1.6 LITER 4-CYLINDER

IDENTIFICATION CODING

ENGINE IDENTIFICATION

Engine may be identified from the official Vehicle Identification Number. Number is stamped on a metal tab fastened to the instrument panel close to windshield on drivers side of car and visible from outside. The eighth digit is the engine identification number.

Engine Code

Engine	Code
1.6L (98") 2-Bbl.	2

SPECIAL ENGINE MARKS

Information identifying oversize tappets and oversize camshaft is stamped in various locations on engine. Information and location is decoded as follows:

.235 OT – This indicates that all 8 tappets are oversize. This mark will appear on the machined pad below rocker arm rail and above No. 1 exhaust port.

.38 O/C & .38 O/S – This indicates that the engine has oversize tappets and/or oversize camshaft. The mark .38 O/C will be located on the cover rail tug on No. 4 exhaust port. The mark .38 O/S will appear on the distributor drive end of the camshaft.

ENGINE REMOVAL

See Engine Removal at end of ENGINE Section.

CYLINDER HEAD & INTAKE MANIFOLD

INTAKE MANIFOLD

Removal – 1) Disconnect negative cable at battery. Drain cooling system and disconnect heater hose located under intake manifold. Disconnect upper radiator hose at cylinder head and disconnect wiring terminal from the cooling fan switch.

2) Remove air cleaner and disconnect necessary vacuum hoses. Disconnect wiring connectors at choke cap wire, bowl vent and idle fuel solenoid.

3) Remove EGR supply tube. Raise vehicle and remove PVS hose connectors, using tool T81P-8564-A (or equivalent). Label connectors and set aside.

4) Remove the bottom 3 intake manifold nuts, locations 2, 3 and 6. *See Fig. 1.* Lower vehicle. Disconnect fuel lines. Disconnect accelerator and, if equipped, speed control cable.

5) If equipped with power steering, remove thermactor pump drive belt, pump, pump mounting bracket and thermactor bypass hose. If equipped with automatic transaxle, disconnect throttle valve linkage at carburetor and remove cable bracket mounting bolts.

6) Remove fuel pump as follows: Loosen fuel pump supply nut at fuel pump outlet. Loosen fuel pump mounting bolts 2 turns and manually rotate engine to position pump push rod on low side of cam. Disconnect fuel lines. Remove pump mounting bolts, fuel pump, gasket and push rod.

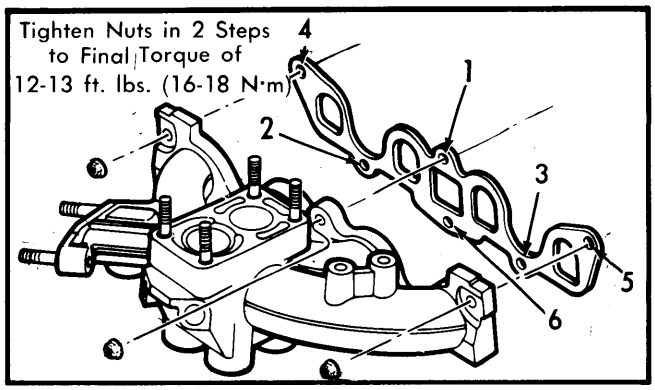

Fig. 1 1.6L Engine Intake Manifold Tightening Sequence

7) Remove remaining intake manifold attaching nuts. Remove intake manifold and gasket, using wrench T81P-9425-A (or equivalent) on center (No. 1 position) nut.

Installation – Clean all mating surfaces on manifold and on cylinder head. Tighten nuts in 2 steps as shown in *Fig. 1.* To complete installation, reverse removal procedure.

CYLINDER HEAD

Removal – 1) Disconnect negative cable at battery. Drain cooling system and disconnect heater hose located under intake manifold. Disconnect upper radiator hose at cylinder head and disconnect wiring terminal from cooling fan switch.

2) Remove air cleaner assembly and PCV hose. Disconnect required vacuum hoses. Remove rocker arm cover and disconnect all necessary drive belts. Remove crankshaft pulley.

3) Remove timing belt cover. Position No. 1 cylinder at TDC. Remove distributor cap and spark plug wires as an assembly. Using torque wrench adapter (T81P-6254-A or equivalent), loosen both belt tensioner bolts and position belt tensioner as far left as possible. Remove timing belt.

4) Disconnect EGR tube. Disconnect PVS hose connectors, label and set aside. Disconnect choke cap wire and fuel lines.

5) Disconnect accelerator cable and, if equipped, speed control cable. If equipped, disconnect altitude compensator from dash panel, and position on heater/AC air intake.

6) Disconnect alternator air intake tube and alternator wiring harness. Then remove alternator and bracket. If equipped with power steering, remove thermactor pump drive belt, pump and pump mounting bracket.

7) Raise vehicle, disconnect exhaust system and lower vehicle.

8) Remove cylinder head bolts and washers and discard bolts. Cylinder head bolts cannot be tightened to specified torque more than once and must therefore be replaced when installing a cylinder head. Remove cylinder head and gasket with intake and exhaust manifolds attached.

Installation – 1) Clean all gasket material from mounting surfaces on block and head. Before installing cylinder head, crankshaft must be rotated so that No. 1 piston is 90° BTDC.

1.6 LITER 4-CYLINDER (Cont.)

To position piston, turn crankshaft until pulley keyway is at 9 o'clock.

2) To time valve train while piston is in position described in step **1)**, turn camshaft until the keyway is at 6 o'clock position. Position No. 1 piston at TDC prior to installing timing belt.

3) Position cylinder head and gasket on cylinder block. Apply Loctite (or equivalent) to all new bolts. Install new bolts and washers. Tighten bolts in 4 steps as follows: Torque all bolts to first specification, then retorque all bolts to second specification. Rotate all bolts clockwise an additional 180° in steps of 90° each. All steps are made in sequence shown in *Fig. 2*. Reverse removal procedure to complete installation.

NOTE – *Camshaft and crankshaft must not be turned until after installation of timing gears and belt.*

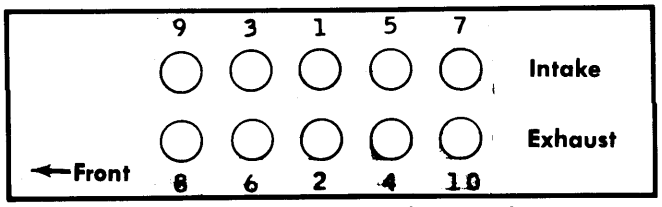

Fig. 2. Cylinder Head Bolt Tightening Sequence

VALVES

VALVE ARRANGEMENT

Left Side – All Exhaust

Right Side – All Intake

VALVE GUIDES

1) If valve guides become worn, they may be reamed to install a new valve with oversize stem. When going from a standard size stem to oversize always use reamers in sequence to obtain final desired bore.

2) Valve seats must be refaced after guide has been reamed, and a suitable tool used to break sharp corner (I.D.) of guide.

3) If it becomes necessary to ream a valve guide to install a valve with an oversized stem, a hand reaming kit, Rotunda 14-0224 (or equivalent) which contains oversized pilots and reamers is available.

VALVE STEM OIL SEALS

1) Oil seals are used on all valve stems and should be replaced whenever valve spring is removed or valve service is performed.

2) Valve stem seals can be replaced with cylinder head attached through use of a suitable spring compressor, (T81P-6513-A). Compressed air must be used to hold valve against seat by installing an air line and adapter in spark plug hole.

3) Remove rocker arm from valve spring to be compressed. Position compressor under rocker arm nut and over valve spring seal. Compress valve spring and remove components as necessary.

VALVE SPRINGS

1) With valve spring removed, check length under specified load in a valve spring tester. Check valve spring free length, if less than specified replace spring.

2) Check each valve spring for squareness using a steel square as shown in *Fig. 3*. If spring is out of square more than .60", replace spring.

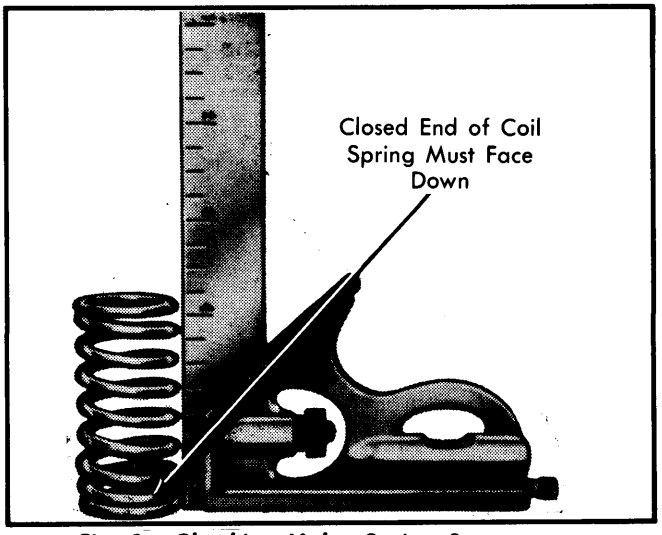

Fig. 3 Checking Valve Spring Squareness

ROCKER ARM

Check rocker arm pad, side rails and fulcrum seat for excessive wear, cracks, nicks or burrs. Discard rocker arm flange nuts when rocker arms are disassembled.

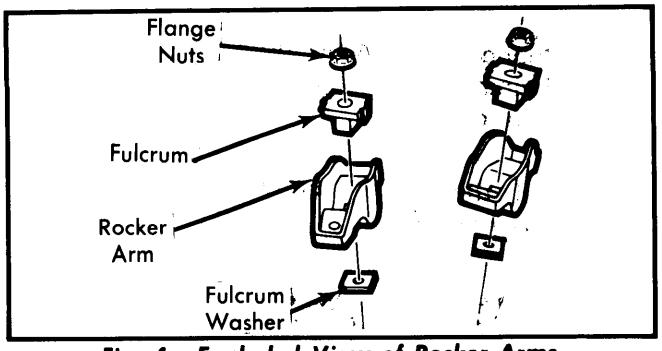

Fig. 4 Exploded View of Rocker Arms

HYDRAULIC LIFTER ASSEMBLIES

Hydraulic lifter assemblies should be kept in sequence and installed in original locations. If any part of lifter assembly is defective, entire lifter should be replaced. Do not intermix internal lifter parts. Assemble lifters and check free operation by pressing down on caps. Lifters may also be checked with hydraulic tester to check leakdown rate.

PISTONS, PINS & RINGS

OIL PAN

See Oil Pan Removal at end of ENGINE Section.

1.6 LITER 4-CYLINDER (Cont.)

PISTON & ROD ASSEMBLY

Removal – 1) Remove ridge on top of cylinder bores (using suitable ridge reamer) before removing pistons from block.

2) Rotate crankshaft and identify connecting rods and rod caps for cylinder identification, mark if necessary. Remove rod caps and push each piston and rod assembly out top of cylinder bore. Install rod caps on mating rods.

Installation – 1) Coat piston rings and cylinder walls with a light coat of engine oil. Position ring gaps as shown in *Fig. 5*. Arrow on top of piston should be pointing towards front of engine. Number on side of connecting rod and rod cap must match and face exhaust manifold side of engine.

2) Using a wooden handle, tap piston into cylinder bore. Install and tighten rod cap. Repeat procedure for each piston assembly.

FITTING PISTONS

Check piston to cylinder bore clearance by measuring piston and bore diameters. Measure outer diameter of piston at centerline of piston pin bore and at 90° to pin bore axis. Oversize pistons are available.

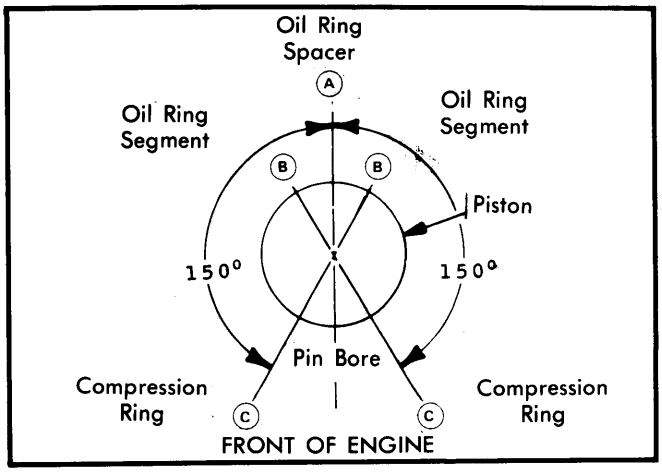

Fig. 5 Piston Ring Gap Spacing

PISTON PINS

Removal – Remove bearing inserts from connecting rod and cap. Mark piston and pin to ensure assembly with same rod. Press piston pin from piston and connecting rod using an arbor press and Piston Pin Removing and Installing Set T68P-6135-A (or equivalent).

Installation – Apply a light coat of engine oil to all parts. Assemble piston to connecting rod. See *Fig. 6*.

CRANKSHAFT & ROD BEARINGS

MAIN & CONNECTING ROD BEARINGS

NOTE – *Following procedures are with oil pan and oil pump removed.*

Connecting Rod Bearings – After ensuring rod caps are marked for cylinder identification, remove rod caps. Use Plastigage method to check for proper clearances. If not within specifications, new bearings must be installed. New bearings are available in .001" or .002" undersize. Coat bearing surfaces with oil, install rod cap and tighten nuts.

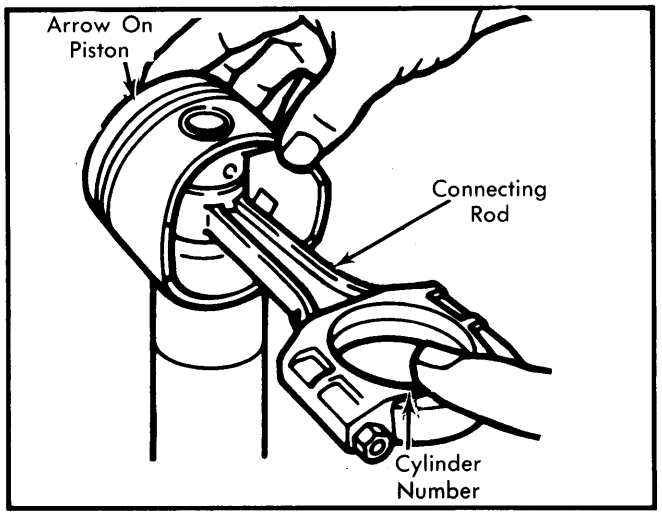

Fig. 6 Piston Pin Installation

NOTE – *Always replace bearings in pairs. Never use a new bearing in combination with a used bearing.*

Main Bearings – 1) Position jack under counterweight adjoining bearing being checked so weight of crankshaft will not compress Plastigage and provide an erroneous reading. With all bearing caps (other than one being checked) tight, check clearances using Plastigage method.

2) If clearances are excessive, a .001" or .002" undersize bearing may be used in combination with a standard bearing. If .002" undersized bearings are used on more than one journal, they must be positioned in cylinder block rather than bearing cap.

NOTE – *Always replace bearings in pairs. Never use a new bearing in combination with a used bearing.*

3) If standard and .002" undersize combinations do not bring bearing clearance within specification limits, crankshaft will have to be refinished and undersized bearings installed.

4) Remove all upper main bearings by inserting a suitable tool in oil hole of crankshaft journal and rotating crankshaft clockwise to roll bearing from engine. Lubricate new inserts, and insert plain (unnotched) side of block. Rotate bearing into place. Install all main bearing caps with arrows pointing to front of engine.

REAR MAIN BEARING OIL SEAL

Removal – With engine removed from vehicle, remove rear cover plate and flywheel. Using a sharp awl and hammer, drive tip of awl through metal casing of seal. Use a sheet metal screw to remove seal, using care not to damage sealing surfaces. See *Fig. 7*.

1.6 LITER 4-CYLINDER (Cont.)

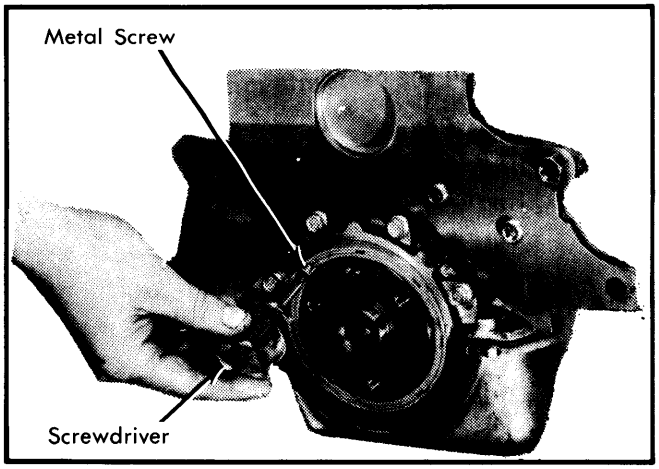

Fig. 7 Removing Crankshaft Rear Oil Seal

Installation – Inspect crankshaft seal area for any damage that may prevent sealing and service or replace crankshaft as necessary. Coat crankshaft seal area and seal lip with engine oil. Start seal in recess and install seal using seal installer (T81P-6701-A or equivalent). *See Fig. 8.* Tighten bolts evenly so seal is straight and properly aligned.

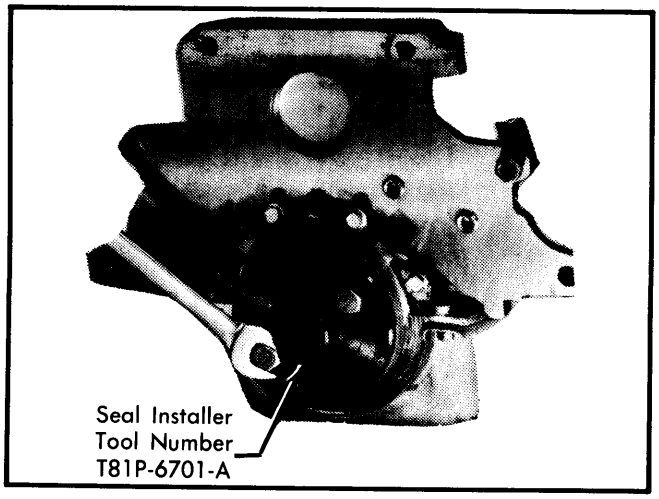

Fig. 8 Installing Rear Main Oil Seal

FRONT CRANKSHAFT OIL SEAL

Removal – Remove timing belt cover, loosen belt tensioner, and remove crankshaft pulley and timing belt. Remove crankshaft gear and timing belt guide plate. Remove seal.

Installation – Install new seal using seal installer (T81P-6700-A or equivalent). *See Fig. 9.* To complete installation, reverse removal procedure.

CAMSHAFT

CAMSHAFT

Removal – 1) Remove timing belt cover, loosen belt tensioner and remove crankshaft pulley. Position No. 1 cylinder at TDC and remove timing belt. Remove rocker arms and hydraulic lifters. Discard rocker arm flange nuts.

NOTE – *When No. 1 cylinder is positioned at TDC, do not turn crankshaft until timing belt is installed.*

2) Remove distributor, timing belt, camshaft sprocket, camshaft key, thrust plate, fuel pump, ignition coil and coil bracket. Remove camshaft through rear of cylinder head. Replace camshaft seal if it shows any signs of wear or damage.

Installation – 1) Lubricate and install camshaft seal. Lubricate camshaft with engine oil. Install camshaft through rear of cylinder head, rotating during installation. Install thrust plate and cam gear. Check camshaft end play, and replace thrust plate if not within specifications.

2) Install fulcrum washer, rocker arms, fulcrum and new flange hex nuts, in order shown in *Fig. 4.* To complete installation, reverse removal procedure.

Fig. 9 Installing Front Crankshaft Oil Seal

CAMSHAFT TIMING & BELT REPLACEMENT

CAUTION – *With timing belt removed and No. 1 cylinder at TDC, do not rotate camshaft. If camshaft must be rotated, align crankshaft pulley 90° BTDC.*

Removal – 1) Whenever removing or replacing a timing belt, remove timing belt cover and align timing mark on camshaft drive sprocket with timing mark on cylinder head. Temporarily attach timing belt cover to ensure crankshaft pulley TDC mark aligns with timing mark on cover.

1.6 LITER 4-CYLINDER (Cont.)

2) Loosen belt tensioner bolts. Pry tensioner away from belt and tighten 1 bolt. Remove crankshaft pulley and timing belt.

Installation – 1) Starting at the crankshaft install new timing belt over cogged sprockets in a counterclockwise direction. Keep belt span from crankshaft to camshaft tight as belt is installed over remaining sprockets.

2) Loosen belt tensioner bolt about ½ turn and allow tensioner to snap against belt. Then tighten one of the tensioner bolts.

3) With the crankshaft pulley installed, hold pulley stationary and tighten pulley attaching bolts. Rotate crankshaft 2 complete revolutions and ensure timing marks are aligned.

4) Hold crankshaft from turning using wrench T81P-6312-A (or equivalent). With camshaft held, turn cam sprocket counterclockwise, using holding tool (D81P-6256-A or equivalent) and a torque wrench. When torque on cam sprocket reads 27-32 ft. lbs. (37-44 N·m) for new belt or 10 ft. lbs. (14 N·m) for a used belt, tighten belt tensioner attaching bolts.

NOTE – *Do not apply torque to camshaft sprocket attaching bolt. Apply torque to hex on sprocket.*

5) When valve timing is correct, crankshaft keyway should point to 12 o'clock position and camshaft to 6 o'clock position. See *Fig. 10*.

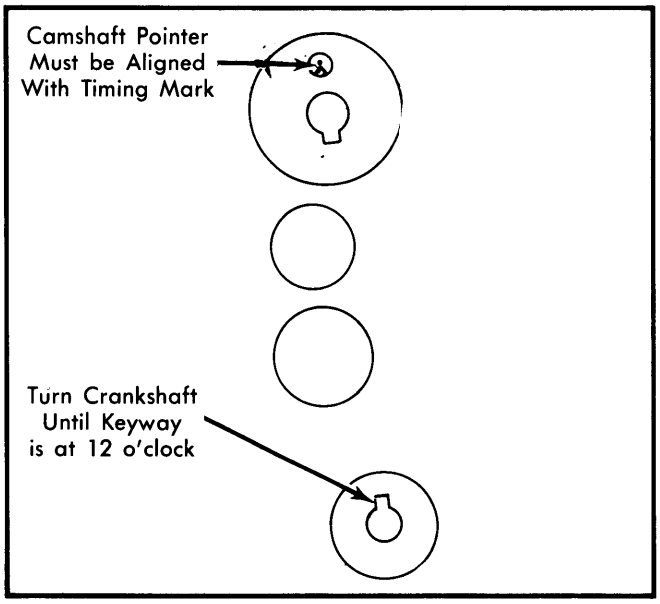

Fig. 10 Position of Camshaft and Crankshaft for Valve Timing

ENGINE OILING

Crankcase Capacity – 4 quarts with filter change.

Oil Filter – Full Flow, cartridge type.

Normal Oil Pressure – 40 psi at 2000 RPM (hot).

Pressure Relief Valve – Note position of relief valve plug before removal. Relief valve must be installed so top of plug does not extend more than .03" (.76 mm) above housing surface, or be threaded in more than flush with housing surface. Plug threads must be coated with sealer.

ENGINE OILING SYSTEM

Engine oiling is a full pressure system. Oil pump is bolted to front of cylinder block with pump drive gear positioned directly over crankshaft. Oil pump is driven directly by crankshaft.

OIL PUMP

Removal – Remove timing belt, crankshaft pulley and gear, drain crankcase. Remove starter and oil pan. See *Oil Pan Removal at end of ENGINE Section*. Remove oil pan retaining bolts and oil pump seal. Remove oil pick up tube and screen assembly from pump and clean.

Disassembly – Remove oil return tube and oil pickup tube and screen assembly. Remove plug from oil pressure relief valve bore and withdraw relief valve and spring. Remove cover plate and extract the outer and inner gears from pump housing. Remove main discharge plug, if necessary.

Inspection – Wash all parts in solvent, and blow dry with compressed air. Inspect all components for wear or damage. Minor imperfections may be removed with an oil stone. Measure outer race-to-housing clearance by mounting rotor assembly in housing and, using a straightedge, measuring distance between straightedge and rotor outer race. Check relief valve spring tension. Spring tension should be 9.6-10.6 lbs. at .921" (42.6-47.1 N at 23.4 mm). If any component is not to specification, pump assembly must be replaced.

Reassembly – To reassemble pump, reverse disassembly procedure and note the following: Before installing relief valve plug, coat threads with sealer. Relief valve plug must be installed so top of plug does not extend more than .03" (.76 mm) above housing surface, or be threaded in more than flush with housing surface. If main discharge valve was removed, coat with same sealer as relief valve plug and install.

Installation – Install new oil pump seal and oil pan gasket set. During installation, reverse removal procedure and use seal installer (T81P-6700A or equivalent) to protect and properly align crankshaft seal. Tighten bolts.

Oil Pump Specifications

Application	Specification In. (mm)
Relief Valve-to-Bore	.0007-.0031 (.02-.08)
Outer Gear-to-Housing	.0027-.0055 (.069-.140)
Inner and Outer Gear-to-Cover	.0015-.0025 (.040-.066)
Inner Gear-to-Housing①	.0028-.0063 (.07-.16)

① – Inside diameter.

1.6 LITER 4-CYLINDER (Cont.)

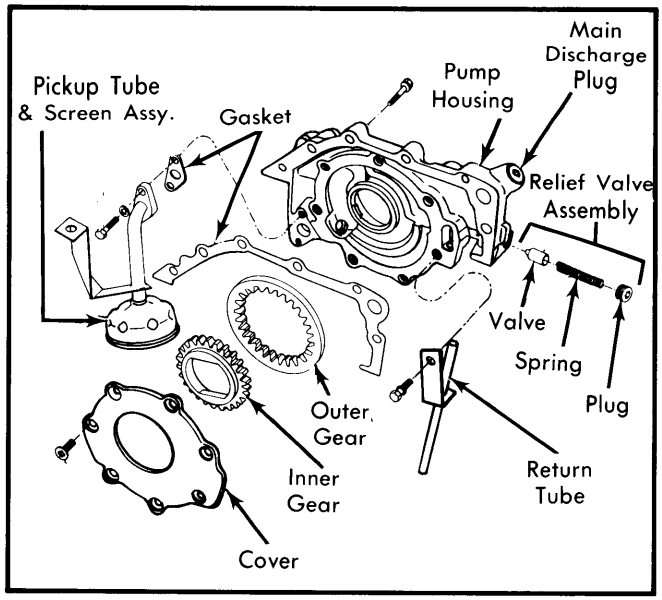

Fig. 11 1.6 Liter Oil Pump Assembly

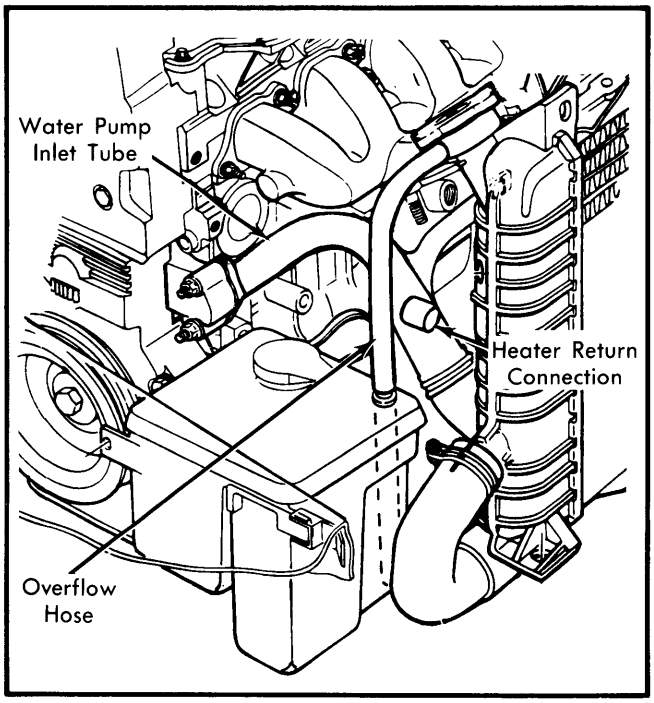

Fig. 12 Heater Tube-to-Water Pump Inlet Tube Connecting Point

ENGINE COOLING

WATER PUMP

Removal – 1) Disconnect negative battery cable. Drain cooling system. Remove accessory drive belts and engine front cover. Position No. 1 cylinder at TDC. Loosen belt tensioner mounting bolts, using tensioner bolt tool (T81P-6254-A or equivalent) on left bolt. Secure tensioner as far left as possible.

2) Remove timing belt and camshaft sprocket. Remove the rear front timing cover stud. Remove heater return tube hose connection from water pump inlet tube. *See Fig. 12.* Remove water pump inlet tube fasteners, tube and gasket. Remove water pump bolts, water pump, and gasket.

Installation – Clean all gasket surfaces. Mount water pump and new gasket on cylinder block. Apply sealer to water pump bolts, and complete installation by reversing removal procedure.

NOTE – *For further information on cooling system capacities and other cooling system components, see appropriate article in ENGINE COOLING SYSTEMS Section.*

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs. (N·m)
Belt Tensioner	17-20 (23-27)
Camshaft Sprocket	37-46 (50-63)
Camshaft Thrust Plate	7-11 (10-15)
Connecting Rod	19-25 (26-34)
Main Bearing Caps	67-80 (91-109)
Cylinder Head	
Step 1	15-30 (20-40)
Step 2	30-44 (40-60)
Steps 3 & 4	①
Crankshaft Pulley	74-90 (100-122)
Flywheel	59-69 (80-94)
Intake Manifold	12-13 (16-18)
Exhaust Manifold	15-20 (91-109)

① – Steps 3 and 4. Tighten an additional 180° clockwise in 2 steps of 90° each.

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

Engine	HP at RPM	Torque (Ft. Lbs. at RPM)	Compr. Ratio	Bore		Stroke		Displ.	
				in.	mm	in.	mm	cu. ins.	cc
1.6L	87@6000	115@3000	8.8:1	3.15	80	3.13	79.5	98	1600

1.6 LITER 4-CYLINDER (Cont.)

ENGINE SPECIFICATIONS (Cont.)

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)
1.6L							
Int.	1.654 (42)	45.6°	45°	.069-.091 (1.75-2.31)	.316 (8.03)	.0008-.0027 (.02-.07)	.377 (9.58)
Exh.	1.457 (37)	45.6°	45°	.069-.091 (1.75-2.31)	.315 (8.00)	.0018-.0037 (.05-.09)	.377 (9.58)

PISTONS, PINS, RINGS

Engine	PISTONS	PINS		RINGS		
	Clearance In. (mm)	Piston Fit In. (mm)	Rod Fit In. (mm)	Rings	End Gap In. (mm)	Side Clearance In. (mm)
1.6L	.0012-.0020 (.03-.05)	.0003-.0005 (.008-.013)	Press Fit	1	.012-.020 (.30-.51)	.002-.003 (.05-.08)
				2	.012-.020 (.30-.51)	.002-.003 (.05-.08)
				3	.016-.055 (.41-1.40)	Snug Fit

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS

Engine	MAIN BEARINGS				CONNECTING ROD BEARINGS		
	Journal Diam. In. (mm)	Clearance In. (mm)	Thrust Bearing	Crankshaft End Play In. (mm)	Journal Diam. In. (mm)	Clearance In. (mm)	Side Play In. (mm)
1.6L	2.282-2.283 (57.96-57.99)	.0008-.0015 (.02-.04)	No. 3	.004-.008 (.102-.203)	1.885-1.886 (47.88-47.90)	.0008-.0015 (.02-.04)	.004-.011 (.10-.28)

VALVE SPRINGS

Engine	Free Length In. (mm)	PRESSURE Lbs. @ In. (kg @ mm)	
		Valve Closed	Valve Open
1.6L	1.724 (43.79)	95@1.461 (43@37.1)	200@1.09 (91@27.7)

CAMSHAFT

Engine	Journal Diam. In. (mm)	Clearance In. (mm)	Lobe Lift In. (mm)
1.6L			.229 (5.82)
No. 1	1.761-1.762 (44.73-44.75)	.0008-.0028 (.021-.071)	
No. 2	1.771-1.772 (44.98-45.01)		
No. 3	1.781-1.782 (45.24-45.26)		
No. 4	1.791-1.792 (45.49-45.51)		
No. 5	1.801-1.802 (45.75-45.77)		