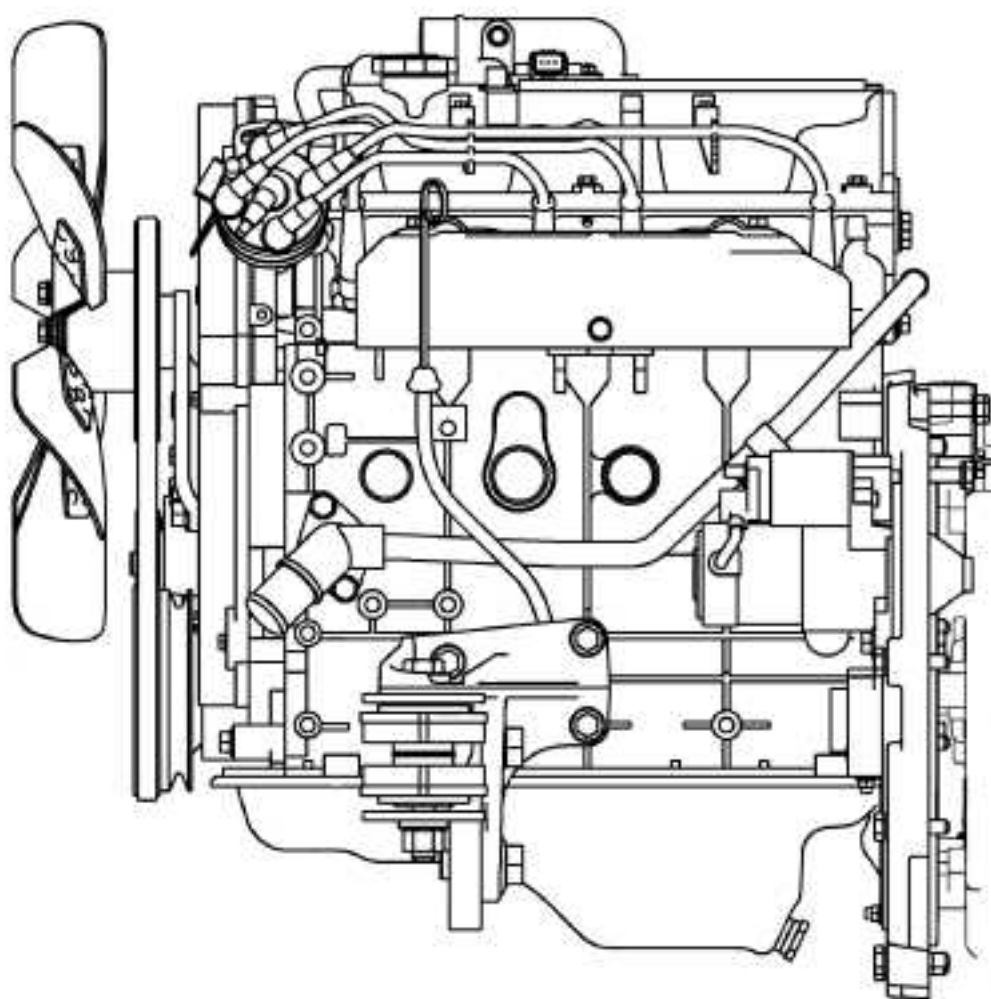


Mazda Engine

FE and F2

**GP/GLP/GDP20-35RK/TK [B871];
GP/GLP/GDP15-20AK [C812]**



INTRODUCTION

GENERAL

This section has the repair instructions for the engine. Removal, disassembly, repair, assembly, installation, checks and adjustments and troubleshooting are included. The specifications are given at the end of the section.

Additional information on engine components are in the sections for **THE GASOLINE FUEL SYSTEM**, **THE LPG FUEL SYSTEM** and **THE ELECTRICAL SYSTEM**.

CAUTION

Disconnect the battery cables before doing any disassembly and repair to the engine or parts of the electrical system.

The diodes and resistors in the electrical system can be damaged if the following cautions are not followed:

- **Do not disconnect the battery when the engine is running. The voltage surge can damage the diodes and resistors.**
- **Do not disconnect an electric wire before the engine is stopped and the key switch is “OFF”.**
- **Do not cause a short circuit by connection of the electric wires to the wrong terminals. Make**

sure a correct identification is made of the wire before it is connected.

- **Make sure a battery is the correct voltage and polarity before it is connected.**
- **Do not check for current flow by making a spark because the transistors can be damaged.**

DESCRIPTION

The Mazda FE and F2 engines are four cylinder engines that have a displacement of 1998 cm³ for FE and 2184 cm³ for F2. They are available with either a gasoline or an LPG fuel system. The firing order is 1-3-4-2. The number one cylinder is toward the end of the engine with the cooling fan.

The overhead camshaft is driven by a cog belt. The camshaft operates the rocker arms that actuate the valves. The rocker arms are offset against the exhaust valve stem to rotate the exhaust valve to prevent carbon damage and irregular wear.

The crankshaft has five main bearings. The main bearing in the center of the crankshaft is also the thrust bearing.

The pistons are aluminum alloy and have three piston rings. Each of the two compression rings have a special shape designed for its position on the piston. The third piston ring is the oil control ring.

REPAIRS

REMOVAL AND INSTALLATION OF THE ENGINE

NOTE: The removal and installation procedures for the engine are not included in this section. See the section for **THE FRAME** for more information.

CYLINDER HEAD, CAMSHAFT AND VALVE MECHANISM

Removal

1. Disconnect the connections at the battery.
2. Drain the cooling system.

3. Remove the air cleaner, the carburetor linkage, the inlet and exhaust manifolds.

4. Remove the coolant hoses.

5. Remove the cooling fan, belt, alternator and the alternator bracket.

6. Remove the bracket for the cooling fan.

7. Remove the upper and lower timing belt covers. See FIGURE 26.

8. Loosen the capscrews for the timing belt tensioner and remove the spring. Remove the capscrews and the timing belt tensioner.

9. Use chalk to mark the direction of rotation of the timing belt. Remove the timing belt. See FIGURE 1.

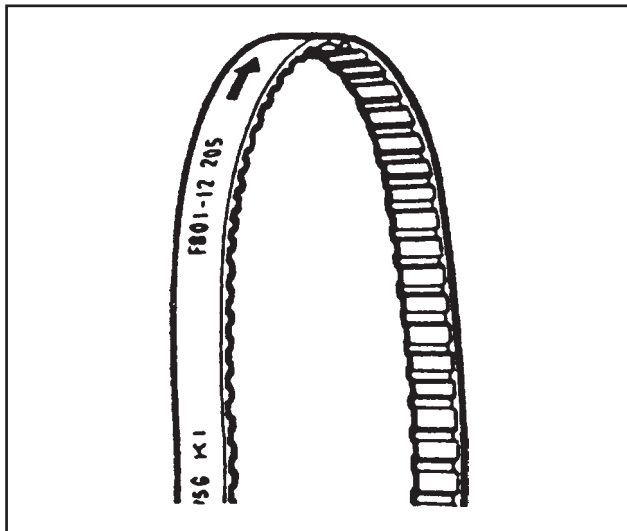


FIGURE 1. TIMING BELT

10. Disconnect the wires at the distributor. Remove the capscrew for the distributor mount and pull the distributor from the front housing.

11. See FIGURE 2. Remove the camshaft pulley. Prevent rotation of the pulley and loosen the capscrew. Remove the capscrew and the pulley.

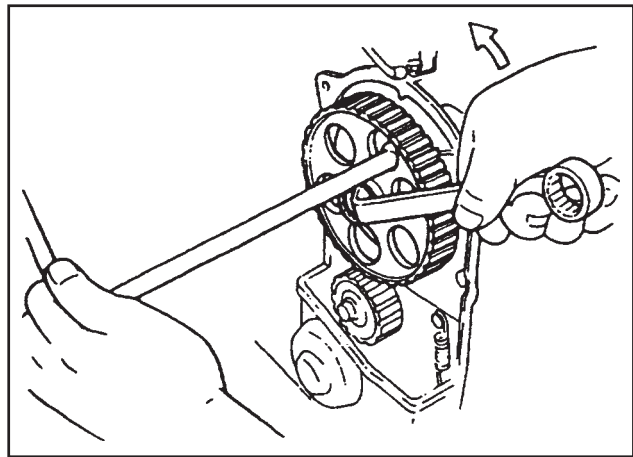


FIGURE 2. REMOVE THE CAMSHAFT GEAR

12. Remove the nuts and capscrews for the front housing, then remove the housing. See FIGURE 22.

13. Remove the cylinder head cover.

14. Loosen the capscrews for the rocker shaft supports in steps. See FIGURE 3. Remove the rocker shaft assembly and the camshaft.

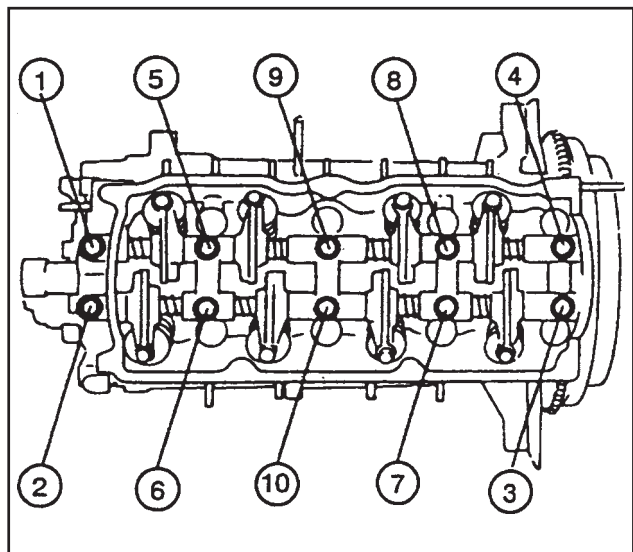


FIGURE 3. SEQUENCE FOR REMOVAL OF THE
ROCKER ASSEMBLY

15. Remove the capscrews for the cylinder head in steps. Remove the capscrews in the sequence shown in FIGURE 4.

16. Lift the cylinder head from the block.

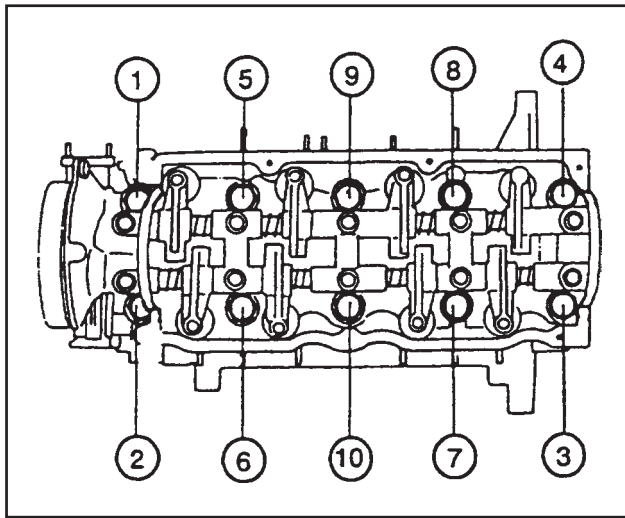


FIGURE 4. SEQUENCE FOR REMOVAL OF THE CYLINDER HEAD

17. Use a valve spring compressor and remove the valve retainers, springs and valves from the head. See FIGURE 5.

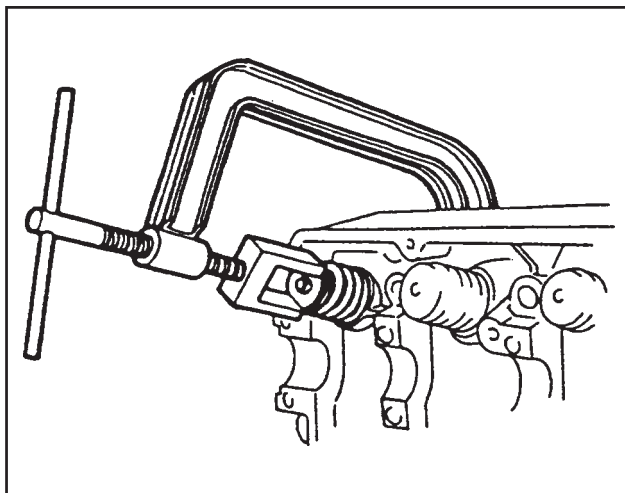


FIGURE 5. REMOVE THE VALVES

Cleaning

⚠ WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Clean all of the parts in solvent. Make sure that all oil passages are clean. Make sure all machined surfaces are smooth.

Inspection And Repairs

CYLINDER HEAD

Check the bottom surface of the cylinder head for distortion. Use a straight edge and a thickness gauge. Do the measurements at the positions shown in FIGURE 6. The maximum amount of distortion is 0.15 mm. When grinding the cylinder head, the maximum amount of correction is 0.2 mm.

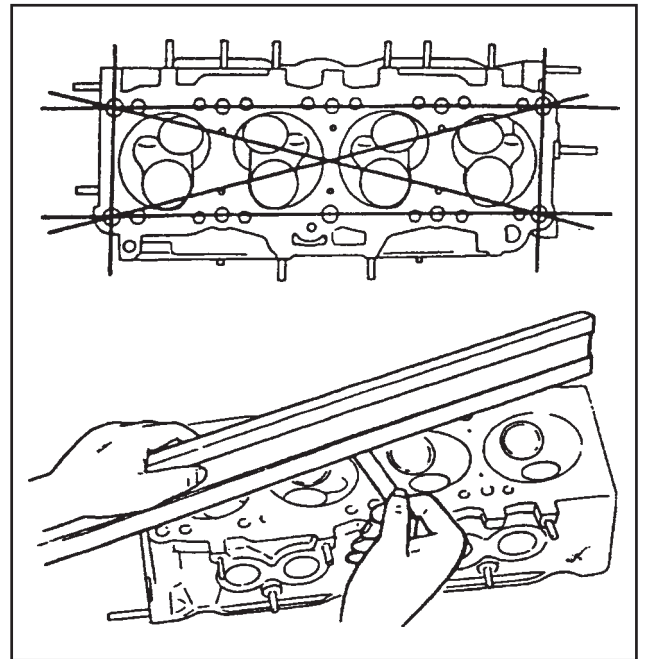


FIGURE 6. CYLINDER HEAD INSPECTION

ROCKER SHAFT ASSEMBLY

Disassemble the rocker shaft assembly. Put marks on the rocker arms so that they can be installed on the same shafts. Clean the oil passages in the rocker shafts and rocker arms. Check the clearance between the rocker arms and the rocker shafts. The maximum clearance is 0.10 mm. The correct dimension for the inside diameter of a rocker arm is 16.000 to 16.027 mm. The correct dimension for the outside diameter of a rocker shaft is 15.966 to 15.984 mm. If the parts do not meet specification, replace the rocker arm(s) or the rocker shaft(s).

CAMSHAFT

Check the camshaft for cracks or damage.

Check the movement of the camshaft in the cylinder head. Use a dial indicator on the end of the camshaft as shown in FIGURE 7. The maximum movement is 0.20 mm.

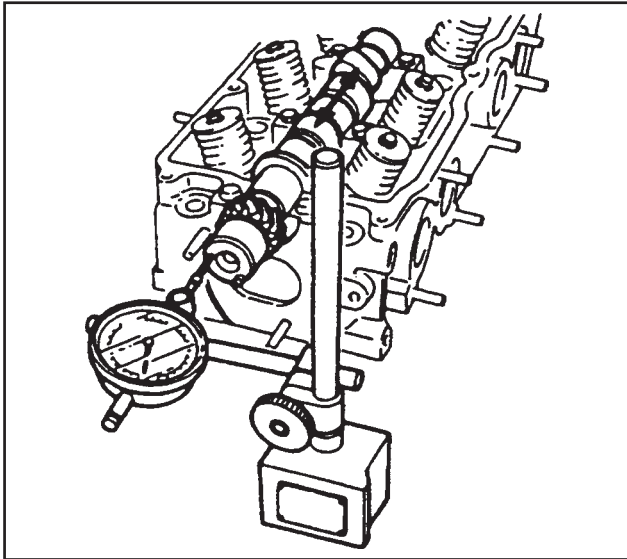


FIGURE 7. CHECK THE CAMSHAFT

Measure the height of the camshaft lobes. See FIGURE 8. The minimum height of the intake and exhaust lobes are 36.902 mm.

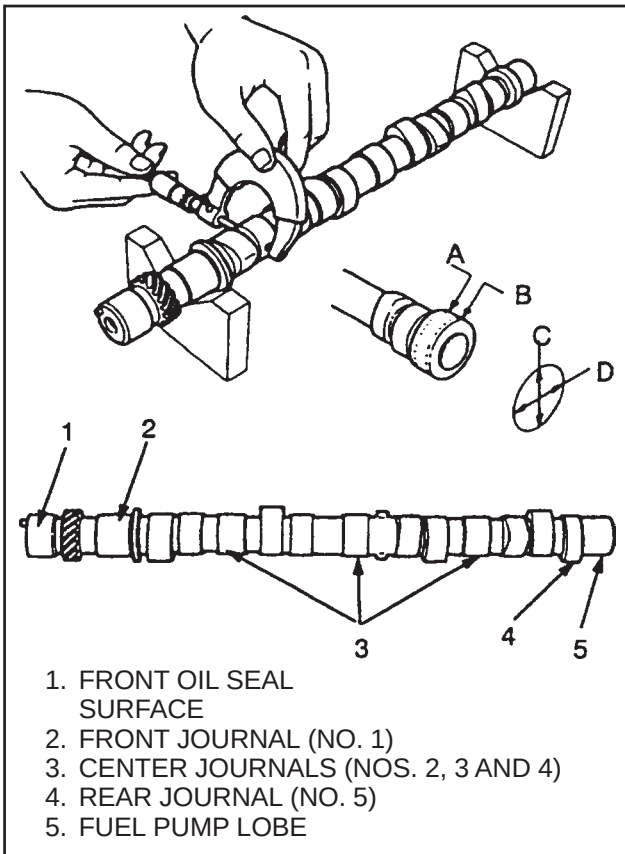


FIGURE 8. CAMSHAFT INSPECTION

Measure the camshaft journals at four points A-D as shown in FIGURE 8. The minimum dimensions for the journals are as follows:

Front and Rear Journals (Nos. 1 and 5) - 31.940 to 31.965 mm

Center Journals (Nos. 2, 3 and 4) - 31.910 to 31.935 mm

Front Oil Seal Surface - 33.961 to 34.000 mm

Fuel Pump Lobe - 37.1 mm

Check the camshaft for being straight. Put the front and rear journals in V blocks and rotate the camshaft one complete turn. See FIGURE 9. The maximum amount that the dial indicator can indicate is 0.03 mm.

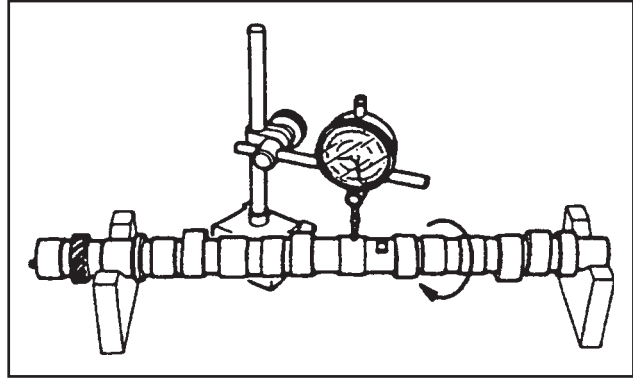


FIGURE 9. CHECK THE CAMSHAFT

Measure the clearance between the camshaft and the bore in the cylinder head. Install the camshaft in the cylinder head. Put a plastic gauge material between the camshaft and the cap. Tighten the capscrews for the caps to 18 to 27 N.m (180 to 270 kgf·cm). See FIGURE 10. The correct clearance for journals Nos. 1 and 5 is 0.035 to 0.085 mm. The correct clearance for journals Nos. 2, 3 and 4 is 0.065 to 0.115 mm. If any of the clearances are greater than 0.15 mm, replace the cylinder head assembly.

Replace the camshaft if there is any damage or it does not meet specifications.

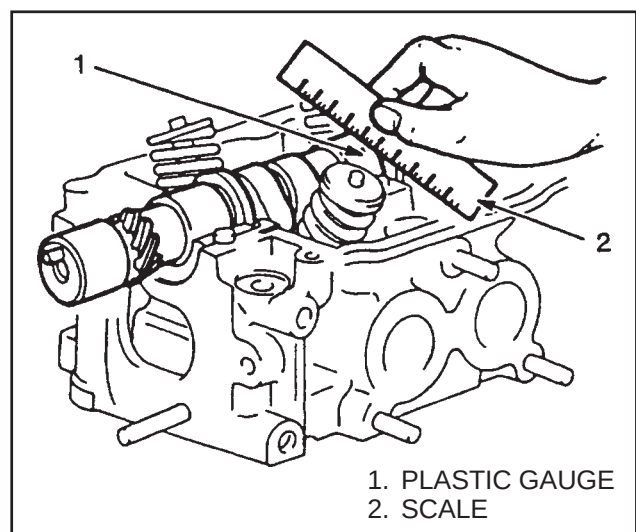


FIGURE 10. MEASURE THE CLEARANCE FOR THE CAMSHAFT

VALVE GUIDES

Measure the clearance between the valve stems and the valve guides. Normal clearance is 0.025 to 0.060 mm. Replace the valve or valve guide when the clearance is more than 0.20 mm.

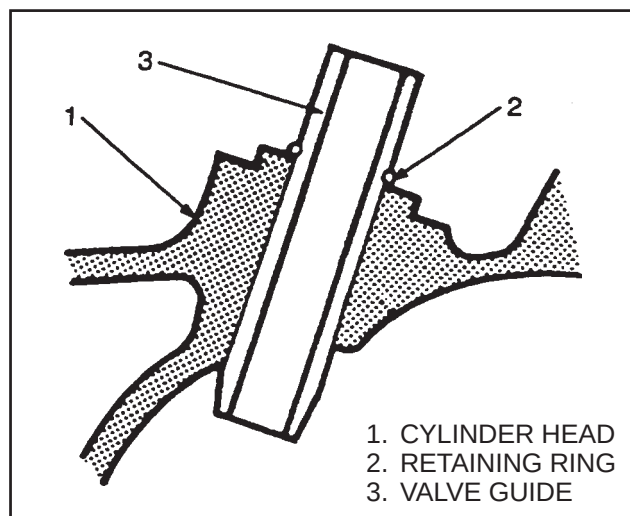


FIGURE 11. VALVE GUIDE

If replacement is necessary, use a tool to remove the valve guide(s). Remove the seal from the valve guide, then remove the valve guide.

To install a valve guide, install the retaining ring on the valve guide. Use the tool and install the valve guide until the retaining ring contacts the cylinder head. See FIGURE 11. The correct height of the valve guide above the valve spring seat is 19.1 to 19.6 mm.

VALVE SEATS

Inspect the condition of the valve seats. If the valve seats have cracks, the cylinder head must be replaced. If the condition of the valve seats is good, check the

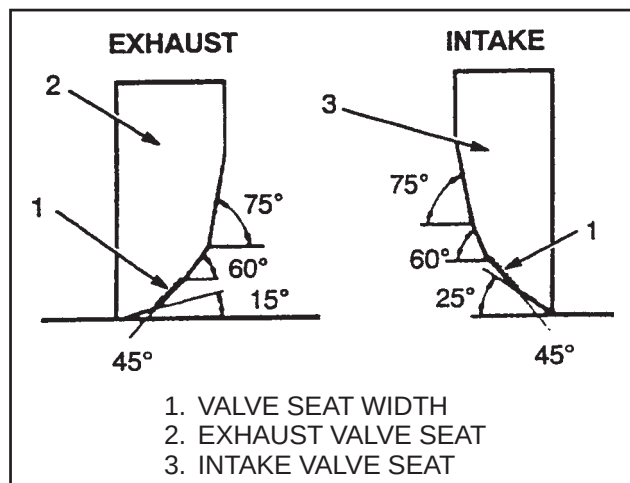


FIGURE 12. VALVE SEAT SPECIFICATIONS

contact pattern of the valve and the valve seat. Use a valve seat grinder to make sure the valve seats are with the specifications shown in FIGURE 12. Use a valve compound to make sure the valves fit the seats.

Check the depth of the valve seat. Insert the valve(s) from the combustion chamber and measure the height from the cylinder head by using a caliper shown in FIGURE 13. Replace the cylinder head assembly when the height is more than 48.0 mm.

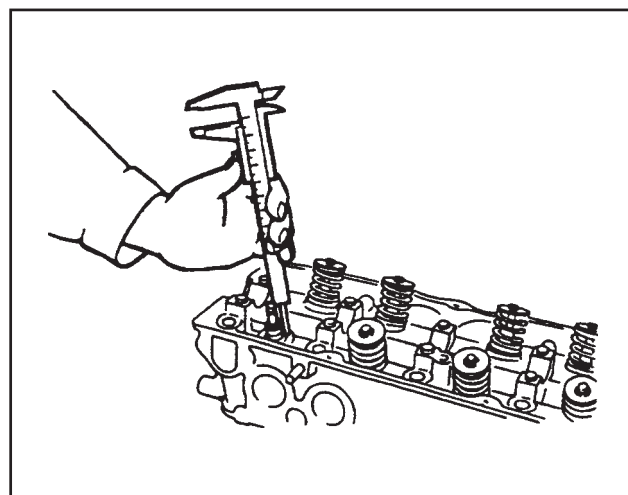


FIGURE 13. MEASURE THE VALVE SEAT DEPTH

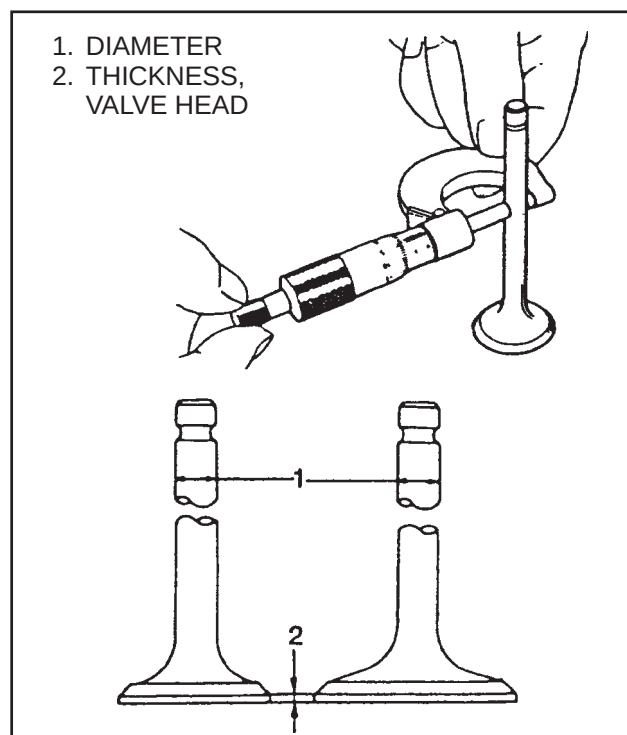


FIGURE 14. INSPECT THE VALVES

VALVES

1. See FIGURE 14. Inspect the stem of each valve for wear. Use a micrometer to measure the outside diameter

of the stem. The minimum dimension for an intake valve is 7.980 mm. The minimum dimension for an exhaust valve is 7.975 mm.

2. Inspect the valves for cracks, burned faces and distortion. Inspect the seat face of the valves for wear and damage. Measure the thickness of the valve head. See FIGURE 14. The minimum thickness for an intake valve is 0.5 mm. The minimum thickness for an exhaust valve is 1.0 mm.

3. If the valves need grinding the correct surface angle is 45° for both intake and exhaust valves.

VALVE SPRINGS

Check the valve springs for damage. See FIGURE 15. Measure the free length of both inner and outer valve springs. The minimum length of the inner spring is 46.3 mm. The minimum length of the outer spring is 50.6 mm. Check the valve springs for being square. See FIGURE 15. If the measurement is more than 1.81 mm, replace the valve spring(s).

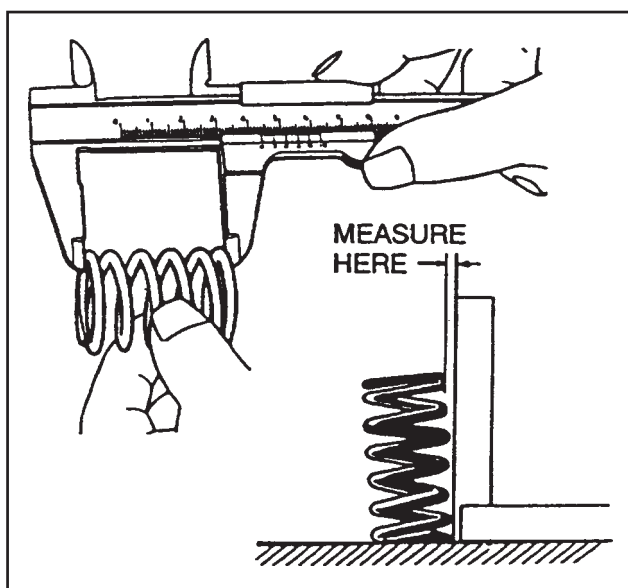


FIGURE 15. INSPECT THE VALVE SPRINGS

TIMING BELT

⚠ CAUTION

Do not allow any oil or water to contaminate the timing belt. Do not twist, turn inside out or bend the timing belt.

Check the timing belt for damage, wear, peeling, or hardening. See FIGURE 16. If there is any oil, water or there is even a slight fault on the timing belt, replace the timing belt.

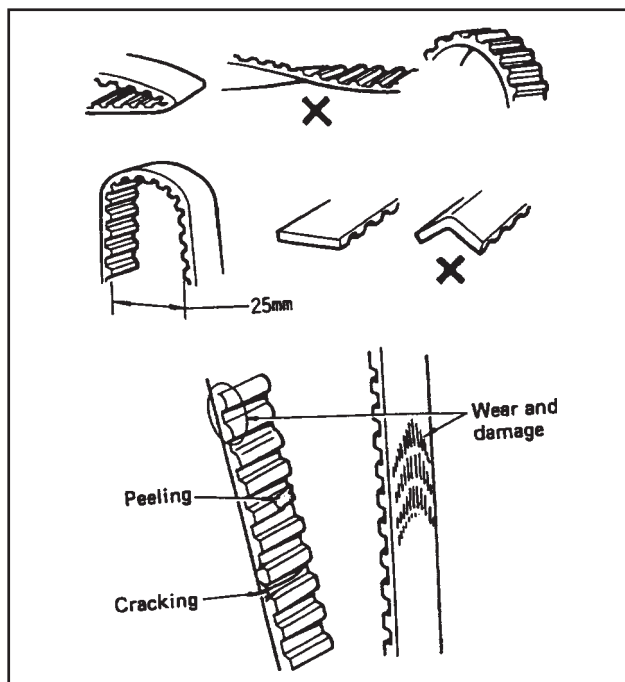


FIGURE 16. INSPECT THE TIMING BELT

Cylinder Head, Installation

1. Use a valve spring compressor and install the valves retainers, springs and valves on the head. Tap the valve end so that the valves and springs are settled down.

⚠ CAUTION

Make sure the shape of the valve cotters of the intake and exhaust valves to avoid wrong usage. See FIGURE 17.

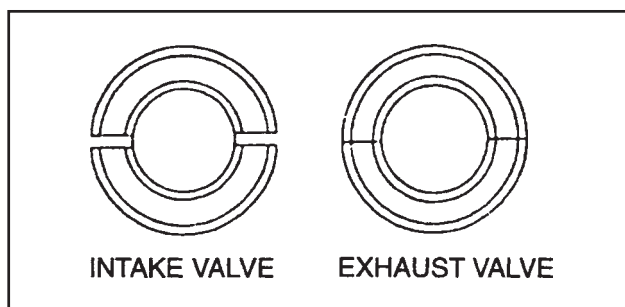


FIGURE 17. VALVE COTTERS

2. Clean the surface of the cylinder head and the surface of the block.

3. Install a new cylinder head gasket to the block. Install the cylinder head.

4. Install the capscrews and washers for the cylinder head. Tighten the capscrews to 80 to 86 N.m (820 to 880 kgf·cm) as shown in FIGURE 18.

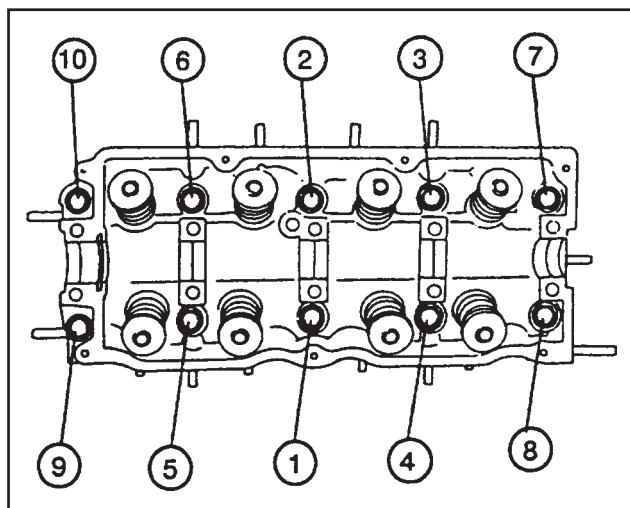


FIGURE 18. INSTALLATION OF THE CYLINDER HEAD

5. See FIGURE 19. Apply a gasket sealer to the areas shown by the arrows. Lubricate the camshaft with clean engine oil, then install the camshaft. Make sure the dowel pin is at the top of the camshaft.

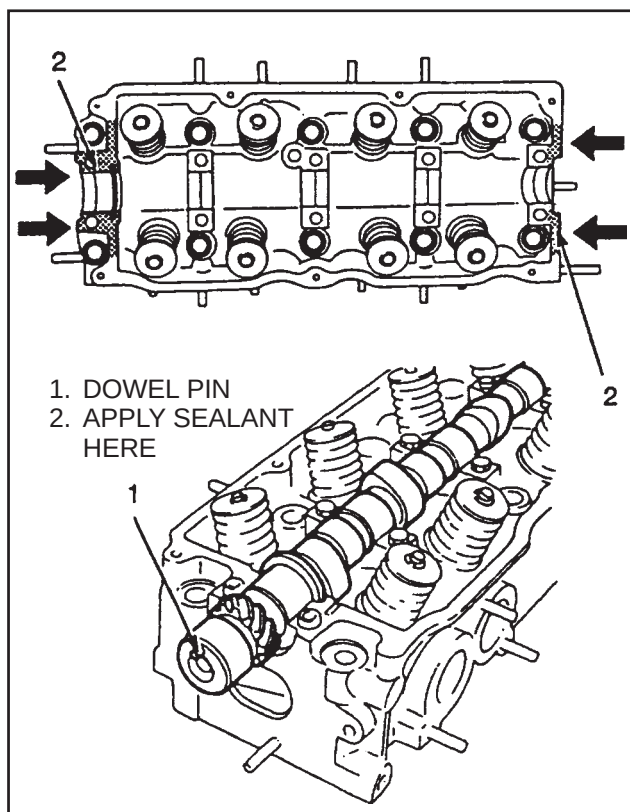


FIGURE 19. INSTALL THE CAMSHAFT

6. Assemble the rocker shaft assembly. See FIGURE 20. Lubricate the rocker arms and shafts with engine oil. Rocker arms Nos. 1 and 3 are the same and Nos. 2 and 4 are the same. Put the capscrews in the rocker shaft supports, then install the assembly on the cylinder head.

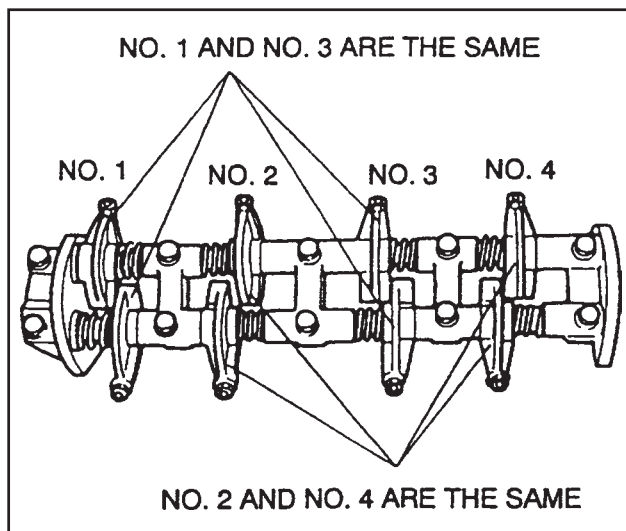


FIGURE 20. ASSEMBLE THE ROCKER SHAFT

7. Tighten the capscrews for the rocker shaft supports to 18 to 26 N.m (180 to 270 kgf·cm) in the sequence shown in FIGURE 21.

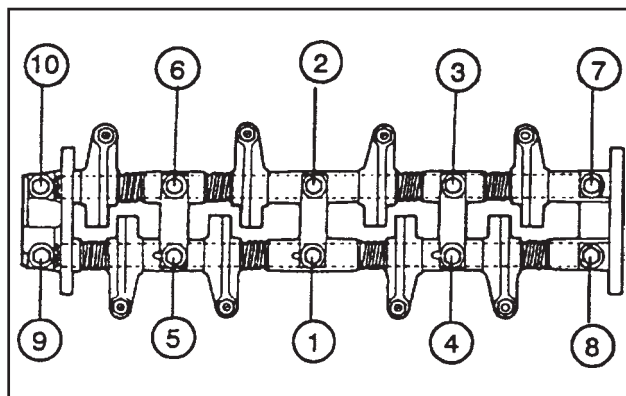


FIGURE 21. INSTALLATION OF THE ROCKER SHAFT ASSEMBLY

8. If necessary, install the oil seal in the front housing. See FIGURE 22. Install the front housing and a new gasket on the cylinder head. Tighten the capscrews for the front housing to 19 to 25 N.m (190 to 260 kgf·cm).

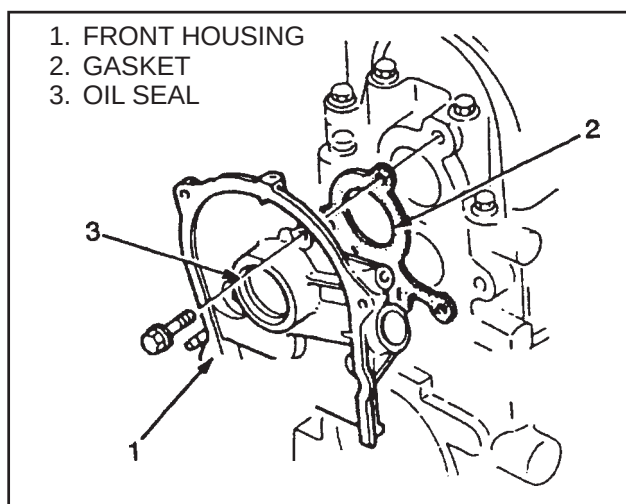


FIGURE 22. FRONT HOUSING

9. With the dowel pin at the top of the camshaft, install the camshaft pulley. Check that the letter “A” for FE or the letter “1” for F2 on the pulley is aligned with the timing mark on the front housing. See FIGURE 23.

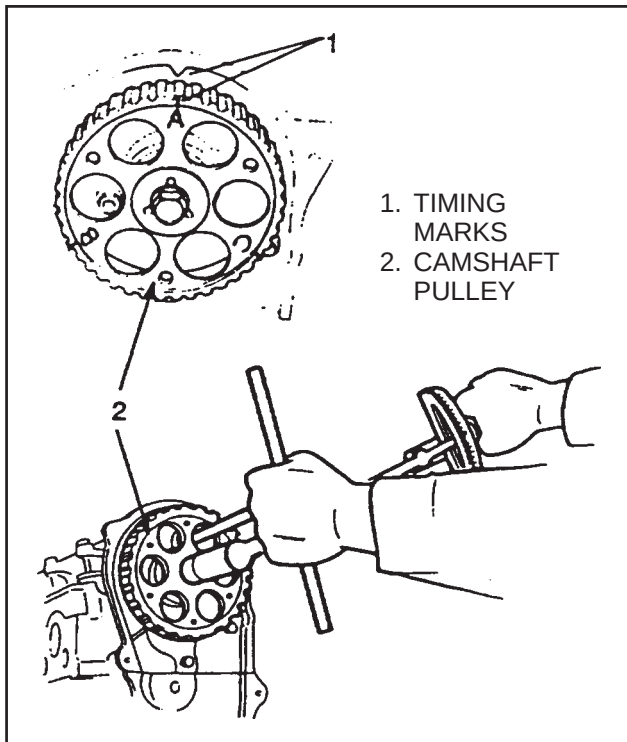


FIGURE 23. INSTALL THE CAMSHAFT PULLEY

10. Install the cap screw and washer for the camshaft pulley. See FIGURE 23. Keep the pulley from turning and tighten the cap screw to 47 to 65 N.m (480 to 660 kgf·cm).

11. Align the timing marks for the timing pulley. See FIGURE 24. Install the crankshaft pulley, tapered ring and the cap screw. Tighten the cap screw to 177 to 196 N.m (1800 to 2000 kgf·cm).

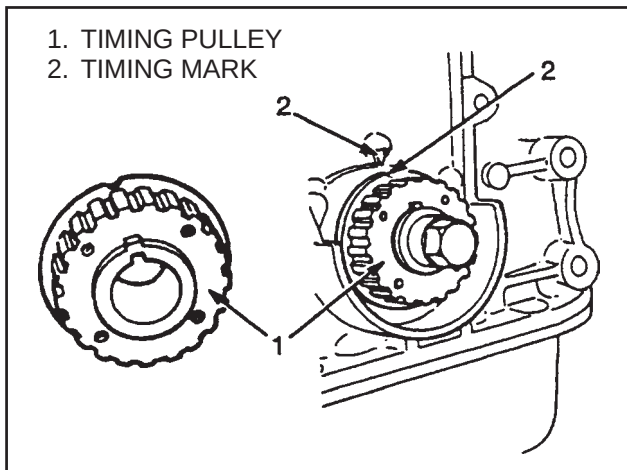


FIGURE 24. INSTALL THE TIMING PULLEY

12. Install the timing belt tensioner and spring. Move the tensioner fully toward the intake side of the engine and temporarily tighten the lock bolt. On F2 engine, install the idler and tighten the cap screw to 37 to 52 N.m (380 to 530 kgf·cm).

13. Clean any oil or grease from the pulleys. Install the timing belt. Install the belt so that it goes in the same direction as the mark made during removal. See FIGURE 1.

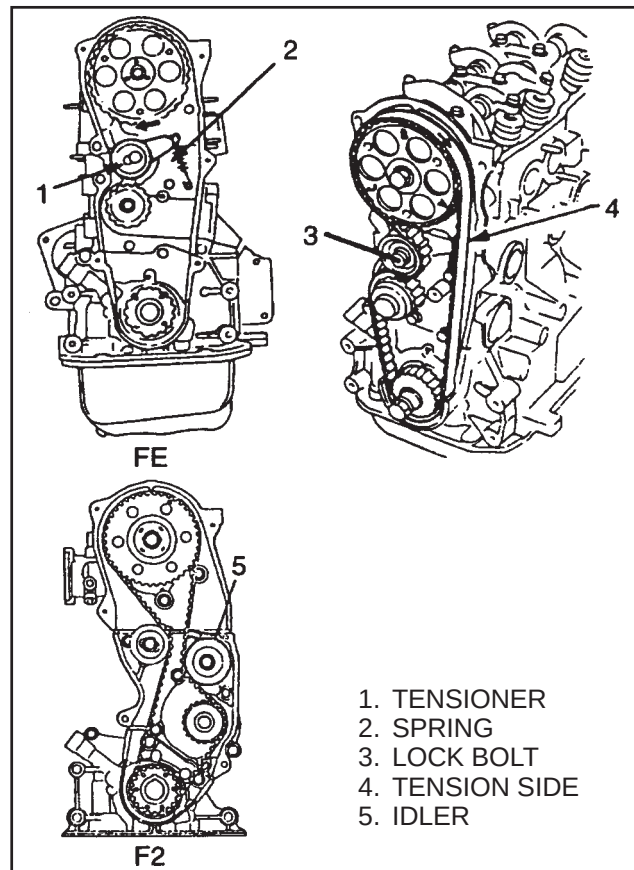


FIGURE 25. INSTALL THE TIMING BELT

14. See FIGURE 25. Loosen the lock bolt and apply spring tension on the belt. Rotate the crankshaft pulley two complete turns clockwise and check the timing marks. If the timing marks are correct, tighten the lock bolt for the tensioner to 20 to 34 N.m (200 to 350 kgf·cm) for FE, to 37 to 52 N.m (380 to 530 kgf·cm) for F2 engine. Check the movement on the tension side of the timing belt. When the tension is correct the belt will move 12 to 14 mm for FE, 9 to 10 mm for F2 engine with 98 N (10 kgf) of force.

15. See FIGURE 26. Install the lower timing belt cover and gasket. Tighten the cap screws to 6.9 to 7.8 N.m (70 to 80 kgf·cm) for FE, to 6.9 to 9.8 N.m (70 to 100 kgf·cm) for F2 engine. Install the upper timing belt

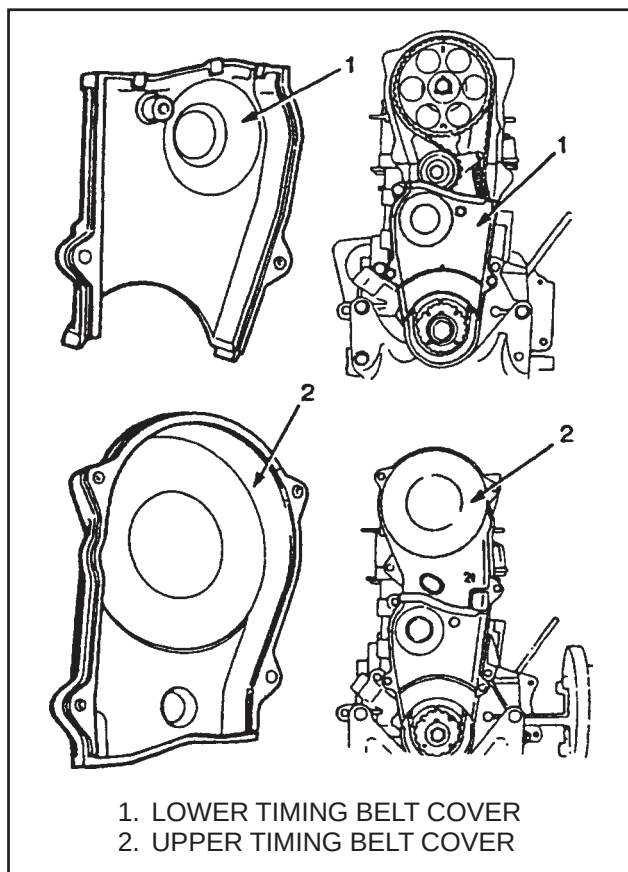


FIGURE 26. TIMING BELT COVERS

cover and gasket. Tighten the capscrews to 8 to 12 N.m (80 to 120 kgf·cm) for FE, to 6.9 to 9.8 N.m (70 to 100 kgf·cm) for F2 engine.

16. Install the distributor as described in the procedures for the DISTRIBUTOR.

17. See FIGURE 27. Apply a gasket sealer to the areas shown by the arrows. Install the cylinder head cover and the gasket. Tighten the capscrews to 3.9 to 5.9 N.m (40 to 60 kgf·cm).

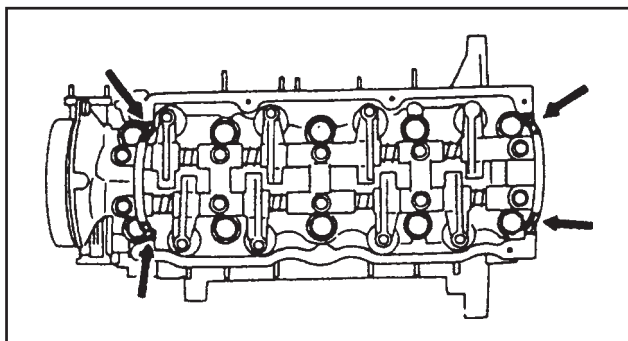


FIGURE 27. INSTALL THE CYLINDER HEAD COVER

18. Install the exhaust manifold and the gasket. Tighten the capscrews to 22 to 28 N·m (220 to 290 kgf·cm).

19. Install the inlet manifold and the gasket. Tighten

the capscrews to 19 to 30 N.m (190 to 310 kgf·cm).

20. Install the air cleaner and the carburetor linkage. Tighten the capscrews for the air cleaner to 19 to 25 N.m (190 to 260 kgf·cm).

21. Install the alternator bracket. Tighten the capscrews to 37 to 52 N.m (380 to 530 kgf·cm).

CRANKSHAFT AND MAIN BEARINGS

Removal

1. Remove the bracket for the cooling fan.

2. Prevent rotation of the crankshaft pulley. Remove the six capscrews and plate from the crankshaft pulley. Remove the six capscrews that hold the crankshaft pulley to the timing pulley.

3. Remove the capscrew from the timing pulley. Install the special tool on the crankshaft to remove the timing pulley. Rotate the tool until it touches the front of the crankshaft. Hit the tool with a hammer to loosen the timing pulley. Remove the pulley, dowel pin and the tapered ring. Remove the tool.

4. Remove the oil pan. For F2 engine, remove the baffle plate. Remove the oil strainer.

5. Remove the rear cover. Remove the front cover with the oil pump.

6. Remove the caps for the connecting rods. Put a mark of identification on each cap so that they will be installed to the same location.

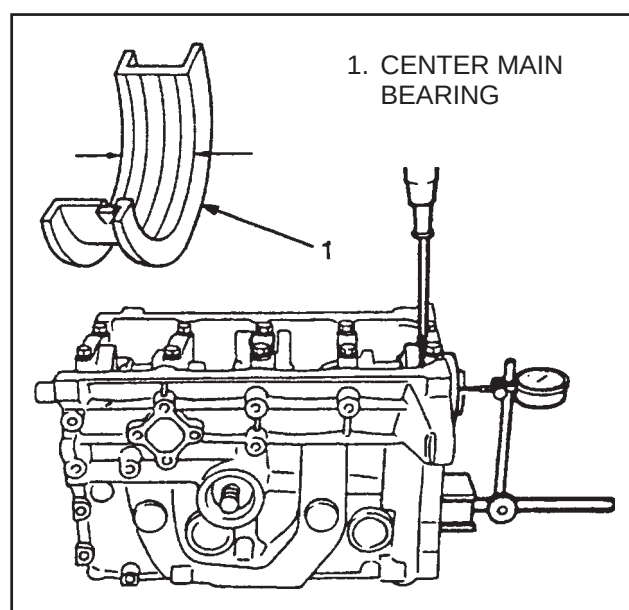


FIGURE 28. MEASURE THE CRANKSHAFT CLEARANCE

7. Before removing the crankshaft, measure the clearance between the crankshaft and the flange of the center main bearing. See FIGURE 28. Push the crankshaft fully forward before making the measurement. The maximum clearance is 0.30 mm. If the clearance is greater than the specification, replace the center main bearing or the crankshaft.

8. Put marks for identification on the bearing caps. Loosen the capscrews for the main bearing caps in steps, then remove the capscrews and the caps. Remove the crankshaft.

Inspection And Repairs

CRANKSHAFT

1. Visually inspect the crankshaft for wear, cracks or other damage. Replace the crankshaft if it has cracks.

2. Use a micrometer to measure the diameter of the journals for the crankshaft. See FIGURE 29. Make the measurement at several locations for each journal. If the measurements are less than specifications, grind the crankshaft and install undersize bearings. The correct dimensions for the journals are as follows:

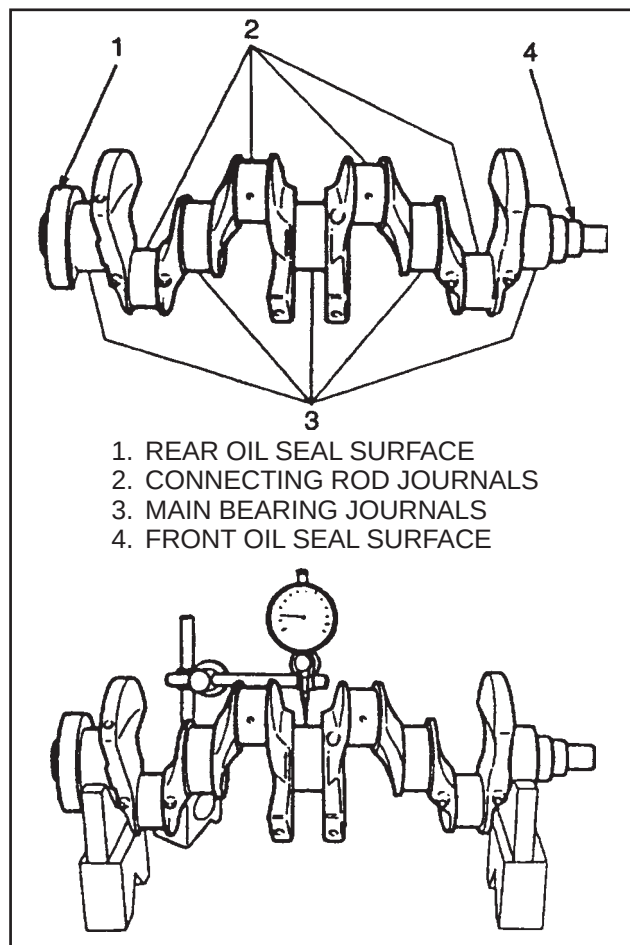


FIGURE 29. CRANKSHAFT INSPECTION

Main Journal Diameter – 59.937 to 59.955 mm

Connecting Rod Journals – 50.940 to 50.955 mm

Rear Oil Seal Surface – 89.946 to 90.000 mm

Front Oil Seal Surface – 33.961 to 34.000 mm

3. Check the crankshaft for being straight. See FIGURE 29. Put the front and rear journals in V blocks and rotate the crankshaft one complete turn. The maximum amount that the dial indicator can indicate is 0.03 mm.

4. Check the passages for oil in the crankshaft. Make sure the passages are clean, with no restrictions.

MAIN BEARINGS

1. Visually inspect the main bearings for wear and damage. Replace the bearings as necessary.

2. Measure the clearance between the main bearings and the crankshaft. Install the crankshaft in the block. Put a plastic gauge material on the journals and install the main bearing caps. Tighten the capscrews for the main bearing caps to 82 to 88 N.m (840 to 900 kgf·cm). Remove the bearing caps. See FIGURE 30. The correct clearance is 0.031 to 0.049 mm. If the clearance is greater than the specifications, replace the main bearings.

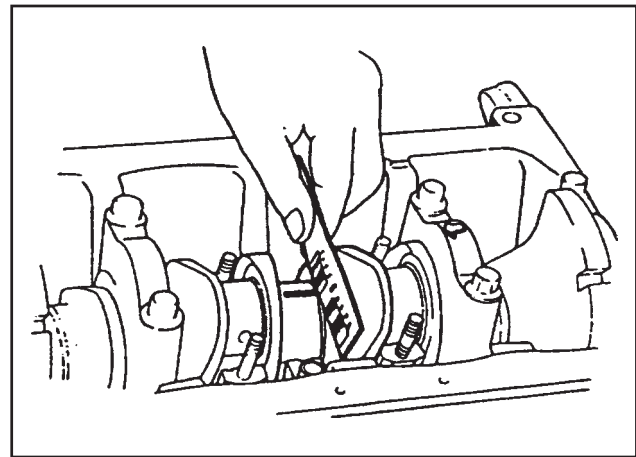


FIGURE 30. CHECK THE CLEARANCE FOR THE MAIN BEARINGS

Installation

1. Clean the main bearings and the areas at the block for the main bearings. Install the main bearings and lubricate them with oil.

2. Install the crankshaft on the bearings. Install the main bearings in the caps and lubricate them with oil. Use

the identification marks and install the main bearing caps. Tighten the capscrews for the main bearing caps to 82 to 88 N.m (840 to 900 kgf·cm).

3. Install the pistons and the connecting rods as described in PISTONS AND THE CONNECTING RODS, Installation.

4. Install the oil pump housing. Make sure the O-ring is in the housing. Lubricate the oil seal with engine oil. Use an adhesive sealant and install the housing to the block. Make sure there is no sealant in the oil port. Tighten the M10 capscrews to 37 to 52 N.m (380 to 530 kgf·cm). Tighten the M8 capscrews to 19 to 25 N.m (190 to 260 kgf·cm).

5. Install the oil seal in the rear cover. Lubricate the surfaces of the oil seal with engine oil and use a press to install the seal. Install the alignment pin in the cylinder block.

6. Install the rear cover and the gasket. See FIGURE 31. Make sure the dowel pin is installed. Tighten the capscrews to 8 to 12 N.m (80 to 120 kgf·cm). Cut the part of the gasket that extends past the bottom of the cylinder block.

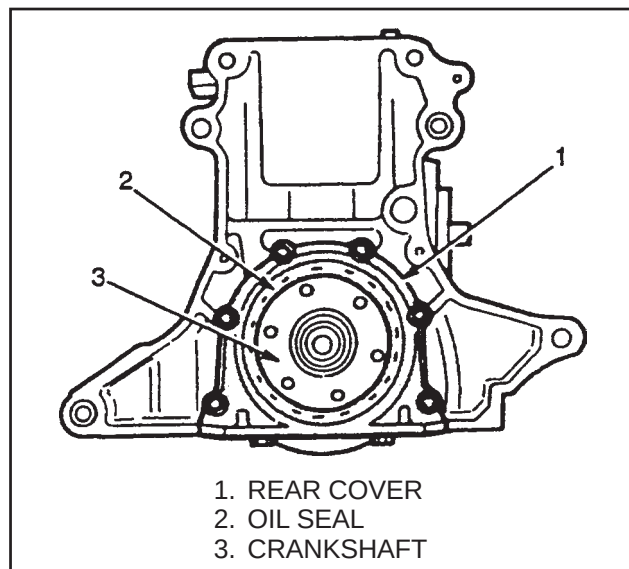


FIGURE 31. REAR COVER

7. Install the oil strainer. Tighten the M6 capscrews to 8 to 12 N.m (80 to 120 kgf·cm). Tighten the M8 capscrews to 16 to 23 N.m (160 to 230 kgf·cm).

8. For M4-2.2G engine, install the baffle plate and tighten the capscrews to 8 to 11 N.m (80 to 110 kgf·cm). Install the oil pan and the gasket. Tighten the capscrews to 7 to 12 N.m (70 to 120 kgf·cm).

9. Install the crankshaft pulley. Align the tip of timing indicator plate with the top mark, left one of two. See FIGURE 32. Prevent rotation of the crankshaft pulley. Put the plain washers on the capscrews for the crankshaft pulley and tighten the capscrews to 29 to 32 N.m (300 to 330 kgf·cm) for FE, to 32 to 37 N.m (330 to 380 kgf·cm) for F2 engine.

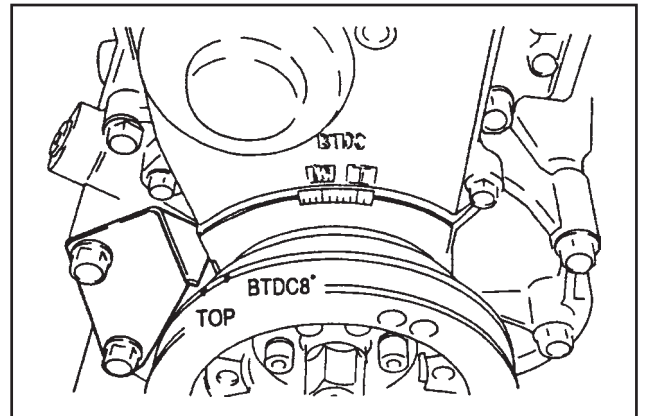


FIGURE 32. CRANKSHAFT PULLEY ALIGNMENT

10. Install the drive plate on the crankshaft pulley end. Tighten the capscrews to 24 to 26 N.m (240 to 270 kgf·cm).

PISTONS AND CONNECTING RODS

Removal And Disassembly

1. Remove the cylinder head as described in CYLINDER HEAD, Removal.
2. Remove the oil pan, baffle plate (F2) and oil strainer.
3. Put a mark for identification on the top of each piston.
4. Clean the carbon from the top of each cylinder bore.
5. Remove the caps and bearings from each connecting rod. Keep the caps and bearings with the correct piston assemblies.
6. Push the connecting rod and piston from the block.
7. Carefully remove the piston rings from the pistons. Use a tool to push the piston pin from the connecting rod.

Cleaning

⚠ WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Clean all of the parts in solvent. Make sure that all oil passages and grooves are clean. Make sure all machined surfaces are smooth.

Inspection And Repairs

PISTONS

1. Inspect the pistons for wear and cracks. Replace a piston that has damage.

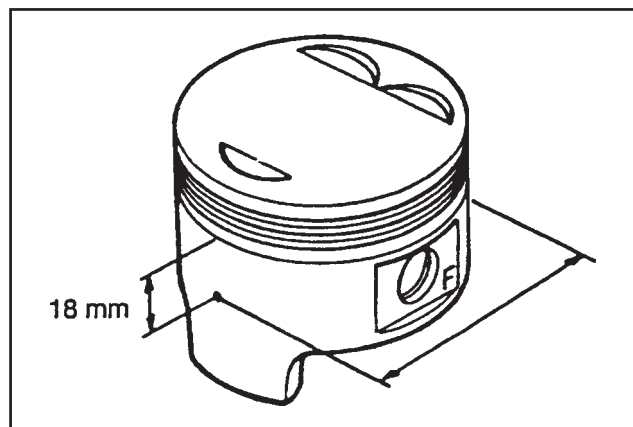


FIGURE 33. MEASURING THE PISTON

2. Measure the outside diameter of the piston as shown in FIGURE 33. The correct dimension is 85.944 to 85.964 mm. The maximum clearance between the piston and the cylinder bore is 0.15 mm.

PISTON RINGS

1. Measure the end clearance of each piston ring as shown in FIGURE 34. Install the piston ring into the cylinder bore where it will be used. Use a thickness gauge to measure the amount of end clearance. The correct dimensions are as follows:

- Top Piston Ring - 0.20 to 0.35 mm
- 2nd Piston Ring - 0.15 to 0.30 mm
- Oil Ring - 0.30 to 0.90 mm
- Maximum clearance is 1.0 mm

2. Measure the clearance between the piston ring and the groove in the piston as shown in FIGURE 34. The correct dimensions are as follows:

- Top Piston Ring - 0.03 to 0.07 mm

2nd Piston Ring - 0.03 to 0.07 mm

Maximum clearance is 0.15 mm

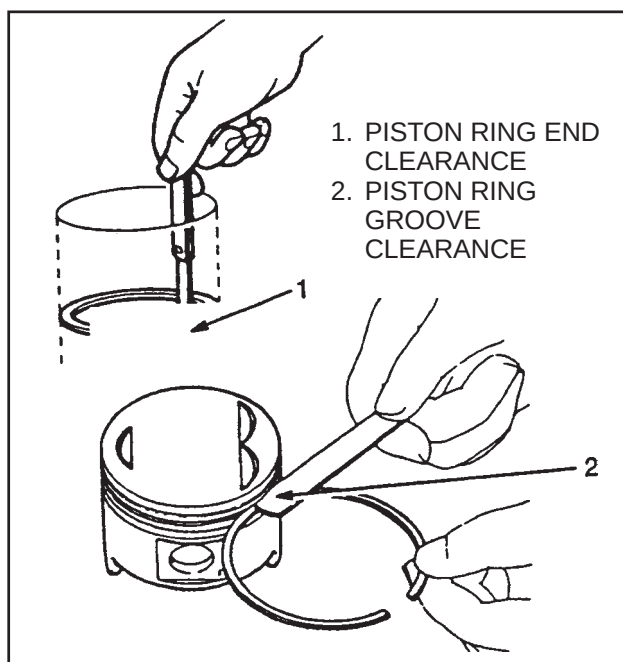


FIGURE 34. MEASURING THE PISTON RINGS

CONNECTING RODS AND BEARINGS

1. Use an alignment tool to check the connecting rods for being straight. The maximum amount of distortion per 100 mm is 0.04 mm. If the amount of distortion is greater than the specification, install a new rod or use a press to straighten the connecting rod.

2. Check the clearance between the rod bearings and the journals of the crankshaft. Clean the rod bearings and journals. Use a plastic gauge material between the journal and the bearing. Tighten the capscrews for the rod caps to 50 to 55 N.m (510 to 560 kgf·cm) for FE, to 65 to 69 N.m (660 to 700 kgf·cm) for F2 engine. Do not rotate the connecting rod. See FIGURE 35. The correct clearance is 0.027 to 0.067 mm. If the clearance is greater than the specifications, replace the bearings.

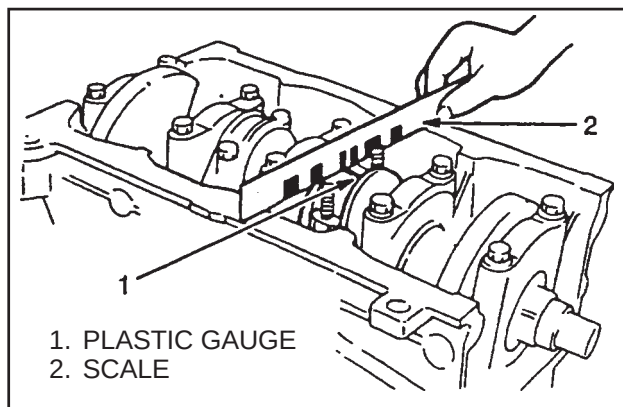


FIGURE 35. CHECK THE CLEARANCE OF THE CONNECTING ROD BEARINGS

Assembly And Installation

PISTONS AND CONNECTING RODS

1. Align the oil port on the large end of the connecting rod with the “F” mark on the piston. See FIGURE 36. Lubricate the piston pin and bore in the piston with engine oil. Use a press to install the piston pin. The force to push the pin into the piston must be 5 to 15 kN (500 to 1500 kg). If the force is not correct, replace the piston pin and/or connecting rod. Use the special tool to make sure the piston pin is installed to the correct depth. After installation, check that the piston moves freely on the piston pin.

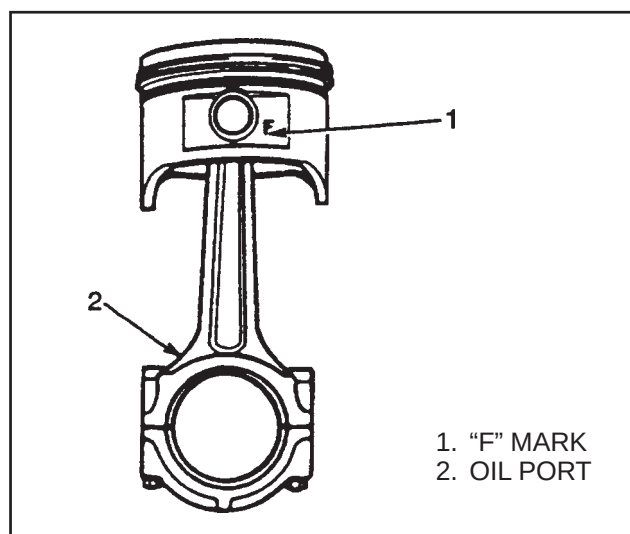


FIGURE 36. CONNECTING ROD AND PISTON

2. Install the piston rings on the pistons. During installation, the writing on each piston ring must be toward the top of the piston. Check that the rings rotate freely, then put the ends of the rings in the positions shown in FIGURE 37. Make sure the ends of the upper and lower oil control rings are each 30° from the piston pin. Also make sure that the top and second rings are each 30° from the piston pin. Lubricate the rings with engine oil.

3. Apply clean engine oil to the piston assembly. Install the bearings for the connecting rods. Install the piston into the correct cylinder making sure the “F” is toward the front (timing belt end) of the engine. See FIGURE 38.

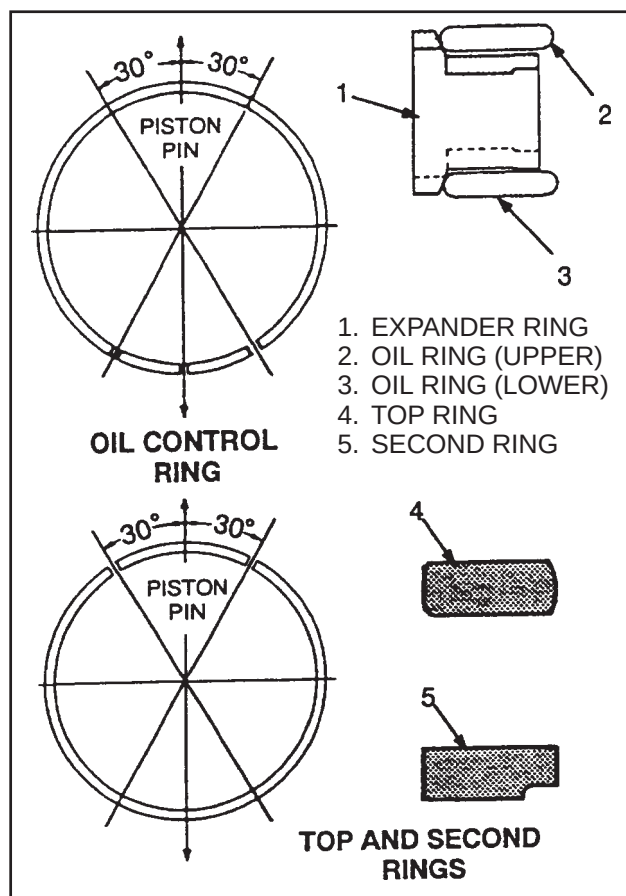


FIGURE 37. PISTON RINGS

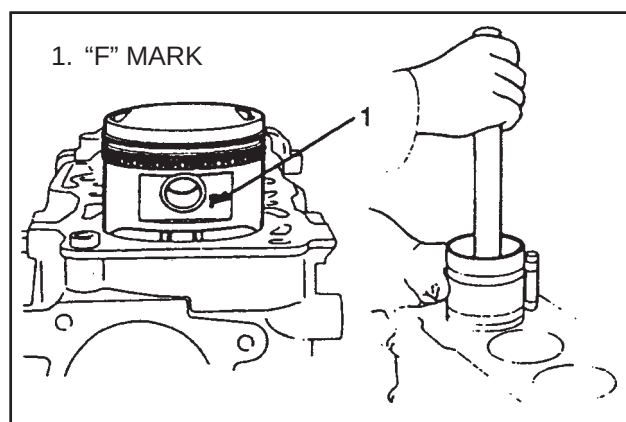


FIGURE 38. INSTALL THE PISTON

4. Apply clean engine oil to the bearing then install the cap to the correct connecting rod. During installation of the caps, make sure to align the identification marks that were made during disassembly. Tighten the nuts for the caps to 50 to 55 N.m (510 to 560 kgf·cm) for FE, to 65 to 69 N.m (660 to 700 kgf·cm) for F2 engine.

CYLINDER BLOCK

Repairs

1. After the engine block is cleaned, check its surface for distortion. See FIGURE 39. If the amount of distortion is greater than 0.15 mm, grind the surface of the engine block. The maximum amount of correction that is permitted is 0.20 mm.

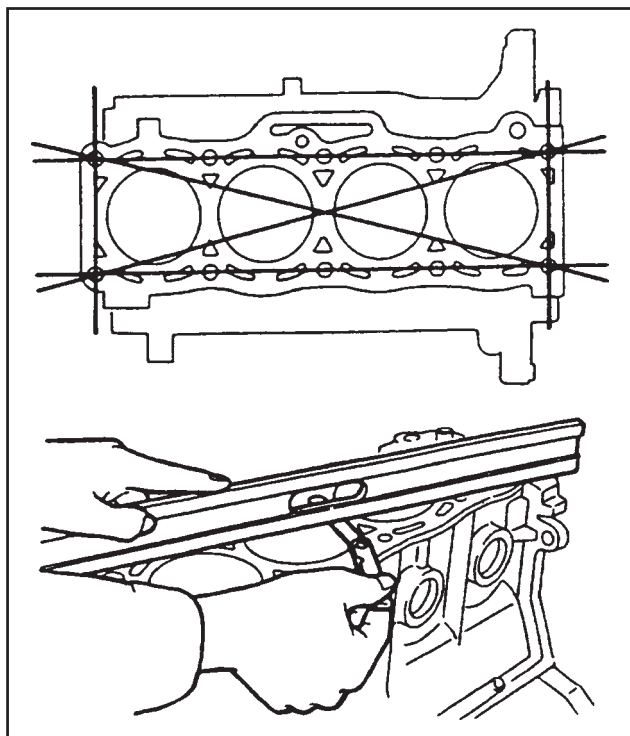


FIGURE 39. INSPECT THE CYLINDER BLOCK

2. Check the cylinder bores for wear and damage. Measure each bore. The correct dimension is 86.000 to 86.019 mm. The wear limit above this dimension is 0.15 mm. Repair the cylinder block or use bigger pistons as necessary.

OIL PUMP

Before removing the oil pump, check the oil pressure. Replace the sending unit with a gauge. The minimum oil pressure at governed rpm is approximately 0.29 MPa (3.0kgf/cm²). If the pressure is less than the specification, the oil pump or the engine bearings need repair.

Removal

1. Remove the bracket for the cooling fan.
2. Remove the upper and lower timing belt covers.
3. Loosen the capscrews for the timing belt tensioner

and remove the spring. Remove the capscrews and the timing belt tensioner.

4. Use chalk to mark the direction of rotation of the timing belt. Remove the timing belt.

5. Prevent rotation of the crankshaft pulley. Remove the six capscrews and plate from the crankshaft pulley. Remove the six capscrews that hold the crankshaft shaft pulley to the timing pulley.

6. Remove the capscrew from the timing pulley. Install the special tool on the crankshaft to remove the timing pulley. Rotate the tool until it touches the front of the crankshaft. Hit the tool with a hammer to loosen the timing pulley. Remove the pulley, dowel pin and the tapered ring. Remove the tool.

7. Remove the capscrews that hold the oil pan to the block and remove the oil pan. For F2 engine, remove the baffle plate. Remove the oil strainer.

8. Remove the capscrews that hold the front cover (pump housing) to the block. Remove the front cover and oil pump assembly.

Disassembly (See FIGURE 40.)

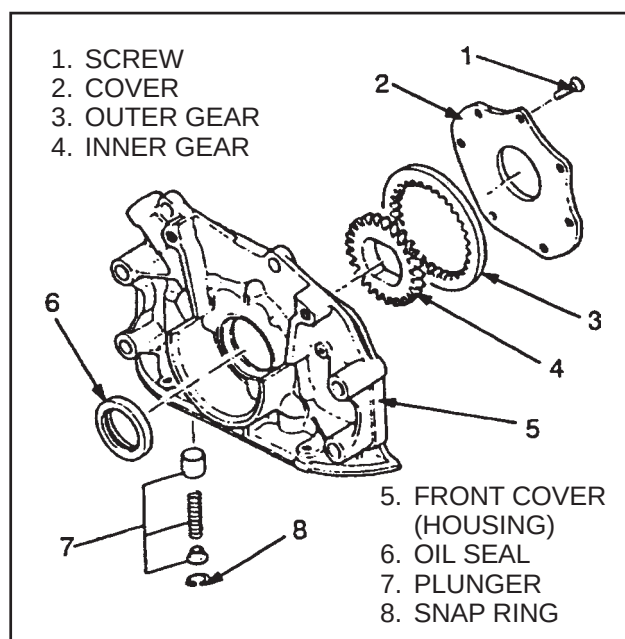


FIGURE 40. OIL PUMP

1. Remove the screws and the pump cover.
2. Remove the outer gear and the inner gear from the pump body.
3. Remove the snap ring to remove the plunger assembly from the housing.

Cleaning

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Clean all of the parts in solvent. Make sure all machined surfaces are smooth.

Inspection

1. Check the front cover (pump housing) and the pump cover for wear or damage. Check the plunger spring for damage.

2. See FIGURE 41. Measure the parts of the oil pump as follows:

- a. For FE engine, measure the clearance between the teeth of the outer gear and the crescent. The correct clearance is 0.20 to 0.32 mm. If the clearance is more than 0.35 mm, repair as necessary.
- b. For FE engine, measure the clearance between the crescent and the teeth of the inner gear. The correct clearance is 0.267 to 0.380 mm. If the clearance is more than 0.40 mm, repair as necessary.
- c. For F2 engine, measure the clearance between the teeth of the outer gear and the teeth of the inner gear. If the clearance is more than 0.18 mm, repair as necessary.
- d. Use a straight edge and measure the side clearance of the gears. The correct clearance is 0.03 to 0.63 mm. If the clearance is more than 0.10 mm, repair as necessary.
- e. Measure the clearance between the body and the outer gear. The correct clearance is 0.090 to 0.184 mm. If the clearance is more than 0.20 mm, repair as necessary.

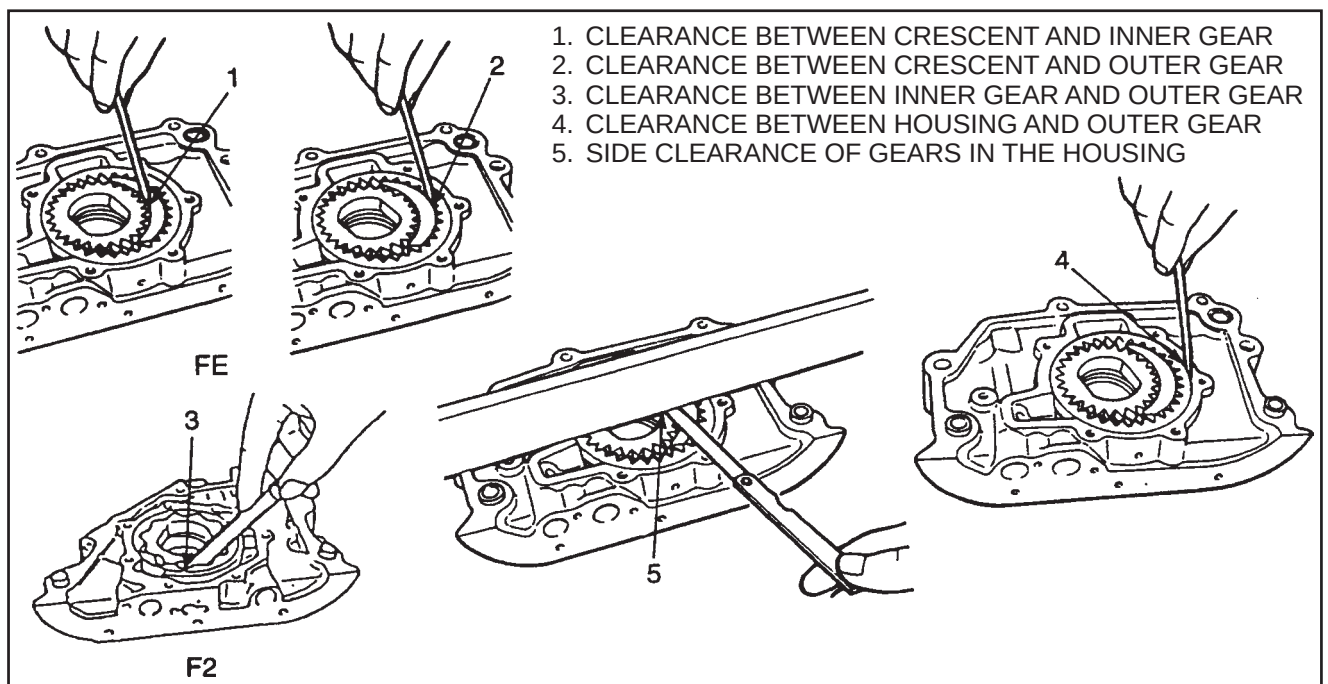


FIGURE 41. MEASURE THE OIL PUMP

Assembly (See FIGURE 40.)

1. Install the oil seal in the oil pump housing. Make sure the front edge of the oil seal is even with the outer edge of the housing.
2. Lubricate the gears with engine oil, then install them in the housing.
3. Install the pump cover. Use a thread locking compound on the screws for the pump cover, then install the screws.
4. Install the plunger assembly and the snap ring.

Installation (See FIGURE 42.)

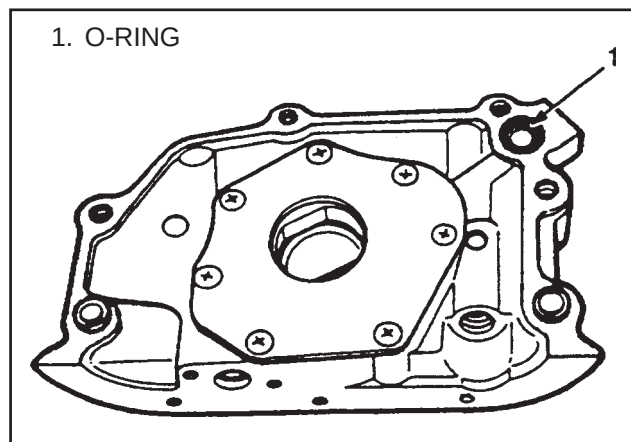


FIGURE 42. OIL PUMP

1. Install the O-ring on the oil pump housing. Use grease to hold the O-ring in position. Lubricate the oil seal with engine oil.
2. Use an adhesive sealant and install the oil pump housing to the block. Make sure there is no sealant in the oil port. Tighten the M10 capscrews to 37 to 52 N.m (380 to 530 kgf·cm). Tighten the M8 capscrews to 19 to 25 N.m (190 to 260 kgf·cm).
3. Install the suction tube assembly. Install the gasket and the oil pan.

COOLING SYSTEM

Thermostat

REPLACEMENT (See FIGURE 43.)

1. Drain the cooling system to the level of the thermostat.
2. Disconnect the hose and remove the thermostat housing. Remove the thermostat.

3. Test the operation of the thermostat. The thermostat must begin to open at $82 \pm 1.5^{\circ}\text{C}$. The thermostat must be completely open at 95°C .

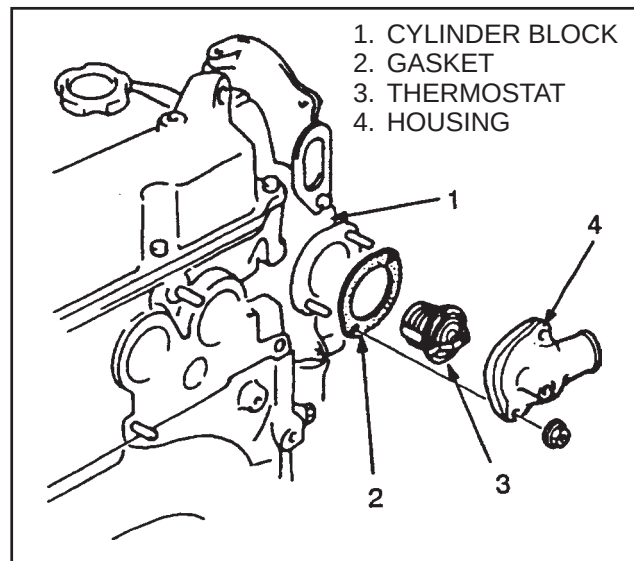


FIGURE 43. THERMOSTAT

4. Install the thermostat and new gasket. Make sure the print side of the gasket is toward thermostat. Install the thermostat housing and tighten the capscrews to 19 to 30 N.m (190 to 310 kgf·cm).
5. Connect the hose and fill the cooling system. Start the engine and check for leaks.

Fan Assembly

REMOVAL

1. Loosen the alternator and remove the fan belt.
2. Remove the capscrews for the fan. Remove the fan and pulley from the hub.
3. Remove the capscrews that hold the fan bracket to the engine. Remove the fan bracket.

DISASSEMBLY AND REPAIR (See FIGURE 44.)

1. Use a press to remove the fan hub from the shaft. Remove the snap ring and push the bearing and shaft from the bracket.
2. Use a press to install the shaft and bearing in the bracket. Push the bearing in until it touches the bracket. Install the snap ring. Install the hub on the shaft. When installed, the shaft must extend 2.1 mm past the hub.

INSTALLATION (See FIGURE 44.)

1. Install the bracket assembly on the cylinder block. For FE engine, tighten the M8 capscrews to 19 to 30 N.m (190 to 310 kgf·cm). Tighten the M10 capscrews to 37 to 52 N.m (380 to 530 kgf·cm). For F2 engine, tighten the capscrews to 64 to 89 N.m (650 to 910 kgf·cm).
2. Install the pulley and fan on the hub. Tighten the capscrews to 8 to 11 N.m (80 to 110 kgf·cm).

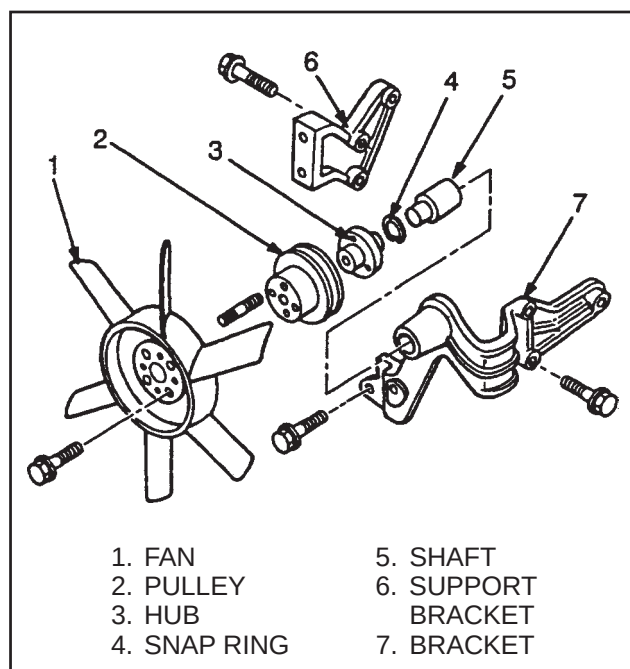


FIGURE 44. FAN ASSEMBLY

3. Install the fan belt. Adjust the tension of the fan belt. Check the movement of the fan belt between the fan and the alternator. When the tension is correct a NEW belt will move 7 to 8 mm with 98 N (10 kg) of force. The tension for an OLD belt is correct when it moves 10 to 12 mm with 98 N (10 kg) of force. Tighten the alternator when the tension is correct.

Water Pump

NOTE: If either the shaft or impeller is damaged, the complete water pump must be replaced.

REMOVAL

1. Drain the cooling system.
2. Loosen the alternator and remove the fan belt.
3. Remove the capscrews for the fan. Remove the fan and pulley from the hub.

4. Remove the capscrews that hold the fan bracket to the engine. Remove the fan bracket.
5. Remove the upper and lower timing belt covers. See FIGURE 26. Loosen the capscrews for the timing belt tensioner and remove the spring. Remove the capscrews and the timing belt tensioner.
6. Use chalk to mark the direction of rotation of the timing belt. See FIGURE 1. Align the timing marks, then remove the timing belt.

⚠ CAUTION

Do not rotate the camshaft gear or the crankshaft gear while the timing belt is removed. If either of the gears is moved, it will be necessary to align the timing marks.

7. Disconnect the hose at the water pump. Remove the capscrews for the water pump, then remove the water pump from the cylinder block.

DISASSEMBLY AND REPAIR FOR FE ENGINE (See FIGURE 45.)

NOTE: For F2 engine, the water pump assembly can not be disassembled.

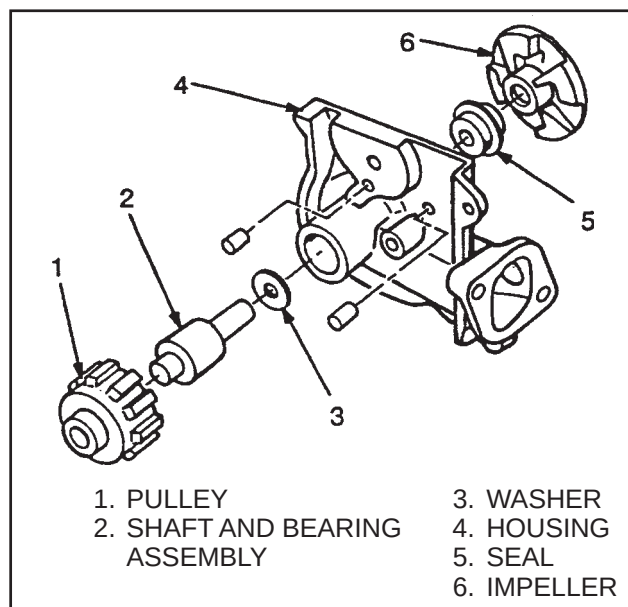


FIGURE 45. WATER PUMP

1. Use a puller to remove the pulley from the shaft.
2. Use a press to remove the impeller from the shaft and the bearing assembly from the housing. Remove the water seal from the housing.

ASSEMBLY FOR FE ENGINE (See FIGURE 45.)

1. Install the water seal in the housing. Put anti-freeze on the lip of the seal.
2. Use a press to install the shaft and bearing in the pump body. Make sure the shaft turns smoothly.
3. Use a press to install the pulley. Use a press to install the impeller. Make sure the surface of the impeller is even with the end of the shaft.

INSTALLATION

1. Install the water pump with a new gasket. Tighten the capscrews to 19 to 25 N.m (190 to 260 kgf·cm).
2. Install the timing belt and the covers as described in the procedures for **Cylinder Head, Installation**.
3. Install the fan assembly as described in the procedures for **Fan Assembly, Installation**.
4. Install the coolant hoses.
5. Fill the coolant system with coolant.
6. Start the engine and check the cooling system for leaks.

⚠ WARNING

DO NOT remove the radiator cap from the radiator when the engine is hot. When the radiator cap is removed, the pressure is released from the system. If the system is hot, the steam and boiling coolant can cause burns. **DO NOT** remove the cover for the radiator when the engine is running.

7. After the engine has been operated, stop the engine. If the coolant is hot, give the engine time to cool. Check the coolant level.

DISTRIBUTOR

NOTE: This section has only the removal and installation procedures for the distributor. The service procedures for the ignition system are found in **THE ELECTRICAL SYSTEM**.

Removal (See FIGURE 46.)

1. Rotate the crankshaft until the number one piston is at TDC on the compression stroke. Make a note of the position of the distributor rotor.
2. Disconnect the wires at the spark plugs.
3. Remove the capscrew from the flange of the distributor shaft housing.
4. Lift the distributor assembly from the engine.

Installation (See FIGURE 46.)

1. Rotate the crankshaft until the number one piston is at TDC on the compression stroke. Put the rotor in the correct position.
2. Lubricate the O-ring and the gear on the distributor with engine oil. Install the distributor, aligning the marks on the distributor housing, distributor gear and engine.
3. Connect the wires at the spark plugs.

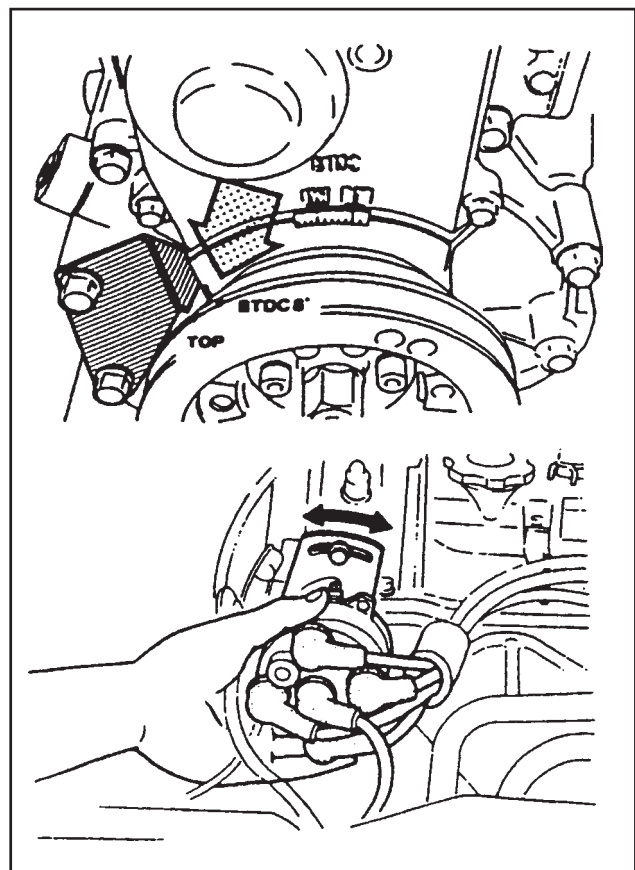


FIGURE 46. INSTALLATION OF THE
DISTRIBUTOR

FLYWHEEL FOR POWERSHIFT TRANSMISSION

Removal (See FIGURE 47.)

1. Remove the capscrews for the flywheel, then remove the flywheel and the flange.
2. If necessary, remove the engine end plate.

Installation (See FIGURE 47.)

1. If the engine end plate was removed, install it on the engine. Tighten the M14 capscrews to 114 to 136 N.m (1160 to 1390 kgf·cm). Tighten the M8 capscrews to 21 to 25 N.m (210 to 250 kgf·cm).
2. Install the flange and the flywheel on the crankshaft. Apply an adhesive sealant on the threads of the capscrews. Then install the capscrews, washers and the backplate. Tighten the capscrews to 96 to 103 N.m (980 to 1050 kgf·cm).

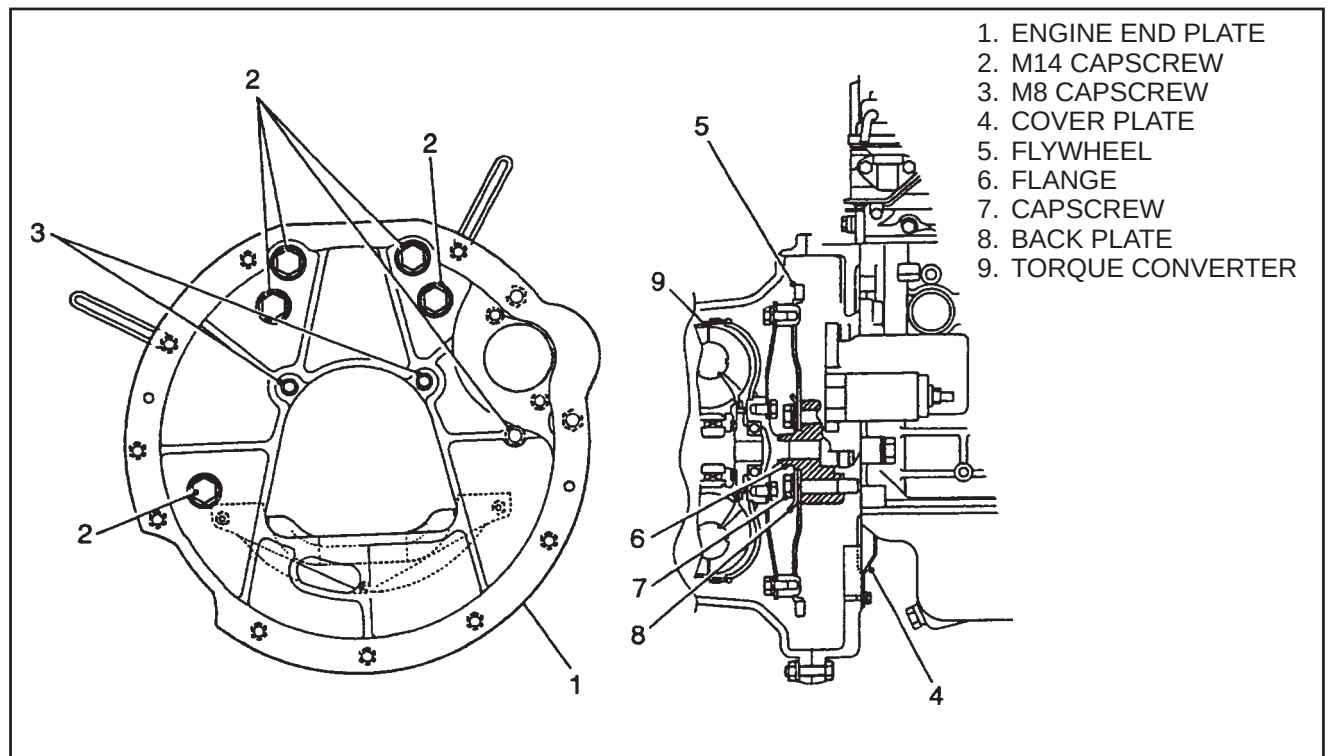


FIGURE 47. END PLATE, FLYWHEEL AND TORQUE CONVERTER

CHECKS AND ADJUSTMENTS

ADJUST THE VALVES (See FIGURE 50.)

1. Rotate the crankshaft until the number one piston is at TDC on the compression stroke (intake and exhaust valves closed). Now adjust the clearance of the intake valves for the No. 1 and No. 2 cylinders and the exhaust valves for the No. 1 and No. 3 cylinders. The correct clearance for all the valves when the engine is hot is 0.3 mm. To adjust the clearance, loosen the lock nut and turn the adjustment screw. Tighten the lock nut to 16 to 21 N.m (160 to 210 kgf·cm).

NOTE: During adjustment of the valves, check the position of the balls that are in the ends of the rocker arms. The flat surface of the ball must be in contact with the stem of the valve.

2. Rotate the crankshaft clockwise one complete turn (360 degrees). Now adjust the remaining valves.

3. If the valves are adjusted when the engine is cold, check the adjustments again after the engine is warm.

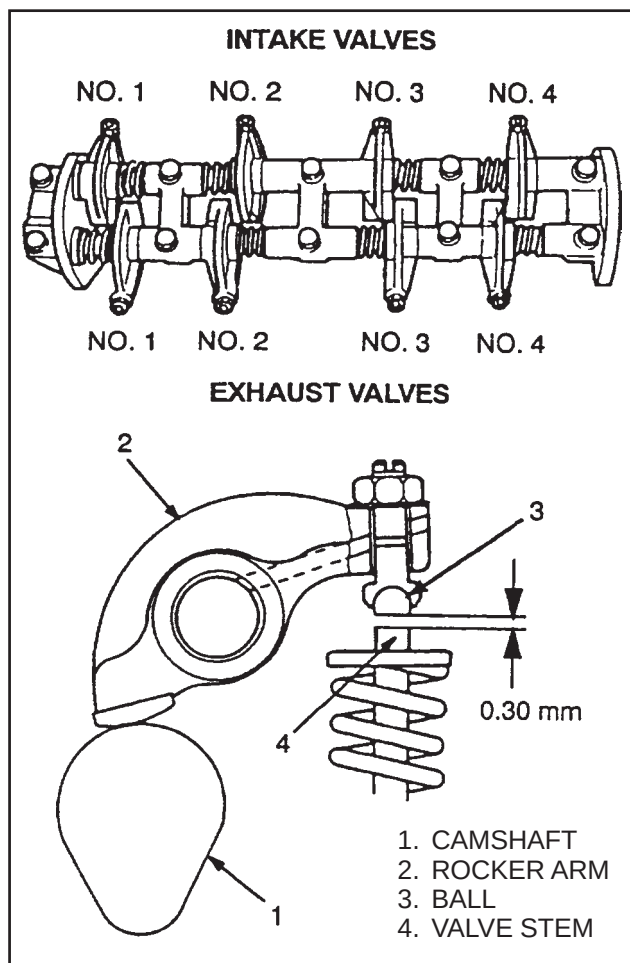


FIGURE 50. ADJUST THE VALVES

CHECK THE COMPRESSION PRESSURE (See FIGURE 51.)

1. Remove the spark plugs from the cylinder head. Disconnect the high tension wire at the ignition coil.

2. Install a compression gauge in the number 1 cylinder. Make sure the gauge has a minimum range of 2 MPa (20 kgf/cm²).

3. Use the starter to crank the engine at least six (6) revolutions. Check the pressure reading and release the pressure. Repeat the test again and make a note of the highest pressure. Do this test for each cylinder.

4. The standard pressure reading is 1.13 MPa (11.5 kgf/cm²). The minimum reading is 0.79 MPa (8.1 kgf/cm²). The maximum variation between cylinders is 0.20 MPa (2 kgf/cm²).

5. If the readings are lower than the minimum reading, there is a problem with the valves, piston rings or cylinder head gasket. Do the following tests to find the problem:

- Add approximately 30 ml of engine oil to each cylinder at the spark plug hole.
- Crank the engine approximately ten revolutions to distribute the oil.
- Install the compression gauge and do the same tests as described in [step 3](#).
- If the compression pressure increases to a normal reading, the low pressure was caused by worn or damaged piston rings. The cylinder bore can also be damaged.
- If the compression reading does not increase, the low pressure was caused by worn valves, valve seats or valve guides.
- If the low pressure readings are in two cylinders next to each other, the cylinder head can be leaking.

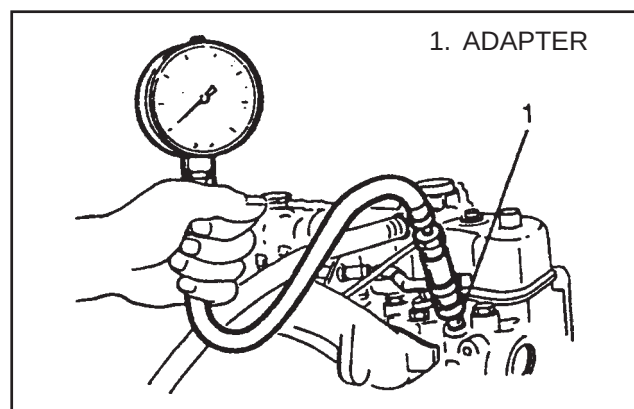


FIGURE 51. CHECK THE COMPRESSION PRESSURE

ENGINE SPECIFICATIONS

Model			FE	F2
Item				
Numbers and arrangement of cylinders			In-line four cylinders	←
Bore x Stroke mm			86.0 x 86.0	86.0 x 94.0
Displacement cc			1998	2184
Compression ratio			8.6	←
Valve opening/closing timing				
Intake	Open (BTDC)		3°	←
	Close (ABDC)		37°	←
Exhaust	Open (BBDC)		37°	←
	Close (ATDC)		3°	←
Compression pressure MPa (kgf/cm²) – rpm	Standard		1.13 (11.5) – 270	←
	Limit		0.79 (8.1) –270	←
	Variation between cylinders		0.20 (2.0) or less	←
Valve clearance				
Valve side mm	Intake		0.30	←
	Exhaust		0.30	←
Cam side mm	Intake		0.20	←
	Exhaust		0.20	←
Numbers of teeth of timing belt			109	110
Cylinder head mm	Height		91.95 ~ 92.05	←
	Distortion limit		0.15	←
	Grinding limit		0.20	←
Valve seat				
Depth amount mm (Length)	Intake	Standard	46.5	←
		Limit	48.0	←
	Exhaust	Standard	46.5	←
		Limit	48.0	←
Valve seat angle	Intake		45°	←
	Exhaust		45°	←
Valve seat width mm	Intake		1.2 ~ 1.6	←
	Exhaust		1.2 ~ 1.6	←
Valve guide, valve, and valve spring				
Gap between the valve stem and guide mm	Standard	Intake	0.025 ~ 0.060	←
		Exhaust	0.025 ~ 0.060	←
	Limit		0.20	←
Valve guide inside diameter mm			8.07 ~ 8.09	←
Valve stem diameter mm	Intake	Standard	8.030 ~ 8.045	←
		Limit	7.980	←
	Exhaust	Standard	8.025 ~ 8.040	←
		Limit	7.975	←

ENGINE SPECIFICATIONS

Item			Model	FE	F2
Valve head thickness	mm	Intake		0.5	←
		Exhaust		1.0	←
Valve face angle		Intake		45°	←
		Exhaust		45°	←
Valve spring outer free length	mm	Standard		52.2	←
		Limit		50.6	←
Valve spring inner free length	mm	Standard		47.7	←
		Limit		46.3	←
Valve spring squareness			mm	1.81 or less	←
Rocker arm and shaft					
Gap between the arm and shaft	mm	Standard		0.016 ~ 0.061	←
		Limit		0.10	←
Rocker arm shaft diameter		mm		15.966 ~ 15.984	←
Rocker arm inside diameter		mm		16.000 ~ 16.027	←
Cam shaft					
Cam shaft deflection limit		mm		0.03	←
Cam shaft end play	mm	Standard		0.08 ~ 0.16	←
		Limit		0.20	←
Journal oil clearance	mm	No. 1		0.035 ~ 0.085	←
		No. 2		0.065 ~ 0.115	←
		No. 3		0.065 ~ 0.115	←
		No. 4		0.065 ~ 0.115	←
		No. 5		0.035 ~ 0.085	←
Oil clearance limit		mm		0.15	←
Standard journal diameter	mm	No. 1		31.940 ~ 31.965	←
		No. 2		31.910 ~ 31.935	←
		No. 3		31.910 ~ 31.935	←
		No. 4		31.910 ~ 31.935	←
		No. 5		31.940 ~ 31.965	←
Journal wear limit		mm		0.05	←
Cam height	Intake	Standard		37.102	←
		Limit		36.902	←
	Exhaust	Standard		37.102	←
		Limit		36.902	←
Connecting rod and bearing					
Length (distance between the holes)		mm		135.95 ~ 136.05	158.45 ~ 158.55
Bending limit (for every 100mm)		mm		0.04	←
Small end diameter		mm		21.943 ~ 21.961	←
Clearance between the small end and piston pin		mm		0.015 ~ 0.010	←

ENGINE SPECIFICATIONS

Model		FE	F2
Item			
Large end play	Standard	0.110 ~ 0.262	←
	Limit	0.30	←
Oil clearance on large end mm	Standard	0.027 ~ 0.067	←
	Limit	0.10	←
Bearing under-size mm		0.025, 0.50, 0.75	←
Crank shaft and bearing			
Crank pin diameter mm	Standard	50.940 ~ 50.955	←
	Wearing limit	0.05	←
	Grinding limit	0.75	←
Main journal diameter mm	Standard	59.937 ~ 59.955	←
	Wearing limit	0.05	←
	Grinding limit	0.75	←
Main journal oil clearance mm	Standard	0.031 ~ 0.049	←
	Limit	0.08	←
Main bearing under-size mm		0.25, 0.50, 0.75	←
Crank shaft deflection limit mm		0.03	←
End play mm	Standard	0.08 ~ 0.18	←
	Limit	0.30	←
Thrust bearing over-size mm		0.25, 0.50, 0.75	←
Cylinder block, piston, and piston pin			
Block surface distortion limit mm		0.15	←
Cylinder bore diameter mm	Standard	86.000 ~ 86.019	←
	Wearing limit	0.15	←
Cylinder boring amount mm		0.25, 0.50	←
Piston diameter mm		85.944 ~ 85.964	←
Gap between piston and cylinder mm	Standard	0.036 ~ 0.075	←
	Limit	0.15	←
Piston over-size mm		0.25, 0.50	←
Gap between piston ring and ring groove mm	Top compression ring	0.03 ~ 0.07	←
	Second compression ring	0.03 ~ 0.07	←
	Limit	0.15	←
Piston ring groove width mm	Top compression ring	1.520 ~ 1.540	←
	Second compression ring	1.520 ~ 1.540	←
	Oil control ring	4.020 ~ 4.040	←
Piston ring end clearance mm	Top compression ring	0.20 ~ 0.35	←
	Second compression ring	0.15 ~ 0.30	←
	Oil control ring	0.3 ~ 0.9	←
	Limit	1.0	←
Piston ring over-size mm		0.25, 0.50	←
Piston pin	Diameter mm	21.947 ~ 21.980	←
	Installation pressure kN (kg)	5 ~ 15 (500 ~ 1500)	←

TORQUE SPECIFICATIONS

Unit : N·m (kgf·cm)

Model		FE	F2
Item			
Cylinder head cover		3.9~ 5.9 (40~ 60)	←
Rocker shaft assy		18~ 26 (180~ 270)	←
Cylinder head	Cold	80~ 86 (820~ 880)	←
	Hot	93~ 98 (950~ 1000)	←
Timing belt cover	Upper	8~ 12 (80~ 120)	6.9~ 9.8 (70~ 100)
	Lower	6.9~ 7.8 (70~ 80)	6.9~ 9.8 (70~ 100)
Cam shaft pulley lock bolt		47~ 65 (480~ 660)	←
Timing tensioner lock bolt		20~ 34 (200~ 350)	37~ 52 (380~ 530)
Drive plate		24~ 26 (240~ 270)	←
Crank shaft pulley		29~ 32 (300~ 330)	32~ 37 (330~ 380)
Timing belt crank pulley bolt		177~196 (1800~ 2000)	←
Front housing assy		19~ 25 (190~ 260)	←
Rear cover assy		8~ 12 (80~ 120)	←
Oil pan		7~ 12 (70~ 120)	←
Oil strainer	M 6	8~ 12 (80~ 120)	←
	M 8	16~ 23 (160~ 230)	←
Oil pump	M 8	19~ 25 (190~ 260)	←
	M10	37~ 52 (380~ 530)	←
Oil pressure switch		12~ 18 (120~ 180)	←
Main bearing cap		82~ 88 (840~ 900)	←
Connecting rod cap		50~ 55 (510~ 560)	65~ 69 (660~ 700)
Intake manifold		19~ 30 (190~ 310)	←
Exhaust manifold		22~ 28 (220~ 290)	←
Spark plug		15~ 23 (150~ 230)	←
Cooling fan		8~ 11 (80~ 110)	←
Cooling fan bearing	M 8	19~ 30 (190~ 310)	←
	M10	37~ 52 (380~ 530)	←
Cooling fan bracket		—	64~ 89 (650~ 910)
Water pump		19~ 25 (190~ 260)	←
Thermostat cover		19~ 30 (190~ 310)	←
Alternator bracket		37~ 52 (380~ 530)	←
Alternator strap		19~ 25 (190~ 260)	←
Alternator flange bolt		19~ 30 (190~ 310)	←
Air cleaner bracket		19~ 25 (190~ 260)	←
Carburetor		12~ 17 (120~ 170)	←
Fuel pump		16~ 22 (160~ 220)	←

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
The engine will not start.	The fuel tank is empty. The battery is not fully charged. The connections at the battery are loose or they have corrosion. The starter system has a problem. There are damaged parts in the engine. The valves are worn or damaged. The piston rings are worn or have damage. The fuel system has a problem. Ignition timing is not correct. Fuel line has a restriction. Fuel filter has a restriction. Ignition system does not operate correctly.	Fill fuel tank. Charge battery. Check and tighten battery connections. Check electrical circuit for starter. Repair engine. Install new valves. Install new piston rings. Check and repair fuel system. Adjust timing. Clean or use new fuel lines. Install a new fuel filter. Check and repair ignition system.
The engine does not run smoothly.	The valve mechanism does not operate correctly. The cylinder head has cracks. The head gasket has a leak. There is a leak in the intake system. Engine is too hot. Fuel lines or fuel filter has a restriction. The ignition timing is not correct.	Check and repair valve mechanism. Install a new cylinder head. Install a new gasket. Check and repair intake system. Check cooling system. Clean or use new fuel lines. Adjust timing.
The engine does not have enough power.	The fuel is the wrong type. The air filter is dirty. The ignition timing is not correct. The valve mechanism does not work correctly. The piston assemblies are worn or damaged. The exhaust system has restrictions. Fuel lines or fuel filter has a restriction. Engine is too hot or too cold. Cylinder head gasket leaks.	Fill tank with correct fuel. Install a new air filter. Adjust timing. Check and repair valve mechanism. Install new pistons. Clean parts or install new muffler or pipes. Clean or use new fuel lines and filter. Check cooling system. Install a new gasket.

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
There is noise inside the engine.	The main bearings are worn or damaged. Engine is too hot. Valves are not adjusted correctly. The bearings for the connecting rods are worn or damaged. The pistons are worn or damaged. Valve spring is broken. There is not enough oil in the engine. The flywheel is loose. A connecting rod is bent. There is a leak in the exhaust system. The valve mechanism does not operate correctly. Spark plugs are dirty.	Install new main bearings. Check and repair cooling system. Adjust valves. Install new bearings. Install new pistons. Install new valve springs. Fill engine with correct oil. Tighten capscrews for flywheel. Repair engine. Repair exhaust system. Check and repair valve mechanism. Install new spark plugs.
The engine gets too hot.	There is not enough coolant in the cooling system. The air filter has a restriction. The water pump has damage. The radiator is dirty. The cooling system has restrictions. The belt for the water pump is worn or not adjusted correctly. The thermostat has damage. The exhaust system has restrictions. Ignition timing is not correct. Cylinder head gasket leaks. Engine compression is not correct.	Fill cooling system. Install a new air filter. Install a new water pump. Clean or repair the radiator. Check radiator and hoses. Check and adjust the belt. Install a new thermostat. Check and repair exhaust system. Adjust timing. Install a new head gasket. Check and repair engine.