ENGINE

CONTENTS

	page		page
2.0L DOHC ENGINE	**52**	**ENGINE DIAGNOSIS**	**7**
2.0L SOHC ENGINE	**12**	**STANDARD SERVICE PROCEDURES**	**1**

STANDARD SERVICE PROCEDURES

INDEX

page

GENERAL INFORMATION
- CHECKING ENGINE OIL LEVEL 5
- CRANKSHAFT SPROCKET BOLT ACCESS PLUG 2
- ENGINE CORE PLUGS 2
- ENGINE OIL SERVICE 5
- ENGINE PERFORMANCE 2
- FORM-IN-PLACE GASKETS 1
- HONING CYLINDER BORES 3
- HYDROSTATIC LOCKED ENGINE 5
- MEASURING MAIN BEARING AND CONNECTING ROD BEARING CLEARANCES 3
- REPAIR OF DAMAGED OR WORN THREADS . . 5

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 to assure obtaining the desired results. **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 which can break off and obstruct fluid feed lines. A continuous bead of the proper width is essential to obtain a leak-free gasket.

There are numerous types of form-in-place gasket materials that are used in the engine area. Mopar Silicone Rubber Adhesive Sealant and Mopar Gasket Maker gasket materials, each have different properties and can not be used in place of the other.

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. The material cures in the absence of air when squeezed between two metallic surfaces. It will not cure if left in the uncovered tube. 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 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 removing all loose material. Inspect stamped parts to

GENERAL INFORMATION (Continued)

assure gasket rails are flat. Flatten rails with a hammer on a heavy steel 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 then using precut gaskets.

Mopar Gasket Maker material should be applied sparingly 1 mm(0.040 inch.) 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 material off the location.

The Mopar Silicone Rubber Adhesive Sealant gasket material or equivalent should be applied in a continuous bead approximately 3 mm (0.120 inch) in diameter. All mounting holes must be circled. For corner sealing, a 3.17 or 6.35 mm (1/8 or 1/4 inch.) 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 material off the 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.

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 inch.) inside the lead in chamfer (Fig. 1).

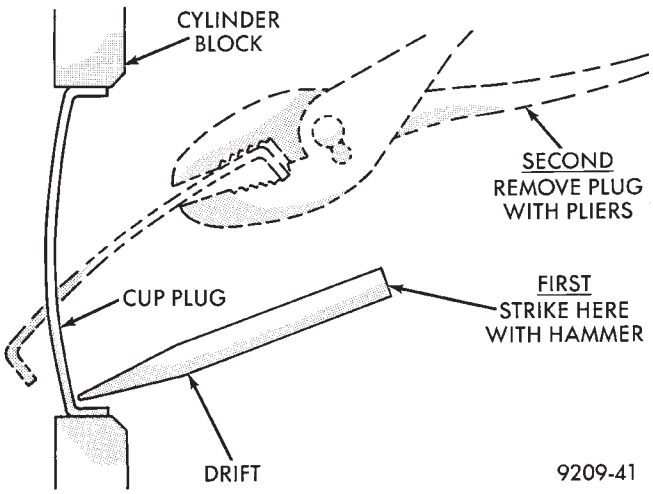


Fig. 1 Core Hole Plug Removal

It is in 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, ignition timing should be checked. timing belt or chain may have skipped one or two teeth. Camshaft and crankshaft timing should also be checked. Refer to Group 9, Engine Timing belt or chain installation.

To provide best vehicle performance and lowest vehicle emissions, it is most important that the tune-up be done accurately. Use the specifications listed on the Vehicle Emission Control Information label found in the engine compartment.

(1) Test cranking amperage draw. See Starting Motor Cranking Amperage Draw Electrical Section of this manual.

(2) Check intake manifold for vacuum leaks.

PERFORM CYLINDER COMPRESSION TEST

(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.

GENERAL INFORMATION (Continued)

(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 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.

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

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

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

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

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

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

(7) 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).

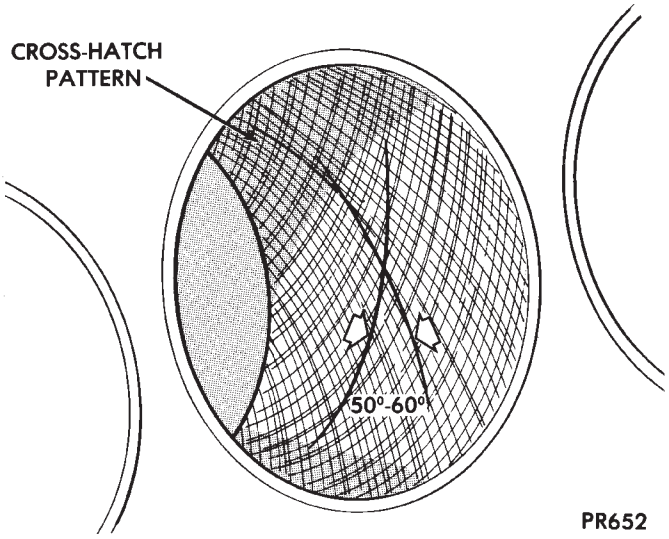


Fig. 2 Cylinder Bore Cross-Hatch Pattern

(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

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:

GENERAL INFORMATION (Continued)

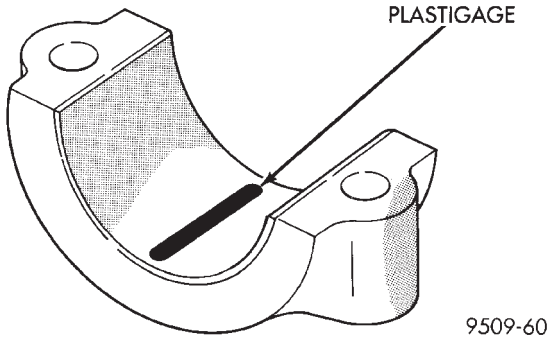


Fig. 3 Plastigage Placed in Lower Shell

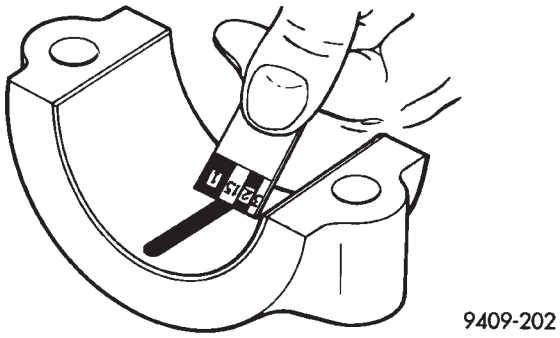


Fig. 4 Clearance Measurement

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.
- 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

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 generally 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.

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.

CHECKING ENGINE OIL LEVEL

The best time to check engine oil level is after it has sat overnight, or if the engine has been running, allow the engine to be shut off for at least 5 minutes before checking oil level.

Checking the oil while the vehicle is on level ground will improve the accuracy of the oil level reading. Add only when the level is at or below the ADD mark (Fig. 5).

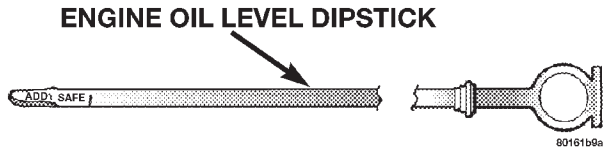


Fig. 5 Oil Level

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.

GENERAL INFORMATION (Continued)

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.

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. 6).

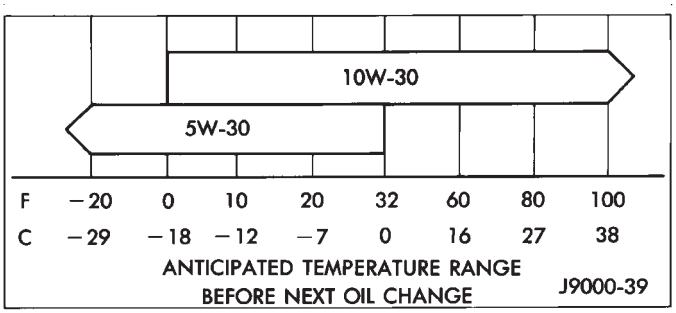


Fig. 6 Temperature/Engine Oil Viscosity

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. 7).

9400-9

Fig. 7 Engine Oil Container Standard Notations

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 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

INDEX

page

DIAGNOSIS AND TESTING
CYLINDER COMBUSTION PRESSURE LEAKAGE TEST 8
CYLINDER COMPRESSION PRESSURE TEST . 7
ENGINE DIAGNOSIS—MECHANICAL 11
ENGINE DIAGNOSIS—PERFORMANCE 10
GENERAL INFORMATION 7
INSPECTION (ENGINE OIL LEAKS IN GENERAL) 8
INTAKE MANIFOLD LEAKAGE DIAGNOSIS 7
LASH ADJUSTER (TAPPET) NOISE DIAGNOSIS 8

DIAGNOSIS AND TESTING

GENERAL INFORMATION

Engine diagnosis is helpful in determining the causes of malfunctions not detected and remedied by routine tune-ups.

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 out lined 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 rocker arms (sohc) or lash adjuster (dohc) and replace.

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.

(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.

DIAGNOSIS AND TESTING (Continued)

(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	1. Weak battery.	1. Test battery specific gravity. Charge or replace as necessary.
	2. Corroded or loose battery connections.	2. Clean and tighten battery connections. Apply a coat of light mineral grease to the terminals.
	3. Faulty starter.	3. Refer to Group 8A, Battery/Starter/Charging System Diagnostics.
	4. Moisture on ignition wires.	4. Wipe wires clean and dry.
	5. Faulty ignition cables.	5. Replace any cracked or shorted cables.
	6. Faulty coil or control unit.	6. Test and replace, if necessary (refer to Group 8D, Ignition system).
	7. Incorrect spark plug gap.	7. Set gap (refer to Group 8D, Ignition System).
	8. Dirt or water in fuel system.	8. Clean system and replace fuel filter.
	9. Faulty fuel pump.	9. Install new fuel pump (refer to Group 14, Fuel System).
ENGINE STALLS OR ROUGH IDLE	1. Idle speed set too low.	1. Refer to Group 14, Fuel System.
	2. Idle mixture too lean or too rich.	2. Refer to Group 14, Fuel System.
	3. Leak in intake manifold.	3. Inspect intake manifold gasket and vacuum hoses. Replace, if necessary (refer to Group 11, Exhaust System & Intake Manifold).
	4. Incorrect ignition wiring.	4. Install correct wiring.
	5. Faulty coil.	5. Test and replace, if necessary (refer to Group 8D, Ignition System).
ENGINE LOSS OF POWER	1. Dirty or incorrectly gapped spark plugs.	1. Clean plugs and set gap (refer to Group 8D, Ignition System).
	2. Dirt or water in fuel system.	2. Clean system and replace fuel filter.
	3. Faulty fuel pump.	3. Install new fuel pump.
	4. Incorrect valve timing.	4. Correct valve timing.
	5. Blown cylinder head gasket.	5. Install new cylinder head gasket.
	6. Low compression.	6. Test compression of each cylinder.
	7. Burned, warped or pitted valves.	7. Install new valves.
	8. Plugged or restricted exhaust system.	8. Install new parts, as necessary.
	9. Faulty ignition cables.	9. Replace any cracked or shorted cables.
	10. Faulty coil.	10. Test and replace, as necessary (refer to Group 8D, Ignition System).
ENGINE MISSES ON ACCELERATION	1. Dirty or gap set too wide in spark plug.	1. Clean spark plugs and set gap (refer to Group 8D, Ignition System).
	2. Dirt in fuel system.	2. Clean fuel system.
	3. Burned, warped or pitted valves.	3. Install new valves.
	4. Faulty coil.	4. Test and replace, if necessary, (refer to Group 8D, Ignition System).
ENGINE MISSES AT HIGH SPEED	1. Dirty or gap set too wide in spark plug.	1. Clean spark plugs and set gap (refer to Group 8D, Ignition System).
	2. Faulty coil.	2. Test and replace, as necessary (refer to Group 8D, Ignition System).
	3. Dirty injector.	3. Clean injectors.
	4. Dirt or water in fuel system.	4. Clean system and replace fuel filter.

DIAGNOSIS AND TESTING (Continued)

ENGINE DIAGNOSIS—MECHANICAL

CONDITION	POSSIBLE CAUSES	CORRECTION
NOISY VALVES	1. High or low oil level in crankcase.	1. Check for correct oil level (refer to Group 0, Lubrication and Maintenance).
	2. Thin or diluted oil.	2. Change oil (refer to Group 0, Lubrication and Maintenance).
	3. Low oil pressure.	3. Check engine oil level.
	4. Dirt in tappets/lash adjusters.	4. Replace rocker arm/hydraulic lash adjuster assembly.
	5. Worn rocker arms.	5. Inspect oil supply to rocker arms.
	6. Worn tappets/lash adjusters.	6. Install new rocker arm/hydraulic lash adjuster assembly.
	7. Worn valve guides.	7. Ream and install new valves with oversize stems.
	8. Excessive runout of valve seats on valve faces.	8. Grind valve seats and valves.
	9. Missing adjuster pivot.	9. Replace rocker arm/hydraulic lash adjuster assembly.
CONNECTING ROD NOISE	1. Insufficient oil supply.	1. Check engine oil level (refer to Group 0, Lubrication and Maintenance).
	2. Low oil pressure.	2. Check engine oil level. Inspect oil pump relief valve and spring.
	3. Thin or diluted oil.	3. Change oil to correct viscosity.
	4. Excessive bearing clearance.	4. Measure bearings for correct clearance. Repair as necessary.
	5. Connecting rod journal out-of-round.	5. Replace crankshaft or grind journals.
	6. Misaligned connecting rods.	6. Replace bent connecting rods.
MAIN BEARING NOISE	1. Insufficient oil supply.	1. Check engine oil level (refer to Group 0, Lubrication and Maintenance).
	2. Low oil pressure.	2. Check engine oil level. Inspect oil pump relief valve and spring.
	3. Thin or diluted oil.	3. Change oil to correct viscosity.
	4. Excessive bearing clearance.	4. Measure bearings for correct clearance. Repair as necessary.
	5. Excessive end play.	5. Check thrust bearing for wear on flanges.
	6. Crankshaft journal out-of-round, worn.	6. Grind journals or replace crankshaft.
	7. Loose flywheel or torque converter.	7. Tighten to correct torque.
OIL PRESSURE DROP	1. Low oil level.	1. Check engine oil level.
	2. Faulty oil pressure sending unit.	2. Install new sending unit.
	3. Low oil pressure.	3. Check sending unit and check main bearing oil clearance.
	4. Clogged oil filter.	4. Install new oil filter.
	5. Worn parts in oil pump.	5. Replace worn parts or pump.
	6. Thin or diluted oil.	6. Change oil to correct viscosity.
	7. Excessive bearing clearance.	7. Measure bearings for correct clearance.
	8. Oil pump relief valve stuck.	8. Remove valve and inspect, clean and install.
	9. Oil pump suction tube loose, bent cracked, or blocked.	9. Remove oil pan and install new tube, or clean if necessary.
	10. Oil pump cover warped or cracked.	10. Install new oil pump.
OIL LEAKS	1. Misaligned or deteriorated gaskets.	1. Replace the gasket.
	2. Loose fastener, broken or porous metal part.	2. Tighten, repair or replace the part.
	3. Misaligned or deteriorated cup or threaded plug.	3. Replace.
OIL CONSUMPTION OR SPARK PLUGS OIL FOULED	1. PCV system malfunction.	1. Check system. Clean and repair, as necessary (refer to Group 25, Emissions Control System).
	2. Worn, scuffed or broken rings.	2. Hone cylinder bores. Install new rings.
	3. Carbon in oil ring slot.	3. Install new rings.
	4. Rings fitted too tightly in grooves.	4. Remove the rings. Check grooves. If groove is not proper width, replace piston.
	5. Worn valve guides.	5. Ream guides and replace valves with oversize valves and seals.
	6. Valve stem seal unseated or defective.	6. Repair or replace seal.

2.0L SOHC ENGINE

INDEX

	page
DESCRIPTION AND OPERATION	
ENGINE COMPONENTS	14
ENGINE IDENTIFICATION	12
ENGINE LUBRICATION SYSTEM	13
GENERAL SPECIFICATION	12
DIAGNOSIS AND TESTING	
CHECKING ENGINE OIL PRESSURE	14
SERVICE PROCEDURES	
CRANKSHAFT END PLAY	17
CYLINDER BORE AND PISTON SIZING	15
FITTING CONNECTING RODS	15
FITTING CRANKSHAFT BEARINGS	17
FITTING PISTON RINGS	15
REMOVAL AND INSTALLATION	
CAMSHAFT OIL SEAL	27
CAMSHAFT	21
CRANKSHAFT	34
CYLINDER HEAD COVER	20
CYLINDER HEAD	24
ENGINE ASSEMBLY	19
FRONT CRANKSHAFT OIL SEAL	32
FRONT MOUNT	17
LEFT MOUNT	18
OIL FILTER ADAPTER	36
OIL FILTER	36
OIL PAN	31
OIL PUMP	37
PISTON AND CONNECTING ROD	38
POWER HOP DAMPER	18
REAR CRANKSHAFT SEAL	33
RIGHT MOUNT	18
ROCKER ARM/HYDRAULIC LASH ADJUSTER	22
SPARK PLUG TUBE	21
TIMING BELT COVER	25
TIMING BELT SYSTEM	28
VALVE SEALS AND SPRINGS IN VEHICLE	23
VIBRATION DAMPER	40
DISASSEMBLY AND ASSEMBLY	
OIL PUMP	41
VALVE SERVICE WITH THE CYLINDER HEAD REMOVED	42
CLEANING AND INSPECTION	
CYLINDER BLOCK AND BORE	46
CYLINDER HEAD AND CAMSHAFT = JOURNALS	44
OIL PUMP	45
SPECIFICATIONS	
ENGINE 2.0L SOHC	47
TORQUE CHART 2.0L SOHC	48
SPECIAL TOOLS	
ENGINE 2.0L SOHC	49

DESCRIPTION AND OPERATION

ENGINE IDENTIFICATION

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

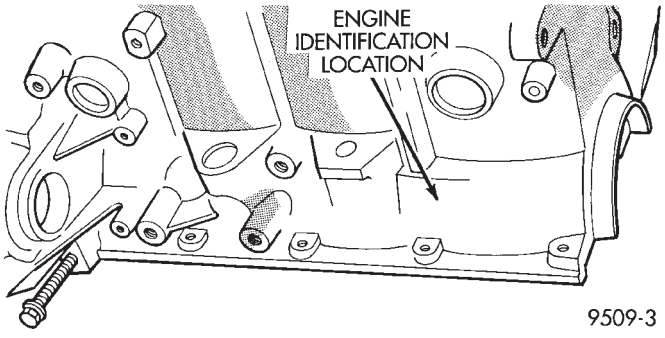


Fig. 1 Engine Identification SOHC

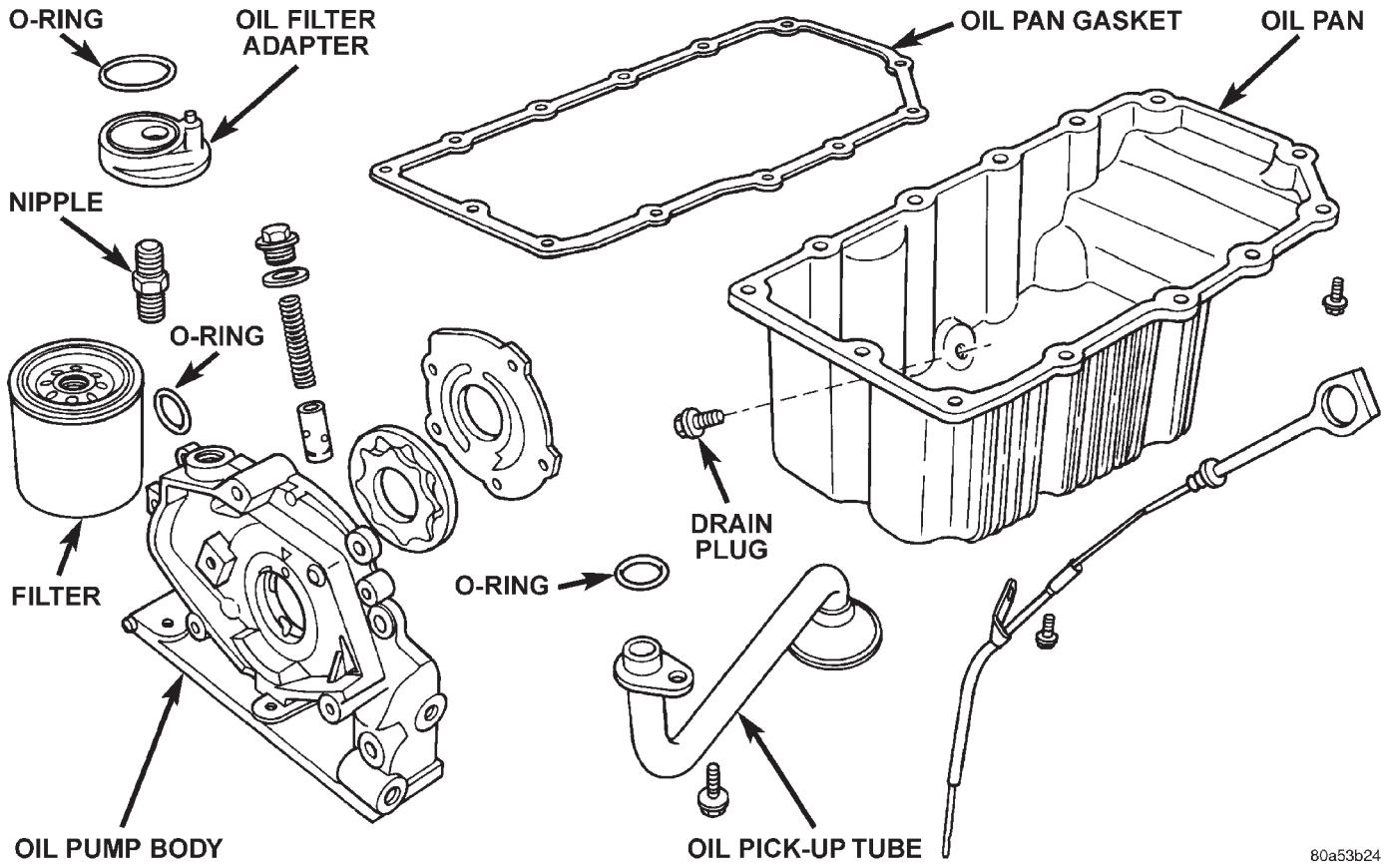
GENERAL SPECIFICATION

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.)

DESCRIPTION AND OPERATION (Continued)



Engine Lubrication Components

ENGINE LUBRICATION SYSTEM

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. Rod bearing oil throw-off lubricates the pistons from directed slots on the side of 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.

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. A cylinder head restrictor, located in the block, provides increased oil flow to the main oil gallery (Fig. 2).

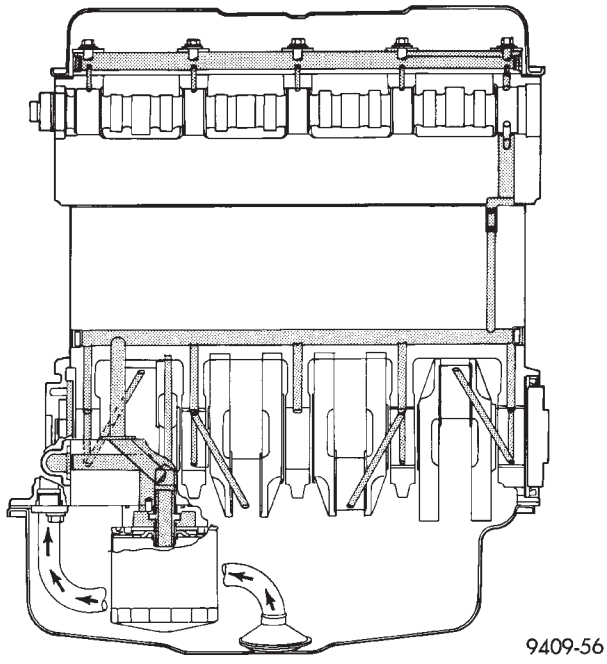


Fig. 2 Engine Lubrication System— SOHC

MAIN/ROD BEARINGS

A diagonal hole in each bulkhead feeds oil to each main bearing. Drilled passages within the crankshaft

DESCRIPTION AND OPERATION (Continued)

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 into the cylinder head. The rocker shafts route oil to the rocker arms/hydraulic lash adjuster assemblies.

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

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 counterweights 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.

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 relearn 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.

(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

DIAGNOSIS AND TESTING (Continued)

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. 3). 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. 3). 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.

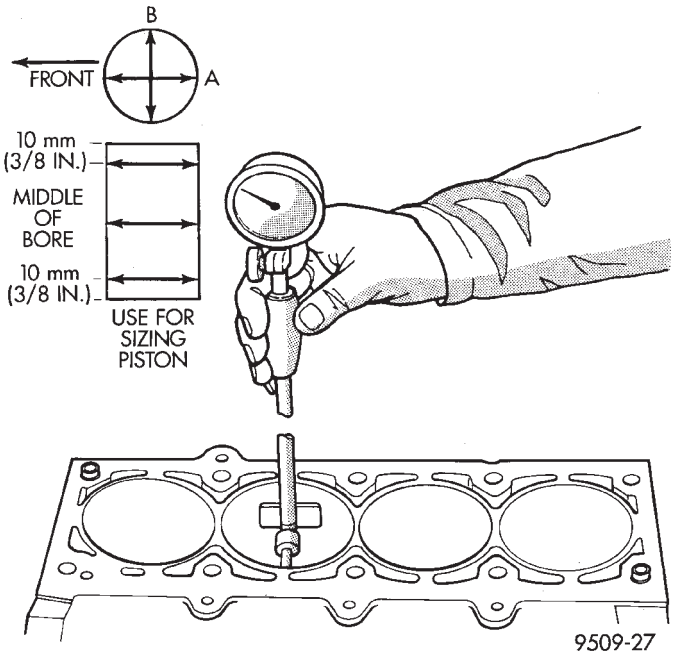


Fig. 3 Checking Cylinder Bore Size

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. 4). Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line shown in (Fig. 3). Refer to Cylinder Bore and Specifications Table. Correct piston to bore clearance must be established in order to assure quiet and economical operation.

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		

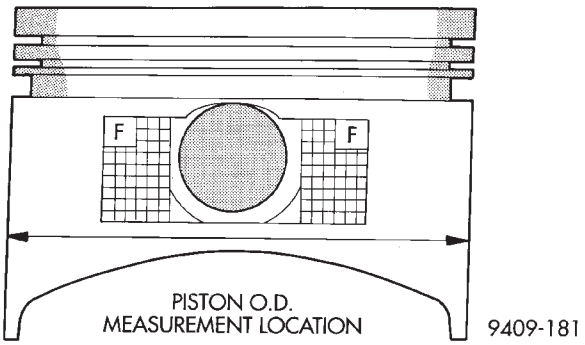


Fig. 4 Piston Measurements

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. 5). Refer to specifications (Fig. 7).

(2) Check piston ring to groove side clearance (Fig. 6). Refer to specification (Fig. 7).

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. 8). Refer to specifications.

SERVICE PROCEDURES (Continued)

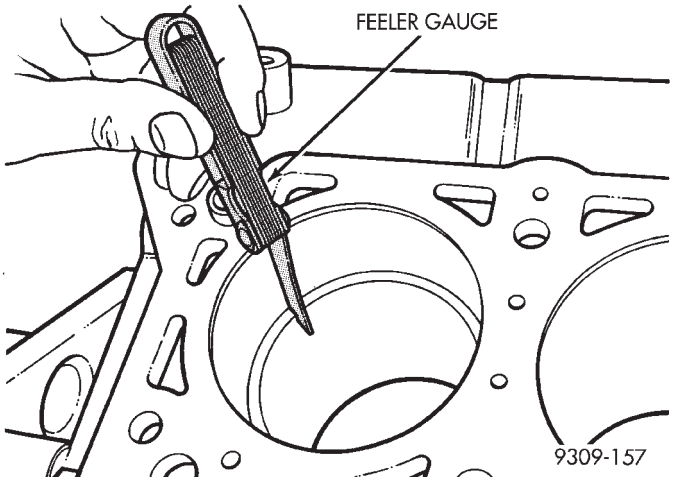


Fig. 5 Piston Ring Gap

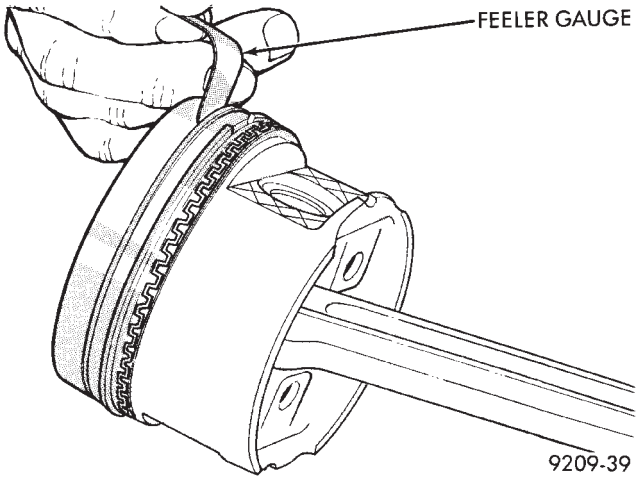


Fig. 6 Piston Ring Side Clearance

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.		

Fig. 7 Piston Ring Specifications

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

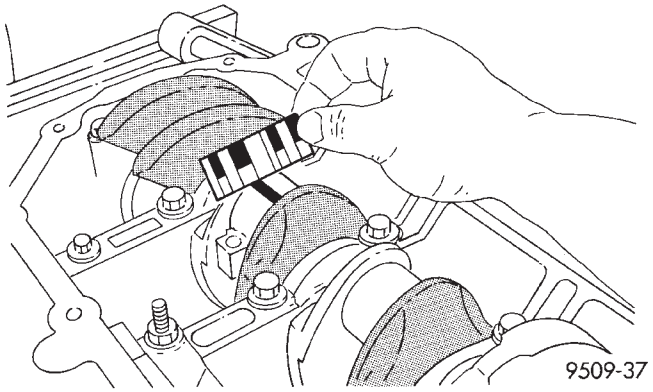


Fig. 8 Checking Connecting Rod Bearing Clearance

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 than 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. 9). Refer to connecting rod specifications (Fig. 10).

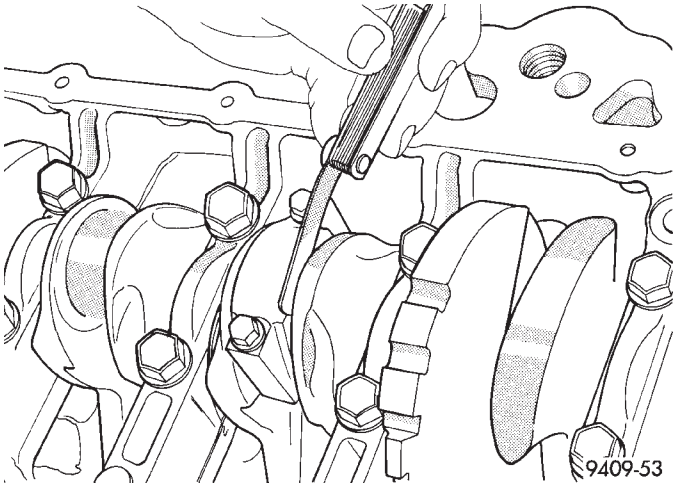


Fig. 9 Checking Connecting Rod Side Clearance

SERVICE PROCEDURES (Continued)

CONNECTING ROD BEARING OIL CLEARANCE	
New Part:	0.026 to 0.059 mm (0.001 to 0.0023 in.)
Wear Limit:	0.075 mm (0.003 in.)
CONNECTING ROD SIDE CLEARANCE	
New Part:	0.13 to 0.38 mm (0.005 to 0.015 in.)
Wear Limit:	0.40 mm (0.016 in.)

Fig. 10 Connecting Rod Specifications

FITTING CRANKSHAFT BEARINGS

Refer to Measuring Main Bearing Clearance in Standard Service Procedures. Refer to (Fig. 11) for specifications.

Crankshaft End-Play	
New Part:	0.09 - 0.24 mm (0.0035 - 0.0094 in.)
Wear Limit:	0.37 mm (0.015 in.)
Main Bearing Clearance	
New Part:	.022 - .062 mm (0.0008 - 0.0024 in.)
Connecting Rod Bearing Clearance	
New Part:	0.026 - .059 mm (0.001 - 0.0023 in.)
Wear Limit:	0.075 mm (0.003 in.)
Crankshaft Journal Sizes	
Main Bearing Journal Diameter	
Standard	52.000 ± 0.008 mm (2.0472 ± 0.0003 in.)
1st Undersize	51.983 ± 0.008 mm (2.0466 ± 0.0003 in.)
Connecting Rod Journal	
Standard	48.000 ± 0.008 mm (1.8897 ± 0.0003 in.)
1st Undersize	47.983 ± 0.008 mm (1.8891 ± 0.0003 in.)

Fig. 11 Crankshaft Specifications

CRANKSHAFT END PLAY

DIAL INDICATOR METHOD

(1) Mount a dial indicator to front of engine, locating probe on nose of crankshaft (Fig. 12).

(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. 11) for specifications.

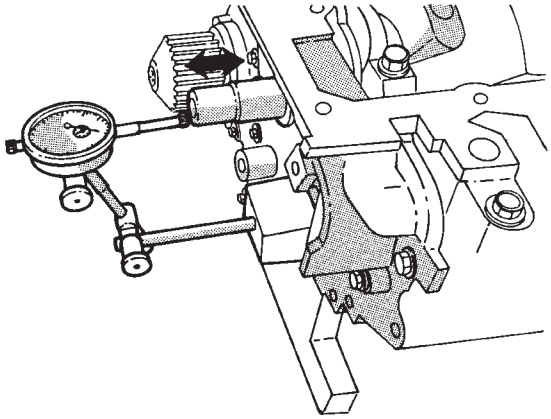


Fig. 12 Checking Crankshaft End Play— Dial Indicator

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 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.

REMOVAL AND INSTALLATION

FRONT MOUNT

(1) Raise vehicle on hoist.

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

(3) Remove the front engine mount thru-bolt from the insulator and engine mount bracket (Fig. 13).

(4) Remove the mass damper. Remove the front mount nuts and remove insulator assembly.

(5) Remove the engine mount bracket, if necessary.

(6) Reverse removal procedure for installation and tighten fasteners in this order.

a. If engine mount bracket was removed, tighten bolt 1 to 3 N·m (20 in. lbs.) and bolts 2, 3 and 4 to 108 N·m (80 ft. lbs.) (Fig. 13).

b. If engine mount bracket was removed, tighten bolts 5 and 1 to 54 N·m (40 ft. lbs.).

c. Tighten engine mount bracket to insulator assembly thru-bolt to 54 N·m (40 ft. lbs.).

d. Tighten insulator assembly nuts to the lower radiator crossmember torque to 54 N·m (40 ft. lbs.).

e. Install mass damper and tighten to 54 N·m (40 ft. lbs.)

REMOVAL AND INSTALLATION (Continued)

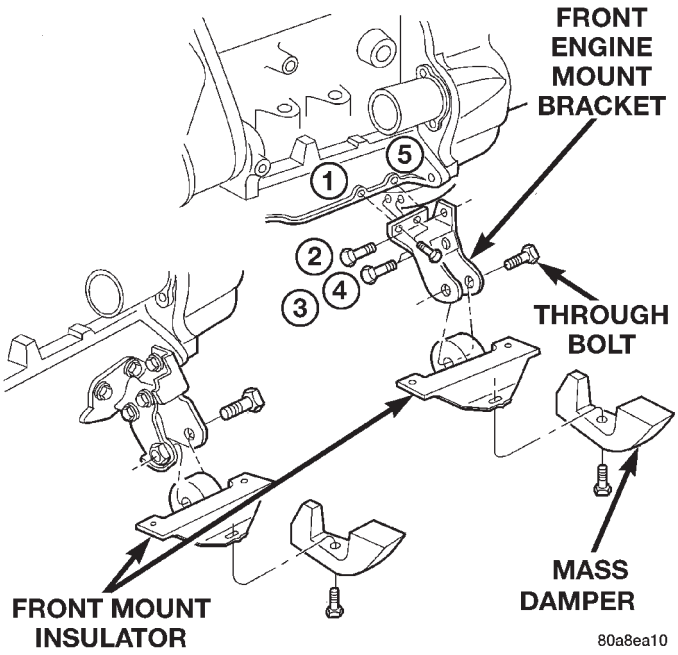


Fig. 13 Engine Mounting—Front

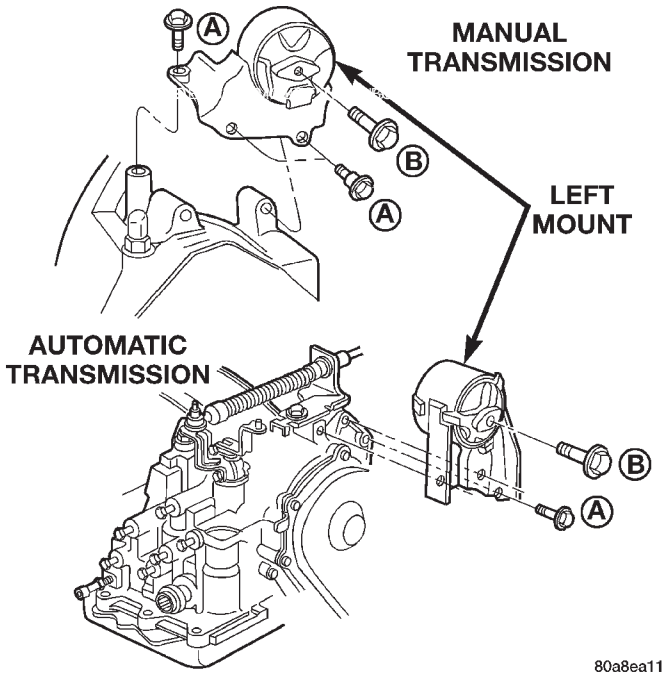


Fig. 14 Engine Mounting—Left

LEFT MOUNT

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

(2) Remove the Power Distribution Center (PDC) on manual transaxle model, from battery tray mount and lay aside.

(3) Support the transmission with a transmission jack.

(4) Remove the thru-bolt access hole cover. Remove the insulator thru-bolt from the mount (Fig. 14).

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

(6) Reverse removal procedure for installation. Tighten fasteners in this order (Fig. 14):

A. 55 N·m (40 ft. lbs.)

B. 108 N·m (80 ft. lbs.)

RIGHT MOUNT

(1) Remove the purge duty solenoid from engine mount bracket.

(2) Remove the right engine mount insulator vertical fasteners from frame rail (Fig. 15).

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

(4) Remove the thru-bolt access hole cover. Remove the thru-bolt from the insulator assembly (Fig. 15). Remove insulator.

(5) Reverse removal procedure for installation. Tighten engine mount to rail fasteners to 54 N·m (40 ft. lbs.), then tighten engine mount to engine bracket thru-bolt to 108 N·m (80 ft. lbs.).

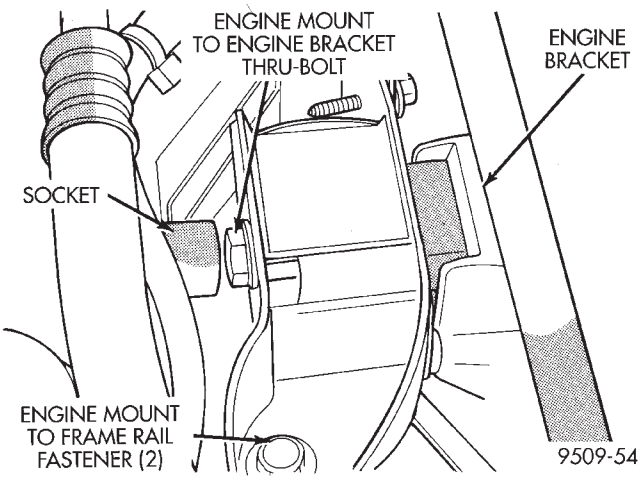


Fig. 15 Engine Mounting—Right

POWER HOP DAMPER

NOTE: Power hop damper is used on manual transmission vehicle only.

(1) Remove the thru-bolt and nut from the front suspension crossmember (Fig. 16).

(2) Remove the damper nut and grommets. Remove the damper.

(3) Remove the power hop damper bracket, if necessary.

(4) Reverse removal procedure for installation. Tighten all bolts and nuts to 54 N·m (40 ft. lbs.)

REMOVAL AND INSTALLATION (Continued)

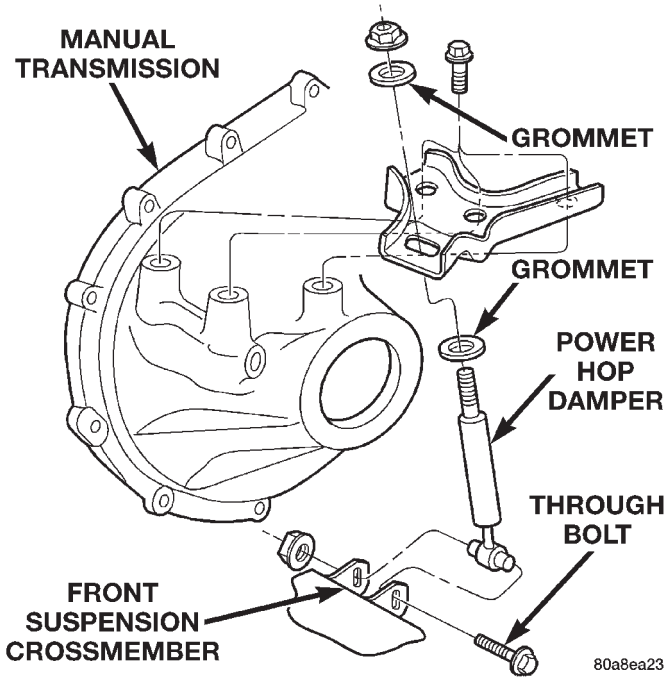


Fig. 16 Power Hop Damper

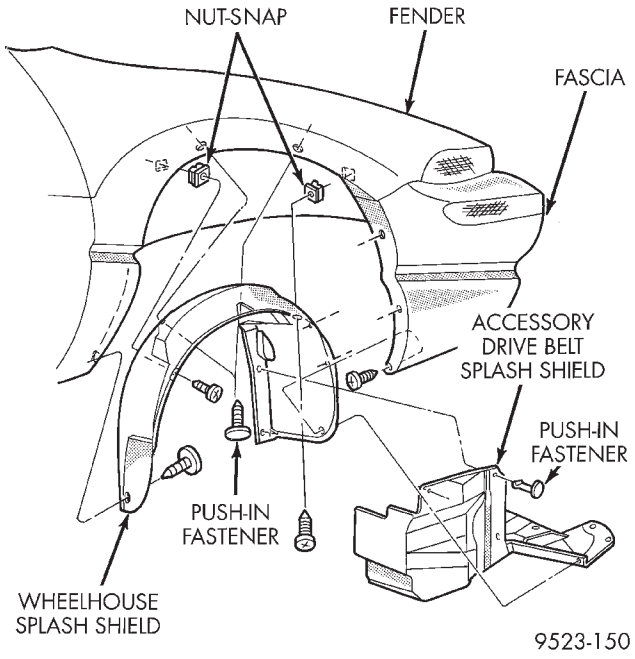


Fig. 17 Right Inner Splash Shield

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 and remove battery and tray. Set Powertrain Control Module (PCM) aside.

(3) Drain cooling system. Refer to Group 7, Cooling System for procedure.

(4) Remove upper radiator hose, radiator and fan module. Refer to Group 7, Cooling System for procedure.

(5) Remove lower radiator hose.

(6) Disconnect automatic transmission cooler lines and plug. If equipped.

(7) Disconnect clutch cable (Manual) and transmission shift linkage.

(8) Disconnect throttle body linkage.

(9) Disconnect engine wiring harness.

(10) Disconnect heater hoses.

(11) Discharge Air Conditioning System. Refer to Group 24, Air Conditioning for procedure.

(12) Hoist vehicle and remove right inner splash shield (Fig. 17).

(13) Remove accessory drive belts. Refer to Group 7, Cooling System for procedure.

(14) Remove axle shafts. Refer to Group 2, Suspension and Driveshafts for procedure.

(15) Disconnect exhaust pipe from manifold.

(16) Remove front engine mount.

(17) Manual transmission: Remove power hop damper.

(18) Lower vehicle. Remove air cleaner assembly.

(19) Remove power steering pump and reservoir, Set them aside.

(20) Remove A/C compressor.

(21) Remove ground straps to body.

(22) Raise vehicle enough to allow engine dolly and cradle Special Tools 6135 and 6710 to be installed under vehicle.

(23) Loosen engine support posts to allow movement for positioning onto engine locating holes and flange on the engine bedplate. Lower vehicle and position cradle until the engine is resting on support posts (Fig. 18). Tighten mounts to cradle frame. This will keep support posts from moving when removing or installing engine and transmission.

(24) Install safety straps around the engine to cradle tighten; straps and lock them into position.

(25) Raise vehicle enough to see if straps are tight enough to hold cradle assembly to engine.

(26) Lower vehicle so weight of the engine and transmission ONLY is on the cradle assembly.

(27) Remove engine and transmission mount thrubolts.

(28) Raise vehicle slowly. It may be necessary to move the engine/transmission assembly with the cradle to allow for removal around body flanges.

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

REMOVAL AND INSTALLATION (Continued)

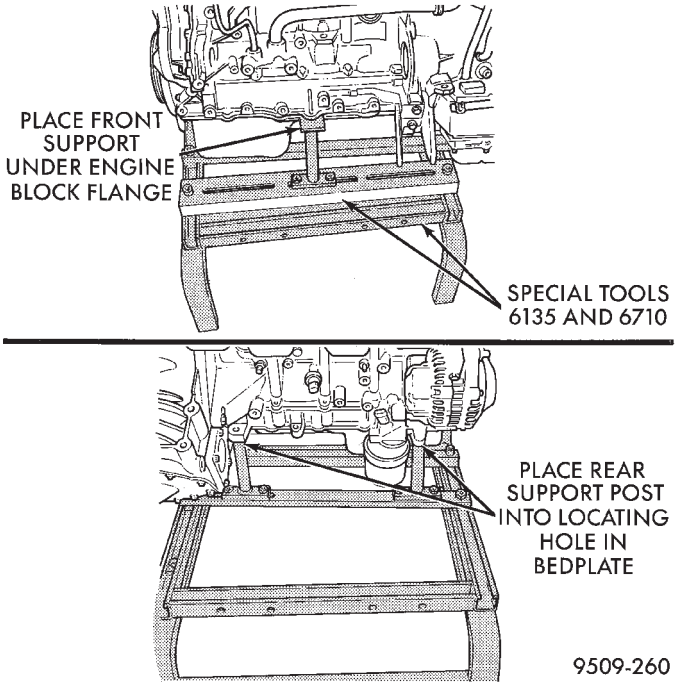


Fig. 18 Positioning Engine Cradle Support Post Mounts

engine and left transmission mounts. Refer to procedures outlined in this section.

(3) Remove safety straps from engine and transmission assembly. Slowly raise vehicle enough to remove the engine dolly and cradle.

(4) Install axle shafts. Refer to Group 2, Suspension and Driveshafts for procedure.

(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 and reservoir. Refer to Group 7, Cooling System Accessory Drive Section for belt tension adjustment.

(8) Install A/C compressor and 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 engine mount. Refer to this section for procedure.

(11) Manual transmission: Install power hop damper.

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

(13) **Manual Transmission:** Connect clutch cable and linkages. Refer to Group 6, Manual Transaxle Clutch.

(14) **Automatic Transmission:** Connect shifter and kickdown linkage. Refer to Group 21, Transaxle for procedures.

(15) Connect fuel line and heater hoses.

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

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

(18) Install radiator and shroud assembly. Install radiator hoses. Fill cooling system. Refer to Group 7, Cooling System for filling procedure.

(19) Install battery tray and battery. Set Powertrain Control Module (PCM) into place.

(20) Install air cleaner and hoses.

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

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

(23) Adjust transmission linkage, if necessary.

CYLINDER HEAD COVER

REMOVAL

(1) Remove air cleaner inlet duct (Fig. 19)

(2) Remove ignition coil pack (Fig. 20).

(3) Remove the cylinder head cover bolts.

(4) Remove cylinder head cover from cylinder head.

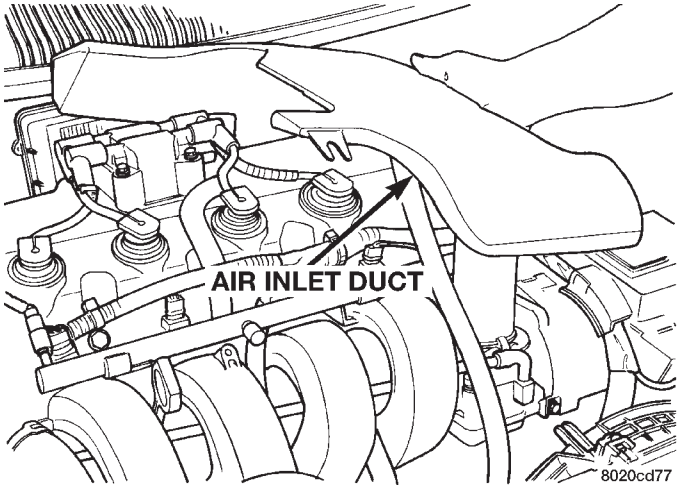


Fig. 19 Inlet Duct Removal

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.

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.).

REMOVAL AND INSTALLATION (Continued)

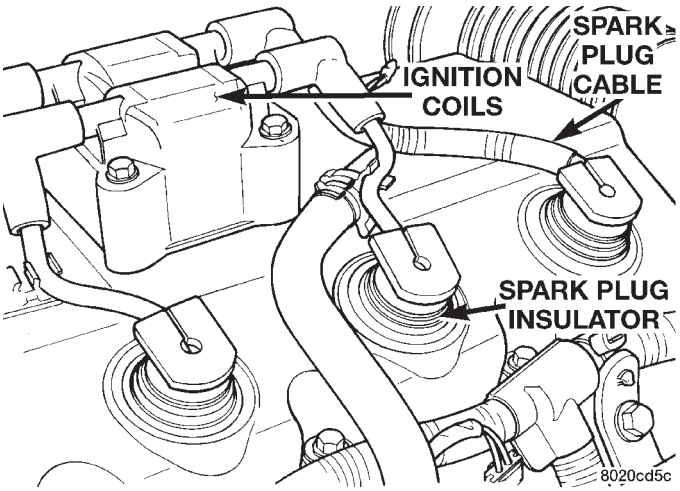


Fig. 20 Ingition Coil Pack

(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. 21). Discard old tube.

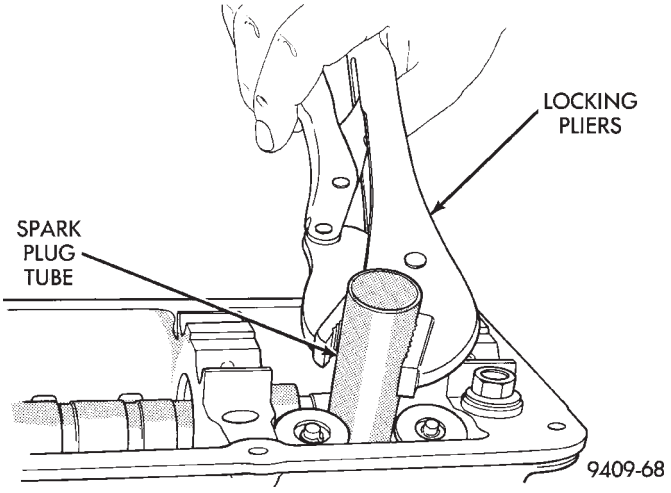


Fig. 21 Servicing Spark Plug Tubes

(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. 22). 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.

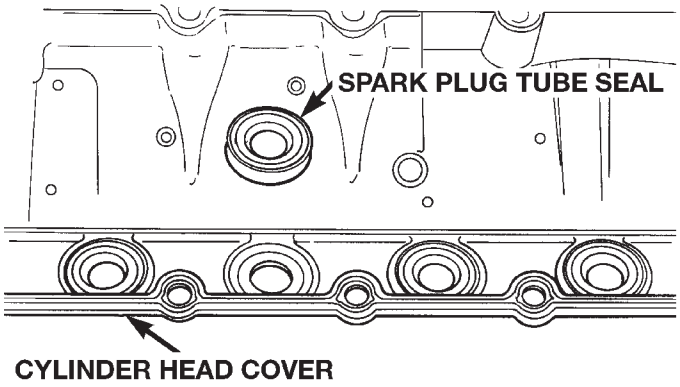


Fig. 22 Spark Plug Tube Seals

CAMSHAFT

NOTE: TO REMOVE CAMSHAFT CYLINDER HEAD MUST BE REMOVED.

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.

REMOVAL AND INSTALLATION (Continued)

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. 23).

(4) Move camshaft as far forward as it will go.

(5) End play travel: 0.13 - 0.33 mm (0.005 - 0.013 in.).

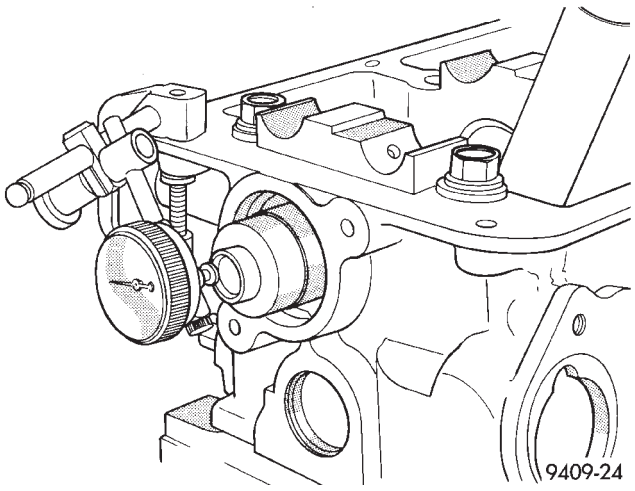


Fig. 23 Camshaft End Play

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. 24) to 23 N·m (200 in. lbs.).

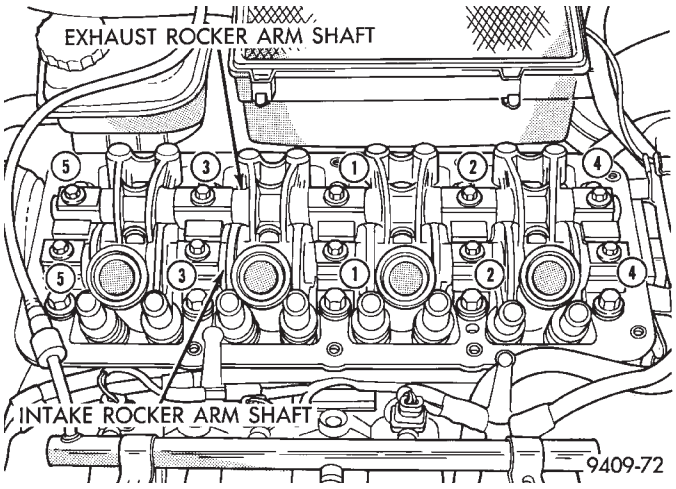


Fig. 24 Rocker Arm Shaft Tightening Sequence

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. 25).

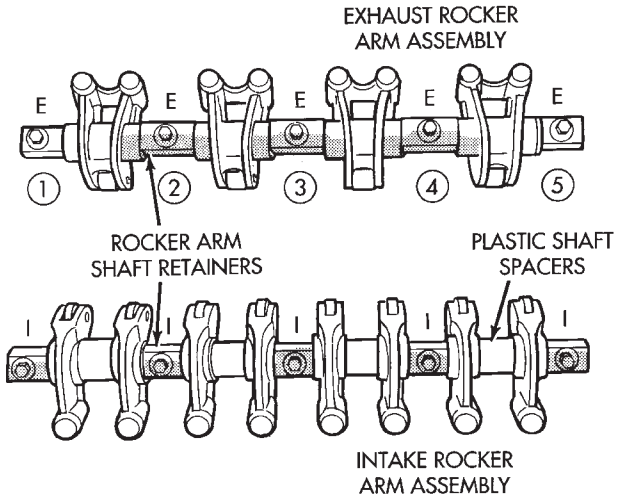


Fig. 25 Rocker Arm Shaft Assemblies

REMOVAL AND INSTALLATION (Continued)

(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. 26) 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. 25).

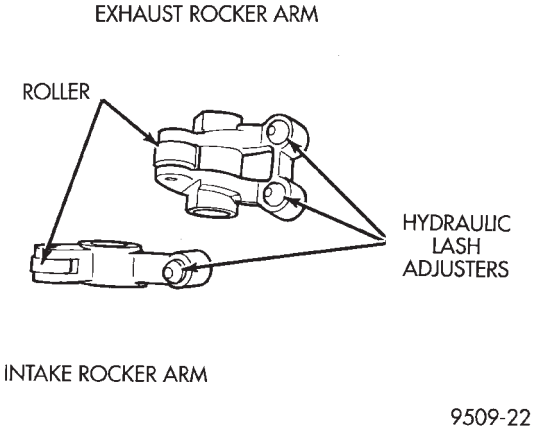


Fig. 26 Rocker Arm Assemblies

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.

(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. 27). Install the retainers in their original positions on the exhaust and intake shafts (Fig. 25).

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. 28).

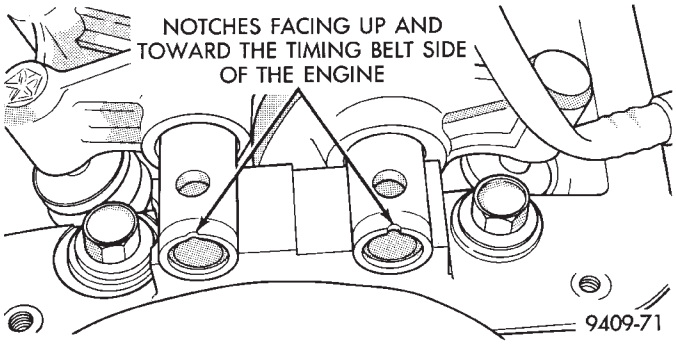


Fig. 27 Rocker Arm Shaft Notches

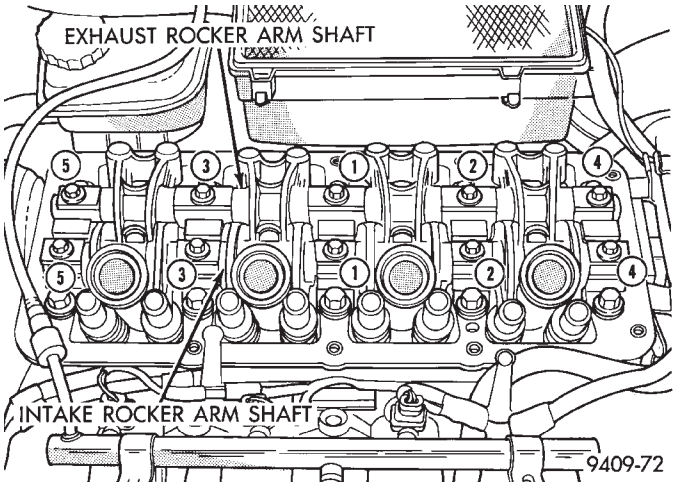


Fig. 28 Rocker Arm Shaft Tightening Sequence

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. 29) compress valve springs and remove valve locks.

(5) Remove valve spring.

REMOVAL AND INSTALLATION (Continued)

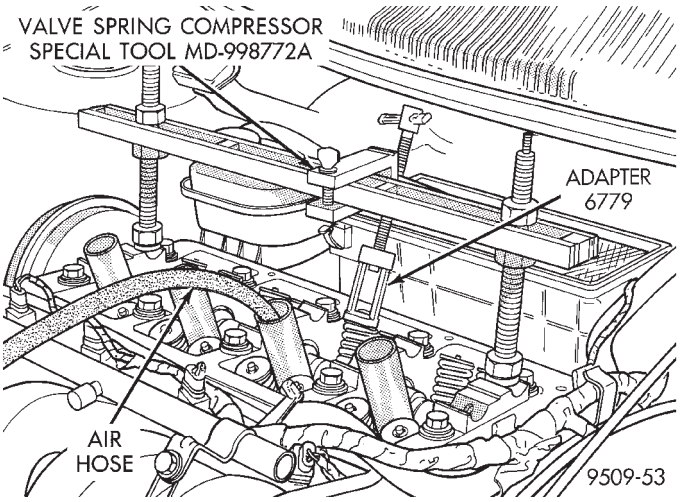


Fig. 29 Removing and Installing Valve Spring

(6) Remove valve stem seal by using a valve stem seal tool (Fig. 30).

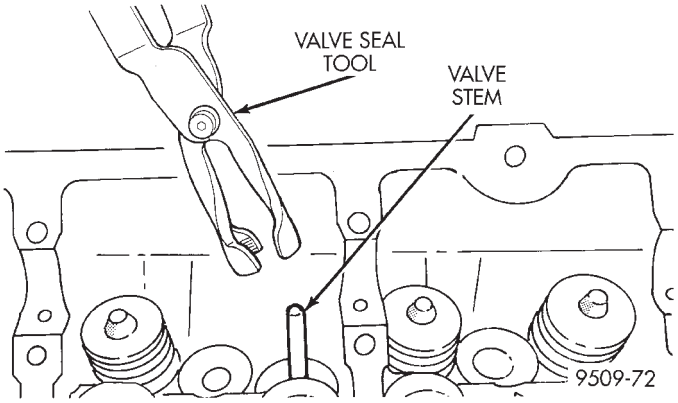


Fig. 30 Valve Stem Oil Seal Tool

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.

(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.

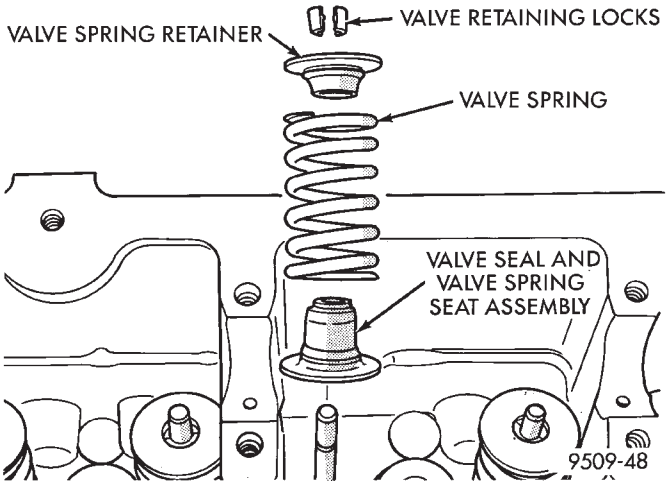


Fig. 31 Valve Spring Assembly

(3) Remove air cleaner inlet duct and air cleaner (Fig. 32), 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 **SOHC ONLY** . 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. 33).

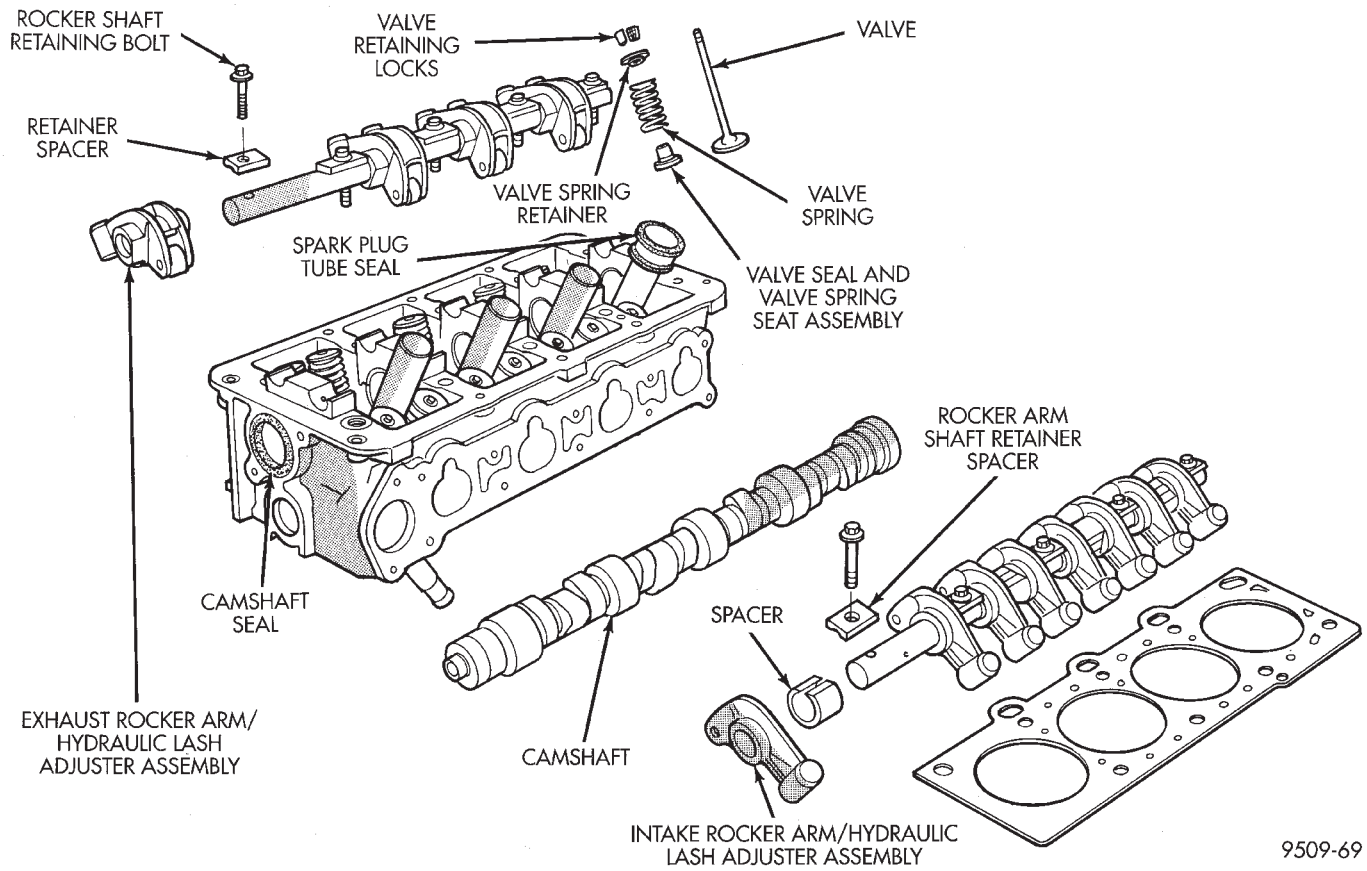
INSTALLATION

(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. 34).

(2) Tighten the cylinder head bolts in the sequence shown in (Fig. 34). 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.)

REMOVAL AND INSTALLATION (Continued)



Cylinder Head and Valve Assembly

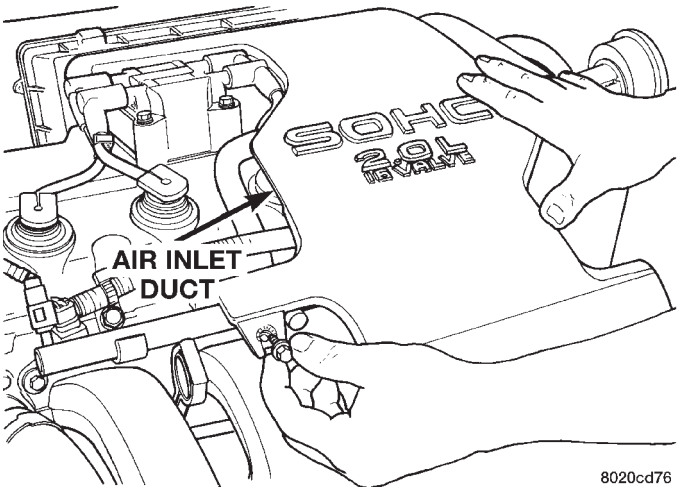


Fig. 32 Air Cleaner Inlet Duct

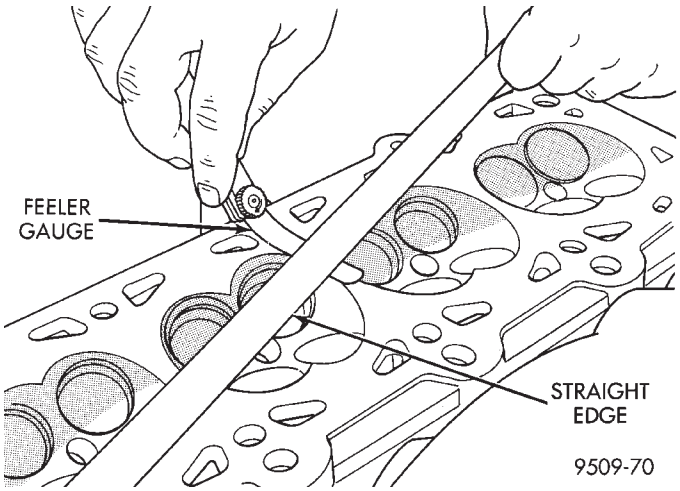


Fig. 33 Checking Cylinder Head Flatness

- 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) Raise vehicle on a hoist and remove right inner splash shield (Fig. 35).

(3) Remove crankshaft vibration damper. Refer to procedure outlined in this section for removal.

REMOVAL AND INSTALLATION (Continued)

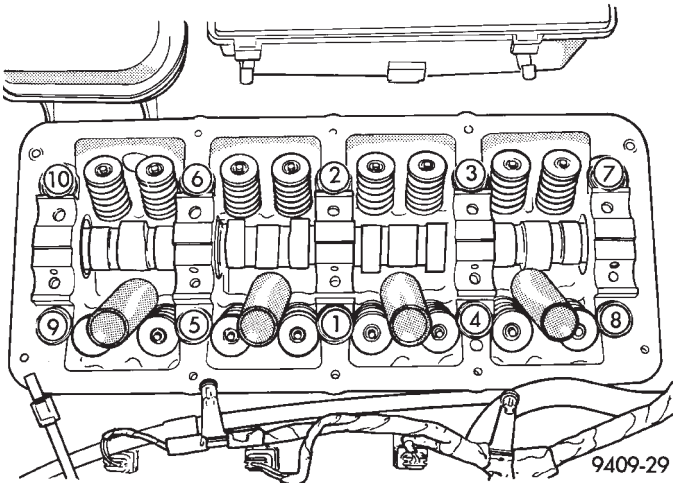


Fig. 34 Cylinder Head Tightening Sequence

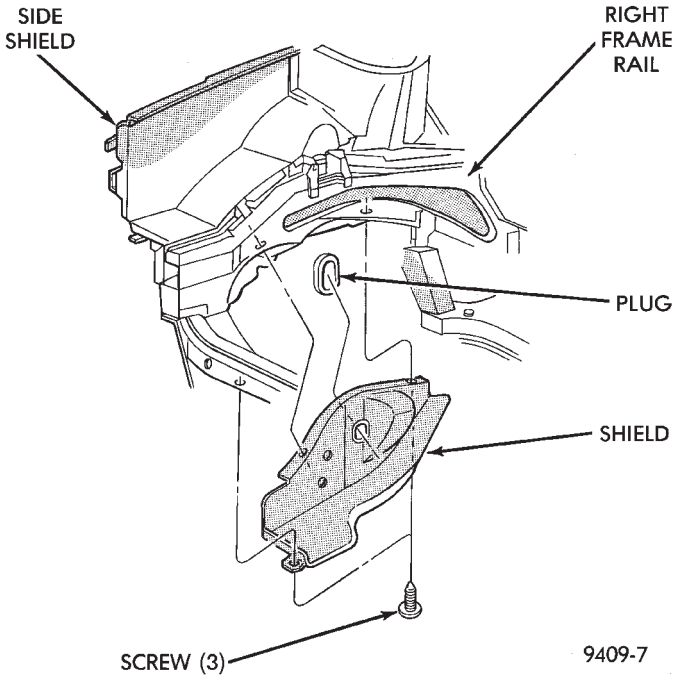


Fig. 35 Right Inner Splash Shield

(4) Lower vehicle and place a jack under engine.

(5) Remove right engine mount. Refer to procedure outlined in this section.

(6) Remove right engine mount bracket (Fig. 36).

(7) Remove front timing belt cover (Fig. 37).

INSTALLATION

(1) Install front timing cover.

(2) Install engine mount bracket.

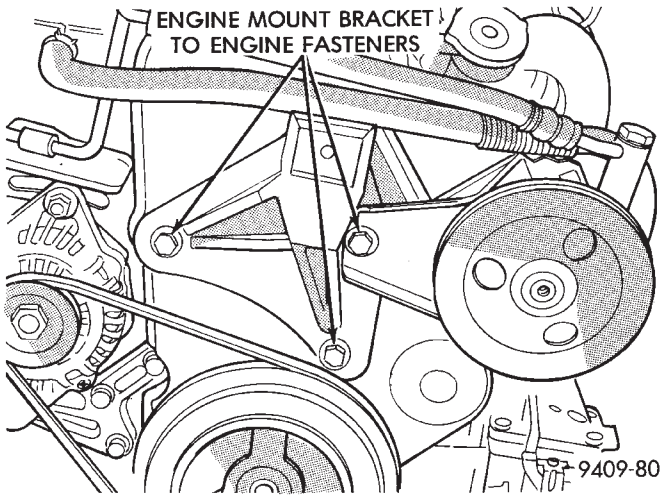


Fig. 36 Right Engine Mount Bracket

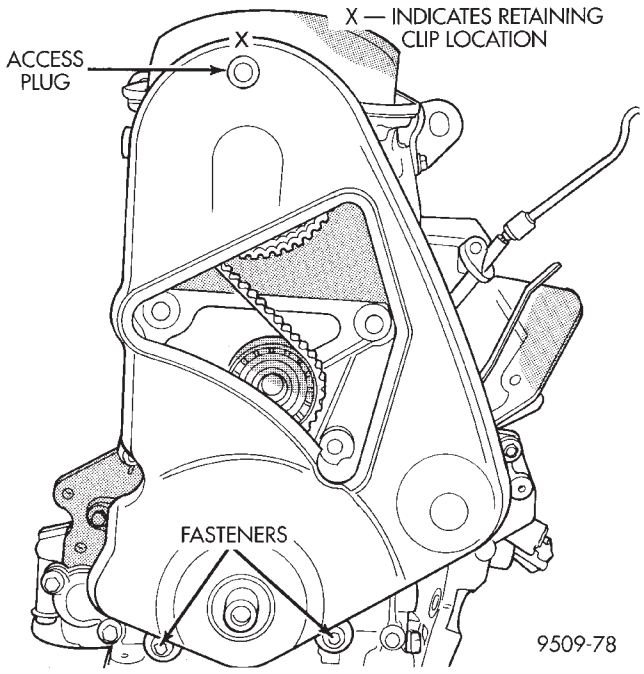


Fig. 37 Timing Belt Cover

(3) Install Right engine mount. Refer to procedure outlined in this section for installation.

(4) Remove jack from under engine.

(5) Install crankshaft vibration damper Refer to procedure outlined in this section for installation.

(6) Install accessory drive belts. Refer to Group 7, Cooling System Accessory Drive section for procedure.

(7) Raise vehicle on hoist and install right inner splash shield.

REMOVAL AND INSTALLATION (Continued)

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 camshaft sprocket bolt, with the Modified Special Tool C-4687-1 as shown in (Fig. 38).

(2) Hold camshaft sprocket with modified tool while removing bolt. Remove sprocket from camshaft.

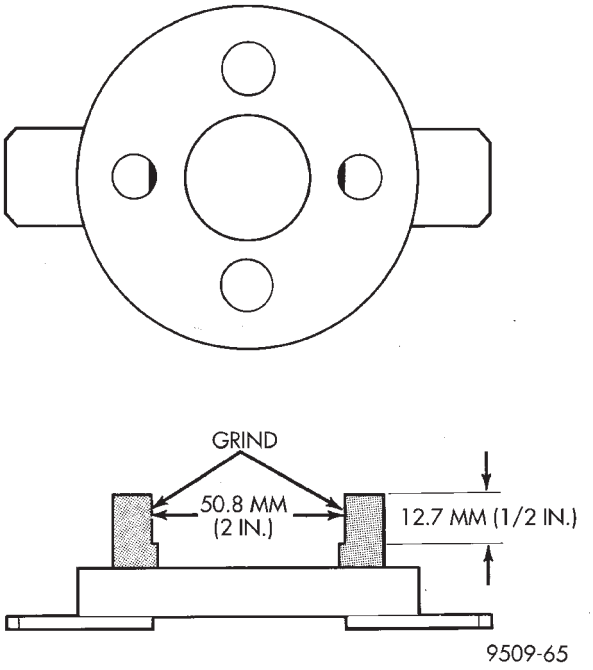


Fig. 38 Modification to Special Tool

(3) Remove camshaft seal using Special Tool C-4679–A (Fig. 39).

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.

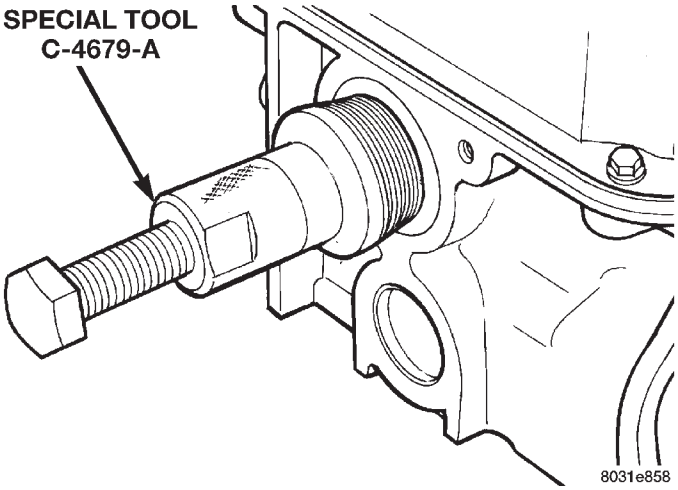


Fig. 39 Removing Camshaft Oil Seal

INSTALLATION

(1) Install camshaft seal flush with cylinder head using Special Tool MD 998306 (Fig. 40).

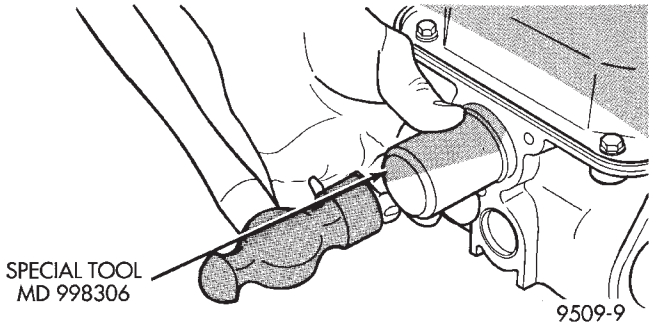


Fig. 40 Installing Camshaft Seal

(2) Install camshaft sprocket retaining bolt. Hold camshaft sprocket with Special Tool C-4687-1 (Fig. 38) and tighten bolt to 115 N·m (85 ft. lbs.).

REMOVAL AND INSTALLATION (Continued)

TIMING BELT SYSTEM

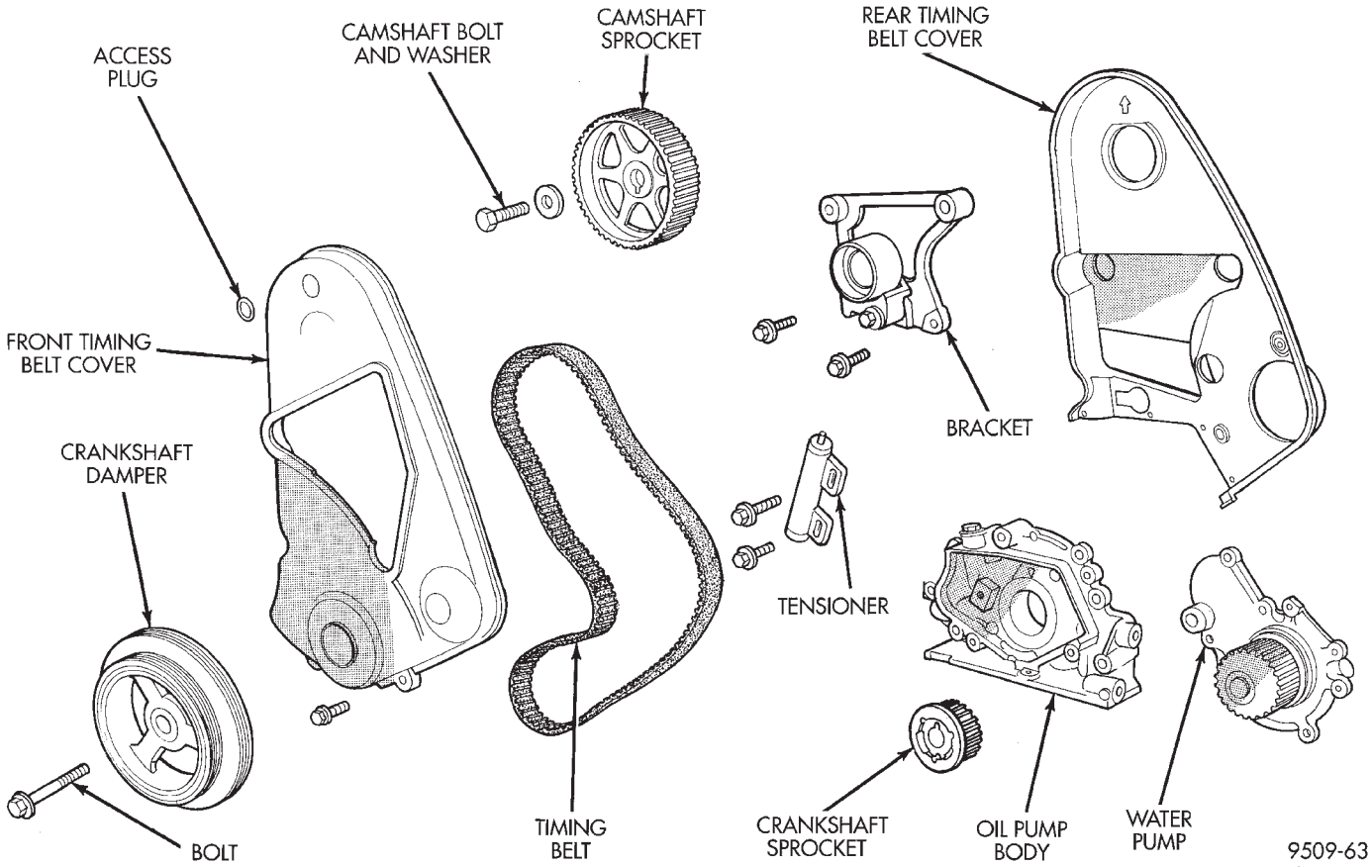


Fig. 41 Timing Belt System

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. 41).
- Check the timing mark on the camshaft sprocket, it should align with the arrow on the rear belt cover (Fig. 42).

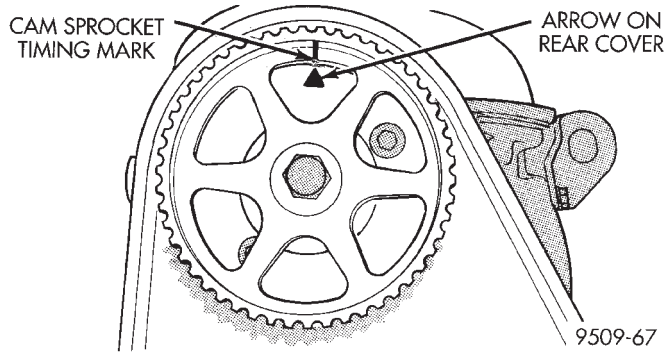


Fig. 42 Camshaft Timing Marks

REMOVAL—TIMING BELT

(1) Remove accessory drive belts. Refer to Group 7, Cooling System for procedure outlined in that section.

(2) Raise vehicle on a hoist and remove right inner splash shield (Fig. 43).

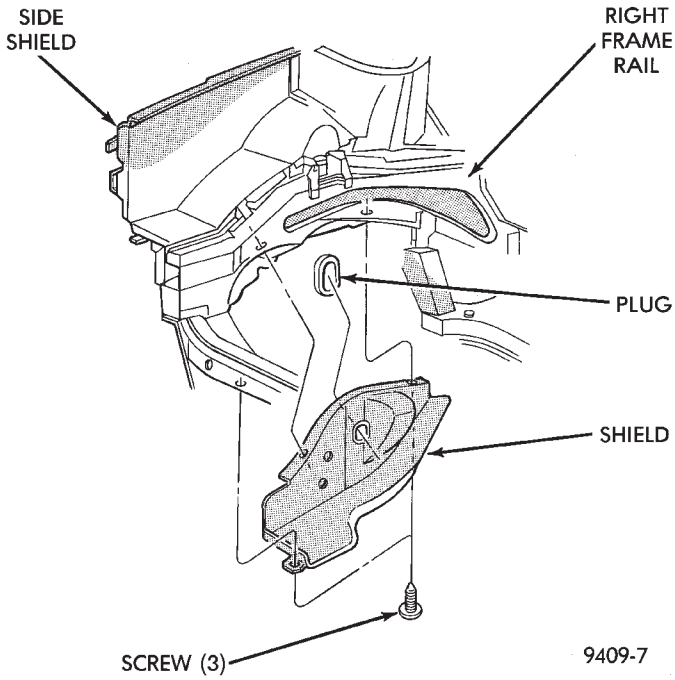


Fig. 43 Right Inner Splash Shield

REMOVAL AND INSTALLATION (Continued)

(3) Remove crankshaft damper bolt. Remove damper using the large side of Special Tool 1026 and insert 6827-A (Fig. 44).

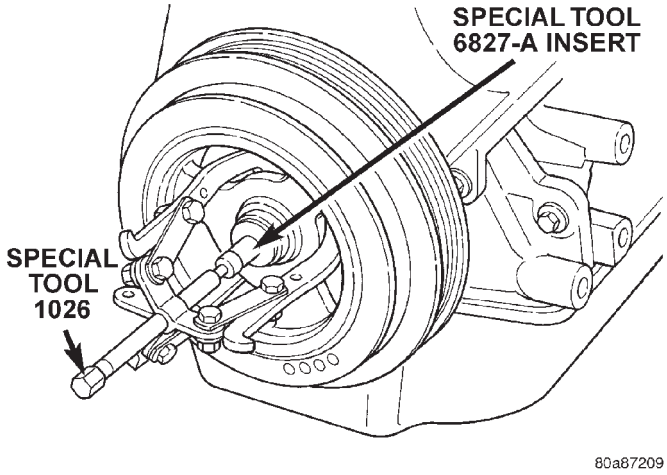


Fig. 44 Crankshaft Damper—Removal

(4) Lower vehicle and place a jack under engine.

(5) Remove right engine mount. Refer to procedure outlined in this section.

(6) Remove right engine mount bracket (Fig. 45).

(7) Remove front timing belt cover (Fig. 46).

CAUTION: Align camshaft and crankshaft timing marks before removing the timing belt.

(8) Loosen timing belt tensioner fasteners (Fig. 48) and remove timing belt and tensioner.

CAUTION: Do not loosen, tighten, or remove the tensioner pivot bolt (Fig. 47).

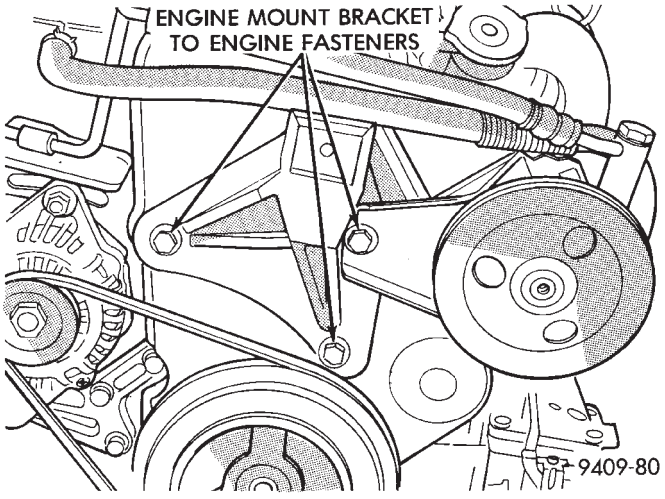


Fig. 45 Right Engine Mount Bracket

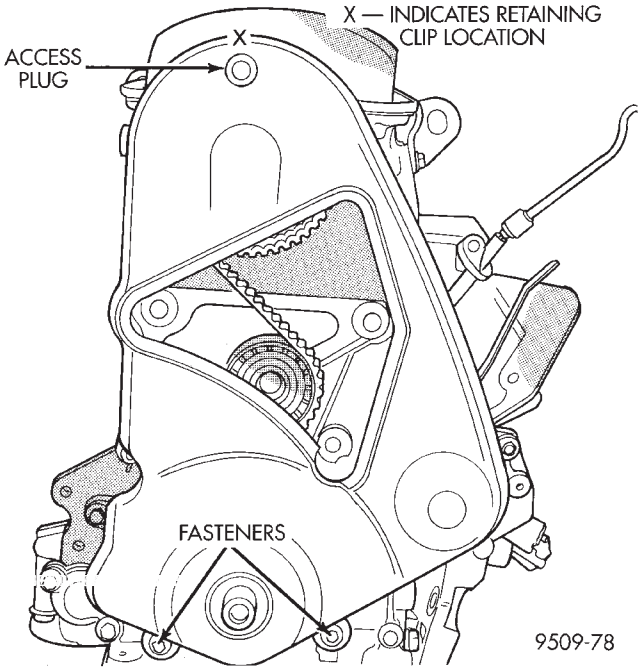


Fig. 46 Timing Belt Cover

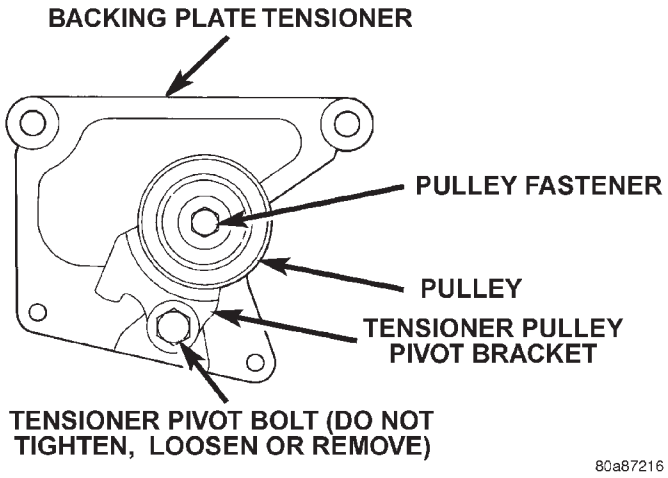


Fig. 47 Tensioner Pulley Assembly

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. 49).

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

REMOVAL AND INSTALLATION (Continued)

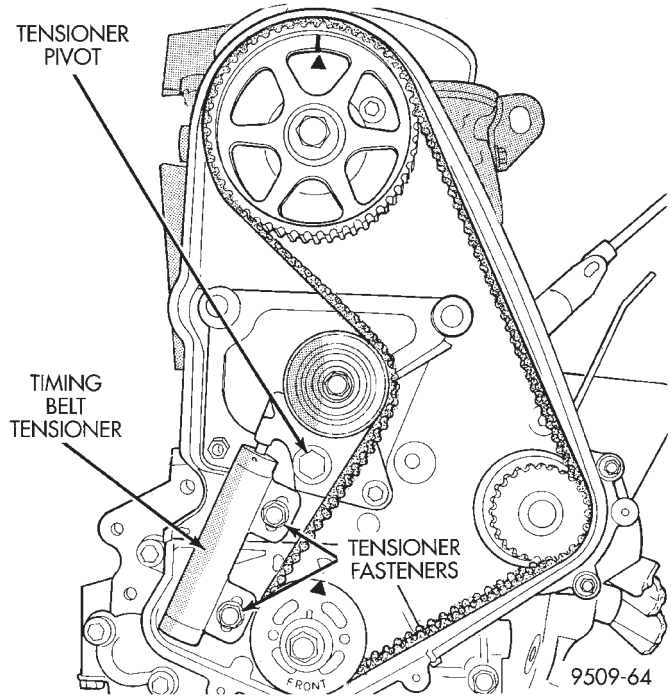


Fig. 48 Remove Timing Belt

through the body and plunger to retain plunger in place until tensioner is installed.

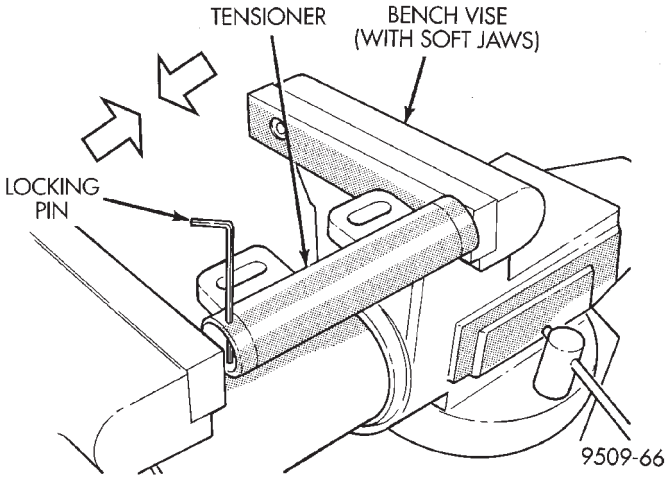


Fig. 49 Compressing Timing Belt Tensioner

(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. 50).

(5) Set camshaft to TDC by aligning mark on sprocket with the arrow on the rear of timing belt cover (Fig. 51).

(6) Move crankshaft to 1/2 mark before TDC (Fig. 52) for belt installation.

(7) Install timing belt. Starting at the crankshaft, go around the water pump sprocket and then around the camshaft sprocket.

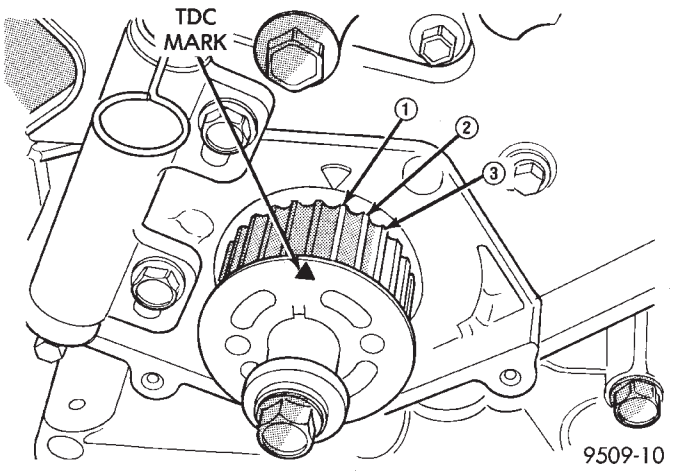


Fig. 50 Crankshaft Sprocket Timing

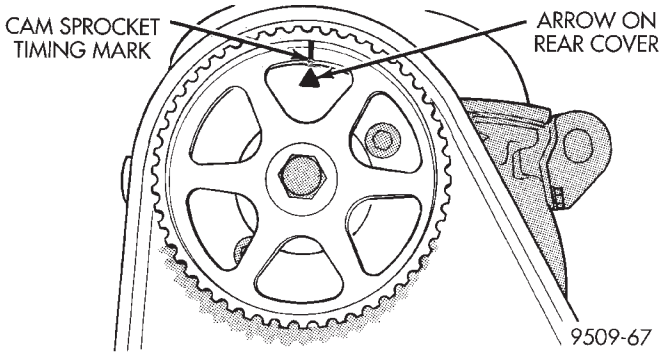


Fig. 51 Camshaft Timing Mark

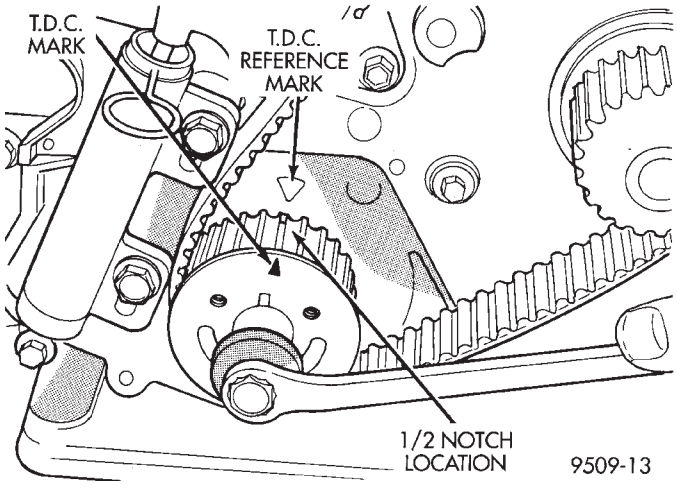


Fig. 52 Adjusting Crankshaft Sprocket for Timing Belt Installation

(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. 53).

(10) With torque being applied to the tensioner pulley move the tensioner up against the tensioner

REMOVAL AND INSTALLATION (Continued)

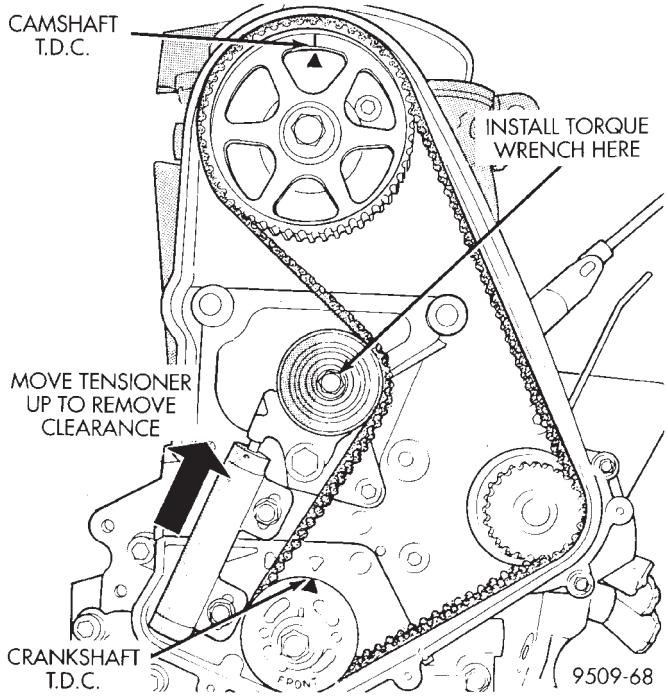


Fig. 53 Adjusting Timing Belt Tension

pulley bracket and tighten fasteners to 31 N·m (275 in. lbs.) (Fig. 53).

(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. 53).

(13) Install front half of timing cover.

(14) Install engine mount bracket.

(15) Install Right engine mount. Refer to procedure outlined in this section.

(16) Remove jack from under engine.

(17) 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. 54).

(18) Install accessory drive belts. Refer to Group 7, Cooling System Accessory Drive section for procedure.

(19) Raise vehicle on hoist and install right inner splash shield.

(20) Perform camshaft and crankshaft timing relearn. Refer to Group 25, Emission Control Systems for procedure.

OIL PAN

REMOVAL

(1) Drain engine oil.

(2) Remove transmission bending bracket. Refer to Engine Support Module Removal and Installation in this section.

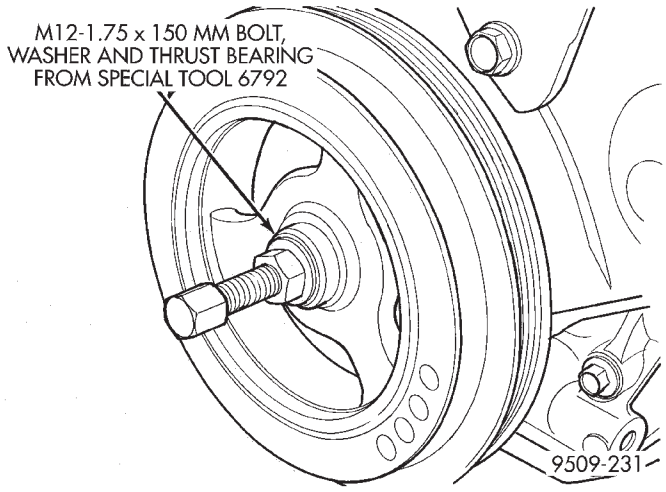


Fig. 54 Crankshaft Damper—Installation

(3) Remove front engine mount and bracket. Refer to Engine Support Module Removal and Installation in this section.

(4) Remove transmission inspection cover.

(5) If equipped with air conditioning remove oil filter and adaptor. Refer to Oil Filter Adapter Removal and Installation in this section.

(6) Remove oil pan.

(7) 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. 55).

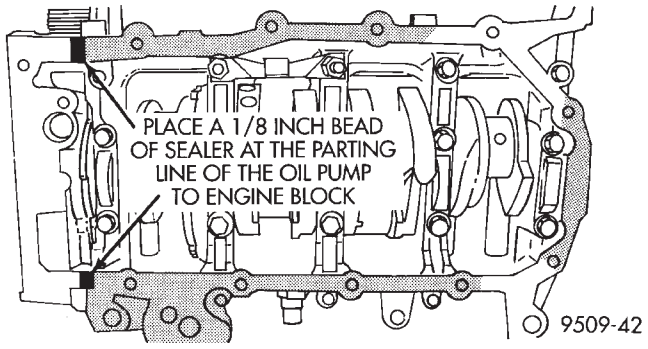


Fig. 55 Oil Pan Sealing

(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 transmission inspection cover.

(6) install front engine mount and bracket.

(7) Install transmission bending bracket.

(8) Install proper amount of oil. With oil filter 4.25 Liters (4.5 Qts.). Without oil filter 3.8 Liters (4.0 Qts.)

REMOVAL AND INSTALLATION (Continued)

FRONT CRANKSHAFT OIL SEAL

REMOVAL

(1) Using Special Tool 1026 and Insert 6827–A, remove crankshaft damper (Fig. 56).

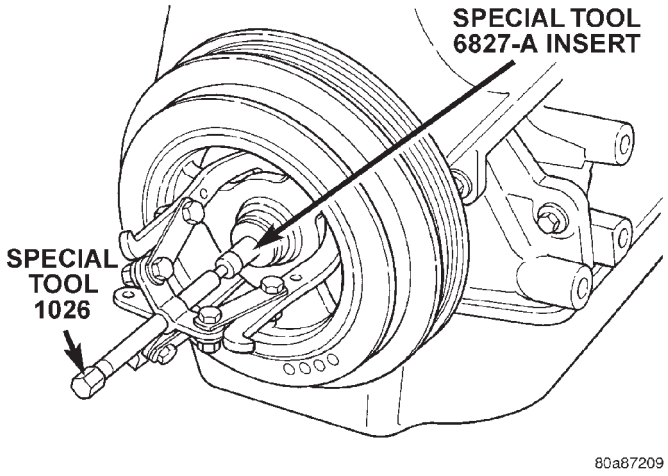


Fig. 56 Crankshaft Damper—Removal

(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. 57).

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

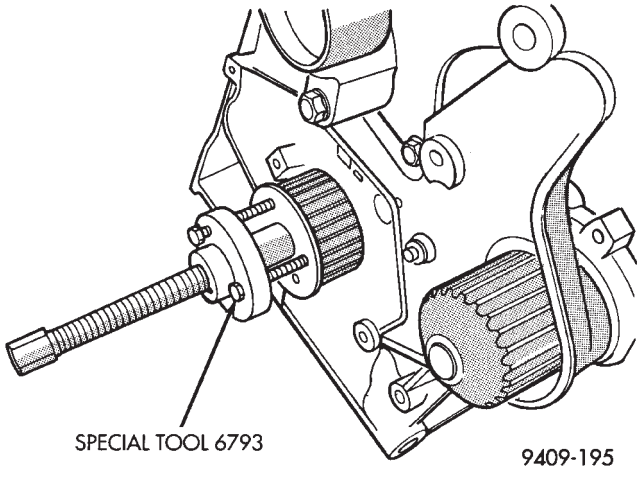


Fig. 57 Crankshaft Sprocket—Removal

(4) Using Tool 6771 to remove front crankshaft oil seal (Fig. 58). Do not damage the seal contact area on the crankshaft.

INSTALLATION

(1) Install new seal by using Tool 6780–1 (Fig. 59).

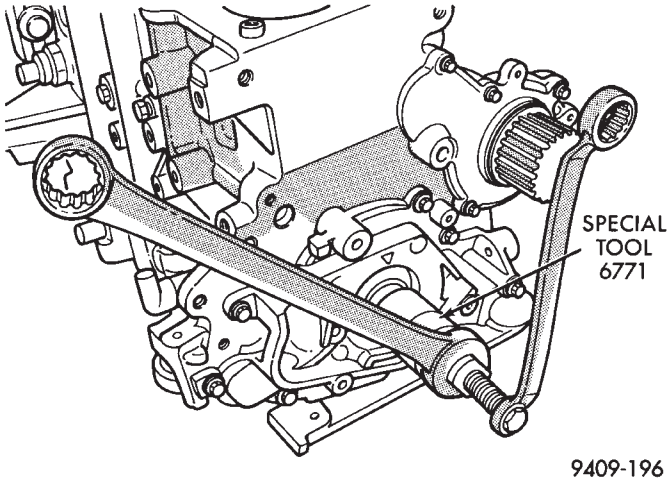


Fig. 58 Front Crankshaft Oil Seal—Removal

(2) Place seal into opening with seal spring towards the inside of engine. Install seal until flush with cover.

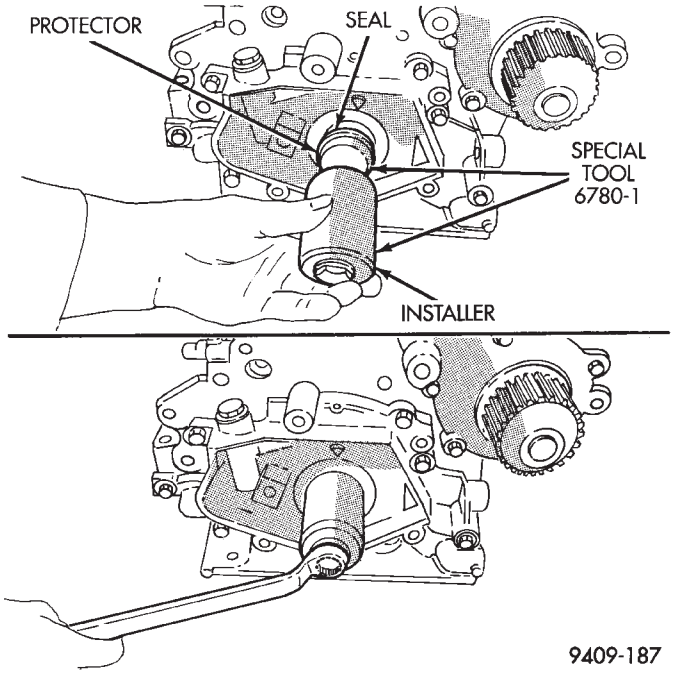


Fig. 59 Front Crankshaft Oil Seal—Installation

(3) Install crankshaft sprocket (Fig. 60). 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.

(5) Install crankshaft damper (Fig. 61). 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.)

REMOVAL AND INSTALLATION (Continued)

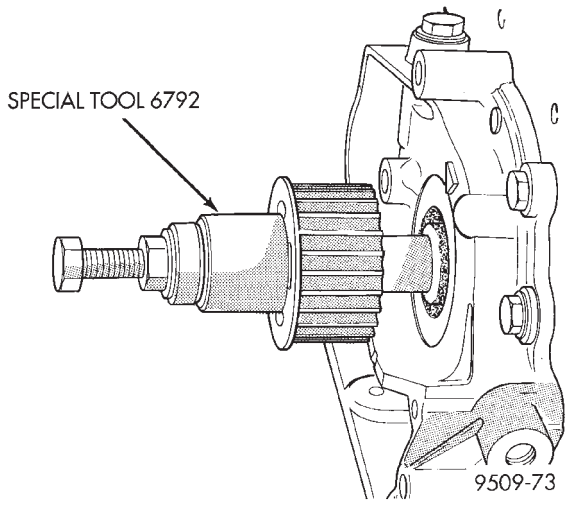


Fig. 60 Crankshaft Sprocket—Installation

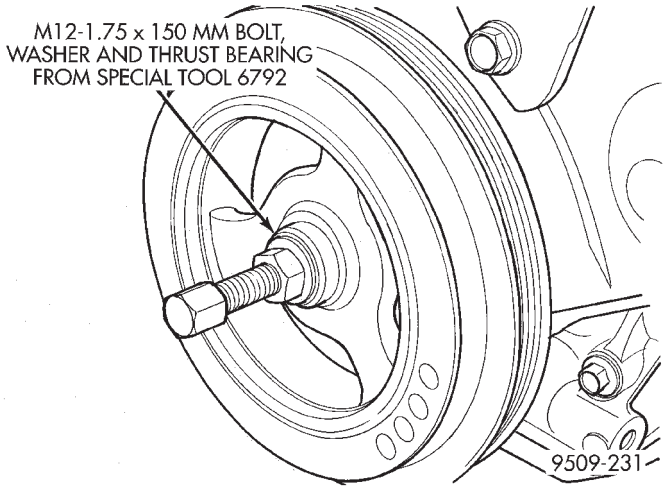


Fig. 61 Crankshaft Damper—Installation

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. 62) 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.

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. 63).

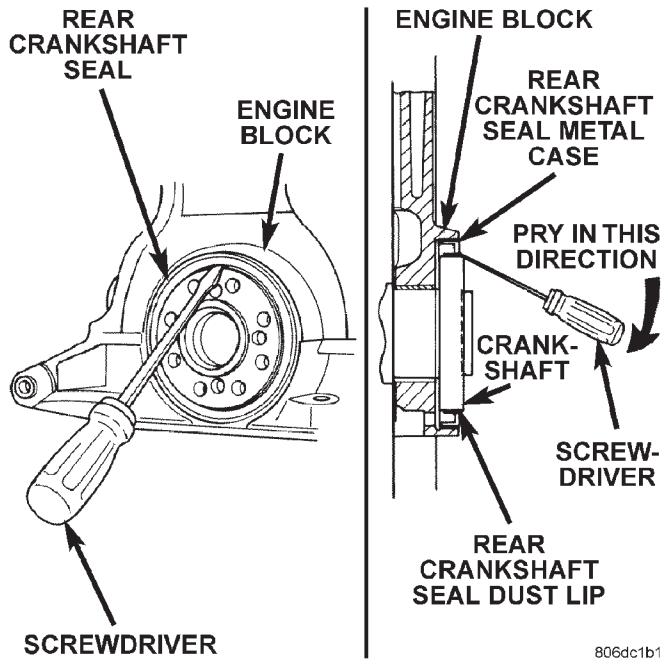


Fig. 62 Rear Crankshaft Oil Seal—Removal

(2) Position seal over pilot tool. Make sure you can read the words **THIS SIDE OUT** on seal (Fig. 63). 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. 64) until the tool bottoms out against the block (Fig. 65).

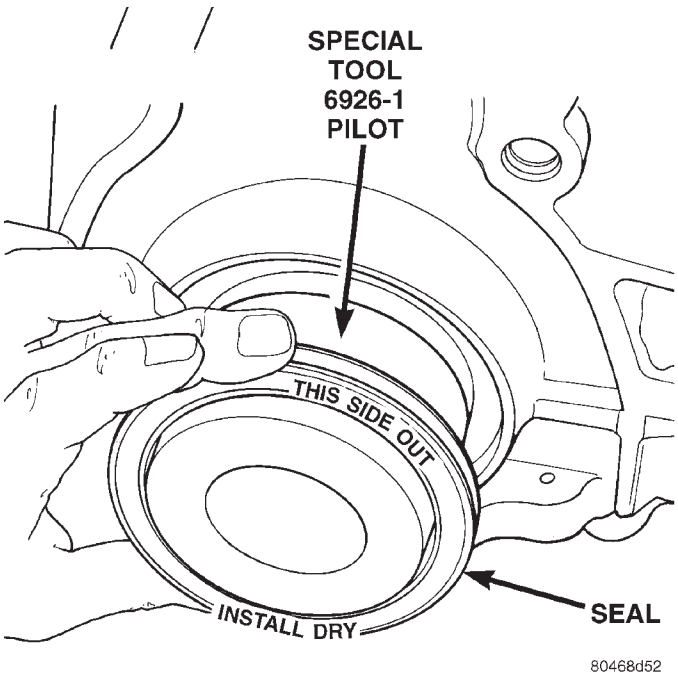


Fig. 63 Rear Crankshaft Seal and Special Tool 6926-1

REMOVAL AND INSTALLATION (Continued)

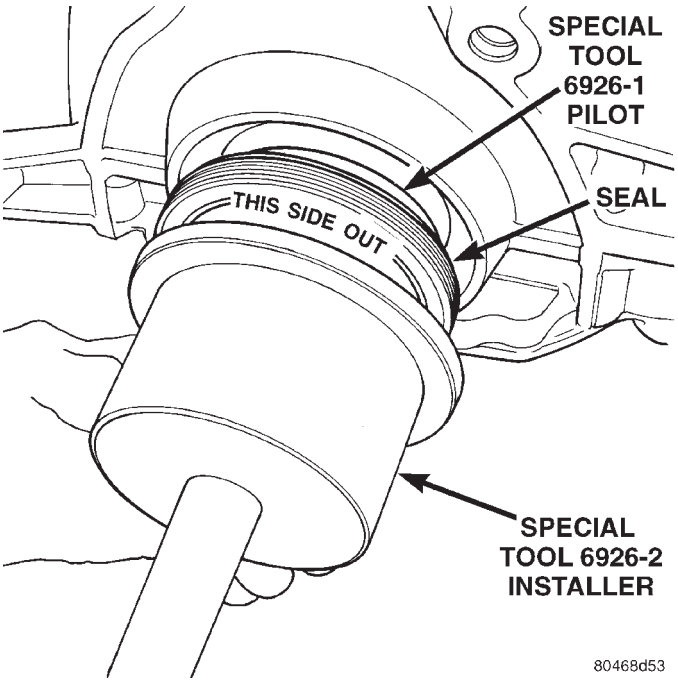


Fig. 64 Crankshaft Seal Special Tool 6926-2

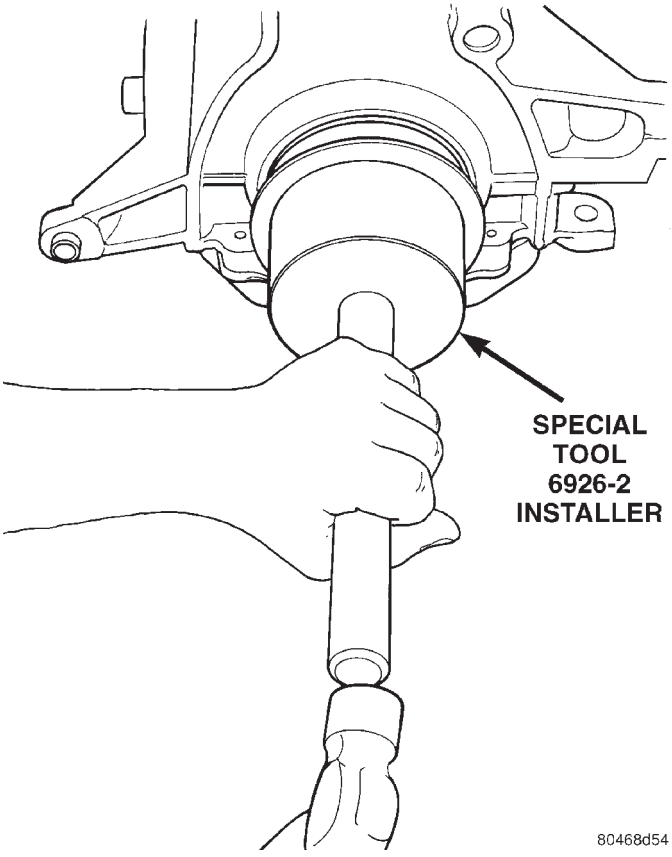


Fig. 65 Rear Crankshaft Seal—Installation

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. 66).
(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.
(7) Lift out crankshaft from cylinder block. Be sure not to damage the main bearings or journals when removing the crankshaft.

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 (bedplate) main bearing cap are plain. Crankshaft end play is controlled by a flanged bearing on the number three main bearing journal (Fig. 67).

NOTE: The upper and lower main Bearing shells are Not interchangeable. The lower shells have a revised tab to prevent improper installation.

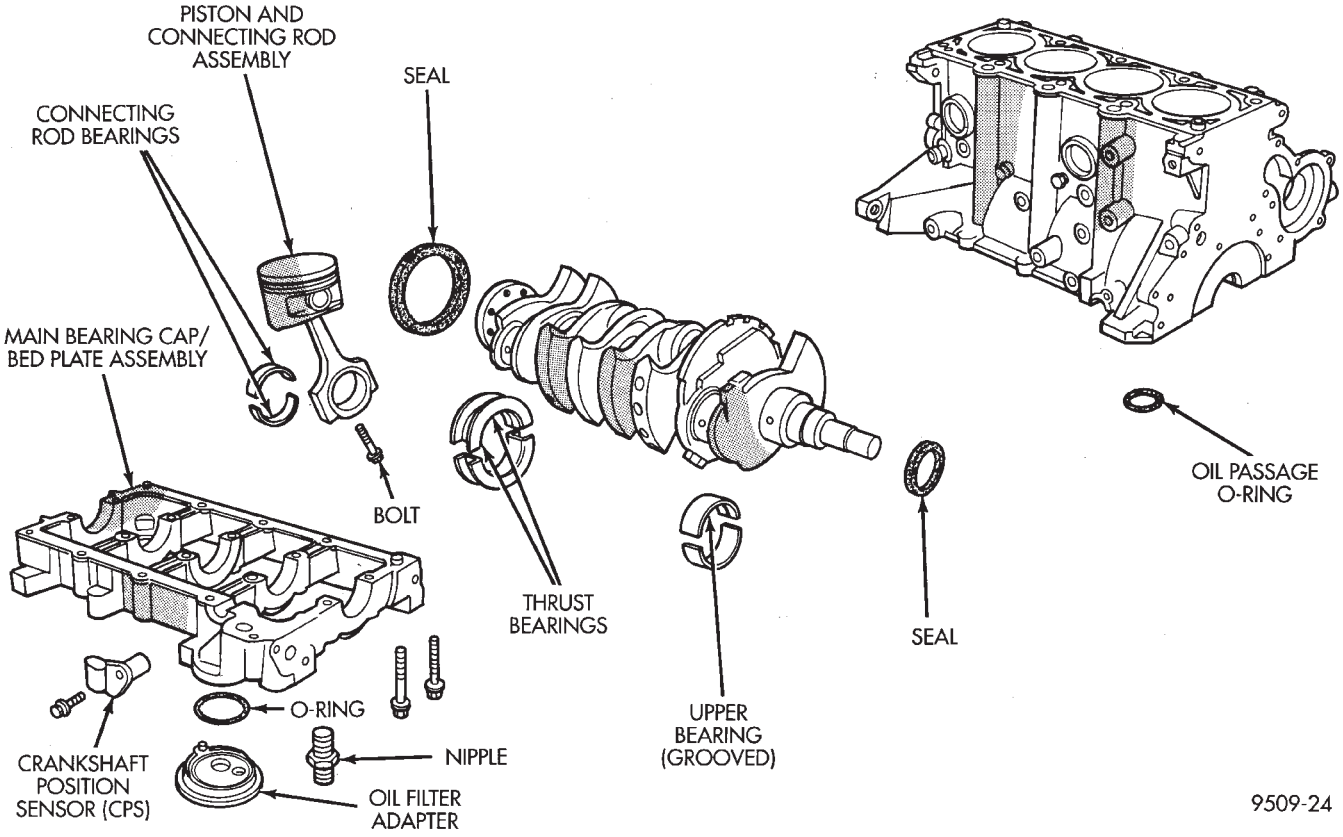
CRANKSHAFT MAIN JOURNALS INSPECTION

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.

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. 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 undersized: 0.016 mm

REMOVAL AND INSTALLATION (Continued)



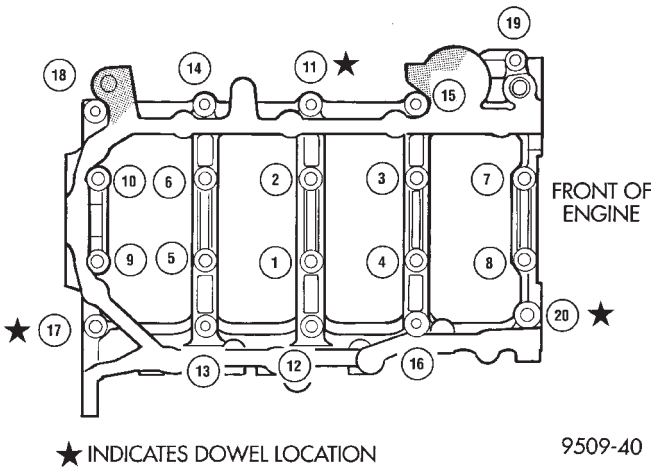


Fig. 66 Bedplate Bolts

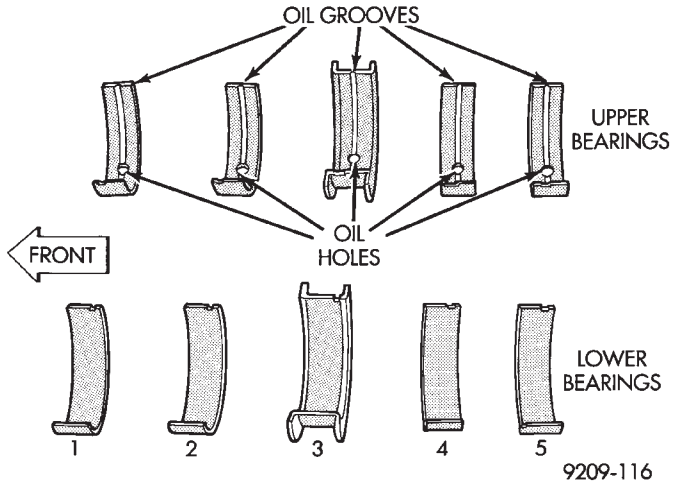


Fig. 67 Main Bearing Identification

(.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. 68).

(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.

REMOVAL AND INSTALLATION (Continued)

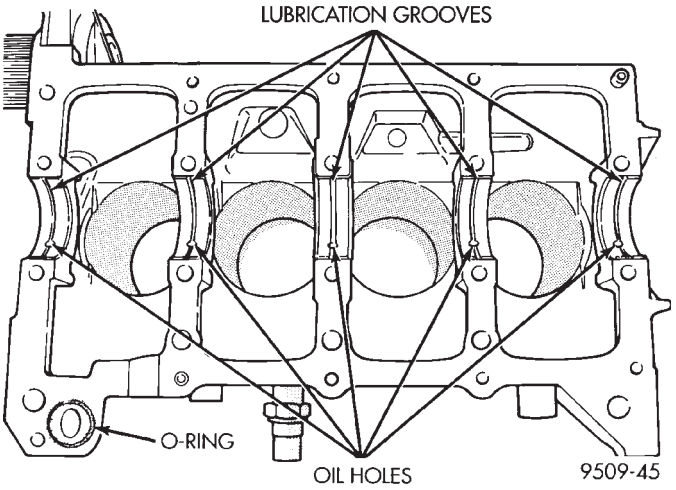


Fig. 68 Installing Main Bearing Upper Shell

(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. 69).

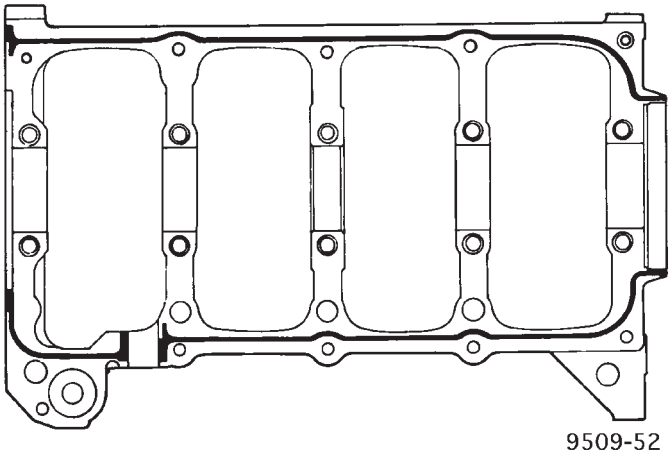


Fig. 69 Main Bearing Caps/Bedplate Sealing

(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 this bolts down together until the bedplate contacts the cylinder block. Torque bolts to 30 N·m (22 ft. lbs.) (Fig. 70).

(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. 70).

(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. 70).

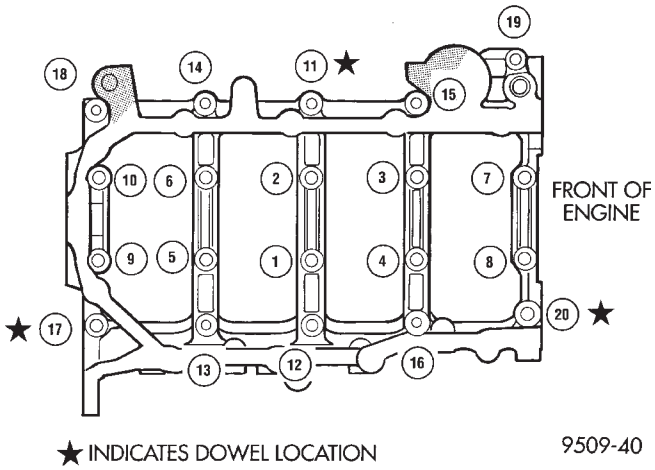


Fig. 70 Main Bearing Caps/Bedplate Torque Sequence

(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.).

(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. 71).

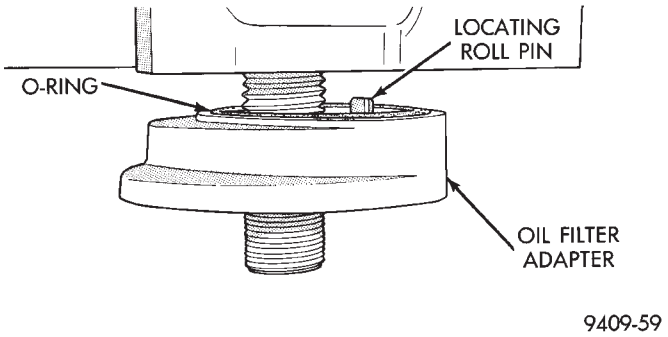


Fig. 71 Engine Oil Filter Adapter to Engine Block

OIL FILTER

REMOVE AND INSTALL

CAUTION: When servicing the oil filter (Fig. 72) 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.

REMOVAL AND INSTALLATION (Continued)

(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.).

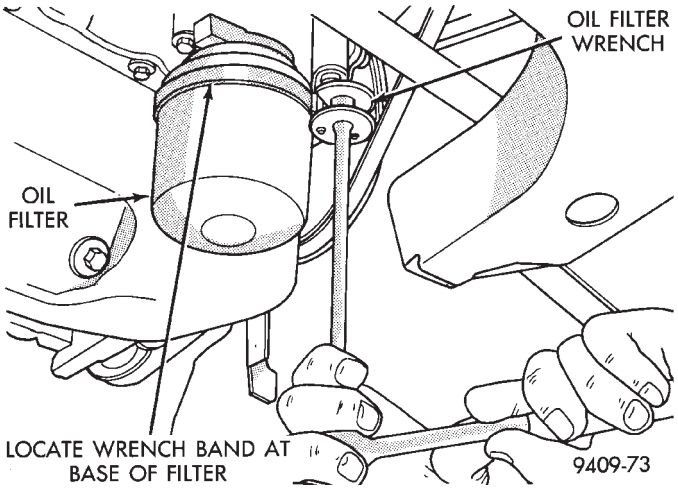


Fig. 72 Engine Oil Filter

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. 73).

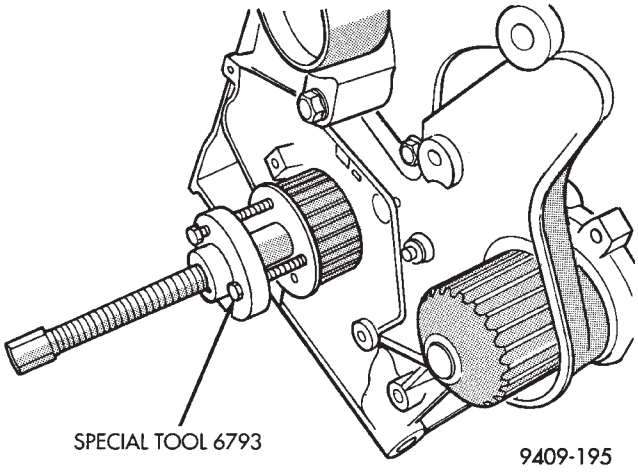


Fig. 73 Crankshaft Sprocket—Removal

(5) Remove oil pick-up tube.

(6) Remove oil pump, (Fig. 74) and front crankshaft seal.

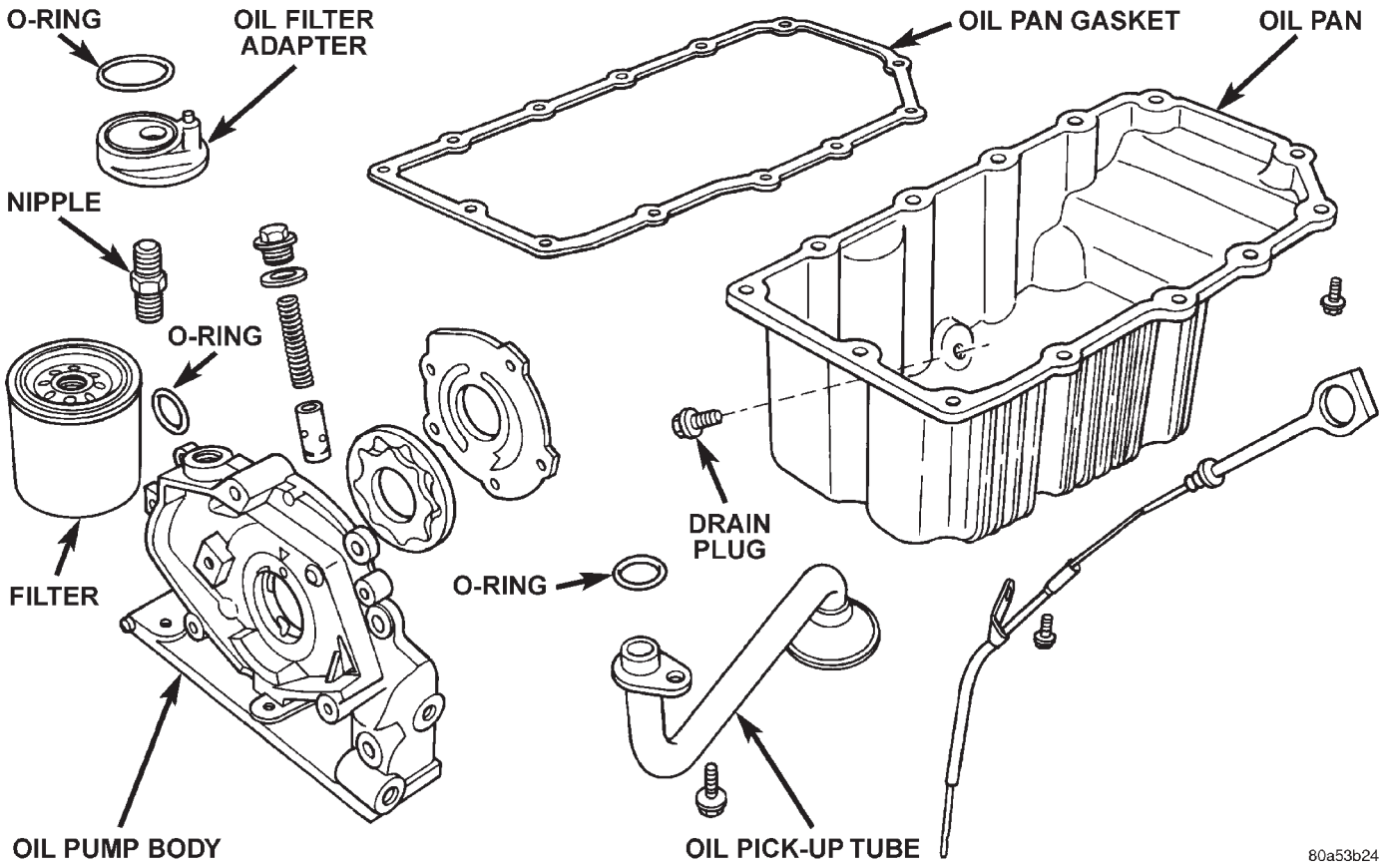


Fig. 74 Oil Pump and Tube

REMOVAL AND INSTALLATION (Continued)

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. 75). Install oil ring into oil pump body discharge passage.

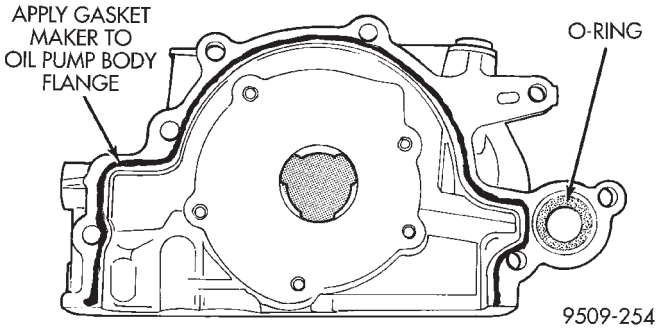


Fig. 75 Oil Pump Sealing

(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. 76).

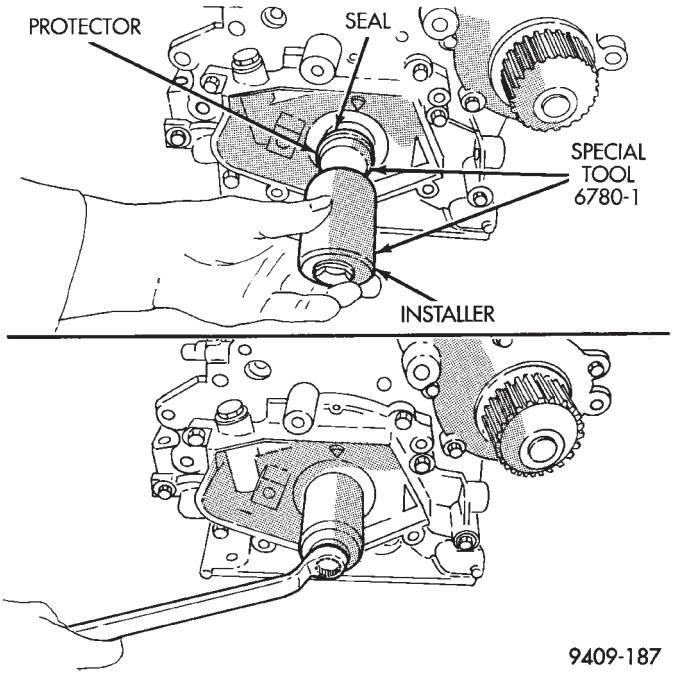


Fig. 76 Front Crankshaft Seal—Installation

(7) Install crankshaft sprocket, using Special Tool 6792 (Fig. 77).

(8) Install oil pump pick-up tube and oil pan.

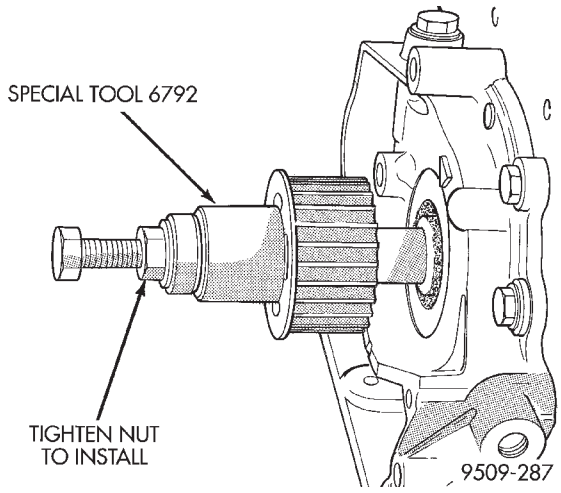


Fig. 77 Crankshaft Sprocket—Installation

(9) Install Timing Belt. Refer to Timing Belt Installation in this section.

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. 78).

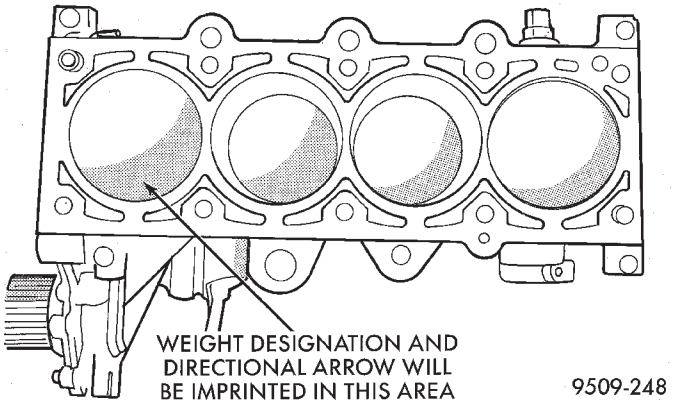


Fig. 78 Piston Markings

(2) Remove oil pan. Scribe the cylinder number on the side of the rod and cap (Fig. 79) for identification.

(3) Pistons will have a stamping in the approximate location shown in (Fig. 78). These stamps will be either a directional arrow or a weight identification for the assembly. L is for light and H is for 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 production assemblies. The weight designation stamps should face toward the timing belt side of the engine.

REMOVAL AND INSTALLATION (Continued)

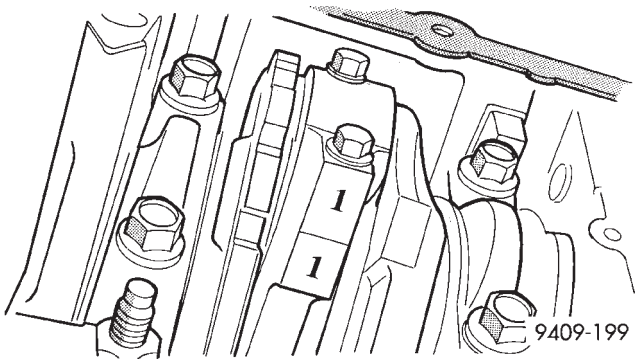


Fig. 79 Identify Connecting Rod to Cylinder

(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. 80).

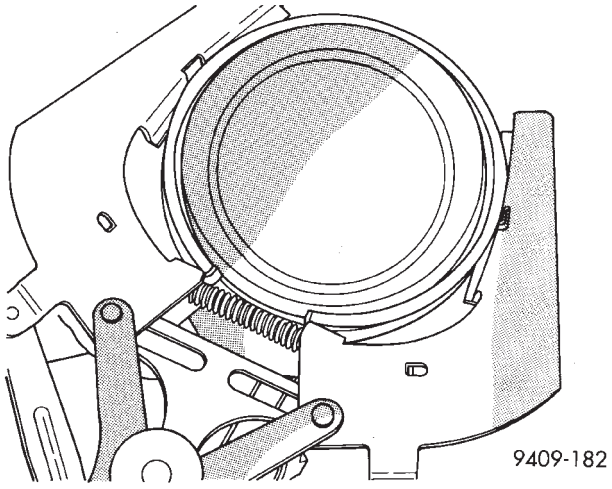


Fig. 80 Piston Rings—Removing and Installing

(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. 81).

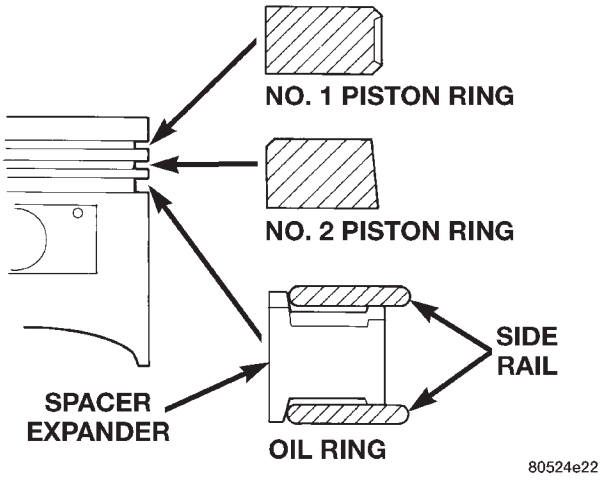


Fig. 81 Piston Ring Installation

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.

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. 82).**

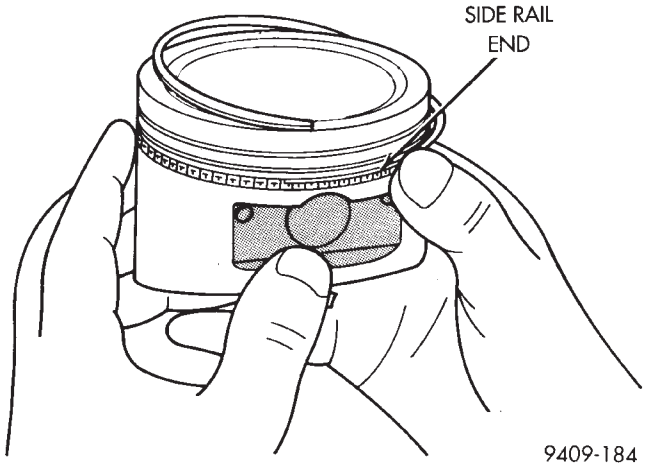


Fig. 82 Installing Side Rail

(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. 81).

(4) Position piston ring end gaps as shown in (Fig. 83).

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

REMOVAL AND INSTALLATION (Continued)

on the thrust direction. Staggering ring gap is important for oil control.

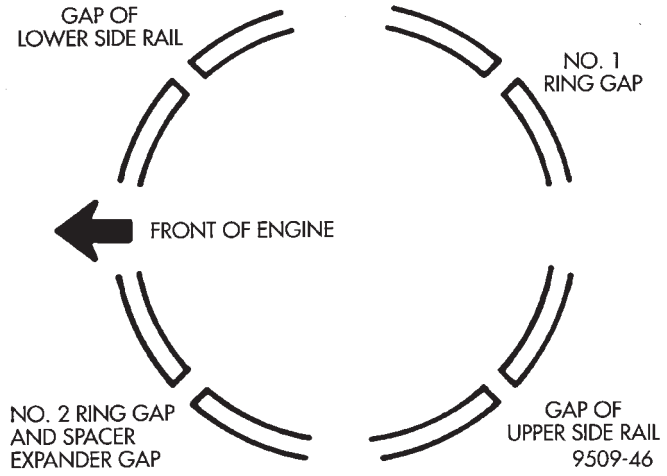


Fig. 83 Piston Ring End Gap Position

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. 83).

(3) Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston (Fig. 84). **Be sure position of rings does not change during this operation** .

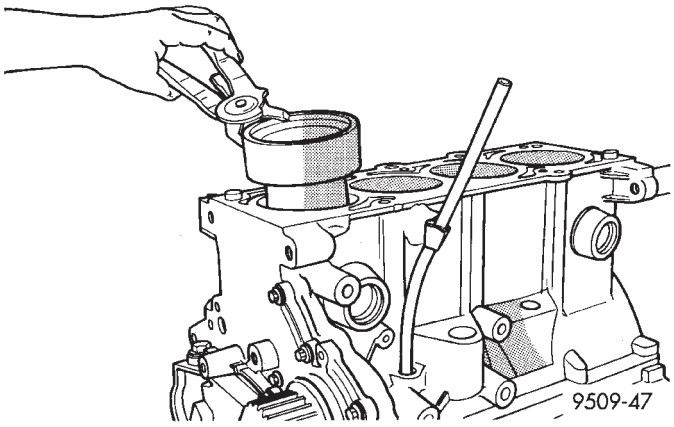


Fig. 84 Installing Piston

(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. 78).

(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. 85).

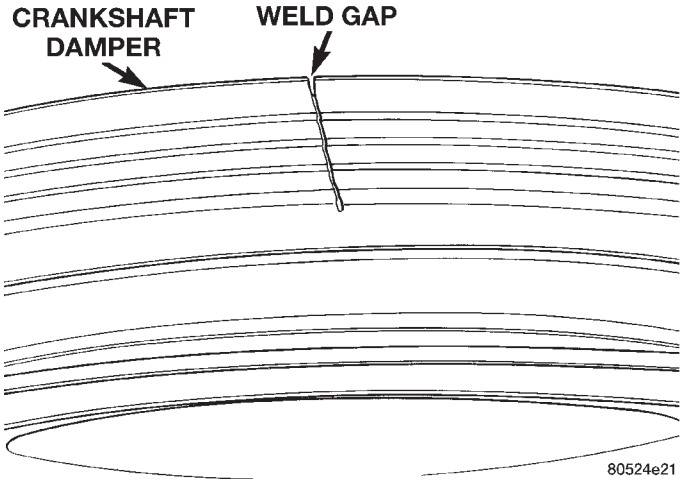


Fig. 85 Weld Gap

REMOVAL

(1) Remove accessory drive belts. Refer to Group 7, Cooling System for procedure outlined in that section.

(2) Raise vehicle on a hoist and remove right inner splash shield (Fig. 86).

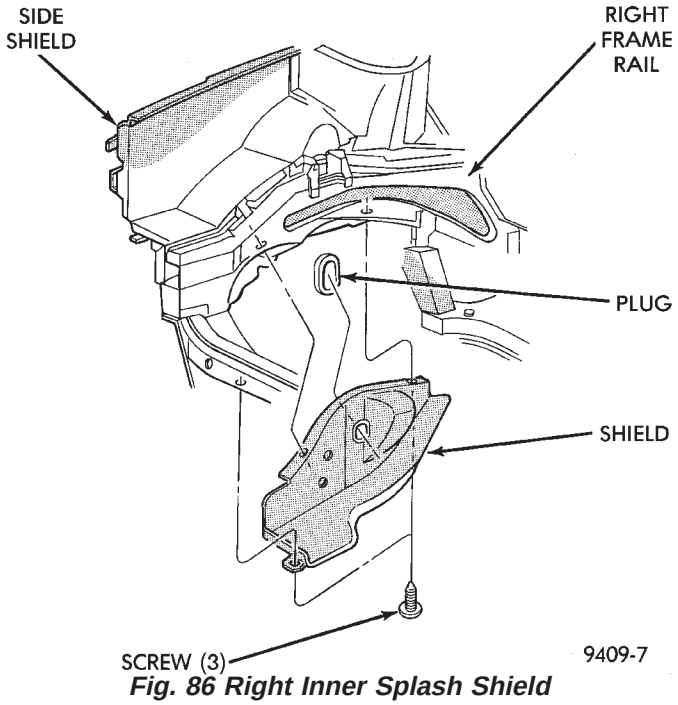


Fig. 86 Right Inner Splash Shield

REMOVAL AND INSTALLATION (Continued)

(3) Remove crankshaft damper bolt. Remove damper using the large side of Special Tool 1026 and insert 6827–A (Fig. 87).

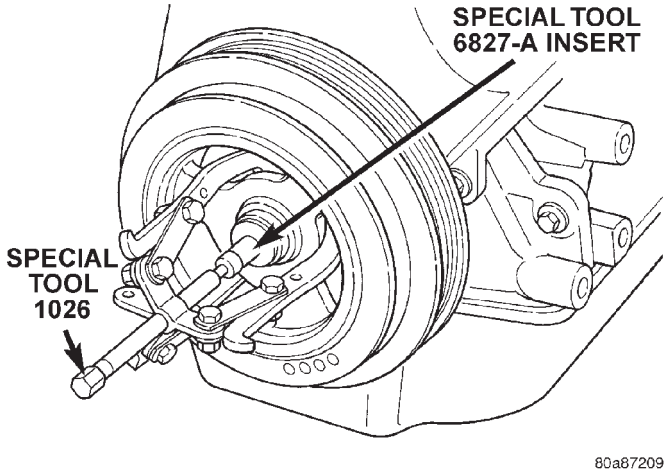


Fig. 87 Crankshaft Damper—Removal

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. 88).

(2) Install accessory drive belts. Refer to Group 7, Cooling System Accessory Drive section for procedure.

(3) Raise vehicle on hoist and install right inner splash shield.

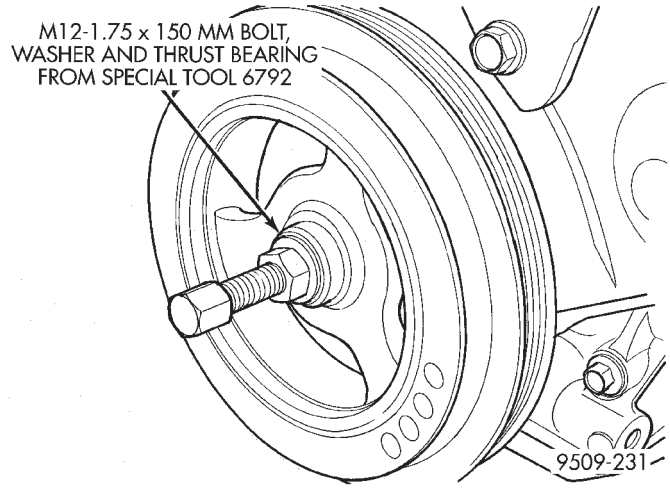


Fig. 88 Crankshaft Damper—Installation

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. 89).

CAUTION: Oil pump pressure relief valve must be installed as shown in (Fig. 89) or serious damage may occur.

(3) Remove spring and relief valve (Fig. 89).

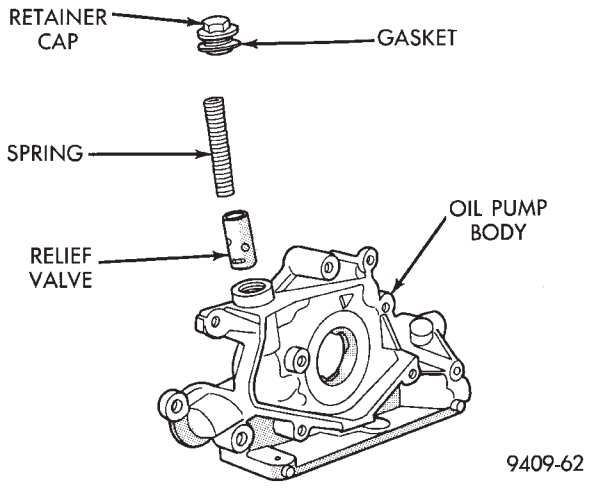


Fig. 89 Oil Pressure Relief Valve

(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. 90).

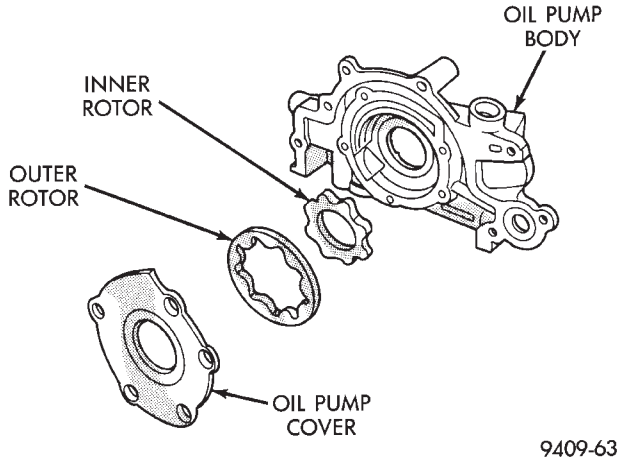


Fig. 90 Oil Pump

DISASSEMBLY AND ASSEMBLY (Continued)

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.

(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. 91). Refer to (Fig. 92) for specifications. Replace guides if they are not within specification.

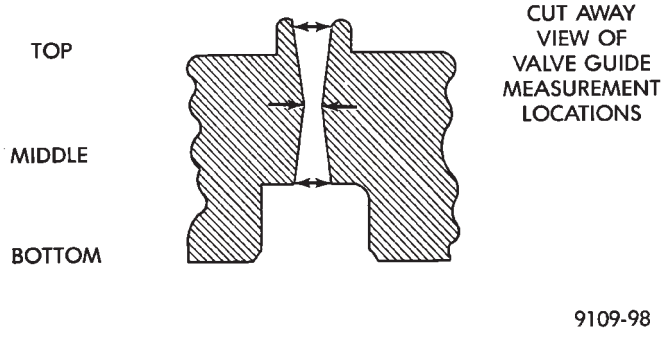


Fig. 91 Checking Wear on Valve Guide—Typical

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	0.023 - 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. 92 Valve Guide Specifications

(3) Check valve guide height (Fig. 93).

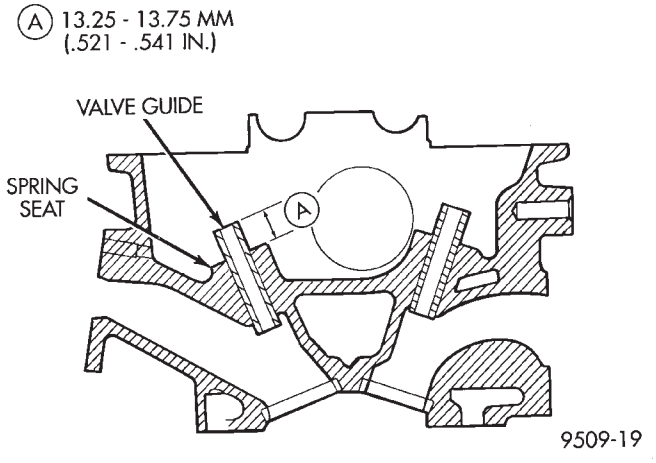


Fig. 93 Valve Guide Height

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. 94). 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.)

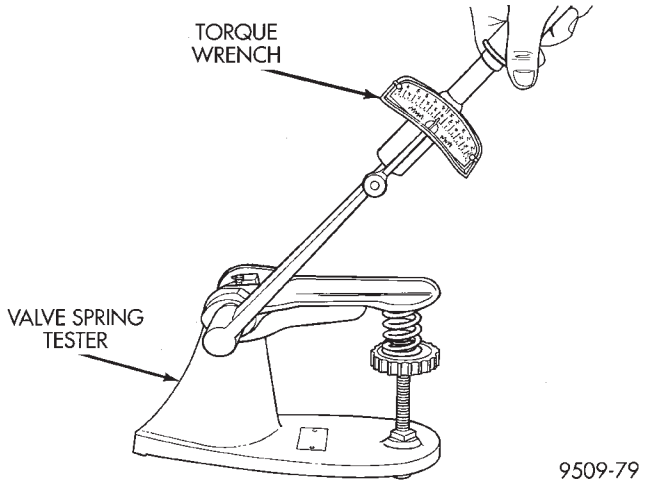


Fig. 94 Testing a Valve Spring

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. 95). 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.

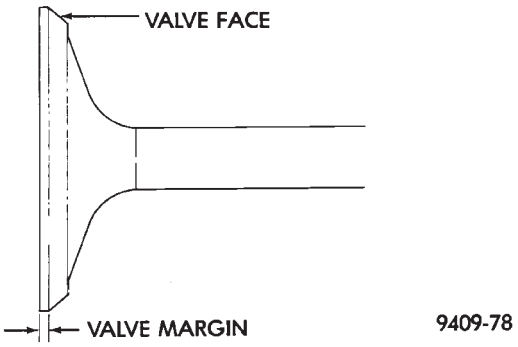


Fig. 95 Refacing Intake and Exhaust Valves

(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. 96) 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.)

9509-21

Fig. 96 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. 97).

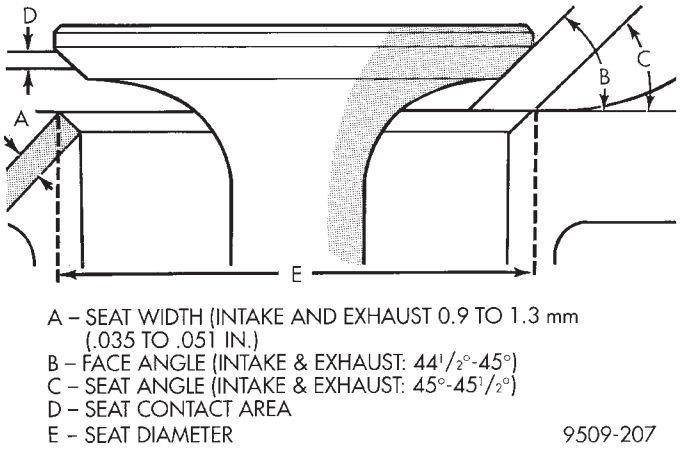


Fig. 97 Refacing Valve Seats

(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. 98). 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)

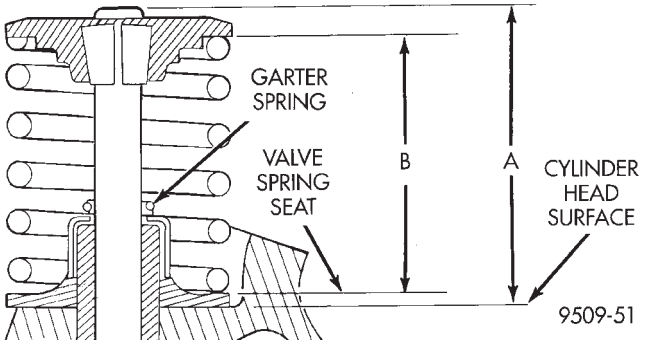


Fig. 98 Checking Spring Installed Height and Valve Tip to Spring Seat Dimensions

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. 99). 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.

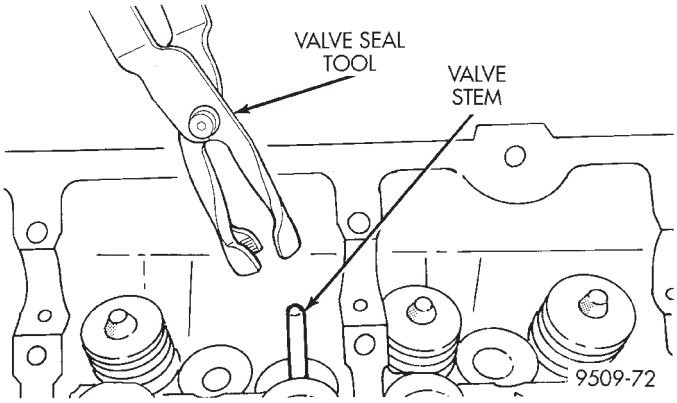


Fig. 99 Valve Stem Oil Seal Tool

(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. 98). 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. 100).

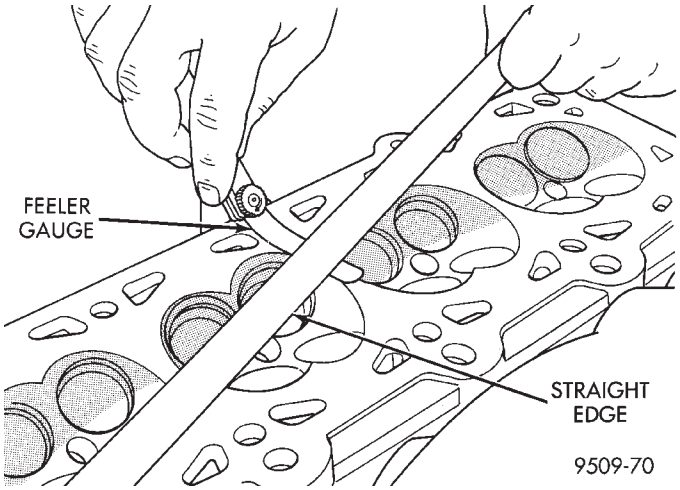


Fig. 100 Checking Cylinder Head Flatness

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. 101). If a 0.076 mm (0.003 inch.) feeler gauge can be inserted between cover and straight edge, cover should be replaced.

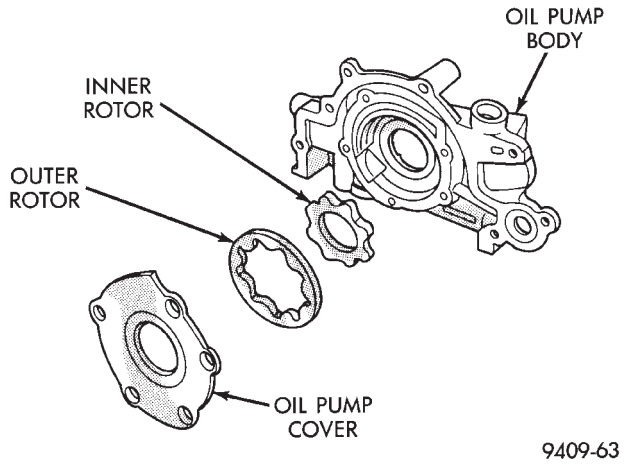


Fig. 101 Checking Oil Pump Cover Flatness

(3) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 7.64 mm (0.301 inch.) or less (Fig. 102), or if the diameter is 79.95 mm (3.148 inches) or less, replace outer rotor.

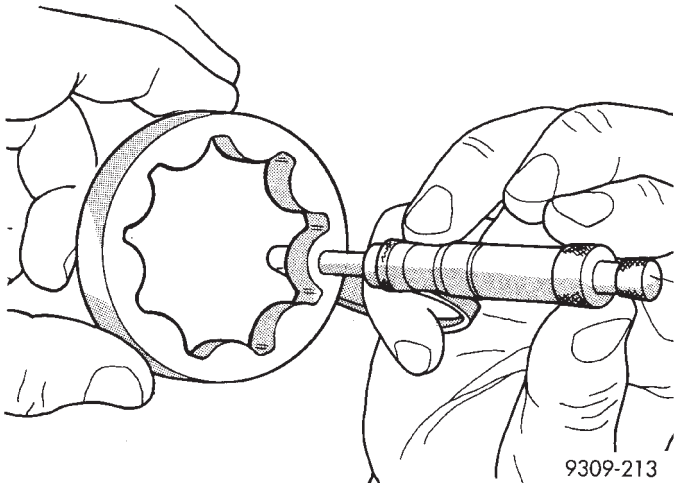


Fig. 102 Measuring Outer Rotor Thickness

(4) If inner rotor measures 7.64 mm (.301 inch) or less replace inner rotor (Fig. 103).

(5) Slide outer rotor into pump housing, press to one side with fingers and measure clearance between rotor and housing (Fig. 104). If measurement is 0.39 mm (0.015 inch.) or more, replace housing only if outer rotor is in specification.

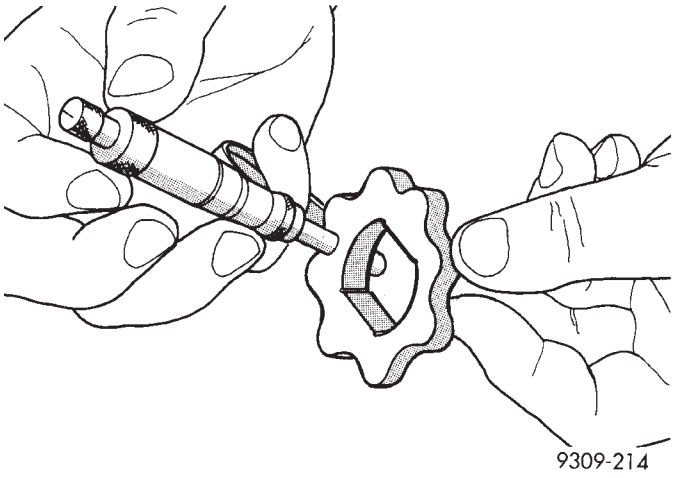


Fig. 103 Measuring Inner Rotor Thickness

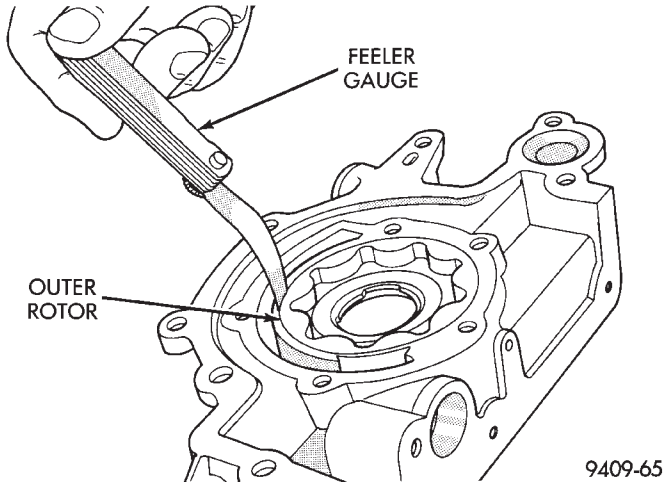


Fig. 104 Measuring Outer Rotor Clearance in Housing

(6) Install inner rotor into pump housing. If clearance between inner and outer rotors (Fig. 105) is .203 mm (.008 inch) or more, replace both rotors.

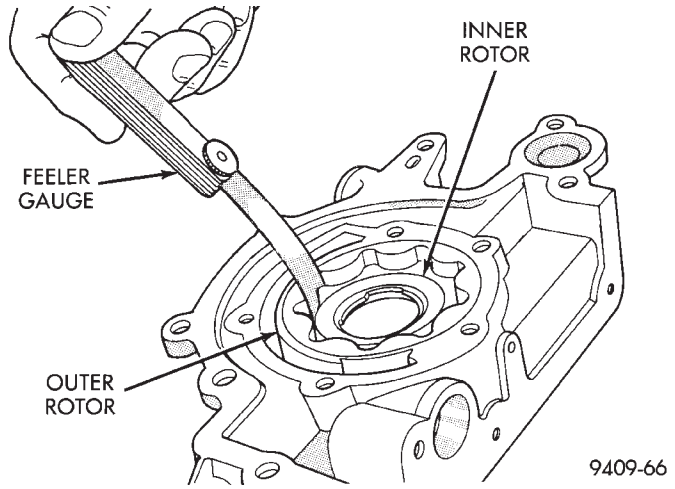


Fig. 105 Measuring Clearance Between Rotors

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. 106). **ONLY** if rotors are in specs.

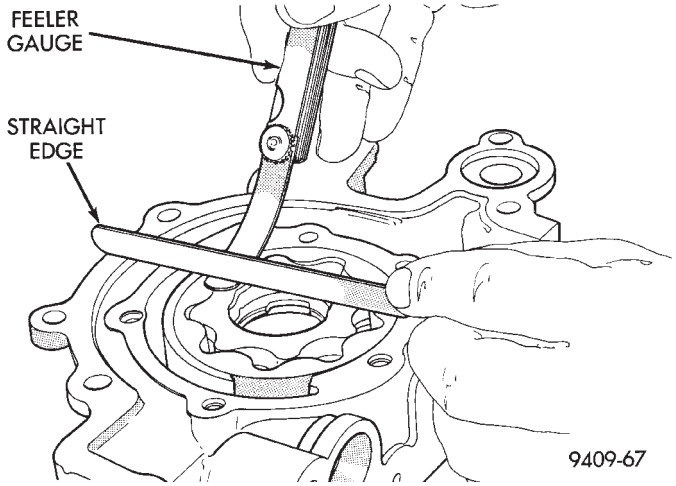


Fig. 106 Measuring Clearance Over Rotors

(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. 107). 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. 107). 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. 108) for specifications.

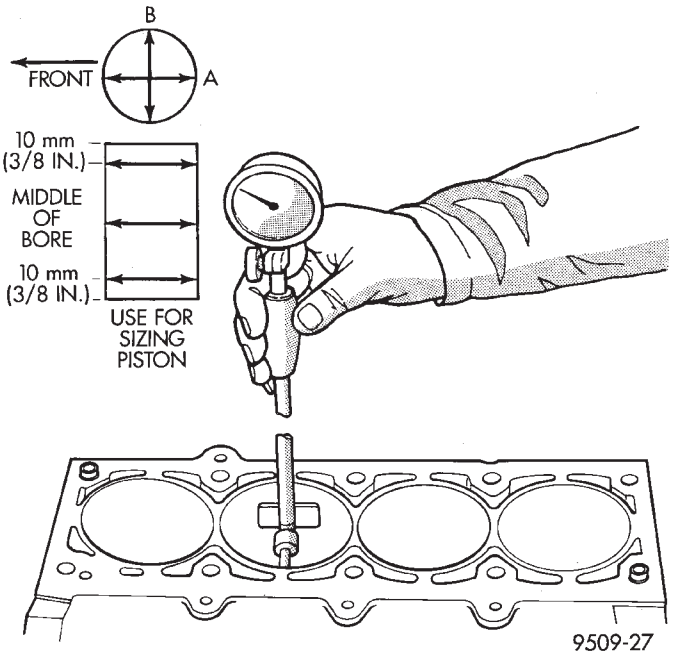


Fig. 107 Checking Cylinder Bore Size

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. 108 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.)

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 – 19.984mm (0.786 – 0.7867 in.)

Rocker Arm Shaft Retainers (Width)

Intake (All) . . . . . 28.46 mm (1.12 in.)
Exhaust . . . . . 1 & 5 29.20 mm (1.14in.) 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.)
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.)

SPECIFICATIONS (Continued)

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.)
- Installed Height . . . . . 40.18 mm (1.580 in.)

* 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

Camshaft Sensor Pick Up
- Bolts . . . . . 9.6 N·m (85 in. lbs.)

Timing Belt Cover
- Bolts M6 . . . . . 12 N·m (105 in. lbs.)

Camshaft Sprocket
- Bolt . . . . . 115 N·m (85 ft. lbs.)

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

Crankshaft Main Bearing Cap/Bedplate
- M8 Bedplate Bolts . . . . . 30 N·m (22 ft. lbs.)
- M11 Main Cap Bolts . . . . . 81 N·m (60 ft. lbs.)

Crankshaft Damper
- Bolt . . . . . 142 N·m (105 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 . . . . . 12 N·m (105 in. lbs.)

Oil Filter Adapter
- Fastener . . . . . 80 N·m (60 ft. lbs.)
- Oil Filter . . . . . 20 N·m (15 ft. lbs.)

Oil Pan
- Bolts . . . . . 12 N·m (105 in. lbs.)
- Drain Plug . . . . . 27 N·m (20 ft. lbs.)

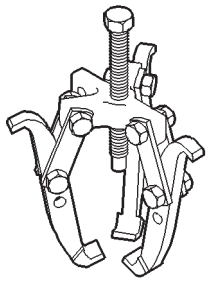
Oil Pump Attaching
- Bolts . . . . . 28 N·m (250 in. lbs.)

SPECIFICATIONS (Continued)

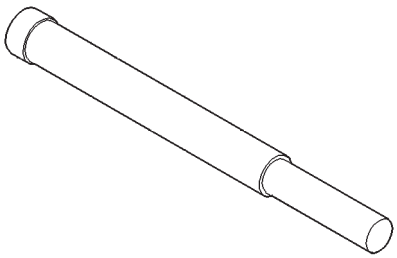
DESCRIPTION	TORQUE
Oil Pump Cover Fastener	12 N·m (105 in. lbs.)
Oil Pump Pick-up Tube Bolt	28 N·m (250 in. lbs.)
Oil Pump Relief Valve Cap	41 N·m (30 ft. lbs.)
Rear Torque Bracket	
Bolts	110 N·m (80 ft. lbs.)
Rocker Arm Shaft	
Bolts	28 N·m (250 in. lbs.)
Spark Plugs	28 N·m (20 ft. lbs.)
Support Module—Front and Rear	
Thru Bolt	61 N·m (45 ft. lbs.)
Thermostat Housing	
Bolts	23 N·m (200 in lbs.)
Timing Belt	
Tensioner	31 N·m (275 in. lbs.)
Timing Belt Tensioner Pivot Bracket	
Bolt	31 N·m (275 in. lbs.)
Timing Belt Tensioner Pulley	
Bolt	68 N·m (50 ft. lbs.)
Water Pump Mounting	
Bolts	12 N·m (105 in. lbs.)

SPECIAL TOOLS

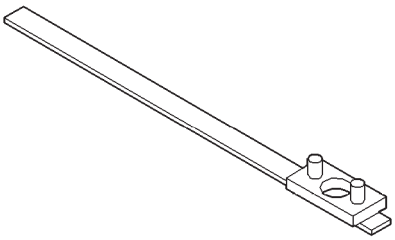
ENGINE 2.0L SOHC



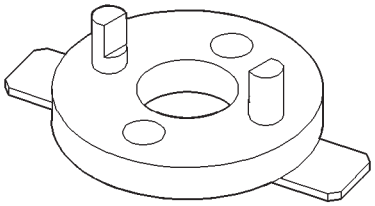
Puller 1026



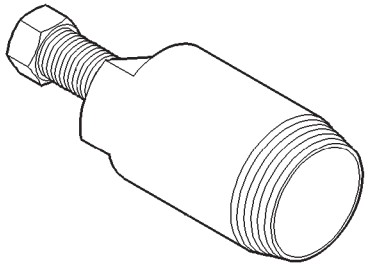
Crankshaft Damper Removal Insert 6827-A



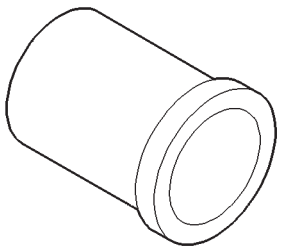
Camshaft Sprocket Remover/Installer C-4687



Camshaft Sprocket Remover/Installer Adapter C-4687-1

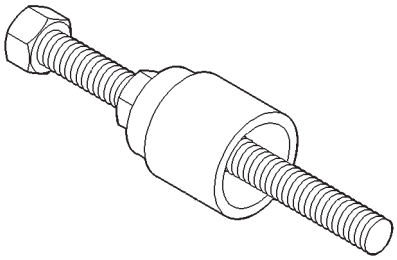


Camshaft Seal Remover C-4679-A

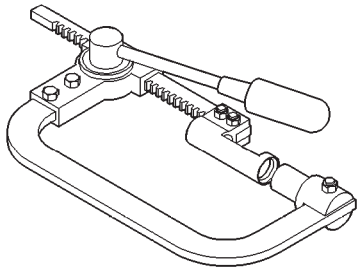


Camshaft Seal Installer MD-998306

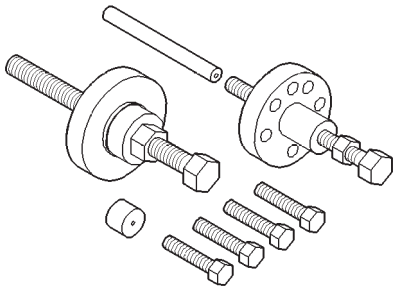
SPECIAL TOOLS (Continued)



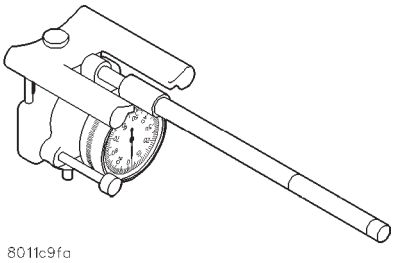
Crankshaft Damper Installer 6792



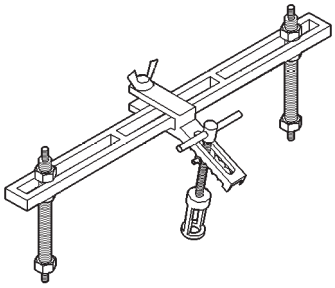
Valve Spring Compressor C-3575-A



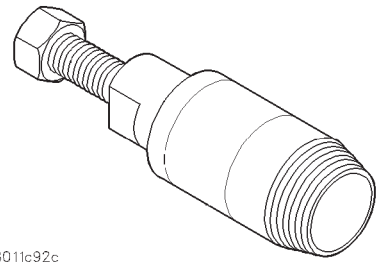
Crankshaft Damper Installer C-4685-C



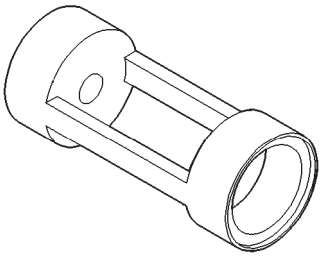
Cylinder Bore Indicator C-119



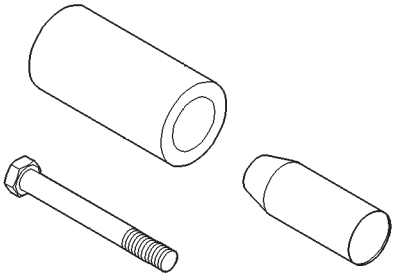
Valve Spring Compressor MD-998772-A



Front Crankshaft Seal Remover 6771

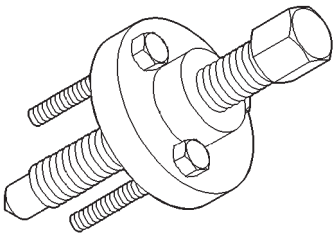


Spring Compressor Adapter 6779

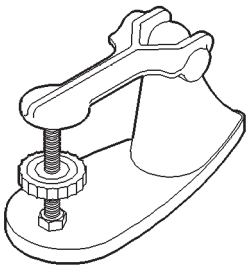


Front Crankshaft Seal Installer 6780

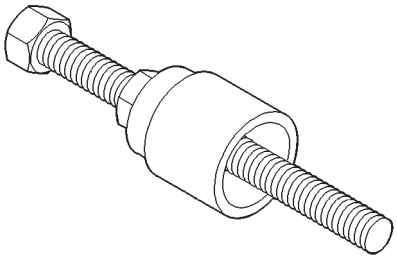
SPECIAL TOOLS (Continued)



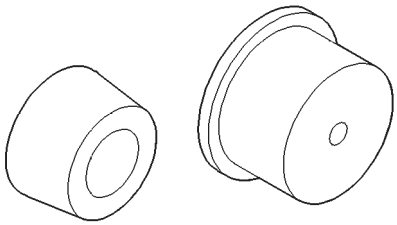
Crankshaft Sprocket Remover 6793



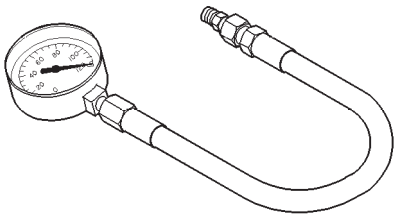
Valve Spring Tester C-647



Crankshaft Sprocket Installer 6792



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



Pressure Gage C-32932

2.0L DOHC ENGINE

INDEX

page

DESCRIPTION AND OPERATION
ENGINE COMPONENTS 54
ENGINE IDENTIFICATION NUMBER 52
ENGINE LUBRICATION SYSTEM 53
GENERAL SPECIFICATION 52
DIAGNOSIS AND TESTING
CHECKING ENGINE OIL PRESSURE 54
SERVICE PROCEDURES
CRANKSHAFT END PLAY 56
CYLINDER BORE AND PISTON SIZING 55
FITTING CONNECTING RODS 56
FITTING CRANKSHAFT BEARINGS 56
FITTING PISTON RINGS 56
REMOVAL AND INSTALLATION
CAMSHAFT OIL SEALS 71
CAM FOLLOWER AND HYDRAULIC LASH ADJUSTER ASSEMBLY 62
CAMSHAFT 61
CRANKSHAFT 75
CYLINDER HEAD COVER 60
CYLINDER HEAD 63
ENGINE ASSEMBLY 59
FRONT CRANKSHAFT OIL SEAL 72
FRONT MOUNT 57
LEFT MOUNT 58
OIL FILTER ADAPTER 77

page

OIL FILTER 77
OIL PAN 70
OIL PUMP 77
PISTON AND CONNECTING ROD 79
POWER HOP DAMPER 58
REAR CRANKSHAFT SEAL 73
RIGHT MOUNT 58
TIMING BELT COVER 67
TIMING BELT 68
VALVE SPRING AND SEALS—CYLINDER HEAD NOT REMOVED 63
VIBRATION DAMPER 66
DISASSEMBLY AND ASSEMBLY
OIL PUMP 81
VALVE SERVICE WITH CYLINDER HEAD REMOVED 81
CLEANING AND INSPECTION
CYLINDER BLOCK AND BORE 85
CYLINDER HEAD AND CAMSHAFT JOURNALS 84
OIL PUMP 84
SPECIFICATIONS
ENGINE 2.0L DOHC 86
TORQUE CHART 2.0L DOHC 88
SPECIAL TOOLS
ENGINE 2.0L DOHC 88

DESCRIPTION AND OPERATION

ENGINE IDENTIFICATION NUMBER

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

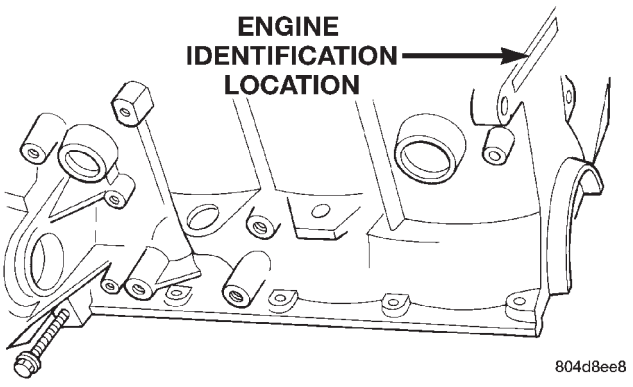


Fig. 1 Engine Identification DOHC

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.)

DESCRIPTION AND OPERATION (Continued)

ENGINE LUBRICATION SYSTEM

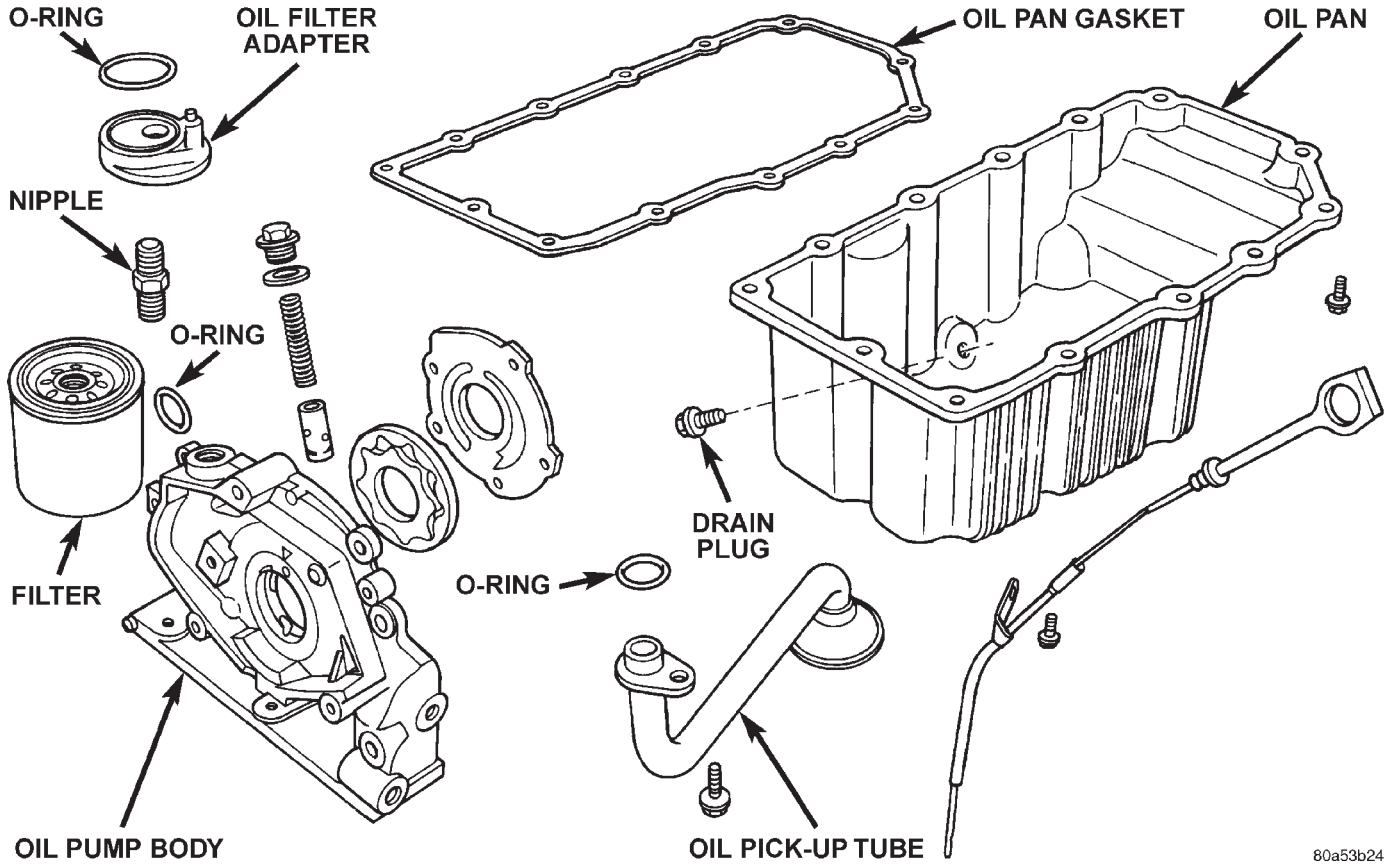


Fig. 2 Engine Lubrication Components

PRESSURE LUBRICATION

Oil drawn up through the pickup tube is pressurized by the pump and routed through the full flow filter (Fig. 2) to the main oil gallery running the length of the cylinder block. A cylinder head restrictor, located in the block, provides increased oil flow to the main oil gallery (Fig. 3).

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.

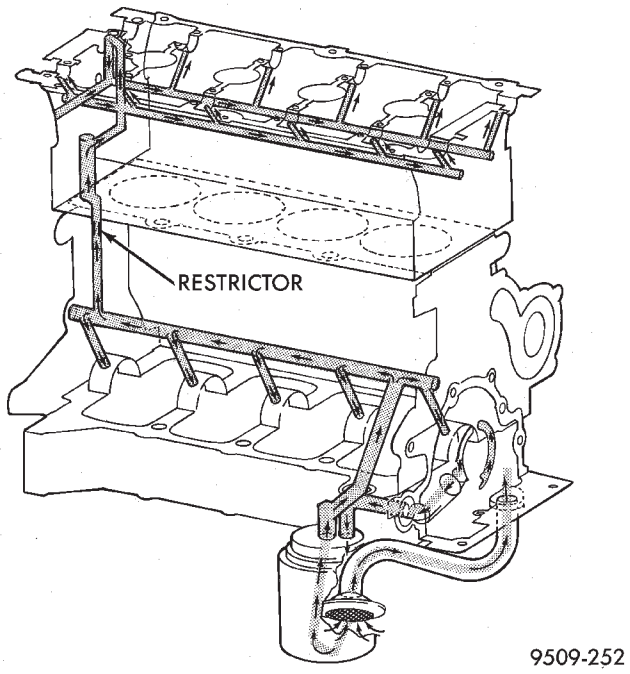


Fig. 3 Engine Lubrication System —DOHC Engine

DESCRIPTION AND OPERATION (Continued)

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

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 counterweights 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 provides motive power; via timing belt to the camshaft sprocket providing timed valve actuation.

PISTONS The DOHC Engine **DO 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.

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 contains of 2 steel rails and a expander spacer.

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 galleys 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 Four 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 fasteners. This long branch fan design enhances low and midspeed 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.

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)

The camshaft and crankshaft timing relearn procedure must be performed. Refer to Group 25, Emission Control Systems 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.

(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.

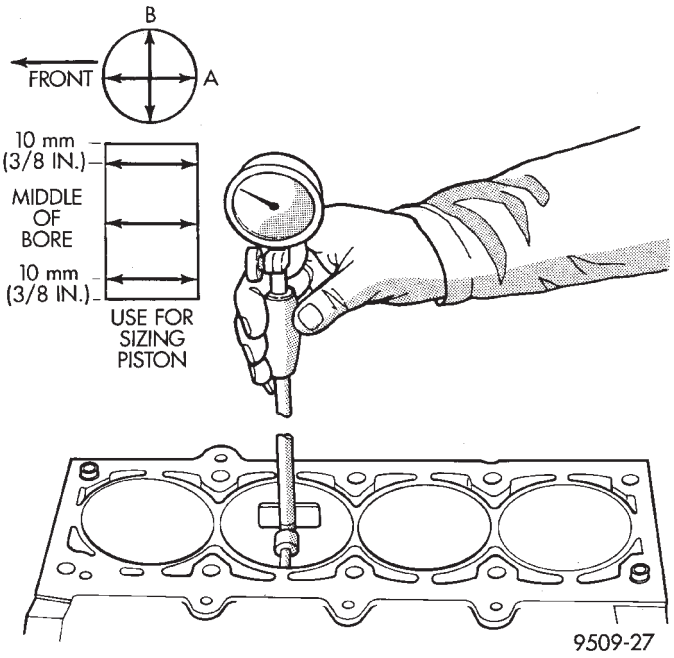


Fig. 4 Checking Cylinder Bore Size

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		
87.457 - 87.475 mm (3.4432 - 3.4439 in.)		
Piston to Bore Clearance		
0.018 - 0.050 mm (0.0007 - 0.0020 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 Piston Specifications Table. Correct piston to bore clearance must be established in order to assure quiet and economical operation.

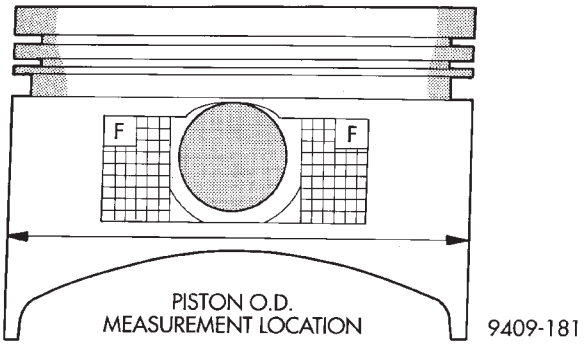


Fig. 5 Piston Measurements

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).

SERVICE PROCEDURES (Continued)

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. 5). Refer to specifications (Fig. 7).

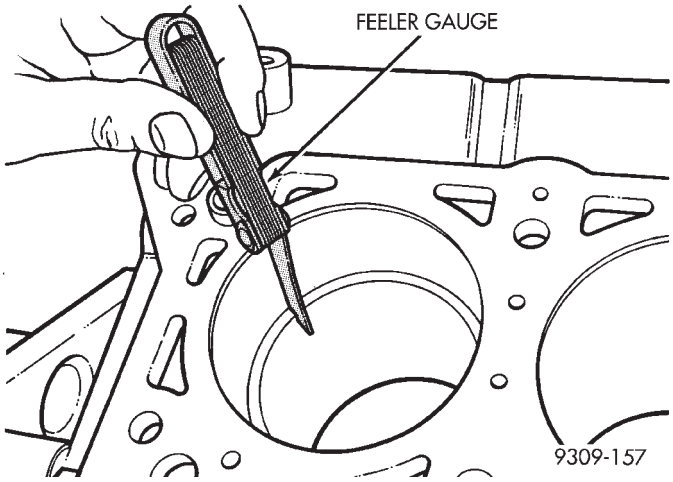


Fig. 6 Piston Ring Gap

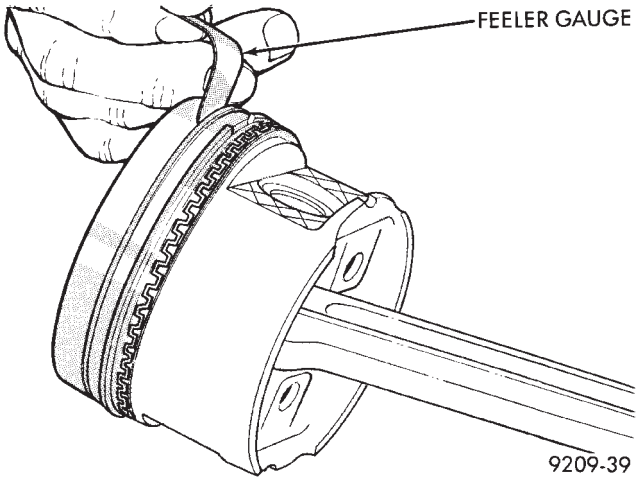


Fig. 7 Piston Ring Side Clearance

(2) Check piston ring to groove side clearance (Fig. 6). Refer to specification (Fig. 7).

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. 8). Refer to specifications.

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

NOTE: The rod bearing bolts should not be reused.

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.		

Fig. 8 Piston Ring Specifications

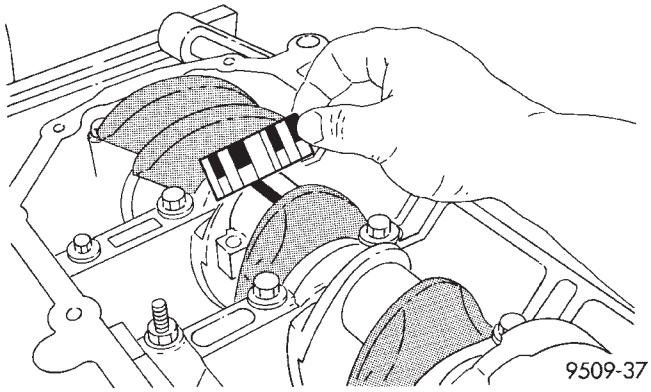


Fig. 9 Checking Connecting Rod Bearing Clearance

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

(3) Install each bolt finger tight than 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. 9). Refer to connecting rod specifications (Fig. 10).

FITTING CRANKSHAFT BEARINGS

Refer to Measuring Main Bearing Clearance in Standard Service Procedures. Refer to (Fig. 11) for specifications.

CRANKSHAFT END PLAY

DIAL INDICATOR METHOD

(1) Mount a dial indicator to front of engine, locating probe on nose of crankshaft (Fig. 12).

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

SERVICE PROCEDURES (Continued)

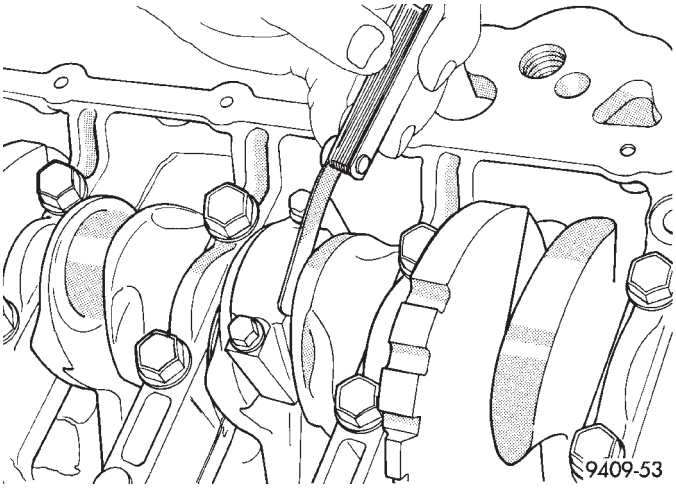


Fig. 10 Checking Connecting Rod Side Clearance

CONNECTING ROD BEARING OIL CLEARANCE	
New Part:	0.026 to 0.059 mm (0.001 to 0.0023 in.)
Wear Limit:	0.075 mm (0.003 in.)
CONNECTING ROD SIDE CLEARANCE	
New Part:	0.13 to 0.38 mm (0.005 to 0.015 in.)
Wear Limit:	0.40 mm (0.016 in.)

Fig. 11 Connecting Rod Specifications

Crankshaft End-Play	
New Part:	0.09 - 0.24 mm (0.0035 - 0.0094 in.)
Wear Limit:	0.37 mm (0.015 in.)
Main Bearing Clearance	
New Part:	.022 - .062 mm (0.0008 - 0.0024 in.)
Connecting Rod Bearing Clearance	
New Part:	0.026 - .059 mm (0.001 - 0.0023 in.)
Wear Limit:	0.075 mm (0.003 in.)
Crankshaft Journal Sizes	
Main Bearing Journal Diameter	
Standard	52.000 ± 0.008 mm (2.0472 ± 0.0003 in.)
1st Undersize	51.983 ± 0.008 mm (2.0466 ± 0.0003 in.)
Connecting Rod Journal	
Standard	48.000 ± 0.008 mm (1.8897 ± 0.0003 in.)
1st Undersize	47.983 ± 0.008 mm (1.8891 ± 0.0003 in.)

Fig. 12 Crankshaft Specifications

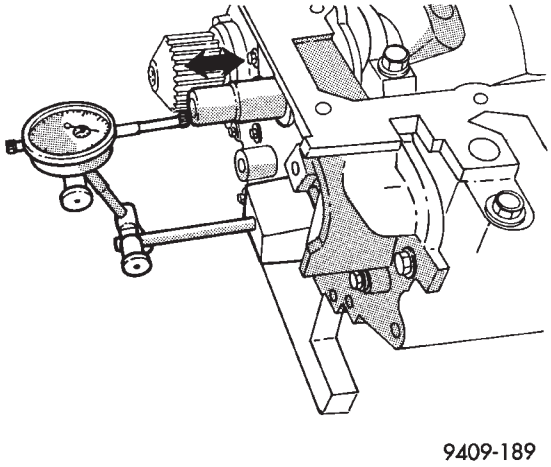


Fig. 13 Checking Crankshaft End Play— Dial Indicator

(3) Zero the dial indicator.

(4) Move crankshaft all the way to the front and read the dial indicator. Refer to (Fig. 11) 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 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.

REMOVAL AND INSTALLATION

FRONT MOUNT

(1) Raise vehicle on hoist.

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

(3) Remove the front engine mount thru-bolt from the insulator and engine mount bracket (Fig. 14).

(4) Remove the mass damper. Remove the front mount nuts and remove insulator assembly.

(5) Remove the engine mount bracket, if necessary.

(6) Reverse removal procedure for installation and tighten fasteners in this order.

a. If engine mount bracket was removed, tighten bolt 1 to 3 N·m (20 in. lbs.) and bolts 2, 3 and 4 to 108 N·m (80 ft. lbs.) (Fig. 14).

b. If engine mount bracket was removed, tighten bolts 5 and 1 to 54 N·m (40 ft. lbs.).

c. Tighten engine mount bracket to insulator assembly thru-bolt to 54 N·m (40 ft. lbs.).

d. Tighten insulator assembly nuts to the lower radiator crossmember torque to 54 N·m (40 ft. lbs.).

REMOVAL AND INSTALLATION (Continued)

e. Install mass damper and tighten to 54 N·m (40 ft. lbs.)

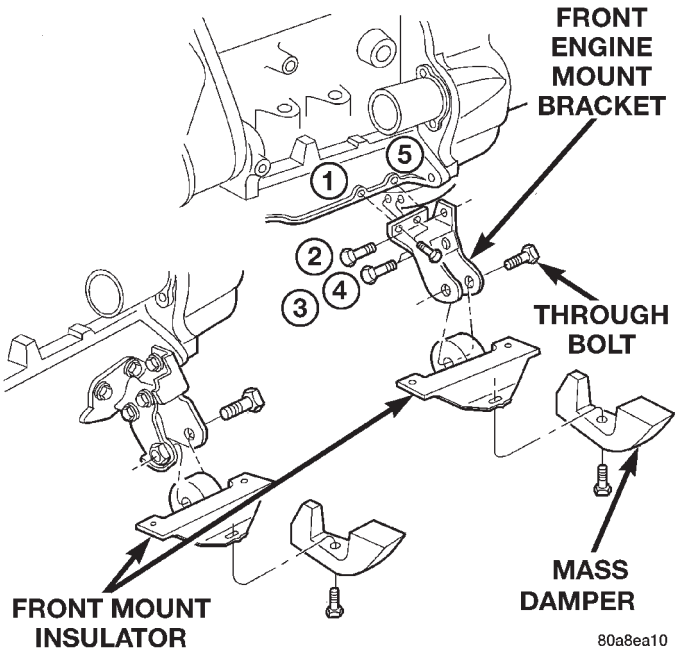


Fig. 14 Engine Mounting—Front

LEFT MOUNT

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

(2) Remove the Power Distribution Center (PDC) on manual transaxle model, from battery tray mount and lay aside.

(3) Support the transmission with a transmission jack.

(4) Remove the thru-bolt access hole cover. Remove the insulator thru-bolt from the mount (Fig. 15).

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

(6) Reverse removal procedure for installation. Tighten fasteners in this order (Fig. 15):

A. 55 N·m (40 ft. lbs.)

B. 108 N·m (80 ft. lbs.)

RIGHT MOUNT

(1) Remove the purge duty solenoid from engine mount bracket.

(2) Remove the right engine mount insulator vertical fasteners from frame rail (Fig. 16).

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

(4) Remove the thru-bolt access hole cover. Remove the thru-bolt from the insulator assembly (Fig. 16). Remove insulator.

(5) Reverse removal procedure for installation. Tighten engine mount to rail fasteners to 54 N·m (40 ft. lbs.), then tighten engine mount to engine bracket thru-bolt to 108 N·m (80 ft. lbs.).

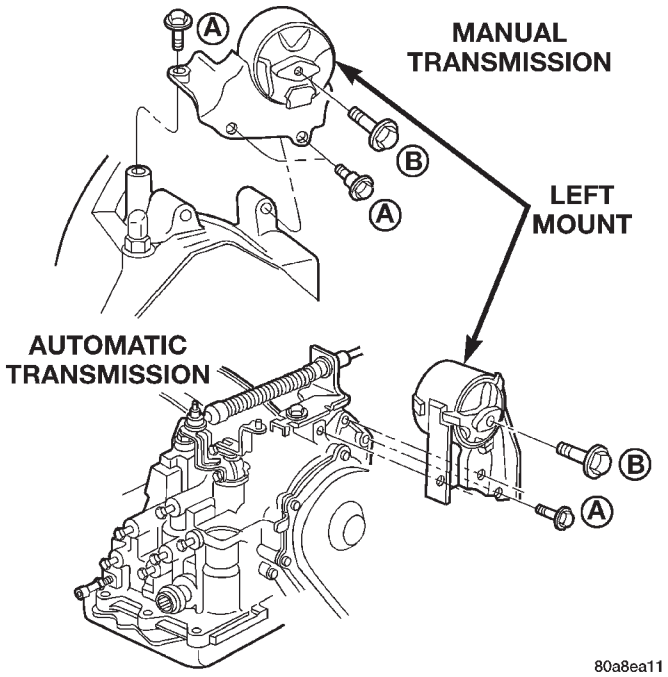


Fig. 15 Engine Mounting—Left

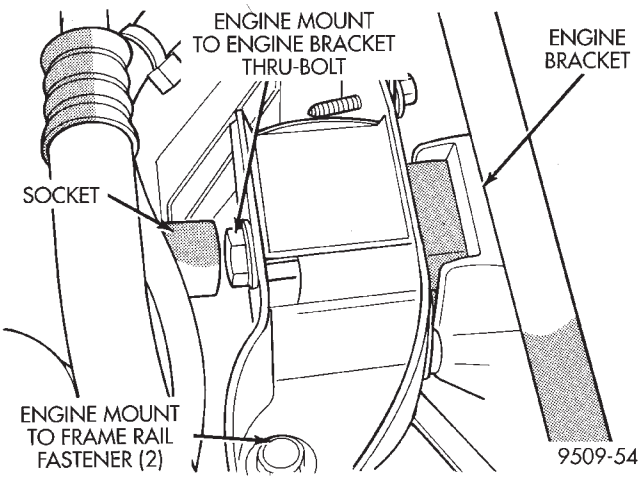


Fig. 16 Engine Mounting—Right

POWER HOP DAMPER

NOTE: Power hop damper is used on manual transmission vehicle only.

(1) Remove the thru-bolt and nut from the front suspension crossmember (Fig. 17).

(2) Remove the damper nut and grommets. Remove the damper.

(3) Remove the power hop damper bracket, if necessary.

(4) Reverse removal procedure for installation. Tighten all bolts and nuts to 54 N·m (40 ft. lbs.)

REMOVAL AND INSTALLATION (Continued)

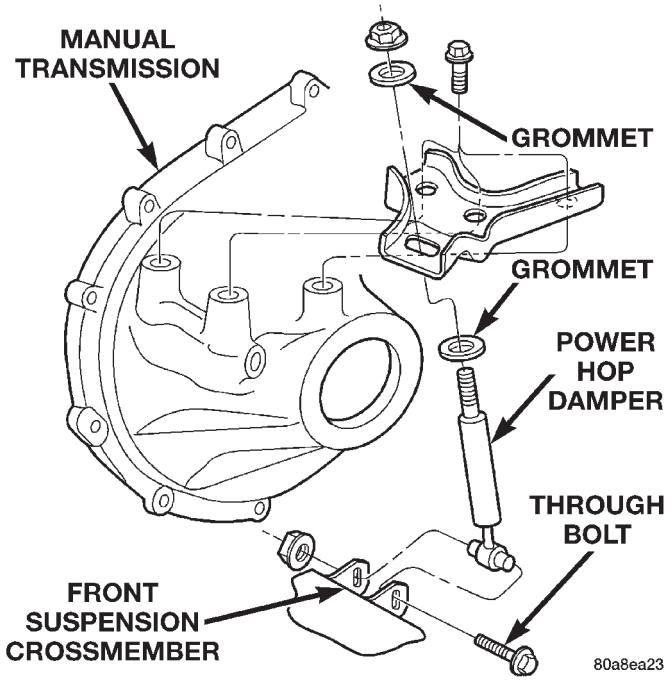


Fig. 17 Power Hop Damper

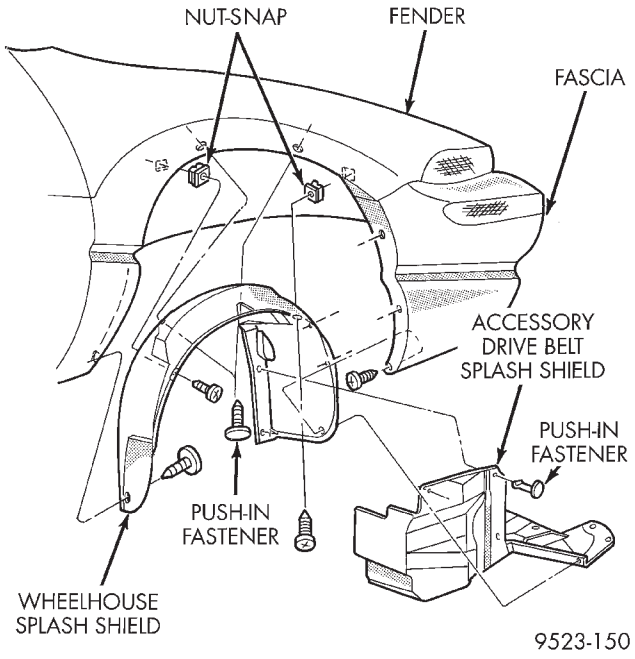


Fig. 18 Right Inner Splash Shield

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 and remove battery and tray. Set Powertrain Control Module (PCM) aside.

(3) Drain cooling system. Refer to Group 7, Cooling System for procedure.

(4) Remove upper radiator hose, radiator and fan module. Refer to Group 7, Cooling System for procedure.

(5) Remove lower radiator hose.

(6) Disconnect automatic transmission cooler lines and plug. If equipped.

(7) Disconnect clutch cable (Manual) and transmission shift linkage.

(8) Disconnect throttle body linkage.

(9) Disconnect engine wiring harness.

(10) Disconnect heater hoses.

(11) Discharge Air Conditioning System. Refer to Group 24, Air Conditioning for procedure.

(12) Hoist vehicle and remove right inner splash shield (Fig. 17).

(13) Remove accessory drive belts. Refer to Group 7, Cooling System for procedure.

(14) Remove axle shafts. Refer to Group 2, Suspension and Driveshafts for procedure.

(15) Disconnect exhaust pipe from manifold.

(16) Remove front engine mount.

(17) Manual transmission: Remove power hop damper.

(18) Lower vehicle. Remove air cleaner assembly.

(19) Remove power steering pump and reservoir, Set them aside.

(20) Remove A/C compressor.

(21) Remove ground straps to body.

(22) Raise vehicle enough to allow engine dolly and cradle Special Tools 6135 and 6710 to be installed under vehicle.

(23) Loosen engine support posts to allow movement for positioning onto engine locating holes and flange on the engine bedplate. Lower vehicle and position cradle until the engine is resting on support posts (Fig. 18). Tighten mounts to cradle frame. This will keep support posts from moving when removing or installing engine and transmission.

(24) Install safety straps around the engine to cradle tighten; straps and lock them into position.

(25) Raise vehicle enough to see if straps are tight enough to hold cradle assembly to engine.

(26) Lower vehicle so weight of the engine and transmission ONLY is on the cradle assembly.

(27) Remove engine and transmission mount thrubolts.

(28) Raise vehicle slowly. It may be necessary to move the engine/transmission assembly with the cradle to allow for removal around body flanges.

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

REMOVAL AND INSTALLATION (Continued)

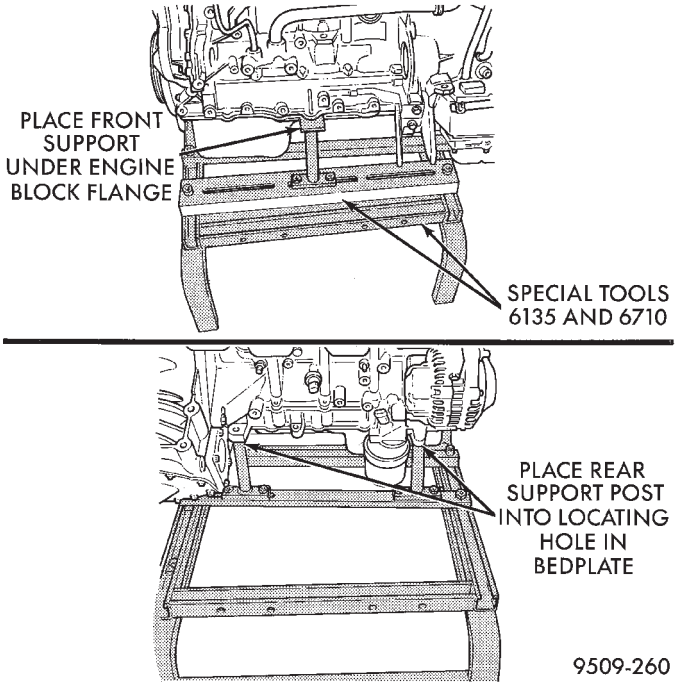


Fig. 19 Positioning Engine Cradle Support Post Mounts

engine and left transmission mounts. Refer to procedures outlined in this section.

(3) Remove safety straps from engine and transmission assembly. Slowly raise vehicle enough to remove the engine dolly and cradle.

(4) Install axle shafts. Refer to Group 2, Suspension and Driveshafts for procedure.

(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 and reservoir. Refer to Group 7, Cooling System Accessory Drive Section for belt tension adjustment.

(8) Install A/C compressor and 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 engine mount. Refer to this section for procedure.

(11) Manual transmission: Install power hop damper.

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

(13) **Manual Transmission:** Connect clutch cable and linkages. Refer to Group 6, Manual Transaxle Clutch.

(14) **Automatic Transmission:** Connect shifter and kickdown linkage. Refer to Group 21, Transaxle for procedures.

(15) Connect fuel line and heater hoses.

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

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

(18) Install radiator and shroud assembly. Install radiator hoses. Fill cooling system. Refer to Group 7, Cooling System for filling procedure.

(19) Install battery tray and battery. Set Powertrain Control Module (PCM) into place.

(20) Install air cleaner and hoses.

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

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

(23) Adjust transmission linkage, if necessary.

CYLINDER HEAD COVER

REMOVAL

(1) Remove ignition coil pack (Fig. 20).

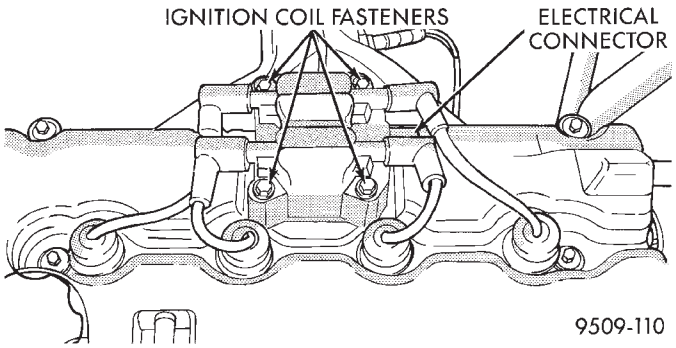


Fig. 20 Ignition Coil Pack

(2) Remove the cylinder head cover fasteners (Fig. 21).

(3) Remove cylinder head cover from cylinder head.

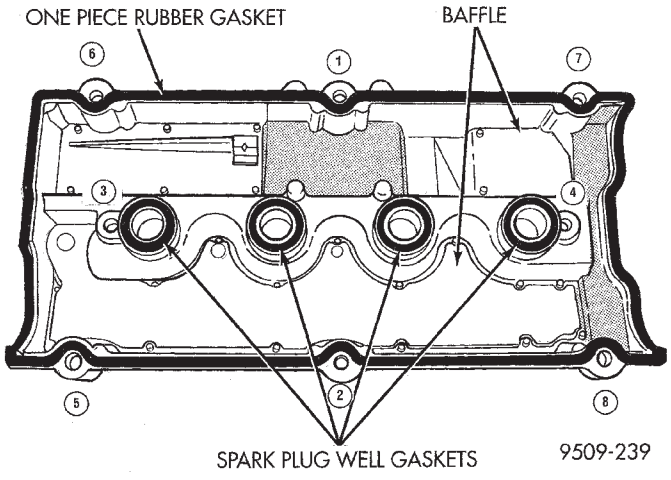


Fig. 21 Cylinder Head Cover and Gasket

REMOVAL AND INSTALLATION (Continued)

COVER INSTALLATION

NOTE: Before installation, clean cylinder head and cover mating surfaces. Make certain the rails are flat.

(1) Install new cylinder head cover gaskets.

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

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

(3) Install cylinder head cover assembly to head and tighten fasteners in sequence shown in (Fig. 21). Using the 3 step torque method:

- Step 1 Tighten all fasteners to 4.5 N·m (40 in. lbs.)
- Step 2 Tighten all fasteners to 9.0 N·m (80 in. lbs.)
- Step 3 Tighten all fasteners to 12 N·m (105 in. lbs.)

(4) Install ignition coil pack. Tighten fasteners to 12 N·m (105 in. lbs.).

CAMSHAFT

REMOVAL

(1) Remove valve 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. 22).

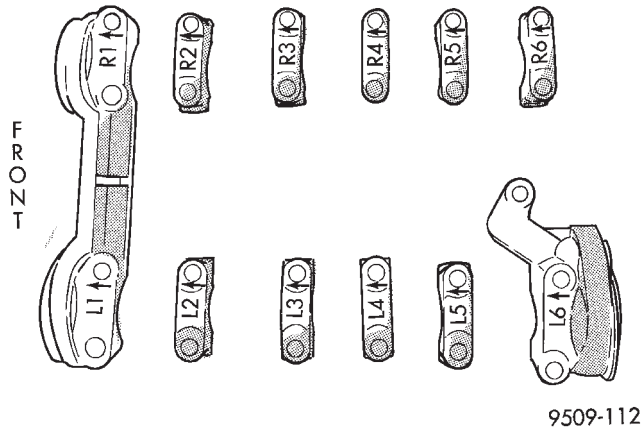


Fig. 22 Camshaft Bearing Cap Identification

(4) Loosen the camshaft bearing cap attaching fasteners in sequence shown in (Fig. 23) one camshaft at a time.

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

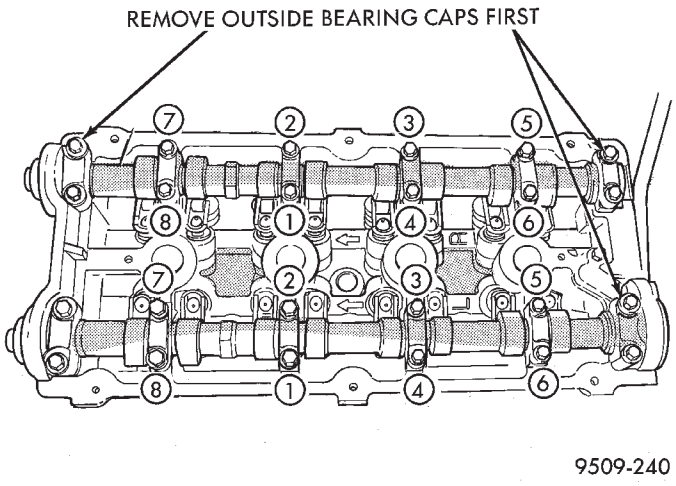


Fig. 23 Camshaft Bearing Cap— Removal

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

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. 24).

(4) Move camshaft as far forward as it will go.

(5) End play travel: 0.05– 0.15 mm (0.002– 0.06 in.).

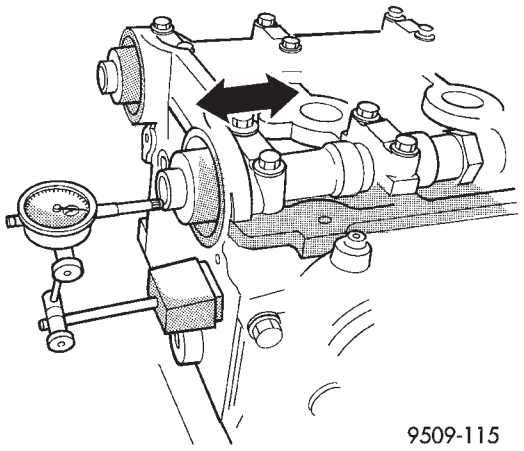


Fig. 24 Camshaft End Play

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

NOTE: Check camshaft for binding in cylinder head. Inspect camshaft bearing journals for damage. If camshafts are binding, also check the cylinder head bearing surface for damage, and check the camshaft bearing oil feed holes in the cylinder head for clogging.

Check the cam surface for abnormal wear and damage, replace if defective. A visible worn groove in the roller follower or on the cam lobes is cause for replacement.

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

(1) Lubricate bearing journals and cam followers with clean oil and install the camshafts. 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. 25).

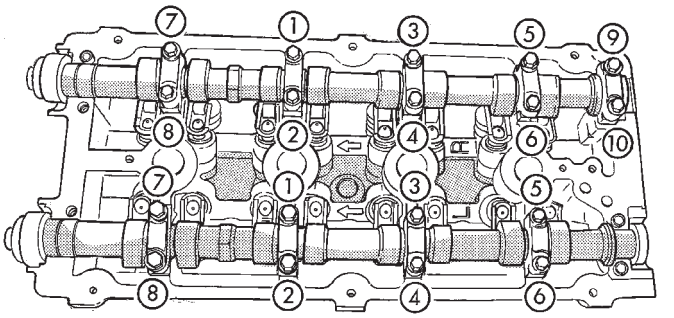


Fig. 25 Camshaft Bearing Cap—Tightening Sequence

(2) Apply Mopar Gasket Maker to No. 1 and No. 6 bearing caps (Fig. 26). Install bearing caps and tighten M8 fasteners to 24 N·m (215 in. lbs.).

(3) Bearing cap number 1, must be installed before the camshaft seals can be installed.

(4) Install timing belt, sprockets and covers. Refer to timing belt service outlined in this section.

(5) Install valve cover using procedure outlined in this section.

CAM FOLLOWER AND HYDRAULIC LASH ADJUSTER ASSEMBLY

REMOVAL

(1) Remove valve cover using procedure outlined in this section.

(2) Remove timing belt, sprockets and covers using procedure outlined in this section.

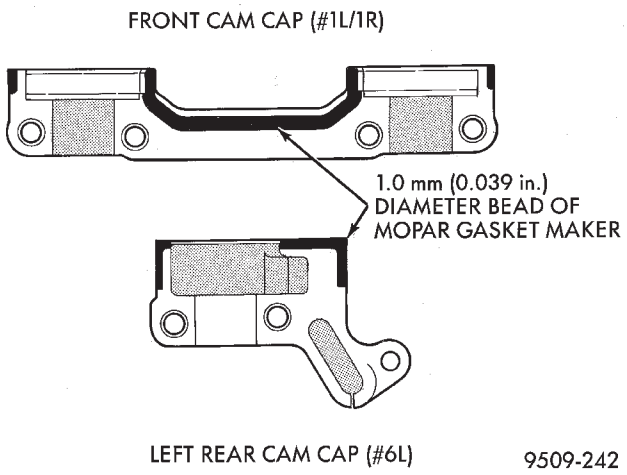


Fig. 26 Camshaft Bearing Cap Sealing

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

NOTE: Inspect the cam follower assembly for wear or damage (Fig. 27). Replace as necessary.

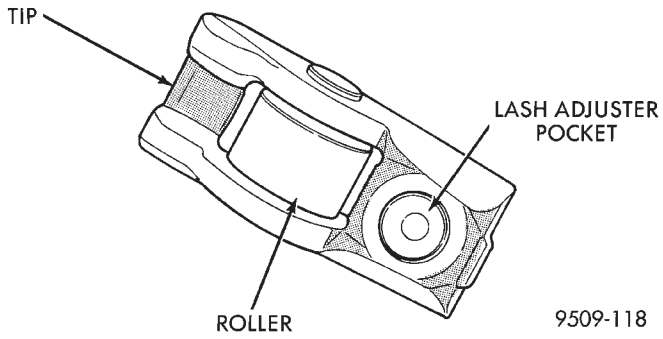


Fig. 27 Cam Follower Assembly

INSTALLATION

(1) Install 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 Lubricate with clean oil and install cam follower assemblies in their original position on the hydraulic adjuster and valve stem (Fig. 28).

(2) Install the camshafts. Refer to procedure previously outlined in this section.

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.

REMOVAL AND INSTALLATION (Continued)

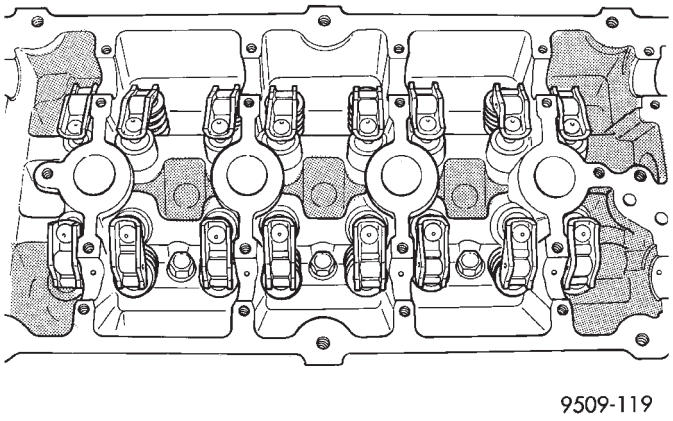


Fig. 28 Cam Follower Assemblies—Installation

Hydraulic Lash adjusters are replaced as an assembly and are not repaired.

VALVE SPRING AND SEALS—CYLINDER HEAD NOT REMOVED

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 MD998772A with adapter 6779 (Fig. 29) compress valve springs and remove valve locks.

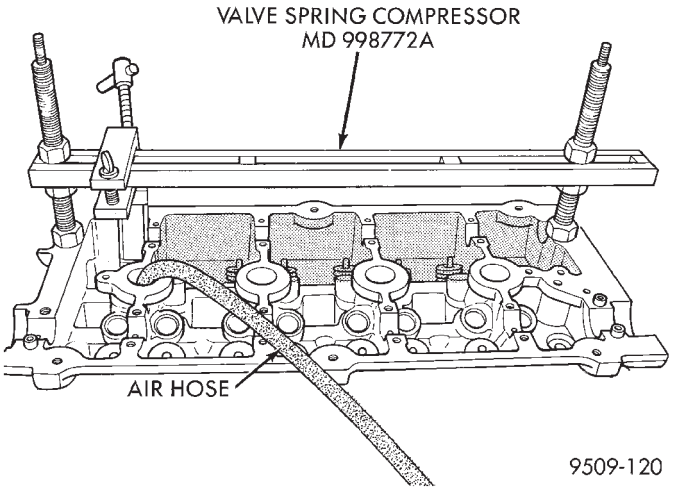


Fig. 29 Removing and Installing Valve Spring

(5) Remove valve spring.

(6) Remove valve stem seal by using a valve stem seal tool (Fig. 30).

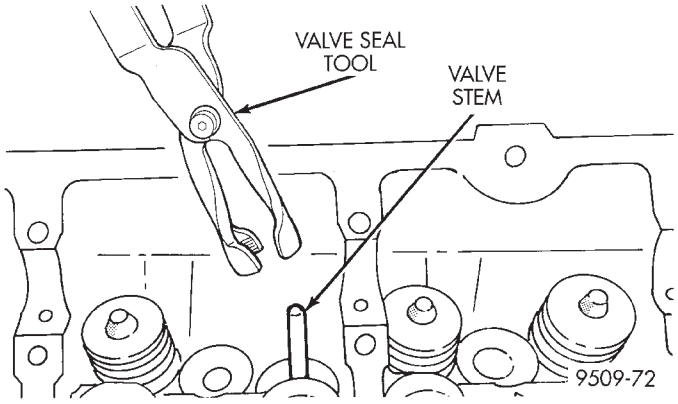


Fig. 30 Valve Stem Oil Seal Tool

INSTALLATION

(1) Install valve seal/valve spring seat assembly (Fig. 31) as outlined in the valve installation procedure in this section.

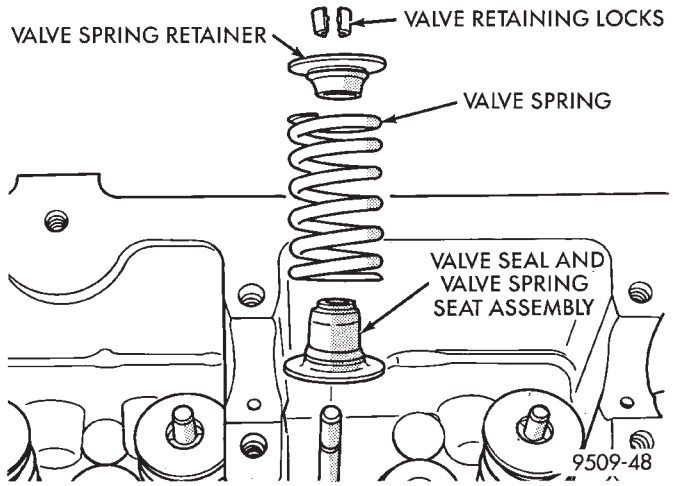


Fig. 31 Valve Stem Seal and Valve Spring Seat Assemblies

(2) Install valve spring and retainer. Using Special Tool MD998772A 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.

(3) Remove air hose and install spark plugs.

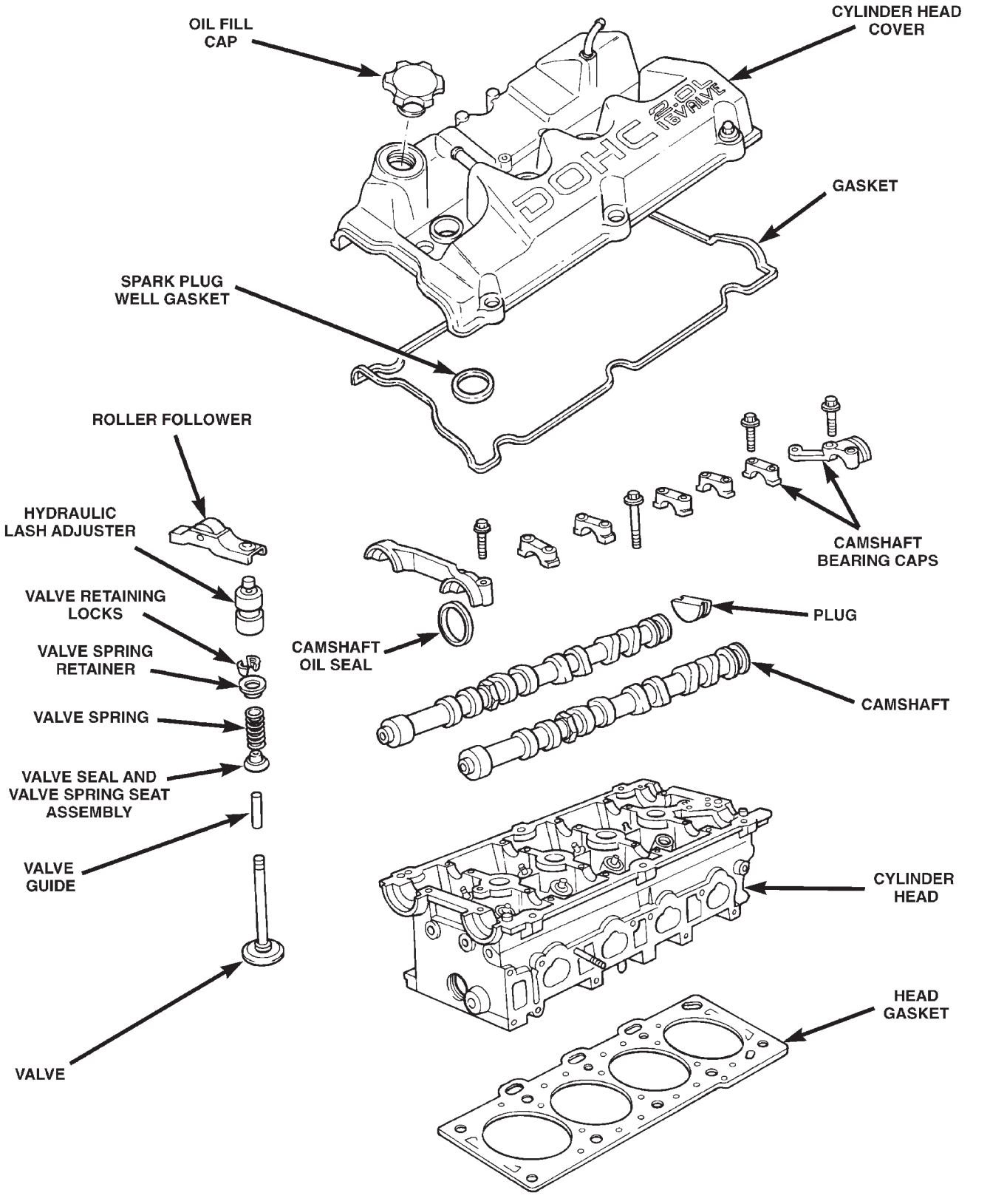
(4) Install camshafts as previously outlined in this section.

(5) Install valve cover as previously outlined in this section.

CYLINDER HEAD

Cylinder Head and Valve Assembly

REMOVAL AND INSTALLATION (Continued)



80500544

REMOVAL AND INSTALLATION (Continued)

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) Remove air cleaner duct and air cleaner, disconnect all vacuum lines, electrical wiring and fuel line from fuel rail and 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 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 cylinder head cover.

(13) Remove camshaft and cam follower assemblies. Refer to Camshaft Service for removal procedure outlined in this section.

(14) Remove cylinder head bolts.

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

CYLINDER HEAD FLATNESS

(1) Cylinder head must be flat within 0.1 mm (0.004 inch) (Fig. 32).

NOTE: Inspect camshaft bearing journals for scoring.

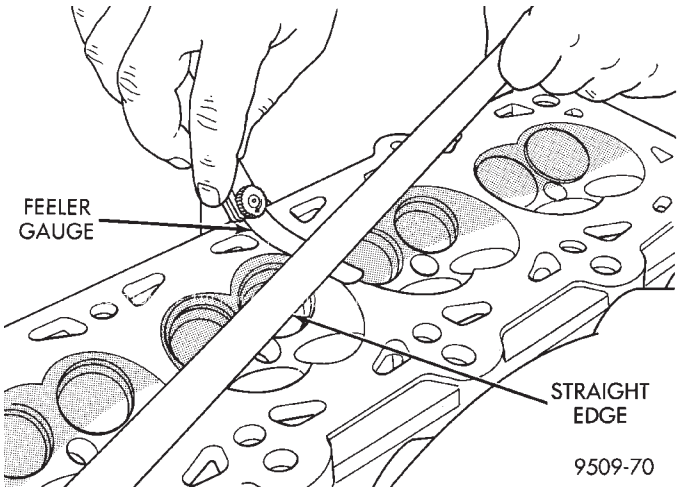


Fig. 32 Checking Cylinder Head Flatness

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. 33).

(2) Tighten the cylinder head bolts in this sequence shown in (Fig. 33). Follow the four step procedure listed below.

- First Bolts 1 thru 6 to 34 N·m (25 ft. lbs.) and Bolts 7 thru 10 to 28 N·m (20 ft. lbs.)
- Second Bolts 1 thru 6 to 68 N·m (50 ft. lbs.) and Bolts 7 thru 10 to 28 N·m (20 ft. lbs.)
- Third Bolts 1 thru 6 to 68 N·m (50 ft. lbs.) and Bolts 7 thru 10 to 28 N·m (20 ft. lbs.)
- Fourth Turn an additional 1/4 Turn, **Do not use a torque wrench for this step.**

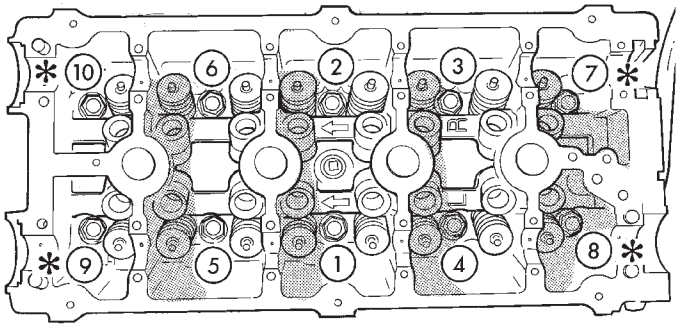


Fig. 33 Cylinder Head Tightening Sequence

REMOVAL AND INSTALLATION (Continued)

(3) Reverse removal procedure, for rest of installation.

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. 85).

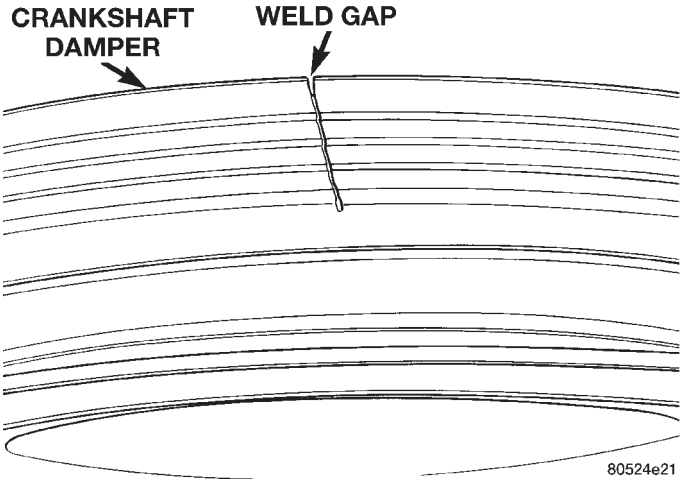


Fig. 34 Weld Gap

REMOVAL

(1) Remove accessory drive belts. Refer to Group 7, Cooling System for procedure outlined in that section.

(2) Raise vehicle on a hoist and remove right inner splash shield (Fig. 86).

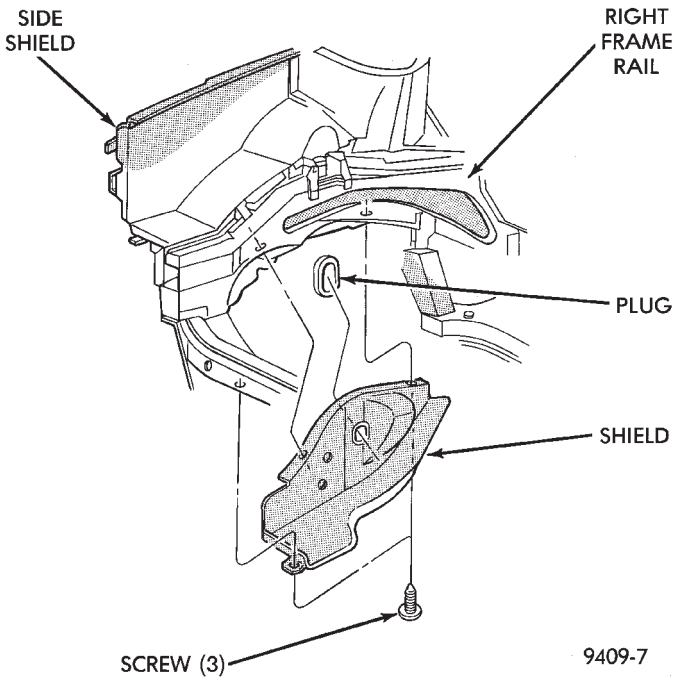


Fig. 35 Right Inner Splash Shield

(3) Remove crankshaft damper bolt. Remove damper using the large side of Special Tool 1026 and insert 6827–A (Fig. 87).

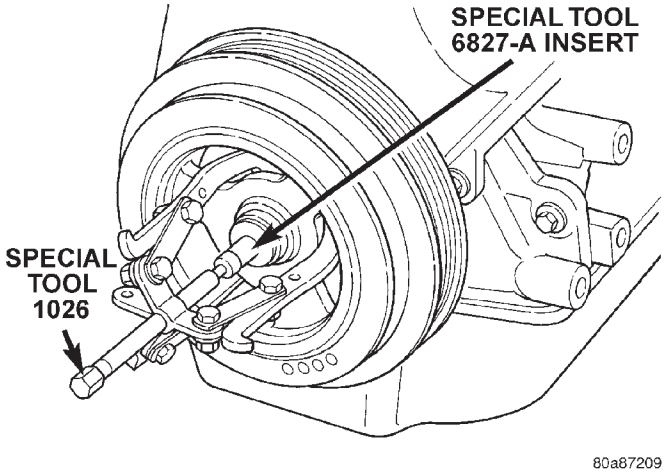


Fig. 36 Crankshaft Damper—Removal

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. 88).

(2) Install accessory drive belts. Refer to Group 7, Cooling System Accessory Drive section for procedure.

(3) Raise vehicle on hoist and install right inner splash shield.

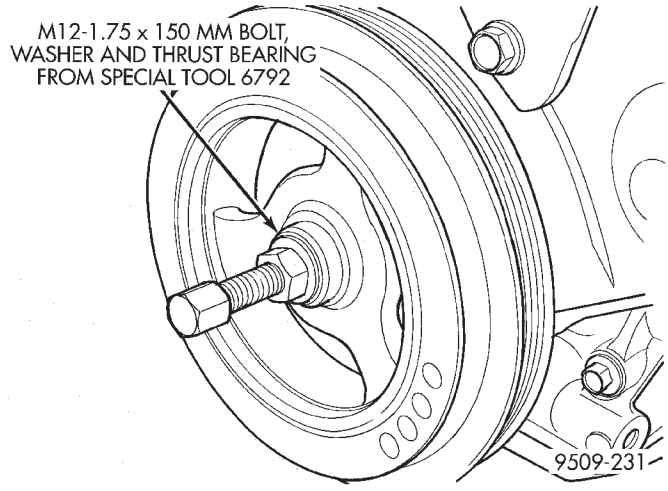


Fig. 37 Crankshaft Damper—Installation

REMOVAL AND INSTALLATION (Continued)

TIMING BELT COVER

REMOVAL

CAUTION: Camshaft or crankshaft should not be rotated after timing belt is removed. Damage to valve components may occur. Always align timing marks before removing timing belt.

(1) Remove accessory drive belts. Refer to Group 7, Cooling System for procedure outlined in that section.

(2) Raise vehicle on a hoist and remove right inner splash shield (Fig. 38).

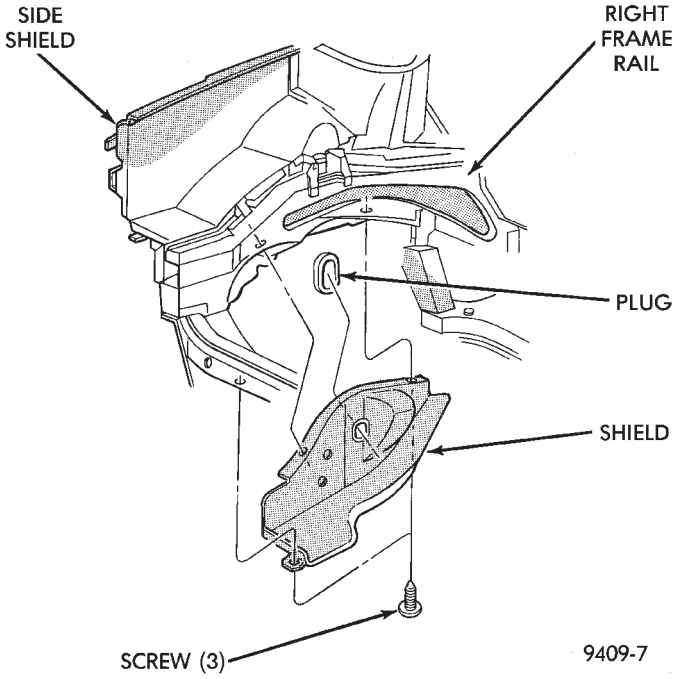


Fig. 38 Right Inner Splash Shield

(3) Remove crankshaft damper bolt. Remove damper using Special Tool 1026 and Insert 6827–A or equivalent (Fig. 39).

(4) Lower vehicle and place a jack under engine

(5) Remove right engine mount. Refer to procedure outlined in this section

(6) Remove right engine mount bracket (Fig. 40)

(7) Remove timing belt cover fasteners, remove cover (Fig. 40).

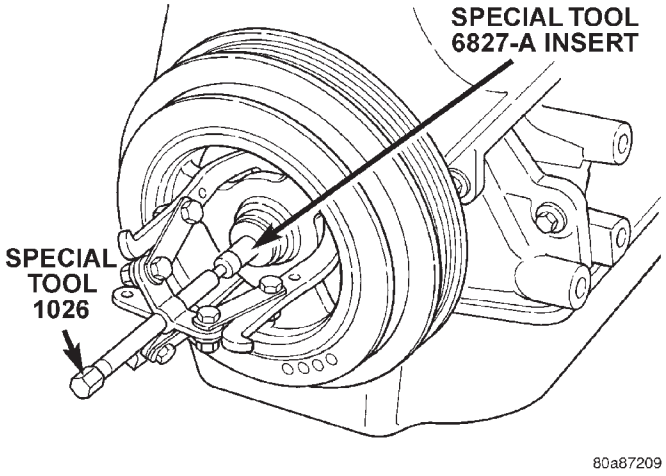


Fig. 39 Crankshaft Damper—Removal

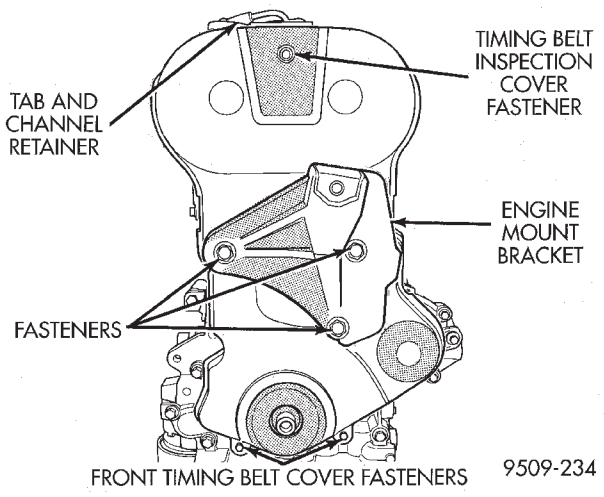


Fig. 40 Front Timing Belt Cover

INSTALLATION

(1) Install front timing cover.

(2) Install engine mount bracket.

(3) Install Right engine mount. Refer to procedure outlined in this section for installation.

(4) Remove jack from under engine.

(5) Install crankshaft vibration damper Refer to procedure outlined in this section for installation.

(6) Install accessory drive belts. Refer to Group 7, Cooling System, Accessory Drive section for procedure.

(7) Raise vehicle on hoist and install right inner splash shield.

REMOVAL AND INSTALLATION (Continued)

TIMING BELT

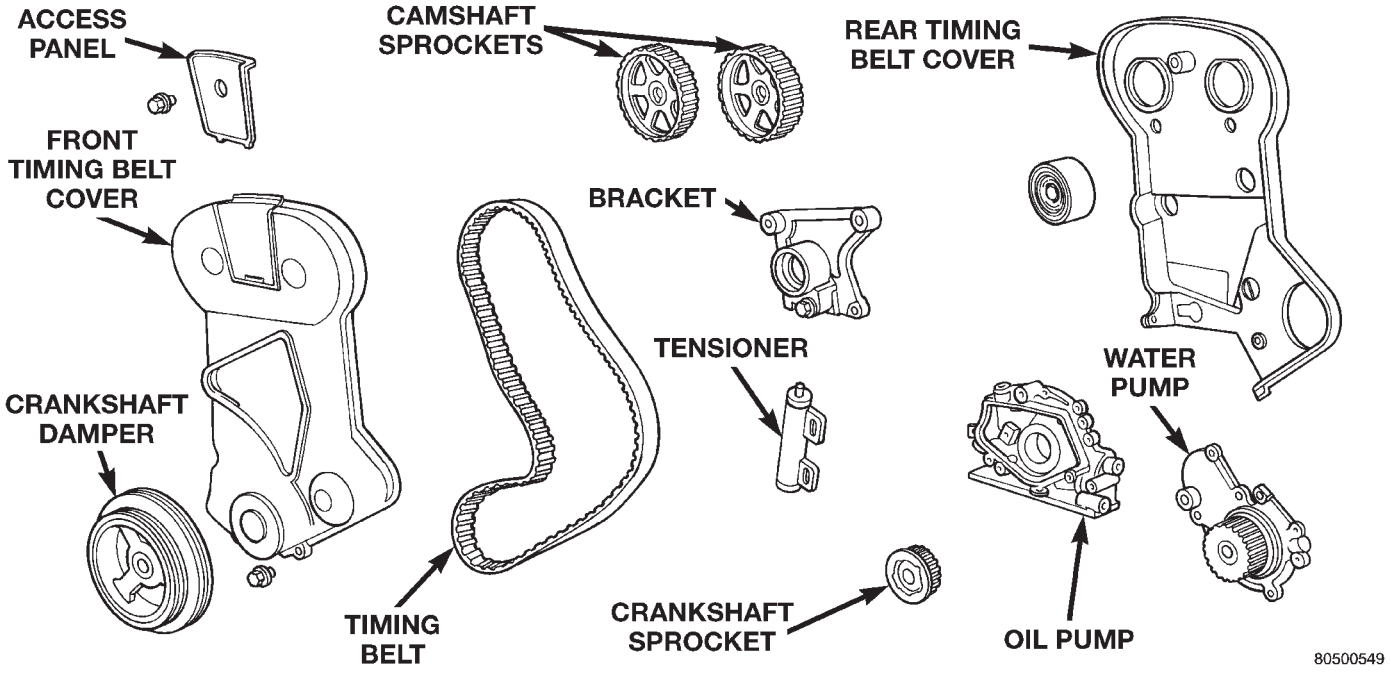


Fig. 41 Typical Timing Belt System—DOHC

CHECKING BELT TIMING —COVER INSTALLED

(1) Remove number one spark plug.

(2) Using a dial indicator, set number one cylinder to TDC on the compression stroke.

(3) Remove the timing belt access cover from the engine (Fig. 41).

(4) Check the timing marks on the camshaft sprockets, they should align with each other (Fig. 42).

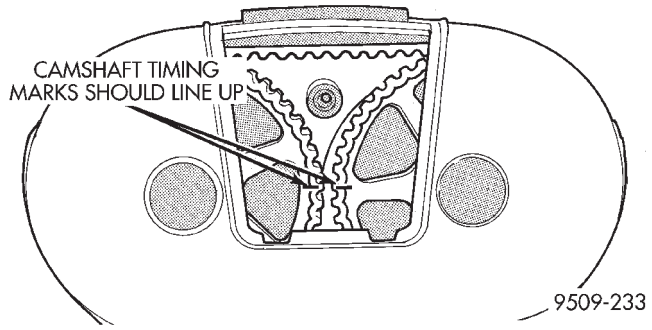


Fig. 42 Camshaft Timing Check

REMOVAL

CAUTION: Camshaft or crankshaft should not be rotate after timing belt is removed. Damage to valve components may occur. Always align timing marks before removing timing belt.

(1) Remove crankshaft damper bolt. Remove damper procedure outlined in this section.

(2) Remove engine mount bracket and timing belt cover fasteners, remove cover.

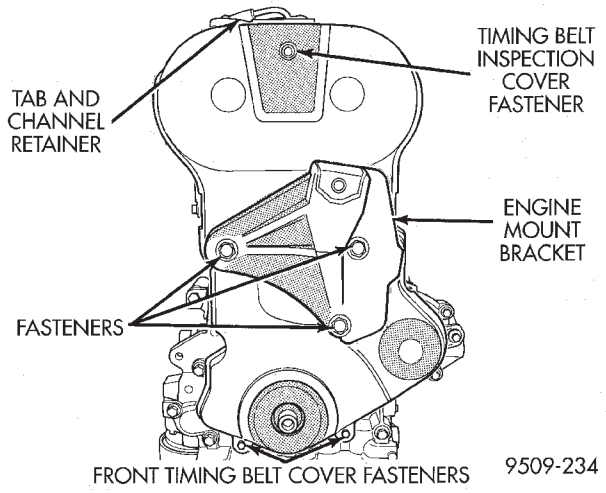


Fig. 43 Front Timing Belt Cover

REMOVAL AND INSTALLATION (Continued)

(3) Align camshaft timing marks. Loosen timing belt tensioner fasteners and remove timing belt.

CAUTION: Do not loosen, tighten, or remove the tensioner pivot bolt (Fig. 44).

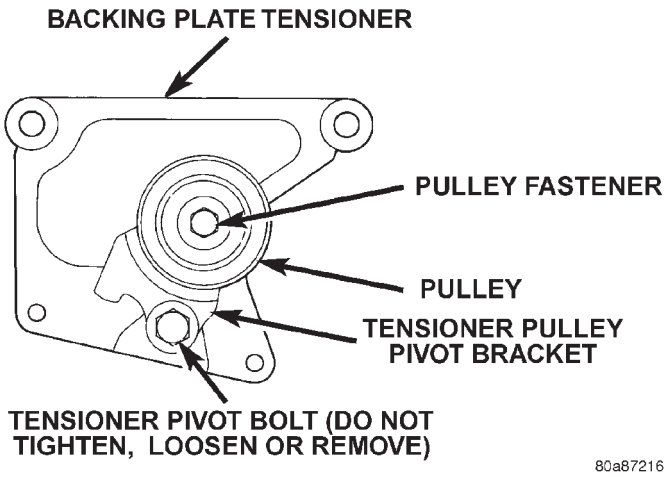


Fig. 44 Tensioner Pulley Assembly

CAMSHAFT AND CRANKSHAFT TIMING PROCEDURE AND BELT INSTALLATION —DOHC 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 and slowly compress the plunger (Fig. 45).

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 pin through the body and plunger to retain plunger in place until tensioner is installed.

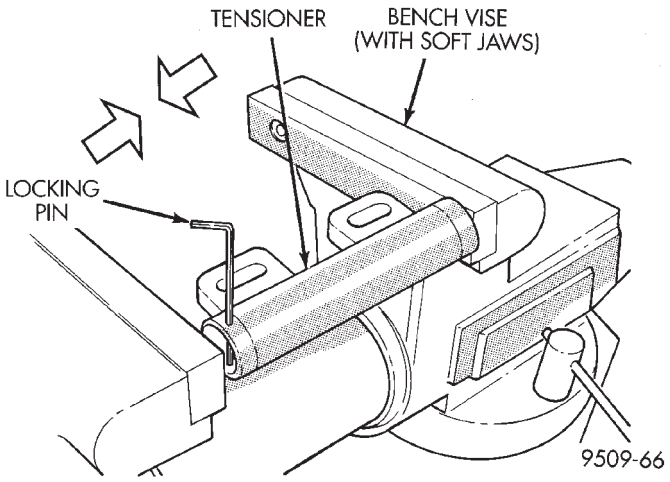


Fig. 45 Compressing Timing Belt Tensioner

(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. 46).

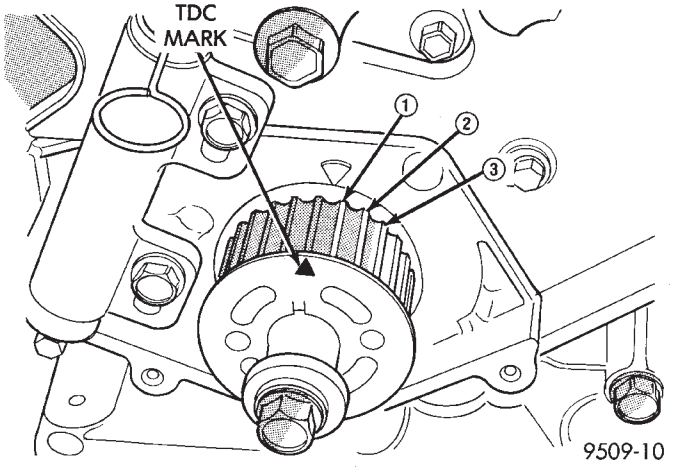


Fig. 46 Crankshaft Sprocket Timing

(5) Set camshafts timing marks together by aligning notches on sprockets (Fig. 47).

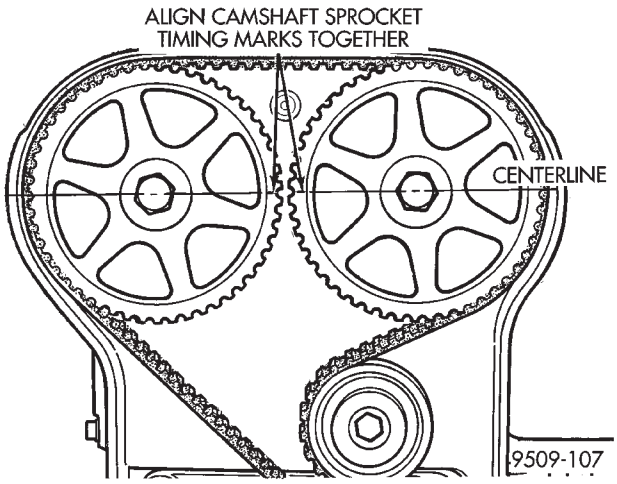


Fig. 47 Camshaft Timing Marks

(6) Rotate crankshaft 1/2 tooth counterclockwise from TDC (Fig. 48).

(7) Install timing belt in this direction. Starting at the crankshaft, go around the water pump sprocket, idler pulley, camshaft sprockets and then around the tensioner pulley (Fig. 49).

(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 to tensioner (Fig. 49).

(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.).

REMOVAL AND INSTALLATION (Continued)

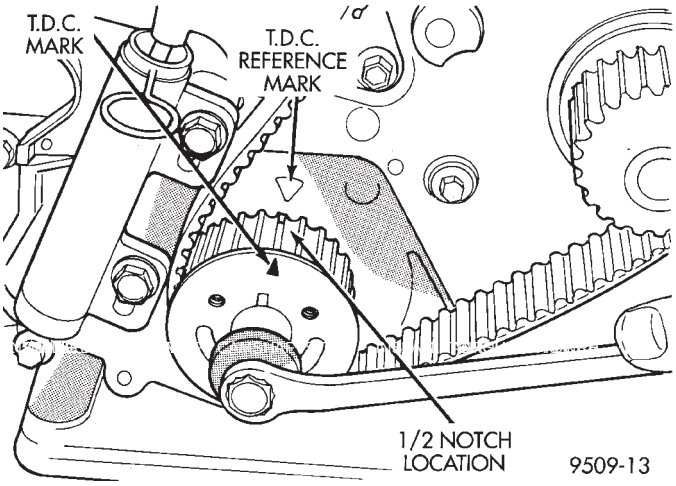


Fig. 48 Adjusting Crankshaft Sprocket for Timing Belt Installation

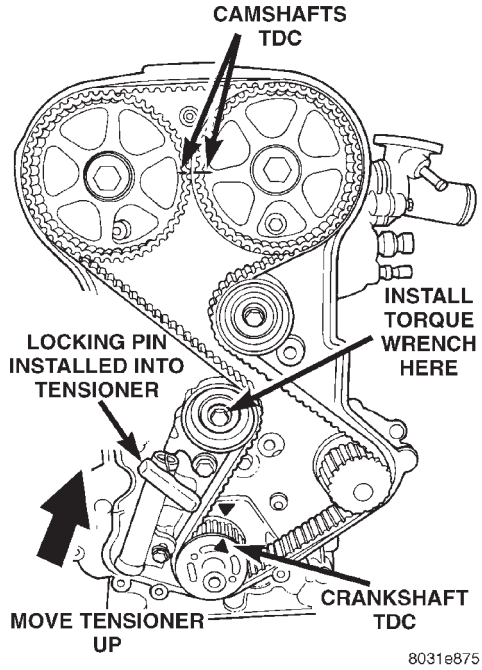


Fig. 49 Adjusting Timing Belt Tension

(11) Pull tensioner plunger pin. Pretension is correct when pin can be removed and installed freely.

(12) Rotate crankshaft 2 revolutions and check the alignment of the timing marks (Fig. 49).

(13) Install front half of timing cover.

(14) Install engine mount bracket.

(15) Install right engine mount. Refer to procedure outlined in this section.

(16) Remove jack from under engine.

(17) 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. 50).

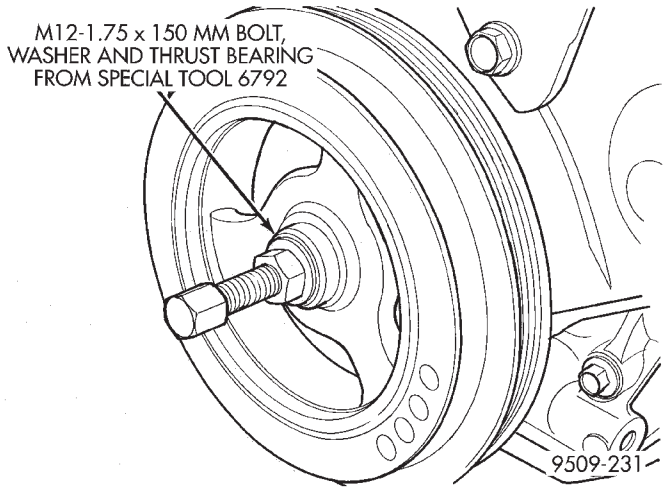


Fig. 50 Crankshaft Damper—Installation

(18) Install accessory drive belts. Refer to Group 7, Cooling System Accessory Drive section for procedure.

(19) Raise vehicle on hoist and install right inner splash shield.

(20) Perform camshaft and crankshaft timing relearn. Refer to Group 25, Emission Control Systems for procedure.

OIL PAN

REMOVAL

(1) Drain engine oil.

(2) Remove transmission bending bracket. Refer to Engine Support Module Removal and Installation in this section.

(3) Remove front engine mount and bracket. Refer to Engine Support Module Removal and Installation in this section.

(4) Remove transmission inspection cover.

(5) If equipped with air conditioning remove oil filter and adaptor. Refer to Oil Filter Adapter Removal and Installation in this section.

(6) Remove oil pan.

(7) 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. 55).

(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 transmission inspection cover.

(6) install front engine mount and bracket.

(7) Install transmission bending bracket.

REMOVAL AND INSTALLATION (Continued)

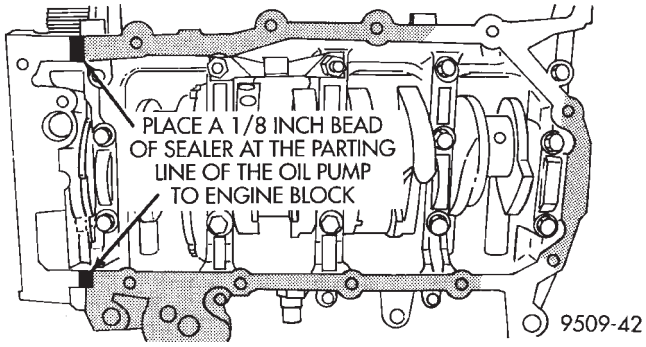


Fig. 51 Oil Pan Sealing

(8) Install proper amount of oil. With oil filter 4.25 Liters (4.5 Qts.). Without oil filter 3.8 Liters (4.0 Qts.)

CAMSHAFT OIL SEALS

REMOVAL

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

CAUTION: Before removing timing belt set crankshaft sprocket 3 notches before TDC, this will prevent possible engine damage (Fig. 52).

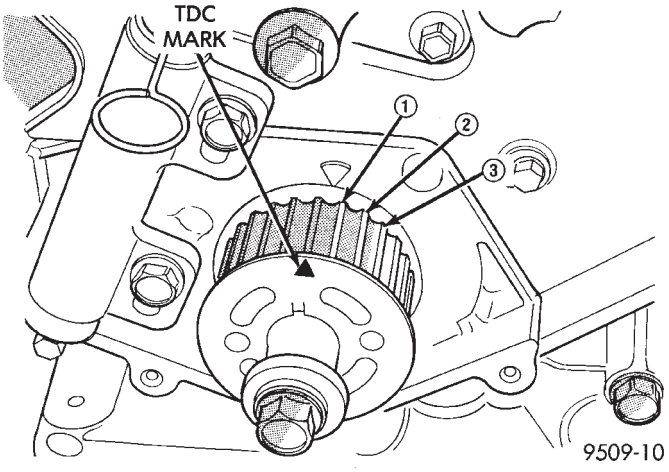


Fig. 52 Crankshaft Sprocket 3 Notches Before TDC

(2) Hold camshaft sprocket with Special Tool C-4687 with adaptor C4687–1 while removing / installing bolts (Fig. 53).

(3) Remove camshaft seal using a pry bar. Be careful not to nick or damage the camshaft seal surface or cylinder head seal retaining bore (Fig. 54).

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.

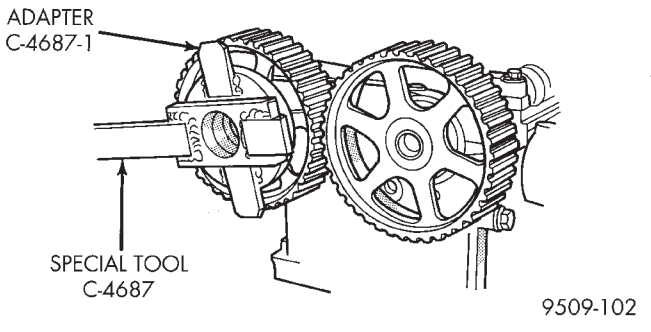


Fig. 53 Removing / Installing Camshaft Sprocket Bolt

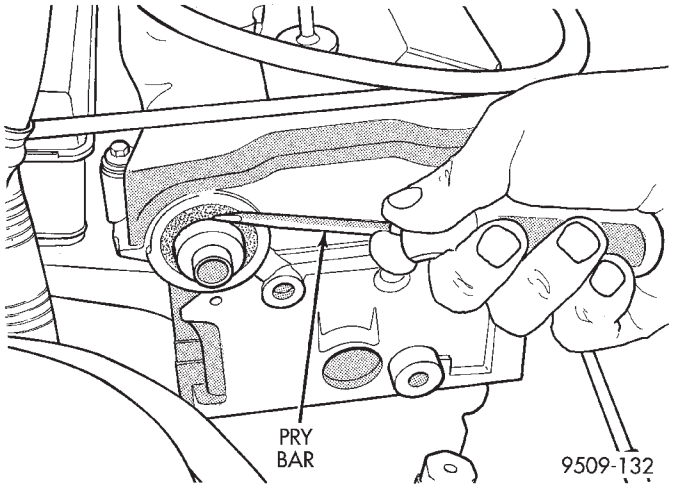


Fig. 54 Removing Camshaft Oil Seals

INSTALLATION

(1) Install camshaft seal into cylinder head using Special Tool MD 998713 until flush with the head (Fig. 55).

(2) Install camshaft sprockets and tighten attaching bolts to 101 N·m (75 ft. lbs.).

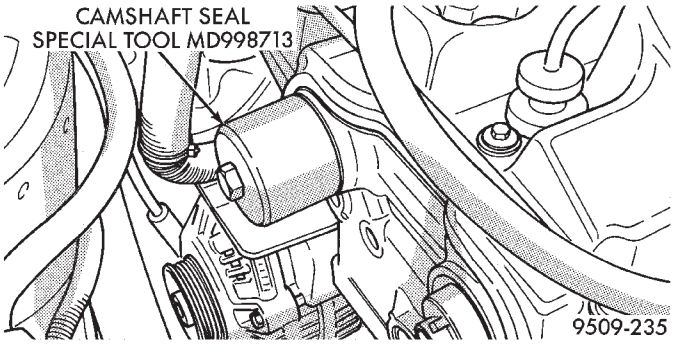


Fig. 55 Installing Camshaft Seals

REMOVAL AND INSTALLATION (Continued)

FRONT CRANKSHAFT OIL SEAL

REMOVAL

(1) Using Special Tool 1026 and Insert 6827–A, remove crankshaft damper (Fig. 56).

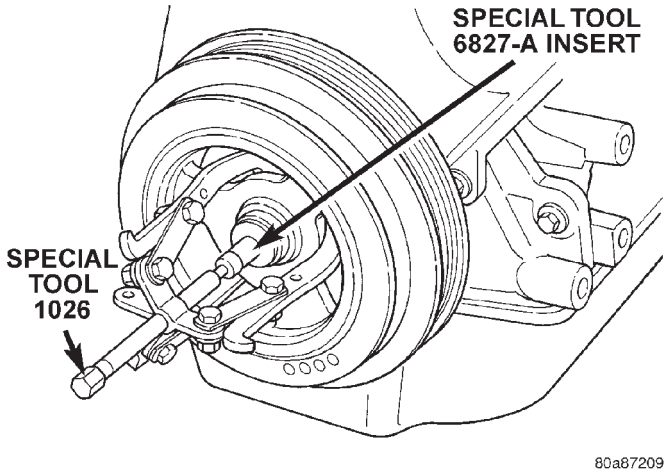


Fig. 56 Crankshaft Damper—Removal

(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. 57).

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

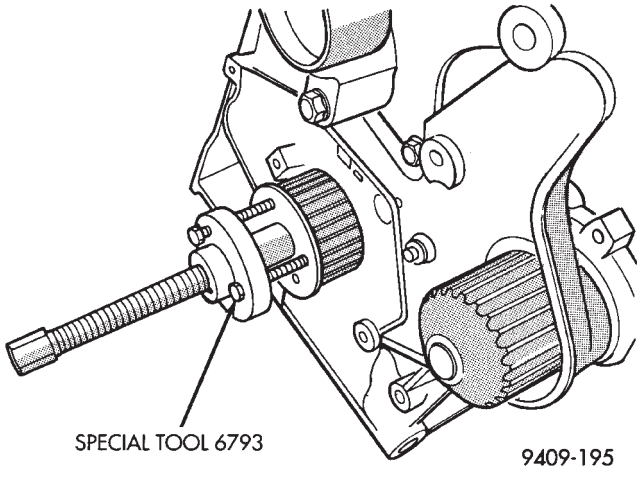


Fig. 57 Crankshaft Sprocket—Removal

(4) Using Tool 6771 to remove front crankshaft oil seal (Fig. 58). Do not damage the seal contact area on the crankshaft.

INSTALLATION

(1) Install new seal by using Tool 6780–1 (Fig. 59).

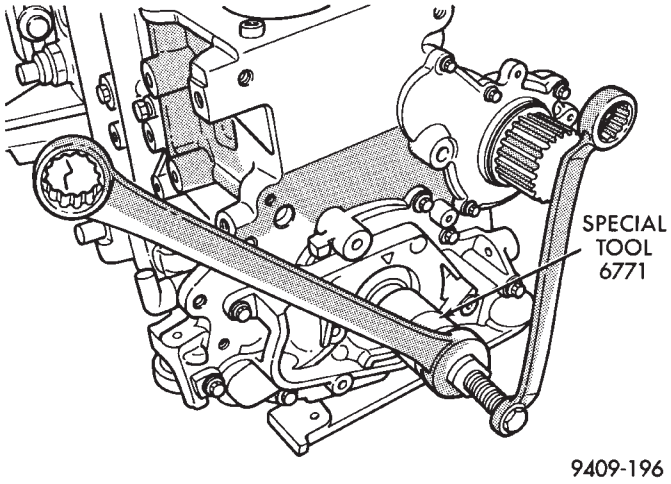


Fig. 58 Front Crankshaft Oil Seal—Removal

(2) Place seal into opening with seal spring towards the inside of engine. Install seal until flush with cover.

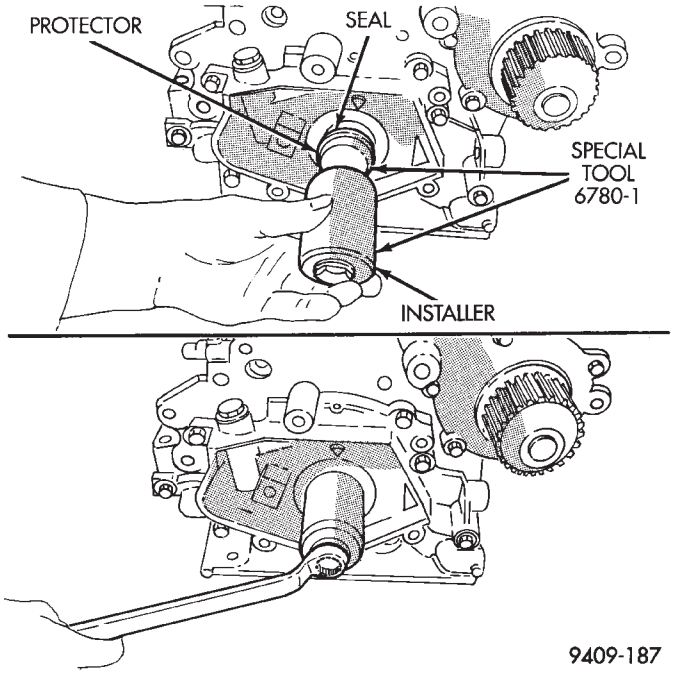


Fig. 59 Front Crankshaft Oil Seal—Installation

(3) Install crankshaft sprocket (Fig. 60). 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.

(5) Install crankshaft damper (Fig. 61). 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.)

REMOVAL AND INSTALLATION (Continued)

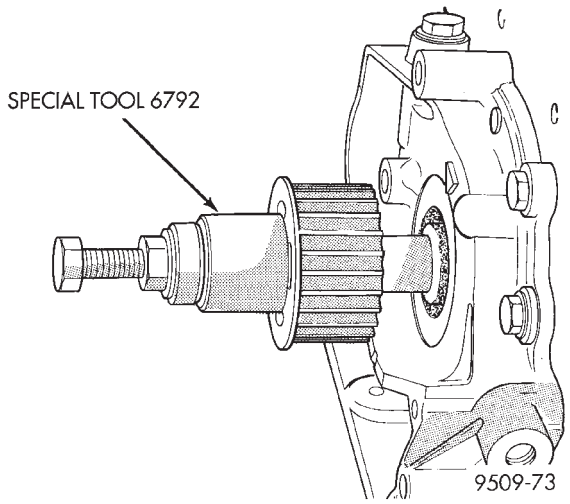


Fig. 60 Crankshaft Sprocket—Installation

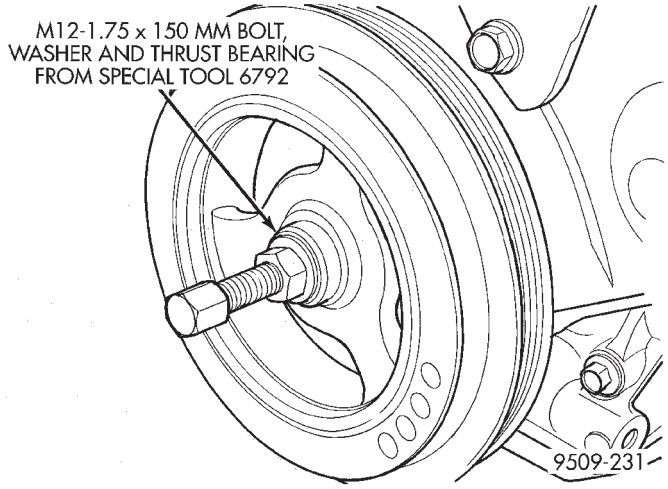


Fig. 61 Crankshaft Damper—Installation

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. 62) 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.

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. 63).

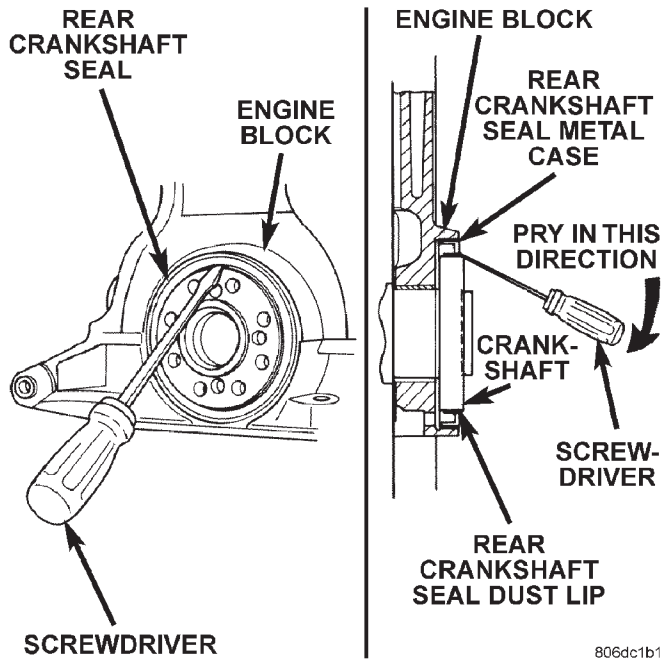


Fig. 62 Rear Crankshaft Oil Seal—Removal

(2) Position seal over pilot tool. Make sure you can read the words **THIS SIDE OUT** on seal (Fig. 63). 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. 64) until the tool bottoms out against the block (Fig. 65).

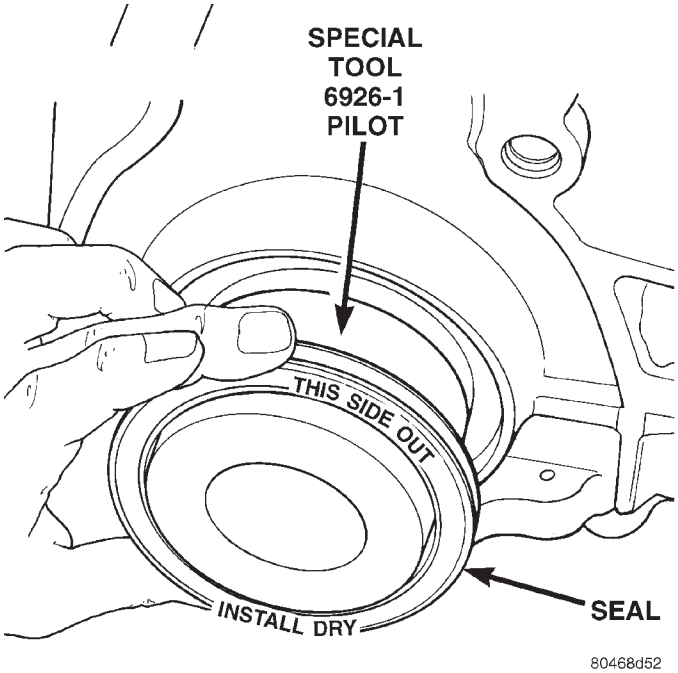


Fig. 63 Rear Crankshaft Seal and Special Tool 6926-1

REMOVAL AND INSTALLATION (Continued)

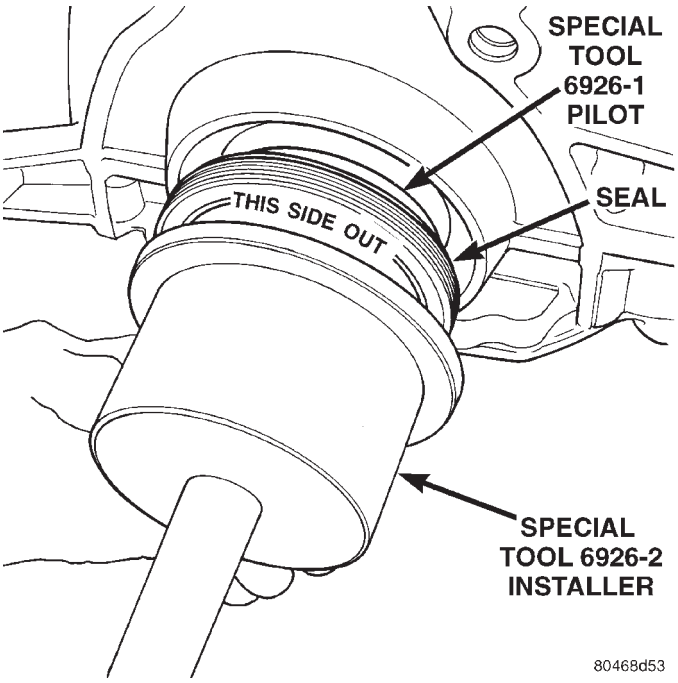


Fig. 64 Crankshaft Seal Special Tool 6926-2

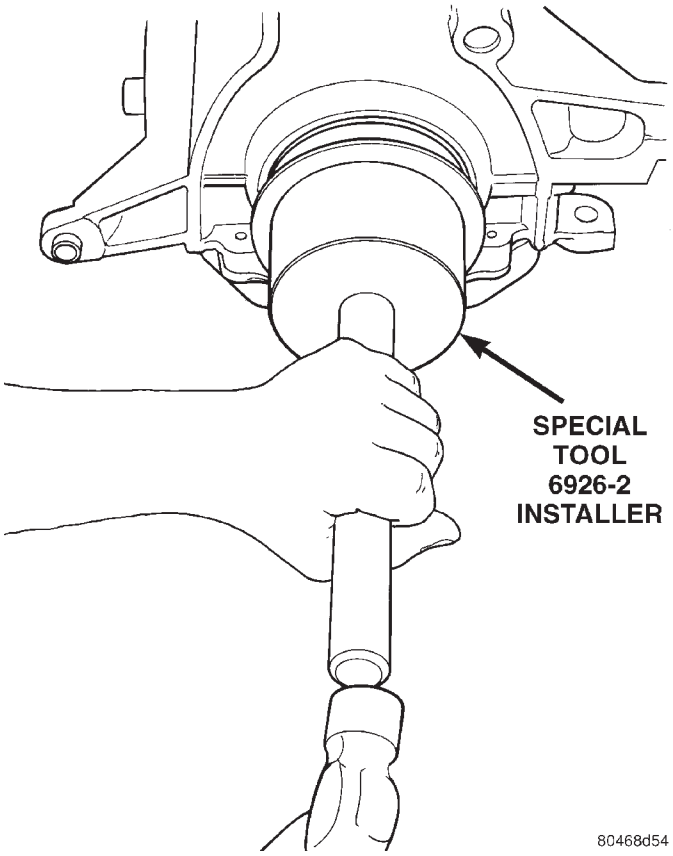
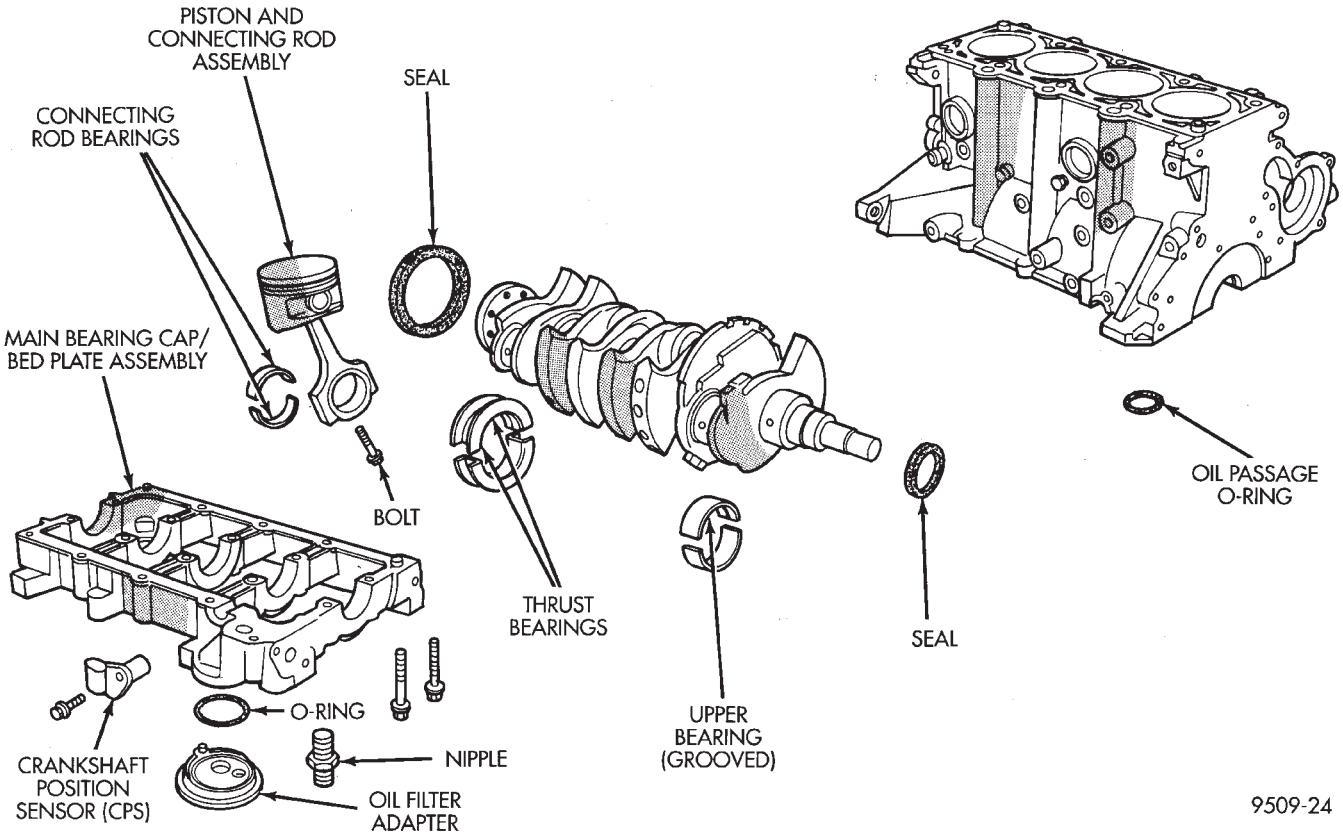


Fig. 65 Rear Crankshaft Seal—Installation

REMOVAL AND INSTALLATION (Continued)

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. 66).

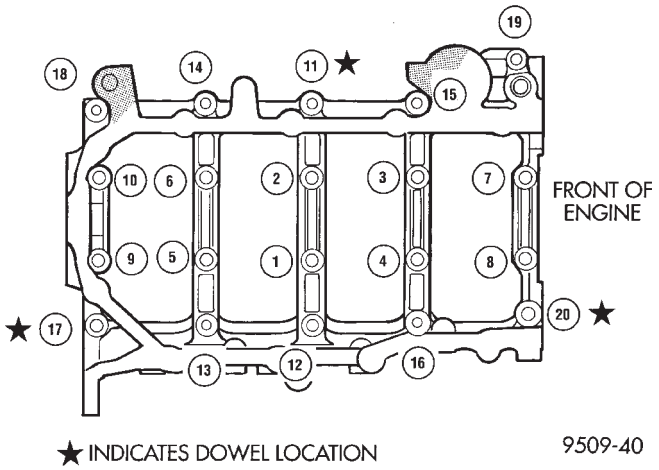


Fig. 66 Bedplate Bolts

(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.

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

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 (bedplate) main bearing cap are plain. Crankshaft end play is controlled by a flanged bearing on the number three main bearing journal (Fig. 67).

NOTE: The upper and lower main Bearing shells are Not interchangeable. The lower shells have a revised tab to prevent improper installation.

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

REMOVAL AND INSTALLATION (Continued)

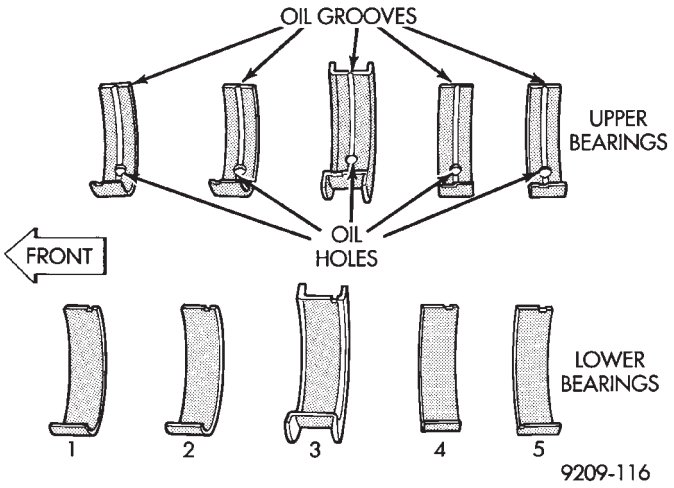


Fig. 67 Main Bearing Identification

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.

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. 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 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. 68).

(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.

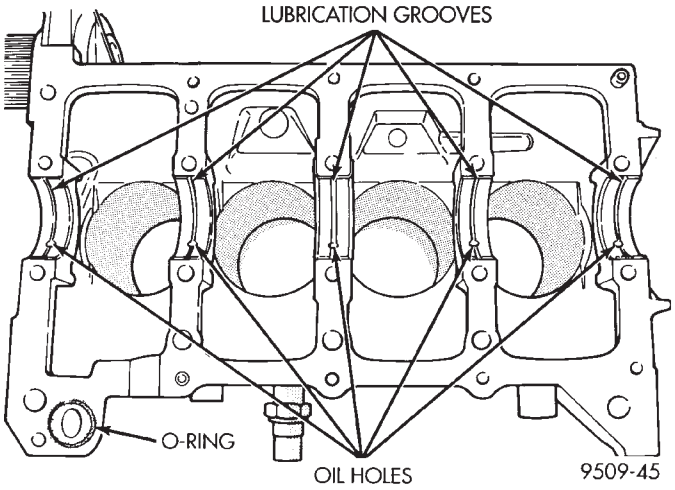


Fig. 68 Installing Main Bearing Upper Shell

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. 69).

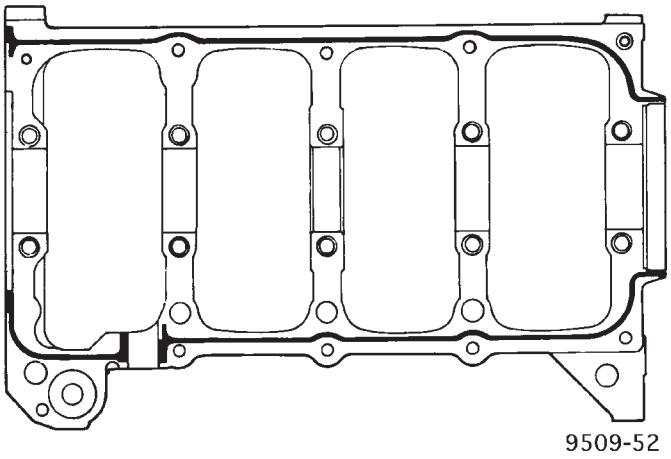


Fig. 69 Main Bearing Caps/Bedplate Sealing

(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 this bolts down together until the bedplate contacts the cylinder block. Torque bolts to 30 N·m (22 ft. lbs.) (Fig. 70).

(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. 70).

REMOVAL AND INSTALLATION (Continued)

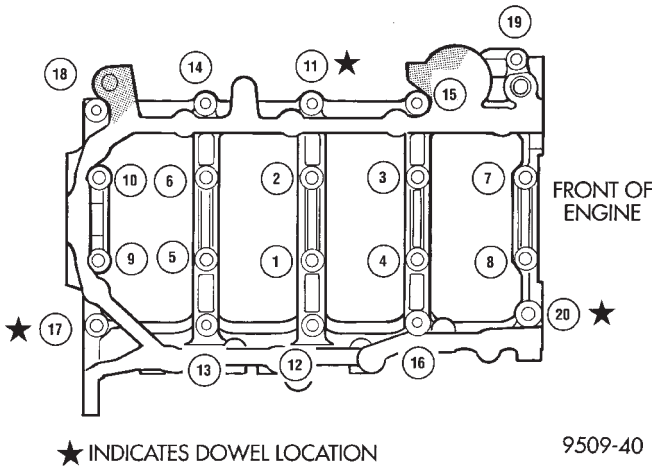


Fig. 70 Main Bearing Caps/Bedplate Torque Sequence

(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. 70).

(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.).

(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. 71).

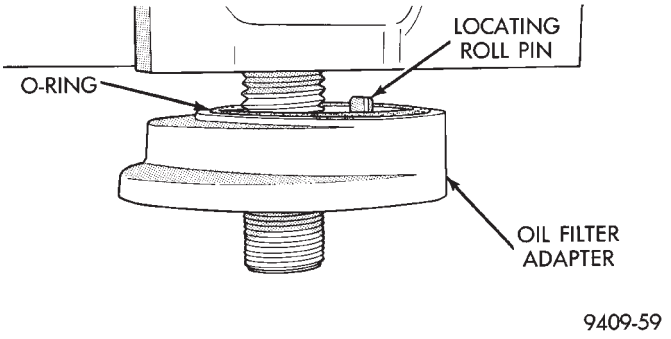


Fig. 71 Engine Oil Filter Adapter to Engine Block

OIL FILTER

REMOVE AND INSTALL

CAUTION: When servicing the oil filter (Fig. 72) 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.).

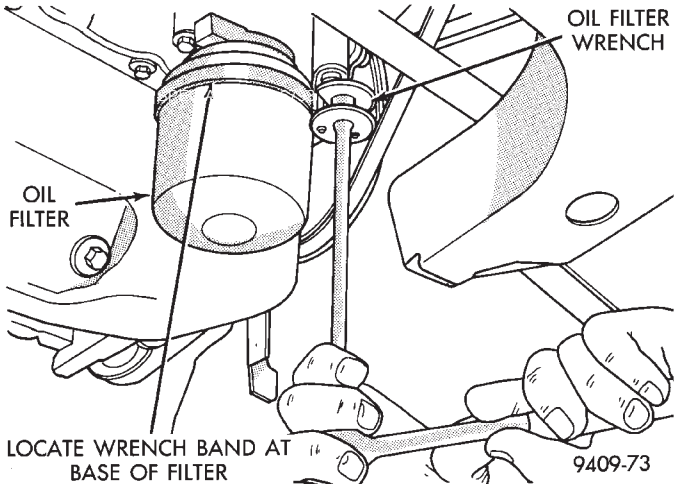


Fig. 72 Engine Oil Filter

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. 73).

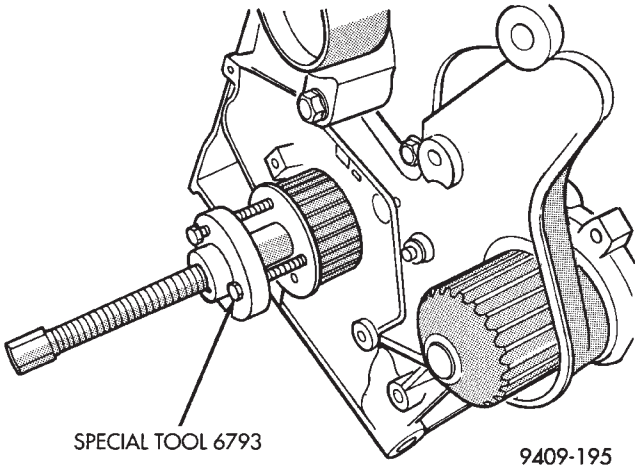


Fig. 73 Crankshaft Sprocket—Removal

(5) Remove oil pick-up tube.

REMOVAL AND INSTALLATION (Continued)

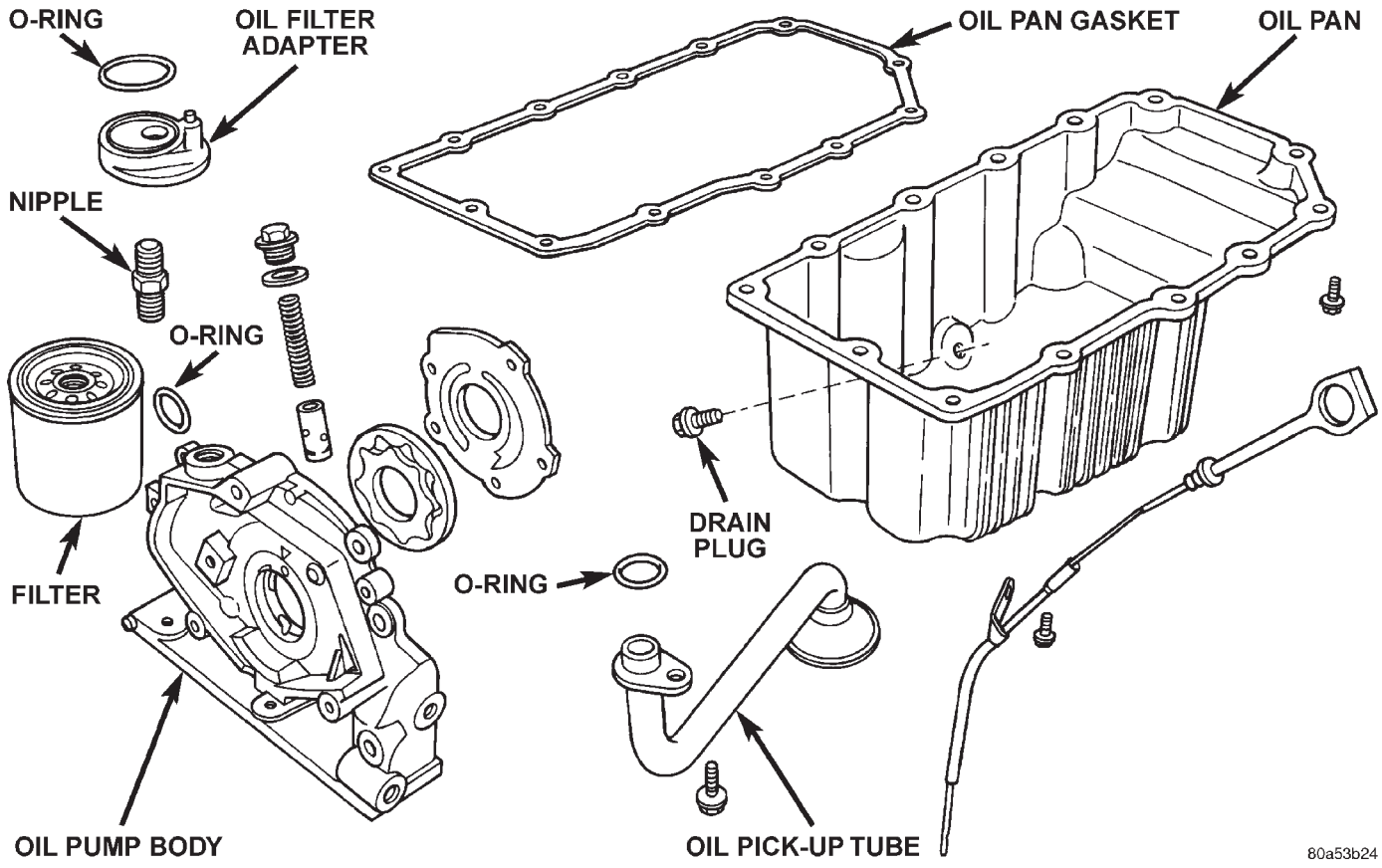


Fig. 74 Oil Pump and Tube

(6) Remove oil pump, (Fig. 74) 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. 75). Install oil ring into oil pump body discharge passage.

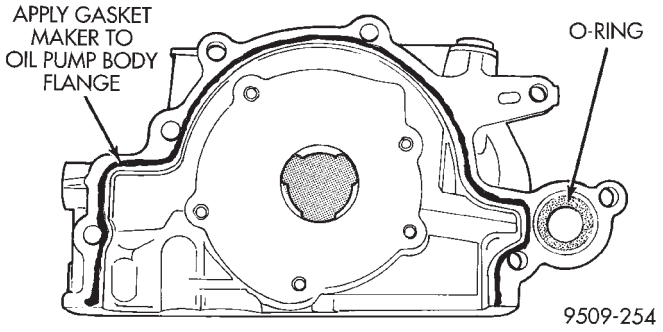


Fig. 75 Oil Pump Sealing

(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. 76).

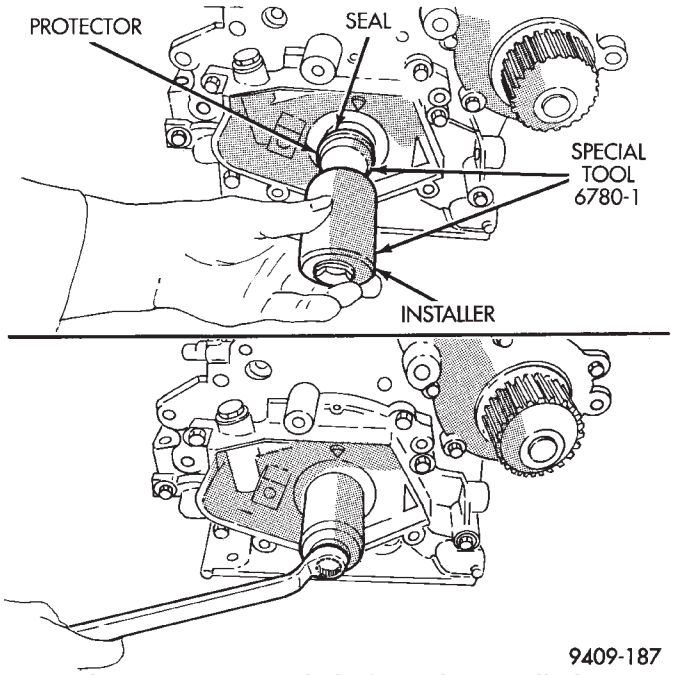


Fig. 76 Front Crankshaft Seal—Installation

REMOVAL AND INSTALLATION (Continued)

(7) Install crankshaft sprocket, using Special Tool 6792 (Fig. 77).

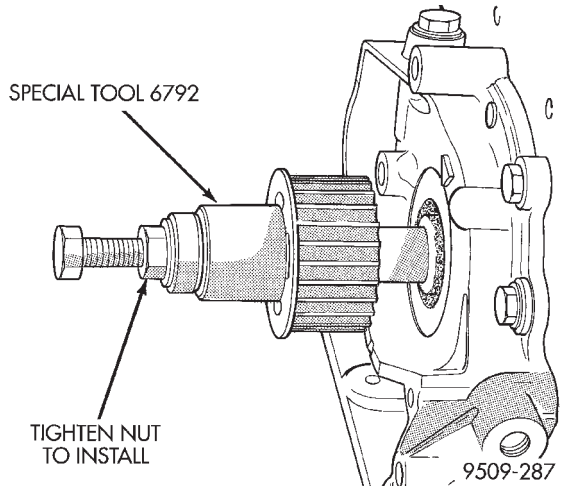


Fig. 77 Crankshaft Sprocket—Installation

(8) Install oil pump pick-up tube and oil pan.

(9) Install Timing Belt. Refer to Timing Belt Installation in this section.

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. 78).

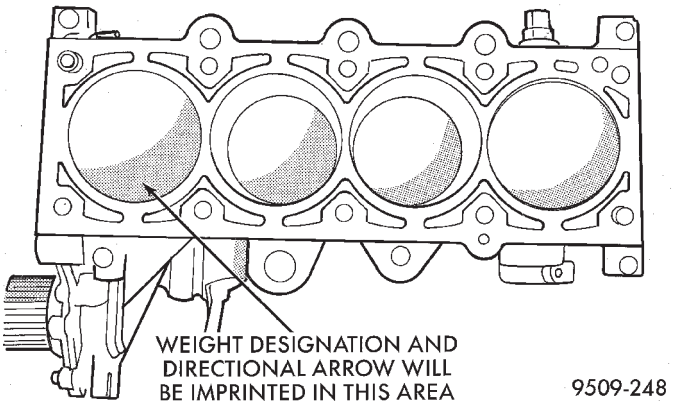


Fig. 78 Piston Markings

(2) Remove oil pan. Scribe the cylinder number on the side of the rod and cap (Fig. 79) for identification.

(3) Pistons will have a stamping in the approximate location shown in (Fig. 78). These stamps will be either a directional arrow or a weight identification for the assembly. L is for light and H is for 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 production assemblies. The weight designation stamps should face toward the timing belt side of the engine.

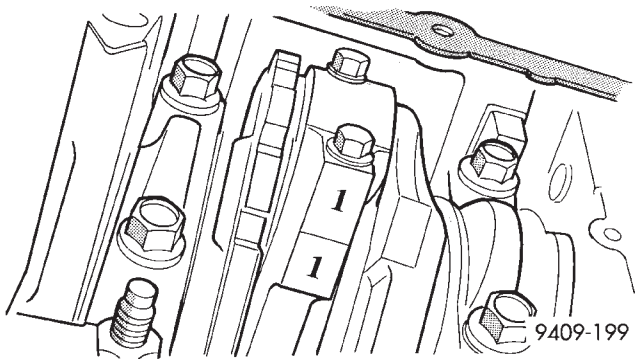


Fig. 79 Identify Connecting Rod to Cylinder

(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. 80).

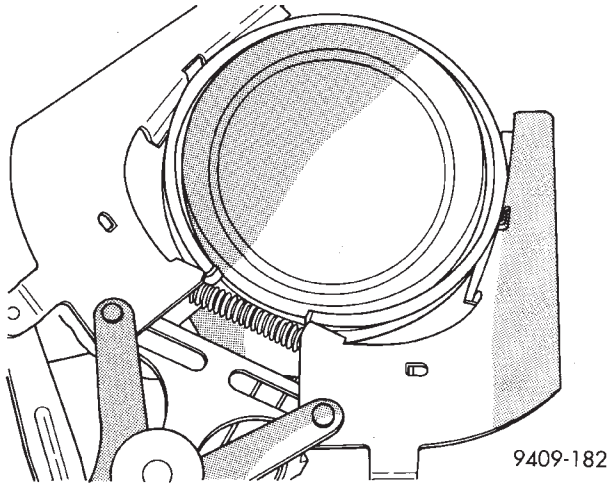


Fig. 80 Piston Rings—Removing and Installing

(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.

REMOVAL AND INSTALLATION (Continued)

PISTON RINGS—INSTALLATION

(1) Install rings with manufacturers I.D. mark facing up, to the top of the piston (Fig. 81).

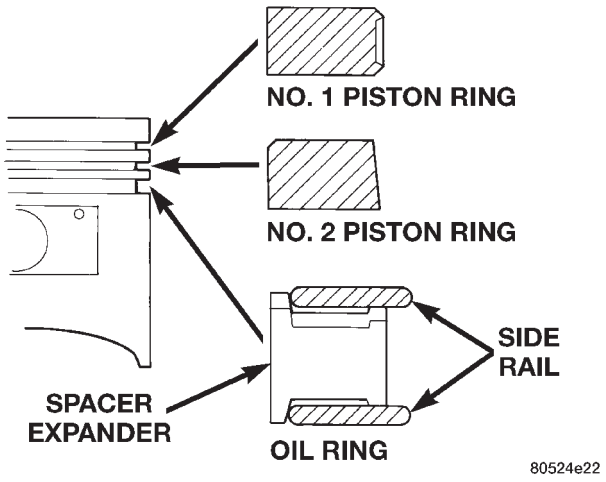


Fig. 81 Piston Ring Installation

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.
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. 82).**

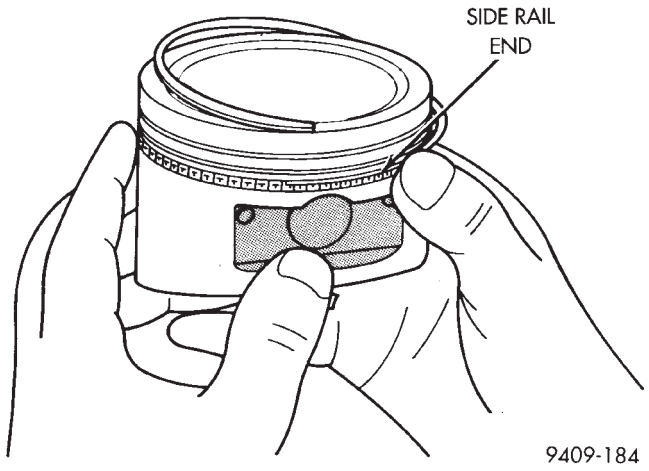


Fig. 82 Installing Side Rail

(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. 81).

(4) Position piston ring end gaps as shown in (Fig. 83).

(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.

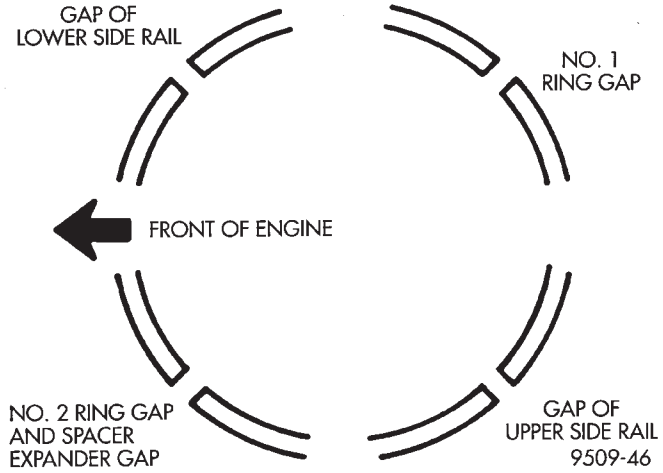


Fig. 83 Piston Ring End Gap Position

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. 83).

(3) Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston (Fig. 84). **Be sure position of rings does not change during this operation** .

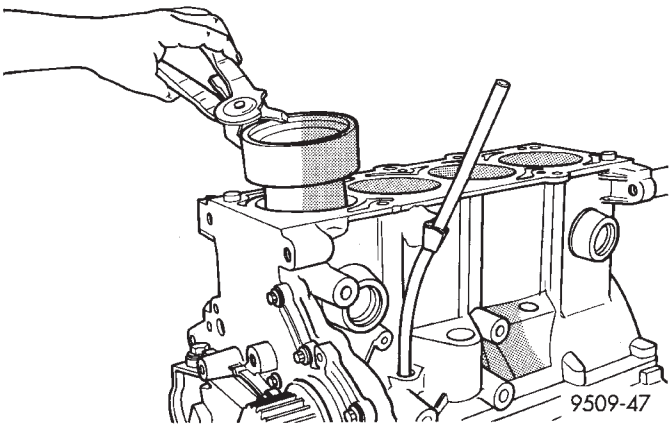


Fig. 84 Installing Piston

(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

REMOVAL AND INSTALLATION (Continued)

should face toward the front of the engine for DOHC engine (Fig. 78).

(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.

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. 89).

CAUTION: Oil pump pressure relief valve must be installed as shown in (Fig. 89) or serious damage may occur.

(3) Remove spring and relief valve (Fig. 89).

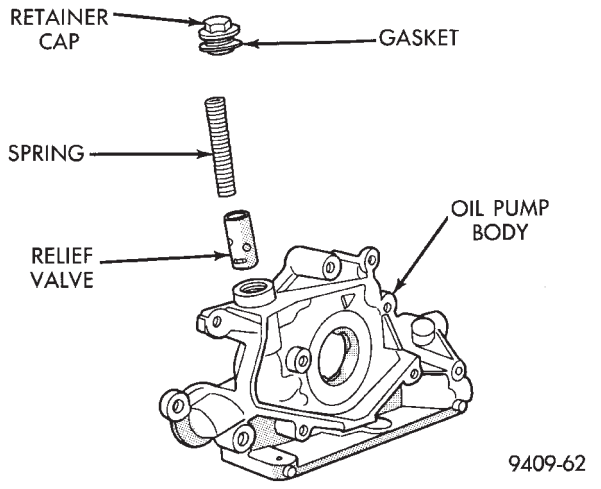


Fig. 85 Oil Pressure Relief Valve

(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. 90).

VALVE SERVICE WITH CYLINDER HEAD REMOVED

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.

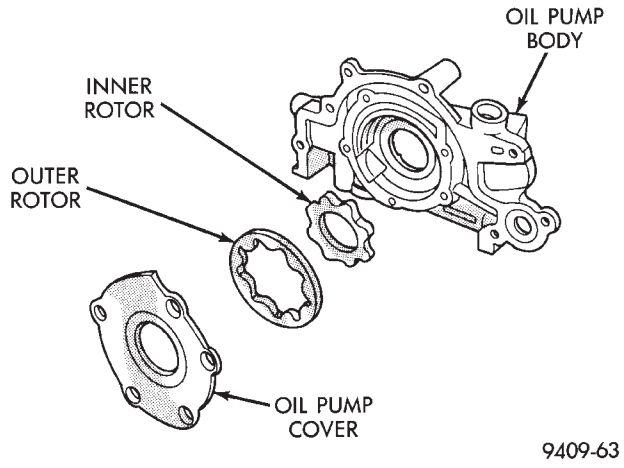


Fig. 86 Oil Pump

(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 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. 87). Refer to (Fig. 88) for specifications. Replace guides if they are not within specification.

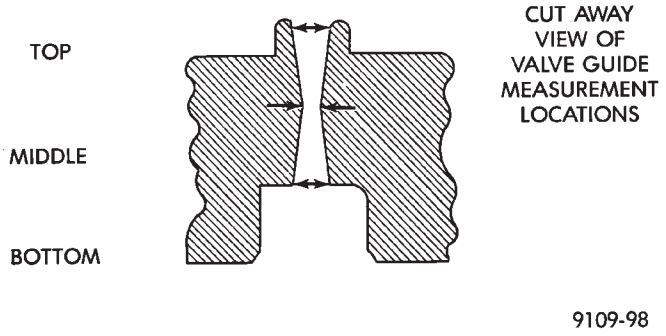


Fig. 87 Checking Wear on Valve Guide—Typical

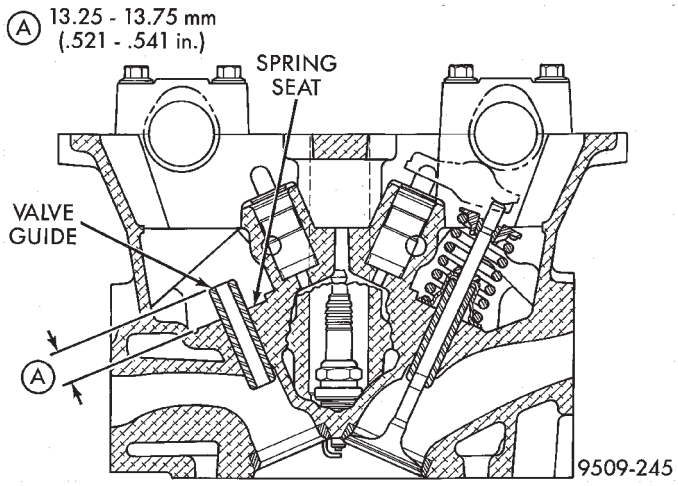
Valve Guide Diameter	Intake Valve	Exhaust Valve
	5.975 - 6.000 mm (0.2352 - 0.2362 in.)	5.975 - 6.000 mm (0.2352 - 0.2362 in.)
Clearance	**New**	**Service Limit**
Intake	0.023 - 0.066 mm (0.001 - 0.0025 in.)	0.25 mm (0.010 in.)
Exhaust	0.051 - 0.094 mm (0.002 - 0.0037 in.)	

9509-244

Fig. 88 Valve Guide Specification

DISASSEMBLY AND ASSEMBLY (Continued)

CHECK VALVE GUIDE HEIGTH



Valve Guide Heigth

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. 89). 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— 58 ft. lbs. @ 38.0 mm (1.50 in.)
- Valve Open Nominal Tension— 130 ft. lbs. @ 29.25 mm (1.17 in.)

(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 and a 45 1/2 degree angles.

(2) Inspect the remaining margin after the valves are refaced (Fig. 91). 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 the reseating stones. A true and complete surface must be obtained.

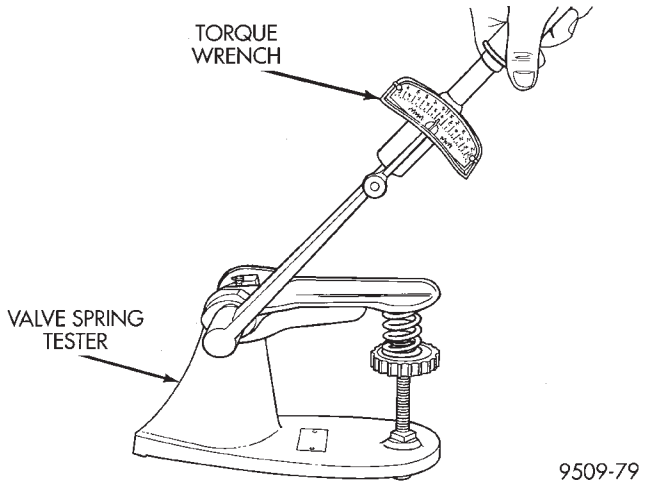


Fig. 89 Testing Valve Spring

(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 34.37 - 34.63 mm (1.353 - 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. 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. Refer to (Fig. 90) for valve specifications.

(7) When seat is properly positioned the width of intake and exhaust seats should be 0.90 to 1.30 mm (0.035 to 0.051 inch.) (Fig. 92).

(8) Check valve tip height dimensions A after grinding the valve seats or faces (Fig. 93). 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 (Fig. 93). The valve tip chamfer may need to be reground to prevent seal damage when the valve is installed.

DISASSEMBLY AND ASSEMBLY (Continued)

Face Angle	
Intake and Exhaust	45 - 44 1/2°
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	111.49 - 111.99 mm (4.389 - 4.409 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.)

9509-246

Fig. 90 Valve Specifications

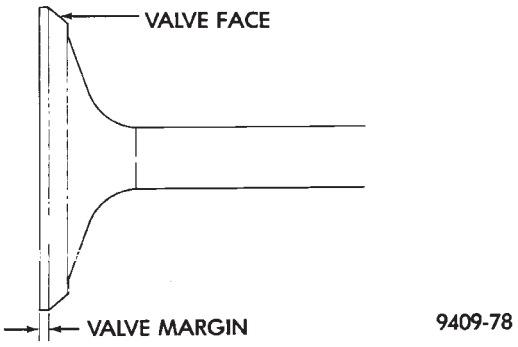
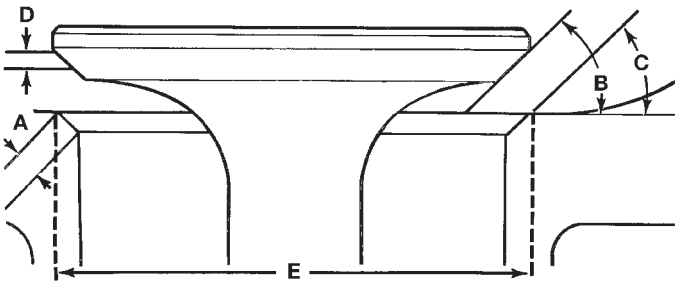


Fig. 91 Refacing Intake and Exhaust Valves



A – SEAT WIDTH (INTAKE AND EXHAUST 0.90 TO 1.30 MM (0.035 TO 0.051 IN.)
B – FACE ANGLE (INTAKE & EXHAUST: 44 1/2°-45°)
C – SEAT ANGLE (INTAKE & EXHAUST: 45°-45 1/2°)
D – SEAT CONTACT AREA
E – SEAT DIAMETER

80524e30

Fig. 92 Refacing Valve Seats

VALVE INSTALLATION

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

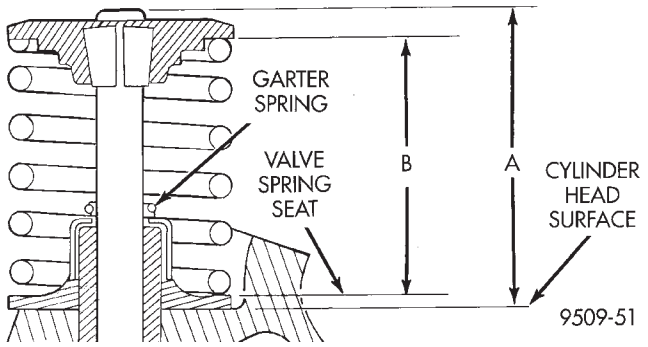


Fig. 93 Checking Spring Installed Height and Valve Tip Height Dimensions

(2) Install new valve stem seals on all valves using a valve stem seal tool (Fig. 94). 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.

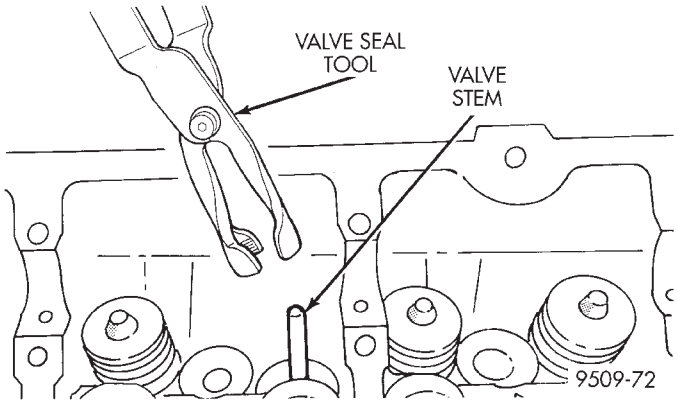


Fig. 94 Valve Stem Oil Seal Tool

(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. 93). 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 7.620 mm (0.030 inch.) spacer under the valve spring seat to bring spring height back within specification.

DISASSEMBLY AND ASSEMBLY (Continued)

(5) Install cam followers and camshaft 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 or adjusters 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. 100).

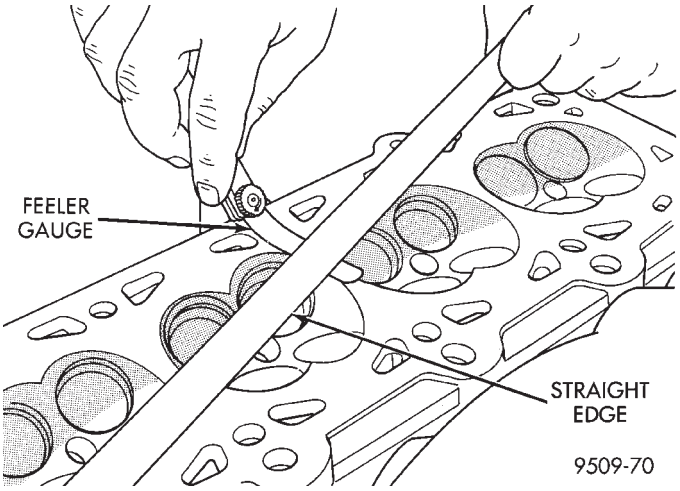


Fig. 95 Checking Cylinder Head Flatness

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.

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. 101). If a 0.076 mm (0.003 inch.) feeler gauge can be inserted between cover and straight edge, cover should be replaced.

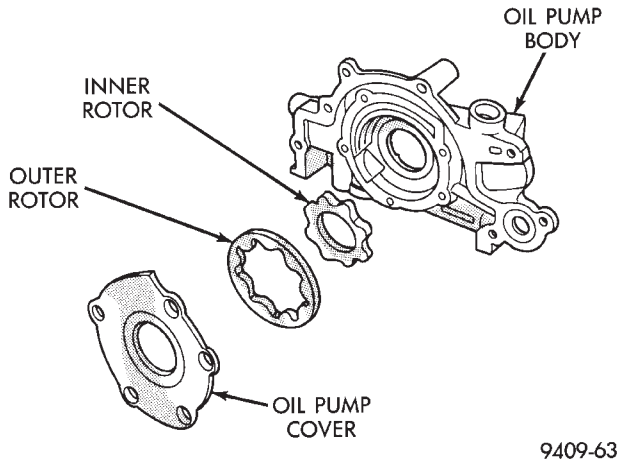


Fig. 96 Checking Oil Pump Cover Flatness

(3) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 7.64 mm (0.301 inch.) or less (Fig. 102), or if the diameter is 79.95 mm (3.148 inches) or less, replace outer rotor.

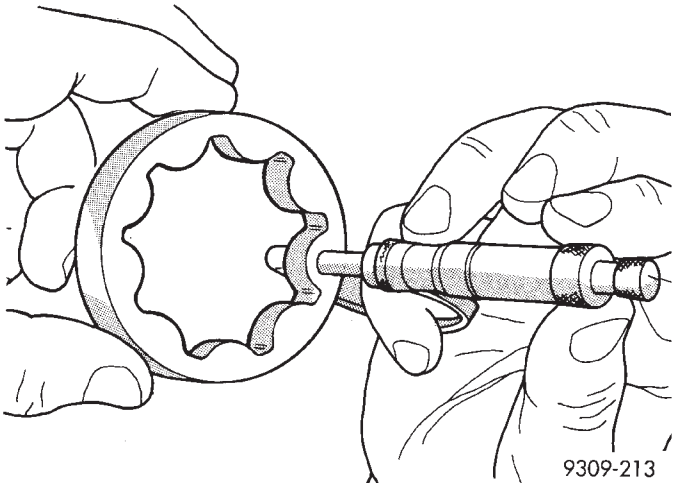


Fig. 97 Measuring Outer Rotor Thickness

(4) If inner rotor measures 7.64 mm (.301 inch) or less replace inner rotor (Fig. 103).

(5) Slide outer rotor into pump housing, press to one side with fingers and measure clearance between rotor and housing (Fig. 104). If measurement is 0.39 mm (0.015 inch.) or more, replace housing only if outer rotor is in specification.

CLEANING AND INSPECTION (Continued)

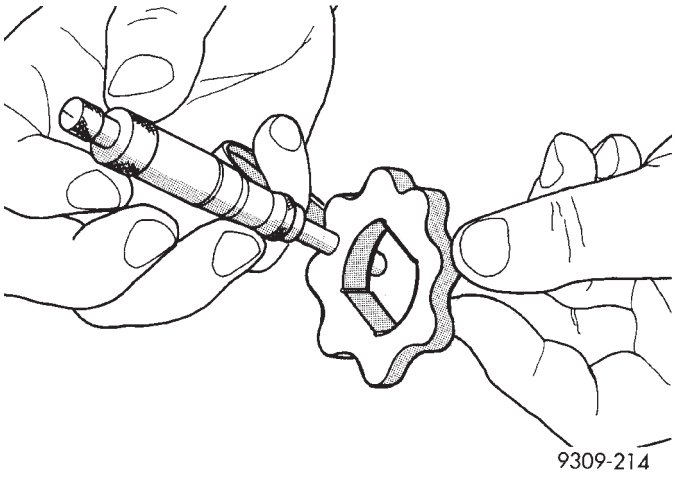


Fig. 98 Measuring Inner Rotor Thickness

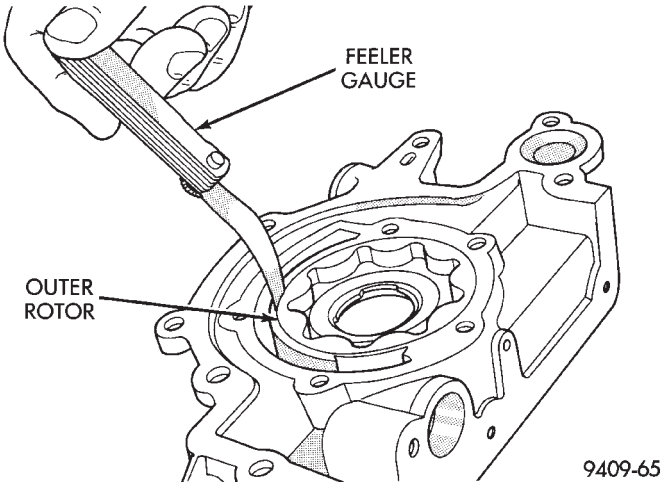


Fig. 99 Measuring Outer Rotor Clearance in Housing

(6) Install inner rotor into pump housing. If clearance between inner and outer rotors (Fig. 105) is .203 mm (.008 inch) or more, replace both rotors.

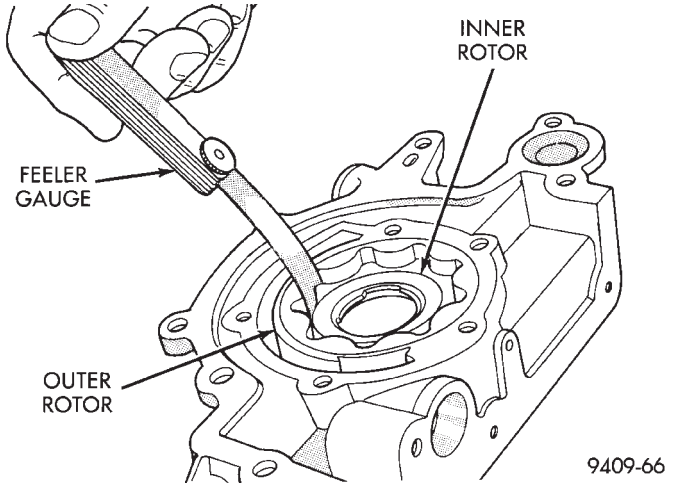


Fig. 100 Measuring Clearance Between Rotors

(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. 106). **ONLY** if rotors are in specs.

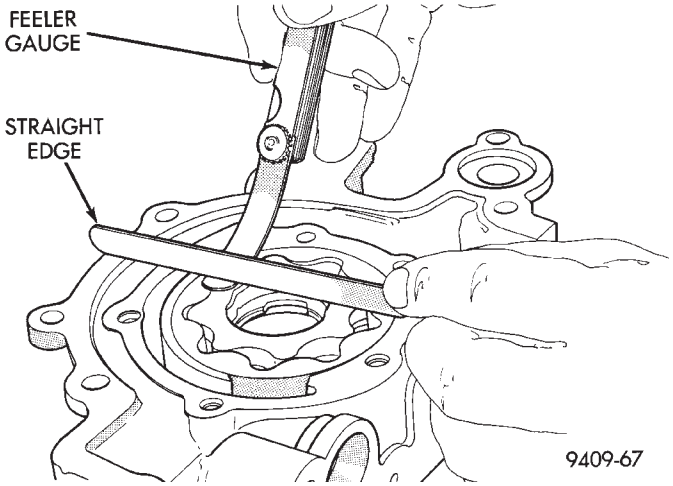


Fig. 101 Measuring Clearance Over Rotors

(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. 107). 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

CLEANING AND INSPECTION (Continued)

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. 107). 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. 108) for specifications.

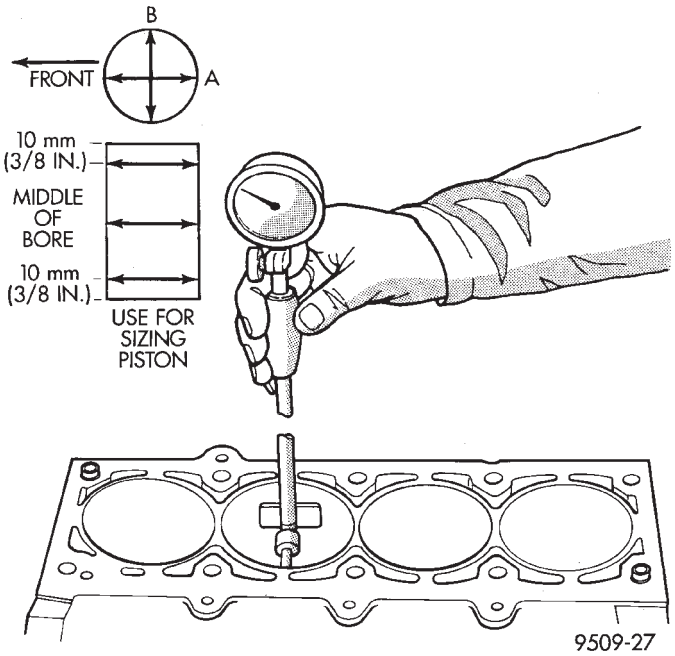


Fig. 102 Checking Cylinder Bore Size

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. 103 Cylinder Bore and Piston Specifications

SPECIFICATIONS

ENGINE 2.0L DOHC

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 . . . . . 0.018 - 0.050 mm (0.0007 - 0.0020 in.)
Weight . . . . . 340 - 350 grams (11.99 - 12.34 oz.)
Head Land Clearance (Diametrical) . . . . . 0.740 - 0.803 mm (0.029 - 0.031 in.)
Piston Length . . . . . 64.8 mm (2.551 in.)
Piston Ring Groove Depth No. 1 . . . . . 3.983 - 4.132 mm (0.157 - 0.163 in.)
Piston Ring Groove Depth No. 2 . . . . . 4.456 - 4.605 mm (0.175 - 0.181 in.)
Piston Ring Groove Depth No. 3 . . . . . 3.841 - 4.075 mm (0.151 - 0.160 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.)

SPECIFICATIONS (Continued)

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.)

Camshaft

Bearing Bore Diameter No. 1 - 6 . . . . . 26.020 mm - 26.041 mm (1.024 - 1.025 in.)
Diametrical Bearing Clearance . . . . . 0.069 - 0.071 mm (0.0027 - 0.003 in.)
End Play . . . . . 0.05 - 0.15 mm (0.002 - 0.006 in.)
Bearing Journal Diameter No. 1 - 6 . . . . . 25.951 - 25.970 mm (1.021 - 1.022 in.)
Lift (Zero Lash) Intake . . . . . 8.75 mm (0.344 in.)
Lift (Zero Lash) Exhaust . . . . 8.00 mm (0.314 in.)

Valve Timing @ .5 mm Lift

Intake Valve Closes (ABDC) . . . . . 38°
Intake Valve Opens (BTDC) . . . . . 1.2°
Intake Valve Duration . . . . . 219.2°
Exhaust Valve Closes (BTDC) . . . . . 3°
Exhaust Valve Opens (BBDC) . . . . . 42°
Exhaust Valve Duration . . . . . 219°
Valve Overlap . . . . . 0°

Cylinder Head

Material . . . . . Cast Aluminum
Gasket Thickness (Compressed) . . . . . 1.15 mm (0.045 in.)
Valve Seat Angle . . . . . 44.5 - 45°
Runout (Max.) . . . . . 0.050 mm (0.002 in.)
Width (Finished) Intake and Exhaust . . . 0.9 - 1.3 mm (0.035 - 0.051 in.)
Valve Guide Finished Diameter ID . . . . . 5.975 - 6.000 mm (0.235 - 0.236 in.)
Guide Bore Diameter (Standard) . . . . . 11.0 - 11.02 mm (0.4330 - 0.4338 in.)

Valves

Head Diameter Intake . . . . . 34.67 - 34.93 mm (1.365 - 1.375 in.)
Head Diameter Exhaust . . . . . 30.37 - 30.36 mm (1.195 - 1.195 in.)
Valve Margin Intake . . . . . 1.15 - 1.48 mm (0.0452 - 0.0582 in.)
Valve Margin Exhaust . . . . . 1.475 - 1.805 mm (0.058 - 0.071 in.)
Length Intake . . . . . 111.49 -111.99 mm (4.389 - 4.409 in.)
Length Exhaust . . . . . 109.59 - 110.09 mm (4.314 - 4.334 in.)
Valve Stem Tip Heigth Intake . . . . . 48.04 mm (1.891 in.)
Valve Stem Tip Heigth Exhaust . . . . . 47.99 mm (1.889 in.)
Stem Diameter Intake . . . . . 5.9034 - 5.952 mm (0.234 - 0.234 in.)
Stem Diameter Exhaust . . . . . 5.906 - 5.924 mm (0.233 - 0.233 in.)
Stem-to-Guide Clearance Intake . . . . . 0.023 - 0.066 mm (0.0009 - 0.0025 in.)
Stem-to-Guide Clearance Exhaust . . . . . 0.051 - 0.094 mm (0.002 - 0.0037 in.)
Maximum Allowable Intake . . . . . 0.076 mm (0.003 in.)
Maximum Allowable Exhaust . . . . . 0.101 mm (0.004 in.)

Valve Spring

Free Length (Approx.) . . . . . 46 mm (1.811 in.)
Spring Tension (Valve Closed) . . . . . 246 - 270 N @ 38.0 mm (55 - 60 lbs. @ 1.496 in.)
Spring Tension (Valve Open) . . . . . 549 - 611 N @ 29.3 mm (123 - 137 lbs. @ 1.53 in.)

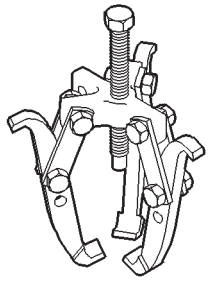
SPECIFICATIONS (Continued)

TORQUE CHART 2.0L DOHC

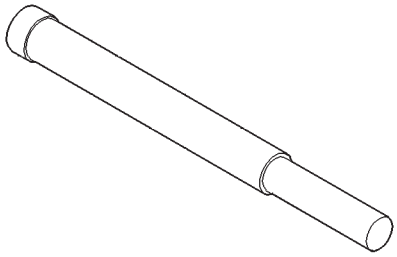
DESCRIPTION	TORQUE
Camshaft Sensor Pick-Up	
Bolts	9.6 N·m (85 in. lbs.)
Timing Belt Cover	
Bolts M6	12 N·m (105 in. lbs.)
Camshaft Sprocket	
Bolt	115 N·m (85 ft. lbs.)
Connecting Rod Cap	
Bolts	27 N·m (20 ft. lbs.) Plus 1/4 Turn
Crankshaft Main Bearing Cap/Bedplate	
M8 Bedplate Bolts	30 N·m (22 ft. lbs.)
M11 Main Cap Bolts	81 N·m (60 ft. lbs.)
Crankshaft Damper	
Bolt	142 N·m (105 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	15 N·m (130 in. lbs.)
Intake Manifold	
Bolts	28 N·m (250 in. lbs.)
Oil Filter Adapter	
Fastener	80 N·m (60 ft. lbs.)
Oil Filter	20 N·m (15 ft. lbs.)
Oil Pan	
Bolts	12 N·m (105 in. lbs.)
Drain Plug	34 N·m (25 ft. lbs.)
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	55 N·m (40 ft. lbs.)
Spark Plugs	
Plug	28 N·m (20 ft. lbs.)
Thermostat Housing	
Bolts	23 N·m (200 in lbs.)
Timing Belt	
Tensioner	28 N·m (250 in. lbs.)
Timing Belt Tensioner Pulley Assembly Plate-Backing	
Bolts	41 N·m (30 ft. lbs.)
Timing Belt Tensioner Pulley	
Bolt	68 N·m (50 ft. lbs.)
Water Pump Mounting	
Bolts	12 N·m (105 in. lbs.)

SPECIAL TOOLS

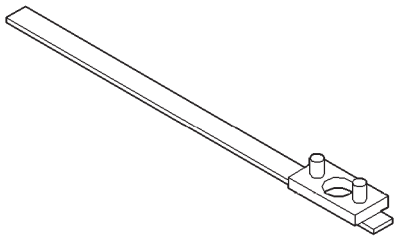
ENGINE 2.0L DOHC



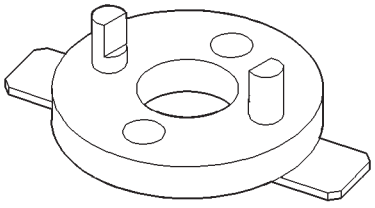
Puller 1026



Crankshaft Damper Removal Insert 6827-A

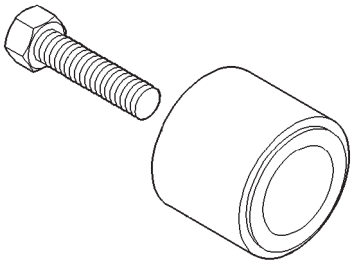


Camshaft Sprocket Remover/Installer C-4687

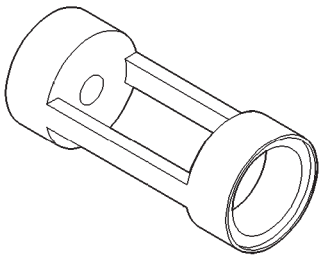


Camshaft Sprocket Remover/Installer Adapter C-4687-1

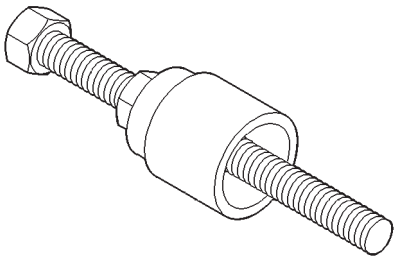
SPECIAL TOOLS (Continued)



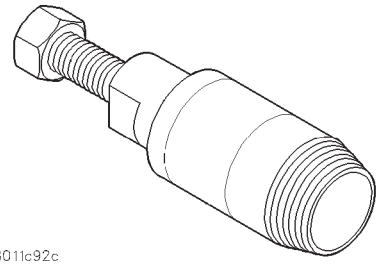
Camshaft Seal Installer MD-998713



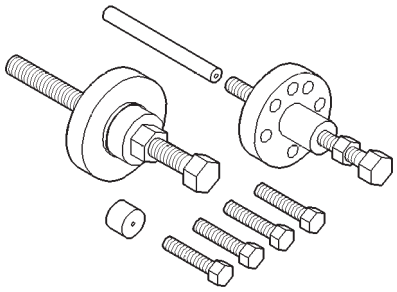
Adapter Spring Compressor 6779



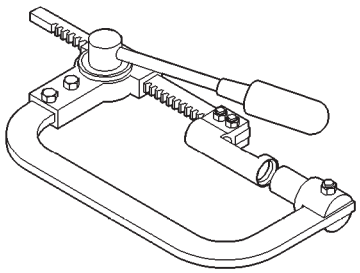
Installer Crankshaft Damper 6792



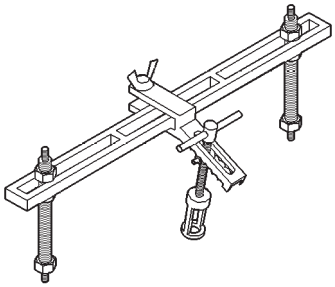
Front Crankshaft Seal Remover 6771



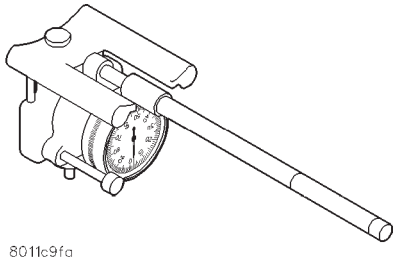
Installer Crankshaft Damper C-4685-C



Valve Spring Compressor C-3575-A

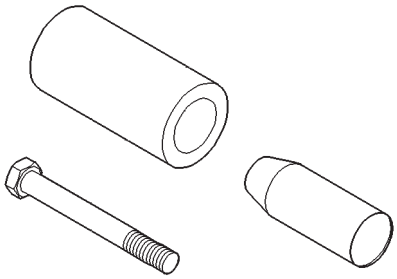


Valve Spring Compressor MD-998772-A

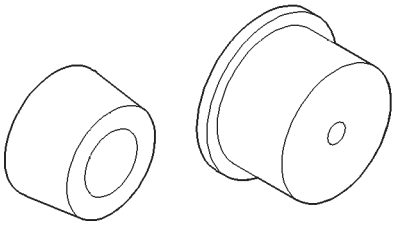


Cylinder Bore Indicator C-119

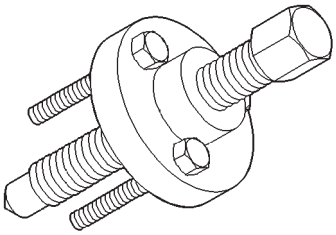
SPECIAL TOOLS (Continued)



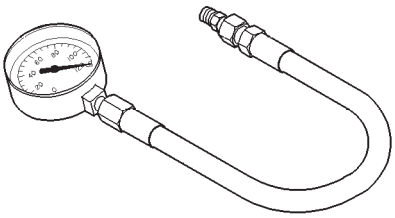
Front Crankshaft Seal Installer 6780



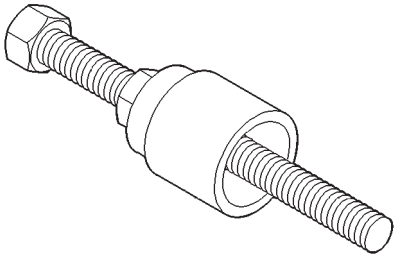
Rear Crankshaft Seal Guide and Installer 6926-1 and 6926-2



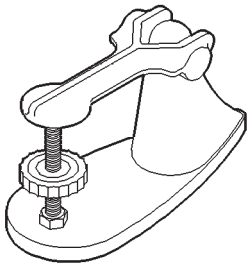
Crankshaft Sprocket Remover 6793



Pressure Gage C-32932



Crankshaft Sprocket Installer 6792



Valve Spring Tester C-647