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ENGINE AND ENGINE OVERALL

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ENGINE MECHANICAL

Engine

REMOVAL & INSTALLATION

♦ See Figure 1

In the process of removing the engine, you will come across a number of steps which call for the removal of a separate component or system, such as "disconnect the exhaust system" or "remove the radiator." In most instances, a detailed removal procedure can be found elsewhere in this manual.

It is virtually impossible to list each individual wire and hose which must be disconnected, simply because so many different model and engine combinations have been manufactured. Careful observation and common sense are the best possible approaches to any repair procedure.

Removal and installation of the engine can be made easier if you follow these basic points:

- If you have to drain any of the fluids, use a suitable container.
 - Always tag any wires or hoses and, if possible, the components they came from before disconnecting them.
 - Because there are so many bolts and fasteners involved, store and label the retainers from components separately in muffin pans, jars or coffee cans. This will prevent confusion during installation.
 - After unbolting the transmission or transaxle, always make sure it is properly supported.
 - If it is necessary to disconnect the air conditioning system, have this service performed by a qualified technician using a recovery/recycling station. If the system does not have to be disconnected, unbolt the compressor and set it aside.
 - When unbolting the engine mounts, always make sure the engine is properly supported. When removing the engine, make sure that any lifting devices are properly attached to the engine. It is recommended that if your engine is supplied with lifting hooks, your lifting apparatus be attached to them.
 - Lift the engine from its compartment slowly, checking that no hoses, wires or other components are still connected.
 - After the engine is clear of the compartment, place it on an engine stand or workbench.
 - After the engine has been removed, you can perform a partial or full teardown of the engine using the procedures outlined in this manual.
1. Relieve fuel system pressure.

** CAUTION

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

2. Disconnect the negative battery cable.
3. Remove the engine undercover if equipped.

4. Matchmark the hood and hinges and remove the hood assembly.

5. Remove the air cleaner assembly and all adjoining air intake duct work.

6. Drain the engine coolant, remove the radiator hoses, and remove the radiator assembly, coolant reservoir, and intercooler, as equipped.

** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

7. Remove the transaxle and transfer case as equipped.

8. Tag and detach the following electrical connections:

- Accelerator cable
- Heater hoses
- Brake booster vacuum hose
- Vacuum hoses
- Fuel lines
- Engine ground cables
- Any applicable sensors
- Coolant temperature and oil pressure sending units
- Exhaust Gas Recirculation (EGR) temperature sensor
- Connection for the idle speed control motor
- Fuel injectors
- Power transistor
- Ignition coil and any applicable distributor connections
- The connections for the alternator
- Power steering pressure switch
- A/C compressor
- Refrigerant temperature switch
- Condenser

9. Remove the air conditioner drive belt and the air conditioning compressor. Leave the hoses attached. Do not discharge the system. Place the compressor aside and secure it using a suitable device.

10. Remove the power steering pump and place the pump aside and secure it using a suitable device.

11. Remove the exhaust manifold-to-exhaust pipe nuts. Discard the gasket.

12. Install the engine hoist equipment and make certain the attaching points on the engine are secure.

13. Raise the hoist enough to support the engine.

14. Remove the front and rear engine roll stoppers.

15. Remove the left engine mount and support bracket.

** WARNING

Double check that all cables, hoses, harness connectors, etc., are disconnected from the engine.

16. Slowly lift the engine and remove it from the vehicle.

To install:

17. Install the engine and secure all control brackets and mounts.

18. Install the transaxle, and transfer case if equipped.

19. The balance of the installation is the reverse of removal with the addition of the following notes:

- a. Use new clamps or O-rings to connect the high pressure fuel line and the fuel return line.
- b. Use new gaskets to connect the exhaust system to the engine.
- c. Fill the engine with the proper amount of engine oil and coolant.
- d. Start the engine, allow it to reach normal operating temperature.
- e. Check for leaks.
- f. Check the ignition timing and adjust if necessary.
- g. Road test the vehicle and check all fluid levels and functions for proper operation.

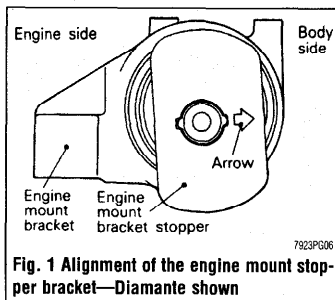


Fig. 1 Alignment of the engine mount stopper bracket—Diamante shown

Rocker Arm (Valve) Cover

REMOVAL & INSTALLATION

Except 3.0L (SOHC and DOHC) and 3.5L Engines

♦ See Figures 2 thru 11

1. Disconnect the negative battery cable.
2. If necessary, remove the air intake hose.
3. If necessary, remove the throttle cable from the cable routing clips.

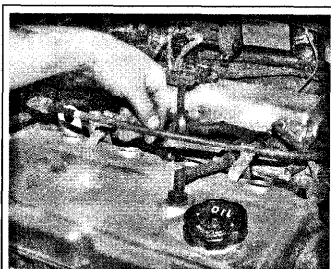


Fig. 2 If necessary, remove the throttle cable from the cable routing clips



Fig. 3 Remove the breather hose from the valve cover

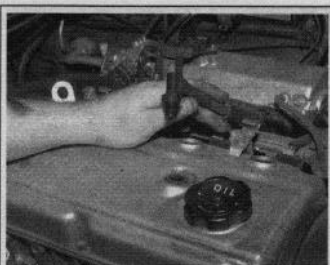


Fig. 4 Remove the PCV valve and hose from the valve cover



Fig. 5 Twist each spark plug wire to remove it from the spark plug . . .



Fig. 6 . . . then position the wires out of the way

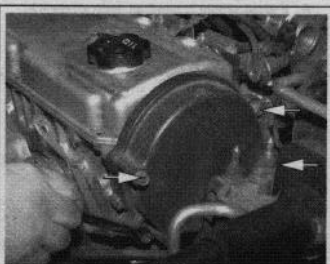


Fig. 7 The upper timing cover is retained by three bolts. Unfasten the bolts . . .



Fig. 8 . . . then carefully remove the cover from the engine

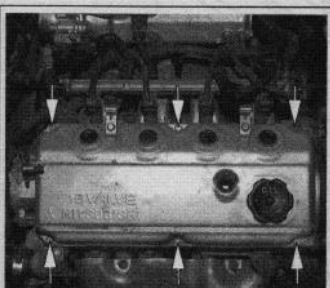


Fig. 9 Remove the valve cover retaining bolts . . .



Fig. 10 . . . then lift the valve cover off of the cylinder head



Fig. 11 Remove the valve cover gasket, thoroughly clean the valve cover and cylinder head, and replace the gasket

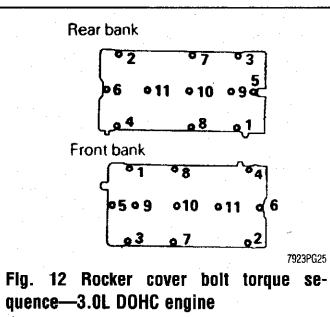
4. If equipped, remove the breather hose from the valve cover.
 5. Remove the crankcase ventilation tube from the valve cover.
 6. On the 1.6L and 2.0L (DOHC) engines, remove the ignition wire cover.
 7. Label and remove the ignition wires and separators.
 8. Remove the upper timing belt cover.
 9. Remove the valve cover retaining bolts, starting from the outside and working in.
 10. Remove the valve cover and gasket from the cylinder head.
- To install:**
11. Clean the valve cover gasket sealing surfaces.
 12. Install new valve cover gaskets and if equipped, O-rings onto the valve covers.

13. Place the valve cover into position and beginning in the center of the valve cover and working outward, tighten the retaining bolts as follows:
 - 1.5L engine: 12–18 inch lbs. (1–2 Nm)
 - 1.6L, 1.8L, 2.0L DOHC, and 2.4L engines: 24–36 inch lbs. (2–3 Nm)
 - 2.0L SOHC engine: 48–60 inch lbs. (4–5 Nm)
14. Install the crankcase ventilation tube.
15. Install the ignition wire separators and the ignition wires.
16. On the 1.6L and 2.0L (DOHC) engines, install the ignition wire cover.
17. Install the air intake hose.
18. Connect the negative battery cable.
19. Run the engine and check for leaks and proper operation.

3.0L and 3.5L Engines

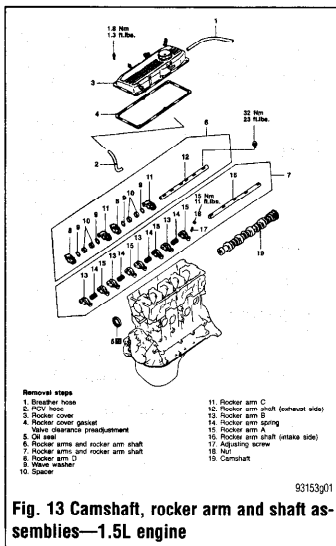
♦ See Figure 12

1. Disconnect the negative battery cable.
2. Remove the upper intake manifold as described in this section.
3. On the 3.0L DOHC engine, remove the ignition wire cover.
4. Remove the ignition wires and spark plugs.
5. Remove the crankcase ventilation tubes from both valve covers.
6. Remove the retaining nuts and engine wiring from both valve covers and move aside.
7. Remove the valve cover retaining bolts and studs.
8. Remove both valve covers from the engine.



To install:

- Clean the valve cover gasket sealing surfaces.
- Install new valve cover gaskets onto the valve covers.
- Place the valve covers into position.
- Reinstall the valve cover retaining bolts and studs and tighten in sequence to:
 - 3.0L SOHC engine: 7 ft. lbs. (9 Nm)
 - 3.0L DOHC engine: 42–54 inch lbs. (4–5 Nm)
 - 3.5L engine: 30 inch lbs. (3 Nm)
- Install the engine wiring and tighten the retaining nuts.
- Install the crankcase ventilation tubes into both valve covers.
- Install the ignition wire separators, the ignition wires, and the spark plugs.
- On the 3.0L DOHC engine, install the ignition wire cover.
- Install the upper intake manifold as described in this section.
- Connect the negative battery cable.
- Run the engine and check for leaks and proper operation.



Rocker Arm/Shafts

REMOVAL & INSTALLATION

1.5L and 1.8L Engines

▶ See Figures 13 and 14

- Disconnect the negative battery cable.
- For 1.8L engines, label and disconnect the spark plug cables.
- Disconnect the accelerator cable, breather hose and PCV hose connections.
- Remove the rocker cover.
- Loosen both rocker arm shaft assemblies gradually and evenly and remove the rocker shafts from the vehicle.
- If disassembly is required, keep all parts in the exact order of removal.

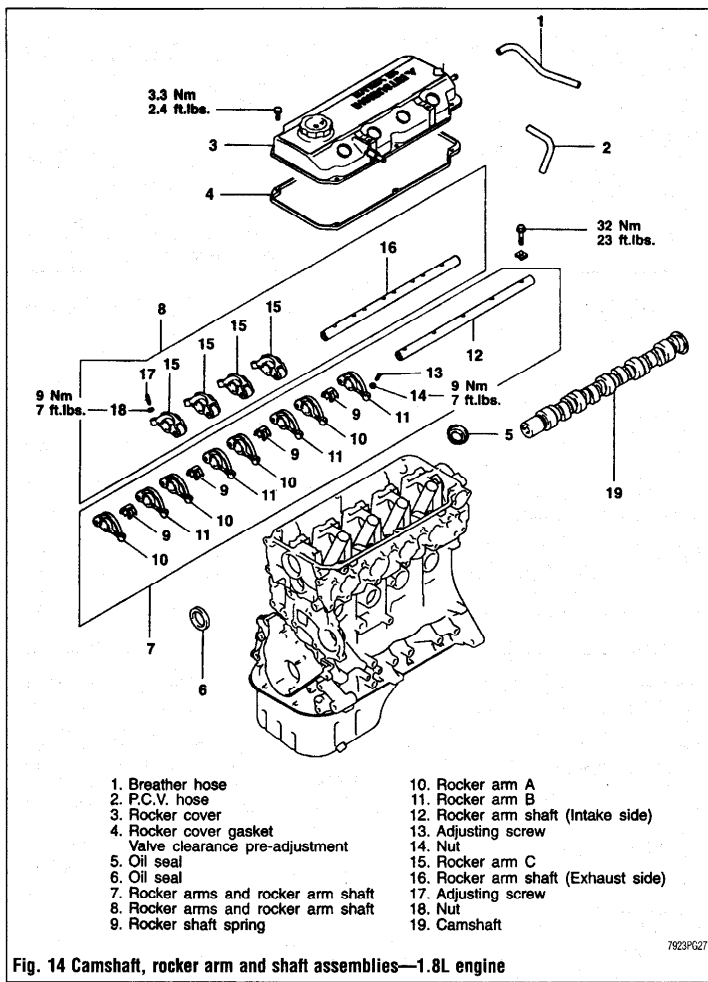
To Install:

- Lubricate the rocker shaft with clean engine oil and install the rockers and springs.
- Install the rocker arm and shaft assemblies. Tighten the rocker arm shaft retainer bolts to 23 ft. lbs. (32 Nm).
- Check valve adjustment and install the valve cover. Tighten the valve cover bolts to 16 inch lbs. (1.8 Nm) for the 1.5L engine or to 29 inch lbs. (3.3 Nm) for the 1.8L engine.
- If detached, connect the spark plug cables.
- Connect the accelerator cable, breather hose and PCV hose.
- Connect the negative battery cable.

2.0L SOHC Engine

▶ See Figure 15

On this engine, the hydraulic lifters are built into the rocker arms. If lifter service is required, simply



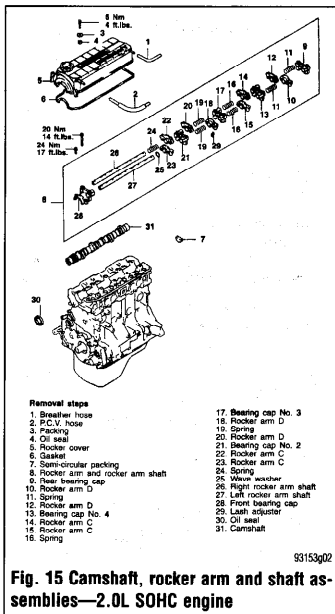


Fig. 15 Camshaft, rocker arm and shaft assemblies—2.0L SOHC engine

remove the lifter from the bore in the rocker arm. It is recommended that all of the rocker arms and lash adjusters be replaced at the same time.

1. Disconnect the negative battery cable.
2. Remove the valve cover.
3. Matchmark the distributor to the cylinder head and remove the distributor.
4. Remove the timing belt.
5. Working in a crisscross pattern from the center outward, loosen the camshaft bearing caps in gradual steps.
6. Remove the rocker arms, shafts and bearing caps as an assembly.

It is essential that all parts be kept in the same order and orientation for reinstallation. Be sure to mark and separate parts, so parts will not be mixed during reassembly.

7. Disassemble rocker shaft assembly. Starting at rear bearing cap, slide each piece off shafts.

Inspect the roller surfaces of the rockers. Replace if there are any signs of damage or if the roller does not turn smoothly. Check the inside bore of the rockers and lifter for wear.

To install:

8. Apply a drop of sealant to the rear edges of the end caps.
9. Install the assembly into the front bearing cap, making sure the notches in the rocker shafts are facing up. Insert the installation bolt, but do not tighten at this point.
10. Install the remaining cap bolts. Tighten all bolts evenly and gradually to 15 ft. lbs. (20 Nm). Remove the lash adjuster retainers.
11. Install the timing belt as required.
12. Align the matchmarks and install the distributor.
13. Remove the lash adjuster retaining tools.

14. Install the valve cover, with a new gasket and semi-circular packing in place.
15. Connect the negative battery cable.
16. Run the engine and check ignition timing.

1.6L and 2.0L DOHC (Turbo and Non-turbo) Engines

See Figure 16

1. Disconnect the negative battery cable.
2. Remove the valve cover and discard the gasket.
3. Install lash adjuster retainer tools MD998443 or equivalent, to the rocker arm.
4. Remove the rocker shaft hold-down bolts gradually and evenly and remove the rocker shaft/arm assemblies.
5. If disassembly is required, keep all parts in the exact order of removal. Inspect the roller surfaces of the rockers. Replace if there are any signs of damage or if the roller does not turn smoothly. Check the inside bore of the rockers and the adjuster tip for wear.

To install:

6. Lubricate the rocker shaft with clean engine oil and install the rockers and springs in their proper places.
7. Install the rocker shaft assemblies on the engine. Tighten the bolts gradually and evenly to 21–25 ft. lbs. (29–35 Nm).

When installing the rocker arm shaft, make certain the notch is properly located.

8. Remove the lash adjuster retaining tools.
9. Install the valve cover with a new gasket.
10. Connect the negative battery cable.

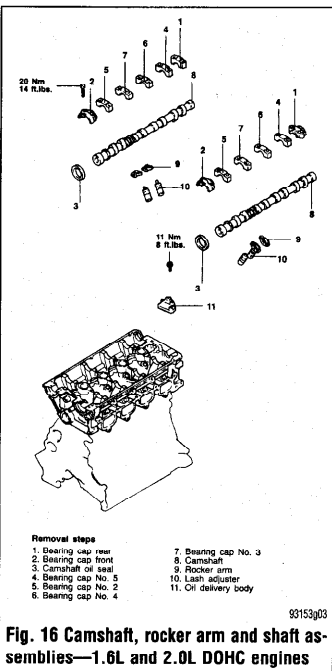


Fig. 16 Camshaft, rocker arm and shaft assemblies—1.6L and 2.0L DOHC engines

2.4L Engine

See Figures 17, 18, and 19

1. Disconnect the negative battery cable.
2. Remove the accelerator cable from the retaining clamps and position the accelerator cable out of the way.
3. Remove the air intake hose.
4. Disconnect the breather hose and the PCV hose.
5. Disconnect the spark plug cables from the spark plugs.
6. Remove the rocker cover and gasket.
7. Install lash adjuster retainer tools MD998443 or equivalent, to the rocker arm.
8. Remove the rocker shaft hold-down bolts gradually and evenly and remove the rocker shaft/arm assemblies.
9. Disassemble the rockers and the rocker shaft springs from the rocker shafts. If they are to be reused, note the location and positioning of all rocker shaft components. It is recommended that all lash adjusters and rockers be replaced as a complete set.

To install:

10. Immerse the lash adjusters in clean diesel fuel, and using a small wire, move the plunger up and down four or five times, while pushing down lightly on the check ball in order to bleed the air from the adjuster.
11. Install the lash adjusters to the rocker arms and attach the special holding tool.
12. Lubricate the rocker shaft with clean engine oil and install the rocker arms.
13. Temporarily tighten the rocker shaft assembly with the mounting bolts so that all rocker arms on the inlet valve side do not push on the valves.
14. Fit the rocker shaft springs from above and position them so that they are at right angles to the plug side. Install the rocker springs before installing the exhaust side rocker shaft and rocker arm assembly.
15. Install the exhaust side rocker shaft assembly in the engine. Tighten the rocker shaft mounting bolts gradually and evenly to 23 ft. lbs. (32 Nm).
16. Remove the lash adjuster retaining tools.
17. Install the rocker cover and tighten the mounting bolts to 30 inch lbs. (3 Nm).
18. Reinstall the spark plug wires to the spark plugs.
19. Reconnect the PCV and breather hoses.
20. Install the air intake hose.
21. Reattach the accelerator cable brackets and reconnect the accelerator cable.
22. Connect the negative battery cable.

3.0L SOHC Engine

See Figures 20 and 21

On this engine, the hydraulic lash adjusters are built into the rocker arms.

1. Disconnect the negative battery cable.
2. Remove the valve cover. Install lash adjuster retainer tools MD998443 or equivalent, to prevent the auto-lash adjuster from falling out of the rocker arm.
3. Loosen rocker arm and shaft assembly evenly in several steps. Remove the rocker arm and shaft assembly as a complete unit.
4. Remove the rear camshaft bearing cap and slide the rocker arms, springs and washers from the shaft. If they are to be reused, note the location and positioning of all rocker shaft components. It is rec-

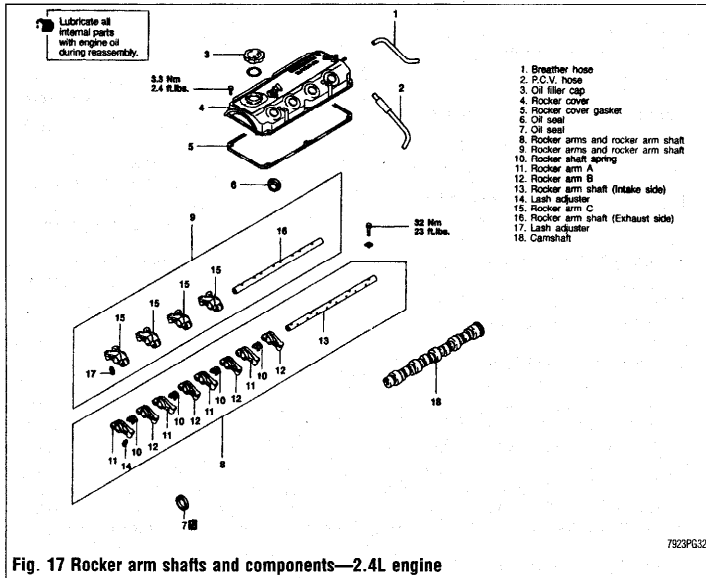


Fig. 17 Rocker arm shafts and components—2.4L engine

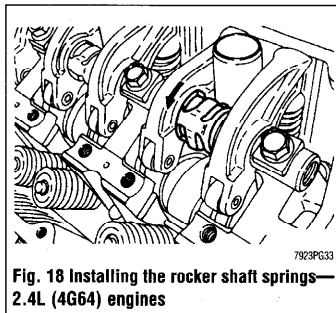


Fig. 18 Installing the rocker shaft springs—2.4L (4G64) engines

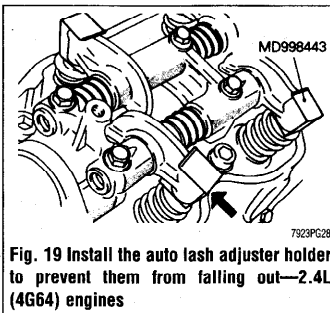


Fig. 19 Install the auto lash adjuster holder to prevent them from falling out—2.4L (4G64) engines

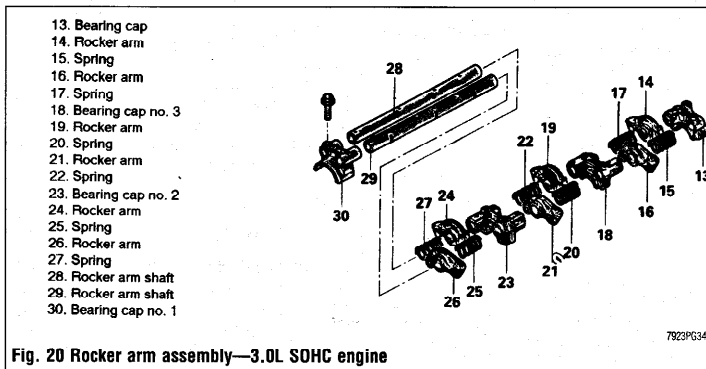


Fig. 20 Rocker arm assembly—3.0L SOHC engine

ommended that all lash adjusters and rockers be replaced as a complete set.

To install:

5. Immerse the lash adjusters in clean diesel fuel. Using a small wire, move the plunger of the lash adjuster up and down 4 or 5 times while pushing

down lightly on the check ball in order to bleed out the air. Install the lash adjusters in the rocker arms.

6. Using a light coat of engine oil, assemble the rocker arms to the shaft. Install the rear camshaft bearing cap.

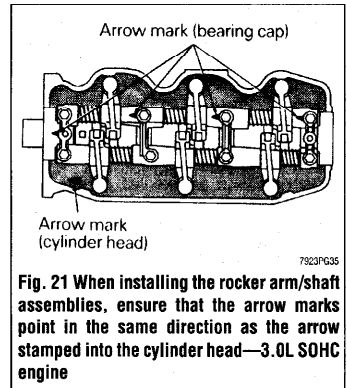


Fig. 21 When installing the rocker arm/shaft assemblies, ensure that the arrow marks point in the same direction as the arrow stamped into the cylinder head—3.0L SOHC engine

7. Lubricate the camshaft and rocker shaft with clean engine oil and position on the cylinder head.

8. Apply a drop of sealant to the rear edges of the end caps.

9. Install the assembly making sure the notches in the rocker shafts are facing up.

10. Install the cap bolts and tighten evenly and gradually to 14 ft. lbs. (20 Nm). Remove the lash adjuster retainers.

11. Install the valve cover.

12. Connect the negative battery cable.

3.0L DOHC Engine

See Figure 22

1. Relieve the fuel system pressure.

CAUTION

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

2. Disconnect battery negative cable.
3. Remove the timing belt cover and timing belt. Refer to the timing belt procedure in this section.

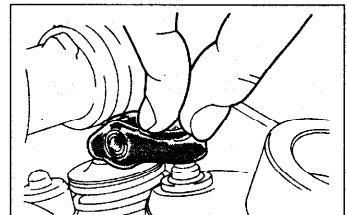


Fig. 22 The rocker arms sit beneath the camshaft and are supported on one end by the valve stem and on the other end by the hydraulic lash adjuster—Diamante with 3.0L DOHC engine

- Remove the center cover, breather and PCV hoses, and spark plug cables.
- Remove the rocker cover.
- Remove the throttle body stay, both camshaft sprockets, and oil seals.
- Remove the Camshaft Position (CMP) sensor and adapter from the rear of the camshaft.
- Remove the intake and exhaust camshafts.
- Remove rocker arms and lash adjusters from the head. It is recommended that all lash adjusters and rockers be replaced as a complete set.

To install:

- Immerse the lash adjusters in clean diesel fuel. Using a small wire, move the plunger of the lash adjuster up and down four or five times while pushing down lightly on the check ball in order to bleed out the air. Lubricate and install the lash adjusters in the cylinder head.
- Lubricate the camshafts with clean engine oil and position the camshafts on the cylinder head.
- Install the bearing caps. Tighten the caps in sequence, in 2 or 3 steps. Caps 2, 3 and 4 have a front mark. Install with the mark aligned with the front mark on the cylinder head. Intake caps have **I** stamped on the cap and exhaust caps have **E**. Also, be sure the rocker arm is correctly mounted on the lash adjuster and the valve stem end. Torque the front and rear retaining cap bolts to 14 ft. lbs. (20 Nm) and tighten the center 3 retaining cap bolts to 8 ft. lbs. (11 Nm).
- Apply a coating of engine oil to the oil seals and install.
- Install the timing belt, valve cover and all related parts. Refer to the timing belt procedure in this section.
- Connect the negative battery cable and check for leaks.

3.5L Engine**See Figure 23**

- Disconnect the negative battery cable.
- Remove the rocker arm cover.

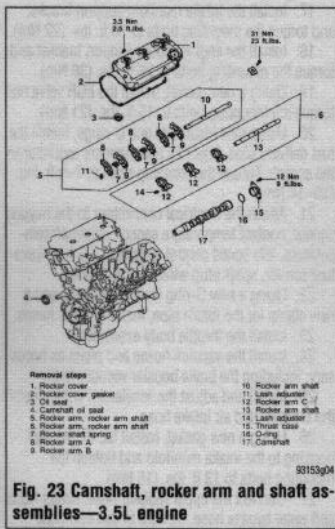


Fig. 23 Camshaft, rocker arm and shaft assemblies—3.5L engine

- Install the lash adjuster clips on the rocker arms, then loosen the bearing cap bolts. Do not remove the bolts from the bearing caps.
 - Remove the rocker arms, shafts and bearing caps as an assembly.
- To install:**
- Install the bearing caps/rocker arm assemblies. Tighten the bolts to 23 ft. lbs. (31 Nm).
 - Remove the lash adjuster clips.
 - Install the rocker arm cover using a new gasket.
 - Connect the negative battery cable.

Thermostat**REMOVAL & INSTALLATION****See Figures 24, 25, 26, and 27**

- Disconnect the negative battery cable.
- Drain the cooling system.

CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused

unless it is contaminated or is several years old.

- Remove any necessary components to access the thermostat.
- Remove the thermostat housing retaining bolts.
- Lift the housing from the engine.
- Remove the thermostat taking note of its original position in the housing.

To install:

In order to prevent leakage, make sure both mating surfaces are clean and free of any old gasket material.

- Install the thermostat so its flange seats tightly in the machined groove in the intake manifold or thermostat case. Refer to its location prior to removal. Align the relief valve with the alignment mark on the thermostat housing.
- Use a new gasket or O-ring and reinstall the thermostat housing. Torque the housing mounting bolts to the following specifications:
 - 1.8L engine: 16 ft. lbs. (22 Nm)
 - 1.5L, 1.6L, 2.0L DOHC, and 1990-92 2.0L SOHC engines: 12-14 ft. lbs. (17-20 Nm)
 - 1993 2.0L SOHC engine: 7-10 ft. lbs. (10-15 Nm)
 - 2.4L engine: 10 ft. lbs. (14 Nm)
 - 3.0L and 3.5L engines: 12-14 ft. lbs. (17-20 Nm)
- Fill the system with coolant.
- Install the removed air intake plumbing.

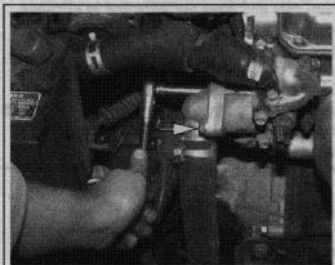


Fig. 24 Remove the thermostat housing retaining bolts



Fig. 25 Carefully lift the housing from the engine



Fig. 26 Remove the thermostat from the thermostat housing, noting the location of the relief valve



Fig. 27 If reusing the thermostat, always replace the O-ring

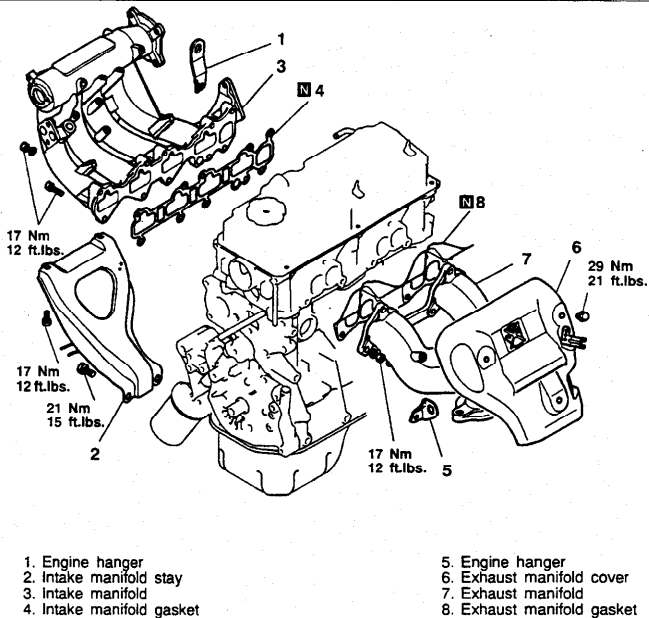


Fig. 28 Exploded view of the intake and exhaust manifold mounting—1.5L (4G15) engine

7929P638

11. Connect the negative battery cable, run the vehicle until the thermostat opens and fill the radiator completely.

12. Once the vehicle has cooled, recheck the coolant level.

Intake Manifold

REMOVAL & INSTALLATION

1.5L Engine

▶ See Figure 28

1. Relieve the fuel system pressure.

*** CAUTION

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

2. Disconnect battery negative cable and drain the cooling system.

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also,

when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Disconnect the upper radiator hose, heater hose and water bypass hose.

4. Remove the thermostat housing from intake manifold.

5. Disconnect the accelerator cable, breather hose and air intake hose.

6. Remove all vacuum hoses and pipes as necessary, including the brake booster vacuum line.

7. Remove the throttle body assembly.

8. Disconnect the high pressure fuel line and the fuel return hose.

9. Tag and detach the electrical connectors from the oxygen sensor, coolant temperature sensor, intake air temperature, idle speed control assembly, EGR temperature sensor, spark plug wires and distributor.

10. Remove the fuel rail, fuel injectors, pressure regulator and insulators.

11. Remove the EGR valve from the intake manifold.

12. Remove the intake manifold support bracket and remove the engine mount support bracket.

13. Remove the intake manifold mounting bolts and remove the intake manifold assembly.

To install:

14. Clean all gasket material from the cylinder head intake mounting surface and intake manifold assembly. Check both surfaces for cracks or other dam-

age. Check the intake manifold water passages and jet air passages for clogging. Clean if necessary.

15. Using a straight edge, measure the distortion of the intake manifold-to-cylinder head. Total distortion or warpage should be 0.006 inches (0.15mm or less).

16. Install a new intake manifold gasket to the head and install the manifold. Torque the manifold in a crisscross pattern, starting from the inside and working outwards to 13 ft. lbs. (18 Nm).

17. Install the intake manifold support bracket and torque the mounting bolts to 16 ft. lbs. (22 Nm).

18. Install the engine mount support bracket and torque the mounting bolts to 26 ft. lbs. (36 Nm).

19. Using a new gasket, install the EGR valve and torque the mounting bolts to 15 ft. lbs. (21 Nm).

20. Using new insulators and O-rings, install the fuel delivery pipe, injectors and pressure regulator to the engine. Torque the retaining bolts to 7–9 ft. lbs. (10–14 Nm).

21. Attach the electrical connectors to the oxygen sensor, coolant temperature sensor, intake air temperature, idle speed control assembly, EGR temperature sensor, spark plug wires and distributor.

22. Using a new O-ring for the feed pipe and a new clamp for the return pipe, install the fuel hoses.

23. Install the throttle body assembly.

24. Install the vacuum hoses and pipes as necessary, including the brake booster vacuum line.

25. Install and adjust the accelerator cable. Install the breather and air intake hose.

26. Using a new gasket, install the thermostat housing to the intake manifold and tighten the mounting bolts to 13 ft. lbs. (18 Nm).

27. Connect the upper radiator hose, heater hose and water bypass hose. Be sure to use new hose clamps.

28. Fill the system with coolant.
29. Connect the negative battery cable, run the vehicle until the thermostat opens, fill the radiator completely.
30. Check and adjust the idle speed and ignition timing.
31. Once the vehicle has cooled, recheck the coolant level.

1.8L Engine

♦ See Figures 29 and 30

1. Relieve the fuel system pressure.

*** CAUTION

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

2. Disconnect battery negative cable and drain the cooling system.

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Disconnect the accelerator cable and the air intake hose.
4. Tag and detach the electrical connectors from the oxygen sensor, coolant temperature sensor, idle speed control assembly, EGR temperature sensor, oil pressure switch, spark plug wires and distributor.
5. Disconnect the wiring from the throttle position sensor, fuel injectors and disconnect the ground cables.
6. Remove all vacuum hoses and pipes as necessary, including the brake booster and PCV vacuum lines.
7. Disconnect the upper radiator hose, heater hose and water bypass hose.
8. Disconnect the high pressure fuel line and the fuel return hose.
9. Remove the fuel rail, fuel injectors, pressure regulator and insulators.
10. Remove the intake manifold support bracket.
11. If the thermostat housing is preventing removal of the intake manifold, remove it.
12. Remove the intake manifold mounting bolts/nuts and remove the intake manifold assembly.

To Install:

13. Clean all gasket material from the cylinder head intake mounting surface and intake manifold assembly. Check both surfaces for cracks or other damage. Check the intake manifold water passages and jet air passages for clogging. Clean if necessary.
14. Using a straight edge, measure the distortion of the intake manifold-to-cylinder head. Total distortion or warpage should be 0.006 inches (0.15mm or less).
15. Install a new intake manifold gasket to the head and install the manifold. Torque the manifold in a crisscross pattern, starting from the inside and working outwards to 14 ft. lbs. (20 Nm).
16. If removed, install the thermostat housing.
17. Install the intake manifold brace bracket.
18. Install the fuel delivery pipe, injectors and pressure regulator to the engine. Torque the retaining bolts to 108 inch lbs. (12 Nm).

19. Using a new O-ring for the feed pipe and a new clamp for the return pipe, install the fuel hoses.
20. Connect the upper radiator hose, heater hose and water bypass hoses.
21. Install the vacuum hoses and pipes as necessary. Be sure to connect the brake booster and PCV vacuum lines.
22. Connect the wiring to the throttle position sensor, fuel injectors and connect the ground cables.
23. Attach the electrical wiring to the oxygen sensor, coolant temperature sensor, idle speed control assembly, EGR temperature sensor, oil pressure switch, spark plug wires and distributor.
24. Connect and adjust the accelerator cable and install the air intake hose.
25. Fill the system with coolant.
26. Connect the negative battery cable, run the vehicle until the thermostat opens, fill the radiator completely.
27. Check and adjust the idle speed and ignition timing.
28. Once the vehicle has cooled, recheck the coolant level.

2.0L SOHC Engine

♦ See Figure 31

1. Relieve the fuel system pressure.

*** CAUTION

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

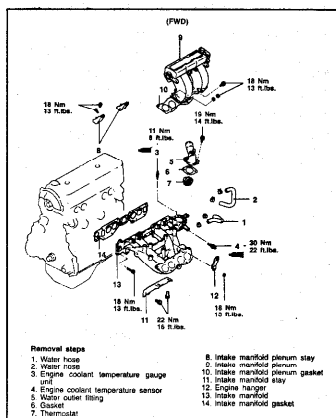
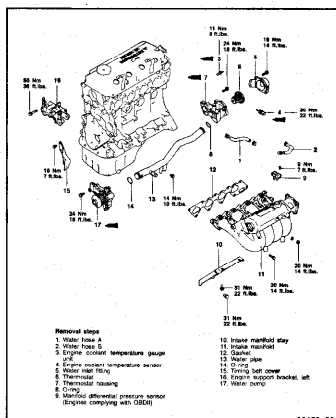
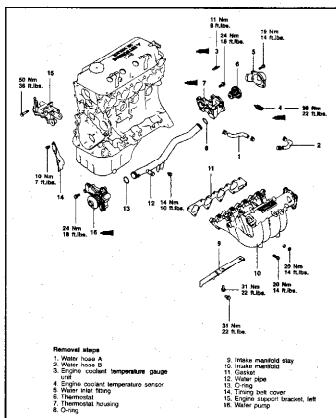


Fig. 29 Exploded view of the intake manifold mounting—1993 1.8L engine

Fig. 30 Exploded view of the intake manifold mounting—1994-00 1.8L engine

Fig. 31 Exploded view of the intake manifold mounting—2.0L SOHC engine

3-10 ENGINE AND ENGINE OVERHAUL

2. Disconnect the battery negative cable.
3. Drain the cooling system.

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

4. Disconnect the accelerator cable and air intake hose.
5. Disconnect the upper radiator hose, heater hose and water bypass hose.
6. Unplug the vacuum connection at the power brake booster and the PCV valve if still connected. Disconnect all remaining vacuum hoses and pipes as necessary.
7. Disconnect the high pressure fuel line, fuel return hose and remove throttle control cable brackets.
8. Tag and detach the electrical connectors from the oxygen sensor, coolant temperature sensor, thermo switch, idle speed control assembly, EGR temperature sensor, distributor, fuel injectors and spark plug wires. Position the engine wiring harness aside.
9. Matchmark the distributor housing to the intake manifold, and remove the distributor.
10. Remove the intake manifold bracket and the engine hanger.
11. If the thermostat housing is preventing removal of the intake manifold, remove it.

12. Remove the intake manifold mounting bolts and remove the intake manifold assembly. Disassemble manifold from the intake plenum on a work bench as required.

To install:

13. Clean all gasket material from the cylinder head intake mounting surface and intake manifold assembly. Check both surfaces for cracks or other damage. Check the intake manifold water passages and jet air passages for clogging. Clean if necessary.
14. Assemble the intake manifold assembly using all new gaskets. Torque air intake plenum bolts to 11–14 ft. lbs. (15–19 Nm).
15. Install a new intake manifold gasket to the head and install the manifold. Torque the manifold in a crisscross pattern, starting from the inside and working outwards to 11–14 ft. lbs. (15–19 Nm).
16. Install the fuel delivery pipe, injectors and pressure regulator to the engine. Torque the retaining bolts to 4 ft. lbs. (6 Nm).
17. Install the thermostat housing, intake manifold brace bracket, and engine hanger bracket.
18. Connect or install all hoses, cables and electrical connectors that were removed or disconnected during the removal procedure.
19. Align the distributor matchmarks and install the distributor.
20. Fill the system with coolant.
21. Connect the negative battery cable, run the vehicle until the thermostat opens, fill the radiator completely.

22. Adjust the accelerator cable. Check and adjust the idle speed and ignition timing.
23. Once the vehicle has cooled, recheck the coolant level.

1.6L and 2.0L DOHC Engines

▶ See Figure 32

1. Relieve the fuel system pressure.

*** CAUTION

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

2. Disconnect battery negative cable and drain the cooling system.

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

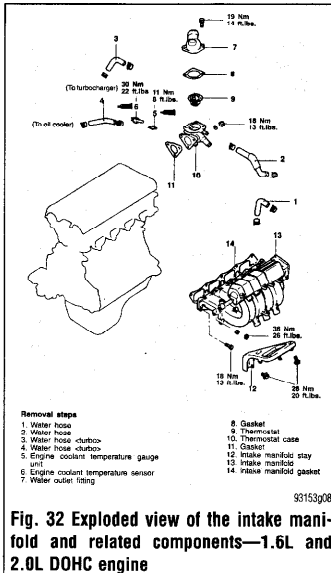


Fig. 32 Exploded view of the intake manifold and related components—1.6L and 2.0L DOHC engine

3. Disconnect the accelerator cable and air intake hose.
4. Disconnect the coolant hose from the throttle housing.
5. Detach the vacuum connection at the power brake booster and the PCV valve if still connected. Disconnect all remaining vacuum hoses and pipes as necessary.
6. Disconnect the high pressure fuel line, fuel return hose and remove throttle control cable brackets.
7. Tag and detach the electrical connectors from the oxygen sensor, coolant temperature sensor, thermo switch, throttle position sensor, idle speed control assembly, EGR temperature sensor, distributor, fuel injectors and spark plug wires. Position the engine wiring harness aside.
8. Remove the intake manifold bracket.
9. Remove the intake manifold mounting bolts and remove the intake manifold assembly. Disassemble manifold on a work bench as required.

To install:

10. Clean all gasket material from the cylinder head intake mounting surface and intake manifold assembly. Check both surfaces for cracks or other damage. Check the intake manifold water passages and jet air passages for clogging. Clean if necessary.
11. Assemble the intake manifold assembly using all new gaskets.
12. Install a new intake manifold gasket to the head and install the manifold. Torque the manifold in a crisscross pattern, starting from the inside and working outwards to 11–14 ft. lbs. (15–20 Nm).
13. Install the fuel delivery pipe, injectors and pressure regulator to the engine. Torque the retaining bolts to 4 ft. lbs. (6 Nm).
14. Install the intake manifold brace bracket and tighten bolts to 13–18 ft. lbs. (18–25 Nm).
15. Connect or install all hoses, cables and electrical connectors that were removed or disconnected during the removal procedure.
16. Fill the system with coolant.
17. Connect the negative battery cable, run the vehicle until the thermostat opens, fill the radiator completely.
18. Adjust the accelerator cable.
19. Check and adjust the idle speed and ignition timing.
20. Once the vehicle has cooled, recheck the coolant level.

2.4L Engine

▶ See Figures 33 thru 51

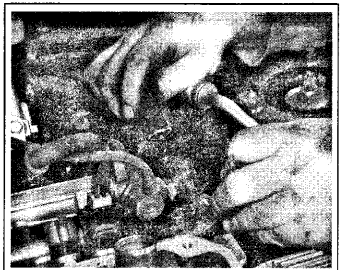
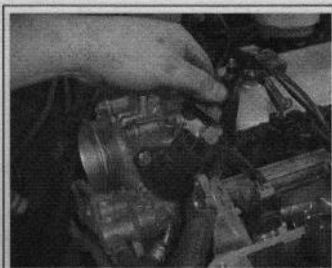
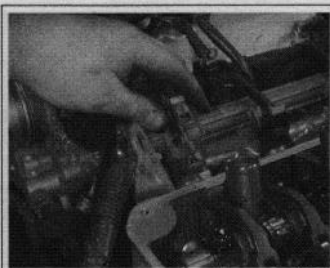


Fig. 33 Detach the A/C temp electrical connector



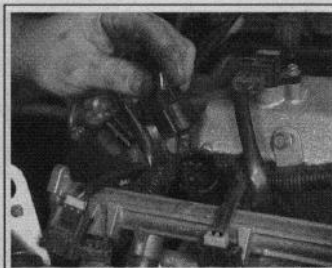
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Fig. 34 Unplug the connector from the Throttle Position (TP) sensor



93153p48

Fig. 35 Detach the connectors from all of the fuel injectors



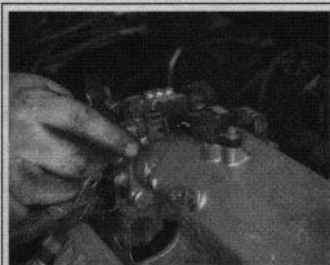
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Fig. 36 Unplug the main engine harness junction electrical connector



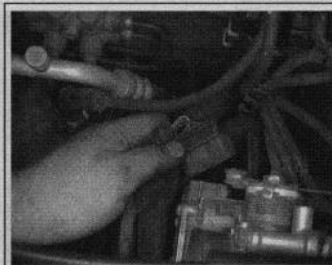
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Fig. 37 Detach the Camshaft Position (CMP) sensor connector



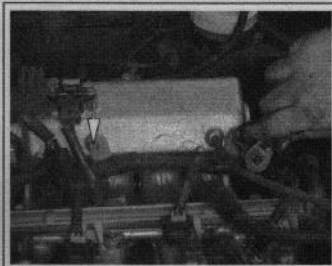
93153p52

Fig. 38 Unplug the connector from the Manifold Absolute Pressure (MAP) sensor



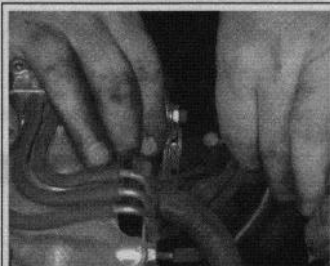
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Fig. 39 Detach the connector for the Idle Air Control (IAC) motor



93153p38

Fig. 40 Remove the engine harness retaining bracket bolts, then move the harness out of the way



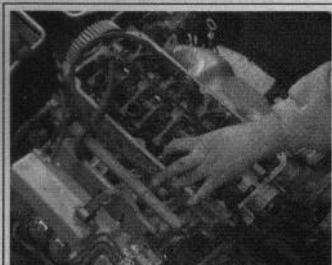
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Fig. 41 Remove the accelerator cable end from the throttle lever



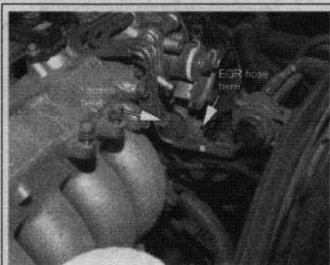
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Fig. 42 Remove the accelerator cable bracket retaining bolts . . .



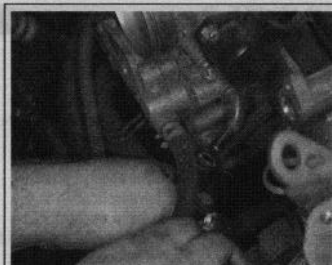
93153p59

Fig. 43 . . . then position the accelerator cable out of the way



93153p66

Fig. 44 Disconnect the EGR hose and the three vacuum hoses on the back of the intake manifold



93153p53

Fig. 45 Remove the hose shown here from the throttle body

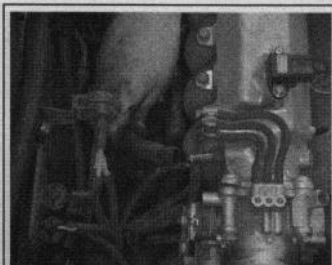


Fig. 46 Remove the brake booster vacuum hose from the back of the intake manifold

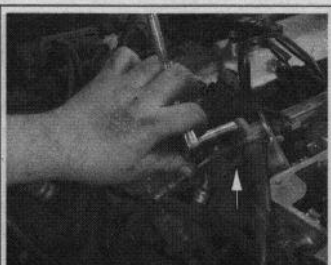


Fig. 47 Remove the fuel feed line-to-fuel rail retaining fitting bolts . . .

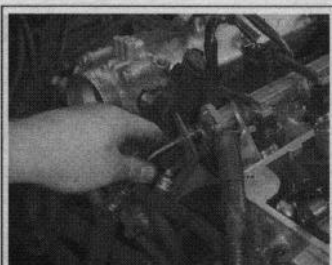


Fig. 48 . . . then remove the fuel feed line from the fuel injector rail

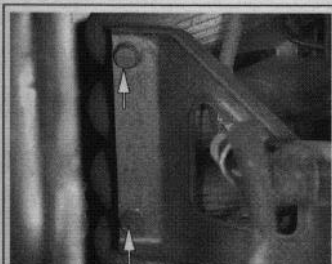


Fig. 49 From underneath the vehicle, remove the two intake manifold support bracket bolts

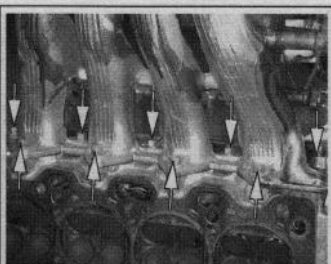


Fig. 50 Remove the intake manifold retaining bolts . . .

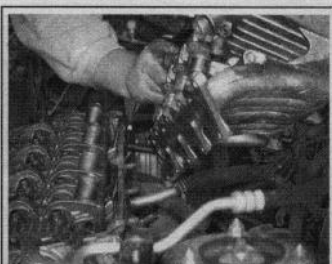


Fig. 51 . . . then remove the manifold from the cylinder head

1. Relieve the fuel system pressure.

*** CAUTION

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

2. Disconnect battery negative cable and drain the cooling system.

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Disconnect the accelerator cable, breather hose and air intake hose.

4. Disconnect the coolant hose from the throttle housing.

5. Detach the vacuum connection at the power brake booster and the PCV valve if still connected. Disconnect all remaining vacuum hoses and pipes as necessary.

*** CAUTION

Fuel injection systems remain under pressure after the engine has been turned OFF. Properly relieve fuel pressure before disconnecting any fuel lines. Failure to do so may result in fire or personal injury.

6. Disconnect the high pressure fuel line, fuel return hose and remove throttle control cable brackets.
 7. Tag and unplug the electrical connectors from the coolant temperature sensor, coolant temperature gauge, IAC valve, ignition coil, EGR temperature sensor, knock sensor, oxygen sensor, throttle position sensor, distributor, A/C temperature sensor, fuel injectors and ignition power transistor. Position the engine wiring harness aside.
 8. Label and disconnect the spark plug wires from the spark plugs.
 9. Remove the intake manifold stay bracket.
 10. Remove the intake manifold mounting bolts and remove the intake manifold assembly. Disassemble manifold on a work bench as required.
- To install:**
11. Clean all gasket material from the cylinder head intake mounting surface and intake manifold assembly. Check both surfaces for cracks or other damage. Check the intake manifold water passages and

jet air passages for clogging. Clean if necessary.

12. Assemble the intake manifold assembly using all new gaskets.

13. Position a new intake manifold gasket on the head, then install the manifold. Torque the manifold in a crisscross pattern, starting from the inside and working outwards to 15 ft. lbs. (20 Nm) for bolts, and to 26 ft. lbs. (35 Nm) for nuts on 1994 vehicles or 15 ft. lbs. (20 Nm) for nuts on 1995-00 vehicles.

14. Install the fuel delivery pipe, injectors and pressure regulator to the engine. Torque the retaining bolts to 4 ft. lbs. (6 Nm).

15. Install the intake manifold brace bracket and tighten bolts to 21 ft. lbs. (29 Nm).

16. Connect or install all hoses, cables and electrical connectors that were removed or disconnected during the removal procedure.

17. Fill the system with coolant.

18. Connect the negative battery cable, run the vehicle until the thermostat opens, fill the radiator completely.

19. Adjust the accelerator cable. Check and adjust the idle speed and ignition timing.

20. Once the vehicle has cooled, recheck the coolant level.

3.0L and 3.5L Engines

▶ See Figures 52 thru 57

1. Relieve the fuel system pressure.

*** CAUTION

Observe all applicable safety precautions when working around fuel. Whenever servic-

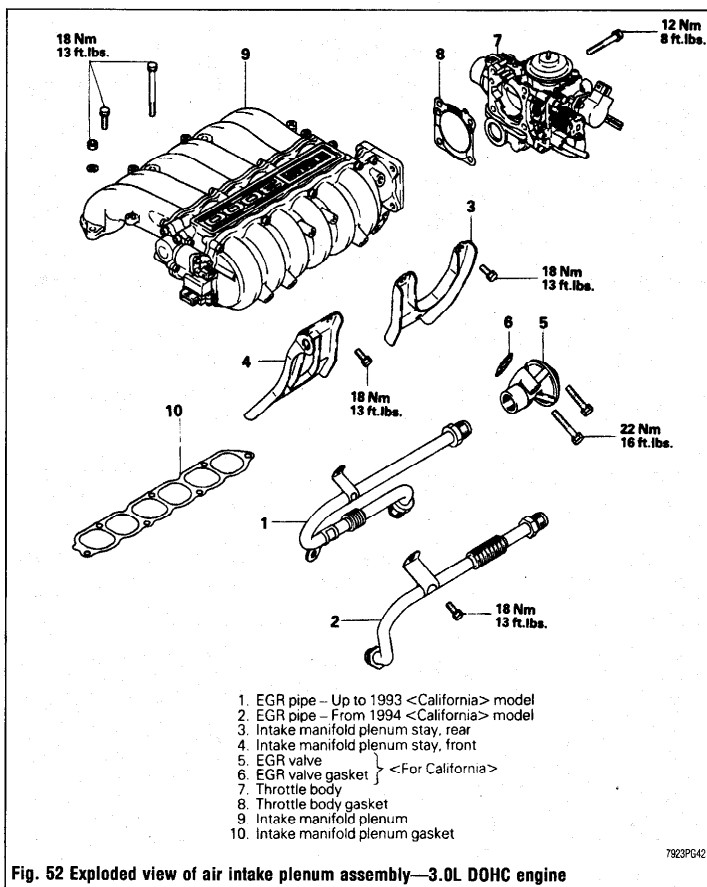


Fig. 52 Exploded view of air intake plenum assembly—3.0L DOHC engine

ing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

2. Disconnect battery negative cable and drain the cooling system.

CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Remove the air intake hose(s).
4. Disconnect the accelerator control cables from the throttle body.
5. Tag and disconnect the vacuum hoses including the brake booster hose.
6. Tag and detach the wire harness connectors.
7. Disconnect the high pressure and return fuel hoses.
8. Disconnect EGR pipe and remove the EGR valve and EGR temperature sensor from the intake plenum assembly.
9. If equipped, remove the manifold pressure sensor.
10. Remove the plenum retaining bracket.
11. Remove the plenum retaining nuts and bolts and remove the air intake plenum from the intake manifold. Discard the gasket.
12. Remove the upper timing belt covers.
13. Remove the water pump stay bracket.

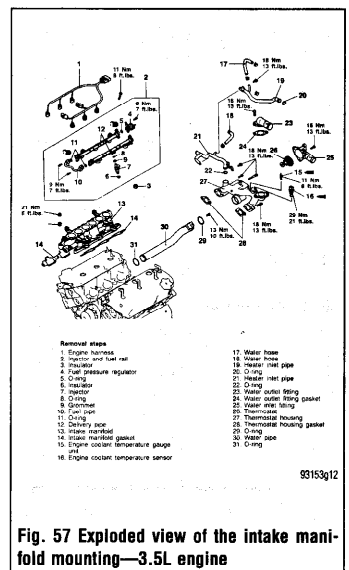
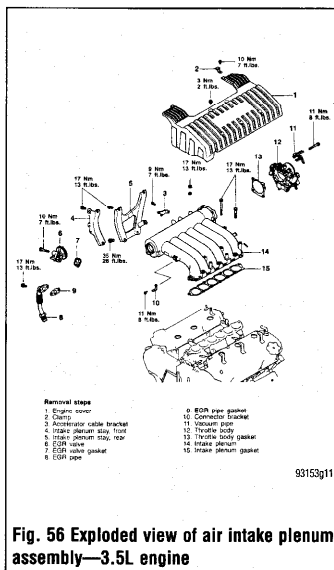
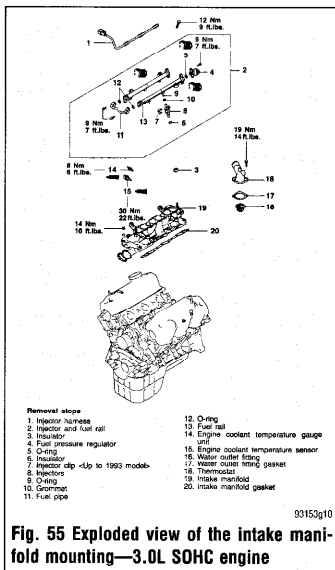
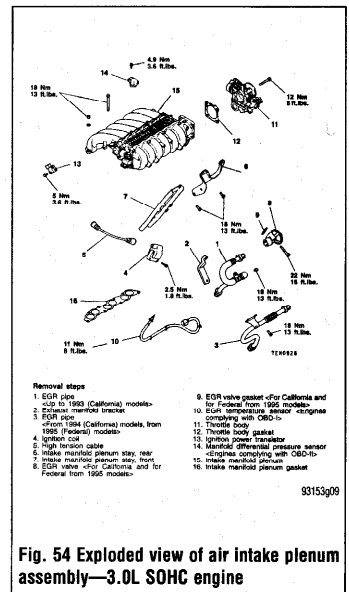
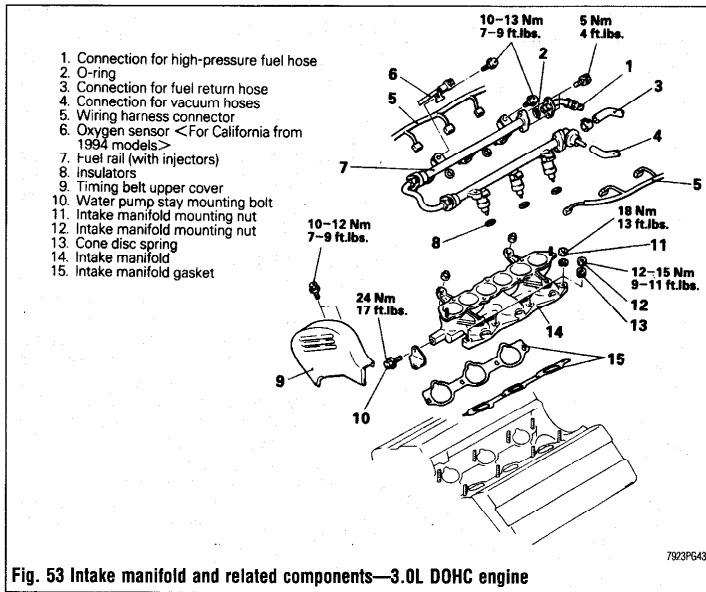
➔ It is not necessary to remove the fuel injectors from the intake unless the manifold assembly is being replaced.

14. Remove the fuel rail with the injectors attached.

15. Disconnect the coolant hoses from the intake manifold. Be sure to note the connections.
16. Remove the intake manifold mounting nuts and remove the intake manifold.
17. Clean the gasket mounting surfaces.

To install:

18. Check all items for cracks, clogging and warpage. Maximum warpage is 0.0059 inches (0.15mm). Replace any questionable parts.
19. Thoroughly clean and dry the mating surfaces of the heads, intake manifold and air intake plenum.
20. Install new intake manifold gaskets to the cylinder heads with the adhesive side facing up.
21. Place the manifold on the cylinder heads.
22. Lubricate the studs lightly with oil and install the nuts.
23. For vehicles produced up to and including November of 1993, tighten the mounting nuts as follows:
 - a. Front bank nuts: 27-43 inch lbs. (3-5 Nm)
 - b. Rear bank nuts: 9-11 ft. lbs. (12-15 Nm)
 - c. Front bank nuts: 9-11 ft. lbs. (12-15 Nm)
24. For vehicles produced after November of 1993, tighten the mounting nuts as follows:
 - a. Front bank nuts: 48-72 inch lbs. (5-8 Nm)
 - b. Rear bank nuts to: 14-17 ft. lbs. (20-23 Nm)
 - c. Front bank nuts to: 14-17 ft. lbs. (20-23 Nm)
25. Using new clamps, connect the coolant hoses to the intake manifold.
26. Using new O-rings, install the fuel rail assembly, if removed. Tighten the mounting bolts to 7-9 ft. lbs. (10-13 Nm).
27. Install a new intake air plenum gasket and install the plenum. Tighten the retaining nuts and bolts evenly and gradually to 13 ft. lbs. (18 Nm).
28. Install the retaining bracket and tighten the retaining bolts to 13 ft. lbs. (18 Nm).
29. If removed, install the manifold pressure sensor.
30. Using a new gasket, install the EGR valve and tighten the bolts to 16 ft. lbs. (22 Nm).
31. Install the EGR temperature sensor and tighten the fitting to 7-9 ft. lbs. (10-12 Nm).
32. Connect the EGR pipe and tighten the fittings to 43 ft. lbs. (60 Nm).
33. Replace the O-ring and connect the high pressure fuel hose. Tighten the retaining bolts to 48 inch lbs. (5 Nm).
34. Using a new hose clamp, connect the fuel return hose.
35. Install the water pump stay bracket.
36. Install the upper timing belt covers.
37. Connect the harness connector and vacuum hoses.
38. Connect and adjust the accelerator cables.
39. Install the air intake hose(s).
40. Fill the system with coolant.
41. Connect the negative battery cable, run the vehicle until the thermostat opens, fill the radiator completely.
42. Check and adjust the idle speed and ignition timing.
43. Once the vehicle has cooled, recheck the coolant level.



Exhaust Manifold

REMOVAL & INSTALLATION

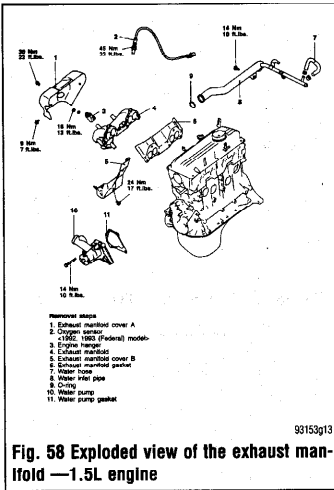
1.5L and 1.8L Engine

See Figures 58 and 59

1. Disconnect battery negative cable.
2. Raise the vehicle and support safely.
3. Remove the exhaust pipe to exhaust manifold nuts and separate exhaust pipe. Discard gasket.

4. Lower vehicle.
5. Remove electric cooling fan assembly, if necessary.
6. If the oxygen sensor is located in the manifold, remove the sensor.
7. Disconnect necessary EGR components.
8. Remove outer exhaust manifold heat shield and engine hanger. Detach the electrical connector and remove the oxygen sensor.
9. Remove the exhaust manifold mounting bolts, the inner heat shield and the exhaust manifold.

- To install:**
10. Clean all gasket material from the mating surfaces and check the manifold for damage.
 11. Using a new gasket, install the manifold. For 1.5L engines, tighten the nuts in a crisscross pattern to 13 ft. lbs. (18 Nm). For 1.8L engines, tighten the inner nuts in a crisscross pattern to 13 ft. lbs. (18 Nm) and tighten the two outer (larger) nuts to 22 ft. lbs. (30 Nm).
 12. Install the heat shields.
 13. Connect EGR components.
 14. If removed, install the oxygen sensor.

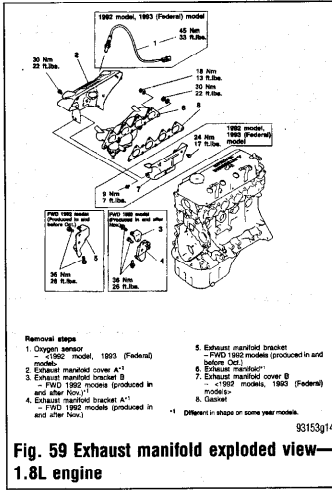
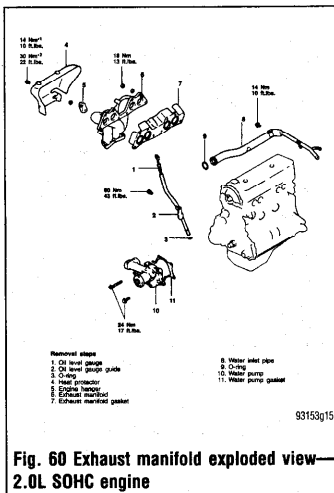


15. Install the electric cooling fan assembly as required.
16. Install a new flange gasket and connect the exhaust pipe.
17. Connect the negative battery cable and check for exhaust leaks.

1.6L and 2.0L Engines

▶ See Figures 60, 61, and 62

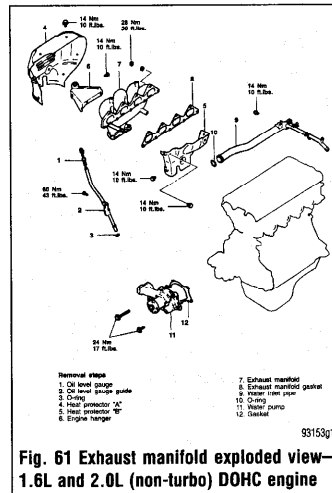
1. Disconnect the negative battery cable.
2. Raise the vehicle and support safely.
3. Remove the front exhaust pipe to exhaust manifold nuts and separate exhaust pipe. Discard the gasket.
4. Lower the vehicle.
5. If equipped with air conditioning, remove condenser cooling fan assembly.
6. Using special tool MD998703 or equivalent, disconnect and remove the oxygen sensor.



7. Remove outer exhaust manifold heat shield and the engine hanger.
8. Remove the exhaust manifold mounting nuts, the inner heat shield and the exhaust manifold from the engine.

To install:

9. Clean all gasket material from the mating surfaces and check the manifold for damage or cracking.
10. Using a new gasket, install the exhaust manifold to the engine. Tighten the nuts to in a crisscross pattern to 11–14 ft. lbs. (15–20 Nm) for 2.0L SOHC engine or to 18–22 ft. lbs. (25–30 Nm) for 1.6L and 2.0L DOHC engine.
11. Install the outer heat shield and tighten the mounting bolts to 10 ft. lbs. (14 Nm).
12. Install the electric cooling fan assembly, if removed.
13. Using a new flange gasket, connect the exhaust pipe and tighten the mounting nuts to 29–36 ft. lbs. (40–50 Nm).



14. Connect the negative battery cable and check for exhaust leaks.

2.4L Engine

▶ See Figures 63 thru 71

1. Disconnect battery negative cable.
2. Raise the vehicle and support safely.
3. Remove the exhaust pipe-to-exhaust manifold nuts, the hanger retaining bolt, then separate the exhaust pipe. Discard the gasket.
4. Remove the outer exhaust manifold heat shield and engine hanger.
5. Remove the exhaust manifold mounting nuts and the exhaust manifold from the engine.

To install:

6. Clean all gasket material from the mating surfaces and check the manifold for damage or cracking.
7. Install a new gasket and install the manifold. Tighten the nuts to in a crisscross pattern to 18–21 ft. lbs. (25–29 Nm).
8. Install the heat shields and tighten the mounting bolts 10 ft. lbs. (14 Nm).
9. Install a new flange gasket and connect the exhaust pipe. Tighten the mounting nuts to 32 ft. lbs. (44 Nm).
10. Connect the negative battery cable and check for exhaust leaks.

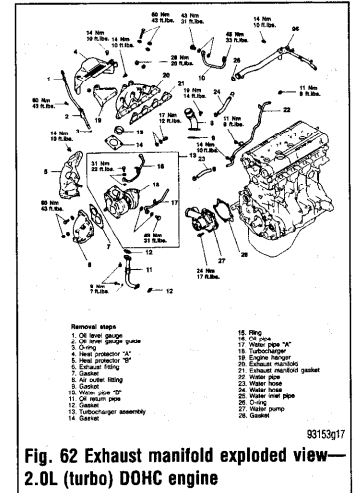
3.0L Engines

▶ See Figures 72 and 73

*** CAUTION

Do not attempt the work on the exhaust system until it has completely cooled.

1. Disconnect battery negative cable.
2. Raise the vehicle and support safely.
3. Remove the exhaust pipe to exhaust manifold nuts and remove the front exhaust pipe.
4. Lower the vehicle.
5. If removing the front manifold, remove condenser electric cooling fan assembly.



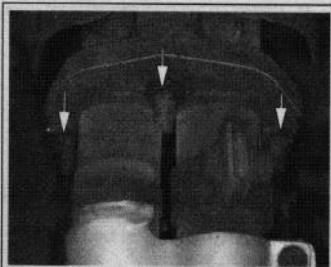


Fig. 63 Remove the exhaust pipe-to-exhaust manifold nuts



Fig. 64 Remove the hanger retaining bolt . . .

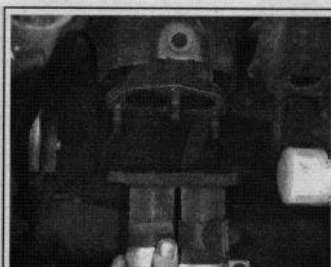


Fig. 65 . . . then separate the pipe from the manifold



Fig. 66 Remove the heat shield retaining bolts . . .



Fig. 67 . . . then remove the heat shield from the exhaust manifold

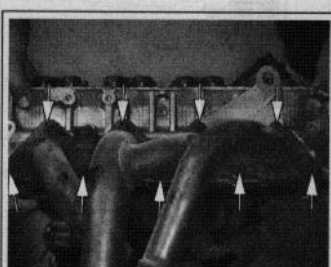


Fig. 68 Remove the exhaust manifold retaining nuts



Fig. 69 Remove the engine lifting eye from the manifold . . .

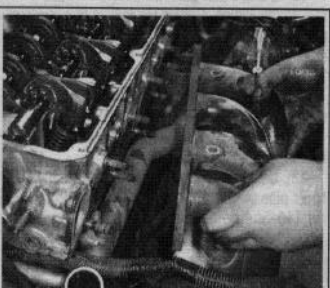


Fig. 70 . . . then remove the manifold from the cylinder head



Fig. 71 Remove the exhaust manifold gasket, thoroughly clean the mounting surfaces, and replace the gasket

6. For the DOHC engine, if removing the front manifold, remove the alternator and mounting bracket from the vehicle.

7. For the DOHC engine, separate the A/C compressor from the mounting bracket. Leaving the hoses connected, position the compressor aside.

8. If removing the front manifold, remove the oil dipstick and tube from the engine.

9. For the DOHC engine, if removing the front manifold, remove the heat protector.

10. If removing the rear manifold, disconnect the EGR tube.

11. For the SOHC engine, if removing the rear manifold, remove the intake plenum stay and the roll stopper bracket.

12. Unplug the electrical connector and remove the oxygen sensor.

13. Remove the exhaust manifold mounting bolts the manifold.

To install:

14. Clean all gasket material from the mating surfaces and check the manifold for damage.

15. Install a new gasket and install the manifold. Tighten the nuts in a crisscross pattern to 21 ft. lbs. (30 Nm) for the SOHC engine or to 14 ft. lbs. (19 Nm) for the DOHC engine.

16. Install the heat shields.

17. Connect the EGR tube and intake plenum stay and roll stopper bracket, if removed.

18. Install the oxygen sensor.

19. Install the electric cooling fan assembly, A/C compressor, dipstick tube and alternator, as required.

20. Install a new flange gasket and connect the exhaust pipe or converter assembly.

21. Install the drive belt(s) and adjust for proper tension.

22. Connect the negative battery cable and check for exhaust leaks.

3.5L Engine

♦ See Figure 74

*** CAUTION

Do not attempt the work on the exhaust system until it has completely cooled.

1. Disconnect battery negative cable.
2. Raise the vehicle and support safely.
3. Remove the exhaust pipe to exhaust manifold nuts and remove the front exhaust pipe.

bolt and gaskets that connect the oil feed line to the turbo center section and the water cooling lines. The water line under the turbo has a threaded connection.

8. Remove the exhaust pipe nuts and gasket and lift off the exhaust manifold. Discard the gasket.

9. Remove the 2 through bolts and 2 nuts that hold the exhaust manifold to the turbocharger.

10. Remove the 2 capscrews from the oil return line (under the turbo). Discard the gasket. Separate the turbo from the exhaust manifold. The 2 water pipes and oil feed line can still be attached.

11. Visually check the turbine wheel (hot side) and compressor wheel (cold side) for cracking or other damage. Check whether the turbine wheel and the compressor wheel can be easily turned by hand. Check for oil leakage. Check whether or not the wastegate valve remains open. If any problem is found, replace the part. Inspect oil passages for restriction or deposits and clean as required.

12. The wastegate can be checked with a pressure tester. Apply approximately 9 psi to the actuator and make sure the rod moves. Do not apply more than 10.3 psi or the diaphragm in the wastegate may be damaged. Vacuum applied to the wastegate actuator should be maintained, replace if leaks vacuum. Do not attempt to adjust the wastegate valve.

To install:

13. Prime the oil return line with clean engine oil. Replace all locking nuts. Before installing the threaded connection for the water inlet pipe, apply light oil to the inner surface of the pipe flange. Assemble the turbocharger and exhaust manifold.

14. Install the exhaust manifold using a new gasket.

15. Connect the water cooling lines, oil feed line and engine hanger.

16. If removed, install the power steering pump and bracket.

17. Install the heat shields, air outlet hose, wastegate hose and air intake bellows.

18. Install the oil dipstick tube and dipstick. Install the oxygen sensor.

19. Install the radiator assembly.

20. Fill the engine with oil, fill the cooling system and reconnect the negative battery cable.

*** WARNING

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

Radiator

REMOVAL & INSTALLATION

♦ See Figures 77 thru 91

1. Disconnect the negative battery cable.
2. Drain the cooling system when safe.

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in suffi-

cient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Disconnect the overflow tube. Some vehicles may also require removal of the overflow tank.

4. Disconnect upper and lower radiator hoses.

5. Detach the electrical connectors from the cooling fan and air conditioning condenser fan, if equipped.

6. For Mirage and Diamante models, remove the fan assembly.

7. Disconnect the thermo sensor wires.

8. If equipped with an automatic transaxle, disconnect and plug the automatic transaxle cooler lines.

9. Remove the upper radiator mounts and lift out the radiator assembly or radiator/fan assembly, as applicable.

To install:

10. Install the radiator or radiator and fan, if removed as an assembly.

11. Connect the automatic transaxle cooler lines, if disconnected.

12. Connect the thermo sensor wires.

13. Install the fan, if removed separately.

14. Install the radiator hoses.

15. Install the air cleaner support bracket, if removed.

16. Install the overflow tube and reservoir, if removed.

17. Fill the system with coolant.

18. Connect the negative battery cable, run the vehicle until the thermostat opens, fill the radiator



Fig. 77 Use a pair of pliers to remove the hose clamp . . .



Fig. 78 . . . then disconnect the overflow hose from the radiator



Fig. 79 Use pliers to release the hose clamp tension . . .



Fig. 80 . . . then remove the upper radiator hose from the radiator

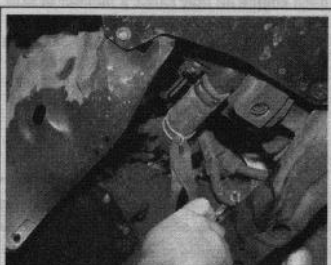


Fig. 81 From underneath the vehicle, remove the hose clamp . . .

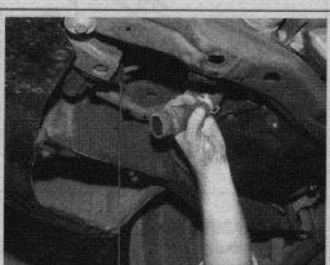
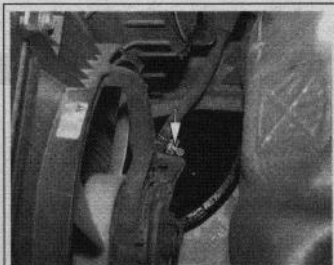
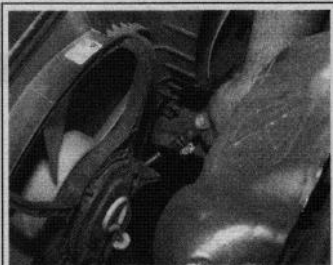


Fig. 82 . . . then disconnect the lower radiator hose



93153p07

Fig. 83 Remove the transaxle hose clamp



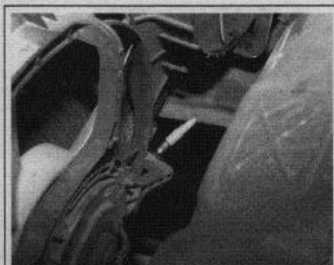
93153p06

Fig. 84 Disconnect the transaxle cooler lines on the passenger side . . .



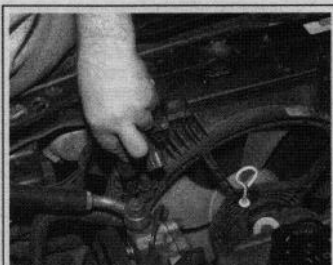
93153p09

Fig. 85 . . . and the cooler lines from underneath the radiator assembly



93153p08

Fig. 86 After the transaxle cooler lines are removed, place a plug over the fitting on the radiator to prevent contamination



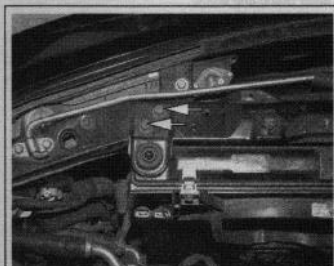
93153p20

Fig. 87 Detach the connectors for the electric fans. The connectors are located on the driver's side top . . .



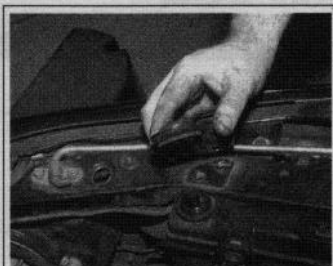
93153p11

Fig. 88 . . . there is also a connector on the lower passenger side of the radiator



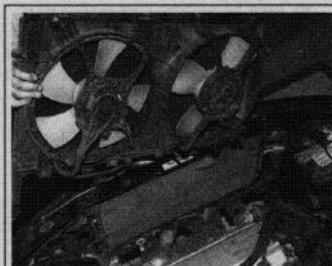
93153p25

Fig. 89 Remove the radiator mount bolts . . .



93153p27

Fig. 90 . . . then remove the mounts from the radiator and radiator support panel



93153p25

Fig. 91 Carefully grasp the radiator and fan assembly and lift it out of the vehicle

completely and check the automatic transaxle fluid level, if equipped.

19. Once the vehicle has cooled, recheck the coolant level.

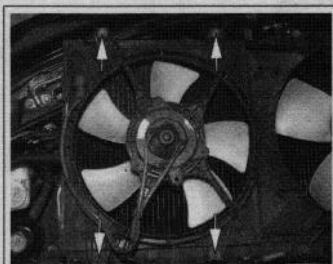
Engine Fan

REMOVAL & INSTALLATION

Except Diamante

▶ See Figures 77 thru 93

1. Disconnect the negative battery cable.
2. Drain and recycle the engine coolant.



93153p24

Fig. 92 The fans are retained to the radiator by four retaining bolts. Remove the retaining bolts . . .



93153p23

Fig. 93 . . . then carefully lift the fan from the radiator

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Remove the overflow hose and disconnect the upper radiator hose.

➔ It is recommended that each clamp be matchmarked to the hose. Observe the marks and reinstall the clamps exactly when reinstalling the radiator.

4. If equipped with an automatic transaxle, remove and plug the fluid cooler hoses.

5. Unplug the electrical connector(s) from the coolant fan motor.

6. Remove the mounting bolts, then remove the fan and shroud assembly from the vehicle.

7. Remove the fan blade retainer nut from the shaft on the fan motor and separate the fan from the motor.

8. Remove the motor to shroud attaching screws and the motor from the shroud.

To Install:

9. Install the motor to the shroud and secure with the mounting bolts.

10. Install the remaining components in the reverse order of removal.

11. Fill the cooling system. Connect the negative battery cable and check the cooling fan for proper operation.

2. Drain the cooling system only when the radiator and the engine are at safe temperatures.

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Unplug the cooling fan and radiator sensor connector(s). Most of these connectors employ a waterproof connector. When disconnecting, make sure all parts of the connector remain intact.

4. Disconnect the upper radiator hose from the radiator and remove overflow tank.

5. Remove the fan mounting screws. The radiator and condenser cooling fans are separately removable.

6. Remove the fan assembly and disassemble as required.

To Install:

7. Position the fan and install the mounting screws.

8. Install the electrical connectors and the upper radiator hose.

9. Refill the cooling system.

10. Connect the negative battery cable and check the fan for proper operation.

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Remove the engine undercover.

4. Disconnect the clamp bolt from the power steering hose.

5. Remove the engine drive belts.

6. Support the engine with the appropriate equipment and remove the engine mount bracket.

7. Remove the timing belt. Refer to the timing belt procedure in this section.

8. Remove the power steering pump bracket.

9. Remove the alternator brace.

➔ The water pump mounting bolts are different in length, note their positioning for re-assembly.

10. Remove the water pump, gasket and O-ring where the water inlet pipe(s) joins the pump.

To install:

11. Thoroughly clean both gasket surfaces of the water pump and block.

12. For 1.5L engines, install a new O-ring into the groove on the front end of the water inlet pipe. Do not apply oils or grease to the O-ring. Wet the O-ring with water only.

13. For 1.8L engines, apply a 0.09–0.12 in. (2.5–3.0mm) continuous bead of sealant to water pump and install the pump assembly. Install the water pump within 15 minutes of the application of the

Diamante

➔ See Figure 94

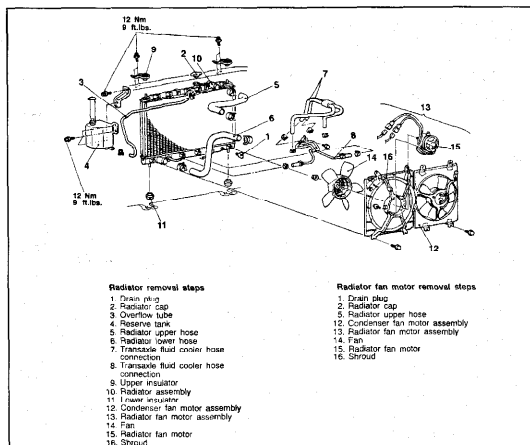
1. Disconnect the negative battery cable.

Water Pump

REMOVAL & INSTALLATION

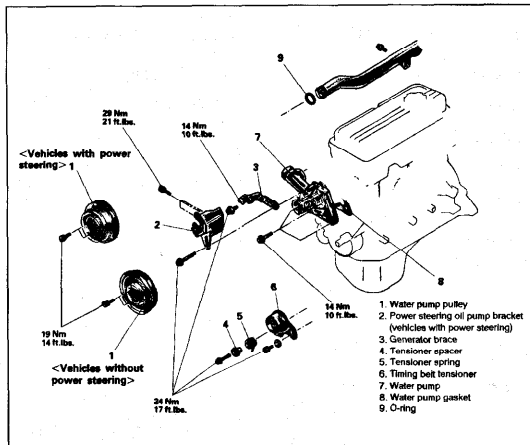
1.5L and 1.8L Engine

➔ See Figures 95 and 96



93153q23

Fig. 94 Exploded view of the fan mounting and related components—Diamante



7923G07

Fig. 95 Water pump and related components—Mirage with 1.5L (4G15) engine

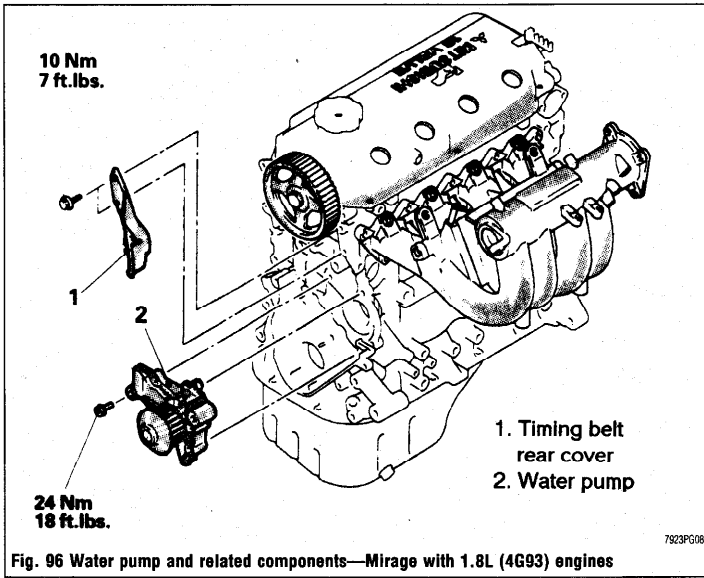


Fig. 96 Water pump and related components—Mirage with 1.8L (4G93) engines

sealant. Wait 1 hour after installation of the water pump to refill the cooling system or start the engine.

14. Install the gasket and pump assembly and tighten the bolts to 17 ft. lbs. (24 Nm). Use care when aligning the water pump with the water inlet pipe.

15. Install the remaining components in the reverse order of removal.

16. Fill the system with coolant.

17. Connect the negative battery cable, run the vehicle until the thermostat opens and fill the radiator completely.

18. Once the vehicle has cooled, recheck the coolant level.

1.6L and 2.0L (SOHC and DOHC) Engines

♦ See Figure 97

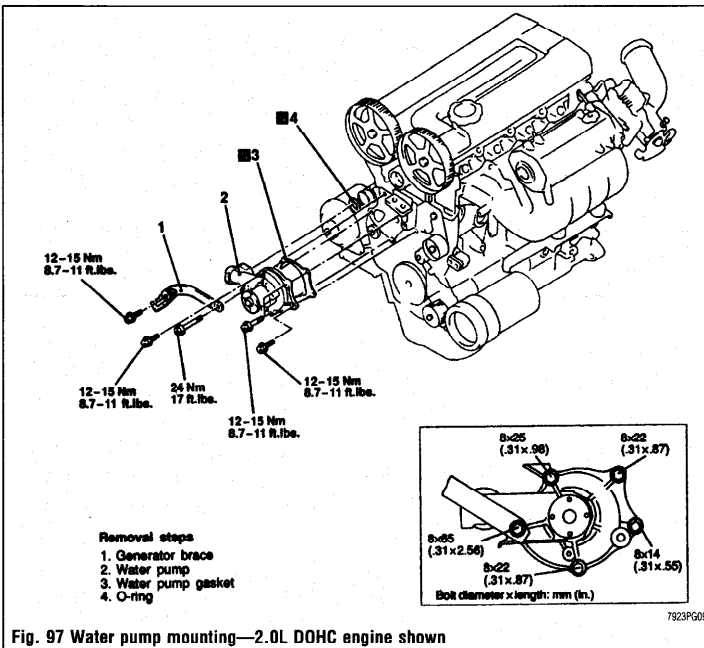


Fig. 97 Water pump mounting—2.0L DOHC engine shown

1. Disconnect the negative battery cable.
2. Drain the engine coolant.

***** CAUTION**

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Remove the timing belt. Refer to the timing belt procedure in this section.
4. If necessary, remove the alternator brace from the water pump.
5. If necessary, remove the timing belt rear cover.
6. Remove the water pump mounting bolts.
7. Remove the water pump, gasket and O-ring.

To install:

8. Install a new O-ring on the water inlet pipe. Coat the O-ring with water or coolant. Do not allow oil or other grease to contact the O-ring.
9. Use a new gasket and install the water pump to the engine block. Torque the mounting bolts to 8.7–11 ft. lbs. (12–15 Nm). Install the alternator brace on the water pump. Torque the brace pivot bolt to 17 ft. lbs. (24 Nm).
10. If removed, install the timing belt rear cover.
11. Install the timing belt. Refer to the timing belt procedure in this section.
12. Install the remaining components.
13. Refill the engine with coolant.
14. Connect the negative battery cable, start the engine and check for leaks.

2.4L Engine

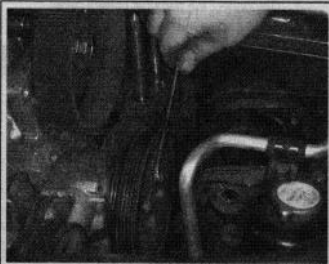
♦ See Figures 98 thru 108

1. Disconnect the negative battery cable.
2. Drain the cooling system.

***** CAUTION**

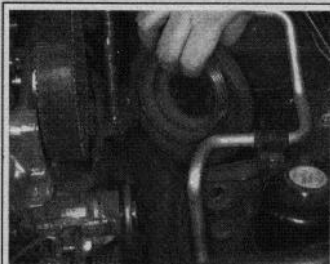
Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Remove the engine undercover.
4. Disconnect the clamp bolt from the power steering hose.
5. Support the engine with the appropriate equipment and remove the engine mount bracket.
6. Remove the engine drive belts and the A/C tensioner bracket.
7. Remove the timing belt covers from the front of the engine.



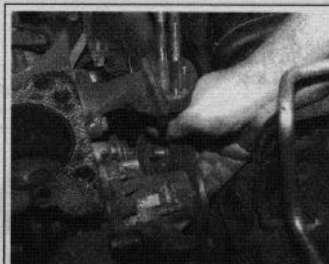
93153p29

Fig. 98 Remove the water pump pulley retaining bolts . . .



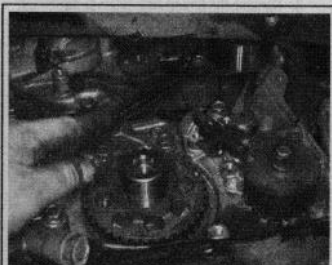
93153p30

Fig. 99 . . . then remove the pulley from the pump



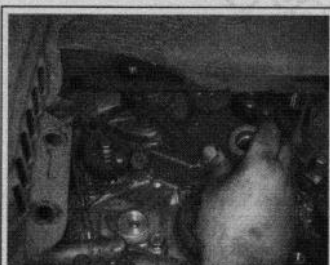
93153p76

Fig. 100 Remove the A/C belt idler pulley



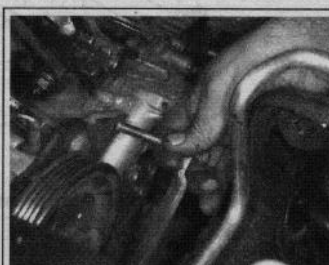
93153p82

Fig. 101 Remove the A/C belt idler pulley bracket retaining bolt . . .



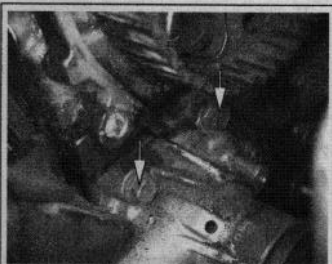
93153p83

Fig. 102 . . . then remove the idler pulley retaining bracket



93153p85

Fig. 103 Remove the alternator brace from the engine



93153p86

Fig. 104 Remove the water pump retaining bolts on the top . . .



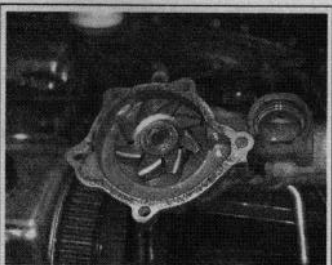
93153p84

Fig. 105 . . . then remove the bolts on the bottom of the pump assembly



93153p87

Fig. 106 Grasp the water pump and remove it from the engine block



93153p88

Fig. 107 If the impeller fins on the water pump show any signs of wear, it is advisable to replace the water pump rather than reuse it

Identification mark.

Generator brace

No.	Identification mark	Bolt diameter (d) x length (l) mm (in.)	Torque Nm (ft.lbs.)
1	4	8 x 14 (31 x .56)	
2	4	8 x 22 (31 x .87)	12-15 (9-10)
3	4	8 x 30 (31 x 1.18)	
4	7	8 x 65 (31 x 2.56)	20-27 (15-18)
5	4	8 x 28 (31 x 1.10)	12-15 (9-10)

Fig. 108 Water pump bolt identification—2.4L Engine

8. Remove the camshaft and silent shaft timing belts. Refer to the timing belt procedure in this section.

9. Remove the A/C belt idler pulley and pulley bracket.

10. Remove the alternator brace.

11. Remove the water pump, gasket and O-ring where the water inlet pipe(s) joins the pump.

To install:

12. Thoroughly clean both gasket surfaces of the water pump and block.

13. Install a new O-ring into the groove on the front end of the water inlet pipe and wet with clean antifreeze only. Do not apply oils or grease to the O-ring.

14. Using a new gasket, install the water pump assembly. Tighten bolts with the head mark **4** to 10 ft. lbs. (14 Nm) and bolts with the head mark **7** to 18 ft. lbs. (24 Nm).

15. Install the A/C pulley and pulley bracket.

16. Install the timing belts. Refer to the timing belt procedure in this section.

17. Install the engine drive belts.

18. Install the engine mount bracket.

19. Install the engine undercover.

20. Fill the system with coolant.

21. Connect the negative battery cable, run the vehicle until the thermostat opens and fill the radiator completely.

22. Once the vehicle has cooled, recheck the coolant level.

3.0L and 3.5L Engines

♦ See Figure 109

1. Disconnect the negative battery cable.
2. Drain the cooling system.

⚠ CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Remove the engine undercover.
4. Disconnect the clamp bolt from the power steering hose.
5. Support the engine with the appropriate equipment and remove the engine mount bracket.
6. Remove the timing belt. Refer to the timing belt procedure in this section.
7. Disconnect the coolant hoses from the pump, if equipped.
8. Remove the alternator brace.

➔ **The water pump bolts are different in size. Note their locations for installation.**

9. Remove the water pump, gasket and O-ring where the water inlet pipe joins the pump.

To install:

10. Thoroughly clean both gasket surfaces of the water pump and block.

11. Install a new O-ring into the groove on the front end of the water inlet pipe. Do not apply oils or grease to the O-ring. Wet with water only.

12. Using a new gasket, install the water pump assembly to the engine block. Torque the mounting bolts to 17 ft. lbs. (24 Nm).

13. Connect the hoses to the pump.

14. Install the timing belt. Refer to the timing belt procedure in this section.

15. Install the engine drive belts.

16. Fill the system with coolant.

17. Connect the negative battery cable, run the vehicle until the thermostat opens and fill the radiator completely.

18. Once the vehicle has cooled, recheck the coolant level.

Cylinder Head

REMOVAL & INSTALLATION

1.5L Engine

♦ See Figures 110 and 111

1. Relieve the fuel system pressure.

⚠ CAUTION

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

2. Disconnect the negative battery cable.
3. Drain the cooling system.

⚠ CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

4. Remove the air intake hose and the air cleaner assembly.
5. Disconnect the ground cable connection and the accelerator cable.
6. Disconnect the PCV and the breather hose connection.
7. Label and disconnect the vacuum hoses from the intake and throttle body.
8. Disconnect the vacuum line for the brake booster.
9. Remove the upper radiator hose, throttle body hoses, bypass hose and heater hose connections.
10. Disconnect the fuel feed and return lines.
11. Remove the spark plug wires.

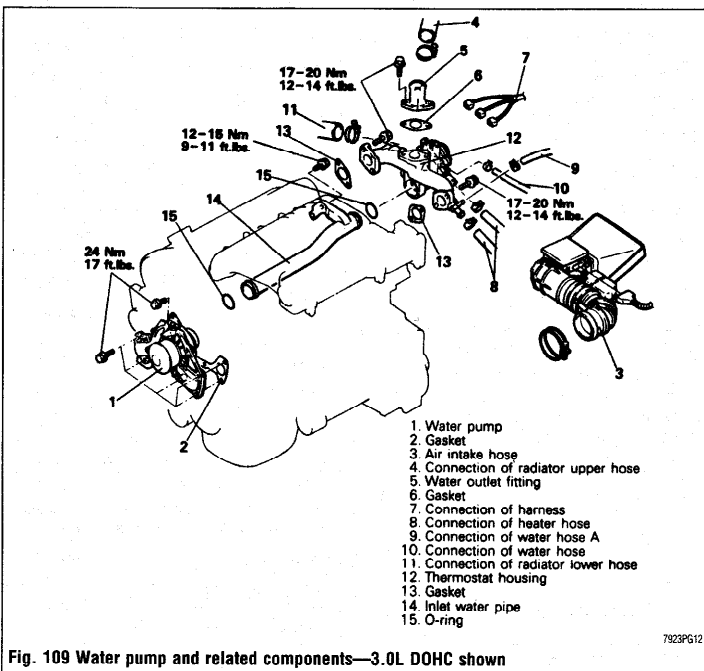
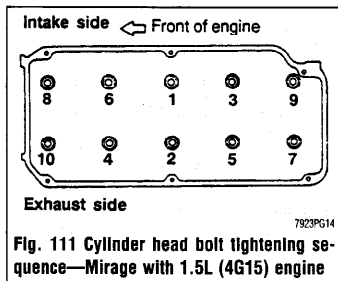
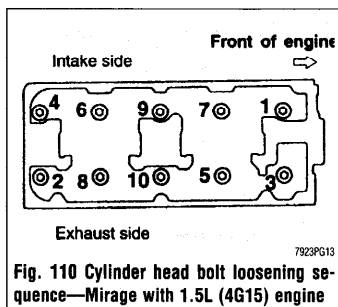


Fig. 109 Water pump and related components—3.0L DOHC shown

7923PG12



12. Disconnect the electrical harness plugs from the following:
 - Crankshaft Position (CKP) and Camshaft Position (CMP) sensors
 - Heated Oxygen (HO₂S) sensor
 - Engine Coolant Temperature (ECT) sensor and gauge sender
 - Idle Speed Control (ISC) motor
 - Throttle Position (TP) sensor
 - Intake Air Temperature (IAT) sensor
 - Exhaust Gas Recirculation (EGR) temperature sensor
 13. Disconnect electrical harness plugs from the ignition distributor, fuel injectors, power transistor and ground cable.
 14. Disconnect the engine control wiring harness.
 15. Remove the clamp that holds the power steering pressure hose to the engine mounting bracket.
 16. Place a jack and wood block under the oil pan and carefully lift just enough to take the weight off the engine mounting bracket and remove the bracket.
 17. Remove the valve cover.
 18. Remove the timing belt upper cover.
 19. Rotate the crankshaft clockwise and align the timing marks.
 20. Attach the timing belt to the camshaft sprocket with cord or a wire tie.
 21. Secure the camshaft from turning and remove the camshaft sprocket with the timing belt attached.
 22. Remove the timing belt rear upper cover.
 23. Remove the exhaust pipe from the exhaust manifold.
 24. Loosen the cylinder head mounting bolts in sequence using three steps.
 25. Remove the cylinder head.
- To install:**
26. Thoroughly clean the mating surfaces of the head and block.

27. Place a new head gasket on the cylinder block with the identification marks facing upward. Do not use sealer on the gasket.
28. Carefully install the cylinder head on the block. Tighten the cylinder head bolts as outlined in the following steps:
 - a. Tighten the bolts to 36 ft. lbs. (49 Nm) in the correct sequence
 - b. Loosen the bolts completely in the reverse of the tightening order.
 - c. Tighten the bolts, in sequence, to 14 ft. lbs. (20 Nm)
 - d. Tighten each bolt, in sequence, 90 degrees
 - e. Tighten each bolt, in sequence, an additional 90 degrees
29. Install a new exhaust pipe gasket and connect the exhaust pipe to the manifold.
30. Install the upper rear timing cover.
31. Align the timing marks and install the cam sprocket. Torque the retaining bolt to 51 ft. lbs. (70 Nm). Check the belt tension and adjust, if necessary. Install the outer timing cover.
32. Install the valve cover and torque the retaining bolts to 16 inch lbs. (1.8 Nm).
33. Install the engine mount bracket and remove the support jack.
34. Install the clamp that holds the power steering pressure hose to the engine mounting bracket.
35. Attach the following electrical connectors:
 - CKP and CMP sensors
 - HO₂S sensor
 - ECT sensor and gauge sender
 - ISC motor
 - TP sensor
 - IAT sensor
 - EGR temperature sensor
36. Connect wiring for the ignition distributor, fuel injectors, power transistor and ground cable.
37. Connect the engine control wiring harness.
38. Replace the O-rings and connect the fuel lines.
39. Install the air cleaner assembly. Connect the breather hose.
40. Fill the system with coolant.
41. Connect the negative battery cable.

1.8L Engine

See Figures 112 and 113

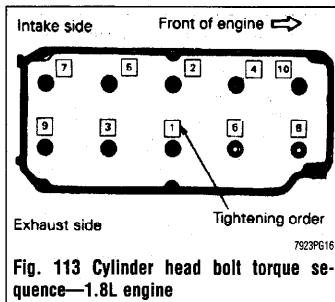
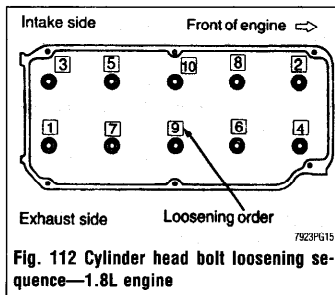
1. Relieve fuel system pressure. Disconnect the negative battery cable.
2. Remove the air cleaner assembly.
3. Drain the cooling system.

CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

4. Disconnect the brake booster vacuum hose and PVC valve connection.

5. Note the locations, then disconnect the vacuum hoses from the intake and throttle body.
6. Remove the upper radiator hose, overflow tube and the water hose from the thermostat to the throttle body.
7. Disconnect the fuel feed and return lines.
8. Unplug the accelerator cable connection from the throttle body.
9. Detach the wiring from the oil pressure switch.
10. Disconnect the wiring from the following components:
 - Heated Oxygen (HO₂S) sensor
 - Engine Coolant Temperature (ECT) sensor and gauge sender
 - Idle Air Control (IAC) motor
 - Exhaust Gas Recirculation (EGR) temperature sensor
 - Throttle Position (TP) sensor
 - Knock sensor
 - Fuel injectors
11. Remove the spark plug wires.
12. Unbolt the control harness assembly and position aside.
13. Remove the thermostat housing, thermostat and the thermostat case with O-ring from the engine.
14. Remove the rocker cover.
15. Remove the timing belt upper cover.
16. Rotate the crankshaft clockwise and align the timing marks.
17. Attach the timing belt to the camshaft sprocket with cord or a wire tie.
18. Secure the camshaft from turning and remove the camshaft sprocket with the timing belt attached.
19. Remove the timing belt rear upper cover.
20. Loosen the cylinder head bolts in two or three steps in the proper sequence.
21. Remove the cylinder head from the engine.



**** CAUTION**

When removing the cylinder head, take care not to bend or damage the plug guide. The plug guide can not be replaced.

To install:

22. Thoroughly clean the mating surfaces of the head and block.
23. Place a new head gasket on the cylinder block with the identification marks facing upward. Do not use sealer on the gasket.
24. Carefully install the cylinder head on the block.
25. Measure the cylinder head bolts prior to installation. Replace any that exceed 3.795 in. (96.4mm).
26. Apply a small amount of engine oil to the thread section of the bolt and install so the chamfer of the washer faces upward.
27. Tighten the cylinder head bolts as follows:
 - a. In the proper tightening sequence, torque bolts to 54 ft. lbs. (75 Nm).
 - b. In the reverse order of the tightening sequence, fully loosen all bolts.
 - c. In the proper tightening sequence, torque bolts to 14 ft. lbs. (20 Nm).
 - d. In the proper tightening sequence, tighten bolts 1/4 turn (90 degrees).
 - e. In the proper tightening sequence, tighten bolts an additional 1/4 turn (90 degrees).
28. Install the camshaft sprocket and tighten the bolt to 65 ft. lbs. (90 Nm), while holding the sprocket in place using the appropriate wrench. Confirm proper timing mark alignment.
29. Install the upper timing belt cover and rocker cover. Torque the rocker cover bolts to 29 inch lbs. (3 Nm).
30. Loosen the water pipe mounting bolt for ease of thermostat housing installation.
31. Apply a thin bead of sealant MD970389 or equivalent, to the water tube connection on the thermostat case.
32. Apply a small amount of water to the O-ring of the water inlet pipe and press the thermostat case assembly onto the water inlet pipe. Install the thermostat case assembly mounting bolt tightening to 16 ft. lbs. (22 Nm).
33. Tighten the water pipe mounting bolt.
34. Install the thermostat into the housing so the jiggle valve is located at the top. Tighten the housing bolts to 10 ft. lbs. (14 Nm).
35. Attach the wiring to the following components:
 - HO₂S sensor
 - ECT sensor and gauge sender
 - IAC motor
 - EGR temperature sensor
 - TP sensor
 - Knock sensor
 - Fuel injectors
36. Connect the upper radiator hose to the thermostat housing.
37. Connect the accelerator cable connection to the throttle body.
38. Connect the oil pressure switch.
39. Install the spark plug wires.
40. Connect the control harness assembly.
41. Replace the O-ring for the high pressure hose and install a new clamp on the return hose and re-connect the fuel lines.

42. Install the air intake hose. Connect the breather hose and air cleaner case cover.
43. Reconnect the brake booster and the PCV vacuum hoses.
44. Fill the system with coolant.
45. Connect the negative battery cable

2.0L SOHC Engine**▶ See Figures 114 and 115**

1. Disconnect the negative battery cable.
2. Drain the cooling system.

**** CAUTION**

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Remove the air intake hose.
4. Disconnect the accelerator cable and remove the bracket.
5. Disconnect the high pressure fuel line and remove the O-ring.

**** CAUTION**

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

6. Disconnect the upper radiator hose, the coolant by-pass hose and the heater hose from the head and/or intake manifold.
7. Disconnect the brake booster vacuum hose.
8. Remove the fuel return hose.
9. Label and detach the vacuum hose(s) running to the manifold. Disconnect the PCV hose at the valve cover.
10. Tag and disconnect the spark plug wires from the distributor cap.
11. Label and detach each electrical connector, including the distributor lead and the injector connectors. Note that some of the wiring must be disconnected at the firewall. When all the connectors are loose, remove the bracket bolts holding the control wiring harness in place and move the harness to an out-of-the-way location.
12. Remove the clamp holding the power steering and air conditioning hoses to the top of the left engine mount bracket. Move the hoses out of the way but don't disconnect either hose from its system.
13. Position a floor jack and a broad piece of lumber under the engine. Elevate the jack just enough to support the engine without raising it.

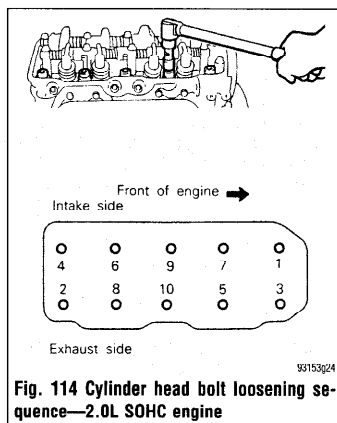


Fig. 114 Cylinder head bolt loosening sequence—2.0L SOHC engine

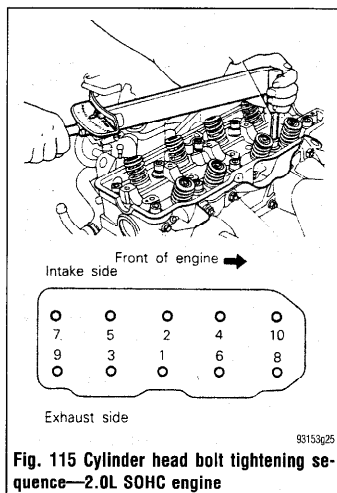


Fig. 115 Cylinder head bolt tightening sequence—2.0L SOHC engine

14. Remove the through-bolt from the left side engine mount. It may be necessary to adjust the jack slightly to allow the bolt to come free. When the bolt has been removed, disconnect the nuts and bolts holding the mounting bracket to the engine and remove the bracket.
15. Remove the valve cover and gasket. Remove the half-circle plug from the head.
16. Remove the upper timing belt cover. Turn the crankshaft clockwise until all the timing marks align, setting the engine to TDC/compression for No. 1 cylinder.
17. Remove the bolt holding the camshaft sprocket to the camshaft. Remove the camshaft sprocket, with the belt attached, and place it on the lower timing belt cover. Do NOT allow the belt to come off the sprocket.

**** WARNING**

Do not rotate the crankshaft once the camshaft sprocket is removed.

18. Remove the self-locking nuts and the small retaining bolt holding the exhaust pipe to the bottom of the exhaust manifold. Separate the pipe from the manifold and remove the gasket.

19. Remove the bolts holding the support brace to the bottom of the intake manifold.

20. Use the special hex wrench (MB 998051-01) and loosen the head bolts in the order shown in 2 or 3 passes. When all are finger loose, remove the bolts.

21. Rock the head gently to break it loose; if tapping is necessary, do so with a rubber or wooden mallet at the corners of the head. DO NOT pry the head up by wedging tools between the head and the block.

22. Lift the head free of the engine. It is coming off with both manifolds and the intake plenum attached; the help of an assistant is recommended for lifting. Support the head assembly on wooden blocks on a suitable workbench. Refer to Cleaning and Inspection in this section for work to be done before installing the head. If the head has been removed for work other than gasket replacement, the rocker assembly and camshaft or other components may be removed.

Before reinstallation, the head should be completely assembled on the bench. This allows proper location and tightening of all the external items.

To install:

23. Place a new gasket on the engine so that the identifying mark faces up (towards the head) and is at the timing belt end of the block. Install a new gasket on the exhaust pipe.

*** WARNING

Do not apply sealant to the head gasket or mating surfaces.

24. Install the head straight down onto the block. Try to eliminate most of the side-to-side adjustments. This may move the gasket out of position. Install the bolts by hand and just start each bolt 1 or 2 turns on the threads.

25. The head bolt torque specification is 68 ft. lbs. (92 Nm) for a cold engine. The bolts must be tightened in the order shown in 3 steps. On the first pass, tighten all the bolts to about 22 ft. lbs. (30 Nm), then proceed through the order tightening each bolt to about 45 ft. lbs. (61 Nm). The final torque is achieved on the third pass.

26. Install the intake manifold support brace to the manifold and tighten the bolts to 16 ft. lbs. (22 Nm).

27. Making sure the gasket is still in place, connect the exhaust pipe to the base of the exhaust manifold. Use new self-locking nuts; tighten the nuts and the small bracket bolt to 26 ft. lbs. (35 Nm).

28. Make sure the camshaft has not changed position during repairs. Carefully install the camshaft sprocket and belt onto the camshaft. Tighten the retaining bolt to 66 ft. lbs. (91 Nm).

29. Install the upper timing belt cover, then tighten the bolts to 8 ft. lbs. (11 Nm).

30. Apply sealant to the contact surfaces of the half-circle plug and install the plug in the head. Install the valve cover and gasket.

31. Install the engine mount bracket to the engine. Tighten the mounting nuts and bolts to 42 ft. lbs. (57 Nm).

32. Adjust the jack (if necessary) so that the engine mount bushing aligns with the bodywork bracket. Install the through-bolt and tighten the nuts snug.

33. Slowly release tension on the floor jack so that the weight of the engine bears fully on the mount. Tighten the through-bolt to 52 ft. lbs. (71 Nm) and the small safety nut to 26 ft. lbs. (36 Nm).

34. Install the bracket holding the power steering hose and air conditioning hose to the top of the engine mount.

35. Position the control wiring harness and install the retaining bolts. Attach each electrical connector to its proper location, making sure the wires are properly routed and firmly connected.

36. Install the spark plug wires in the distributor cap.

37. Connect the PCV hose and the vacuum hose(s).

38. Connect the fuel return line. Connect the brake booster vacuum hose.

39. Install the heater hose, the coolant by-pass hose and the upper radiator hose. Pay close attention to the position and routing of these hoses and insure that they are not crimped or constricted. Install the clamps in the same location as before removal.

40. Install a new O-ring on the high pressure fuel line and lubricate it with a coating of gasoline. Carefully connect the high pressure fuel line to the fuel rail, taking care not to damage the O-ring. Tighten the bolts only to 4 ft. lbs. (6 Nm).

41. Connect the accelerator cable and adjust it as necessary.

42. Install the air intake hose.

43. Fill the cooling system with coolant.

44. Changing the oil and filter is recommended to eliminate pollutants in the oil.

*** WARNING

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

45. Connect the negative battery cable.

46. Start the engine and check for leaks of fuel, vacuum or oil.

47. Check the operation of all engine electrical systems as well as dashboard gauges and lights.

48. Perform necessary adjustments to the accelerator cable, drive belts and engine specifications. Adjust the coolant level after the engine has cooled off.

1.6L and 2.0L DOHC Engines

◆ See Figures 116, 117, and 118

1. Relieve fuel system pressure.
2. Disconnect the negative battery cable.
3. Drain the cooling system.

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

4. Disconnect the accelerator cable. There will be 2 cables if equipped with cruise-control.

5. Remove the air cleaner with the air intake hose.

6. Detach the electrical connectors from the the oxygen sensor, engine coolant temperature sensor, the engine coolant temperature gauge unit and the engine coolant temperature switch on vehicles with air conditioning.

7. Disconnect the wiring from the ISC motor, throttle position sensor, crankshaft angle sensor, fuel injectors, ignition coil, power transistor, noise filter, knock sensor on turbocharged engines, EGR temperature sensor (California vehicles), ground cable and engine control wiring harness.

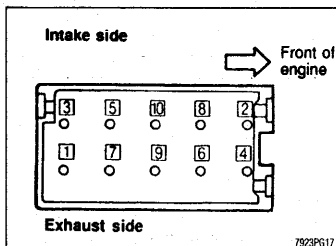


Fig. 116 Cylinder head bolt removal sequence—1.6L and 2.0L DOHC engines

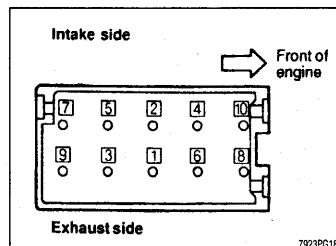


Fig. 117 Cylinder head bolt torque sequence—1.6L and 2.0L DOHC engines

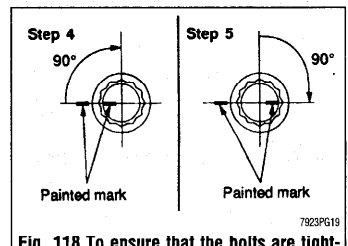


Fig. 118 To ensure that the bolts are tightened exactly 180 total degrees, mark the head bolt and cylinder head as shown—1.6L and 2.0L DOHC engines

8. Remove the upper radiator hose and the overflow tube.
9. Remove the spark plug cable center cover, then remove the spark plug cables.
10. Disconnect and plug the high pressure fuel line.
11. Disconnect the small vacuum hoses.
12. Remove the heater hose and water bypass hose.
13. Remove the PCV hose.
14. If turbocharged, remove the vacuum hoses, water line and eyebolt connection for the oil line for the turbo.
15. Disconnect and plug the fuel return hose.
16. Disconnect the brake booster vacuum hose.
17. Remove the timing belt.
18. Remove the valve cover and the half-round seal.

19. On non-turbocharged engines, remove the exhaust pipe self-locking nuts and separate the exhaust pipe from the exhaust manifold. Discard the gasket.

20. On turbocharged engines, remove the sheet metal heat protector and remove the bolts that attach the turbocharger to the exhaust manifold.

21. Loosen the cylinder head mounting bolts in 3 steps, starting from the outside and working inward. Lift off the cylinder head assembly and remove the head gasket.

To install:

22. Thoroughly clean and dry the mating surfaces of the head and block. Check the cylinder head for cracks, damage or engine coolant leakage. Remove scale, sealing compound and carbon. Clean oil pas-

sages thoroughly. Check the head for flatness. End to end, the head should be within 0.002 in. (0.05mm) normally, with 0.008 in. (0.2mm) the maximum allowed out of true. The total thickness allowed to be removed from the head and block is 0.008 in. (0.2mm) maximum.

23. Place a new head gasket on the cylinder block with the identification marks at the front top (upward) position. Make sure the gasket has the proper identification mark for the engine. Do not use sealer on the gasket. Replace the turbo gasket and ring, if equipped.

24. Carefully install the cylinder head on the block. Using 3 even steps, torque the head bolts, in sequence, to 65–72 ft. lbs. (90–100 Nm). This torque applies to a cold engine. If checking cylinder head bolt torque on hot engine, the desired specification is 72–80 ft. lbs. (100–110 Nm).

25. On turbocharged engine, install the heat shield. On non-turbocharged engines, install a new exhaust pipe gasket and connect the exhaust pipe to the manifold.

26. Apply sealer to the perimeter of the half-round seal and to the lower edges of the half-round portions of the belt-side of the new gasket. Install the valve cover.

27. Install the timing belt and all related items.

28. Connect or install all previously disconnected hoses, cables and electrical connections. Adjust the throttle cable(s).

29. Install the spark plug cable center cover.

30. Replace the O-rings and connect the fuel lines.

31. Install the air cleaner and intake hose. Connect the breather hose.

32. Change the engine oil and oil filter.

33. Fill the system with coolant.

34. Connect the negative battery cable.

35. Run the vehicle until the thermostat opens, and fill the radiator completely.

36. Check and adjust the idle speed and ignition timing.

37. Once the vehicle has cooled, recheck the coolant level.

2.4L Engine

♦ See Figures 119 thru 131

1. Relieve the fuel system pressure.
2. Disconnect the negative battery cable.
3. Remove the air cleaner with all air intake hoses.
4. Drain the cooling system.

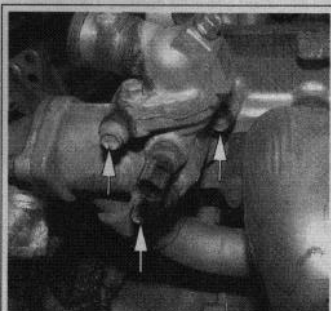
*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.



93153p44

Fig. 119 Remove the upper radiator hose



93153p94

Fig. 122 Remove the three thermostat housing retaining bolts . . .



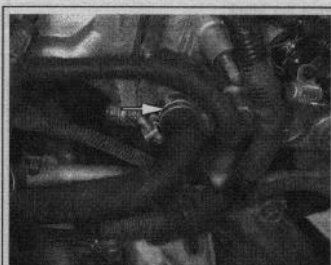
93153p43

Fig. 120 . . . and also the lower radiator hoses from the thermostat housing



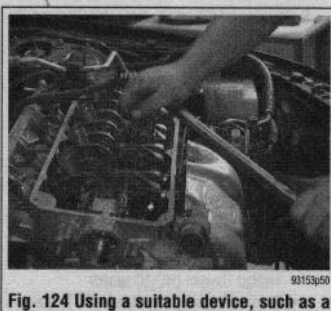
93153p97

Fig. 123 . . . then remove the thermostat housing from the cylinder head



93153p42

Fig. 121 Remove the heater hose from the cylinder head



93153p50

Fig. 124 Using a suitable device, such as a breaker bar and the appropriate socket, loosen the thermostat head bolts in the proper sequence

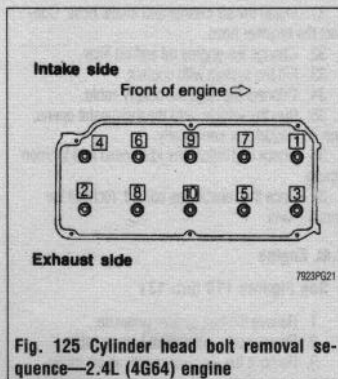


Fig. 125 Cylinder head bolt removal sequence—2.4L (4G64) engine

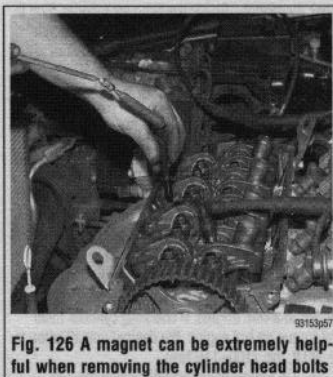


Fig. 126 A magnet can be extremely helpful when removing the cylinder head bolts

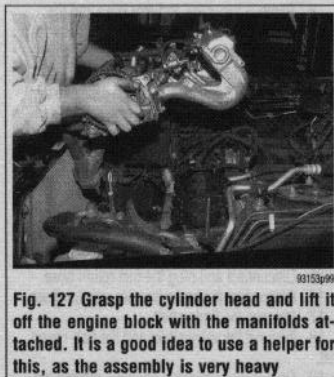


Fig. 127 Grasp the cylinder head and lift it off the engine block with the manifolds attached. It is a good idea to use a helper for this, as the assembly is very heavy

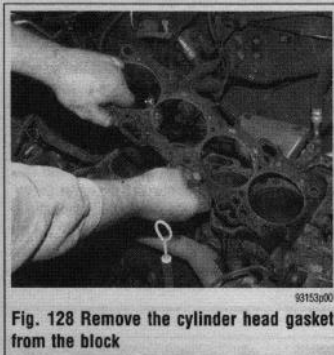


Fig. 128 Remove the cylinder head gasket from the block



Fig. 129 Thoroughly clean the gasket surfaces of the cylinder head

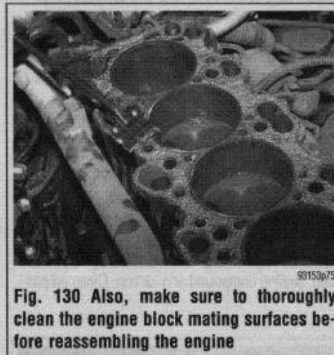


Fig. 130 Also, make sure to thoroughly clean the engine block mating surfaces before reassembling the engine

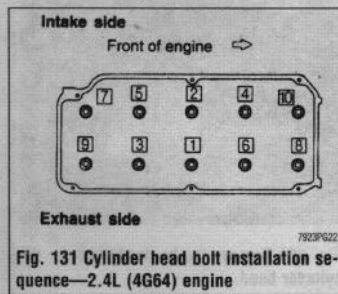


Fig. 131 Cylinder head bolt installation sequence—2.4L (4G64) engine

5. Disconnect the accelerator cable. Remove the cable mounting brackets and position the cable aside.

6. Remove the breather hose.

7. Label and disconnect the vacuum lines at the throttle body.

8. Disconnect and plug the high pressure fuel line.

9. Disconnect and plug the fuel return hose.

10. Label and detach the connectors from the following components:

- A/C compressor
- Power steering pressure switch
- Heated Oxygen (HO₂S) sensor
- Engine Coolant Temperature (ECT) gauge sender
- ECT sensor
- Manifold Absolute Pressure (MAP) sensor

- Intake Air Temperature (IAT) sensor
- Throttle Position (TP) sensor
- Idle Air Control (IAC) motor
- Injector harness
- Ignition coil
- Camshaft Position (CMP) sensor
- Exhaust Gas Recirculation (EGR) solenoid valve

11. Remove the spark plug wire cover and wires.

12. At the thermostat case assembly, remove the coolant hoses and unbolt the thermostat case from the engine.

13. Remove the upper timing belt cover.

14. Align all timing marks.

15. Secure the timing belt to the camshaft sprocket with cord or a wire tie.

16. Remove the camshaft sprocket.

17. Remove the valve cover and the half-round seal.

18. Disconnect the intake manifold stay bracket from the intake manifold.

19. Remove the exhaust pipe self-locking nuts and separate the exhaust pipe from the exhaust manifold. Discard the gasket.

20. Loosen the cylinder head mounting bolts in 3 steps, starting from the outside and working inward. Lift off the cylinder head assembly and remove the head gasket.

21. Thoroughly clean the mating surfaces of the head and block.

22. Place a new head gasket on the cylinder block with the identification marks at the front top (upward) position. Do not use sealer on the gasket.

To install:

23. Inspect the cylinder head bolt length prior to installation. If the length exceeds 3.91 in. (99.4mm), the bolt must be replaced. Install the washer onto the bolt so the chamfer on the washer faces towards the head of the bolt.

24. Carefully install the cylinder head on the block and tighten the cylinder head bolts as follows:

a. Following the proper tightening sequence, tighten the cylinder head bolts to 58 ft. lbs. (78 Nm).

b. Loosen all bolts completely.

c. Torque bolts to 15 ft. lbs. (20 Nm).

d. Tighten bolts an additional 1/4 turn.

e. Tighten bolts an additional 1/4 turn.

25. Install the new exhaust pipe gasket and connect the exhaust pipe to the manifold. Tighten the bolts to 33 ft. lbs. (44 Nm).

26. Install the thermostat case and tighten the mounting bolts to 18 ft. lbs. (24 Nm).

27. Connect the coolant hoses to the thermostat case.

28. Apply sealer to the perimeter of the half-round seal and to the lower edges of the half-round portions of the belt-side of the new gasket. Install the valve cover.

29. Install the camshaft sprocket with the timing belt attached. Remove the cord or wire tie.

30. Install the upper timing belt cover.

31. Connect the intake manifold stay and tighten the mounting bolts to 22 ft. lbs. (30 Nm).

32. Attach the connectors to the following components:

- A/C compressor
- Power steering pressure switch

- HO₂S sensor
- ECT gauge sender
- ECT sensor
- MAP sensor
- IAT sensor
- TP sensor
- IAC motor
- Injector harness
- Ignition coil
- CMP sensor
- EGR solenoid valve

33. Install the spark plug wires and cover.
34. Replace the O-rings and connect the fuel lines.
35. Install the air cleaner and intake hose. Connect the breather hose.
36. Fill the cooling system.
37. Connect the negative battery cable

3.0L DOHC Engine

▶ See Figures 132 and 133

1. Relieve fuel system pressure. Disconnect the negative battery cable.
2. Drain the cooling system.

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Remove the air intake hoses.
4. Remove air intake plenum and intake manifold.
5. Remove the exhaust manifold.
6. Remove the timing belt. Refer to the timing belt procedure in this section.
7. Remove the breather hose.
8. Remove the spark plug wire center cover and remove the spark plug wires.
9. Remove the rocker covers.
10. Remove the intake camshaft sprockets.
11. Remove the rear timing belt cover.
12. Remove the ignition coil assembly.
13. Disconnect all water hoses from the thermostat housing and remove the housing.
14. Disconnect the water inlet from the front head.
15. Loosen the cylinder head mounting bolts in the reverse of the torque sequence and loosen the bolts in three steps. Lift off the cylinder head assembly and remove the head gasket.

To install:

16. Thoroughly clean the sealing surfaces of the head and block.
17. Place a new head gasket on the cylinder block with the identification marks in the front top (upward) position. Do not use sealer on the gasket.
18. Carefully install the cylinder head on the block. Be sure the head bolt washers are installed with the chamfered edge upward. Using three even steps, torque the head bolts in sequence, to 76–83 ft. lbs. (105–115 Nm).

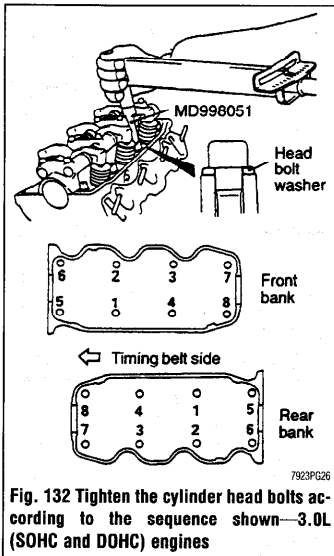


Fig. 132 Tighten the cylinder head bolts according to the sequence shown—3.0L (SOHC and DOHC) engines

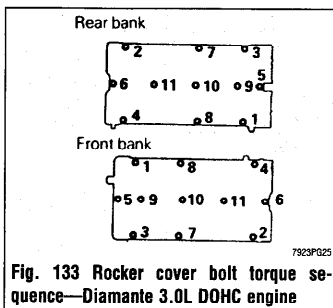


Fig. 133 Rocker cover bolt torque sequence—Diamante 3.0L DOHC engine

19. Install new O-ring and connect the water inlet to the head. Tighten the mounting bolt to 9–11 ft. lbs. (12–15 Nm).
20. Replace the gaskets and install the thermostat housing. Tighten the mounting bolts to 12–14 ft. lbs. (17–20 Nm).
21. Using new hose clamps, connect the hoses to the thermostat housing.
22. Install the ignition coil and torque the mounting bolts to 7 ft. lbs. (10 Nm).
23. Install the rear timing belt cover and torque the mounting bolts to 17 ft. lbs. (24 Nm).
24. Install the intake camshaft sprockets. Tighten the retaining bolt to 65 ft. lbs. (90 Nm).
25. Apply sealer to the lower edges of the valve cover. Tighten the bolts in the proper sequence to 44–51 inch lbs. (5–6 Nm).
26. Connect the spark plug wires and install the center cover. Tighten the bolts that secure the center cover to 27 inch lbs. (3 Nm)
27. Install the breather hose.
28. Install the timing belt. Refer to the timing belt procedure in this section.
29. Install the exhaust manifold assembly.
30. Using all new gaskets, install the intake manifold and air intake plenum.
31. Install the air intake hoses.
32. Change the engine oil and oil filter.

33. Fill the system with coolant.
34. Connect the negative battery cable.
35. Adjust the accelerator cable.
36. Start the engine.
37. Check and adjust the idle speed and ignition timing.
38. Once the vehicle has cooled, recheck the coolant level.

3.0L SOHC Engine

▶ See Figure 132

1. Relieve the fuel system pressure.
2. Disconnect the negative battery cable.
3. Drain the cooling system.

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

4. Remove the air intake hose.
 5. Remove the exhaust manifold.
 6. Remove the air intake plenum and intake manifold.
 7. Remove the timing belt. Refer to the timing belt procedure in this section.
 8. Remove the camshaft sprockets and the rear timing belt cover.
 9. Remove the power steering pump bracket. If removing the rear head, remove the alternator brace.
 10. Disconnect the water inlet pipe.
 11. Remove the purge pipe assembly.
 12. Remove the valve cover.
 13. Using the reverse sequence of the installation sequence, loosen the cylinder head mounting bolts in three steps. Lift off the cylinder head assembly and remove the head gasket.
- To install:**
14. Thoroughly clean the sealing surfaces of the head and block.
 15. Place a new head gasket on the cylinder block making sure the identification mark on the cylinder head gasket is in the front top (upward) location. Do not use sealer on the gasket.
 16. Carefully install the cylinder head on the block. Be sure the head bolt washers are installed with the chamfered edge upward. Using three even steps, torque the head bolts in sequence, to 76–83 ft. lbs. (105–115 Nm).
 17. Apply sealer to the lower edges of the half-round portions and install the valve cover. Tighten valve cover bolts to 7 ft. lbs. (9 Nm).
 18. Install the purge pipe assembly.
 19. Connect the water inlet pipe.
 20. Install the power steering pump bracket and alternator brace.
 21. Install the rear timing belt cover and camshaft sprockets. Torque the retaining bolt to 65 ft. lbs. (90 Nm).
 22. Install the timing belt. Refer to the timing belt procedure in this section.

23. Using all new gaskets, install the intake manifold, air intake plenum and exhaust manifold.
24. Install the air intake hose.
25. Fill the system with coolant.
26. Connect the negative battery cable.
27. Start the engine.
28. Check and adjust the idle speed and ignition timing.
29. Once the vehicle has cooled, recheck the coolant level.

3.5L Engine

♦ See Figure 134

1. Disconnect the negative battery cable.
2. Drain the engine coolant

*** CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

3. Remove the timing belt. Refer to the timing belt procedure in this section.
4. Remove the intake and exhaust manifolds.
5. Remove the spark plug wires.
6. Remove the cylinder head covers.
7. Remove the timing belt rear center cover.
8. Loosen the cylinder head bolts gradually in three stages, in the opposite of the installation sequence.
9. Remove the cylinder head.

To install:

10. Clean the cylinder head and mounting surface on the engine block.
11. Install the cylinder head using a new gasket.
12. Tighten the bolts in sequence using three stages to 76–83 ft. lbs. (103–113 Nm).
13. Install the timing belt rear center cover.
14. Install the cylinder head covers using new gaskets. Tighten the bolts to 2–3 ft. lbs. (3–4 Nm).
15. Install the spark plug wires.
16. Install the intake and exhaust manifolds.
17. Install the timing belt. Refer to the timing belt procedure in this section.

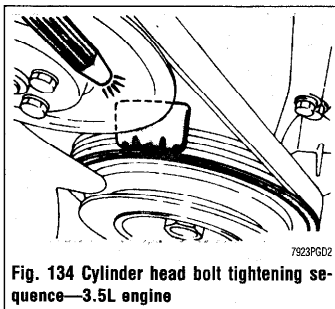


Fig. 134 Cylinder head bolt tightening sequence—3.5L engine

18. Install any remaining components.
19. Refill the cooling system.
20. Connect the negative battery cable.

Oil Pan

REMOVAL & INSTALLATION

1.5L Engine

♦ See Figure 135

1. Disconnect the negative battery cable.
2. Drain the engine oil.

*** CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

3. Remove the bell housing lower cover.
4. Remove the oil pan retainer bolts. Tap the oil pan with a rubber mallet to break seal.

Do not use a prytool when removing the oil pan. If available, oil pan remover tool MD998727 or equivalent may be used to break the seal.

To install:

5. Clean all gasket surfaces of the cylinder block and the oil pan.
6. Apply sealant to the gasket surfaces of the oil pan.
7. Install the oil pan onto the cylinder block within 15 minutes after applying sealant. Install the fasteners and tighten to 60 inch lbs. (7 Nm).
8. Install the bell housing cover.
9. Install the oil drain plug with a new seal and tighten to 29 ft. lbs. (40 Nm).
10. Lower the vehicle and fill the crankcase to the proper level with clean engine oil.

*** WARNING

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

11. Connect the negative battery cable. Start the engine and check for leaks.

1.8L Engine

♦ See Figure 136

1. Disconnect the negative battery cable.
2. Raise the vehicle and support safely.
3. Remove the oil pan drain plug and drain the engine oil.

*** CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should

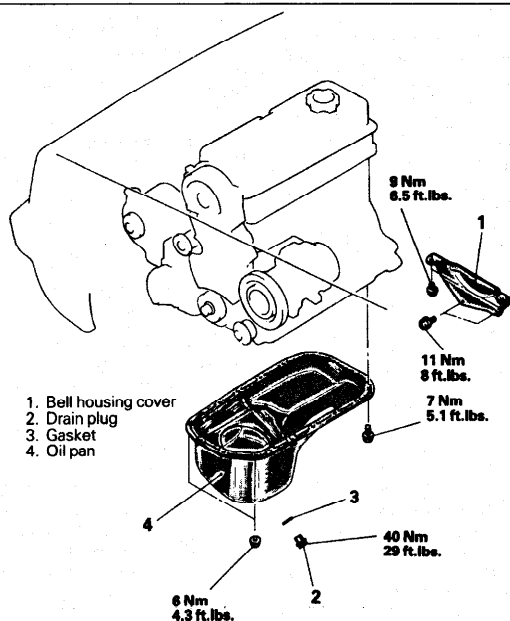


Fig. 135 Oil pan and related components—Mirage 1.5L (4G15) engine

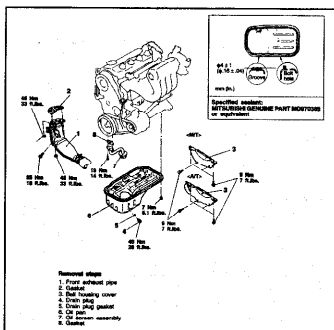


Fig. 136 Oil pan and related components—1.8L engine

be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

4. Disconnect and lower the exhaust pipe from the engine manifold.
5. Remove the bell housing lower cover.
6. Remove the oil pan retainer bolts and remove the oil pan.

➔ **Do not use a prytool when removing the oil pan. If available, oil pan remover tool MD998727 or equivalent may be used break the seal.**

To install:

7. Clean all gasket surfaces of the cylinder block and the oil pan.
8. Apply sealant around the gasket surfaces of the oil pan.
9. Install the oil pan onto the cylinder block within 15 minutes after applying sealant. Install the fasteners and tighten to 60 inch lbs. (5 Nm).
10. Install the bell housing cover.
11. Connect the exhaust pipe to the engine manifold with new gasket in place. Tighten the exhaust pipe to manifold flange nuts to 33 ft. lbs. (45 Nm). Install and tighten the support bolt to 18 ft. lbs. (25 Nm).
12. Install the oil drain plug and tighten to 29 ft. lbs. (40 Nm).
13. Fill the crankcase to the proper level.

***** WARNING**

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

14. Connect the negative battery cable. Start the engine and check for leaks.

1.6L and 2.0L Engines

FRONT WHEEL DRIVE

➔ **See Figures 137 and 138**

1. Disconnect the negative battery cable.
2. Raise the vehicle and support safely.
3. Remove the oil pan drain plug and drain the engine oil.

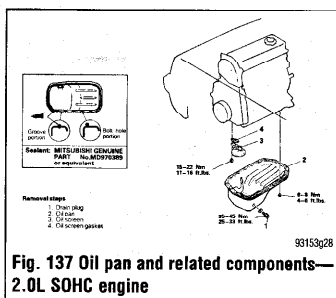


Fig. 137 Oil pan and related components—2.0L SOHC engine

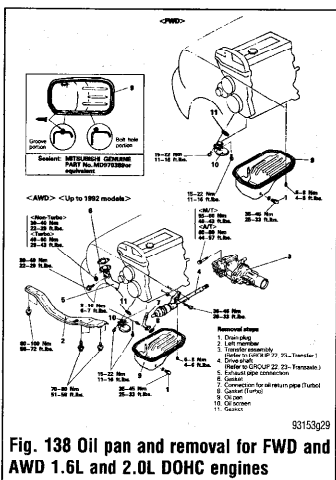


Fig. 138 Oil pan and removal for FWD and AWD 1.6L and 2.0L DOHC engines

***** CAUTION**

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

4. Disconnect and lower the exhaust pipe from the engine manifold.
5. Using the appropriate equipment, support the weight of the engine.
6. Remove the retainer bolts and the center crossmember.
7. Remove the oil pan bolts. Using special tool MD998727, tap in between the engine block and the oil pan.

➔ **Do not use a chisel, screwdriver or similar tool when removing the oil pan. Damage to engine components may occur.**

8. Inspect the oil pan for damage and cracks. Replace if faulty. While the pan is removed, inspect the oil screen for clogging, damage and cracks. Replace if faulty.

To install:

9. Using a wire brush or other tool, scrape clean all gasket surfaces of the cylinder block and the oil pan so that all loose material is removed. Clean sealing surfaces of all dirt and oil.

10. Apply sealant around the gasket surfaces of the oil pan in such a manner that all bolt holes are circled and there is a continuous bead of sealer around the entire perimeter of the oil pan.

➔ **The continuous bead of sealer should be applied in a bead approximately 0.16 in. (4mm) in diameter.**

11. Install the oil pan onto the cylinder block within 15 minutes after applying sealant. Install the fasteners and tighten to 4–6 ft. lbs. (6–8 Nm).

12. Install the crossmember and tighten the mounting bolts to 72 ft. lbs. (100 Nm).

13. Connect the exhaust pipe to the engine manifold with new gasket in place. Tighten the exhaust pipe to manifold flange nuts to 29 ft. lbs. (40 Nm).

14. Install the oil drain plug and tighten to 33 ft. lbs.

15. Lower the vehicle and fill the crankcase to the proper level with clean engine oil.

***** WARNING**

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

16. Connect the negative battery cable.
17. Start the engine and check for leaks.

ALL WHEEL DRIVE

➔ **See Figure 138**

1. Disconnect the negative battery cable.
2. Raise the vehicle and support safely.
3. Remove the oil pan drain plug and drain the engine oil.

***** CAUTION**

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

4. Disconnect and lower the exhaust pipe from the engine manifold.
5. Remove the transfer assembly and right driveshaft.
6. Using the appropriate equipment, support the weight of the engine and remove the center crossmember.
7. Disconnect the return pipe for the turbocharger from the side of the oil pan.
8. Remove the oil pan bolts. Using special tool MD998727, tap in between the engine block and the oil pan.

➔ **Do not use a chisel, screwdriver or similar tool when removing the oil pan. Damage to engine components may occur.**

9. Inspect the oil pan for damage and cracks. Replace if faulty. While the pan is removed, inspect the oil screen for clogging, damage and cracks. Replace if faulty.

To install:

10. Using a wire brush or other tool, scrape clean all gasket surfaces of the cylinder block and the oil pan so that all loose material is removed. Clean sealing surfaces of all dirt and oil.

11. Apply sealant around the gasket surfaces of the oil pan in such a manner that all bolt holes are circled and there is a continuous bead of sealer around the entire perimeter of the oil pan.

➔ **The continuous bead of sealer should be applied in a bead approximately 0.16 in. (4mm) in diameter.**

12. Install the oil pan onto the cylinder block within 15 minutes after applying sealant. Install the fasteners and tighten to 4–6 ft. lbs. (6–8 Nm).

13. Install the oil return pipe using a new gasket, if removed. Tighten retainers to 5–7 ft. lbs. (7–10 Nm).

14. Install the left member and tighten the forward retainer bolts to 72 ft. lbs. (100 Nm). Tighten the rearward left member bolts to 58 ft. lbs. (80 Nm).

15. Install the transfer assembly and right drive-shaft.

16. Connect the exhaust pipe from the engine manifold with new gasket in place. Tighten the exhaust pipe to manifold flange nuts to 29 ft. lbs. (40 Nm).

17. Install the oil drain plug and tighten to 33 ft. lbs.

18. Lower the vehicle and fill the crankcase to the proper level with clean engine oil.

***** WARNING**

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

19. Connect the negative battery cable. Start the engine and check for leaks.

2.4L Engine

➔ See Figure 139

1. Disconnect the negative battery cable.

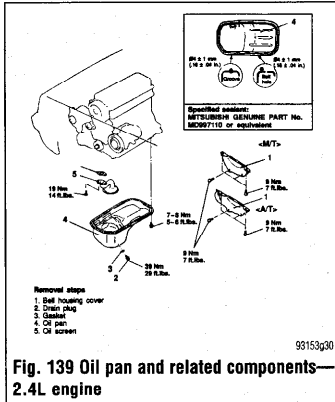


Fig. 139 Oil pan and related components—2.4L engine

2. Remove the oil pan drain plug and drain the engine oil.

***** CAUTION**

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

3. Remove the oil dipstick and tube assembly.
4. Detach the Heated Oxygen (HO₂S) sensor connector.
5. Remove the front exhaust pipe from the vehicle.
6. Remove the bell housing cover.
7. Remove the oil pan retainer bolts. Using special tool MD998727 or equivalent, tap in between the engine block and the oil pan.

➔ **Do not use a prytool when removing the oil pan. Damage to engine components may occur.**

To install:

8. Apply sealant around the gasket surfaces of the oil pan.
9. Install the oil pan onto the cylinder block within 15 minutes after applying sealant. Install the fasteners and tighten to 6 ft. lbs. (8 Nm).
10. Install the oil drain plug and tighten to 29 ft. lbs. (39 Nm).
11. Install the bell housing cover, and tighten the mounting bolts to 7 ft. lbs. (9 Nm).
12. Install the front exhaust pipe and tighten the bolts at the catalytic converter to 36 ft. lbs. (49 Nm). Tighten the nuts at the exhaust manifold to 32 ft. lbs. (44 Nm).
13. Reconnect the HO₂S sensor connector.
14. Fill the crankcase to the proper level.

***** WARNING**

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

15. Connect the negative battery cable. Start the engine and check for leaks.

3.0L Engines

➔ See Figure 140

1. Disconnect the negative battery cable.
2. Remove the oil pan drain plug and drain the engine oil.

***** CAUTION**

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used en-

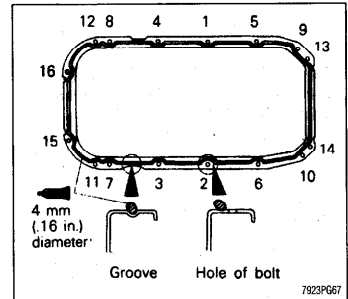


Fig. 140 Oil pan bolt tightening sequence and application of sealant to the pan—Diamante 3.0L engines

gine oil. Soap and water, or waterless hand cleaner should be used.

3. Remove the left side crossmember. If equipped with 4WS, it will also be necessary to remove the right side crossmember.
4. Remove the starter motor.
5. Disconnect the roll stopper stay bracket, from the rear transaxle stay bracket. Remove the both transaxle stay brackets.
6. Remove the bell housing lower cover.
7. Remove the oil pan mounting bolts. Using special tool MD998727 or equivalent, separate and remove the engine oil pan.

To install:

8. Apply a 0.16 in. (4mm) continuous bead of sealer around the surface of the oil pan.
- ➔ **Assemble the oil pan to the cylinder block within 15 minutes after applying the sealant.**
9. Install the oil pan mounting bolts. Following proper sequence, tighten mounting bolts to 48 inch lbs. (6 Nm).
10. Install lower bell housing cover and the starter motor.
11. Install the transaxle stay brackets and connect the roll stopper bracket.
12. Install the crossmember(s) and tighten the mounting bolts to 43–51 ft. lbs. (60–70 Nm).
13. Fill the engine with the proper amount of oil.

***** WARNING**

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

14. Connect the negative battery cable and check for leaks.

3.5L Engine

➔ See Figures 141, 142, and 143

1. Disconnect the negative battery cable.
2. Drain the engine oil.

***** CAUTION**

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure

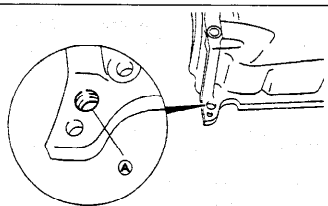


Fig. 141 Install a bolt in the threaded hole to force the oil pan from the engine block—3.5L engine

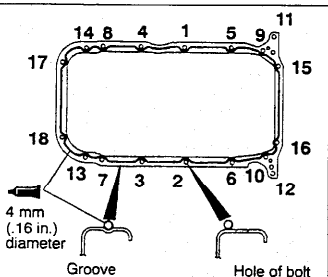


Fig. 142 Apply sealant and tighten the bolts in the order shown—3.5L engine, upper oil pan shown

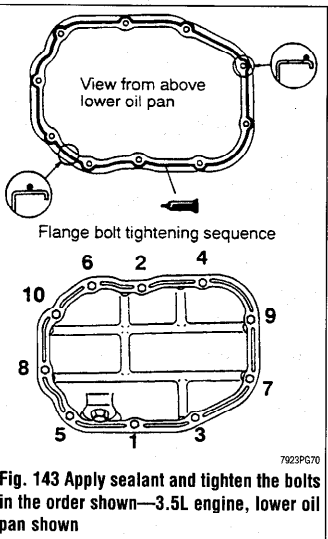


Fig. 143 Apply sealant and tighten the bolts in the order shown—3.5L engine, lower oil pan shown

to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

3. Remove the mounting bolts from the lower oil pan.

4. Place a block of wood against the side of the pan and tap the block with a hammer to break the seal and remove the lower pan.
5. Remove the starter.
6. Remove the dipstick tube.
7. Unbolt the upper oil pan.

WARNING

Do not pry or use seal breaker tool to remove the oil pan. Damage to the aluminum surface can result.

8. Screw a bolt into the threaded hole to force the oil pan from the engine block and remove the pan.
 9. Remove the bolt used to remove the pan.
- To install:**
10. Clean and degrease the sealing surfaces of the upper oil pan and engine block.
 11. Apply a bead of silicone sealant along the mounting surface of the upper oil pan.

12. Install the upper oil pan. Tighten the bolts in sequence to 4 ft. lbs. (6 Nm).
13. Install the dipstick tube using a new O-ring.
14. Install the starter assembly.
15. Clean and degrease the sealing surface of the lower oil pan.
16. Place a bead of sealant on the mounting surface of the lower oil pan. Install the lower pan. Tighten the bolts in sequence to 7-9 ft. lbs. (10-12 Nm).
17. Install the drain plug using a new washer. Tighten the drain plug to 29 ft. lbs. (39 Nm).
18. Lower the vehicle and fill the crankcase to the correct level.

WARNING

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

19. Connect the negative battery cable.
20. Start the engine and check for leaks.

Oil Pump

REMOVAL & INSTALLATION

1.5L and 1.8L Engines

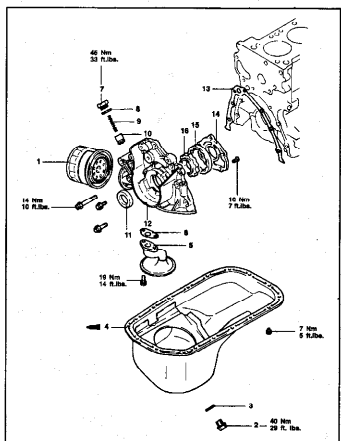
See Figures 144 and 145

Whenever the oil pump is disassembled or the cover removed, the gear cavity must be filled with petroleum jelly to seal the pump and act as a prime. Do not use grease.

1. Disconnect the negative battery cable.
2. Raise and support the vehicle.
3. Drain the engine oil.

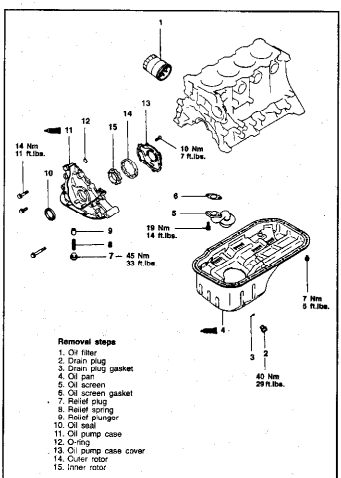
CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your



- Removal steps**
1. Oil filter
 2. Drain plug
 3. Drain plug gasket
 4. Oil pan
 5. Oil screen
 6. Oil screen gasket
 7. Gasket
 8. Releier spring
 9. Releier plunger
 10. Oil seal
 11. Front case
 12. Front case gasket
 13. Oil pump cover
 14. Outer rotor
 15. Inner rotor

Fig. 144 Exploded view of the oil pump mounting—1.5L engine



- Removal steps**
1. Oil filter
 2. Drain plug
 3. Drain plug gasket
 4. Oil pan
 5. Oil screen
 6. Oil screen gasket
 7. Releier spring
 8. Releier plunger
 9. Oil seal
 10. Front case
 11. Oil pump case
 12. O-ring
 13. Oil pump case cover
 14. Outer rotor
 15. Inner rotor

Fig. 145 Exploded view of the oil pump mounting—1.8L engine

hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

4. Support the engine using a suitable device
5. Remove the front engine mount bracket and accessory drive belts.
6. Remove timing belt upper and lower covers.
7. Remove the timing belt and crankshaft sprocket. Refer to the timing belt procedure in this section.
8. Remove the oil pan and remove the oil screen.

3-34 ENGINE AND ENGINE OVERHAUL

9. Remove the front cover mounting bolts. Note the lengths of the mounting bolts as they are removed for proper installation.

10. Remove the front case assembly and oil pump assembly.

11. Remove the oil pump cover.

12. Remove the inner and outer gears from the front case.

To Install

13. Remove all gasket material from the mating surfaces and clean all parts.

14. Thoroughly coat both oil pump gears with clean engine oil and install them in the correct direction of rotation.

15. Install the pump cover and tighten the bolts to 84 inch lbs. (10 Nm).

16. Coat the relief valve and spring with clean engine oil. Install them and tighten the plug to 33 ft. lbs. (45 Nm).

17. Install a new front crankshaft seal and coat the lips of the seal with clean engine oil.

18. Install the front case and oil pump assembly to the engine block using a new gasket. Tighten the bolts to 10 ft. lbs. (14 Nm).

19. Install the oil screen with new gasket. Torque the screen bolts to 14 ft. lbs. (19 Nm).

20. Install the oil pan.

21. Install the crankshaft sprocket and timing belt. Refer to the timing belt procedure in this section.

22. Fill the crankcase to the proper level.

*** WARNING

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

23. Connect the negative battery cable.

1.6L, 2.0L and 2.4L Engines

♦ See Figures 146, 147, 148, and 149

► Whenever the oil pump is disassembled or the cover removed, the gear cavity must be filled with petroleum jelly to seal the pump and act as a prime. Do not use grease.

1. Disconnect the negative battery cable.
2. Rotate the engine so No. 1 cylinder is on Top Dead Center (TDC) of its compression stroke.
3. Drain the engine oil.

*** CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

4. Using the proper equipment, support the weight of the engine. Remove the front engine mount bracket and accessory drive belts.
5. Remove timing belt upper and lower covers.
6. Remove the timing belt and crankshaft sprocket. Refer to the timing belt procedure in this section.

7. Detach the electrical connector from the oil pressure sending unit and remove the oil pressure sensor. Remove the oil filter and the oil filter bracket.

8. Remove the oil pan, oil screen and gasket.

9. Using special tool MD998162, remove the plug cap in the engine front cover.

10. Remove the plug on the side of the engine block. Insert a Phillips screwdriver with a shank diameter of 0.32 in. (8mm) into the plug hole. This will hold the silent shaft.

11. Remove the driven gear bolt that secures the oil pump driven gear to the silent shaft.

12. Remove the front cover mounting bolts. Note the lengths of the mounting bolts as they are removed for proper installation.

13. Remove the front case cover and oil pump assembly. If necessary, the silent shaft can come out with the cover assembly.

14. Remove the oil pump cover, located on the back of the engine front cover. Remove the oil pump drive and driven gears.

15. After disassembling the oil pump, clean all components and remove gasket material from mating surfaces.

16. Assemble the oil pump gears into the front case and rotate it to ensure smooth rotation and no looseness. Be sure there is no ridge wear on the contact surface between the front case and the gear surface of the oil pump front cover.

To Install

17. Align the timing mark on the oil pump drive gear with that on the driven gear and install them into the engine front case. Apply engine oil to the gears.

18. Install the oil pump cover and tighten the retainers bolts to 13 ft. lbs. (18 Nm).

19. Using the appropriate driver, install a new crankshaft seal into the front case.

20. Position new front case gasket in place. Set seal guide tool MD998285 on the front end of the crankshaft to protect the seal from damage. Apply a thin coat of oil to the outer circumference of the seal pilot tool.

21. Install the front case assembly through a new front case gasket and temporarily tighten the flange bolts.

22. Mount the oil filter on the bracket with new oil filter bracket gasket in place. Install the bolts with washers and tighten to 14 ft. lbs. (19 Nm).

23. Insert a Phillips screwdriver into the hole in the left side of the engine block to lock the silent shaft in place.

24. Install the oil pump drive gear onto the left silent shaft. Tighten the driven gear bolt to 27 ft. lbs. (37 Nm).

25. Install a new O-ring to the groove in the front case and install the plug cap. Using the special tool MD998162, tighten the cap to 17 ft. lbs. (24 Nm).

26. Install the oil screen in position with new gasket in place.

27. Clean both mating surfaces of the oil pan and the cylinder block. Apply sealant in the groove in the oil pan flange.

► After applying sealant to the oil pan, do not exceed 15 minutes before installing the oil pan.

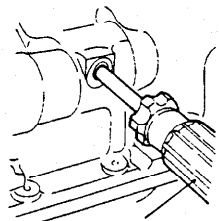
28. Install the oil pan to the engine and secure with the retainers. Tighten bolts to 5 ft. lbs. (7 Nm).

29. Install the oil pressure gauge unit and the oil pressure switch. Connect the electrical harness connector.

30. Install the oil cooler. Secure with oil cooler bolt tightened to 31 ft. lbs. (43 Nm).

31. Refill the crankcase.

32. Install new oil filter.



Phillips screwdriver

Fig. 146 Holding the silent shaft for oil pump gear removal—2.0L engine

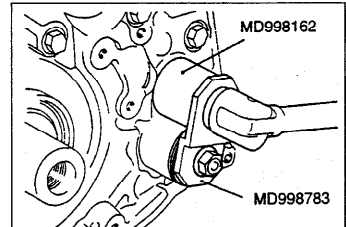


Fig. 147 Use the special socket and holder to remove the balance shaft plug—2.0 engine

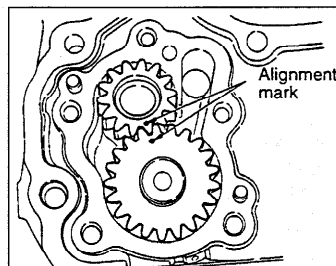


Fig. 148 Aligning oil pump timing marks—2.0L engine

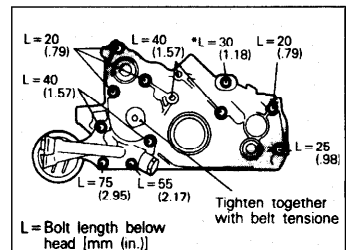


Fig. 149 Front case bolt identification—2.0L and 2.4L engines

*** WARNING

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

33. Connect the negative battery cable and start the engine.
34. Verify correct oil pressure.
35. Inspect for leaks.

3.0L Engines

♦ See Figure 150

→ Whenever the oil pump is disassembled or the cover removed, the gear cavity must be filled with petroleum jelly to seal the pump and act as a prime. Do not use grease.

1. Disconnect the negative battery cable.
2. Drain the engine oil.

*** CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

3. Remove the front engine mount bracket and accessory drive belts.
4. Remove timing belt upper and lower covers.
5. Remove the timing belt and crankshaft sprocket. Refer to the timing belt procedure in this section.
6. Remove the oil pan.
7. Remove the oil screen and gasket.
8. Remove the front cover mounting bolts. Note the lengths of the mounting bolts as they are removed for proper installation.
9. Remove the front case cover and oil pump assembly.

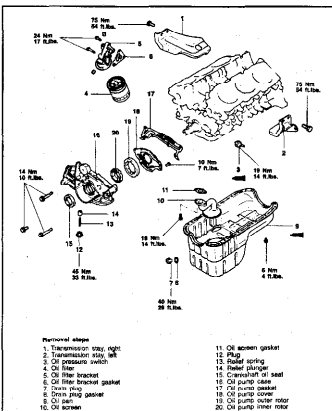


Fig. 150 Exploded view of the oil pump mounting—3.0L engines

To install:

10. Thoroughly clean all gasket material from all mounting surfaces.
11. Apply engine oil to the entire surface of the gears or rotors.
12. Assemble the front case cover and oil pump assembly to the engine block.
13. Install the oil screen with new gasket.
14. Install the oil pan
15. Install the crankshaft sprocket and timing belt. Refer to the timing belt procedure in this section.
16. Install the timing belt covers.
17. Install the drive belts and the front engine mount bracket.
18. Connect the negative battery cable, refill the crankcase and check for adequate oil pressure.

*** WARNING

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

3.5L Engine

♦ See Figures 151 and 152

1. Disconnect the negative battery cable.
2. Remove the timing belt. Refer to the timing belt procedure in this section.
3. Drain the engine oil.

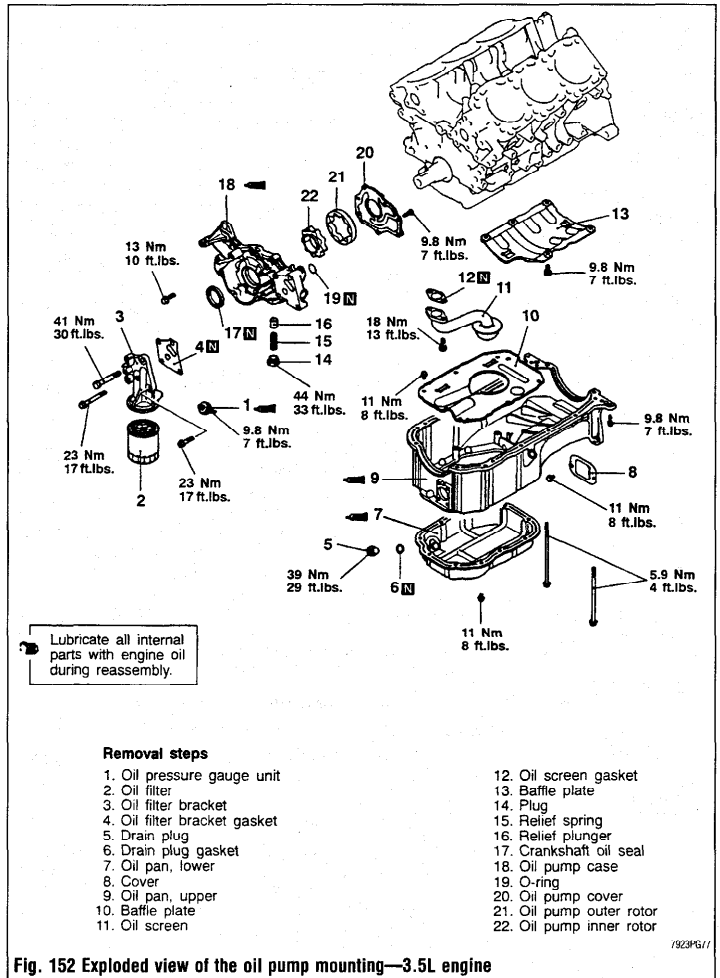
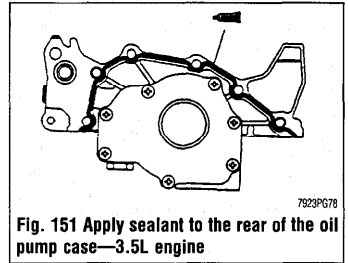


Fig. 152 Exploded view of the oil pump mounting—3.5L engine

CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

- Remove the splash shield from the wheel well.
- Remove the oil filter adapter.
- Remove the lower and upper oil pans.
- Remove the lower baffle, oil pump pick-up and upper baffle.
- Remove the oil pump case mounting bolts and the oil pump case.
- Remove the oil pump gear cover.
- Make matchmarks on the oil pump rotors before removing them.
- Remove the crankshaft seal from the oil pump case.

To install:

- Install a new crankshaft seal in the oil pump cover.
- Apply engine oil to the rotors, then align the matchmarks and install the rotors in the oil pump case.
- Install the rotor cover. Tighten the bolts to 7 ft. lbs. (10 Nm).
- Apply a 0.113 in. (3mm) bead of sealant to the back of the oil pump case. Install the case on the engine and tighten the bolts to 10 ft. lbs. (14 Nm).
- Install the upper baffle plate and oil pump pick-up using a new gasket. Tighten the baffle bolts to 7 ft. lbs. (10 Nm) and the pick-up bolts to 13 ft. lbs. (18 Nm).
- Install the lower baffle in the upper oil pan. Tighten the bolts to 8 ft. lbs. (11 Nm).
- Install the oil pans.
- Install the oil filter adapter using a new gasket. Tighten the larger bolt to 30 ft. lbs. (41 Nm) and the smaller bolt to 17 ft. lbs. (23 Nm).
- Install the timing belt and remaining components. Refer to the timing belt procedure in this section.
- Fill the engine with the correct amount of oil.

WARNING

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

- Connect the negative battery cable.
- Start the engine and check for leaks.

Crankshaft Damper

REMOVAL & INSTALLATION

♦ See Figures 153 and 154

- Disconnect the negative battery cable.
- Remove the accessory drive belts from around the crankshaft pulley. Refer to Section 1.

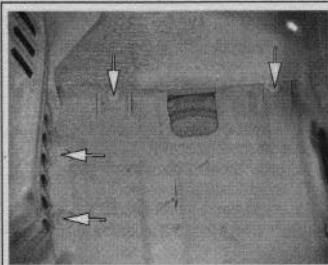


Fig. 153 Remove the fasteners, then remove the side inner fender splash shield

- Raise and support the vehicle.
- Remove the passenger side front wheel.
- Remove the passenger side inner fender splash shield to gain access to the crankshaft damper.
- On the 1.5L, 1.6L, 2.0L and 2.4L engines, remove the pulley-to-sprocket bolts.
- On the 1.5L, 1.8L, 3.0L and 3.5L engines, remove the crankshaft pulley center retaining bolt.
- Remove the damper from the crankshaft using a suitable puller.

To install:

- Place the damper onto the crankshaft, ensuring the key-way is aligned.
- On the 1.5L, 1.8L, 3.0L and 3.5L engines, install the crankshaft pulley center retaining bolt and tighten the bolt as follows:
 - 1.5L engine: 51–72 ft. lbs. (70–100 Nm)
 - 1.8L and 3.5L engines: 134 ft. lbs. (185 Nm)
 - 3.0L engines: 108–116 ft. lbs. (150–160 Nm)
- On the 1.5L, 1.6L, 2.0L and 2.4L engines, install the pulley-to-sprocket bolts and tighten the bolts as follows:
 - 1.5L engine: 10 ft. lbs. (14 Nm)
 - 1.6L and 2.0L engines: 14–22 ft. lbs. (20–30 Nm)
 - 2.4L engine: 18 ft. lbs. (25 Nm)
- On the 1.6L and 2.0L engines, install the pulley-to-sprocket bolts and tighten them to 14–22 ft. lbs. (20–30 Nm).
- Install the splash shield.
- Install the wheel, then carefully lower the vehicle.
- Install the accessory drive belts. Refer to Section 1.
- Connect the negative battery cable.

Timing Cover and Belt

REMOVAL & INSTALLATION

Refer to Section 1 for the proper timing belt service interval.

1.5L Engine

1990–94 MODELS

♦ See Figures 155 and 156

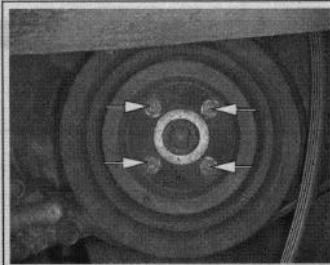


Fig. 154 Unfasten the crankshaft pulley retaining bolts, then remove the pulley

- Disconnect the negative battery cable.
- Remove the engine under cover.
- Raise and safely support the weight of the engine using the appropriate equipment. Remove the front engine mount bracket and accessory drive belts.
- If necessary, remove the coolant reservoir tank.
- Using the proper equipment, slightly raise the engine to take the weight off the side engine mount. Remove the engine mount bracket.
- Remove the drive belts, tension pulley brackets, water pump pulley and crankshaft pulley.
- Remove all attaching screws and remove the upper and lower timing belt covers.
- Make a mark on the back of the timing belt indicating the direction of rotation so it may be re-assembled in the same direction if it is to be reused. Loosen the timing belt tensioner and remove the timing belt.

If coolant or engine oil comes in contact with the timing belt, they will drastically shorten its life. Also, do not allow engine oil or coolant to contact the timing belt sprockets or tensioner assembly.

- Remove the tensioner spacer, tensioner spring and tensioner assembly.
- Inspect the timing belt for cracks on back surface, sides, bottom and check for separated canvas. Check the tensioner pulley for smooth rotation.

To install:

- Position the tensioner, tensioner spring and tensioner spacer on engine block.
- Align the timing marks on the camshaft sprocket and crankshaft sprocket. This will position No. 1 piston on TDC on the compression stroke.
- Position the timing belt on the crankshaft sprocket and keeping the tension side of the belt tight, set it on the camshaft sprocket.
- Apply counterclockwise force to the camshaft sprocket to give tension to the belt and make sure all timing marks are aligned.
- Loosen the pivot side tensioner bolt and the slot side bolt. Allow the spring to take up the slack.
- Tighten the slot side tensioner bolt and then the pivot side bolt. If the pivot side bolt is tightened first, the tensioner could turn with bolt, causing over tension.
- Turn the crankshaft clockwise. Loosen the pivot side tensioner bolt and then the slot side bolt to allow the spring to take up any remaining slack.

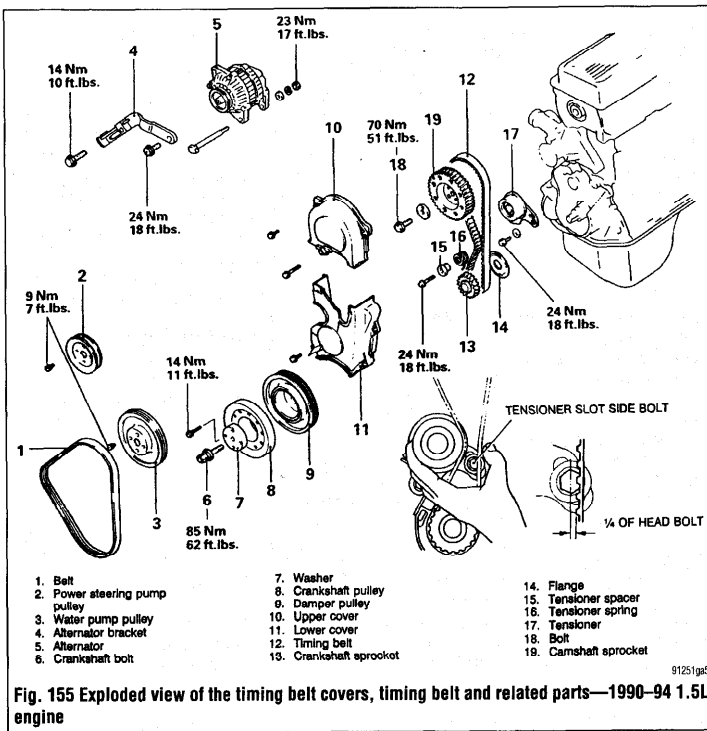


Fig. 155 Exploded view of the timing belt covers, timing belt and related parts—1990-94 1.5L engine

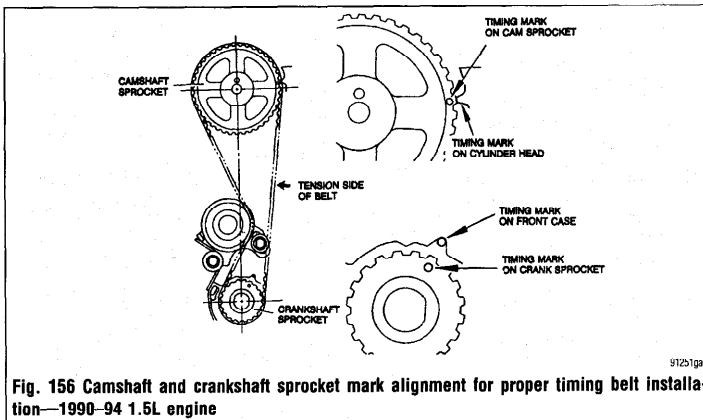


Fig. 156 Camshaft and crankshaft sprocket mark alignment for proper timing belt installation—1990-94 1.5L engine

Tighten the slot bolt and then the pivot side bolt to 14-20 ft. lbs. (20-27 Nm).

18. Check the belt tension by holding the tensioner and timing belt together by hand and give the belt a slight thumb pressure at a point level with tensioner center. Make sure the belt cog crest comes as deep as about 1/4 of the width of the slot side tensioner bolt head. Do not manually over-tighten the belt or it will make a howling noise.

19. Install the timing belt covers and all related items.

20. Connect the negative battery cable.

1995-00 MODELS

See Figure 157

1. Disconnect the negative battery cable.
2. Remove the engine undercover.
3. Rotate the crankshaft clockwise and position the engine at TDC of the compression stroke.
4. Raise and safely support the weight of the engine using the appropriate equipment. Remove the A/C clamp, front engine mount bracket and accessory drive belts.
5. Remove the crankshaft pulley.

6. Remove timing belt upper and lower covers.
7. Make a mark on the back of the timing belt indicating the direction of rotation so it may be re-assembled in the same direction if it is to be reused. Loosen the timing belt tensioner and move the tensioner to provide slack to the timing belt. Tighten the tensioner in this position.
8. Remove the timing belt.

** WARNING

Coolant and engine oil will damage the rubber in the timing belt, drastically reducing its life. Do not allow engine oil or coolant to contact the timing belt, the sprockets or tensioner assembly.

9. If defective, remove the tensioner spacer, tensioner spring and tensioner assembly.

To install:

10. Position the tensioner, tensioner spring and tensioner spacer on engine block.

11. Align the timing marks on the camshaft sprocket and crankshaft sprocket. This will position No. 1 piston on TDC on the compression stroke.

12. Position the timing belt on the crankshaft sprocket and keeping the tension side of the belt tight, set it on the camshaft sprocket, then the tensioner.

13. Apply slight counterclockwise force to the camshaft sprocket to give tension to the belt and be sure all timing marks are aligned.

14. Loosen the pivot side tensioner bolt and the slot side bolt. Allow the spring to remove the slack.

15. Tighten the slot side tensioner bolt, then the pivot side bolt. If the pivot side bolt is tightened first, the tensioner could turn with bolt, causing over tension.

16. Turn the crankshaft clockwise. Loosen the pivot side tensioner bolt, then the slot side bolt to allow the spring to take up any remaining slack. Tighten the slot bolt, then the pivot side bolt to 17 ft. lbs. (24 Nm).

17. Install the timing belt covers and tighten the cover bolts to 84-96 inch lbs. (10-11 Nm). Install all other applicable components.

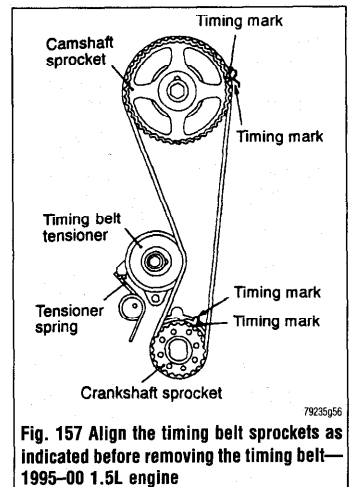


Fig. 157 Align the timing belt sprockets as indicated before removing the timing belt—1995-00 1.5L engine

1.6L & 2.0L (Non-Turbo) DOHC Engines

♦ See Figure 158

➔ **The 1.6L engine is not equipped with silent shafts. Disregard all instructions pertaining to silent shafts if working on that engine.**

1. Disconnect the negative battery cable.
2. Remove the engine undercover.
3. If necessary, remove the coolant reservoir.
4. Using the proper equipment, slightly raise the engine to take the weight off the side engine mount. Remove the engine mount bracket.
5. Remove the drive belts, tension pulley brackets, water pump pulley and crankshaft pulley.
6. Remove all attaching screws and remove the upper and lower timing belt covers.
7. Rotate the crankshaft clockwise and align the timing marks so No. 1 piston will be at TDC of the compression stroke. At this time the timing marks on the camshaft sprocket and the upper surface of the cylinder head should coincide, and the dowel pin of the camshaft sprocket should be at the upper side.

➔ **Always rotate the crankshaft in a clockwise direction. Make a mark on the back of the timing belt indicating the direction of rotation so it may be reassembled in the same direction if it is to be reused.**

8. Remove the auto tensioner and remove the outermost timing belt.
9. Remove the timing belt tensioner pulley, tensioner arm, idler pulley, oil pump sprocket, special washer, flange and spacer.
10. Remove the silent shaft (inner) belt tensioner and remove the belt.

To install:

11. Align the timing marks on the crankshaft sprocket and the silent shaft sprocket. Fit the inner timing belt over the crankshaft and silent shaft sprocket. Ensure that there is no slack in the belt.
12. While holding the inner timing belt tensioner with your fingers, adjust the timing belt tension by applying a force towards the center of the belt, until the tension side of the belt is taut. Tighten the tensioner bolt.

➔ **When tightening the bolt of the tensioner, ensure that the tensioner pulley shaft does not rotate with the bolt. Allowing it to rotate with the bolt can cause excessive tension on the belt.**

13. Check belt for proper tension by depressing the belt on it's long side with your finger and noting the belt deflection. The desired reading is 0.20–0.28 in. (5–7mm). If tension is not correct, readjust and check belt deflection.

14. Install the flange, crankshaft and washer to the crankshaft. The flange on the crankshaft sprocket must be installed towards the inner timing belt sprocket. Tighten bolt to 80–94 ft. lbs. (110–130 Nm).

15. To install the oil pump sprocket, insert a Phillips screwdriver with a shaft 0.31 in. (8mm) in diameter into the plug hole in the left side of the cylinder block to hold the left silent shaft. Tighten the nut to 36–43 ft. lbs. (50–60 Nm).

16. Using a wrench, hold the camshaft at it's hexagon between journal No. 2 and 3, then tighten the bolt to 58–72 ft. lbs. (80–100 Nm). If no hexagon is present between journal No. 2 and 3, hold the sprocket stationary with a spanner wrench while tightening the retainer bolt.

17. Carefully push the auto tensioner rod in until the set hole in the rod aligns with the hole in the cylinder. Place a wire into the hole to retain the rod.

18. Install the tensioner pulley onto the tensioner arm. Locate the pinhole in the tensioner pulley shaft to the left of the center bolt. Then, tighten the center bolt finger-tight.

19. When installing the timing belt, turn the 2 camshaft sprockets so their dowel pins are located on top. Align the timing marks facing each other with the top surface of the cylinder head. When you let go of the exhaust camshaft sprocket, it will rotate 1 tooth in the counterclockwise direction. This should be taken into account when installing the timing belts on the sprocket.

➔ **Both camshaft sprockets are used for the intake and exhaust camshafts and are provided with 2 timing marks. When the sprocket is mounted on the exhaust camshaft, use the timing mark on the right with the dowel pin hole on top. For the intake camshaft sprocket, use the 1 on the left with the dowel pin hole on top.**

20. Align the crankshaft sprocket and oil pump sprocket timing marks.

21. After alignment of the oil pump sprocket timing marks, remove the plug on the cylinder block and insert a Phillips screwdriver with a shaft diameter of 0.31 in. (8mm) through the hole. If the shaft can be inserted 2.4 in. deep, the silent shaft is in the correct position. If the shaft of the tool can only be inserted 0.8–1.0 in. (20–25mm) deep, turn the oil pump sprocket 1 turn and realign the marks. Reinsert the tool making sure it is inserted 2.4 in. deep. Keep the tool inserted in hole for the remainder of this procedure.

➔ **The above step assures that the oil pump socket is in correct orientation to the silent shafts. This step must not be skipped or a vibration may develop during engine operation.**

22. Install the timing belt as follows:
 - a. Install the timing belt around the intake camshaft sprocket and retain it with 2 spring clips or binder clips.
 - b. Install the timing belt around the exhaust sprocket, aligning the timing marks with the cylinder head top surface using 2 wrenches. Retain the belt with 2 spring clips.

c. Install the timing belt around the idler pulley, oil pump sprocket, crankshaft sprocket and the tensioner pulley. Remove the 2 spring clips.

d. Lift upward on the tensioner pulley in a clockwise direction and tighten the center bolt. Make sure all timing marks are aligned.

e. Rotate the crankshaft 1/4 turn counterclockwise. Then, turn in clockwise until the timing marks are aligned again.

23. To adjust the timing (outer) belt, turn the crankshaft 1/4 turn counterclockwise, then turn it clockwise to move No. 1 cylinder to TDC.

24. Loosen the center bolt. Using tool MD998738 or equivalent and a torque wrench, apply a torque of 22–25 inch. lbs. (2.6–2.8 Nm). Tighten the center bolt.

25. Screw the special tool into the engine left support bracket until its end makes contact with the tensioner arm. At this point, screw the special tool in some more and remove the set wire attached to the auto tensioner, if the wire was not previously removed. Then remove the special tool.

26. Rotate the crankshaft 2 complete turns clockwise and let it sit for approximately 15 minutes. Then, measure the auto tensioner protrusion (the distance between the tensioner arm and auto tensioner body) to ensure that it is within 0.15–0.18 in. (3.8–4.5mm). If out of specification, repeat Step 1–4 until the specified value is obtained.

27. If the timing belt tension adjustment is being performed with the engine mounted in the vehicle, and clearance between the tensioner arm and the auto tensioner body cannot be measured, the following alternative method can be used:

a. Screw in special tool MD998738 or equivalent, until its end makes contact with the tensioner arm.

b. After the special tool makes contact with the arm, screw it in some more to retract the auto tensioner pushrod while counting the number of turns the tool makes until the tensioner arm is brought into contact with the auto tensioner body. Make sure the number of turns the special tool makes conforms with the standard value of 2 1/2–3 turns.

c. Install the rubber plug to the timing belt rear cover.

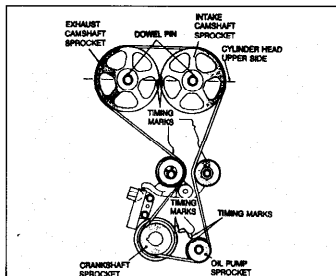
28. Install the timing belt covers and all related items.

29. Connect the negative battery cable.

1.8L & 2.0L SOHC Engines

♦ See Figures 159, 160, and 161

1. Position the engine so the No. 1 piston is at TDC of the compression stroke.
2. Disconnect the negative battery cable.
3. Remove the engine undercover.
4. Using the proper equipment, slightly raise the engine to take the weight off the side engine mount. Remove the engine mount bracket.
5. Remove the drive belts, tension pulley brackets, water pump pulley and crankshaft pulley.
6. Remove all attaching screws and remove the upper and lower timing belt covers.
7. Remove the timing belt covers.
8. Remove the outer crankshaft sprocket and flange.
9. Remove the silent shaft (inner) belt tensioner and remove the belt.



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Fig. 158 Camshaft and crankshaft timing belt sprocket alignment marks—1990–94 Mitsubishi 1.6L and 2.0L DOHC engines

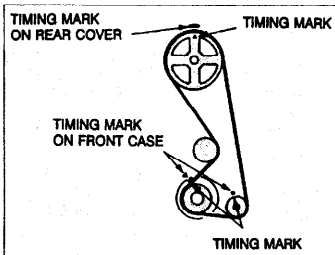


Fig. 159 Camshaft and crankshaft sprocket alignment for proper timing belt replacement—1.8L and 2.0L SOHC engines

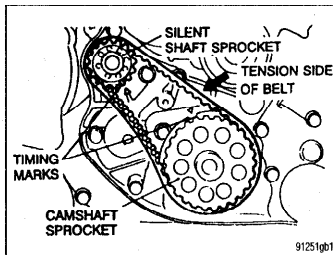


Fig. 160 Silent shaft sprocket alignment marks for belt replacement—1.8L and 2.0L SOHC engines

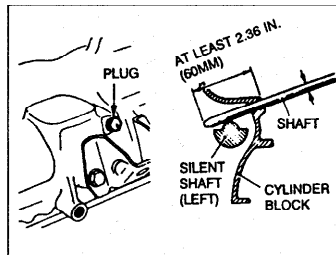


Fig. 161 Checking the rear silent shaft for proper positioning—1.8L and 2.0L SOHC engines

To install:

10. Align the timing marks of the silent shaft sprockets and the crankshaft sprocket with the timing marks on the front case.
11. Wrap the timing belt around the sprockets so there is no slack in the upper span of the belt and the timing marks are still aligned.
12. Install the tensioner pulley and move the pulley by hand so the long side of the belt deflects about $\frac{1}{4}$ in. (6mm).
13. Hold the pulley tightly so the pulley cannot rotate when the bolt is tightened. Tighten the bolt to 15 ft. lbs. (20 Nm) and recheck the deflection amount.
14. Install the timing belt tensioner fully toward the water pump and tighten the bolts. Place the upper end of the spring against the water pump body.
15. Align the timing marks of the camshaft, crankshaft and oil pump sprockets with their corresponding marks on the front case or rear cover.

➔ **There is a possibility to align all timing marks and have the oil pump sprocket and silent shaft out of time, causing an engine vibration during operation. If the following step is not followed exactly, there is a 50 percent chance that the silent shaft alignment will be 180 degrees off.**

16. Before installing the timing belt, ensure that the left side (rear) silent shaft (oil pump sprocket) is in the correct position as follows:
 - a. Remove the plug from the rear side of the block and insert a tool with shaft diameter of 0.31 in. (8mm) into the hole.
 - b. With the timing marks still aligned, the shaft of the tool must be able to go in at least $2\frac{1}{3}$ in. (59mm). If the tool can only go in about 1 in. (25mm), the shaft is not in the correct orientation and will cause a vibration during engine operation. Remove the tool from the hole and turn the oil pump sprocket 1 complete revolution. Realign the timing marks and insert the tool. The shaft of the tool must go in at least $2\frac{1}{3}$ in. (59mm).
 - c. Recheck and realign the timing marks.
 - d. Leave the tool in place to hold the silent shaft while continuing.
17. Install the belt to the crankshaft sprocket, oil pump sprocket, then camshaft sprocket, in that order. While doing so, make sure there is no slack between the sprocket except where the tensioner is installed.
18. Recheck the timing marks' alignment. If all are aligned, loosen the tensioner mounting bolt and allow the tensioner to apply tension to the belt.

19. Remove the tool that is holding the silent shaft and rotate the crankshaft a distance equal to 2 teeth on the camshaft sprocket. This will allow the tensioner to automatically apply the proper tension on the belt. Do not manually overtighten the belt or it will howl.
20. Tighten the lower mounting bolt first, then the upper spacer bolt.
21. To verify correct belt tension, check that the deflection at the longest span of the belt is about $\frac{1}{2}$ in. (13mm).
22. The installation of the timing belt covers and all related items, is the reverse of the removal procedure. Make sure all pieces of packing are positioned in the inner grooves of the covers when installing.
23. Connect the negative battery cable.

2.0L (Turbo) DOHC Engine

♦ See Figures 162 and 163

1. Disconnect the negative battery cable.
2. Remove the engine undercover.
3. Remove the engine mount bracket.
4. Remove the drive belts.
5. Remove the belt tensioner pulley.
6. Remove the water pump pulleys.
7. Remove the crankshaft pulley.
8. Remove the stud bolt from the engine support bracket and remove the timing belt covers.
9. Rotate the crankshaft clockwise to line up the camshaft timing marks. Always turn the crankshaft in the normal direction of rotation only.
10. Loosen the tension pulley center bolt.

➔ **If the timing belt is to be reused, mark the direction of rotation on the flat side of the belt with an arrow.**

11. Move the tension pulley towards the water pump and remove the timing belt.
12. Remove the crankshaft sprocket center bolt using special tool MB9G67 to hold the crankshaft sprocket while removing the center bolt. Then, use MB998778 or equivalent puller to remove the sprocket.
13. Mark the direction of rotation on the timing belt B with an arrow.
14. Loosen the center bolt on the tensioner and remove the belt.

*** WARNING

Do not rotate the camshafts or the crankshaft while the timing belt is removed.

To install:

15. Place the crankshaft sprocket on the crankshaft. Use tool MB9G67 or equivalent to hold the crankshaft sprocket while tightening the center bolt. Tighten the center bolt to 80–94 ft. lbs. (108–127 Nm).
16. Align the timing marks on the crankshaft sprocket B and the balance shaft.
17. Install timing belt B on the sprockets. Position the center of the tensioner pulley to the left and above the center of the mounting bolt.
18. Push the pulley clockwise toward the crankshaft to apply tension to the belt and tighten the mounting bolt to 14 ft. lbs. (19 Nm). Do not let the pulley turn when tightening the bolt because it will cause excessive tension on the belt. The belt should deflect 0.20–0.28 in. (5–7mm) when finger pressure is applied between the pulleys.
19. Install the crankshaft sensing blade and the crankshaft sprocket. Apply engine oil to the mounting bolt and tighten the bolt to 80–94 ft. lbs. (108–127 Nm).
20. Use a press or vise to compress the auto-tensioner pushrod. Insert a set pin when the holes are lined up.

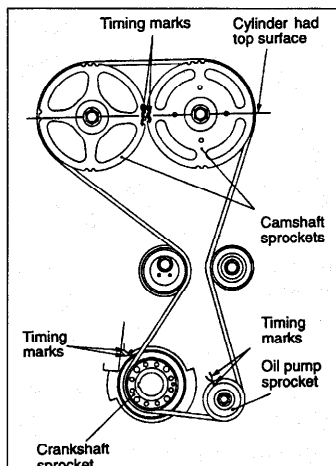


Fig. 162 Camshaft and crankshaft timing belt sprocket TDC alignment mark positioning for timing belt removal and installation—2.0L turbo engine

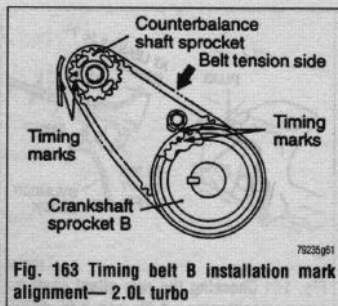


Fig. 163 Timing belt B installation mark alignment—2.0L turbo

WARNING

Do not compress the pushrod too quickly, damage to the pushrod can occur.

21. Install the auto-tensioner on the engine.
22. Align the timing marks on the camshaft sprocket, crankshaft sprocket and the oil pump sprocket.
23. After aligning the mark on the oil pump sprocket, remove the cylinder block plug and insert a prytool in the hole to check the position of the counterbalance shaft. The prytool should go in at least 2.36 in. (60mm) or more, if not, rotate the oil pump sprocket once and realign the timing mark so the prytool goes in. Do not remove the prytool until the timing belt is installed.
24. Install the timing belt on the intake camshaft and secure it with a clip.
25. Install the timing belt on the exhaust camshaft.
26. Align the timing marks with the cylinder head top surface using two wrenches. Secure the belt with another clip.
27. Install the belt around the idler pulley, oil pump sprocket, crankshaft sprocket and the tensioner pulley.
28. Turn the tensioner pulley so the pinholes are at the bottom. Press the pulley lightly against the timing belt.
29. Screw the special tool into the left engine support bracket until it contacts the tensioner arm, then screw the tool in a little more and remove the pushrod pin from the auto-tensioner. Remove the special tool and tighten the center bolt to 35 ft. lbs. (48 Nm).
30. Turn the crankshaft $\frac{1}{4}$ turn counterclockwise, then clockwise until the timing marks are aligned.
31. Loosen the center bolt. Install Mitsubishi Special Tool MD998767, or equivalent, on the tensioner pulley. Turn the tensioner pulley counterclockwise with a torque of 2.6 ft. lbs. (3.5 Nm) and tighten the center bolt to 35 ft. lbs. (48 Nm). Do not let the tensioner pulley turn when tightening the bolt.
32. Turn the crankshaft clockwise two revolutions and align the timing marks.
33. After 15 minutes, measure the protrusion of the pushrod on the auto-tensioner. The standard measurement is 0.150–0.177 in (3.8–4.5mm). If the protrusion is out of specification, loosen the tensioner pulley, apply the proper torque to the belt and retighten the center bolt.
34. Install the timing belt covers and all applicable components.

2.4L Engine

See Figures 164 thru 182

1. Be sure that the engine's No. 1 piston is at TDC in the compression stroke.

CAUTION

Wait at least 90 seconds after the negative battery cable is disconnected to prevent possible deployment of the air bag.

2. Disconnect the negative battery cable.
3. Remove the spark plug wires from the tree on the upper cover.
4. Drain the cooling system.

CAUTION

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

5. Remove the shroud, fan and accessory drive belts.
6. Remove the radiator as required.



Fig. 164 Remove the upper engine mount-to-mount bracket nuts

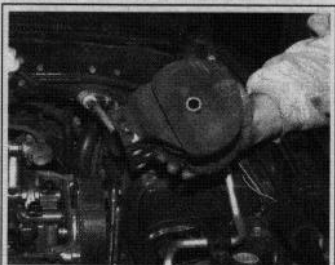


Fig. 166 . . . then remove the engine mount from the vehicle

7. Remove the power steering pump, alternator, air conditioning compressor, tension pulley and accompanying brackets, as required.

8. Remove the upper front timing belt cover.
9. Remove the water pump pulley and the crankshaft pulley(s).
10. Remove the lower timing belt cover mounting screws and remove the cover.
11. If the belt(s) are to be reused, mark the direction of rotation on the belt.
12. Remove the timing (outer) belt tensioner and remove the belt. Unbolt the tensioner from the block and remove.
13. Remove the outer crankshaft sprocket and flange.
14. Remove the silent shaft (inner) belt tensioner and remove the inner belt. Unbolt the tensioner from the block and remove it.
15. To remove the camshaft sprockets, use SST MB9g67-01 and MIT308239, or their equivalents.

To install:

16. Install the camshaft sprockets and tighten the center bolt to 65 ft. lbs. (90 Nm).
17. Align the timing mark of the silent shaft belt sprockets on the crankshaft and silent shaft with the marks on the front case. Wrap the silent shaft belt around the sprockets so there is no slack in the upper span of the belt and the timing marks are still in line.
18. Install the tensioner initially so the actual center of the pulley is above and to the left of the installation bolt.
19. Move the pulley up by hand so the center span of the long side of the belt deflects about $\frac{1}{4}$ in. (6mm).



Fig. 165 Remove the upper engine mount through-bolt . . .



Fig. 167 Remove the three upper timing cover retaining bolts . . .



Fig. 168 . . . then remove the upper timing cover

93153p64



Fig. 169 Remove the A/C belt tensioner pulley and bracket assembly

93153p65



Fig. 170 Loosen the bolt on the tensioner pulley and slide the pulley to the left to relieve the tension on the timing belt

93153p64



Fig. 171 Make sure you mark the rotation of the timing belt if you plan on reusing the belt

93153p66

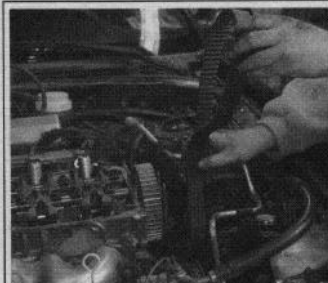


Fig. 172 Remove the timing belt from the engine by lifting it out the top

93153p65



Fig. 173 Unfasten the two timing belt tensioner retaining bolts . . .

93153p67

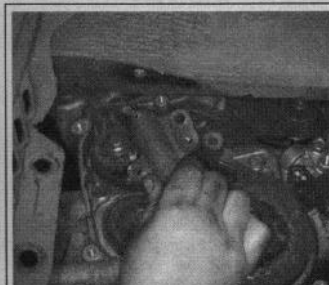


Fig. 174 . . . then remove the tensioner from the engine block

93153p68



Fig. 175 Remove the bolt and remove the crankshaft timing belt pulley

93153p69



Fig. 176 After unfastening the retainer, remove the CKP trigger wheel from the crankshaft

93153p69

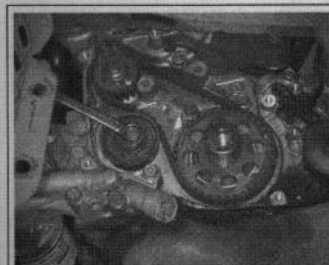


Fig. 177 Remove the silent shaft tensioner retaining bolt . . .

93153p79



Fig. 178 . . . then remove the tensioner from the engine block

93153p80

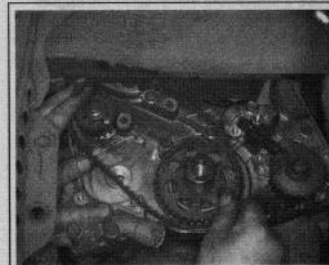


Fig. 179 Remove the silent shaft belt from the engine

93153p81

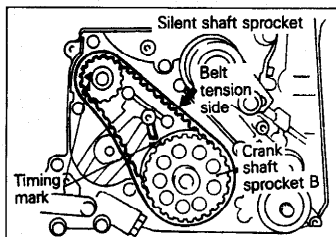


Fig. 180 Silent shaft alignment marks. Notice the tension side of the inner (silent shaft) belt—2.4L engine

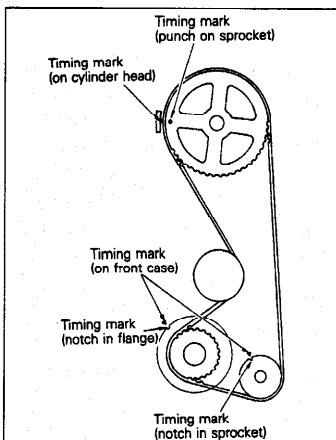


Fig. 181 Timing belt pulley alignment marks—2.4L engine

20. Hold the pulley tightly so it does not rotate when the bolt is tightened. Tighten the bolt to 15 ft. lbs. (20 Nm). If the pulley has moved, the belt will be too tight.

21. Install the timing belt tensioner fully toward the water pump and temporarily tighten the bolts. Place the upper end of the spring against the water pump body. Align the timing marks of the cam, crankshaft and oil pump sprockets with the corresponding marks on the front case or head.

⚠ If the following steps are not followed exactly, there is a chance that the silent shaft alignment will be 180 degrees off. This will cause a noticeable vibration in the engine and the entire procedure will have to be repeated.

22. Before installing the timing belt, ensure that the left side silent shaft is in the correct position.

➡ It is possible to align the timing marks on the camshaft sprocket, crankshaft sprocket and the oil pump sprocket with the left balance shaft out of alignment.

23. With the timing mark on the oil pump pulley aligned with the mark on the front case, check the alignment of the left balance shaft to assure correct shaft timing.

a. Remove the plug located on the left side of the block in the area of the starter.

b. Insert a tool having a shaft diameter of 0.3 in. (8mm) into the hole.

c. With the timing marks still aligned, the tool must be able to go in at least 2 1/3 in. (59mm). If it can only go in about 1 in. (25mm), turn the oil pump sprocket one complete revolution.

d. Recheck the position of the balance shaft with the timing marks realigned. Leave the tool in place to hold the silent shaft while continuing.

24. Install the belt to the crankshaft sprocket, oil pump sprocket and the camshaft sprocket, in that order. While doing so, be sure there is no slack between the sprockets except where the tensioner will take it up when released.

25. Recheck the timing marks' alignment.

26. If all are aligned, loosen the tensioner mounting bolt, and allow the tensioner to apply tension to the belt.

27. Remove the tool that is holding the silent shaft in place and turn the crankshaft clockwise a distance equal to two teeth of the camshaft sprocket. This will allow the tensioner to automatically tension the belt the proper amount.

*** WARNING

Do not manually apply pressure to the tensioner. This will overtighten the belt and will cause a howling noise.

28. First tighten the lower mounting bolt and then tighten the upper spacer bolt.

*** WARNING

If any binding is felt when adjusting the timing belt tension by turning the crankshaft, STOP turning the engine, because the pistons may be hitting the valves.

29. To verify that belt tension is correct, check that the deflection of the longest span (between the camshaft and oil pump sprockets) is 1/2 in. (13mm).

30. Install the lower timing belt cover. Be sure the packing is properly positioned in the inner grooves of the covers when installing.

31. Install the water pump pulley and the crankshaft pulley(s).

32. Install the upper front timing belt cover.

33. Install the power steering pump, alternator, air conditioning compressor, tension pulley and accompanying brackets, as required.

34. Install the radiator, shroud, fan and accessory drive belts.

35. Install the spark plug wires to the tree on the upper cover.

36. Refill the cooling system.

37. Connect the negative battery cable. Start the engine and check for leaks.

3.0L SOHC Engine

1992-94 MODELS

♦ See Figures 182 and 183

1. Disconnect the negative battery cable.
2. Remove the engine undercover.
3. Remove the cruise control actuator.
4. Remove the accessory drive belts.

5. Remove the air conditioner compressor tension pulley assembly.

6. Remove the tension pulley bracket.

7. Using the proper equipment, slightly raise the engine to take the weight off the side engine mount. Remove the engine mounting bracket.

8. Detach the power steering pump pressure switch connector. Remove the power steering pump and wire aside.

9. Remove the engine support bracket.

10. Remove the crankshaft pulley.

11. Remove the timing belt cover cap.

12. Remove the timing belt upper and lower covers.

13. If the same timing belt will be reused, mark the direction of the timing belt's rotation for installation in the same direction. Make sure the engine is positioned so the No. 1 cylinder is at the TDC of its compression stroke and the sprockets' timing marks are aligned with the engine's timing mark indicators.

14. Loosen the timing belt tensioner bolt and remove the belt. If the tensioner is not being removed, position it as far away from the center of the engine as possible and tighten the bolt.

15. If the tensioner is being removed, paint the outside of the spring to ensure that it is not installed backwards. Unbolt the tensioner and remove it along with the spring.

To install:

16. Install the tensioner, if removed, and hook the upper end of the spring to the water pump pin and the lower end to the tensioner in exactly the same position as originally installed. If not already done, position both camshafts so the marks align with those on the rear. Rotate the crankshaft so the timing mark aligns with the mark on the oil pump.

17. Install the timing belt on the crankshaft sprocket and while keeping the belt tight on the tensioner side, install the belt on the front camshaft sprocket.

18. Install the belt on the water pump pulley, then the rear camshaft sprocket and the tensioner.

19. Rotate the front camshaft counterclockwise to tension the belt between the front camshaft and the crankshaft. If the timing marks became misaligned, repeat the procedure.

20. Install the crankshaft sprocket flange.

21. Loosen the tensioner bolt and allow the spring to apply tension to the belt.

22. Turn the crankshaft 2 full turns in the clockwise direction until the timing marks align again.

Now that the belt is properly tensioned, torque the tensioner lock bolt to 21 ft. lbs. (29 Nm). Measure the belt tension between the rear camshaft sprocket and the crankshaft with belt tension gauge. The specification is 46-68 lbs. (210-310 N).

23. Install the timing covers. Make sure all pieces of packing are positioned in the inner grooves of the covers when installing.

24. Install the crankshaft pulley. Tighten the bolt to 108-116 ft. lbs. (150-160 Nm).

25. Install the engine support bracket.

26. Install the power steering pump and reconnect wire harness at the power steering pump pressure switch.

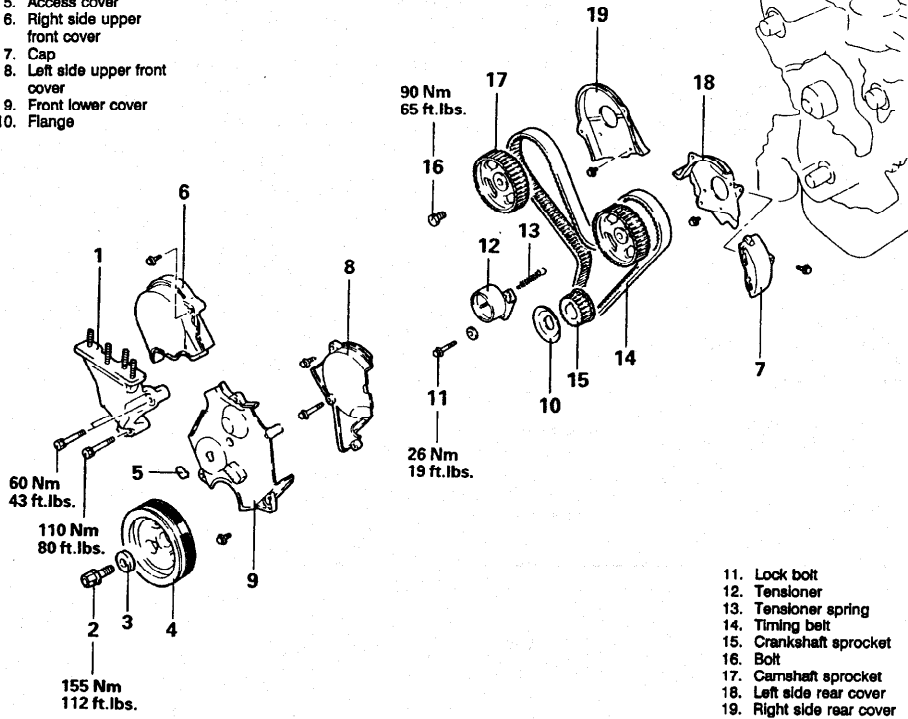
27. Install the engine mounting bracket and remove the engine support fixture.

28. Install the tension pulleys and drive belts.

29. Install the cruise control actuator.

30. Install the engine undercover.

1. Engine support bracket
2. Bolt
3. Washer
4. Crankshaft pulley
5. Access cover
6. Right side upper front cover
7. Cap
8. Left side upper front cover
9. Front lower cover
10. Flange



11. Lock bolt
12. Tensioner
13. Tensioner spring
14. Timing belt
15. Crankshaft sprocket
16. Bolt
17. Camshaft sprocket
18. Left side rear cover
19. Right side rear cover

Fig. 182 Exploded view of the timing belt covers, timing belt and related parts—1992-94 Mitsubishi 3.0L SOHC engine

91251g3

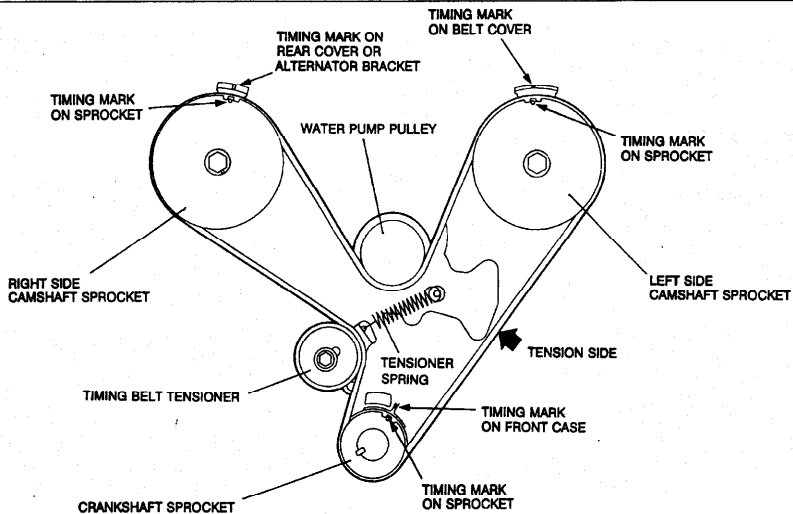


Fig. 183 Crankshaft and camshaft sprocket alignment for proper timing belt replacement—1992-94 Mitsubishi 3.0L SOHC engine

91251g4

3-44 ENGINE AND ENGINE OVERHAUL

31. Connect the negative battery cable.
32. Road test the vehicle.

EXCEPT 1992-94 MODELS

♦ See Figure 184

1. Position the engine so the No. 1 cylinder is at TDC of its compression stroke.
2. Disconnect the negative battery cable.

*** CAUTION

Wait at least 90 seconds after the negative battery cable is disconnected to prevent possible deployment of the air bag.

3. Remove the engine undercover.
4. Remove the front undercover panel.
5. Remove the cruise control pump and the link assembly.
6. Remove the alternator.
7. Raise and suspend the engine so that force is not applied to the engine mount.
8. Remove the timing covers from the engine.
9. If the same timing belt will be reused, mark the direction of the timing belt's rotation for installation in the same direction. Make sure the engine is positioned so the No. 1 cylinder is at the TDC of its compression stroke and the timing marks are aligned with the engine's timing mark indicators on the valve covers or head.

10. Loosen the center bolt of tensioner pulley and unbolt auto-tensioner assembly. The auto-tensioner assembly must be reset to correctly adjust belt tension. Remove the timing belt.

11. Using a wrench, hold the camshaft at its hexagon and remove the camshaft sprocket bolt.

12. Remove and position the auto-tensioner into a vise with soft jaws. The plug at the rear of tensioner protrudes, be sure to use a washer as a spacer to protect the plug from contacting vise jaws.

13. Slowly push the rod into the tensioner until the set hole in rod is aligned with set hole in the auto-tensioner.

14. Insert a 0.055 in. (1.4mm) wire into the aligned set holes. Unclamp the tensioner from the vise and install it on the engine. Tighten tensioner to 17 ft. lbs. (24 Nm).

15. Clean and inspect both auto tensioner mounting bolts. Coat the threads of the old bolts with thread sealer. If new bolts are installed, inspect the heads of the new bolts. If there is white paint on the bolt head, no sealer is required. If there is no paint on the head of the bolt, apply a coat of thread sealer to the bolt. Install both bolts and tighten to 17 ft. lbs. (24 Nm).

To Install:

16. Install the tensioner, if removed, and hook the upper end of the spring to the water pump pin and the lower end to the tensioner in exactly the same position as originally installed.

17. Ensure both camshafts are still positioned so the timing marks align with those on the rear timing covers.

18. Rotate the crankshaft so the timing mark aligns with the mark on the front cover.

19. Install the timing belt on the crankshaft sprocket and while keeping the belt tight on the tension side, install the belt on the front (left) camshaft sprocket.

20. Install the belt on the water pump pulley, then the rear (right) camshaft sprocket and the tensioner.

21. Loosen the bolt that secures the adjustment of the tensioner and lightly press the tensioner against the timing belt.

22. Check that the timing marks are in alignment.

23. Rotate the crankshaft 2 full turns in the clockwise direction only, then realign the timing marks.

24. Tighten the bolt that secures the tensioner to 19 ft. lbs. (26 Nm).

25. Install the lower and the upper timing belt covers, along with all other applicable components.

3.0L DOHC Engine

1992-94 MODELS

♦ See Figure 185

1. Position the engine so the No. 1 cylinder is at TDC of its compression stroke.
2. Disconnect the negative battery cable.
3. Remove the engine undercover.

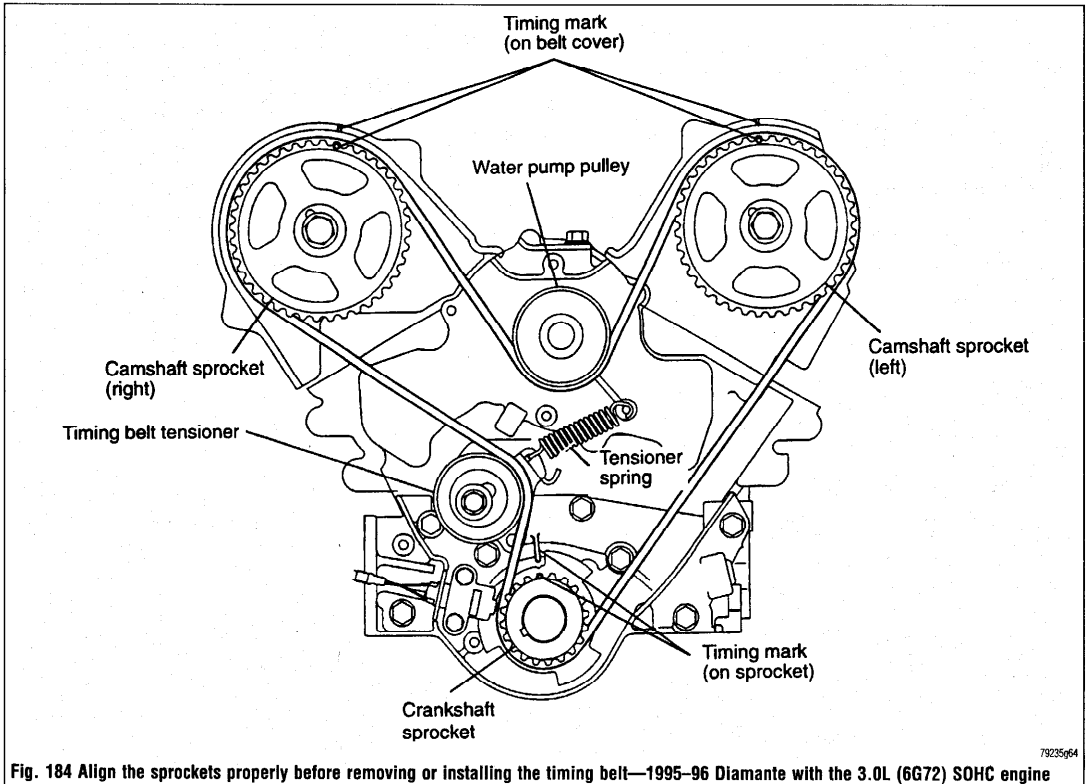


Fig. 184 Align the sprockets properly before removing or installing the timing belt—1995-96 Diamante with the 3.0L (6G72) SOHC engine

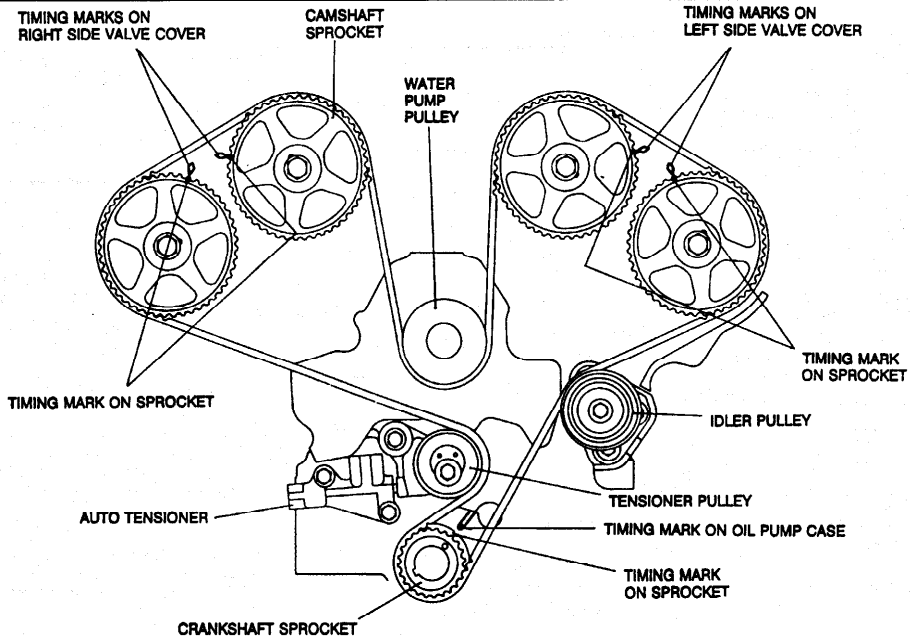


Fig. 185 Crankshaft and camshaft sprocket alignment for proper timing belt replacement—1992-94 Mitsubishi 3.0L DOHC engine

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4. Remove the cruise control actuator.
5. Remove the alternator. Remove the air hose and pipe.
6. Remove the belt tensioner assembly and the power steering belt.
7. Remove the crankshaft pulley.
8. Disconnect the brake fluid level sensor.
9. Remove the timing belt upper cover.
10. Using the proper equipment, slightly raise the engine to take the weight off the side engine mount. Remove the engine mount bracket.
11. Remove the alternator/air conditioner idler pulley.
12. Remove the engine support bracket. The mounting bolts are different lengths; mark them for proper installation.
13. Remove the timing belt lower cover. Timing belt cover mounting bolts are different in length, note their position during removal.
14. If the same timing belt will be reused, mark the direction of the timing belt's rotation for installation in the same direction. Make sure the engine is positioned so the No. 1 cylinder is at the TDC of its compression stroke and the sprockets' timing marks are aligned with the engine's timing mark indicators on the valve covers or head.
15. Loosen the timing belt tensioner bolt and remove the belt.
16. Remove the tensioner assembly.

To install:

17. If the auto tensioner rod is fully extended, reset it as follows:

- a. Clamp the tensioner in a soft-jaw vice in level position.
- b. Slowly push the rod in with the vice until the set hole in the rod is aligned with the hole in the cylinder.

- c. Insert a stiff wire into the set holes to retain the position.
- d. Remove the assembly from the vice.
18. Leave the retaining wire in the tension and install to the engine.
19. If the timing marks of the camshaft sprockets and crankshaft sprocket are not aligned at this point, proceed as follows:

➔ Keep fingers out from between the camshaft sprockets. The sprockets may move unexpectedly because of valve spring pressure and could pinch fingers.

- a. Align the mark on the crankshaft sprocket with the mark on the front case. Then move the sprocket 2 teeth clockwise to lower the piston so the valve can't touch the piston when the camshafts are being moved.
- b. Turn each camshaft sprocket 1 at a time to align the timing marks with the mark on the valve cover or head. If the intake and exhaust valves of the same cylinder are opened simultaneously, they could interfere with each other. Therefore, if any resistance is felt, turn the other camshaft to move the valve.
- c. Align the timing mark of the crankshaft sprocket, then continue 1 tooth farther in the counterclockwise direction to facilitate belt installation.

20. Using 4 spring loaded paper clips to hold the belt on the cam sprockets, install the belt to the sprockets in the following order:

- **1st**—exhaust camshaft sprocket for the front head
- **2nd**—intake camshaft sprocket for the front head
- **3rd**—water pump pulley

- **4th**—intake camshaft sprocket for the rear head
- **5th**—exhaust camshaft sprocket for the rear head
- **6th**—idler pulley
- **7th**—crankshaft sprocket
- **8th**—tensioner pulley

21. Turn the tensioner pulley so its pin holes are located above the center bolt. Then press the tensioner pulley against the timing belt and simultaneously tighten the center bolt.

22. Make certain that all timing marks are still aligned. If so, remove the 4 clips.

23. Turn the crankshaft 1/4 turn counterclockwise, then turn it clockwise until all timing marks are aligned.

24. Loosen the center bolt on the tensioner pulley. Using tool MD998767 or equivalent and a torque wrench, apply a torque of 7 ft. lbs. (10 Nm). Tighten the tensioner bolt; make sure the tensioner doesn't rotate with the belt.

25. Remove the set wire attached to the auto tensioner, if the wire was not previously removed.

26. Rotate the crankshaft 2 complete turns clockwise and let it sit for approximately 5 minutes. Then, make sure the set pin can easily be inserted and removed from the hole in the tensioner.

27. Measure the auto tensioner protrusion (the distance between the tensioner arm and auto tensioner body) to ensure that it is within 0.15–0.18 in. (3.8–4.5mm). If out of specification, repeat Steps 1–4 until the specified value is obtained.

28. Make sure all pieces of packing are positioned in the inner grooves of the lower cover, position cover on engine and install mounting bolts in their original location.

3-46 ENGINE AND ENGINE OVERHAUL

29. Install the engine support bracket and secure using mounting bolts in their original location. Lubricate the rearing area of the reamer bolt and tighten slowly.

30. Install the idler pulley.

31. Install the engine mount bracket. Remove the engine support fixture.

32. Make sure all pieces of packing are positioned in the inner grooves of the upper cover and install.

33. Connect the brake fluid level sensor.

34. Install the crankshaft pulley. Tighten the bolt to 130–137 ft. lbs. (180–190 Nm).

35. Install the belt tensioner assembly and the power steering belt.

36. Install the air hose and pipe.

37. Install the alternator.

38. Install the cruise control actuator.

39. Install the engine undercover.

40. Connect the negative battery cable.

5. Remove the alternator. Remove the air hose and pipe.

6. Remove the belt tensioner assembly and the power steering belt.

7. Remove the crankshaft pulley.

8. Disconnect the brake fluid level sensor.

9. Remove the timing belt upper cover.

10. Using the proper equipment, slightly raise the engine to take the weight off the side engine mount. Remove the engine mount bracket.

11. Remove the alternator/air conditioner idler pulley.

12. Remove the engine support bracket. The mounting bolts are different lengths; mark them for proper installation.

13. Remove the timing belt lower cover. Timing belt cover mounting bolts are different in length, note their position during removal.

*** CAUTION

Be sure to disconnect the negative battery cable. Wait at least 90 seconds after the negative battery cable is disconnected to prevent possible deployment of the air bag.

14. If the same timing belt will be reused, mark the direction of the timing belt's rotation for installation in the same direction. Be sure the engine is positioned so the No. 1 cylinder is at the TDC of its compression stroke and the timing marks are aligned with

the engine's timing mark indicators on the rear timing covers.

*** WARNING

Turning the camshaft sprocket when the timing belt is removed could cause the valves to contact with the pistons, resulting in severe engine damage.

15. Remove the bolts that secure the auto-tensioner to the engine block and remove the tensioner.

To install:

→ The auto-tensioner assembly must be reset to correctly adjust belt tension.

16. Loosen the center bolt of tensioner pulley to provide timing belt slack.

17. Remove the timing belt assembly.

18. Position the auto-tensioner into a vise with soft jaws. The plug at the rear of tensioner protrudes, be sure to use a washer as a spacer to protect the plug from contacting vise jaws.

19. Slowly push the rod into the tensioner until the set hole in rod is aligned with set hole in the auto-tensioner.

20. Insert a 0.055 in. (1.4mm) wire into the aligned set holes. Remove the tensioner from the vise and install it on the engine.

21. Tighten tensioner mounting bolts to 17 ft. lbs. (24 Nm).

1995–96 MODELS

♦ See Figure 186

1. Position the engine so the No. 1 cylinder is at TDC of its compression stroke.

2. Disconnect the negative battery cable.

3. Remove the engine undercover.

4. Remove the cruise control actuator.

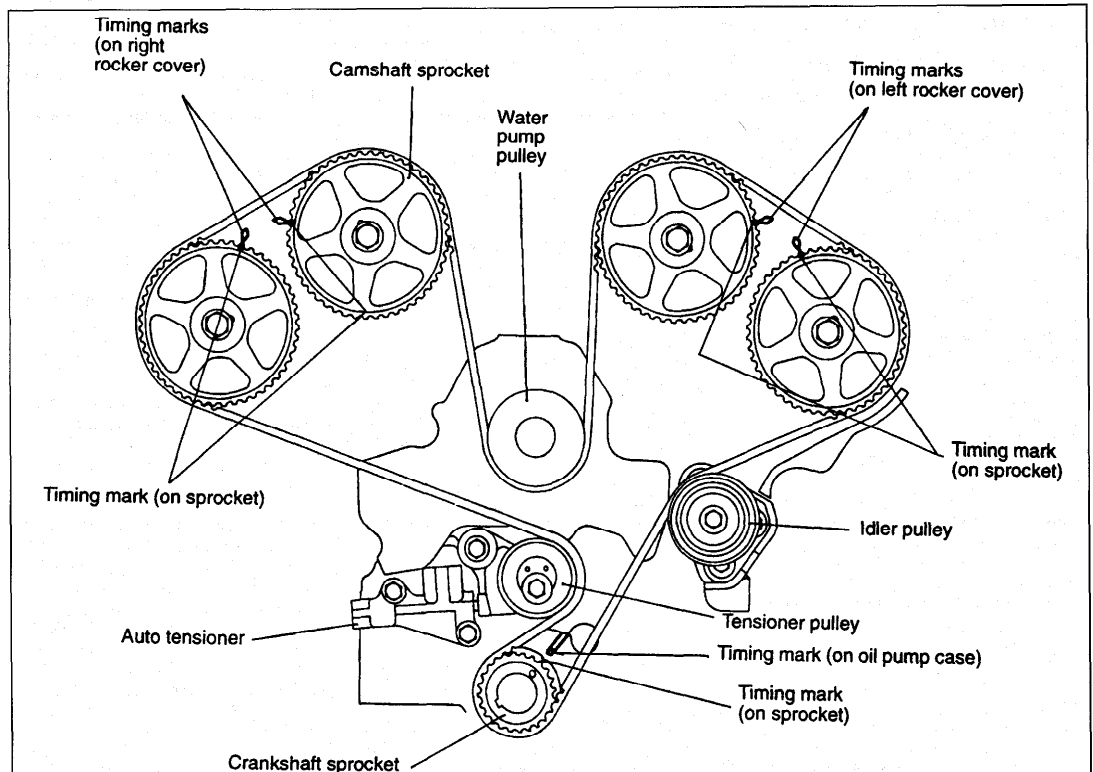


Fig. 186 Sprocket alignment for timing belt installation—1995–96 Diamante with the 3.0L (6G72) DOHC engine

***** WARNING**

DO NOT rotate or turn the camshafts when removing the sprockets or severe engine damage will result from internal component interference.

22. Align the mark on the crankshaft sprocket with the mark on the front case. Then, move the crankshaft sprocket 1 tooth counterclockwise.

23. Align the timing marks of the camshafts with the marks on the rear covers.

24. Using large paper clips to secure the timing belt to the sprockets, install the timing belt in the following order. Be sure camshafts-to-cylinder heads and crankshaft-to-front cover timing marks are aligned. Install the timing belt around the pulleys in the following order:

- Exhaust camshaft sprocket (front bank).
- Intake camshaft sprocket (front bank).
- Water pump pulley.
- Intake camshaft sprocket (rear bank).
- Exhaust camshaft sprocket (rear bank).
- Tensioner pulley.
- Crankshaft pulley.
- Idler pulley.

Since the camshaft sprockets turn easily, secure them with box wrenches when installing the timing belt.

25. Align all timing marks on the crankshaft and raise the tensioner pulley against the belt to remove slack, snug tensioner bolt.

26. Check the alignment of all the timing marks and remove the clips that secure the timing belt to the camshaft sprockets.

27. Rotate the engine $\frac{1}{4}$ turn counterclockwise, then rotate the engine clockwise to align the timing marks. Check that all the timing marks are in alignment.

28. Loosen the center bolt on the tensioner pulley.

29. Using tool MD998752 or equivalent and a torque wrench, apply 84 inch lbs. (10 Nm) to the tool on the tensioner. Tighten the tensioner bolt to 35 ft. lbs. (49 Nm) and be sure the tensioner does not rotate with the bolt.

30. Rotate the crankshaft two complete turns clockwise and let it sit for approximately five minutes. Then, check that the set pin can easily be inserted and removed from the hole in the auto-tensioner.

31. Remove the set wire attached to the auto-tensioner.

32. Measure the auto-tensioner protrusion (the distance between the tensioner arm and auto-tensioner body) to ensure that it is within 0.15–0.18 in. (3.8–4.5mm). If out of specification, repeat adjustment procedure until the specified value is obtained.

33. Check again that the timing marks on all sprockets are in proper alignment.

34. Install the timing belt covers and all other applicable components.

3.5L Engine**See Figure 187**

- Disconnect the negative battery cable.
- Drain the cooling system.

***** CAUTION**

Never open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

- Remove the drive belts.
- Remove the upper radiator shroud.
- Remove the fan and fan pulley.
- Without disconnecting the lines, remove the power steering pump from its bracket and position it to the side. Remove the pump brackets.
- Remove the belt tensioner pulley bracket.
- Without releasing the refrigerant, remove the air conditioning compressor from its bracket and position it to the side.
- Remove the bracket.

10. Remove the cooling fan bracket.

11. On some vehicles it may be necessary to remove the pulley from the crankshaft to access the lower cover bolts.

12. Remove the timing belt cover bolts and the upper and lower covers from the engine.

13. Detach the crankshaft position sensor connector.

14. Using SST MB9G67-01 and MD998754, or their equivalents, remove the crankshaft pulley from the crankshaft.

15. Use a shop rag to clean the timing marks to assist in properly aligning the timing marks.

16. Loosen the center bolt on the tension pulley and remove the timing belt.

If the same timing belt will be reused, mark the direction of timing belt's rotation, for installation in the same direction. Be sure engine is positioned so No. 1 cylinder is at the TDC of its compression stroke and the sprockets timing marks are aligned with the engine's timing mark indicators.

17. Remove the auto-tensioner, the tension pulley and the tension arm assembly.

18. Remove the sprockets by holding the hexagonal portion of the camshaft with a wrench while removing the sprocket bolt.

To install:

19. Install the crankshaft pulley and turn the crankshaft sprocket timing mark forward (clockwise) three teeth to move the piston slightly past No. 1 cylinder top dead center.

20. If removed, install the camshaft sprockets and tighten the bolts to 64 ft. lbs. (88 Nm).

21. Align the timing mark of the left bank side camshaft sprocket.

22. Align the timing mark of the right bank side camshaft sprocket, and hold the sprocket with a wrench so that it doesn't turn.

23. Set the timing belt onto the water pump pulley.

24. Check that the camshaft sprocket timing mark of the left bank side is aligned and clamp the timing belt with double clips.

25. Set the timing belt onto the idler pulley.

***** WARNING**

If any binding is felt when adjusting the timing belt tension by turning the crankshaft, STOP turning the engine, because the pistons may be hitting the valves.

26. Turn the crankshaft one turn counterclockwise and set the timing belt onto the crankshaft sprocket.

27. Set the timing belt on the tension pulley.

28. Place the tension pulley pin hole so that it is towards the top. Press the tension pulley onto the timing belt, and then provisionally tighten the fixing bolt. Tighten the bolt to 35 ft. lbs. (48 Nm).

29. Slowly turn the crankshaft two full turns in the clockwise direction until the timing marks align. Remove the four double clips.

30. Install the crankshaft position sensor connector.

31. Install the upper and lower covers on the engine and secure them with the retaining screws. Be sure the packing is properly positioned in the inner grooves of the covers when installing.

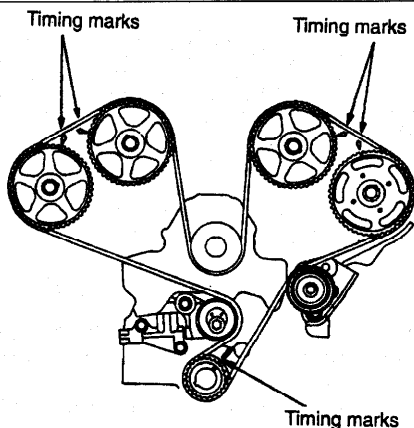


Fig. 187 Clean the timing marks to verify their position when aligning—3.5L engine

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32. Install the crankshaft pulley if it was removed. Tighten the bolt to 110 ft. lbs. (150 Nm).
33. Install the air conditioning bracket and compressor on the engine. Install the belt tensioner.
34. Install the power steering pump into position. Install the fan pulley and fan.
35. Install the fan shroud on the radiator.
36. Refill the cooling system.
37. Connect the negative battery cable.
38. Start the engine and check for fluid leaks.

INSPECTION

See Figures 188 thru 195

An inspection of the timing belt should be performed at least any time the upper timing belt cover is off. If the timing belt shows any signs of failure, it should be replaced. Recommended timing belt replacement intervals can be found in Section 1 of this manual.

Front Crankshaft Seal

REMOVAL & INSTALLATION

See Figure 196

On all engines, the camshaft oil seal requires the removal of the timing belt(s). It is advised to replace the seal while replacing the timing belts.

The seal is located behind the crankshaft timing sprocket.

1. To remove the seal use a suitable seal removal tool and pry it out of the cover.
2. Thoroughly clean the sealing area of the front cover.
3. Using a suitable installation tool (a large socket works well if none is available), install the seal into the front cover.

WARNING

Make sure to install the seal to the correct depth, if the seal is installed too far, an oil leak will occur.

Camshaft, Bearings and Lifters

REMOVAL & INSTALLATION

1.5L Engine

See Figures 197 and 198

1. Disconnect the negative battery cable.
2. Rotate the engine and position the No. 1 piston to TDC of its compression stroke.
3. Disconnect the accelerator cable, breather hose and PCV hose connections.
4. Matchmark the positioning of the distributor housing and the positioning of the distributor rotor to the engine block and remove the distributor.
5. Remove the valve cover and discard the gasket.
6. Loosen both rocker arm assemblies gradually and evenly, and remove the rocker shafts from the vehicle.
7. Remove the timing belt covers.

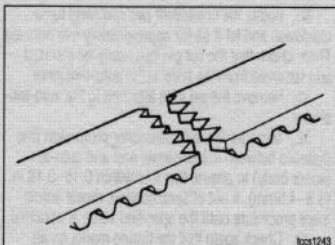


Fig. 188 Check for premature parting of the belt

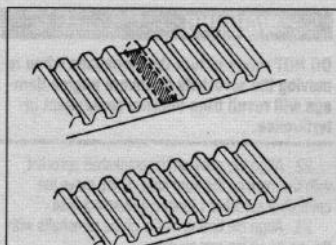


Fig. 189 Check if the teeth are cracked or damaged

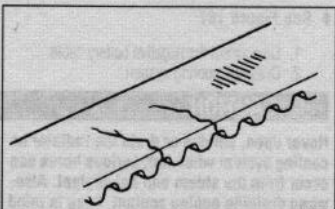


Fig. 190 Look for noticeable cracks or wear on the belt face

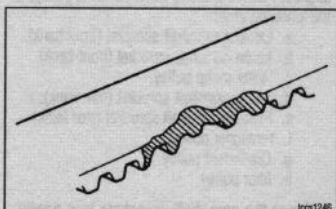


Fig. 191 You may only have damage on one side of the belt; if so, the guide could be the culprit

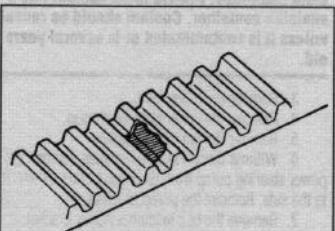


Fig. 192 Foreign materials can get in between the teeth and cause damage

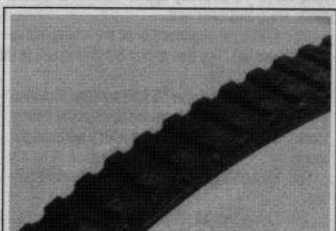


Fig. 193 Inspect the timing belt for cracks, fraying, glazing or damage of any kind



Fig. 194 Damage on only one side of the timing belt may indicate a faulty guide

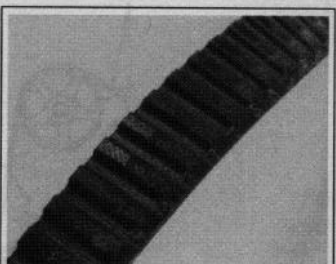


Fig. 195 ALWAYS replace the timing belt at the interval specified by the manufacturer

DO NOT allow the camshaft or the crankshaft to rotate after the timing belt is removed.

8. Remove the timing belt assembly.
9. Holding the camshaft sprocket from turning, loosen and remove the bolt that secures the sprocket.

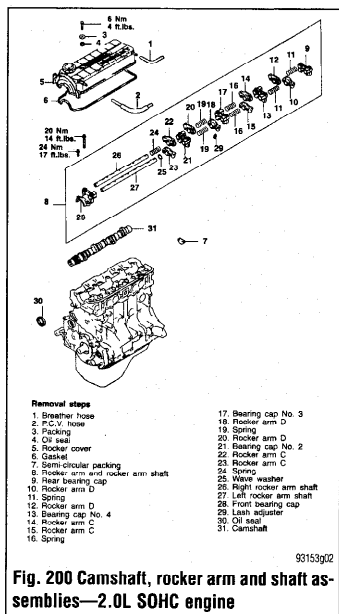


Fig. 200 Camshaft, rocker arm and shaft assemblies—2.0L SOHC engine

- Align the matchmarks and install the distributor.
- Remove the lash adjuster retaining tools.
- Install the valve cover and all related parts.
- Connect the negative battery cable and run engine to check for leaks.
- Check and adjust ignition timing, if necessary.

1.6L and 2.0L DOHC Engines

▶ See Figures 201 and 202

- Disconnect the negative battery cable.
- Remove the accelerator cable bracket and position the cable aside.
- Remove the breather hose and disconnect the PCV hose.
- Label and disconnect the spark plug cables.
- Matchmark the distributor housing to the cylinder head, and remove the distributor.
- Remove the rocker cover.
- Install lash adjuster retaining tools MD998443 or equivalent, to the rocker arm.

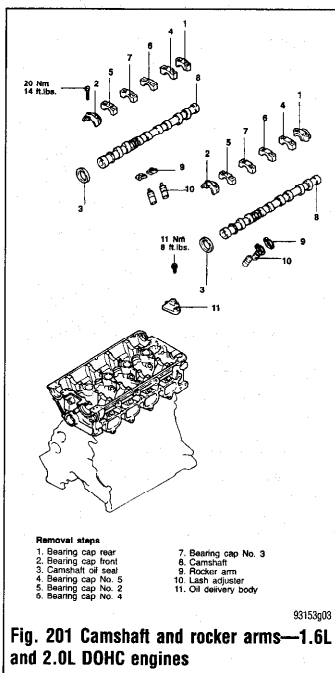


Fig. 201 Camshaft and rocker arms—1.6L and 2.0L DOHC engines

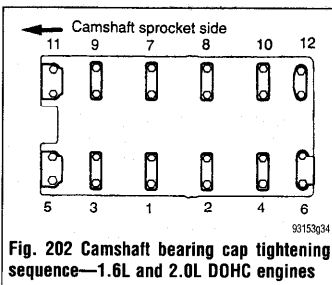


Fig. 202 Camshaft bearing cap tightening sequence—1.6L and 2.0L DOHC engines

- Remove the accelerator cable bracket and position the cable aside.
- Install lash adjuster retaining tools MD998443 or equivalent, to the rocker arm.
- Remove the valve cover and semi-circular packing.
- Matchmark the distributor housing to the cylinder head, and remove the distributor.
- Remove the timing belt covers and the timing belt.
- Remove the camshaft sprocket.
- Remove the carrier bolts and remove the rocker arms, rocker shafts and bearing caps from the engine as an assembly.
- Remove the camshaft from the cylinder head.
- Inspect the bearing journals on the camshaft for excess wear or damage.
- Measure the cam lobe height and compare to the desired readings.
- Inspect the bearing surfaces in the cylinder head.
- Replace any components that are damaged or show signs of excess wear.

To install:

- Lubricate the camshaft journals and camshaft with clean engine oil and install the camshaft in the cylinder head.
- Align the camshaft bearing caps with the arrow marks (depending on cylinder numbers) and install in numerical order.
- Install the rocker shaft assembly to the cylinder head. Torque the bearing cap bolts from the center outward, in three steps, until a final torque of 15 ft. lbs. (20 Nm) is reached.
- Apply a coating of engine oil to the oil seal.
- Using the proper size driver, press-fit the seal into the cylinder head.
- Install the camshaft sprocket and torque retaining bolt to 65 ft. lbs. (90 Nm).
- Install the timing belt.

- Remove the timing belt covers and the timing belt assembly.
- Remove the camshaft sprocket retainer bolt while holding shaft stationary with an appropriate wrench. Remove the sprocket from the shaft.
- Remove the camshaft oil seal.
- Remove both rocker arm shaft assemblies from the head. Do not disassemble the rocker arms and rocker arm shaft assemblies.
- Remove the camshaft from the cylinder head.
- Inspect the bearing journals on the camshaft, cylinder head, and bearing caps.

To install:

- Lubricate the camshaft journals and camshaft with clean engine oil and install the camshaft in the cylinder head.
- Install the rocker arm and shaft assemblies. Tighten the rocker arm shaft retainer bolts to 21–25 ft. lbs. (29–35 Nm).
- Apply a coating of engine oil to the oil seal.
- Using the proper size driver, press-fit the seal into the cylinder head.
- Install camshaft sprocket and retainer bolt. Tighten the bolts to 65 ft. lbs. (90 Nm).
- Install the timing belt and belt covers.
- Align the matchmarks and install the distributor.
- Remove the lash adjuster retaining tools.
- Install the rocker cover using new gasket material on mating surfaces.
- Connect the spark plug cables.
- Install the breather hose and connect the PCV hose.
- Connect the negative battery cable.
- Run the engine at idle until normal operating temperature is reached. Check idle speed and ignition timing; adjust as required.

2.4L Engine

▶ See Figures 203 and 204

- Relieve the fuel system pressure following proper procedure.
- Disconnect the negative battery cable.
- Disconnect the accelerator cable, PCV hoses, breather hoses, spark plug cables and the remove the valve cover.

➔ **Always rotate the crankshaft in a clockwise direction. Make a mark on the back of the timing belt indicating the direction of rotation so it may be reassembled in the same direction if it is to be reused.**

- Rotate the crankshaft clockwise and align the timing marks so that the No. 1 piston will be at TDC of the compression stroke. At this time the timing marks on the camshaft sprocket and the upper surface of the cylinder head should coincide, and the dowel pin of the camshaft sprocket should be at the upper side.
- Remove the timing belt upper and lower covers.
- Remove the camshaft timing belt.
- Use a wrench between the No. 2 and No. 3 journals to hold the camshaft; remove the camshaft sprockets.
- Loosen the bearing cap bolts in 2–3 steps. Label and remove all camshaft bearing caps.

➔ **If the bearing caps are difficult to remove, use a plastic hammer to gently tap the rear part of the camshaft.**

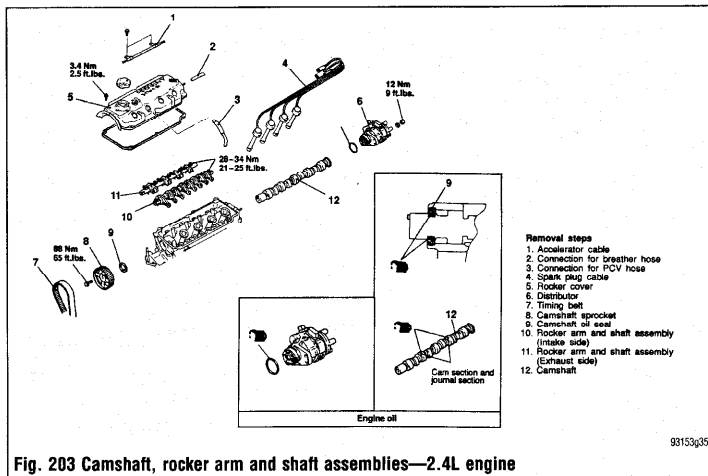


Fig. 203 Camshaft, rocker arm and shaft assemblies—2.4L engine

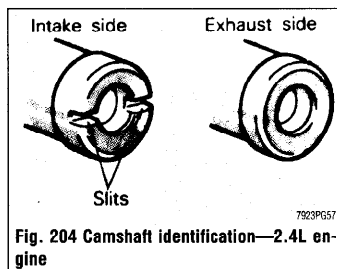


Fig. 204 Camshaft identification—2.4L engine

9. Remove the intake and exhaust camshafts.
10. Remove the rocker arms and lash adjusters.

➔ **It is essential that all parts be kept in the same order and orientation for reinstallation. In order to prevent confusion during installation, be sure to mark and separate all parts.**

To install:

11. Install the lash adjusters and rocker arms into the cylinder head. Lubricate lightly with clean oil prior to installation.
12. Lubricate the camshafts with heavy engine oil and position the camshafts on the cylinder head.
13. Check the camshaft journals and lobes for wear or damage. Also, check the cylinder head oil holes for clogging. Visually inspect the rocker arm roller and replace if dented, damaged, or evidence of seizure is evident. Check the roller for smooth rotation. Replace if excess play or binding is present. Also, inspect the valve contact surface for possible damage or seizure. It is recommended that all rocker arms and lash adjusters be replaced together.

➔ **Do not confuse the intake camshaft with the exhaust camshaft. The intake camshaft has a split on the rear face for driving the crank angle sensor.**

14. Make sure the dowel pin on both camshaft sprocket ends are located on the top.
15. Install the bearing caps. Tighten the caps in sequence and in 2 or 3 steps. No. 2 and 5 caps are of the same shape. Check the markings on the caps to identify the cap number and intake/exhaust symbol.

Only **L** (intake) or **R** (exhaust) is stamped on No. 1 bearing cap. Also, make sure the rocker arm is correctly mounted on the lash adjuster and the valve stem end. Torque the retaining bolts to 15 ft. lbs. (20 Nm).

16. Apply a coating of engine oil to the oil seal.
17. Install the camshaft sprockets. While holding the camshaft at its hexagon, between number 2 and 3 journals tighten sprocket bolts to 58–72 ft. lbs. (80–100 Nm).
18. Install the timing belt, covers and related components.
19. Install the valve cover, using new gasket, and reconnect all related components.
20. Reconnect the negative battery cable.

3.0L DOHC Engine

➔ **See Figures 205 and 206**

1. Relieve the fuel system pressure.
2. Disconnect negative battery cable.
3. Remove the intake manifold plenum.
4. Remove the timing belt cover and the timing belt.

WARNING

DO NOT rotate the crankshaft or camshafts after the timing belt has been removed. If rotated, severe internal engine damage will result from the pistons hitting the valves.

5. Remove the center cover, breather, PCV hoses, and the spark plug cables.
6. Remove the rocker cover and the semi-circular packing.
7. Matchmark the position of the crankshaft position sensor at the rear of the camshaft, then remove the sensor.
8. If equipped with a camshaft sensor, remove the sensor from the front of the engine.
9. Being sure to hold the flats of the camshaft, loosen the camshaft sprocket bolts.
10. Noting the positioning and location of the sprockets, remove the sprockets from the camshafts.

➔ **Be sure to note the positioning of the knock pin at the end of the camshafts for reinstallation purposes.**

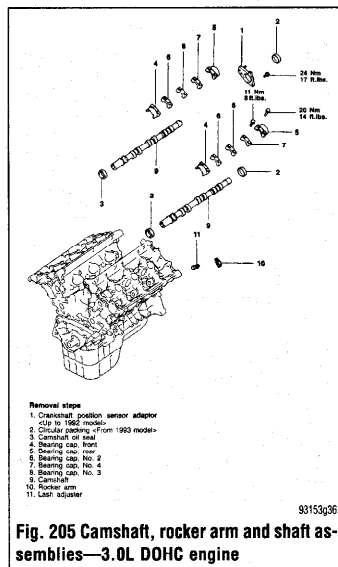
➔ **Be sure to keep the valve train components labeled and in proper order for reassembly.**

11. Loosen the bearing cap bolts in 2–3 steps.
12. Label and remove all camshaft bearing caps.

➔ **If the bearing caps are difficult to remove, use a plastic hammer to gently tap the components.**

13. Mark the components and remove the intake and the exhaust camshafts.

14. Remove the rocker arms and the lash adjusters. Be sure to note the location of the valve train components for reinstallation purposes.



- Removal steps**
1. Crankshaft position sensor adaptor (1991 to 1992 models)
 2. Circular padding (1993 models)
 3. Camshaft oil seal
 4. Bearing cap front
 5. Bearing cap rear
 6. Bearing cap No. 2
 7. Bearing cap No. 4
 8. Bearing cap No. 3
 9. Camshaft
 10. Rocker arm
 11. Lash adjuster

Fig. 205 Camshaft, rocker arm and shaft assemblies—3.0L DOHC engine

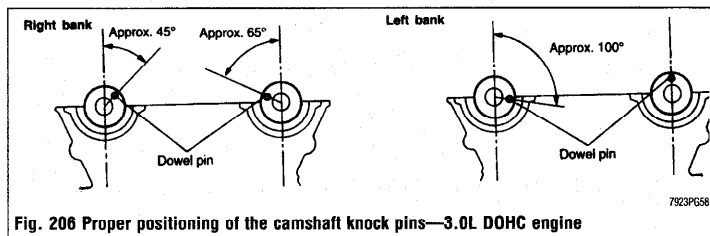


Fig. 206 Proper positioning of the camshaft knock pins—3.0L DOHC engine

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15. Check the camshaft journals for wear or damage. Check the cam lobes for damage. Also, check the cylinder head oil holes for clogging.

To install:

➔ Lubricate the valve train components with clean engine oil.

16. Bleed and install the lash adjusters to the original bores in the cylinder head.

17. Install the rocker arms to the cylinder head.

18. Lubricate the camshafts with clean engine oil and position the camshafts on the cylinder head.

*** WARNING ***

Be sure to properly position the knock pins of the camshaft to prevent valve to piston interference.

➔ Do not confuse the intake camshaft with the exhaust camshaft. The intake camshaft on the Diamante has a B or J stamped on the hexagon depending on the application. The exhaust camshaft on the Diamante has a D or K stamped on the hexagon depending on application.

➔ Install the bearing caps according to the identification mark and cap number. Bearing caps No. 2, 3 and 4 are marked as such. The caps also are marked I for intake or E for exhaust.

19. Install the bearing caps. Tighten the caps in sequence, gradually in 2 or 3 steps. Caps 2, 3 and 4 have a front mark. Install with the mark aligned with the front mark on the cylinder head. Torque the retaining bolts for caps No. 2, 3 and 4 to 8 ft. lbs. (11 Nm) and torque the retaining bolts for the front and rear caps to 14 ft. lbs. (20 Nm).

20. Apply a coating of engine oil to the oil seals and install the oil seals to the front and rear of the camshafts.

21. Holding the flats of the camshaft, install and tighten the sprocket bolts to 65 ft. lbs. (90 Nm).

22. If removed, install the camshaft position sensor and tighten the mounting bolts to 78 inch lbs. (9 Nm).

23. Aligning the matchmark, install the crankshaft position sensor at the rear of the camshaft and tighten the mounting nut to 7 ft. lbs. (12 Nm).

24. Align the marks on the camshaft and crankshaft sprockets. Install the timing belt assembly.

25. Install the rocker cover and the semi-circular packing.

26. Install the intake manifold plenum.

27. Install the spark plug cables, center cover, breather and PCV hoses.

28. Connect the negative battery cable and check for leaks.

3.0L SOHC Engine

➔ See Figures 207, 208, 209, and 210

1. Disconnect the negative battery cable.
2. Rotate and position the engine to TDC of compression stroke.

3. If removing the right side (front) camshaft, matchmark the distributor rotor and distributor housing to the engine block and remove the distributor.

4. Remove the intake manifold plenum stay bracket.

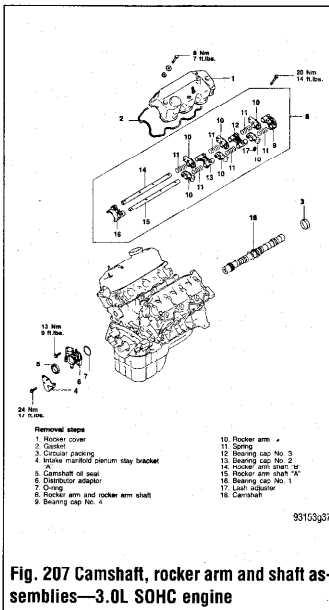


Fig. 207 Camshaft, rocker arm and shaft assemblies—3.0L SOHC engine

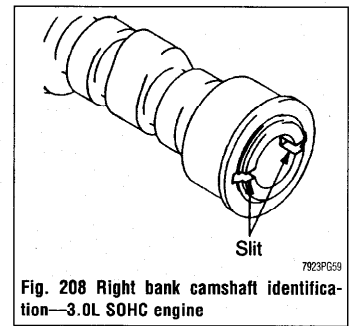


Fig. 208 Right bank camshaft identification—3.0L SOHC engine

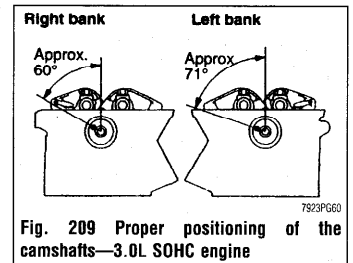


Fig. 209 Proper positioning of the camshafts—3.0L SOHC engine

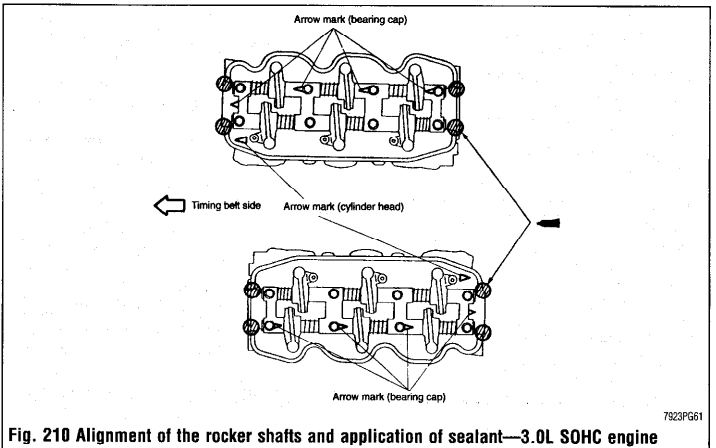


Fig. 210 Alignment of the rocker shafts and application of sealant—3.0L SOHC engine

5. Remove the distributor housing adapter and discard the O-ring.

6. Remove the valve covers and the timing belt.

7. Using camshaft sprocket holding tool MB9967 or MD998719 or equivalent, hold the sprocket and loosen the bolt.

8. Remove the bolt and note the positioning of the knock pin at the end of the camshaft and remove the sprocket.

9. Install auto lash adjuster retainer tools MD998443 or equivalent, on the rocker arms.

➔ Be sure to note the position of the rocker arms, rocker shafts and bearing caps for re-installation purposes.

10. Remove the camshaft bearing caps but do not remove the bolts from the caps.

11. Remove the rocker arms, rocker shafts and bearing caps, as an assembly.

12. Remove the camshaft from the cylinder head.

13. Inspect the bearing journals on the camshaft, cylinder head, and bearing caps.

To install:

➔ The right bank camshaft is identified by a 4mm slit at the rear end of the camshaft.

14. Lubricate the camshaft journals and camshaft with clean engine oil and install the camshaft in the cylinder head. Be sure to properly position the knock pin of the camshaft as noted during removal.

15. Apply sealer at the ends of the bearing caps and install the rocker arms, rocker shafts and bearing caps as an assembly. Properly position the arrows on the bearing caps.

16. Torque the bearing cap bolts in the following sequence: No. 3, No. 2, No. 1 and No. 4 to 85 inch lbs. (10 Nm).
17. Repeat the sequence increasing the torque to 14 ft. lbs. (20 Nm).
18. Remove the auto lash adjuster retainers from the rocker arms.
19. Install the camshaft sprocket and bolt.
20. Using camshaft sprocket holding tool MB9g67 and MD998719 or equivalent, hold the sprocket and tighten the bolt to 65 ft. lbs. (90 Nm).
21. Install the timing belt and valve covers.
22. Using a new O-ring, install the distributor extension housing.
23. Install the intake manifold plenum stay bracket.
24. Install the distributor assembly. Be sure to align the rotor and distributor housing matchmarks.
25. Connect the negative battery cable and check for leaks.

3.5L Engine

♦ See Figures 211 and 212

1. Disconnect the negative battery cable.
 2. Remove the timing belt. Refer to the timing belt procedure in this section.
 3. Remove the rocker arm cover.
 4. Install the lash adjuster clips on the rocker arms, then loosen the bearing cap bolts. Do not remove the bolts from the bearing caps.
 5. Remove the rocker arms, shafts and bearing caps as an assembly.
 6. Remove the camshafts.
- To install:**
7. Lubricate the camshafts with engine oil and position them on the cylinder heads.
 8. Position the dowel pins as shown in the drawing.
 9. Install the bearing caps/rocker arm assemblies. Tighten the bolts to 23 ft. lbs. (31 Nm).
 10. Install the rocker arm cover using a new gasket.
 11. Install the timing belt and remaining components. Refer to the timing belt procedure in this section.
 12. Connect the negative battery cable.

INSPECTION

Camshaft Lobe Lift

Camshaft lobe lift is the amount (measured in inches or millimeters) that the camshaft is capable of LIFTING the valve train components in order to open the valves. The lobe lift is a measure of how much taller the "egg shaped" portion of the camshaft lobe is above the base or circular portion of the shaft lobe. Lift is directly proportional to how far the valves can open and a worn camshaft (with poor lobe lift) cannot fully open the valves. The lobe lift therefore can be directly responsible for proper or poor engine performance.

Lobe lift can be measured in 2 ways, depending on what tools are available and whether or not the camshaft has been removed from the engine. A dial gauge can be used to measure the lift with the camshaft installed, while a micrometer is normally only used once the shaft has been removed from the engine.

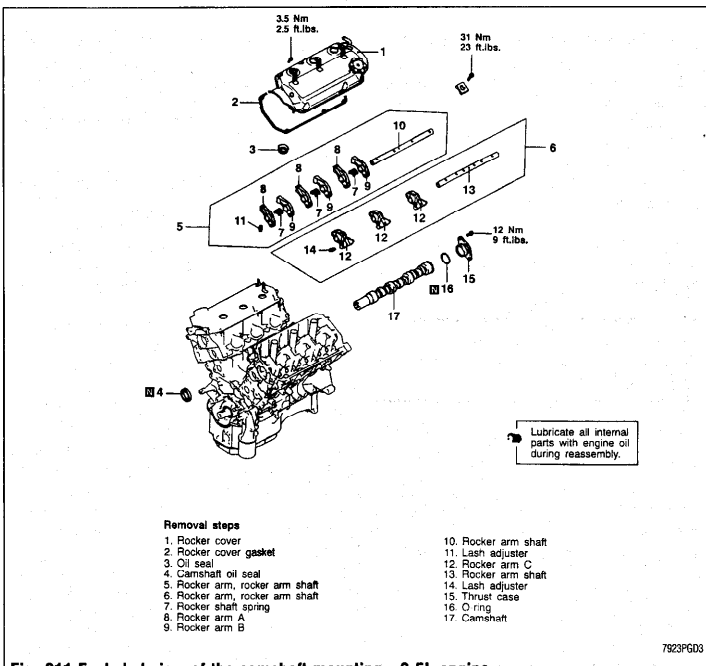
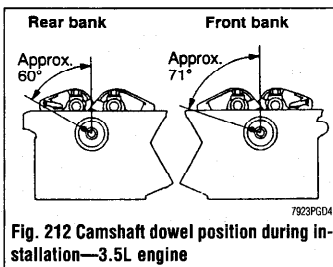


Fig. 211 Exploded view of the camshaft mounting—3.5L engine



DIAL GAUGE METHOD

Lobe lift may be checked with the camshaft installed. In all cases, a dial gauge is positioned somewhere on the valve train (pushrod, lifter, or camshaft itself) and the camshaft is then turned to measure the lift.

Check the lift of each lobe in consecutive order and make a note of the reading.

1. Remove the valve cover for access to the camshaft.
2. Install a dial indicator so that the actuating point of the indicator is directly placed on the camshaft.

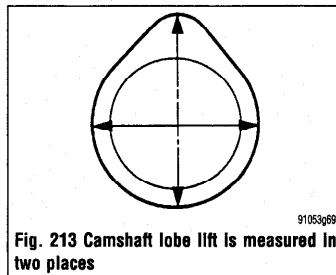
➡ A remote starter can be used to turn the engine over during the next steps. If a remote starter is not available, remove the spark plugs in order to relieve engine compression, and turn the engine over using a large wrench or socket on the crankshaft damper bolt. **BE SURE to only turn the engine in the normal direction of rotation.**

3. Turn the crankshaft over until the tappet is on the base circle of the camshaft lobe.
 4. Zero the dial indicator. Continue to rotate the crankshaft slowly until the pushrod (or camshaft lobe) is in the fully raised position.
 5. Compare the total lift recorded on the dial indicator with the elevation specification shown in the Engine Specification chart.
- To check the accuracy of the original indicator reading, continue to rotate the crankshaft until the indicator reads zero. If the lift on any lobe is below specified wear limits listed, the camshaft and the valve tappets must be replaced.
6. Install the valve cover(s).

MICROMETER

♦ See Figure 213

A micrometer may be used to measure camshaft lobe lift, but this is usually only after it has been removed from the engine. Once the valve cover is removed



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from the, access may be possible (though a little awkward) to measure the camshaft lobes using a micrometer.

In any case, two measurements are necessary for each lobe. Measurement **Y** or the total LOBE HEIGHT and measurement **X** or the total LOBE WIDTH. To find the lobe lift, you simply subtract **X** from **Y** (subtract the width from the height).

Note each measurement, then make your calculation to determine the lift. Note the final results and repeat the process on the remaining camshaft lobes. Finally, you should compare your results to the specifications charts and decide if a new camshaft is in your future.

Balance Shaft

REMOVAL & INSTALLATION

2.0L and 2.4L Engines

▶ See Figure 214

▶ **A special oil seal guide tool, MD998285, and a plug cap socket tool, MD998162, or exact equivalents are needed to complete this operation.**

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle.
3. Drain the engine oil.

*** CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

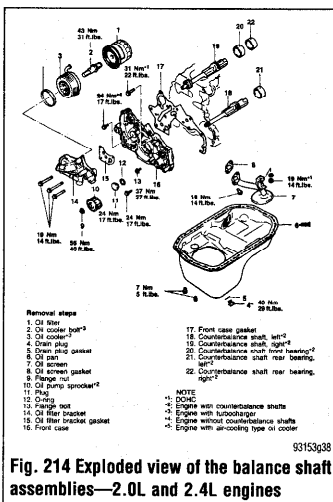


Fig. 214 Exploded view of the balance shaft assemblies—2.0L and 2.4L engines

4. Remove the oil filter, oil pressure switch, oil gauge sending unit, oil filter mounting bracket and gasket.

5. Remove engine oil pan, oil screen and gasket.

6. Remove the relief plug, gasket, relief spring and relief plunger.

7. Lower the vehicle.

8. Using the proper equipment, support the weight of the engine.

9. Remove the front engine mount bracket and accessory drive belt.

10. Remove the timing belts and sprockets.

11. Using special tool MD998162, remove the plug cap in the engine front cover.

12. Remove the plug on the side of the engine block. Insert a Phillips screwdriver with a shank diameter of 0.32 in. (8mm) into the plug hole. This will hold the silent shaft.

13. Remove the driven gear bolt that secures the oil pump driven gear to the silent shaft.

14. Remove and tag the front cover mounting bolts. Note the lengths of the mounting bolts as they are removed for proper installation.

15. Remove the front case cover and oil pump assembly. If necessary, the silent shaft can come out with the cover assembly.

16. Remove the silent shaft oil seals, the crankshaft oil seal and front case gasket.

17. Remove the silent shafts and inspect as follows:

- a. Check the oil holes in the shaft for clogging.
- b. Check journals of the shaft for seizure, damage and contact with bearing. If there is anything wrong with the journal, replace the silent shaft bearing, silent shaft or front case.
- c. Check the silent shaft oil clearance. If the clearance is beyond the specifications, replace the silent shaft bearing, silent shaft or front case. The specifications for oil clearances are as follows:

Right shaft

• Front—0.0012–0.0024 in. (0.03–0.06mm)

• Rear—0.0008–0.0021 in. (0.02–0.05mm)

Left shaft

• Front—0.0020–0.0036 in. (0.05–0.09mm)

• Rear—0.0017–0.0033 in. (0.04–0.08mm)

To install:

18. Lubricate the bearing surface of the shaft and the bearing journals with clean engine oil. Carefully install the silent shafts to the block.

19. Clean the gasket material from the mating surface of the cylinder block and the engine front cover. Install new gasket in place.

20. Install the oil pump drive gear and driven gear to the front case, lining up the timing marks.

21. Lubricate the gears with clean engine oil. Install the oil pump cover, with new gasket in place and tighten the mounting bolts to 13 ft. lbs. (18 Nm).

22. Using proper size driver, install the crankshaft oil seal into the front engine case.

23. Using the proper size socket wrench, press in the silent shaft oil seal into the front case.

24. Place pilot tool MD998285 or equivalent, onto the nose of the crankshaft. Apply clean engine oil to the outer circumference of the pilot tool.

25. Install the front case onto the engine block and temporarily tighten the flange bolts (other than those for tightening the filter bracket).

26. Mount the oil filter bracket with new gasket in place. Install the 4 bolts with washers and tighten to 16 ft. lbs. (22 Nm).

27. Insert the Phillips screwdriver into the hole on the side of the engine block.

28. Secure the oil pump driven gear onto the left silent shaft by tightening the driven gear flange bolt to 29 ft. lbs. (40 Nm).

29. Install a new O-ring onto the groove in the front case. Using special socket tool, install and tighten the plug cap to 20 ft. lbs. (27 Nm).

30. Install the oil pump relief plunger and spring into the bore in the oil filter bracket and tighten to 36 ft. lbs. (50 Nm). Make sure a new gasket is in place.

31. Clean both mating surfaces of the oil pan and the cylinder block.

32. Apply sealant in the groove in the oil pan flange, keeping towards the inside of the bolt holes. The width of the sealant bead applied is to be about 0.16 in. (4mm) wide.

▶ **After applying sealant to the oil pan, do not exceed 15 minutes before installing the oil pan.**

33. Install the oil pan to the engine and secure with the retainers. Tighten bolts to 6 ft. lbs. (8 Nm).

34. Install the oil pressure gauge unit and the oil pressure switch. Attach the electrical harness connector.

35. Install new oil filter and fill engine with clean engine oil.

36. Install the timing belts and all related items.

▶ **The timing of the oil pump sprocket and connected silent shaft can be incorrect, even with the timing mark aligned. Make certain that all special timing belt installation procedures are followed to ensure proper orientation of the silent shafts.**

37. Install any remaining components removed during disassembly.

38. Connect the negative battery cable and start the engine.

39. Check for proper timing and inspect for leaks.

Rear Main Seal

REMOVAL & INSTALLATION

▶ See Figure 215

1. Disconnect the negative battery cable.

2. Remove the transaxle from the vehicle, as outlined in Section 7.

3. Remove the flywheel/driveplate assembly.

4. Remove the rear engine plate and the bellhousing cover.

5. If the crankshaft rear oil seal case is leaking, remove it. Otherwise, just remove the oil seal. Some engines have a separator that should also be removed.

To install:

6. Lubricate the inner diameter of the new seal with clean engine oil.

7. Install the oil seal in the crankshaft rear oil seal case using tool MD998376 or equivalent. Press the seal all the way in without tilting it. Force the oil separator into the oil seal case so the oil hole in the separator is downward.

8. Run a bead of sealer along any seams between the seal case and block. Install the seal case with a new gasket.
9. Install the flywheel/driveplate and transaxle.
10. Connect the negative battery cable and check for leaks.
11. Adjust oil level as necessary.

Flywheel/Driveplate

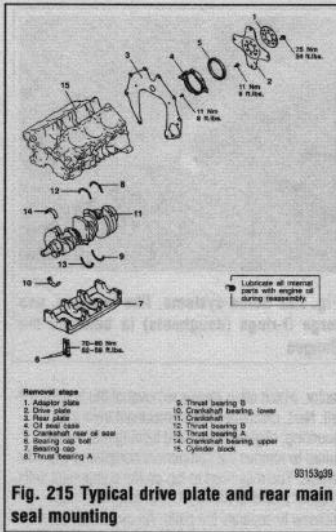
REMOVAL & INSTALLATION

♦ See Figure 215

1. Disconnect the negative battery cable.
2. Remove the transaxle, as outlined in Section 7.
3. If equipped with a manual transaxle, remove the clutch disc and pressure plate. Refer to Section 7.
4. Mark the position of the flywheel/driveplate on the crankshaft and remove the retaining bolts.
5. On automatic transaxle equipped models, remove the driveplate adapter.
6. Remove the flywheel/driveplate from the engine.

To install:

7. Coat the threads of the driveplate/flywheel retaining bolts with thread locking compound.
8. Position the driveplate/flywheel on the crankshaft flange.
9. On automatic transaxle equipped models, install the driveplate adapter.
10. Install and tighten the bolts, in a alternating star pattern, to the following specifications:
 - 1.5L engine: 96 ft. lbs. (135 Nm)
 - 1.6L, 2.0L and 2.4L engines: 94–101 ft. lbs. (130–140 Nm)
 - 1.8L engine: 72 ft. lbs. (100 Nm)
 - 3.0L and 3.5L engines: 53–56 ft. lbs. (72–76 Nm)
11. If equipped with a manual transaxle, install the clutch and pressure plate.
12. Install the transaxle. Refer to Section 7.
13. Connect the negative battery cable.



EXHAUST SYSTEM

Inspection

♦ See Figures 216 thru 222

— Safety glasses should be worn at all times when working on or near the exhaust system. Older exhaust systems will almost always be covered with loose rust particles which will shower you when disturbed. These particles are more than a nuisance and could injure your eye.

CAUTION

DO NOT perform exhaust repairs or inspection with the engine or exhaust hot. Allow the system to cool completely before attempting any work. Exhaust systems are noted for sharp edges, flaking metal and rusted bolts. Gloves and eye protection are required. A

healthy supply of penetrating oil and rags is highly recommended.

Your vehicle must be raised and supported safely to inspect the exhaust system properly. Placing 4 safety stands under the vehicle for support should provide enough room for you to slide under the vehicle and inspect the system completely. Start the inspection at the exhaust manifold or turbocharger pipe where the header pipe is attached and work your way

to the back of the vehicle. On dual exhaust systems, remember to inspect both sides of the vehicle. Check the complete exhaust system for open seams, holes, loose connections, or other deterioration which could

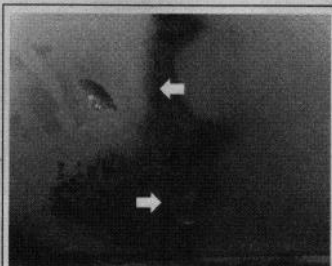


Fig. 216 Cracks in the muffler are a guaranteed leak

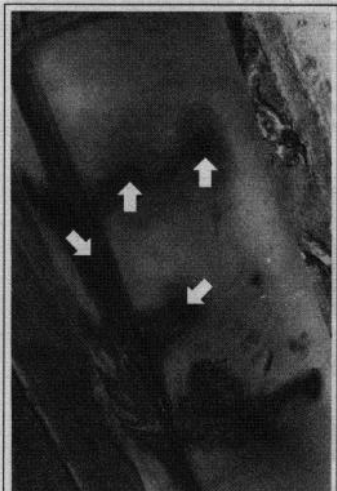


Fig. 217 Check the muffler for rotted spot welds and seams

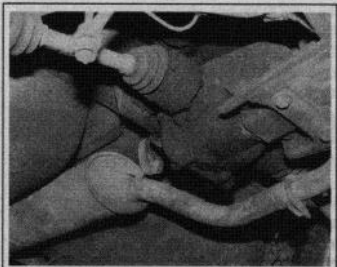


Fig. 218 Make sure the exhaust components are not contacting the body or suspension

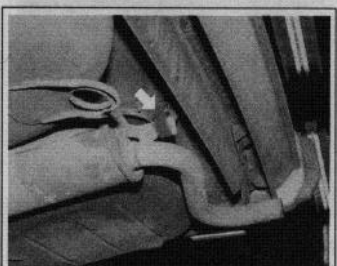


Fig. 219 Check for overstretched or torn exhaust hangers

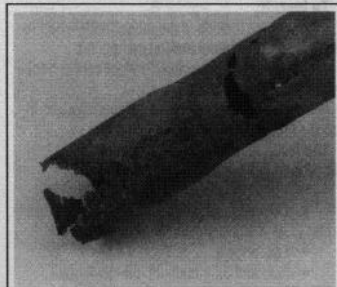


Fig. 220 Example of a badly deteriorated exhaust pipe

permit exhaust fumes to seep into the passenger compartment. Inspect all mounting brackets and hangers for deterioration, some models may have rubber O-rings that can be overstretched and non-supportive. These components will need to be replaced if found. It has always been a practice to use a pointed tool to poke up into the exhaust system where the deterioration spots are to see whether or not they crumble. Some models may have heat shield covering certain parts of the exhaust system, it will be necessary to remove these shields to have the exhaust visible for inspection also.

REPLACEMENT

♦ See Figure 223

There are basically two types of exhaust systems. One is the flange type where the component ends are attached with bolts and a gasket in-between. The other exhaust system is the slip joint type. These components slip into one another using clamps to hold them together.

*** CAUTION

Allow the exhaust system to cool sufficiently before spraying a solvent exhaust fasteners. Some solvents are highly flammable and could ignite when sprayed on hot exhaust components.

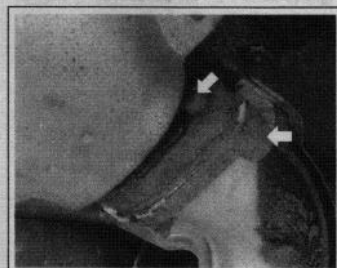


Fig. 223 Nuts and bolts will be extremely difficult to remove when deteriorated with rust

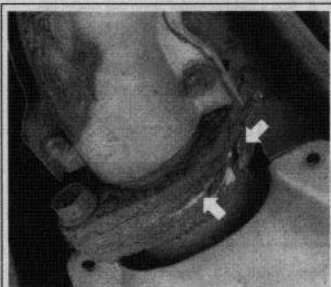


Fig. 221 Inspect flanges for gaskets that have deteriorated and need replacement

Before removing any component of the exhaust system, ALWAYS squirt a liquid rust dissolving agent onto the fasteners for ease of removal. A lot of knuckle skin will be saved by following this rule. It may even be wise to spray the fasteners and allow them to sit overnight.

Flange Type

♦ See Figure 224

*** CAUTION

Do NOT perform exhaust repairs or inspection with the engine or exhaust hot. Allow the system to cool completely before attempting any work. Exhaust systems are noted for sharp edges, flaking metal and rusted bolts. Gloves and eye protection are required. A healthy supply of penetrating oil and rags is highly recommended. Never spray liquid rust dissolving agent onto a hot exhaust component.

Before removing any component on a flange type system, ALWAYS squirt a liquid rust dissolving agent onto the fasteners for ease of removal. Start by unbolting the exhaust piece at both ends (if required). When unbolting the headpipe from the manifold, make sure that the bolts are free before trying to remove them. If you snap a stud in the exhaust manifold, the stud will have to be removed with a bolt ex-

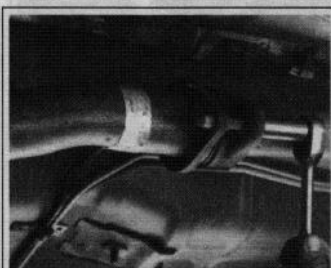


Fig. 224 Example of a flange type exhaust system joint



Fig. 222 Some systems, like this one, use large O-rings (doughnuts) in between the flanges

tractor, which often means removal of the manifold itself. Next, disconnect the component from the mounting; slight twisting and turning may be required to remove the component completely from the vehicle. You may need to tap on the component with a rubber mallet to loosen it. If all else fails, use a hacksaw to separate the parts. An oxy-acetylene cutting torch may be faster but the sparks are DANGEROUS near the fuel tank, and at the very least, accidents could happen, resulting in damage to the under-car parts, not to mention yourself.

Slip Joint Type

♦ See Figure 225

Before removing any component on the slip joint type exhaust system, ALWAYS squirt a liquid rust dissolving agent onto the fasteners for ease of removal. Start by unbolting the exhaust piece at both ends (if required). When unbolting the headpipe from the manifold, make sure that the bolts are free before trying to remove them. If you snap a stud in the exhaust manifold, the stud will have to be removed with a bolt extractor, which often means removal of the manifold itself. Next, remove the mounting U-bolts from around the exhaust pipe you are extracting from the vehicle. Don't be surprised if the U-bolts break while removing the nuts. Loosen the exhaust pipe from any mounting brackets retaining it to the floor pan and separate the components.



Fig. 225 Example of a common slip joint type system

ENGINE RECONDITIONING

Determining Engine Condition

Anything that generates heat and/or friction will eventually burn or wear out (for example, a light bulb generates heat, therefore its life span is limited). With this in mind, a running engine generates tremendous amounts of both; friction is encountered by the moving and rotating parts inside the engine and heat is created by friction and combustion of the fuel. However, the engine has systems designed to help reduce the effects of heat and friction and provide added longevity. The oiling system reduces the amount of friction encountered by the moving parts inside the engine, while the cooling system reduces heat created by friction and combustion. If either system is not maintained, a break-down will be inevitable. Therefore, you can see how regular maintenance can affect the service life of your vehicle. If you do not drain, flush and refill your cooling system at the proper intervals, deposits will begin to accumulate in the radiator, thereby reducing the amount of heat it can extract from the coolant. The same applies to your oil and filter; if it is not changed often enough it becomes laden with contaminants and is unable to properly lubricate the engine. This increases friction and wear.

There are a number of methods for evaluating the condition of your engine. A compression test can reveal the condition of your pistons, piston rings, cylinder bores, head gasket(s), valves and valve seats. An oil pressure test can warn you of possible engine bearing, or oil pump failures. Excessive oil consumption, evidence of oil in the engine air intake area and/or bluish smoke from the tailpipe may indicate worn piston rings, worn valve guides and/or valve seats. As a general rule, an engine that uses no more than one quart of oil every 1000 miles is in good condition. Engines that use one quart of oil or more in less than 1000 miles should first be checked for oil leaks. If any oil leaks are present, have them fixed before determining how much oil is consumed by the engine, especially if blue smoke is not visible at the tailpipe.

COMPRESSION TEST

◆ See Figure 226

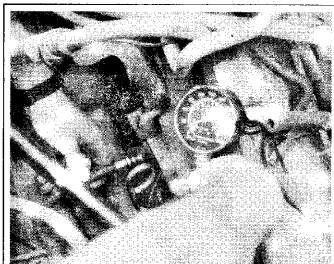


Fig. 226 A screw-in type compression gauge is more accurate and easier to use without an assistant

A noticeable lack of engine power, excessive oil consumption and/or poor fuel mileage measured over an extended period are all indicators of internal engine wear. Worn piston rings, scored or worn cylinder bores, blown head gaskets, sticking or burnt valves, and worn valve seats are all possible culprits. A check of each cylinder's compression will help locate the problem.

► **A screw-in type compression gauge is more accurate than the type you simply hold against the spark plug hole. Although it takes slightly longer to use, it's worth the effort to obtain a more accurate reading.**

1. Make sure that the proper amount and viscosity of engine oil is in the crankcase, then ensure the battery is fully charged.
2. Warm-up the engine to normal operating temperature, then shut the engine **OFF**.
3. Disable the ignition system.
4. Label and disconnect all of the spark plug wires from the plugs.
5. Thoroughly clean the cylinder head area around the spark plug ports, then remove the spark plugs.
6. Set the throttle plate to the fully open (wide-open throttle) position. You can block the accelerator linkage open for this, or you can have an assistant fully depress the accelerator pedal.
7. Install a screw-in type compression gauge into the No. 1 spark plug hole until the fitting is snug.

WARNING

Be careful not to crossthread the spark plug hole.

8. According to the tool manufacturer's instructions, connect a remote starting switch to the starting circuit.
9. With the ignition switch in the **OFF** position, use the remote starting switch to crank the engine through at least five compression strokes (approximately 5 seconds of cranking) and record the highest reading on the gauge.
10. Repeat the test on each cylinder, cranking the engine approximately the same number of compression strokes and/or time as the first.
11. Compare the highest readings from each cylinder to that of the others. The indicated compression pressures are considered within specifications if the lowest reading cylinder is within 75 percent of the pressure recorded for the highest reading cylinder. For example, if your highest reading cylinder pressure was 150 psi (1034 kPa), then 75 percent of that would be 113 psi (779 kPa). So the lowest reading cylinder should be no less than 113 psi (779 kPa).
12. If a cylinder exhibits an unusually low compression reading, pour a tablespoon of clean engine oil into the cylinder through the spark plug hole and repeat the compression test. If the compression rises after adding oil, it means that the cylinder's piston rings and/or cylinder bore are damaged or worn. If the pressure remains low, the valves may not be seating properly (a valve job is needed), or the head gasket may be blown near that cylinder. If compression

in any two adjacent cylinders is low, and if the addition of oil doesn't help raise compression, there is leakage past the head gasket. Oil and coolant in the combustion chamber, combined with blue or constant white smoke from the tailpipe, are symptoms of this problem. However, don't be alarmed by the normal white smoke emitted from the tailpipe during engine warm-up or from cold weather driving. There may be evidence of water droplets on the engine dipstick and/or oil droplets in the cooling system if a head gasket is blown.

OIL PRESSURE TEST

Check for proper oil pressure at the sending unit passage with an externally mounted mechanical oil pressure gauge (as opposed to relying on a factory installed dash-mounted gauge). A tachometer may also be needed, as some specifications may require running the engine at a specific rpm.

1. With the engine cold, locate and remove the oil pressure sending unit.
2. Following the manufacturer's instructions, connect a mechanical oil pressure gauge and, if necessary, a tachometer to the engine.
3. Start the engine and allow it to idle.
4. Check the oil pressure reading when cold and record the number. You may need to run the engine at a specified rpm, so check the specifications.
5. Run the engine until normal operating temperature is reached (upper radiator hose will feel warm).
6. Check the oil pressure reading again with the engine hot and record the number. Turn the engine **OFF**.
7. Compare your hot oil pressure reading to that given in the chart. If the reading is low, check the cold pressure reading against the chart. If the cold pressure is well above the specification, and the hot reading was lower than the specification, you may have the wrong viscosity oil in the engine. Change the oil, making sure to use the proper grade and quantity, then repeat the test.

Low oil pressure readings could be attributed to internal component wear, pump related problems, a low oil level, or oil viscosity that is too low. High oil pressure readings could be caused by an overfilled crankcase, too high of an oil viscosity or a faulty pressure relief valve.

Buy or Rebuild?

Now that you have determined that your engine is worn out, you must make some decisions. The question of whether or not an engine is worth rebuilding is largely a subjective matter and one of personal worth. Is the engine a popular one, or is it an obsolete model? Are parts available? Will it get acceptable gas mileage once it is rebuilt? Is the car it's being put into worth keeping? Would it be less expensive to buy a new engine, have your engine rebuilt by a pro, rebuild it yourself or buy a used engine from a salvage yard? Or would it be simpler and less expensive to buy another car? If you have considered all these matters and more, and have still decided to rebuild the engine, then it is time to decide how you will rebuild it.

—The editors at Chilton feel that most engine machining should be performed by a professional machine shop. Don't think of it as wasting money, rather, as an assurance that the job has been done right the first time. There are many expensive and specialized tools required to perform such tasks as boring and honing an engine block or having a valve job done on a cylinder head. Even inspecting the parts requires expensive micrometers and gauges to properly measure wear and clearances. Also, a machine shop can deliver to you clean, and ready to assemble parts, saving you time and aggravation. Your maximum savings will come from performing the removal, disassembly, assembling and installation of the engine and purchasing or renting only the tools required to perform the above tasks. Depending on the particular circumstances, you may save 40 to 60 percent of the cost doing these yourself.

A complete rebuild or overhaul of an engine involves replacing all of the moving parts (pistons, rods, crankshaft, camshaft, etc.) with new ones and machining the non-moving wearing surfaces of the block and heads. Unfortunately, this may not be cost effective. For instance, your crankshaft may have been damaged or worn, but it can be machined undersize for a minimal fee.

So, as you can see, you can replace everything inside the engine, but, it is wiser to replace only those parts which are really needed, and, if possible, repair the more expensive ones. Later in this section, we will break the engine down into its two main components: the cylinder head and the engine block. We will discuss each component, and the recommended parts to replace during a rebuild on each.

Engine Overhaul Tips

Most engine overhaul procedures are fairly standard. In addition to specific parts replacement procedures and specifications for your individual engine, this section is also a guide to acceptable rebuilding procedures. Examples of standard rebuilding practice are given and should be used along with specific details concerning your particular engine.

Competent and accurate machine shop services will ensure maximum performance, reliability and engine life. In most instances it is more profitable for the do-it-yourself mechanic to remove, clean and in-

spect the component, buy the necessary parts and deliver these to a shop for actual machine work.

Much of the assembly work (crankshaft, bearings, piston rods, and other components) is well within the scope of the do-it-yourself mechanic's tools and abilities. You will have to decide for yourself the depth of involvement you desire in an engine repair or rebuild.

TOOLS

The tools required for an engine overhaul or parts replacement will depend on the depth of your involvement. With a few exceptions, they will be the tools found in a mechanic's tool kit (see Section 1 of this manual). More in-depth work will require some or all of the following:

- A dial indicator (reading in thousandths) mounted on a universal base
- Micrometers and telescope gauges
- Jaw and screw-type pullers
- Scraper
- Valve spring compressor
- Ring groove cleaner
- Piston ring expander and compressor
- Ridge reamer
- Cylinder hone or glaze breaker
- Plastigage®
- Engine stand

The use of most of these tools is illustrated in this section. Many can be rented for a one-time use from a local parts jobber or tool supply house specializing in automotive work.

Occasionally, the use of special tools is called for. See the information on Special Tools and the Safety Notice in the front of this book before substituting another tool.

OVERHAUL TIPS

Aluminum has become extremely popular for use in engines, due to its low weight. Observe the following precautions when handling aluminum parts:

- Never hot tank aluminum parts (the caustic hot tank solution will eat the aluminum).
- Remove all aluminum parts (identification tag, etc.) from engine parts prior to the tanking.
- Always coat threads lightly with engine oil or anti-seize compounds before installation, to prevent seizure.
- Never overtighten bolts or spark plugs especially in aluminum threads.

When assembling the engine, any parts that will be exposed to frictional contact must be prelubed to provide lubrication at initial start-up. Any product specifically formulated for this purpose can be used, but engine oil is not recommended as a prelude in most cases.

When semi-permanent (locked, but removable) installation of bolts or nuts is desired, threads should be cleaned and coated with Loctite® or another similar, commercial non-hardening sealant.

CLEANING

♦ See Figures 227, 228, 229, 230, and 231

Before the engine and its components are inspected, they must be thoroughly cleaned. You will need to remove any engine varnish, oil sludge and/or carbon deposits from all of the components to insure an accurate inspection. A crack in the engine block or cylinder head can easily become overlooked if hidden by a layer of sludge or carbon.

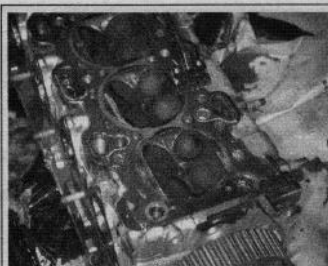


Fig. 227 Thoroughly clean the gasket surfaces of the cylinder head as well as . . .

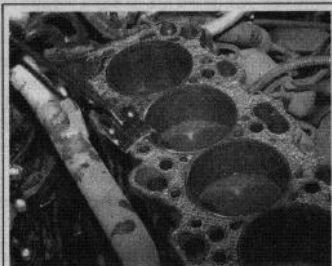


Fig. 228 . . . the engine block before re-assembling the engine

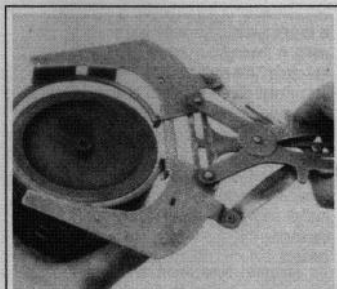


Fig. 229 Use a ring expander tool to remove the piston rings

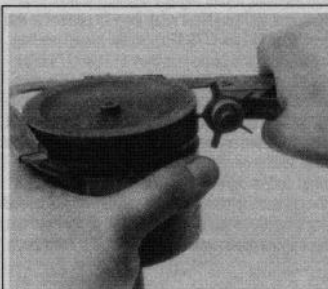


Fig. 230 Clean the piston ring grooves using a ring groove cleaner tool, or . . .

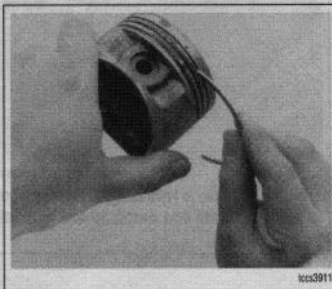


Fig. 231 . . . use a piece of an old ring to clean the grooves. Be careful, the ring can be quite sharp

Most of the cleaning process can be carried out with common hand tools and readily available solvents or solutions. Carbon deposits can be chipped away using a hammer and a hard wooden chisel. Old gasket material and varnish or sludge can usually be removed using a scraper and/or cleaning solvent. Extremely stubborn deposits may require the use of a power drill with a wire brush. If using a wire brush, use extreme care around any critical machined surfaces (such as the gasket surfaces, bearing saddles, cylinder bores, etc.). USE OF A WIRE BRUSH IS NOT RECOMMENDED ON ANY ALUMINUM COMPONENTS. Always follow any safety recommendations given by the manufacturer of the tool and/or solvent. You should always wear eye protection during any cleaning process involving scraping, chipping or spraying of solvents.

An alternative to the mess and hassle of cleaning the parts yourself is to drop them off at a local garage or machine shop. They will, more than likely, have the necessary equipment to properly clean all of the parts for a nominal fee.

*** CAUTION

Always wear eye protection during any cleaning process involving scraping, chipping or spraying of solvents.

Remove any oil galley plugs, freeze plugs and/or pressed-in bearings and carefully wash and degrease all of the engine components including the fasteners and bolts. Small parts such as the valves, springs, etc., should be placed in a metal basket and allowed to soak. Use pipe cleaner type brushes, and clean all passageways in the components. Use a ring expander and remove the rings from the pistons. Clean the piston ring grooves with a special tool or a piece of broken ring. Scrape the carbon off of the top of the piston. You should never use a wire brush on the pistons. After preparing all of the piston assemblies in this manner, wash and degrease them again.

*** WARNING

Use extreme care when cleaning around the cylinder head valve seats. A mistake or slip may cost you a new seat.

When cleaning the cylinder head, remove carbon from the combustion chamber with the valves installed. This will avoid damaging the valve seats.



tc33041

Fig. 234 Drill out the damaged threads with the specified size bit. Be sure to drill completely through the hole or to the bottom of a blind hole

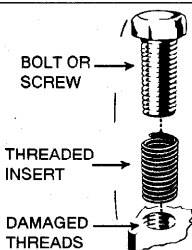
REPAIRING DAMAGED THREADS

♦ See Figures 232, 233, 234, 235 and 236

Several methods of repairing damaged threads are available. Heli-Coil® (shown here), Keenserts® and Microdot® are among the most widely used. All involve basically the same principle—drilling out stripped threads, tapping the hole and installing a prewound insert—making welding, plugging and oversize fasteners unnecessary.

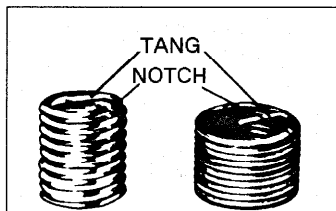
Two types of thread repair inserts are usually supplied: a standard type for most inch coarse, inch fine, metric coarse and metric fine thread sizes and a spark lug type to fit most spark plug port sizes. Consult the individual tool manufacturer's catalog to determine exact applications. Typical thread repair kits will contain a selection of prewound threaded inserts, a tap (corresponding to the outside diameter threads of the insert) and an installation tool. Spark plug inserts usually differ because they require a tap equipped with pilot threads and a combined reamer/tap section. Most manufacturers also supply blister-packed thread repair inserts separately in addition to a master kit containing a variety of taps and inserts plus installation tools.

Before attempting to repair a threaded hole, remove any snapped, broken or damaged bolts or studs. Penetrating oil can be used to free frozen threads. The offending item can usually be removed with locking pliers or using a screw/stud extractor. After the hole is clear, the thread can be repaired, as shown in the series of accompanying illustrations and in the kit manufacturer's instructions.



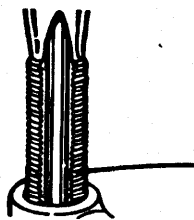
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Fig. 232 Damaged bolt hole threads can be replaced with thread repair inserts



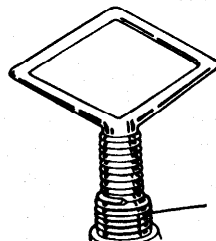
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Fig. 233 Standard thread repair insert (left), and spark plug thread insert



tc33042

Fig. 235 Using the kit, tap the hole in order to receive the thread insert. Keep the tap well oiled and back it out frequently to avoid clogging the threads



tc33043

Fig. 236 Screw the insert onto the installer tool until the tang engages the slot. Thread the insert into the hole until it is $1/4$ - $1/2$ turn below the top surface, then remove the tool and break off the tang using a punch

remove any covers remaining on the engine such as the rocker arm, front or timing cover and oil pan. Some front covers may require the vibration damper and/or crank pulley to be removed beforehand. The idea is to reduce the engine to the bare necessities (cylinder head(s), valve train, engine block, crankshaft, pistons and connecting rods), plus any other 'in block' components such as oil pumps, balance shafts and auxiliary shafts.

Finally, remove the cylinder head(s) from the engine block and carefully place on a bench. Disassembly instructions for each component follow later in this section.

Cylinder Head

There are two basic types of cylinder heads used on today's automobiles: the Overhead Valve (OHV) and the Overhead Camshaft (OHC). The latter can also be broken down into two subgroups: the Single Overhead Camshaft (SOHC) and the Dual Overhead Camshaft (DOHC). Generally, if there is only a single camshaft on a head, it is just referred to as an OHC head. Also, an engine with an OHV cylinder head is also known as a pushrod engine.

Most cylinder heads these days are made of an aluminum alloy due to its light weight, durability and heat transfer qualities. However, cast iron was the material of choice in the past, and is still used on many vehicles today. Whether made from aluminum or iron, all cylinder heads have valves and seats. Some use two valves per cylinder, while the more hi-tech engines will utilize a multi-valve configuration using 3, 4 and even 5 valves per cylinder. When the valve contacts the seat, it does so on precision machined surfaces, which seals the combustion chamber. All cylinder heads have a valve guide for each valve. The guide centers the valve to the seat and allows it to move up and down within it. The clearance between the valve and guide can be critical. Too much clearance and the engine may consume oil, lose vacuum and/or damage the seat. Too little, and the valve can stick in the guide causing the engine to run poorly if at all, and possibly causing severe damage. The last component all cylinder heads have are valve springs. The spring holds the valve against its seat. It also returns the valve to this position when the valve has been opened by the valve train or camshaft. The spring is fastened to the valve by a retainer and valve locks (sometimes called keepers). Aluminum heads will also have a valve spring shim to keep the spring from wearing away the aluminum.

An ideal method of rebuilding the cylinder head would involve replacing all of the valves, guides, seats, springs, etc. with new ones. However, depending on how the engine was maintained, often this is not necessary. A major cause of valve, guide and seat wear is an improperly tuned engine. An engine that is running too rich, will often wash the lubricating oil out of the guide with gasoline, causing it to wear rapidly. Conversely, an engine which is running too lean will place higher combustion temperatures on the valves and seats allowing them to wear or even burn. Springs fall victim to the driving habits of the individual. A driver who often runs the engine rpm to the redline will wear out or break the springs faster than one that stays well below it. Unfortunately, mileage takes it toll on all of the parts. Generally, the valves, guides, springs and seats in a cylinder head can be machined and re-used, saving you money. However, if a valve is burnt, it may be wise to replace all of the valves, since they were all operating in the

same environment. The same goes for any other component on the cylinder head. Think of it as an insurance policy against future problems related to that component.

Unfortunately, the only way to find out which components need replacing, is to disassemble and carefully check each piece. After the cylinder head(s) are disassembled, thoroughly clean all of the components.

DISASSEMBLY

♦ See Figures 237 and 238

Whether it is a single or dual overhead camshaft cylinder head, the disassembly procedure is relatively

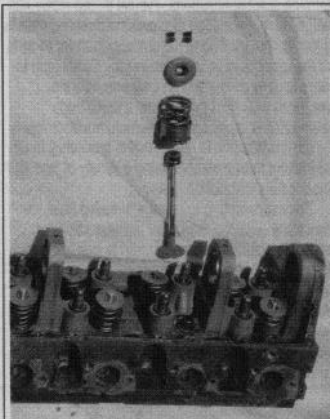


Fig. 237 Exploded view of a valve, seal, spring, retainer and locks from an OHC cylinder head

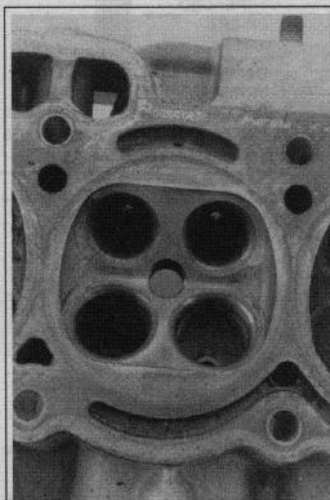


Fig. 238 Example of a multi-valve cylinder head. Note how it has 2 intake and 2 exhaust valve ports

unchanged. One aspect to pay attention to is careful labeling of the parts on the dual camshaft cylinder head. There will be an intake camshaft and followers as well as an exhaust camshaft and followers and they must be labeled as such. In some cases, the components are identical and could easily be installed incorrectly. DO NOT MIX THEM UP! Determining which is which is very simple; the intake camshaft and components are on the same side of the head as was the intake manifold. Conversely, the exhaust camshaft and components are on the same side of the head as was the exhaust manifold.

Cup Type Camshaft Followers

♦ See Figures 239, 240, and 241

Most cylinder heads with cup type camshaft followers will have the valve spring, retainer and locks recessed within the follower's bore. You will need a C-clamp style valve spring compressor tool, an OHC spring removal tool (or equivalent) and a small magnet to disassemble the head.

1. If not already removed, remove the camshaft(s) and/or followers. Mark their positions for assembly.
2. Position the cylinder head to allow use of a C-clamp style valve spring compressor tool.

➔ It is preferred to position the cylinder head gasket surface facing you with the valve springs facing the opposite direction and the head laying horizontal.

3. With the OHC spring removal adapter tool positioned inside of the follower bore, compress the valve spring using the C-clamp style valve spring compressor.

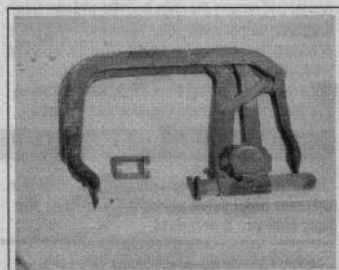
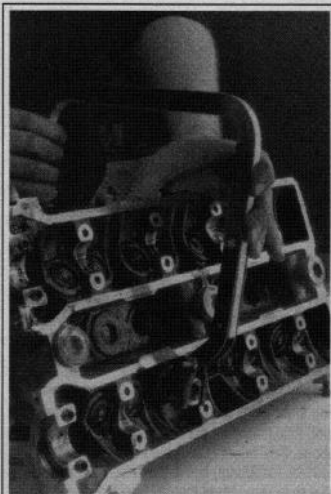


Fig. 239 C-clamp type spring compressor and an OHC spring removal tool (center) for cup type followers



Fig. 240 Most cup type follower cylinder heads retain the camshaft using bolt-on bearing caps



tca3p05

Fig. 241 Position the OHC spring tool in the follower bore, then compress the spring with a C-clamp type tool

4. Remove the valve locks. A small magnetic tool or screwdriver will aid in removal.
5. Release the compressor tool and remove the spring assembly.

6. Withdraw the valve from the cylinder head.
7. If equipped, remove the valve seal.

➔ **Special valve seal removal tools are available. Regular or needlenose type pliers, if used with care, will work just as well. If using ordinary pliers, be sure not to damage the follower bore. The follower and its bore are machined to close tolerances and any damage to the bore will effect this relationship.**

8. If equipped, remove the valve spring shim. A small magnetic tool or screwdriver will aid in removal.
9. Repeat Steps 3 through 8 until all of the valves have been removed.

Rocker Arm Type Camshaft Followers

➔ See Figures 242 thru 250

Most cylinder heads with rocker arm-type camshaft followers are easily disassembled using a standard valve spring compressor. However, certain models may not have enough open space around the spring for the standard tool and may require you to use a C-clamp style compressor tool instead.

1. If not already removed, remove the rocker arms and/or shafts and the camshaft. If applicable, also remove the hydraulic lash adjusters. Mark their positions for assembly.
2. Position the cylinder head to allow access to the valve spring.
3. Use a valve spring compressor tool to relieve the spring tension from the retainer.

➔ **Due to engine varnish, the retainer may stick to the valve locks. A gentle tap with a hammer may help to break it loose.**

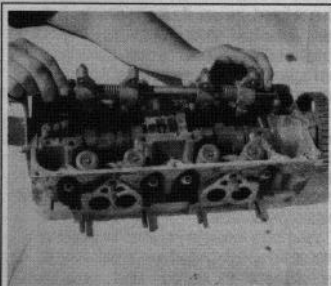
4. Remove the valve locks from the valve tip and/or retainer. A small magnet may help in removing the small locks.
5. Lift the valve spring, tool and all, off of the valve stem.
6. If equipped, remove the valve seal. If the seal is difficult to remove with the valve in place, try removing the valve first, then the seal. Follow the steps below for valve removal.
7. Position the head to allow access for withdrawing the valve.

➔ **Cylinder heads that have seen a lot of miles and/or abuse may have mushroomed the valve lock groove and/or tip, causing difficulty in removal of the valve. If this has happened, use a metal file to carefully remove the high spots around the lock grooves and/or tip. Only file it enough to allow removal.**

8. Remove the valve from the cylinder head.
9. If equipped, remove the valve spring shim. A small magnetic tool or screwdriver will aid in removal.
10. Repeat Steps 3 through 9 until all of the valves have been removed.

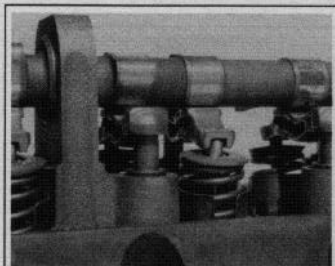
INSPECTION

Now that all of the cylinder head components are clean, it's time to inspect them for wear and/or dam-



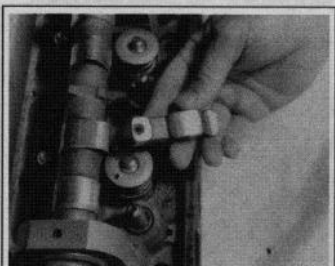
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Fig. 242 Example of the shaft mounted rocker arms on some OHC heads



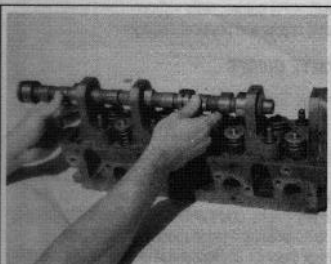
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Fig. 243 Another example of the rocker arm type OHC head. This model uses a follower under the camshaft



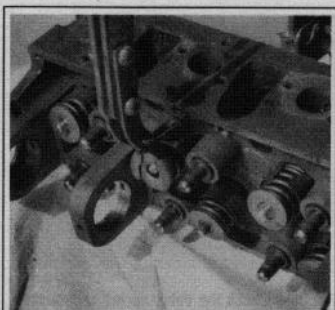
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Fig. 244 Before the camshaft can be removed, all of the followers must first be removed . . .



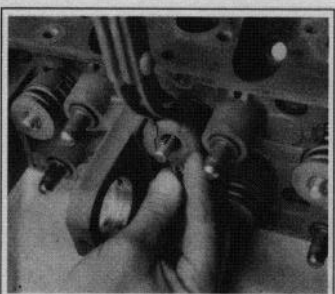
tca3p09

Fig. 245 . . . then the camshaft can be removed by sliding it out (shown), or unbolting a bearing cap (not shown)



tca3p07

Fig. 246 Compress the valve spring . . .



tca3p08

Fig. 247 . . . then remove the valve locks from the valve stem and spring retainer



Fig. 248 Remove the valve spring and retainers from the cylinder head

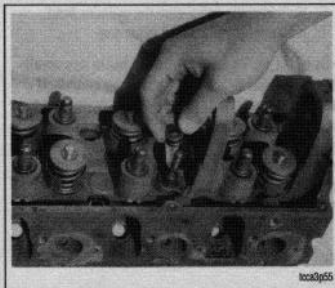


Fig. 249 Remove the valve seal from the guide. Some gentle prying or pliers may help to remove stubborn ones

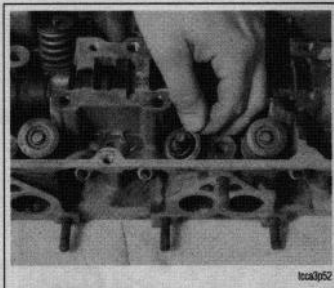


Fig. 250 All aluminum and some cast iron heads will have these valve spring shims. Remove all of them as well

age. To accurately inspect them, you will need some specialized tools:

- A 0–1 in. micrometer for the valves
- A dial indicator or inside diameter gauge for the valve guides
- A spring pressure test gauge

If you do not have access to the proper tools, you may want to bring the components to a shop that does.

Valves

♦ See Figures 251 and 252

The first thing to inspect are the valve heads. Look closely at the head, margin and face for any cracks, excessive wear or burning. The margin is the best place to look for burning. It should have a squared

edge with an even width all around the diameter.

When a valve burns, the margin will look melted and the edges rounded. Also inspect the valve head for any signs of tulipping. This will show as a lifting of the edges or dishing in the center of the head and will usually not occur to all of the valves. All of the heads should look the same, any that seem dished more than others are probably bad. Next, inspect the valve lock grooves and valve tips. Check for any burrs around the lock grooves, especially if you had to file them to remove the valve. Valve tips should appear flat, although slight rounding with high mileage engines is normal. Slightly worn valve tips will need to be machined flat. Last, measure the valve stem diameter with the micrometer. Measure the area that rides within the guide, especially towards the tip where most of the wear occurs. Take several measurements

along its length and compare them to each other. Wear should be even along the length with little to no taper. If no minimum diameter is given in the specifications, then the stem should not read more than 0.001 in. (0.025mm) below the unworn area of the valve stem. Any valves that fail these inspections should be replaced.

Springs, Retainers and Valve Locks

♦ See Figures 253 and 254

The first thing to check is the most obvious, broken springs. Next check the free length and squareness of each spring. If applicable, insure to distinguish between intake and exhaust springs. Use a ruler and/or carpenter's square to measure the length. A carpenter's square should be used to check the springs for squareness. If a spring pressure test gauge is available, check each spring's rating and compare to the specifications chart. Check the readings against the specifications given. Any springs that fail these inspections should be replaced.

The spring retainers rarely need replacing, however they should still be checked as a precaution. Inspect the spring mating surface and the valve lock retention area for any signs of excessive wear. Also check for any signs of cracking. Replace any retainers that are questionable.

Valve locks should be inspected for excessive wear on the outside contact area as well as on the inner notched surface. Any locks which appear worn or broken and its respective valve should be replaced.

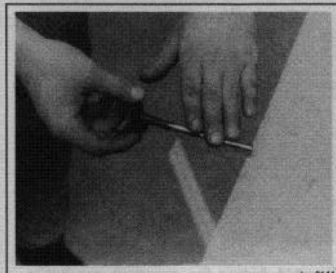


Fig. 251 Valve stems may be rolled on a flat surface to check for bends

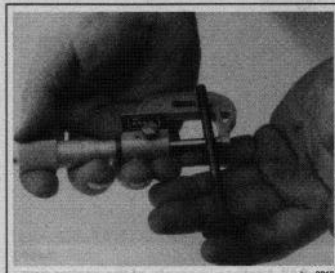


Fig. 252 Use a micrometer to check the valve stem diameter

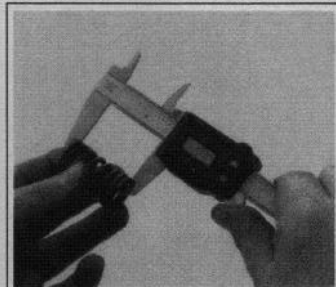


Fig. 253 Use a caliper to check the valve spring free-length

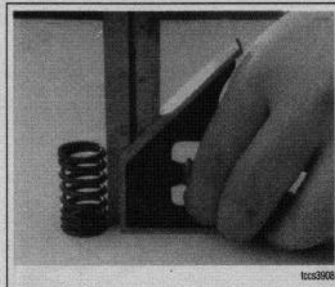


Fig. 254 Check the valve spring for squareness on a flat surface; a carpenter's square can be used

Cylinder Head

There are several things to check on the cylinder head: valve guides, seats, cylinder head surface flatness, cracks and physical damage.

VALVE GUIDES

♦ See Figure 255

Now that you know the valves are good, you can use them to check the guides, although a new valve, if available, is preferred. Before you measure anything, look at the guides carefully and inspect them for any cracks, chips or breakage. Also if the guide is a removable style (as in most aluminum heads), check them for any looseness or evidence of movement. All of the guides should appear to be at the same height from the spring seat. If any seem lower (or higher) from another, the guide has moved. Mount a dial indicator onto the spring side of the cylinder head. Lightly oil the valve stem and insert it

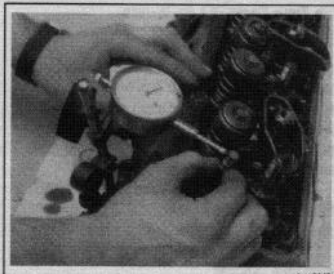


Fig. 255 A dial gauge may be used to check valve stem-to-guide clearance; read the gauge while moving the valve stem

into the cylinder head. Position the dial indicator against the valve stem near the tip and zero the gauge. Grasp the valve stem and wiggle towards and away from the dial indicator and observe the readings. Mount the dial indicator 90 degrees from the initial point and zero the gauge and again take a reading. Compare the two readings for a out of round condition. Check the readings against the specifications given. An Inside Diameter (I.D.) gauge designed for valve guides will give you an accurate valve guide bore measurement. If the I.D. gauge is used, compare the readings with the specifications given. Any guides that fail these inspections should be replaced or machined.

VALVE SEATS

A visual inspection of the valve seats should show a slightly worn and pitted surface where the valve face contacts the seat. Inspect the seat carefully for severe pitting or cracks. Also, a seat that is badly worn will be recessed into the cylinder head. A severely worn or recessed seat may need to be replaced. All cracked seats must be replaced. A seat concentricity gauge, if available, should be used to check the seat run-out. If run-out exceeds specifications the seat must be machined (if no specification is given use 0.002 in. or 0.051mm).

CYLINDER HEAD SURFACE FLATNESS

♦ See Figures 256 and 257

After you have cleaned the gasket surface of the cylinder head of any old gasket material, check the head for flatness.

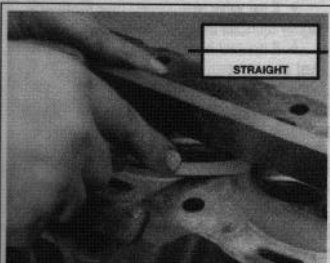


Fig. 256 Check the head for flatness across the center of the head surface using a straightedge and feeler gauge

Place a straightedge across the gasket surface. Using feeler gauges, determine the clearance at the center of the straightedge and across the cylinder head at several points. Check along the centerline and diagonally on the head surface. If the warpage exceeds 0.003 in. (0.076mm) within a 6.0 in. (15.2cm) span, or 0.006 in. (0.152mm) over the total length of the head, the cylinder head must be resurfaced. After resurfacing the heads of a V-type engine, the intake manifold flange surface should be checked, and if necessary, milled proportionally to allow for the change in its mounting position.

CRACKS AND PHYSICAL DAMAGE

Generally, cracks are limited to the combustion chamber, however, it is not uncommon for the head to crack in a spark plug hole, port, outside of the head or in the valve spring/rocker arm area. The first area to inspect is always the hottest: the exhaust seat/port area.

A visual inspection should be performed, but just because you don't see a crack does not mean it is not there. Some more reliable methods for inspecting for cracks include Magnaflex[®], a magnetic process or Zygo[®], a dye penetrant. Magnaflex[®] is used only on ferrous metal (cast iron) heads. Zygo[®] uses a spray on fluorescent mixture along with a black light to reveal the cracks. It is strongly recommended to have your cylinder head checked professionally for cracks, especially if the engine was known to have overheated and/or leaked or consumed coolant. Contact a local shop for availability and pricing of these services.

Physical damage is usually very evident. For example, a broken mounting ear from dropping the head or a bent or broken stud and/or bolt. All of these defects should be fixed or, if unreparable, the head should be replaced.

Camshaft and Followers

Inspect the camshaft(s) and followers as described earlier in this section.

REFINISHING & REPAIRING

Many of the procedures given for refinishing and repairing the cylinder head components must be performed by a machine shop. Certain steps, if the inspected part is not worn, can be performed yourself inexpensively. However, you spent a lot of time and effort so far, why risk trying to save a couple bucks if you might have to do it all over again?



Fig. 257 Checks should also be made along both diagonals of the head surface

Valves

Any valves that were not replaced should be relaced and the tips ground flat. Unless you have access to a valve grinding machine, this should be done by a machine shop. If the valves are in extremely good condition, as well as the valve seats and guides, they may be lapped in without performing machine work.

It is a recommended practice to lap the valves even after machine work has been performed and/or new valves have been purchased. This insures a positive seal between the valve and seat.

LAPPING THE VALVES

➔ Before lapping the valves to the seats, read the rest of the cylinder head section to insure that any related parts are in acceptable enough condition to continue.

➔ Before any valve seat machining and/or lapping can be performed, the guides must be within factory recommended specifications.

1. Invert the cylinder head.
2. Lightly lubricate the valve stems and insert them into the cylinder head in their numbered order.
3. Raise the valve from the seat and apply a small amount of fine lapping compound to the seat.
4. Moisten the suction head of a hand-lapping tool and attach it to the head of the valve.
5. Rotate the tool between the palms of both hands, changing the position of the valve on the valve seat and lifting the tool often to prevent grooving.
6. Lap the valve until a smooth, polished circle is evident on the valve and seat.
7. Remove the tool and the valve. Wipe away all traces of the grinding compound and store the valve to maintain its lapped location.

⚠ WARNING

Do not get the valves out of order after they have been lapped. They must be put back with the same valve seat with which they were lapped.

Springs, Retainers and Valve Locks

There is no repair or refinishing possible with the springs, retainers and valve locks. If they are found to be worn or defective, they must be replaced with new (or known good) parts.

Cylinder Head

Most refinishing procedures dealing with the cylinder head must be performed by a machine shop. Read the sections below and review your inspection data to determine whether or not machining is necessary.

VALVE GUIDE

➔ If any machining or replacements are made to the valve guides, the seats must be machined.

Unless the valve guides need machining or replacing, the only service to perform is to thoroughly clean them of any dirt or oil residue.

There are only two types of valve guides used on automobile engines: the replaceable-type (all aluminum heads) and the cast-in integral-type (most cast iron heads). There are four recommended methods for repairing worn guides.

- Knurling
- Inserts
- Reaming oversize
- Replacing

Knurling is a process in which metal is displaced and raised, thereby reducing clearance, giving a true center, and providing oil control. It is the least expensive way of repairing the valve guides. However, it is not necessarily the best, and in some cases, a knurled valve guide will not stand up for more than a short time. It requires a special knurler and precision reaming tools to obtain proper clearances. It would not be cost effective to purchase these tools, unless you plan on rebuilding several of the same cylinder head.

Installing a guide insert involves machining the guide to accept a bronze insert. One style is the coil-type which is installed into a threaded guide. Another is the thin-walled insert where the guide is reamed oversize to accept a split-sleeve insert. After the insert is installed, a special tool is then run through the guide to expand the insert, locking it to the guide. The insert is then reamed to the standard size for proper valve clearance.

Reaming for oversize valves restores normal clearances and provides a true valve seat. Most cast-in type guides can be reamed to accept an valve with an oversize stem. The cost factor for this can become quite high as you will need to purchase the reamer and new, oversize stem valves for all guides which were reamed. Oversizes are generally 0.003 to 0.030 in. (0.076 to 0.762mm), with 0.015 in. (0.381mm) being the most common.

To replace cast-in type valve guides, they must be drilled out, then reamed to accept replacement guides. This must be done on a fixture which will allow centering and leveling off of the original valve seat or guide, otherwise a serious guide-to-seat misalignment may occur making it impossible to properly machine the seat.

Replaceable-type guides are pressed into the cylinder head. A hammer and a stepped drift or punch may be used to install and remove the guides. Before removing the guides, measure the protrusion on the spring side of the head and record it for installation. Use the stepped drift to hammer out the old guide from the combustion chamber side of the head. When installing, determine whether or not the guide also seals a water jacket in the head, and if it does, use the recommended sealing agent. If there is no water jacket, grease the valve guide and its bore. Use the stepped drift, and hammer the new guide into the cylinder head from the spring side of the cylinder head. A stack of washers the same thickness as the measured protrusion may help the installation process.

VALVE SEATS

➤ Before any valve seat machining can be performed, the guides must be within factory recommended specifications.

➤ If any machining or replacements were made to the valve guides, the seats must be

machined.

If the seats are in good condition, the valves can be lapped to the seats, and the cylinder head assembled. See the valves section for instructions on lapping.

If the valve seats are worn, cracked or damaged, they must be serviced by a machine shop. The valve seat must be perfectly centered to the valve guide, which requires very accurate machining.

CYLINDER HEAD SURFACE

If the cylinder head is warped, it must be machined flat. If the warpage is extremely severe, the head may need to be replaced. In some instances, it may be possible to straighten a warped head enough to allow machining. In either case, contact a professional machine shop for service.

➤ Any OHC cylinder head that shows excessive warpage should have the camshaft bearing journals align bored after the cylinder head has been resurfaced.

*** WARNING

Failure to align bore the camshaft bearing journals could result in severe engine damage including but not limited to: valve and piston damage, connecting rod damage, camshaft and/or crankshaft breakage.

CRACKS AND PHYSICAL DAMAGE

Certain cracks can be repaired in both cast iron and aluminum heads. For cast iron, a tapered threaded insert is installed along the length of the crack. Aluminum can also use the tapered inserts, however welding is the preferred method. Some physical damage can be repaired through brazing or welding. Contact a machine shop to get expert advice for your particular dilemma.

ASSEMBLY

➤ See Figure 258

The first step for any assembly job is to have a clean area in which to work. Next, thoroughly clean all of the parts and components that are to be assembled. Finally, place all of the components onto a suitable work space and, if necessary, arrange the parts to their respective positions.

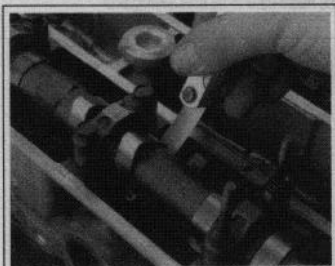


Fig. 258 Once assembled, check the valve clearance and correct as needed

Cup Type Camshaft Followers

To install the springs, retainers and valve locks on heads which have these components recessed into the camshaft follower's bore, you will need a small screwdriver-type tool, some clean white grease and a lot of patience. You will also need the C-clamp style spring compressor and the OHC tool used to disassemble the head.

1. Lightly lubricate the valve stems and insert all of the valves into the cylinder head. If possible, maintain their original locations.

2. If equipped, install any valve spring shims which were removed.

3. If equipped, install the new valve seals, keeping the following in mind:

- If the valve seal presses over the guide, lightly lubricate the outer guide surfaces.
- If the seal is an O-ring type, it is installed just after compressing the spring but before the valve locks.

4. Place the valve spring and retainer over the stem.

5. Position the spring compressor and the OHC tool, then compress the spring.

6. Using a small screwdriver as a spatula, fill the valve stem side of the lock with white grease. Use the excess grease on the screwdriver to fasten the lock to the driver.

7. Carefully install the valve lock, which is stuck to the end of the screwdriver, to the valve stem then press on it with the screwdriver until the grease squeezes out. The valve lock should now be stuck to the stem.

8. Repeat Steps 6 and 7 for the remaining valve lock.

9. Relieve the spring pressure slowly and insure that neither valve lock becomes dislodged by the retainer.

10. Remove the spring compressor tool.

11. Repeat Steps 2 through 10 until all of the springs have been installed.

12. Install the followers, camshaft(s) and any other components that were removed for disassembly.

Rocker Arm Type Camshaft Followers

1. Lightly lubricate the valve stems and insert all of the valves into the cylinder head. If possible, maintain their original locations.

2. If equipped, install any valve spring shims which were removed.

3. If equipped, install the new valve seals, keeping the following in mind:

- If the valve seal presses over the guide, lightly lubricate the outer guide surfaces.
- If the seal is an O-ring type, it is installed just after compressing the spring but before the valve locks.

4. Place the valve spring and retainer over the stem.

5. Position the spring compressor tool and compress the spring.

6. Assemble the valve locks to the stem.

7. Relieve the spring pressure slowly and insure that neither valve lock becomes dislodged by the retainer.

8. Remove the spring compressor tool.

9. Repeat Steps 2 through 8 until all of the springs have been installed.

10. Install the camshaft(s), rockers, shafts and any other components that were removed for disassembly.

Engine Block

GENERAL INFORMATION

A thorough overhaul or rebuild of an engine block would include replacing the pistons, rings, bearings, timing belt/chain assembly and oil pump. For OHV engines also include a new camshaft and lifters. The block would then have the cylinders bored and honed oversize (or if using removable cylinder sleeves, new sleeves installed) and the crankshaft would be cut undersize to provide new wearing surfaces and perfect clearances. However, your particular engine may not have everything worn out. What if only the piston rings have worn out and the clearances on everything else are still within factory specifications? Well, you could just replace the rings and put it back together, but this would be a very rare example. Chances are, if one component in your engine is worn, other components are sure to follow, and soon. At the very least, you should always replace the rings, bearings and oil pump. This is what is commonly called a "freshen up".

Cylinder Ridge Removal

Because the top piston ring does not travel to the very top of the cylinder, a ridge is built up between the end of the travel and the top of the cylinder bore.

Pushing the piston and connecting rod assembly past the ridge can be difficult, and damage to the piston ring lands could occur. If the ridge is not removed before installing a new piston or not removed at all, piston ring breakage and piston damage may occur.

It is always recommended that you remove any cylinder ridges before removing the piston and connecting rod assemblies. If you know that new pistons are going to be installed and the engine block will be bored oversize, you may be able to forego this step. However, some ridges may actually prevent the assemblies from being removed, necessitating its removal.

There are several different types of ridge reamers on the market, none of which are inexpensive. Unless a great deal of engine rebuilding is anticipated, borrow or rent a reamer.

1. Turn the crankshaft until the piston is at the bottom of its travel.
2. Cover the head of the piston with a rag.
3. Follow the tool manufacturers instructions and cut away the ridge, exercising extreme care to avoid cutting too deeply.
4. Remove the ridge reamer, the rag and as many of the cuttings as possible. Continue until all of the cylinder ridges have been removed.

DISASSEMBLY

See Figures 259 and 260

The engine disassembly instructions following assume that you have the engine mounted on an engine stand. If not, it is easiest to disassemble the engine on a bench or the floor with it resting on the bell

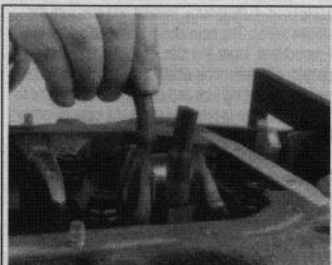


Fig. 259 Place rubber hose over the connecting rod studs to protect the crankshaft and cylinder bores from damage

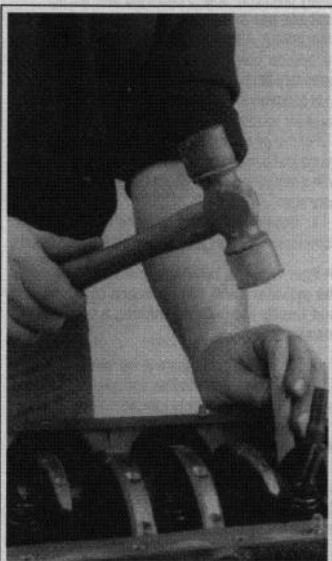


Fig. 260 Carefully tap the piston out of the bore using a wooden dowel

housing or transmission mounting surface. You must be able to access the connecting rod fasteners and turn the crankshaft during disassembly. Also, all engine covers (timing, front, side, oil pan, whatever) should have already been removed. Engines which are seized or locked up may not be able to be completely disassembled, and a core (salvage yard) engine should be purchased.

If not done during the cylinder head removal, remove the timing chain/belt and/or gear/sprocket assembly. Remove the oil pick-up and pump assembly and, if necessary, the pump drive. If equipped, remove any balance or auxiliary shafts. If necessary, remove the cylinder ridge from the top of the bore. See the cylinder ridge removal procedure earlier in this section.

Rotate the engine over so that the crankshaft is exposed. Use a number punch or scribe and mark each connecting rod with its respective cylinder number. The cylinder closest to the front of the engine is al-

ways number 1. However, depending on the engine placement, the front of the engine could either be the flywheel or damper/pulley end. Generally the front of the engine faces the front of the vehicle. Use a number punch or scribe and also mark the main bearing caps from front to rear with the front most cap being number 1 (if there are five caps, mark them 1 through 5, front to rear).

WARNING

Take special care when pushing the connecting rod up from the crankshaft because the sharp threads of the rod bolts/studs will score the crankshaft journal. Insure that special plastic caps are installed over them, or cut two pieces of rubber hose to do the same.

Again, rotate the engine, this time to position the number one cylinder bore (head surface) up. Turn the crankshaft until the number one piston is at the bottom of its travel, this should allow the maximum access to its connecting rod. Remove the number one connecting rods fasteners and cap and place two lengths of rubber hose over the rod bolts/studs to protect the crankshaft from damage. Using a sturdy wooden dowel and a hammer, push the connecting rod up about 1 in. (25mm) from the crankshaft and remove the upper bearing insert. Continue pushing or tapping the connecting rod up until the piston rings are out of the cylinder bore. Remove the piston and rod by hand, put the upper half of the bearing insert back into the rod, install the cap with its bearing insert installed, and hand-tighten the cap fasteners. If the parts are kept in order in this manner, they will not get lost and you will be able to tell which bearings came from what cylinder if any problems are discovered and diagnosis is necessary. Remove all the other piston assemblies in the same manner. On V-style engines, remove all of the pistons from one bank, then reposition the engine with the other cylinder bank head surface up, and remove that bank's piston assemblies.

The only remaining component in the engine block should now be the crankshaft. Loosen the main bearing caps evenly until the fasteners can be turned by hand, then remove them and the caps. Remove the crankshaft from the engine block. Thoroughly clean all of the components.

INSPECTION

Now that the engine block and all of its components are clean, it's time to inspect them for wear and/or damage. To accurately inspect them, you will need some specialized tools:

- Two or three separate micrometers to measure the pistons and crankshaft journals
- A dial indicator
- Telescoping gauges for the cylinder bores
- A rod alignment fixture to check for bent connecting rods

If you do not have access to the proper tools, you may want to bring the components to a shop that does.

Generally, you shouldn't expect cracks in the engine block or its components unless it was known to leak, consume or mix engine fluids, it was severely overheated, or there was evidence of bad bearings and/or crankshaft damage. A visual inspection

should be performed on all of the components, but just because you don't see a crack does not mean it is not there. Some more reliable methods for inspecting for cracks include Magnaflox®, a magnetic process or Zyglol®, a dye penetrant. Magnaflox® is used only on ferrous metal (cast iron). Zyglol® uses a spray on fluorescent mixture along with a black light to reveal the cracks. It is strongly recommended to have your engine block checked professionally for cracks, especially if the engine was known to have overheated and/or leaked or consumed coolant. Contact a local shop for availability and pricing of these services.

Engine Block

ENGINE BLOCK BEARING ALIGNMENT

Remove the main bearing caps and, if still installed, the main bearing inserts. Inspect all of the main bearing saddles and caps for damage, burrs or high spots. If damage is found, and it is caused from a spun main bearing, the block will need to be align-bored or, if severe enough, replacement. Any burrs or high spots should be carefully removed with a metal file.

Place a straightedge on the bearing saddles, in the engine block, along the centerline of the crankshaft. If any clearance exists between the straightedge and the saddles, the block must be align-bored.

Align-boring consists of machining the main bearing saddles and caps by means of a flycutter that runs through the bearing saddles.

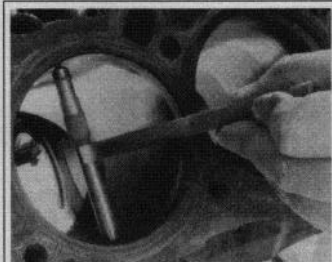
DECK FLATNESS

The top of the engine block where the cylinder head mounts is called the deck. Insure that the deck surface is clean of dirt, carbon deposits and old gasket material. Place a straightedge across the surface of the deck along its centerline and, using feeler gauges, check the clearance along several points. Repeat the checking procedure with the straightedge placed along both diagonals of the deck surface. If the reading exceeds 0.003 in. (0.076mm) within a 6.0 in. (15.2cm) span, or 0.006 in. (0.152mm) over the total length of the deck, it must be machined.

CYLINDER BORES

♦ See Figure 261

The cylinder bores house the pistons and are slightly larger than the pistons themselves. A common piston-to-bore clearance is 0.0015–0.0025 in.



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Fig. 261 Use a telescoping gauge to measure the cylinder bore diameter—take several readings within the same bore

(0.0381mm–0.0635mm). Inspect and measure the cylinder bores. The bore should be checked for out-of-roundness, taper and size. The results of this inspection will determine whether the cylinder can be used in its existing size and condition, or a rebore to the next oversize is required (or in the case of removable sleeves, have replacements installed).

The amount of cylinder wall wear is always greater at the top of the cylinder than at the bottom. This wear is known as taper. Any cylinder that has a taper of 0.0012 in. (0.305mm) or more, must be rebored. Measurements are taken at a number of positions in each cylinder: at the top, middle and bottom and at two points at each position; that is, at a point 90 degrees from the crankshaft centerline, as well as a point parallel to the crankshaft centerline. The measurements are made with either a special dial indicator or a telescopic gauge and micrometer. If the necessary precision tools to check the bore are not available, take the block to a machine shop and have them mike it. Also if you don't have the tools to check the cylinder bores, chances are you will not have the necessary devices to check the pistons, connecting rods and crankshaft. Take these components with you and save yourself an extra trip.

For our procedures, we will use a telescopic gauge and a micrometer. You will need one of each, with a measuring range which covers your cylinder bore size.

1. Position the telescopic gauge in the cylinder bore, loosen the gauges lock and allow it to expand.

➔ **Your first two readings will be at the top of the cylinder bore, then proceed to the middle and finally the bottom, making a total of six measurements.**

2. Hold the gauge square in the bore, 90 degrees from the crankshaft centerline, and gently tighten the lock. Tilt the gauge back to remove it from the bore.

3. Measure the gauge with the micrometer and record the reading.

4. Again, hold the gauge square in the bore, this time parallel to the crankshaft centerline, and gently tighten the lock. Again, you will tilt the gauge back to remove it from the bore.

5. Measure the gauge with the micrometer and record this reading. The difference between these two readings is the out-of-round measurement of the cylinder.

6. Repeat steps 1 through 5, each time going to the next lower position, until you reach the bottom of the cylinder. Then go to the next cylinder, and continue until all of the cylinders have been measured.

The difference between these measurements will tell you all about the wear in your cylinders. The measurements which were taken 90 degrees from the crankshaft centerline will always reflect the most wear. That is because at this position is where the engine power presses the piston against the cylinder bore the hardest. This is known as thrust wear. Take your top, 90 degree measurement and compare it to your bottom, 90 degree measurement. The difference between them is the taper. When you measure your pistons, you will compare these readings to your piston sizes and determine piston-to-wall clearance.

Crankshaft

Inspect the crankshaft for visible signs of wear or damage. All of the journals should be perfectly round and smooth. Slight scores are normal for a used

crankshaft, but you should hardly feel them with your fingernail. When measuring the crankshaft with a micrometer, you will take readings at the front and rear of each journal, then turn the micrometer 90 degrees and take two more readings, front and rear. The difference between the front-to-rear readings is the journal taper and the first-to-90 degree reading is the out-of-round measurement. Generally, there should be no taper or out-of-roundness found, however, up to 0.0005 in. (0.0127mm) for either can be overlooked. Also, the readings should fall within the factory specifications for journal diameters.

If the crankshaft journals fall within specifications, it is recommended that it be polished before being returned to service. Polishing the crankshaft insures that any minor burrs or high spots are smoothed, thereby reducing the chance of scoring the new bearings.

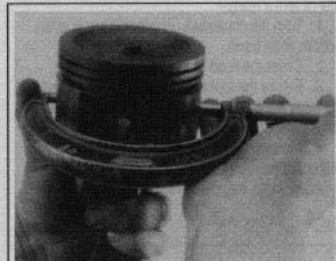
Pistons and Connecting Rods

PISTONS

♦ See Figure 262

The piston should be visually inspected for any signs of cracking or burning (caused by hot spots or detonation), and scuffing or excessive wear on the skirts. The wrist pin attaches the piston to the connecting rod. The piston should move freely on the wrist pin, both sliding and pivoting. Grasp the connecting rod securely, or mount it in a vise, and try to rock the piston back and forth along the centerline of the wrist pin. There should not be any excessive play evident between the piston and the pin. If there are C-clips retaining the pin in the piston then you have wrist pin bushings in the rods. There should not be any excessive play between the wrist pin and the rod bushing. Normal clearance for the wrist pin is approx. 0.001–0.002 in. (0.025mm–0.051mm).

Use a micrometer and measure the diameter of the piston, perpendicular to the wrist pin, on the skirt. Compare the reading to its original cylinder measurement obtained earlier. The difference between the two readings is the piston-to-wall clearance. If the clearance is within specifications, the piston may be used as is. If the piston is out of specification, but the bore is not, you will need a new piston. If both are out of specification, you will need the cylinder rebored and oversize pistons installed. Generally if two or more pistons/bores are out of specification, it is best to rebore the entire block and purchase a complete set of oversize pistons.



tbs3210

Fig. 262 Measure the piston's outer diameter, perpendicular to the wrist pin, with a micrometer

CONNECTING ROD

You should have the connecting rod checked for straightness at a machine shop. If the connecting rod is bent, it will unevenly wear the bearing and piston, as well as place greater stress on these components. Any bent or twisted connecting rods must be replaced. If the rods are straight and the wrist pin clearance is within specifications, then only the bearing end of the rod need be checked. Place the connecting rod into a vice, with the bearing inserts in place, install the cap to the rod and torque the fasteners to specifications. Use a telescoping gauge and carefully measure the inside diameter of the bearings. Compare this reading to the rod's original crankshaft journal diameter measurement. The difference is the oil clearance. If the oil clearance is not within specifications, install new bearings in the rod and take another measurement. If the clearance is still out of specifications, and the crankshaft is not, the rod will need to be reconditioned by a machine shop.

➡ You can also use Plastigage® to check the bearing clearances. The assembling section has complete instructions on its use.

Camshaft

Inspect the camshaft and lifters/followers as described earlier in this section.

Bearings

All of the engine bearings should be visually inspected for wear and/or damage. The bearing should look evenly worn all around with no deep scores or pits. If the bearing is severely worn, scored, pitted or heat blue, then the bearing, and the components that use it, should be brought to a machine shop for inspection. Full-circle bearings (used on most camshafts, auxiliary shafts, balance shafts, etc.) require specialized tools for removal and installation, and should be brought to a machine shop for service.

Oil Pump

➡ The oil pump is responsible for providing constant lubrication to the whole engine and so it is recommended that a new oil pump be installed when rebuilding the engine.

Completely disassemble the oil pump and thoroughly clean all of the components. Inspect the oil pump gears and housing for wear and/or damage. Insure that the pressure relief valve operates properly and there is no binding or sticking due to varnish or debris. If all of the parts are in proper working condition, lubricate the gears and relief valve, and assemble the pump.

REFINISHING

♣ See Figure 263

Almost all engine block refinishing must be performed by a machine shop. If the cylinders are not to be rebored, then the cylinder glaze can be removed with a ball hone. When removing cylinder glaze with a ball hone, use a light or penetrating type oil to lubricate the hone. Do not allow the hone to run dry as this may cause excessive scoring of the cylinder bores and wear on the hone. If new pistons are required, they will need to be installed to the connecting rods. This should be performed by a machine

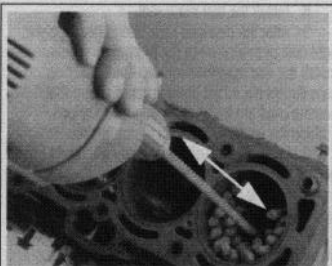


Fig. 263 Use a ball type cylinder hone to remove any glaze and provide a new surface for seating the piston rings

shop as the pistons must be installed in the correct relationship to the rod or engine damage can occur.

Pistons and Connecting Rods

♣ See Figure 264

Only pistons with the wrist pin retained by C-clips are serviceable by the home-mechanic. Press fit pistons require special presses and/or heaters to remove/install the connecting rod and should only be performed by a machine shop.

All pistons will have a mark indicating the direction to the front of the engine and the must be installed into the engine in that manner. Usually it is a notch or arrow on the top of the piston, or it may be the letter F cast or stamped into the piston.

ASSEMBLY

Before you begin assembling the engine, first give yourself a clean, dirt free work area. Next, clean every engine component again. The key to a good assembly is cleanliness.

Mount the engine block into the engine stand and wash it one last time using water and detergent (dishwashing detergent works well). While washing it, scrub the cylinder bores with a soft bristle brush and thoroughly clean all of the oil passages. Completely dry the engine and spray the entire assembly down with an anti-rust solution such as WD-40® or similar product. Take a clean lint-free rag and wipe up any excess anti-rust solution from the bores, bearing saddles, etc. Repeat the final cleaning process on the



Fig. 264 Most pistons are marked to indicate positioning in the engine (usually a mark means the side facing the front)

crankshaft. Replace any freeze or oil galley plugs which were removed during disassembly.

Crankshaft

♣ See Figures 265, 266, 267, and 268

1. Remove the main bearing inserts from the block and bearing caps.
2. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearing. Be sure that the bearing inserts and bearing bores are clean. Foreign material under inserts will distort bearing and cause failure.
3. Place the upper main bearing inserts in bores with tang in slot.

➡ The oil holes in the bearing inserts must be aligned with the oil holes in the cylinder block.

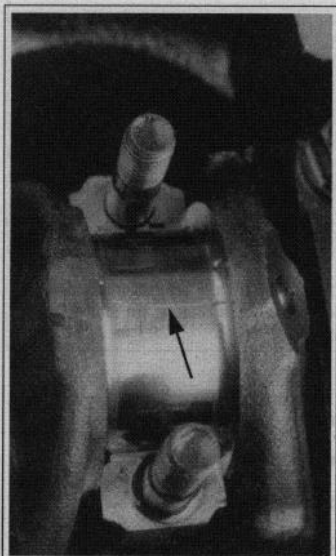


Fig. 265 Apply a strip of gauging material to the bearing journal, then install and torque the cap

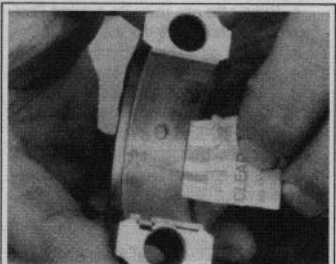


Fig. 266 After the cap is removed again, use the scale supplied with the gauging material to check the clearance

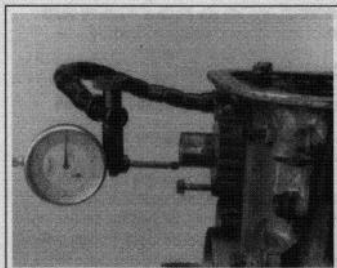


Fig. 267 A dial gauge may be used to check crankshaft end-play

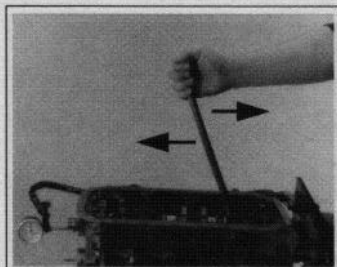


Fig. 268 Carefully pry the crankshaft back and forth while reading the dial gauge for end-play

4. Install the lower main bearing inserts in bearing caps.
5. Clean the mating surfaces of block and rear main bearing cap.
6. Carefully lower the crankshaft into place. Be careful not to damage bearing surfaces.
7. Check the clearance of each main bearing by using the following procedure:
 - a. Place a piece of Plastigage® or its equivalent, on bearing surface across full width of bearing cap and about 1/4 in. off center.
 - b. Install cap and tighten bolts to specifications. Do not turn crankshaft while Plastigage® is in place.
 - c. Remove the cap. Using the supplied Plastigage® scale, check width of Plastigage® at widest point to get maximum clearance. Difference between readings is taper of journal.
 - d. If clearance exceeds specified limits, try a 0.001 in. or 0.002 in. undersize bearing in combination with the standard bearing. Bearing clearance must be within specified limits. If standard and 0.002 in. undersize bearing does not bring clearance within desired limits, refinish crankshaft journal, then install undersize bearings.

8. Install the rear main seal.
9. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings. Install the rear main bearing cap. Install all bearing caps except the thrust bearing cap. Be sure that main bearing caps are installed in original locations. Tighten the bearing cap bolts to specifications.
10. Install the thrust bearing cap with bolts finger-tight.
11. Pry the crankshaft forward against the thrust surface of upper half of bearing.
12. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This aligns the thrust surfaces of both halves of the bearing.
13. Retain the forward pressure on the crankshaft. Tighten the cap bolts to specifications.
14. Measure the crankshaft end-play as follows:
 - a. Mount a dial gauge to the engine block and position the tip of the gauge to read from the crankshaft end.
 - b. Carefully pry the crankshaft toward the rear of the engine and hold it there while you zero the gauge.
 - c. Carefully pry the crankshaft toward the front of the engine and read the gauge.
 - d. Confirm that the reading is within specifications. If not, install a new thrust bearing and repeat the procedure. If the reading is still out of specifications with a new bearing, have a machine shop inspect the thrust surfaces of the crankshaft, and if possible, repair it.
15. Rotate the crankshaft so as to position the first rod journal to the bottom of its stroke.

Pistons and Connecting Rods

▶ See Figures 269, 270, 271, and 272

1. Before installing the piston/connecting rod assembly, oil the pistons, piston rings and the cylinder walls with light engine oil. Install connecting rod bolt protectors or rubber hose onto the connecting rod bolts/studs. Also perform the following:
 - a. Select the proper ring set for the size cylinder bore.
 - b. Position the ring in the bore in which it is going to be used.
 - c. Push the ring down into the bore area where normal ring wear is not encountered.
 - d. Use the head of the piston to position the ring in the bore so that the ring is square with the cylinder wall. Use caution to avoid damage to the ring or cylinder bore.
 - e. Measure the gap between the ends of the ring with a feeler gauge. Ring gap in a worn cylinder is normally greater than specification. If the ring gap is greater than the specified limits, try an oversize ring set.
 - f. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land according to specification. The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at

the inner portion of the lower land. If the lower lands have high steps, the piston should be replaced.

2. Unless new pistons are installed, be sure to install the pistons in the cylinders from which they were removed. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one engine or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number. The notch on the piston head goes toward the front of the engine.

3. Install all of the rod bearing inserts into the rods and caps.

4. Install the rings to the pistons. Install the oil control ring first, then the second compression ring and finally the top compression ring. Use a piston ring expander tool to aid in installation and to help reduce the chance of breakage.

5. Make sure the ring gaps are properly spaced around the circumference of the piston. Fit a piston ring compressor around the piston and slide the piston and connecting rod assembly down into the cylinder bore, pushing it in with the wooden hammer handle. Push the piston down until it is only slightly below the top of the cylinder bore. Guide the connecting rod onto the crankshaft bearing journal carefully, to avoid damaging the crankshaft.

6. Check the bearing clearance of all the rod bearings, fitting them to the crankshaft bearing journals. Follow the procedure in the crankshaft installation above.

7. After the bearings have been fitted, apply a light coating of assembly oil to the journals and bearings.

8. Turn the crankshaft until the appropriate bearing journal is at the bottom of its stroke, then push the piston assembly all the way down until the connecting rod bearing seats on the crankshaft journal. Be careful not to allow the bearing cap screws to strike the crankshaft bearing journals and damage them.

9. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal.

10. Prime and install the oil pump and the oil pump intake tube.

11. Install the auxiliary/balance shaft(s)/assembly(ies).

Cylinder Head(S)

1. Install the cylinder head(s) using new gaskets.
2. Install the timing sprockets/gears and the belt/chain assemblies.

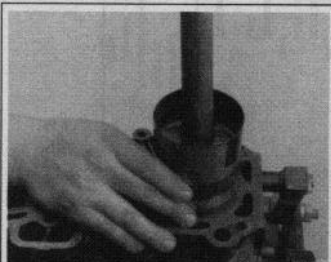
Engine Covers and Components

Install the timing cover(s) and oil pan. Refer to your notes and drawings made prior to disassembly and install all of the components that were removed. Install the engine into the vehicle.



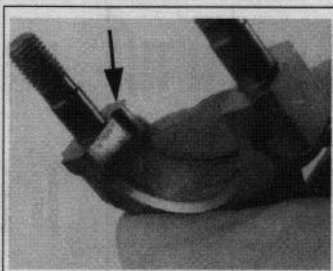
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Fig. 269 Checking the piston ring-to-ring groove side clearance using the ring and a feeler gauge



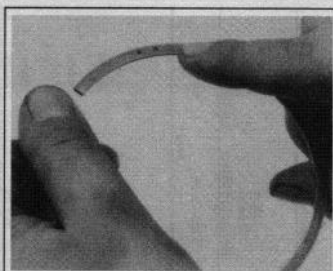
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Fig. 272 Install the piston and rod assembly into the block using a ring compressor and the handle of a hammer



tccs3917

Fig. 270 The notch on the side of the bearing cap matches the tang on the bearing insert



tccs3222

Fig. 271 Most rings are marked to show which side of the ring should face up when installed to the piston

Engine Start-up and Break-in

STARTING THE ENGINE

Now that the engine is installed and every wire and hose is properly connected, go back and double check that all coolant and vacuum hoses are connected. Check that your oil drain plug is installed and properly tightened. If not already done, install a new oil filter onto the engine. Fill the crankcase with the proper amount and grade of engine oil. Fill the cooling system with a 50/50 mixture of coolant/water.

1. Connect the vehicle battery.
2. Start the engine. Keep your eye on your oil pressure indicator; if it does not indicate oil pressure within 10 seconds of starting, turn the vehicle off.

⚠️ WARNING

Damage to the engine can result if it is allowed to run with no oil pressure. Check the engine oil level to make sure that it is full. Check for any leaks and if found, repair the leaks before continuing. If there is still no indication of oil pressure, you may need to prime the system.

3. Confirm that there are no fluid leaks (oil or other).

4. Allow the engine to reach normal operating temperature (the upper radiator hose will be hot to the touch).

5. At this point you can perform any necessary checks or adjustments, such as checking the ignition timing.

6. Install any remaining components or body panels which were removed.

BREAKING IT IN

Make the first miles on the new engine, easy ones. Vary the speed but do not accelerate hard. Most importantly, do not lug the engine, and avoid sustained high speeds until at least 100 miles. Check the engine oil and coolant levels frequently. Expect the engine to use a little oil until the rings seat. Change the oil and filter at 500 miles, 1500 miles, then every 3000 miles past that.

KEEP IT MAINTAINED

Now that you have just gone through all of that hard work, keep yourself from doing it all over again by thoroughly maintaining it. Not that you may not have maintained it before, heck you could have had one to two hundred thousand miles on it before doing this. However, you may have bought the vehicle used, and the previous owner did not keep up on maintenance. Which is why you just went through all of that hard work. See?

1.5L ENGINE MECHANICAL SPECIFICATIONS

Description	English	Metric
	Specifications	Specifications
General Information		
Engine type	4 Cylinder In-Line Overhead Camshaft	
Displacement	89.6 cubic in.	1.5L
Bore	2.972 in.	75.5mm
Stroke	3.228 in.	82mm
Compression ratio	9.2:1	
Firing order	1-3-4-2	
Cylinder Head		
Overall height	4.209-4.217 in.	106.9-107.1mm
Flatness (maximum)	0.002 in.	0.05mm
Camshaft bearing-to-camshaft clearance	0.0016-0.0031 in.	0.04-0.08mm
Camshaft		
Camshaft height		
Intake		
Standard	1.5256 in.	38.75mm
Limit	1.5059 in.	38.25mm
Exhaust		
Standard	1.5394 in.	39.1mm
Limit	1.5197 in.	38.6mm
Journal outside diameter	1.8110 in.	46mm
Bearing oil clearance		
Standard	0.0024-0.0039 in.	0.06-0.10mm
Limit	0.0055 in.	0.14mm
Rocker arms		
Inside diameter	0.744 in.	18.9mm
Arm-to-shaft clearance		
Standard	0.0004-0.0016 in.	0.01-0.04mm
Limit	0.004 in.	0.1mm
Rocker arm shaft		
Outside diameter	0.744 in.	18.9mm
Valves		
Valve length		
Intake	3.9665 in.	100.75mm
Exhaust	3.9783 in.	101.05mm
Stem outside diameter		
Intake	0.2585-0.2591 in.	6.565-6.580mm
Exhaust	0.2571-0.2579 in.	6.530-6.550mm
Face angle (all)	45-45°	
Head thickness (margin)		
Intake		
Standard	0.039 in.	1.0mm
Limit	0.020 in.	0.5mm
Exhaust		
Standard	0.059 in.	1.5mm
Limit	0.039 in.	1.0mm
Stem-to-guide clearance		
Intake		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.0039 in.	0.10mm
Exhaust		
Standard	0.0020-0.0035 in.	0.05-0.09mm
Limit	0.0059 in.	0.15mm
Valve clearance		
Hot engine		
Intake	0.0059 in.	0.15mm
Exhaust	0.0098 in.	0.25mm
Cold engine		
Intake	0.0028 in.	0.07mm
Exhaust	0.0067 in.	0.17mm

8315301

1.5L ENGINE MECHANICAL SPECIFICATIONS

Description	English	Metric
	Specifications	Specifications
Valve guide		
Length		
Intake	1.732 in.	44.0mm
Exhaust	1.949 in.	49.5mm
Service sizes	0.002, 0.010, 0.020 in.	0.05, 0.25, 0.50mm
Valve seat		
Seat contact width	0.035-0.051 in.	0.9-1.3mm
Seat angle (all)	44-44.5°	
Valve spring		
Free length		
Intake		
Standard	1.815 in.	46.1mm
Limit	1.776 in.	45.1mm
Exhaust		
Standard	1.843 in.	46.8mm
Limit	1.803 in.	45.8mm
Load		
Intake	51 ft. lbs.	230Nm
Exhaust	64 ft. lbs.	290Nm
Cylinder Block		
Bore		
Diameter	2.9724-2.9736 in.	75.50-75.53mm
Out-of-round (max.)	0.008 in.	0.02mm
Taper (max.)	0.008 in.	0.02mm
Overall height		
Standard	10.075-10.083 in.	255.9-256.1mm
Limit	10.073 in.	254.82mm
Gasket surface flatness (max.)	0.004 in.	0.1mm
Piston		
Outside diameter	2.9713-2.9724 in.	75.47-75.50
Piston-to-cylinder clearance	0.0008-0.0016 in.	0.02-0.04mm
Ring groove width		
No. 1	0.0598-0.0606 in.	1.52-1.54mm
No. 2	0.0594-0.0602 in.	1.51-1.53mm
Oil Control	0.1581-0.1593 in.	4.015-4.045mm
Service sizes	0.002, 0.010, 0.020 in.	0.05, 0.25, 0.50mm
Piston Rings		
Side clearance		
No. 1		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.0047 in.	0.12mm
No. 2		
Standard	0.0008-0.0024 in.	0.02-0.06mm
Limit	0.0047 in.	0.12mm
End gap		
No. 1		
Standard	0.0079-0.0157 in.	0.20-0.40mm
Limit	0.031 in.	0.8mm
No. 2		
Standard	0.0079-0.0138 in.	0.20-0.35mm
Limit	0.031 in.	0.8mm
Oil		
Standard	0.0079-0.0276 in.	0.20-0.70mm
Limit	0.039 in.	1.0mm
Connecting rod		
Bend (max.)		
	0.0020 in.	0.05mm
Twist (max.)		
	0.0039 in.	0.10mm
Rod big end side clearance		
Standard	0.0039-0.0098 in.	0.10-0.25mm
Limit	0.016 in.	0.4mm

8315302

1.5L ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Connecting rod (cont'd)		
Piston pin press-in load	1,100-3,300 ft. lbs.	5,000-15,000Nm
Connecting rod bearing oil clearance		
Standard	0.0008-0.0024 in.	0.02-0.06mm
Limit	0.0059 in.	0.15mm
Crankshaft		
Main bearing oil clearance		
Standard	0.0008-0.0028 in.	0.02-0.07mm
Limit	0.0059 in.	0.15mm
Pin outside diameter	1.65 in.	42mm
Journal outside diameter	1.89 in.	48mm
Out-of-round (max.)	0.0006 in.	0.015mm
Crankshaft end-play		
Standard	0.002-0.0071 in.	0.05-0.18mm
Limit	0.0098 in.	0.25mm
Flywheel		
Run-out (max.)	0.0051 in.	0.13mm
Oil Pump		
Tip clearance		
Standard	0.0024-0.0071 in.	0.06-0.18mm
Limit	0.0138 in.	0.35mm
Side clearance		
Standard	0.0016-0.0039 in.	0.04-0.10mm
Limit	0.0079 in.	0.20mm
Body clearance		
Standard	0.0039-0.0071 in.	0.10-0.18mm
Limit	0.0138 in.	0.35mm
Relief spring		
Free length	1.835 in.	46.8mm
Load (@ 1.579 in. (40.1mm))	13 ft. lbs.	61Nm

1.6L ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
General Information		
Engine type	4 Cylinder In-Line Double Overhead Camshaft	
Displacement	97.3 cubic in.	1.6L
Bore	3.240 in.	82.3mm
Stroke	2.953 in.	75mm
Compression ratio	9.2:1	
Firing order	1-3-4-2	
Cylinder Head		
Overall height	5.193-5.201 in.	131.9-132.1mm
Flatness (maximum)	0.002 in.	0.05mm
Camshaft bearing-to-camshaft clearance	0.0016-0.0031 in.	0.04-0.08mm
Camshaft		
Camshaft height		
Intake		
Standard	1.3858 in.	35.20mm
Limit	1.3651 in.	34.70mm
Exhaust		
Standard	1.3743 in.	34.907mm
Limit	1.3546 in.	34.407mm
Journal outside diameter	1.02 in.	26mm
Bearing oil clearance	0.0020-0.0035 in.	0.05-0.09mm
End-play	0.004-0.008 in.	0.1-0.2mm

93153-03

1.6L ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Valves		
Valve length		
Intake	4.311 in.	109.50mm
Exhaust	4.319 in.	109.70mm
Stem outside diameter		
Intake	0.2585-0.2586 in.	6.565-6.568mm
Exhaust	0.2571-0.2579 in.	6.530-6.550mm
Face angle (all)	45-45.5°	
Head thickness (margin)		
Intake		
Standard	0.039 in.	1.0mm
Limit	0.028 in.	0.7mm
Exhaust		
Standard	0.059 in.	1.5mm
Limit	0.039 in.	1.0mm
Stem-to-guide clearance		
Intake		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.0039 in.	0.10mm
Exhaust		
Standard	0.0020-0.0035 in.	0.05-0.09mm
Limit	0.0059 in.	0.15mm
Valve guide		
Length		
Intake	1.791 in.	45.5mm
Exhaust	1.988 in.	50.5mm
Service sizes	0.002, 0.010, 0.020 in.	0.05, 0.25, 0.50mm
Valve seat		
Seat contact width	0.035-0.051 in.	0.9-1.3mm
Seat angle (all)	44-44.5°	
Valve spring		
Free length		
Standard	1.902 in.	48.3mm
Limit	1.862 in.	47.3mm
Load	66 ft. lbs.	300Nm
Out of squareness		
Standard	less than 1.5°	
Limit	4.0°	
Cylinder Block		
Bore		
Diameter	3.2402-3.2413 in.	82.30-82.33mm
Out-of-round (max.)	0.004 in.	0.01mm
Taper (max.)	0.004 in.	0.01mm
Gasket surface flatness (max.)	0.0039 in.	0.1mm
Piston		
Outside diameter	3.2390-3.2402 in.	82.27-82.30
Piston-to-cylinder clearance	0.0008-0.0016 in.	0.02-0.04mm
Ring groove width		
No. 1	0.0480-0.0488 in.	1.22-1.24mm
No. 2	0.0598-0.0606 in.	1.52-1.54mm
Oil Control	0.1185-0.1193 in.	3.01-3.03mm
Service sizes	0.010, 0.020, 0.030, 0.039 in.	0.25, 0.50, 0.75, 1.0mm
Piston Rings		
Side clearance		
No. 1		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.0047 in.	0.12mm
No. 2		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.0047 in.	0.12mm

93153-04

1.6L ENGINE MECHANICAL SPECIFICATIONS

Description	English	Metric
	Specifications	Specifications
Piston Rings (cont'd)		
End gap		
No. 1		
Standard	0.0098-0.0157 in.	0.25-0.40mm
Limit	0.031 in.	0.8mm
No. 2		
Standard	0.0138-0.0197 in.	0.35-0.50mm
Limit	0.039 in.	1.0mm
Oil		
Standard	0.0079-0.0276 in.	0.20-0.70mm
Limit	0.039 in.	1.0mm
Service sizes	0.010, 0.020, 0.030, 0.039 in.	0.25, 0.50, 0.75, 1.0mm
Connecting rod		
Bend (max.)		
Standard	0.0020 in.	0.05mm
Limit	0.0039 in.	0.10mm
Twist (max.)		
Standard	0.0039-0.0098 in.	0.10-0.25mm
Limit	0.016 in.	0.4mm
Rod big end side clearance		
Standard	1.653-3.858 ft. lbs.	7.500-17.500Nm
Limit	0.0008-0.0020 in.	0.02-0.05mm
Piston pin press-in load		
Standard	0.004 in.	0.1mm
Limit		
Connecting rod bearing oil clearance		
Standard		
Limit		
Crankshaft		
Main bearing oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Pin outside diameter		
Standard	1.77 in.	45mm
Limit	2.24 in.	57mm
Journal outside diameter		
Standard	0.0006 in.	0.015mm
Limit		
Out-of-round (max.)		
Standard	0.002-0.0071 in.	0.05-0.18mm
Limit	0.0098 in.	0.25mm
Crankshaft end-play		
Standard		
Limit		
Flywheel		
Run-out (max.)		
Standard	0.0051 in.	0.13mm
Limit		
Oil Pump		
Tip clearance		
Drive gear		
Standard	0.0063-0.0083 in.	0.16-0.21mm
Limit	0.0098 in.	0.25mm
Driven gear		
Standard	0.0051-0.0071 in.	0.13-0.18mm
Limit	0.0098 in.	0.25mm
Side clearance		
Drive gear		
Standard	0.0031-0.0055 in.	0.08-0.14mm
Limit	0.0098 in.	0.25mm
Driven gear		
Standard	0.0024-0.0047 in.	0.06-0.12mm
Limit	0.0098 in.	0.25mm
Relief spring		
Free length	1.835 in.	46.6mm
Load (@ 1.579 in. (40.1mm))	13 ft. lbs.	61Nm

93153c05

1.8L ENGINE MECHANICAL SPECIFICATIONS

Description	English	Metric
	Specifications	Specifications
General Information		
Engine type		
Displacement	4 Cylinder In-Line Overhead Camshaft	111.9 cubic in.
Bore	3.19 in.	81mm
Stroke	3.50 in.	89mm
Compression ratio	9.5:1	
Firing order	1-3-4-2	
Cylinder Head		
Overall height	4.720-4.728 in.	119.9-120.1mm
Flatness (maximum)	0.008 in.	0.2mm
Camshaft		
Camshaft height		
Intake		
Standard	1.46 in.	37.11mm
Limit	1.44 in.	36.61mm
Exhaust		
Standard	1.46 in.	37.15mm
Limit	1.44 in.	36.65mm
Valves		
Valve length		
Intake		
Standard	4.337 in.	110.15mm
Limit	4.317 in.	109.65mm
Exhaust		
Standard	4.476 in.	113.70mm
Limit	4.457 in.	113.25mm
Stem outside diameter		
Intake		
Standard	0.2340 in.	6.0mm
Limit	0.2340 in.	6.0mm
Exhaust		
Standard	0.2340 in.	6.0mm
Limit	0.2340 in.	6.0mm
Face angle (all)		
Head thickness (margin)	45-45.5°	
Intake		
Standard	0.039 in.	1.0mm
Limit	0.020 in.	0.5mm
Exhaust		
Standard	0.051 in.	1.3mm
Limit	0.031 in.	0.8mm
Stem-to-guide clearance		
Intake		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.0039 in.	0.10mm
Exhaust		
Standard	0.0020-0.0035 in.	0.05-0.09mm
Limit	0.0059 in.	0.15mm
Valve guide		
Projection		
Standard	0.551 in.	14.0mm
Limit	0.234 in.	6.0mm
Valve seat		
Seat contact width		
Standard	0.035-0.051 in.	0.9-1.3mm
Seat angle (all)		
Standard	44-44.5°	
Valve spring		
Free length		
Intake		
Standard	2.00 in.	50.9mm
Limit	1.96 in.	49.9mm
Exhaust		
Standard	2.00 in.	50.9mm
Limit	1.96 in.	49.9mm
Load @ 1.74 in. (44.2mm)		
Intake	59 ft. lbs.	216Nm
Exhaust	59 ft. lbs.	216Nm

93153c06

1.8L ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Cylinder Block		
Bore		
Diameter	3.19 in.	81.0mm
Out-of-round (max.)	0.0004 in.	0.01mm
Taper (max.)	0.0004 in.	0.01mm
Overall height	10.374 in.	263.5mm
Gasket surface flatness (max.)	0.004 in.	0.1mm
Piston		
Outside diameter	3.19 in.	81.0mm
Piston pin outside diameter	0.75 in.	19.0mm
Piston pin press-in load	1,100-3,300 ft. lbs.	5,000-15,000Nm
Piston-to-cylinder clearance	0.0008-0.0016 in.	0.02-0.04mm
Piston Rings		
Side clearance		
No. 1		
Standard		
Limit	0.0012-0.0028 in.	0.03-0.07mm
No. 2		
Standard		
Limit	0.0008-0.0024 in.	0.02-0.06mm
End gap		
No. 1		
Standard		
Limit	0.0098-0.0157 in.	0.25-0.40mm
No. 2		
Standard		
Limit	0.0157-0.0217 in.	0.40-0.55mm
Oil		
Standard		
Limit	0.0078-0.0236 in.	0.20-0.60mm
Connecting rod		
Rod big end side clearance		
Standard		
Limit	0.0039-0.0098 in.	0.10-0.25mm
Crankshaft pin oil clearance		
Standard		
Limit	0.0008-0.0020 in.	0.02-0.06mm
Crankshaft		
Crankshaft journal outside diameter		
Pin outside diameter	1.97 in.	50mm
Journal oil clearance	1.77 in.	45mm
Standard		
Limit	0.0008-0.0016 in.	0.02-0.04mm
Out-of-round (max.)		
Crankshaft end-play	0.004 in.	0.1mm
Standard		
Limit	0.0006 in.	0.015mm
Standard		
Limit	0.002-0.0098 in.	0.05-0.25mm
Oil Pump		
Tip clearance		
Standard		
Limit	0.0024-0.0071 in.	0.06-0.18mm
Side clearance		
Standard		
Limit	0.0138 in.	0.35mm
Standard		
Limit	0.0016-0.0039 in.	0.04-0.10mm
Limit		
0.0079 in.		

93153c07

1.8L ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Oil Pump (cont'd)		
Body clearance		
Standard		
Limit	0.0039-0.0071 in.	0.10-0.18mm
0.0138 in.		
0.35mm		

2.0L SOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
General Information		
Engine type	4 Cylinder In-Line Overhead	Camshaft
Displacement	121.9 cubic in.	2.0L
Bore	3.35 in.	85mm
Stroke	3.46 in.	88mm
Compression ratio		8.5:1
Firing order		1-3-4-2
Cylinder Head		
Overall height	3.539-3.547 in.	89.9-90.1mm
Flatness (maximum)	0.008 in.	0.2mm
Camshaft		
Camshaft height		
Identification mark D		
Intake		
Standard		
Limit	1.67 in.	42.4mm
Exhaust		
Standard		
Limit	1.65 in.	41.9mm
Identification mark AR		
Intake		
Standard		
Limit	1.75 in.	44.53mm
Exhaust		
Standard		
Limit	1.73 in.	44.03mm
Camshaft journal outside diameter		
Standard		
Limit	1.75 in.	44.53mm
1.73 in.		
33.95mm		
Valves		
Stem outside diameter		
Intake		
Standard		
Limit	0.315 in.	8.0mm
Exhaust		
Standard		
Limit	0.311 in.	7.9mm
Face angle (all)		
45-45°		
Head thickness (margin)		
Intake		
Standard		
Limit	0.047 in.	1.2mm
Exhaust		
Standard		
Limit	0.020 in.	0.5mm
Stem-to-guide clearance		
Intake		
Standard		
Limit	0.0008-0.0024 in.	0.03-0.06mm
Exhaust		
Standard		
Limit	0.0039 in.	0.10mm
Standard		
Limit	0.0020-0.0035 in.	0.05-0.09mm
0.0059 in.		
0.15mm		
Valve guide		
Inside diameter		
Standard		
Limit	0.315 in.	8.0mm
Outside diameter		
Standard		
Limit	0.516 in.	13.1mm
Valve seat		
Seat contact width		
Standard		
Limit	0.035-0.051 in.	0.9-1.3mm
Seat angle (all)		
44-44.5°		

93153c08

2.0L SOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Valve spring		
Free length		
Standard	1.96 in.	49.8mm
Limit	1.98 in.	49.9mm
Squareness		
Standard		2°
Limit		4°
Cylinder Block		
Inside diameter	3.35 in.	85mm
Out-of-round (max.)	0.008 in.	0.02mm
Taper (max.)	0.008 in.	0.02mm
Overall height	11.413-11.421 in.	289.9-290.1mm
Gasket surface flatness (max.)	0.002 in.	0.05mm
Piston		
Outside diameter	3.346 in.	84.99mm
Piston-to-cylinder clearance	0.004-0.0012 in.	0.01-0.03mm
Piston Rings		
Side clearance		
No. 1		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.004 in.	0.1mm
No. 2		
Standard	0.0008-0.0024 in.	0.02-0.06mm
Limit	0.004 in.	0.1mm
End gap		
No. 1		
Standard	0.0098-0.0157 in.	0.25-0.40mm
Limit	0.031 in.	0.8mm
No. 2		
Standard	0.0079-0.0138 in.	0.20-0.35mm
Limit	0.031 in.	0.8mm
Oil		
Standard	0.0079-0.0276 in.	0.20-0.70mm
Limit	0.039 in.	1.0mm
Connecting rod		
Rod big end side clearance		
Standard	0.0039-0.0098 in.	0.10-0.25mm
Limit	0.016 in.	0.4mm
Piston pin outside diameter	0.83 in.	21mm
Piston pin press-in load	1,653-3,858 ft. lbs.	7,500-17,500Nm
Crankshaft pin oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Crankshaft		
Main bearing oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Pin outside diameter	1.77 in.	45mm
Journal outside diameter	2.24 in.	57mm
Out-of-round (max.)	0.0006 in.	0.015mm
Crankshaft end-play		
Standard	0.002-0.0071 in.	0.05-0.18mm
Limit	0.0098 in.	0.25mm
Flywheel		
Run-out (max.)	0.0051 in.	0.13mm
Oil Pump		
Side clearance		
Drive gear	0.0031-0.0055 in.	0.08-0.14mm
Driven gear	0.0024-0.0047 in.	0.06-0.12mm

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2.0L DOHC (NON-TURBO) ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
General Information		
Engine type	4 Cylinder In-Line Dual Overhead Camshaft	
Displacement	121.9 cubic in.	2.0L
Bore	3.35 in.	85mm
Stroke	3.46 in.	88mm
Compression ratio		9.8:1
Firing order		1-3-4-2
Cylinder Head		
Overall height	5.193-5.201 in.	131.9-132.1mm
Flatness (maximum)	0.008 in.	0.2mm
Camshaft		
Camshaft height		
Identification mark A, D		
Intake		
Standard	1.4 in.	35.49mm
Limit	1.38 in.	34.99mm
Identification mark B, C, E, F		
Intake		
Standard	1.39 in.	35.20mm
Limit	1.37 in.	34.70mm
Identification mark A		
Exhaust	1.39 in.	35.20mm
Limit	1.37 in.	34.70mm
Identification mark C		
Exhaust	1.4 in.	35.49mm
Standard	1.38 in.	34.99mm
Limit		
Identification mark E, F		
Exhaust	1.37 in.	34.91mm
Standard	1.35 in.	34.41mm
Limit	1.02 in.	25.96mm
Camshaft journal outside diameter		
Valves		
Stem outside diameter		
Intake	0.260 in.	6.6mm
Exhaust	0.256 in.	6.5mm
Face angle (all)		45-45.5°
Head thickness (margin)		
Intake		
Standard	0.039 in.	1.0mm
Limit	0.020 in.	0.5mm
Exhaust		
Standard	0.059 in.	1.5mm
Limit	0.031 in.	0.8mm
Stem-to-guide clearance		
Intake		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.0038 in.	0.10mm
Exhaust		
Standard	0.0020-0.0035 in.	0.05-0.09mm
Limit	0.0059 in.	0.15mm
Valve guide		
Inside diameter	0.260 in.	6.6mm
Outside diameter	0.476 in.	12.1mm
Valve seat		
Seal contact width	0.035-0.051 in.	0.9-1.3mm
Seat angle (all)		44-44.5°
Valve spring		
Free length		
Standard	1.80 in.	48.3mm

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2.0L DOHC (NON-TURBO) ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Valve spring (cont'd)		
Limit	1.98 in.	49.9mm
Squareness		
Standard	2°	
Limit	4°	
Cylinder Block		
Inside diameter	3.35 in.	85mm
Out-of-round (max.)	0.008 in.	0.02mm
Taper (max.)	0.008 in.	0.02mm
Overall height	11.413-11.421 in.	289.9-290.1mm
Gasket surface flatness (max.)	0.002 in.	0.05mm
Piston		
Outside diameter	3.346 in.	84.99mm
Piston-to-cylinder clearance	0.008-0.0016 in.	0.02-0.04mm
Piston Rings		
Side clearance		
No. 1		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.004 in.	0.1mm
No. 2		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.004 in.	0.1mm
End gap		
No. 1		
Standard	0.0098-0.0157 in.	0.25-0.40mm
Limit	0.031 in.	0.8mm
No. 2		
Standard	0.0177-0.0236 in.	0.45-0.60mm
Limit	0.031 in.	0.8mm
Oil		
Standard	0.0079-0.0276 in.	0.20-0.70mm
Limit	0.039 in.	1.0mm
Connecting rod		
Rod big end side clearance		
Standard	0.0039-0.0098 in.	0.10-0.25mm
Limit	0.010 in.	0.4mm
Piston pin outside diameter	0.83 in.	21mm
Piston pin press-in load	1,653-3,858 ft. lbs.	7,500-17,500Nm
Crankshaft pin oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Crankshaft		
Main bearing oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Pin outside diameter	1.77 in.	45mm
Journal outside diameter	2.24 in.	57mm
Out-of-round (max.)	0.0006 in.	0.015mm
Crankshaft end-play		
Standard	0.002-0.0071 in.	0.05-0.18mm
Limit	0.0098 in.	0.25mm
Flywheel		
Flun-out (max.)	0.0051 in.	0.13mm
Oil Pump		
Side clearance		
Drive gear	0.0031-0.0055 in.	0.08-0.14mm
Driven gear	0.0024-0.0047 in.	0.06-0.12mm

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2.0L DOHC (TURBO) ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
General Information		
Engine type	4 Cylinder In-Line Dual Overhead Camshaft	
Displacement	121.9 cubic in.	2.0L
Bore	3.35 in.	85mm
Stroke	3.46 in.	88mm
Compression ratio		7.8:1
Firing order		1-3-4-2
Cylinder Head		
Overall height	5.193-5.201 in.	131.9-132.1mm
Flatness (maximum)	0.008 in.	0.2mm
Camshaft		
Camshaft height		
Identification mark A, D		
Intake		
Standard	1.4 in.	35.49mm
Limit	1.38 in.	34.99mm
Identification mark B, C, E, F		
Intake		
Standard	1.39 in.	35.20mm
Limit	1.37 in.	34.70mm
Identification mark A		
Exhaust		
Standard	1.39 in.	35.20mm
Limit	1.37 in.	34.70mm
Identification mark C		
Exhaust		
Standard	1.4 in.	35.49mm
Limit	1.38 in.	34.99mm
Identification mark E, F		
Exhaust		
Standard	1.37 in.	34.91mm
Limit	1.35 in.	34.41mm
Camshaft journal outside diameter	1.02 in.	25.96mm
Valves		
Stem outside diameter		
Intake	0.260 in.	6.6mm
Exhaust	0.256 in.	6.5mm
Face angle (all)		45-45.5°
Head thickness (margin)		
Intake		
Standard	0.039 in.	1.0mm
Limit	0.020 in.	0.5mm
Exhaust		
Standard	0.059 in.	1.5mm
Limit	0.031 in.	0.8mm
Stem-to-guide clearance		
Intake		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.0039 in.	0.10mm
Exhaust		
Standard	0.0020-0.0035 in.	0.05-0.09mm
Limit	0.0059 in.	0.15mm
Valve guide		
Inside diameter		
Standard	0.260 in.	6.6mm
Outside diameter	0.476 in.	12.1mm
Valve seat		
Seat contact width		
Standard	0.035-0.051 in.	0.9-1.3mm
Seat angle (all)		44-44.5°

93153:12

2.0L DOHC (TURBO) ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Valve spring		
Free length		
Standard	1.90 in.	48.3mm
Limit	1.98 in.	49.9mm
Squareness		
Standard		2°
Limit		4°
Cylinder Block		
Inside diameter	3.35 in.	85mm
Out-of-round (max.)	0.008 in.	0.02mm
Taper (max.)	0.008 in.	0.02mm
Overall height	11.413-11.421 in.	289.9-290.1mm
Gasket surface flatness (max.)	0.002 in.	0.05mm
Piston		
Outside diameter	3.334 in.	84.98mm
Piston-to-cylinder clearance	0.012-0.0020 in.	0.03-0.05mm
Piston Rings		
Side clearance		
No. 1		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.004 in.	0.1mm
No. 2		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.004 in.	0.1mm
End gap		
No. 1		
Standard	0.0098-0.0157 in.	0.25-0.40mm
Limit	0.031 in.	0.8mm
No. 2		
Standard	0.0177-0.0236 in.	0.45-0.60mm
Limit	0.031 in.	0.8mm
Oil		
Standard	0.0079-0.0276 in.	0.20-0.70mm
Limit	0.039 in.	1.0mm
Connecting rod		
Rod big end side clearance		
Standard	0.0039-0.0098 in.	0.10-0.25mm
Limit	0.016 in.	0.4mm
Piston pin outside diameter	0.83 in.	21mm
Piston pin press-in load	1,653-3,858 ft. lbs.	7,500-17,500Nm
Crankshaft pin oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Crankshaft		
Main bearing oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Pin outside diameter	1.77 in.	45mm
Journal outside diameter	2.24 in.	57mm
Out-of-round (max.)	0.0008 in.	0.015mm
Crankshaft end-play		
Standard	0.002-0.0071 in.	0.05-0.18mm
Limit	0.0098 in.	0.25mm
Flywheel		
Run-out (max.)	0.0051 in.	0.13mm
Oil Pump		
Side clearance		
Drive gear	0.0031-0.0055 in.	0.08-0.14mm
Driven gear	0.0024-0.0047 in.	0.06-0.12mm

93153c13

2.4L SOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
General Information		
Engine type	4 Cylinder In-Line Overhead Camshaft	
Displacement	143.4 cubic in.	2.4L
Bore	3.41 in.	86.5mm
Stroke	3.94 in.	100mm
Compression ratio		8.5:1
Firing order		1-3-4-2
Cylinder Head		
Overall height	3.539-3.547 in.	89.9-90.1mm
Flatness (maximum)	0.008 in.	0.2mm
Camshaft		
Camshaft height		
Identification mark D		
Intake		
Standard		
Limit	1.07 in.	42.4mm
Exhaust		
Standard		
Limit	1.67 in.	42.4mm
Identification mark AR		
Intake		
Standard	1.75 in.	44.53mm
Limit	1.73 in.	44.03mm
Exhaust		
Standard	1.75 in.	44.53mm
Limit	1.73 in.	44.03mm
Camshaft journal outside diameter	1.34 in.	33.95mm
Valves		
Stem outside diameter		
Intake	0.315 in.	8.0mm
Exhaust	0.311 in.	7.9mm
Face angle (all)		45-45.5°
Head thickness (margin)		
Intake		
Standard	0.047 in.	1.2mm
Limit	0.020 in.	0.5mm
Exhaust		
Standard	0.079 in.	2.0mm
Limit	0.031 in.	0.8mm
Stem-to-guide clearance		
Intake		
Standard	0.0008-0.0024 in.	0.03-0.06mm
Limit	0.0039 in.	0.10mm
Exhaust		
Standard	0.0020-0.0035 in.	0.05-0.09mm
Limit	0.0059 in.	0.15mm
Valve guide		
Inside diameter	0.315 in.	8.0mm
Outside diameter	0.516 in.	13.1mm
Valve seat		
Seat contact width	0.035-0.051 in.	0.9-1.3mm
Seat angle (all)		44-44.5°
Valve spring		
Free length		
Standard	1.96 in.	49.8mm
Limit	1.98 in.	49.9mm
Squareness		
Standard		2°
Limit		4°

93153c14

2.4L SOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Cylinder Block		
Inside diameter	3.35 in.	85mm
Out-of-round (max.)	0.008 in.	0.02mm
Taper (max.)	0.008 in.	0.02mm
Overall height	11.413-11.421 in.	289.9-290.1mm
Gasket surface flatness (max.)	0.002 in.	0.05mm
Piston		
Outside diameter	3.346 in.	84.99mm
Piston-to-cylinder clearance	0.004-0.0012 in.	0.01-0.03mm
Piston Rings		
Side clearance		
No. 1		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.004 in.	0.1mm
No. 2		
Standard	0.0008-0.0024 in.	0.02-0.06mm
Limit	0.004 in.	0.1mm
End gap		
No. 1		
Standard	0.0098-0.0157 in.	0.25-0.40mm
Limit	0.031 in.	0.8mm
No. 2		
Standard	0.0079-0.0138 in.	0.20-0.35mm
Limit	0.031 in.	0.8mm
Oil		
Standard	0.0079-0.0276 in.	0.20-0.70mm
Limit	0.039 in.	1.0mm
Connecting rod		
Rod big end side clearance		
Standard	0.0039-0.0098 in.	0.10-0.25mm
Limit	0.016 in.	0.4mm
Piston pin outside diameter	0.83 in.	21mm
Piston pin press-in load	1,653-3,858 ft. lbs.	7,500-17,500Nm
Crankshaft pin oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Crankshaft		
Main bearing oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Pin outside diameter	1.77 in.	45mm
Journal outside diameter	2.24 in.	57mm
Out-of-round (max.)	0.0006 in.	0.015mm
Crankshaft end-play		
Standard	0.002-0.0071 in.	0.05-0.18mm
Limit	0.0098 in.	0.25mm
Flywheel		
Run-out (max.)	0.0051 in.	0.13mm
Oil Pump		
Side clearance		
Drive gear	0.0031-0.0055 in.	0.08-0.14mm
Driven gear	0.0024-0.0047 in.	0.06-0.12mm

2.4L DOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
General Information		
Engine type	4 Cylinder In-Line Dual Overhead Camshaft	
Displacement	143.4 cubic in.	2.4L

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2.4L DOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
General Information (cont'd)		
Bore	3.41 in.	86.5mm
Stroke	3.94 in.	100mm
Compression ratio		8.5:1
Firing order		1-3-4-2
General Information		
Engine type	4 Cylinder In-Line Dual Overhead Camshaft	
Displacement	121.9 cubic in.	2.0L
Bore	3.35 in.	85mm
Stroke	3.46 in.	88mm
Compression ratio		9.8:1
Firing order		1-3-4-2
Cylinder Head		
Overall height	5.193-5.201 in.	131.9-132.1mm
Flatness (maximum)	0.008 in.	0.2mm
Camshaft		
Camshaft height		
Identification mark A, D		
Intake		
Standard	1.4 in.	35.49mm
Limit	1.38 in.	34.99mm
Identification mark B, C, E, F		
Intake		
Standard	1.39 in.	35.20mm
Limit	1.37 in.	34.70mm
Identification mark A		
Exhaust		
Standard	1.39 in.	35.20mm
Limit	1.37 in.	34.70mm
Identification mark C		
Exhaust		
Standard	1.4 in.	35.49mm
Limit	1.38 in.	34.99mm
Identification mark E, F		
Exhaust		
Standard	1.37 in.	34.91mm
Limit	1.35 in.	34.41mm
Camshaft journal outside diameter		
	1.02 in.	25.96mm
Valves		
Stem outside diameter		
Intake		
Exhaust	0.260 in.	6.6mm
	0.256 in.	6.5mm
Face angle (all)		
Head thickness (margin)		45-45.5°
Intake		
Standard	0.039 in.	1.0mm
Limit	0.020 in.	0.5mm
Exhaust		
Standard	0.059 in.	1.5mm
Limit	0.031 in.	0.8mm
Stem-to-guide clearance		
Intake		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.0039 in.	0.10mm
Exhaust		
Standard	0.0020-0.0035 in.	0.05-0.09mm
Limit	0.0059 in.	0.15mm
Valve guide		
Inside diameter	0.260 in.	6.6mm
Outside diameter	0.476 in.	12.1mm

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2.4L DOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Valve seat		
Seat contact width	0.035-0.051 in.	0.9-1.3mm
Seat angle (all)	44-44.5°	
Valve spring		
Free length		
Standard	1.90 in.	48.3mm
Limit	1.98 in.	49.9mm
Squareness		
Standard		2°
Limit		4°
Cylinder Block		
Inside diameter	3.35 in.	85mm
Out-of-round (max.)	0.008 in.	0.02mm
Taper (max.)	0.008 in.	0.02mm
Overall height	11.413-11.421 in.	290.9-290.1mm
Gasket surface flatness (max.)	0.002 in.	0.05mm
Piston		
Outside diameter	3.345 in.	84.99mm
Piston-to-cylinder clearance	0.008-0.0016 in.	0.02-0.04mm
Piston Rings		
Side clearance		
No. 1		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.004 in.	0.1mm
No. 2		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.004 in.	0.1mm
End gap		
No. 1		
Standard	0.0098-0.0157 in.	0.25-0.40mm
Limit	0.031 in.	0.8mm
No. 2		
Standard	0.0177-0.0236 in.	0.45-0.60mm
Limit	0.031 in.	0.8mm
Oil		
Standard	0.0079-0.0276 in.	0.20-0.70mm
Limit	0.039 in.	1.0mm
Connecting rod		
Rod big end side clearance		
Standard	0.0039-0.0098 in.	0.10-0.25mm
Limit	0.016 in.	0.4mm
Piston pin outside diameter	0.83 in.	21mm
Piston pin press-in load	1,653-3,858 ft. lbs.	7,500-17,500Nm
Crankshaft pin oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Crankshaft		
Main bearing oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Pin outside diameter	1.77 in.	45mm
Journal outside diameter	2.24 in.	57mm
Out-of-round (max.)	0.0006 in.	0.015mm
Crankshaft end-play		
Standard	0.002-0.0071 in.	0.05-0.18mm
Limit	0.0098 in.	0.25mm
Flywheel		
Run-out (max.)	0.0051 in.	0.13mm

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2.4L DOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Oil Pump		
Side clearance		
Drive gear	0.0031-0.0055 in.	0.08-0.14mm
Driven gear	0.0024-0.0047 in.	0.06-0.12mm

3.0L SOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
General Information		
Engine type	6 Cylinder 60° Single Overhead Camshaft	
Displacement	181.4 cubic in.	3.0L
Bore	3.59 in.	91.1mm
Stroke	2.99 in.	76mm
Compression ratio		10.0:1
Firing order		1-2-3-4-5-6
Cylinder Head		
Overall height	3.31 in.	84mm
Flatness (maximum)	0.008 in.	0.2mm
Camshaft		
Camshaft height		
Standard	1.62 in.	41.25mm
Limit	1.60 in.	40.75mm
Camshaft journal outside diameter	1.34 in.	33.95mm
Valves		
Stem outside diameter		
Intake	0.315 in.	8.0mm
Exhaust	0.311 in.	7.9mm
Face angle (all)		45-45.5°
Head thickness (margin)		
Intake		
Standard	0.047 in.	1.2mm
Limit	0.028 in.	0.7mm
Exhaust		
Standard	0.079 in.	2.0mm
Limit	0.059 in.	1.5mm
Stem-to-guide clearance		
Intake		
Standard	0.0012-0.0024 in.	0.03-0.06mm
Limit	0.0039 in.	0.10mm
Exhaust		
Standard	0.0020-0.0035 in.	0.05-0.09mm
Limit	0.0059 in.	0.15mm
Valve guide		
Inside diameter	0.315 in.	8.0mm
Outside diameter	0.516 in.	13.1mm
Valve seat		
Seat contact width	0.035-0.051 in.	0.9-1.3mm
Seat angle (all)		44-44.5°
Valve spring		
Free length		
Standard	1.96 in.	49.8mm
Limit	1.92 in.	48.8mm
Load (installed height) lbs. (Nm) at in. (mm)	72.5 lbs. @ 1.591 in.	329 Nm @ 40.4mm
Squareness		
Standard		2°
Limit		4°
Cylinder Block		
Inside diameter	3.59 in.	91.1mm
Out-of-round (max.)	0.008 in.	0.02mm

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3.0L SOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Cylinder Block (cont'd)		
Taper (max.)	0.008 in.	0.02mm
Overall height	8.26-8.29 in.	210.4-210.6mm
Gasket surface flatness (max.)	0.0039 in.	0.1mm
Piston		
Outside diameter	3.58 in.	91.1mm
Piston-to-cylinder clearance	0.008-0.0020 in.	0.02-0.04mm
Piston Rings		
Side clearance		
No. 1		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.004 in.	0.1mm
No. 2		
Standard	0.0008-0.0024 in.	0.02-0.06mm
Limit	0.004 in.	0.1mm
End gap		
No. 1		
Standard	0.0118-0.0177 in.	0.30-0.40mm
Limit	0.031 in.	0.8mm
No. 2		
Standard	0.0177-0.0236 in.	0.45-0.60mm
Limit	0.031 in.	0.8mm
Oil		
Standard	0.0079-0.0236 in.	0.20-0.60mm
Limit	0.039 in.	1.0mm
Connecting rod		
Rod big end side clearance		
Standard	0.0039-0.0098 in.	0.10-0.25mm
Limit	0.016 in.	0.4mm
Piston pin outside diameter	0.87 in.	22mm
Piston pin press-in load	1,652-3,867 ft. lbs.	7,350-17,200Nm
Crankshaft pin oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Crankshaft		
Main bearing oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Pin outside diameter	1.97 in.	50mm
Journal outside diameter	2.36 in.	60mm
Out-of-round (max.)	0.0006 in.	0.015mm
Crankshaft end-play		
Standard	0.002-0.0098 in.	0.05-0.25mm
Limit	0.012 in.	0.3mm
Oil Pump		
Tip clearance		
Standard	0.0024-0.0071 in.	0.06-0.18mm
Side clearance	0.0016-0.0039 in.	0.04-0.10mm
Body clearance		
Standard	0.0039-0.0071 in.	0.10-0.18mm
Limit	0.0138 in.	0.35mm

3.0L DOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
General Information		
Engine type	6 Cylinder 60° Dual Overhead Camshaft	
Displacement	181.4 cubic in.	3.0L
Bore	3.59 in.	91.1mm
Stroke	2.99 in.	76mm

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3.0L DOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
General Information (cont'd)		
Compression ratio		10.0:1
Firing order		1-2-3-4-5-6
Cylinder Head		
Overall height	5.20 in.	132mm
Flatness (maximum)	0.008 in.	0.2mm
Camshaft		
Camshaft height		
Standard	1.37 in.	34.91mm
Limit	1.37 in.	34.91mm
Camshaft journal outside diameter		
Standard	1.02 in.	25.95mm
Valves		
Stem outside diameter		
Intake	0.260 in.	6.6mm
Exhaust	0.256 in.	6.5mm
Face angle (all)		
Head thickness (margin)		45-45°
Intake		
Standard	0.039 in.	1.0mm
Limit	0.019 in.	0.5mm
Exhaust		
Standard	0.059 in.	1.5mm
Limit	0.039 in.	1.0mm
Stem-to-guide clearance		
Intake		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.0039 in.	0.10mm
Exhaust		
Standard	0.0020-0.0035 in.	0.05-0.09mm
Limit	0.0059 in.	0.15mm
Valve guide		
Inside diameter		
Standard	0.260 in.	6.6mm
Limit	0.476 in.	12.1mm
Valve seat		
Seat contact width		
Standard	0.035-0.051 in.	0.9-1.3mm
Seat angle (all)		
		44-44.5°
Valve spring		
Free length		
Standard	1.78 in.	45.2mm
Limit	1.74 in.	44.2mm
Load (installed height) lbs. (Nm) at in. (mm)		
Standard	52.9 lbs. @ 1.492 in.	240 Nm @ 37.9mm
Squarness		
Standard		2°
Limit		4°
Cylinder Block		
Inside diameter		
Standard	3.56 in.	93mm
Out-of-round (max.)	0.008 in.	0.2mm
Taper (max.)	0.008 in.	0.2mm
Overall height	8.97-8.98 in.	227.9-228.1mm
Gasket surface flatness (max.)	0.0039 in.	0.1mm
Piston		
Outside diameter	3.66 in.	93mm
Piston-to-cylinder clearance	0.008-0.0020 in.	0.02-0.04mm
Piston Rings		
Side clearance		
No. 1		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.004 in.	0.1mm
No. 2		
Standard	0.0008-0.0024 in.	0.02-0.06mm
Limit	0.004 in.	0.1mm

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3.0L DOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Piston Rings (cont'd)		
End gap		
No. 1		
Standard	0.0118-0.0177 in.	0.30-0.40mm
Limit	0.031 in.	0.8mm
No. 2		
Standard	0.0177-0.0236 in.	0.45-0.60mm
Limit	0.031 in.	0.8mm
Oil		
Standard	0.0039-0.0137 in.	0.10-0.35mm
Limit	0.039 in.	1.0mm
Connecting rod		
Rod big end side clearance		
Standard	0.0039-0.0098 in.	0.10-0.25mm
Limit	0.016 in.	0.4mm
Piston pin outside diameter	0.87 in.	22mm
Piston pin press-in load	1,652-3,867 ft. lbs.	7,350-17,200Nm
Crankshaft pin oil clearance		
Standard	0.0012-0.0020 in.	0.03-0.05mm
Limit	0.004 in.	0.1mm
Crankshaft		
Main bearing oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Pin outside diameter	2.17 in.	55mm
Journal outside diameter	2.52 in.	64mm
Out-of-round (max.)	0.0006 in.	0.015mm
Crankshaft end-play		
Standard	0.002-0.0098 in.	0.05-0.25mm
Limit	0.012 in.	0.3mm
Oil Pump		
Tip clearance		
Standard	0.0024-0.0071 in.	0.06-0.18mm
Side clearance	0.0016-0.0039 in.	0.04-0.10mm
Body clearance		
Standard	0.0039-0.0071 in.	0.10-0.18mm
Limit	0.0138 in.	0.35mm

3.5L SOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
General Information		
Engine type	6 Cylinder 60° Single Overhead Camshaft	3.5L
Displacement	213.5 cubic in.	3.5L
Bore	3.65 in.	93mm
Stroke	3.37 in.	85.9mm
Compression ratio		9.0:1
Firing order		1-2-3-4-5-6
Cylinder Head		
Overall height		
Standard	4.72 in.	120mm
Flatness (maximum)		
Standard	0.008 in.	0.2mm
Camshaft		
Camshaft height		
Intake		
Standard	1.48 in.	37.58mm
Limit	1.46 in.	37.08mm
Exhaust		
Standard	1.45 in.	36.95mm
Limit	1.44 in.	36.45mm
Camshaft journal outside diameter		
Standard	1.77 in.	44.95mm

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3.5L SOHC ENGINE MECHANICAL SPECIFICATIONS

Description	English Specifications	Metric Specifications
Valves		
Stem outside diameter		
Intake	0.236 in.	6.0mm
Exhaust	0.236 in.	6.0mm
Face angle (all)		
Head thickness (margin)	45-45.5°	
Intake		
Standard	0.0039 in.	0.10mm
Limit	0.019 in.	0.5mm
Exhaust		
Standard	0.047 in.	1.2mm
Limit	0.028 in.	0.7mm
Stem-to-guide clearance		
Intake		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.0039 in.	0.10mm
Exhaust		
Standard	0.0016-0.0028 in.	0.04-0.07mm
Limit	0.0059 in.	0.15mm
Valve guide		
Inside diameter		
Standard	0.315 in.	6.0mm
Limit	0.433 in.	11.0mm
Valve seat		
Seat contact width		
Standard	0.035-0.051 in.	0.9-1.3mm
Seat angle (all)		
Standard	44-44.5°	
Valve spring		
Free length		
Standard	2.01 in.	51mm
Limit	1.97 in.	50mm
Squareness		
Standard		2°
Limit		4°
Cylinder Block		
Inside diameter		
Standard	3.65 in.	93mm
Out-of-round (max.)	0.008 in.	0.02mm
Taper (max.)	0.008 in.	0.02mm
Overall height	8.29-8.29 in.	210.4-210.8mm
Gasket surface flatness (max.)	0.002 in.	0.05mm
Piston		
Outside diameter		
Standard	3.65 in.	93mm
Piston-to-cylinder clearance	0.004-0.0012 in.	0.01-0.03mm
Piston Rings		
Side clearance		
No. 1		
Standard	0.0012-0.0028 in.	0.03-0.07mm
Limit	0.004 in.	0.1mm
No. 2		
Standard	0.0008-0.0024 in.	0.02-0.06mm
Limit	0.004 in.	0.1mm
End gap		
No. 1		
Standard	0.0118-0.0177 in.	0.30-0.45mm
Limit	0.031 in.	0.8mm
No. 2		
Standard	0.0177-0.0236 in.	0.45-0.60mm
Limit	0.031 in.	0.8mm
Oil		
Standard	0.0079-0.0236 in.	0.20-0.60mm
Limit	0.039 in.	1.0mm

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3.5L SOHC ENGINE MECHANICAL SPECIFICATIONS

Description	Metric Specifications	
	English	Metric
Connecting rod		
Rod big end side clearance		
Standard	0.0039-0.0098 in.	0.10-0.25mm
Limit	0.016 in.	0.4mm
Piston pin outside diameter	0.67 in.	22mm
Piston pin press-in load		Finger pressure
Crankshaft pin oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Crankshaft		
Main bearing oil clearance		
Standard	0.0008-0.0020 in.	0.02-0.05mm
Limit	0.004 in.	0.1mm
Pin outside diameter	1.97 in.	50mm
Journal outside diameter	2.36 in.	60mm
Out-of-round (max.)	0.0006 in.	0.015mm
Crankshaft end-play		
Standard	0.002-0.0098 in.	0.05-0.25mm
Limit	0.012 in.	0.3mm
Oil pump		
Tip clearance	0.0024-0.0071 in.	0.06-0.18mm
Side clearance	0.0016-0.0039 in.	0.04-0.10mm
Body clearance		
Standard	0.0039-0.0071 in.	0.10-0.18mm
Limit	0.0138 in.	0.35mm

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TORQUE SPECIFICATIONS

Components	Metric	
	English	Metric
Camshaft		
Camshaft sprocket bolt		
1.5L engine	51 ft. lbs.	70 Nm
1.6L, 1.8L, and 2.0L (SOHC and DOHC) engines	65 ft. lbs.	90 Nm
2.4L engine	58-77 ft. lbs.	80-100 Nm
3.0L (SOHC and DOHC) engine	65 ft. lbs.	90 Nm
Bearing cap retaining bolts		
2.0L SOHC engine	15 ft. lbs.	20 Nm
1.6L and 2.0L DOHC engines	21-25 ft. lbs.	29-35 Nm
2.4L engine	15 ft. lbs.	20 Nm
3.0L (SOHC and DOHC) engine		①
3.5L engine	23 ft. lbs.	31 Nm
Crankshaft damper/pulley		
Pulley bolts		
1.5L engine	10 ft. lbs.	14 Nm
1.6L and 2.0L (SOHC and DOHC) engines	14-22 ft. lbs.	20-30 Nm
2.4L engine	18 ft. lbs.	25 Nm
Center retaining bolt		
1.5L engine	51-72 ft. lbs.	70-100 Nm
1.8L and 3.5L engines	134 ft. lbs.	185 Nm
3.0L (SOHC and DOHC) engine	108-116 ft. lbs.	150-160 Nm
Cylinder head		
Cylinder head bolts (all engines)		①
Exhaust manifold retaining bolts/nuts		
1.5L engine	13 ft. lbs.	18 Nm
1.6L and 2.0L DOHC engines	18-22 ft. lbs.	25-30 Nm
1.8L engine	22 ft. lbs.	30 Nm
2.0L SOHC engine	11-14 ft. lbs.	15-19 Nm
2.4L engine	18-21 ft. lbs.	25-29 Nm
3.0L SOHC engine	21 ft. lbs.	29 Nm
3.0L DOHC engine	14 ft. lbs.	19 Nm
3.5L engine	21 ft. lbs.	29 Nm
Flywheel/driveplate retaining bolts		
1.5L engine	98 ft. lbs.	135 Nm
1.6L, 2.0L (SOHC and DOHC), and 2.4L engines	94-101 ft. lbs.	130-140 Nm
1.8L engine	72 ft. lbs.	100 Nm
3.0L SOHC, 3.0L DOHC, and 3.5L engines	53-56 ft. lbs.	72-76 Nm
Intake manifold retaining bolts		
1.5L engine	13 ft. lbs.	18 Nm
1.6L and 2.0L DOHC engines	11-14 ft. lbs.	15-19 Nm
1.8L engine	14 ft. lbs.	20 Nm
2.0L SOHC engine		
Plenum bolts	11-14 ft. lbs.	15-19 Nm
Manifold bolts	11-14 ft. lbs.	15-19 Nm
2.4L engine	18 ft. lbs.	25 Nm
1994 models		
Bolts	15 ft. lbs.	20 Nm
Nuts	26 ft. lbs.	35 Nm
1995-00 models		
Bolts	15 ft. lbs.	20 Nm
Nuts	15 ft. lbs.	20 Nm
3.0L SOHC, 3.0L DOHC, and 3.5L engines		①

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TORQUE SPECIFICATIONS

Components	English	Metric
Oil pan retaining bolts		
1.5L engine	60 inch lbs.	7 Nm
1.6L and 2.0L DOHC engines	4-6 ft. lbs.	6-8 Nm
1.8L engine	60 inch lbs.	7 Nm
2.0L SOHC engine	4-6 ft. lbs.	6-8 Nm
2.4L engine	6 ft. lbs.	8 Nm
3.0L SOHC engine	48 inch lbs.	6 Nm
3.0L DOHC engine	48 inch lbs.	6 Nm
3.5L engine		
Upper oil pan	4 ft. lbs.	6 Nm
Lower oil pan	7-9 ft. lbs.	10-12 Nm
Oil Pump		
1.5L and 1.8L engines		
Pump cover	64 inch lbs.	10 Nm
Relief valve	33 ft. lbs.	45 Nm
Pump screen	14 ft. lbs.	19 Nm
1.6L, 2.0L (SOHC and DOHC), and 2.4L engines		
Oil filler bracket	14 ft. lbs.	19 Nm
Pump cover	17 ft. lbs.	24 Nm
Pump drive gear retaining bolt	27 ft. lbs.	37 Nm
Plug cap	17 ft. lbs.	24 Nm
3.0L (SOHC and DOHC) engine		
Baffle plate retaining bolts	8 ft. lbs.	11 Nm
Pump case retaining bolts	10 ft. lbs.	14 Nm
Pump cover retaining bolts	7 ft. lbs.	10 Nm
3.5L engine		
Baffle plate retaining bolts	7 ft. lbs.	10 Nm
Pump case retaining bolts	10 ft. lbs.	14 Nm
Pick-up retaining bolts	13 ft. lbs.	18 Nm
Rotor cover	7 ft. lbs.	10 Nm
Rocker arm (valve) cover retaining bolts		
1.5L engine		
	12-18 inch lbs.	1-2 Nm
1.6L, 1.8L, 2.0L DOHC, and 2.4L engines		
	24-36 inch lbs.	2-3 Nm
2.0L SOHC engine		
	48-60 inch lbs.	4-5 Nm
3.0L SOHC engine		
	7 ft. lbs.	9 Nm
3.0L DOHC engine		
	42-54 inch lbs.	4-5 Nm
3.5L engine		
	30 inch lbs.	3 Nm
Rocker arms and pushrods		
Rocker arm retaining bolts		
1.5L, 1.8L and 2.4L engines		
	23 ft. lbs.	32 Nm
1.6L and 2.0L DOHC engines		
	21-25 ft. lbs.	29-35 Nm
3.5L engine		
	18 ft. lbs.	25 Nm
Thermostat		
1.8L engine		
	16 ft. lbs.	22 Nm
1.5L, 1.6L, 2.0L DOHC, and 1990-92 2.0L SOHC engines		
	12-14 ft. lbs.	17-20 Nm
1993 2.0L SOHC engine		
	7-10 ft. lbs.	10-15 Nm
2.4L engine		
	10 ft. lbs.	13 Nm
3.0L SOHC, 3.0L DOHC, and 3.5L engines		
	12-14 ft. lbs.	17-20 Nm

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TORQUE SPECIFICATIONS

Components	English	Metric
Timing belts		
1.5L engine		
	18 ft. lbs.	25 Nm
Pivot bolt		
1990-94 models		
	14-20 ft. lbs.	20-27 Nm
1995-00 models		
	17 ft. lbs.	24 Nm
2.0L DOHC turbo engine		
Balance shaft tensioner pulley bolt		
	14 ft. lbs.	19 Nm
Timing belt tensioner pulley bolt		
	35 ft. lbs.	48 Nm
2.4L engine		
Balance shaft tensioner pulley bolt		
	15 ft. lbs.	20 Nm
Timing belt tensioner pulley bolt		
	35 ft. lbs.	48 Nm
3.0L SOHC engine		
Tensioner lock bolt		
	21 ft. lbs.	29 Nm
3.0L DOHC engine		
1992-94 models		
Tensioner lock bolt		
	7 ft. lbs.	10 Nm
1995-96 models		
Tensioner retaining bolts		
	17 ft. lbs.	24 Nm
3.5L engine		
Tensioner pulley fixed bolt		
	18 ft. lbs.	25 Nm
	35 ft. lbs.	48 Nm
Water pump		
Pump retaining bolts		
1.5L and 1.8L engines		
	17 ft. lbs.	24 Nm
1.6L and 2.0L (SOHC and DOHC) engines		
	9-11 ft. lbs.	12-15 Nm
2.4L engine		
Bolts marked with <4>		
	10 ft. lbs.	14 Nm
Bolts marked with <7>		
	18 ft. lbs.	24 Nm
3.0L SOHC, 3.0L DOHC, and 3.5L engines		
	17 ft. lbs.	24 Nm

Ⓢ Refer to the procedure

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