ENGINE

BMW - 2.5L, 2.8L & 3.2L

ENGINE IDENTIFICATION

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

ENGINE IDENTIFICATION CODES

Application	Code
2.5L & 2.8L	M52
3.2L	S52

REMOVAL & INSTALLATION

FUEL PRESSURE RELEASE

WARNING: ALWAYS relieve fuel pressure before disconnecting any fuel injection-related component. DO NOT allow fuel to contact engine or electrical components.

Fuel system pressure release procedure is not available from manufacturer. Disconnect negative terminal of fuel pump connector, under left rear side of vehicle. It may also be possible to remove fuel pump relay, start engine and run engine until fuel pressure drops (engine stalls).

On 3-series, fuel pump relay is located in fuse/relay block in left rear corner of engine compartment. On 5-series, fuel pump relay is located in right rear corner of engine compartment, next to DME control unit and DME master relay.

ENGINE

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.

NOTE: Remove transmission before removing engine. For vehicles with automatic transmissions, see TRANSMISSION REMOVAL & INSTALLATION article in TRANSMISSION SERVICING. For vehicles with manual transmissions, see RWD article in CLUTCHES.

Removal (3-Series)

1. Remove engine splash guard. Release hinge at hood, and prop hood open past center position. Disconnect negative battery cable. Battery is located in trunk.

2. Remove air cleaner/air mass sensor assembly. Pull off hoses for idle speed control valve and crankcase breather. Remove transmission.
3. Remove generator air intake duct. Remove side rivets, and pull out radiator cooling fan cowl. Using Pulley Holder (11-5-030) and 32-mm Wrench (11-5-040), turn cooling fan nut clockwise to remove cooling fan.
4. Drain engine coolant. Disconnect radiator hoses, coolant level switch and transmission oil cooler lines from radiator (if equipped). Disconnect A/C temperature switch from side of radiator. Remove clips and radiator.
5. Disconnect coolant hoses from heater control valve and heater at engine compartment firewall. Remove electrical lead along fresh air intake duct. Remove fresh air intake duct. Disconnect throttle cable, and pull out cable together with rubber retainer.
6. Disconnect vacuum hose from power brake booster. Remove oil filler cap and engine covers. See **Fig. 1**.

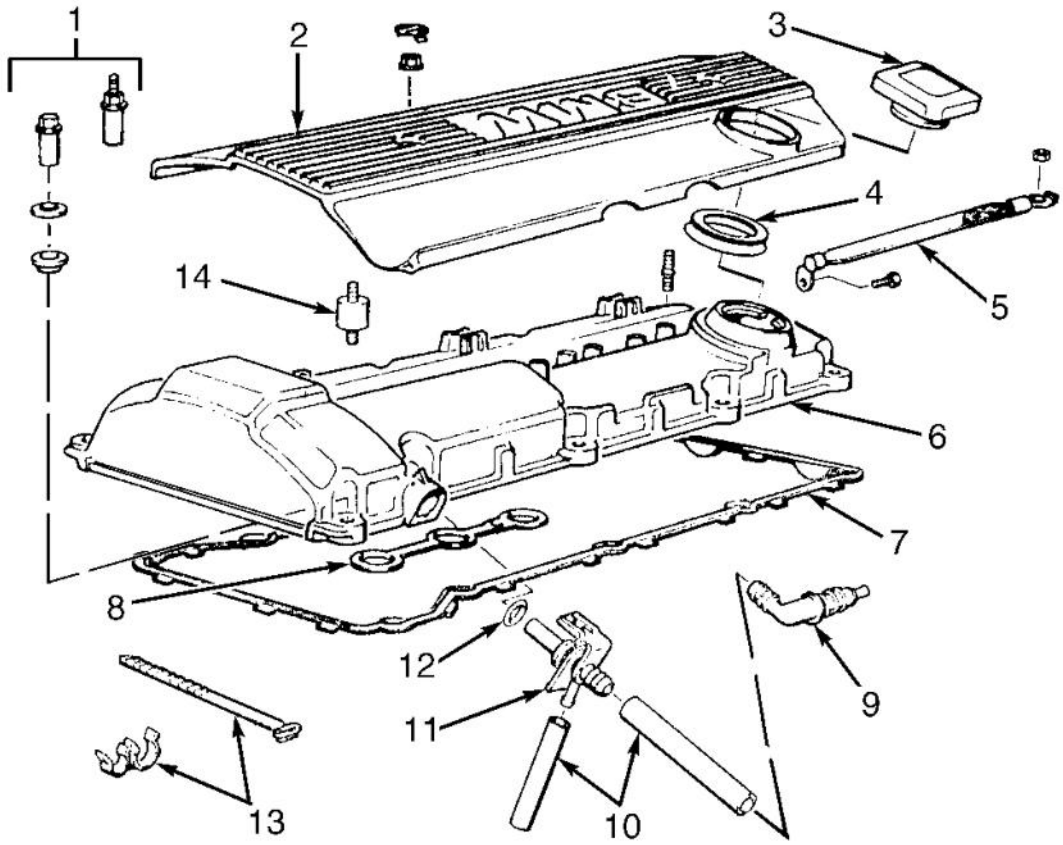


Fig. 1: Exploded View Of Engine Cover Assembly
Courtesy of BMW OF NORTH AMERICA, INC.

7. Remove ground strap from timing case cover. Remove ignition coil cover plate. Disconnect wiring from ignition coils, and remove plate together with wiring.
8. Detach hose at cylinder head breather vent. Disconnect wiring at air temperature sensor. Disconnect wiring, vacuum hoses and fuel lines at throttle body. Disconnect vacuum hose from idle speed control valve (on manifold).
9. Disconnect hoses from fuel lines at engine carrier. Remove support brackets for intake manifold. Remove intake manifold from cylinder head. Disconnect wiring from temperature gauge, temperature sensor, oil pressure switch and idle speed control valve.

10. Disconnect wiring from cylinder identifying sensor and DME pulse sensor. Disconnect wiring from starter and generator. Remove screws and wiring harness duct. Set wiring harness aside.
11. Note serpentine belt routing. Insert socket into drive belt tensioner bolt. Compress tensioner by slowly rotating socket clockwise, and remove drive belt.
12. Remove bolts and power steering pump from engine. DO NOT disconnect power steering lines. Remove bolts and power steering pump oil supply tank. Hang power steering pump and oil tank aside.
13. Insert socket into A/C compressor drive belt tensioner. Compress tensioner by slowly rotating socket clockwise, and remove A/C compressor drive belt. Remove 4 bolts and A/C compressor. DO NOT disconnect refrigerant lines.
14. Attach Engine Lifting Device (11-0-020) to engine lift points. Remove ground strap and right engine mount. Remove left engine mount nut. Remove engine from vehicle.

Installation

1. To install, reverse removal procedure. Ensure serpentine belt is correctly routed and properly seated in grooves. Turn 32-mm Wrench (11-5-040) counterclockwise, and tighten cooling fan nut. See TORQUE SPECIFICATIONS.
2. Fill and bleed cooling system. To do so, turn ignition on. Place A/C-heater controls on HEAT position to ensure heater valve is open. Add coolant to expansion tank. Run engine at 2500 RPM and add coolant to expansion tank as level drops.

Removal (5-Series)

1. Remove transmission. Remove engine splash guard. Disconnect battery cables, and remove battery. Remove battery tray.
2. Remove generator air intake duct. Disconnect wiring at air mass sensor. Remove air cleaner/airflow sensor assembly. Remove side rivets, and pull out radiator cooling fan cowl.
3. Using Pulley Holder (11-5-030) and 32-mm Wrench (11-5-040), turn cooling fan nut clockwise to remove cooling fan. Drain engine coolant. Plug is located on exhaust manifold side of engine block.
4. Disconnect radiator hoses, coolant level switch and transmission oil cooler lines (if equipped) from radiator. Remove trim next to radiator. Disconnect A/C temperature switch from side of radiator. Remove clips and radiator.
5. Disconnect coolant hoses from heater control valve and heater at engine compartment firewall. Remove nut, spacer and throttle cable cover. Disconnect throttle cable, and pull out cable together with rubber retainer.
6. Disconnect vacuum hose from power brake booster. Remove oil filler cap and engine covers. Remove ignition coil ground strap from timing case cover. Remove ignition coil cover plate. Disconnect wiring from ignition coils, and remove plate together with wiring.
7. Detach hose at cylinder head breather vent. Disconnect wiring at air temperature sensor. Disconnect wiring, vacuum hoses and fuel lines at throttle body. Disconnect throttle valve switch. Disconnect vacuum hose from idle speed control valve (on manifold).
8. Disconnect hoses from fuel lines at engine carrier. Remove intake manifold from cylinder head. Disconnect wiring from temperature gauge, temperature sensor, oil pressure switch and idle speed control valve.

9. Disconnect wiring from cylinder identifying sensor and DME pulse sensor. Detach connector, for oxygen sensor, from holder. Disconnect wiring from starter and generator. Remove bolts and wiring harness duct. Set wiring harness aside.
10. Note serpentine belt routing. Insert socket into drive belt tensioner bolt. Compress tensioner by slowly rotating socket clockwise, and remove drive belt.
11. Remove bolts and power steering pump from engine. DO NOT disconnect power steering lines. Remove bolts and power steering pump oil supply tank. Hang power steering pump and oil tank aside.
12. Insert socket into A/C compressor drive belt tensioner. Compress tensioner by slowly rotating socket clockwise, and remove A/C compressor drive belt. Remove A/C compressor. DO NOT disconnect refrigerant lines.
13. Attach Engine Lifting Device (11-0-020) to engine lift points. Remove ground strap and right engine mount. Remove left engine mount nut. Remove engine from vehicle.

Installation

1. To install, reverse removal procedure. Ensure serpentine belt is correctly routed and properly seated in grooves. Tighten cooling fan nut. See **TORQUE SPECIFICATIONS**.
2. Fill and bleed cooling system. To do so, add coolant to expansion tank and fill to level mark. Place A/C-heater control on WARM setting to ensure heater valve is open. Start and run engine at fast idle speed. Open bleed screw on expansion tank and continue to add coolant to expansion tank as coolant level drops. Tighten bleed screw as soon as coolant is free of air bubbles.

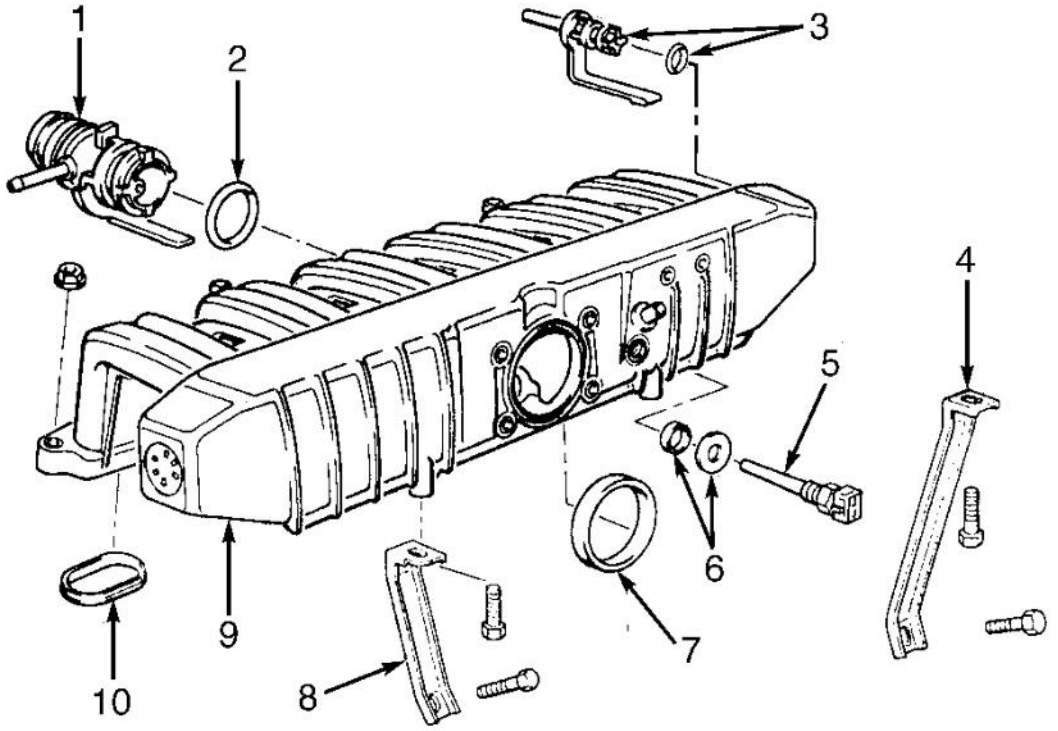
INTAKE MANIFOLD

Removal

1. Remove engine splash guard. On 3-series, release hinge at hood, and prop hood open past center position. On all models, disconnect negative battery cable. Battery is located in trunk of 3-series.
2. Remove air cleaner/air mass sensor assembly. Drain engine coolant. Disconnect coolant hoses from heater control valve and heater at engine compartment firewall.
3. On 3-series, remove generator air intake duct. Remove grille from fresh air intake duct, below wiper arms. Remove screws and electrical lead along fresh air intake duct. Remove right holder, left screw and fresh air intake duct.
4. On 5-series, remove nut, spacer and throttle cable cover. On all models, disconnect throttle cable, and pull out cable together with rubber retainer. Disconnect vacuum hose from power brake booster.
5. Remove oil filler cap, screw caps, screws and engine covers. See **Fig. 1**. If necessary, pull forward on cover and swing it out over oil filler neck. Remove ignition coil ground strap from timing case cover. Remove ignition coil cover plate. Disconnect wiring from ignition coils, and remove plate together with wiring.
6. Detach hose at cylinder head breather vent. Disconnect wiring at air temperature sensor. Disconnect wiring, vacuum hoses and fuel lines at throttle body.
7. Disconnect vacuum hose from idle speed control valve (on manifold). Disconnect hoses from fuel lines at engine carrier. On 3-series, remove support brackets for intake manifold. On all models, remove intake manifold from cylinder head. See **Fig. 2**.

Installation

To install, reverse removal procedure. Ensure no parts fall into intake ports. Replace oval intake manifold gasket. Fill and bleed cooling system.



1. Idle Speed Control Valve Connector
2. "O" Ring
3. Crankcase Breather & "O" Ring
4. Rear Bracket
5. Temperature Air Sensor
6. Gasket & Washer
7. Gasket
8. Front Bracket
9. Intake Manifold
10. Oval Gasket

G92C00572

Fig. 2: Exploded View Of Intake Manifold Assembly
Courtesy of BMW OF NORTH AMERICA, INC.

EXHAUST MANIFOLD

Removal & Installation

Remove exhaust manifold flange bolts. Remove exhaust manifold. To install, reverse removal procedure. Tighten nuts to specification. See **TORQUE SPECIFICATIONS**.

CYLINDER HEAD

Removal

1. Remove intake manifold. See **INTAKE MANIFOLD**. Remove thermostat housing. Disconnect wiring from ignition coils, and remove coils.
2. Remove cylinder head cover. Remove pulse sensor from side of cylinder head. Detach wiring harness duct above thermostat housing opening. Remove upper timing case cover and front engine lifting eye.
3. Pull off camshaft cover. With cylinder No. 1 coming up on TDC, turn crankshaft in normal direction of rotation until cylinder No. 1 intake and exhaust cam lobes face each other. Arrows on sprockets face up. Use TDC Aligning Plug (11-2-300) to hold crankshaft in TDC position.
4. Install Camshaft Locating Fixture (11-3-240) to cylinder head. See **Fig. 32** or **Fig. 3**. Press down on upper chain tensioner and hold in place using Holding Spring (11-3-290). See **Fig. 4**.
5. Remove oil line connector and electrical connector from Variable Camshaft Control (VANOS). See **Fig. 17**. Remove upper timing chain cover with VANOS assembly. See **Fig. 5**.
6. Remove camshaft sprocket nuts (intake) and bolts (exhaust). Remove intake sprocket thrust washer. Remove upper camshaft sprockets and upper timing chain.
7. Remove upper chain tensioner. Remove chain guide directly below front end of camshaft. Remove lower timing chain tensioner plug, spring and piston. Remove lower chain sprocket from exhaust camshaft and tie up lower timing chain.
8. Remove 2 bolts directly below front end of camshaft. Use E12 Torx Bit (11-2-250) to loosen cylinder head bolts in several steps, starting from outside bolts and working toward inside (center) bolts. Remove cylinder head.

NOTE: Some cylinder head washers are staked into position.

CAUTION: During cylinder head installation, wait recommended time to permit hydraulic cam followers to compress. Failure to wait recommended time may damage engine. See VALVE TRAIN SERVICING PRECAUTIONS.

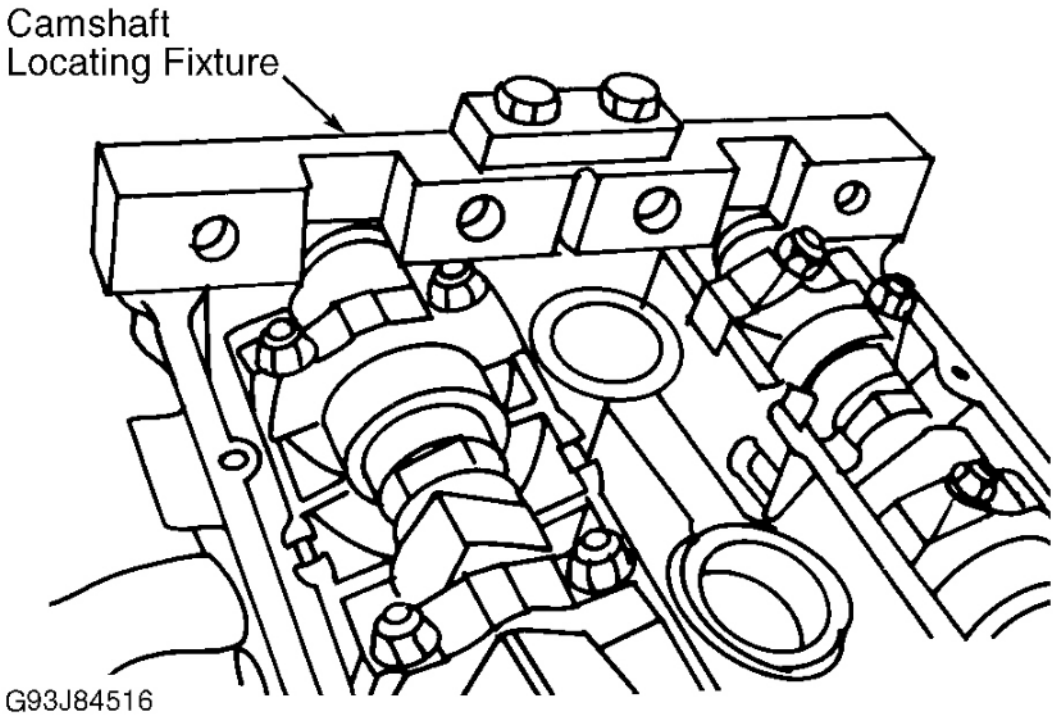


Fig. 3: Holding Camshafts At TDC
Courtesy of BMW OF NORTH AMERICA, INC.

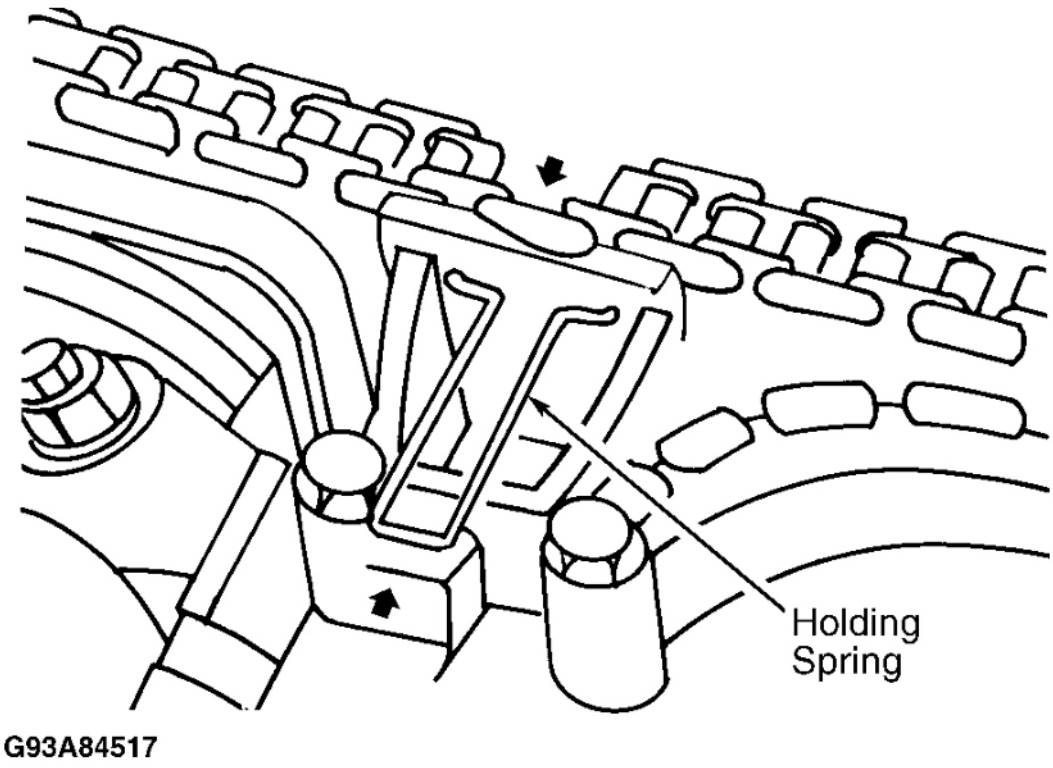


Fig. 4: Compressing Upper Timing Chain Tensioner
Courtesy of BMW OF NORTH AMERICA, INC.

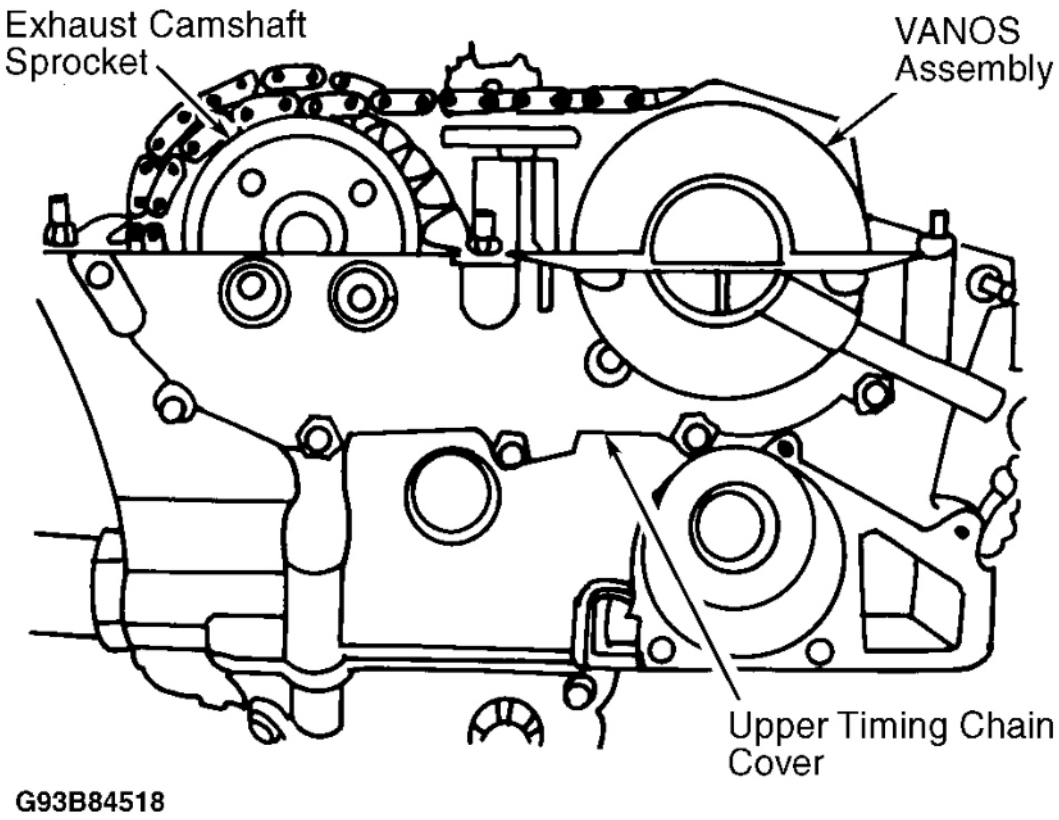


Fig. 5: Removing Upper Timing Chain Cover
Courtesy of BMW OF NORTH AMERICA, INC.

Installation

1. Ensure cylinder head dowels are installed and not damaged. Remove oil from head bolt threaded holes in cylinder block. Lubricate threads of NEW head bolts.

   NOTE: A .012" (0.3 mm) thicker cylinder head gasket is available for machined cylinder heads.

2. Install cylinder head gasket. Wait for hydraulic cam followers to compress. See **VALVE TRAIN SERVICING PRECAUTIONS**. Install cylinder head. Tighten NEW, lightly oiled cylinder head bolts. See **Fig. 6**. See **TORQUE SPECIFICATIONS**.

   NOTE: When installing a new cylinder head, also use NEW washers, but DO NOT stake them into place.

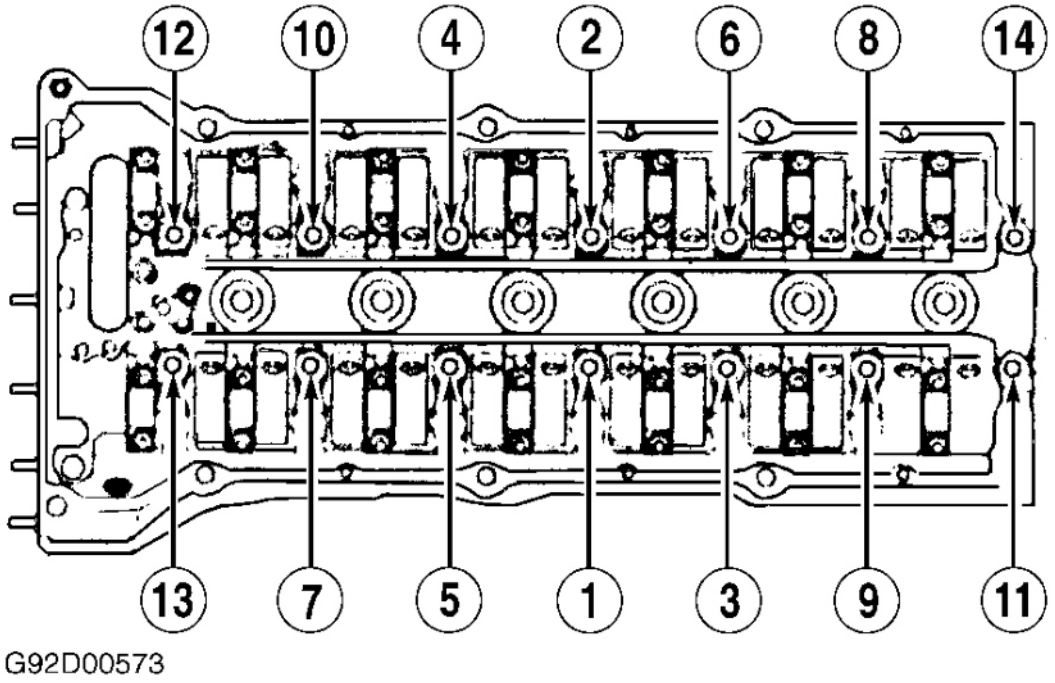


Fig. 6: Tightening Cylinder Head Bolts
Courtesy of BMW OF NORTH AMERICA, INC.

3. Ensure camshafts are aligned with Camshaft Locating Fixture (11-3-240). See **Fig. 32** or **Fig. 3**. Install lower timing chain on sprocket and install on exhaust camshaft.
4. Ensure arrow on exhaust camshaft sprocket is up and tapped holes are at left side of slots in sprocket. Finger tighten bolts.
5. Install Chain Adjusting Screw (11-3-390) to side of cylinder head. See **Fig. 7**. Tighten screw finger tight. Tapped holes in camshaft should now be centered in sprocket slots.

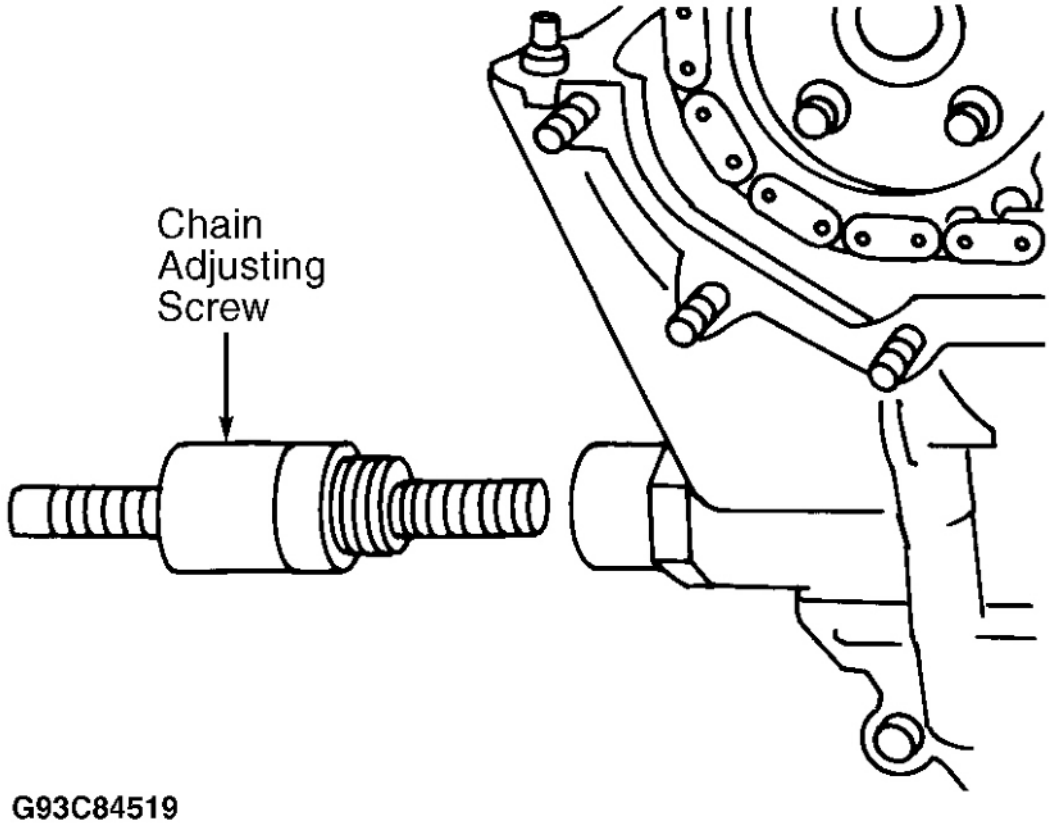


Fig. 7: View Of Chain Adjusting Screw
Courtesy of BMW OF NORTH AMERICA, INC.

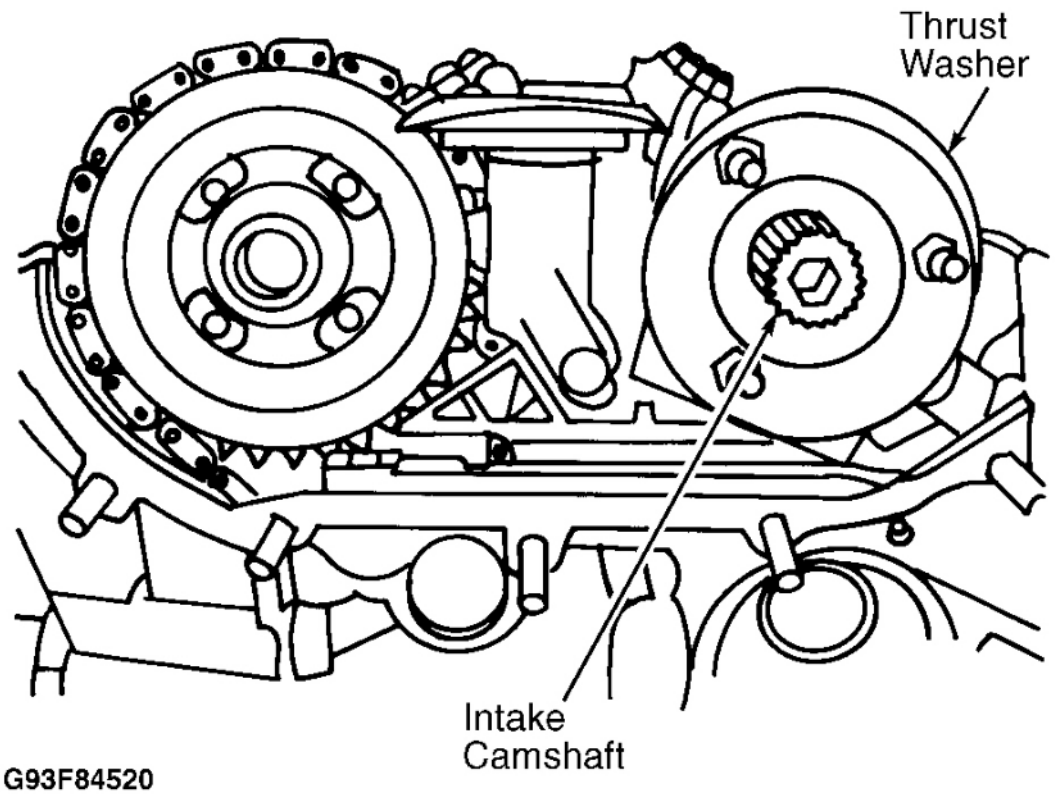


Fig. 8: Installing Thrust Washer To Intake Camshaft
Courtesy of BMW OF NORTH AMERICA, INC.

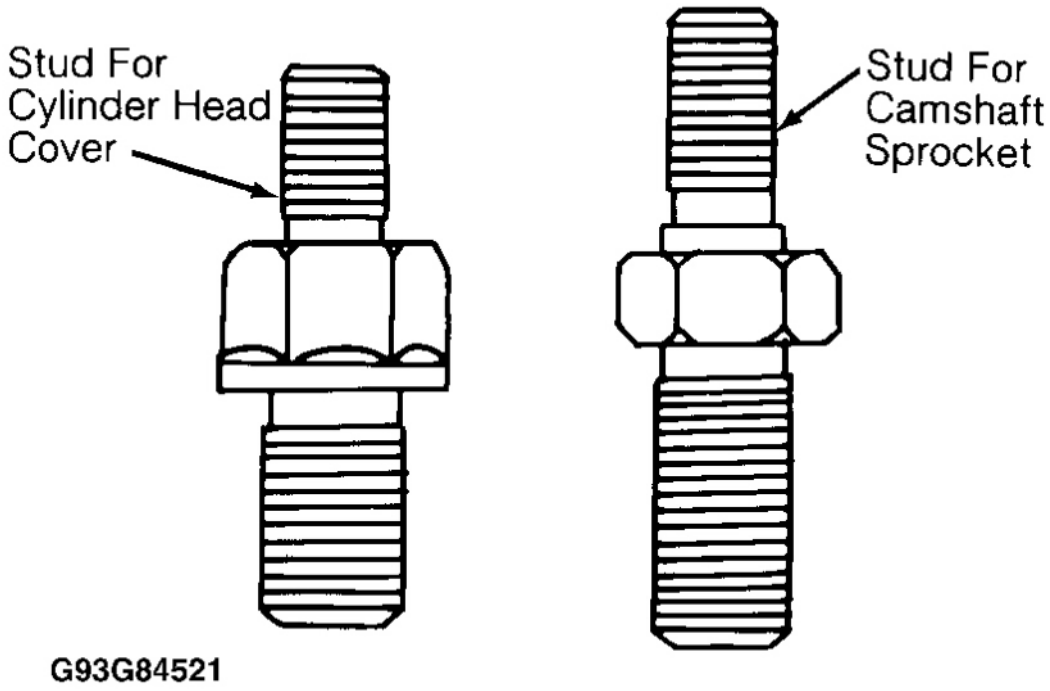


Fig. 9: View Of Camshaft Sprocket Stud & Cylinder Head Cover Stud
Courtesy of BMW OF NORTH AMERICA, INC.

6. Install chain guide and upper chain tensioner. Install intake pulse sensing wheel (if removed). Install thrust washer bolts to intake camshaft. DO NOT mix bolts for cylinder head cover and sprockets. See **Fig. 8** and **Fig. 9**.
7. Install upper timing chain and sprockets to camshafts. Ensure tapped camshaft holes are centered in sprocket slots. See **Fig. 10**. Install intake camshaft thrust washer and tighten nuts to specification. See **TORQUE SPECIFICATIONS**.
8. Install thrust washer on exhaust camshaft and tighten bolts finger tight. Turn both sprockets clockwise as far as possible. See **Fig. 11**. Push splined gear of VANOS housing as far as stop. See **Fig. 12**.
9. Apply Sealant (3-Bond 1209) to top corners of cylinder head. Install, but do not tighten, upper timing chain cover and VANOS assembly. See **Fig. 13**.
10. Turn VANOS splined shaft to engage splines on camshaft. Turn upper timing chain/sprockets counterclockwise until camshaft sprocket meshes with VANOS splined shaft. Push VANOS splined shaft into camshaft sprocket splines. See **Fig. 14**, **Fig. 15** and **Fig. 16**.

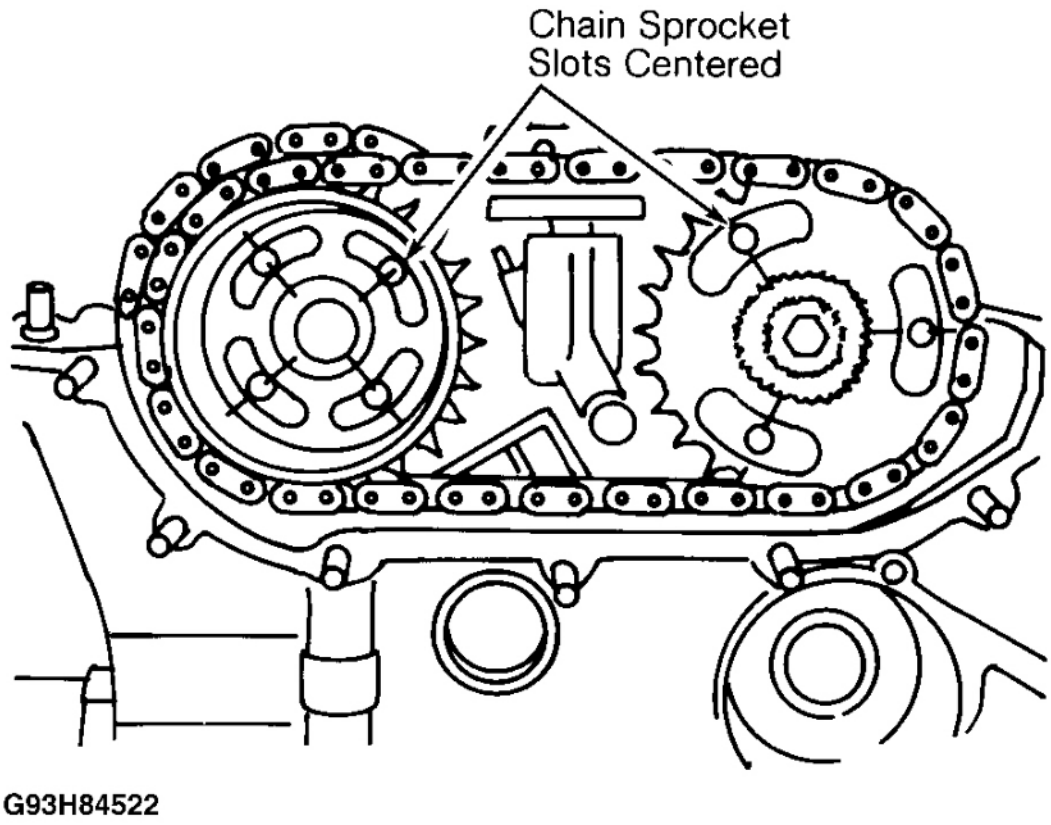


Fig. 10: Centering Chain Sprockets To Camshaft Holes
Courtesy of BMW OF NORTH AMERICA, INC.

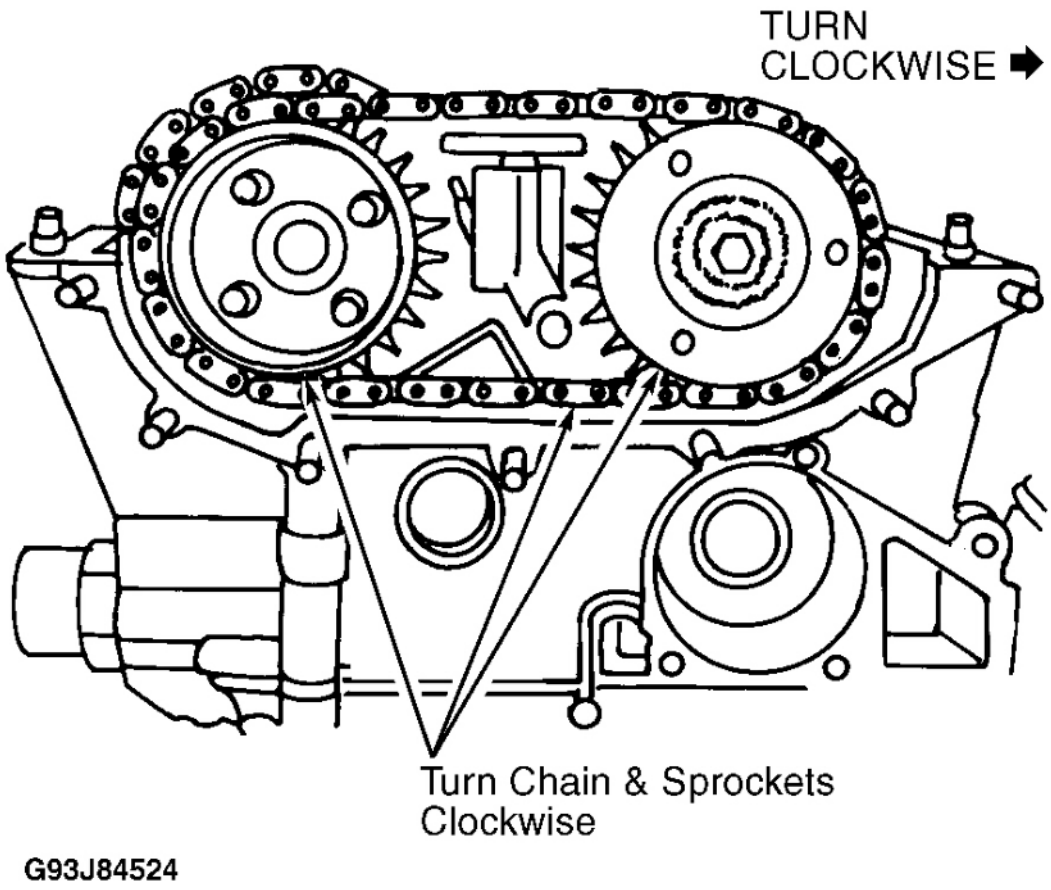


Fig. 11: Turning Sprockets & Chain
Courtesy of BMW OF NORTH AMERICA, INC.

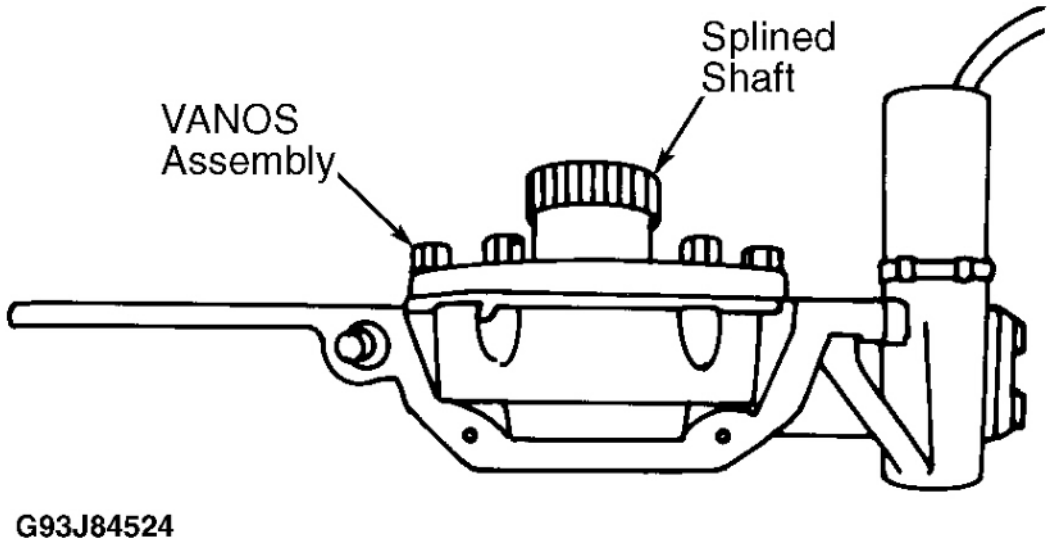


Fig. 12: Compressing Splined Shaft Into VANOS
Courtesy of BMW OF NORTH AMERICA, INC.

11. Tighten upper timing chain cover and VANOS assembly nuts. Remove Holding Spring (11-3-290) from upper chain tensioner. See **Fig. 4**. Tighten Chain Adjusting Screw (11-3-390) and camshaft sprocket bolts to specification. See **TORQUE SPECIFICATIONS**.
12. Remove Chain Adjusting Screw (11-3-390). See **Fig. 7**. Install timing chain tensioner with groove in piston perpendicular to tensioner rail. Remove TDC Aligning Plug (11-2-300) and Camshaft LocatingFixture (11-3-240) from engine.

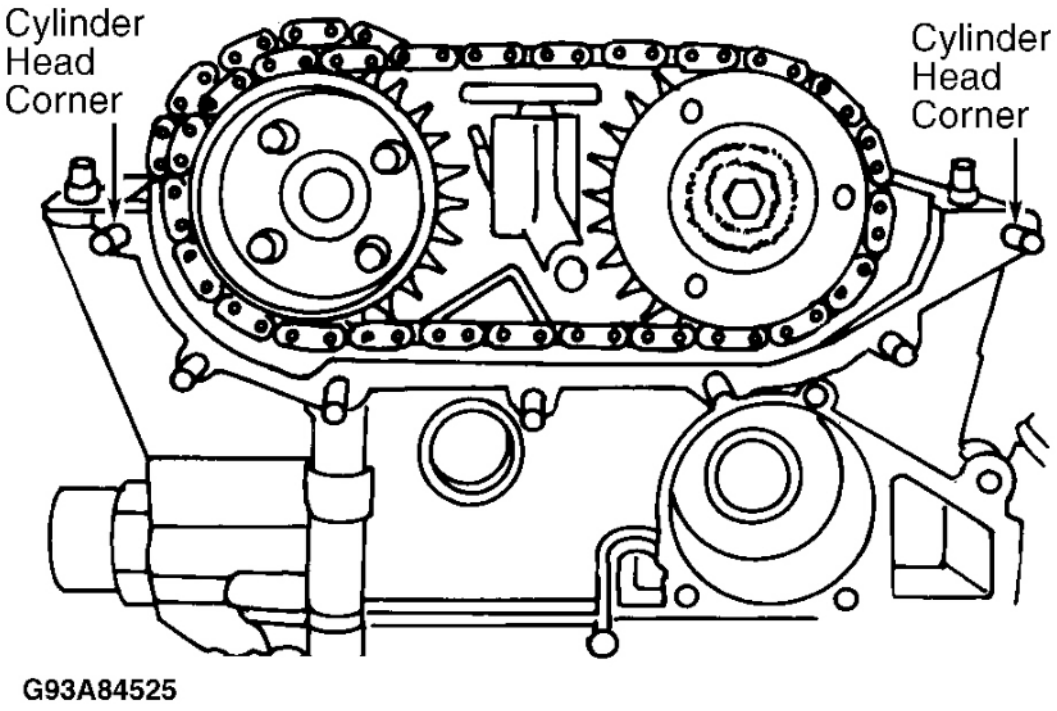


Fig. 13: Apply Sealant To Top Corners Of Cylinder Head
Courtesy of BMW OF NORTH AMERICA, INC.

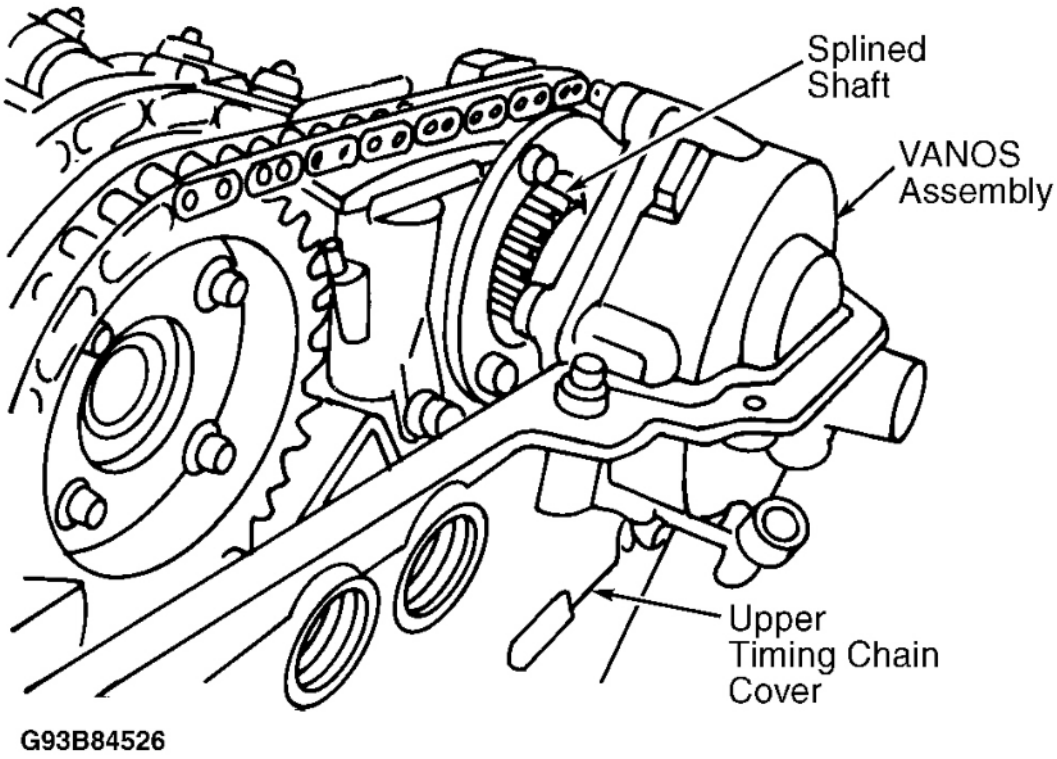


Fig. 14: Engage Splined Shaft Into Camshaft Sprocket
Courtesy of BMW OF NORTH AMERICA, INC.

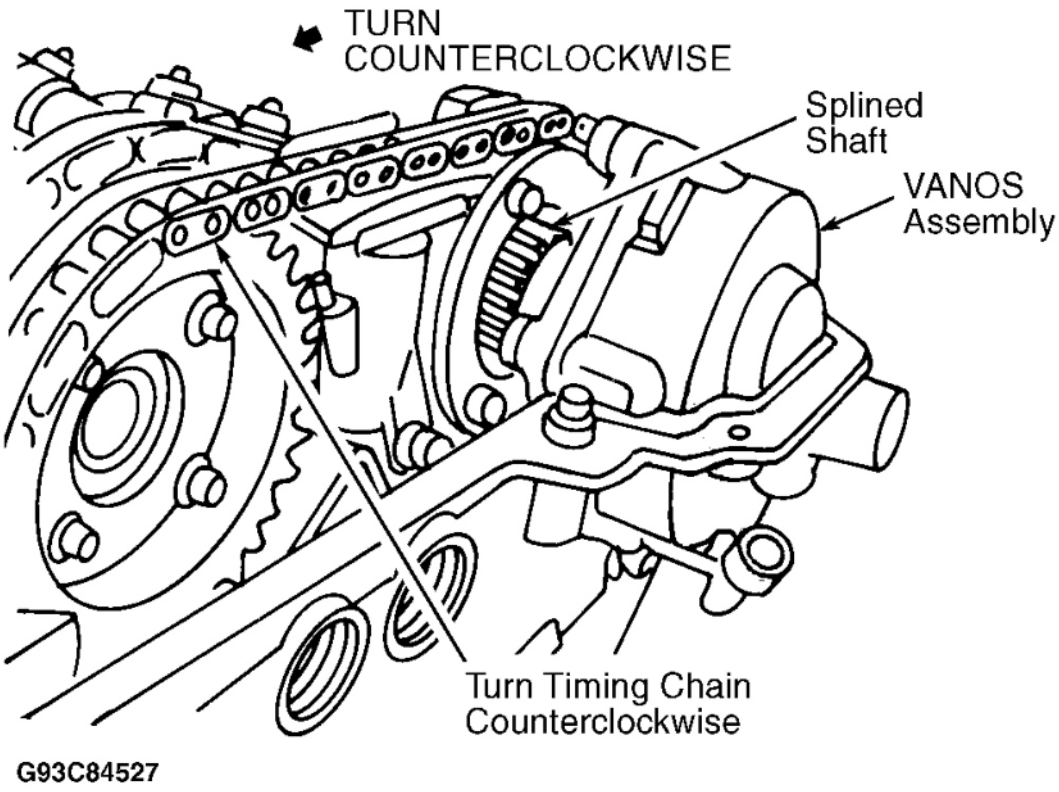


Fig. 15: Meshing Splined Shaft With Camshaft Sprocket
Courtesy of BMW OF NORTH AMERICA, INC.

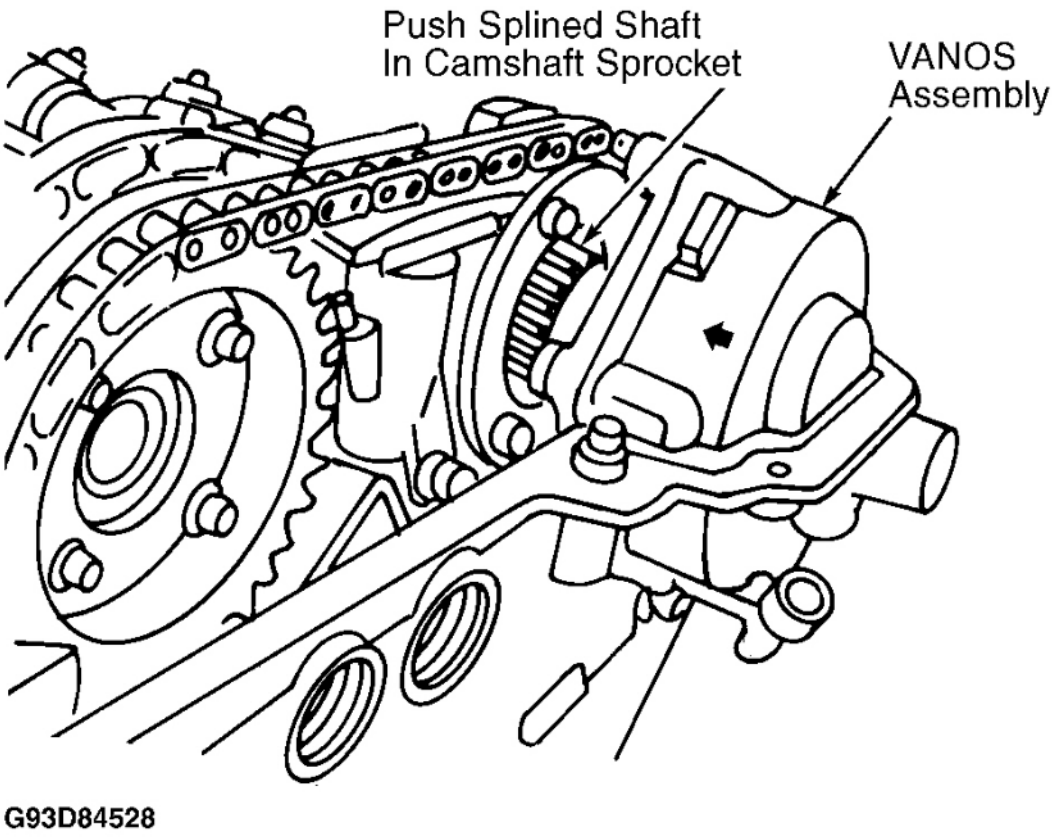


Fig. 16: Pushing Splined Shaft Into Camshaft Sprocket
Courtesy of BMW OF NORTH AMERICA, INC.

13. Install VANOS Air Hose Adapter (11-3-450) to oil fitting and Jumper Harness (12-6-410) to VANOS solenoid connector. See **Fig. 17**. Apply 28-110 psi (2.0-8.0 kg/cm^2) of air pressure to hose adapter.
14. Connect positive lead of jumper harness to positive terminal of battery and ground lead to negative terminal of battery. Using a vernier caliper, measure distance camshaft moves. See **Fig. 18**.
15. Camshaft sprocket should move .33-.49" (8.5-12.5 mm). If not, check VANOS assembly. Remove VANOS testing tools. Connect VANOS oil fitting and electrical connector. Ensure cylinder head cover gasket is correctly seated at rear of cylinder head. To complete installation, reverse removal procedure.

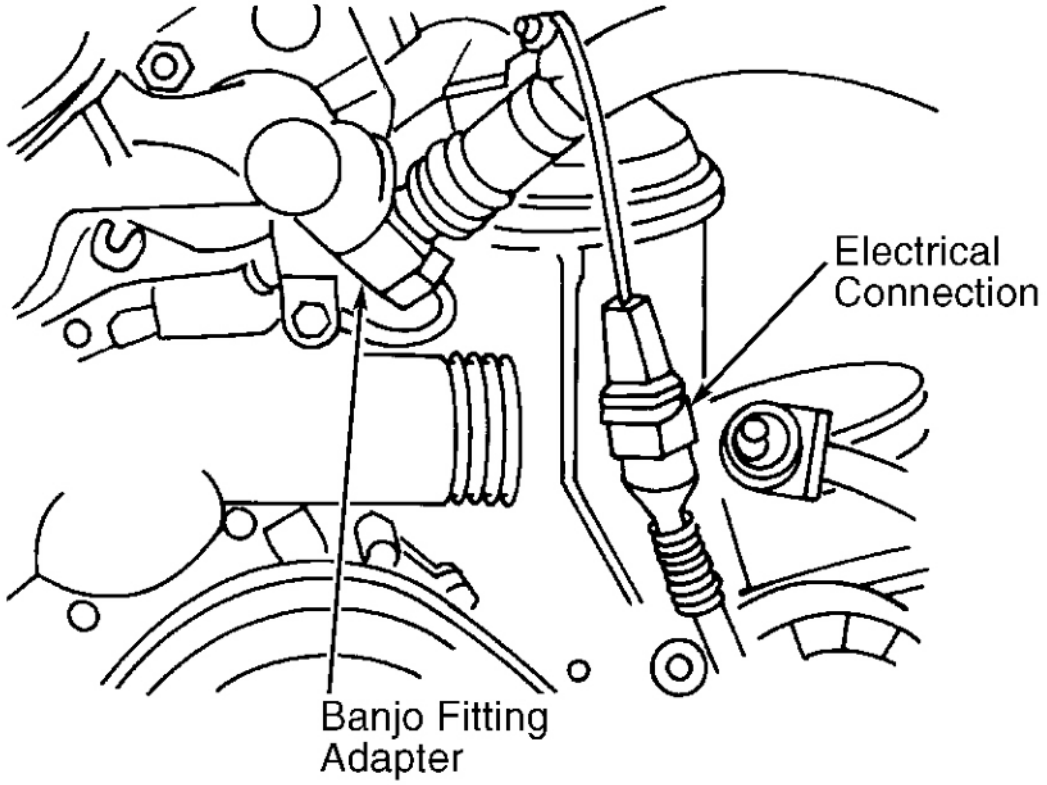


Fig. 17: Testing VANOS Solenoid
Courtesy of BMW OF NORTH AMERICA, INC.

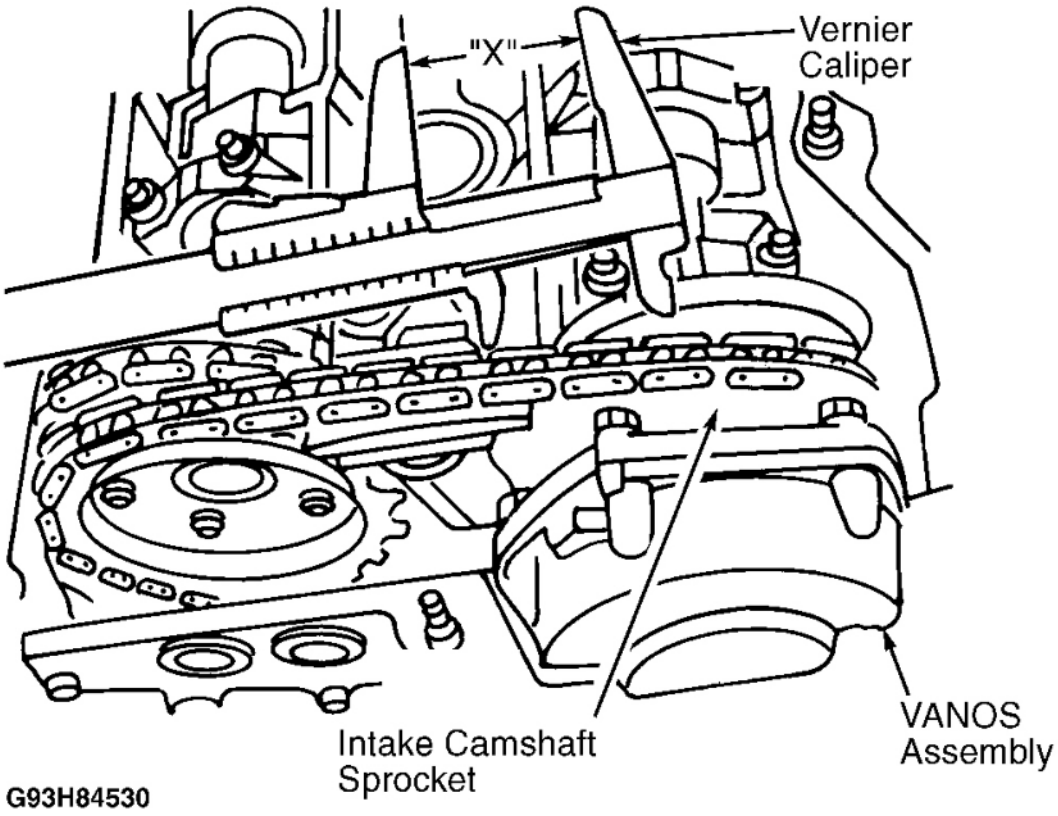
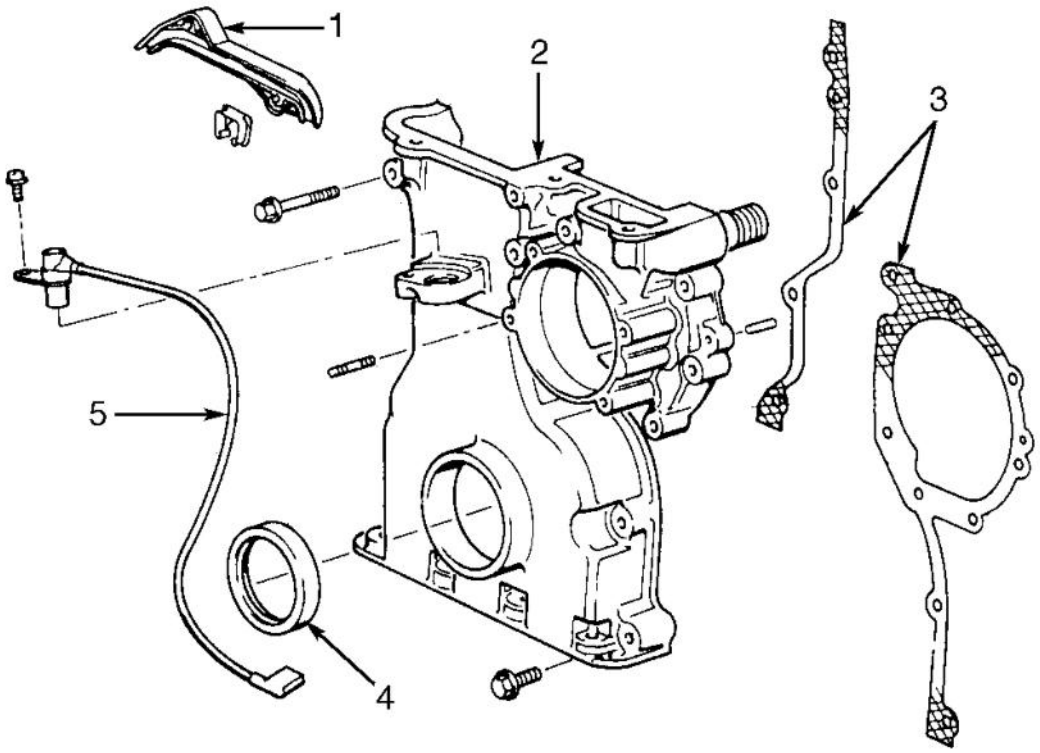


Fig. 18: Testing Camshaft Sprocket Travel
Courtesy of BMW OF NORTH AMERICA, INC.

CRANKSHAFT FRONT SEAL

Removal & Installation

1. Install Flywheel Holder (11-2-170) to hold flywheel in place. If necessary, remove 6 bolts and vibration damper. Remove bolt, washer and vibration damper hub.
2. Remove crankshaft front seal. See **Fig. 19**. To install, reverse removal procedure. Use Seal Installer (11-3-280), hub bolt and washer to press in new seal.



1. Wiring Harness Duct
2. Lower Timing Case Cover
3. Gasket
4. Crankshaft Front Seal
5. Pulse Sensor

G92E00574

Fig. 19: Exploded View Of Lower Timing Case Cover
Courtesy of BMW OF NORTH AMERICA, INC.

TIMING CHAIN

Removal & Installation

1. Remove timing chain and sprockets from cylinder head. See CYLINDER HEAD. Remove lower timing case cover. See **Fig. 19**. Fold down tensioner rail, and lift out timing chain.
2. Remove retainers and timing chain guide. Remove chain tensioner for oil pump timing chain. To install, reverse removal procedure.

CAMSHAFT

NOTE: Intake or exhaust camshaft may be replaced with engine installed in vehicle.

Removal

1. On 3-series, release hinge at hood, and prop hood open past center position. On all models, remove side rivets, and pull out radiator cooling fan cowl. Using 32-mm Wrench (11-5-040) and Pulley Holder (11-5-030), turn cooling fan nut clockwise to remove cooling fan.
2. On 3-series, remove grille from fresh air intake duct, below wiper arms. Remove screws and electrical lead along fresh air intake duct. Remove right holder and fresh air intake duct.
3. On all models, remove oil filler cap, screw caps, screws and engine covers. Remove ignition coil ground strap from timing case cover. Remove ignition coil cover plate. Disconnect wiring from ignition coils, and remove plate together with wiring. Remove ignition coils.
4. Detach hose at cylinder head breather vent. Remove cylinder head cover. Remove pulse sensor from side of timing case cover. Remove wiring harness duct located directly above thermostat housing.
5. Remove engine lift bracket and upper timing case cover. Pull off camshaft cover. With cylinder No. 1 coming up on TDC, turn crankshaft in normal direction of rotation until cylinder No. 1 intake and exhaust cam lobes face each other. Arrows on sprockets should face up.

NOTE: If camshaft position has to be turned so much that valves on 1st and 6th cylinders are moved, first turn crankshaft 30 degrees in normal direction of rotation past TDC. This will keep valves from contacting pistons. After aligning camshafts, turn crankshaft back to TDC position.

6. Remove valve cover mounting studs. Use Camshaft Locating Fixture (11-3-240) to align and hold camshafts. See **Fig. 32** or **Fig. 3**. Camshafts may be turned using a 27-mm open end wrench. Use TDC Aligning Plug (11-2-300) to hold crankshaft in TDC position.
7. Remove timing chain tensioner from side of timing case cover. Press down on upper chain tensioner and hold in place using Spring Holder (11-3-290). See **Fig. 6**. Remove timing chain sprockets and timing chain. See **Fig. 20**. See **CYLINDER HEAD**.

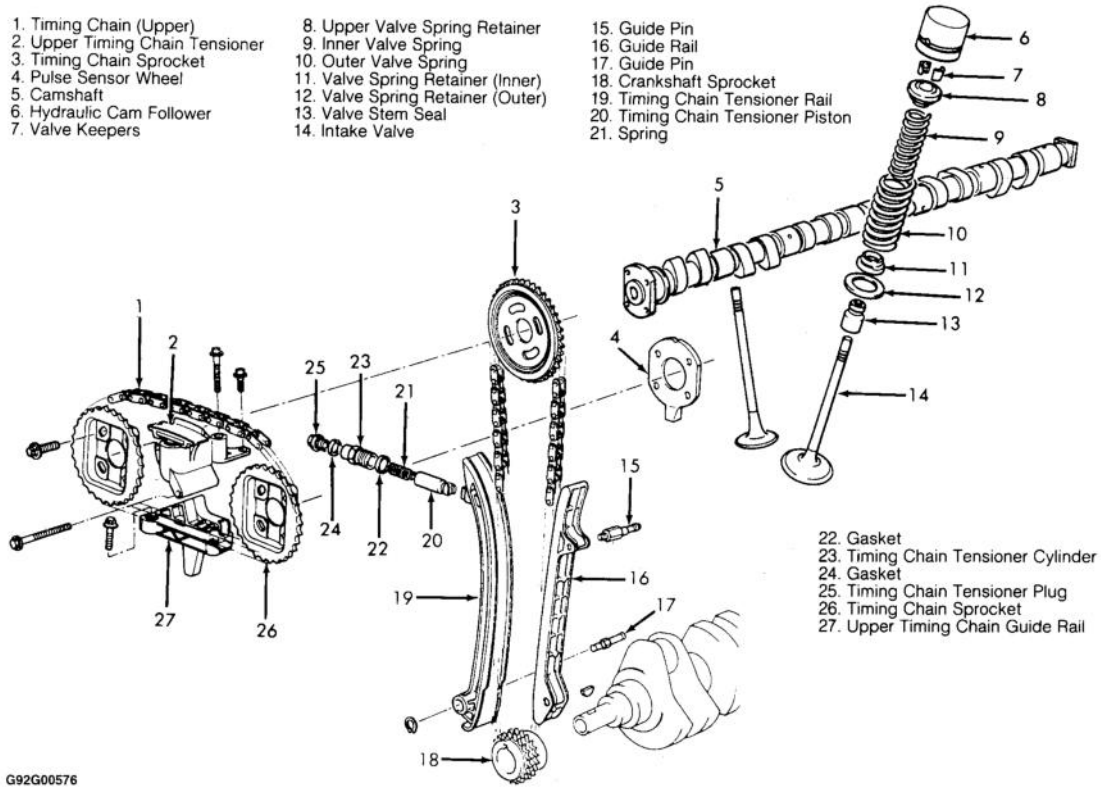


Fig. 20: Exploded View Of Valve Train Components
Courtesy of BMW OF NORTH AMERICA, INC.

8. Prepare Camshaft Fixture (11-3-260) and Adapter (11-3-270). See **Fig. 21**. Remove spark plugs from cylinder head. Mount and bolt fixture in spark plug holes. Tighten fixture bolts. See **TORQUE SPECIFICATIONS**.

CAUTION: Camshaft may be damaged during removal/installation if fixture is not used. In addition, valves may be bent by contacting tops of pistons.

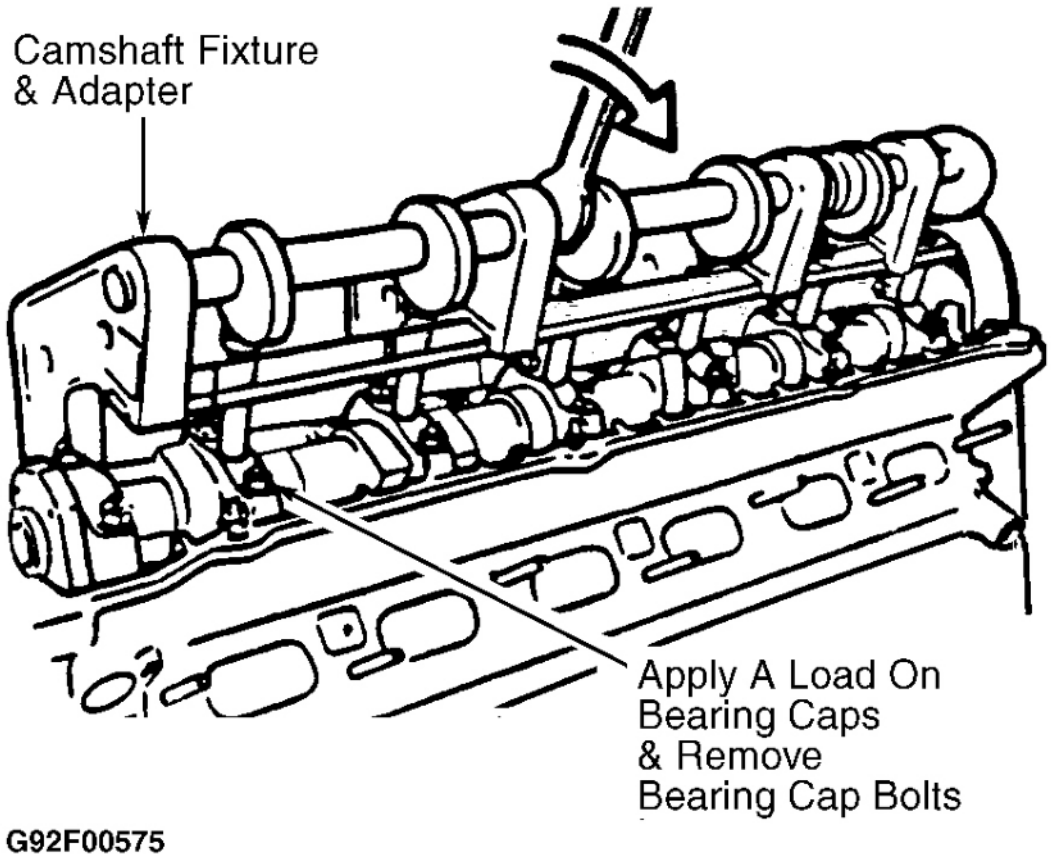


Fig. 21: Removing Camshaft Bearing Cap Bolts
Courtesy of BMW OF NORTH AMERICA, INC.

9. Load bearing caps by turning eccentric shaft on fixture. Remove bearing cap bolts. Slowly release load from bearing caps, and remove fixture. Lift out bearing caps and camshafts.
10. Hold hydraulic cam followers with an assistant or using Suction Cups (11-3-250). Lift out bearing plate complete with hydraulic cam followers. Inspect bearing surfaces of hydraulic cam followers for wear.

NOTE: On 3-series, camshafts, camshaft bearing caps and camshaft bearing plates (journals) are marked with "A" for exhaust and "E" for intake. On 5-series, camshafts, camshaft bearing caps and camshaft bearing plates (journals) are marked with AD for exhaust and ED for intake. Intake camshaft also has a notch cut into camshaft sprocket mounting flange.

Installation

1. Check centering sleeves on mounting bolts for bearing caps No. 2 and 7. Install camshaft so intake and exhaust valve camshaft lobes for cylinder No. 1 face each other. Install bearing plate complete with

hydraulic cam followers. Install camshaft bearing caps.

2. Install fixture, and tighten fixture bolts to 17 ft. lbs. (23 N.m). Apply a load on bearing caps by turning eccentric shaft on fixture. Tighten bearing cap bolts to specification. See **TORQUE SPECIFICATIONS**. Slowly release load, and remove fixture. Wait for hydraulic cam followers to compress. See **VALVE TRAIN SERVICING PRECAUTIONS**.
3. Install exhaust camshaft timing chain sprocket with arrow pointing up and slots aligned with bolt holes at left. Ensure pulse sensor wheel is installed on intake camshaft.
4. Install camshaft sprockets and timing chain. See **CYLINDER HEAD**. Install and adjust VANOS assembly. See **CYLINDER HEAD**.
5. Install timing chain tensioner with groove in piston perpendicular to tensioner rail. Ensure cylinder head cover gasket is correctly seated at rear of cylinder head. To complete installation, reverse removalprocedure.

CRANKSHAFT REAR SEAL

Removal & Installation

1. Remove transmission. See appropriate article in CLUTCHES (M/T), or REMOVAL & INSTALLATION article in TRANSMISSION SERVICING (M/T). Use Flywheel Holder (11-2-170) to hold flywheel in place. On manual transmission vehicles, remove 6 bolts and clutch pressure plate. On all vehicles, remove flywheel. Remove crankshaft rear cover and seal.
2. With crankshaft cover removed, use Seal Installer (11-1-260) to install crankshaft rear seal. Place Sleeve (11-2-213) over crankshaft. Lubricate crankshaft rear seal, and slide cover into place. To complete installation, reverse removal procedure.

NOTE: Using Crankshaft Ball Bearing Installer (11-2-030) and Drift (00-5-000), install transmission shaft pilot bearing in crankshaft (if necessary).

WATER PUMP

Removal & Installation

Hold water pump pulley on drive belt and remove bolts. Remove drive belt and pump pulley. Remove water pump bolts. Use two 6 mm metric bolts in water pump threaded holes to press water pump out. Lightly lubricate "O" ring, and install water pump. To complete installation, reverse removal procedure.

THERMOSTAT

Removal

Remove fan coupling with fan wheel and fan cowl. Drain and dispose of coolant.

Installation:

Replace seal.

Drain plug for coolant in engine block: M14 x 1.5 thread - Tightening torque: 18 Ft. Lbs. (25 N.m)

Bleed cooling system and checking for water leaks.

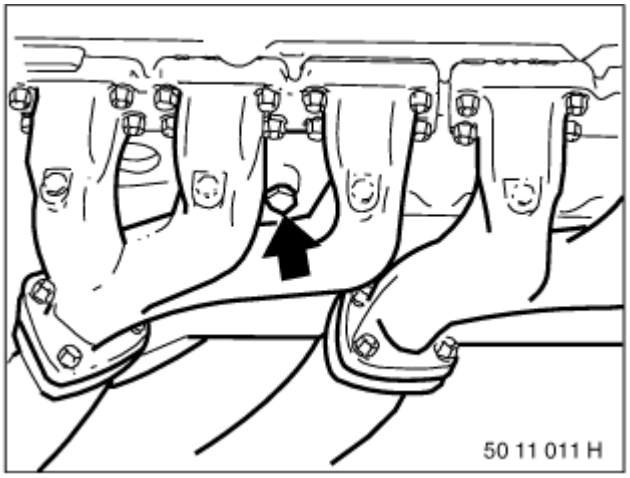


Fig. 22: Locating Drain Plug
Courtesy of BMW OF NORTH AMERICA, INC.

Unfasten water hoses.

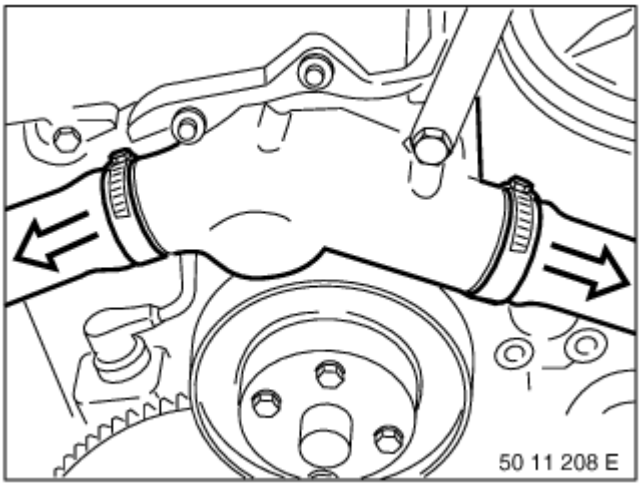


Fig. 23: Locating Water Hoses
Courtesy of BMW OF NORTH AMERICA, INC.

Unscrew suspension eye.

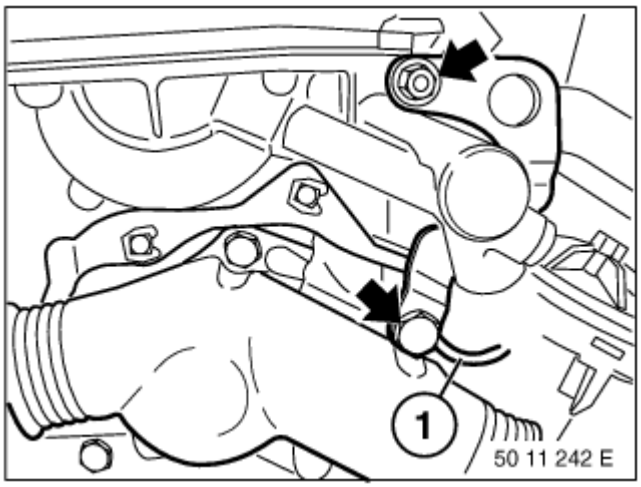


Fig. 24: Locating Suspension Eye Nuts And Bolts
Courtesy of BMW OF NORTH AMERICA, INC.

Remove cable channel.

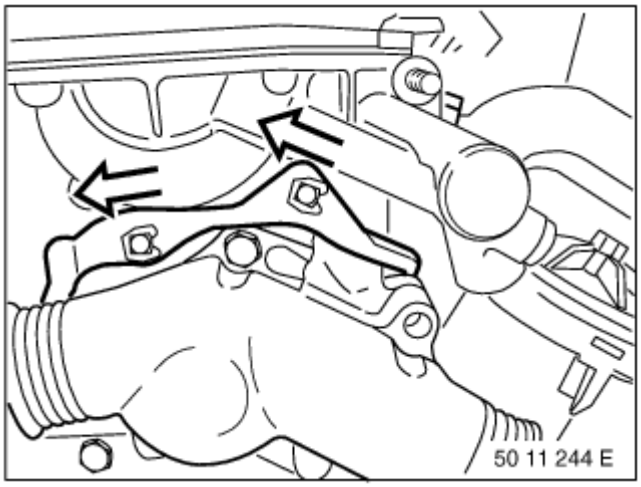


Fig. 25: Locating Cable Channel
Courtesy of BMW OF NORTH AMERICA, INC.

Unfasten thermostat housing.

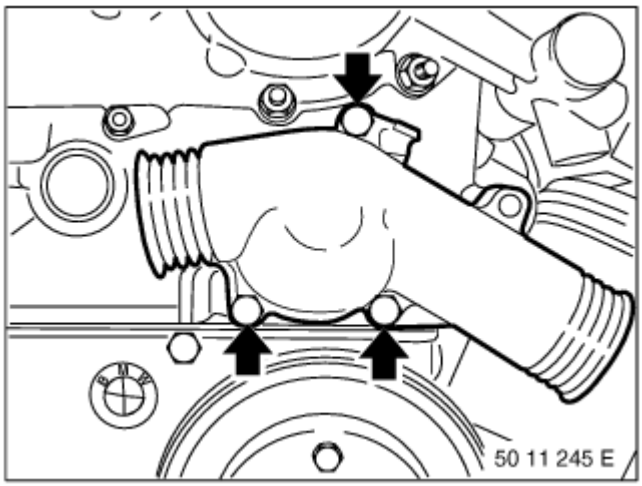


Fig. 26: Locating Thermostat Housing Bolts
Courtesy of BMW OF NORTH AMERICA, INC.

Installation:

Keep sealing faces clean and free of oil.

Replace seal.

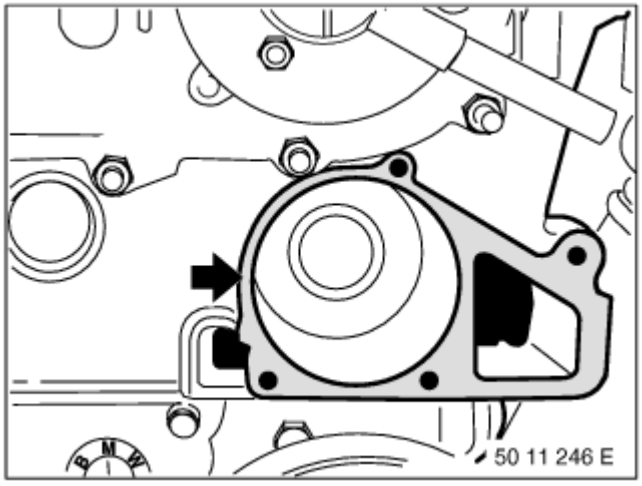


Fig. 27: Identifying Thermostat Housing Seal
Courtesy of BMW OF NORTH AMERICA, INC.

Installation:

Check installed direction.

Vent with arrow facing upwards

Replace seal.

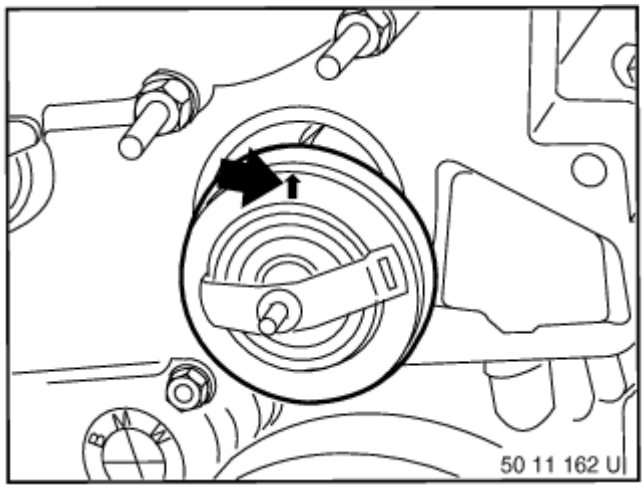


Fig. 28: Locating Vent Arrow
Courtesy of BMW OF NORTH AMERICA, INC.

Installation

OIL PAN

Removal

1. Drain engine oil. Disconnect wiring from oxygen sensor. Detach wiring from holder at transmission crossmember.
2. Remove bolts and exhaust pipes from exhaust manifold. On vehicles with automatic transmission, remove crossmember for center of gravity suspension.
3. Remove bolts, and detach exhaust pipe from transmission holder. Detach rubber rings from exhaust pipes. Remove rear bolts and lower exhaust assembly down.
4. On all models, release hinge at hood, and prop hood open past center position. Remove air cleaner/air mass sensor assembly.
5. Remove generator air intake duct. Remove rivets, and pull out radiator cooling fan cowl. Using Pulley Holder (11-5-030) and 32-mm Wrench (11-5-040), turn cooling fan nut clockwise to remove cooling fan. Remove clips at top of radiator.
6. On 3-series, remove grille from fresh air intake duct. Remove electrical lead along fresh air intake duct. Remove right holder and fresh air intake duct.
7. On all models, remove guide tube for engine oil dipstick. Note serpentine belt routing. Insert socket into drive belt tensioner bolt. Compress tensioner by slowly rotating socket clockwise, and remove drive belt.
8. Remove power steering pump bolts. Remove power steering pump. DO NOT disconnect power steering lines. Remove bolts and power steering pump oil supply tank. Hang power steering pump and oil tank aside.
9. On 3-series, insert socket into A/C compressor drive belt tensioner bolt. Compress tensioner by slowly rotating socket clockwise, and remove A/C compressor drive belt. Remove A/C compressor. DO NOT disconnect refrigerant lines.
10. Remove ground strap and right engine mount nut. Remove left engine mount nut. Loosen lower nuts on right/left engine mount. Attach Engine Holding Hoop (00-0-200) and Sling (00-0-204) to engine carrier.

Raise engine as far as possible. Ensure wiring harness, ducts and hoses are not stretched or pinched.

11. On all models, remove oil pan bolts. Lower oil pan. Turn sprocket nut clockwise, and pull oil pump sprocket off splines. Remove bolts and oil strainer. Remove bolts and oil pump. Remove oil pan by pulling it rearward.

Installation

1. To install, reverse removal procedure. Use Elastic Sealing Compound (3 Bond 1027B) to fill joints between oil pan and front timing case and rear cover.
2. Tighten oil pump sprocket nut counterclockwise. Nut uses left-hand threads. Ensure serpentine belt is correctly routed and properly seated in grooves. Turn 32-mm Wrench (11-5-040) counterclockwise, and tighten cooling fan nut. See **TORQUE SPECIFICATIONS**.

OVERHAUL

CYLINDER HEAD

Valves & Valve Springs

1. Remove cylinder head and camshaft. Remove valve springs, spring retainers and valve stem oil seals.
2. Determine valve seat depth by inserting valve in corresponding valve guide, measuring protrusion from tip of valve stem to valve guide, and noting distance.
3. Machine valve seat. See VALVE SEATS. Insert same valve again, and measure protrusion from valve stem to valve guide, noting distance. Difference between readings is amount of machining.

Valve Stem Oil Seals

Pull off valve stem oil seal. To install oil seals, place Assembly Sleeve (11-1-380) over valve stem. Lubricate valve stem oil seal, and install. Using Assembly Mandrel (11-1-200), press valve stem oil seal against stop.

Valve Guides

1. Insert a NEW valve in valve guide to be checked. End of valve stem must be flush with valve guide. Place dial indicator tip on side of valve head. Wobble valve from side-to-side to measure valve guide wear. Maximum tilt is 0.020" (0.50 mm).
2. If necessary, ream valve guide, and install a replacement valve with an oversize stem diameter of 0.004" (0.10 mm) or 0.008" (0.20 mm). Press reamer guide (cone) on valve seat, and ream out valve guide from combustion chamber side. Ream guide only once. Machine valve seat after reaming valve guide.

Valve Seats

1. Machine valve seats using Valve Seat Lathe (00-3-520) and Valve Seat Reseating Set (00-3-580), following instructions supplied with tools. After machining valve seat angle, produce valve seat diameter "B" and valve seat width "D" by machining correction angles "D" and "E" and countersinking "C". See **Fig. 29**. See **VALVE SEAT CORRECTION ANGLES** table.

2. If more than 0.008" (0.20 mm) is machined off valve seat, install a valve with a thicker valve head. Valve heads are available in .008" (.20 mm) increments. Valve stems are available in .004" (.10 mm) increments.

Valve Seat Correction Angles

See VALVE SEATS. See **VALVE SEAT CORRECTION ANGLES** table.

VALVE SEAT CORRECTION ANGLES (1)

Application	Specification
Dimension "A"	45 Degrees
Dimension "B"	15 Degrees
Dimension "C"	60 Degrees
Dimension "D"	
Intake Valve	1.149-1.165" (29.20-29.60 mm)
Exhaust Valve	1.031-1.047" (26.20-26.60 mm)
Dimension "E"	0.064" (1.65 mm)
(1) See **Fig. 29**.	

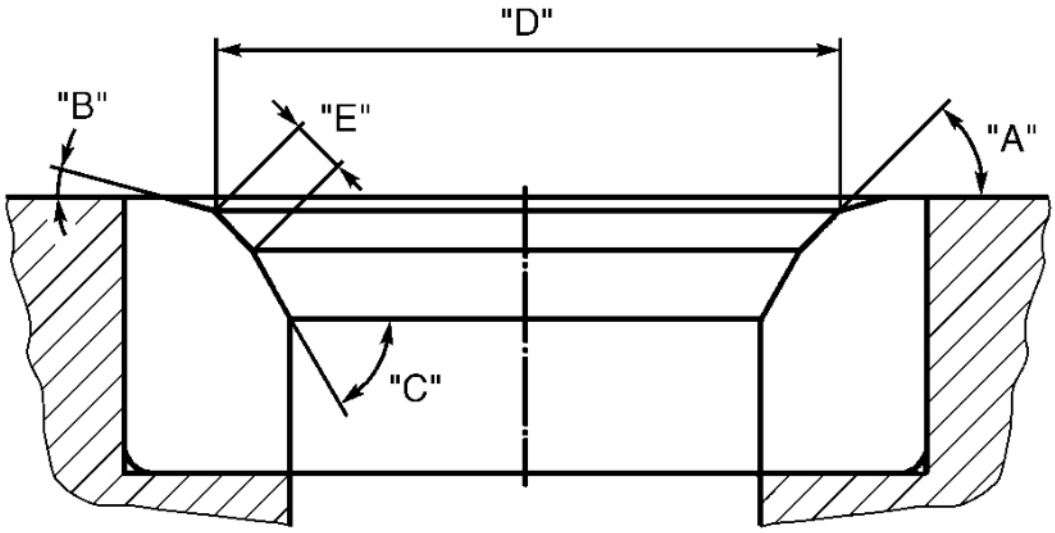


Fig. 29: Identifying Valve Seat Angles
Courtesy of BMW OF NORTH AMERICA, INC.

Cylinder Head Height

1. Check flatness of cylinder head using a 0.0012" (0.03 mm) feeler gauge and straightedge. If necessary, machine cylinder head.
2. Ensure cylinder head height exceeds minimum cylinder head height. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.

NOTE: A .012" (0.30 mm) thicker cylinder head gasket is available for machined cylinder heads.

CYLINDER BLOCK ASSEMBLY

Piston & Rod Assembly

1. Install piston, connecting rod and bearings in corresponding cylinder. Connecting rods and bearing caps have numbers stamped on them. Ensure arrows on top of pistons point toward front of engine.
2. Lubricate connecting rod bearings with oil. Install bearing caps, ensuring numbers match and are aligned. Install and tighten NEW connecting rod bolts. Using Torque Angle Gauge (11-2-110), tighten connecting rod bolts an additional torque angle. See **TORQUE SPECIFICATIONS**.

NOTE: If piston and connecting rod assembly have been separated, ensure piston is installed with arrow pointing toward right when connecting rod numbers are facing you.

Fitting Pistons

1. Measure piston diameter about 33/64" (13 mm) from lower edge of piston skirt. Set dial indicator to zero using measured piston diameter.
2. Measure cylinder bore diagonally at bottom, middle and top of bore. Piston-to-cylinder wall clearance should be within specification. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS.

Piston Rings

1. Measure piston ring end gaps. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS. Install piston rings with word TOP facing up (top of piston crown). See **Fig. 30**.
2. Position piston ring gaps 120 degrees apart from each other, but DO NOT position gaps above piston pin eye. Measure piston ring side clearances.

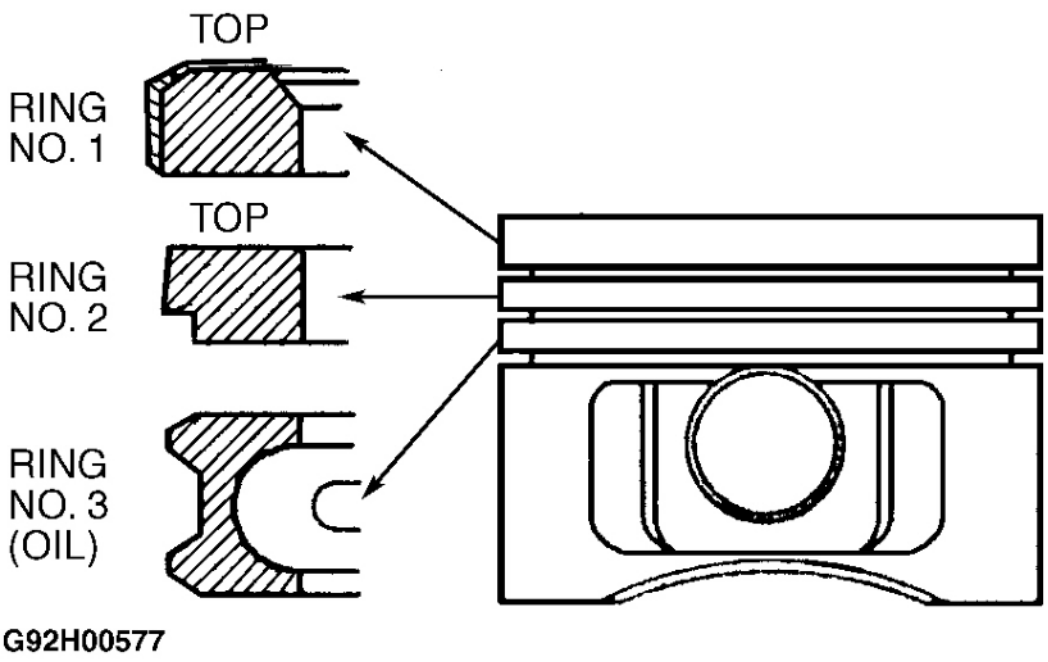


Fig. 30: Installing Piston Rings
Courtesy of BMW OF NORTH AMERICA, INC.

Connecting Rod & Bushing

1. Check connecting rod for parallelism and distortion. If connecting rod replacement is necessary, use only connecting rods of same weight.
2. Piston pin should pass through connecting rod bushing using only thumb pressure. If necessary, replace bushing. Press in bushing with gaps located at 135 degrees or 225 degrees from top. Ream out connecting rod bushing to 0.8662-0.8665" (22.0005-22.010 mm).

Rod Bearings

Select connecting rod bearing shells matching color code on connecting rod. Use Plastigage to check connecting rod bearing oil clearance. See **ENGINE SPECIFICATIONS**. Install new bearing shells or bearing shells with a different color code to correct oil clearance.

Crankshaft & Main Bearings

1. Main bearing caps are marked for location. Bearing cap No. 6 (thrust bearing) has a shoulder on side of cap. Ensure oil spray jets are installed in oil passages for bearings No. 2, 3, 4, 5, 6 and 7.
2. Use Plastigage to check connecting rod bearing oil clearance. See **ENGINE SPECIFICATIONS**. Install new bearing shells or bearing shells with a different color code to correct oil clearance.
3. Install upper bearing shells having same color code as dot on bearing support in crankcase. Install lower

bearing shells having same color code as dot on crankshaft throw. Ensure grooves of bearing shell guide are located on same side. Tighten lubricated main bearing cap bolts. See **TORQUE SPECIFICATIONS**.

NOTE: Reground crankshafts are marked with Yellow, Green or White paint. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table under ENGINE SPECIFICATIONS.

Thrust Bearing

Bearing cap No. 6 has a shoulder on side of cap. Ensure thrust bearing and bearing cap No. 6 are installed in same location.

ENGINE OILING

ENGINE LUBRICATION SYSTEM

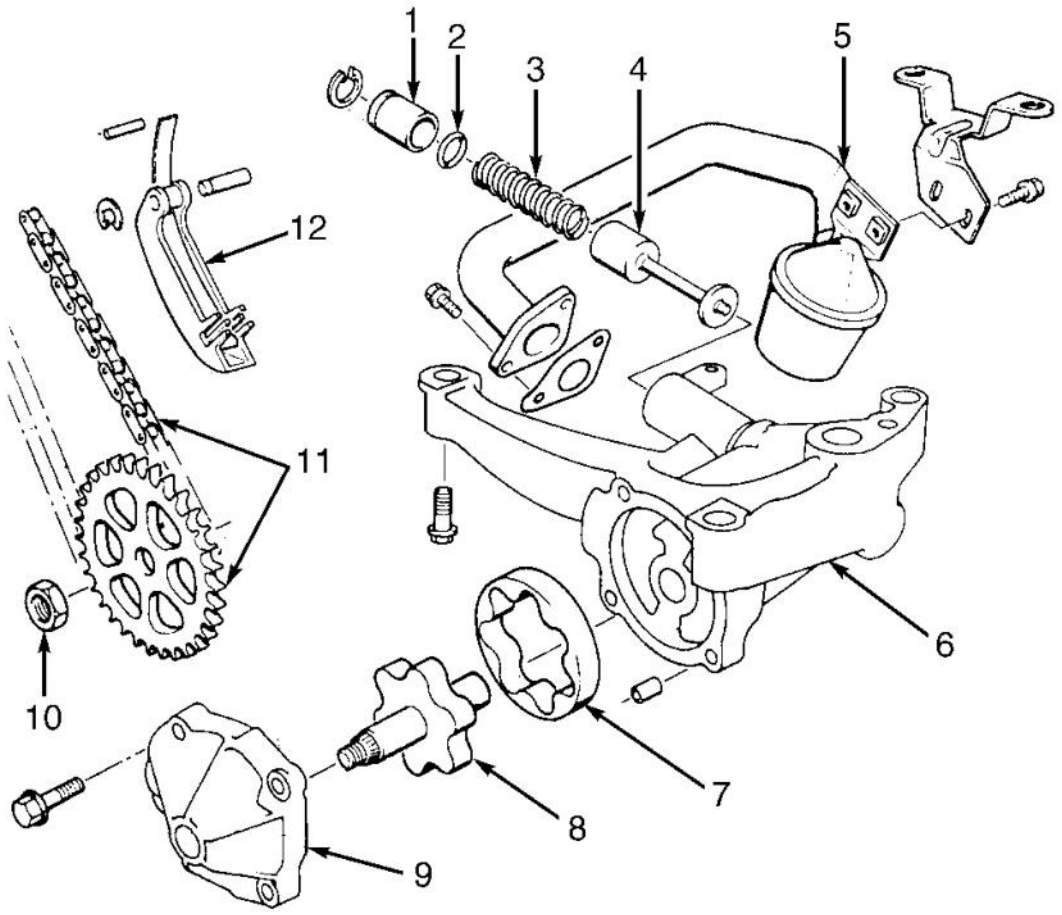
Oil pump is a rotary-type oil pump. Oil pump is bolted to engine block and driven directly from crankshaft by a single-roller chain and tensioner. See **Fig. 31**. Oil filter is mounted vertically on intake side of engine.

Oil Capacity

Oil change amount including filter is 7.0 qts. (6.5L).

Oil Pressure

Oil pressure should be more than 7 psi (.5 kg/cm^2) at idle and 56 psi (4.0 kg/cm^2) at 3000 RPM.



1. Bushing
2. "O" Ring
3. Spring
4. Valve
5. Pick-Up Tube
6. Oil Pump Housing
7. Outer Rotor
8. Inner Rotor
9. Oil Pump Cover
10. Nut (Left-Hand Threads)
11. Oil Pump Chain & Sprocket
12. Oil Pump Chain Tensioner

G92I00578

Fig. 31: Exploded View Of Oil Pump Assembly
Courtesy of BMW OF NORTH AMERICA, INC.

OIL PUMP

NOTE: A chain tensioner is used on oil pump drive chain. Tensioner is located next to crankshaft sprocket.

Removal & Disassembly

1. Remove oil pan. See **OIL PAN** under REMOVAL & INSTALLATION. Turn oil pump sprocket nut clockwise to remove nut. Nut uses left-hand threads.
2. Carefully remove sprocket and chain. Remove oil pump. Locate oil pressure relief valve on oil pump housing. Lightly press down on oil pressure relief valve spring, and remove snap ring.
3. Remove oil pressure relief valve components. Remove oil pump pick-up tube. Remove pump shaft/rotor assembly. See **Fig. 31**.

Inspection

1. Measure pump body-to-outer rotor clearance. Clearance should be 0.004-007" (0.10-0.18 mm). Measure pump body-to-outer (inner) rotor axial clearance. Clearance should be 0.002-0.003" (0.05-0.08 mm).
2. Inspect oil pressure relief valve components for wear and damage. See **Fig. 31**. Measure length of unloaded relief valve spring. Spring length should be 3.31" (84.1 mm).

Reassembly & Installation

To reassemble oil pump, reverse disassembly procedure. A gasket is used between oil pump housing and pick-up tube. Tighten oil pump sprocket nut counterclockwise.

VALVE TRAIN SERVICING PRECAUTIONS

CAUTION: Hydraulic cam followers expand when camshaft is removed and require a certain amount of time after installation before they compress. Wait recommended time to permit hydraulic cam followers to compress. If wait time is not followed, valves appear to be closed but may actually be open and come in contact with pistons. Failure to wait recommended time may damage engine.

1. If camshafts will be removed and installed without removing cylinder head from engine, turn crankshaft in normal direction of rotation about 30 degrees from TDC. This will keep valves from hitting pistons.
2. Install camshafts with lobes for cylinder No. 1 facing each other. Use Camshaft Locating Fixture (11-3-240) to align and hold camshafts. See **Fig. 32** or **Fig. 3**.

NOTE: Always wait specified time between installation of camshaft and installation of cylinder head. See CYLINDER HEAD INSTALLATION WAITING TIMES table.

CYLINDER HEAD INSTALLATION WAITING TIMES

Temperature °F (°C)	Minutes
68 (20)	4
50-68 (10-20)	11
32-50 (0-10)	30

3. Wait recommended time to permit hydraulic cam followers to compress. See **CYLINDER HEAD INSTALLATION WAITING TIMES** table. Turn crankshaft back to TDC position.

4. Use TDC Aligning Plug (11-2-300) to hold crankshaft in TDC position. Install timing chain. Remove camshaft and crankshaft holders. Wait at least 10 minutes before cranking engine. See **ENGINE CRANKING WAITING TIMES** table.

NOTE: Engine may be cranked only after waiting specified time after installation of camshaft and timing chain. See ENGINE CRANKING WAITING TIMES table.

ENGINE CRANKING WAITING TIMES

Temperature °F (°C)	Minutes
68 (20)	10
50-68 (10-20)	30
32-50 (0-10)	75

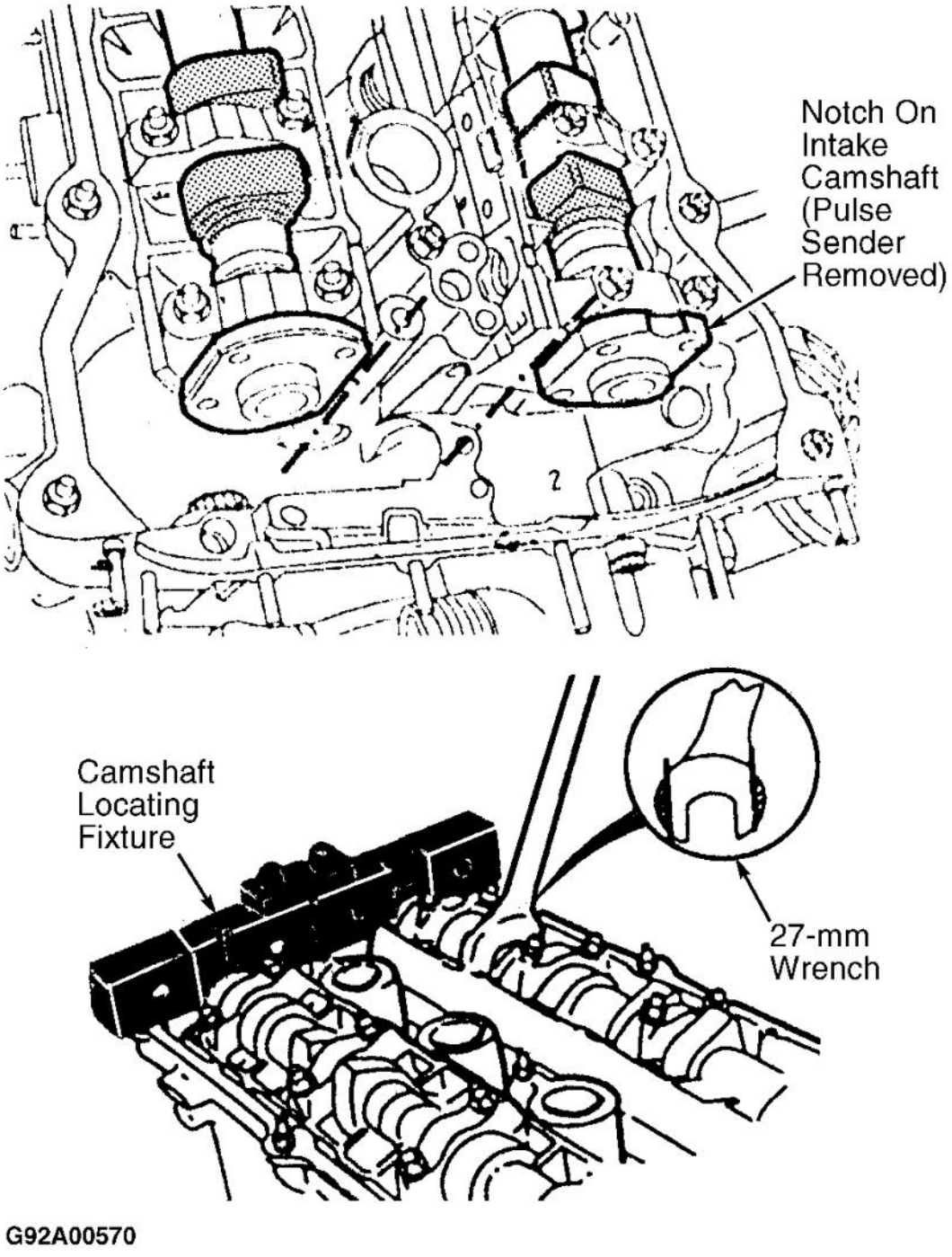


Fig. 32: Servicing Valve Train
Courtesy of BMW OF NORTH AMERICA, INC.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Camshaft Bearing Cap Bolts	11 (15)
Camshaft Sprocket Bolts Splined Shaft-To-Intake Camshaft Bolts	
Step 1	30 (40)
Step 2	60 Degrees
Clutch Drive Plate	17 (23)
Connecting Rod Bolts (1)	
Step 1	15 (20)
Step 2 (Torque Angle)	70 Degrees
Coolant Drain Plug (Crankcase)	22 (30)
Cooling Fan Nut	(2) 22 (30)
Cylinder Head Bolts (3)	
Step 1 (Aluminum Block)	24 (40)
Step 1 (Cast Iron Block)	22 (30)
Step 2 (Torque Angle - All)	90 Degrees
Step 3 (Torque Angle - All)	90 Degrees
Exhaust Manifold Nuts	15 (20)
Flywheel-To-Crankshaft Bolts (Loctite)	83-96 (113-130)
Front/Rear Crankshaft End Cover Bolts (8 mm)	16 (22)
Intake Camshaft Sprocket Splined Hub	
Step 1	30 (40)
Step 2	60 Degrees
Intake Manifold Bolts	11 (15)
Main Bearing Cap Bolts (4)	
Step 1	15-18 (20-24)
Step 2 (Torque Angle)	50 Degrees
Aluminum Block	70 Degrees
Cast Iron Block	50 Degrees
Oil Filter Cover	20-24 (27-33)
Oil Pan Cover Bolts (8 mm)	15 (20)
Oil Pump Sprocket Nut	18 (24)
Starter Bolts	35-37 (47-50)
Suspension Bar-To-Cylinder Head	15-18 (20-24)
Timing Chain Tensioner Piston Cylinder	48-55 (65-75)
Timing Chain Tensioner Plug	28-31 (38-42)
Upper/Lower Timing Case Cover Bolts (8 mm)	16 (22)
Vibration Damper Bolts	17 (23)
Vibration Damper Hub Bolt	317 (440)
VANOS Banjo Bolt	24 (33)
VANOS Oil Line-To-Filter Nut	37 (50)

Water Pump Bolts (8 mm)	16 (22)
	INCH Lbs. (N.m)
Cylinder Head Bolts (Small)	86 (10)
Cylinder Head Cover Bolts	86 (10)
Front/Rear Crankshaft End Cover Bolts (6 mm)	79 (9)
Fuel Injectors-To-Intake Manifold	86 (10)
Oil Pan Cover Bolts (6 mm)	79 (9)
Oil Pump Cover Bolts	79 (9)
Sprocket-To-Camshaft Flange Bolt	
Step 1	48 (5)
Step 2	(5)
Thermostat Housing Bolts	79 (9)
Upper/Lower Timing Case Cover Bolts (6 mm)	79-96 (9-11)
Water Pump Bolts (6 mm)	79 (9)
Water Pump Pulley Bolts	79 (9)

(1) Use NEW, lightly oiled bolts.

(2) Reverse thread. Specification applies to use of BMW 32-mm Wrench (11-5-040). If using conventional 32-mm wrench, tighten nut to 29 ft. lbs. (40 N.m).

(3) Use NEW, lightly oiled bolts. Tighten bolts in sequence. See **Fig. 6**.

(4) Use cleaned, lightly oiled bolts.

(5) Tighten bolt an additional 16 ft. lbs. (22 N.m).

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

Application	Specification
2.5L (1)	
Displacement	152 Cu. In. (2.5L)
Bore	3.310" (84 mm)
Stroke	2.950" (75 mm)
Compression Pressure	(1)
Compression Ratio	10.5:1
Fuel System	SFI
Horsepower @ RPM	170 @ 5500
Torque Ft. Lbs. @ RPM	181 @ 3500
2.8L	
Displacement	170 Cu. In. (2.8L)
Bore	3.307" (84 mm)
Stroke	3.307" (84 mm)

Compression Pressure	(1)
Compression Ratio	10.2:1
Fuel System	SFI
Horsepower @ RPM	189 @ 5900
Torque Ft. Lbs. @ RPM	210 @ 3950
3.2L	
Displacement	195 Cu. In. (3.2L)
Bore	3.401" (86.4 mm)
Stroke	3.527" (89.6 mm)
Compression Pressure	(1)
Compression Ratio	10.5:1
Fuel System	SFI
Horsepower @ RPM	240 @ 6000
Torque Ft. Lbs. @ RPM	231 @ 3800
(1) Additional 2.5L specifications are not available.	

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

Application	In. (mm)
2.8L	
Crankshaft	
End Play	0.0031-0.0064 (0.080-0.163)
Runout	0.008 (0.20)
Main Bearings	
Journal Diameter	
Standard	
Yellow	2.3616-2.3618 (59.984-59.990)
Green	2.3613-2.3615 (59.977-59.983)
White	2.3611-2.3613 (59.971-59.977)
Undersize 1 - 0.001" (0.25 mm)	
Yellow	2.3517-2.3520 (59.733-59.740)
Green	2.3515-2.3517 (59.727-59.733)
White	2.3512-2.3514 (59.721-59.726)
Undersize 2 - 0.023" (0.59 mm)	
Yellow	2.3419-2.3421 (59.484-59.490)
Green	2.3416-2.3418 (59.477-59.483)
White	2.3414-2.3416 (59.471-59.477)
Journal Out-Of-Round	(1)
Journal Taper	(1)

Oil Clearance	0.0008-0.0023 (0.020-0.058)
Connecting Rod Bearings	
Journal Diameter	
Standard	1.7707-1.7634 (44.975-44.791)
Undersize 1	1.7608-1.7614 (44.725-44.741)
Undersize 2	1.7509-1.7516 (44.475-44.491)
Journal Out-Of-Round	(1)
Journal Taper	(1)
Oil Clearance	0.0008-0.0022 (0.020-0.055)
3.2L	
Crankshaft	
End Play	0.0031-0.0064 (0.080-0.163)
Runout	0.008 (0.20)
Main Bearings	
Journal Diameter	
Standard	
Yellow	2.3616-2.3618 (59.984-59.990)
Green	2.3613-2.3615 (59.977-59.983)
White	2.3611-2.3613 (59.971-59.977)
Undersize 1 - 0.001" (0.25 mm)	
Yellow	2.3517-2.3520 (59.733-59.740)
Green	2.3515-2.3517 (59.727-59.733)
White	2.3512-2.3514 (59.721-59.726)
Undersize 2 - 0.019" (0.50 mm)	
Yellow	2.3419-2.3421 (59.484-59.490)
Green	2.3416-2.3418 (59.477-59.483)
White	2.3414-2.3416 (59.471-59.477)
Journal Out-Of-Round	(1)
Journal Taper	(1)
Oil Clearance	0.0008-0.0023 (0.020-0.058)
Connecting Rod Bearings	
Journal Diameter	
Standard	1.7716 (45.00)
Undersize 1	1.7618 (44.75)
Undersize 2	1.7519 (44.50)
Journal Out-Of-Round	(1)
Journal Taper	(1)
Oil Clearance	0.0008-0.0022 (0.020-0.055)
(1) Information is not available from manufacturer.	

CONNECTING RODS

CONNECTING RODS

Application	In. (mm)
2.8L	
Bushing Pin Bore Diameter	
Outside	0.9449-0.9461 (24.000-24.031)
Inside	0.8663-0.8665 (22.005-22.010)
Crankpin Bore Diameter	
Red	1.8898-1.8901 (48.000-48.009)
Blue	1.8901-1.8904 (48.009-48.016)
Center-To-Center Length	(1)
Maximum Bend	0.0016 (0.040)
Maximum Twist	0.002 (0.05)
Side Play	(1)
3.2L	
Bushing Pin Bore Diameter	
Outside	0.9457-0.9446 (24.021-23.995)
Inside	0.8665-0.8659 (22.010-21.995)
Crankpin Bore Diameter	1.8898-1.8904 (48.000-48.016)
Center-To-Center Length	(1)
Maximum Bend	0.0016 (0.040)
Maximum Twist	0.002 (0.05)
Side Play	(1)

(1) Information is not available from manufacturer.

PISTONS, PINS & RINGS

PISTONS, PINS & RINGS

Application	In. (mm)
2.8L	
Piston	
Clearance	
Standard	0.0004-0.0016 (0.010-0.040)
Maximum	0.0043 (0.11)
Diameter	
Standard	3.3063 (83.980)
Intermediate	3.3094 (84.060)
Oversize 1	3.3161 (84.230)
Oversize 2	3.3260 (84.480)
Pins	

Diameter	(1)
Piston Fit	(2)
Rod Fit	(1)
Rings	
No. 1 (Plain)	
End Gap	0.008-0.016 (0.20-0.40)
Side Clearance	0.0008-0.0023 (0.020-0.060)
No. 2 (Tapered)	
End Gap	0.008-0.016 (0.20-0.40)
Side Clearance	0.0008-0.0025 (0.020-0.065)
No. 3 (Oil)	
End Gap	0.016-0.055 (0.40-1.40)
Side Clearance	(1)
3.2L	
Piston	
Clearance	
Standard	0.0010-0.0022 (0.026-0.058)
Maximum	0.0043 (0.11)
Diameter	
Standard	3.4001 (86.365)
Oversize 1	3.4080 (86.565)
Pins	
Diameter	(1)
Piston Fit	(2)
Rod Fit	(1)
Rings	
No. 1 (Plain)	
End Gap	0.009-0.016 (0.25-0.40)
Side Clearance	0.0011-0.0025 (0.030-0.065)
No. 2 (Tapered)	
End Gap	0.008-0.016 (0.20-0.40)
Side Clearance	0.0008-0.0021 (0.020-0.055)
No. 3 (Oil)	
End Gap	0.098-0.019 (0.25-0.50)
Side Clearance	0.0008-0.0021 (0.020-0.055)

(1) Information is not available from manufacturer.

(2) Thumb pressure.

CYLINDER BLOCK

CYLINDER BLOCK

Application	In. (mm)
2.8L	
Cylinder Bore Diameter	
Standard	3.3071-3.3076 (84.000-84.014)
Oversize 1 (1)	3.3170-3.3163 (84.250-84.234)
Oversize 2 (2)	3.3268-3.3667 (84.500-85.514)
Maximum Taper	0.0004 (0.010)
Maximum Out-Of-Round	0.0004 (0.010)
3.2L	
Cylinder Bore Diameter	3.4015-3.3863 (86.400-86.014)
Maximum Taper	0.0004 (0.010)
Maximum Out-Of-Round	0.0002 (0.005)

(1) Aluminum block with cast iron liners or cast iron block.

(2) Cast iron block only.

VALVES & VALVE SPRINGS

VALVES & VALVE SPRINGS

Application	Specification
2.8L	
Intake Valves	
Face Angle	45°
Head Diameter	1.299" (33.0 mm)
Minimum Margin	(1)
Minimum Refinish Length	(1)
Stem Diameter	0.235" (5.975 mm)
Valve Tip Maximum Refinish	(1)
Exhaust Valves	
Face Angle	45°
Head Diameter	1.201" (30.5 mm)
Minimum Margin	(1)
Minimum Refinish Length	(1)
Stem Diameter	0.234" (5.960 mm)
Valve Tip Maximum Refinish	(1)
Valve Springs	(1)
3.2L	
Intake Valves	
Face Angle	45°

Head Diameter	1.181" (30.0 mm)
Minimum Margin	(1)
Minimum Refinish Length	(1)
Stem Diameter	0.236" (6.0 mm)
Valve Tip Maximum Refinish	(1)
Exhaust Valves	
Face Angle	45°
Head Diameter	1.062" (27 mm)
Minimum Margin	(1)
Minimum Refinish Length	(1)
Stem Diameter	0.236" (6.0 mm)
Valve Tip Maximum Refinish	(1)
Valve Springs	(1)
(1) Information is not available from manufacturer.	

CYLINDER HEAD

CYLINDER HEAD

Application	Specification
2.8L	
Cylinder Head Height	
New	5.512" (140.00 mm)
Minimum	5.500" (139.70 mm)
Maximum Warpage	0.0012" (0.03 mm)
Maximum Grind	0.010-0.014" (0.25-0.35 mm)
Valve Seats	
Intake Valve	
Seat Angle	45°
Seat Width	0.055-0.075" (1.40-1.90 mm)
Maximum Seat Runout	0.0012" (0.03 mm)
Seat Diameter	1.275" (32.40 mm)
Exhaust Valve	
Seat Angle	45°
Seat Width	0.055-0.075" (1.40-1.90 mm)
Maximum Seat Runout	0.0012" (0.03 mm)
Seat Diameter	1.157" (29.40 mm)
Valve Seat Inserts	
Intake	
Standard	
Insert Diameter	1.3426" (34.100 mm)

Bore Diameter	1.3386" (34.000 mm)
Oversize 1	
Insert Diameter	1.3504" (34.300 mm)
Bore Diameter	1.3465" (34.200 mm)
Oversize 2	
Insert Diameter	1.3583" (34.500 mm)
Bore Diameter	1.3544" (34.400 mm)
Exhaust	
Standard	
Insert Diameter	1.2441" (31.600 mm)
Bore Diameter	1.2402" (31.500 mm)
Oversize 1	
Insert Diameter	1.2520" (31.800 mm)
Bore Diameter	1.2481" (31.700 mm)
Oversize 2	
Insert Diameter	1.2599" (32.000 mm)
Bore Diameter	1.2559" (31.900 mm)
Installing Temperature	
Valve Seat Insert	-240°F (-150°C)
Cylinder Head	68°F (20°C)
Valve Guides	
Valve Guide Bore Diameter	(1)
Valve Guide I.D. (Installed)	
Standard	0.2362" (6.000 mm)
Oversize 1	0.2401" (6.100 mm)
Oversize 2	0.2440" (6.200 mm)
Valve Guide Installed Height (2)	0.173-0.197" (4.40-5.00 mm)
Valve Stem-To-Guide Oil Clearance	(3)
3.2L	
Cylinder Head Height	
New	5.512" (140.00 mm)
Minimum	(1)
Maximum Warpage	(1)
Maximum Grind	(1)
Valve Seats	
Intake Valve	
Seat Angle	45°
Seat Width	0.055-0.075" (1.40-1.90 mm)
Maximum Seat Runout	(1)
Seat Diameter	(1)

Exhaust Valve	
Seat Angle	45°
Seat Width	0.055-0.075" (1.40-1.90 mm)
Maximum Seat Runout	(1)
Seat Diameter	(1)
Valve Seat Inserts	(1)
Valve Guides	
Valve Guide Bore Diameter	(1)
Valve Guide I.D. (Installed)	
Standard	0.2362" (6.000 mm)
Oversize 1	0.2401" (6.100 mm)
Oversize 2	0.2440" (6.200 mm)
Valve Guide Installed Height	(1)
Valve Stem-To-Guide Oil Clearance	(3)

(1) Information is not available from the manufacturer.

(2) Measured from valve guide collar to cylinder head, on camshaft side.

(3) See **CYLINDER HEAD** under OVERHAUL.

CAMSHAFT

CAMSHAFT

Application	In. (mm)
2.8L	
Bore Diameter	(1)
End Play	0.006-0.013 (0.15-0.33)
Journal Diameter	1.18 (30.00)
Journal Runout	(1)
Lobe (Cam) Height	1.8504-1.8528 (47.000-47.060)
Lobe Lift	(1)
Oil Clearance	0.0008-0.0021 (0.020-0.054)
3.2L	
Bore Diameter	(1)
End Play	0.006-0.013 (0.15-0.33)
Journal Diameter	(1)
Journal Runout	(1)
Lobe (Cam) Height	(1)
Lobe Lift	(1)
Oil Clearance	0.0008-0.0021 (0.020-0.054)

(1) Information is not available from manufacturer.

VALVE LIFTERS

VALVE LIFTERS

Application	In. (mm)
2.8L & 3.2L	
Bore Diameter	(1)
Lifter Diameter	(1)
Oil Clearance	(1)
(1) Information is not available from manufacturer.	