4000 4-CYLINDER DIESEL

ENGINE CODING

Engine Identification—Code for Audi diesel engine is stamped on cylinder block below mating surface of head, near fuel injection pump. Left side of block.

Engine Identification

Application	Code
All Models	CR

ENGINE & CYLINDER HEAD

ENGINE

Removal – 1) Disconnect battery, remove engine cover plate and cover plate on transmission. Open heater control valve, open cap on expansion tank and drain coolant by detaching hose from thermostat and bottom radiator hose. If equipped with air conditioning, do not loosen any air conditioning system hoses. Detach radiator cowl from radiator and remove complete with both fans. Remove front grille and detach condensor from radiator.

2) Disconnect plugs from fan and thermoswitch. Remove radiator nuts and remove radiator with fan. Remove fuel supply line and fuel return line from injector pump. Disconnect accelerator cable from pump lever and detach bracket from pump body. Disconnect cold start cable at pin and detach retaining washer from bracket. Disconnect wire from fuel shutoff solenoid. Remove gear shift light switch complete with wiring from bracket.

3) Disconnect wiring from oil pressure switch, coolant temperature sensors, glow plugs and thermoswitch. Detach coolant hose and loosen clutch cable from bracket and unhook from clutch lever. Loosen right and left engine mounts at top and detach vacuum hose to vacuum pump at reservoir. Remove alternator. Remove front engine stop bolts. If equipped with air conditioning, detach compressor belt after removing pulley nuts. Remove compressor bracket at top and bottom of engine. Remove compressor with bracket, place on side and tie in place so that hoses are not under tension.

4) Remove exhaust pipe from manifold and disconnect starter cable and remove from intermediate plate. Remove exhaust pipe from front transmission support. Remove starter and place on carrier. Remove 2 transmission-to-engine bolts from below. Remove flywheel cover plate. Install transmission support bar (VW 785/1B). Attach lifting unit (US 1105) to engine and lift engine and transmission with crane until transmission housing touches steering rack. Adjust support bar (VW 785/1B) to contact transmission. Remove 3 transmission-to-engine bolts from above. Pry engine apart from transmission. Lift engine and guide out of engine compartment.

Installation—Place starter on engine carrier before installing engine and connect starter cable so it can not touch engine. Do not interchange fuel supply and return line. Return line is marked OUT on screw head. To install engine, reverse removal procedure. Adjust throttle and clutch cables, align exhaust system components and refill coolant expansion tank.

CYLINDER HEAD

Removal & Installation – 1) Remove expansion tank cap and disconnect lower radiator hose to drain coolant. Disconnect battery. Remove radiator fan, pulleys and fan belts. Remove drive belt for power steering. Remove valve cover and front timing belt cover. Disconnect all wires to cylinder head.

2) Remove air cleaner and attached hoses. Disconnect vacuum pump and move to wheel housing. Remove vacuum pump plunger from cylinder head. Remove and plug fuel delivery pipes and disconnect cold start device. Set No. 1 piston to TDC. Loosen water pump retaining bolts to relieve tension on timing gear belt.

3) Hold rear camshaft drive gear in place, and remove center retaining bolt. Camshaft must not rotate, or damage could result to valves and pistons. Tap gear loose from camshaft tapered end. Remove injection pump drive belt by loosening retaining bracket bolts. Hold rear camshaft sprocket, and remove center retaining bolt. Tap gear loose from camshaft. Remove injectors and glow plugs before removing head.

4) When replacing head gasket make sure gasket thickness is the same by matching notches on side of head gasket. Markings on head gasket must face up. Reverse removal procedure. To install, ensure that cylinder head and block mating surfaces are clean. Install cylinder head gasket dry, using no sealant. Install bolts 8 and 10 first to center cylinder head. Tighten head bolts in sequence illustrated in *Fig. 1*.

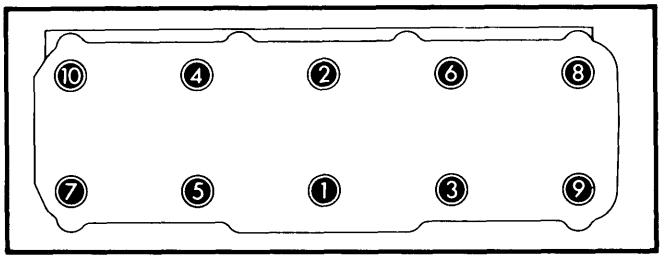

Fig. 1 Cylinder Head Tightening Sequence (Reverse Sequence When Removing)

NOTE—*Every time head is removed, cylinder head bolts must be torqued, and again after about 1000 miles as described in specifications. Piston height must be measured when installing new pistons or short block. Head gasket is then selected according to measurement.*

CAMSHAFT

TIMING BELT

Removal & Installation – 1) Remove belt cover and valve cover, turn engine to TDC on cylinder No. 1 and fix camshaft in position with tool (2065A). Align tool as follows; turn camshaft until one end of tool touches cylinder head. Measure gap at other end of tool with feeler gauge. Take half of measurement and insert feeler of this thickness between tool and cylinder head. Turn camshaft so that tool rests on feeler. Insert second feeler of same thickness between other end of tool and cylinder head.

2) Lock injection pump sprocket in position with pin (2064). Check that marks on sprocket, bracket and pump body are aligned (engine at TDC). Loosen tensioner and remove V-belt pulley from crankshaft, remove drive belt. To install, reverse

4000 4-CYLINDER DIESEL (Cont.)

removal procedure. Check belt tension between camshaft sprocket and injection pump sprocket with tool (VW210), scale should read 12-13. Turn crankshaft 2 turns in direction of engine rotation, strike belt with rubber hammer one time between camshaft sprocket and injection pump. Recheck tension.

CAMSHAFT

1) To remove camshaft, first remove camshaft drive belt and vacuum pump drive belt and sprockets. Remove outer bearing caps 1, 5, and 3 first. Then, diagonally loosen bearing caps 2 and 4 and lift off camshaft. To install, reverse removal procedure and lubricate bearing shells, journals and contact faces of caps. Position cap 5 by tapping end of camshaft with soft-faced hammer. Lightly tighten bearing caps 2 and 4 diagonally.

2) To check camshaft end play, camshaft followers must be removed and camshaft must be free of tension. Only camshaft bearing caps 1 and 5 should be installed. With dial indicator and mounting tool (VW 387) in place on end of camshaft, check for maximum end play of .006" (.15 mm).

VALVE TIMING

See TIMING BELT procedure in this article.

INJECTION PUMP TIMING

1) To check injection pump timing, set crankshaft to TDC on No. 1 cylinder. Push in cold start device completely when checking or adjusting injection timing. Remove plug from injection pump cover. Install adaptor and dial gauge 0 to .118" (0 to 3 mm), in place of plug and preload gauge to approximately .097" (2.5 mm). Turn engine slowly counterclockwise (opposite to normal rotation) until dial gauge needle stops moving.

2) Zero gauge and turn engine clockwise until TDC mark on flywheel is aligned with boss on bell housing. Check that gauge reads .031-.035" (.78-.88 mm). If necessary, loosen bolts on mounting plate and support. Set lift by turning pump until gauge reads .034" (.86 mm). Tighten pump mounting bolts and recheck injection pump timing.

NOTE – *To avoid fuel leaks, always replace seal for center plug.*

VALVES

VALVE ARRANGEMENT

E-I-E-I-I-E-I-E (front to rear).

VALVE GUIDE SERVICING

1) With head disassembled, insert new valve in guide which has been cleaned of carbon deposits. With end of stem flush with end of guide, check back and forth travel of head with dial indicator. Maximum reading for intake valve is .039" (1.0 mm) and for exhaust valve is .051" (1.3 mm).

2) Before replacing worn guides, ensure that valve seats can be resurfaced and that head is not cracked. Use tool (10-206) and press worn guides out from combustion chamber side. Do not use more than 1 ton pressure or guide shoulder may break. Ream guides by hand and reface valve seats.

VALVE STEM OIL SEALS

Removal & Installation – **1)** Seals may be replaced with cylinder head installed or removed from engine. Remove camshaft, adjusting disc and followers. Turn crankshaft until piston of cylinder concerned is at TDC. Remove valve springs, allowing valve to rest on piston crown.

2) Using special pliers (10-218), pull valve stem seals off. To install new seal, slide plastic sleeve from gasket set onto valve stem. Lubricate new seal and place in installer tool (10-204). Push seal carefully onto valve guide and reverse removal procedure.

VALVE SPRINGS

Removal & Installation – With camshaft and followers removed, compress spring with suitable tool (US 1020 and 1020/1 or 2037) and remove valve locks (keepers). Lift off valve springs. Valve spring seats may be removed with pliers (10-218) if required. To install, reverse removal procedure.

CAM FOLLOWERS (TAPPETS)

Removal & Installation – With camshaft removed, lift off followers and adjusting disc. Mark all components for installation in original position and inspect for wear or damage. To install, coat with oil and replace in original position.

VALVE CLEARANCE ADJUSTMENT

1) With cylinder head cover removed, turn crankshaft so that cam lobes of cylinder to be checked point upward. Check for specified clearance. If not within tolerances given, replace adjusting disc to mid-point of clearance range. Adjusting discs are available in .0019" (.05 mm) increments from .1181" (3.0 mm) to .1673" (4.25 mm).

2) To replace disc, turn crankshaft so piston is not at TDC so that valves do not contact pistons when cam followers are pressed down. Use follower depressor tool (VW546) to press follower down, then remove adjusting disc with etched marking downward (toward cam follower).

3) Rotate crankshaft so that lobes point upward and recheck clearance. Start and run engine until coolant temperature is warmed to approximately 95°F (35°C) and recheck clearance.

NOTE – *Valve clearances must be checked and readjusted after 1000 miles following cylinder head, camshaft or valve replacement or grinding.*

Valve Clearances

Application	Hot In. (mm)	①Cold In. (mm)
Intake	.008-012 (.20-.30)	.006-.010 (.15-.25)
Exhaust	.016-.020 (.40-.50)	.014-.018 (.35-.45)

① – Cold setting are given for reference as initial setting after engine rework.

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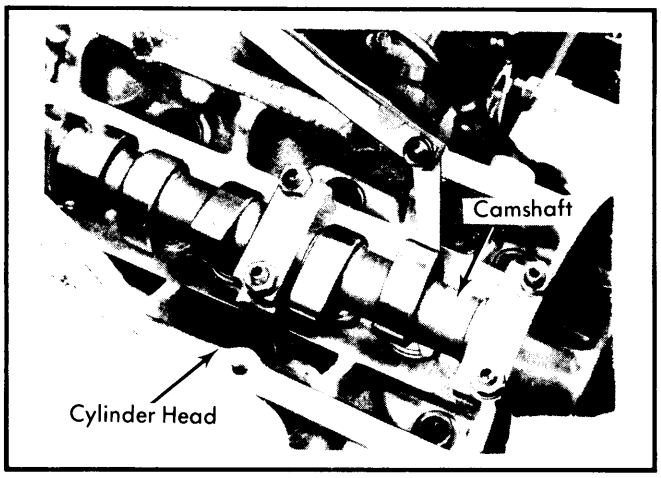

Fig. 2 Adjusting Valve Clearance

PISTON, PINS & RINGS

OIL PAN

Removal & Installation – Oil pan may be removed while engine is installed. Support engine with bar (10-222). Remove cover plate under engine and drain engine oil. Remove 4 bolts from subframe and lower subframe. Remove oil pan. To install, use new oil pan gasket and tighten pan bolts in a criss-cross pattern.

PISTON & ROD ASSEMBLY

Removal & Installation – Note that rod caps and rods are not marked for reassembly, mark each cap and rod before removing from block. Remove cap nuts and push piston/rod assembly out top of cylinder. When assembling, note that arrow on piston top points to crankshaft pulley (front of engine). Valve detents will be at left side of block. Raised casting marks on connecting rod and cap must face oil filter side of engine.

FITTING PISTONS

1) Measure cylinder at 3 points: 3/8" (10 mm) from top and bottom, and at center of bore. Measure in line with and at 90° to thrust face.

NOTE – *Do not measure when block is mounted in repair stand with adapter (VW 540) due to possible distortion.*

2) Measure pistons at 9/16" (15 mm) from bottom of piston skirt, 90° to pin bore. Subtract this measurement from that of corresponding cylinder bore and note piston-to-cylinder clearance. If clearance exceeds .027" (.07 mm), oversize pistons must be installed.

3) Place each piston ring squarely into bottom of cylinder about 9/16" (15 mm) and measure end gap. Measure ring side clearance in pistons with feeler gauge.

4) Install rings on pistons with "TOP" mark facing piston crown. Ring gaps should be spaced 120° apart. Use suitable compressor (US 1008A or equivalent) and install piston/rod assemblies.

PISTON PINS

Removal & Installation – Use pin type drift to pry circlip from pin boss. Press out pin with suitable driver (10-508). If pin is too tight, heat piston to approximately 140° F (60° C) prior to removal. Assemble piston/connecting rod assembly so that arrow on piston top faces forward when assembly is correctly installed. Use new circlips to retain pins.

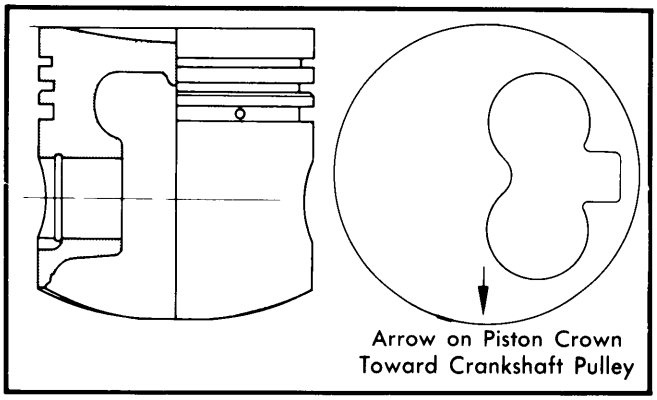

Fig. 3 Side and Top View of Diesel Piston

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS

MAIN & CONNECTING ROD BEARINGS

Check crankshaft end play at number 3 main bearing with feeler gauge. Check main and connecting rod bearing clearance using Plastigage method. Main bearings are numbered 1 through 5 with 1 at drive belt end and 5 at flywheel end. Install bearing shells with grooves in block and shells without grooves in bearing caps. All bearing shells must be installed in original position if they are not being replaced. Use new connecting rod cap nuts.

NOTE – *Bearing clearance may be checked with engine installed in vehicle. Do not turn crankshaft when checking with Plastigage.*

CRANKSHAFT REAR OIL SEAL

Removal & Installation – With flywheel removed, use tool (2086) to pry oil seal from sealing flange. Coat lips and outer edge of new seal with oil. Push seal into position by hand, then use installing tool (2003/1) to press in until properly seated.

CRANKSHAFT FRONT OIL SEAL

Removal & Installation – Lubricate threaded head of oil seal extractor tool (2085). Set in position and screw it as far as possible into oil seal by pushing firmly in. Loosen knurled screw and turn inner part against crankshaft until oil seal is pulled out. Clamp extractor in a vise and remove oil seal with pliers. Install seal flush with front cover.

NOTE – *When installing crankshaft pulley bolt, coat threads and contact surface of bolt head with loctite 573 or equivalent.*

ENGINE OILING

Crankcase Capacity – 3.7 qt. with filter change; 3.2 qt. without filter change.

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Oil Filter – Replaceable spin-on type filter is mounted on right side of engine block.

Normal Oil Pressure – Minimum of 28 psi (1.97 kg/cm²) at 2000 RPM with engine at normal operating temperature.

OIL PUMP

Gear-type pump is mounted at front of engine and is driven by the crankshaft. The oil suction tube extends from the oil pump base to the oil pan. The pump is non-serviceable, and must be replaced as an assembly if defective.

Removal – With oil pan removed, remove oil suction pipe and unbolt pump from engine.

Installation – Ensure that driving dog on crankshaft engages pump gear properly and reverse removal procedure. Align drive belt sprocket with Woodruff key and apply Loctite 573 (or equivalent) to threads and contact surface of pulley bolt before installing.

ENGINE COOLING

Cooling Capacity – 7.4 qts.

Thermostat — Opens at 185° F (85° C).

Expansion Tank Cap – Relieves pressure at 15 psi. (1.06 kg/cm²).

Radiator – Diesel models use a main and an auxiliary radiator, both cross flow type, and a coolant expansion tank. An electric cooling fan is actuated by a thermoswitch at temperatures above 200°F (93°C) and turned off at lower temperatures.

WATER PUMP

Removal & Installation – Allow engine to cool, then drain cooling system. Remove "V" belts, timing belt covers. See Timing Belt procedures in this article. Remove retaining bolts and water pump. To install, use new "O" ring on pump and reverse removal procedure.

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs. (N·m)
Head Bolts	
Step 1	29 (40)
Step 2	43 (60)
Step 3	①54 (75)
Camshaft Bearing Caps	14 (20)
Main Bearing Caps	47 (65)
Connecting Rod Caps	33 (45)
Flywheel (Loctite)	54 (75)
Crankshaft Pulley (Loctite)	250 (350)
Camshaft Sprocket Bolt	
Front	33 (45)
Rear	72 (100)
Intake Manifold	22 (30)
Injectors	51 (70)
Injector Pipes	18 (25)
Engine Mounting Bolts	25 (35)
Engine-to-Transmission	40 (55)

① – Turn bolt in sequence with breaker bar ½ turn (180°) further. Run engine until it reaches normal operating temperature, stop engine and retighten head bolts in sequence ¼ turn (90°) further with breaker bar without loosening them.

At 1000 miles (with engine warm or cold) retighten bolts with breaker bar, turning bolts in sequence ¼ turn (90°) without loosening them.

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

Year	Displ.		Carburetor	HP at RPM	Torque (Ft. Lbs. at RPM)	Compr. Ratio	Bore		Stroke	
	cu. ins.	cc					in.	mm	in.	mm
1981	96.9	1588	Fuel Inj.	52 @ 4800	71 @ 3000	23:1	3.01	76.51	3.4	86.40

VALVES

Engine & Valve	Head Diam. In. (mm)	Face Angle	Seat Angle	Seat Width In. (mm)	Stem Diameter In. (mm)	Stem Clearance In. (mm)	Valve Lift In. (mm)
1588 cc							
Int.	1.338 (34.0)	45°	45°	.078 (2.0)	.314 (7.97)	.039 (1.0)	.....
Exh.	1.220 (31.0)	45°	45°	.096 (2.4)	.313 (7.95)	.051 (1.3)	.....

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ENGINE SPECIFICATIONS (Cont.)

PISTONS, PINS, RINGS

Engine	PISTONS	PINS		RINGS		
	Clearance In. (mm)①	Piston Fit In. (mm)	Rod Fit In. (mm)	Rings	End Gap In. (mm)②	Side Clearance In. (mm)
1588 cc	.011 (.03)	Push Fit	.....	Upper	.012-.020 (.30-.50)	.002-.004③ (.06-.09)
				Center	.012-.020 (.30-.50)	.002-.003① (.06-.08)
				Oil	.010-.016 (.25-.40)	.001-.002① (.03-.06)

① – Wear Limit – .027" (.07 mm).
② – Wear Limit – .040" (1.0 mm).
③ – Wear Limit – .008" (.2 mm).
④ – Wear Limit – .006" (.15 mm).

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS

Engine	MAIN BEARINGS				CONNECTING ROD BEARINGS		
	Journal Diam. In. (mm)	Clearance In. (mm)①	Thrust Bearing	Crankshaft End Play In. (mm)②	Journal Diam. In. (mm)	Clearance In. (mm)	Side Play In. (mm)②
1588 cc	2.124 (53.96)	.001-.003 (.03-.08)	No. 3	.003-.007 (.08-.18)	1.88 (47.77)	.0011-.0034 (.028-.088)	.015 (.37)

① – Wear Limit .007" (.17)
② – Wear Limit .015" (.37)