

# 1.9L 4-CYLINDER TURBO DIESEL

## Article Text

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### ARTICLE BEGINNING

1999-2000 ENGINES  
Volkswagen 1.9L Turbo Diesel

1999-2000: Beetle, Jetta, Passat  
2000: Golf

**\* 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	Engine Code
Beetle, Golf & Jetta .....	ALH
Passat .....	AHH

### ADJUSTMENTS

#### INJECTION PUMP

##### Priming

1) Thread Adapter (1318/10) into injection pump return/supply opening. Connect hand vacuum Pump (VAG 1390) using approximately 40" (1016 mm) of transparent plastic hose. Operate vacuum pump until fuel flows out of return/supply opening.

**NOTE:** DO NOT allow fuel into vacuum pump.

2) Remove adapter and connect return/supply line. Install valve cover and vacuum pump. Dynamically check start of injection cycle and adjust if necessary.

##### Timing Adjustment

1) Connect Scan Tool (VAG 1551/1552) and run engine at idle. Test injection pump timing. If scan tool display indicates a value of 90 and a range of 34 to 73, no further adjustment is necessary. If adjustment is necessary, loosen mounting bolts on injection pump. Hold pump shaft securely. Loosen third mounting nut on injection pump. See Figs. 4 and 5.

2) Turn pump counterclockwise (left) if injection timing is early, turn pump clockwise (right) if injection timing is late. Tighten mounting bolts to 15 ft. lbs. (20 N.m) in sequence. Test injection pump timing, if within specification, no further adjustment is necessary. Repeat procedure if 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.

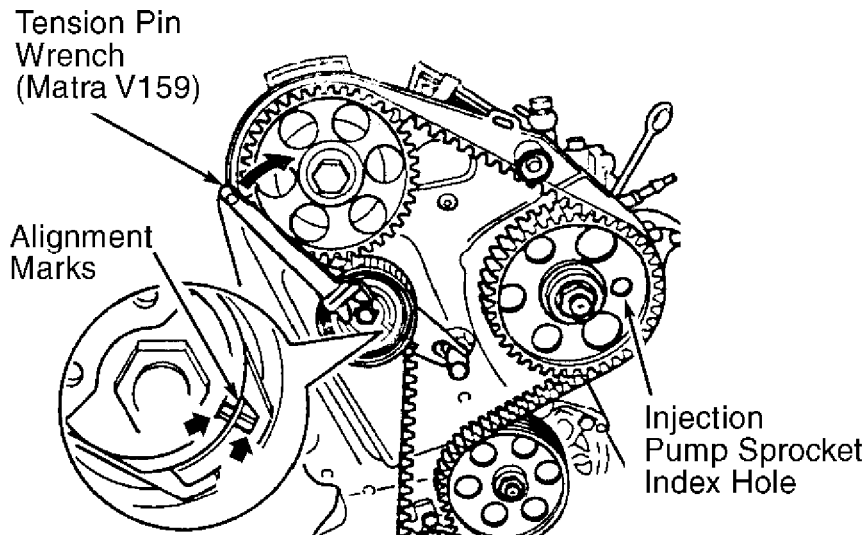
#### TIMING BELT TENSION ADJUSTMENT CHECK

**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 United States, Inc.

#### VALVE CLEARANCE ADJUSTMENT

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

#### TROUBLE SHOOTING

**NOTE:** See TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

#### REMOVAL & INSTALLATION

\* PLEASE READ THIS FIRST \*

**NOTE:** When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle.

**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.

**WARNING:** 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.

## BLEEDING COOLING SYSTEM

### Removal

Remove engine cover. Remove center and left damping covers. Remove cap from coolant expansion tank. Remove drain plug from radiator and coolant hose from oil cooler to drain coolant from oil cooler. Drain coolant from radiator.

### Installation

Close drain plug on radiator. Connect coolant hose onto oil cooler. Fill coolant to MAX. mark on expansion tank. Install coolant expansion tank cover. Run engine until radiator fan turns on. Turn engine off, check coolant level and fill to MAX. mark if necessary. Install center and left damping covers. Install engine cover.

## 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.

## INJECTION PUMP

**WARNING:** Diesel fuel can present a fire hazard. Ensure there is nothing in the area that can ignite diesel fuel.

### Removal

1) Unbolt all fuel lines at fuel pump. Cover openings with a clean cloth. Remove connecting line between charge air cooler and intake manifold. Remove upper toothed belt guard, valve cover and vacuum pump for brake servo. If engine is removed, go to step 2) or 3). If engine is in chassis, go to step 4).

2) With engine removed. On manual transmissions, use Flywheel Holder (2068 A TDC) to establish TDC. Set tool adjustment to 3.78" (96 mm) on ALH engines, and 4.21" (107 mm) on AHH Engines. Use left hand notch of vernier scale as reference point. Turn crankshaft until flywheel TDC aligns with point of tool setting device, arrow "A".

3) With engine removed. On automatic transmissions, use Flywheel Holder (2068 A TDC) to establish TDC. Set tool adjustment to (30 mm) on ALH engines, and (107 mm) on AHH Engines. Use left hand notch of vernier scale as reference point. Turn crankshaft until flywheel TDC aligns with point of setting device, arrow "B".

4) With engine in chassis. Using marks on flywheel, position No. 1 cylinder at TDC. Lock camshaft using Setting Bar (3418) on ALH engines, or Setting Bar (2065A) on AHH Engines. Centralize setting bar so that one end of setting bar contacts cylinder head. Using feeler gauge, establish gap at other end of setting bar. Place feeler gauge corresponding to half of gap between setting bar and cylinder head. Turn camshaft until setting bar contacts feeler gauge. Place 2nd feeler gauge, of same thickness, at other end between setting bar and cylinder head. See Fig. 2.

**CAUTION:** DO NOT loosen injection pump hub nut for any reason.

Otherwise, diesel injection pump basic setting will be altered and cannot be reset with normal workshop equipment.

5) Remove injection pump sprocket mounting bolts. See Fig. 3. Remove belt tensioner lock nut. Relieve tooth belt tension, remove camshaft and injection pump sprockets. Disconnect quantity adjuster harness connector and unclip connector from retainer. Remove mounting bolts. See Fig. 4. Remove bolt from rear support. See Fig. 5. Remove diesel injection pump.

#### Installation

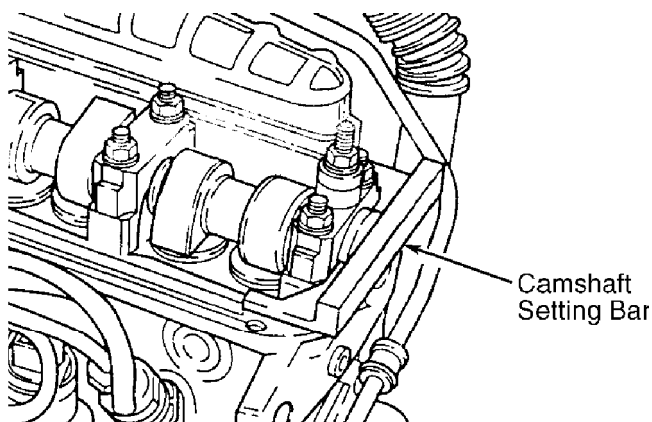
1) To install, position injection pump into bracket, tighten mounting on rear support, with conical nut, first. Install front mounting bolts, tight bolts to 18 ft. lbs. (25 N.m). Lightly tighten NEW bolts to mount injection pump sprocket onto hub. Do not tighten to specification at this time. See Fig. 3. Align injection pump sprocket to center of elongated mounting holes. Lock injection pump sprocket using Locking Pin (3359). Loosen camshaft sprocket mounting bolt one-half turn.

NOTE: Injection pump sprocket mounting bolts are one-time use, torque-to-yield type. Replace with NEW bolts when they have been loosened.

2) Place a drift through rear of timing belt guard and lightly tap camshaft sprocket with a hammer to release from camshaft taper. Remove camshaft sprocket. Align TDC mark on flywheel and reference mark. Install timing belt onto injection pump and tensioning roller. Install camshaft sprocket into timing belt and secure sprocket allowing camshaft to turn. Tension timing belt with Tensioner Pin Wrench (MATRA V159) on eccentric and turning clockwise until notch and raised marks align. See Fig. 1.

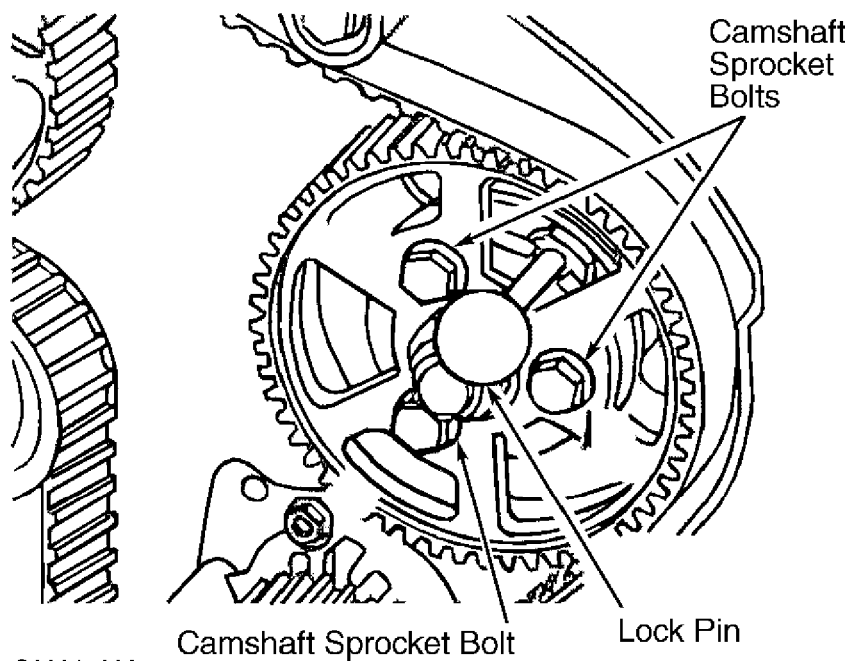
3) On ALH engine, ensure timing belt guard retaining hook is properly seated and attached to guard behind tensioner pulley. On all engines, tighten tensioner mounting nut to 15 ft. lbs. (20 N.m). Check TDC mark on flywheel. Tighten NEW mounting bolts for injection pump sprocket. Tight bolts to 15 ft. lbs. (20 N.m). After dynamically checking injection timing, tighten these bolts an additional 1/4 turn (90 degrees).

4) Tighten camshaft sprocket mounting bolt to 33 ft.lbs. (45 N.m). Remove Locking Pin (3359), and Setting Bar (3418) from camshaft. Turn camshaft 2 rotations until crankshaft is set to cylinder No. 1 TDC. Reconnect ignition lines, fuel supply line and electrical wiring. After engine is started, dynamically check injection pump timing, see INJECTION PUMP , under ADJUSTMENTS. After dynamically checking injection timing, tighten pump mounting bolts an additional 1/4 turn (90 degrees).



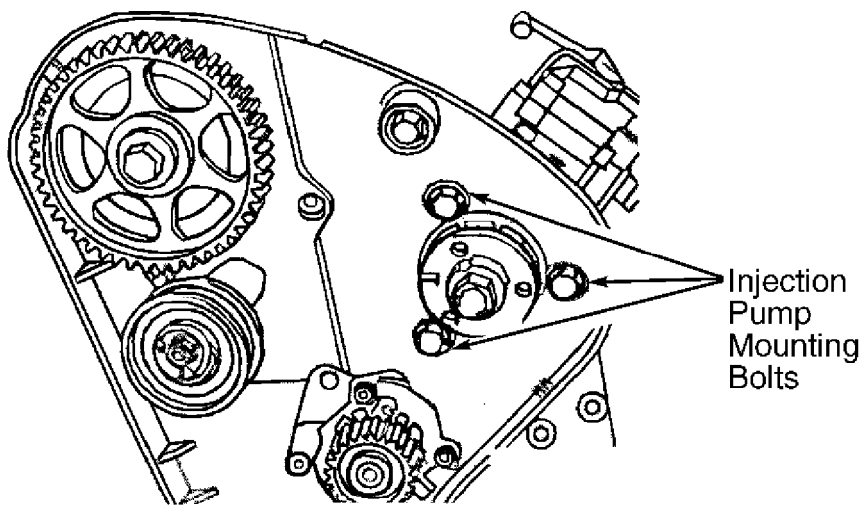
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Fig. 2: Locking Camshaft With Setting Bar  
Courtesy of Volkswagen United States, Inc.



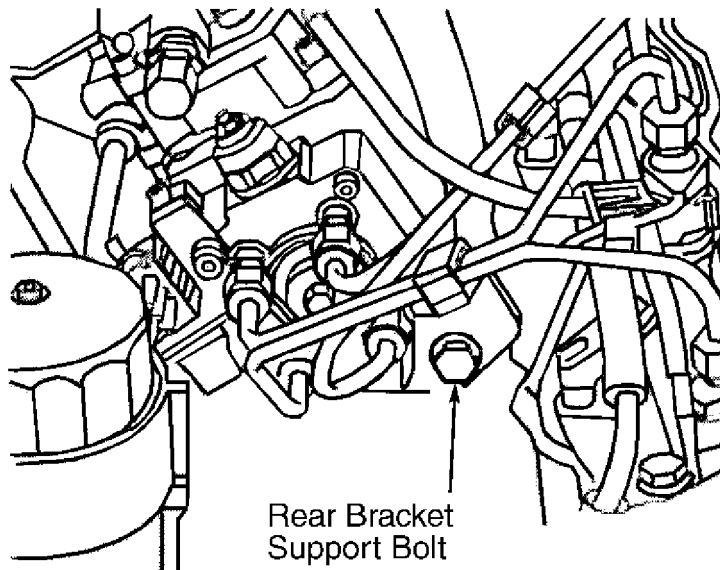
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**Fig. 3: Identifying Camshaft Sprocket Bolts**  
 Courtesy of Volkswagen United States, Inc.



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**Fig. 4: Identifying Injection Pump Mounting Bolts**  
 Courtesy of Volkswagen United States, Inc.



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**Fig. 5: Identifying Rear Bracket Support Bolt**  
 Courtesy of Volkswagen United States, Inc.

ENGINE

**WARNING:** Ensure jacks and safety stands are positioned properly and hoist brackets are attached to correct position on engine.

Ensure vehicle will not roll off stands.

**NOTE:** Engine and transaxle are removed as an assembly.

#### 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.

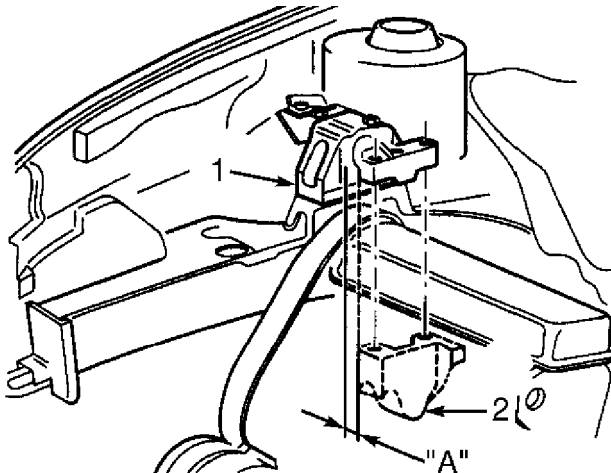
5) Remove starter. Remove right axle shaft from vehicle. See FWD AXLE SHAFTS article in DRIVE AXLES. Disconnect left axle shaft from transmission. Support engine/transmission assembly with suitable jack. Remove coolant hose bracket and lower from engine block.

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

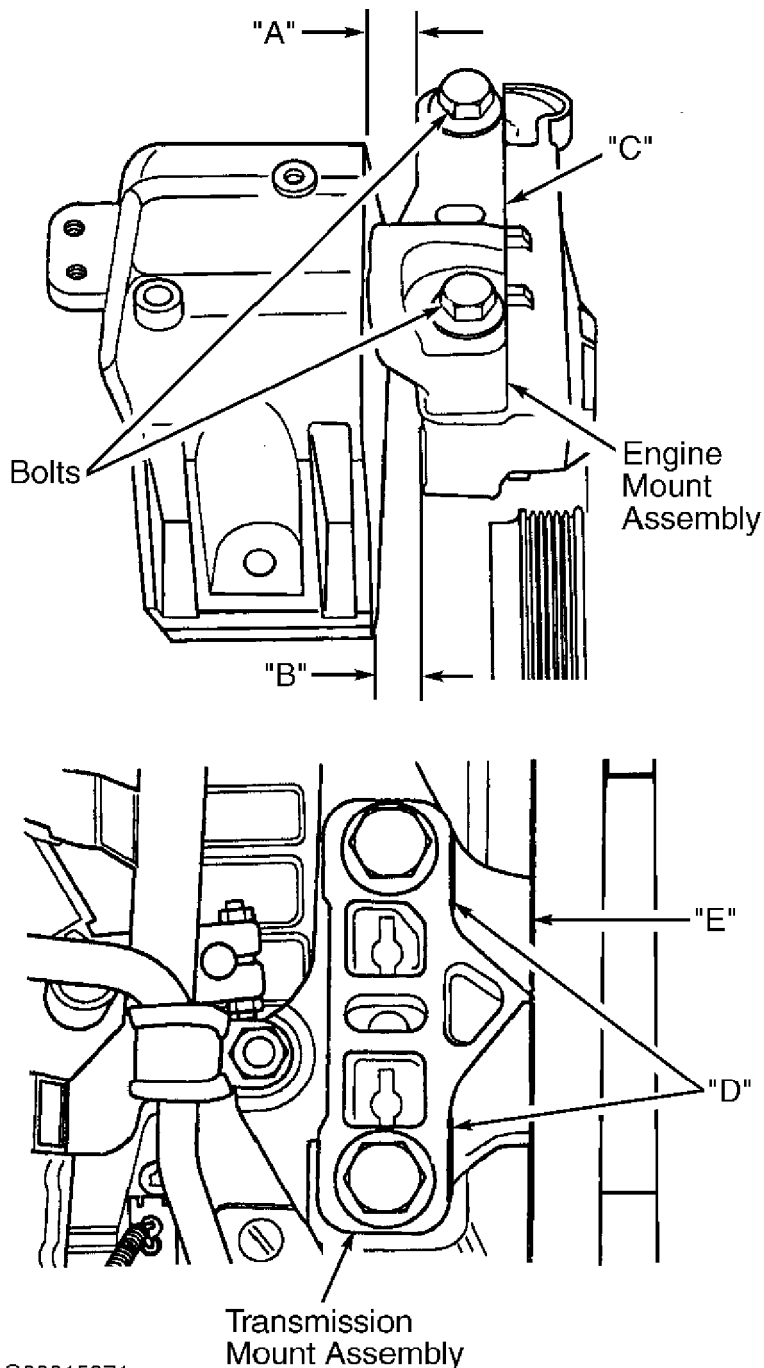
1) To install, reverse removal procedure. Ensure centering dowels for engine/transmission assembly are installed.

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. 6. Fill fluids to proper level. Tighten all fasteners to specification. See TORQUE SPECIFICATIONS.



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**Fig. 6: Aligning Upper Engine Mount (Beetle)**  
Courtesy of Volkswagen United States, Inc.



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**Fig. 7: Aligning Engine Mounts (Golf & Jetta)**  
 Courtesy of Volkswagen United States, Inc.

**Removal (Golf & Jetta)**

1) Turn ignition off. support hood in vertical position. Disconnect battery cables and remove battery from vehicle. Remove engine cover. Remove air cleaner, air cleaner housing, and intake hose as an assembly. Remove sound dampening tray.

**NOTE:** To prevent damage to condenser and A/C system, avoid bending, kinking and stretching, refrigerant lines and hoses.

2) Remove retaining clamps from refrigerant lines. Remove A/C compressor. Support A/C compressor onto side of vehicle body.

3) On vehicles with A/C and M/T, disconnect selector mechanism from transmission. Remove hydraulic clutch slave clutch.

4) On vehicles with A/C and A/T, remove transmission range selector lever cable from transmission.

5) On both vehicles, remove vacuum and breather hoses from engine. Disconnect all wiring from transmission, generator and starter, and support them to one side for clearance.

6) Remove fuel supply and return line from fuel filter. Seal fuel line to prevent contamination of fuel system. Remove right head light assembly. Remove pipe between charge air cooler and intake manifold. Remove right sound damper cover. Mark direction of rotation

for ribbed belt. Swing tension roller in a counterclockwise direction using a 16-mm wrench on tensioning level. Remove accessory drive belt.

7) Remove power steering pump with bracket and support to one side. Remove power steering hose mounting clamps. Remove right inner constant velocity joint protective cover from engine. Remove right drive shaft and disconnect left drive shaft from transmission. Drain engine coolant. See BLEEDING COOLING SYSTEM. Remove radiator hoses off engine. Remove bolts from pendulum support. Remove exhaust pipe.

8) Remove coolant hose and lower bracket from cylinder block. Insert Engine/Transmission Jack (VAG 1383) into Engine Support (T10012). Insert engine support into mounting holes on engine. Tighten M10 x 25.5 x 8.8 nut and bolt to 30 ft. lbs. (40 N.m).

9) Slightly lift engine/transmission with a jack. Remove engine-side engine mount. Remove engine/transmission mount from transmission bracket. Lower engine/transmission assembly. Carefully guide power steering lines past transmission.

#### Installation

1) To install, reverse removal procedure. Ensure centering dowels for engine/transmission assembly are installed. Tighten engine mounts to specification. See TORQUE SPECIFICATIONS. Improper engine mount tightening will result in excessive engine vibration and premature engine mount wear.

2) On vehicles with M/T, inspect that clutch disc is centered. Inspect clutch release bearing for wear, replace if necessary. Install hydraulic clutch slave cylinder. Install selector mechanism. If necessary adjust gear shift cables. On vehicles with A/T, use NEW lock washer on selector cable mount. Install selector cable onto transmission, adjust if necessary.

3) 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.

4) On all models, Install engine mount assembly to body. Aligned engine mount. Standard clearance for point "A" of engine/transmission mount is .55" (14 mm). Standard clearance for point "B" is .40" (10 mm). See Fig. 7. Bolts must be aligned flush with edge "C". Tighten bolts to specification. Install transmission mount assembly, edges "D" and "E" must be parallel to each other. See Fig. 7. Tighten bolts to specification. See TORQUE SPECIFICATIONS table.

5) Fill all fluids to proper level. Bleed air from cooling system. See BLEEDING COOLING SYSTEM. Check for fluid leaks.

#### Removal (Passat)

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 specification. 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.

## TURBOCHARGER

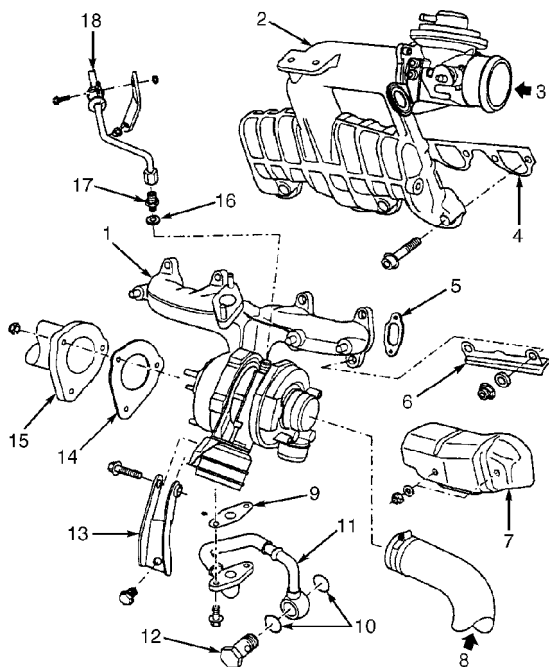
### Removal

1) Turn ignition off. Disconnect negative battery cable. Remove intake manifold-to-turbocharger and turbocharger-to-air cleaner hoses. See Figs. 8 or 9.

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

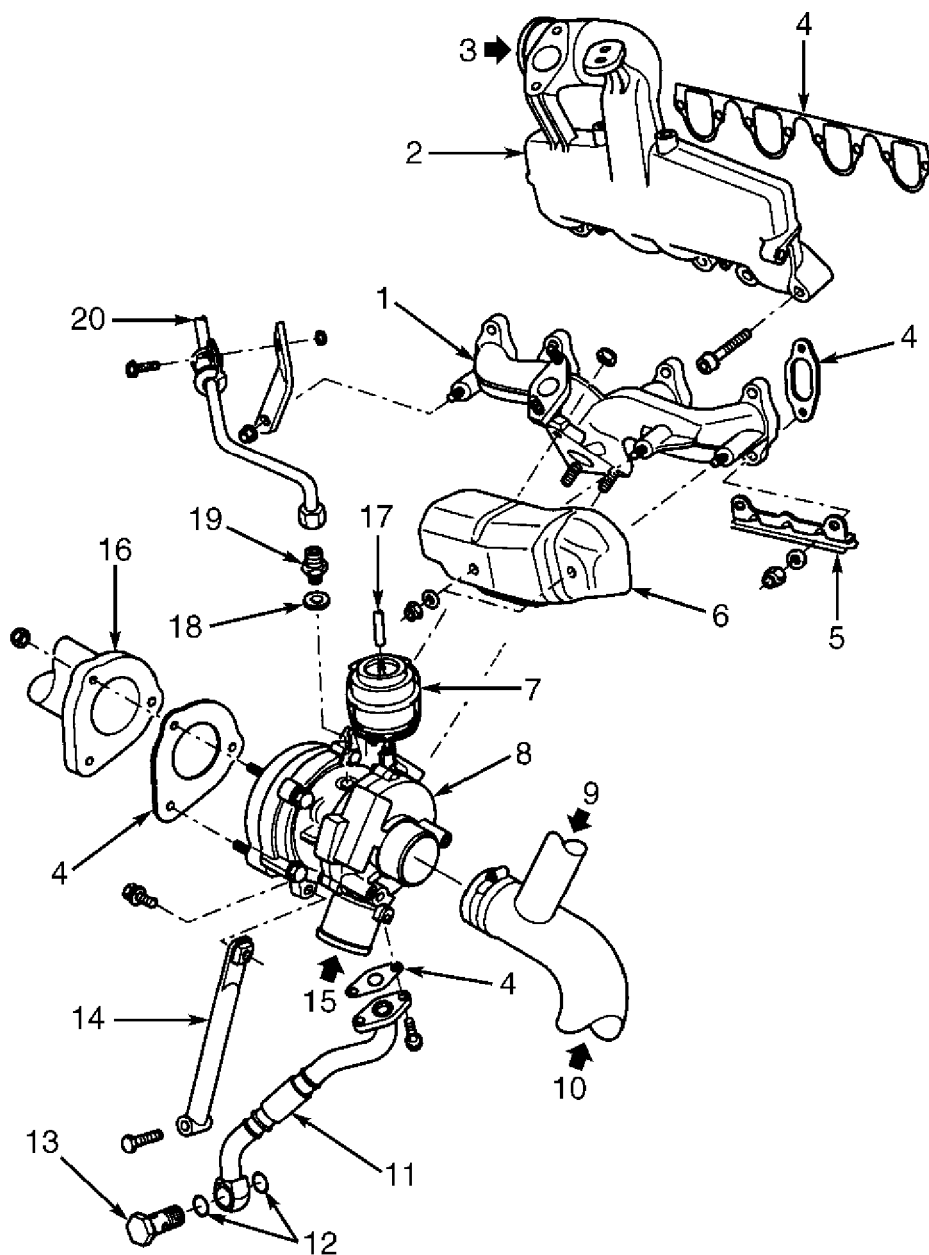
Install hose to wastegate by-pass valve. Apply anti-seize compound to bolt threads. Install turbocharger to exhaust manifold. Install turbocharger/engine mount. Install front exhaust pipe with NEW gasket. Fill turbocharger with engine oil through oil supply connection and install oil supply line. To 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. 8: Exploded View Of Turbocharger & Exhaust (ALH)  
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. 9: 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 Figs. 8 or 9. 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 (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. 11.

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. 10. Remove cylinder head.

### Removal (Golf & Jetta)

1) Turn ignition off. 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) Remove accessory drive belts. Remove front exhaust pipe. Relieve fuel pressure. See FUEL PRESSURE RELEASE. Disconnect and plug fuel supply and return lines at fuel injection pump.

3) Remove vacuum ventilation lines from cylinder head. Remove glow plug harness connector. Remove all electrical wires from cylinder head and set aside. Remove oil pressure line and oil pressure from turbocharger and cylinderhead. Remove two-part injector lines as one

unit. Remove vacuum pump from brake booster.

4) Remove upper half of timing belt cover. Remove valve cover. Remove timing belt from camshaft sprocket. See TIMING BELT. If reusing timing belt, mark direction of belt rotation for installation reference. Slightly turn crankshaft counterclockwise. Using Counter holder loosen center bolt on camshaft sprocket one turn.

5) Install 2-arm Puller (T40001) with claws going through center of camshaft sprocket. Remove camshaft sprocket and tensioner. Remove bolts for belt cover located at rear of cylinder head. Loosen and remove cylinder head bolts in reverse order of tightening sequence. Lift cylinder head guiding bolt for tensioner through rear of belt cover.

#### Removal (Passat)

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. 10. 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).

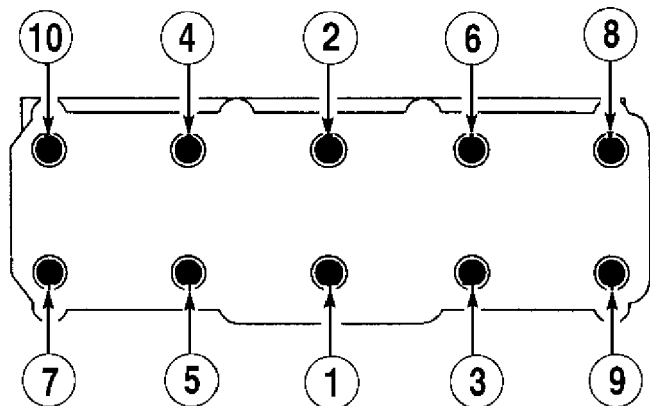
NOTE: Always replace cylinder head bolts. Handle cylinder head gasket carefully as not to damage silicone layer on gasket.

#### 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.

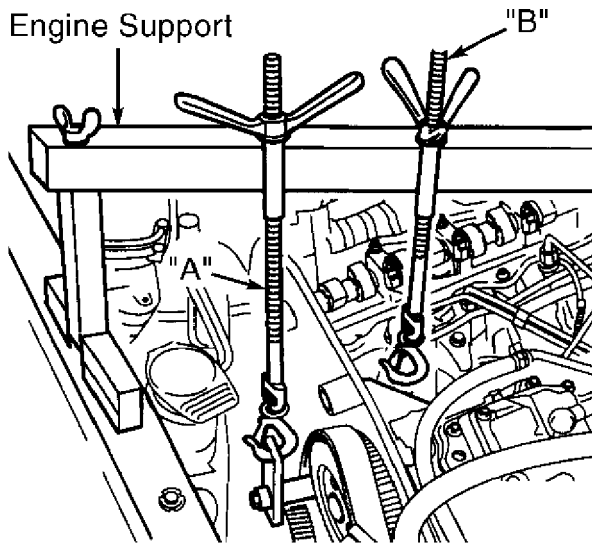
3) Rotate camshaft until cylinder No. 1 lobes are pointing straight up. Rotate crankshaft clockwise to TDC before installing timing belt. Install timing belt. See TIMING BELT. Check timing belt tension. See TIMING BELT TENSION ADJUSTMENT CHECK under ADJUSTMENTS. Fill and bleed cooling system. See BLEEDING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



REMOVE IN REVERSE ORDER

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Fig. 10: Cylinder Head Bolt Tightening Sequence  
Courtesy of Volkswagen United States, Inc.



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Fig. 11: Attaching Engine Support (Beetle)  
 Courtesy of Volkswagen United States, Inc.

#### FRONT COVER OIL SEAL

##### 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.

##### Removal (Golf, Jetta & Passat)

1) Remove accessory drive belt. Remove crankshaft pulley and timing belt. See TIMING BELT. Using bolt from Seal Extractor Set, 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 onto crankshaft. Slide oil seal over guide sleeve. Using sleeve from seal extractor set, press in NEW oil seal into crankshaft.

#### 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. 2. 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.

#### 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, by hand, 2 complete revolutions. 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 to help alignment pin installation. 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 to position cylinder No. 1 is at TDC compression stroke.

3) Lock camshaft using Setting Bar (3148). See Fig. 2. 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 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-face 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 lifters to bleed down.

#### 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. 12. 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 install camshaft. 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 specification and camshaft has already been replaced, cylinder head must be replaced. If camshaft has not been replaced, measure runout. If runout is within specification, replace cylinder head. See CAMSHAFT table under ENGINE SPECIFICATIONS. If runout exceeds specification, replace camshaft and recheck. If oil clearance still exceeds specification, replace cylinder head.

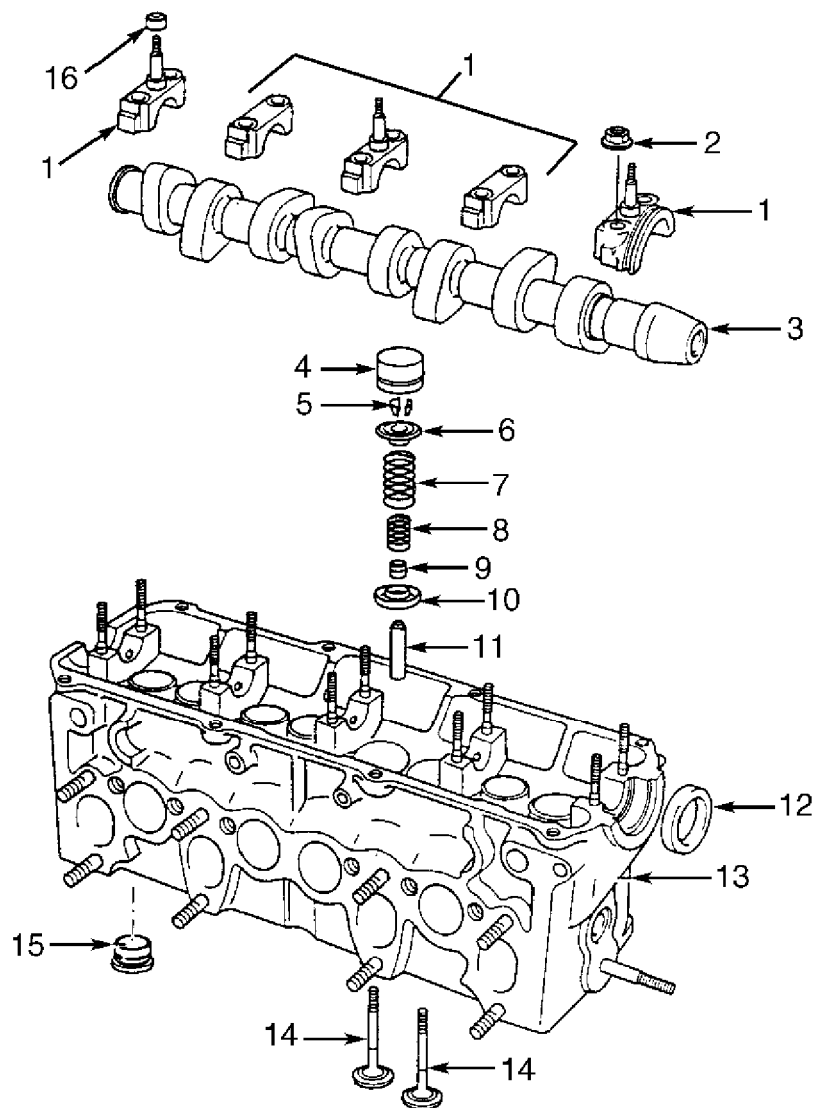
**NOTE:** When installing camshaft, ensure cylinder No. 1 camshaft lobes are pointing up.

#### 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. 12: 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. For A/T, see TRANSMISSION REMOVAL & INSTALLATION article in TRANSMISSION SERVICING. For M/T, see FWD article in CLUTCHES. 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 pistons are replaced, 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

AA

Number Of 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.

AA

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 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 specification. See VALVES & VALVE SPRINGS table under ENGINE SPECIFICATIONS. Valve grinding is not permitted. Valve lapping by hand is permitted.

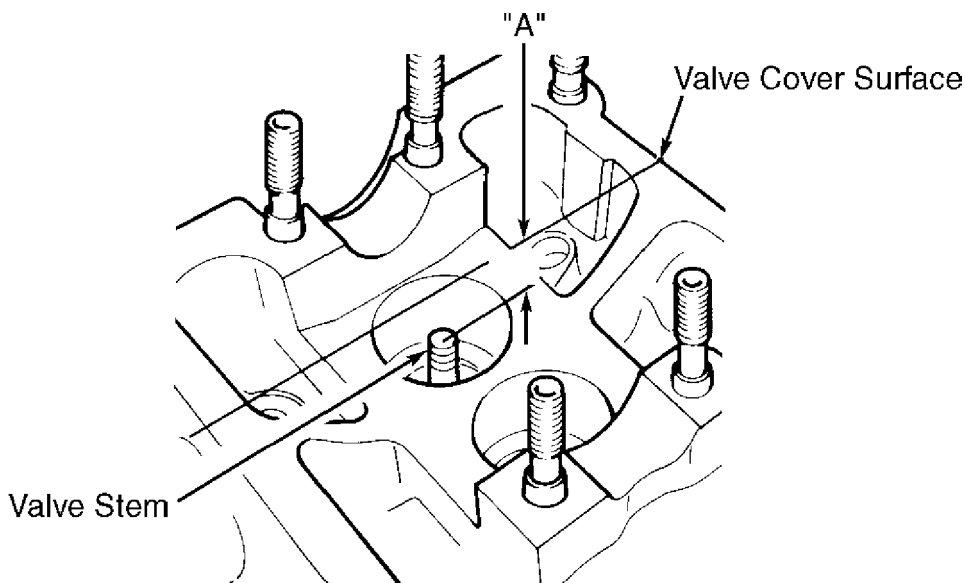
Valve Seats

- 1) Insert valve into cylinder head. Holding valve closed, measure the valve stem-to-cylinder head edge distance. See Fig. 13.
- 2) This measurement determines installed valve height. Subtract measured distance from minimum specification. See INSTALLED VALVE HEIGHT MINIMUM table.

INSTALLED VALVE HEIGHT MINIMUM

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

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



G96A19117  
 Fig. 13: Measuring Installed Valve 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. 14. Pistons and rods are to be replaced in sets 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. 14.

**Fitting Pistons**

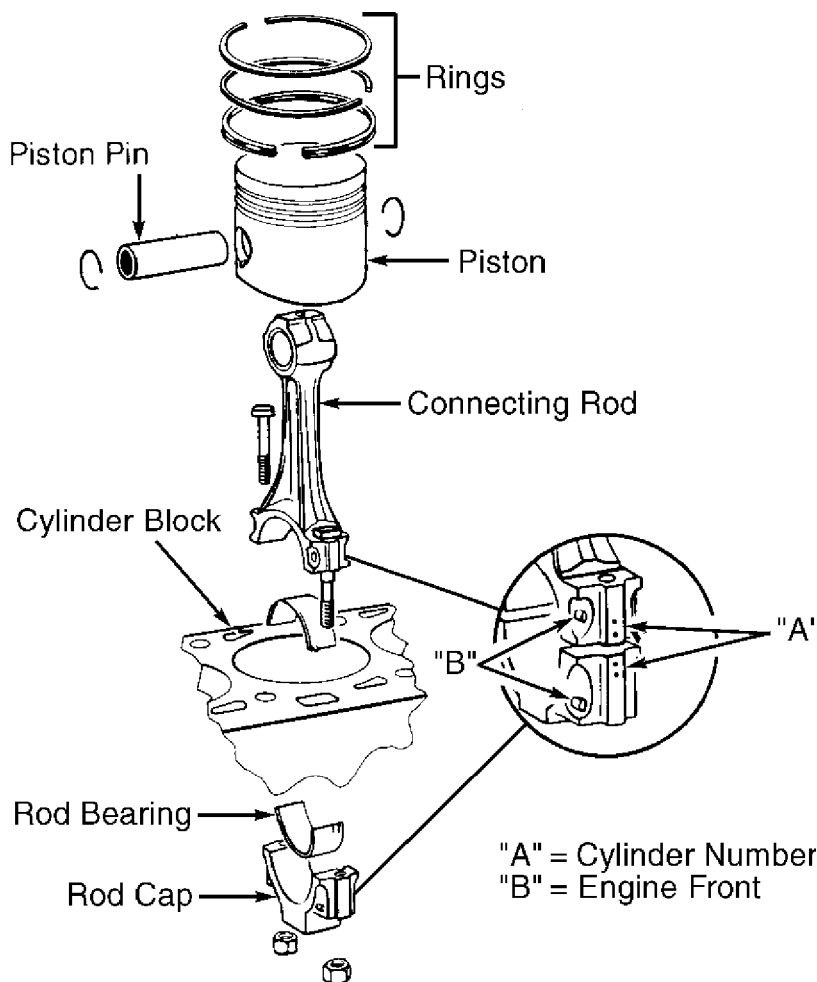
Measure clearance with cylinder block supported on work bench. Check clearance of piston-to-cylinder bore. See PISTON-TO-CYLINDER BORE DIMENSIONS table. Piston diameter is stamped on top of piston.

**PISTON-TO-CYLINDER BORE DIMENSIONS**

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

**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 piston pin (down). Position ring gaps on piston at 120 degree intervals. See Fig. 14. Ensure no ring gap aligns with piston pin.



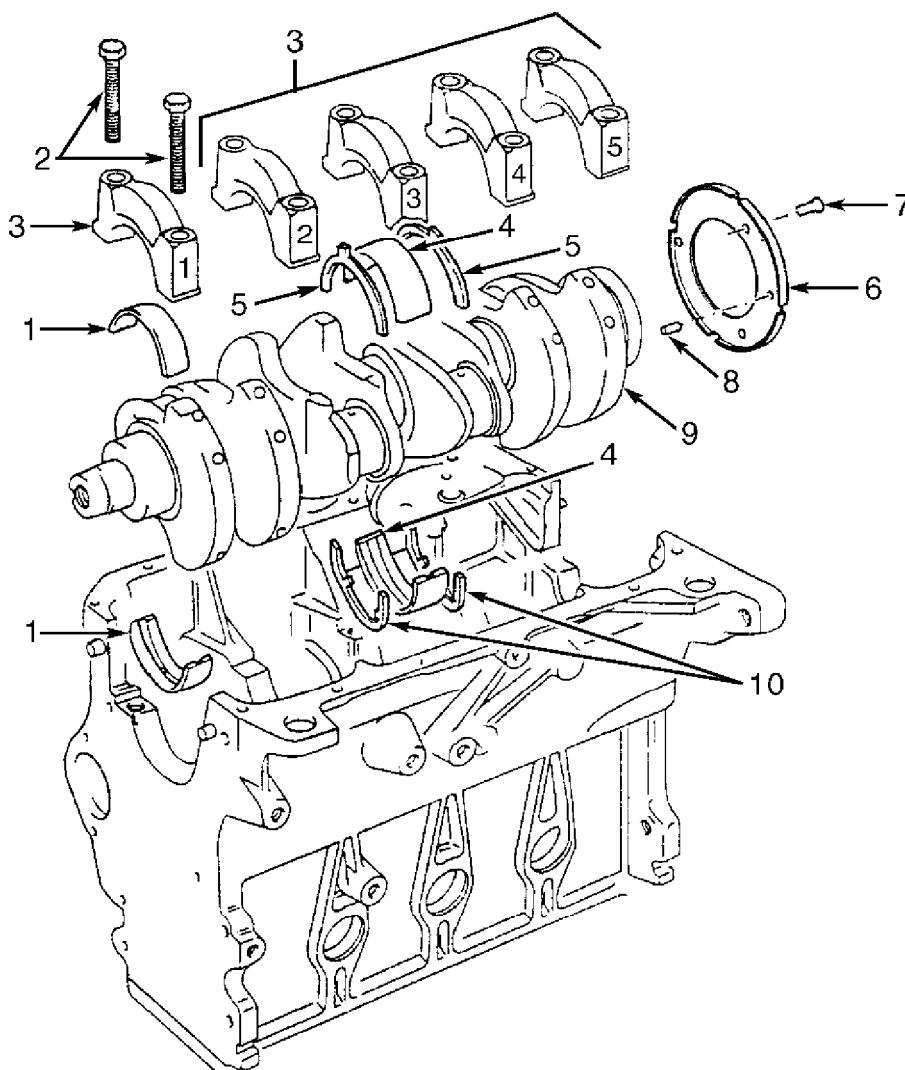
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**Fig. 14: Assembling Piston & Rod**  
 Courtesy of Volkswagen United States, Inc.

**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 to specification. See TORQUE SPECIFICATIONS.

#### Crankshaft & Main Bearings

Main bearing caps are marked with matching journal for installation in original position. See Fig. 15. Measure crankshaft axial clearance. Axial clearance wear limit is .015" (.37 mm). Measure crankshaft radial clearance. Radial clearance wear 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. 15: 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. 15.

#### 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 OILING

### 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/cm<sup>2</sup>). Oil pressure should not exceed 102 psi (7.2 kg/cm<sup>2</sup>) 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

Beetle ..... 30 (40)  
Except Beetle ..... 33 (45)  
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  
Beetle ..... (1) 88 (120)

Except Beetle .....	(1)	66	(90)
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, Golf & Jetta (ALH Engine)			
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)
Passat (AHH Engine)			
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 .....		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			
Beetle .....		11	(15)
Except Beetle			
Long Bolt .....		18	(25)
Short Bolt .....		7	(10)
Oil Pump Sprocket Bolt .....		18	(25)
Oil Spray Jet Bolt			
Beetle .....		18	(25)
Except Beetle .....		7	(10)
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		
Beetle	.....	18 (25)
Except Beetle	.....	22 (30)
Oil Supply Line Nuts	.....	18 (25)
Water Pump Mounting Bolt		
Beetle	.....	11 (15)
Except Beetle	.....	89 (10)
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		
Beetle	.....	44 (5)
Except Beetle	.....	89 (10)
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	19.5:1
Fuel System	Diesel

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CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

AA

Application	In. (mm)
Crankshaft	
End Play	
Standard	.003-.007 (.07-.17)
Service Limit	.015 (.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	.001-.003 (.03-.08)
Service Limit	.007 (.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)

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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

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Application	In. (mm)
-------------	----------

Pistons	
Diameter	
Standard	3.1287 (79.470)
1st Oversize	3.1386 (79.720)
2nd Oversize	3.1484 (79.970)

Piston Pins	
Diameter	(1)
Piston Fit	Interference
Rod Fit	Interference

Rings	
No. 1	
End Gap	
Standard	.008-.016 (.20-.40)
Service Limit	.039 (1.00)
Side Clearance	.002-.003 (.06-.09)
Service Limit	.010 (.25)
No. 2	
End Gap	
Standard	.008-.016 (.20-.40)
Service Limit	.039 (1.00)
Side Clearance	.002-.003 (.06-.08)
Service Limit	.010 (.25)
No. 3 (Oil)	
End Gap	
Standard	.010-.020 (.25-.50)
Service Limit	.039 (1.00)
Side Clearance	.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)

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VALVES & VALVE SPRINGS

VALVES & VALVE SPRINGS

AA

Application Specification

Intake Valves

Face Angle	.....	45ø
Head Diameter	.....	1.415" (35.95 mm)
Stem Diameter	.....	.274" (6.96 mm)
Valve Length	.....	3.813" (96.85 mm)
Valve Stem Installed Height (Minimum)	.....	1.41" (35.80 mm)

Exhaust Valves

Face Angle	.....	45ø
Head Diameter	.....	1.238" (31.45 mm)
Stem Diameter	.....	.273" (6.943 mm)
Valve Length	.....	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) .004" (.10 mm)

Valve Seats

Intake

Seat Angle	.....	45ø
Seat Width	.....	.063" (1.60 mm)

Exhaust

Seat Angle	.....	45ø
Seat Width	.....	.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" (.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	.....	.006 (.15)
Maximum Runout	.....	.004 (.10)
Oil Clearance	.....	.0004 (.010)

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END OF ARTICLE