrations 10.11, 10.13, 10.14, 10.15a, 10.15b, 10.16, 10.17 and 10.18

11 Check each hydraulic lash adjuster for excessive wear, scoring, pitting, or an out-of-round condition **(see illustration)**. Replace as necessary.

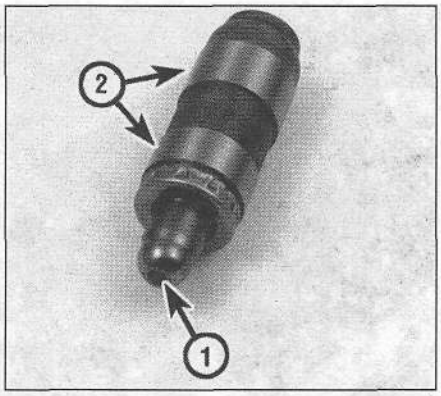
12 Measure the outside diameter of each adjuster at the top and bottom of the adjuster. Then take a second set of measurements at a right angle to the first. If any measurement is significantly different from the others, the adjuster is tapered or out of round and must be replaced. If the necessary equipment is available, measure the diameter of the lash adjuster and the inside diameter of the corresponding cylinder head bore. Subtract the diameter of the lash adjuster from the bore diameter to obtain the oil clearance. Compare the measurements obtained to those given in this Chapter's Specifications. If the adjusters or the cylinder head bores are excessively worn, new adjusters or a new cylinder head, or both, may be required. If the valve train is noisy, particularly if the noise persists after a cold start, you can suspect a faulty hydraulic adjuster.

13 Inspect the rocker arms for signs of wear or damage. The areas of wear are the tip that contacts the valve stem, the socket that contacts the lash adjuster and the roller that contacts the camshaft **(see illustration)**.

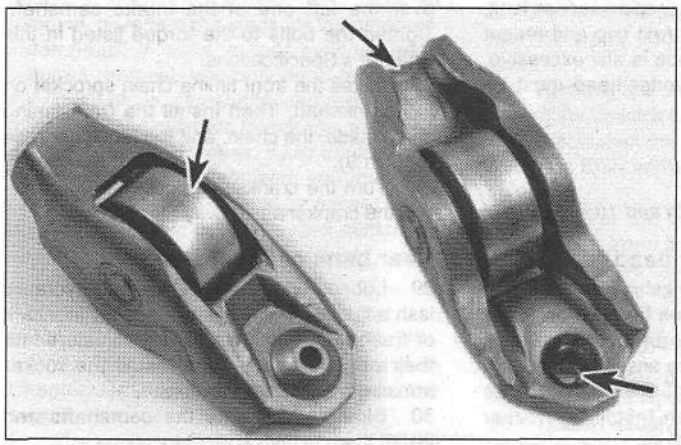
14 Examine the camshaft lobes for scoring, pitting, galling (wear due to rubbing), and evidence of overheating (blue, discolored areas). Look for flaking of the hardened surface layer of each lobe **(see illustration)**. If any such wear is evident, replace the camshaft.

15 Calculate the camshaft lobe lift by measuring the lobe height and the diameter of the base circle of the lobe **(see illustrations)**. Subtract the base circle measurement from the lobe height to determine the lobe lift. If the lobe lift is less than that listed in this Chapter's Specifications the camshaft lobe is worn and should be replaced.

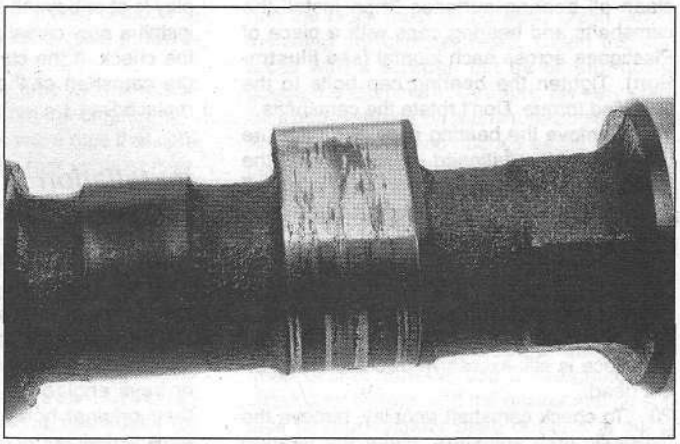
16 Inspect the camshaft bearing journals and the cylinder head bearing surfaces for pitting or excessive wear. If any such wear is evident, replace the component concerned. Using a micrometer, measure the diameter of each camshaft bearing journal at several points **(see illustration)**. If the diameter of



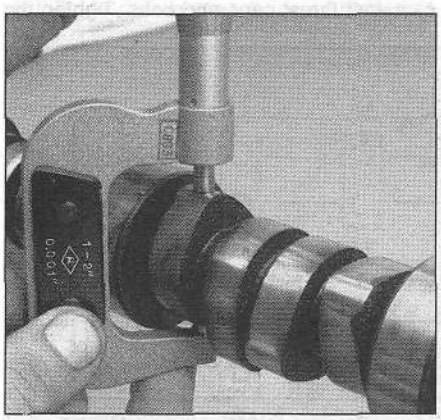
10.11 Inspect the lash adjusters for signs of excessive wear or damage, such as pitting, scoring or signs of overheating (bluing or discoloration), where the tip contacts the rocker arm (1) and the side surfaces that contact the bore in the cylinder head (2)



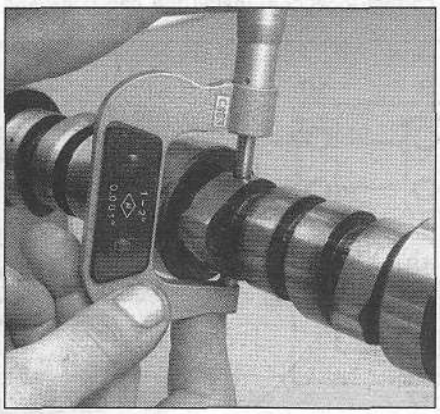
10.13 Check the roller surface (left arrow) of the rocker arm and the areas where the valve stem and lash adjuster contact the rocker arm (right arrows)



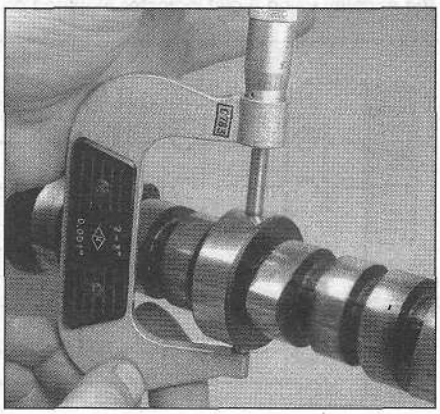
10.14 Check the cam lobes for pitting, excessive wear, and scoring. If scoring is excessive, as shown here, replace the camshaft



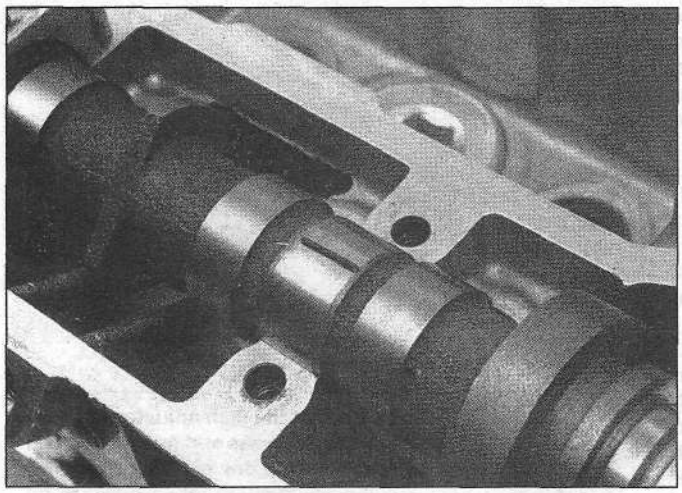
10.15a Measure the camshaft lobe height (greatest dimension) . . .



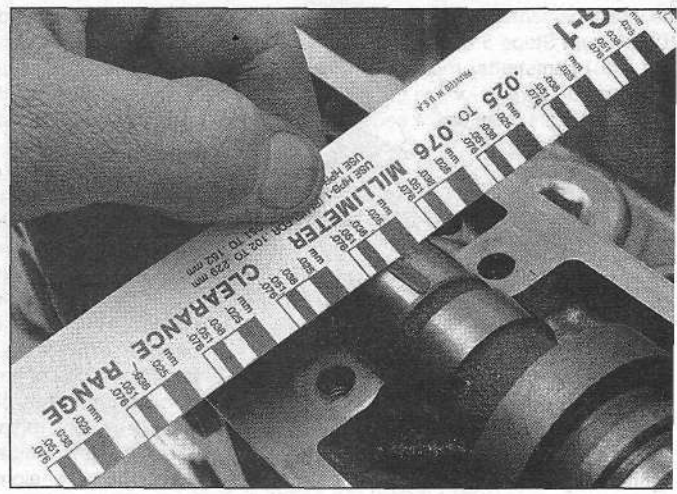
10.15b . . . and subtract the camshaft lobe base circle diameter (smallest dimension) to obtain the lobe lift specification



10.16 Measure each journal diameter with a micrometer. If any journal is less than the specified minimum, replace the camshaft



10.17 Lay a strip of Plastigage on each camshaft journal, in line with the camshaft



10.18 Compare the width of the crushed Plastigage to the scale on the package to determine the journal oil clearance

any journal is less than specified, replace the camshaft.

17 To check the bearing journal oil clearance, remove the rocker arms and hydraulic lash adjusters (if not already done), use a suitable solvent and a clean lint-free rag to clean all bearing surfaces, then install the camshafts and bearing caps with a piece of Plastigage across each journal **(see illustration)**. Tighten the bearing cap bolts to the specified torque. Don't rotate the camshafts.

18 Remove the bearing caps and measure the width of the flattened Plastigage with the Plastigage scale **(see illustration)**. Scrape off the Plastigage with your fingernail or the edge of a credit card. Don't scratch or nick the journals or bearing caps.

19 If the oil clearance of any bearing is worn beyond the specified service limit, install a new camshaft and repeat the check. If the clearance is still excessive, replace the cylinder head.

20 To check camshaft endplay, remove the hydraulic lash adjusters, clean the bearing surfaces carefully, and install the camshafts and bearing caps. Tighten the bearing cap bolts to the specified torque, then measure the endplay using a dial indicator mounted on the cylinder head so that its tip bears on the camshaft end.

21 Lightly but firmly tap the camshaft fully toward the gauge, zero the gauge, then tap the camshaft fully away from the gauge and note the gauge reading. If the measured endplay is at or beyond the specified service limit, install a new camshaft thrust cap and repeat the check. If the clearance is still excessive, the camshaft or the cylinder head must be replaced.

Installation

Refer to illustrations 10.25 and 10.31

Front bank cylinder head

22 Make sure the crankshaft keyway is at the 11 o'clock position **(see illustration 9.2)**.

23 Lubricate the rocker arms and hydraulic lash adjusters with engine assembly lubricant or fresh engine oil. Install the adjusters into their original bores, then install the rocker arms in their correct locations.

24 Similarly lubricate the camshafts and install them in their correct locations.

25 Install the camshaft bearing caps in their correct locations. Install the cap bolts and tighten by hand until snug. Then, install th camshaft thrust caps and bolts. Tighten th bolts in four to five steps, following th sequence shown **(see illustration)** to th torque listed in this Chapter's Specifications.

26 Install the seal retainer and a new sea over the left end of the intake camshaf Tighten the bolts to the torque listed in thi Chapter's Specifications.

27 Install the front timing chain sprocket o the crankshaft. Then install the front timin chain guide, the chain, and the tensioner (se Section 9).

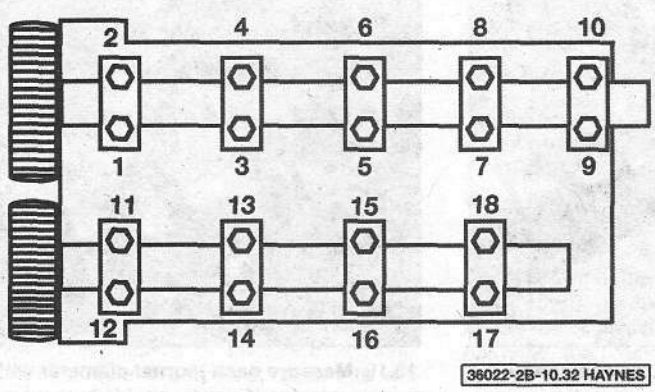
28 Turn the crankshaft clockwise and pos tion the crankshaft keyway at 3 o'clock.

Rear bank cylinder head

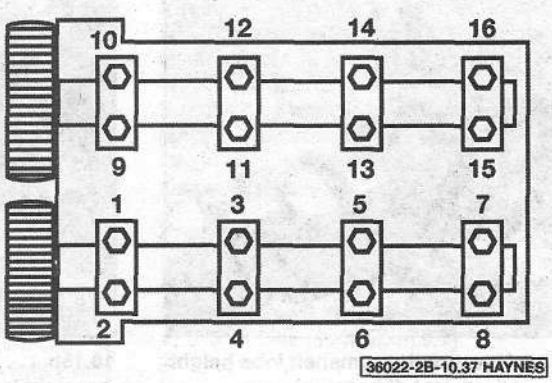
29 Lubricate the rocker arms and hydrauli lash adjusters with engine assembly lubrican or fresh engine oil. Install the adjusters int their original bores, then install the rocke arms in their correct locations.

30 Similarly lubricate the camshafts an install them in their correct locations.

31 Install the camshaft bearing caps in the correct locations. Install the cap bolts an tighten by hand until snug. Then, install th camshaft thrust caps and bolts. Tighten th



10.25 Front bank camshaft bearing cap tightening sequence



10.31 Rear bank camshaft bearing cap tightening sequence

bolts in four to five steps, following the sequence shown **(see illustration)** to the torque listed in this Chapter's Specifications.

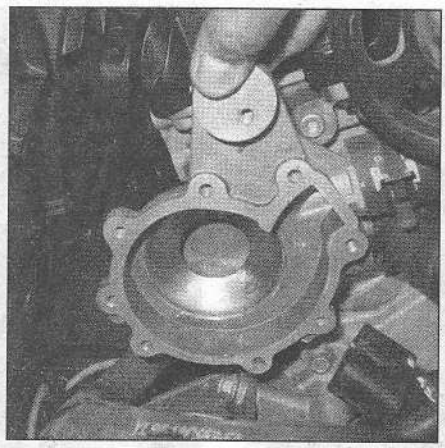
32 Install the rear timing chain, chain guide and tensioner (see Section 9).

33 Install the engine front cover (see Section 8).

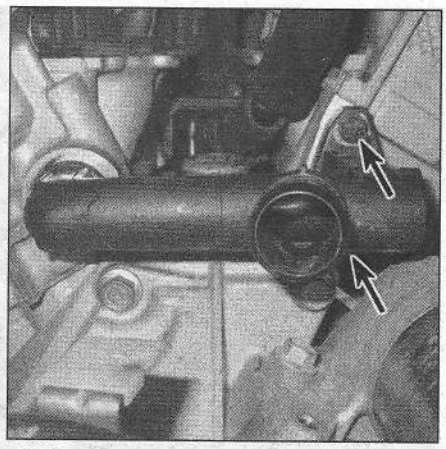
34 Reinstall the remaining parts in the reverse order of removal.

35 Refer to Chapter 1 and fill the crankcase with the recommended oil; fill the power steering reservoir with the correct fluid and refill the cooling system.

36 Reconnect the battery, then start the engine and check for leaks. The Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Chapter 5, Section 1).



11.8 Remove the water pump housing from the left bank (front) cylinder head



11.11a Remove the coolant bypass tube mounting bolts . . .

11 Cylinder heads - removal and installation

Warning: *Wait until the engine is completely cool before beginning this procedure.*

Note: *The following instructions describe the steps necessary to remove both cylinder heads. If only one cylinder head requires removal, disregard the steps for the other cylinder head. If just the rear cylinder head requires removal, you only need to remove the timing chain, camshafts, and rocker arms from the rear cylinder head; the front can remain installed. However, if just the front cylinder head must be removed, you must first remove the rear timing chain for access to the front chain. In this case, the rear camshafts and rocker arms can remain installed.*

Removal

Refer to illustrations 11.8, 11.11a and 11.11b

1 Relieve the fuel system pressure (see Chapter 4). Disconnect the cable from the negative battery terminal (see Chapter 5).

2 Drain the cooling system (see Chapter 1).

3 Remove the upper and lower intake manifolds (see Section 5).

4 Drain the engine oil (see Chapter 1). Remove the oil pan (see Section 12).

5 Remove the engine front cover (see Section 8).

6 Remove the timing chains, camshafts, rocker arms and lash adjusters as necessary (see Sections 9 and 10).

7 Remove the exhaust manifold(s) (see Section 6).

8 Remove the water pump (see Chapter 3) and the water pump housing **(see illustration)**.

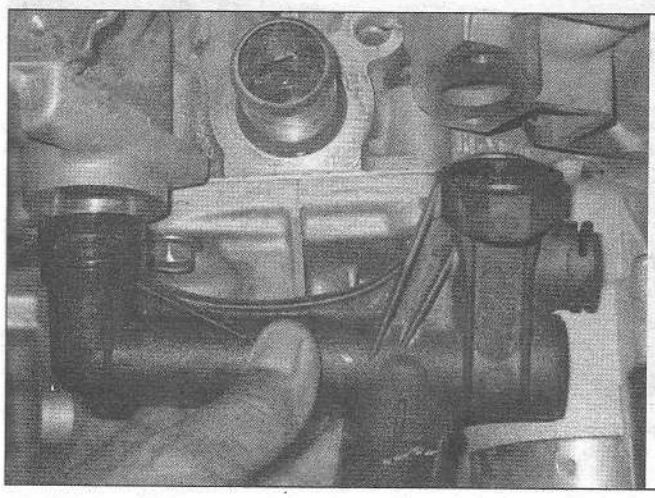
9 Remove the dipstick tube mounting bolt and lift the dipstick tube from the engine.

10 Disconnect the EGR valve pipe that connects the EGR valve to the rear exhaust manifold.

11 Remove the hoses and any electrical connectors from the coolant bypass tube. Remove the two fasteners securing the coolant bypass tube **(see illustrations)**. Then remove the tube.

12 Loosen each cylinder head bolt, one turn at a time, following the reverse order of the tightening sequence **(see illustration 11.23a)**. When all cylinder head bolts are loose, remove and discard the bolts. New torque-to-yield cylinder head bolts must be used during installation.

13 Remove the cylinder head from the engine block and place it on a workbench.



11.11b . . . and remove the tube from the cylinder heads

Caution: *If the cylinder head sticks to the block, pry only on a casting protrusion to prevent damaging the mating surfaces.* Remove and discard the cylinder head gasket.

Installation

Refer to illustrations 11.21a and 11.21b

14 The mating surfaces of the cylinder head and the block must be perfectly clean before installing the cylinder head. Clean the surfaces with a scraper, but be careful not to gouge the aluminum. **Caution:** *Be very careful when scraping on aluminum engine parts. Aluminum is soft and gouges easily. Severely gouged parts may require replacement.*

15 Check the mating surfaces of the block and the cylinder head for nicks, deep scratches, and other damage. If slight, they can be removed carefully with a file; if excessive, machining may be the only alternative to replacement.

16 If you suspect warpage of the cylinder head gasket surface, use a straightedge to check it for distortion. If the gasket mating surface of your cylinder head or block is out of specification or is severely nicked or scratched, consult an automotive machine shop for advice.

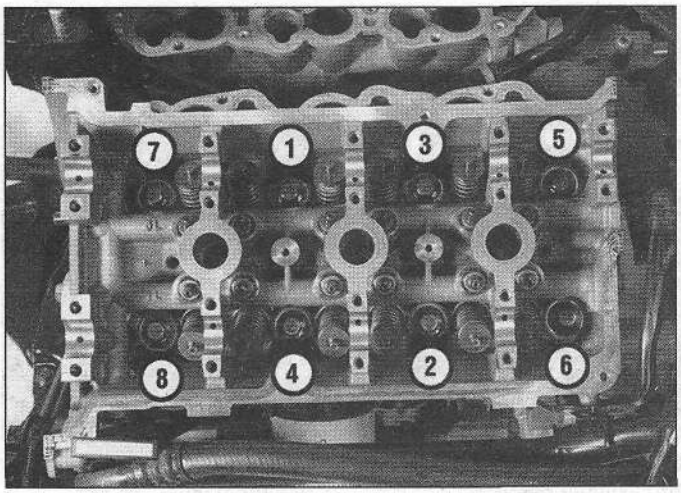
17 Clean the mating surfaces of the cylinder head and block with a clean shop towel and solvent as needed.

18 Ensure that the two locating dowels are in position in the cylinder block and that all cylinder head bolt holes are free of oil, corrosion, or other contamination.

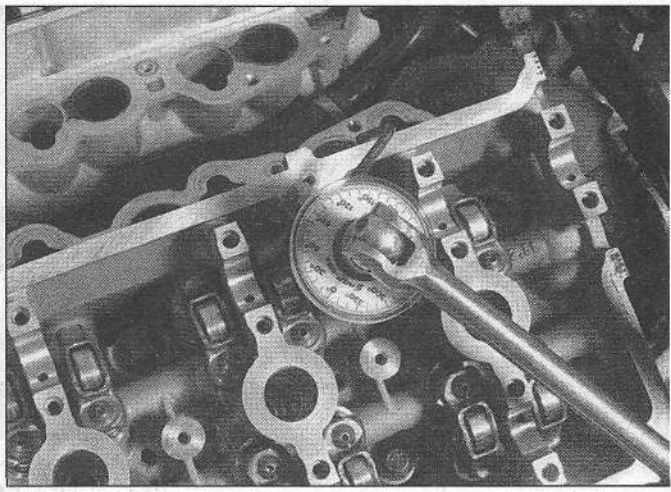
19 Install new cylinder head gaskets on the block, over the locating dowels.

20 Carefully install the cylinder heads. Use caution when lowering the cylinder heads onto the cylinder block to prevent damage to the cylinder heads or block. Make sure the cylinder heads fit properly over the locating dowels in the block.

21 Install new cylinder head bolts and turn down by hand until snug. **Caution:** *The cylinder head bolts are the torque-to-yield type and are stretched during tightening. Therefore, the original bolts must be discarded and new bolts installed during assembly.* Using a torque



11.21a Cylinder head bolt TIGHTENING sequence



11.21b An angle gauge takes all the "guesswork" out of tightening the torque-to-yield cylinder head bolts

wrench and an angle gauge, tighten the cylinder head bolts in the sequence shown to the torque listed in this Chapter's Specifications **(see illustrations)**. **Note:** *The method used for the cylinder head bolt tightening procedure is referred to as the "torque angle" or "torque-to-yield" method; follow the procedure exactly. Tighten the bolts using a torque wrench, then use a breaker bar and a special torque angle adapter (available at auto parts stores) to tighten the bolts the required angle.*

22 Install the rest of the parts in the reverse order of removal. Tighten fasteners to the torque values listed in this Chapter's Specifications.

23 Refer to Chapter 1 and fill the engine with fresh engine oil, then fill the cooling system.

24 Reconnect the battery. After you're done, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Chapter 5, Section 1).

25 Start the engine and check for leaks.

12 Oil pan - removal and installation

Removal

Refer to illustrations 12.8a and 12.8b

1 Disconnect the cable from the negative battery terminal (see Chapter 5).

2 Raise the vehicle and support it securely on jackstands.

3 Drain the engine oil (see Chapter 1). Reinstall the oil drain plug and tighten it to the torque listed in the Chapter 1 Specifications, using a new gasket if necessary.

4 Remove the oil filter (see Chapter 1).

5 Disconnect the oxygen sensor connector(s) (see Chapter 6).

6 Refer to Chapter 4 and remove the crossover and flexible exhaust pipe and converter assembly from the vehicle. **Note:** *V6 engines are equipped with upstream catalytic converters designed integrally with the exhaust manifolds.*

7 Remove the driveplate access cover.

8 Remove the bolts that secure the oil pan to the transaxle **(see illustrations)**.

9 Remove the oil pan fasteners and remove the oil pan. Note the location of any stud bolts.

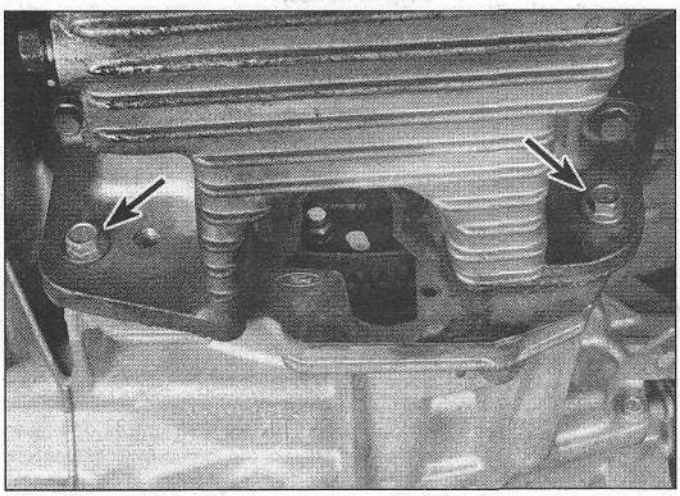
10 Remove and discard the oil pan gasket. If necessary, remove the fasteners that secure the oil screen and pick-up tube and remove the screen and tube assembly.

11 Thoroughly clean the oil pan and cylinder block mating surfaces using lacquer thinner or acetone. The surfaces must be free of any residue that will keep the sealant from adhering properly. Clean the oil pan inside and out with solvent and dry with compressed air.

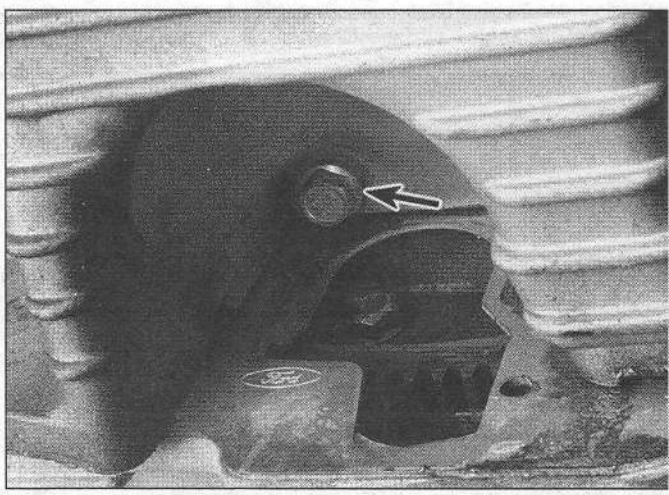
Installation

Refer to illustration 12.14

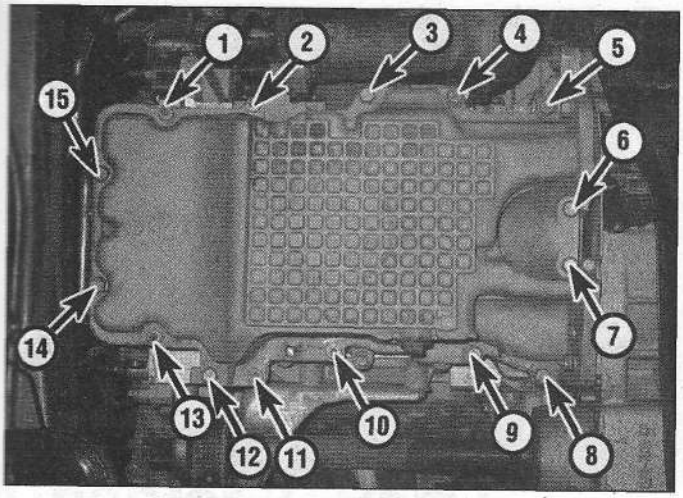
12 If removed, install a new O-ring seal onto the oil pick-up tube. Install the tube and screen assembly and tighten the retaining fasteners to the torque listed in this Chapter's Specifications. Use a new self-locking nut to secure the pick-up tube support bracket. Tighten the nut to the torque listed in this Chapter's Specifications.



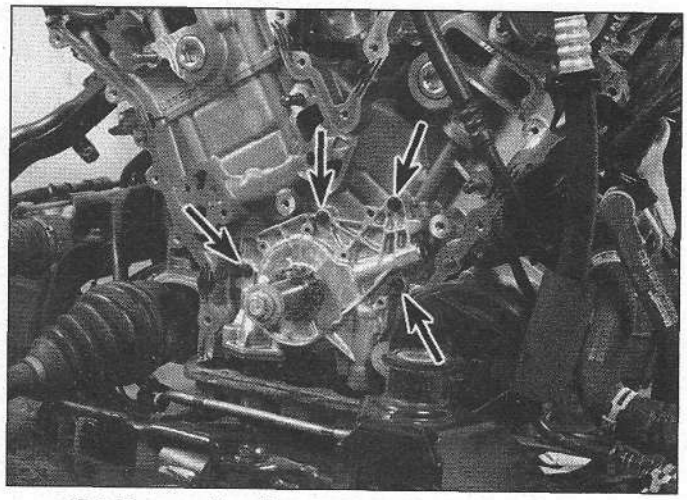
12.8a Remove these bolts that secure the oil pan to the transaxle . . .



12.8b . . . and these two in the recess at the rear of the pan



12.14 Oil pan bolt tightening sequence



13.3 Remove the oil pump retaining bolts and pull the oil pump off the crankshaft

13 Install a new gasket on the oil pan. Apply a 1/8-inch bead of RTV sealant to the oil pan gasket in the area of the engine front cover-to-cylinder block parting line.

14 Install the oil pan, being careful not to dislodge the pan gasket. Install the pan bolts and tighten by hand. Be sure to install any stud bolts in the locations noted during removal. Install the oil pan-to-transaxle bolts. Firmly push the oil pan against the transaxle and tighten the pan-to-transaxle bolts snugly. Then, tighten the oil pan bolts **(see illustration)** gradually and evenly, to the torque listed in this Chapter's Specifications.

15 The remainder of installation is the reverse of removal, noting the following items:

a) Tighten all fasteners to the torque values listed in this Chapter's Specifications.
b) Always replace any self-locking nuts disturbed on removal.
c) Refer to Chapter 1 and fill the engine with fresh engine oil. Install a new oil filter.
d) Refill the cooling system (see Chapter 1).
e) Start the engine and check for leaks.

16 Reconnect the battery. After you're done, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Chapter 5, Section 1).

13 Oil pump - removal, inspection and installation

Note: *Because of the difficulty of removing the oil pump, this job is best done as part of complete engine overhaul with the engine out of the vehicle.*

Removal

Refer to illustration 13.3

1 Remove the oil pan and oil screen and pick-up tube assembly (see Section 12).

2 Remove the engine front cover (see Section 8), timing chains and crankshaft sprockets (see Section 9).

3 Loosen each of the four oil pump mounting bolts one turn. Then, gradually and evenly, loosen each bolt in several steps. When all bolts are loose, remove the bolts and oil pump **(see illustration)**.

Inspection

Refer to illustrations 13.4 and 13.5

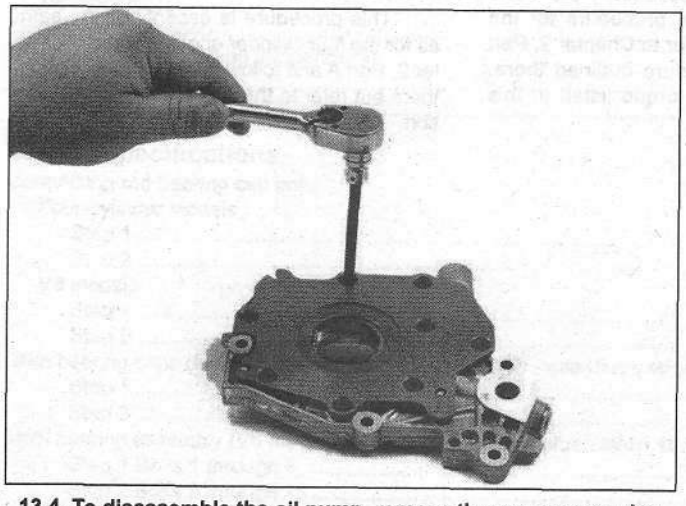
4 Remove the oil pump cover from the oil pump body **(see illustration)**.

5 Note any identification marks on the rotors and withdraw the rotors from the pump body **(see illustration)**.

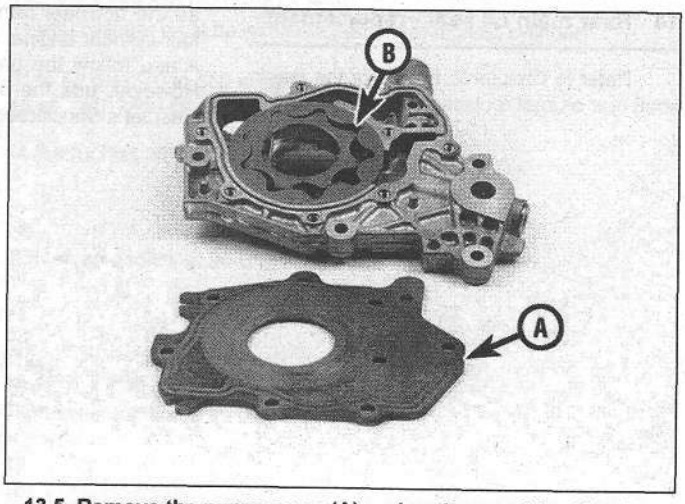
6 Thoroughly clean and dry the components.

7 Inspect the rotors for obvious wear or damage. If either rotor, the pump body or the cover is scored or damaged, the complete oil pump assembly must be replaced.

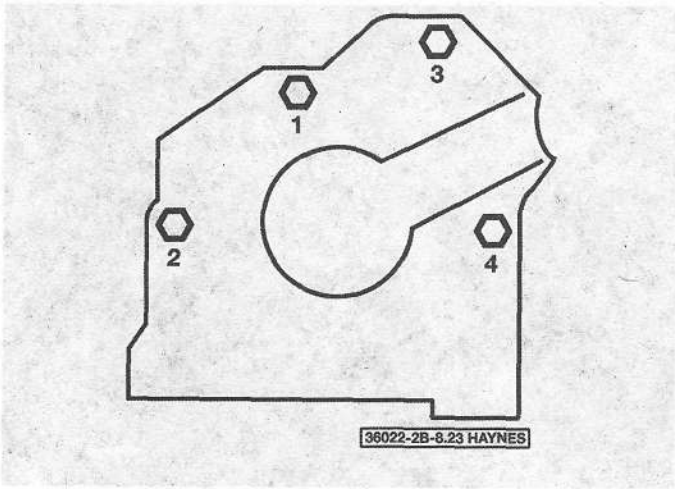
8 If the oil pump components are in acceptable condition, dip the rotors in clean engine oil and install them into the pump body with



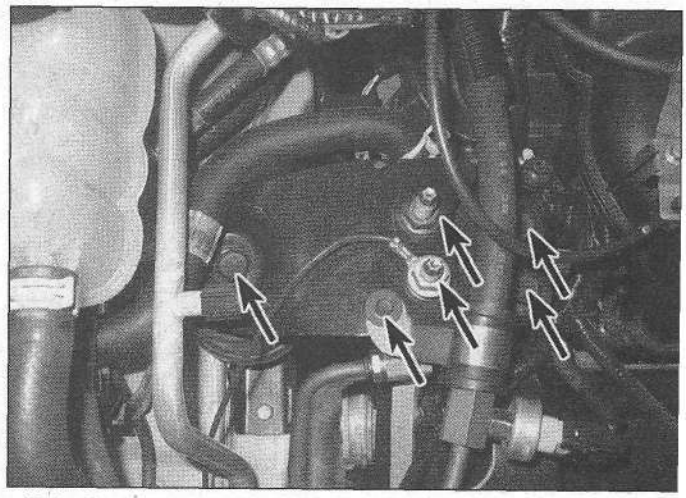
13.4 To disassemble the oil pump, remove the screws securing the pump cover to the pump body



13.5 Remove the pump cover (A) and noting any identification marks on the rotors, remove the inner and outer rotors (B) from the pump body



13.11 Oil pump bolt tightening sequence



16.1a Remove the engine mount bracket bolts and separate the bracket from the engine and insulator

any identification marks positioned as noted during disassembly.

9 Install the cover and tighten the screws securely.

Installation

Refer to illustration 13.11

10 Rotate the oil pump inner rotor so it aligns with the flats on the crankshaft. Install the oil pump over the crankshaft and fit it firmly against the cylinder block.

11 Install the oil pump bolts and tighten by hand until snug. Tighten the bolts gradually and evenly, in sequence, to the torque listed in this Chapter's Specifications **(see illustration)**.

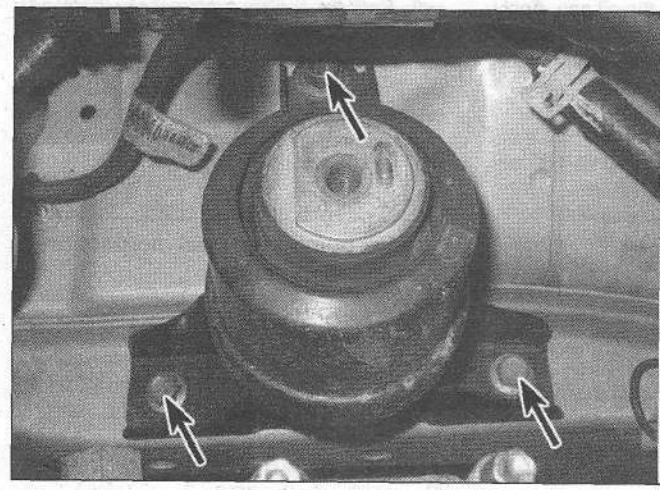
12 Install the remainder of the components in the reverse order of removal.

13 Refer to Chapter 1 and fill the engine with fresh engine oil. Install a new oil filter. Refill the cooling system.

14 Start the engine and check for leaks.

14 Rear main oil seal - replacement

Refer to Chapter 2, Part A for the crankshaft rear oil seal replacement procedure.



16.1b Remove the engine mount insulator bolts and separate the insulator from the engine compartment

15 Driveplate - removal and installation

This procedure is essentially the same as the flywheel removal procedure for the four-cylinder engine. Refer to Chapter 2, Part A and follow the procedure outlined there. However, use the bolt torque listed in this Chapter's Specifications.

16 Engine mounts - inspection and replacement

Refer to illustrations 16.1a and 16.1b

This procedure is essentially the same as for the four cylinder engine. Refer to Chapter 2, Part A and follow the procedure outlined there but refer to the illustrations for this Section.