

V6 ENGINE

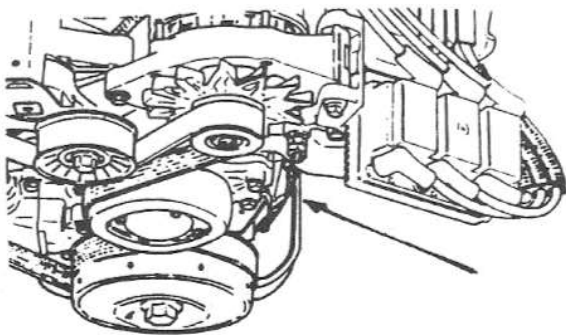
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ENGINE MAINTENANCE & REBUILD

ENGINE MAINTENANCE

Engine number location



Engine Number

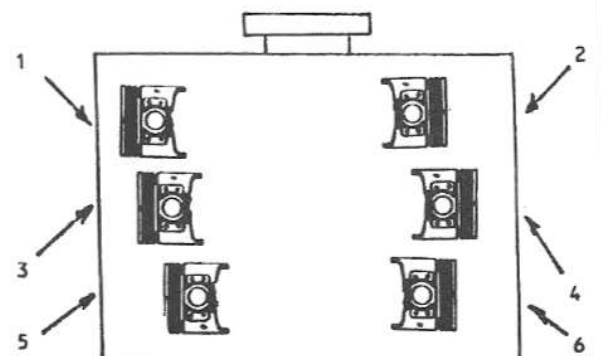
Engine No. Location

On the left hand side engine block casting near the front.

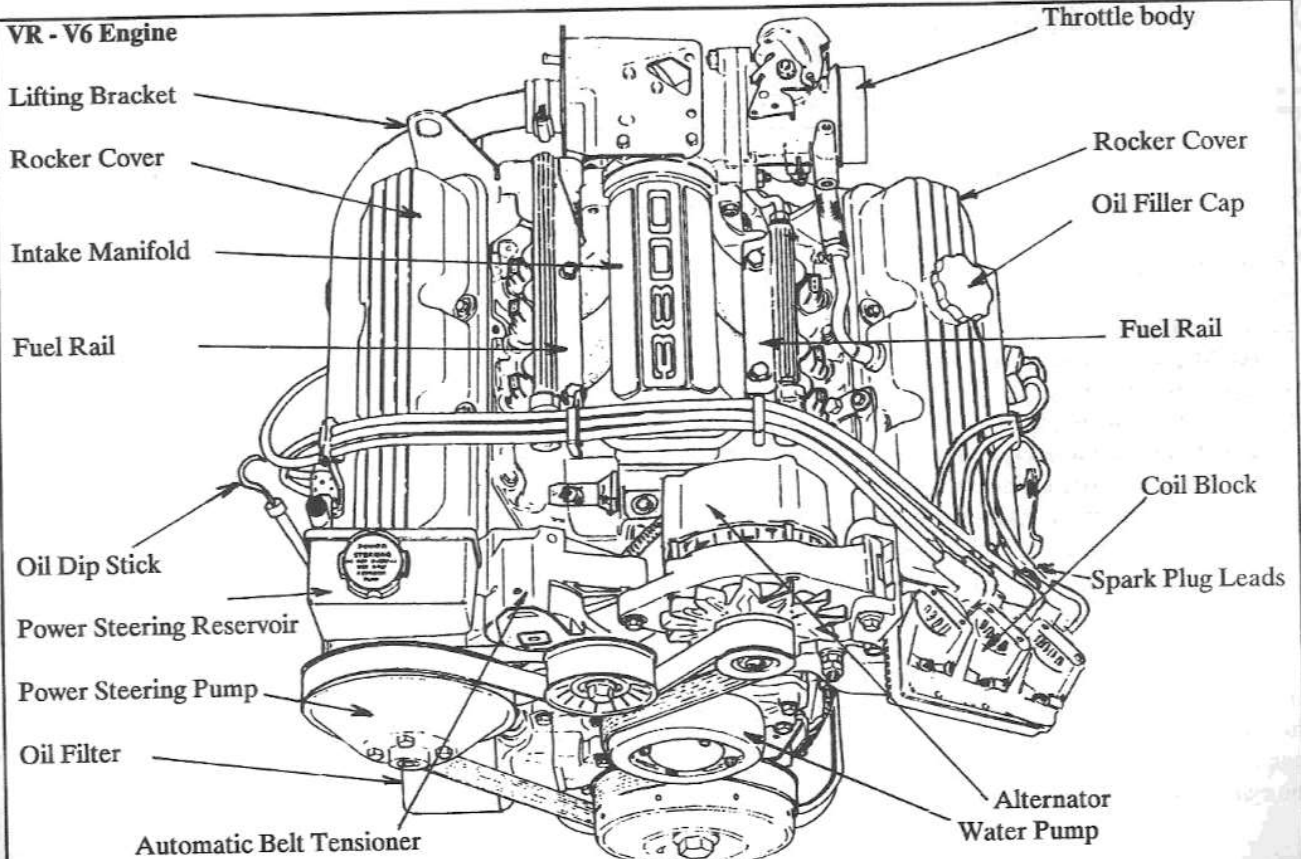
Engine Firing Order

Firing order is 1 - 6 - 5 - 4 - 3 - 2.

Engine Firing Order



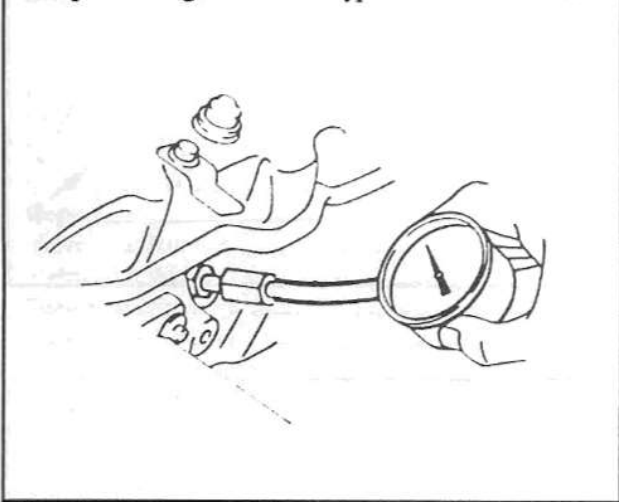
VR - V6 Engine



Compression Test

1. Make sure the engine sump oil is at the correct level. Run the engine until it is at normal operating temperature. Remove the spark plugs.
2. Remove the Eng Comp and Eng Inj fusible link adjacent to the battery. Have an assistant to help by hold the accelerator down and turn the ignition key to crank the engine over.
3. Have the assistant hold the accelerator down to the floor. Install a compression gauge in No. 1 cylinder. Crank the engine at least five pumping strokes, and record the highest gauge test.
4. Repeat the test on each cylinder to obtain the highest reading.
5. Replace the Eng Comp & Eng Inj fusible links.

Compress Gauge. - Screw in type are most accurate



Test Conclusions

The test pressure should fall within the band specified and the compression of all cylinders should be uniform within 100 kPa.

Excessive deposits in the cylinder or wrong cylinder head on the engine is indicated by a reading of more than the allowable tolerance above normal.

A reading of more than the standard tolerance above average shows leakage at the cylinder head gasket, piston rings or valve or wrong cylinder head on the engine.

Squirt about one tablespoon of engine oil on top of the pistons if one or more cylinders read low. Repeat compression pressure check on these cylinders.

- a. The piston rings are at fault if compression improves remarkably.
- b. Valves are sticking or seating faulty if compression does not improve.
- c. If two adjacent cylinders indicate low compression pressure and squirting oil on the pistons does not increase the compression, the cause may be a cylinder head gasket leak between the cylinders. Engine oil and/or coolant in the cylinders could result from this problem.

During a compression test, if the pressure fails to increase steadily and stays the same during the first two successive strokes, but increases higher on the succeeding strokes, or fails to climb during the entire test, it shows a sticking valve.

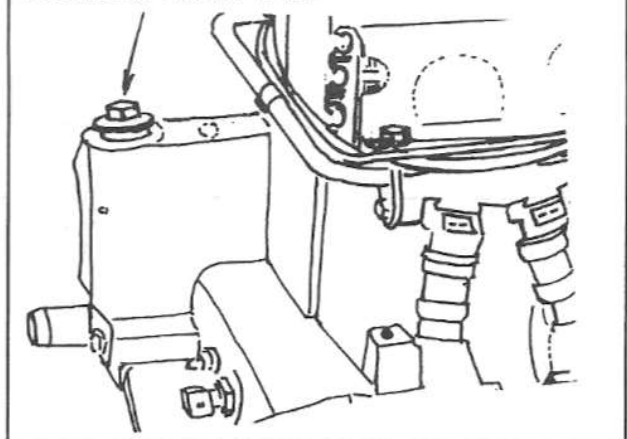
Positive Crankcase Ventilation System

Rough engine idle may indicate a malfunctioning positive crank-case ventilation system. Do not compensate for this faulty idle condition by detaching the crankcase ventilation system and/or making adjustments. The removal of the crankcase ventilation system from the engine will adversely alter the fuel economy and engine ventilation with resultant shortening of engine life.

Check PCV System Function

1. With the engine running-
 - (a) Unscrew the PCV Valve cap, loosen do not remove, a hissing noise will occur as the air passes from around the cap.
 - (b) Tighten the PCV valve and check for vacuum leaks around the PCV valve cap.

Location of V6 PCV valve.

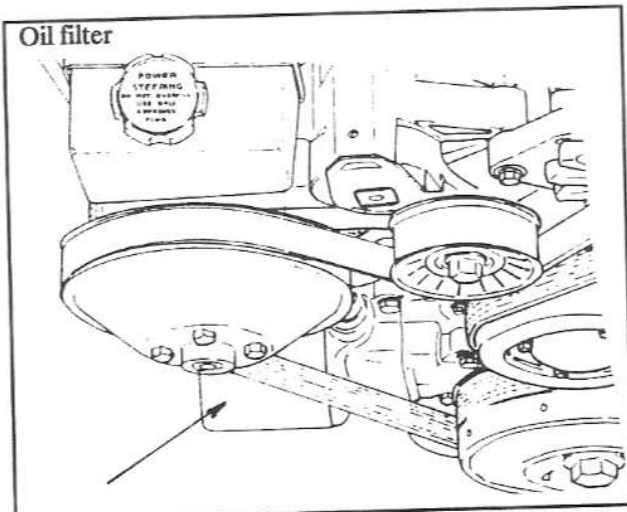


2. With the engine stopped-
 - (a) Take the PCV valve out from its mounting and shake it. Clean valve in solvent and air dry, A metallic clicking noise will indicate the valve is free. The system is operating and no further service is required if the ventilation system passes the above test. If it fails any of the tests: Take the PCV valve out from its mounting. Wash valve in a solvent base fluid, make sure that plenty of fluid is allowed to flush through the valve then allow to and air dry. Shake the valve, blow through the valve, air should only pas in one direction, if so this will indicate the valve is free.
3. Replace the "O" ring at the base of the PCV valve seat inthe intake manifold.
4. Install the valve in its mounting.
5. Replace PCV valve cap and tighten to specification. PCV Valve Cap Torque: 10-16Nm.

V6 ENGINE MAINTENANCE & REBUILD

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Oil Filter



Replacement

Put a drip pan beneath the filter. Remove the filter from the adaptor fitting. Clean the filter adaptor recess and the gasket surface of the block.

Cover the gasket on the replacement filter with oil. Place the filter on the adaptor fitting. Hand tighten the filter until the gasket contacts the block face, then move it 3/4 turn.

Run the engine at fast idle and inspect for oil leaks. If the oil leaks are visible repair the leakage. Check the oil level and add if required.

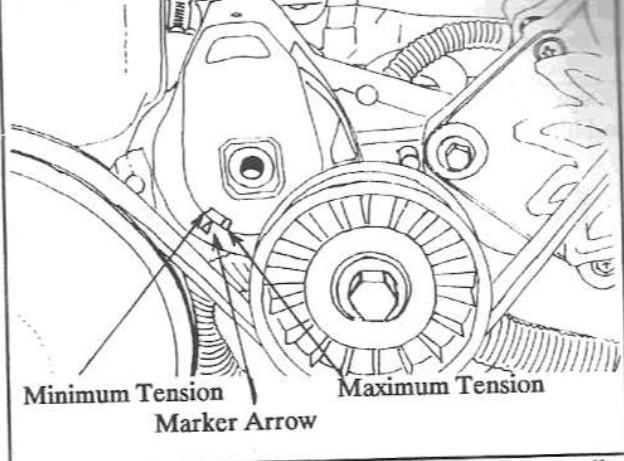
REPLACE DRIVE BELT and ADJUST BELT TENSION

1. Loosen the locknut on the automatic adjusting idler pulley mounting stud and turning the stud, relieve the tension on the drive belt.

2. Remove the belt if belt is to be removed.

3. Install new drive belt (if applicable) on crankshaft, alternator, power steering, air conditioner and water pump pulleys.

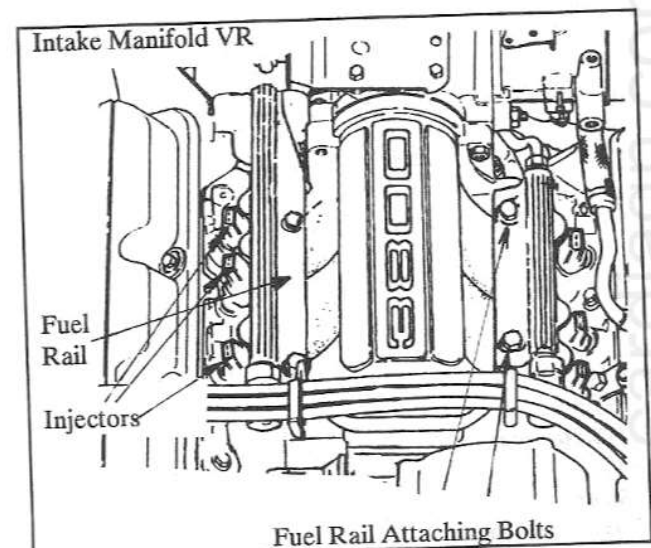
Drive Belt Tensioner



4. Adjust belt, turn the automatic adjuster idler pulley mounting stud anti-clockwise to adjust tension.

5. Check belt wear reference marks on tensioner. Install a new automatic tensioner if tension is not within specification.

Intake Manifold



Remove

1. [VS Remove manifold top cover 4 nuts, lift cover off, remove alternator support rod.]

(a) Empty the cooling system, by removing the lower radiator hose.

(b) Disconnect coolant hose from intake manifold to radiator.

(c) Remove water pump by pass hoses.

(d) Disconnect heater inlet hose.

(e) Remove radiator hose from thermostat housing.

2. (a) Disconnect the vacuum hoses from the manifold.

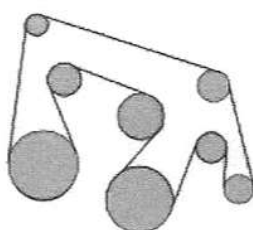
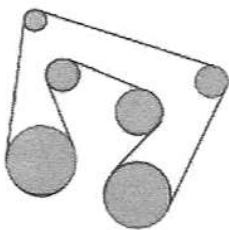
(b) Remove breather pipe from left rocker cover.

3. Disconnect the throttle cable from the throttle body.

(Disconnect cruise control cable from throttle body if connected).

V6 without air conditioning

V6 with air conditioning

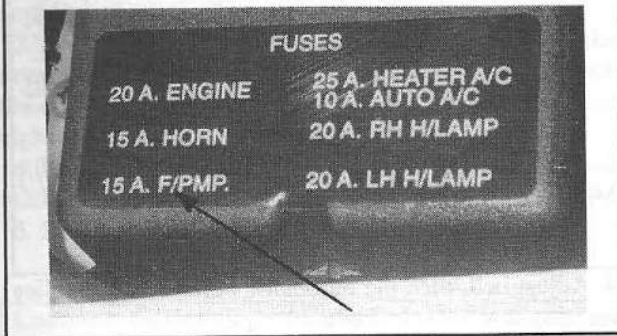


V6C848

4. Detach the kickdown cable (auto only).
5. Depressurise the fuel system as described in the Tune-up and Maintenance Chapter.

Depressurise the fuel system as described in the Tune-up and Maintenance Chapter

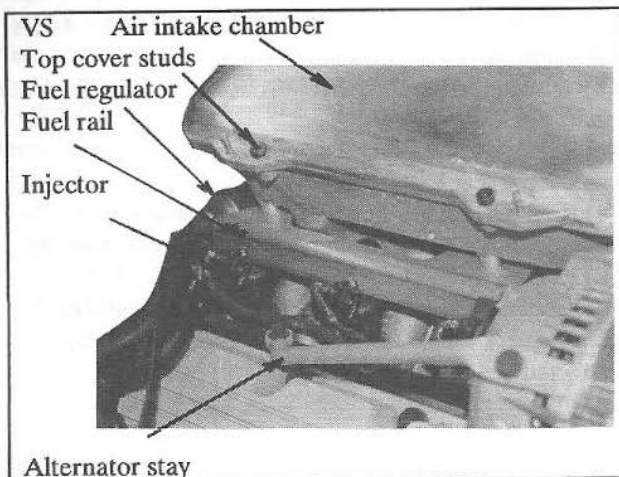
Remove Fuel pump fuse.



- (a) Remove hoses clamps and hoses from fuel injector rail and fuel pressure regulator.
- (b) Remove hoses from throttle body and emission control carbon canister.
6. (a) Remove Drive belt, and tension assembly.
- (b) Remove alternator.
7. Remove spark plug leads from drivers side of engine.
8. Remove rubber air flow duct from throttle body. VS remove MAF (Mass Air Flow) wiring and MAF with air flow duct.
9. Disconnect and label wiring connectors from, throttle position switch, idle air control valve, coolant temperature sensor, temperature gauge unit, MAT sensor and injectors.
10. VS (a) Remove the upper manifold air chamber attaching bolts.
- VS (b) Remove PCV valve, spring and "O" ring.
- Remove intake manifold attaching bolts, and remove manifold.
11. Remove sensors, fuel rail and throttle body if necessary.

Clean

Take all the gasket material from the machined surfaces of the manifold. Clean the manifold in an appropriate solvent and dry it with compressed air.



Inspect

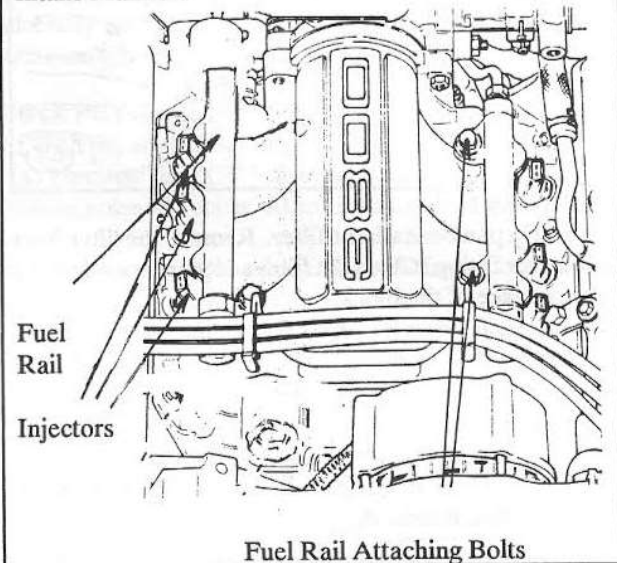
Check the manifold for cracks, damaged gasket surfaces, or other faults that would make it unsuitable for further use.

Replace any bolts that are stripped or otherwise damaged. Take any foreign matter out that may have entered the manifold as a result of repairs.

Install

1. (a) Install water outlet and thermostat housing. Torque thermostat housing bolts to specification.

Intake Manifold



Torque Thermostat housing Attaching Bolts: 20-25Nm
(b) Install [VS oil baffle with holes towards centre lobe of manifold] rubber "O" ring and PCV valve, VR tighten to specification.

VR PCV Valve Cap Torque: 10-16Nm.
(c) Install water pump by-pass hose fitting, use a sealant and tighten to specified torque.

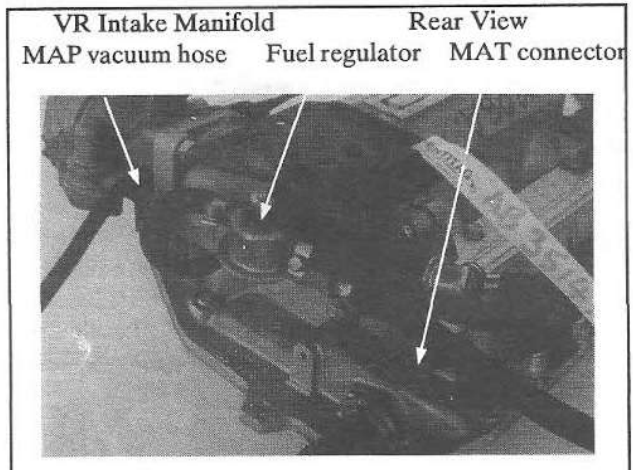
Torque: 25 - 35 Nm.

2. Install throttle body and torque to specification.

Throttle Body Attaching Bolts: 15-20Nm

Install rubber air flow duct.

3. Install sensors to specified torque, apply sealant to threads.



V6 ENGINE MAINTENANCE & REBUILD

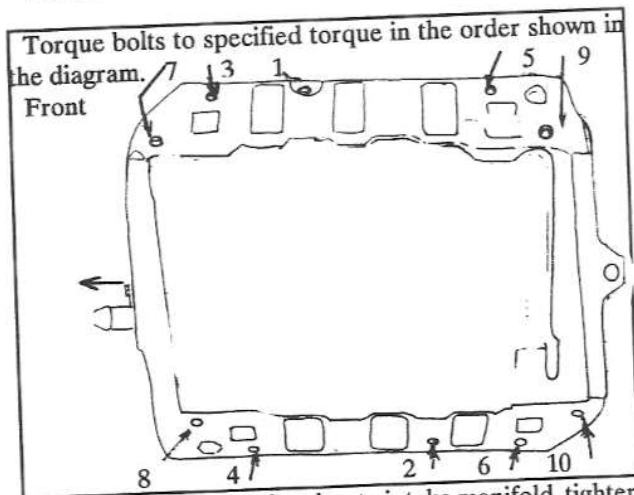
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Torque:**MAT Sensor - Hand tighten + 1 turn.****Coolant Temperature Sensor - 8 - 12 Nm.****Coolant Temperature Sender - 8 - 12 Nm.**

4. Install fuel rail with injectors and throttle body with adaptor assemblies.

5. Install manifold and new gaskets, ensure that the gaskets fit correctly and apply sealant to the front and rear gasket seals as well as the intake manifold attaching bolts. Torque bolts to specification in the order shown below.

Intake manifold bolts specified torque: 8 - 12 Nm.



Torque bolts to specified torque in the order shown in the diagram.

Front

VS Install upper air chamber to intake manifold, tighten bolts to specification.

VS Intake Manifold Air Chamber bolt torque: 10-14Nm

6. Reconnect all wiring connectors to the correct components as labelled during removal.

7. Connect the throttle cable and cruise control cable if applicable.

8. If automatic transmission reconnect the kick down cable.

9. Reconnect fuel hoses to the throttle body, fuel rail and emission control carbon canister.

10. Reconnect all vacuum hoses, including breather hose to left rocker cover.

11. Reconnect spark plug leads.

12. Install drive belt tensioner assembly and drive belt.

13. Reconnect all coolant hoses and refill coolant system.

14. VS Install alternator support rod and engine top cover, tighten to specification.

Alternator Support Rod Torque Specification: 20-30Nm

Engine Top Cover Nut Torque specification: 4-6Nm

14. Start vehicle and check for coolant, fuel or vacuum leaks.

Valve Rocker Covers and Valve Rocker Arm

Remove

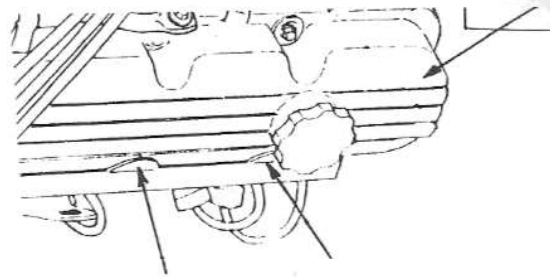
Right cover:

1. Disconnect spark plug leads.

2. Remove rocker cover bolts and remove rocker cover.

Take care not to damage gasket as it may be reusable type.

Rocker cover



Pull back plastic lugs on spark plug lead cover

Left cover:

1. Remove breather hose from cover.

2. Pull back plastic lugs on spark plug lead cover.

3. Remove rocker cover bolts and remove rocker cover. Take care not to damage gasket as it may be reusable type.

Valve rocker arms:

1. Remove rocker arm pivot bolts.

2. Remove rocker arm pivots and rocker arms.

3. Remove push rods if necessary.

Caution: Always keep valve and rocker components in order so as assembly can be completed with the correct components in the correct order otherwise push rods could be damaged.

Assembly

Rocker Arms and Push Rods:

1. Clean and air dry rocker arms and push rods, replace if excessive wear is noticeable.

2. Apply engine oil to the rocker arms and push rods.

3. Install rocker arms and pivots, fit pivot bolts and torque to specification.

Pivot bolts torque specification: 32-44Nm

Right cover:

1. Clean the mating faces of the rocker cover and cylinder head. Apply a 2-3 mm wide bead of sealer to the sealing flange of the rocker cover.

2. Install the cover on the cylinder head and tighten bolts to specification.

Rocker cover bolt torque specification: 7-11Nm

Left cover:

1. Clean the mating faces of the rocker cover and cylinder head. Apply a 2-3 mm wide bead of sealer to the sealing flange of the rocker cover.

2. Install the cover on the cylinder head and tighten bolts to specification.

Rocker cover bolt torque specification: 7-11Nm

3. Reconnect breather hose to rocker cover.

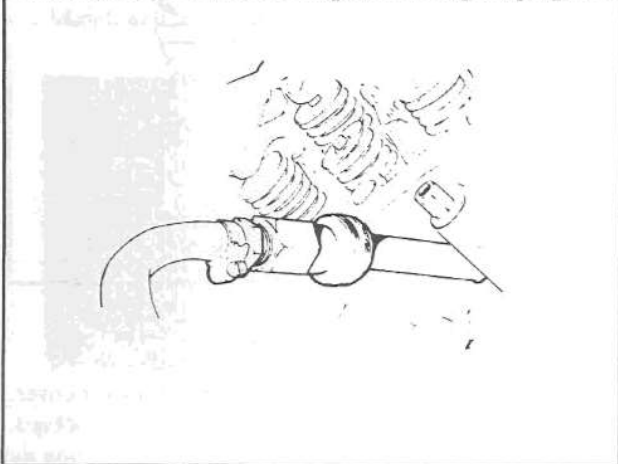
Valve Spring Retainer and Stem Oil Seal

Replace

1. Take the rocker arm covers off and remove the rocker arm assembly. Remove the spark plug from the affected cylinder.

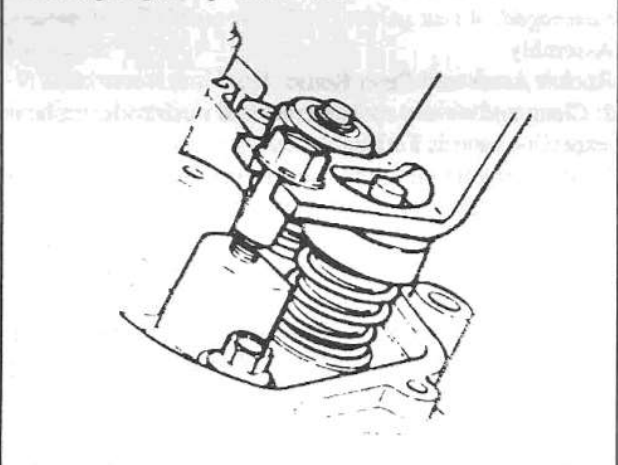
2. Rotate the crankshaft so that the piston of the affected cylinder is below TDC.
3. Install an air line with an adaptor in the spark hole.

Install an air line with an adaptor in the spark plug hole.



4. Place the valve spring compressor tool on the cylinder head and turn on the air supply.
5. Compress the valve spring by using the valve spring compression tool and remove the valve spring retainer

Valve spring compression tool



locks, the spring retainer and the valve spring. The valve will not be seating or damaged if the air pressure fails to hold the valve in the closed position. Remove the cylinder head for further inspection if this condition occurs. Take the valve stem seal out.

6. Grease the valve stem. Work a new seal onto the valve stem by using your fingers.

7. Use a seal inserter to position the seal correctly on the valve guide.

*** The valve spring seat must be in position on the cylinder head and seal inserter must be used to ensure that the seal is correctly located. DO NOT bottom the seal on the top of the valve guide.**

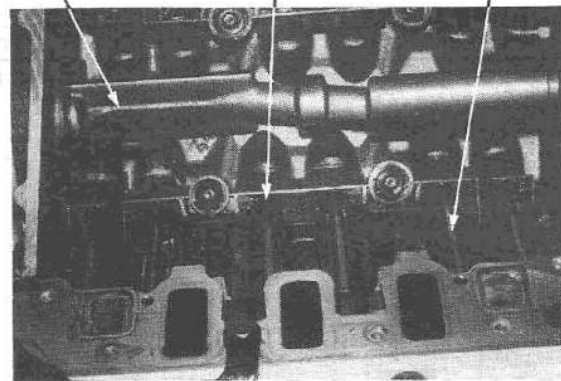
8. Install the valve spring and retainer. Compress the spring and install the retainer locks.

9. Turn the air off and remove the air line and adaptor. Install the spark plug.
10. Remove the spring compressor and install the rocker arm and shafts assembly and the rocker arm cover.

Hydraulic Valve Lifter

Hydraulic Valve Lifter Location

Balance shaft Hydraulic Valve Lifter Push Rods



Remove

1. Take the rocker cover off and the rocker arm assembly off the cylinder head. Remove the push rods, remember to keep all rocker and push rods in the order that they were removed.
2. Remove the intake manifold as previously described.
3. Remove valve lifter guide retainer plate and valve lifters.
4. Clean and test the lifters.

Note: Keep the lifters in order of removal for installation in the original order. If the lifters are dismantled do not mix components as they must remain matched units.

Leakdown Testing

1. Dismantle and clean tappet to remove all traces of engine oil.

*** Do not mix parts from different tappets. Parts are select-fitted and are not interchangeable.**

*** Tappets cannot be checked with engine oil in them. Only testing fluids can be used.**

2. Place tappet in tester, with plunger facing upward. Pour hydraulic tester fluid into cup to a level that will cover tappet assembly. The fluid can be purchased from manufacturer of tester. Using kerosene or any other fluid will not provide an accurate test.

3. Place an 8.0 mm steel ball in plunger cap. Adjust length of ram so that pointer is 1.6 mm below starting mark when ram contracts tappet plunger, to facilitate timing as pointer passes Start Timing mark. Make sure that the scale is marked to correspond with 1.6 mm plunger travel.

4. Work tappet plunger up and down until tappet fills with fluid and all traces of air bubbles have disappeared.

5. Allow ram and weight to force tappet plunger downward. Measure exact time it takes for pointer to

travel from Start Timing to Stop Timing marks of tester. A tappet that is satisfactory must have a leakdown rate within minimum and maximum limits specified.

Hydraulic Lash Adjuster Leak Down Rate

(Time required for plunger to leak down 2.4 mm of travel with a 22 N load and test fluid in adjuster)

5-30 seconds

6. Replace the tappet if it is not within specification. It is recommended that if a flat tappet is replaced with a new tappet to install a new camshaft. There is no need to clean and disassemble the new tappets prior to testing because oil contained in the new tappets is test fluid.

8. Remove fluid from cup and bleed fluid from tappet by working plunger up and down. This step will aid in depressing tappet plungers when checking valve clearance.

Dismantle

1. Remove push rod seat snap ring using a small, fine-bladed screwdriver.

2. Now that the retaining clip has been removed the plunger cap, metering valve and plunger should freely come out, with the force of the plunger spring.

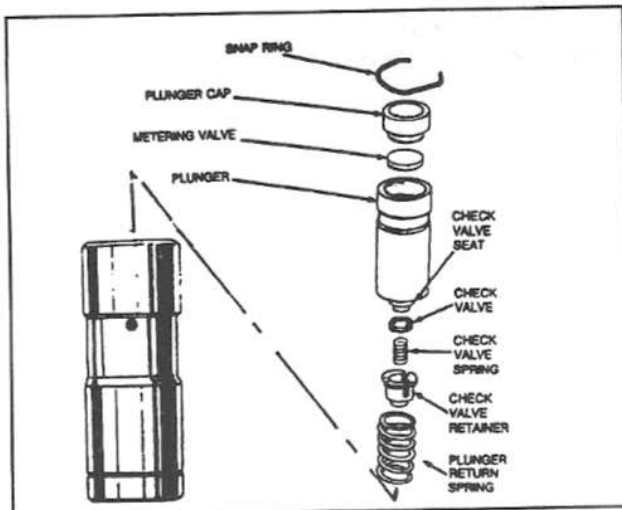
3. If the components are stuck in the lifter body it will help if the lifter is soaked in a cleaning fluid solution, as this will help free the components.

4. Use a small screw driver to remove the valve retainer.

Clean and Inspection

Use a clean work bench area, if the components are contaminated the lifter will not function correctly.

Wash all components in a cleaning fluid solution and allow to air dry.



If the lifter body or plunger are showing signs of wear or damaged, the lifter should be replaced with a new lifter.

Assembly

1. Install the valve retainer to the plunger, as shown in the diagram. Use a screw driver to fit the retainer valve to the plunger.

2. Place the lifter vertically on the work bench, insert the plunger spring into the lifter.

3. Place the plunger into the top of the lifter body with the oil holes aligned. Use a fine nail or piece of wire, push the nail into the oil holes to unseat the steel ball inside the lifter, this will allow the plunger to be pushed all the way down into the lifter. Remove nail.

4. Install metering valve, plunger cap and snap ring.

Install

1. Install the hydraulic valve lifters into the same lifter position from which they were removed.

2. Install manifold and new gaskets, ensure that the gaskets fit correctly and apply sealant to the front and rear gasket seals as well as the intake manifold attaching bolts. Torque bolts to specified torque in the order shown in the diagram.

Intake manifold bolts specified torque: 8 - 12 Nm.

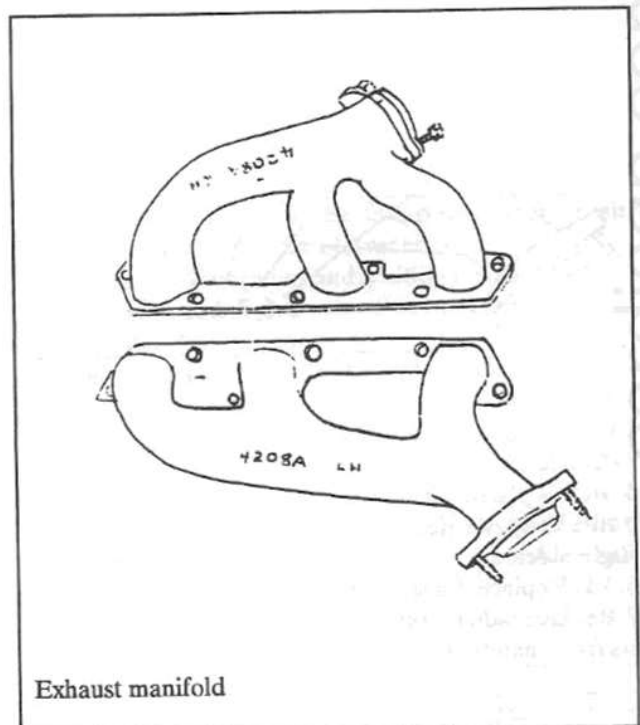
2. Reinstall the push rods, rocker assemblies in the order that they were removed.

Pivot bolts torque specification: 32-44Nm

3. Reinstall the rocker cover/s, and spark plug leads.

Rocker cover bolt torque specification: 7-11Nm

Exhaust Manifolds



Exhaust manifold

Remove

Left Side:

1. Remove plastic air flow duct between air cleaner and throttle body. VS Remove dipstick, bracket and tube.
2. Remove spark plug leads.
3. Remove wiring connector from oxygen sensor.
4. Remove exhaust pipe bolts at exhaust pipe and manifold joint.
5. Remove manifold attaching bolts, remove exhaust manifold.

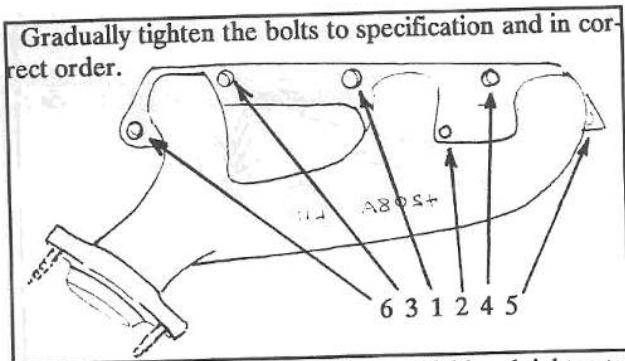
Right side:

1. Remove spark plug leads.
2. VR Remove dip stick and dip stick tube assembly.
3. Remove radiator inlet pipe to thermostat, remove stud nuts from manifold.
4. Remove exhaust pipe bolts at exhaust pipe and manifold join.
5. Remove manifold attaching bolts, remove exhaust manifold.

Install

1. Clean mating surfaces of the cylinder head and the manifold.
2. Using anti-seize coat the threads of all nuts and bolts.
3. Place a new sealing gasket on the converter inlet pipe and new sealing gasket between the two sections of manifold and construct leaving the nuts finger tight.
4. To align the gasket, install four guide studs in the cylinder head. Place the manifold on the studs. Install the bolts on the lower holes, remove the guide studs, install the upper bolts. Gradually tighten the bolts to specification and in correct order.

Exhaust manifold torque specification: 40-60Nm



5. Install the exhaust pipe to the manifold and tighten to specification.

Exhaust pipe to manifold nuts torque: 20-27Nm

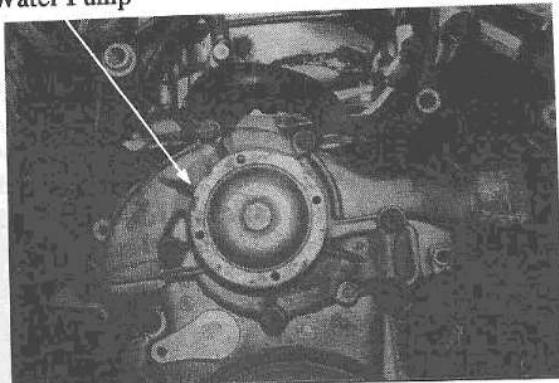
Left Side:

6. Install plastic air flow duct between air cleaner and throttle body. VS Replace dipstick, bracket and tube.

Right side:

6. VR Replace dip stick and dip stick tube assembly.
7. Replace radiator inlet pipe to thermostat, replace stud nuts from manifold.

Water Pump

**WATER PUMP****Remove**

1. Let the engine cool to ambient temperature (less than 50 degrees Celsius) then remove radiator cap.

*** Whilst the engine coolant temperature is above 50 degrees Celsius do not remove the radiator cap, as personal injury may result.**

2. Remove fan shroud and electrical fan, if you require, as this will give you a larger area to work in.

3. Loosen water pump pulley to hub bolts.

4. Remove the drive belt by loosening the bolt on the automatic belt tensioner. (This will slacken off the drive belt enabling the belt to be removed).

5. Unfasten radiator lower hose clamp at engine front cover connection, detach hose from front cover and allow coolant to drain into a suitable splash tray.

6. Remove water pump attaching bolts, remove water pump and pulley to cylinder block joining bolts.

7. Lightly tap water pump housing to separate it from the cover and spacer plate, remove gaskets and clean surfaces of any old gasket material, if the surfaces are not clean for installation the new gaskets may leak.

8. Inspect water pump for damage and excessive corrosion or worn bearings.

*** The water pump is not a repairable unit, and must be replaced if it is damaged.**

Install

1. Cover threads of bolts with Loctite 242 sealant or equivalent.

*** Do not apply sealant to the first 2-3mm of thread on each bolt.**

2. Install water pump, new gaskets, spacer plate and tighten bolts to the correct torque specifications.

Water pump to cylinder block attaching bolt torque specification - bolts: 20-35 Nm.

Water pump to front cover attaching bolt torque specification - bolts: 12-15 Nm.

3. Install pump pulley and secure bolts.

Water Pump Pulley Attaching bolts: 8-16Nm

4. Install drive belt as previously described under 'replace and adjust drive belt'.

5. Replace the radiator hose to front cover connection and secure hose clamp. Refill cooling system.

6. Check for coolant leaks and connect battery earth cable.

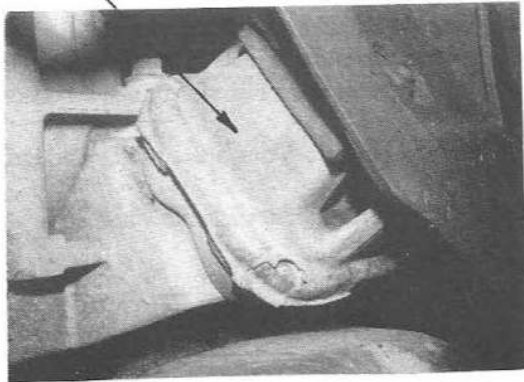
7. Test drive vehicle to make sure the cooling system is working correctly.

MAJOR REPAIRS & ENGINE REBUILD

Front Engine Mounts**Remove**

1. Support the engine on the oil pan or with lifting hooks

Front Engine Mount



on engine .

2. Remove the engine mount to crossmember nuts.
3. Raise the engine just enough to allow the bolts to be removed.
4. Remove the front engine mounts.

Inspect

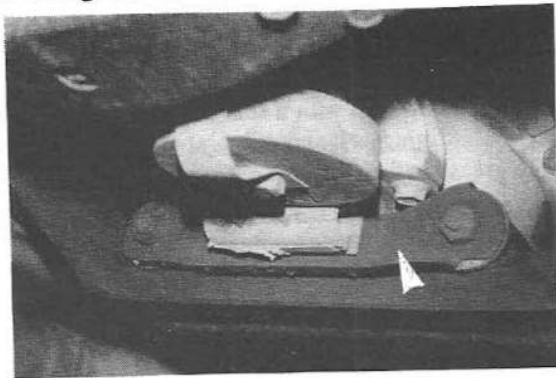
If oil is leaking from the front engine mount, replace the engine mount.

Install

1. Install the insulator to the engine bracket.
2. Fit the mount on the engine and install the bolts.
3. Position the insulator to body bracket through bolt.
4. Lower the engine, remove support from under engine.

Engine mount to bracket cross member: 35-65Nm

Rear Engine Mount



Engine mount to cylinder block: 35-65Nm

Engine Rear Support

Remove

1. Prop the transmission with a floor jack to relieve weight from the supporting crossmember.
2. Withdraw the retaining nuts and washers, from the supporting crossmember, and remove the supporting crossmember.
3. Take the washers and bolts out which hold the engine rear support insulator assembly beneath the transmission.

Take the insulator assembly out.

Install

1. Place the engine rear support insulator assembly in below the transmission, and install the retaining bolts and washers.

Rear Crossmember to side frame bolt: 40-50Nm

Support to rear mounting nut: 20-25Nm

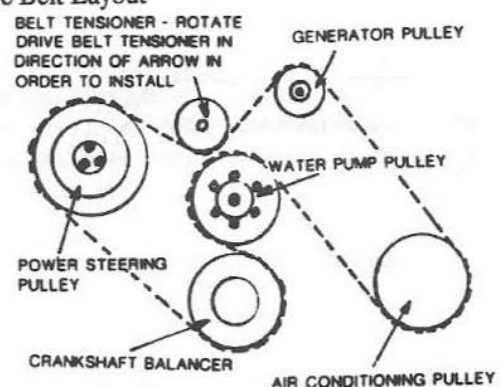
2. Install the supporting crossmember and the retaining nuts and washers. Take the floor jack out.

Timing Chain Cover / Oil Pump and Timing Chain

Remove

1. Detach the battery cables and remove the battery shroud.

Drive Belt Layout



2. Detach drive belt from the fan, power steering, air conditioner. VS remove the alternator.

3. VS Remove idler pulley and ignition modual- coils.

4. Empty the cooling system by disconnecting the lower radiator hose. Detach upper radiator hose from thermostat housing. Remove the fan shield and radiator shroud.

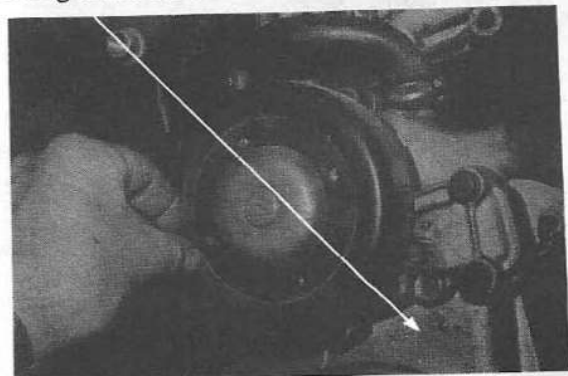
5. Remove the water pump as previously described.

6. Remove the electrical connectors from the temperature sensor, oil pressure sensor, timing sensor (near crankshaft balancer).

7. Remove the crankshaft balancer bolt and washer and use a pulley remover to remove balancer. Remove crank angle sensor

8. Remove the front bolts from the sump.

Timing Chain Cover



9. It may be an advantage to remove the oil filter.
10. Remove the timing chain cover and gasket.

Install

1. Replace the timing chain cover / oil pump with new gaskets, apply oil resistant sealer to the gaskets before assembly. Take care not to damage the sump gasket when installing the cover.

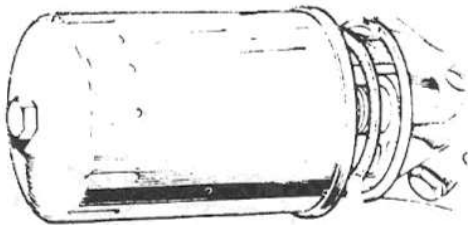
The crankshaft sprocket flat area must line up with the corresponding flat area on the oil pump inner gear.

2. Tighten the bolts for the cover then install and torque the bolts on the sump.

Timing Cover / Oil Pump to Cylinder Block: 20-40Nm

Oil Sump to Timing Cover bolts torque: 8-12Nm

Oil Filter tighten until surfaces meet plus 2/3 turn.



3. Install a new oil filter if the oil filter was removed.

Oil Filter tighten until surfaces meet plus 2/3 turn.

4. Replace the crank angle sensor, tighten bolts.

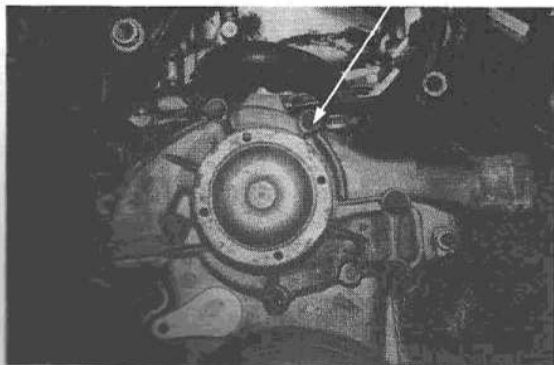
Crank Sensor bolts specified torque: 20-40Nm

5. Replace the crankshaft balancer and bolt, torque bolt to specification.

Crankshaft Balancer bolt torque: 270-325Nm

6. Refit the electrical connectors to the temperature sensor, oil pressure sensor, timing sensor (near crankshaft balancer).

Water Pump to Front Cover: 8-15Nm



7. Install the water pump as previously described.

Water Pump to Cover: 8-15Nm

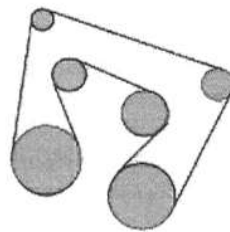
8. Install the fan shield and radiator shroud.

9. Install the upper radiator hose to the thermostat housing, and lower radiator hose. Fill coolant system to correct level.

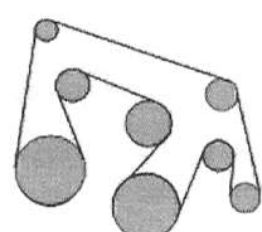
10. VS Remove the alternator, idler pulley and ignition module- coils.

11. Install drive belt tensioner assembly and drive belt as previously described.

V6 without air conditioning



V6 with air conditioning



11. Refit the battery cables.

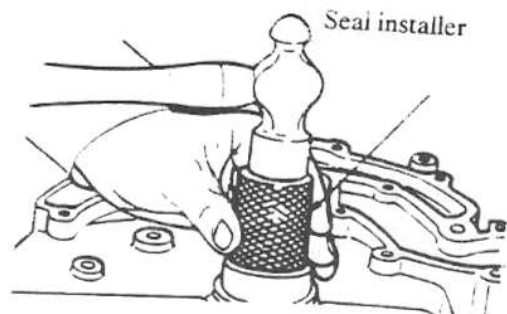
12. Start engine and test for oil and water leaks.

Timing Chain Cover / Oil Pump Front Oil Seal**Replace**

1. Remove the timing chain cover as described above.

2. Remove the old seal with a screw driver or punch.

3. Install the new seal with a seal installer (taking note that the seal is fitting as it should) as shown, lubricate the seal with grease before fitting.

Timing Chain Oil Seal

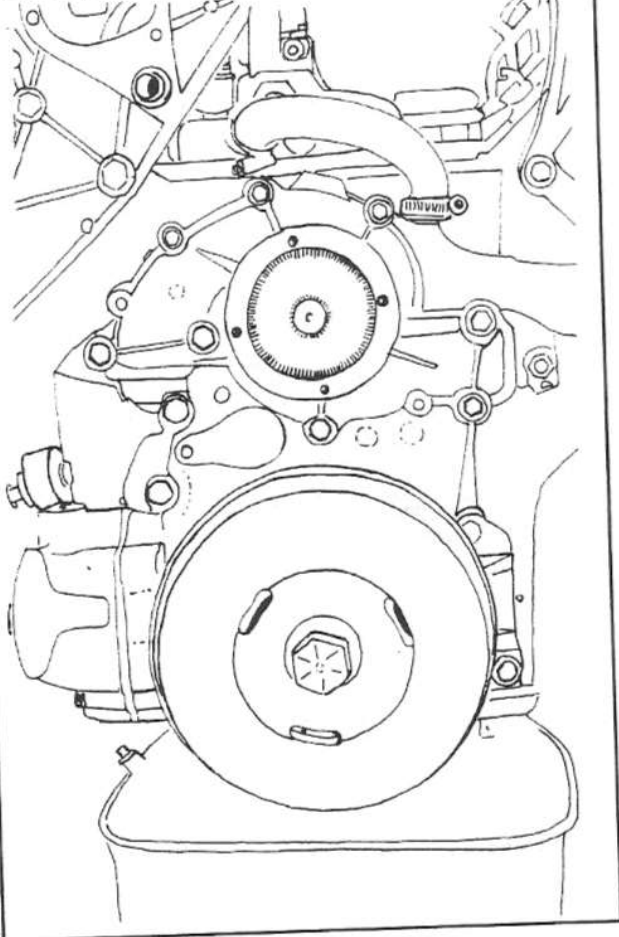
V6 ENGINE MAINTENANCE & REBUILD

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4. Reinstall the timing chain cover as described above.

OIL PUMP

Oil Pump location inside front cover



Remove

1. Remove Timing Chain Cover / Oil Pump as previously described on page No 87.
2. Remove the oil pump cover screws, cover and gasket cover from inside the Timing chain / oil pump cover.
3. Remove the oil seal from the cover with a screw driver or similar.
4. Remove the oil filter if not removed.
5. Remove the oil filter adapter bolts and adapter.
6. Remove pressure regulator valve and spring.

Assembly

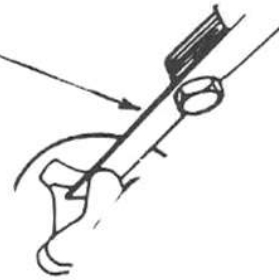
1. Install new front seal to timing chain cover / oil pump with a seal insertion tool.
2. Oil all parts and install the oil pressure relief valve plunger, spring, and a new cap. Inspect the inside of the pump housing and the outer gear and inner rotor for damage or excessive wear.

Measure the clearance between the bore and valve, replace if not within specification.

Regulator valve to Bore clearance: 0.038-0.076mm

Inner to Outer: 0.15mm

Feeler gauge



3. Install the outer gear, and the inner rotor shaft assembly with the flat surfaces to the front of the car. Inspect clearances of outer gear and rotor gear, replace if not within specification.

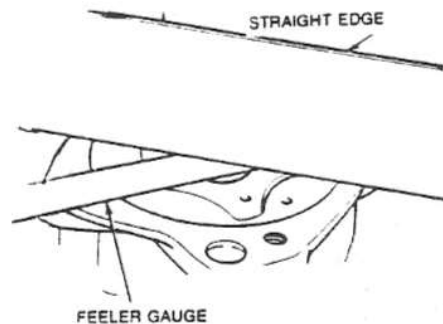
Inner gear tip to Outer race clearance: 0.15mm max

Outer race to pump housing clearance: 0.025-0.090mm

The inner rotor and outer gear are serviced as an assembly. One part should not be replaced without replacing the other.

4. Inspect the mating surface of the pump cover for wear. Replace the cover if the surface is worn, scored or grooved. Check that clearance between the pump cover and gear/ rotor is within specification.

Clearance of pump cover: 0.025-0.090mm



Clearance of pump cover: 0.025-0.090mm

5. Install the oil pump cover and new gasket.

6. Install oil filter adapter and tighten bolts to specification.

Oil Filter adaptor bolts torque specification: 27-40Nm

7. Pour oil into oil pump and install a new filter to adaptor.

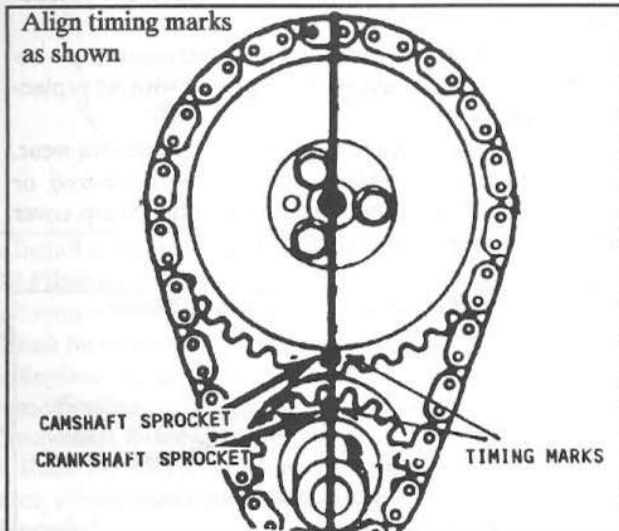
8. Install the Timing chain cover / oil pump to engine as described on page No. 88

9. Start engine and check for leaks.

TIMING CHAIN AND GEARS**Remove**

1. Detach the battery cables and remove the battery shroud.
2. Detach drive belt from the fan, power steering, air conditioner. VS remove the alternator.
3. VS Remove idler pulley and ignition modual- coils.
4. Empty the cooling system by disconnecting the lower radiator hose. Detach upper radiator hose from thermostat housing. Remove the fan shield and radiator shroud.
5. Remove the water pump as previously described.
6. Remove the electrical connectors from the temperature sensor, oil pressure sensor, timing fitting sensor (near crankshaft balancer).
7. Remove the crankshaft balancer bolt and washer and use a pulley remover if necessary to remove balancer. Remove crank sensor.
8. Remove the front bolts from the sump.
9. It may be an advantage to remove the oil filter.
10. Remove the timing chain cover and gasket.

Align timing marks
as shown



11. Stop crankshaft from turning with engine in vehicle:

Manual Trans: Hand brake on, wheels blocked, put transmission in low gear.

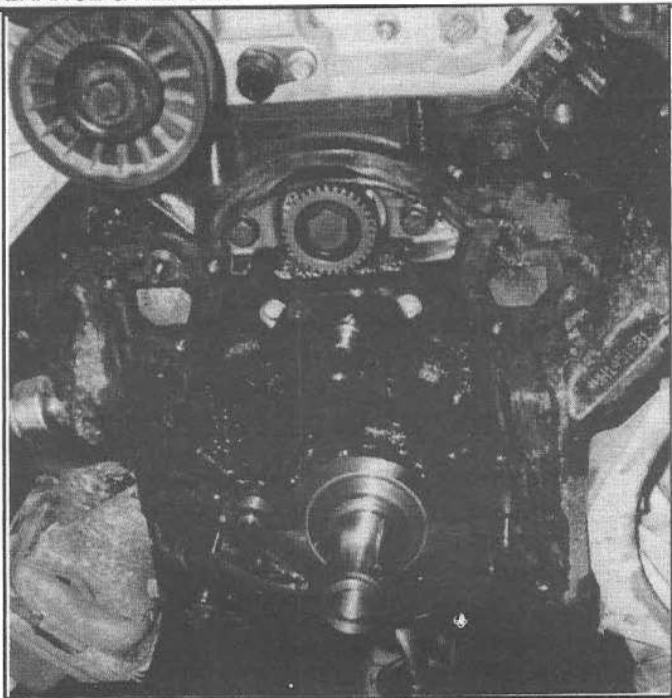
Automatic Trans: Place bar between the torque converter and flexplate.

Engine out of vehicle: Jam ring gear with a block of wood against a solid support.

12. Loosen balance shaft gear retaining nut.
13. (a) Remove thrust bearing from front of camshaft.
(b) Align timing marks as described.
(c) Loosen and remove camshaft gear bolts, remove timing chain and camshaft gear.
14. Remove balance shaft gear.
15. Remove crankshaft gear.
16. Remove timing chain dampener and spring.

Clean

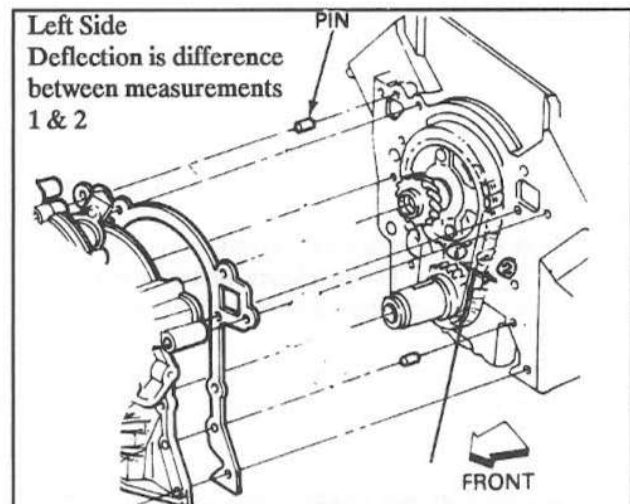
Clean all parts in solvent and dry with compressed air.



Grease the timing chain with engine oil prior to installing it on the engine.

Inspect

Check the chain for broken links. Check the sprockets for cracks and worn or damaged teeth. Restore all segments of the timing chain and sprocket assembly if any one item needs replacement.



Inspect Timing Chain Slack: When timing chain is assembled with the timing chain tensioner in position the chain slack or movement should not exceed 25mm.

Install

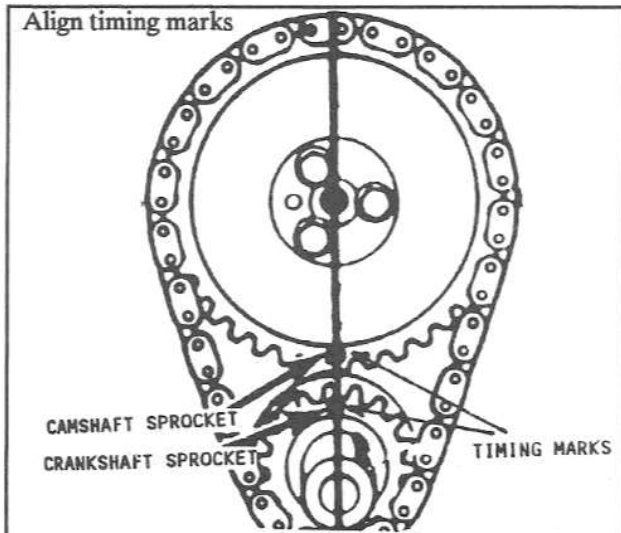
1. Install timing chain tensioner and spring.

Timing Chain Tensioner bolt torque: 12-25Nm

2. Install crankshaft gear, with timing mark at top and crankshaft with number one cylinder at T.D.C.

3. Fit balance shaft gear with timing marks in correct position.

Balance Shaft Gear bolt torque: 18-22Nm plus 35° turn



4. Align the timing marks of the gears, with the chain fitted slide the unit back into position, have the timing chain tensioner held back so this can happen. Lubricate all components with clean engine oil.

5. Fit the camshaft gear bolt and washer, tightening bolt fit thrust bearing and spring.

Camshaft Gear bolt torque: 30-40Nm

6. Check timing chain slack, as previously described.

7. Replace the timing chain cover with new gaskets, apply oil resistant sealer to the gaskets before assembly. Take care not to damage the sump gasket when installing the cover.

The crankshaft sprocket flat area must line up with the corresponding flat area on the oil pump inner gear.

8. Tighten the bolts for the cover then install and torque the bolts on the sump.

Timing Cover to Cylinder Block bolts torque: 20-40Nm

Oil Sump to Timing Cover bolts torque: 8-12Nm

9. Install a new oil filter if the oil filter was removed.

Oil Filter tighten until surfaces meet plus 2/3 turn.

10. Replace the crank angle sensor, tighten bolts.

Crank Sensor bolts specified torque: 20-40Nm

11. Replace the crankshaft balancer and bolt, torque bolt to specification.

Crankshaft Balancer bolt torque: 270-325Nm

12. Refit the electrical connectors to the temperature sensor, oil pressure sensor, timing fitting sensor (near crankshaft balancer).

13. Install the water pump as previously described.

Water Pump to Front Cover: 8-15Nm

14. Install the fan shield and radiator shroud.

15. Install the upper radiator hose to the thermostat housing, and lower radiator hose. Fill coolant system to correct level.

16. Install drive belt tensioner assembly and drive belt as previously described.

17. Refit the battery cables.

18. Start engine and test for oil and water leaks.

CAMSHAFT

Camshaft Lobe Lift

Inspect the lift of each lobe in consecutive order.

* Make sure that the ignition is turned 'off' for the entire test, remove the Eng Comp and Eng Inj fusible links located next to battery.

1. Remove the rocker arm covers. Attach an auxiliary starter switch between the battery and starter solenoid terminals of the relay socket.

2. Place a dial indicator with a flat adaptor on the stylus so that the stylus contacts the rocker arm. Push the crankshaft over until the rocker arm is on the base circle of the camshaft lobe. The rocker arm will be in its lowest position.

3. Zero the dial indicator. Turn the crankshaft slowly until the rocker arm is in fully raised position. Compare the total lift recorded on the indicator with specifications.

Camshaft Lobe Lift: VR Inlet-6.43mm Outlet-6.48

VS Inlet-6.56mm Outlet-6.48

4. Turn the crankshaft until the indicator reads zero, to check the accuracy of the original indicator reading. The camshaft and the rocker arm operating on the worn lobe(s) must be replaced, if the lift on any lobe is below specified wear limits.

* Comparing the size of one camshaft lobe to another, with a micrometer or other measuring instrument, is not a satisfactory method of checking camshaft lobe lift, owing to tolerance on base circle radius.

5. Take the dial indicator out and install the rocker cover.

6. Replace the Eng Comp and Eng Inj fusible links located next to battery.

Remove

1. Remove the rocker arm covers as previously described.

2. Remove the intake manifold as previously described.

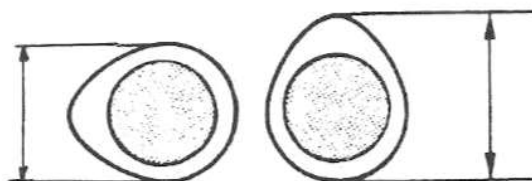
3. Remove the rocker arms, pivots, push rods and hydraulic lifters as previously described.

4. Remove the timing chain cover and timing chain as previously described.

5. Slide the camshaft out from the front of the engine.

Camshaft Lobe Lift: VR Inlet-6.43mm Outlet-6.48

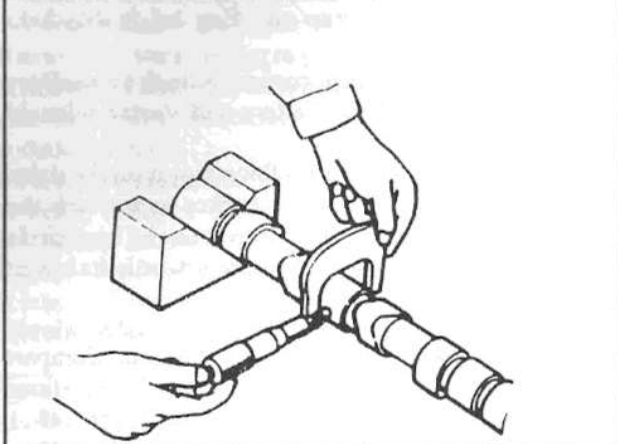
VS Inlet-6.56mm Outlet-6.48



Clean and Inspect

Clean the camshaft in solvent and wipe it dry. Check the camshaft lobes for scoring and signs of abnormal wear. Lobe wear characteristics may result in pitting in the general area of the lobe toe. This pitting is not damaging to the operation of the camshaft, providing that the lobe lift is within specification.

Camshaft Journal Diameter: 45.339-45.364mm



Measure the camshaft journal diameter to check that the journals are within specification.

Camshaft Journal Diameter: VR 45.334-45.369mm
VS 46.858-46.893mm

The lift of the camshaft lobes can be checked with the camshaft installed on V blocks.

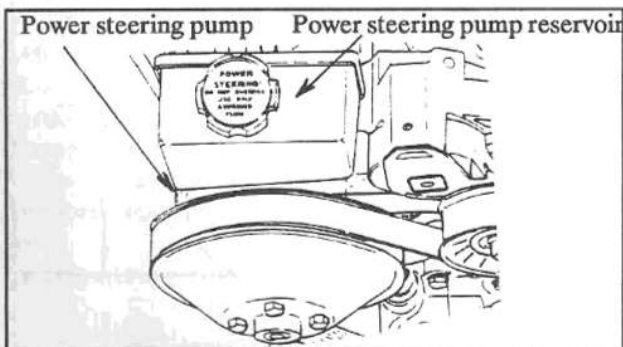
Camshaft Lobe Lift: VR Inlet-6.43mm Outlet-6.48
VS Inlet-6.56mm Outlet-6.48

Install

1. Oil the camshaft journals with engine oil and slide the camshaft carefully back into the cylinder block.
2. Replace the timing chain and cover as previously described
3. Replace the rocker arms, pivots, push rods and hydraulic lifters as previously described.
4. Replace the intake manifold as previously described.
5. Replace the rocker arm covers as previously described.

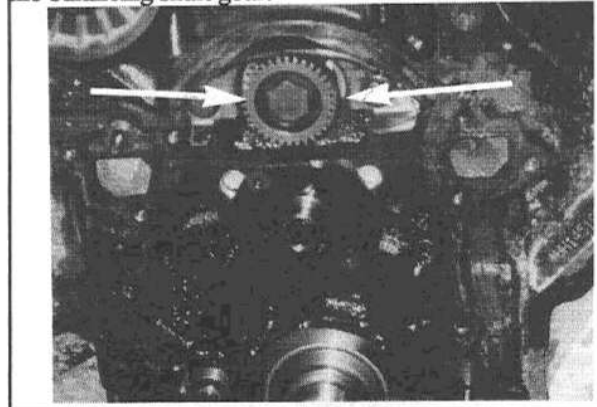
Balancing Shaft**Remove**

1. Remove the Timing chain cover / Oil pump as previously described.



2. Remove intake manifold as previously described.
3. Remove hydraulic valve lifter guides.
4. Loosen the balancing shaft attaching bolt.
5. Remove the balance shaft retainer.

Lever the balancing shaft out, using two levers behind the balancing shaft gear.



6. Lever the balancing shaft out, using two levers behind the balancing shaft gear. If the shaft will not move, remove gear, use a slide hammer attached to the gear bolt to remove the balancing shaft.

7. Remove balancing shaft bearings if necessary with a screw type bearing remover. The balancing shaft rear welsh plug will need to be removed.

Install

1. Install a new rear bearing if the bearing was to be replaced, flat end of bearing race towards back of engine. Rear Bearing flat face to be 22.5mm in from rear of cylinder block

2. Install the front balancing shaft bearing, if this is very tight it can be seated when the balancing shaft is installed during the next two steps.

3. Cover the balancing shaft and balancing shaft front and rear bearings with clean engine oil.

4. Install balancing shaft, use a soft head hammer to seat the bearing to its correct position.

5. Install the balancing shaft retainer and bolts, tighten to specification.

Balancing Shaft retaining bolts

specified torque: 30-40Nm

6. Install balancing shaft gear bolt, tighten to specification

Balancing shaft gear bolt

specified torque: 18-22Nm + 30° turn.

7. Check balancing shaft end play with a micrometer on the end of the gear attaching bolt, if not within specification replace bearings if not replaced.

Balancing shaft end play specification: 0.20mm

8. Replace hydraulic valve lifter guides.

Hydraulic Valve Lifter Guide bolts: 30-40Nm

9. Replace intake manifold as previously described.

Intake manifold bolts specified torque: 8 - 12 Nm.

10. Replace the Timing chain cover / Oil pump as previously described.

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Timing Cover to Cylinder Block bolts torque: 20-40Nm

Oil Sump to Timing Cover bolts torque: 8-12Nm

11. Install a new oil filter if the oil filter was removed.

Oil Filter tighten until surfaces meet plus 2/3 turn.

12. Replace the crank sensor, tighten bolts.

Crank Sensor bolts specified torque: 20-40Nm

13. Replace the crankshaft balancer and bolt, torque bolt to specification.

Crankshaft Balancer bolt torque: 270-325Nm

Crankshaft Sensor & Crankshaft Balancer

Remove

1. Detach drive belt from the alternator, power steering, air conditioner.

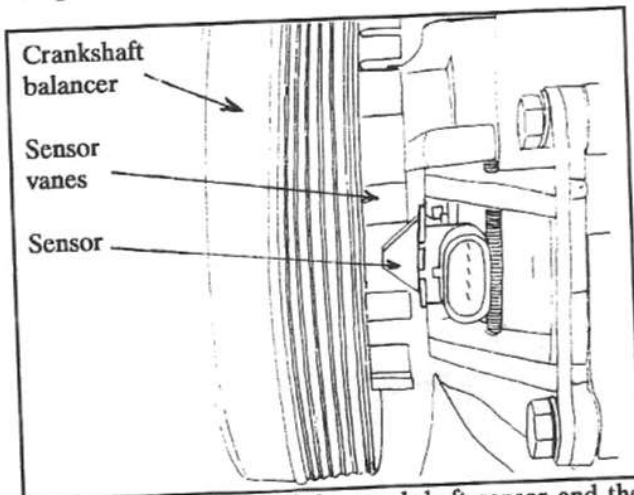
2. Remove the crankshaft balancer bolt and washer and use a pulley remover if necessary to remove balancer.

Remove crank sensor.

3. Remove wiring loom connector from crank sensor.

3. Remove crankshaft sensor attaching bolts and sensor.

Inspection



Inspect the surfaces of the crankshaft sensor and the rings on the crankshaft balancer for damage or bent sections, repair if necessary

Install

1. Replace the crankshaft sensor, tighten bolts.

Crank Sensor bolts specified torque: 20-40Nm

2. Loosen sensor adjusting bolt.

3. Replace the crankshaft balancer and bolt, tighten bolt to specification.

Crankshaft Balancer bolt torque: 270-325Nm

4. Place a specified size feeler gauge between the outer crankshaft balancer ring and crankshaft sensor.

Gap between the outer crankshaft balancer ring and crankshaft sensor: 0.50mm

5. Tighten sensor adjuster bolt to specification.

Sensor adjuster bolt torque: 4-5Nm

6. Refit the electrical connectors.

7. Install drive belt and adjust belt, turn the automatic adjuster idler pulley mounting stud anti-clockwise.

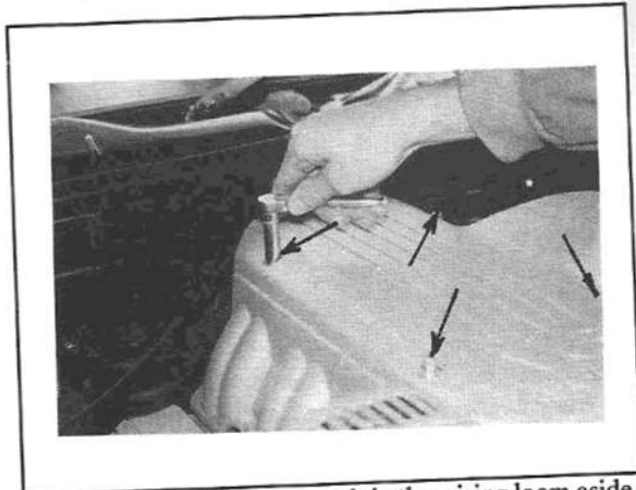
Cylinder Heads

Remove

1. Release the fuel pressure in the fuel lines as previously described in tune-up chapter.

2. Remove earth cable from battery and battery to engine. VS Remove the top engine cover 4 nuts and cover.

3. Remove the power steering pump attaching bolts and power steering pump reservoir, place to one side with the hoses attached.

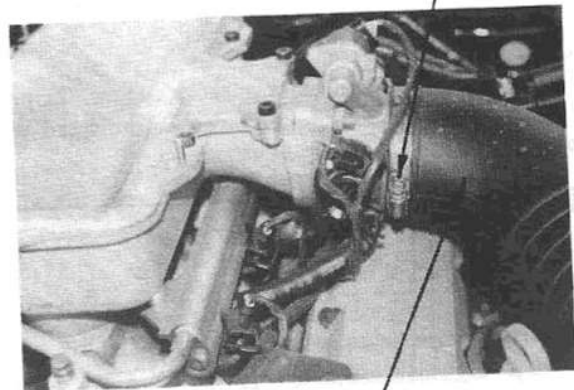


4. Remove the alternator and tie the wiring loom aside.

5. Empty the coolant by disconnecting the lower radiator hose from the engine, then disconnect the upper hose.

6. Disconnect the coolant hoses from the right side of the engine compartment, label if necessary.

Remove the air ducting



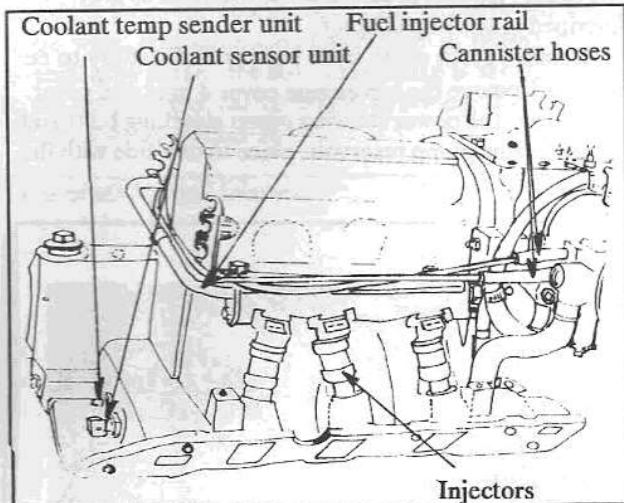
7. Remove the air ducting between the air cleaner and throttle body.

8. Disconnect and remove the drive belt.

9. Remove the exhaust manifold bolts and leave the manifolds on the exhaust pipes.

10. Disconnect the vacuum lines from the intake manifold including the canister purge line. Detach the

fuel feed and return lines at the injector rail and pressure regulator.



11. Detach the wiring from the sensors positioned in the thermostat housing, the throttle positioner, injectors, ignition coil block, oil pressure sender, MAP sensor (VR), idle control valve, MAT sensor. Label and tie these wiring looms to the back of the engine compartment.

12. Detach the kickdown cable and cruise control cable if fitted.

13. Remove the coil assembly and spark plug leads VS idler pulleys.

14. Remove the intake manifold.

15. Remove the rocker cover.

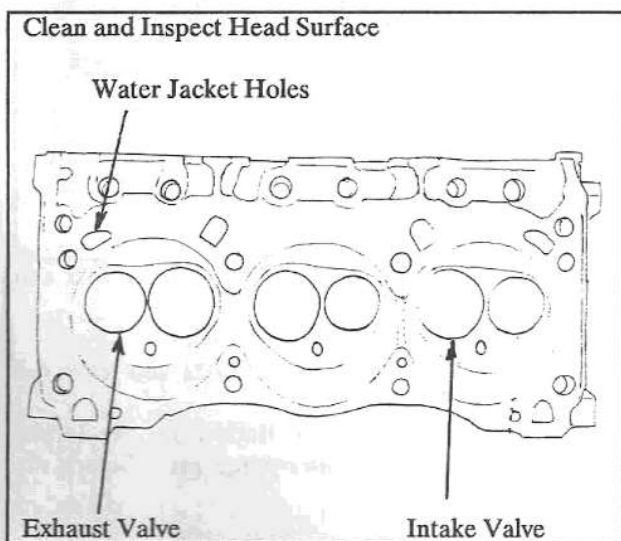
16. Remove the rocker arms, pivots and push rods.

17. Remove the cylinder head studs, lift the heads clear of the cylinder block.

18. The cylinder heads assembly may now be taken apart as required on a clean bench.

Install

1. Clean the heads and block gasket surfaces. Inspect the flatness of the mating surfaces, if the head was removed for a gasket change.



3. Do not place sealer to the cylinder head gasket. Place the gasket over the dowels in the cylinder block. Make sure the "Arrows" point towards the front.

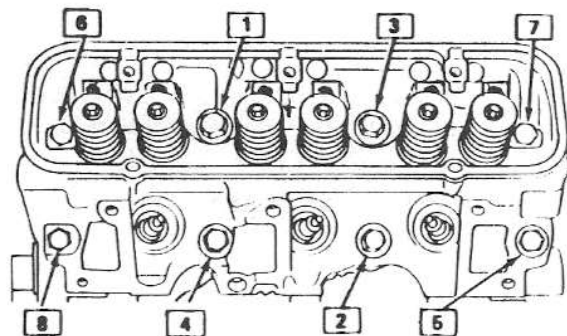
Left Gasket: Arrow to front, "L" shaped slot through exhaust.

Right Gasket: Arrow to front, 5mm hole through the exhaust.

4. Install the correct length head studs and tighten finger tight, coat the head studs with a lock tight sealant.

5. Tighten the head studs in the correct manner and to specified torque.

Tighten head studs in order shown use correct length studs in correct position



Step 1 - Head Stud Torque specification: 35Nm

Step 2 - Head Stud further tighten 90° but not over 90Nm

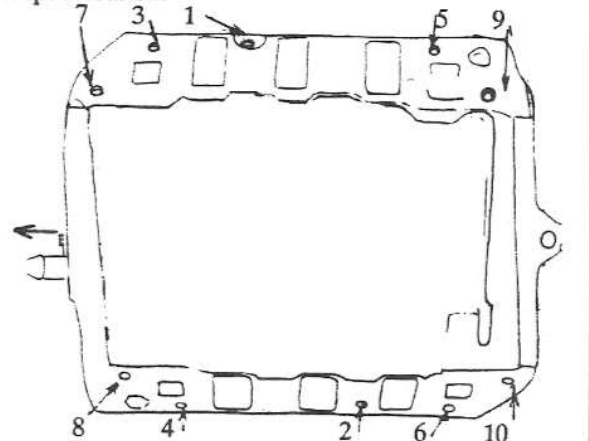
Step 3 - Head Stud torque specification: 81Nm

6. Replace the push rods, rocker arms, pivots and pivot bolts, tighten to specification.

Pivot bolts torque specification: 32-44Nm

7. Install the intake manifold, tighten bolts to specification and in the correct order.

Install intake manifold bolts in the order shown to correct specification.



Intake manifold bolts specified torque: 8 - 12 Nm.

8. Install the rocker cover, tighten bolts to specification.

Rocker cover bolt torque specification: 7-11Nm

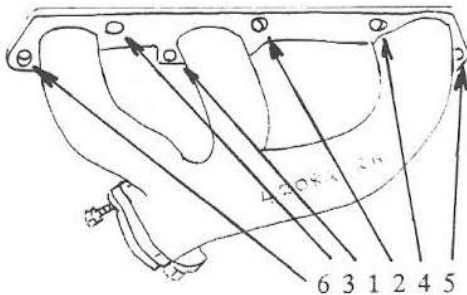
9. Lift the exhaust manifolds to the cylinder heads, fit studs and tighten to specification.

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Exhaust manifold torque specification: 40-60Nm

Install exhaust manifold bolts in the order shown to correct specification.

**Exhaust manifold torque specification: 40-60Nm**

10. Replace the coil assembly and spark plug leads.

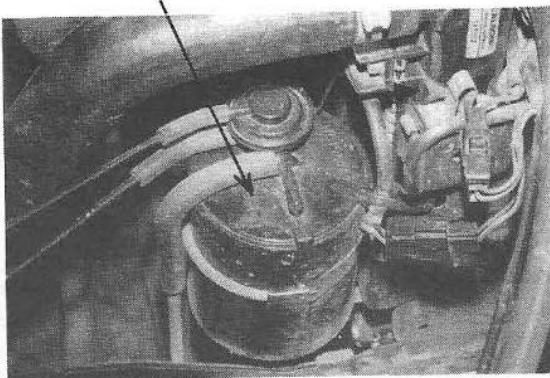
11. Refit the kickdown cable and cruise control cable if fitted.

Sensor locations

Sensor locations on VR Intake Manifold Rear View
MAP vacuum hose Fuel regulator MAT connector



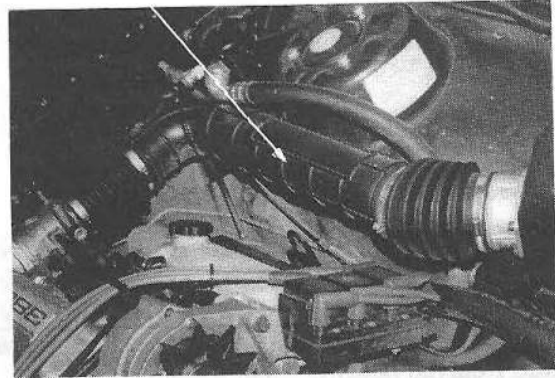
12. Reposition the wiring to the sensors positioned in the thermostat housing, the throttle positioner, injectors, ignition coil block, oil pressure sender, MAP sensor-VR, idle control valve, MAT sensor. Take note of the labels used during removal.

Carbon canister purge container

13. Reconnect the vacuum lines to the intake manifold including the canister purge line. Connect the fuel feed and return lines at the throttle body and fuel rail, tighten clamps.

14. Replace the air ducting to the throttle body and air cleaner, VS MAF sensor and loom.

Replace the air ducting to the throttle body and air cleaner



15. Connect the coolant hoses to the right side of the engine compartment.

16. Connect the radiator hoses to the engine. Refill cooling system with specified coolant.

17. Replace the power steering reservoir to the belt tensioner bracket, tighten bolts to specification.

Replace the the power steering pump

Power steering pump Power steering pump reservoir



Power steering reservoir screws torque: 0.5-2.5Nm

18. Replace the power steering pump attaching bolts.

Power steering pump attaching bolts torque: 10-20Nm.

19. Install the alternator and install the wiring loom.

20. Install the drive belt and tension as previously described.

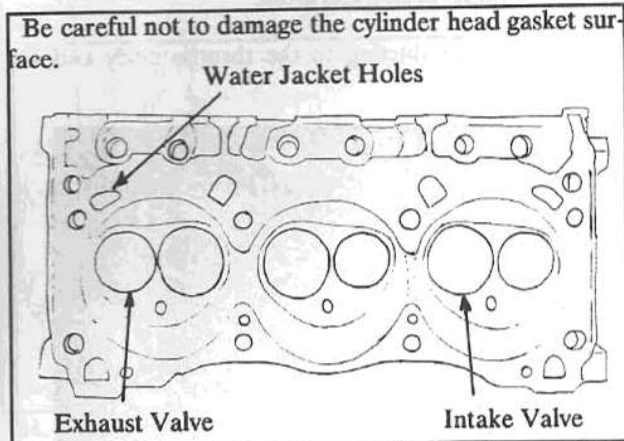
21. Connect earth cable to battery and battery to engine.

22. Start engine and test drive, check for any leaks.

Cylinder Head Rebuild**Clean**

With the valves installed to protect the valve seats, take the deposits from the combustion chambers and valve

heads with a scraper and a wire brush. Be careful not to damage the cylinder head gasket surface. Clean the valve guide bores with a valve guide cleaning tool after the valves are removed. Use cleaning solvent to remove dirt, grease and other deposits and clean all bolt holes.



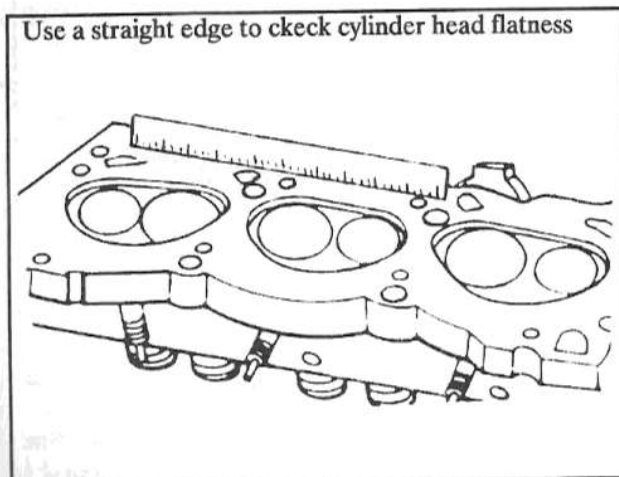
Using a fine wire brush or buffing wheel remove all deposits from the valves.

Inspect

Inspect the cylinder heads for cracks, and inspect the gasket surface for burrs and nicks. Replace the head if it is cracked.

The following inspection procedures are for a cylinder head that is to be completely inspected. For individual repair operations, use only the pertinent inspection procedure.

Cylinder Head Flatness



When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface for conformance to specifications.

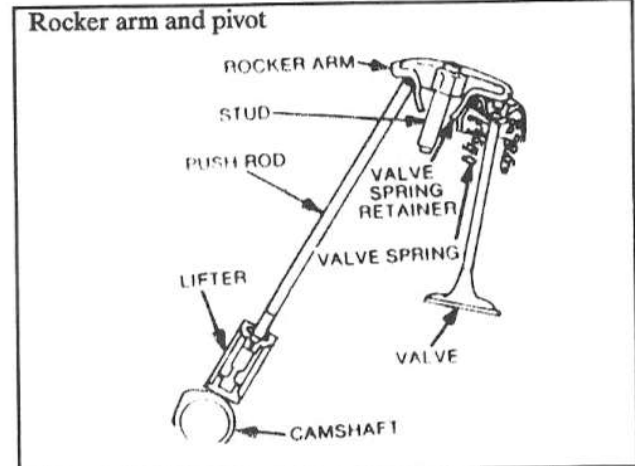
Do not plane or grind off more than 0.25 mm, if it is required to refinish the cylinder head gasket surface.

Valve Rocker Arm Assembly

Clean

Clean all the parts completely and check that the oil passages are open.

Inspect

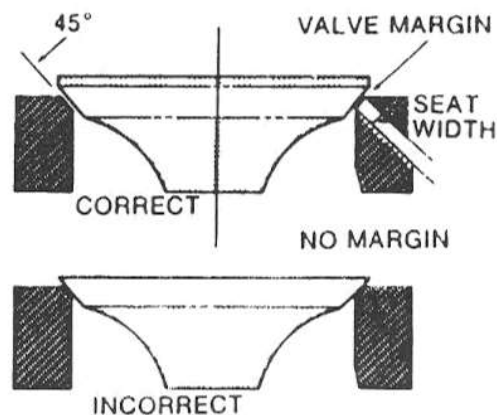


Check the rocker arm and pivot assembly is not damaged or badly worn. If the rocker arm is grooved, replace the rocker arm. Inspect the rocker pivot bolts for stripped or broken threads.

Valve Seat Runout

Inspect the valve seat runout by coating the face of a new or refaced valve with Prussian blue. Place the valve in the valve seat and turn it back and forth several times about 1/8 turn. Remove the valve and if the blue has not been transferred to the seat showing a full circle contact reface the seat.

Valve margin and seat width



Valve Seat Width

Measure the valve seat width. If the width is not within specifications reface the valve seats.

* Valve seat angles are 45°.

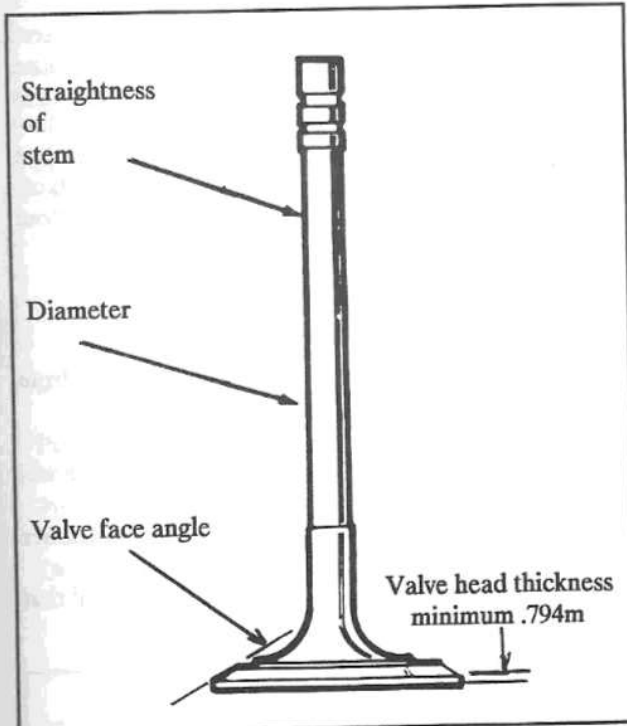
* Valve seat width:

Exhaust: VR 2.05mm +/- .25mm; VS 2.05mm +/- .25mm

Intake VR 1.80mm +/- .25mm; VS 1.80mm +/- .25mm

If the seat is too wide after grinding, it may be narrowed by using a 25° or 65° grinding stone. The 25° stone will lower the seat and the 65° stone will raise the seat.

Valves and Springs



Refer to diagram for inspection points. Check the valve face and the rim of the valve head for pits, grooves, scores or other defects. Check the stem for a bent shape and the end of the stem for grooves or scores. Check the valve head for indications of burning, erosion, warpage and cracking. Faults such as minor pits, grooves, etc., may be eliminated by refacing the valve.

Replace valves that are severely ruined. Check the valve springs, valve spring retainers, locks and seals for faults.

Valve Face Runout

Valve face runout will become apparent when the valve is being refaced.

Minimum valve head margin thickness: .63mm
Valve face angle: 45°

Replace the valve if the valve face cannot be trued before the minimum valve head thickness is reached.

Valve Stem Clearance

Inspect the valve stem to valve guide clearance of each valve guide. With the cylinder head gasket face uppermost, slide a "new" inlet or exhaust valve as suitable into the guide to be checked until the end of the stem is flush with the top of the valve guide.

Install a dial indicator on the cylinder head gasket face so that the plunger can be placed on the edge of the valve head 90 degrees to the camshaft axis.

Move the valve head from side to side at right angles to the camshaft axis as far as the clearance will allow and note

the indicator reading, whilst the dial indicator is in this position and the end of the valve stem flush with the top of the guide.

Maximum Clearance - Valve stem to Valve Guide:

Intake - 0.038 - 0.089 mm

Exhaust - 0.038 - 0.082 mm

If the valve head deflection is not within specification for inlet or exhaust valves the guide in question is worn excessively and should be replaced or reamed out to accept a valve with an oversized stem.

VALVE SPRING PRESSURE

Inspect the springs for proper pressure at the specified spring lengths.

Maximum allowable variance in spring end length: 1.60 mm, while rotating spring on level desk.

Valve spring compressed height/load:

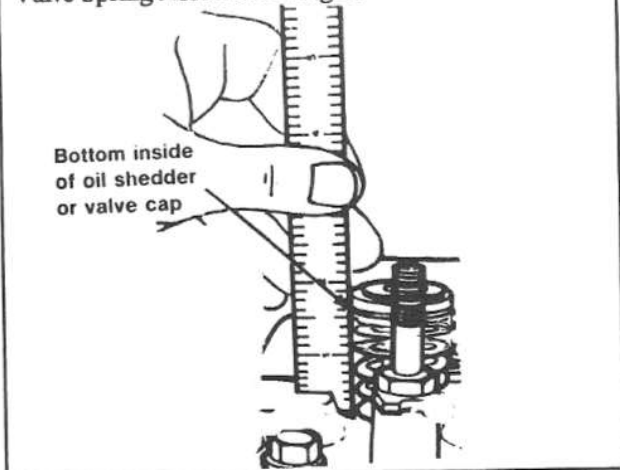
Valve spring height:

VR - inner spring 334 - 369 Nm (31.9 mm).

VR - outer spring 618 - 681 Nm (31.9 mm).

VS - 970-1060Nm (32.4mm)

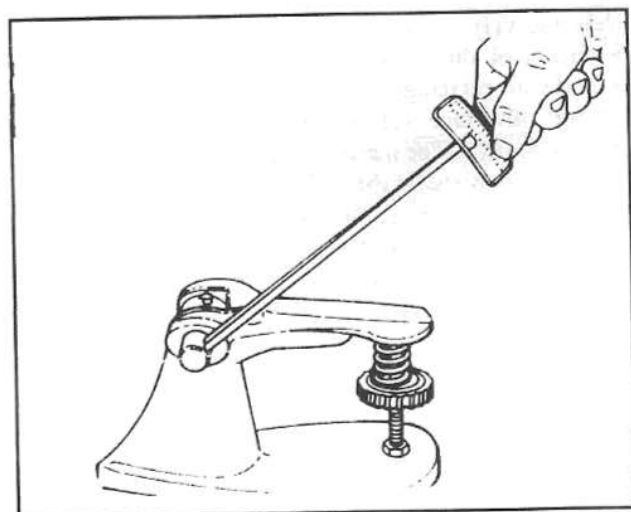
Valve Spring Assembled height:



Assembled height:

VR Installed height: 42.93-44.45mm.

VS Installed height: 43.19-44.19mm.



Weak valve springs cause poor engine performance; thus if the pressure of any spring approaches the wear limit, replace the spring.

VALVE SPRING SQUARENESS

Using a steel square and surface plate, inspect each spring for squareness. On the surface plate, stand the spring and square on end. Slide the spring up to the square. Rotate the spring slowly and observe the space between the top coil of the spring and the square. Replace the spring if it is out of square more than 1.6 mm.

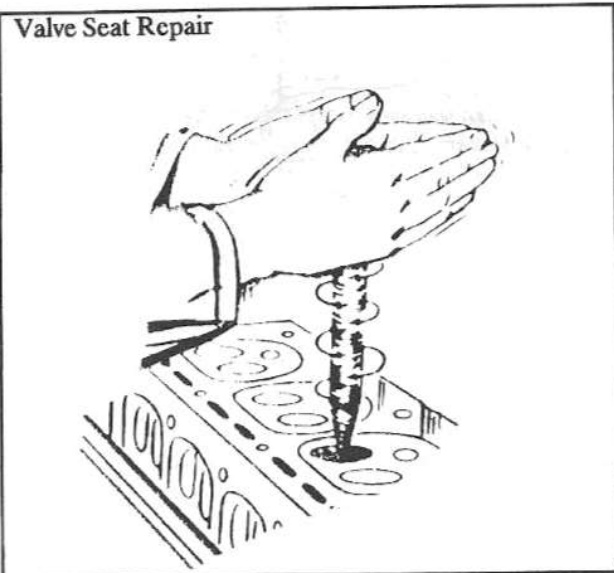
VALVES

Valve faults, such as minor pits, grooves, etc., can be removed. Replace any valves that are severely damaged, or if the face runout or stem clearance exceeds specifications.

Replace any defective part of the valve assembly and grease valve stems with a suitable Molybond before installing.

Valve Seat Repair

Valve Seat Repair



Refacing Valve Seats

Refacing of the valve seats should be closely co-ordinated with refacing of the valve so that the completed seat and valve face will be concentric and the specified interference fit will be maintained. Check that the refacer grinding wheels are properly dressed.

Grind the valve seats to 45 degrees. Detach only enough stock to clean up pits, grooves, or to adjust the valve seat runout. Use a seat width scale to measure the seat width, after the seat has been refaced. If necessary narrow the seat to bring it within specifications.

Remove enough stock from the top edge and/or bottom edge of the seat to reduce the width specifications, if the valve seat width exceeds the maximum limit.

To remove stock from the top of the seats (lower seats), use a 25 degree angle grinding wheel and to remove stock from the bottom of the seats (raise the seats), use a 65 degree angle wheel.

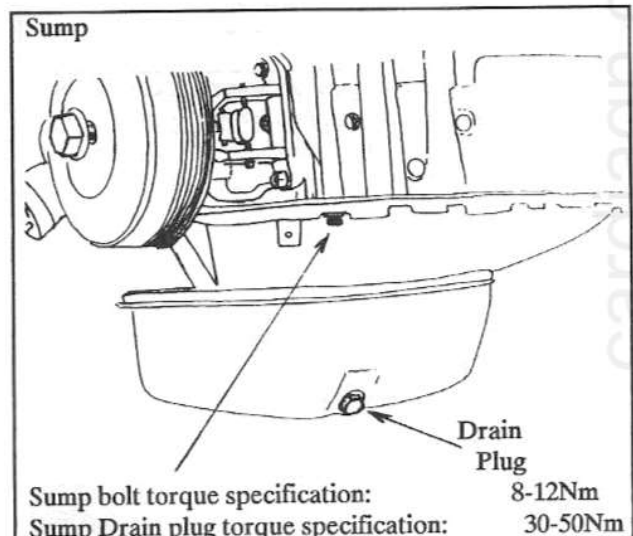
The completed valve seat should contact the estimated centre of the valve face.

It is good to practice to determine where the valve seat contacts the face. To do this, coat the seat with Prussian blue, then set the valve in place. Rotate the valve with light pressure. The contact is successful if the blue is transferred to the centre of the valve face. Lower the valve seat if the blue is transferred to the top edge of the valve face. Raise the valve seat if the blue is transferred to the bottom edge of the valve face.

SUMP / SUMP GASKET

Remove

1. Remove the sump drain plug and drain the oil from the sump.
2. Remove the dipstick.
3. If engine is in the vehicle the front crossmember will need to be removed, see Front end chapter.
4. Remove the bolts attaching the sump to the cylinder block.
5. Remove the sump taking care not to spill any oil that may be still in the sump.

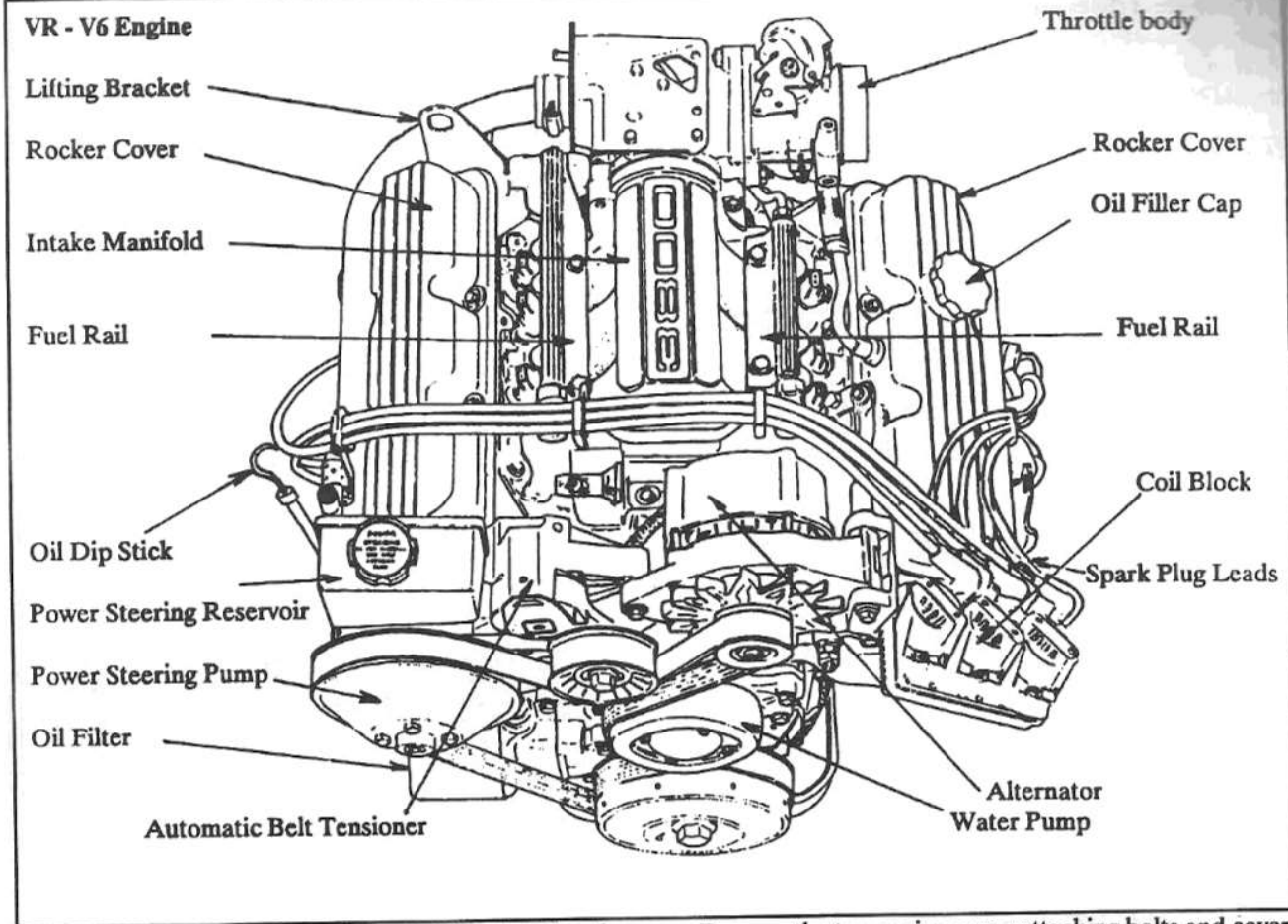


Install

1. Clean the surfaces of the cylinder block and sump of any old gasket material.
2. Replace the sump drain plug with a new seal if removed, tighten to specification.
3. Where the side gaskets meet the end seals on the timing cover and the block place small amount of oil sealant.
4. Place the gasket in position on the cylinder block, it may be necessary to coat the gaskets with a thin coating of sealant to keep gaskets in position.

V6 ENGINE MAINTENANCE & REBUILD

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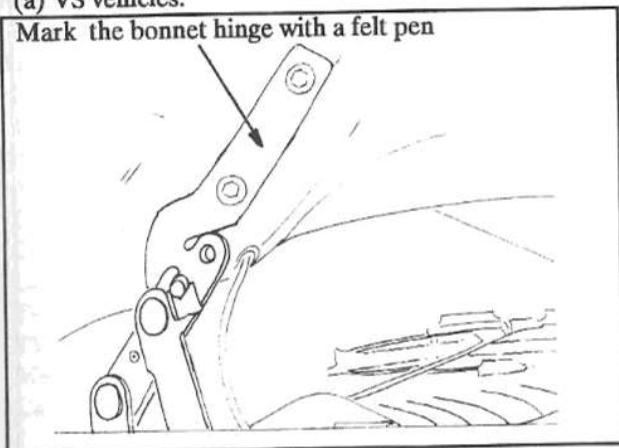
5. Install the front and rear seals checking that the tabs on the seals are located over the ends of the gaskets.
6. Install the sump and secure bolts to specification.
Sump bolt torque specification: 8-12Nm
7. Replace front crossmember if removed.
8. Replace dip stick.

ENGINE**Remove**

1. Remove the bonnet to enable the engine to lift out. Mark the bonnet hinge with a felt pen to help align the bonnet during installation.

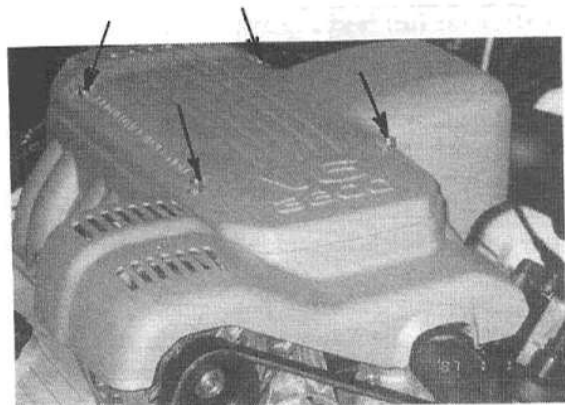
(a) VS vehicles:

Mark the bonnet hinge with a felt pen



2. Remove the top engine cover attaching bolts and cover
3. Release the fuel pressure in the fuel lines as previously described in tune-up chapter.
4. Remove earth cable from battery and battery to engine, also earth strap from ignition coil assembly.
5. Remove the power steering pump attaching bolts and power steering pump reservoir, place to one side with the hoses attached.
6. Empty the coolant by disconnecting the lower radiator hose from the engine, then disconnect the upper hose.

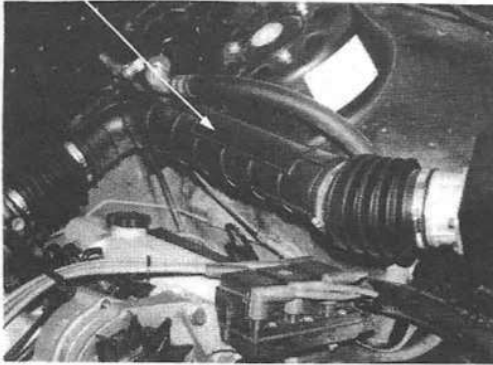
VS Remove the engine top cover.



7. Disconnect the coolant hoses from the right side of the engine compartment, label if necessary.

8. Remove the air ducting between the air cleaner and throttle body.

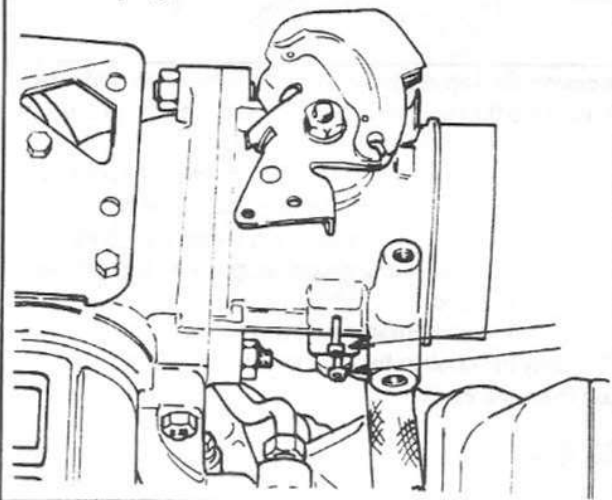
Air Ducting



9. Remove the exhaust manifold bolts and leave the manifolds on the exhaust pipes.

10. Disconnect the vacuum lines from the intake manifold including the canister purge lines and brake booster pipe.

Canister purge lines



11. Detach the fuel feed and return lines at the injector rail and pressure regulator.

12. Detach the wiring from the sensors positioned in the thermostat housing, the throttle positioner, injectors, ignition coil block, oil pressure sender, MAP sensor-VR, idle control valve, MAT sensor. Label and tie these wiring looms to the back of the engine compartment.

13. Detach the kickdown cable and cruise control cable if fitted.

14. Detach the engine wiring loom connectors from the ECM/PCM located behind passenger side kick panel in the front section of the passenger compartment.

Sensor locations

Sensor locations on VR Intake Manifold Rear View
MAP vacuum hose Fuel regulator MAT connector



ECM and wiring loom



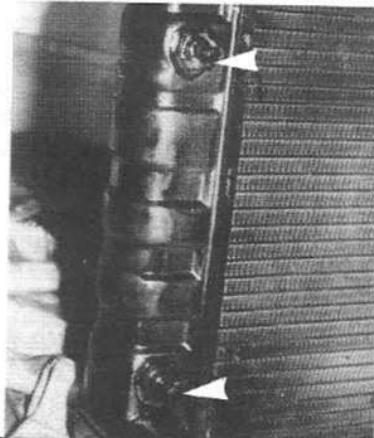
15. Remove wiring connectors from the transmission, automatic or manual.

16. Manual transmission vehicles, disconnect the clutch activating cable.

17. Automatic transmission vehicles, cable activated remove the cable, electrical activated transmission remove the wiring connectors.

18. Automatic transmissions remove the transmission fluid cooler tubes from the radiator.

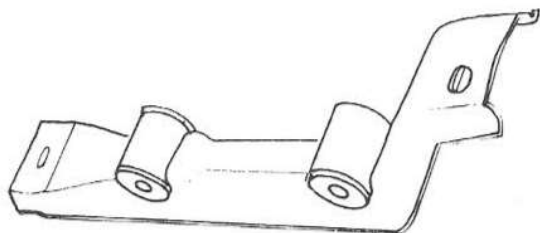
Automatic transmission fluid cooler tubes at radiator.



V6 ENGINE MAINTENANCE & REBUILD

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Rear transmission mount

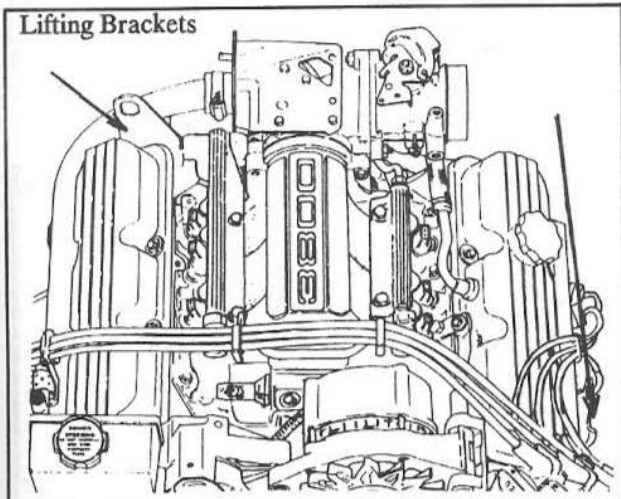


19. Remove the rear transmission mount as previously described.

20. Remove the tail shaft as described in the Tail shaft and universals chapter.

21. Install a lifting sling to the lifting brackets on engine.

Lifting Brackets



22. Take the weight of the engine and transmission assembly on the lifting sling and remove the front engine mount through bolts.

23. Raise the engine and transmission assembly from the vehicle.

24. Place the engine on a clean work area and separate the transmission from the engine.

Install

1. Bolt the engine and transmission together and tighten the bolts to specification.

Automatic Transmission:

Converter housing bolt to engine: 40-45 Nm

Crossmember bolt: 40-51 Nm

Crossmember brace bolt: 30-40 Nm

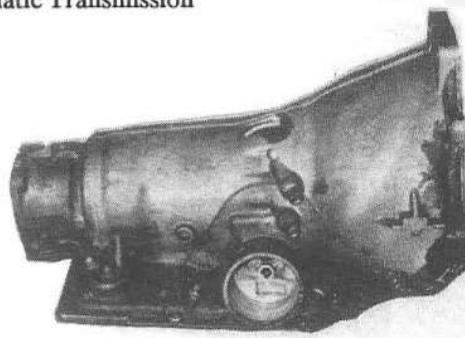
Torque converter to flex plate bolts: 40-45 Nm

TV cable to transmission screw: 8-10 Nm

Manual Transmission.

Case Cover to Transmission Case Attaching

Automatic Transmission



Bolt: 8 - 15Nm

Transmission Extension to Transmission

Case Attaching Bolt: 40 - 60Nm

2. Lift the engine and transmission assembly and lower into the vehicle.

3. Replace the rear transmission mount as previously described.

Rear transmission mount



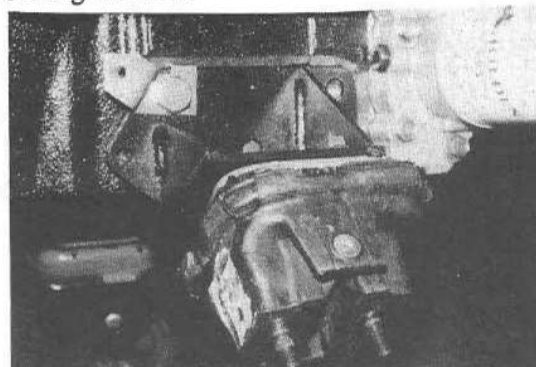
Rear Crossmember to side frame bolt: 40-50Nm

Support to rear mounting nut: 20-25Nm

4. Replace the front engine mount as previously described.

Engine mount to bracket cross member: 35-65Nm

Front engine mount

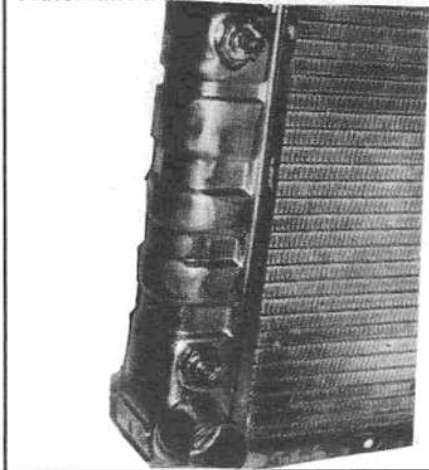


Engine mount to cylinder block: 35-65Nm

5. Install the tail shaft as described in the Tail shaft and universals chapter.

6. Automatic transmissions install the transmission fluid cooler tubes to the radiator.

Automatic transmission fluid cooler tubes at radiator.



7. Automatic transmission vehicles, cable activated replace the cable, electrical activated transmission replace the wiring connectors.

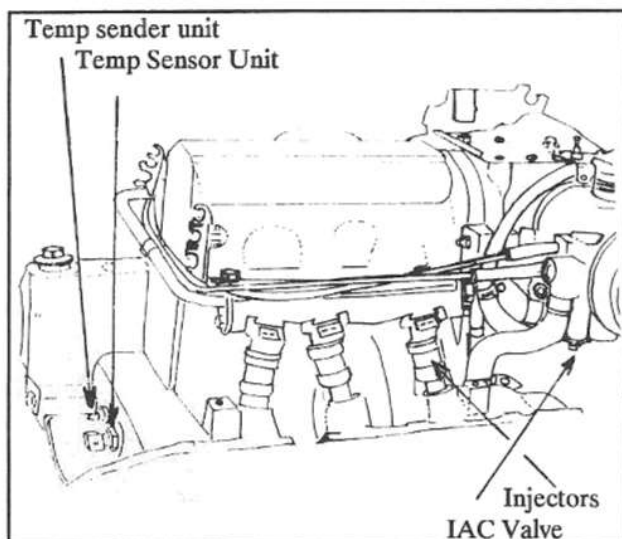
8. Manual transmission vehicles, connect the clutch activating cable.

9. Replace wiring connectors to the transmission, automatic or manual.

10. Refit the engine wiring loom connectors to the ECM located behind passenger side kick panel in the front section of the passenger compartment.

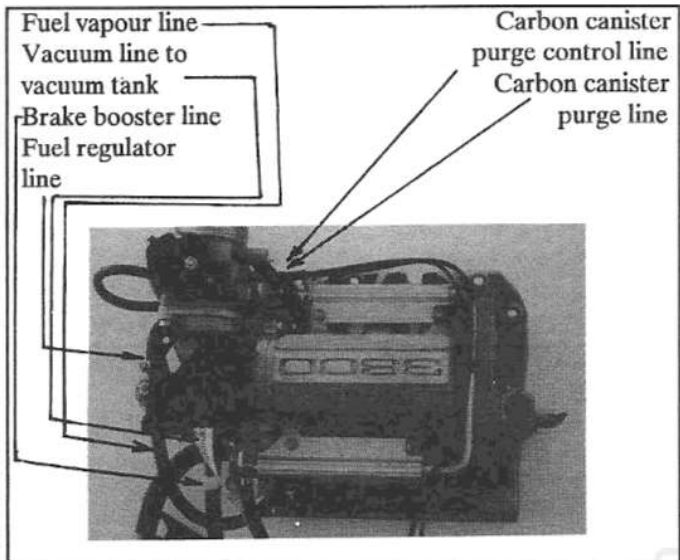
11. Install the kickdown cable and cruise control cable if fitted.

12. Refit the wiring to the sensors positioned in the thermostat housing, the throttle positioner, injectors, ignition coil block, oil pressure sender, MAP sensor, idle control valve, MAT sensor. The labelled connectors (from removal) will help to identify the correct connectors.



13. Install the fuel feed and return lines to the injector rail and pressure regulator.

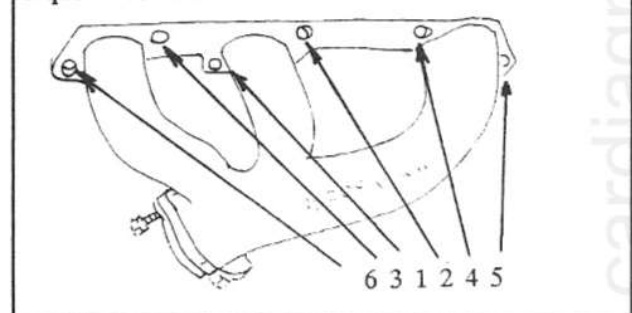
14. Reconnect the vacuum lines to the intake manifold including the canister purge lines and brake booster pipe.



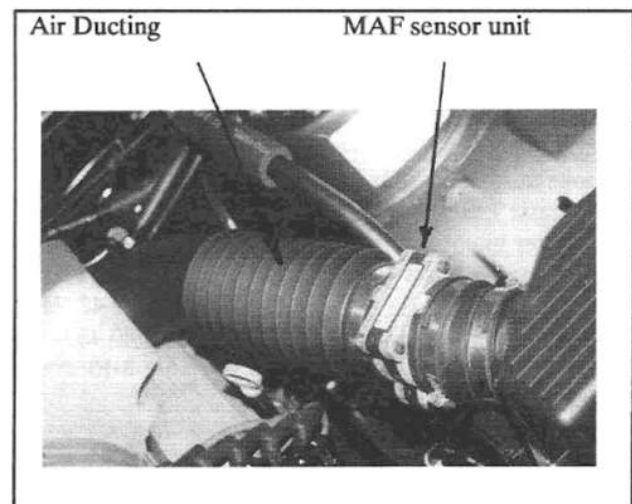
15. Install the exhaust manifolds and bolts to specified torque in correct order.

Exhaust manifold torque specification: 40-60Nm

Install the exhaust manifolds and bolts to specified torque in correct order.



16. Replace the air ducting between the air cleaner and throttle body VS - MAF sensor and wiring loom.

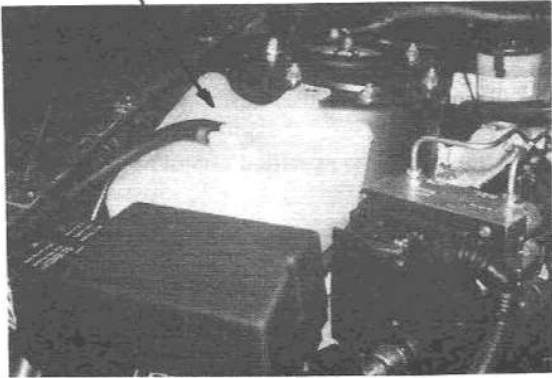


17. Reconnect the coolant hoses at the right side of the engine compartment.

18. Reconnecting the lower and upper radiator hoses to the engine. Refill the coolant system with specified coolant.

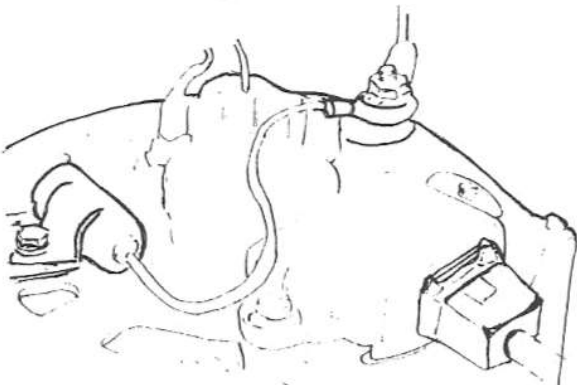
Coolant Specification: HN2043 Eg Techaloy Plus +

Coolant fill container



19. Replace the alternator and wiring loom connectors.

Alternator and wiring loom connectors



20. Replace the power steering pump attaching bolts and power steering pump reservoir.

Power steering reservoir screws torque: 0.5-2.5Nm

Power steering pump attaching bolts torque: 10-20Nm.

21. Replace the earth cable to battery and battery to engine, also earth strap to ignition coil assembly.

22. VS vehicles replace top engine cover, tighten nuts.

VS Engine Top Cover Nuts Spec Torque: 4-6Nm

23. Install the bonnet, align the bonnet with felt pen marks to help aligning the bonnet to correct position.

Rear Main Bearing Oil Seal

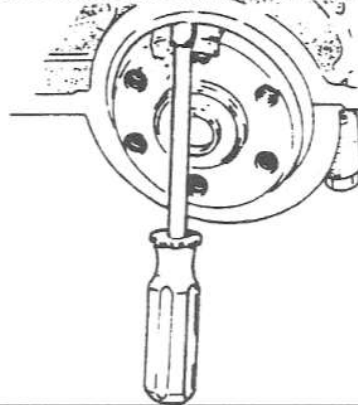
Remove

1. Remove the flywheel or driveplate.
2. Place a suitable lever between the seal and a protection strip and remove the seal.

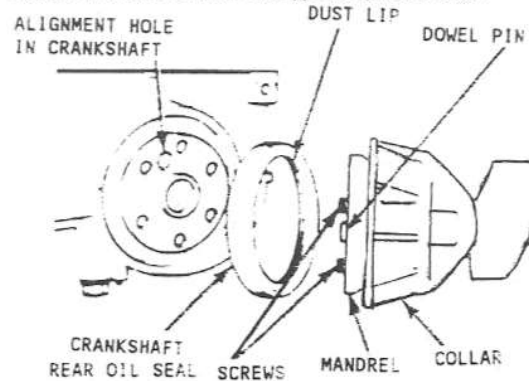
Install

1. Oil the lip of the seal and the shaft. Install the seal evenly using the special tool.

Remove the old seal with a screw driver



Install the seal evenly using the special tool.



2. Replace the flywheel of drive plate and tighten to specification.

Flywheel or Flexplate torque specification: 75-90Nm

Rear Main Bearing Cap Side Seals

Remove

1. Remove the rear main bearing cap, it may be necessary to use slide hammers

2. Clean all sealant from the lower bearing half and cylinder block, if sealant was previously used.

Use a special tool such as a narrow blade or handle section of a file to help remove the old seal / sealant from the rear main bearing cap and cylinder block.

Install Without seal plug inserts

1. Use sealant and a sealant gun, apply sealant in the groove either side of the bearing cap, apply enough sealant to neatly fill the groove in the bearing cap.

Specified Sealant Quality: HN 1373

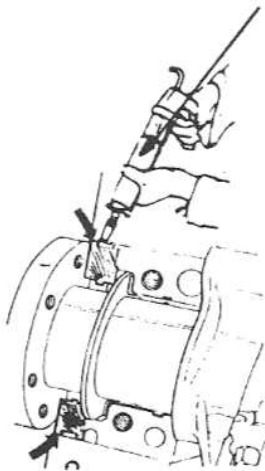
2. Install rear main bearing cap as described in this manual. Torque the bearing cap bolts to specification.

Main bearing cap bolts specified torque:

VR 31-39Nm plus 45° Turn

VS 12-18Nm plus 45° Turn

Sealant & sealant gun



3. Use sealant and a sealant gun, inject sealant into the groove either side of the bearing cap. Apply sealant until the sealant has filled the groove and starts to force its way past the sealant tube nozzle at the top groove of the rear main bearing cap.

Specified Sealant Quality: HN 1373

4. Install sump as previously described, tighten bolts as previously described.

Sump Attaching bolts specified torque: 8-12Nm

Install With seal plug inserts

1. Install rear main bearing cap and rear main seal.

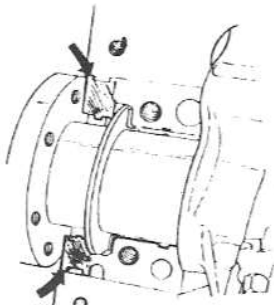
2. Tighten the rear main bearing cap as described in this manual. Torque the bearing cap bolts to specification.

Main bearing cap bolts specified torque:

VR 31-39Nm plus 42°-48° Turn

VS 12-18Nm plus 42°-48° Turn

3. Coat the lower half of seal plug inserts with a film of sealant, this is to help the plug slide into position only.



Specified Sealant Quality: HN 1373

4. Insert the seal plug into the groove of the rear bearing cap with the darkest section towards the bearing cap.

5. Use a soft hammer to drive the seal plug into position, as the seal plug must force its way down and pack the lower section of the seal groove.

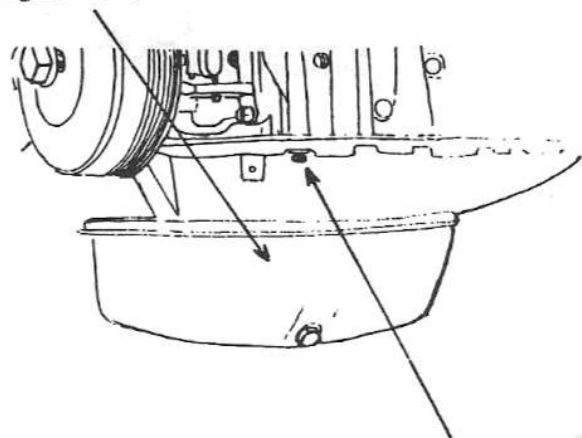
Continue to hit the seal plug into the groove until the plug is flush with the bearing cap and cylinder block, however do not have the seal below the cylinder block surface.

6. Install sump as previously described, tighten bolts as previously described.

Sump Attaching bolts specified torque: 8-12Nm

VR Sump

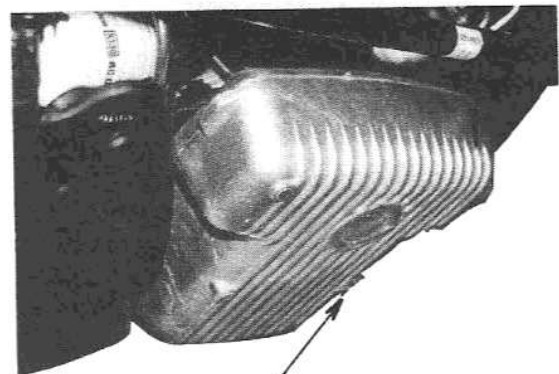
Tighten Sump Bolts to 8-12Nm



Tighten Drain Plug

VS Sump

Tighten Sump Bolts to 8-12Nm



Tighten Drain Plug

Clutch Pilot Bearing**Remove**

Remove the transmission, clutch pressure plate, disc as described in Clutch chapter. Remove the bearing with a bearing puller, or a slide hammer.

Install

Install the pilot bearing and adapter. Install the clutch pressure plate, disc, and the transmission following the procedures in Clutch chapter.

Flywheel/Flex Plate**Remove**

1. Remove the transmission.

Manual Transmissions

Clutch pressure plate and clutch, on a manual shift transmission as described in the clutch and manual transmissions chapters.

Automatic Transmission

Remove the transmission and converter housing as described in Automatic transmission chapter.

2. Remove the Flywheel/Flex plate.

Inspect

Check for cracks, damaged surfaces, chipped or stripped teeth or other faults that would make it unsuitable for further use.

Replace any bolts that are stripped or otherwise damaged.

Install

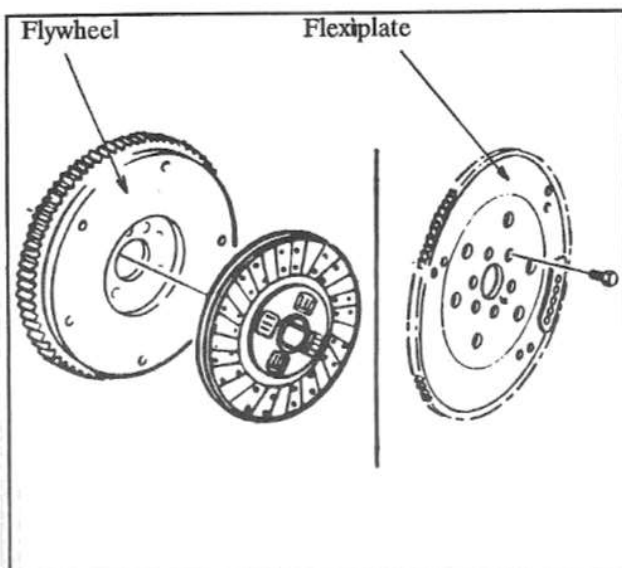
1. Place the flywheel/drive plate on the crankshaft flange. Place oil resistant sealer on the retaining bolts. Install and torque the bolts in sequence across from each other to specifications.

Flywheel/Flexplate step1 18-22Nm step2 +43-53° turn

2. Install the transmission.

Manual Transmissions

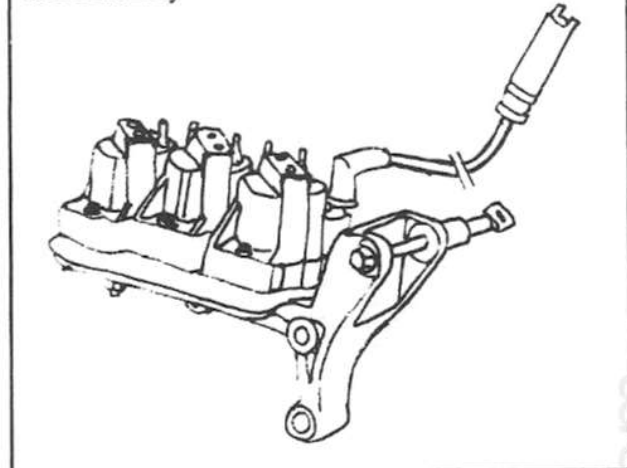
Install clutch pressure plate and clutch, on a manual shift transmission as described in the clutch and manual transmissions chapters.

*Automatic Transmission*

Install the transmission and converter housing as described in Automatic transmission chapter.

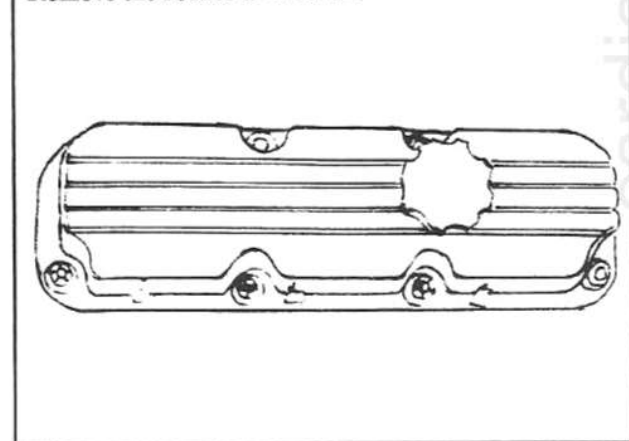
Engine**Dismantle**

1. Drain the engine oil and remove the dipstick tube.
2. Take the exhaust manifolds off if fitted.

Coil Assembly

3. Remove the coil assembly, spark plug leads and spark plugs

4. Remove the oil filter, oil filter adaptor, oil pressure sender unit.

Remove the rocker arm covers

5. Remove the rocker arm covers and inspect the rocker arm pivots and arms.

6. Remove the drive belt and tensioner.

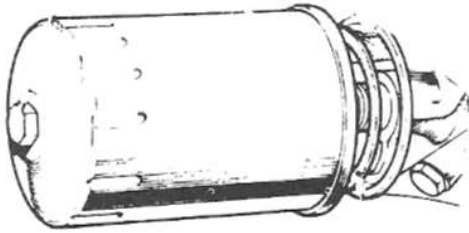
7. Remove the alternator assembly and mounting brackets.

8. Remove the water pump.

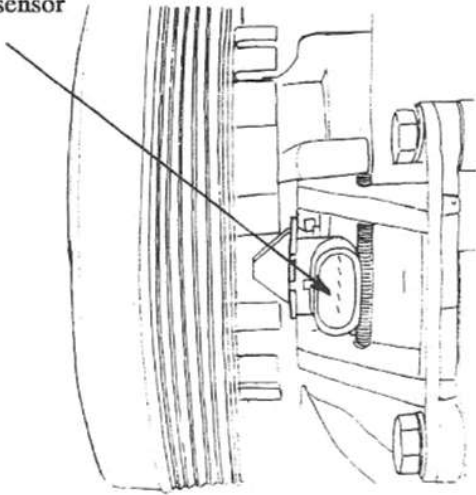
9. Remove the crankshaft damper using a pulley puller.

10. Remove the crank sensor.

Oil Filter and adaptor

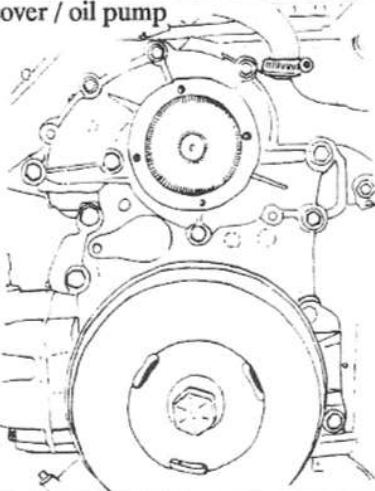


Crank sensor



11. Remove the timing cover / oil pump and hold the camshaft gear and loosen the camshaft gear bolt one half turn.

Timing cover / oil pump



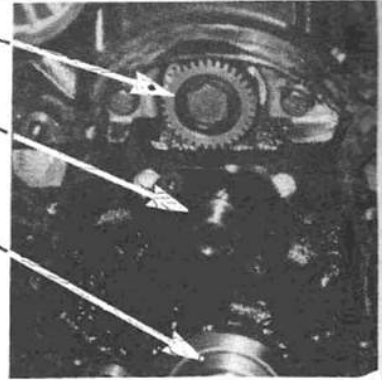
12. Remove the camshaft timing chain, gear and camshaft as described under camshaft section.

Balance Shaft

Cam shaft

Crankshaft

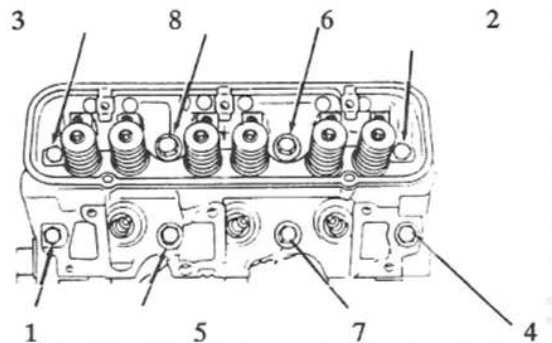
Camshaft



13. Remove the intake manifold as described under intake manifold

14. Remove the cylinder heads after loosening the bolts gradually from each end to the centre.

Remove the cylinder head bolts in the correct order.



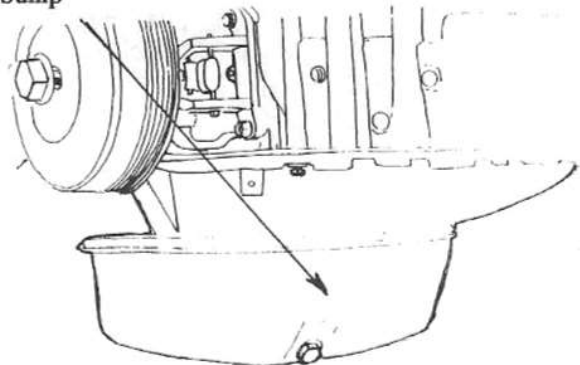
15. Mark the flywheel and the clutch, on a vehicle with a manual transmission, so that they may be replaced in the same relationship. Remove the clutch and pressure plates.

16. Remove the flywheel, clutch pilot bearing and the engine rear cover plate.

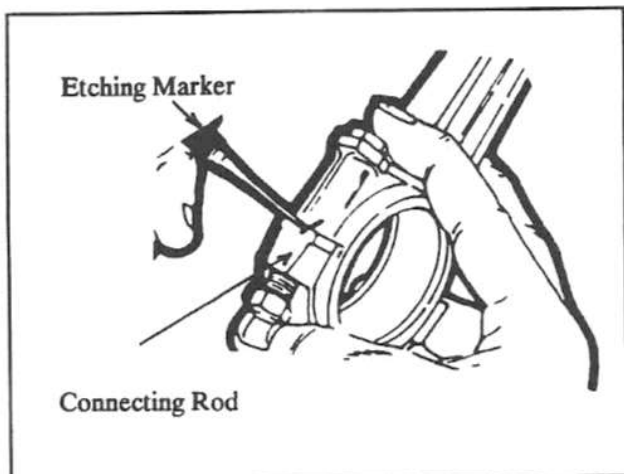
17. Remove the flywheel and cover plate for automatic transmission.

18. Remove the sump and throw away gaskets and seals. Remove the oil pump pickup strainer and pipe.

Sump

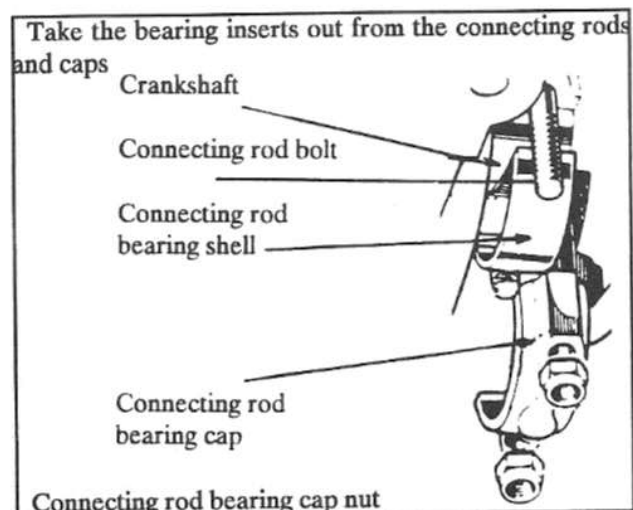


19. Check that all main and connecting rod bearing caps are marked so they can be installed in their original position.

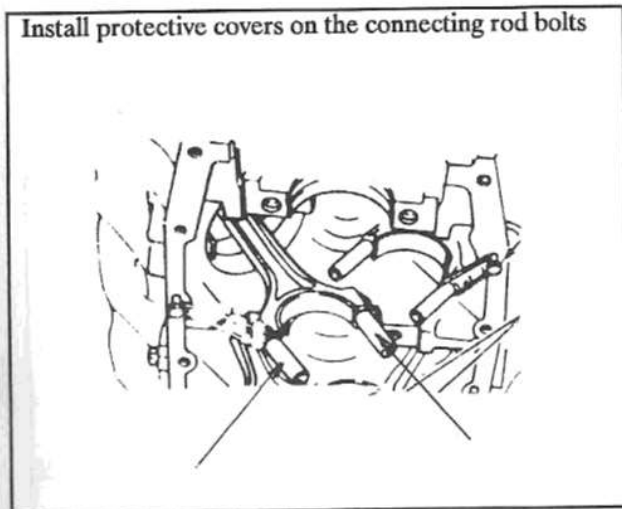


tion. Turn the crankshaft until the connecting rod bearing that is to be removed is easily accessible.

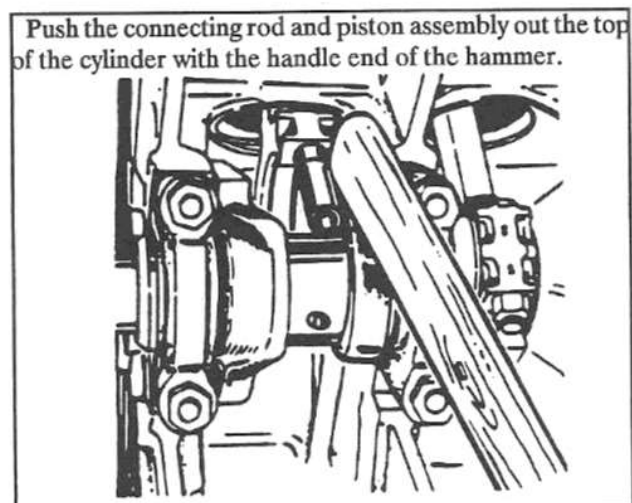
20. Take the bearing inserts out from the connecting rods and caps. Remove the connecting rod bearing caps.



21. Install protective covers on the connecting rod bolts.

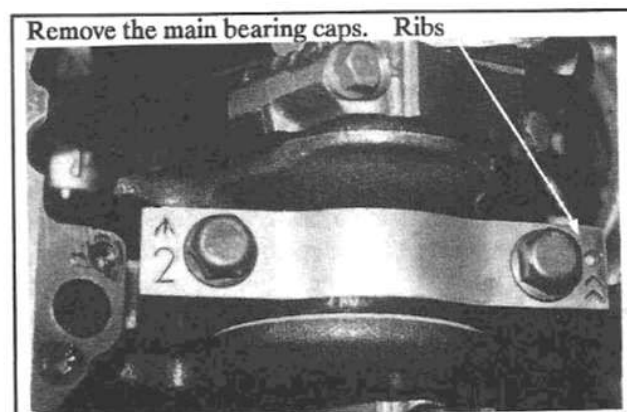


22. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of the hammer.



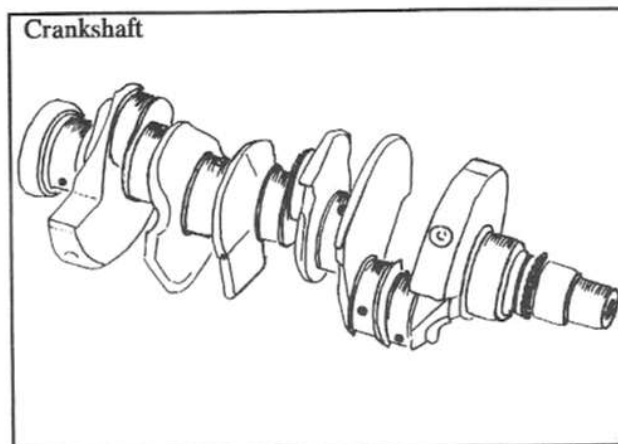
Avoid damage to the crank shaft or the cylinder wall when removing the piston and connecting rod.

23. Remove the main bearing caps.



24. Remove the rear main bearing seal.

25. Lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces. Remove the main bearing inserts from the block and bearing caps.

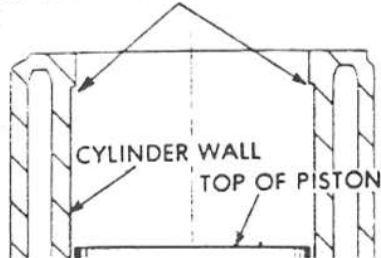


Cylinder Block**Refinishing Cylinder Walls**

Detach any ridges and/or deposits from the upper end

Cylinder block

RIDGE CAUSED BY CYLINDER WEAR



of the cylinder bores. Remove the cylinder ridges with a ridge cutter.

When removing ridges never cut into the ring travel area in excess of 0.8 mm.

Only when the walls have minor faults such as light scuffs or scratches, honing is recommended for refinishing. The quantity of metal that has to be removed will calculate the grade of hone to be used. If coarse stones are used to begin the honing operation, leave adequate material so that all hone marks can be removed with the finishing hone, which is used to gain the required piston clearance.

Cylinder walls that are severely marred and/or worn beyond the specified limits should be refinished. Prior to any cylinder being refinished, all the main bearing caps must be in place and tightened to the proper torque so that the crankshaft bearing bores will not become distorted from the refinishing operation.

Refinish only the cylinder or the cylinders that require the refinishing. All pistons are the same weight, both standard and oversize, thus, various sizes of pistons can be used without upsetting engine balance.

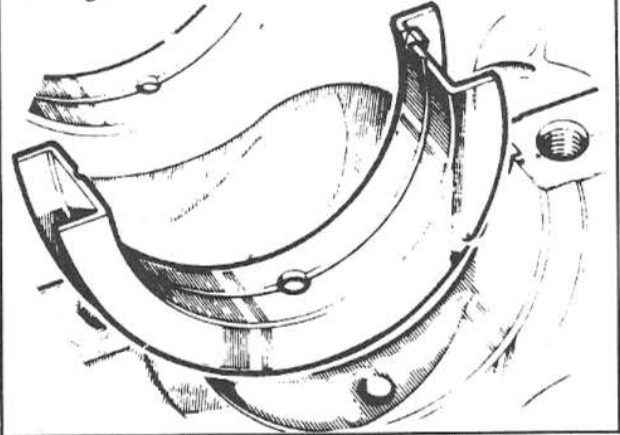
To calculate the maximum oversize, refinish the cylinder with the most wear first. Replace the cylinder block, if the cylinder will not clean up when refinished to the maximum oversize piston size recommended.

Assembly

Clean all segments, and clean all sealer and adhesive from all joining components.

1. Install the correct undersize bearings if the crankshaft main bearing journals have been refinished to a definite undersize. Check that the bearing bores are clean. Place the main upper arm bearing inserts in position in the bore with the tang fitting in the slot provided.

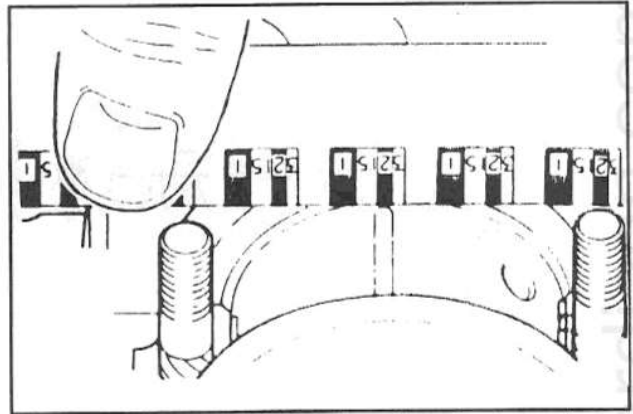
Bearing shell tangs must be positioned correctly



No. 2 upper main bearing incorporates the thrust bearing flanges in the cylinder block. Install the lower main bearing inserts in the bearing caps.

2. Lower the crankshaft into place. Do not damage the bearing surfaces.

3. Inspect the clearance of each main bearing as described in "Main Bearing Replacement".



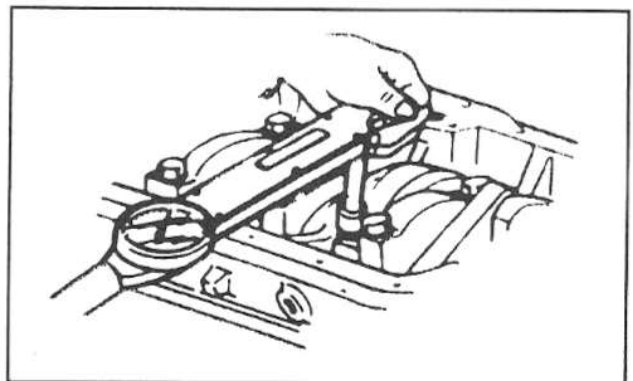
4. Apply a light coat of engine oil to the journals and bearings. Apply oil resistance sealer to the rear main bearing cap at the rear of the top mating surface.

Install the bearing caps. Check that the main bearing caps are installed in their original locations. Torque the bearing cap bolts to specification.

Main bearing cap bolts specified torque:

VR 31-39Nm plus 45° Turn

VS 12-18Nm plus 45° Turn

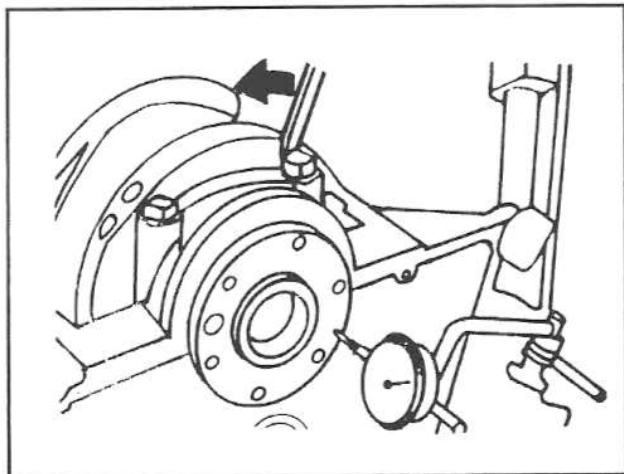


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5. Install the rear main bearing oil seal with the help of special tool as described under Rear main bearing oil seal section.

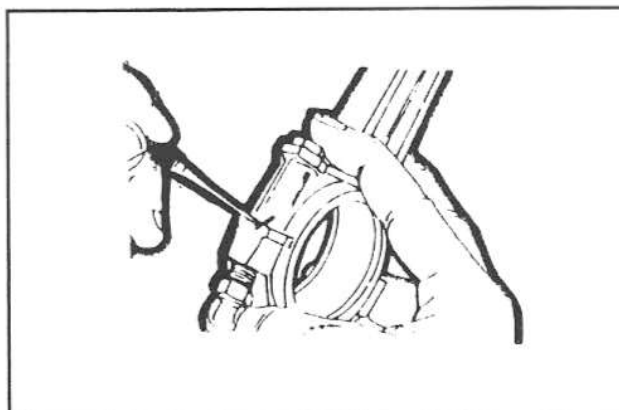
6. Inspect the crankshaft end play as described in "Rear main bearing seal".



7. Oil the piston rings, pistons, and cylinder walls with light engine oil.

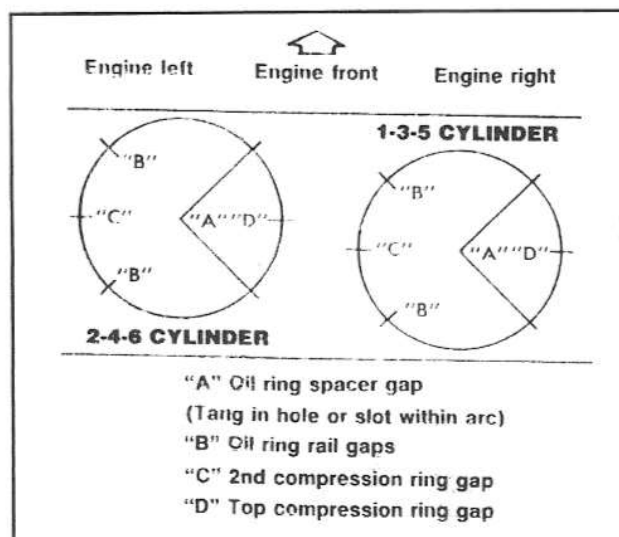
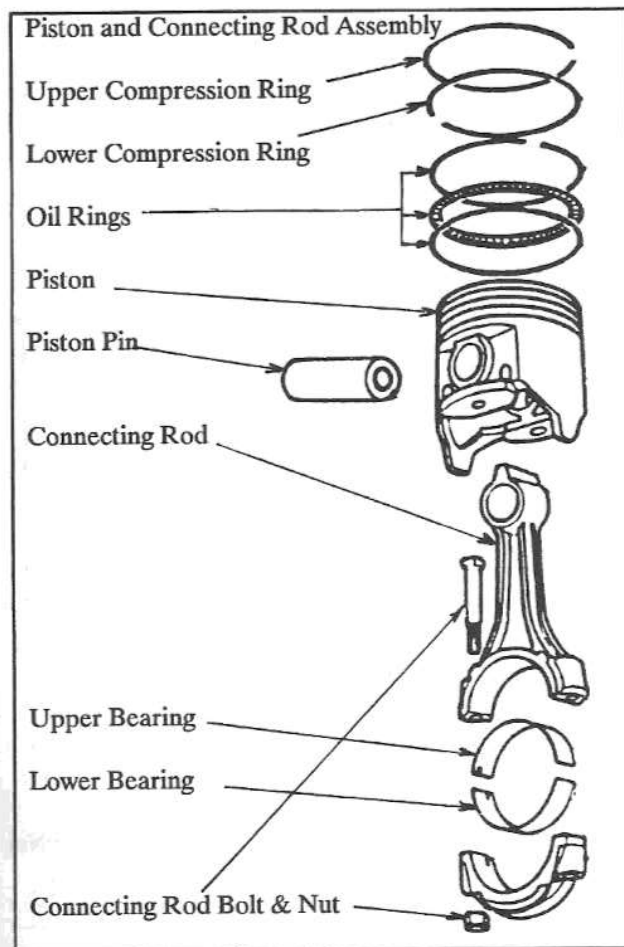
8. Check that the pistons are installed in the same cylinders from which they were removed, or to which they were fitted. The connecting rod and bearing caps should

have been numbered from 1 - 6 when the engine was dismantled.

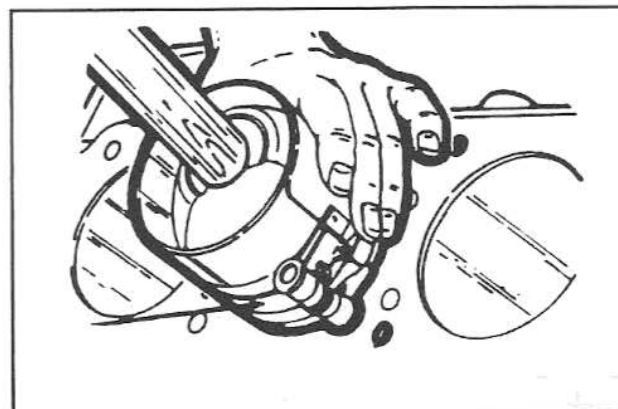


The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. New bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number if a connecting rod is ever transposed from one block or cylinder to another.

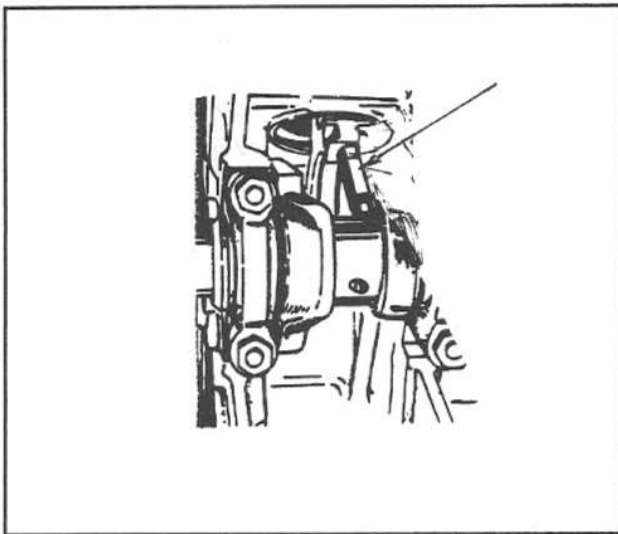
9. Check that the ring gaps are properly spaced around the circumference of the piston.



9. Place a piston ring compressor on the piston and press the piston in with a hammer handle until the piston is



below the surface of the cylinder block. Direct the con-



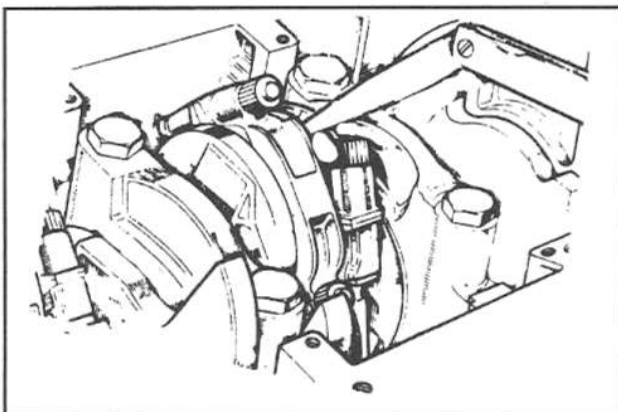
necting rods to avoid damaging the crankshaft journals. Place the piston with the arrow on the piston head toward the front of the engine.

Place the piston with the arrow on the piston head toward the front of the engine.



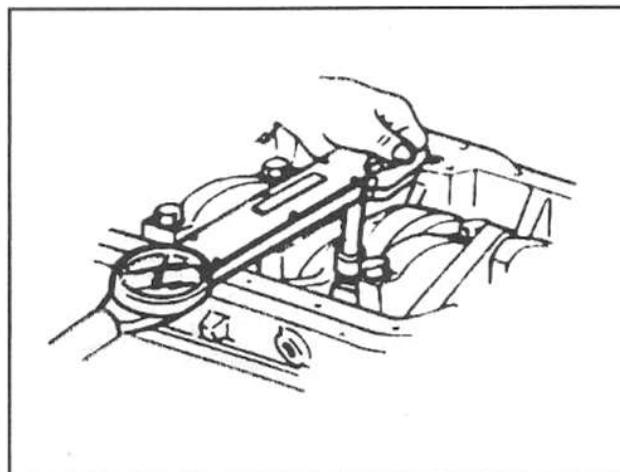
10. Inspect the clearance of each bearing following the procedure under 'Connecting Rod Bearings Replacement'.

Connecting rod side clearance: 0.10-0.38mm



11. Apply a light coat of engine oil to the journals and bearings. Rotate the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the connecting rod bearing seats on the crankshaft journal. Take the protection covers off.

12. Place the connecting rod cap on. Torque the nuts to specification.



Connecting rod cap bolt torque: 24-30Nm + 50°

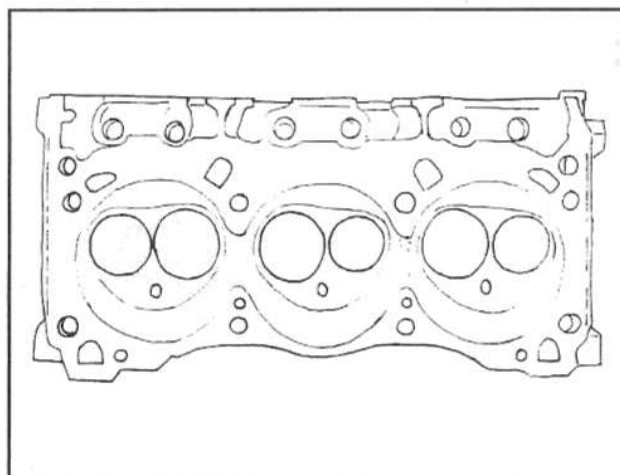
13. Inspect the connecting rod side clearance on each crankshaft journal.

14. Install the oil pump pickup pipe and strainer.

15. Install the sump and tighten bolts to specification.

Sump bolt specification: 8-12Nm

15. Install the cylinder head gaskets. Place the gasket over the dowels in the cylinder block. Make sure the



"TOP" marking is on the up side of the gasket, if the gaskets have arrows stamped on them the arrow must point towards the rear of the engine.

16. Install the cylinder heads as described under cylinder heads, tighten bolts to specified torque in correct order.

Step 1 - Head Stud Torque specification: 35Nm

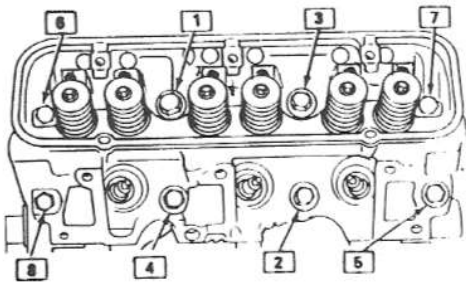
Step 2 - Head Stud further tighten 90° but not over 90Nm

Step 3 - Head Stud torque specification: 81Nm

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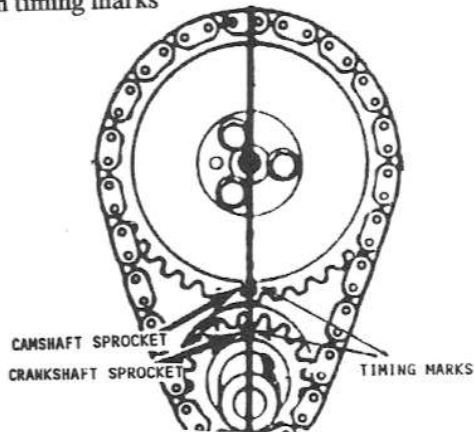
Tighten bolts to specified torque in correct order.



17. Install the balancing shaft, as described in balance shaft section.

18. Install the camshaft as in camshaft section.

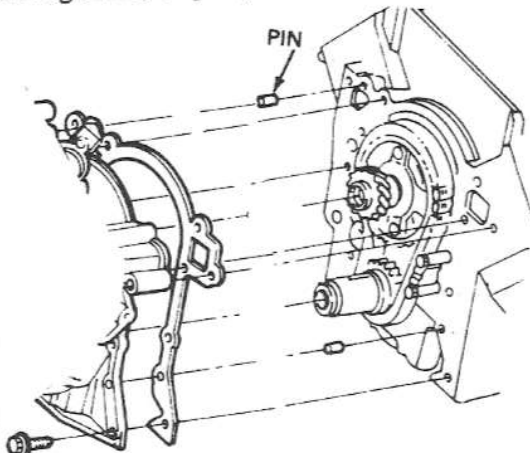
Align timing marks



19. Install the timing chain / oil pump cover with new gaskets as previously described.

The crankshaft sprocket flat area must line up with the corresponding flat area on the oil pump inner gear.

Timing chain / oil pump cover with new gaskets



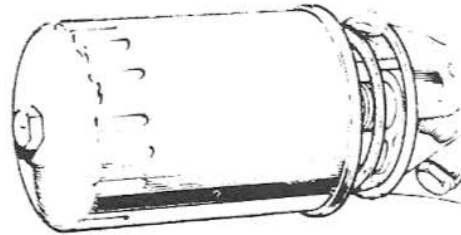
20. Tighten the bolts for the cover then install and torque the bolts on the sump.

Timing Cover / Oil Pump to Cylinder Block: 20-40Nm

Oil Sump to Timing Cover bolts torque: 8-12Nm

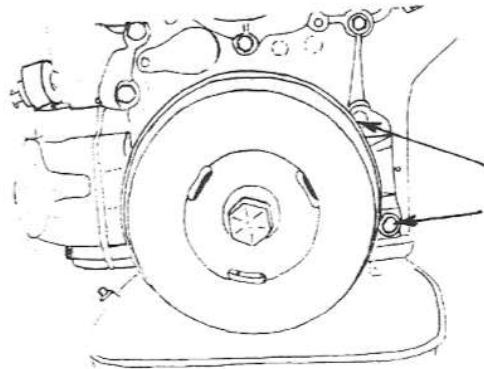
21. Install a new oil filter if the oil filter was removed.

Install a new oil filter



Oil Filter tighten until surfaces meet plus 2/3 turn.

22. Replace the crank sensor and adjust as described under Crankshaft sensor and crankshaft balancer section, tighten the attaching bolts.

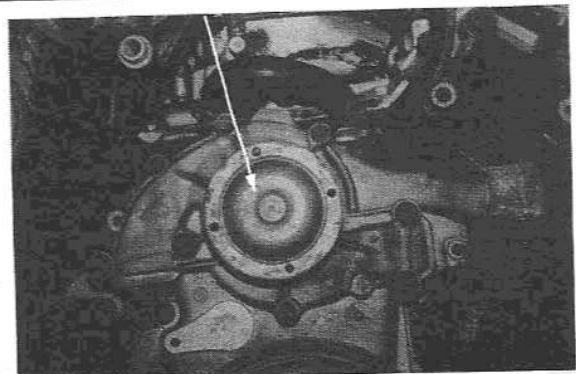


Crank Sensor bolts specified torque: 20-40Nm

23. Replace the crankshaft balancer and bolt, torque bolt to specification.

Crankshaft Balancer bolt torque: 270-325Nm

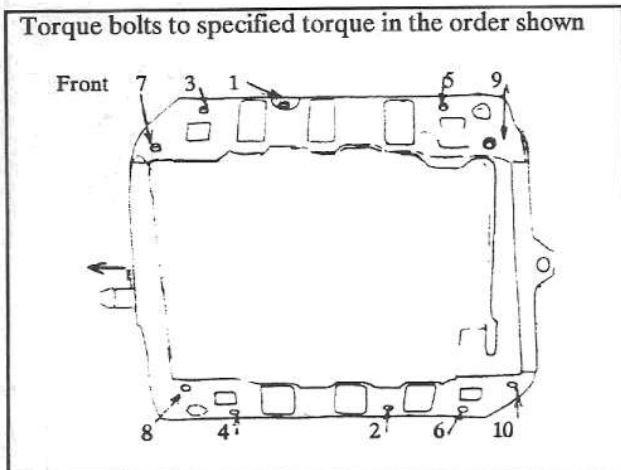
24. Install the water pump as previously described.



Water Pump to Cover: 8-15Nm

25. Install the hydraulic valve lifters into the same lifter position from which they were removed.

26. Install intake manifold and new gaskets, ensure that the gaskets fit correctly and apply sealant to the front and rear gasket seals as well as the intake manifold attaching bolts. Torque bolts to specified torque in the order shown in the diagram.

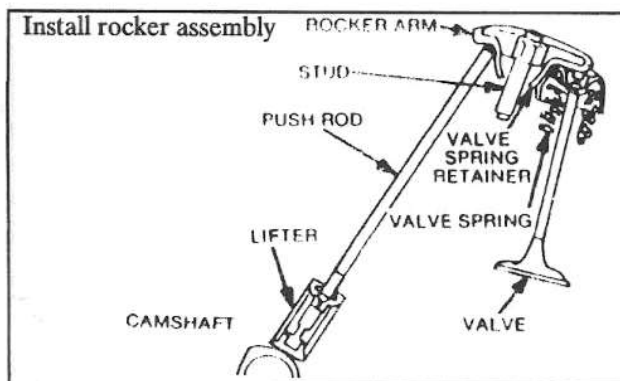


Intake manifold bolts specified torque: 8 - 12 Nm.

VS Install upper air chamber to intake manifold, tighten bolts to specification.

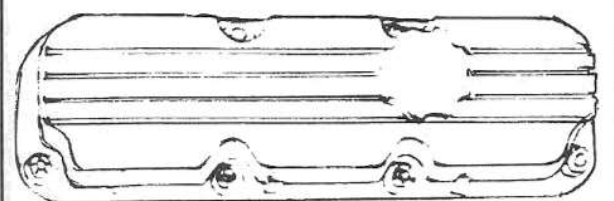
VS Intake Manifold Air Chamber bolt torque: 10-14Nm

27. Reinstall the push rods, rocker assemblies in the order that they were removed.



Pivot bolts torque specification: 32-44Nm

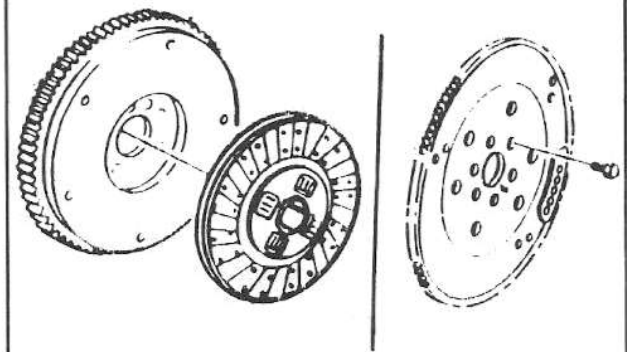
28. Reinstall the rocker covers.

Rocker Cover

Rocker cover bolt torque specification: 7-11Nm

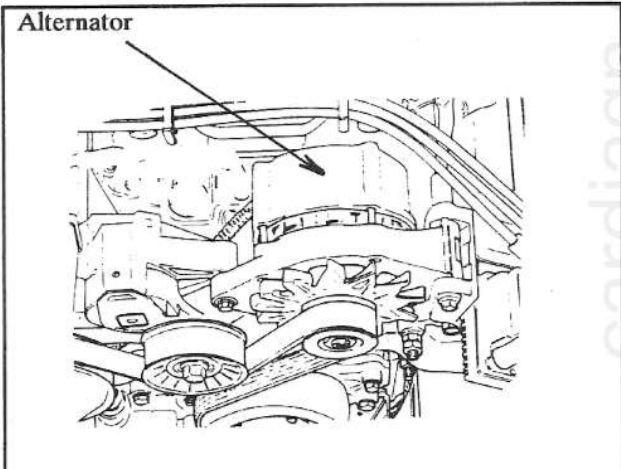
29. Install the clutch pilot bearing in the crankshaft on manual transmission vehicles. Install the clutch assembly on the flywheel using a suitable tool to align the disc.

30. Place lock tight sealer to the bolt threads and install the flywheel, tighten bolts to specified torque. Install the engine rear cover plate.

Flywheel / Flexiplate

Flywheel / Flexiplate bolt specifications: 75-90 Nm

31. Install the alternator assembly and mounting brackets.



Alternator Upper Attaching Nut And Bolt

Torque Specification: 34-44 Nm.

Alternator Attaching Bolt

Torque Specification: 12-16 Nm.

VS Alternator Support Rod Torque: 20-30Nm

32. Install starter motor, tighten bolts to specification.

Starter Motor To Block Bolts: 40-60Nm

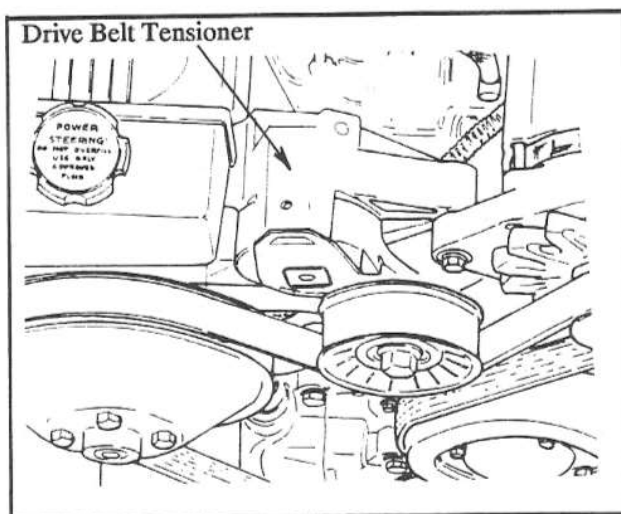
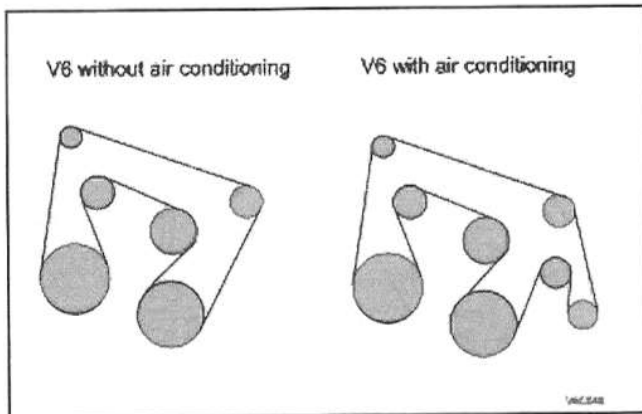
Starter Motor Brace To Block: 12-16Nm

33. Install the drive belt and tensioner. Adjust belt, turn the automatic adjuster idler pulley mounting stud to adjust tension.

Drive Belt Tension Specification:

57 kg new 34 kg used

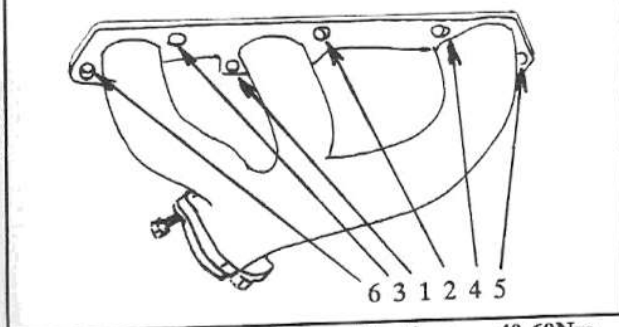
34. Install the coil assembly, spark plug leads and spark plugs



Spark Plug specified torque: 20-30Nm

35. Install the exhaust manifolds. Tighten the bolts to specification and in correct order.

Install the exhaust manifolds. Tighten the bolts to specification and in correct order.



Exhaust manifold torque specification: 40-60Nm

36. VS Install alternator support rod and engine top cover, tighten to specification.

Engine Top Cover Nut Torque specification: 4-6Nm

36. Install the dipstick tube.

37. Fill the engine with specified amount of engine oil.

Oil capacity including Oil Filter: VR 3.8Litres VS 4.0Litres

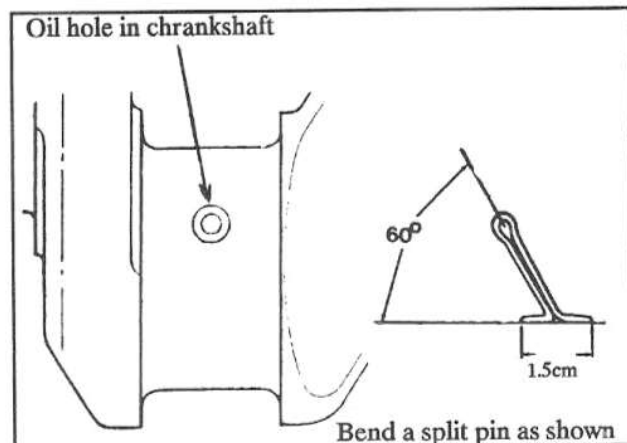
Main Bearing Replacement (Engine in vehicle)

Remove

1. Remove the oil level dip stick and the sump.
2. Remove the oil pickup pipe and strainer.
3. Remove one bearing at a time, leaving the other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.

If the rear main bearing is removed care must be taken with the rear main seal and side sealant check later in this chapter.

4. To remove the upper section of the bearing shell, place an appropriate flat headed pin or a split pin bent as shown below, in the oil hole in the crankshaft.



** Care must be taken not to damaged the crankshaft.*

Turn the crankshaft in the direction so that the pin will force the bearing out of the block. Remove the pin. Clean the crankshaft journal.

5. Place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that the pin can be installed in the oil hole in the crankshaft. With the pin placed in the oil hole in the crankshaft, rotate the crankshaft in the opposite direction to engine rotation until the bearing seats itself. Turn the shaft back slightly to remove the pin.

Clean

Using solvent clean the bearing inserts and caps thoroughly, and dry them with compressed air. Do not scrape gum or varnish deposits from the bearing shells.

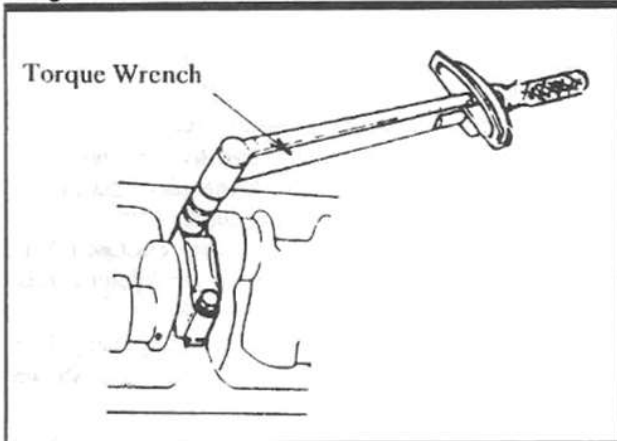
Inspect

Carefully inspect each bearing. Replace any bearings that have a scored, chipped or worn surface. The copper lead bearing base may be visible through the bearing overlay, although this does not mean that the bearing is worn. If the bearing clearance is within its limits it is not essential to replace the bearing. Inspect the clearance of bearings that seem to be suitable with Plastigage.

Install

1. Install the cap bearing and place a piece of Plastigage on the crankshaft journal full width of the bearing cap and about 5 mm off centre.

2. Install the cap and torque the bolts to specifications.



Main bearing cap bolts specified torque:

VR 31-39Nm plus 45° Turn

VS 12-18Nm plus 45° Turn

Do not turn the crankshaft while the Plastigage is in place.

3. Take the cap off. Using the Plastigage scale, check the width of the Plastigage. When checking the width of the Plastigage, check at the widest point in order to get the minimum clearance. Check at the narrowest point in order to get the maximum clearance. The variation between the two readings is the taper.

Clean all of the plastigage from the crankshaft journal.

4. If the clearance is more than specified, fit under size bearings.

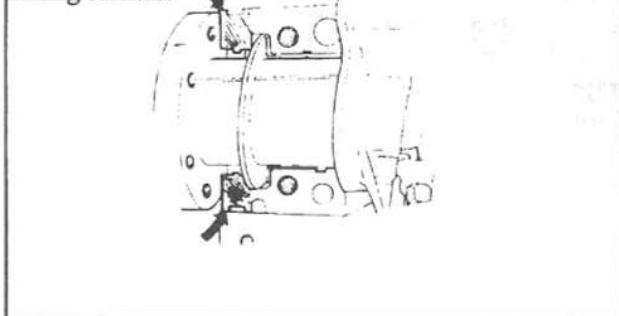
Main Bearing clearance: .013-0.051mm

The bearing clearance must be within specified limits. If the standard and 0.0254 mm undersize bearings do not bring the clearance within the desired limits, refinish the crankshaft journals; then install undersize bearings.

5. If the rear main bearings are replaced, replace the oil seal as featured under Rear Main Bearing Seal Replacement. Apply oil resistant sealer to the rear main bearing cap mating surface.

6. Apply a light coat of engine oil to the journal and

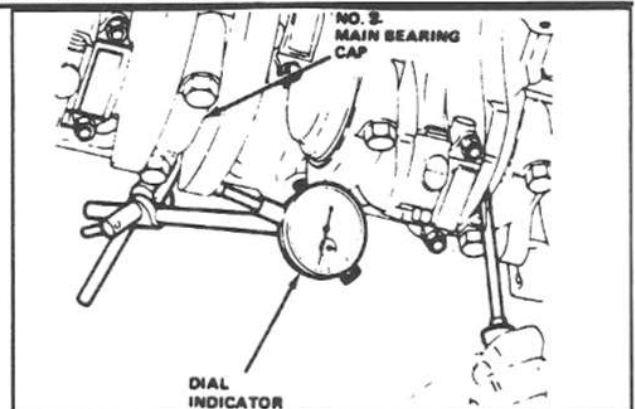
Apply oil resistant sealer to the rear main bearing cap mating surface.



bearings, then install the bearing cap.

7. Repeat the procedure for the remaining bearings that require replacement.

8. Check crankshaft end float by using a screw driver to move the crankshaft forward and back. Place a feeler gauge between the No 2 bearing flange and the crankshaft,



check that end float is within specification, if not replace No 2 bearing shells

Crankshaft End Float specification: 0.08-0.28mm

* The No. 2 main bearing incorporates the crankshaft thrust flanges.

9. Clean the oil pump inlet pipe screen and refit, tighten bolts to specification.

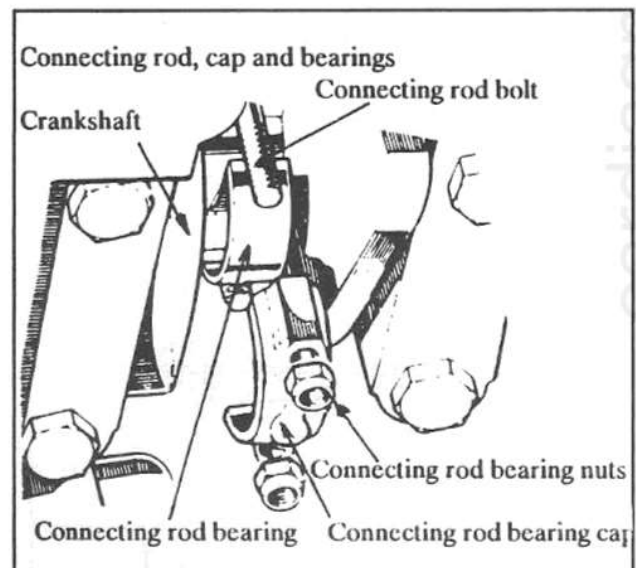
Oil pickup pipe attaching bolt specified torque: 8-12Nm

10. Install sump, tighten bolts to specification.

Sump attaching bolt specified torque: 8-12Nm

Connecting Rod Bearings (Engine in Vehicle)

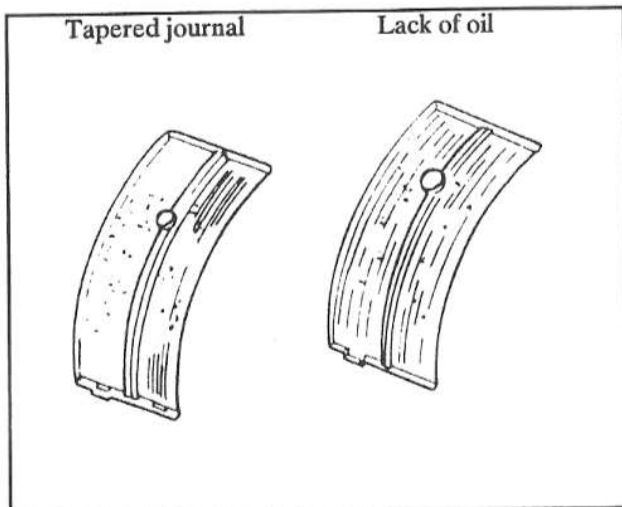
Remove



1. Remove spark plugs.
2. Remove the oil level dip stick and the sump.
3. Remove the oil pickup pipe and strainer.
4. Rotate the crankshaft until the connecting rod is easy to work on. Detach the connecting rod cap and the bearing inserts from the rod and cap.
5. Check that the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause failure.

Clean

Using solvent clean the bearing inserts and caps thoroughly, and dry them with compressed air. Do not scrape gum or varnish deposits from the bearing shells.

**Inspect**

Carefully inspect each bearing. Replace any bearing that has a scored, chipped or worn surface. The copper lead bearing base may be visible through the bearing overlay, although this does not mean that the bearing is worn. If the bearing clearance is within its limits it is not essential to replace the bearing. Inspect the clearance of bearings that seem to be suitable with Plastigage

Install

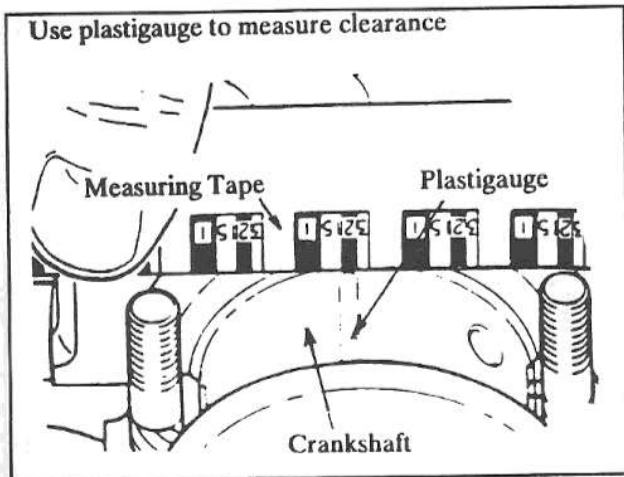
1. Clean the crankshaft journal. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slot provided.

2. Pull the connecting rod assembly firmly onto the crankshaft journal.

3. Place a piece of Plastigage on the crankshaft journal, the full width of the cap and about 5 mm off centre.

4. Place the cap and torque the connecting rod nuts to specification.

Connecting Rod Cap bolt specified torque: 20-30Nm
Do not turn the crankshaft while the Plastigage is in place.

Use plastigauge to measure clearance

5. Take the cap off. Use the plastigage scale and inspect the width of the plastigage. When inspecting the width of the Plastigage, inspect at the widest point in order to get minimum clearance. Inspect at the narrowest point in order to get the maximum clearance. The difference between the two readings is the taper.

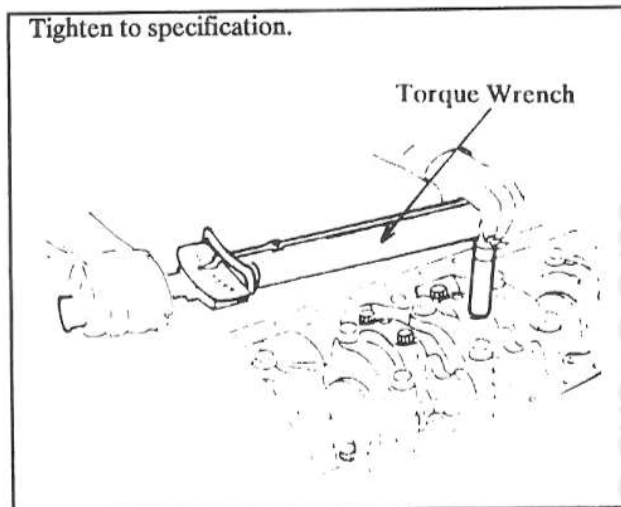
6. If the clearance is more than the specified limit, fit under size connecting rod bearing shells.

Connecting Rod Bearing clearance: 0.008-0.071mm

If the clearance is more than the specified limit, fit under size bearings. Bearing clearance must be within specified limits, replace crankshaft if necessary.

Clean all plastigage from crankshaft journal and apply a light coat of engine oil to the journal and bearings. Install the connecting rod cap. Tighten to specification.

Tighten to specification.

**Connecting Rod Bearing Cap bolt**

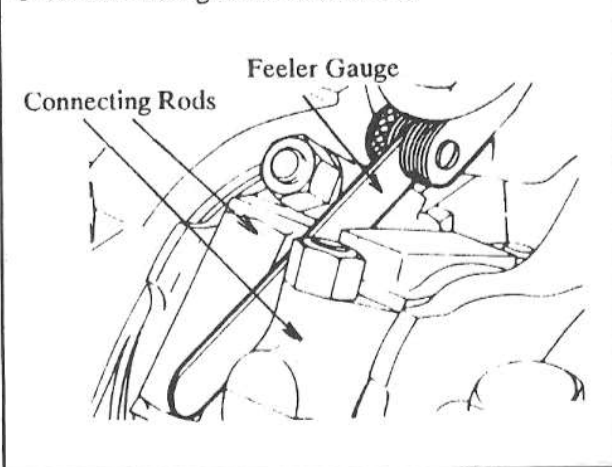
specification: 24-30Nm + 50° turn

7. Repeat the procedure for the remaining connecting rods that require new bearings and clean the oil pump inlet pipe screen.

8. Check connecting rod side clearance.

Connecting Rod side

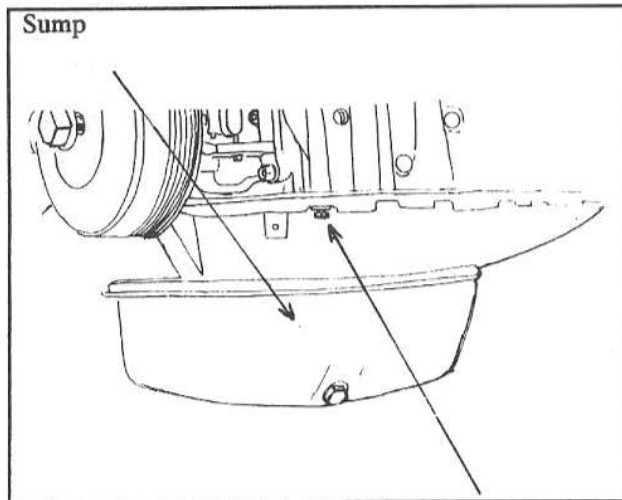
clearance specification: 0.10-0.38mm

Check connecting rod side clearance

9. Clean the oil pump inlet pipe screen and refit, tighten bolts to specification.

Oil pickup pipe attaching bolt specified torque: 8-12Nm

10. Install sump, tighten bolts to specification.



Sump attaching bolt specified torque: 8-12Nm

11. Install spark plugs and tighten to specification.

Spark Plug tightening specification: 20-30Nm

Piston and Connecting Rod Assemblies

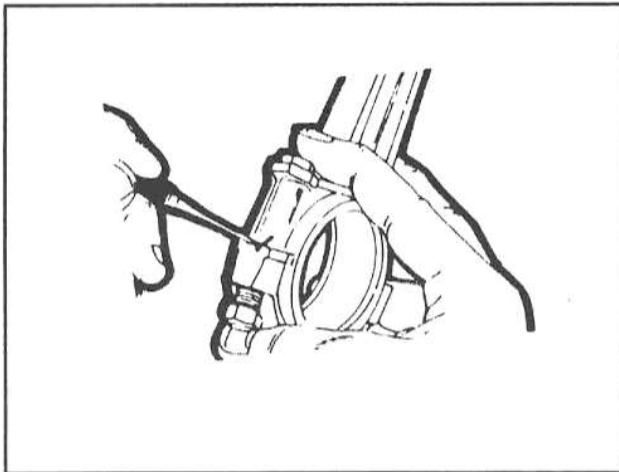
Remove

1. Refer to 'Cylinder Head Removal' and remove the head and connecting parts.

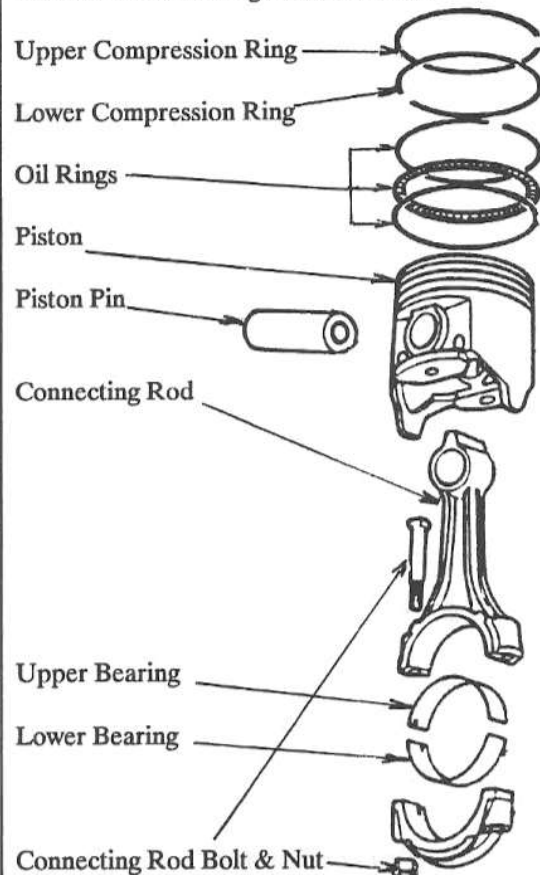
2. Take the oil pan and connecting parts out. Take the oil pump inlet tube and the oil pump out.

3. Rotate the crankshaft until the piston is at the bottom of its travel and put a cloth on the piston head to accumulate the cuttings. Take any ridge and/or deposits out from the upper end of the cylinder bores. Take the cylinder ridge out and using ridge cutter. Follow the instructions furnished by the tool manufacturer. Do not cut into the ring travel area in excess of 0.8 mm when taking out ridges.

4. Check that all the connecting rod caps are marked so that they can be installed in their original positions. Take the connecting rod cap out.

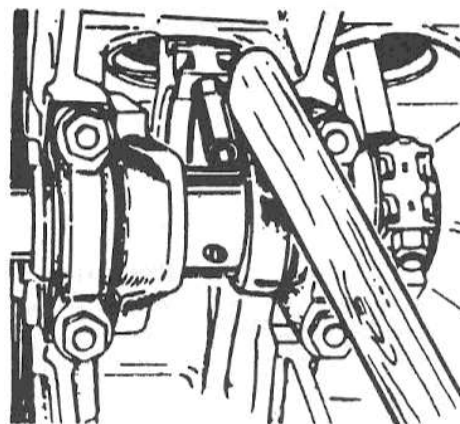


Piston and Connecting Rod Assembly



5. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the crank pin or the cylinder wall when taking the piston and rod out, cover the rod bolt threads with tape or plastic tube.

Cover the rod bolt threads with tape or plastic tube.



Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer.

Connecting Rods**Clean**

Take the bearings out from the rod and cap. Identify the bearings if they are not to be used again. Using solvent clean the connecting rod, including the rod bore and the back of the inserts. Do not use a caustic cleaning solution. Using compressed air blow out all the passages.

Inspect

Inspect and check the connecting rods and related parts for conformance to specifications. Various forms of engine wear caused by these parts can be readily identified.

Examine the I.D. of the connecting rod piston pin bore. Restore the connecting rod if the pin bore is not within specifications.

Piston Pin diameter: 22.995-23.000mm

Piston Pin clearance:

In piston: 0.010-0.20mm

In Connecting rod: 0.018-0.043mm

Restore defective connecting rod nuts and bolts.

If the connecting rod has been withdrawn from the piston it should be checked for bends or twist before assembling it to the piston. Connecting rods can be inspected for bend or twist while assembled to the piston.

Connecting Rod alignment:

Bend: 0.020mm per 25mm

Twist: 0.038 per 25mm

Check the connecting rods for bend or twist on a suitable alignment fixture. If the bend and/or twist exceeds specifications, the connecting rod must be straightened or replaced.

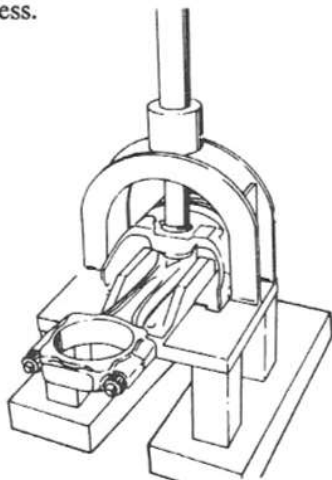
Dismantle

1. Take the bearing inserts out from the connecting rod and cap.

2. Mark the pistons and pins to secure assembly with the same rod and installation in the same cylinders from which they were removed.

3. Take the piston pin out from the piston and connecting rod with a press.

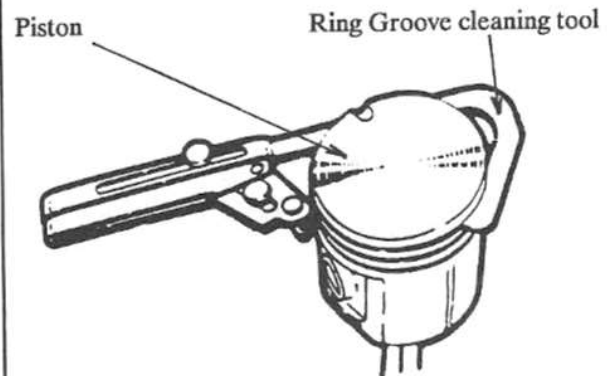
Take the piston pin out from the piston and connecting rod with a press.



4. Remove the piston rings.

Pistons, Connecting Pins and Rings**Clean**

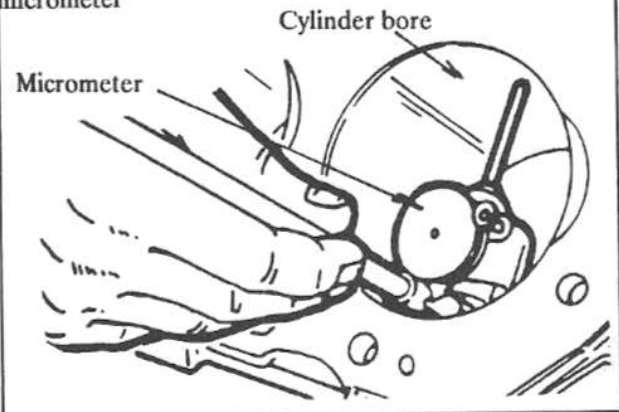
Withdraw the deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins and rings with solvent. Do not use a caustic cleaning solution or a wire brush to clean pistons. Clean the ring grooves with a groove cleaner. Check the oil slots are clean.

Clean the piston ring grooves**Inspect**

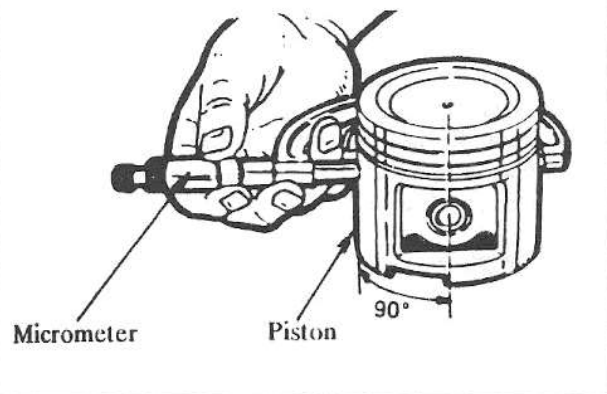
Check the pistons for fractures at the ring lands, skirt and pin bosses, and for scuffed, rough or scored skirts. If the lower inner portion of the ring grooves has a high step restore the piston. The step will interfere with ring operation and cause excessive ring side clearance.

Detonation or pre-ignition are usually caused by spongy, eroded areas near the edge of the top of the piston. A bent connecting rod can cause a shiny surface on the thrust surface of the piston, offset from the centre line between the piston pin holes. Pistons that show signs of excessive wear, wavy ring lands or fractures or damage from detonation or pre-ignition replace.

By measuring the piston and bore diameters check for out of round and check the piston to cylinder bore clearance. At the centre of the piston pin bore measure

Measure the bore diameter with an inside measuring micrometer

Measure the piston diameter 40mm from top of piston.



the O.D. of the piston with micrometers and at 90 degrees to the pin bore axis.

Cylinder Bore

Standard Bore diameter: 96.507-96.533mm

Taper: 0.013mm max

Out or round: 0.010mm max

Piston

Piston standard size: 96.477-96.497mm

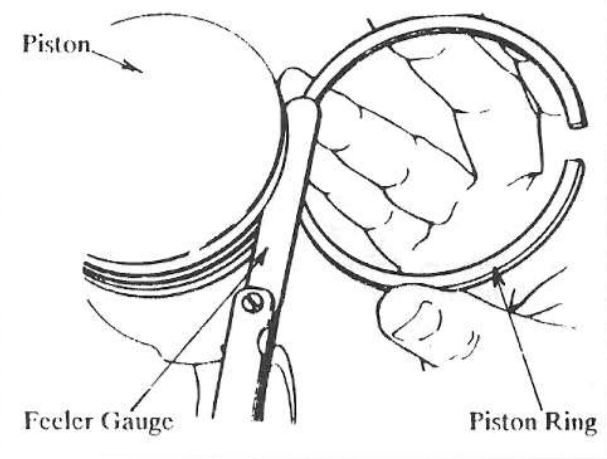
Available sizes: .254 and .508mm

Piston to Bore clearance: 0.10-0.056mm

Inspect the ring side clearance following the procedure under Fitting Piston Rings.

Check piston ring side clearance

Measure the ring side clearance.



Piston Ring clearance:

Top Ring 0.039-0.079mm

Second Ring: 0.039-0.79mm

Oil Control Ring 0.028-0.206mm

Piston pins following showing signs of fracture, etching or wear replace. Inspect the piston pin fit in the piston and rod.

Piston Pin diameter: 22.995-23.000mm

Piston Pin clearance:

In piston: 0.010-0.20mm

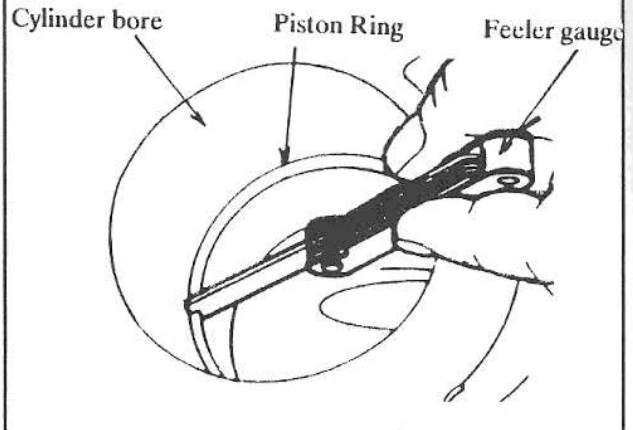
In Connecting rod: 0.018-0.043mm

Inspect the O.D. of the piston pin and the I.D. on the pin bore in the piston. Replace any piston pin, or piston that is not within specifications.

Replace all rings that are scored, chipped or cracked.

Inspect the end gap and check for specification.

Inspect the end gap



Compression Ring End Gap specification:

Top ring: 0.254-0.635mm

Second ring: 0.254-0.635mm

It is good practice to always install new rings when overhauling an engine. Rings should not be transferred from one position to another regardless of length of time in service.

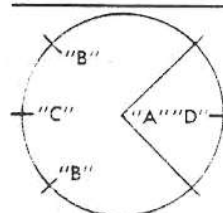
Check that the rings gaps are accurately spaced around the border of the piston. Install the piston with the arrow on the piston head toward the front of the engine.

Check that the rings gaps are accurately spaced around the piston.

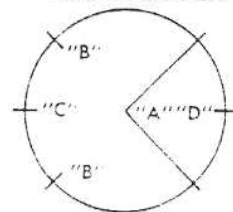
Engine left

Engine front

Engine right



1-3-5 CYLINDER



2-4-6 CYLINDER

"A" Oil ring spacer gap

(Tang in hole or slot within arc)

"B" Oil ring rail gaps

"C" 2nd compression ring gap

"D" Top compression ring gap

Fitting Pistons

Pistons are obtainable in average sizes.

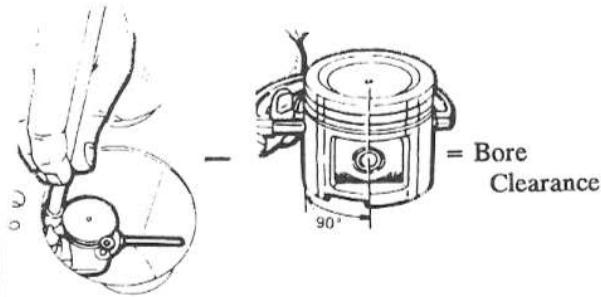
Follow the procedures in Cleaning and Inspection to measure the piston O.D. and cylinder bore I.D. The

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dimensions should be within specifications, and the piston to bore clearance (bore I.D. minus piston O.D.) must be within the specified limits.

Bore I.D. minus piston O.D = Bore clearance

**Cylinder Bore**

Standard Bore diameter: 96.507-96.533mm

Taper: 0.013mm max

Out of round: 0.010mm max

Piston

Piston standard size: 96.477-96.497mm

Available sizes: .254 and .508mm

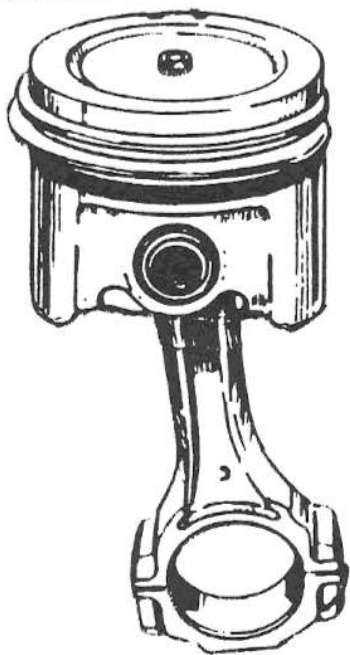
Piston to Bore clearance: 0.10-0.056mm

Refinish the cylinder if the correct clearance cannot be achieved.

Mark the piston when it has been placed for assembly in the cylinder to which it was adjusted.

New piston rings will give adequate service, if the taper, out-of-round and piston to cylinder bore clearance conditions of the cylinder bore are within specified limits.

Pistons are available in oversize of 0.254 and 0.508mm



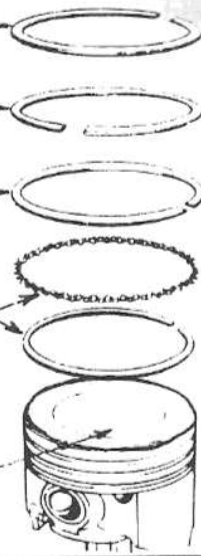
Rings from top of piston
Top Compression
Ring

Second Compression
Ring

Oil Rings

Expander

Piston



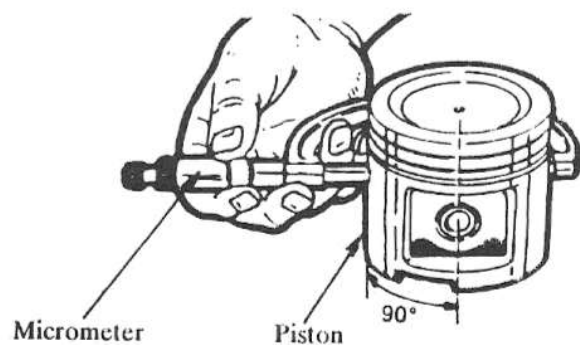
Pistons are available in oversize of 0.254 and 0.508mm. Remove the cylinder wall gauge, if the new rings are to be positioned in a used cylinder that has not been refinished.

Clean the cylinder bore thoroughly.

1. Take a cylinder bore check, to calculate the size piston to be used. Follow the method used in Cleaning and Inspection.

2. Choose the proper size piston to provide the desired clearance, 0.010 - 0.056. Measure the piston diameter in line with centreline of the piston pin at 90 degrees to the piston pin axis.

Measure the piston diameter in line with centreline of the piston pin at 90 degrees to the piston pin axis.



3. Check that the piston and cylinder block are at room temperature (21 deg. C).

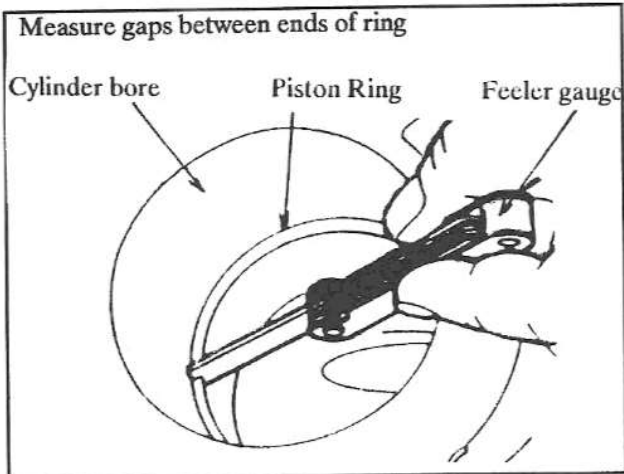
Allow the cylinder bore to cool and check that piston and bore are clean and dry prior to the piston fit check.

4. Choose the appropriate ring set for the size cylinder bore.

5. Place the ring in the cylinder bore in which it is going to be used and push the ring down into the bore area where normal ring wear is not encountered.

6. So that the ring is square with the cylinder wall, use the head of a piston to position the ring in the bore. Use caution to avoid damage to the ring or cylinder bore.

7. Using a feeler gauge measure the gap between the ends of the ring. Try another ring size if the ring gap is less or greater than the indicated limits.

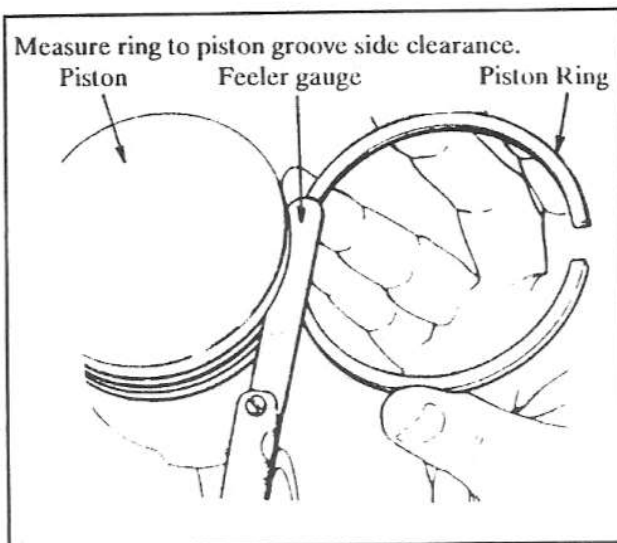


Compression Ring End Gap specification:

Top ring: 0.254-0.635mm

Second ring: 0.254-0.635mm

8. Using a feeler gauge, insert the gauge between the ring and its lower land to check the ring side clearance of the



compression rings. The gauge should slide freely around the whole ring circumference without binding. Any wear that arises will form a step at the inner portion of the lower land. If the lower lands have high steps, the piston should be replaced.

Piston Ring clearance:

Top Ring 0.039-0.079mm

Second Ring: 0.039-0.79mm

Oil Control Ring 0.028-0.206mm

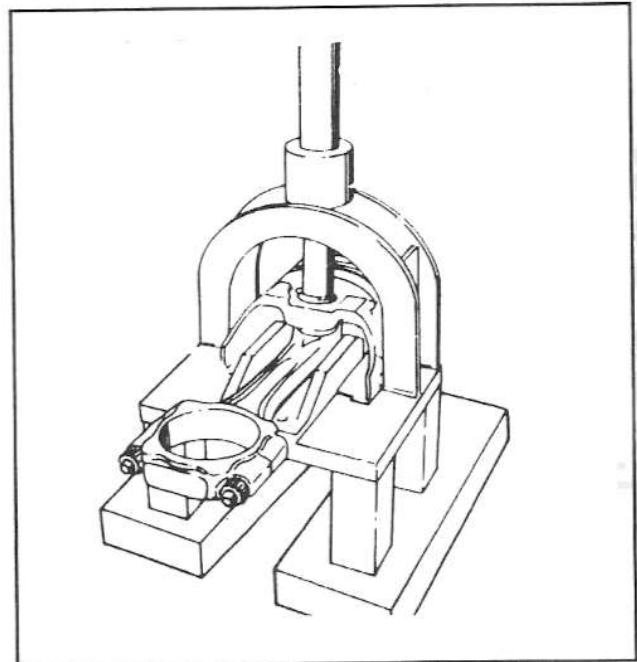
Assembly

Inspect the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod.

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications. Check that the attaching of the connecting rod to the piston, is assembled with the notch in the piston toward the front of the engine, the number stamped on the connecting rod and cap will be on the camshaft side of the engine (oil squirt hole in the connecting rod to the thrust side of the piston).

1. Place a light coat of engine oil to all parts.

2. Start the piston pin in the piston and connecting rod (this may require a light tap with a mallet). Using a press, force the piston pin through the piston and connecting rod until the pin is in the middle of the piston.



3. Inspect the end gap of the piston rings and it must be within regulations. Follow the instructions contained on the piston ring package and install the piston rings.

4. Inspect the ring side clearance of the compression rings with a feeler gauge.

5. Ensure the bearing inserts and bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

Install

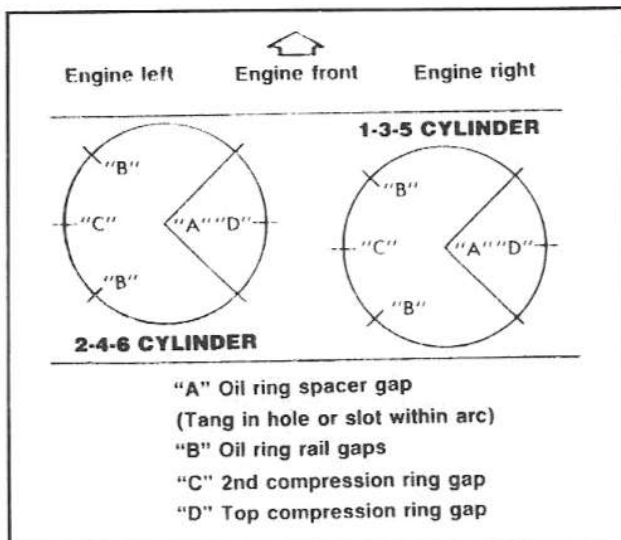
1. Oil the piston rings, pistons and cylinder walls using light engine oil.

2. Check that the pistons are installed in their original cylinders from which they were removed, or to which they were fitted. The connecting rod and bearing caps are numbered from 1-6 from removal if not stamped on the

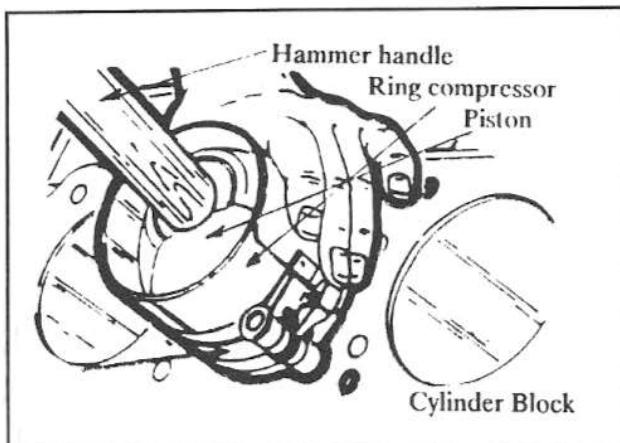
connecting cap. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore.

3. New bearings should be installed and the connecting rod should be numbered to correspond with the new cylinder, if a connecting rod is ever taken from one block or cylinder to another.

4. Check that the rings gaps are accurately spaced around the border of the piston.



5. Install a piston ring compressor on the piston and push the piston in with a hammer handle until it is somewhat below the top of the cylinder.

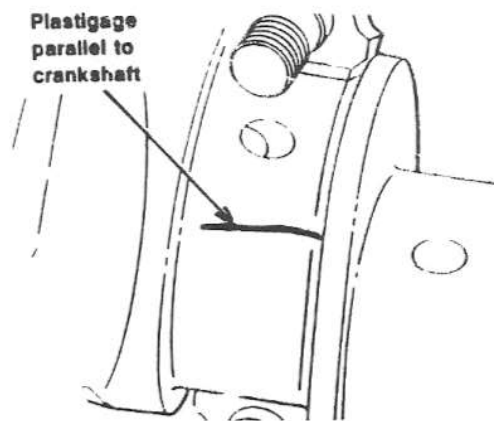


6. Ensure to direct the connecting rods to avoid damaging the crankshaft journals. Install the piston with the arrow on the piston head toward the front of the engine.

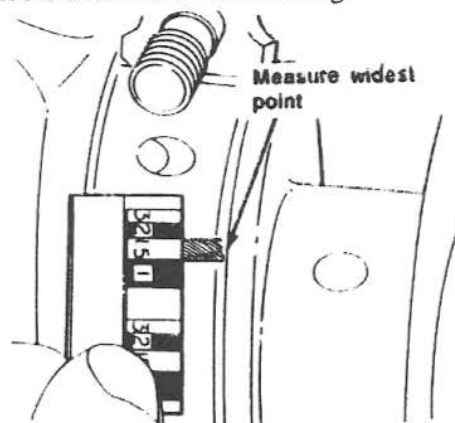
7. Inspect the clearance of each bearing following the procedure under Connecting Rod Bearing Replacement section.

8. Apply a light coat of engine oil to the journals and bearings.

9. Rotate the crankshaft throw to the bottom of its stroke, then push the piston down until the connecting rod bearing seats on the crankshaft journal.



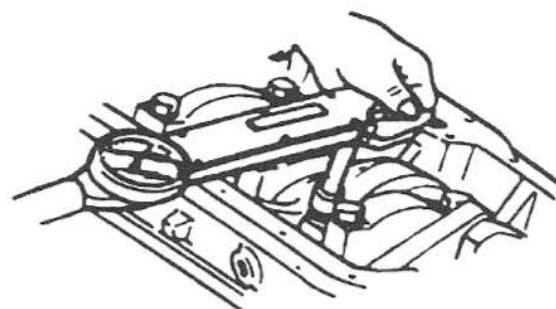
Inspect the clearance of each bearing



10. Install the connecting rod cap. Tighten connecting rod cap to specification.

Connecting Rod Bearing cap bolt
specification: 24-30Nm + 50° turn

Tighten connecting rod cap bolts to specification.

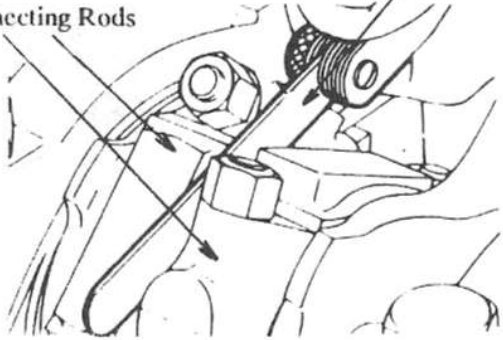


11. Check the connecting rod side clearance on each crankshaft journal.

Connecting Rod side
clearance specification: 0.10-0.38mm

Check connecting rod side clearance Feeler gauge

Connecting Rods



12. Install the oil pump inlet tube.

13. Install the oil pan and related parts. Install the cylinder head.

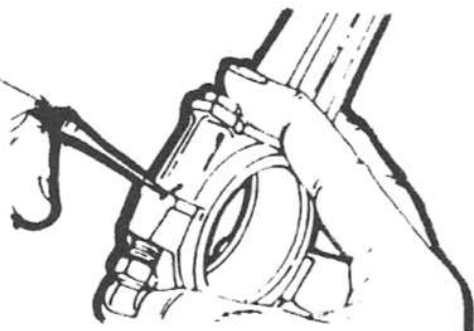
Crankshaft

Remove

1. Remove the timing cover / oil pump cover and timing chain.
2. Remove the flywheel or flexplate.
3. Remove the sump and gasket.
4. Remove the oil pump pickup pipe.
5. Check all bearing caps (main and connecting rod) are

Check all bearing caps (main and connecting rod) are marked so that they can be installed in their original position

Eicher



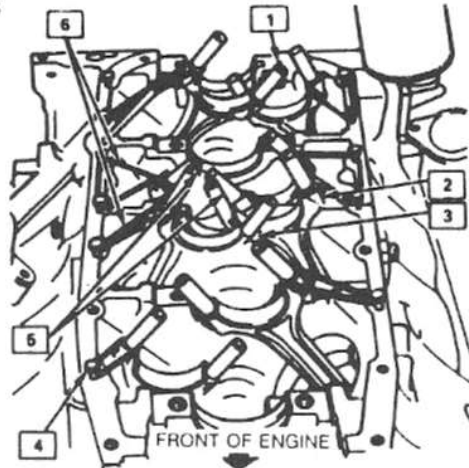
Connecting rod and cap

marked so that they can be installed in their original positions.

6. Take the connecting rod caps off. Install journal protection sleeves over the uncovered bolt threads, as each cap is taken off.

7. Take the main bearing caps out and remove the rear main bearing oil seal.

Install journal protection sleeves over the uncovered bolt threads



1. Rubber hose
2. #4 rod
3. #3 rod
4. Oil pan bolt
5. Note overlap of adjacent rods
6. Rubber band

8. Raise the crankshaft carefully out of the block so that the thrust bearing surfaces are not damaged, handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.

Clean

To avoid possible fractures or damage to the finished surfaces, handle the crankshaft with care. Use solvent to clean the crankshaft, then use compressed air to blow out all the oil passages.

Inspect

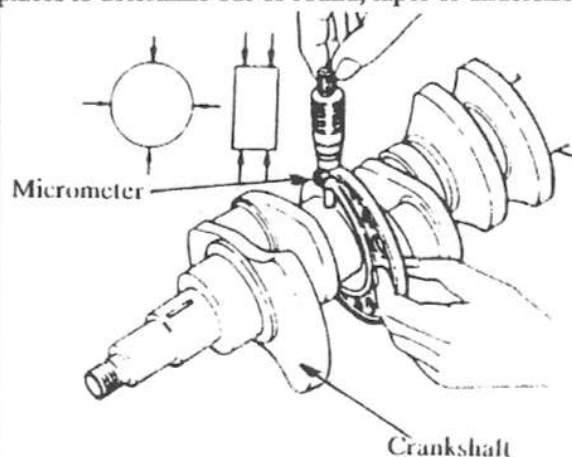
Check main and attaching rod journals for cracks, scratches, grooves or scores.

Measure the diameter of each journal in at least four places to determine out-of-round, taper or undersize.

Main Bearing Journal Diameter

Standard	63.470-63.495mm
Ovality	.008mm max.
Taper	.008mm max.

Measure the diameter of each journal in at least four places to determine out-of-round, taper or undersize.



Connecting Rod Journal Diameter**Standard** 57.117-57.147mm**Ovality** .008mm max.**Out-Of-Round** .008mm max.

Place the crankshaft in "V" blocks with a dial gauge micrometer adjusted to main journal number 2 or 3. Check that the runout of the crankshaft does not exceed specification.

Crankshaft Runout specification: 0.008mm max.

The spigot bearing is placed into the bore of the crankshaft, on engines that use a manual shift transmission. The bearing and adaptor are serviced as an assembly.

Check the spigot bearing for roughness, evidence of overheating, seal damage, or loss of lubricant. Replace it if any of these cases are found.

Repairs

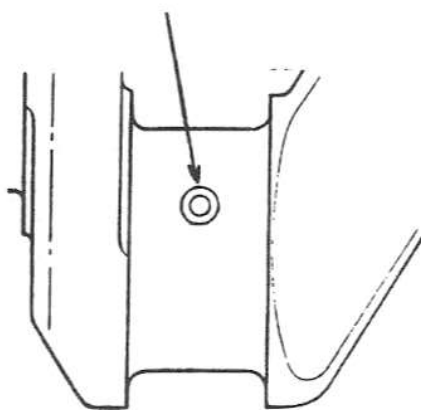
Dress slight imperfections with an oil stone. If the journals are severely damaged or exceed the wear limit, they should be refinished to size for the next undersize bearing.

Refinishing Journals

Refinish the journal to give the correct clearance with the next undersized bearing. Replace the crankshaft, if the journal will not clean up to give the correct clearance with the utmost undersized bearing available. Always copy the same journal shoulder radius that remained originally. Too small a radius will result in fatigue failure of the crankshaft. Too large of a radius will result in bearing failure due to radius ride of the bearing.

After refinishing the journals, chamfer the oil holes, then buff the journal with a No. 320 or 500 grit polishing cloth and engine oil. Crocus cloth may be used also as a polishing detergent.

Check crankshaft oil passages for obstruction.

**Install**

1. Remove the main inserts from the block and bearing caps.
2. Remove the connecting rod bearings inserts from the connecting rods and caps.

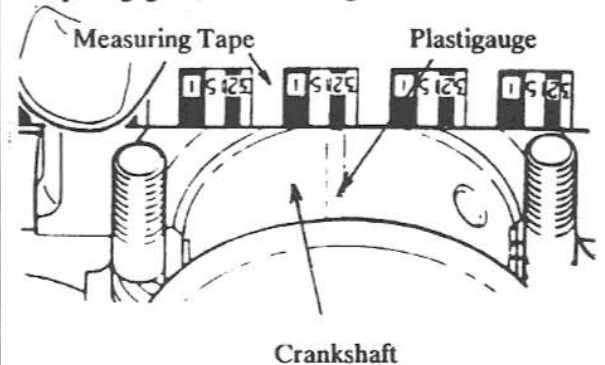
3. Install the correct undersize bearings, if the crankshaft main bearing journals have been refinished to a certain undersize.

4. Check that the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.

5. Put the upper main bearing inserts in place in the bores with the tang fitting in the slot supplied.

6. Install the lower main bearing inserts in the bearing caps.

Use plastigage to check bearing clearance



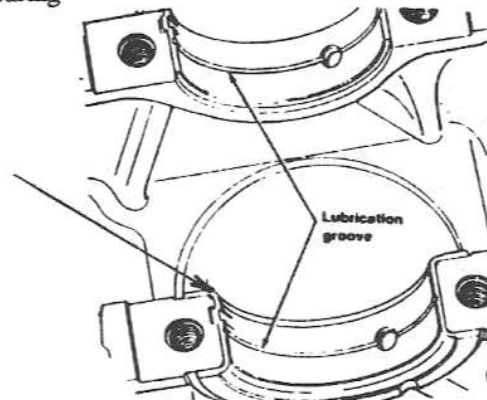
7. Lower the crankshaft carefully into place and do not damage the bearing surfaces.

8. Inspect the clearance of each main bearing. Using a piece of Plastigage on the crankshaft journal the full width of the journal and about 5 mm of middle. Follow steps under Main Bearing Replacement.

9. Place a light coat of engine oil on the journals and bearings.

10. Place a thin coat of oil resistant sealer to the rear main bearing cap at the rear top mating surface. Do not apply sealer to the area forward of the oil slinger groove. Install all the bearing caps.

No. 2 main bearing incorporates the crankshaft thrust bearing

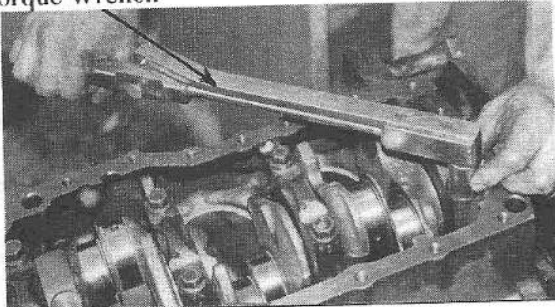


* No. 2 main bearing incorporates the crankshaft thrust bearing.

11. Tighten the main bearing bolt to specification.

Tighten the main bearing bolt to specification.

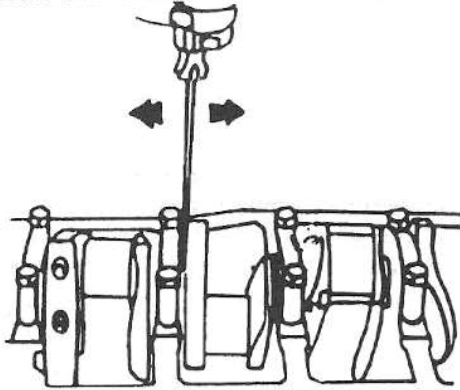
Torque Wrench



Main bearing cap bolts specified torque:
 VR 31-39Nm plus 45° Turn
 VS 12-18Nm plus 45° Turn

12. Push the crankshaft toward the rear of the engine. Install a dial indicator micrometer so that the contact point rests against the crankshaft flange and the indicator axis is parallel to the crankshaft axis.

Push the crankshaft forward and note the reading on the dial

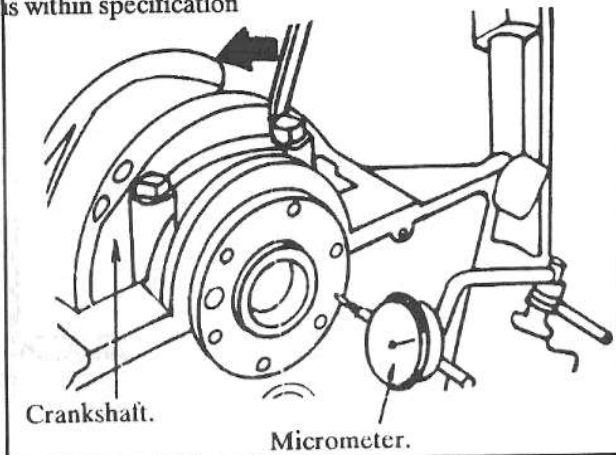


Zero the dial indicator micrometer. Push the crankshaft forward and note the reading on the dial.

Crankshaft End float specification: 0.08-0.28mm

If the end play exceeds specification, replace the thrust bearing. If the end play is less than the lowest limit, inspect the thrust bearing faces for scratches, burrs, nicks or dirt.

Turn the crankshaft slowly to check that flange run out is within specification



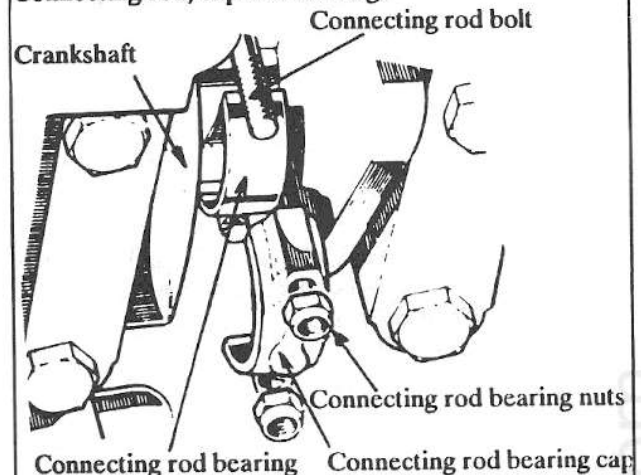
13. With the dial indicator micrometer still located as for point 11, turn the crankshaft slowly to check that flange run out is within specification.

Crankshaft Rear Flange Runout spec: 0.05mm max.

13. Install the rear main bearing oil seal. See Rear main bearing seal VN or VP.

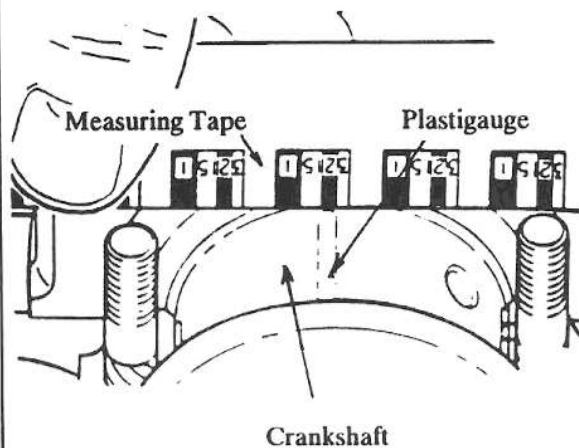
14. Install new bearing inserts in the connecting rods and caps.

Connecting rod, cap and bearings



15. Take the protection sleeves off from the bolts. Check the clearance of each bearing following the procedure under Connecting Rod Bearing Replacement. If the bearing clearances are to specification, place a light coat of engine oil to the journals and bearings.

Use plastigauge to measure clearance

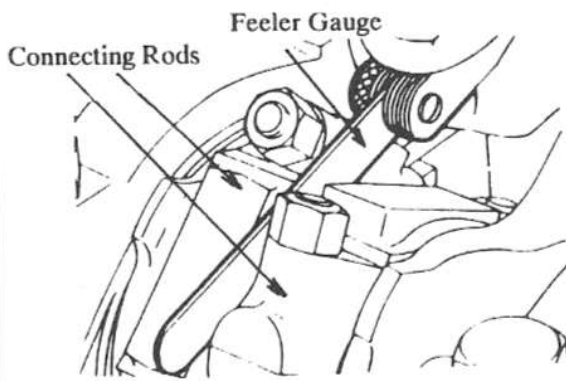


Connecting Rod Bearing clearance: 0.008-0.071mm

16. Install the connecting rod cap and fit new nuts, tighten to specification.

**Connecting Rod Cap bolt specification:
 20-30Nm plus 50° turn**

Check connecting rod side clearance



17. Check the connecting rod side clearance on each connecting rod crankshaft journal.

Connecting Rod Side Clearance spec: 0.10-0.38mm

18. Install the timing chain, gears and sprockets, timing chain / oil pump front cover as previously described.

19. Install crankshaft sensor and crankshaft balancer pulley, following methods under Crankshaft sensor and balancer section.

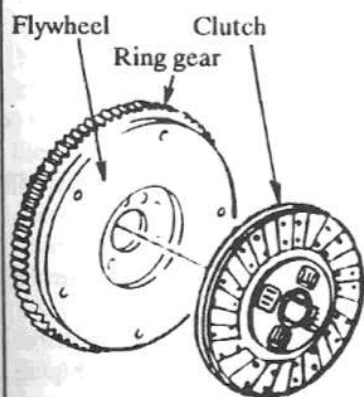
20. Clean the oil pump pickup pipe, oil pump screen and install.

21. Install the sump as previously described. Tighten bolts to specification.

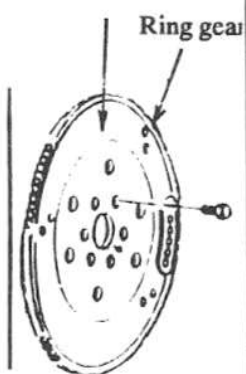
Sump attaching bolts: 8-12Nm

22. Install the flywheel/flexiplate on the crankshaft as

Flywheel & clutch



Flexiplate



previously described. Tighten bolts to specification.

Flywheel/flexiplate Attaching bolts: 75-90Nm

23. Install the clutch for manual transmission vehicles.

24. Install the oil level dipstick.

25. Install and adjust the drive belt.

Cylinder Block

Clean

Clean the bore with soap or detergent and water after any cylinder bore repair operation. To remove the soap or detergent rinse in clean water and dry the bores with a clean lint free cloth. Then wipe the bore with a clean cloth dipped in engine oil. Rusting of the cylinder bore may result if this procedure is not followed.

Using solvent thoroughly clean the block, if the engine is disassembled. From all machine surfaces remove the old gasket material. Remove all pipe plugs that seal oil passages, clean out all the passages. Using compressed air blow out all passages, both holes, etc.

Check that the threads in the cylinder head bolt holes are clean.

Dirt in the threads may cause binding and result in false torque reading. Use a tap to true-up threads and to remove any deposits.

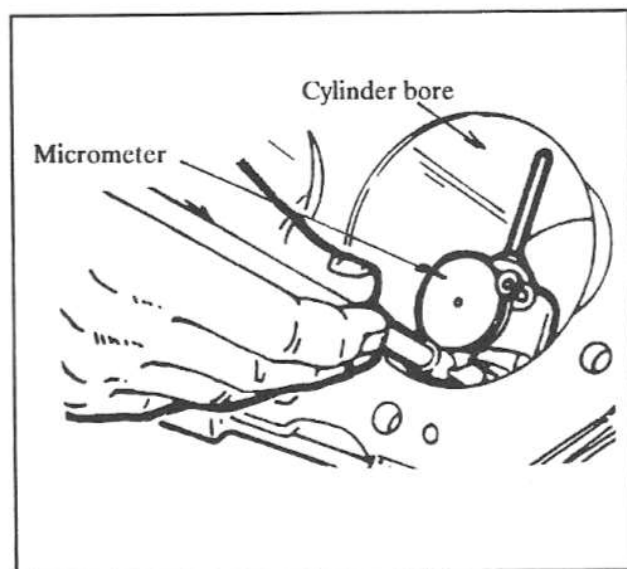
Inspect

Check for cracks, after the block has been cleaned. Tiny cracks that are not visible to the naked eye may be found by coating the suspected area with a mixture of 25% kerosene and 75% light motor oil. Wipe the area dry and instantly apply a coat of zinc oxide dissolved in wood alcohol. The coating will become discoloured at the defective area if cracks are existing. If the block is cracked replace it.

Inspect all machined gasket surfaces for burrs, nicks, scratches and scores.

Restore all expansion-type plugs that show evidence of leakage.

Check the cylinder walls for scoring, roughness or other signs of wear. Inspect the cylinder bore for out-of-round and taper. Following the instructions of the manufacturer, measure the bore with an accurate gauge. Measure the diameter of each cylinder bore at the top, middle and



bottom with a gauge placed at right angles and parallel to the centreline of the engine. Use the measurements obtained at 90 degrees to the engine centreline when calculating the piston to cylinder bore clearance.

Improve cylinders that are deeply scored and/or when out-of-round and/or taper exceeds the water limits.

It may be possible to remove the imperfections by honing the cylinder walls and installing new service piston rings providing the piston clearance is within its limits, if the cylinder walls have slight surface imperfections, but the out-of-round and taper are within its limits.

Use a thin grade of honing stone for this procedure.

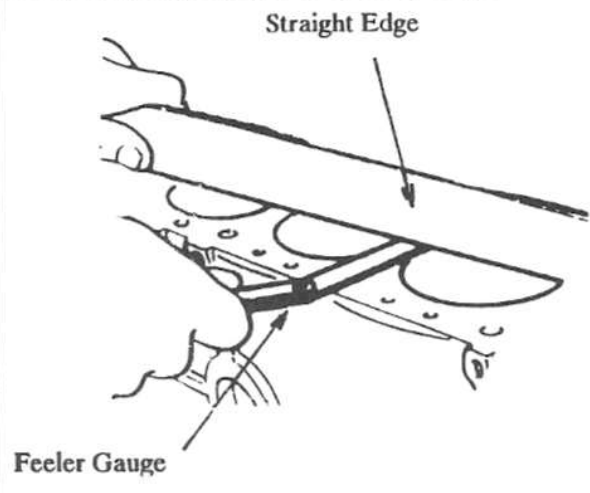
Refinishing Cylinder Walls

Only when the walls have minor faults such as light scuffs or scratches, honing is recommended for refinishing. The quantity of metal that has to be removed will calculate the grade of hone to be used. If coarse stones are used to begin the honing operation, leave adequate material so that all hone marks can be removed with the finishing hone, which is used to gain the required piston clearance.

Cylinder walls that are severely marred and/or worn beyond the specified limits should be refinished. Prior to any cylinder being refinished, all the main bearing caps must be in place and tightened to the proper torque so that the crankshaft bearing bores will not become distorted from the refinishing operation.

Refinish only the cylinder of the cylinders that require it. All pistons are the same weight, both standard and over-size, thus, various sizes of pistons can be used without upsetting engine balance.

Check block top surface with a straight edge.



PROBLEM SOLVING AND DIAGNOSIS

PROBLEM:

Engine will not crank.

POSSIBLE CAUSE:

Usually is in the starting system. If the system is not at fault, check for a hydrostatic lock or a seized engine.

PROBLEM:

Engine cranks normally but will not start.

POSSIBLE CAUSE:

The cause is probably in the ignition or the fuel system. Perform the following test to determine which system is at fault:

Detach a spark plug wire. Check the spark intensity.

If there is no spark or a weak spark at the spark plugs.

The cause is in the ignition system.

Replace the spark plug lead, recheck spark intensity.

Check fault code number 41 or ignition check as described in tune-up chapter, also check ignition chapter.

If there is a good spark at the spark plugs.

Check the ignition system. Check the spark plugs. Check fault code number 41 or ignition check as described in tune-up chapter, also check ignition chapter.

Fuel System

Check fuel system.

Engine

Mechanical failure in camshaft drive. Failed crank sensor unit.

PROBLEM:

Engine starts, but fails to keep running.

POSSIBLE CAUSE:

Fuel System

Check fuel system

Exhaust System

Exhaust system blocked.

Ignition System

Defective spark plugs. Leakage in the high tension wiring. Defective electronic control unit.

PROBLEM:

Engine runs, but misses.

POSSIBLE CAUSE:

Misses steadily at all speeds.

Remove ignition wire from one spark plug at a time, until all cylinders have been checked. Test spark on a special spark test implement.

Ignition System

If the miss is isolated in a particular cylinder, perform a spark test on the ignition lead of that cylinder.

If a good spark does not occur, the trouble is in the secondary circuit of the system. Check the spark plug wire.

If a good spark does occur, check the spark plug. If the spark plug is not at fault, a mechanical component of the engine is probably at fault.

Engine

Intake manifold gasket leak.

Perform a manifold vacuum or compression test to determine which mechanical component of the engine is at fault.

Misses erratically at all speeds.

Exhaust System

Exhaust system restricted.

Ignition System

Defective secondary wiring, coil or spark plugs.

Defective electronic control unit.

High tension leakage across the coils.

Defective ignition switch.

Check fuel system.

Fuel System

Check fuel system.

Engine

Perform a manifold vacuum or compression test to determine which mechanical component of the engine is at fault.

Misses at idle only.

Ignition System

Defective coils, ignition wiring or spark plugs.

Engine

Valve clearance set too tight. Worn camshaft lobe(s).

Perform a manifold vacuum or compression test to determine which mechanical component of the engine is at fault.

Misses at high speed only.

Fuel System

Check fuel system.

Ignition System

Defective spark plugs.

Cooling System

Engine overheating.

Engine

Perform a manifold vacuum or compression test to determine which mechanical component of the engine is at fault.

PROBLEM:

Rough engine idle.

POSSIBLE CAUSE:

Fuel System

Check fuel system.

Ignition System

Fouled or improperly adjusted spark plugs.

Incorrect ignition timing. Spark plug misfiring.

Engine

Perform a manifold vacuum or compression test to determine which mechanical component is at fault.

PROBLEM:

Poor acceleration.

POSSIBLE CAUSE:

Ignition System

Incorrect ignition timing. Fouled or improperly adjusted spark plugs.

Fuel System

Check fuel system.

Brakes

Improper adjustment - too tight.

Transmissions

Clutch slippage (manual shift transmissions). Improper band adjustment (automatic transmission).

Converter One-Way Clutch (automatic transmissions).

Engine

Perform a manifold vacuum or compression test to determine which mechanical component of the engine is at fault.

PROBLEM:

Excessive fuel consumption.

POSSIBLE CAUSE:

Final Checks

Fuel System

Ignition System

Check: Ignition timing, spark plug condition and adjustment.

Engine

Perform a manifold vacuum or engine compression test to determine which mechanical component of the engine is at fault. Check valve clearance.

Cooling System

Check the thermostat operation and heat range.

Transmission

Check band adjustment (automatic transmissions).

PROBLEM:

Engine Overheating.

POSSIBLE CAUSE:

Temperature sending unit and gauge.

Unit or gauge defective (not indicating correct temperature).

Engine

Cylinder head bolts not properly torqued. Incorrect valve clearance.

Low oil level or incorrect viscosity oil used.

Cooling System

Insufficient coolant. Cooling system leaks. Drive belt tension incorrect. Radiator fins obstructed. Thermostat defective. Thermostat improperly installed. Cooling system passage blocked. Water pump inoperative.

Ignition System

Incorrect ignition timing. Incorrect distributor advance.

Exhaust System

Restrictions in system.

PROBLEM:

Loss of coolant.

POSSIBLE CAUSE

Cooling System

Leaking radiator or water pump. Loose or damaged hose connections. Radiator cap defective. Overheating. Engine

Cylinder head gasket defective. Intake manifold to cylinder head gasket defective. Cylinder head or intake manifold bolts not properly torqued. Cylinder block core plugs leaking. Temperature sending unit leaking. Cracked cylinder head or block, or warped cylinder head or block gasket surface.

Specifications

GENERAL

Type.....	90° V6, OHV
Displacement.....	3791 cc
Compression ratio.....	8.5:1
Bore and Stroke(nominal).....	96.52x86.36mm
Firing Order.....	1-6-5-4-3-2
Cylinder numbering.....	- front to rear
Left Bank.....	1-3-5
Right Bank.....	2-4-6
Fuel type needed.....	Unleaded
Fuel octane rating.....	91
Power- kiloWatts.....	125Kg@4800rpm
Torque- Newtonmetre.....	292Nm@3600rpm
Taxable Horsepower- (RAC/SAE).....	34.6

CYLINDER BLOCK

Bore diameter.....	96.507-96.533mm
Bore out-of-round.....	0.010 mm max.
Bore taper.....	0.013 mm max.
Cylinder block to cylinderhead surface flatness....	0.08mm max.overall or .013mm per 25.4mm

CYLINDER HEAD

Thickness.....	1.372mm to 1.676mm
Min. combustion chamber volume.....	37.4cc (with valves and spark plugs installed)

VALVE - INTAKE

Material.....	High Manganese Med.Carbon Steel
Diameter head.....	43.561-43.307mm
Diameter stem.....	8.666-8.641mm
Angle valve face.....	45°
Angle valve seat.....	45°
Width valve seat.....	1.52-2.03mm
Valve seat run-out.....	0.05mm
Clearance in guide.....	0.038-0.089mm
Valve installed height (valve tip to spring seat).....	49.66 +/- .51mm
Valve head margin thickness.....	0.63mm min.
Valve oversize avail.....	0.254mm

VALVE - EXHAUST

Material.....	High Alloy Exhaust Valve Steel
Diameter head.....	37.719-37.973mm
Diameter stem.....	8.666-8.648mm
Angle face valve.....	45°
Angle valve seat.....	45°
Width valve seat.....	2.29-2.79mm
Valve seat run-out.....	0.05 mm
Clearance in guide.....	0.038-0.082mm
Valve installed height (valve tip to spring seat).....	49.66 +/- .51mm
Valve head margin thickness.....	0.63mm min.
Valve oversize avail.....	0.254mm

VALVE SPRINGS

Allowable variance in spring end length.....	1.60mm
Valve spring compressed height/load:	
Valve opened height	
Outer Spring.....	618-681/31.9N/mm
Inner Spring.....	334-369/31.9N/mm
Assembled height	
Outer Spring.....	280-307/43.9N/mm
Inner Spring.....	164-182/43.9N/mm
Valve spring installed height.....	43.69 +/- 0.76mm

VALVE TIMING

Inlet	
Opens - BTC.....	18°
Closes - ABC.....	8° 30'
Duration.....	282° 30'
Exhaust	
Opens - BBC.....	64°
Closes - ATC.....	38° 30'
Duration.....	282° 30'

CAMSHAFT

Material.....	5150 Steel
Bearing Journal	
Diameter.....	45.339-45.364mm
Number.....	4
Clearance in bearings.....	0.013-0.089mm
Camshaft bearing diameter(installed).....	45.337-45.428mm
Cam lift	
Intake.....	6.909mm
Exhaust.....	6.909mm

PISTONS

Material.....	Cast Alum Alloy
Piston diameter.....	96.477-96.497mm
Piston to bore clearance.....	0.010-0.056mm
Piston pin bore offset & direction....	1.016mm (Major Thrust Side)
Piston and pin assemblies serviced....	Std.0.25,0.508mm
Ring Groove widths	
Compression ring upper.....	1.530-1.555mm

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Compression ring lower.....	1.530-1.555mm
Oil control ring.....	3.030-3.055mm

PISTON RINGS

Compression ring upper	
Type.....	Molybdenum filled, Balanced Section, Barrel Lapped Type.
Ring width.....	1.476-1.491mm
Side clearance.....	0.039-0.079mm
Gap.....	0.254-0.635mm

Compression ring lower

Type.....	Inverted Torsional Taper Faced Type
Ring width.....	1.476-1.491mm
Side clearance.....	0.039-0.079mm
Gap.....	0.254-0.635mm

Oil Control Ring.

Type.....	Segmented with Circumferential Expanded Type Spacer
Ring Assembly Width.....	2.850-3.002mm
Side Clearance.....	0.028-0.206mm
Rail gap.....	0.381-1.397mm

CONNECTING ROD

Type.....	Malleable Cast Iron 'I' Section
Length (centre to centre).....	162.052-162.154mm
Alignment.....	Bend: 0.020mm/25.4mm Twist: 0.038mm/25.4mm

PISTON PINS

Material.....	Steel-Case Hardened and Tempered
Length.....	60.1-60.6mm
Diameter.....	22.995-23.000mm
Piston to pin clearance.....	0.010-0.020mm
Piston to connecting rod fit.....	0.018-0.04mm Interference Fit

CRANKSHAFT

Material.....	Nodular Cast Iron
Main Bearing Journal	
Diameter.....	63.470-63.495mm
Out-of-round.....	0.008mm
Taper.....	0.008mm
Crankshaft End Float.....	0.08-0.28mm
Bearing Clearance.....	0.013-0.051mm
End Thrust.....	Against Main Bearing No.2
Connecting Rod JournalDia.....	57.117-57.147mm
Stroke.....	86.36mm
Out-of-round.....	0.008mm
Taper.....	0.008mm
Bearing Clearance.....	0.008-0.071mm
Side Clearance.....	0.10-0.38mm

BALANCE SHAFT

End Play.....	0-.203mm
Front Radial Play.....	0-.028mm
Rear Radial Play.....	0.127-.119mm
Gear Lash.....	0.50-.127mm

LUBRICATION

Main bearings.....	Pressure
Connecting rod bearings.....	Pressure
Piston pins.....	Splash
Camshaft bearings.....	Pressure
Timing Chain.....	Splash
Balance shaft bearings.....	Splash
Cylinder walls.....	Splash
Oil Pump	
Oil pressure regulator.....	Approx. 340kPa
Oil pressure hot.....	275kPa min @ 1850rpm and above
Oil filter by-pass valve.....	69 kPa
Oil Pump Gears	
Inner gear tip to outer gear clearance.....	0.15mm max.
Outer gear to housing clearance.....	0.203-0.381mm max
Inner & outer gear end to housing clearance...	0.025- -.0899mm
Oil pan capacity (less filter) VR	3.8 litres
Oil pan capacity (less filter) VS	4.0 litres
Oil Filter	
Capacity.....	0.3 litres

LUBRICANTS

General Engine Oil	SG Quality
Camshaft lobes.....	Lubrizol 6612
Hydraulic valve lifters and bores.....	Lubrizol 6612
Crankshaft thrust bearing surfaces.....	Molybdenum Disulphide Grease Holden Spec. HN1271
Oil pump gears and pump cavity.....	Petroleum Jelly
Camshaft thrust face to cylinder block.....	Molybdenum Disulphide Grease Holden Spec.HN1271

SEALANTS.

Rear main bearing cap (side seal)...	RTV1080 Holden Spec. HN1770
Main bearing cap to cylinder block....	Loctite 515
Gasket Eliminator Holden Spec. HN1581	
Rear Main Bearing Cap Side Seal ...	RTV 732, Holden specification HN 1373
Intake Manifold Corner Edge Seal ...	RTV 732, Holden specification HN 1373
Camshaft rear welsh plug, Balance shaft rear welsh plug.....	Loctite 620 Holden Spec. HN1952
MAT sensor, Coolant temperature sender, By-pass hose union, Cylinder block coolant drain plug threads, Cylinder block coolant welsh plug, Cylinder head bolt thread, Rocker arm pivot bolt thread Front cover to cylinder block bolt thread.....	Loctite 243 Holden Spec. HN1256 class 2 Type 2
Intake manifold seal corners	TRV 1080

Timing chain damper bolt.....	12-26
Starter motor to engine mount bracket bolt.....	15-35
Starter motor bolt:	
Manual Transmission.....	36-50
Automatic Transmission.....	44-56
Air conditioning compressor bolt.....	35-65
MAT sensor.....	Hand tighten plus 1 turn
Main bearing cap bolts specified torque:	
VR	31-39Nm plus 45 ⁰ Turn
VS	12-18Nm plus 45 ⁰ Turn
Oil pan bolt.....	8-12
Oil pan drain plug.....	30-60
Oil pump suction pipe flange to crankcase bolt.....	8-12
Clutch pressure plate to flywheel bolt.....	20-25
Water pump pulley to hub bolt.....	12-20
Balance shaft driven gear retaining bolt.....	18-22 + 35 ⁰
Idler assembly/power steering pump mounting bolt.....	40-54
Idler assembly/power steering pump pulley bolt...	10-20
Right hand lifting bracket bolt.....	40-54
Belt tensioner bolt/stud.....	40-60
Oxygen sensor to exhaust manifold.....	38-46
Water outlet to intake manifold bolt.....	20-34
Bleed pipe to intake manifold.....	4-7
Ignition module to generator support bracket nut.....	8-11
Generator brace bracket to cylinder head bolt.....	40-60
Knock sensor.....	14-22
Rear crossmember to side frame bolt.....	40-50
Support to rear mounting nut.....	20-25
Rear mount to extension bolt.....	40-50
Oil cooler line to oil pan clip screw.....	5-7
VS top engine cover	8-11

[illegible]

