

1600 & 1800 4-CYLINDER

ENGINE CODING

ENGINE IDENTIFICATION

Engine number is stamped on a machined pad near distributor. See table below for engine codes.

Engine Identification	
Application	Code
2-WD	
Federal	
Man. Trans.	E71AA3, E71GA3A
Auto. Trans.	E81TA
Calif.	
Man. Trans.	E71AC3
Auto. Trans.	E81TC
4-WD	
Federal	E71WA3, E71WA4
Calif.	E71WC3, E71WC4

ENGINE

ENGINE

NOTE — It is possible to remove engine with transmission fitted. Removal procedure given is with transmission remaining in vehicle.

REMOVAL & INSTALLATION

Removal — 1) Disconnect battery cable. Remove spare wheel from engine compartment. Remove air cleaner assembly.

2) Disconnect fuel line from fuel pump intake, allow fuel to drain into a suitable container. Drain radiator and engine block. Disconnect radiator hoses at engine.

3) Disconnect all wiring to engine and accessories. On 4-WD models remove engine fan from pulley. On Automatic Transmission models disconnect oil cooler pipes.

4) Remove 2 upper radiator bolts and lift out radiator. Remove nuts on each of engine-to-firewall struts and remove strut by moving to rear to clear engine hanger.

5) Remove all control cables and vacuum hoses from engine. On automatic transmission models, disconnect torque converter from engine by rotating crankshaft to allow removal of 4 bolts through timing hole. Use care that bolts do not fall into housing. On manual transmission models, remove clutch return spring. Remove nuts from brackets on engine and firewall, and remove engine stabilizer.

6) Remove engine-to-transmission bolts and nuts and disconnect exhaust pipe. Remove bolts securing front engine mounts-to-engine. Slightly hoist engine with chain hoist attached to front to rear hangers and separate engine from transmission.

7) When separating engine from transmission, ensure that torque converter remains with transmission (Automatic Transmission only). Also, it may be helpful to slightly jack up transmission during removal procedure. Remove engine completely and place on engine stand.

Installation — To install, reverse removal procedure and tighten all bolts and nuts. Adjust all controls and fill engine with suitable coolant.

ENGINE DISASSEMBLY & REASSEMBLY

NOTE — Remove engine, place on engine stand (399814300X2 or equivalent). Remove starter and proceed as follows:

Disassembly — 1) Separate engine from transmission if necessary. Ensure that converter remains attached to automatic transmission (if equipped). Drain oil and coolant. Make sure that liquid does not run over clutch cover. On manual transmission models, remove clutch cover and disc.

2) Disconnect ignition wiring from engine. Remove distributor and distributor plate. Remove bolts securing alternator to alternator bracket and remove alternator. Remove EGR pipe and cover. Disconnect wiring harness leads for oil pressure gauge or switch. Remove clamp securing air suction manifold. Remove connecting hoses from valve covers. Unclamp heater hoses. Disconnect 2 water by-pass hoses from intake manifold. Remove intake manifold assembly. Remove alternator brackets and air suction system.

3) Remove oil filter duct. 4WD models have a bracket. Use a puller to remove crankshaft pulley. Remove oil pump and filter as an assembly. Remove water pump with hoses and tubes attached. Remove pressure plate and clutch disc.

NOTE — Insert rod through timing hole to prevent flywheel from turning.

4) Turn engine over on stand and remove oil pan, crankcase, gasket and transmission cover (if necessary). Remove oil strainer and brackets. Remove either flywheel or converter drive plate. Take off flywheel housing.

5) Remove spark plugs and valve cover. Remove rocker assembly and push rods. Remove cylinder head bolts in sequence. See Fig. 1. Remove cylinder head and gasket. Use Allen wrench and remove crankcase plug.

NOTE — Keep push rods in proper order for proper reassembly.

6) Position pistons at bottom dead center and remove circlip with long nosed pliers. Access to No. 1 and No. 2 pins is through front crankcase plug holes. Access to No. 3 and No. 4 pins is through rear service holes. Remove pins and pistons, marking for reassembly.

7) Work through hole in camshaft gear and straighten lockwasher, then remove nut. Remove nuts and washers and separate cases. Use valve lifter clips (899804100 or equivalent), to prevent upper crankcase lifters from falling off.

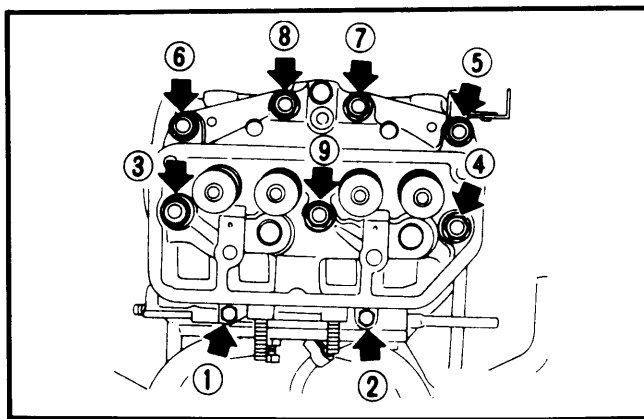


Fig. 1 Cylinder Head Nut Loosening Sequence

1600 & 1800 4-CYLINDER (Cont.)

NOTE — Pull camshaft to rear for crankcase clearance.

8) Remove oil seal. Lift out crankshaft, distributor gear, and connecting rods. Keep crankshaft bearings in order for reassembly. Remove camshaft and gear. Remove oil pressure switch and valve lifters.

Reassembly — Lubricate all friction surfaces with engine oil prior to reassembly. Install crankshaft and camshaft with bearings in left half (No. 2 & 4 Cyl.) of crankcase. Apply gasket sealer to mating surfaces of crankcase and continue to reverse order of disassembly. Tighten crankcase halves and cylinder heads in sequence shown in Fig. 3.

NOTE — Use spacers (899848600) in place of rocker arm supports when tightening head nuts.

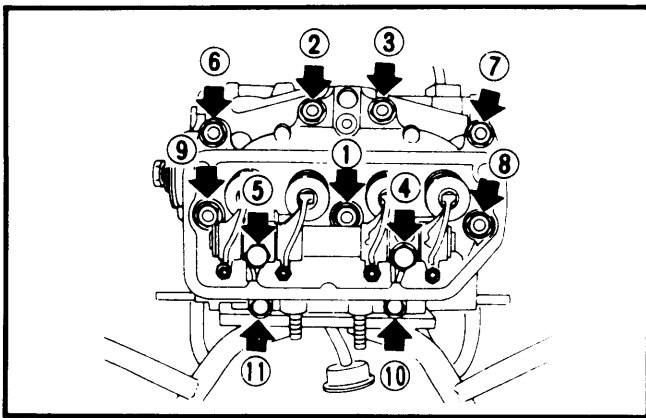


Fig. 2 Cylinder Head Tightening Sequence

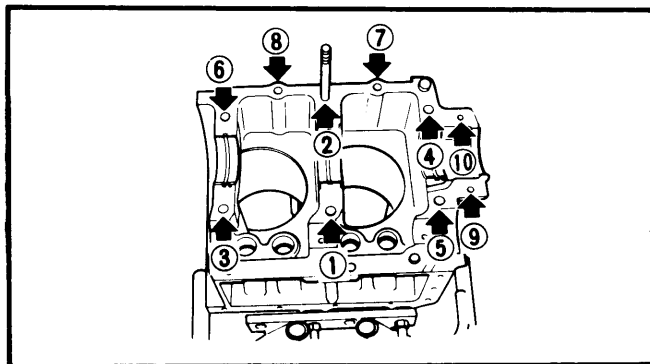


Fig. 3 Tightening Sequence for Crankcase

VALVES

VALVE ARRANGEMENT

I-E-E-I (both banks, front to rear).

VALVE GUIDE SERVICING

1) Check valve guide for wear or damage. Replace defective guides by using a drift punch and driving out guide through top of head. Press in new guide from top of head until it projects .689-.709" (17.50-18.00 mm) for intake valve guide and .886-.906" (22.50-23.01 mm) for exhaust valve guide.

2) Ream valve guide to provide correct clearance. Inspect valve seat to make sure it is true with guide. Reface valve seat if necessary.

VALVE STEM OIL SEALS

Valve stem oil seals are used only on intake valves. Slide seal off of valve guide and replace with a new seal. Use care when inserting stem not to damage seal.

VALVE SPRING

Using a spring compressor, remove "O" ring, valve keepers and spring retainer. Check spring under pressure and at free length. Spring squareness must be within .083" (2.10 mm). Replace if necessary. Install spring with wide spaced coil (paint marks) facing valve spring retainer.

ROCKER ARM ASSEMBLY

Check rocker shaft, rocker arm and bushing for wear or damage. Replace any worn parts. Press in new bushing and ream until a clearance of .0006-.002" (.016-.052 mm) is achieved between bushing and shaft.

VALVE TAPPET SERVICE

Remove lifters from crankcase. Inspect tappet for wear or clogged oil hole. Replace lifter if lifter-to-crankcase clearance exceeds .004" (.10 mm). Standard lifter clearance is .0012-.0028" (.030-.07 mm).

VALVE CLEARANCE ADJUSTMENT

With engine cold, rotate engine to TDC of firing stroke. Insert feeler gauge between rocker arm and valve stem. Clearances should be as follows:

Valve Clearance		
Application	Intake In. (mm)	Exhaust In. (mm)
1600 cc & 1800 cc010 (.25)	.014 (.35)

PISTONS, PINS & RINGS

FITTING PISTONS

1) Measure piston bore .028" (.7 mm) from top of cylinder in line with crankshaft and again 90° from centerline of crankshaft. Make same measurements 1.48" (37 mm) and then 2.65" (67 mm) from top of cylinder bore. If inner cylinder diameter exceeds .0197" (.50 mm) more than standard bore of 3.6205-3.6216" (91.960-91.990 mm) after boring and honing, replace crankcase.

2) Measure piston 1.04" (26.3 mm) from bottom of skirt, 90° from piston pin hole.

NOTE — Measurement of both pistons and cylinder bores should be performed at 68° F (20° C). All cylinders must be bored at same size and use same size pistons.

3) Check piston ring end gap and side clearance. Check gap at bottom of cylinder bore. Fit piston rings with "R" or "N" facing up.

PISTON PIN

Check piston pin for damage, cracks, wear or distortion. Check connecting rod bushing for wear. If pin or bushing are worn beyond specification, replace bushing in connecting rod

1600 & 1800 4-CYLINDER (Cont.)

and ream to fit standard pin. Piston pin is a thumb push fit at 68° F (20° C).

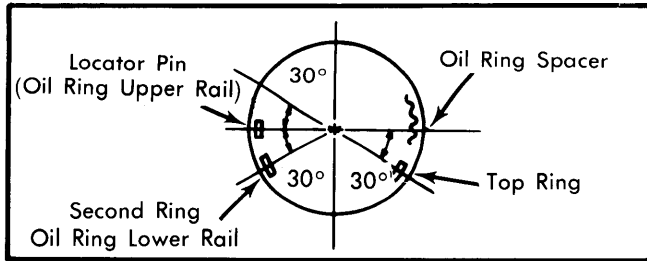


Fig. 4 Piston Ring Gap Position

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS

MAIN & CONNECTING ROD BEARINGS

1) Check connecting rod side play with a feeler gauge. If side play exceeds specifications, replace connecting rod.

2) Use Plastigage method to measure both main and connecting rod bearing clearances. Main bearing inserts are available in standard, .001" (.03 mm), .002" (.05 mm) and .010" (.25 mm) undersize. Connecting rod bearing inserts are available in standard, .002" (.05 mm) and .010" (.25 mm) undersize.

3) Check crankshaft for bend by placing front and rear main journals on "V" blocks and fitting a dial indicator on center journal. Correct or replace crankshaft if bend exceeds .0014" (.035 mm).

REAR MAIN BEARING OIL SEAL SERVICE

Seal is replaced when crankcase halves are split. After crankcase halves have been reassembled, install new seal.

CAMSHAFT

ENGINE FRONT COVER OIL SEAL

With front cover removed, drive out old seal. Install new seal using installer tool (499067000), with or without front cover on engine.

CAMSHAFT

1) Camshaft may be removed when crankcase has been split. Check for wear or damage, replace camshaft if necessary. Using a dial indicator, check that bend does not exceed .002" (.051 mm).

2) Measure thrust clearance between camshaft and camshaft plate. Standard clearance is .0008-.0035" (.02-.09 mm). If clearance exceeds limit of .008" (.20 mm), replace camshaft plate. Measure camshaft lobe height. If less than 1.269-1.273" (32.23-32.33 mm) overall, replace camshaft.

NOTE — If camshaft is replaced, all valve lifters should also be replaced. Check identification marks. 1600 cc engine uses camshaft marked "51", while 1800 cc engine uses camshaft "72".

3) Measure camshaft gear runout with dial indicator. Replace camshaft if runout exceeds .010" (.25 mm). Measure backlash

between camshaft gear and crankshaft gear. If backlash exceeds .0039" (.10 mm), replace camshaft gear. Standard value of backlash is .0004-.0020" (.01-.05 mm).

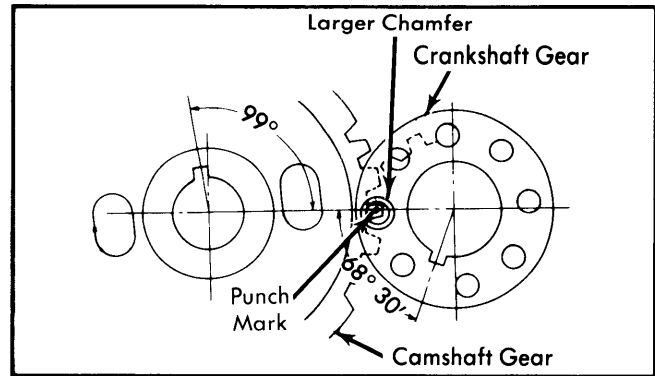


Fig. 5 Align Camshaft with Crankshaft as Shown

VALVE TIMING

With crankcase halves split, install crankshaft and camshaft so punch mark on camshaft gear is visible through chamfered hole in crankshaft gear.

ENGINE OILING

Crankcase Capacity — 1600 cc engine: 3.5 quarts (upper level) and 2.5 quarts (lower level). 1800 cc engine: 4.0 quarts (upper level) and 3.0 quarts (lower level).

Oil Filter — Full-flow.

Normal Oil Pressure — 1600 cc engine: 35 psi (2.5 kg/cm²) @ 500 RPM, 57 psi (4.0 kg/cm²) @ 2500 RPM. 1800 cc engine: 50 psi (3.5 kg/cm²) @ 500 RPM, 57 psi (4.0 kg/cm²) @ 2500 RPM.

Pressure Regulator Valve — Non-adjustable, opens at 57-64 psi (4.0-4.5 kg/cm²).

ENGINE OILING SYSTEM

Oil is pressure fed by a camshaft driven trochoid type oil pump. Pump incorporates an oil relief and by-pass valve in its body. Oil pump is located externally on engine. Oil from pump passes from main oil gallery to journals of camshaft and crankshaft. From there, oil goes to main bearings, pistons pin bearings and cylinder walls. Oil passes through valve lifters and push rods to oil rocker arms.

OIL PUMP

Removal — Remove four attaching bolts and pull pump and filter forward. Remove oil filter from pump.

Disassembly — 1) Remove screws, lift cover and rotor from pump body. Remove "O" ring. Remove by-pass spring and ball. Unscrew plug and remove washers, spring and pressure relief valve.

2) Measure rotor-to-drive gear and rotor-to-body clearance. Measure rotor side clearance and measure diameters of rotor and drive gear. Replace any component that exceeds wear limits.

3) Inspect relief valve spring, valve and pump body for wear or damage.

1600 & 1800 4-CYLINDER (Cont.)

NOTE — Make sure oil pump shaft is aligned with slot in camshaft when reassembling.

Reassembly — Reassemble in reverse order, using all new gaskets and "O" rings.

Installation — Install oil filter on pump. Using rearward movement reinstall oil pump and four attaching bolts.

Oil Pump Clearances	
Application	Clearance In. (mm)
Rotor-to-Drive Gear0008-.0047 (.02-.11)
Outer Rotor-to-Body0012-.0051 (.03-.13)
Rotor Side Clearance0009-.0083 (.15-.21)

Oil Pump Dimensions	
Application	Dimension In. (mm)
Drive Gear O.D.	1.1693-1.1709 (29.70-29.74)
Rotor O.D.	1.5957-1.5968 (40.53-40.56)
Relief Valve Spring Free Length	1.851 (47.10)

ENGINE COOLING

THERMOSTAT

Thermostat — On Federal Sedan, Hatchback and Hardtop models with automatic transmission, thermostat begins to open at 182-188°F (83.5-86.5°C) and fully opens at 208°F (98°C). On all other models, thermostat begins to open at 188-193°F (86.5-89.5°C) and fully opens at 212°F (100°C).

Coolant Capacity — 5.6-5.8 quarts.

WATER PUMP

Removal — Drain coolant and disconnect main radiator outlet hose. Remove drive belt and attaching bolts, remove water pump.

Disassembly — 1) Remove four screws attaching cover plate and gasket. Remove pulley and locking clip.

2) Withdraw shaft, impeller and mechanical seal from pump body. Press pump shaft from impeller.

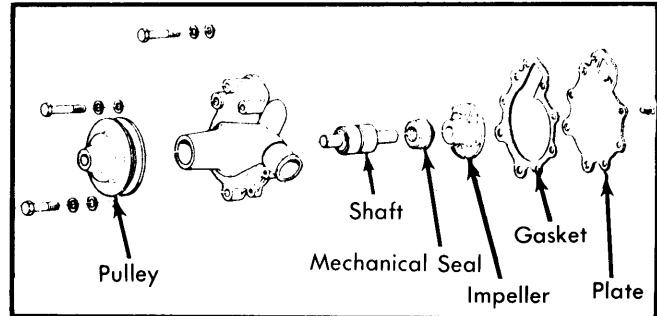


Fig. 6 Exploded View of Water Pump

Reassembly — 1) Using an arbor press, press pump shaft into pump body until locking clip may be installed. Apply sealing compound to edge of mechanical seal and in housing with carbon ring facing toward impeller.

2) Press impeller onto shaft until impeller-to-body clearance is .020-.028" (0.5-0.7 mm). Press on bearing outer race, not shaft. Support impeller side of pump shaft and press on pulley until distance between center of pulley groove and rear face of pump housing is 2.406-2.429" (61.1-61.7 mm) for 1800 cc engine or 2.524-2.547" (64.1-64.7 mm) for 1600 cc engine.

Installation — Install water pump together with slotted clip, water pipe, and water by-pass pipe as a unit. Gradually tighten bolts alternately and evenly in several steps to prevent leakage. The clamps for the water hose should be positioned low to prevent interference with the EGR pipe.

ELECTRIC COOLING FAN

All models are equipped with an electric cooling fan motor. 4-WD models use a combination of electric fan, engine drive fan and forced cooling (water cooling). All other models utilize electric fan and forced cooling (water cooling).

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										
1600 cc	97	1595	2-Bbl.	67@5200	81@2400	9.01:1	3.62	92	2.36	60
1800 cc	109	1781	2-Bbl.	71@4400	94@2400	8.7:1	3.62	92	2.64	67

Subaru Engines

1600 & 1800 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)
1600 cc & 1800 cc Int.	45°	45°	.028-.051 (.7-1.3)	.3130-.3136 (7.950-7.965)	.0014-.0026 (.035-.065)
Exh.	45°	45°	.039-.071 (1.0-1.8)	.3128-.3134 (7.945-7.960)	.0016-.0028 (.040-.070)

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)
1600 cc & 1800 cc	.0004-.0016 (.010-.040)	.00004-.00067 (.001-.017)	.0002-.0016 (.005-.040)	No. 1	.0079-.0138 ^① (.20-.35)	.0016-.0031 ^③ (.04-.08)
				No. 2	.0079-.0138 ^① (.20-.35)	.0012-.0028 ^③ (.03-.07)
				No. 3	.0079-.0354 ^② (.20-.90)

- ① — Limit .0591" (1.5 mm).
 ② — Limit .07987" (2.0 mm).
 ③ — Limit .0059" (.15 mm).

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS							
Engine	MAIN BEARINGS				CONNECTING ROD BEARINGS		
	Journal Diam. In (mm)	Clearance ^① In. (mm)	Thrust Bearing	Crankshaft End Play ^② In. (mm)	Journal Diam. In. (mm)	Clearance ^③ In. (mm)	Side Play ^④ In. (mm)
1600 cc Front & Rear	1.9668-1.9673 (49.957-49.970)	.0004-.0014 (.010-.035)	Center	.0016-.0054 (.040-.137)	1.7715-1.7720 (44.995-45.010)	.0008-.0028 (.020-.070)	.0028-.013 (.07-.33)
	Center	1.9673-1.9678 (49.970-49.982)					
1800 cc Front & Rear	2.1636-2.1642 (54.995-54.970)	.0004-.0012 (.010-.030)	Center	.0016-.0054 (.040-.137)	1.7715-1.7720 (44.995-45.010)	.0008-.0028 (.020-.070)	.0028-.013 (.07-.33)
	Center	2.1636-2.1642 (54.995-54.970)					

- ① — Limit front and rear .0022" (.055 mm);
 Limit center .0018" (.045 mm).
 ② — Limit .0118" (.30 mm).
 ③ — Limit .0039" (.10 mm).
 ④ — Limit .016" (.40 mm).

1600 & 1800 4-CYLINDER (Cont.)

ENGINE SPECIFICATIONS (Cont.)

CAMSHAFT			
Engine	Journal Diam. In. (mm)	Clearance In. (mm)⓪	Lobe Lift In. (mm)
1600 cc Front & Center	1.0236-1.0243 (26.000-26.018)	.0010-.0023 (.025-.059)	.2262 (5.745)
1800 cc Front & Center	1.2598-1.2605 (32.000-32.018)	.0010-.0023 (.025-.059)	.2262 (5.745)
1600 cc & 1800 cc Rear	1.4173-1.4180 (36.000-36.018)	.0010-.0023 (.025-.059)	.2262 (5.745)

⓪ — Limit — .0039" (.1 mm).

VALVE SPRINGS			
Engine	Free Length In. (mm)	PRESSURE Lbs. @ In. (kg @ mm)	
		Valve Closed	Valve Open
1600 cc & 1800 cc Inner	1.921 (48.8)	19.0-22.1@1.476 (8.6-10.0@37.5)	41.7-48.3@1.122 (18.9-21.9@28.5)
1600 cc & 1800 cc Outer	1.783 (45.3)	32.9-38.1@1.555 (14.9-17.3@39.5)	112.5-127.9@1.201 (51.0-58.0@30.5)

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs. (N·m)
Cylinder Head	
Step 1	22 (30)
Step 2	43 (58)
Step 3	47 (64)
Connecting Rod Nuts	29-31 (39-42)
Crankshaft Pulley	39-42 (47-54)
Crankcase Plug	46-56 (63-76)
Crankcase Halves	
6 mm Bolts	3-4 (4-5)
8 mm Bolts	17-20 (23-27)
10 mm Bolts	29-35 (39-48)
Intake Manifold	13-16 (18-22)
Flywheel	30-33 (41-45)
Rocker Arm	47 (64)