

PART 2. OVERHEAD VALVE (OHV) ENGINE

SPECIFICATIONS

ENGINE ASSEMBLY

| | |
|-------------------------------------|--|
| Type | Liquid cooled horizontally opposed 4 cyl OHV |
| Firing order | 1-3-2-4 |
| Capacity: | |
| 1600 models | 1595 cc |
| 1800 models | 1781 cc |
| Compression ratio: | |
| 1600 cc models | 9:1 |
| 1800 cc, 1979-1980 models | 8.7:1 |
| 1800 cc, 1981-1987 models | 9.2:1 |
| Compression pressure at 350 rpm: | |
| 1600 cc models | 1078 kPa |
| 1800 cc, 1979-1980 models | 1078 kPa |
| 1800 cc, 1981-1987 models | 1128 kPa |
| Maximum variation between cylinders | 10 percent |
| Bore | 92 mm |
| Stroke: | |
| 1600 cc models | 60 mm |
| 1800 cc models | 67 mm |

NOTE: Specifications regarding engine tuning are listed in the Engine Tune-up section.

CYLINDER HEADS

| | |
|---|--------------------------------------|
| Type | Two heads, one per pair of cylinders |
| Material | Aluminium alloy |
| Face distortion limit | 0.05 mm |
| Face machining limit | 0.5 mm |
| Standard height: | |
| 1600 cc models | 89.6 mm |
| 1800 cc models | 90.6 mm |
| Valve seat angle | 45 deg |
| Valve seat contact width: | |
| Inlet | 0.7-1.3 mm |
| Exhaust | 1.0-1.8 mm |
| Valve guides | Replaceable |
| Valve guide installed height: | |
| Inlet | 17.5-18.5 mm |
| Exhaust | 22.5-23.5 mm |
| Valve guide bore diameter | 8.000-8.015 mm |
| Inlet valve stem oil seal, installed height | 23.2 mm |

VALVES

| | |
|--|--------------|
| Valve clearance (cold): | |
| Inlet | 0.23-0.27 mm |
| Exhaust | 0.33-0.37 mm |
| Valve face angle | 45 deg |
| Minimum valve head thickness (margin): | |
| Inlet 1979-1983 models | 0.5 mm |
| Inlet 1984-1987 models | 1.0 mm |
| Exhaust | 0.8 mm |

Valve stem diameter:

| | |
|---------|----------------|
| Inlet | 7.950-7.965 mm |
| Exhaust | 7.945-7.960 mm |

Stem to guide clearance:

| | |
|------------|----------------|
| Inlet — | |
| Standard | 0.035-0.065 mm |
| Wear limit | 0.15 mm |
| Exhaust — | |
| Standard | 0.040-0.070 mm |
| Wear limit | 0.15 mm |

Valve spring free length:

| | |
|--------------|---------|
| Outer spring | 45.3 mm |
| Inner spring | 48.8 mm |

Maximum valve spring

out of square

2 mm

Valve timing:

| | |
|----------------|-------------|
| Inlet opens | 24 deg btdc |
| Inlet closes | 64 deg abdc |
| Exhaust opens | 70 deg bbdc |
| Exhaust closes | 18 deg atdc |

ROCKER ARMS AND SHAFTS

| | |
|-----------------------------|------------------|
| Rocker shaft outer diameter | 17.982-18.003 mm |
| Rocker arm inner diameter | 18.016-18.034 mm |
| Shaft to arm clearance | 0.013-0.052 mm |

VALVE LIFTERS AND PUSHRODS

| | |
|----------------------|------------------|
| Diameter of lifter | 20.949-20.970 mm |
| Lifter hole diameter | |
| in crankcase | 21.000-21.021 mm |

Lifter to hole clearance:

| | |
|----------|----------------|
| Standard | 0.030-0.072 mm |
| Limit | 0.100 mm |

Pushrod length:

| | |
|--------------------------|----------------|
| 1600 cc models | 220.4-220.8 mm |
| 1800 cc 1979-1982 models | 231.7-232.1 mm |
| 1800 cc 1983-1987 models | 230.7-231.1 mm |

ENGINE BLOCK

| | |
|----------|---|
| Type | Vertically split, matched two piece casting |
| Material | Light alloy with integral cast iron liners |

Rebore limit (oversize)

0.5 mm

Face distortion limit

0.05 mm

Stud protrusion:

| | |
|----------------|--------------|
| 1600 cc models | 90.5-92.5 mm |
| 1800 cc models | 91.5-93.5 mm |

Bore:

| | |
|-------------------------|------------------|
| Diameter | 91.985-92.015 mm |
| Taper limit | 0.05 mm |
| Ovality limit | 0.05 mm |
| Limit between cylinders | 0.05 mm |

Bore to piston clearance at 20°C:

| | |
|----------|--------------|
| Standard | 0.01-0.04 mm |
| Limit | 0.06 mm |

CRANKSHAFT AND MAIN BEARINGS

| | |
|---|---------------------|
| Number of main bearings | 3 |
| End float taken at | Centre main bearing |
| Maximum end float | 0.3 mm |
| Main bearing journal diameter (standard): | |
| 1600 cc models, | |
| front and rear | 49.957–49.970 mm |
| 1600 cc models, centre | 49.970–49.982 mm |
| 1800 cc 1979–1983 | |
| models | 54.955–54.970 mm |
| 1800 cc 1984–1987 models, | |
| front | 54.957–54.972 mm |
| 1800 cc 1984–1987 models, | |
| centre | 54.954–54.970 mm |
| 1800 cc 1984–1987 models, | |
| rear | 54.955–54.970 mm |
| Main bearing oil clearance 1600 cc engine models: | |
| Front and rear journals — | |
| Standard | 0.010–0.035 mm |
| Limit | 0.055 mm |
| Centre journal — | |
| Standard | 0.010–0.030 mm |
| Limit | 0.045 mm |
| Main bearing oil clearance 1800 cc engine models: | |
| Front and rear journals — | |
| Standard | 0.010–0.030 mm |
| Limit | 0.055 mm |
| Centre journal — | |
| Standard | 0.010–0.025 mm |
| Limit | 0.045 mm |
| Maximum main bearing journal | |
| taper limit | 0.07 mm |
| Maximum main bearing journal | |
| ovality limit | 0.03 mm |
| Main bearing journal | |
| regrinding limit (undersize) | 0.25 mm |
| Crankpin diameter | |
| (standard) | 44.995–45.010 mm |
| Crankpin oil clearance: | |
| Standard 1979–1983 models | 0.02–0.07 mm |
| Standard 1984–1987 models | 0.01–0.06 mm |
| Limit | 0.10 mm |
| Maximum crankpin taper limit | 0.07 mm |
| Maximum crankpin ovality limit | 0.03 mm |
| Crankpin regrinding limit (undersize) | 0.25 mm |
| Maximum crankshaft bend | 0.035 mm |

CONNECTING RODS, BEARINGS AND GUDGEON PINS

| | |
|--|-----------------|
| Bend or twist limit (per 100 mm) | 0.1 mm |
| Side clearance on crankpin: | |
| Standard | 0.07–0.33 mm |
| Limit | 0.4 mm |
| Gudgeon pin: | |
| Diameter 1979–1980 | |
| models | 20.992–21.00 mm |
| Diameter 1981–1987 | |
| models | 20.922–20.00 mm |

| | |
|-------------------------------|-----------------|
| Clearance in piston | |
| 1979–1980 models | -0.001–0.017 mm |
| Clearance in piston | |
| 1981–1987 models | 0.004–0.010 mm |
| Clearance in connecting rod | |
| 1979–1980 models | 0.005–0.040 mm |
| Clearance in connecting rod | |
| 1981–1987 models | 0.00–0.022 mm |
| Small end bush bore diameter: | |
| 1979–1980 models | 21.00–21.06 mm |
| 1981–1987 models | 21.00–21.016 mm |

PISTONS AND RINGS

| | |
|----------------------------------|--|
| Piston diameter (standard) | 91.96–91.99 mm |
| Piston measuring point | At 90 deg to gudgeon pin axis and 26.3 mm above skirt edge |

| | |
|-----------------------------|---|
| Number of rings per piston: | |
| Compression | 2 |
| Oil control | 1 |

Ring gap:

| | |
|-------------------------------------|--------------|
| Upper and lower compression rings — | |
| Standard | 0.20–0.35 mm |
| Limit 1979–1980 models | 1.50 mm |
| Limit 1981–1987 models | 1.00 mm |
| Oil control — | |
| Standard | 0.2–0.9 mm |
| Limit 1979–1980 models | 2.0 mm |
| Limit 1981–1987 models | 1.5 mm |

Ring side clearance:

| | |
|--------------------------|--------------|
| Upper compression ring — | |
| Standard | 0.04–0.08 mm |
| Limit | 0.15 mm |
| Lower compression ring — | |
| Standard | 0.03–0.07 mm |
| Limit | 0.15 mm |
| Oil control | 0 mm |

CAMSHAFT

| | |
|-----------------------------------|---------|
| Number of bearings | 3 |
| Maximum bend limit | 0.05 mm |
| Gear to crankshaft gear backlash: | |

| | |
|----------------|--------------|
| Standard | 0.01–0.05 mm |
| Limit | 0.10 mm |

End float:

| | |
|----------------|--------------|
| Standard | 0.02–0.09 mm |
| Limit | 0.2 mm |

Bearing oil clearance:

| | |
|----------------|----------------|
| Standard | 0.025–0.059 mm |
| Limit | 0.1 mm |

Journal diameter:

| | |
|-----------------------------|------------------|
| Front and centre journals — | |
| 1600 cc models | 25.959–25.975 mm |
| 1800 cc models | 31.959–31.975 mm |
| Rear journal | 35.959–35.975 mm |

Cam lobe height:

| | |
|----------------|----------------|
| Standard | 32.57–32.67 mm |
| Limit | 32.42 mm |

Camshaft to crankshaft gear backlash:

| | |
|------------------------------------|--------------|
| Standard | 0.01–0.05 mm |
| Limit | 0.10 mm |
| Maximum camshaft gear runout | 0.25 mm |

LUBRICATION

| | |
|--|----------|
| Oil pump type | Trochoid |
| Driven by | Camshaft |
| Maximum clearance outer rotor to pump body | 0.25 mm |
| Maximum inner to outer rotor tip clearance | 0.20 mm |
| Maximum rotor end float | 0.20 mm |
| Free length of relief valve spring | 47.10 mm |
| Free length of the by-pass valve spring: | |
| 1600 cc models | 40.7 mm |
| 1800 cc models | 37.1 mm |

TORQUE WRENCH SETTINGS

Cylinder head nuts and bolts:

| | |
|----------------|-------|
| 1st step | 29 Nm |
| 2nd step | 59 Nm |
| 3rd step | 64 Nm |

| | |
|---|-------|
| Cylinder head studs (Loctite 270 or 271 on threads) | 44 Nm |
|---|-------|

Engine block nuts and bolts:

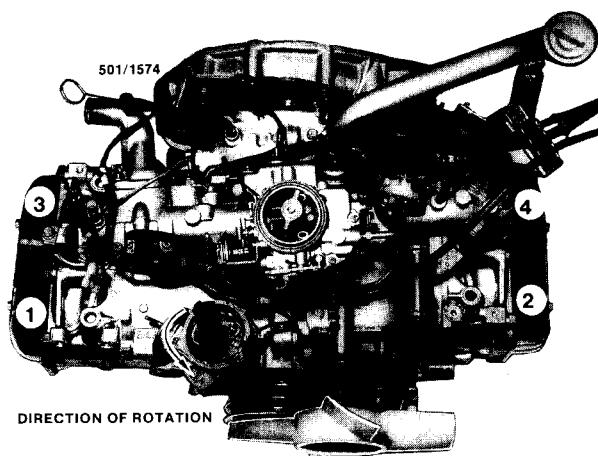
| | |
|---|-------|
| 10 mm | 47 Nm |
| 8 mm | 26 Nm |
| 6 mm | 5 Nm |
| Gudgeon pin access plugs | 76 Nm |
| Rocker cover bolts | 4 Nm |
| Flywheel bolts | 45 Nm |
| Drive plate bolts | 53 Nm |
| Crankshaft pulley bolt | 74 Nm |
| Connecting rod nuts (oiled) | 42 Nm |
| Inlet manifold bolts | 22 Nm |
| Sump bolts | 5 Nm |
| Flywheel housing bolts | 27 Nm |
| Engine to transaxle bolts and nuts | 54 Nm |
| Engine mounting to front crossmember nuts | 33 Nm |
| Torque stay nuts | 18 Nm |
| Oil drain plug | 25 Nm |

1. DESCRIPTION

The water cooled, four cylinder, horizontally opposed, overhead valve engine is fitted to Subaru Sedan, Coupe and Station Wagon models from 1979 to 1984 and all Utility from 1982 to 1987.

The 1600 cc and 1800 cc versions of the engine are similar in construction and specification, the main difference being the increased stroke length in the 1800 cc engine.

The engine block is a two-piece light alloy casting. As the two engine block halves are machined to mate together replacement can only be made in pairs.



Top view of the OHV engine assembly showing the cylinder numbering sequence.

A single light alloy, cylinder head is fitted to each pair of cylinders. The cylinder heads incorporate hardened valve seat inserts and replaceable valve guides.

The crankshaft is supported in the engine block by three main bearings of the precision insert replaceable type. Crankshaft end float is controlled by the centre main bearing. The renewable crankshaft gear is a press fit onto the crankshaft and it is located with a woodruff key.

The camshaft is supported directly by the engine block. A light alloy gear is pressed onto one end of the camshaft and meshes with the crankshaft gear.

The cams actuate the valves by transmitting movement through solid cam followers, pushrods and rocker arms.

The connecting rod bearings are of the precision insert replaceable type, at the big end and a renewable bronze bush, at the small end.

The pistons are fitted with two compression rings and one oil control ring. The gudgeon pin is fully floating in both the piston and the connecting rod and is retained in position by snap rings.

The oil pump is of the twin rotor (trochoid) type. It is mounted to the front face of the engine block and is driven directly by the camshaft. The oil pump pressure relief valve is of the non adjustable, plunger and spring type mounted in the oil pump body. The oil filter is the full flow disposable type. The oil filter bypass valve is of the non adjustable, ball and spring type mounted in the oil pump body.

The cylinders are numbered from the front to the rear, the right hand side consists of cylinders one and three and the left hand side consists of cylinders two and four.

2. ENGINE ASSEMBLY

Special Equipment Required:

To Remove and Instal — Suitable lifting tackle, trolley jack

TO REMOVE AND INSTAL

(1) Disconnect the negative battery terminal and instal protective covers around the engine compartment.

(2) Remove the spare wheel from the engine compartment being careful not to damage the air cleaner or the surrounding body panels.

(3) Remove the spare wheel carrier bolts and withdraw the spare wheel carrier from the engine compartment.

(4) Suitably mark and disconnect the evaporative system hoses from the pipes located on the passenger side front suspension tower.

(5) Suitably mark and disconnect the engine ventilation hoses from the air cleaner.

(6) Remove the air cleaner from the carburettor, refer to the Fuel System section if necessary.

(7) Suitably mark and disconnect the fuel supply hose and, if applicable the return hose from the carburettor.

(8) Disconnect the heater control vacuum hose, the brake servo unit hose and on automatic transaxle vehicles, the kickdown hose from the inlet manifold vacuum pipes.

(9) Suitably mark and disconnect the engine wiring harness connectors adjacent to the coil, the alternator wiring at the alternator, the high tension lead from the coil and the main earth lead and small earth lead adjacent to the master cylinder.

(10) Disconnect the main positive lead from the support bracket.

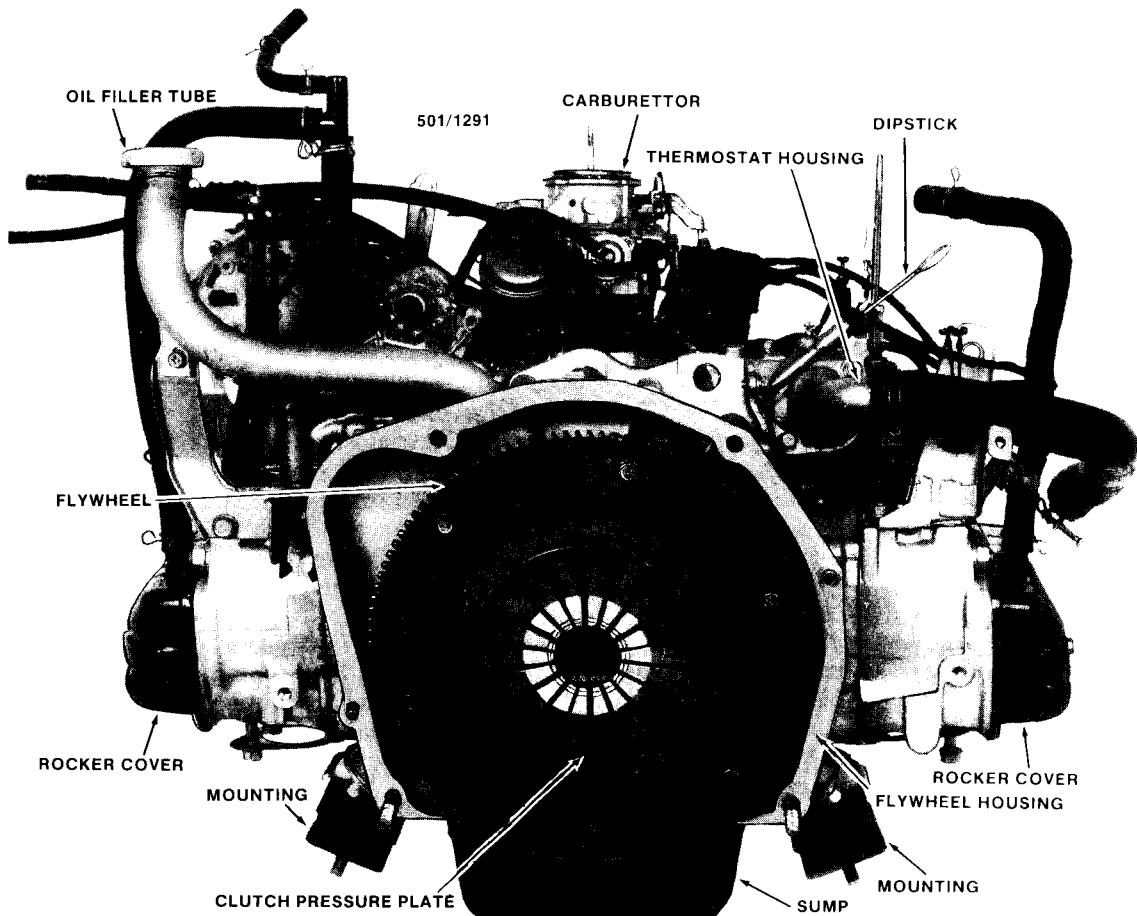
(11) Disconnect the throttle cable from its support bracket by loosening the adjusting nuts. Operate the carburettor throttle lever by hand until the lever is in a position when the throttle cable can be released from its slot.

(12) On vehicles with a manual choke, loosen the choke cable support bracket screw and disconnect the choke cable from the carburettor.

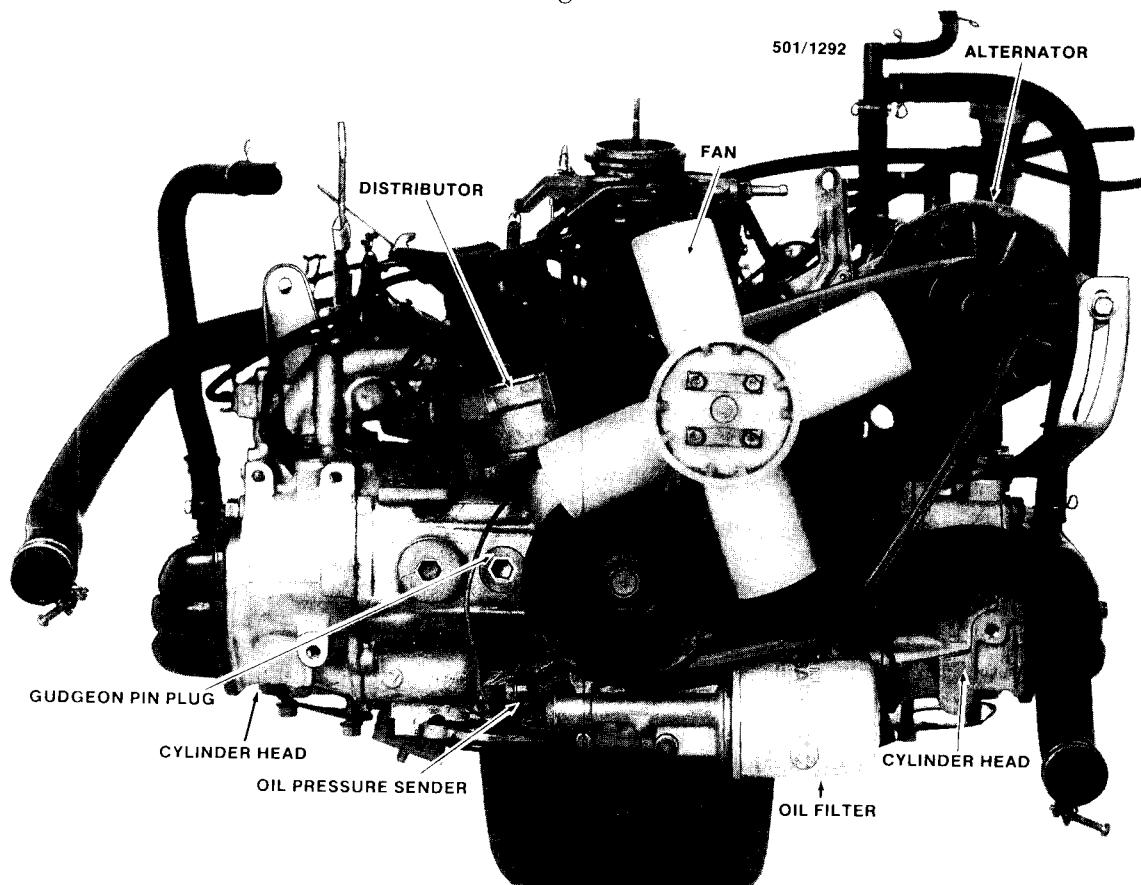
(13) On vehicles with a manual transaxle, disconnect the clutch lever return spring from the engine block.

(14) Remove the nuts retaining the torque stay rod to the engine and the bulkhead. Withdraw the torque stay rod and mounting rubbers from the engine compartment.

(15) On vehicles with an automatic transaxle, remove the timing mark aperture cover on the flywheel housing. Working through the timing mark



Rear view of the engine assembly. Manual transaxle model shown.



Front view of the engine assembly, engine driven fan model shown.

aperture, remove the bolts retaining the torque convertor to the drive plate. It will be necessary to rotate the engine using a spanner on the crankshaft pulley to reach all the retaining bolts.

(16) Working underneath the vehicle remove the engine splash plates.

(17) Place a drain tin under the right hand side of the radiator and drain the engine coolant by loosening the drain cock in the bottom of the radiator.

(18) Loosen the hose clamps and disconnect the radiator hoses from the radiator.

(19) If applicable, disconnect the wiring from the radiator fan and the thermoswitch at the connectors.

(20) On vehicles with an automatic transaxle, disconnect the transmission cooler hoses from the radiator. Plug the hoses and the radiator connections to prevent the entry of dirt.

(21) Remove the bolts retaining the radiator to the front panel and manoeuvre the radiator from the vehicle.

NOTE: When a radiator that has been in use for some time is removed from a vehicle for repairs to the engine, it should not be allowed to stand empty for any length of time, but should be immersed in a tank of water or otherwise kept full. Failure to observe this precaution may result in over

heating when the engine is put back into service.

This is caused by internal deposits in the radiator drying and flaking and so obstructing the circulation of the cooling system.

(22) On vehicles equipped with power steering, remove the pump and belt using the following procedures:

(a) Remove the idler pulley locknut cap being careful not to damage it.

(b) Loosen the idler pulley locknut, turn the adjusting bolt to slacken the drive belt and remove the power steering pump drive belt.

(c) Remove the power steering pump retaining bolts but leave the power steering hoses connected.

NOTE: If the power steering hoses are removed, the system will have to be bled. Refer to the Power Steering section.

(d) Manoeuvre the power steering pump from its installed position on the engine and place it in the spare wheel aperture.

(e) Remove the bolts retaining the idler pulley bracket to the engine block and withdraw the idler pulley bracket.

(23) On vehicles equipped with air conditioning, remove the compressor leaving the hoses connected to prevent having to regas the system and place the unit to one side.

(24) Raise the front of the vehicle and support on chassis stands.

(25) Remove the nuts retaining the front engine pipe to the cylinder heads. Suitably support the front engine pipe.

(26) Remove the bolts, nuts and springs retaining the engine pipe to the intermediate pipe.

(27) Remove the bolt retaining the front engine pipe support and carefully lower the front engine pipe from the vehicle.

(28) Remove both the front engine mounting to crossmember retaining nuts.

(29) Remove the lower engine to transaxle retaining nuts.

(30) Lower the vehicle to the floor.

(31) Instal suitable lifting tackle to the engine assembly and lift the engine slightly until the engine weight is just off the engine mountings.

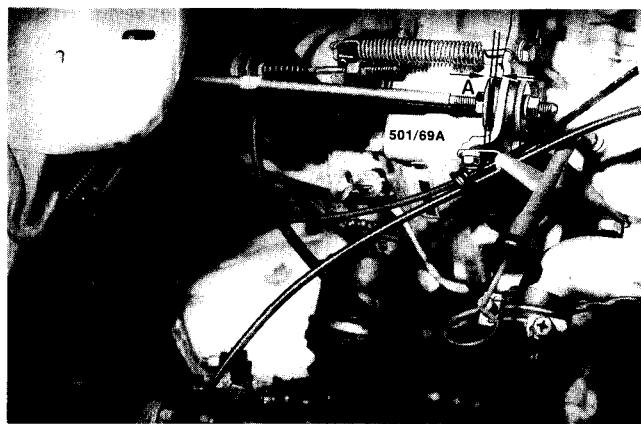
(32) Remove the upper engine to transaxle retaining nuts.

(33) Support the weight of the transaxle as near to the flywheel housing as possible using a trolley jack. Use a block of wood between the head of the jack and the transaxle to prevent damage to the transaxle.

(34) Using the lifting tackle slightly raise the engine. Raise the trolley jack to support the weight of the transaxle.

(35) Check around the engine assembly to ensure that nothing will foul on the engine assembly and also that all relevant items have been disconnected or removed.

(36) Slide the engine forwards until the input shaft on the transaxle is withdrawn from the clutch assembly on vehicles fitted with a manual transaxle or the drive plate clears the torque converter on vehicle fitted with an automatic transaxle.



Installed view of the engine torque stay rod showing where the clearance should be measured. Clearance A = 0.8–1.2 mm for manual transaxle models or 1.8–2.2 mm for automatic transaxle models.

(37) Raise the engine upwards and manoeuvre the engine from the vehicle. It may be necessary to have an assistant hold the bonnet open as wide as possible at this point.

(38) Place the engine on a work bench or suitable engine stand. If necessary, remove the auxiliary components from the engine referring to the relevant sections for the correct procedure.

Installation is a reversal of the removal procedure with attention to the following points:

(1) On vehicles fitted with a manual transaxle ensure that the clutch driven plate is centred on the flywheel and that the spigot bearing in the rear of the crankshaft is in a serviceable condition before installing the engine.

(2) Ensure that the engine mountings are in a serviceable condition. Renew if necessary.

(3) When installing the engine assembly to manual transaxle models, rotate the engine two or three times using the crankshaft pulley to help alignment of the clutch assembly.

(4) Ensure that the engine assembly is installed and bolted securely to all mountings and that the weight is taken by the mountings before connecting the various components to the engine and transaxle.

(5) Instal and adjust the engine torque stay rod using the following procedure:

(a) Slide the torque stay rod into the engine bracket ensuring that the flywheel side nut, rubber cushion and washer are in place. Loosely instal the other rubber cushion, washer and nut.

(b) Instal the bulkhead end of the torque stay rod over the stud, instal the washer and tighten the retaining nut to the specified torque.

(c) Adjust the flywheel side nut of the torque stay so there is 0.8–1.2 mm clearance on manual transaxle models or 1.8–2.2 mm clearance on automatic transaxle models between the rubber cushion and the washer. Refer to the illustration if necessary.

(d) When the clearance is correct hold the flywheel side nut with a suitable spanner and torque the other torque stay nut to Specifications.

(6) Ensure that the various drain plugs are secure.

(7) Fill the radiator with clean water and add corrosion inhibitor or antifreeze as necessary. Refer to the Lubrication and Maintenance and Cooling System sections.

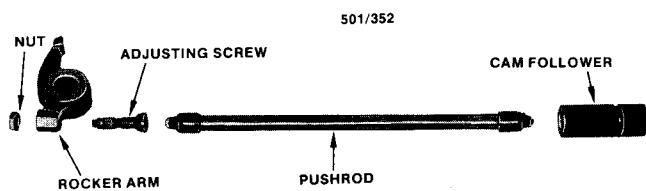
(8) Fill the crankcase with the correct amount and the recommended grade of lubricant. Refer to the Lubrication and Maintenance section if necessary.

3. ROCKER ASSEMBLIES AND PUSHRODS

TO REMOVE

(1) Disconnect the negative battery terminal.

(2) Disconnect the PVC hoses from the rocker covers.



View of a rocker, pushrod and lifter removed from the engine assembly.

(3) Remove the rocker cover retaining bolts and remove the rocker covers from the engine. Discard the gaskets.

(4) Progressively and evenly loosen the cylinder head bolts that retain the rocker pedestals. Remove the bolts.

(5) Withdraw the rocker assemblies from each cylinder head being careful not to dislodge the pushrods at this stage.

(6) Twist and remove each pushrod from its installed position.

NOTE: Keep the rocker assemblies and pushrods in order so they can be installed to their original positions. The cam followers will not fall from the engine block.

TO DISMANTLE, INSPECT AND ASSEMBLE

(1) Suitably mark the front of the rocker shaft as an aid to assembly.

(2) Remove the front snap ring from each shaft. Slide each component off the rocker shafts ensuring that they are kept in their correct order to aid assembly.

(3) Clean all the rocker assembly components in a suitable cleaning solvent and blow dry with compressed air.

(4) Check the oil ways in the rocker assembly components for obstructions by blowing through with compressed air.

(5) Visually inspect the components for wear and scoring paying particular attention to the wearing

surface of the adjusting screw. Renew any obviously worn or damaged components.

(6) Use suitable micrometers to measure the inside diameter of each rocker arm and the outside diameter of the rocker shaft relative to the arm. If the clearance exceeds Specification replace the worn components.

(7) Liberally lubricate the working surfaces of the rocker arms and shafts with engine oil before assembly.

(8) Position the rear snap ring in its groove in the rocker shaft and slide the rocker shaft components onto the shaft in the reverse order of removal. Secure the rocker components with the front snap ring.

(9) Inspect the pushrods for bend by rolling them on a flat table top. Inspect the ends of the pushrods for excessive wear. Renew pushrods as necessary.

(10) Ensure that the oil passage in each pushrod is clear. Blow out with compressed air if necessary.

TO INSTAL

Installation is a reversal of the removal procedure with attention to the following points:

(1) Insert the pushrods into their respective cam followers ensuring that they are clean and liberally oiled.

(2) If not already done so thoroughly clean the rocker assemblies with solvent and compressed air and liberally lubricate the rocker assemblies with engine oil.

(3) Thoroughly clean the rocker covers and cylinder head mating surfaces. Adhere new rocker cover gaskets to the rocker covers using an oil resistant sealer.

(4) Tighten the cylinder head bolts retaining the rocker assemblies progressively and evenly to the specified torque.

(5) Adjust the valve clearances as described in the Engine Tune-up section.

(6) Instal the rocker covers ensuring that the bolt seals are in good condition.

4. INLET MANIFOLD

TO REMOVE AND INSTAL

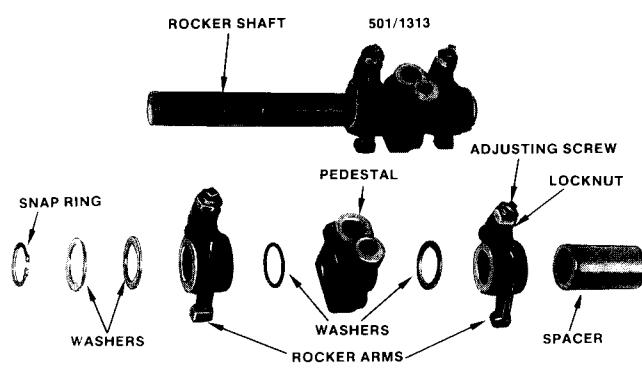
(1) Disconnect the negative battery terminal.

(2) Drain the cooling system, refer to the Cooling System section if necessary.

(3) Remove the spare wheel from the engine compartment being careful not to damage the air cleaner or surrounding bodywork.

(4) Remove the air cleaner from the engine, refer to the Fuel System section if necessary.

(5) Suitably mark and disconnect the fuel supply and, if applicable, the return hose from the carburettor.



Partially dismantled view of rocker assembly.

(6) Disconnect the heater control vacuum hose, the brake servo unit hose, the coasting by-pass valve hose and on automatic transaxle vehicles, the kick-down hose from the inlet manifold vacuum pipes.

(7) Disconnect the wiring to the carburettor at the connector and release the wiring harness from the inlet manifold retainers.

(8) If applicable, prize off the EGR pipe cover and disconnect the EGR pipe from the inlet manifold and cylinder head.

(9) Disconnect the throttle cable from its support bracket by loosening the adjusting nuts. Operate the carburettor throttle lever by hand until the lever is in a position when the throttle cable can be released from its slot.

(10) On vehicles with a manual choke, loosen the choke cable support bracket screw and disconnect the choke cable from the carburettor.

(11) Remove the bolts retaining the inlet manifold to the cylinder heads, withdraw the manifold and discard the gaskets.

(12) Remove the thermostat housing retaining bolts. Withdraw the thermostat housing and the thermostat. Discard the gasket and test the thermostat as described in the Cooling System section.

(13) If necessary remove the carburettor mounting nuts and remove the carburettor from the inlet manifold. Discard the gaskets located at either side of the spacer block.

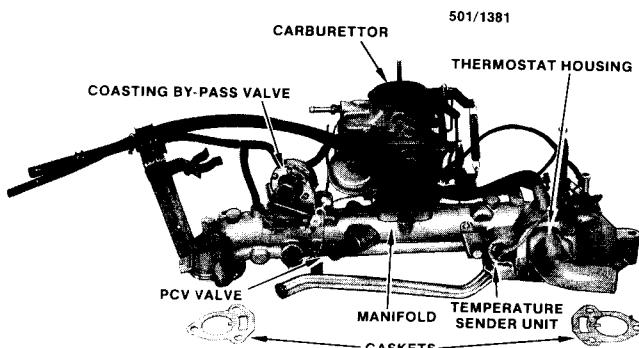
(14) If necessary and applicable, remove the vacuum fittings, the thermal vacuum valve (TVV), the PCV valve, the EGR valve and the water hose fittings from the inlet manifold.

Installation is a reversal of the removal procedure with attention to the following points:

(1) Thoroughly clean the mating surfaces of the inlet manifold and the cylinder heads.

(2) Position the inlet manifold gaskets on the engine block, instal the inlet manifold and tighten the retaining bolts finger tight.

(3) Torque the inlet manifold retaining bolts in stages to the specified torque.



View of the inlet manifold and carburettor assembly removed from the vehicle.

(4) If removed, apply suitable thread sealant to the water hose fittings and the TVV and tighten them securely.

(5) Instal the thermostat and housing using a new gasket.

(6) Instal the carburettor using new gaskets. Refer to the Fuel System section if necessary.

(7) Fill the cooling system with the correct coolant as outlined in the Cooling System section, run the engine and check for leaks. Rectify as necessary.

5. ENGINE SUMP AND OIL PUMP PICK UP

ENGINE SUMP

To Remove and Instal

(1) Raise the front of the vehicle and support it on chassis stands.

(2) If applicable, remove the sump guard retaining bolts and withdraw the sump guard from the vehicle.

(3) Remove the sump plug and drain the engine oil into a suitable container.

(4) Instal and tighten the sump plug.

(5) Remove the sump retaining bolts and withdraw the sump from the vehicle.

NOTE: It may be necessary to use wedges to dislodge the sump. Ensure that the engine block mounting face or the oil pump pick up are not damaged during this operation.

Installation is a reversal of the removal procedure with attention to the following points:

(1) Clean all traces of old sealant and gasket from the sump and engine block.

(2) Thoroughly wash the sump, both inside and outside removing all traces of sludge, carbon deposits and metal particles.

(3) Clean the oil pump pick up screen and blow dry with compressed air.

(4) Apply a suitable sealer to both sides of the new sump gasket and position the gasket on the sump.

(5) Instal the sump to the engine block and tighten the retaining bolts finger tight. Ensure that the sump gasket is correctly positioned.

(6) Tighten the sump bolts progressively in a diagonal sequence to the specified torque.

(7) Instal the sump guard if applicable.

(8) Fill the sump with the recommended quantity and grade of oil.

(9) Start the engine and check for oil leaks. Rectify as necessary.

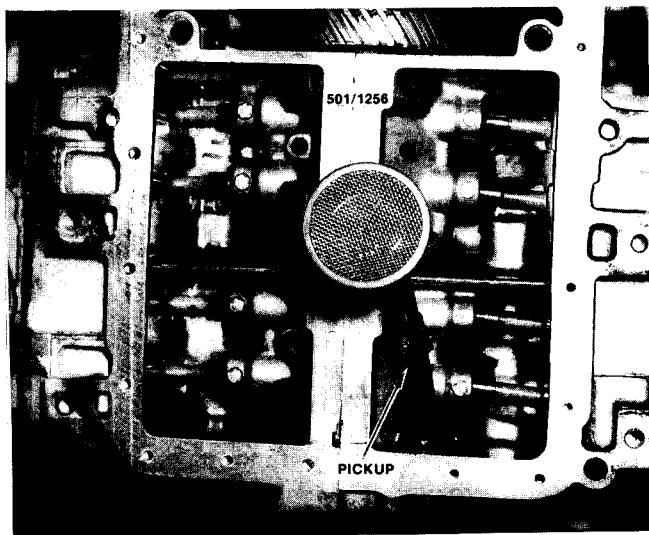
OIL PUMP PICK UP

To Remove

(1) Remove the sump as previously described.

(2) Remove the bolt retaining the oil pump pick up tube to the engine block.

(3) Using suitable tools and with suitable pro-



View of the engine block with the sump removed showing the oil pump pick up.

tection, withdraw the oil pump pick up from the engine block assembly. Discard the 'O' ring.

NOTE: The oil pump pick up is a very tight fit in the engine block assembly therefore it should be removed only if necessary.

To Install

- (1) Using a new 'O' ring instal the oil pump pick up using a brass drift or similar.
- (2) Tighten the retaining bolt securely.
- (3) Instal the sump as previously described.
- (4) Run the engine ensuring that oil pressure is immediately obtained and check for leaks.

6. CAMSHAFT AND CAM FOLLOWERS

Special Equipment Required:

To Check Camshaft — Vee blocks, dial indicator, suitable micrometers or Plastigage
To Renew Camshaft Gear — Press and press plates

TO REMOVE

- (1) Remove the engine from the vehicle as previously described.
- (2) Dismantle the engine and check the camshaft gear to crankshaft gear backlash as described under the heading Pistons, Connecting Rods and Cylinder Bores.
- (3) If the camshaft gear to crankshaft gear backlash is excessive it will be necessary to renew the camshaft and/or the crankshaft gear using a press and press plates.

TO CHECK AND INSPECT

- (1) Clean the camshaft with a suitable solvent and blow dry with compressed air.

- (2) Check the camshaft lobes for pitting and wear.

(3) Support the camshaft at each end on vee blocks and using a dial indicator with its plunger bearing on the centre journal, rotate the camshaft and check for bend. Renew or repair the camshaft as necessary.

(4) With the camshaft still supported on the vee blocks, mount the dial indicator so that its plunger bears on the side of the camshaft gear. Rotate the camshaft and check the camshaft gear runout. Renew the camshaft gear if the runout exceeds the maximum specified.

(5) Using Plastigage, calculate the camshaft bearing oil clearance as follows:

(a) Place one half of the engine block assembly, cylinder head mounting face down on a bench ensuring that the camshaft journals are clean.

(b) Instal the camshaft to this half temporarily.

(c) Insert three pieces of Plastigage across the three journals of the camshaft.

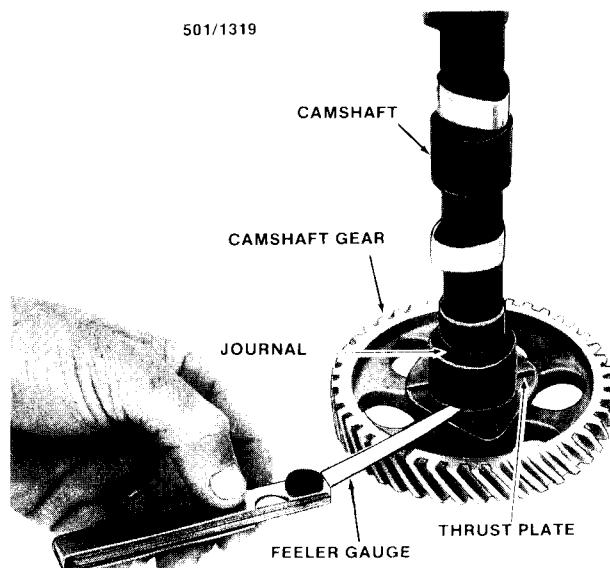
(d) Instal the other half of the engine block and torque the retaining nuts and bolts to Specifications.

NOTE: Do not turn or move the camshaft while checking the bearing clearance.

(e) Remove the engine block retaining nuts and bolts and separate the engine block being careful not to disturb the camshaft.

(f) Measure the spread width of the strips of Plastigage using the scale on the packet to determine the bearing clearance. Compare the measurement to Specifications.

NOTE: If the camshaft bearing clearance is excessive the engine should be taken to an engine reconditioning specialist for repair.



Measuring the camshaft end float using a feeler gauge.

(6) Measure the camshaft end float using the following procedure:

(a) Stand the camshaft up on the camshaft gear being careful not to allow the camshaft to fall over.

(b) Using a suitable feeler gauge measure the clearance between the camshaft thrust plate and the No. 1 camshaft journal. If the clearance exceeds Specifications, renew the camshaft thrust plate and/or gear using suitable press plates and a press.

(7) Check the cam followers for pitting, scoring or other forms of wear and renew if necessary.

TO INSTAL

Installation is a reversal of the removal procedure with attention to the following points:

(1) Use new lock tabs on the camshaft thrust plate retaining bolts.

(2) Lubricate the camshaft lobes and camshaft bearings with clean engine oil prior to assembly.

(3) Instal the camshaft gear to the engine and align the timing marks as described under the heading Crankshaft and Main Bearings.

7. CYLINDER HEADS

Special Equipment Required:

To Dismantle and Assemble — Valve spring compressor

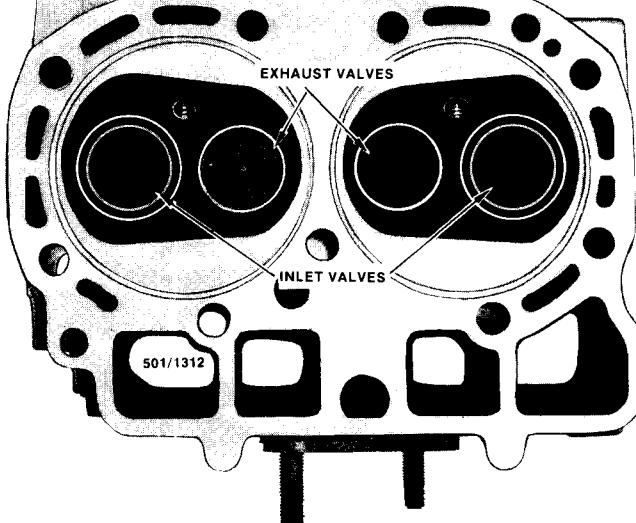
To Inspect — Suitable micrometers, straight edge, small inside micrometer or dial gauge

TO REMOVE AND INSTAL

(1) Disconnect the negative battery terminal.

(2) Drain the cooling system. Refer to the Cooling System section if necessary.

(3) Remove the rocker assemblies and the push-rods as described previously in this section.



Underside view of the cylinder head showing the valve arrangement.

(4) Remove the inlet manifold and front engine pipe from the cylinder heads as described under the appropriate headings in this section.

(5) Disconnect the high tension leads from the spark plugs and remove the spark plugs from the cylinder head.

(6) On vehicles equipped with air conditioning or power steering remove the air conditioning compressor or power steering pump from the engine leaving the hoses connected. Place the compressor or pump to one side clear of the work area.

(7) Where applicable, disconnect the alternator wiring and remove the alternator from the cylinder head. If necessary refer to the Electrical System section for the correct procedure.

(8) Remove the nuts retaining the engine mountings to the engine and raise the engine sufficiently to allow the cylinder heads to be withdrawn from the engine. Use a block of wood between the jack and the engine sump to prevent damage to the sump.

(9) Loosen the cylinder head retaining nuts a little at a time in the reverse order of the tightening sequence.

(10) Remove the cylinder head retaining nuts completely and withdraw the cylinder heads from the engine.

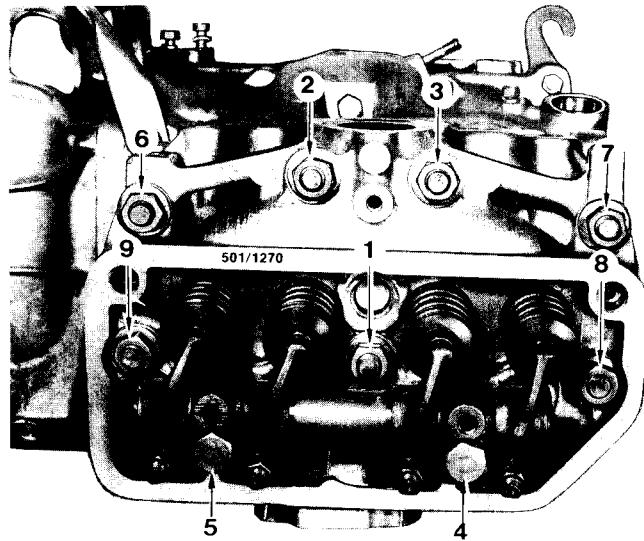
Installation is a reversal of the removal procedure with attention to the following points:

(1) Ensure that the gasket surfaces of the cylinder heads and engine block are perfectly clean and free from any burrs or pieces of old gasket.

NOTE: Ensure that no pieces of gasket are allowed to enter the cam follower bores or oilways.

(2) Clean the cylinder head studs, the bolts and the threads in the cylinder block. Lubricate the threads with engine oil before installation.

(3) Sparingly apply head gasket sealant. Three



Cylinder head nut and bolt tightening sequence.

Bond 1201 or Dow Corning 92-024 evenly to both sides of the new cylinder head gasket.

(4) Place the head gaskets on the engine block ensuring that they are correctly positioned.

(5) Slide the cylinder heads onto the engine block studs and hand tighten the cylinder head nuts.

(6) Instal the pushrods and rocker assemblies and hand tighten the cylinder head bolts.

(7) Torque each cylinder head in three stages following the tightening sequence in the illustration. First stage 29 Nm, second stage 59 Nm, third and final stage 64 Nm.

(8) When each cylinder head has been torqued recheck the torque on No. 1 nut on each cylinder head to ensure that the cylinder heads have been sufficiently torqued.

(9) Check and adjust the valve clearances as described in the Engine Tune-up section.

(10) Instal the rocker covers to the cylinder heads using new gaskets and tighten the retaining bolts securely.

(11) Fill the radiator with coolant. Refer to the Cooling System section if necessary.

(12) Start the engine and check for oil or water leaks and rectify as necessary. Check and if necessary adjust the ignition timing as described in the Engine Tune-up section.

(13) Run the engine until it reaches normal operating temperature then switch the engine off. Allow the engine to cool for at least two hours or until the engine block is cool to touch.

(14) Retorque the cylinder head nuts and bolts using the following procedure.

TO RETORQUE CYLINDER HEAD NUTS AND BOLTS

(1) Disconnect the negative battery terminal.

(2) Ensure that the engine block is cool to touch or an incorrect torque may be applied to the cylinder head nuts and bolts.

(3) Remove the left and right side rocker cover retaining bolts and remove the rocker covers being careful not to damage the gaskets.

(4) Loosen the inlet manifold retaining bolts on the right hand side of the engine 60°.

NOTE: Do not loosen the inlet manifold mounting bolts on the left hand side of the engine. Do not loosen the inlet manifold retaining bolts by more than 90° or coolant leakage may result.

(5) Using an offset socket loosen cylinder head nut number one on one cylinder head, as shown in the tightening sequence 60°. Apply engine oil to the stud threads.

NOTE: Do not loosen the cylinder head nuts or bolts by more than 90° or coolant leakage may result.

(6) Loosen and tighten cylinder head nut number one within the 60° range four or five times to clean its thread and then tighten to the specified torque.

(7) Repeat steps five and six for all the cylinder head nuts and bolts in order as shown on the tightening sequence.

(8) To ensure that the cylinder head is sufficiently torqued, tighten cylinder head nut number one to the specified torque again without loosening, after all the other cylinder head nuts and bolts have been retorqued.

(9) Repeat the procedure for the other cylinder head.

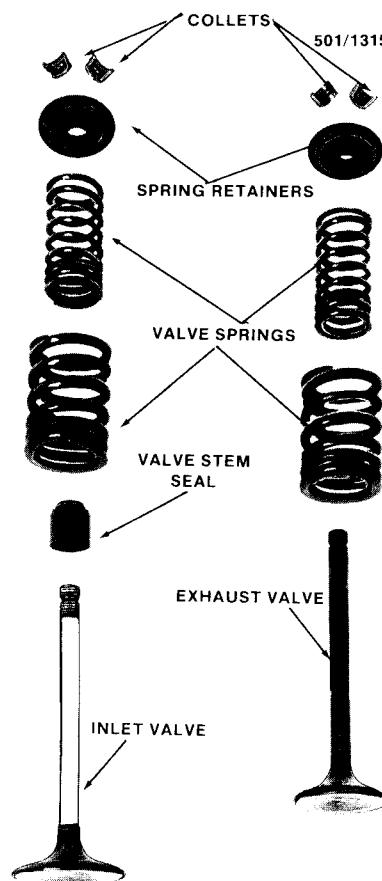
(10) Check and adjust the valve clearances as described in the Engine Tune-up section.

(11) Tighten all the inlet manifold retaining bolts to the specified torque.

(12) Run the engine and check for leaks. Rectify if necessary.

TO DISMANTLE

(1) Before removing the valves, the deposits in the combustion chambers should be cleaned off. This will protect the valve seats. Be careful not to damage the cylinder head gasket face.



Dismantled view of valves and spring components.

(2) Place and support each cylinder head on its side. Compress each valve spring in turn using a suitable valve spring compressor and remove the valve retaining collets.

(3) Release the compressor and remove the valve spring retainer and valve springs.

NOTE: Keep these components in order. The springs may differ between inlet and exhaust valves.

(4) Remove the valve stem seals from the inlet valve guides.

(5) Remove any burrs from the stem locking grooves of the valve to prevent damage to the valve guides when the valves are removed from the cylinder heads.

(6) Remove the valves keeping them in order for assembly to their original positions.

TO CLEAN AND INSPECT

(1) Clean the valves thoroughly and discard any burnt, warped or cracked valves.

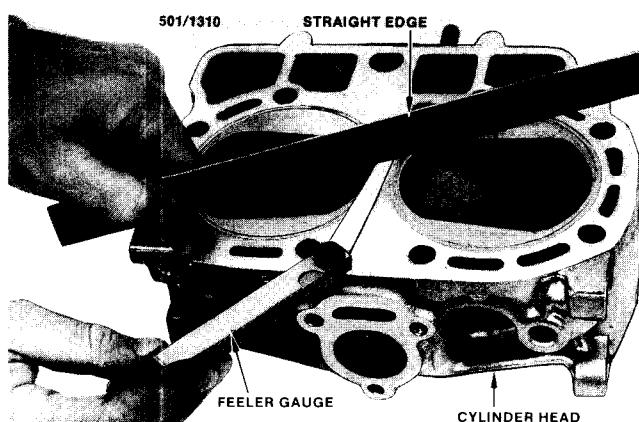
(2) Carefully clean the deposits from the inlet and exhaust ports, valve guides and manifolds taking care not to damage any mating surfaces. Check the condition of the valve seats and if necessary, recut the valve seats with a valve cutter to the recommended angle.

NOTE: If the valve seats in the cylinder head are worn, cracked or recessed excessively then new inserts will have to be installed. This is best left to an engine reconditioning shop with the necessary specialised equipment.

(3) Clean the cylinder head mounting faces, water jacket holes and manifold mating surfaces.

(4) Wash the cylinder head in a suitable solvent and blow dry with compressed air.

(5) Inspect the cylinder head for cracks or damage. Renew or repair the cylinder head if necessary.



Checking the cylinder head for distortion using a straight edge and feeler gauge.

(6) Check the cylinder head for distortion by using a steel straight edge and a feeler gauge. If excessive distortion exists the cylinder head must be surface ground.

(7) The most accurate method of measuring valve guide clearance is by using a suitable inside micrometer or a go-no go gauge to measure the valve guide and a micrometer to measure the valve stem. Compare the measurements with Specifications and if necessary have the valve guides renewed by an engine reconditioning specialist.

To measure valve guide clearance using a dial gauge, clamp the dial gauge on the cylinder head with the indicator plunger bearing against the valve stem just above the valve guide. A reading will be obtained by moving the valve head just off its seat and rocking the valve towards then away from the plunger. Compare this measurement with Specifications and if necessary have the valve guides renewed by an engine reconditioning specialist.

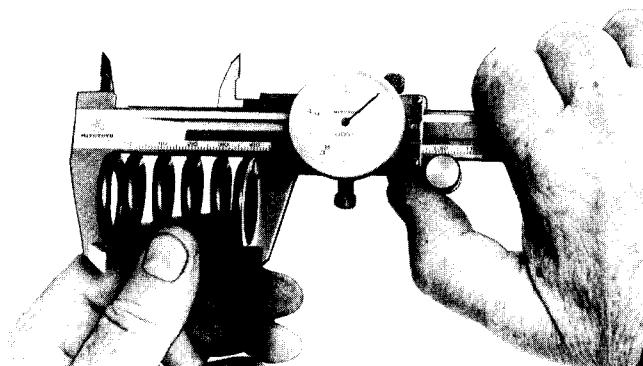
(8) With a suitable valve refacing machine reface each valve head to the specified angle, refer to Specifications and reface each valve stem flat and true. Discard any valve that proves to be excessively bent and similarly any valve that has a head margin reduced to less than Specifications after the refacing operation.

(9) Lap the valves to the valve seats with a suitable oil or water mixed lapping compound. Apply a smear of Prussian blue to the valves after lapping and check the valves on their respective seats to ensure that a true and concentric seating has been obtained.

If the seating mark is not in the centre of the valve face, the seat in the cylinder head will have to be recut and crowned and throated accordingly to centralise the seat face marking in the centre of the valve face.

NOTE: Ensure that all lapping compound is washed from the valves and valve seats before assembling the cylinder head.

(10) Check the valve spring free and loaded lengths against a new spring by comparison. Place the two springs end to end, with a plate or flat washer



Checking the free length of the valve spring.

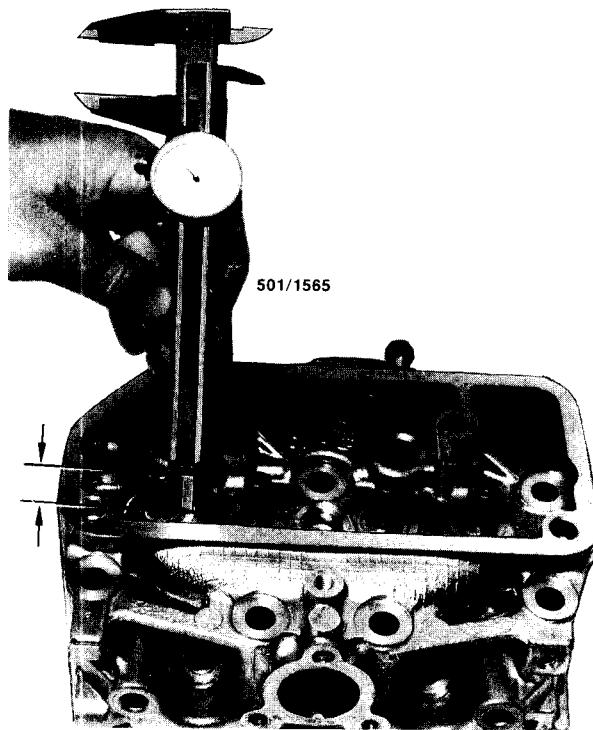
between them, between the jaws of a vice. When the vice is closed approximately 13.0 mm, the original spring should be within five per cent of the length of the new spring when measured from the plate to the vice jaw.

(11) Renew unserviceable components.

TO ASSEMBLE

(1) Place the cylinder heads face down on a clean rag on the workbench.

(2) Instal the inlet valve oil seals using a suitable tubular drift until the top edge of the seal is 23.2 mm above the spring seat.



Checking the installed height of the inlet valve oil seals. Refer text.

(3) With the cylinder head supported on its side, lubricate the valve stems and faces sparingly with engine oil and insert each valve into its respective guide.

(4) Place the inner and outer valve spring and retainer over the valve stem, ensuring that the close coiled ends of the springs are towards the cylinder head and the paint mark is towards the rocker cover. Compress the assembly and instal the two collets. Release the valve spring compressor and check to see that the two collets have correctly engaged with the valve stem groove.

(5) After the eight valves have been correctly assembled tap each valve spring lightly with a soft faced hammer to give better seating of the valves.

(6) Instal the cylinder heads to the engine block as previously described.

8. OIL PUMP

Special Equipment Required:

To Inspect — Micrometer, depth gauge

TO REMOVE AND DISMANTLE

(1) Disconnect the negative battery terminal.

(2) Remove the alternator and if applicable the power steering and air conditioning drive belts.

(3) Disconnect the oil sender unit wiring from the oil sender(s) if applicable.

(4) Remove the crankshaft pulley retaining bolt and using suitable levers carefully prise the crankshaft pulley from the crankshaft.

NOTE: When removing the crankshaft pulley be careful not to damage the front seal.

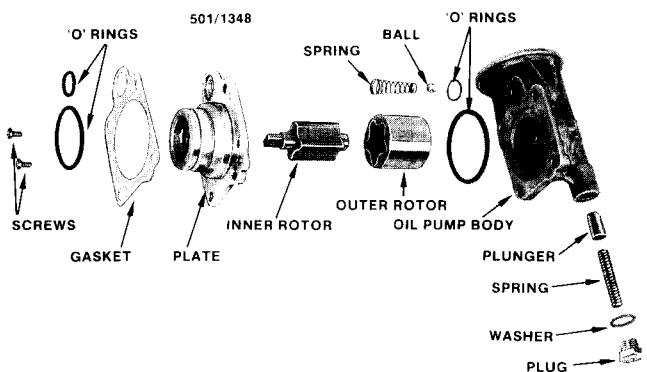
(5) Remove the oil pump retaining bolts and remove the oil pump assembly and bracket complete with oil filter from the engine block. Discard the 'O' rings and the gasket.

(6) Remove the oil filter using an oil filter wrench.

(7) If applicable, remove the oil pressure sender(s) from the oil pump body.

(8) Remove the screws retaining the oil pump plate to the oil pump body.

(9) Remove the oil pump plate and the bypass spring and ball, taking care not to misplace the spring and ball.



Dismantled view of oil pump, 1800 cc model shown.

(10) Remove and discard the 'O' rings.

(11) Remove the inner and outer rotors from the oil pump body.

(12) Remove the oil relief valve plug and withdraw the spring, the shim, if applicable and the plunger from the oil pump body. Discard the plug sealing washer.

TO CHECK AND INSPECT

(1) Thoroughly clean the oil pump components in a suitable solvent, blow dry with compressed air and temporarily assemble the rotors in the oil pump body.

(2) Measure the inner to outer rotor tip clearance using a suitable feeler gauge. If the clearance exceeds Specifications renew the rotor set.

(3) Measure the clearance between the outer rotor and the oil pump body using a suitable feeler gauge. If the clearance exceeds Specifications renew the pump body and the rotor set.

(4) Check the rotor to body end float for oil pumps fitted to 1800 cc engines using the following procedure:

(a) Temporarily instal the oil pump plate to the oil pump body ensuring that the rotor set is installed. Tighten the retaining screws securely.

(b) Measure the rotor end float using a suitable feeler gauge as shown in the illustration. If the clearance exceeds Specifications renew the rotor set and the oil pump cover or plate.

(5) Check the rotor to body end float for oil pumps fitted to 1600 cc engines using the following procedure:

(a) Ensure that the rotor set is seated in the oil pump body by turning the inner rotor a few turns.

(b) Place a straight edge across the surface of the oil pump body which normally abuts the oil pump plate. Using a suitable feeler gauge check the depth that the rotor set is below the body. Refer to the figure rotor end float in Specifications for the correct rotor depth. Renew the rotor set or body if the rotor end float is beyond the specified limit.

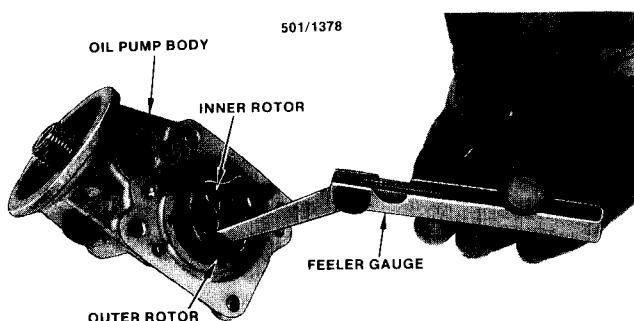
(6) Dismantle the oil pump again and check the wearing surface of the rotor shaft with a micrometer. Renew the inner rotor and/or the oil pump plate if necessary.

(7) Inspect the pressure relief valve plungers and bore for signs of excessive wear. Renew the components as necessary.

(8) Inspect the pressure relief spring for damage and breakage. Renew if necessary.

(9) Inspect the by pass ball and seat for signs of pitting or excessive wear. Renew the components as necessary.

(10) Inspect the bypass spring for damage and breakage. Renew if necessary.



Measuring the inner to outer rotor tip clearance using a feeler gauge.

TO ASSEMBLE AND INSTAL

Assembly and installation is a reversal of the removal operations with attention to the following points:

(1) Lubricate all components sparingly with engine oil during assembly.

(2) Use new 'O' rings and gaskets upon assembly.

(3) Tighten the screws retaining the oil pump plate to the body securely.

(4) When installing the bypass plug and the oil pressure sender unit(s) apply a thin coat of suitable sealant to the thread of each part.

(5) Apply sealant to the inside bore of the crankshaft pulley and instal to the crankshaft ensuring that the oil seal is in a serviceable condition. Tighten the retaining bolt to Specifications.

NOTE: If sealant is not applied to the crankshaft pulley bore oil leakage may result.

(6) Instal a new oil filter. Coat the sealing gasket with engine oil when installing.

(7) Top up the engine oil if necessary and run the engine ensuring that the oil pressure warning lamp goes out and that no oil leaks exist.

9. PISTONS, CONNECTING RODS AND CYLINDER BORES

Special Equipment Required:

To Inspect — Micrometer, cylinder measuring gauge

To Remove Gudgeon Pin Plugs — 14 mm Allen key

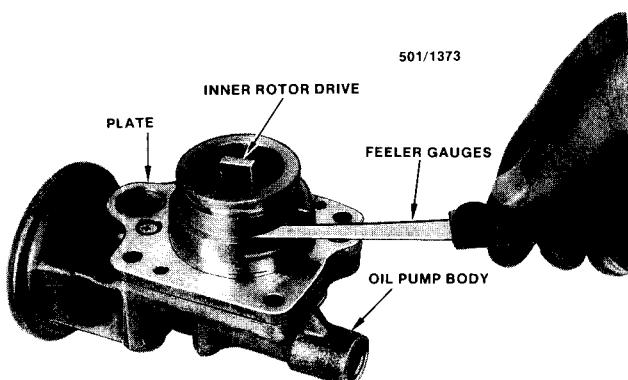
To Remove Ridge From Bores — Ridge removal tool

To Deglaze Cylinder Bores — Cylinder surfacing hone

To Instal — Piston ring compressor

TO REMOVE

(1) Remove the engine from the vehicle as previously described.



Checking the rotor to body end float for oil pumps fitted to 1800 cc engines.

(2) Remove the inlet manifold and the cylinder heads as previously described.

(3) Drain the engine oil. Remove the sump.

NOTE: The oil pick up pipe assembly is a very tight fit in the engine block and it should only be removed if necessary.

(4) Remove the distributor from the engine block, refer to the Electrical System section if necessary.

(5) Remove the flywheel or drive plate as described later in this section. Discard the 'O' ring where fitted.

(6) Remove the flywheel housing retaining bolts and remove the flywheel housing from the engine block.

(7) Remove the water pump from the engine block, refer to the Cooling System section if necessary.

(8) Remove the oil pump from the engine block as previously described.

(9) Rotate the crankshaft until pistons number one and two are at BDC (Bottom Dead Centre).

(10) Using the 14 mm Allen key, remove the gudgeon pin plugs.

(11) Using suitable long nose pliers, remove the gudgeon pin snap rings from pistons one and two.

(12) Using snap ring pliers or another suitable tool, remove the gudgeon pins from pistons one and two.

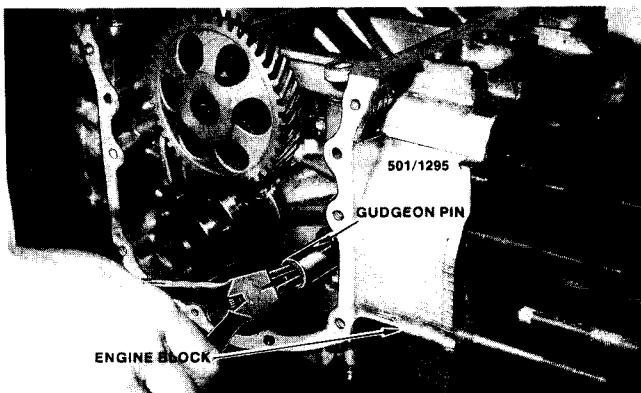
NOTE: It may be necessary to construct a suitable slide hammer puller to remove the gudgeon pins.

If using a slide hammer puller be careful not to damage the snap ring grooves of the piston.

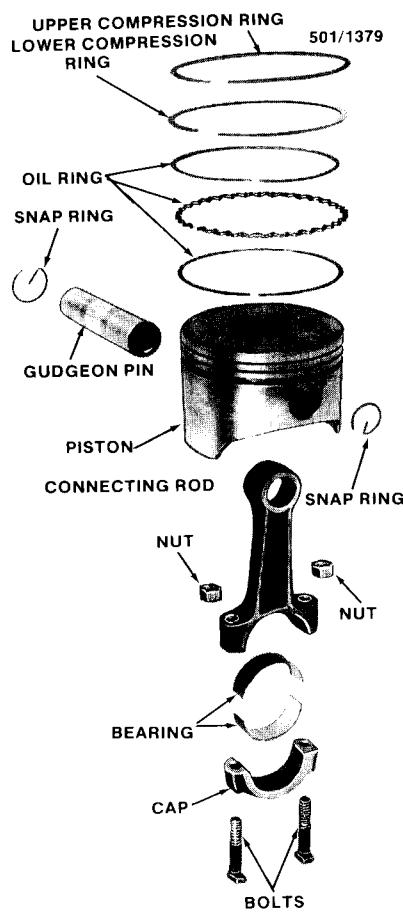
(13) Rotate the crankshaft until pistons number three and four are on BDC.

(14) Remove the gudgeon pin snap rings and the gudgeon pins as previously described.

(15) Before completely dismantling the engine block, it will be necessary to check the camshaft gear to crankshaft gear backlash using the following procedure:



Removing the gudgeon pin using a suitable tool.



Piston and connecting rod components.

(a) Suitably mount a dial gauge on the engine block so that the plunger of the dial gauge rests on a tooth of the camshaft gear.

(b) Without moving the crankshaft, rotate the camshaft gear away from the plunger of the dial gauge. Zero the dial gauge. Rotate the camshaft gear towards the plunger of the dial gauge, again being careful not to rotate the crankshaft and take a reading on the dial gauge.

(c) Compare this backlash figure with Specifications and renew the camshaft or crankshaft gears as necessary when the engine block is dismantled.

(16) Working through the access holes in the camshaft gear, straighten the lock tabs securing the camshaft plate retaining bolts.

(17) Remove the camshaft plate retaining bolts.

(18) Loosen all bolts and nuts retaining the engine block halves progressively a few turns at a time then remove all bolts from the engine block assembly.

(19) Slide the cam followers as far as they will go towards the cylinder head mounting faces of the engine block. Slide short lengths of soft copper wire or similar into the oil holes of each cam follower. This will prevent the lifters falling and becoming mixed up or damaged when the engine block is separated.