4000 4-CYLINDER

ENGINE CODING

ENGINE IDENTIFICATION

Engine number is stamped on side of engine block near distributor. Number prefix indicates the following application:

Engine Identification Codes

Application	Engine Code
Federal	YG
Calif.	YK

ENGINE & CYLINDER HEAD

ENGINE

NOTE – *Unless otherwise specified, leave all fuel injection lines connected to components.*

Removal – 1) Disconnect battery ground strap. Remove grille, condenser from radiator, and air duct from throttle valve housing. Remove hose from air duct to auxiliary air regulator. Remove fuel distributor, air flow sensor, fuel injectors, and air cleaner as one unit. Remove cold start valve.

NOTE – *Cap or plug fuel injectors and cold start valve.*

2) Remove front engine mount. Loosen nuts on outer half of crankshaft pulley and remove "V" belt. Discharge refrigerant from air conditioning system and remove air conditioning lines from compressor. Support bracket and plug all open connections.

3) Disconnect wire to compressor clutch. Remove crankcase vent hose connection from valve cover and move air conditioning hoses to one side, away from engine. Remove upper compressor mounting bolts and 3 lower compressor mounting bolts. Remove compressor from vehicle.

4) Open heater control valve fully. Remove cap from coolant expansion tank. Drain coolant from engine by removing hoses, saving coolant for later installation. Remove upper radiator hose from engine, lower radiator hose from radiator, and plug from radiator fan.

5) Disconnect plug from radiator thermo switch. Remove both rubber mounts and lift radiator, fan and fan shroud out of vehicle as an assembly.

6) Disconnect clutch cable. Disconnect wiring. Remove control pressure regulator, leaving fuel lines connected. Remove air hose, if equipped. Unplug blue wire from alternator at plug between battery and rear of engine. Remove charcoal filter hose at intake air duct.

7) Disconnect wiring on oil pressure switch and coolant temperature gauge sender. Remove wires from ignition coil. Remove heater hoses.

8) Remove throttle cable. Remove vacuum hoses from the following:

- Ignition distributor retard unit (clear hose).
- Ignition distributor advance unit (violet hose), leading to charcoal filter.
- Throttle valve housing (gray hose) leading to vacuum amplifier.
- EGR temperature control valve (blue angled connection) to vacuum amplifier.
- Throttle valve housing stage 1 (red hose) to vacuum amplifier.
- Intake manifold (hose leading to brake booster).

9) Pull out fuel injectors. Remove 3 upper engine-to-transmission bolts. Remove right and left engine mount nuts. Remove exhaust pipe attaching nuts from manifold and remove pipe. Remove cover plate.

10) Remove front engine mount. Disconnect starter cables and label for later installation. Remove starter. Remove 2 lower engine-to-transmission bolts. Loosen right and left engine mount nuts on subframe. Through starter hole, remove torque converter bolts.

11) Remove bolt for front exhaust pipe support. Install transmission support tool. Install engine lift chain (US 1105). Lift engine until weight is taken off engine mounts. Adjust support bar to contact transmission.

12) Pry engine apart from transmission. Carefully lift engine out of engine compartment, using caution not to damage transmission mainshaft, clutch and body. Mount engine on stand.

Installation – To install engine, reverse removal procedure. When tightening engine mount and subframe bolts, run engine at idle speed. Tighten mount bolts. Adjust throttle and clutch cables, align exhaust system components and refill coolant expansion tank.

CYLINDER HEAD

Removal & Installation – 1) Disconnect battery ground cable. Drain coolant system and disconnect hoses which are connected to cylinder head. Disconnect exhaust pipe and electrical wires. Disengage accelerator linkage and disconnect at holder. Loosen alternator tensioner and remove "V" belt and camshaft drive belt.

2) Loosen head bolts in reverse order or tightening sequence shown in *Fig. 1*. To install, ensure that cylinder head and block cylinder head mating surfaces are clean. Install cylinder head gasket DRY, using no sealant. Use only polygon cylinder head bolts. Install bolts 8 and 10 first to center cylinder head. Tighten head bolts in sequence illustrated.

NOTE – *DO NOT torque polygon cylinder head bolts after first 1000 miles, nor after 1000 miles following repair.*

3) When installing "V" belt, adjust tension so that thumb pressure permits $\frac{3}{8}$-$\frac{9}{16}$" (10-15 mm) deflection of belt inward, midway between alternator and crankshaft belt pulley. When installing camshaft timing belt, adjust tensioning arm until belt can be turned 90° with thumb and index finger at a point midway between camshaft sprocket and intermediate sprocket.

4000 4-CYLINDER (Cont.)

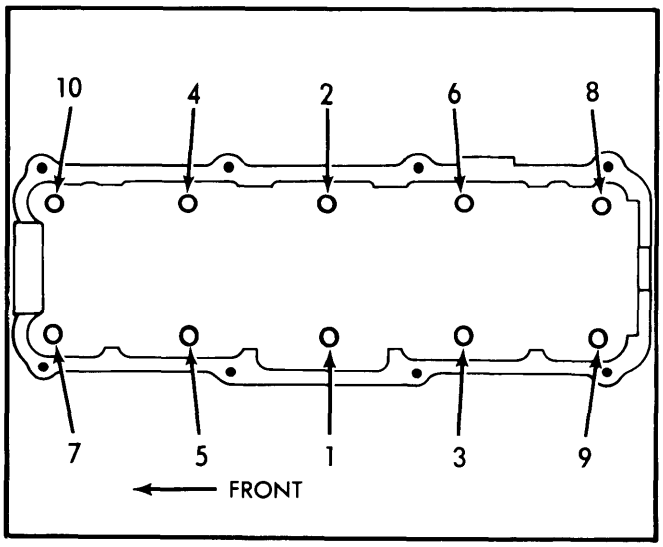

Fig. 1 Cylinder Head Tightening Sequence (Reverse Sequence When Removing)

CAMSHAFT

TIMING BELT

1) Remove radiator grille. Loosen alternator mounting bolts and remove "V" belt. Remove camshaft belt guard. Loosen mounting nut of camshaft belt tensioner arm and remove tension from belt. Slide belt forward off camshaft sprocket.

2) Install new belt and adjust tensioner arm until belt can be turned 90° with thumb and index finger at a point midway between camshaft sprocket and intermediate sprocket. Check valve timing.

CAMSHAFT

Removal – Remove bearing caps 1, 3, and 5. Diagonally loosen bearing caps 2 and 4 in steps. Remove caps and lift out camshaft.

Installation – To install, lubricate bearing shells, journals and contact faces of caps. Install caps 1, 3, and 5, observing off-center bearing position. See *Fig.* 2. Numbers on bearing caps are not always on same side. Tighten bearing caps diagonally. Install caps 2 and 4 and tighten diagonally.

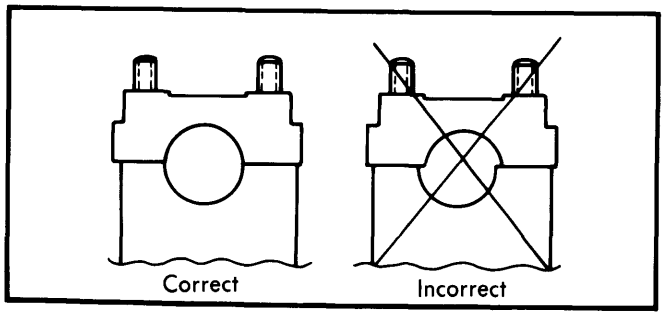

Fig. 2 Checking Bearing Cap Alignment

CAMSHAFT OIL SEAL

Removal – Remove upper drive belt cover. Set crankshaft to TDC on cylinder 1. Loosen drive belt and remove camshaft sprocket. Remove Woodruff key. Using special tool (10-219), remove oil seal.

Installation – Install protective sleeve (10-203) over camshaft. Push seal over sleeve, and using remainder of special tool (10-203), press seal in until flush. Check camshaft end play with cam followers removed. Maximum end play is .006" (.15 mm). Reinstall cam followers.

VALVE TIMING

1) Turn camshaft sprocket until punch mark on rear of camshaft sprocket is aligned with upper edge of lower drive belt cover (arrow) or valve cover gasket on left side of engine. See *Fig.* 3.

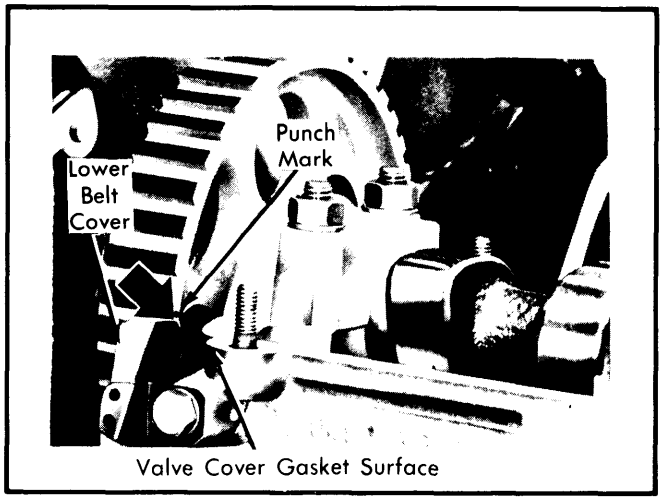

Fig. 3 Camshaft Drive Sprocket Timing Mark Alignment

2) Turn crankshaft pulley and intermediate shaft sprocket until notch in crankshaft pulley is aligned with punch mark on intermediate shaft sprocket. See *Fig.* 4. Slide camshaft drive belt in place and adjust tension, as previously described.

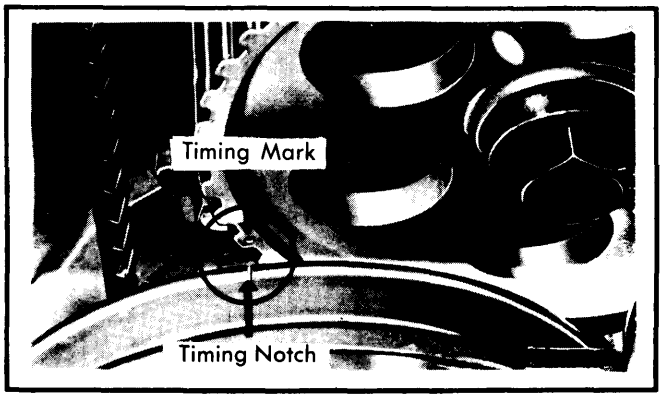

Fig. 4 Intermediate Shaft Sprocket Aligned with TDC Notch in Crankshaft Pulley

VALVES

VALVE ARRANGEMENT

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

4000 4-CYLINDER (Cont.)

VALVE SPRINGS

With cam followers removed, install valve spring compressor tool (10-210). Compress springs and remove valve keepers and collar. Lift out valve springs. To install, reverse removal procedure.

MECHANICAL VALVE LIFTER ASSEMBLY

With camshaft and adjusting discs removed, lift out cam followers. Inspect for wear or damage. Replace as necessary. Lightly oil cam followers and replace in original location.

VALVE STEM OIL SEALS

NOTE – *Valve stem oil seals may be replaced with cylinder head installed on vehicle.*

Removal & Installation – With camshaft and spark plug removed, turn crankshaft until affected piston is at BDC. Install air hose adapter (VW 653/3) in spark plug hole and apply constant pressure. Using spring compressor (VW 541 or 10-210), remove valve keepers. Lift seal off valve stem with remover (10-218). Slide plastic sleeve onto valve stem. Lubricate new seal and push in place with installing tool (10-204).

NOTE – *Do not attempt to install seal without using plastic sleeve, or seal will be damaged, causing engine to use excessive oil.*

VALVE GUIDE SERVICING

1) Before taking measurements, clean valve guides with a cleaning broach. To measure, attach a suitable device with a dial indicator (VW 387 or US 4420A) to mounting surface of cylinder head. Insert a new valve into valve guide until stem is flush with end of guide. Rock valve against dial indicator and check amount of guide-to-stem clearance. Maximum valve rock should not exceed .039" (1.0 mm) for intake valves or .051" (1.3 mm) for exhaust valves.

2) Use suitable press and adaptor (10-206) to remove and install valve guides. Press worn guides out from combustion chamber side. Coat new guide with oil and press into cold cylinder head from camshaft side. Do not use more than 1 ton of pressure or guide shoulder may break. Ream guide by hand to proper size.

VALVE CLEARANCE ADJUSTMENT

NOTE – *Cold settings are given for reference as initial settings after engine work. Final adjustments are to be made with engine moderately warm (coolant temperature approximately 95° F (35° C).*

1) Remove accelerator linkage, upper drive belt cover and cylinder head cover. Turn crankshaft pulley bolt in a clockwise direction until cam lobes of cylinder to be adjusted point upward. See *Fig. 5*.

NOTE – *Do not turn camshaft by mounting bolt as this will stretch drive belt. If crankshaft sprocket bolt is turned counter-clockwise, bolt could be loosened. If this should occur accidentally, remove bolt and clean threads. Coat threads with Loctite or equivalent, then install bolt and torque to specification.*

Fig. 5 Adjusting Valve Clearance

2) Adjust valve clearances in firing order (1-3-4-2). Using a feeler gauge, measure valve clearance of each cylinder in turn. If clearance is within .002" (.05 mm) of specification, no adjustment is necessary.

Valve Clearance Specifications

Application	In. (mm)
Intake	
Hot	.008-.012 (.20-.30)
Cold	.006-.010 (.15-.25)
Exhaust	
Hot	.016-.020 (.40-.51)
Cold	.014-.018 (.36-.46)

3) Compare measured clearance for each valve to specifications. If adjustment is required, determine thickness of adjusting disc currently used. If measured clearance is larger than specifications, replace adjusting disc with thicker disc. If clearance is less than specification, install a thinner disc. Adjust clearance to middle of tolerance range.

4) Adjusting discs are available in .002" (.05 mm) increments from .1181" (3.0 mm) to .1673" (4.25 mm). Thickness is stamped on bottom side of disc.

5) To remove discs from cam followers, turn cam followers so that they are adjacent to each other between cam lobes. Insert cam follower tool (VW 546) and depress cam followers. Remove adjusting discs with special tool (US 4476 or 10-208). To install discs, depress cam followers and slip discs into place with side indicating thickness downward. Remove tool. Repeat procedure until all valves are properly adjusted.

4000 4-CYLINDER (Cont.)

PISTONS, PINS & RINGS

OIL PAN

Drain engine oil. Attach a suitable lifting device to engine and apply supporting tension to engine. Remove front sub frame attaching bolts at left and right. Remove cover plate. Unscrew oil pan bolts and remove pan. When installing, use a new gasket, installing it dry without adhesive. Install oil pan bolts and tighten in a crisscross pattern.

PISTON & ROD ASSEMBLY

1) Before removing connecting rods, mark rod, cap and piston for proper installation. Remove nuts from connecting rod bolts, remove caps, and carefully push piston and rod assemblies out top of cylinders.

2) On reassembly of piston and rod assemblies, forged marks on rod and cap, as well as locating projections on bearing inserts, should face toward timing gear at front of engine. See *Fig. 6*. All connecting rods must be of same weight class. Weight class numbers are stamped on bottom of connecting rod caps. Using a ring compressor tool (US 1008A), install piston and rod assemblies with arrow on top of piston facing timing gear (front of engine).

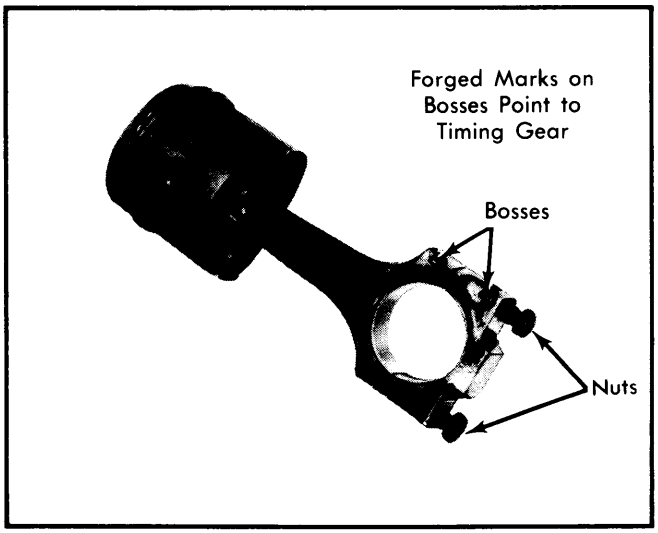

Fig. 6 Identification Marks on Connecting Rod Bosses

FITTING PISTONS

1) Measure cylinder at three points: .39" (10 mm) from top and bottom, and at center of cylinder bore. Take measurements in line with thrust face and at 90° to thrust face.

2) Measure piston diameter at .39" (10 mm) from bottom of piston skirt (measuring at 90° to pin bore). Combining this measurement with measurement of corresponding cylinder bore, if piston-to-cylinder clearance exceeds .003" (.07 mm), oversize pistons must be installed.

NOTE – *Top of piston is marked with an arrow, denoting direction piston is to be installed in cylinder, and with a 4-digit number indicating piston diameter in millimeters (for example, 79.48).*

3) Place piston rings squarely in top of cylinder bore (above ring ridge) and measure end gap; replace as necessary. Measure ring side clearance; replace rings and/or pistons if clearance exceeds .006" (.15 mm). Install rings on piston with end gaps 120° offset to each other and stamped word "TOP" on rings facing upward.

PISTON PINS

Use pin-drift to lift circlip from piston groove. Use tool (VW 207c) to remove and install piston pins. If pins are too tight it may be necessary to warm pistons to about 140°F (60°C) for removal and replacement.

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS

MAIN & CONNECTING ROD BEARINGS

1) Push crankshaft toward one end and measure crankshaft end play at No. 3 (thrust) bearing. Main bearing caps are stamp-numbered "1" to "5" from timing gear end to flywheel end. They must be installed in original positions upon reassembly. Measure connecting rod side play. Remove rod and main bearing caps and check bearing clearance, using Plastigage method.

2) Measure crankshaft journals with a micrometer to determine if crankshaft is out-of-round. Maximum ovality permissible is .0012" (.03 mm). Install main inserts with bearing half having oil groove into block. Lubricate bearings and install caps.

Crankshaft Journal Diameters

Size	Main Bearing Inches (mm)	Connecting Rod Inches (mm)
Standard	2.124 (53.97)	1.809 (45.97)
1st US	2.114 (53.72)	1.799 (45.72)
2nd US	2.104 (53.47)	1.789 (45.47)
3rd US	2.094 (53.22)	1.779 (45.22)

REAR MAIN BEARING OIL SEAL

Rear main bearing oil seal may be replaced with engine in vehicle, if transmission and flywheel are removed. Carefully pry oil seal from crankcase. Install guide tool (2003/2A) on crankshaft and press seal into position as far as possible by hand. Press seal in until properly seated with installing tool (2003/1).

INTERMEDIATE SHAFT OIL SEAL

Press seal out of flange. Coat new seal lips with oil and press new seal into flange, using suitable tool (10-203). Press until flush.

FRONT MAIN BEARING OIL SEAL

1) Remove "V" belt and upper drive belt cover. Set crankshaft to TDC. Remove "V" belt pulley from crankshaft and loosen

4000 4-CYLINDER (Cont.)

drive belt sprocket. To remove drive belt sprocket bolt, engage 4th gear and apply foot brake. Have assistant remove water pump pulley and lower drive belt cover. Then loosen drive belt and remove drive belt sprocket.

2) Pry old seal out of front cover with extractor tool (10-219). Using installation tool (10-203), press new seal into place after coating seal lips with oil. Press in until flush and then to a depth of .080" (2 mm) below outer edge of cover.

NOTE – *When pressing seal into place, install washer from socket bolt between tool (10-203) and bolt head.*

3) To install remaining components, reverse removal procedure and check valve timing.

ENGINE OILING

Crankcase Capacity – 3.2 qts. (3.7 qts. with filter).

Oil Filter – Replaceable, spin-on type. Hand-tighten.

Normal Oil Pressure – 28 psi (1.97 kg/cm^2) at 2000 RPM with oil temperature at 176° F (80° C).

ENGINE OILING SYSTEM

Oiling system is a pressure feed system. A gear type oil pump lifts oil from oil pan and pressure feeds it to crankshaft journals, camshaft bearings and intermediate shaft. Other parts of system receive oil mist or splash for lubrication.

OIL PUMP

Removal & Installation – Remove oil pan and two oil pump mounting bolts. Pull pump straight down and out of engine. Remove two pump cover bolts and separate cover from pump body. Ensure that oil pump gear end clearance is not more than .006" (.15 mm). Remove pump drive shaft and gears. Bend up metal edges and remove filter screen. To reassembly, reverse disassembly procedures.

ENGINE COOLING

Cooling System Capacity – With air conditioning – 7.4 qts.; without air conditioning – 6.5 qts.

Thermostat – Arrow should point toward fender when installed. Begins to open at 194°F (90°C); opening ends at 216°F (102°C).

Expansion Tank Cap – Pressure relief valve opens at 17-19 psi (1.20-1.33 kg/cm^2)

Cooling Fan – Begins to operate at 199-208° F (93-98° C); shuts down at 190-199° F (88-93° C). Switch located in radiator.

WATER PUMP

1) Drain coolant and remove alternator. Remove camshaft belt guard, hose clamps and pump hoses. Remove water pump mounting bolts and lift out pump by turning slightly.

2) Remove pulley and pump body mounting screws. Separate pump assembly from housing. To reassemble, reverse diassembly procedure using new gasket and pump-to-block seal.

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	97	1588	Fuel Inj.	76@5500	83@3200	8.2:1	3.13	79.5	3.15	80.0

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							
Intake	1.338 (34)	45°	45°	.079 (2.0)	.314 (7.98)	.008-.012 (.20-.30)	.....
Exhaust	1.220 (31)	45°	45°	.094 (2.4)	.313 (7.95)	.016-.020 (.40-.51)	.....

4000 4-CYLINDER (Cont.)

ENGINE SPECIFICATIONS (Cont.)

PISTONS, PINS, RINGS

Engine	PISTONS	PINS		RINGS		
	Clearance In. (mm) ①	Piston Fit In. (mm)	Rod Fit In. (mm) ③	Rings	End Gap In. (mm) ④	Side Clearance In. (mm) ⑤
1588 cc	.0011 (.028)	②	.0011-.0034 (.028-.086)	Comp. Oil	.012-.018 (.30-.46) .010-.016 (.25-.40)	.0008-.002 (.02-.05) .0008-.002 (.02-.05)

① — Wear limit .003" (.07 mm). ② — Push fit at 140°F (60°C). ③ — Wear limit .004" (.12 mm).
④ — Wear limit .040" (1.0 mm). ⑤ — 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) ③	Side Play In. (mm)
1588 cc	2.125 (53.97)	.001-.003 (.025-.076)	No. 3	.003-.007 (.077-.178)	1.810 (45.97)	.0011-.0034 (.028-.086)	.015 (.38)

① — Wear limit .007" (.17 mm). ② — Wear limit .010" (.25 mm).
③ — Wear limit .004" (.12 mm).

VALVE SPRINGS

Engine	Free Length In. (mm)	PRESSURE Lbs. @ In. (kg @ mm)	
		Valve Closed	Valve Open
1588 cc Inner	.....	.....	46-51 @ .72 (21-23 @ 18.3)
Outer	.....	.....	96-106 @ .92 (44-48 @ 22.3)

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs. (N·m)
Head Bolts (Cold Only)	
Step 1	29 (40)
Step 2	43 (60)
Step 3	①54 (75)
Main Bearing Caps	47 (65)
Connecting Rod Caps	33 (45)
Flywheel (Use Loctite)	54 (75)
Intermediate Shaft Sprocket	58 (80)
Crankshaft Drive Belt Sprocket	58 (80)
Intake Manifold	18 (25)
Camshaft Bearing Caps	14 (20)
Camshaft Sprocket	58 (80)
Engine-to-Transmission Bolts	40 (55)
Drive Belt Tension Nut	33 (45)
Crankshaft "V" Belt Pulley	14 (20)

① — After torque to 54 ft. lbs. (75 N·m), turn 90° more.