

1999-2000 ENGINES

2.3L V6

ENGINE IDENTIFICATION

NOTE: For repair procedures not covered in this article, see **ENGINE OVERHAUL PROCEDURES** article in **GENERAL INFORMATION**.

Engine code identifies basic engine type. Engine is also identified by engine number. Engine code and number are stamped on front of cylinder block. See **Fig. 1**. The 2.3L V6 engine is identified as code KJ.

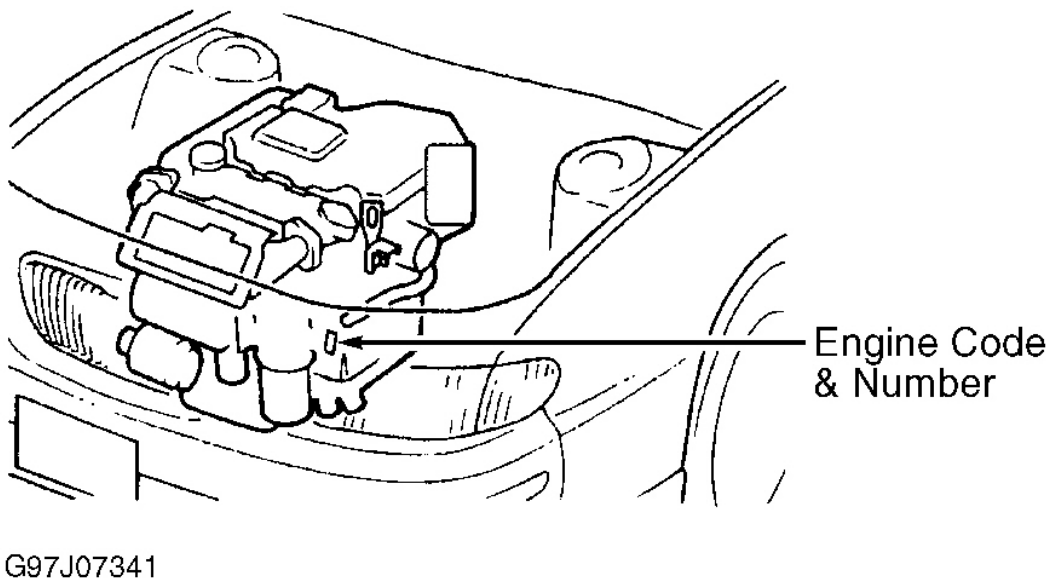


Fig. 1: Locating Engine Code & Number
Courtesy of MAZDA MOTORS CORP.

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

Inspection

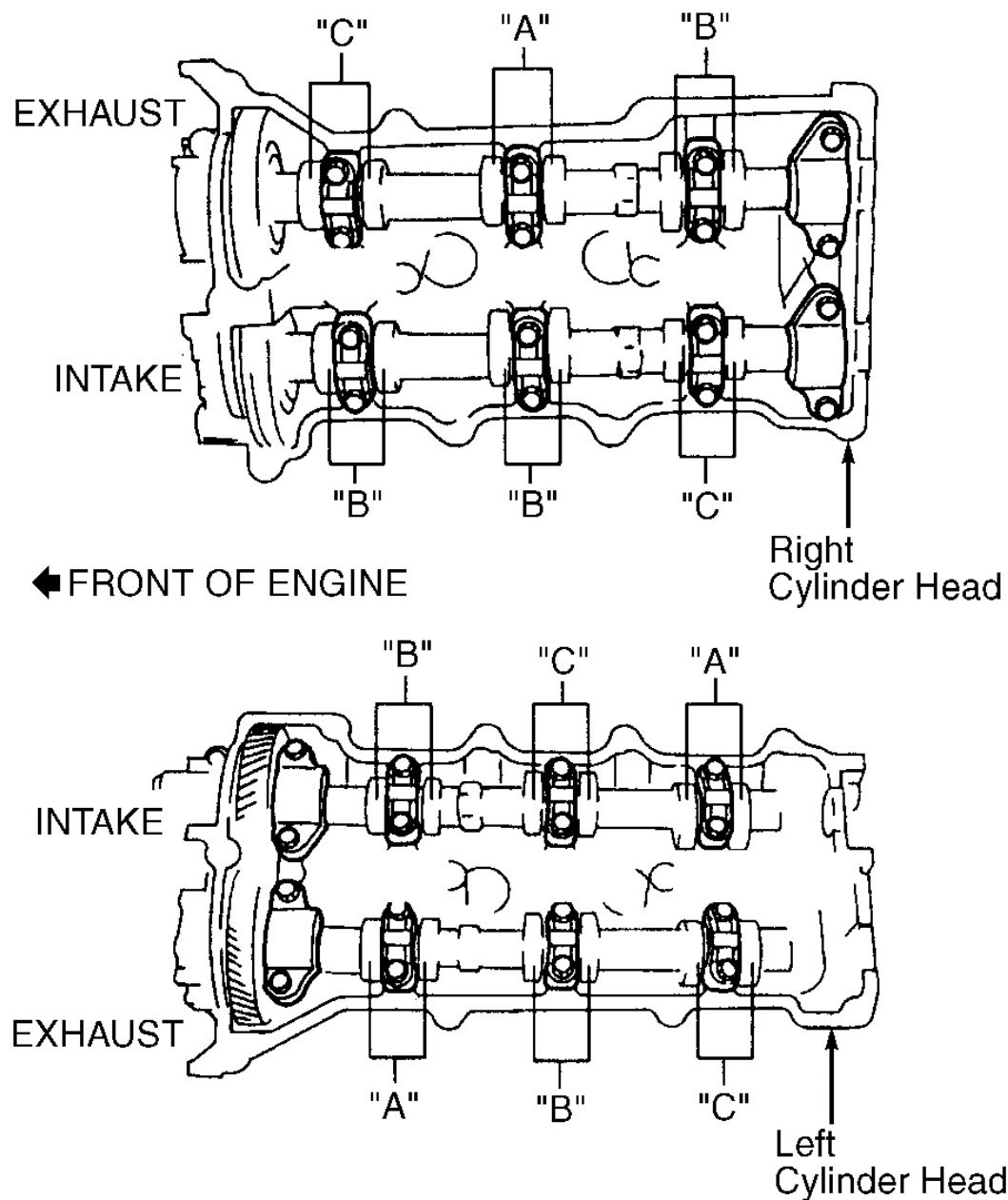
1. Remove intake manifold. See **INTAKE MANIFOLD** under REMOVAL & INSTALLATION. Remove valve cover. Ensure engine is cold. Measure valve clearance between camshaft lobe and adjustment shim.
2. With engine at Top Dead Center (TDC), measure clearance at position "A". See **Fig. 2**. Ensure clearance is .011-.012" (.27-.33 mm) for all measured valves. If clearance is not within specification, see

ADJUSTMENT.

3. Rotate crankshaft 240 degrees clockwise, positioning No. 3 cylinder at TDC of compression stroke. Measure valve clearance at position "B". See **Fig. 2**. Ensure clearance is within specification. If clearance is not within specification, see **ADJUSTMENT**.
4. Rotate crankshaft 240 degrees clockwise, positioning No. 5 cylinder at TDC of compression stroke. Measure valve clearance at position "C". See **Fig. 2**. Ensure clearance is within specification. If clearance is not within specification, see **ADJUSTMENT**.

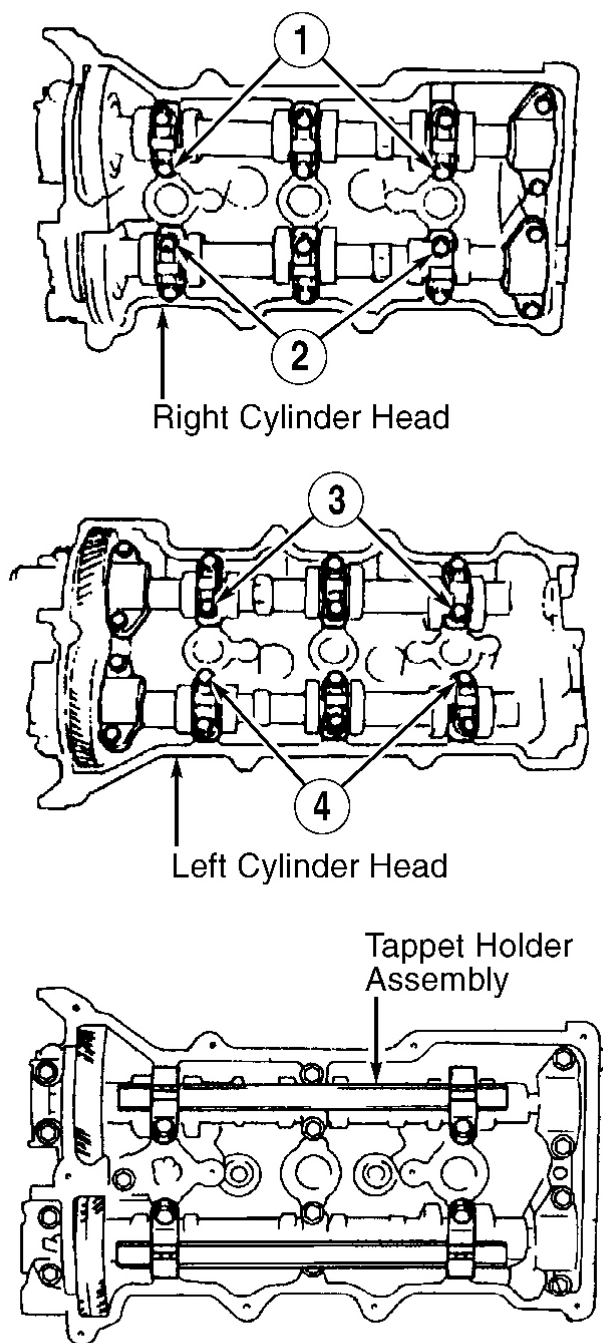
Adjustment

1. Turn engine clockwise until camshaft lobe of valve requiring adjustment is pointing straight up. Remove appropriate camshaft cap bolts for valves requiring adjustment as indicated in illustration. See **Fig. 3**.
 - No. 1 - Right cylinder head exhaust valve.
 - No. 2 - Right cylinder head intake valve.
 - No. 3 - Left cylinder head exhaust valve.
 - No. 4 - Left cylinder head intake valve.
2. Install Tappet Holder (49-T012-0A0), with body toward center of cylinder head, to camshaft caps where bolts were removed. Tighten tappet holder bolts to 99-125 INCH lbs. (11.3-14.2 N.m). Align marks on shaft and clamp of tappet holder. Tighten shaft holder clamp bolts to secure shaft after alignment.
3. Rotate notch in tappet so small screwdriver can be inserted. Position tappet holder body over tappet that requires shim replacement. Tighten holder body to shaft. Tighten holder bolt to compress tappet.
4. Using small screwdriver, pry shim from tappet. Using magnet, remove shim. Measure shim. Change to appropriate shim thickness to meet valve clearance specification.
5. Loosen bolt compressing tappet. Remove tappet holder assembly. Reinstall camshaft cap bolts and tighten to specifications. See **TORQUE SPECIFICATIONS**. Recheck valve clearance. Install valve cover with NEW gasket. Install intake manifold. See **INTAKE MANIFOLD** under REMOVAL & INSTALLATION.



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Fig. 2: Measuring Valve Clearance
 Courtesy of MAZDA MOTORS CORP.



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Fig. 3: Installing Tappet Holder Tool
 Courtesy of MAZDA MOTORS CORP.

NOTE: Before installing valve cover, apply sealant on cylinder head and valve cover at

designated areas. See Fig. 15. Tighten valve cover bolts to specification in sequence. See Fig. 16.

TROUBLE SHOOTING

To trouble shoot engine mechanical components, see appropriate table in TROUBLE SHOOTING article in GENERAL INFORMATION.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See **COMPUTER RELEARN PROCEDURES** article in GENERAL INFORMATION before disconnecting battery.

NOTE: For reassembly reference, label all electrical connectors, vacuum hoses and fuel lines before removal. Also place mating marks on engine hood and other major assemblies before removal.

FUEL PRESSURE RELEASE

1. Remove cruise control actuator. Start engine. Remove fuel pump relay located in engine compartment, behind left front strut tower. Allow engine to idle until it stalls. Crank engine several times to eliminate remainder of fuel pressure. Turn ignition off. Install fuel pump relay.
2. Before disconnecting any fuel line connections, cover connection with shop towel to absorb any residual gasoline that may remain in fuel line. Carefully loosen fuel line connection, allowing residual gasoline to be released.

COOLING SYSTEM BLEEDING

Fill radiator and coolant reservoir. Start engine and allow to idle until engine is at normal operating temperature. Accelerate engine to 2200-2800 RPM for 5 minutes. Shut engine off and allow engine to cool. Remove filler cap. Verify coolant level is near filler neck. If coolant level is not near filler neck, top off coolant and repeat procedure. Fill coolant reservoir to FULL level.

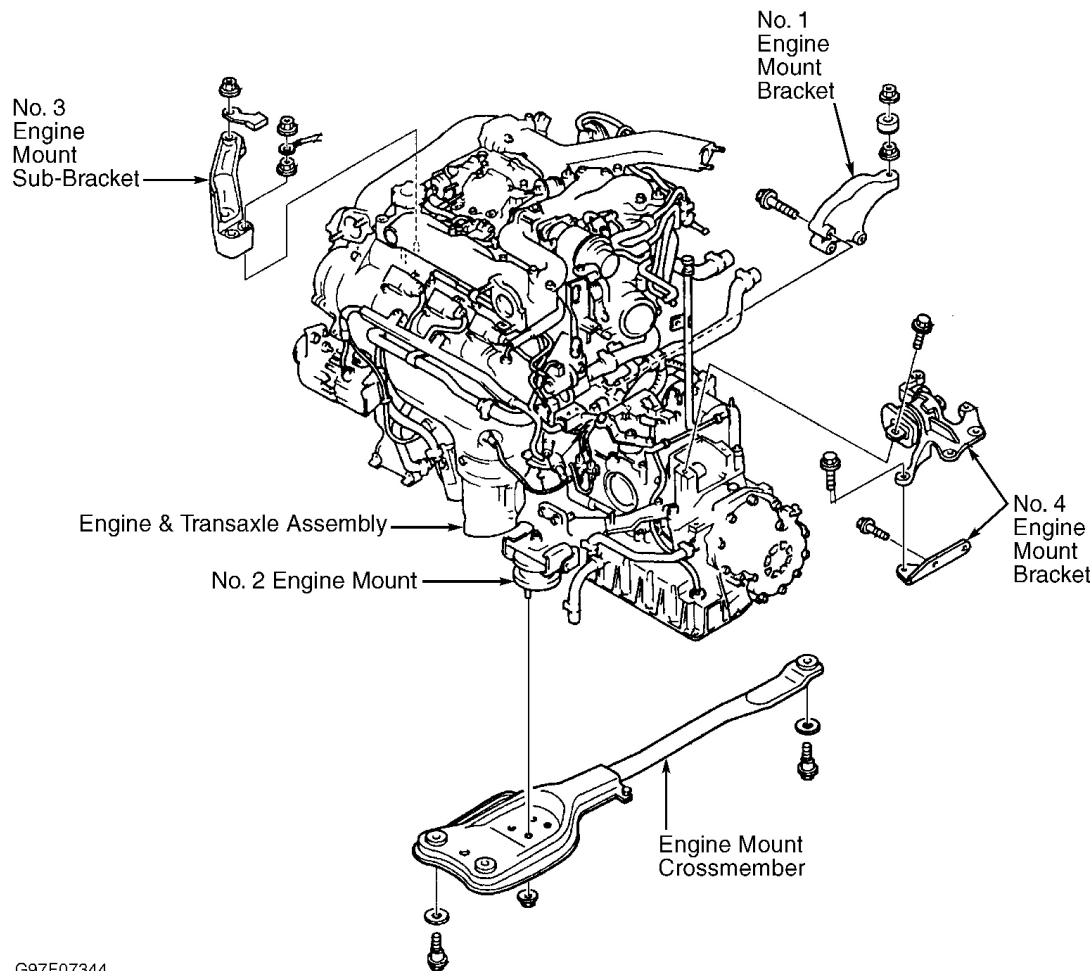
ENGINE

CAUTION: Cover fuel hoses with rag because fuel will spray out when fuel lines are disconnected.

NOTE: Remove engine and transaxle as an assembly.

Removal

1. Release fuel pressure. See **FUEL PRESSURE RELEASE**. Disconnect negative battery cable. Drain cooling system, engine oil and transaxle fluid. Reference mark hood hinges and remove hood. Raise and support vehicle. Remove front wheels.
2. Remove dynamic chamber cover by removing nuts in center of cover, then unsnapping clips along side of cover from front to back. Remove lower engine covers. Remove air intake duct and air cleaner assembly. Remove battery and battery tray. Disconnect necessary control cables, electrical connections, coolant hoses, vacuum hoses and fuel lines. Remove drive belt, crankshaft pulley and vacuum pump pulley. Vacuum pump pulley has left hand threads. Remove A/C compressor, leaving hoses attached and wire aside. Remove power steering pump, leaving hoses attached, and wire aside.
3. Remove front grill, radiator cover and coolant reservoir. Disconnect electrical connectors from electric cooling fans. Remove radiator and condenser fan assemblies. Remove transmission cooler lines from radiator.
4. Remove upper and lower hose at radiator. Remove radiator retaining bolts from bracket at bottom corners of radiator. Remove radiator assembly. Disconnect heater hoses at bulkhead.
5. Remove accelerator cable and drive belt. Remove A/C compressor and power steering oil pump with hoses still connected. Position compressor and oil pump away from engine, and hold with wire.
6. Remove selector cable and front exhaust pipe. Using ball joint separator, remove upper lateral ball joint. Separate lower ball joints. Using bar inserted between axle shaft and transaxle, pry axle shafts from transaxle. DO NOT damage oil seal when removing axle shaft. Remove drive shaft and intermediate (joint) shaft.
7. Support engine with hoist. Remove No. 1 engine mount bracket. See **Fig. 4**. Remove engine mount crossmember. Using engine hoist, remove weight from No. 3 and 4 engine mounts. Remove No. 4 engine mount assembly. Remove No. 3 engine mount sub-bracket. Lift engine and transaxle from vehicle.



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Fig. 4: Removing Engine & Transaxle Assembly
 Courtesy of MAZDA MOTORS CORP.

Installation

1. Loosen No. 4 engine mount outer bracket bolts and hand tighten. Install engine and transaxle. Install and hand tighten No. 3 engine mount sub-bracket bolts. Install No. 4 engine mount assembly into bracket, hand tight. Tighten No. 4 engine mount lower bolts at chassis to specification. See **TORQUE SPECIFICATIONS**.
2. Remove engine hoist and support engine-transaxle assembly with Engine Support (49 G017 5A0). Install engine mount crossmember to chassis and tighten to specification. Install No. 2 engine mount bolts through engine mount crossmember, and hand tighten. Install No. 1 engine mount bracket.
3. Tighten No. 1 engine mount bracket bolts to specification. See **TORQUE SPECIFICATIONS**. Remove engine support. Tighten all remaining engine mounts to specification. Install NEW retaining ring on end of axle shaft. Coat axle shaft splines and sliding surfaces with grease. Install axle shafts in transaxle, with opening of retaining ring facing upward.
4. Pull outward on axle shafts to ensure retaining ring is seated in transaxle. Install and tighten intermediate

(joint) shaft support bearing bracket evenly to specification.

5. To install remaining components, reverse removal procedure. Tighten fasteners to specification. See **TORQUE SPECIFICATIONS**. Fill engine with oil. Fill A/T transaxle with M-III or Dexron II ATF.
6. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**. Ensure accelerator cable has .06-.16" (1.5-4.0 mm) deflection at throttle body when installed. If deflection is not as specified, rotate nut on end of cable at throttle body until specified deflection is obtained.

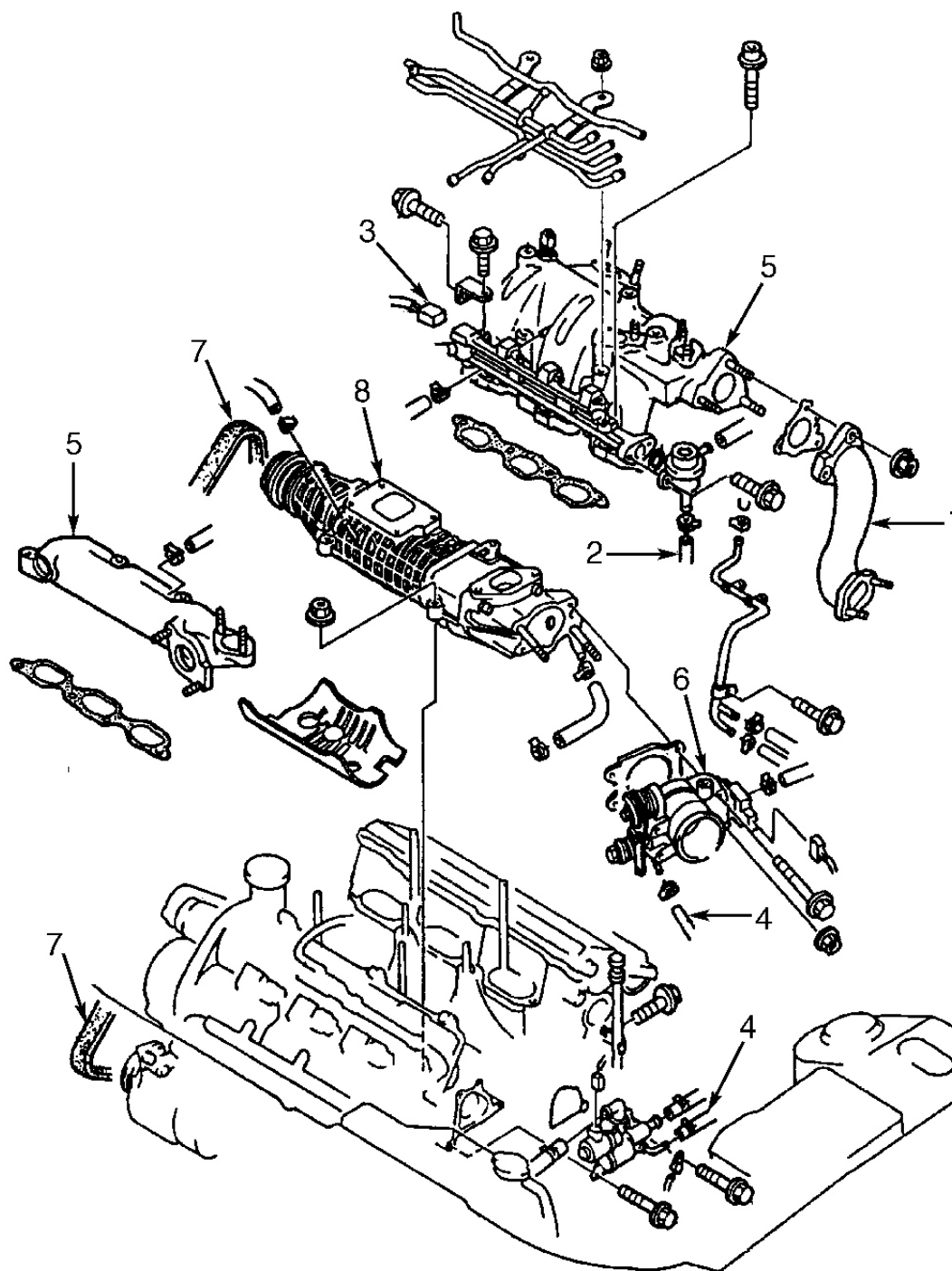
INTAKE MANIFOLD

Removal

1. Remove negative battery cable. Remove dynamic chamber cover by removing nuts in center of cover, then unsnapping clips along side of cover from front to back. Release fuel pressure. See **FUEL PRESSURE RELEASE**. Drain cooling system. Remove charge air cooler air duct. Remove air cleaner assembly with air ducts.
2. Remove MAF sensor and air intake hose. Remove air resonator box. Remove left and right charge air coolers. Remove accelerator cable. Remove air intake pipes that connect to charge air cooler assemblies. Remove EGR valve.
3. Remove charge air cooler pipe and fuel inlet hose. See **Fig. 5**. Remove fuel distributor connector. Remove coolant hose at throttle body and intake manifold. Remove intake manifold assembly.

Installation

1. To install reverse removal procedure. Install all intake manifold retaining bolts and nuts before tightening to specification. Tighten all fasteners in sequence to specification. See **Fig. 6**.
2. Install and tighten all retaining bolts to specification. See **TORQUE SPECIFICATIONS**. When installing charge air cooler air intake pipe assembly, hand tighten listed nuts and bolts until air intake pipe No. 3 meets intake manifold. See **Fig. 7**. Ensure rubber collars are not twisted or distorted. Tighten bolts in sequence. Tighten bolts "A" to 70-95 INCH lbs. (7.9-10.7 N.m). Tighten all other bolts shown to 14-18 ft. lbs. (19-25 N.m).
3. Hand tighten listed nuts and bolts until charge air coolers and air intake pipe No. 1 and No. 2 meet intake manifold. See **Fig. 8**. Ensure rubber collars are not twisted or distorted. Tighten bolts "A" to 44-78 INCH lbs. (5.0-8.8 N.m). Tighten bolts "B" to 70-95 INCH lbs. (7.9-10.7 N.m). Tighten all other bolts shown to 14-18 ft. lbs. (19-25 N.m).
4. To install remaining components, reverse removal procedure. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**. Ensure accelerator cable has .04-.08" (1.0-3.0 mm) free play at throttle body when installed. If free play is not as specified, rotate nut on end of cable at throttle body until specified free play is obtained.



- 1. Charge Air Cooler Pipe
- 2. Fuel Hose
- 3. Fuel Distributor Connector
- 4. Coolant Hoses

- 5. Intake Manifold Assembly
- 6. Throttle Body Assembly
- 7. Drive Belt
- 8. Lysholm Compressor

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Fig. 5: Exploded View Of Intake Manifold & Related Components
Courtesy of MAZDA MOTORS CORP.

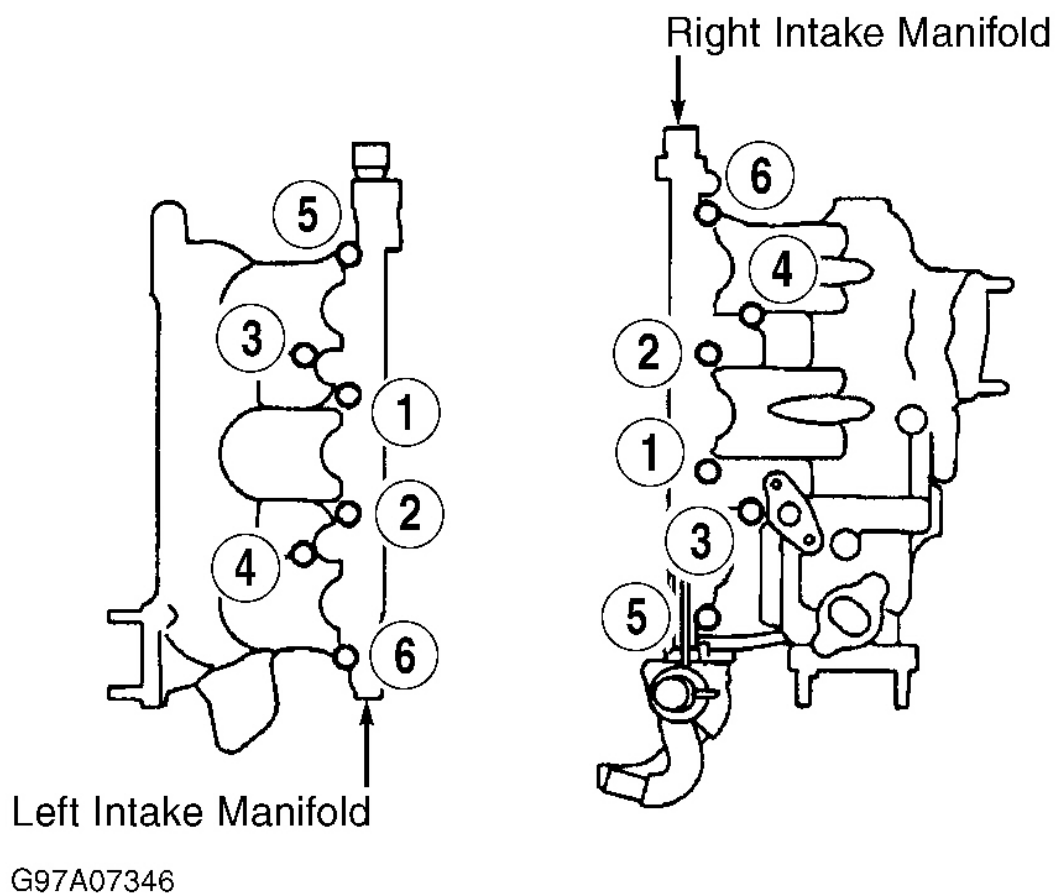


Fig. 6: Intake Manifold Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

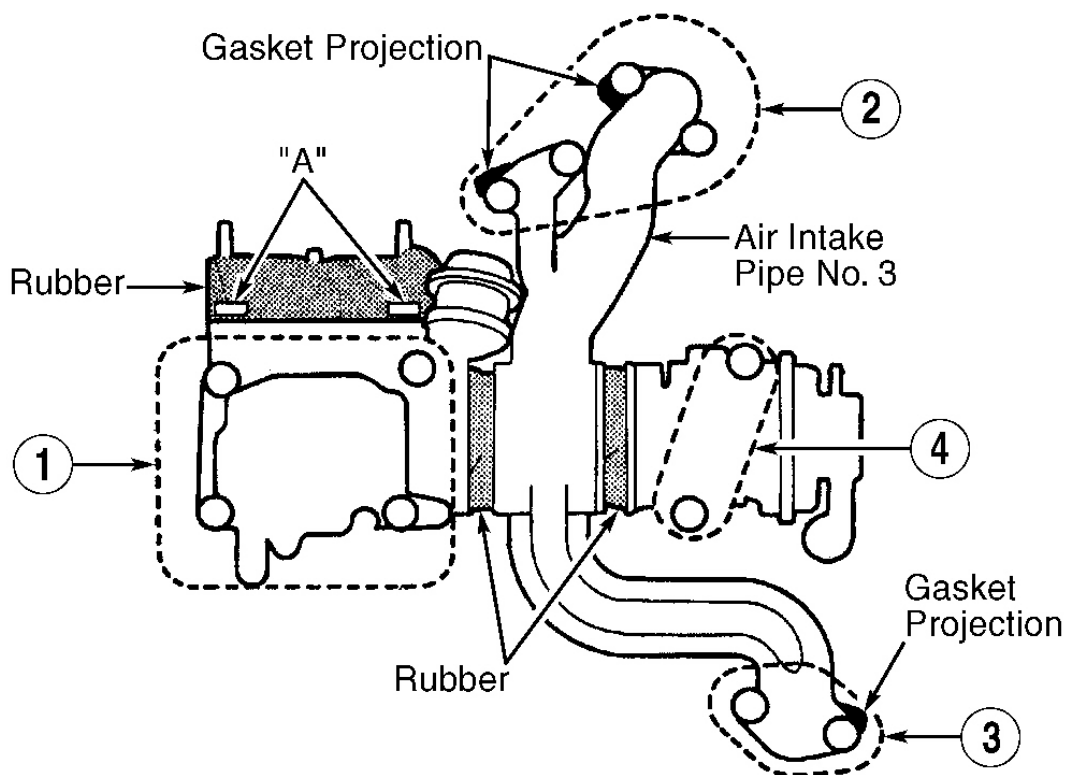
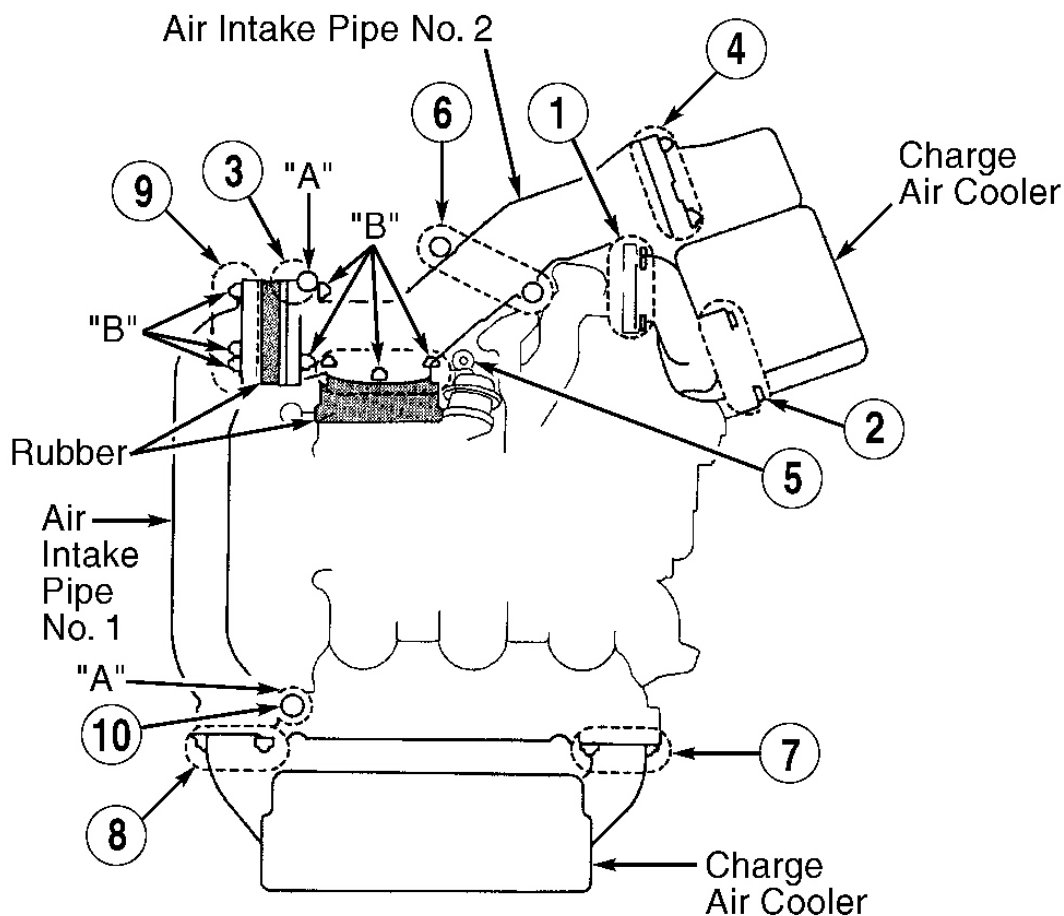


Fig. 7: Installing Charge Air Cooler & Air Intake Pipe Assembly (View 1)
Courtesy of MAZDA MOTORS CORP.



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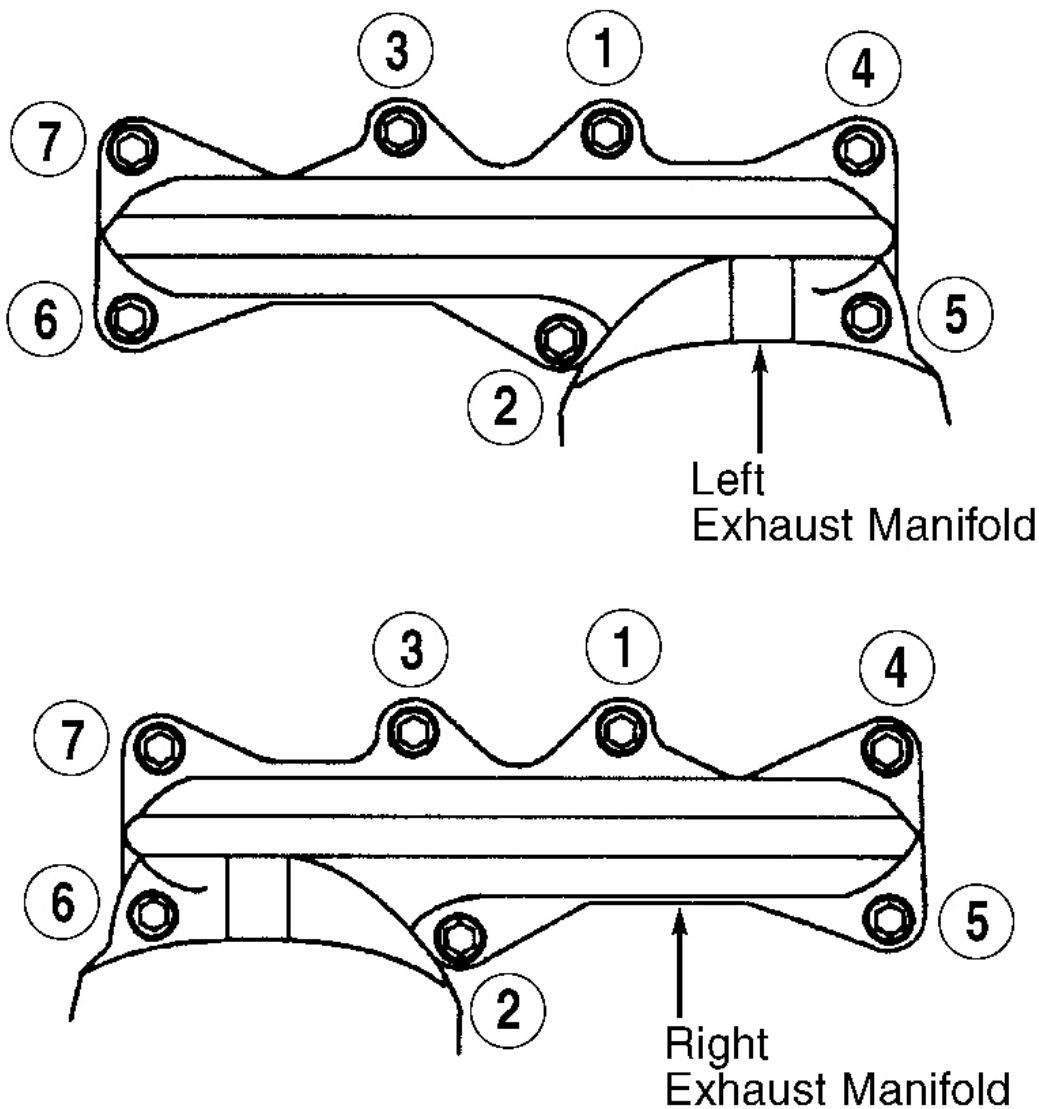
Fig. 8: Installing Charge Air Cooler & Air Intake Pipe Assembly (View 2)
 Courtesy of MAZDA MOTORS CORP.

EXHAUST MANIFOLD

NOTE: Exhaust manifolds are also identified as warm-up three-way catalytic converters.

Removal & Installation

1. Disconnect exhaust pipe from exhaust manifold. Remove exhaust manifold heat insulator. Remove retaining bolts, nuts, exhaust manifold and gasket.
2. To install, reverse removal procedure using NEW exhaust manifold gasket. Tighten bolts and nuts in sequence to specification. See **TORQUE SPECIFICATIONS**. See **Fig. 9**.



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Fig. 9: Exhaust Manifold Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD

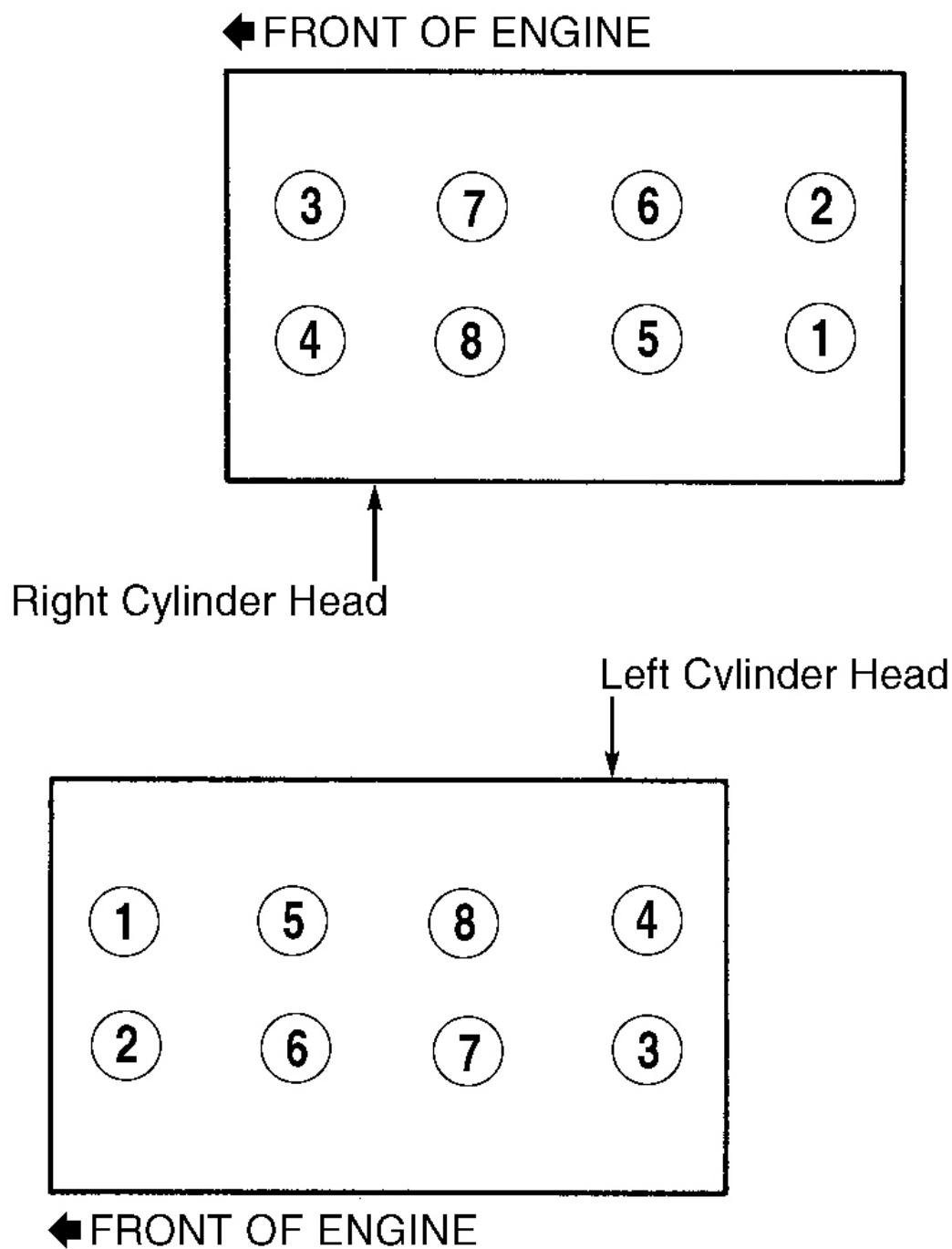
Removal

1. Remove intake manifold. See **INTAKE MANIFOLD**. Remove front header pipe and right exhaust manifold. See **EXHAUST MANIFOLD**. Remove throttle body assembly from Lysholm compressor. See **Fig. 5**. Remove drive belt and Lysholm compressor.

2. Remove timing belt. See **TIMING BELT**. Remove spacer at front of left cylinder head. Remove all ignition coils. Remove valve covers.
3. Remove camshaft pulleys while holding camshafts with wrench on cast hexagon area of camshaft. Remove camshafts. See **CAMSHAFT**. Remove lower radiator hose. Remove water inlet pipe.
4. Remove Lysholm compressor bracket. Remove generator bolt. Remove left cylinder head rubber insulator.

CAUTION: Loosen cylinder head bolts in proper sequence to prevent cylinder head warpage. See Fig. 10.

5. Loosen cylinder head bolts in sequence using several steps. See **Fig. 10**. Remove cylinder head bolts and washers, cylinder heads and gaskets.

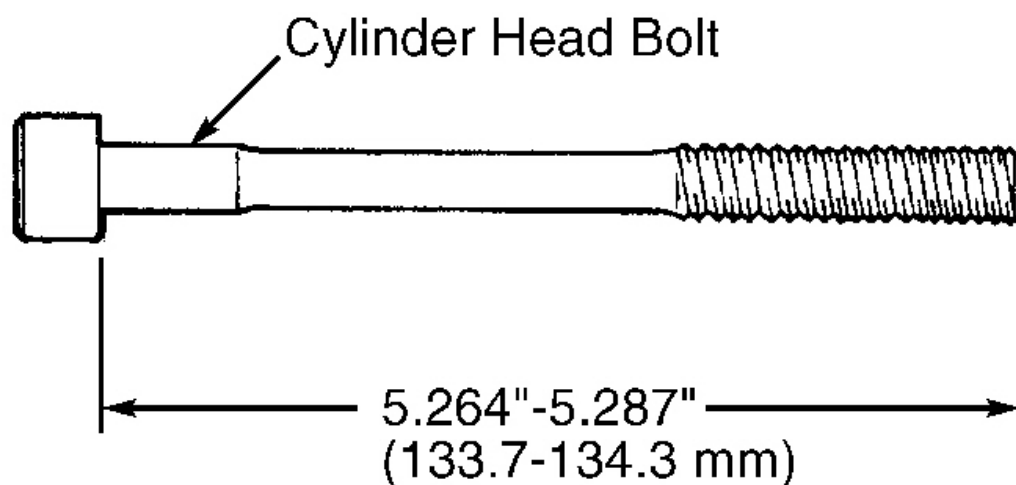


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Fig. 10: Cylinder Head Bolt Removal Sequence
Courtesy of MAZDA MOTORS CORP.

Inspection

1. Inspect cylinder head for cracks or warpage at cylinder block and manifold areas. Resurface or replace cylinder head if warpage exceeds specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. Measure cylinder head bolt length. See **Fig. 11**. Replace cylinder head bolts if length is not 5.264-5.315" (133.7-135.0 mm).
2. Ensure cylinder head bolt holes are completely clean. Inspect cylinder block deck surface for warpage. Replace cylinder block if warpage exceeds specification. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS. Inspect camshaft and components. See **CAMSHAFT**.



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Fig. 11: Measuring Cylinder Head Bolt Length
Courtesy of MAZDA MOTORS CORP.

Installation

1. Install NEW "O" ring onto oil control plugs. Coat "O" rings with engine oil. Install cylinder head gasket on cylinder block, paying attention to identification marks on head gaskets. See **Fig. 12**.
2. Ensure oil control plug "O" rings are coated with engine oil. Install cylinder head. Apply engine oil on cylinder head bolt threads and cylinder head bolt-to-cylinder head contact surfaces.
3. Install cylinder head bolts and tighten to specification in sequence. See **Fig. 13**. See **TORQUE SPECIFICATIONS**. After tightening head bolts to specification, put a paint mark on each head bolt. Using paint mark as a reference, further tighten head bolts 85-95 degrees in sequence, then tighten an additional 85-95 degrees. See **Fig. 13**.
4. Install rubber insulator on left cylinder head. Fit knock sensor harness through drill hole in block and pass under rubber insulator. See **Fig. 14**. Install camshafts using proper installation procedure. See

CAMSHAFT. To install remaining components, reverse removal procedure.

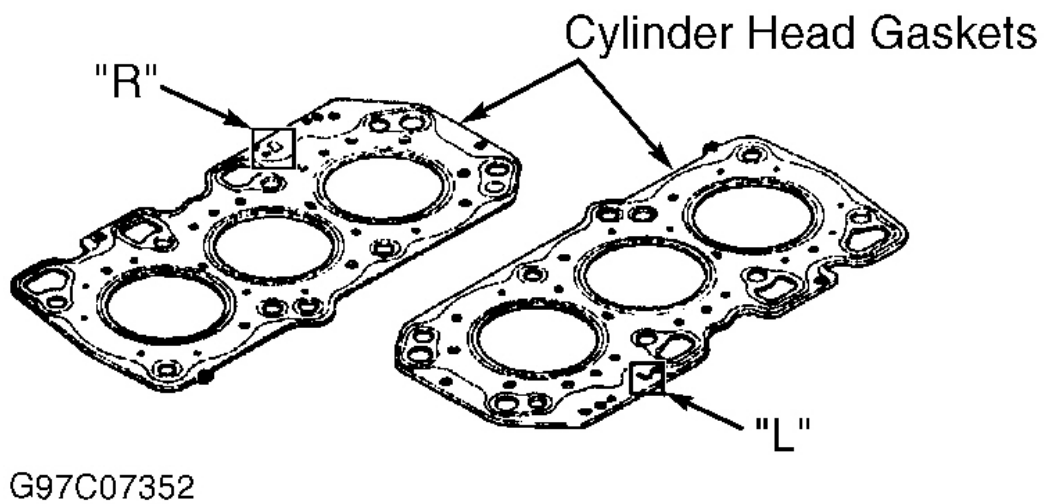


Fig. 12: Identifying Cylinder Head Gaskets
Courtesy of MAZDA MOTORS CORP.

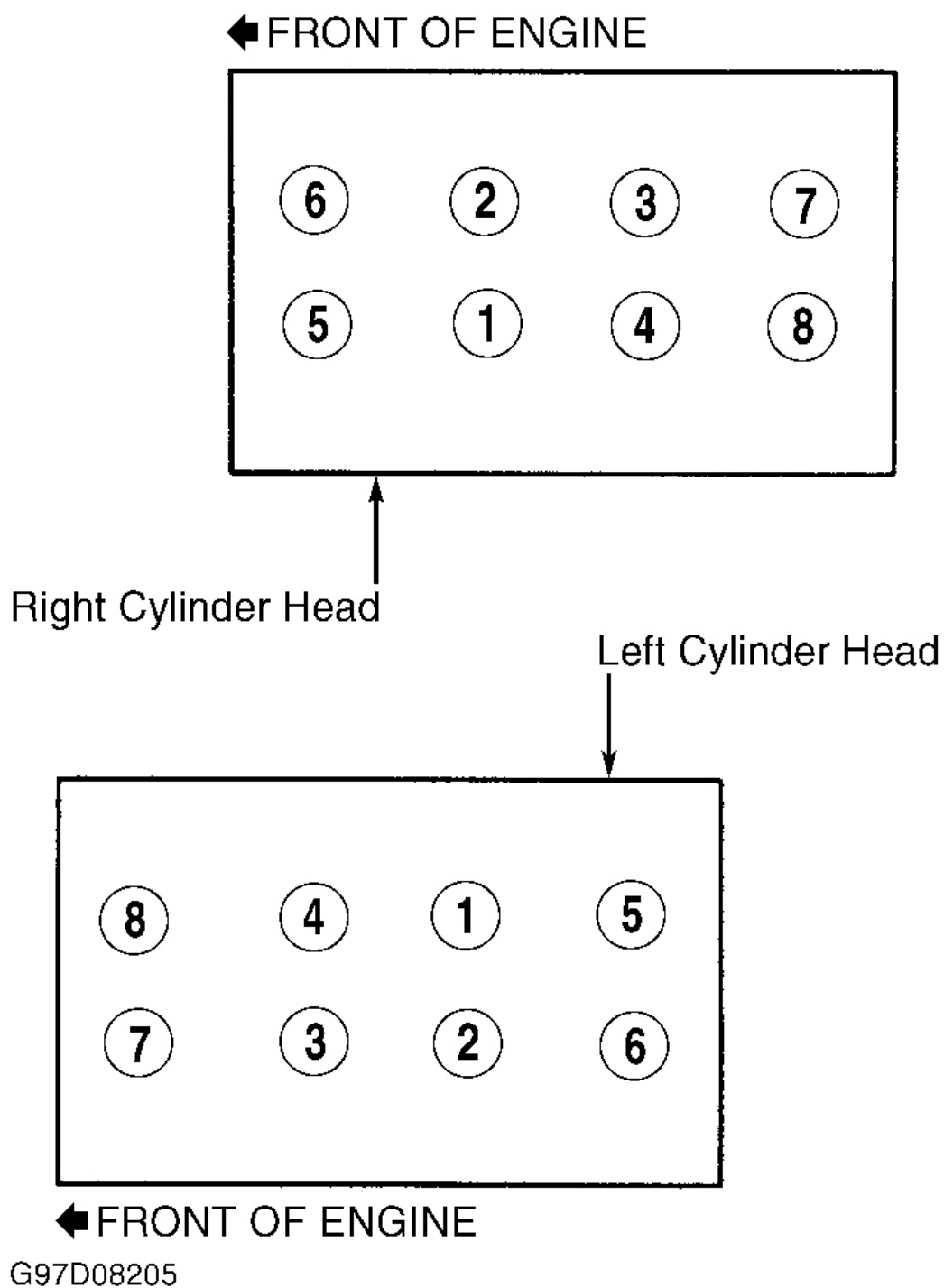


Fig. 13: Cylinder Head Bolt Installation Sequence
Courtesy of MAZDA MOTORS CORP.

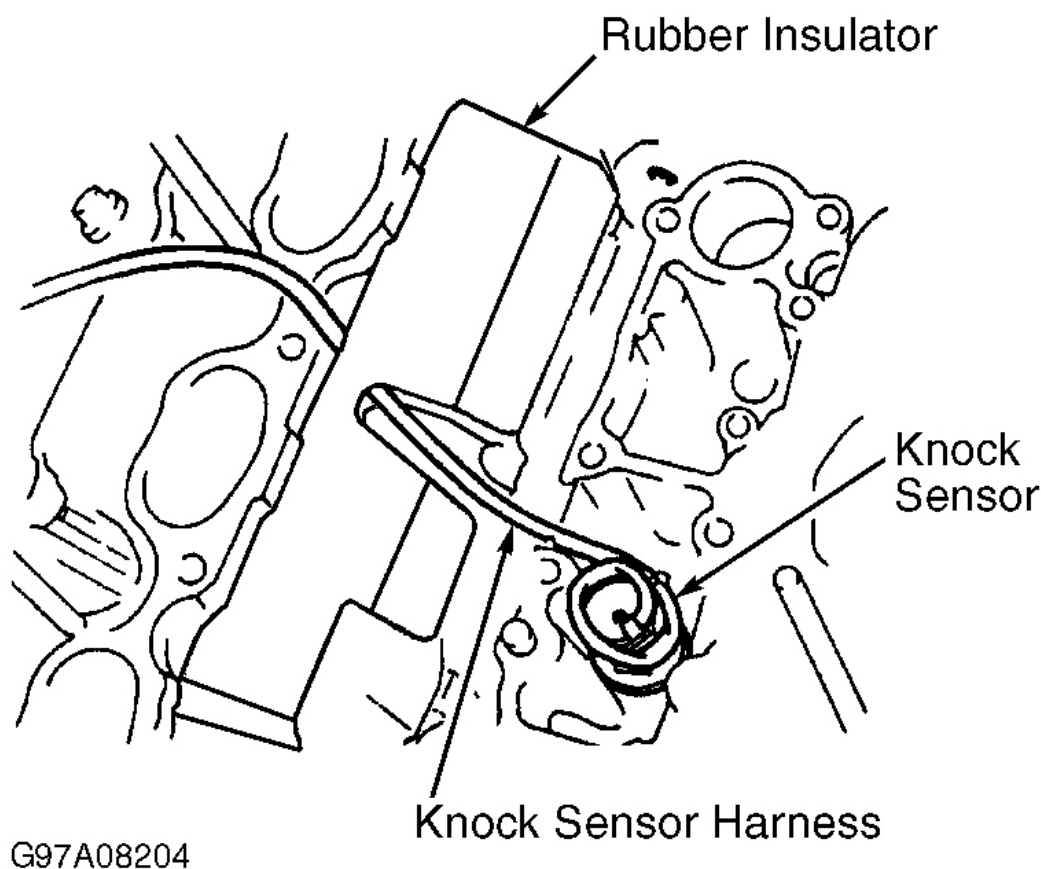
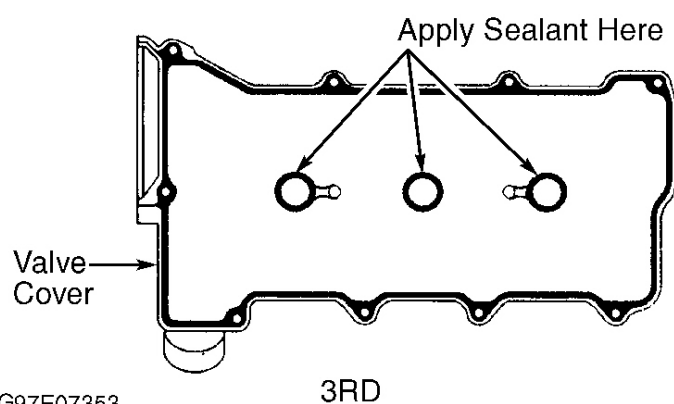
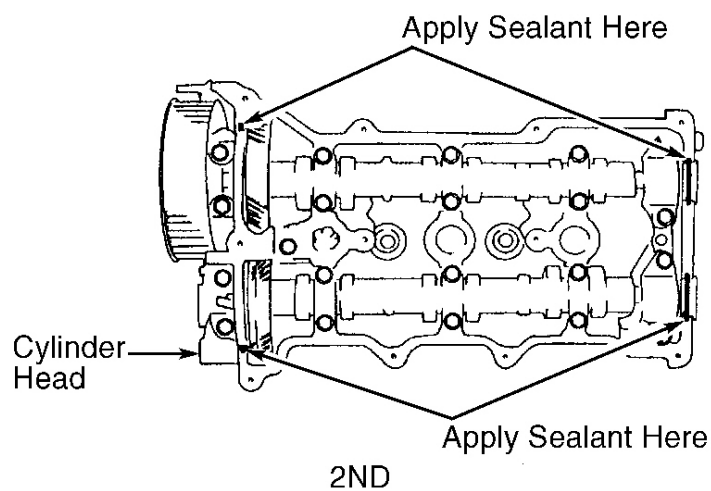
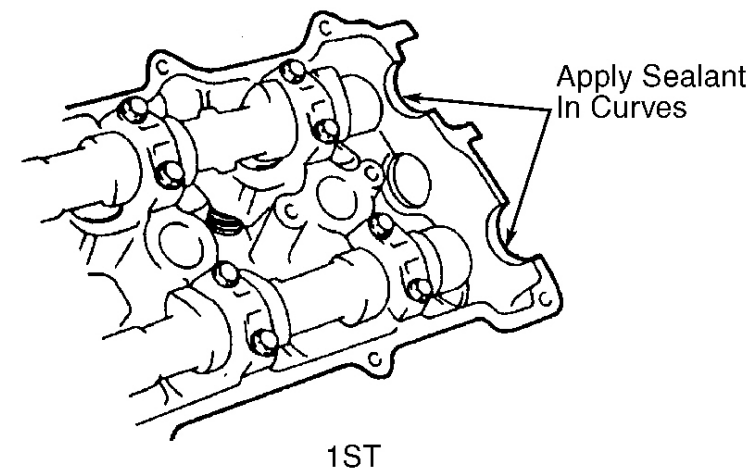


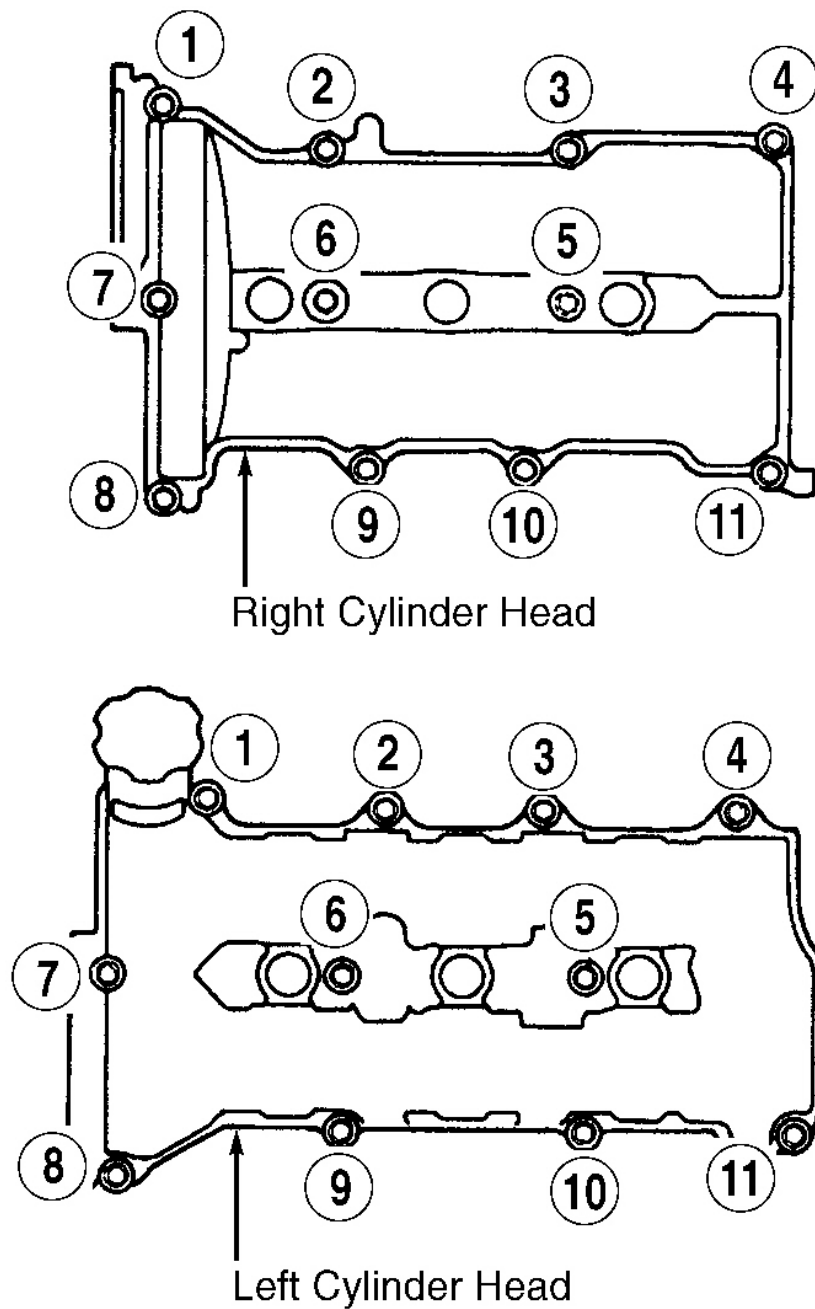
Fig. 14: Installing Knock Sensor Harness
Courtesy of MAZDA MOTORS CORP.

5. Install camshaft pulleys, aligning timing marks with camshaft knock pins. Apply oil to threads and install camshaft lock bolts to specification. See **TORQUE SPECIFICATIONS**. Measure valve clearance. See **VALVE CLEARANCE ADJUSTMENT** under ADJUSTMENTS.
6. Before installing valve cover and gasket, apply sealant at specified areas on cylinder head, then install rubber half-moon seals at end of cylinder heads. See **Fig. 15**. Apply sealant to valve cover where gasket contacts cover and over top of half moon seals in cylinder heads. Install gasket in valve cover. Install valve cover and gasket on cylinder head.
7. Install and tighten valve cover bolts to specification in sequence using several steps. See **Fig. 16**. See **TORQUE SPECIFICATIONS**. Install timing belt. See **TIMING BELT**. Install spacer at front of left cylinder head.
8. Install Lysholm compressor bracket bolts in sequence. See **Fig. 17**. Install Lysholm compressor and drive belt. Install throttle body assembly onto Lysholm compressor. Install front header pipe and right exhaust manifold. See **EXHAUST MANIFOLD**. See **Fig. 5**.



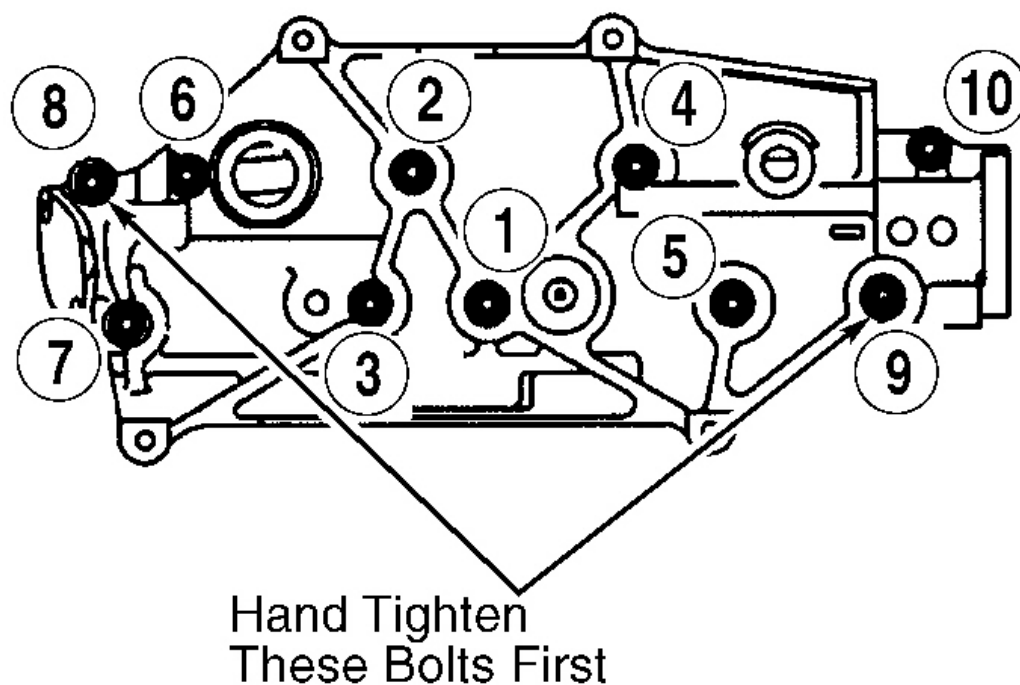
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Fig. 15: Applying Sealant To Cylinder Head Valve Cover
 Courtesy of MAZDA MOTORS CORP.



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Fig. 16: Valve Cover Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.



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Fig. 17: Lysholm Compressor Bracket Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

CRANKSHAFT FRONT OIL SEAL

Removal & Installation

1. Disconnect negative battery cable. Remove timing belt. See **TIMING BELT**. Using puller, remove crankshaft sprocket. Remove Woodruff key from crankshaft. Using a knife, cut seal lip from seal. Pry seal from oil pump body. DO NOT damage sealing surfaces.
2. To install, apply engine oil to seal lip of new seal. Install seal on crankshaft. Using hammer and pipe of suitable diameter, tap seal into oil pump body until seal surface is even with oil pump body. To install remaining components, reverse removal procedure.

TIMING BELT

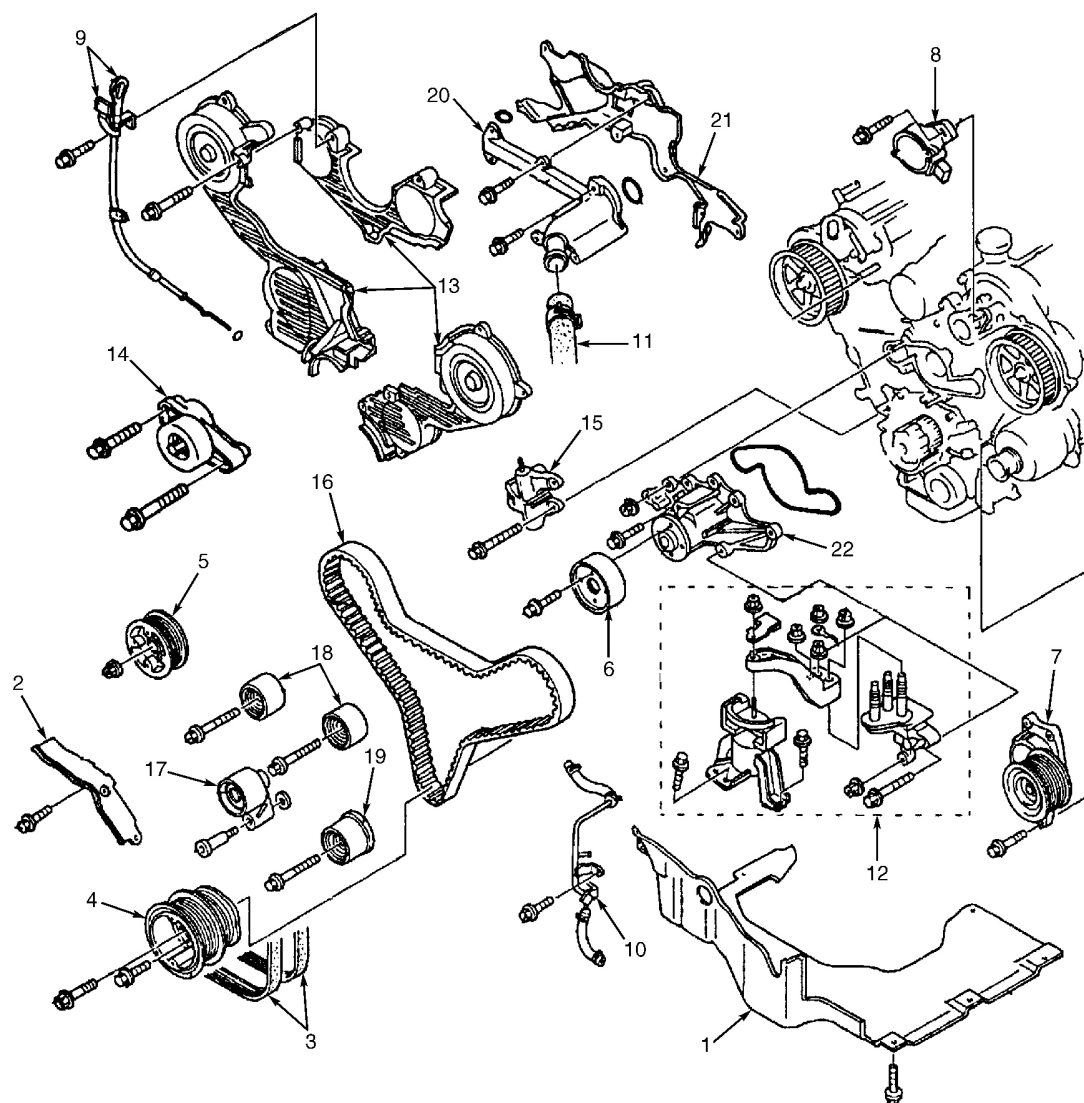
CAUTION: DO NOT damage crankshaft position sensor rotor on rear of crankshaft pulley during crankshaft pulley removal.

Removal

1. Disconnect negative battery cable. Drain coolant. Raise and support vehicle. Remove right front wheel. Remove lower engine covers. Remove accessory drive belts.

CAUTION: DO NOT damage crank angle sensor rotor on rear of crankshaft pulley during crankshaft pulley removal.

2. Remove crankshaft pulley retaining bolt. Using puller, remove crankshaft pulley. Remove power steering pump pulley. Remove water pump pulley. Remove generator drive belt auto tensioner. See **Fig. 18**. Remove camshaft position sensor from right hand camshaft.
3. Remove engine oil dipstick and pipe. Remove vacuum pipe. Remove upper radiator hose. Support engine using hoist. Remove No. 3 engine mount and brackets from timing belt end of engine. Remove retaining bolts, timing belt covers and gaskets. Remove power steering belt auto tensioner. See **Fig. 18**.
4. Install crankshaft pulley retaining bolt in crankshaft. Rotate crankshaft so No. 1 cylinder is at TDC on compression stroke. The crankshaft and camshaft timing marks should align. See **Fig. 19**.
5. If reusing timing belt, place reference mark on timing belt to indicate direction of rotation. Hold timing belt tensioner and remove lower retaining bolt first, then remove upper bolt. Remove timing belt tensioner. Remove timing belt.



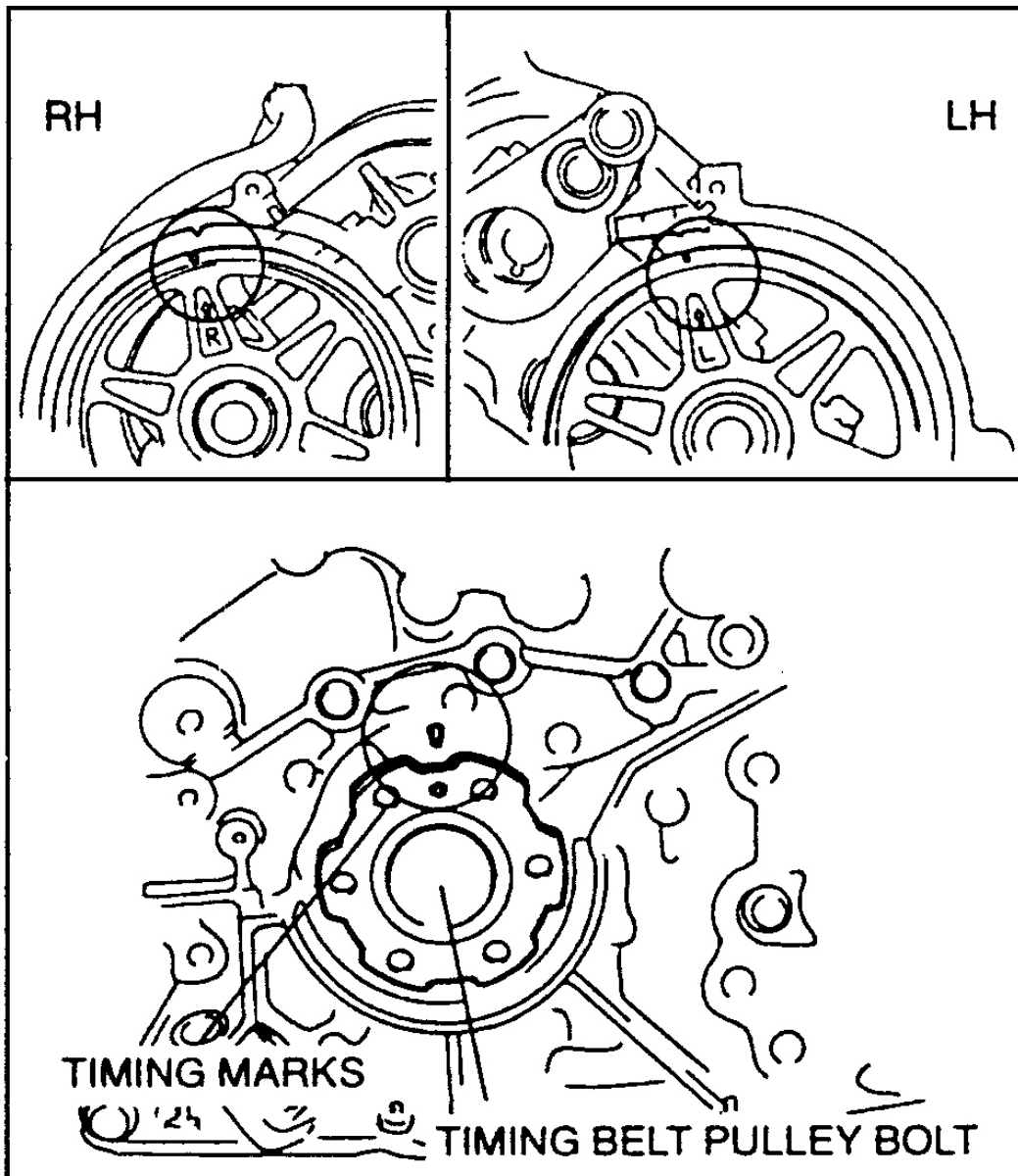
- 1. Splash Shield
- 2. Dust Cover
- 3. Drive Belt
- 4. Crankshaft Pulley
- 5. Power Steering Pump Pulley
- 6. Water Pump Pulley

- 7. Generator Belt Tensioner
- 8. Camshaft Position Sensor
- 9. Dipstick & Dipstick Tube
- 10. Vacuum Pipe
- 11. Upper Radiator Hose
- 12. No. 3 Engine Mount
- 13. Timing Belt Cover
- 14. Power Steering Belt Tensioner

- 15. Timing Belt Tensioner
- 16. Timing Belt
- 17. Tensioner Pulley
- 18. No. 1 Idler Pulley
- 19. No. 2 Idler Pulley
- 20. Water Outlet Pipe
- 21. Seal Plate
- 22. Water Pump

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Fig. 18: Exploded View Of Timing Belt & Components
 Courtesy of MAZDA MOTORS CORP.



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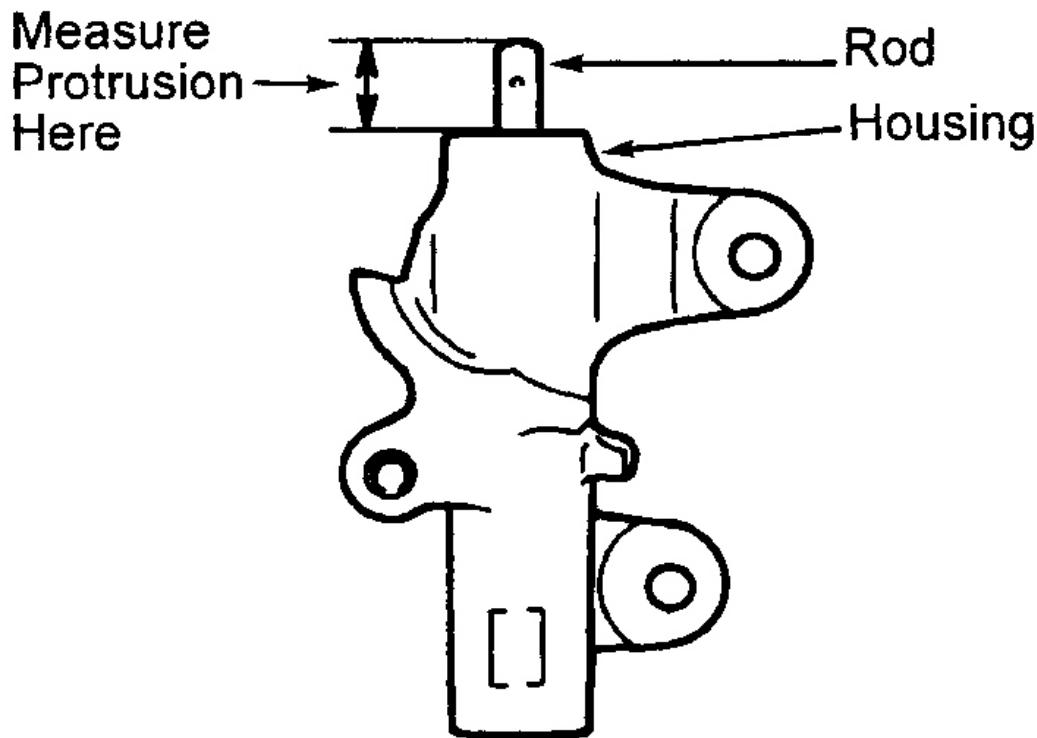
Fig. 19: Aligning Timing Marks
Courtesy of MAZDA MOTORS CORP.

Inspection

1. Inspect timing belt for damaged teeth, cracking and oil contamination. Inspect timing belt auto tensioner for signs of oil leakage. Replace timing belt auto tensioner if oil leakage exists. Measure timing belt auto tensioner rod protrusion from end of rod to edge of the housing. See **Fig. 20**. Replace timing belt auto tensioner if distance is not .563-.594" (14.3-15.1 mm).

NOTE: The following information on repairing the front engine oil leaks is from Mazda technical service bulletin MT0596-07; May, 1996.

- Oil leaking from the front of the engine on 1995-96 models may be caused by the No. 3 engine mount bracket stud. See **Fig. 21**. To repair the oil leak, remove No. 3 engine mount bracket. Remove mounting stud from engine. Clean all threads thoroughly. Apply Loctite PST Pipe Sealant with Teflon (No. 565) to stud threads. Install stud on engine block.



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Fig. 20: Measuring Timing Belt Tensioner Rod Protrusion
Courtesy of MAZDA MOTORS CORP.

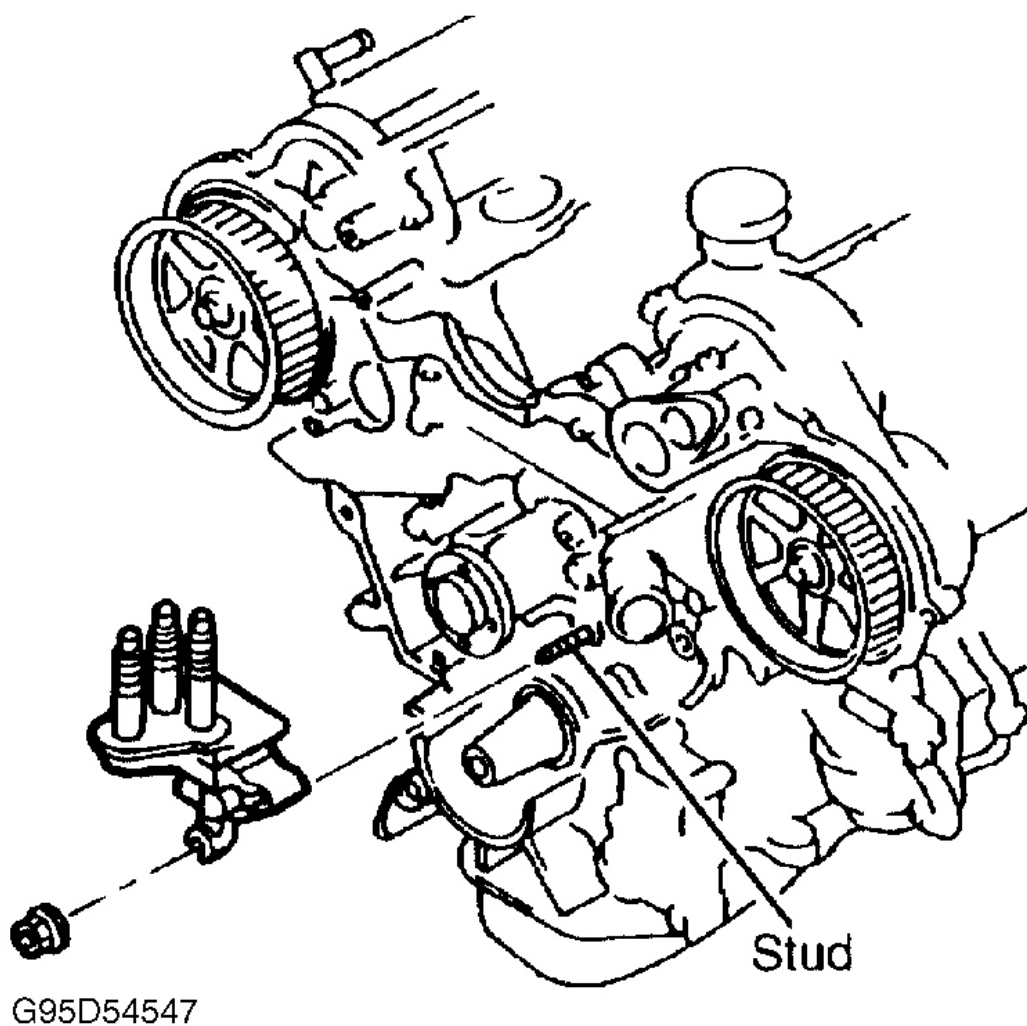


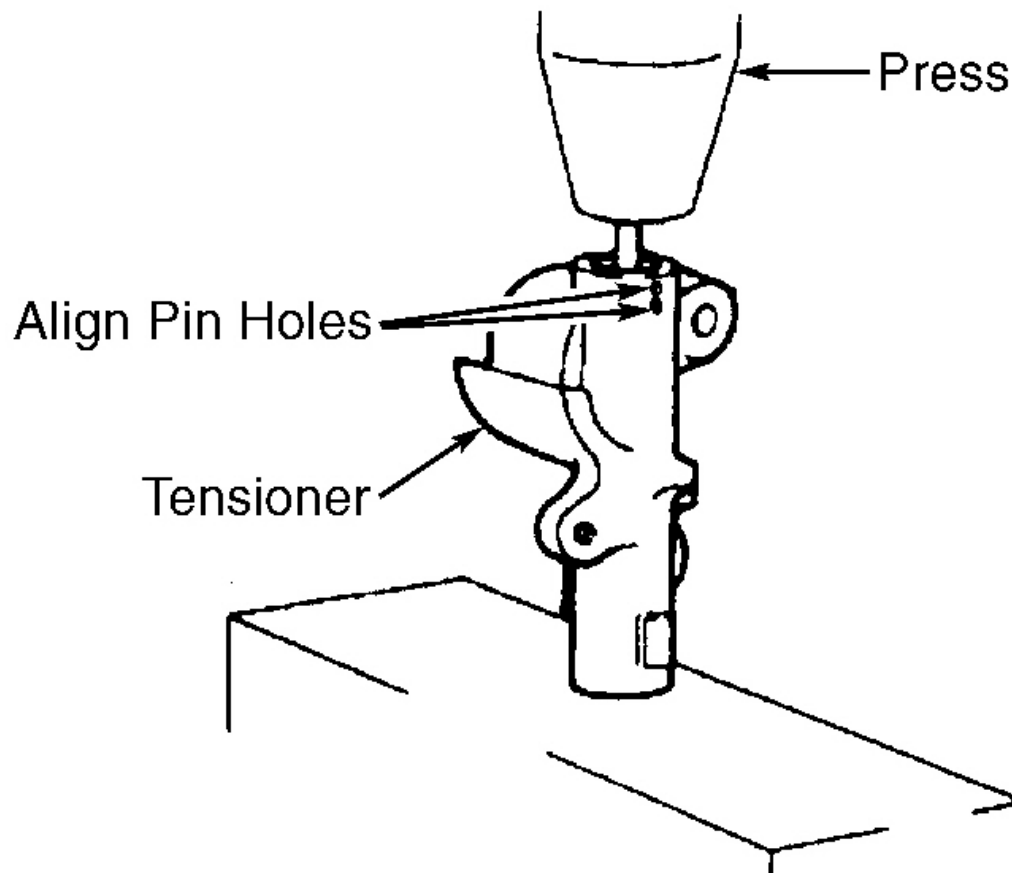
Fig. 21: Locating Engine Mount Bracket Stud
Courtesy of MAZDA MOTORS CORP.

Installation

1. Place timing belt auto tensioner in a press using a flat washer to prevent damage to timing belt tensioner. See **Fig. 22**. Using no more than 2200 lbs. of pressure, compress tensioner rod until holes in rod and housing are aligned. Install a .055-.063" (1.4-1.6 mm) diameter pin through holes in housing and rod to hold rod in retracted position. See **Fig. 22**.
2. Install timing belt on sprockets and around idler pulleys in the sequence shown. See **Fig. 23**. Ensure all slack is on tensioner pulley side. Install timing belt auto tensioner. Tighten timing belt auto tensioner bolts to specification. See **TORQUE SPECIFICATIONS**. Ensure all timing marks align. See **Fig. 19**.

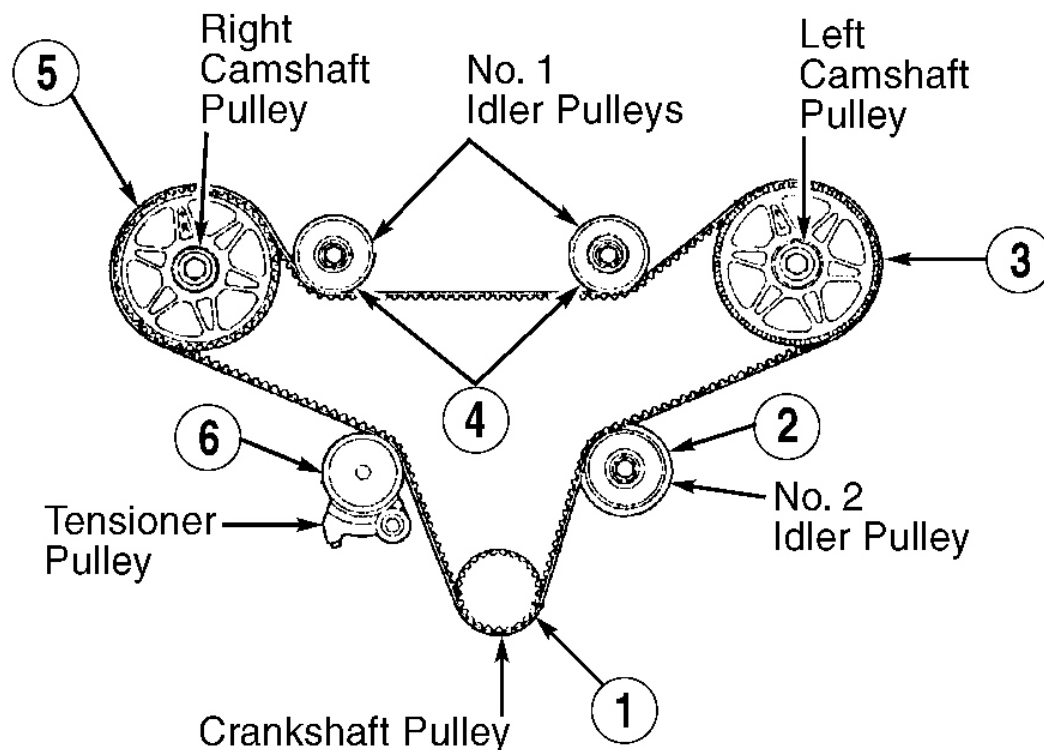
CAUTION: If reusing timing belt, ensure timing belt is installed in original direction of rotation.

3. Remove pin from timing belt tensioner, allowing tension to be applied on timing belt. Rotate crankshaft 2 full revolutions clockwise from TDC to TDC. Ensure timing marks on camshaft sprockets and crankshaft sprockets are properly aligned. See **Fig. 19**. If timing marks are not aligned, remove and repeat entire timing belt installation procedure.
4. Install timing belt covers using NEW gaskets. Tighten retaining bolts to specification. See **TORQUE SPECIFICATIONS**. Install dipstick tube with new "O" ring.
5. To install remaining components, reverse removal procedure. Tighten fasteners to specification. See **TORQUE SPECIFICATIONS**. Check ignition timing. Adjust drive belts to proper tension.



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Fig. 22: Retracting Timing Belt Tensioner Rod
Courtesy of MAZDA MOTORS CORP.



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Fig. 23: Installing Timing Belt
 Courtesy of MAZDA MOTORS CORP.

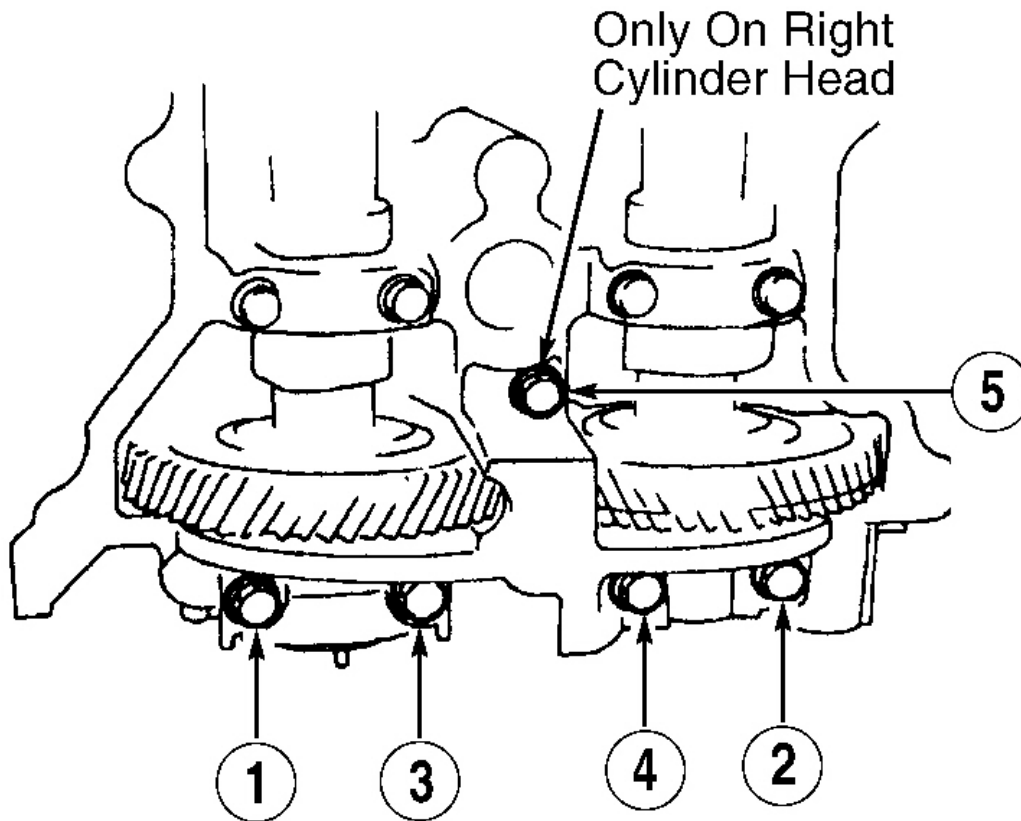
CAMSHAFT

Removal

1. Remove intake manifold. See **INTAKE MANIFOLD**. Remove front header pipe and right exhaust manifold. See **EXHAUST MANIFOLD**. Remove timing belt. See **TIMING BELT**. Remove spacer at front of left cylinder head. Remove ignition coils. Remove valve covers.
2. Remove camshaft pulleys while holding camshafts with wrench on cast hexagon area of camshaft. Rotate camshafts clockwise until camshaft lobes are not contacting adjustment shims. Loosen front camshaft cap bolts in sequence in 5-6 steps. See **Fig. 24**. Remove front camshaft caps.
3. Note location of remaining camshaft bearing caps for reassembly reference. Camshaft bearing caps on right cylinder head are numbered for location with No. 1 at timing belt end of engine. See **Fig. 25**. Camshaft bearing caps on left cylinder head contain letters for location with "A" at timing belt end of engine.

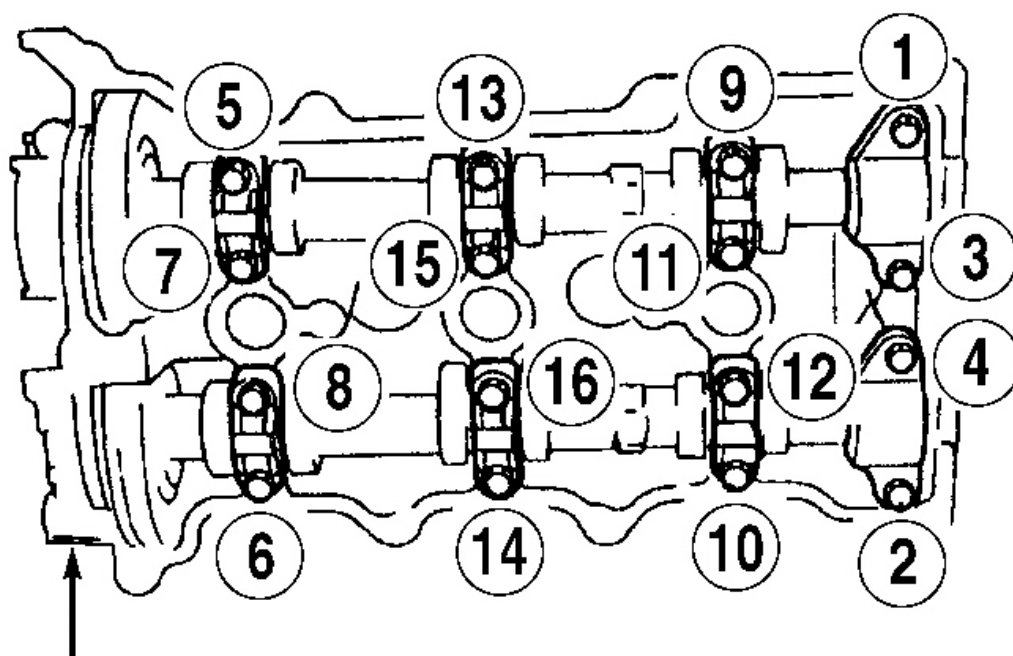
CAUTION: Remove thrust bearing caps last to prevent damage to thrust caps.
 See **Fig. 25**.

4. Loosen remaining camshaft bearing cap bolts, in sequence, using several steps. Remove all camshaft bearing caps except thrust bearing cap. Thrust bearing caps are removed last. Thrust bearing caps are identified with No. 4 and No. 8 on right cylinder head and "A" and "E" on left cylinder head.

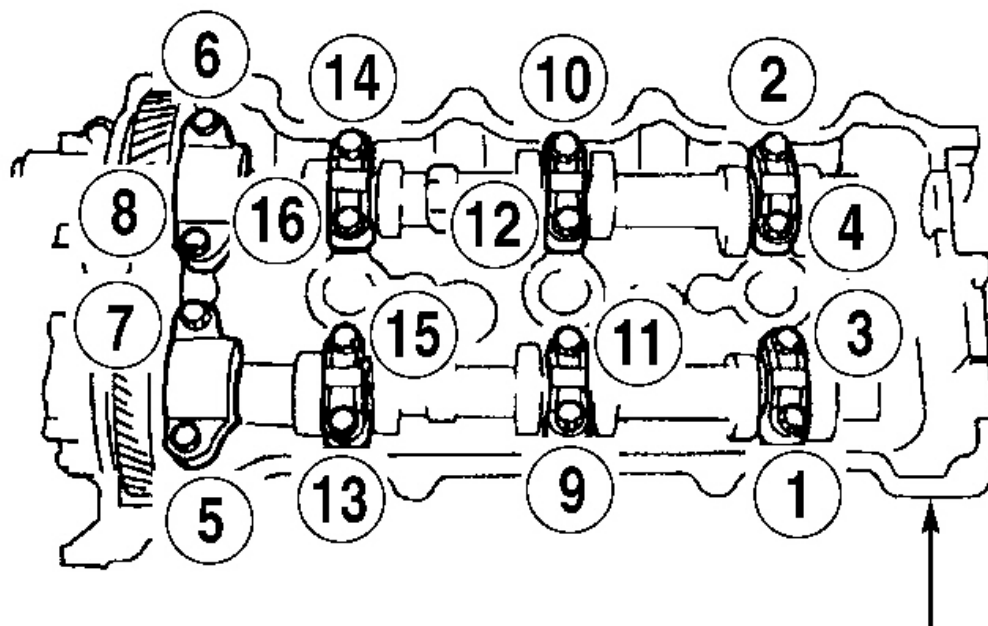


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Fig. 24: Front Camshaft Cap Bolt Removal Sequence
Courtesy of MAZDA MOTORS CORP.



Right
Cylinder Head



Left Cylinder Head

G97E08201

Fig. 25: Identifying Thrust Caps & Camshaft Bearing Cap Bolt Removal Sequence
Courtesy of MAZDA MOTORS CORP.

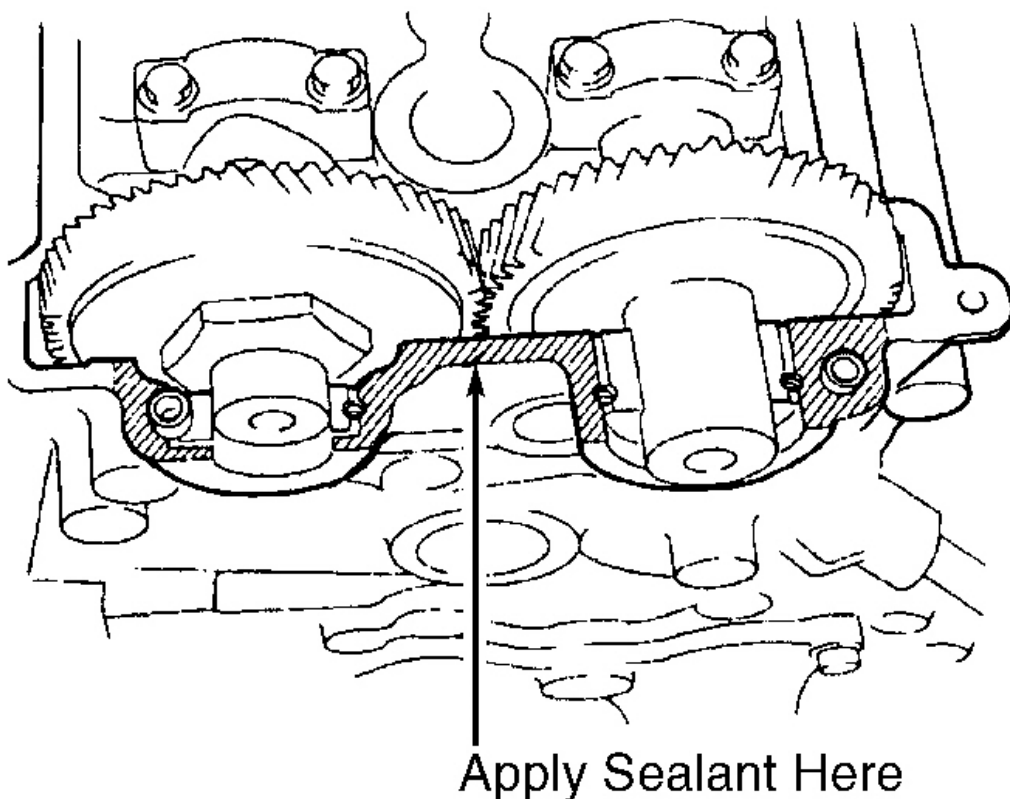
Inspection

Inspect components for damage. Check camshaft journal diameter, lobe height and runout. Replace camshaft if any measurement is not within specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.

Installation

1. Apply oil to camshaft journals, lobes and gears. Align camshaft gear timing marks. See **Fig. 19**. Ensure camshaft bearing cap surfaces are clean on cylinder head. Install thrust bearing caps (with bolts) by hand, gradually in several steps. Apply sealant at designated areas on cylinder head. See **Fig. 26**.

CAUTION: DO NOT allow sealant to contact camshaft.



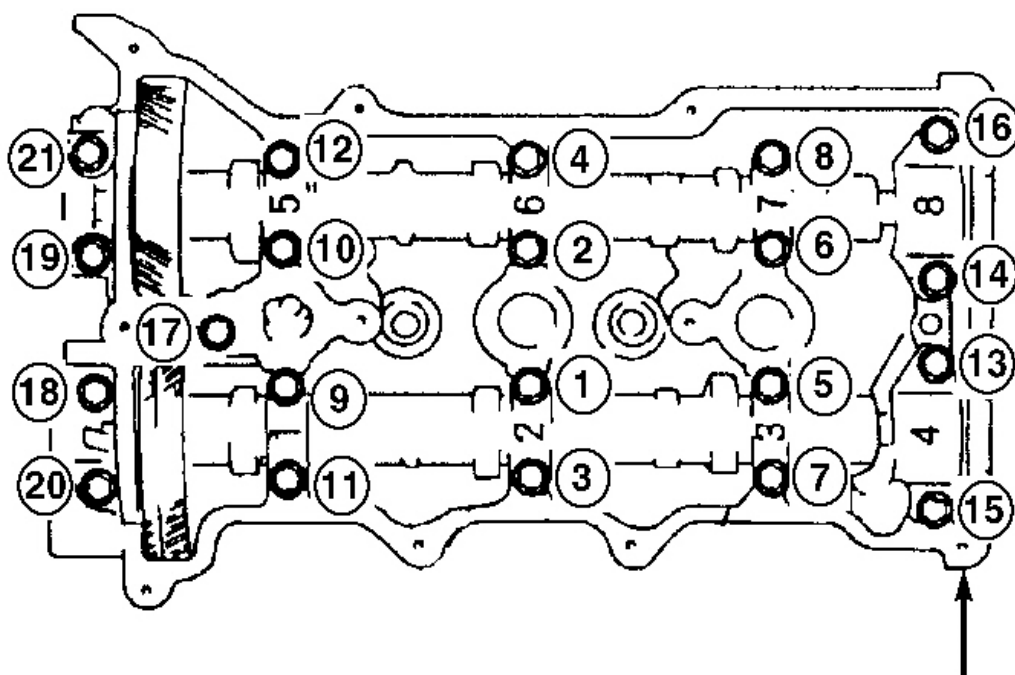
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Fig. 26: Identifying Camshaft Bearing Sealant Application Areas

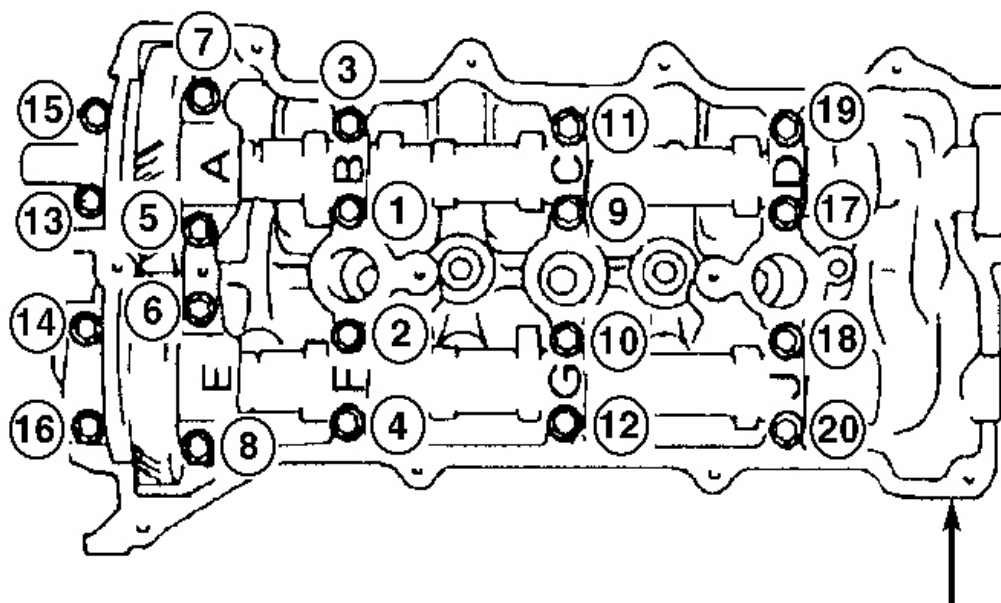
Courtesy of MAZDA MOTORS CORP.

NOTE: Camshaft bearing caps on right cylinder head are identified by numbers, with No. 1 at timing belt end of engine. Camshaft bearing caps on left cylinder head are identified by letters, with "A" at timing belt end of engine.

2. Loosely install remaining camshaft bearing caps and bolts. Tighten camshaft bearing cap bolts to specification in sequence using several steps. See **Fig. 27**. See **TORQUE SPECIFICATIONS**. DO NOT let camshafts bind.



Right Cylinder Head



Left Cylinder Head

G97I08203

Fig. 27: Camshaft Bearing Cap Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

3. Lubricate NEW camshaft oil seal. Using hammer and suitable driver, tap camshaft oil seal into cylinder head. Apply sealant to NEW blind cap. Using soft-face hammer, tap blind cap into cylinder head.
4. Hold camshaft from turning by using a wrench on camshaft hex. Install left and right camshaft pulleys as identified by "L" and "R" stamp marks. Apply oil to camshaft pulley bolts. Tighten camshaft pulley bolts to specification. See **TORQUE SPECIFICATIONS**.
5. Measure valve clearance. See **VALVE CLEARANCE ADJUSTMENT** under ADJUSTMENTS. Apply sealant at specified areas on cylinder head. See **Fig. 15**. Apply sealant on NEW valve cover gasket and install in valve cover. Install valve cover and gasket.
6. Install and tighten valve cover bolts to specification in sequence using several steps. See **Fig. 16**. See **TORQUE SPECIFICATIONS**. Rotate crankshaft so No. 1 cylinder is at TDC on compression stroke. Ensure timing mark on crankshaft pulley aligns with TDC mark on timing belt cover.
7. Install timing belt. See **TIMING BELT**. To install remaining components, reverse removal procedure. Tighten all fasteners to specification. See **TORQUE SPECIFICATIONS**. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING** under REMOVAL & INSTALLATION.

CRANKSHAFT REAR OIL SEAL

Removal & Installation

1. Disconnect negative battery cable. Remove transaxle and flexplate. For transaxle removal procedure, see TRANSMISSION REMOVAL & INSTALLATION article in TRANSMISSION SERVICING. Pry out oil seal.
2. To install, apply light coat of oil to seal lip and push seal over crankshaft. Tap seal into rear cover until it is flush with edge of rear cover. DO NOT bottom seal in cover.
3. Completely remove used sealant from flexplate bolts. Apply lock-type sealant to bolts, and install flexplate to crankshaft. Tighten flexplate bolts in a crisscross pattern. See **TORQUE SPECIFICATIONS**. Install transaxle.

WATER PUMP

Removal

Disconnect negative battery cable. Drain cooling system. Remove engine mount bracket located above water pump on cylinder block. Remove timing belt and water pump together. See **TIMING BELT**. Remove retaining bolts, water pump and seal ring.

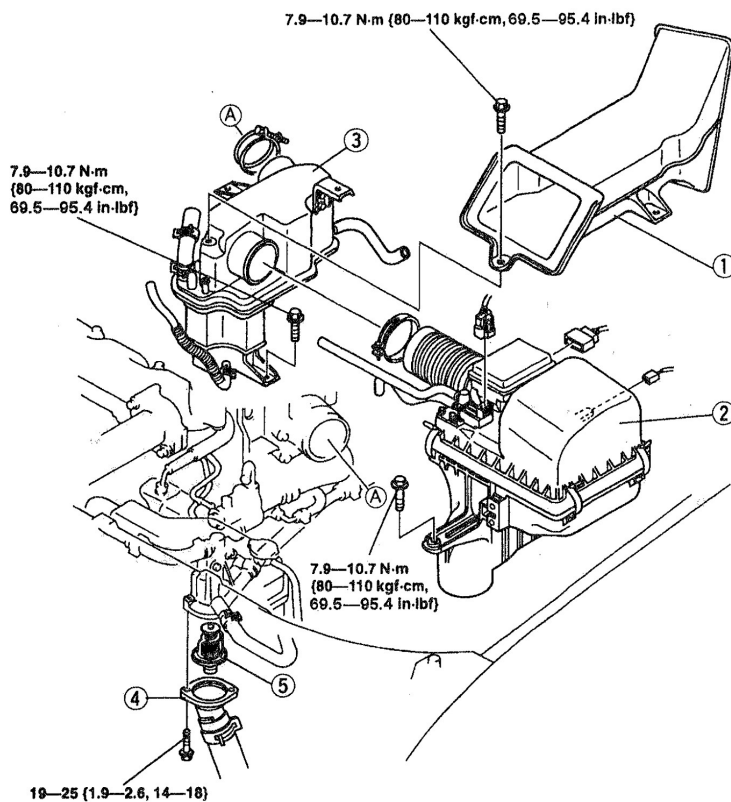
Installation

To install, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**.

THERMOSTAT

Removal & Installation

1. Disconnect the negative battery cable.
2. Drain the engine coolant.
3. Remove components in order indicated in illustration.
4. Install in reverse order of removal. See **Installation Note**
5. Start engine and check for coolant leaks.



N-m (kgf-m, ft-lbf)

WLU112WAA

1	Charge air cooler air duct
2	Air cleaner component INTAKE-AIR SYSTEM REMOVAL/INSTALLATION [KJ]

3	Resonator
4	Thermostat cover
5	Thermostat Installation Note

Fig. 28: Removing/Installing Thermostat (2.3L Turbo)
Courtesy of MAZDA MOTORS CORP.

Installation Note

Install the thermostat into the thermostat cover with the jiggle pin and projection aligned.

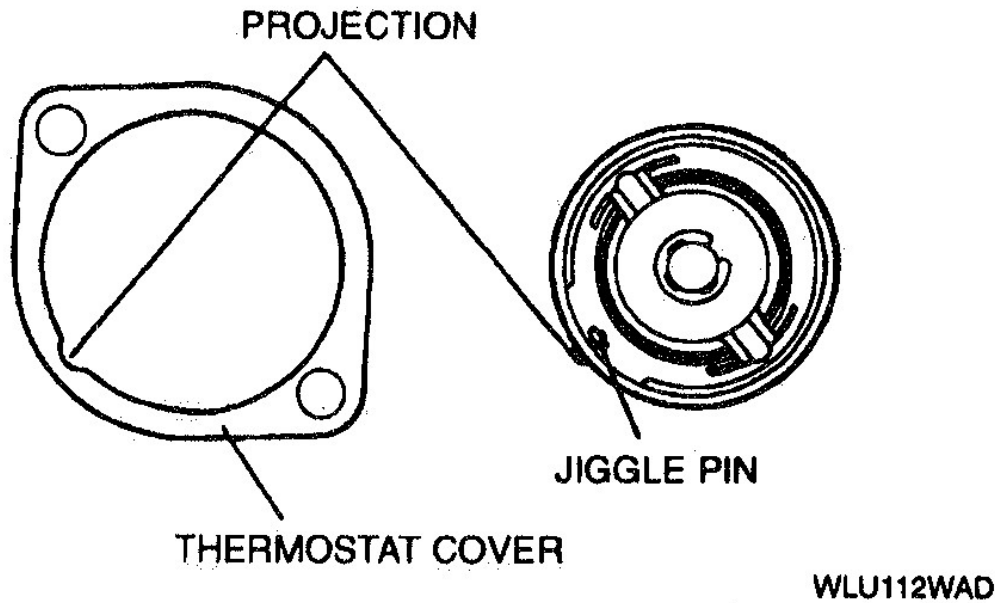


Fig. 29: Installing Note (2.3L Turbo)
Courtesy of MAZDA MOTORS CORP.

Thermostat Inspection

1. Visually check that the thermostat valve is airtight.
2. Place the thermostat and a thermometer into water.
3. Heat the water and check the following:
 - initial-opening temperature 176-183 degrees F (80-84 degrees C)
 - Full-open temperature 203 degrees F (95 degrees C)
 - Fully open lift 0.33 in. (8.5 mm)

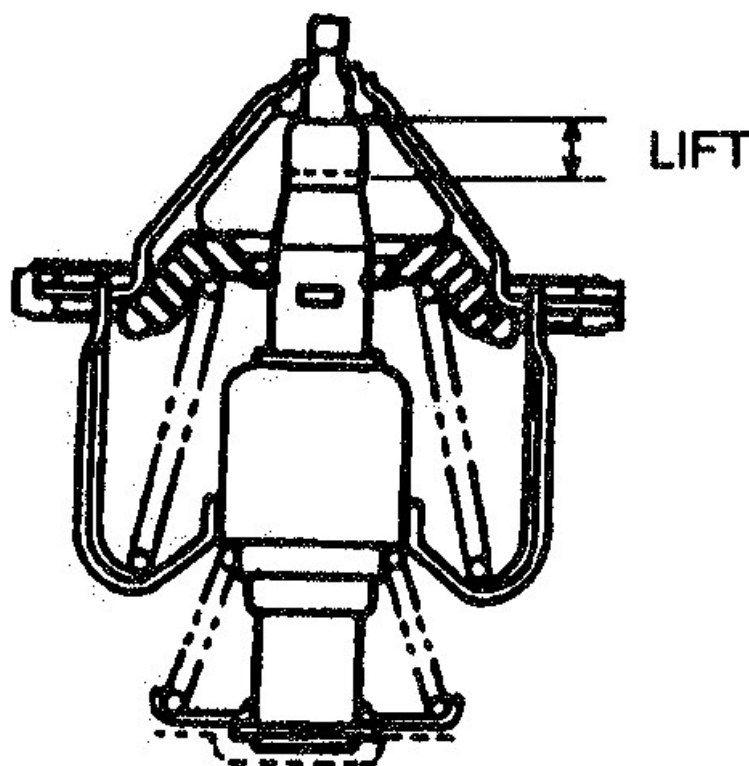


Fig. 30: Thermostat Lift Measurement Area
Courtesy of MAZDA MOTORS CORP.

OIL PAN

Removal

1. Disconnect negative battery cable. Raise and support vehicle. Drain engine oil. Remove lower engine covers. Remove front exhaust pipe.
2. Remove oil pan retaining bolts. Install a screwdriver or seal cutter between cylinder block and oil pan. Slightly pry apart to separate oil pan from cylinder block. Remove oil pan. Remove retaining bolts, pick-up tube and gasket (if necessary).

Installation

1. Install gasket and pick-up tube (if removed). Tighten retaining bolts to specification. See **TORQUE SPECIFICATIONS**. Ensure sealing surfaces are clean. Apply bead of sealant on inside of bolt holes and at center of oil pan sealing surface, between bolt holes.

CAUTION: Before installing oil pan bolts, ensure oil pan bolts and cylinder block

bolt holes are free of sealant. Cylinder block may crack if bolts are not cleaned before installation.

2. Install oil pan. Install bolts, and tighten to specification. See **TORQUE SPECIFICATIONS**. To install remaining components, reverse removal procedure. Fill crankcase with oil.

OVERHAUL

CYLINDER HEAD

Cylinder Head

1. Inspect cylinder head warpage at cylinder block and manifold areas. Resurface or replace cylinder head if warpage exceeds specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.

CAUTION: Ensure cylinder head height is within specification after resurfacing cylinder head. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. See **Fig. 31**.

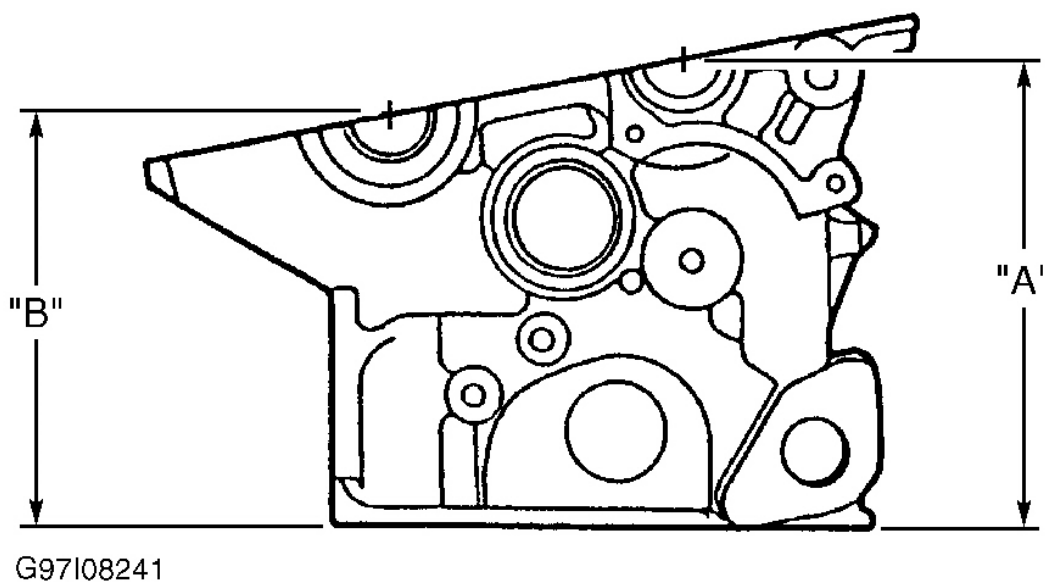


Fig. 31: Measuring Cylinder Head Height
Courtesy of MAZDA MOTORS CORP.

2. Ensure valve stem installed height is within specification. See **VALVES**. Ensure cylinder head-to-tappet oil clearance is within specification. See **TAPPET** table under ENGINE SPECIFICATIONS.

Camshaft

1. Visually inspect camshaft gears. If helical gear is defective, replace camshaft. If friction gear is defective, replace friction gear. Ensure matching marks are aligned. Tighten lock nut to specification. See **TORQUE SPECIFICATIONS**. Inspect remaining components for damage. Measure camshaft journal diameter, lobe height and runout. Replace camshaft if not within specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.
2. With tappet and shim removed from cylinder head, install one camshaft in cylinder head, without camshaft bearing caps. Check camshaft end play. Install Plastigage on camshaft journals. Install bearing caps and tighten to specification. See **TORQUE SPECIFICATIONS**.
3. Remove bearing caps and measure bearing oil clearance. Repeat procedure on remaining camshaft. Replace camshaft and/or cylinder head if end play or oil clearance is not within specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.

Tappet Bore

Measure tappet bore in 2 directions. Ensure bore is within specification. See TAPPET BORE in **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.

Valve Springs

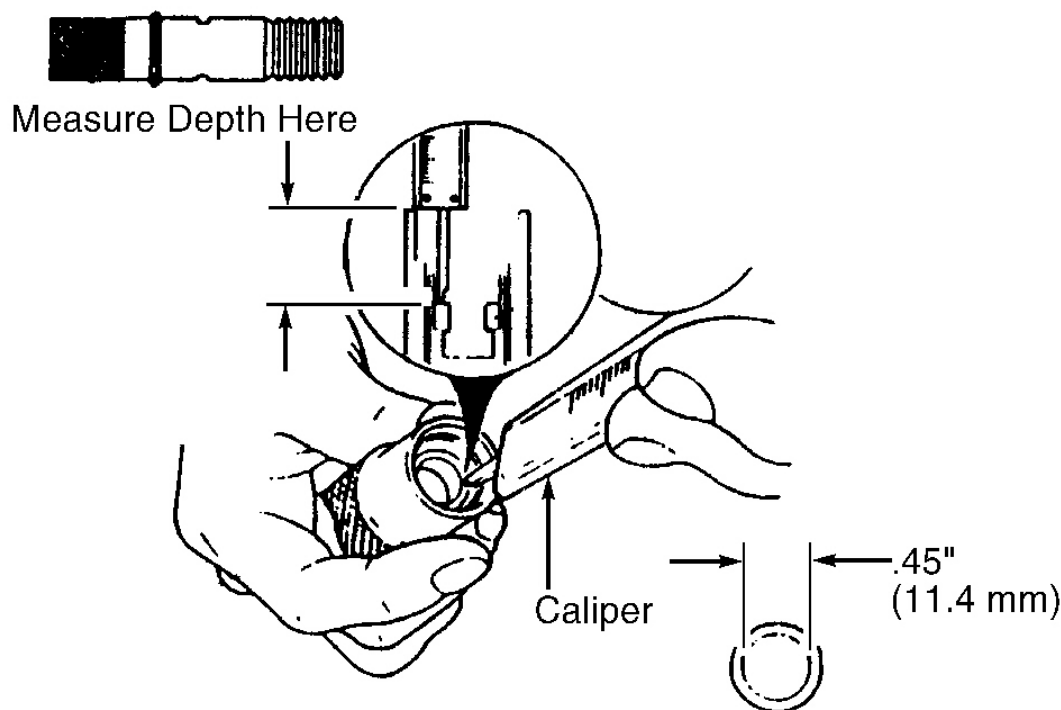
Ensure valve spring free length, pressure and out-of-square are within specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.

Valve Stem Oil Seals

1. Lubricate valve stem oil seal with engine oil. Assemble Valve Stem Oil Seal Installer Set (49-L012-001, 49-L012-005 and 49-L012-002).
2. Adjust valve stem oil seal installer so depth is set at specified distance for proper valve stem oil seal application. See **Fig. 32**. Adjust depth to .591" (15.00 mm) for intake valve stem oil seal or .531" (13.50 mm) for exhaust valve stem oil seal.

NOTE: Intake and exhaust valve seals are different. Exhaust valve seal has 2 ridges on top and intake valve seal has one or none. Ensure proper valve stem oil seal is used.

3. Insert valve stem oil seal into installer. Press valve stem oil seal on valve guide until fully seated. Remove valve stem oil seal installer.



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Fig. 32: Adjusting Valve Stem Oil Seal Installer
 Courtesy of MAZDA MOTORS CORP.

Valve Guides

1. Ensure valve guide inside diameter and installed height are within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. Replace valve guide if inside diameter exceeds specification or valve guide installed height is not within specification.

NOTE: Measure valve guide installed height from top of valve guide to cylinder head surface.

2. To replace valve guide, using hammer and Valve Guide Remover (49-B012-005), drive valve guide toward camshaft side of cylinder head. To install, assemble Valve Guide Installer Set (49-L012-004, 49-L012-003 and 49-L012-002).
3. Adjust valve guide installer so depth is set at specified distance for proper valve guide application. See **Fig. 33**. Adjust depth to .528-.551" (13.40-14.00 mm) for intake valve guide, or .469-.492" (11.90-12.50 mm) for exhaust valve guides.

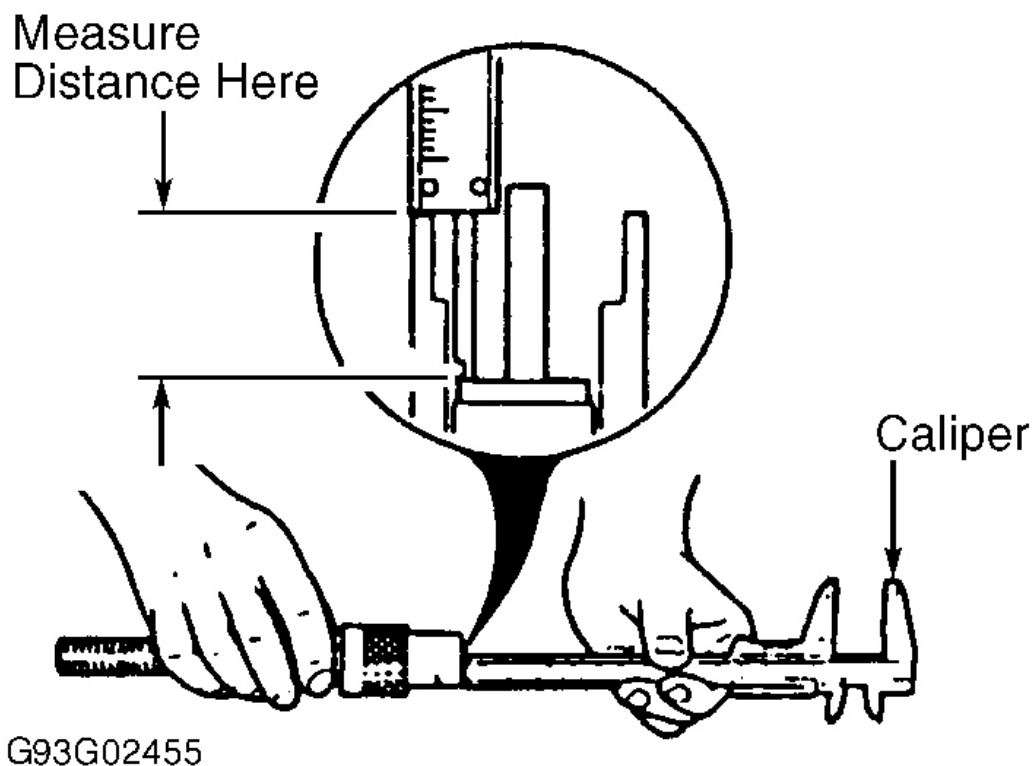


Fig. 33: Adjusting Valve Guide Installer
Courtesy of MAZDA MOTORS CORP.

4. Using hammer and valve guide installer, drive valve guide in from camshaft side of cylinder head until valve guide installer contacts cylinder head.
5. Ensure valve guide installed height is within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. If valve guide installed height is not within specification, readjust depth on valve guide installer and adjust valve guide installed height.

Valve Seat

Ensure valve seat angle and seat width are within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. Valve seat replacement information is not available from manufacturer.

Valve Seat Correction Angles

Use a 70- degree stone to lower exhaust valve seat and a 75-degree stone to lower intake valve seat contact area. Use 25-degree stone to raise exhaust valve seat, and a 35-degree stone to raise intake valve seat contact area.

Valves

1. Ensure valve length, stem diameter, head diameter and valve margin are within specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.
2. To check valve installed height, ensure valve is within minimum refinish length. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.
3. Install valve in cylinder head. Using caliper, measure valve protrusion from top of valve stem to spring seat on cylinder head. See **Fig. 34**. If valve stem protrusion is 1.709-1.728" (43.40-43.90 mm), valve and cylinder head can be used. If valve stem protrusion exceeds 1.732" (44.00 mm) replace cylinder head.

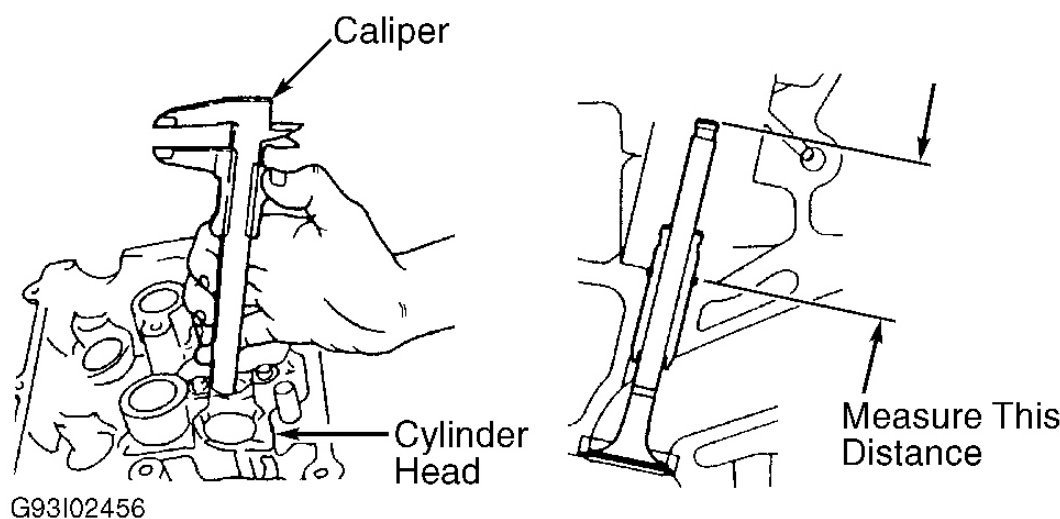


Fig. 34: Measuring Valve Installed Height
Courtesy of MAZDA MOTORS CORP.

TAPPET

Measure tappet outside diameter in 2 directions. Calculate oil clearance between tappet housing bore and tappet. Ensure tappet oil clearance is within specification. See **TAPPET** table under ENGINE SPECIFICATIONS. If oil clearance is not within specification, replace tappet or cylinder head as necessary.

CYLINDER BLOCK ASSEMBLY

Piston & Rod Assembly

1. Ensure piston, connecting rod and connecting rod cap are match marked for reassembly reference. Hold piston/rod assembly with connecting rod positioned horizontally. Pull connecting rod upward. Release connecting rod and ensure connecting rod drops freely. Replace piston or piston pin if connecting rod fails to drop freely.
2. To remove piston from connecting rod, remove piston pin clip from both ends of piston pin. Using Piston Pin Driver (49 T011 001) and hammer, remove piston pin.
3. Ensure piston pin diameter and pin-to-piston fit are within specification. See **PISTONS, PINS & RINGS**

table under ENGINE SPECIFICATIONS.

4. Ensure connecting rod bend, center-to-center length, crankpin bore and piston pin bore diameter are within specification. See **CONNECTING RODS** table under ENGINE SPECIFICATIONS.
5. To assemble piston on connecting rod, ensure front mark on top of piston ("L" or "R") and connecting rod are facing upward. Install piston clip in piston groove at one end of piston. Apply oil to piston pin. From opposite side of piston, install piston pin until it contacts clip on opposite side. It may be necessary to heat piston to ease installation of piston pin. Install 2nd clip in groove. Ensure connecting rod pivots freely.

Fitting Pistons

1. Measure piston skirt at 90-degree angle to piston pin 1.12" (28.5 mm) below lowest piston ring groove. Measure cylinder bore diameter just below top of bore, at middle of cylinder bore and just above bottom of cylinder bore and record measurements.
2. If cylinder taper and out-of-round are NOT within specification, bore cylinder to next oversize. If cylinder taper and out of round are within specification, subtract piston diameter measurement from cylinder bore measurement to determine piston-to-cylinder clearance. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS. If piston-to-cylinder clearance is excessive, replace piston or bore cylinder to next oversize.

Piston Rings

Ensure piston ring end gap and side clearance are within specification. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS. Position piston ring gaps in proper areas. See **Fig. 35**.

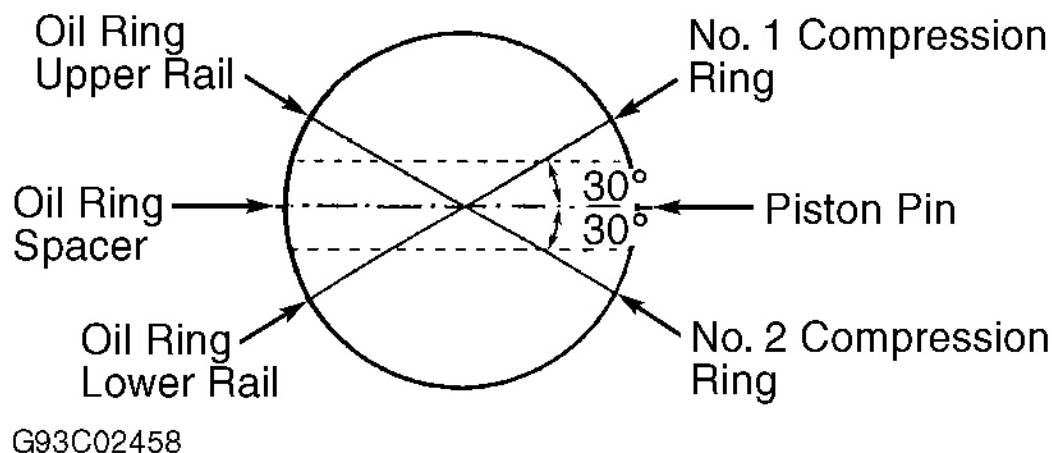


Fig. 35: Positioning Piston Rings
Courtesy of MAZDA MOTORS CORP.

Rod Bearings

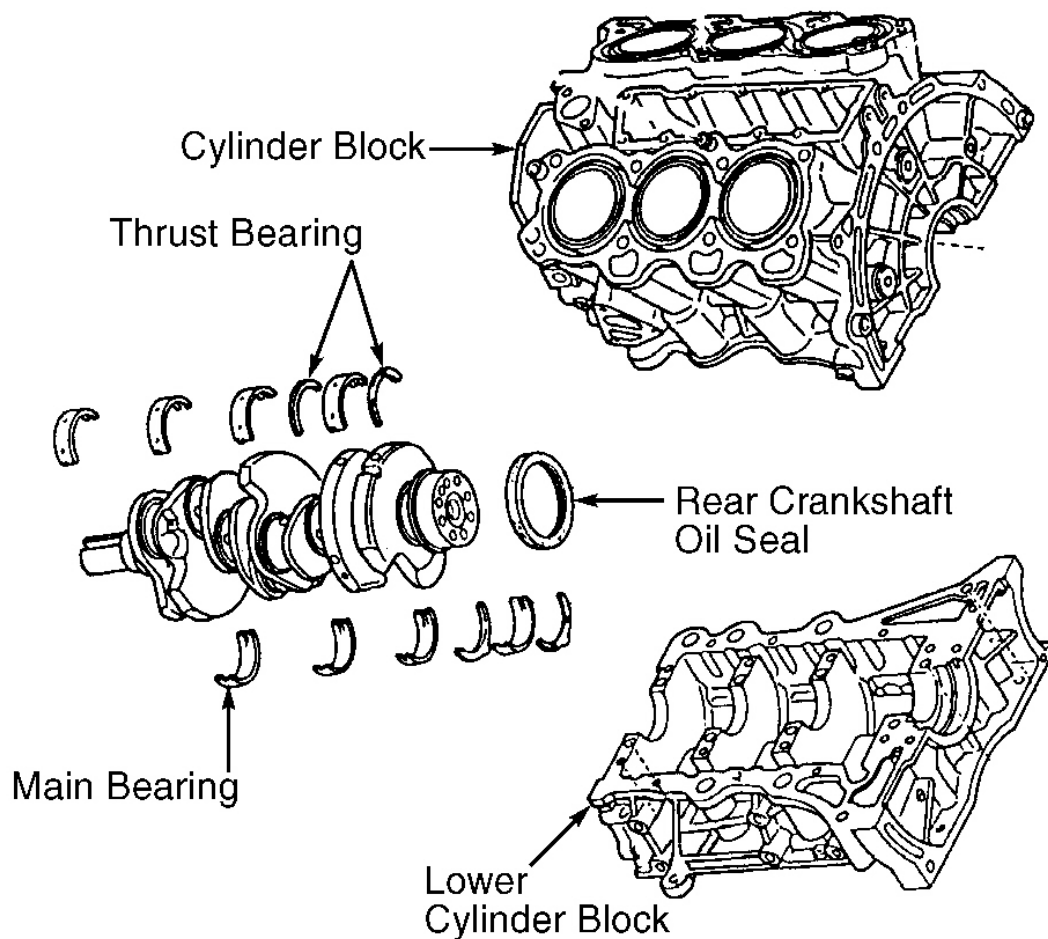
1. Ensure connecting rod and connecting rod cap are marked with matching cylinder number for reassembly reference. Install piston so front mark ("R" or "L") on top of piston is toward timing belt end of engine.
2. Measure connecting rod cap bolt length. Measurement is taken from contact surface of bolt head to tip of bolt shank. Replace bolt if measurement exceeds 1.889" (48.00 mm). Coat connecting rod bolt threads with engine oil before tightening to specification. Ensure bearing oil clearance and connecting rod side play are within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.

Crankshaft & Main Bearings

1. Before removing crankshaft, measure and record crankshaft end play. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS. If end play exceeds maximum, grind crankshaft thrust width to 1.214-1.215" (30.82-30.87 mm) or 1.224-1.225" (31.07-31.12 mm) and install .010" (.25 mm) or .020" (.50 mm) oversize thrust bearing. Note that cylinder block contains a lower cylinder block section. See **Fig. 36**. Loosen lower cylinder block bolts in sequence using several steps. See **Fig. 37**.

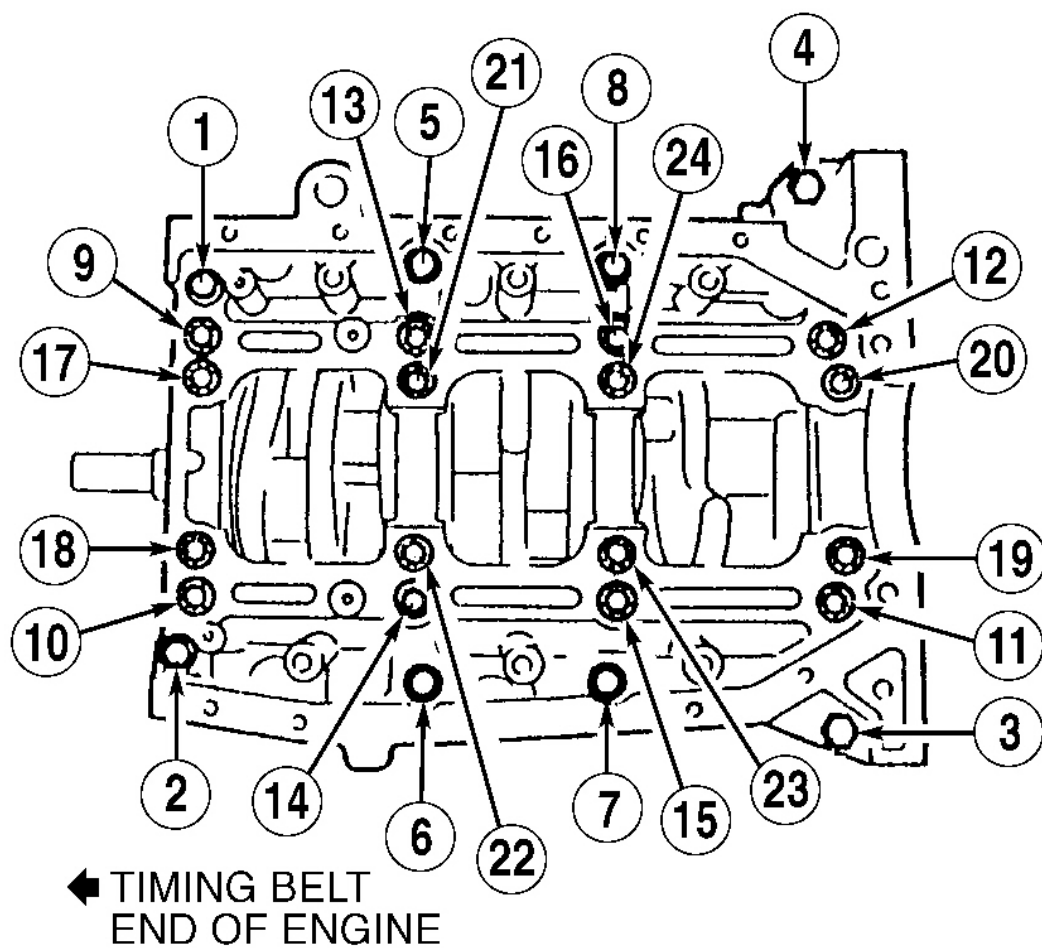
CAUTION: Do not pry on cylinder block except where indicated. See **Fig. 38**.
Note location and length of lower cylinder block bolts for reassembly reference. Bolts must be installed in proper location. See **Fig. 40**.

2. Remove lower cylinder block retaining bolts. To loosen lower cylinder block, tap on lower cylinder block while prying with a screwdriver at rear of cylinder block. See **Fig. 38**. Separate lower cylinder block from cylinder block.



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Fig. 36: Exploded View Of Cylinder Block, Crankshaft & Main Bearings
 Courtesy of MAZDA MOTORS CORP.



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Fig. 37: Loosening Lower Cylinder Block Bolts
Courtesy of MAZDA MOTORS CORP.

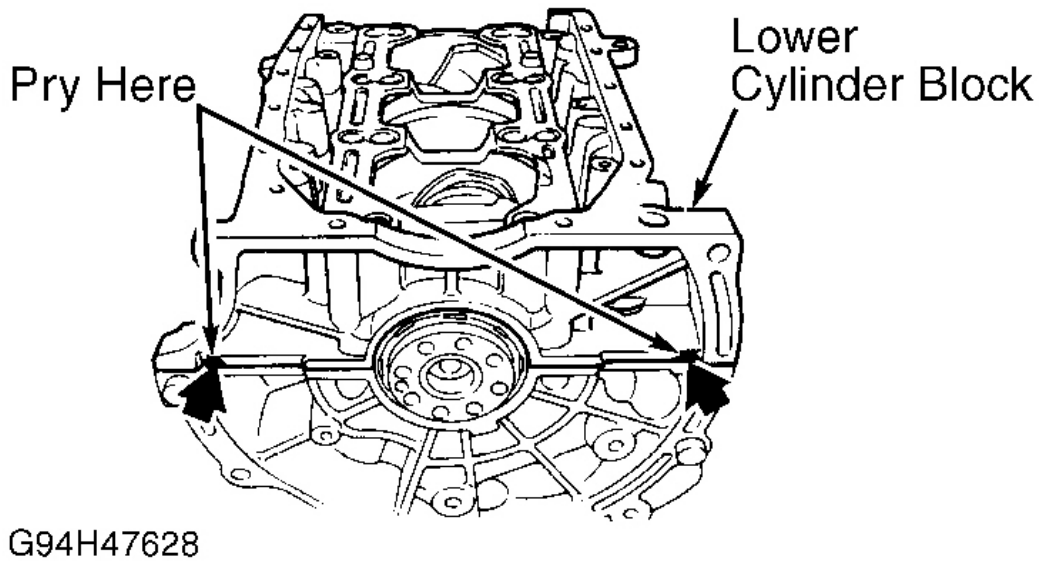


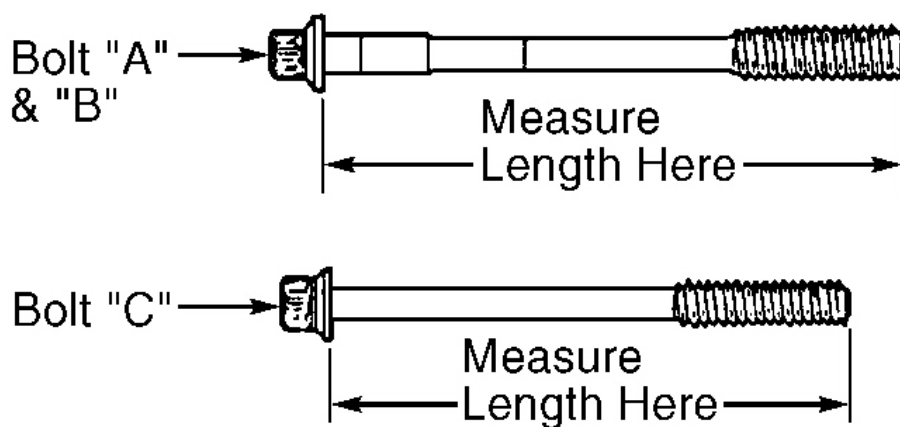
Fig. 38: Identifying Lower Cylinder Block Prying Areas
 Courtesy of MAZDA MOTORS CORP.

3. Measure lower cylinder block bolt length at specified areas on retaining bolts "A", "B" and "C". See **Fig. 39**. Replace bolts if not within specification. See **LOWER CYLINDER BLOCK BOLT SPECIFICATIONS** table.

NOTE: Lower cylinder block bolts "A" have a No. 4 stamped on top of bolt head and bolts "B" are stamped with an "I". Bolts "C" are the shortest bolts. Bolts "D" are outer bolts.

LOWER CYLINDER BLOCK BOLT SPECIFICATIONS

Application	In. (mm)
Bolt "A" Length	
Standard	5.34-5.37 (135.7-136.3)
Maximum	5.45 (138.5)
Bolt "B" Length	
Standard	5.34-5.37 (135.7-136.3)
Maximum	5.45 (138.5)
Bolt "C" Length	
Standard	4.71-4.74 (119.7-120.3)
Maximum	4.76 (121.0)



NOTE: Bolt "A" has a No. 4 stamped on the head and bolt "B" has an "I" on the head. Bolt "C" is the shortest bolt.

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Fig. 39: Measuring Lower Cylinder Block Bolts
Courtesy of MAZDA MOTORS CORP.

4. Ensure crankshaft journal diameter, taper and out-of-round are within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.

CAUTION: DO NOT remove fillet roll on crankshaft journals when grinding journals for undersize bearings.

5. Crankshaft journals can be ground for .010" (.25 mm) undersize bearings if diameter is not within specification. Grind crankshaft rod journals to 2.0745-2.0749" (52.690-52.705 mm). Grind main bearing journals to 2.4287-2.4293" (61.688-61.705 mm) for undersize bearings.
6. To check oil clearance, install upper main and thrust bearings in cylinder block. Rear (No. 4) main bearing is wider than all other main bearings. Install lower main and thrust bearings, and lower cylinder block.
7. Coat lower cylinder block bolt threads and bolt-to-lower cylinder block surface with engine oil. Install bolts "A", "B" and "C" in proper location on cylinder block. See **Fig. 40**.

NOTE: Manufacturer does not require lower cylinder block bolts "D" to be installed when checking oil clearance.

8. Tighten bolts to specification in sequence using several steps. Perform STEPS 1 and 2 of illustration. See **Fig. 40**. Measure inside diameter of main bearings on front and rear main bearings. Subtract crankshaft main journal diameter from main bearing inside diameter to determine oil clearance.
9. Ensure crankshaft main bearing oil clearance is within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.
10. Crankshaft main journals can be ground for .010" (.25 mm) undersize bearings if oil clearance is not within specification.

CAUTION: DO NOT remove fillet roll on crankshaft journals when grinding journals for undersize bearings.

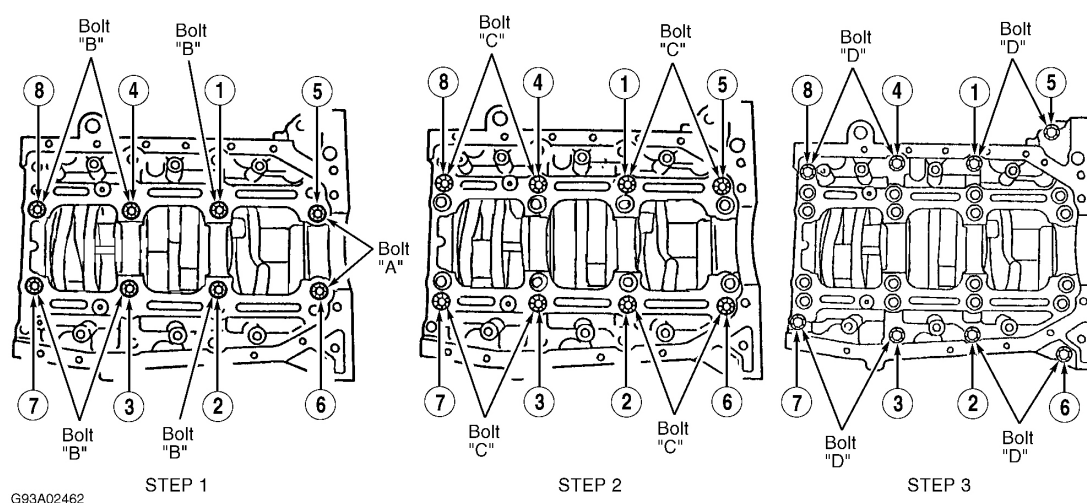
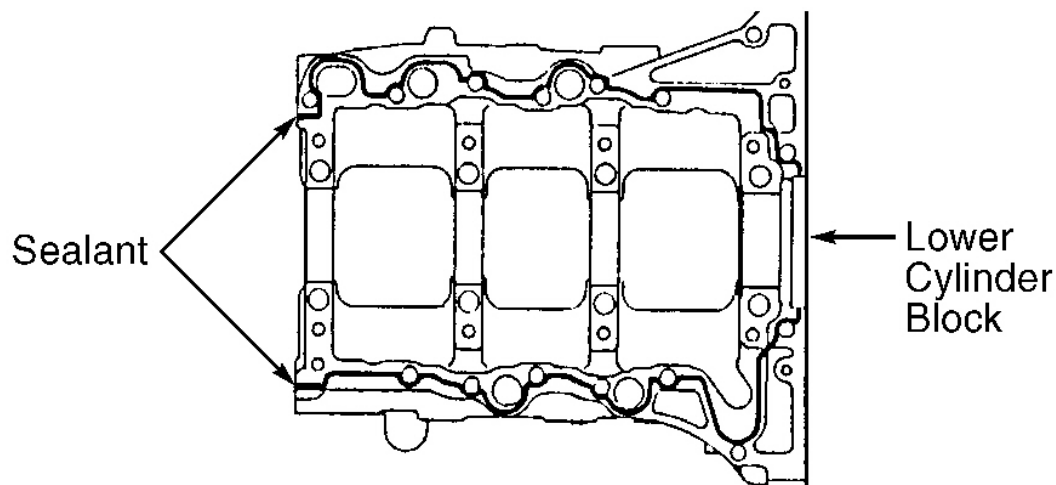


Fig. 40: Identifying Lower Cylinder Block Bolt Location & Installation Sequence
Courtesy of MAZDA MOTORS CORP.

11. When performing final installation of crankshaft, ensure oil jet is installed in cylinder block. See **OIL JET** under ENGINE OILING. Install main and thrust bearings in cylinder block and in lower cylinder block. Rear (No. 4) main bearing is wider than all other main bearings.

CAUTION: Ensure thrust bearing is installed on rear (No. 4) main bearing with oil groove facing inward.

12. Coat all bearings and crankshaft journals with engine oil. Install crankshaft. Ensure lower cylinder block and cylinder block sealing surfaces are clean. Apply sealant on cylinder block in specified areas. See **Fig. 41**. DO NOT allow sealant to enter bolt holes.
13. Install lower cylinder block. Coat lower cylinder block bolt threads with engine oil. Install bolts in proper location on cylinder block. Tighten bolts to specification in sequence using several steps. See **Fig. 40**. Ensure crankshaft end play is within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS. Replace thrust bearing if end play is not within specification.



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Fig. 41: Applying Sealant On Lower Cylinder Block
 Courtesy of MAZDA MOTORS CORP.

Thrust Bearing

Install thrust bearing on rear (No. 4) main bearing, with grooves facing toward crankshaft (away from cylinder block). Replace thrust bearing if crankshaft end play is not within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.

Cylinder Block

1. Inspect cylinder block deck surface warpage. Replace cylinder block if deck warpage exceeds specification. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS.
2. Measure cylinder bore diameter just below top of bore, at middle of cylinder bore and just above bottom of cylinder bore. Ensure cylinder bore diameter, taper and out-of-round are within specification. If cylinder bore diameter, taper or out-of-round exceeds specification, bore cylinder to nearest oversize. Cylinder block can be bored for .010" (.25 mm) or .020" (.50 mm) oversize pistons.

ENGINE OILING

ENGINE LUBRICATION SYSTEM

The crankshaft driven oil pump provides pressurized lubrication for engine lubrication.

Crankcase Capacity

Crankcase capacity is 5.2 qts. (4.9L) after engine overhaul. Oil capacity with oil filter is 4.2 qts. (4.0L).

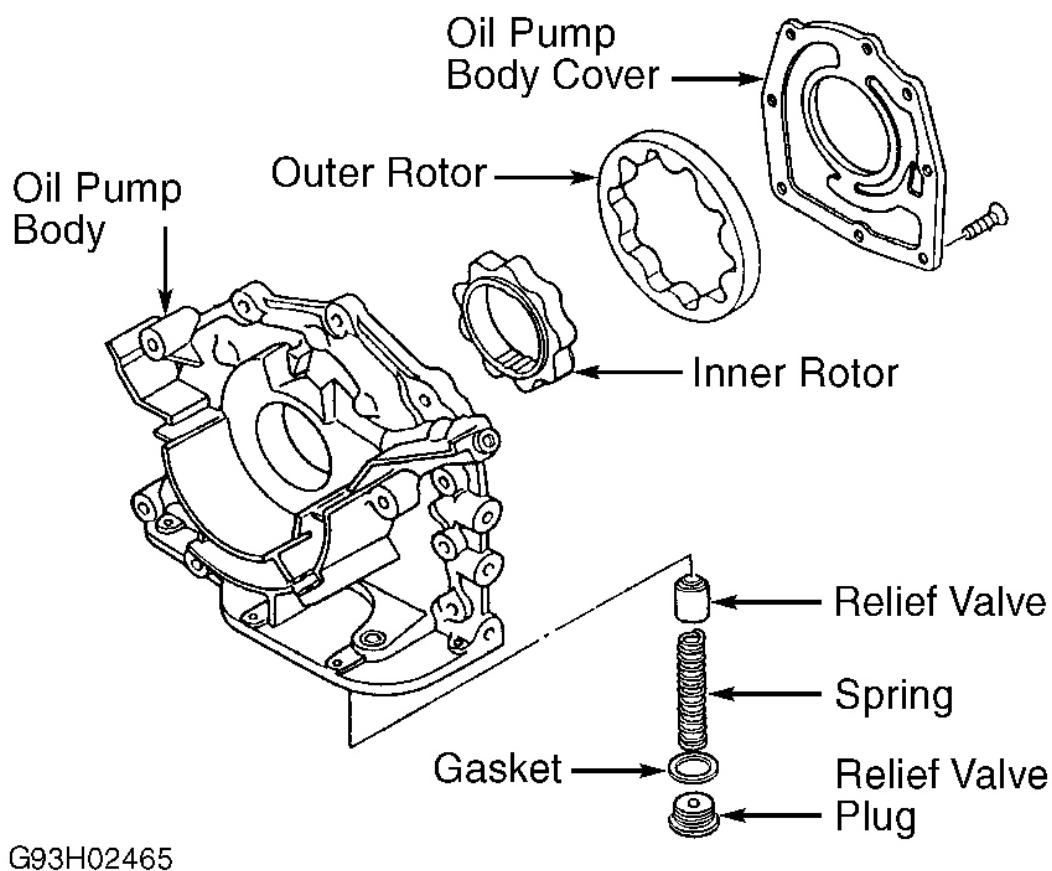
Oil Pressure

Inspect oil pressure at gallery above oil filter. With engine at normal operating temperature, oil pressure should be 44-66 psi (3.1-4.7 kg/cm²) at 3000 RPM.

OIL PUMP

Removal & Disassembly

Remove oil pan. See **OIL PAN** under REMOVAL & INSTALLATION. Remove oil pump pick-up tube and baffle plate. Remove retaining bolts, oil pump and "O" ring. Remove oil pump body cover and oil pump components. See **Fig. 42**.



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Fig. 42: Exploded View Of Oil Pump
Courtesy of MAZDA MOTORS CORP.

Inspection

1. Inspect components for damage. Ensure relief valve slides freely in bore. Install inner and outer rotors in

oil pump body. Using feeler gauge, measure clearance between outer rotor and oil pump body. See **OIL PUMP SPECIFICATIONS** table.

2. Measure rotor tip clearance between tips of both rotors. Place straightedge across oil pump body, above both rotors. Measure rotor end clearance between straightedge and rotor surface. Replace rotor assembly or oil pump body if any measurement exceeds specification.
3. Measure free length of spring for relief valve. Replace spring if free length is not 1.842" (46.79 mm).

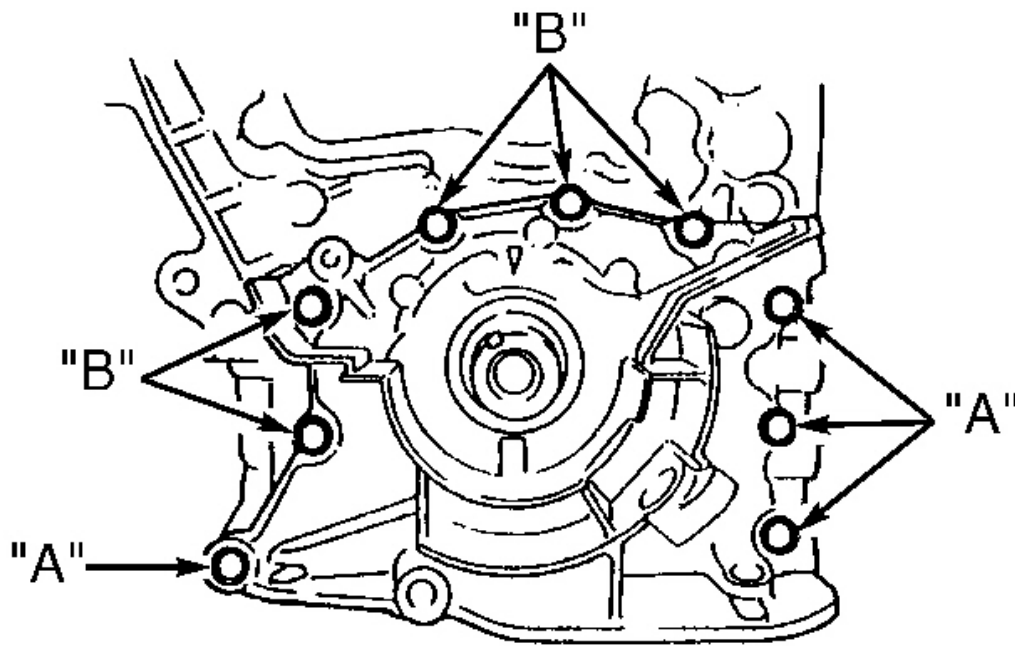
OIL PUMP SPECIFICATIONS

Application	In. (mm)
Outer Rotor-To-Body Clearance	.0045-.0087 (.113-.220) Maximum
Rotor End Clearance	.0051 (.130) Maximum
Rotor Tip Clearance	.0079 (.200) Maximum

Reassembly & Installation

1. To reassemble, coat rotors with engine oil. Install rotors in oil pump body. Ensure reference marks (dots) on rotors face outside of oil pump body (toward oil pump cover) and are aligned at top of oil pump body.
2. Install oil pump body cover, and tighten bolts to specification. See **TORQUE SPECIFICATIONS**. Install relief valve, spring, NEW gasket and relief valve plug. Tighten relief valve plug to specification.
3. Install crankshaft front seal (if removed) until seal surface is even with oil pump body. Coat seal lip with grease. To install, apply sealant on rear of oil pump. Coat NEW "O" ring with oil and install on rear of oil pump. Install oil pump. Ensure splined teeth on rotor of oil pump engages with splines on crankshaft.
4. Install proper length bolts in designated locations. See **Fig. 43**. Install baffle plate and retaining bolts. Tighten retaining bolts to specification. Install gasket and pick-up tube. To install remaining components, reverse removal procedure. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS**.

CAUTION: Before installing oil pan bolts, ensure oil pan bolts and cylinder block bolt holes are free of sealant. Cylinder block may be cracked if bolts are installed with old sealant.



Bolt "A" Length - 1.57" (40.0 mm)

Bolt "B" Length - .98" (25.0 mm)

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Fig. 43: Identifying Oil Pump Bolt Length & Location

Courtesy of MAZDA MOTORS CORP.

OIL COOLER

Removal & Installation

1. Disconnect negative battery cable. Drain cooling system. Disconnect coolant hoses from oil cooler. Remove oil filter and cooler hose. Remove insulator. Remove oil cooler.
2. To install, reverse removal procedure. Tighten retaining nut to specification. See **TORQUE SPECIFICATIONS**. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING** under REMOVAL & INSTALLATION.

OIL JET

Removal & Installation

1. With crankshaft and main bearings removed, remove oil jet from cylinder block main bearing bore. See **Fig. 44**.
2. Ensure threads on oil jet and cylinder block are clean. Apply thread sealant on oil jet threads. Install oil jet and tighten to specification. See **TORQUE SPECIFICATIONS**.

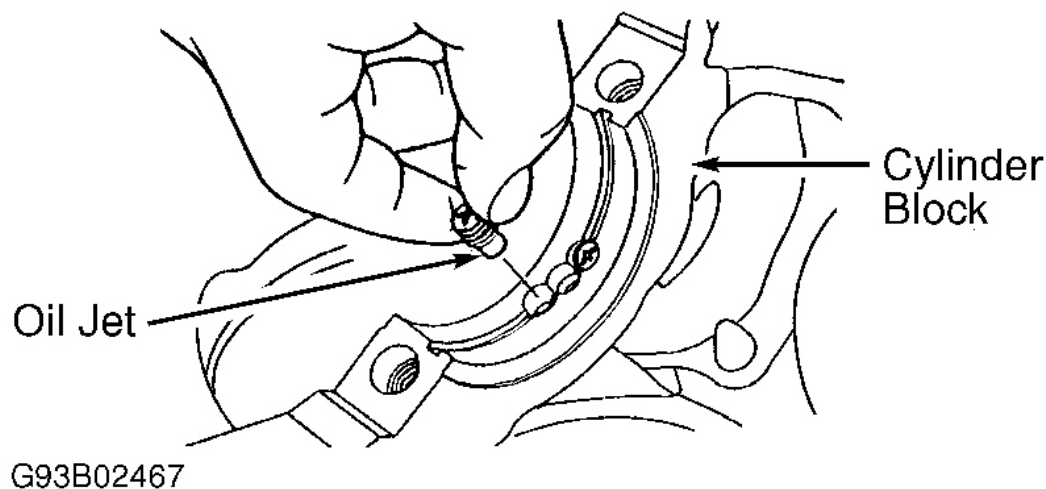


Fig. 44: Identifying Oil Jet

Courtesy of MAZDA MOTORS CORP.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Axle Shaft Bracket-To-Cylinder Block Bolt	31-46 (42-62)
Baffle Plate Bolt	14-18 (19-25)
Camshaft Position Sensor	14-18 (19-25)
Camshaft Sprocket Bolt	91-103 (123-140)
Connecting Rod Bolt	
Step 1	16-20 (22-27)
Step 2	Additional 83-97 Degrees
Coolant Outlet Bolt	14-18 (19-25)
Crankshaft Pulley Bolt	116-122 (157-166)
Cylinder Head Bolt ⁽¹⁾	
Step 1	17-19 (23-26)
Step 2	Additional 85-95

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	Degrees
Step 3	Additional 85-95 Degrees
Drain Plug	22-30 (30-41)
Engine Mount Bracket Above Water Pump-To-Cylinder Block Bolt	32-44 (44-60)
Engine Mount Crossmember Retaining Bolt/Nut	50-68 (67-93)
Engine Mount-To-Engine Mount Crossmember Nut	55-77 (75-104)
Engine Mount-To-Transaxle Case Nut	27-38 (37-52)
Engine-To-Transaxle Case Bolt	50-73 (68-99)
Exhaust Manifold Bolt/Nut	12-16 (16-22)
Flexplate Bolt	45-49 (61-67)
Friction Gear Nut	51-58 (69-79)
Front Exhaust Pipe-To-Exhaust Manifold Nut	28-38 (38-51)
Front Suspension Crossmember Bolt	69-93 (94-126)
Fuel Rail Bolt	14-18 (19-25)
Generator Bolt	12-16 (16-22)
Generator Bracket	28-38 (38-51)
Intake Manifold Bolt/Nut	14-18 (19-25)
Joint Shaft Bolt	32-45 (43-61)
Knock Sensor	14-25 (19-34)
Lower Control Arm Ball Joint	
Bolt	58-86 (79-116)
Nut	41-59 (55-80)
Lower Cylinder Block Bolt ⁽²⁾	
Bolt "A"	
Step 1	17-19 (23-26)
Step 2	Additional 75-85 Degrees
Bolt "B"	
Step 1	17-19 (23-26)
Step 2	Additional 65-75 Degrees
Bolt "C"	
Step 1	13-16 (18-22)
Step 2	Additional 55-65 Degrees
Bolt "D"	14-18 (19-25)
Lysholm Compressor Bracket	14-18 (19-25)
No. 1 Idler Pulley Bolt	28-38 (38-51)
No. 2 Idler Pulley Bolt	28-38 (38-51)
Oil Cooler-To-Oil Filter Adapter Nut	19-25 (25-34)

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Oil Pan Bolt	
Long Bolt	14-18 (19-25)
Short Bolt	(3)
Oil Pressure Switch	9-13 (12-17)
Oil Pump Bolt	14-18 (19-25)
Power Steering Pump Bracket Bolt	(4)
Power Steering Pump Pulley Nut	37-43 (50-58)
Relief Valve Plug	42-50 (57-68)
Right (Timing Belt Side) Engine Mount	
Nut	55-75 (74-102)
Through-Bolt	63-86 (86-116)
Selector Cable Nut	12-14 (16-19)
Shift Rod-To-Transaxle Bolt (M/T)	12-17 (16-23)
Spark Plug	11-17 (15-23)
Stabilizer Bar Link Nut	32-45 (43-61)
Stabilizer Rod-To-Transaxle Bolt (M/T)	23-34 (31-46)
Starter-To-Transaxle Case Bolt	27-38 (37-52)
Tensioner Pulley Bolt	28-32 (38-44)
Throttle Body Bolt/Nut	14-18 (19-25)
Tie Rod End Nut	31-42 (42-57)
Timing Belt Tensioner Bolt	14-18 (19-25)
Transaxle Mount & Bracket Bolt/Nut	50-68 (68-92)
Vacuum Pump	16-22 (22-30)
Water Pump Bolt	14-18 (19-25)
Wheel Lug Nut	65-87 (88-118)
INCH Lbs. (N.m)	
Air Cooler/Duct Bolts	69.5-95.4 (7.9-10.7)
Air Pipe-To-Intake Manifold Bolt	71-97 (8-11)
Camshaft Bearing Cap Bolt ⁽⁵⁾	97-124 (11-14)
Crankshaft Position Sensor Bracket Bolt	71-97 (8-11)
Cylinder Block Valley Cover Bolt	71-97 (8-11)
Fuel Injector Retainer Bolt	18-35 (2-4)
Ignition Coil	40-57 (4.6-6.4)
Oil Jet	27-45 (3-5)
Oil Pump Body Cover Bolt	54-80 (6-9)
Oil Strainer Bolts	69.5-95.4 (7.9-10.7)
Pick-Up Tube Bolt	71-97 (8-11)
Pressure Regulator Bolt	62-89 (7-10)
Seal Plate Bolt	71-97 (8-11)
Timing Belt Cover Bolt	71-97 (8-11)
	44-80 (5-9)

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Valve Cover Bolt ⁽⁶⁾	
Water Pump Pulley Bolt	69.5-95.4 (7.9-10.7)
<p>(1) Tighten bolts to specification in sequence. See Fig. 13.</p> <p>(2) Identify bolts and tighten bolts to specification in proper sequence. See Fig. 40.</p> <p>(3) Tighten bolts to 69.5-95.4 INCH lbs. (8-10.7 N.m).</p> <p>(4) Tighten 2 upper bolts on front of bracket to 23-34 ft. lbs. (31-46 N.m). Tighten lower bolt on front of bracket to 14-19 ft. lbs. (19-26 N.m). Tighten bolt on rear of bracket-to-cylinder block to 24-33 ft. lbs. (32-45 N.m)</p> <p>(5) Tighten bolts to specification in sequence. See Fig. 27.</p> <p>(6) Tighten bolts to specification in sequence. See Fig. 16.</p>	

ENGINE SPECIFICATIONS**GENERAL SPECIFICATIONS****GENERAL SPECIFICATIONS**

Application	Specification
Displacement	137 Cu. In. (2.3L)
Bore	3.16" (80.3 mm)
Stroke	2.92" (74.2 mm)
Compression Ratio	10.0:1
Fuel System	MFI

CRANKSHAFT, MAIN BEARINGS & CONNECTING ROD BEARINGS SPECIFICATIONS**CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS**

Application	In. (mm)
Crankshaft	
End Play	
Standard	.0032-.0111 (.080-.282)
Maximum	.0126 (.320)
Maximum Runout	.0006 (.015)
Main Bearing Journals	
Journal Diameter	2.4385-2.4391 (61.938-61.955)
Journal Out-Of-Round	.0016 (.04)
Oil Clearance	
Standard	.0015-.0022 (.037-.057)
Maximum	.0025 (.064)
Connecting Rod Journals	

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Journal Diameter	2.0843-2.0848 (52.940-52.955)
Journal Out-Of-Round	.0012 (.030)
Oil Clearance	
Standard	.0010-.1290 (.023-.043)
Maximum	.0031 (.080)

CONNECTING RODS SPECIFICATIONS**CONNECTING RODS**

Application	In. (mm)
Pin Bore Diameter	.8269-.8273 (21.003-21.014)
Crankpin Bore Diameter	2.2047-2.2053 (56.000-56.015)
Center-To-Center Length	5.425-5.429 (137.80-137.90)
Maximum Bend	.002 Per 1.969 (.05 Per 50.01)
Side Play	
Standard	.0071-.129 (.178-.330)
Maximum	.015 (.40)

PISTONS, PISTON PINS & PISTON RINGS SPECIFICATIONS**PISTONS, PINS & RINGS**

Application	In. (mm)
Pistons	
Clearance	
Standard	.0004-.0014 (.010-.036)
Maximum	.0044 (.112)
Diameter	3.1603-3.1615 (80.271-80.303)
Pin Bore Diameter	.8263-.8267 (20.988-21.000)
Pins	
Diameter	.8263-.8264 (20.987-20.993)
Piston Fit	.0004-.0010 (.8269-.8273)
Rod Fit (Interference Fit)	.005-.0013 (.0002-.0005)
Rings	
No. 1	
End Gap ⁽¹⁾	.006-.0098 (.15-.25)
Side Clearance ⁽²⁾	.0014-.0025 (.035-.065)
No. 2	
End Gap ⁽¹⁾	.009-.013 (.25-.35)
Side Clearance ⁽²⁾	.0012-.0025 (.030-.065)
No. 3 (Oil)	
End Gap ⁽¹⁾	.0079-.0275 (.20-.70)

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Side Clearance ⁽²⁾

.0028-.0062 (.07-.016)

(1) Maximum end gap is .040" (1.0 mm).

(2) Maximum side clearance is .006" (.15 mm).

CYLINDER BLOCK SPECIFICATIONS**CYLINDER BLOCK**

Application	In. (mm)
Cylinder Bore	
Standard Diameter	3.1615-3.1622 (80.300-80.322)
Maximum Taper	.0009 (.022)
Maximum Out-Of-Round	.0008 (.020)
Maximum Deck Warpage	.0059 (.15)

ENGINE VALVES & VALVE SPRINGS SPECIFICATIONS**VALVES & VALVE SPRINGS**

Application	Specification
Intake Valves	
Face Angle	45°
Head Diameter	1.253-1.265" (31.85-32.15 mm)
Margin	.306-.052" (.775-1.325 mm)
Valve Length	4.2386-4.2700" (107.66-108.46 mm)
Stem Diameter	
Standard	.2351-.2356" (5.970-5.985 mm)
Minimum	.2331" (5.920 mm)
Exhaust Valves	
Face Angle	45°
Head Diameter	1.080-1.092" (27.45-27.75 mm)
Margin	.054-.074" (1.355-1.905 mm)
Valve Length	4.2406-4.2720" (107.71-108.51 mm)
Minimum	3.7200" (94.49 mm)
Stem Diameter	
Standard	.2349-.2354" (5.965-5.980 mm)
Minimum	.2329" (5.915 mm)
Valve Springs	
Length @ 42-46 lbs. (187-205 N)	1.413" (35.90 mm)
Out-Of-Square	.062" (1.57 mm)

CYLINDER HEAD SPECIFICATIONS

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CYLINDER HEAD

Application	Specification
Cylinder Head Height ⁽¹⁾	
At Measurement "B"	5.031-5.035" (127.81-127.91 mm)
At Measurement "A"	5.743-5.747" (145.89-145.99 mm)
Maximum Warpage ⁽²⁾	
Cylinder Block Surface	.004" (.10 mm)
Manifold Surface	.006" (.15 mm)
Tappet Bore	1.1811-1.1820" (30.000-30.025 mm)
Valve Installed Height	
Standard	1.709" (43.4 mm)
Serviceable	1.709-1.728" (43.4-43.9 mm)
Valve Seats	
Intake Valve	
Seat Angle	45°
Seat Width	.031-.055" (.80-1.40 mm)
Exhaust Valve	
Seat Angle	45°
Seat Width	.031-.055" (.80-1.40 mm)
Valve Guides	
Intake Valve	
Valve Guide I.D.	.2366-.2374" (6.01-6.03 mm)
Valve Guide Installed Height	.528-.551" (13.4-14.0 mm)
Valve Stem-To-Guide Oil Clearance	
Standard	.0010-.0024" (.025-.060 mm)
Maximum	.008" (.20 mm)
Exhaust Valve	
Valve Guide I.D.	.2366-.2374" (6.01-6.03 mm)
Valve Guide Installed Height	.469-.492" (11.9-12.5 mm)
Valve Stem-To-Guide Oil Clearance	
Standard	.0012-.0026" (.030-.065 mm)
Maximum	.008" (.20 mm)
(1) See Fig. 31 .	
(2) DO NOT remove more than .006" (.15 mm) material from original surface of cylinder head.	

CAMSHAFT SPECIFICATIONS**CAMSHAFT**

Application	In. (mm)
End Play	.0020-.0039 (.05-.10)

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Journal Runout	.0008 (.020)
Journal Diameter ⁽¹⁾ (2)	
No. 1 Journal	
Left Exhaust Camshaft	
Standard	1.1802-1.1809 (29.975-29.995)
Minimum	1.1781 (29.925)
Left Intake Camshaft	
Standard	1.0213-1.0220 (25.940-25.960)
Minimum	1.0193 (25.890)
Right Exhaust Camshaft	
Standard	1.0213-1.0220 (25.904-25.960)
Minimum	1.0193 (25.890)
Right Intake Camshaft	
Standard	1.1801-1.1809 (29.975-29.995)
Minimum	1.1781 (29.925)
No. 2, 3 & 4 Journals	
Standard	1.0201-1.0208 (25.910-25.930)
Minimum	1.0181 (25.860)
No. 5 Journal	
Standard	1.0213-1.0220 (25.940-25.960)
Minimum	1.0193 (25.890)
Oil Clearance ⁽²⁾	
No. 1 & 5 Journals	
Standard	.0016-.0031 (.040-.081)
Maximum	.0047 (.120)
No. 2, 3 & 4 Journals	
Standard	.0028-.0043 (.070-.111)
Maximum	.0059 (.150)
Lobe Height	
Exhaust	1.6869 (42.847)
Intake	1.7179 (43.635)
(1) Left and right as viewed from rear of engine.	
(2) The No. 1 journal is timing belt end and No. 5 journal is flywheel end.	

TAPPET SPECIFICATIONS**TAPPET**

Application	In. (mm)
Oil Clearance	.0009-.0025 (.025-.066)