

1.9L 4-CYL DIESEL

Article Text

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ARTICLE BEGINNING

1997-98 ENGINES
Volkswagen 1.9L Turbo Diesel

Beetle, Jetta, Passat

* PLEASE READ THIS FIRST *

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

ENGINE IDENTIFICATION

Engine identification code is stamped on engine block, between the injection pump and exhaust manifold. Engine identification is also on a sticker on the timing belt cover and on vehicle data plate.

ENGINE CODES

| Application | Code |
|----------------------|---------------------|
| Beetle | ALH |
| Jetta & Passat | AAZ, AHH, AHU Or 1Z |

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

NOTE: Hydraulic valve lifters are used. Valve clearance adjustment is not necessary.

THROTTLE CABLE ADJUSTMENT

Turn engine off. Depress accelerator pedal to wide-open throttle position. Adjust throttle cable by positioning retaining clip on throttle cable bracket in engine compartment to the outer cable grooves. Ensure injection pump lever just contacts the stop without excessive pressure.

TIMING BELT TENSION ADJUSTMENT CHECK

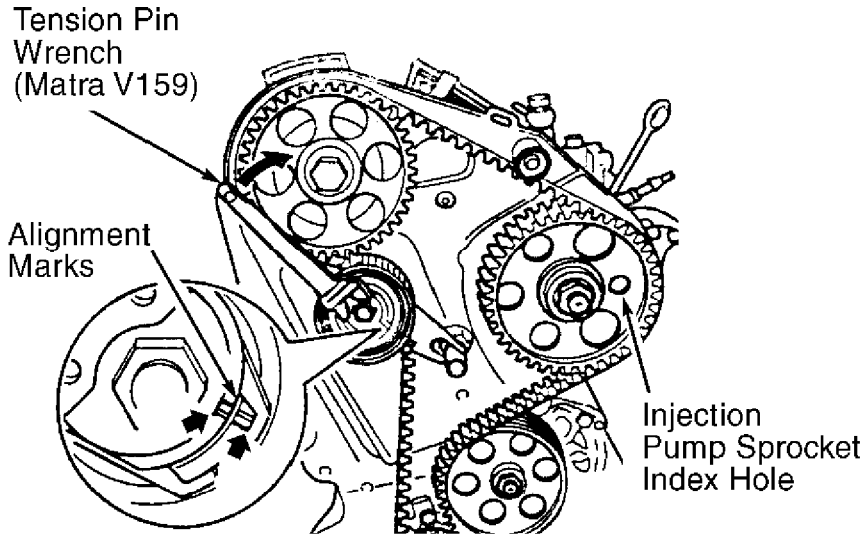
CAUTION: DO NOT rotate crankshaft while belt tension adjuster bolt is loose.

1) Remove accessory drive belts. Remove drive belt tensioner pulley and lever. Remove front cover. Inspect timing belt. Replace belt if cracked, or if oil or coolant soaked. Rotate crankshaft clockwise until No. 1 piston is at TDC of compression stroke and TDC mark on flywheel and bellhousing are aligned.

2) Rotate crankshaft 2 complete revolutions clockwise. Ensure No. 1 cylinder is at TDC, and injection pump sprocket can be locked using Locating Pin (2064). If injection pump sprocket does not align with index hole, remove timing belt and realign sprocket. To remove timing belt, see TIMING BELT under REMOVAL & INSTALLATION.

3) Install Tensioner Pin Wrench (MATRA V159) on timing belt tensioner pulley. See Fig. 1. Check belt tension by applying firm thumb pressure on wrench handle. Watch alignment mark at tensioner pulley. With pressure still applied, tensioner should move. Release thumb pressure. Tensioner should return to original position (with

notches aligned). Replace timing belt if tensioner pulley alignment notches do not align.



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Fig. 1: Timing Belt Tension Adjustment
Courtesy of Volkswagen of America

REMOVAL & INSTALLATION

* PLEASE READ THIS FIRST *

CAUTION: Radio/cassette or radio/CD player is equipped with an anti-theft protection circuit. Whenever battery is disconnected, radio will go into anti-theft mode. When battery is reconnected, radio will display CODE, and will be inoperative until proper code number is entered. Obtain security code before disconnecting battery.

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

BLEEDING COOLING SYSTEM

Information is not available from manufacturer.

FUEL PRESSURE RELEASE

Remove fuel pump relay (located in fuse/relay panel). Crank engine for 5 seconds. Turn ignition switch off. Reinstall fuel pump relay.

ENGINE

WARNING: Ensure jacks and safety stands are positioned properly and hoist brackets are attached to correct position on engine. Make sure car will not roll off stands and fall while working under it.

NOTE: Engine and transaxle are removed as an assembly.

Removal (Except Beetle)

1) Disconnect battery cables. Remove battery. Support hood in a vertical position. Remove air cleaner housing and intake hoses as an assembly. Disconnect throttle and cold start accelerator cable. Remove power steering pump and bracket and secure aside. Drain engine coolant. Disconnect exhaust pipe from turbocharger. Unbolt drive axle shafts from transaxle.

2) Relieve fuel pressure. See FUEL PRESSURE RELEASE.

Disconnect fuel supply and return lines. Disconnect hoses to charge air cooler. Disconnect intake manifold pressure line. Remove hood lock carrier assembly. Remove radiator fan and shroud. Disconnect all wiring harness connectors as required.

3) On vehicles equipped with A/C, remove mounting bolts to receiver-drier bracket, refrigerant line clamps, and suspend components without stretching or bending hoses. Remove A/C compressor and wire aside.

4) On vehicles equipped with manual transaxle, remove clutch slave cylinder. On all vehicles, disconnect shift linkages. Using an engine hoist, slightly raise engine. Remove all engine and transaxle mounting nuts and bolts. Remove engine and transaxle as an assembly.

Installation

1) To install, reverse removal procedure. Ensure that engine mount front and rear recess is aligned with tabs on mounting bracket. Tighten engine mounts to specifications. See TORQUE SPECIFICATIONS. Improper engine mount tightening will result in excessive engine vibration and premature engine mount wear.

2) Install drive axle shafts. Ensure all wire harness connectors and hoses are connected properly. Install and adjust throttle and cold start accelerator cables. See THROTTLE CABLE ADJUSTMENT under ADJUSTMENTS.

3) Install transaxle shift linkages. Adjust accessory drive belt tension. Fill all fluids to proper level. Bleed air from cooling system. See BLEEDING COOLING SYSTEM. Check for fluid leaks.

Removal (Beetle)

1) Disconnect and remove battery. Relieve fuel pressure. See FUEL PRESSURE RELEASE. Remove engine cover. Remove power steering reservoir from battery tray with hoses attached and secure aside. Disconnect and plug fuel supply and return lines from fuel filter.

2) Remove air cleaner. Remove connecting pipe, with EGR vacuum regulator attached, between charge air cooler and intake manifold. Disconnect shift linkage from transmission. On M/T models, remove clutch slave cylinder. On all models, remove engine undercover. Drain engine coolant.

3) Remove line between charge air cooler and turbocharger. Remove radiator hoses. Remove auxiliary filter on right side of vehicle. Remove pendulum support. Disconnect all necessary vacuum and breather hoses from engine. Remove front exhaust pipe. Remove accessory drive belt. Remove power steering hose brackets. Remove power steering pump with hoses attached and set aside.

4) On vehicles equipped with A/C, it is not necessary to discharge A/C system. Remove refrigerant hose brackets. Remove A/C compressor with hoses attached. Secure A/C compressor aside to prevent stressing hoses.

5) Remove starter. Remove right axle shaft from vehicle. See AXLE SHAFTS - FRONT article in DRIVE AXLES. Disconnect left axle shaft from transmission. Support engine/transmission assembly with suitable jack. Remove coolant hose bracket and lower from engine block.

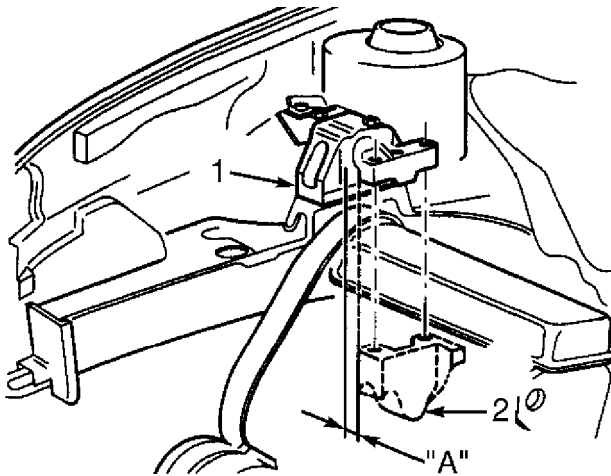
6) Slightly raise engine. Remove engine mount-to-engine bolts. Remove transmission mount-to-transmission bolts. Carefully lower engine/transmission assembly. Ensure power steering hoses clear transmission. Separate transmission from engine and remove engine from vehicle.

Installation

1) To install, reverse removal procedure. Ensure centering dowels for engine/transmission assembly are installed.

2) On A/T models, use NEW lock washer on shift cable. On all models, adjust all cables as necessary. Engine/transmission assembly is transversely aligned when distance "A" between upper engine mount "1" and "2" is .39" (10 mm). See Fig. 2. Fill fluids to proper level.

Tighten all fasteners to specification. See TORQUE SPECIFICATIONS.



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Fig. 2: Aligning Upper Engine Mount (Beetle)
 Courtesy of Volkswagen United States, Inc.

TURBOCHARGER

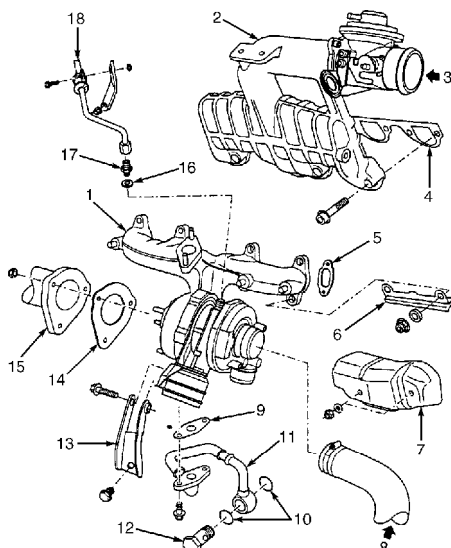
Removal

1) Turn ignition off. Disconnect negative battery cable. Remove intake manifold-to-turbocharger and turbocharger-to-air cleaner hoses. See Fig. 3, 4 Or 5. On AHU and 1Z engines, remove hose to wastegate by-pass valve.

2) On all engines, remove exhaust pipe and oil supply line from turbocharger. Remove mounting clip from intake manifold. Remove turbocharger/engine mount. Disconnect oil return line from turbocharger. Remove turbocharger-to-exhaust manifold mounting nuts and bolts. Remove turbocharger.

Installation

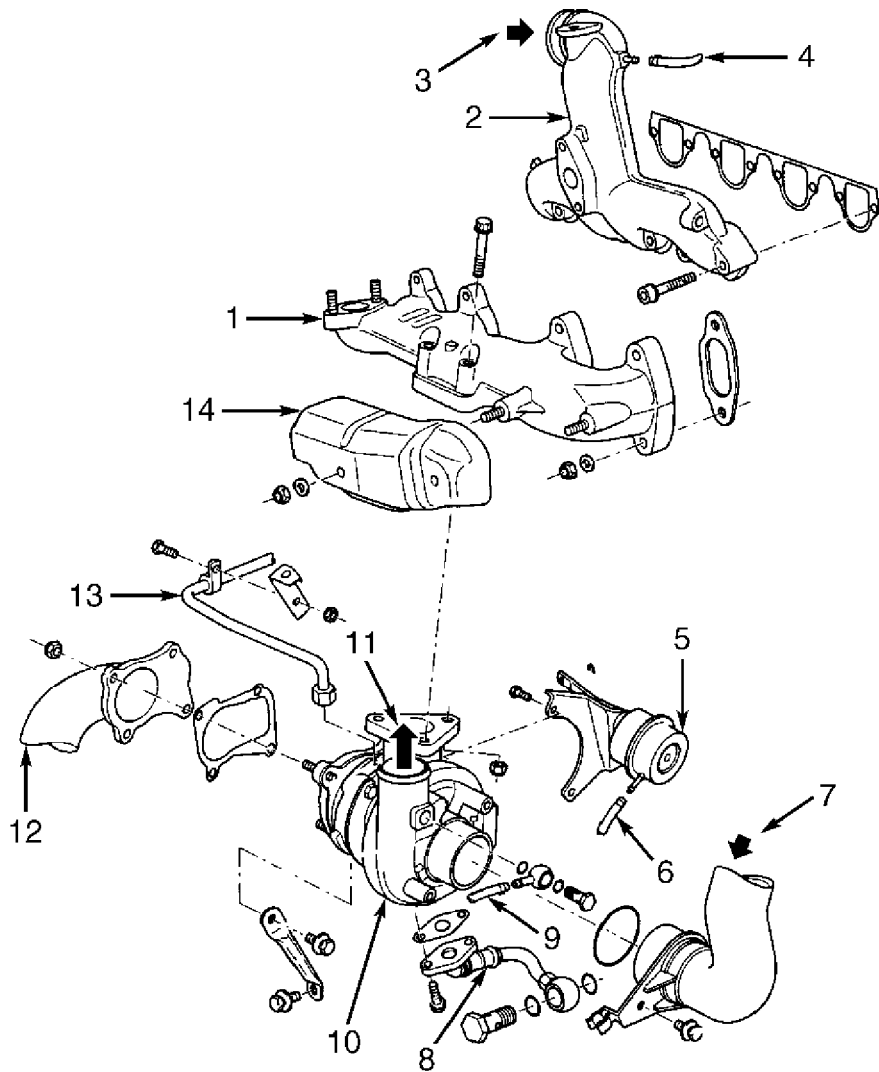
Install hose to wastegate by-pass valve. Apply anti-seize compound to bolt threads. Install turbocharger to exhaust manifold. Install turbocharger/engine mount. Install front exhaust pipe with NEW gasket. Fill turbocharger with engine oil through oil supply connection and install oil supply line. To complete installation, reverse removal procedure. Tighten components to specification. See TORQUE SPECIFICATIONS.



- | | |
|---------------------------|-----------------------|
| 1. Exhaust Manifold | 10. Sealing Ring |
| 2. Intake Manifold | 11. Oil Return Pipe |
| 3. From Charge Air Cooler | 12. Banjo Bolt |
| 4. Gasket | 13. Bracket |
| 5. Gasket | 14. Gasket |
| 6. Bracket | 15. From Exhaust Pipe |
| 7. Heat Shield | 16. Sealing Ring |
| 8. From Air Cleaner | 17. Connection |
| 9. Gasket | 18. Oil Supply Line |

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Fig. 3: Exploded View Of Turbocharger & Exhaust (ALH)
 Courtesy of Volkswagen United States, Inc.

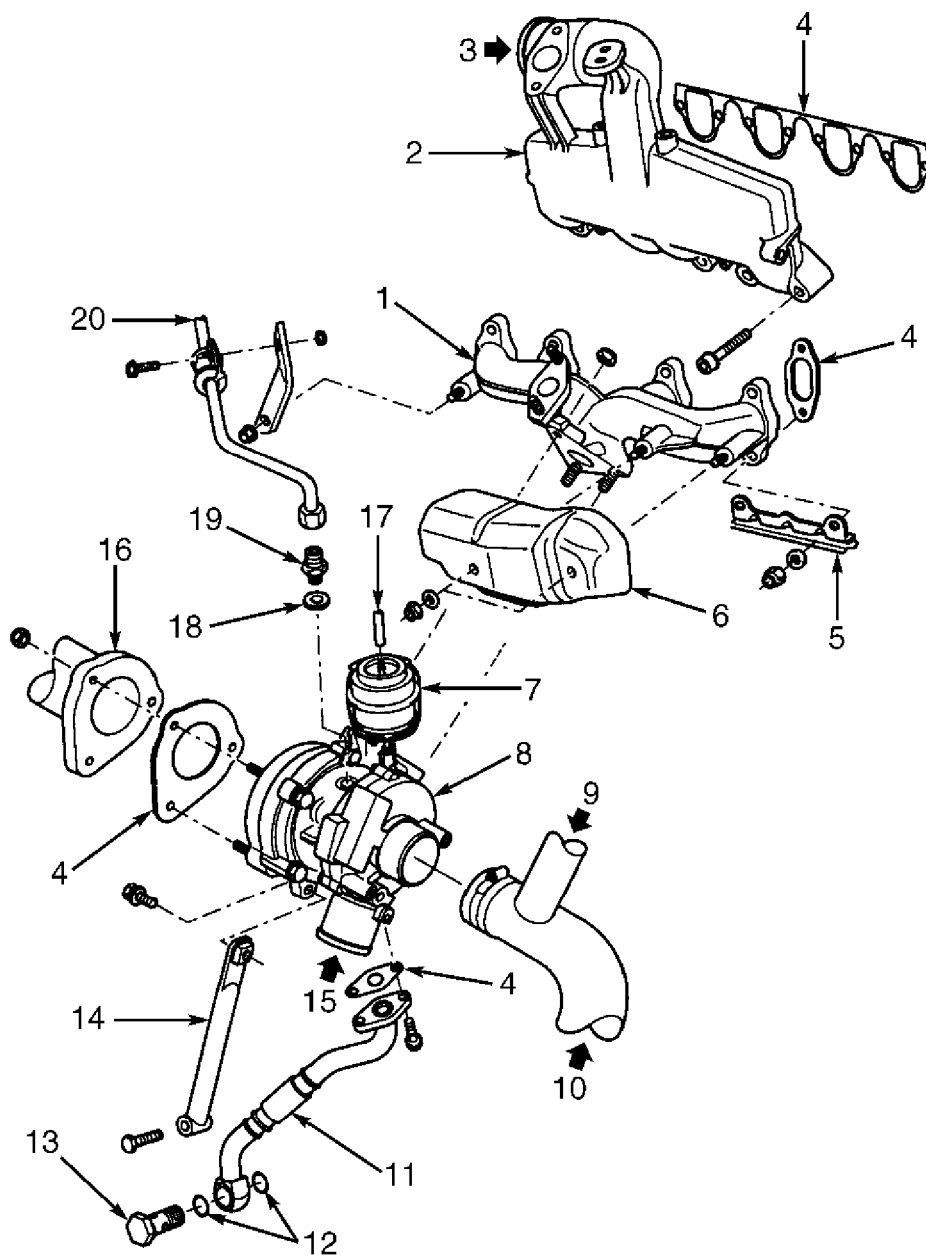


- | | |
|--|---|
| 1. Exhaust Manifold | 8. Turbocharger-To-Cylinder Block Oil Return Line |
| 2. Intake Manifold | 9. Turbocharger-To-Wastegate By-Pass Regulator Valve Hose |
| 3. From Charge Air Cooler | 10. Turbocharger |
| 4. Intake Manifold-To-ECM Hose | 11. To Charge Air Cooler |
| 5. Wastegate Valve | 12. Front Exhaust Pipe |
| 6. Wastegate Valve-To-Wastegate By-Pass Regulator Valve Hose | 13. Oil Supply Line |
| 7. From Air Cleaner | 14. Heat Shield |

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Fig. 4: Exploded View Of Turbocharger & Exhaust Manifold Components (AHU & 1Z)

Courtesy of Volkswagen United States, Inc.



- | | |
|---------------------------------|---|
| 1. Exhaust Manifold | 11. Oil Return Pipe |
| 2. Intake Manifold | 12. Sealing Ring |
| 3. From Charge Air Cooler | 13. Banjo Bolt |
| 4. Gasket | 14. Retainer |
| 5. Bracket | 15. To Charge Air Cooler |
| 6. Heat Shield | 16. From Exhaust Pipe |
| 7. Boost Pressure Control Valve | 17. Hose-To-Wastegate By-Pass Regulator |
| 8. Turbocharger | 18. Seal |
| 9. To PCV Valve | 19. Connection |
| 10. From Air Cleaner | 20. Oil Supply Line |

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Fig. 5: Exploded View Of Turbocharger & Exhaust Manifold Components (AHH)

Courtesy of Volkswagen United States, Inc.

INTAKE MANIFOLD

NOTE: Reference mark all hoses and harness connectors before disconnecting.

Removal

Allow engine to cool. Disconnect negative battery cable. Disconnect all hoses to intake manifold. Remove air cleaner assembly and intake air duct. Remove intake manifold assembly.

Installation

1) To install, reverse removal procedure. Clean intake manifold gasket mating surfaces. Install NEW gaskets. Install and

tighten manifold bolts to specification. See TORQUE SPECIFICATIONS.

2) Check throttle cable adjustment. See THROTTLE CABLE ADJUSTMENT under ADJUSTMENTS. Fill and bleed air from cooling system. See BLEEDING COOLING SYSTEM.

EXHAUST MANIFOLD

Removal & Installation

Allow engine to cool. Disconnect negative battery cable. Remove exhaust pipe from turbocharger. Remove turbocharger. See TURBOCHARGER. Remove exhaust manifold assembly. See Fig. 3, 4 or 5. To install, reverse removal procedure. Tighten exhaust manifold nuts and bolts to specification. See TORQUE SPECIFICATIONS.

CYLINDER HEAD

CAUTION: To prevent cylinder head damage, DO NOT remove cylinder head while engine is hot.

CAUTION: DO NOT rotate engine with timing belt removed, engine damage will occur.

Removal (Except Beetle)

1) Drain coolant. Remove intake and exhaust manifolds. See EXHAUST MANIFOLD and INTAKE MANIFOLD. Remove drive belts. Remove timing belt. See TIMING BELT. If reusing timing belt, mark direction of belt rotation for installation reference.

2) Remove PCV system, then remove valve cover. Remove crankcase breather. Remove cylinder head bolts in reverse of tightening sequence. See Fig. 6. Remove cylinder head.

Removal (Beetle)

1) Ensure engine is not hot and pistons are not positioned at TDC. Disconnect negative battery cable. Remove engine cover. Remove air cleaner. Drain coolant. Remove intake and exhaust manifolds. See EXHAUST MANIFOLD and INTAKE MANIFOLD.

2) Relieve fuel pressure. See FUEL PRESSURE RELEASE. Disconnect and plug fuel supply and return lines at fuel filter. Remove front exhaust pipe. Remove accessory drive belts.

3) Remove wiper arms. Remove plenum chamber cover. Remove fuel filter with bracket. Disconnect all necessary wiring connections. Remove coolant reservoir and set aside.

4) Remove timing belt. See TIMING BELT. If reusing timing belt, mark direction of belt rotation for installation reference. Remove brake booster vacuum pump. Remove turbocharger oil supply line. Remove PCV system, then remove valve cover. Remove crankcase breather.

5) Remove injector lines. Remove glow plug harness connector. Install Engine Support Bracket (10-222A with 10-222A/1 legs attached to cylinder head lifting eyes). Raise engine slightly at spindle "B". See Fig. 7.

6) Attach Bracket T10014 to cylinder block using threaded hole in water pump area. Lift engine slightly at spindle "A" bracket until tension is relieved at lifting eyes. Remove spindle "B". Position engine at TDC with camshaft sprocket loosened (timing belt removed).

7) Remove tension roller and camshaft sprocket. Remove rear belt guard upper bolt. Remove cylinder head bolts in reverse of tightening sequence. See Fig. 6. Remove cylinder head.

Inspection (All Models)

Clean gasket mating surfaces. Cylinder head with cracks between valve seats may be reused provided that cracks are not greater

than .002" (.50 mm) wide. DO NOT reuse cylinder head if warpage exceeds .004" (.10 mm).

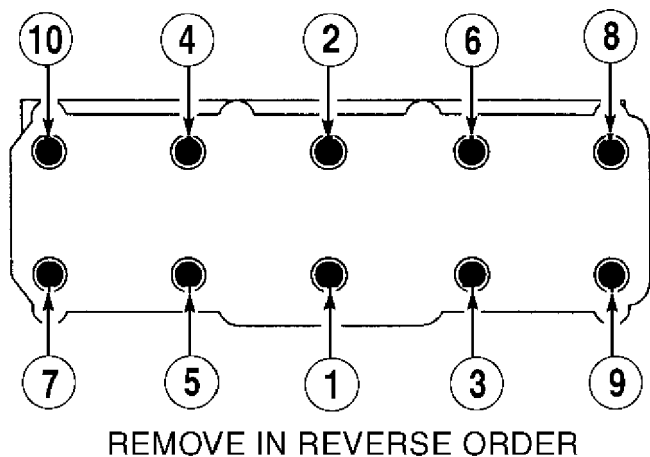
NOTE: Always replace cylinder head bolts. Handle cylinder head gasket carefully as not to damage silicone layer on gasket.

Installation (All Models)

1) To install, reverse removal procedure. Set crankshaft to TDC mark, then rotate crankshaft counterclockwise until all pistons are below TDC. Align appropriate cylinder head gasket using Guide Pin (3070). See CYLINDER HEAD under OVERHAUL.

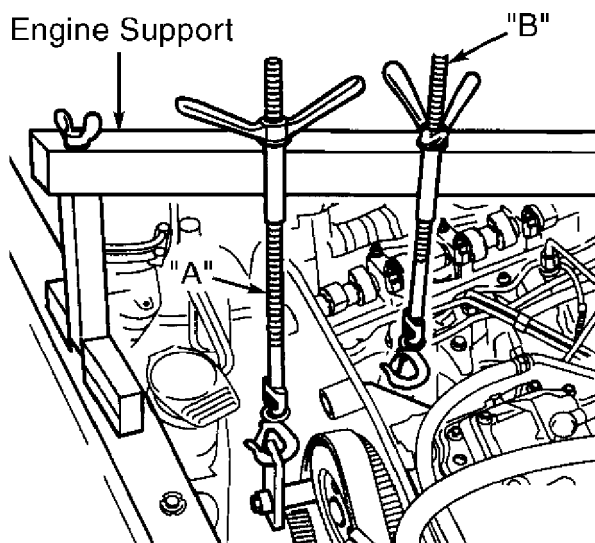
2) Install cylinder head. Remove guide pins and install NEW cylinder head bolts. Tighten bolts by hand, then tighten bolts in 4 stages. See TORQUE SPECIFICATIONS.

3) Rotate camshaft until cylinder No. 1 lobes are pointing straight up. Rotate crankshaft clockwise to TDC before installing timing belt. Install timing belt. See TIMING BELT. Check timing belt tension. See TIMING BELT TENSION ADJUSTMENT CHECK under ADJUSTMENTS. Fill and bleed cooling system. See BLEEDING COOLING SYSTEM.



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Fig. 6: Cylinder Head Bolt Tightening Sequence
Courtesy of Volkswagen United States, Inc.



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Fig. 7: Attaching Engine Support (Beetle)
Courtesy of Volkswagen United States, Inc.

FRONT COVER OIL SEAL

Removal (Except Beetle)

1) Remove crankshaft pulley and timing belt. See TIMING BELT. Using bolt from Seal Extractor Set (3083), screw bolt into crankshaft as far as it will go. Unscrew inner part of oil seal extractor 2 turns out from outer part, then tighten lock nut on extractor.

2) Lubricate threaded head of seal extractor and screw into

oil seal as far as possible. Loosen lock nut on extractor and rotate inner section against crankshaft until oil seal is pulled out.

Installation

Lubricate seal lip with engine oil. Place guide sleeve from Seal Extractor Set (3083) onto crankshaft. Slide oil seal over guide sleeve. Using sleeve from seal extractor set, press in NEW oil seal into crankshaft.

Removal (Beetle)

1) Remove crankshaft pulley and timing belt. See TIMING BELT. Using Counterholding Tool (3415), remove timing belt sprocket. Drain engine oil. Remove oil pan. Unbolt front sealing flange and remove if necessary.

2) Lubricate threaded head of seal extractor and screw into oil seal as far as possible. Loosen lock nut on extractor and rotate inner section against crankshaft until oil seal is pulled out. Using a flat scraper, remove any sealant residue on cylinder block. Ensure sealing surface is free from oil and grease.

Installation

Lubricate seal lip with engine oil. Place guide sleeve from Seal Extractor Set (2080A) onto crankshaft. Slide oil seal over guide sleeve. Using Sleeve (3265) from seal extractor set, press in NEW oil seal into crankshaft using center bolt.

TIMING BELT

CAUTION: DO NOT rotate engine with timing belt removed unless instructed to do so, engine damage will occur.

Removal (Except Beetle)

1) Remove accessory drive belts. Remove drive belt tensioner pulley and lever. Remove timing belt covers. Remove valve cover. Rotate crankshaft clockwise until No. 1 piston is at TDC of compression stroke and TDC mark on flywheel and bellhousing are aligned.

2) Lock camshaft using Setting Bar (2065A). See Fig. 8. Center setting bar by turning camshaft so one side of setting bar contacts cylinder head. Using feeler gauge, measure gap between other end of setting bar and cylinder head. Divide that measurement in half. Use this reading and place feeler gauge on between cylinder head and setting bar.

3) Turn camshaft until setting bar contacts feeler gauge. Using a second feeler gauge with the same measurement as the first one, place feeler gauge on the opposite side (between setting bar and cylinder head).

4) Using Lock Pin (2064), insert pin into injection pump sprocket aligning hole. Remove crankshaft pulley and idler pulley. If timing belt is to be reused, mark direction of rotation on belt. Loosen timing belt tensioner. Remove timing belt.

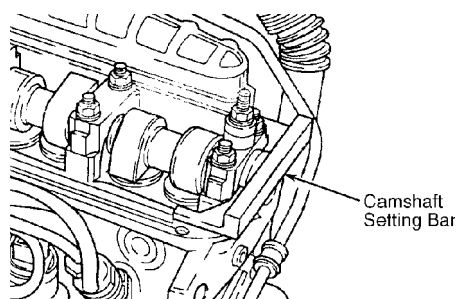


Fig. 8: Locking Camshaft With Setting Bar
Courtesy of Volkswagen United States, Inc.

Installation

1) Ensure cylinder No. 1 is at TDC. Check reference mark on flywheel and bellhousing. Ensure cylinder No. 1 lobes on camshaft are pointing up and Setting Bar (2065A) is installed. Ensure injection pump is on No. 1 and Lock Pin (2064) is installed in injection pump aligning hole.

2) Loosen camshaft sprocket bolt 1/2 turn. Using soft-faced hammer and drift, loosen sprocket from tapered end of camshaft. Install timing belt over sprockets.

3) If reusing old belt, ensure belt is traveling correct direction. Install Tensioner Pin Wrench (MATRA V159) on timing belt tensioner pulley. See Fig. 1. Apply firm thumb pressure on wrench handle until notches are aligned. Tighten tensioner roller clamp nut. Tighten camshaft sprocket bolt.

4) Ensure TDC marks on flywheel are still aligned. Remove setting bar and lock pin. Rotate crankshaft 2 complete revolutions (by hand). Place crankshaft at TDC. Ensure lock pin and setting bar can be inserted. If lock pin or setting bar cannot be inserted, recheck timing belt installation. Correct as needed.

5) Injection pump pulley mounting bolts may be loosened and retightened to help alignment pin to be inserted. To complete installation, reverse removal procedure. Tighten nuts and bolts to specification. See TORQUE SPECIFICATIONS.

Removal (Beetle)

1) Remove tube between charge air cooler and air intake pipe. Relieve fuel pressure. See FUEL PRESSURE RELEASE. Disconnect and plug fuel supply at fuel filter. Remove fuel filter and bracket.

2) Remove upper timing belt cover. Remove valve cover and brake booster vacuum pump. Remove right side insulation tray. Remove accessory drive belt. Rotate engine till cylinder No. 1 is at TDC compression stroke.

3) Lock camshaft using Setting Bar (3148). See Fig. 8. Center setting bar by turning camshaft so one side of setting bar contacts cylinder head. Using feeler gauge, measure gap between other end of setting bar and cylinder head. Divide that measurement in half. Use this reading and place feeler gauge on between cylinder head and setting bar.

4) Turn camshaft until setting bar contacts feeler gauge. Using a second feeler gauge with the same measurement as the first one, place feeler gauge on the opposite side (between setting bar and cylinder head).

5) Using Lock Pin (3359), insert pin into injection pump sprocket aligning hole. Loosen camshaft sprocket mounting bolt. Install Engine support (10222A with Legs 10222A/1).

6) Remove upper engine mount. Remove crankshaft pulley and idler pulley. Remove lower belt cover. If timing belt is to be reused, mark direction of rotation on belt. Loosen timing belt tensioner. Remove timing belt.

Installation

1) Ensure cylinder No. 1 is at TDC. Check reference mark on flywheel and bellhousing. Loosen camshaft sprocket bolt 1/2 turn. Using soft-faced hammer and drift, loosen sprocket from tapered end of camshaft. Install timing belt over sprockets.

2) If reusing old belt, ensure belt is traveling correct direction. Install Tensioner Pin Wrench (MATRA V159) on timing belt tensioner pulley. See Fig. 1. Apply firm thumb pressure on wrench handle until notches are aligned. Tighten tensioner roller clamp nut. Tighten camshaft sprocket bolt.

3) Ensure TDC marks on flywheel are still aligned. Remove alignment tools. Rotate crankshaft 2 complete revolutions. Place crankshaft at TDC. Ensure alignment tools can be inserted. If alignment tools cannot be inserted, recheck timing belt installation.

Correct as needed.

4) Injection pump pulley mounting bolts may be loosened and retightened to help alignment pin to be inserted. To complete installation, reverse removal procedure. Tighten nuts and bolts to specification. See TORQUE SPECIFICATIONS.

CAMSHAFT

CAUTION: If NEW lifters have been installed, to prevent damage to valves and/or pistons, DO NOT start engine for 30 minutes after installation to allow hydraulic compensation elements to settle.

Removal

Remove timing belt. See TIMING BELT. Remove camshaft sprocket. Remove camshaft bearing caps 1, 3 and 5, then loosen bearing caps No. 2 and 4, alternately and diagonally. See Fig. 9. Remove camshaft caps and camshaft.

Inspection

1) Remove lifters from cylinder head. Place camshaft on cylinder head. Install and tighten the first and last bearing caps to specified torque. See TORQUE SPECIFICATIONS. Note offset on camshaft bearing caps before installation. Check camshaft axial clearance by pushing camshaft back and forth. Maximum wear limit is .006" (.15 mm).

2) Remove bolts and camshaft holders from cylinder head. Remove camshaft from cylinder head and wipe clean. Replace camshaft if lobes and bearing journals show excessive wear, pitting or scoring. Clean camshaft bearing surfaces in cylinder head and set camshaft back in place. Insert Plastigage across each journal. Install camshaft holders and tighten bolts as specified. See TORQUE SPECIFICATIONS.

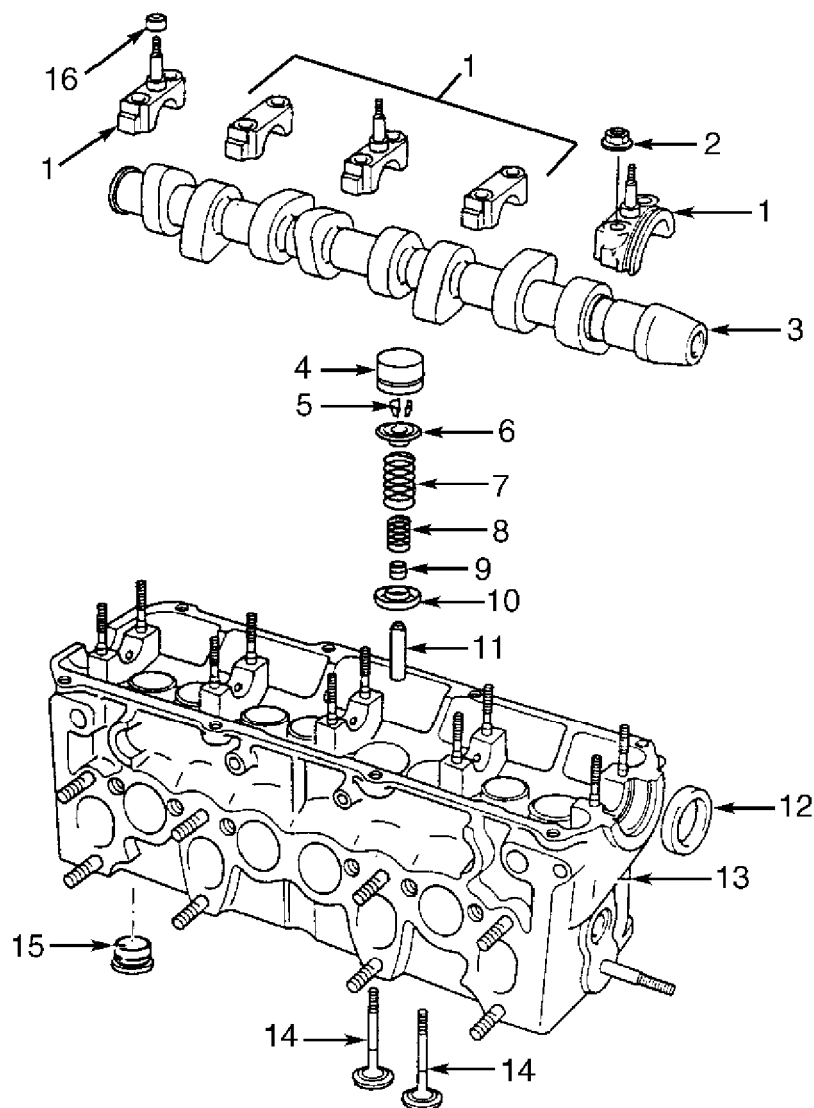
3) Measure widest portion of Plastigage on each journal. If camshaft-to-bearing cap oil clearance is out of specifications and camshaft has already been replaced, cylinder head must be replaced. If camshaft has not been replaced, measure runout. If runout is within specifications, replace cylinder head. See CAMSHAFT table under ENGINE SPECIFICATIONS. If runout exceeds specifications, replace camshaft and recheck. If oil clearance still exceeds specifications, replace cylinder head.

NOTE: When installing camshaft, ensure cylinder No. 1 camshaft lobes are pointing up.

Installation

1) Lubricate camshaft journals and journal surfaces in caps and cylinder head. Install camshaft with cylinder No. 1 camshaft lobes pointing up.

2) Install and tighten camshaft bearing caps No. 2 and 4, alternately and diagonally. Install and tighten bearing caps 1, 3 and 5. Seat bearing cap No. 5 by lightly tapping on end of camshaft. Tighten camshaft bearing cap bolts to specification. See TORQUE SPECIFICATIONS. To complete installation, reverse removal procedure.



- | | |
|-----------------------------|------------------------------|
| 1. Camshaft Bearing Caps | 9. Valve Stem Seal |
| 2. Bearing Cap Nut | 10. Lower Valve Spring Plate |
| 3. Camshaft | 11. Valve Guide |
| 4. Hydraulic Lifter | 12. Oil Seal |
| 5. Valve Keepers | 13. Cylinder Head |
| 6. Upper Valve Spring Plate | 14. Valves |
| 7. Outer Valve Spring | 15. Swirl Chamber |
| 8. Inner Valve Spring | 16. Lower Sealing Cone |

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Fig. 9: Exploded View Of Cylinder Head Components
 Courtesy of Volkswagen United States, Inc.

REAR CRANKSHAFT OIL SEAL

NOTE: Rear crankshaft oil seal and retaining flange **MUST BE** replaced as a unit.

Removal & Installation

Remove flywheel and discard bolts. See TRANSMISSION REMOVAL & INSTALLATION - A/T article in AUTOMATIC TRANSMISSION SERVICING section for automatic transaxle or CLUTCH article for manual transaxle. Remove retaining flange and seal assembly. Replace flange and seal assembly as a unit. To complete installation, reverse removal procedure. Install NEW flywheel bolts.

WATER PUMP

NOTE: On Beetle, removal of water pump requires removal of timing belt. See TIMING BELT.

Removal & Installation (Except Beetle)

Disconnect negative battery cable. Turn heater control to

hot. Drain cooling system. Remove accessory drive belts. Remove water pump. To install, reverse removal procedure. Fill and bleed air from cooling system. See BLEEDING COOLING SYSTEM.

OIL PAN

Removal & Installation

1) Remove center, left and right engine undercovers. Remove oil pan bolts. Remove oil pan using rubber hammer if necessary. Remove sealant residue from cylinder block and oil pan. Ensure surfaces are free from grease and oil.

2) To install, apply 2-3 mm thick silicone bead around sealing surface of oil pan. Immediately install oil pan and lightly tighten all bolts. Ensure oil pan is flush with cylinder block. Tighten bolts to specification. See TORQUE SPECIFICATIONS. To complete installation, reverse removal procedures. Allow sealer to dry for 30 minutes before installing engine oil.

OVERHAUL

CYLINDER HEAD

Cylinder Head

1) Clean all gasket mating surfaces. Check cylinder head for warpage. See CYLINDER HEAD table under ENGINE SPECIFICATIONS. DO NOT machine cylinder head.

2) When engine block or new pistons are installed, check piston crown projection with piston at TDC. To check piston projection, use a dial indicator and Mounting Block (VW385/17) mounted on top of engine block.

3) Measure clearance between top surface of engine block and crown/top of piston to determine appropriate head gasket thickness. See HEAD GASKET IDENTIFICATION table. If clearance is greater than the thickest available head gasket, repair lower end as necessary.

HEAD GASKET IDENTIFICATION

| Notches On Gasket (1) | | Piston Projection - In. (mm) |
|-----------------------|-------|------------------------------|
| 1 | ..... | .036-.039 (0.91-1.00) |
| 2 | | .040-.043 (1.01-1.10) |
| 3 | | .044-.047 (1.11-1.20) |

(1) - Notches are located next to gasket part number.

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Valve Stem Oil Seals

Remove camshaft. See CAMSHAFT under REMOVAL & INSTALLATION. To prevent damage to the new valve stem seals, place plastic sleeve on the end of valve stem. Lubricate valve stem seal and place in Seal Installer (US 5042) and carefully push onto valve guide.

Valve Spring

Remove valve spring using Lever (VW 541/1A) and Press Piece (VW 541/5 or US 5042). Valves are supported by piston crown.

Valve Guide Inspection

Place dial indicator against valve head. Insert new valve into guide until end of valve stem is flush with end of guide. Ensure that intake and exhaust valves are not interchanged. Move valve from side to side and note play. Play should not exceed .05" (1.3 mm).

NOTE: Always reface valve seat after replacing valve guide.

Valve Seat

Valve seat should be reworked just enough to produce a perfect seating pattern. Valve seat angle should not exceed 45 degrees. If reworking dimension is exceeded, replace cylinder head.

Valves

Measure valve stem diameter and margin. Replace valve if not within specifications. See VALVES & VALVE SPRINGS table under ENGINE SPECIFICATIONS. Valve grinding is not permitted. Valve lapping by hand is permitted.

Valve Seats

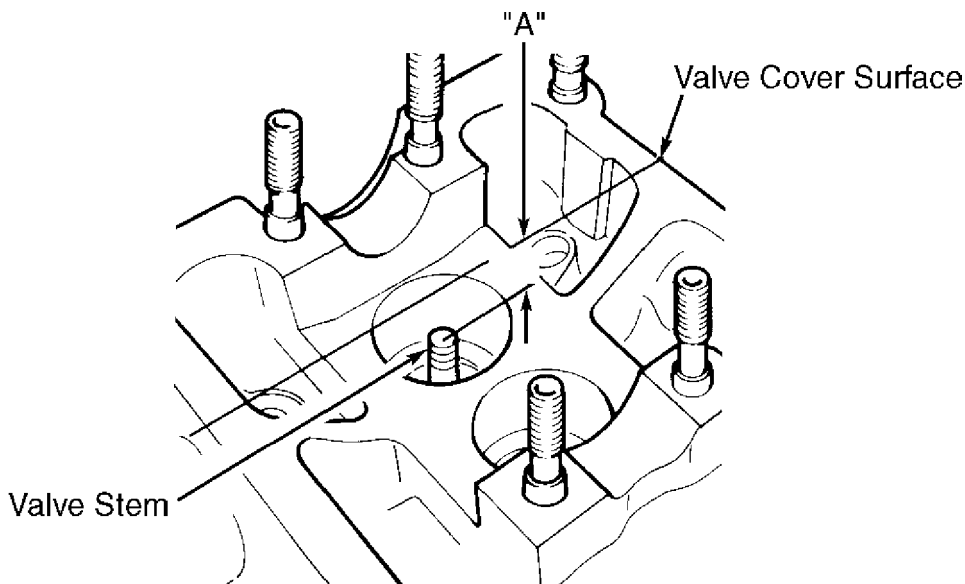
1) Insert valve into cylinder head. Holding valve closed, measure the valve stem-to-cylinder head edge distance. See Fig. 10.

2) This measurement determines installed valve height. Subtract measured distance from minimum specification. See MINIMUM VALVE INSTALLED HEIGHT table.

MINIMUM VALVE INSTALLED HEIGHT

| Application | In. (mm) |
|---------------|----------------|
| Intake Valve | 1.41 (35.8 mm) |
| Exhaust Valve | 1.42 (36.1 mm) |

3) The difference is maximum refacing allowable for valve and seat. If valve installed height is too high, replace cylinder head assembly. If valve installed height is too low or too high, cam followers will not work correctly.



G96A19117
Fig. 10: Measuring Valve Installed Height
Courtesy of Volkswagen United States, Inc.

CYLINDER BLOCK ASSEMBLY

Piston & Rod Assembly

1) Ensure piston, rod and rod caps are marked with matching cylinder number prior to removal. Ensure engine front arrow is marked on top of piston and front mark exists on rod and cap. See Fig. 11. Pistons and rods are to be replaced in set of 4. Rod cap bolts MUST BE replaced after removing or loosening.

2) Mark piston in relation to piston pin. Remove circlips from ends of piston pin bore. Use Piston Pin Replacer/Installer (VW 222A) to remove and install the piston pin. If the piston pin is too tight, heat piston to 140°F (60°C). Ensure rod is properly positioned

with piston. See Fig. 11.

Fitting Pistons

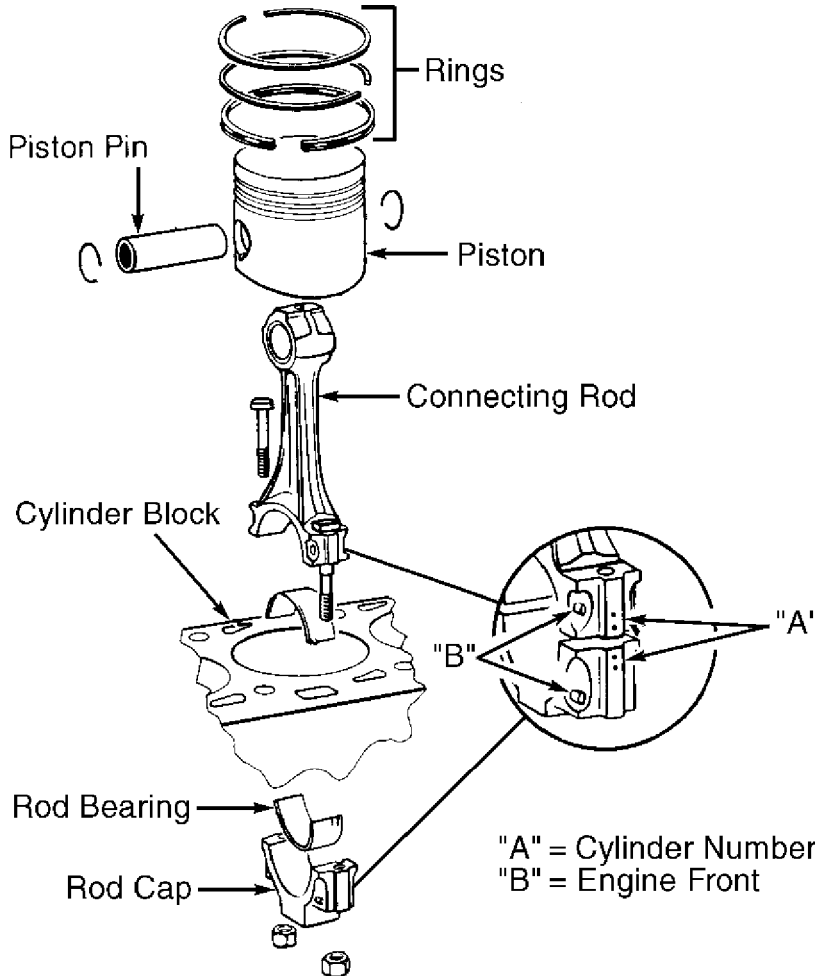
Measure clearance with cylinder block supported on work bench. Check clearance of piston-to-cylinder bore. See PISTON-TO-CYLINDER BORE DIMENSIONS table. Piston diameter is stamped on top of piston.

PISTON-TO-CYLINDER BORE DIMENSIONS

| Size | Piston Diameter | Cylinder Bore |
|--------------|-------------------|-------------------|
| Standard | 3.128" (79.47 mm) | 3.130" (79.51 mm) |
| 1st Oversize | 3.138" (79.72 mm) | 3.140" (79.76 mm) |
| 2nd Oversize | 3.148" (79.97 mm) | 3.149" (80.01 mm) |

Piston Rings

Measure ring end gap. Measure ring side clearance with piston. If not within specification, replace as necessary. See PISTONS, PINS & RINGS table under ENGINE SPECIFICATIONS. Install rings on piston with TOP mark facing upward. Recessed edge on outside of center ring must face position pin (down). Position ring gaps on piston at 120 degree intervals. See Fig. 11. Ensure no ring gap aligns with piston pin.



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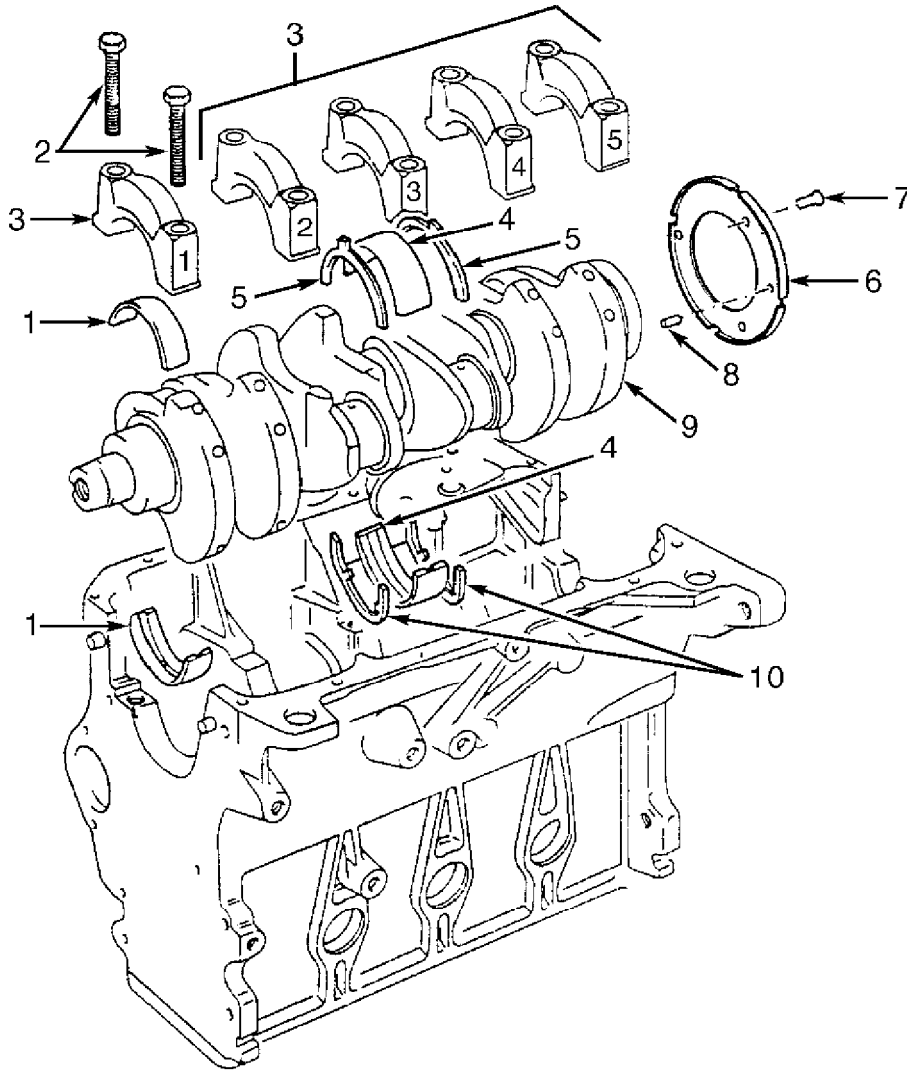
Fig. 11: Assembling Piston and Rod
 Courtesy of Volkswagen United States, Inc.

Rod Bearings

Mark rod caps for reinstallation. Measure oil clearance using Plastigage. Measure rod side play. Replace or machine as necessary. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS and CONNECTING RODS tables under ENGINE SPECIFICATIONS. Tighten specification. See TORQUE SPECIFICATIONS.

Crankshaft & Main Bearings

Main bearing caps are marked with matching with matching journal for installation in original position. See Fig. 12. Measure crankshaft axial clearance. Axial clearance wear limit is .015" (.37 mm). Measure crankshaft radial clearance. Radial clearance limit is .007" (.17 mm).



- | | |
|------------------------|------------------------------|
| 1. Crankshaft Bearings | 6. Engine Speed Sensor Wheel |
| 2. Bearing Cap Bolts | 7. Sensor Bolt |
| 3. Bearing Caps | 8. Sensor Wheel Dowel Pin |
| 4. Crankshaft Bearing | 9. Crankshaft |
| 5. Thrust Washer | 10. Thrust Washer |

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Fig. 12: Exploded View Of Crankshaft Assembly
Courtesy of Volkswagen United States, Inc.

Thrust Bearing

Replace worn parts as necessary. Thrust washer thickness is fixed. DO NOT change thrust washer thickness by grinding or shimming. Install thrust washers as specified. See Fig. 12.

Cylinder Block

1) Measure engine block while supported on work bench. Measure cylinder bore taper at 3 positions. If taper exceeds specification, re-bore cylinder for oversize pistons. See CYLINDER BLOCK table under ENGINE SPECIFICATIONS.

2) Using a feeler gauge and straightedge, measure cylinder block deck warpage. Replace cylinder block if warped beyond service limit. See CYLINDER BLOCK table.

ENGINE LUBRICATION SYSTEM

Crankcase Capacity
See CRANKCASE CAPACITY table.

CRANKCASE CAPACITY

| Application | Qts. (L) |
|----------------------------|-----------|
| Without Filter Replacement | 4.2 (4) |
| With Filter Replacement | 4.7 (4.5) |

Oil Pressure

Check oil pressure with engine at normal operating temperature. Minimum oil pressure with engine at 2000 RPM should be 29 psi (2.0 kg/cm²). Oil pressure should not exceed 102 psi (7.2kg/cm²) at higher engine RPM.

OIL PUMP

Removal & Installation

Remove oil pan. See OIL PAN under REMOVAL & INSTALLATION. Remove oil pump mounting bolts and remove oil pump assembly. To install, reverse removal procedure.

Inspection

Measure backlash rotor clearance. Measure axial play. Replace components if not within specification. See OIL PUMP SPECIFICATIONS table. Inspect both rotors and pump housing for scoring or other damage and replace if necessary.

OIL PUMP SPECIFICATIONS

| Application | In. (mm) |
|------------------|-------------|
| Backlash | |
| Standard (New) | .002 (0.05) |
| Service Limit | .008 (0.20) |
| Axial Play Limit | .006 (0.15) |

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

| Application | Ft. Lbs. (N.m) |
|--------------------------------------|----------------|
| Axle Shaft Flange Bolts | |
| Except Beetle | 33 (45) |
| Beetle | 30 (40) |
| Camshaft Bearing Cap Nuts | 15 (20) |
| Camshaft Sprocket Bolt | 33 (45) |
| Connecting Rod Cap Bolt | (1) 22 (30) |
| Crankshaft Bearing Cap Bolt | (1) 48 (65) |
| Crankshaft Rear Oil Seal Flange Bolt | 18 (25) |
| Crankshaft Sprocket Bolt | |
| Except Beetle | (1) 66 (90) |
| Beetle | (1) 88 (120) |
| Cylinder Head Bolt (2) | |
| Step 1 | 30 (40) |
| Step 2 | 44 (60) |
| Step 3 | (1) |
| Step 4 | (1) |

| | | | |
|---|-----|-----|---------|
| Drive Plate Bolt | (1) | 44 | (60) |
| Engine Mounts | | | |
| Beetle | | | |
| Front | | | |
| Mount-To-Body Bolt | (1) | 30 | (40) |
| Mount/Bracket-To-Body Bolt | | 18 | (25) |
| Mount-To-Engine Bracket Bolt | (1) | (2) | 44 (60) |
| Right Rear Engine/Transmission | | | |
| Mount-To-Body Bolt | (1) | 30 | (40) |
| Mount-To-Body Bolt | | 18 | (25) |
| Mount-To-Transmission Console Bolt | (1) | 44 | (60) |
| Except Beetle | | | |
| Front | | | |
| Bracket-To-Mount Top Bolt | | 44 | (60) |
| Mount-To-Frame Bottom Bolt | | 41 | (55) |
| Mounting Bracket-To-Engine Bolt | | 44 | (60) |
| Left Rear | | | |
| Bracket-To-Engine Mount Bolt | | 44 | (60) |
| Bracket-To-Transaxle Bolt | | 18 | (25) |
| Engine Mount Bolt | | 22 | (30) |
| Right Rear | | | |
| Bracket-To-Engine Mount Bolt | | 44 | (60) |
| Engine Mount Bolt | | 44 | (60) |
| Mounting Bracket-To-Engine Bolt | | 18 | (25) |
| Engine-To-Transaxle Mounting Bolt | | | |
| 10 mm Bolt | | 44 | (60) |
| 12 mm Bolt | | 59 | (80) |
| EGR | | | |
| Connecting Pipe-To-EGR Bolt | | 18 | (25) |
| Connecting Pipe-To-Manifold Nut | | 18 | (25) |
| Exhaust Manifold Nut | | 18 | (25) |
| Exhaust-To-Turbocharger Bolt (Beetle) | | 18 | (25) |
| Flywheel Bolt | (1) | 44 | (60) |
| Front Exhaust Pipe Bolt | | 18 | (25) |
| Front Seal Flange Bolt | | 11 | (15) |
| Fuel Injectors | | 52 | (70) |
| Fuel Injector Lines | | 18 | (25) |
| Generator Mounting Bolt | | 18 | (25) |
| Glow Plugs | | 11 | (15) |
| Idler Pulley Bolt | (1) | 30 | (40) |
| Injection Pump Pulley Bolt (1) | | 15 | (20) |
| Intake Manifold Bolt | | 18 | (25) |
| Oil Cooler Nut | | 18 | (25) |
| Oil Filter Bracket Mount Bolt | | 18 | (25) |
| Oil Filter Sealing Cap | | 18 | (25) |
| Oil Pan-To-Engine Block Bolt | | 15 | (20) |
| Oil Pan-To-Transmission Bolt | | 33 | (45) |
| Oil Pan Drain Plug | | 22 | (30) |
| Oil Pump Housing Bolts | | | |
| Except Beetle | | | |
| Long Bolt | | 18 | (25) |
| Short Bolt | | 7 | (10) |
| Beetle | | 11 | (15) |
| Oil Pump Sprocket Bolt | | 18 | (25) |
| Oil Spray Jet Bolt | | | |
| Except Beetle | | | |
| Beetle | | 7 | (10) |
| Beetle | | 18 | (25) |
| Oil Supply Banjo Bolt | | 15 | (20) |
| Pendulum Support | | | |
| Support-To-Transmission Bolt | (1) | 30 | (40) |
| Support To Engine Bolt | (1) | 15 | (20) |
| Tensioner-To-Engine Block Bolt | | 18 | (25) |
| Timing Belt Tension Adjuster Bolt | | 15 | (20) |
| Torque Converter-To-Drive Plate Bolt (Beetle) | | 44 | (60) |

| | |
|-------------------------------------|---------|
| Turbocharger | |
| Exhaust Manifold Nuts & Bolts | 18 (25) |
| Oil Return Line Banjo & Flange Bolt | |
| Except Beetle | 22 (30) |
| Beetle | 18 (25) |
| Oil Supply Line Nuts | 18 (25) |
| Water Pump Mounting Bolt | |
| Except Beetle | 89 (10) |
| Beetle | 11 (15) |
| Wiper Arm Bolt (Beetle) | 15 (20) |

INCH Lbs. (N.m)

| | |
|--|-------------|
| Accessory Belt Tensioner Pulley Bolt | (1) 89 (10) |
| Engine Speed Sensor Bolt | 89 (10) |
| Lower Timing Belt Cover Bolt | 89 (10) |
| Rear Crankshaft Sealing Flange Bolt | 89 (10) |
| Sensor Wheel Mount Bolt | (1) 89 (10) |
| Valve Cover Nuts | |
| Except Beetle | 89 (10) |
| Beetle | 44 (5) |
| Water Pump Mounting Bolts | 89 (10) |

(1) - Tighten bolt to specification plus additional 90 degrees.

(2) - Use NEW bolts.

AA

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS

AA

| Application | Specification |
|-----------------------|--------------------|
| Displacement | 116 Cu. In. (1.9L) |
| Bore | 3.13" (79.5 mm) |
| Stroke | 3.76" (95.5 mm) |
| Compression Ratio | |
| Except AAZ | 19.5:1 |
| AAZ | 22.5:1 |
| Fuel System | Diesel |
| Horsepower @ RPM | |
| Except AAZ | 88.5 @ 3750 |
| AAZ | 74 @ 4200 |
| Torque Ft. Lbs. @ RPM | |
| AAZ | 110 @ 2400-3400 |
| AHU, AHH & ALH | 154 @ 1900 |
| 1Z | 149 @ 1900 |

AA

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

AA

| Application | In. (mm) |
|--------------------------|-------------------------|
| Crankshaft | |
| End Play | |
| Standard | 0.003-0.007 (0.07-0.17) |
| Service Limit | 0.015 (0.37) |
| Crankshaft Main Bearings | |
| Journal Diameter | |
| Standard | 2.130 (54.00) |

| | | |
|-------------------------|-------|------------------------|
| 1st Undersize | ..... | 2.116 (53.75) |
| 2nd Undersize | ..... | 2.106 (53.50) |
| 3rd Undersize | ..... | 2.097 (53.25) |
| Oil Clearance | | |
| Standard | ..... | 0.001-0.003 (0.03-.08) |
| Service Limit | ..... | 0.007 (0.17) |
| Connecting Rod Bearings | | |
| Journal Diameter | | |
| Standard | ..... | 1.8819 (47.80) |
| 1st Undersize | ..... | 1.8720 (47.55) |
| 2nd Undersize | ..... | 1.8622 (47.30) |
| 3rd Undersize | ..... | 1.8524 (47.05) |
| Oil Clearance | | |
| Standard | ..... | .003 (.08) |

AA

CONNECTING RODS

CONNECTING RODS

AA

| | | |
|-----------------------|-------|------------|
| Application | | In. (mm) |
| Bore Diameter | | |
| Crank Pin Bore | ..... | (1) |
| Rod Pin Bore | ..... | (1) |
| Axial Clearance Limit | ..... | .015 (.37) |

(1) - Information is not available from manufacturer.

AA

PISTONS, PINS & RINGS

PISTONS, PINS & RINGS

AA

| | | |
|------------------|-------|-----------------|
| Application | | In. (mm) |
| Pistons | | |
| Diameter | | |
| Standard | | |
| Except ALH & AHH | ..... | 3.1291 (79.480) |
| ALH & AHH | ..... | 3.1287 (79.470) |
| 1st Oversize | | |
| AAZ | ..... | 3.1390 (79.730) |
| Except AAZ | ..... | 3.1386 (79.720) |
| 2nd Oversize | | |
| ALH & AHH | ..... | 3.1484 (79.970) |
| Except ALH & AHH | ..... | 3.1488 (79.980) |
| Piston Pins | | |
| Diameter | ..... | (1) |
| Piston Fit | ..... | Interference |
| Rod Fit | ..... | Interference |

Rings

No. 1

End Gap

| | | |
|---------------|-------|-----------------------|
| Standard | ..... | .008-.016 (0.20-0.40) |
| Service Limit | ..... | .039 (1.00) |

Side Clearance

| | | |
|---------------|-------|---------------------|
| AAZ | ..... | .003-.005 (.09-.12) |
| AHU & 1Z | ..... | .002-.005 (.06-.12) |
| AHH & ALH | ..... | .002-.003 (.06-.09) |
| Service Limit | ..... | .010 (.25) |

No. 2

End Gap

| | | |
|----------|-------|---------------------|
| Standard | | .008-.016 (.20-.40) |
|----------|-------|---------------------|

| | |
|---------------------|-----------------------|
| Service Limit | |
| AAZ | .024 (.60) |
| Except AAZ | .039 (1.00) |
| Side Clearance | |
| Standard | .002-.003 (.06-.08) |
| Service Limit | .010 (.25) |
| No. 3 (Oil) | |
| End Gap | |
| Standard | .010-.020 (0.25-0.50) |
| Service Limit | |
| AAZ | .047 (1.20) |
| Except AAZ | .039 (1.00) |
| Side Clearance | |
| Standard | .001-.002 (.03-.06) |
| Service Limit | .006 (.15) |

(1) - Information is not available from manufacturer.

AA

CYLINDER BLOCK

CYLINDER BLOCK

AA

| | |
|-------------------------|-----------------|
| Application | In. (mm) |
| Cylinder Bore | |
| Standard Diameter | 3.1303 (79.510) |
| 1st Oversize | 3.1402 (79.760) |
| 2nd Oversize | 3.1500 (80.010) |
| Deck Warpage | .004 (.10) |
| Out Of Round | .0039 (.100) |
| Taper | .0039 (.100) |

AA

VALVES & VALVE SPRINGS

VALVES & VALVE SPRINGS

AA

| | |
|---|-------------------|
| Application | Specification |
| Intake Valves | |
| Face Angle | 45° |
| Head Diameter | |
| AAZ | 1.417" (36 mm) |
| Except AAZ | 1.415" (35.95 mm) |
| Stem Diameter | |
| AHH & ALH | 0.274" (6.96 mm) |
| AAZ, AHU & 1Z | 0.314" (7.97 mm) |
| Valve Length | |
| AAZ | 3.740" (95.0 mm) |
| Except AAZ | 3.813" (96.85 mm) |
| Valve Stem Installed Height (Minimum) | 1.41" (35.80 mm) |
| Exhaust Valves | |
| Face Angle | 45° |
| Head Diameter | |
| AAZ | 1.220" (36.0 mm) |
| Except AAZ | 1.238" (31.45 mm) |
| Stem Diameter | |
| AHH & ALH | 0.273" (6.943 mm) |
| Except AHH & ALH | 0.313" (7.95 mm) |
| Valve Length | |
| AAZ | 3.740" (95.0 mm) |
| Except AAZ | 3.813" (96.85 mm) |
| Valve Stem Installed Height (Minimum) | 1.42" (36.10 mm) |

Valve Springs Free Length (1)

(1) - Information is not available from manufacturer.

AA

CYLINDER HEAD

CYLINDER HEAD

AA

Application Specification

Cylinder Head Height (1)(2)

Maximum Warpage (3) 0.004" (0.10 mm)

Valve Seats

Intake

Seat Angle 45ø

Seat Width 0.063" (1.60 mm)

Exhaust

Seat Angle 45ø

Seat Width 0.106" (2.70 mm)

Valve Guides

Valve Guide Installed Height (1)

Valve Stem-To-Guide Oil Clearance (4) .051" (1.3 mm)

(1) - Information is not available from manufacturer.

(2) - Replace cylinder head if swirl chamber projection is greater than .003" (0.07 mm).

(3) - Resurfacing of cylinder head is not allowed. Use different head gasket thickness depending on piston projection.

(4) - New valve installed in cylinder head. Dial indicator is used to measure valve rock (side-to-side play) in guide.

AA

CAMSHAFT

CAMSHAFT

AA

Application In. (mm)

Camshaft Journal Diameter 1.50 (38.0)

End Play 0.006 (0.15)

Maximum Runout 0.004 (0.10)

Oil Clearance 0.0004 (0.010)

AA

END OF ARTICLE