

Chapter 4

Engine

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Specifications

ENGINE ASSEMBLY

Type	V6 DOHC 24 valve
Model	5VZ-FE
Capacity	3 378 cc
Maximum power	132 kW @ 4800 rpm
Maximum torque	303 Nm @ 3600 rpm
Bore	93.5 mm
Stroke	82.0 mm
Compression ratio	9.6:1
Lubricant:	
Grade —	
Recommended	SAE 10W – 30 SH, SJ or ILSAC
Alternative	SAE 15W – 40 or 20W – 50 SH or SJ
Capacity with filter	5.2 litres

TUNE UP

Firing order	1-2-3-4-5-6
Valve clearance (cold):	
Inlet	0.13 – 0.23 mm
Exhaust	0.27 – 0.37 mm
Spark plugs:	
Type —	
NGK	BKR5EKB – 11
Nippondenso	K16TR11
Gap	1.1 mm

Spark plug lead resistance (maximum)	25 k/ohms
Ignition timing	8 – 12° BTDC (refer to text)
CO concentration	1.0 – 2.0 %
¹ Idle speed	700 ± 50 rpm
Compression pressure at 250 rpm (minimum):	
Nominal	1 200 kPa
Minimum	1 000 kPa
Allowable variation	100 kPa
Drive belt deflection with a force of 100 N (10 kg):	
Alternator belt —	
New	12 – 14 mm
Used	14 – 17 mm
Power steering belt —	
New	7 – 8 mm
Used	8 – 10 mm
Air conditioner belt —	
New	4 – 5 mm
Used	5 – 7 mm

¹ Measured with the vehicle in Park or Neutral and all accessories Off.

CYLINDER HEAD

Material	Aluminium alloy
Face distortion limit	0.10 mm
Valve seat:	
Width	1.0 – 1.4 mm
Angle	45°
Valve guide bore:	
Standard	10.985 – 11.027 mm
Oversize	11.050 – 11.077 mm
Spark plug tube installed height	49 – 49.4 mm

CAM FOLLOWERS

Cam follower diameter	30.966 – 30.976 mm
Cam follower bore diameter	31.000 – 31.018 mm
Oil clearance:	
Standard	0.024 – 0.052 mm
Limit	0.08 mm

CAMSHAFT

Number of bearing journals:	
Inlet	5
Exhaust	4
Camshaft journal:	
Diameter	26.949 – 26.965 mm
Maximum out of round	0.06 mm
Oil clearance —	
Standard	0.035 – 0.072 mm
Maximum	0.10 mm

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Camshaft end float:	
Standard	0.033 – 0.080 mm
Limit	0.12 mm
Camshaft gear backlash:	
Standard	0.020 – 0.200 mm
Maximum	0.30 mm
Cam lobe height:	
Inlet —	
Standard	42.31 – 42.41 mm
Minimum	42.16 mm
Exhaust —	
Standard	41.96 – 42.06 mm
Minimum	41.81 mm
Camshaft sub gear spring end gap	18.2 – 18.8 mm

VALVES AND SPRINGS

Minimum valve head margin:	
Standard	1.0 mm
Minimum	0.5 mm
Valve length:	
Inlet —	
Standard	95.15 mm
Minimum	94.60 mm
Exhaust —	
Standard	94.90 mm
Minimum	94.40 mm
Valve assembled height	37.0 mm
Valve guide type	Replaceable
Valve guide diameter:	
Inside	6.010 – 6.030 mm
Outside —	
Standard	11.033 – 11.044 mm
Oversize	11.083 – 11.094 mm
Valve stem diameter:	
Inlet	5.970 – 5.985 mm
Exhaust	5.965 – 5.980 mm
Valve stem to guide clearance:	
Standard —	
Inlet	0.025 – 0.060 mm
Exhaust	0.030 – 0.065 mm
Minimum —	
Inlet	0.08 mm
Exhaust	0.10 mm
Valve face angle	44.5°
Valve springs:	
Free length	44.78 mm
Maximum out of square	2.0 mm
Valve spring loaded length	
at 186 – 206 kg	33.3 mm

CYLINDER BLOCK

Type	6 cyl 60° V configuration
Material	Cast iron alloy
Bore diameter:	
Grade 1	93.500 – 93.510 mm
Grade 2	93.510 – 93.520 mm
Grade 3	93.520 – 93.530 mm
Maximum —	
Standard	93.730 mm
Oversize	94.230 mm
Face distortion limit	
(maximum)	0.05 mm

CRANKSHAFT AND MAIN BEARINGS

Number of main bearings	4
End float clearance:	
Standard	0.020 – 0.220 mm
Limit	0.300 mm
Thrust washer thickness	2.44 – 2.49 mm
Main bearing journal:	
Diameter —	
Standard	63.985 – 64.000 mm
Undersize	63.745 – 63.755 mm
Maximum out of round and taper	0.02 mm
Maximum journal runout	0.06 mm
Main bearing oil clearance:	
Standard —	
No 1	0.020 – 0.038 mm
Others	0.024 – 0.042 mm
Undersize —	
No 1	0.019 – 0.059 mm
Others	0.023 – 0.063 mm
Maximum	0.08 mm
Crankpin journal:	
Diameter —	
Standard	54.987 – 55.000 mm
Undersize	54.745 – 54.755 mm
Maximum out of round and taper	0.02 mm

CONNECTING RODS AND BEARINGS

Connecting rod side clearance:	
Standard	0.150 – 0.330 mm
Maximum	0.380 mm
Connecting rod bend limit	0.05 mm per 100 mm
Connecting rod twist limit	0.15 mm per 100 mm
Connecting rod bearing oil clearance:	
Standard	0.024 – 0.053 mm
Oversize	0.023 – 0.069 mm
Limit	0.08 mm
² Connecting rod bolt outside diameter:	
Standard	7.86 – 8.00 mm
Minimum	7.60 mm

² Measured 15 mm from the end of the connecting rod bolt.

PISTONS AND GUDGEON PINS

³ Piston diameter:	
Grade 1	93.356 – 93.366 mm
Grade 2	93.367 – 93.376 mm
Grade 3	93.377 – 93.386 mm
Oversize	93.856 – 93.886 mm
Piston oil clearance:	
Standard	0.134 – 0.154 mm
Maximum	0.174 mm
Gudgeon pins:	
Diameter	21.997 – 22.009 mm
Oil clearance —	
Standard	0.005 – 0.011 mm
Maximum	0.05 mm

³ Measured 26 mm from the top of piston, at right angles to gudgeon pin centerline.

PISTON RINGS

Number:	
Compression	2
Oil control	1
Piston ring to groove side clearance:	
No 1	0.040 – 0.080 mm
No 2	0.030 – 0.070 mm
Piston ring end gap:	
Standard —	
No 1	0.30 – 0.50 mm
No 2	0.40 – 0.60 mm
Oil ring	0.15 – 0.55 mm
Maximum —	
No 1	1.10 mm
No 2	1.20 mm
Oil ring	1.15 mm

FLYWHEEL/DRIVEPLATE

Runout limit (lateral):	
Flywheel	0.2 mm
Driveplate	0.1 mm

LUBRICATION

Oil pump type	Rotor
Filter type	Disposable spin on
Oil pressure hot:	
At idle speed (minimum)	29 kPa
At 3 000 rpm	245 – 520 kPa
Oil pump clearances:	
Standard —	
Inner rotor tip to outer rotor	0.11 – 0.24 mm
Outer rotor to body	0.10 – 0.18 mm
Rotor assembly end clearance	0.03 – 0.09 mm
Maximum —	
Inner rotor tip to outer rotor	0.35 mm
Outer rotor to body	0.30 mm
Rotor assembly end clearance	0.15 mm

TORQUE WRENCH SETTINGS

Alternator:	
To support bracket through bolt	51 Nm
Support bracket to cylinder head	19 Nm
Adjuster bar to cylinder block	42 Nm
Camshaft:	
Bearing cap bolts	16 Nm
Cover plate —	
Cap bolts	16 Nm
Bracket retaining nut and bolt	8 Nm
Sprocket bolt	110 Nm
Cam angle sensor bolt	8 Nm
Coolant bypass pipe bolts/nut	9 Nm
Coolant drain plug in cylinder block	39 Nm
Connecting rod nuts:	
First stage	25 Nm
Second stage	+ 90°
Crank angle sensor bolt	8 Nm
Crankshaft pulley bolt	250 Nm
Cylinder head bolts:	
Multihex bolts —	
First stage	34 Nm
Second stage	+ 90°
Third stage	+ 90°
Allen head bolt	18 Nm

Dipstick guide bolt	8 Nm
Driveplate/flywheel to crankshaft bolts	85 Nm
Engine lifting hook	40 Nm
Engine mounting:	
Front —	
Bracket to cylinder block bolts	44 Nm
To crossmember bolts	38 Nm
To bracket bolts/nuts	40 Nm
Rear —	
Crossmember to chassis bolts	58 Nm
To transmission housing	18 Nm
To crossmember bolts	18 Nm
Exhaust:	
Manifold to cylinder head nuts	40 Nm
Heat shield bolts	8 Nm
Engine pipe to manifold nuts	45 Nm
Engine pipe to resonator flange bolts	52 Nm
Resonator to rear muffler flange bolts	52 Nm
Fuel rail:	
Pressure pipe banjo bolt	34 Nm
Pressure regulator bolts	8 Nm
Retaining bolts	13 Nm
Ignition coil assembly bolts	8 Nm
Inlet manifold to cylinder head	18 Nm
Main bearing cap bolts:	
First stage	61 Nm
Second stage	+ 90°
Oil cooler to cylinder block union bolt	59 Nm
Oil pump:	
End cover screws	10 Nm
Pick up pipe nuts/bolts	8 Nm
Relief valve plug	37 Nm
To cylinder block bolts —	
10 mm bolts	42 Nm
8 mm bolts	20 Nm
Oil pressure switch	15 Nm
Oxygen sensor	20 Nm
Power steering:	
Pump to bracket bolts	39 Nm
Through bolt	64 Nm
Bracket to cylinder head bolts	19 Nm
Plenum chamber:	
To inlet manifold nuts/bolts	18 Nm
Upper to lower plenum chamber nuts/bolts	18 Nm
Support bracket —	
To cylinder head bolt	40 Nm
To upper plenum chamber bolt	18 Nm
Rear crankshaft oil seal carrier bolts	8 Nm
Rocker cover bolts	6 Nm
Spark plugs	18 Nm
Starter motor retaining bolts	39 Nm
Sump drain plug	25 Nm
Sump retaining bolts/nuts	8 Nm
Thermostat housing nuts	20 Nm
Throttle body to plenum chamber nuts/bolts	18 Nm
Timing belt:	
Camshaft sprocket bolt	110 Nm
Cover bolts	9 Nm
Crankshaft pulley bolt	250 Nm
Guide pulley bolt	40 Nm
Tensioner pivot bolt	35 Nm
Tensioner retainer bolts	27 Nm
Water pump bolts	20 Nm

Description

The engine fitted to the vehicles covered in this manual is a six cylinder, water cooled, V configuration type with overhead camshafts.

The four camshafts drive 12 valves in each cylinder head, and run directly in the crossflow alloy cylinder heads. The inlet camshafts are driven by the crankshaft via a toothed rubber timing belt which, must be renewed every 150 000 km. Belt tension is regulated by an automatic tensioner assembly.

The exhaust camshafts are driven by the inlet camshafts via a helical gear arrangement. Backlash between the inlet and exhaust camshaft drive gears is minimised by a spring loaded sub gear on each exhaust camshaft. The camshaft lobes bear directly on hollow cam followers to reduce inertia in the valve train. The camshaft end float is controlled by thrust flanges located on each side of the front bearing. The cam followers have a recess in the top to allow different valve clearance adjusting shims to be installed without removing the camshafts. The valve adjusting shims are made of hardened ground steel to ensure a long service life.

The crankshaft is supported by four main bearings and the end float is taken at number two main bearing by renewable thrust bearing plates. The crankshaft bearing caps are united by a cradle. This cradle reduces vibration in the cylinder block wall, and reinforces the crankshaft support.

The pistons are constructed of a high temperature aluminium alloy and have two compression rings and one oil ring. The alloy steel type gudgeon pins are fully floating in both the pistons and the connecting rods at operating temperature. The gudgeon pins are retained in position by snap rings. The connecting rods are of forged carbon steel.

The connecting rod studs used on this engine are of the plastic region type (stretch type). Whenever these type of studs are removed they must be carefully inspected for signs of thinning at one point or distortion. If any doubt about the condition of these studs exists, the connecting rod must be renewed as an assembly.

The main and connecting rod bearings are of the renewable aluminium alloy type.

The oil pump, which is driven directly by the crankshaft, is a trochoid rotor type installed on the front of the engine. The relief valve is installed in the passage on the delivery side of the oil pump regulating the maximum oil pressure supplied to the engine. The oil cooler is mounted on the side of the engine, has coolant flowing through it and operates as a heat exchange. It removes the excess heat from the engine oil and transfers it to the cooling system. The oil filter is a full flow, disposable type. Oil control at the crankshaft is provided by oil seals installed in the oil pump body at the front of the cylinder block and in a carrier at the rear of the cylinder block. Oil control at the front of the inlet camshafts is by oil seals located in the cylinder heads.

The engine and transmission assembly are supported by three rubber bonded mountings, with one on each side of the cylinder block and one on the transmission extension housing.

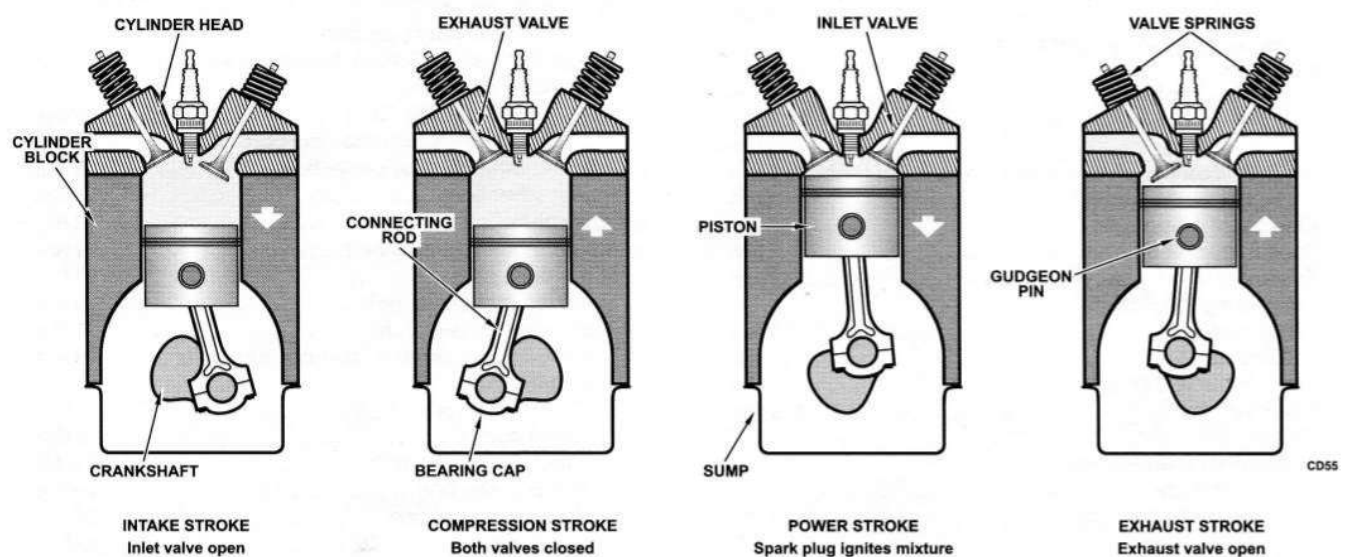
Routine Maintenance

ENGINE TUNE-UP

In the past, an engine tune-up was an important part of regular maintenance. As mechanical and electrical components became worn, the engine would not perform as well as it should. It was necessary to have certain items checked, cleaned and adjusted or renewed.

On vehicles covered by this manual, the engine ECU (electronic control unit) controls many things that were previously manually adjustable. However, the term tune-up is still commonly used when referring to engine maintenance procedures performed in a set order. When trying to locate a fault such as a misfire or poor performance, it is good mechanical practice to perform a tune-up before starting other diagnosis. Despite the use of electronic engine management systems, a tune-up can be confidently performed at home without using specialised equipment.

The components which are renewed during a tune-up will depend on the age and condition of the vehicle. With a new, well maintained vehicle you may only need to renew the spark plugs and filters. With an older (high kilometers) vehicle you may have to renew the above components as well as spark plug leads.



Major components and operating principle of the engine.

Similarly, the adjustments required will vary with the age and condition of the vehicle. On vehicles covered by this manual, the spark plug gap and to a lesser degree the valve clearance require regular checking and if necessary adjustment. Idle speed and mixture (CO concentration) is set in the factory and controlled by the ECU, and should not normally require adjustment.

The following is a summary of the procedures required for an engine tune-up and the order in which they should be done. The major procedures are described individually in more detail later in this chapter.

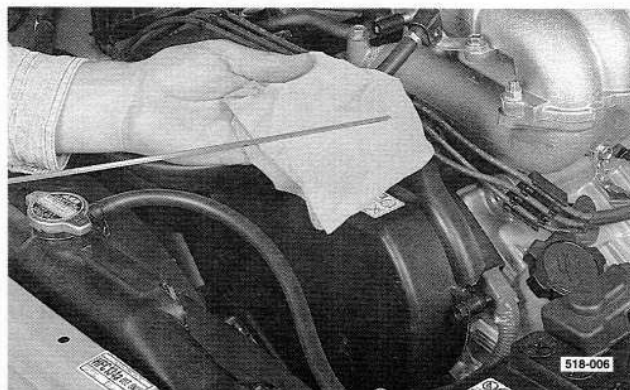
Tune-up Procedures

- 1 Check the engine compartment for any obvious problems:
 - a Battery, ensuring that the case top is clean, the terminals are tight and not corroded. Top up the battery if necessary and ensure that it is firmly mounted.
 - b Engine compartment fluid levels, including coolant condition.
 - c Fuel, coolant and vacuum hoses for hardening, softening, leakage, etc.
 - d Electrical connections for looseness, corrosion, frayed or deteriorated wiring.
- 2 Air cleaner.
- 3 Fuel filter.
- 4 Engine drive belts.
- 5 Valve clearance. This only necessary every 80 000 Km.
- 6 Cylinder compression test. This need only be done if trying to rectify a fault, eg. misfire, rough idle, or if the mechanical condition of the engine is unknown, perhaps after the car has been purchased. It is impossible to tune an engine that is not in good mechanical condition. If the compression test indicates a problem, mechanical repairs must be made before continuing with the tune-up. It is also a good idea to write down the compression figures for future reference.
- 7 Spark plugs.
- 8 High tension leads.
- 9 Idle speed and CO concentration.

ENGINE OIL AND FILTER

To Check Oil Level

- 1 Park the vehicle on a level surface, turn off the engine and raise the bonnet.
- 2 Wait approximately one minute to allow the oil to drain into the sump.



Checking the engine oil for correct level and dilution on the dipstick.



Equipment necessary for an oil change. Note the spare drain plug washer in case the one on the vehicle is damaged.

- 3 Remove the dipstick and wipe it clean, using a lint free cloth. Insert the dipstick fully into the tube.
- 4 Withdraw the dipstick and check the oil level. The oil level should be maintained between the marks on the dipstick. The difference between the marks on the dipstick represents approximately 1.2 litres of engine oil. If oil needs to be added to the engine, proceed as follows:
 - a Clean around the oil filler cap on the top of the engine and remove the cap.
 - b Add the required quantity of engine oil.
 - c Repeat steps 2 to 4 until the oil level reaches the Full mark.

To Renew Oil and Filter



It is best to drain the engine sump with the oil at operating temperature. However, when the oil is hot take care to avoid scalding.

- 1 Drive the front of the vehicle onto car ramps and stop the engine. Chock the front wheels.
- 2 Raise the rear of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.



Engine sump drain plug and oil filter location. Stoneguard removed.

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TIP Keep the vehicle as level as possible to avoid false readings when checking the lubricant levels.

- 3 Using a wire brush and a cloth, clean around the engine sump drain plug.
- 4 Place a container under the engine sump, remove the drain plug with the appropriate size ring spanner and allow the engine sump to completely drain.
- 5 Remove the oil filter with a filter removal tool, turning it in an anticlockwise direction. Allow the residual engine oil to drain into the container.

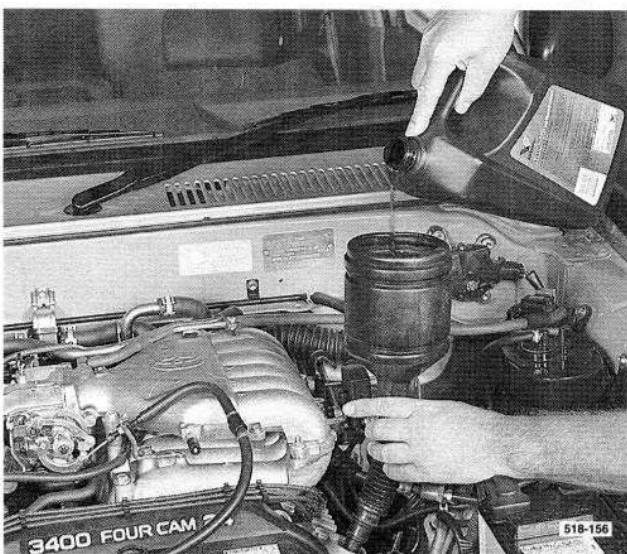
TIP To prevent the oil leaking from the old filter contaminating the stoneguard, remove the bolts retaining the front and rear stoneguards and withdraw them from the vehicle.

- 6 Allowing for the angle at which the oil filter is installed on the engine, fill the oil filter with as much clean oil as possible, to help with initial oil pressure when the engine is started again. Smear oil onto the sealing gasket of the new filter and tighten the filter by hand as per the tightening instructions supplied with the new filter. If tightening instructions are not supplied, tighten the filter by hand three quarters of a turn after it contacts the filter housing.

TIP Before installing the new filter ensure that the sealing gasket from the old filter has not adhered to the filter sealing seat on the engine.

- 7 When the engine has completely drained, check the drain plug seal, to ensure that it is serviceable.
- 8 Install and tighten the sump drain plug securely. Wipe around the plug after installation.
- 9 Using the funnel, fill the engine with the specified amount and grade of engine oil. Start the engine and check that the oil warning lamp extinguishes within a few seconds.

TIP To prevent overfilling, do not to pour all the specified amount of oil into the engine. Retain at least half a litre and top up to the level mark on the dipstick after running the engine for a few minutes.

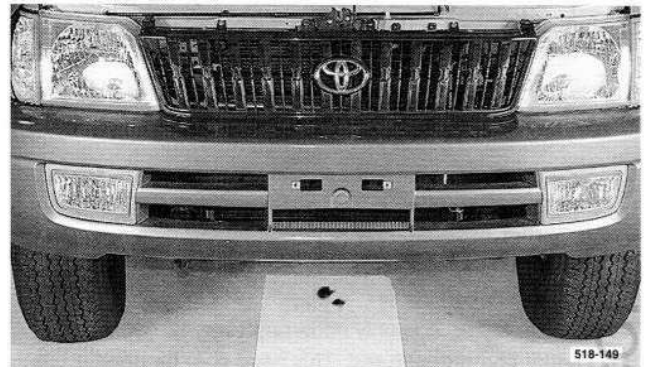


Filling the engine with oil.

- 10 Stop the engine, wait approximately one minute and check the oil level on the dipstick, as previously described. If necessary, add oil to bring the level to the full mark on the dipstick.
- 11 Check thoroughly for oil leaks at the engine sump drain plug and engine oil filter if a new filter was installed.
- 12 Perform all other routine maintenance items that coincide with the oil change intervals.

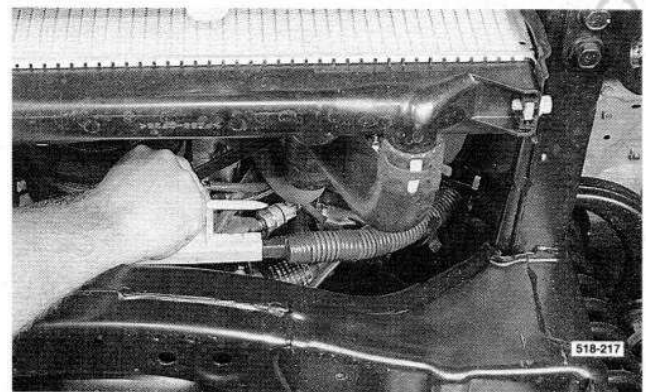
Oil Leaks

Prior to checking for oil leaks, the engine should be completely degreased and cleaned. Excessive oil leaks can be easily detected by placing white paper on the floor directly beneath the engine while it is running at operating temperature.



Run the engine over white paper to check for oil leaks.

- 1 Check the front and rear crankshaft oil seals, rocker cover gaskets and around the perimeter of the sump for excessive dampness. Check the oil filter gasket for leakage.
- 2 If applicable, tighten the retaining nuts and bolts as required, or renew faulty oil seal(s) or the oil filter, referring to the appropriate heading.
- 3 Check the oil pressure switch for leakage and renew if necessary.
- 4 Refill the engine with the required quantity and grade of engine oil.



Oil pressure switch location.

AIR CLEANER ELEMENT

The genuine air cleaner element can be cleaned during its normal service life but should be renewed at the intervals recommended in Routine Maintenance (chapter 2).

These intervals are only a guide for normal operating conditions and should be reduced accordingly if the vehicle is operating under extremely dusty conditions.

i Fabric air cleaner elements should not be washed in petrol or any type of cleaning solvent. If the element has been washed in solvent or has become oil soaked, it should be discarded and a new element installed.

To Inspect and Renew

- 1 Disconnect the vacuum hose from the air cleaner top cover. Release the retaining clips and carefully lift the cover ensuring that the air flow sensor wiring is not damaged.

i If difficulty is experienced raising the air cleaner cover, disconnect the air flow sensor wiring connector, loosen the retaining clamp and withdraw the air inlet hose from the silencer.

- 2 Remove the air cleaner element from the housing. Inspect the element for contamination and damage. If the element is only moderately dirty, it can be cleaned as follows:
 - a Using compressed air, blow the dust from the element directing the air flow from the inside to the outside of the element.
 - b Submerge the element in a container of clean water and plunge the element up and down at least ten times. Renew the water and repeat the procedure until the water remains clean.
 - c Remove any excess water from the element by shaking it or using compressed air.
- 3 Using a lint free cloth, remove any dust accumulation from the air cleaner body.
- 4 Release the retaining clips and remove the dust cup from the bottom of the air cleaner body.
- 5 Empty any dirt from the dust cup and clean the cup using a damp cloth.

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

- 1 Align the locating tab and install the dust cup, ensuring that the seal is in serviceable condition. Lock the retaining clips securely.
- 2 Ensure that the element is seated correctly.
- 3 Ensure that the clips firmly engage the cover.
- 4 Ensure that the vacuum hose and if disconnected, the air flow sensor wiring connector is securely connected.



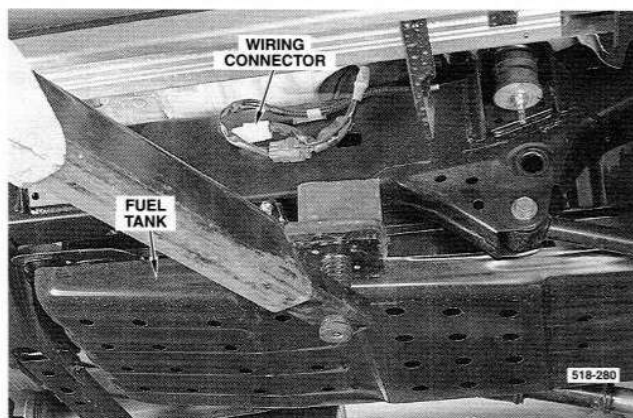
Service the air cleaner element regularly.

FUEL FILTER

To Renew

- 1 Raise the front and rear of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 2 Reduce the fuel system pressure as follows:
 - a With the engine running, switch the sub fuel tank switch On. The light in the sub fuel tank gauge will illuminate.
 - b Working under the left hand side of the vehicle, forward of the rear wheel, disconnect the white main fuel tank wiring connector.
 - c When the engine stalls, operate the starter for 5 seconds.
 - d Turn the ignition Off and connect the wiring connector securely.
- 3 Place a container beneath the fuel filter.

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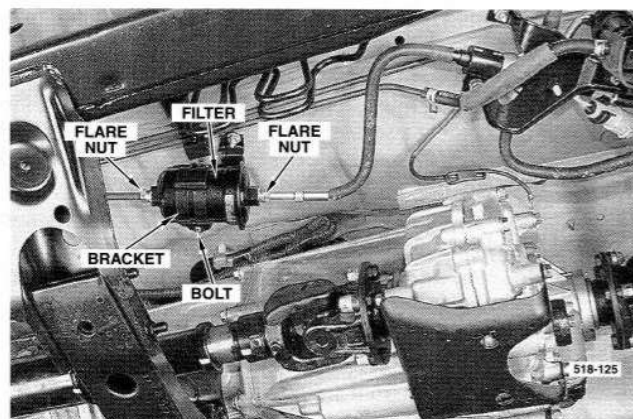
Location of the sub fuel pump wiring connector.



To prevent the loss of fuel, loosen the fuel filler cap to release any pressure from inside the fuel tank and tighten the cap.

- 4 Using two spanners, one to hold the union on the filter and the other on the flare nut, loosen and separate the steel fuel pipe from the union on both ends of the fuel filter.
- 5 Loosen the bolt retaining the filter to the bracket and withdraw the filter from the vehicle.

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



Location of the fuel filter.

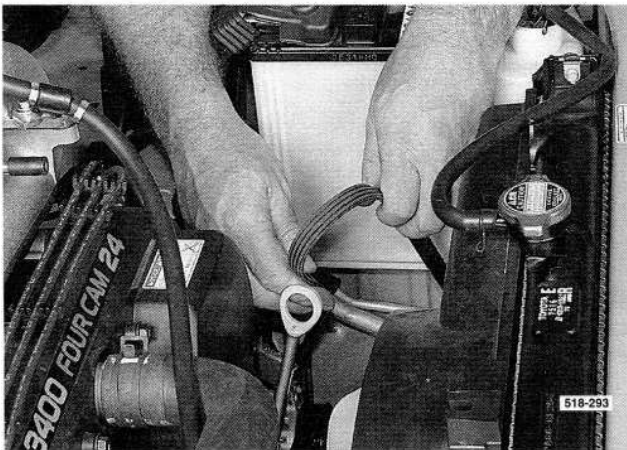
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- 1 Install the new filter with the word OUT stamped on the filter pointing towards the front of the vehicle.
- 2 Attach both flare nuts to the unions on the filter and hand tighten the flare nuts. Ensure that both nuts are correctly engage the threads of the unions. Using two spanners, tighten the fuel pipes securely.
- 3 Tighten the bolt retaining the fuel filter to the bracket securely.
- 4 Test the fuel system for external leakage as described in Fuel and Engine Management (chapter 7).

DRIVE BELTS

To Inspect

Check the drive belts for cracks or separation between the rubber and the fibre cords by examining the belt. Cracks on the ribs are acceptable, however if adjacent ribs have missing sections exceeding 13 mm, the belt should be renewed. It is essential that all drive belts be adjusted to prevent slip, but without imposing excessively upon the component bearings.



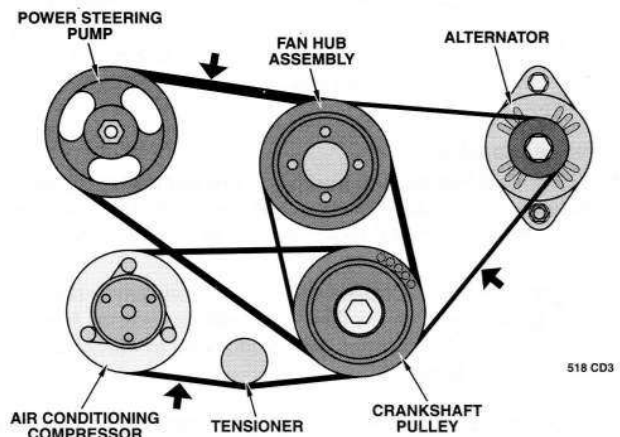
A drive belt with a few cracks is acceptable, however if cracks run across two adjoining ribs, or there are sections missing from the belt, it should be renewed.



If a drive belt is slipping and the belt tension is correct, remove the drive belts and check that the pulleys operated by each drive belt rotate smoothly without binding. A belt is considered used after 5 minutes on a running engine.

To Renew or Adjust — Power Steering Belt

- 1 To check the belt tension, apply a force of 100 Newtons (10 kg) to the point shown in the illustration. A new belt should deflect 7 – 8 mm, while the deflection of a used belt should be 8 – 10 mm.
- 2 Loosen the pivot bolt on the power steering pump body and the locknut on the steering pump belt adjuster.
- 3 If the power steering drive belt needs to be renewed, proceed as follows:
 - a Loosen the adjusting bolt, until the power steering pump can be moved enough to allow the belt to be removed.
 - b Manoeuvre the belt from around the crankshaft and fan hub.
 - c Install the new belt, ensuring that it sits centrally on each pulley.

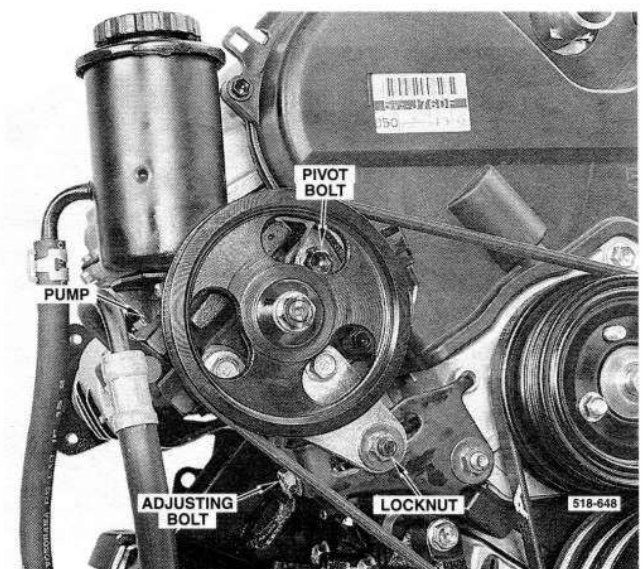


Check the drive belt deflection at the points indicated.

- 4 Turn the adjusting bolt clockwise to increase, or anticlockwise to decrease the tension.
- 5 Securely tighten the locknut and the pivot bolt.
- 6 If a new belt has been installed, run the engine for approximately five minutes and recheck belt tension. Adjust if necessary.

To Renew or Adjust — Air Conditioning Belt

- 1 Raise the front of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 2 Remove the bolts retaining the stoneguards to the chassis frame and withdraw the guards from beneath the vehicle.
- 3 To check the belt tension, apply a force of 100 Newtons (10 kg) to the point shown in the illustration. A new belt should deflect 4 – 5 mm, while the deflection of a used belt should be 5 – 7 mm.
- 4 Loosen the locknut on the air conditioning belt tensioner pulley assembly.
- 5 If the air conditioning drive belt needs to be renewed, proceed as follows:

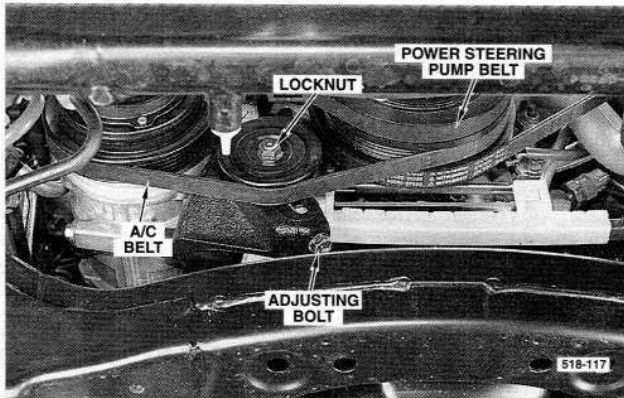


Power steering pump belt adjusting point.

- a Remove the power steering drive belt, as previously described.
- b Loosen the adjusting bolt, until the belt can be removed from the tensioner pulley, the compressor and the crankshaft pulley.
- c Install the new belt, ensuring it sits centrally on each pulley.
- 6 Turn the adjusting bolt clockwise to increase, or anticlockwise to decrease the tension.
- 7 Securely tighten the locknut on the tensioner assembly.
- 8 If a new belt has been installed, run the engine for approximately five minutes and recheck belt tension. Adjust if necessary.

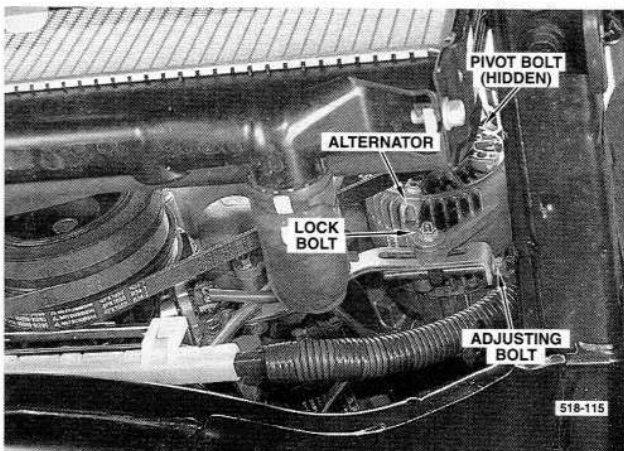
To Renew or Adjust — Alternator Belt

- 1 To check the belt tension, apply a force of 100 Newtons (10 kg) to the point shown in the illustration. A new belt should deflect 12 – 14 mm, while the deflection of a used belt should be 14 – 17 mm.
- 2 Loosen the pivot and lock bolts on the alternator.



The air conditioning compressor belt tension is adjusted using the idler pulley.

- 3 If the alternator drive belt needs to be renewed, proceed as follows:
 - a Remove the power steering and the air conditioning drive belts, as previously described.
 - b Loosen the adjusting bolt, until the belt can be removed from the alternator and then the crankshaft and the fan hub.



Alternator drive belt adjusting point.

- c Install the new belt, ensuring it sits centrally on each pulley.
- 4 Turn the adjusting bolt clockwise to increase, or anticlockwise to decrease the tension.
- 5 Securely tighten the pivot and lock bolts.

SPARK PLUGS



When working on or near electronic ignition systems, care should be taken as dangerous high voltages are present.

The ignition switch should be turned Off before removing or installing any electrical connections, otherwise damage to the ignition system as well as severe electrical shock could result.

4

To Remove and Install

The spark plugs should be renewed at the intervals recommended in Routine Maintenance (chapter 2). Special twin electrode type spark plug are used on this engine. Conventional spark plugs are shown as the symptoms are similar.

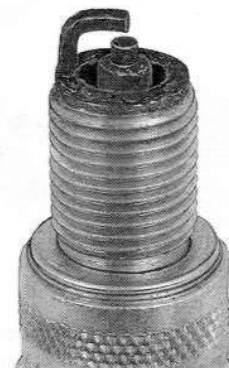
- 1 To remove the driver side spark plugs, proceed as follows:
 - a Disconnect the vacuum hose from the air cleaner top cover and from the resonator. Disconnect the wiring connector from the air flow sensor.
 - b Release the clips retaining the wiring to the resonator and to the air inlet hose.
 - c Using a twisting motion, remove the PCV breather hose from the air inlet hose.
 - d Release the clamp retaining the air inlet hose to the throttle body.
 - e Release the clips retaining the cover to the air cleaner body and carefully lift the cover away from the body. Withdraw the assembly from the engine compartment.

WORN OUT SPARK PLUG INDICATED BY ROUNDED ELECTRODES. RENEW.



SP10

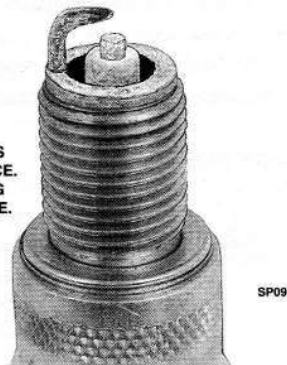
BLACK DAMP DEPOSITS INDICATING INCORRECT PLUG TYPE OR HIGH OIL CONSUMPTION. MAY NOT BE FIRING.



SP11

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OVERHEATING, BURNT ELECTRODES AND WHITE BLISTERED APPEARANCE. INCORRECT PLUG, ENGINE RUNNING TOO HOT OR PLUG LOOSE IN ENGINE.

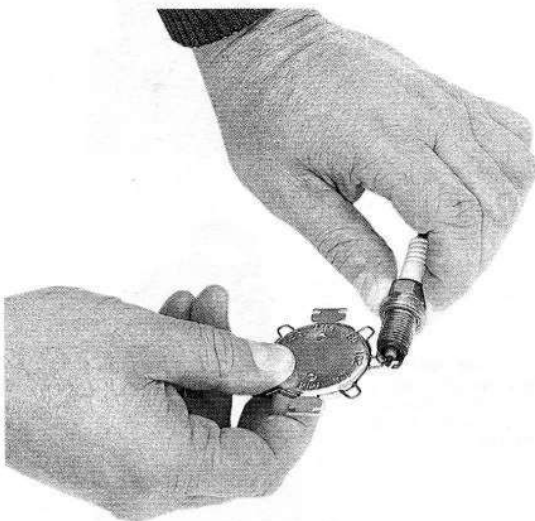


- f Release the locking tab retaining the high tension lead to the coil and withdraw the lead from each coil. Disconnect the wiring connector from each coil.
- g Ensure that the area around each coil is clean and remove the bolts retaining the coils to the rocker cover. While twisting the coil, withdraw it from each spark plug.
- 2 On the passenger side, ensure that the area around each spark plug boot is clean to prevent foreign matter entering the spark plug tube when the boot is removed.
- 3 Remove the high tension leads, pulling on the boots only to prevent damage to the leads.
- 4 Using a suitable spark plug socket, remove the plugs from the cylinder head by turning them in an anticlockwise direction.

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

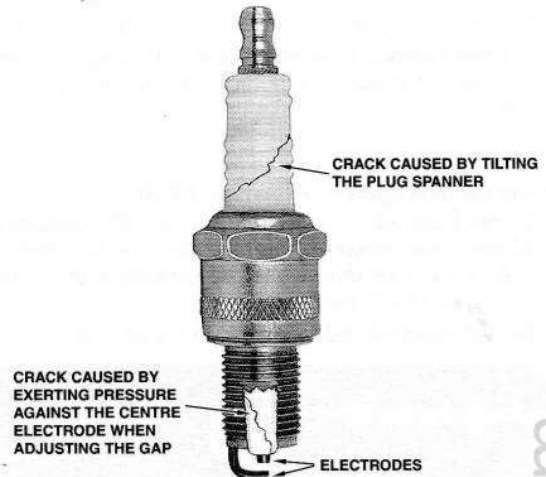
- 1 Measure the gap between each electrode, preferably with a clean wire gauge. Move the side electrodes towards or away from the centre electrode to obtain the correct gap.
- 2 Screw the plugs into the cylinder head finger tight and use a torque wrench to tighten the plugs to the specified torque.

i If a torque wrench is unavailable, extreme care must be taken when tightening the spark plugs as overtightening may lead to stripping of the thread from the cylinder head. Tighten the plugs until the seat of the plug just contacts the cylinder head and then tighten an additional quarter of a turn.



Checking the spark plug electrode gap with a wire gauge. The gap must be checked and equal at both side electrodes.

- 3 Push the high tension leads and the coils securely on the spark plugs.
- 4 Securely tighten the bolts retaining the coils to the rocker cover and connect the leads to the coils, ensuring that the locking tabs are securely engaged.
- 5 Install the air inlet and resonator assembly, and connect the wiring and vacuum hoses securely.



To Inspect

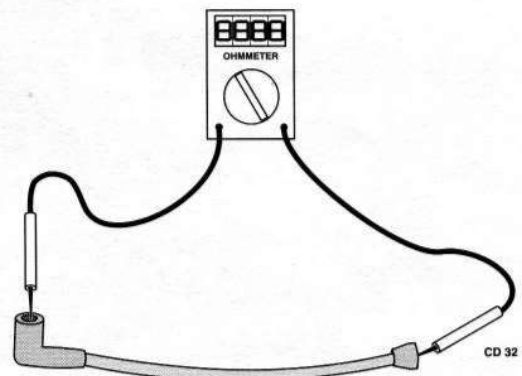
Spark plugs removed from an engine in good mechanical condition should have a light powdery deposit ranging from light brown to greyish tan in colour. After considerable service the electrodes will show signs of wear or normal burning.

Spark plugs showing a thick black oily deposit indicate an engine in poor mechanical condition or possibly that spark plugs with a too low a heat range have been installed.

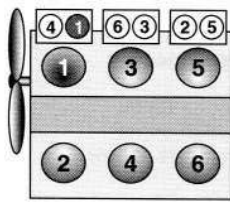
Spark plugs showing a white or yellowish deposit indicates sustained high speed driving or possibly that spark plugs with a heat range too high have been installed, particularly when these deposits are accompanied by blistering of the porcelain and burning of the electrodes.

HIGH TENSION LEADS

- 1 Remove the high tension leads from the engine as previously described under the Spark Plug heading.



Checking the high tension lead resistance using an ohmmeter.



FIRING ORDER
1 2 3 4 5 6

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Cylinder numbering sequence, showing the location of the No. 1 spark plug and the coils.

- 2 Check the leads for perishing or cracking and renew as necessary. Do not attempt to repair faulty leads.



Always remove the lead from a spark plug by twisting and pulling on the rubber boot only.

The high tension leads have a carbon impregnated core. Care must be taken when removing the leads to ensure that the leads are not damaged by stretching which will break the core and render the lead unserviceable. The leads are retained to the coil by a locking tab.

The factory fitted leads are numbered on the outside of each lead. The number on these leads represent the number of the coil from which the lead is originated.

- 3 When the leads are removed it is recommended that an ohmmeter is used to check the leads. Test one lead at a time by connecting the meter probes to each end of the high tension lead. Resistance for each lead should be within Specifications. The leads may be carefully cleaned, using a cloth moistened with kerosene. After they are clean, wipe completely dry.

IGNITION TIMING AND IDLE SPEED

Connecting a Timing Light

- 1 Connect the timing light lead inductive pickup to the No 1 high tension lead.
- 2 Where applicable, connect the power leads of the timing light to the battery.



Do not disconnect the timing light power leads with the engine running as voltage surges could damage the alternator.

To Check Ignition Timing

The base ignition timing is controlled by the engine ECU and there is no provision for adjustment. Ensuring that the base timing is correct, will assist in the diagnosis and repair of other fuel management related problems.

- 1 Connect the timing light to the engine as described previously in this chapter.
- 2 Apply the handbrake and place the transmission in Neutral.
- 3 Start the engine and allow it to reach normal operating temperature.
- 4 Run the engine at 1 000 rpm for 5 seconds and check that it returns to the specified idle speed.
- 5 Bridge terminals TE1 and E1 on early models, or TC and E1 on late models of the engine compartment diagnosis connector, using a split pin or paper clip.

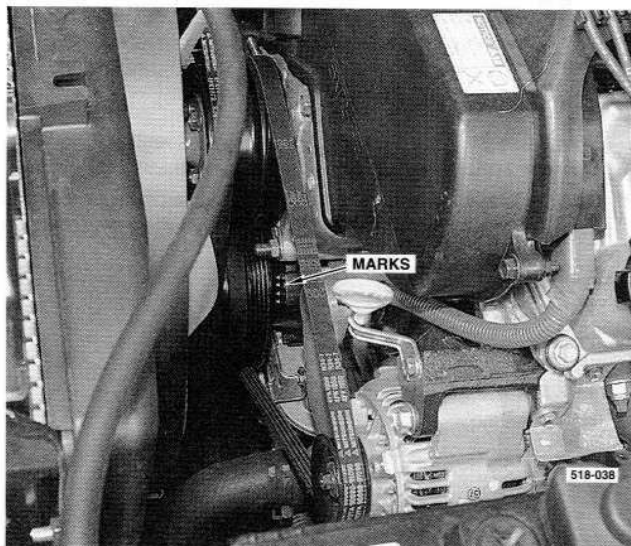


Diagnosis connector location. The terminal identification is printed on the inside of the cover.



Bridging terminals TE1 and E1, or TC and E1 will cause the idle speed to increase up to 1 200 rpm for approximately five seconds, after which it should return to the normal speed.

- 6 With the engine idling at the specified speed, check the ignition timing with the timing light. The 10° BTDC timing mark on the timing cover should be aligned with the notch on the crankshaft pulley.
- 7 Remove the bridge wire from the diagnosis connector.
- 8 Check that the ignition timing is between 10° and 24° BTDC at idle speed, and changing rapidly, indicating that the engine ECU is controlling timing.



Ignition timing marks location.

To Check and Adjust Idle Speed

The engine idle speed is controlled by the idle speed control (ISC) valve, which is mounted to the throttle body assembly. The correct idle speed is calculated by the engine ECU, eliminating the need for idle speed adjustment.

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If the idle speed is not to Specifications, check the ISC valve and all vacuum hoses.



High or erratic idle speed could be caused by vacuum leaks in the intake system. Check for disconnected or perished vacuum hoses and/or leaking gaskets.

If the idle speed is slow or uneven, a build up of deposits may exist in the throttle body or the ISC valve may be faulty. Remove the throttle body and clean any deposits using a cloth and carburettor cleaner. Check the ISC valve as described in Fuel and Engine Management (chapter 7).

To Check and Adjust CO Concentration

It should be necessary only to check the CO reading when there is a suspicion, that the idle fuel mixture is not correct. The CO content can only be accurately checked using an exhaust gas analyser. A two gas analyser is sufficient.

Before adjusting the CO concentration, eliminate all other causes of a rich or lean mixture. If no other faults can be found, adjust the CO concentration as follows:

- 1 Drive the vehicle, until the engine reaches operating temperature.
- 2 Operate the engine at approximately 2 500 rpm for about 2 minutes and return the engine to idle speed.
- 3 Wait 1 minute to allow the system to stabilise, and connect a gas analyser to the vehicle following the instrument manufacturers instructions. Ensure that all accessories are Off and measure the CO concentration.
- 4 If the CO reading is outside of Specifications, remove the plug and rotate the CO adjusting screw slightly to adjust the mixture.



A special tool (Part No 09243-00020) is available from the manufacturer to adjust the adjusting screw. Turning the adjuster clockwise will make the fuel mixture richer, while turning it anticlockwise will lean the fuel mixture. The screw should not be forced past its limits. Replace the plug when adjustment is completed

- 5 Wait at least three minutes for the gas analyser needle to stabilise and if necessary, make further adjustments.
- 6 If the CO reading cannot be adjusted to Specifications, check the following possible causes of a rich fuel mixture, referring

to the Fuel and Engine Management section for testing procedures:

- Restricted air cleaner element
- Restricted PCV valve
- High fuel pressure
- Faulty coolant temperature sensor
- Leaking injectors
- Throttle position sensor out of adjustment
- Faulty air flow meter/sensor
- Faulty ECU

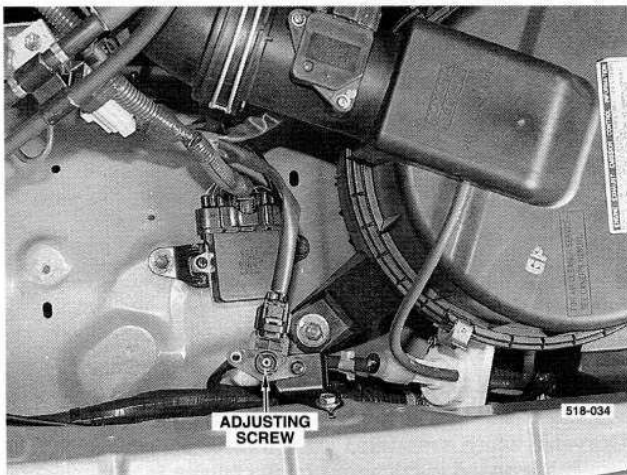
- 7 Once the fault has been rectified, repeat the CO checking and adjusting procedure.

EXHAUST SYSTEM

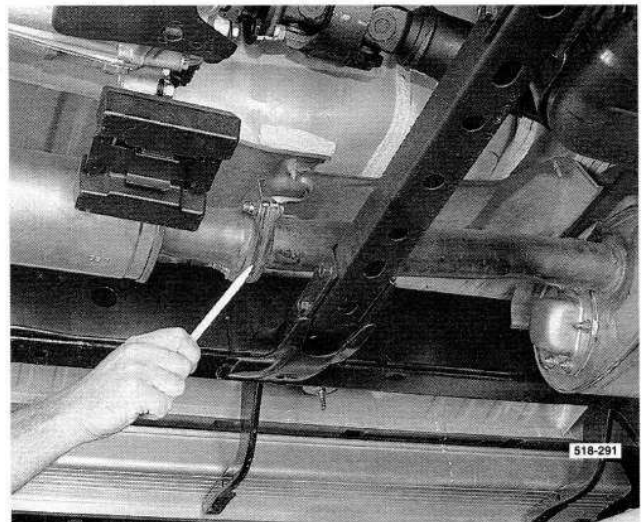
Operations relating to the removal and installation of the exhaust system are covered under the Exhaust System heading at the end of this chapter.

To Inspect

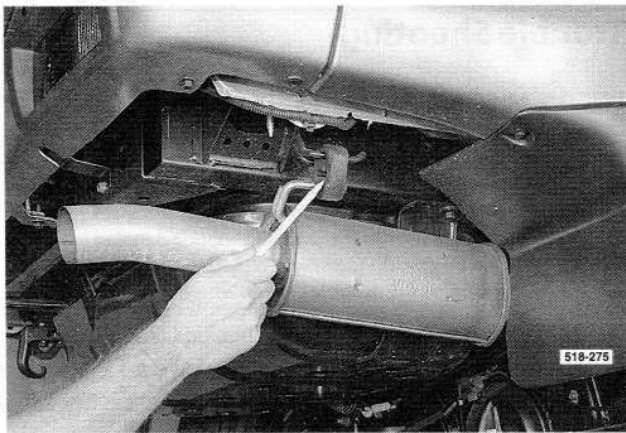
- 1 Raise the front and rear of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 2 Check the alignment of the exhaust system, ensuring it has sufficient operating clearance.
- 3 Inspect the condition of the mounting rubbers. Any rubber which is broken or oil soaked should be renewed and the source of the oil leak identified and repaired.
- 4 Have an assistant hold a thick wadded cloth at the opening of the tail pipe for a short period (approx. 5 seconds), while the engine is running at idle speed. Check the system for excessive leaks, which will be heard as a hissing noise.
- 5 Check the condition of the gaskets. Any gasket excessively protruding from the joints, should be renewed.
- 6 Inspect the resonator and rear muffler for corrosion, dents or damage.
- 7 Lightly bump the resonator and the muffler with a rubber mallet. They should not have any loose parts inside.
- 8 Inspect the exhaust system heat shields for damage and correct installation. Renew the heat shields as necessary.



CO adjusting screw location.



Check the exhaust system gaskets for leaks.



Check the exhaust mountings and mounting rubbers for deterioration or damage.

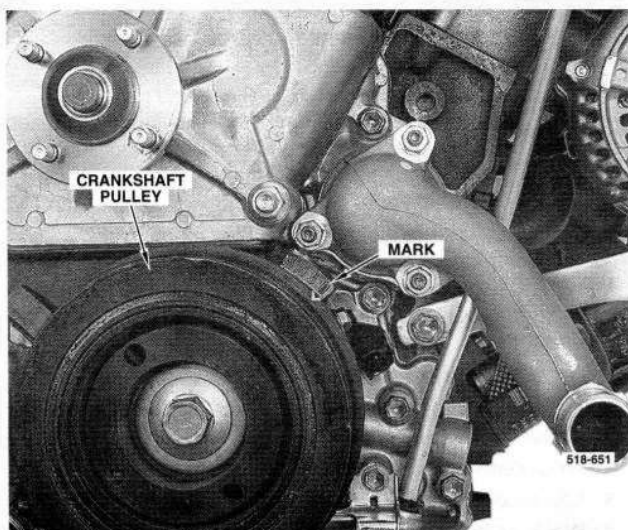
- 9 Check the tightness of the nuts and bolts retaining the joints.

VALVE CLEARANCES

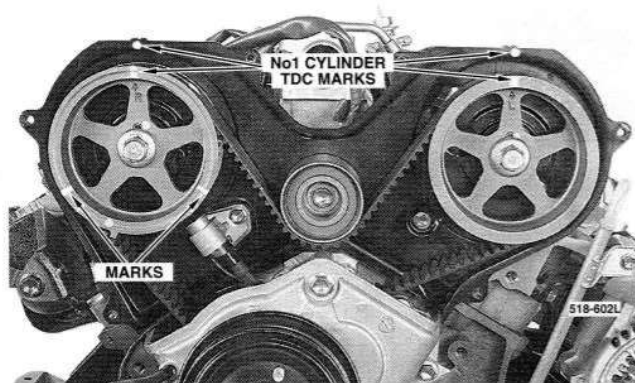
Checking the valve clearances is not a difficult procedure, however the adjusting procedure can be extremely awkward without the special Toyota service tool, especially if more than a couple of valves require adjustment. If valves of this type have not been adjusted by you before, it is recommended that the tool be obtained or the vehicle be referred to an authorised dealer or a specialist workshop, that has the service tools. The Toyota part No. for the tool required is 09248 – 55040

To Check and Adjust

- 1 Allow the engine to cool to ambient temperature.
- 2 Remove the rocker covers as described later in this chapter and remove the spark plugs.
- 3 Remove the upper timing belt cover as described under the Timing Belt Covers heading in this chapter.
- 4 Using a socket and bar, rotate the crankshaft clockwise, until the marks on the camshaft sprockets are aligned with the marks on the rear timing belt covers, as shown in the illustration and the timing mark on the crankshaft pulley is aligned

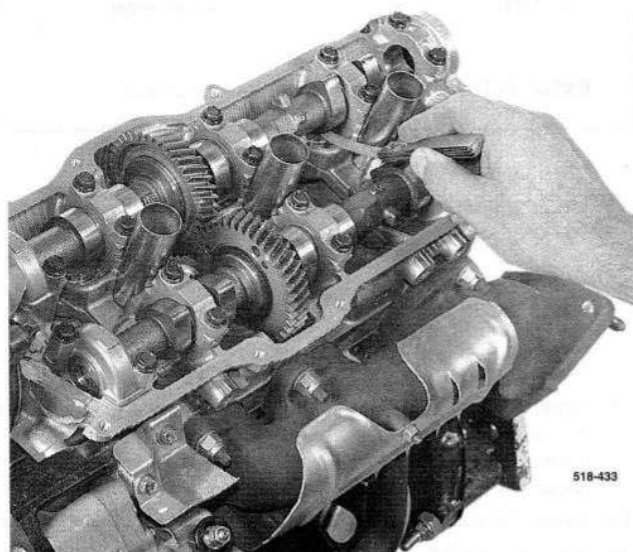


Crankshaft pulley aligned with TDC mark.

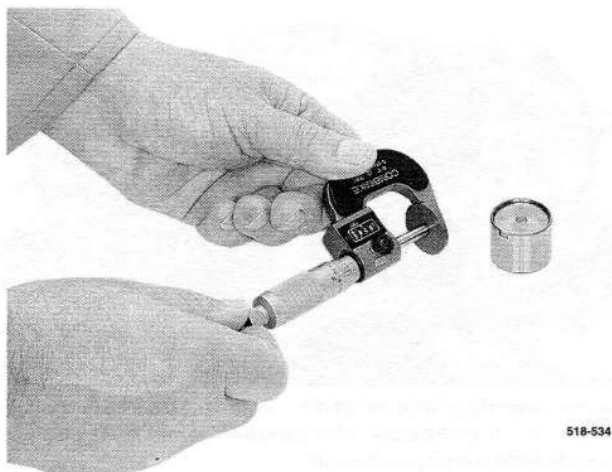


Engine correctly positioned at No. 1 cylinder TDC. The two marks on the bottom of the driver side camshaft sprocket are made by the technician working on the car.

- with the 0 mark (TDC) on the lower timing belt cover. In this position, the No 1 piston is at TDC on the compression stroke.
- 5 Using feeler gauges, measure the clearance between the cam followers and the cam lobes on the following valves: No 1 and No 6 inlet valves and No 2 and No 3 exhaust valves. Record the measurements. See page 31 for an illustration of the cylinder numbering sequence, if necessary.
- 6 Working on the driver side camshaft sprocket, count 16 teeth on the sprocket in an anticlockwise direction, from the factory mark on the sprocket. Clearly mark this position on the sprocket face.
- 7 Rotate the crankshaft clockwise, until the new mark made in the previous operation on the face of the camshaft sprocket is aligned with the mark on the rear timing belt cover.
- 8 Using feeler gauges, measure the clearance between the cam followers and the cam lobes on the following valves: No 2 and No 3 inlet valves and No 4 and No 5 exhaust valves. Record the measurements.
- 9 Count 16 teeth on the camshaft sprocket in an anticlockwise direction, from the mark made on the sprocket in step 5. Clearly mark this new position on the sprocket face.



Measuring the valve clearance using feeler gauges.



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Measuring the follower shim thickness.

- 10 Using a socket and bar, rotate the crankshaft clockwise, until the new mark made in the previous operation is aligned with the mark on the rear timing belt cover.
- 11 Using feeler gauges, measure the clearance between the cam followers and the cam lobes on the following valves: No 4 and No 5 inlet valves and No 1 and No 6 exhaust valves. Record the measurements.
- 12 If a valve clearance is outside Specifications, adjust the clearance using the following procedure:
 - a Rotate the engine until the cam lobe of the valve requiring adjustment is uppermost. Rotate the cam follower until the slot is facing the side of the engine.
 - b Using the manufacturers special tools or with an assistant carefully using two screwdrivers to depress the cam follower, remove the shim from the top of the cam follower using a small screwdriver and/or pencil magnet.
 - c Measure the thickness of the shim using a micrometer and using the following formulas, calculate the thickness of the shim required to restore the valve clearance to Specifications.

INLET	$N = T + (A - 0.18 \text{ mm})$
EXHAUST	$N = T + (A - 0.32 \text{ mm})$

N = Required shim thickness;

T = Original shim thickness;

A = Recorded valve clearance.

TIP Shims are available in thicknesses from 2.50 mm to 3.30 mm in increments of 0.05 mm.

- d Install the required shim to the cam follower and repeat the procedure for the other valves which have incorrect clearances. Repeat steps 4 to 12 and ensure that the valve clearances are now correct.
- 13 Install the rocker covers as described later in this chapter.
- 14 Install the upper timing belt cover, referring to the appropriate heading in this chapter, if necessary.

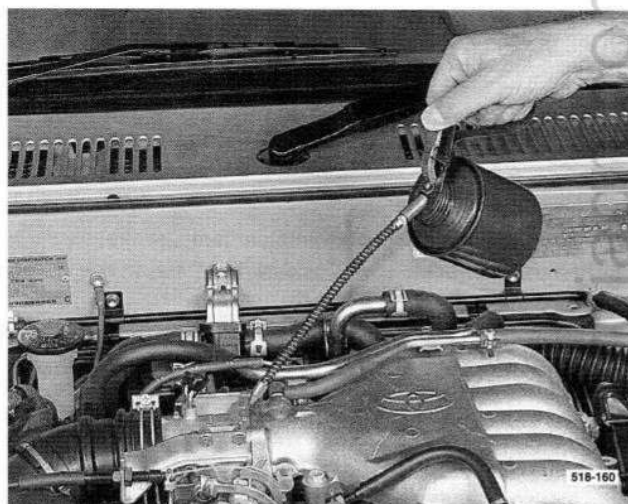
Trouble Shooting

ENGINE MISFIRES AT IDLING SPEED



Engine misfire can be caused by ignition, fuel or mechanical faults. If the misfire cannot be rectified by performing the operations described at the start of this chapter, refer to the Trouble Shooting heading in Fuel and Engine Management (chapter 7) prior to checking the following possible causes.

- 1 Air leak at the inlet manifold or plenum chamber gasket(s): Tighten the manifold bolts or renew the gasket(s) as necessary.
- 2 Insufficient valve clearance: Check and if necessary adjust the valve clearance.
- 3 Blown head gaskets: Check the cylinder compressions and renew the head gaskets as necessary.
- 4 Burnt valves or seats in the cylinder head: Check the cylinder compressions and overhaul the cylinder heads as necessary.
- 5 Weak or broken valve springs: Remove the camshafts and followers and check the condition of the valve springs.
- 6 Broken or worn piston rings: Check the cylinder compressions and renew the piston rings as necessary.



Checking for vacuum leaks using engine oil.



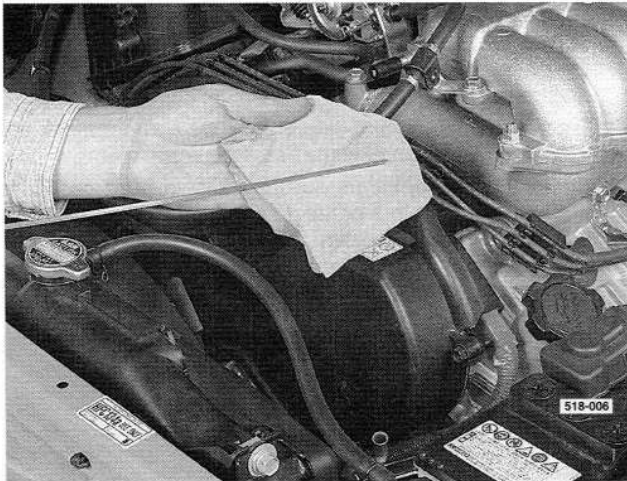
Check for air leaks at the inlet manifold by applying engine oil or dewatering fluid around the manifold joints while the engine is idling. If the engine speed alters or smoke begins to emit from the exhaust system, there is an air leak at the inlet manifold.

Cylinder compressions should be checked using a compression gauge as described later in this chapter.

Broken valve springs will usually be obvious by excessive valve (tappet) noise.

NOISY VALVE OPERATION

- 1 Incorrectly adjusted valve clearances: Check and if necessary adjust the valve clearance.
- 2 Worn camshaft lobes: Renew the camshafts.
- 3 Low oil pressure: Refer to the Low Oil Pressure heading.
- 4 Weak or broken valve springs: Remove the camshaft and followers and check the condition of the valve springs.



Checking the engine oil for correct level and dilution on the dipstick.

- 5 Worn valve guides: Overhaul the cylinder heads.

CONNECTING ROD BEARING NOISE

- 1 Low oil pressure: Refer to the Low Oil Pressure heading.
- 2 Excessive bearing clearance: Renew the bearing shells. Regrind the crankshaft if the crankpin journals are oval, tapered or scored.
- 3 Misaligned connecting rod bearings: Align the connecting rods and renew the connecting rod bearing shells.



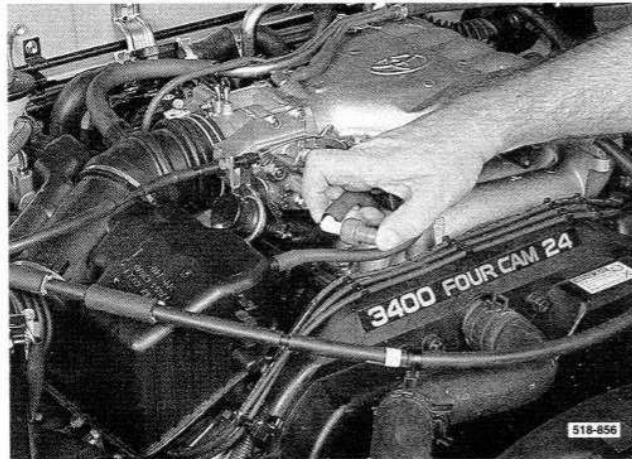
Connecting rod bearing noise is indicated by a metallic knock which is usually loudest at approximately 60 km/h with the throttle closed. Before dismantling the engine to inspect the connecting rods, check the engine oil for correct level and dilution on the dipstick. Also remove the oil pressure switch and connect an oil pressure gauge into the oil gallery to check the oil pressure readings.

MAIN BEARING NOISE

- 1 Low oil pressure: Refer to the Low Oil Pressure heading.
- 2 Loose flywheel/driveplate: Install new flywheel/driveplate bolts and tighten to the specified torque.
- 3 Excessive crankshaft end float: Renew the thrust washers and inspect the main bearings.
- 4 Excessive bearing to journal clearance: Renew the bearing shells. Regrind the crankshaft if the journals are oval, tapered or scored.



Main bearing noise is indicated by a heavy but dull knock when the engine is under load. A loose flywheel/driveplate is indicated by a thud or dull click when the engine stops and is usually accompanied by vibration. Crankshaft end float noise is indicated by a sharp rap at idle speed. The crankshaft can be checked for excessive end float by levering the crankshaft backwards and forwards. If the oil pressure is satisfactory, consult an engine reconditioning specialist or remove the main bearing caps and check the bearing clearance using Plastigage. Ovality and wear on the main bearing journals can only be checked with a micrometer after the crankshaft has been removed.



Checking the PCV system operation.

EXCESSIVE OIL CONSUMPTION

- 1 Incorrect engine oil: Drain the engine sump and fill with the correct grade of oil.
- 2 Oil leaks: Check that the relevant retaining bolts or nuts are tight or renew the gasket or seal as necessary. Also check the oil cooler and associated hoses for leaks.
- 3 Faulty positive crankcase ventilation (PCV) system operation: Check the PCV system as described in Emission Control (chapter 8).
- 4 Damaged or worn valve stem oil seals: Renew the valve stem oil seals.
- 5 Excessive valve stem to valve guide clearance: Have a cylinder head specialist renew the valves and/or guides as necessary.
- 6 Worn or broken piston rings: Renew the piston rings and/or pistons as necessary.
- 7 Rings too tight or stuck in grooves: Renew the rings and clean out the ring grooves.
- 8 Excessive wear in the cylinders, pistons and rings: Recondition the cylinders and install oversize pistons and rings.
- 9 Compression rings incorrectly installed or the oil control rings blocked or broken: Renew the piston rings.

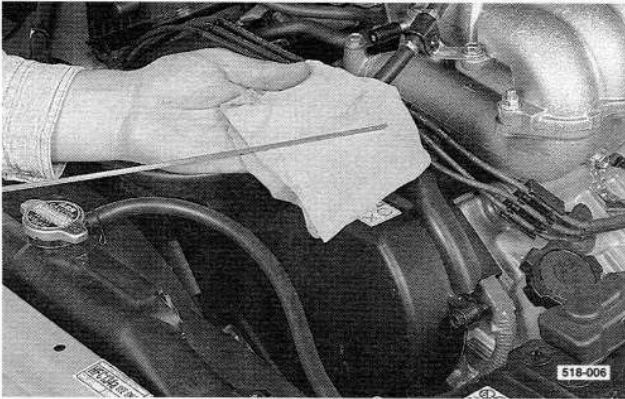


Damaged or worn valve stem oil seals which allow oil to be drawn down past the valve stems into the combustion chambers can be diagnosed by allowing the engine to idle for a few minutes and then opening the throttle. If oil is being drawn down past the valve stems, a heavy discharge of blue smoke will be seen at the tailpipe. Piston, ring and cylinder bore faults are normally accompanied by a loss of compression. Cylinder compressions can only be accurately checked using a compression gauge as described later in this chapter.

LOW OIL PRESSURE

- 1 Low engine oil level: Check and replenish the oil to the full mark on the dipstick.
- 2 Incorrect or diluted oil: Drain the engine sump and fill with the correct grade of oil. If the oil is diluted, check for the source of the water or fuel. Ensure that the engine is not overheating.

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Checking the engine oil for correct level and dilution on the dipstick.

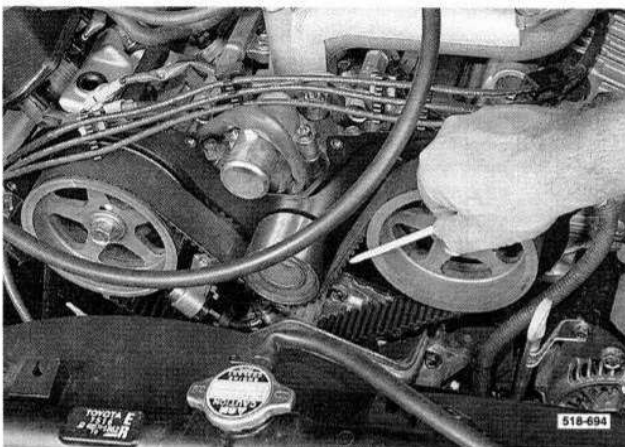
- 3 Blocked oil filter: Renew the oil filter.
- 4 Oil pump pressure relief valve stuck open or the spring broken: Free up the valve or renew the spring.
- 5 Split or obstructed oil pump pickup pipe: Remove the pickup pipe and clear the obstruction or renew the pickup pipe.
- 6 Excessive bearing clearance: Renew the bearing shells and check the condition of the crankshaft journals.
- 7 Excessive wear of the oil pump components: Dismantle the oil pump and renew the components as necessary.



Remove the oil pressure switch and connect a pressure gauge into the oil gallery. Check the oil pressure with the engine cold and hot. If the oil pump or pressure relief valve are faulty, low pressure will be indicated with the engine both hot and cold. However, if the bearings are at fault, a fairly high oil pressure will be indicated when the engine is cold but a marked fall in pressure will be noted when the engine is hot.

ENGINE ROTATES BUT WILL NOT START

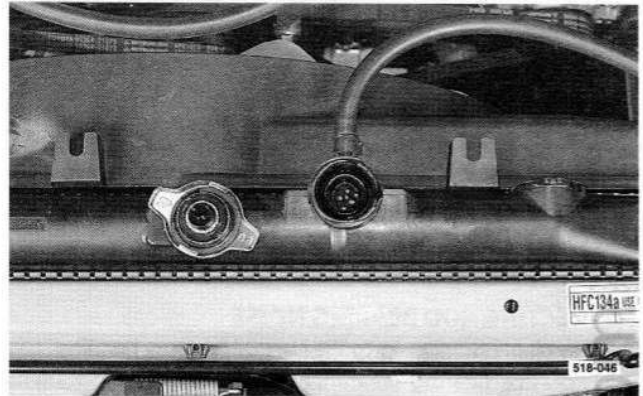
- 1 Ignition system fault: Refer to Roadside Trouble Shooting (chapter 3).
- 2 Fuel system fault: Refer to Fuel and Engine Management (chapter 7).
- 3 Broken timing belt: Remove the top timing belt cover and examine the timing belt.



Check the condition of the timing belt.

ENGINE WILL NOT ROTATE

- 1 Starter motor drive jammed: Remove the starter motor, check and renew the damaged drive and/or the flywheel ring gear.
- 2 Engine overheated and seized: Remove and dismantle the engine, check and renew the damaged components.
- 3 Coolant in the cylinders due to a blown head gasket or cracked cylinder block or head: Remove the cylinder head(s) and if the gasket is blown, check the cylinder block and head(s) for distortion. Renew the cylinder head(s) and/or the cylinder block if cracked or excessively distorted.



A blown head gasket may be indicated by bubbles in the radiator filler neck while the engine is running.

- 4 Broken crankshaft, connecting rod or piston due to overheating, excessive engine speed, fatigue, etc: Remove and dismantle the engine, examine and renew the components as necessary.
- 5 Valve head broken off due to overheating, excessive engine speed, fatigue, etc: Remove the cylinder head(s), check the head(s), pistons and cylinders for damage and repair or renew as necessary.

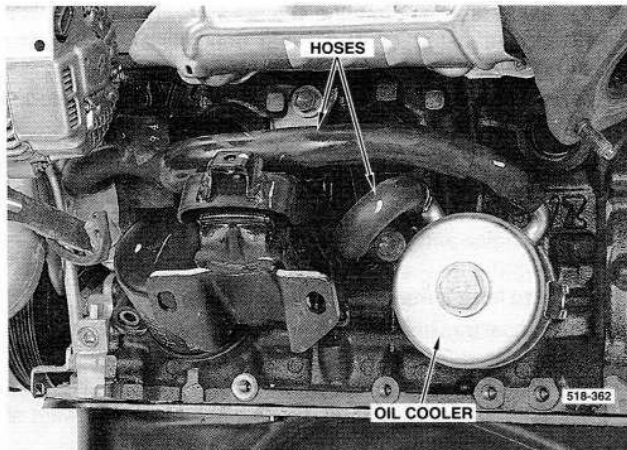


Invariably when an engine seizes because of overheating due to lack of oil and/or coolant, damage is done to the bearings, pistons etc. Although there may be instances where an engine will restart and run after it has cooled and the oil and coolant have been replenished, it will generally be found that oil consumption increases, oil pressure drops and the engine will be noisier, depending on the extent of damage.

Sufficient coolant can enter a cylinder due to a blown gasket, cracked cylinder block or head to prevent the engine rotating. Normally this is preceded by difficult starting, misfiring, excessive steam from the exhaust and loss of coolant from the radiator cap or reserve tank. With the engine fast idling, excessive discharge may be noticed from the reserve tank overflow pipe. When a cylinder head gasket blows allowing water into the cylinders, or compression loss between cylinders, it is essential to check the gasket faces on the cylinder block and head for distortion.

OIL DILUTION

- 1 Hole in oil cooler: Remove the oil cooler and check for holes in the assembly. Renew the oil cooler if necessary.



Check the oil cooler and hoses for leakage.

- 2 Leak in the head gasket: Check the compression of each cylinder as described under Cylinder Compression heading in this chapter.

Cylinder Compression Test

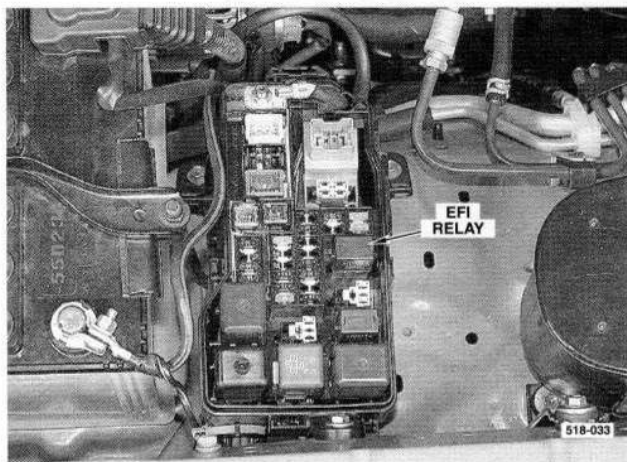


To Test Compression — Compression gauge

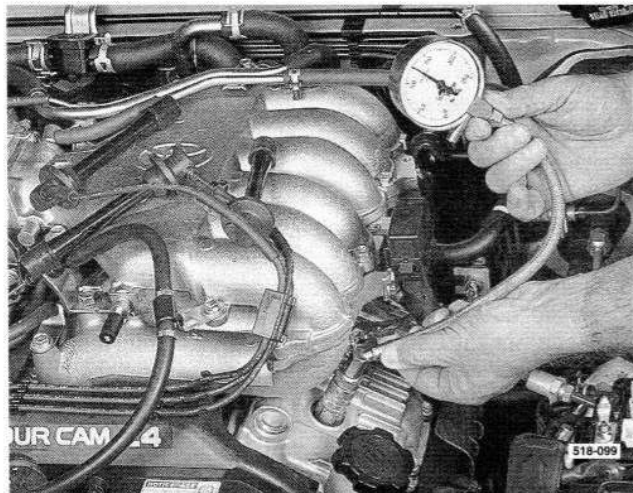
A compression test is one of the best methods of assessing the mechanical condition of the upper part of the engine (pistons, rings, valves and head gasket). It is also the best place to start looking for poor performance, a misfire or bad fuel economy. Unless cylinder compressions are even, renewing other components to try to get an engine running better will be a waste of time.

Compression testing is also performed if an engine is overheating, or losing coolant and no leaks externally have been found. If compression pressure is getting into the coolant, unsatisfactory cooling system performance will result.

The accuracy of compression gauges vary, so the important thing to look for in a test is that all cylinders are even, rather than the actual result.



The EFI relay must be removed prior to performing a compression test.



Using a compression gauge to measure the compression pressure.

- 1 Ensure that the battery is fully charged.
- 2 Run the engine until it reaches normal operating temperature.
- 3 Stop the engine and remove the high tension leads, the coils and the spark plugs as previously described under the Routine Maintenance heading in this chapter.
- 4 Remove the EFI relay from the engine compartment fuse and relay box.



Failure to remove the EFI relay can result in damage to the ignition system or an explosion.

- 5 Install a compression gauge to No 1 cylinder. Refer to the instrument manufacturers instructions if necessary.
- 6 Have an assistant fully depress the throttle pedal and operate the starter motor. Observe the compression gauge and stop the engine when the gauge has reached the highest reading, usually after three or four revolutions.
- 7 Record the reading and check the compression of the remaining cylinders in the same manner.
- 8 Compare all the readings taken. Refer to Specifications for the minimum acceptable pressure. The difference between the highest and lowest readings should not exceed 100 kPa.
- 9 If a low reading is recorded on one or more cylinders, the trouble source may be isolated as follows:
 - a Inject a small amount of engine oil into the spark plug hole of the cylinder and ensure that the oil is evenly distributed by rotating the engine.
 - b Repeat the compression test on the cylinder concerned.

A substantial increase of compression pressure indicates faulty or worn piston rings, piston or cylinder. An insignificant increase of compression pressure indicates burnt, obstructed or sticking valves or a leaking cylinder head gasket.

Engine Assembly

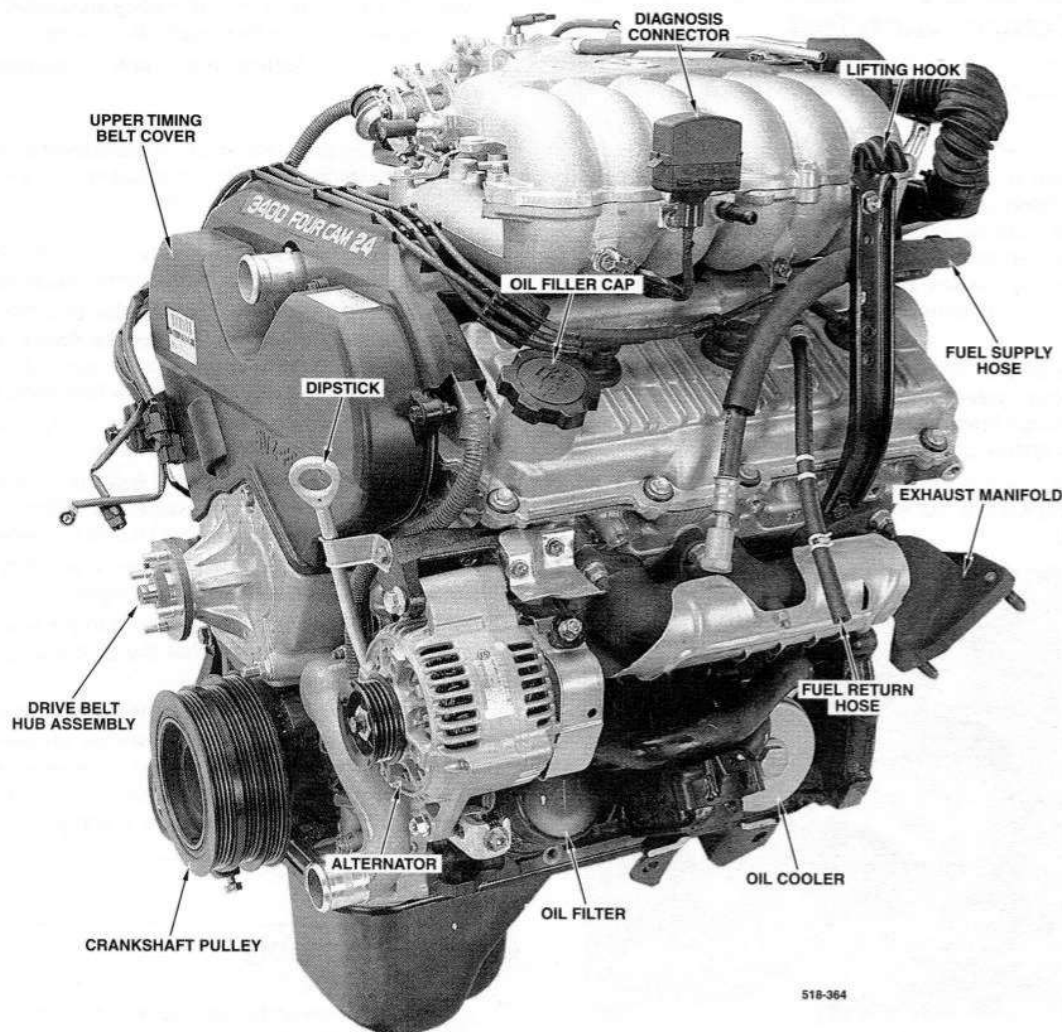


To Remove and Install Engine — Suitable lifting tackle and trolley jack

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TO REMOVE AND INSTALL

- 1 Place suitable protection around the engine compartment to prevent damage to the vehicle body.
- 2 Reduce the fuel system pressure as described previously in this chapter under the Fuel Filter heading.
- 3 Disconnect the negative battery terminal.
- 4 Raise the front of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 5 Drain cooling system and remove the fan assembly and the radiator as described in Cooling System (chapter 5). Release the clamps and disconnect the heater hoses from the fittings on the firewall.
- 6 Disconnect the windscreen washer hose on the drivers side of the bonnet. While an assistant supports the bonnet, remove the retaining bolts and carefully remove the bonnet.
- 7 Remove the air cleaner assembly, referring to Fuel and Engine Management (chapter 7), if necessary.
- 8 Open the throttle valve and disconnect the inner throttle cable and if fitted, the cruise control cable from the throttle lever.
- 9 Remove the bolts retaining the outer throttle cable and if fitted, the cruise control cable brackets and place the cable(s) with the bracket(s) clear of the work area.
- 10 Disconnect the wiring connectors from the alternator. If necessary, refer to Engine Electrical (chapter 6).
- 11 Remove the starter motor, referring to Engine Electrical (chapter 6), if necessary.
- 12 Release the clips retaining the wiring to the front, lower side of the engine and place it clear of the work area.
- 13 Remove the flywheel/driveplate cover plate, using a screwdriver to lever it from the rear of the sump.
- 14 On manual transmission models, proceed as follows:
 - a Working under the vehicle, disconnect the wiring connectors from the reverse lamp switch and the speed sensor. Release the wiring from the bracket and place it forward of the transmission.
 - b While working under the vehicle, remove the bolt retaining the clutch pipe bracket to the cylinder head.
 - c Working on the left hand side of the engine, remove the spring clip retaining the clutch pipe to the bracket. Remove the bolt retaining the support bracket and place the clutch pipe clear of the work area.

*Left hand side of the engine.*

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15 On models with automatic transmission, proceed as follows:
a Disconnect the wiring connectors from the left hand side of the transmission.

b Remove the bolts retaining the torque converter to the driveplate. Using a screwdriver, carefully lever the converter towards the transmission to separate it from the driveplate.

16 Remove the nuts retaining the engine pipes to the exhaust manifolds and separate the components on both sides of the vehicle.

17 Remove the drive belts from the engine, referring to the Routine Maintenance heading in this chapter.

18 On models with air conditioning, disconnect the wiring connector and remove the compressor retaining bolts. Secure the compressor to the chassis using wire or rope.



Do not disconnect the hose fittings from the air conditioner compressor as escaping refrigerant can cause eye injury and will necessitate regassing of the system.

19 Referring to Steering (chapter 12), remove the power steering pump from the engine and place the pump with the hoses still connected, clear of the work area.

20 Suitably mark and disconnect the wiring connectors from the following components: the igniter, the CO adjuster

screw and the earth wiring connectors from the right hand side inner guard and from the right hand side firewall.

21 Disconnect the canister purge hose and the brake booster vacuum hoses from the engine.

22 Disconnect the fuel supply and return hoses and seal the ends of the hoses and pipes to prevent the entry of foreign matter.



To prevent the loss of fuel, open the fuel filler cap to release the pressure from the fuel tank. Leave the cap loose while the fuel hoses are disconnected.

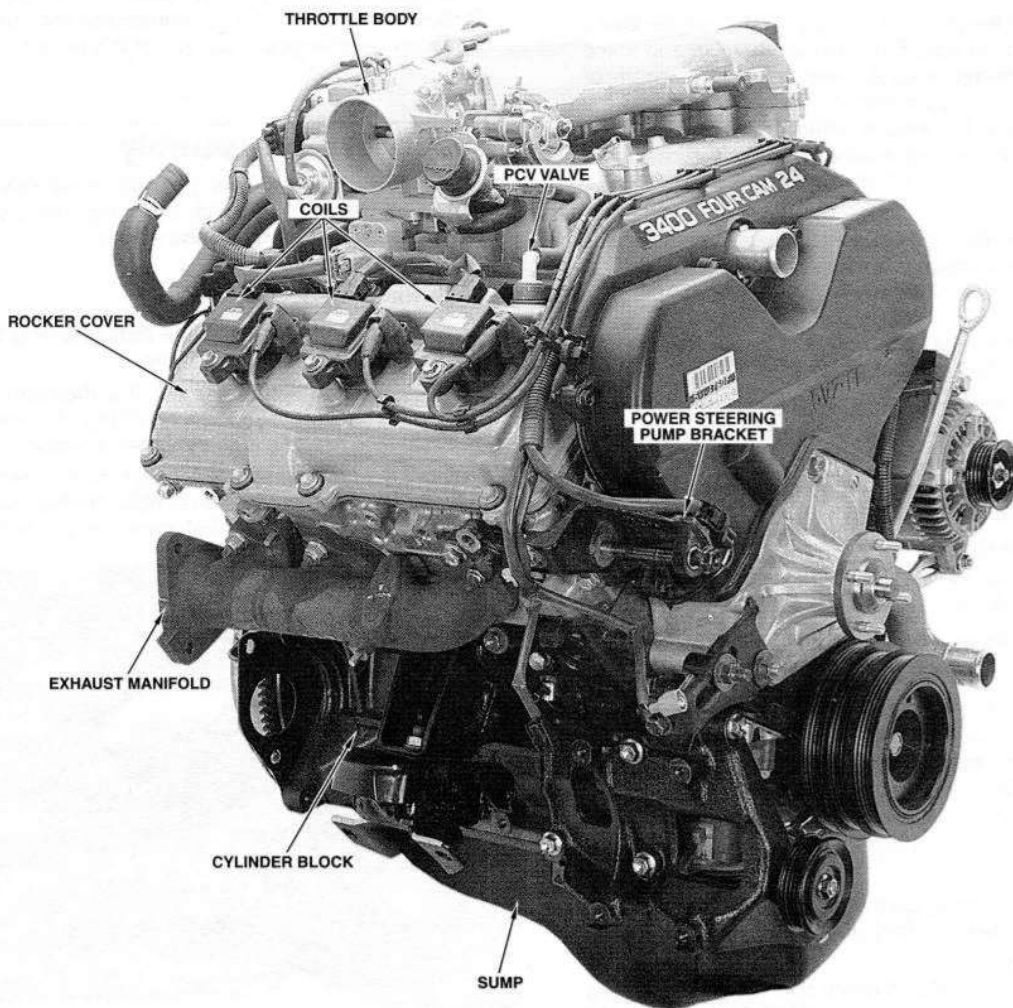
4

23 Working inside the vehicle on the passengers side, remove the screws retaining the glove compartment and withdraw the compartment from the dashboard.

24 Working in the dashboard aperture, disconnect the wiring connectors shown on the illustration.

25 Remove the nut retaining the engine wiring harness bracket located on the firewall, at the left side of the engine compartment.

26 Remove the nuts retaining the frame and release the rubber boot from the left side of the firewall. Carefully pull the engine wiring harness through the firewall into the engine compartment.

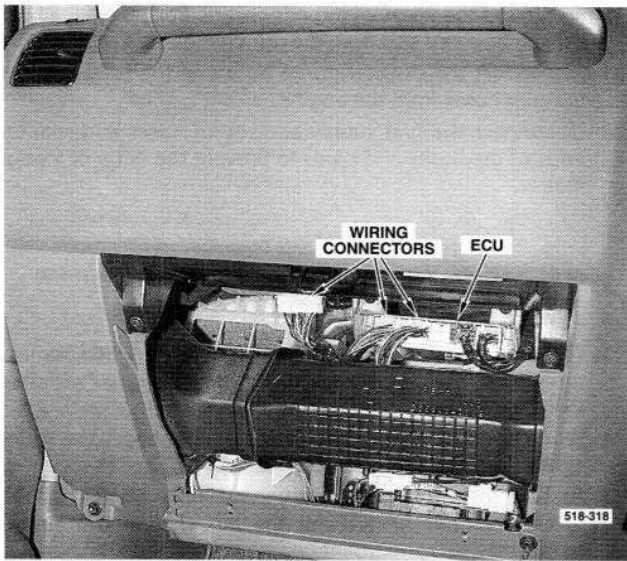


Right hand side of the engine.

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The labelled wiring connectors form part of the engine wiring harness.

- 27 Remove the nuts and bolts retaining the front engine mountings to the crossmember.
- 28 Attach a suitable length chain or rope to the engine lifting hook on the left hand side of the plenum chamber and to the power steering pump bracket. Place a 700 mm length of timber on top of the upper plenum chamber, between the chain. Slightly raise the engine using the tackle, ensuring that the ends of the timber securely engage the chain and the timber is located horizontally to the top of the engine.

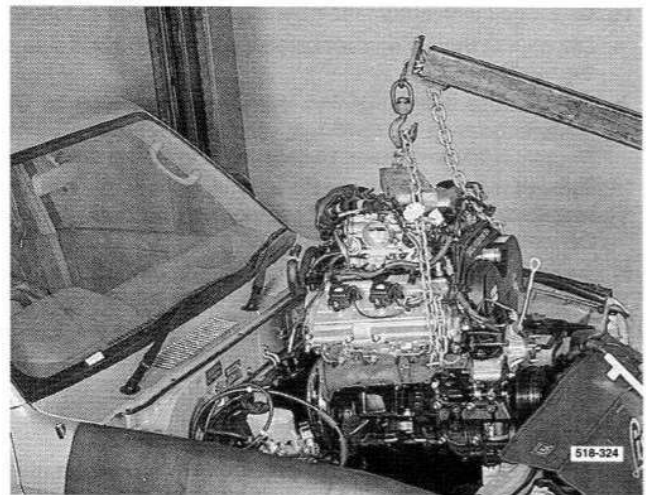


Remove the No 1 ignition coil if the chain/rope interferes with the coil. Place a clean cloth into the spark plug opening to prevent dirt entering the engine.

- 29 Working under the vehicle, remove the bolts retaining the clutch housing to the cylinder block.
- 30 Ensuring that all electrical wiring and hoses are clear and disconnected, carefully raise the engine and remove it from the vehicle.

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

- 1 Tighten all bolts securely.
- 2 Ensure that the wiring and vacuum hoses are correctly routed and securely connected.
- 3 Connect the fuel supply and return hoses securely.
- 4 Renew the engine exhaust pipe gaskets.
- 5 Securely tighten the fuel filler cap.
- 6 If necessary, fill the engine with the correct grade and quantity of oil. Fill the cooling system as described in Cooling System (chapter 5).
- 7 Check for external fuel leakage before starting the engine. This procedure is described in Fuel and Engine Management (chapter 7).
- 8 Start and run the engine until it reaches normal operating temperature and check for fuel, oil and coolant leaks. Rectify as necessary.
- 9 Allow the engine to cool and check that the nuts retaining the exhaust engine pipe to the manifold flanges are tight and that all hoses and connections are secure.



Removing the engine from the vehicle.

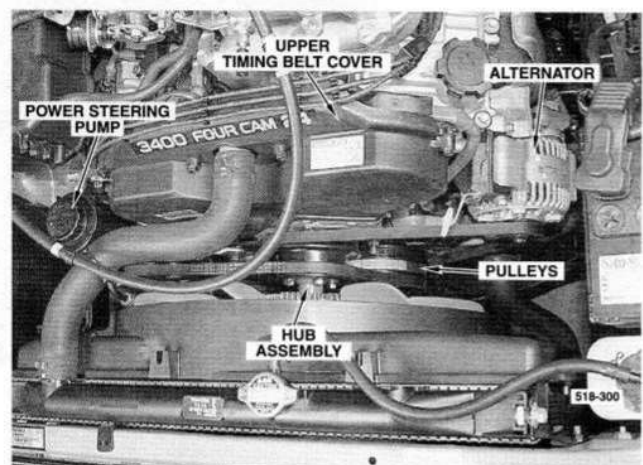
- 10 If new components have been installed to the engine, for example pistons, rings, bearings etc, the engine must be run-in at reduced speeds and loads for the first 1 000 km or so. Do not operate the engine at full throttle or allow it to labour in any gear during this period. Follow the component manufacturers advice and it is recommended that the engine oil and filter are changed at the end of this period.

Drive Belt Hub Assembly

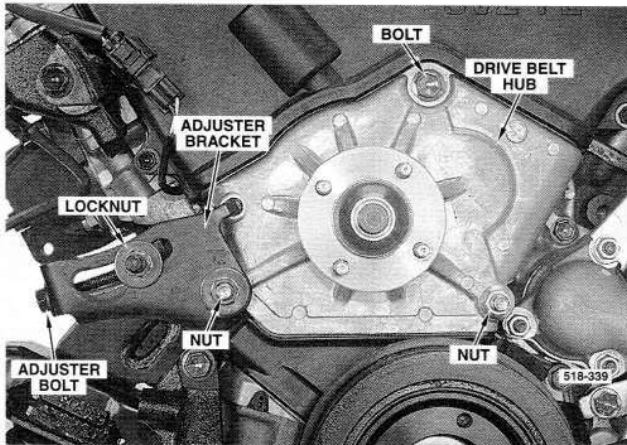
The alternator and the power steering pump drive belts are supported by the drive belt hub assembly. The assembly also carries the cooling fan coupling and the fan.

TO REMOVE AND INSTALL

- 1 Loosen, but do not remove the nuts retaining the cooling fan to the drive belt hub assembly.
- 2 Remove the power steering and the alternator drive belts from the hub assembly, referring to the Routine Maintenance heading in this chapter, if necessary.
- 3 Remove the fan assembly retaining nuts and manoeuvre the cooling fan from the hub assembly. Noting their installed position, remove the drive belt pulleys from the hub.



Drive belt hub and associated components.



Adjuster bracket and drive belt hub assembly location.

- 4 Remove the power steering pump belt adjuster bracket as follows:
 - a Remove the adjuster locknut from the adjuster.
 - b Remove the nut retaining the belt adjuster and withdraw the adjuster from the drive belt hub assembly.
- 5 Remove the upper timing belt cover, referring to the Timing Belt Covers heading in this chapter.
- 6 Remove the nut and bolt retaining the drive belt hub assembly to the cylinder block and withdraw it from the vehicle.

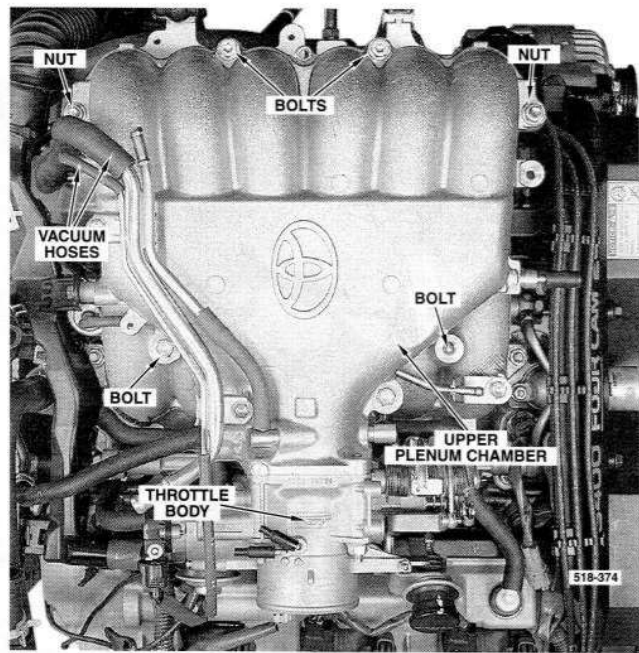
Installation is a reversal of the removal procedure with attention to the following points:

- 1 Rotate the hub by hand and check the bearing for rough rotation, wear or looseness in the hub body. Renew the assembly if necessary.
- 2 Install the hub assembly to the cylinder block and tighten the retaining bolt and nuts securely.
- 3 Install the upper timing belt cover, ensuring that the gaskets are in serviceable condition. Refer to the Timing Belt Covers heading later in this chapter, for the procedure to renew the gaskets.
- 4 Install the drive belt pulleys in the position noted during removal and the cooling fan. Tighten the retaining nuts to the specified torque.

Plenum Chambers

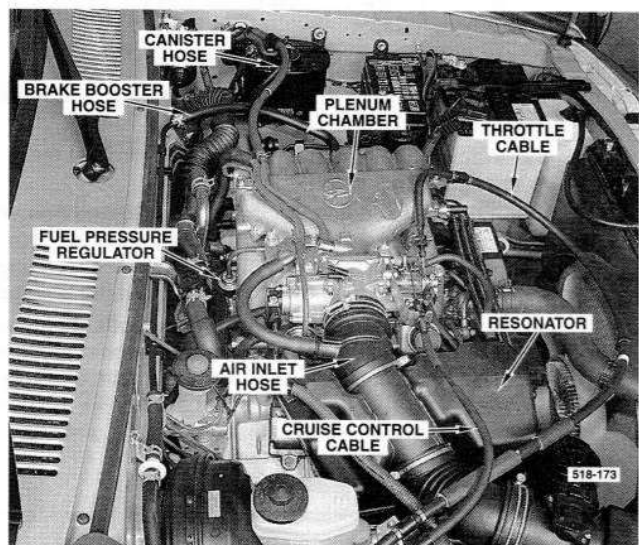
TO REMOVE AND INSTALL

- 1 Disconnect the negative battery terminal.
- 2 Suitably mark and disconnect the vacuum hoses from the brake booster, the charcoal canister purge control valve, fuel pressure regulator and the PCV valve.
- 3 Remove the air inlet hose and the air cleaner top cover, as follows:
 - a Disconnect the vacuum hose from the air cleaner top cover and from the resonator.
 - b Release the clips retaining the wiring to the resonator and to the air inlet hose. Disconnect the air flow sensor wiring connector.
 - c Using a twisting motion, remove the PCV breather hose from the air inlet hose.

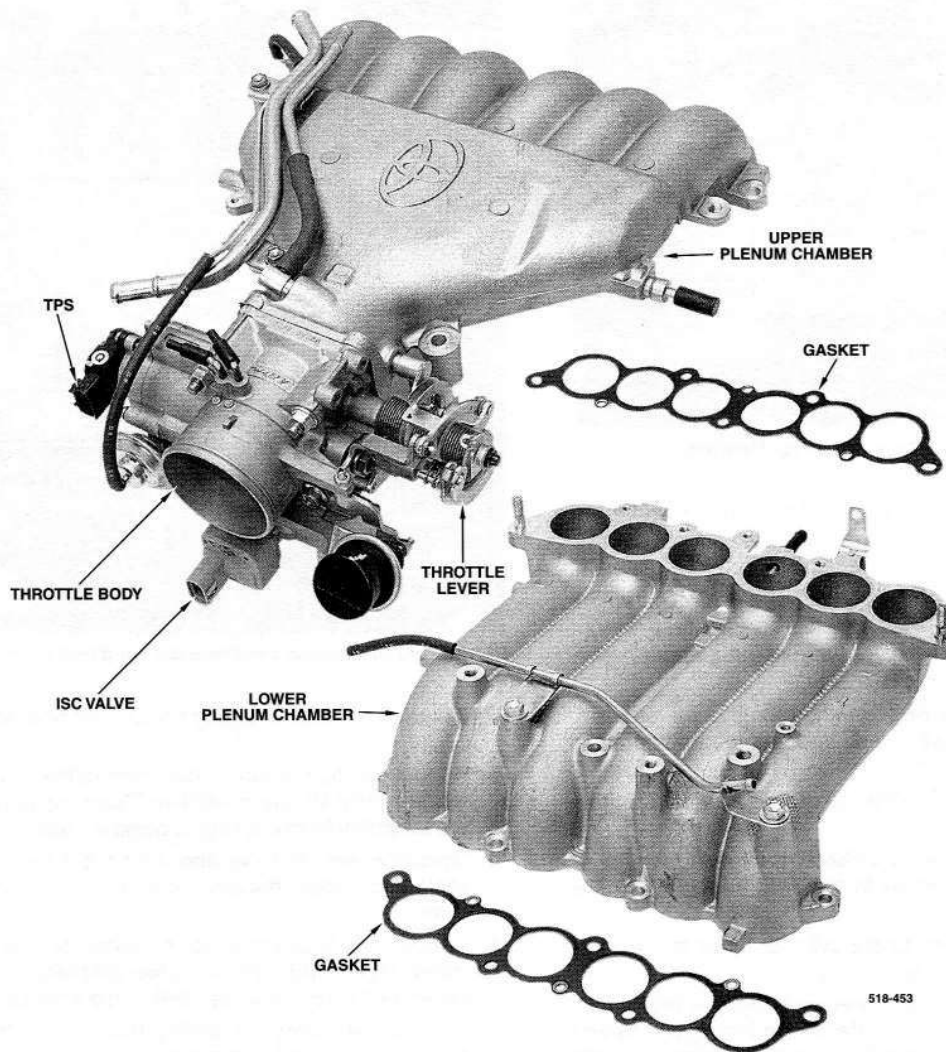


Upper plenum chamber retaining nuts and bolt locations.

- d Release the clamp retaining the air inlet hose to the throttle body.
- e Release the clips retaining the cover to the air cleaner body and carefully lift the cover away from the body. Withdraw the assembly from the engine compartment.
- 4 Open the throttle valve and disconnect the inner throttle cable and if fitted, the cruise control cable from the throttle lever.
- 5 Remove the bolts retaining the outer throttle cable and if fitted, the cruise control cable brackets and place the cable(s) with the bracket(s) clear of the work area.
- 6 Release the clamps retaining the coolant hoses to the throttle body, and using a twisting motion, remove the hoses from the fittings. Using 8 mm diameter bolts, seal the end of the hoses.



Plenum chamber installed, showing components.



Plenum chamber components.



Remove and seal one coolant hose at a time, to prevent the loss of coolant.

- 7 Disconnect the idle speed control (ISC) valve and throttle position sensor (TPS) wiring connectors.
- 8 Remove the bolt retaining the wiring harness to the rear of the lower plenum chamber.
- 9 Working at the left hand side of the plenum chamber, remove the bolts retaining the earth wiring and the fuel return hose bracket to the lower plenum chamber. Release the retaining clip and withdraw the diagnosis connector from the bracket.
- 10 Noting their installed location, remove the bolts retaining the plenum chamber support bracket to the upper plenum chamber and to the cylinder head. On automatic transmission models, withdraw the bracket from the engine compartment. On manual transmission models, gently pull the bracket away from the components.

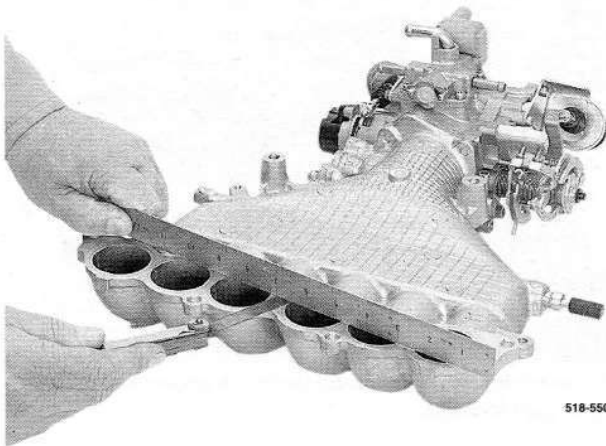


On manual transmission models the clutch hydraulic pipe is attached to the support bracket. Pulling the bracket excessively, may damage the clutch pipe.

- 11 Remove the bolts and nuts retaining the upper plenum chamber to the lower plenum chamber and withdraw the upper plenum chamber from the engine compartment. Discard the gasket.
- 12 Remove the bolts and nuts retaining the lower plenum chamber to the inlet manifold and withdraw the lower plenum chamber from the engine compartment. Discard the gasket.
- 13 If necessary, remove the nuts and bolts, disconnect the vacuum hose and separate the throttle body from the upper plenum chamber. Discard the gasket.
- 14 Using clean, lint free cloth block the openings of the inlet manifold to prevent the entry of dirt.

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

- 1 Ensure that all traces of the old gasket material have been removed from the gasket surfaces.
- 2 Using a straight edge and feeler gauges, check both plenum chamber mating surfaces for distortion. If distortion is greater than 0.1 mm, the plenum chamber(s) should be machined or renewed, as necessary.

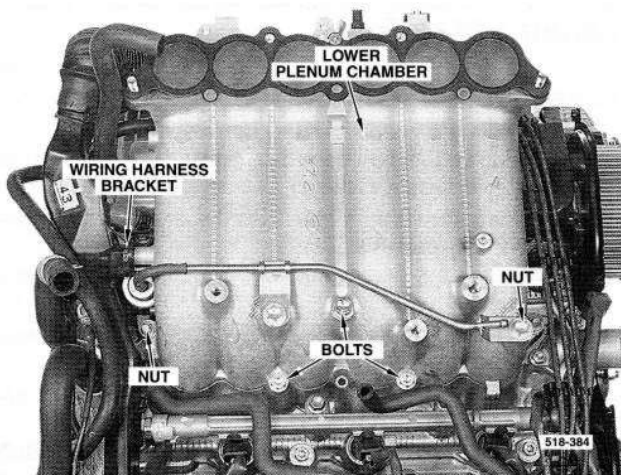


Checking the plenum chamber face for distortion.

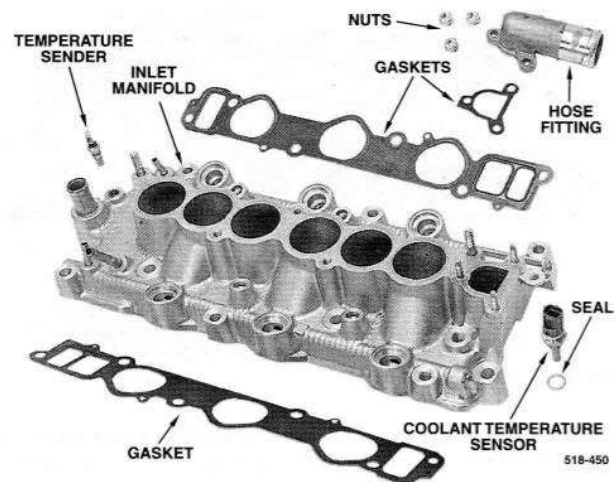
- 3 Using new gaskets install the lower and upper plenum chambers to the inlet manifold and tighten the retaining nuts and bolts evenly, in a circular pattern, starting in the centre of the plenum chamber, to the specified torque.

i When installing the gaskets to the plenum chambers, ensure that the holes in the gaskets are aligned with the holes in the plenum chambers.

- 4 If removed, install throttle body to the upper plenum chamber, using a new gasket and tighten the retaining nuts/bolts to the specified torque.
- 5 Moisten the pre-heater hoses with coolant and connect them to the throttle body fittings. Install the hose clamps and if necessary, replenish the radiator with coolant.
- 6 Install the support bracket and tighten the retaining bolts to the specified torque.
- 7 While holding the throttle linkage in the wide open position, connect the throttle, and if fitted, the cruise control cables.
- 8 Install the air cleaner components and tighten the retaining clamps securely. If necessary, refer to Part 1 of Fuel and Engine Management (chapter 7).
- 9 Connect the vacuum hoses and the wiring connectors securely.



Lower plenum chamber retaining nuts and bolt locations.



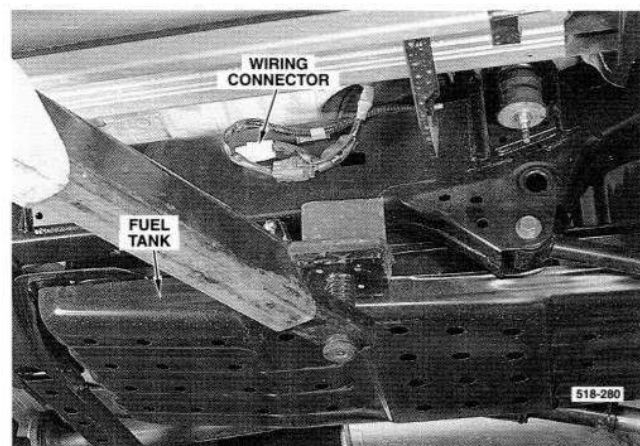
Inlet manifold components.

Inlet Manifold

TO REMOVE AND INSTALL

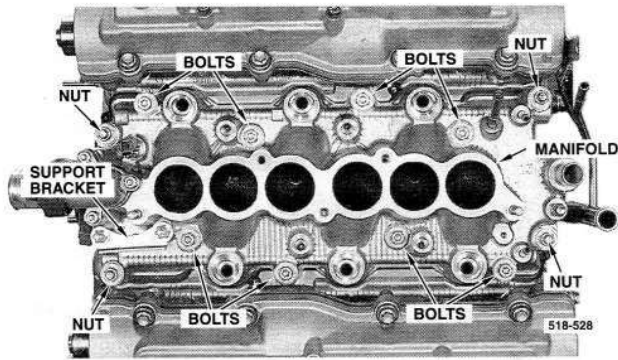
- 1 Reduce the fuel system pressure as follows:
 - a Working under the left hand side of the vehicle, forward of the rear wheel, disconnect the white wiring connector.
 - b With the engine running on the main tank, switch the sub fuel tank switch On. The light in the sub fuel tank gauge will illuminate.
 - c When the engine stalls, operate the starter for 5 seconds.
 - d Turn the ignition Off and connect the wiring connector securely.
- 2 Drain the cooling system, referring to Cooling System (chapter 5), if necessary. Once the coolant has drained, install the radiator drain plug and tighten securely.
- 3 Remove the upper and lower plenum chambers as previously described.
- 4 Disconnect the fuel supply and return hoses at the fuel rail. Discard the banjo bolt sealing washers.

TIP Loosen the fuel filler cap, to prevent pressure build up in the tank and subsequent fuel leakage while the fuel hoses are disconnected.



Location of the sub fuel pump wiring connector.

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Inlet manifold installed.

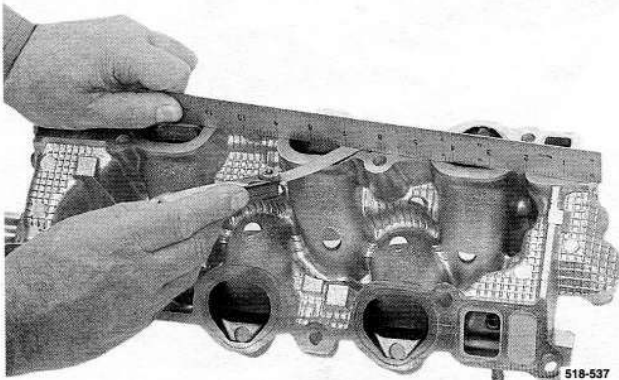
- 5 Suitably mark and disconnect the wiring connectors from the fuel injectors and from the coolant temperature sensor.
- 6 Working at the rear of the inlet manifold, disconnect the temperature gauge sender wiring connector. Remove the bolt retaining the harness and place the wiring harness clear of the work area.

i If the earth wiring at the rear of the right hand side cylinder head prevents moving the harness, remove the bolt retaining the earth wiring connector to the cylinder head and move it with the harness.

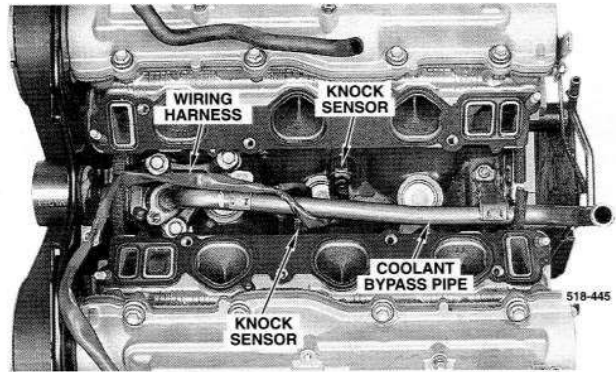
- 7 Release the clamp retaining the heater hose to the fitting on the inlet manifold, and using a twisting motion, withdraw the hose from the fitting.
- 8 Remove the upper and rear timing belt covers, as described previously in this chapter.
- 9 Remove the bolt retaining the inlet manifold support bracket to the guide pulley bracket, located at the front of the engine.
- 10 Remove the nuts, bolts and washers retaining the inlet manifold to the cylinder heads. Remove the front bolt retaining the bracket to the cylinder block. Carefully lift the inlet manifold away from the heads and withdraw it from the engine compartment. Discard the gaskets.
- 11 If necessary, remove the fuel rail from the inlet manifold. Refer to Fuel and Engine Management (chapter 7).

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

- 1 Ensure that all traces of the old gasket material have been removed from the gasket surfaces.



Checking the inlet manifold faces for distortion.



Inlet manifold removed showing the knock sensors and coolant by pass pipe location.

- 2 Using a straight edge and feeler gauges, check the inlet manifold mating surfaces for distortion. If distortion is greater than 0.1 mm, the manifold should be machined or renewed, as necessary.
- 3 Inspect the condition of the coolant bypass pipe and its gasket. Also check the condition of the knock sensor wiring harness. Renew components as necessary.
- 4 Using a new gaskets install the inlet manifold to the cylinder heads. Tighten the retaining nuts and bolts to the specified torque evenly, in a circular pattern, starting in the centre of the inlet manifold.

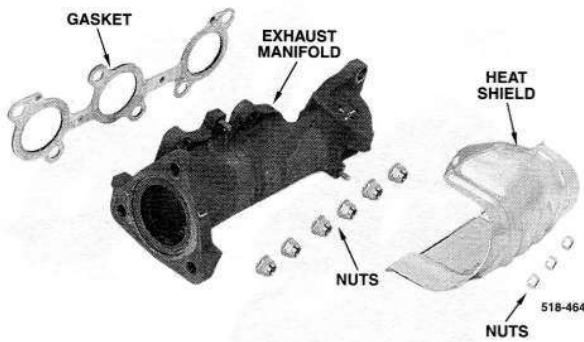
i When installing the gasket, ensure that the holes in the gasket are aligned with the holes in the cylinder head.

- 5 Using new sealing washers, install the fuel supply hose and tighten the banjo bolt to the specified torque. Install the fuel return hose. Tighten the fuel filler cap securely.
- 6 Install the plenum chambers as previously described.
- 7 Install the top radiator hose and securely attach the hose clamps. Refill the cooling system, referring to Cooling System (chapter 5), if necessary.
- 8 Connect the wiring connectors and the vacuum hoses securely.

Exhaust Manifolds

TO REMOVE AND INSTALL

- 1 Disconnect the negative battery terminal.
- 2 If working on the right hand side exhaust manifold, remove the air inlet hose and the air cleaner top cover, as follows:
 - a Disconnect the vacuum hose from the air cleaner top cover and from the resonator.
 - b Release the clips retaining the wiring to the resonator and to the air inlet hose.
 - c Using a twisting motion, remove the PCV breather hose from the air inlet hose.
 - d Release the clamp retaining the air inlet hose to the throttle body.
 - e Release the clips retaining the air cleaner body and carefully lift the cover away from the body. Withdraw the assembly from the engine compartment.



Right hand exhaust manifold components.

- 3 Remove the nuts retaining the heat shield to the exhaust manifold and withdraw the shield from the engine compartment. Repeat the operation on the opposite side of the engine.
- 4 Remove the lower set of nuts retaining the exhaust manifold to cylinder head on both sides of the engine.
- 5 Raise the front of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 6 Working under the vehicle, remove the nuts retaining the engine pipe to the exhaust manifold on both sides of the engine. Separate the engine pipes from the manifolds and discard the gaskets.
- 7 Remove the upper row of retaining nuts from both exhaust manifolds and manoeuvre the manifolds from the engine compartment. Discard the gaskets.

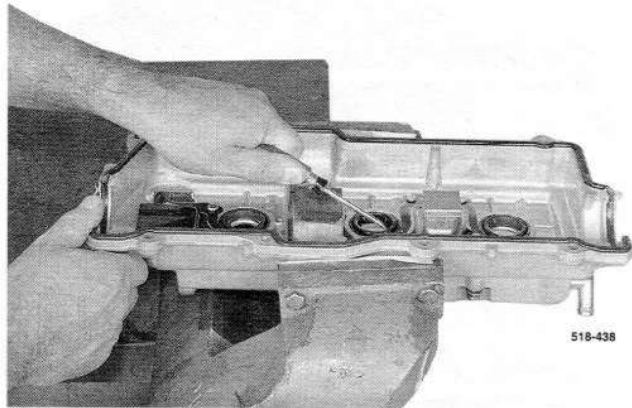
Installation is a reversal of the removal procedure with attention to the following points:

- 1 Ensure that all traces of the old gasket material have been removed from the gasket surfaces.
- 2 Using a straight edge and feeler gauges, check the exhaust manifold mating surfaces for distortion. If distortion is greater than 1 mm, the manifold should be machined or renewed, as necessary.
- 3 Using a new gasket, install the exhaust manifolds, ensuring that the holes in the gasket are aligned with the holes in the cylinder head.

Rocker Covers

TO REMOVE AND INSTALL

- 1 Disconnect the negative battery terminal.
- 2 To remove the left hand side rocker cover, proceed as follows:
 - a Remove the upper and lower plenum chambers, as previously described in this chapter.
 - b Ensure that the area around each spark plug boot is clean to prevent foreign matter entering the spark plug tube when the boot is removed.
 - c Remove the high tension leads, pulling on the boots only to prevent damage to the leads. Place the leads clear of the work area.
- 3 To remove the right hand side rocker cover, proceed as follows:



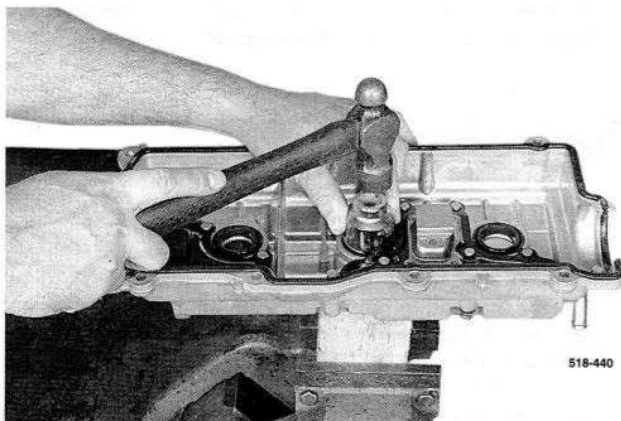
Renewing the spark plug tube seals.

- a Disconnect the vacuum hose from the air cleaner top cover and from the resonator. Disconnect the wiring connector from the air flow sensor.
- b Release the clips retaining the wiring to the resonator and to the air inlet hose.
- c Using a twisting motion, remove the PCV breather hose from the air inlet hose.
- d Release the clamp retaining the air inlet hose to the throttle body.
- e Release the clips retaining the cover to the air cleaner body and carefully lift the cover away from the body. Withdraw the assembly from the engine compartment.
- f Release the locking tab retaining the spark plug lead to the coil and withdraw the lead from each coil. Disconnect the wiring connector from each coil.
- g Ensure that the area around each coil is clean and remove the bolts retaining the coils to the rocker cover. While twisting the coil, withdraw it from each spark plug.
- 4 Remove the bolts retaining the rocker cover to the cylinder head and withdraw the sealing washers. Remove the cover from the cylinder head.



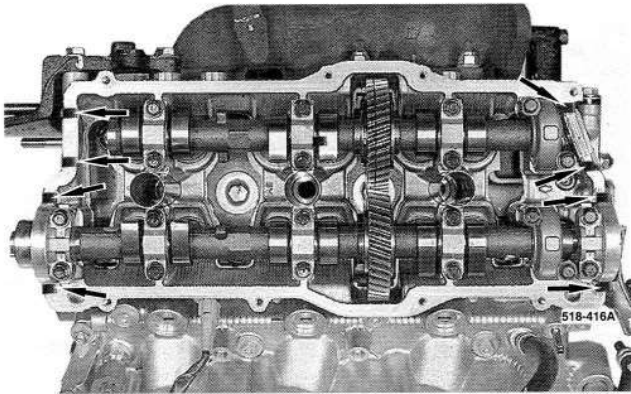
It may be necessary to use a flat bladed screwdriver to gently prise the cover from the cylinder head.

- 5 Remove the half moon seals from the cylinder head, located at the front and rear of each exhaust camshaft.



Installing a new spark plug tube seal.

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Apply sealant sparingly to the areas shown prior to installing the rocker cover.

- 6 Check the condition of the spark plug tube seals. If damaged, hard or brittle, renew all the seals as follows:
 - a Using a flat bladed screwdriver, carefully raise the tab retaining the seal in the rocker cover.
 - b Noting their installed direction, prise the seals from the cover using a flat bladed screwdriver, wrapped in cloth.
 - c Clean the seal seating surface in the rocker cover with a suitable solvent.
 - d Lightly oil the outside of the new seal. Using a 32 mm socket or tube, press the seal into the rocker cover until the lip of the seal is flush with the rocker cover inner surface.
 - e Carefully bend the retaining tab onto the seal.

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

- 1 Check the condition of the rocker cover gasket and the sealing washers. Renew if hard, brittle or damaged.
- 2 Clean the half moon seal seats in the cylinder head, and apply a small amount of Permatex Ultra Grey or equivalent sealant to the grooves of the half moon seal. Press the half moon seal firmly into the cylinder head, ensuring that it is level with the rocker cover gasket sealing surface on the cylinder head. Remove the excess sealant.
- 3 Apply Permatex Ultra Grey or equivalent sealant to the cylinder head contact surface, as shown in the illustration.
- 4 If removed, install a new gasket to the rocker cover. Sparingly apply a 10 mm wide band of Permatex Ultra Grey or equivalent sealant to the outer end of the spark plug tubes and install the rocker cover.
- 5 If necessary, install new sealing washers to the bolts and tighten the retaining bolts to the specified torque.

Timing Belt Covers

UPPER COVER

To Remove and Install

- 1 Release the high tension leads from the retaining clips and release the cam angle sensor wiring connector from the front of the top timing belt cover. Place the wiring clear of the work area.
- 2 Drain the coolant from the radiator to a level below the top radiator hose, referring to Cooling System (chapter 5), if



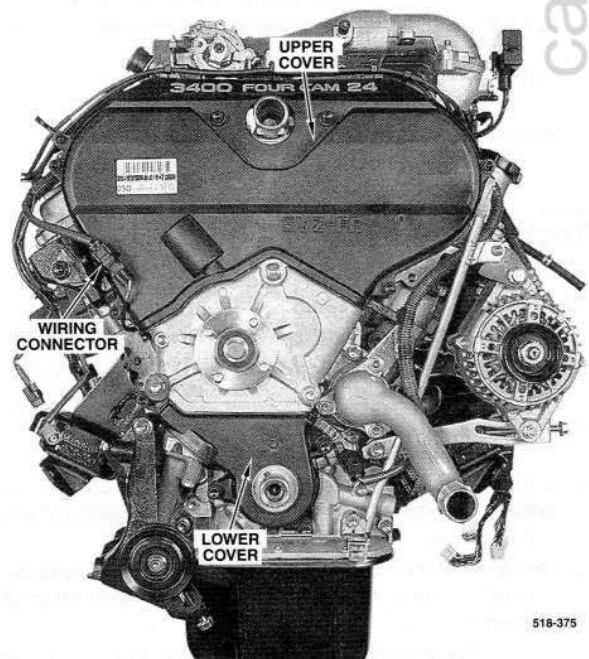
Timing belt covers removed from the vehicle.

necessary. Once enough coolant is drained, install the radiator drain plug and tighten it securely.

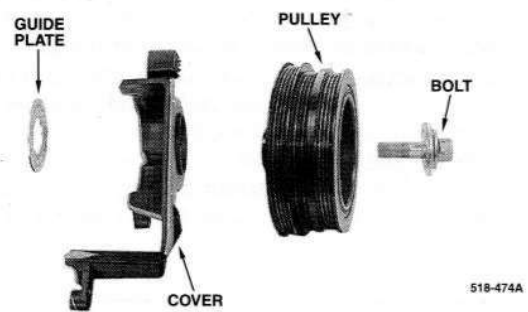
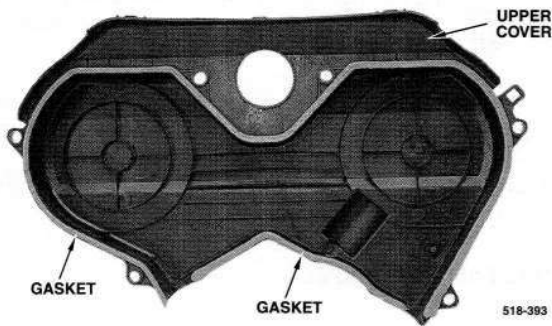
- 3 Release the throttle cable from the bracket attached to the top radiator hose. Release the top radiator hose clamps and using a twisting motion, remove the hose from the fittings.
- 4 Remove the retaining bolts and withdraw the top timing belt cover from the cylinder heads.

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

- 1 Check the condition of the gaskets on the upper timing belt cover. If the gaskets are damaged or perished, proceed as follows:



The cam angle sensor wiring is clipped to the upper cover.



Gasket correctly installed to the upper cover.

- a Using a scraper, remove the old gasket material from the cover.
- b Thoroughly clean the mating surface of the cover, using suitable solvent.
- c Peel the protective backing from the new gaskets and stick the gaskets to the timing belt cover, using the illustration as a guide.

i If a new gasket is not available, use Permatex The Right Stuff or an equivalent spray gasket to form a new sealing surface. Apply the sealant in a 2 – 3 mm thick bead, following the groove on the back of the cover. Allow the spray gasket applied to stand for about ten minutes prior to installation.

- 2 Install the retaining bolts and tighten to the specified torque.
- 3 Lubricate the hose fittings using coolant and install the radiator hose. Fill the cooling system, referring to Cooling System (chapter 5), if necessary.

LOWER COVER

To Remove and Install

- 1 Raise the front of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 2 Remove the bolts retaining the stoneguards and withdraw both guards from beneath the vehicle.
- 3 Remove the starter motor as described in Engine Electrical (chapter 6).
- 4 Using a lever through the starter motor mounting aperture, lock the engine at the ring gear teeth. Have an assistant remove the crankshaft pulley retaining bolt from the front of the crankshaft.

i Ensure that the lever is located securely in the ring gear teeth. The crankshaft pulley retaining bolt is extremely tight, and is loosened by rotating it anticlockwise.

- 5 Using a suitable remove the crankshaft pulley from the engine.
- 6 Remove the bolts retaining the wiring harness to the to the oil pump housing and position the harness clear of the work area.
- 7 Remove the bolts retaining the lower timing belt cover and withdraw the cover from the engine. Note the installed position of the timing belt guide plate, but do not remove it.

Lower cover and crankshaft pulley components.

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

- 1 Check the timing cover gaskets for deterioration and damage. To renew the gaskets, proceed as follows:
 - a Using a scraper, remove the old gasket material from the cover.
 - b Thoroughly clean the mating surface of the cover, using suitable solvent.
 - c Peel the protective backing from the new gaskets and stick the gaskets to the timing belt cover.

i If a new gasket is not available, use Permatex The Right Stuff or an equivalent spray gasket to form a new sealing surface. Apply the sealant in a 2 – 3 mm thick bead, following the groove on the back of the cover. Allow the spray gasket applied to stand for about ten minutes prior to installation.

- 2 Ensure that the dished side of the timing belt guide plate is facing toward the front of the vehicle.
- 3 Install the lower timing belt cover and the wiring harness. Tighten the retaining bolts to the specified torque.
- 4 Install the crankshaft pulley and tighten the retaining bolt to the specified torque. Use the same method used on removal to prevent the crankshaft turning.

REAR COVER

To Remove and Install

- 1 Remove the timing belt and the camshaft sprockets as described later in this chapter.
- 2 Remove the bolts retaining the cam angle sensor bracket and place the bracket with the sensor clear of the work area.
- 3 Remove the bolt retaining the timing belt guide pulley and withdraw the pulley from the engine.
- 4 Remove the retaining bolts and withdraw the rear timing belt cover from the engine.

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

- 1 Check the rear timing cover gaskets for deterioration and damage. To renew the gaskets, proceed as follows:
 - a Using a scraper, remove the old gasket material from the cover.
 - b Thoroughly clean the mating surface of the cover, using suitable solvent.

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- c On early models with stick on gaskets, peel the protective backing from the new gaskets and stick the gaskets to the timing belt cover, using the illustration as a guide.
 - d On late models, use Permatex The Right Stuff or an equivalent spray gasket to form a new sealing surface, about 2 – 3 mm thick. Allow the spray gasket applied, to stand for about ten minutes prior to installation.
- 2 Install the cam angle sensor bracket and the timing belt guide pulley. Tighten the bolts to the specified torque.

Timing Belt

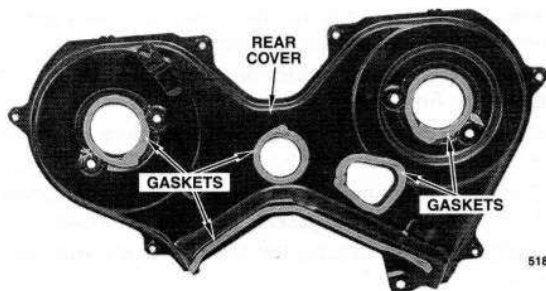
TO REMOVE

- 1 Drain the cooling system and remove the radiator, referring to Cooling System (chapter 5), if necessary.
- 2 On models with air conditioning, disconnect the wiring connector and remove the compressor retaining bolts. Secure the compressor to the chassis using wire or rope.



Do not disconnect the hose fittings from the air conditioner compressor as escaping refrigerant can cause eye injury and will necessitate regassing of the system.

- 3 Remove the retaining bolts, and noting the installed position of the spacers, withdraw the air conditioning compressor bracket from the engine.
- 4 Remove the drive belt hub assembly as previously described in this chapter.
- 5 Rotate the engine until the timing mark on the crankshaft pulley is aligned with the 0 mark (TDC) on the lower timing belt cover, and at the same time the timing marks on the camshaft sprockets align with the marks on the rear timing belt cover. If the marks do not align, rotate the crankshaft clockwise another full turn.
- 6 Remove the crankshaft pulley and the lower timing belt cover as previously described under the Timing Belt Covers heading in this chapter. Ensure, that the crankshaft pulley has not moved prior to removing the crankshaft pulley.
- 7 Remove the bolts retaining the air conditioning support bracket, gather the spacers, noting their installed position and withdraw the bracket from the cylinder block.
- 8 Noting the installed position, remove the timing belt guide plate from the crankshaft sprocket.
- 9 If the timing belt is to be reused, place a directional arrow and matchmarks on each sprocket and the belt to assist with installation.



Rear timing belt cover with gasket correctly installed.



It is important to return a used timing belt to the original direction of rotation or adverse wear could result.

- 10 Evenly loosen the bolts retaining the timing belt tensioner and withdraw the tensioner from the engine. Withdraw the dust seal from the belt tensioner aperture.
- 11 Slide the timing belt off the camshaft and crankshaft sprockets and remove the belt from the engine.

TO CLEAN AND INSPECT

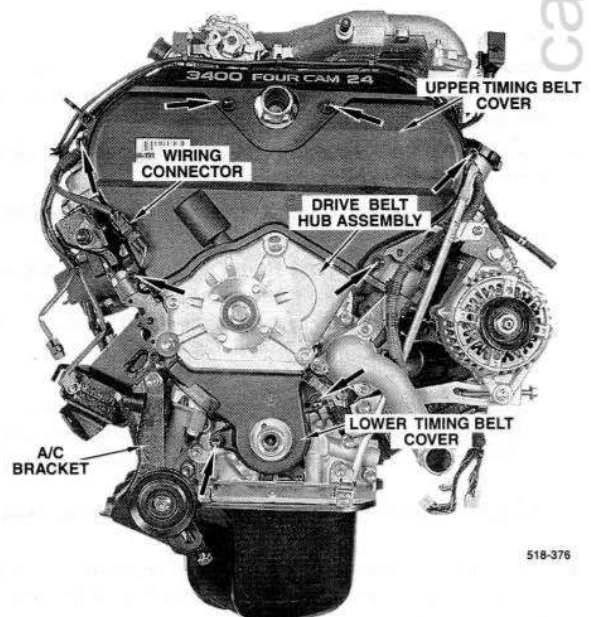


Do not wash the timing belt, sprockets or tensioner pulley. Keep these components free of oil and grease. Wipe the components with a clean cloth if required.

- 1 Inspect the crankshaft and camshaft sprockets for foreign material on the teeth or wear and damage. If necessary, ensure that the crankshaft sprocket mark is aligned with the mark on the oil pump housing, and ease the crankshaft sprocket from the end of the crankshaft, using two large screwdrivers. Ensure that the key in crankshaft is not misplaced.
- 2 Check the condition of the crank angle sensor teeth. If necessary, renew the crankshaft sprocket.
- 3 If the camshaft sprockets are to be removed, proceed as follows:
 - a Remove the relevant rocker cover(s), as previously described in this chapter.
 - b Hold the hexagonal segment of the exhaust camshaft with a spanner to prevent the camshaft turning and remove the camshaft sprocket retaining bolt. Withdraw the sprocket from the camshaft.



Ensure that the cylinder head is not damaged while removing the sprocket.

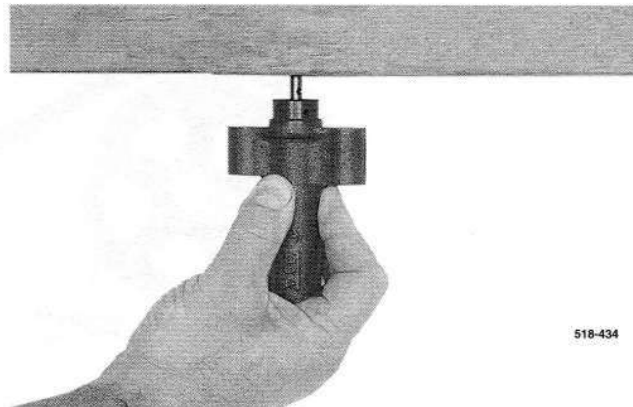


Upper and lower timing cover locations. The arrows indicate the retaining bolt positions.

- 4 Inspect the tensioner as follows:
 - a Check the rod seal for signs of leakage. If more than a very slight weep is present around the seal, renew the tensioner.
 - b While holding the tensioner rod upwards, attempt to push the rod into the tensioner. If the rod moves, the tensioner must be renewed.
 - c Measure the rod protrusion from the tensioner body. If the protrusion exceeds 10.8 mm, renew the tensioner.
- 5 Turn the tensioner, the guide pulley and the water pump pulley by hand and check for wear and roughness in the bearing. Check the contact surface of each pulley for wear and damage. Renew the pulley and/or the water pump, if the contact surface is worn or damaged, the bearing is unserviceable or grease is leaking from the pulley seals.
- 6 Ensure that the tensioner arm is pivoting freely. If necessary, remove the pivot bolt and withdraw the arm. Check the condition of the bush. Renew the tensioner assembly if the bush is worn or damaged.
- 7 Inspect the timing belt for damage or wear. Check the belt thoroughly for peeling, cracking or hardening of the rubber. Check to ensure that the belt is not contaminated with oil or coolant. Renew the belt and rectify the leaks if contamination is evident.



When inspecting the timing belt do not bend, twist or turn the belt inside out as damage could occur.



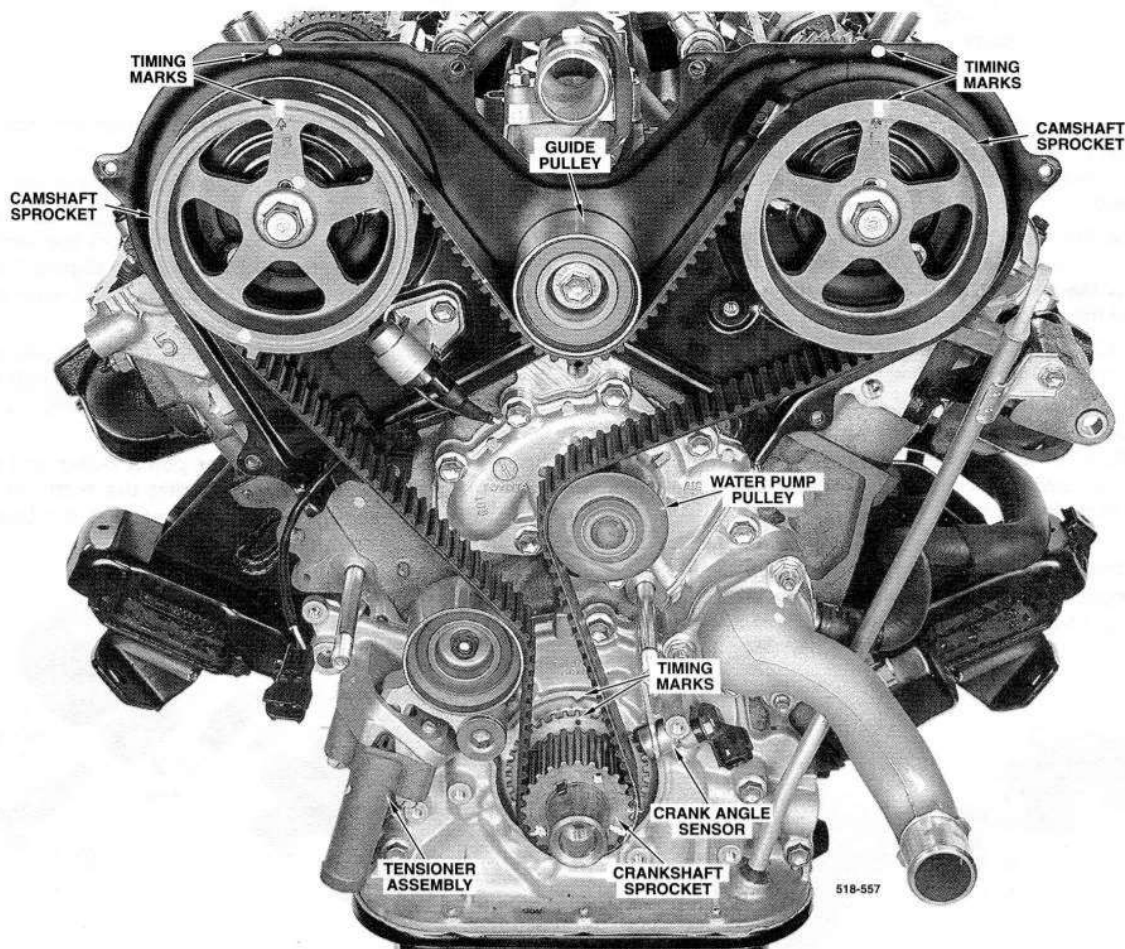
Checking the tensioner for wear and movement.

- 8 If the timing belt is worn or damaged on one side only, check the alignment of the sprockets, the guide and the tensioner pulley.

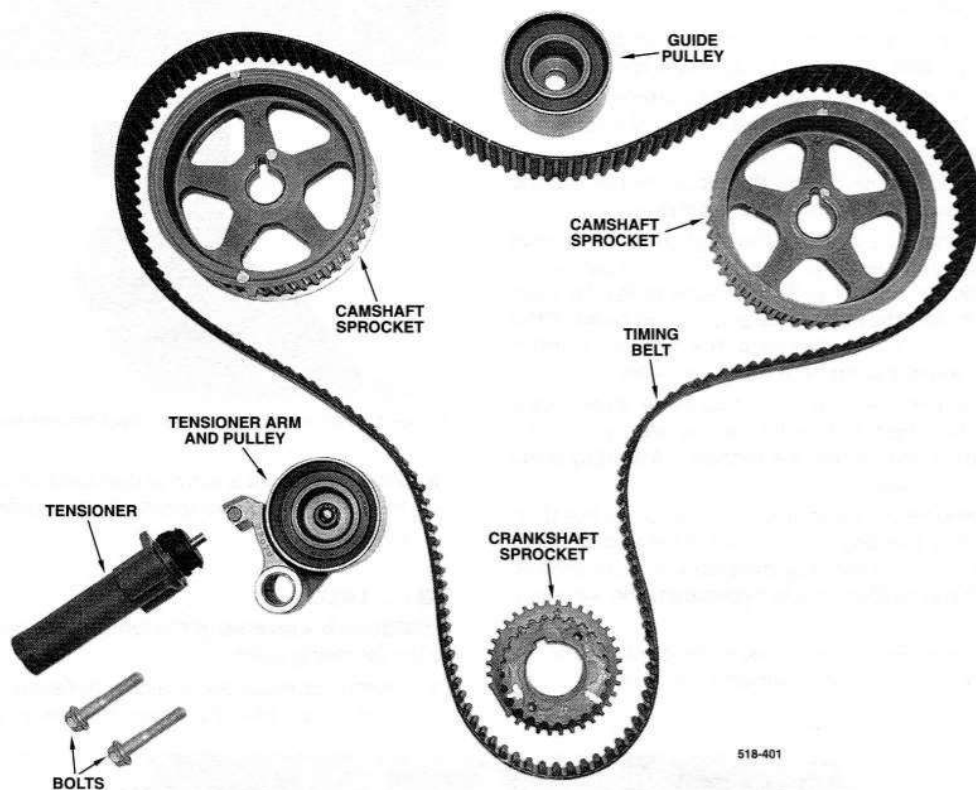
TO INSTALL

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

- 1 If removed, install the tensioner pulley and arm, ensuring, that the washer is placed between the arm and the cylinder block.



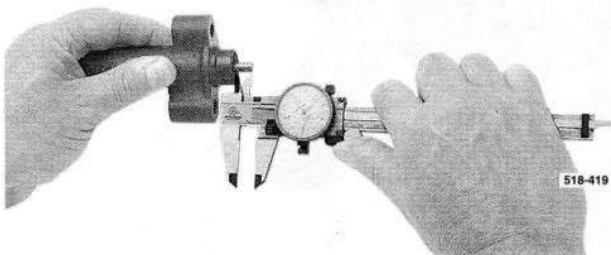
Timing marks correctly aligned prior to renewing the timing belt.



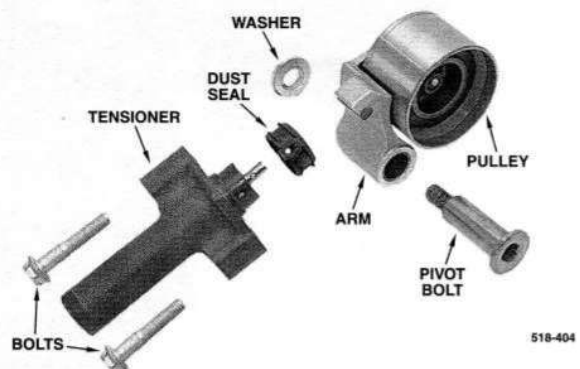
Timing belt and associated components.

- 2 Install the dust seal to the tensioner body, ensuring, that the protrusion on the seal is aligned with the protrusion on the tensioner body, and the holes in the seal and the tensioner are aligned.
- 3 Place the tensioner assembly with the piston rod in an upright position in a press fitted with soft jaws. Slowly compress the piston rod until the holes in the tensioner body and the piston rod are aligned.
- 4 Insert a 1.27 mm thick wire into the hole in the tensioner body, ensuring that the wire is pushed through the piston rod and is engaging the other side of the tensioner body.
- 5 If removed, install the camshaft sprocket to each exhaust camshaft, ensuring that the dowel pin is aligned with the hole in the sprocket. Hold the sprockets using the same method as during removal.
- 6 If removed, install the crankshaft sprocket, ensuring that the key in the crankshaft is in the correct position.
- 7 Ensure that the timing marks are correctly aligned.
- 8 Place the belt over the right hand side camshaft sprocket, ensuring that the belt correctly engages the teeth of the sprocket, and that the timing marks are aligned. If installing the original belt, ensure that the arrow marked on the belt is facing the direction of rotation.
- 9 While applying pressure to the belt, guide the belt under the guide pulley and over the left hand side camshaft sprocket, ensuring that the mark on the sprocket is aligned with the mark on the rear timing belt cover.
- 10 Place the belt over the water pump pulley and over the crankshaft sprocket, ensuring that the teeth on the belt correctly engage the sprocket, and that the belt is tight between the components.

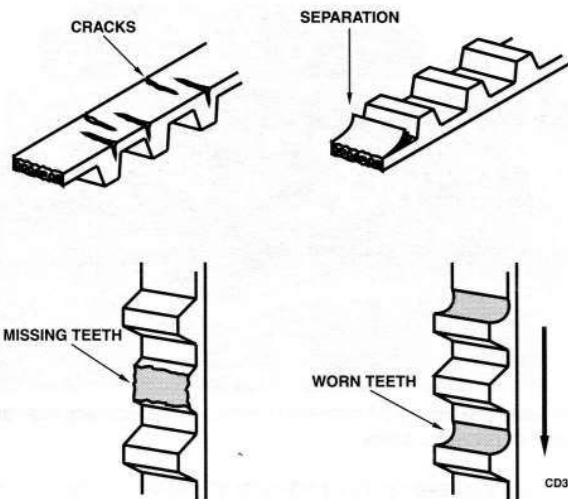
i The sprockets are marked with an L for left and R for right. They must be returned to the correct camshaft. The right hand side also has a tooth for the cam angle sensor.



Measure the tensioner rod protrusion using vernier calipers.

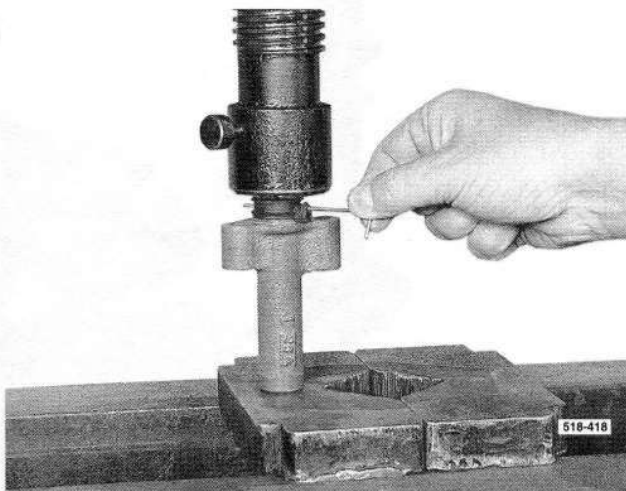


Timing belt tensioner components.



Check the timing belt for the illustrated faults.

- 11 While keeping the belt tight, install the belt over the tensioner pulley.
- 12 Install the tensioner assembly and evenly tighten the retaining bolts to the specified torque. Remove the wire from the tensioner.
- 13 Temporarily install the crankshaft pulley retaining bolt. Rotate the engine clockwise two full turns, aligning the timing marks at the end of the turn. If the timing marks do not align, the belt is not installed correctly. Remove the belt and repeat the procedure from step 8.
- 14 Place the timing belt guide plate on the crankshaft, ensuring that the dished side of the guide plate is facing the front of the vehicle.
- 15 Install the lower timing belt cover and the crankshaft pulley, referring to the Timing Belt Covers heading in this chapter.
- 16 Install the drive belt hub assembly, as previously described in this chapter.
- 17 Refill the cooling system, referring to Cooling System (chapter 5), if necessary.
- 18 Road test the vehicle and check for correct engine performance.



Insert the lock wire after pressing the rod into tensioner, prior to installing the tensioner to the vehicle.

Camshafts and Cam Followers

To Check Camshaft — Dial gauge, micrometer, V blocks



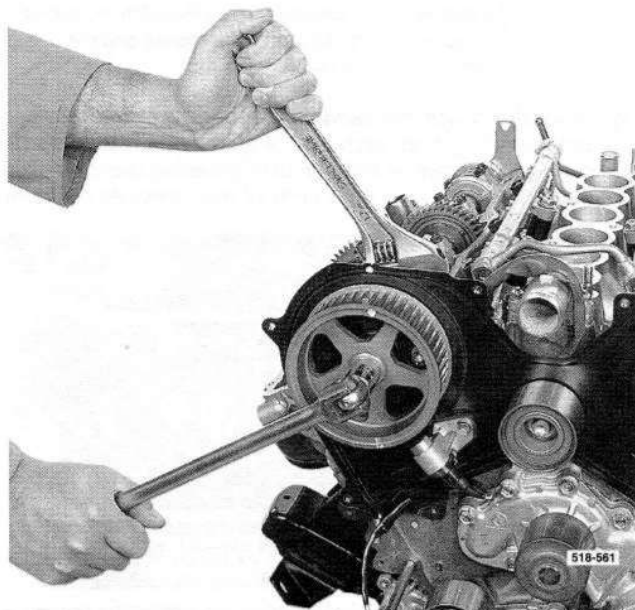
TO REMOVE

- 1 Disconnect the negative battery terminal.
- 2 Remove the rocker cover as previously described.
- 3 Measure and note the valve clearances, referring to Routine Maintenance heading in this chapter.
- 4 Remove the timing belt as previously described in this chapter.
- 5 Hold the hexagonal segment of the exhaust camshaft with a spanner to prevent it turning and remove the camshaft sprocket retaining bolt. Withdraw the sprocket.



The sprockets are marked R for the right hand side and L for the left hand side sprocket.

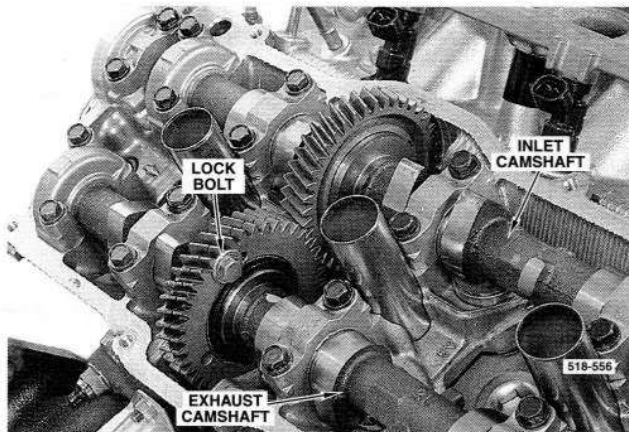
- 6 Remove the rear timing belt cover, referring to the Timing Belt Covers heading in this chapter.
- 7 Remove the camshafts from the cylinder head, using the following procedure:
 - a Rotate the right hand cylinder head camshafts until the lock-bolt hole in the exhaust camshaft sub gear is vertical above the camshaft. In this position, the double dot marks on the camshaft gears are matched. The single dot marks are positioned outside and are aligned with the rocker cover mating surface of the cylinder head. The dowel pin on the inlet camshaft will point downward. In this position the camshaft lobes will exert equal force on all the cam followers.
 - b Ensure that the left hand cylinder head exhaust camshaft lockbolt hole in sub gear is vertical above the camshaft. In this position, the single dot marks on the camshaft gears are matched, and the double dot marks are positioned on the



Loosening the camshaft sprocket bolt.

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Lock bolt installed to the exhaust camshaft sub gear hole.

outside and are aligned with the rocker cover mating surface of the cylinder head. The dowel pin on the inlet camshaft will point upward. In this position the camshaft lobes will exert equal force on all the cam followers.

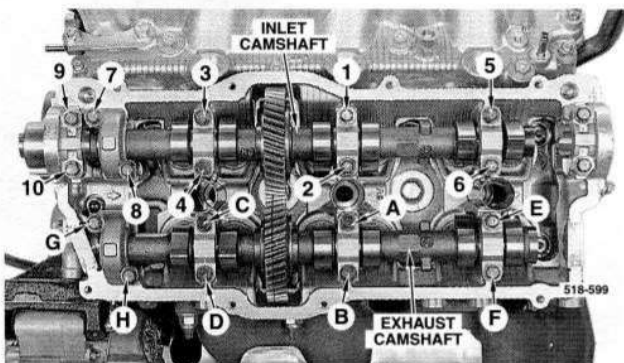
- c Suitably mark the installed position of each camshaft, as the shafts are not interchangeable.
- d Prise the oil seal from the front of the inlet camshaft.
- e Install a bolt 16–20 mm long, 6 mm diameter and 1 mm pitch into the sub gear hole to lock the sub gear to each exhaust camshaft gear.
- f Prior to removing the camshaft bearing caps, check that the caps are marked to ensure that they are installed correctly on assembly. Do not mark the caps using a punch.

i The inlet camshaft bearing caps have a letter *I* stamped on the bearing cap, followed by the bearing number, while the exhaust bearing caps are marked with a letter *E* followed by the bearing number.

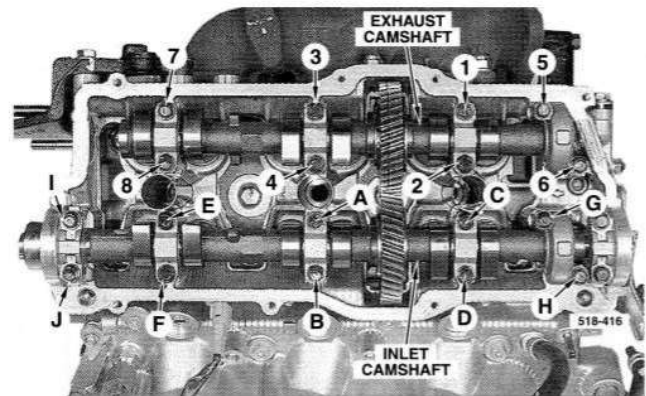
The arrows on the bearing caps on the right hand side of the engine point to the front of the engine, and are numbered from the front to the rear.

The arrows on the bearing caps on the left hand side of the engine point to the rear of the engine, and are numbered from the rear to the front.

- g Gradually loosen the camshaft bearing cap bolts, progressively working from each end of the camshaft towards the centre, in the reverse order of the tightening sequence illustrated, ensuring that both ends of the camshaft are lifting



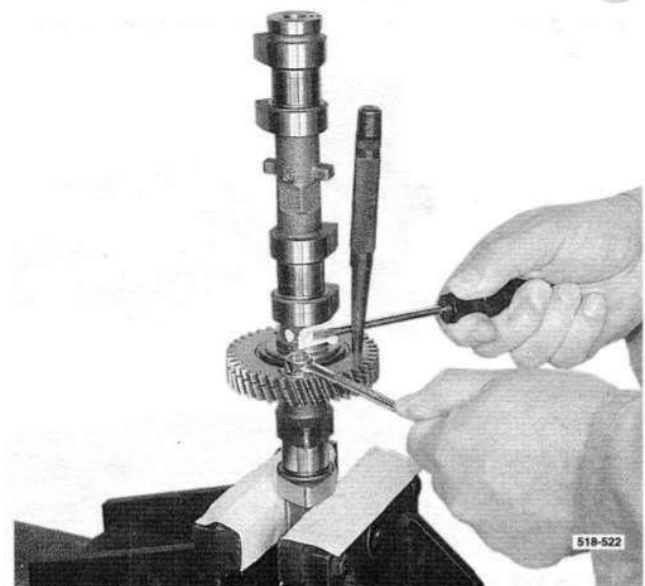
Left hand cylinder head camshaft bearing cap tightening sequence. Loosen in reverse order.



Right hand cylinder head camshaft bearing cap tightening sequence. Loosen in reverse order.

freely and evenly. Pay particular attention to the camshaft thrust faces which can break if binding occurs.

- h Lift each camshaft from the cylinder head.
- 8 Suitably mark the cam followers and the shims, located in the top of the cam followers, to ensure replacement to their original positions and remove the cam followers and shims from the cylinder head. Arrange them in the order of removal.
- 9 Dismantle the exhaust camshaft using the following procedure:
 - a Carefully mount the hexagonal segment of the camshaft in a vice equipped with soft jaws. Ensure that the camshaft gear is uppermost and the lobes are not damaged.
 - b Hold the end of a pin punch in a vacant hole in the sub gear and lever the sub gear in a clockwise direction, as shown in the illustration.
 - c With the aid of an assistant, remove the sub gear lock bolt which was installed during the camshaft removal procedure. Remove the pin punch.
 - d Remove the snap ring retaining the sub gear.
 - e Remove the wave washer, sub gear and sub gear spring from the camshaft.



Removing the sub gear lock bolt from the exhaust camshaft.

TO INSPECT

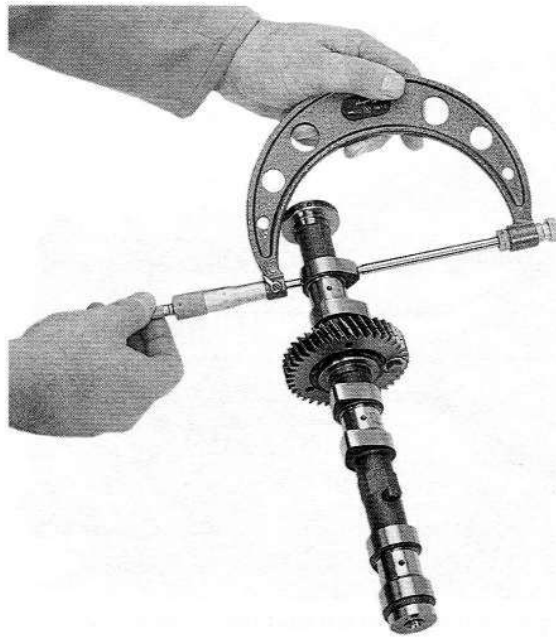
- 1 Thoroughly wash and dry each camshaft.
- 2 Check the camshaft lobes, journals, thrust faces and gears for pitting and wear. If wear is evident, measure the lobes with a micrometer and compare with Specifications. Support the camshaft at each end on V blocks and using a dial gauge with its plunger contacting the centre journal, rotate the camshaft and check for runout. Renew the camshaft if the runout is excessive or if pitting or wear is excessive.
- 3 Check the bearing surfaces for signs of scoring or overheating. If a bearing surface is worn or damaged, renew the cylinder head.
- 4 Check the camshaft endfloat as follows:
 - a Ensure that the cam followers are suitably marked and removed as previously described, while performing the following inspections of the camshafts.
 - b With the sub gear removed, place the exhaust camshaft on the cylinder head, so the lock bolt hole is in the uppermost position. In this position none of the camshaft lobes are in contact with the valves.
 - c Place the inlet camshaft on the cylinder head, so the dowel pin is pointing upwards on the left hand side camshaft, or if working on the right hand side camshaft, the dowel pin is pointing downward. In this position none of the camshaft lobes are in contact with the valves.
 - d Install the bearing caps to the camshafts, ensuring that they are in numerical order, placed on the relevant camshaft with the arrows facing in the appropriate direction.

i The inlet camshaft bearing caps have a letter *I* stamped on the bearing cap, followed by the bearing number, while the exhaust bearing caps are marked with a letter *E* followed by the bearing number.

The arrows on the bearing caps on the right hand side of the engine point to the front of the engine, and are numbered from the front to the rear.

The arrows on the bearing caps on the left hand side of the engine point to the rear of the engine, and are numbered from the rear to the front.

- e Gradually and progressively tighten the bearing cap bolts to the specified torque working from the centre outwards,



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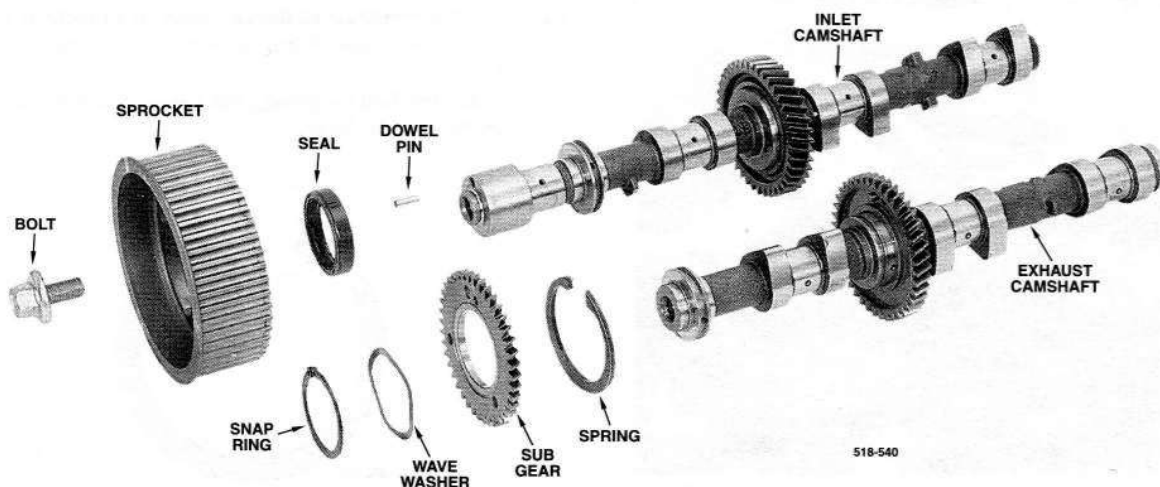
Measuring the camshaft lobe height using a micrometer.

referring to the illustrations under the heading Camshafts and Cam Followers — To Remove.

- f Mount a dial gauge to the cylinder head with the plunger against the front of the inlet camshaft. Lever the camshaft back and forth and measure the end float. Repeat the procedure on the exhaust camshaft.

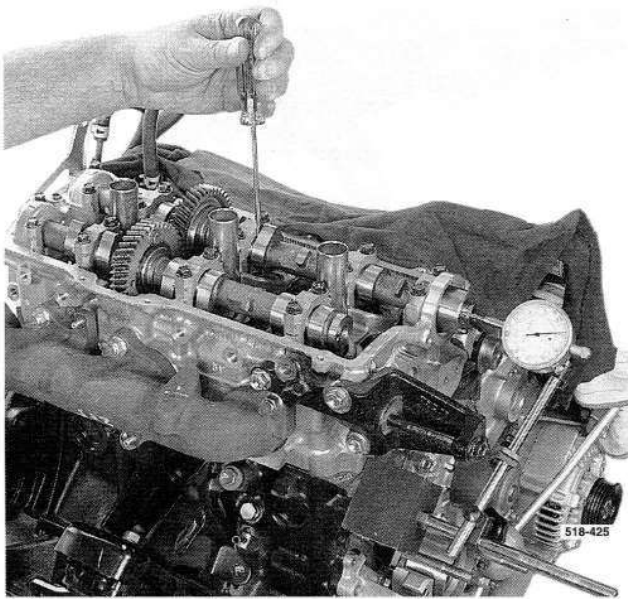
If the end float exceeds the specified limit, remove the camshaft(s) and check for worn thrust faces on the cylinder head and camshaft. Renew the camshaft and/or the cylinder head, as necessary.

- 5 While the camshafts are installed for the end float check, also check the camshaft gear backlash as follows:
 - a Install a dial gauge with the plunger contacting a tooth of the exhaust camshaft gear.
 - b Hold the inlet camshaft and rotate the exhaust camshaft backwards and forwards to measure the backlash. Renew the camshafts if the backlash is excessive.



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Camshafts dismantled.

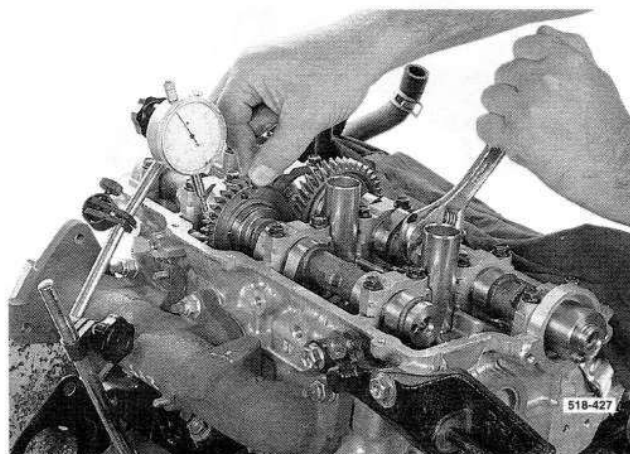


Measuring the inlet camshaft end float using a dial gauge.

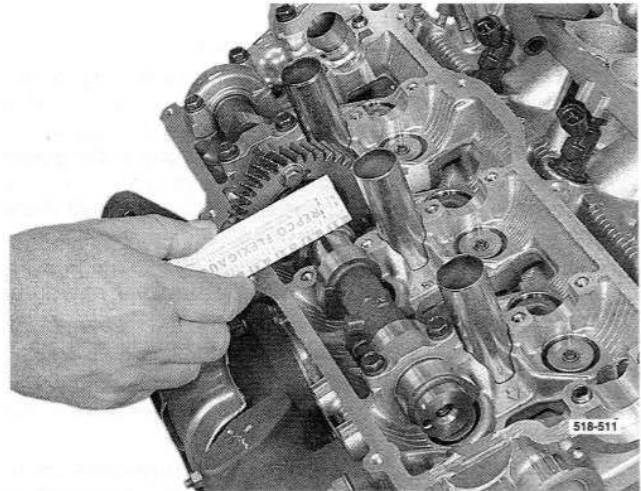
- 6 Check the oil clearance of the camshaft journals as follows:
 - a Ensure that the camshaft journals and the bearing surfaces are clean.
 - b Install the camshafts to the cylinder head, as described previously in the end float check operations, but do not install the bearing caps.
 - c Install lengths of Plastigage across each camshaft journal.
 - d Install the bearing caps and gradually and progressively tighten the bearing cap bolts to the specified torque working from the centre outwards, referring to the illustrations under the heading To Remove. Ensure that the caps are in numerical order.

i Do not rotate the camshafts, while the Plastigage is installed.

- e Remove the bearing caps and compare the spread width of the Plastigage with the scale on the packet. If the clearance exceeds Specifications, measure the camshaft journals with



Checking the camshaft gear backlash using a dial gauge with the sub gear removed.



Checking the camshaft bearing journal oil clearance, using Plastigage.

a micrometer and compare with Specifications. Renew the camshafts or the cylinder head and bearing caps as necessary.

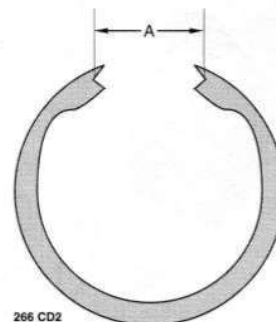
- 7 Check the cam followers and the shims for wear and pitting. Renew parts as necessary.

TIP If a shim is badly worn or pitted, examine the corresponding cam lobe for wear. Renew the camshaft if necessary.

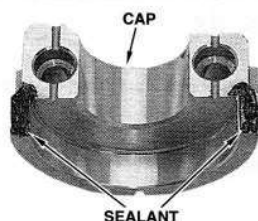
- 8 If the engine has done a lot of work or other problems are evident, measure the diameters of the cam follower and the cam follower bore in the cylinder head. Calculate the oil clearance and renew the cam followers and if necessary, the cylinder head if the clearance exceeds Specifications.

i Depending on the measuring equipment available, it may be necessary to remove the valves and springs from the cylinder head as described under the Cylinder Head heading.

- 9 Measure the distance between the sub gear spring ends. Renew the spring if the spring end gap exceeds Specifications.
- 10 Check the condition of the camshaft cover plate at the rear of the cylinder head. If the cover plate is leaking, proceed as follows:
 - a Remove the bolts retaining the cap and withdraw the cap from the cylinder head.



Measure the sub gear spring end gap. Dimension A= 18.2 – 18.8 mm.



To prevent oil leaks, apply a small amount of Permatex Ultra Grey sealant to the camshaft cover plate cap as shown.

- b Noting the installed depth of the cover plate, withdraw it from the cylinder head.

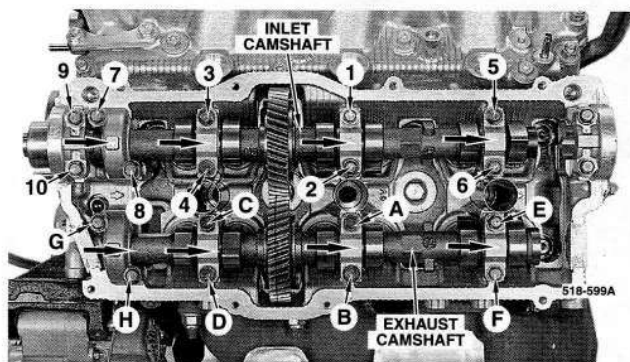
TO INSTALL

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

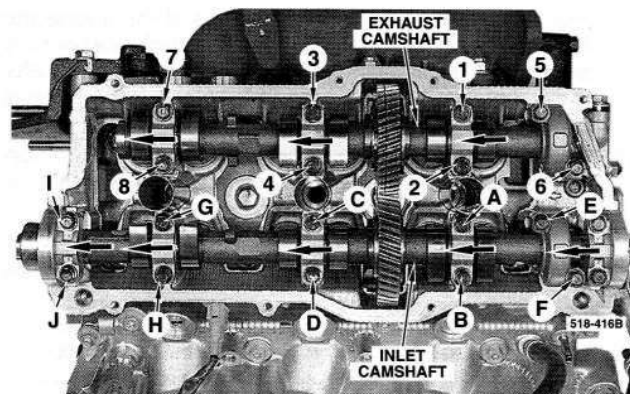
- 1 If removed, install the camshaft cover plate to the cylinder head, as follows:
 - a Install the cover plate to the head, ensuring that it is straight, and it is fully seated.
 - b Apply a small amount of Permatex Ultra Grey or equivalent sealant to the mating surface of the cap, as shown in the illustration.
 - c Install the cover plate cap bolts and tighten to the specified torque.
- 2 Assemble the exhaust camshaft using the following procedure:
 - a Clamp the hexagonal area of the camshaft in a vice equipped with soft jaw guards. Position the drive gear uppermost.
 - b Install the sub gear spring adjacent to the drive gear with the end of the spring contacting the dowel.
 - c Install the sub gear and the wave washer.
 - d Install the snap ring ensuring that the snap ring is correctly positioned in the snap ring groove.
 - e Using pin punches and a screwdriver, rotate the sub gear clockwise against spring tension and install the lock bolt used previously to lock the sub gear to the drive gear.



Ensure that the teeth of the sub gear are aligned with the drive gear before tightening the lock bolt.



Left hand cylinder head camshaft bearing cap tightening sequence. The arrows indicate the direction the bearing caps should face.



Right hand cylinder head camshaft bearing cap tightening sequence. The arrows indicate the direction the bearing caps should face.

- 3 Lubricate the cam followers and shims with clean engine oil and install them to the cylinder head to the positions noted on removal.
- 4 Lubricate the journals, thrust faces and cam lobes with clean engine oil prior to installation. Do not allow the oil to enter the bearing cap retaining bolt holes.
- 5 Place the inlet camshaft on the cylinder head, so the dowel pin is pointing upwards on the left hand side camshaft, and the dowel pin is pointing downwards on the right hand side camshaft. In this position the camshaft lobes are exerting equal force on their respective cam followers.
- 6 Install the bearing caps to the inlet camshafts, ensuring that they are in numerical order, placed on the relevant camshaft with the arrows facing in the appropriate direction.



The inlet camshaft bearing caps have a letter I stamped on the bearing cap, followed by the bearing number, while the exhaust bearing caps are marked with a letter E followed by the bearing number.

The arrows on the bearing caps on the right hand side of the engine point to the front of the engine, and are numbered from the front to the rear.

The arrows on the bearing caps on the left hand side of the engine point to the rear of the engine, and are numbered from the rear to the front.

- 7 To prevent oil leaks in the front seal area, apply a small amount of Permatex Ultra Grey or equivalent sealant to the No 1 inlet camshaft bearing cap contact face, adjacent to the oil seal recess, as shown on the illustration.
- 8 Gradually and progressively tighten the bearing cap bolts to the specified torque working from the centre outwards, referring to the illustration. Remove the excess sealant protruding from the front inlet camshaft bearing cap.



It is important that the camshaft be kept level as it is pushed down into position by the bearing caps. Damage to or breakage of the thrust faces could occur if the camshaft is tilted during installation.

- 9 Apply multipurpose grease to the lip of a new camshaft oil seal and install the seal squarely into the front bearing cap using a suitable mandrel or tube, until it is flush with the bearing cap.
- 10 Mesh the exhaust camshaft gear with the inlet camshaft gear and roll the camshaft into the cylinder head. Ensure that the

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single dot mark on the left hand side and the double dot marks on the right hand side exhaust camshafts are correctly aligned with the relevant dot marks on the inlet camshafts. In this position the sub gear bolt holes on the exhaust camshafts are pointing upwards.

- 11 Install the exhaust camshaft bearing caps to the cylinder head, ensuring that they are in numerical order, and that the arrows point to the appropriate direction.
- 12 Gradually and progressively tighten the bearing cap bolts to the specified torque, in the order shown in the illustration.

TIP It is important that the camshaft be kept level as it is being pushed down into position by the bearing caps. Damage to or breakage of the thrust faces could occur if the camshaft is tilted during installation.

- 13 Remove each sub gear lock bolt from the exhaust camshaft.
- 14 Install the camshaft sprockets, ensuring that the dowel pins are aligned with the holes in the camshaft sprockets and tighten the bolts to the specified torque.
- 15 If necessary, rock the camshaft sprockets, until the timing mark on the sprocket is aligned with the mark on the rear timing belt cover and the dot marks on the camshaft gears are aligned.
- 16 Install the timing belt as previously described under the Timing Belt heading in this chapter.
- 17 Check and if necessary, adjust the valve clearances, as described in the Routine Maintenance heading in this chapter.
- 18 Install the rocker covers and the plenum chambers as described under the appropriate headings in this chapter.

Cylinder Heads



To Dismantle and Assemble — Valve spring compressor and adaptor

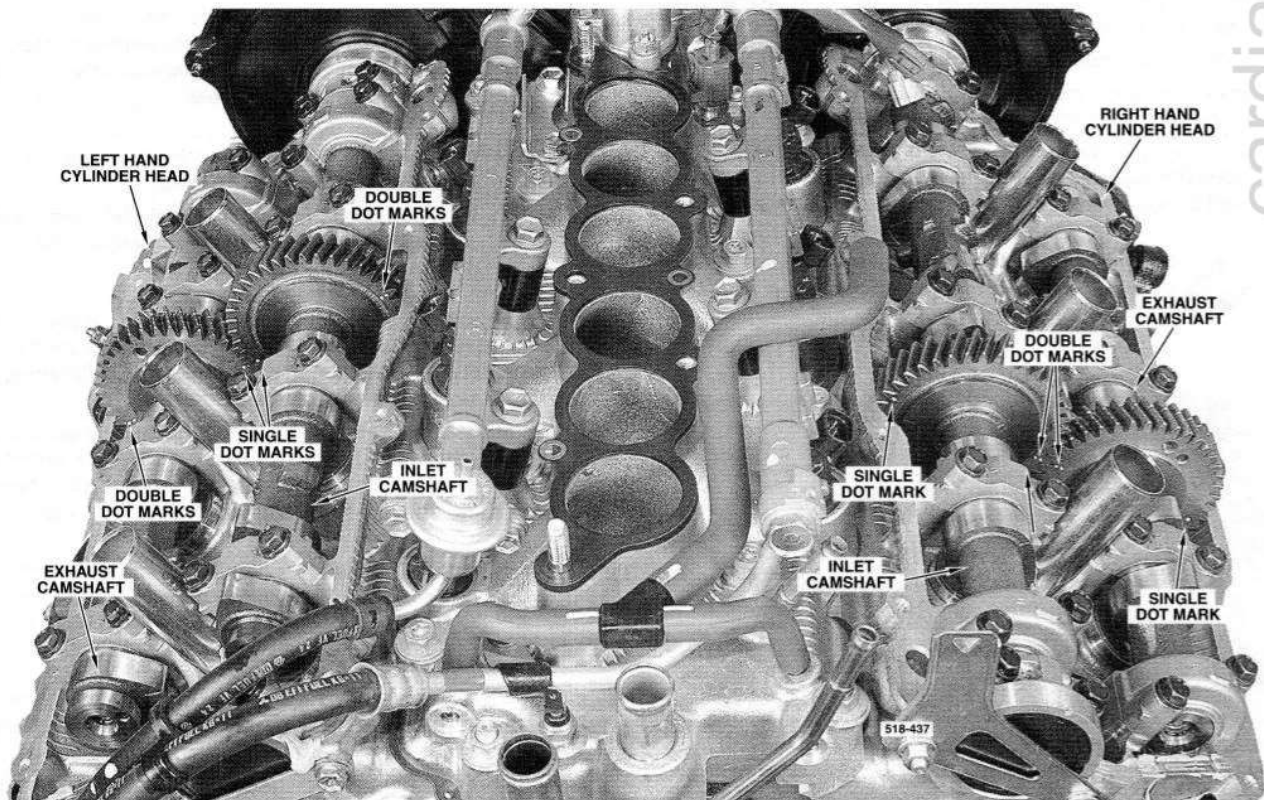
To Inspect — Straight edge, inside and outside micrometers

TO REMOVE AND INSTALL



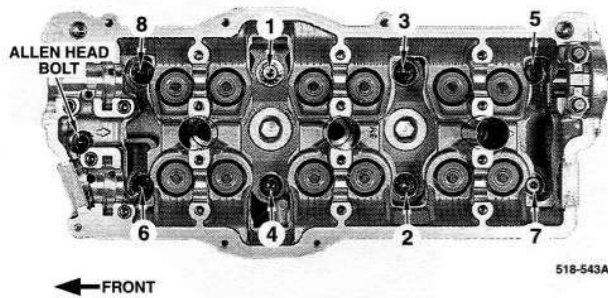
Allow the engine to cool prior to the removal of the cylinder heads or distortion may occur.

- 1 Remove the plenum chambers, the inlet manifold, the exhaust manifolds, the rocker covers and the camshafts as previously described.
- 2 Remove the power steering pump retaining bolts and place the pump clear of the work area. If necessary, refer to Steering (chapter 12). Remove the power steering pump retaining bracket from the cylinder head.
- 3 Remove the alternator, referring to Engine Electrical (chapter 6), if necessary and withdraw the heat shield from bracket. Remove the alternator retaining bracket from the cylinder head.
- 4 Remove the bolt retaining the earth lead to the right hand side cylinder head.
- 5 Progressively loosen the cylinder head retaining bolts in the reverse order of the tightening sequence shown in the illustration. Remove the allen head bolt.



View from the rear to the front of the engine showing the camshaft timing marks aligned correctly.

LEFT CYLINDER HEAD



Left hand cylinder head bolt tightening sequence. Loosen in the reverse order.

- 6 Lift each cylinder head away from the cylinder block and remove the cylinder heads from the vehicle. To assist in breaking the gasket adhesion, insert a lever between the cylinder block and the cylinder head at the rear of the engine when working on the right hand side cylinder head or at the front when removing the left hand side head. Do not lever on the gasket surface.
- 7 Using a sharp scraper, clean the cylinder block and the cylinder head, ensuring that both surfaces are free from gasket material, using care to prevent foreign material entering the cylinders.

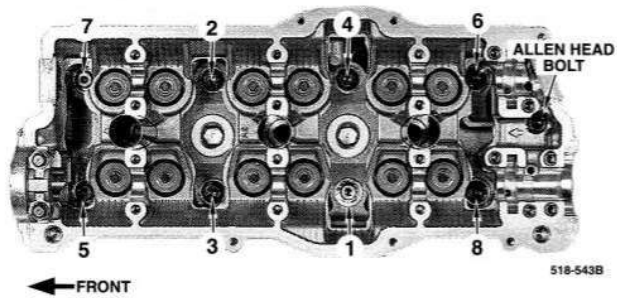
TIP Permatex Gasket Remover or equivalent will assist in removing any traces of old gasket material.

- 8 Check the cylinder block face for distortion diagonally and lengthwise using a straight edge and feeler gauges. If the cylinder block is distorted more than specified, it will be necessary to remove and dismantle the engine and consult an engine reconditioning specialist.
- 9 Inspect the cylinder block and pistons for damage.
- 10 Check the cylinder head surfaces for distortion as described under the heading To Clean and Inspect.



Levering the right hand side cylinder head from the cylinder block, to break the gasket adhesion.

RIGHT CYLINDER HEAD



Right hand cylinder head bolt tightening sequence. Loosen in the reverse order.

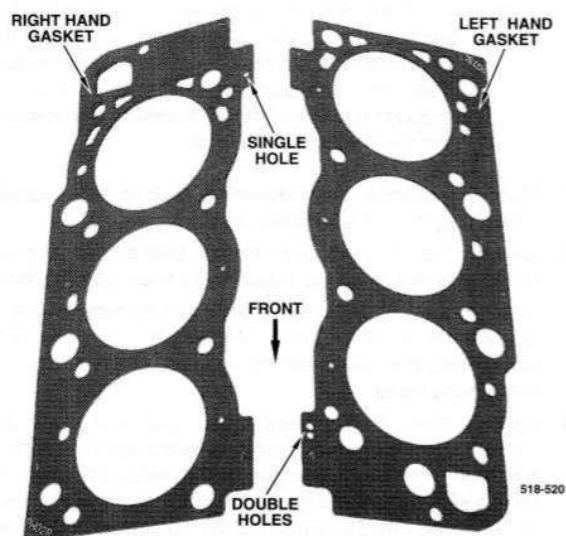
Installation is a reversal of the removal procedure with attention to the following points:

- 1 Ensure that the cylinders and the cylinder head bolt threads are free of foreign materials. Remove the oil residual from the cylinder head bolt holes. If necessary, clean the thread holes using a suitable tap.
- 2 Use new gaskets and seals during assembly.
- 3 Ensure that No 1 piston is on TDC.
- 4 Install new cylinder head gaskets to the cylinder block. The gasket holes, especially the oil passage, should be aligned with the corresponding holes in the cylinder block. Refer to the illustration for the correct positioning of the gasket. Carefully lower the cylinder head onto the cylinder block and engage the dowel pins.

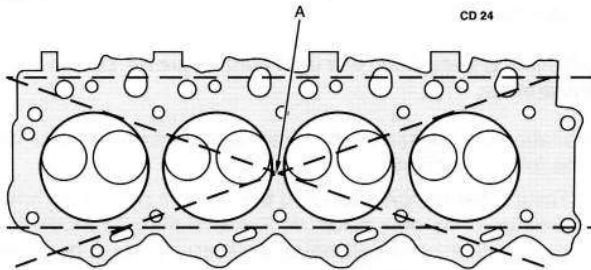
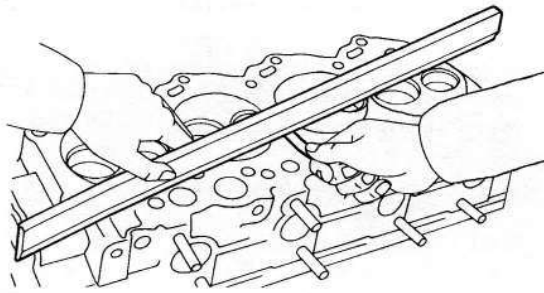
i Do not slide the cylinder head across the dowels as this may damage the cylinder head face.

- 5 Lightly oil the threads of the retaining bolts and the washers. Place the washers onto the bolts.

! Never put oil directly in the bolt holes in the cylinder head as damage or incorrect torque settings could result.



Cylinder head gaskets showing the installation marks.



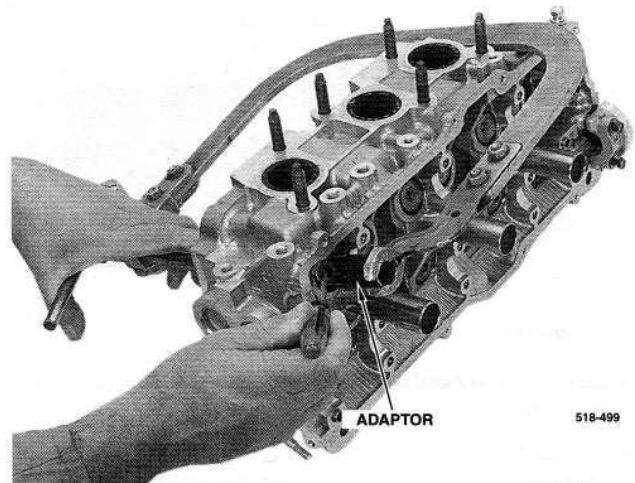
Check the cylinder heads for distortion using a straight edge and feeler gauge. It is common to find a depression in area A.

- 6 Progressively tighten the cylinder head bolts in three stages, to the specified torque, following the illustrated sequence.
- 7 Install the camshafts and the timing belt, referring to the appropriate heading in this chapter.
- 8 Install the rocker covers, using new gaskets.
- 9 Install the inlet manifold, the plenum chambers and the exhaust manifolds, as previously described.
- 10 Securely tighten the fuel filler cap.
- 11 Start and run the engine and check for oil, water and fuel leaks. Rectify as necessary.

TO DISMANTLE

i Overhauling the cylinder heads requires the use of specialist equipment. Buying or hiring this equipment is usually too expensive to be considered when overhauling a pair of cylinder heads. Overhauling the cylinder heads is best left to a cylinder head specialist with the necessary equipment. Some specialists offer a cylinder head exchange service which greatly reduces the amount of time the vehicle is off the road.

- 1 Place the cylinder head down on a clean cloth to prevent scratching the cylinder head face.
- 2 Suitably mark the valves to ensure that all the components of the cylinder head are returned to their original locations.
- 3 Drill 24 holes in two pieces of board to receive the valves removed from the cylinder heads. Number the holes to ensure that the valves can be replaced in their original positions in the head.
- 4 Position the cylinder head on its side and using a valve spring compressor, compress a valve spring. With some types of valve spring compressor an adaptor maybe necessary to allow clearance from the rocker cover sealing surface. An adaptor can be fabricated by cutting an opening in a short length of metal tubing. Remove the collets from the valve spring retainer.



Removing the valve collets using a valve spring compressor and adaptor.

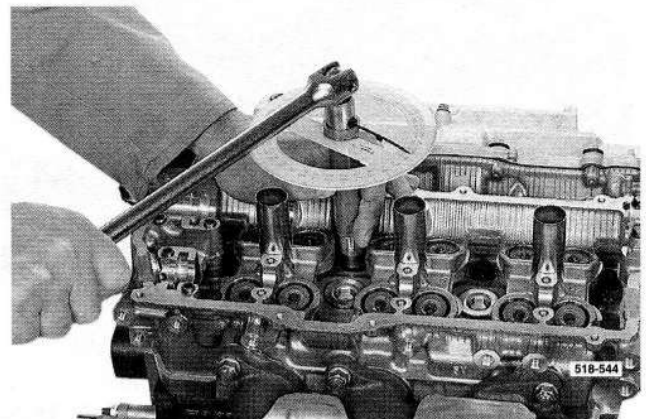


If the collets are stuck to the valve spring retainer, apply light pressure to the retainer and tap the edge of the retainer using a brass punch and hammer.

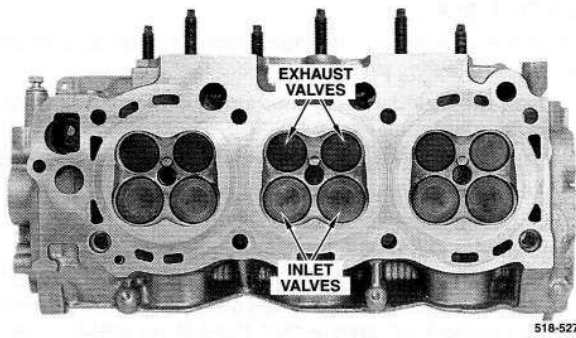
- 5 Release the spring compressor and remove the retainer, spring and seat from the cylinder head.
- 6 Remove all burrs from the end of the valve stem using a small file to ensure that the valve guide is not damaged as the valve is withdrawn.
- 7 As each valve is withdrawn, insert it into its appropriate hole in the piece of board to ensure correct installation to the original position during assembly.
- 8 Repeat the removal procedure with the remaining valves.
- 9 Remove the oil seal from the valve guide using long nosed pliers.

TO CLEAN AND INSPECT

- 1 Thoroughly clean the cylinder head in solvent and dry it with compressed air, if available.
- 2 Inspect the cylinder head for cracks or damage. Check the camshaft bearing surfaces for scoring or pitting.
- 3 Thoroughly clean the valves of carbon deposits, using a wire brush and electric drill. Do not mark the valve seats. Clean the valve guides using a piece of wadded cloth and a suitable solvent.

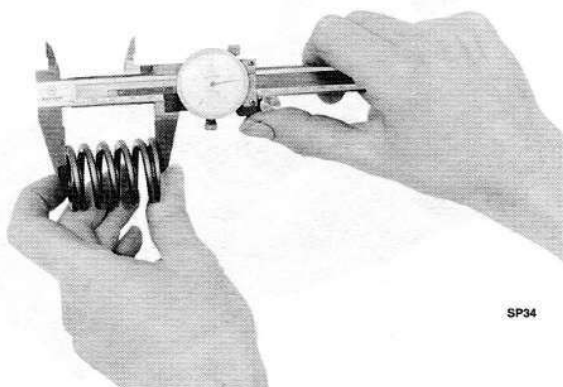


Tightening the cylinder head using an angle gauge.

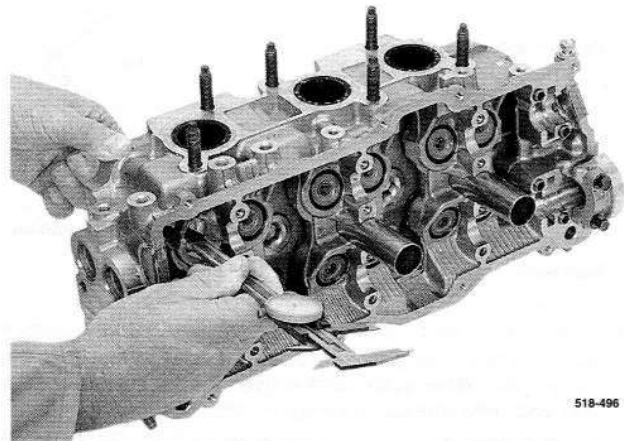


Valve arrangement in the cylinder head.

- 4 Inspect each valve for burning, distortion or cracking. A valve with any one or more of these characteristics should be discarded and a new valve fitted.
- 5 Using inside and outside micrometers, measure the valve stem and the valve guide bores. Subtract the outside diameter of the valve stem from the inside diameter of the valve guide to calculate the oil clearance. Compare to Specifications. Renew the valve and/or the valve guide, as necessary. This work is best referred to a cylinder head specialist.
- 6 Check each valve spring free length as shown in the illustration and compare to Specifications.
- 7 Stand the valve springs upright and check their squareness using a set square. Rotate each spring slowly and observe the distance between the top coil of the spring and the square. Renew the spring if it is more than 2 mm out of square.
- 8 To check the tension of a valve spring if a spring tester is not available, check the springs by comparison with a new spring as follows:
 - a Install one of the springs and the new spring in a vice, end to end, with a steel plate in between.
 - b Tighten the vice until the new spring is compressed to a length of 33.3 mm and measure the length of the original spring.
 - c If the length of the original spring is within five percent of the new spring, it indicates that the tension is acceptable.
- 9 Remove all carbon deposits from the combustion chambers, cylinder head face and valve throats. Check the condition of the valve seats and if necessary, recut the valve seats with a valve seat cutter to the specified angle and width.



Measuring the valve spring free length, using vernier calipers.



Measuring the installed height of the valve.

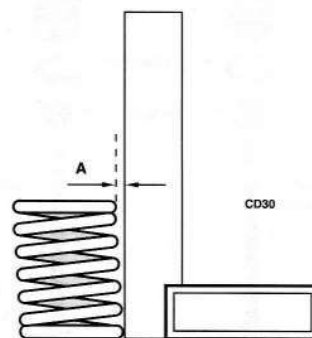


If the valve seats in the cylinder head are worn, cracked or recessed excessively, new inserts will have to be installed. This work is best referred to a cylinder head specialist who has the necessary specialised equipment.

- 10 Using a steel straight edge and feeler gauges, check along and across the cylinder head face for distortion. If the cylinder head is distorted more than 0.10 mm the manufacturer states that the cylinder head should be renewed. If the distortion is less, the head should be machined. Consult a cylinder head specialist.
- 11 Check the cylinder head face and combustion chambers for cracks and burn marks. Inspect the coolant transfer holes in the cylinder head for corrosion. Check the spark plug tubes for looseness and leaks. If necessary, renew the head or consult an engine reconditioning specialist.
- 12 If the cylinder head is to be renewed, the spark plug tubes must be removed from the old head, using vice grips or similar. If the spark plug tube(s) suffer damage during removal, renew the spark plug tube(s).

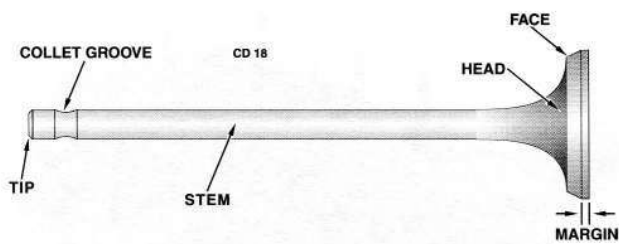
TO REFACE VALVES AND VALVE SEATS

- 1 Reface the valves to the specified angle on a suitable valve refacing machine. If a valve head margin thickness is less than specified limit after the grinding operation, the valve should be renewed.
- 2 Inspect the valve stem tips and if pitted, they should be reground taking care to remove only enough material to restore tip flatness.

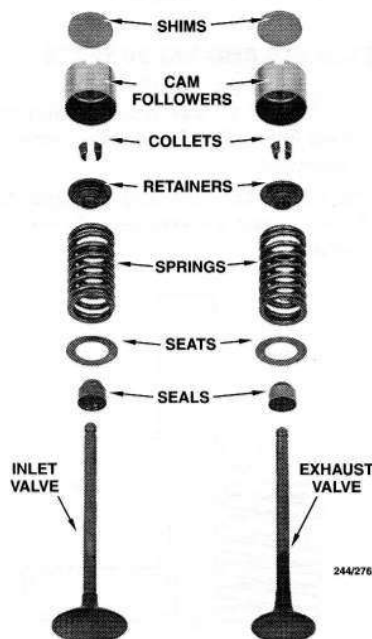


Renew the valve spring if the distortion at A exceeds 2 mm.

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**Various parts of the valve.**

- 3 Using a valve seat cutter, cut the valve seats to the specified angle. When cutting the valve seats it is important that the correct size valve guide pilot is used for the cutting tool. A true and complete surface must be obtained.
- 4 Lap the valves to the valve seats with a suitable oil or water mixed lapping compound until a true and concentric seating has been obtained.
- 5 Check the valve to seat contact using the following procedure:
 - a Apply a smear of Prussian Blue to the valve face and rotate the valve approximately 1/6 of a turn while lightly holding the valve head against the seat.
 - b Withdraw the valve and check that the marking on the seat is complete and even around the seat, indicating full seat contact. Remove all Prussian Blue from the valve and seat.
 - c If the valve is not seating fully, install the valve and rotate it one complete revolution.
 - d Withdraw the valve and check the marking on the seat. If full seat contact is indicated, the valve requires refacing. If partial seat contact is indicated, recut the seat.
- 6 Install the valves and measure the installed height of each valve, measuring from the spring seat on the cylinder head to the valve stem tip and compare with Specifications. If the installed height on any valve exceeds Specifications, the cylinder head will require new valve seat inserts.

**Inlet and exhaust valve components.****TO ASSEMBLE**

Assembly is a reversal of the dismantling procedure with attention to the following points:

- 1 Clean the cylinder head thoroughly removing all traces of abrasive material.
- 2 If a new cylinder head is being installed, it will be necessary to install the spark plug tubes as follows:
 - a Apply Permatex Lock Nut or equivalent to the spark plug tube holes in the cylinder head.
 - b Press the spark plug tubes into the cylinder head until the tube protrudes 49.0 – 49.4 mm above the camshaft bearing cap mating face. Ensure that there is no sealant near the spark plug threads.



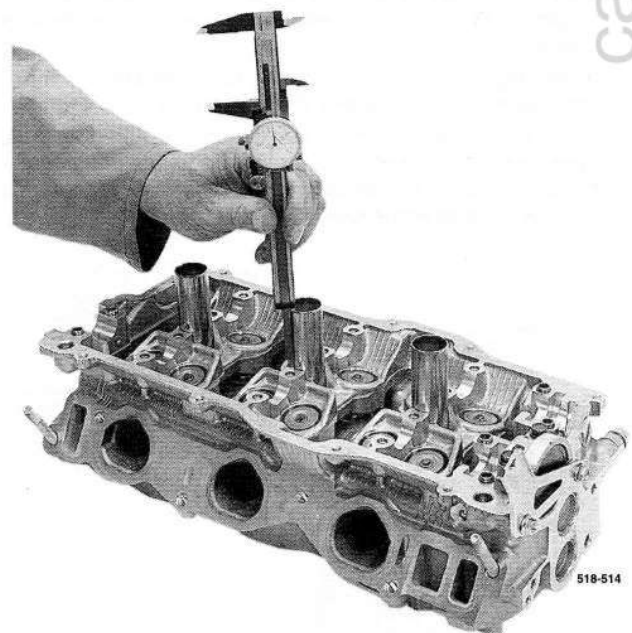
Place the cylinder head on soft timber blocks while pressing in the spark plug tubes, to prevent damage to the head.

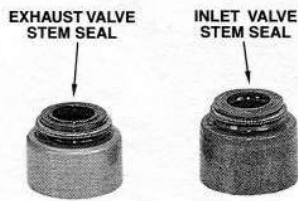
- 3 Using a suitable tube, carefully push the new valve stem seals onto the valve guides. Ensure that each seal is installed squarely and pushed until it is fully seated on the guide.



At the time of publication the exhaust valve seals had a black coloured band around the top of the seal and a plain body, while the inlet valve seals had silver markings on the top of the seal and a coated body. Consult your parts supplier prior to installing the seals.

- 4 With the cylinder head supported on its side, lubricate the valve stems and guides sparingly with clean engine oil and insert each valve into its respective guide, ensuring that the valves are installed in their original position.
- 5 Install the valve spring seats and the valve springs. Note that the valve springs are installed with the close coils at the bottom.
- 6 Place the retainer over the valve, compress the assembly using the valve spring compressor and install the collets.

**Measuring the installed height of a spark plug tube.**



Comparison of valve guide seals. Install the longer seals to the inlet valve guides.

Slowly release the valve spring compressor and check that the collets are correctly engaged with the valve stem grooves.

TIP A dab of multipurpose grease applied to the inside surface of the collets will hold the collets in the correct position on the valve stem during installation.

- 7 Lightly tap the end of the valve stem using a soft faced hammer to seat the collets in the valve stem groove.
- 8 Repeat these operations with the remaining valves.
- 9 Install the cylinder head as previously described.
- 10 Install the camshafts to the cylinder head as previously described. Progressively tighten the bearing cap retaining bolts to the specified torque in a spiral sequence working from the centre. Refer to the Camshafts heading in this chapter.

Sump and Pickup Pipe



To Remove Sump — Seal cutter or sharp knife

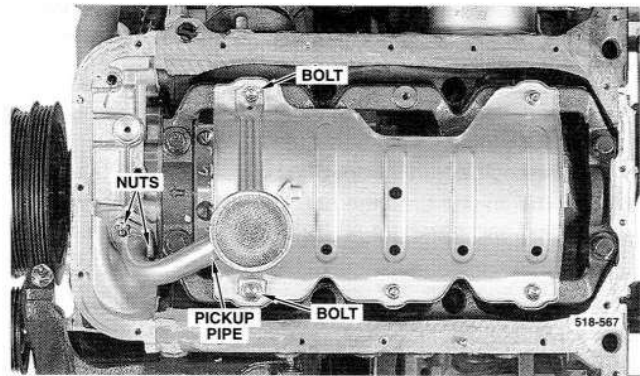
Due to the design of the chassis and front axle assembly it is necessary to remove the engine to allow sump removal.

TO REMOVE

- 1 Disconnect the negative battery terminal.
- 2 Raise the front of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 3 Remove the sump plug and drain the engine oil into a container. Inspect the sump plug washer and renew if necessary. When the oil has drained, install and tighten the sump plug securely.
- 4 Remove the engine as previously described in this chapter.
- 5 Place a container under the sump and remove the retaining bolts.
- 6 Support the sump, and remove the two remaining nuts. Insert a sealant cutter and hammer this around the sump until the sump can be separated from the cylinder block. Lower the sump to clear the oil pump pickup pipe and remove the sump from the engine.



The use of a screwdriver or chisel in place of the seal cutter can damage the gasket surface and result in oil leakage. If a seal cutter is not available, a sharp knife inserted between the mating faces and tapped around with a hammer is an acceptable substitute.



Sump removed showing the oil pump pickup.

- 7 If necessary, remove the nuts and bolts retaining the oil pump pick up pipe and withdraw the pipe. Discard the gasket.

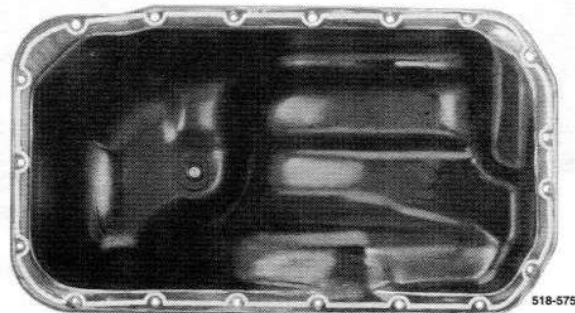
TO CLEAN AND INSPECT

- 1 Clean the cylinder block, oil pump housing, rear crankshaft seal housing and the sump mating surfaces. Use a scraper or a razor blade to remove the sealant. When all sealant has been removed, clean the sump mating face with solvent which will not leave a residue or affect the painted surfaces.
- 2 Wash the inside of the sump using cleaning solvent. Check for any metal deposits which may indicate an imminent bearing failure.
- 3 Inspect the sump for cracks or damage to the mating face. Inspect the threads on the sump plug and sump for damage and wear. Repair or renew as necessary.
- 4 Thoroughly clean the pickup pipe and screen using a brush and cleaning solvent.
- 5 Inspect the pickup pipe for cracks or dents. Renew as necessary.

TO INSTALL

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

- 1 If removed, install the oil pump pickup pipe using a new gasket. Tighten the retaining nuts to the specified torque.
- 2 Apply a continuous 3 – 5 mm diameter bead of Permatex Ultra Grey or equivalent sealant to the centre of the sump mating face. The bead must be inside the bolt holes, approximately 6 mm from the centre of the holes.
- 3 Install the sump to the engine within 5 minutes of applying the sealant. Progressively tighten the sump retaining nuts and bolts to the specified torque.



Apply sealant to the sump as shown in the illustration.

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If the sealant has started to cure prior to installing the sump, the sealant must be removed and new sealant applied.

- 4 Install the engine, referring to the Engine Assembly heading in this chapter.
- 5 Fill the engine with the specified oil.
- 6 Run the engine until the normal operating temperature is reached and check for oil leaks. Rectify leaks as necessary.

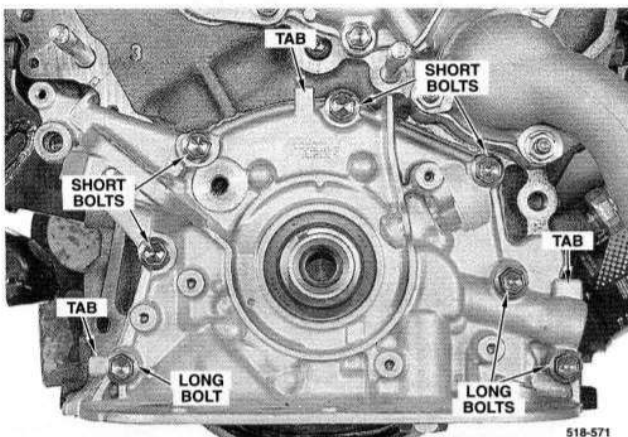
Oil Pump

TO REMOVE

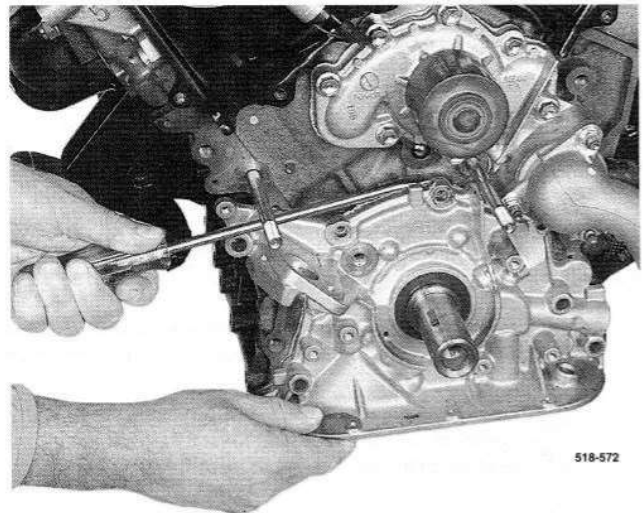
- 1 Remove the drive belts referring to the Routine Maintenance heading in this chapter.
- 2 Remove the engine, the sump and pickup pipe as previously described.
- 3 Remove the timing belt and withdraw the crankshaft sprocket, as described in this chapter under the Timing Belt heading.
- 4 Remove the bolt retaining the crank angle sensor to the oil pump housing and place the sensor clear of the work area.
- 5 Withdraw the dipstick. Remove the bolt retaining the dipstick tube to the alternator support bracket and remove the tube from the engine. Discard the O ring.
- 6 Noting their installed position, remove the oil pump retaining bolts.
- 7 Using a soft faced hammer, gently tap the oil pump to separate it from the cylinder block. Alternatively, carefully lever the oil pump away from the cylinder block, using the tabs on the pump body as a fulcrum point. Manoeuvre the oil pump from the end of the crankshaft. Discard the O ring.

TO DISMANTLE

- 1 Using an impact driver, remove the screws retaining the oil pump end cover to the housing. Ease the oil pump cover from the housing.
- 2 Withdraw the inner and outer rotors from the oil pump housing.
- 3 Remove the plug retaining the pressure relief valve in the oil pump housing and, noting their installed location, withdraw the spring and the piston.



Oil pump installed showing the locations of the short and long bolts.

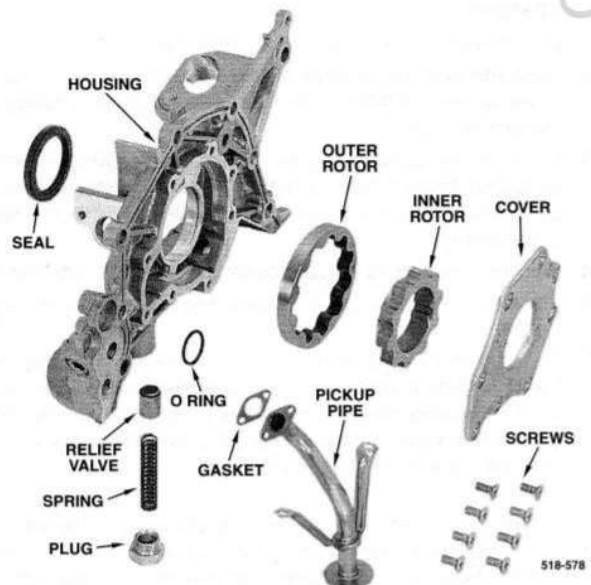


Levering the oil pump from the cylinder block. Note that the levering force is only applied at one of the tabs.

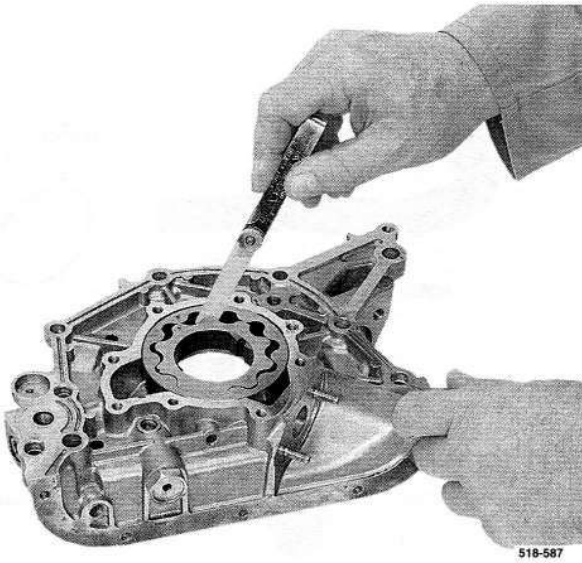
- 4 Prise the crankshaft oil seal from the oil pump housing using an oil seal removal tool or a screwdriver. Use care not to scratch the seal bore. Discard the oil seal.
- 5 Remove all traces of old gasket from the oil pump housing and the cylinder block.

TO INSPECT

- 1 Thoroughly clean the oil pump components in cleaning solvent, dry with compressed air, if available, and temporarily assemble the rotors in the oil pump housing.
- 2 Measure the inner to outer rotor tip clearance. If the clearance exceeds Specifications, renew the rotor set.
- 3 Measure the outer rotor to the oil pump housing clearance. If the clearance exceeds Specifications, renew the rotor set and/or the oil pump housing as necessary.
- 4 Measure the end clearance between the rotors and the oil pump housing using a straight edge and feeler gauges.



Oil pump components.



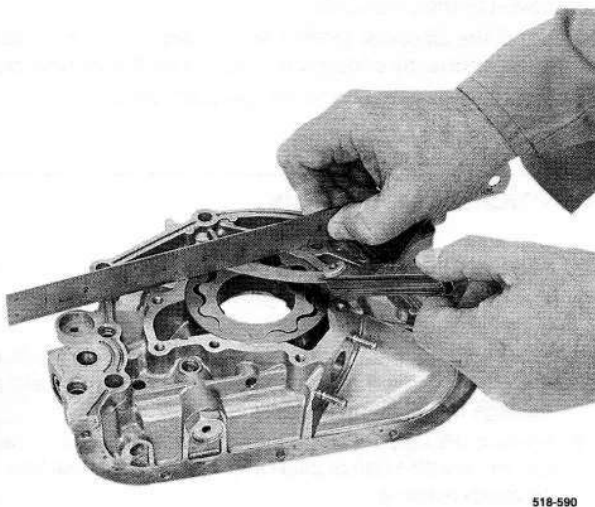
Measuring the inner to outer rotor tip clearance.

Renew the rotor set and/or the oil pump housing as necessary.

- 5 Check the pressure relief valve spring for breakage or loss of tension. Renew the spring if its condition is suspect.
- 6 Check the relief valve piston for wear and scoring. Apply a light film of oil to the valve and check that it slides freely in the oil pump housing by its own weight. Check that the oil passages are clear.
- 7 Thoroughly clean the oil pump pickup and screen with a wire or bottle brush.
- 8 Blow the oil pump pickup and screen clean with compressed air.

TO ASSEMBLE

Assembly is a reversal of the dismantling procedure with attention to the following points:



Measuring the end clearance between the rotors and the oil pump housing.

- 1 Ensure that all components are thoroughly clean and liberally coat the components with clean engine oil.
- 2 Install a new crankshaft oil seal squarely into the front of the oil pump housing with the seal lips facing inwards, until the seal face is flush with the housing. Apply a small amount of multipurpose grease to the oil seal lip.
- 3 Install the relief valve piston and spring into the oil pump housing and install the plug.
- 4 Install the inner and outer rotors into the oil pump housing. Ensure that the marks on the rotors are facing the cover.
- 5 Install the oil pump end cover and tighten the retaining screws to the specified torque.



It is good practice to pack the space between the rotors with petroleum jelly. This will achieve rapid increase of oil pressure when starting the engine.

TO INSTALL

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

- 1 Remove all traces of sealant material from the cylinder block and the oil pump housing, using suitable solvent, if necessary.

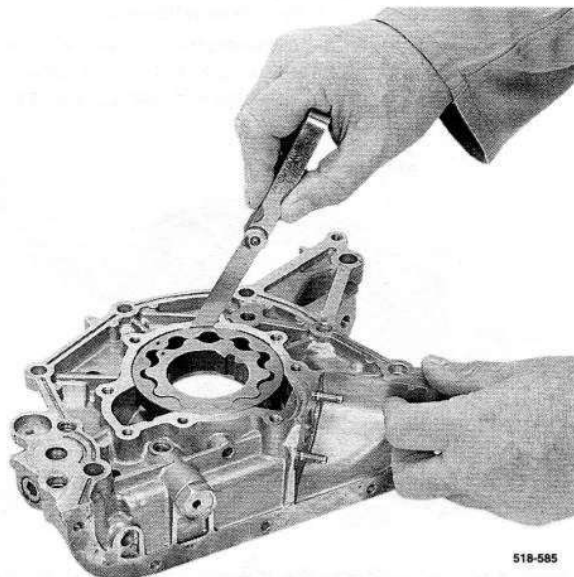


It is recommended, that the front crankshaft oil seal is renewed whenever the oil pump is removed.

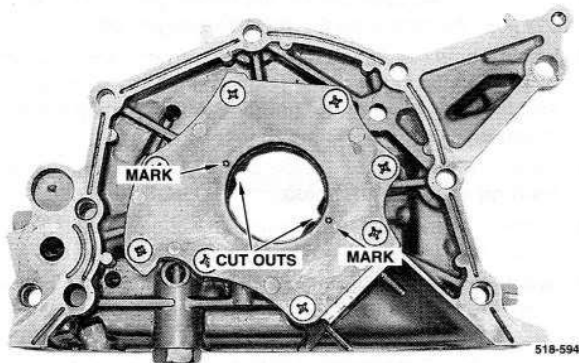
- 2 Ensure, that the marks on the end cover are aligned with the cut outs on the inner rotor.
- 3 Apply a 3 mm wide bead of Permatex Ultra Grey or equivalent sealant to the rear of the housing, to the position shown on the illustration and place a new O ring in the groove. Install the oil pump.



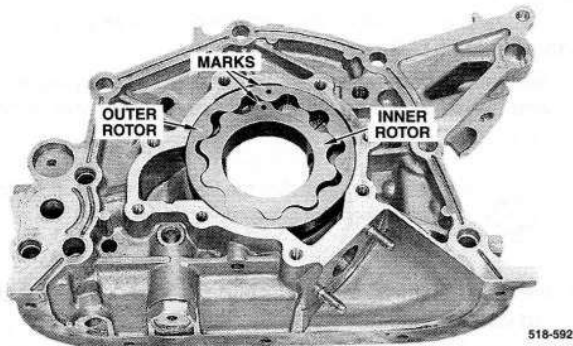
If difficulty is experienced sliding the oil pump onto the crankshaft, rock the pump slightly to the left and to the right, until the inner rotor engages the flat portion of the crankshaft.



Measuring the outer rotor to oil pump housing clearance.

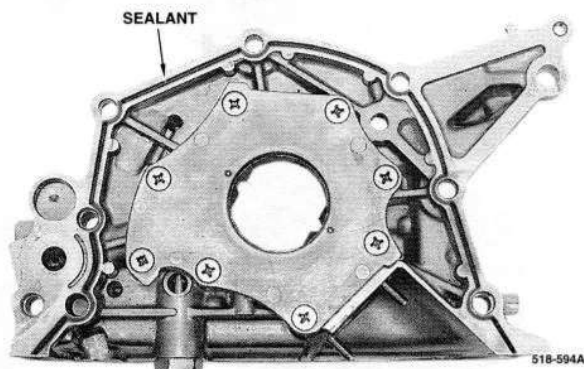


Ensure that the cut outs and marks are aligned prior to installing the oil pump.



End cover removed, showing the inner and outer rotors correctly aligned.

- 4 Install the oil pump retaining bolts, ensuring that the bolts are positioned as noted during removal. If in doubt, refer to the illustration. Tighten the bolts to the specified torque.
- 5 Install the pickup pipe, sump and the timing belt as previously described under the relevant headings.
- 6 Fill the engine with the recommended quantity and grade of engine oil. Run the engine, check that the oil lamp goes out within a few seconds. Also check for oil leaks and rectify as necessary.



Apply a bead of sealant to the oil pump housing grooves and around the inside of the bolt holes as shown in the illustration.



Oil cooler components.

Oil Cooler

TO REMOVE AND INSTALL

- 1 Raise the front of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 2 Drain the cooling system, referring to Cooling System (chapter 5), if necessary.
- 3 Release the hose clamps and using a twisting motion, disconnect the cooler hoses from the fittings on the oil cooler.
- 4 While supporting the oil cooler, remove the union bolt and withdraw the cooler from the engine. Discard the gasket from the union bolt and the O ring from the oil cooler housing.

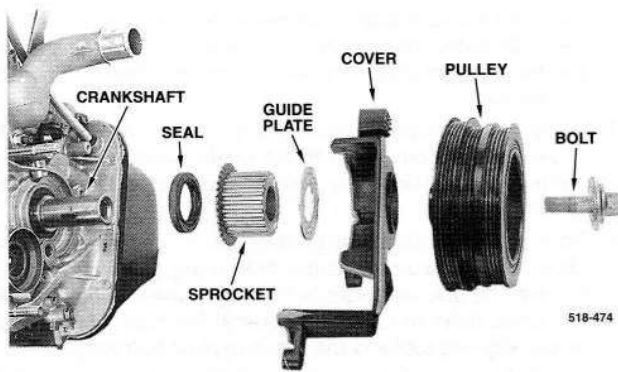
Installation is a reversal of the removal procedure with attention to the following points:

- 1 Install a new O ring to the oil cooler housing and a new gasket to the union bolt.
- 2 Install the oil cooler to the cylinder block, ensuring, that the locator correctly engages the casting on the cylinder block.
- 3 Tighten the union bolt to the specified torque.

Crankshaft Oil Seals

TO RENEW FRONT CRANKSHAFT OIL SEAL

- 1 Remove the timing belt as previously described under the Timing Belt heading in this chapter.
- 2 Using a centre punch, tap a small hole into the front face of the oil seal. Use care not to make the hole too deep and damage the oil pump housing.
- 3 Screw a self tapping screw into the oil seal. Grip the head of the screw with a pair of pliers and withdraw the seal from the oil pump housing.
- 4 Check the seal contact surface on the crankshaft for scoring or damage. If necessary, refer the engine to an engine reconditioning specialist.

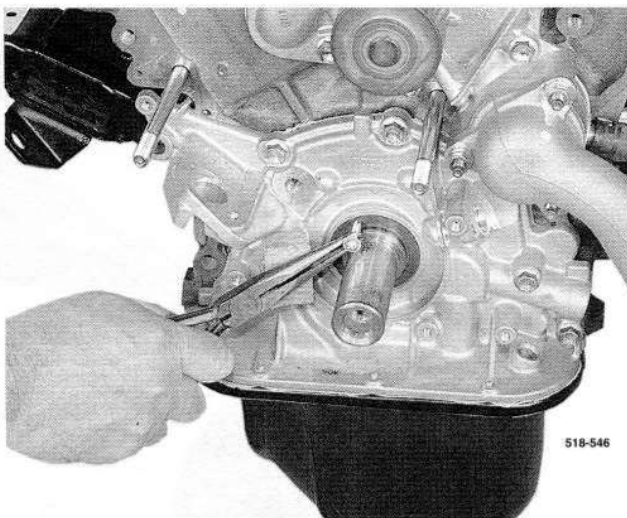


Front crankshaft oil seal removed showing various components.

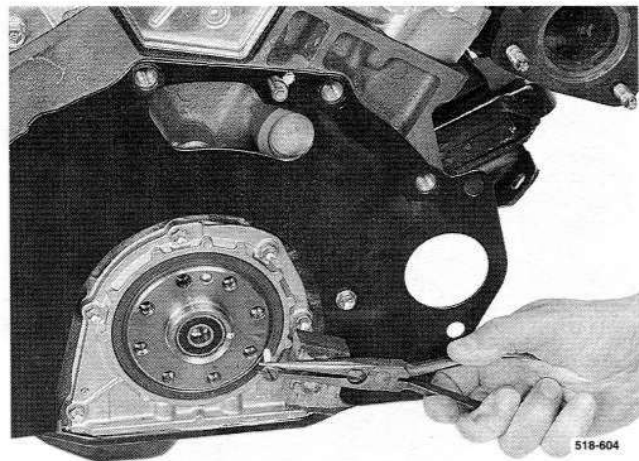
- 5 Apply multipurpose grease to the oil seal lip and install the seal squarely into the oil pump housing using a mandrel or tube that pushes on the outer edge of the seal only. The oil seal lip must face towards the engine and the outer face of the oil seal must be flush with the face of the oil pump housing.
- 6 Install the crankshaft sprocket and the timing belt as previously described.

TO RENEW REAR CRANKSHAFT OIL SEAL

- 1 Remove the transmission from the vehicle as described in the relevant transmission chapter.
- 2 Remove the flywheel/driveplate as described later in this chapter.
- 3 Using a centre punch, tap a small hole into the front face of the oil seal. Use care not to make the hole too deep and damage the carrier.
- 4 Screw a self tapping screw into the oil seal. Grip the head of the screw with a pair of pliers and, noting the installed depth of the seal, withdraw the seal from the housing.
- 5 Check the seal contact surface on the crankshaft for scoring or damage. If scored or damaged, refer the engine to an engine reconditioning specialist.
- 6 Apply multipurpose grease to the oil seal lip and install the oil seal to the housing, using a mandrel or tube that pushes



Removing the front crankshaft oil seal using a self tapping screw, pliers and a block of wood as a fulcrum.



Removing the rear crankshaft oil seal using a self tapping screw, pliers and a block of wood as a fulcrum.

- on the outer edge of the seal only. The oil seal lip must face towards the engine and must be flush with the housing.
- 7 Install the flywheel/driveplate as described later in this chapter.
 - 8 Install the transmission to the engine as described in the relevant transmission chapter.

Flywheel/Driveplate

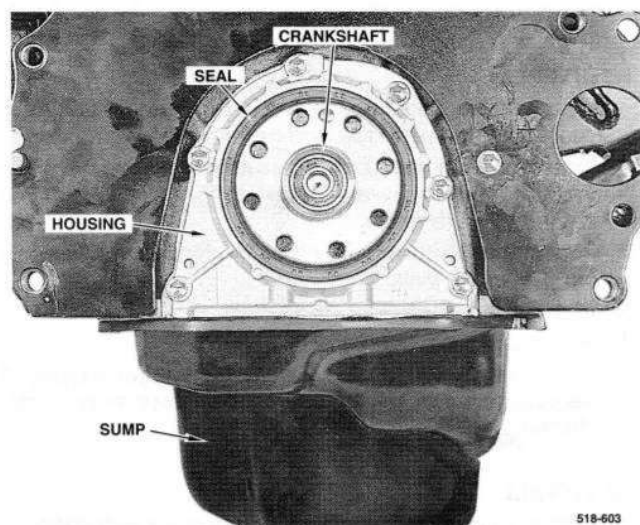


To Inspect — Dial gauge

To Renew Flywheel Ring Gear — Suitable heat source

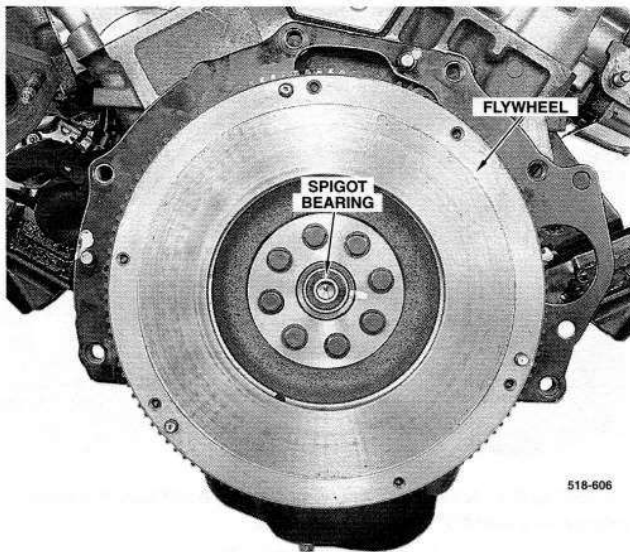
TO REMOVE

- 1 Remove the transmission from the vehicle as described in the relevant transmission chapter.
- 2 On manual transmission models, proceed as follows:
 - a Mark the flywheel and the clutch pressure plate cover to ensure correct assembly.



Rear crankshaft oil seal and associated components.

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Clutch removed showing the flywheel and spigot bearing.

- b Progressively loosen and remove the pressure plate retaining bolts.
- c Lift the pressure plate from the flywheel and remove the clutch driven plate.
- 3 Using a dial gauge, check the runout of the flywheel clutch face contacting surface, or the rim around the outer circumference of the driveplate.
- 4 Rotate the flywheel/driveplate one complete turn and check the runout. If the runout exceeds specifications, check for dirt, rust etc. between the flywheel/driveplate and the crankshaft. If no problem can be found, renew the flywheel or driveplate.
- 5 Suitably mark the flywheel or driveplate so that the unit can be installed in the original position on the crankshaft.
- 6 Hold the flywheel/driveplate stationary and remove the retaining bolts.
- 7 On automatic transmission models, mark the installed position and installed direction of the adaptor and withdraw it from the flywheel. Lift the flywheel or driveplate from the crankshaft. On automatic transmission models, noting its installed position, withdraw the spacer from the crankshaft.

TO INSPECT

- 1 Where applicable, inspect the flywheel clutch face contacting surface for cracks or excessive scoring.
- 2 Inspect the ring gear teeth for damage, cracks or wear. The ring gear can be renewed separately from the flywheel, but not from the driveplate.
- 3 Inspect the driveplate bolt holes for elongation, caused by loose retaining bolts.
- 4 Inspect the driveplate for cracks.
- 5 Renew components as necessary.
- 6 Check the condition of the crankshaft spigot bearing. If necessary, renew the bearing as described later in this chapter.

TO INSTALL

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

- 1 Align the marks made when removing the flywheel/driveplate. On automatic transmission models, install the spacer and the adaptor plates, in the position and direction noted on removal.
- 2 Apply a few drops of Permatex Stud Lock or equivalent thread locking compound to the retaining bolts. Install and tighten the retaining bolts evenly, and progressively to the specified torque.
- 3 On manual transmission models, align the clutch driven plate with the adaptor centre hole using an aligning tool. Tighten the pressure plate bolts progressively in a diagonal sequence. Refer to Clutch (chapter 9) for more information on the aligning tool and the pressure plate bolt torque.
- 4 Install the transmission to the vehicle as described in the relevant transmission chapter.

TO RENEW FLYWHEEL RING GEAR

- 1 With the flywheel removed from the vehicle, drill a 3 mm diameter hole between two teeth of the ring gear.



Do not drill completely through the ring gear as this will damage the flange on the flywheel.

- 2 Secure the flywheel, with the drilled hole uppermost, in a vice equipped with soft jaw guards.
- 3 Place a cold chisel above the hole in the ring gear and hit it sharply to split the ring gear.
- 4 Observe the direction of the teeth leading edges of the old ring gear. The new gear must be installed to the flywheel with the teeth leading edges in the same direction.
- 5 Remove the ring gear, clean the mounting face on the flywheel and remove any burrs.
- 6 Polish a few spots of the new ring gear with emery cloth and heat the ring gear evenly until the polished spots turn dark blue.



Do not heat the ring gear past the point required to achieve a dark blue colour or the tempering of the gear teeth will be impaired.



Splitting the ring gear.

- 7 With the flywheel suitably supported, pick the ring gear up using pliers and place it evenly onto the flywheel.



Allow the ring gear to cool slowly. Do not quench in water.

Crankshaft Spigot Bearing

TO REMOVE AND INSTALL

- 1 Remove the transmission from the vehicle as described in Manual Transmission (chapter 10).
- 2 Remove the clutch assembly as described in Clutch (chapter 9).
- 3 Using a puller or slide hammer, remove the spigot bearing from the crankshaft and discard the bearing.



If a puller is not available, fill the inside of the bearing with heavy grease. Insert the clutch aligning tool into the bearing and tap the tool with a mallet. The hydraulic force of the grease will force the bearing from the crankshaft. Remove the grease from the crankshaft.

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

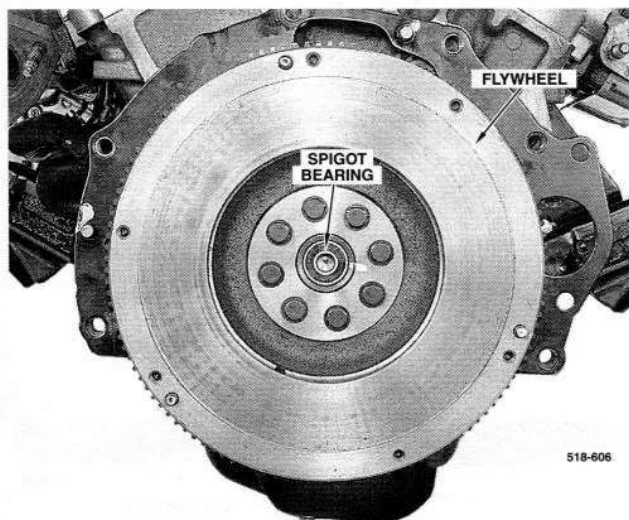
- 1 Using a tube or mandrel, install the bearing until it abuts the shoulder inside the cavity.
- 2 Install the clutch assembly and the transmission as described in the relevant chapters.

Engine Overhaul

Engine overhaul refers to major work on the pistons, connecting rods, crankshaft bearings and cylinder block as well as checking the items already covered in this chapter.

OPTIONS

If the engine is worn and the rest of the vehicle is in good enough condition to warrant overhauling the engine, there are four common steps that can be taken:



Clutch removed showing the spigot bearing.

- 1 Install a reconditioned long engine. A long engine usually includes the cylinder block and heads assembled with camshafts rocker covers and sump etc. ready to bolt on your manifolds and other components such as starter motor, alternator, power steering pump etc.

Installing a long engine from an engine reconditioning specialist is usually the best policy if intending to keep a vehicle that is otherwise in good condition for a long period. Usually it is possible to install the engine yourself or the specialist will do it for you, for an agreed fee.

- 2 Install a reconditioned short engine. A short engine is only the cylinder block, pistons and crankshaft. All other components come from your old engine.

A short engine is really only a proposition if the cylinder heads have been recently reconditioned or the engine has done only relatively low mileage and something has gone wrong with the lower part of the engine. If the other components are well worn the restored compression of the short engine will soon show up weaknesses in other areas.

- 3 Install a good secondhand engine from a wrecker or specialist. This is usually the most economical option and may be the best option to keep an old vehicle on the road for a while longer. These engines often come with some accessories installed but great care must be taken to ensure that the engine chosen, is actually suitable for the vehicle. Imported engines can vary a lot from the local product originally installed in this vehicle so the best policy is to try and get an engine from the same type of vehicle as yours.

Ensure that some sort of warranty comes with the engine and if possible, test run it at the wreckers etc. before purchase.

- 4 Overhaul the engine yourself. This is really only economically and practically viable for those with previous experience and quality measuring equipment. It must be remembered that the modern engine runs tighter clearances and is less tolerant of assembly glitches than older style engines. If taking this path the following information may help you. Systematically mark components or note the manufactures marks as the engine is progressively dismantled. It will still be necessary to take certain components to a specialist for operations like reboring, crankshaft checking and piston to connecting rod installation.

The specialist should check clearances for you however, take nothing for granted and check everything with the comprehensive specifications listed at the start of this chapter. Cleanliness is one of the most important aspects of engine assembly along with checking that all components are installed correctly. If there is a fault with the engine when it goes back together it can cost you a lot of money and time.

Overhauling this engine, even though of advanced design follows standard workshop practice, with attention to the following points:

- a The main bearing shells have a plain half and a grooved half. The grooved half with the oil hole must be installed in the cylinder block.
- b The No1 main bearing shells are 22 mm wide. The remaining bearing shells are 20 mm wide.
- c Crankshaft end float is adjustable at the No 3 main bearing using thrust washers. The thrust washers must be installed with the grooves facing outwards.
- d The crankshaft and main bearings are graded. Consult your parts supplier about the correct size replacement crankshaft bearings.

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- e Tighten the main bearing cap bolts in a diagonal sequence, starting in the centre and working outward. The main bearing caps are united by a cradle arrangement.
- f The connecting rod bolts are of the plastic region type. Measure the diameter of each bolt, 15 mm from the end of the bolt. If the diameter is less than 7.6 mm, renew the connecting rod bolts and nuts as an assembly.

GENERAL PROCEDURES

When installing an overhauled or secondhand engine certain items should be inspected, renewed or cleaned to prevent problems occurring.

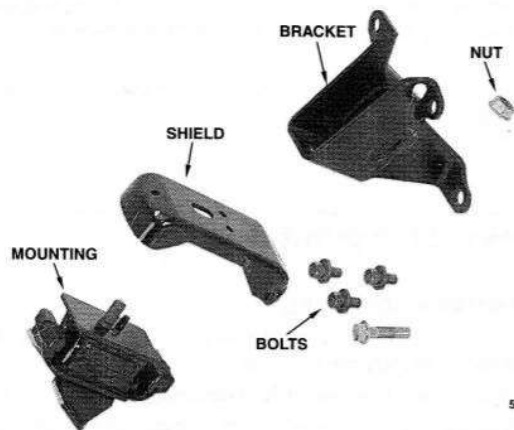
- 1 The radiator should be flushed out and if suspect should be taken to a radiator specialist for through cleaning and checking. It is advisable to renew the thermostat and water pump as a matter of course. Thoroughly inspect the radiator cap and renew if it is suspect. Always use the correct coolant in the cooling system.
The temperature gauge, radiator fan and coolant temperature sensor must all be functioning correctly.
- 2 The timing belt should be renewed.
- 3 Install new spark plugs of the correct type. Check the high tension leads and renew if necessary.
- 4 Install a new air cleaner element and fuel filter. Remove the injectors and have them cleaned by a specialist.
- 5 All hoses in the engine compartment must be thoroughly checked for splits, perishing and hardening. New hoses should be fitted unless the old hoses are perfect. Fuel hoses are a vital safety item and only high quality hoses suitable for fuel injection systems are to be used.
- 6 Inspect the engine mountings and the exhaust system for wear and deterioration and renew components as necessary.
- 7 Use engine oil of the correct grade and a new oil filter to prevent excessive wear on start up. Ensure that the oil pressure warning lamp system is functioning correctly and repair if necessary.
- 8 Refer to the engine installation procedure for more information on how to treat an overhauled engine.

Engine Mountings**TO REMOVE AND INSTALL**

Engine mountings that are oil soaked should be renewed and the cause of the oil leak rectified to ensure a normal working life for the new mounting.

Front Engine Mountings

- 1 Remove the nut retaining the engine mounting to the bracket on the side of the cylinder block.
- 2 Raise the front of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 3 Remove the bolts retaining the front and rear stoneguards and withdraw them from the vehicle.
- 4 Remove the nuts and bolts retaining the engine mounting to the vehicle chassis.



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Front engine mounting components.

- 5 Support the engine on a floor jack, placing a piece of timber between the jack and the clutch housing to prevent damage to the housing.
- 6 Carefully raise the engine high enough to allow the mounting to be removed from the engine. Noting the installed position of the shield, withdraw the mounting and the shield from the engine compartment.
- 7 If necessary, remove the bolts retaining the bracket to the cylinder block, and withdraw the bracket from the engine.

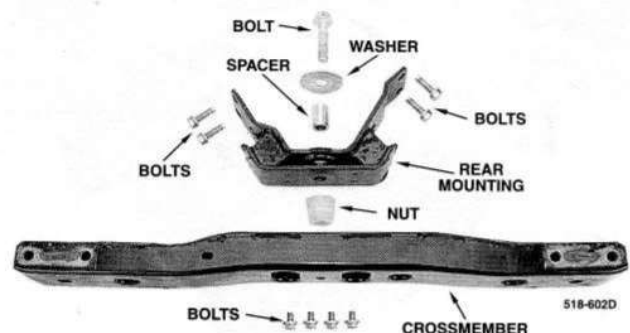
When removing the left hand side engine mounting, the oil filter must be removed to allow access to the retaining bolt.

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

- 1 If removed, install the bracket to the cylinder block and tighten the retaining bolts to the specified torque. If removed, install a new oil filter.
- 2 Install the engine mounting, ensuring that the shield is placed on top of the mounting in the position noted during removal.
- 3 Lower the engine and tighten the retaining nuts and bolts to the specified torque.

Rear Engine Mounting

- 1 Raise the front and rear of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.



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Rear crossmember and mounting components.

- 2 Support the weight of the transmission and transfer case on a floor jack with a piece of timber between the jack and the transfer case or transmission.
- 3 Remove the bolts retaining the rear mounting to the crossmember.
- 4 Remove the bolts retaining the crossmember to the chassis rail and withdraw the crossmember from the vehicle.
- 5 Remove the bolts retaining the mounting to the transmission housing, and noting its installed direction, withdraw the rear mounting from the vehicle.
- 6 If necessary, remove the plastic encapsulated nut retaining the load relief bolt, and noting their installed position, separate the bolt, the washer and the spacer.

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

- 1 Install the rear mounting to the vehicle in the direction noted during removal. Tighten the retaining bolts to the specified torque.
- 2 Install the crossmember to the vehicle and lower the transmission. Install the retaining bolts and tighten them to the specified torque.

Exhaust System

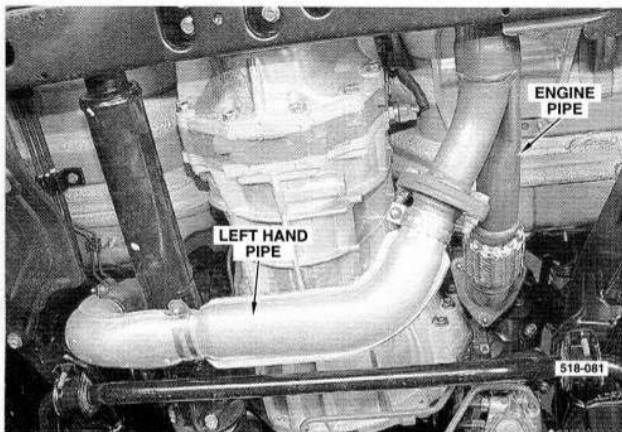
TO REMOVE AND INSTALL



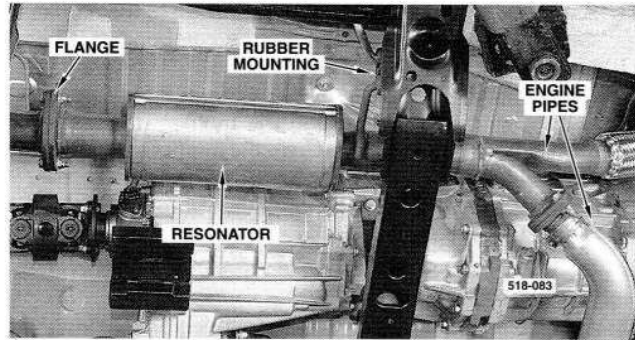
It is advisable to soak all nuts and bolts necessary to remove the exhaust system with a suitable penetrating oil to prevent the bolts and studs breaking. It is good mechanical practice when working on the exhaust system, to wrap the end of the tail pipe in a piece of soft cloth to prevent damage to the rear bumper.

Engine Pipes and Resonator

- 1 Raise the front and rear of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 2 Remove the nuts retaining the engine pipe assembly to the exhaust manifolds.
- 3 While supporting the left hand pipe, remove the bolts retaining the left hand pipe to the right hand engine pipe. Withdraw the left hand pipe and discard the gaskets.



Front engine pipe locations.



Engine pipe and resonator location.

- 4 Remove the nuts and bolts retaining the resonator flange to the muffler assembly. Separate the flanges and discard the gasket.
- 5 Apply soapy water to the rubber mounting supporting the engine pipe assembly.
- 6 While supporting the resonator, disengage the rubber mounting and withdraw the engine pipe and resonator assembly from the vehicle.
- 7 If necessary, remove the heat shields from the left hand engine pipe.

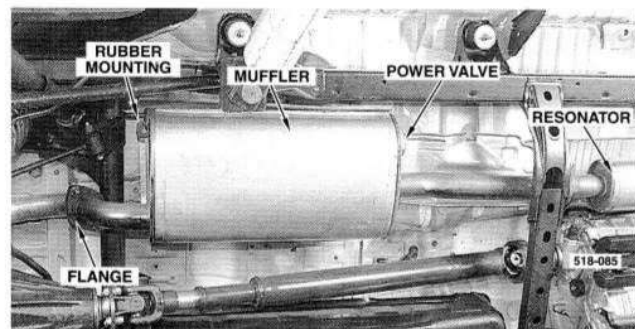
Installation is a reversal of the removal procedure with attention to the following points:

- 1 Clean the mating surfaces and use new gaskets between the engine pipes and the exhaust manifolds/muffler assembly flanges.
- 2 If removed, install the heat shields.
- 3 Apply soapy water to the rubber mounting prior to installing the engine pipe assembly.
- 4 Install the retaining nuts and bolts but do not tighten, until the exhaust system is correctly aligned.
- 5 Tighten the retaining bolts and nuts to the specified torque.

Muffler Assembly

The valve located at the front of the muffler alters the gas flow under high speed, thus increasing the power output and at the same time reducing the fuel consumption. The valve is retained by nuts and can be removed.

- 1 Raise the front and rear of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 2 Remove the nuts and bolts retaining the muffler assembly to the resonator flange and separate the components. Discard the gasket.



Muffler and mounting location.

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- 3 Remove the bolts retaining the rear flange of the muffler to the silencer flange and separate the components. Discard the gasket.
- 4 Apply soapy water to the rubber mounting supporting the muffler, and while supporting the muffler, disengage the rubber mounting and manoeuvre the muffler assembly from the vehicle.

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

- 1 Clean the mating surfaces and use new gaskets between the engine pipe and muffler assembly flanges.
- 2 Apply soapy water to the rubber mounting prior to installing the muffler assembly.
- 3 Install the retaining nuts and bolts but do not tighten, until the exhaust system is correctly aligned.
- 4 Tighten the retaining bolts and nuts to the specified torque.

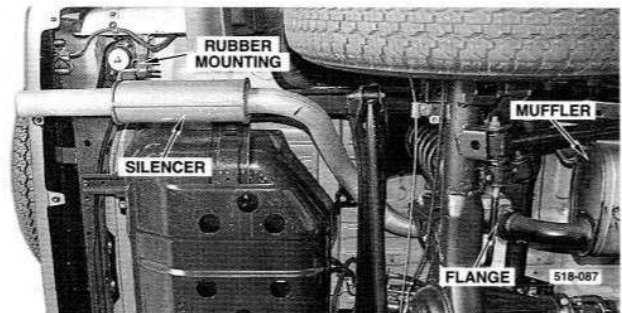
Silencer Assembly

- 1 Raise the rear of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 2 Remove the bolts retaining the silencer to the muffler assembly flange and separate the components. Discard the gasket.
- 3 Apply soapy water to the rubber mounting supporting the silencer, and while supporting the silencer, disengage the

rubber mounting and manoeuvre the assembly from the vehicle.

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

- 1 Clean the mating surfaces and use new gaskets between the silencer and muffler assembly flanges.
- 2 Apply soapy water to the rubber mounting prior to installing the silencer assembly.
- 3 Install the retaining bolts but do not tighten, until the exhaust system is correctly aligned.
- 4 Tighten the retaining bolts and nuts to the specified torque.



Silencer and tailpipe mounting and flange locations.

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