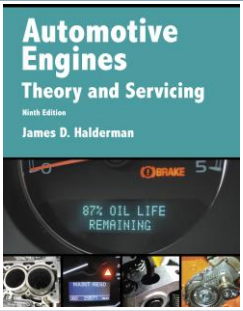
Automotive Engines Theory and Servicing

Ninth Edition



Chapter 23

In-Vehicle Engine Service

OBJECTIVES

23.1 Explain thermostat replacement and water pump replacement in engines.

23.2 Discuss intake manifold gasket inspection and replacement.

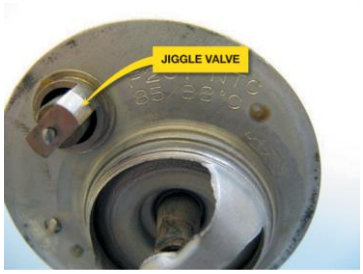
23.3 Describe the steps involved in timing belt replacement.

23.4 Discuss hybrid engine precautions.

THERMOSTAT REPLACEMENT (1 OF 4)

- All thermostat valves move during operation to maintain the desired coolant temperature.
- Thermostats can fail in the following ways.
  - Stuck open
  - Stuck closed
  - Stuck partially open
  - Skewed

FIGURE 23–1 If the thermostat has a jiggle valve, it should be placed toward the top to allow air to escape. If a thermostat were to become stuck open or open too soon, this can set a diagnostic trouble code P0128 (coolant temperature below thermostat regulating temperature).



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THERMOSTAT REPLACEMENT (2 OF 4)

- STEP 1 Allow the engine to cool for several hours so the engine and the coolant should be at room temperature.
- STEP 2 Drain the coolant into a suitable container.
- STEP 3 Remove any necessary components to get access to the thermostat.
- STEP 4 Remove the thermostat housing and thermostat.

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THERMOSTAT REPLACEMENT (3 OF 4)

- STEP 5 Replace the thermostat housing gasket and thermostat. Torque all fasteners to specifications.
- STEP 6 Refill the cooling system with the specified coolant and bleed any trapped air from the system.

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THERMOSTAT REPLACEMENT (4 OF 4)

- STEP 7 Pressurize the cooling system to verify that there are no leaks around the thermostat housing.
- STEP 8 Run the engine until it reaches normal operating temperature and check for leaks.
- STEP 9 Verify that the engine is reaching correct operating temperature.

WATER PUMP REPLACEMENT (1 OF 4)

- A water pump will require replacement if any of the following conditions are present.
  - Leaking coolant from the weep hole
  - Bearing noisy or loose
  - Lack of proper coolant flow caused by worn or slipping impeller blades

WATER PUMP REPLACEMENT (2 OF 4)

- STEP 1 Allow the engine to cool to room temperature.
- STEP 2 Drain the coolant and dispose of properly or recycle.
- STEP 3 Remove engine components to gain access to the water pump as specified in service information.

WATER PUMP REPLACEMENT (3 OF 4)

- STEP 4 Remove the water pump assembly.
- STEP 5 Clean the gasket surfaces and install the new water pump using a new gasket or seal as needed. Torque all fasteners to factory specifications.
- STEP 6 Install removed engine components.

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WATER PUMP REPLACEMENT (4 OF 4)

- STEP 7 Fill the cooling system with the specified coolant.
- STEP 8 Run the engine, check for leaks, and verify proper operation.

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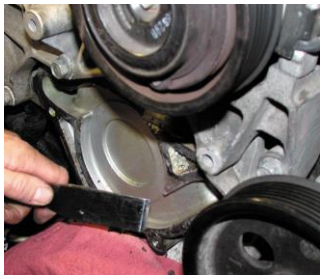
FIGURE 23–2 Use caution if using a steel scraper to remove a gasket from aluminum parts. It is best to use a wood or plastic scraper.



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INTAKE MANIFOLD GASKET INSPECTION (1 OF 4)

- Many V-type engines leak oil, coolant, or experience an air (vacuum) leak caused by a leaking intake manifold gasket.

INTAKE MANIFOLD GASKET INSPECTION (2 OF 4)

- This failure can be contributed to one or more of the following:
  - Expansion/contraction rate difference between the cast-iron head and the aluminum intake manifold. This type of failure is called fretting.
  - Plastic (Nylon 6.6) gasket deterioration caused by the coolant

FIGURE 23–3 An intake manifold gasket that failed and allowed coolant to be drawn into the cylinder(s).

INTAKE MANIFOLD GASKET INSPECTION (3 OF 4)

- Because intake manifold gaskets are used to seal oil, air, and coolant in most causes, determining that the intake manifold gasket is the root cause can be a challenge.

INTAKE MANIFOLD GASKET INSPECTION (4 OF 4)

- To diagnose a possible leaking intake manifold gasket, perform the following tests.
  - Visual inspection
  - Coolant level
  - Air (vacuum) leak

INTAKE MANIFOLD GASKET REPLACEMENT (1 OF 6)

- STEP 1 Be sure the engine has been off for about an hour and then drain the coolant into a suitable container.
- STEP 2 Remove covers and other specified parts needed to get access to the retaining bolts.
- STEP 3 To help ensure that the manifold does not warp when removed, loosen all fasteners in the reverse order of the tightening sequence.

INTAKE MANIFOLD GASKET REPLACEMENT (2 OF 6)

- STEP 4 Remove the upper intake manifold (plenum), if equipped, and inspect for faults.
- STEP 5 Remove the lower intake manifold, using the same bolt removal procedure of starting at the ends and working toward the center.

INTAKE MANIFOLD GASKET REPLACEMENT (3 OF 6)

- STEP 6 Thoroughly clean the area and replace the intake manifold if needed. Check that the correct replacement manifold is being used, and even the current part could look different from the original.
- STEP 7 Install the intake manifold using new gaskets as specified.

INTAKE MANIFOLD GASKET REPLACEMENT (4 OF 6)

- STEP 8 Torque all fasteners to factory specifications and in the proper sequences.
- STEP 9 Reinstall all parts needed to allow the engine to start and run, including refilling the coolant if needed.
- STEP 10 Start the engine and check for leaks and proper engine operation.

INTAKE MANIFOLD GASKET REPLACEMENT (5 OF 6)

- STEP 11 Reset or relearn the idle if specified, using a scan tool.
- STEP 12 Install all of the remaining parts and perform a test drive to verify proper operation and no leaks.
- STEP 13 Check and replace the air filter if needed.

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INTAKE MANIFOLD GASKET REPLACEMENT (6 OF 6)

- STEP 14 Change the engine oil if the intake manifold leak could have caused coolant to leak into the engine, which would contaminate the oil.

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FIGURE 23–4 The lower intake manifold attaches to the cylinder heads.

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TIMING BELT REPLACEMENT (1 OF 7)

- Timing belts have a limited service and a specified replacement interval ranging from 60,000 miles (97,000 km) to about 100,000 miles (161,000 km).
- Timing belts are required to be replaced if any of the following conditions occur.
  - Meets or exceeds the vehicle manufacturer's recommended timing belt replacement interval.

TIMING BELT REPLACEMENT (2 OF 7)

- The timing belt has been contaminated with coolant or engine oil.
- The timing belt has failed (missing belt teeth or broken).

TIMING BELT REPLACEMENT (3 OF 7)

- STEP 1 Allow the engine to cool before removing components to help eliminate the possibility of personal injury or warpage of the parts.
- STEP 2 Remove all necessary components to gain access to the timing belt and timing marks.

TIMING BELT REPLACEMENT (4 OF 7)

- STEP 3 If the timing belt is not broken, rotate the engine until the camshaft and crankshaft timing marks are aligned according to the specified marks.
- STEP 4 Loosen or remove the tensioner as needed to remove the timing belt.

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TIMING BELT REPLACEMENT (5 OF 7)

- STEP 5 Replace the timing belt and any other recommended items.
  - Components that some vehicle manufacturers recommend replacing in addition to the timing belt include:
    - Tensioner assembly
    - Water pump

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TIMING BELT REPLACEMENT (6 OF 7)

    - Camshaft oil seal(s)
    - Front crankshaft seal
- STEP 6 Check (verify) that the camshaft timing is correct by rotating the engine several revolutions.
- STEP 7 Install enough components to allow the engine to start to verify proper operation. Check for any leaks, especially if seals have been replaced.

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TIMING BELT REPLACEMENT (7 OF 7)

- STEP 8 Complete the reassembly of the engine and perform a test drive before returning the vehicle to the customer.

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FIGURE 23–7 A single overhead camshaft engine with a timing belt that also rotates the water pump.

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HYBRID ENGINE PRECAUTIONS (1 OF 4)

- Gasoline engines used in hybrid electric vehicles and in extended range electric vehicles can be a hazard to be around under some conditions.
  - These vehicles are designed to stop the gasoline engines unless needed.

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HYBRID ENGINE PRECAUTIONS (2 OF 4)

- This feature is called idle stop.
- This means that the engine is not running, but could start at any time if the computer detects the need to charge the hybrid batteries or other issue that requires the gasoline engine to start and run.

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HYBRID ENGINE PRECAUTIONS (3 OF 4)

- Always check service information for the exact procedures to follow when working around or under the hood of a hybrid electric vehicle.
- These precautions could include:
  - Before working under the hood or around the engine, be sure that the ignition is off and the key is out of the ignition.
  - Check that the “Ready” light is off.

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HYBRID ENGINE PRECAUTIONS (4 OF 4)

- Do not touch any circuits that have orange electrical wires or conduit. The orange color indicates dangerous high-voltage wires, which could cause serious injury or death if touched.
- Always use high-voltage linesman’s gloves whenever depowering the high-voltage system.

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FIGURE 23–8 A Toyota/Lexus hybrid electric vehicle has a ready light. If the ready light is on, the engine can start at anytime without warning.

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1 Before starting the process of adjusting the valves, look up the specifications and exact procedures. The technician is checking this information from a computer CD-ROM-based information system.

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2 The tools necessary to adjust the valves on an engine with adjustable rocker arms include basic hand tools, feeler gauge, and a torque wrench.

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3 An overall view of the 4-cylinder engine that is due for a scheduled valve adjustment according to the vehicle manufacturer's recommendations.

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4 Start the valve adjustment procedure by first disconnecting and labeling, if necessary, all vacuum lines that need to be removed to gain access to the valve cover.

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5 The air intake tube is being removed from the throttle body.

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6 With all vacuum lines and the intake tube removed, the valve cover can be removed after removing all retaining bolts.

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7 Notice how clean the engine appears. This is a testament of proper maintenance and regular oil changes by the owner.

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8 To help locate how far the engine is being rotated, the technician is removing the distributor cap to be able to observe the position of the rotor.

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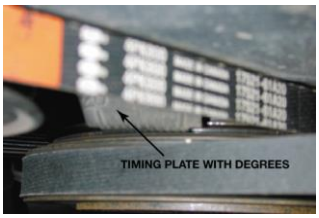
9 The engine is rotated until the timing marks on the front of the crankshaft line up with zero degrees—top dead center (TDC)—with both valves closed on #1 cylinder.



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10 With the rocker arms contacting the base circle of the cam, insert a feeler gauge of the specified thickness between the camshaft and the rocker arm. There should be a slight drag on the feeler gauge.

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11 If the valve clearance (lash) is not correct, loosen the retaining nut and turn the valve adjusting screw with a screwdriver to achieve the proper clearance.

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12 After adjusting the valves that are closed, rotate the engine one full rotation until the engine timing marks again align.

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13 The engine is rotated until the timing marks again align indicating that the companion cylinder will now be in position for valve clearance measurement.

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14 On some engines, it is necessary to watch the direction the rotor is pointing to help determine how far to rotate the engine. Always follow the vehicle manufacturer's recommended procedure.

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15 The technician is using a feeler gauge that is one-thousandth of an inch thinner and another one thousandth of an inch thicker than the specified clearance as a double-check that the clearance is correct.

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16 Adjusting a valve takes both hands—one to hold the wrench to loosen and tighten the lock nut and one to turn the adjusting screw. Always double check the clearance after an adjustment is made.

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17 After all valves have been properly measured and adjusted as necessary, start the reassembly process by replacing all gaskets and seals as specified by the vehicle manufacturer.

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18 Reinstall the valve cover being careful to not pinch a wire or vacuum hose between the cover and the cylinder head.

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19 Use a torque wrench and torque the valve cover retaining bolts to factory specifications.

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20 Reinstall the distributor cap.

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21 Reinstall the spark plug wires and all brackets that were removed to gain access to the valve cover.

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22 Reconnect all vacuum and air hoses and tubes. Replace any vacuum hoses that are brittle or swollen with new ones.

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23 Be sure that the clips are properly installed. Start the engine and check for proper operation.

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24 Double-check for any oil or vacuum leaks after starting the engine.

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SUMMARY (1 OF 3)

- Thermostats can fail in the following ways.
  - Stuck open
  - Stuck closed
  - Stuck partially open
  - Skewed
- A water pump should be replaced if any of the following conditions are present.

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SUMMARY (2 OF 3)

  - Leaking from the weep hole
  - Noisy bearing
  - Loose bearing
  - Lack of normal circulation from worn impeller blades
- A leaking intake manifold gasket can cause coolant to get into the oil or oil into the coolant, as well as other faults, such as a poor running engine.

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SUMMARY (3 OF 3)

- When a timing belt is replaced, most vehicle manufacturers also recommend that the following items be replaced.
  - Tensioner assembly; Water pump; Camshaft seal(s); Front crankshaft seal
- When working on a Toyota/Lexus hybrid electric vehicle (HEV), be sure that the key is off and out of the ignition and the READY light is off.

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