

LUV & P'UP 4-CYLINDER DIESEL

ENGINE CODING

ENGINE IDENTIFICATION

Engine number is stamped on the right side of the cylinder block next to the intake manifold. Diesel engine is identified by the number C223.

ENGINE & CYLINDER HEAD

ENGINE

Removal — **1)** Mark hood hinges for reassembly and remove hood. Disconnect battery cables. Remove cables, battery hold-down and battery. Drain engine cooling system, crankcase and transmission. Remove engine under cover.

2) Remove air cleaner assembly. Disconnect radiator hoses and loosen compressor drive belts. Remove fan, fan shroud, radiator grill and radiator. Disconnect accelerator control cable. Disconnect air conditioner compressor control cable (if equipped).

3) Disconnect fuel lines, all transmission and transaxle wiring, vacuum hose at fast idle actuator and connector at fuel cut solenoid. Disconnect heater hoses at heater unit inside of cab. Disconnect sensing resistor, thermostat and air conditioner compressor switch connectors.

4) Disconnect vacuum hoses from vacuum pump. Disconnect alternator wiring. Disconnect exhaust pipe from manifold and remove mounting bracket from engine backing plate. Remove all starter wiring and battery cable from starter.

5) Working from passenger compartment, slide shift lever boot(s) up and remove gearshift and transfer lever retaining bolts. On 4WD models, remove return spring from transfer shift lever. Remove shift lever(s). Disconnect speedometer and ground cables from transmission.

6) Mark for installation and remove propeller shaft(s). On long wheel base 4WD models, 1st and 2nd rear propeller shafts must be removed separately and center support bearing must be removed with 1st shaft as a unit. Remove clutch fork return spring and clutch cable from hooked portion of fork. Remove cable through stiffener bracket.

7) Remove rear bracket to transmission mount bolts, attach engine hoist and raise engine and transmission for clearance to remove crossmember to frame bracket bolts. On 4WD models remove rear mounting nuts from transfer case, then lower assembly and support rear of engine.

8) On 2WD models, remove transmission rear extension mounting nuts. Remove engine mounting bolt and nuts. Disconnect any remaining engine or transmission to chassis wiring, pull engine forward and carefully remove engine and transmission as an assembly.

9) On 4WD models, remove transfer side case. Remove shifter cover and gasket from top of transfer case. Remove transmission-to-engine attaching bolts and remove transmission. When removing transmission, turn side case surface downward and pull the case straight back until disengaged from clutch. Lift engine slightly and remove engine mounting bolts and nuts. Disconnect any remaining engine or transmission to chassis wiring, pull engine forward and carefully remove engine and transmission as an assembly.

Installation — Replace any rubber engine mounts showing signs of deterioration, separation or unusual wear. Reverse removal procedures to complete installation. Check all fluid levels.

CYLINDER HEAD

Removal — **1)** Drain cooling system. Remove air cleaner, remove intake manifold retaining bolts (2) and nuts (4) and remove intake manifold. Disconnect exhaust pipe from exhaust manifold, remove nuts holding manifold in place and remove manifold.

2) Disconnect upper radiator hose and remove fan and fan shroud. Disconnect injection pipes, remove nozzle holder retaining nuts and remove nozzle holder assembly. Loosen rocker shaft retaining bolts in several steps starting from the ends and working towards the middle. Remove rocker shaft with rocker arms and mounting brackets.

3) Remove push rods. Disconnect fuel over-flow line and loosen head bolts in reverse of tightening sequence. Remove cylinder head and gasket.

Installation — Install new head gasket with "TOP" mark facing up and install cylinder head. Replace push rods and install rocker shaft. Reverse removal procedure to complete installation.

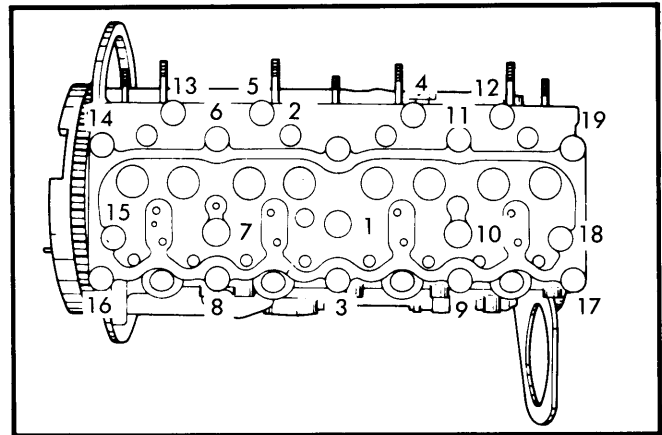


Fig. 1 Cylinder Head Tightening Sequence (Loosen in Reverse Sequence)

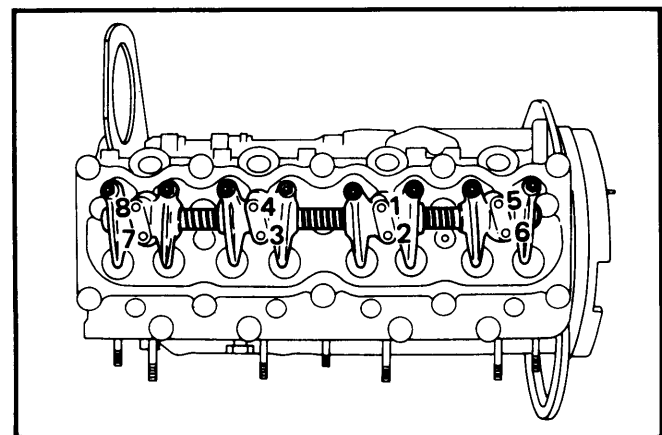


Fig. 2 Rocker Shaft Tightening Sequence (Loosen in Reverse Sequence)

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CAMSHAFT

ENGINE FRONT COVER

Removal — Drain cooling system. Remove battery, fan and fan shroud. Disconnect radiator hoses at engine, remove radiator grill and radiator. Remove all belts. Remove crankshaft pulley retaining bolts and remove crankshaft pulley. Remove front cover retaining bolts and remove front cover (2 pieces).

Installation — Reverse removal procedure to install.

TIMING BELT

Removal — Remove engine front cover. Remove injection pump timing pulley flange bolts and remove flange. Remove tension pulley retaining nut. Remove tension pulley and center. Remove timing belt.

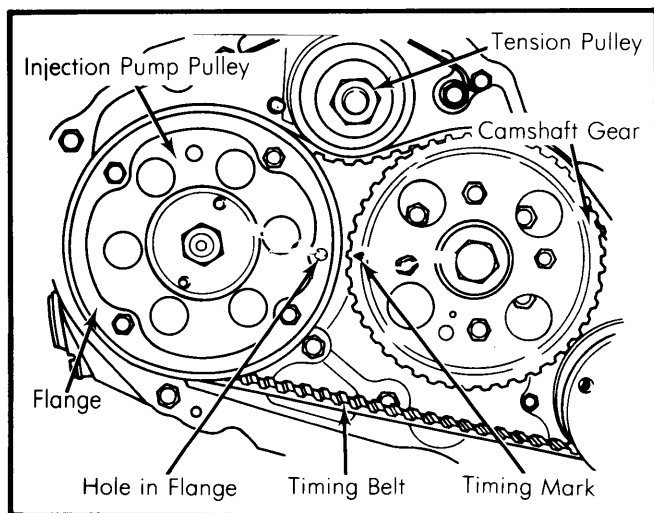


Fig. 3 Timing Belt Installation

Installation — 1) Before installing timing belt, check that the timing marks on the injection pump, camshaft and crankshaft pulleys are properly aligned. See Fig. 4. Install timing belt over crankshaft pulley first, then camshaft pulley and injection pump pulley.

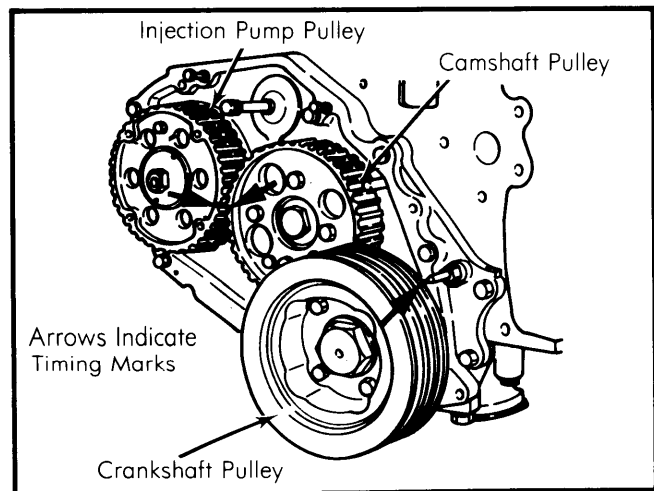


Fig. 4 Timing Mark Alignment

2) Install tension pulley center and tension pulley. The end of the tension center must be in contact with 2 pins on the timing pulley housing. See Fig. 5. Hand tighten nut, install tension spring and tighten nut to 22-36 ft. lbs. (30-50 N•m).

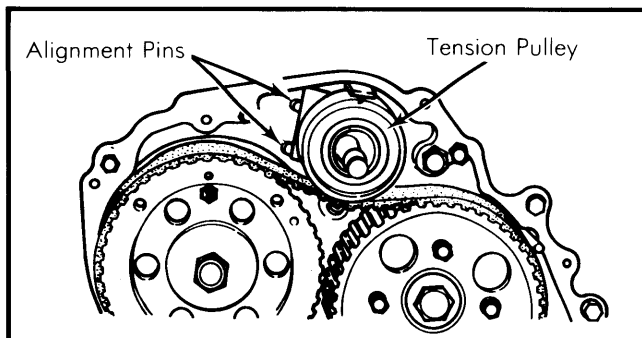


Fig. 5 Tension Pulley Installation

3) Turn crankshaft 2 turns plus 90 degrees in direction of normal rotation. Loosen tension pulley nut completely and allow pulley to take up slack. Tighten nut to proper specification. Install injection pump pulley flange and check that hole in flange lines up with timing mark on camshaft gear.

4) Turn crankshaft 2 turns more, bringing No. 1 cylinder to TDC on the compression stroke. Check timing mark alignment. Check belt tension with gauge (J-29771). Tension should be 33-55 lbs. (147-245 N). Adjust valves. Reverse removal procedure to complete installation.

INJECTION PUMP TIMING

1) Check that notched lines on injection pump flange and injection pump front bracket are aligned. With No. 1 cylinder at TDC on compression stroke and timing pulley housing cover removed, check timing belt tension and timing mark alignment.

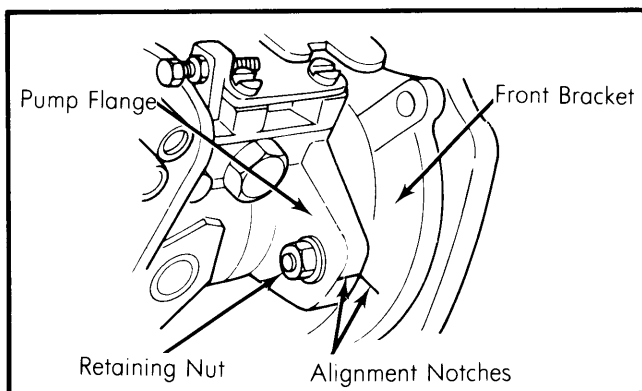


Fig. 6 Injection Pump Alignment Marks

2) Disconnect injection pipe from pump and remove distributor head screw. Install static timing gauge (dial indicator) and set lift approximately .04" (1 mm) from the plunger.

3) Turn engine until No. 1 cylinder is 45-60° BTDC, then calibrate dial indicator to zero. Turn crankshaft pulley slightly in both directions and check that gauge indication is stable. Turn crankshaft in normal direction of rotation until timing mark (15° BTDC) is aligned with indicator. Dial indicator should read .020" (.5 mm).

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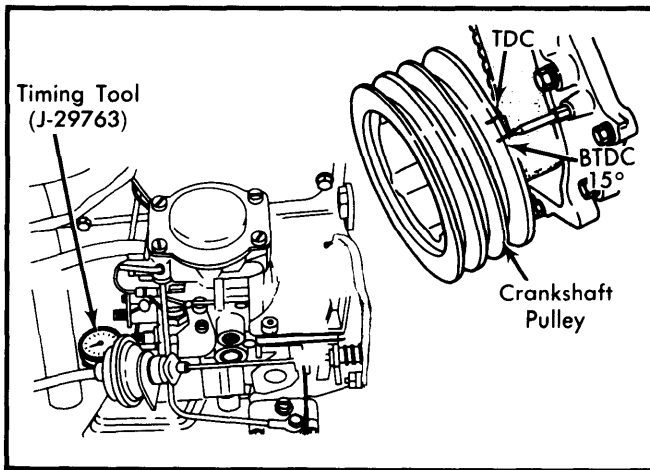


Fig. 7 Injection Pump Timing Adjustment

4) If indicator reading is not correct, loosen the 2 injection pump flange retaining nuts and rotate housing until a correct reading is obtained. Tighten nuts and recheck reading.

CAMSHAFT

Removal — 1) Remove engine front cover and timing belt as described. Remove rocker shaft assembly as described in *Cylinder Head* removal section. Remove push rods.

2) Install a 6 mm bolt through hole in camshaft pulley and into threaded hole in housing to prevent turning of pulley. Remove timing pulley bolts and remove pulley with puller (J-22888). Remove camshaft carefully so as not to damage camshaft bearings.

Installation — Coat camshaft lobes, bearing surfaces and camshaft bearings with oil. Carefully install camshaft to avoid damage to bearings. Reverse removal procedure to complete installation.

VALVES

VALVE ARRANGEMENT

E-I-I-E-E-I-I-E

VALVES

Removal — Remove cylinder head. Remove rocker shaft. Compress valve springs and remove valve stem locks. Remove retainers, inner and outer valve springs, spring seats and valves. Retain components in correct order for installation.

Installation — Lubricate inner face of valve seals and install on valve guide. Reverse removal procedure to complete installation. Valve springs are of a varied pitch design. Be sure that they are installed with the close coiled end (painted green) against the cylinder head.

VALVE GUIDE SERVICE

Check valve stem clearance in valve guide with a dial indicator. Insert valve in valve guide and move left or right (parallel with rocker arm). Measure stem movement .4" (10 mm) above guide edge. If movement exceeds .008" (.2 mm) and valve stem is not worn, the valve guide must be replaced.

Removal — Drive out old guide with tool (J-26512) from combustion chamber side.

Installation — To install new guide, coat outer surface of guide with engine oil and drive into head from opposite side with tool (J-26512). Guide should project from cylinder head .472" (12 mm). Whenever a valve is replaced, a new guide should be used.

VALVE SEAT INSERTS

Check condition of valve seat contact area. If pitted, worn or otherwise damaged, replace seat.

Removal — With valve in place, measure depth of valve face below surface of head with depth gauge. If valve is more than .08" (2.0 mm) below head surface, seat must be replaced. To remove, arc-weld a bead of metal around contact surface of seat. Allow to cool a few minutes. Pry out valve seat.

Installation — Install new seat with press. Grind to correct width and angle. Lap valve and seat to complete installation.

SWIRL CHAMBER REPLACEMENT

Removal — Measure chamber depth in head with straight edge and feeler gauge. If depth exceeds .001" (.02 mm), chamber must be replaced. Use a drift of .15-.20" (3-5 mm) diameter to drive out old chamber. Insert drift through injection nozzle hole to swirl chamber and drive out with hammer.

Installation — Install lock ball into groove in swirl chamber. Align lock ball in chamber with groove in cylinder head and drive in. Use press to seat chamber. A piece of metal should be placed between press and chamber to prevent damage. Grind face of swirl chamber flush with face of cylinder head to complete installation.

VALVE SPRINGS

Valve springs must be less than .04" (1.0 mm) out of square. Inner valve spring should have a free length of 1.89" (47.9 mm) and a compressed length of 1.46" (37 mm) at 12.2-13.8 lbs. (54.3-61.4 N). Outer valve spring should have a free length of 1.86" (47.3 mm) and a compressed length of 1.54" (39 mm) at 43.2-48.7 lbs. (192-216 N). If tension required is less than 11.0 lbs. (49.1 N) for the inner spring or 39.8 lbs. (177.1 N) for the outer, the spring should be replaced. Inner and outer springs should always be replaced as a set.

VALVE ADJUSTMENT

Valve adjustment can be made with engine warm or cold. Bring No. 1 cylinder to TDC on compression stroke and adjust No. 1 and No. 2 intake valves, No. 1 and No. 3 exhaust valves. Rotate crankshaft 180° and adjust remaining valves (No. 3 and 4 intake, No. 2 and 4 exhaust).

Valve Adjustment Clearances

Application	Clearance
Engine Cold016" (.40 mm)
Engine Warm015" (.37 mm)

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PISTONS, PINS & RINGS

PISTON AND ROD ASSEMBLY

Removal — Remove engine from vehicle. Remove cylinder head. Remove crankcase and oil pan as an assembly. Remove oil pipe sleeve nut, oil pump bolts and oil pump with oil pipe. Remove rod cap with bearing half. Push piston/rod assembly with bearing half up and out through top of engine. Rod caps must be kept with their respective piston and rod assembly as caps are not interchangeable.

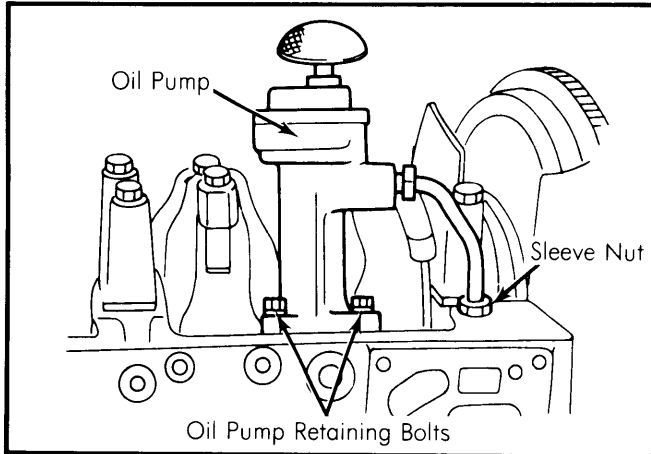


Fig. 8 Oil Pump Removal and Installation

Installation — 1) Lightly oil rings, piston and cylinder wall. Make sure ring gaps are located 180° apart and not on thrust side of piston or in line with piston pin. Make sure bearing halves are properly seated in connecting rod and cap.

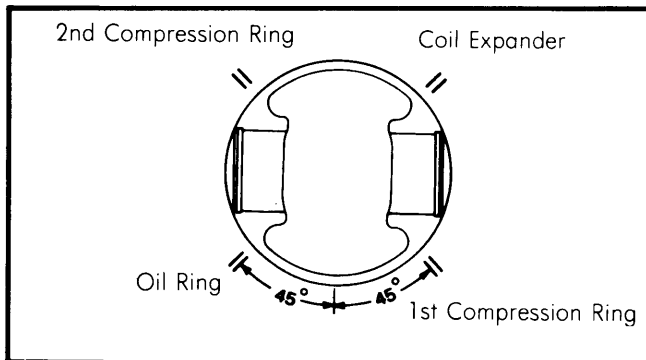


Fig. 9 Piston Ring Gap Locations

2) Install a ring compressor and compress rings. Install piston in cylinder. Ensure mark in piston top points towards front of engine. With piston installed in cylinder, and connecting rod and bearings seated against crankshaft journal, install rod caps to their respective piston and rod assembly. Make sure that marks in cap and rod end match and are installed on the same side.

3) Lubricate threads of rod bolts and seating face of nuts with engine oil. Reverse removal procedure to complete installation.

FITTING PISTONS

1) Measure cylinder bores for wear at depths of .6" and 4.5" (16 and 114 mm). Measurements should be made in line with

and at right angles to the crankshaft centerline. If excessive wear is found, cylinder should be bored to accommodate next oversize piston. Whenever one cylinder is bored, all cylinders must be bored.

2) Measure piston diameter at right angle to piston pin. Subtract this figure from cylinder diameter to obtain piston to wall clearance. Final hone of cylinder wall should provide .006-.007" (.16-.18 mm) clearance.

Piston Specifications

Piston Size In. (mm)	Piston Diameter In. (mm)
Standard	3.454-3.455 (87.73-87.75)
.020 (.50) O/S	3.477-3.478 (88.33-88.35)
.040 (1.0) O/S	3.497-3.498 (88.83-88.85)

PISTON PINS

Removal — To remove pin, use snap ring pliers and remove snap rings from piston. Use a brass rod to drive out pin.

Inspection — Visually inspect pin for signs of damage or excessive wear. Replace if needed. With hole gauge and micrometer, measure piston pin diameter and diameter of pin hole in piston. Subtract pin diameter from hole diameter to get pin to piston clearance figure. Clearance should be .0002-.0014" (.004-.034 mm). If clearance exceeds this limit, pin and piston should be replaced.

Installation — Heat piston to about 175° F (80° C). Coat pin with oil and install in piston and rod. Make sure that piston and rod are joined so that the combustion chamber on the piston is on the same side as the match marks on the connecting rod. Install snap rings.

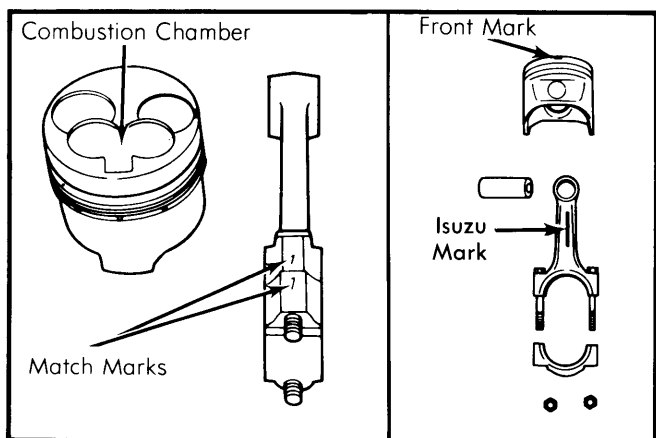


Fig. 10 Piston to Rod Positioning

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS

MAIN & CONNECTING ROD BEARINGS

Removal — With engine removed from vehicle, remove cylinder head and timing belt as outlined. Remove flywheel and rear plate. Remove piston and rod assemblies, camshaft

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and front timing pulley housing. Loosen crankshaft main bearing caps starting with outside caps and working toward the middle. Remove caps and lift out crankshaft.

Inspection — Check all shaft journals and crankpins for scoring, wear, or cracks. Taper and out-of-round on all journals must not exceed .001" (.015 mm). Check crankshaft for bend using dial indicator at center journal. If bend exceeds limit of .0024" (.06 mm), the crankshaft must be replaced.

NOTE — *Crankshafts have been specially hardened and should never be ground to obtain correct clearances. If journals are worn beyond acceptable limits, the crankshaft must be replaced.*

Installation — **1)** Install main bearing halves to engine block ensuring that all bearings are on their respective journal. Fit tab on bearing into corresponding slot in bearing seat. All main bearing halves are grooved. Install thrust bearing with the oil groove turned outward.

2) Coat all bearing surfaces liberally with clean engine oil. Carefully install crankshaft. Install arch gasket on No. 1 and No. 5 main bearing caps. Use liquid gasket sealer to hold gasket in place while installing caps. Apply a thin film of gasket sealer to contact surfaces of No. 1 and 5 caps before installing. Make sure that projecting part of arch gasket (.002" max.) fits into the proper position on cylinder block.

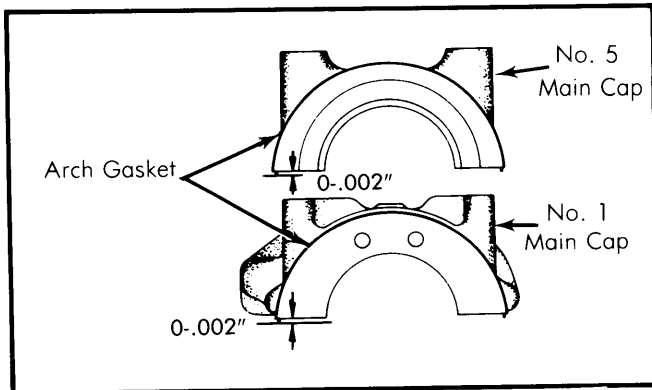


Fig. 11 Arch Gasket Installation

3) Install remaining main caps and tighten in sequence of No. 3, No. 4, No. 2, No. 5 and No. 1. Check that crankshaft rotates smoothly when all caps have been tightened. Reverse removal procedure to complete installation.

MAIN BEARINGS

Check all bearings for scoring or wear and replace if damage is found. Clean oil from crankshaft and place a strip of Plastigage on crankshaft journal. Install main bearing cap with bearing installed, and tighten.

NOTE — *Plastigage should run parallel with crankshaft and not block oil hole. Do not turn crankshaft while Plastigage is inserted.*

Remove cap and measure width of Plastigage at widest point using gauge provided. If clearance is not to specifications, replace bearings.

CONNECTING ROD BEARINGS

Check all bearings for scoring or signs of excessive wear and replace if damage is found. Measure inside diameter of bear-

ings and outside diameter of crankshaft connecting rod journals. Use these figures to determine rod bearing clearance. If not to specifications, replace rod bearings. Assemble rod caps to rods with bearings in place and tighten rod bolts.

ENGINE OILING

ENGINE OILING SYSTEM

Oil drawn from pan passes through a screen to oil pump. Oil is delivered to full flow oil filter, oil cooler, and main oil gallery. Main oil gallery supplies oil to crankshaft main bearings and drilled passages in crankshaft which in turn lubricate connecting rod bearings. Oil gallery feeds oil to vacuum pump and rocker arm shaft to lubricate rocker arms and cam bearings. Oil is fed from gallery to oil jet pipe which sprays oil from below piston to lubricate cylinder walls and piston pins.

Crankcase Capacity (with filter) — 6.4 quarts.

Oil Filter — Full-flow with disposable cartridge.

Oil Pressure — 50-60 psi (3.5-4.5 kg/cm²).

OIL PUMP

Removal — Oil pump is mounted inside of engine crankcase at the rear of the block. It is gear driven off of the camshaft. To remove, first remove oil pan and crankcase. Remove oil pipe sleeve nut and the 2 bolts holding pump in place. Remove oil pump.

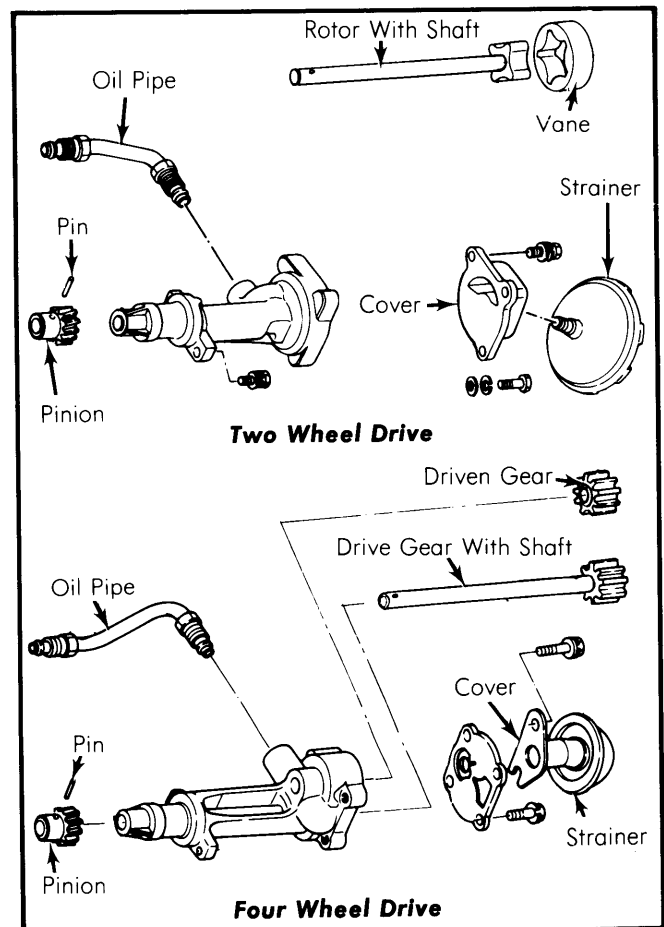


Fig. 12 Oil Pump Assemblies

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Inspection — Disassemble oil pump and wash all parts thoroughly in clean solvent. Inspect for signs of unusual wear or damage. Replace as needed. Check all clearances to specifications. If vane to pump body clearance or rotor shaft to pump body clearance is beyond specification, entire pump assembly must be replaced.

Make sure mating surfaces of pump and block are clean and always use a new gasket.

Thermostat — Opens at 180°F (82°C). Full open at 203°F (95°C).

Cooling System Capacity — 7 quarts.

Installation — Reverse removal procedure to install.

Oil Pump Specifications	
Application	① Clearance In. (mm)
2WD	
Vane Depth in Housing	.006 (.15)
Rotor-to-Vane Side Clearance	.006 (.15)
Vane-to-Pump Body Side Clearance	.011 (.27)
Rotor Shaft-to-Pump Body	.008 (.20)
4WD	
Gear Depth in Housing	.004 (.09)
Gear Tip Side Clearance	.006 (.14)

① — Clearances given are wear limits.

TIGHTENING SPECIFICATIONS	
Application	Ft. Lbs. (N•m)
Cylinder Head	
New Bolt	54-61 (76-85)
Used Bolt	61-69 (85-97)
Camshaft	
Hub	72-87 (101-122)
Pulley	78-95 (109-133)
Connecting Rod	58-65 (81-91)
Crankshaft Gear Bolt	124-151 (174-211)
Crankshaft Pulley Bolts	10-17 (14-24)
Crankcase Pan	10-17 (14-24)
Engine Plate - Rear	55-67 (77-94)
Flywheel	65-72 (91-101)
Main Bearing Caps	116-130 (162-182)
Manifolds (Intake & Exhaust)	10-17 (14-24)
Injection Pump Timing Pulley	42-52 (59-73)
Oil Jet Pipe (1)	24-27 (34-38)
Oil Jets (4)	22 (31)
Oil Cooler	54-61 (76-85)
Rocker Shaft	10-17 (14-24)
Tension Pulley	78-95 (109-133)
Timing Pulley Housing	10-17 (14-24)
Water Pump	24-31 (34-43)

ENGINE COOLING

WATER PUMP

Removal & Installation — Drain cooling system and remove battery, fan, fan shroud and upper radiator hose. Remove drive belts and fan pulley. Remove water pump retaining bolts (5) and remove pump. Reverse removal procedure to install.

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	136.6	2238	Fuel Inj.	.....	.....	21:1	3.46	88	3.62	92

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)
2238 Int.	45°	45°	.051 (1.3)	.315 (8.0)	.0015-.0027	.....
Exh.	45°	45°	.051 (1.3)	.315 (8.0)	.0025-.0037 (.064-.093)	.....

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)
2238	2.3591-2.3594 (59.92-59.93)	.0011-.0033 (.029-.085)	①	.0039-.0100 (0.10-0.250)	2.0835-2.039 (52.92-52.93)	.0016-.0040 (.040-.014)

① — Utilizes thrust washer on No. 3 main journal.

Isuzu & LUV Engines

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ENGINE SPECIFICATIONS (Cont.)

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)
2238	.0062-.0070 (.157-.177)	.0002 (.004)	⓪ .003-.0008 (.008-.020)	No. 1	.0079-.0158 (.20-.40)	.0018-.0028 (.045-.070)
				No. 2	.0079-.0158 (.20-.40)	.0012-.0021 (.030-.055)
				Oil	.0079-.0158 (.20-.40)	.0008-.0021 (.020-.054)

⓪ — Floating pin. Clearance shown is between bushing and pin.

VALVE SPRINGS				
Engine	Free Length In. (mm)	PRESSURE Lbs. @ In. (kg @ mm)		
		Valve Closed	Valve Open	
2238	Inner	1.89 (47.9)	⓪ 13.0@1.46 (5.9@37)
	Outer	1.86 (47.3)	46.0@1.54 (20.9@39)

⓪ — Compressed height as measured in tester.

VALVE TIMING				
Engine	INTAKE		EXHAUST	
	Open (BTDC)	Close (ABDC)	Open (BBDC)	Close (ATDC)
2238	16°	54°	56°	14°

CAMSHAFT			
Engine	Journal Diam. In. (mm)	Clearance In. (mm)	Lobe Lift In. (mm)
2238	1.89 (48.0)	.002 (.05)	.....