

# ENGINE

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## STANDARD SERVICE PROCEDURES

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### GENERAL INFORMATION

#### FORM-IN-PLACE GASKETS

There are numerous places where form-in-place gaskets are used on the engine. Care must be taken when applying form-in-place gaskets. **Do not use form-in-place gasket material unless specified**. Bead size, continuity, and location are of great importance. Too thin a bead can result in leakage while too much can result in spill-over; a continuous bead of the proper width is essential to obtain a leak-free joint.

Two types of form-in-place gasket materials are used in the engine. **Mopar** Silicone Rubber Adhesive Sealant and **Mopar** Gasket Maker, (anaerobic) each have different properties and cannot be used interchangeably.

**CAUTION: Silicone sealer and anaerobic sealers each will inhibit the cure of the other and care should be taken to keep usages separated as much as possible.**

#### *MOPAR SILICONE RUBBER ADHESIVE SEALANT*

**Mopar** Silicone Rubber Adhesive Sealant or equivalent, normally black in color, is available in three ounce tubes. Moisture in the air causes the **Mopar** Silicone Rubber Adhesive Sealant material to cure. This material is normally used on flexible metal flanges. It has a shelf life of one year and will not properly cure if over age. Always inspect the package for the expiration date before use.

#### *MOPAR GASKET MAKER*

**Mopar** Gasket Maker is an anaerobic type gasket material normally red in color. The material cures in the absence of air when squeezed between two metallic surfaces. It will not cure if left in the uncovered tube. It is normally red in color. The anaerobic material is for use between two machined surfaces. Do not use on flexible metal flanges.

#### *MOPAR TORQUE CURE GASKET MAKER*

**Mopar** Torque Cure Gasket Maker is a unique anaerobic type gasket material to be used **ONLY** between the bedplate and engine block. The material cures in the absence of air when torqued between two metallic surfaces. It will not cure if left in the uncovered tube. This anaerobic material is specially

## GENERAL INFORMATION (Continued)

made to seal the area between the bedplate and cylinder block without disturbing the bearing clearance or alignment of these components.

## GASKET DISASSEMBLY

Parts assembled with form-in-place gaskets may be disassembled without unusual effort. In some instances, it may be necessary to lightly tap the part with a mallet or other suitable tool to break the seal between the mating surfaces. A flat gasket scraper may also be lightly tapped into the joint but care must be taken not to damage the mating surfaces.

## SURFACE PREPARATION

Scrape clean or wire brush all gasket surfaces to remove all loose material. Inspect stamped parts to ensure gasket rails are flat. Flatten rails with a hammer on a flat plate if required. Gasket surfaces must be free of oil and dirt. Make sure old gasket material is removed from blind attaching holes.

## FORM-IN-PLACE GASKET APPLICATION

Assembling parts using a form-in-place gasket requires care but it's easier than using pre-cut gaskets.

**Mopar** Gasket Maker material should be applied sparingly 1 mm (0.040 in.) diameter or less of sealant to one gasket surface. Be certain the material surrounds each mounting hole. Excess material can easily be wiped off. Components should be torqued in place within 15 minutes. The use of a locating dowel is recommended during assembly to prevent smearing the material off location.

The **Mopar** Silicone Rubber Adhesive Sealant gasket material or equivalent should be applied in a continuous bead approximately 3 mm (0.120 in.) in diameter. All mounting holes must be circled. For corner sealing, a 3.17 or 6.35 mm (1/8 or 1/4 in.) drop is placed in the center of the gasket contact area. Uncured sealant may be removed with a shop towel. Components should be torqued in place while the sealant is still wet to the touch (within 10 minutes). The usage of a locating dowel is recommended during assembly to prevent smearing of material off location.

## CRANKSHAFT SPROCKET BOLT ACCESS PLUG

An Access plug is located in the right inner fender shield. Remove the plug and insert the proper size socket, extension and ratchet, when crankshaft rotation is necessary.

## ENGINE CORE PLUGS

## REMOVAL

Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup

plug (Fig. 1). With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 1).

**CAUTION:** Do not drive cup plug into the casting as restricted cooling can result and cause serious engine problems.

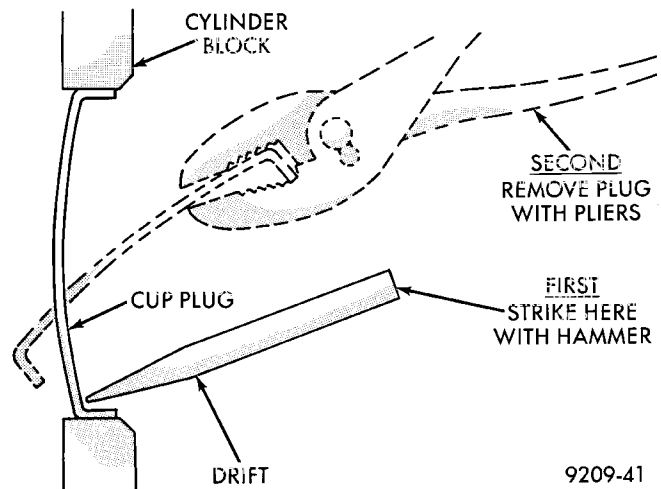


Fig. 1 Core Hole Plug Removal

## INSTALLATION

Thoroughly remove all rust and clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer. Lightly coat inside of cup plug hole with sealer. Make certain the new plug is cleaned of all oil or grease. Using proper drive plug, drive plug into hole so that the sharp edge of the plug is at least 0.5 mm (0.020 in.) inside the lead in chamfer (Fig. 1).

It is not necessary to wait for curing of the sealant. The cooling system can be refilled and the vehicle placed in service immediately.

## ENGINE PERFORMANCE

If a loss of performance is noticed, timing belt or chain may have skipped one or two teeth. Camshaft and crankshaft timing should be checked. Refer to Group 9, Engine Timing belt or chain installation.

It is important that the vehicle is operating to its optimum performance level to maintain fuel economy and lowest vehicle emissions. If vehicle is not operating to these standards, refer to Engine Diagnosis outlined in this section. The following procedures can assist in achieving the proper engine diagnosis.

- (1) Test cranking amperage draw. Refer to Group 8B, Starting.
- (2) Check intake manifold for vacuum leaks.
- (3) Perform cylinder compression pressure test. Refer to Engine Diagnosis, outlined in this section.
- (4) Clean or replace spark plugs as necessary and adjust gap as specified in Group 8D, Ignition System. Tighten to specifications.

## GENERAL INFORMATION (Continued)

(5) Test resistance of spark plug cables. Refer to Group 8D, Ignition System.

(6) Test ignition coils primary and secondary resistance. Replace parts as necessary. Refer to Group 8D, Ignition System.

(7) Check fuel pump pressure at idle and different RPM ranges. Refer to Group 14, Fuel System for Specifications.

(8) The air filter elements should be replaced as specified in Group 0, Lubrication and Maintenance.

(9) Inspect crankcase ventilation system as outlined in Group 25, Emission Control Systems.

(10) Road test vehicle as a final test.

## HONING CYLINDER BORES

(1) Used carefully, the cylinder bore resizing hone C-823 equipped with 220 grit stones, is the best tool for this job. In addition to deglazing, it will reduce taper and out-of-round as well as removing light scuffing, scoring or scratches. Usually a few strokes will clean up a bore and maintain the required limits.

(2) Deglazing of the cylinder walls may be done using a cylinder surfacing hone, Tool C-3501, equipped with 280 grit stones, if the cylinder bore is straight and round. 20-60 strokes depending on the bore condition, will be sufficient to provide a satisfactory surface. Inspect cylinder walls after each 20 strokes, using a light honing oil. **Do not use engine or transmission oil, mineral spirits or kerosene.**

(3) Honing should be done by moving the hone up and down fast enough to get a cross-hatch pattern. When hone marks **intersect** at 50-60 degrees, the cross hatch angle is most satisfactory for proper seating of rings (Fig. 2).

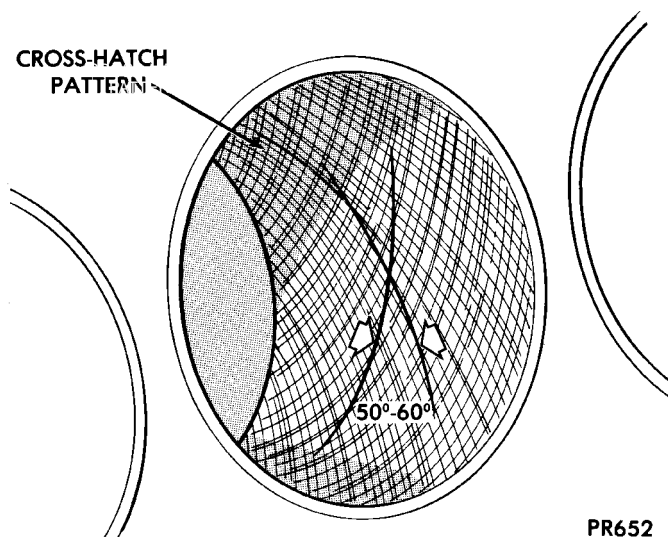


Fig. 2 Cylinder Bore Cross-Hatch Pattern

(4) A controlled hone motor speed between 200-300 RPM is necessary to obtain the proper cross-

hatch angle. The number of up and down strokes per minute can be regulated to get the desired 50-60 degree angle. Faster up and down strokes increase the cross-hatch angle.

(5) After honing, it is necessary that the block be cleaned again to remove all traces of abrasive.

**CAUTION:** Ensure all abrasives are removed from engine parts after honing. It is recommended that a solution of soap and hot water be used with a brush and the parts then thoroughly dried. The bore can be considered clean when it can be wiped clean with a white cloth and cloth remains clean. Oil the bores after cleaning to prevent rusting.

## MEASURING MAIN BEARING AND CONNECTING ROD BEARING CLEARANCES

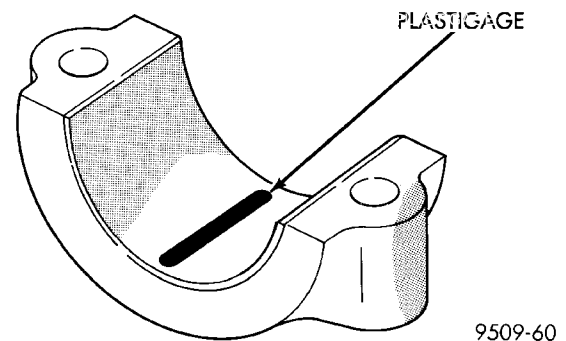


Fig. 3 Plastigage Placed in Lower Shell

## PLASTIGAGE METHOD

Engine crankshaft bearing clearances can be determined by use of Plastigage or equivalent. The following is the recommended procedure for the use of Plastigage:

**NOTE:** The total clearance of the main bearings can only be determined by removing the weight of the crankshaft. This can be accomplished by either of two methods:

## PREFERRED METHOD

Shimming the bearings adjacent to the bearing to be checked in order to remove the clearance between upper bearing shell and the crankshaft. This can be accomplished by placing a minimum of 0.254 mm (0.010 in.) shim (e. g. cardboard, matchbook cover, etc.) between the bearing shell and the bearing cap on the adjacent bearings and tightening bolts to 14-20 N·m (10-15 ft. lbs.). The number of main bearing will vary from engine to engine.

## ENGINE WITH 5 MAIN BEARINGS

- When checking #1 main bearing shim #2 main bearing.

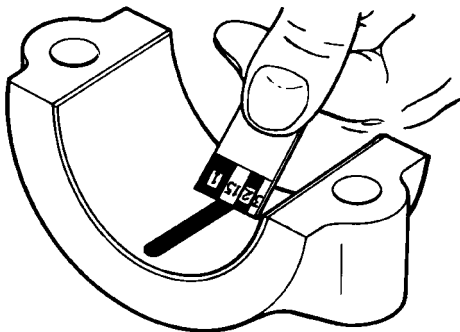
## GENERAL INFORMATION (Continued)

- When checking #2 main bearing shim #1 & 3 main bearing.
- When checking #3 main bearing shim #2 & 4 main bearing.
- When checking #4 main bearing shim #3 & 5 main bearing.
- When checking #5 main bearing shim #4 main bearing.

**ENGINE WITH 4 MAIN BEARING**

- When checking #1 main bearing shim # 2 main bearing.
- When checking #2 main bearing shim #1 & #3 main bearing.
- When checking #3 main bearing shim #2 & #4 main bearing.
- When checking #4 main bearing shim #3 main bearing.

**NOTE: REMOVE ALL SHIMS BEFORE REASSEMBLING ENGINE**



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**Fig. 4 Clearance Measurement**

**ALTERNATIVE METHOD**

The weight of the crankshaft can be supported by a jack under the counterweight adjacent to the bearing being checked.

**PLASTIGAGE PROCEDURE**

- (1) Remove oil film from surface to be checked. Plastigage is soluble in oil.
- (2) Place a piece of Plastigage across the entire width of the bearing shell in the cap approximately 6.35 mm (1/4 in.) off center and away from the oil holes (Fig. 3). (In addition, suspected areas can be checked by placing the Plastigage in the suspected area). Torque the bearing cap bolts of the bearing being checked to the proper specifications.
- (3) Remove the bearing cap and compare the width of the flattened Plastigage (Fig. 4) with the metric scale provided on the package. Locate the band closest to the same width. This band shows the amount of clearance in thousandths of a millimeter. Differences in readings between the ends indicate the amount of taper present. Record all readings taken. Refer to Engine Specifications. **Plastigage gener-**

**ally is accompanied by two scales. One scale is in inches, the other is a metric scale.**

**NOTE: Plastigage is available in a variety of clearance ranges. Use the most appropriate range for the specifications you are checking.**

**CONNECTING ROD BEARING CLEARANCE**

Engine connecting rod bearing clearances can be determined by use of Plastigage or equivalent. The following is the recommended procedure for the use of Plastigage:

- (1) Rotate the crankshaft until the connecting rod to be checked is at the bottom of its stroke.
- (2) Remove oil film from surface to be checked. Plastigage is soluble in oil.
- (3) Place a piece of Plastigage across the entire width of the bearing shell in the bearing cap approximately 6.35 mm (1/4 in.) off center and away from the oil hole (Fig. 3). In addition, suspect areas can be checked by placing plastigage in the suspect area.
- (4) Assemble the rod cap with Plastigage in place. Tighten the rod cap to the specified torque. **Do not rotate the crankshaft while assembling the cap or the Plastigage may be smeared, giving inaccurate results.**
- (5) Remove the bearing cap and compare the width of the flattened Plastigage (Fig. 4) with the scale provided on the package. Locate the band closest to the same width. This band indicates the amount of oil clearance. Differences in readings between the ends indicate the amount of taper present. Record all readings taken. Refer to Engine Specifications. **Plastigage generally is accompanied by two scales. One scale is in inches, the other is a metric scale. If the bearing clearance exceeds 0.076 mm (0.003 in.) replace bearing.**

**NOTE: Plastigage is available in a variety of clearance ranges. Use the most appropriate range for the specifications you are checking.**

**REPAIR OF DAMAGED OR WORN THREADS**

Damaged or worn threads (including aluminum head spark plug threads) can be repaired. Essentially, this repair consists of drilling out worn or damaged threads, tapping the hole with a special Heli-Coil Tap, (or equivalent) and installing an insert into the tapped hole. This brings the hole back to its original thread size.

**CAUTION: Be sure that the tapped holes maintain the original centerline.**

Heli-Coil tools and inserts are readily available from automotive parts jobbers.

## GENERAL INFORMATION (Continued)

## HYDROSTATIC LOCKED ENGINE

When an engine is suspected to be hydrostatically locked, regardless of what caused the problem, these steps should be used.

**CAUTION: Do Not Use Starter Motor To Rotate Engine, severe damage may occur.**

(1) Inspect air cleaner, induction system and intake manifold to insure system is dry and clear of foreign material.

(2) Remove negative battery cable.

(3) Place a shop towel around the spark plugs when removing them from the engine. This will catch any fluid that may possibly be in the cylinder under pressure.

(4) With all spark plugs removed, rotate engine crankshaft using a breaker bar and socket.

(5) Identify the fluid in the cylinder(s) (i.e., coolant, fuel, oil or other).

(6) Make sure all fluid has been removed from the cylinders. Inspect engine for damage (i.e., Connecting Rods, Pistons, Valves etc.)

(7) Repair engine or components as necessary to prevent this problem from occurring again.

**CAUTION: Squirt approximately 1 teaspoon of oil into cylinders, rotate engine to lubricate the cylinder walls to prevent damage on restart.**

(8) Install new spark plugs.

(9) Drain engine oil and remove oil filter.

(10) Fill engine with specified amount of approved oil and install new oil filter.

(11) Connect negative battery cable.

(12) Start engine and check for any leaks.

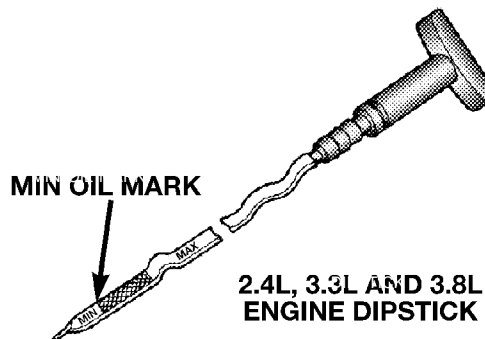
## ENGINE OIL

*Checking Oil Level*

To assure proper engine lubrication, the engine oil must be maintained at the correct level. Check the oil level at regular intervals, such as every fuel stop.

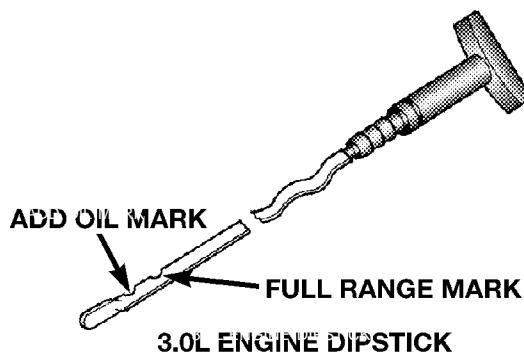
The best time to check the oil level is about 5 minutes after a fully warmed-up engine is shut off, or before starting the vehicle after it has sat overnight.

Checking the oil while the vehicle is on level ground, will improve the accuracy of the oil level readings. For 2.4L, 3.3L and 3.8L engines, maintain the oil level between the MIN and MAX markings on the dipstick. Adding one quart of oil when the reading is at the MIN mark will result in a MAX reading on these engines. For the 3.0L engine, add one full quart when the level on the dipstick is at or below the ADD mark.



2.4L, 3.3L AND 3.8L  
ENGINE DIPSTICK

8000cbda



3.0L ENGINE DIPSTICK

8008a54c

## ENGINE OIL SERVICE

**WARNING: NEW OR USED ENGINE OIL CAN BE IRRITATING TO THE SKIN. AVOID PROLONGED OR REPEATED SKIN CONTACT WITH ENGINE OIL. CONTAMINANTS IN USED ENGINE OIL, CAUSED BY INTERNAL COMBUSTION, CAN BE HAZARDOUS TO YOUR HEALTH. THOROUGHLY WASH EXPOSED SKIN WITH SOAP AND WATER. DO NOT WASH SKIN WITH GASOLINE, DIESEL FUEL, THINNER, OR SOLVENTS, HEALTH PROBLEMS CAN RESULT. DO NOT POLLUTE, DISPOSE OF USED ENGINE OIL PROPERLY. CONTACT YOUR DEALER OR GOVERNMENT AGENCY FOR LOCATION OF COLLECTION CENTER IN YOUR AREA.**

*ENGINE OIL SPECIFICATION*

**CAUTION: Do not use non-detergent or straight mineral oil when adding or changing crankcase lubricant. Engine failure can result.**

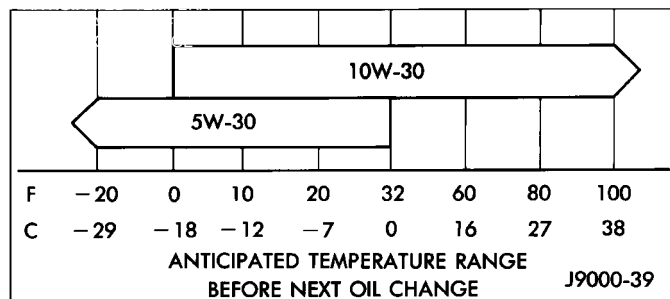
*API SERVICE GRADE CERTIFIED*

Use an engine oil that is API Service Grade Certified or an oil that conforms to the API Service Grade SH or SH/CD. MOPAR provides engine oils that conform to all of these service grades.

## GENERAL INFORMATION (Continued)

## SAE VISCOSITY

An SAE viscosity grade is used to specify the viscosity of engine oil. SAE 30 specifies a single viscosity engine oil. Engine oils also have multiple viscosities. These are specified with a dual SAE viscosity grade which indicates the cold-to-hot temperature viscosity range. Select an engine oil that is best suited to your particular temperature range and variation (Fig. 5).



**Fig. 5 Temperature/Engine Oil Viscosity**

## ENERGY CONSERVING OIL

An Energy Conserving type oil is recommended for gasoline engines. They are designated as either ENERGY CONSERVING or ENERGY CONSERVING II.

## CONTAINER IDENTIFICATION

Standard engine oil identification notations have been adopted to aid in the proper selection of engine oil. The identifying notations are located on the label of engine oil plastic bottles and the top of engine oil cans (Fig. 6).

## ENGINE OIL ADDITIVES

In some instances, such as infrequent operation, short trip driving, and during break-in after a major overhaul, addition of special materials containing anti-rust and anti-scuff additives are beneficial. A



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**Fig. 6 Engine Oil Container Standard Notations**

suitable product for this purpose is MOPAR Engine Oil Supplement.

## ENGINE OIL CHANGE

Change engine oil at mileage and time intervals described in the Maintenance Schedule.

## TO CHANGE ENGINE OIL

Run engine until achieving normal operating temperature.

- (1) Position the vehicle on a level surface and turn engine off.
- (2) Hoist and support vehicle on safety stands. Refer to Hoisting and Jacking Recommendations.
- (3) Remove oil fill cap.
- (4) Place a suitable drain pan under crankcase drain.
- (5) Remove drain plug from crankcase and allow oil to drain into pan. Inspect drain plug threads for stretching or other damage. Replace drain plug and gasket if damaged.
- (6) Install drain plug in crankcase.
- (7) Lower vehicle and fill crankcase with specified type and amount of engine oil described in this section.
- (8) Install oil fill cap.
- (9) Start engine and inspect for leaks.
- (10) Stop engine and inspect oil level.

## ENGINE DIAGNOSIS

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## DIAGNOSIS AND TESTING

## GENERAL INFORMATION

Engine diagnosis is helpful in determining the causes of malfunctions.

These malfunctions may be classified as either mechanical (e.g., a strange noise), or performance (e.g., engine idles rough and stalls).

Refer to the Service Diagnosis—Mechanical Chart and the Service Diagnosis—Performance Chart, for possible causes and corrections of malfunctions. Refer to Group 14, Fuel System, for the fuel system diagnosis.

Additional tests and diagnostic procedures may be necessary for specific engine malfunctions that cannot be isolated with the Service Diagnosis charts. Information concerning additional tests and diagnosis is provided within the following:

- Cylinder Compression Pressure Test
- Cylinder Combustion Pressure Leakage Test
- Engine Cylinder Head Gasket Failure Diagnosis
- Intake Manifold Leakage Diagnosis

## INTAKE MANIFOLD LEAKAGE DIAGNOSIS

An intake manifold air leak is characterized by lower than normal manifold vacuum. Also, one or more cylinders may not be functioning.

**WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.**

- (1) Start the engine.
- (2) Spray a small stream of water (Spray Bottle) at the suspected leak area.
- (3) If a change in RPM'S, the area of the suspected leak has been found.
- (4) Repair as required.

## CYLINDER COMPRESSION PRESSURE TEST

The results of a cylinder compression pressure test can be utilized to diagnose several engine malfunctions.

Ensure the battery is completely charged and the engine starter motor is in good operating condition. Otherwise the indicated compression pressures may not be valid for diagnosis purposes.

- (1) Check engine oil level and add oil if necessary.
- (2) Drive the vehicle until engine reaches normal operating temperature. Select a route free from traffic and other forms of congestion, observe all traffic laws, and accelerate through the gears several times briskly.

(3) Remove all spark plugs from engine. As spark plugs are being removed, check electrodes for abnormal firing indicators fouled, hot, oily, etc. Record cylinder number of spark plug for future reference.

(4) Disconnect coil wire from distributor and secure to good ground to prevent a spark from starting a fire (Conventional Ignition System). For Direct Ignition System DIS disconnect the coil connector.

(5) Be sure throttle blade is fully open during the compression check.

(6) Insert compression gage adaptor into the #1 spark plug hole in cylinder head. Crank engine until maximum pressure is reached on gage. Record this pressure as #1 cylinder pressure.

(7) Repeat the previous step for all remaining cylinders.

(8) Compression should not be less than (689kPa) 100 psi and not vary more than 25 percent from cylinder to cylinder.

(9) If one or more cylinders have abnormally low compression pressures, repeat the compression test.

(10) If the same cylinder or cylinders repeat an abnormally low reading on the second compression test, it could indicate the existence of a problem in the cylinder in question. **The recommended compression pressures are to be used only as a guide to diagnosing engine problems. An engine should not be disassembled to determine the**

## DIAGNOSIS AND TESTING (Continued)

**cause of low compression unless some malfunction is present.**

(11) Clean or replace spark plugs as necessary and adjust gap as specified in Group 8, Electrical. Tighten to specifications.

(12) Test resistance of spark plug cables. Refer to Group 8, Electrical Ignition System Secondary Circuit Inspection.

(13) Test coil output voltage, primary and secondary resistance. Replace parts as necessary. Refer to Group 8, Electrical Ignition System.

(14) Check fuel pump pressure at idle and different RPM ranges. Refer to Group 14, Fuel System for Specifications.

(15) The air filter elements should be replaced as specified in Group 0, Lubrication and Maintenance,.

(16) Inspect crankcase ventilation system as outlined in Group 0, Lubrication and Maintenance. For emission controls see Group 25, Emission Controls for service procedures.

(17) Inspect and adjust accessory belt drives referring to Group 7, Cooling System, Accessory Drive Belts for proper adjustments.

(18) Road test vehicle as a final test.

**CYLINDER COMBUSTION PRESSURE LEAKAGE TEST**

The combustion pressure leakage test provides an accurate means for determining engine condition.

Combustion pressure leakage testing will detect:

- Exhaust and intake valve leaks (improper seating).
- Leaks between adjacent cylinders or into water jacket.
- Any causes for combustion/compression pressure loss.

**WARNING: DO NOT REMOVE THE RADIATOR CAP WITH THE SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.**

Check the coolant level and fill as required. DO NOT install the radiator cap.

Start and operate the engine until it attains normal operating temperature, then turn the engine OFF.

Clean spark plug recesses with compressed air.

Remove the spark plugs.

Remove the oil filler cap.

Remove the air cleaner.

Calibrate the tester according to the manufacturer's instructions. The shop air source for testing should maintain 483 kPa (70 psi) minimum, 1 379 kPa (200 psi) maximum and 552 kPa (80 psi) recommended.

Perform the test procedures on each cylinder according to the tester manufacturer's instructions. While testing, listen for pressurized air escaping through the throttle body, tailpipe and oil filler cap opening. Check for bubbles in the radiator coolant.

All gauge pressure indications should be equal, with no more than 25% leakage.

**FOR EXAMPLE:** At 552 kPa (80 psi) input pressure, a minimum of 414 kPa (60 psi) should be maintained in the cylinder.

**LASH ADJUSTER (TAPPET) NOISE DIAGNOSIS**

A tappet-like noise may be produced from several items. Check the following items.

(1) Engine oil level too high or too low. This may cause aerated oil to enter the adjusters and cause them to be spongy.

(2) Insufficient running time after rebuilding cylinder head. Low speed running up to 1 hour may be required.

(3) During this time, turn engine off and let set for a few minutes before restarting. Repeat this several times after engine has reached normal operating temperature.

(4) Low oil pressure.

(5) The oil restrictor pressed into the vertical oil passage to the cylinder head is plugged with debris.

(6) Air ingested into oil due to broken or cracked oil pump pick up.

(7) Worn valve guides.

(8) Rocker arm ears contacting valve spring retainer.

(9) Rocker arm loose, adjuster stuck or at maximum extension and still leaves lash in the system.

(10) Faulty lash adjuster.

a. Check lash adjusters for sponginess while installed in cylinder head. Depress part of rocker arm over adjuster. Normal adjusters should feel very firm. Spongy adjusters can be bottomed out easily.

b. Remove suspected lash adjusters, and disassemble **Do not reuse retainer caps**. Do not interchange parts and make sure that care and cleanliness is exercised in the handling of parts.

c. Clean out dirt and varnish with solvent.

d. Reassemble with engine oil.

e. Check for sponginess.

f. If still spongy, replace with new adjuster.

**INSPECTION (ENGINE OIL LEAKS IN GENERAL)**

Begin with a through visual inspection of the engine, particularly at the area of the suspected leak. If an oil leak source is not readily identifiable, the following steps should be followed:

(1) Do not clean or degrease the engine at this time because some solvents may cause rubber to swell, temporarily stopping the leak.

## DIAGNOSIS AND TESTING (Continued)

(2) Add an oil soluble dye (use as recommended by manufacturer). Start the engine and let idle for approximately 15 minutes. Check the oil dipstick to make sure the dye is thoroughly mixed as indicated with a bright yellow color under a black light.

(3) Using a black light, inspect the entire engine for fluorescent dye, particularly at the suspected area of oil leak. If the oil leak is found and identified, repair per service manual instructions.

(4) If dye is not observed, drive the vehicle at various speeds for approximately 24km (15 miles), and repeat inspection.

(5) **If the oil leak source is not positively identified at this time**, proceed with the air leak detection test method as follows:

(6) Disconnect the fresh air hose (makeup air) at the cylinder head cover and plug or cap the nipple on the cover.

(7) Remove the PCV valve hose from the cylinder head cover. Cap or plug the PCV valve nipple on the cover.

(8) Attach an air hose with pressure gauge and regulator to the dipstick tube.

**CAUTION: Do not subject the engine assembly to more than 20.6 kPa (3 PSI) of test pressure.**

(9) Gradually apply air pressure from 1 psi to 2.5 psi maximum while applying soapy water at the suspected source. Adjust the regulator to the suitable test pressure that provide the best bubbles which will pinpoint the leak source. If the oil leak is detected and identified, repair per service manual procedures.

(10) If the leakage occurs at the rear oil seal area, refer to the section, Inspection for Rear Seal Area Leak.

(11) If no leaks are detected, turn off the air supply and remove the air hose and all plugs and caps. Install the PCV valve and breather cap hose. Proceed to next step.

(12) Clean the oil off the suspect oil leak area using a suitable solvent. Drive the vehicle at various speeds approximately 24 km (15 miles). Inspect the engine for signs of an oil leak by using a black light.

#### INSPECTION FOR REAR SEAL AREA LEAKS

Since it is sometimes difficult to determine the source of an oil leak in the rear seal area of the engine, a more involved inspection is necessary. The following steps should be followed to help pinpoint the source of the leak.

If the leakage occurs at the crankshaft rear oil seal area:

- (1) Disconnect the battery.
- (2) Raise the vehicle.

(3) Remove torque converter or clutch housing cover and inspect rear of block for evidence of oil. Use a black light to check for the oil leak. If a leak is present in this area remove transmission for further inspection.

(a) Circular spray pattern generally indicates seal leakage or crankshaft damage.

(b) Where leakage tends to run straight down, possible causes are a porous block, oil galley cup plug, bedplate to cylinder block mating surfaces and seal bore. See proper repair procedures for these items.

(4) If no leaks are detected, pressurized the crankcase as outlined in the, Inspection (Engine oil Leaks in general)

**CAUTION: Do not exceed 20.6 kPa (3 psi).**

(5) If the leak is not detected, very slowly turn the crankshaft and watch for leakage. If a leak is detected between the crankshaft and seal while slowly turning the crankshaft, it is possible the crankshaft seal surface is damaged. The seal area on the crankshaft could have minor nicks or scratches that can be polished out with emery cloth.

**CAUTION: Use extreme caution when crankshaft polishing is necessary to remove minor nicks and scratches. The crankshaft seal flange is especially machined to complement the function of the rear oil seal.**

(6) For bubbles that remain steady with shaft rotation, no further inspection can be done until disassembled.

(7) After the oil leak root cause and appropriate corrective action have been identified. Refer to Rear Crankshaft Seals, for proper replacement procedures.

## DIAGNOSIS AND TESTING (Continued)

## ENGINE DIAGNOSIS PERFORMANCE

CONDITION	POSSIBLE CAUSE	CORRECTION
ENGINE WILL NOT START	<ol style="list-style-type: none"> <li>1. Weak battery.</li> <li>2. Corroded or loose battery connections.</li> <li>3. Faulty starter.</li> <li>4. Moisture on ignition wires.</li> <li>5. Faulty ignition cables.</li> <li>6. Faulty coil or control unit.</li> <li>7. Incorrect spark plug gap.</li> <li>8. Dirt or water in fuel system.</li> <li>9. Faulty fuel pump.</li> </ol>	<ol style="list-style-type: none"> <li>1. Test battery specific gravity. Charge or replace as necessary.</li> <li>2. Clean and tighten battery connections. Apply a coat of light mineral grease to the terminals.</li> <li>3. Refer to Group 8A, Battery/Starter/Charging System Diagnostics.</li> <li>4. Wipe wires clean and dry.</li> <li>5. Replace any cracked or shorted cables.</li> <li>6. Test and replace, if necessary (refer to Group 8D, Ignition system).</li> <li>7. Set gap (refer to Group 8D, Ignition System).</li> <li>8. Clean system and replace fuel filter.</li> <li>9. Install new fuel pump (refer to Group 14, Fuel System).</li> </ol>
ENGINE STALLS OR ROUGH IDLE	<ol style="list-style-type: none"> <li>1. Idle speed set too low.</li> <li>2. Idle mixture too lean or too rich.</li> <li>3. Leak in intake manifold.</li> <li>4. Incorrect ignition wiring.</li> <li>5. Faulty coil.</li> <li>6. Burned, warped or pitted.</li> </ol>	<ol style="list-style-type: none"> <li>1. Refer to Group 14, Fuel System.</li> <li>2. Refer to Group 14, Fuel System.</li> <li>3. Inspect intake manifold gasket and vacuum hoses. Replace, if necessary (refer to Group 1), Exhaust System &amp; Intake Manifold).</li> <li>4. Install correct wiring.</li> <li>5. Test and replace, if necessary (refer to Group 8D, Ignition System).</li> <li>6. Install new valves.</li> </ol>
ENGINE LOSS OF POWER	<ol style="list-style-type: none"> <li>1. Dirty or incorrectly gapped spark plugs.</li> <li>2. Dirt or water in fuel system.</li> <li>3. Faulty fuel pump.</li> <li>4. Incorrect valve timing.</li> <li>5. Blown cylinder head gasket.</li> <li>6. Low compression.</li> <li>7. Burned, warped or pitted valves.</li> <li>8. Plugged or restricted exhaust system.</li> <li>9. Faulty ignition cables.</li> <li>10. Faulty coil.</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean plugs and set gap (refer to Group 8D, Ignition System).</li> <li>2. Clean system and replace fuel filter.</li> <li>3. Install new fuel pump.</li> <li>4. Correct valve timing.</li> <li>5. Install new cylinder head gasket.</li> <li>6. Test compression of each cylinder.</li> <li>7. Install new valves.</li> <li>8. Install new parts, as necessary.</li> <li>9. Replace any cracked or shorted cables.</li> <li>10. Test and replace, as necessary (refer to Group 8D, Ignition System).</li> </ol>
ENGINE MISSES ON ACCELERATION	<ol style="list-style-type: none"> <li>1. Dirty or gap set too wide in spark plug.</li> <li>2. Dirt in fuel system.</li> <li>3. Burned, warped or pitted valves.</li> <li>4. Faulty coil.</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean spark plugs and set gap (refer to Group 8D, Ignition System).</li> <li>2. Clean fuel system.</li> <li>3. Install new valves.</li> <li>4. Test and replace, if necessary, (refer to Group 8D, Ignition System).</li> </ol>
ENGINE MISSES AT HIGH SPEED	<ol style="list-style-type: none"> <li>1. Dirty or gap set too wide in spark plug.</li> <li>2. Faulty coil.</li> <li>3. Dirty injector.</li> <li>4. Dirt or water in fuel system.</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean spark plugs and set gap (refer to Group 8D, Ignition System).</li> <li>2. Test and replace, as necessary (refer to Group 8D, Ignition System).</li> <li>3. Clean injectors.</li> <li>4. Clean system and replace fuel filter.</li> </ol>

## DIAGNOSIS AND TESTING (Continued)

## ENGINE DIAGNOSIS MECHANICAL

CONDITION	POSSIBLE CAUSE	CORRECTION
NOISY VALVES	<ol style="list-style-type: none"> <li>1. High or low oil level in crankcase.</li> <li>2. Thin or diluted oil.</li> <li>3. Low oil pressure.</li> <li>4. Dirt in lash adjusters.</li> <li>5. Worn rocker arms.</li> <li>6. Worn lash adjusters.</li> <li>7. Worn valve guides.</li> <li>8. Excessive runout of valve seats on valve faces.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check for correct oil level (refer to Group 0, Lubrication and Maintenance).</li> <li>2. Change oil (refer to Group 0, Lubrication and Maintenance).</li> <li>3. Check engine oil level.</li> <li>4. Replace rocker arm/hydraulic lash adjuster assembly.</li> <li>5. Replace rocker arms.</li> <li>6. Install new hydraulic lash adjuster assembly.</li> <li>7. Ream and install new valves with oversize stems.</li> <li>8. Grind valve seats and valves.</li> </ol>
CONNECTING ROD NOISE	<ol style="list-style-type: none"> <li>1. Insufficient oil supply.</li> <li>2. Low oil pressure.</li> <li>3. Thin or diluted oil.</li> <li>4. Excessive bearing clearance.</li> <li>5. Connecting rod journal out-of-round.</li> <li>6. Misaligned connecting rods.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check engine oil level (refer to Group 0, Lubrication and Maintenance).</li> <li>2. Check engine oil level. Inspect oil pump relief valve and spring.</li> <li>3. Change oil to correct viscosity.</li> <li>4. Measure bearings for correct clearance. Repair as necessary.</li> <li>5. Replace crankshaft or grind journals.</li> <li>6. Replace bent connecting rods.</li> </ol>
MAIN BEARING NOISE	<ol style="list-style-type: none"> <li>1. Insufficient oil supply.</li> <li>2. Low oil pressure.</li> <li>3. Thin or diluted oil.</li> <li>4. Excessive bearing clearance.</li> <li>5. Excessive end play.</li> <li>6. Crankshaft journal out-of-round, worn.</li> <li>7. Loose flywheel or torque converter.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check engine oil level (refer to Group 0, Lubrication and Maintenance).</li> <li>2. Check engine oil level. Inspect oil pump relief valve and spring.</li> <li>3. Change oil to correct viscosity.</li> <li>4. Measure bearings for correct clearance. Repair as necessary.</li> <li>5. Check thrust bearing for wear on flanges.</li> <li>6. Grind journals or replace crankshaft.</li> <li>7. Tighten to correct torque.</li> </ol>
OIL PRESSURE DROP	<ol style="list-style-type: none"> <li>1. Low oil level.</li> <li>2. Faulty oil pressure sending unit.</li> <li>3. Low oil pressure.</li> <li>4. Clogged oil filter.</li> <li>5. Worn parts in oil pump.</li> <li>6. Thin or diluted oil.</li> <li>7. Excessive bearing clearance.</li> <li>8. Oil pump relief valve stuck.</li> <li>9. Oil pump suction tube loose, bent cracked, or blocked.</li> <li>10. Oil pump cover warped or cracked.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check engine oil level.</li> <li>2. Install new sending unit.</li> <li>3. Check sending unit and check main bearing oil clearance.</li> <li>4. Install new oil filter.</li> <li>5. Replace worn parts or pump.</li> <li>6. Change oil to correct viscosity.</li> <li>7. Measure bearings for correct clearance.</li> <li>8. Remove valve and inspect, clean and install.</li> <li>9. Remove oil pan and install new tube, or clean if necessary.</li> <li>10. Install new oil pump.</li> </ol>
OIL LEAKS	<ol style="list-style-type: none"> <li>1. Misaligned or deteriorated gaskets.</li> <li>2. Loose fastener, broken or porous metal part.</li> <li>3. Misaligned or deteriorated cup or threaded plug.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace the gasket.</li> <li>2. Tighten, repair or replace the part.</li> <li>3. Replace</li> </ol>
OIL CONSUMPTION OR SPARK PLUGS OIL FOULED	<ol style="list-style-type: none"> <li>1. PCV system malfunction.</li> <li>2. Worn, scuffed or broken rings.</li> <li>3. Carbon in oil ring slot.</li> <li>4. Rings fitted too tightly in grooves.</li> <li>5. Worn valve guides.</li> <li>6. Valve stem seal unseated or defective.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check system. Clean and repair, as necessary (refer to Group 25, Emissions Control System).</li> <li>2. Hone cylinder bores. Install new rings.</li> <li>3. Install new rings.</li> <li>4. Remove the rings. Check grooves. If groove is not proper width, replace piston.</li> <li>5. Ream guides and replace valves with oversize valves and seals.</li> <li>6. Repair or replace seal.</li> </ol>

## 2.4L ENGINE

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## DESCRIPTION AND OPERATION

**ENGINE IDENTIFICATION**

The engine identification number is located on the rear of the cylinder block (Fig. 1).

**ENGINE LUBRICATION SYSTEM***OIL PAN*

A formed steel oil pan provides lower engine protection as well as serving as the engine oil reservoir. Pan flanges to block are sealed with a gasket. The oil pickup tube has a strainer and cover.

*PRESSURE LUBRICATION*

Oil drawn up through the pickup tube is pressurized by the pump and routed through the full flow filter to the main oil gallery running the length of the cylinder block. Oil pickup, pump and check valve provide oil flow to the main oil gallery.

*MAIN/ROD BEARINGS*

A diagonal hole in each bulkhead feeds oil to each main bearing. Drilled passages within the crankshaft route oil from main bearing journals to connecting rod journals.

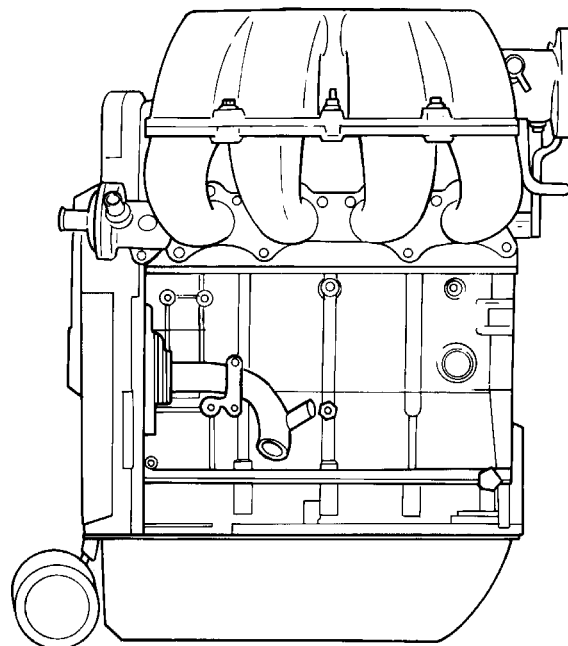
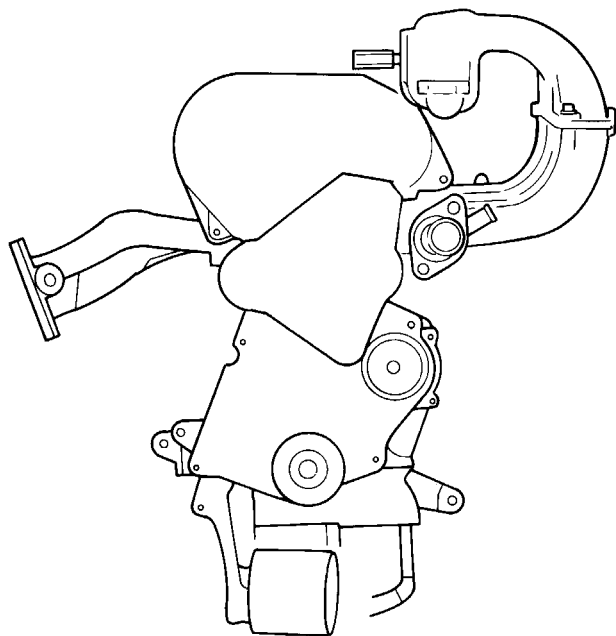
*CAMSHAFT/HYDRAULIC LASH ADJUSTERS*

A vertical hole at the number five bulkhead routes pressurized oil through a restrictor up past a cylinder head bolt to an oil gallery running the length of the cylinder head. The camshaft journals are partially slotted to allow a predetermined amount of pressurized oil to pass into the bearing cap cavities with small holes directed to spray lubricate the camshaft lobes.

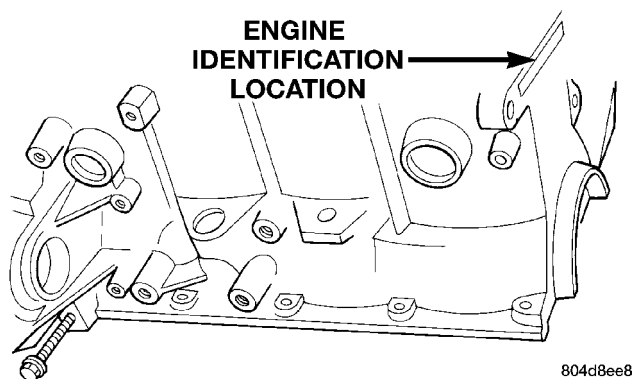
*BALANCE SHAFTS*

Balance shaft lubrication is provided through an oil passage from the number 1 main bearing cap through the balance shaft carrier support leg. This

## DESCRIPTION AND OPERATION (Continued)



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**Engine—2.4L**

804d8ee8

**Fig. 1 Engine Identification**

passage directly supplies oil to the front bearings and internal machined passages in the shafts that routes oil from front to rear shaft bearing journals

**SPLASH LUBRICATION**

Oil returning to the pan from pressurized components supplies lubrication to the valve stems. Cylinder bores and wrist pins are splash lubricated from directed slots on the connecting rod thrust collars.

**ENGINE COMPONENTS**

**BALANCE SHAFTS:** 2.4L engines are equipped with two balance shafts installed in a carrier attached to the lower crankcase. The shafts interconnect through gears to rotate in opposite directions. These gears are driven by a short chain from the crankshaft, to rotate at two times crankshaft speed. This counterbalances certain engine reciprocating masses.

**CYLINDER BLOCK AND BEDPLATE ASSEMBLY:** A closed deck design is used for cooling and weight reduction with water pump molded into the block. Nominal wall thickness is 4.5 mm. The bedplate incorporates main bearing caps. Rear seal retainer is integral with the block.

**CRANKSHAFT:** A nodular cast iron crankshaft is used. The engine has 5 main bearings, with number 3 flanged to control thrust. The 60 mm diameter main and 50 mm diameter crank pin journals (all) have undercut fillets that are deep rolled for added strength. To evenly distribute bearing loads and minimize internal stress, 8 counterweights are used. Hydrodynamic seals provide end sealing, where the crankshaft exits the block. Anaerobic gasket material is used for parting line sealing in the block. A sintered powder metal timing belt sprocket is mounted on the crankshaft nose. This sprocket provides motive power; via timing belt to the camshaft sprockets (providing timed valve actuation) and to the water pump.

**PISTONS:** There is provisions for free wheeling valve train. Piston has a unique height. All engines use pressed in piston pins to attach forged powder metal connecting rods. Incorporate hex head cap screw threaded into the connecting rod. Piston and Rods are serviced as a assembly.

**PISTONS RINGS:** The piston rings include a molybdenum faced top ring for reliable compression sealing and a chrome plated taper faced intermediate ring for additional cylinder pressure control. There are also standard oil control rings.

## DESCRIPTION AND OPERATION (Continued)

**CYLINDER HEAD:** Features a Dual Over Head Camshaft (DOHC) 4 valves per cylinder cross flow design. The valves are arranged in two inline banks, with the ports of the bank of two intake valves per cylinder facing toward the radiator side of engine and ports of the bank of two exhaust valves per cylinder facing toward the dash panel. Incorporates powder metal valve guides and seats. Integral oil galleries within the cylinder head supplies oil to the hydraulic lash adjusters, camshaft and valve mechanisms.

**CAMSHAFTS:** The nodular iron camshafts have six bearing journals and 2 cam lobes per cylinder. Flanges at the rear journals control camshaft end play. Provision for cam position sensor is located on the intake camshaft at the rear of cylinder head. A hydrodynamic oil seal is used for oil control at the front of the camshaft.

**VALVES:** 4 valves per cylinder are actuated by roller cam followers which pivot on stationary hydraulic lash adjusters. All valves have 6 mm diameter chrome plated valve stems. The valve sizes are 34.8 mm (1.370 inch.) diameter intake valves and 30.5 mm (1.20 inch.) diameter exhaust valves. Viton rubber valve stem seals are integral with the spring seats. Valve springs, spring retainers, and locks are conventional.

**INTAKE MANIFOLD:** The intake manifold is a two piece aluminum casting, attached to the cylinder head with ten screws. This long branch fan design enhances low and midspeed torque.

**EXHAUST MANIFOLD:** The exhaust manifold is made of cast iron for strength and high temperatures.

**ENGINE LUBRICATION:** Refer to Group 0 Lubrication and Maintenance for recommended oil to be used in various engine application. System is full flow filtration, pressure feed type. The oil pump is mounted in the front engine cover and driven by the crankshaft. Pressurized oil is then routed through the main oil gallery, running the length of the cylinder block, supplying main and rod bearings with further routing. Pistons are lubricated from rod bearing throw off and lubricating slots on the connecting rod assemblies. Camshaft and valve mechanisms are lubricated from a full length cylinder head oil gallery supplied from the crankcase main oil gallery.

## DIAGNOSIS AND TESTING

## CHECKING ENGINE OIL PRESSURE

- (1) Remove oil pressure sending unit and install gauge assembly C-3292.
- (2) Run engine until thermostat opens.

**CAUTION:** If oil pressure is 0 at idle, Do Not Run engine at 3000 RPM

(3) Oil Pressure: **Curb Idle** 25 kPa (4 psi) minimum **3000 RPM** 170/550 kPa (25/80 psi).

(4) If oil pressure is 0 at idle. Shut off engine, check for pressure relief valve stuck open or a clogged oil pickup screen.

## SERVICE PROCEDURES

## FITTING PISTONS

Piston and cylinder wall must be clean and dry. Piston diameter should be measured 90 degrees to piston pin about 14 mm (9/16 inch.) from the bottom of the skirt as shown in (Fig. 4). Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line shown in (Fig. 2). Refer to (Fig. 3) for specifications. Correct piston to bore clearance must be established in order to assure quiet and economical operation.

Chrysler engines use pistons designed specifically for each engine model. Clearance and sizing locations vary with respect to engine model.

**NOTE:** Pistons and cylinder bores should be measured at normal room temperature, 70°F (21°C).

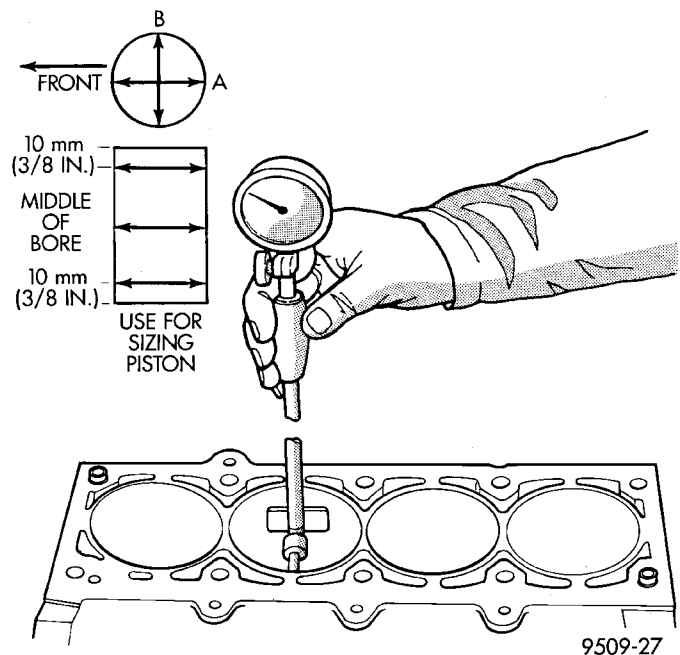


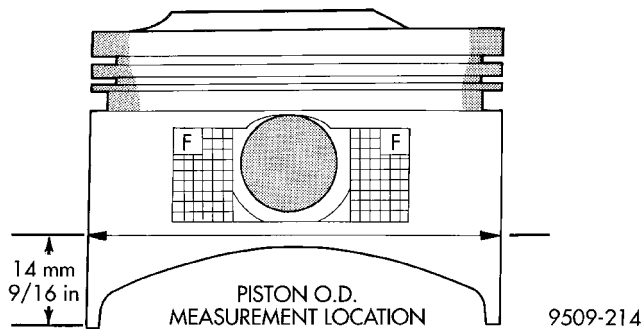
Fig. 2 Checking Cylinder Bore Size

## FITTING PISTON RINGS

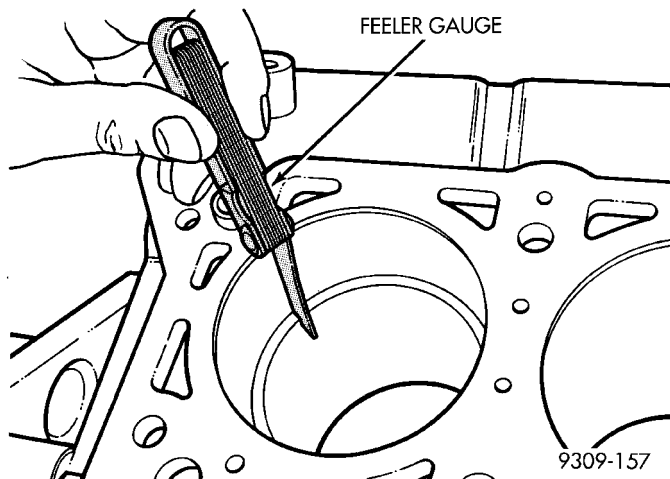
(1) Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioning at least 12 mm (0.50 inch) from bottom of

## SERVICE PROCEDURES (Continued)

Standard Bore	Maximum-Out-of-Round	Maximum Taper
87.5 mm (3.445 in.)	0.051 mm (0.002 in.)	0.051 mm (0.002 in.)
Standard Piston Size		
87.450-87.468 mm (3.4434-3.4441 in.)		
Piston to Bore Clearance: 0.024- 0.057 mm (.0009 to .0022 in.)		
Measurements taken at Piston Size Location.		

**Fig. 3 Cylinder Bore and Piston Specifications****Fig. 4 Piston Measurement**

cylinder bore. Check gap with feeler gauge (Fig. 5). Refer to specification in piston ring specifications table.

**Fig. 5 Piston Ring Gap**

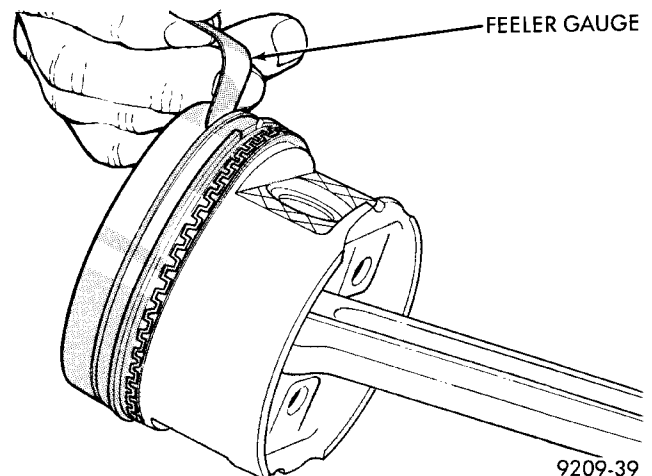
(2) Check piston ring to groove side clearance (Fig. 6). Refer to specification in piston ring specifications table.

**PISTON RINGS—INSTALLATION**

(1) Install rings with manufacturers I.D. mark facing up, to the top of the piston (Fig. 7).

**PISTON RING SPECIFICATIONS**

Ring Position	Ring Gap	Wear Limit
Upper Ring	0.025 to 0.51 mm (0.0098 to 0.020 in.)	0.8 mm (0.031 in.)
Intermediate Ring	0.23 to 0.48 mm (0.009 to 0.018 in.)	0.8 mm (0.031 in.)
Oil Control Ring	0.25 to 0.64 mm (0.0098 to 0.025 in.)	1.0 mm (0.039 in.)
Ring Position	Groove Clearance	Max. Clearance
Upper Ring	0.030 to 0.080 mm (0.0011 to 0.0031 in.)	0.10 mm (0.004 in.)
Intermediate Ring	0.025 to 0.065 mm (0.0010 to 0.0026 in.)	0.10 mm (0.004 in.)
Oil Control Ring - Three Piece. Oil Ring Side Rails Must Be Free To Rotate After Assembly.		

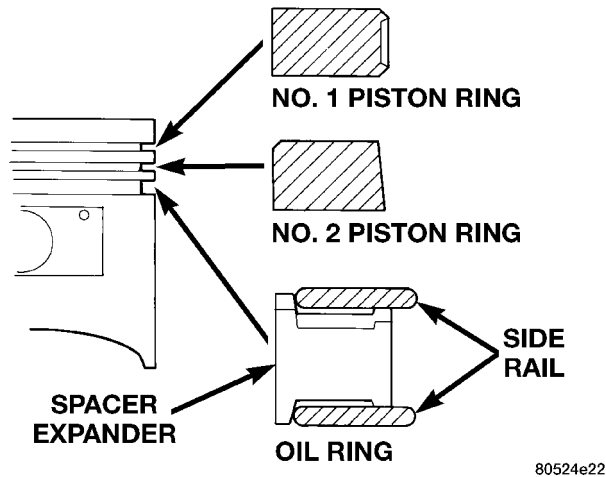
**Fig. 6 Piston Ring Side Clearance**

**CAUTION:** Install piston rings in the following order:

- a. Oil ring expander.
- b. Upper oil ring side rail.
- c. Lower oil ring side rail.
- d. No. 2 Intermediate piston ring.
- e. No. 1 Upper piston ring.

(2) Install the side rail by placing one end between the piston ring groove and the expander. Hold end firmly and press down the portion to be installed until side rail is in position. **Do not use a piston ring expander** (Fig. 8).

## SERVICE PROCEDURES (Continued)

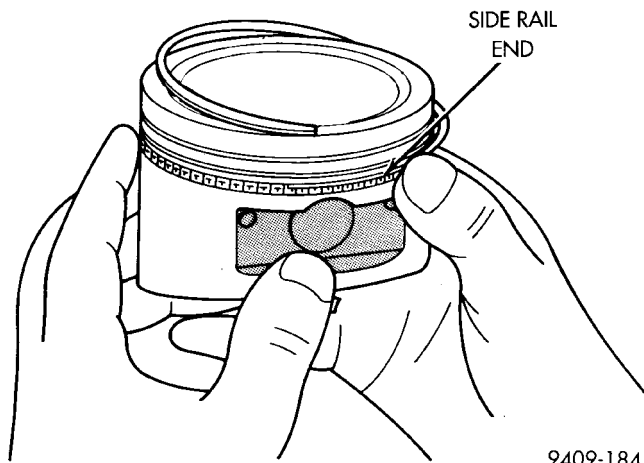


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Fig. 7 Piston Ring Installation

(3) Install upper side rail first and then the lower side rail.

(4) Install No. 2 piston ring and then No. 1 piston ring.



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Fig. 8 Installing Side Rail

(5) Position piston ring end gaps as shown in (Fig. 9).

(6) Position oil ring expander gap at least 45° from the side rail gaps but **not** on the piston pin center or on the thrust direction. Staggering ring gap is important for oil control.

## FITTING CONNECTING ROD BEARINGS

Engine connecting rod bearing clearances can be determined by use of Plastigage or equivalent. The following is the recommended procedure for the use of Plastigage:

(1) Rotate the crankshaft until the connecting rod to be checked is at the bottom of its stroke.

(2) Remove oil film from surface to be checked. Plastigage is soluble in oil.

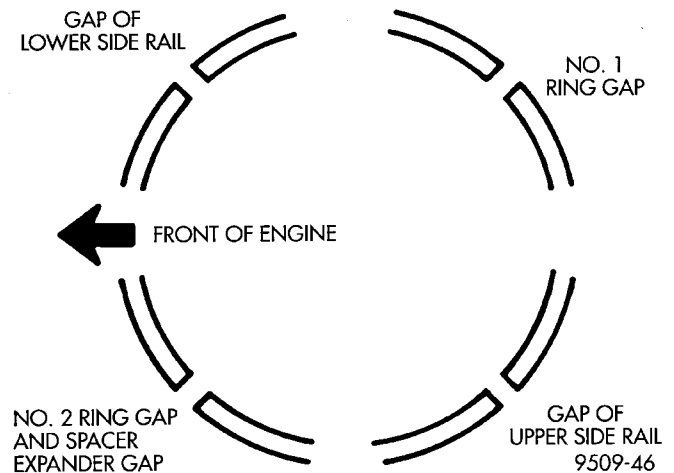
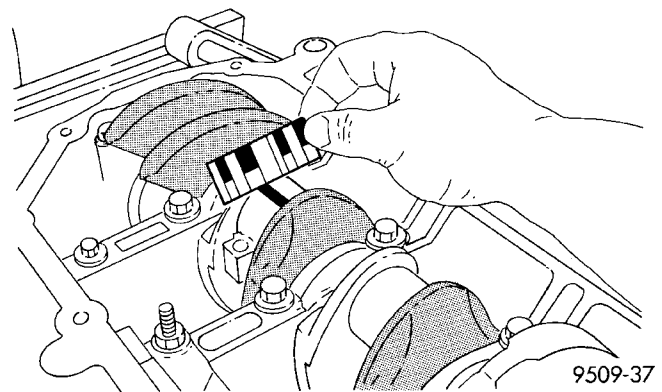


Fig. 9 Piston Ring End Gap Position

(3) Place a piece of Plastigage across the entire width of the bearing shell in the bearing cap approximately 6.35 mm (1/4 in.) off center and away from the oil hole (Fig. 10). In addition, suspect areas can be checked by placing plastigage in the suspect area.



9509-37

Fig. 10 Measuring Plastigage Width

(4) Before assembling the rod cap with Plastigage in place, the crankshaft must be rotated until the connecting rod being checked starts moving toward the top of the engine. Only then should the cap be assembled and torqued to specifications. **Do not rotate the crankshaft while assembling the cap or the Plastigage may be smeared, giving inaccurate results.**

(5) Remove the bearing cap and compare the width of the flattened Plastigage (Fig. 10) with the metric scale provided on the package. Locate the band closest to the same width. This band shows the amount of clearance in thousandths of a millimeter. Differences in readings between the ends indicate the amount of taper present. Record all readings taken. Refer to Engine Specifications. **Plastigage generally is accompanied by two scales. One scale is in inches, the other is a metric scale.**

## SERVICE PROCEDURES (Continued)

(6) Plastigage is available in a variety of clearance ranges. The 0.025-0.076 mm (.001-.003 in.) is usually the most appropriate for checking engine bearing proper specifications.

## FITTING MAIN BEARINGS

Refer to the Engine General Information Section for Measuring Main Bearings. For Crankshaft specifications refer to Crankshaft Specification Table.

## CRANKSHAFT SPECIFICATION TABLE

<b>Crankshaft End-Play</b> New Part: 0.09 - 0.24 mm (0.0035 - 0.0094 in.) Wear Limit: 0.37 mm (0.015 in.)
<b>Main Bearing Clearance</b> New Part: 0.018 - 0.058 mm (0.0007 - 0.0023 in.)
<b>Connecting Rod Bearing Clearance</b> New Part: 0.025 - 0.071 mm (0.001 - 0.003 in.) Wear Limit: 0.075 mm (0.003 in.)
<b>Crankshaft Journal Sizes</b> Main Bearing Journal Diameter Standard 60.000 ± 0.008 mm (2.3622 ± 0.0003 in.) 1 st Undersize 59.975 ± 0.008 mm (2.361 ± 0.0003 in.)
<b>Connecting Rod Journals</b> Standard 49.992 ± 0.008 mm (1.968 ± 0.0003 in.) 1 st Undersize 49.967 ± 0.008 mm (1.967 ± 0.0003 in.)

## CRANKSHAFT MAIN BEARINGS

The crankshaft is supported in five main bearings. All upper and lower bearing shells in the crankcase have oil grooves. The number three lower main thrust bearing is plain. Crankshaft end play is controlled by a flanged bearing on the number three main bearing journal (Fig. 11).

Upper and lower Number 3 bearing halves are flanged to carry the crankshaft thrust loads and are NOT interchangeable with any other bearing halves in the engine (Fig. 11). All bearing cap bolts removed during service procedures are to be cleaned and oiled before installation. Bearing shells are available in standard and the following undersized: 0.025 mm (0.001 in.), 0.050 mm (0.002 in.), 0.250 mm (0.010 inch.) 0.275 mm (0.011 inch.) 0.300 mm (0.012 inch.). Never install an undersize bearing that will reduce clearance below specifications.

## MAIN BEARING INSTALLATION

(1) Install the main bearing shells with the lubrication groove in the cylinder block (Fig. 12).

(2) Make certain oil holes in block line up with oil holes in bearings. Bearing tabs must seat in the block tab slots.

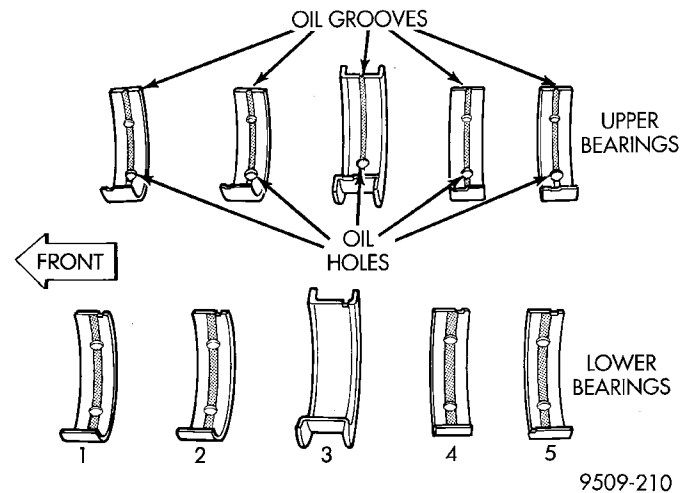


Fig. 11 Main Bearing Identification

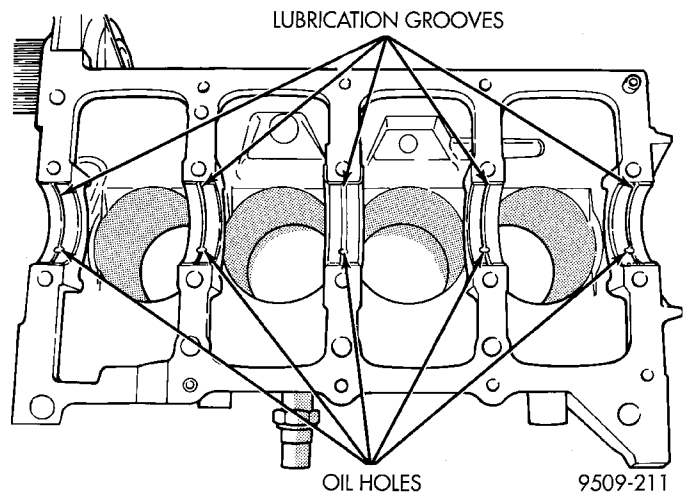


Fig. 12 Installing Main Bearing Upper Shell

**CAUTION:** Do not get oil on the bedplate mating surface. It will may effect the sealer ability to seal the bedplate to cylinder block.

(3) Oil the bearings and journals and install crankshaft.

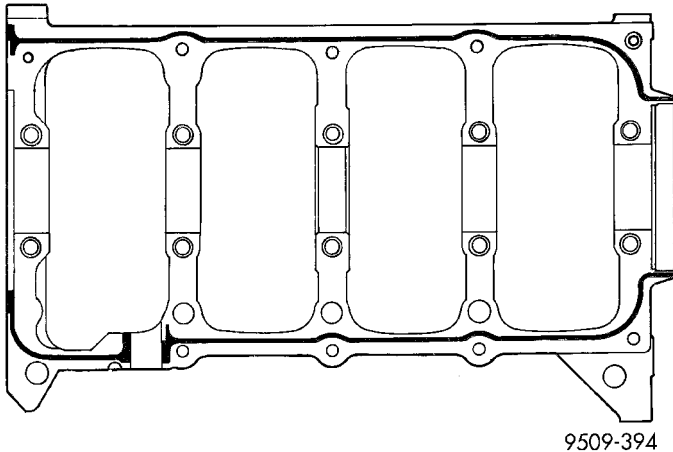
**CAUTION:** Use only the specified anaerobic sealer on the bedplate or damage may occur to the engine. Ensure that both cylinder block and bedplate surfaces are clean.

(4) Apply 1.5 to 2.0 mm (0.059 to 0.078 in.) bead of anaerobic sealer Mopar Torque Cure Gasket Maker to cylinder block as shown in (Fig. 13).

(5) Install lower main bearings into main bearing cap/bedplate. Make certain the bearing tabs are seated into the bedplate slots. Install the main bearing/bedplate into engine block.

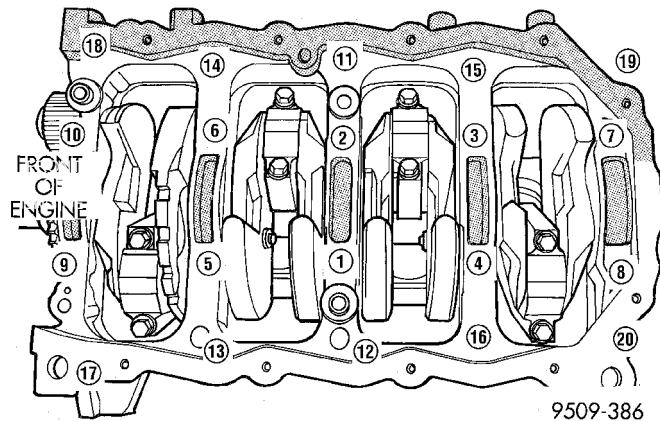
(6) Before installing the bolts the threads should be oiled with clean engine oil, wipe off any excess oil.

## SERVICE PROCEDURES (Continued)



9509-394

**Fig. 13 Main Bearing Caps/Bedplate Sealing**



9509-386

**Fig. 14 Main Bearing Caps/Bedplate Torque Sequence**

(7) Install main bearing bedplate to engine block bolts 11, 17 and 20 finger tight. Tighten these bolts down together until the bedplate contacts the cylinder block. Then torque these bolts to 28 N·m (20 ft. lbs.).

(8) Install main bearing bedplate to engine block bolts (1 through 10) and torque each bolt to 41 N·m (30 ft. lbs.) in sequence then in sequence turn each bolt 1/4 turn shown in (Fig. 14).

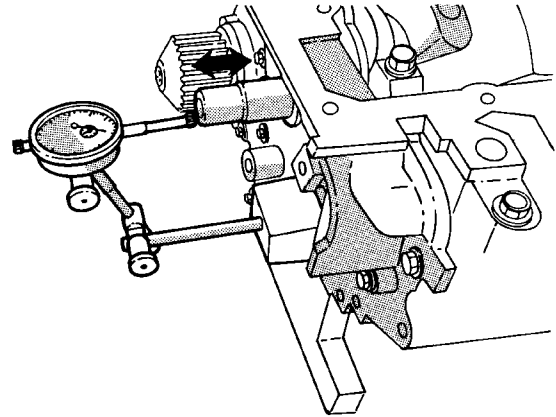
(9) Install main bearing bedplate to engine block bolts (11 through 20), and torque each bolt to 28 N·m (20 ft. lbs.) in sequence shown in (Fig. 14).

(10) After the main bearing bedplate is installed, check the crankshaft turning torque. The turning torque should not exceed 5.6 N·m (50 in. lbs.).

### CRANKSHAFT END PLAY

(1) Mount a dial indicator to front of engine, locating probe on nose of crankshaft (Fig. 15).

(2) Move crankshaft all the way to the rear of its travel.



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**Fig. 15 Checking Crankshaft End Play—Typical**

(3) Zero the dial indicator.

(4) Move crankshaft all the way to the front and read the dial indicator. Refer to Crankshaft Specification Table for end-play specification.

### CRANKSHAFT SPECIFICATION TABLE

Crankshaft End-Play
New Part: 0.09 - 0.24mm (0.0035 - 0.0094 in.)
Wear Limit: 0.37 mm (0.015 in.)

### OPTIONAL CRANKSHAFT END PLAY CHECK

(1) Move crankshaft all the way to the rear of its travel using a lever inserted between a main bearing cap and a crankshaft cheek, using care not to damage any bearing surface. **DO NOT** loosen main bearing cap.

(2) Use a feeler gauge between number three thrust bearing and machined crankshaft surface to determine end play.

### VALVE SERVICE RECONDITION

#### VALVE REMOVAL

(1) With cylinder head removed, compress valve springs using Special Tool MD 998735 or equivalent.

(2) Remove valve retaining locks, valve spring retainers, valve stem seals and valve springs.

(3) Before removing valves, **remove any burrs from valve stem lock grooves to prevent damage to the valve guides**. Identify valves to insure installation in original location.

#### VALVE INSPECTION

(1) Clean valves thoroughly and discard burned, warped and cracked valves.

(2) Measure valve stems for wear. Measure stem about 60 mm beneath the valve lock grooves.

## SERVICE PROCEDURES (Continued)

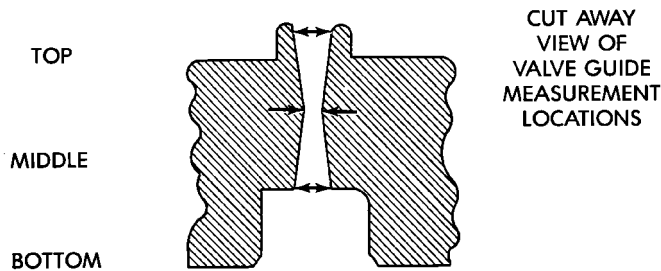
(3) If valve stems are worn more than 0.05 mm (0.002 in.), replace valve.

## VALVE GUIDES

(1) Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.

(2) Using a small hole gauge and a micrometer, measure valve guides in 3 places top, middle and bottom (Fig. 16). Refer to (Fig. 17) for specifications. Replace guides if they are not within specification.

(3) Check valve guide height (Fig. 18).



9109-98

Fig. 16 Checking Wear on Valve Guide—Typical

Valve Guide Diameter	Intake Valve	Exhaust Valve
	5.975 - 6.000 mm (0.2352 - 0.2362 in.)	5.975 - 6.000 mm (0.2352 - 0.2362 in.)
Clearance	New	Service Limit
Intake	0.048 - 0.066 mm (0.0018 - 0.0025 in.)	0.25 mm (0.010 in.)
Exhaust	0.0736 - 0.094 mm (0.0029 - 0.0037 in.)	

9509-205

Fig. 17 Valve Guide Specification

Ⓐ 13.25 - 13.75 MM  
(.521 - .541 IN.)

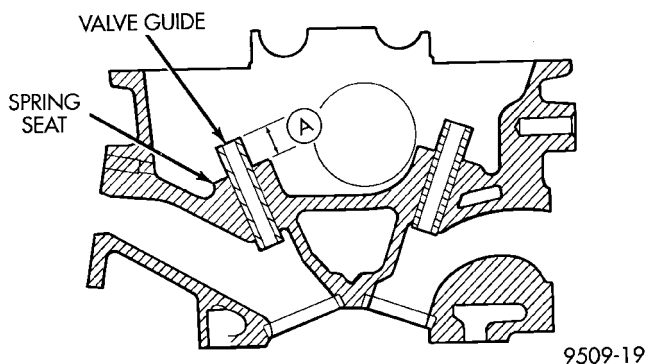


Fig. 18 Valve Guide Height

## TESTING VALVE SPRINGS

(1) Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested. As an example, the compression length of the spring to be tested is 33.34 mm (15/16 inches). Turn tool table until surface is in line with the 33.34 mm (15/16 inch) mark on the threaded stud and the zero mark on the front. Place spring over stud on the table and lift compressing lever to set tone device (Fig. 19). Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by two. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Discard the springs that do not meet specifications. The Following specifications apply to both intake and exhaust valve springs;

- Valve Closed Nominal Tension— 76 ft. lbs. @ 38.0 mm (1.50 in.)
- Valve Open Nominal Tension— 136 ft. lbs. @ 29.75 mm (1.17 in.)

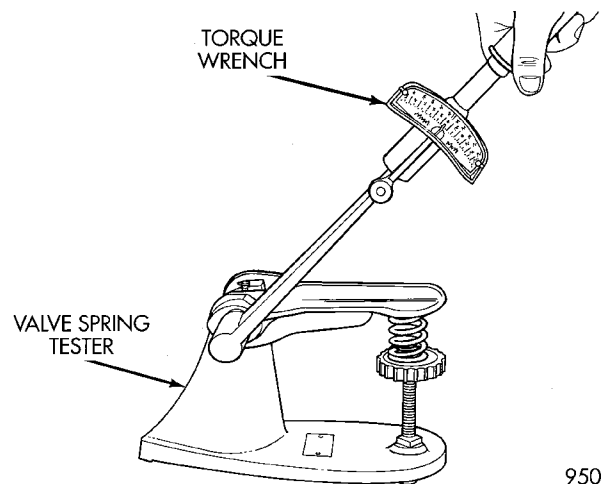


Fig. 19 Testing Valve Springs

(2) Inspect each valve spring for squareness with a steel square and surface plate, test springs from both ends. If the spring is more than 1.5 mm (1/16 inch) out of square, install a new spring.

## REFACING VALVES AND VALVE SEATS

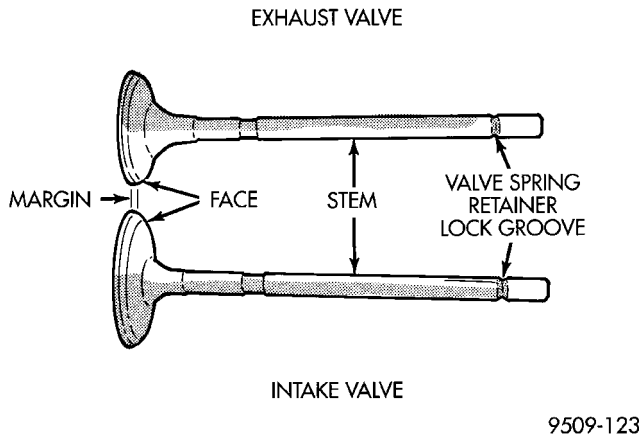
(1) The intake and exhaust valve seats and valve face have a 45 and a 45 1/2 degree angles.

(2) Inspect the remaining margin after the valves are refaced (Fig. 20). Intake valves with less than 1.2 mm (3/64 inch.) margin and Exhaust valves with less than 0.9 mm (1/32 inch.) margin should be discarded.

(3) When refacing valve seats, it is important that the correct size valve guide pilot be used for reseating stones. A true and complete surface must be obtained.

(4) Measure the concentricity of valve seat and valve guide using a valve seat runout dial indicator.

SERVICE PROCEDURES (Continued)



9509-123

**Intake and Exhaust Valves**

Face Angle	
Intake and Exhaust .....	45 - 44 <sup>1</sup> / <sub>2</sub> °
Head Diameter	
Intake .....	34.67 - 34.93 mm (1.364 - 1.375 in.)
Exhaust .....	30.37 - 30.63 mm (1.195 - 1.205 in.)
Length (Overall)	
Intake .....	112.76 - 113.32 mm (4.439 - 4.461 in.)
Exhaust .....	109.59 - 110.09 mm (4.314 - 4.334 in.)
Stem Diameter	
Intake .....	5.934 - 5.952 mm (0.233 - 0.234 in.)
Exhaust .....	5.906 - 5.924 mm (0.233 - 0.233 in.)
Valve Margin	
Intake .....	1.285 - 1.615 mm (0.050 - 0.063 in.)
Exhaust .....	0.985 - 1.315 mm (0.038 - 0.051 in.)

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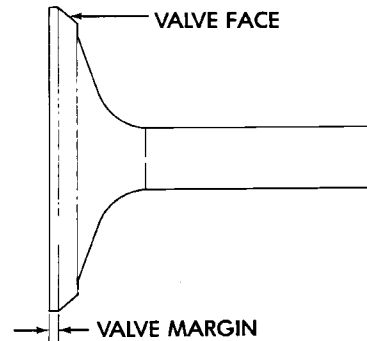
**Valve Specifications**

Total runout should not exceed. 0.051 mm (0.002 inch.) (total indicator reading).

(5) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to top edge of the valve face, lower valve seat with a 15 degrees stone. If the blue is transferred to the bottom edge of valve face raise valve seat with a 65 degrees stone.

- Intake valve seat diameter is 34.37 34.63 mm (1.158 1.363 inch.)
- Exhaust valve seat diameter is 29.37 29.63 mm (1.156 1.166 inch.)

(6) Valve seats which are worn or burned can be reworked, provided that correct angle and seat width are maintained. Otherwise the cylinder head must be replaced.

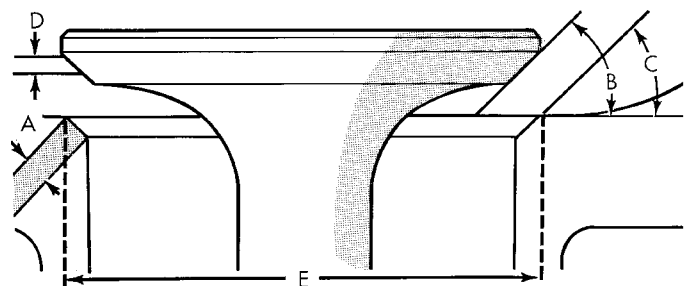


9409-78

**Fig. 20 Refacing Intake and Exhaust Valves**

(7) When seat is properly positioned the width of intake and exhaust seats should be 0.9 to 1.3 mm (0.35 to 0.051 inch.) (Fig. 21).

(8) Check valve tip height dimensions A after grinding the valve seats or faces (Fig. 22). Grind valve tip to 47.99 mm (1.889 in.) for exhaust valve and 48.04 mm (1.891 in.) for intake valve when installed in the head. The valve tip chamfer may need to be reground to prevent seal damage when the valve is installed.



- A - SEAT WIDTH (INTAKE AND EXHAUST 0.9 TO 1.3 mm (.035 TO .051 IN.))
- B - FACE ANGLE (INTAKE & EXHAUST: 44<sup>1</sup>/<sub>2</sub>°-45°)
- C - SEAT ANGLE (INTAKE & EXHAUST: 45°-45<sup>1</sup>/<sub>2</sub>°)
- D - SEAT CONTACT AREA
- E - SEAT DIAMETER

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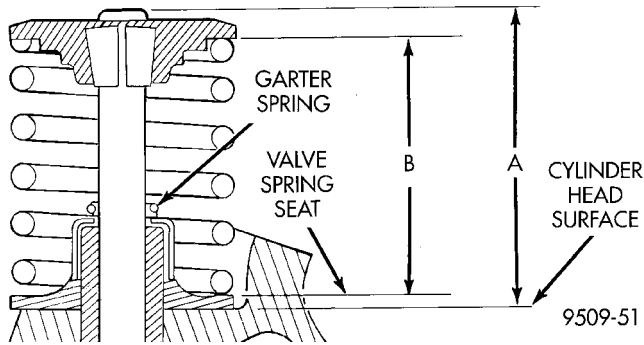
**Fig. 21 Refacing Valve Seats**

**VALVE INSTALLATION**

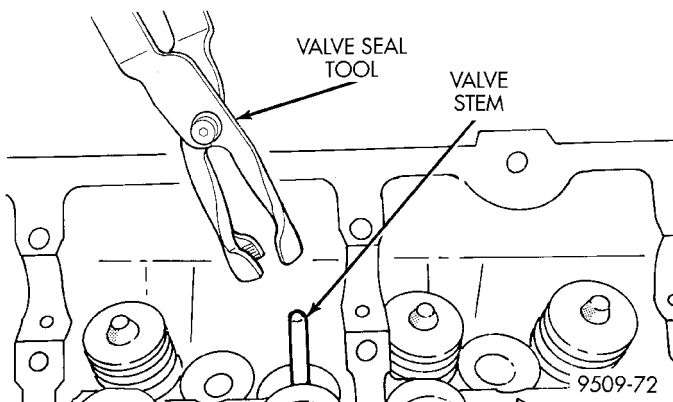
(1) Coat valve stems with clean engine oil and insert in cylinder head.

(2) Install new valve stem seals on all valves using a valve stem seal tool (Fig. 23). The valve stem seals should be pushed firmly and squarely over valve guide.

## SERVICE PROCEDURES (Continued)



**Fig. 22 Checking Spring Installed Height and Valve Tip Height Dimensions**



**Fig. 23 Valve Stem Oil Seal Special Tool C4745**

**CAUTION:** When oversize valves are used, the corresponding oversize valve seal must also be used. Excessive guide wear may result if oversize seals are not used with oversize valves.

(3) Install valve springs and retainers. Compress valve springs only enough to install locks, taking care not to misalign the direction of compression. Nicked valve stems may result from misalignment of the valve spring compressor.

**CAUTION:** When depressing the valve spring retainers with valve spring compressor the locks can become dislocated. Check to make sure both locks are in their correct location after removing tool.

(4) Check the valve spring installed height B after refacing the valve and seat (Fig. 22). Make sure measurements are taken from top of spring seat to the bottom surface of spring retainer. If height is greater than 38.75 mm (1.525 in.), install a .762 mm (0.030 inch.) spacer under the valve spring seat to bring spring height back within specification.

(5) Install rocker arm shafts as previously described in this section.

(6) Checking dry lash. Dry lash is the amount of clearance that exists between the base circle of an

installed cam and the rocker arm roller when the adjuster is drained of oil and completely collapsed. Specified dry lash is 1.17 mm (0.046 in.) for intake and 1.28 mm (0.050 in.) for exhaust. After performing dry lash check, refill adjuster with oil and allow 10 minutes for adjuster/s to bleed down before rotating cam.

## REMOVAL AND INSTALLATION

## FRONT MOUNT

## REMOVAL

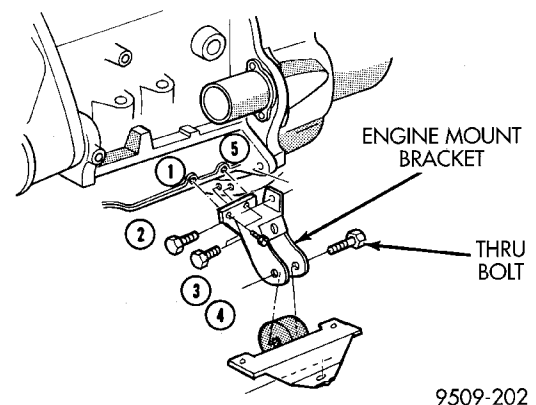
- (1) Support the engine and transmission assembly with a floor jack so it will not rotate.
- (2) Remove the front engine mount through bolt from the insulator and front crossmember mounting bracket (Fig. 24).
- (3) Remove six screws from air dam to allow access to the front mount screws.
- (4) Remove the front engine mount screws and remove the insulator assembly.
- (5) Remove the front mounting bracket, if necessary (Fig. 24).

## INSTALLATION

(1) Reverse removal procedure for installation and tighten fasteners in this order. For engine mount adjustment procedure, refer to Adjustments, Engine Mounts in this Section.

- (a) Tighten bolts 2,3 and 4 to 108 N·m (80 ft. lbs.).
  - (b) Tighten bolts 1 and 5 to 54 N·m (40 ft. lbs.).
- (2) Install six screws to air dam and tighten to 12 N·m (105 in. lbs.).

REFER TO TEXT  
FOR TORQUE VALUES



**Fig. 24 Engine Mounting-Front**

## REMOVAL AND INSTALLATION (Continued)

## LEFT SIDE MOUNT

## REMOVAL

- (1) Raise vehicle on hoist and remove left front wheel.
- (2) Support the transmission with a transmission jack.
- (3) Remove the insulator through bolt from the mount.
- (4) Remove the transmission mount fasteners and remove mount (Fig. 25).

## INSTALLATION

- (1) Reverse removal procedure for installation.
- (2) Tighten mount to transmission bolts to 55 N·m (40 ft. lbs.)
- (3) Tighten through bolt to 75 N·m (55 ft. lbs.) (Fig. 25).
- (4) Engine mount adjustment, Refer to Engine Mount Adjustment in this section.

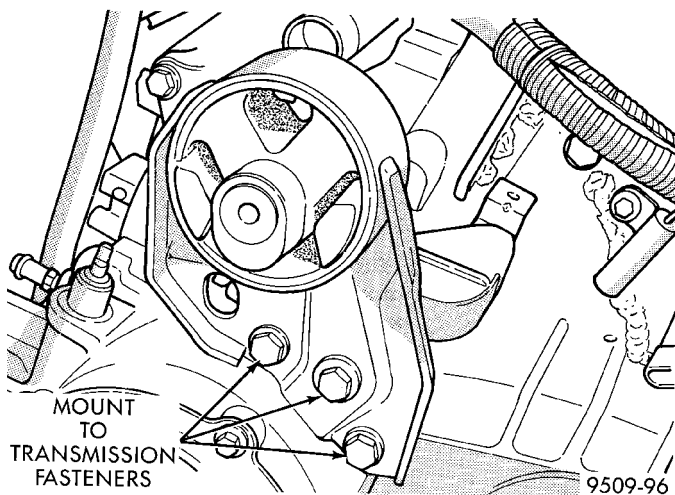


Fig. 25 Typical Engine Mounting—Left

## RIGHT SIDE MOUNT

## REMOVAL

**NOTE:** Right mount should only be serviced as an assembly to prevent noise, vibration and harshness concerns.

- (1) Remove the purge duty solenoid and wiring harness from engine mount bracket.
- (2) Remove the two right engine mount insulator vertical fasteners from frame rail and loosen the one horizontal fastener. **Do not remove the large nut located at the end of the core (Fig. 26).**
- (3) Remove the load on the engine mounts by carefully supporting the engine and transmission assembly with a floor jack.
- (4) Remove the vertical and horizontal fasteners from the engine side bracket. Remove the mount assembly.

## INSTALLATION

- (1) Reverse removal procedure for installation. Tighten assembly in the following order:
  - a. Engine mount to rail fasteners to 68 N·m (50 ft. lbs.).
  - b. The vertical engine fastener to 102 N·m (75 ft. lbs.).
  - c. The horizontal fastener to 150 N·m (111 ft. lbs.).

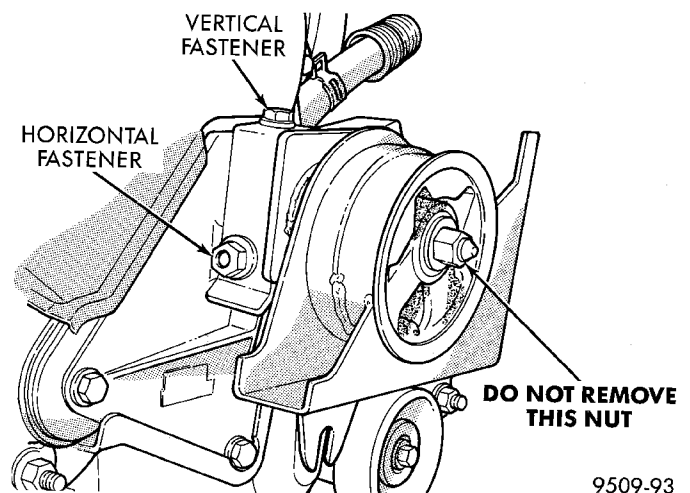


Fig. 26 Engine Mounting—Right Side

## REMOVAL AND INSTALLATION (Continued)

## REAR MOUNT

## REMOVAL

- (1) Raise vehicle on hoist and remove the left front wheel.
- (2) Support the transmission with a transmission jack so it will not rotate.
- (3) Remove the insulator thru bolt from the mount and rear suspension crossmember.
- (4) Remove the four transmission mount fasteners and remove the mount.

## INSTALLATION

- (1) Reverse the removal procedure for installation. Refer to (Fig. 27).

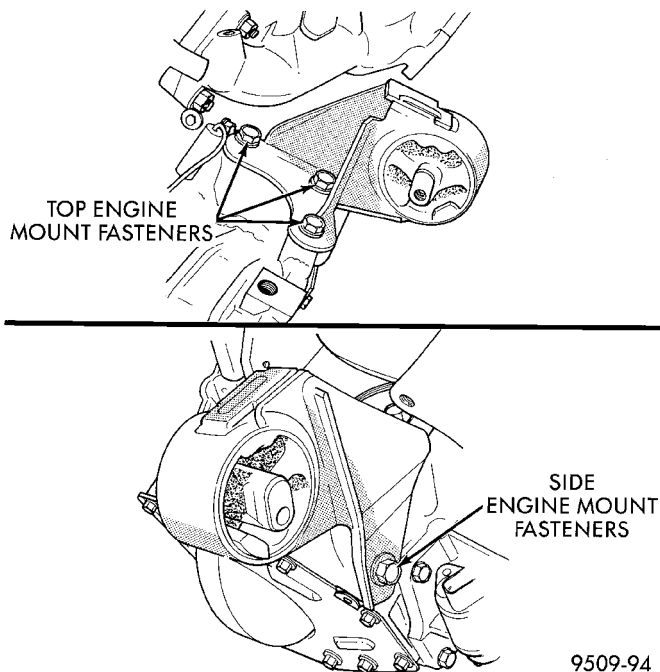


Fig. 27 Engine Mounting—Rear

## ENGINE ASSEMBLY

## REMOVAL

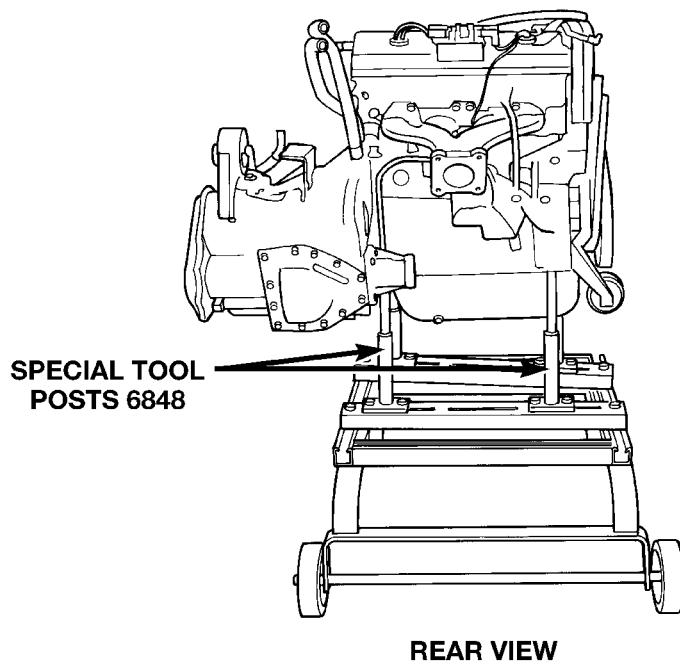
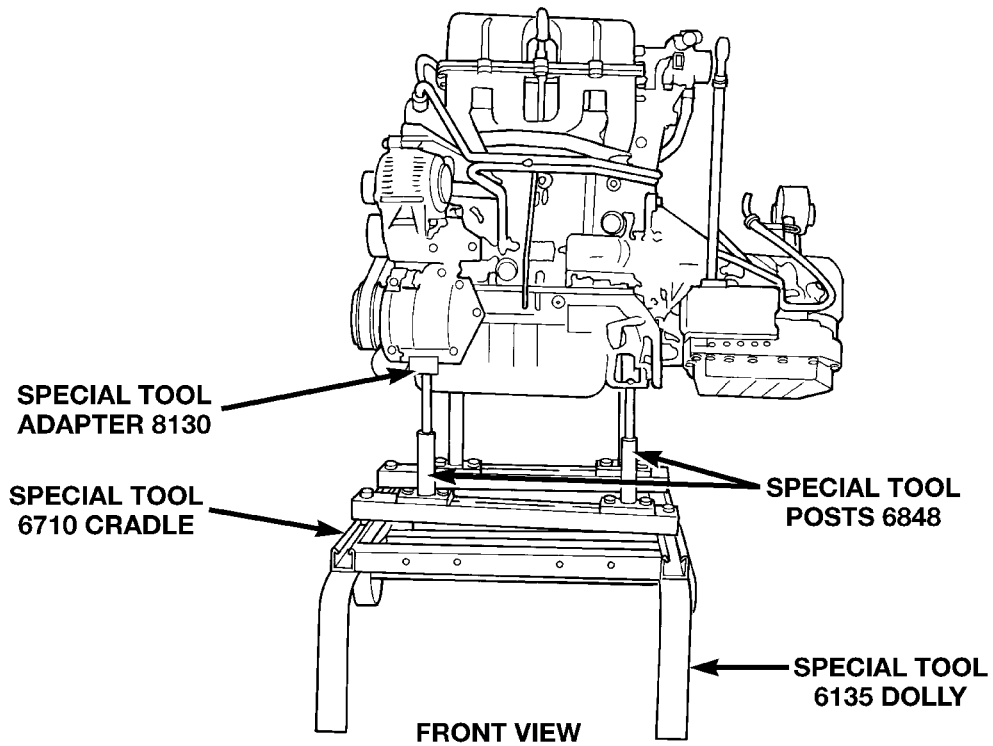
- (1) Perform fuel pressure release procedure. Refer to Group 14, Fuel System for procedure. Remove fuel line to fuel rail.
- (2) Disconnect battery.
- (3) Remove Air cleaner and hoses.
- (4) Drain cooling system. Refer to Group 7, Cooling System for procedure.
- (5) Remove upper radiator hose and remove radiator fans. Refer to Group 7, Cooling System for procedure.
- (6) Remove lower radiator hose.
- (7) Disconnect automatic transmission cooler lines and plug, if equipped.
- (8) Disconnect transmission shift linkage.
- (9) Disconnect throttle body linkage.

- (10) Disconnect engine wiring harness.
- (11) Disconnect heater hoses.
- (12) Discharge Air Conditioning System. Refer to Group 24, Air Conditioning for procedure.
- (13) Hoist vehicle and remove right inner splash shield. Remove wheels and tires.
- (14) Loosen power steering belt for pump removal. Refer to Group 7, Cooling System for procedure.
- (15) Remove axle shafts. Refer to Group 2, Suspension and Driveshafts for procedure.
- (16) Disconnect exhaust pipe from manifold.
- (17) Remove front and rear engine mount brackets from the body.
- (18) Remove bending braces and front engine mount bracket. Remove transmission inspection cover.
- (19) Mark flexplate to torque converter and remove torque converter bolts.
- (20) Install front engine mount bracket.
- (21) Lower vehicle.
- (22) Remove power steering pump. Set pump aside.
- (23) Remove A/C lines at compressor and cap.
- (24) Remove ground straps to body.
- (25) Raise vehicle enough to allow engine dolly Special Tool 6135, cradle Special Tool 6710 with Posts Special Tool 6848 and Adaptor Special Tool 8130 to be installed under vehicle (Fig. 28).
- (26) Loosen cradle posts to allow movement for proper positioning. Locate two rear posts (right side of engine) into the holes on the engine bedplate. Locate the two front posts (left side of engine) on the front engine bracket and A/C compressor bracket (Fig. 28). Lower vehicle and position cradle mounts until the engine is resting on mounts. Tighten mounts to cradle frame. This will keep mounts from moving when removing or installing engine and transmission.
- (27) Lower vehicle so the weight of **ONLY THE ENGINE AND TRANSMISSION** are on the cradle.
- (28) Remove engine and transmission mount bolts.
- (29) Raise vehicle slowly. It may be necessary to move the engine/transmission assembly on the cradle to allow for removal around the body.

## INSTALLATION

- (1) Position engine and transmission assembly under vehicle and slowly lower the vehicle over the engine and transmission.
- (2) Align engine and transmission mounts to attaching points. Install mounting bolts at the right engine and left transmission mounts. Refer to procedures outlined in this section.
- (3) Slowly raise vehicle enough to remove the engine dolly and cradle Special Tools 6135 and 6710.
- (4) Install axle shafts. Refer to Group 2, Suspension and Driveshafts for procedure.

REMOVAL AND INSTALLATION (Continued)



*Fig. 28 Positioning Engine Cradle Support Post Mounts—Typical*

## REMOVAL AND INSTALLATION (Continued)

(5) Install transmission and engine braces and splash shields.

(6) Connect exhaust system to manifold. Refer to Group 11, Exhaust System and Intake Manifold for procedure and torque specifications.

(7) Install power steering pump. Refer to Cooling System Group 7, Accessory Drive Section for belt tension adjustment.

(8) Install A/C compressor hoses. Refer to Group 24, Heater and Air Conditioning for procedure.

(9) Install accessory drive belts. Refer to Group 7, Cooling System Accessory Drive Section for belt tension adjustment.

(10) Install front and rear engine mounts. Refer to this section for procedure.

(11) Install inner splash shield. Install wheels and tires.

(12) Connect automatic transmission cooler lines, and shift linkage. Refer to Group 21, Transmission for procedures.

(13) Connect fuel line and heater hoses.

(14) Install ground straps. Connect engine and throttle body connections and harnesses. Refer to Group 8, Electrical for procedure.

(15) Connect throttle body linkage. Refer to Group 14, Fuel System for procedure.

(16) Install radiator fans. Install radiator hoses. Fill cooling system. Refer to Group 7, Cooling System for filling procedure.

(17) Connect battery.

(18) Install air cleaner and hoses.

(19) Install oil filter. Fill engine crankcase with proper oil to correct level.

(20) Start engine and run until operating temperature is reached.

(21) Adjust transmission linkage, if necessary.

## CYLINDER HEAD COVER

## REMOVAL

(1) Remove ignition coil pack and plug wires (Fig. 29). Remove ground strap.

(2) Remove the cylinder head cover fasteners.

(3) Remove cylinder head cover from cylinder head.

## INSTALLATION

**NOTE:** Replace spark plug well seals when installing a new cylinder head cover gasket.

(1) Install new cylinder head cover gaskets and spark plug seals (Fig. 30).

**CAUTION:** Do not allow oil or solvents to contact the timing belt as they can deteriorate the rubber and cause tooth skipping.

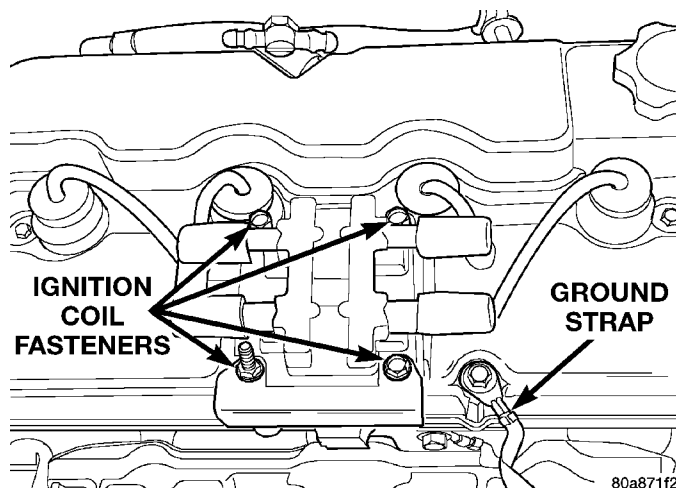


Fig. 29 Ignition Coil Pack and Ground Strap

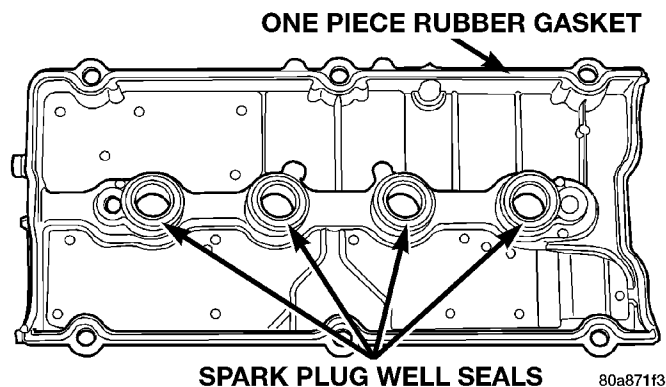


Fig. 30 Cylinder Head Cover Gasket and Spark Plug Seals

(2) Apply Mopar Silicone Rubber Adhesive Sealant at the camshaft cap corners and at the top edge of the 1/2 round seal.

(3) Install cylinder head cover assembly to head and tighten fasteners in sequence shown in (Fig. 31). Using the 3 step torque method:

(a) Tighten all fasteners to 4.5 N·m (40 in. lbs.)

(b) Tighten all fasteners to 9.0 N·m (80 in. lbs.)

(c) Tighten all fasteners to 12 N·m (105 in. lbs.)

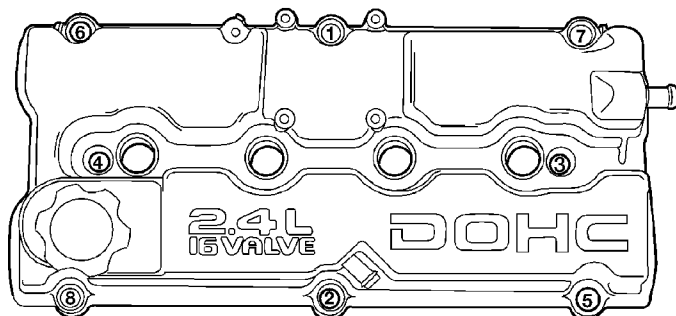


Fig. 31 Cylinder Head Cover Tightening Sequence

## REMOVAL AND INSTALLATION (Continued)

- (4) Install ignition coil pack and plug wires. Tighten fasteners to 12 N·m (105 in. lbs.).
- (5) Install ground strap.

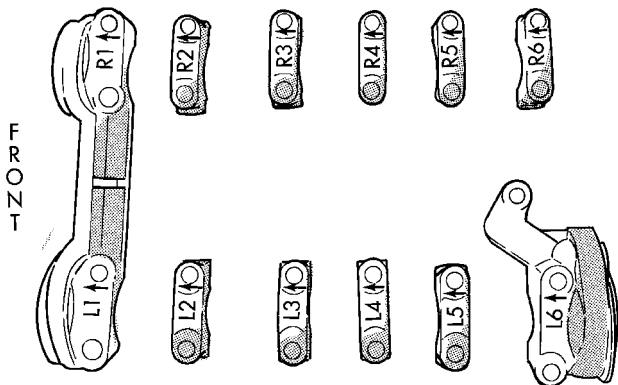
## CAMSHAFT

## REMOVAL

- (1) Remove cylinder head cover using procedure outlined in this section.
- (2) Remove timing belt, sprockets and covers. Refer to Timing Belt Service outlined in this section.
- (3) Bearing caps are identified for location. Remove the outside bearing caps first (Fig. 32).
- (4) Loosen the camshaft bearing cap attaching fasteners in sequence shown (Fig. 33) one camshaft at a time.

**CAUTION:** Camshafts are not interchangeable. The intake cam number 6 thrust bearing face spacing is wider.

- (5) Identify the camshafts before removing from the head. The camshafts are not interchangeable.

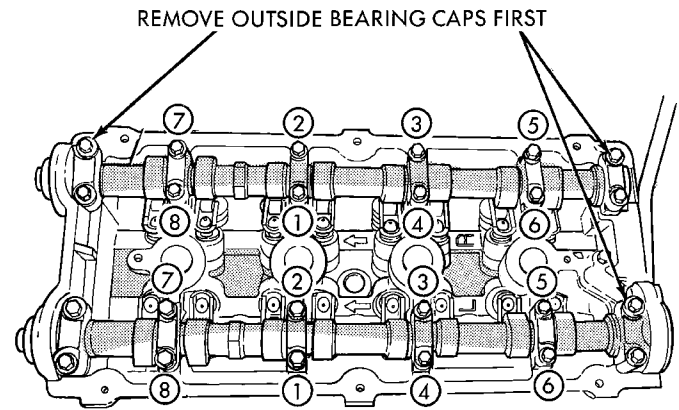


9509-112

**Fig. 32 Camshaft Bearing Cap Identification**

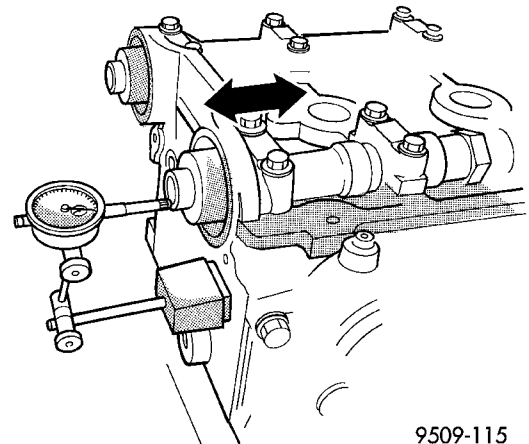
## CAMSHAFT END PLAY

- (1) Oil camshaft journals and install camshaft **WITHOUT** cam follower assemblies. Install rear cam caps and tighten screws to specified torque.
- (2) Using a suitable tool, move camshaft as far rearward as it will go.
- (3) Zero dial indicator (Fig. 34).
- (4) Move camshaft as far forward as it will go.
- (5) End play travel: 0.05–0.15 mm (0.002–0.010 in.).
- (6) If end play is excessive check cylinder head and camshaft for wear; replace as necessary.



9509-113

**Fig. 33 Camshaft Bearing Cap— Removal**



9509-115

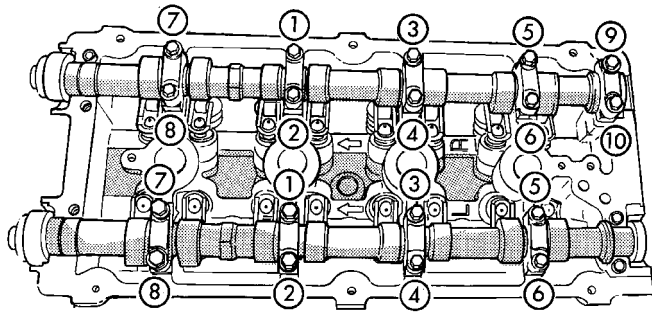
**Fig. 34 Camshaft End Play**

## INSTALLATION

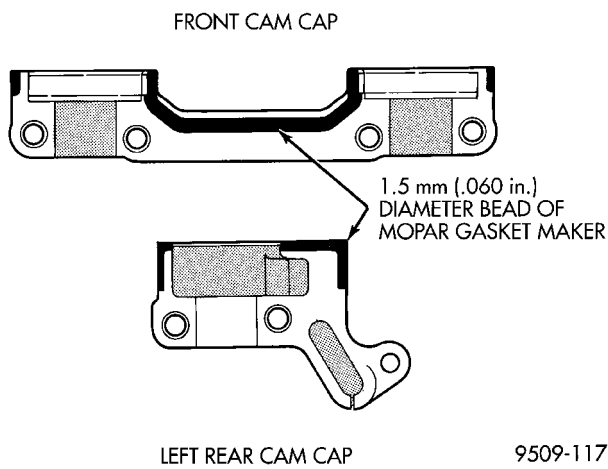
**CAUTION:** Ensure that **NONE** of the pistons are at top dead center when installing the camshafts.

- (1) Remove camshaft retaining caps and lubricate bearing journals. Install cam followers and camshafts with clean oil. Install right and left camshaft bearing caps #2 thru #5 and right #6. Tighten M6 fasteners to 12 N·m (105 in. lbs.) in sequence shown in (Fig. 35).
- (2) Apply Mopar Gasket Maker to No. 1 and No. 6 bearing caps (Fig. 36). Install bearing caps and tighten M8 fasteners to 28 N·m (250 in. lbs.).
- (3) Bearing end caps must be installed before seals can be installed.
- (4) Install timing belt, sprockets and covers. Refer to timing belt service outlined in this section.
- (5) Install cylinder head cover using procedure outlined in this section.

## REMOVAL AND INSTALLATION (Continued)



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**Fig. 35 Camshaft Bearing Cap Tightening Sequence**

LEFT REAR CAM CAP

9509-117

**Fig. 36 Camshaft Bearing Cap Sealing****CAMSHAFT FOLLOWER****REMOVAL**

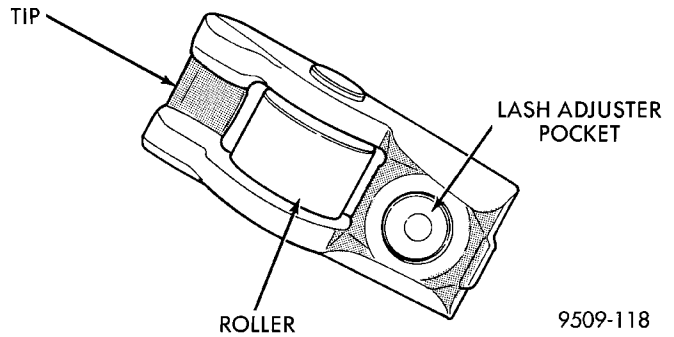
- (1) Remove cylinder head cover using procedure outlined in this section.
- (2) Remove timing belt, sprockets and covers using procedure outlined in this section.
- (3) Remove camshaft. Refer to procedure previously outline this section.
- (4) Remove cam follower assemblies from cylinder head. Keep the cam followers in the order they have been removed from the head for reassembly.

**INSPECTION**

Inspect the cam follower assembly for wear or damage (Fig. 37). Replace as necessary.

**INSTALLATION**

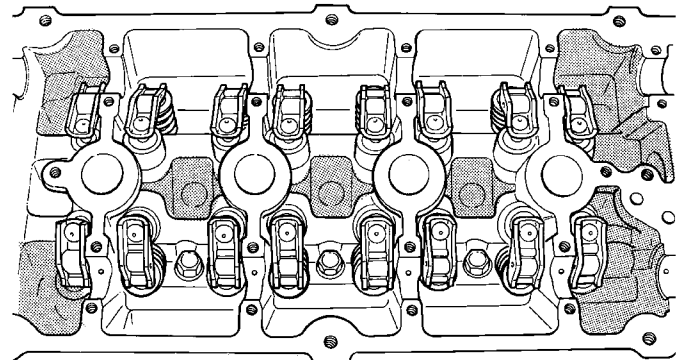
- (1) Lubricate with clean oil and install cam follower assemblies in their original position on the hydraulic adjuster and valve stem (Fig. 38).
- (2) Install the camshafts. Refer to procedure previously outlined in this section.
- (3) Install timing belt, sprockets and covers using procedure outlined in this section.



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**Fig. 37 Cam Follower Assembly**

- (4) Install cylinder head cover using procedure outlined in this section.



9509-119

**Fig. 38 Cam Follower Assemblies—Installation**  
**BALANCE SHAFTS CARRIER ASSEMBLY****BALANCE SHAFTS****REMOVAL**

Refer to Timing Belt Cover, and Timing Belt removal procedure in this section. To repair balance shafts carrier assembly.

- (1) Remove chain cover, guide and tensioner (Fig. 39). Also see Carrier Assembly Removal for service procedures requiring only temporary relocation of assembly.

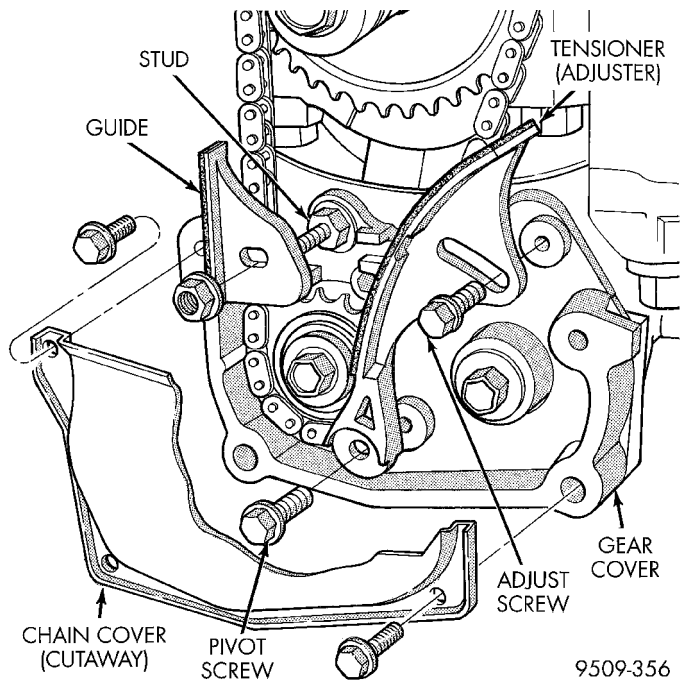
- (2) Remove gear cover retaining stud (double ended to also retain chain guide). Remove cover and balance shaft gears (Fig. 39).

- (3) Remove balance shaft gear and chain sprocket retaining screws and crankshaft chain sprocket. Remove chain and sprocket assembly (Fig. 40). Using two wide pry bars, work the sprocket back and forth until it is off the shaft.

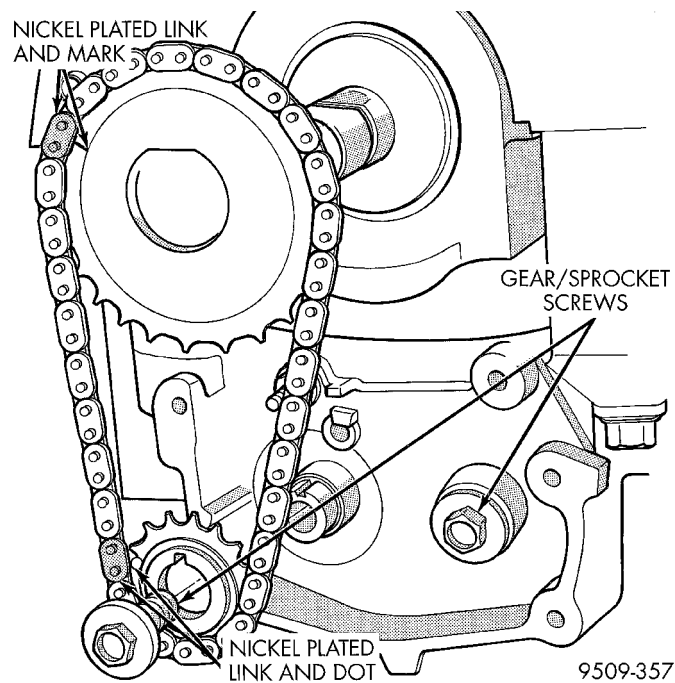
- (4) Remove carrier gear cover and balance shafts (Fig. 41).

- (5) Remove four carrier to crankcase attaching bolts to separate carrier from engine bedplate.

REMOVAL AND INSTALLATION (Continued)



**Fig. 39 Chain Cover, Guide and Tensioner**



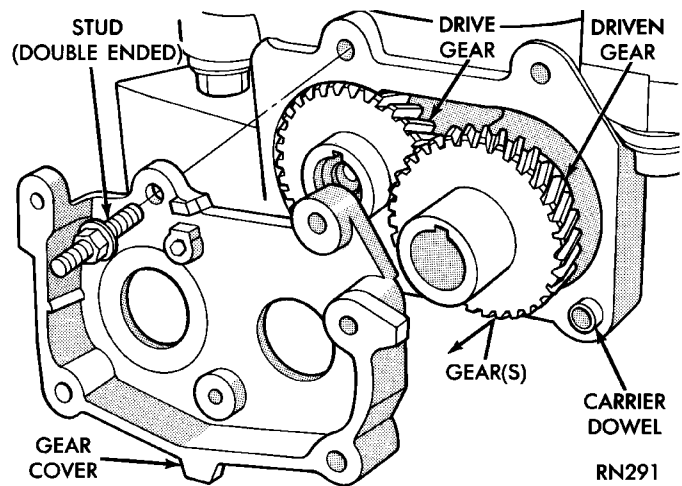
**Fig. 40 Drive Chain and Sprockets**

**BALANCE SHAFT CARRIER**

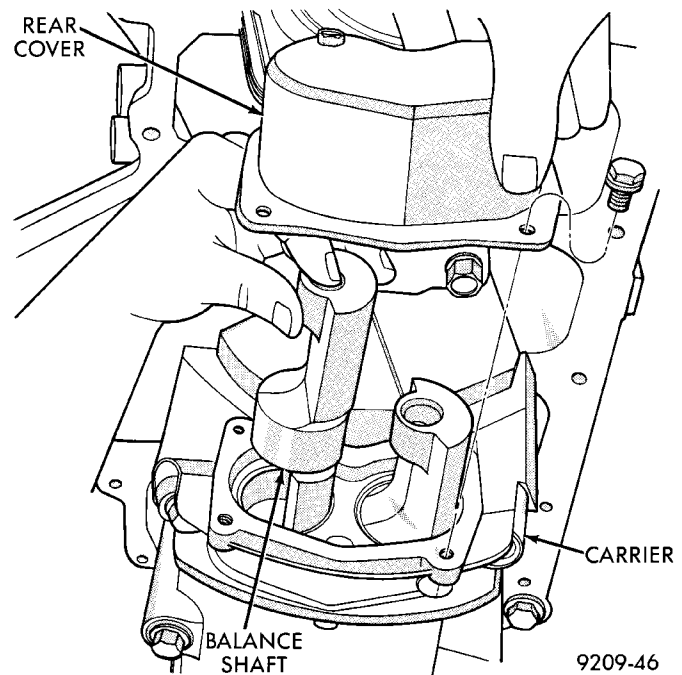
**REMOVAL**

The following components will remain intact during carrier removal. Gear cover, gears, balance shafts and the rear cover (Fig. 42).

(1) Remove chain cover and driven balance shaft chain sprocket screw.



**Fig. 41 Gear Cover and Gears**



**Fig. 42 Balance Shaft(s)—Removal/Installation**

(2) Loosen tensioner pivot and adjusting screws, move driven balance shaft inboard through driven chain sprocket. Sprocket will hang in lower chain loop.

(3) Remove carrier to crankcase attaching bolts to remove carrier.

*Balance Shaft Installation*

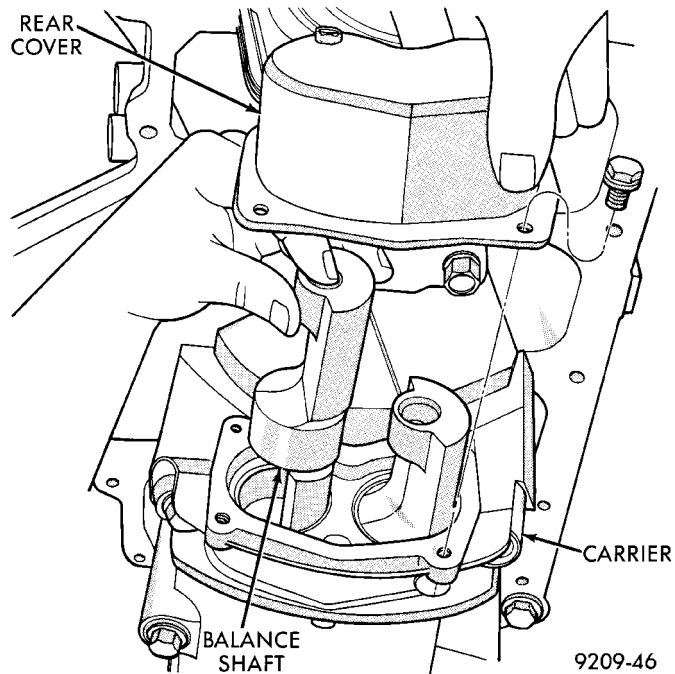
Balance shaft and carrier assembly installation is the reverse of the removal procedure. **During installation crankshaft to balance shaft timing must be established. Refer to Timing procedure outlined in this section.**

## REMOVAL AND INSTALLATION (Continued)

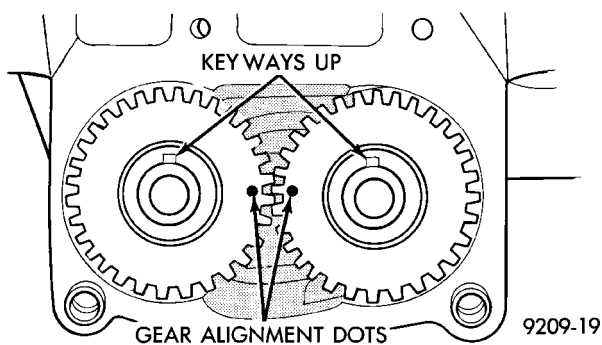
## TIMING

(1) With balance shafts installed in carrier (Fig. 43) position carrier on crankcase and install four attaching bolts and tighten to 54 N·m (40 ft. lbs.).

(2) Turn balance shafts until both shaft key ways are up Parallel to vertical centerline of engine. Install short hub drive gear on sprocket driven shaft and long hub gear on gear driven shaft. After installation gear and balance shaft keyways must be up with gear timing marks meshed as shown in (Fig. 44).



**Fig. 43 Balance Shaft(s)—Removal/Installation**

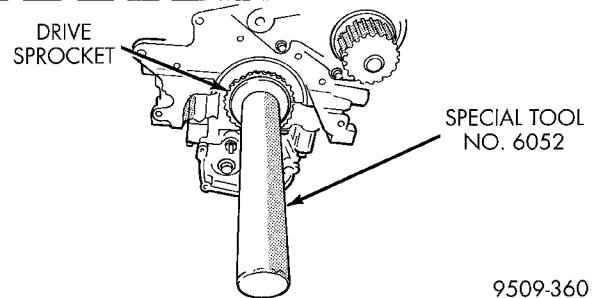
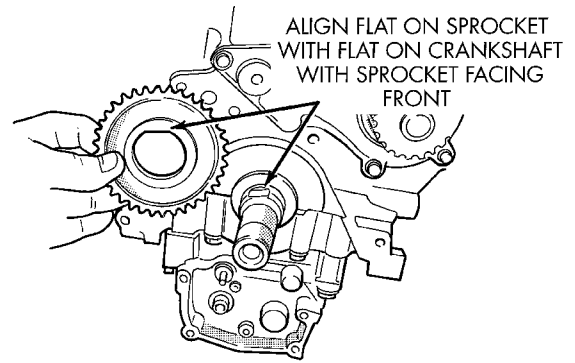


**Fig. 44 Gear Timing**

(3) Install gear cover and tighten double ended stud/washer fastener to 12 N·m (105 in. lbs.).

(4) Install crankshaft sprocket using Special Tool 6052 (Fig. 45).

(5) Turn crankshaft until number one cylinder is at Top Dead Center (TDC). The timing marks on the chain sprocket should line up with the parting line



**Fig. 45 Crankshaft Sprocket—Installation**

on the left side of number one main bearing cap. (Fig. 46).

(6) Place chain over crankshaft sprocket so that the nickel plated link of the chain is over the number 1 cylinder timing mark on the crankshaft sprocket (Fig. 46).

(7) Place balance shaft sprocket into the timing chain (Fig. 46) so that the timing mark on the sprocket (yellow dot) mates with the (lower) nickel plated link on the chain

(8) With balance shaft keyways pointing up (12 o'clock) slide the balance shaft sprocket onto the nose of the balance shaft. The balance shaft may have to be pushed in slightly to allow for clearance.

**NOTE: THE TIMING MARK ON THE SPROCKET, THE (LOWER) NICKEL PLATED LINK, AND THE ARROW ON THE SIDE OF THE GEAR COVER SHOULD LINE UP WHEN THE BALANCE SHAFTS ARE TIMED CORRECTLY.**

(9) If the sprockets are timed correctly install the balance shaft bolts and tighten to 28 N·m (250 in. lbs.). A wood block placed between crankcase and crankshaft counterbalance will prevent crankshaft and gear rotation.

## CHAIN TENSIONING

(1) Install chain tensioner loosely assembled.

(2) Position guide on double ended stud making sure tab on the guide fits into slot on the gear cover. Install and tighten nut/washer assembly to 12 N·m (105 in. lbs.).

## REMOVAL AND INSTALLATION (Continued)

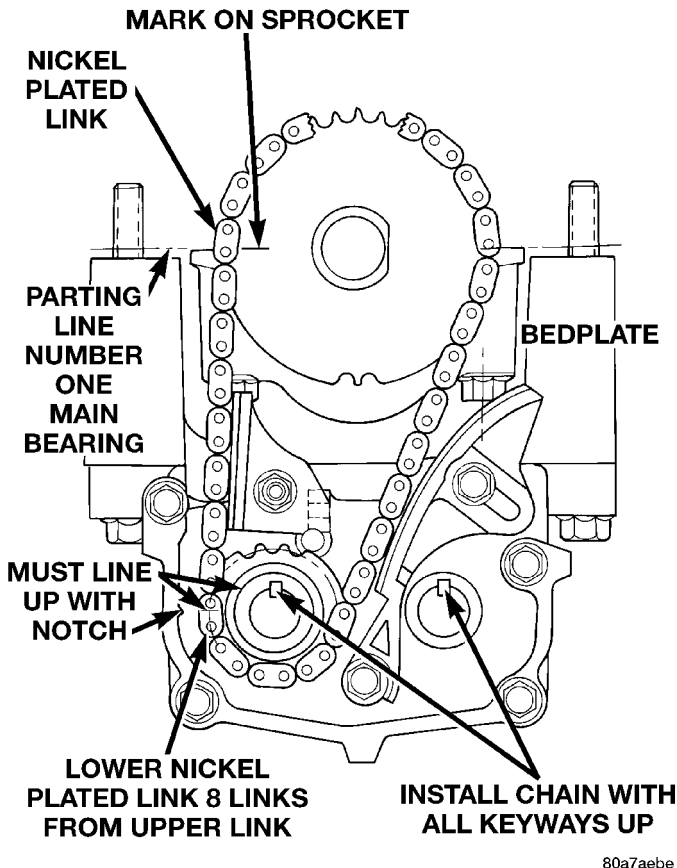


Fig. 46 Balance Shaft Timing

(3) Place a shim 1 mm (0.039 in.) thick x 70 mm (2.75 in.) long or between tensioner and chain. Push tensioner and shim up against the chain. **Apply firm pressure (5.5 to 6.6 lbs.) directly behind the adjustment slot to take up all slack.** Chain must have shoe radius contact as shown in (Fig. 47).

(4) With the load applied, tighten top tensioner bolt first, then bottom pivot bolt. Tighten bolts to 12 N·m (105 in. lbs.). Remove shim.

(5) Install carrier covers and tighten screws to 12 N·m (105 in. lbs.).

## HYDRAULIC LASH ADJUSTER

## REMOVAL

(1) Remove cylinder head cover. Refer to procedure outlined in this section.

(2) Remove cam follower assembly. Refer to camshaft removal procedure outlined in this section to gain access to cam followers and lash adjusters.

(3) Mark hydraulic lash adjusters for reassembly in their original position. Lash adjusters are serviced as a assembly.

## INSTALLATION

(1) Install hydraulic lash adjuster assembly making sure adjusters are at least partially full of oil.

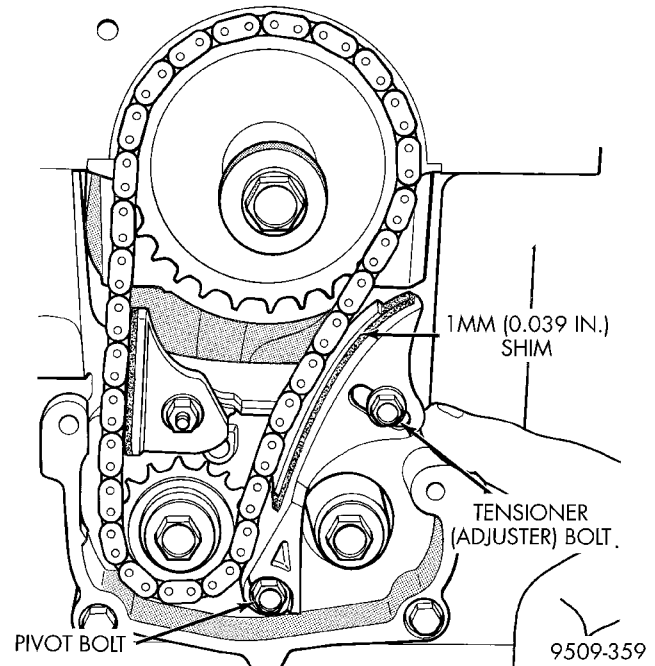


Fig. 47 Chain Tension Adjustment

This is indicated by little or no plunger travel when the lash adjuster is depressed.

(2) Install cam follower assembly as previously outlined in this section.

(3) Install camshaft as previously outlined in this section.

(4) Install cylinder head cover as previously outlined in this section.

## VALVE SPRINGS AND VALVE SEALS IN VEHICLE

## REMOVAL

(1) Remove camshafts as previously outlined in this section.

(2) Rotate crankshaft until piston is at TDC on compression.

(3) With air hose attached to adapter tool installed in spark plug hole, apply 90-120 psi air pressure.

(4) Using Special Tool MD-998772-A with adapter 6779 (Fig. 48) compress valve springs and remove valve locks.

(5) Remove valve spring.

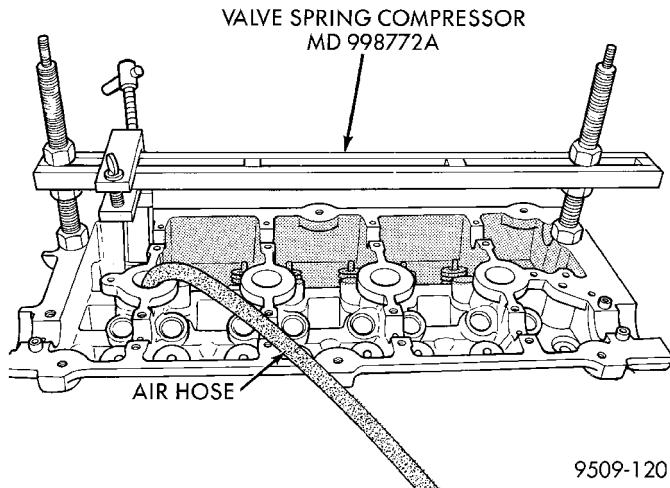
(6) Remove valve stem seal by using valve stem seal tool.

## INSTALLATION

(1) Install valve seal/valve spring seat assembly (Fig. 49). Push the assembly down to seat it onto the valve guide.

(2) Install valve spring and retainer, use Special Tool MD-998772-A with adapter 6779 to compress valve springs only enough to install locks (Fig. 48).

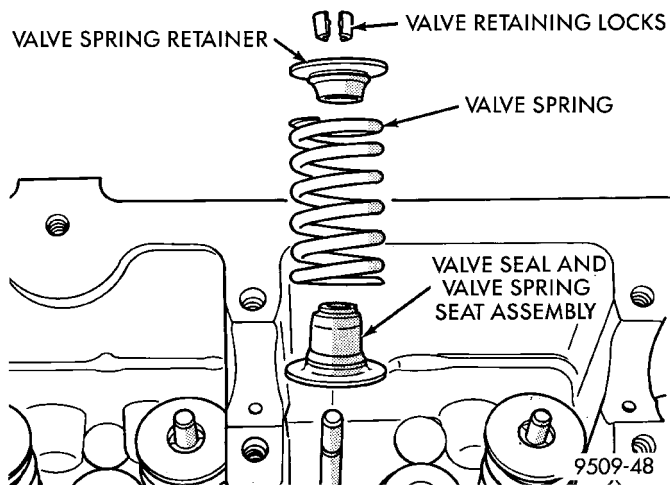
## REMOVAL AND INSTALLATION (Continued)



**Fig. 48 Valve Spring—Removal/Installation**

Correct alignment of tool is necessary to avoid nicking valve stems.

- (3) Remove air hose and install spark plugs.
- (4) Install camshafts as previously outlined in this section.
- (5) Install cylinder head cover as previously outlined in this section.



**Fig. 49 Valve Stem Seal/Valve Spring Seat  
CYLINDER HEAD**

## REMOVAL

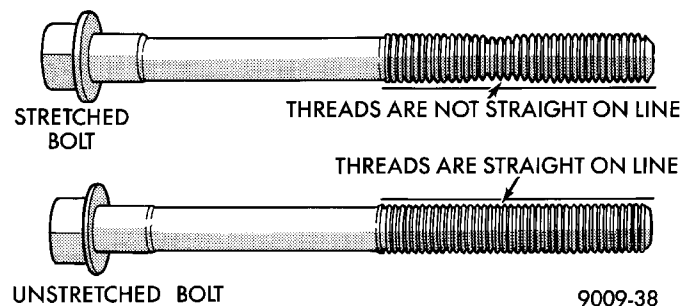
- (1) Perform fuel system pressure release procedure **before attempting any repairs**. Refer to Group 14, Fuel System for procedure.
- (2) Disconnect negative battery cable. Drain cooling system. Refer to Group 7, Cooling System for procedure.
- (3) Remove air cleaner and disconnect all vacuum lines, electrical wiring and fuel lines from throttle body.
- (4) Remove throttle linkage. Refer to Group 14, Fuel System for procedures

- (5) Remove accessory drive belts. Refer to Group 7, Cooling System for procedure.
- (6) Remove power brake vacuum hose from intake manifold.
- (7) Raise vehicle and remove exhaust pipe from manifold.
- (8) Remove power steering pump assembly and set aside.
- (9) Disconnect coil pack wiring connector and remove coil pack and plug wires from engine.
- (10) Remove cam sensor and fuel injectors wiring connectors.
- (11) Remove timing belt and camshaft sprocket. Refer to procedure outlined in this section.
- (12) Remove timing belt idler pulley and rear timing belt cover.
- (13) Remove cylinder head cover using procedure outlined in this section.
- (14) Remove camshafts and cam followers. Refer to procedures outlined in this section for procedures.
- (15) Remove cylinder head bolts and remove cylinder head from engine block.
- (16) Inspect and clean cylinder head. Refer to Cleaning and Inspection outlined in this section for procedures.

## INSTALLATION

**NOTE:** The Cylinder head bolts should be examined **BEFORE** reuse. If the threads are necked down, the bolts should be replaced (Fig. 50).

Necking can be checked by holding a scale or straight edge against the threads. If all the threads do not contact the scale the bolt should be replaced.



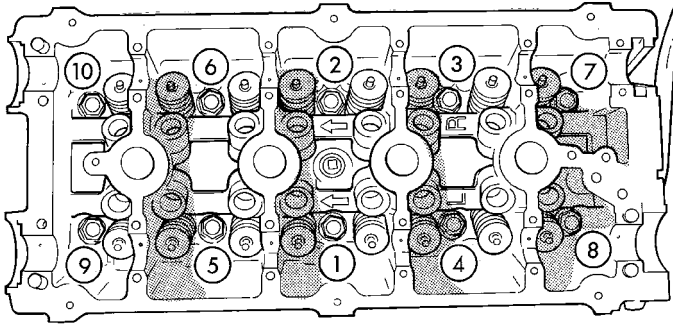
**Fig. 50 Checking Bolts for Stretching (Necking)**

- (1) Before installing the bolts, the threads should be coated with engine oil.
- (2) Tighten the cylinder head bolts in the sequence shown in (Fig. 51). Using the 4 step torque turn method, tighten according to the following values:
  - First All to 34 N·m (25 ft. lbs.)
  - Second All to 68 N·m (50 ft. lbs.)
  - Third All to 68 N·m (50 ft. lbs.)

## REMOVAL AND INSTALLATION (Continued)

**CAUTION:** Do not use a torque wrench for the following step.

- Fourth Turn an additional 1/4 Turn,



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**Fig. 51 Cylinder Head Tightening Sequence**

- (3) Install camshafts and cam followers. Refer to procedures outlined in this section for procedures.
- (4) Install cylinder head cover using procedure outlined in this section.
- (5) Install rear timing belt cover and timing belt idler pulley.
- (6) Install timing belt and camshaft sprocket. Refer to procedure outlined in this section.
- (7) Install cam sensor and fuel injectors wiring connectors.
- (8) Install coil pack and plug wires onto the engine. Connect coil pack wiring connector.
- (9) Install power steering pump assembly.
- (10) Raise vehicle and install the exhaust pipe to the manifold.
- (11) Install power brake vacuum hose to the intake manifold.
- (12) Install accessory drive belts. Refer to Group 7, Cooling System for procedure.
- (13) Install throttle linkage. Refer to Group 14, Fuel System for procedures.
- (14) Install air cleaner and connect all vacuum lines, electrical wiring and fuel lines to the throttle body.
- (15) Fill cooling system. Refer to Group 7, Cooling System for procedure. Connect negative battery cable.

## VALVES AND VALVE SPRINGS

### REMOVAL

- (1) With cylinder head removed, compress valve springs using a universal valve spring compressor.
- (2) Remove valve retaining locks, valve spring retainers, valve stem seals and valve springs.

(3) Before removing valves, **remove any burrs from valve stem lock grooves to prevent damage to the valve guides.** Identify valves to insure installation in original location.

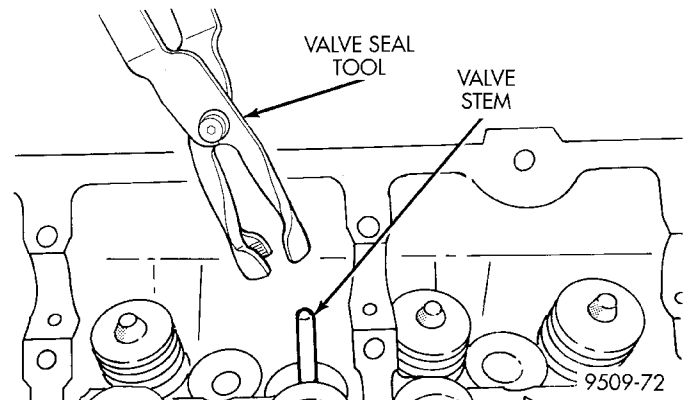
(4) Inspect and clean the valves. Refer to Cleaning and Inspection outlined in this section for procedure.

### INSTALLATION

(1) Coat valve stems with clean engine oil and insert in cylinder head.

(2) Install new valve stem seals on all valves using a valve stem seal tool (Fig. 52). The valve stem seals should be pushed firmly and squarely over valve guide.

**CAUTION:** When oversize valves are used, the corresponding oversize valve seal must also be used. Excessive guide wear may result if oversize seals are not used with oversize valves.



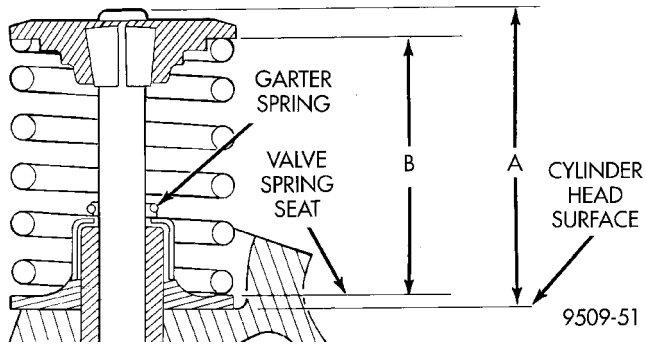
**Fig. 52 Valve Stem Oil Seal Tool**

(3) Install valve springs and retainers. Compress valve springs only enough to install locks, taking care not to misalign the direction of compression. Nicked valve stems may result from misalignment of the valve spring compressor.

**CAUTION:** When depressing the valve spring retainers with valve spring compressor the locks can become dislocated. Ensure both locks are in the correct location after removing tool.

(4) Check the valve spring installed height B after refacing the valve and seat (Fig. 53). Make sure measurements are taken from top of spring seat to the bottom surface of spring retainer. If height is greater than 38.75 mm (1.525 in.), install a .762 mm (0.030 in.) spacer under the valve spring seat to bring spring height back within specification.

## REMOVAL AND INSTALLATION (Continued)

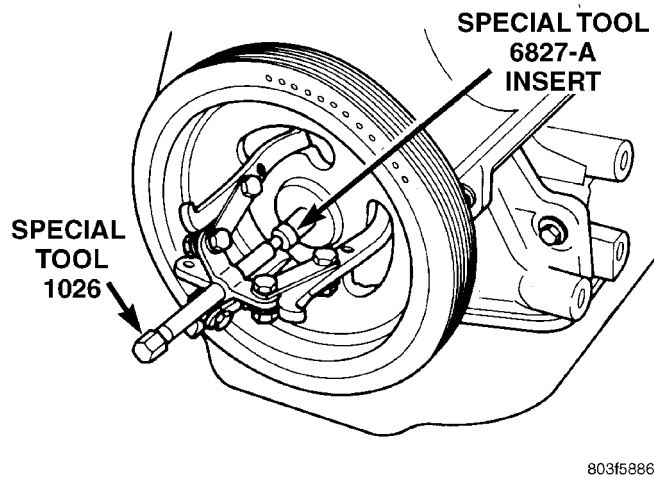


**Fig. 53** Checking Spring Installed Height and Valve Tip Height Dimensions

## VIBRATION DAMPER

## REMOVAL

Remove crankshaft vibration damper bolt. Remove damper by using Special Tool 1026 and Insert 6827-A (Fig. 54).



**Fig. 54** Crankshaft Vibration Damper—Removal

## INSTALLATION

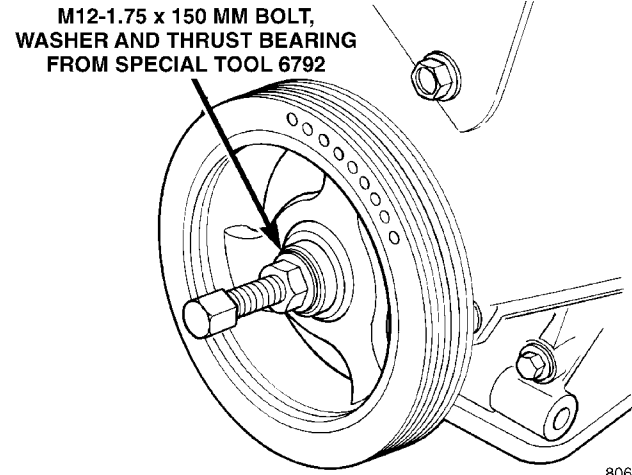
Install crankshaft vibration damper using M12 1.75 x 150 mm bolt, washer, thrust bearing and nut from Special Tool 6792. Install crankshaft vibration damper bolt and tighten to 142 N·m (105 ft. lbs.) (Fig. 55).

## TIMING BELT COVER

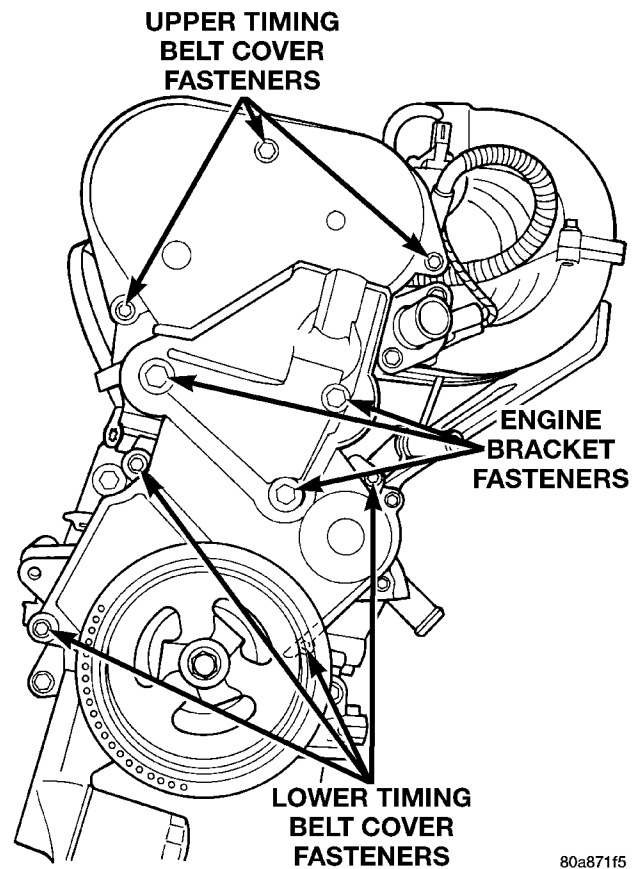
## FRONT COVER

## REMOVAL

- (1) Remove crankshaft damper. Refer to crankshaft damper removal for procedure.
- (2) Remove front timing belt cover fasteners (Fig. 56) and remove cover.
- (3) Remove engine mount bracket (Fig. 56).



**Fig. 55** Crankshaft Vibration Damper—Installation



**Fig. 56** Front Timing Belt Cover

## INSTALLATION

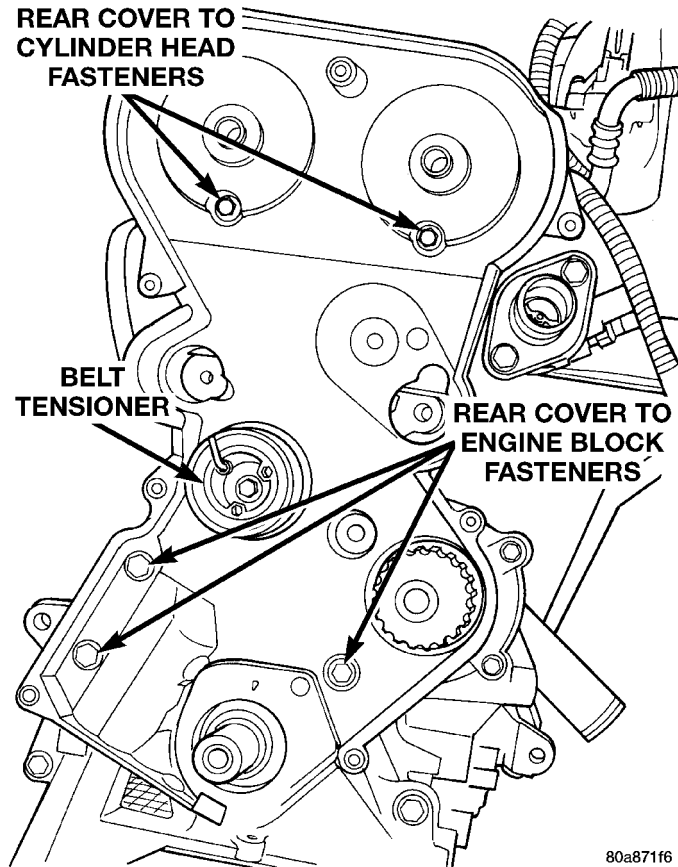
- (1) Install the engine mount bracket and front timing belt cover (Fig. 56).
- (2) Install crankshaft damper. Refer to crankshaft damper installation for procedure.

## REMOVAL AND INSTALLATION (Continued)

## REAR COVER

## REMOVAL

- (1) Remove Front Cover. Refer to Front Cover Removal procedure outlined in this section.
- (2) Remove Timing Belt. Refer to procedure outlined in this section.
- (3) Remove timing belt tensioner.
- (4) Remove idler and tensioner pulleys (Fig. 57).
- (5) Remove rear timing belt fasteners and remove cover from engine (Fig. 57).



**Fig. 57 Rear Timing Belt Cover Fasteners**

## INSTALLATION

- (1) Install rear timing belt cover and fasteners (Fig. 57).
- (2) Install idler and tensioner pulleys (Fig. 57).
- (3) Install Timing Belt. Refer to procedure outlined in this section.
- (4) Install front cover. Refer to Front Cover installation procedure outlined in this section.

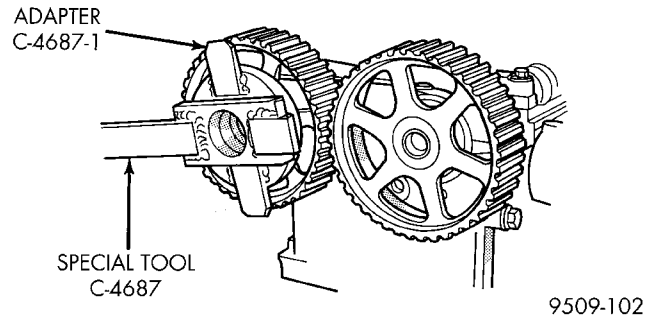
## FRONT CAMSHAFT OIL SEAL

## REMOVAL

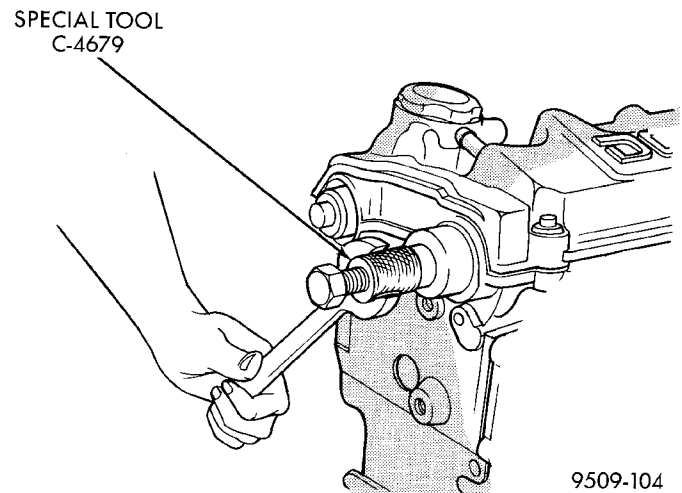
- (1) Remove front timing belt cover and timing belt. Refer to procedure outlined in this section.

- (2) Hold camshaft sprocket with Special Tool C-4687 and adapter C-4687-1 while removing center bolt (Fig. 58).

- (3) Remove camshaft seal using Special Tool C-4679-A (Fig. 59).



**Fig. 58 Camshaft Sprocket—Removal/Installation**



**Fig. 59 Camshaft Oil Seal—Removal With C-4679-A**

**CAUTION:** Do not nick shaft seal surface or seal bore

## INSTALLATION

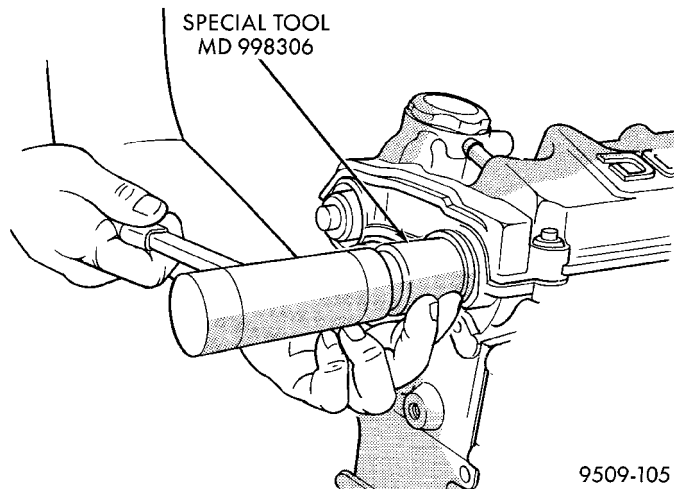
- (1) Shaft seal surface must be free of varnish, dirt or nicks. Polish with 400 grit paper if necessary.
- (2) Install camshaft seal into cylinder head using Special Tool MD-998306 until flush with head (Fig. 60).
- (3) Install camshaft sprocket and tighten center bolt to 101 N·m (75 ft. lbs.) (Fig. 58).

## TIMING BELT

## REMOVAL

- (1) Raise vehicle on hoist. Remove right front wheel.
- (2) Remove right inner splash shield.
- (3) Remove accessory drive belts. Refer to Group 7, Cooling System.

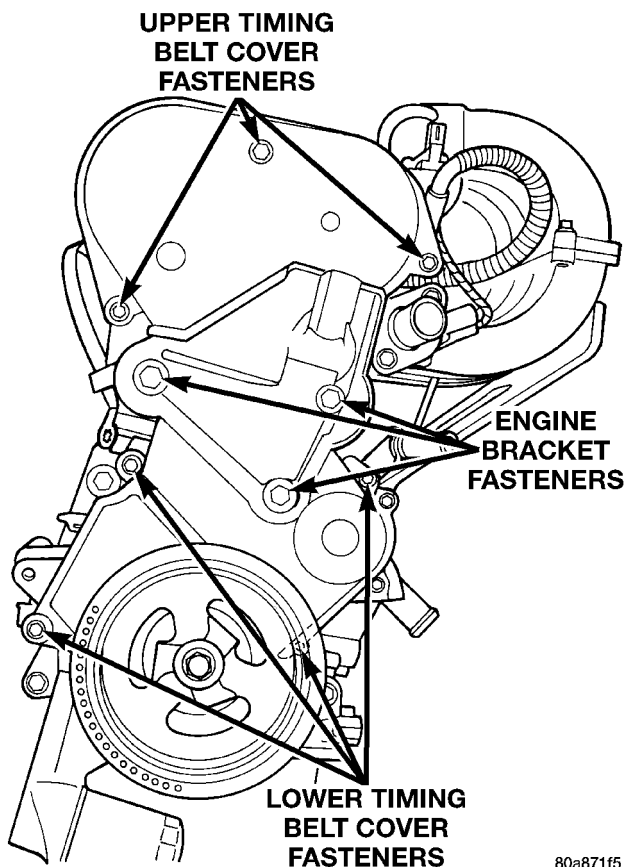
## REMOVAL AND INSTALLATION (Continued)

**Fig. 60 Camshaft Seal—Installation**

(4) Remove crankshaft damper bolt, and remove damper. Refer to Removal and Installation procedure in this section.

(5) Remove lower timing belt cover fasteners and remove cover (Fig. 61).

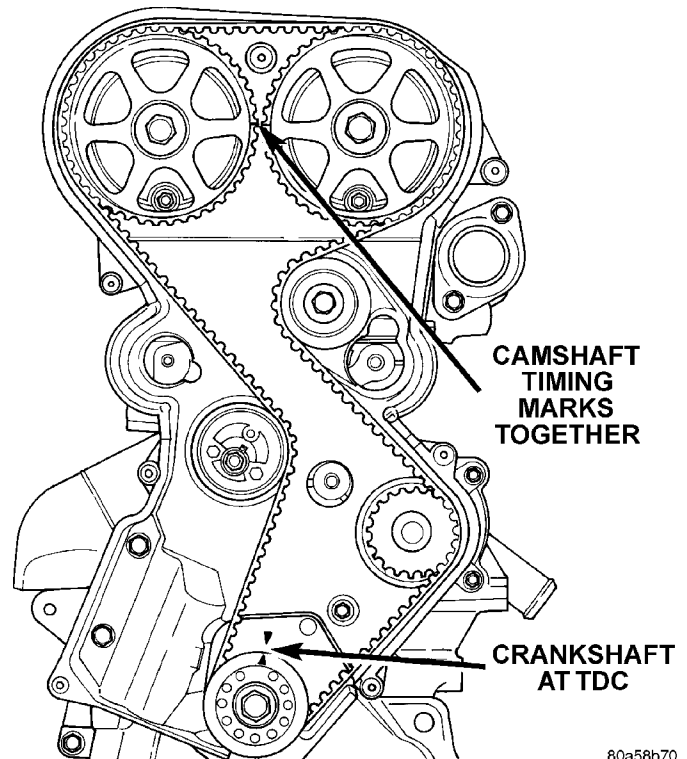
(6) Lower vehicle and remove upper timing belt cover fasteners and remove cover.

**Fig. 61 Timing Belt Covers**

(7) Remove right engine mount and support bracket. Refer to Removal and Installation procedure in this section.

**CAUTION:** When aligning crankshaft and camshaft timing marks always rotate engine from crankshaft. Camshaft should not be rotated after timing belt is removed. Damage to valve components may occur. Always align timing marks before removing timing belt.

(8) Align crankshaft and camshafts timing marks (Fig. 62) to TDC.

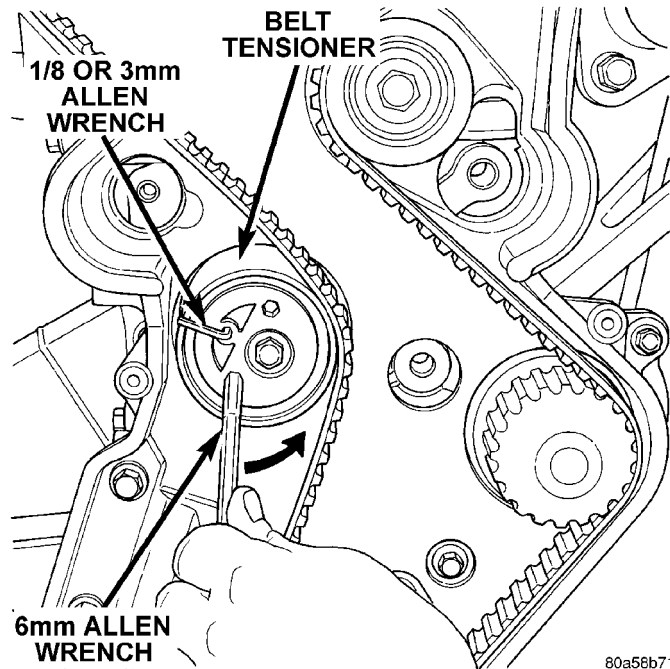
**Fig. 62 Crankshaft and Camshaft Timing**

(9) Install 6 mm Allen wrench into belt tensioner. Before rotating the tensioner insert the long end of a 1/8" or 3 mm Allen wrench into the pin hole on the front of the tensioner (Fig. 63). While rotating the tensioner counterclockwise push in lightly on the 1/8" or 3 mm Allen wrench, until it slides into the locking hole.

(10) Remove timing belt.

**CAUTION:** If timing belt was damaged due to incorrect tracking (alignment), the belt tensioner assembly must be replaced. Refer to Timing Belt Tensioner Assembly Removal and Installation procedure outlined in this section.

## REMOVAL AND INSTALLATION (Continued)



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**Fig. 63 Locking Timing Belt Tensioner****INSTALLATION**

- (1) Set crankshaft sprocket to TDC by aligning the sprocket with the arrow on the oil pump housing.
- (2) Set camshafts timing marks so that the exhaust camshaft sprocket is a 1/2 notch below the intake camshaft sprocket (Fig. 64).

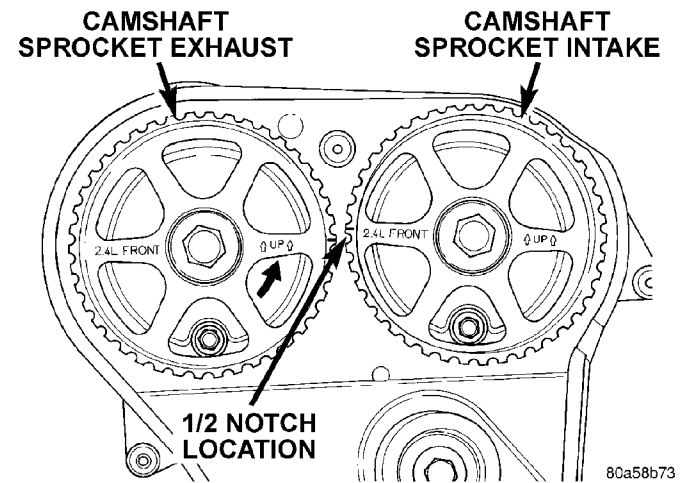
**CAUTION:** Ensure that the arrows on both camshaft sprockets are facing up.

- (3) Install timing belt. Starting at the crankshaft, go around the water pump sprocket, idler pulley, camshaft sprockets and then around the tensioner (Fig. 65).
- (4) Move the exhaust camshaft sprocket counter-clockwise (Fig. 65) to align marks and take up belt slack.

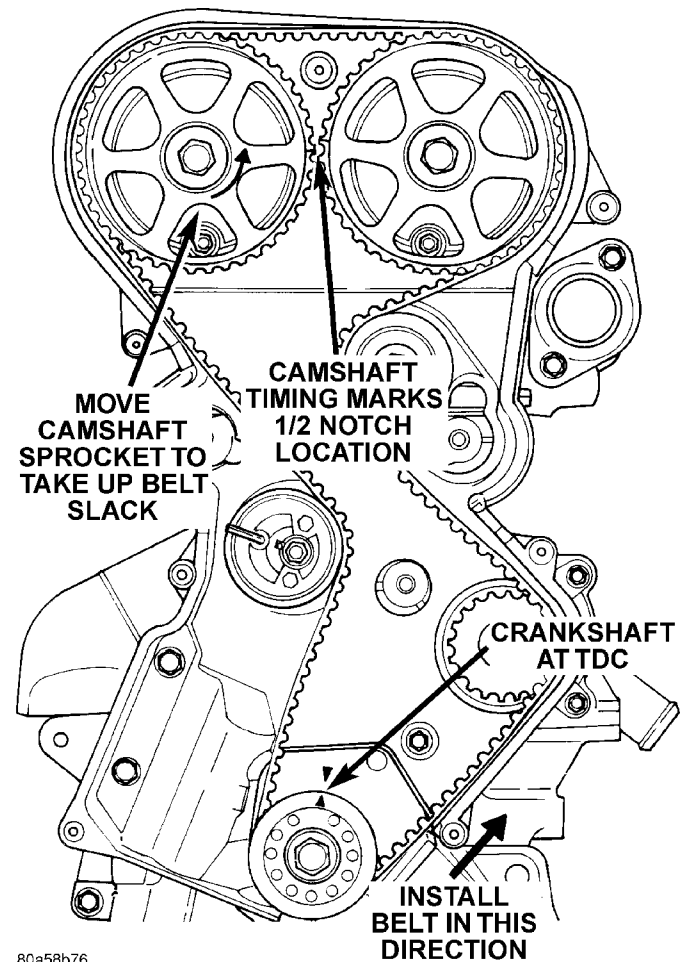
**NOTE:** A new tensioner is held in the wound position by a pull pin.

- (5) Remove the pull pin or Allen wrench from the belt tensioner.
- (6) Rotate crankshaft 2 revolutions and check the alignment of the timing marks (Fig. 62).
- (7) Install right engine mount and support bracket. Refer to Removal and Installation procedure in this section.
- (8) Install upper timing belt cover bolts 4.5 N·m (40 in. lbs.).
- (9) Install the lower timing belt cover bolts 4.5 N·m (40 in. lbs.).
- (10) Install crankshaft damper. Refer to Service procedure outlined in this section.

- (11) Install accessory drive belts. Refer to Group 7, Cooling System.
- (12) Install right inner splash shield.
- (13) Install right front wheel.



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**Fig. 64 Camshaft Sprocket Alignment**

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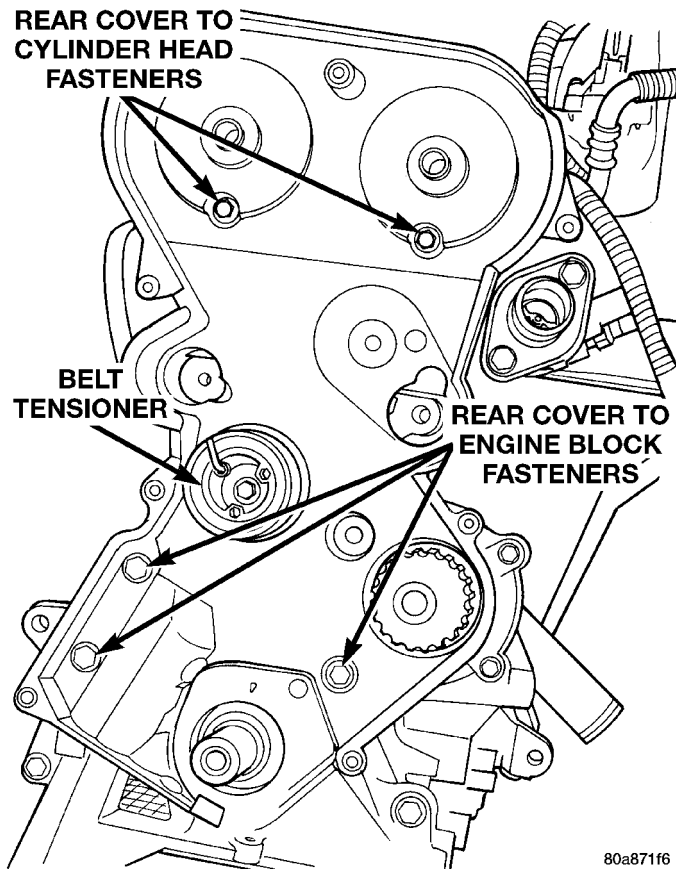
**Fig. 65 Timing Belt—Installation**

## REMOVAL AND INSTALLATION (Continued)

## TIMING BELT TENSIONER ASSEMBLY

*Removal*

- (1) Remove timing belt. Refer to Removal and Installation procedure in this section.
- (2) Remove timing belt idler pulley.
- (3) Hold camshaft sprocket with Special tool 6847 while removing bolt. Remove both cam sprockets.

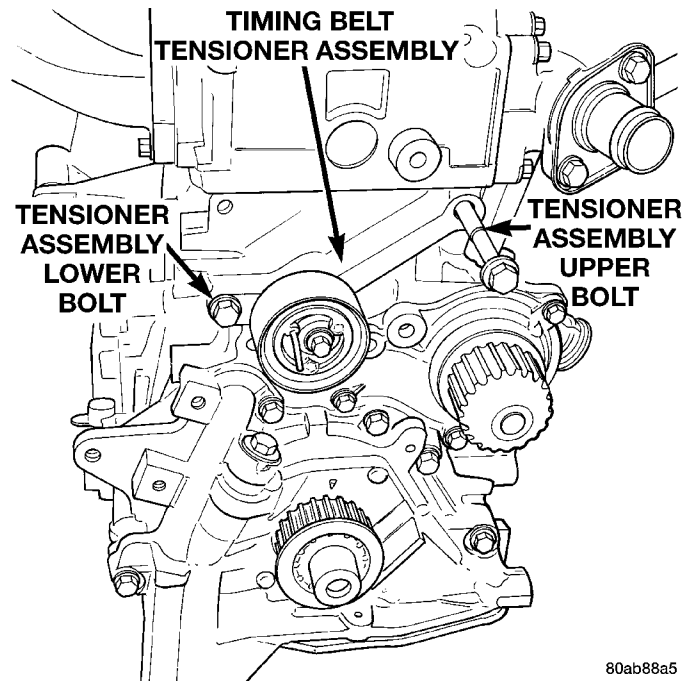


**Fig. 66 Rear Timing Belt Cover Fasteners**

- (4) Remove rear timing belt cover fasteners and remove cover from engine (Fig. 66).
- (5) Remove lower bolt attaching timing belt tensioner assembly to engine and remove tensioner as an assembly (Fig. 67).

*Installation*

- (1) Align timing belt tensioner assembly to engine and install lower mounting bolt **but do not tighten** (Fig. 67). To properly align tensioner assembly—install one of the engine bracket mounting bolts (M10) 5 to 7 turns into the tensioner's upper mounting location (Fig. 67).
- (2) Torque the tensioner's lower mounting bolt to 61 N·m (45 ft. lbs.). Remove the upper bolt used for tensioner alignment.
- (3) Install the rear timing belt cover and fasteners.
- (4) Install the timing belt idler pulley and torque mounting bolt to 61 N·m (45 ft. lbs.).



**Fig. 67 Timing Belt Tensioner Assembly—Removal/Installation**

- (5) Install the camshaft sprockets and torque bolts to 101 N·m (75 ft. lbs.).
- (6) Install the timing belt. Refer to procedure outlined in this section.

**CAUTION:** Do not run the engine without the engine mount attached to engine.

- (7) After completing engine assembly, but before the upper cover is installed, start the engine and idle for a few seconds. Shut engine off and measure the timing belt tracking. Tracking is measured as shown in (Fig. 68). Measure from the outer edge of the intake cam sprocket to the timing belt. The belt should be 2–6 mm (0.079–0.236 in.) in from the outer edge of the sprocket.

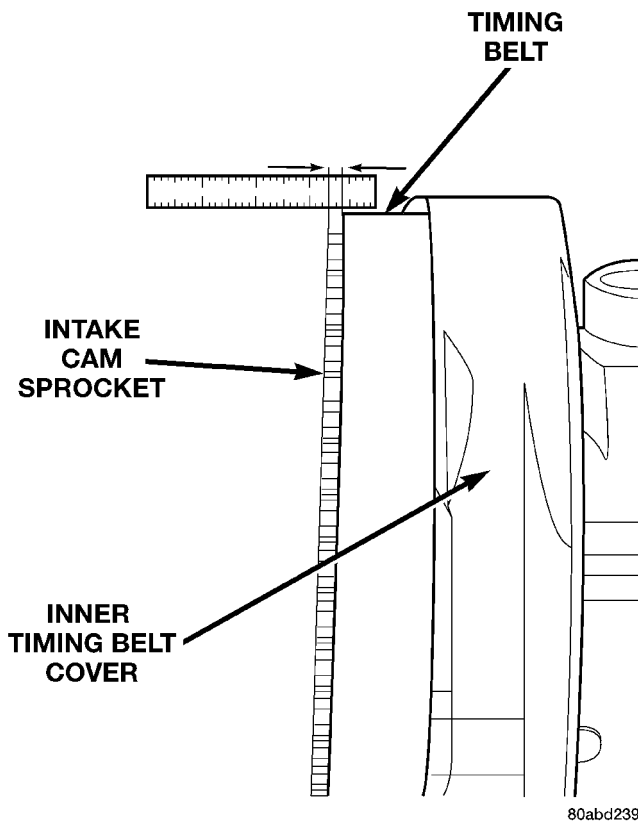
## FRONT CRANKSHAFT OIL SEAL

*REMOVAL*

- (1) Using large side of Special Tool 1026 and Insert 6827-A, remove crankshaft damper (Fig. 69).
- (2) Remove outer timing belt cover and timing belt. Refer to Timing Belt System outlined in this section.
- (3) Remove crankshaft sprocket using Special Tool 6793 and insert C-4685-C2 (Fig. 70).

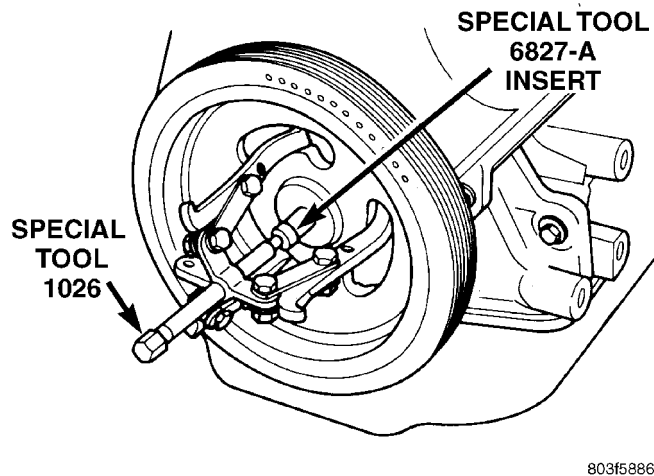
**CAUTION:** Do not nick shaft seal surface or seal bore.

## REMOVAL AND INSTALLATION (Continued)



**Fig. 68 Timing Belt Tracking**

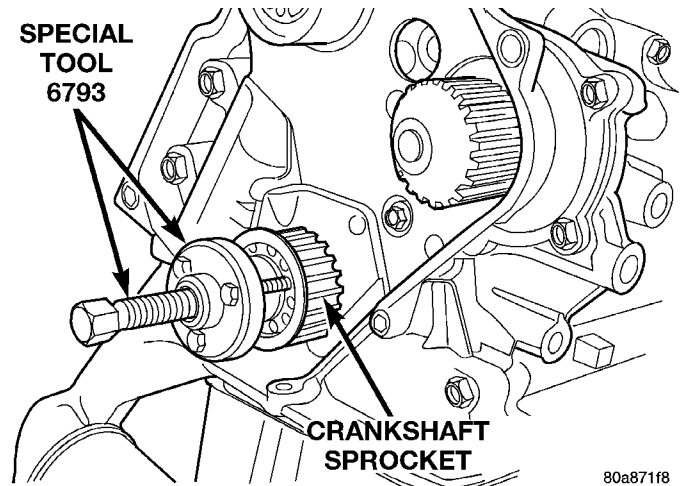
(4) Using Tool 6771 to remove front crankshaft oil seal (Fig. 71). Be careful not to damage the seal surface of cover.



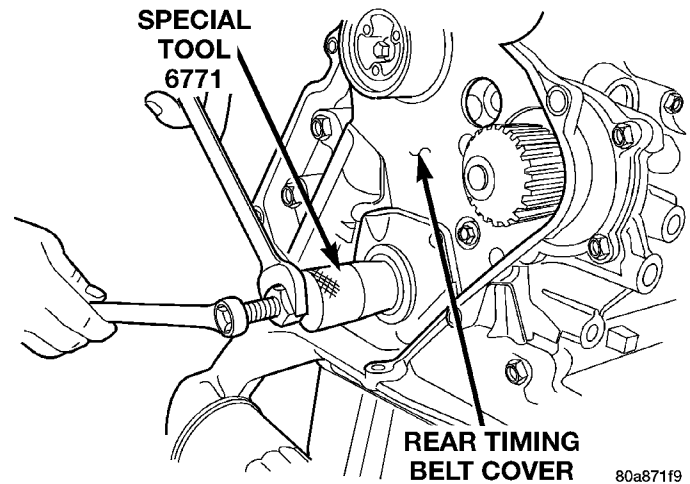
**Fig. 69 Crankshaft Damper—Removal**

#### INSTALLATION

- (1) Install new seal by using Tool 6780 (Fig. 72).
- (2) Place seal into opening with seal spring towards the inside of engine. Install seal until flush with cover.



**Fig. 70 Crankshaft Sprocket—Removal**



**Fig. 71 Front Crankshaft Oil Seal—Removal**

(3) Install crankshaft sprocket (Fig. 73). Using Special Tool 6792.

(4) Install timing belt and timing belt covers. Refer to Timing System Section for timing belt covers and belt.

(5) Install crankshaft damper (Fig. 74). Use thrust bearing/washer and 12M 1.75 x 150 mm bolt from Special Tool 6792. Install crankshaft damper bolt and tighten to 142 N·m (105 ft. lbs.)

#### OIL PAN

##### REMOVAL

- (1) Drain engine oil and remove oil pan.
- (2) Clean oil pan and all gasket surfaces.

##### INSTALLATION

- (1) Apply Mopar Silicone Rubber Adhesive Sealant or equivalent at the oil pump to engine block parting line (Fig. 75).
- (2) Install the oil pan gasket to block.

## REMOVAL AND INSTALLATION (Continued)

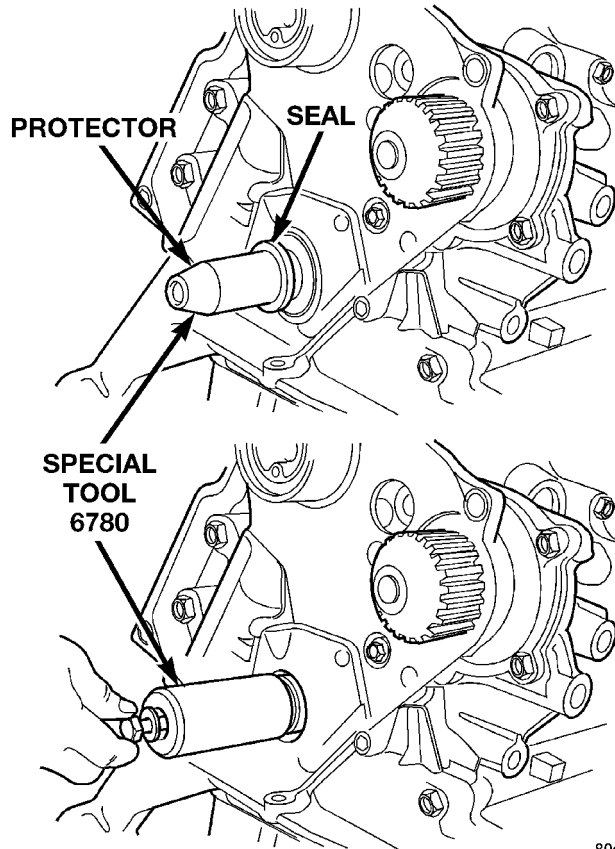


Fig. 72 Front Crankshaft Oil Seal—Installation

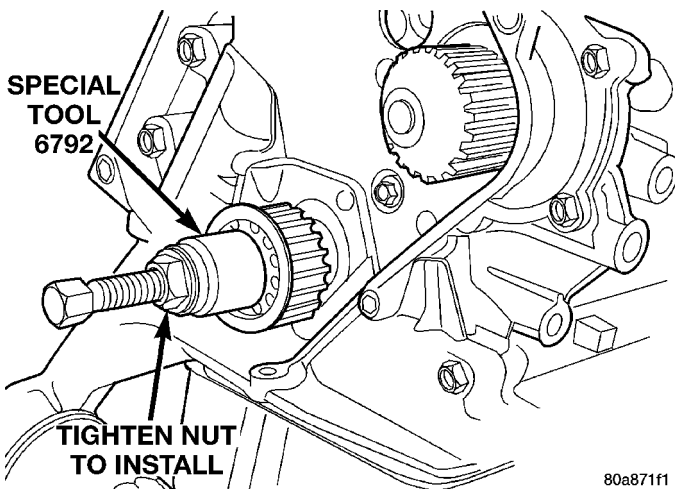
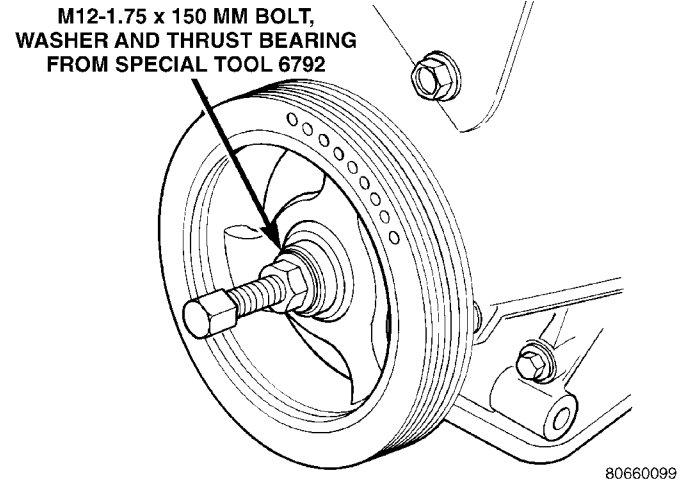


Fig. 73 Crankshaft Sprocket—Installation

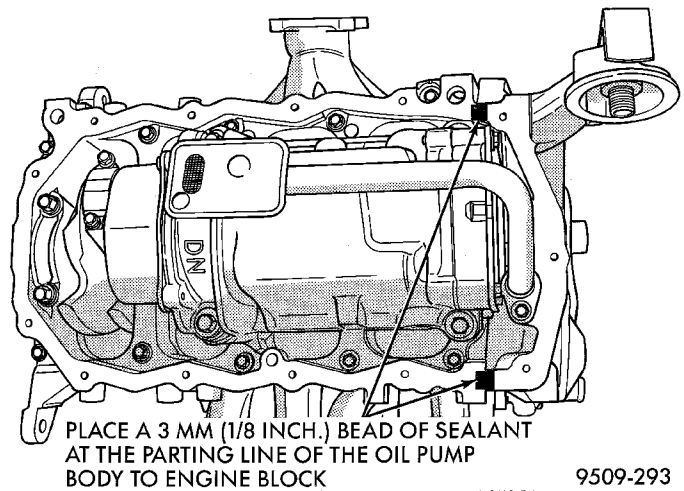
(3) Install pan and tighten the fasteners in a circular pattern beginning in the middle of the pan rail. Tighten oil pan fasteners using this 3 step method:

- 5 N·m (40 in. lbs.)
- 9 N·m (80 in. lbs.)
- 12 N·m (105 in. lbs.)



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Fig. 74 Crankshaft Damper—Installation



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Fig. 75 Oil Pan Sealing

## CRANKSHAFT

## REMOVAL

**NOTE:** Crankshaft can not be removed when engine is in vehicle.

- (1) Remove oil filter and oil pan. Refer to procedure outlined in this section.
- (2) Remove Timing Belt Cover, Timing Belt and Oil Pump. Refer to procedure outlined in this section.
- (3) Remove Balance Shafts Assembly. Refer to procedure outlined in this section.
- (4) Remove all main bearing cap bedplate bolts from the engine block. Refer to procedure outlined in this section.
- (5) Using a mallet gently tap the bedplate loose from the engine block dowel pins.

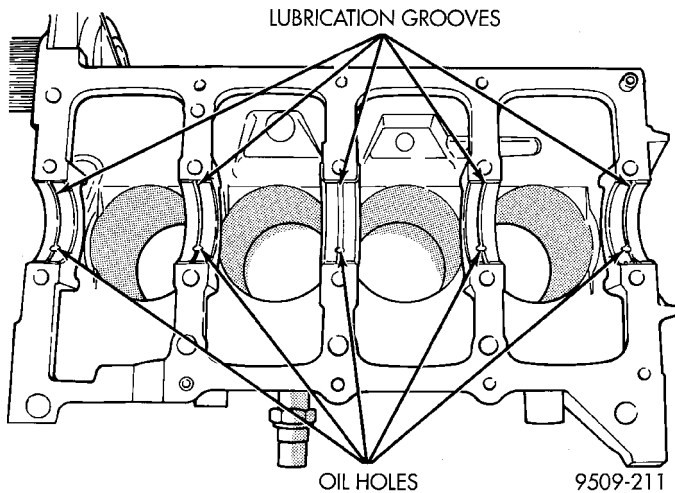
**CAUTION:** Do not pry up on one side of the bedplate. Damage may occur to cylinder block to bedplate alignment and thrust bearing.

## REMOVAL AND INSTALLATION (Continued)

(6) Bedplate should be removed evenly from the cylinder block dowel pins to prevent damage to the dowel pins and thrust bearing.

(7) Lift out crankshaft from cylinder block. Do not damage the main bearings or journals when removing the crankshaft.

## INSTALLATION



**Fig. 76 Installing Main Bearing Upper Shell**

(1) Install the main bearing shells with the lubrication groove in the cylinder block (Fig. 76).

(2) Make certain oil holes in block line up with oil hole in bearings and bearing tabs seat in the block tab slots.

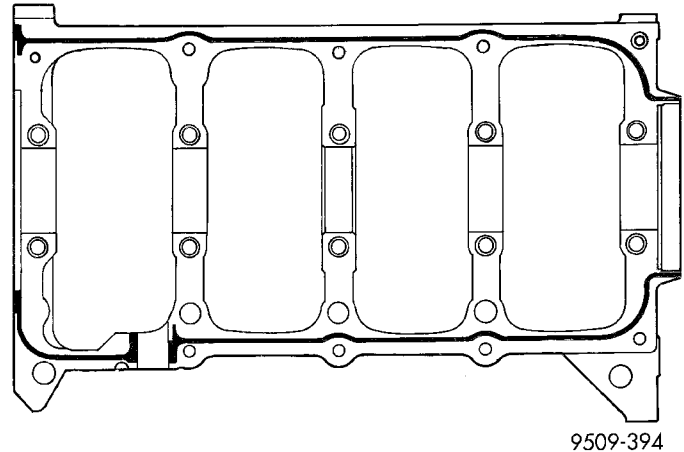
**CAUTION:** Do not get oil on the bedplate mating surface. It will may effect the sealer ability to seal the bedplate to cylinder block.

(3) Oil the bearings and journals. Install crankshaft.

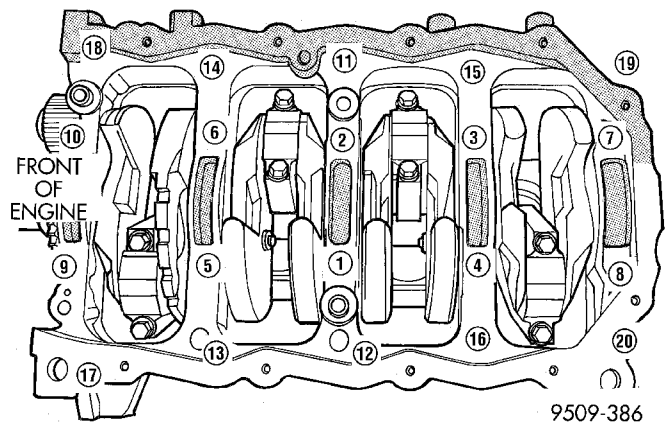
**CAUTION:** Use only the specified anaerobic sealer on the bedplate or damage may occur to the engine.

(4) Apply 1.5 to 2.0 mm (0.059 to 0.078 in.) bead of Mopar Torque Cure Gasket Maker to cylinder block as shown in (Fig. 77).

(5) Install lower main bearings into main bearing cap/bedplate. Make certain the bearing tabs are seated into the bedplate slots. Install the main bearing/bedplate into engine block.



**Fig. 77 Main Bearing Caps/Bedplate Sealing**



**Fig. 78 Main Bearing Caps/Bedplate Torque Sequence**

(6) Before installing the bolts the threads should be oiled with clean engine oil, wipe off any excess oil.

(7) Install main bearing bedplate to engine block bolts 11, 17 and 20 finger tight. Tighten this bolts down together until the bedplate contacts the cylinder block. Then torque these bolts to 28 N·m (20 ft. lbs.).

(8) Install main bearing bedplate to engine block bolts (1 thru 10) and torque each bolt to 41 N·m (30 ft. lbs.) in sequence, then in sequence tighten bolts an additional 1/4 turn (Fig. 78).

(9) Install main bearing bedplate to engine block bolts (11 thru 20), and torque each bolt to 28 N·m (20 ft. lbs.) in sequence shown in (Fig. 78).

(10) After the main bearing bedplate is installed, check the crankshaft turning torque. The turning torque should not exceed 5.6 N·m (50 in. lbs.).

## REMOVAL AND INSTALLATION (Continued)

## REAR CRANKSHAFT SEAL

## REMOVAL

(1) Insert a 3/16 flat bladed screwdriver between the dust lip and the metal case of the crankshaft seal. Angle the screwdriver (Fig. 79) through the dust lip against metal case of the seal. Pry out seal.

**CAUTION:** Do not permit the screwdriver blade to contact crankshaft seal surface. Contact of the screwdriver blade against crankshaft edge (chamfer) is permitted.

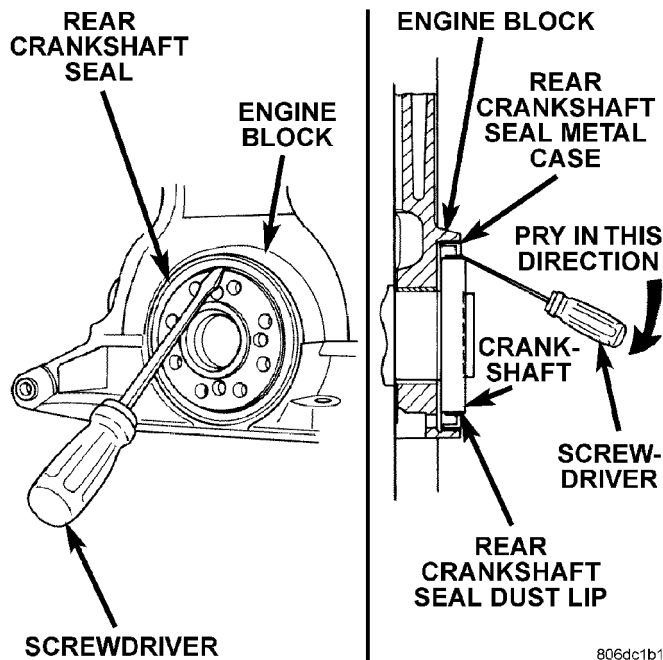


Fig. 79 Rear Crankshaft Oil Seal—Removal

## INSTALLATION

**CAUTION:** If burr or scratch is present on the crankshaft edge (chamfer), cleanup with 400 grit sand paper to prevent seal damage during installation of new seal.

**NOTE:** When installing seal, no lube on seal is needed.

(1) Place Special Tool 6926-1 on crankshaft. This is a pilot tool with a magnetic base (Fig. 80).

(2) Position seal over pilot tool. Make sure you can read the words **THIS SIDE OUT** on seal (Fig. 80). Pilot tool should remain on crankshaft during installation of seal. Ensure that the lip of the seal is facing towards the crankcase during installation.

**CAUTION:** If the seal is driven into the block past flush, this may cause an oil leak.

(3) Drive the seal into the block using Special Tool 6926-2 and handle C-4171 (Fig. 81) until the tool bottoms out against the block (Fig. 82).

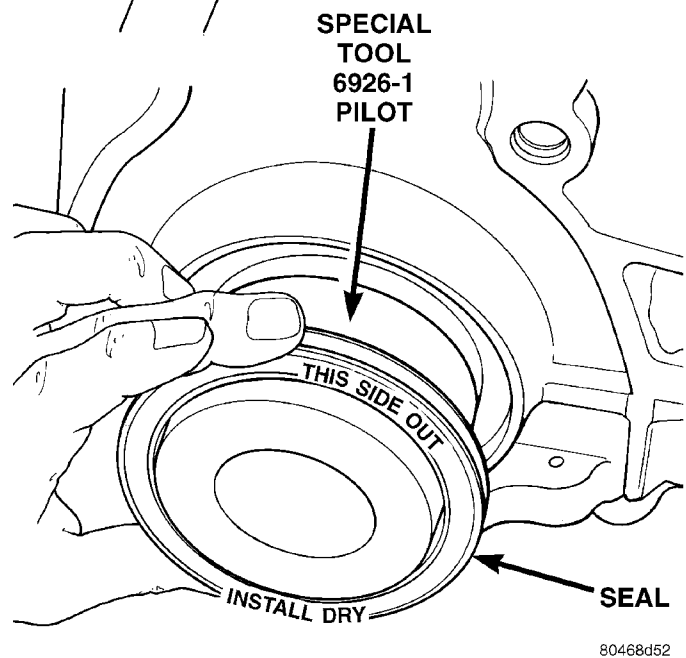


Fig. 80 Rear Crankshaft Seal and Special Tool 6926-1

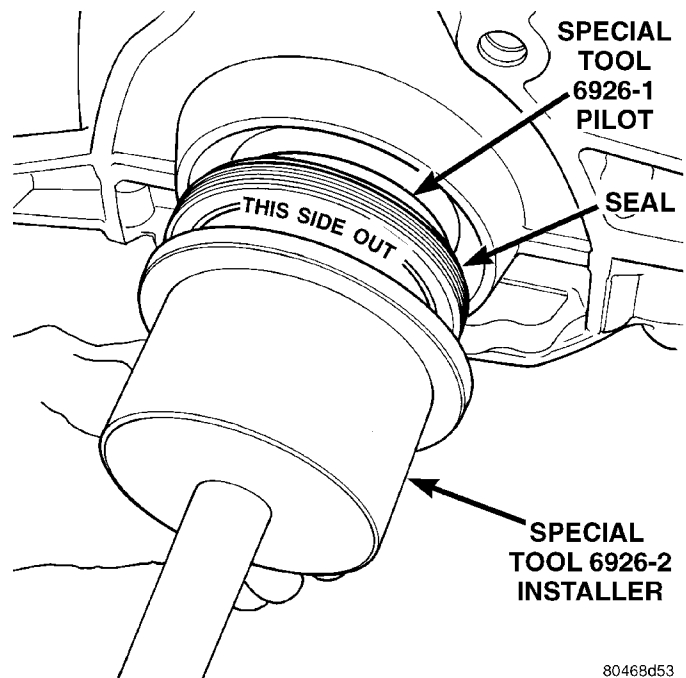
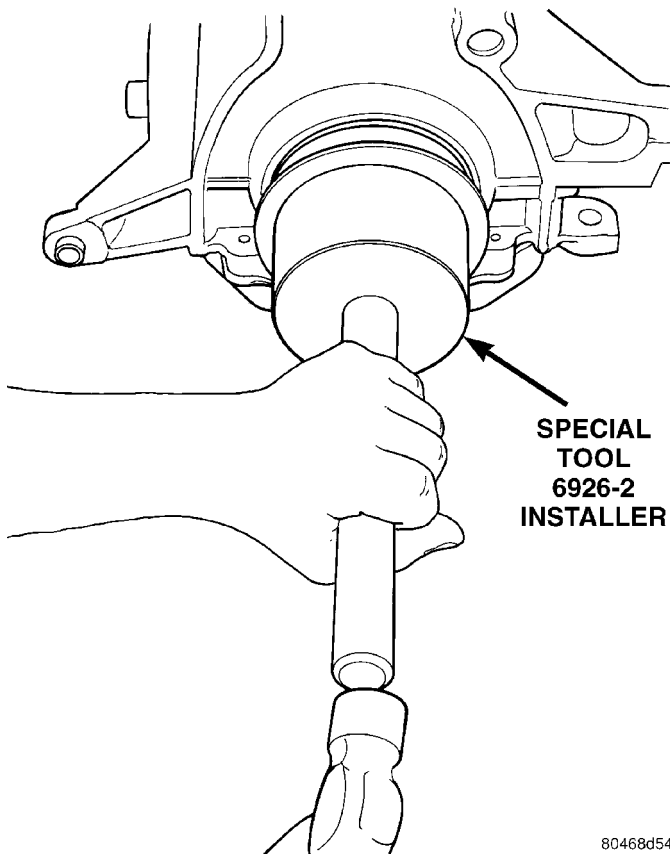


Fig. 81 Crankshaft Seal Special Tool 6926-2

## REMOVAL AND INSTALLATION (Continued)



**SPECIAL  
TOOL  
6926-2  
INSTALLER**

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**Fig. 82 Rear Crankshaft Seal—Installation**

## OIL FILTER

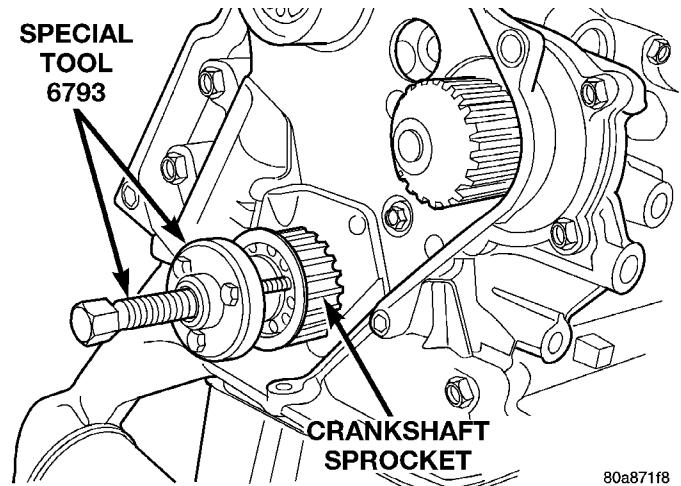
**CAUTION:** When servicing the oil filter avoid deforming the filter can by installing the remove/install tool band strap against the can to base lock seam. The lock seam joining the can to the base is reinforced by the base plate.

- (1) Turn counterclockwise to remove.
- (2) To install, lubricate new filter gasket. Check filter mounting surface. The surface must be smooth, flat and free of debris or old pieces of rubber. Screw filter on until the gasket contacts base. Tighten to 21 N·m (15 ft. lbs.).

## OIL PUMP

## REMOVAL

- (1) Disconnect negative cable from battery.
- (2) Remove Timing Belt. Refer to Timing Belt Removal in this section.
- (3) Remove Oil Pan. Refer to Oil Pan Removal in this section.
- (4) Remove Crankshaft Sprocket using Special Tool 6793 and insert C-4685-C2 (Fig. 83).
- (5) Remove oil pick-up tube.



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**Fig. 83 Crankshaft Sprocket—Removal**

- (6) Remove oil pump (Fig. 84) and front crankshaft seal.

## INSTALLATION

- (1) Make sure all surfaces are clean and free of oil and dirt.
- (2) Apply Mopar Gasket Maker to oil pump as shown in (Fig. 85). Install oil ring into oil pump body discharge passage.

**CAUTION:** Silicone sealer and anaerobic sealers each will inhibit the cure of the other and care should be taken to keep usages separated as much as possible.

- (3) Prime oil pump before installation, by coating internal rotors with oil.
- (4) Align oil pump rotor flats with flats on crankshaft as you install the oil pump to the block.

**NOTE:** Front crankshaft seal **MUST** be out of pump to align, or damage may result.

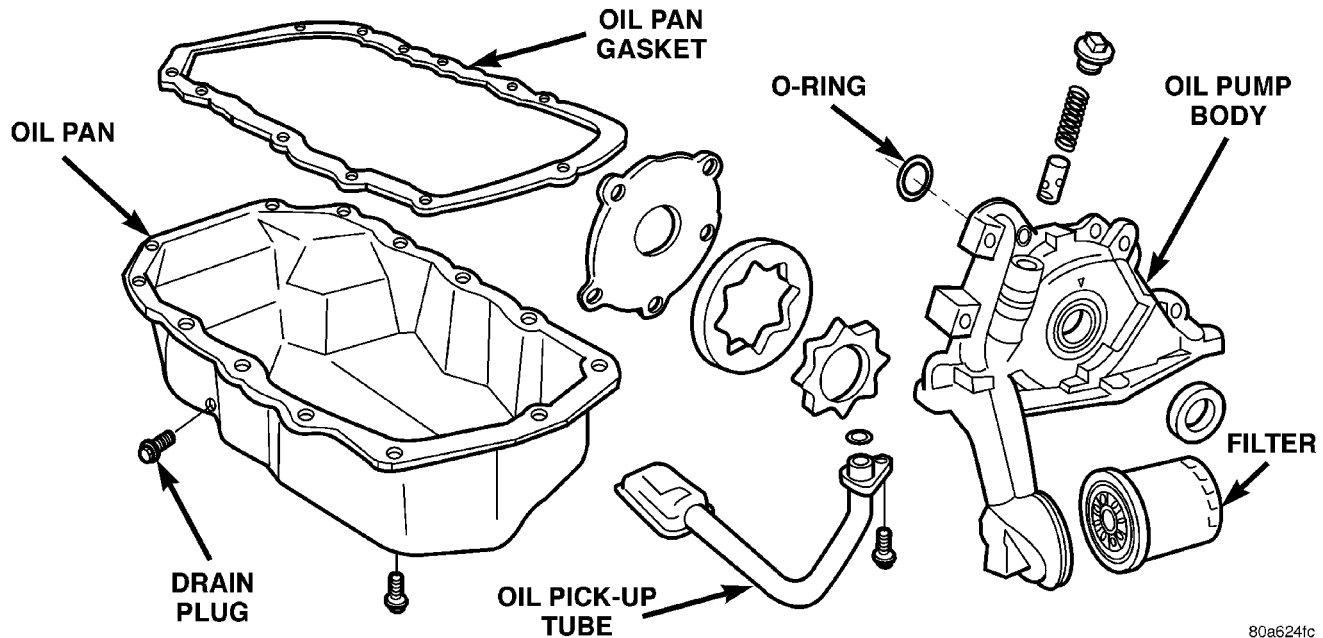
- (5) Install new front crankshaft seal using Special Tool 6780 (Fig. 86).
- (6) Install crankshaft sprocket, using Special Tool 6792 (Fig. 87).
- (7) Install oil pump pick-up tube and oil pan.
- (8) Install Timing Belt. Refer to Timing Belt Installation in this section.

## PISTON AND CONNECTING ROD

## REMOVAL

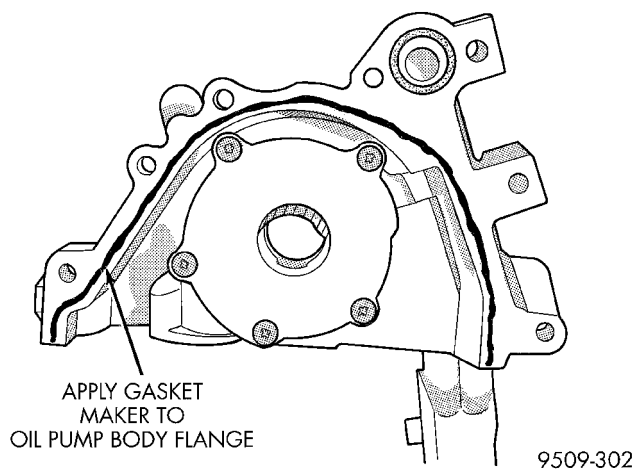
**NOTE:** Cylinder Head must be removed before Pistons and Rods. Refer to Cylinder Head Removal in this section.

## REMOVAL AND INSTALLATION (Continued)



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Fig. 84 Oil Pump



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Fig. 85 Oil Pump Sealing

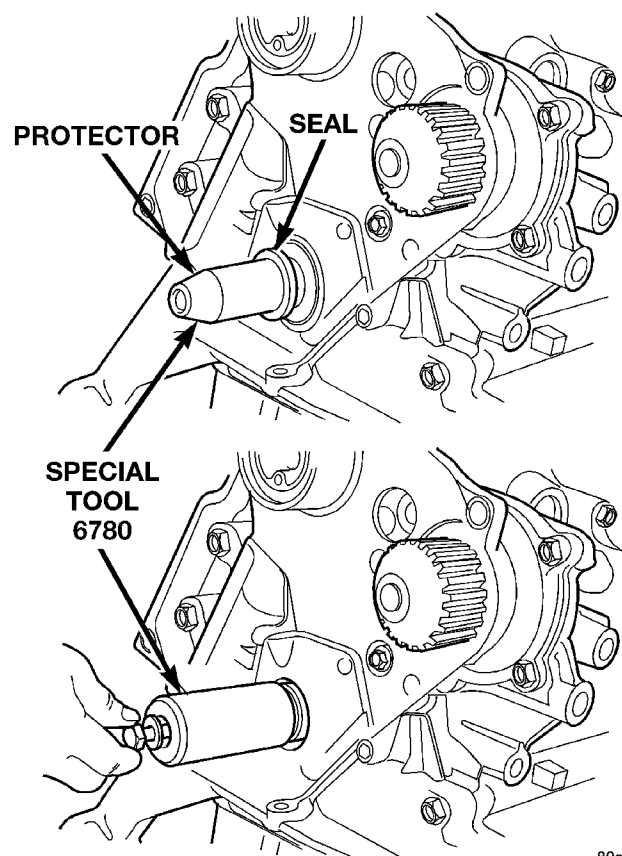
(1) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. **Be sure to keep tops of pistons covered during this operation**. Mark piston with matching cylinder number (Fig. 88).

(2) Remove oil pan. Scribe the cylinder number on the side of the rod and cap (Fig. 89) for identification.

(3) Pistons have a directional stamping in the front half of the piston facing towards the **front** of engine.

(4) Pistons and connecting rods must be removed from top of cylinder block. Rotate crankshaft so that each connecting rod is centered in cylinder bore.

(5) Remove Balance Shaft Assembly. Refer to Balance Shaft Removal in this section.



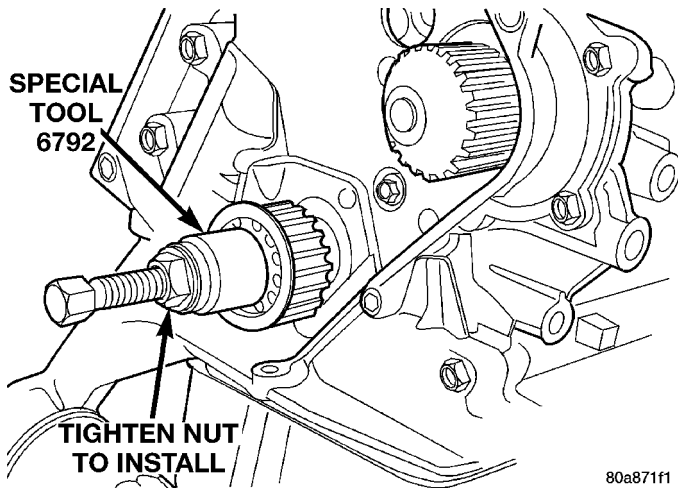
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Fig. 86 Front Crankshaft Seal—Installation

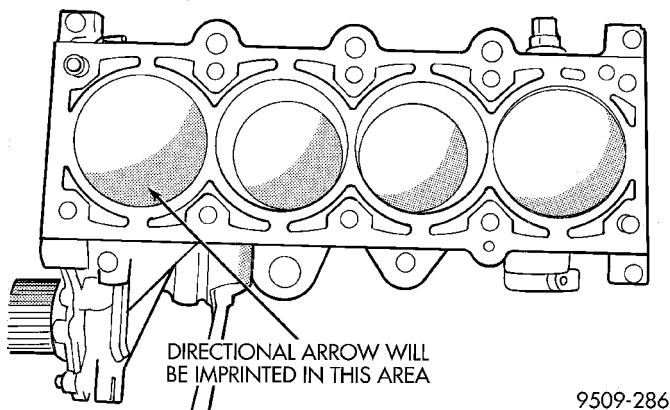
(6) Remove connecting rod cap bolts. Push each piston and rod assembly out of cylinder bore.

**NOTE:** Be careful not to nick crankshaft journals.

## REMOVAL AND INSTALLATION (Continued)



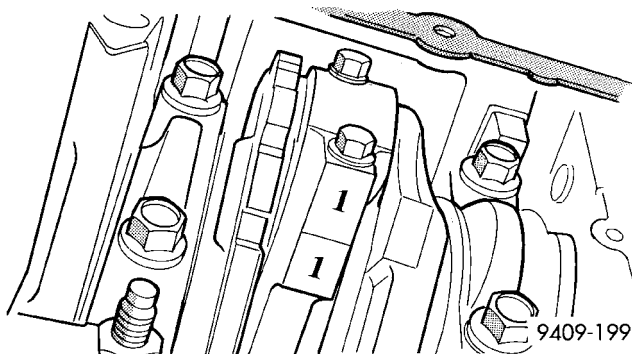
**Fig. 87 Crankshaft Sprocket—Installation**



**Fig. 88 Piston Markings**

(7) After removal, install bearing cap on the mating rod.

(8) Piston and Rods are serviced as an assembly.

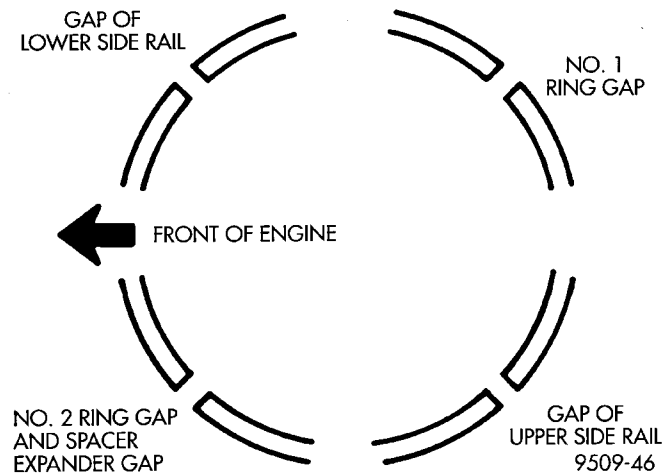


**Fig. 89 Identify Connecting Rod to Cylinder**

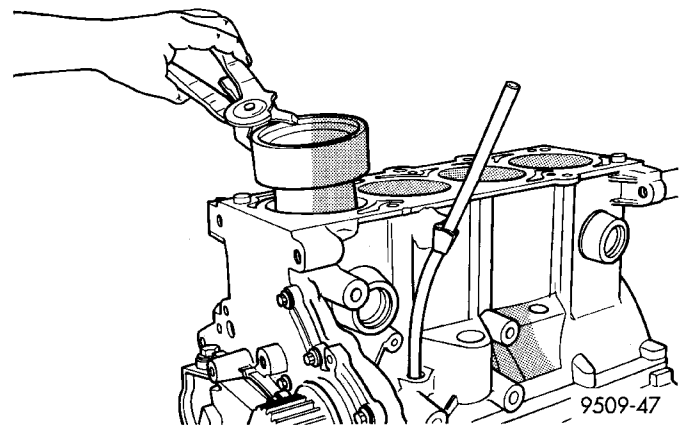
#### INSTALLATION

(1) Before installing pistons and connecting rod assemblies into the bore, be sure that compression ring gaps are staggered so that neither is in line with oil ring rail gap.

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located as shown in (Fig. 90). As viewed from top.



**Fig. 90 Piston Ring End Gap Position**



**Fig. 91 Piston—Installation**

(3) Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston (Fig. 91). **Be sure position of rings does not change during this operation.**

(4) The directional stamp on the piston should face toward the front of the engine (Fig. 88).

(5) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Insert rod and piston assembly into cylinder bore and guide rod over the crankshaft journal.

(6) Tap the piston down in cylinder bore, using a hammer handle. At the same time, guide connecting rod into position on connecting rod journal.

**NOTE: The rod bearing bolts should not be reused.**

(7) Before installing the **NEW** bolts the threads should be coated with clean engine oil.

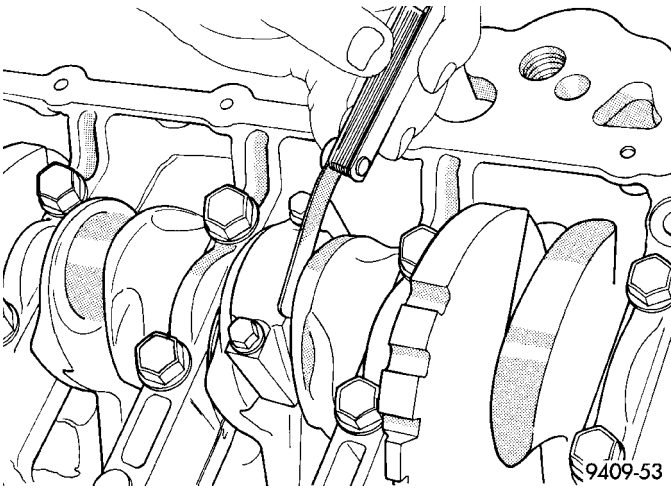
## REMOVAL AND INSTALLATION (Continued)

(8) Install each bolt finger tight then alternately torque each bolt to assemble the cap properly.

**CAUTION:** Do not use a torque wrench for second part of last step.

(9) Tighten the bolts to 27 N·m PLUS 1/4 turn (20 ft. lbs. PLUS 1/4 turn)

(10) Using a feeler gauge, check connecting rod side clearance (Fig. 92).



**Fig. 92** Checking Connecting Rod Side Clearance

## DISASSEMBLY AND ASSEMBLY

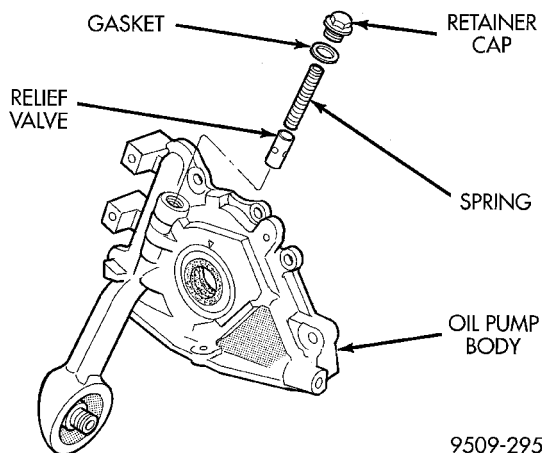
## OIL PUMP

## DISASSEMBLY

(1) To remove the relief valve, proceed as follows:

(a) Remove the threaded plug and gasket from the oil pump (Fig. 93).

(b) Remove spring and relief valve.



**Fig. 93** Oil Pressure Relief Valve

(2) Remove oil pump cover screws, and lift off cover.

(3) Remove pump rotors.

(4) Wash all parts in a suitable solvent and inspect carefully for damage or wear.

## ASSEMBLY

(1) Assemble pump, using new parts as required. **Install the inner rotor with chamfer facing the cast iron oil pump cover.**

(2) Prime oil pump before installation by filling rotor cavity with engine oil.

(3) Install cover and tighten screws to 12 N·m (105 in. lbs.).

**CAUTION:** Oil pump pressure relief valve must be installed as shown in (Fig. 93) or serious damage may occur.

(4) Install relief valve, spring, gasket and cap as shown in (Fig. 93). Tighten cap to 41 N·m (30 ft. lbs.)

## CLEANING AND INSPECTION

## CYLINDER HEAD

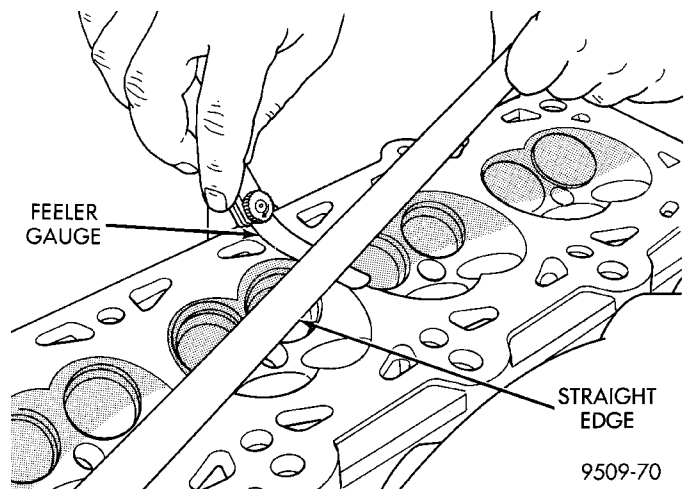
## CLEANING

Remove all gasket material from cylinder head and block. Be careful not to gouge or scratch the aluminum head sealing surface.

## INSPECTION

(1) Cylinder head must be flat within 0.1 mm (0.004 inch) (Fig. 94).

(2) Inspect camshaft bearing journals for scoring.



**Fig. 94** Checking Cylinder Head Flatness

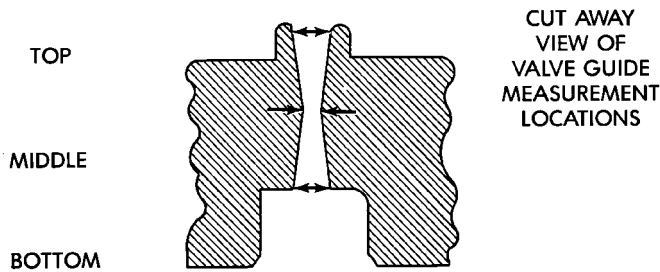
## VALVE GUIDES

(1) Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.

(2) Using a small hole gauge and a micrometer, measure valve guides in 3 places top, middle and bottom (Fig. 95). Refer to (Fig. 96) for specifications. Replace guides if they are not within specification.

CLEANING AND INSPECTION (Continued)

(3) Check valve guide height (Fig. 97).



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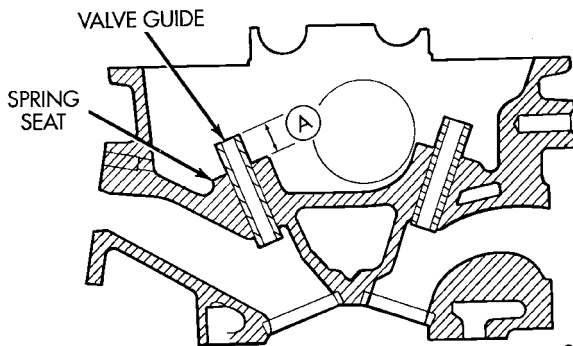
Fig. 95 Checking Wear on Valve Guide—Typical

Valve Guide Diameter	Intake Valve	Exhaust Valve
	5.975 - 6.000 mm (0.2352 - 0.2362 in.)	5.975 - 6.000 mm (0.2352 - 0.2362 in.)
Clearance	New	Service Limit
Intake	0.048 - 0.066 mm (0.0018 - 0.0025 in.)	0.25 mm (0.010 in.)
Exhaust	0.0736 - 0.094 mm (0.0029 - 0.0037 in.)	

9509-205

Fig. 96 Valve Guide Specifications

(A) 13.25 - 13.75 mm  
(.521 - .541 in.)



9509-19

Fig. 97 Valve Guide Height

VALVE AND VALVE SPRING

VALVES

- (1) Clean valves thoroughly and discard burned, warped and cracked valves.
- (2) Measure valve stems for wear. Measure stem about 60 mm beneath the valve lock grooves.
- (3) If valve stems are worn more than 0.05 mm (.002 in.), replace valve.

VALVE SPRINGS

(1) Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested for correct tension. Discard the springs that do not meet specifications. The following specifications apply to both intake and exhaust valves springs:

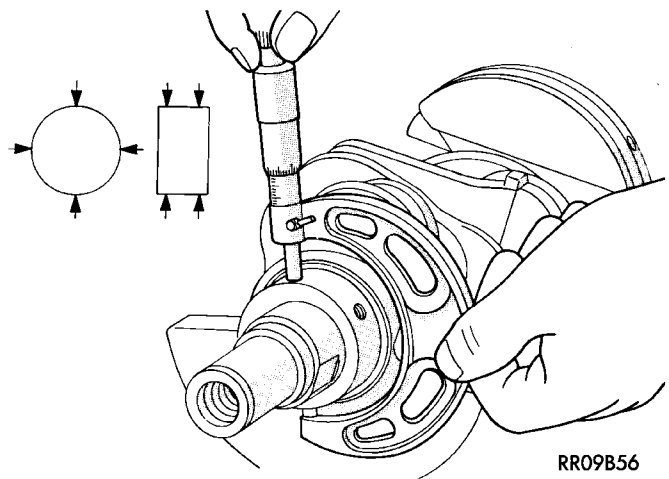
- Valve Closed Nominal Tension— 76 ft. lbs. @ 38.0 mm (1.50 in.)
- Valve Open Nominal Tension— 136 ft. lbs. @ 29.75 mm (1.17 in.)

(2) Inspect each valve spring for squareness with a steel square and surface plate, test springs from both ends. If the spring is more than 1.5 mm (1/16 inch) out of square, install a new spring.

CRANKSHAFT

The crankshaft journals should be checked for excessive wear, taper and scoring (Fig. 98). Limits of taper or out-of-round on any crankshaft journals should be held to .025 mm (.001 inch). Journal grinding should not exceed .305 mm (.012 inch) under the standard journal diameter. **DO NOT** grind thrust faces of Number 3 main bearing. **DO NOT** nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all passages.

**CAUTION:** With the nodular cast iron crankshafts used it is important that the final paper or cloth polish after any journal regrind be in the same direction as normal rotation in the engine.



RR09B56

Fig. 98 Crankshaft Journal Measurements

OIL PUMP

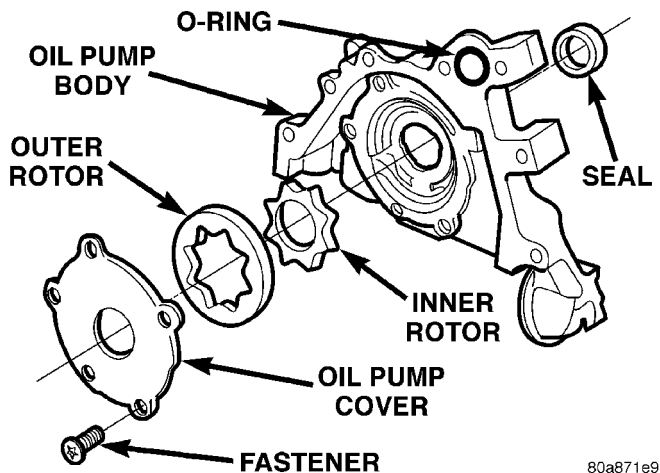
- (1) Clean all parts thoroughly. Mating surface of the oil pump should be smooth (Fig. 99). Replace pump cover if scratched or grooved.
- (2) Lay a straightedge across the pump cover surface (Fig. 100). If a .076 mm (.003 inch) feeler gauge

## CLEANING AND INSPECTION (Continued)

can be inserted between cover and straight edge, cover should be replaced.

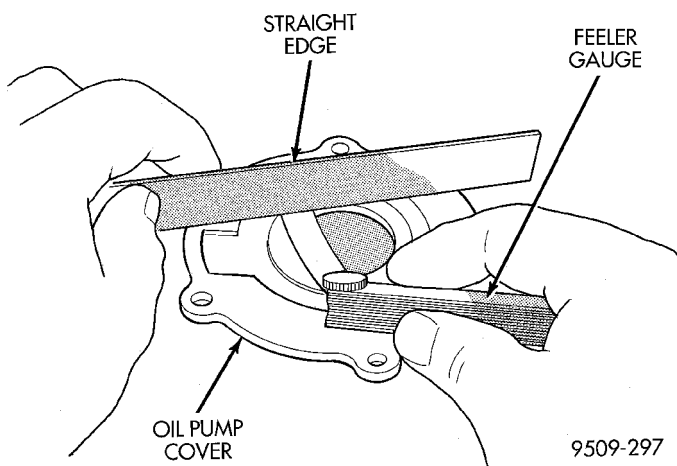
(3) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 9.40 mm (0.370 inch.) or less (Fig. 101), or if the diameter is 79.95 mm (3.148 inches.) or less, replace outer rotor.

(4) If inner rotor measures 9.40 mm (.370 inch.) or less replace inner rotor (Fig. 102).



80a871e9

**Fig. 99 Oil Pump**



9509-297

**Fig. 100 Checking Oil Pump Cover Flatness**

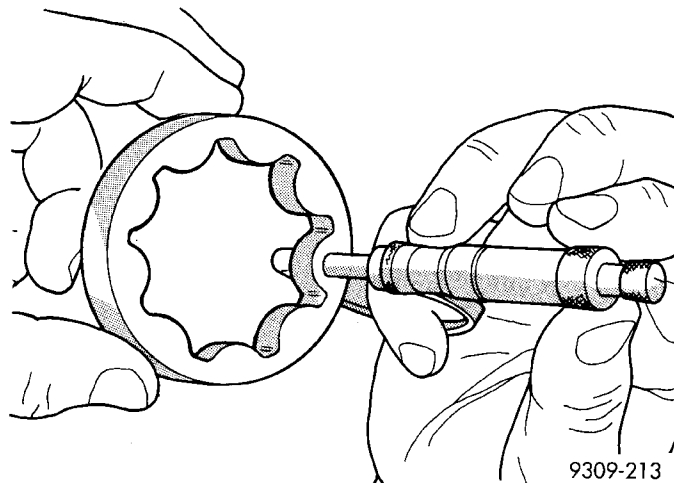
(5) Slide outer rotor into pump housing, press to one side with fingers and measure clearance between rotor and housing (Fig. 103). If measurement is 0.39 mm (0.015 inch.) or more, replace housing only if outer rotor is in specification.

(6) Install inner rotor into pump housing. If clearance between inner and outer rotors (Fig. 104) is .203 mm (.008 inch) or more, replace both rotors.

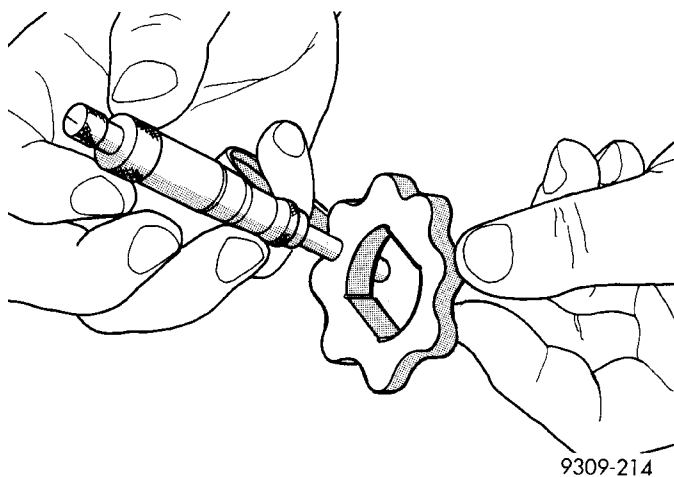
(7) Place a straightedge across the face of the pump housing, between bolt holes. If a feeler gauge of .102 mm (.004 inch) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 105), **ONLY** if rotors are in specs.

(8) Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400 grit wet or dry sandpaper.

(9) The relief valve spring has a free length of approximately 60.7 mm (2.39 inches) it should test between 18 and 19 pounds when compressed to 40.5 mm (1.60 inches). Replace spring that fails to meet specifications.



**Fig. 101 Measuring Outer Rotor Thickness**



**Fig. 102 Measuring Inner Rotor Thickness**

(10) If oil pressure is low and pump is within specifications, inspect for worn engine bearings or other reasons for oil pressure loss.

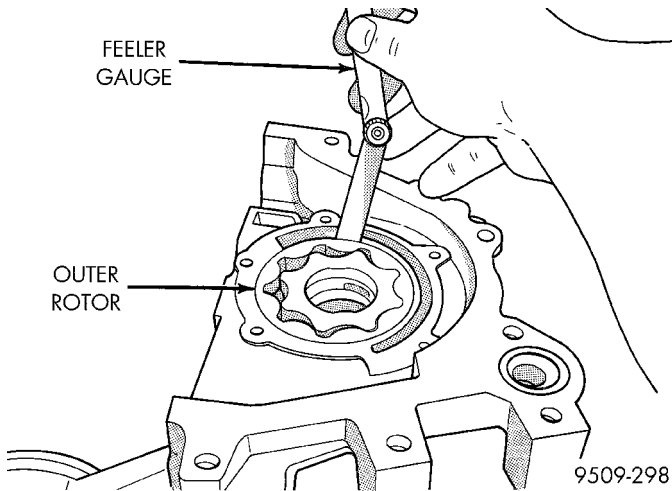
### CYLINDER BLOCK

(1) Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.

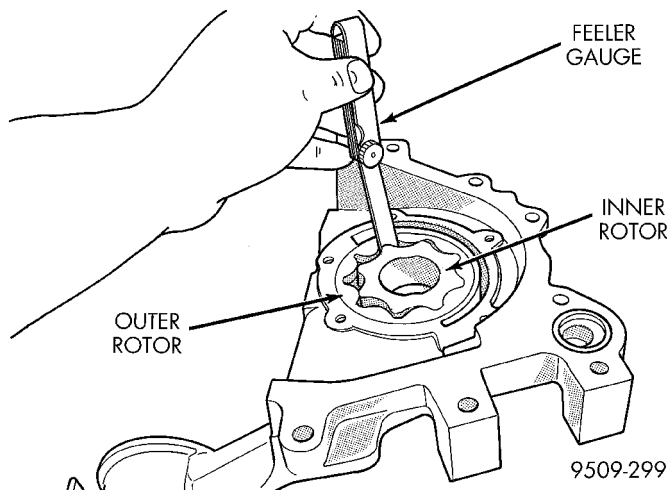
(2) If new core plugs are installed, refer to Engine Core Plugs outlined in this section.

(3) Examine block and cylinder bores for cracks or fractures.

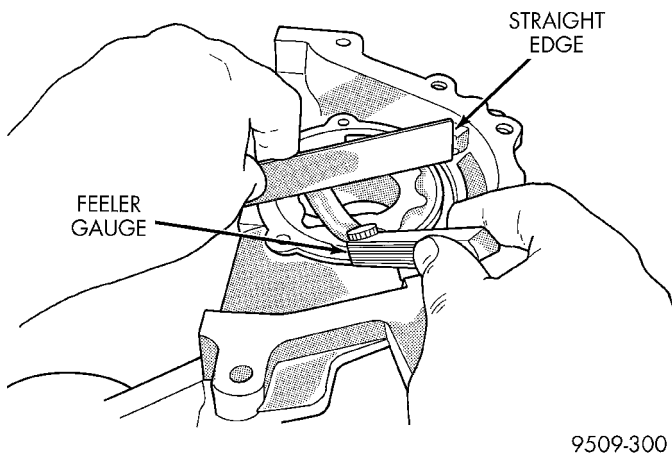
CLEANING AND INSPECTION (Continued)



**Fig. 103 Measuring Outer Rotor Clearance in Housing**



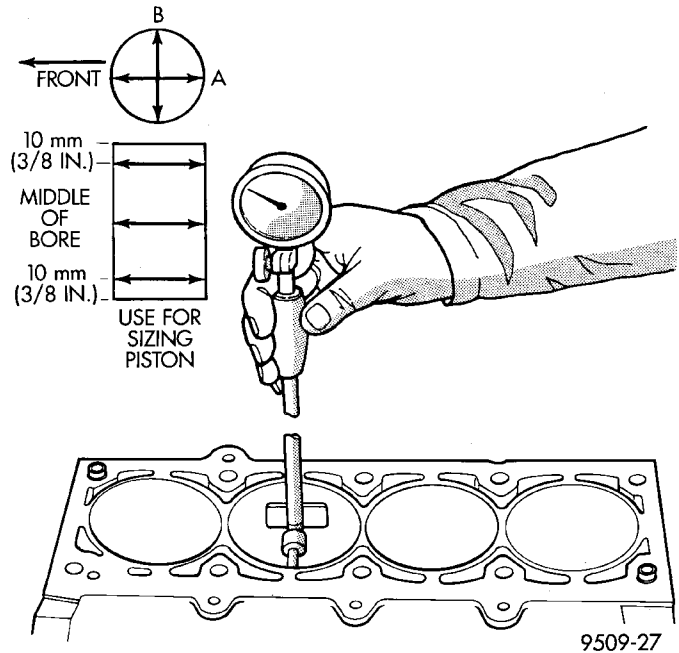
**Fig. 104 Measuring Clearance Between Rotors**



**Fig. 105 Measuring Clearance Over Rotors**

**CYLINDER BORE INSPECTION**

The cylinder walls should be checked for out-of-round and taper with Tool C119 (Fig. 106). The cyl-



**Fig. 106 Checking Cylinder Bore Size**

inder bore out-of-round is 0.050 mm (.002 inch) maximum and cylinder bore taper is 0.051 mm (0.002 inch) maximum. If the cylinder walls are badly scuffed or scored, the cylinder block should be replaced, and new pistons and rings fitted.

Measure the cylinder bore at three levels in directions A and B (Fig. 106). Top measurement should be 10 mm (3/8 in.) down and bottom measurement should be 10 mm (3/8 in.) up from bottom of bore. Refer to (Fig. 107) for specifications.

Standard Bore	Maximum Out-of-Round	Maximum Taper
87.5 mm (3.445 in.)	0.051 mm (0.002 in.)	0.051 mm (0.002 in.)
Standard Piston Size		
87.450 - 87.468 mm (3.4434 - 3.4441 in.)		
Piston to Bore Clearance: 0.024 - 0.057 mm (.0009 to .0022 in.)		
Measurements taken at Piston Size location.		

9509-208

**Fig. 107 Cylinder Bore and Piston Specifications**

**ADJUSTMENTS**

**ENGINE MOUNTS**

**ENGINE MOUNT INSULATOR ADJUSTMENT**

(1) Remove the load on the engine motor mounts by carefully supporting the engine and transmission assembly with a floor jack.

## ADJUSTMENTS (Continued)

(2) Loosen the right engine mount insulator vertical fastener and the fore and aft fasteners, and the front engine mount bracket to front crossmember screws.

(3) Pry the engine right or left as required to achieve the proper drive shaft assembly length. Refer to Group 2, Suspension and Driveshafts for drive-shaft identification and related assembly length measuring.

(4) Tighten engine mounts and fasteners in the following order:

(a) Right engine mount insulator vertical bolts to 102 N·m (75 ft. lbs.) and the fore and aft bolts to 150 N·m (110 ft. lbs.).

(b) Front engine mount screws to 54 N·m (40 ft. lbs.) the clearance between the snubbers and the engine should be 2 mm (0.078 inch.) each side.

(c) Left engine mount through bolt to 75 N·m (55 ft. lbs.).

(5) Recheck driveshaft length.

## SPECIFICATIONS

## ENGINE 2.4L

Type	In-Line OHV, DOHC
Number of Cylinder	4
Bore	87.5 mm (3.445 in.)
Stroke	101 mm (3.976 in.)
Compression Ratio	9.4:1
Displacement	2.4 Liters (148 Cubic Inches)
Firing Order	1, 3, 4, 2
Compression Pressure	1172-1551 kPa (170-225 psi)
Maximum Variation Between Cylinder	25 %
Lubrication	Pressure Feed-Full Flow Filtration (Direct Crankshaft Driven Pump)

**Cylinder Block**

Cylinder Bore Diameter	87.4924 - 87.5076 mm (3.4446 - 3.4452 in.)
Out-of-Round (Max.)	0.051 mm (0.002 in.)
Taper (Max.)	0.051 mm (0.002 in.)

**Pistons**

Clearance at 14 mm (9/16 in.) From Bottom of Skirt	0.024 - 0.057 mm (0.0009 - 0.0022 in.)
Weight	332 - 346 grams (11.85 - 12.20 oz.)
Top Land Clearance (Diametrical)	0.614 - 0.664 mm (0.024 - 0.026 in.)
Piston Length	60.30 mm (2.374 in.)

**Piston Ring Groove Depth**

No. 1	4.640 - 4.784 mm (0.182 - 0.188 in.)
No. 2	4.575 - 4.719 mm (0.180 - 0.185 in.)
No.3	4.097 - 4.236 mm (0.161 - 0.166 in.)

**Piston Pins**

Clearance in Piston	0.005 - 0.018 mm
In Rod (Interference)	0.018 - 0.043 mm (0.0007 - 0.0017 in.)
Diameter	21.998-22.003 mm (0.8660 - 0.8662 in.)
End Play	None
Length	72.75 - 73.25 mm (2.864 - 2.883 in.)

**Piston Ring Gap**

Top Compression Ring	0.25 - 0.51 mm (0.0098 - 0.020 in.)
2nd Compression Ring	0.23 - 0.48 mm (0.009 - 0.018 in.)
Oil Control (Steel Rails)	0.25 - 0.64 mm (0.0098 - 0.025 in.)

**Piston Ring Side Clearance**

Top and Second Compression Rings	0.030 - 0.080 mm (0.0011 - 0.0031 in.)
Oil Ring (Pack)	0.012 - 0.178 mm (0.0004 - 0.0070 in.)

**Piston Ring Width**

Compression Rings	1.47 - 1.50 mm (0.057 - 0.059 in.)
Oil Ring (Pack)	2.72 - 2.88 mm (0.107 - 0.1133 in.)

**Connecting Rod**

Bearing Clearance	0.025 - 0.071 mm (0.0009 - 0.0027 in.)
Piston Pin Bore Diameter	20.96 - 20.98 mm (0.8252 - 0.8260 in.)
Large End Bore Diameter	53.007 - 52.993 mm (2.0868 - 2.0863)
Side Clearance	0.013 - 0.0150 mm (0.0051 - 0.0150 in.)
Total Weight (Less Bearing)	565.8 grams (19.96 oz.)

**Crankshaft**

Connecting Rod Journal Diameter	49.984 - 50.000 mm (1.967 - 1.9685 in.)
Out-of-Round (Max.)	0.0035 mm (0.0001 in.)
Taper (Max.)	0.0038 mm (0.0001 in.)
Main Bearing Diametrical Clearance No. 1 - 5	0.018 - 0.058 mm (0.0007 - 0.0023 in.)
End Play	0.09 - 0.24 mm (0.0035 - 0.0094 in.)

**Main Bearing Journals**

Diameter	59.992 - 60.008 mm (2.361 - 2.3625 in.)
Out-of-Round (Max.)	0.0035 mm (0.0001 in.)
Taper (Max.)	0.0038 (0.0001 in.)

**Hydraulic Lash Adjusters**

Body Diameter	15.901 - 15.913 mm (0.626 - 0.6264 in.)
Plunger Travel Minimum (Dry)	3.0 mm (0.118 in.)

## SPECIFICATIONS (Continued)

**Camshaft**

Bearing Bore Diameter

No. 1-6 . . . 26.020 - 26.041 mm (1.024 - 1.025 in.)

Diametrical Bearing Clearance . . . 0.069 - 0.071 mm  
(0.0027 - 0.003 in.)

End Play . . . . 0.050 - 0.170 mm (0.0019 - 0.0066 in.)

Bearing Journal Diameter

No. 1-6 . . . 25.951 - 25.970 mm (1.021 - 1.022 in.)

Lift (Zero Lash) Intake . . . . . 8.25 mm (0.324 in.)

Exhaust . . . . . 6.52 mm (0.256 in.)

**Valve Timing**

Intake Valve Closes (ABDC) . . . . . 51°

Opens (BTDC) . . . . . 5°

Duration . . . . . 236°

Exhaust Valve Closes (ATDC) . . . . . 10°

Opens (BBDC) . . . . . 50°

Duration . . . . . 240°

Valve Overlap . . . . . 15°

**Cylinder Head**

Material . . . . . Cast Aluminum

Gasket Thickness (Compressed) . 1.15 mm (0.045 in.)

Valve Seat Angle . . . . . 45°

Runout (Max.) . . . . . 0.050 mm (0.002 in.)

Width (Finish) Intake and Exhaust . . . . 0.9 - 1.3 mm  
(0.035 - 0.051 in.)Guide Bore Diameter (Std) . . . . . 11.0 - 11.02 mm  
(0.4330 - 0.4338 in.)Finished Guide Bore ID . . . . . 5.975 - 6.000 mm  
(0.235 - 0.236 in.)**Valves**

Face Angle Intake and Exhaust . . . . . 45 - 44½ °

Head Diameter Intake . . . . . 34.67 - 34.93 mm  
(1.364 - 1.375 in.)

Exhaust . . . . . 30.37 - 30.63 mm (1.195 - 1.205 in.)

Length (Overall) Intake . . . . . 112.76 - 113.32 mm  
(4.439 - 4.461 in.)

Exhaust . . . . . 109.59 - 110.09 mm (4.314 - 4.334 in.)

Stem Diameter Intake . . . . . 5.934 - 5.952 mm  
(0.233 - 0.234 in.)

Exhaust . . . . . 5.906 - 5.924 mm (0.233 - 0.233 in.)

Valve Margin Intake . . . . . 1.285 - 1.615 mm  
(0.050 - 0.063 in.)

Exhaust . . . . . 0.985 - 1.315 mm (0.038 - 0.051 in.)

Valve Stem Tip Height

Intake . . . . . 48.04 mm (1.891 in.)

Exhaust . . . . . 47.99 mm (1.889 in.)

Stem Diameter Intake . . . . . 5.934 - 5.952 mm  
(0.234 - 0.234 in.)

Exhaust . . . . . 5.906 - 5.924 mm (0.233 - 0.233 in.)

Stem-to-Guide Clearance Intake . . 0.048 - 0.066 mm  
(0.0018 - 0.0025 in.)

Exhaust . . . 0.0736 - 0.094 mm (0.0029 - 0.0037 in.)

Max. Allowable Intake and

Exhaust . . . . . 0.025 mm (0.010 in.)

**Valve Springs**

Free Length (Approx.) . . . . . 48.4 mm (1.905 in.)

Spring Tension

(Valve Closed) . . . . . 338 N ± 20 N @ 38.0 mm  
(75.98 lbs. ± 4.5 lbs. @ 1.496 in.)

Spring Tension

(Valve Open) . . . . . 607 N ± 30 N @ 29.75 mm  
(136 lbs. ± 7 lbs. @ 1.172 in.)

Number of Coils . . . . . 7.82

Wire Diameter . . . . . 3.86 mm (0.151 in.)

Installed Spring Height . . . . . 38.00 mm (1.496 in.)

**Oil Pump**

Clearance over Rotors (Max.) . . . 0.10 mm (0.004 in.)

Cover Out-of-Flat (Max.) . . . . 0.025 mm (0.001 in.)

Inner Rotor Thickness (Min.) . . . 9.40 mm (0.370 in.)

Outer Rotor Clearance (Max.) . . 0.39 mm (0.015 in.)

Diameter (Min.) . . . . . 79.95 mm (3.148 in.)

Thickness (Min.) . . . . . 9.40 mm (0.370 in.)

Tip Clearance between

Rotors (Max.) . . . . . 0.20 mm (0.008 in.)

**Oil Pressure**

At Curb Idle Speed\* . . . . . 25 kPa (4 psi)

At 3000 rpm . . . . . 170 — 550 kPa (25 — 80 psi)

## SPECIFICATIONS (Continued)

## TORQUE CHART 2.4L

**DESCRIPTION . . . . . TORQUE****Balance Shaft Carrier to Block**

Bolts . . . . . 54 N·m (40 ft. lbs.)

**Balance Shaft Gear Cover**

Double Ended Fastener . . . . . 12 N·m (105 in. lbs.)

**Balance Shaft Sprockets**

Bolts . . . . . 28 N·m (250 in. lbs.)

**Balance Shaft Chain Tensioner**

Bolts . . . . . 12 N·m (105 in. lbs.)

**Balance Shaft Carrier Cover**

Fasteners . . . . . 12 N·m (105 in. lbs.)

**Camshaft Sensor Pick Up**

Bolts . . . . . 27 N·m (20 ft. lbs.)

**Timing Belt Cover**

Outer to Inner Attaching Bolts M6 . 4.5 N·m (40 in. lbs.)

Inner Cover to Head/Oil Pump Bolts M6 . 12 N·m (105 in. lbs.)

**Camshaft Sprocket**

Bolt . . . . . 101 N·m (75 ft. lbs.)

**Connecting Rod Cap**

Bolts . . . . . 27 N·m (20 ft. lbs.) Plus 1/4 Turn

**Crankshaft Main Bearing Cap/Bedplate**

M8 Bedplate Bolts . . . . . 34 N·m (250 in. lbs.)

Main Cap Bolts M11 . 41 N·m (30 ft. lbs.) Plus 1/4 Turn

**Crankshaft Damper**

Bolt . . . . . 135 N·m (100 ft. lbs.)

**Cylinder Head**

Bolts . . . . . Refer To Cylinder Head Installation

**Cylinder Head Cover**

Bolts . . . . . 12 N·m (105 in. lbs.)

**Engine Mount Bracket**

Bolts . . . . . 41 N·m (30 ft. lbs.)

**Exhaust Manifold to Cylinder Head**

Bolts . . . . . 23 N·m (200 in. lbs.)

**Exhaust Manifold Heat Shield**

Bolts . . . . . 12 N·m (105 in. lbs.)

**Front Torque Bracket—2.0/2.4L Engine**

Bolts . . . . . 33 N·m (24 ft. lbs.)

**Front Torque Bracket Strut—2.0/2.4L Engine**

Long Bolts . . . . . 110 N·m (80 ft. lbs.)

Short Bolt . . . . . 61 N·m (45 ft. lbs.)

**Intake Manifold**

Bolts . . . . . 27 N·m (20 ft. lbs.)

**Oil Filter**

Filter . . . . . 20 N·m (15 ft. lbs.)

**Oil Pan**

Oil Pan Bolts step 1 . . . . . 5 N·m (40 in. lbs.)

Oil Pan Bolts step 2 . . . . . 9 N·m (80 in. lbs.)

Oil Pan Bolts step 3 . . . . . 12 N·m (105 in. lbs.)

Drain Plug . . . . . 27 N·m (20 ft. lbs.)

**DESCRIPTION . . . . . TORQUE****Oil Pump Attaching**

Bolts . . . . . 28 N·m (250 in. lbs.)

Oil Pump Cover Fastener . . . . . 12 N·m (105 in. lbs.)

Oil Pump Pick-up Tube Bolt . . . . . 28 N·m (250 in. lbs.)

Oil Pump Relief Valve Cap . . . . . 41 N·m (30 ft. lbs.)

**Rear Torque Bracket**

Bolts . . . . . 110 N·m (80 ft. lbs.)

**Spark Plugs**

Plugs . . . . . 28 N·m (20 ft. lbs.)

**Support Module—Front and Rear**

Thru Bolt . . . . . 61 N·m (45 ft. lbs.)

**Thermostat Housing**

Bolts . . . . . 23 N·m (200 in. lbs.)

**Timing Belt Tensioner**

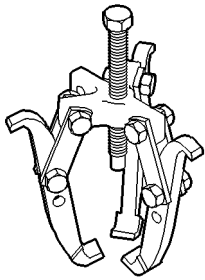
Center Bolt . . . . . 28 N·m (252 in. lbs.)

**Water Pump Mounting**

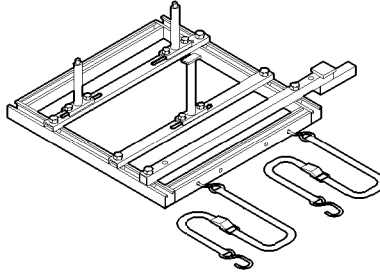
Bolts . . . . . 12 N·m (105 in. lbs.)

SPECIAL TOOLS

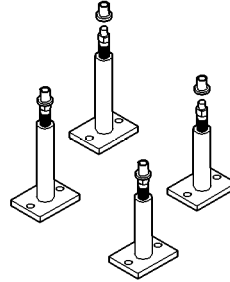
ENGINE 2.4L



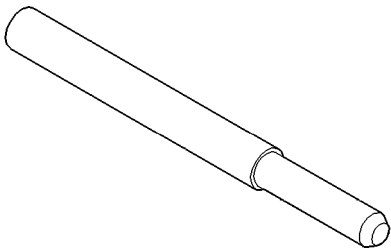
**Puller 1026**



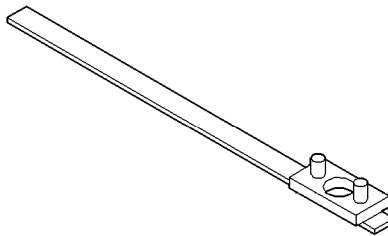
**Cradle 6710**



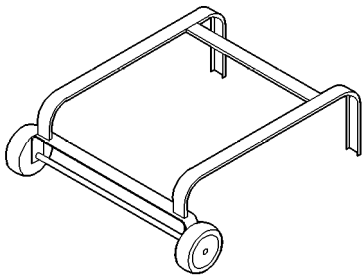
**Post Kit Engine Cradle 6848**



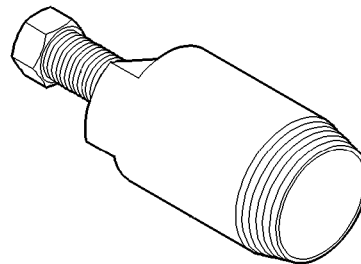
**Crankshaft Damper Removal Insert 6827-A**



**Camshaft Sprocket Remover C-4687**

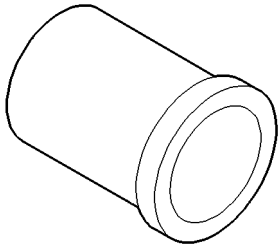


**Dolly 6135**

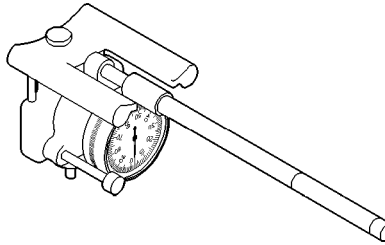


**Camshaft Seal Remover C-4679-A**

SPECIAL TOOLS (Continued)

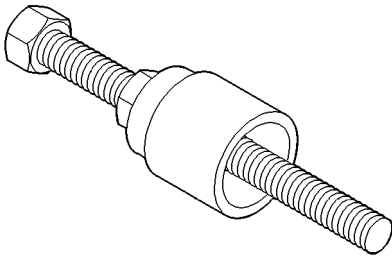


**Camshaft Seal Installer MD-998306**

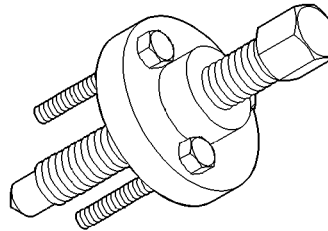


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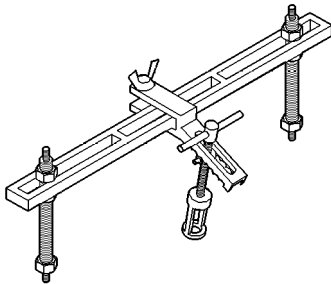
**Cylinder Bore Gage C-119**



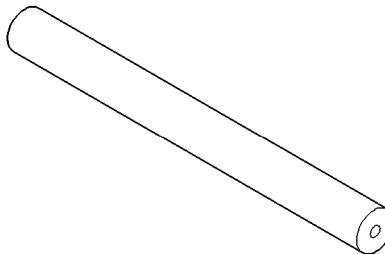
**Crankshaft Damper Installer 6792**



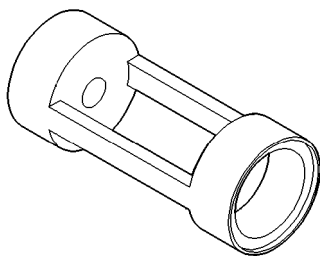
**Crankshaft Sprocket Remover 6793**



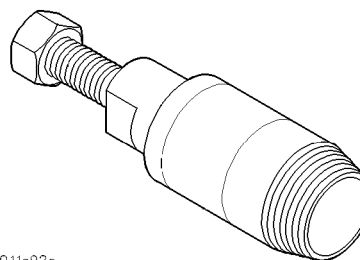
**Valve Spring Compressor MD-998772-A**



**Crankshaft Sprocket Remover Insert C-4685-C2**



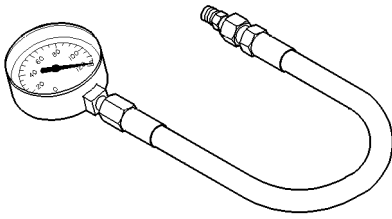
**Valve Spring Compressor Adapter 6779**



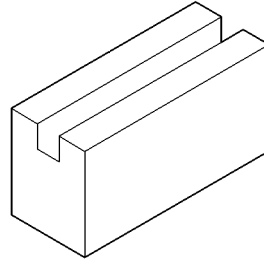
8011c92c

**Crankshaft Seal Remover 6771**

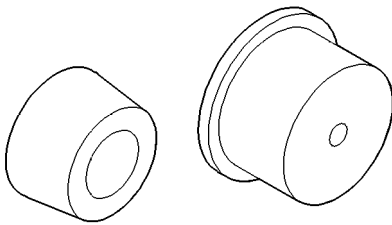
SPECIAL TOOLS (Continued)



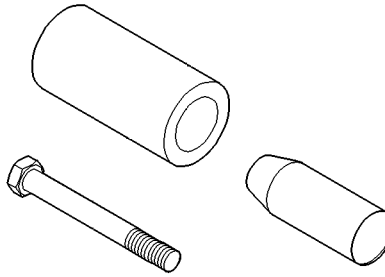
**Oil Pressure Gage C-3292**



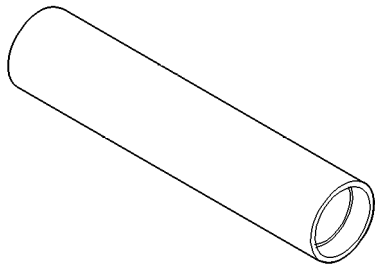
**Post Adapter 8130**



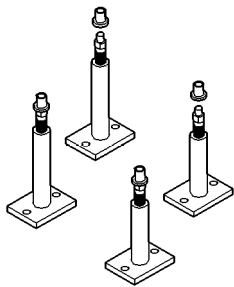
**Rear Crankshaft Seal Guide and Installer 6926-1 and 6926-2**



**Front Crankshaft Oil Seal Installer 6780**



**Balance Shaft Sprocket Installer 6052**



**Post Kit Engine Cradle 6848**

## 3.0L ENGINE

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## DESCRIPTION AND OPERATION

## ENGINE IDENTIFICATION NUMBER

The engine identification number is located on the rear of the cylinder block just below the cylinder head (Fig. 1).

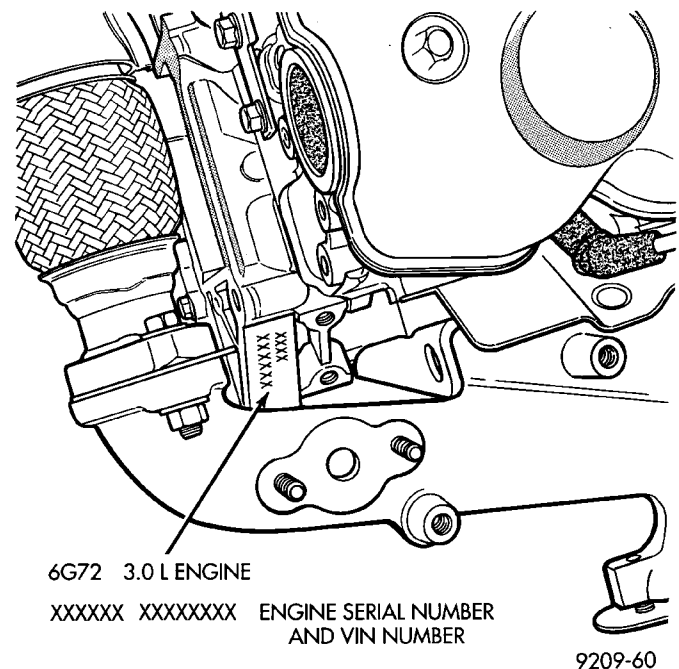
## ENGINE LUBRICATION

System is a full flow filtration, pressure feed type. The oil pump is mounted behind the timing belt cover. The pump inner rotor is driven by the crankshaft. The engine oil pan contains a baffle plate to control oil level fluctuation during engine operation.

## ENGINE COMPONENTS

**BLOCK:** The cylinder block is a light weight design created by reducing thickness in many parts and a short 10 mm (3/8 in.) block skirt. High rigidity is provided with ribs cast in the outer wall, a full length water jacket, and a mono-block or beam type, main bearing cap. This single unit four bearing cap is designed to control vibration of the cylinder block partition walls.

**CRANKSHAFT:** A six throw, five weight crankshaft is supported by four main bearings with number three being the thrust bearing. The six separate connecting rod throws pins reduce torque fluctua-



**Fig. 1 Engine Identification**

tions while a torsional vibration damper is used to control torsion caused vibration of the crankshaft. Rubber lipped seals are used at front and rear. The

## DESCRIPTION AND OPERATION (Continued)

front seal is retained in the oil pump case and the rear is retained in a block-mounted housing.

**PISTONS:** Are aluminum alloy with a steel strut, short height, and thin wall so as to be autothermic and light weight. The piston head with valve recesses, in combination with the cylinder head, forms a compact spherical head with clearance for total valve lift with pistons at top dead center. The piston skirt, top and second ring lands are finished to a tapered roughness for oil retention and high resistance to scuffing. Piston pins, pressed into place, join the pistons to the connecting rods.

**CYLINDER HEAD:** The alloy cylinder heads feature cross-flow type intake and exhaust ports. Valve guides and inserts are hardened cast iron. Valves of heat resistance steel are arranged in a V with each camshaft on center. To improve combustion speed the chambers are a compact spherical design with a squish area of approximately 30 percent of the piston top area. The cylinder heads are common to either cylinder bank by reversing the direction of installation.

**CAMSHAFTS:** Two overhead camshafts provide valve actuation, one front (radiator side of cylinder bank) and one rear. The front camshaft is provided with a distributor drive and is longer. Both camshafts are supported by four bearing journals, thrust for the front camshaft is taken at journal two and the rear at journal three. Front and rear camshaft driving sprockets are interchangeable. The sprockets and the engine water pump are driven by a single notched timing belt.

**ROCKER ARM SHAFTS:** The shafts are retained by the camshaft bearing journal caps. Four shafts are used, one for each intake and exhaust rocker arm assembly on each cylinder head. The hollow shafts provide a duct for lubricating oil flow from the cylinder head to the valve mechanisms.

**ROCKER ARMS:** Are of light weight die-cast with roller type follower operating against the cam shaft. The valve actuating end of the rocker arms are machined to retain hydraulic lash adjusters, eliminating valve lash adjustment.

**VALVES:** Are made of heat resistant steel, valve springs are especially designed to be short. The valve spring wire cross-section is oval shaped and provides the same spring tension as longer springs. Valve spring retainers, locks and seals are conventional.

**INTAKE MANIFOLD:** The aluminum alloy manifold is a cross type with long runners to improve inertia. The runners, attaching below at the cylinder head, also attach above and support an air plenum. The air plenum chamber absorbs air pulsations created during the suction phase of each cylinder.

**EXHAUST MANIFOLDS:** Both manifolds are a log style made of ductile cast iron. Exhaust gasses,

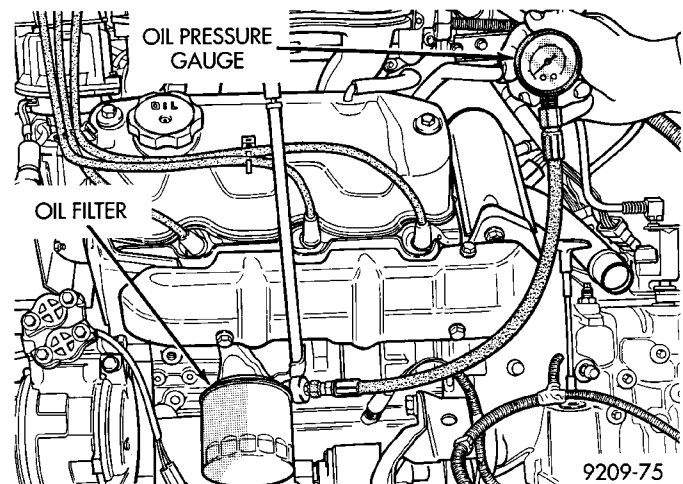
collected from the front cylinder bank, leave the front manifold through an end outlet and are fed through an upper crossover tube to the rear manifold. The collected exhaust from both manifolds are combined, and exit to the exhaust pipe through an articulated joint.

## DIAGNOSIS AND TESTING

## CHECKING ENGINE OIL PRESSURE

Check oil pressure using gauge at oil pressure switch location. Oil pressure should be 41 kPa ( 6 psi.) at idle or 241 to 517 kPa (35 to 75 psi.) at 3000 RPM.

(1) Remove pressure sending unit and install oil pressure gauge. (Fig. 2).



*Fig. 2 Checking Engine Oil Pressure*

**CAUTION:** If oil pressure is 0 at idle, Do Not Run engine at 3000 RPM.

(2) Warm engine at high idle until thermostat opens.

## SERVICE PROCEDURES

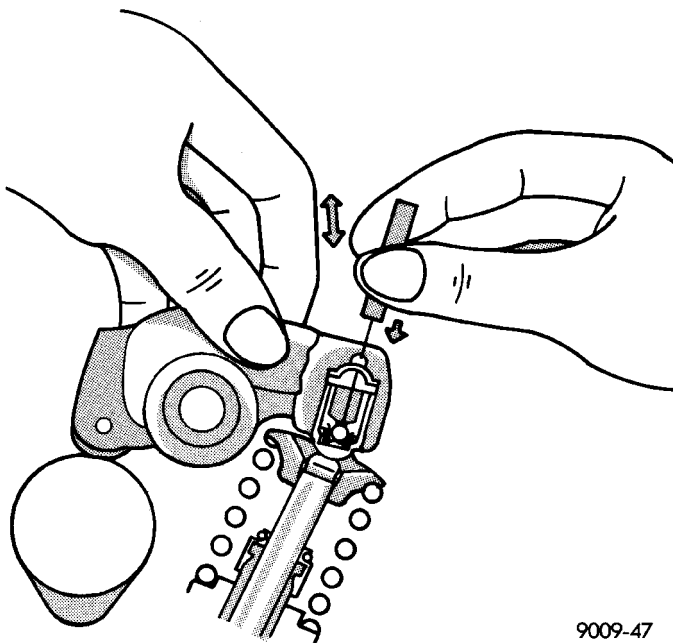
## AUTO LASH ADJUSTER

The automatic lash adjusters are precision units installed in machined openings in the valve actuating ends of the rocker arms. Do not disassemble the auto lash adjuster.

## FUNCTION CHECK

Check auto adjusters for free play by inserting a small wire through the air bleed hole in the rocker arm and **very lightly** pushing the auto adjuster ball check down (Fig. 3). While lightly holding the check ball down move the rocker up and down to check for free play. If there is no play replace the adjuster.

## SERVICE PROCEDURES (Continued)



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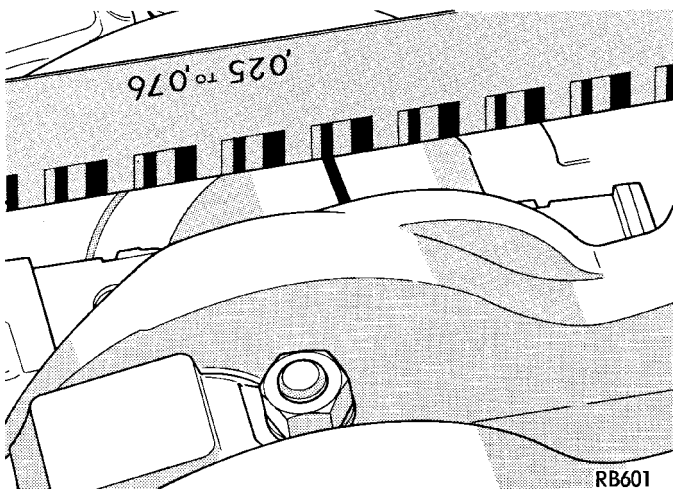
**Fig. 3 Auto Lash Adjuster—Function Check****FITTING CONNECTING ROD BEARINGS****CONNECTING ROD CLEARANCE**

(1) Following procedures specified in the Standard Service Procedures Section for Measuring Main Bearing Clearance and Connecting Rod Bearing Clearance (Fig. 4). Refer to (Fig. 6) for specifications.

(2) Tighten nuts to 52 N·m (38 ft. lbs.).

(3) Remove connecting rod cap and measure Plastigage (Fig. 4).

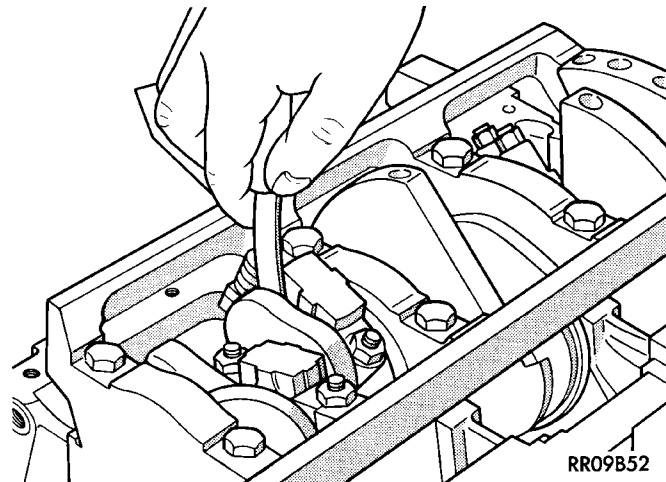
**CAUTION:** Do not rotate crankshaft or the Plastigage may be smeared.



RB601

**Fig. 4 Connecting Rod—Checking Bearing Clearance****CONNECTING ROD SIDE CLEARANCE**

Using a feeler gauge, check connecting rod side clearance (Fig. 5). Refer to (Fig. 6) for specification.



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**Fig. 5 Checking Connecting Rod Side Clearance****CONNECTING ROD BEARING OIL CLEARANCE**

NEW PART:	.020 to .067 mm (.0008 to .0028 in.)
-----------	---

**CONNECTING ROD SIDE CLEARANCE**

NEW PART:	0.10 to 0.25 mm (.004 to .010 in.)
WEAR LIMIT:	0.4 mm (.015 in.)

**Fig. 6 Connecting Rod Specifications****CONNECTING ROD BEARING OIL CLEARANCE**

NEW PART:	.020 TO .067 mm (.0008 TO .0028 in.)
-----------	---

**CONNECTING ROD SIDE CLEARANCE**

NEW PART:	0.10 TO 0.25 mm (.004 TO .010 in.)
WEAR LIMIT:	0.4 mm (.015 in.)

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**FITTING MAIN BEARING****INSPECTION**

Visually check the main and connecting rod bearing journals for wear, scuffs or scoring and replace if necessary.

**CRANKSHAFT OIL CLEARANCE—MECHANICAL MEASUREMENT**

Measure the journal outside diameter and the main bearing inside diameter (Fig. 7) & (Fig. 8). If the clearance exceeds the specifications limit (Fig. 9). Replace the main bearing(s) and if necessary replace the crankshaft.

SERVICE PROCEDURES (Continued)

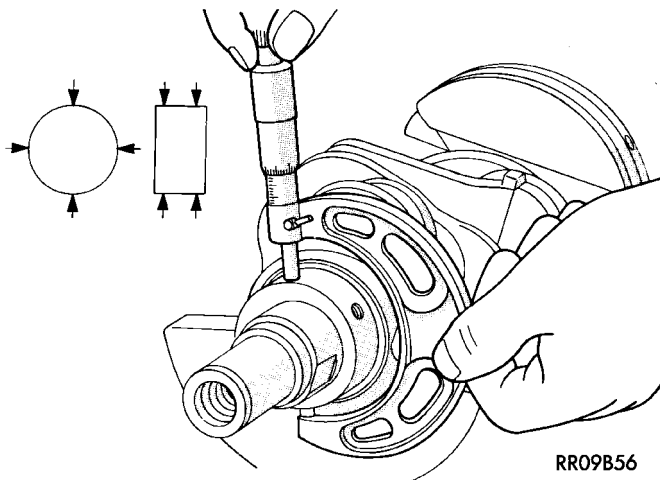


Fig. 7 Measure Crankshaft Journal O.D.

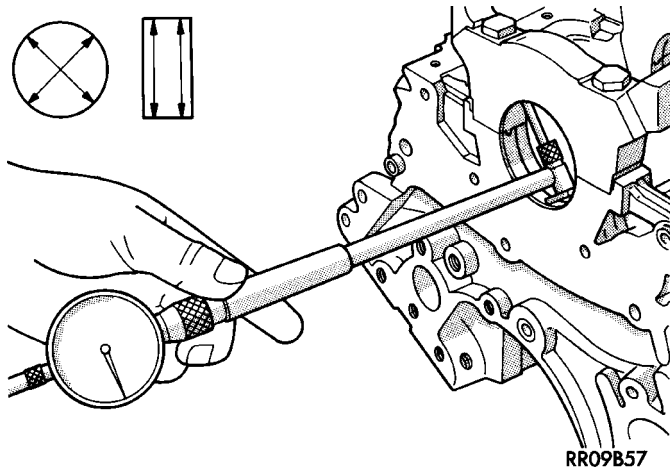


Fig. 8 Measure Main Bearing I.D.

PLASTIGAGE MEASUREMENT

- (1) Remove oil from journal and bearing shell.
- (2) Install crankshaft.
- (3) Cut plastigage to same length as width of the bearing and place it in parallel with the journal axis (Fig. 10).

**CAUTION:** Do not rotate crankshaft or the plastigage will be smeared.

- (4) Install the main bearing cap carefully and tighten the bolts to specified torque.

- (5) Carefully remove the bearing cap and measure the width of the plastigage at the widest part using the scale on the plastigage package (Fig. 11). Refer to specification (Fig. 9) for proper clearances. Also see Measuring Main and Connecting Rod Bearing Clearance in Standard Service Procedures.

CRANKSHAFT BEARING INSTALLATION

When the bearings need replacing, select and install the proper bearing by the following procedure.

CRANKSHAFT END-PLAY		
NEW PART:	.05 TO 0.25 mm	(.002 to .0010 in.)
WEAR LIMIT:	0.30 mm	(.012 in.)
MAIN BEARING OIL CLEARANCE		
NEW PART:	.020 TO .048 mm	(.0008 TO .0018 in.)
WEAR LIMIT:	.10 mm	(.0039 in.)
CRANKSHAFT JOURNAL SIZES		
CRANKSHAFT MAIN BEARING JOURNAL		
ALL	DIAMETER	
STANDARD	59.980 mm (2.361 in.)	
CRANKSHAFT CONNECTING ROD JOURNAL		
ALL	DIAMETER	
STANDARD	50.00 mm (1.968 in.)	

Fig. 9 Crankshaft Clearance Specification

CRANKSHAFT END-PLAY		
NEW PART:	.05 TO 0.25 mm	(.002 TO .0010 in.)
WEAR LIMIT:	0.30 mm	(.012 in.)
MAIN BEARING OIL CLEARANCE		
NEW PART:	.020 TO .048 mm	(.0008 TO .0018 in.)
WEAR LIMIT:	.10 mm	(.0039 in.)
CRANKSHAFT JOURNAL SIZES		
CRANKSHAFT MAIN BEARING JOURNAL		
ALL	DIAMETER	
STANDARD	59.980 mm (2.361 in.)	
CRANKSHAFT CONNECTING ROD JOURNAL		
ALL	DIAMETER	
STANDARD	50.00 mm (1.968 in.)	

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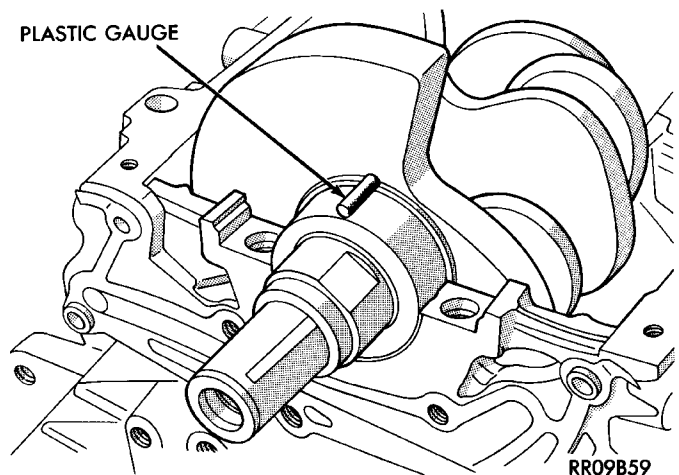


Fig. 10 Measure Oil Clearance with Plastigage

## SERVICE PROCEDURES (Continued)

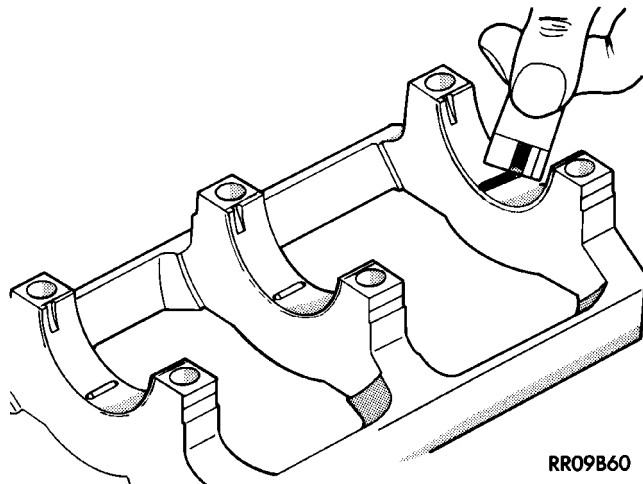


Fig. 11 Measuring Clearance

(1) Measure the crankshaft journal diameter and confirm its classification from the following (Fig. 12). In the case of a bearing supplied as a service part, its identification color is painted at the position show in (Fig. 13).

**NOTE:** Service replacement parts have identification marks, but factory-assembled parts have no identification marks. Service crankshaft identification may have marks or paint at counterweights (Fig. 12).

### CHECKING CRANKSHAFT END PLAY

- (1) Mount a dial indicator to front of engine, locating probe on nose of crankshaft (Fig. 14).
- (2) Move crankshaft all the way to the rear of its travel.
- (3) Zero the dial indicator.
- (4) Move crankshaft all the way to the front and read the dial indicator. Refer to (Fig. 15) for specification.

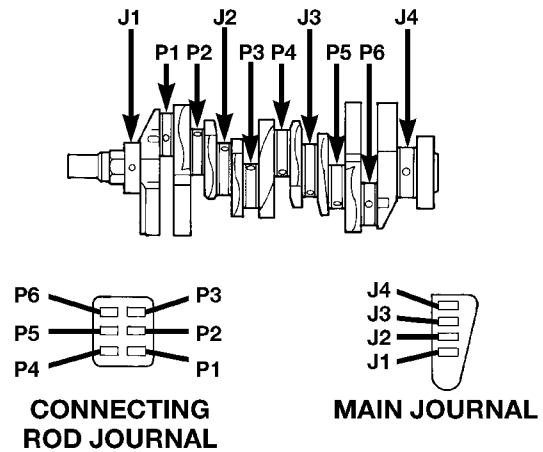
### VALVE SERVICE RECONDITION

- (1) With suitable valve spring compressor, remove spring retainer locks, retainer, valve spring, spring seat and valve (Fig. 16).
- (2) Remove valve stem seals with suitable tool (Fig. 17). Do not reuse valve stem seals.

### VALVES

- (1) Check valve stem tip for pitting or depression at point A (Fig. 18).
- (2) Check for wear and ridge wear at Point B.
- (3) Check for even contact (at face center) with valve seat, Point C.
- (4) Check margin (Fig. 18). Replace valve if margin is out of specification. Refer to (Fig. 20).
- (5) Check valve guide height (Fig. 19).

### CRANKSHAFT SIZE IDENTIFICATION



#### MAIN JOURNAL

SIZE	NEW	CURRENT
59.543 to 59.695 mm (2.344 to 2.350 in.)	2	WHITE ENAMEL
59.695 to 59.848 mm (2.350 to 2.356 in.)	1	NONE
59.848 to 60.000 mm (2.356 to 2.362 in.)	0	YELLOW ENAMEL

#### CONNECTING ROD JOURNAL

SIZE	NEW	CURRENT
49.492 to 49.619 mm (1.949 to 1.954 in.)	III	WHITE ENAMEL
49.619 to 49.873 mm (1.954 to 1.964 in.)	II	NONE
49.873 to 50.000 mm (1.964 to 1.969 in.)	I	YELLOW ENAMEL

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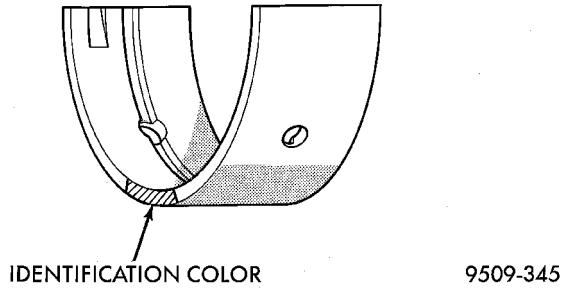
Fig. 12 Crankshaft Size Identification

- (6) Measure valve stem to guide clearance. Refer to specification (Fig. 20).
- (7) Measure Valve spring free length and squareness (Fig. 21). Refer to (Fig. 20) for specifications.

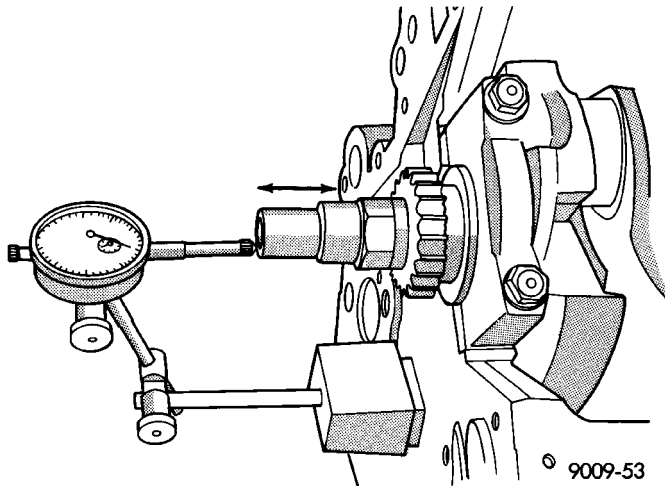
### VALVE SEAT

Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve

SERVICE PROCEDURES (Continued)



**Fig. 13 Bearing Identification**

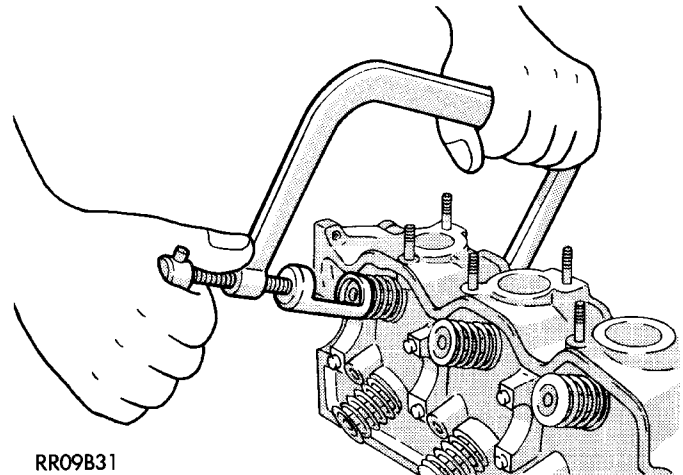


**Fig. 14 Checking Crankshaft End Play**

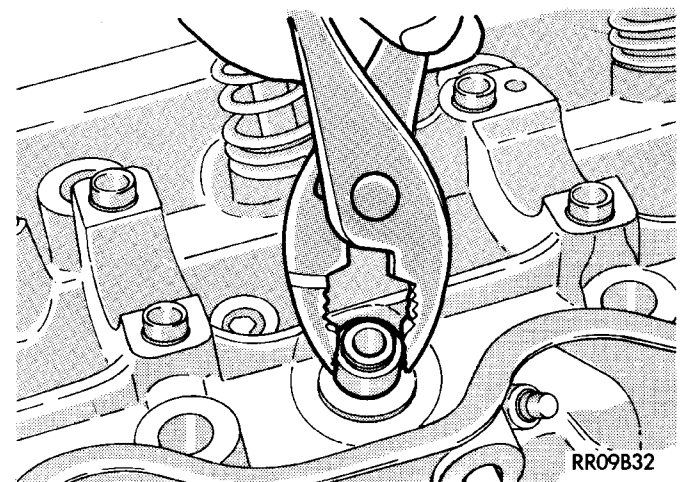
CRANKSHAFT END-PLAY	
NEW PART: .05 TO 0.25 mm	(.002 TO .0010 in.)
WEAR LIMIT: 0.30 mm	(.012 in.)
MAIN BEARING OIL CLEARANCE	
NEW PART: .020 TO .048 mm	(.0008 TO .0018 in.)
WEAR LIMIT: .10 mm	(.0039 in.)
CRANKSHAFT JOURNAL SIZES	
CRANKSHAFT MAIN BEARING JOURNAL	
ALL	DIAMETER
STANDARD	59.980 mm (2.361 in.)
CRANKSHAFT CONNECTING ROD JOURNAL	
ALL	DIAMETER
STANDARD	50.00 mm (1.968 in.)

**Fig. 15 Crankshaft Clearance Specification**

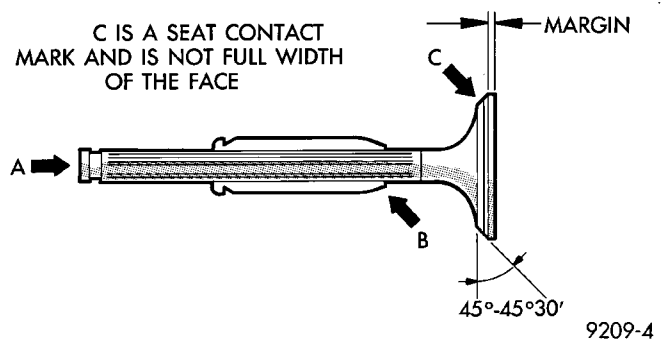
face, contact is satisfactory. If the blue is transferred to top edge of the valve face, lower valve seat with a 15 degrees stone. If the blue is transferred to the bottom edge of valve face raise valve seat with a 65 degree stone (Fig. 22).



**Fig. 16 Remove Valves**



**Fig. 17 Remove Valve Stem Seals**



**Fig. 18 Valve Inspection**

**INSTALLATION**

- (1) Install valve spring seat.
- (2) Using suitable tool install seal by tapping lightly until seal is in place (Fig. 23).
- (3) Install valve spring with the enamelled ends facing the rocker arms (Fig. 24).

SERVICE PROCEDURES (Continued)

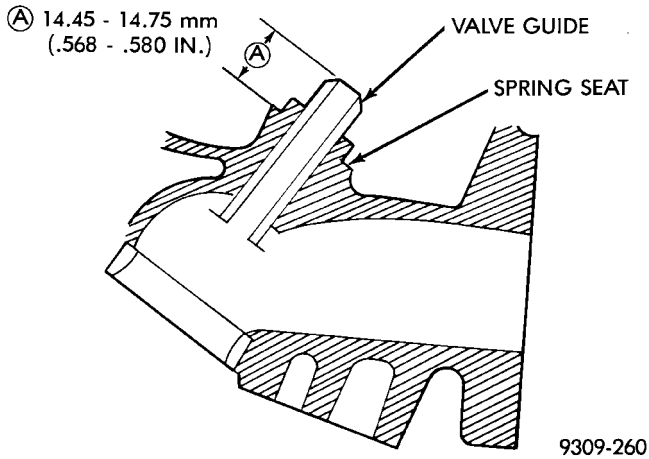


Fig. 19 Valve Guide Height

VALVE DIMENSIONS		
<b>INTAKE VALVE (MINIMUM)</b>		
STEM DIAMETER: 7.960 mm (.313 in.)		
FACE ANGLE: 45°		
VALVE MARGIN: .700 mm (.028 in.)		
LENGTH: 103.0 mm (4.055 in.)		
<b>EXHAUST VALVE (MINIMUM)</b>		
STEM DIAMETER: 7.930 mm (.312 in.)		
FACE ANGLE: 45°		
VALVE MARGIN: 1.50 mm (.059 in.)		
LENGTH: 102.70 mm (4.043 in.)		
VALVE GUIDE CLEARANCE	NEW	SERVICE LIMIT
INTAKE	0.03 TO 0.06 mm (.001 TO .002 in.)	0.10 mm (.004 in.)
EXHAUST	0.05 TO 0.09 mm (.002 TO .0035 in.)	0.15 mm (.006 in.)
VALVE SPRING SPECIFICATION		
FREE LENGTH	NEW	49.8 mm (1.960 in.)
	SERVICE LIMIT	48.8 mm (1.921 in.)
SQUARENESS	NEW	2° MAXIMUM
	SERVICE LIMIT	4° MAXIMUM
SPRING TENSION	INSTALLED HEIGHT	40.4 mm AT 33 KG (1.59 in. 73 LBS.)

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Fig. 20 Valve Specification

**CAUTION:** During reassembly, compressing the valve spring more than necessary to install valve spring retainer locks can cause the retainer to be forced against the stem seal and damaging it.

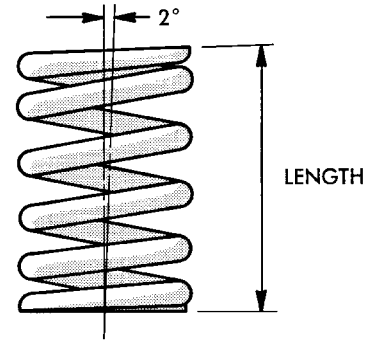


Fig. 21 Valve Spring

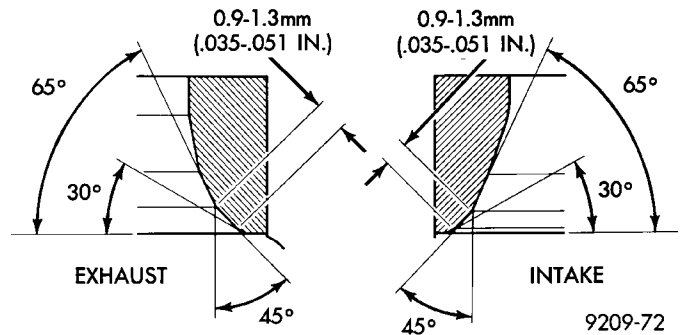


Fig. 22 Valve Seat Reconditioning

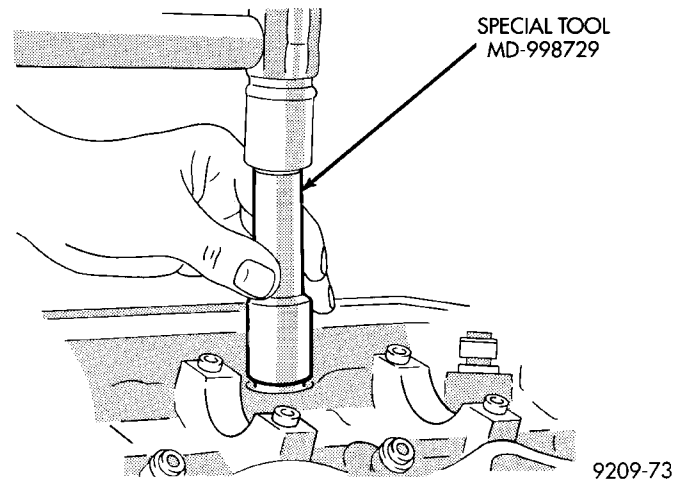


Fig. 23 Install Valve Stem Seals

REMOVAL AND INSTALLATION

ENGINE MOUNTS

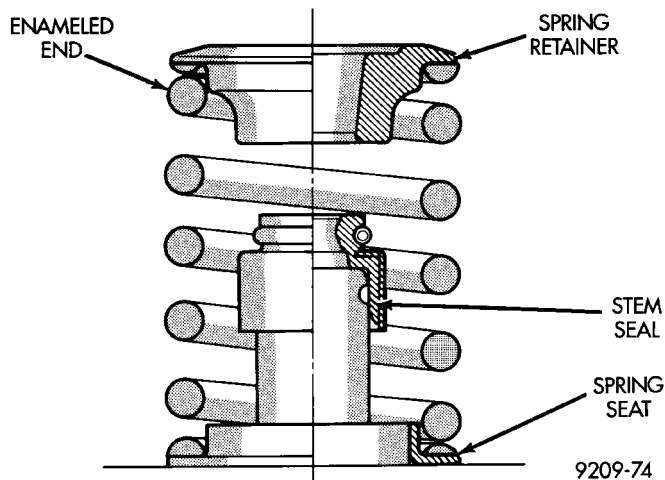
RIGHT SIDE MOUNT

REMOVAL

**NOTE:** Right mount should only be serviced as an assembly to prevent noise, vibration and harshness concerns.

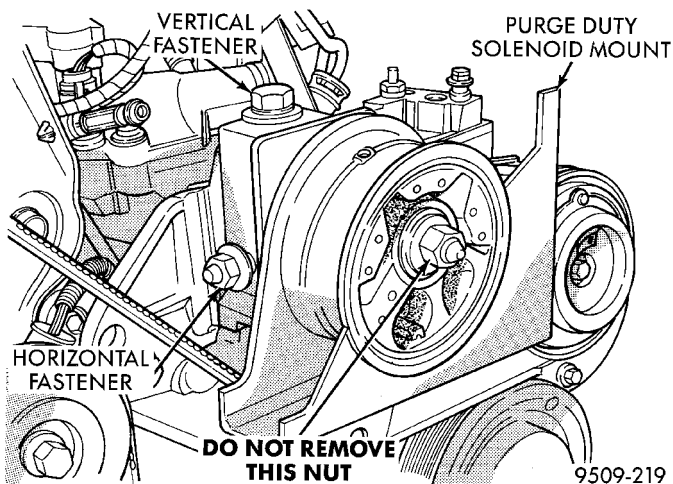
- (1) Remove the purge duty solenoid and wiring harness from engine mount.

## REMOVAL AND INSTALLATION (Continued)



**Fig. 24 Installed Valve Spring Position**

(2) Remove the two right engine mount insulator vertical fasteners and loosen the horizontal fastener. **Do Not remove the large nut on the end of the core from the frame rail (Fig. 25).**



**Fig. 25 Engine Mount—Right**

(3) Remove the load on the engine motor mounts by carefully supporting the engine and transmission assembly with a floor jack.

(4) Remove the vertical and horizontal fasteners from the engine side bracket. Remove the engine mount assembly

## INSTALLATION

(1) Reverse removal procedure for installation. Tighten assembly in the following order:

- (a) Engine mount to rail fasteners to 68 N·m (50 ft. lbs.).
- (b) The vertical engine fastener to 102 N·m (75 ft. lbs.).
- (c) The horizontal fastener to 150 N·m (111 ft. lbs.).

(2) Install the purge duty solenoid and wiring harness to the engine mount.

(3) Engine mount adjustment, Refer to Engine Mount Insulator Adjustment.

## FRONT MOUNT

## REMOVAL

(1) Support the engine and transmission assembly with a floor jack so it will not rotate.

(2) Remove the front engine mount through bolt from the insulator and front crossmember mounting bracket (Fig. 26).

(3) Remove six screws from air dam to allow access to the front mount screws.

(4) Remove the front engine mount screws and remove the insulator assembly.

(5) Remove the front mounting bracket, if necessary (Fig. 26).

## INSTALLATION

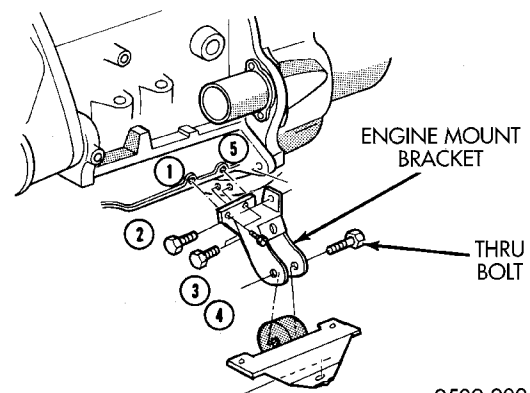
(1) Reverse removal procedure for installation and tighten fasteners in this order:

- (a) Tighten bolts 2,3, and 4 to 108 N·m (80 ft. lbs.).
- (b) Tighten bolts 1 and 5 to 54 N·m (40 ft. lbs.).

(2) Engine mount adjustment. Refer to Engine Mount Insulator Adjustment of this section.

(3) Install six screws to air dam and tighten to 12 N·m (105 in. lbs.).

REFER TO TEXT  
FOR TORQUE VALUES



**Fig. 26 Engine Mount—Front**

## LEFT SIDE MOUNT

## REMOVAL

(1) Raise vehicle on hoist and remove left front wheel.

(2) Support the transmission with a transmission jack.

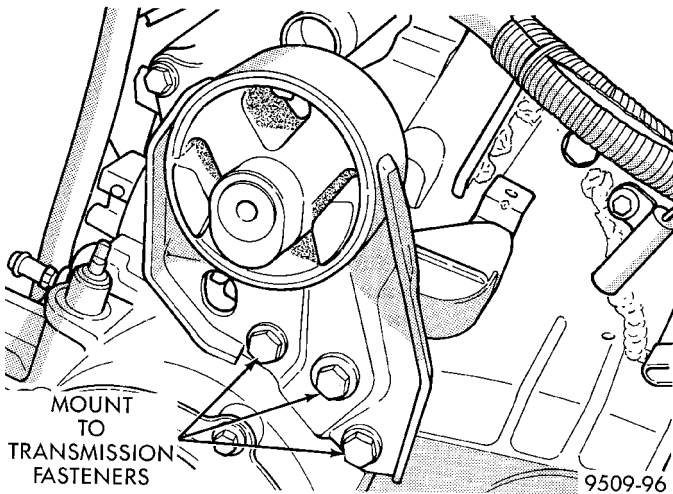
(3) Remove the insulator through bolt from the mount.

## REMOVAL AND INSTALLATION (Continued)

(4) Remove the transmission mount fasteners and remove mount.

## INSTALLATION

- (1) Reverse removal procedure for installation.
- (2) Tighten mount to transmission bolts to 55 N·m (40 ft. lbs.) (Fig. 27).
- Tighten through bolt to 75 N·m (55 ft. lbs.)
- (3) Engine mount adjustment, Refer to Engine Mount Insulator Adjustment of this section.



**Fig. 27 Engine Mount—Left**

## REAR MOUNT

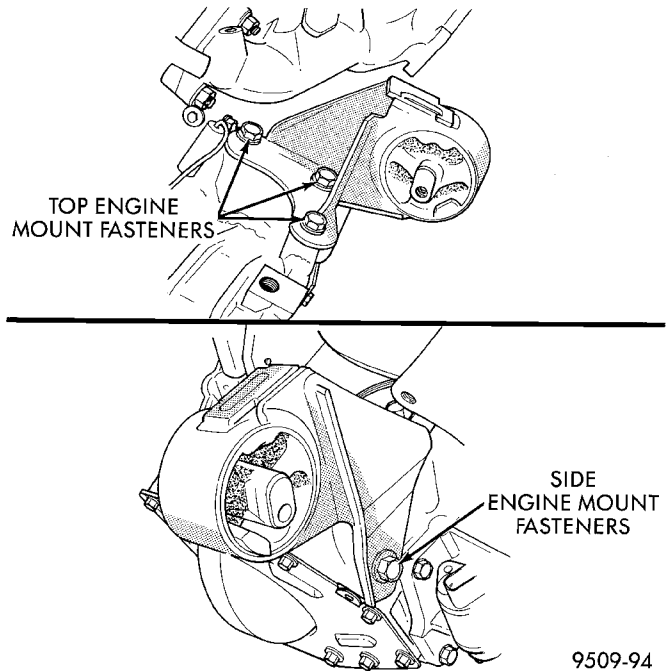
- (1) Raise vehicle on hoist.
- (2) Support the transmission with a transmission jack so it will not rotate.
- (3) Remove the insulator through bolt from the mount and rear suspension crossmember.
- (4) Remove the four transmission mount fasteners and remove the mount.
- (5) Reverse the removal procedure for installation. Refer to (Fig. 28).

## ENGINE MOUNT RUBBER INSULATORS

Insulator location on (right side) is adjustable to allow right/left drive train adjustment in relation to driveshaft assembly length. See Engine Mount Adjustments in this section.

Check and reposition right engine mount insulator. Adjust drive train position, if required, for the following conditions:

- Driveshaft distress: See Group 2, Suspension and Driveshafts.
- Any front end structural damage (after repair).
- Insulator replacement.



**Fig. 28 Engine Mount—Rear**

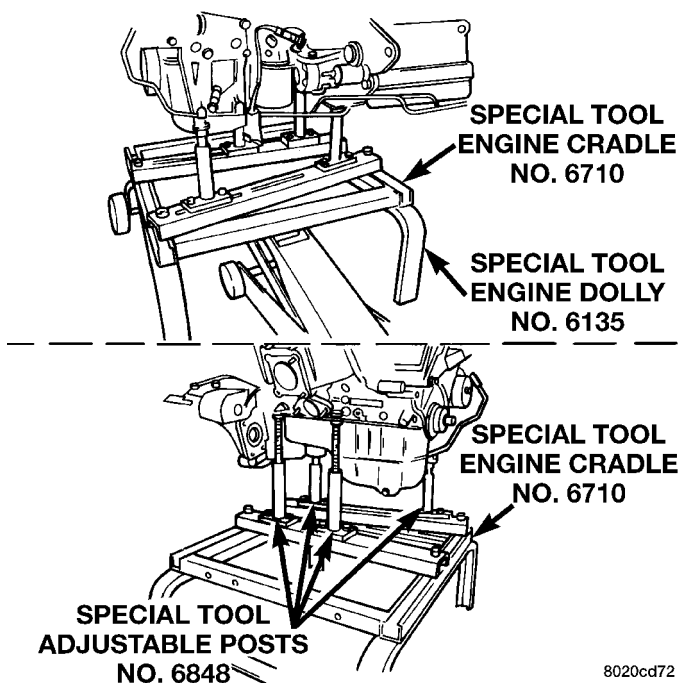
## ENGINE ASSEMBLY

## REMOVAL

- (1) Perform fuel pressure release procedure. Refer to Group 14, Fuel System for procedure. Remove fuel line to fuel rail.
- (2) Disconnect battery.
- (3) Remove Air cleaner and hoses.
- (4) Remove battery cover, battery and battery tray, with integral vacuum reservoir, from vehicle.
- (5) Block off heater hoses to rear heater assembly, if equipped.
- (6) Drain cooling system. Refer to Group 7, Cooling System for procedure.
- (7) Disconnect heater hoses.
- (8) Remove fan module and radiator. Refer to Group 7, Cooling System for procedure.
- (9) Disconnect transmission shift linkage.
- (10) Disconnect throttle body linkage and vacuum hoses from throttle body.
- (11) Remove accessory drive belts. Refer to Accessory Drive System located in Group 7, Cooling System for procedure.
- (12) Remove air conditioning compressor from engine and set it aside.
- (13) Disconnect generator wiring harness and remove generator.
- (14) Hoist vehicle and remove axle shafts. Refer to Group 2, Driveshaft for procedure.
- (15) Remove right and left inner splash shields.
- (16) Disconnect exhaust pipe from manifold.
- (17) Remove front engine mount and bracket as an assembly.

## REMOVAL AND INSTALLATION (Continued)

- (18) Remove rear transmission mount and bracket.
- (19) Remove power steering pump and bracket assembly.
- (20) Remove wiring harness and connectors from front of engine.
- (21) Remove bending braces and install tool number 6910 on engine.
- (22) Remove trans inspection cover and mark flexplate to torque converter.
- (23) Remove driveplate to torque converter bolts.
- (24) Lower the vehicle.
- (25) Remove ground straps to body.
- (26) Raise vehicle enough to allow engine dolly Special Tool 6135 and cradle Special Tool 6710 with post Special Tool 6848 and adaptor Special Tool 6909 to be installed under vehicle (Fig. 29).
- (27) Loosen cradle engine mounts to allow movement for positioning onto engine locating holes on the engine. Lower vehicle and position cradle mounts until the engine is resting on mounts. Tighten mounts to cradle frame. This will keep mounts from moving when removing or installing engine and transmission.
- (28) Lower vehicle so the weight of **ONLY THE ENGINE AND TRANSMISSION** is on the cradle.
- (29) Remove right engine mount assembly and left transmission mount through bolt. Refer to Engine Mounts Section of this Group.
- (30) Raise vehicle slowly. It may be necessary to move the engine/transmission assembly on the cradle to allow for removal around body flanges.



8020cd72

**Fig. 29 Positioning Engine Cradle Support Post Mounts—Typical**

## INSTALLATION

- (1) Position engine and transmission assembly under vehicle and slowly lower the vehicle over the engine and transmission. It may be necessary to move the engine/transmission assembly with the cradle for clearance around body flanges.
- (2) Align engine and transmission mounts to attaching points. Install mounting bolts at the right engine and left transmission mounts. Refer to procedures outlined in this section.
- (3) Slowly raise vehicle enough to remove the engine dolly and cradle Special Tools 6135, 6710, 6848 and 6909.
- (4) Remove Special tools 6910 and install bending braces.
- (5) Lower vehicle. Install generator and wiring harness.
- (6) Connect wiring harness on the front of the engine.
- (7) Install Air Conditioning Compressor.
- (8) Install power steering pump and bracket and accessory drive belt. Refer to Group 7, Accessory Drive Belts Section for installation procedure.
- (9) Raise vehicle and install axle shafts. Refer to Group 2, Driveshafts for procedure.
- (10) Install transmission and engine mount and bracket assemblies. Refer to Engine Mounts in this section for procedure.
- (11) Connect exhaust system to manifold. Refer to Group 11, Exhaust System and Intake Manifold for procedure and torque specifications.
- (12) Install left and right inner splash shields.
- (13) Connect automatic transmission shifter linkage. Refer to Group 21, Transmission for procedures.
- (14) Lower vehicle and connect fuel line and heater hoses. Remove plugs from rear heater hoses and install, if equipped.
- (15) Install ground straps. Connect engine and throttle body connections and harnesses.
- (16) Connect throttle body linkage. Refer to Group 14, Fuel System for procedure.
- (17) Install radiator and fan module assembly. Install radiator hoses. Fill cooling system. Refer to Group 7, Cooling for procedures.
- (18) Install battery tray, battery and cover.
- (19) Install air cleaner and hoses.
- (20) Install oil filter. Fill engine crankcase with proper oil to correct level.
- (21) Start engine and run until operating temperature is reached.
- (22) Adjust transmission linkage, if necessary.

## CYLINDER HEAD COVER

## REMOVAL

- (1) Disconnect negative cable from battery.

## REMOVAL AND INSTALLATION (Continued)

(2) Remove air inlet resonator when removing left head cover.

(3) When Removing left cylinder head cover, remove dipstick tube.

(4) When removing right cylinder head cover remove wiper unit. Refer to Wiper Unit Removal in Group 8K.

(5) When removing right cylinder head cover, remove accessory drive belt. Refer to Accessory Drive Belt Removal in Group 7.

(6) When removing right cylinder head cover, disconnect generator wiring and remove generator.

(7) Relocate spark plug wires.

(8) Remove vacuum connections.

(9) Remove rocker cover screws and remove cover (Fig. 30).

## INSTALLATION

(1) Clean cylinder head and cover mating surfaces. Install new gasket.

(2) See (Fig. 30) and apply sealant such as Mopar Silicone Rubber Adhesive Sealant to cover ends.

(3) Install cover and tighten cover bolt washer and gasket assembly to 10 N·m (88 in. lbs.).

(4) Reverse removal procedures for installation.

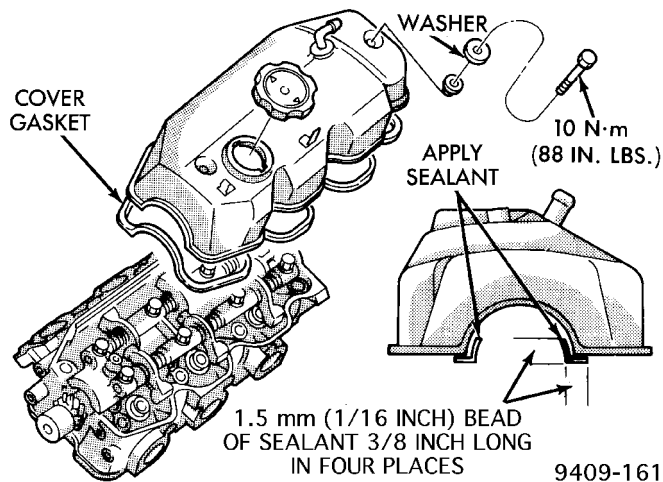


Fig. 30 Rocker Cover

## CAMSHAFT

## REMOVAL

**NOTE: SEE AUTO LASH ADJUSTER FUNCTION CHECK BEFORE DISASSEMBLY**

(1) Install auto lash adjuster retainers (Fig. 31).

(2) Remove distributor adaptor (Fig. 32).

(3) When removing camshaft bearing caps do not remove the bolts from the bearing caps. Remove the rocker arm, rocker shafts and bearing cap as an assembly.

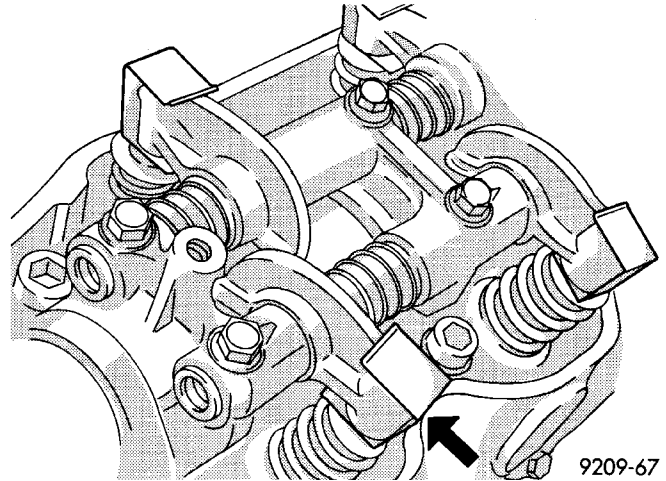


Fig. 31 Auto Lash Adjuster Retainers

## CAMSHAFT INSPECTION

(1) Inspect camshaft bearing journals for damage and binding (Fig. 33). If journals are binding, also check the cylinder head for damage. Also check cylinder head oil holes for clogging.

(2) Front cylinder head camshaft check the tooth surface of the distributor drive gear teeth of the camshaft and replace if abnormal wear is evident (Fig. 33).

(3) Check the cam surface for abnormal wear and damage and replace if defective. Also measure the cam height (Fig. 33) and replace if out of limit, standard value is 41.25 mm (1.624 in.), wear **limit** is 40.75 mm (1.604 in.).

## CAMSHAFT INSTALL

Lubricate camshaft journals and cams with engine oil and install camshaft on cylinder head.

## ROCKER ARMS

## INSTALL ROCKER ARM SHAFT ASSEMBLY

(1) Apply Mopar Silicone Rubber Adhesive Sealant at bearing cap ends as shown in (Fig. 34).

(2) Install the rocker arm shaft assembly making sure that the arrow mark on the bearing cap and the arrow mark on the cylinder head are in the same direction (Fig. 34).

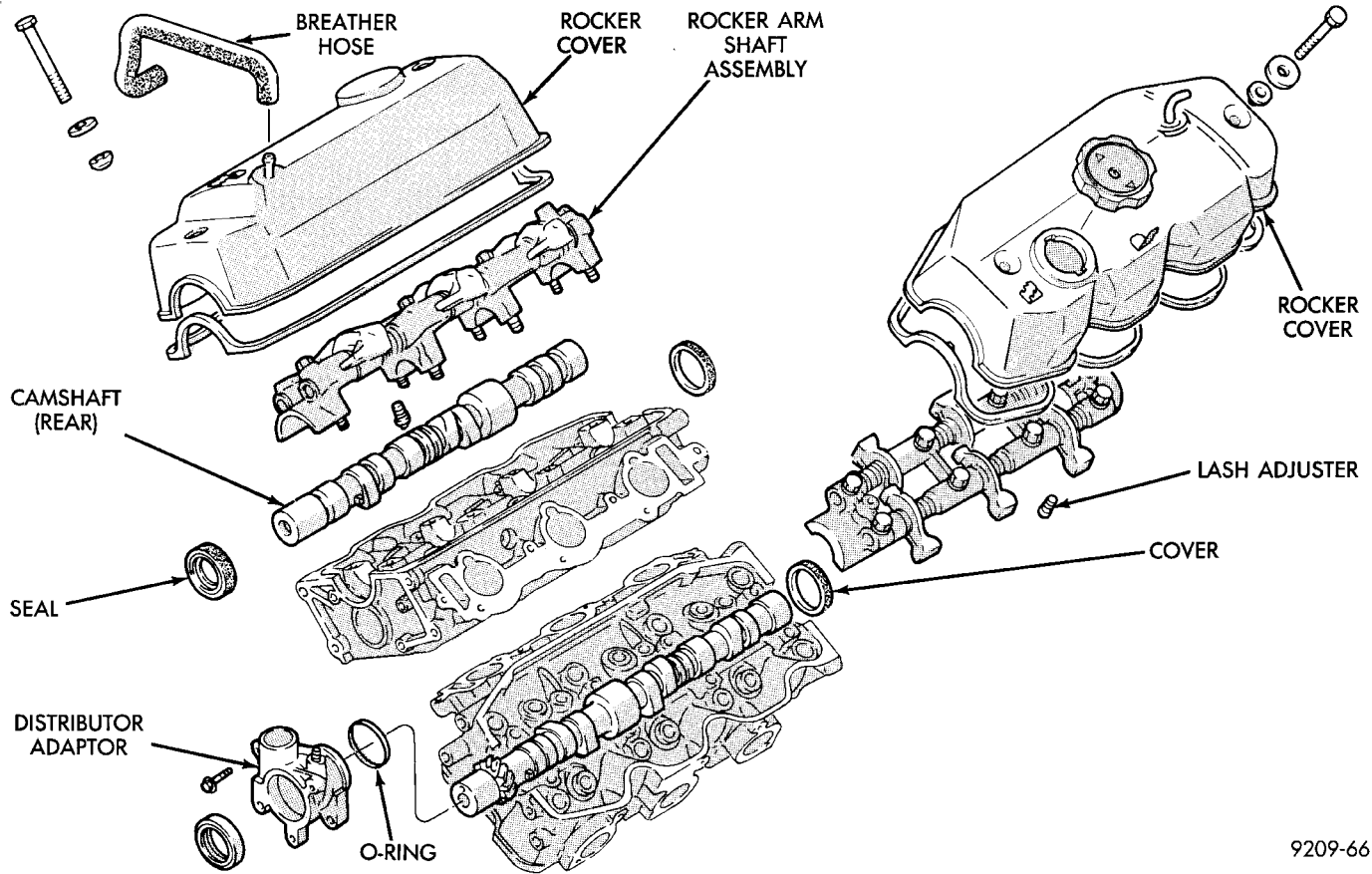
**NOTE: The direction of arrow marks on the front and rear assemblies are opposite to each other.**

(3) Tighten bearing cap bolts in the following order to 10 N·m (85 in. lbs.). First #3, then #2, #1 and #4.

(4) Repeat step 3 increasing the torque to 20 N·m (180 in.lbs.).

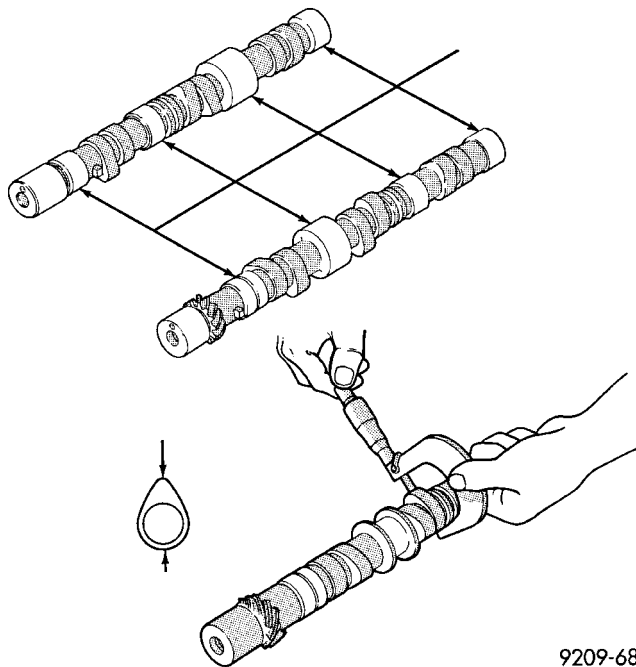
(5) Install distributor drive adaptor assembly (Fig. 35).

REMOVAL AND INSTALLATION (Continued)



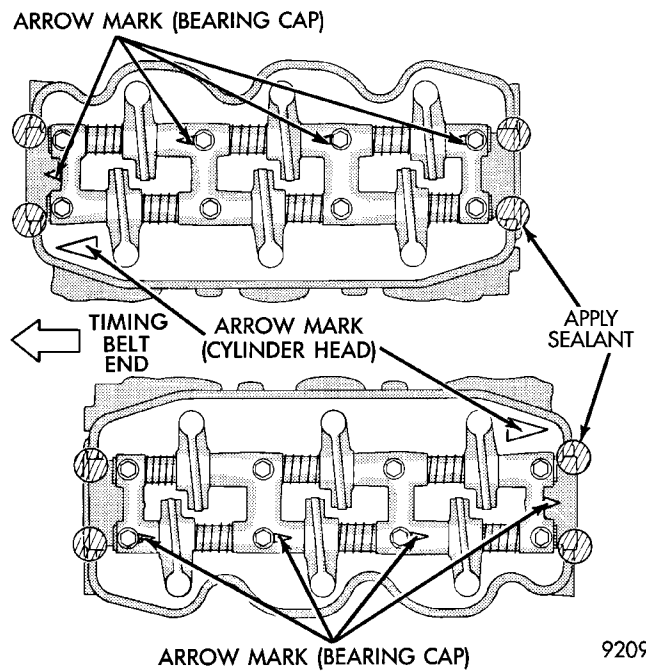
9209-66

**Fig. 32 Cylinder Heads and Camshafts**



9209-68

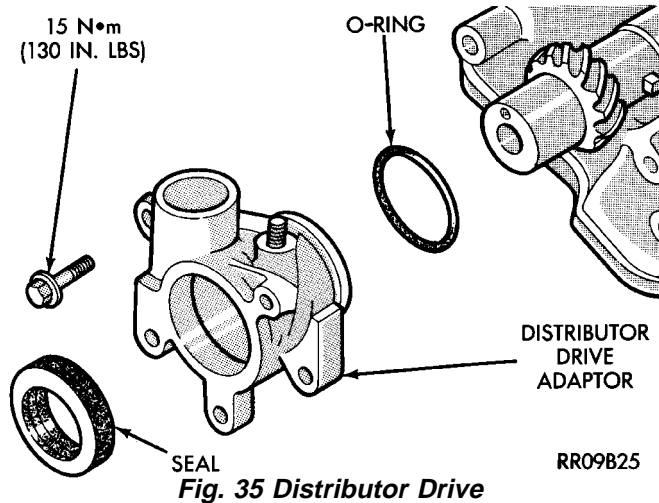
**Fig. 33 Checking Camshafts**



9209-7

**Fig. 34 Rocker Arm Shaft Direction**

## REMOVAL AND INSTALLATION (Continued)



## CAMSHAFT SEAL

## CAMSHAFT END SEAL (PLUG)— IN VEHICLE SERVICE

- (1) Remove air cleaner assembly from engine.
- (2) Use a small punch and a hammer, carefully remove cam plug from cylinder head.
- (3) Clean the area of the cylinder head where the new cam plug will be installed.
- (4) Apply a light coating of Mopar Silicone Rubber Adhesive Sealant to the outer diameter of the NEW cam plug.
- (5) Using a suitable installing tool and a hammer, install the new cam plug to a depth of 0.5 mm (0.020 in.) below the surface of the cylinder head.
- (6) Replace air cleaner assembly.

## CAMSHAFT OIL SEAL PLUG— OUT OF VEHICLE SERVICE

- (1) Apply light coat of engine oil to the camshaft oil seal lip.
- (2) Install the oil seal using camshaft oil seal installer tool MD-998713 (Fig. 36).

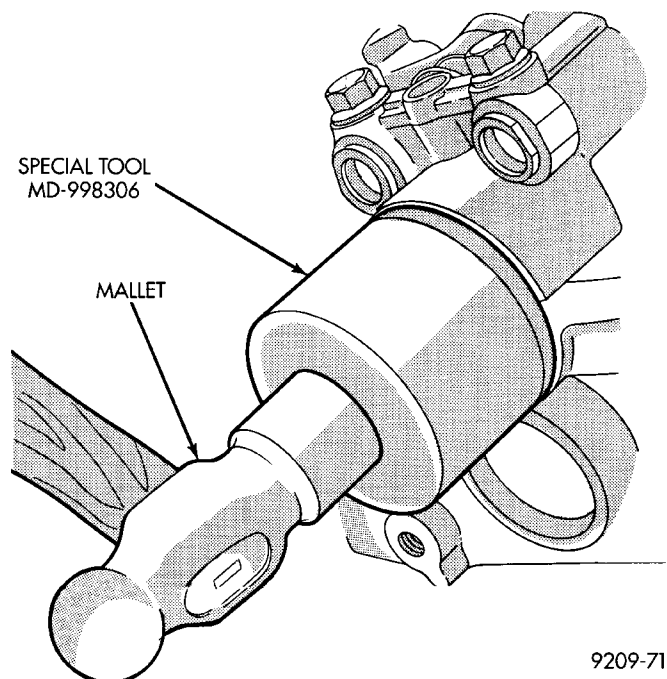
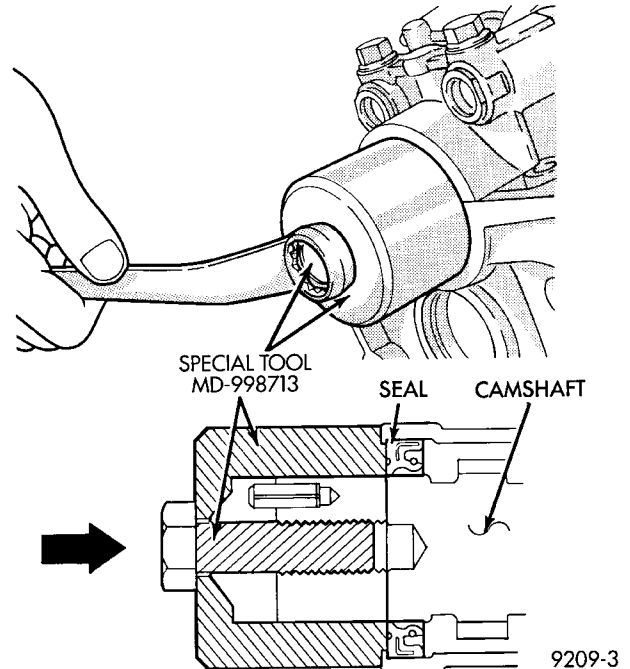
## CAMSHAFT END SEAL (PLUG) SERVICE — OUT OF VEHICLE SERVICE

Install end seal plug with Special Tool MD-998306 (Fig. 37).

## CYLINDER HEAD

## REMOVAL

- (1) See Timing System this group for disassembly and remove camshaft sprockets.
- (2) See Camshaft Rocker Arms Removal.
- (3) Remove upper intake manifold assembly. Refer to Intake and Exhaust Manifolds, Group 11.
- (4) Remove distributor.
- (5) Remove exhaust manifolds and cross over Refer to Intake and Exhaust Manifolds, Group 11.

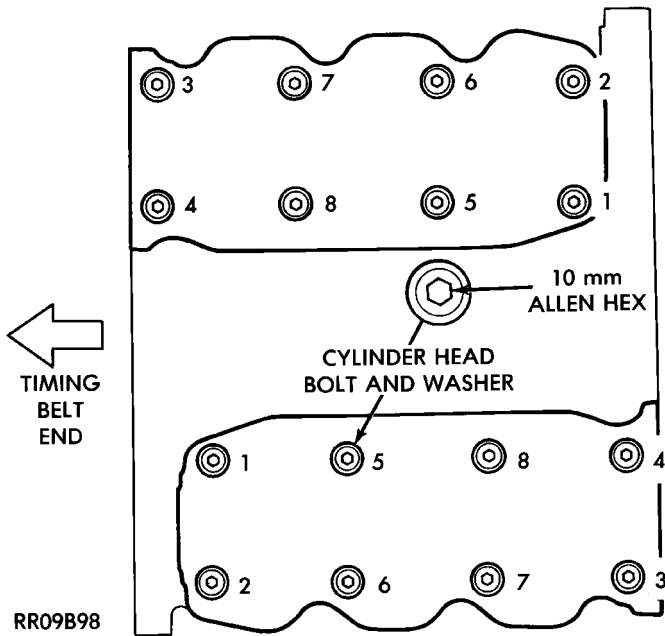


- (6) Remove cylinder head bolts in sequence shown in (Fig. 38) and remove cylinder head.

## INSTALLATION

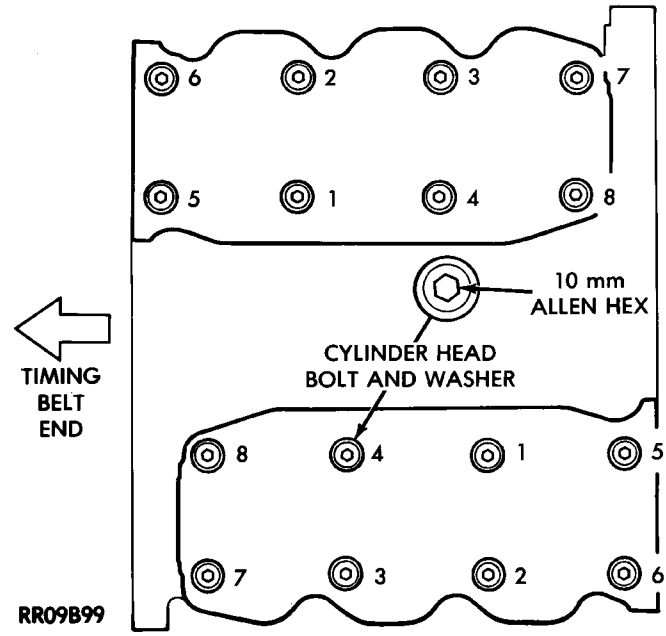
- (1) Clean surfaces of head and block, install head gasket over locating dowels.
  - (2) Install head on locating dowels.
  - (3) Install 10 mm allen hex head bolts with washers.
  - (4) Tighten bolts in the order shown in (Fig. 39).
- When tightening the cylinder head bolts, tighten

REMOVAL AND INSTALLATION (Continued)



**Fig. 38 Cylinder Head Bolt Removal Sequence**

gradually, working in two or three steps and finally tighten to specified torque of 108 N·m (80 ft. lbs.).

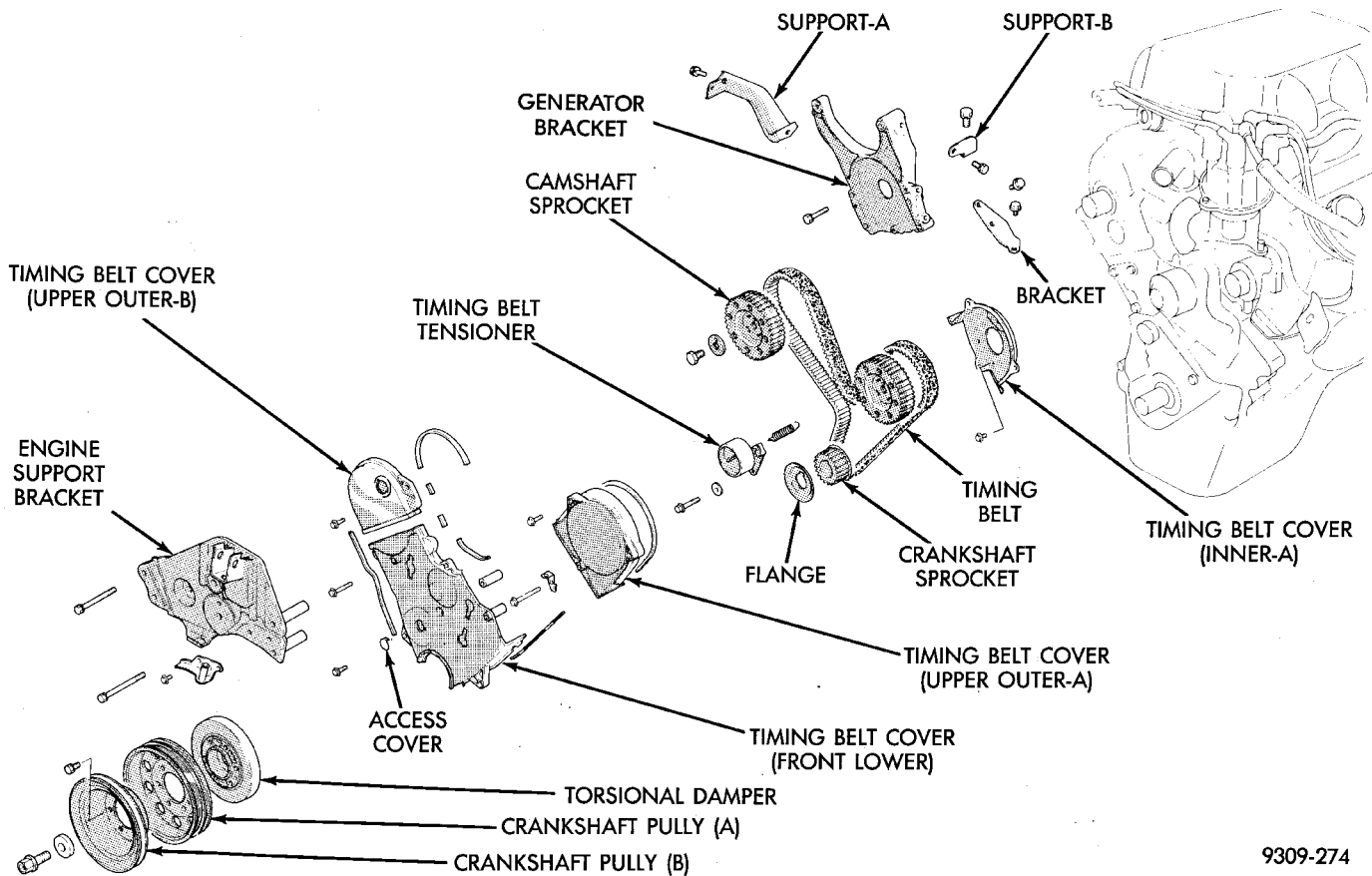


**Fig. 39 Cylinder Head Bolt Tightening Sequence**

**TIMING BELT**

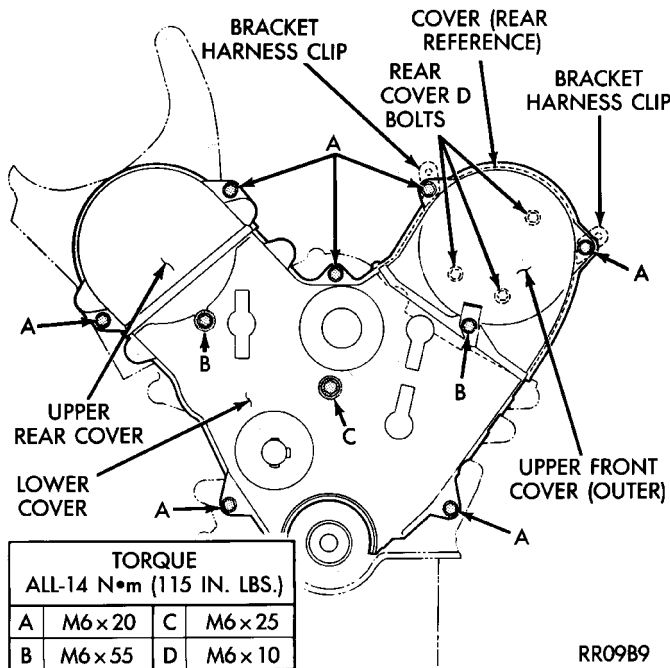
**REMOVAL**

(1) Mark belt running direction for installation (Fig. 42).



**Fig. 40 Timing Belt System**

## REMOVAL AND INSTALLATION (Continued)

**Fig. 41 Timing Belt Covers**

- (2) Loosen timing belt tensioner bolt (Fig. 44) and remove timing belt.
- (3) Remove crankshaft sprocket flange shield (Fig. 40).

**CAMSHAFT SPROCKETS**

To remove camshaft sprockets

1. Hold camshaft sprocket with Spanner Tool MB-990775 loosen and remove bolt and washer (Fig. 43).

2. Remove camshaft sprocket from camshaft.

To install camshaft sprockets

3. Place camshaft sprocket on camshaft.
4. Install bolt and washer to camshaft. Using Spanner Tool MB-990775 hold camshaft sprocket and torque bolt to 95 N•m (70 ft. lbs.) (Fig. 43).

**TIMING BELT TENSIONER**

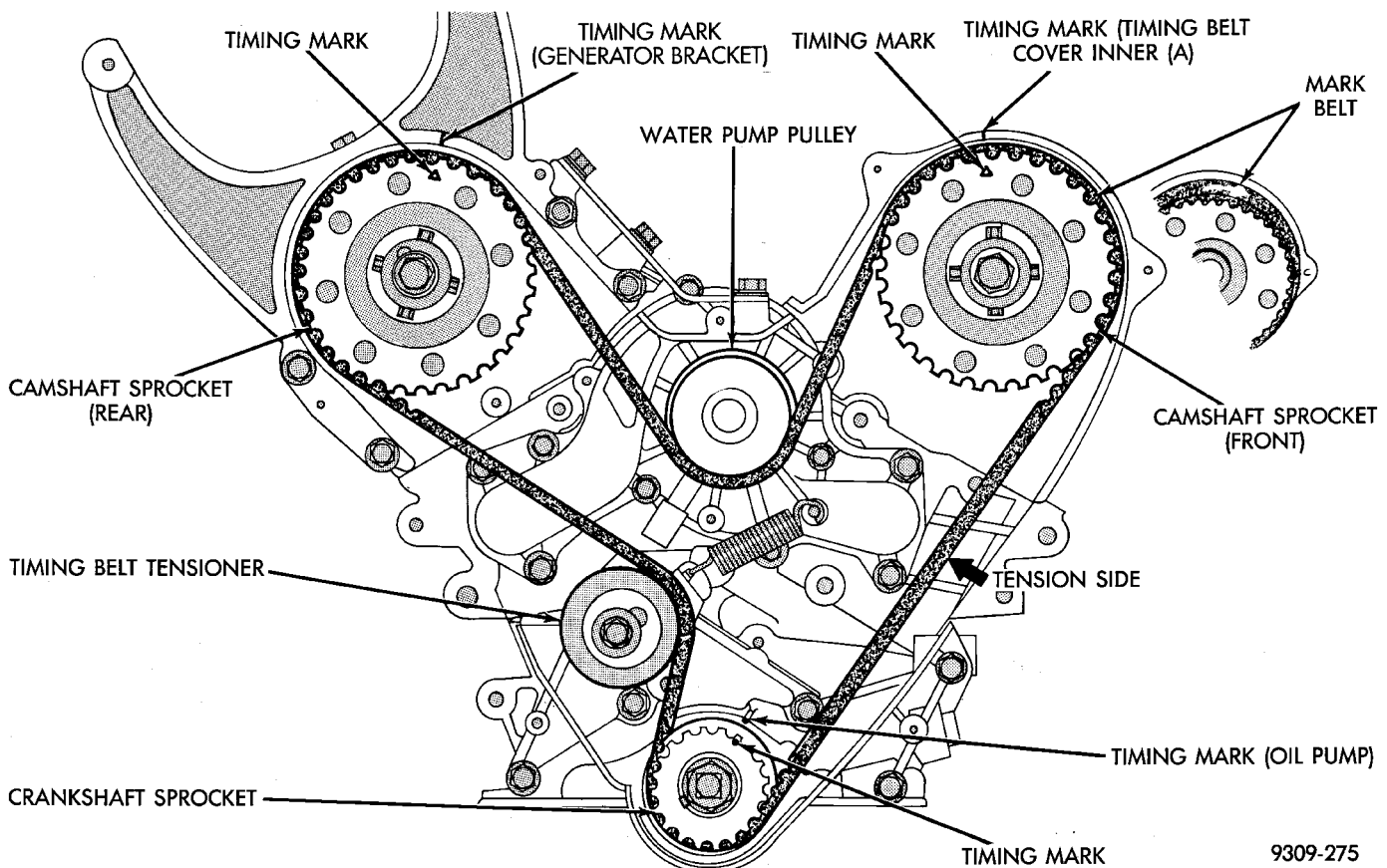
- (1) Install timing belt tensioner and tensioner spring.

- (2) Hook spring upper end to water pump pin and lower end to tensioner bracket with hook out (Fig. 44).

- (3) Turn timing belt tensioner counterclockwise full travel in adjustment slot and tighten bolt to temporarily hold this position (Fig. 45).

**INSTALLATION—TIMING BELT**

- (1) Install timing belt on crankshaft sprocket and keep belt tight on tension side (Fig. 42). Install belt on the front (radiator side) camshaft sprocket. Install

**Fig. 42 Timing Belt Engine Sprocket Timing**

REMOVAL AND INSTALLATION (Continued)

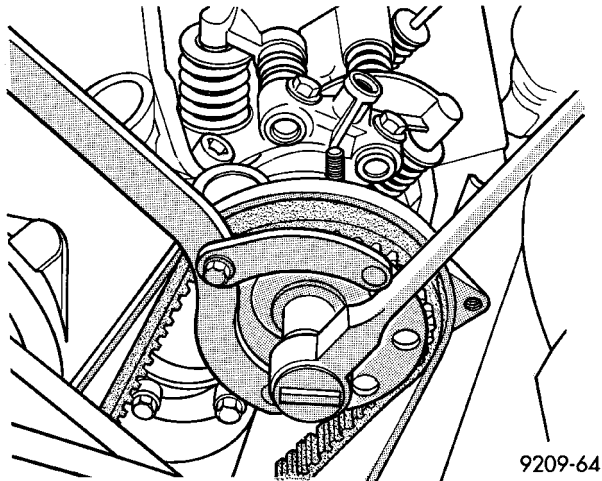


Fig. 43 Camshaft Sprockets

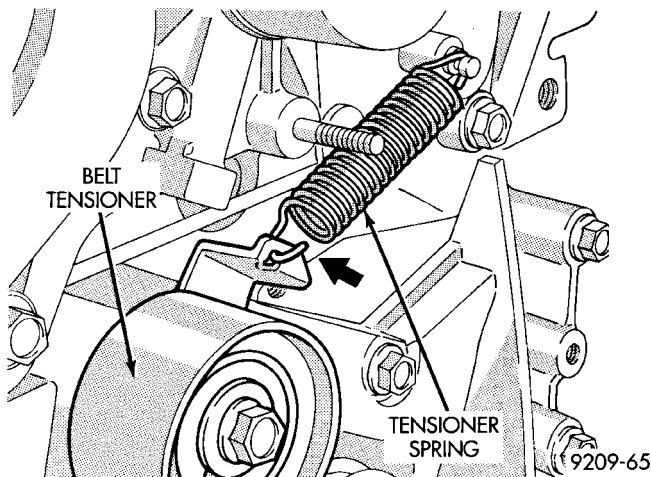


Fig. 44 Timing Belt Tensioner

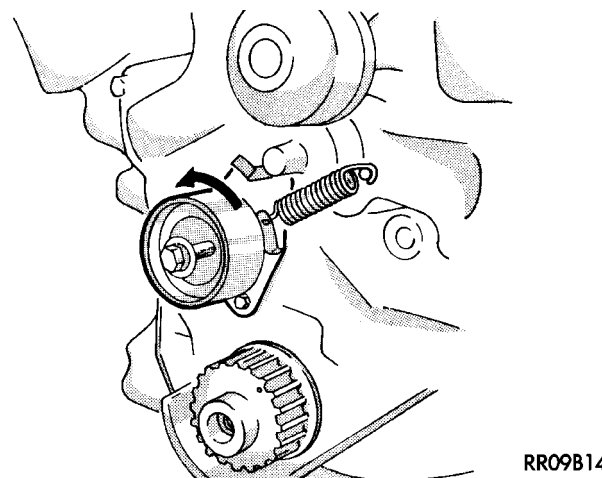


Fig. 45 Positioning Belt Tensioner

belt on the water pump pulley, rear camshaft sprocket and finally on the timing belt tensioner.

(2) Rotate the front camshaft sprocket in opposite direction to take up belt slack. Check that all timing marks are aligned (Fig. 42).

- (3) Install crankshaft sprocket flange (Fig. 40).
- (4) Loosen tensioner bolt and allow spring to tension timing belt.
- (5) Turn crankshaft two full turns in clockwise direction. **Turn smoothly and in clockwise direction ONLY.**
- (6) Align the timing marks on the sprockets and tighten the timing belt tensioner locking bolt to 25 N-m (250 in. lbs.) torque.
- (7) Reassembly belt covers, engine bracket, insulator, crankshaft pulleys, accessories and accessory drive belts in reverse order.

OIL PAN

Oil pan to crankcase sealing is provided with Mopar Silicone Rubber Adhesive Sealant or equivalent gasket material. See Form-In-Place Gaskets in Standard Service Procedures.

- (1) Apply sealant as shown in (Fig. 46).

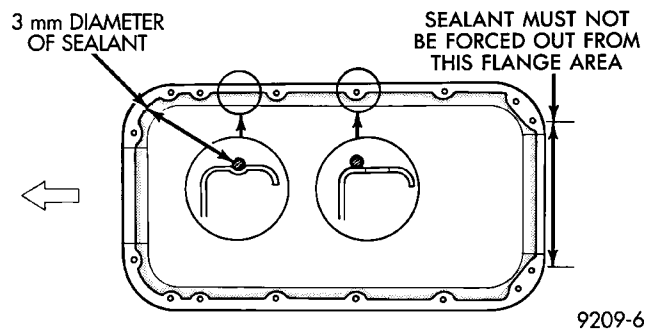


Fig. 46 Oil Pan Sealing

- (2) Install pan and tighten screws to 6 N-m (50 in. lbs.) in sequence shown in (Fig. 47).

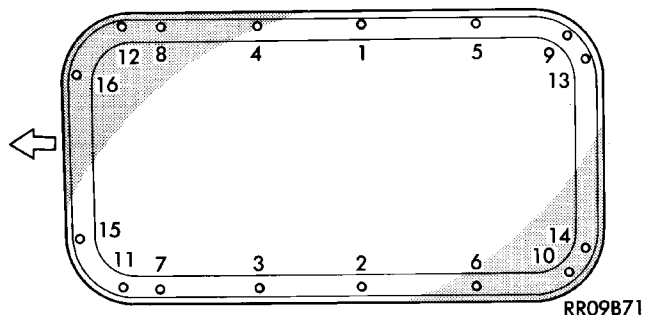
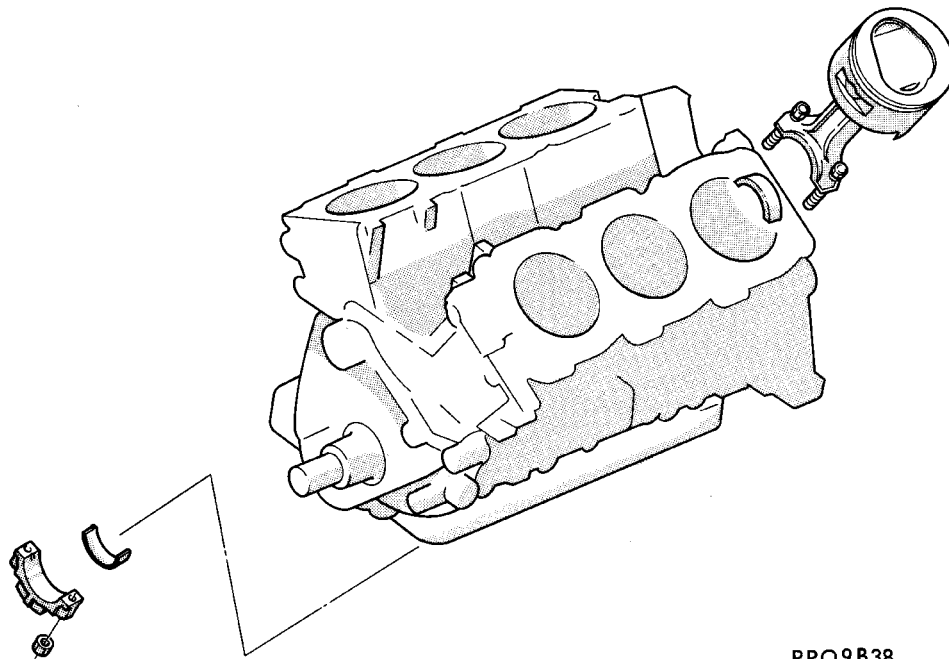
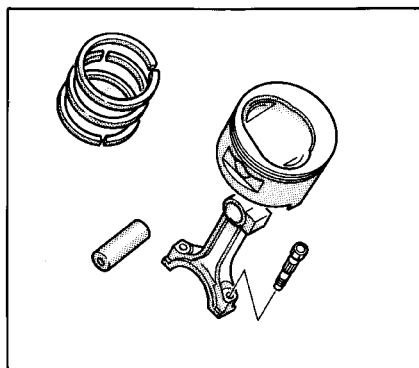


Fig. 47 Oil Pan Screw Tightening Sequence

## REMOVAL AND INSTALLATION (Continued)



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Fig. 48 Pistons and Connecting Rods

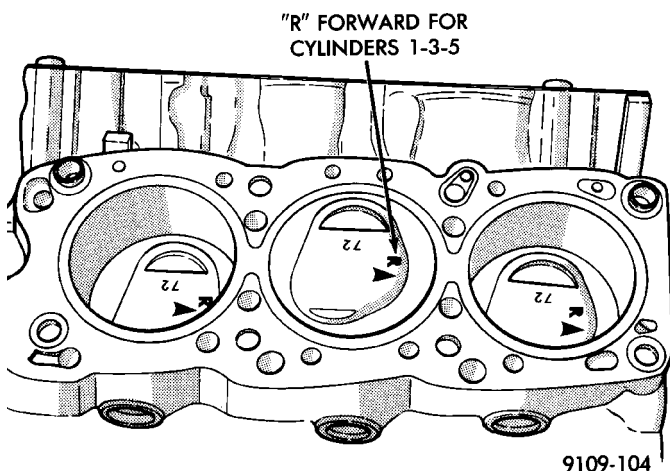
## PISTON AND CONNECTING ROD

(1) Identify and mark pistons. **The pistons are not interchangeable from bank to bank** (Fig. 49).

(2) Pistons with the letter R and arrow toward the front of engine are to be installed in cylinders 1-3-5. Pistons with the letter L and arrow toward the front of engine are to be installed in cylinders 2-4-6.

(3) Mark connecting rod and cap with cylinder number (Fig. 50).

(4) Remove piston rings (Fig. 51).

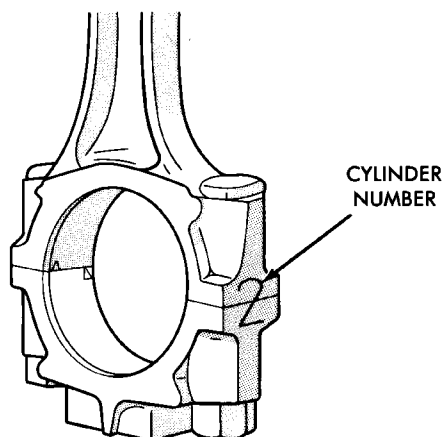


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Fig. 49 Mark Pistons

## FITTING PISTONS

Measure approximately 2 mm (0.080 in.) above the bottom of the piston skirt and across the thrust face (Fig. 52). See Boring Cylinder in Cylinder Block.



RR09B40

Fig. 50 Mark Matching Parts

## FITTING PISTON RINGS

(1) Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioning at least 16 mm (0.63 in.) from bottom of cylinder bore. Check gap with feeler gauge (Fig. 53). Refer to (Fig. 54) for specification.

(2) Check piston ring to groove clearance (Fig. 55). Refer to Piston Ring Specification Chart (Fig. 54).

## PISTON RINGS—INSTALLATION

(1) The No. 1 and No. 2 piston rings have a different cross section. Install rings with manufacturers mark and size mark facing up, to the top of the piston (Fig. 56).

REMOVAL AND INSTALLATION (Continued)

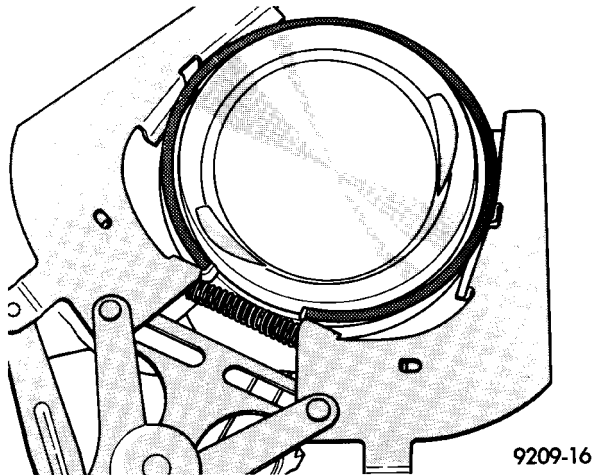


Fig. 51 Remove Piston Rings

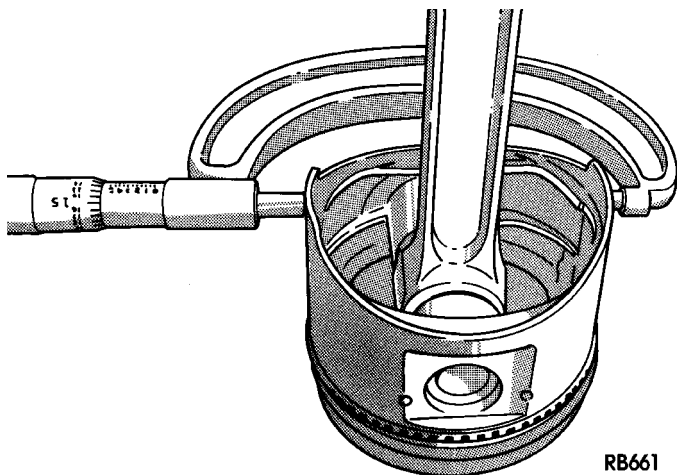


Fig. 52 Piston Clearance and Wear

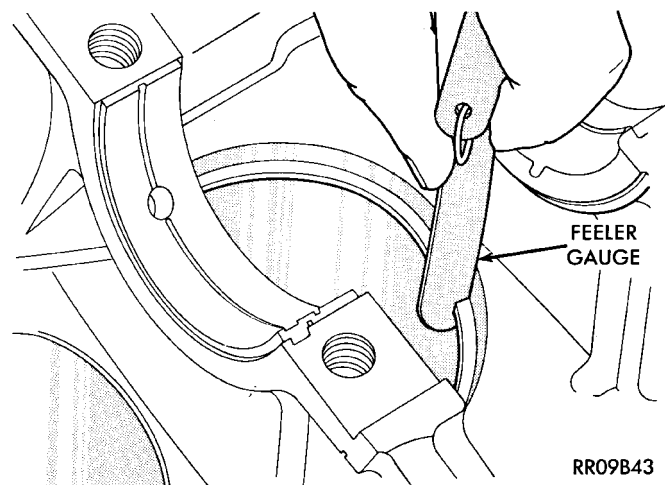


Fig. 53 Check Gap on Piston Rings

**CAUTION:** Install piston rings in the following order:

- a. Oil ring expander.

RING POSITION	RING GAP	WEAR LIMIT
UPPER RING	0.30 TO 0.45 mm (.012 TO .018 in.)	0.8 mm (.031 in.)
INTERMEDIATE RING	0.25 TO 0.40 mm (.010 TO .016 in.)	0.8 mm (.031 in.)
OIL CONTROL RING	0.30 TO 0.90 mm (.012 TO .035 in.)	1.0 mm (.039 in.)
RING POSITION	GROOVE CLEARANCE	MAXIMUM CLEARANCE
UPPER RING	0.05 TO 0.09 mm (.002 TO .0035 in.)	.10 mm (.004 in.)
INTERMEDIATE RING	0.02 TO 0.06 mm (.0007 TO .002 in.)	.10 mm (.004 in.)

OIL CONTROL RING-THREE PIECE. OIL RING SIDE RAILS MUST BE FREE TO ROTATE AFTER ASSEMBLY.

Fig. 54 Piston Ring Specification Chart

RING POSITION	RING GAP	WEAR LIMIT
UPPER RING	0.30 TO 0.45 mm (.012 TO .018 in.)	0.8 mm (.031 in.)
INTERMEDIATE RING	0.25 TO 0.40 mm (.010 TO .016 in.)	0.8 mm (.031 in.)
OIL CONTROL RING	0.30 TO 0.90 mm (.012 TO .035 in.)	1.0 mm (.039 in.)
RING POSITION	GROOVE CLEARANCE	MAXIMUM CLEARANCE
UPPER RING	0.05 TO 0.09 mm (.002 TO .0035 in.)	.10 mm (.004 in.)
INTERMEDIATE RING	0.02 TO 0.06 mm (.0007 TO .002 in.)	.10 mm (.004 in.)

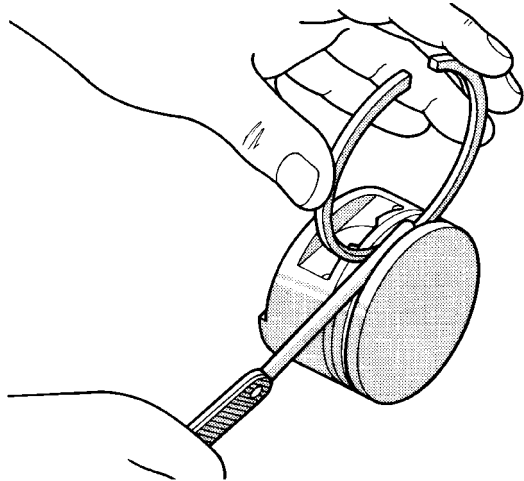
OIL CONTROL RING-THREE PIECE. OIL RING SIDE RAILS MUST BE FREE TO ROTATE AFTER ASSEMBLY.

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- b. Upper oil ring side rail.
- c. Lower oil ring side rail.
- d. No. 2 Intermediate piston ring.
- e. No. 1 Upper piston ring.

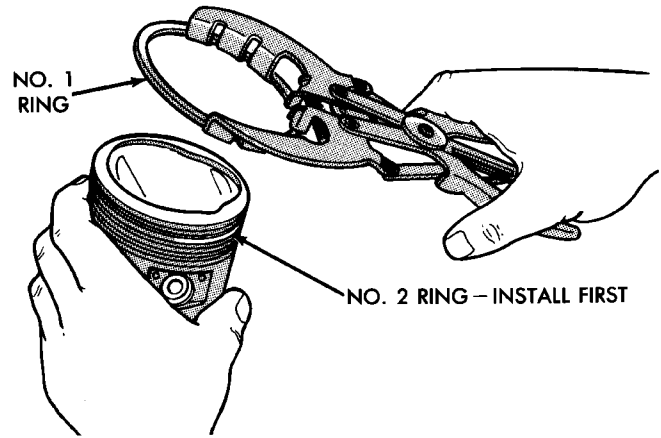
(2) Install the side rail by placing one end between the piston ring groove and the expander. Hold end firmly and press down the portion to be installed until side rail is in position. **Do not use a piston ring expander** (Fig. 57).

## REMOVAL AND INSTALLATION (Continued)



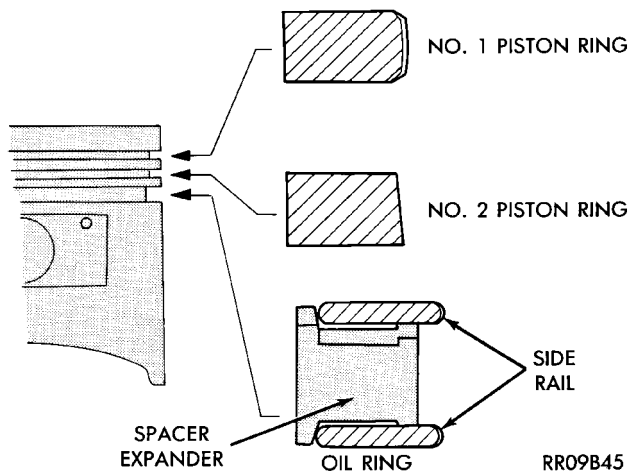
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Fig. 55 Piston Ring Clearance



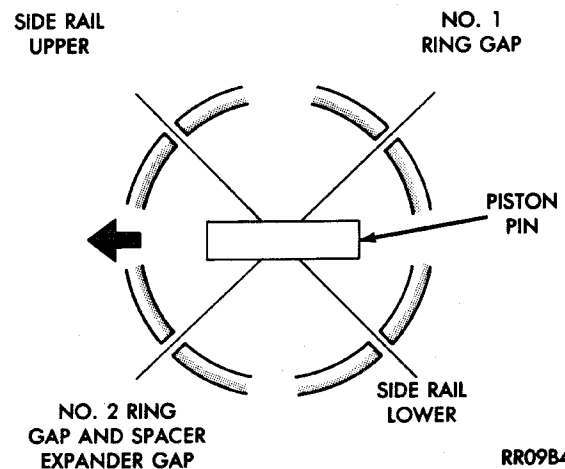
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Fig. 58 Installing Upper and Intermediate Rings



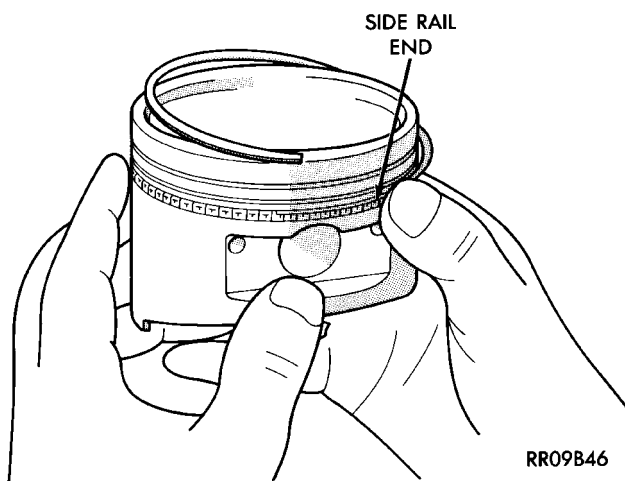
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Fig. 56 Piston Ring—Installation



RR09B48

Fig. 59 Piston Ring End Gap Position



RR09B46

Fig. 57 Side Rail—Installation

(3) Install upper side rail first and then the lower side rail.

(4) Install No. 2 piston ring and then No. 1 piston ring (Fig. 58).

(5) Position piston ring end gaps as shown in (Fig. 59).

(6) Position oil ring expander gap at least 45° from the side rail gaps but **not** on the piston pin center or on the thrust direction.

(7) Connecting rod front mark 72 must always face forward, toward timing belt end. (Fig. 60)

(8) Install the piston and connecting rod assembly into their respective bore from the cylinder block top.

**CAUTION:** Piston assemblies are not to be interchanged from bank to bank.

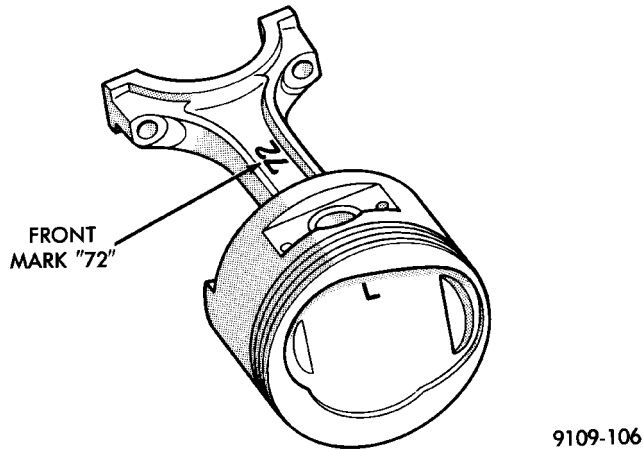
(9) Check alignment marks made during disassembly and that bearing position notches new or used are on the same side as shown in (Fig. 61).

## CRANKSHAFT

## REMOVAL

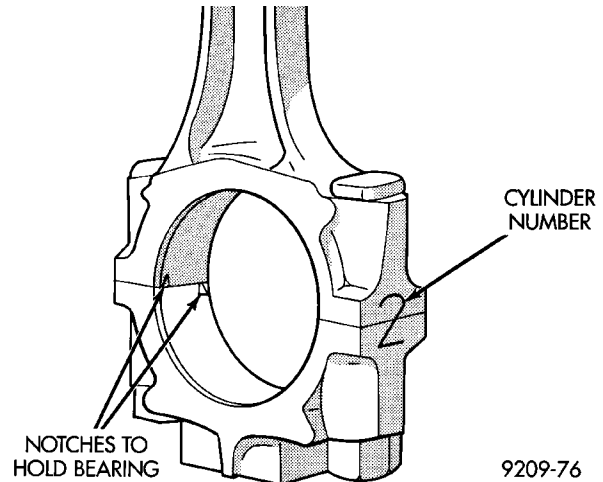
(1) Remove front mounted oil pump assembly and gasket (Fig. 62) and (Fig. 63).

REMOVAL AND INSTALLATION (Continued)



**Fig. 60 Identify Piston and Rod Assembly for Cylinder Installation**

- (2) Remove rear oil seal retainer and seal as assembly (Fig. 64).
- (3) Release mono-block main bearing cap bolts evenly. Remove lower bearing shells and identify for reassembly.
- (4) Lift out crankshaft and remove upper thrust washers from each side of number three main bearing in the crankcase (Fig. 62).

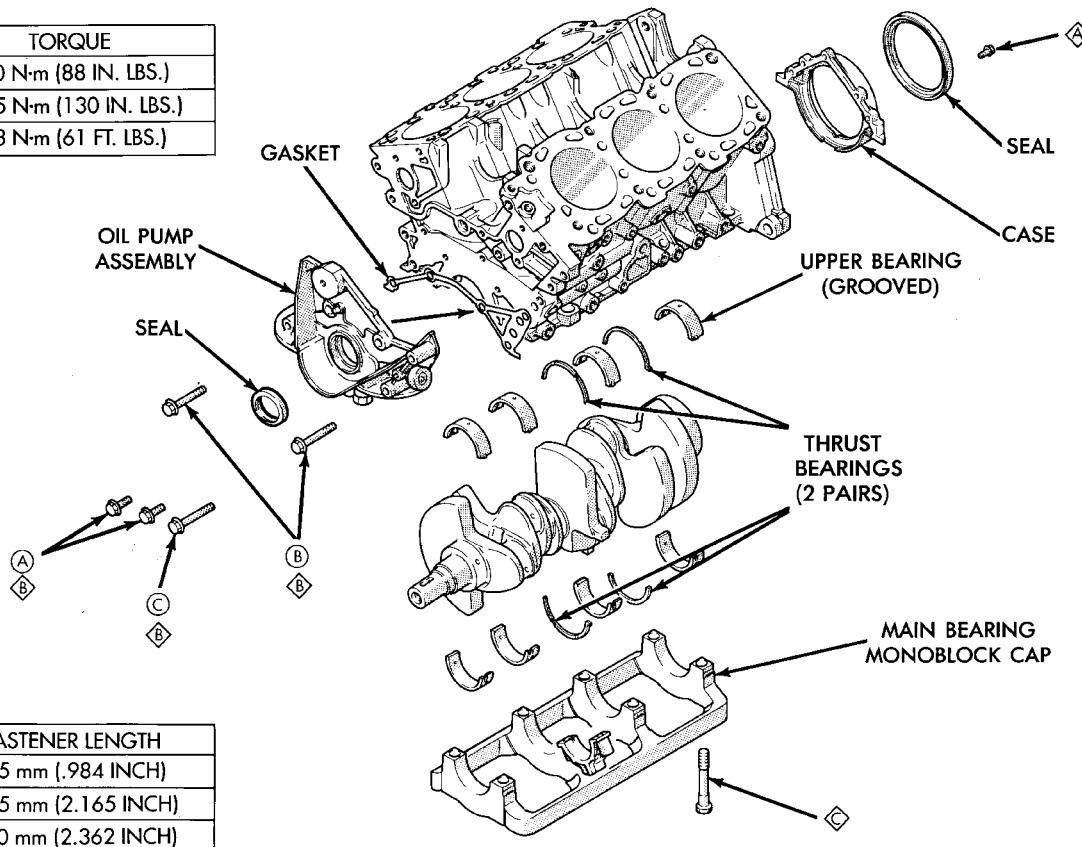


**Fig. 61 Connecting Rod and Cap**

**CRANKSHAFT BEARINGS—INSTALLATION**

- (1) Install upper main bearing shells making certain oil holes are in alignment, and bearing tabs seat in block tabs. All upper bearings have oil grooves (Fig. 65).
- (2) **THRUST BEARINGS.** Crankshaft thrust bearings (washers) are installed at journal #3 separately from the radial bearings. Thrust bearings shown in (Fig. 65) are different, one has end positioning tabs, while the other is plain. One **pair** of each

TORQUE	
◆A	10 N·m (88 IN. LBS.)
◆B	15 N·m (130 IN. LBS.)
◆C	83 N·m (61 FT. LBS.)

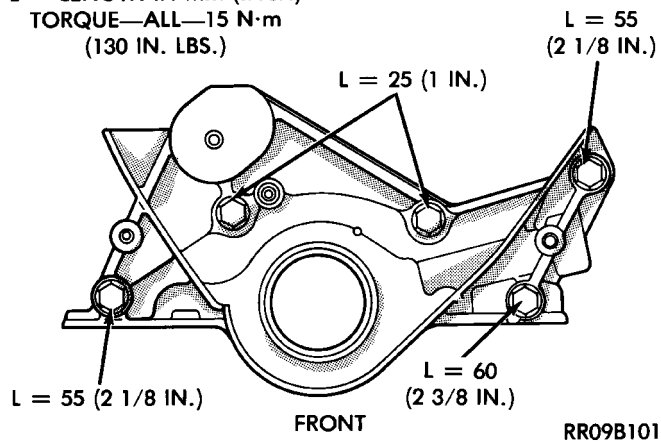


FASTENER LENGTH	
◆A	25 mm (.984 INCH)
◆B	55 mm (2.165 INCH)
◆C	60 mm (2.362 INCH)

**Fig. 62 Crankshaft and Cylinder Block**

## REMOVAL AND INSTALLATION (Continued)

L = LENGTH IN mm (INCH)  
TORQUE—ALL—15 N·m  
(130 IN. LBS.)



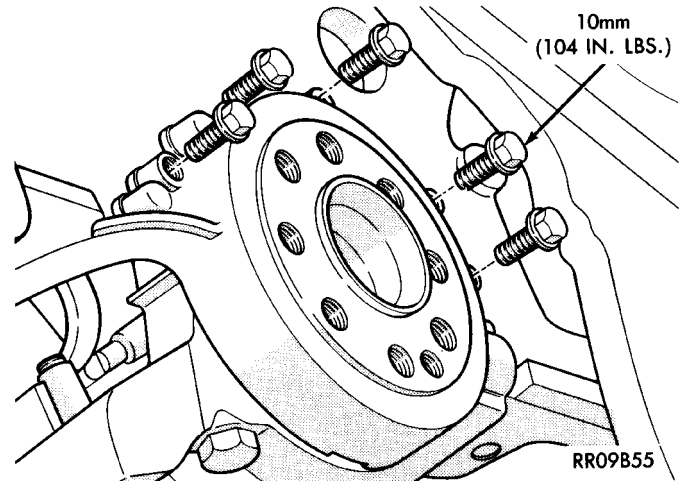
**Fig. 63 Oil Pump Assembly**

thrust washers are installed into the block and one pair into the main bearing cap (Fig. 65).

(3) Apply a thin film of grease to plain side of thrust washers and position them on each side of number three main bearing. Grooved surface towards crankshaft.

(4) Oil the bearings and journals and install crankshaft.

(5) Install lower main bearing shells without oil grooves in mono-block cap.

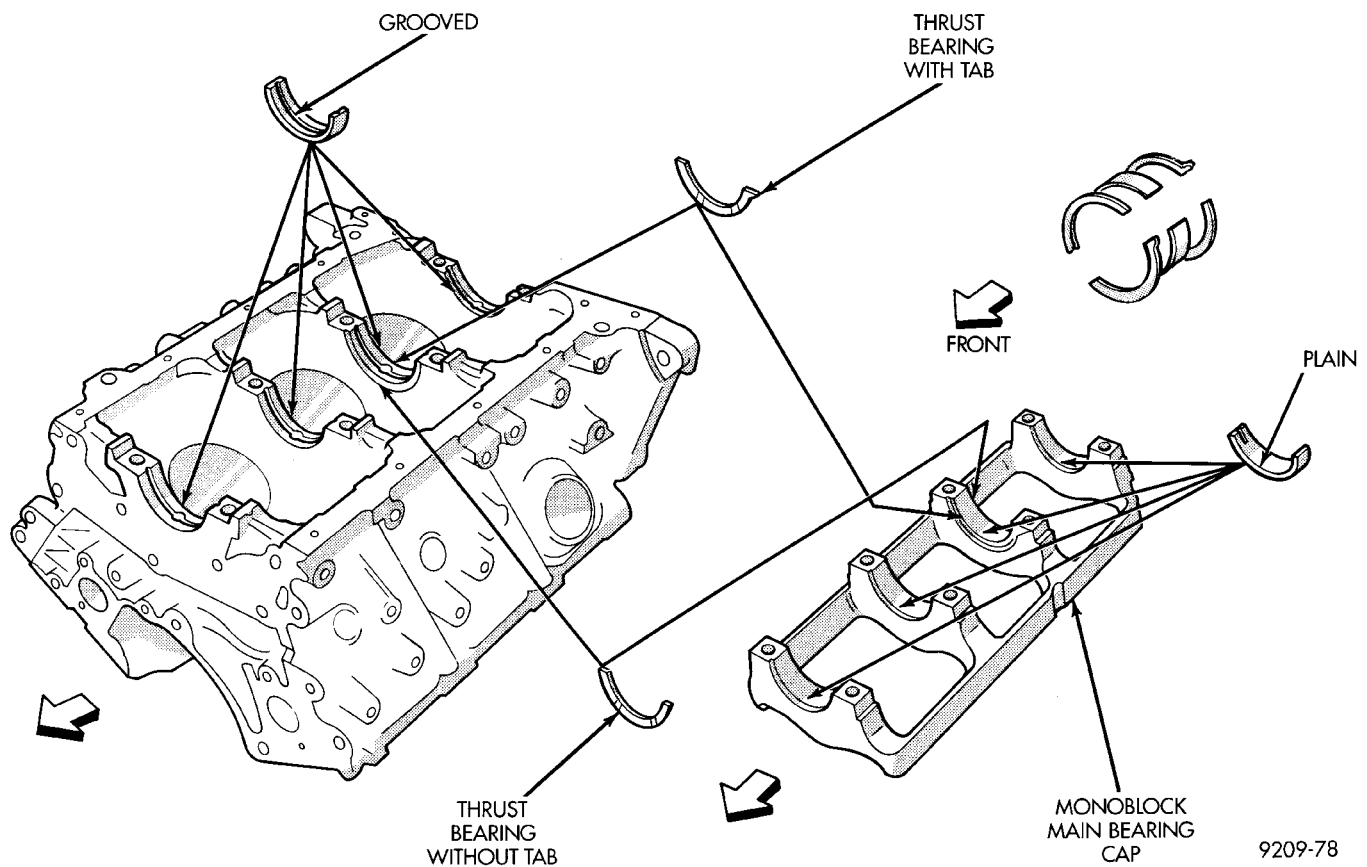


**Fig. 64 Rear Seal Assembly**

(6) Install one pair of thrust washers in cap. Refer to Thrust Bearings (Fig. 65).

(7) Carefully install bearing cap with arrows (Fig. 66) toward timing belt end.

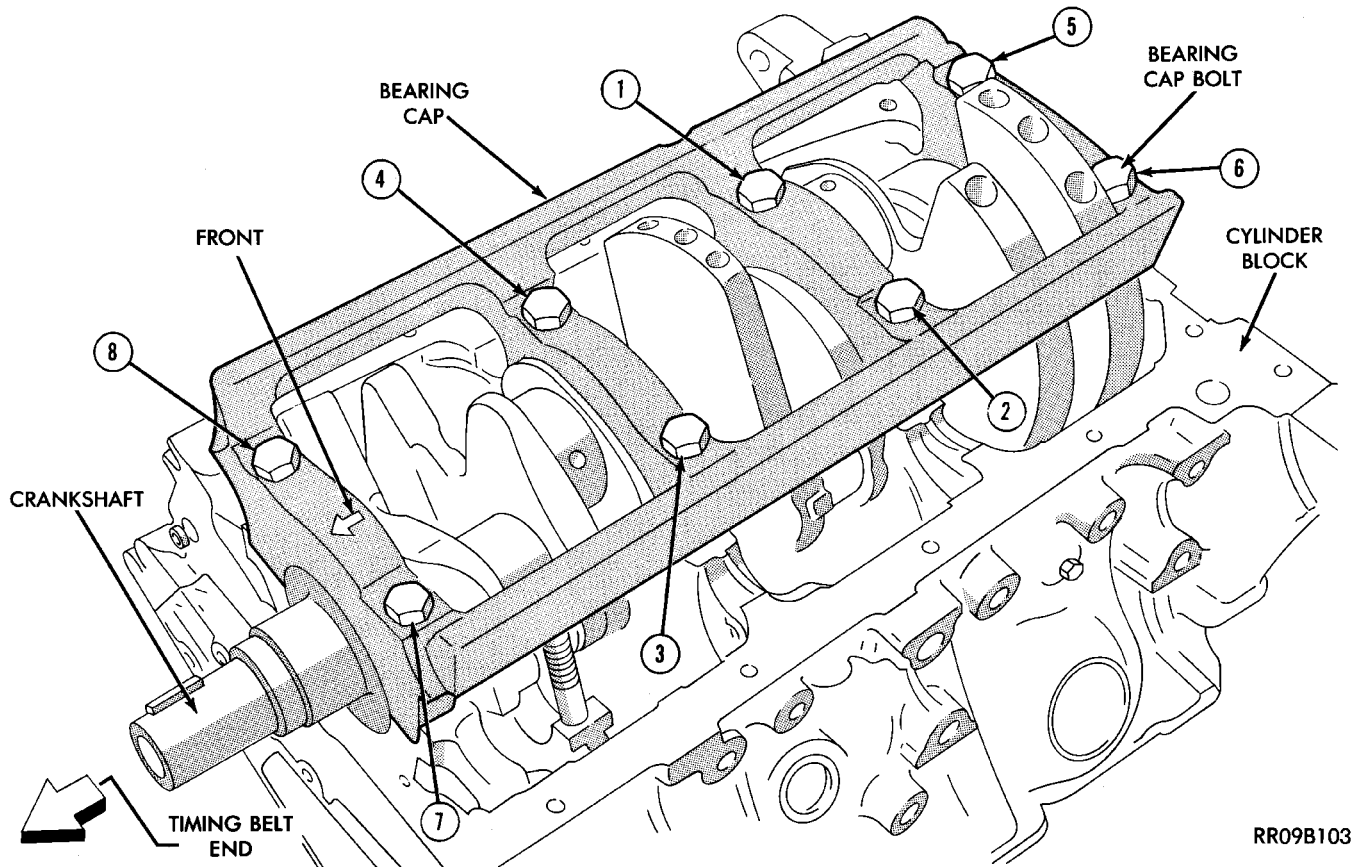
(8) Oil the bearing cap bolt threads, install and tighten bolts progressively in sequence shown in (Fig. 66) to 80 N·m (60 ft. lbs.) torque.



**Fig. 65 Main Bearings—Installation**

9209-78

## REMOVAL AND INSTALLATION (Continued)



**Fig. 66 Crankshaft Main Bearing Cap**

## REAR CRANKSHAFT SEAL

### REAR CRANKSHAFT SEAL RETAINER

(1) Install rear crankshaft oil seal in housing with Special Tool MD-998718 (Fig. 67).

(2) Apply Mopar Silicone Rubber Adhesive Sealant or equivalent to oil seal housing (Fig. 68) per procedure detailed in form-in-place gasket section in Standard Service Procedures.

(3) Apply light coating of engine oil to the entire circumference of oil seal lip.

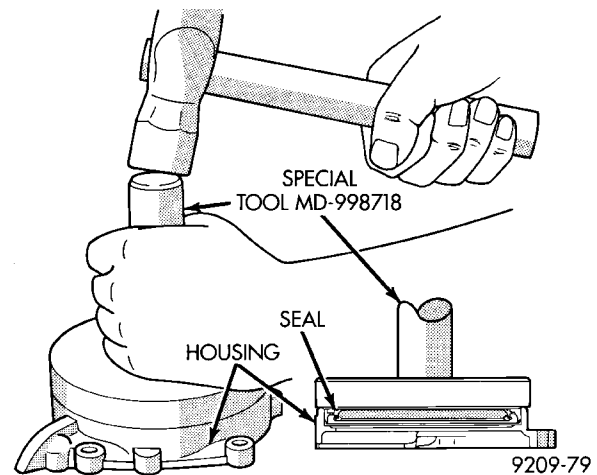
(4) Install seal assembly on cylinder block and tighten bolts to 12 N·m (104 in. lbs.)

### FRONT CRANKSHAFT OIL SEAL

(1) Install oil pump gasket and oil pump case (Fig. 70) and (Fig. 69).

**CAUTION:** Install bolts, depending on length in locations shown in (Fig. 69).

(2) Using front crankshaft oil seal installer Special Tool MD-998717 install oil seal in oil pump (Fig. 70).



**Fig. 67 Rear Crankshaft Oil Seal—Installation**

## OIL PUMP

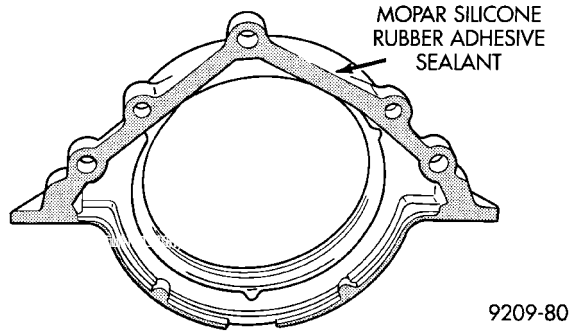
### REMOVAL

1. Remove accessory drive belts. Refer to Accessory Drive Belts Group 7, Cooling System.

2. Remove Timing Belt. Refer to procedure in this section.

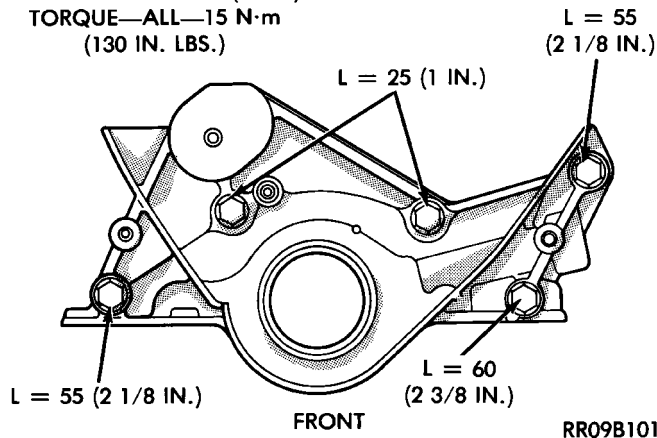
3. Remove 5 bolts that attach oil pump to block (Fig. 71).

REMOVAL AND INSTALLATION (Continued)

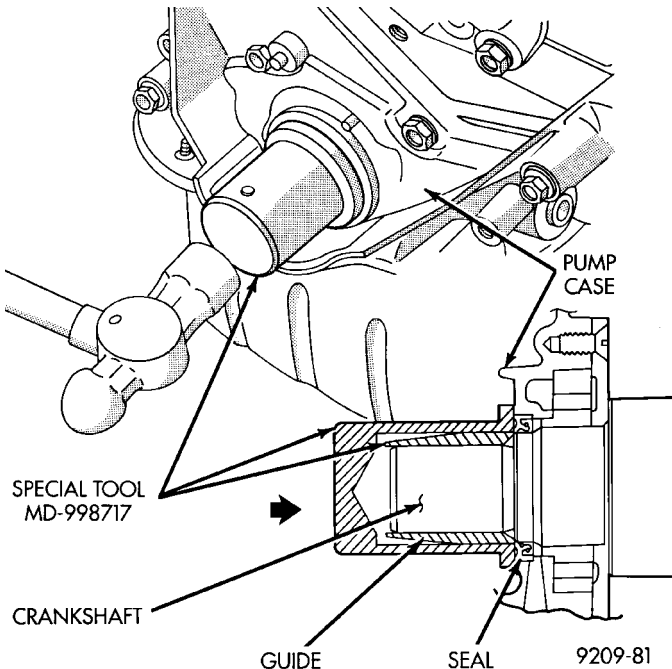


**Fig. 68 Apply Sealant to Oil Seal Housing**

L = LENGTH IN mm (INCH)  
TORQUE—ALL—15 N·m  
(130 IN. LBS.)



**Fig. 69 Oil Pump**

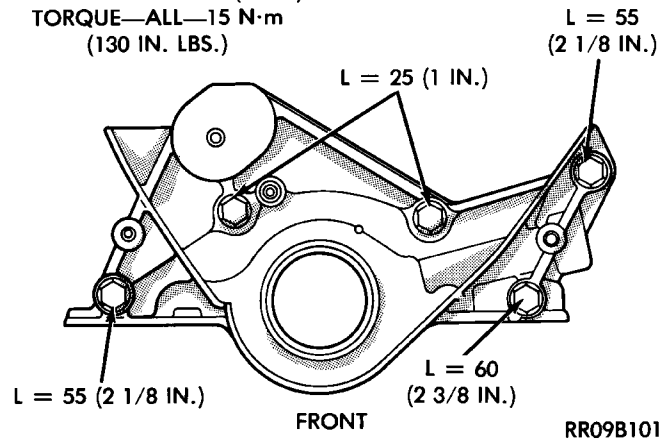


**Fig. 70 Front Crankshaft Oil Seal—Installation**

**INSTALLATION**

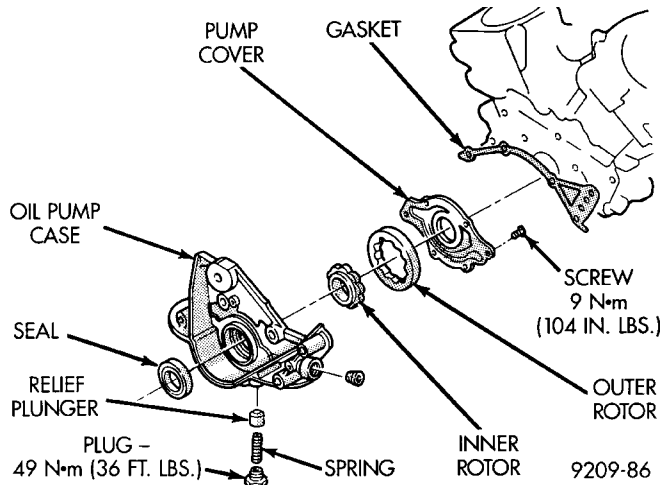
- (1) Clean block and pump surfaces.

L = LENGTH IN mm (INCH)  
TORQUE—ALL—15 N·m  
(130 IN. LBS.)



**Fig. 71 Oil Pump Assembly**

- (2) Install new gasket (Fig. 72) make sure correct length bolts are used (Fig. 71).
- (3) Torque bolts to 13 N·m (120 in. lbs.).



**Fig. 72 Oil Pump Components**

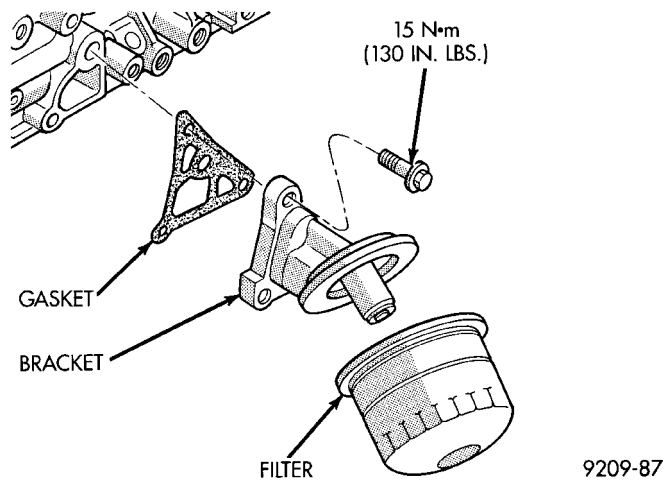
**OIL FILTER AND ADAPTOR**

- (1) Check the oil filter mounting surface. The surface must be smooth, flat and free of debris or old pieces of rubber (Fig. 73).
- (2) Check adaptor for cracks and oil leaks.

**CAUTION:** When servicing the oil filter avoid deforming the filter. Install the remove/install tool band strap against the can-to-base lock seam. The lock seam joining the can-to-base is reinforced by the base plate.

- (3) Using Tool C-4065, turn filter counterclockwise to remove from base. Properly discard filter.
- (4) Wipe base clean, then inspect gasket contact surface.
- (5) Lubricate gasket of new filter with clean engine oil.

REMOVAL AND INSTALLATION (Continued)



**Fig. 73 Oil Filter and Adaptor**

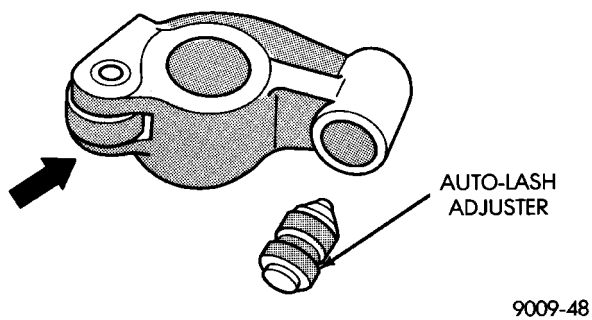
(6) Install new filter until gasket contacts base. Tighten filter 1 turn or 20 N·m (15 ft. lbs.). Use filter wrench if necessary.

(7) Start engine and check for leaks.

DISASSEMBLY AND ASSEMBLY

ROCKER ARMS AND SHAFTS

(1) Check rocker arms for wear or damage (Fig. 74). Replace as necessary. Also see Auto Lash Adjuster.



**Fig. 74 Inspect Rocker Arms**

ROCKER ARM SHAFTS

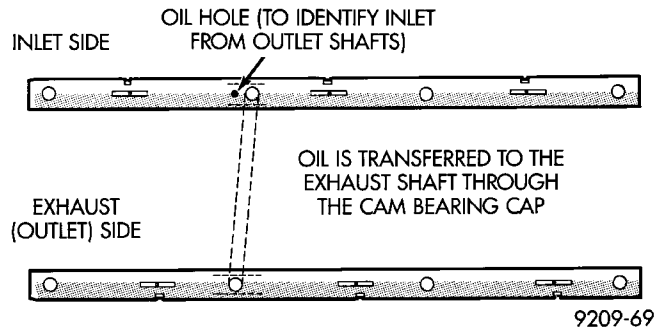
The rocker arm shaft is hollow and is used as a lubrication oil duct. The rocker arm shaft on the **inlet** side has a 3 mm (0.188 in.) diameter oil passage hole from the cylinder head. The **exhaust** side **does not** have this oil passage (Fig. 75).

(1) Check the rocker arm mounting portion of the shafts for wear or damage. Replace if heavily damaged or worn.

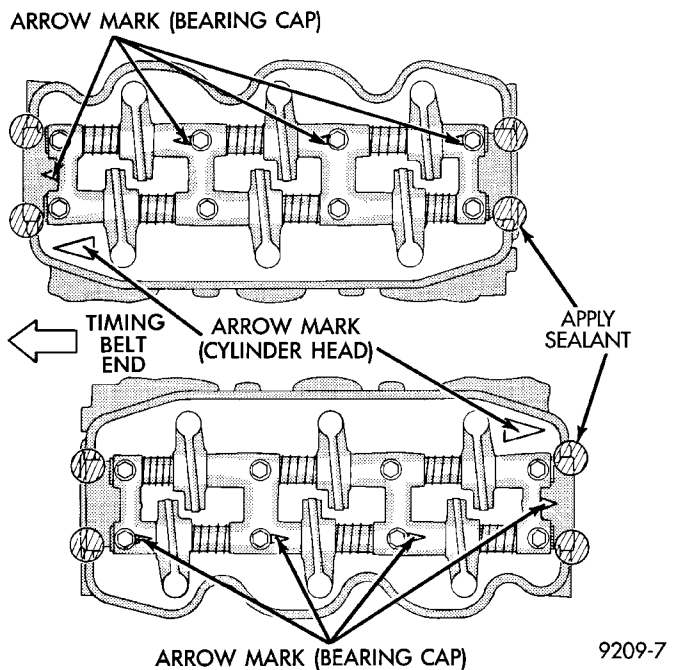
(2) Check oil holes for clogging with small wire, clean as required (Fig. 75).

REASSEMBLE

(1) Align the camshaft bearing caps with arrows (depending on cylinder bank) directed as shown in



**Fig. 75 Rocker Arm Shaft Identification**



**Fig. 76 Camshaft Bearing Caps Position**

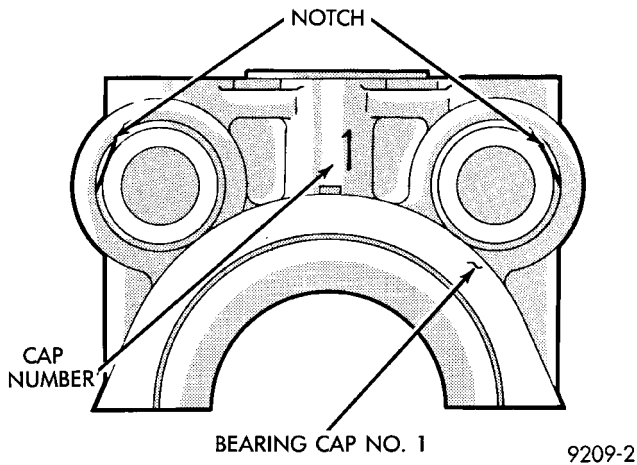
(Fig. 76) and in numerical order. Identify number one bearing cap number one and number four caps are similar (Fig. 77).

(2) Install rocker shafts so that bearing cap number one with end notches positioned as shown in (Fig. 77) that the machined portion of the rocker shaft is facing down.

(3) Install attaching bolts to retain assembly.

ASSEMBLE ROCKER ASSEMBLY

Install the rocker arms, bearing caps and springs. **Springs are the same and can be used at all locations** on the rocker arm shafts (Fig. 76) and (Fig. 78). Insert bolts in number four bearing cap to retain assembly.



**Fig. 77 Number One Camshaft Bearing Cap**

## CLEANING AND INSPECTION

### TIMING BELT

#### INSPECTION

(1) Remove the upper front outer timing belt cover by loosening the three attaching bolts (Fig. 80).

(2) Inspect both sides of the timing belt drive & back. Replace belt if any of the following conditions exist:

- Rubber back side is glossy, hardened back without resilience and leaves no indent when pressed with fingernail.
- Cracks on rubber back.
- Cracks or peeling of canvas.
- Cracks on rib root.
- Missing teeth.
- The sides are normal if they are sharp as if cut by a knife (Fig. 79).

**NOTE:** If none of the above conditions are seen on the belt, the belt cover can be installed.

### CYLINDER HEAD

#### CLEANING AND INSPECTION

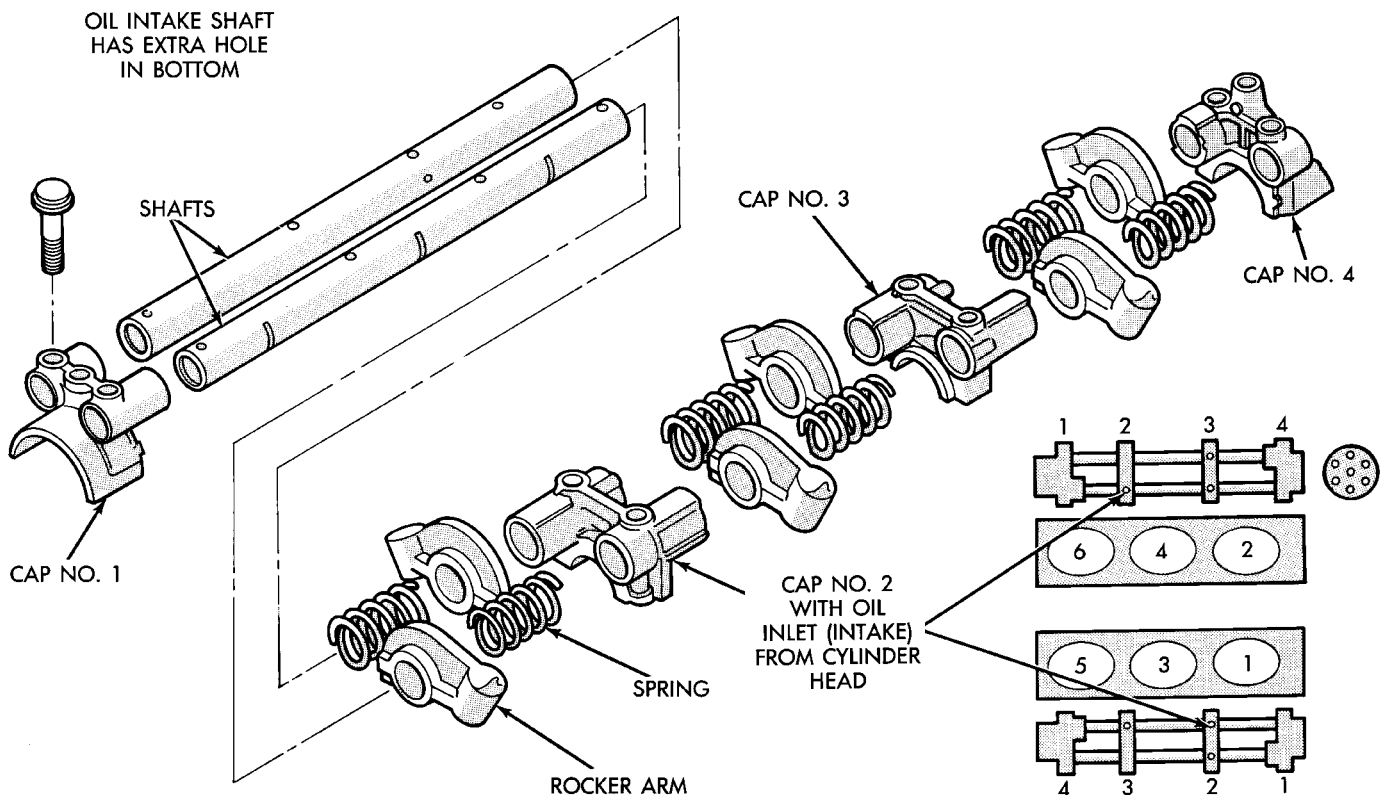
(1) Before cleaning, check for leaks, damage and cracks.

(2) Clean cylinder head and oil passages.

(3) Check cylinder head for flatness (Fig. 81).

(4) Cylinder head must be flat within:

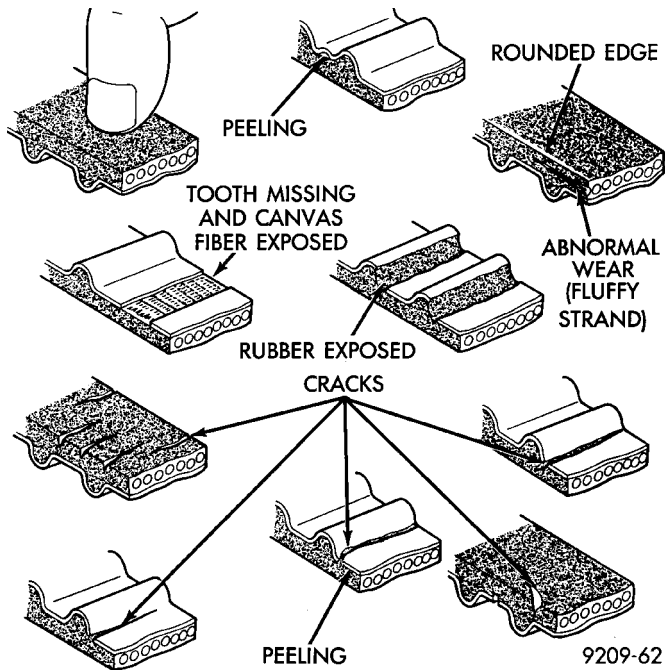
- Standard dimension = less than 0.05 mm (.002 in.)
- Service Limit = 0.2 mm (.008 in.)
- Grinding Limit = Maximum of 0.2 mm (.008 in.) is permitted.



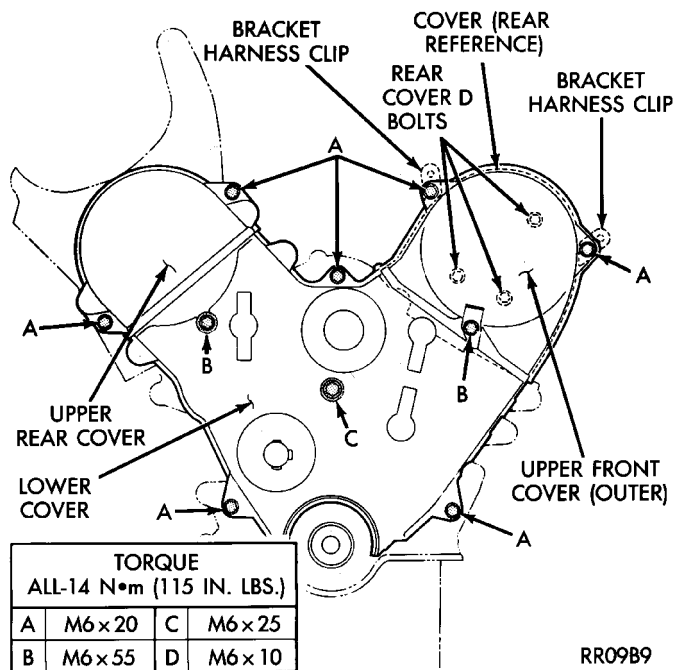
9209-70

**Fig. 78 Rocker Arm and Shafts**

CLEANING AND INSPECTION (Continued)



**Fig. 79 Timing Belt Inspection**



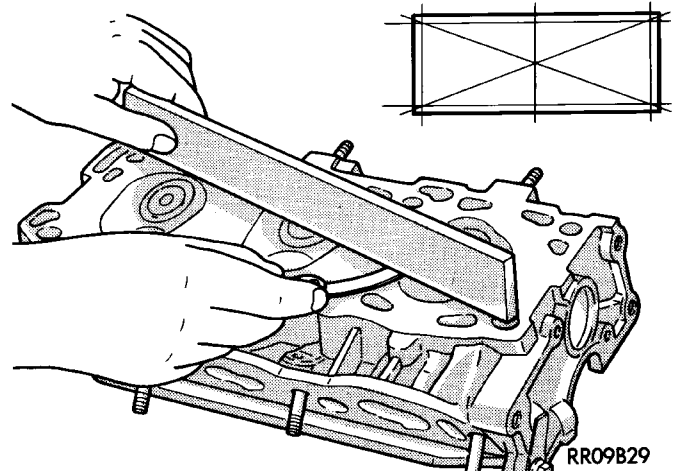
**Fig. 80 Timing Belt Covers**

**CAUTION:** This is a combined total dimension of stock removal from cylinder head if any and block top surface.

**CYLINDER BORE**

**INSPECTION**

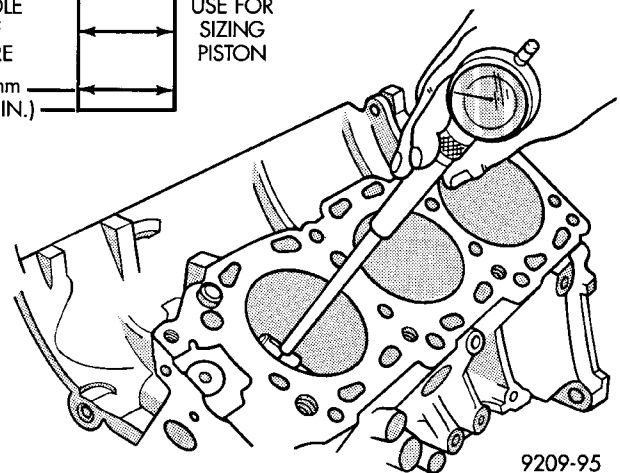
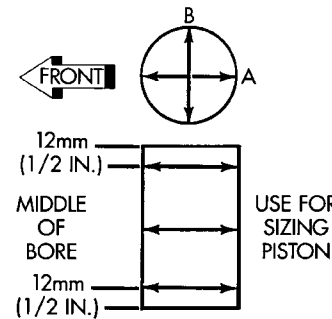
(1) Measure the cylinder bore at three levels in directions A and B (Fig. 82). Top measurement



**Fig. 81 Check Cylinder Head**

should be 12 mm (0.50 in.) down and bottom measurement should be 10 mm (0.38 in.) up.

- (2) Standard bore dimension: 91.1 mm (3.587 in.)
- (3) Maximum out-of-round or taper: 0.02 mm (0.0008 in.).

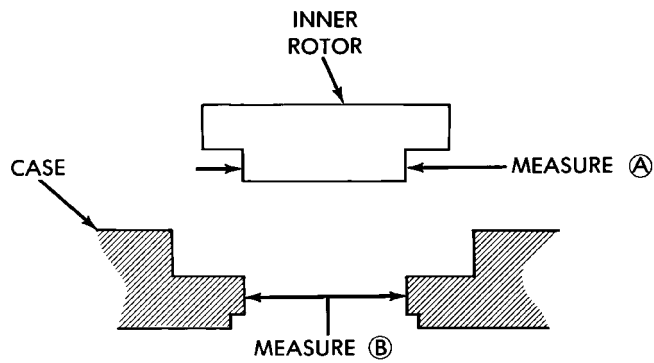


**Fig. 82 Checking Cylinder Bore Size**

**OIL PUMP**

- (1) Check oil pump case for damage and remove rear cover.
- (2) Remove pump rotors and inspect case for excessive wear.
- (3) Measure clearance between case and inner rotor (Fig. 83).
- (4) Insert the rotor into the oil pump case (Fig. 84) and (Fig. 85) and measure clearance with a feeler gauge as indicated.

## CLEANING AND INSPECTION (Continued)

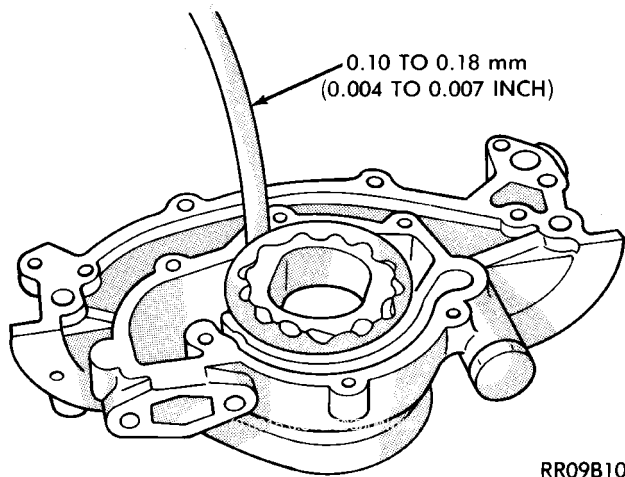


SUBTRACT MEASUREMENT A FROM MEASUREMENT B,  
IF OVER 0.006 IN., REPLACE OIL PUMP ASSEMBLY.

9209-114

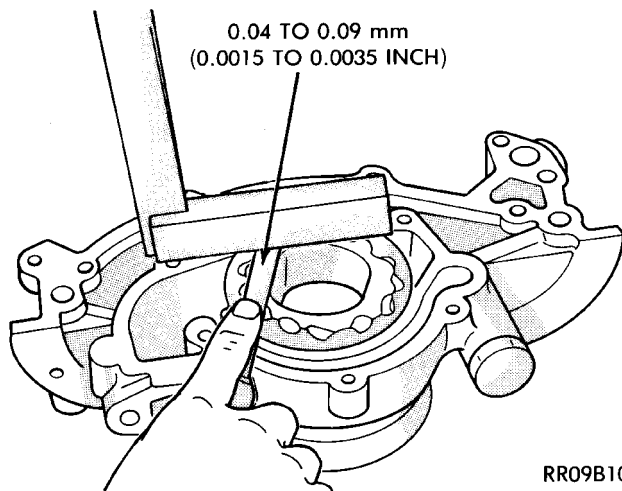
**Fig. 83 Inner Rotor to Case**

(5) Replace if out of limits.



RR09B108

**Fig. 84 Checking Clearance Between Outer Rotor and Case**



RR09B109

**Fig. 85 Checking Rotor End Clearance**

## OIL RELIEF PLUNGER

(1) Check that the oil relief plunger slides smoothly.

(2) Check for broken relief spring.

## ADJUSTMENTS

## ENGINE MOUNTS

## ENGINE MOUNT INSULATOR ADJUSTMENT

(1) Remove the load on the engine motor mounts by carefully supporting the engine and transmission assembly with a floor jack.

(2) Loosen the right engine mount insulator vertical fastener and the fore and aft fasteners, and the front engine mount bracket to front crossmember screws.

(3) Pry the engine right or left as required to achieve the proper drive shaft assembly length. Refer to Group 2, Suspension and Driveshafts for drive shaft identification and related assembly length measuring.

(4) Tighten engine mounts and fasteners in the following order:

(a) Right engine mount insulator vertical bolts to 102 N·m (75 ft. lbs.) and the fore and aft bolts to 150 N·m (110 ft. lbs.).

(b) Front engine mount screws to 54 N·m (40 ft. lbs.) the clearance between the snubbers and the engine should be 2 mm (0.078 inch.) each side.

(c) Left engine mount through bolt to 75 N·m (55 ft. lbs.).

(5) Recheck driveshaft length.

## SPECIFICATIONS

## ENGINE 3.0 L

<b>Standard</b>		
Type	60° V SOHC (Per Bank)	
Number of Cylinders	6	
Bore	91.1 mm (3.587 inches)	
Stroke	76 mm (2.992 inches)	
Compression Ratio	8.85:1	
Displacement	3.0 Liters (181 Cubic inches)	
Firing Order	1-2-3-4-5-6	
Basic Ignition Timing	Refer to Emission Control Information on Label in Vehicle	
Valve Timing		
Intake —Open	19° BTDC	
—Close	59° ABDC	
Exhaust —Open	59° BBDC	
—Close	19° ATDC	
Description	Standard Dimension	Service Limit
Compression Pressure	178 psi @ 250 RPM	—
Maximum Variation Between Cylinders	1.0 Kg/cm <sup>2</sup> (14PSI)	25%
Valve Clearance —Hot Engine	Hydraulic Lash Adjusters	—
<b>Cylinder Head</b>		
Flatness of Gasket Surface	0.05 mm (0.002 inch)	—
Grinding Limit of Gasket Surface	—	0.2 mm (0.008 inch)
<b>Manifold—Flatness of Installing Surface</b>		
Intake	0.10 mm (0.004 inch)	0.2 mm (0.0008 inch)
Exhaust	0.15 mm (0.006 inch)	0.3 mm (0.001 inch)
<b>Valves</b>		
Thickness of Valve Head (Margin)		
Intake	1.2 mm (0.047 inch)	0.7 mm (0.027 inch)
Exhaust	2.0 mm (0.079 inch)	1.5 mm (0.059 inch)
Valve Stem to Guide Clearance		
Intake	0.03 to 0.06 mm (0.001 to 0.002 inch)	0.10 (0.004 inch)
Exhaust	0.05 to 0.09 mm (0.0019 to 0.003 inch)	0.15 mm (0.006 inch)
Valve Face Angle	45° to 45° 30'	—
Valve Overall Length		
Intake	103.0 mm (4.055 inches)	—
Exhaust	102.7 mm (4.043 inches)	—
Valve Stem Diameter		
Intake	7.960 to 7.975 mm (0.313 to 0.314 inch)	—
Exhaust	7.930 to 7.950 mm (0.312 to 0.3125 inch)	—
<b>Valve Guide</b>		
Overall Length		
Intake	44 mm (1.732 inches)	—
Exhaust	48 mm (1.889 inches)	—
O.D.	13.055 to 13.065 mm (0.514 to 0.5143 inch)	—
I.D.	8.000 to 8.018 mm (0.314 to 0.315 inch)	—
<b>Valve Seat</b>		
Seat Surface Angle	44° to 44° .3'	—
Contact Width	0.9 to 1.3 mm (0.035 to 0.051 inch)	—
Sinkage	—	0.2 mm (0.078 inch)
<b>Valve Spring</b>		
Free Height	49.8 mm (1.960 inches)	48.8
Loaded Height	40.4 mm at 33 kg (1.59 inch at 73 lbs.)	—
Perpendicularity Intake and Exhaust	2° Maximum	4° Maximum

## SPECIFICATIONS (Continued)

Description	Standard Dimension	Service Limit
<b>Piston</b>		
O.D.	91.06 to 91.09 mm (3.585 to 3.586 inches)	—
Piston to Cylinder Clearance	0.03 to 0.05 mm (0.0012 to 0.002 inch)	—
Ring End Gap		
No. 1	0.30 to 0.45 mm (.012 to .018 inch)	0.8 mm (0.31 inch)
No. 2	0.45 to 0.60 mm (.018 to .024 inch)	0.8 mm (0.31 inch)
Oil	0.20 to 0.60 mm (.008 to .024 inch)	1.0 mm (.039 inch)
Ring Side Clearance		
No. 1	0.030 to 0.090 mm (.002 to .0035 inch)	0.1 mm (.0039 inch)
No. 2	0.040 to 0.085 mm (.0016 to .0033 inch)	0.1 mm (.0039 inch)
Oversize Service Pistons	0.25 to 0.50 mm (0.010 to 0.020 inch) 0.75 to 1.00 mm (0.030 to 0.039 inch)	
<b>Connecting Rod</b>		
Length—Center to Center	140.9 to 141.0 mm (5.547 to 5.551 inches)	—
Parallelism—Twist	0.05 mm (0.0019 inch)	—
Torsion	0.1 mm (0.0039 inch)	—
Big End Thrust Clearance	0.10 to 0.25 mm (0.004 to 0.010 inch)	0.4 mm (0.016 inch)
<b>Crankshaft</b>		
End Play	0.05 to 0.25 mm (0.002 to 0.010 inch)	0.3 mm (0.012 inch)
Main Journal Diameter	59.980 to 60.000 mm (2.361 to 2.362 inches)	—
Pin Diameter	49.980 to 50.000 mm (1.968 to 1.969 inches)	—
Bearing Surface Out-of-Round	0.03 mm Max. (0.001 inch) Max.	—
Bearing Surface Taper	0.005 mm Max. (0.0002 inch) Max.	—
Bearing Oil Clearance	0.015 to 0.050 mm (0.0006 to 0.002 inch)	—
Undersize Service Bearings	0.25 to 0.50 — 0.75 mm (0.010 to 0.020 — 0.030 inch)	
<b>Cylinder Block</b>		
I.D. (Bore)	91.1 mm (3.587 inches)	—
Flatness of Top Surface	0.05 mm (0.002 inch)	0.1 mm (0.0039 inch)
Grinding Limit of Top Surface	0.2 mm* (0.008 inch)	0.2 mm* (0.008 inch)
*Includes/Combined With Cylinder Head Grinding		
<b>Oil Pump</b>		
Relief Valve Opening Pressure	5.0 to 6.0 kg/cm <sup>2</sup> (71.45 to 85.75 psi)	—
Outer Rotor to Case Clearance	0.10 to 0.18 mm (0.004 to 0.007 inch)	0.18 mm (0.007 inch)
Rotor End Clearance	0.04 to 0.09 mm (0.0015 to 0.0035 inch)	0.09 mm (0.0035 inch)
Inner Rotor Pilot to Case Clearance	0.03 to 0.07 mm (0.001 to 0.0028 inch)	0.15 mm (0.006 inch)
Minimum Pressure, Engine Fully Warmed Up at Idle 3000 RPM	41 kPa (6 psi) 241-517 kPa (35-75 psi)	

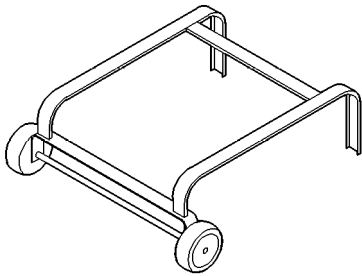
## SPECIFICATIONS (Continued)

## TORQUE CHART

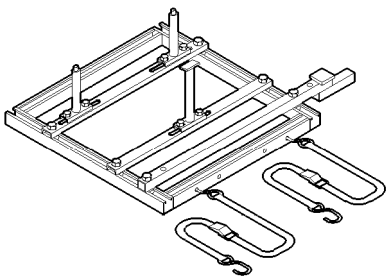
<b>DESCRIPTION</b>	<b>TORQUE</b>
Camshaft Bearing Cap Retaining Bolts . . . . .	Refer to procedure outlined in this section.
Camshaft Sensor Pick-Up Bolts . . . . .	28 N·m (20 ft. lbs.)
Timing Belt Cover Bolts M6 Outer to Inner Attaching . . . . .	4.5 N·m (40 in. lbs.)
M6 Inner Cover to Head/Oil Pump Attaching . . . . .	12 N·m (105 in. lbs.)
Connecting Rod Cap Bolts . . . . .	28 N·m (20 ft. lbs.) Plus ¼ Turn
Crankshaft Main Bearing Cap/Bedplate M8 Bedplate Bolts . . . . .	34 N·m (250 in. lbs.)
M11 Main Cap Bolts . . . . .	41 N·m (30 ft. lbs.) Plus ¼ Turn
Crankshaft Pulley Bolt . . . . .	135 N·m (100 ft. lbs.)
Cylinder Head Bolts . . . . .	Refer to procedure outlined in this section.
Cylinder Head Cover Bolts . . . . .	12 N·m (105 in. lbs.)
Engine Mount Bracket Attaching Bolts . . . . .	41 N·m (30 ft. lbs.)
Exhaust Manifold-to-Cylinder Head Bolts . . . . .	23 N·m (200 in. lbs.)
Exhaust Manifold Heat Shield . . . . .	12 N·m (105 in. lbs.)
Intake Manifold Bolts . . . . .	28 N·m (20 ft. lbs.)
Oil Filter to Engine Block Adapter . . . . .	55 N·m (40 ft. lbs.)
Oil Filter . . . . .	20 N·m (15 ft. lbs.)
Oil Pan Bolts . . . . .	12 N·m (105 in. lbs.)
Oil Pan Drain Plug . . . . .	34 N·m (25 ft. lbs.)
Oil Pump Attaching Bolts . . . . .	28 N·m (20 ft. lbs.)
Oil Pump Cover Bolts . . . . .	12 N·m (105 in. lbs.)
Oil Pump Pick-Up Tube Screw . . . . .	28 N·m (20 ft. lbs.)
Oil Pump Relief Valve Retaining Cap . . . . .	55 N·m (40 ft. lbs.)
Spark Plugs . . . . .	28 N·m (20 ft. lbs.)
Thermostat Housing Bolts . . . . .	23 N·m (200 in. lbs.)
Timing Belt Tensioner . . . . .	28 N·m (20 ft. lbs.)
Timing Belt Tensioner Pulley Assembly . . . . .	41 N·m (30 ft. lbs.)
Water Pump-to-Engine Block . . . . .	12 N·m (105 in. lbs.)

SPECIAL TOOLS

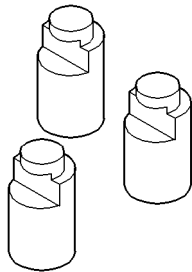
ENGINE 3.0L



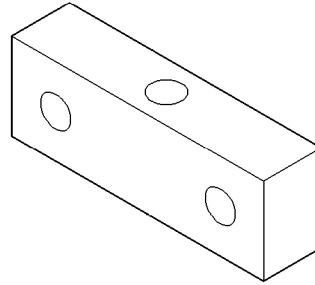
**Dolly 6135**



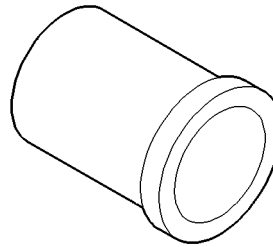
**Cradle 6710**



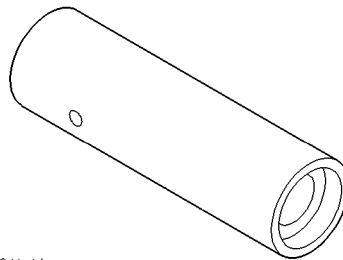
**Adaptor 6909**



**Adaptor 6910**

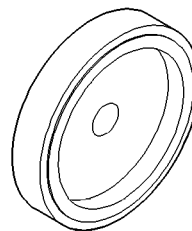


**Camshaft End Plug Installer MD-998306**



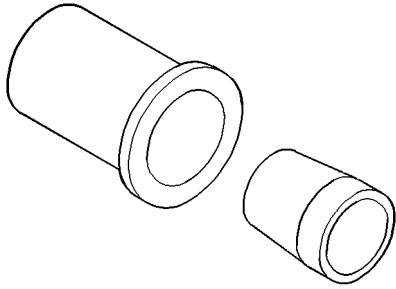
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**Valve Stem Seal Installer MD-998729**

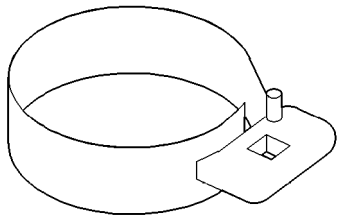


**Rear Crankshaft Seal Installer MD-998718**

SPECIAL TOOLS (Continued)

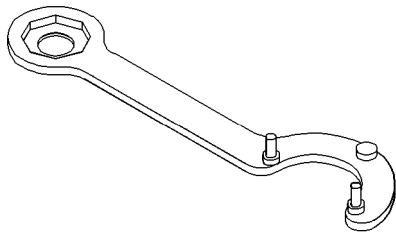


**Front Crankshaft Seal Installer MD-998717**



8011d480

**Oil Filter Wrench C-4065**



**Spanner Camshaft Sprocket MB-990775**

## 3.3/3.8L ENGINE

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## DESCRIPTION AND OPERATION

## ENGINE IDENTIFICATION

The engine identification number is located on the rear of the cylinder block just below the cylinder head (Fig. 1).

## ENGINE LUBRICATION SYSTEM

The lubrication system is a full flow filtration pressure feed type. Oil from the oil pan is pumped by a internal gear type oil pump directly coupled to the crankshaft. The pressure is regulated by a relief valve located in the chain case cover. The oil is pumped through an oil filter and feeds a main oil galley. This oil gallery feeds oil under pressure to the main and rod bearings, camshaft bearings. Passages in the cylinder block feed oil to the hydraulic lifters and rocker shaft brackets which feeds the rocker arm pivots (Fig. 2).

## ENGINE COMPONENTS

**ENGINE:** The 3.3L (201 Cubic Inches) and 3.8L (231 Cubic Inches) displacement engines are 60° V type six cylinder power plants with cast iron cylinder blocks and aluminum cylinder heads (Fig. 3). Firing order for these engines is 1-2-3-4-5-6. High turbulence cylinder heads allow a 8.9-1 compression ratio.

**CRANKSHAFT:** The nodular iron crankshaft is supported by four main bearings, with number two being the thrust bearing. Crankshaft end sealing is provided by front and rear rubber seals.

**PISTONS:** The pistons are cast aluminum alloy. Three rings are used. Piston pins, press fitted into place, join the pistons to forged steel connecting rods.

**CAMSHAFT:** The nodular iron camshaft is mounted in four steel backed babbitt bearings. A thrust plate located in front of the first bearing, and bolted to the block, controls end play. Silent timing chain drives the camshaft. This chain is enclosed by a cast aluminum cover which also carries a front crankshaft seal, provides front oil pan closure, water pump mounting.

DESCRIPTION AND OPERATION (Continued)

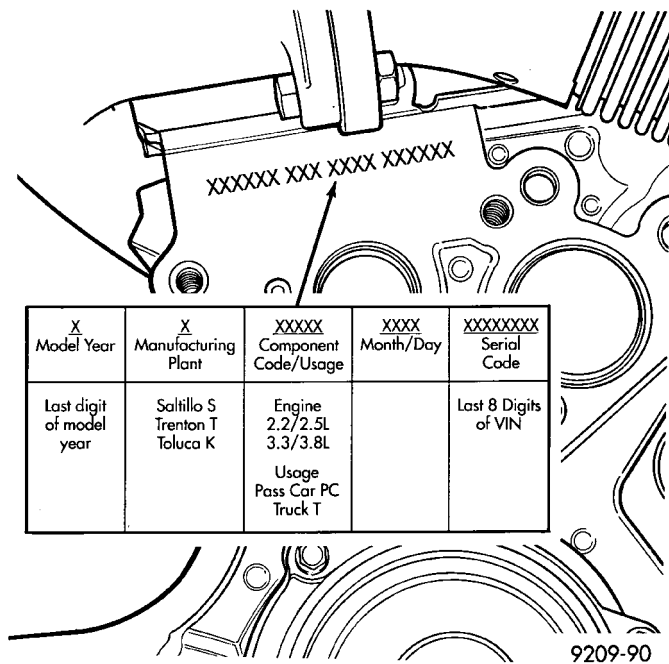


Fig. 1 Engine Identification

**CYLINDER HEADS:** Cylinder heads are designed to create high flow combustion chambers to improve performance, while minimizing the change to the burn rate of the chamber. Valve seat and guides are inserts. A steel flanged composition type gasket is used between head and block.

**CYLINDER HEAD COVERS:** The covers are sealed with steel reinforced silicon rubber gaskets.

**INTAKE MANIFOLD:** The intake manifold is a tuned two-piece semi-permanent mold aluminum

casting with individual primary runners leading from a plenum to the cylinders. The manifold is designed to boost torque in the 3600 rpm range and contributes to the engine's broad, flat torque curve, which was desired for excellent engine tractability, response and usable power output.

The intake manifold is also cored with upper level EGR passages for balanced cylinder to cylinder EGR distribution.

**VALVE TRAIN:** Valve train design incorporates the use of hydraulic roller tappets. Rocker arms are installed on a rocker arm shaft attached to the cylinder head with four bolts and retainers. Viton valve stem seals provide valve sealing. Conventional type pushrods, retainers and valve stem locks are used. Unique beehive style valve spring are used with lightweight retainers for improved high RPM performance.

**EXHAUST MANIFOLDS:** Exhaust manifolds are log type with a crossover and is attached directly to the cylinder heads.

DIAGNOSIS AND TESTING

HYDRAULIC TAPPETS

The valve train includes roller tappet assemblies, aligning yokes and yoke retainer.

Roller tappet alignment is maintained by machined flats on tappet body being fitted in pairs into six aligning yokes. The yokes are secured by an alignment yoke retainer (Fig. 4).

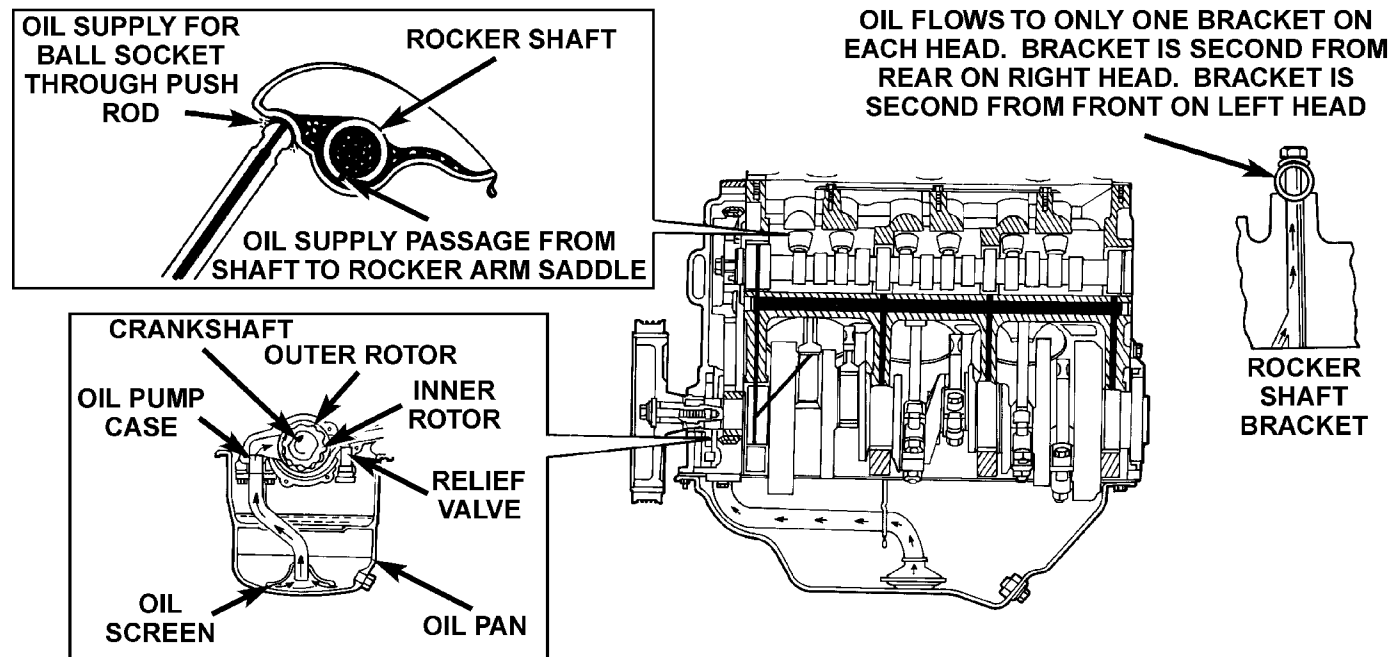
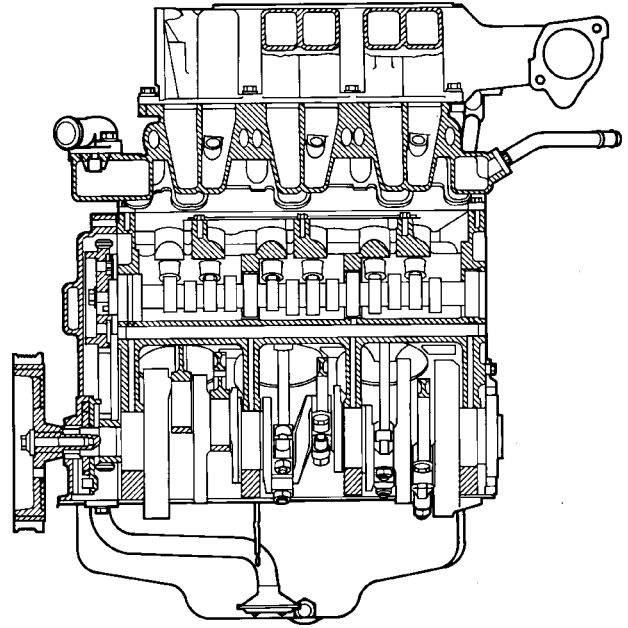
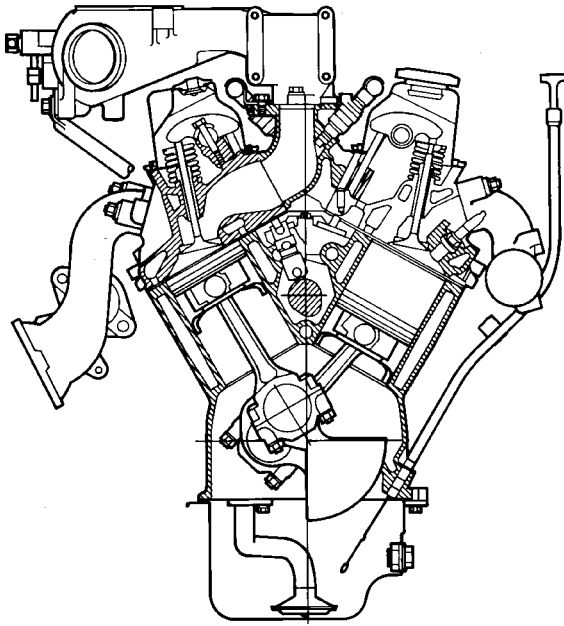


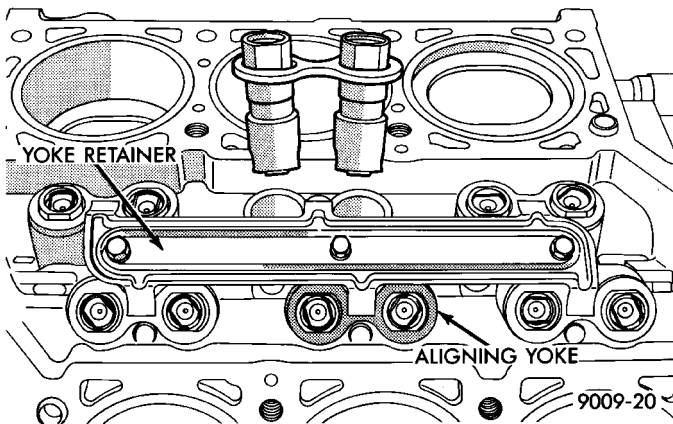
Fig. 2 Engine Oiling System

## DIAGNOSIS AND TESTING (Continued)



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**Fig. 3 3.3/3.8L V-6 Engines**



**Fig. 4 Roller Tappets Aligning Yoke and Retainer**

**PRELIMINARY STEP TO CHECKING THE HYDRAULIC TAPPETS**

Before disassembling any part of the engine to correct tappet noise, read the oil pressure at the gauge. Install a reliable gauge at pressure sending unit if vehicle has no oil pressure gauge and check the oil level in the oil pan. The pressure should be between 30 and 80 psi (206.8 to 551.6 kPa) at 2000 rpm.

The oil level in the pan should never be above the MAX mark on dipstick, or below the MIN mark. Either of these two conditions could be responsible for noisy tappets. **Oil Level Check: stop engine after reaching normal operating temperature .** Allow 5 minutes to stabilize oil level, check dipstick.

**OIL LEVEL TOO HIGH**

If oil level is above the MAX mark on dip stick, it is possible for the connecting rods to dip into the oil while engine is running and create foam. Foam in oil pan would be fed to the hydraulic tappets by the oil pump causing them to become soft and allow valves to seat noisily.

**OIL LEVEL TOO LOW**

Low oil level may allow pump to take in air which when fed to the tappets, causes them to become soft and allows valves to seat noisily. Any leaks on intake side of pump through which air can be drawn will create the same tappet action. Check the lubrication system from the intake strainer to the pump cover, including the relief valve retainer cap. When tappet noise is due to aeration, it may be intermittent or constant, and usually more than one tappet will be noisy. When oil level and leaks have been corrected, engine should be operated at fast idle to allow all of the air inside of the tappets to be bled out.

**VALVE TRAIN NOISE DIAGNOSIS**

To determine source of valve train noise, operate engine at idle with cylinder head covers removed and listen for source of the noise.

## DIAGNOSIS AND TESTING (Continued)

**NOTE:** Worn valve guides or cocked springs are sometimes mistaken for noisy tappets. If such is the case, noise may be dampened by applying side thrust on the valve spring. If noise is not appreciably reduced, it can be assumed the noise is in the tappet. Inspect the rocker arm push rod sockets and push rod ends for wear.

Valve tappet noise ranges from light noise to a heavy click. A light noise is usually caused by excessive leak-down around the unit plunger which will necessitate replacing the tappet, or by the plunger partially sticking in the tappet body cylinder. A heavy click is caused either by a tappet check valve not seating, or by foreign particles becoming wedged between the plunger and the tappet body causing the plunger to stick in the down position. This heavy click will be accompanied by excessive clearance between the valve stem and rocker arm as valve closes. In either case, tappet assembly should be removed for inspection and cleaning.

## CHECKING ENGINE OIL PRESSURE

Check oil pressure using gauge at oil pressure switch location. Oil pressure should be 34.47 kPa (5 psi.) at idle or 205 to 551 kPa (30 to 80 psi.) at 3000 RPM.

(1) Remove pressure sending unit and install oil pressure gauge (Fig. 5).

**CAUTION:** If oil pressure is 0 at idle, do not run engine at 3000 RPM.

(2) Warm engine at high idle until thermostat opens.

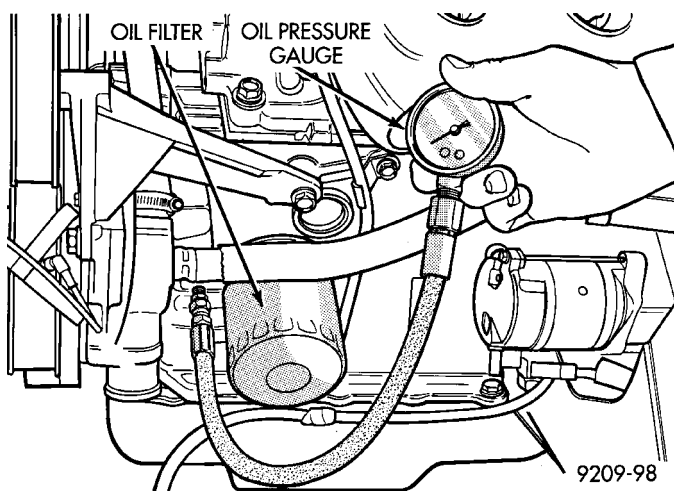


Fig. 5 Checking Oil Pump Pressure

## SERVICE PROCEDURES

## VALVE TIMING

(1) Remove front cylinder head cover and all 6 spark plugs.

(2) Rotate engine until the #2 piston is at TDC of the compression stroke.

(3) Install a degree wheel on the crankshaft pulley.

(4) With proper adaptor, install a dial indicator into #2 spark plug hole. Using the indicator find TDC on the compression stroke.

(5) Position the degree wheel to zero.

(6) Remove dial indicator from spark plug hole.

(7) Place a 5.08 mm (0.200 in.) spacer between the valve stem tip of #2 intake valve and rocker arm pad. Allow tappet to bleed down to give a solid tappet effect.

(8) Install a dial indicator so plunger contacts the #2 intake valve spring retainer as nearly perpendicular as possible. Zero the indicator.

(9) Rotate the engine clockwise until the intake valve has lifted .254 mm (0.010 in.).

**CAUTION:** Do not turn crankshaft any further clockwise as intake valve might bottom and result in serious damage.

(10) Degree wheel should read 6 degrees BTDC to 6 degrees ATDC.

## MEASURING TIMING CHAIN FOR STRETCH

(1) Place a scale next to timing chain so that any movement of chain may be measured.

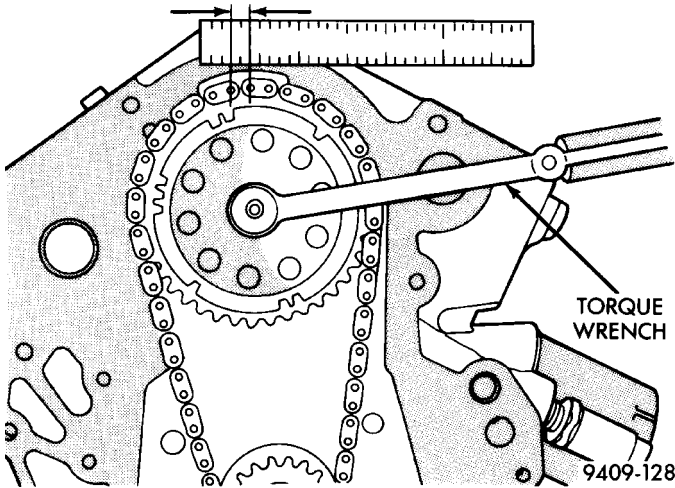
(2) Place a torque wrench and socket on camshaft sprocket attaching bolt and apply torque in direction of crankshaft rotation to take up slack; 41 N·m (30 ft. lb.) with cylinder head installed or 20 N·m (15 ft. lb.) with cylinder heads removed. **With a torque applied to the camshaft sprocket bolt, crankshaft should not be permitted to move. It may be necessary to block crankshaft to prevent rotation.**

(3) Holding a scale even, with dimension reading as shown (Fig. 6), along edge of chain links. Apply torque in the reverse direction to 41 N·m (30 ft. lbs.) with cylinder heads installed, or 20 N·m (15 ft. lbs.) with cylinder heads removed. Check amount of chain movement.

(4) Install a new timing chain, if its movement exceeds 3.175 mm (1/8 inch).

(5) If chain is not satisfactory, refer to Timing Chain Removal and Installation in this section.

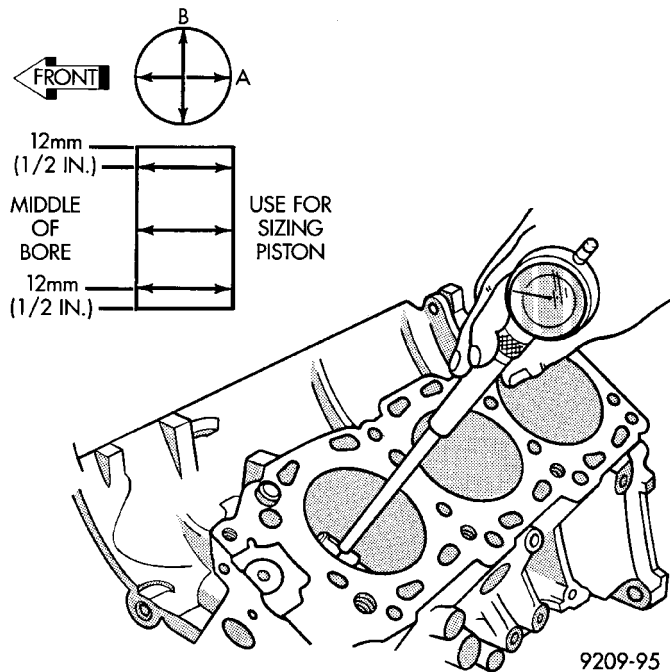
SERVICE PROCEDURES (Continued)



**Fig. 6 Measuring Timing Chain Wear and Stretch**  
**FITTING PISTONS AND RINGS**

**FITTING PISTONS**

The piston and cylinder wall must be clean and dry. Piston diameter should be measured 90 degrees to piston pin at size location shown in (Fig. 9). Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line shown in (Fig. 7). Refer to (Fig. 8) for specifications. **Pistons and cylinder bores should be measured at normal room temperature, 70°F (21°C)**



**Fig. 7 Checking Cylinder Bore Size**

**FITTING RINGS**

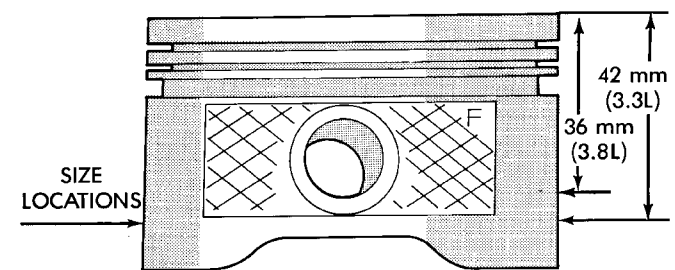
(1) Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The

Engine	Standard Bore	Maximum Out-of-Round	Maximum Taper
3.3L	92.993-93.007 mm 3.661-3.6617 inch.	.076 mm (.003 inch.)	.51 mm (.002 inch.)
3.8L	95.993-96.007 mm 3.7792-3.780 inch.	Same	Same
Standard Piston Size			
3.3L	92.950-92.968 mm (3.6594-3.6602 inch.)		
3.8L	95.950-95.968 mm (3.7776-3.7783 inch.)		
Piston to Bore Clearance: .025-.057 mm (.0009 to .0022 inches.)			
Measurements taken at Piston Size location.			

**Fig. 8 Cylinder Bore and Piston Specifications**

Engine	Standard Bore	Maximum Out-of-Round	Maximum Taper
3.3L	92.993-93.007 mm 3.661-3.6617 inch.	.076 mm (.003 inch.)	.51 mm (.002 inch.)
3.8L	95.993-96.007 mm 3.7792-3.780 inch.	Same	Same
Standard Piston Size			
3.3L	92.950-92.968 mm (3.6594-3.6602 inch.)		
3.8L	95.950-95.968 mm (3.7776-3.7783 inch.)		
Piston to Bore Clearance: .025-.057 mm (.0009 to .0022 inches .)			
Measurements taken at Piston Size location.			

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**Fig. 9 Piston Measurements**

ring gap measurement must be made with the ring positioning at least 12 mm (0.50 in.) from bottom of cylinder bore. Check gap with feeler gauge (Fig. 10). Refer to specifications (Fig. 11).

(2) Check piston ring to groove clearance: (Fig. 12). Refer to specification (Fig. 11).

SERVICE PROCEDURES (Continued)

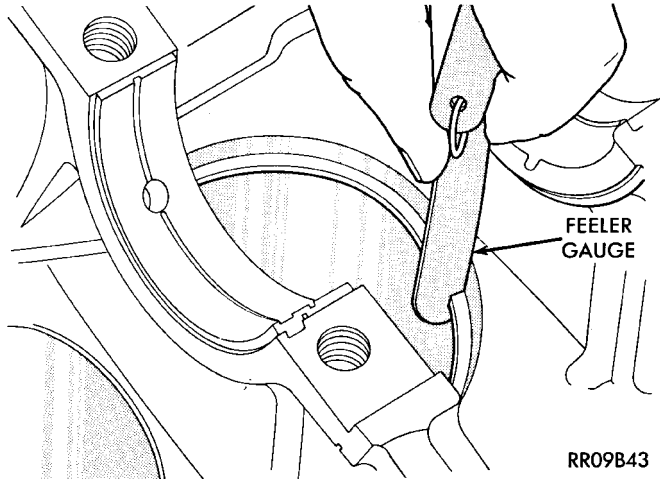


Fig. 10 Check Gap on Piston Rings

FITTING CONNECTING ROD BEARINGS

Fit all rods on one bank until complete.

The bearing caps are not interchangeable and should be marked at removal to insure correct assembly.

The bearing shells must be installed with the tangs inserted into the machined grooves in the rods and caps. Install cap with the tangs on the same side as the rod.

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 in.). Bearings are available in 0.025 mm (0.001 in.), 0.051 mm (0.002 in.), 0.076 mm (0.003 in.), 0.254 mm (0.010 in.) and 0.305 mm (0.012 in.) undersize. **Install the bearings in pairs. Do not use a new bearing half with an old bearing half. Do not file the rods or bearing caps.**

(1) Follow procedure specified in the Standard Service Procedure Section for Measuring Main Bearing Clearance and Connecting Rod Bearing Clearance (Fig. 13).

**NOTE:** The rod bearing bolts should be examined before reuse. If the threads are necked down the bolts should be replaced (Fig. 16). Necking can be checked by holding a scale or straight edge against the threads. If all the threads do not contact the scale the bolt should be replaced.

(2) Before installing the nuts the threads should be oiled with engine oil.

(3) Install nuts finger tight on each bolt then alternately torque each nut to assemble the cap properly.

(4) Tighten the nuts to 54 N·m PLUS 1/4 turn (40 ft. lbs. PLUS 1/4 turn).

(5) Using a feeler gauge, check connecting rod side clearance (Fig. 14). Refer to (Fig. 15) for specifications.

Ring Position	Ring Gap	Wear Limit
Upper Ring	0.30 to 0.55 mm (.012 to .022 in.)	1.0 mm (.039 in.)
Intermediate Ring	0.30 to 0.55 mm (.012 to .022 in.)	1.0 mm (.039 in.)
Oil Control Ring	0.25 to 1.00 mm (.010 to .039 in.)	1.88 mm (.074 in.)
Ring Position	Groove Clearance	Maximum Clearance
Upper Ring	0.030 to 0.085 mm (.001 to .0030 in.)	.10 mm (.004 in.)
Intermediate Ring	0.030 to 0.095 mm (.001 to .0037 in.)	.10 mm (.004 in.)
Oil Control Ring	0.014 to .266 mm (.0005 to .009 in.)	.266 mm (.009 in.)

Fig. 11 Piston Ring Specifications

Ring Position	Ring Gap	Wear Limit
Upper Ring	0.30 to 0.55 mm (.012 to .022 in.)	1.0 mm (.039 in.)
Intermediate Ring	0.30 to 0.55 mm (.012 to .022 in.)	1.0 mm (.039 in.)
Oil Control Ring	0.25 to 1.00 mm (.010 to .039 in.)	1.88 mm (.074 in.)
Ring Position	Groove Clearance	Maximum Clearance
Upper Ring	0.030 to 0.085 mm (.001 to .0030 in.)	.10 mm (.004 in.)
Intermediate Ring	0.030 to 0.095 mm (.001 to .0037 in.)	.10 mm (.004 in.)
Oil Control Ring	0.014 to .266 mm (.0005 to .009 in.)	.266 mm (.009 in.)

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FITTING MAIN BEARINGS

CRANKSHAFT OIL CLEARANCE

Measure the journal outside diameter as shown in (Fig. 18). Refer to specification (Fig. 17).

SERVICE PROCEDURES (Continued)

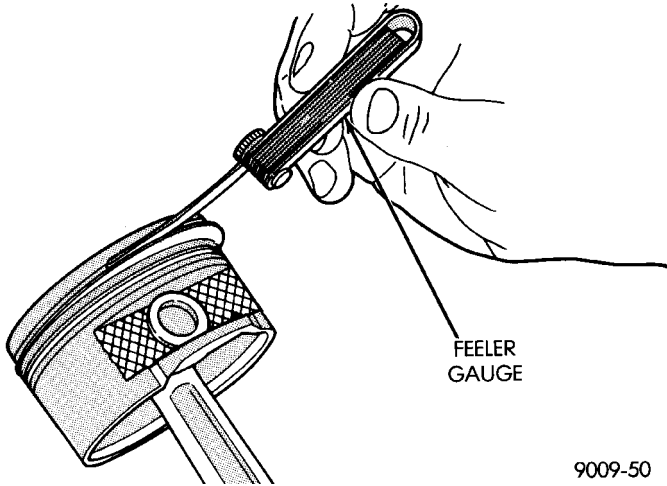


Fig. 12 Measuring Piston Ring Side Clearance

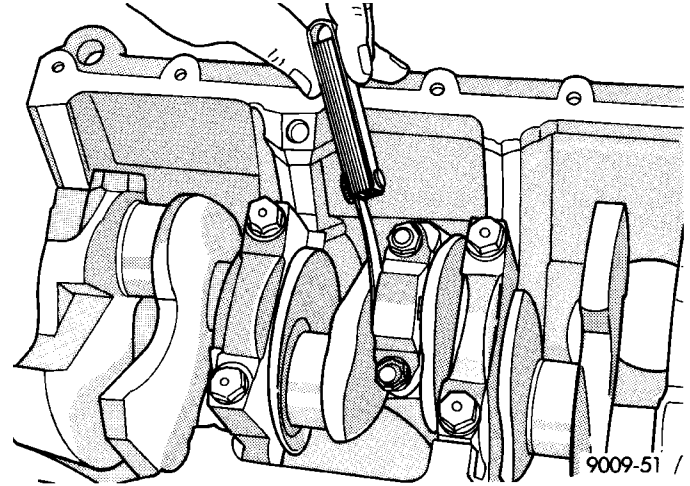


Fig. 14 Checking Connecting Rod Side Clearance

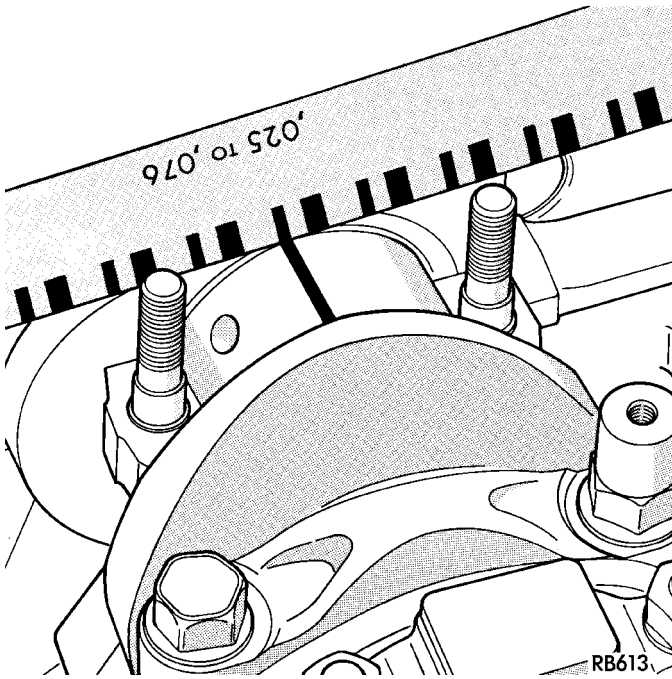


Fig. 13 Checking Connecting Rod Bearing Clearance

PLASTIGAGE (OIL CLEARANCE) MEASUREMENT

- (1) Remove oil from journal and bearing shell.
- (2) Install crankshaft.
- (3) Cut plastigage to same length as width of the bearing and place it in parallel with the journal axis (Fig. 19).
- (4) Install the main bearing cap carefully and tighten the bolts to specified torque.

**CAUTION:** Do not rotate crankshaft or the plastigage will be smeared.

- (5) Carefully remove the bearing cap and measure the width of the plastigage at the widest part using

Connecting Rod Bearing Clearance	
New Part:	.019 to .087 mm (.0008 to .0034 in.)
Wear Limit:	.104 mm (.0041 in.)
Connecting Rod Side Clearance	
New Part:	0.13 to 0.32 mm (.005 to .013 in.)
Wear Limit:	0.38 mm (.015 in.)

Fig. 15 Connecting Rod Specifications

Connecting Rod Bearing Clearance	
New Part:	.019 to .087 mm (.0008 to .0034 in.)
Wear Limit:	.104 mm (.0041 in.)
Connecting Rod Side Clearance	
New Part:	0.13 to 0.32 mm (.005 to .013 in.)
Wear Limit:	0.38 mm (.015 in.)

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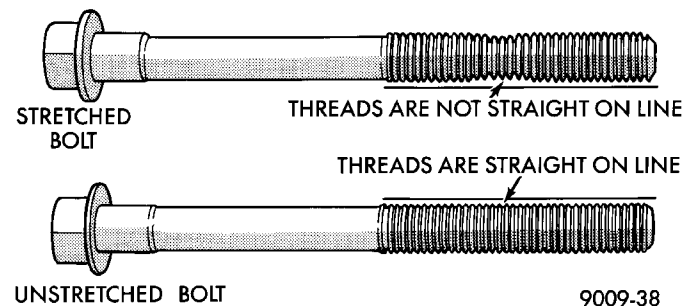


Fig. 16 Check for Stretched (Necked) Bolts

the scale on the plastigage package (Fig. 19). Refer to specification (Fig. 17) for proper clearances. If the

## SERVICE PROCEDURES (Continued)

Crankshaft End-Play New Part: 0.10 to 0.30 mm (.004 to .012 in.) Wear Limit: 0.38 mm (.015 in.)	
Main and Connecting Rod Bearing Clearance New Part: .019 to .077 mm (.0007 to .0030 in.) Wear Limit: .102 mm (.004 in.)	
Crankshaft Journal Sizes	
Crankshaft Main Bearing Journal	
ALL	Diameter
Standard	64.00 $\pm$ 0.013 mm (2.519 $\pm$ .0005 in.)
Crankshaft Connecting Rod Journal	
ALL	Diameter
Standard	58.00 mm + 0.005/ -0.021 mm 2.283 in. + 0.0002/ -0.0008 in.

Fig. 17 Crankshaft Specification

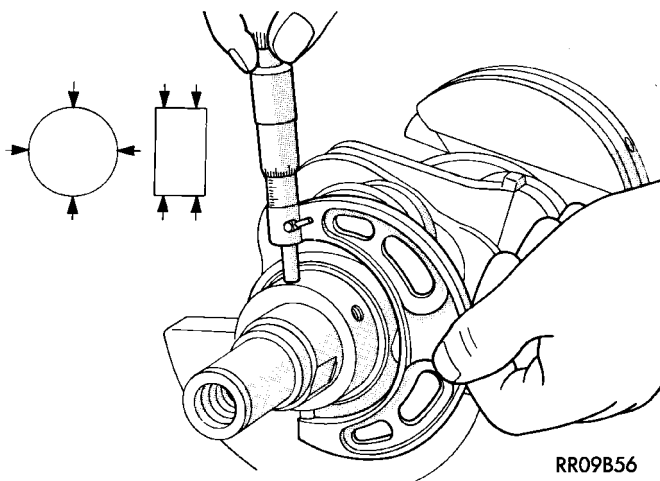


Fig. 18 Measure Crankshaft Journal O.D.

clearance exceeds the specified limits. Replace the main bearing(s) and if necessary have the crankshaft machined to next undersize.

**CAUTION:** Do not rotate crankshaft or the Plastigage may be smeared.

## CRANKSHAFT END PLAY

## DIAL INDICATOR

(1) Mount a dial indicator to front of engine, locating probe on nose of crankshaft (Fig. 20).

(2) Move crankshaft all the way to the rear of its travel.

(3) Zero the dial indicator.

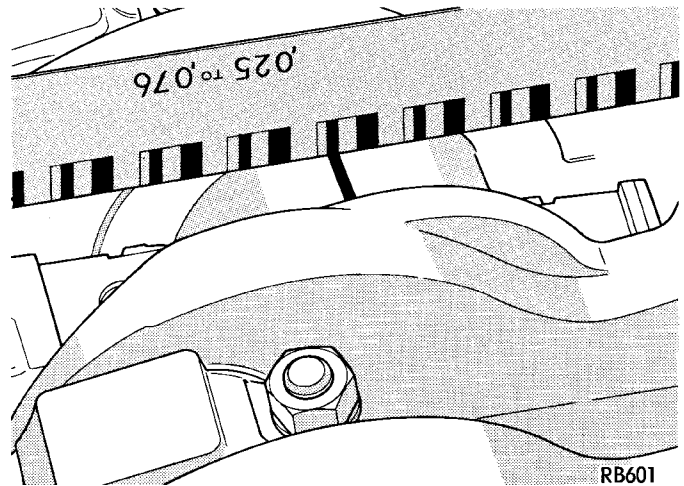


Fig. 19 Measuring Bearing Clearance with Plastigage

(4) Move crankshaft all the way to the front and read the dial indicator. Specifications: New Part: 0.09 to 0.24 mm (0.004 to 0.009 in.)

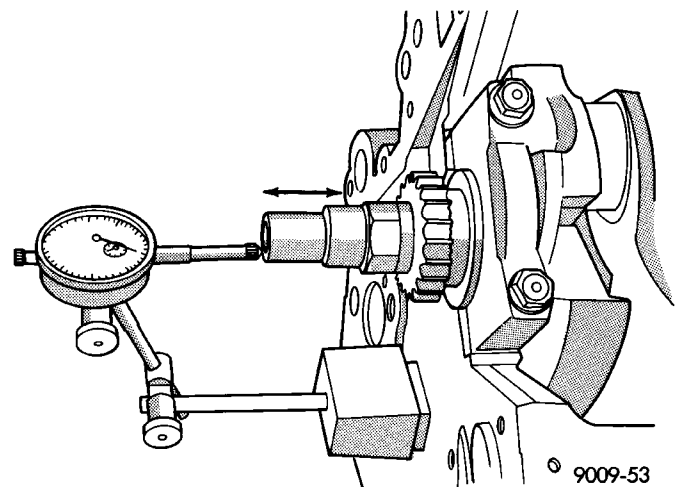


Fig. 20 Checking Crankshaft End Play

## FEELER GAUGE

(1) Move crankshaft all the way to the rear of its travel using a lever inserted between a main bearing cap and a crankshaft cheek using care not to damage any bearing surface. **Do not** loosen main bearing cap.

(2) Use a feeler gauge between number 2 thrust bearing and machined crankshaft surface to determine end play. Refer to Specifications.

## VALVE SERVICE RECONDITION

## VALVE INSPECTION

(1) Clean valves thoroughly and discard burned, warped and cracked valves.

## SERVICE PROCEDURES (Continued)

(2) Measure valve stems for wear. Refer to specifications (Fig. 23). **Valve stems are chrome plated and should not be polished.**

(3) Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.

(4) Measure valve stem guide clearance as follows:

a. Install valve into cylinder head so it is 14 mm (0.551 in.) off the valve seat. A small piece of hose may be used to hold valve in place.

b. Attach dial indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 21).

(5) Move valve to and from the indicator. Refer to specifications (Fig. 23).

(6) Ream the guides for valves with oversized stems if dial indicator reading is excessive or if the stems are scuffed or scored.

(7) Service valves with oversize stems and over size seals are available in 0.15 mm (0.005 in.), 0.40 mm, (0.015 in.) and 0.80 mm (0.030 in.) oversize.

**NOTE: Oversize seals must be used with oversize valves.**

(8) Reamers to accommodate the oversize valve stem are shown in (Fig. 23).

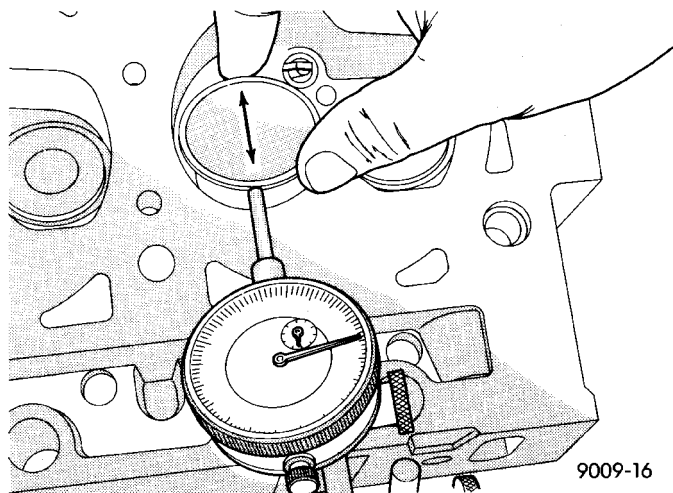


Fig. 21 Measuring Valve Guide Wear

(9) Slowly turn reamer by hand and clean guide thoroughly before installing new valve. **Do not attempt to ream the valve guides from standard directly to 0.80 mm (0.030 in.)** Use step procedure of 0.15 mm (0.005 in.), 0.40 mm (0.015 in.) and 0.80 mm (0.030 in.) so the valve guides may be reamed true in relation to the valve seat. After reaming guides, the seat runout should be measured and resurfaced if necessary. See Refacing Valves and Valve Seats.

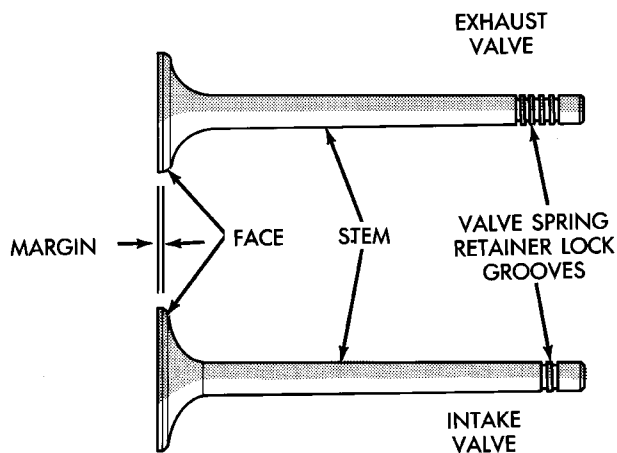


Fig. 22 Intake and Exhaust Valves

Valve Guide Dial Indicator Reading, Maximum	Intake Valve 0.247 mm (0.009 in.)	Exhaust Valve 0.414 mm (0.016 in.)
Valve Guide Reamer Oversize	Valve Guide Size	
0.15 mm (.005 in.)	8.125-8.150 mm (.3198-.3206 in.)	
0.40 mm (.015 in.)	8.375-8.400 mm (.3297-.3307 in.)	
0.80 mm (.030 in.)	8.775-8.800 mm (.3454-.3464 in.)	

Fig. 23 Valve Guide Specifications

Valve Guide Dial Indicator Reading, Maximum	Intake Valve 0.247 mm (0.009 in.)	Exhaust Valve 0.414 mm (0.016 in.)
Valve Guide Reamer Oversize	Valve Guide Size	
0.15 mm (.005 in.)	8.125-8.150 mm (.3198-.3208 in.)	
0.40 mm (.015 in.)	8.375-8.400 mm (.3297-.3307 in.)	
0.80 mm (.030 in.)	8.775-8.800 mm (.3454-.3464 in.)	

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#### VALVE GUIDES

**NOTE:** Replace cylinder head if guide does not clean up with 0.80 mm (0.030 in.) oversize reamer, or if guide is loose in cylinder head.

#### REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 44-1/2 to 45 degree face angle. The valve seats have a 45 to 45-1/2 degree face angle. The valve face and valve seat angles are shown in (Fig. 25).

## SERVICE PROCEDURES (Continued)

Valve Dimensions	
<b>Intake Valve (minimum)</b>	
Stem diameter:	7.935 mm (.3124 in.)
Face angle:	44 1/2°
Valve margin:	.794 mm (.031 in.)
Head diameter:	45.5 mm (1.79 in.)
Length:	125.38 mm (4.936 in.)
<b>Exhaust Valve (minimum)</b>	
Stem diameter:	7.906 mm (.3112 in.)
Face angle:	44 1/2°
Valve margin:	1.191 mm (.0469 in.)
Head diameter:	37.5 mm (1.476 in.)
Length:	126.00 mm (4.964 in.)

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Fig. 24 Valve Dimensions

## VALVES

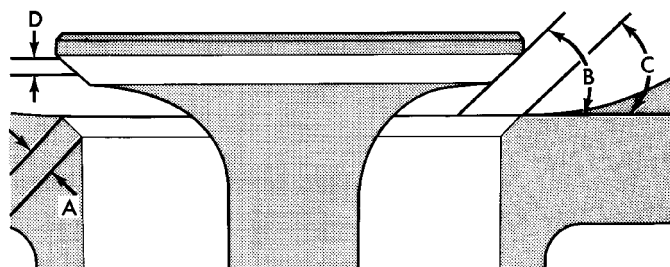
(1) Inspect the remaining margin after the valves are refaced. Refer to specifications (Fig. 24).

## VALVE SEATS

**CAUTION:** Remove metal from valve seat only. Do not remove metal from cylinder head (Fig. 26).

(1) When refacing valve seats, it is important that the correct size valve guide pilot be used for reseating stones. A true and complete surface must be obtained.

(2) Measure the concentricity of valve seat using dial indicator. Total runout should not exceed 0.051 mm (0.002 in.) total indicator reading.



A- SEAT WIDTH (INTAKE 1.75 TO 2.25mm (.069 TO .088 IN.)  
EXHAUST: 1.50 TO 2.00mm (.059 TO .078 IN.)  
B- FACE ANGLE (INTAKE & EXHAUST: 44 1/2°)  
C- SEAT ANGLE (INTAKE & EXHAUST: 45°-45 1/2°)  
D- SEAT CONTACT AREA

9009-88

Fig. 25 Valve Seats

(3) Inspect the valve seat using Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to top edge of valve face, lower valve seat with

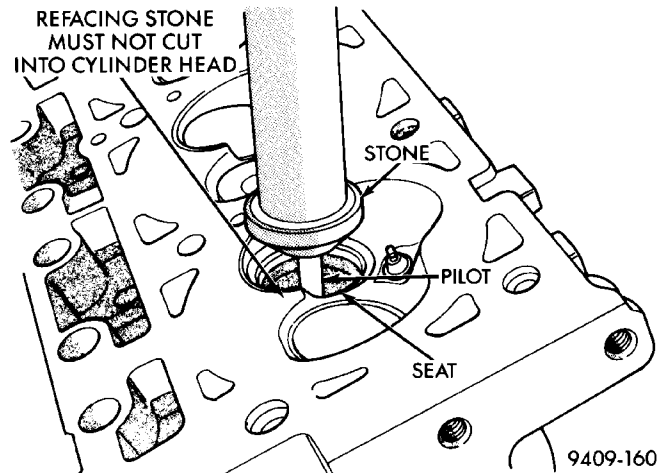


Fig. 26 Refacing Valve Seats

a 15 degree stone. If the blue is transferred to the bottom edge of valve face raise valve seat with a 65 degrees stone.

**NOTE:** Valve seats which are worn or burned can be reworked, provided that correct angle and seat width are maintained. Otherwise cylinder head must be replaced.

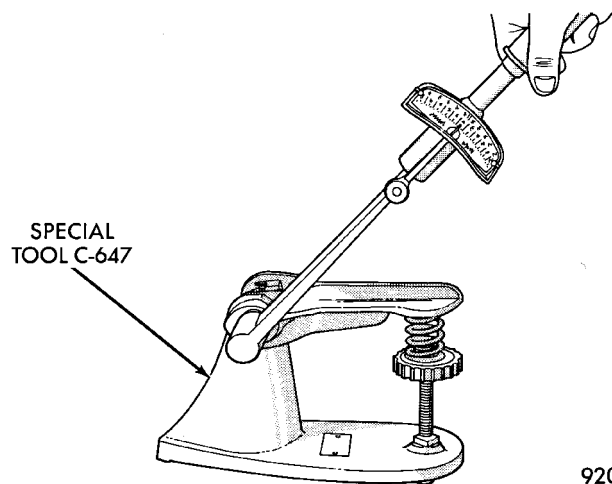
(4) When seat is properly positioned the width of intake seats should be 1.75 to 2.25 mm (0.69 to 0.88 in.) The width of the exhaust seats should be 1.50 to 2.00 mm (0.059 to 0.078 in.) (Fig. 25).

(5) Check the valve spring installed height after refacing the valve and seat (Fig. 28).

## TESTING VALVE SPRINGS

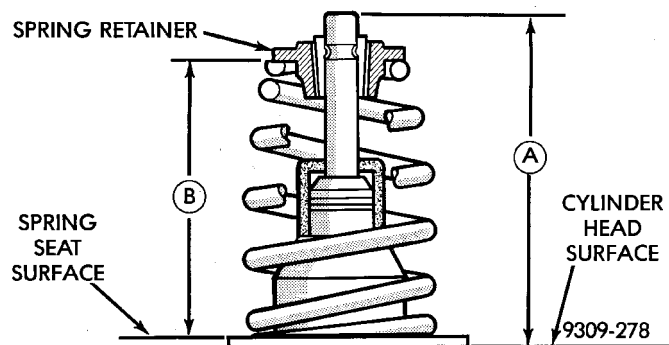
Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested (Fig. 27). **As an example;** the compression length of the spring to be tested is 33.34 mm (1-5/16 inches). Turn table of Tool C-647 until surface is in line with the 33.34 mm (1-5/16 inch) mark on the threaded stud and the zero mark on the front. Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by two. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to specifications to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.

## SERVICE PROCEDURES (Continued)



9209-37

Fig. 27 Testing Valve Springs



9309-278

Fig. 28 Checking Valve Installed Height

## REMOVAL AND INSTALLATION

## WIPER UNIT

When performing work on the upper engine. Refer to Section 8K, Windshield Wipers and Washers for removal of the Wiper Unit.

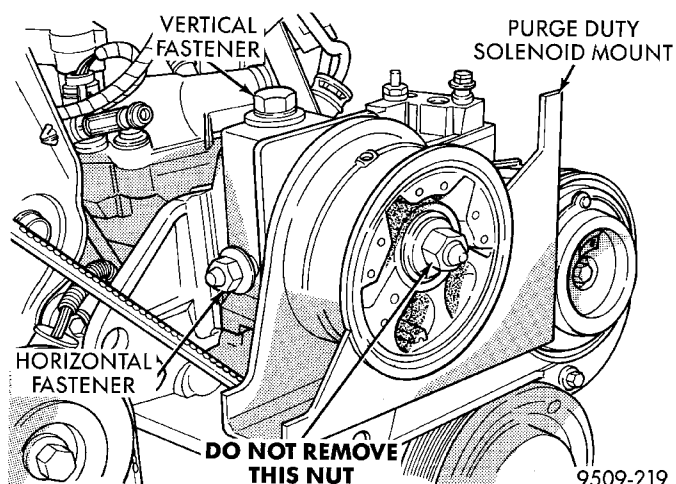
## ENGINE MOUNTS

## RIGHT SIDE MOUNT

## REMOVAL

**NOTE:** Right mount should only be serviced as an assembly to prevent noise, vibration and harshness concerns.

- (1) Remove the purge duty solenoid and wiring harness from engine mount.
- (2) Remove the two right engine mount insulator vertical fasteners and loosen the horizontal fastener, **Do Not** remove the large nut on the end of the core from frame rail (Fig. 29).
- (3) Remove the load on the engine motor mounts by carefully supporting the engine and transmission assembly with a floor jack.



9509-219

Fig. 29 Engine Mount—Right

- (4) Remove the vertical and horizontal fasteners from the engine side bracket. Remove the engine mount assembly

## INSTALLATION

- (1) Reverse removal procedure for installation. Tighten assembly in the following order:
  - a. Engine mount to rail fasteners to 68 N·m (50 ft. lbs.).
  - b. The vertical engine fastener to 102 N·m (75 ft. lbs.)
  - c. The horizontal fastener to 150 N·m (111 ft. lbs.).
- (2) Install the purge duty solenoid and wiring harness to the engine mount.
- (3) Engine mount adjustment, Refer to Engine Mount Insulator Adjustment of this section.

## FRONT MOUNT

## REMOVAL

- (1) Support the engine and transmission assembly with a floor jack so it will not rotate.
- (2) Remove the front engine mount through bolt from the insulator and front crossmember mounting bracket (Fig. 30).
- (3) Remove six screws from air dam to allow access to the front mount screws.
- (4) Remove the front engine mount screws and remove the insulator assembly.
- (5) Remove the front mounting bracket, if necessary (Fig. 30).

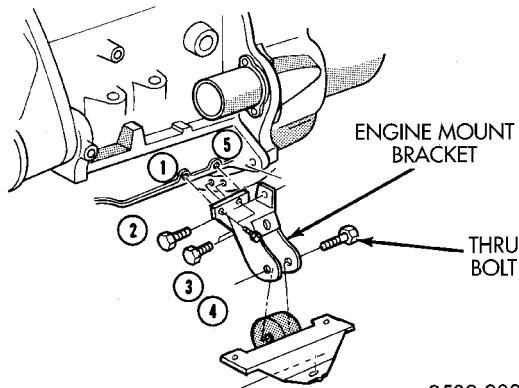
## INSTALLATION

- (1) Reverse removal procedure for installation and tighten fasteners in this order:
  - a. Tighten bolts 2,3, and 4 to 108 N·m (80 ft. lbs.).
  - b. Tighten bolts 1 and 5 to 54 N·m (40 ft. lbs.).
- (2) Engine mount adjustment, Refer to Engine Mount Insulator Adjustment of this section.

## REMOVAL AND INSTALLATION (Continued)

(3) Install six screws to air dam and tighten to 12 N·m (105 in. lbs.).

REFER TO TEXT  
FOR TORQUE VALUES



**Fig. 30 Engine Mounting—Front**

## LEFT SIDE MOUNT

## REMOVAL

- (1) Raise vehicle on hoist and remove left front wheel.
- (2) Support the transmission with a transmission jack.
- (3) Remove the insulator through bolt from the mount.
- (4) Remove the transmission mount fasteners and remove mount.

## INSTALLATION

- (1) Reverse removal procedure for installation.
- (2) Tighten mount to transmission bolts to 55 N·m (40 ft. lbs.).
- (3) Tighten through bolt to 75 N·m (55 ft. lbs.) (Fig. 31).
- (4) Engine mount adjustment, Refer to Engine Mount Insulator Adjustment of this section.

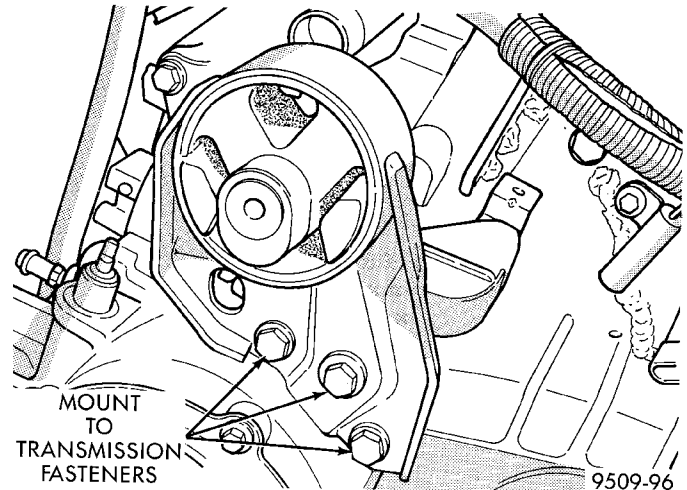
## REAR MOUNT

## REMOVAL

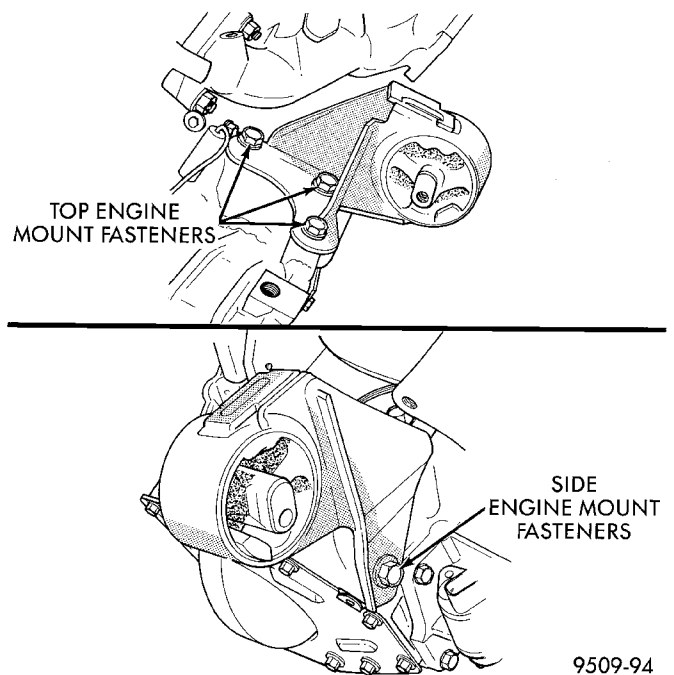
- (1) Raise vehicle on hoist.
- (2) Support the transmission with a transmission jack so it will not rotate.
- (3) Remove the insulator through bolt from the mount and rear suspension crossmember.
- (4) Remove the four transmission mount fasteners and remove the mount.

## INSTALLATION

- (1) Reverse the removal procedure for installation. Refer to (Fig. 32). Tighten through bolt to 75 N·m (55 ft. lbs.)



**Fig. 31 Engine Mounting—Left**



**Fig. 32 Engine Mounting—Rear**

## ENGINE MOUNT RUBBER INSULATORS

Insulator location on (right side) is adjustable to allow right/left drive train adjustment in relation to drive shaft assembly length.

Check and reposition right engine mount insulator. See Adjustments in this section. Adjust drive train position, if required, for the following conditions:

- a. Drive shaft distress. See Group 2, Suspension and Driveshafts.
- b. Any front end structural damage (after repair).
- c. Insulator replacement.

## REMOVAL AND INSTALLATION (Continued)

## ENGINE ASSEMBLY

## REMOVAL

(1) Perform fuel pressure release procedure. Refer to group 14 fuel system for procedure. Remove fuel line to fuel rail.

(2) Disconnect battery.

(3) Remove air cleaner and hoses.

(4) Remove battery cover, battery and battery tray, with integral vacuum reservoir, from vehicle.

(5) Block off heater hoses to rear heater assembly, if equipped.

(6) Drain cooling system. Refer to Group 7, Cooling System for procedure.

(7) Disconnect heater hoses.

(8) Remove fan module and radiator. Refer to Group 7 Cooling System for procedure.

(9) Disconnect transmission shift linkage.

(10) Disconnect throttle body linkage and vacuum hoses from throttle body.

(11) Remove accessory drive belts. Refer to Group 7, Accessory Drive Belts located in Cooling System for procedure.

(12) Remove air conditioning compressor from engine and set it aside.

(13) Disconnect generator wiring harness and remove generator.

(14) Hoist vehicle and remove axle shafts. Refer to Group 2, Suspension and Driveshafts for procedure.

(15) Remove right and left inner splash shields.

(16) Disconnect exhaust pipe from manifold.

(17) Remove front engine mount and bracket as an assembly.

(18) Remove rear transmission mount and bracket.

(19) Remove power steering pump and bracket assembly.

(20) Remove wiring harness and connectors from front of engine.

(21) Remove bending braces and install tool number 6912 on engine.

(22) Remove transmission inspection cover and mark flexplate to torque converter.

(23) Remove driveplate to torque converter bolts.

(24) Lower the vehicle.

(25) Remove ground straps to body.

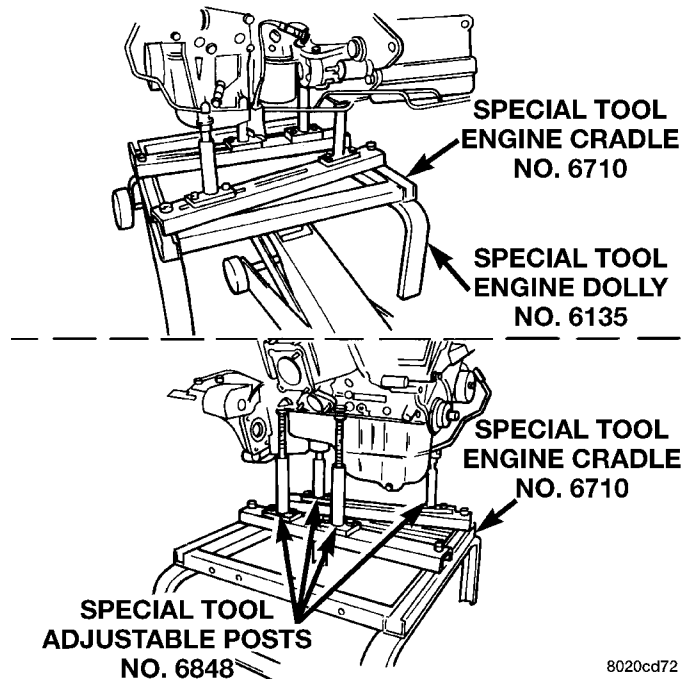
(26) Raise vehicle enough to allow engine dolly Special Tool 6135 and cradle Special Tool 6710 with post Special Tool 6848 and adaptor Special Tool 6909 to be installed under vehicle (Fig. 33).

(27) Loosen cradle engine mounts to allow movement for positioning onto engine locating holes on the engine. Lower vehicle and position cradle mounts until the engine is resting on mounts. Tighten mounts to cradle frame. This will keep mounts from moving when removing or installing engine and transmission.

(28) Lower vehicle so the weight of **ONLY THE ENGINE AND TRANSMISSION** is on the cradle.

(29) Remove right engine mount assembly and left transmission mount through bolt. Refer to Engine Mounts Section of this Group.

(30) Raise vehicle slowly. It may be necessary to move the engine/transmission assembly on the cradle to allow for removal around body flanges.



**Fig. 33 Positioning Engine Cradle Support Post Mounts—Typical**

## INSTALLATION

(1) Position engine and transmission assembly under vehicle and slowly lower the vehicle over the engine and transmission. It may be necessary to move the engine/transmission assembly with the cradle for clearance around body flanges.

(2) Align engine and transmission mounts to attaching points. Install mounting bolts at the right engine and left transmission mounts. Refer to procedures outlined in this section.

(3) Slowly raise vehicle enough to remove the engine dolly and cradle Special Tools 6135, 6710, 6848 and 6909.

(4) Remove Special tools 6912 and install bending braces.

(5) Lower vehicle. Install generator and wiring harness.

(6) Connect wiring harness on the front of the engine.

(7) Install Air Conditioning Compressor.

(8) Install power steering pump and bracket and accessory drive belt. Refer to Accessory drive Section Located in group 7 for installation procedure.

## REMOVAL AND INSTALLATION (Continued)

(9) Raise vehicle and install axle shafts. Refer to Group 2, Suspension and Driveshafts for procedure.

(10) Install transmission and engine mount and bracket assemblies. Refer to Engine Mounts section of this Group.

(11) Connect exhaust system to manifold. Refer to Group 11, Exhaust System and Intake Manifold for procedure and torque specifications.

(12) Install left and right inner splash shields.

(13) Connect automatic transmission shifter linkage. Refer to Group 21, Transmission for procedures.

(14) Lower vehicle and connect fuel line and heater hoses. Remove plugs from rear heater hoses and install, if equipped.

(15) Install ground straps. Connect engine and throttle body connections and harnesses.

(16) Connect throttle body linkage. Refer to Group 14, Fuel System for procedure.

(17) Install radiator and fan module assembly. Install radiator hoses. Fill cooling system. See Group 7 for filling procedure.

(18) Install battery tray, battery and cover.

(19) Install air cleaner and hoses.

(20) Install oil filter. Fill engine crankcase with proper oil to correct level.

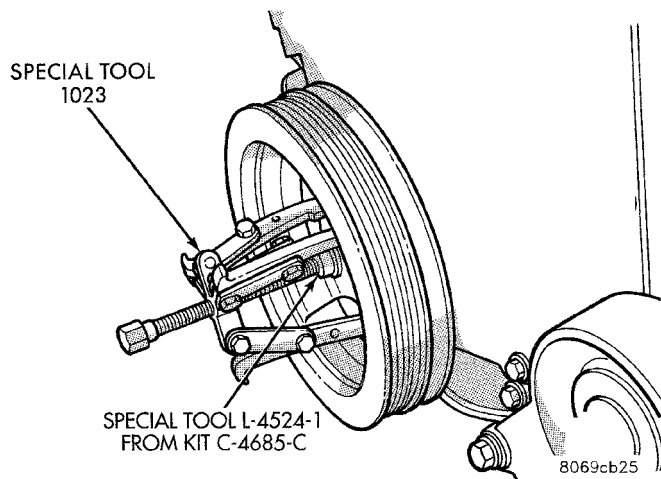
(21) Start engine and run until operating temperature is reached.

(22) Adjust transmission linkage, if necessary.

## CRANKSHAFT DAMPER

## REMOVAL

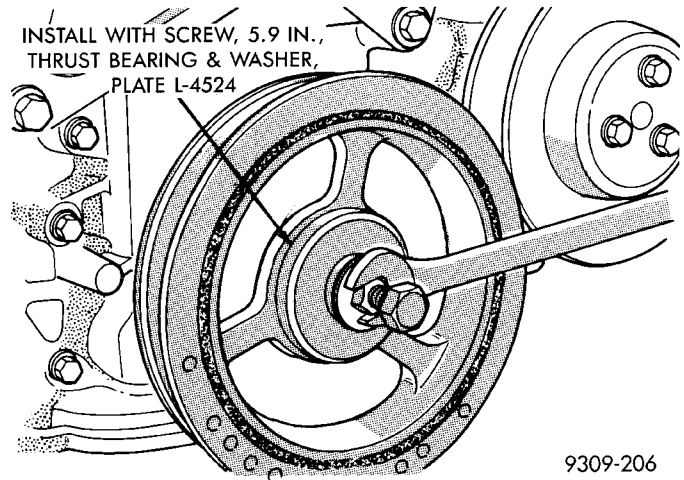
- (1) Disconnect battery
- (2) Raise vehicle on hoist.
- (3) Remove right wheel and inner splash shield.
- (4) Remove drive belt. Refer to Group 7, Cooling System for procedure.
- (5) Remove crankshaft pulley (Fig. 34).



**Fig. 34 Crankshaft Damper—Removal**

## INSTALLATION

- (1) Install crankshaft pulley (Fig. 35).
- (2) Install drive belt. Refer to Cooling System Group 7 for installation procedure.
- (3) Install inner splash shield and wheel.
- (4) Connect battery.



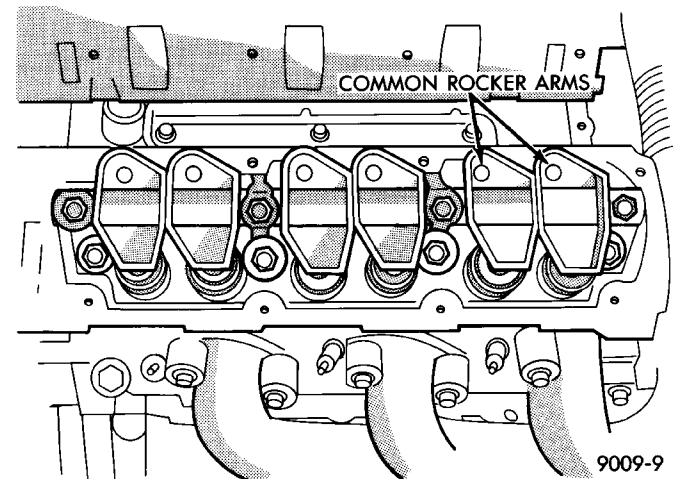
9309-206

**Fig. 35 Crankshaft Damper—Installation**

## ROCKER ARMS AND SHAFT ASSEMBLY

## REMOVAL

- (1) Remove upper intake manifold assembly. Refer to Group 11, Intake and Exhaust Manifolds.
- (2) Disconnect spark plug wires by pulling on the boot straight out in line with plug.
- (3) Disconnect closed ventilation system.
- (4) Remove cylinder head cover and gasket.
- (5) Remove four rocker shaft bolts and retainers.
- (6) Remove rocker arms and shaft assembly.
- (7) If rocker arm assemblies are disassembled for cleaning or replacement. Assemble rocker arms in their original position. Refer to (Fig. 36) for rocker arm for positioning on the shaft.



9009-9

**Fig. 36 Rocker Arm Location Left Bank**

## REMOVAL AND INSTALLATION (Continued)

## INSTALLATION

(1) Install rocker arm and shaft assemblies with the stamped steel retainers in the four positions, tighten to 28 N·m (250 in. lbs.) (Fig. 36).

**CAUTION: THE ROCKER ARM SHAFT SHOULD BE TORQUED DOWN SLOWLY, STARTING WITH THE CENTER BOLTS. ALLOW 20 MINUTES TAPPET BLEED DOWN TIME AFTER INSTALLATION OF THE ROCKER SHAFTS BEFORE ENGINE OPERATION.**

(2) Clean cylinder head cover gasket surface. Inspect cover for distortion and straighten if necessary.

(3) Clean head rail if necessary. Install a new gasket and tighten cylinder head cover fasteners to 12 N·m (105 in. lbs.).

(4) Install closed crankcase ventilation system.

(5) Install spark plug wires.

(6) Install upper intake manifold assembly. Refer to Group 11, Exhaust Systems and Intake Manifolds.

## VALVE STEM SEALS OR SPRINGS, CYLINDER HEAD NOT REMOVED

(1) Perform fuel system pressure release procedure **before attempting any repairs**

(2) Disconnect negative battery cable.

(3) Remove Air Cleaner Cover and hose assembly.

(4) Remove upper Intake Manifold. Refer to Group 11, Exhaust System and Intake Manifolds for removal procedure.

(5) Remove cylinder head covers and spark plugs.

(6) Remove connector wire from ignition coils.

(7) Using suitable socket and flex handle at crankshaft pulley retaining screw, turn engine so the number 1 piston is at Top Dead Center on the compression stroke.

(8) Remove rocker arms with rocker shaft and install a dummy shaft. The rocker arms should not be disturbed and left on shaft.

(9) With air hose attached to spark plug adapter installed in number 1 spark plug hole, apply 90 to 100 psi air pressure (620.5 to 689 kPa). This is to hold valves into place while servicing components.

(10) Using Tool C-4682 or Equivalent compress valve spring and remove retainer valve locks and valve spring.

(11) The intake valve stem seals should be pushed firmly and squarely over the valve guide using the valve stem as guide. **Do Not Force** seal against top of guide. When installing the valve retainer locks, compress the spring **only enough** to install the locks.

**CAUTION: Do not pinch seal between retainer and top of valve guide.**

(12) Follow the same procedure on the remaining 5 cylinders using the firing sequence 1-2-3-4-5-6. **Make sure piston in cylinder is at TDC on the valve spring that is being covered.**

(13) Remove spark plug adapter tool.

(14) Remove dummy shaft and install rocker shaft assembly and tighten screws to 28 N·m (250 in. lbs.).

(15) Install cylinder head covers tighten screws to 14 N·m (120 in. lbs.) and connector to ignition coils.

(16) Install Intake Manifold. Refer to Group 11, Exhaust System and Intake Manifold for procedure.

## CYLINDER HEAD

## REMOVAL

(1) Drain cooling system. Refer to Group 7, Cooling System for procedure and disconnect negative battery cable.

(2) Remove intake manifold, and throttle body. Refer to Group 11, Exhaust System and Intake Manifold.

**WARNING: INTAKE MANIFOLD GASKET IS MADE OF VERY THIN METAL AND MAY CAUSE PERSONAL INJURY, HANDLE WITH CARE.**

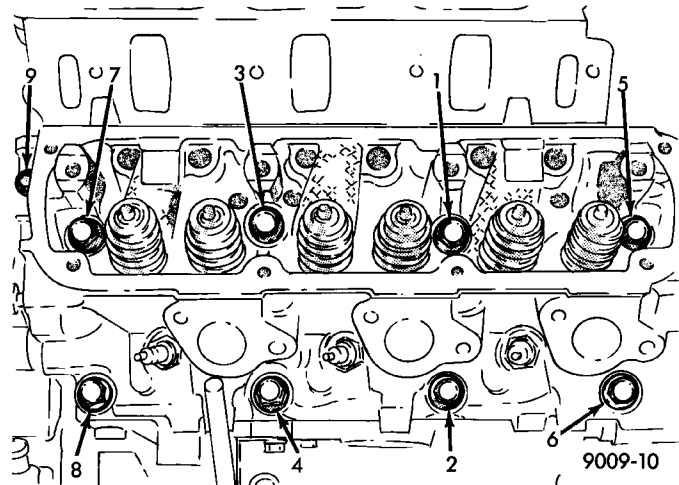
(3) Disconnect coil wires, sending unit wire, heater hoses and bypass hose.

(4) Remove PCV system hoses, evaporation control system hose and cylinder head covers.

(5) Remove exhaust manifolds.

(6) Remove rocker arm and shaft assemblies. Remove push rods and **tag to ensure installation in original locations.**

(7) Remove the 9 head bolts from each cylinder head and remove cylinder heads (Fig. 37).



**Fig. 37 Cylinder Head Bolts Location and Tightening Sequence**

## REMOVAL AND INSTALLATION (Continued)

## INSTALLATION

(1) Clean all surfaces of cylinder block and cylinder heads.

(2) Install new gaskets on cylinder block (Fig. 38).

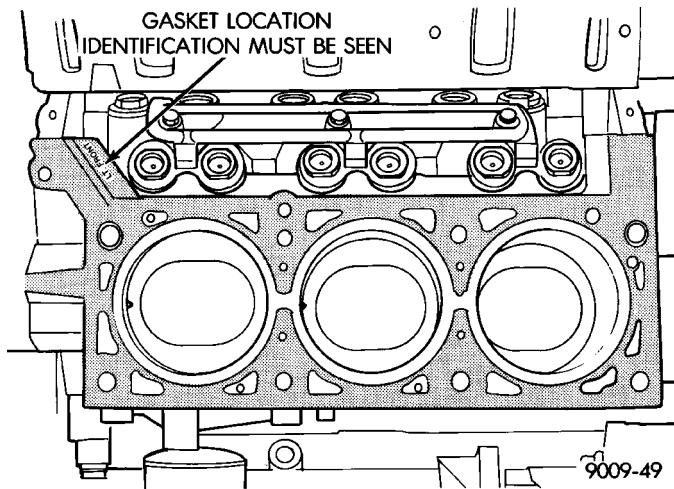


Fig. 38 Head Gasket Installation

(3) The Cylinder head bolts are torqued using the torque yield method, they should be examined **BEFORE** reuse. If the threads are necked down, the bolts should be replaced (Fig. 39).

(4) Necking can be checked by holding a scale or straight edge against the threads. If all the threads do not contact the scale the bolt should be replaced.

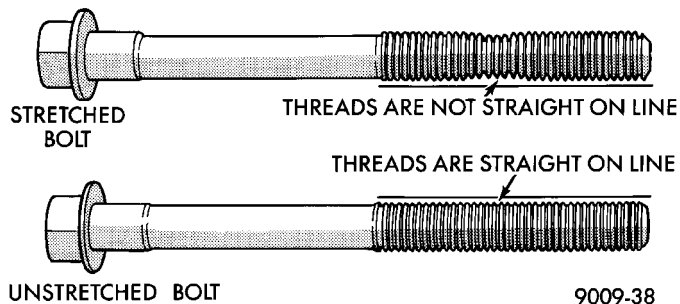


Fig. 39 Checking Bolts for Stretching (Necking)

(5) Tighten the cylinder head bolts 1 thru 8 in the sequence shown in (Fig. 37). Using the 4 step torque turn method, tighten according to the following values:

- First-All to 61 N-m (45 ft. lbs.)
- Second-All to 88 N-m (65 ft. lbs.)
- Third-All (again) to 88 N-m (65 ft. lbs.)
- Fourth-Turn an additional 1/4 Turn. (**Do not use a torque wrench for this step.**)

**NOTE:** Bolt torque after 1/4 turn should be over 122 N-m (90 ft. lbs.). If not, replace the bolt.

(6) Tighten head bolt number 9 (Fig. 37) to 33 N-m (25 ft. lbs.) after head bolts 1 thru 8 have been tightened to specifications.

(7) Inspect push rods and replace worn or bent rods.

(8) Install push rods, rocker arm and shaft assemblies with the stamped steel retainers in the four positions, tighten to 28 N-m (250 in. lbs.) (Fig. 40).

(9) Place new cylinder head cover gaskets in position and install cylinder head covers. Tighten to 12 N-m (105 in. lbs.).

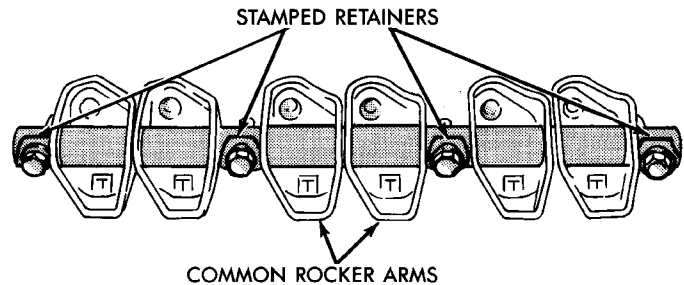


Fig. 40 Rocker Arm Shaft Retainers

## INTAKE MANIFOLD SEALING

The intake manifold gasket is a one-piece stamped steel gasket with a sealer applied from the manufacturer. This gasket has end seals incorporated with it.

**WARNING: INTAKE MANIFOLD GASKET IS MADE OF VERY THIN METAL AND MAY CAUSE PERSONAL INJURY, HANDLE WITH CARE.**

(1) Clean all surfaces of cylinder block and cylinder heads.

(2) Place a drop (about 1/4 in. diameter) of Mopar Silicone Rubber Adhesive Sealant or equivalent, onto each of the **four** manifold to cylinder head gasket corners (Fig. 41).

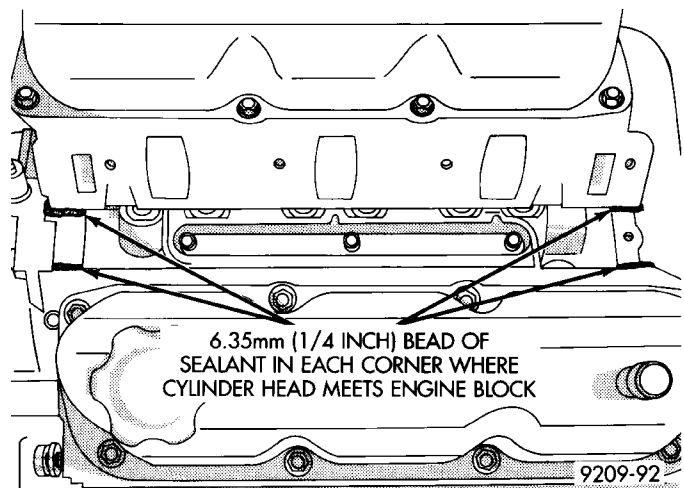


Fig. 41 Intake Manifold Gasket Sealing

## REMOVAL AND INSTALLATION (Continued)

(3) Carefully install the intake manifold gasket (Fig. 42). Torque end seal retainer screws to 12 N-m (105 in. lbs.).

(4) Install intake manifold and (8) bolts and torque to 1 N-m (10 in. lbs.). Then tighten bolts to 22 N-m (200 in. lbs.) in sequence shown in (Fig. 43). Then tighten again to 22 N-m (200 in. lbs.). After intake manifold is in place, **inspect to make sure seals are in place.** Refer to Group 11, Exhaust System and Intake Manifold to complete Intake Manifold Assembly.

(5) Install exhaust manifolds and tighten bolts to 27 N-m (20 ft. lbs.) and nuts to 20 N-m (15 ft. lbs.).

(6) Adjust spark plugs to specification in Group 8, Electrical Section and install the plugs.

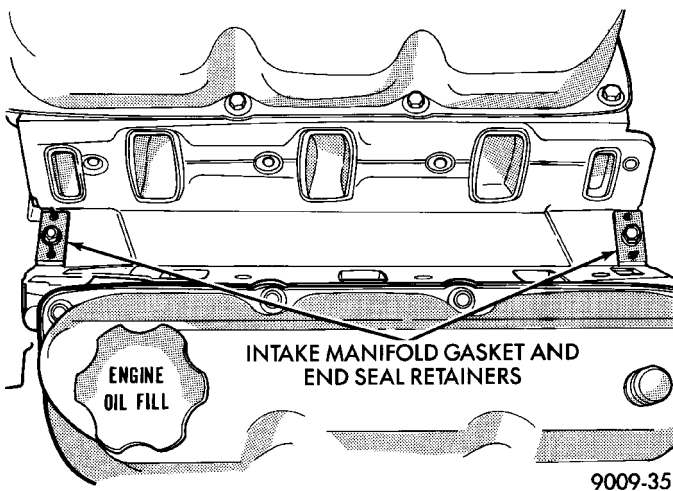


Fig. 42 Intake Manifold Gasket Retainers

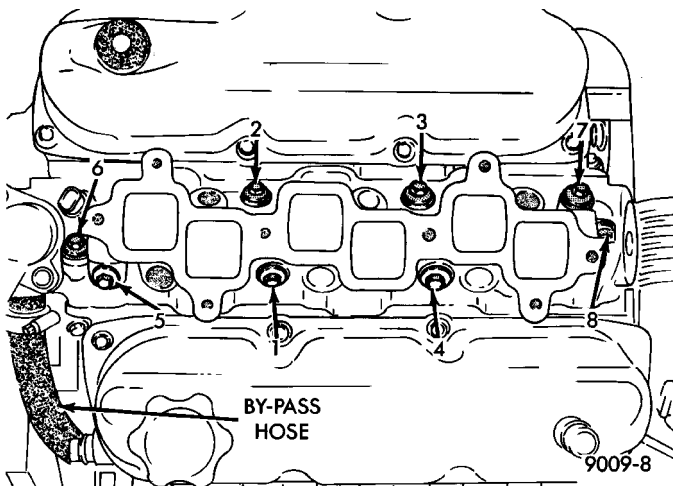


Fig. 43 Intake Manifold Removal and Installation

## VALVES AND VALVE SPRINGS

## REMOVAL

(1) With cylinder head removed, compress valve springs using Valve Spring Compressor Tool C-3422-B with adapter 6412 as shown in (Fig. 44).

(2) Remove valve retaining locks, valve spring retainers, valve stem seals and valve springs.

(3) Before removing valves, **remove any burrs from valve stem lock grooves to prevent damage to the valve guides.** Identify valves to insure installation in original location.

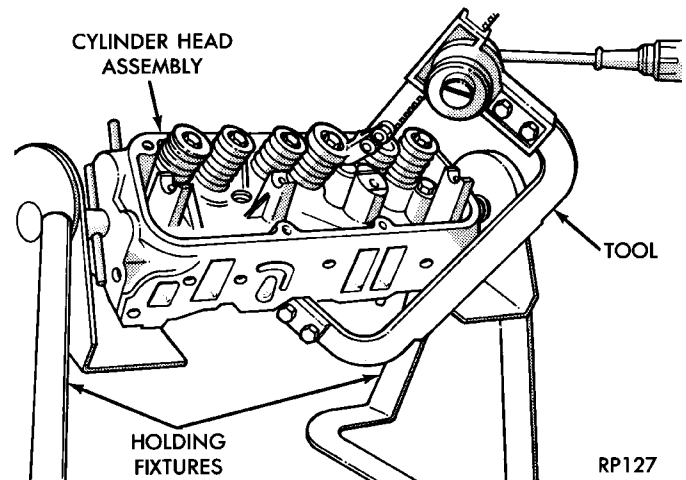


Fig. 44 Compress Valve Springs with Special Tool C-3422-B with Adapter 6412

## VALVE INSTALLATION

(1) Coat valve stems with clean engine oil and insert them in cylinder head.

(2) Check valve tip to spring seat dimensions A after grinding the valve seats or faces. Grind valve tip to give 49.541 to 51.271 mm (1.950 to 2.018 in.) over spring seat when installed in the head (Fig. 45). Check valve tip for scoring, if necessary, the tip chamfer should be reground to prevent seal damage when the valve is installed.

(3) Install valve spring seat spacer on head (Fig. 46).

(4) Install new cup seals on all valve stems and over valve guides (Fig. 45). Install valve springs and valve retainers (Fig. 46).

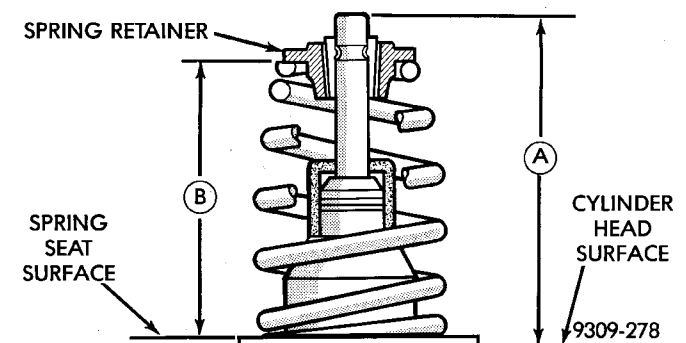


Fig. 45 Checking Valve Installed Height

(5) Compress valve springs with Valve Spring Compressor Tool C-3422-B, with adapter 6412 install locks and release tool. **If valves and/or seats are**

## REMOVAL AND INSTALLATION (Continued)

reground, measure the installed height of springs dimension B, make sure measurements are taken from top of spring seat to the bottom surface of spring retainer. If height is greater than 1-19/32 inches, (40.6 mm), install a 1/32 inch (.794 mm) spacer in head counterbore to bring spring height back to normal 1-17/32 to 1-19/32 inch (39.1 to 40.6 mm).

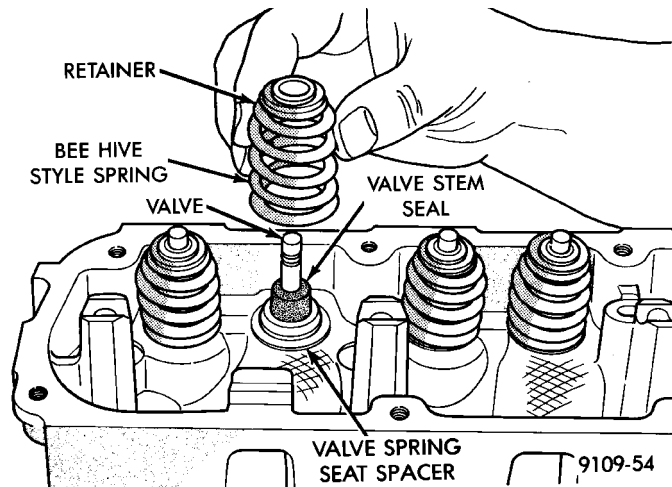


Fig. 46 Valve Seal and Spring—Installation

## TAPPET REMOVAL

- (1) Refer to Cylinder Head Removal in this section. Cylinder Head must be removed to gain access to tappets for service.
- (2) Remove yoke retainer and aligning yokes.
- (3) Use Tool C-4129 to remove tappets from their bores. If all tappets are to be removed, identify tappets to insure installation in original location.

**NOTE:** If the tappet or bore in cylinder block is scored, scuffed, or shows signs of sticking, ream the bore to next oversize and replace with oversize tappet.

**CAUTION:** The plunger and tappet bodies are not interchangeable. The plunger and valve must always be fitted to the original body. It is advisable to work on one tappet at a time to avoid mixing of parts. Mixed parts are not compatible. Do not disassemble a tappet on a dirty work bench.

## INSTALLATION

- (1) Lubricate tappets.
- (2) Install tappets in their original positions.
- (3) With roller tappets, install aligning yokes (Fig. 47).
- (4) Install yoke retainer and torque screws to 12 N·m (105 in. lbs.) (Fig. 47).

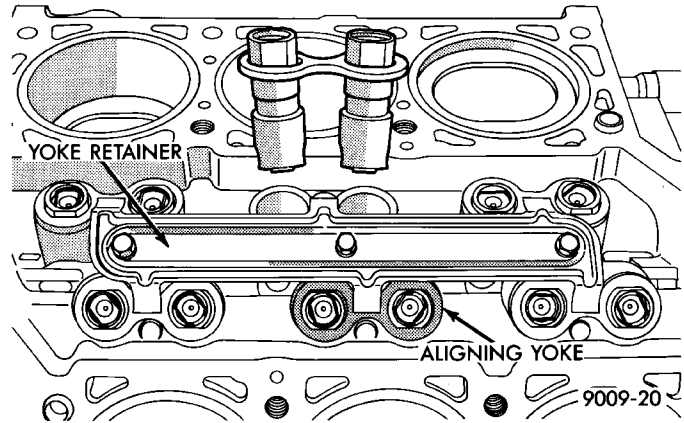


Fig. 47 Roller Tappets Aligning Yoke and Retainer

- (5) Install cylinder heads. Refer to cylinder head installation of this section for procedure.
- (6) Start and operate engine. Warm up to normal operating temperature.

**CAUTION:** To prevent damage to valve mechanism, engine must not be run above fast idle until all hydraulic tappets have filled with oil and have become quiet.

## TIMING CHAIN COVER

## REMOVAL

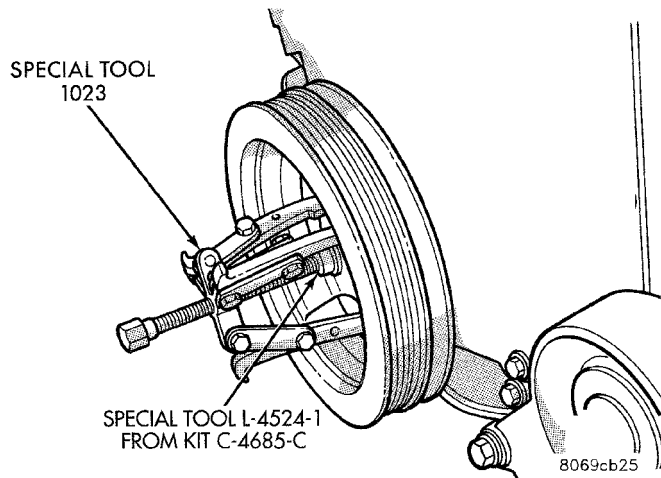
- (1) Disconnect battery.
- (2) Drain cooling system. Refer to Cooling System Group 7 for procedure.
- (3) Support engine and remove right engine mount.
- (4) Raise vehicle on hoist. Drain engine oil.
- (5) Remove oil pan and oil pump pick-up. It may be necessary to remove transmission inspection cover.
- (6) Remove right wheel and inner splash shield.
- (7) Remove drive belt. Refer to Cooling System Group 7 for procedure.
- (8) Remove A/C compressor and set aside.
- (9) Remove A/C compressor mounting bracket.
- (10) Remove crankshaft damper (Fig. 48).
- (11) Remove idler pulley from engine bracket.
- (12) Remove engine bracket (Fig. 49).
- (13) Remove cam sensor from chain case cover (Fig. 50).
- (14) Remove chain case cover (Fig. 50).

## INSTALLATION

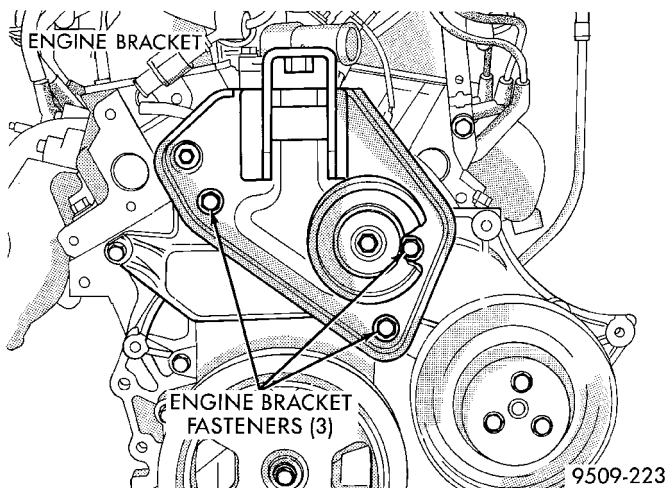
- (1) Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs. Crankshaft oil seal must be removed to insure correct oil pump engagement.

**NOTE:** DO NOT USE SEALER ON COVER GASKET

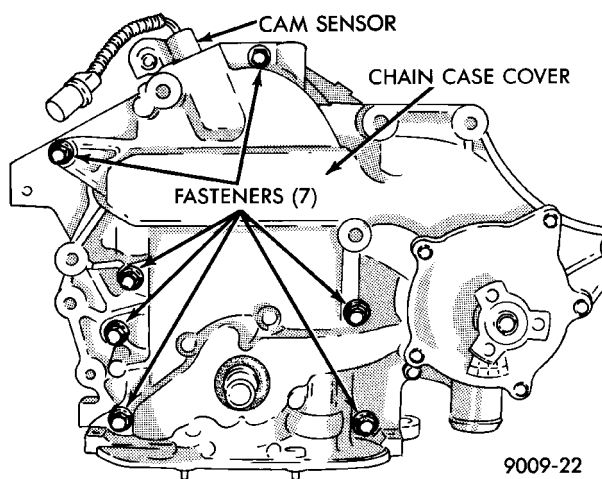
## REMOVAL AND INSTALLATION (Continued)



**Fig. 48 Crankshaft Damper—Removal**



**Fig. 49 Engine Bracket**



**Fig. 50 Timing Chain Case Cover**

(2) Use a new cover gasket, and O-rings (Fig. 51). Adhere new gasket to chain case cover, making sure that the lower edge of the gasket is flush to 0.5 mm

(0.020 in.) passed the lower edge of the cover. Refer to oil pan sealing outlined in this section.

(3) Rotate crankshaft so that the oil pump drive flats are vertical.

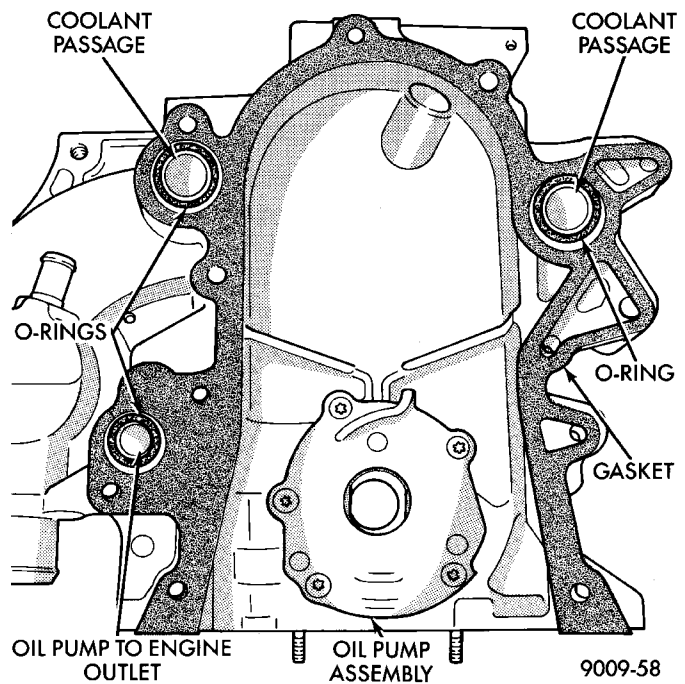
(4) Position oil pump inner rotor so the mating flats are in the same position as the crankshaft drive flats (Fig. 51).

(5) Install cover onto crankshaft. Make sure the oil pump is engaged on the crankshaft correctly or severe damage may result.

(6) Install chain case cover screws and torque to 27 N·m (20 ft. lbs.).

(7) Install crankshaft oil seal (Fig. 52).

(8) Install crankshaft pulley (Fig. 53).



**Fig. 51 Timing Chain Case Cover Gaskets and O-Rings**

(9) Install engine bracket (Fig. 49) and torque fasteners to 54 N·m (40 ft. lbs.).

(10) Install idler pulley on engine bracket.

(11) Install cam sensor. Refer to Group 8D, Ignition System for installation procedure.

(12) Install A/C compressor mounting bracket.

(13) Install A/C compressor.

(14) Install drive belt. Refer to Group 7, Cooling System for installation procedure.

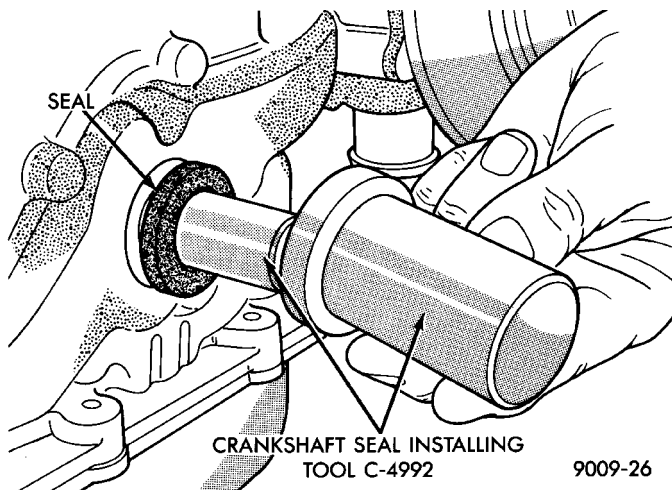
(15) Install inner splash shield and wheel.

(16) Install oil pump pick-up and oil pan and transmission inspection cover if removed.

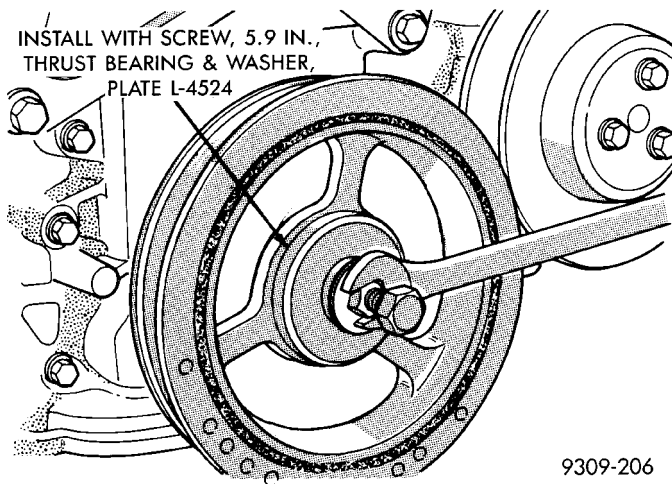
(17) Install engine mount.

(18) Fill crankcase with oil to proper level.

## REMOVAL AND INSTALLATION (Continued)



**Fig. 52 Crankshaft Oil Seal—Installation**



**Fig. 53 Crankshaft Damper—Installation**

(19) Fill cooling system. Refer to Group 7, Cooling System for procedure.

(20) Connect battery.

## TIMING CHAIN

### REMOVAL

(1) Remove camshaft sprocket attaching bolt, and timing chain with camshaft sprocket.

(2) Using a suitable puller remove the crankshaft sprocket. Be careful not to damage the crankshaft surface.

### INSTALLATION

(1) Position a new crankshaft sprocket on the shaft, install sprocket with suitable tool and mallet. Be sure sprocket is seated into position.

(2) Rotate crankshaft so the timing arrow is to the 12 o'clock position.

(3) Place timing chain around camshaft sprocket and place the timing mark to the 6 o'clock position.

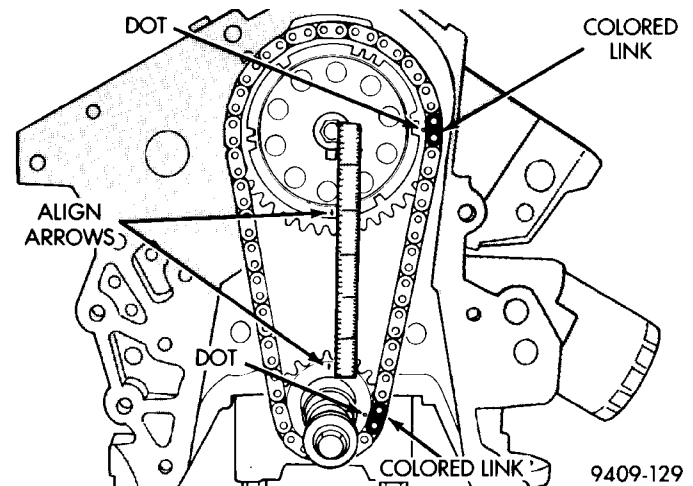
(4) Align the dark colored links with the dot on the camshaft sprocket, place timing chain around crankshaft sprocket with the dark colored link lined up with the dot on the sprocket and install camshaft sprocket into position.

(5) Use a straight edge to check alignment of timing marks (Fig. 54).

(6) Install camshaft bolt and washer. Tighten to 54 N·m (40 ft. lbs.).

(7) Rotate crankshaft 2 revolutions. Timing marks should line up. If timing marks do not line up remove cam sprocket and realign.

(8) Check camshaft end play. With new thrust plate the specification is 0.0127 to 0.304 mm (0.005 to 0.012 in.). Old thrust plate specification is 0.31 mm (0.012 in.) maximum. If not within these limits install new thrust plate.



**Fig. 54 Timing Marks Alignment**

## CAMSHAFT

### REMOVAL—ENGINE REMOVED FROM VEHICLE

Remove intake manifold, cylinder head covers, cylinder heads, timing chain case cover and timing chain.

(1) Remove rocker arm and shaft assemblies.

(2) Remove push rods and tappets; identify so each part will be replaced in its original location.

(3) Remove camshaft thrust plate (Fig. 55).

(4) Install a long bolt into front of camshaft to facilitate removal of the camshaft; remove camshaft, being careful not to damage cam bearings with the cam lobes.

### INSTALLATION

(1) Lubricate camshaft lobes and camshaft bearing journals and insert the camshaft to within 2 inches of its final position in cylinder block.

## REMOVAL AND INSTALLATION (Continued)

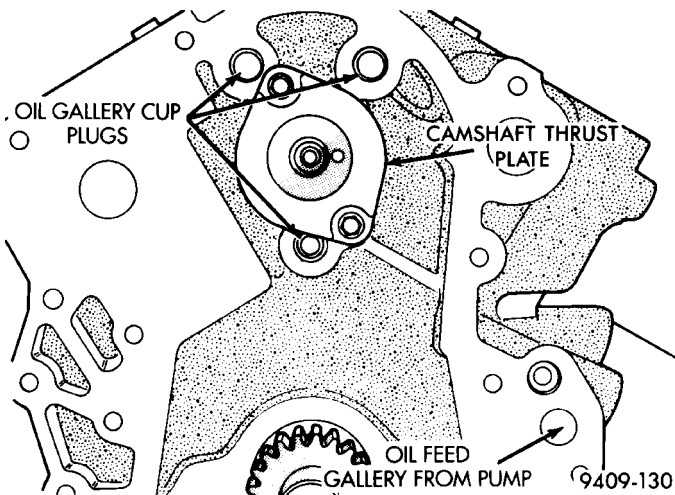


Fig. 55 Camshaft Thrust Plate

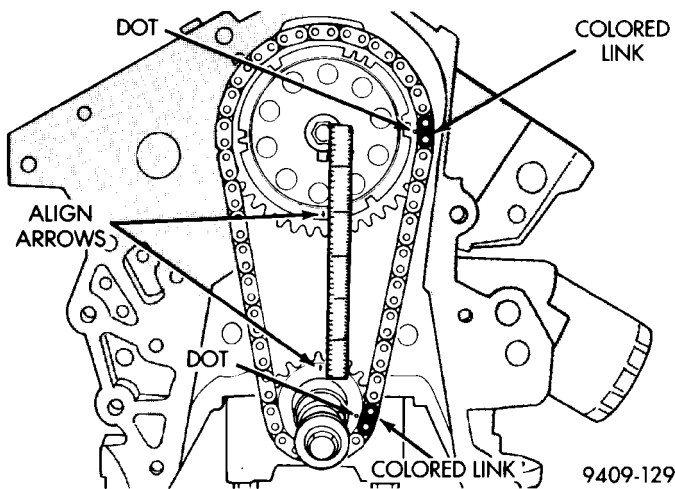


Fig. 56 Alignment of Timing Marks

**NOTE:** Whenever an engine has been rebuilt or a new camshaft or tappets have been installed, add one pint of Mopar® Engine Oil Supplement or equivalent to engine oil to aid in break-in. The oil mixture should be left in engine for a minimum of 805km (500 miles) and drained at the next normal oil change.

(2) Install camshaft thrust plate with two screws as shown in (Fig. 55). Tighten to 12 N·m (105 in. lbs.) torque.

(3) Rotate crankshaft so the timing arrow is at the 12 o'clock position.

(4) Place timing chain around camshaft sprocket and place the timing mark to the 6 o'clock position.

(5) Align the dark colored links with the dot on the camshaft sprocket, place timing chain around crankshaft sprocket with the dark colored link lined up with the dot on the sprocket and install camshaft sprocket into position.

(6) Using straight edge to check alignment of timing marks (Fig. 56).

(7) Install the camshaft bolt. Tighten bolt to 54 N·m (40 ft. lbs.).

(8) Rotate crankshaft 2 revolutions. Timing marks should line up. If timing marks do not line up, remove cam sprocket and realign.

(9) Measure camshaft end play. End Play should measure 0.0127 to 0.304 mm (0.005 to 0.012 inches.) 0.310 mm (0.012 in. Max.). If not within limits install a new thrust plate.

(10) Each tappet reused must be installed in the same position from which it was removed. **When camshaft is replaced, all of the tappets must be replaced.**

## CAMSHAFT BEARINGS

### REMOVAL

(1) With engine removed from vehicle and completely disassembled, drive out rear cam bearing core hole plug.

(2) Install proper size adapters and horseshoe washers (part of Tool C-3132-A) at back of each bearing shell to be removed and drive out bearing shells (Fig. 57).

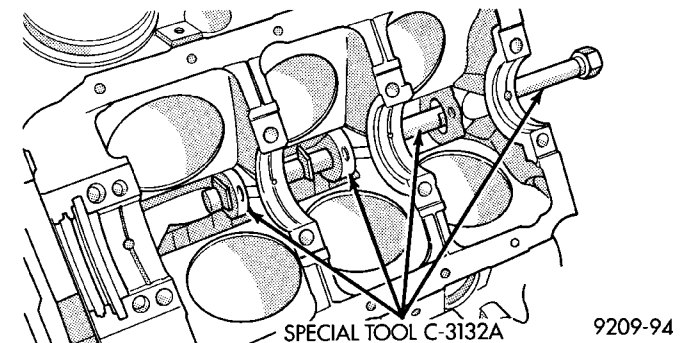


Fig. 57 Removed Installation of Camshaft Bearings with Tool C-3132-A—Typical

### INSTALLATION

(1) Install new camshaft bearings with Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

(2) Position rear bearing in the tool. Install horseshoe lock and by reversing removal procedure, carefully drive bearing shell into place.

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. Number two bearing must index with the oil passage to the left cylinder head and Number three bearing must index with the oil passage to the right cylinder head. If the camshaft bearing shell oil holes are not in exact alignment, remove and reinstall them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

## REMOVAL AND INSTALLATION (Continued)

## OIL PAN

## REMOVAL

- (1) Disconnect battery negative cable, remove engine oil dipstick.
- (2) Raise vehicle. Drain engine oil.
- (3) Remove bending brace to transaxle attaching bolt.
- (4) Remove bolts attaching dust cover to transaxle housing. Lower dust cover to gain access to oil pan bolts.
- (5) Remove oil pan screws and remove oil pan.

## INSTALLATION

- (1) Clean surfaces and apply a 1/8 inch bead of Mopar Silicone Rubber Adhesive Sealant or equivalent, at the parting line of the chain case cover and the rear seal retainer (Fig. 58).
- (2) Use a new pan gasket (Fig. 59).
- (3) Install pan and tighten screws to 12 N·m (105 in. lb.).

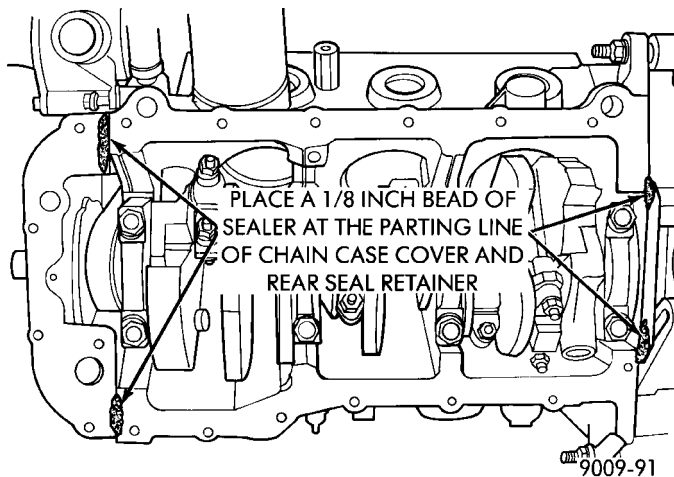


Fig. 58 Oil Pan Sealing

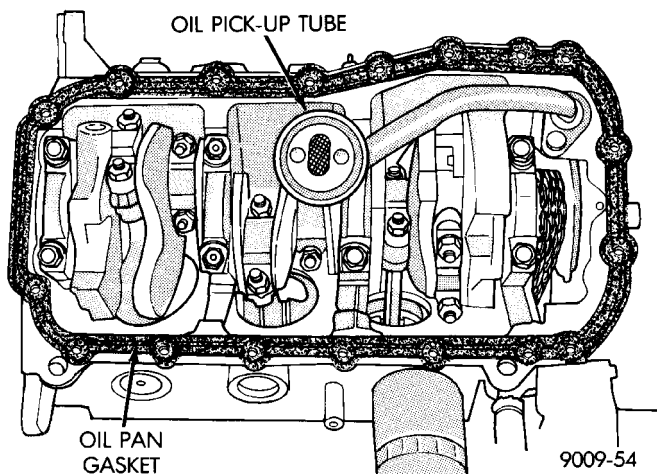


Fig. 59 Oil Pan Gasket Installation

- (4) Install dust shield and bending brace to transaxle housing.
- (5) Lower vehicle and install oil dipstick.
- (6) Connect battery negative cable.
- (7) Fill crankcase with oil to proper level.

## PISTON

## REMOVAL

**NOTE:** Heads and Oil Pan removed. Refer to procedure in this section.

- (1) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. **Be sure to keep tops of pistons covered during this operation. Pistons and connecting rods must be removed from top of cylinder block. When removing piston and connecting rod assemblies from the engine, rotate crankshaft so that each connecting rod is centered in cylinder bore.**

- (2) Inspect connecting rods and connecting rod caps for cylinder identification. Identify them if necessary (Fig. 60).

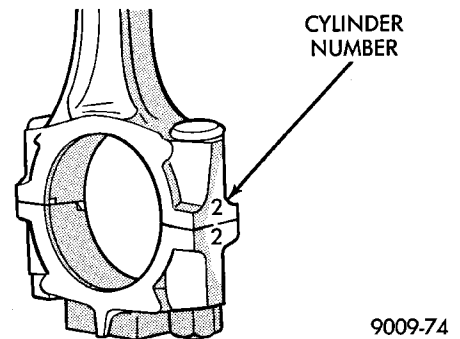


Fig. 60 Identify Connecting Rod to Cylinder

- (3) Remove connecting rod cap. Install connecting rod bolt protectors on connecting rod bolts (Fig. 61). Push each piston and rod assembly out of cylinder bore.

**NOTE:** Be careful not to nick crankshaft journals.

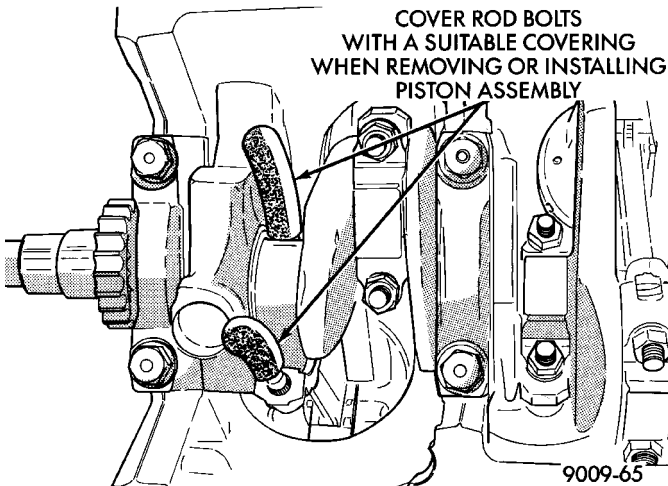
- (4) After removal, install bearing cap on the mating rod.

## INSTALLING PISTON AND CONNECTING ROD ASSEMBLY

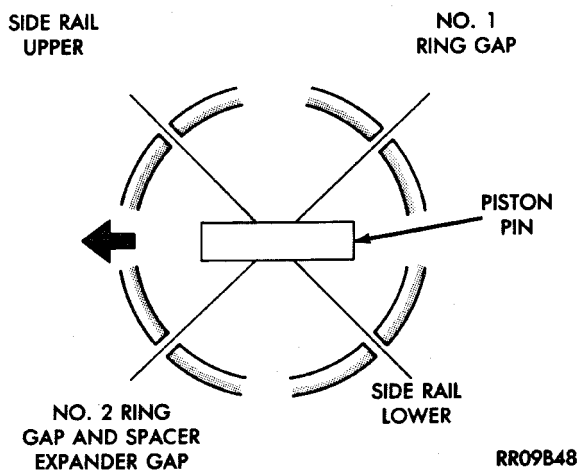
- (1) Before installing pistons and connecting rod assemblies into the bore, be sure that compression ring gaps are staggered so that neither is in line with oil ring rail gap (Fig. 62).

- (2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located as shown in (Fig. 62).

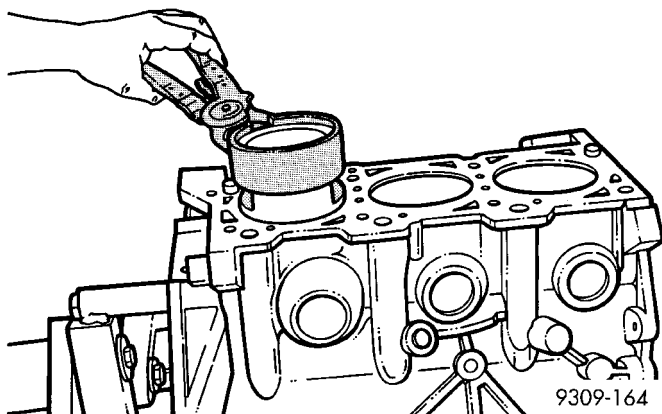
## REMOVAL AND INSTALLATION (Continued)



**Fig. 61 Connecting Rod Protectors**

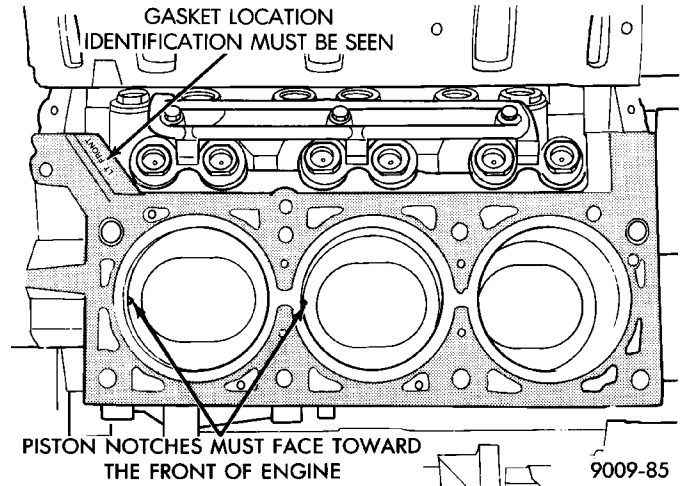


**Fig. 62 Piston Ring End Gap Position**



**Fig. 63 Piston—Installation**

(3) Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston and tighten with the special wrench. **Be sure position of rings does not change during this operation.**



**Fig. 64 Piston I.D. Notches**

(4) Install connecting rod bolt protectors on rod bolts (Fig. 61).

(5) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Insert rod and piston into cylinder bore and guide rod over the crankshaft journal.

(6) Tap the piston down in cylinder bore, using a hammer handle. At the same time, guide connecting rod into position on connecting rod journal.

(7) The notch or groove on top of piston must be pointing toward front of engine (Fig. 64).

(8) Install rod caps. Install nuts on cleaned and oiled rod bolts and tighten nuts to 54 N·m (40 ft. lb.) Plus 1/4 turn.

## CRANKSHAFT

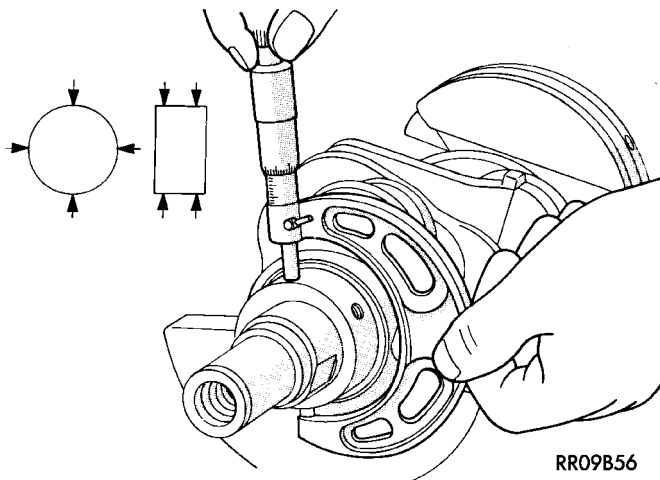
### MAIN BEARINGS

Bearing caps are not interchangeable and should be marked at removal to insure correct assembly (Fig. 66). Upper and lower bearing halves are NOT interchangeable. Lower main bearing halves of 1, 3 and 4 are interchangeable. Upper main bearing halves of 1, 3 and 4 are interchangeable.

### CRANKSHAFT MAIN JOURNALS

The crankshaft journals should be checked for excessive wear, taper and scoring. (Fig. 65) Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 in.). Journal grinding should not exceed 0.305 mm (0.012 in.) under the standard journal diameter. Do NOT grind thrust faces of Number 2 main bearing. Do NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all passages.

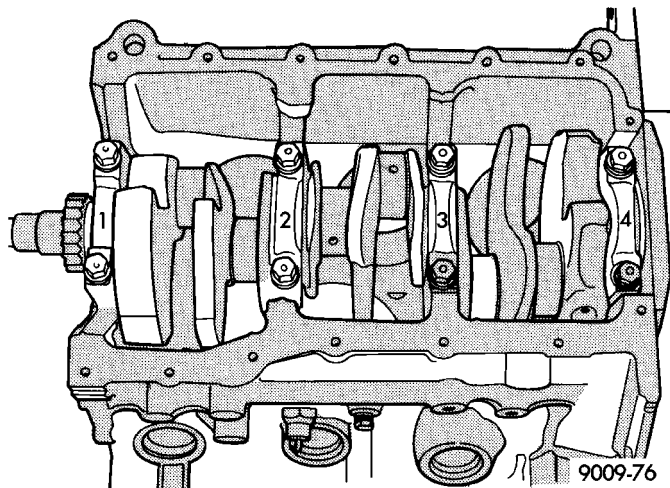
REMOVAL AND INSTALLATION (Continued)



RR09B56

**Fig. 65 Measure Crankshaft Journal O.D.**

**CAUTION:** With the nodular cast iron crankshafts used it is important that the final paper or cloth polish after any journal regrind be in the same direction as normal rotation in the engine.



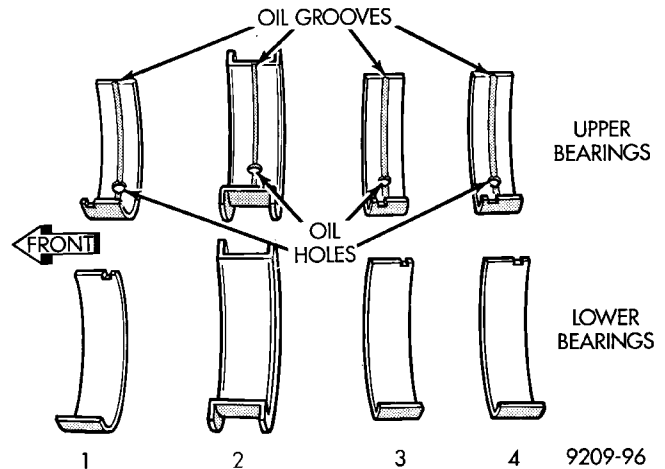
9009-76

**Fig. 66 Main Bearing Cap Identification**

Upper and lower Number 2 bearing halves are flanged to carry the crankshaft thrust loads and are NOT interchangeable with any other bearing halves in the engine (Fig. 67). All bearing cap bolts removed during service procedures are to be cleaned and oiled before installation. Bearing shells are available in standard and the following undersizes: 0.025 mm (0.001 in.), 0.051 mm (0.002 in.), 0.076 mm (0.003 in.), 0.254 mm (0.010 in.), and 0.305 mm (0.012 in.). Never install an undersize bearing that will reduce clearance below specifications.

**REMOVAL**

- (1) Remove oil pan and identify bearing caps before removal.
- (2) Remove bearing caps one at a time. Remove upper half of bearing by inserting Special Main Bear-



UPPER BEARINGS

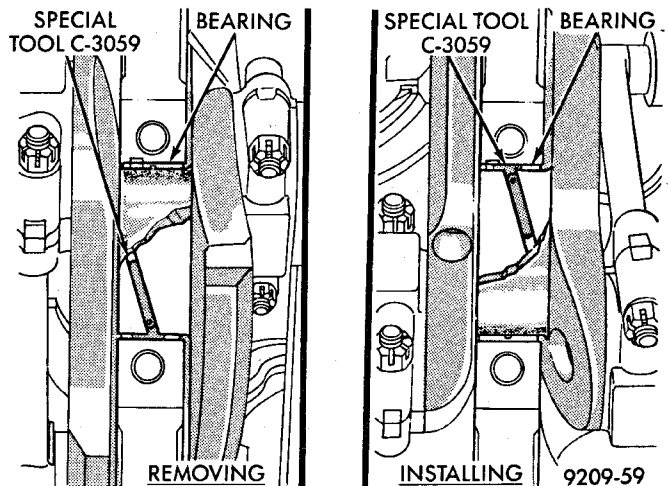
LOWER BEARINGS

9209-96

**Fig. 67 Main Bearing Identification**

ing Tool C-3059. (Fig. 68) into the oil hole of crankshaft.

- (3) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.



**Fig. 68 Removing and Installing Upper Main Bearing With Special Tool C-3059**

**INSTALLATION**

**NOTE:** Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened.

When installing a new upper bearing shell, slightly chamfer the sharp edges from the plain side.

- (1) Start bearing in place, and insert Main Bearing Tool C-3059 into oil hole of crankshaft (Fig. 68).
- (2) Slowly rotate crankshaft counterclockwise sliding the bearing into position. Remove Special Main Bearing Tool C-3059.
- (3) Install each main cap and tighten bolts finger tight.

## REMOVAL AND INSTALLATION (Continued)

(4) Tighten number 1, 3 and 4 main cap bolts to 41 N·m + 1/4 Turn (30 ft. lbs.+ 1/4 Turn).

(5) Rotate the crankshaft until number 6 piston is at TDC.

(6) To ensure correct thrust bearing alignment the following procedure must be done:

a. Move crankshaft all the way to the rear of its travel.

b. Then, move crankshaft all the way to the front of its travel.

c. Wedge a appropriate tool between the rear of the cylinder block and rear crankshaft counterweight. This will hold the crankshaft in it's most forward position.

d. Tighten the #2 Thrust Bearing cap bolts to 41 N·m + 1/4 Turn (30 ft. lbs.+ 1/4 Turn). Remove the holding tool.

**NOTE:** Whenever an engine has been rebuilt, add one pint of Mopar® Engine Oil Supplement or equivalent to engine oil to aid in break in. The oil mixture should be left in engine for a minimum of 805 km (500 miles) and drained at the next normal oil change.

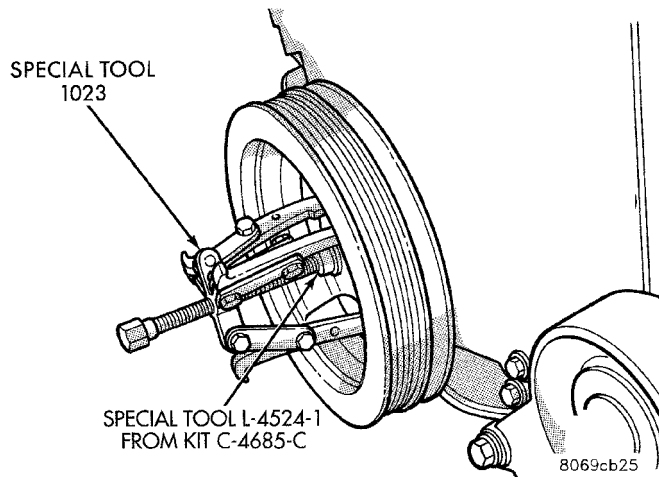
## FRONT CRANKSHAFT OIL SEAL

## REMOVAL

(1) Raise vehicle on hoist. Remove right wheel and inner splash shield.

(2) Remove drive belt. Refer to Group 7, Cooling System for procedure.

(3) Remove crankshaft damper (Fig. 69).

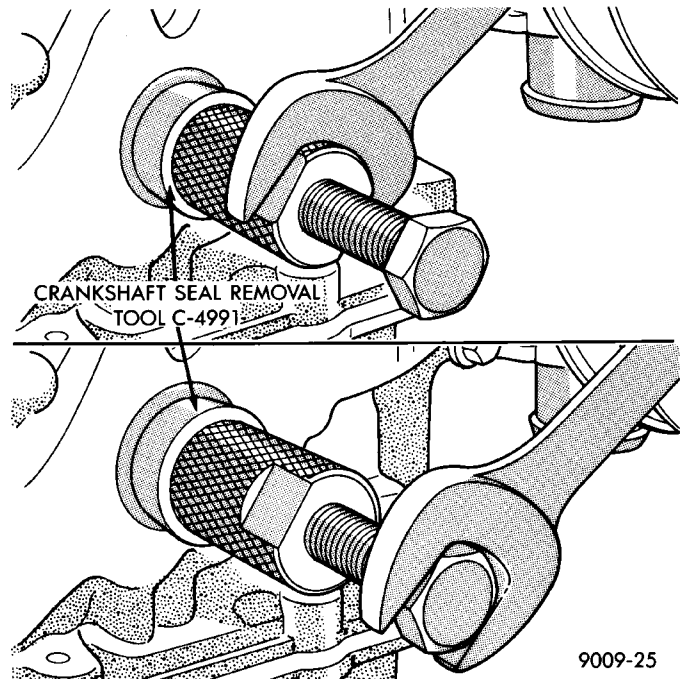


**Fig. 69 Crankshaft Damper—Removal**

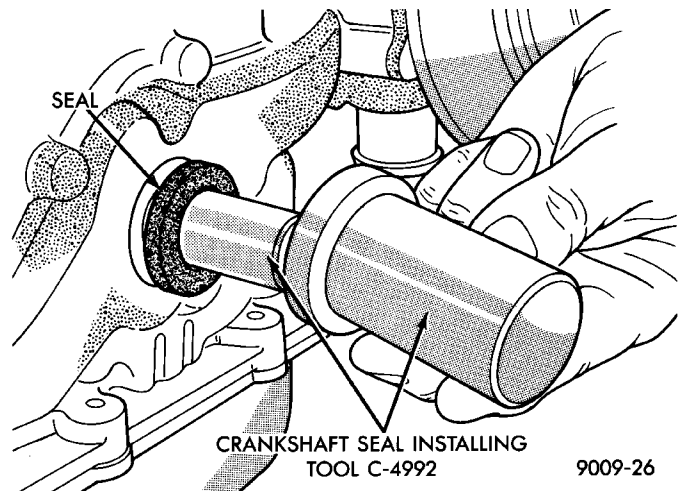
(4) Using Tool C-4991 to remove oil seal (Fig. 70). Be careful not to damage that crankshaft seal surface of cover.

## INSTALLATION

(1) Install new seal by using Tool C-4992 (Fig. 71).



**Fig. 70 Crankshaft Oil Seal—Removal**



**Fig. 71 Crankshaft Oil Seal—Installation**

(2) Place seal into opening with seal spring towards the inside of engine. Install seal until flush with cover.

(3) Install crankshaft pulley using plate L-4524. Thrust Bearing/washer and 5.9 inch screw (Fig. 72).

(4) Install drive belt Refer to Group 7, Cooling System for installation procedure.

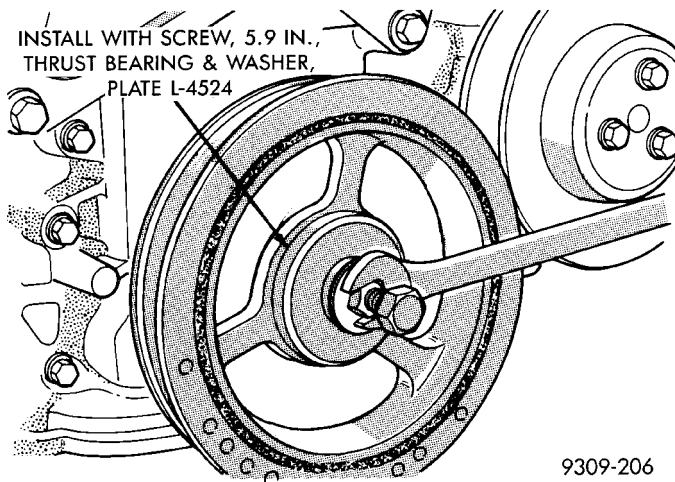
(5) Install inner splash shield and wheel.

## REAR CRANKSHAFT OIL SEAL

## REMOVAL

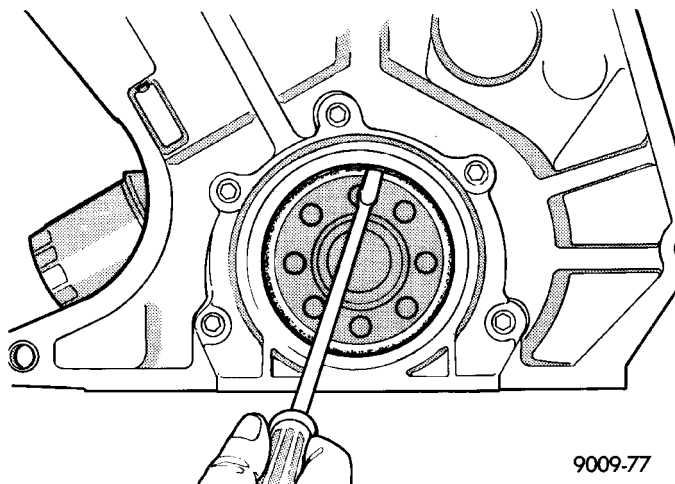
(1) Insert a 3/16 flat bladed pry tool between the dust lip and the metal case of the crankshaft seal. Angle the pry tool (Fig. 73) through the dust lip against metal case of the seal. Pry out seal.

## REMOVAL AND INSTALLATION (Continued)



**Fig. 72 Crankshaft Damper—Installation**

**CAUTION:** Do not permit the pry tool blade to contact crankshaft seal surface. Contact of the pry tool blade against crankshaft edge (chamfer) is permitted.



**Fig. 73 Rear Crankshaft Oil Seal—Removal**

## INSTALLATION

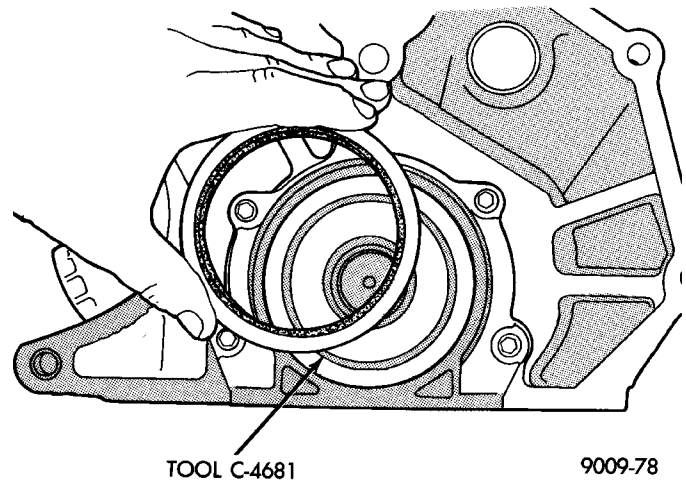
**CAUTION:** If burr or scratch is present on the crankshaft edge (chamfer), cleanup with 400 grit sand paper to prevent seal damage during installation of new seal.

- (1) Place Special Seal Pilot Tool C-4681 on crankshaft (Fig. 74).
- (2) Lightly coat seal O.D. with Loctite Stud N' Bearing Mount or equivalent.
- (3) Place seal over Special Seal Pilot Tool C-4681 and tap in place with a plastic hammer.

## REAR CRANKSHAFT SEAL RETAINER

When retainer removal is required, remove retainer and clean engine block and retainer of old gasket. Make sure surfaces are clean and free of oil.

Install new gasket and tighten screws to 12 N·m (105 in. lbs.).

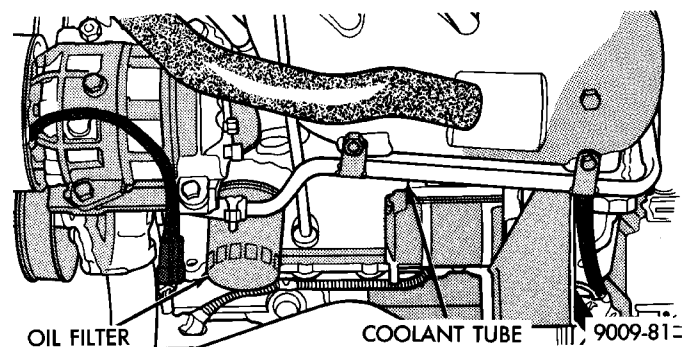


**Fig. 74 Rear Crankshaft Oil Seal—Installation**

## OIL FILTER

**CAUTION:** When servicing the oil filter (Fig. 75) avoid deforming the filter can by installing the remove/install tool band strap against the can-to-base lock seam. The lock seam joining the can to the base is reinforced by the base plate.

- (1) Using Tool C-4065, turn filter counterclockwise to remove from base. Properly discard filter.
- (2) Wipe base clean, then inspect gasket contact surface.
- (3) Lubricate gasket of new filter with clean engine oil.
- (4) Install new filter until gasket contacts base. Tighten filter 1 turn or 20 N·m (15 ft. lbs.). Use filter wrench if necessary.
- (5) Start engine and check for leaks.



**Fig. 75 Oil Filter**

## ENGINE OIL GALLEY PLUGS

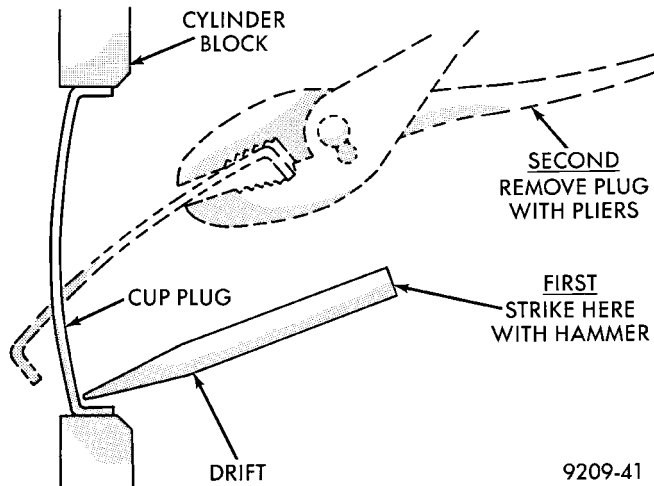
## REMOVAL

Using a blunt tool such as a drift and a hammer, strike the bottom edge of the cup plug. With the cup

## REMOVAL AND INSTALLATION (Continued)

plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 76).

**CAUTION:** Do not drive cup plug into the casting as restricted cooling can result and cause serious engine problems.



**Fig. 76 Core Hole Plug Removal**

## INSTALLATION

Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer. Lightly coat inside of cup plug hole with Loctite Stud N' Bearing Mount or equivalent. Make certain the new plug is cleaned of all oil or grease. Using proper drive plug, drive plug into hole so that the sharp edge of the plug is at least 0.5 mm (0.020 in.) inside the lead-in chamfer.

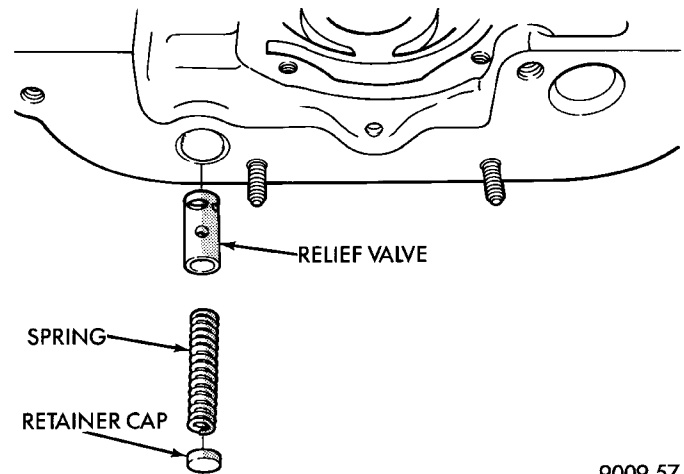
## DISASSEMBLY AND ASSEMBLY

## OIL PUMP

It is necessary to remove the oil pan, oil pickup and chain case cover to service the oil pump rotors. The oil pump pressure relief valve can be serviced by removing the oil pan and oil pickup tube. Refer to Timing Chain Cover Removal and Installation of this section for procedures.

## DISASSEMBLY

- (1) To remove the relief valve, proceed as follows:
- (2) Drill a 3.175 mm (1/8 inch) hole into the relief valve retainer cap and insert a self-threading sheet metal screw into cap.
- (3) Clamp screw into a vise and while supporting chain case cover, remove cap by tapping chain case cover using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 77).
- (4) Remove oil pump cover screws, and lift off cover.
- (5) Remove pump rotors.



**Fig. 77 Oil Pressure Relief Valve**

- (6) Wash all parts in a suitable solvent and inspect carefully for damage or wear (Fig. 80).

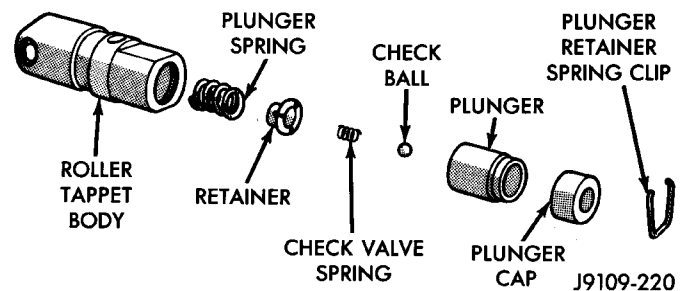
## OIL PUMP ASSEMBLY

- (1) Assemble pump, using new parts as required. **Install the inner rotor with chamfer facing the cast iron oil pump cover.**
- (2) Tighten cover screws to 12 N·m (105 in. lbs.).
- (3) Prime oil pump before installation by filling rotor cavity with engine oil.
- (4) Install chain case cover. Refer to Timing Chain Cover Installation of this section.

## HYDRAULIC TAPPETS

## DISASSEMBLY

- (1) Pry out plunger retainer spring clip (Fig. 78).
- (2) Clean varnish deposits from inside of tappet body above plunger cap.
- (3) Invert tappet body and remove plunger cap, plunger, flat or ball check valve, check valve spring, check valve retainer and plunger spring. Check valve could be flat or ball.



**Fig. 78 Hydraulic Roller Tappet Assembly**

## ASSEMBLY

- (1) Clean all tappet parts in a solvent that will remove all varnish and carbon.
- (2) Replace tappets that are unfit for further service with new assemblies.

## DISASSEMBLY AND ASSEMBLY (Continued)

(3) If plunger shows signs of scoring or wear, valve is pitted, or valve seat on end of plunger indicates any condition that would prevent valve from seating, install a new tappet assembly.

(4) Assemble tappets (Fig. 78).

## CLEANING AND INSPECTION

## CYLINDER HEAD

(1) Before cleaning, check for leaks, damage and cracks.

(2) Clean cylinder head and oil passages.

(3) Check cylinder head for flatness (Fig. 79).

(4) Inspect all surfaces with a straightedge if there is any reason to suspect leakage. If out of flatness exceeds 0.019 mm (0.00075 in.) times the span length in inches in any direction, either replace head or lightly machine the head surface. As an example, if a 12 inch span is 0.1 mm (.004 in.) out of flat, allowable is  $12 \times .019 \text{ mm}$  (.00075 in.) equals .22 mm (.009 in.) This amount of out of flat is acceptable. Maximum of 0.2 mm (.008 in.) for grinding is permitted.

**CAUTION:** This is a combined total dimension of stock removal from cylinder head and block top surface.

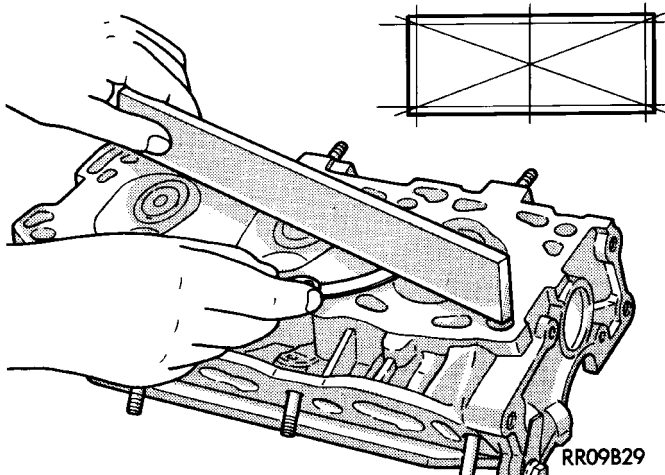


Fig. 79 Check Cylinder Head

## OIL PAN

(1) Clean oil pan in solvent and wipe dry with a clean cloth. Clean all gasket material from mounting surfaces of pan and block.

(2) Inspect oil drain plug and plug hole for stripped or damaged threads and repair as necessary. Install a new drain plug gasket. Tighten to 27 N·m (20 ft. lbs.).

(3) Inspect oil pan mounting flange for bends or distortion. Straighten flange if necessary.

(4) Clean oil screen and pipe in clean solvent. Inspect condition of screen.

## OIL PUMP

## INSPECTION AND REPAIR

(1) Clean all parts thoroughly. Mating surface of the chain case cover should be smooth. Replace pump cover if scratched or grooved.

(2) Lay a straightedge across the pump cover surface (Fig. 81). If a 0.076 mm (0.003 in.) feeler gauge can be inserted between cover and straight edge, cover should be replaced.

(3) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 7.64 mm (0.301 in.) or less (Fig. 82), or if the diameter is 79.95 mm (3.148 inches.) or less, replace outer rotor.

(4) If inner rotor measures 7.64 mm (0.301 in.) or less replace inner rotor (Fig. 83).

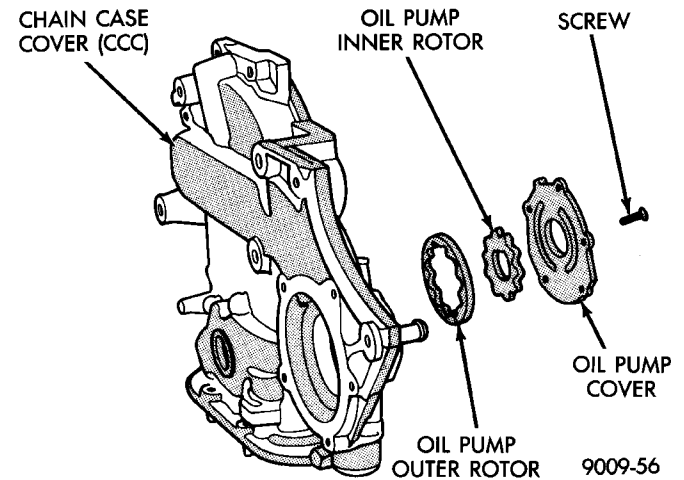


Fig. 80 Oil Pump

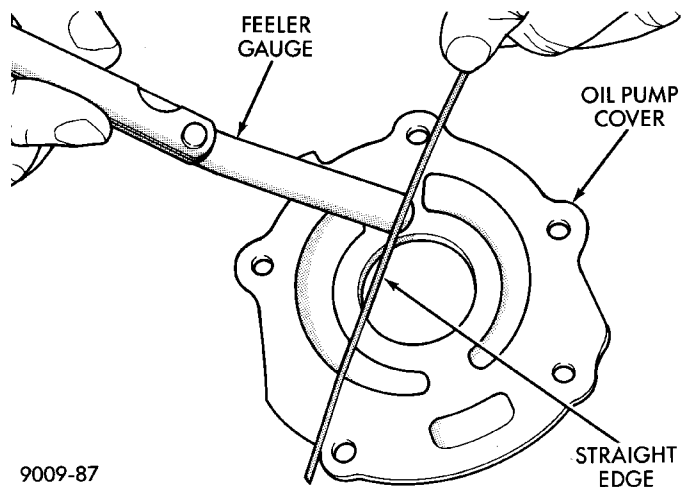


Fig. 81 Checking Oil Pump Cover Flatness

(5) Slide outer rotor into chain case cover, press to one side with fingers and measure clearance between

## CLEANING AND INSPECTION (Continued)

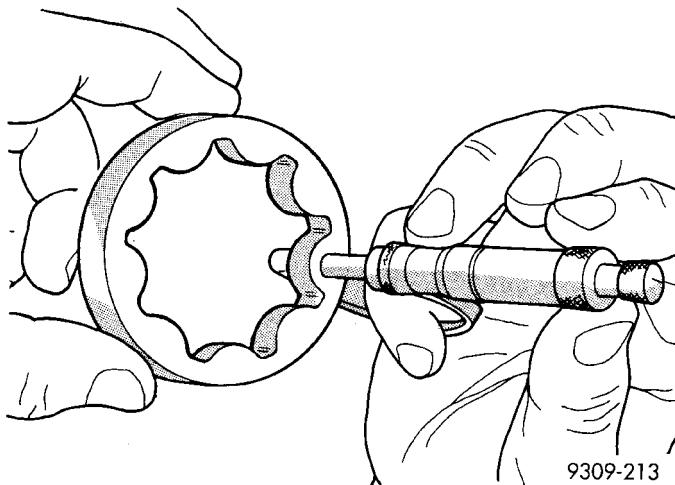
rotor and chain case cover (Fig. 84). If measurement is 0.39 mm (0.015 in.) or more, replace CCC only if outer rotor is in specification.

(6) Install inner rotor into chain case cover. If clearance between inner and outer rotors (Fig. 85) is 0.203 mm (0.008 in.) or more, replace both rotors.

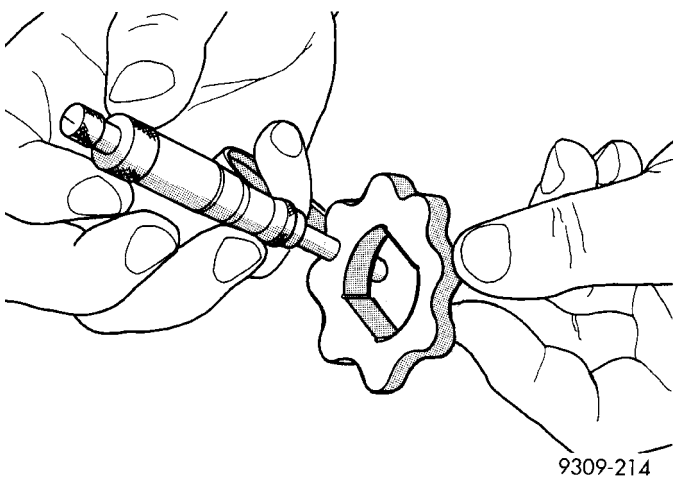
(7) Place a straightedge across the face of the chain case cover, between bolt holes. If a feeler gauge of 0.10 mm (0.004 in.) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 86). **ONLY** if rotors are in specs.

(8) Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400-grit wet or dry sandpaper.

(9) The relief valve spring has a free length of approximately 49.5 mm (1.95 inches) it should test between 19.5 and 20.5 pounds when compressed to 34 mm (1-11/32 inches). Replace spring that fails to meet specifications (Fig. 77).

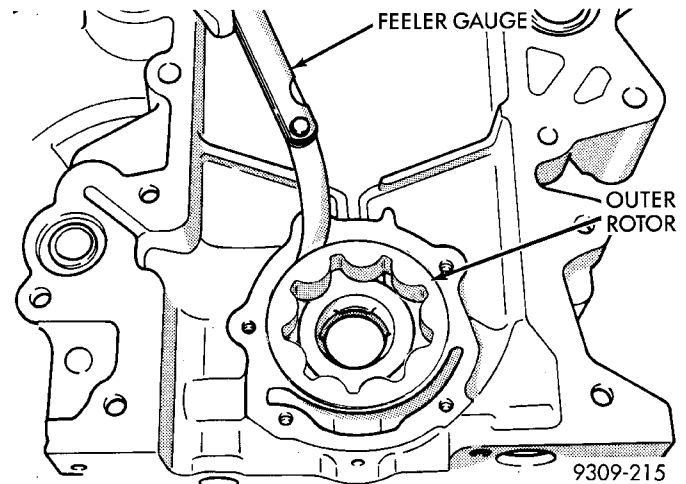


**Fig. 82 Measuring Outer Rotor Thickness**

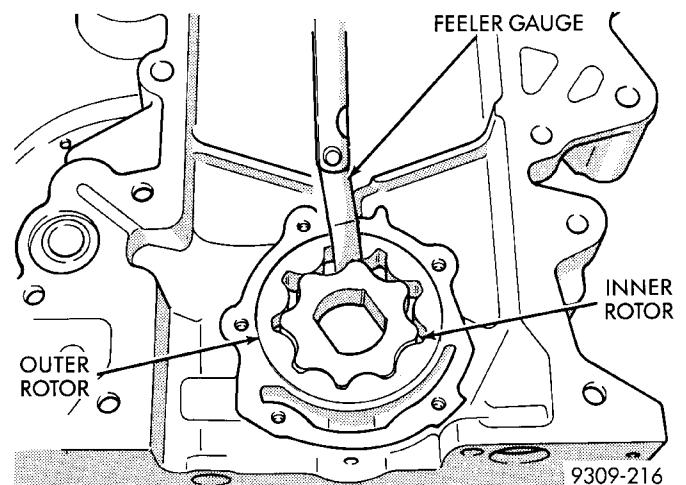


**Fig. 83 Measuring Inner Rotor Thickness**

(10) If oil pressure is low and pump is within specifications, inspect for worn engine bearings or other reasons for oil pressure loss.



**Fig. 84 Measuring Outer Rotor Clearance in Housing**



**Fig. 85 Measuring Clearance Between Rotors**  
**ENGINE BLOCK AND BORE**

## CLEANING AND INSPECTION

(1) Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.

(2) If new core plugs are installed, see Engine Core Oil and Cam Plugs.

(3) Examine block for cracks or fractures.

## CYLINDER BORE INSPECTION

The cylinder walls should be checked for out-of-round and taper with Tool C-119 (Fig. 87). If the cylinder walls are badly scuffed or scored, the cylinder block should be replaced.

Measure the cylinder bore at three levels in directions A and B (Fig. 87). Top measurement should be 12 mm (0.50 in.) down and bottom measurement

CLEANING AND INSPECTION (Continued)

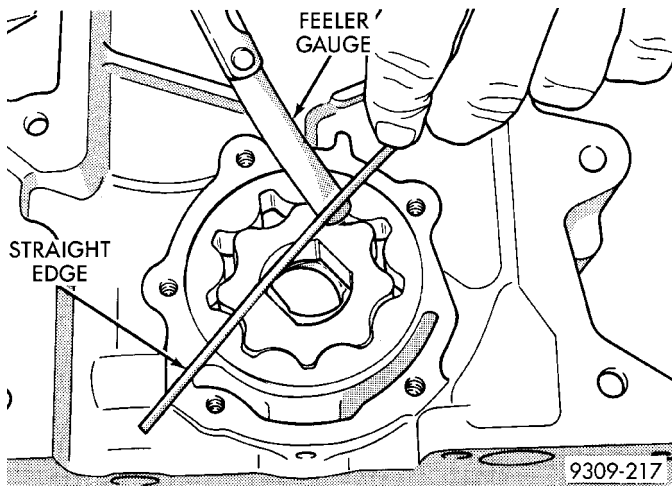


Fig. 86 Measuring Clearance Over Rotors

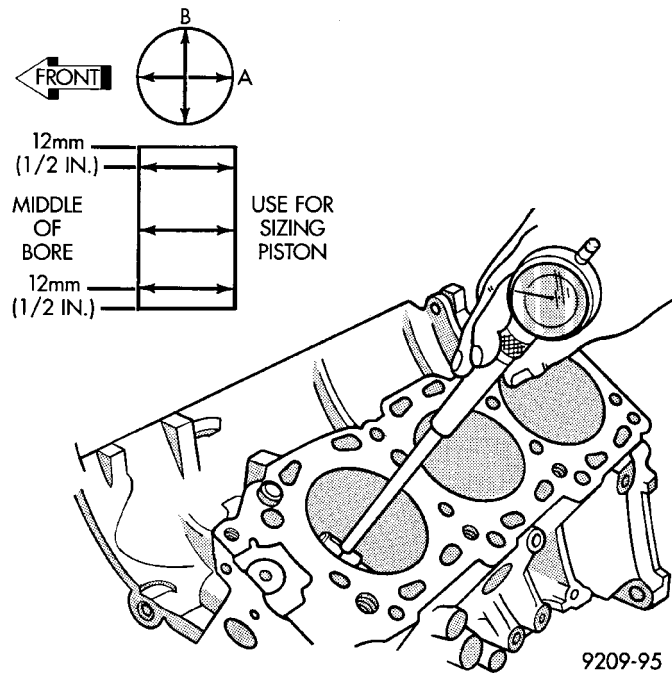


Fig. 87 Checking Cylinder Bore Size

should be 12 mm (0.50 in.) up from bottom of bore. Refer to (Fig. 88) for specifications.

ADJUSTMENTS

ENGINE MOUNTS

ENGINE MOUNT INSULATOR ADJUSTMENT

(1) Remove the load on the engine motor mounts by carefully supporting the engine and transmission assembly with a floor jack.

(2) Loosen the right engine mount insulator vertical fastener and the fore and aft fasteners, and the front engine mount bracket to front crossmember screws.

Engine	Standard Bore	Maximum Out-of-Round	Maximum Taper
3.3L	92.993-93.007 mm 3.661-3.6617 inch.	.076 mm (.003 inch.)	.51 mm (.002 inch.)
3.8L	95.993-96.007 mm 3.7792-3.780 inch.	Same	Same
<b>Standard Piston Size</b>			
3.3L	92.950-92.968 mm (3.6594-3.6602 inch.)		
3.8L	95.950-95.968 mm (3.7776-3.7783 inch.)		
Piston to Bore Clearance: .025-.057 mm (.0009 to .0022 inches.)			
Measurements taken at Piston Size location.			

Fig. 88 Cylinder Bore and Piston Specifications

Engine	Standard Bore	Maximum Out-of-Round	Maximum Taper
3.3L	92.993-93.007 mm 3.661-3.6617 inch.	.076 mm (.003 inch.)	.51 mm (.002 inch.)
3.8L	95.993-96.007 mm 3.7792-3.780 inch.	Same	Same
<b>Standard Piston Size</b>			
3.3L	92.950-92.968 mm (3.6594-3.6602 inch.)		
3.8L	95.950-95.968 mm (3.7776-3.7783 inch.)		
Piston to Bore Clearance: .025-.057 mm (.0009 to .0022 inches .)			
Measurements taken at Piston Size location.			

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(3) Pry the engine right or left as required to achieve the proper drive shaft assembly length. Refer to Group 2, Suspension and Driveshafts for drive-shaft identification and related assembly length measuring.

(4) Tighten engine mounts and fasteners in the following order:

(a) Right engine mount insulator vertical bolts to 102 N-m (75 ft. lbs.) and the fore and aft bolts to 150 N-m (110 ft. lbs.).

(b) Front engine mount screws to 54 N-m (40 ft. lbs.) the clearance between the snubbers and the engine should be 2 mm (0.078 inch.) each side.

(c) Left engine mount through bolt to 75 N-m (55 ft. lbs.).

(5) Recheck driveshaft length.

## SPECIFICATIONS

## ENGINE 3.3/3.8L

3.3L Engine		3.8L Engine	
Type		60° V-6 Engine	
Bore	93.0 mm (3.661 inches)		96.0 mm (3.779 inches)
Stroke	81.0 mm (3.188 inches)		87.0 mm (3.425 inches)
Compression Ratio		8.9:1	
Displacement	3.3 Liters (201 cubic inches)		3.8 Liters (2.31 cubic inches)
Brake Horsepower	162 @ 4800 RPM		162 @ 4400 RPM
Torque	194 lbs. -ft. @ 3600 RPM		213 lbs. -ft. @ 3600 RPM
Firing Order		1-2-3-4-5-6	
Minimum Compression Pressure, see "Engine Performance" in Standard Service Procedures		689.5 kPa (100 psi)	
Maximum Variation Between Cylinders		25%	
<b>Cylinder Number (Front to Rear)</b>			
Front Bank		2, 4, 6	
Rear Bank		1, 3, 5	
<b>Cylinder Block</b>			
Cylinder Bore (Standard)	93.0 mm (3.660 inches)		96.0 mm (3.779 inches)
Cylinder Bore Out-of-Round (Maximum Allowable Before Reconditioning)		0.076 mm (0.003 inch)	
Cylinder Bore Taper (Maximum Allowable Before Reconditioning)		0.051 mm (0.002 inch)	
Reconditioning Working Limits (For Taper and Out-of-Round)		0.001 inch	
Maximum Allowable Oversize (Cylinder Bores)		0.020 inch	
Tappet Bore Diameter		0.9051 inch-0.9059 inch	
<b>Pistons</b>			
Type Material		Aluminum Alloy Tin Coated	
Clearance at Size Location		0.025-0.057 mm (0.001 to 0.0022 inch)	
Weight (Std. Only)	381 ± 5 gms		438 ± 5 gms
Pistons For Service		Standard Only	
<b>Piston Pins</b>			
Type		Press Fit in Rod (Serviced as an Assembly)	
Diameter		22.88 mm (0.9009-0.9007 inch)	
Length	67.25-67.75mm (2.648-2.667 inches)		71.25-71.75 mm (2.805-2.824 inches)
Clearance in Piston (Light Thumb Push @ 70° F)		0.006-0.019 mm (0.0002-0.0007 inch)	
Clearance in Rod		(Interference)	
<b>Piston Rings</b>			
Number of Rings Per Piston		3	
Compression		2	
Oil		1	
Oil Ring Type		3-Piece, Steel Rail, Chrome-Face	
Ring Width			
Compression		1.46-1.5 mm (0.0575-0.0591 inch)	
Oil—Steel Rails		0.510 mm (0.0201 inch)	
Ring Gap			
Compression		0.300-0.550 mm (0.0118-0.0217 inch)	
Oil—Steel Rails		0.250-1.00 mm (0.0098-0.0394 inch)	
Ring Side Clearance			
Compression		0.030-0.095 mm (0.0012-0.0037 inch)	
Oil—Steel Rails		0.014-0.226 mm (0.0005-0.0089 inch)	
Service Rings			
Ring Gap			
Compression		0.300-0.550 mm (0.0018-0.0217 inch)	
Oil—Steel Rails		0.250-1.00 mm (0.0098-0.0394 inch)	
Ring Side Clearance			
Compression		0.030-0.095 mm (0.0012-0.0037 inch)	
Oil—Steel Rails		0.014-0.226 mm (0.0005-0.0089 inch)	

## SPECIFICATIONS (Continued)

<b>CONNECTING RODS</b>	
Side Clearance	0.127-0.381 mm (0.005-0.015 inch)
<b>CONNECTING ROD BEARINGS</b>	
Type	Aluminum Lead (Bi-Metal)
Clearance Desired	0.019-0.076 mm (0.00075-0.003 inch.)
Maximum Allowable (wear limit)	0.102 mm (0.004 inch.)
Bearings for Service	Std., 0.025 mm (0.001), 0.051mm (0.002) 0.076 mm (0.003), 0.254 mm (0.010), 0.305 mm (0.012 inches.)
<b>CRANKSHAFT</b>	
Type	Cast Nodular Iron
Bearings	Aluminum Lead (Bi-Metal)
Thrust Taken By	No. 2 Main Bearing
End Play	0.076-0.228 mm (0.003-0.009 inch.)
Maximum Allowable (wear limit)	0.381 mm (0.015 inch.)
Diametral Clearance Desired #1, 2, 3 and 4	0.018-0.087 mm (0.0007-0.003 inch.)
Maximum Diametral Clearance #1, 2, 3 and 4 (wear limit)	0.102 mm (0.004 inch.)
<b>MAIN BEARING JOURNALS</b>	
Diameter	64 mm (2.519 inch.)
Maximum Allowable Out-of-Round and/or Taper	0.025 mm (0.001 inch.)
Bearings for Service	Std., 0.025 mm (0.001), 0.051 mm (0.002) 0.076 mm (0.003), 0.254 mm (0.010), 0.305 mm (0.012 inches.)
<b>CONNECTING ROD JOURNALS</b>	
Diameter	58 mm (2.283 inch.)
Maximum Allowable Out-of-Round and/or Taper	0.025 mm (0.001 inch.)
<b>CAMSHAFT</b>	
Drive	Chain
Bearings	Steel Backed Babbitt
Number	4
Diametral Clearance	0.025-0.101 mm (0.001-0.004 inch.)
Maximum Allowable Before Reconditioning	0.127 mm (0.005 inch.)
Thrust Taken By	Thrust Plate
End Play	0.127-0.304 mm (0.005-0.012 inch.)
Maximum Allowable	0.304 mm (0.012 inch.)
<b>CAMSHAFT JOURNALS</b>	
Diameter	
No. 1	50.724-50.775 (1.9970-1.9990 inch.)
No. 2	50.317-50.368 (1.9809-1.9829 inch.)
No. 3	49.936-49.987 (1.9659-1.9679 inch.)
No. 4	49.530-49.581 (1.9499-1.9520 inch.)

## SPECIFICATIONS (Continued)

**Camshaft Bearings**

## Diameter

No. 1	50.825-50.800 (2.0009-1.9999 inch.)
No. 2	50.419-50.393 (1.9849-1.9839 inch.)
No. 3	50.038-50.013 (1.9699-1.9690 inch.)
No. 4	49.632-49.606 (1.9540-1.9529 inch.)
Oil Clearance	.0254-.0762 mm (.001-.003 inch.)

**Valve Timing**

Intake Opens (BTC)	2°
Intake Closes (ABC)	58°
Exhaust Opens (BBC)	48°
Exhaust Closes (ATC)	12°
Valve Overlap	14°
Intake Valve Duration	240°
Exhaust Valve Duration	240°

**Timing Chain**

Number of Links	64
Pitch	.375 inch
Width	.750 inch

**Tappets**

Type	Roller Hydraulic
Body Diameter	22.95-22.96 mm (0.9035-0.9040 inch)
Clearance to Block	0.02-0.06 mm (0.0007-0.0024 inch)
Service Tappets Available	Std., 0.025 mm (0.001), 0.20 mm (0.008), 0.762 mm (0.030 inches)

**Cylinder Head**

Valve Seat Run-Out (Maximum)	0.760 mm (0.003 inch)
Intake Valve Seat Angle	45-45-1/2°
Seat Width (Finished)	1.75-2.25 mm (0.069-0.088 inch)
Exhaust Valve Seat Angle	45-45-1/2°
Seat Width (Finished)	1.50-2.00 mm (0.057-0.078 inch)
Cylinder Head Gasket (Thickness Compressed)	1.78 mm (0.070 inch)

**Valve Guides**

Type	Powdered Metal Inserts
Guide Bore Diameter	7.975-8.000 mm (0.314-0.315 inch)

**Valves—(Intake)**

Head Diameter	45.5 mm (1.79 inches)
Length Overall (New)	125.385-126.025 mm (4.936-4.961 inches)
Stem Diameter (Standard)	7.935-7.953 mm (0.312-0.313 inch)
Stem to Guide Clearance	0.025-0.095 mm (0.001-0.003 inch)
Maximum Allowable ( By Rocking Method)	0.247 mm (0.010 inch)
Face Angle	44-1/2°
Valves for Service (Oversized Stem Diameter)	Std., 0.015 mm (0.005), 0.40 mm (0.015), 0.80 mm (0.030 inches)
Lift (Zero Lash)	10.16 mm (0.400 inch)
Minimum Valve Length After Grinding Tip	124.892 (4.916 inches)
Valve Tip Height (From Cylinder Head Surface)	49.541-51.271 mm (1.950-2.018 inch.)

## SPECIFICATIONS (Continued)

**VALVES (EXHAUST)**

Head Diameter	37.5 mm (1.476 inch)
Length Overall (New)	126.005–126.645 mm (4.960–4.986 inch)
Stem Diameter (Standard)	7.906–7.924 mm (0.3112–0.3119 inch)
Stem to Guide Clearance	0.051–0.175 mm (0.002–0.006 inch)
Maximum Allowable by Rocking Method	0.414 mm (0.016 inch)
Face Angle	45°
Valves for Service (Oversize Stem Diameter)	Std., 0.015 mm (0.005), 0.40 mm (0.015), 0.80 mm (0.030 inches)
Lift (Zero Lash)	10.16 mm (0.400 inch)
Minimum Valve Length After Grinding Tip	125.512 mm (4.941 inch)
Valve Tip Height (From Cylinder Head Surface)	49.541–51.271 mm (1.950–2.018 inch)

**ENGINE VALVE SPRINGS** Intake/Exhaust

Number	12
Free Length (Approx.)	48.5 mm (1.909 inch)
Wire Diameter	4.75 mm (0.187 inch)
Number of coils	6.8
Load When Compressed to-Valve Closed	95–100 lbs. @ 1.570 inch
-Valve Open	207.229 lbs. @ 1.169 inch
Valve Spring Installed Height (Spring Seat to Retainer)	41.2–42.7 mm (1.622–1.681 inch)

**ENGINE LUBRICATION**

Pump Type	Rotary Full Pressure
Capacity	4.3 Liters (4.5 qts.) Without Oil Filter Change, 4.7 Liters (5.0 qts.) With Oil Filter Change.
Pump Drive	Crankshaft
Minimum Pressure, Engine Fully Warmed Up at Idle	34.47 kPa (5 psi)
3000 RPM	205–551 kPa (30–80 psi)
Oil Filter Bypass Valve Setting	62–103 kPa (9–15 psi)
Oil Pressure Switch Minimum Actuating Pressure	14–28 kPa (2–4 psi)
Oil Filter Type	Full Flow

**OIL PUMP—INSPECTION LIMITS FOR REPLACEMENT**

Oil Pump Cover Out of Flat	0.076 mm (0.003) inch or more
Outer Rotor Thickness	7.64 mm (0.301 inch or less)
Outer Rotor Diameter	79.95 (3.148 inch or less)
Inner Rotor Thickness	7.64 mm (0.301 inch or less)
Clearance Over Rotors—Outer	0.10 mm (0.004 inch or more)
—Inner	0.10 mm (0.004 inch or more)
Outer Rotor Clearance	0.39 mm (0.015 inch or more)
Tip Clearance Between Rotors	0.20 mm (0.008 inch or more)

## SPECIFICATIONS (Continued)

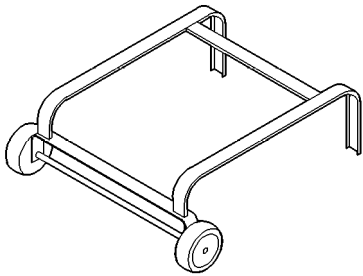
## TORQUE CHART

DESCRIPTION	TORQUE
A/C Compressor Bracket to Water Pump Bolt .....	41 N·m (30 ft. lbs.)
A/C Compressor to Bracket Bolt .....	68 N·m (50 ft. lbs.)
A/C Compressor Support Bolts .....	41 N·m (30 ft. lbs.)
Generator Adjusting Strap Bolt .....	23 N·m (200 in. lbs.)
Generator Adjusting Strap Mounting Bolt ....	41 N·m (30 ft. lbs.)
Generator Bracket Bolt .....	41 N·m (30 ft. lbs.)
Generator Mounting Pivot Nut .....	41 N·m (30 ft. lbs.)
Camshaft Sprocket Bolt .....	54 N·m (40 ft. lbs.)
Camshaft Thrust Plate .....	12 N·m (105 in. lbs.)
Chain Case Cover Bolt	
M8x1.25 .....	27 N·m (20 ft. lbs.)
M10x1.5 .....	54 N·m (40 ft. lbs.)
Connecting Rod Nut .....	54 N·m (40 ft. lbs.) +1/4 Turn
Crankshaft Pulley Screw to Crankshaft .....	54 N·m (40 ft. lbs.)
Cylinder Head Bolt .....	33 N·m (25 ft. lbs.)
Cylinder Head Bolt .....	61, 88, 88 N·m (45, 65, 65 ft. lbs.) +1/4 Turn
Cylinder Head Covers – Bolt .....	12 N·m (105 in. lbs.)
Exhaust Manifold Screw .....	23 N·m (200 in. lbs.)
Exhaust Crossover Pipe Flange Nut/Bolt .....	33 N·m (25 ft. lbs.)

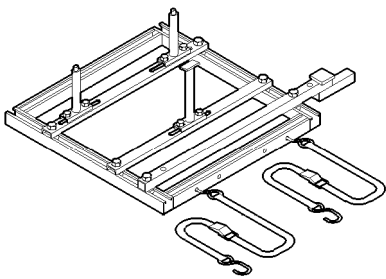
DESCRIPTION	TORQUE
Intake Manifold Bolt .....	23 N·m (200 in. lbs.)
Intake Manifold Gasket Retaining Screws...	12 N·m (105 in. lbs.)
Intake Manifold Plenum Bolt .....	28 N·m (250 in. lbs.)
Main Bearing Cap Bolt .....	41 N·m (30 ft. lbs.) +1/4 Turn
Oil Filter Attaching Nipple .....	41 N·m (30 ft. lbs.)
Oil Level Sensor Plug .....	41 N·m (30 ft. lbs.)
Oil Pan Drain Plug .....	34 N·m (25 ft. lbs.)
Oil Pan Screw .....	12 N·m (105 in. lbs.)
Oil Pressure Gauge Sending Unit .....	7 N·m (60 in. lbs.)
Oil Pump Cover Bolt T-30 .....	12 N·m (105 in. lbs.)
Oil Pump Pick-up Tube Screw .....	28 N·m (250 in. lbs.)
Rocker Shaft Bracket Bolt .....	28 N·m (250 in. lbs.)
Spark Plug .....	27 N·m (20 ft. lbs.)
Starter Mounting Bolt .....	68 N·m (50 ft. lbs.)
Strut Intake Manifold to Cylinder Head Bolt .....	54 N·m (40 ft. lbs.)
Tappet Retainer Yoke Screw .....	12 N·m (105 in. lbs.)
Temperature Gauge Sending Unit .....	7 N·m (60 in. lbs.)
Water Pump to (Chain Case Cover) Bolt .....	12 N·m (105 in. lbs.)

SPECIAL TOOLS

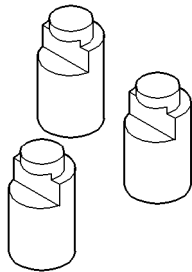
ENGINE 3.3/3.8



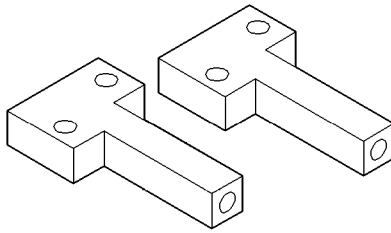
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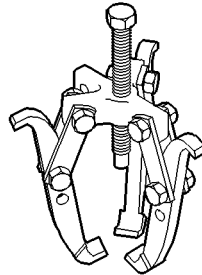
**Cradle 6710**



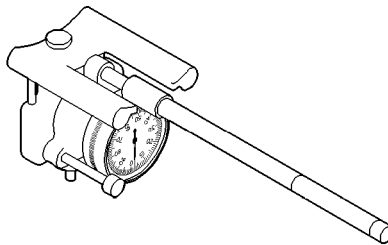
**Adaptor 6909**



**Adaptor 6912**



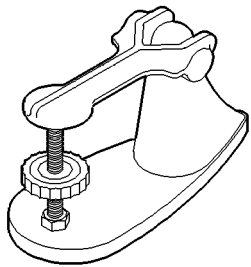
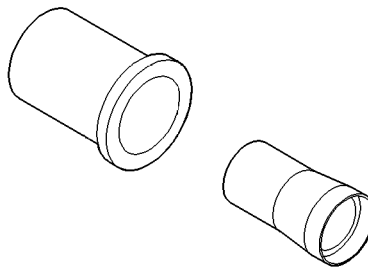
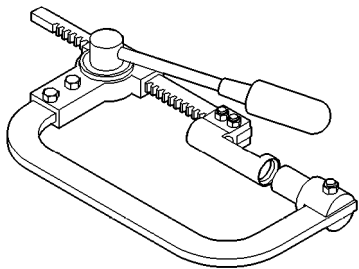
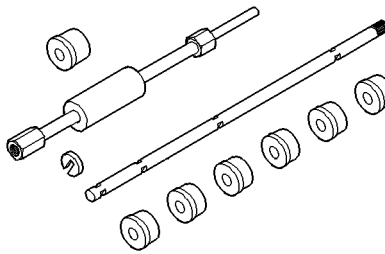
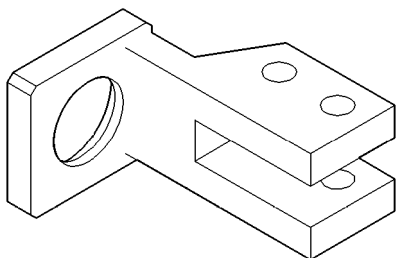
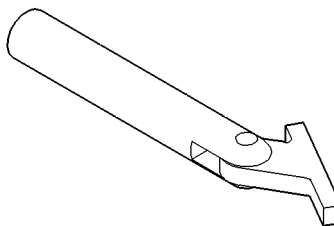
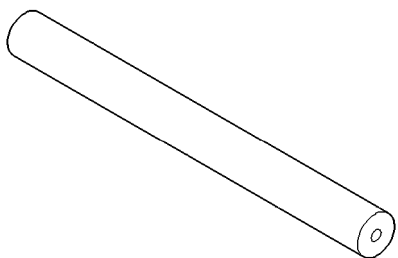
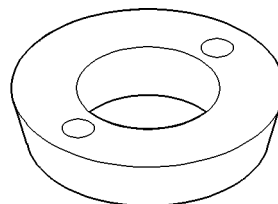
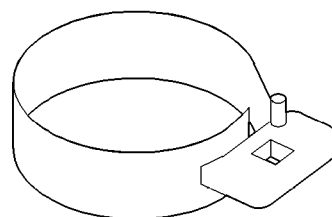
**Puller 1023**



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**Indicator, Cylinder Bore C-119**

## SPECIAL TOOLS (Continued)

**Tester Valve Spring C-647****Front Crankshaft Seal Installer C-4992****Valve Spring Compressor C-3422-B****Camshaft Bearing Remover and Installer C-3132-A****Adaptor Valve Compressor 6412****Crankshaft Main Bearing Remover and Installer C-3059****Insert Crankshaft Pulley Remover C-4685-C2****Rear Crankshaft Seal Pilot Tool C-4681****Oil Filter Wrench C-4065**



# ENGINE

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## 2.0L SOHC ENGINE

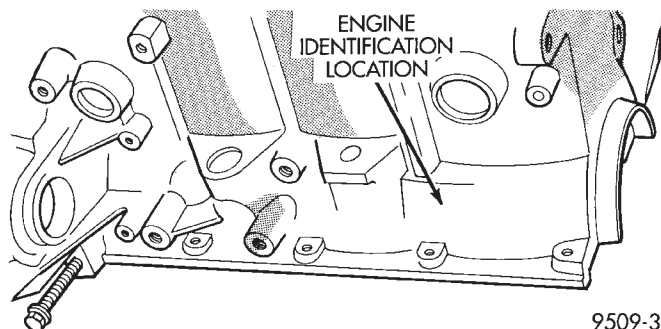
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### DESCRIPTION AND OPERATION

#### ENGINE IDENTIFICATION

The engine identification number is located on the left rear of the cylinder block behind starter (Fig. 1).



9509-3

Fig. 1 Engine Identification SOHC

## DESCRIPTION AND OPERATION (Continued)

## GENERAL SPECIFICATION

Type	In-Line OHV, DOHC & SOHC
Bore	87.5mm (3.445 Inch)
Stroke	83.0mm (3.268 inch)
Compression Ratio	DOHC - 9.6:1 SOHC - 9.8:1
Displacement	2.0 Liters (122 Cubic Inch)
Firing Order	1, 3, 4, 2
Compression Pressure	1172 - 1551 kPa (170 - 225 psi)

## Maximum Variation

Between Cylinders	25%
Lubrication . . . Pressure Feed - Full Flow Filtration (Crankshaft Driven Pump)	

**Engine Oil Capacity**

With Oil Filter Change	4.25 Liter (4.5 Qts.)
Without Oil Filter Change	3.8 Liter (4.0 Qts.)

## LUBRICATION SYSTEM

The pressurized system (Fig. 2) uses a rotary pump (3) located in the front of the engine block, driven by a gear which meshes directly with the crankshaft gear. All the oil sent to every lubricated part is filtered. The pump sends the oil through a pressure relief valve (2) to the filter (7) and through galleries in the crankcase to the crankshaft bearings (8), camshaft bearings (11) and turbocharger (10). The piston pins, connecting rod small ends and insides of the pistons are lubricated and cooled by oil sprayed out from jets (9) in the crankshaft mounting blocks. The lubricating oil is sent to the rockers (12) through an external pipe (Fig. 3). A valve in the filter cartridge enables the oil to be circulated even when the cartridge is clogged.

Sump inlet (1). Pressure relief valve (2). Oil pump (3). Oil cooler (6). Filter cartridge (7). Crankshaft bearings (8). Jet valve (9). Turbocharger bearings (10). Camshaft bearings (11). Rockers (12).

## ENGINE COMPONENTS

**CYLINDER BLOCK AND BEDPLATE ASSEMBLY** A partial open deck is used for cooling and weight reduction with water pump molded into the block. Nominal wall thickness is 4 mm. The bedplate incorporates main bearing caps. Rear seal retainer is integral with the block.

**CRANKSHAFT** A nodular cast iron crankshaft is used. The engine has 5 main bearings, with number 3 flanged to control thrust. The 52 mm diameter main and 48 mm diameter crank pin journals (all) have undercut fillet radiuses that are deep rolled for added strength. To optimize bearing loading 8 coun-

terweights are used. Hydrodynamic seals provide end sealing, where the crankshaft exits the block. Anaerobic gasket material is used for parting line sealing. A sintered iron timing belt sprocket is mounted on the crankshaft nose. This sprocket transmits crankshaft movement, via timing belt to the camshaft sprocket providing timed valve actuation.

**PISTONS** The SOHC Engine **DOES NOT** have provision for a free wheeling valve train. Non free wheeling valve train means, in the event of a broken timing belt Pistons will contact the Valves. All engines use pressed-in piston pins to attach forged powdered metal connecting rods. The connecting rods are a cracked cap design and are not repairable. Hex head cap screw are used to provide alignment and durability in the assembly. Pistons And Connecting rods are serviced as an assembly.

**PISTON RINGS** The piston rings include a molybdenum faced top ring for reliable compression sealing and a taper faced intermediate ring for additional cylinder pressure control. Oil Control Ring Package consist of 2 steel rails and a expander spacer.

**CYLINDER HEAD — SOHC** It features a Single Over Head Camshaft, four-valves per cylinder cross flow design. The valves are arranged in two inline banks, with the two intake per cylinder facing toward the radiator. The exhaust valves facing toward the dash panel. Rocker arm shafts mount directly to the cylinder head. It incorporates powder metal valve guides and seats. The hollow rocker arm shafts supplies oil to the hydraulic lash adjusters, camshaft and valve mechanisms.

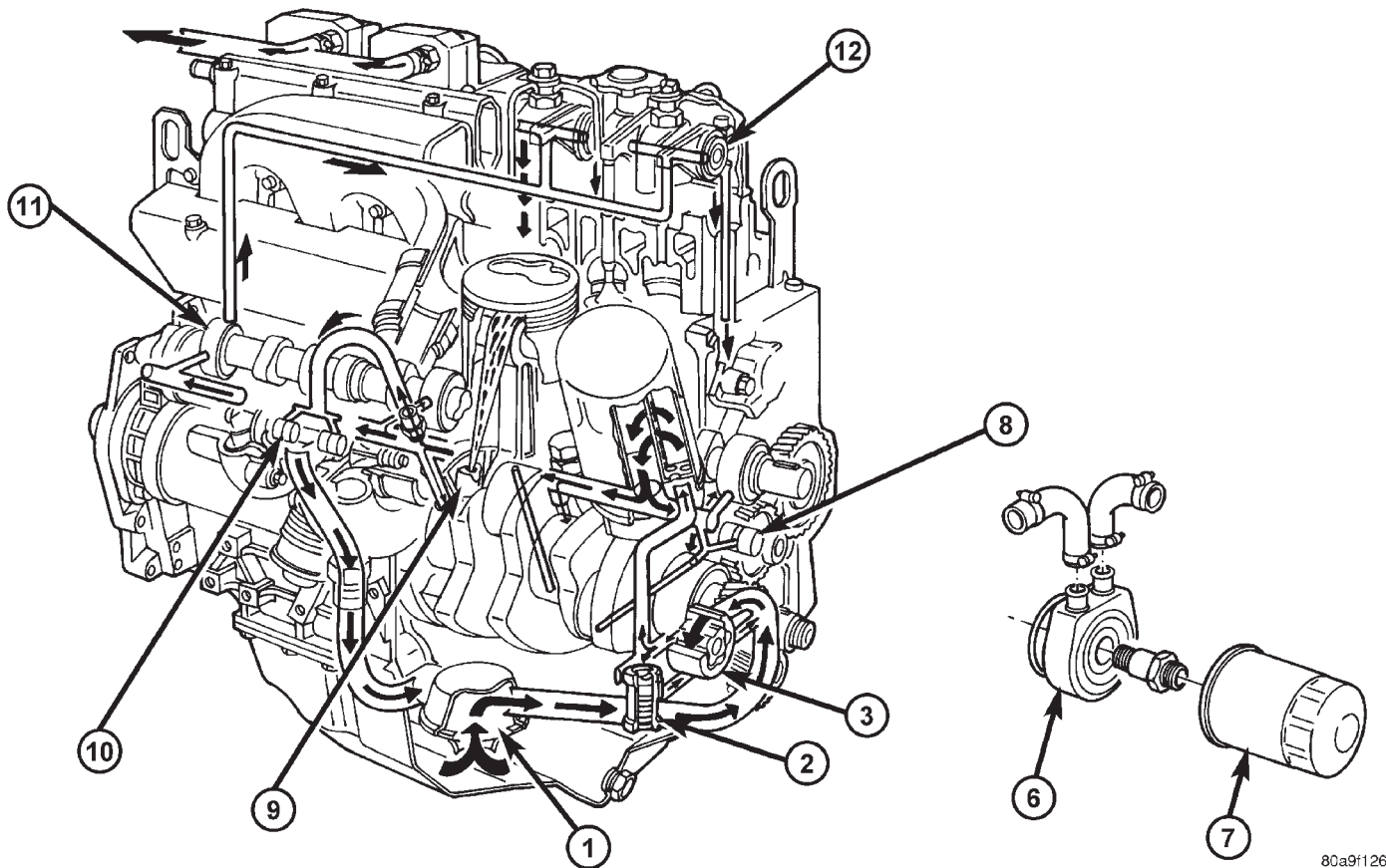
**CAMSHAFT — SOHC** The nodular iron camshaft has five bearing journals and 3 cam lobes per cylinder. Provision for cam position sensor on the cam at the rear of cylinder head which also acts as thrust plate. A hydrodynamic oil seal is used for oil control at the front of the camshaft.

**VALVES — SOHC** Four valves per cylinder are actuated by roller rocker arms/hydraulic lash adjusters assemblies which pivot on rocker arm shafts. All valves have 6 mm diameter chrome plated valve stems. The valve train has 33 mm (1.299 inch) diameter intake valves and 28 mm (1.10 inch) diameter exhaust valves. Viton rubber valve stem seals are integral with spring seats. Valve springs, spring retainers, and locks are conventional design.

**INTAKE MANIFOLD** The intake manifold is a molded plastic composition, attached to the cylinder head with ten fasteners. This long branch design enhances low and midrange torque.

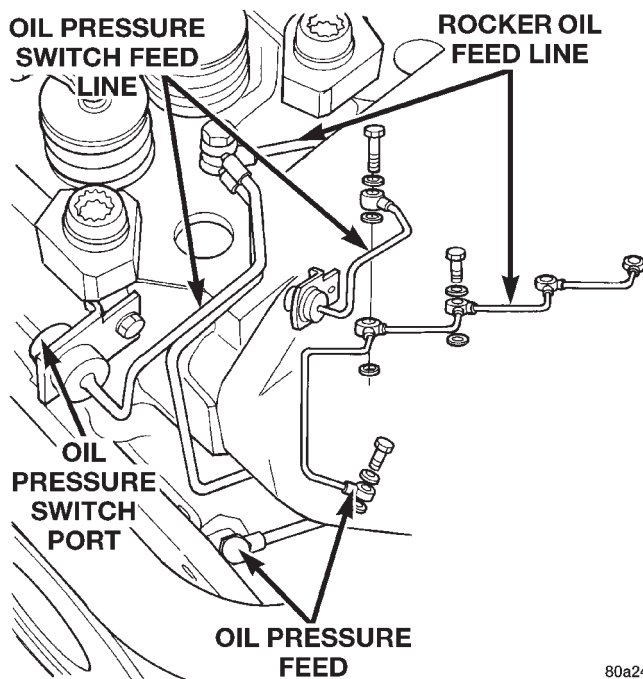
**EXHAUST MANIFOLD** The exhaust manifold is made of nodular cast iron for strength and high temperatures. Exhaust gasses exit through a machined, articulated joint connection to the exhaust pipe.

## DESCRIPTION AND OPERATION (Continued)



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Fig. 2 Lubrication System



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Fig. 3 Lubrication Lines

**PARTS REPLACED**

If any of the following parts have been changed or replaced:

- Camshaft
- Camshaft Position Sensor
- Camshaft Position Sensor Target Magnet
- Cylinder Block
- Cylinder Head
- Water Pump
- Powertrain Control Module (PCM)
- Timing belt and tensioner.

The camshaft and crankshaft timing realign procedure must be performed. Refer to Group 25, for procedure.

**DIAGNOSIS AND TESTING****CHECKING ENGINE OIL PRESSURE**

- (1) Remove oil pressure switch and install gauge assembly C-3292 with adaptor.
- (2) Run engine until thermostat opens.

**CAUTION:** If oil pressure is 0 at idle, Do Not perform the 3000 RPM test in the next step.

DIAGNOSIS AND TESTING (Continued)

(3) Oil Pressure: **Curb Idle** 25 kPa (4 psi) minimum **3000 RPM** 170-550 kPa (25-80 psi).

(4) If oil pressure is 0 at idle. Shut off engine, check for pressure relief valve stuck open, a clogged oil pick-up screen or a damaged oil pick-up tube O-ring.

SERVICE PROCEDURES

CYLINDER BORE AND PISTON SIZING

The cylinder walls should be checked for out-of-round and taper with Tool C-119 (Fig. 4). The cylinder bore out-of-round is 0.050 mm (.002 inch) maximum and cylinder bore taper is 0.051 mm (0.002 inch) maximum. If the cylinder walls are badly scuffed or scored, the cylinder block should be rebored and honed, and new pistons and rings fitted. Whatever type of boring equipment is used, boring and honing operation should be closely coordinated with the fitting of pistons and rings in order that specified clearances may be maintained. **Refer to Honing Cylinder Bores outlined in the Standard Service Procedures for specification and procedures.**

Measure the cylinder bore at three levels in directions A and B (Fig. 4). Top measurement should be 10 mm (3/8 inch) down and bottom measurement should be 10 mm (3/8 inch.) up from bottom of bore. Refer to Cylinder Bore and Piston Specifications Table.

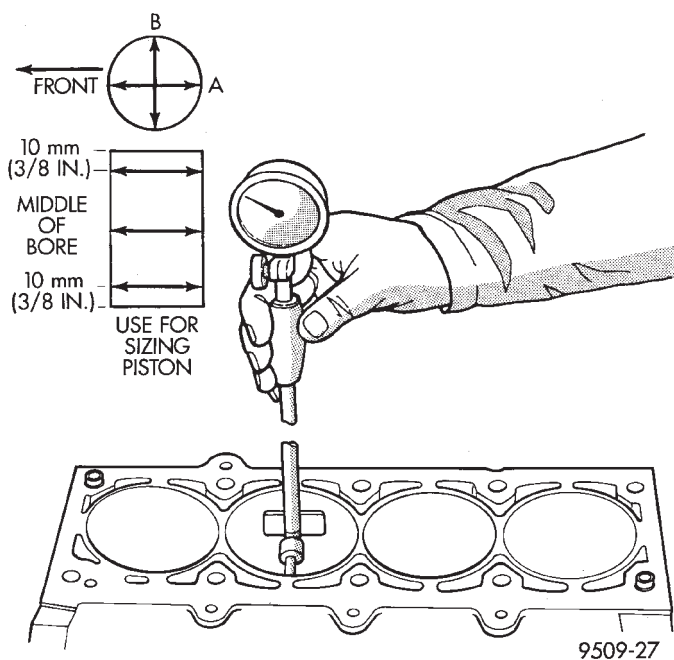


Fig. 4 Checking Cylinder Bore Size

CYLINDER BORE AND PISTON SPECIFICATIONS TABLE

Standard Bore	Maximum Out-of-Round	Maximum Taper
87.5 mm (3.445 in.)	0.051 mm (0.002 in.)	0.051 mm (0.002 in.)
Standard Piston Size		
87.463 - 87.481 mm (3.4434 - 3.4441 in.)		
Piston to Bore Clearance		
0.012 - 0.044 mm (0.0004 - 0.0017 in.)		
Measurements Taken at Piston Size Location		

SIZING PISTONS

Piston and cylinder wall must be clean and dry. Piston diameter should be measured 90 degrees to piston pin about 17.5 mm (11/16 inch) from the bottom of the skirt as shown in (Fig. 5). Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line shown in (Fig. 4). Refer to Cylinder Bore and Specifications Table. Correct piston to bore clearance must be established in order to assure quiet and economical operation.

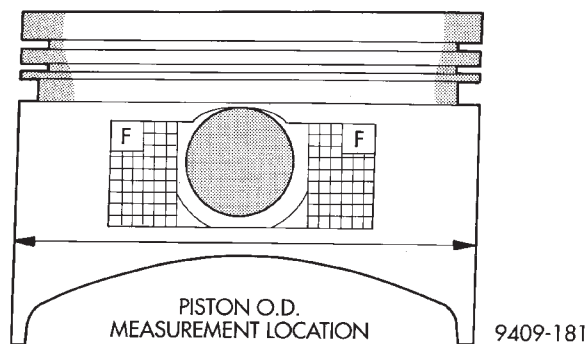


Fig. 5 Piston Measurements

Chrysler engines use pistons designed specifically for each engine model. Clearance and sizing locations vary with respect to engine model.

**NOTE:** Pistons and cylinder bores should be measured at normal room temperature, 21°C (70°F).

FITTING PISTON RINGS

(1) Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioning at least 12 mm (0.50 inch) from bottom of cylinder bore. Check gap with feeler gauge (Fig. 6). Refer to specifications (Fig. 8).

(2) Check piston ring to groove side clearance (Fig. 7). Refer to specification (Fig. 8).

## SERVICE PROCEDURES (Continued)

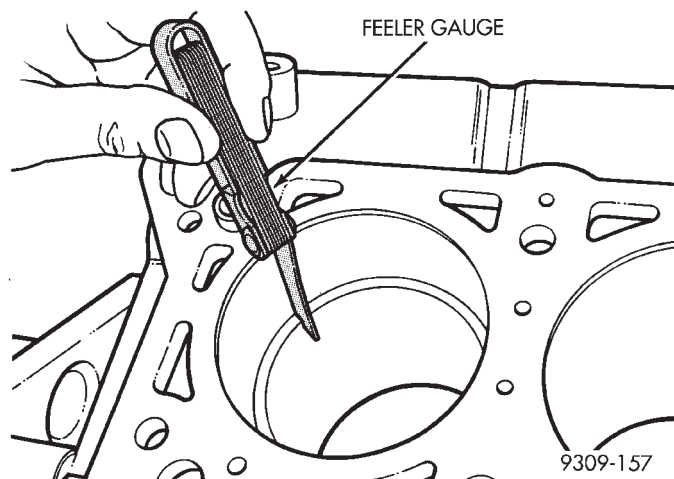


Fig. 6 Piston Ring Gap

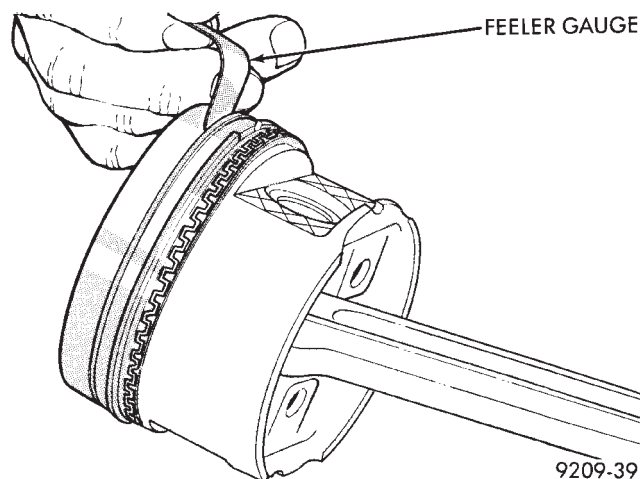


Fig. 7 Piston Ring Side Clearance

## FITTING CONNECTING RODS

(1) Follow the procedure specified in the Standard Service Procedures Section for Measuring Main Bearing Clearance and Connecting Rod Bearing Clearance (Fig. 9). Refer to specifications.

**CAUTION:** Do not rotate crankshaft or the Plasti-gage may be smeared.

**NOTE:** The rod bearing bolts should not be reused.

(2) Before installing the **NEW** bolts the threads should be oiled with clean engine oil.

(3) Install each bolt finger tight then alternately torque each bolt to assemble the cap properly.

(4) Tighten the bolts to 27 N·m PLUS 1/4 turn (20 ft. lbs. PLUS 1/4 turn) **Do not use a torque wrench for last step.**

(5) Using a feeler gauge, check connecting rod side clearance (Fig. 10). Refer to connecting rod specifications (Fig. 11).

Ring Position	Ring Gap	Wear Limit
Upper Ring	0.23 to 0.52 mm (0.009 to 0.020 in.)	0.8 mm (0.031 in.)
Intermediate Ring	0.49 to 0.78 mm (0.019 to 0.031 in.)	1.0 mm (0.039 in.)
Oil Control Ring	0.23 to 0.66 mm (0.009 to 0.026 in.)	1.0 mm (0.039 in.)
Ring Position	Groove Clearance	Maximum Clearance
Upper Ring	0.025 to 0.065 mm (0.0010 to 0.0026 in.)	0.10 mm (0.004 in.)
Intermediate Ring	0.025 to 0.065 mm (0.0010 to 0.0026 in.)	0.10 mm (0.004 in.)

OIL CONTROL RING - THREE PIECE. OIL RING SIDE RAILS MUST BE FREE TO ROTATE AFTER ASSEMBLY

9509-28

Fig. 8 Piston Ring Specifications

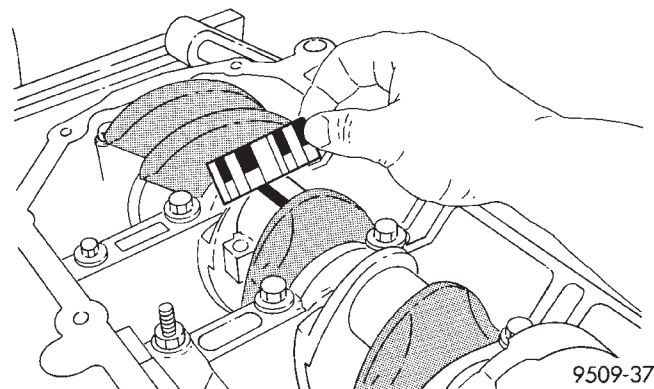


Fig. 9 Checking Connecting Rod Bearing Clearance

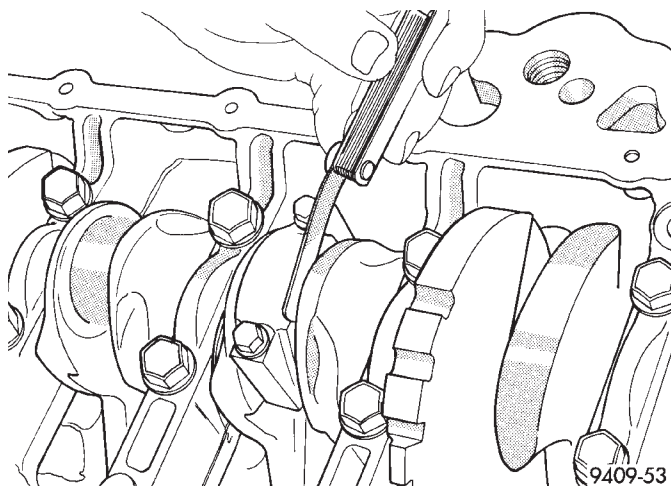


Fig. 10 Checking Connecting Rod Side Clearance

SERVICE PROCEDURES (Continued)

<b>CONNECTING ROD BEARING OIL CLEARANCE</b>	
New Part:	0.026 to 0.059 mm (0.001 to 0.0023 in.)
Wear Limit:	0.075 mm (0.003 in.)
<b>CONNECTING ROD SIDE CLEARANCE</b>	
New Part:	0.13 to 0.38 mm (0.005 to 0.015 in.)
Wear Limit:	0.40 mm (0.016 in.)

9509-250

**Fig. 11 Connecting Rod Specifications**

**FITTING CRANKSHAFT BEARINGS**

Refer to Measuring Main Bearing Clearance in Standard Service Procedures. Refer to (Fig. 12) for specifications.

<b>Crankshaft End-Play</b>	
New Part:	0.09 - 0.24 mm (0.0035 - 0.0094 in.)
Wear Limit:	0.37 mm (0.015 in.)
<b>Main Bearing Clearance</b>	
New Part:	.022 - .062 mm (0.0008 - 0.0024 in.)
<b>Connecting Rod Bearing Clearance</b>	
New Part:	0.026 - .059 mm (0.001 - 0.0023 in.)
Wear Limit:	0.075 mm (0.003 in.)
<b>Crankshaft Journal Sizes</b>	
<b>Main Bearing Journal Diameter</b>	
Standard	52.000 ± 0.008 mm (2.0472 ± 0.0003 in.)
1st Undersize	51.983 ± 0.008 mm (2.0466 ± 0.0003 in.)
<b>Connecting Rod Journal</b>	
Standard	48.000 ± 0.008 mm (1.8897 ± 0.0003 in.)
1st Undersize	47.983 ± 0.008 mm (1.8891 ± 0.0003 in.)

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**Fig. 12 Crankshaft Specifications**

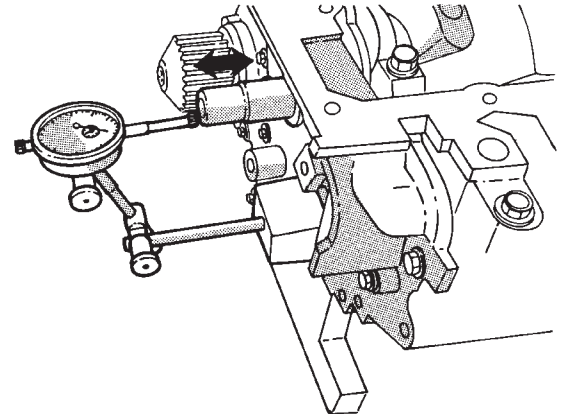
**CRANKSHAFT END PLAY**

**DIAL INDICATOR METHOD**

- (1) Mount a dial indicator to front of engine, locating probe on nose of crankshaft (Fig. 13).
- (2) Move crankshaft all the way to the rear of its travel.
- (3) Zero the dial indicator.
- (4) Move crankshaft all the way to the front and read the dial indicator. Refer to (Fig. 12) for specifications.

**FEELER GAGE METHOD**

- (1) Move crankshaft all the way to the rear of its travel using a lever inserted between a main bearing cap and a crankshaft cheek, using care not to dam-



9409-189

**Fig. 13 Checking Crankshaft End Play— Dial Indicator**

age any bearing surface. Do **not** loosen main bearing cap.

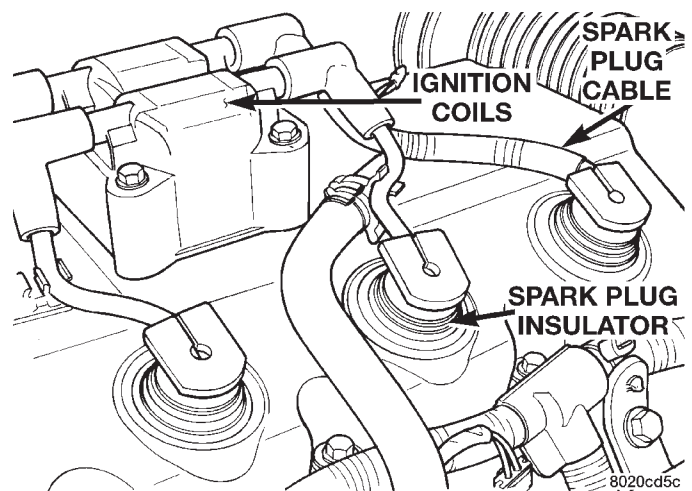
- (2) Use a feeler gauge between number three thrust bearing and machined crankshaft surface to determine end play.

**REMOVAL AND INSTALLATION**

**CYLINDER HEAD COVER**

**REMOVAL**

- (1) Remove ignition coil pack (Fig. 14).
- (2) Remove the cylinder head cover bolts.
- (3) Remove cylinder head cover from cylinder head.



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**Fig. 14 Ignition Coil Pack**

**INSTALLATION**

Before installation, clean cylinder head and cover mating surfaces. Make certain the cylinder head cover mating surface is flat.

- (1) Install new valve cover gasket.

## REMOVAL AND INSTALLATION (Continued)

**CAUTION:** Do not allow oil or solvents to contact the timing belt as they can deteriorate the rubber and cause tooth skipping.

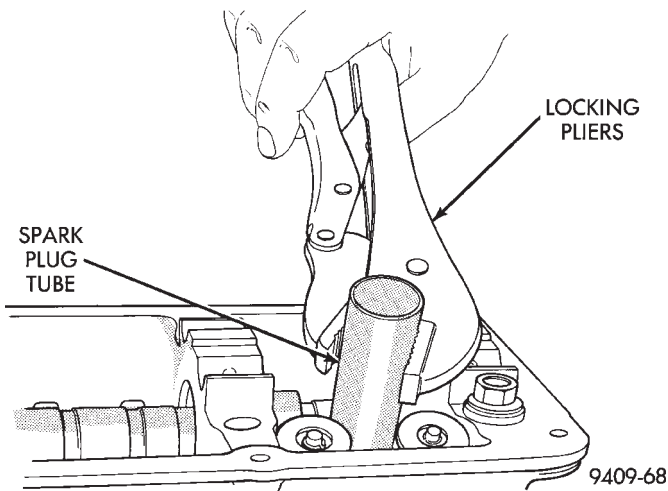
(2) Install cover assembly to head and tighten fasteners to 12 N·m (105 in. lbs.).

(3) Install ignition coil pack. Tighten fasteners to 23 N·m (200 in. lbs.).

**SPARK PLUG TUBE**

(1) Remove valve cover. Refer to procedure outlined in this section.

(2) Using locking pliers remove the tube from the cylinder head (Fig. 15). Discard old tube.



**Fig. 15 Servicing Spark Plug Tubes**

(3) Clean area around spark plug with MOPAR parts cleaner or equivalent.

(4) Apply Loctite sealer 271 or Mopar Stud and Bearing Mount or equivalent to a new tube approximately 1 mm from the end in a 3 mm wide area.

(5) Install sealer end of tube into the cylinder head. Then carefully install the tube using a hardwood block and mallet until the tube is seated into the bottom of the bore.

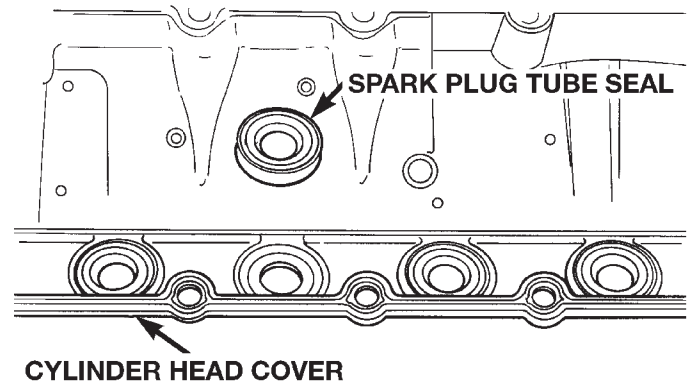
(6) Install valve cover. Refer to procedure outlined in this section.

**SPARK PLUG TUBE SEALS**

The spark plug tube seals are located in the cylinder head cover (Fig. 16). These seals are pressed into the cylinder head cover to seal the end of the spark plug tubes. If these seals show signs of hardness and/or cracking they should be replaced.

**CAMSHAFT**

**NOTE: TO REMOVE CAMSHAFT CYLINDER HEAD MUST BE REMOVED.**



80524e66

**Fig. 16 Spark Plug Tube Seals**

**REMOVAL**

(1) Refer to Timing Belt Removal for timing belt and camshaft sprocket removal and installation.

(2) Remove the cylinder head cover.

(3) Mark rocker arm shaft assemblies for installation.

(4) Remove rocker arm shaft bolts. Refer to procedure outlined in this section.

(5) Remove the timing belt and camshaft sprocket. Refer to timing belt service outlined in this section.

(6) Remove cylinder head. Refer to procedure outlined in this section.

(7) Remove camshaft sensor and remove camshaft from the rear of the head.

**NOTE: Check oil feed holes for blockage.**

**Inspect cylinder head journals for wear, Refer to Cylinder Head, Inspect and Cleaning.**

**Check camshaft bearing journals for scratches and worn areas. If light scratches are present, they may be removed with 400 grit sand paper. If deep scratches are present, replace the camshaft and check the cylinder head for damage. Replace the cylinder head if worn or damaged. Check the lobes for pitting and wear. If the lobes show signs of wear, check the corresponding rocker arm roller for wear or damage. Replace rocker arm/hydraulic lash adjuster if worn or damaged. If lobes show signs of pitting on the nose, flank or base circle; replace the camshaft.**

**CAMSHAFT END PLAY**

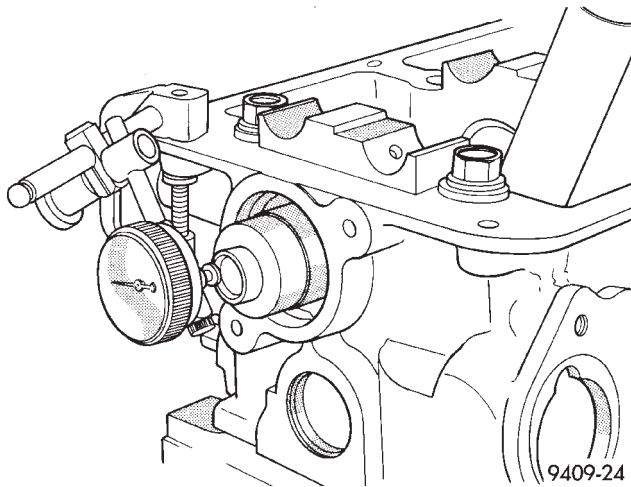
(1) Oil camshaft journals and install camshaft without rocker arm assemblies. Install cam sensor and tighten screws to specified torque.

(2) Using a suitable tool, move camshaft as far rearward as it will go.

(3) Zero dial indicator (Fig. 17).

## REMOVAL AND INSTALLATION (Continued)

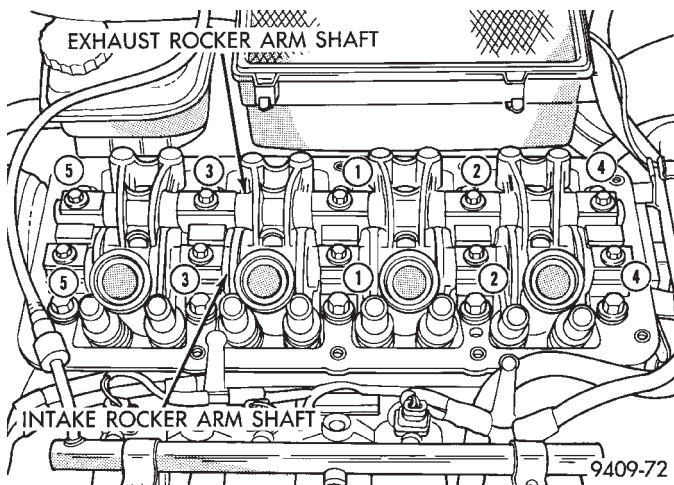
- (4) Move camshaft as far forward as it will go.
- (5) End play travel: 0.13 - 0.33 mm (0.005 - 0.013 in.).



**Fig. 17 Camshaft End Play**

## INSTALLATION

- (1) Lubricate camshaft journals. Install camshaft into the cylinder head carefully.
- (2) Install cam sensor and tighten fasteners to 9.5 N·m (85 in. lbs.).
- (3) Install camshaft seal. Camshaft must be installed before the camshaft seal is installed. Refer to procedure outlined in this section.
- (4) Install camshaft sprocket and tighten to 115 N·m (85 ft. lbs.).
- (5) Install timing belt. (Refer to procedure outlined in this section).
- (6) Install rocker arm assemblies in correct order as removed. Tighten the rocker arm assemblies in sequence shown in (Fig. 18) to 23 N·m (200 in. lbs.).

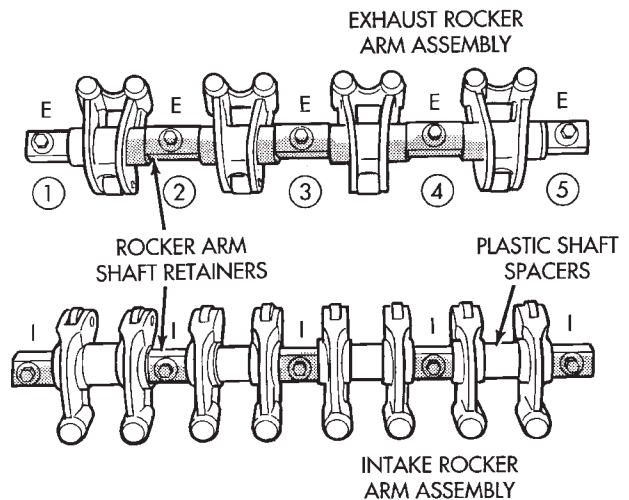


**Fig. 18 Rocker Arm Shaft Tightening Sequence**

## ROCKER ARM/HYDRAULIC LASH ADJUSTER

## REMOVAL

- (1) Remove valve cover using procedure outlined in this section.
- (2) Identify the rocker arm shaft assemblies before removal.
- (3) Loosen the attaching fasteners. Remove rocker arm shaft assemblies from cylinder head.
- (4) Identify the rocker arms spacers and retainers for reassembly. Disassemble the rocker arm assemblies by removing the attaching bolts from the shaft (Fig. 19).



9509-15

**Fig. 19 Rocker Arm Shaft Assemblies**

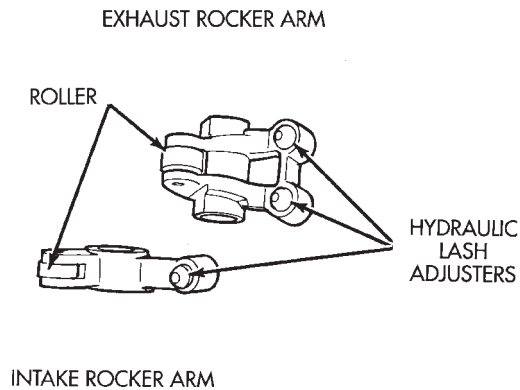
- (5) Slide the rocker arms and spacers off the shaft. Keep the spacers and rocker arms in the same location for reassembly.

**NOTE:** Inspect the rocker arm for scoring, wear on the roller or damage to the rocker arm (Fig. 20) Replace if necessary. Check the location where the rocker arms mount to the shafts for wear or damage. Replace if damaged or worn. The rocker arm shaft is hollow and is used as a lubrication oil duct. Check oil holes for clogging with small wire, clean as required. Lubricate the rocker arms and spacers. Install onto shafts in their original position (Fig. 19).

## INSTALLATION

**CAUTION:** Set crankshaft to 3 notches before TDC before installing rocker arm shafts. Refer to Timing Belt System and Camshaft Seal Service of this section for procedure.

## REMOVAL AND INSTALLATION (Continued)



9509-22

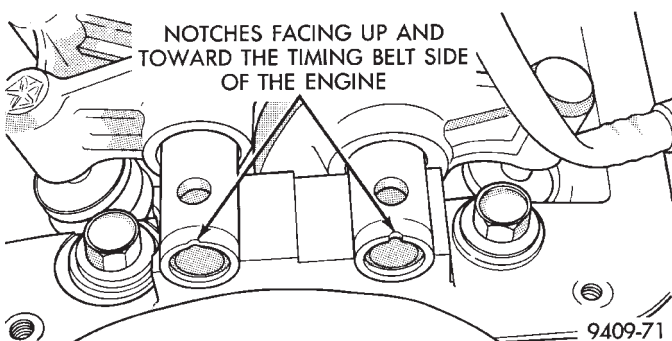
**Fig. 20 Rocker Arm Assemblies**

(1) Install rocker arm/hydraulic lash adjuster assembly making sure that adjusters are at least partially full of oil. This is indicated by little or no plunger travel when the lash adjuster is depressed. If there is excessive plunger travel. Place the rocker arm assembly into clean engine oil and pump the plunger until the lash adjuster travel is taken up. If travel is not reduced, replace the assembly. Hydraulic lash adjuster and rocker arm are serviced as an assembly.

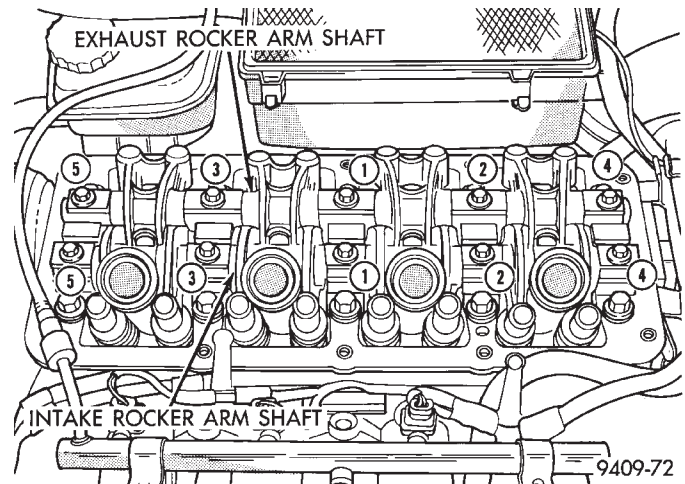
(2) Install rocker arm and shaft assemblies with NOTCH in the rocker arm shafts pointing up and toward the timing belt side of the engine (Fig. 21). Install the retainers in their original positions on the exhaust and intake shafts (Fig. 19).

**CAUTION:** When installing the intake rocker arm shaft assembly be sure that the plastic spacers do not interfere with the spark plug tubes. If the spacers do interfere rotate until they are at the proper angle. To avoid damaging the spark plug tubes, do not attempt rotating the spacers by forcing down the shaft assembly.

(3) Tighten bolts to 23 N·m (200 in. lbs.) in sequence shown in (Fig. 22).



9409-71

**Fig. 21 Rocker Arm Shaft Notches**

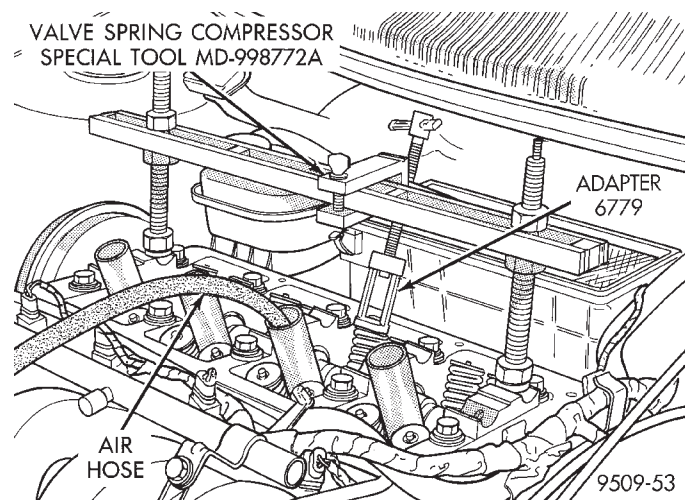
9409-72

**Fig. 22 Rocker Arm Shaft Tightening Sequence****HYDRAULIC LASH ADJUSTER NOISE**

A tappet-like noise may be produced from several items. Refer to Lash Adjuster Noise - Diagnosis in Standard Service Procedures, outlined in this Group. **Lash adjusters are replaced with the rocker arm as an assembly.**

**VALVE SEALS AND SPRINGS IN VEHICLE****REMOVAL**

- (1) Remove rocker arm shafts assemblies as previously outlined in this section.
- (2) Rotate crankshaft until piston is at TDC on compression.
- (3) With air hose attached to adapter tool installed in spark plug hole, apply 90-120 psi air pressure.
- (4) Using Special Tool MD-998772A with adapter 6779 (Fig. 23) compress valve springs and remove valve locks.



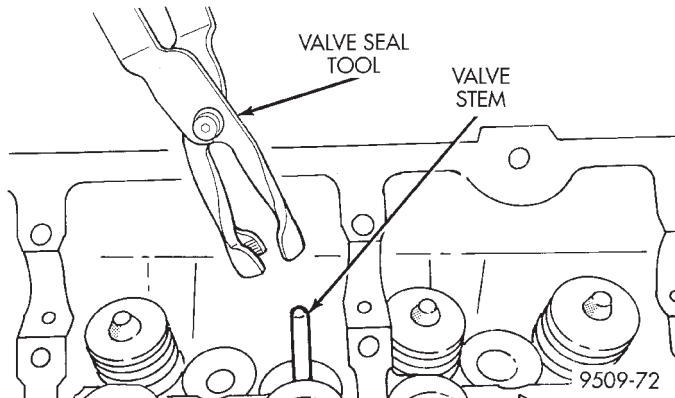
9509-53

**Fig. 23 Removing and Installing Valve Spring**

- (5) Remove valve spring.

## REMOVAL AND INSTALLATION (Continued)

(6) Remove valve stem seal by using a valve stem seal tool (Fig. 24).

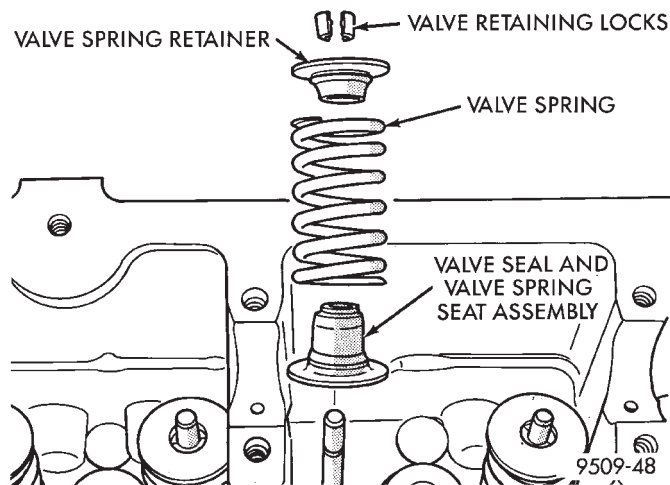


**Fig. 24 Valve Stem Oil Seal Tool**

## INSTALLATION

(1) Install valve seal/valve spring seat assembly as outlined in the Valve Installation procedure in this section.

(2) Using Special Tool MD-998772A compress valve springs only enough to install locks. Correct alignment of tool is necessary to avoid nicking valve stems (air pressure required), piston at TDC.



**Fig. 25 Valve Spring Assembly**

(3) Install rocker arm shaft assemblies as previously outlined in this section.

(4) Install valve cover as previously outlined in this section.

## CYLINDER HEAD

## REMOVAL

(1) Perform fuel system pressure release procedure **before attempting any repairs**. Refer to Group 14, Fuel System

(2) Disconnect negative battery cable. Drain cooling system. Refer to Group 7, Cooling System.

(3) Disconnect all vacuum lines, electrical wiring and fuel lines from throttle body.

(4) Remove throttle linkage.

(5) Remove accessory drive belts. Refer to Group 7, Cooling System for procedure.

(6) Remove power brake vacuum hose from intake manifold.

(7) Raise vehicle and remove exhaust pipe from manifold.

(8) Remove power steering pump assembly and set aside.

(9) Disconnect coil pack wiring connector and remove coil pack and bracket from engine.

(10) Remove cylinder head cover.

(11) Remove cam sensor and fuel injectors wiring connectors.

(12) Remove intake manifold. Removal procedure outline in Group 11.

(13) Remove timing belt and camshaft sprocket. Refer to procedure outlined in this section.

(14) Remove rocker arm shaft assemblies.

(15) Remove cylinder head bolts.

**NOTE: Inspect camshaft bearing journals for scoring. Cylinder head must be flat within 0.1 mm (0.004 inch) (Fig. 26).**

## INSTALLATION

(1) Before installing the bolts the threads should be oiled with engine oil. The 4 short bolts 110 mm (4.330 in.) are to be installed in positions 7, 8, 9, and 10 (Fig. 27).

(2) Tighten the cylinder head bolts in the sequence shown in (Fig. 27). Using the 4 step torque method, tighten according to the following values:

- First All to 34 N·m (25 ft. lbs.)
- Second All to 68 N·m (50 ft. lbs.)
- Third All to 68 N·m (50 ft. lbs.)
- Fourth Turn an additional 1/4 Turn, **Do not use a torque wrench for this step.**

For the rest of installation, reverse removal procedure.

## TIMING BELT COVER

## REMOVAL

(1) Remove accessory drive belts. Refer to Group 7, Cooling System for procedure outlined in that section.

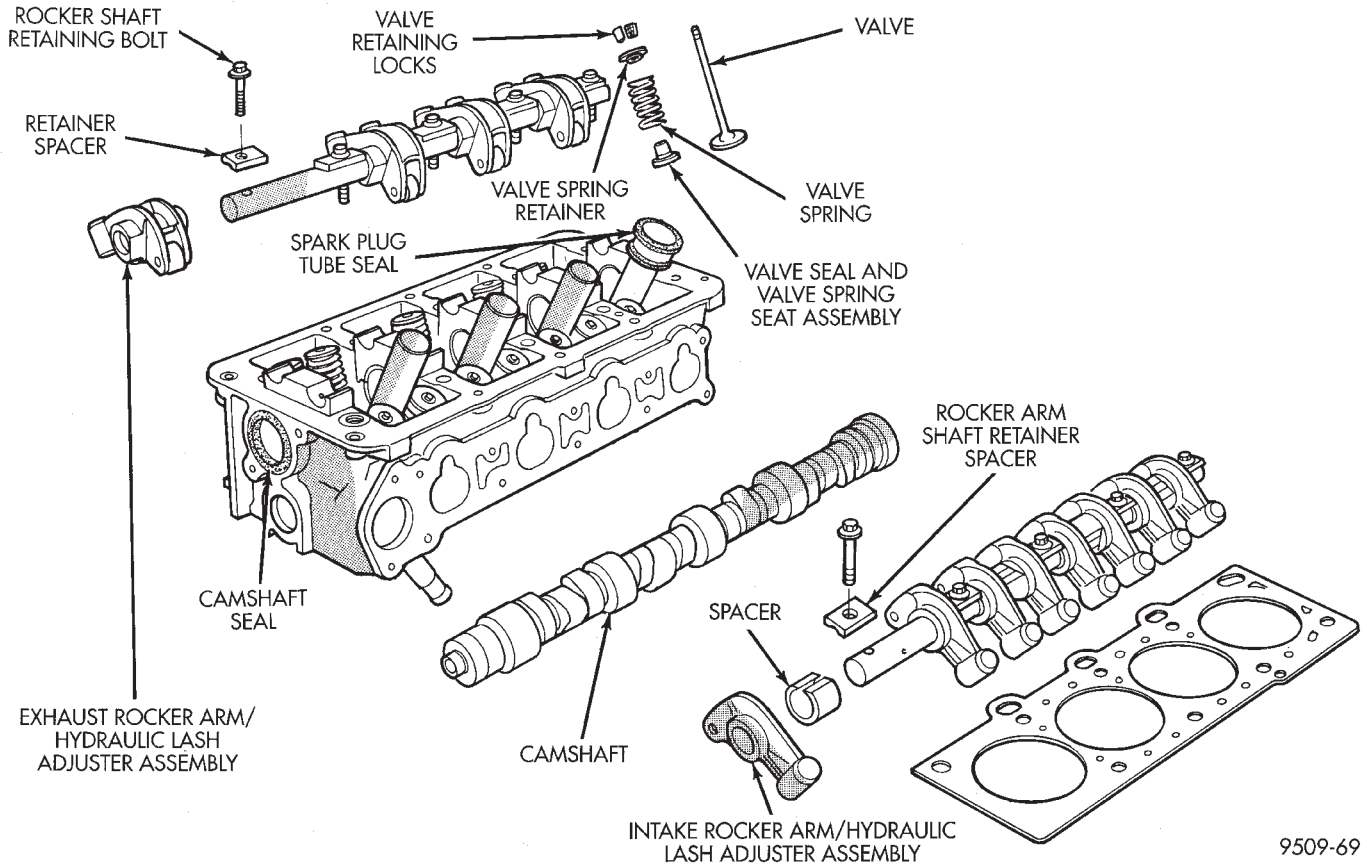
(2) Remove crankshaft vibration damper. Refer to procedure outlined in this section for removal.

(3) Remove front timing belt cover (Fig. 28).

## INSTALLATION

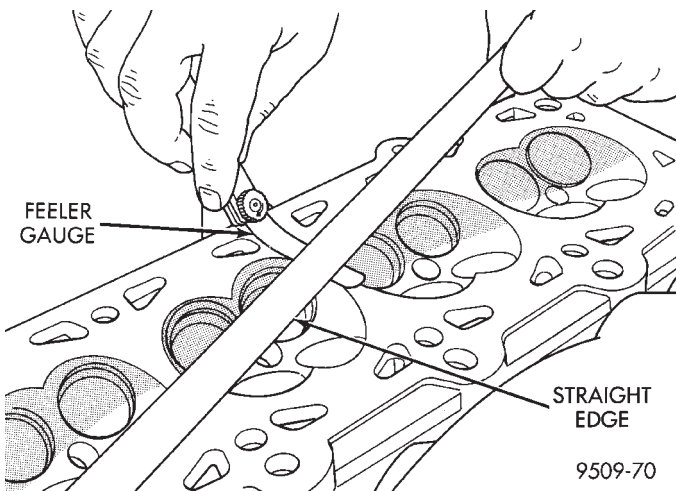
(1) Install front timing cover.

REMOVAL AND INSTALLATION (Continued)



9509-69

**Cylinder Head and Valve Assembly**

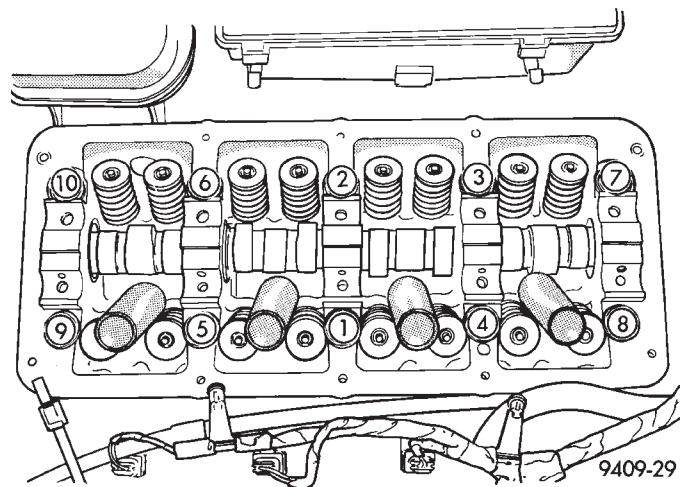


9509-70

**Fig. 26 Checking Cylinder Head Flatness**

(2) Install crankshaft vibration damper. Refer to procedure outlined in this section for installation.

(3) Install accessory drive belts. Refer to Group 7, Cooling System Accessory Drive section for procedure.



9409-29

**Fig. 27 Cylinder Head Tightening Sequence**

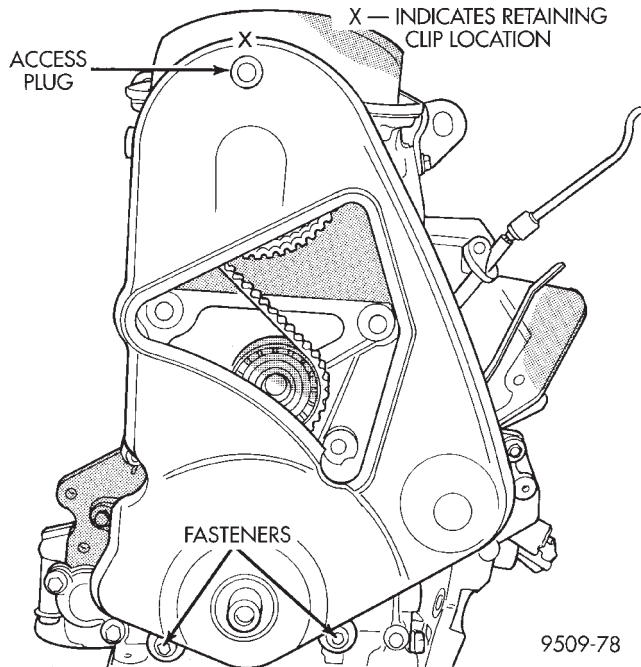
**CAMSHAFT OIL SEAL**

**REMOVAL**

**CAUTION:** Do Not Rotate the camshaft or crankshaft when timing belt is removed damage to the engine may occur.

(1) Remove timing belt cover and belt. Removal procedure is outlined in this section. Remove cam-

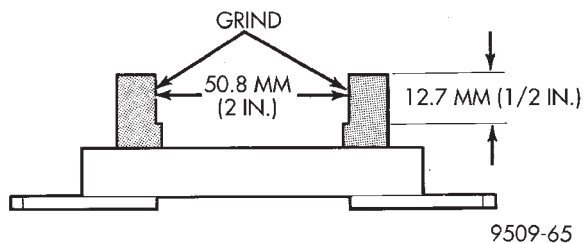
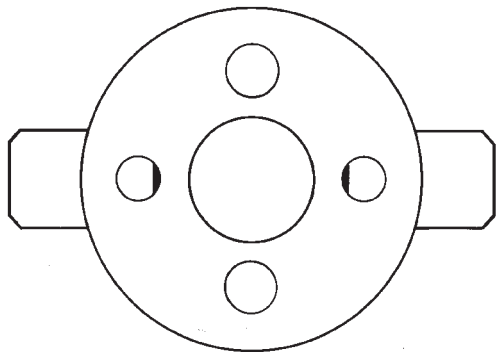
REMOVAL AND INSTALLATION (Continued)



**Fig. 28 Timing Belt Cover**

shaft sprocket bolt, with the Modified Special Tool C-4687-1 as shown in (Fig. 29).

(2) Hold camshaft sprocket with modified tool while removing bolt. Remove sprocket from camshaft.

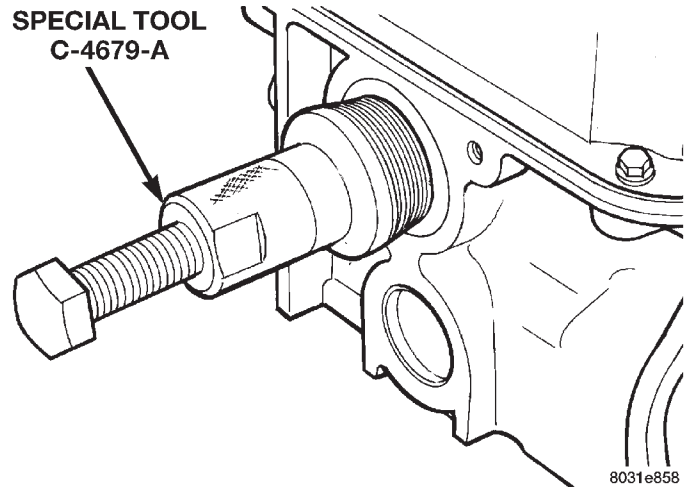


**Fig. 29 Modification to Special Tool**

(3) Remove camshaft seal using Special Tool C-4679-A (Fig. 30).

**CAUTION:** Do not nick shaft seal surface or seal bore.

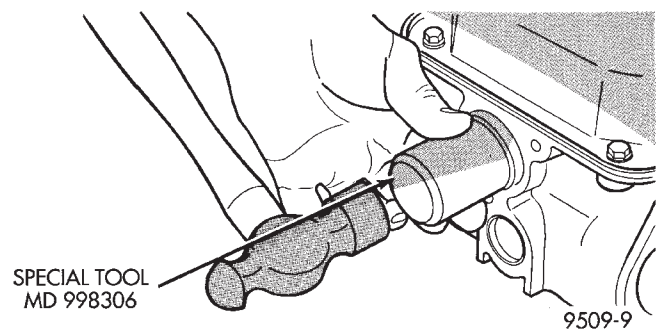
(4) Shaft seal lip surface must be free of varnish, dirt or nicks. Polish with 400 grit paper if necessary.



**Fig. 30 Removing Camshaft Oil Seal**

INSTALLATION

(1) Install camshaft seal flush with cylinder head using Special Tool MD 998306 (Fig. 31).



**Fig. 31 Installing Camshaft Seal**

(2) Install camshaft sprocket retaining bolt. Hold camshaft sprocket with Special Tool C-4687-1 (Fig. 29) and tighten bolt to 115 N·m (85 ft. lbs.).

TIMING BELT SYSTEM

CHECKING BELT TIMING—COVER INSTALLED

- Remove number one spark plug.
- Using a dial indicator, set number one cylinder to TDC on the compression stroke.
- Remove the access plug from the outer timing belt cover (Fig. 32).
- Check the timing mark on the camshaft sprocket, it should align with the arrow on the rear belt cover (Fig. 33).

REMOVAL—TIMING BELT

(1) Remove accessory drive belts. Refer to Group 7, Cooling System for procedure outlined in that section.

## REMOVAL AND INSTALLATION (Continued)

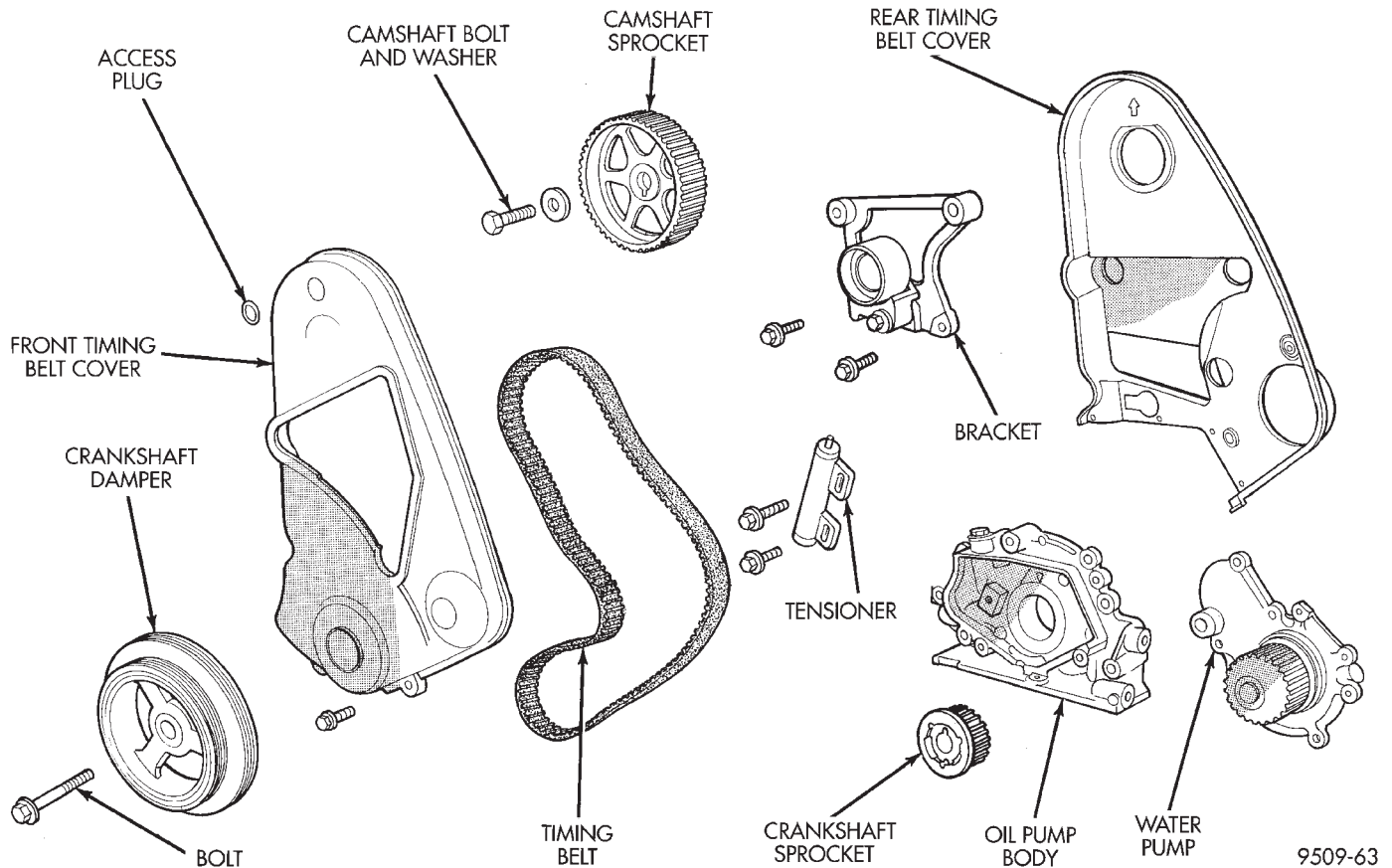


Fig. 32 Timing Belt System

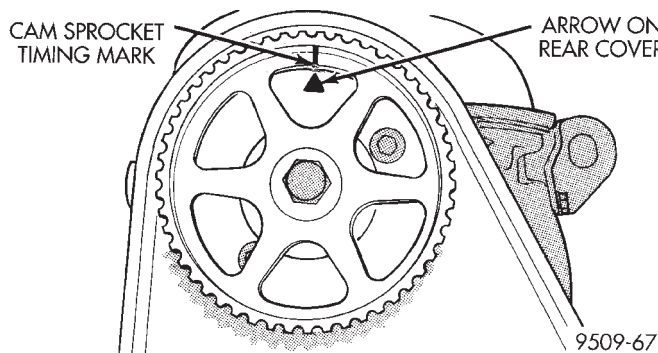


Fig. 33 Camshaft Timing Marks

(2) Remove crankshaft damper bolt. Remove damper using the large side of Special Tool 1026 and insert 6827-A (Fig. 34).

(3) Remove front timing belt cover (Fig. 35).

**CAUTION:** Align camshaft and crankshaft timing marks before removing the timing belt.

(4) Loosen timing belt tensioner fasteners (Fig. 37) and remove timing belt and tensioner.

**CAUTION:** Do not loosen, tighten, or remove the tensioner pivot bolt (Fig. 36).

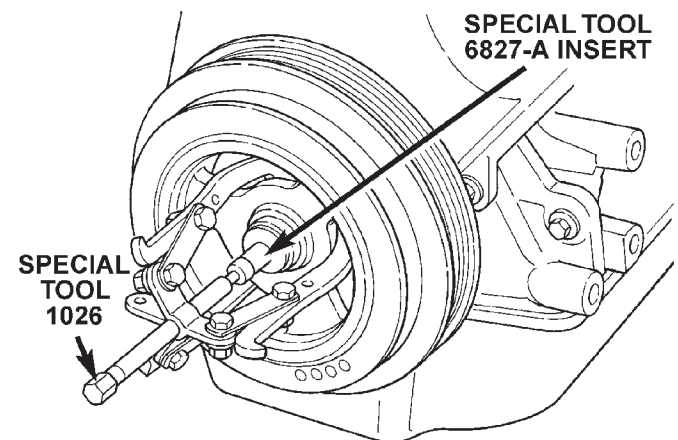


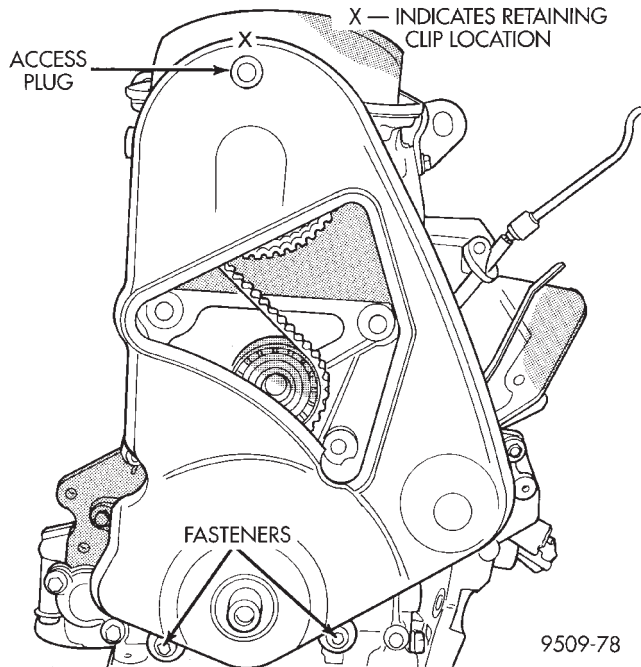
Fig. 34 Crankshaft Damper—Removal

**CAMSHAFT AND CRANKSHAFT TIMING PROCEDURE AND BELT INSTALLATION—SOHC ENGINE**

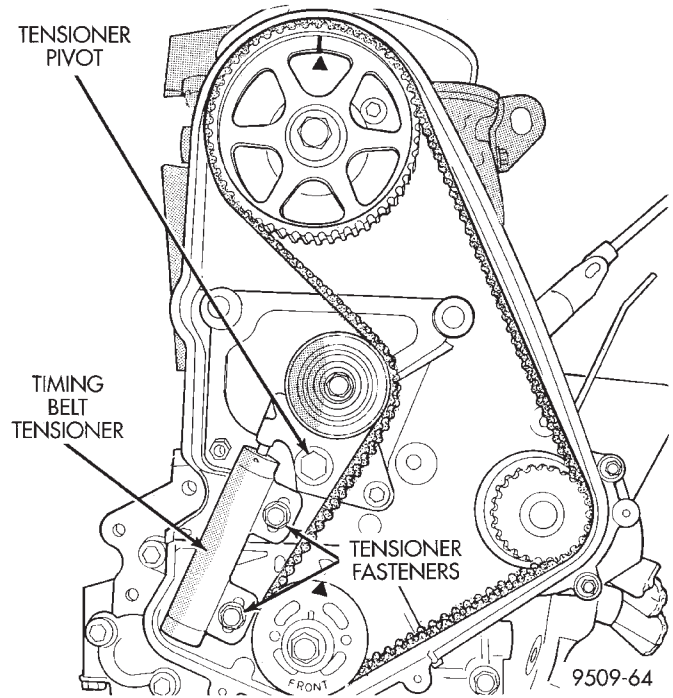
(1) When tensioner is removed from the engine it is necessary to compress the plunger into the tensioner body.

(2) Place the tensioner into a vise equipped with soft jaws and slowly compress the plunger (Fig. 38).

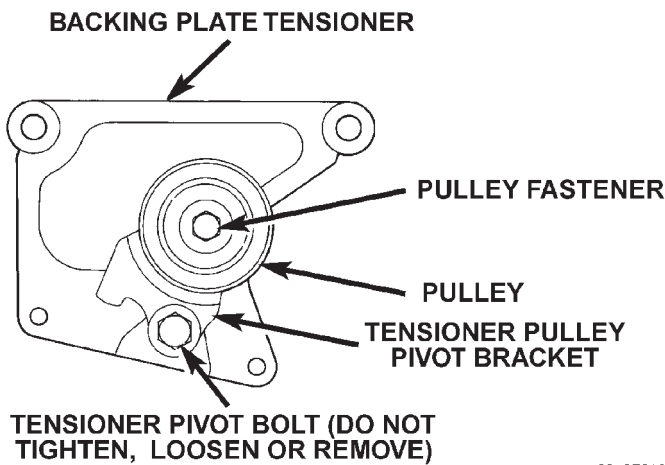
REMOVAL AND INSTALLATION (Continued)



**Fig. 35 Timing Belt Cover**



**Fig. 37 Remove Timing Belt**



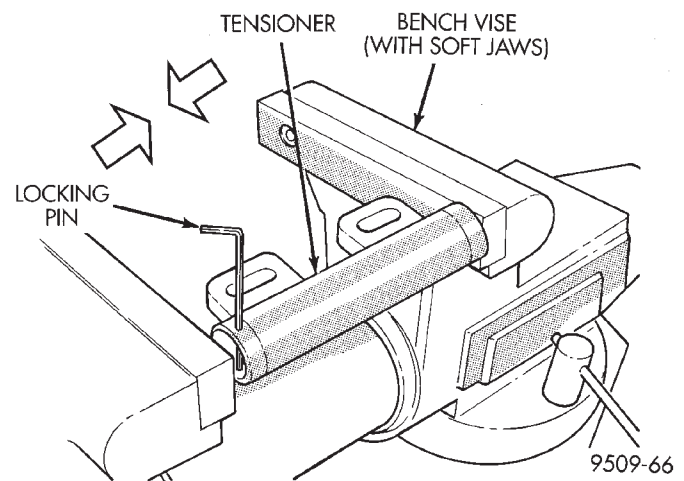
**Fig. 36 Tensioner Pulley Assembly**

**CAUTION:** Index the tensioner in the vise the same way it is installed on the engine. This is to ensure proper pin orientation when tensioner is installed on the engine.

(3) When plunger is compressed into the tensioner body install a 1.9 mm (5/64) allen wrench or pin through the body and plunger to retain plunger in place until tensioner is installed.

(4) Set crankshaft sprocket to TDC by aligning the sprocket with the arrow on the oil pump housing, then back off to 3 notches before TDC (Fig. 39).

(5) Set camshaft to TDC by aligning mark on sprocket with the arrow on the rear of timing belt cover (Fig. 40).



**Fig. 38 Compressing Timing Belt Tensioner**

(6) Move crankshaft to 1/2 mark before TDC (Fig. 41) for belt installation.

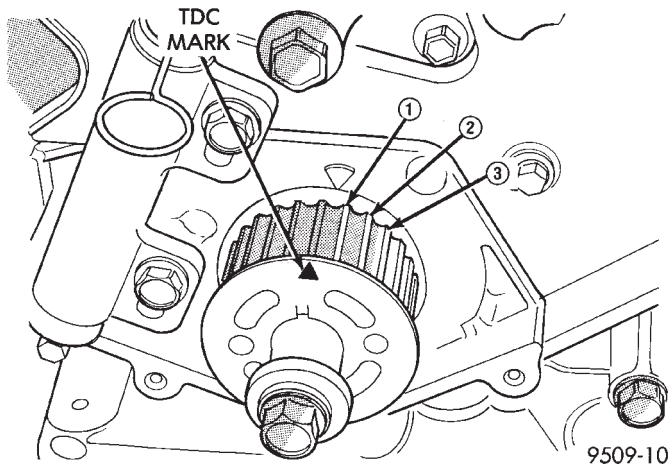
(7) Install timing belt. Starting at the crankshaft, go around the water pump sprocket and then around the camshaft sprocket.

(8) Move crankshaft sprocket to TDC to take up belt slack. Install tensioner to block but do not tighten fasteners.

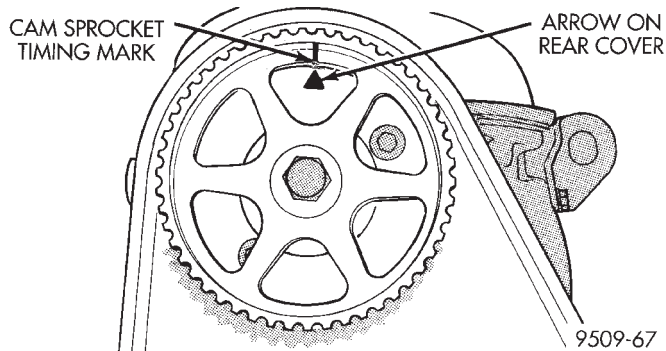
(9) Using a torque wrench on the tensioner pulley apply 28 N·m (250 in. lbs.) of torque (Fig. 42).

(10) With torque being applied to the tensioner pulley move the tensioner up against the tensioner pulley bracket and tighten fasteners to 31 N·m (275 in. lbs.) (Fig. 42).

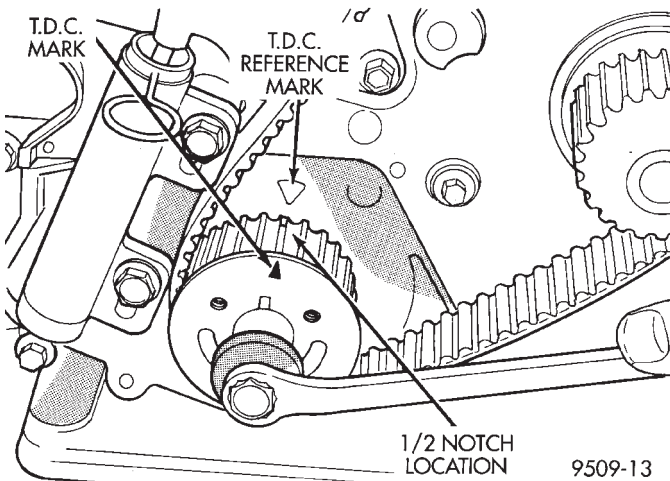
## REMOVAL AND INSTALLATION (Continued)



**Fig. 39 Crankshaft Sprocket Timing**



**Fig. 40 Camshaft Timing Mark**



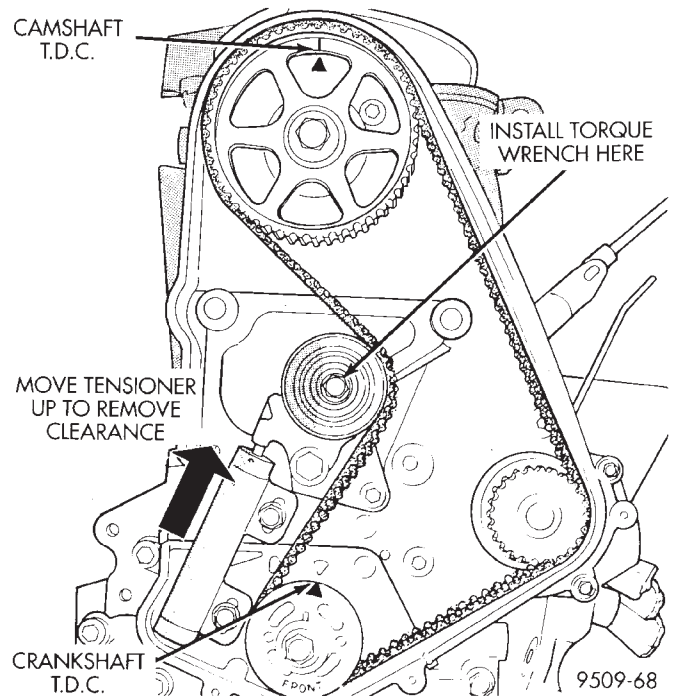
**Fig. 41 Adjusting Crankshaft Sprocket for Timing Belt Installation**

(11) Pull tensioner plunger pin. Pretension is correct when pin can be removed and installed.

(12) Rotate crankshaft 2 revolutions and check the alignment of the timing marks (Fig. 42).

(13) Install front half of timing cover.

(14) Install crankshaft damper using M12-1.75 x 150 mm bolt, washer, thrust bearing and nut from

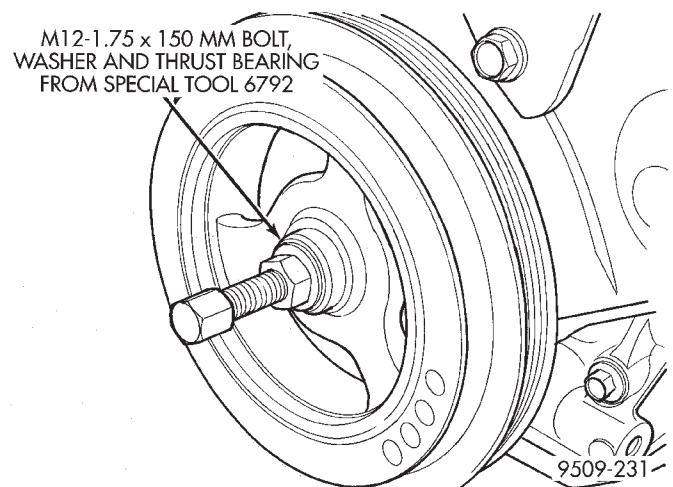


**Fig. 42 Adjusting Timing Belt Tension**

Special Tool 6792. Install crankshaft damper bolt and tighten to 142 N-m (105 ft. lbs.) (Fig. 43).

(15) Install accessory drive belts. Refer to Group 7, Cooling System Accessory Drive section for procedure.

(16) Perform camshaft and crankshaft timing relearn. Refer to Group 25, Emission Control Systems for procedure.



**Fig. 43 Crankshaft Damper—Installation**

## OIL PAN

## REMOVAL

(1) Drain engine oil.

(2) Remove transmission inspection cover.

## REMOVAL AND INSTALLATION (Continued)

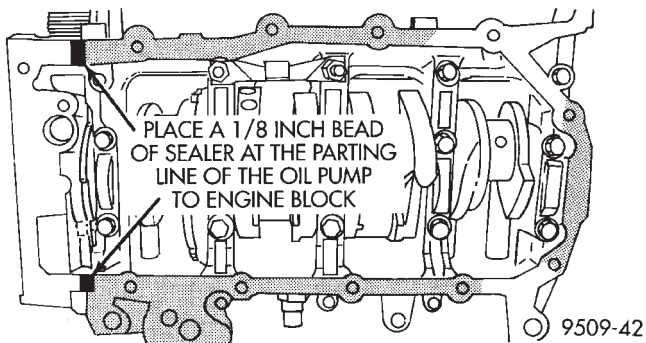
(3) If equipped with air conditioning remove oil filter and adaptor. Refer to Oil Filter Adapter Removal and Installation in this section.

(4) Remove oil pan.

(5) Clean oil pan and all gasket surfaces.

## INSTALLATION

(1) Apply Mopar Silicone Rubber Adhesive Sealant or equivalent at the oil pump to engine block parting line (Fig. 44).



**Fig. 44 Oil Pan Sealing**

(2) Install a new oil pan gasket to pan.

(3) Install pan and tighten screws to 12 N-m (105 in. lbs.).

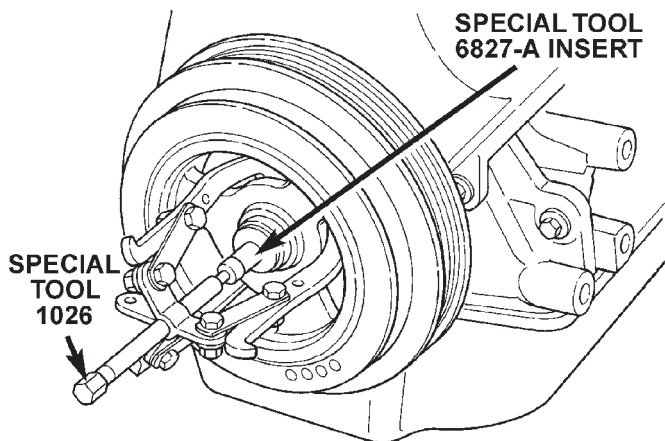
(4) Install oil filter and adaptor.

(5) Install proper amount of oil. With oil filter 4.25 Liters (4.5 Qts.). Without oil filter 3.8 Liters (4.0 Qts.)

## FRONT CRANKSHAFT OIL SEAL

## REMOVAL

(1) Using Special Tool 1026 and Insert 6827-A, remove crankshaft damper (Fig. 45).

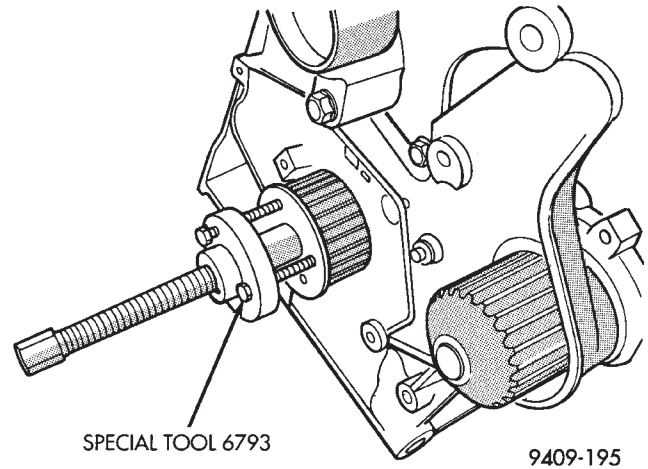


**Fig. 45 Crankshaft Damper—Removal**

(2) Remove outer timing belt cover and timing belt. Refer to Timing Belt System outlined in this section.

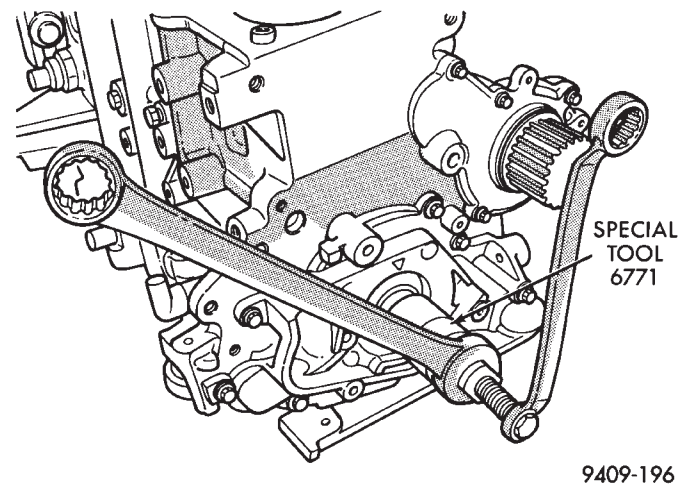
(3) Remove crankshaft sprocket using Special Tool 6793 and insert C- 4685-C2 (Fig. 46).

**CAUTION:** Do not nick shaft seal surface or seal bore.



**Fig. 46 Crankshaft Sprocket—Removal**

(4) Using Tool 6771 to remove front crankshaft oil seal (Fig. 47). Do not damage the seal contact area on the crankshaft.



**Fig. 47 Front Crankshaft Oil Seal—Removal**

## INSTALLATION

(1) Install new seal by using Tool 6780-1 (Fig. 48).

(2) Place seal into opening with seal spring towards the inside of engine. Install seal until flush with cover.

(3) Install crankshaft sprocket (Fig. 49). Using Special Tool 6792.

**NOTE:** Make sure the word "front" on the sprocket is facing you.

(4) Install timing belt and covers. Refer to Timing Belt System in this section for installation.

## REMOVAL AND INSTALLATION (Continued)

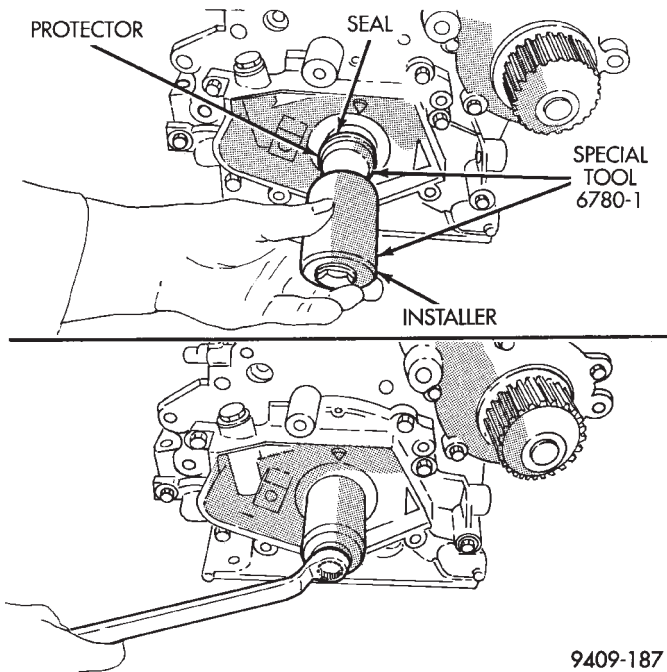


Fig. 48 Front Crankshaft Oil Seal—Installation

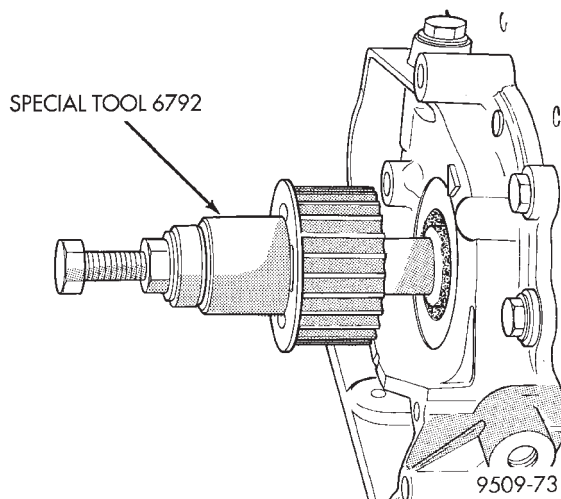


Fig. 49 Crankshaft Sprocket—Installation

(5) Install crankshaft damper (Fig. 50). Use thrust bearing/washer and 12M-1.75 x 150 mm bolt from Special Tool 6792. Install crankshaft damper bolt and tighten to 142 N·m (105 ft. lbs.)

## REAR CRANKSHAFT SEAL

### REMOVAL

(1) Insert a 3/16 flat bladed screwdriver between the dust lip and the metal case of the crankshaft seal. Angle the screwdriver (Fig. 51) through the dust lip against metal case of the seal. Pry out seal.

**CAUTION:** Do not permit the screwdriver blade to contact crankshaft seal surface. Contact of the

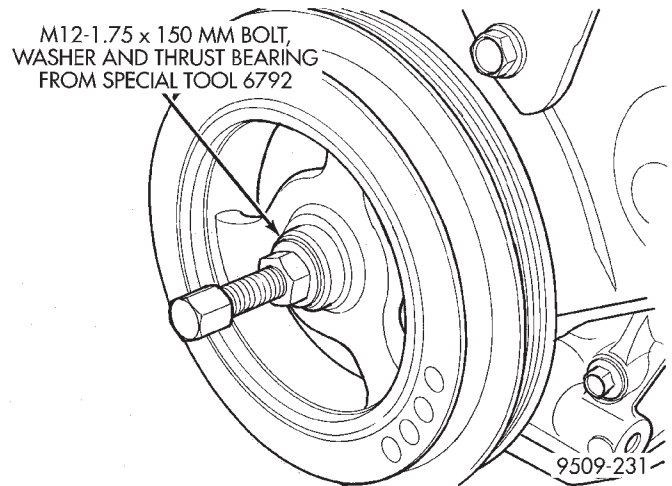


Fig. 50 Crankshaft Damper—Installation  
screwdriver blade against crankshaft edge (chamfer) is permitted.

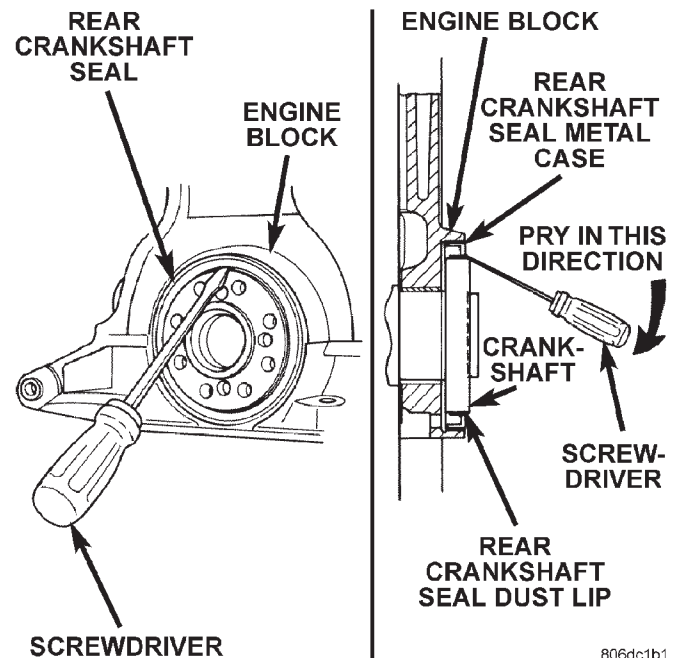


Fig. 51 Rear Crankshaft Oil Seal—Removal  
INSTALLATION

**CAUTION:** If burr or scratch is present on the crankshaft edge (chamfer), cleanup with 400 grit sand paper to prevent seal damage during installation of new seal.

**NOTE:** When installing seal, no lube on seal is needed.

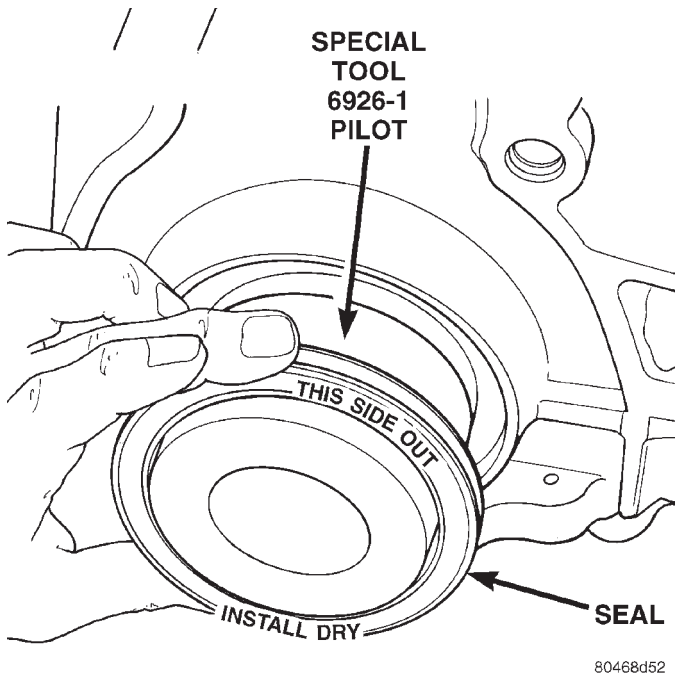
(1) Place Special Tool 6926-1 on crankshaft. This is a pilot tool with a magnetic base (Fig. 52).

## REMOVAL AND INSTALLATION (Continued)

(2) Position seal over pilot tool. Make sure you can read the words **THIS SIDE OUT** on seal (Fig. 52). Pilot tool should remain on crankshaft during installation of seal. Ensure that the lip of the seal is facing towards the crankcase during installation.

**CAUTION:** If the seal is driven into the block past flush, this may cause an oil leak.

(3) Drive the seal into the block using Special Tool 6926-2 and handle C-4171 (Fig. 53) until the tool bottoms out against the block (Fig. 54).



**Fig. 52 Rear Crankshaft Seal and Special Tool 6926-1**

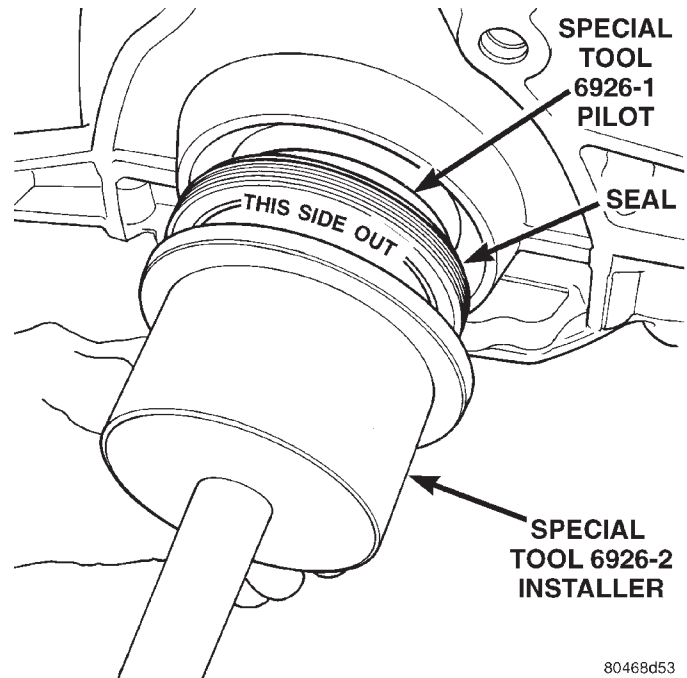
## CRANKSHAFT

## REMOVAL

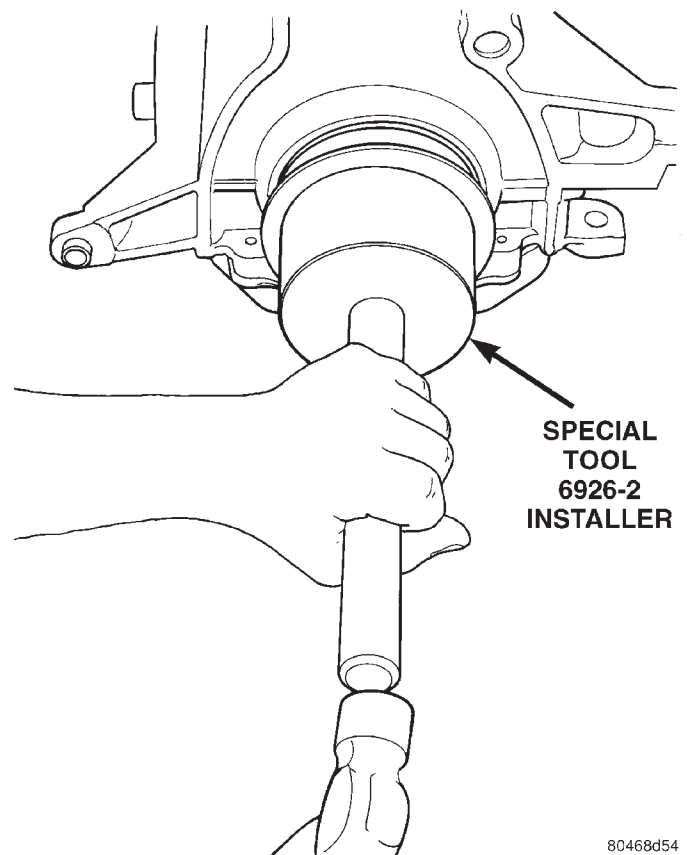
- (1) Remove oil filter and adapter from bedplate.
- (2) Remove oil pan.
- (3) Remove crankshaft sprocket and oil pump both procedures outlined in this section.
- (4) Remove all main bearing cap and bedplate bolts from the engine block (Fig. 55).
- (5) Using a mallet tap the bedplate loose from the engine block dowel pins.

**CAUTION:** Do not pry up on one side of the bedplate. Damage may occur to cylinder block and bedplate alignment.

- (6) Bedplate should be removed evenly from the cylinder block dowel pins.



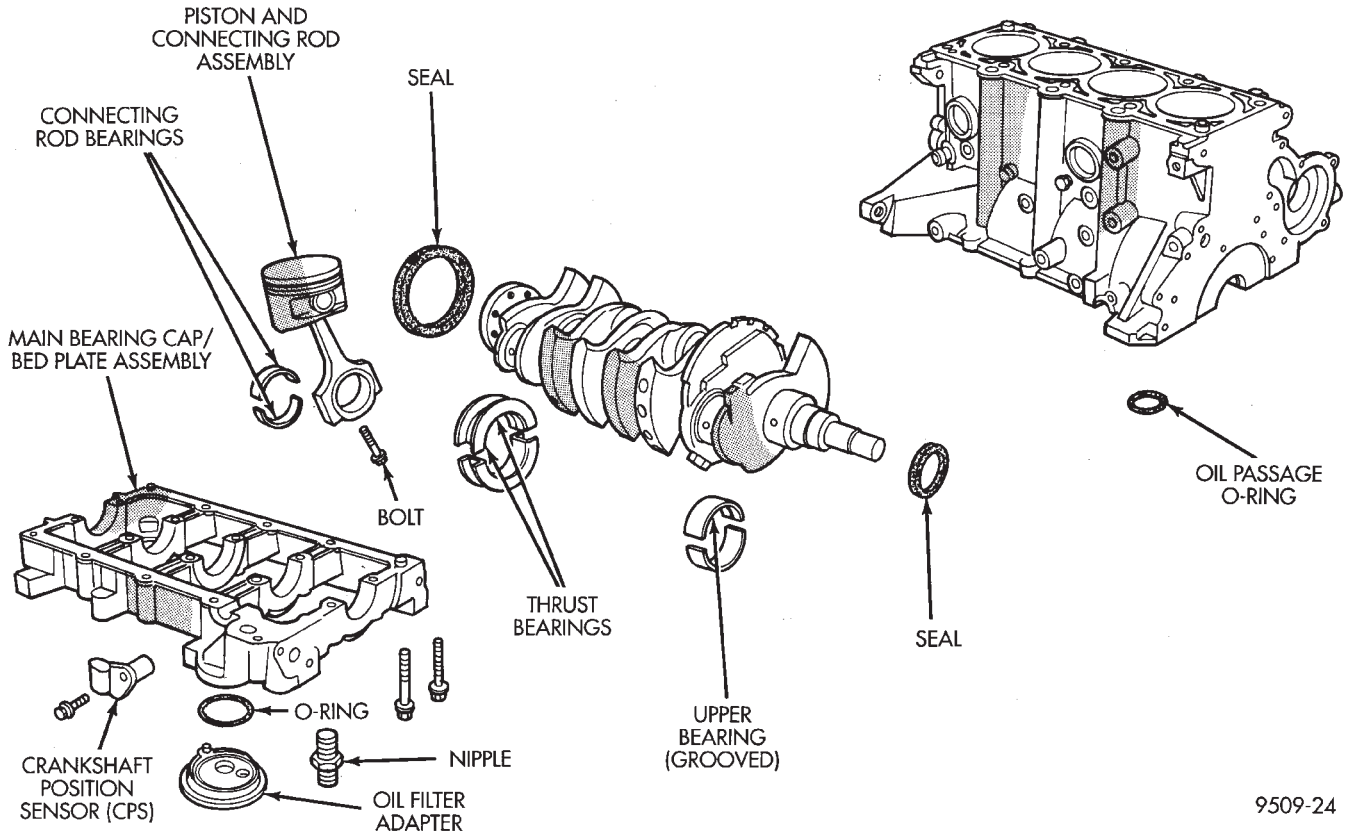
**Fig. 53 Crankshaft Seal Special Tool 6926-2**



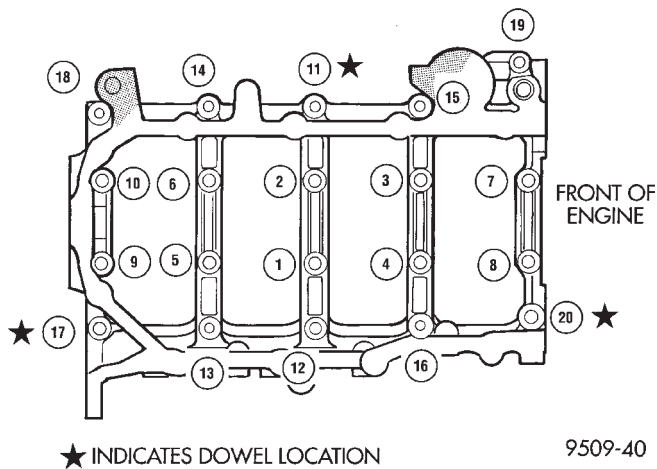
**Fig. 54 Rear Crankshaft Seal—Installation**

- (7) Lift out crankshaft from cylinder block. Be sure not to damage the main bearings or journals when removing the crankshaft.

REMOVAL AND INSTALLATION (Continued)



9509-24



★ INDICATES DOWEL LOCATION

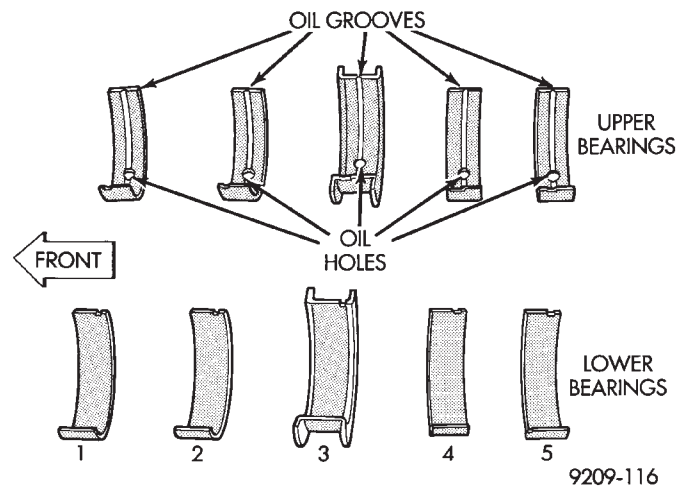
9509-40

**Fig. 55 Bedplate Bolts**

**CRANKSHAFT MAIN BEARINGS LOCATION**

The crankshaft is supported in five main bearings. All upper bearing shells in the crankcase have oil grooves. All lower bearing shells installed in the (bed-plate) main bearing cap are plain. Crankshaft end play is controlled by a flanged bearing on the number three main bearing journal (Fig. 56).

**NOTE:** The upper and lower main Bearing shells are Not interchangeable. The lower shells have a revised tab to prevent improper installation.



9209-116

**Fig. 56 Main Bearing Identification**

**CRANKSHAFT MAIN JOURNALS INSPECTION**

The crankshaft journals should be checked for excessive wear, taper and scoring. Limits of taper or out-of-round on any crankshaft journals should be held to .025 mm (.001 inch). Journal grinding should not exceed .305 mm (.012 inch) under the standard journal diameter. DO NOT grind thrust faces of Number 3 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all passages.

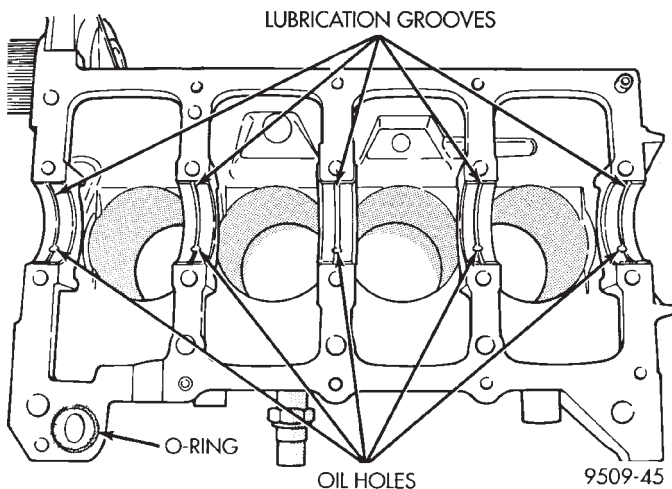
## REMOVAL AND INSTALLATION (Continued)

**CAUTION:** With the nodular cast iron crankshafts used it is important that the final paper or cloth polish after any journal regrind be in the same direction as normal rotation in the engine.

Upper and lower Number 3 bearing halves are flanged to carry the crankshaft thrust loads and are NOT interchangeable with any other bearing halves in the engine (Fig. 56). All bearing cap bolts removed during service procedures are to be cleaned and oiled before installation. Bearing shells are available in standard and the following undersized: 0.016 mm (.0006 inch), .032 mm (.0012 inch), .250 mm (.010 inch). Never install an undersize bearing that will reduce clearance below specifications.

## INSTALLATION

(1) Install the main bearing shells with the lubrication groove in the cylinder block. Install O-ring into recess in the block (Fig. 57).



**Fig. 57 Installing Main Bearing Upper Shell**

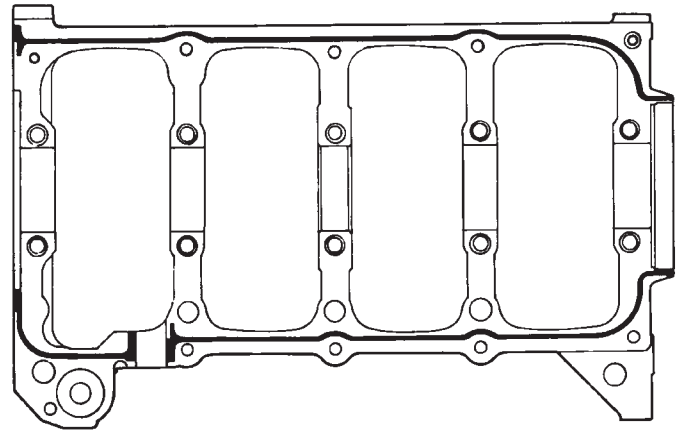
(2) Make certain oil holes in block line up with oil hole in bearings and bearing tabs seat in the block tab slots.

**CAUTION:** Do Not get oil on the bedplate mating surface. It will affect the sealer ability to seal the bedplate to cylinder block.

(3) Oil the bearings and journals and install crankshaft and O-ring in cylinder block.

**CAUTION:** Use only the specified anaerobic sealer on the bedplate or damage may occur to the engine.

(4) Apply 1.5 to 2.0 mm (0.059 to 0.078 in.) bead of Mopar Torque Cure Gasket Maker to cylinder block as shown in (Fig. 58).



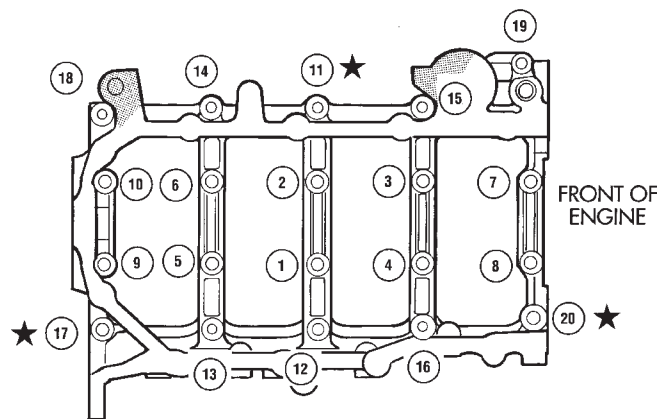
9509-52

**Fig. 58 Main Bearing Caps/Bedplate Sealing**

(5) Install lower main bearings into main bearing cap/bedplate. Make certain the bearing tabs are seated into the bedplate slots. Install the main bearing/bedplate into engine block.

(6) Before installing the bolts the threads should be oiled with clean engine oil, wipe off any excess oil.

(7) Install main bearing bedplate to engine block bolts 11, 17 and 20 finger tight. Tighten these bolts down together until the bedplate contacts the cylinder block. Torque bolts to 30 N·m (22 ft. lbs.) (Fig. 59).



★ INDICATES DOWEL LOCATION

9509-40

**Fig. 59 Main Bearing Caps/Bedplate Torque Sequence**

(8) Install main bearing bedplate to engine block bolts (1 thru 10) and torque each bolt to 81 N·m (60 ft. lbs.) in sequence shown in (Fig. 59).

(9) Install main bearing bedplate to engine block bolts (11 thru 20), with baffle studs in positions 12, 13 and 16 and torque each bolt to 30 N·m (22 ft. lbs.) in sequence shown in (Fig. 59).

(10) After the main bearing bedplate is installed, check the crankshaft turning torque. The turning torque should not exceed 5.6 N·m (50 in. lbs.).

## REMOVAL AND INSTALLATION (Continued)

(11) Install oil pump. If crankshaft end play is to be checked refer to service procedures in this section.

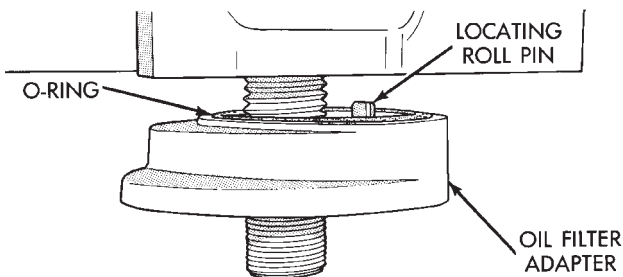
(12) Install crankshaft sprocket.

(13) Install oil filter adapter and filter. Refer to procedure outlined in this section.

## OIL FILTER ADAPTER

## REMOVE AND INSTALL

Ensure O-ring is in the groove on adapter. Align roll pin into engine block and tighten assembly to 80 N·m (60 ft. lbs.) (Fig. 60).



9409-59

**Fig. 60 Engine Oil Filter Adapter to Engine Block**

## OIL FILTER

## REMOVE AND INSTALL

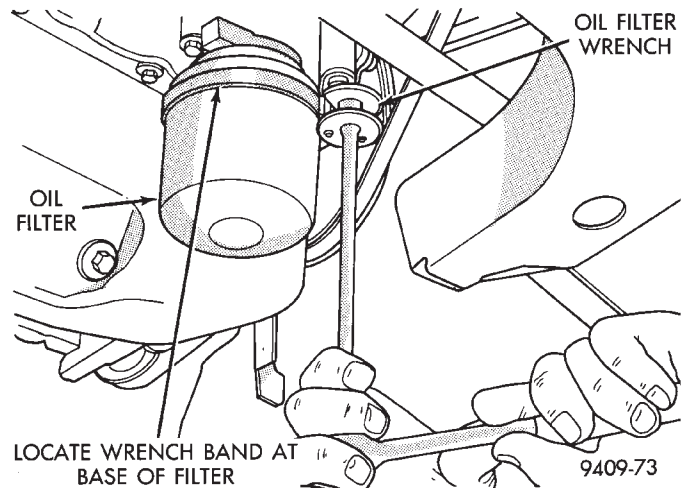
**CAUTION:** When servicing the oil filter (Fig. 61) avoid deforming the filter, install tool band strap against the seam at the base of the filter. The seam, joining the can to the base is reinforced by the base plate.

- (1) Turn counterclockwise to remove.
- (2) To install, lubricate new filter gasket. Check filter mounting surface. The surface must be smooth, flat and free of debris or old pieces of rubber. Screw filter on until gasket contacts base. Tighten to 21 N·m (15 ft. lbs.).

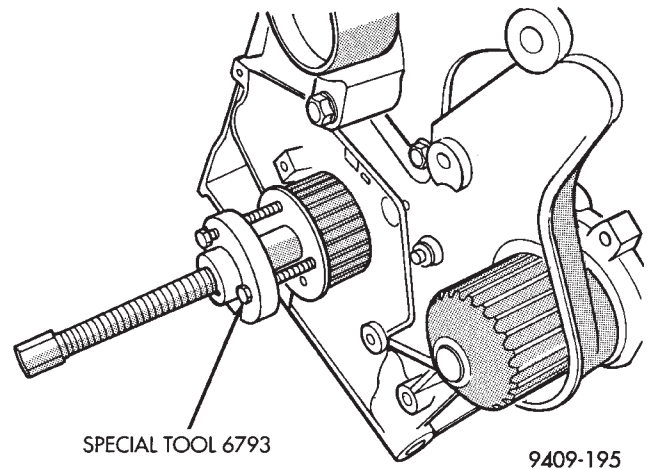
## OIL PUMP

## REMOVAL

- (1) Disconnect negative battery cable.
- (2) Remove Timing Belt. Refer to Timing Belt System, in this section.
- (3) Remove Oil Pan. Refer to Oil Pan Removal in this section.
- (4) Remove Crankshaft Sprocket using Special Tool 6793 and insert C4685-C2 (Fig. 62).
- (5) Remove oil pick-up tube.
- (6) Remove oil pump, (Fig. 63) and front crankshaft seal.



**Fig. 61 Engine Oil Filter**



**Fig. 62 Crankshaft Sprocket—Removal**

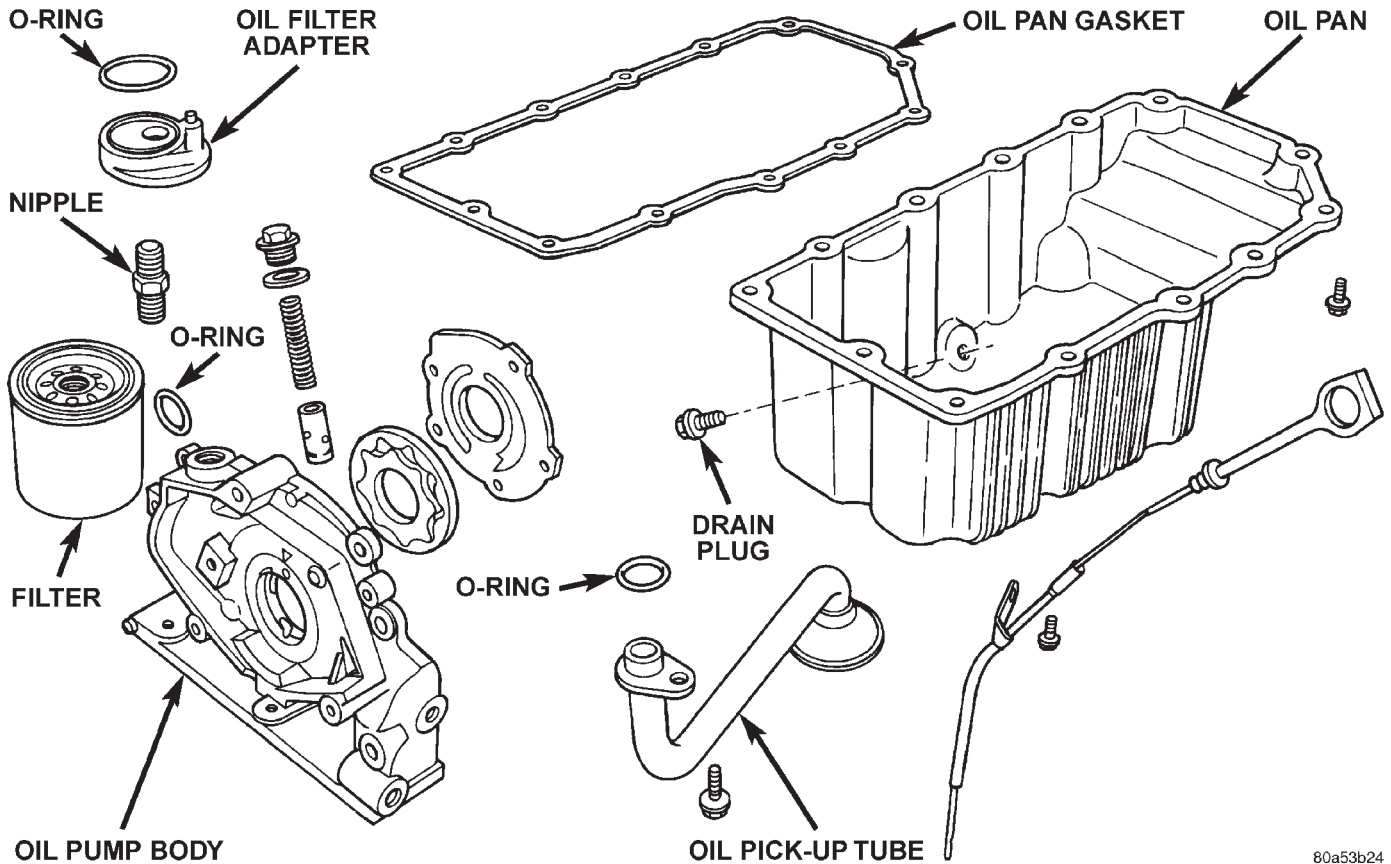
## INSTALLATION

- (1) Make sure all surfaces are clean and free of oil and dirt.
- (2) Apply Mopar Gasket Maker to oil pump as shown in (Fig. 64). Install oil ring into oil pump body discharge passage.
- (3) Prime oil pump before installation.
- (4) Align oil pump rotor flats with flats on crankshaft as you install the oil pump to the block.

**NOTE:** Front crankshaft seal **MUST** be out of pump to align, or damage may result.

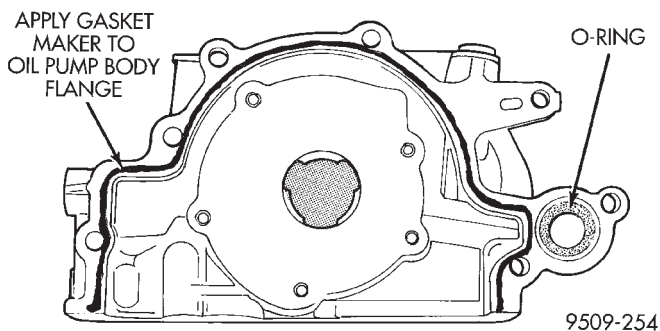
- (5) Torque all oil pump attaching bolts to 28 N·m (250 in. lbs.).
- (6) Install new front crankshaft seal using Special Tool 6780 (Fig. 65).
- (7) Install crankshaft sprocket, using Special Tool 6792 (Fig. 66).
- (8) Install oil pump pick-up tube and oil pan.
- (9) Install Timing Belt. Refer to Timing Belt Installation in this section.

REMOVAL AND INSTALLATION (Continued)



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**Fig. 63 Oil Pump and Tube**



**Fig. 64 Oil Pump Sealing**

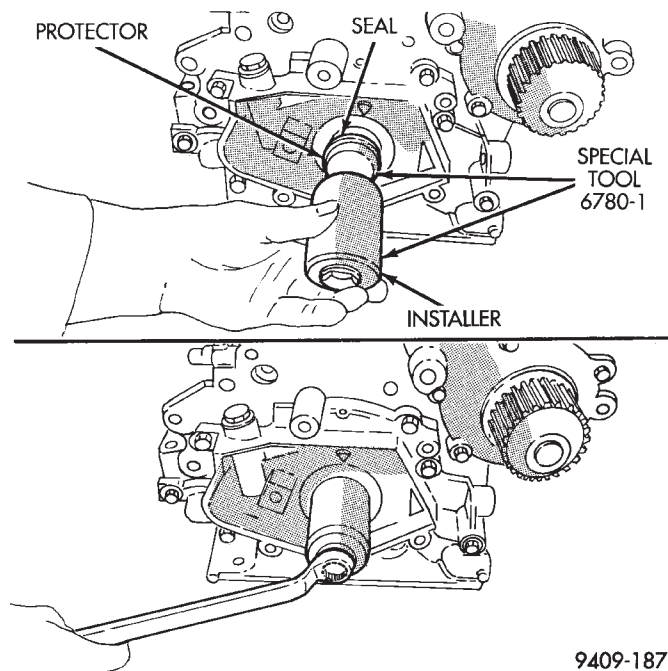
**PISTON AND CONNECTING ROD**

**REMOVAL**

(1) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. **Be sure to keep tops of pistons covered during this operation**. Mark piston with matching cylinder number (Fig. 67).

(2) Remove oil pan. Scribe the cylinder number on the side of the rod and cap (Fig. 68) for identification.

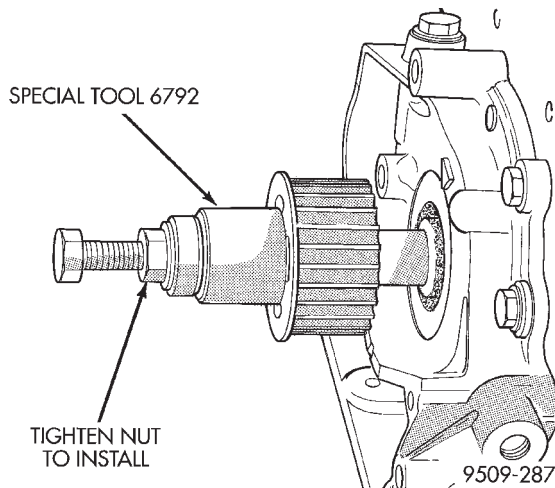
(3) Pistons will have a stamping in the approximate location shown in (Fig. 67). These stamps will be either a directional arrow or a weight identification for the assembly. L is for light and H is for



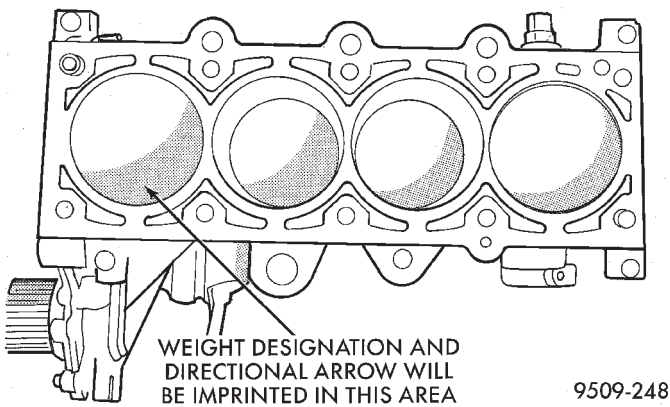
**Fig. 65 Front Crankshaft Seal—Installation**

heavy. These assemblies should all be the same weight class. Service piston assemblies are marked with a S and can be used with either L or H produc-

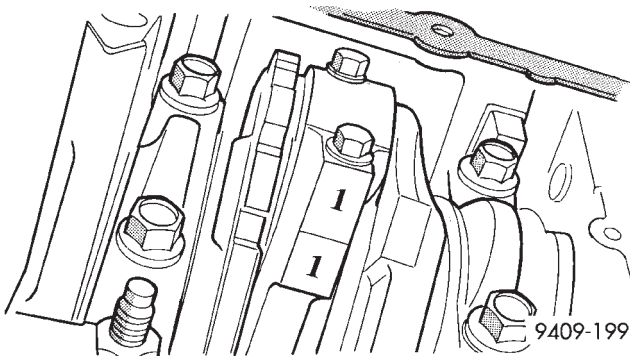
## REMOVAL AND INSTALLATION (Continued)



**Fig. 66 Crankshaft Sprocket—Installation**



**Fig. 67 Piston Markings**



**Fig. 68 Identify Connecting Rod to Cylinder**

tion assemblies. The weight designation stamps should face toward the timing belt side of the engine.

(4) Pistons and connecting rods must be removed from top of cylinder block. Rotate crankshaft so that each connecting rod is centered in cylinder bore.

(5) Remove connecting rod cap bolts **Do not use old bolts if reinstalling connecting rod.** Push each piston and rod assembly out of cylinder bore.

**NOTE:** Be careful not to nick crankshaft journals.

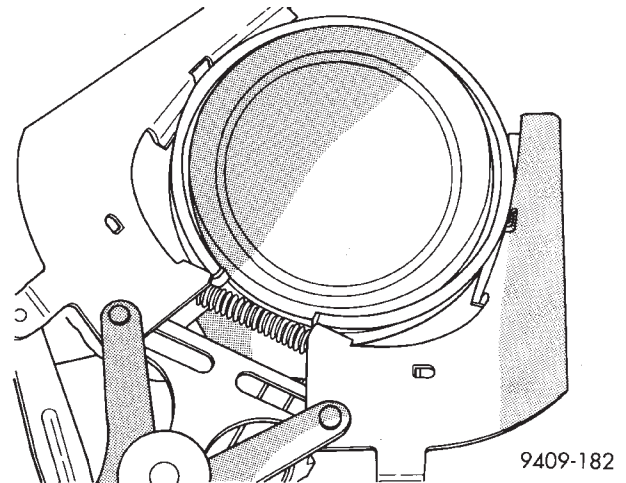
(6) After removal, install bearing cap on the mating rod.

(7) Piston and Rods are serviced as an assembly.

#### PISTON RING—REMOVAL

(1) ID mark on face of upper and intermediate piston rings must point toward piston crown.

(2) Using a suitable ring expander, remove upper and intermediate piston rings (Fig. 69).



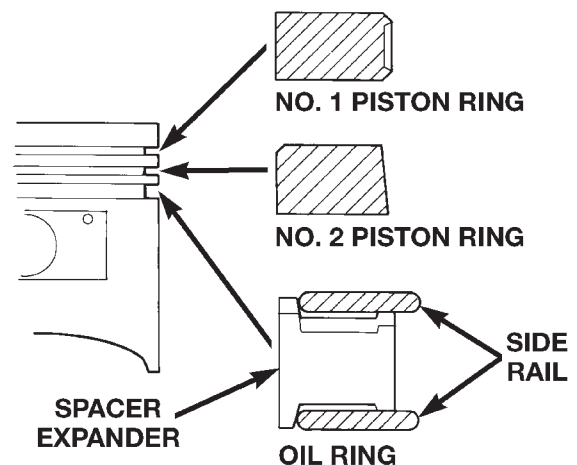
**Fig. 69 Piston Rings—Removing and Installing**

(3) Remove the upper oil ring side rail, lower oil ring side rail and then oil ring expander from piston.

(4) Clean ring grooves of any carbon deposits.

#### PISTON RINGS—INSTALLATION

(1) Install rings with manufacturers I.D. mark facing up, to the top of the piston (Fig. 70).



**Fig. 70 Piston Ring Installation**

**CAUTION:** Install piston rings in the following order:

- a. Oil ring expander.
- b. Upper oil ring side rail.

## REMOVAL AND INSTALLATION (Continued)

- c. Lower oil ring side rail.
- d. No. 2 Intermediate piston ring.
- e. No. 1 Upper piston ring.
- f. Install the side rail by placing one end between the piston ring groove and the expander. Hold end firmly and press down the portion to be installed until side rail is in position. **Do not use a piston ring expander (Fig. 71).**

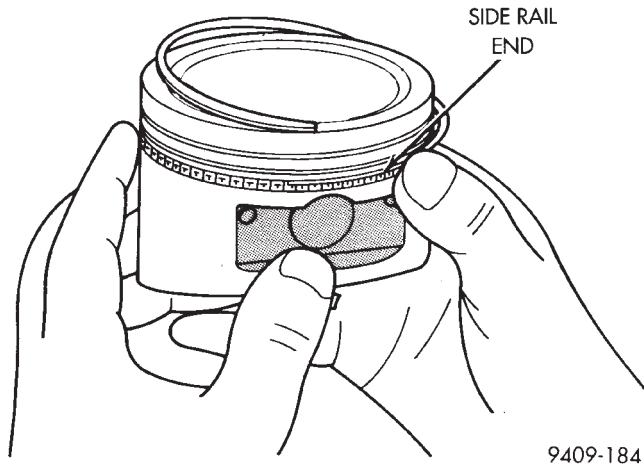


Fig. 71 Installing Side Rail

- (2) Install upper side rail first and then the lower side rail.
- (3) Install No. 2 piston ring and then No. 1 piston ring (Fig. 70).
- (4) Position piston ring end gaps as shown in (Fig. 72).
- (5) Position oil ring expander gap at least 45° from the side rail gaps but **not** on the piston pin center or on the thrust direction. Staggering ring gap is important for oil control.

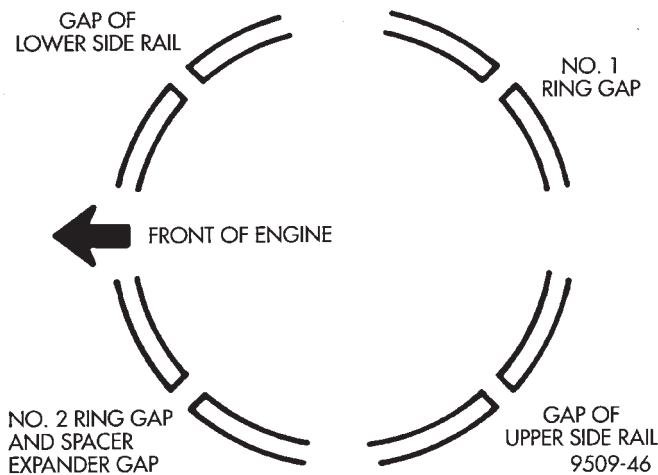


Fig. 72 Piston Ring End Gap Position

## PISTON AND ROD —INSTALLATION

- (1) Before installing pistons and connecting rod assemblies into the bore, be sure that compression

ring gaps are staggered so that neither is in line with oil ring rail gap.

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located as shown in (Fig. 72).

(3) Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston (Fig. 73). **Be sure position of rings does not change during this operation .**

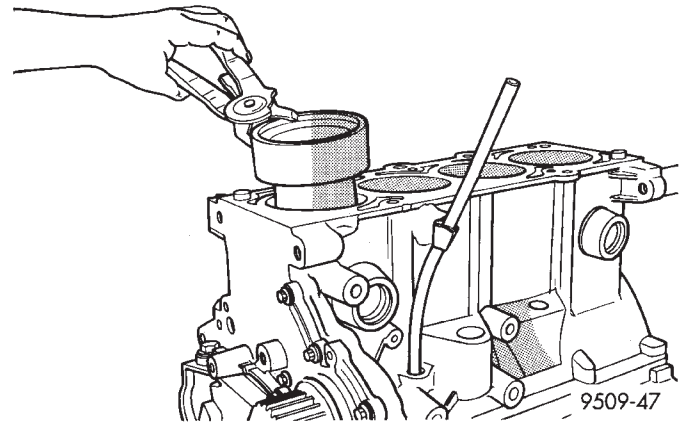


Fig. 73 Installing Piston

(4) The weight stamp designation L or H will be in the front half of the piston should face toward the front of the engine for SOHC engine. The arrow should face toward the front of the engine for DOHC engine (Fig. 67).

(5) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Insert rod and piston assembly into cylinder bore and guide rod over the crankshaft journal.

(6) Tap the piston down in cylinder bore, using a hammer handle. At the same time, guide connecting rod into position on connecting rod journal.

(7) Install rod caps. Install **New** bolts and tighten to 27 N·m (20 ft.lb.) Plus 1/4 turn.

## VIBRATION DAMPER

**NOTE:** If a gap is found in the crankshaft damper, in the area where the Poly-V Generator belt rides this is normal and is acceptable (Fig. 74).

## REMOVAL

(1) Remove accessory drive belts. Refer to Group 7, Cooling System for procedure outlined in that section.

(2) Remove crankshaft damper bolt. Remove damper using the large side of Special Tool 1026 and insert 6827-A (Fig. 75).

## REMOVAL AND INSTALLATION (Continued)

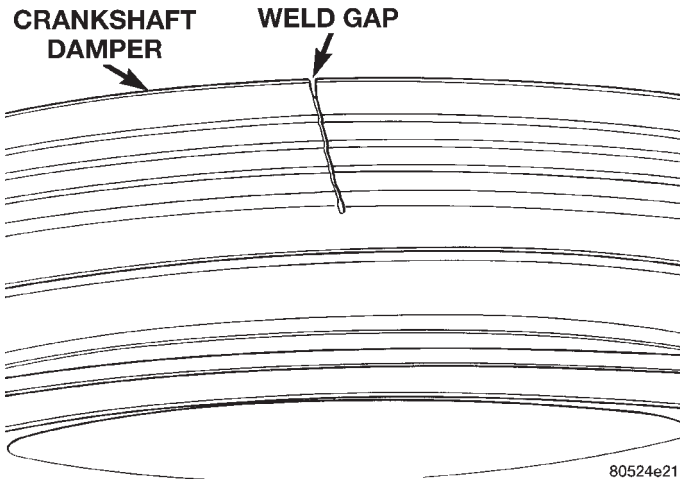


Fig. 74 Weld Gap

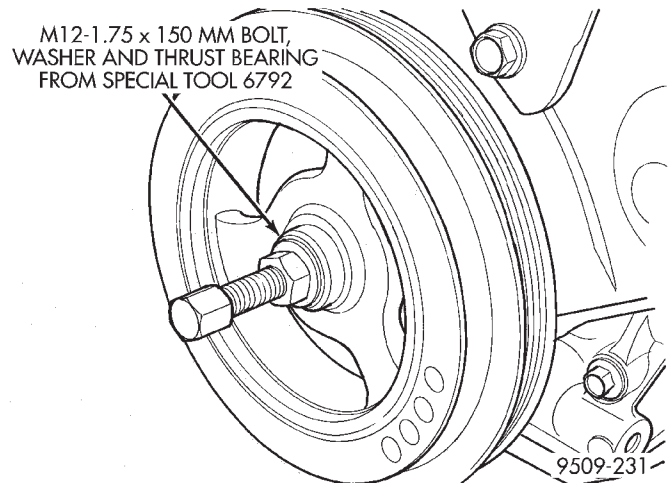


Fig. 76 Crankshaft Damper—Installation

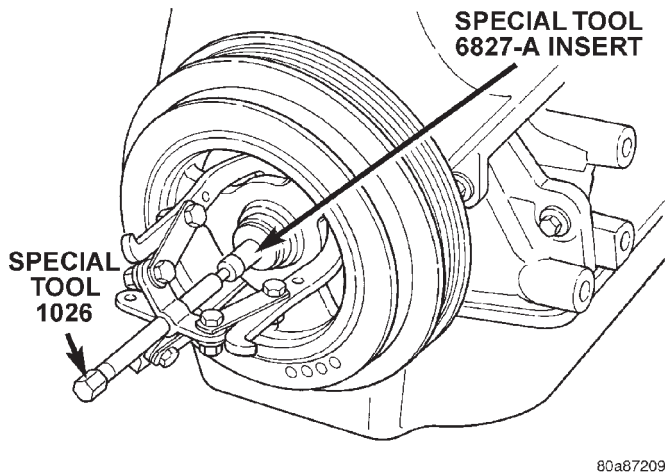


Fig. 75 Crankshaft Damper—Removal

## INSTALLATION

(1) Install crankshaft damper using M12-1.75 x 150 mm bolt, washer, thrust bearing and nut from Special Tool 6792. Install crankshaft damper bolt and tighten to 142 N·m (105 ft. lbs.) (Fig. 76).

(2) Install accessory drive belts. Refer to Group 7, Cooling System Accessory Drive section for procedure.

## DISASSEMBLY AND ASSEMBLY

## OIL PUMP

(1) To remove the relief valve, proceed as follows:

(2) Remove the threaded plug and gasket from the oil pump (Fig. 77).

**CAUTION:** Oil pump pressure relief valve must be installed as shown in (Fig. 77) or serious damage may occur.

(3) Remove spring and relief valve (Fig. 77).

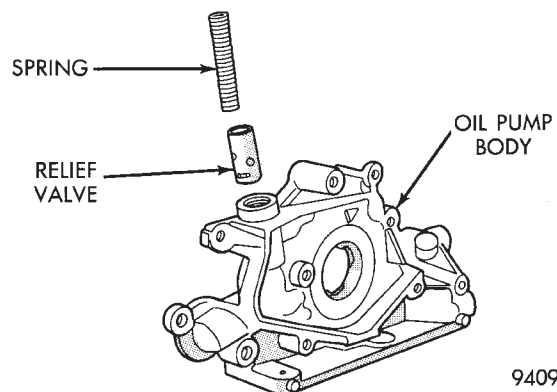


Fig. 77 Oil Pressure Relief Valve

(4) Remove oil pump cover screws, and lift off cover.

(5) Remove pump rotors.

(6) Wash all parts in a suitable solvent and inspect carefully for damage or wear (Fig. 78).

## VALVE SERVICE WITH THE CYLINDER HEAD REMOVED

## REMOVAL

(1) With cylinder head removed, compress valve springs using Special Tool C-3422-B or equivalent.

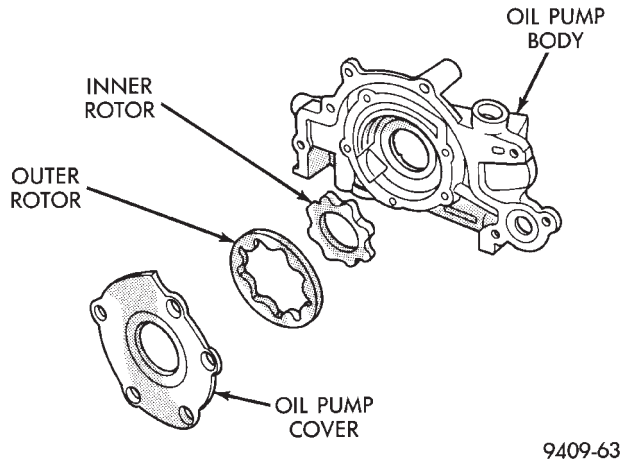
(2) Remove valve retaining locks, valve spring retainers, valve stem seals and valve springs.

(3) Before removing valves, **remove any burrs from valve stem lock grooves to prevent damage to the valve guides.** Identify valves to insure installation in original location.

## VALVE INSPECTION

(1) Clean valves thoroughly and discard burned, warped and cracked valves.

DISASSEMBLY AND ASSEMBLY (Continued)



9409-63

**Fig. 78 Oil Pump**

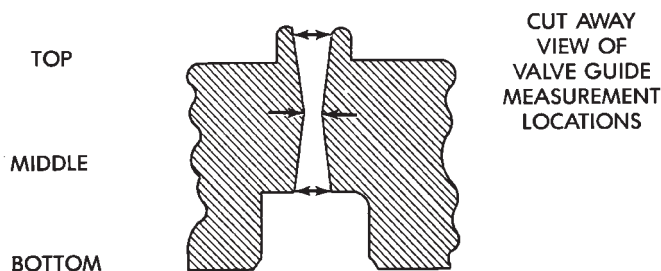
(2) Measure valve stems for wear. Measure stem about 60 mm beneath the valve lock grooves.

(3) If valve stems are worn more than 0.05 mm (.002 in.), replace valve.

**VALVE GUIDES**

(1) Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.

(2) Using a small hole gauge and a micrometer, measure valve guides in 3 places top, middle and bottom (Fig. 79). Refer to (Fig. 80) for specifications. Replace guides if they are not within specification.



9109-98

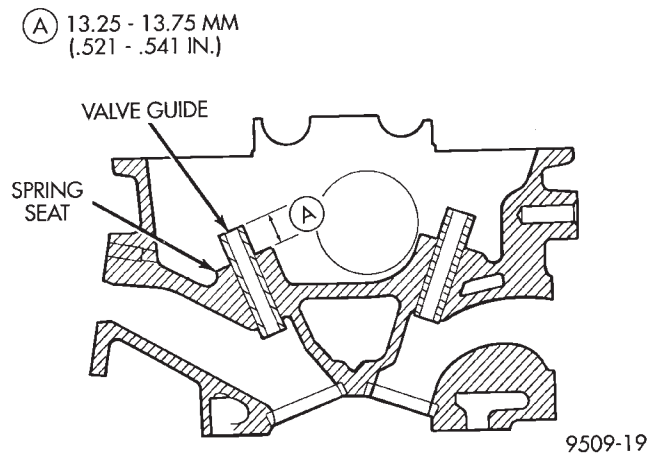
**Fig. 79 Checking Wear on Valve Guide—Typical**

Valve Guide Diameter	Intake Valve	Exhaust Valve
	5.975 - 6.000 mm (0.2352 - 0.2362 in.)	5.975 - 6.000 mm (0.2352 - 0.2362 in.)
<b>Clearance</b>	<b>New</b>	<b>Service Limit</b>
Intake	0.023 - 0.066 mm (0.001 - 0.0025 in.)	0.25 mm (0.010 in.)
Exhaust	0.051 - 0.094 mm (0.002 - 0.0037 in.)	

9509-244

**Fig. 80 Valve Guide Specifications**

(3) Check valve guide height (Fig. 81).



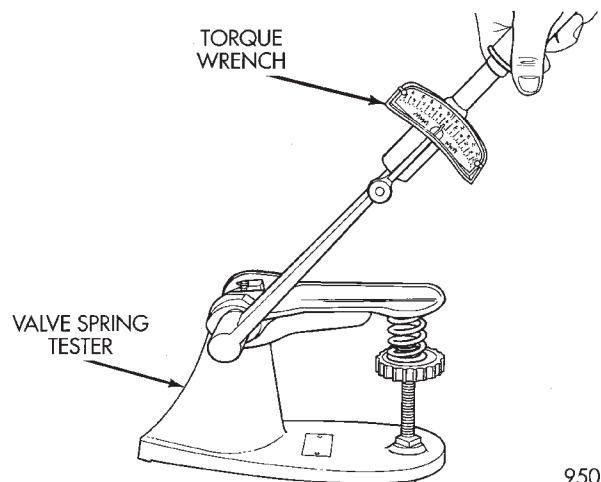
9509-19

**Fig. 81 Valve Guide Height**

**TESTING VALVE SPRINGS**

(1) Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested Special Tool C-647. As an example, the compression length of the spring to be tested is 33.34 mm (1-5/16 inches). Turn tool table until surface is in line with the 33.34 mm (1-5/16 inch) mark on the threaded stud and the zero mark on the front. Place spring over stud on the table and lift compressing lever to set tone device (Fig. 82). Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by two. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Discard the springs that do not meet specifications. The Following specifications apply to both intake and exhaust valve springs.

- Valve Closed Nominal Force— 67 lbs. @ 39.8 mm (1.57 in.)
- Valve Open Nominal Force— 160 lbs. @ 32.6 mm (1.28 in.)



9509-79

**Fig. 82 Testing a Valve Spring**

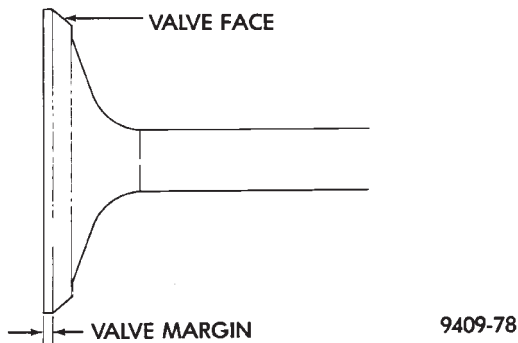
## DISASSEMBLY AND ASSEMBLY (Continued)

(2) Verify springs are not distorted with a steel square and surface plate, check springs from both ends. If the spring is more than 1.5 mm (1/16 inch) out of square, install a new spring.

## REFACING VALVES AND VALVE SEATS

(1) The intake and exhaust valve seats and valve face have a 45 degree angle.

(2) Inspect the remaining margin after the valves are refaced (Fig. 83). Intake valves with less than 0.95 mm (1/32 inch.) margin and Exhaust valves with less than 1.05 mm (3/64 inch) margin should be discarded.



**Fig. 83 Refacing Intake and Exhaust Valves**

(3) When refacing valve seats, it is important that the correct size valve guide pilot be used for reseating stones. A true and complete surface must be obtained See (Fig. 84) for valve specification.

Face Angle	
Intake and Exhaust .....	45 - 45-1/2°
Head Diameter	
Intake .....	33.12 - 33.37 mm (1.303 - 1.313 in.)
Exhaust .....	28.57 - 28.83 mm (1.124 - 1.135 in.)
Length (Overall)	
Intake .....	114.69 - 115.19 mm (4.515 - 4.535 in.)
Exhaust.....	116.94 - 117.44 mm (4.603 - 4.623 in.)
Stem Diameter	
Intake .....	5.934 - 5.952 mm (0.234 - 0.234 in.)
Exhaust.....	5.906 - 5.924 mm (0.233 - 0.233 in.)
Valve Margin	
Intake .....	1.15 - 1.48 mm (0.0452 - 0.0582 in.)
Exhaust .....	1.475 - 1.805 mm (0.0580 - 0.0710 in.)

**Fig. 84 Valve Specifications**

(4) Measure the concentricity of valve seat and valve guide using a valve seat runout dial indicator.

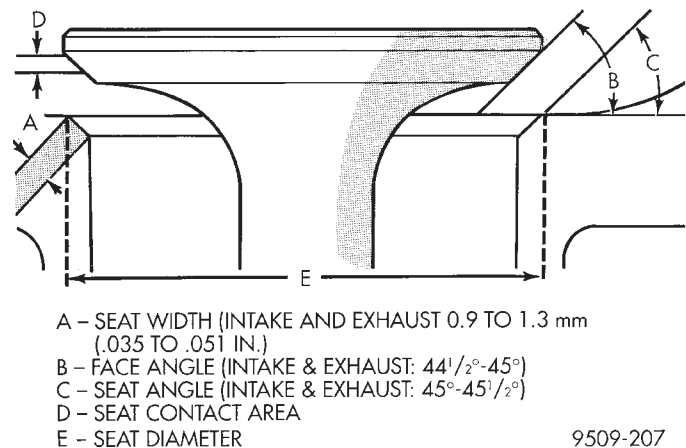
Total runout should not exceed. 0.051 mm (0.002 inch.) (total indicator reading).

(5) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to top edge of the valve face, lower valve seat with a 15 degrees stone. If the blue is transferred to the bottom edge of valve face raise valve seat with a 65 degrees stone.

- Intake valve seat diameter is 33 mm (1.299 in.)
- Exhaust valve seat diameter is 28 mm (1.102 in.)

(6) Valve seats which are worn or burned can be reworked, provided that correct angle and seat width are maintained. The intake valve seat must be serviced when the valve seat width is 2.0 mm (0.079 in.) or greater. The exhaust valve seat must be serviced when the valve seat width is 2.5 mm (0.098 in.) or greater. Otherwise the cylinder head must be replaced.

(7) When seat is properly positioned the width of intake and exhaust seats should be 0.75 to 1.25 mm (0.030 to 0.049 in.) (Fig. 85).



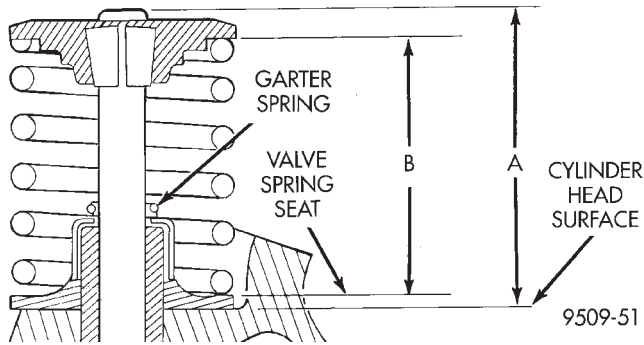
**Fig. 85 Refacing Valve Seats**

(8) Check valve tip to spring seat dimensions A after grinding the valve seats or faces. Grind valve tip to 43.51 - 44.57 mm (1.71 - 1.75 in.) for exhaust valve and 45.01 - 46.07 mm (1.77 - 1.81 in.) for intake valve over spring seat when installed in the head (Fig. 86). The valve tip chamfer may need to be reground to prevent seal damage when the valve is installed.

## CLEANING

Clean all valve guides, valves and valve spring assemblies thoroughly with suitable cleaning solution before reassembling.

## DISASSEMBLY AND ASSEMBLY (Continued)



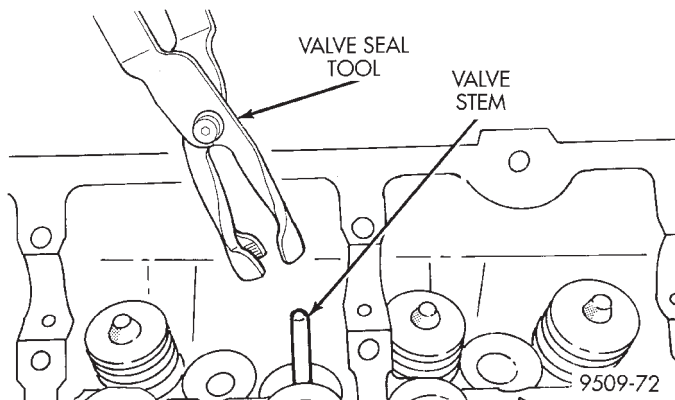
**Fig. 86** Checking Spring Installed Height and Valve Tip to Spring Seat Dimensions

## VALVE INSTALLATION

(1) Coat valve stems with clean engine oil and insert in cylinder head.

(2) Install new valve stem seals on all valves using a valve stem seal tool (Fig. 87). The valve stem seals should be pushed firmly and squarely over valve guide.

**CAUTION:** If oversize valves are used, there is only one oversize valve available. The same stem seal is used on both the standard and oversize valve.



**Fig. 87** Valve Stem Oil Seal Tool

(3) Install valve springs and retainers. Compress valve springs only enough to install locks, taking care not to misalign the direction of compression. Nicked valve stems may result from misalignment of the valve spring compressor.

**CAUTION:** When depressing the valve spring retainers with valve spring compressor the locks can become dislocated. Check to make sure both locks are in their correct location after removing tool.

(4) Check the valve spring installed height B after refacing the valve and seat (Fig. 86). Make sure measurements are taken from top of spring seat to the bottom surface of spring retainer. If height is greater than 40.18 mm (1.58 in.), install a 0.762 mm (0.030

in.) spacer under the valve spring seat to bring spring height back within specification.

(5) Install rocker arm shafts as previously described in this section.

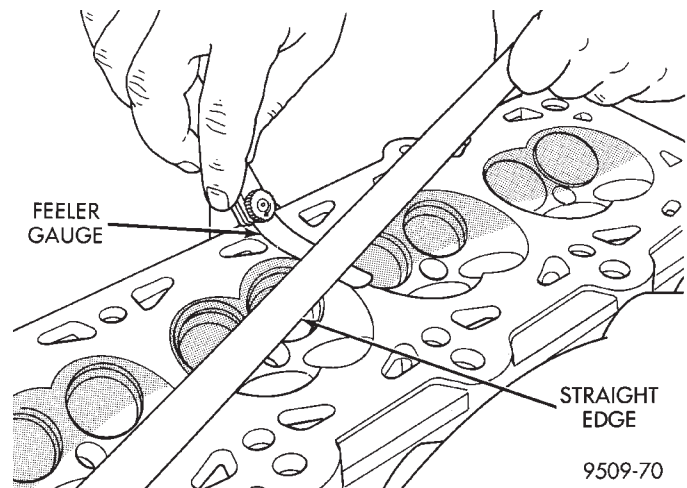
(6) Checking dry lash. Dry lash is the amount of clearance that exists between the base circle of an installed cam and the rocker arm roller when the adjuster is drained of oil and completely collapsed. Specified dry lash is 1.17 mm (0.046 in.) for intake and 1.28 mm (0.050 in.) for exhaust. After performing dry lash check, refill adjuster with oil and allow 10 minutes for adjuster/s to bleed down before rotating cam.

## CLEANING AND INSPECTION

## CYLINDER HEAD AND CAMSHAFT JOURNALS

## INSPECTING CYLINDER HEAD

Cylinder head must be flat within 0.1 mm (0.004 inch) (Fig. 88).



**Fig. 88** Checking Cylinder Head Flatness

Inspect cylinder head journals for wear.

Check camshaft journals for scratches and worn areas. If light scratches are present, they may be removed with 400 grit sand paper. If deep scratches are present, replace the camshaft and check the cylinder head for damage. Replace the cylinder head if worn or damaged. Check the lobes for pitting and wear. If the lobes show signs of wear, check the corresponding rocker arm roller for wear or damage. Replace rocker arm/hydraulic lash adjuster if worn or damaged. If lobes show signs of pitting on the nose, flank or base circle; replace the camshaft.

## CLEANING

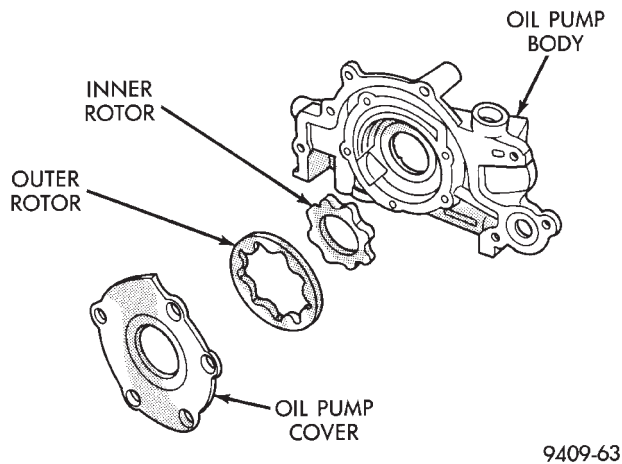
Remove all gasket material from cylinder head and block. Be careful not to gouge or scratch the aluminum head sealing surface.

## CLEANING AND INSPECTION (Continued)

**OIL PUMP**

(1) Clean all parts thoroughly. Mating surface of the oil pump should be smooth. Replace pump cover if scratched or grooved.

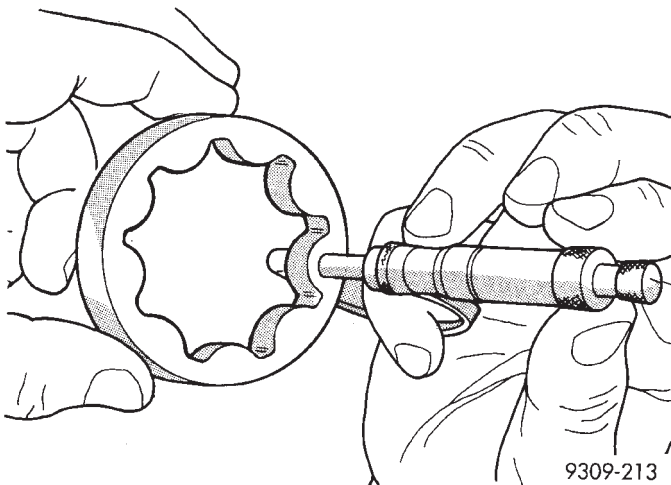
(2) Lay a straightedge across the pump cover surface (Fig. 89). If a 0.076 mm (0.003 inch.) feeler gauge can be inserted between cover and straight edge, cover should be replaced.



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**Fig. 89 Checking Oil Pump Cover Flatness**

(3) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 7.64 mm (0.301 inch.) or less (Fig. 90), or if the diameter is 79.95 mm (3.148 inches) or less, replace outer rotor.

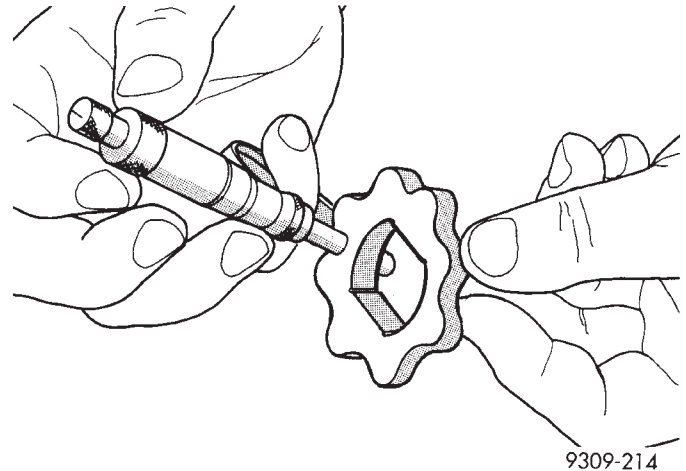


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**Fig. 90 Measuring Outer Rotor Thickness**

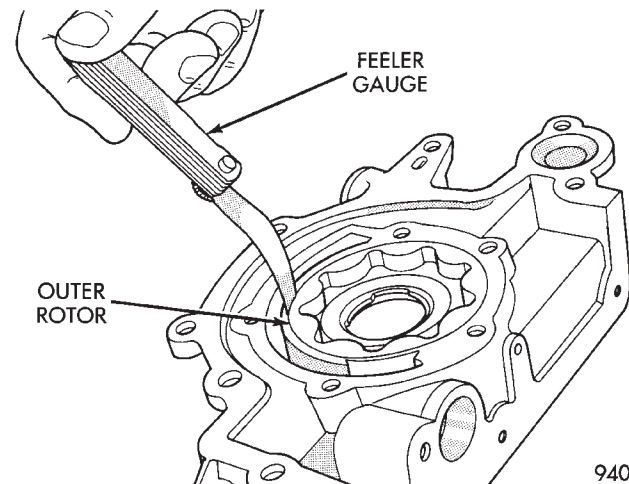
(4) If inner rotor measures 7.64 mm (.301 inch) or less replace inner rotor (Fig. 91).

(5) Slide outer rotor into pump housing, press to one side with fingers and measure clearance between rotor and housing (Fig. 92). If measurement is 0.39 mm (0.015 inch.) or more, replace housing only if outer rotor is in specification.



9309-214

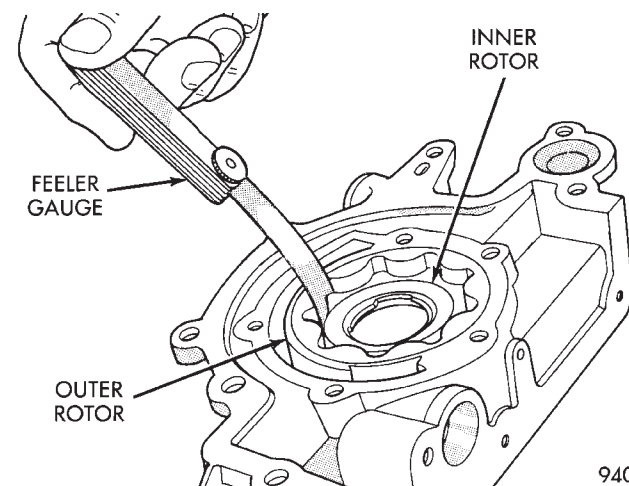
**Fig. 91 Measuring Inner Rotor Thickness**



9409-65

**Fig. 92 Measuring Outer Rotor Clearance in Housing**

(6) Install inner rotor into pump housing. If clearance between inner and outer rotors (Fig. 93) is .203 mm (.008 inch) or more, replace both rotors.

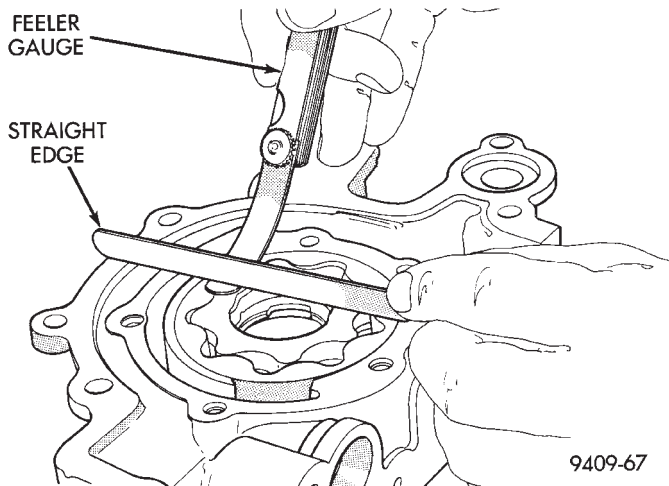


9409-66

**Fig. 93 Measuring Clearance Between Rotors**

CLEANING AND INSPECTION (Continued)

(7) Place a straightedge across the face of the pump housing, between bolt holes. If a feeler gauge of .102 mm (.004 inch) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 94). **ONLY** if rotors are in specs.



**Fig. 94 Measuring Clearance Over Rotors**

(8) Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400-grit wet or dry sandpaper.

(9) The relief valve spring has a free length of approximately 60.7 mm (2.39 inches) it should test between 18 and 19 pounds when compressed to 40.5 mm (1.60 inches). Replace spring that fails to meet specifications.

(10) If oil pressure is low and pump is within specifications, inspect for worn engine bearings, damaged or missing oil pick-up tube o-ring, clogged oil pick-up tube screen, clogged oil filter and stuck open pressure relief valve or other reasons for oil pressure loss.

**CYLINDER BLOCK AND BORE**

(1) Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.

(2) If new core plugs are installed, Refer to Engine Core Plugs outlined in this section.

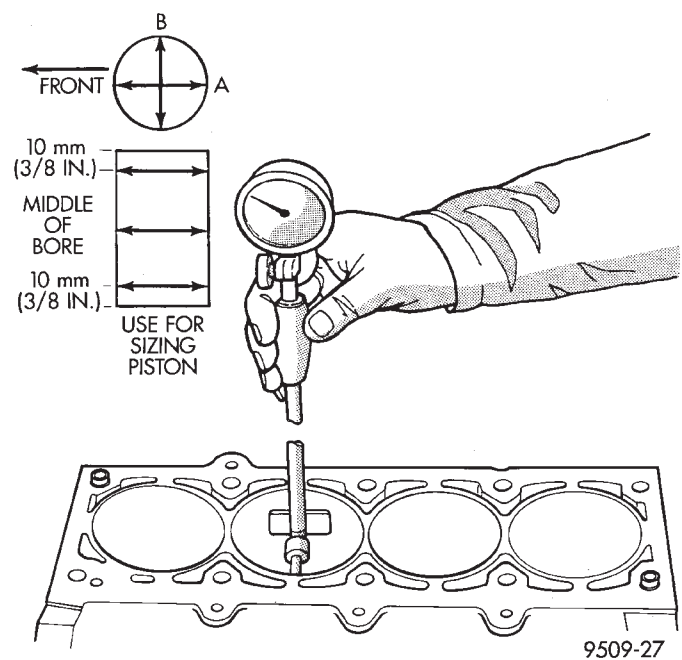
(3) Examine block and cylinder bores for cracks or fractures.

**CYLINDER BORE INSPECTION**

The cylinder walls should be checked for out-of-round and taper with Tool C-119 (Fig. 95). The cylinder bore out-of-round is 0.050 mm (.002 inch) maximum and cylinder bore taper is 0.051 mm (0.002 inch) maximum. If the cylinder walls are badly

scuffed or scored, the cylinder block should be rebored and honed, and new pistons and rings fitted. Whatever type of boring equipment is used, boring and honing operation should be closely coordinated with the fitting of pistons and rings in order that specified clearances may be maintained. **Refer to Honing Cylinder Bores outlined in the Standard Service Procedures for specification and procedures.**

Measure the cylinder bore at three levels in directions A and B (Fig. 95). Top measurement should be 10 mm (3/8 inch) down and bottom measurement should be 10 mm (3/8 inch.) up from bottom of bore. Refer to (Fig. 96) for specifications.



**Fig. 95 Checking Cylinder Bore Size**

Standard Bore	Maximum Out-of-Round	Maximum Taper
87.5 mm (3.445 inch.)	0.051 mm (0.002 inch.)	0.051 mm (0.002 inch.)
Standard Piston Size 87.463 - 87.481 mm (3.4434 - 3.4441 inch.)		
Piston to Bore Clearance: 0.012 - 0.044 mm (.0005 to .0017 inches.) Measurements taken at Piston Size location.		

9509-249

**Fig. 96 Cylinder Bore and Piston Specifications**

## SPECIFICATIONS

## ENGINE 2.0L SOHC

**Cylinder Block**

Cylinder Bore Diameter . . .	87.4924 - 87.5076 mm (3.4446 - 3.4452 in.)
Out-of-Round (Max.) . . . . .	0.051 mm (0.002 in.)
Taper (Max.) . . . . .	0.051 mm (0.002 in.)

**Pistons**

Clearance 17.5 mm (11/16 in.) from bottom of skirt . . . . .	0.012 - 0.044 mm (0.0004 - 0.0017 in.)
Weight . . . . .	325 - 335 grams (11.47 - 11.82 oz.)
Land Clearance (Diametrical) . . . . .	0.734 - 0.797 mm (0.029 - 0.031 in.)
Piston Length . . . . .	64 mm (2.520 in.)
Piston Ring Groove Depth No. 1 . . . . .	3.989 - 4.188 mm (0.157 - 0.165 in.)
Piston Ring Groove Depth No. 2 . . . . .	4.462 - 4.661 mm (0.176 - 0.184 in.)
Piston Ring Groove Depth No. 3 . . . . .	3.847 - 4.131 mm (0.151 - 0.163 in.)

**Piston Pins**

Clearance in Piston . . . . .	0.008 - 0.020 mm (0.0003 - 0.0008 in.)
In Rod (Interference) . . . . .	0.018 - 0.043 mm (0.0007 - 0.0017 in.)
Diameter . . . . .	20.998 - 21.003 mm (0.8267 - 0.8269 in.)
End Play . . . . .	None
Length . . . . .	74.75 - 75.25 mm (2.943 - 2.963 in.)

**Piston Rings**

Ring Gap Top Compression Ring . .	0.23 - 0.52 mm (0.009 - 0.020 in.)
Ring Gap 2nd Compression Ring . .	0.49 - 0.78 mm (0.019 - 0.031 in.)
Ring Gap Oil Control (Steel Rails) . . . . .	0.23 - 0.66 mm (0.009 - 0.026 in.)
Ring Side Clearance Both Compression Rings . . . . .	0.025 - 0.065 mm (0.0010 - 0.0026 in.)
Oil Ring (Pack) . . . . .	0.004 - 0.178 mm (0.0002 - 0.0070 in.)
Ring Width Compression Rings . . .	1.17 - 1.19 mm (0.046 - 0.047 in.)
Oil Ring (Pack) . . . . .	2.854 - 3.008 mm (0.1124 - 0.1184 in.)

**Cylinder Block****Connecting Rod**

Bearing Clearance . . . . .	0.026 - 0.059 mm (0.001 - 0.0023 in.)
Piston Pin Bore Diameter . . . . .	20.96 - 20.98 mm (0.8252 - 0.8260 in.)
Large End Bore Diameter . . .	50.991 - 51.005 mm (2.0075 - 2.0081 in.)
Side Clearance . . . . .	0.13 - 0.38 mm (0.005 - 0.015 in.)
Total Weight (Less Bearing) . . . . .	543 grams (1.20 lbs.)

**Crankshaft**

Connecting Rod Journal Diameter . . . . .	47.9924 - 48.0076 mm (1.8894 - 1.8900 in.)
Out-of-Round (Max.) . . . . .	0.0035 mm (0.0001 in.)
Taper (Max.) . . . . .	0.0038 mm (0.0001 in.)
Main Bearing Diametrical Clearance No. 1 - 5 . . . . .	0.022 - 0.062 mm (0.0008 - 0.0024 in.)
End Play . . . . .	0.09 - 0.24 mm (0.0035 - 0.0094 in.)

**Main Bearing Journals**

Diameter . . . . .	51.9924 - 52.0076 mm (2.0469 - 2.0475 in.)
Out-of-Round (Max.) . . . . .	0.0035 mm (0.0001 in.)
Taper (Max.) . . . . .	0.0038 mm (0.0001 in.)

## ENGINE 2.0L SOHC

**Rocker Arm Shaft**

Rocker Arm Shaft Diameter . .	19.996 - 19.984 mm (0.786 - 0.7867 in.)
-------------------------------	--

**Rocker Arm Shaft Retainers (Width)**

Intake (All) . . . . .	28.46 mm (1.12 in.)
Exhaust . . . . .	1 & 5 29.20 mm (1.14 in.) 2, 3, and 4 - 40.45 mm (1.59 in.)

**Rocker Arm/Hydraulic Lash Adjuster \***

Rocker Arm Inside Diameter . .	20.00 - 20.02 mm (0.787 - 0.788 in.)
Rocker Arm Shaft Clearance . . .	0.016 - 0.054 mm (0.0006 - 0.0021 in.)
Body Diameter . . . . .	22.949 - 22.962 mm (0.9035 - 0.9040 in.)
Plunger Travel Minimum (Dry) . . . . .	2.2 mm (0.087 in.)
Rocker Arm Ratio . . . . .	1.4 to 1

**Camshaft**

No. 1 . . . . .	41.20 - 41.221 mm (1.622 - 1.6228 in.)
No. 2 . . . . .	41.6 - 41.621 mm (1.637 - 1.638 in.)

## SPECIFICATIONS (Continued)

No. 3	42.0 – 42.021 mm (1.653 – 1.654 in.)
No. 4	42.4 – 42.421 mm (1.669 – 1.670 in.)
No. 5	42.8 – 42.821 mm (1.685 – 1.6858 in.)

**Bearing Journal Diameter**

No. 1	41.128 – 41.147 mm (1.619 – 1.6199 in.)
No. 2	41.528 – 41.547 mm (1.634 – 1.635 in.)
No. 3	41.928 – 41.947 mm (1.650 – 1.651 in.)
No. 4	42.328 – 42.374 mm (1.666 – 1.668 in.)
No. 5	42.728 – 42.747 mm (1.682 – 1.6829 in.)
Diametrical Bearing Clearance	0.053 – 0.093 mm (0.0027 – 0.003 in.)
Max. Allowable	0.12 mm (0.0047 in.)
End Play	0.05 – 0.39 mm (0.0059 in.)

**Lift (Zero Lash )**

Intake	7.8 mm (0.307 in.)
Exhaust	7.03 mm (0.277 in.)

**Valve Timing Exhaust Valve**

Closes (ATDC)	5.4°
Opens (BBDC)	43.7°
Duration	229.1°

**Valve Timing Intake Valve \*\***

Closes (ABDC)	41.1°
Opens (ATDC)	13.9°
Duration	207.2°
Valve Overlap	0°

**Cylinder Head**

Material	Cast Aluminum
Gasket Thickness (Compressed)	1.15 mm (0.045 in.)

**Valve Seat**

Angle	45°
Runout (Max.)	0.050 mm (0.002)
Width (Finish) Intake and Exhaust	0.75 – 1.25 mm (0.030 – 0.049 in.)

**Valve Guide Finished**

Diameter I.D.	5.975 – 6.000 mm (.235 – .236 in.)
Guide Bore Diameter (Std.)	11.0 – 11.02 mm (0.4330 – 0.4338 in.)

**Valves**

Face Angle Intake and Exhaust	45 – 45-1/2°
Head Diameter Intake	32.12 – 33.37 mm (1.303 – 1.313 in.)
Head Diameter Exhaust	28.57 – 28.83 mm (1.124 – 1.135 in.)

**Valve Margin**

Intake	1.15 – 1.48 mm (0.0452 – 0.0582 in.)
Exhaust	1.475 – 1.805 mm (0.058 – 0.071 in.)

**Valve Length (Overall)**

Intake	114.69 – 115.19 mm (4.515 – 4.535 in.)
Exhaust	109.59 – 110.09 mm (4.603 – 4.623 in.)

**Valve Stem Tip Height**

Intake	45.01 – 46.07 mm (1.77 – 1.81 in.)
Exhaust	43.51 – 44.57 mm (1.71 – 1.75 in.)

**Stem Diameter**

Intake	5.934 – 5.952 mm (0.234 – 0.234 in.)
Exhaust	5.906 – 5.924 mm (0.233 – 0.233 in.)

**Stem to Guide Clearance**

Intake	0.048 – 0.066 mm (0.0018 – 0.0025 in.)
Exhaust	0.0736 – 0.094 mm (0.0029 – 0.0037 in.)
Max. Allowable Intake	0.076 mm (0.003 in.)
Max. Allowable Exhaust	0.101 mm (0.004 in.)

**Valve Springs**

Free Length (Approx.)	44.4 mm (1.747 in.)
Nominal Force (Valve closed)	91 N·m @ 39.8 mm (67 ft. lbs. @ 1.57 in.)

Nominal Force (Valve open)	239 N·m @ 32.6 mm (176 lbs. @ 1.28 in.)
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Installed Height	40.18 mm (1.580 in.)
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\* SERVICE AS AN ASSEMBLY WITH ROCKER ARM.

\*\* ALL READINGS IN CRANKSHAFT DEGREES, AT 0.5 mm (0.019 in.) OF VALVE LIFT.

**TORQUE CHART 2.0L SOHC**

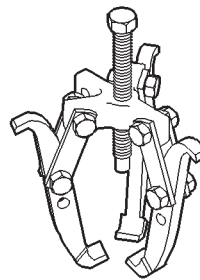
DESCRIPTION	TORQUE
<b>Camshaft Sensor Pick Up</b>	
Bolts	9.6 N·m (85 in. lbs.)
<b>Timing Belt Cover</b>	
Bolts M6	12 N·m (105 in. lbs.)
<b>Camshaft Sprocket</b>	
Bolt	115 N·m (85 ft. lbs.)
<b>Connecting Rod Cap</b>	
Bolts	27 N·m (20 ft. lbs.) Plus 1/4 Turn
<b>Crankshaft Main Bearing Cap/Bedplate</b>	
M8 Bedplate Bolts	30 N·m (22 ft. lbs.)
M11 Main Cap Bolts	81 N·m (60 ft. lbs.)
<b>Crankshaft Damper</b>	
Bolt	142 N·m (105 ft. lbs.)
<b>Cylinder Head</b>	
Bolts	Refer To Cylinder Head Installation
<b>Cylinder Head Cover</b>	
Bolts	12 N·m (105 in. lbs.)
<b>Engine Mount Bracket</b>	
Bolts	41 N·m (30 ft. lbs.)
<b>Exhaust Manifold to Cylinder Head</b>	
Bolts	23 N·m (200 in. lbs.)
<b>Exhaust Manifold Heat Shield</b>	
Bolts	12 N·m (105 in. lbs.)
<b>Front Torque Bracket—2.0/2.4L Engine</b>	
Bolts	33 N·m (24 ft. lbs.)
<b>Front Torque Bracket Strut—2.0/2.4L Engine</b>	
Long Bolts	110 N·m (80 ft. lbs.)
Short Bolt	61 N·m (45 ft. lbs.)
<b>Intake Manifold</b>	
Bolts	12 N·m (105 in. lbs.)
<b>Oil Filter Adapter</b>	
Fastener	80 N·m (60 ft. lbs.)
Oil Filter	20 N·m (15 ft. lbs.)

SPECIFICATIONS (Continued)

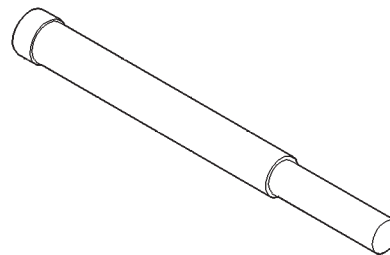
DESCRIPTION	TORQUE
<b>Oil Pan</b>	
Bolts . . . . .	12 N·m (105 in. lbs.)
Drain Plug . . . . .	27 N·m (20 ft. lbs.)
<b>Oil Pump Attaching</b>	
Bolts . . . . .	28 N·m (250 in. lbs.)
Oil Pump Cover Fastener . . .	12 N·m (105 in. lbs.)
Oil Pump Pick-up Tube Bolt .	28 N·m (250 in. lbs.)
Oil Pump Relief Valve Cap . . .	41 N·m (30 ft. lbs.)
<b>Rear Torque Bracket</b>	
Bolts . . . . .	110 N·m (80 ft. lbs.)
<b>Rocker Arm Shaft</b>	
Bolts . . . . .	28 N·m (250 in. lbs.)
Spark Plugs . . . . .	28 N·m (20 ft. lbs.)
<b>Support Module—Front and Rear</b>	
Thru Bolt . . . . .	61 N·m (45 ft. lbs.)
<b>Thermostat Housing</b>	
Bolts . . . . .	23 N·m (200 in lbs.)
<b>Timing Belt</b>	
Tensioner . . . . .	31 N·m (275 in. lbs.)
<b>Timing Belt Tensioner Pivot Bracket</b>	
Bolt . . . . .	31 N·m (275 in. lbs.)
<b>Timing Belt Tensioner Pulley</b>	
Bolt . . . . .	68 N·m (50 ft. lbs.)
<b>Water Pump Mounting</b>	
Bolts . . . . .	12 N·m (105 in. lbs.)

SPECIAL TOOLS

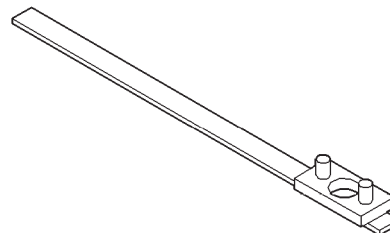
ENGINE 2.0L SOHC



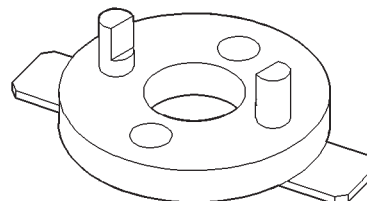
*Puller 1026*



*Crankshaft Damper Removal Insert 6827-A*

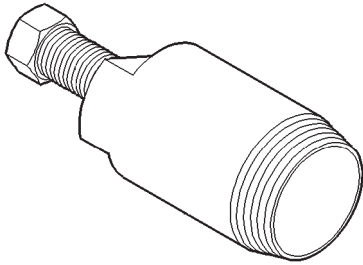


*Camshaft Sprocket Remover/Installer C-4687*

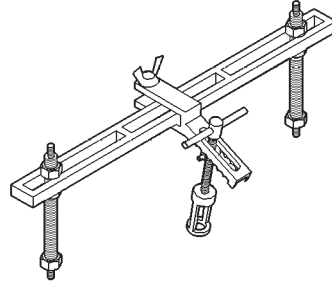


*Camshaft Sprocket Remover/Installer Adapter C-4687-1*

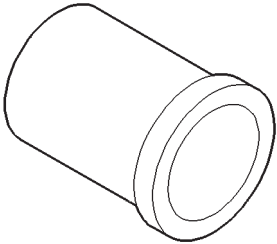
SPECIAL TOOLS (Continued)



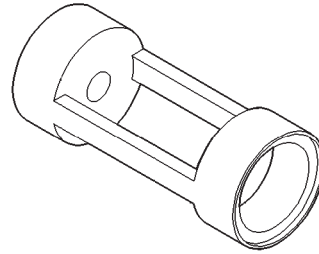
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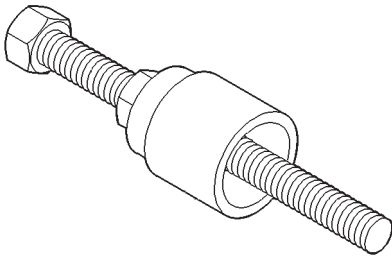
**Valve Spring Compressor MD-998772-A**



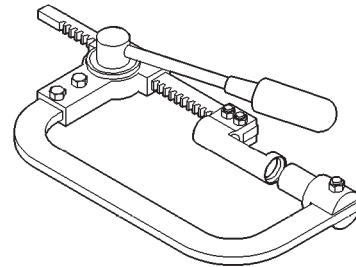
**Camshaft Seal Installer MD-998306**



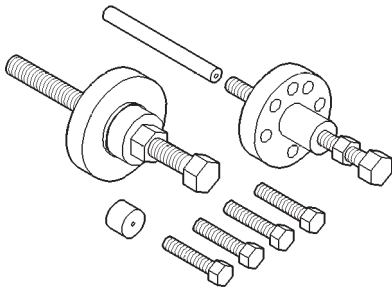
**Spring Compressor Adapter 6779**



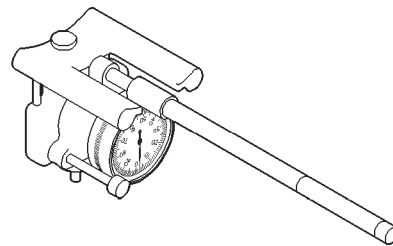
**Crankshaft Damper Installer 6792**



**Valve Spring Compressor C-3575-A**



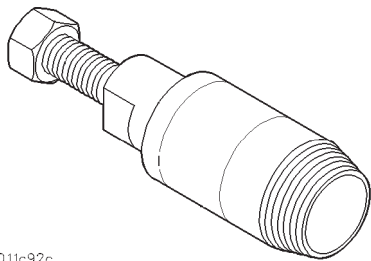
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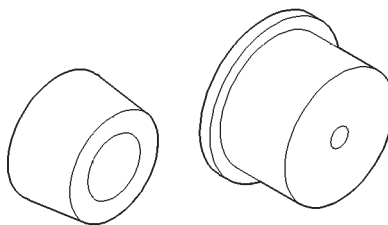
**Cylinder Bore Indicator C-119**

SPECIAL TOOLS (Continued)

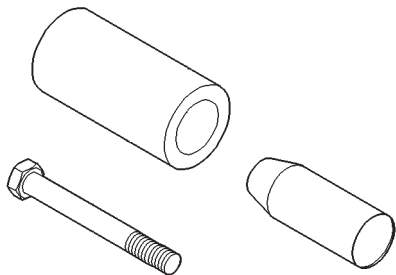


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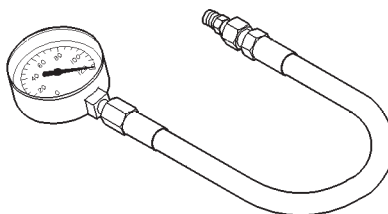
**Front Crankshaft Seal Remover 6771**



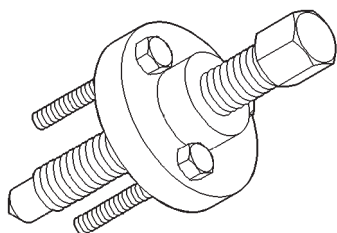
**Rear Crankshaft Seal Guide and Installer 6926-1 and 6926-2**



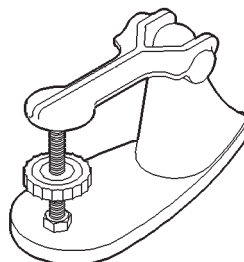
**Front Crankshaft Seal Installer 6780**



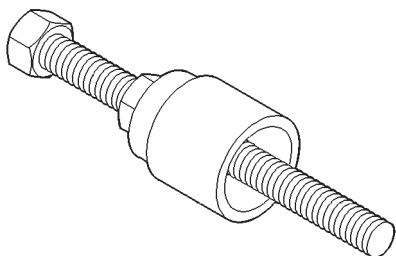
**Pressure Gage C-32932**



**Crankshaft Sprocket Remover 6793**



**Valve Spring Tester C-647**



**Crankshaft Sprocket Installer 6792**

## 2.5L VM DIESEL

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### GENERAL INFORMATION

#### GENERAL SPECIFICATION

Type .....	425CLIEE (36B)
Displacement .....	2.5L (2499 cc)
Bore .....	92.00 mm
Stroke .....	94.00 mm
Compression Ratio .....	20.95:1
Vacuum at Idle .....	600 mm/Hg (23.6 In/Hg)
Thermostat Opening .....	80°C±2°C
Generator Rating .....	Bosch 50/120 Amp
Cooling System Capacity .....	9.5 Liter

Type .....	425CLIEE (36B)
Power Steering Capacity .....	0.75 Liter
Engine Oil Capacity .....	6.8 Liters With Oil Filter Change
Timing System .	Pushrod Operated Overhead valves, With Chain-Driven Camshaft.
Air Intake .....	Dry Filter
Fuel Feed .....	Vacuum Pump Incorporated in Injection Pump.
Fuel System .....	Indirect Fuel Injection (Precombustion Chamber)
Combustion Cycle .....	4 Stroke
Cooling System .....	Water Cooled



## DIAGNOSIS AND TESTING

## ENGINE DIAGNOSIS—PERFORMANCE

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE WILL NOT CRANK OR CRANKS SLOWLY	<ol style="list-style-type: none"> <li>1. Starting motor operating, but not cranking the engine.</li> <li>2. Crankshaft rotation restricted.</li> <li>3. Starting circuit connections loose or corroded.</li> <li>4. Neutral safety or starter relay inoperative.</li> <li>5. Battery charge low.</li> <li>6. No voltage to starter solenoid.</li> <li>7. Solenoid or starter motor inoperative.</li> </ol>	<ol style="list-style-type: none"> <li>1. Remove the starter motor. Check for broken flywheel teeth or a broken starter motor spring.</li> <li>2. Rotate the engine to check for rotational resistance.</li> <li>3. Clean and tighten connections.</li> <li>4. Check starter relay supply voltage and proper operation of neutral safety switch (if equipped). Replace defective parts.</li> <li>5. Check Battery voltage. Replace battery if a charge cannot be held.</li> <li>6. Check voltage to solenoid. If necessary, replace the solenoid.</li> <li>7. Replace starter motor.</li> </ol>
ENGINE CRANKS, BUT WILL NOT START, NO SMOKE	<ol style="list-style-type: none"> <li>1. No fuel in supply tank.</li> <li>2. Electrical fuel shutdown solenoid not operating.</li> <li>3. Fuel injection system defective: Cranking speed sensor. Loose connection between ECU and harness. No power supply to the ECU. Loose connection between injection pump and harness.</li> <li>4. Air intake or exhaust plugged.</li> <li>5. Fuel filter plugged.</li> <li>6. Excessive fuel inlet restriction.</li> <li>7. Injection pump not getting fuel or fuel is aerated.</li> <li>8. One or more injectors worn or not operating properly.</li> <li>9. Camshaft out of time.</li> </ol>	<ol style="list-style-type: none"> <li>1. Fill fuel supply.</li> <li>2. Check for loose wires and verify that the fuel shutdown solenoid is functioning. Check for fault codes in the ECU.</li> <li>3. Check for fault codes at ECU. Refer to Group 14, Fuel System for repairs procedures.</li> <li>4. Remove the obstruction.</li> <li>5. Drain fuel/water separator and replace fuel filter.</li> <li>6. Check for restriction. Correct cause.</li> <li>7. Check fuel flow/bleed fuel system.</li> <li>8. Check/replace bad or improperly operating injectors.</li> <li>9. Check/correct timing chain sprocket alignment.</li> </ol>
ENGINE HARD TO START, OR WILL NOT START, SMOKE FROM EXHAUST	<ol style="list-style-type: none"> <li>1. Incorrect starting procedure.</li> <li>2. Cranking speed too slow.</li> <li>3. Cylinder head heater plugs defective.</li> <li>4. Insufficient intake air</li> <li>5. Air in fuel system or the fuel supply is inadequate.</li> <li>6. Contaminated fuel.</li> <li>7. Fuel screen plugged.</li> <li>8. One or more injectors worn or not operating properly.</li> <li>9. Injector pump out of time.</li> <li>10. Engine compression low.</li> <li>11. Fuel injection system defective.</li> </ol>	<ol style="list-style-type: none"> <li>1. The fuel shutoff solenoid control must be in the run position. Ensure the proper procedure is being used.</li> <li>2. Check the battery, starter motor and look for loose or corroded wiring connections.</li> <li>3. Verify system is working. Verify connection between heater plug relay and ECU. Repair/replace inoperative parts.</li> <li>4. Inspect or replace air filter and check for obstruction in air supply.</li> <li>5. Check the fuel flow through the filter and bleed system. Locate and eliminate the air source.</li> <li>6. Verify by operating the engine with clean fuel from a temporary tank. Check for the presence of gasoline. Drain and flush fuel supply tank. Replace fuel/water separator filter.</li> <li>7. Check fuel screen.</li> <li>8. Check/replace improperly operating injectors.</li> <li>9. Check pump timing. Refer to Group 14, Fuel System for procedure.</li> <li>10. Check compression to identify the problem.</li> <li>11. Vacuum modulator defective causing EGR to open in cold condition. Check for fault codes in the ECU.</li> </ol>

## DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
LUBRICATING OIL PRESSURE LOW	<ol style="list-style-type: none"> <li>1. Low oil level.</li> <li>2. Oil viscosity thin, diluted, or wrong specification.</li> <li>3. Improperly operating pressure switch/gauge</li> <li>4. Relief valve stuck open.</li> <li>5. Plugged oil filter.</li> <li>6. Oil cooler was replaced, shipping plugs left in cooler.</li> <li>7. Worn oil pump.</li> <li>8. Suction tube loose or seal leaking.</li> <li>9. Worn bearing or wrong bearing installed.</li> <li>10. Oil jets under piston loose or bad fit.</li> </ol>	<ol style="list-style-type: none"> <li>1a. Check and fill with clean engine oil.</li> <li>1b. Check for severe external oil leaks that could reduce the pressure.</li> <li>2. Verify the correct oil is being used. Check for oil dilution.</li> <li>3. Verify the pressure switch is functioning correctly. If not, replace switch/gauge.</li> <li>4. Check/replace valve.</li> <li>5. Change oil filter. Oil filter change interval may need to be revised.</li> <li>6. Check/removed shipping plugs.</li> <li>7. Check/replace oil pump.</li> <li>8. Check and replace seal.</li> <li>9. Inspect and replace connecting rod or main bearings. check and replace piston cooling oil jet.</li> <li>10. Check oil jets position.</li> </ol>
LUBRICATING OIL LOSS	<ol style="list-style-type: none"> <li>1. External oil leaks.</li> <li>2. Crankcase being overfilled.</li> <li>3. Incorrect oil specification or viscosity.</li> <li>4. Oil cooler leak.</li> <li>5. High blow-by forcing oil out the breather.</li> </ol>	<ol style="list-style-type: none"> <li>1. Visually inspect for oil leaks. Repair as required.</li> <li>2. Verify that the correct dipstick is being used.</li> <li>3a. Make sure the correct oil is being used.</li> <li>3b. Look for reduced viscosity from dilution with fuel.</li> <li>3c. Review/reduce the oil change intervals.</li> <li>4. Check and replace the oil cooler.</li> <li>5. Check the breather tube area for signs of oil loss.</li> <li>6. Inspect air duct for evidence of oil transfer.</li> <li>7. Perform blow-by check. Repair as required.</li> </ol>
LUBRICATING OIL LOSS (CONT.)	<ol style="list-style-type: none"> <li>6. Turbocharger leaking oil into the air intake.</li> <li>7. Piston rings not sealing (oil being consumed by the engine).</li> </ol>	
COMPRESSION KNOCKS	<ol style="list-style-type: none"> <li>1. Air in fuel system.</li> <li>2. Poor quality fuel or water/gasoline contaminated fuel.</li> <li>3. Engine Overloaded.</li> <li>4. Improperly operating injectors.</li> <li>5. Fuel injection system defective.</li> </ol>	<ol style="list-style-type: none"> <li>1. Bleed the fuel system (refer to Group 14, Fuel System).</li> <li>2. Verify by operating from a temporary tank with good fuel. Clean and flush the fuel supply tank. Replace fuel/water separator.</li> <li>3. Verify the engine load rating is not being exceeded.</li> <li>4. Check and replace injectors.</li> <li>5a. Instrumented injection. 5b. Timing solenoid of the fuel pump. 5c. Pre and post heat time of the glow plugs. Check the fault codes in the ECU.</li> </ol>
EXCESSIVE ENGINE NOISES	<ol style="list-style-type: none"> <li>1. Drive belt squeal, insufficient tension or abnormally high loading.</li> <li>2. Intake air and exhaust leak.</li> <li>3. Excessive valve lash.</li> <li>4. Turbocharger noise.</li> <li>5. Power function knock.</li> <li>6. Fuel injection system defective.</li> </ol>	<ol style="list-style-type: none"> <li>1. Inspect the drive belts. Make sure water pump pulley, generator and power steering all turn freely.</li> <li>2. Refer to excessive exhaust smoke. (Engine Diagnosis and Testing)</li> <li>3. Make sure the rocker arms are not bent. Defective hydraulic lash adjuster.</li> <li>4. Check turbocharger impeller and turbine wheel for housing contact.</li> <li>5. Check and replace rod and main bearings.</li> <li>6a. Instrumented injection. 6b. Timing solenoid of the fuel pump. 6c. Pre and post heat time of the glow plugs. Check the fault codes in the ECU.</li> </ol>

## HYDRAULIC TAPPETS

Before disassembling any part of the engine to correct tappet noise, check the oil pressure. If vehicle has no oil pressure gauge, install a reliable gauge at

the pressure sending unit. The pressure should be between 3.5 bars to 5.0 bars at 4000 RPM.

Check the oil level after the engine reaches normal operating temperature. Allow 5 minutes to stabilize

## DIAGNOSIS AND TESTING (Continued)

oil level, check dipstick. The oil level in the pan should never be above the FULL mark or below the ADD OIL mark on dipstick. Either of these 2 conditions could be responsible for noisy tappets.

**OIL LEVEL HIGH**

If oil level is above the FULL mark, it is possible for the connecting rods to dip into the oil. With the engine running, this condition could create foam in the oil pan. Foam in oil pan would be fed to the hydraulic tappets by the oil pump causing them to lose length and allow valves to seat noisily.

**OIL LEVEL LOW**

Low oil level may allow oil pump to take in air. When air is fed to the tappets, they lose length which allows valves to seat noisily. Any leaks on intake side of oil pump through which air can be drawn will create the same tappet action. Check the lubrication system from the intake strainer to the pump cover, including the relief valve retainer cap. When tappet noise is due to aeration, it may be intermittent or constant, and usually more than 1 tappet will be noisy. When oil level and leaks have been corrected, operate the engine at fast idle. Run engine for a sufficient time to allow all of the air inside the tappets to be bled out.

**TAPPET NOISE DIAGNOSIS**

(1) To determine source of tappet noise, operate engine at idle with cylinder head covers removed.

(2) Feel each valve spring or rocker arm to detect noisy tappet. The noisy tappet will cause the affected spring and/or rocker arm to vibrate or feel rough in operation.

**NOTE:** Worn valve guides or cocked springs are sometimes mistaken for noisy tappets. If such is the case, noise may be dampened by applying side thrust on the valve spring. If noise is not appreciably reduced, it can be assumed the noise is in the tappet. Inspect the rocker arm push rod sockets and push rod ends for wear.

(3) Valve tappet noise ranges from light noise to a heavy click. A light noise is usually caused by excessive leak down around the unit plunger or by the plunger partially sticking in the tappet body cylinder. The tappet should be replaced. A heavy click is caused by a tappet check valve not seating or by foreign particles becoming wedged between the plunger and the tappet body. This will cause the plunger to stick in the down position. This heavy click will be accompanied by excessive clearance between the valve stem and rocker arm as valve closes. In either case, tappet assembly should be removed for inspection and cleaning.

(4) The valve train generates a noise very much like a light tappet noise during normal operation. Care must be taken to ensure that tappets are making the noise. In general, if more than one tappet seems to be noisy, its probably not the tappets.

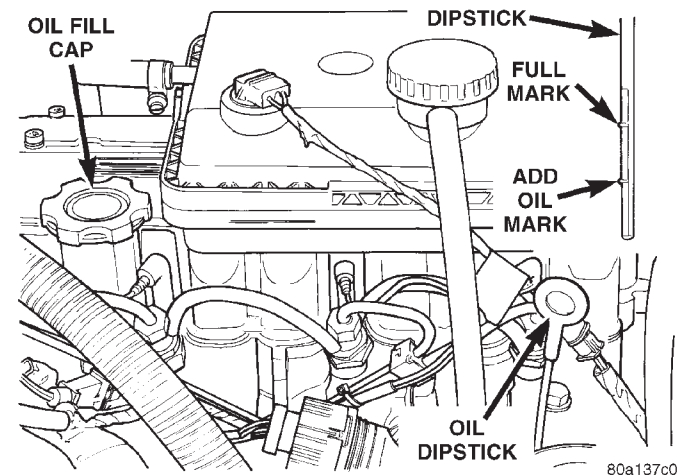
## SERVICE PROCEDURES

**CHECKING OIL LEVEL**

To assure proper engine lubrication, the engine oil must be maintained at the correct level. Check the oil level at regular intervals, such as every fuel stop.

The best time to check the oil level is about 5 minutes after a fully warmed-up engine is shut off, or before starting the vehicle after it has sat overnight.

Checking the oil while the vehicle is on level ground, will improve the accuracy of the oil level readings (Fig. 4).



**Fig. 4 Checking Engine Oil**

**CHANGING ENGINE OIL AND FILTER**

Change engine oil and filter at mileage and time intervals described in the Maintenance Schedule.

**ENGINE OIL CHANGE**

**WARNING:** NEW OR USED ENGINE OIL CAN BE IRRITATING TO THE SKIN. AVOID PROLONGED OR REPEATED SKIN CONTACT WITH ENGINE OIL. CONTAMINANTS IN USED ENGINE OIL, CAUSED BY INTERNAL COMBUSTION, CAN BE HAZARDOUS TO YOUR HEALTH. THOROUGHLY WASH EXPOSED SKIN WITH SOAP AND WATER. DO NOT WASH SKIN WITH GASOLINE, DIESEL FUEL, THINNER, OR SOLVENTS, HEALTH PROBLEMS CAN RESULT. DO NOT POLLUTE, DISPOSE OF USED ENGINE OIL PROPERLY. CONTACT YOUR DEALER OR GOVERNMENT AGENCY FOR LOCATION OF COLLECTION CENTER IN YOUR AREA.

## SERVICE PROCEDURES (Continued)

Run engine until achieving normal operating temperature.

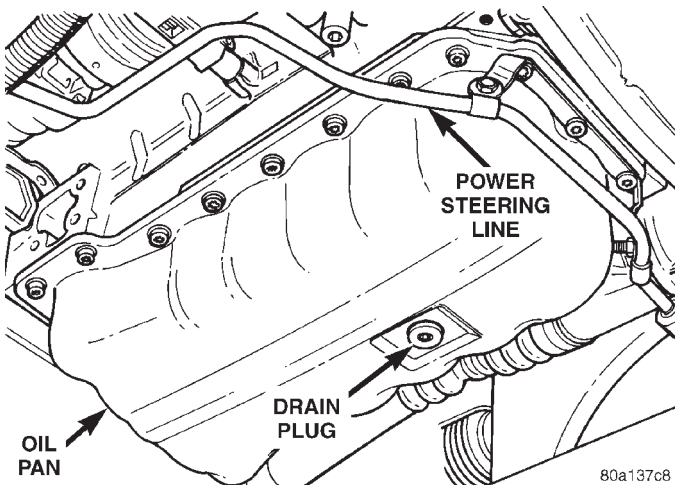
(1) Position the vehicle on a level surface and turn engine off.

(2) Remove oil fill cap.

(3) Hoist vehicle. Refer to Hoisting and Jacking Recommendations.

(4) Place a suitable drain pan under crankcase drain.

(5) Remove drain plug from crankcase and allow oil to drain into pan (Fig. 5). Inspect drain plug threads for stretching or other damage. Replace drain plug if damaged.



**Fig. 5 Oil Drain Plug**

(6) Install drain plug in crankcase.

(7) Lower vehicle and fill crankcase with specified type and amount of engine oil.

(8) Install oil fill cap.

(9) Start engine and inspect for leaks.

(10) Stop engine and inspect oil level.

## ENGINE OIL

## ENGINE OIL QUALITY

Use only oils conforming to API (American Petroleum Institute) quality SG, SG/CD, or CCMC G4. Use only Diesel engine oil meeting standard **MIL-2104C** or API service classification **SG/CD** or **CCMM PD1**.

## OIL VISCOSITY

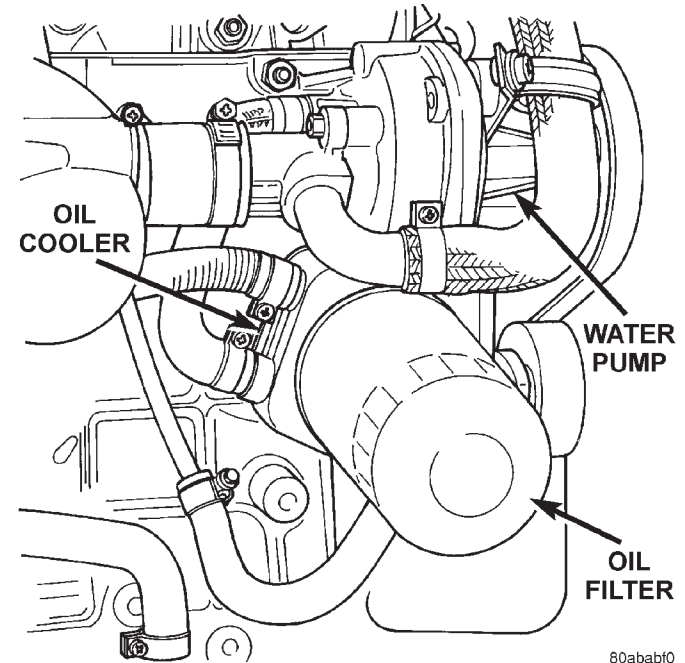
Grade 15W-40 is recommended for temperatures between +35°C to -10°C (95°F to 14°F). Low viscosity oils must have the proper API quality or the CCMC G5 designation. Low viscosity oils are preferred when minimum temperatures consistently fall below -12°C (10°F).

## ENGINE OIL FILTER CHANGE

(1) Position a drain pan under the oil filter.

(2) Using a suitable oil filter wrench loosen filter.

(3) Rotate the oil filter counterclockwise to remove it from the oil filter base (Fig. 6).



**Fig. 6 Oil Filter**

(4) When filter separates from base, tip gasket end upward to minimize oil spill. Remove filter from vehicle.

(5) With a cloth, wipe clean the gasket sealing surface of oil and grime.

## OIL FILTER INSTALLATION

(1) Lightly lubricate oil filter gasket with engine oil.

(2) Thread filter onto the base. When gasket makes contact with sealing surface, hand tighten filter one full turn, do not over tighten.

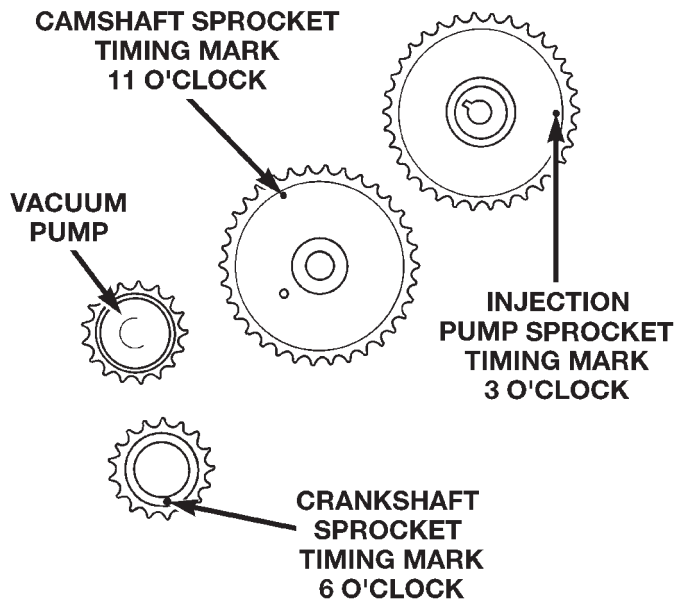
(3) Add oil, verify crankcase oil level and start engine. Inspect filter area for oil leaks.

## TIMING PROCEDURE

**CAUTION:** It could take up to 70 crankshaft revolutions to align sprocket timing marks with the dark chain links. If the chain is removed (Fig. 7) before the sprocket marks are in their proper locations you must first loosen the rocker arm supports before rotating crankshaft or camshaft sprockets. This will prevent the valves from hitting the pistons.

Installing timing chain (Fig. 8). Starting at the crankshaft align the dark link on the chain to the timing mark on the crankshaft sprocket. Next align

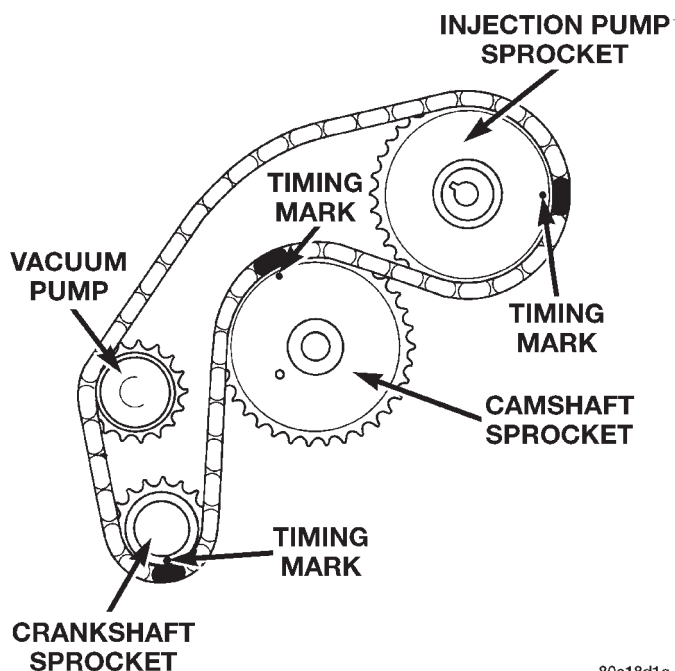
## SERVICE PROCEDURES (Continued)



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**Fig. 7 Alignment Timing Sprockets**

the second dark link on the chain with the timing mark on the camshaft sprocket. Third Align the final dark link on the chain to the timing mark on the injection pump sprocket. Last install the chain around the vacuum pump. For injection pump timing refer to Group 14, Fuel for the proper procedure.



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**Fig. 8 Timing Procedure**

## VALVE AND SEAT REFACING

### VALVE REFACING

(1) Use a valve refacing machine to reface the intake and exhaust valves to the specified angle.

(2) After refacing, a margin of at least 4.52-4.49 mm (.178-.177 inch) must remain (Fig. 9). If the margin is less than 4.49 mm (.177 inch), the valve must be replaced.

### VALVE SEAT REFACING

(1) Install a pilot of the correct size in the valve guide bore. Reface the valve seat to the specified angle with a good dressing stone. Remove only enough metal to provide a smooth finish.

(2) Use tapered stones to obtain the specified seat width when required.

### VALVE STAND DOWN

Valve stand down is to maintain the adequate compression ratio.

(1) Invert cylinder head.

(2) Fit each valve to its respective valve guide.

(3) Using a straight edge and feeler gauge (Fig. 10), check valve head stand down: Inlet valve head stand down .80 to 1.2 mm (.031 to .047 in.) and exhaust valve stand down .79 to 1.19 mm (.031 to .047 in).

(4) If valve head stand down is not in accordance with above, discard original valves, check stand down with new valves and recut valve seat inserts to obtain correct stand down.

### VALVE GUIDE HEIGHT

(1) Valve Guides height requirement.

(2) Measurement A (Fig. 11): 13.50 - 14.00 mm.

### VALVE STEM-TO-GUIDE CLEARANCE MEASUREMENT

(1) Measure and record internal diameter of valve guides. Valve guide internal diameter is 8.0 to 8.015 mm (.3149 to .3155 in.).

(2) Measure valve stems and record diameters. Intake valve stem diameter 7.94 to 7.96 mm (.3125 to .3133 in). Exhaust valve stem diameter 7.92 to 7.94 mm (.3118 to .31215 in).

(3) Subtract diameter of valve stem from internal diameter of its respective valve guide to obtain valve stem clearance in valve guide. Clearance of inlet valve stem in valve guide is .040 to .075 mm (.0015 to .0029 in). Clearance of exhaust valve stem in valve guide is .060 to .095 mm (.0023 to .0037 in).

(4) If valve stem clearance in valve guide exceeds tolerances, new valve guides must be installed.

SERVICE PROCEDURES (Continued)

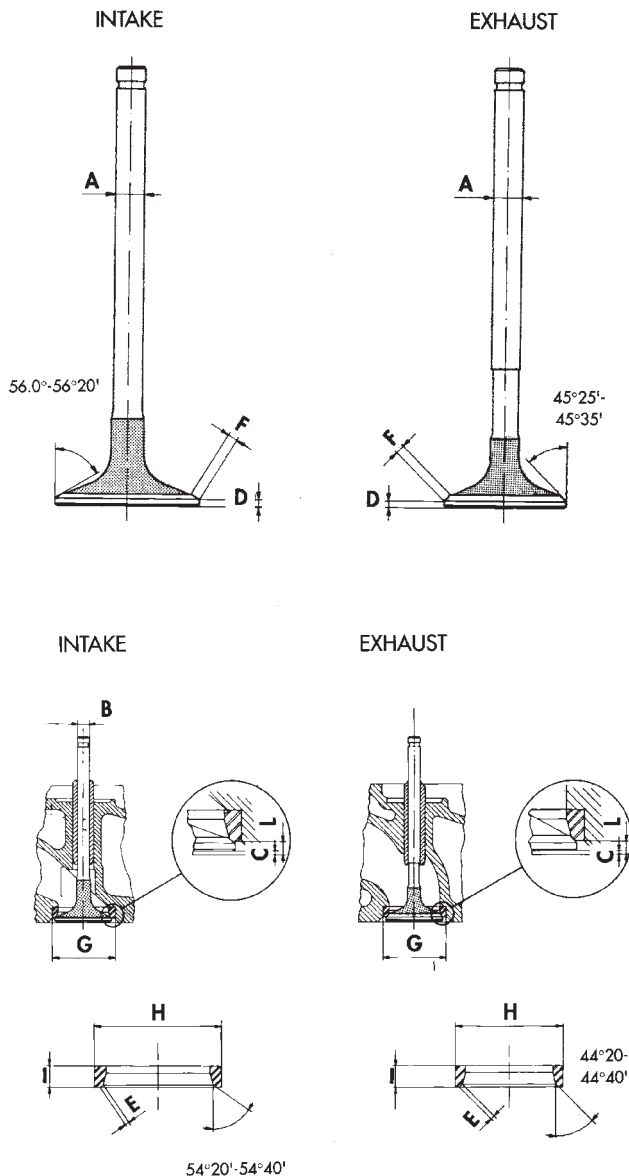
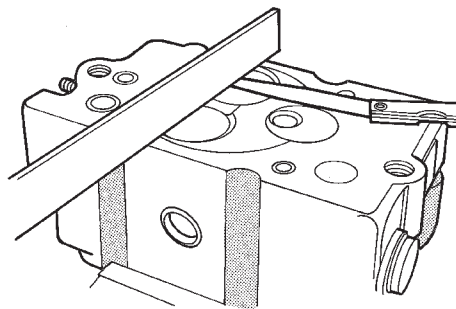


Fig. 9 Valve Specification

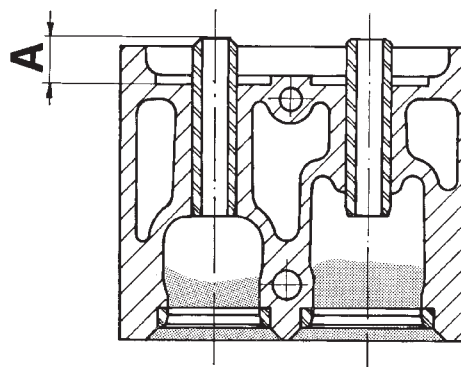
MEASUREMENT	INTAKE	EXHAUST
A	7.940-7.960	7.922-7.940
B	8.00-8.015	8.000-8.015
C	0.880-1.140	0.990-1.250
D	2.2±0.08	2.09 <sup>+0.07</sup> / <sub>-0.05</sub>
E	1.80-2.20	1.65-2.05
F	2.73-3.44	2.45-3.02
G	41.962-41.985	35.964-35.987
H	42.070-42.086	36.050-36.066
I	7.14-7.19	7.00-7.05
L	3.11-3.26	3.10-3.25

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J9509-166

Fig. 10 Checking Valve Stand Down



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Fig. 11 Valve Guide Height

FITTING PISTON RING

(1) Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioning at least 12 mm (0.50 in.) from bottom of cylinder bore (Fig. 12). Check gap with feeler gauge. Top compression ring gap .25 to .50mm (.0098 to .0196 in.). Second compression ring gap .25 to .35mm (.0098 to .0137 in.). Oil control ring gap .25 to .58mm (.0098 to .0228 in.).

(2) If ring gaps exceed dimension given, new rings or cylinder liners must be fitted. Keep piston rings in piston sets.

(3) Check piston ring to groove clearance (Fig. 13). Top compression ring gap .08 to .130mm (.0031 to .0051 in.). Second compression ring gap .070 to .102mm (.0027 to .0040 in.). Oil control ring gap .040 to .072mm (.0015 to .0028 in.).

CRANKSHAFT END PLAY

(1) Attach dial indicator to engine block (Fig. 14).

(2) Move crankshaft toward front of engine and zero indicator.

(3) Move crankshaft toward the rear of engine and record measurement.

## SERVICE PROCEDURES (Continued)

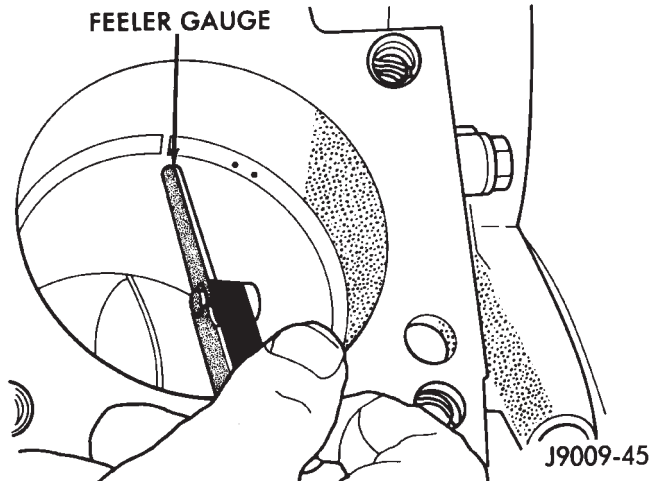


Fig. 12 Ring Gap Measurement

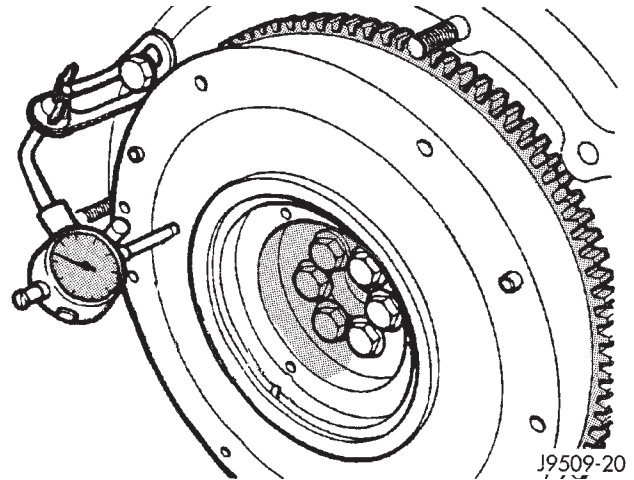


Fig. 14 Measuring Crankshaft End Play

## REMOVAL AND INSTALLATION

## ENGINE MOUNT—FRONT

- (1) Disconnect battery.
- (2) Remove lower air dam at front fascia.
- (3) Remove the bolts holding tow bracket and front mount to the lower crossmember.
- (4) Remove thru bolt in engine mount (Fig. 15). Remove mount.
- (5) Reverse removal procedure for installation.
- (6) Torque engine mount thru bolt to 65 N·m (48 ft. lbs.)
- (7) Torque crossmember bolts for tow bracket and engine mount to 54 N·m (40 ft. lbs.)

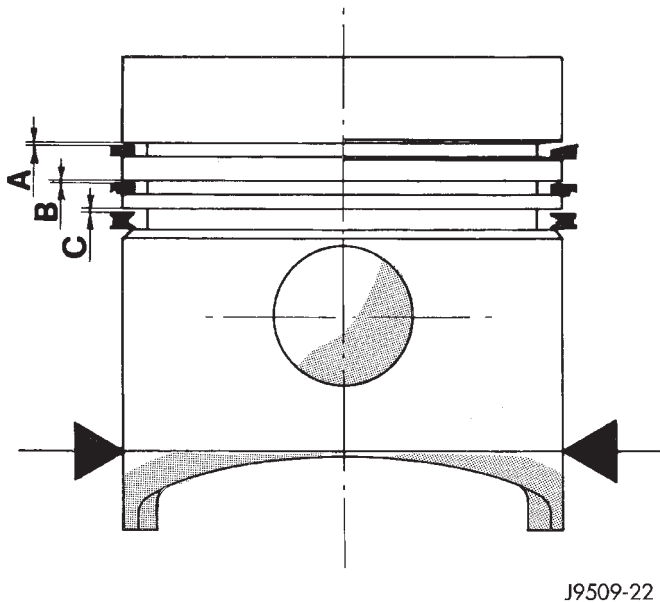


Fig. 13 Piston Ring Side Clearance

(4) Subtract specified crankshaft end float from figure obtained. Crankshaft end float 0.08 to 0.21mm.

(5) Select thrust washer which will give correct end float.

(6) Refer to crankshaft main bearing Installation if not in specification.

**NOTE:** If engine is disassembled refer to Crankshaft Main Bearing Removal and Installation for this procedure.

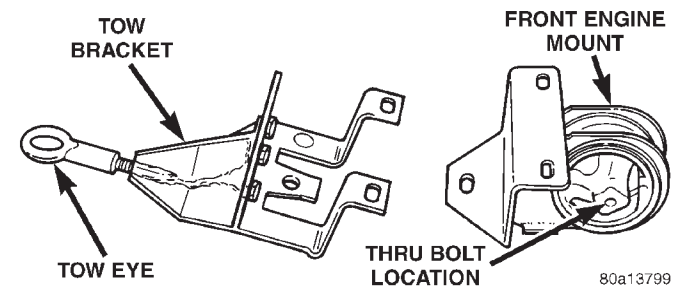


Fig. 15 Front Engine Mount and Tow Bracket

## ENGINE MOUNT—RIGHT

- (1) Remove the right engine mount top support bracket bolt (Fig. 16).
- (2) Remove the load on the engine motor mounts by carefully supporting the engine and transmission assembly with a floor jack.
- (3) Remove the engine mount to frame bolts.
- (4) Remove the thru bolt from the mount assembly. Remove insulator
- (5) If replacing or removing right engine mount bracket the torque on the mounting bolts is 40 N·m (30 ft. lbs.)
- (6) Reverse removal procedure for installation.

## REMOVAL AND INSTALLATION (Continued)

(7) Torque engine mount top bolt (Vertical) to 101 N·m (75 ft. lbs.)

(8) Torque engine mount thru bolt (Horizontal) to 145 N·m (107 ft. lbs.)

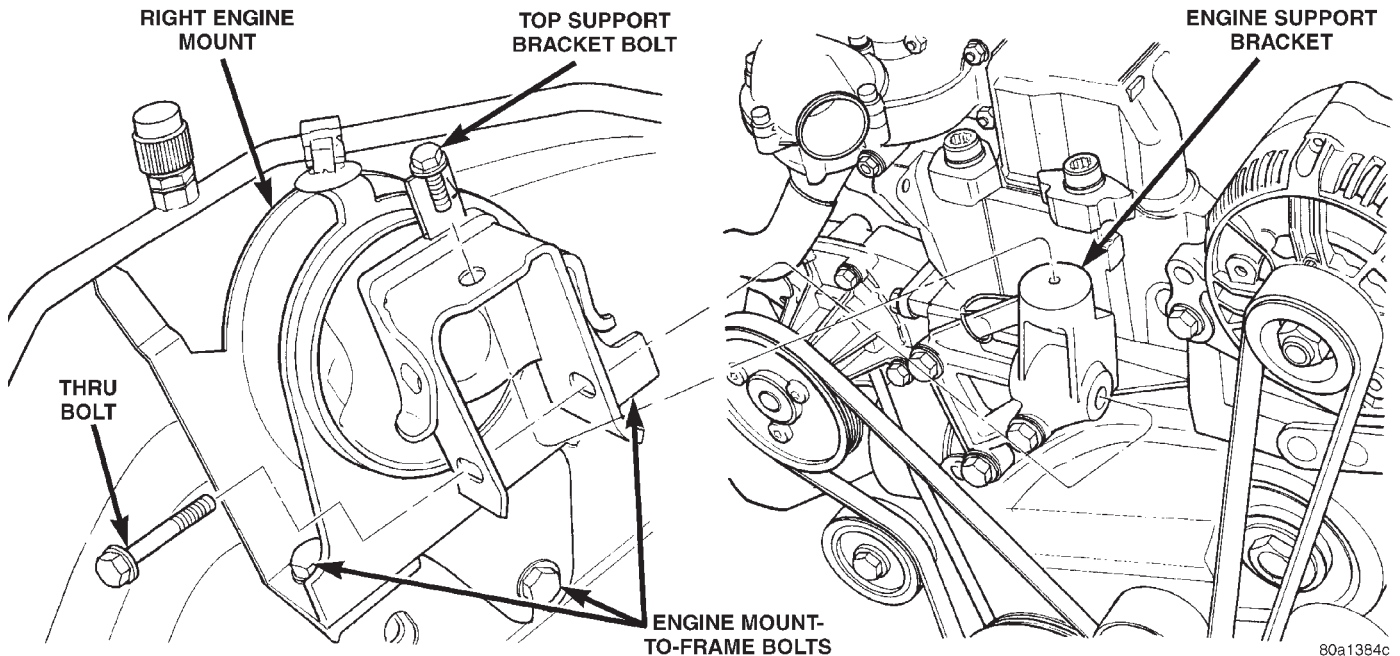
(9) Torque engine mount to frame bolts to 68 N·m (50 ft. lbs.)

(5) Disconnect both shifter cables at transmission. Remove the retainers holding the cables to the mount (Fig. 19).

(6) Remove the mount assembly.

(7) Reverse removal procedure for installation.

(8) Install mount assembly. Torque bolts at engine



**Fig. 16 Right Engine Mount—VM Diesel**

## MOUNT—LEFT SIDE

(1) Raise vehicle on hoist and remove left front wheel.

(2) Remove inner splash shield.

(3) Support the transmission with a transmission jack.

(4) Remove the insulator thru bolt from the mount (Fig. 17).

(5) Remove the transmission mount bolts and remove mount. It may be necessary to lower transmission slightly to remove mount.

(6) Reverse removal procedure for installation.

(7) Install mount. Torque transmission mount bolts to 54 N·m (40 ft. lbs.).

(8) Align mount into frame bracket with transmission jack, install thru bolt. Torque thru bolt to 71 N·m (53 ft. lbs.).

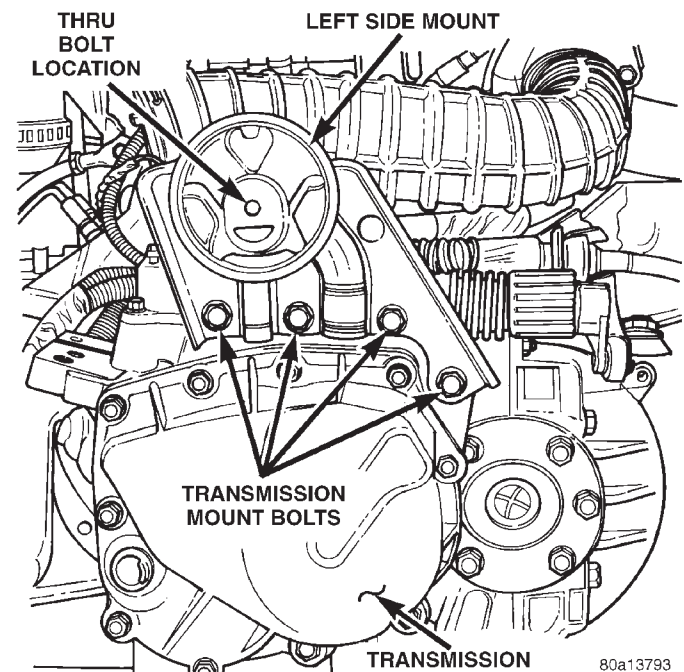
## ENGINE MOUNT—REAR

(1) Raise vehicle on hoist.

(2) Support the engine and transmission assembly with a transmission jack so it will not rotate.

(3) Remove the thru bolt from the insulator at crossmember connection (Fig. 18).

(4) Remove the bolts holding the mount to the engine and transmission.

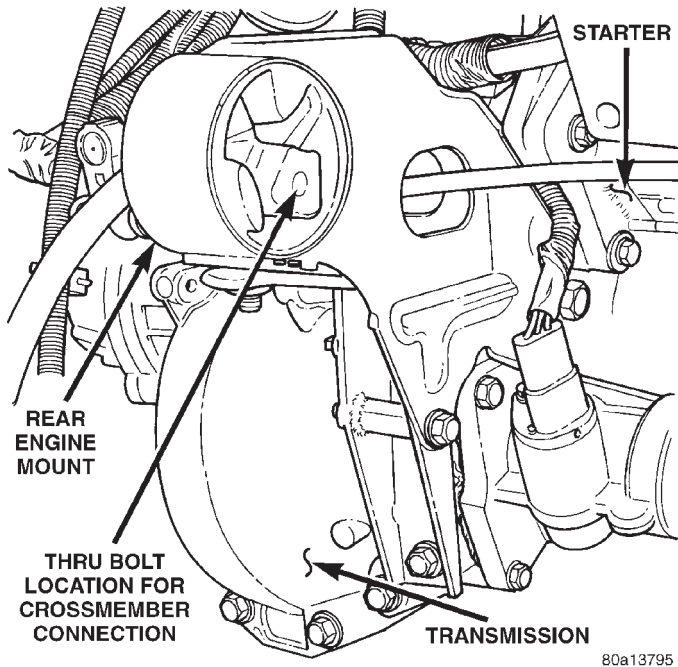


**Fig. 17 Left Side Mount—VM Diesel**

and transmission to 101 N·m (75 ft. lbs.).

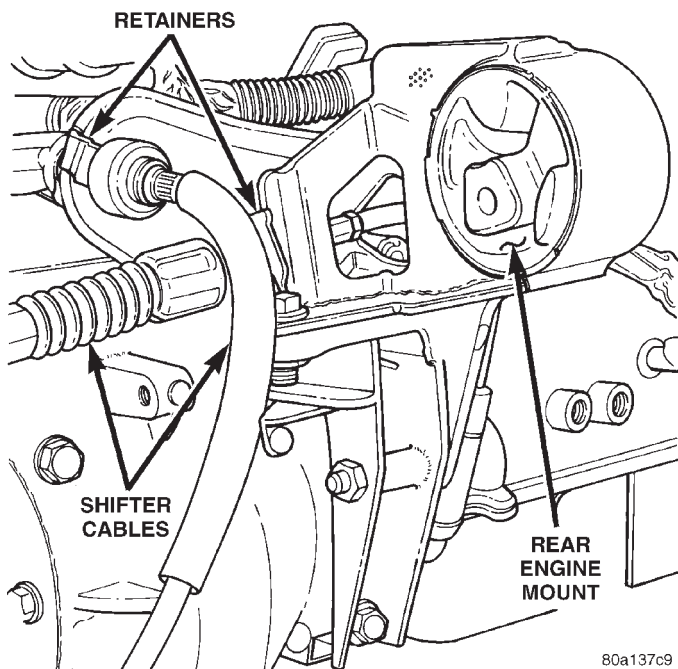
(9) Align insulator at crossmember and install thru bolt. Torque to 68 N·m (50 ft. lbs.).

## REMOVAL AND INSTALLATION (Continued)



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Fig. 18 Rear Engine Mount—VM Diesel



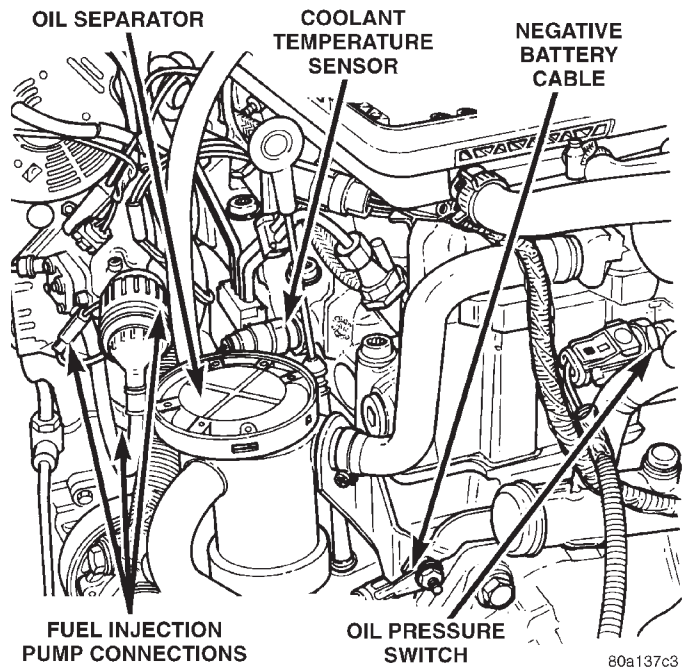
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Fig. 19 Shift Cables at Rear Mount  
ENGINE ASSEMBLY

## REMOVAL

- (1) Disconnect the battery.
- (2) Remove the air cleaner assembly and inlet hose.
- (3) Remove both hoses at intercooler and engine.
- (4) Disconnect EGR vacuum hose.
- (5) Disconnect brake booster vacuum hose.

- (6) Disconnect oil pressure switch connector (Fig. 20).
- (7) Disconnect Wiring harness bracket at transaxle shift tower.
- (8) Disconnect transaxle wiring at speed sensor, crank sensor, and backup light switch.
- (9) Remove both transmission shift cables at transmission.
- (10) Remove negative battery cable at cylinder block (Fig. 20).
- (11) Remove oil separator.
- (12) Remove connectors at coolant temperature sensor and A/C compressor.
- (13) Disconnect fuel injection pump wiring connectors (Fig. 20).
- (14) Disconnect glow plug connectors.
- (15) Disconnect electrical connector at number 1 fuel injector.
- (16) Raise vehicle on hoist.
- (17) Remove right side splash shield (Fig. 21).



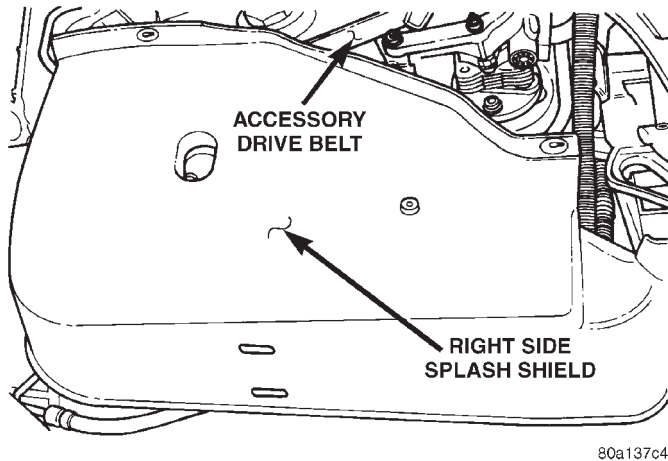
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Fig. 20 Component Locations

**WARNING: THE COOLANT IN A RECENTLY OPERATED ENGINE IS HOT AND PRESSURIZED. USE CARE TO PREVENT SCALDING BY HOT COOLANT. CAREFULLY RELEASE THE PRESSURE BEFORE REMOVING THE RADIATOR DRAIN COCK AND CAP.**

- (18) Drain the cooling system (refer to Group 7, Cooling).
- (19) Lower vehicle.
- (20) Remove Coolant pressure bottle and disconnect low coolant level sensor.
- (21) Disconnect both heater hoses.
- (22) Remove the lower radiator hose.
- (23) Remove the upper radiator hose.

## REMOVAL AND INSTALLATION (Continued)



**Fig. 21 Right Side Splash Shield**

- (24) Remove fuel line at injector pump and cap.
- (25) Remove power steering reservoir and reposition.
- (26) Remove upper radiator crossmember.
- (27) Disconnect cooling fan module connector.
- (28) Remove radiator support bolts. **It is necessary to loosen the receiver/dryer to gain access to the radiator bolts.**
- (29) Remove radiator and fans as an assembly.
- (30) Remove accessory drive belt generator/power steering. Refer to Group 7, for procedure.
- (31) Remove both power steering lines at pump, and cap both lines.

**NOTE: It is not necessary to discharge A/C system for engine removal.**

(32) Remove A/C compressor. Secure compressor away from engine for clearance during engine removal.

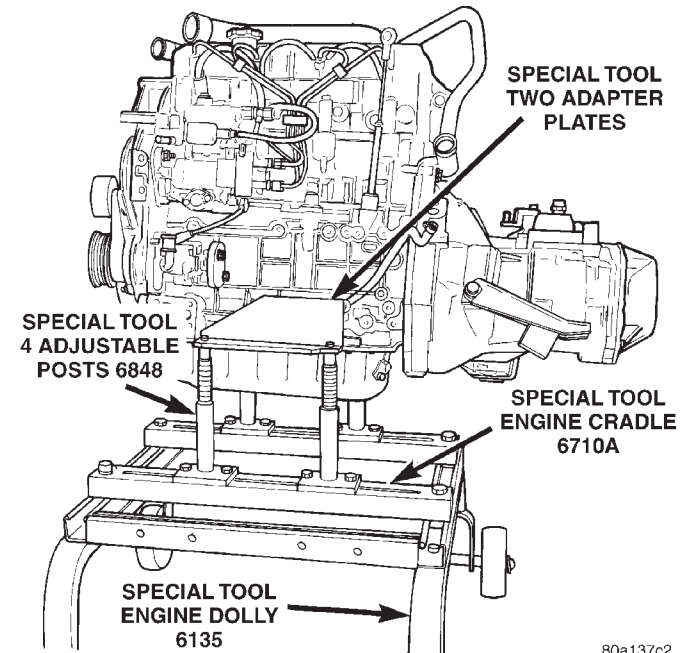
(33) Remove Generator and adjusting bracket.

**NOTE: Do not remove the mounting base from the generator. It is aligned at the factory and cannot be realigned in the field.**

- (34) Hoist vehicle.
- (35) Remove exhaust pipe at turbo outlet.
- (36) Remove connections at starter.
- (37) Remove power steering high pressure line bracket at rear of oil pan.
- (38) Remove both driveshafts from transaxle. Refer to Group 2, Suspension and Driveshafts.
- (39) Disconnect clutch cable at transaxle.
- (40) Remove reinforcement plate on lower crossmember.
- (41) Remove front and rear engine mounts. Refer to procedure outlined in this section.
- (42) Drain engine oil and remove oil filter if necessary.

(43) Mount both special tool, engine support brackets VM-1026 to cylinder block (Fig. 22).

(44) Using engine dolly and cradle assembly with 4 adjustable posts align posts with holes in the engine support brackets.



**Fig. 22 Engine Removal**

(45) Lower vehicle so weight of **only the engine and transmission** is on the dolly and cradle assembly.

(46) Remove left side splash shield to gain access to thru bolt for left side mount.

(47) Remove right engine mount and left side mount. Refer to procedure outlined in this section.

(48) Raise vehicle slowly. It may be necessary to move the engine/transmission assembly on the dolly to allow for removal around body.

(49) Reverse removal procedure for installation.

## CYLINDER HEAD COVER

### REMOVAL

- (1) Disconnect the battery cables.
- (2) Remove generator bracket.
- (3) Remove breather hose.
- (4) Remove coolant pressure tank.
- (5) Remove cylinder head cover.

### INSTALLATION

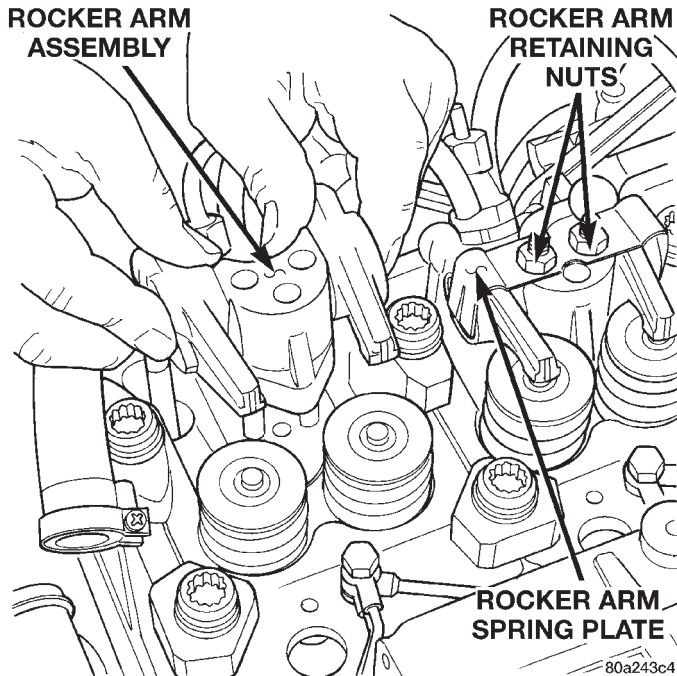
- (1) Install cylinder head cover, torque nuts to 23.5 N·m (208 in. lbs.).
- (2) Install coolant pressure tank.
- (3) Install breather hose.
- (4) Install generator bracket, tighten bolts to 7 N·m (4 ft. lbs.).

## REMOVAL AND INSTALLATION (Continued)

- (5) Connect battery cable.

**ROCKER ARMS AND PUSH RODS****REMOVAL**

- (1) Disconnect the battery cables.
- (2) Remove generator bracket.
- (3) Remove breather hose.
- (4) Remove coolant pressure tank.
- (5) Remove cylinder head cover.
- (6) Remove rocker retaining nuts (Fig. 23).



**Fig. 23 Rocker Arm Retaining Nut**

- (7) Remove rocker assembly. Place them on a bench in the same order as removed.
- (8) Remove the push rods and place them on a bench in the same order as removed.

**INSTALLATION**

- (1) Install the push rods in the same order as removed.
- (2) Install rocker arm assemblies in the same order as removed. Tighten the rocker arm nuts to 29.4 N·m (264 in. lbs.) torque.
- (3) Install cylinder head cover, torque nuts to 14.7 N·m (132 in. lbs.).
- (4) Install coolant pressure tank.
- (5) Install breather hose.
- (6) Install generator bracket, tighten bolts to 7 N·m (4 ft. lbs.).
- (7) Connect the service valves to the A/C compressor ports, if equipped with air conditioning.
- (8) Connect battery cable.

**VALVE SPRINGS—CYLINDER HEAD NOT REMOVED**

This procedure can be done with the engine cylinder head installed on the block.

**REMOVAL**

Each valve spring is held in place by a retainer and a set of conical valve locks. The locks can be removed only by compressing the valve spring.

- (1) Remove the engine cylinder head cover, refer to cylinder head cover removal in this section.
  - (2) Remove rocker arms assemblies for access to each valve spring to be removed.
  - (3) Remove push rods. Retain the push rods, and rocker arms assemblies in the same order and position as removed.
  - (4) Inspect the springs and retainer for cracks and possible signs of weakening.
  - (5) Install an air hose adaptor in the fuel injector hole.
  - (6) Connect an air hose to the adapter and apply air pressure slowly. Maintain at least 621 kPa (90 psi) of air pressure in the cylinder to hold the valves against their seats.
  - (7) Tap the retainer or tip with a rawhide hammer to loosen the lock from the retainer. Use Valve Spring Compressor Tool to compress the spring and remove the locks.
  - (8) Remove valve spring and retainer.
- Inspect the valve stems, especially the grooves. An Arkansas smooth stone should be used to remove nicks and high spots.

**INSTALLATION**

- (1) Install valve spring and retainer.
- (2) Compress the valve spring with Valve Spring Compressor Tool and insert the valve locks. Release the spring tension and remove the tool. Tap the spring from side-to-side to ensure that the spring is seated properly on the engine cylinder head.
- (3) Disconnect the air hose. Remove the adaptor from the fuel injector hole and install the fuel injector.
- (4) Repeat the procedures for each remaining valve spring to be removed.
- (5) Install the push rods. Ensure the bottom end of each rod is centered in the plunger cap seat of the hydraulic valve tappet.
- (6) Install the rocker arm assemblies, at their original location.
- (7) Tighten the rocker arm assembly nut to 106 N·m (78 ft. lbs.) torque.
- (8) Install the engine cylinder head cover, refer to cylinder head cover installation in this section.

## REMOVAL AND INSTALLATION (Continued)

## CYLINDER HEAD

## REMOVAL

- (1) Disconnect the battery cable.

**WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAIN COCK WITH THE SYSTEM HOT AND PRESSURIZED BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.**

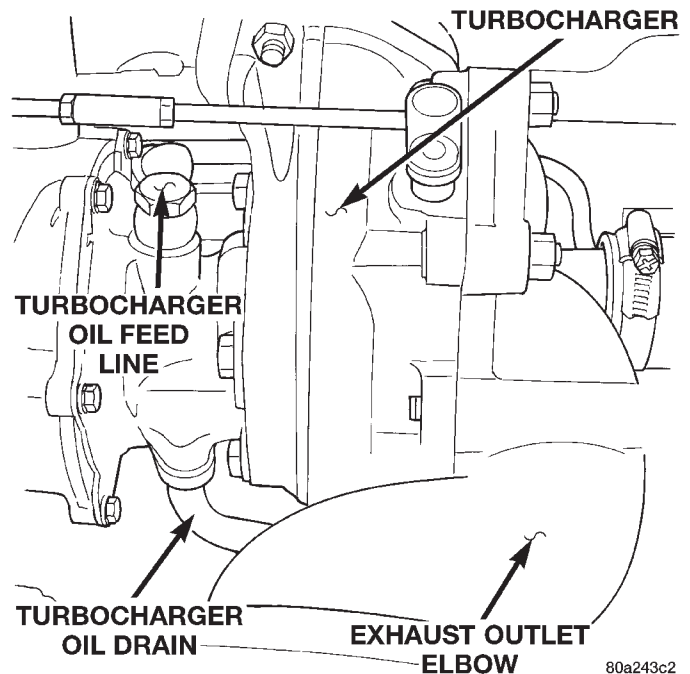
- (2) Drain the cooling system. Refer to Group 7, Cooling.

- (3) Remove wiper module. Refer to Group 8K, Windshield Wiper Unit Removal for procedure.

- (4) Remove coolant pressure bottle.

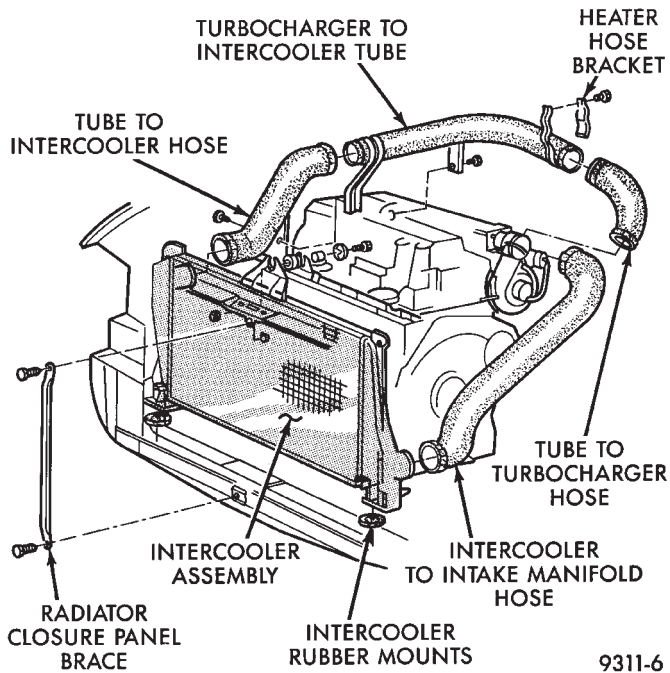
- (5) Remove intercooler hose at intake manifold (Fig. 24).

- (6) Remove intercooler hose at turbocharger intercooler tube.



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Fig. 25 Turbocharger



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Fig. 24 Intercooler Assembly

- (7) Remove the upper radiator hose.
- (8) Remove water manifold.
- (9) Disconnect the heater hoses and coolant pressure bottle hoses.

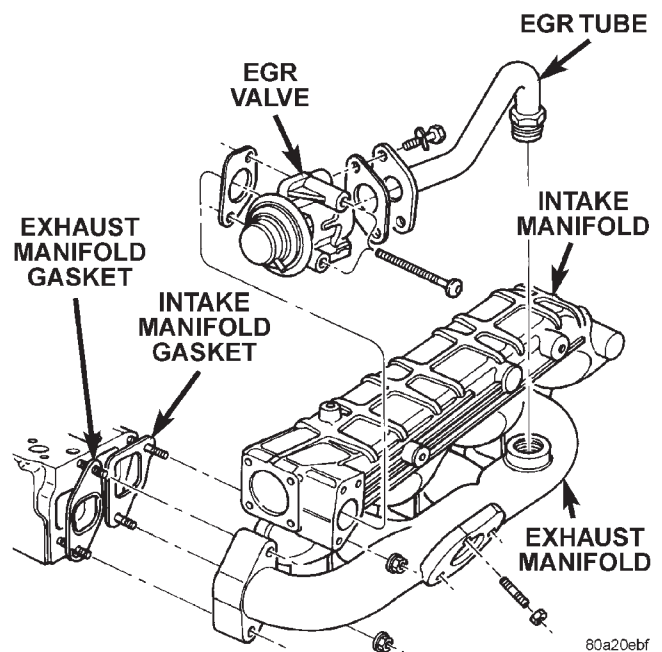
- (10) Disconnect EGR tube from EGR valve (Fig. 26).

- (11) Remove exhaust pipe from turbocharger elbow and.

- (12) Disconnect oil feed line from turbo (Fig. 25).

- (13) Disconnect oil drain line from turbo.

- (14) Remove Intake manifold. Refer to Group 11, Exhaust System and Intake Manifold.



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Fig. 26 EGR Valve and Tube

- (15) Remove lift eye and brake vacuum tube at rear of exhaust manifold.

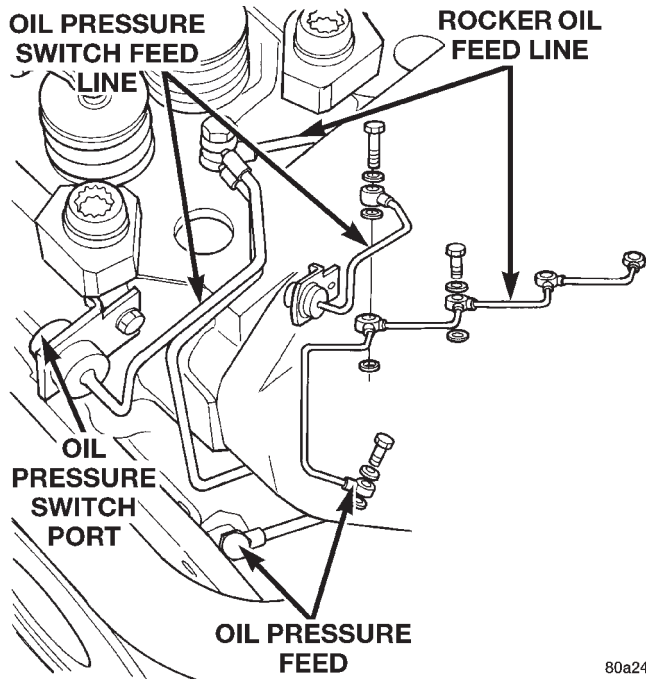
- (16) Remove the support strut from block to turbocharger exhaust elbow.

- (17) Remove Exhaust manifold. Refer to Group 11, Exhaust System and Intake Manifold.

- (18) Remove oil line at pressure switch.

- (19) Remove oil feed line for rocker arm assemblies (Fig. 27).

REMOVAL AND INSTALLATION (Continued)

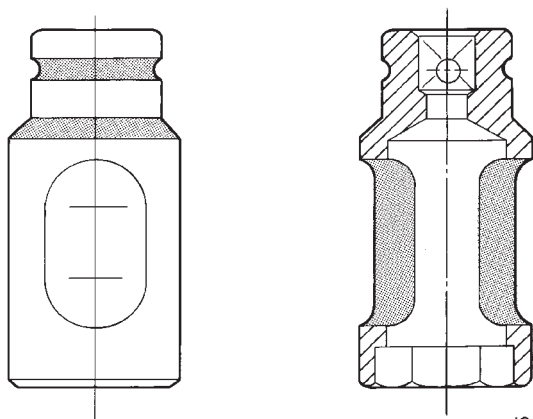


**Fig. 27 Rocker Arm Oil Feed Lines**

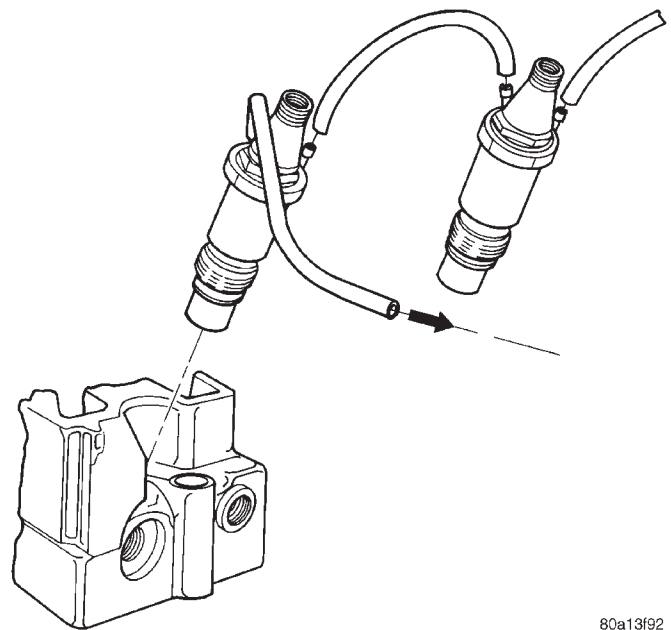
- (20) Remove Crankcase breather hose from valve cover
- (21) Remove the engine cylinder head cover.
- (22) Remove the injector sensor wire at the connector, and glow plug Connectors.

**NOTE:** The attachment point for the injector sensor wire at the injector is not a connector. The connector is located in the wire 4 to 6 inches away from the injector.

- (23) Remove injector fuel lines from injectors to pump.
- (24) Remove fuel injectors with tool VM-1012A (Fig. 28) and (Fig. 29) Refer to Group 14, Fuel System.

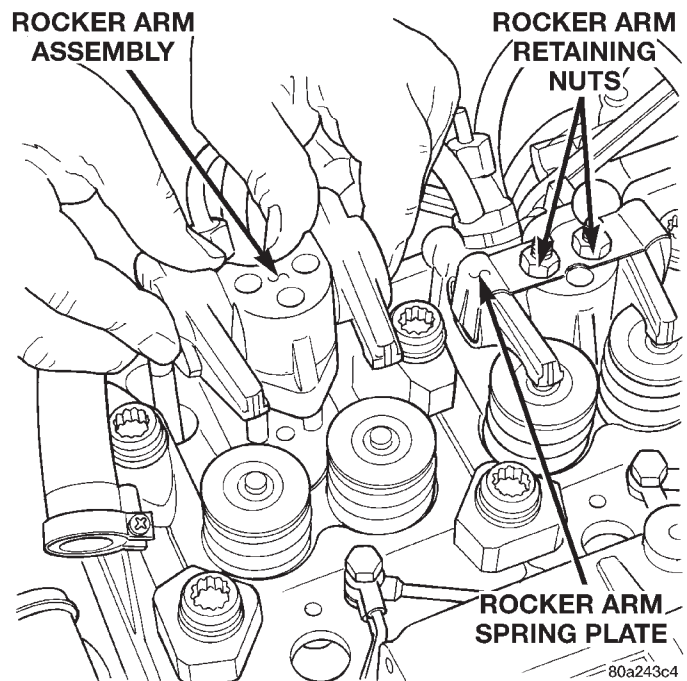


**Fig. 28 Fuel Injector Tool VM-1012A**



**Fig. 29 Fuel Injector**

- (25) Remove rocker retaining nuts (Fig. 30).



**Fig. 30 Rocker Arm Retaining Nut**

- (26) Remove rocker assemblies. Place them on a bench in the same order as removed.
- (27) Remove the push rods and place them on a bench in the same order as removed.
- (28) Mark cylinder heads to ensure installation in there original position.
- (29) Remove the engine cylinder head bolts with special tool VM-1018 and VM-1019.

REMOVAL AND INSTALLATION (Continued)

(30) Remove the engine cylinder heads and gasket.

**NOTE:** A single steel head gasket is used for 4 cylinder heads (Fig. 33).

(31) Stuff clean lint free shop towels into the cylinder bores.

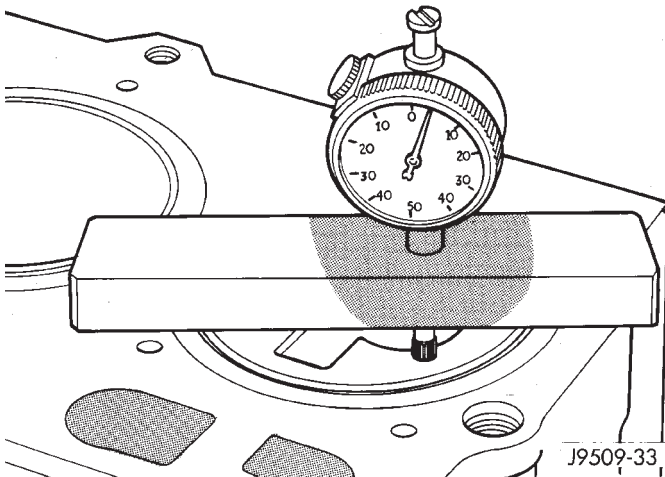
CYLINDER HEAD GASKET

**NOTE:** If cylinder wall liners have not been removed; the same thickness head gasket removed, may be used.

**CAUTION:** Piston protrusion must be measured, to determine cylinder head gasket thickness, if one or more cylinder wall liners have been replaced.

Cylinder head gaskets are available in three thicknesses. The different thicknesses are marked with identification holes (one, two or none) (Fig. 33). The gasket is to be installed DRY. **DO NOT use a gasket sealing compound on the gasket.**

(1) Use special tool VM-1010 with dial indicator special tool VM- 1013 (Fig. 31).



**Fig. 31 Measuring Piston Protrusion**

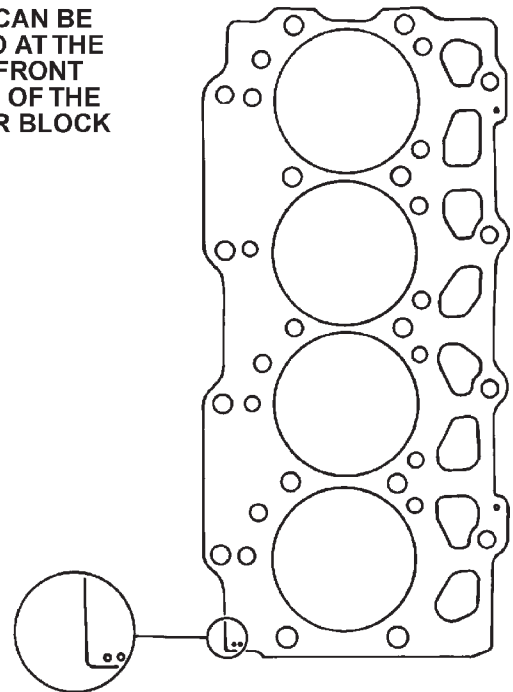
- (2) Bring the piston of cylinder no. 1 exactly to top dead center.
- (3) Zero the dial indicator on the cylinder block mating surface.
- (4) Setup the dial indicator on the piston crown (above the center of the piston pin) 5mm (1/8 in.) from the edge of the piston and note the measurement (Fig. 32).
- (5) Repeat the procedure with the rest of the cylinders.
- (6) Establish the thickness of the gasket for all four cylinder heads on the basis of the greatest piston protrusion (Fig. 33).

Measured dimension (mm) . . . . .	0.53 - 0.62
Cyl. head gasket thickness (mm) . . . . .	1.42
Piston clearance (mm). . . . .	0.80 - 0.89
Measured dimension (mm) . . . . .	0.63 - 0.72
Cyl. head gasket thickness (mm) . . . . .	1.52
Piston clearance (mm). . . . .	0.80 - 0.89
Measured dimension (mm) . . . . .	0.73 - 0.82
Cyl. head gasket thickness (mm) . . . . .	1.62
Piston clearance (mm). . . . .	0.80 - 0.89

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**Fig. 32 Piston Protrusion Chart**

**HOLES CAN BE LOCATED AT THE RIGHT FRONT CORNER OF THE CYLINDER BLOCK**



HOW TO IDENTIFY GASKET THICKNESS	
NO HOLES . . . . .	1.42 mm
2 HOLES . . . . .	1.52 mm
1 HOLE . . . . .	1.62 mm

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**Fig. 33 Head Gasket Identification**

INSTALLATION CYLINDER HEAD

- (1) Remove the shop towels from the cylinder bores. Coat the bores with clean engine oil.
- (2) Install cylinder head alignment studs (VM-1009).
- (3) After determining the correct head gasket thickness, clean the block and head mating surfaces, place the engine cylinder head gasket over the dowels.
- (4) Place the engine cylinder head over the dowels.

**CAUTION:** Engine cylinder head bolts can be reused up to three times.

## REMOVAL AND INSTALLATION (Continued)

(5) Tighten the engine cylinder head bolts in sequence according to the following procedure (Fig. 34):

a. The threads and underside heads of the bolts should be lubricated. Use the cylinder head alignment studs tool number VM-1009. Position the heads on the block and secure with the ten large center bolts and spacers (clamps), finger tight only.

b. Ensure that the various clamps are installed correctly and the head gasket remain in their proper position, completely covered. Then, lubricate and install the eight small bolts, also finger tight.

(6) Loosen assembly oil feed line for rocker arm assemblies

(7) Install the intake and exhaust manifolds with new gaskets, partially tightening the nuts to a maximum of 5 N·m (44 in. lbs.). This will align the heads (refer to Group 11, Exhaust System and Intake Manifold for the proper procedures). Install lift eye and brake vacuum tube at this time.

(8) Then, tighten the 12mm bolts with special tool VM-1019 in the following manner:

(11) Side bolts (M1-M2): Tighten M1 bolts to 30 N·m, then rotate them  $85^\circ (\pm 5)$ . Tighten M2 bolts to 30 N·m, then rotate them  $85^\circ (\pm 5)$ .

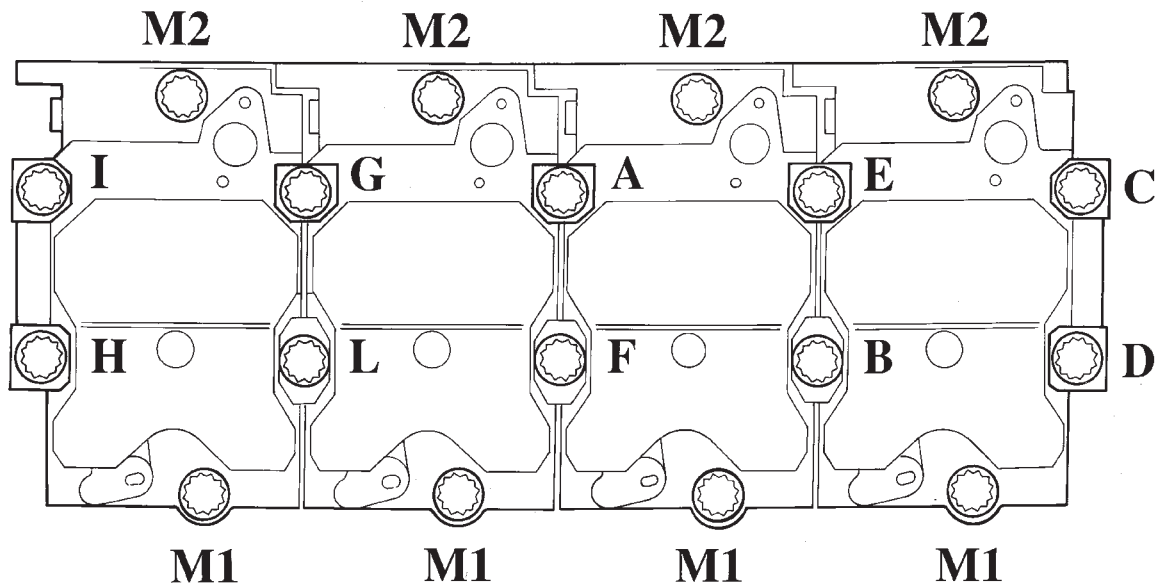
(12) **2nd Phase:** After 20 minutes of engine operation at operating temperature, allow engine to cool down completely. Then retorque the head bolts as follows:

(13) Central bolts A-L: Starting from bolt A, slacken and retorque it immediately to  $30 \text{ N}\cdot\text{m} + 65^\circ$ . Rotate the bolt an additional  $65^\circ$ . Then proceed in the same way, bolt by bolt, following alphabetical order, as indicated.

(14) Side bolts M1-M2: **Without slackening**, torque bolts M1 then bolts M2 to 90 N·m (66 ft. lbs.).

(15) Tighten intake nuts to 30 N·m (22 ft. lbs.) and exhaust manifolds nuts to 30 N·m (22 ft. lbs.) specified torque after completing Phase 2.

(16) If the engine cylinder head is to be replaced and the original valves used, measure the valve stem diameter. Only standard size valves can be used with a service replacement engine cylinder head unless the replacement head valve stem guide bores are



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**Fig. 34 Engine Cylinder Head Bolt Tightening Sequence**

(9) **1st Phase:** Tightening Head Bolts (Fig. 34). Central bolts (A-L): Tighten all bolts, starting with bolt A then B-C-D-E-F-G-H-I-L, to 30 N·m. Repeat the operation with the same torque. Following the same sequence rotate each bolt through an angle of  $70^\circ$  using angle torque tool. Then rotate the bolts an additional  $70^\circ$  following tightening sequence.

(10) Then, tighten the 14mm bolts with special tool VM-1018 in the following manner:

reamed to accommodate oversize valve stems. Remove all carbon buildup and reface the valves.

(17) Tighten oil feed lines for rocker arm assemblies and oil pressure switch to 13 N·m (112 in. lbs.).

(18) Install push rods and rocker arm assemblies, tighten nut to 29.4 N·m (264 in. lbs.).

(19) Install fuel injectors use tool VM-1012 (refer to Group 14, Fuel System).

(20) Install valve cover, tighten nuts to 14.7 N·m (132 in. lbs.).

## REMOVAL AND INSTALLATION (Continued)

- (21) Connect crankcase breather hose.
- (22) Connect the injector sensor wire connector, and the glow plug connectors.
- (23) Install oil feed line, tighten banjo bolts to 12.7 N·m (108 in. lbs), and oil drain line to turbo.
- (24) Install water manifold tighten bolts to 12 N·m (106 in. lbs.).
- (25) Install exhaust pipe to turbo elbow, tighten bolts to 28 N·m (250 in. lbs.).
- (26) Install the support strut from block to turbo-charger exhaust elbow.
- (27) Install EGR tube to EGR valve, tighten bolts to 26 N·m (19 ft. lbs.).
- (28) Install intercooler hoses at intake manifold.
- (29) Install coolant pressure bottle and hoses.
- (30) Install wiper module. Refer to Group 8K, Windshield Wiper Unit Installation for procedure.
- (31) Install intercooler hose at turbocharger tube.
- (32) Install fuel injector lines from the pump to injectors, tighten nuts to 17.6 N·m (156. lbs.).
- (33) Connect the upper radiator hose.
- (34) Connect negative cable to battery.
- (35) Fill the cooling system. Check for leaks.

**WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.**

- (36) Operate the engine with the radiator cap off. Inspect for leaks and continue operating the engine until the thermostat opens. Add coolant, if required.

## VALVES AND VALVE SPRINGS—HEAD OFF

This procedure is done with the engine cylinder head removed from the block.

## REMOVAL

- (1) Remove the engine cylinder head from the cylinder block. Refer to cylinder head removal in this section.
- (2) Use Valve Spring Compressor Tool and compress each valve spring.
- (3) Remove the valve locks, retainers, and springs.
- (4) Use an Arkansas smooth stone or a jewelers file to remove any burrs on the top of the valve stem, especially around the groove for the locks.
- (5) Remove the valves, and place them in a rack in the same order as removed.

## INSTALLATION

- (1) Fit each valve to its respective valve guide.

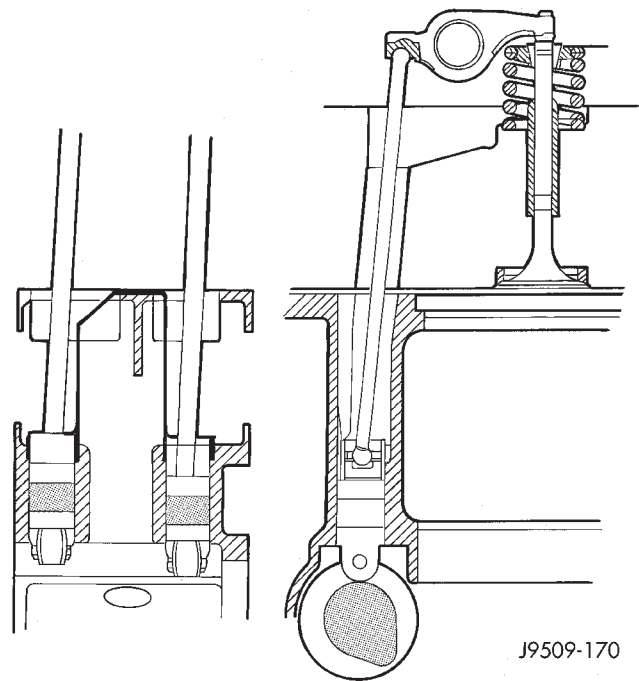
**NOTE: If valves and valve seats have been refaced refer to Service Procedures in this section. Follow The Valve Stand Down procedure.**

- (2) Install lower, washer and spring.
- (3) Install upper spring collar, and compress valve spring with spring compressor tool. Install split cone retainers.

## HYDRAULIC TAPPETS

## REMOVAL

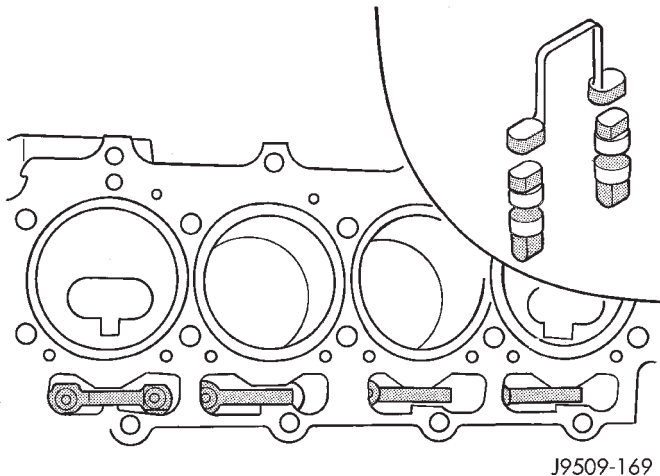
- (1) Remove coolant pressure bottle.
- (2) Remove cylinder head cover. Refer to cylinder head cover removal in this section.
- (3) Remove rocker assembly and push rods. Identify push rods to ensure installation in original location (Fig. 35).



**Fig. 35 Tappet and Rocker Arm Assembly**

- (4) Remove cylinder head, intake manifold, and exhaust manifold. Refer to cylinder head removal in this section.
- (5) Remove yoke retainer and aligning yokes (Fig. 36).
- (6) Slide Hydraulic Tappet Remover/Installer Tool through opening in block and seat tool firmly in the head of tappet.
- (7) Pull tappet out of bore with a twisting motion. If all tappets are to be removed, identify tappets to ensure installation in original location.
- (8) If the tappet or bore in cylinder block is scored, scuffed, or shows signs of sticking, ream the bore to next oversize. Replace with oversize tappet.

## REMOVAL AND INSTALLATION (Continued)



**Fig. 36 Tappet and Yoke**

**CAUTION:** The plunger and tappet bodies are not interchangeable. The plunger and valve must always be fitted to the original body. It is advisable to work on one tappet at a time to avoid mixing of parts. Mixed parts are not compatible. **DO NOT** disassemble a tappet on a dirty work bench.

#### INSTALLATION

- (1) Lubricate tappets.
- (2) Install tappets and yoke retainers in their original positions. Ensure that the oil feed hole in the side of the tappet body faces up (away from the crankshaft).
- (3) Install cylinder head, intake manifold, and exhaust manifold. Refer to cylinder head installation in this section.
- (4) Install push rods in original positions.
- (5) Install rocker arms in original positions.
- (6) Install cylinder head cover. Refer to cylinder valve cover installation in this section.
- (7) Start and operate engine. Warm up to normal operating temperature.

**CAUTION:** To prevent damage to valve mechanism, engine must not be run above fast idle until all hydraulic tappets have filled with oil and have become quiet.

#### VIBRATION DAMPER

##### REMOVAL

- (1) Disconnect the battery cable.
- (2) Raise vehicle on hoist.
- (3) Remove right side lower splash shield.
- (4) Remove generator, power steering belt. Refer to Group 7, Cooling.
- (5) Remove water pump belt. Refer to Group 7, Cooling.

(6) Remove engine starter. Refer to Group, 8B for procedure

(7) Install flywheel locking tool VM.1014 to prevent engine rotation.

**NOTE:** Crankshaft damper nut is left handed thread.

- (8) Remove vibration damper nut.
- (9) Remove vibration damper. No special tool is needed for removal.

**CAUTION:** If thread sealant is used it is important to remove all the old thread sealant from the threads on the crankshaft.

#### INSTALLATION

**NOTE:** Before installing damper be sure the O-ring inside the center of the damper is in its groove.

- (1) Install vibration damper.

**CAUTION:** Correct torque on the vibration damper nut is important or engine damage can occur.

- (2) Install vibration damper nut and tighten to 441 N-m (325 ft. lbs.).
- (3) Remove flywheel locking tool, and install engine starter.
- (4) Install both accessory drive belts. Refer to Group 7, Cooling.
- (5) Install right splash shield.
- (6) Lower vehicle.
- (7) Connect the battery cable.

#### TIMING CHAIN COVER OIL SEAL

##### REMOVAL

- (1) Disconnect the battery cable.
- (2) Remove vibration damper. Refer to vibration damper removal in this section.
- (3) Pry out seal (Fig. 37).

##### INSTALLATION

Remove the oil seal ring. The seating diameter must be 68.000 - 68.030 mm.

- (1) Install new seal using special tool VM-1015.
- (2) Install vibration damper. Refer to vibration damper installation in this section.
- (3) Connect the battery cable.

#### INJECTION PUMP

For removal and installation of injection pump refer to Group 14, Fuel.

## REMOVAL AND INSTALLATION (Continued)

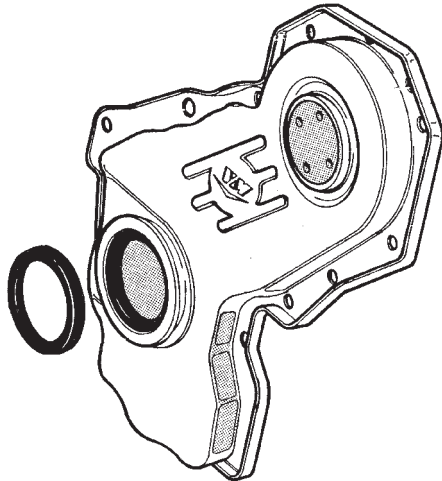


Fig. 37 Front Cover Seal

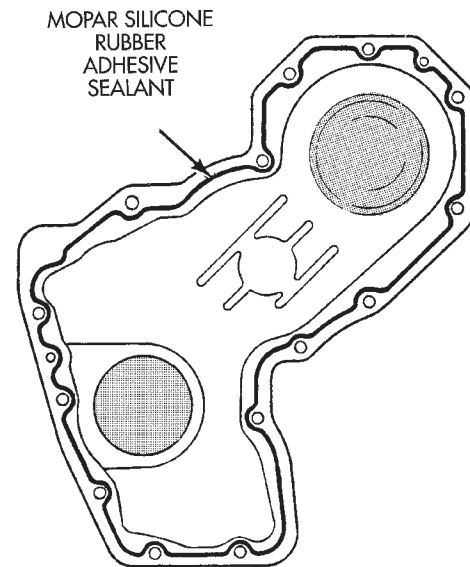


Fig. 38 Front Cover Sealer Location

## TIMING CHAIN COVER

## REMOVAL

- (1) Disconnect the battery cable.
- (2) Raise vehicle on hoist.
- (3) Remove right splash shield.
- (4) Remove accessory drive belts. Refer to Group 7, Cooling.
- (5) Remove vibration damper nut.

**NOTE:** Crankshaft damper nut is left handed thread.

- (6) Remove vibration damper.
- (7) Remove power steering/air conditioning pulley nut. Remove pulley.

**CAUTION:** Remove old loctite from threads on pump.

- (8) Remove pump shaft support bracket assembly.
- (9) Disconnect the water drain pipe hose at the timing cover.

**CAUTION:** When separating the timing chain cover from the block take care not to damage the mating surface of the timing chain cover or block. Also take care not to damage the timing chain or components located inside the timing chain cover near the edge.

- (10) Remove timing chain cover.

## INSTALLATION

- (1) Apply a continuous 3 mm bead of Silicone Sealer to timing cover, install within 10 minutes, tighten Torx bolts to 11 N-m (96 in. lbs) (Fig. 38).
- (2) Install pump shaft support bracket assembly, tighten nuts to 24.5 N-m (216 in. lbs.).

- (3) Install Power steering/air conditioning pulley, tighten to 170 N-m (125 ft. lbs.).

**CAUTION:** Correct torque on the power steering/air conditioning pulley nut is important or engine damage can occur.

- (4) Connect water drain pipe hose at the timing cover.

**NOTE:** Before installing damper be sure O-ring on inside center of damper is in place.

- (5) Install vibration damper.

**CAUTION:** Correct torque on the vibration damper nut is important or engine damage can occur.

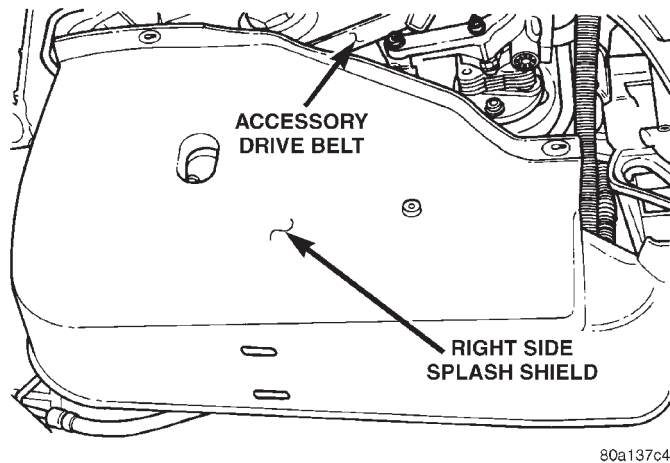
- (6) Tighten vibration damper nut to 441 N-m (325 ft. lbs.).
- (7) Install accessory drive belts. Refer to Group 7, cooling for procedure.
- (8) Install splash shield.
- (9) Lower vehicle.
- (10) Connect battery cable.

## TIMING CHAIN

## REMOVAL

- (1) Disconnect battery.
- (2) Raise vehicle on hoist.
- (3) Remove right splash shield (Fig. 39).
- (4) Remove both accessory drive belts. Refer to Group 7, Cooling.

## REMOVAL AND INSTALLATION (Continued)



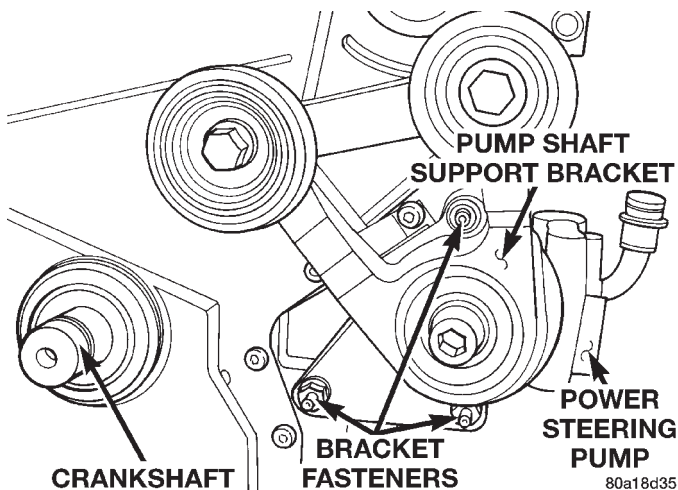
**Fig. 39 Splash Shield**

(5) Remove crankshaft vibration damper. Refer to removal procedure outlined in this section.

(6) Remove power steering/air conditioning pulley nut. Remove pulley.

**CAUTION:** Remove old thread sealant from threads on pump.

(7) Remove pump shaft support bracket assembly (Fig. 40).



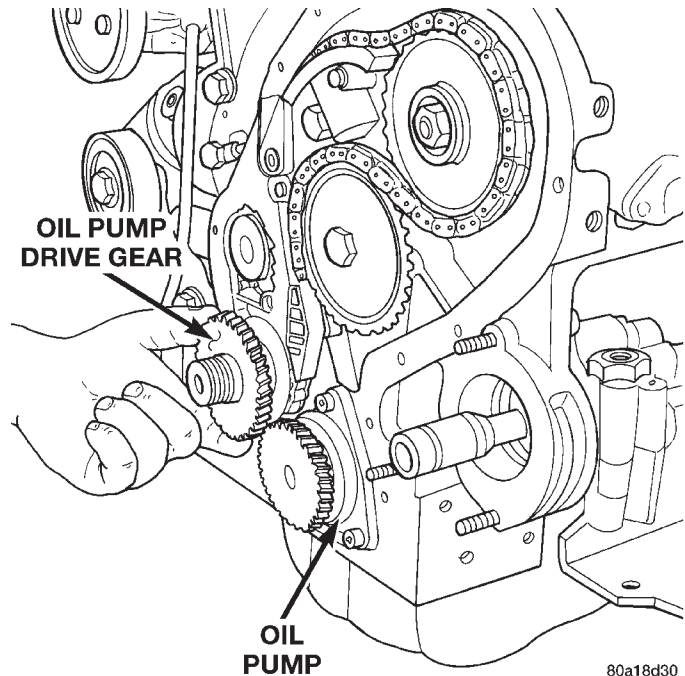
**Fig. 40 Pump Shaft Support Bracket**

(8) Remove timing chain cover. Refer to removal procedure outlined in this section.

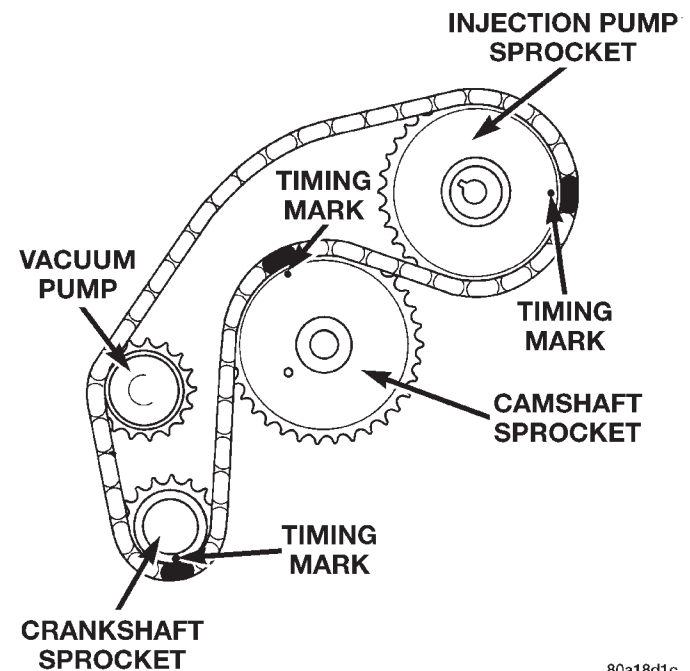
(9) Remove oil pump drive gear attached to crankshaft (Fig. 41).

(10) Rotate crankshaft to align timing marks on injection pump sprocket, camshaft sprocket, and crankshaft sprocket with three dark plated links on timing chain (Fig. 42).

**CAUTION:** It could take up to 70 crankshaft revolutions to align sprocket timing marks with the dark chain links. If the chain is removed (Fig. 43) before



**Fig. 41 Oil Pump Drive Gear**



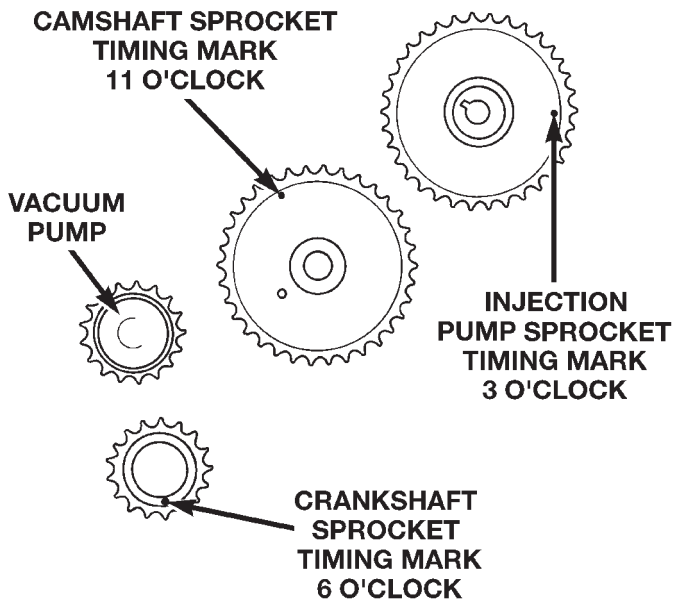
**Fig. 42 Timing Marks**

the sprocket marks are in their proper locations you must first loosen the rocker arm supports before rotating crankshaft or camshaft sprockets. This will prevent the valves from hitting the pistons.

- (11) Remove lower chain guide (Fig. 44).
- (12) Remove hydraulic tensioner blade (Fig. 45).
- (13) Remove hydraulic tensioner oil feed line (Fig. 46).
- (14) Remove hydraulic tensioner.

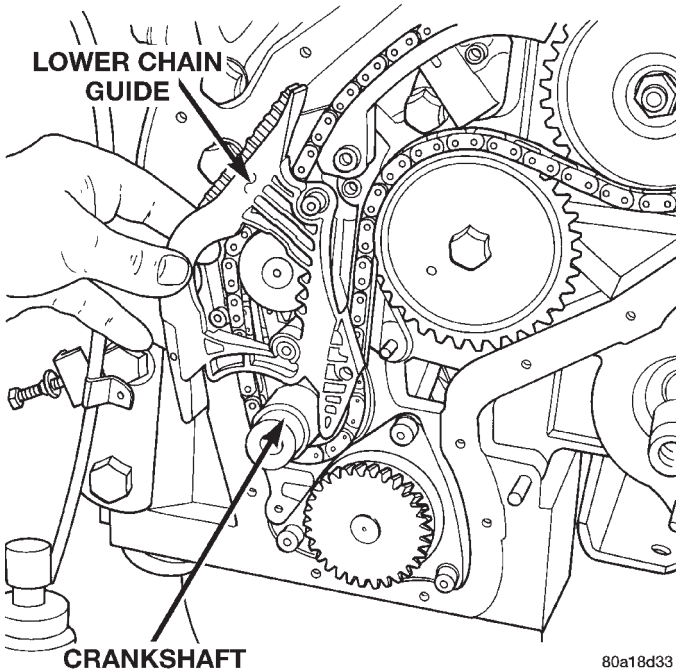
## REMOVAL AND INSTALLATION (Continued)

(15) Remove timing chain.



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**Fig. 43 Alignment Timing Sprockets**

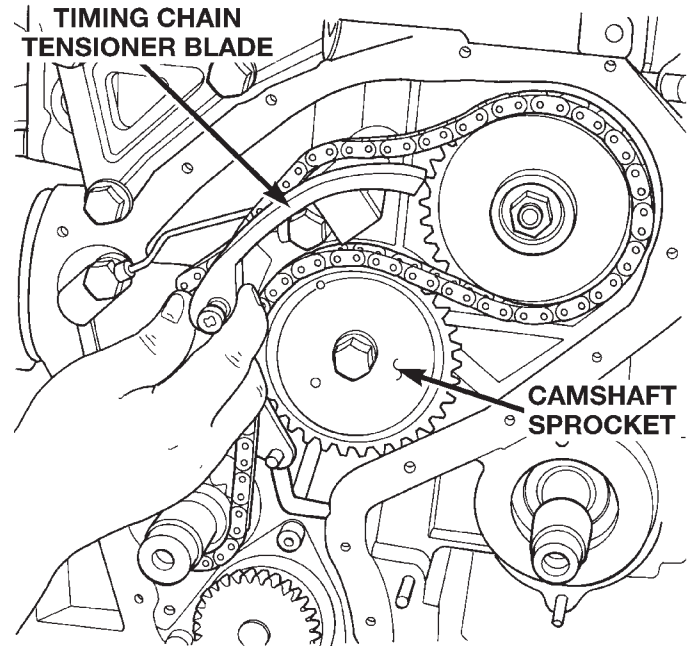


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**Fig. 44 Lower Chain Guide**

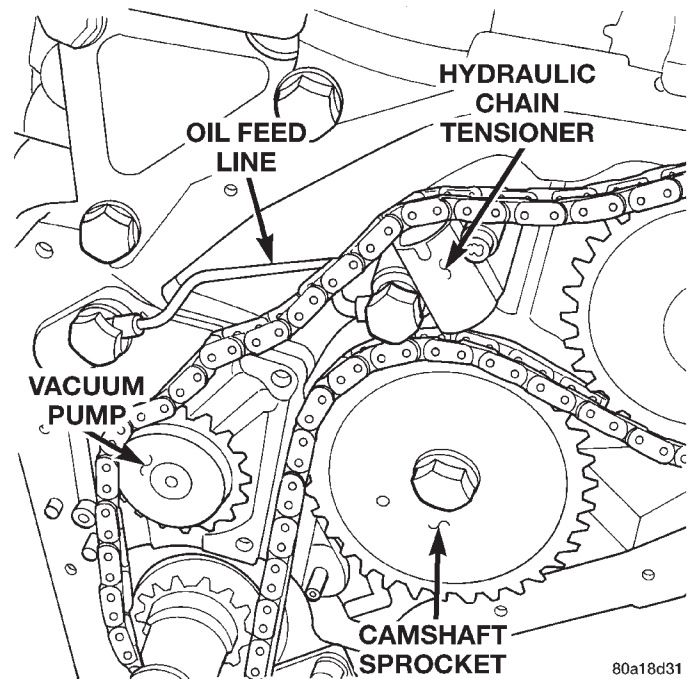
**INSTALLATION**

(1) Install timing chain. Starting at the crankshaft align the dark link on the chain to the timing mark on the crankshaft sprocket. Next align the second dark link on the chain with the timing mark on the camshaft sprocket. Third Align the final dark link on the chain to the timing mark on the injection pump



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**Fig. 45 Tensioner Blade**



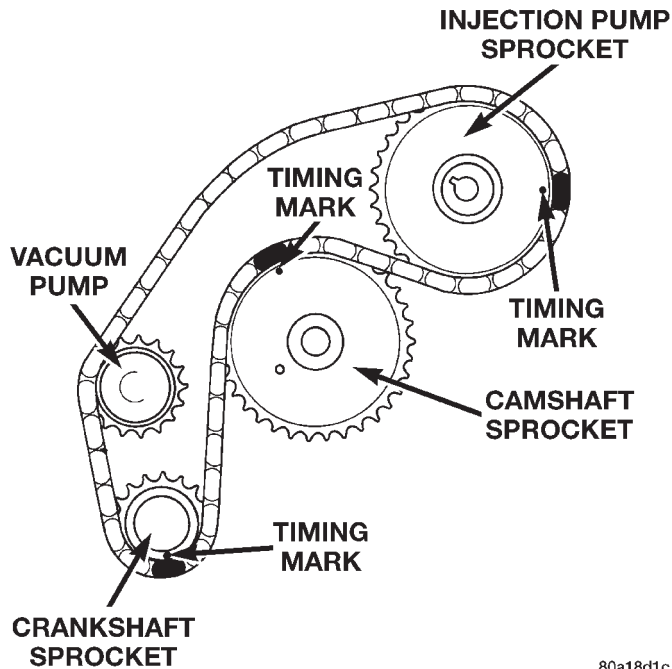
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**Fig. 46 Hydraulic Tensioner and Oil Feed Line**

sprocket. Last install the chain around the vacuum pump (Fig. 47).

- (2) Install hydraulic tensioner.
- (3) Install hydraulic tensioner oil feed line tighten to 16.7 N·m (145 in. lbs.).
- (4) Install hydraulic tensioner blade. Tighten Bolt to 28 N·m (260 in. lbs.)
- (5) Install lower chain guide.
- (6) Install oil pump drive gear on crankshaft.

## REMOVAL AND INSTALLATION (Continued)

**Fig. 47 Timing Chain Procedure**

(7) Install timing chain cover. Refer to installation procedure outlined in this section.

(8) Install pump shaft support bracket assembly. Tighten nuts to 24.5 N·m (216 in. lbs.).

(9) Install power steering/air conditioning pulley. Tighten nut to 170 N·m (125 ft. lbs.).

**CAUTION:** Correct torque on the power steering/air conditioning pulley nut is important or engine damage can occur.

(10) Install crankshaft vibration damper. Torque to 441 N·m (325 ft. lbs.).

**CAUTION:** Correct torque on the crankshaft vibration damper nut is important or engine damage can occur.

(11) Install both accessory drive belts. Refer to Group 7, Cooling.

(12) Install splash shield.

(13) Lower vehicle.

(14) Connect battery.

**CRANKSHAFT SPROCKET****REMOVAL**

(1) Remove vibration damper. Refer to procedure in this section.

(2) Remove timing chain cover. Refer to procedures in this section.

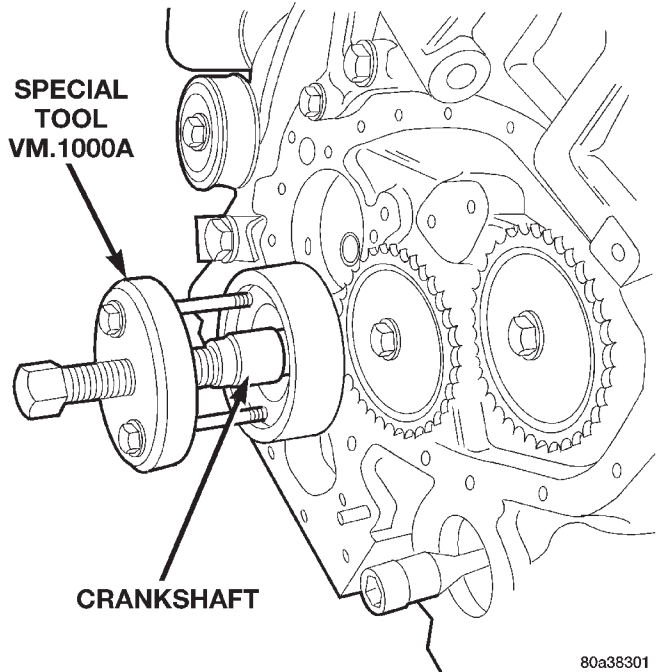
(3) Remove oil pump drive gear on crankshaft.

(4) Remove oil pump.

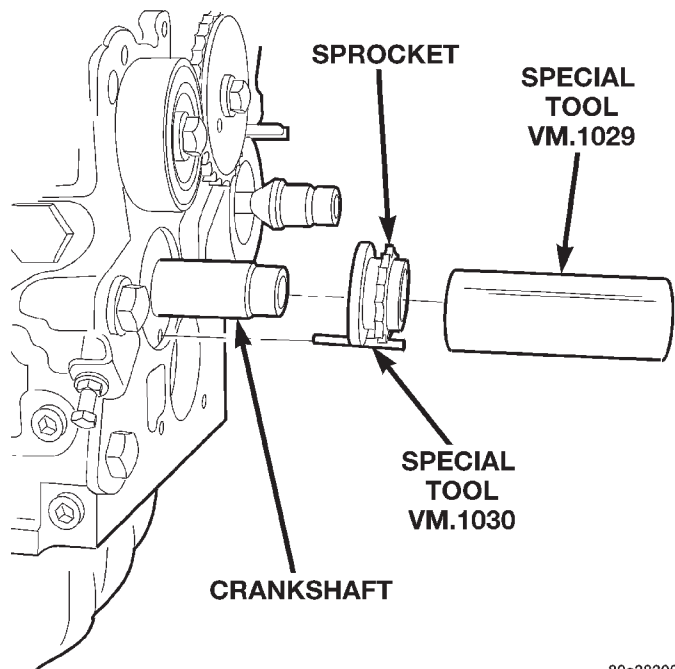
(5) Remove timing chain. Refer to procedure in this section.

(6) Remove vacuum pump.

(7) Install crankshaft sprocket remover VM.1000A and remove sprocket (Fig. 48).

**Fig. 48 Crankshaft Sprocket—Removal****INSTALLATION**

(1) Install crankshaft sprocket alignment pin VM.1030 into hole in crankshaft (Fig. 49).

**Fig. 49 Crankshaft Sprocket—Installation**

(2) Heat new crankshaft sprocket.

## REMOVAL AND INSTALLATION (Continued)

- (3) Align notch in sprocket with alignment pin in crankshaft.
- (4) Using crankshaft sprocket installer VM.1029 press on the new sprocket.
- (5) Remove alignment pin.
- (6) Install vacuum pump.

**CAUTION:** The vacuum pump must be centered in the block and tighten with two bolts. Ensure that the pump spins freely. If vacuum pump drags or does not spin freely loosen bolts and perform procedures again.

- (7) Install timing chain.
- (8) Install oil pump.
- (9) Install oil pump drive gear on crankshaft.
- (10) Install timing chain cover.
- (11) Install vibration damper.

**CAUTION:** Correct torque on the crankshaft vibration damper nut is important or engine damage can occur.

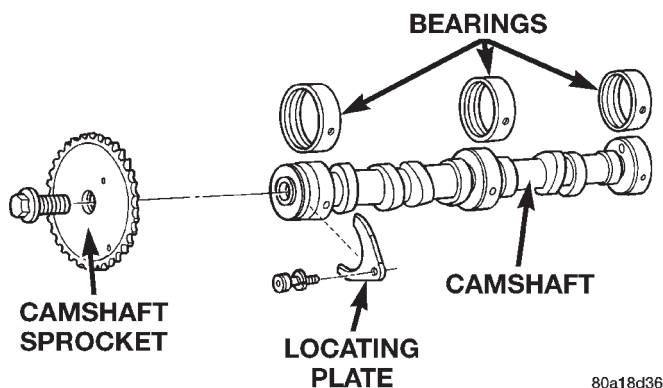
## HYDRAULIC TENSIONER

Refer to Timing Chain Removal and Installation in this section.

## CAMSHAFT

## REMOVAL

- (1) To service camshaft (Fig. 50) the engine must be removed from vehicle.



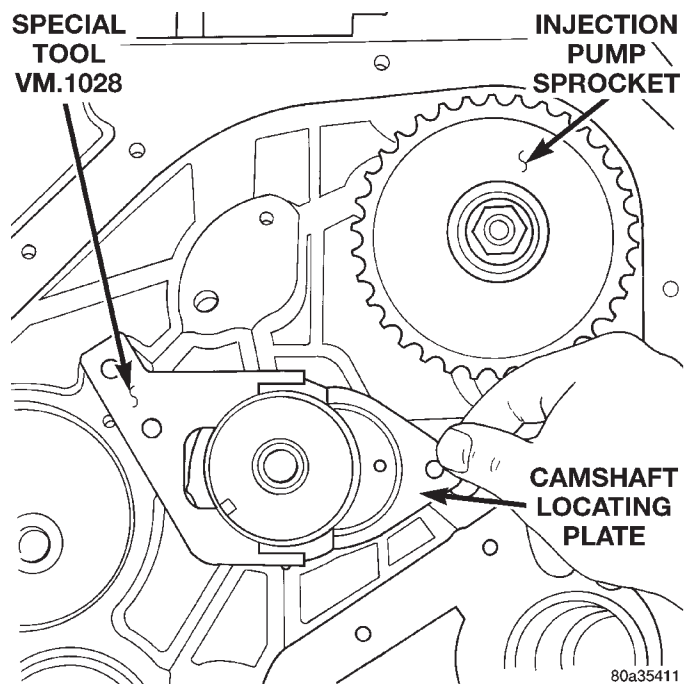
**Fig. 50 Camshaft Assembly**

- (2) Remove valve cover. Refer to valve cover removal in this section.
- (3) Remove rocker arms and push rods. Identify push rods to ensure installation in their original location.
- (4) Remove cylinder head. Refer to cylinder head removal in this section.
- (5) Remove hydraulic tappets. Refer to tappet removal in this section.

- (6) Remove vibration damper. Refer to vibration damper removal in this section.
- (7) Remove power steering pulley.
- (8) Remove pump shaft support bracket.
- (9) Remove timing chain cover. Refer to timing chain cover removal in this section.
- (10) Remove timing chain. Refer to removal procedure in this section.
- (11) Install camshaft sprocket holding tool VM.1031 to lock the camshaft sprocket in place.
- (12) Remove camshaft sprocket bolt and remove sprocket (Fig. 50).
- (13) Remove locating plate, and reinstall sprocket and bolt finger tight.
- (14) Remove camshaft.

## INSTALLATION

- (1) Coat the camshaft journals with clean engine oil and carefully install the camshaft.
- (2) Install camshaft locating plate alignment tool on block then install locating plate (Fig. 51).



**Fig. 51 Locating Plate Alignment**

- (3) Tighten locating bolt to 11 N·m ( 96 in. lbs.) torque. Be sure to align the timing marks as shown in timing chain installation procedure.
- (4) Install camshaft sprocket center bolt and tighten to 19.6 N·m + 60° (170 in. lbs. + 60°). Remove sprocket holding tool.
- (5) Install hydraulic tappets and retaining yokes.
- (6) Install cylinder heads.
- (7) Push rods, and rocker arm assemblies. In their original location.
- (8) Install valve cover.
- (9) Install Timing case cover.

## REMOVAL AND INSTALLATION (Continued)

- (10) Install Vibration damper.
- (11) Reinstall Engine.

## CAMSHAFT BEARINGS

This procedure requires that the engine is removed from the vehicle.

## REMOVAL

- (1) With engine completely disassembled, drive out rear cam bearing core hole plug.
- (2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer Tool) at back of each bearing shell. Drive out bearing shells (Fig. 50).

## INSTALLATION

- (1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool by sliding the new camshaft bearing shell over proper adapter.
- (2) Position rear bearing in the tool. Install horseshoe lock and by reversing removal procedure, carefully drive bearing shell into place.
- (3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

## CRANKSHAFT MAIN BEARINGS

## REMOVAL

- (1) Disconnect battery cable.
- (2) Remove engine from vehicle, refer to engine removal in this section.
- (3) Install engine to engine stand.
- (4) Remove accessory drive system.
- (5) Remove cylinder head cover, refer to cylinder head cover removal in this section.
- (6) Remove rocker arm and push rods, refer to rocker arm and push rod section in this section.
- (7) Remove intake, exhaust manifold and turbo-charger, refer to Group 11, Exhaust System and Intake Manifold.
- (8) Remove water manifold.
- (9) Remove oil feed lines to rocker arms.
- (10) Remove cylinder heads.
- (11) Remove oil pan and oil pick-up.
- (12) Remove piston and connecting rods from crankshaft journals.
- (13) Remove pistons and connecting rods from block.
- (14) Remove vibration damper. Refer to procedure in this section.
- (15) Remove front cover. Refer to procedure in this section.

- (16) Remove oil pump drive gear.
- (17) Remove timing chain. Refer to procedure in this section.
- (18) Install special tool VM-1004 onto crankshaft over gear (Fig. 52).

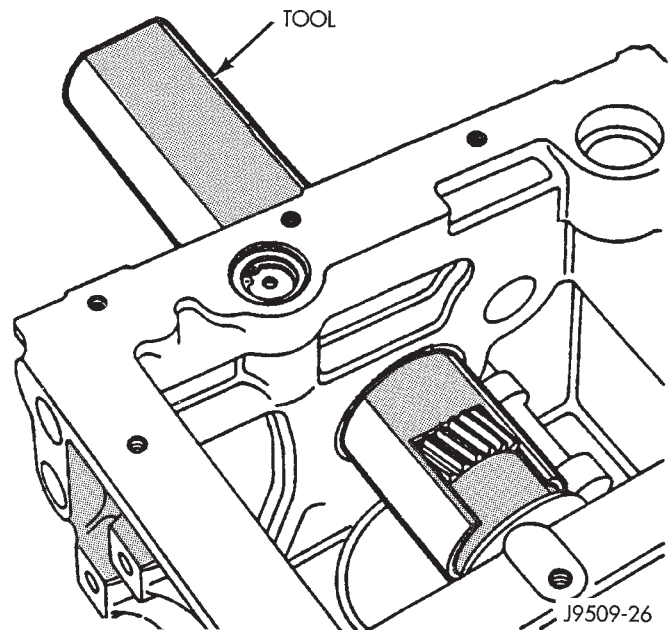


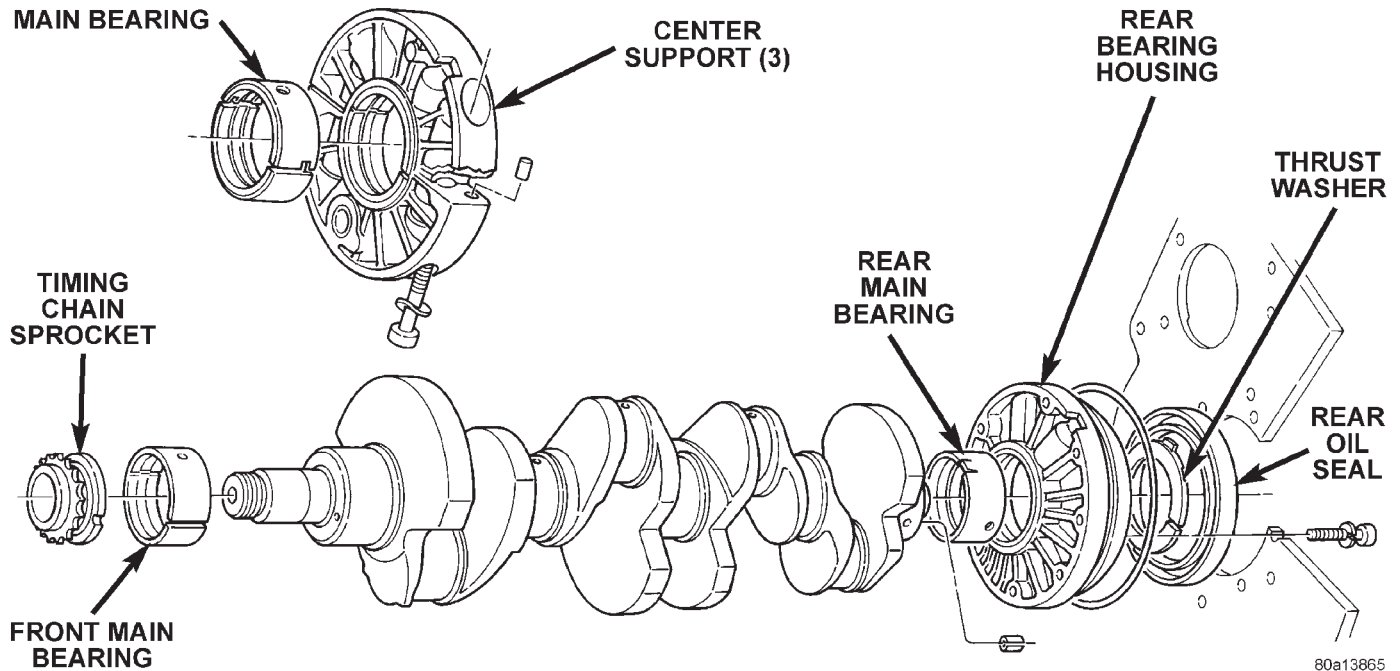
Fig. 52 Crankshaft Special Tool VM.1004

- (19) Remove main bearing oil feed and carrier locators from block.
- (20) Remove flywheel and adaptor plate from engine block.
- (21) Remove thrust bearings from rear main bearing carrier (Fig. 53).
- (22) Slide crankshaft and bearing carriers rearward to rear of block. If you encounter difficulty in removing the complete assembly as previously described, slide the assembly rearward sufficiently to gain access to the main bearing carrier bolts. Mark the carriers for assembly and remove the bolts, two for each carrier (Fig. 54).
- (23) Separate the two halves of each carrier, remove from the crankshaft and temporarily re-assemble the carriers (Fig. 55). Withdraw the crankshaft through the rear of the crankcase.

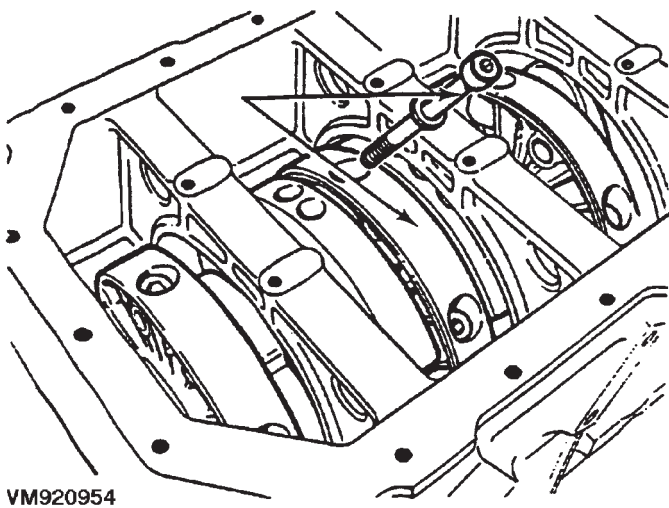
## INSTALLATION

**NOTE:** Assemble engine according to sequence described, thus saving time and preventing damages to engine components. Clean parts with a suitable solvent and dry them with compressed air before assembly. Use new gaskets where applicable and torque wrenches for correct tightening of components.

## REMOVAL AND INSTALLATION (Continued)



**Fig. 53 Crankshaft and Bearings**



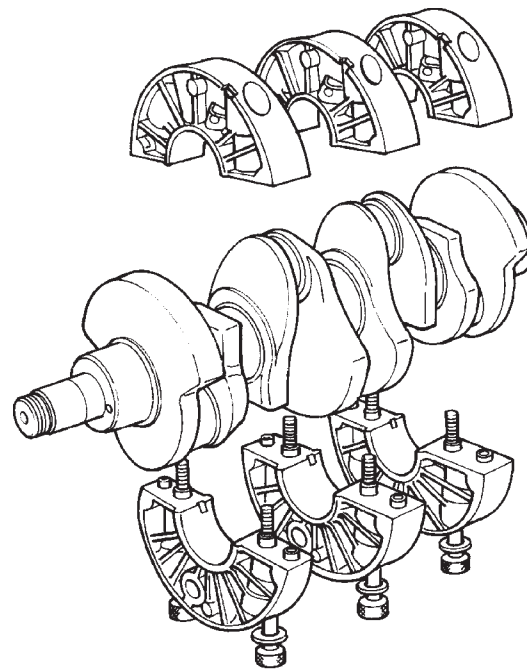
**Fig. 54 Carrier Bolts**

(1) Thoroughly clean crankcase and oil passages, and blow dry with compressed air.

(2) Install new main bearing shells in each of the carrier halves. Assemble the carriers to the crankshaft journals, ensuring that the carriers are installed in their original locations. Secure each carrier with the two bolts tightening evenly to 42 N·m (31 ft. lbs.) (Fig. 55).

(3) Slide special tool (VM-1002) over the crankshaft gear and, insert the crankshaft and carrier assembly into the crankcase in the same manner used for removal.

(4) Align the holes in the lower carriers, with the center of the crankcase webs (Fig. 56).



**Fig. 55 Crankshaft and Carrier Bearing Assembly**

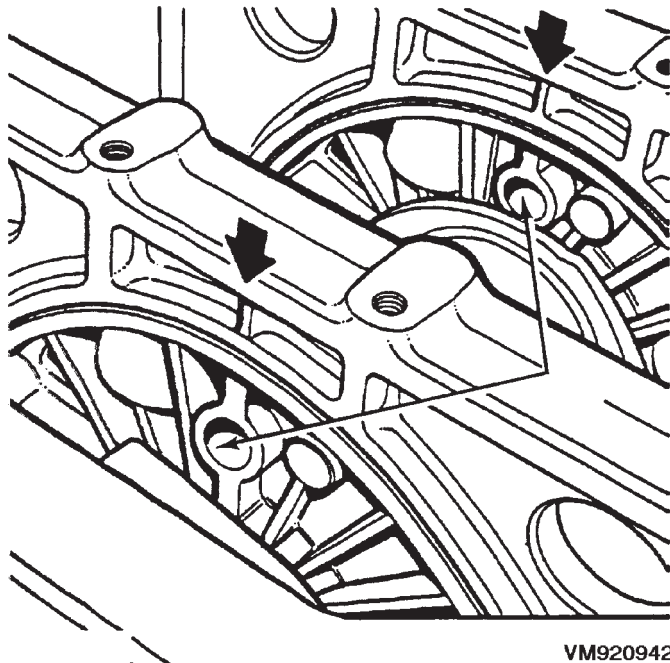
(5) Secure each carrier assembly to the crankcase with the main bearing oil feed and carrier locators and tighten them to 54 N·m (40 ft. lbs).

(6) Install rear main bearing carrier onto crankshaft ensuring arrow on bearing carrier aligns with vertical web in center of crankcase.

(7) Install rear oil seal.

(8) Install new O-rings in adaptor plate.

## REMOVAL AND INSTALLATION (Continued)



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**Fig. 56 Main Bearing Carrier Alignment**

(9) Install adaptor plate and tighten bolts to 47 N·m (35 ft. lbs.).

(10) Install bolts to main bearing carrier and tighten to 26.5 N·m (20 ft. lbs.).

(11) Position flywheel and O-ring on crankshaft and align bolt holes.

**NOTE:** For purposes of checking crankshaft end play used flywheel bolts may be used. Final assembly requires new flywheel bolts.

(12) Install 2 flywheel bolts, 180° apart, and tighten bolts to 20 N·m plus 60° (15 ft. lbs.) plus 60°.

(13) Attach dial indicator to engine block.

(14) Move crankshaft toward front of engine and zero indicator.

(15) Move crankshaft toward the rear of engine and record measurement.

(16) Subtract specified crankshaft end play from figure obtained. Crankshaft end play 0.08 to 0.21 mm (0.0032 to 0.0083 in.).

(17) Select thrust washers which will give correct end play.

(18) Remove tools and flywheel.

(19) Lubricate thrust washer halves and fit them into the rear main bearing carrier.

(20) To verify correct end play, install 2 flywheel bolts 180° apart, and tighten bolts to 20 N·m plus 60° (15 ft. lbs. plus 60°).

(21) Measure crankshaft end play with a dial gauge. Crankshaft end play should not exceed 0.08-0.21 mm (0.0032 to 0.0083 in.) (Fig. 57). If end clearance exceeds these values install oversize thrust washer.

**CAUTION:** Use **NEW** flywheel bolt for the following procedure.

(22) Install new O-ring on flywheel. Install flywheel. The 6 flywheel bolts must be tightened as follows:

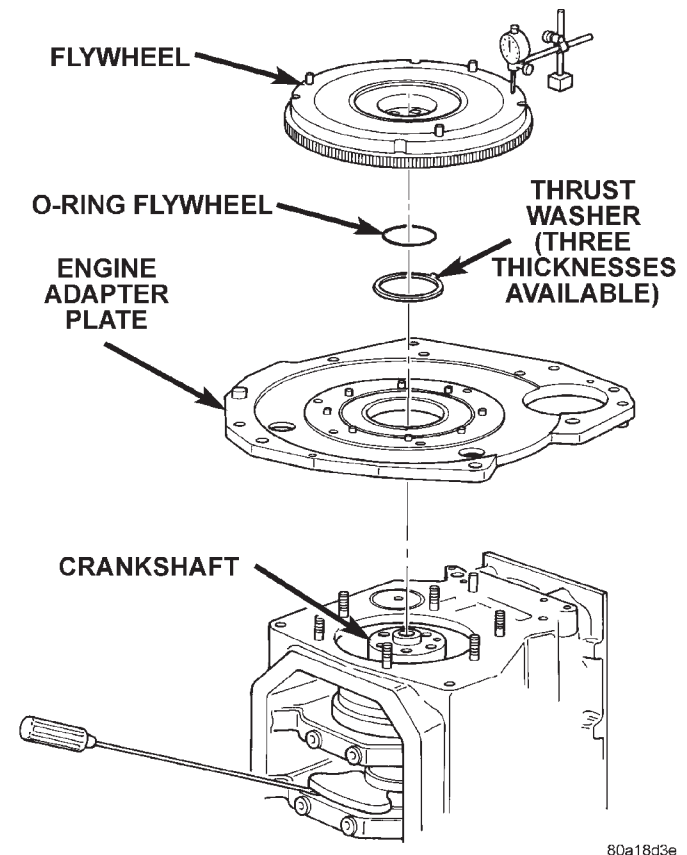
a. Torque the 6 flywheel bolts to 60 N·m (44 ft. lbs.).

b. Loosen 2 of the 6 bolts, 180° apart. Torque the 2 bolts to 20 N·m (180 in. lbs.). Then using a torque angle gauge rotate the 2 bolts 65° additional.

c. Loosen the next 2 bolts, 180° apart and follow the same procedure.

d. Loosen the last 2 bolts, 180° apart and follow the same procedure.

(23) Install Transmission. Refer to procedure in Group 21, Transmission.



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**Fig. 57 Measuring Crankshaft End Play**

(24) Install pistons and connecting rod assemblies, refer to piston and connecting rods in this section.

(25) Install oil pick up tube and tighten bolts to 25 N·m (18 ft. lbs.).

(26) Install oil pan, refer to oil pan installation in this section.

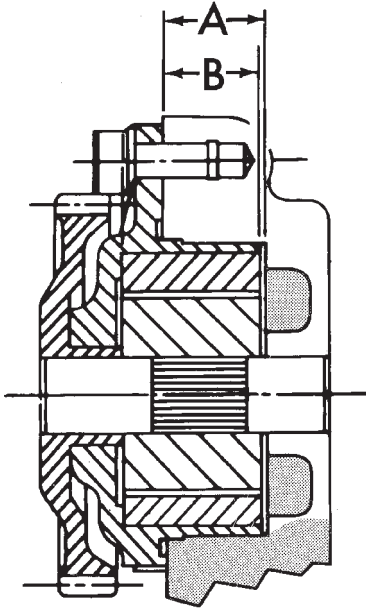
(27) Install timing chain. Refer to procedure in this section.

(28) Install vacuum pump. Tighten retaining screws to 20 N·m (15 ft. lbs.).

## REMOVAL AND INSTALLATION (Continued)

**CAUTION:** The vacuum pump must be centered in the block and tighten with two bolts. Ensure that the pump spins freely. If vacuum pump drags or does not spin freely loosen bolts and perform procedures again.

(29) Before installing oil pump check pump bore depth in block (A) and pump body height (B) (Fig. 58). Difference between A and B should be 0.020-0.082 mm (.0007 to 0032 in.).



**Fig. 58 Oil Pump Bore Depth**

(30) Install oil pump and tighten retaining screws to 27 N·m (20 ft. lbs.). Check for normal backlash between pump and crankshaft gears.

(31) Install oil pump drive Gear.

(32) Install front cover. Refer to procedure in this section.

(33) Install vibration damper. Refer to procedure in this section.

(34) Install cylinder heads. Refer to procedure in this section.

(35) Install rocker arms and push rods. Refer to procedure in this section.

(36) Install cylinder head cover. Refer to procedure in this section.

(37) Install accessory drive system.

(38) Install engine in vehicle. Refer to procedure in this section.

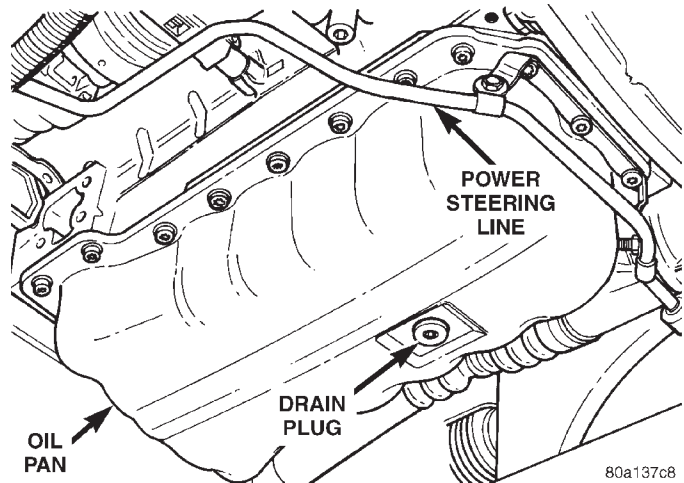
(39) Fill engine with the correct amount of fluids specified.

(40) Connect battery cable.

## OIL PAN

## REMOVAL

- (1) Disconnect battery cable.
- (2) Raise vehicle on hoist.
- (3) Drain oil.
- (4) Remove oil pan bolts (Fig. 59).
- (5) Remove oil pan.



**Fig. 59 Oil Pan**

## INSTALLATION

(1) Install oil pan. Apply a continuous 3 mm bead of Silicone Sealer to oil pan, install within 10 minutes.

(2) Install oil pan bolts and torque bolts to 11 N·m (8 ft. lbs.).

(3) Install oil drain plug tighten to 79 N·m (58 ft. lbs.).

(4) Lower vehicle.

(5) Fill engine with proper amount of oil.

(6) Connect battery cable.

## OIL PUMP

## REMOVAL

(1) Raise vehicle on hoist.

(2) Remove right splash shield.

(3) Remove both accessory drive belts. Refer to Group 7, Cooling.

(4) Remove pump shaft support bracket assembly.

(5) Remove vibration damper. Refer to Vibration Damper Removal in this section.

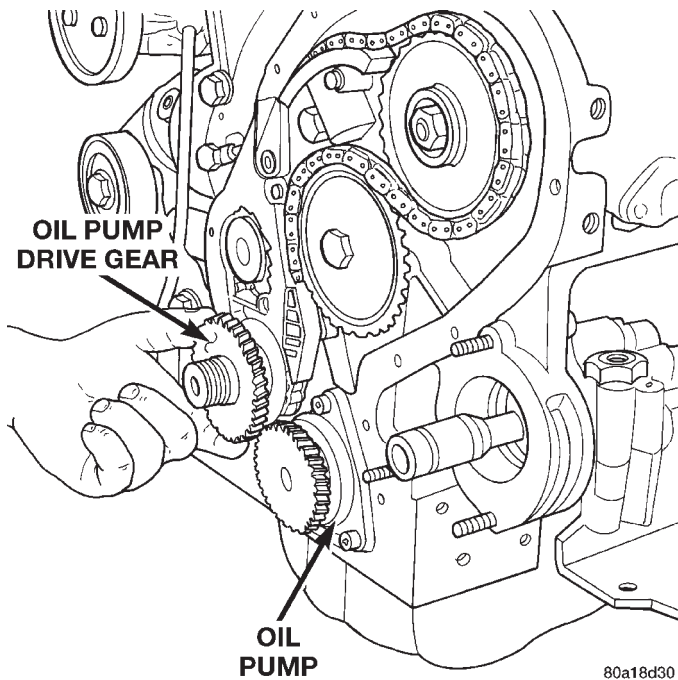
**NOTE:** Crankshaft damper nut is left handed thread.

(6) Remove front cover. Refer to Timing Chain Cover Removal in this section.

(7) Remove oil pump drive gear at crankshaft (Fig. 60).

(8) Remove oil pump.

## REMOVAL AND INSTALLATION (Continued)



**Fig. 60 Oil Pump Drive Gear**

**INSTALLATION**

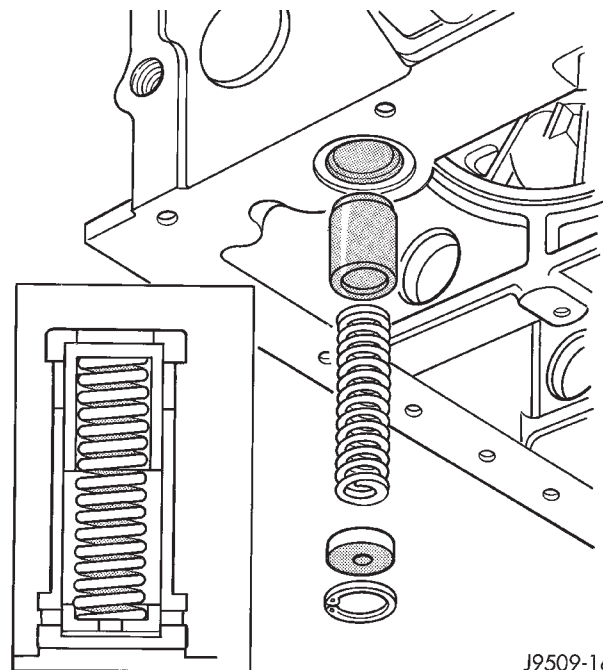
- (1) Install new O-ring and lubricate with clean engine oil.
- (2) Install oil pump and tighten retaining screws to 27.5 N·m (240 in. lbs.).
- (3) Install oil pump drive gear on crankshaft.
- (4) Install front cover. Refer to Timing Chain Cover Installation in this section.
- (5) Install pump shaft support bracket assembly.

**CAUTION:** Correct torque on the vibration damper nut is important or engine damage can occur.

- (6) Install vibration damper. Torque nut to 441 N·m (325 ft. lbs.).
- (7) Install both accessory drive belts. Refer to Group 7, Cooling.
- (8) Install right splash shield.

**OIL PUMP PRESSURE RELIEF VALVE****REMOVAL**

- (1) Remove oil pan.
- (2) Remove clip retaining relief valve.
- (3) Remove relief valve cap, spring, and plunger (Fig. 61).
- (4) Check relief valve spring length. Relief valve spring free length is 57.5mm (2.263 in.). If spring length is less or spring is distorted it must be replaced.
- (5) Check plunger for scoring, replace if necessary.



**Fig. 61 Oil Pressure Relief Valve**

**INSTALLATION**

- (1) Thoroughly clean all components and relief valve pocket in cylinder block.
- (2) Fit plunger, spring and cap into block.
- (3) Compress spring and install retaining clip. Ensure clip is completely seated in groove.

**OIL FILTER ADAPTER AND OIL COOLER****REMOVAL**

- (1) Remove oil filter.
- (2) Remove oil cooler adapter bolt.
- (3) Remove oil cooler (Fig. 62).

**INSTALLATION**

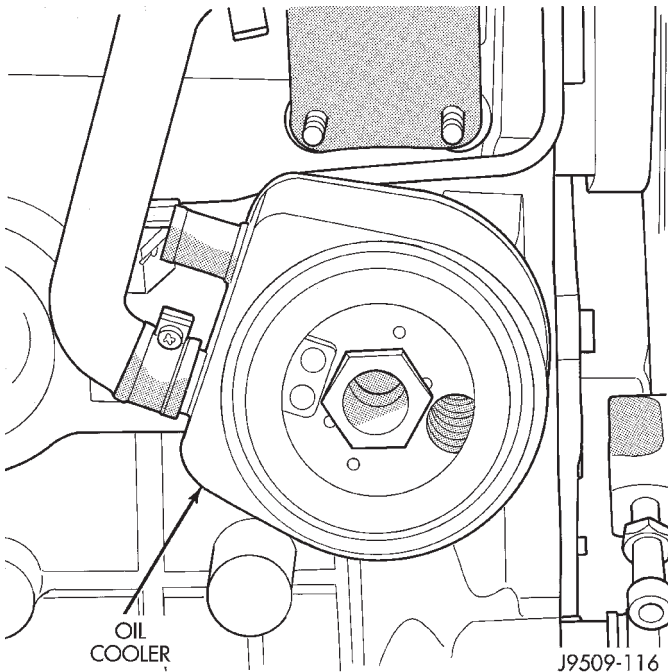
- (1) Install oil cooler with new gasket, tighten oil cooler adapter bolt to 60 N·m (44 ft. lbs.).
- (2) Install oil filter adapter to oil cooler and tighten to 49 N·m (36. lbs.).
- (3) Install oil filter and tighten to 9.8 N·m (85 in. lbs.) and add oil.

**VACUUM PUMP****REMOVAL**

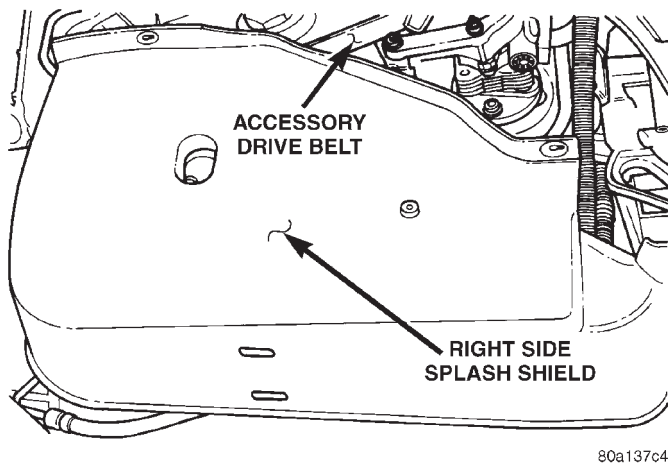
- (1) Disconnect the battery cable.
- (2) Raise vehicle on hoist.
- (3) Remove right splash shield (Fig. 63).
- (4) Remove accessory drive belts. Refer to Group 7, Cooling.
- (5) Remove vibration damper nut.

**NOTE:** Crankshaft damper nut is left handed thread.

## REMOVAL AND INSTALLATION (Continued)



**Fig. 62 Oil Cooler**



**Fig. 63 Splash Shield**

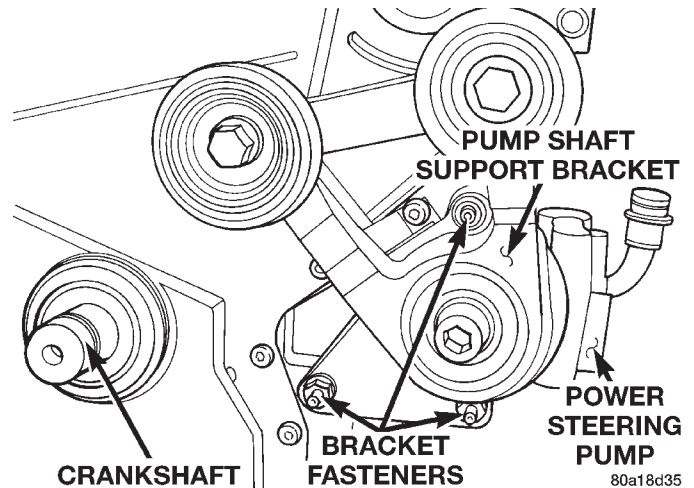
- (6) Remove vibration damper.
- (7) Remove power steering/air conditioning pulley nut. Remove pulley.

**CAUTION:** Remove old thread sealant from threads on pump.

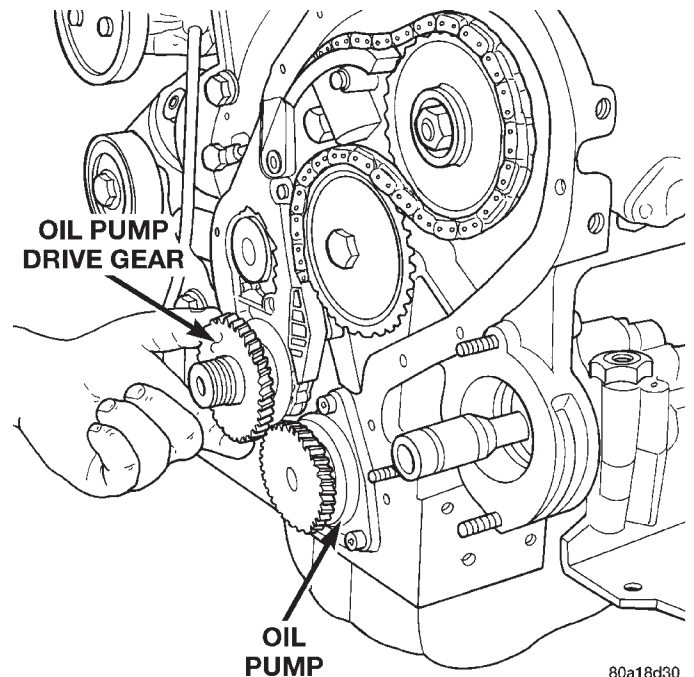
- (8) Remove pump shaft support bracket assembly (Fig. 64).

**CAUTION:** When separating the timing chain cover from the block take care not to damage the mating surface of the timing chain cover.

- (9) Remove timing chain cover.



**Fig. 64 Pump Shaft Support Bracket**



**Fig. 65 Oil Pump Drive Gear**

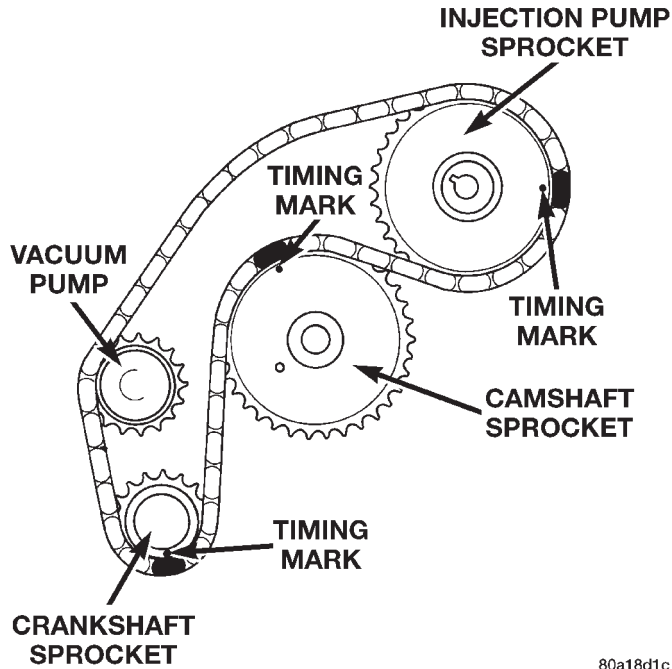
- (10) Remove oil pump drive gear on crankshaft (Fig. 65).

- (11) Remove lower chain guide (Fig. 68).

- (12) Rotate crankshaft to align timing marks on injection pump sprocket, camshaft sprocket, and crankshaft sprocket with three dark plated links on timing chain (Fig. 66).

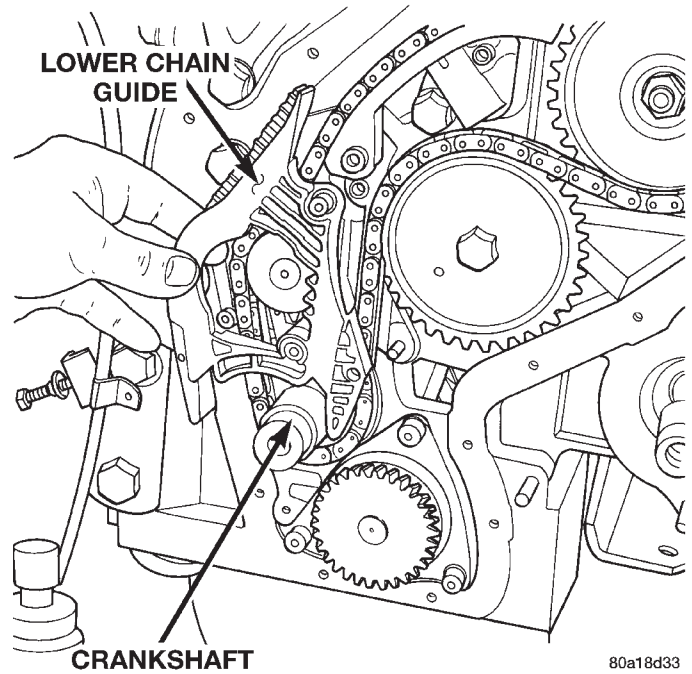
**CAUTION:** It could take up to 70 crankshaft revolutions to align sprocket timing marks with the dark chain links. If the chain is removed (Fig. 67) before the sprocket marks are in their proper locations you must first loosen the rocker arm supports before rotating crankshaft or camshaft sprockets. This will prevent the valves from hitting the pistons.

REMOVAL AND INSTALLATION (Continued)



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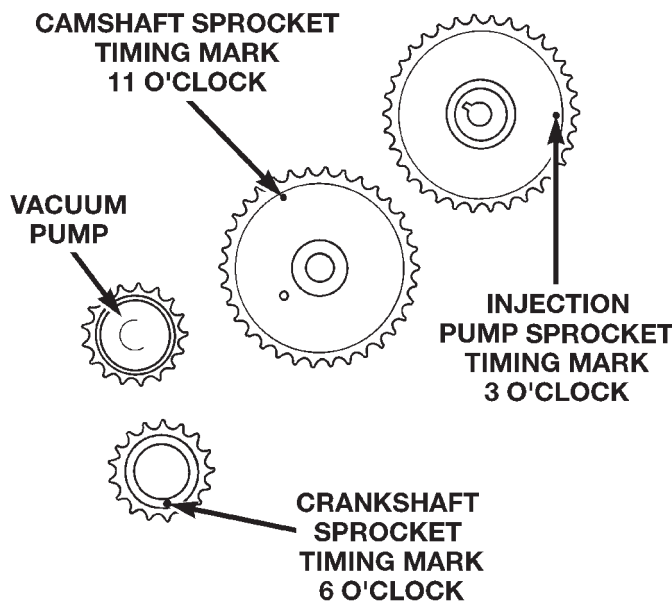
Fig. 66 Timing Marks



80a18d33

Fig. 68 Lower Chain Guide

- (13) Remove hydraulic tensioner blade (Fig. 69).
- (14) Remove hydraulic tensioner oil feed line (Fig. 70).
- (15) Remove hydraulic tensioner.
- (16) Remove timing chain.
- (17) Remove vacuum pump (Fig. 71).

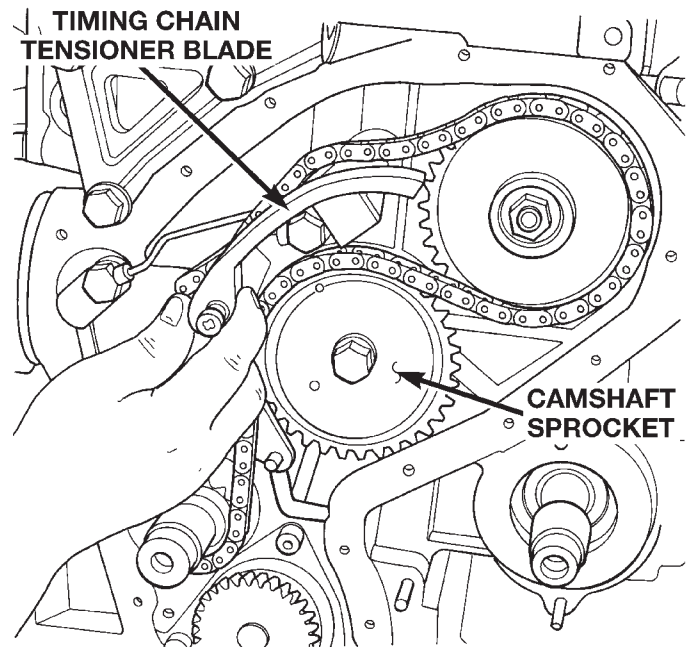


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Fig. 67 Alignment Timing Sprockets

INSTALLATION

- (1) Install vacuum pump with new O-ring (Fig. 72).



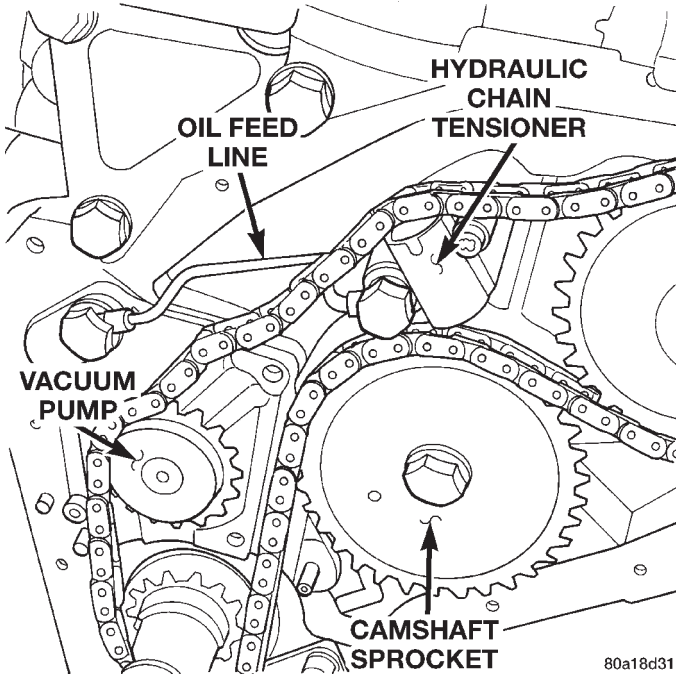
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Fig. 69 Hydraulic Tensioner Blade

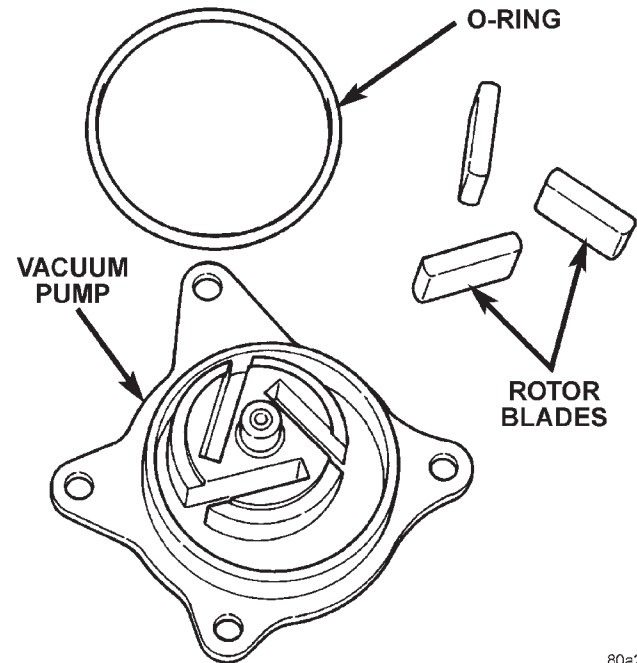
**CAUTION:** The vacuum pump must be centered in the block and tighten with two bolts. Ensure that the pump spins freely. If vacuum pump drags or does not spin freely loosen bolts and perform procedures again.

- (2) Install timing chain. Starting at the crankshaft align the dark link on timing chain to the timing mark on the crankshaft sprocket. Next align the second dark link on the chain with the timing mark on

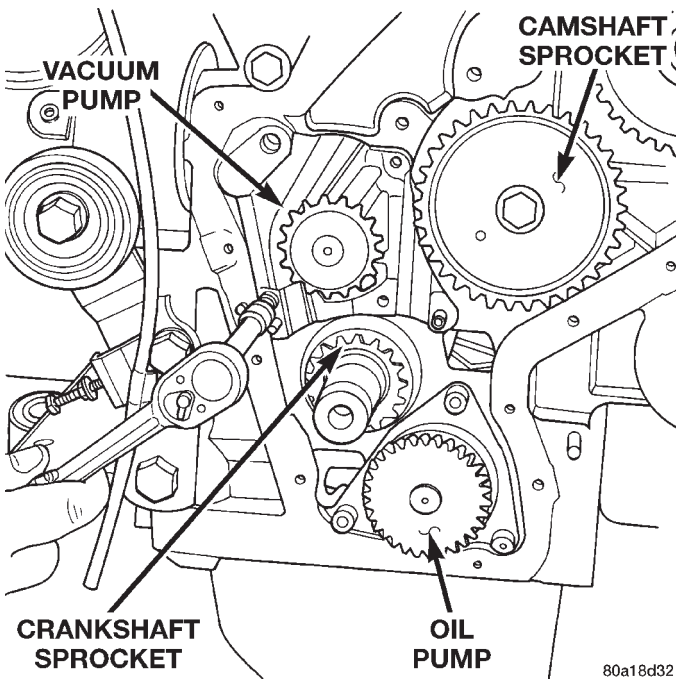
## REMOVAL AND INSTALLATION (Continued)



**Fig. 70 Hydraulic Tensioner and Oil Feed Line**



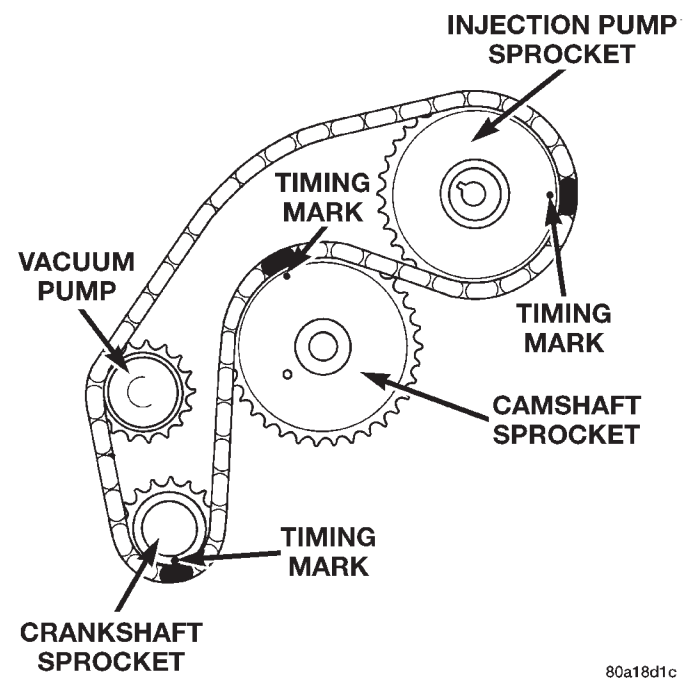
**Fig. 72 Vacuum Pump Assembly**



**Fig. 71 Vacuum Pump—Removal**

the camshaft sprocket. Third align the final dark link on the chain to the timing mark on the injection pump sprocket. Last install the chain around the vacuum pump (Fig. 73).

- (3) Install hydraulic tensioner.
- (4) Install hydraulic tensioner oil feed line.
- (5) Install hydraulic tensioner blade. Torque bolt to 28 N·m (260 in. lbs.).
- (6) Install lower chain guide.
- (7) Install oil pump drive gear on crankshaft.



**Fig. 73 Timing Chain Procedure**

(8) Install timing chain cover. Refer to installation procedure outlined in this section.

(9) Install pump shaft support bracket assembly. Tighten nuts to 24.5 N·m (216 in. lbs.).

**CAUTION:** Correct torque on the power steering/air conditioning pulley nut is important or engine damage can occur.

## REMOVAL AND INSTALLATION (Continued)

(10) Install power steering/air conditioning pulley. Tighten nut to 170 N·m (125 ft. lbs.).

**CAUTION:** Correct torque on the crankshaft vibration damper nut is important or engine damage can occur.

(11) Install crankshaft vibration damper. Torque to 441 N·m (325 ft. lbs.)

(12) Install both accessory drive belts. Refer to Group 7, Cooling.

(13) Install splash shield.

(14) Lower vehicle.

(15) Connect battery.

## PISTONS AND CONNECTING ROD

## REMOVAL

(1) Disconnect the battery cable.

(2) Remove cylinder heads, refer to cylinder head removal in this section.

(3) Raise vehicle on hoist.

(4) Remove oil pan, refer to oil pan removal in this section.

(5) Remove top carbon ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. **Be sure to keep tops of pistons covered during this operation**. Mark piston with matching cylinder number.

(6) Pistons and connecting rods must be removed from top of cylinder block. Rotate crankshaft so that each connecting rod is centered in cylinder bore.

(7) Remove connecting rod cap. Push each piston and rod assembly out of cylinder bore.

**CAUTION:** During piston and rod removal, **DO NOT** rotate piston and connecting rod or damage to the oil jets extending out into the cylinder bore will occur (Fig. 74).

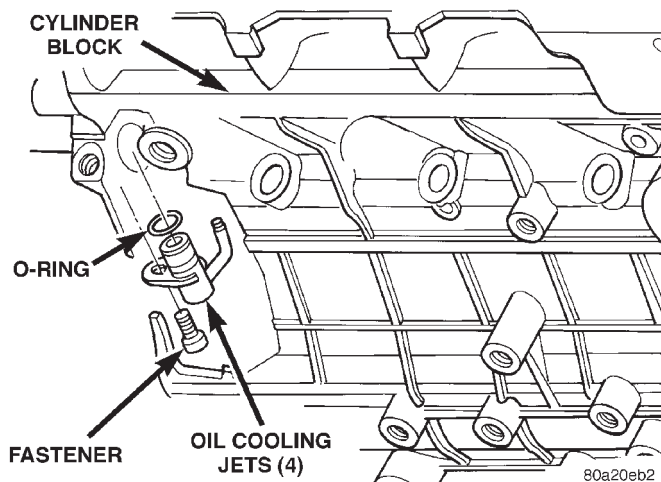


Fig. 74 Oil Jets

**NOTE:** Be careful not to nick crankshaft journals.

(8) After removal, install bearing cap on the mating rod.

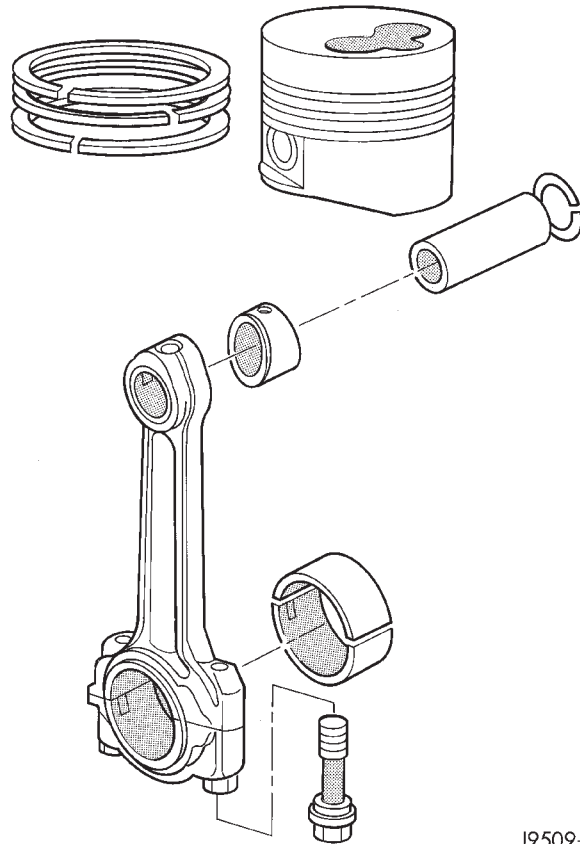


Fig. 75 Piston Assembly

## PISTON PIN—REMOVAL

- (1) Secure connecting rod in a soft jawed vice.
- (2) Remove 2 clips securing piston pin (Fig. 75).
- (3) Push piston pin out of piston and connecting rod.

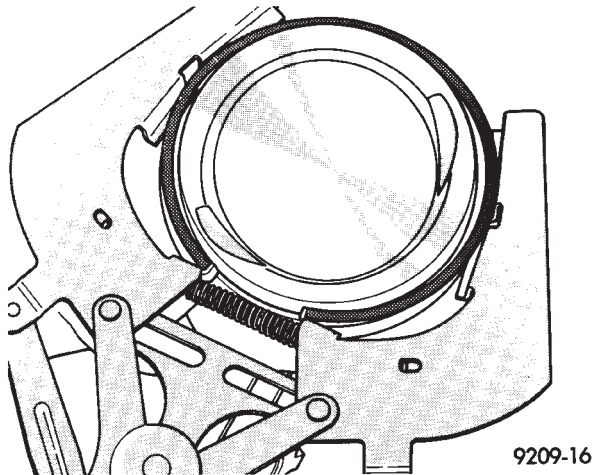
## PISTON RING—REMOVAL

- (1) Identification (ID) mark on face of upper and intermediate piston rings must point toward piston crown.
- (2) Using a suitable ring expander, remove upper and intermediate piston rings (Fig. 76).
- (3) Remove the upper oil ring side rail, lower oil ring side rail and then oil ring expander from piston.
- (4) Carefully clean carbon from piston crowns, skirts and ring grooves ensuring the 4 oil holes in the oil control ring groove are clear.

## FITTING PISTON RINGS

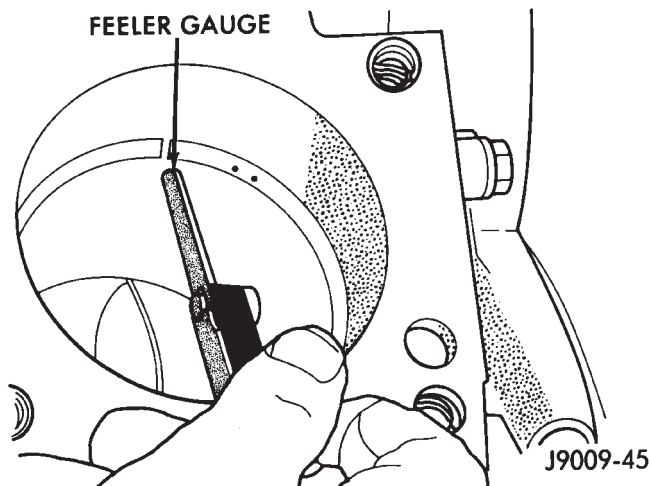
- (1) Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioning at least 12 mm (0.50 in.) from bottom of

## REMOVAL AND INSTALLATION (Continued)



**Fig. 76 Piston Rings—Removing and Installing**

cylinder bore. Check gap with feeler gauge (Fig. 77). Top compression ring gap .25 to .50 mm (.0098 to .0196 in.). Second compression ring gap .25 to .35 mm (.0098 to .0137 in.). Oil control ring gap .25 to .58 mm (.0098 to .0228 in.).



**Fig. 77 Ring Gap Measurement**

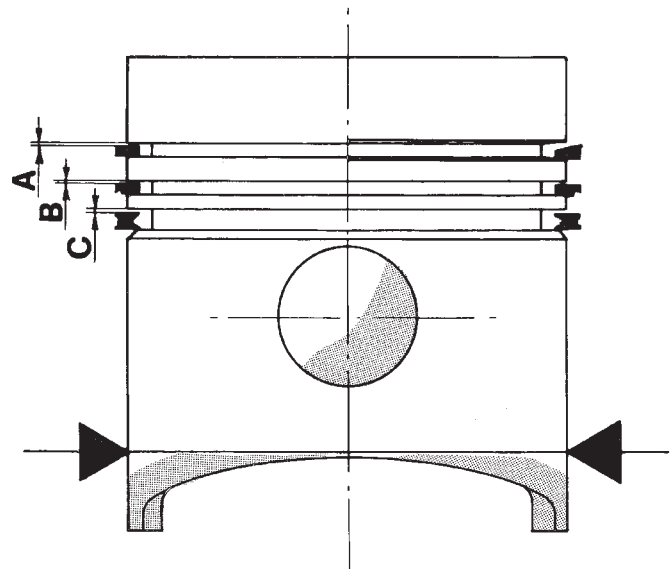
(2) If ring gaps exceed dimension given, new rings or cylinder liners must be fitted. Keep piston rings in piston sets.

(3) Check piston ring to groove clearance (Fig. 78). Top compression ring gap .08 to .130 mm (.0031 to .0051 in.). Second compression ring gap .070 to .102 mm (.0027 to .0040 in.). Oil control ring gap .040 to .072 mm (.0015 to .0028 in.).

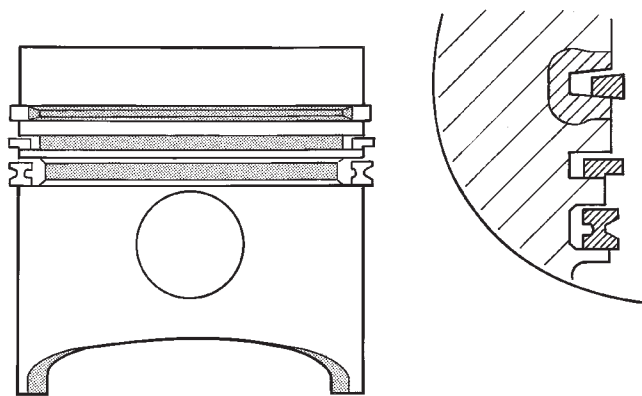
#### PISTON RINGS—INSTALLATION

(1) Install rings on the pistons using a suitable ring expander (Fig. 76).

(2) Top compression ring is tapered and chromium plated. The second ring is of the scraper type and must be installed with scraping edge facing bottom of the piston. The third is an oil control ring (Fig. 79).



**Fig. 78 Piston Ring Side Clearance**



**Fig. 79 Piston Ring Identification**

Ring gaps must be positioned, before inserting piston into the liners, as follows (Fig. 80).

(3) Top ring gap must be positioned at 30 degrees to the right of the combustion chamber recess (looking at the piston crown from above).

(4) Second piston ring gap should be positioned on the opposite side of the combustion chamber recess.

(5) Oil control ring gap to be located 30 degrees to the left of combustion chamber recess.

(6) When assembling pistons check that components are installed in the same position as before disassembly, determined by the numbers stamped on the crown of individual pistons. Engine cylinders are numbered starting from gear train end of the engine. **Face chamber recess side of piston towards camshaft**. Therefore, the numbers stamped on con

## REMOVAL AND INSTALLATION (Continued)

rod big end should also face in the same direction. To insert piston into cylinder, use a ring compressor as shown in (Fig. 81).

**PISTON PIN—INSTALLATION**

- (1) Secure connecting rod in soft jawed vice.
- (2) Lubricate piston pin and piston with clean oil.
- (3) Position piston on connecting rod.

**CAUTION:** Ensure combustion recess in piston crown and the bearing cap numbers on the connecting rod are on the same side.

- (4) Install piston pin.
- (5) Install clips in piston to retain piston pin.
- (6) Remove connecting rod from vice.

**PISTON—INSTALLATION**

(1) Before installing pistons, and connecting rod assemblies into the bore, be sure that compression ring gaps are staggered so that neither is in line with oil ring rail gap (Fig. 80).

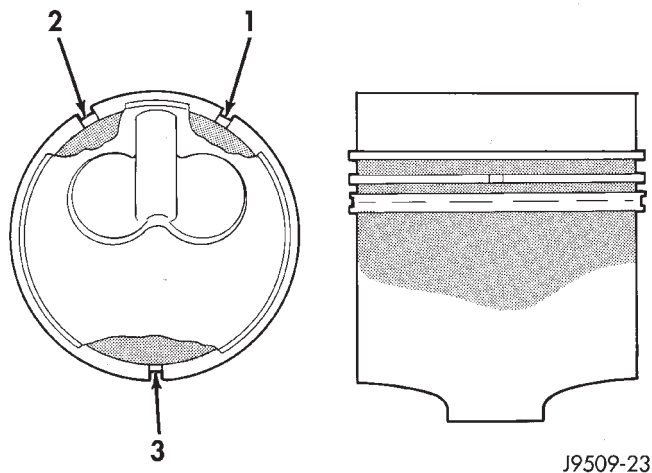


Fig. 80 Piston Ring Gap Location

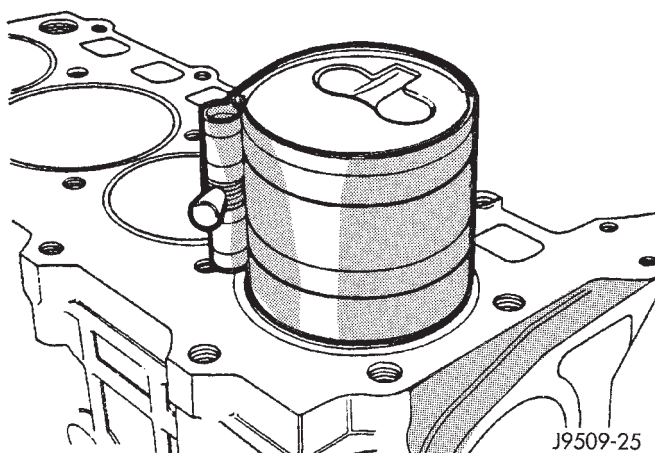


Fig. 81 Installing Piston

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located as shown in (Fig. 80).

(3) Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston and tighten with the special wrench (Fig. 81). **Ensure position of rings does not change during this operation.**

(4) Face chamber recess side of piston towards camshaft.

(5) Install connecting rod bolt protectors on rod bolts.

(6) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Insert rod and piston into cylinder bore and guide rod over the crankshaft journal.

**CAUTION:** During piston and rod installation. **DO NOT** rotate piston and connecting rod or damage to the oil jets extending out into the cylinder bore will occur (Fig. 74).

(7) Tap the piston down in cylinder bore, using a hammer handle. At the same time, guide connecting rod into position on connecting rod journal.

(8) Install rod caps. Install nuts on cleaned and oiled rod bolts and tighten nuts to 29.5 N·m (22 ft. lb.) plus 60°.

**CYLINDER LINER****REMOVAL**

(1) Remove cylinder heads (refer to cylinder head removal in this section).

(2) Remove Oil pan (refer to oil pan removal in this section).

(3) Remove pistons (refer to piston removal in this section).

(4) Use tool VM-1001 to remove liners (Fig. 82).

(5) Remove shims from cylinder liner or cylinder block recess. Keep shims with each cylinder liner.

**INSTALLATION**

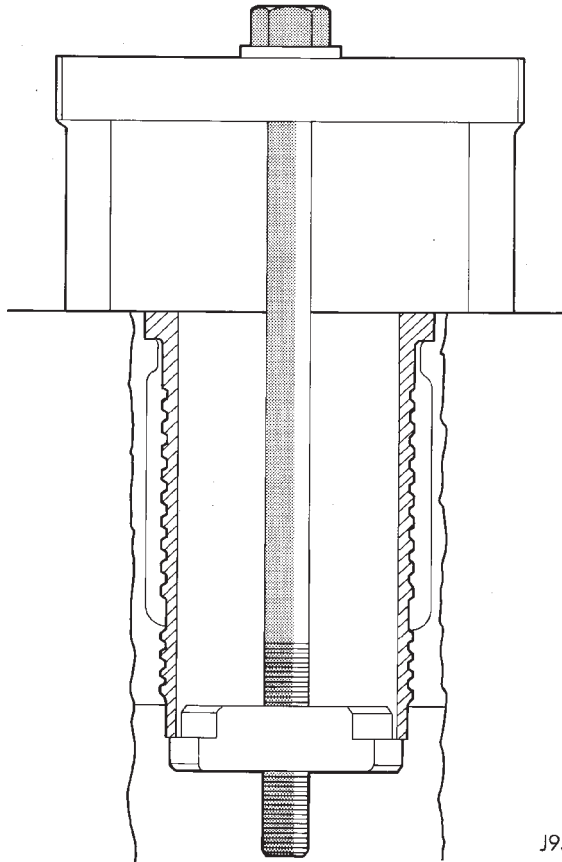
(1) Carefully clean residual **sealer** from liner and crankcase, and degrease the crankcase where it comes into contact with the liners. Referring to (Fig. 83), install the liners in the crankcase as shown (A), rotating them back and forth by 45° in order to guarantee correct positioning.

(2) Measure the liner recess relative to block deck with a dial indicator mounted on a special tool VM-1010 A. **All the measurements must be taken on camshaft side.** Zero dial gauge on block deck.

(3) Move dial gauge to cylinder liner record reading on dial gauge.

(4) Remove liner and special tool.

## REMOVAL AND INSTALLATION (Continued)



**Fig. 82 Cylinder Liner—Removal**

(5) Then select the correct shim thickness to give proper protrusion (0.01 - 0.06 mm).

(6) Fit the shim and the O-rings onto the liner.

(7) Lubricate the lower liner location in the block. Apply LOCTITE 275 to the corner of the liner seat. Apply LOCTITE 275 uniformly to the upper part of the liner at area.

(8) Fit the liners in the crankcase making sure that the shim is positioned correctly in the seat. Lock the liners in position using special tool (VM-1016) and bolts (Fig. 84). Clean the residual LOCTITE on the upper surface of the block deck.

(9) Recheck the liner protrusion. It should be 0.01 - 0.06 mm.

**NOTE:** A period of six hours must elapse between the liners being installed and engine start-up. If engine assembly is not continued after liner installation, the liners need to be clamped for twelve hours minimum.

(10) Refer to Cylinder Head Removal and Installation procedure in this section. To measure piston protrusion for installation of proper head gasket thickness.

### CRANKSHAFT—REMOVAL

Refer to CRANKSHAFT MAIN BEARING REMOVAL in this section.

### REAR CRANKSHAFT OIL SEAL

#### REMOVAL

(1) Remove transmission. Refer to Group 21, Transmission for removal procedure.

(2) Remove flywheel.

**NOTE:** Inspect O-ring in flywheel (Fig. 85).

(3) Remove rear crankshaft oil seal from retainer (Fig. 86).

**CAUTION:** When removing seal from retainer take care not to damage retainer.

#### INSTALLATION

(1) Install crankshaft oil seal.

**CAUTION:** Use NEW flywheel bolt for the following procedure.

(2) Install new O-ring on flywheel. Install flywheel. The 6 flywheel bolts must be tightened as follows:

a. Torque the 6 flywheel bolts to 60 N·m (44 ft. lbs.).

b. Loosen 2 of the 6 bolts, 180° apart. Torque the 2 bolts to 20 N·m (180 in. lbs.). Then using a torque angle gauge rotate the 2 bolts 65° additional.

c. Loosen the next 2 bolts, 180° apart and follow the same procedure.

d. Loosen the last 2 bolts, 180° apart and follow the same procedure.

(3) Install Transmission. Refer to procedure in Group 21, Transmission.

## DISASSEMBLY AND ASSEMBLY

### HYDRAULIC TAPPETS

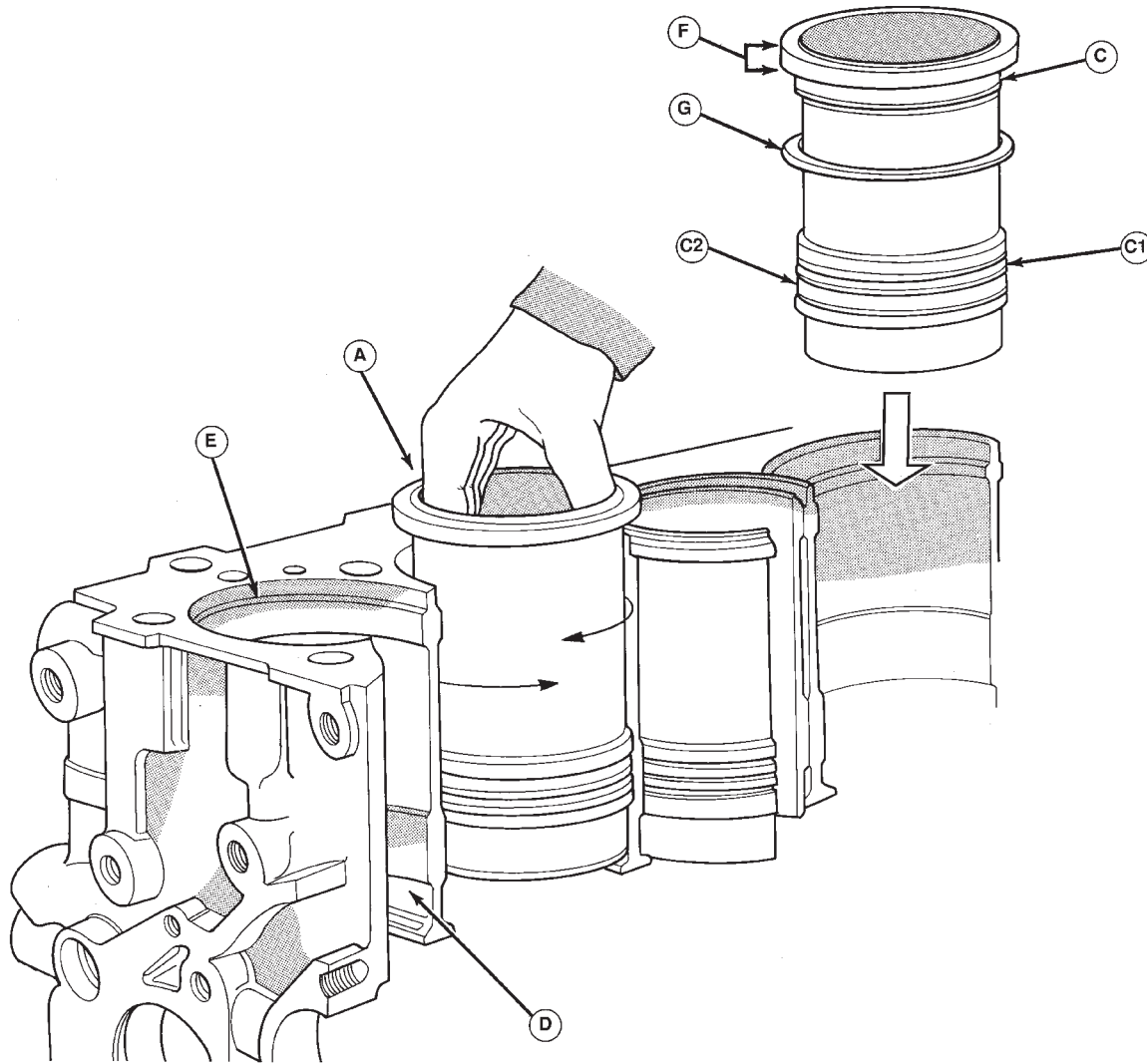
#### DISASSEMBLE AND ASSEMBLE

(1) Pry out plunger retainer spring clip.

(2) Clean varnish deposits from inside of tappet body above plunger cap.

(3) Invert tappet body and remove plunger cap, plunger, check valve, check valve spring, check valve retainer and plunger spring. Check valve could be flat or ball.

Assemble tappets in reverse order.



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**Fig. 83 Cylinder Liner—Installation**

## CLEANING AND INSPECTION

### CYLINDER HEAD COVERS

Remove any original sealer from the cover sealing surface of the engine cylinder head.

Remove all residue from the sealing surface using a clean, dry cloth.

### ROCKER ARMS AND PUSH RODS

#### CLEANING

Clean all the components (Fig. 87) with cleaning solvent.

Use compressed air to blow out the oil passages in the rocker arms and push rods.

#### INSPECTION

Inspect the pivot surface area of each rocker arm. Replace any that are scuffed, pitted, cracked or excessively worn.

Inspect the valve stem tip contact surface of each rocker arm and replace any rocker arm that is deeply pitted.

Inspect each push rod end for excessive wear and replace as required. If any push rod is excessively worn because of lack of oil, replace it and inspect the corresponding hydraulic tappet for excessive wear.

Inspect the push rods for straightness by rolling them on a flat surface or by shining a light between the push rod and the flat surface.

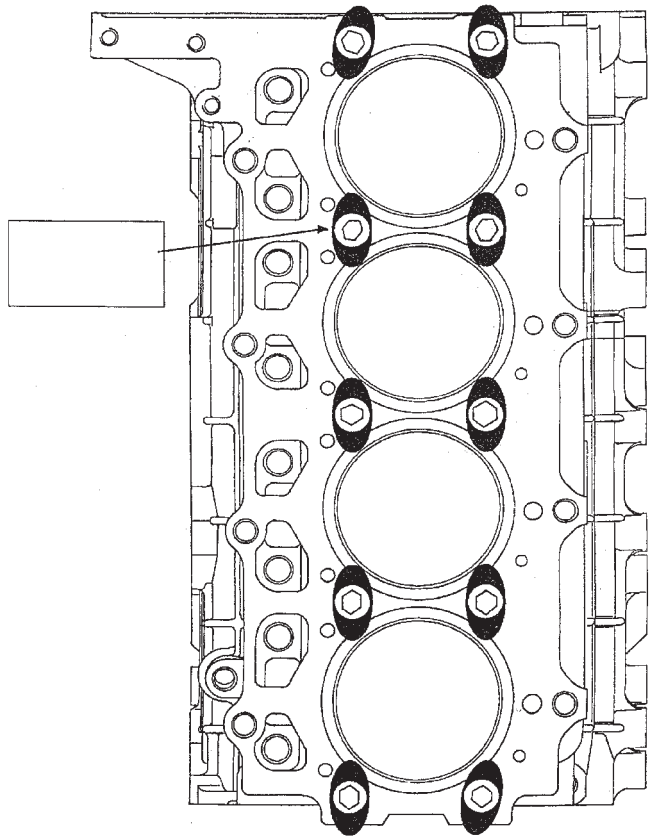
A wear pattern along the length of the push rod is not normal. Inspect the engine cylinder head for obstruction if this condition exists.

### CYLINDER HEAD

#### CLEANING

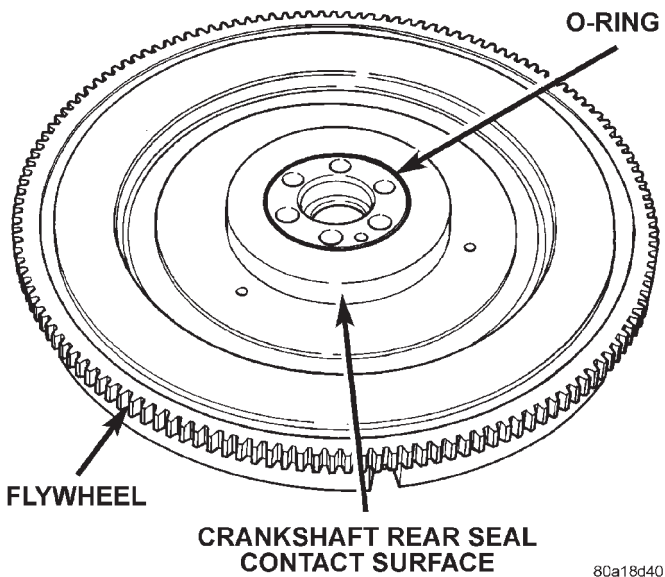
Thoroughly clean the engine cylinder head and cylinder block mating surfaces. Clean the intake and exhaust manifold and engine cylinder head mating surfaces. Remove all gasket material and carbon.

CLEANING AND INSPECTION (Continued)



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**Fig. 84 Liner Clamp Location**

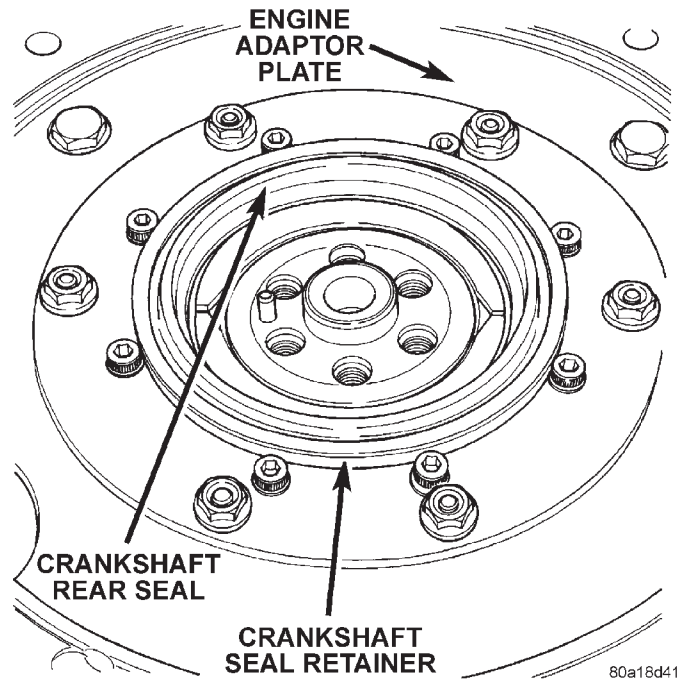


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**Fig. 85 Flywheel**

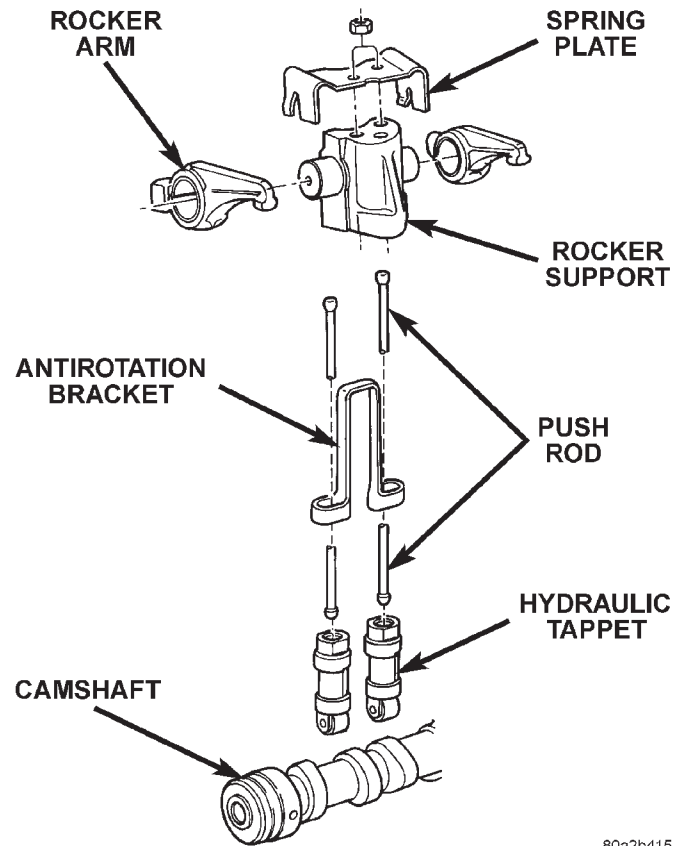
Check to ensure that no coolant or foreign material has fallen into the tappet bore area.

Remove the carbon deposits from the combustion chambers and top of the pistons.



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**Fig. 86 Crankshaft Seal**



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**Fig. 87 Rocker Arm Components**

CLEANING AND INSPECTION (Continued)

INSPECTION

Use a straightedge and feeler gauge to check the flatness of the engine cylinder head and block mating surfaces (Fig. 88).

Minimum cylinder head thickness 89.95mm (3.541 in.)

**CAUTION:** If only one cylinder head is found to be distorted and requires machining, it will also be necessary to machine the remaining cylinders heads and end plates by a corresponding amount to maintain correct cylinder alignment.

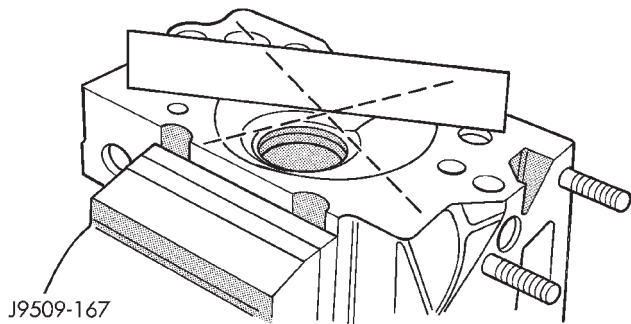
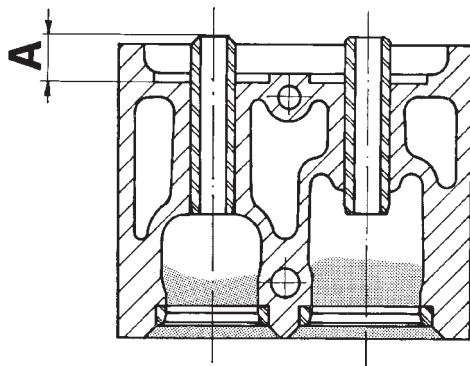


Fig. 88 Checking Cylinder Head Flatness

VALVE GUIDE HEIGHT

- (1) Valve Guides height requirement.
- (2) Measurement A (Fig. 89): 13.50 - 14.00 mm.



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Fig. 89 Valve Guide Height

VALVE STEM-TO-GUIDE CLEARANCE MEASUREMENT

(1) Measure and record internal diameter of valve guides. Valve guide internal diameter is 8.0 to 8.015 mm (.3149 to .3155 in.).

(2) Measure valve stems and record diameters. Intake valve stem diameter 7.94 to 7.96 mm (.3125 to .3133 in). Exhaust valve stem diameter 7.92 to 7.94 mm (.3118 to .31215 in).

(3) Subtract diameter of valve stem from internal diameter of its respective valve guide to obtain valve

stem clearance in valve guide. Clearance of inlet valve stem in valve guide is .040 to .075 mm (.0015 to .0029 in). Clearance of exhaust valve stem in valve guide is .060 to .095 mm (.0023 to .0037 in).

(4) If valve stem clearance in valve guide exceeds tolerances, new valve guides must be installed.

TIMING CHAIN COVER

Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs.

VALVES AND VALVE SPRINGS

VALVE CLEANING

Clean all carbon deposits from the combustion chambers, valve ports, valve stems, valve stem guides and heads.

Clean all grime and gasket material from the engine cylinder head machined gasket surfaces.

INSPECTION

Inspect for cracks in the combustion chambers and valve ports.

Inspect for cracks on the exhaust seat.

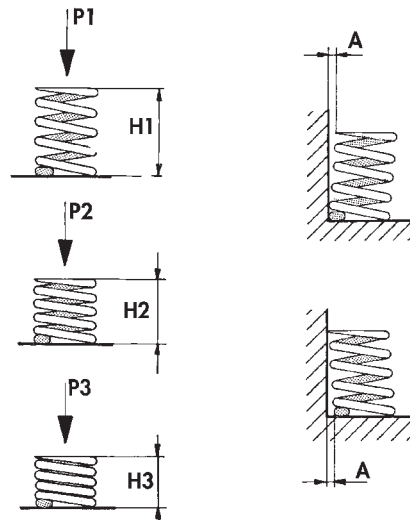
Inspect for cracks in the gasket surface at each coolant passage.

Inspect valves for burned, cracked or warped heads.

Inspect for scuffed or bent valve stems.

Replace valves displaying any damage.

Check valve spring height. (Fig. 90).



LOAD Kg	HEIGHT mm	STATE	
P1	0.00	H1 44.65	FREE LENGTH
P2	33-35	H2 38.60	VALVE CLOSED
P3	90-95	H3 28.20	VALVE OPEN

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Fig. 90 Valve Spring Chart

## CLEANING AND INSPECTION (Continued)

## HYDRAULIC TAPPETS

(1) Clean all tappet parts in a solvent that will remove all varnish and carbon.

(2) Replace tappets that are unfit for further service with new assemblies.

(3) If plunger shows signs of scoring or wear, install a new tappet assembly. If valve is pitted, or valve seat on end of plunger is prevented from seating, install a new tappet assembly.

## OIL PUMP

## CLEANING

Wash all parts in a suitable solvent and inspect carefully for damage or wear (Fig. 92).

## INSPECTION

(1) Before installing oil pump check pump bore depth in block (A) and pump body height (B) (Fig. 91). Difference between A and B should be 0.020-0.082 mm.

(2) Check clearance between rotors (Fig. 93).

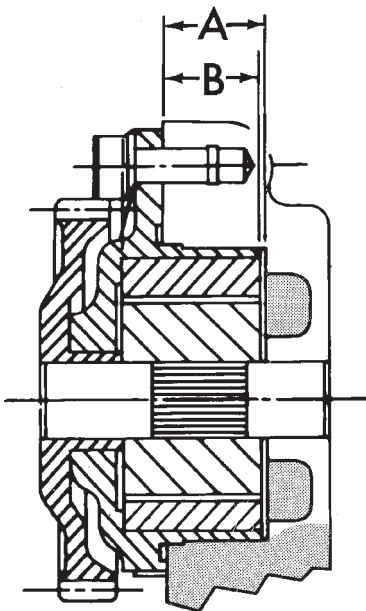


Fig. 91 Oil Pump Bore Depth

## PISTON AND CONNECTING ROD

## PISTONS

(1) Piston Diameter: Size Group A: 91.93-91.94mm (3.6191-3.6196 in.) Size Group B: 91.94-91.95mm (3.6196-3.6200 in.). Maximum wear limit .05mm (.0019 in.).

(2) Check piston pin bores in piston for roundness. Make 3 checks at 120° intervals. Maximum out of roundness .05mm (.0019in.).

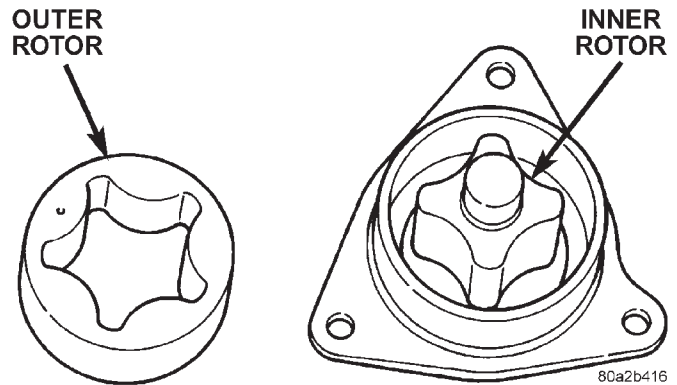


Fig. 92 Oil Pump Inner and Outer Rotors

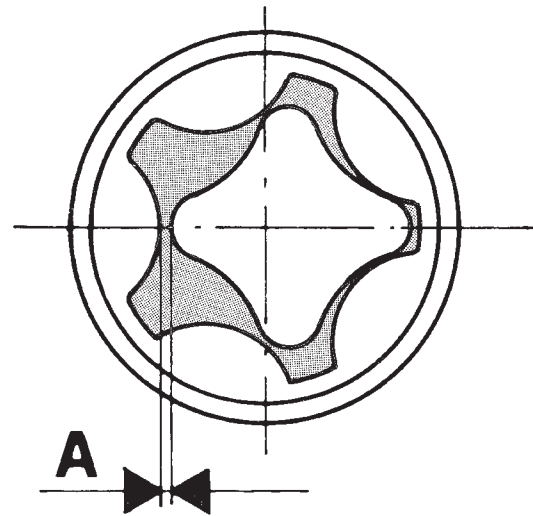


Fig. 93 Checking Rotor Clearance

(3) The piston diameter should be measured approximately 15 mm (.590 in.) up from the base.

(4) Skirt wear should not exceed 0.1 mm (.00039 in.).

(5) The clearance between the cylinder liner and piston should not exceed 0.25 mm (.0009 in.).

(6) Make sure the weight of the pistons does not differ by more than 5 g.

## CONNECTING ROD

(1) Assemble bearing shells and bearing caps to their respective connecting rods ensuring that the serrations on the cap and reference marks are aligned.

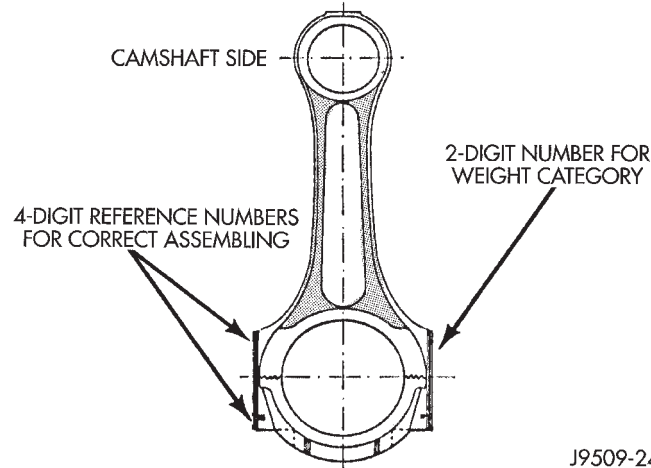
(2) Tighten bearing cap bolts to 29 N·m (21 ft. lbs.) plus 60°.

(3) Check and record internal diameter of crank end of connecting rod.

CLEANING AND INSPECTION (Continued)

Note: When changing connecting rods, all four must have the same weight and be stamped with the same number. **Replacement connecting rods will only be supplied in sets of four.**

(4) Connecting rods are supplied in sets of four since they all must be of the same weight category. Max allowable weight difference is 18 gr. **NOTE:** On one side of the big end of the con-rod there is a two-digit number which refers to the weight category. On the other side of the big end there is a four digit number on both the rod and the cap. These numbers must both face the camshaft as well as the recess on the piston crown (Fig. 94). Lightly heat the piston in oven. Insert piston pin in position and secure it with provided snap rings. **The Four digit numbers marked on con rod big end and rod cap must be on the same side as the camshaft (Fig. 94).** After having coated threads with Molyguard, tighten con rod bolts to 29 N·m (21 ft. lbs.) plus 60°.



**Fig. 94 Connecting Rod Identification**

**PISTON PIN**

(1) Measure the diameter of piston pin in the center and both ends (Fig. 95).

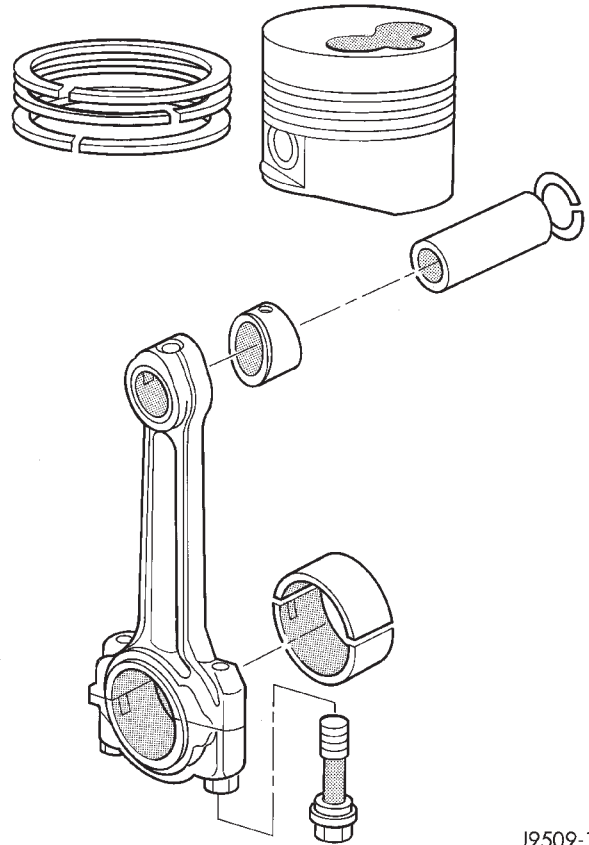
(2) Piston pin diameter is 29.990 to 29.996mm (1.1807 to 1.1809 in.).

**CRANKSHAFT**

**CRANKSHAFT JOURNALS**

(1) Using a micrometer, measure and record crankshaft connecting rod journals, take reading of each journal 120° apart. Crankshaft journal diameter is 53.84 to 53.955mm (2.1196 to 2.1242 in.).

(2) Crankshaft journals worn beyond limits or show signs of out of roundness must be reground or replaced. Minimum reground diameter is 53.69mm (2.1137 in.).

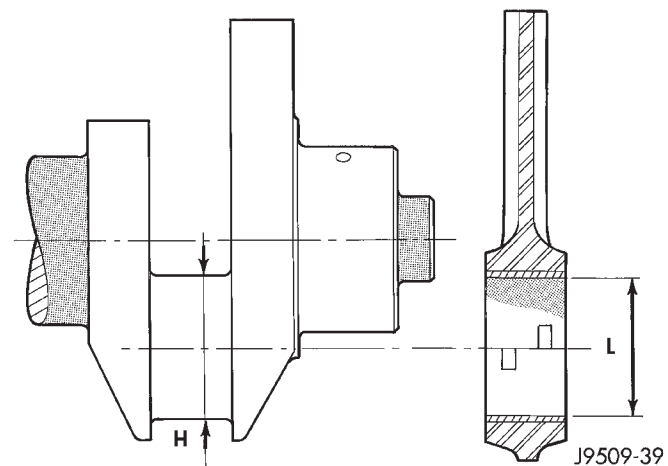


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**Fig. 95 Piston, Connecting Rod and Pin**

**BEARING-TO-JOURNAL CLEARANCE**

Compare internal diameters of connecting rod with crankshaft journal diameter. Maximum clearance between connecting rod and crankshaft journals .022 to .076mm (.0008 to .0029 in.) (Fig. 96).



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**Fig. 96 Bearing Clearance**

**CRANKSHAFT MAIN BEARING**

**INSPECTION**

(1) Fit main bearing carriers together and torque to 42 N·m (31 ft. lbs.)

CLEANING AND INSPECTION (Continued)

- (2) Check internal diameter of bearings.
- (3) If internal diameter of original bearing is being checked and figures are not within specifications, new bearings must be used.
- (4) Check crankshaft main bearing journals to bearing clearances. Clearances of main bearings is .03 to .088mm (.0011 to .0035 in.).

**OIL PAN**

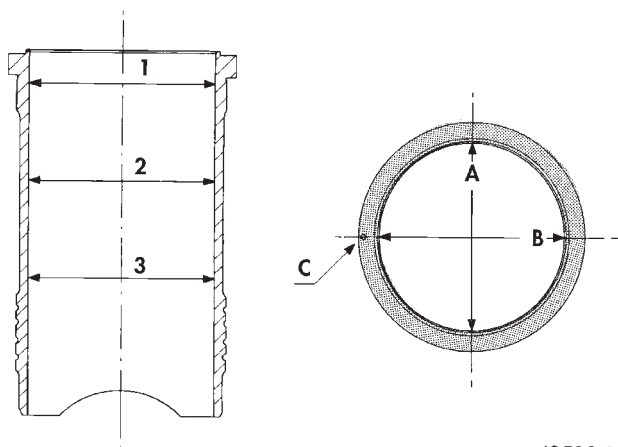
Remove all gasket material from cylinder block. Be careful not gouge pan sealing surface.

**CYLINDER LINER**

*INSPECTION*

The cylinder walls should be checked for out-of-round and taper with dial bore gauge. The cylinder bore out-of-round is 0.100 mm (.0039 inch) maximum and cylinder bore taper is 0.100 mm (0.0039 inch) maximum. If the cylinder walls are badly scuffed or scored, new liners should be installed and honed, and new pistons and rings fitted.

Measure the cylinder bore at three levels in directions A and B (Fig. 97). Top measurement should be 10 mm (3/8 inch) down and bottom measurement should be 10 mm (3/8 inch.) up from bottom of bore.



J9509-13

**Fig. 97 Liner Inspection**

**SPECIFICATIONS**

**2.5L VM DIESEL**

DESCRIPTION	SPECIFICATIONS
Type	425CLIEE (36B)
Number of Cylinder	4
Bore	92 mm
Stroke	94 mm
Capacity	2499.5 cm <sup>3</sup>
Injection Order	1-3-4-2
Compression Ratio	21:1 (± 0.5)

**DESCRIPTION SPECIFICATIONS**

**Crankshaft**

**Front Journal Diameter**

Nominal	62.985–63.000 mm
-0.25	62.735–62.750 mm
-0.125	62.860–62.875 mm

**Front Bearing Diameter**

Nominal	63.043–63.088 mm
-0.25	62.793–62.838 mm
-0.125	62.918–62.963 mm

Clearance Between Journal and Bearing:  
0.043–0.103 mm

**Center Journal Diameter**

Nominal	63.005–63.020 mm
-0.25	62.755–62.770 mm
-0.125	62.880–62.895 mm

**Center Bearing Diameter**

Nominal	63.050–63.093 mm
-0.25	62.800–62.843 mm
-0.125	62.925–62.968 mm

Clearance Between Journal and Bearing:  
0.030–0.088 mm

**Rear Journal Diameter**

Nominal	79.980–80.000 mm
-0.25	79.730–79.750 mm
-0.125	79.855–79.875 mm

**Rear Bearing Diameter**

Nominal	80.045–80.070 mm
-0.25	79.795–79.820 mm
-0.125	79.920–79.945 mm

Clearance Between Journal and Bearing:  
0.045–0.090 mm (Wear Limit: 0.200 mm)

**Connecting Rod Journal**

Nominal	53.940–53.955 mm
-0.25	53.690–53.705 mm
-0.125	53.815–53.830 mm

**Connecting Rod Bearing**

Nominal	53.977–54.016 mm
-0.25	53.727–53.766 mm
-0.125	53.852–53.891 mm

Clearance Between Journal and Bearing:  
0.022–0.076 mm (Wear Limit: 0.200 mm)

**Crankshaft End Play**

End Play	0.08–0.21 mm
Adjustment	Thrust Washers
Thrust Washers Available	2.31–2.36 mm
Thrust Washers Available	2.41–2.46 mm
Thrust Washers Available	2.51–2.56 mm

**Main Bearing Carriers**

Front	67.025–67.050 mm
Center	66.670–66.690 mm
Rear	85.985–86.005 mm

**Liners**

Internal Diameter	92.000–92.010 mm
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## SPECIFICATIONS (Continued)

DESCRIPTION	SPECIFICATIONS
Protrusion	0.01–0.06 mm
Adjustment	Shims
Available Shims:	0.15 mm
Available Shims:	0.17 mm
Available Shims:	0.20 mm
Available Shims:	0.23 mm
Available Shims:	0.25 mm

**Cylinder Head**

Minimum Thickness	89.95–90.05 mm
Gasket	Steel
Gasket thickness:	1.42 ± 0.1 mm 0 Holes
Gasket thickness:	1.62 ± 0.1 mm 1 Holes
Gasket thickness:	1.52 ± 0.1 mm 2 Holes

**End Plates**

Height	89.02–90.00 mm
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**Connecting Rods**

Weight (Without the crank bearing)	1129–1195 grams
Small End Bearing Internal Diameter	
Minimum	30.035 mm
Maximum	30.050 mm
Crankshaft Bearings	
Standard Internal Diameter	53.997–54.016 mm

**Pistons**

Skirt Diameter	91.935–91.945 mm
(Measured at approximately 15 mm above the bottom of the skirt)	
Piston Clearance	0.055–0.075 mm
Top of Piston to Cylinder Head	0.80–0.89 mm
Piston Protrusion	0.53–0.62 mm Fit Gasket (1.42), 0 Holes
Piston Protrusion	0.73–0.82 mm Fit Gasket (1.62), 1 Holes
Piston Protrusion	0.63–0.72 mm Fit Gasket (1.52), 2 Holes

**Piston Pins**

Type	Full Floating
Pin Diameter	29.990–29.996 mm
Clearance	0.004–0.014 mm

**Piston Rings (Clearance in Groove)**

Top	0.080–0.130 mm
Second	0.070–0.102 mm
Oil Control	0.040–0.072 mm

**Piston Rings (Fitted Gap)**

Top	0.25–0.50 mm
Second	0.20–0.35 mm
Oil Control	0.25–0.58 mm

**Camshaft**

Journal Diameter Front	53.460–53.480 mm
Bearing Clearance	0.06–0.13 mm
Journal Diameter Center	53.460–53.480 mm
Bearing Clearance	0.06–0.13 mm
Journal Diameter Rear	53.460–53.480 mm
Bearing Clearance	0.06–0.13 mm

DESCRIPTION	SPECIFICATIONS
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**Tappets**

Outside Diameter	22.195–22.212 mm
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**Rocker Gear**

Shaft Diameter	21.979–22.00 mm
Bushing internal diameter	22.020–22.041 mm
Assembly Clearance	0.020–0.062 mm

**Valves (Intake)**

Opens	26° B.T.D.C.
Closes	58° A.B.D.C.

**Valves (Exhaust)**

Opens	64° B.B.D.C.
Closes	38° A.T.D.C.

**Valve Face Angle**

Intake	55°30'– 55°50'
Exhaust	45°25'– 45°35'

**Valve Head Diameter**

Intake	40.05–40.25 mm
Exhaust	33.8–34.0 mm

**Valve Head Stand Down**

Intake	1.08–1.34 mm
Exhaust	1.99–1.25 mm

**Valve Stem Diameter**

Intake	7.940–7.960 mm
Exhaust	7.922–7.940 mm

**Valve Clearance in Guide**

Intake	0.040–0.075 mm
Exhaust	0.060–0.093 mm

**Valve Guide**

Inside Diameter	8.0–8.015 mm
Fitted Height	13.5–14.0 mm

**Valve Spring**

Free Length	44.65 mm
Fitted Length	38.6 mm
Load at Fitted Length	34 ± 6% Kg
Load at Top of Lift	92.5 ± 4% Kg
Number of Coils	5.33 Valve Timing

**Oil Pressure**

at 4000 rpm	3.0 to 4.5 bar (Oil at 90–100°C)
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Pressure Relief Valve Opens	6.38 bar
Pressure Relief Valve–Free Length	57.5 mm

**Oil Pump**

Outer Rotor End Float	0.03–0.09 mm
Inner Rotor End Float	0.03–0.09 mm
Outer Rotor to Body	
Diameter Clearance	0.130–0.230 mm
Rotor Body to Drive Gear Clearance (Pump Not Fitted)	3.27–3.73 mm

**TORQUE**

DESCRIPTION	TORQUE
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**Generator Mounting Bracket**

Bolts	47 N·m (35 ft. lbs.)
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## SPECIFICATIONS (Continued)

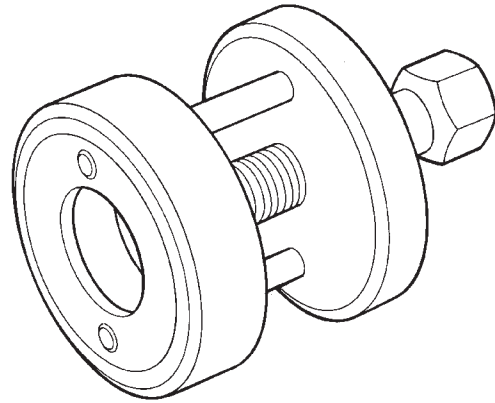
DESCRIPTION	TORQUE	DESCRIPTION	TORQUE
<b>Camshaft Locating Plate</b>		Nuts . . . . .	28 N·m (250 in. lbs.)
Bolt . . . . .	11 N·m (96 in. lbs.)	<b>Glow Plugs</b>	
<b>Camshaft Sprocket</b>		Plugs . . . . .	14 N·m (120 in. lbs.)
Bolt . . . . .	19.6 N·m + 60° (170 in. lbs. + 60°)	<b>Idler Pulley Pump Support Bracket</b>	
<b>Cylinder Head</b>		Nuts . . . . .	26 N·m (228 in. lbs.)
Bolts . . . . .	See Cylinder Head Installation Procedure	<b>Idler Pulleys (left handed threads)</b>	
<b>Connecting Rod</b>		Bolts . . . . .	47 N·m (35 ft. lbs.)
Bolts . . . . .	29.5 N·m +60° (22 ft. lbs. +60°)	<b>Injector Pump fuel lines</b>	
<b>Crankshaft Bearing Carrier</b>		Nuts . . . . .	17.6 N·m (156 in. lbs.)
Bolts . . . . .	44 N·m (32 ft. lbs.)	<b>Injector Pump Sprocket</b>	
<b>Crankshaft damper (Pulley)</b>		Nut . . . . .	86.3 N·m (63 ft. lbs.)
Nut . . . . .	441 N·m (325 ft. lbs.)	<b>Injector Pump Mounting</b>	
<b>EGR Valve to Intake Manifold</b>		Nuts . . . . .	27.5 N·m (240 in. lbs.)
Tube . . . . .	26 N·m (19 ft. lbs.)	<b>Injector</b>	
<b>EGR Tube to EGR Valve</b>		Tighten to . . . . .	65 N·m (48 ft. lbs.)
Bolts . . . . .	26 N·m (19 ft. lbs.)	<b>Intake Manifold Mounting</b>	
<b>Engine Mount—Front</b>		Nuts . . . . .	30 N·m (264 in. lbs.)
Support Bracket Engine Bolts . . . . .	68 N·m (50 ft. lbs.)	<b>Main Bearing Oil Delivery Union</b>	
Support Bracket Transmission Bolts . . . . .	101 N·m (75 ft. lbs.)	Bolts . . . . .	54 N·m (40 ft. lbs.)
Support Cushion Crossmember Bolts . . . . .	54 N·m (40 ft. lbs.)	<b>Oil Feed Line To Rocker Arms</b>	
Support Cushion Thru Bolt . . . . .	65 N·m (48 ft. lbs.)	Bolts . . . . .	12.7 N·m (108 in. lbs.)
<b>Engine Mount—Rear</b>		<b>Oil Feed Line to Block</b>	
Support Bracket Transmission Bolts . . . . .	101 N·m (75 ft. lbs.)	Bolts . . . . .	12.7 N·m (108 in. lbs.)
Support Bracket to Engine Bracket . . . . .	101 N·m (75 ft. lbs.)	<b>Oil Feel Line to Vacuum Pump</b>	
Support Cushion Thru Bolt . . . . .	68 N·m (50 ft. lbs.)	Bolts . . . . .	16.7 N·m (145 in. lbs.)
<b>Engine Mount—Left</b>		<b>Oil Filter</b>	
Transmission Mounting Bolts . . . . .	54 N·m (40 ft. lbs.)	Tighten to . . . . .	9.8 N·m (85 in. lbs.)
Support Cushion Thru Bolt . . . . .	71 N·m (53 ft. lbs.)	<b>Oil Filter Adaptor</b>	
<b>Engine Mount—Right</b>		Fastener . . . . .	49 N·m (36 ft. lbs.)
Mount to Frame Rail Bolts . . . . .	68 N·m (50 ft. lbs.)	<b>Oil Filter Base</b>	
Mount Bolt (Horizontal) . . . . .	145 N·m (107 ft. lbs.)	Fastener . . . . .	49 N·m (36 ft. lbs.)
Mount Bolt (Vertical) . . . . .	101 N·m (75 ft. lbs.)	<b>Oil Pan Mounting</b>	
<b>Right Engine Mount Bracket</b>		Bolts . . . . .	12 N·m (108 in. lbs.)
Bolts . . . . .	40 N·m (30 ft. lbs.)	<b>Oil Pickup Tube</b>	
<b>Exhaust Pipe to Turbocharger</b>		Bolts . . . . .	11.3 N·m (100 in. lbs.)
Bolts . . . . .	28 N·m (250 in. lbs.)	<b>Oil Pump Mounting</b>	
<b>Exhaust Manifold Outlet to Turbo</b>		Bolts . . . . .	27.5 N·m (240 in. lbs.)
Nuts . . . . .	32 N·m (24 ft. lbs.)	<b>Oil Pan Drain</b>	
<b>Exhaust Elbow to Turbo</b>		Plug . . . . .	54 N·m (40 ft. lbs.)
Bolts . . . . .	30 N·m (22 ft. lbs.)	<b>Power Steering Pressure Hose</b>	
<b>Exhaust Manifold Mounting</b>		Fastener . . . . .	28 N·m (240 in. lbs.)
Nuts . . . . .	30 N·m (22 ft. lbs.)	<b>Power Steering Pulley</b>	
<b>Flywheel</b>		Nut . . . . .	170 N·m (125 ft. lbs.)
Bolts . . . . .	See Rear Crankshaft Seal Installation Procedure	<b>Rear Crankshaft Bearing Carrier</b>	
<b>Engine Adaptor Plate</b>		Bolts . . . . .	10.8 N·m (95 in. lbs.)
Bolts . . . . .	47 N·m (35 ft. lbs.)	<b>Rocker Arm Cover</b>	
<b>Front Timing Chain Cover</b>		Bolts . . . . .	14.7 N·m (132 in. lbs.)
Bolts . . . . .	11 N·m (96 in. lbs.)	<b>Rocker Arm Mounting</b>	
<b>Fuel Filter</b>		Nuts . . . . .	29.4 N·m (264 in. lbs.)
		<b>Power Steering Pump Mounting</b>	
		Nuts . . . . .	24.5 N·m (216 in. lbs.)
		<b>Turbocharger Mounting</b>	
		Nuts . . . . .	32 N·m (288 in. lbs.)

SPECIFICATIONS (Continued)

DESCRIPTION	TORQUE
<b>Turbocharger Oil Delivery</b>	
Bolt .....	27.5 N·m (240 in. lbs.)
<b>Turbocharger Oil Drain</b>	
Bolts .....	10.8 N·m (95 in. lbs.)
<b>Vacuum Pump Mounting</b>	
Bolts .....	10.8 N·m (95 in. lbs.)
<b>Water Manifold Mounting</b>	
Bolts .....	11.8 N·m (108 in. lbs.)
<b>Water Pump Pulley</b>	
Bolts .....	27.5 N·m (240 in. lbs.)

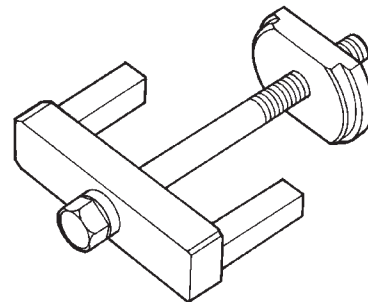
SPECIAL TOOLS

2.5L VM DIESEL



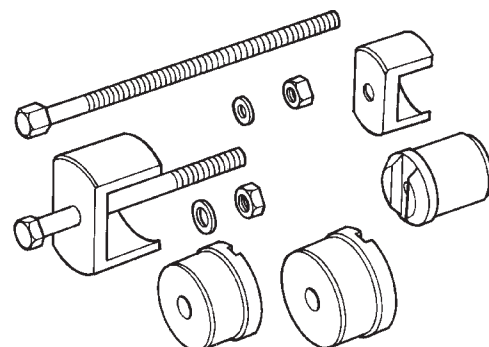
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**Crankshaft Sprocket Remover VM.1000A**



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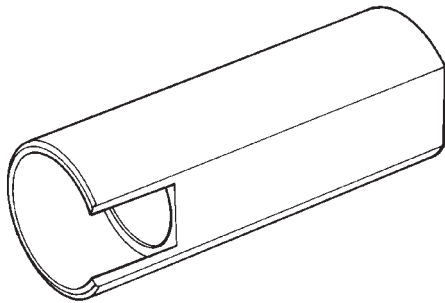
**Cylinder Liner Puller VM.1001**



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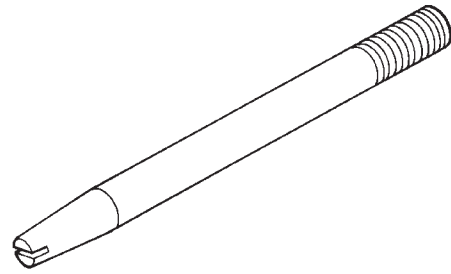
**Crankshaft Bearing Remover/Installer VM.1002**

SPECIAL TOOLS (Continued)



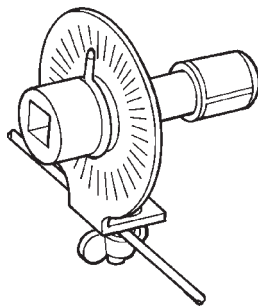
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***Crankshaft Remover/Installer Sleeve VM.1004***



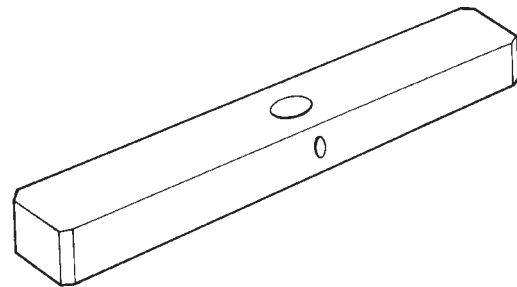
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***Cylinder Head Guide Studs VM.1009***



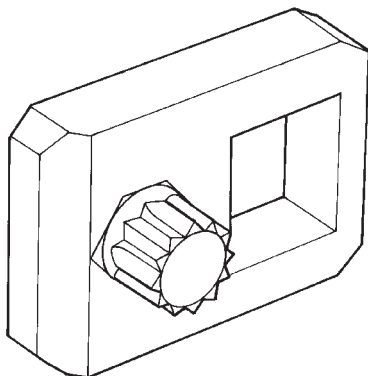
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***Torque Angle Gauge VM.1005***



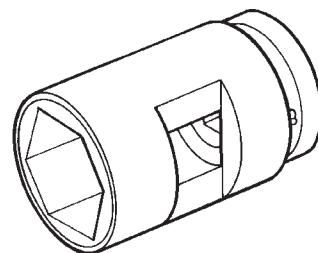
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***Cylinder Liner Protrusion Tool VM.1010***



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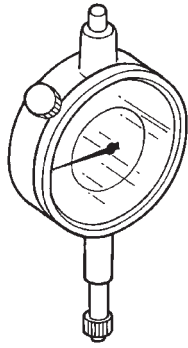
***Cylinder Head Bolt Wrench VM.1006A***



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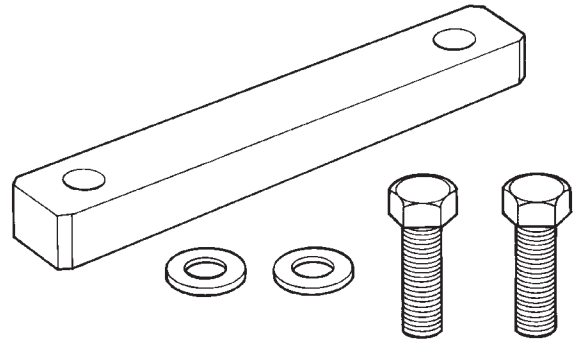
***Injector Socket Remover/Installer VM.1012A***

SPECIAL TOOLS (Continued)



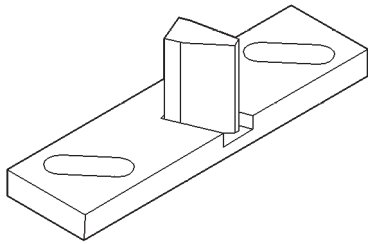
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**Dial Indicator Gauge VM.1013**

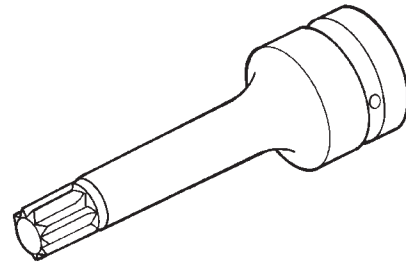


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**Cylinder Retainers VM.1016**

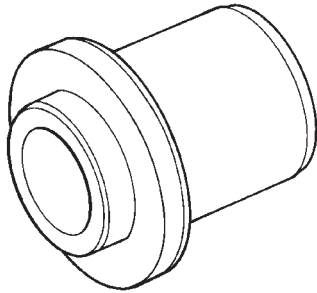


**Flywheel Locking Tool VM.1014**



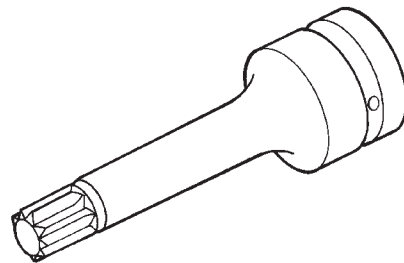
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**Cylinder Head Bolt Wrench M12 VM.1018**



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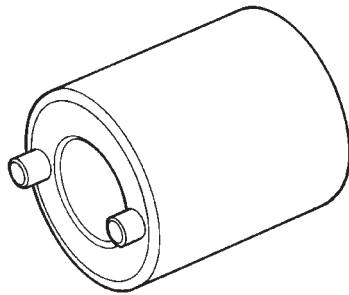
**Timing Cover Oil Seal Installer VM.1015**



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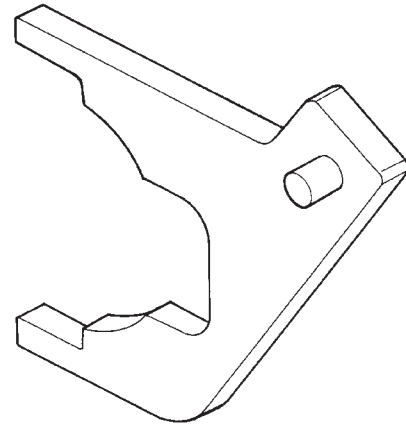
**Cylinder Head Bolt Wrench M14 VM.1019**

SPECIAL TOOLS (Continued)



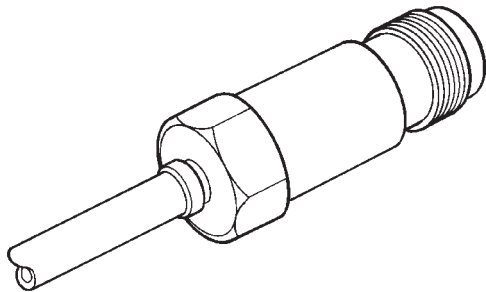
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**Adapter Oil Filter VM.1020**



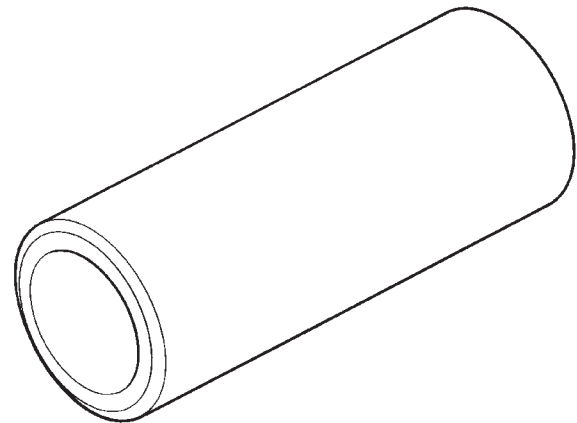
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**Camshaft Locating Plate Alignment VM.1028**



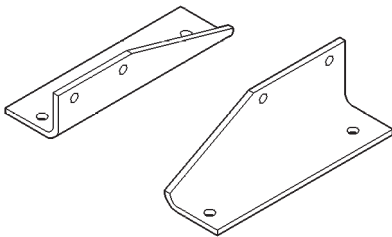
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**Adapter Cylinder Leakage Tester VM.1021**



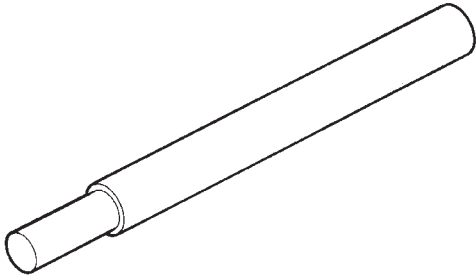
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**Crankshaft Sprocket Installer VM.1029**



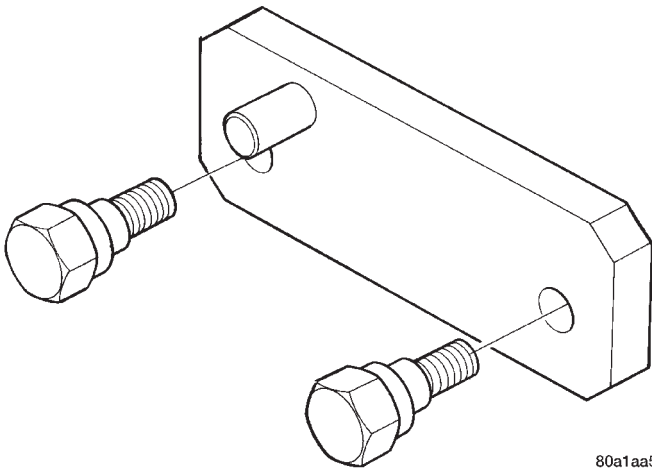
**Support Brackets Engine Removal/Installation  
VM.1026**

SPECIAL TOOLS (Continued)



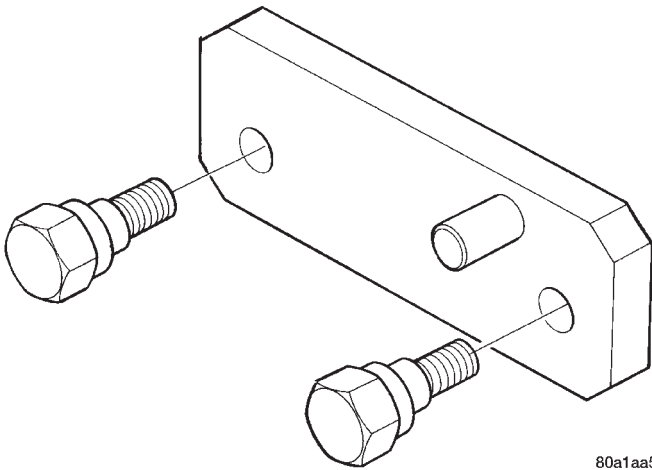
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**Locating Pin Crankshaft Sprocket VM.1030**



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**Camshaft Sprocket Locking Tool VM.1031**



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**Injection Pump Sprocket Locking Tool VM.1032**