

ENGINE

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STANDARD SERVICE INFORMATION

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GENERAL INFORMATION

FORM-IN-PLACE GASKETS

There are numerous places where form-in-place gaskets are used on the engine. Care must be taken when applying form-in-place gaskets 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 gaskets.

There are numerous types of form-in-place gasket materials 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.

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

Clean all gasket surfaces using a plastic scraper to remove all loose material. Inspect all parts to assure gasket rails are flat. 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.

GENERAL INFORMATION (Continued)

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.

ENGINE PERFORMANCE

If a loss of performance is noticed, the timing belt or chain may have skipped one or two teeth. The camshaft and crankshaft timing should be checked. Refer to Engine Timing Belt or Chain outlined in this section.

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

- (1) Test cranking amperage draw. Refer to Group 8B, Starting.
- (2) Tighten the intake manifold bolts to specifications.
- (3) Perform cylinder compression pressure test. Refer to Engine Diagnosis outlined in this section.
- (4) Clean or replace spark plugs as necessary and adjust gap as specified in Group 8D, Ignition System. Tighten to specifications.
- (5) Test resistance of spark plug cables. Refer to Group 8D, Ignition System.
- (6) Test ignition coils primary and secondary resistance. Replace parts as necessary. Refer to Group 8D, Ignition System.
- (7) Test fuel pump for correct pressure. Refer to Group 14, Fuel System.
- (8) The air filter elements should be replaced as specified in Group 0, Lubrication and Maintenance.
- (9) Inspect crankcase ventilation system as outlined in Group 25, Emission Control Systems.
- (10) Inspect and adjust accessory belt drives referring to Accessory Belt Drive in Cooling System, Group 7 for proper adjustments.
- (11) Road test vehicle as a final test.

MEASURING WITH PLASTIGAGE

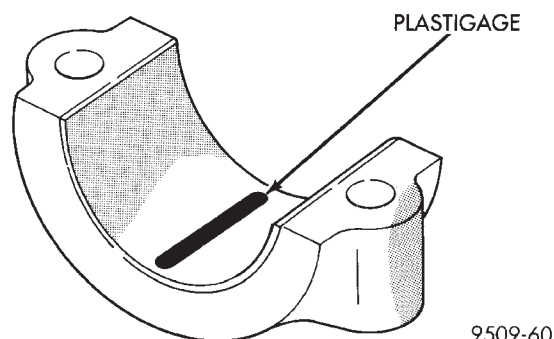


Fig. 1 Plastigage Placed in Lower Shell

PLASTIGAGE METHOD

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

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

PREFERRED METHOD

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

ENGINE WITH 5 MAIN BEARINGS

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

GENERAL INFORMATION (Continued)

- When checking #4 main bearing shim #3 main bearing.

NOTE: REMOVE ALL SHIMS BEFORE REASSEMBLING ENGINE

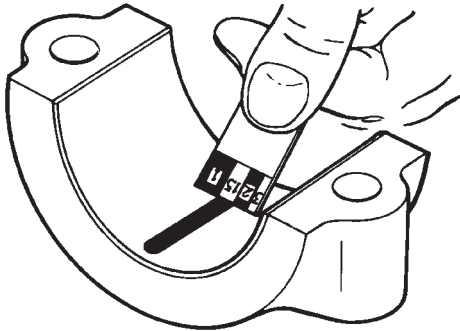


Fig. 2 Clearance Measurement

ALTERNATIVE METHOD

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

PLASTIGAGE PROCEDURE

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

(2) Place a piece of Plastigage across the entire width of the bearing shell in the cap approximately 6.35 mm (1/4 in.) off center and away from the oil holes (Fig. 1). (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. 2) 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. 1). 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. 2) 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.

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.

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)

API SERVICE GRADE CERTIFIED

Use an engine oil that is API Service Grade Certified. MOPAR® provides engine oils that conforms to this service grade.

SAE VISCOSITY

An SAE viscosity grade is used to specify the viscosity of engine oil. Use only engine oils with multiple viscosities such as 5W-30 or 10W-30. 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. 3).

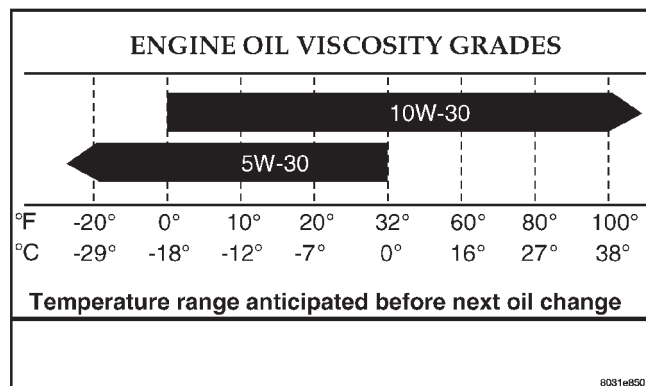


Fig. 3 Temperature/Engine Oil Viscosity

ENERGY CONSERVING OIL

An Energy Conserving type oil is recommended for gasoline engines. The designation of ENERGY CONSERVING is located on the label of an engine oil container.

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. 4).



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Fig. 4 Engine Oil Container Standard Notations

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. Refer to Group 0, Lubrication and Maintenance.
- (8) Install oil fill cap.
- (9) Start engine and inspect for leaks.
- (10) Stop engine and inspect oil level.

ENGINE OIL FILTER CHANGE

FILTER SPECIFICATION

All engines are equipped with a high quality full-flow, disposable type oil filter. Chrysler Corporation recommends a Mopar® or equivalent oil filter be used.

OIL FILTER REMOVAL

Refer to Removal and Installation Section in Group 09, Engine for procedure.

USED ENGINE OIL DISPOSAL

Care should be exercised when disposing used engine oil after it has been drained from a vehicle engine. Refer to the WARNING listed above.

SERVICE PROCEDURES

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.

SERVICE PROCEDURES (Continued)

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. 5).

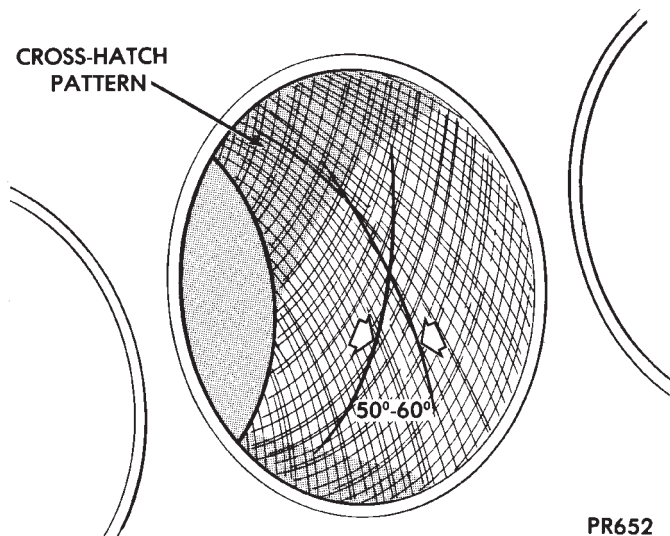


Fig. 5 Cylinder Bore Cross-Hatch Pattern

(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.

HYDROSTATIC LOCKED ENGINE

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

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

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

(2) Remove negative battery cable.

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

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

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

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

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

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

(8) Install new spark plugs.

(9) Drain engine oil and remove oil filter.

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

(11) Connect negative battery cable.

(12) Start engine and check for any leaks.

ENGINE CORE PLUGS**REMOVAL**

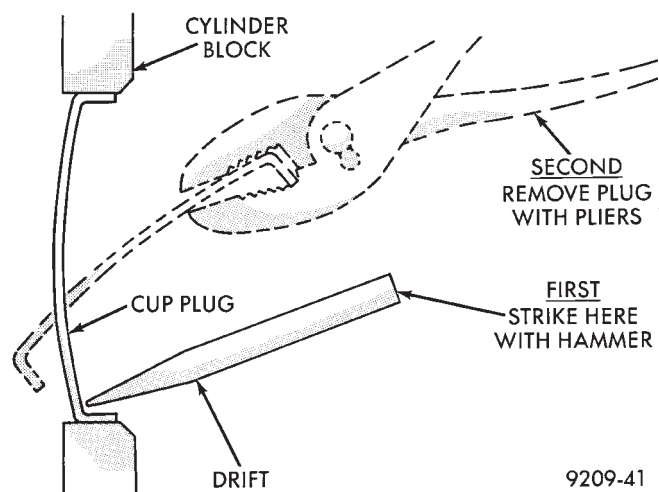
Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup plug (Fig. 6). With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 6).

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. 6).

SERVICE PROCEDURES (Continued)



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

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Fig. 6 Core Hole Plug Removal

ENGINE DIAGNOSIS

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DIAGNOSIS AND TESTING

GENERAL INFORMATION

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

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 engine RPM'S change, the area of the suspected leak has been found.
- (4) Repair as required.

CYLINDER COMPRESSION TEST

(1) Before performing a cylinder compression test. 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.

(2) Check engine oil level and add oil if necessary.

(3) Drive the vehicle until engine reaches normal operating temperature.

(4) Select a route free from traffic and other forms of congestion, observe all traffic laws, and accelerate through the gears several times briskly.

CAUTION: Do not overspeed the engine. The higher engine speed may loosen valve seat deposits which can prevent accurate compression readings.

a. Clean the spark plug recesses with compressed air.

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

c. Disconnect the coil connector for Direct Ignition System (DIS) systems, or for coil-over-plug ignitions remove the ASD relay.

d. Be sure throttle blade is fully open during the compression check.

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

f. Repeat Step "e" for all remaining cylinders.

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

h. If one or more cylinders have abnormally low compression pressures, repeat steps 4e through 4g.

i. If the same cylinder or cylinders repeat an abnormally low reading on the second compression test, it could indicate the existence of a problem with the cylinder(s) in question.

DIAGNOSIS AND TESTING (Continued)

NOTE: 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.

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

(6) Connect spark plug wires and ignition coil electrical connector on DIS systems. Install ignition coils and connect electrical connector on coil-over-plug systems.

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, with 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 per cylinder.

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

DIAGNOSIS AND TESTING (Continued)

LASH ADJUSTER (TAPPET) NOISE DIAGNOSIS

LASH ADJUSTER (TAPPET) NOISE	
POSSIBLE CAUSES	CORRECTION
1. Engine oil level—too high or too low. This may cause aerated oil to enter the adjusters and cause them to be spongy.	1. Check and correct engine oil level.
2. Insufficient running time after rebuilding cylinder head.	2. Low speed running of up to 1 hour may be required to fully evacuate trapped air from the valve train system. 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.
3. Air trapped in lash adjuster (after 1 hour run time).	3. See below: (a) Check lash adjusters for sponginess while installed in cylinder head. Depress part of rocker arm over adjuster. Normal adjusters should feel very firm. Very spongy adjusters can be bottomed out easily. (b) Before proceeding, check for and perform any applicable Technical Service Bulletin for this condition. (c) If lash adjuster(s) still spongy, replace with new adjuster/rocker arm assembly*.
4. Low oil pressure	4. See below: (a) Check and correct engine oil level. (b) Check engine oil pressure. (c) Check for excessive bearing clearance and correct. (d) Check for worn oil pump.
5. Oil passage to cylinder head(s) plugged with debris.	5. Check cylinder head oil passages and cylinder head gasket restrictor for blockage. Clean or replaced as necessary.
6. Worn valve guide(s).	6. Ream guide(s) and replace valve(s) with oversize valves and seal(s).
7. Air injected into oil due to broken or cracked oil pump pickup tube.	7. Inspect pickup tube and replace as necessary.
8. Collapsed lash adjuster due to debris injection.	8. Clean debris from engine and replace lash adjuster/rocker assembly*.
9. Intake rocker arm's roller clevis ear(s) contacting camshaft bearing journal(s) on side.	9. Inspect camshaft end play and all valve train components for wear. Replace as necessary.
*The 3.2/3.5L engine lash adjusters are serviced with the rocker arms, do not disassemble.	

DIAGNOSIS AND TESTING (Continued)

INSPECTION (ENGINE OIL LEAKS IN GENERAL)

Begin with a thorough 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.

(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 24 km (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:

- Disconnect the fresh air hose (makeup air) at the cylinder head cover and plug or cap the nipple on the cover.
- Remove the PCV valve hose from the cylinder head cover. Cap or plug the PCV valve nipple on the cover.
- 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.

- 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.

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

(6) 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.

(7) 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. 2. Corroded or loose battery connections. 3. Faulty starter. 4. Faulty coil(s) or control unit. 5. Incorrect spark plug gap. 6. Contamination in fuel system. 7. Faulty fuel pump. 8. Incorrect engine timing.	1. Test battery. Charge or replace as necessary. Refer to Group 8A, Battery. 2. Clean and tighten battery connections. Apply a coat of light mineral grease to terminals. 3. Test starting system. Refer to Group 8B, Starting. 4. Test and replace as needed. Refer to Group 8D, Ignition System. 5. Set gap. Refer to Group 8D, Ignition System. 6. Clean system and replace fuel filter. 7. Test fuel pump and replace as needed. Refer to Group 14, Fuel System. 8. Check for a skipped timing belt/chain or a loose camshaft sprocket (3.2/3.5L).
ENGINE STALLS OR IDLES ROUGH	1. Idle speed too low. 2. Incorrect fuel mixture. 3. Intake manifold leakage. 4. Faulty coil(s).	1. Test minimum air flow. Refer to Group 14, Fuel System. 2. Refer to Group 14, Fuel System. 3. Inspect intake manifold, manifold gasket, and vacuum hoses. Refer to Group 11, Exhaust System and Intake Manifold. 4. Test and replace as necessary. Refer to Group 8D, Ignition System.
ENGINE LOSS OF POWER	1. Dirty or incorrectly gapped plugs. 2. Contamination in fuel system. 3. Faulty fuel pump. 4. Incorrect valve timing. 5. Leaking cylinder head gasket. 6. Low compression. 7. Burned, warped, or pitted valves. 8. Plugged or restricted exhaust system. 9. Faulty coil(s).	1. Clean plugs and set gap. Refer to Group 8D, Ignition System. 2. Clean system and replace fuel filter. 3. Test and replace as necessary. Refer to Group 14, Fuel System. 4. Correct valve timing. 5. Replace cylinder head gasket. 6. Test compression of each cylinder. 7. Replace valves. 8. Install new parts, as necessary. 9. Test and replace as necessary. Refer to Group 8D, Ignition System.
ENGINE MISSES ON ACCELERATION	1. Dirty or incorrectly gapped spark plugs. 2. Contamination in Fuel System. 3. Burned, warped, or pitted valves. 4. Faulty coil(s).	1. Clean spark plugs and set gap. Refer to Group 8D, Ignition System. 2. Clean fuel system and replace fuel filter. 3. Replace valves. 4. Test and replace as necessary. Refer to Group 8D, Ignition System.
ENGINE MISSES AT HIGH SPEED	1. Dirty or incorrect spark plug gap. 2. Faulty coil(s). 3. Dirty fuel injector(s). 4. Contamination in fuel system.	1. Clean spark plugs and set gap. Refer to Group 8D, Ignition System. 2. Test and replace as necessary. Refer to Group 8D, Ignition System. - Test and replace as necessary. Refer to Group 14, 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. 2. Thin or diluted oil. 3. Low oil pressure. 4. Dirt in tappets/lash adjusters. 5. Worn rocker arms. 6. Worn tappets/lash adjusters. 7. Worn valve guides. 8. Excessive runout of valve seats on valve faces. 9. Missing adjuster pivot.	1. Check and correct engine oil level. 2. Change oil to correct viscosity. 3. Check and correct engine oil level. 4. Replace rocker arm/hydraulic lash adjuster assembly. 5. Inspect oil supply to rocker arms. 6. Install new rocker arm/hydraulic lash adjuster assembly. 7. Ream guides and install new valves with oversize stems. 8. Grind valve seats and valves. 9. Replace rocker arm/hydraulic lash adjuster assembly.
CONNECTING ROD NOISE	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Connecting rod journal out-of-round. 6. Misaligned connecting rods.	1. Check engine oil level. 2. Check engine oil level. Inspect oil pump relief valve and spring. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair as necessary. 5. Replace crankshaft or grind surface. 6. Replace bent connecting rods.
MAIN BEARING NOISE	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Excessive end play. 6. Crankshaft journal out-of-round or worn. 7. Loose flywheel or torque converter.	1. Check engine oil level. 2. Check engine oil level. Inspect oil pump relief valve and spring. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair as necessary. 5. Check thrust bearing for wear on flanges. 6. Replace crankshaft or grind journals. 7. Tighten to correct torque.
OIL PRESSURE DROP	1. Low oil level. 2. Faulty oil pressure sending unit. 3. Low oil pressure. 4. Clogged oil filter. 5. Worn parts in oil pump. 6. Thin or diluted oil. 7. Oil pump relief valve stuck. 8. Oil pump suction tube loose. 9. Oil pump cover warped or cracked. 10. Excessive bearing clearance.	1. Check engine oil level. 2. Install new sending unit. 3. Check sending unit and main bearing oil clearance. 4. Install new oil filter. 5. Replace worn parts or pump. 6. Change oil to correct viscosity. 7. Remove valve and inspect, clean, or replace. 8. Remove oil pan and install new tube or clean, if necessary. 9. Install new oil pump. 10. Measure bearings for correct clearance.

DIAGNOSIS AND TESTING (Continued)

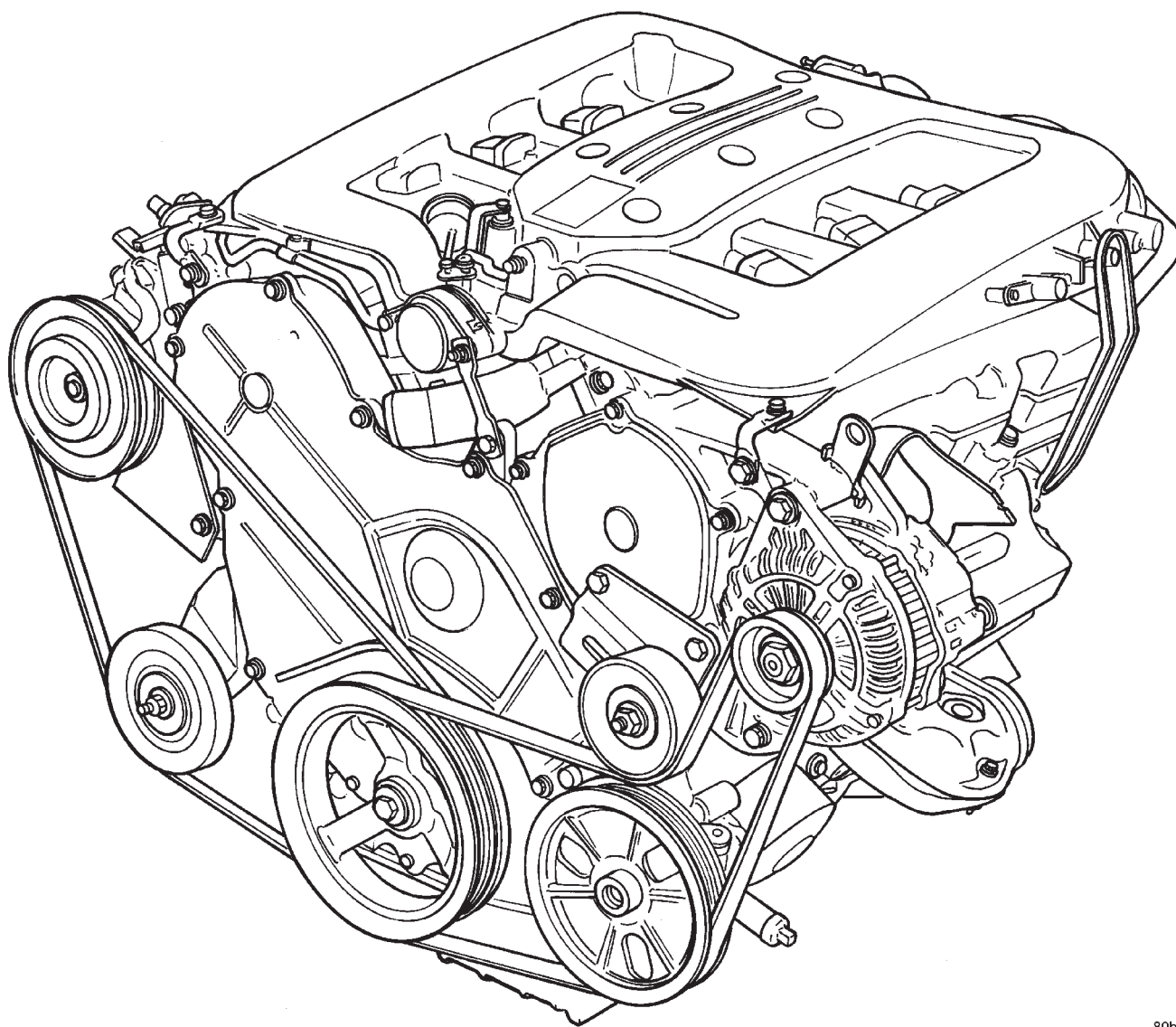
CONDITION	POSSIBLE CAUSES	CORRECTION
OIL LEAKS	1. Misaligned or deteriorated gaskets. 2. Loose fastener, broken or porous metal part. 3. Misaligned or deteriorated cup or threaded plug.	1. Replace gasket(s). 2. Tighten, repair or replace the part. 3. Replace as necessary.
OIL CONSUMPTION OR SPARK PLUGS FOULED	1. PCV system malfunction. 2. Worn, scuffed or broken rings. 3. Carbon in oil ring slots. 4. Rings fitted too tightly in grooves. 5. Worn valve guide(s). 6. Valve stem seal(s) worn or damaged.	1. Check system and repair as necessary. Refer to Group 25, Emission Control Systems. 2. Hone cylinder bores. Install new rings. 3. Install new rings. 4. Remove rings and check grooves. If groove is not proper width, replace piston. 5. Ream guide(s) and replace valve(s) with oversize valve(s) and seal(s). 6. Replace seal(s).

3.5L ENGINE

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DESCRIPTION AND OPERATION

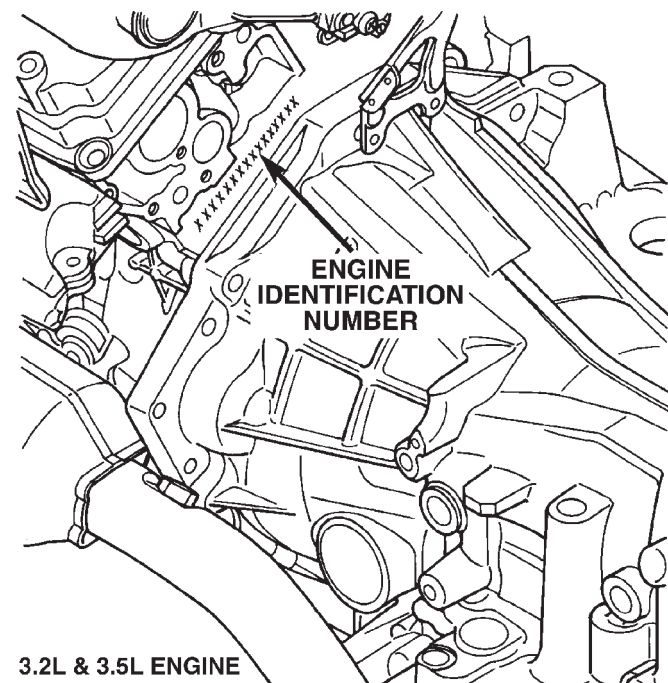
3.5L ENGINE

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DESCRIPTION AND OPERATION (Continued)

ENGINE IDENTIFICATION NUMBER

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



3.2L & 3.5L ENGINE

<u>X</u> Model Year	<u>X</u> Manufacturing Plant	<u>XXXXX</u> Component Code/Usage	<u>XXXX</u> Month/Day	<u>XXXXX</u> Serial Code
Last digit of model year	Trenton T	Engine 3.2L 3.5L Usage Pass Car PC		

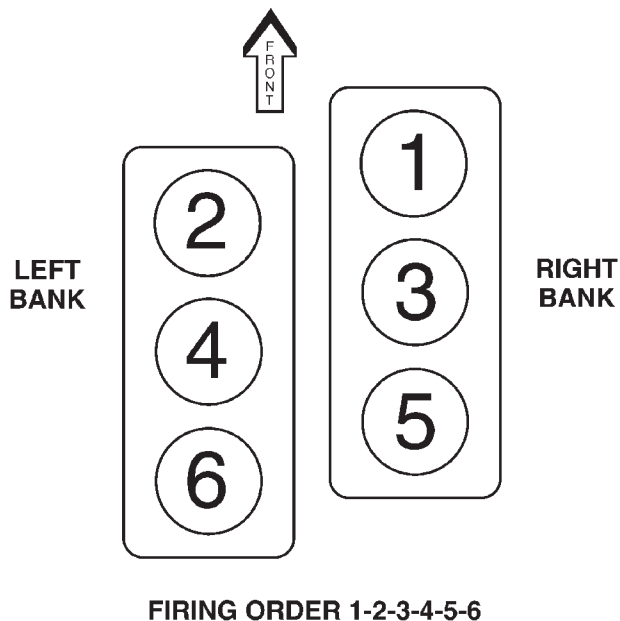
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Fig. 1 Engine Identification

3.5L GENERAL SPECIFICATIONS

Type 60° SOHC V-6 24 Valve
 Displacement 3.5 Liters 3518 cc
 (214 Cubic Inches)
 Bore 96.0 mm (3.780 in.)
 Stroke 81.0 mm (3.189 in.)
 Compression Ratio 9.9:1
 Horsepower 253 @ 6400 rpm
 Torque 255 lb. ft. @ 3950 rpm
 Lead Cylinder #1 Right Bank
 Firing Order 1, 2, 3, 4, 5, 6
 Cylinder Block Aluminum Deep Skirt With
 Cast-In-Place Iron Liners
 Crankshaft Forged Steel
 Camshaft Two Unique Castings
 (Right And Left)
 Cylinder Head Aluminum
 Piston Aluminum (Full Floating Piston Pin)

Lubrication . . Pressure Feed-Full Flow Filtration
 (Direct Crankshaft Driven Pump)
 Cooling System Liquid Cooled-Forced
 Circulation



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Cylinder Numbering & Firing Order—3.2/3.5L

ENGINE LUBRICATION SYSTEM

The lubrication system is a full flow filtration pressure feed type. Engine oil stored in the oil pan is drawn in and discharged by a gerotor type oil pump. The oil pump is directly coupled to the crankshaft. Oil pressure is regulated by a relief valve. The oil is fed through an oil filter and to the crankshaft journals from the oil gallery in the cylinder block. This gallery also feeds oil under pressure to the cylinder heads. Oil flows through each cylinder heads oil passage to the rocker shafts. Oil then feeds the camshaft journals, rocker arms, and hydraulic lash adjusters (Fig. 2).

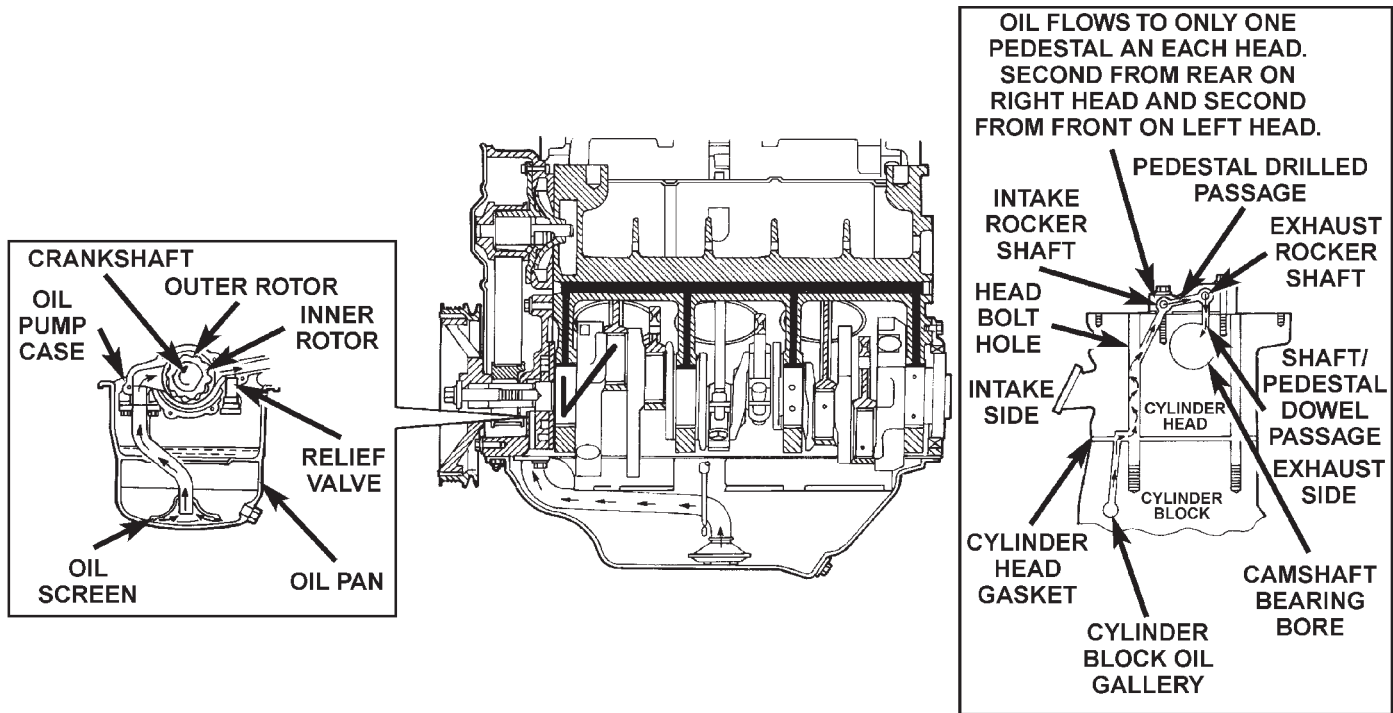
3.5L ENGINE COMPONENTS

NOTE: The 3.5L engine is a **NON free-wheeling** design.

CYLINDER BLOCK

The cylinder block is made of heat treated aluminum with cast-in-place iron liners. The block is a closed deck design with the right bank forward. To provide high rigidity and improved NVH, the block has cast-in contours and ribs, along with powdered

DESCRIPTION AND OPERATION (Continued)



80a53b54

Fig. 2 Oil Lubrication System

metal 6 bolt main caps (4 vertical, 2 horizontal), with a die cast aluminum structural beam windage tray mounted to the main caps.

CRANKSHAFT

The crankshaft is constructed of a forged micro alloy steel. A six throw, nine counterweight crankshaft is supported by four select fit main bearings with number two serving as the thrust washer location. The six separate connecting rod throws are an even-firing design which reduces torque fluctuations while a torsional vibration damper is used to control torsion caused vibration of the crankshaft. Rubber lipped seals are used at front and rear. The front seal is retained in the oil pump case and the rear is retained in a block-mounted housing.

PISTONS AND CONNECTING RODS

The pistons are made of a high strength aluminum alloy. Top land height has been decreased to reduce emissions. Piston skirts are coated with a solid lubricant for scuff resistance. Connecting rod is forged steel with a squirt hole and attaches to the piston with a full floating pin retained by lock rings.

CYLINDER HEAD

The aluminum alloy cylinder heads feature cross-flow type intake and exhaust ports. Valve guides and seat inserts are powdered metal. Valves are arranged in a "V", with each camshaft on center. To improve combustion speed the chambers are a compact spher-

ical design with a squish area of approximately 30 percent of the piston top area. The cylinder heads are common to either cylinder bank by reversing the direction of installation.

CAMSHAFTS AND TIMING DRIVE

A single overhead camshaft per cylinder head provides valve actuation. The left camshaft accommodates a cam sensor pick-up wheel and is therefore longer. Each camshaft is supported by four bearing journals. Thrust for each camshaft is taken at a thrust plate attached to the rear of each cylinder head. Right and left camshaft driving sprockets are not interchangeable because of the cam sensor pick-up wheel on the left sprocket. The sprockets and the engine water pump are driven by a single notched timing belt. Camshaft bearing lubrication is provided via oil feed passage through each rocker shaft pedestal dowel.

ROCKER ARM SHAFTS

The shafts are tubular steel and are supported by several forged aluminum alloy pedestals, which are fastened to the cylinder head. Four shafts are used, one for each intake and exhaust rocker arm bank on each cylinder head. The shafts are hollow to provide a duct for lubricating oil flow from the cylinder head to the valve mechanisms. One hollow dowel per pedestal is used to locate the pedestal to the cylinder head, orient the exhaust rocker shaft, and serve as a cam bearing oil feed passage.

DESCRIPTION AND OPERATION (Continued)

ROCKER ARMS

Rocker arms are of light weight permanent mold aluminum alloy with a roller type follower operating against the camshaft. The valve actuating end of the rocker arms are machined to retain hydraulic lash adjusters, eliminating the need for manual valve lash adjustment.

VALVES

Valves are made of highly heat-resistant steel and are chrome plated to prevent stem scuffing. The intake valve is a one-piece forging, while the exhaust valve has a forged head with a welded stem for lock groove hardenability. Both valves employ a three-groove lock design.

VALVE SPRINGS

Valve springs are unique for intake versus exhaust. Both are made from chrome silicon alloy wire and incorporate a "bee-hive" design. Valve spring retainers and locks are common. The valve spring seat is integral with the valve stem oil seal, which incorporates a garter spring to maintain consistent lubrication control to the valve stem.

INTAKE MANIFOLD

The composite intake manifold is a cross-flow type with long runners to improve air charge inertia. An active Short Runner Valve (SRV) opens during certain operating conditions to improve top end performance. A Manifold Tuning Valve (MTV) connects the plenums at specific engine speeds to maximize low RPM torque without reducing high RPM power.

EXHAUST MANIFOLDS

Both manifolds are a log style made of ductile cast iron. The outlets are designed for V-Band clamp attachment of close coupled catalytic converters.

ENGINE LUBRICATION

System is a full-flow filtration, pressure feed type. The oil pump body is mounted to the engine block. The pump inner rotor is driven by the crankshaft. A windage tray, increases power by minimizing oil windage at high engine RPM. For increased oil cooling, an oil-to-coolant oil cooler is used. This cooler is mounted inside the radiator tank.

DIAGNOSIS AND TESTING

HYDRAULIC LASH ADJUSTER

The hydraulic lash adjusters are precision units installed in machined openings in the valve actuating ends of the rocker arms. **Do not disassemble the hydraulic lash adjuster from the rocker arm assembly (Fig. 3).** Damage to the adjuster and rocker arm will occur.

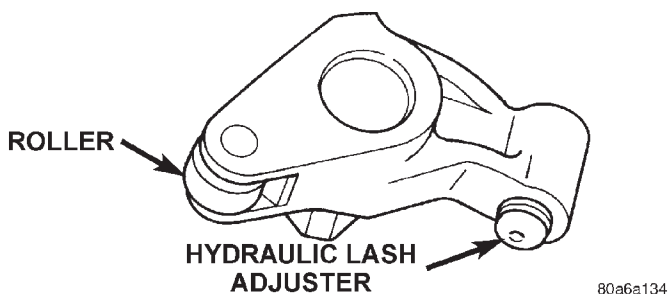


Fig. 3 Hydraulic Lash Adjuster

CHECKING ENGINE OIL PRESSURE

Check oil pressure using gauge at oil pressure switch location. Oil pressure should be 34 kPa (5 psi) at idle or 205 to 550 kPa (30 to 80 psi.) at 3000 RPM.

(1) Remove pressure sending unit. The pressure sending unit is located on the left front of engine near the oil filter.

(2) Install oil pressure gauge.

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

(3) Warm engine to normal operating temperature.

TESTING VALVE SPRINGS

VALVE SPRING IDENTIFICATION

The valve springs are of two different lengths and are wound in different directions. The valve springs are color coded: the intake spring has a right hand coil direction with orange dye on the top coils and the exhaust spring has a left hand coil direction with green dye on the top coils (Fig. 4).

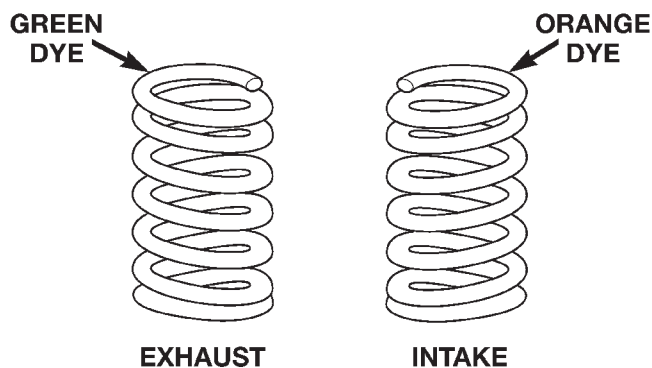


Fig. 4 Valve Spring Identification

TESTING VALVE SPRINGS

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested (Fig. 5). **As an example;** the compression length of the spring to be tested is 38.00 mm (1.496 inches.). Turn table of Tool C-647 until surface is in line with the 38.00 mm (1.496 inches.) mark on the

DIAGNOSIS AND TESTING (Continued)

threaded stud and the zero mark on the front. Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by two. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to Specifications Section to obtain specified height and allowable tensions. Replace springs that do not meet specifications.

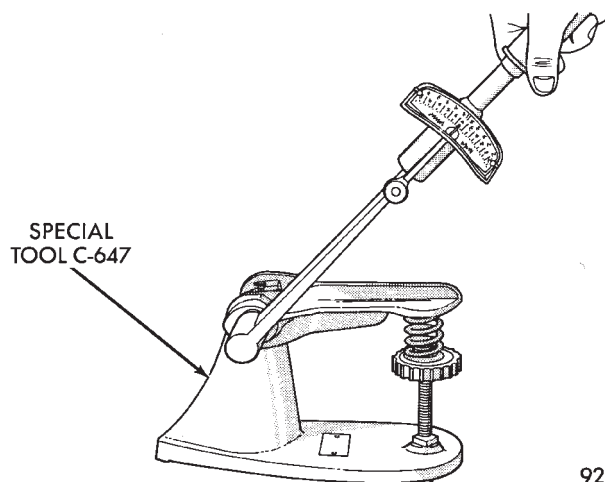
SERVICE PROCEDURES

PISTONS

Pistons are machined to two different weight specifications and matched to rods based on weight. All piston and rod assemblies weigh the same, to maintain engine balance.

FITTING PISTONS

Piston and cylinder wall must be clean and dry. Piston diameter should be measured 90 degrees to piston pin at size location shown in (Fig. 6). Cylin-



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Fig. 5 Testing Valve Spring with Tool C-647

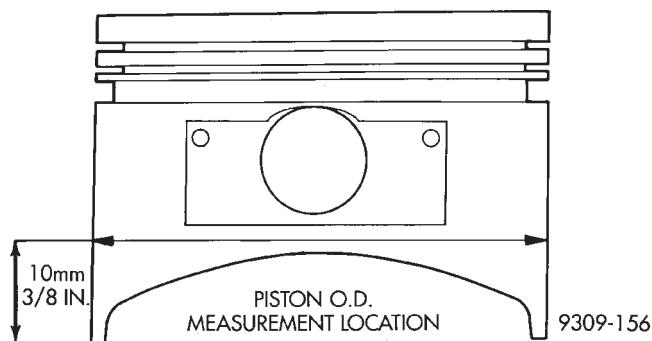
der bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line. Refer to Cylinder Bore and Piston Specification Chart. **Pistons and cylinder bores should be measured at normal room temperature, 70°F (21°C).**

CYLINDER BORE AND PISTON SPECIFICATION CHART

ENGINE	STANDARD CYLINDER BORE	MAXIMUM OUT-OF-ROUND	MAXIMUM TAPER	STANDARD PISTON SIZE
3.5L	96.0 mm ± 0.0076 mm (3.780 in. ± 0.0003 in.)	0.076 mm (0.003 in.)	0.051 mm (0.002 in.)	95.980 ± 0.019 mm (3.7788 ± 0.0008 in.)
Piston to Bore Clearance: -0.007 to +0.047 mm (-0.0003 to 0.0018 in.) Measurement taken at Piston Size location.				

SERVICE PROCEDURES (Continued)

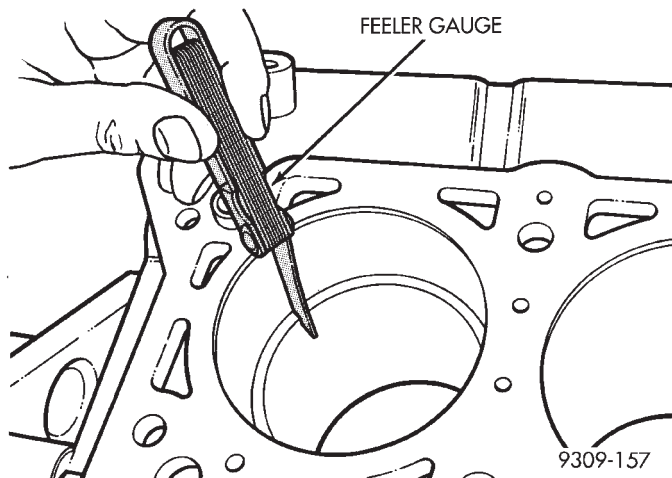
PISTON PINS

**Fig. 6 Piston Measurements**

The piston pin is full floating and is held in place by lock rings. Pistons and rods are weight matched for balance. **Do Not switch pistons with other rods.** Piston and Rods are serviced as an assembly for balance.

FITTING PISTON RINGS

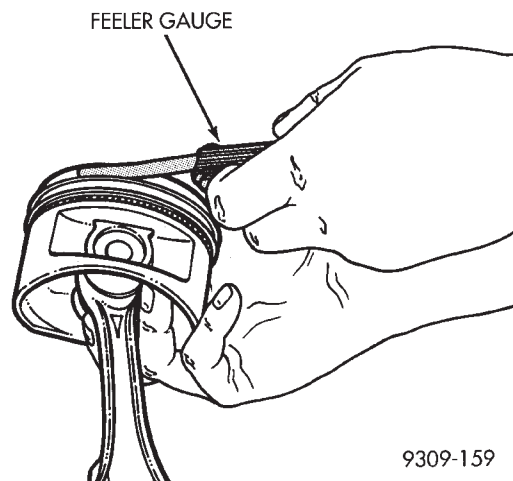
(1) Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioning at least 12 mm (0.50 inch.) from bottom of cylinder bore. Check gap with feeler gauge (Fig. 7). Refer to Piston Ring Specification Chart.

**Fig. 7 Check Gap on Piston Rings**

(2) Check piston ring to groove clearance: (Fig. 8). Refer to Piston Ring Specification Chart.

PISTON RING SPECIFICATION CHART

RING POSITION	RING GAP	WEAR LIMIT
Upper Ring:	0.20 - 0.36 mm (0.008 - 0.014 in.)	0.56 mm (0.0221 in.)
Intermediate Ring:	0.23 - 0.50 mm (0.0091 - 0.0197 in.)	0.8 mm (0.031 in.)
Oil Control Ring:	0.25 - 0.76 mm (0.010 - 0.030 in.)	1.0 mm (0.039 in.)
RING POSITION	GROOVE CLEARANCE	MAXIMUM CLEARANCE
Upper Ring:	0.035 - 0.085 mm (0.0014 - 0.0034 in.)	0.10 mm (0.004 in.)
Intermediate Ring:	0.035 - 0.085 mm (0.0014 - 0.0034 in.)	0.10 mm (0.004 in.)
Oil Control Ring-Three Piece:	0.038 - 0.184 mm (0.0015 - 0.0073 in.)	0.211 mm (0.0084 in.)

**Fig. 8 Measuring Piston Ring Side Clearance****PISTON RINGS—INSTALLATION**

(1) The No. 1 and No. 2 piston rings have a different cross section. Insure that the No. 2 ring is installed with manufacturers I.D. mark (dot) facing up, towards top of the piston (Fig. 9).

SERVICE PROCEDURES (Continued)

CAUTION: Install piston rings in the following order:

- (2) Oil ring expander.
- (3) Upper oil ring side rail.
- (4) Lower oil ring side rail.
- (5) No. 2 Intermediate piston ring.
- (6) No. 1 Upper piston ring.
- (7) 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 during this step (Fig. 10).**

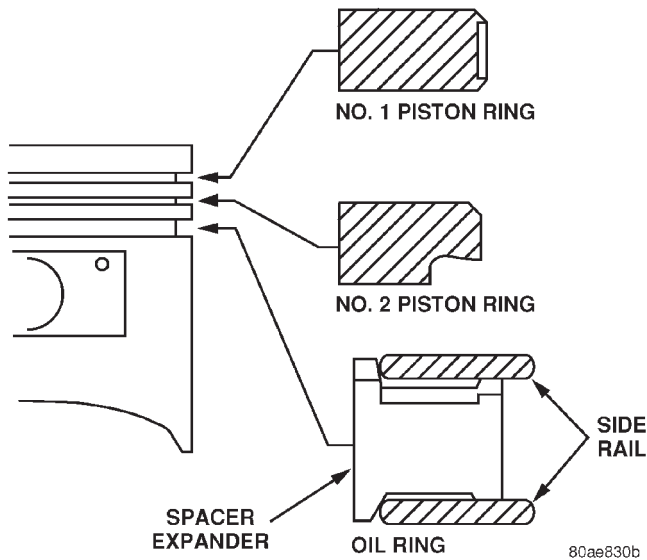


Fig. 9 Piston Ring—Installation

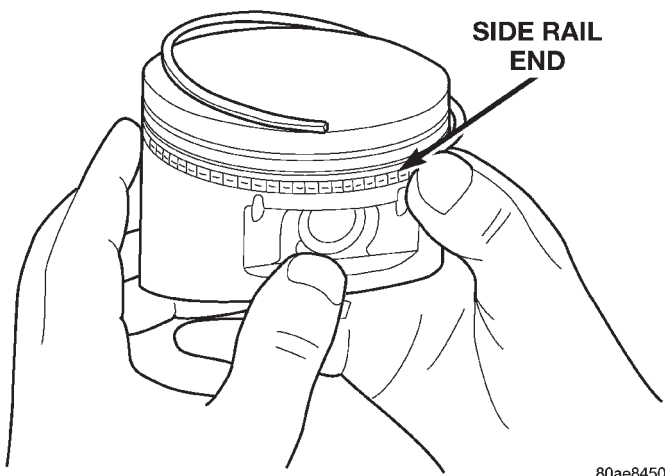


Fig. 10 Side Rail—Installation

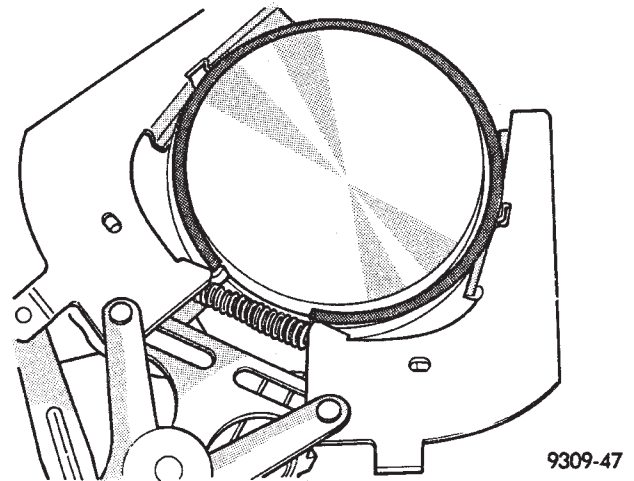


Fig. 11 Upper and Intermediate Rings—Installation

- (8) Install upper side rail first and then the lower side rail.
- (9) Install No. 2 piston ring and then No. 1 piston ring (Fig. 11).
- (10) Position piston ring end gaps as shown in (Fig. 12).
- (11) 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.

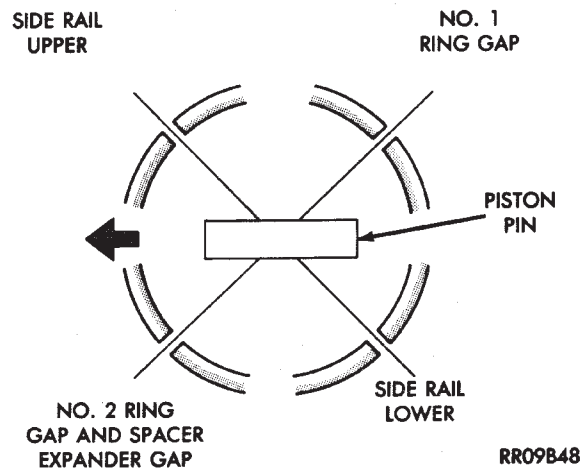


Fig. 12 Piston Ring End Gap Position

INSTALLATION OF CONNECTING ROD BEARINGS

Fit all rods on one bank until complete.

The bearing caps are not interchangeable and should be marked at removal to insure correct assembly.

SERVICE PROCEDURES (Continued)

The bearing shells must be installed with the tangs inserted into the machined grooves in the rods and caps. Install cap with the tangs on the same side as the rod.

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 in.). Bearings are available in 0.025 mm (0.001 in.), 0.076 mm (0.003 in.), and 0.254 mm (0.010 in.) undersize. **Install the bearings in pairs. Do not use a new bearing half with an old bearing half. Do not file the rods or bearing caps.**

(1) Follow procedure specified in the Standard Service Procedure Section for Measuring Main Bearing Clearance and Connecting Rod Bearing Clearance (Fig. 13). Refer to Connecting Rod Bearing Oil Clearance Chart for specifications.

NOTE: The rod bearing bolts should be examined before reuse. If the threads are necked down the bolts should be replaced (Fig. 14).

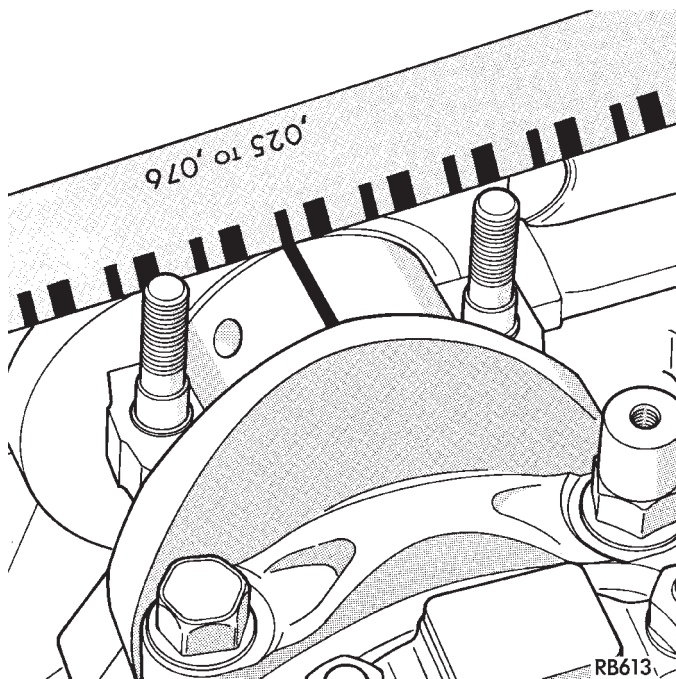


Fig. 13 Checking Connecting Rod Bearing Clearance—Typical

CONNECTING ROD BEARING OIL CLEARANCE CHART

New Part:	0.019 to 0.087 mm (0.0008 to 0.0034 in.)
Wear Limit:	0.095 mm (0.0037 in.)

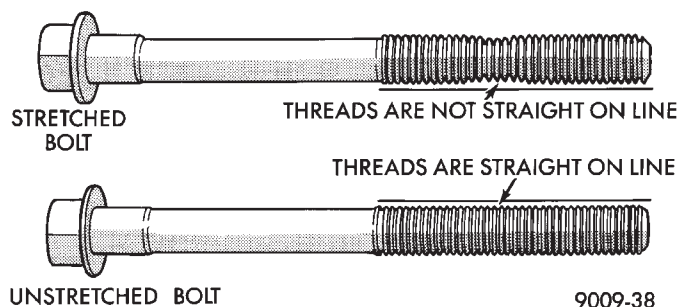


Fig. 14 Check for Stretched Bolts

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

(3) Before installing the nuts the threads should be oiled with engine oil.

(4) Install nuts on each bolt finger tight then alternately torque each nut to assemble the cap properly.

(5) Tighten the nuts to 54 N·m PLUS 1/4 turn (40 ft. lbs. PLUS 1/4 turn).

(6) Using a feeler gauge, check connecting rod side clearance (Fig. 15). Refer to Connecting Rod Side Clearance Chart for specifications.

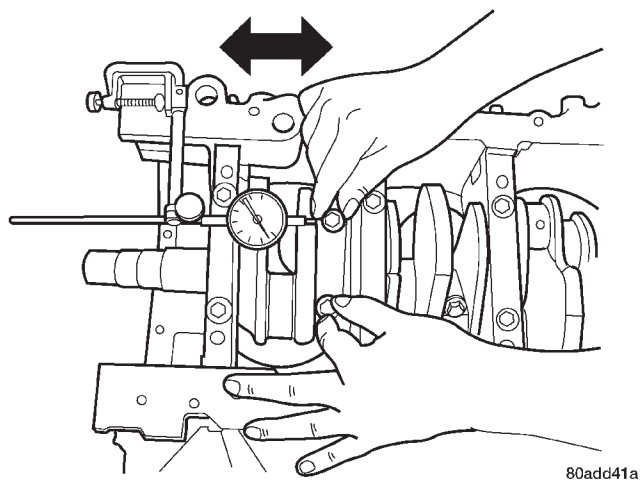


Fig. 15 Connecting Rod Side Clearance Measuring
CONNECTING ROD SIDE CLEARANCE CHART

New Part:	0.13 to 0.38 mm (0.005 to 0.015 in.)
Wear Limit:	0.40 mm (0.0157 in.)

CRANKSHAFT MAIN BEARING FITTING

The main bearings are a "select fit" to achieve proper oil clearances. For main bearing selection, the block and crankshaft have grade identification marks.

SERVICE PROCEDURES (Continued)

The marks for the cylinder block main bore grade are located on the left side pan rail, just rear of the left engine mount bracket (Fig. 16). These grade marks (1, 2, or 3) are read left to right, corresponding to main bore 1, 2, 3, 4.

The grade marks for the crankshaft are located on the rearmost crankshaft counter weight as shown in (Fig. 17). The crankshaft journal grade marks (A, B, or C) are read left to right, corresponding with journal number 1, 2, 3, 4.

Use the Main Bearing Selection Chart to properly select the main bearings. For an example, if the main bore grade is 3 and the journal grade is B, the proper select fit bearing would be a (2) +0.003 mm (+0.0002 in.).

NOTE: Service main bearings have a number from (1 – 5) marked in ink on the bearing surface (Fig. 18). For verification, use the Main Bearing Selection Chart for number to size identification.

The upper main bearing has a oil feed hole and a center groove to allow lubrication of the main journal and must be properly positioned in the block.

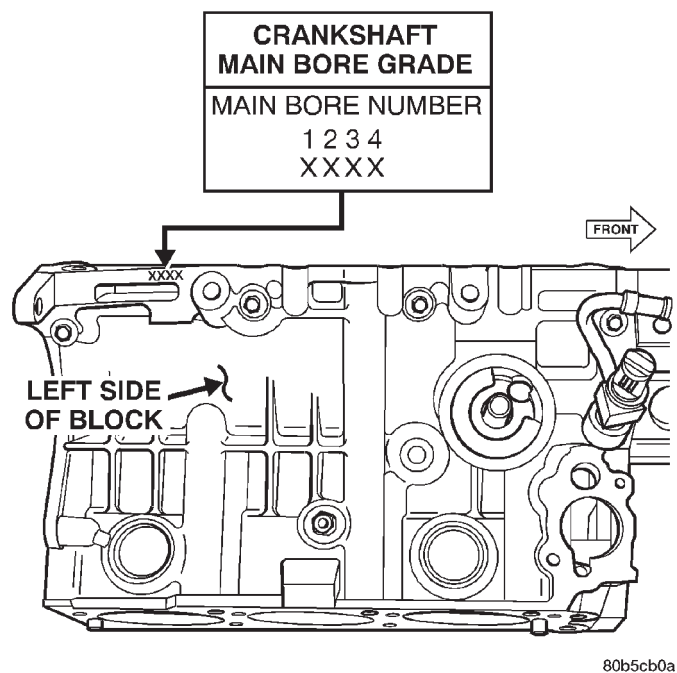


Fig. 16 Cylinder Block Main Bore Grade Marking Location

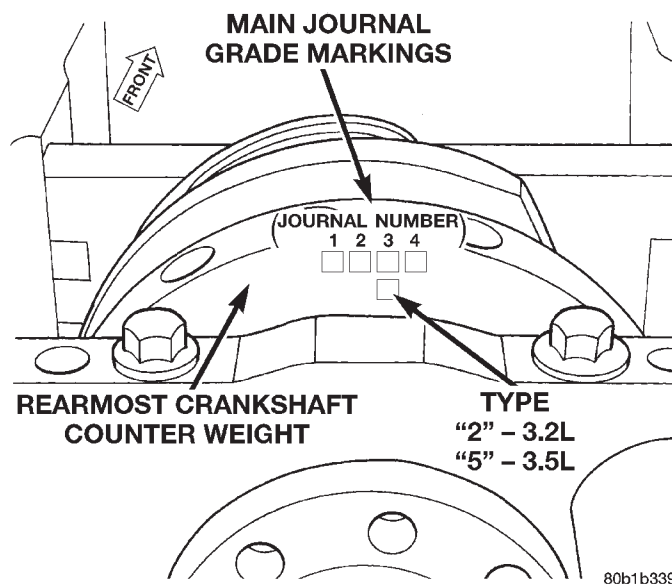


Fig. 17 Crankshaft Main Journal Grade Marking Location—Rear Of Block (Inverted) View

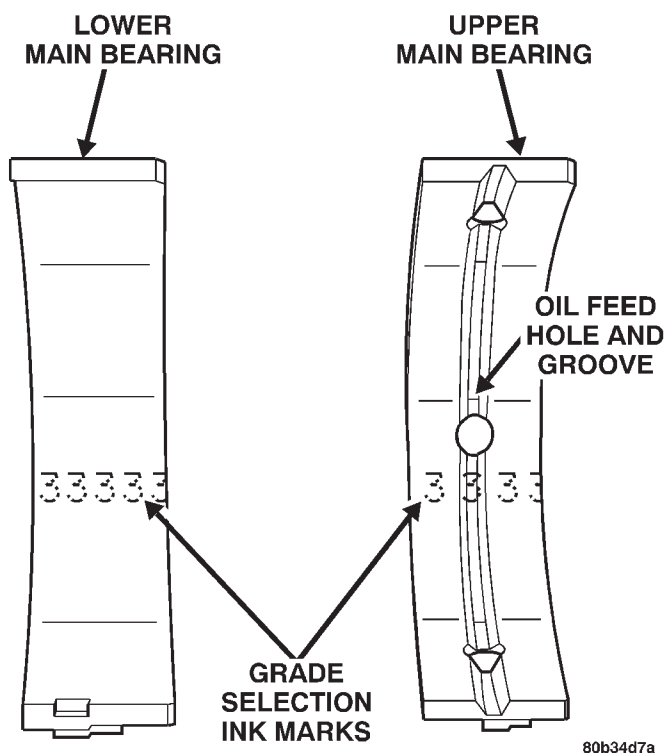


Fig. 18 Main Bearing Grade Marks

SERVICE PROCEDURES (Continued)

MAIN BEARING SELECTION CHART—3.2/3.5L

Main Bearing Bore Grade Marks			
Crankshaft Main Journal Grade Marks	1	2	3
	A	(3) standard	(2) +003 mm (+0.0002 in.)
			(1) +0.006 mm (+0.0003 in.)
	B	(4) -0.003 mm (-0.0002 in.)	(3) standard
			(2) +003 mm (+0.0002 in.)
	C	(5) -0.006 mm (-0.0003 in.)	(4) -0.003 mm (-0.0002 in.)
			(3) standard

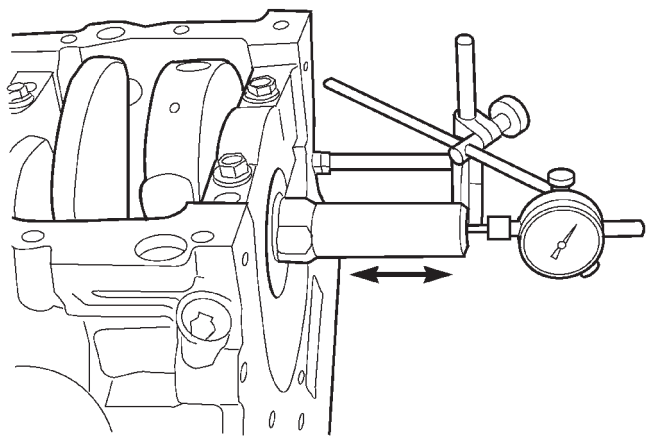
CHECKING CRANKSHAFT END PLAY

(1) Using Dial Indicator C-3339 and Mounting Post L-4438, attach to front of engine, locating probe perpendicular on nose of crankshaft (Fig. 19).

(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 Crankshaft End Play Specification Chart.



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Fig. 19 Checking Crankshaft End Play

CRANKSHAFT END PLAY SPECIFICATION CHART

New Part:	0.0475 to 0.2725 mm (0.0019 to 0.0108 in.)
Wear Limit:	0.43 mm (0.017 in.)

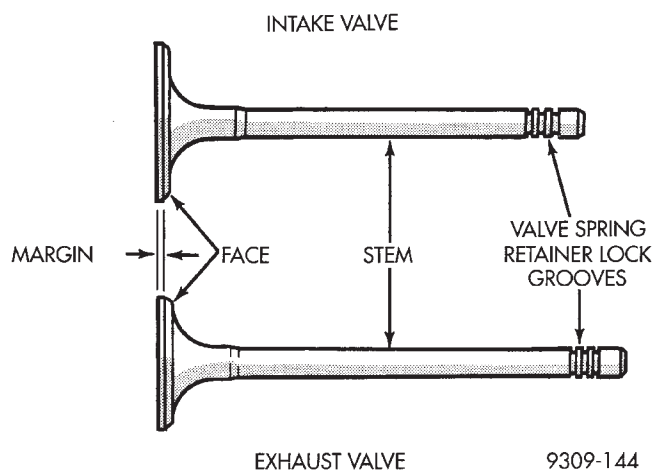
REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 44.5 to 45 degree face angle. The valve seats have a 45 to 45.5 degree face angle. The valve face and valve seat angles are shown in (Fig. 21).

VALVE SPECIFICATION CHART

FACE ANGLE	
Intake and Exhaust:	44.5° – 45°
HEAD DIAMETER	
Intake:	36.37 – 36.63 mm (1.4319 – 1.4421 in.)
Exhaust:	28.87 – 29.13 mm (1.1366 – 1.1468 in.)
LENGTH (OVERALL)	
Intake:	114.41 – 114.99 mm (4.5043 – 4.5272 in.)
Exhaust:	125.67 – 126.25 mm (4.9476 – 4.9705 in.)
STEM DIAMETER	
Intake:	6.935 – 6.953 mm (0.2730 – 0.2737 in.)
Exhaust:	6.906 – 6.924 mm (0.2719 – 0.2726 in.)
VALVE MARGIN	
Intake:	0.835 – 1.165 mm (0.0329 – 0.0459 in.)
Exhaust:	1.44 – 1.77 mm (0.0567 – 0.0697 in.)

VALVES



9309-144

Fig. 20 Intake and Exhaust Valves

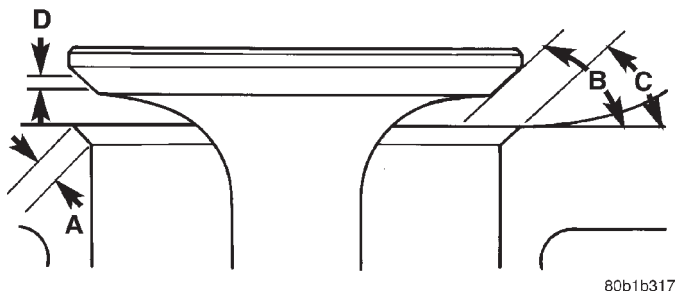
(1) Inspect the remaining margin after the valves are refaced (Fig. 20). Refer to Valve Specifications Chart.

SERVICE PROCEDURES (Continued)

VALVE SEATS

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

(2) Measure the concentricity of valve seat using dial indicator. Total runout should not exceed 0.051 mm (0.002 inch.) total indicator reading.



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Fig. 21 Valve Seats

ITEM	DESCRIPTION	SPECIFICATION	
A	Seat Width	Intake: 0.75 – 1.25 mm (0.030 – 0.049 in.)	Exhaust: 1.25 – 1.75 mm (0.049 – 0.069 in.)
B	Face Angle	Intake & Exhaust: 44.5 – 45°	
C	Seat Angle	Intake & Exhaust: 45 – 45.5°	
D	Seat Contact Area	Valve to seat contact must be at center of valve face.	

(3) 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 valve face, then lower valve seat with a 15 degree stone. If the blue is transferred to the bottom edge of valve face, then raise valve seat with a 65 degree stone.

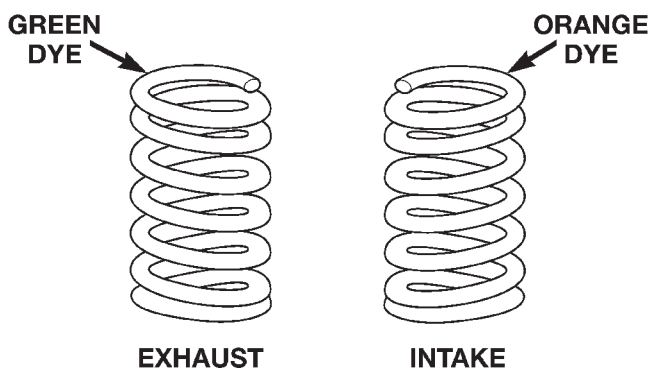
NOTE: Valve seats which are worn or burned can be reworked, provided that correct angle and seat width are maintained. Otherwise cylinder head must be replaced.

(4) When seat is properly positioned the width of the intake seats should be 0.75 to 1.25 mm (0.0296 to 0.0493 in.) and exhaust seats should be 1.25 to 1.75 mm (0.049 to 0.069 in.) (Fig. 21).

(5) Check the valve spring installed height after refacing the valve and seat (Fig. 23).

VALVE SPRING IDENTIFICATION

The valve springs are of two different lengths and are wound in different directions. The valve springs are color coded, intake spring is right hand coil direction with orange dye on the top coils and the exhaust spring is left hand coil direction with a green dye on the top coils (Fig. 22).



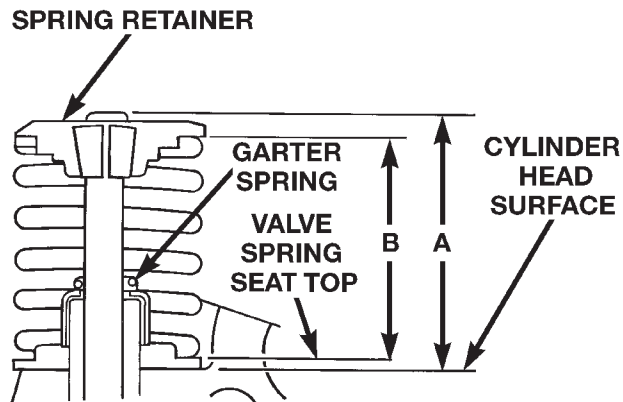
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Fig. 22 Valve Spring I.D.

VALVE INSTALLATION

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

(2) If valves or seats have been reground, check valve tip height (A) (Fig. 23). If valve tip height is greater than 43.65 mm (1.7185 in.) intake or 45.98 mm (1.8102 in.) exhaust, grind valve tip until within specifications. Make sure measurement is taken from cylinder head surface to the top of valve stem.



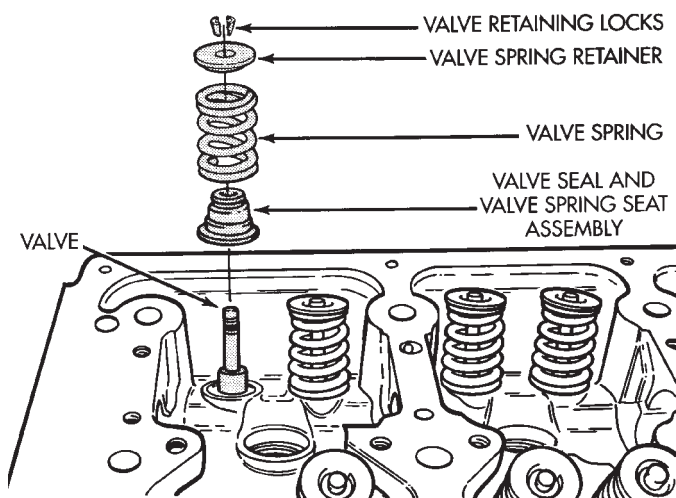
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Fig. 23 Checking Valve Tip Height and Valve Spring Installed Height

(3) Install valve seal/spring seat assembly over valve guides on all valve stems (Fig. 24). Ensure that the garter spring is intact around the top of the rubber seal. Install valve springs, valve retainers.

SERVICE PROCEDURES (Continued)

(4) Compress valve springs with a valve spring compressor install locks and release tool. **If valves and/or seats are reground, measure the installed height of springs (B) (Fig. 23), 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 (1.5256 in.), install a 0.762 mm (0.030 in.) spacer in head counterbore under the valve spring seat to bring spring height back within specification.



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Fig. 24 Valve Seal and Spring—Installation

REMOVAL AND INSTALLATION

ENGINE MOUNTS—LEFT AND RIGHT

REMOVAL

- (1) Raise vehicle on hoist.
- (2) Remove the isolator attaching nuts from top of the mounting bracket (Fig. 25).
- (3) Support the engine with a jack and a block of wood across the full width of the oil pan.
- (4) Remove the lower attaching nuts from the bottom of the isolator to the frame (Fig. 25).
- (5) Raise engine carefully with jack enough to remove the isolator with heat shield from its mount.

INSTALLATION

- (1) Install isolator mount with heat shield onto the frame.
- (2) Lower the engine onto the isolator mount.
- (3) Remove jack from vehicle.
- (4) Tighten the isolator to frame nuts to 61 N·m (45 ft. lbs.) (Fig. 25).
- (5) Install the upper attaching nuts to mount and tighten to 61 N·m (45 ft. lbs.) (Fig. 25).
- (6) Lower vehicle.

ENGINE HYDRO-MOUNT ISOLATORS

Engine hydro-mounts may show surface cracks, this will not effect performance and hydro-mount should not be replaced. Only replace the engine hydro-mounts when leaking fluid:

- Driveshaft distress: Refer to Driveshafts in Suspension, Group 2.
- Any front end structural damage (after repair).
- Isolator replacement.

ENGINE MOUNT—REAR

REMOVAL

- (1) Raise vehicle on hoist.
- (2) Support transaxle with a jack.
- (3) Remove isolator nuts from the mount to transaxle mount bracket (Fig. 25).
- (4) Remove rear mount isolator bolts to crossmember and remove mount (Fig. 25).

INSTALLATION

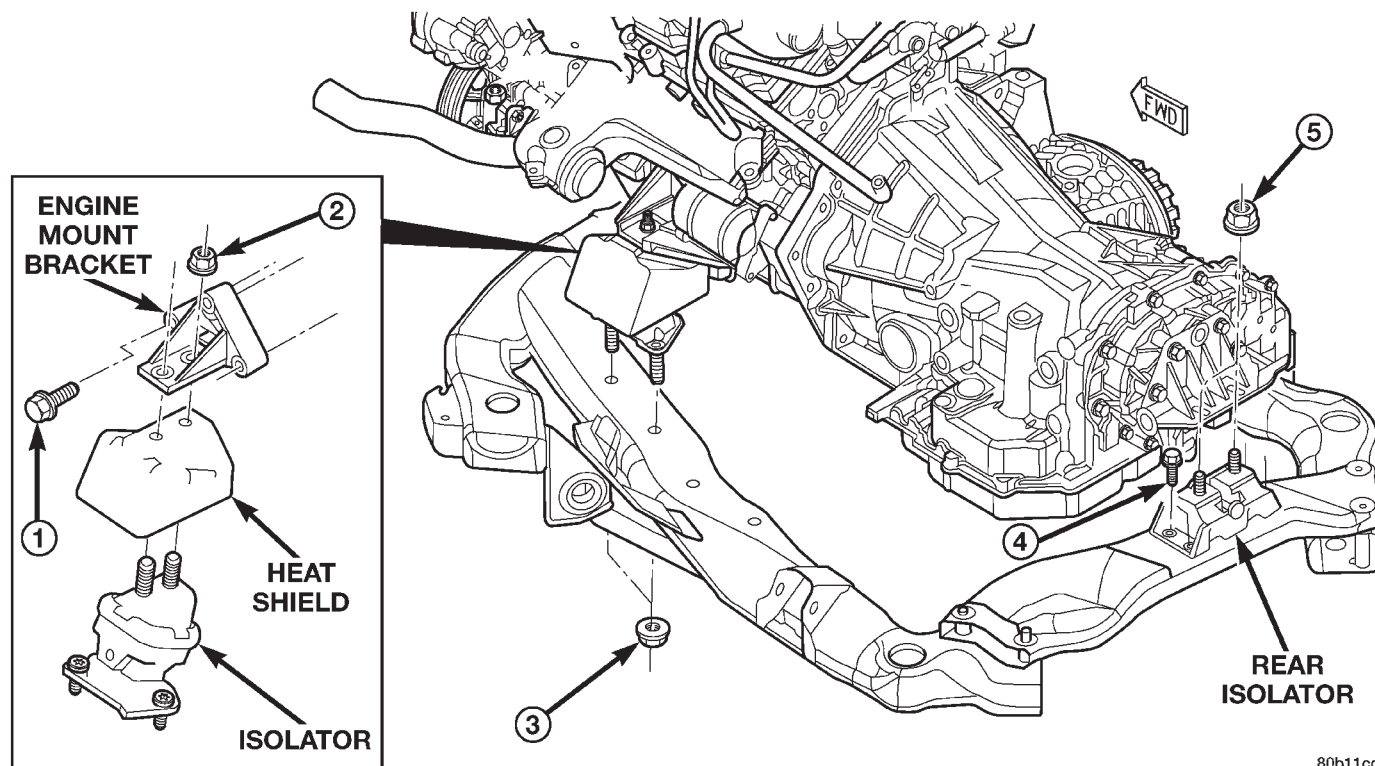
- (1) Position isolator onto crossmember.
- (2) Install bolts attaching isolator to crossmember and tighten to 33 N·m (250 in. lbs.) (Fig. 25).
- (3) Lower transaxle onto isolator
- (4) Install isolator nuts and tighten to 61 N·m (45 ft. lbs.) (Fig. 25).
- (5) Lower vehicle.

ENGINE ASSEMBLY

REMOVAL

- (1) Disconnect negative cable at right strut tower (Fig. 26).
- (2) Mark hood position at hinges and remove hood.
- (3) Remove both wiper arms.
- (4) Remove both cowl covers (Fig. 27).
- (5) Remove cowl support (Fig. 28).
- (6) Remove air cleaner assembly with air inlet hose (Fig. 29).
- (7) Remove upper radiator crossmember. Refer to Group 23, Body for procedure.
- (8) Disconnect hood release cable from hood latch.
- (9) Remove fan module.
- (10) Drain cooling system. Refer to Group 7, Cooling System for procedure.
- (11) Remove A/C and accessory drive belts. Refer to Group 7, Cooling System for procedure.
- (12) Disconnect upper radiator hose at engine.
- (13) Disconnect lower radiator hose at radiator.
- (14) Disconnect engine oil and transmission cooler lines at radiator.
- (15) Remove power steering line bracket at left side of radiator.
- (16) Remove fasteners attaching air conditioning condenser to radiator.
- (17) Remove Radiator.

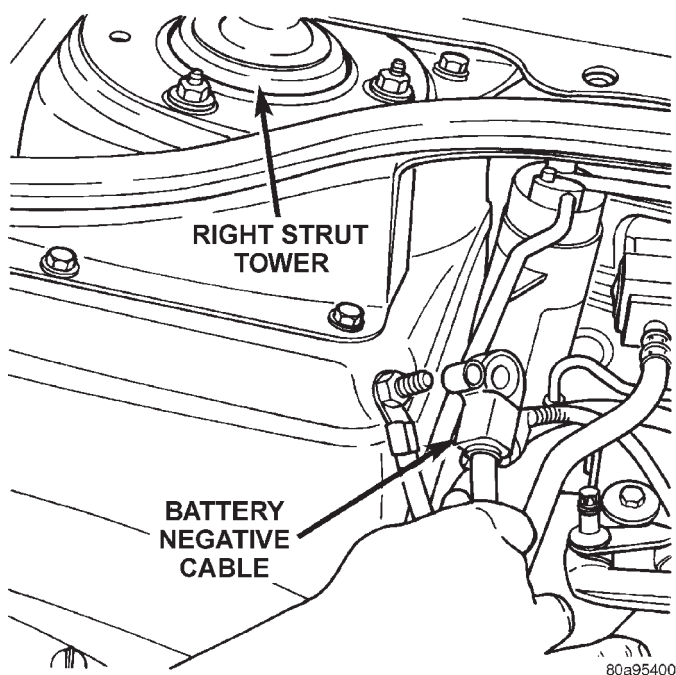
REMOVAL AND INSTALLATION (Continued)



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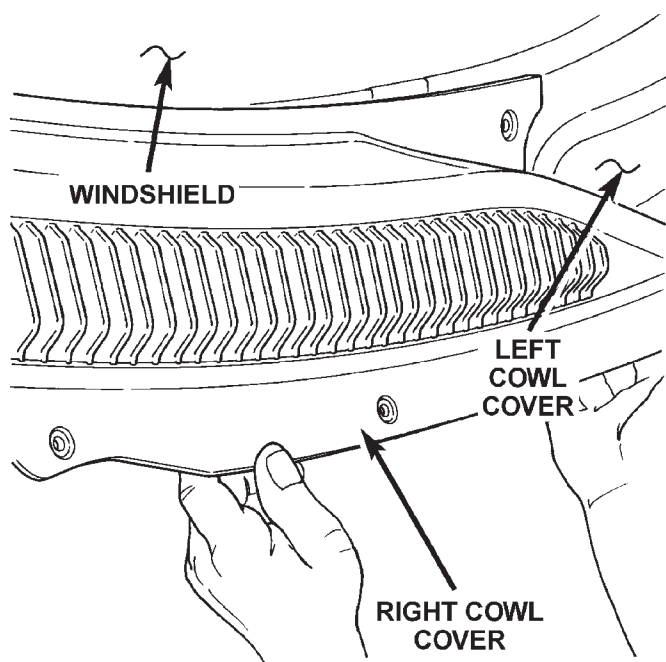
Fig. 25 Engine Mounting—Right, Left, and Rear

ITEM	DESCRIPTION	TORQUE	ITEM	DESCRIPTION	TORQUE
1	Bolt (Qty 3 Per Side)	61 N·m (45 ft. lbs.)	4	Bolt (Qty 4)	33 N·m (250 in. lbs.)
2	Nut (Qty 2 Per Side)	61 N·m (45 ft. lbs.)	5	Nut (Qty 2)	61 N·m (45 ft. lbs.)
3	Nut (Qty 2 Per Side)	61 N·m (45 ft. lbs.)			



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Fig. 26 Negative Cable—Disconnect



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Fig. 27 Cowl Covers

REMOVAL AND INSTALLATION (Continued)

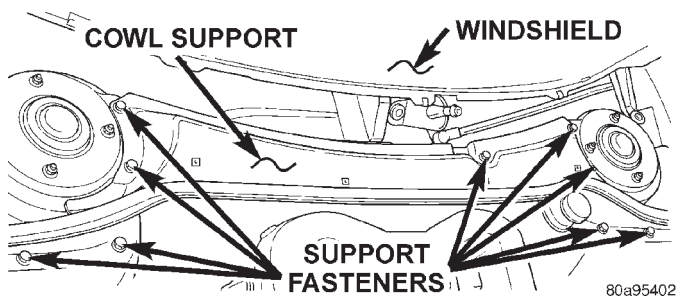


Fig. 28 Cowl Support

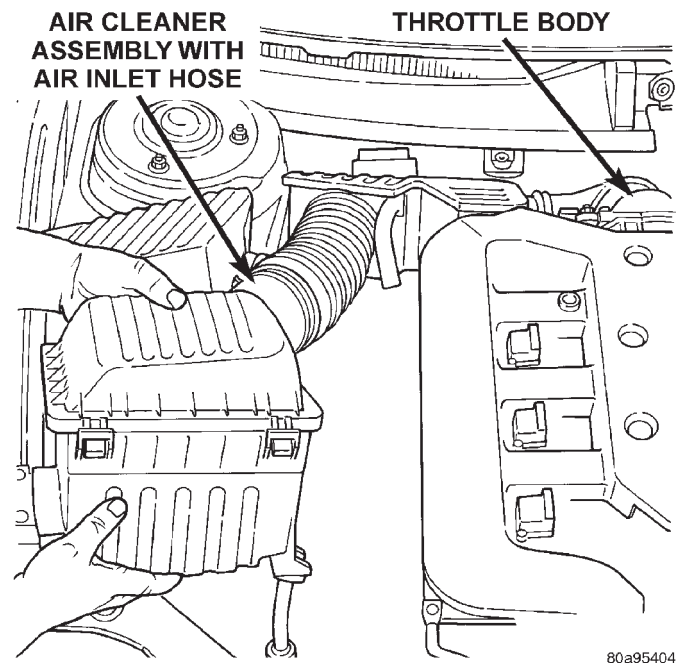


Fig. 29 Air Cleaner With Inlet Hose

- (18) Remove generator.
- (19) Remove power steering pump mounting bolts and set pump aside.
- (20) Remove air conditioning compressor mounting bolts and set aside.
- (21) Loosen and remove V-Band clamp at right exhaust manifold.
- (22) Remove front and rear support bracket fasteners attaching right side catalytic converter down pipe.
- (23) Release fuel pressure. Refer to Group 14, Fuel Delivery System for procedure.
- (24) Disconnect fuel line.
- (25) Disconnect throttle and speed control cables from bracket.
- (26) Disconnect both hoses at coolant bottle.
- (27) Disconnect all vacuum hoses.
- (28) Disconnect ground straps at both cylinder heads.

CAUTION: Upper Intake manifold is a composite design. Therefore, manifold should be removed before lifting engine or damage to the manifold could occur.

- (29) Remove upper intake manifold. Cover intake manifold openings with tape.
- (30) Disconnect heater hoses.
- (31) Remove rear throttle body support bracket.
- (32) Remove fastener for water pipe at transmission to block bolt.
- (33) Remove four upper transmission to block bolts.
- (34) Disconnect all electrical connections.
- (35) Hoist vehicle.
- (36) Drain engine oil.
- (37) Remove structural collar and mark flex plate to torque converter position.
- (38) Remove bolts holding torque converter to flex plate.
- (39) Disconnect both transmission oil cooler line brackets from engine.
- (40) Loosen and remove left exhaust manifold V-Band clamp.
- (41) For starter removal, loosen the left converter exhaust pipe band clamp and exhaust pipe support bracket at transaxle.
- (42) Remove starter.
- (43) Remove left engine mount bolts.
- (44) Remove right engine mount bolts.
- (45) Remove crankshaft position sensor.
- (46) Remove two lower transmission to block bolts.
- (47) Lower vehicle.
- (48) Attach lifting device to engine.
- (49) Insert floor jack with small block of wood under transmission pan to support transmission.
- (50) Hoist engine from engine compartment.

INSTALLATION

- (1) Attach lifting device and lower engine into engine compartment.
- (2) Align engine mounts and install fasteners but **do not tighten** until all mounting bolts have been installed.
- (3) Install transmission case to engine block tighten bolts to 102 N·m (75 ft. lbs.).
- (4) Remove engine lifting device.
- (5) Raise vehicle.
- (6) Tighten engine mount fastener to 61 N·m (45 ft. lbs.).
- (7) Align flex plate to torque converter and install mounting bolts tighten to 75 N·m (55 ft. lbs.).
- (8) Install crankshaft position sensor.
- (9) Install starter.
- (10) Install new V-Band clamp at left side exhaust manifold to catalytic converter. Tighten V-Band clamp to 11 N·m (100 in. lbs.).

REMOVAL AND INSTALLATION (Continued)

(11) Install left side catalytic converter down pipe support fastener at transaxle. Tighten fastener to 47 N·m (35 ft. lbs.).

(12) Tighten the left converter down pipe band clamp.

(13) Install the transmission oil cooler lines bracket to engine.

(14) Install structural collar. Refer to procedure in this section.

(15) Lower vehicle.

(16) Connect all electrical connections.

(17) Install four upper transmission to block bolts tighten to 102 N·m (75 ft. lbs.).

(18) Install water pipe and retaining fasteners to the transaxle/cylinder block double-ended bolts.

(19) Install rear throttle body support bracket.

(20) Connect heater hoses.

(21) Install intake manifold. Refer to Group 11, Exhaust System And Intake Manifold for procedure.

(22) Connect ground straps at both cylinder heads.

(23) Connect all vacuum hoses.

(24) Connect both hoses at coolant bottle.

(25) Connect throttle and speed control cables to bracket and throttle arm.

(26) Connect fuel line.

(27) Install new V-Band clamp at right exhaust manifold. Tighten V-Band clamp to 11 N·m (100 in. lbs.).

(28) Install and tighten right side catalytic converter down pipe support bracket fastener at transaxle mount.

(29) Install air conditioning compressor and tighten fasteners to 28 N·m (250 in. lbs.).

(30) Install power steering pump and tighten fasteners to 28 N·m (250 in. lbs.).

(31) Install generator.

(32) Install radiator.

(33) Attach air conditioning condenser to radiator.

(34) Install power steering line bracket to radiator.

(35) Connect engine oil and transmission cooler lines to radiator.

(36) Install lower radiator hose.

(37) Install upper radiator hose.

(38) Install A/C and accessory drive belts. Refer to Group 7, Cooling System for procedure.

(39) Install fan module.

(40) Fill cooling system. Refer to Group 7, Cooling System for procedure.

(41) Fill engine with proper amount of oil.

(42) Connect hood release cable to hood latch and install upper radiator crossmember.

(43) Install air cleaner and air inlet hose.

(44) Install cowl support.

(45) Install both cowl covers.

(46) Install both wiper arms.

(47) Install hood.

(48) Connect negative cable at right strut tower.

CRANKSHAFT DAMPER

REMOVAL

(1) Disconnect negative cable at right strut tower.

(2) Remove upper radiator crossmember. Refer to Group 23, Body for procedure.

(3) Remove fan module. Refer to Group 7, Cooling System for procedure.

(4) Remove the accessory drive belts. Refer to Group 7, Accessory Drive System for procedure.

(5) Use Special Tool 8191 to hold crankshaft damper while removing center bolt (Fig. 30).

(6) Use Special Tool 1023 puller, and insert C-4685-C2, remove crankshaft damper (Fig. 31).

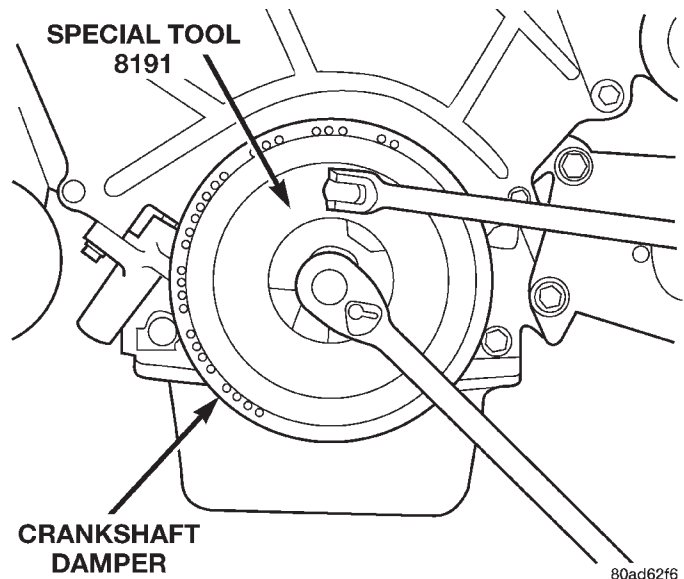


Fig. 30 Crankshaft Damper Center Bolt—Removal and Installation

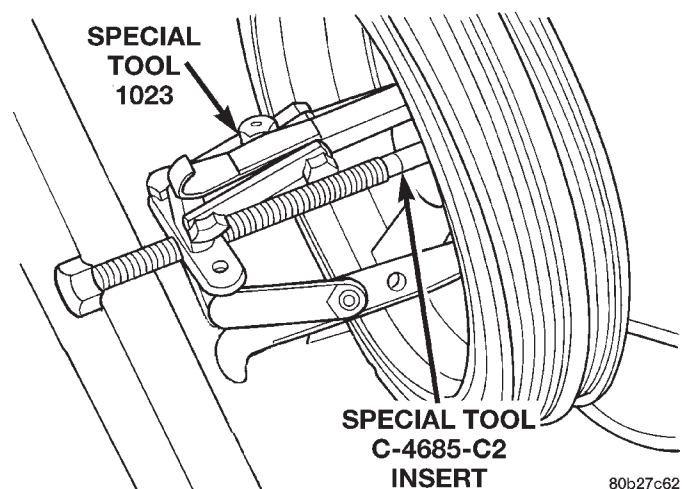
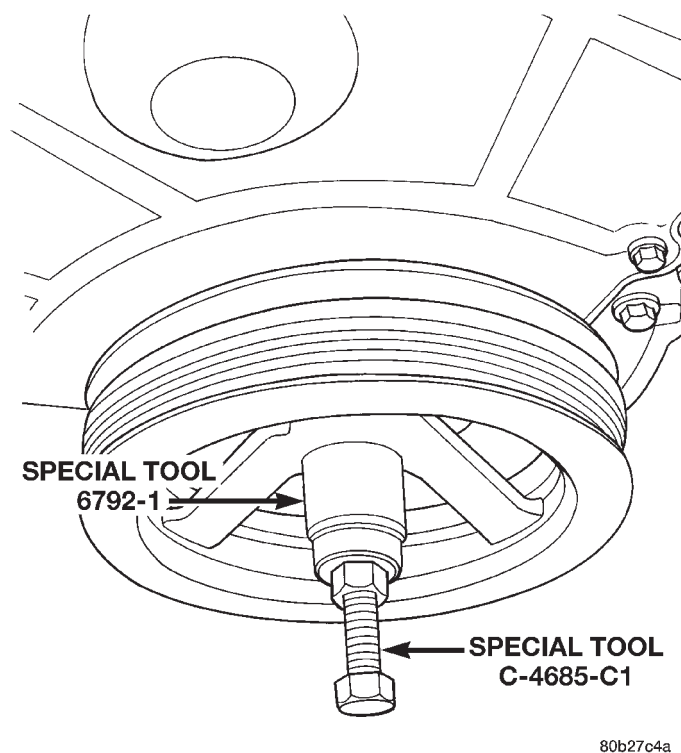


Fig. 31 Crankshaft Damper—Removal

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

**Fig. 32 Crankshaft Damper—Installation**

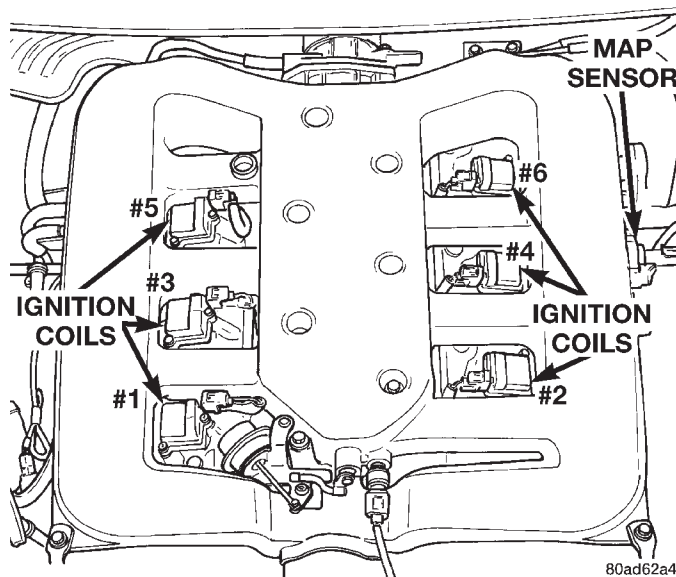
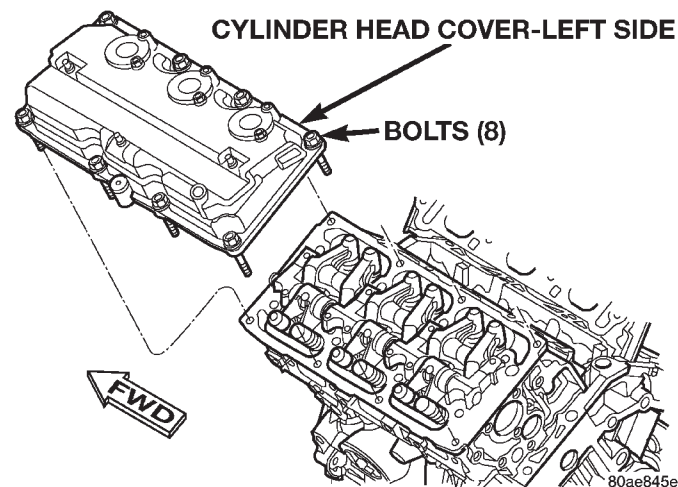
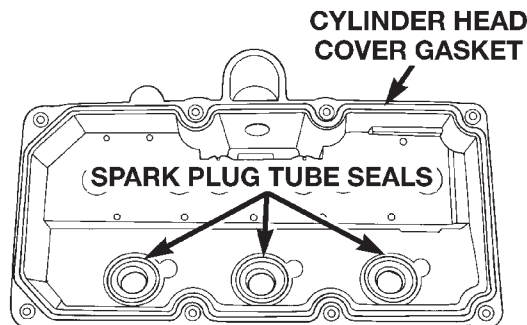
(1) Install crankshaft damper using Special Tools C-4685-C1 (5.9 in.) Bolt, with Nut and Thrust Bearing from 6792, and 6792-1 Installer (Fig. 32). Install center bolt and tighten to 115 N·m (85 ft. lbs.) (Fig. 30).

- (2) Install accessory drive belts.
- (3) Install fan module.
- (4) Install upper radiator crossmember.
- (5) Connect negative cable.

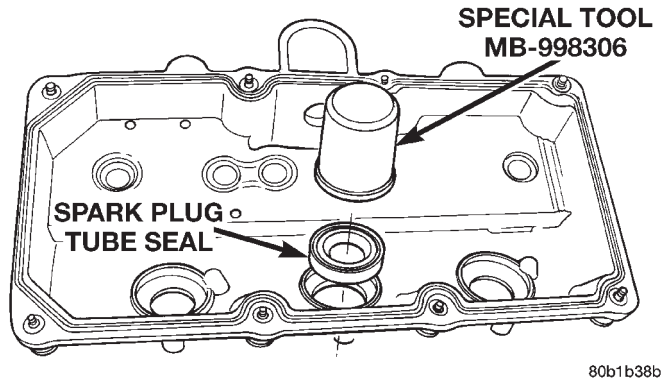
CYLINDER HEAD COVERS**REMOVAL**

WARNING: DO NOT START OR RUN ENGINE WITH CYLINDER HEAD COVER REMOVED FROM THE ENGINE. DAMAGE OR PERSONAL INJURY MAY OCCUR.

- (1) Remove air cleaner assembly and upper intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold for procedure.
- (2) Cover lower intake manifold with a suitable cover during service.
- (3) Disconnect electrical connectors and remove ignition coils (Fig. 33).
- (4) Remove cylinder head cover bolts and remove cover (Fig. 34).

**Fig. 33 Ignition Coils****Fig. 34 Cylinder Head Covers****Fig. 35 Cylinder Head Cover Gasket and Spark Plug Tube Seals**

REMOVAL AND INSTALLATION (Continued)

**Fig. 36 Spark Plug Tube Seal Installation****INSTALLATION**

(1) Clean cylinder head and cover mating surfaces. Inspect and replace gasket and seals as necessary (Fig. 35).

(2) To replace spark plug tube seals:

- a. Using a pry tool, carefully remove tube seals.
- b. Position new seal with the part number on seal facing cylinder head cover.
- c. Install seals with Special Tool MB-998306 (Fig. 36).

(3) Install cylinder head cover bolts and tighten to 12 N·m (105 in. lbs.) (Fig. 34).

(4) Install ignition coils and connect all electrical connectors.

(5) Install upper intake plenum and air cleaner assembly.

SPARK PLUG TUBES**REMOVAL**

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

(2) Using locking pliers remove the tube from the cylinder head (Fig. 37). Discard old tube.

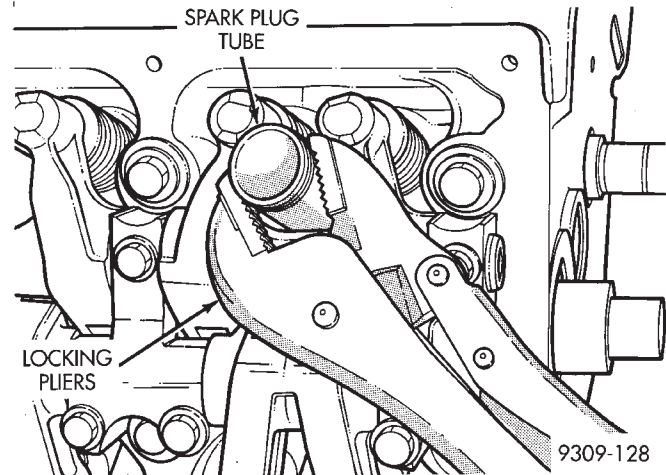
(3) Clean area around spark plug with Mopar® Parts Cleaner or equivalent.

INSTALLATION

(1) Apply Mopar® Stud and Bearing Mount to a new tube approximately 1 mm (0.039 in.) from the end of tube, in a 3 mm (0.118 in.) wide area.

(2) Install sealer end of tube into the cylinder head. Then carefully install the tube using a hardwood block and mallet. Install the tube until it is seated into the bottom of the bore.

(3) Install cylinder head cover. Refer to procedure outlined in this section.

**Fig. 37 Servicing Spark Plug Tubes****CYLINDER HEAD****REMOVAL**

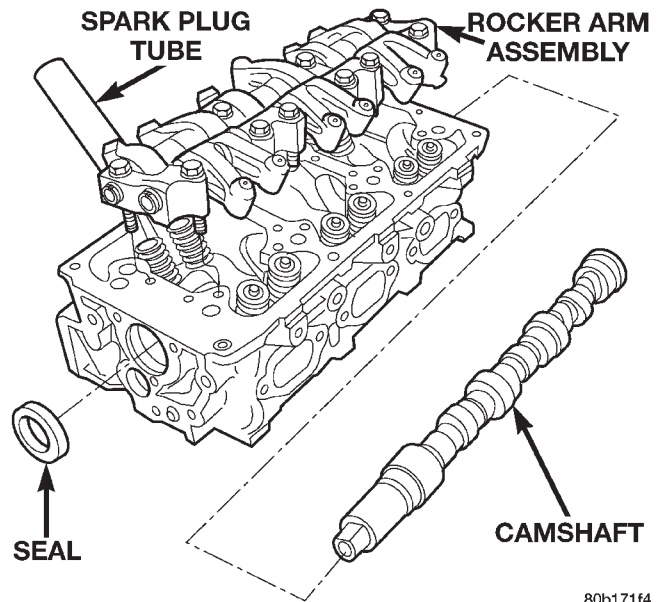
(1) Drain cooling system. Refer to Group 7, Cooling System for procedure.

(2) Remove crankshaft damper.

(3) Remove timing belt covers.

(4) Remove camshaft sprockets. Refer to Camshaft Sprocket and Engine Timing Procedure in this section.

(5) Remove intake manifold assembly. Refer to Group 11, Intake and Exhaust Manifolds, for procedure.

**Cylinder Head, Camshaft, and Rocker Arms**

REMOVAL AND INSTALLATION (Continued)

(6) Remove rear timing belt cover to cylinder head fasteners (Fig. 38). Remove the rear covers.

(7) The right side rear timing belt cover has O-rings to seal the water pump passages to cylinder block (Fig. 39). Do not reuse O-rings.

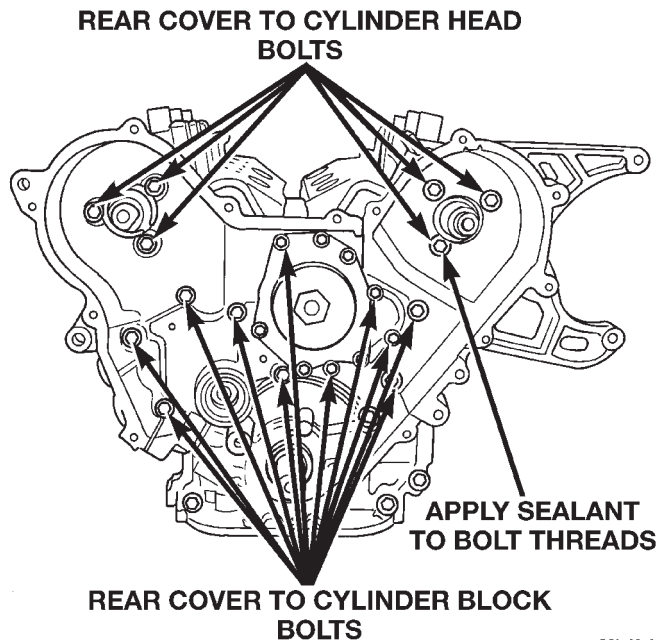


Fig. 38 Rear Timing Belt Cover Attaching Bolts

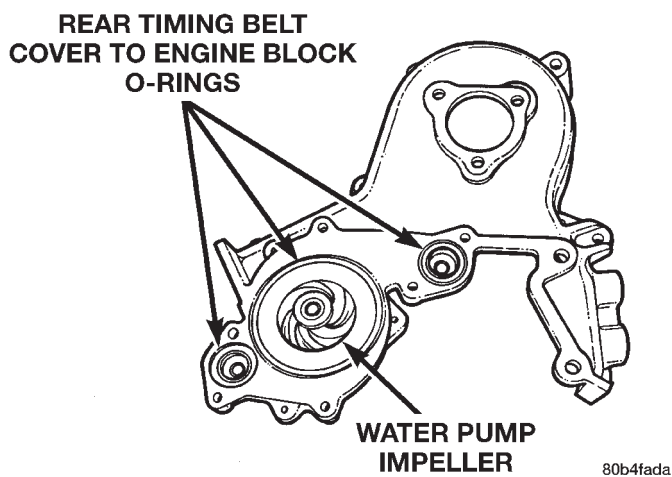


Fig. 39 Right Side Timing Belt Cover Water Pump O-Rings

(8) Remove cylinder head bolts and remove cylinder head.

INSTALLATION

The cylinder head bolts are tightened using a torque plus angle procedure. The bolts must be examined **BEFORE** reuse. If the threads are necked down the bolts should be replaced (Fig. 40).

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

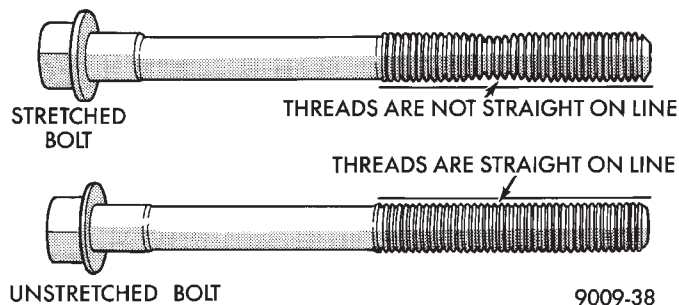


Fig. 40 Checking Bolts for Stretching (Necking)

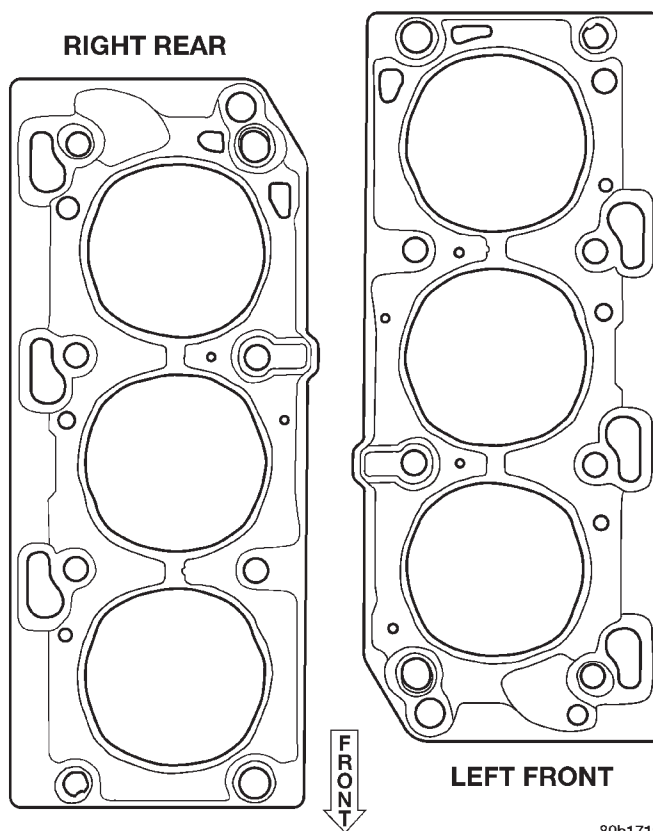


Fig. 41 Cylinder Head Gasket Identification

REMOVAL AND INSTALLATION (Continued)

CAUTION: When cleaning cylinder head and cylinder block surfaces, **DO NOT** use a metal scraper because the surfaces could be cut or ground. Use **ONLY** a wooden or plastic scraper.

(1) Clean sealing surfaces of cylinder head and block.

CAUTION: Ensure that the correct head gaskets are used and are oriented correctly on cylinder block. The 3.5L engine head gaskets have perfectly round combustion sealing rings. The 3.2L engine does **NOT** have perfectly round combustion sealing rings.

(2) Install head gasket over locating dowels. Ensure the gasket is installed on the correct side of engine (Fig. 41).

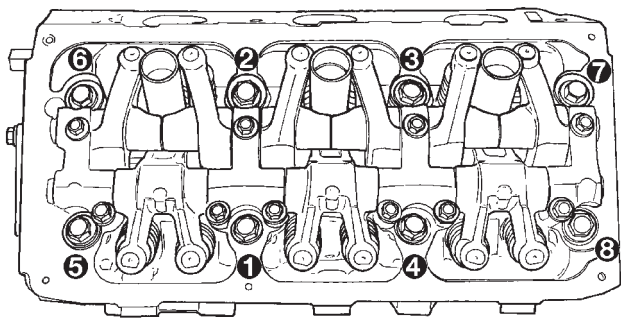
(3) Install cylinder head over locating dowels.

(4) Before installing the bolts, lubricate the threads with engine oil.

(5) Tighten the cylinder head bolts in the sequence shown in (Fig. 42). Using the 4 step torque-turn method, tighten according to the following torque values:

- Step 1: All to 61 N·m (45 ft. lbs.)
- Step 2: All to 88 N·m (65 ft. lbs.)
- Step 3: All (again) to 88 N·m (65 ft. lbs.)
- Step 4: + 90° Turn **Do not use a torque wrench for this step.**

(6) Bolt torque after 90° turn should be over 122 N·m (90 ft. lbs.) in the tightening direction. If not, replace the bolt.



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Fig. 42 Cylinder Head Bolt Tightening Sequence

(7) Clean right rear timing belt cover O-ring sealing surfaces and grooves. Lubricate new O-rings with synthetic grease to facilitate assembly.

(8) Install rear timing belt covers (Fig. 38). (Fig. 39). Tighten bolts to specified torque:

- M10—54 N·m (40 ft. lbs.)
- M8—28 N·m (20 ft. lbs.)
- M6—12 N·m (105 in. lbs.)

(9) Install camshaft sprockets and timing belt. Refer to procedure in this section.

(10) Install timing belt covers. Refer to procedure in this section.

(11) Install intake and exhaust manifolds. Refer to Group 11, Intake and Exhaust Manifolds for procedures.

(12) Install crankshaft damper.

(13) Fill cooling system. Refer to Group 7, Cooling System for procedure.

CRANKSHAFT

REMOVAL

(1) Remove engine from vehicle. Refer to Engine Assembly Removal and Installation in this section.

(2) Remove oil pan.

(3) Remove oil pick-up tube.

(4) Remove idler pulley for accessory drive belt.

(5) Remove front lower timing belt cover.

(6) Remove front main timing belt cover.

(7) Remove front left side timing belt cover.

(8) Remove crankshaft damper. Refer to procedure in this section.

(9) Remove timing belt tensioner and timing belt.

(10) Remove crankshaft sprocket. Refer to Front Crankshaft Oil Seal Removal and Installation for procedure.

(11) Tap dowel pin out of crankshaft. Refer to Front Crankshaft Oil Seal Removal and Installation for procedure.

(12) Remove oil pump assembly.

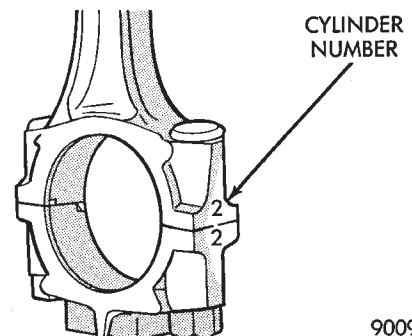
(13) Remove rear crankshaft oil seal retainer.

(14) Remove connecting rod bearing caps. Connecting rod bearing caps are not interchangeable and should be marked before removal to insure correct assembly (Fig. 43).

(15) Remove main bearing caps. Main bearing caps are not interchangeable and are marked to insure correct assembly (Fig. 44).

(16) Remove Crankshaft.

NOTE: Before installing Crankshaft refer to Fitting Main Bearings and Installation of Connecting Rod Bearings in this section.



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Fig. 43 Connecting Rod to Cylinder Identification

REMOVAL AND INSTALLATION (Continued)

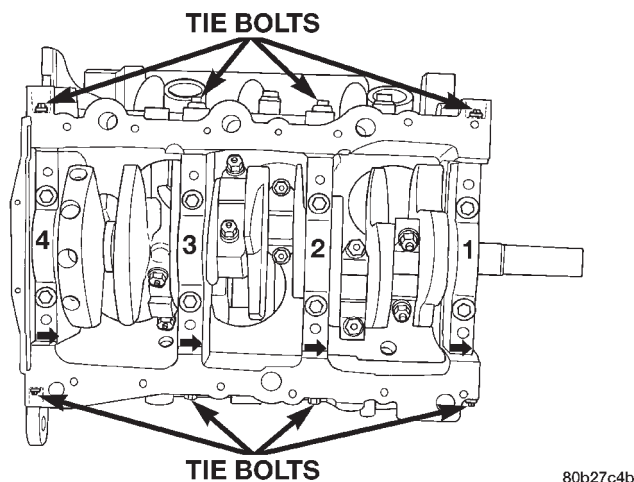


Fig. 44 Main Bearing Cap Identification

INSTALLATION

2 PIECE THRUST WASHER (UPPER ONLY)

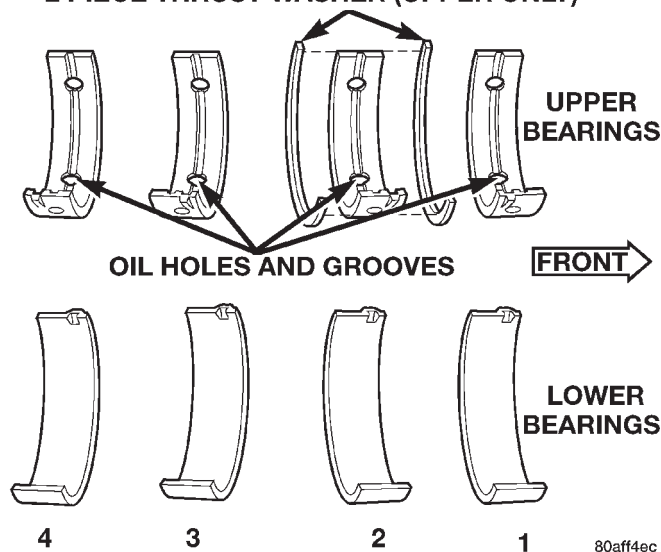


Fig. 45 Main Bearing Identification

CAUTION: Main bearings are select fit. Refer to Crankshaft Main Bearing Fitting in this section for proper bearing selection.

- (1) Install Crankshaft.
- (2) Move crankshaft forward to limit of travel. Lubricate and install the front thrust washer by rolling the washer onto the machined shelf between the No. 2 upper main bulk head and crankshaft thrust surface (Fig. 46).
- (3) Move crankshaft rearward to limit of travel. Lubricate and install the rear thrust washer by rolling the washer onto the machined shelf between the No. 2 upper main bulk head and crankshaft thrust surface.
- (4) Lubricate lower main bearings with clean engine oil.

NOTE: Lubricate main bearing cap bolts with engine oil before installation.

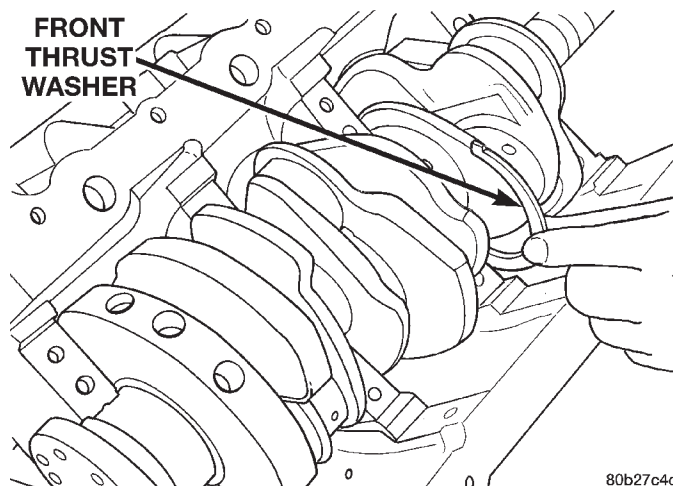


Fig. 46 Thrust Washer Installation

- (5) Install each main cap and tighten bolts finger tight.

The main bearing cap bolts must be tightened in the proper sequence. First the inner main cap bolts, secondly the windage tray bolts, lastly the main cap tie (horizontal) bolts.

- (6) Install the inside main bearing cap bolts and tighten to 20 N·m + 1/4 turn (15 ft. lbs. + 1/4 turn).

- (7) Measure crankshaft end play. Refer to Service Procedures in this section.

- (8) Install connecting rods and measure side clearance. Refer to Service Procedures in this section.

- (9) Install windage tray. Lubricate bolts with engine oil and tighten to 27 N·m + 1/4 turn (20 ft. lbs. + 1/4 turn).

- (10) Install the main cap tie (horizontal) bolts and tighten to 28 N·m (250 in. lbs.).

- (11) Install rear crankshaft oil seal retainer and oil seal. Refer to procedure in this section.

- (12) Install oil pump assembly. Refer to Oil Pump Removal and Installation in this section.

- (13) Install dowel pin in crankshaft. Refer to Front Crankshaft Oil Seal Removal and Installation for procedure.

- (14) Install crankshaft sprocket. Refer to Front Crankshaft Oil Seal Removal and Installation for procedure.

- (15) Install Timing Belt. Refer to Camshaft Sprockets and Timing Procedure in this section.

- (16) Install (3) timing belt covers.

- (17) Install crankshaft damper. Refer to procedure in this section.

- (18) Install idler pulley for accessory drive belt.

- (19) Install oil pick-up tube and tighten bolt to 28 N·m (250 in. lbs.).

- (20) Install oil pan. Refer to procedures outlined in this section.

- (21) Install engine assembly.

- (22) Fill engine crankcase with proper amount of oil.

REMOVAL AND INSTALLATION (Continued)

CAMSHAFT

REMOVAL

Camshafts are serviced from the rear of the cylinder head. The cylinder head must be removed.

(1) Remove Camshaft Sprocket. Refer to Camshaft Sprocket Removal in this section.

(2) Remove cylinder head. Refer to Cylinder Head Removal in this section.

(3) Mark the rocker arm and shaft assembly before removal. Remove the rocker arm and shaft assembly from the head.

(4) Remove the rear camshaft cover and O-ring from head.

CAUTION: Be careful not to Nick or Scratch the journals when removing the camshaft.

(5) Carefully remove the camshaft from the rear of the cylinder head.

INSTALLATION

(1) Lubricate camshaft journals and cam with clean engine oil and install camshaft into cylinder head.

(2) Install the rocker arm assembly. Refer to procedure outlined in this section.

NOTE: Refer to Camshaft Sprocket and Timing Procedure to complete camshaft installation.

CAMSHAFT SPROCKETS AND TIMING PROCEDURE

REMOVAL

CAUTION: The 3.2/3.5L engines are NOT a free-wheeling design. Therefore, care should be taken not to rotate the camshafts or crankshaft with the timing belt removed.

CAUTION: When camshaft sprocket bolts are loosened or removed, the camshafts must be re-timed to the engine. Also, the camshaft sprocket bolts must NOT be reused. Refer to camshaft timing and timing belt installation procedure outlined in this section.

(1) Hold camshaft sprocket with 36 mm (1 7/16 in.) box wrench loosen and remove bolt and washer. To remove the bolt with engine in the vehicle it may be necessary to lift that side of the engine because the right bolt is 213 mm (8 3/8 in.) long and the left bolt is 255 mm (10.0 in.) long.

(2) Remove camshaft sprocket from camshaft. Each sprocket has a D shaped hole that allows it to rotate several degrees in each direction on its shaft.

This design must be timed with the engine to ensure proper performance of the engine. Refer to camshaft and timing belt installation outlined in this section for procedure.

TIMING PROCEDURE—3.2/3.5L

CAUTION: The camshaft sprockets are not interchangeable from side to side (Fig. 47).

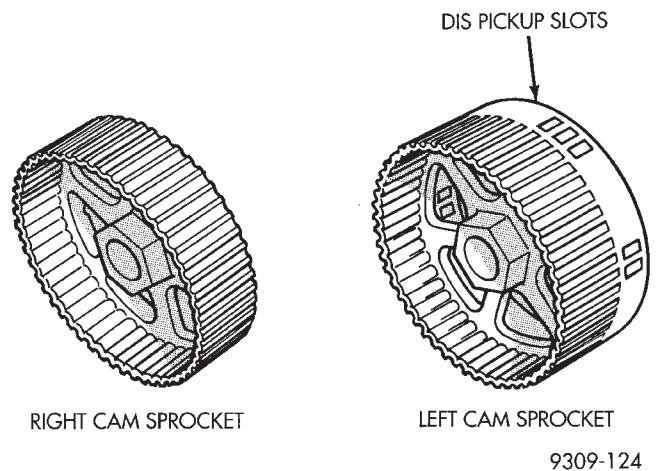


Fig. 47 Camshaft Sprocket Identification

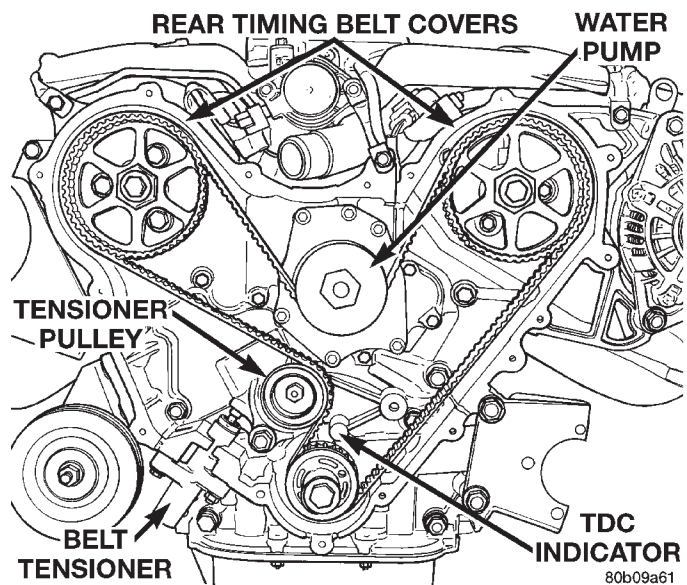


Fig. 48 Timing Belt System

(1) Place crankshaft sprocket to the TDC mark on the oil pump housing (Fig. 48).

(2) Install a dial indicator in number 1 cylinder to check TDC of the piston (Fig. 53). Rotate the crankshaft until the piston is at exactly TDC. This is important for good engine performance.

(3) Install the camshaft alignment Special Tools 6642 to the rear of each cylinder head (Fig. 49).

REMOVAL AND INSTALLATION (Continued)

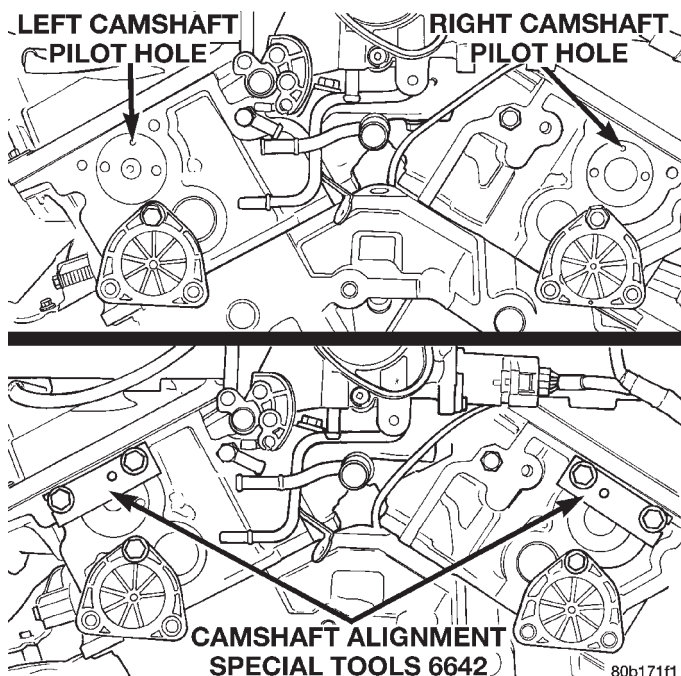


Fig. 49 Camshaft Alignment Special Tools 6642

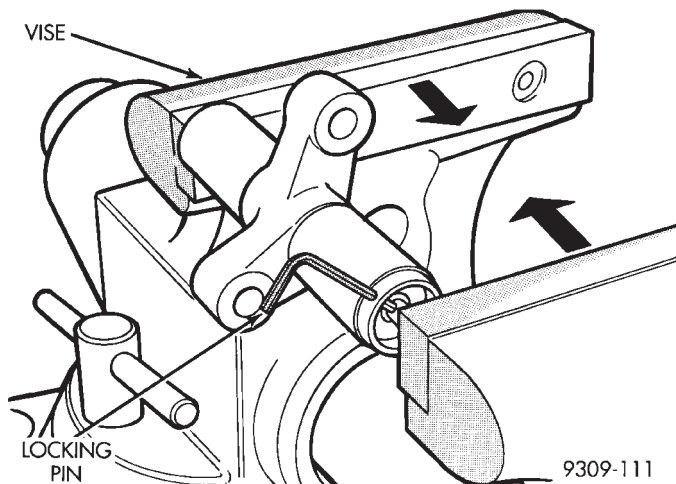


Fig. 50 Compressing Timing Belt Tensioner

CAUTION: Compress the tensioner slowly, as damage to the tensioner could result.

(4) Slowly pre-load the tensioner with a vise and install locking pin (Fig. 50).

NOTE: Once pin is installed, the tensioner must be stored with the plunger facing upward until it is ready to be reinstalled.

(5) Install camshaft sprockets onto the camshafts. Install **NEW** sprocket attaching bolts into place. The 255 mm (10 in.) bolt is to be installed in the left camshaft and the 213 mm (8 3/8 in.) bolt is to be installed into the right camshaft. **Do not tighten the bolts.** Camshaft sprocket mark should be positioned between the marks on the cover (Fig. 51) at both sprocket.

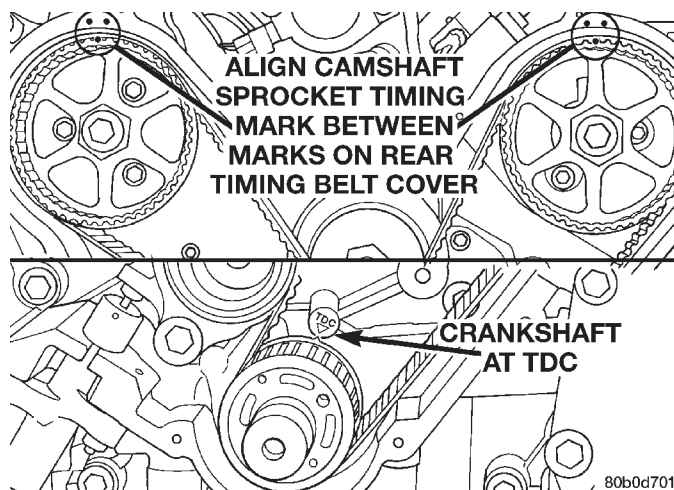


Fig. 51 Camshaft Sprocket Timing Marks

(6) Install the timing belt starting at the crankshaft sprocket going in a counterclockwise direction (Fig. 52). Install the belt around the last sprocket. Maintain tension on the belt as it is positioned around the tensioner pulley. Each camshaft sprockets mark should still fall between the cover marks.

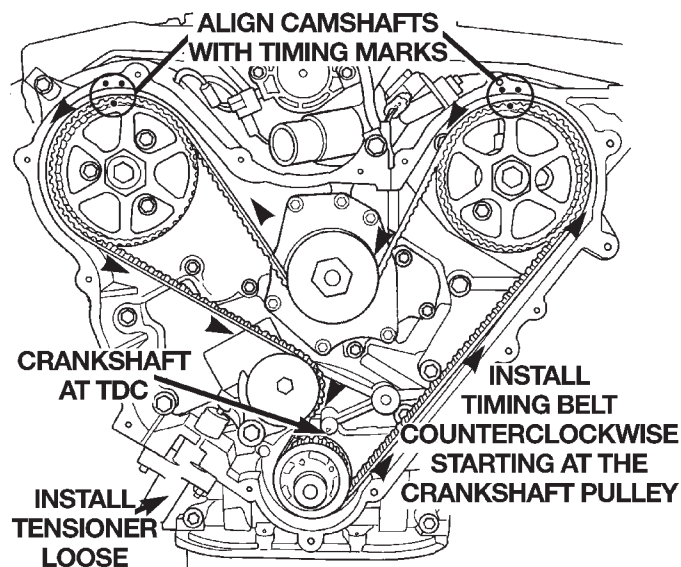


Fig. 52 Timing Belt—Installation

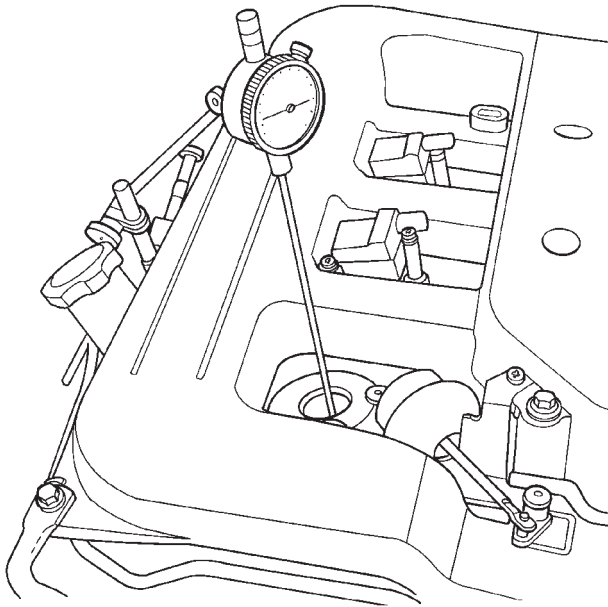
(7) Holding the tensioner pulley against the belt, install the tensioner into the housing and tighten to 28 N·m (250 in. lbs.).

(8) When tensioner is in place pull retaining pin to allow the tensioner to extend to the pulley bracket.

(9) With number 1 piston at TDC (Fig. 53), hold the camshaft sprocket hex with a 36 mm (1 7/16 in.) wrench and tighten the camshaft bolts to 102 N·m (75 ft. lbs.) plus a 90 degree turn for the Right side and 115 N·m (85 ft. lbs.) plus a 90 degree turn for the Left side.

(10) Remove dial indicator and install spark plug.

REMOVAL AND INSTALLATION (Continued)



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Fig. 53 Dial Indicator Locating Piston at TDC

(11) Remove camshaft alignment Special Tools 6642 and install cam covers and O-rings. Tighten fasteners to 28 N·m (250 in. lbs.).

(12) Install timing belt covers. Refer to Timing Belt Covers in this section.

(13) Install crankshaft damper.

(14) Install accessory drive belts. Refer to Group 7, Cooling System for procedure.

(15) Fill cooling system. Refer to Group 7, Cooling System for procedure.

(16) Start engine and allow to idle for approximately 1 minute. If a noticeable noise is present from the timing belt/tensioner, air has possibly entered the tensioner.

(a) To remove air from tensioner; using a DRB III, operate the engine at speed of 1600 – 2000 RPM for 10 minutes. This will purge air from tensioner and noise will be dissipated.

NOTE: If air is present, the tensioner will be soft and may generate noise. This noise should disappear after no more than 15 minutes of engine running time.

ROCKER ARM AND SHAFT ASSEMBLY

CAUTION: The rocker arm shafts are hollow and are used as lubrication oil passages. The rocker arm and shaft assembly on the **RIGHT** side of the engine has an oil passage hole from the cylinder head to the third rocker shaft support. The rocker arm shaft assembly on the **LEFT** side of the engine has an oil passage hole from the cylinder head to the second rocker shaft support.

REMOVAL

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

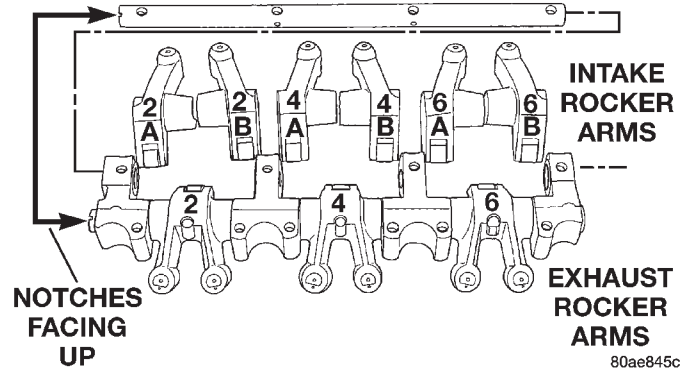
(2) Identify the rocker arm assembly and rocker arms before disassembly (Fig. 54).

(3) Remove rocker arm assembly bolts.

(4) Remove rocker arm assembly.

NOTE: To prevent air ingestion into lash adjusters, avoid turning rocker arm assembly upside down.

CAUTION: Do not allow rocker arm assembly to rest on lash adjusters, as damage may occur to lash adjusters and/or plastic retainers.

**Fig. 54 Rocker Arms and Shaft Identification—Left Bank****DISASSEMBLY**

(1) Remove dowel pin using a 4 mm screw, nut, spacer, and washer installed into the pin (Fig. 55). Tighten the screw into the pin, then loosen the nut on the screw. This will pull the dowel out of the shaft support. Do not reuse dowel pins. Remove the rocker arms and pedestals in order.

(2) Check the rocker arm mounting portion of the shafts for wear or damage. Replace if damaged or heavily worn.

(3) Check shaft oil holes for clogging with small wire, clean as required.

REMOVAL AND INSTALLATION (Continued)

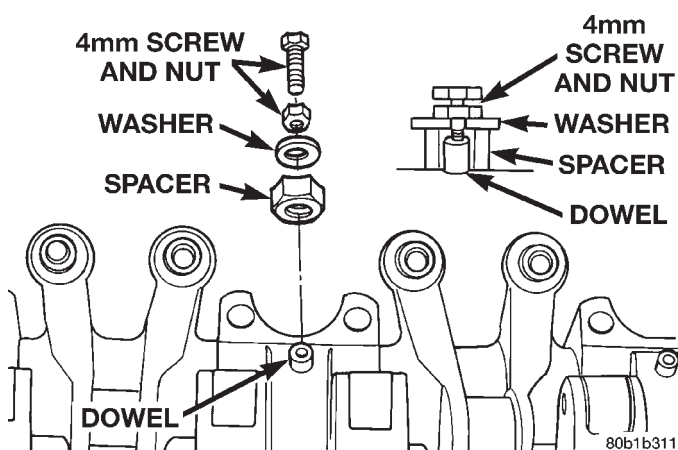


Fig. 55 Rocker Arms and Shaft—Disassembly

ASSEMBLY

CAUTION: New dowel pins must be installed during assembly.

(1) Install the rocker arms, and pedestals onto the shaft.

NOTE: The notches on the rocker shafts face up (Fig. 54). Notches on the right cylinder bank face towards rear of engine. Notches on left cylinder bank face toward front of engine.

(2) Install dowel pins (Fig. 56). Dowel pins pass through the pedestal into the exhaust rocker shafts. Dowel pins should be pressed in until they bottom-out against the rocker shaft in the pedestal.

CAUTION: Inspect all lash adjuster plastic retaining caps for proper retention before installation.

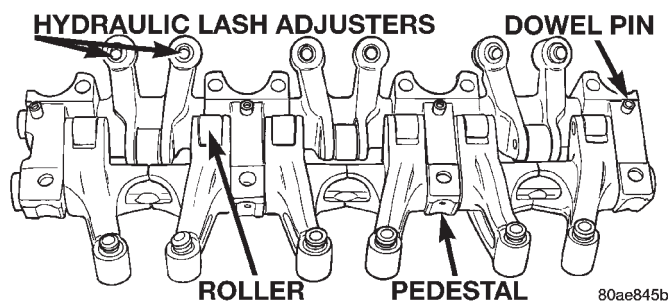


Fig. 56 Assemble Rocker Arms and Shaft

INSTALLATION

NOTE: Rocker arm and shaft assembly can be installed either prior to or after cylinder head installation.

(1) Rotate camshafts to the position shown in (Fig. 57). With the camshafts in these positions the lobes are in a neutral position (no load to the valve). This will allow the rocker arm shaft assembly to be tightened into position with little or no valve spring load on it.

(2) Install the rocker arm and shaft assembly making sure that the identification marks face toward the front of engine for left head and toward the rear of the engine for right head.

(3) Tighten bolts in sequence to 31 N·m (275 in. lbs.) (Fig. 58).

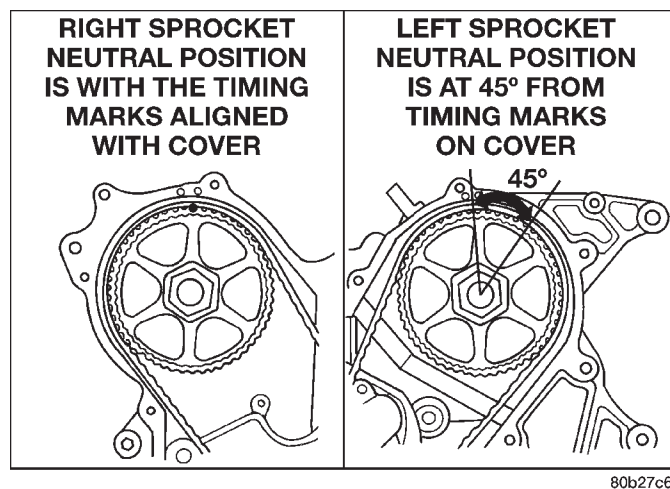


Fig. 57 Camshaft Sprockets Neutral Position

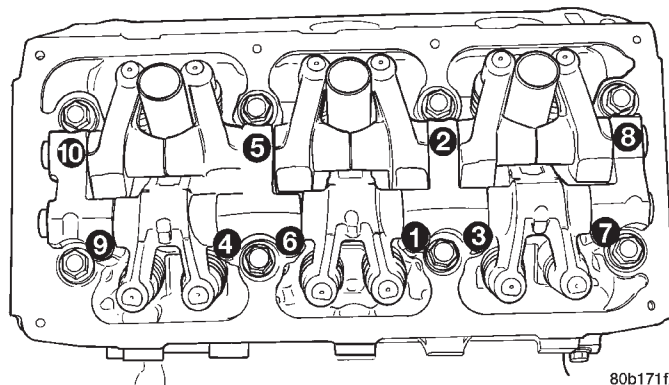


Fig. 58 Rocker Arm and Shaft Assembly Tightening Sequence

VALVE STEM SEALS OR VALVE SPRINGS—IN VEHICLE

(1) Perform fuel system pressure release procedure **before attempting any repairs**. Refer to Group 14, Fuel System for procedure.

(2) Disconnect negative battery cable.

(3) Remove air cleaner housing and hose assembly.

(4) Remove Intake Manifold. Refer to Group 11, Exhaust System and Intake Manifold for removal procedure.

REMOVAL AND INSTALLATION (Continued)

(5) Remove cylinder head covers and spark plugs. Refer to this section for procedure.

(6) Remove rocker arm and shaft assembly. Refer to this section for procedure.

(7) Rotate the crankshaft clockwise, until the number 1 piston is at TDC (Top Dead Center) on the compression stroke.

(8) With air hose attached to spark plug adapter installed in number 1 spark plug hole, apply 620.5 to 689 kPa (90 to 100 psi) air pressure. This is to hold valves into place while servicing components.

(9) Using Tool MD 998772A with adapter 6527 or equivalent, compress valve spring and remove valve locks, retainer, and valve spring.

(10) Remove valve stem seals by using a valve stem seal tool (Fig. 59).

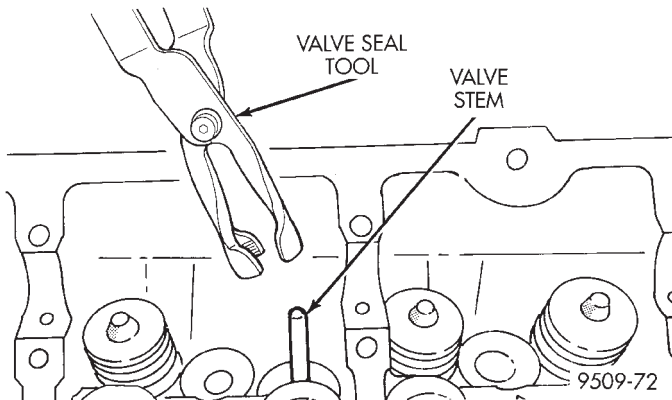


Fig. 59 Valve Stem Seal—Removal

(11) The valve stem seal/valve spring seat should be pushed firmly and squarely over the valve guide using the valve stem as guide. **Do Not Force** seal against top of guide. When installing the valve retainer locks, compress the spring **only enough** to install the locks.

CAUTION: Do not remove garter spring around the seal at the top of the valve stem seal (Fig. 60).

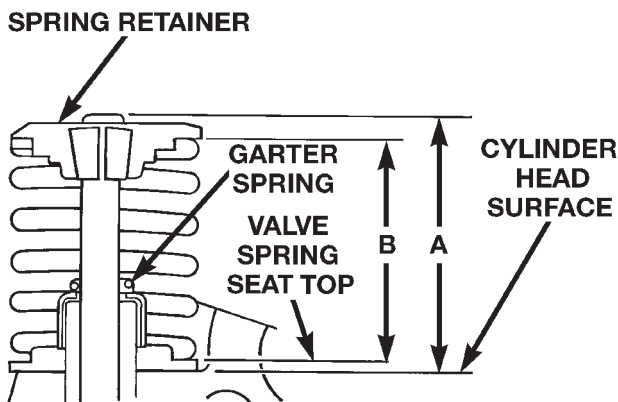


Fig. 60 Valve Seal Garter Spring

(12) Follow the same procedure on the remaining 5 cylinders using the firing sequence 1-2-3-4-5-6. **Make sure piston in cylinder is at TDC on the valve spring that is being covered.**

(13) Remove spark plug adapter tool.

(14) Remove Special Tool MD 998772A and install rocker arm assembly. Refer to procedure outlined in this section.

(15) Install cylinder head covers. Refer to procedure outline in this section.

(16) Install ignition coils and connect all electrical connectors.

(17) Install intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold.

(18) Connect negative cable.

VALVE AND VALVE SPRINGS

REMOVAL

(1) With cylinder head removed, compress valve springs using the Valve Spring Compressors shown in (Fig. 61).

(2) Remove valve retaining locks, valve spring retainers, valve springs and valve spring seat/stem seal assembly.

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

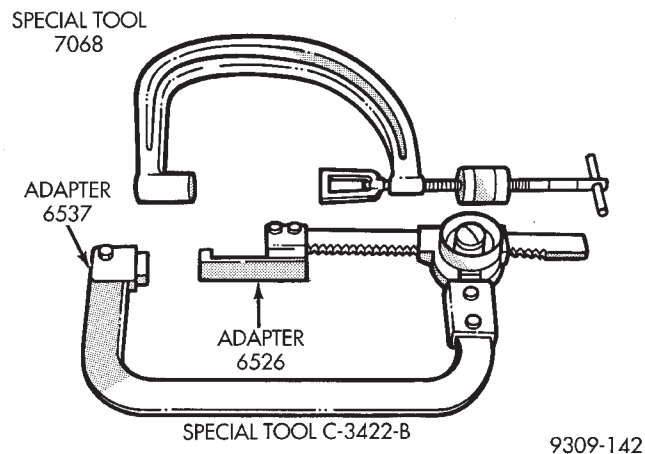


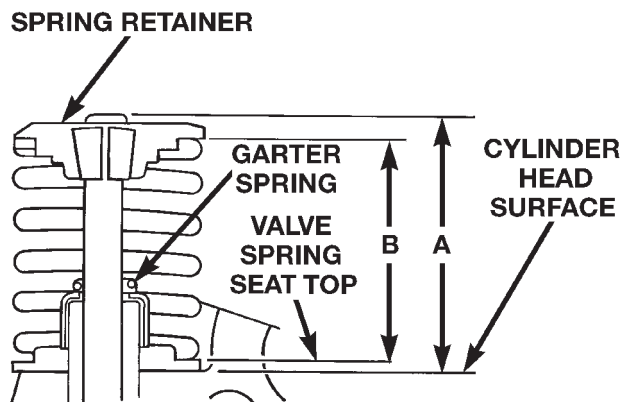
Fig. 61 Valve Spring Compressors

INSTALLATION

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

(2) If valves or seats have been reground, check valve tip height (A) (Fig. 62). If valve tip height is greater than 43.65 mm (1.7185 in.) intake or 45.98 mm (1.8102 in.) exhaust, grind valve tip until within specifications. Make sure measurement is taken from cylinder head surface to the top of valve stem.

REMOVAL AND INSTALLATION (Continued)

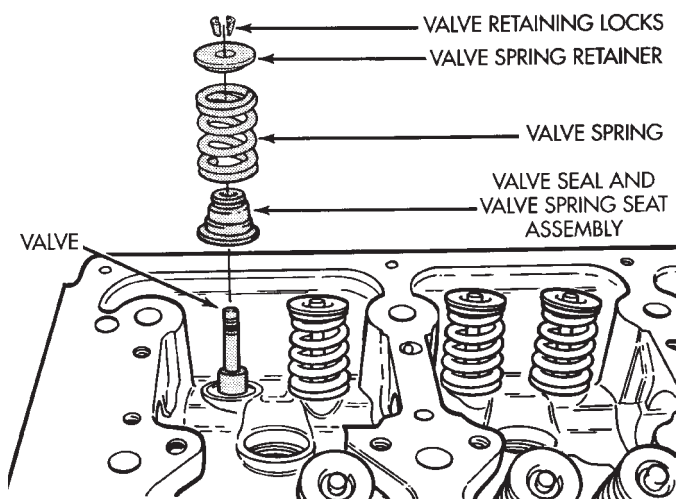


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Fig. 62 Checking Valve Tip Height and Valve Spring Installed Height

(3) Install valve seal/spring seat assembly over valve guides on all valve stems (Fig. 63). Ensure that the garter spring is intact around the top of the rubber seal. Install valve springs, valve retainers.

(4) Compress valve springs with a valve spring compressor install locks and release tool. **If valves and/or seats are reground, measure the installed height of springs (B) (Fig. 62), 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 (1.5256 inches), install a .762 mm (0.030 inch.) spacer in head counterbore under the valve spring seat to bring spring height back within specification.



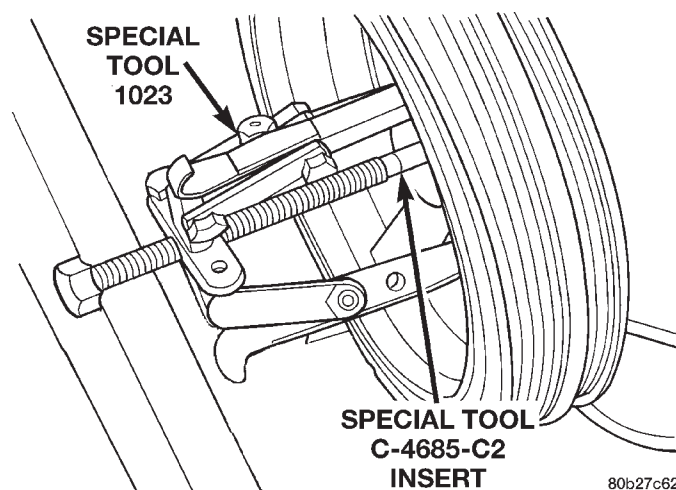
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Fig. 63 Valve, Spring, and Valve Seal—Installation

TIMING BELT COVERS

REMOVAL

- (1) Disconnect negative cable from remote jumper terminal.
- (2) Remove upper radiator crossmember. Refer to Group 23, Body for procedure.
- (3) Remove fan module. Refer to Group 7, Cooling System for procedure.
- (4) Remove the accessory drive belts. Refer to Group 7, Accessory Drive System for service procedure.
- (5) Use Special Tool 8191 to hold crankshaft damper while removing center bolt.
- (6) Remove crankshaft damper using Special Tools 1023 and C-4685-C2 (Fig. 64).



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Fig. 64 Crankshaft Damper—Removal

(7) Remove the lower belt cover located behind the crankshaft damper (Fig. 65).

(8) Remove the stamped steel cover (Fig. 65). **Do not remove the sealer on the cover, it is reusable (Fig. 66).** If some sealer is missing use Mopar® Silicone Rubber Adhesive Sealant or equivalent to replace the missing sealer.

(9) Remove the left cast cover (Fig. 65).

INSTALLATION

- (1) Install the left cast cover (Fig. 65) and accessory belt tensioner pulley and bracket.
- (2) Install the right stamped steel cover (Fig. 65).
- (3) Install the lower cover (Fig. 65).
- (4) Install the crankshaft damper using Special Tools C-4685-C1 Bolt (5.9 in.) and 6792-1. Install center bolt, and while holding damper with Special Tool 8191, tighten center bolt to 115 N·m (85 ft. lbs.).
- (5) Install the fan module and upper radiator crossmember.
- (6) Connect negative cable to remote jumper terminal.

REMOVAL AND INSTALLATION (Continued)

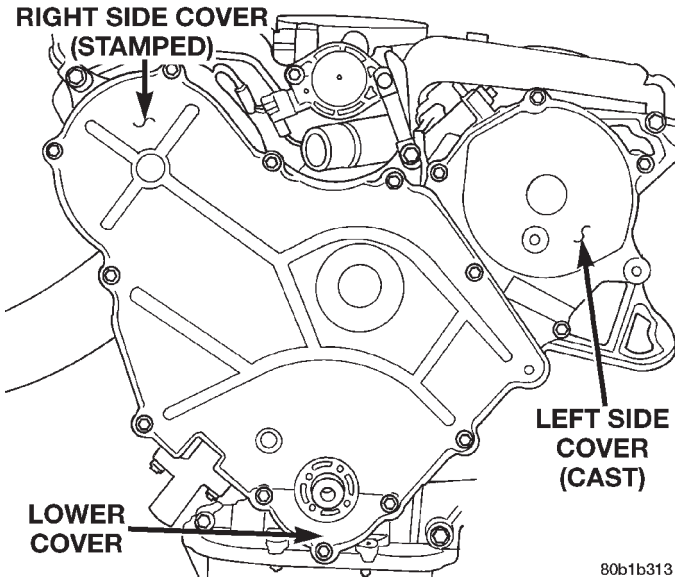


Fig. 65 Timing Belt Covers

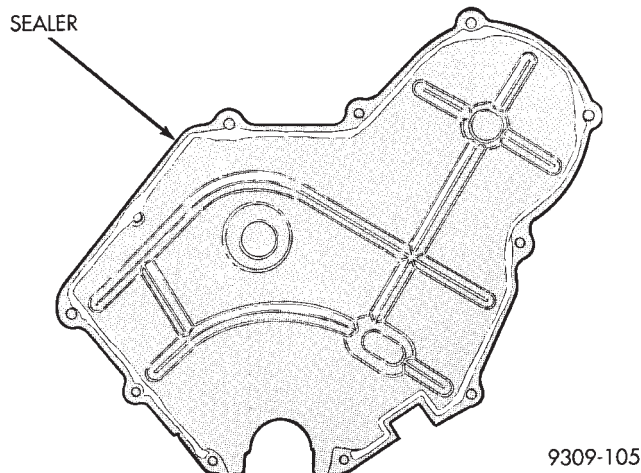


Fig. 66 Sealer, Timing Belt Cover

TIMING BELT

REMOVAL

CAUTION: The following procedure can only be used when the camshaft sprockets **HAVE NOT BEEN LOOSENED** or removed from the camshafts. Refer to Camshaft Sprocket and Engine Timing in this Section, if sprocket(s) or camshaft(s) have been loosened or removed.

CAUTION: The 3.2/3.5L are **NOT** freewheeling engines. Therefore, care should be taken not to rotate the camshafts or crankshaft with the timing belt removed.

- (1) Disconnect negative cable from remote jumper terminal.
- (2) Remove upper radiator crossmember. Refer to Group 23, body for procedure.
- (3) Disconnect fan module electrical connector.
- (4) Remove fan module. Refer to Group 7, Cooling System for procedure.
- (5) Remove accessory drive and air conditioning drive belts. Refer to Group 7, Cooling System for procedure.
- (6) Remove crankshaft damper and front timing belt covers. Refer to procedure outlined in this section.
- (7) Mark belt running direction, if timing belt is to be reused.

CAUTION: When aligning timing marks, always rotate engine by turning the crankshaft. Failure to do so will result in valve and/or piston damage.

- (8) Rotate engine clockwise until crankshaft mark aligns with the TDC mark on oil pump housing and the camshaft sprocket timing marks are between the marks on the rear covers (Fig. 67).

CAUTION: Align the camshaft sprockets between the marks on rear belt covers before timing belt removal or damage to valve and/or pistons could occur.

- (9) Using a ink or paint marker; mark the exact position of the camshaft sprocket timing mark relative to the two timing marks on the rear timing cover.

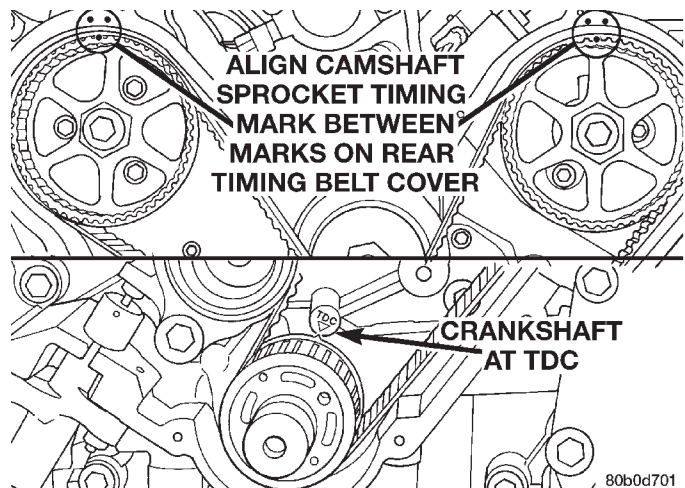


Fig. 67 Engine Timing Mark Alignment

NOTE: When timing belt tensioner is removed from engine, always store in the vertical (plunger facing upward) position.

REMOVAL AND INSTALLATION (Continued)

(10) Remove the timing belt tensioner (Fig. 68) and remove timing belt.

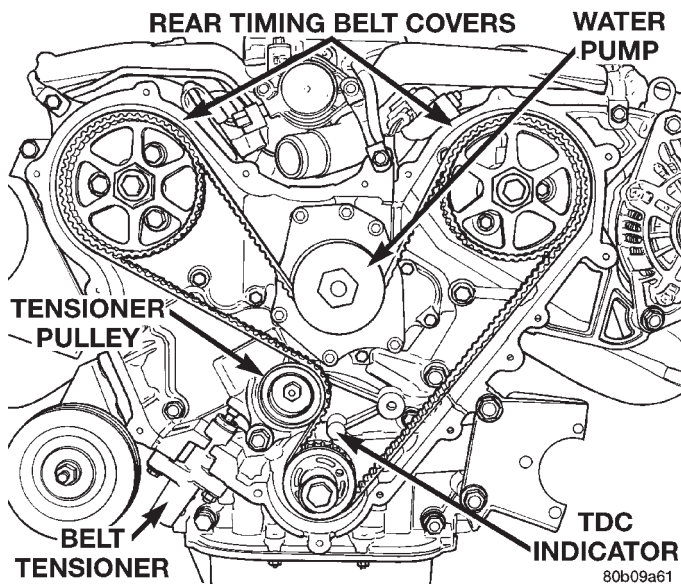


Fig. 68 Timing Belt System

TIMING BELT TENSIONER

(11) When tensioner is removed from the engine it is necessary to compress the plunger into the tensioner body.

CAUTION: Compress the tensioner slowly, as damage to tensioner could result.

(12) Place the tensioner into a vise and SLOWLY compress the plunger (Fig. 69). Total bleed down of tensioner should take about 5 minutes.

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.

(13) 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.

NOTE: When timing belt tensioner is removed from engine, always store in the vertical (plunger facing upward) position.

INSTALLATION

CAUTION: This procedure can only be used when the camshaft sprockets HAVE NOT BEEN LOOSENED or removed from the camshafts.

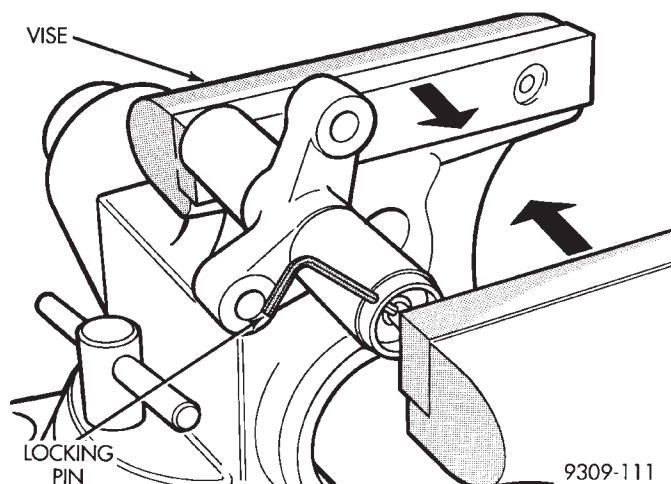


Fig. 69 Compressing Timing Belt Tensioner

CAUTION: If camshafts have moved from the timing marks, always rotate camshaft towards the direction nearest to the timing marks (DO NOT TURN CAMSHAFTS A FULL REVOLUTION OR DAMAGE to valves and/or pistons could result).

(1) Align the crankshaft sprocket with the TDC mark on oil pump cover (Fig. 70).

(2) Align the camshaft sprockets (to reference mark made upon removal) between the marks on the rear covers (Fig. 67).

(3) Install the timing belt starting at the crankshaft sprocket going in a counterclockwise direction (Fig. 70). Install the belt around the last sprocket. Maintain tension on the belt as it is positioned around the tensioner pulley.

(4) Holding the tensioner pulley against the belt, install the tensioner into the housing and tighten to 28 N·m (250 in. lbs.). Each camshaft sprocket mark should still fall between the cover marks.

(5) When tensioner is in place pull retaining pin to allow the tensioner to extend to the pulley bracket.

(6) Rotate crankshaft sprocket 2 revolutions and check the timing marks on the camshafts and crankshaft. The marks should line up within their respective locations (Fig. 70). If marks do not line up, repeat procedure.

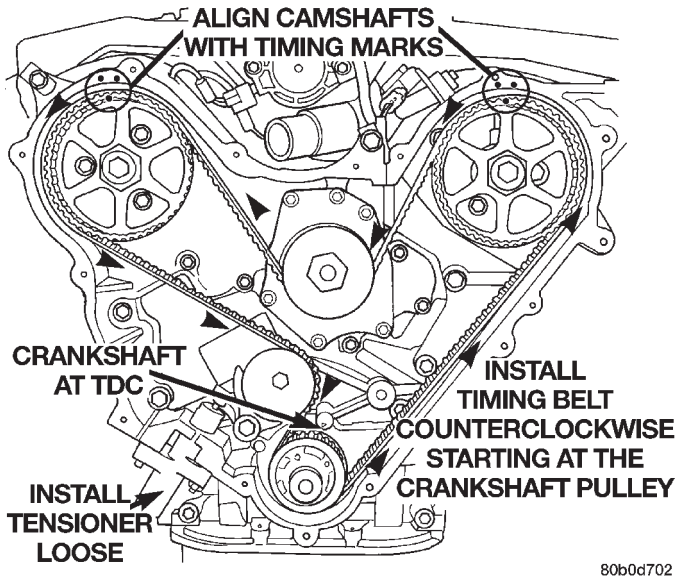
(7) Install timing belt covers and crankshaft damper. Refer to procedure outlined in this section.

(8) Install air conditioning drive and accessory drive belts. Refer to Group 7, Cooling System for procedure.

(9) Install fan module. Refer to Group 7, Cooling System for procedure.

(10) Install upper radiator crossmember. Refer to Group 23, body for procedure.

REMOVAL AND INSTALLATION (Continued)

**Fig. 70 Timing Belt Installation**

(11) Connect negative cable to remote jumper terminal.

(12) Start engine and allow to idle for approximately 1 minute. If a noise is present from the timing belt/tensioner, air has possibly entered the tensioner.

(a) To remove air from tensioner; using a DRB III, operate the engine at speed of 1600 – 2000 RPM for 10 minutes. This will purge air from tensioner.

NOTE: If air is present, the timing belt tensioner will be soft and may generate noise. This noise should disappear after no more than 15 minutes of engine running time.

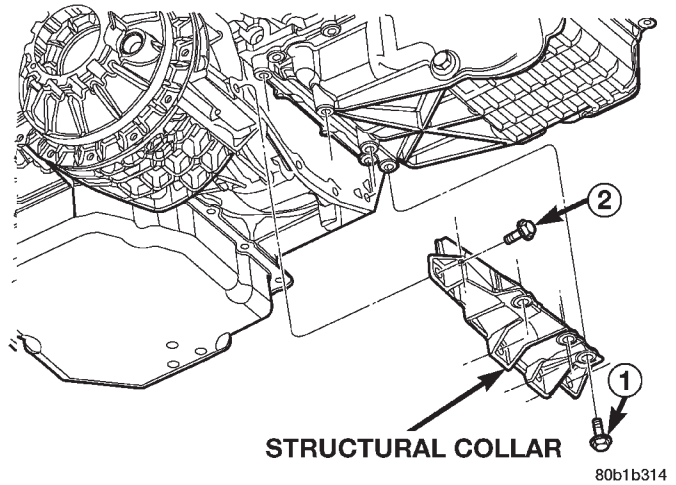
OIL PAN**REMOVAL**

(1) Disconnect negative cable from auxiliary jumper terminal.

(2) Remove dipstick and tube.

(3) Raise vehicle on hoist and drain engine oil.

(4) Remove structural collar from rear of oil pan and transmission housing (Fig. 71).

**Fig. 71 Structural Collar**

(5) Disconnect engine oil cooler line from pan.

(6) Disconnect transmission oil cooler line clips.

(7) Remove oil pan (Fig. 72).

(8) Remove oil pan gasket.

(9) Clean oil pan and all gasket surfaces.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Apply a 1/8 inch bead of Mopar® Silicone Rubber Adhesive or equivalent at the parting line of the oil pump housing and the rear seal retainer (Fig. 73).

(2) Install oil pan gasket to the engine block.

(3) Install pan and attaching fasteners (Fig. 72).

(4) Install the structural collar (Fig. 71), using the follow procedure:

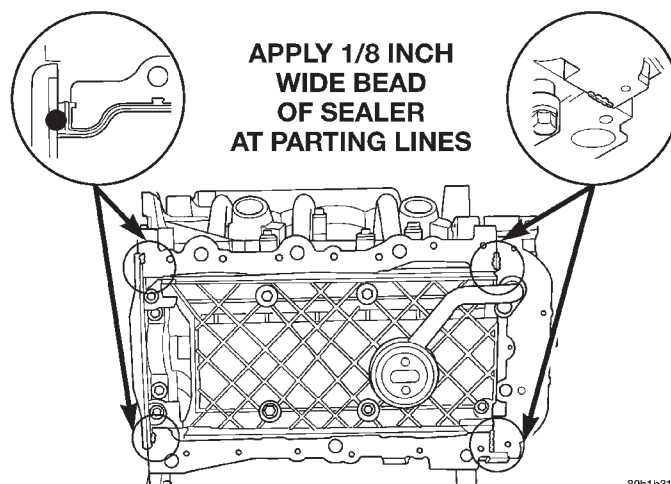
(a) Install the **vertical** collar to oil pan bolts (1). Torque to 1.1 N·m (10 in. lbs.).

(b) Install collar to transmission bolts (2) and tighten to 55 N·m (40 ft. lbs.).

(c) Starting with center vertical bolts (1) and working outward, final torque all bolts to 55 N·m (40 ft. lbs.).

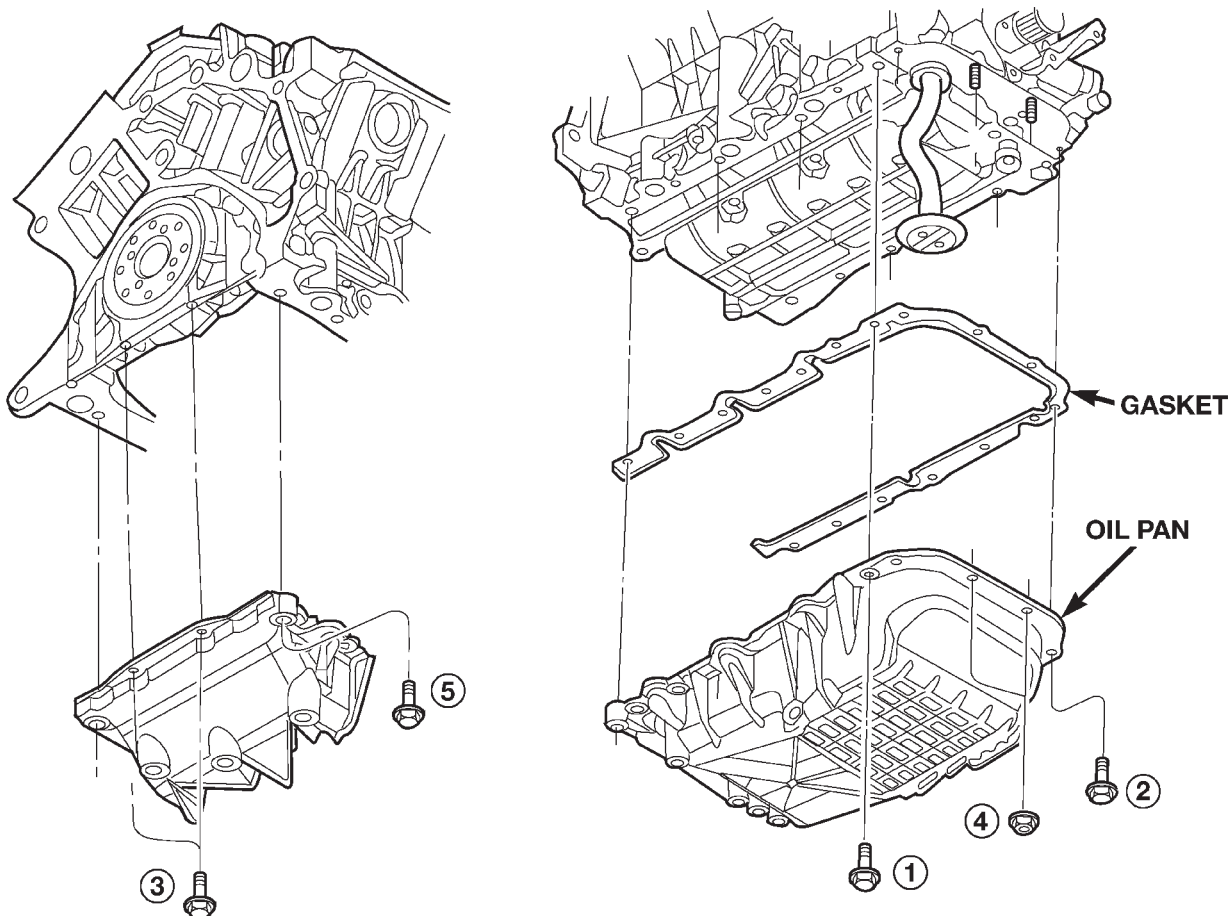
(5) Lower vehicle and install dipstick and tube.

(6) Fill engine crankcase with proper oil to correct level.



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Fig. 73 Oil pan Sealing



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Fig. 72 Oil Pan—Removal and Installation

ITEM	DESCRIPTION	TORQUE	ITEM	DESCRIPTION	TORQUE
1	Bolt—M8	28 N·m (250 in. lbs.)	4	Nut—M6	12 N·m (105 in. lbs.)
2	Bolt—M6	12 N·m (105 in. lbs.)	5	Bolt—M8	28 N·m (250 in. lbs.)
3	Bolt—M6	12 N·m (105 in. lbs.)			

REMOVAL AND INSTALLATION (Continued)

(7) Connect negative cable to remote jumper terminal.

CAMSHAFT OIL SEAL

REMOVAL

(1) With camshaft sprockets removed. Refer to procedure in this section.

(2) Use Special Tool C-3981B to remove camshaft oil seal (Fig. 74).

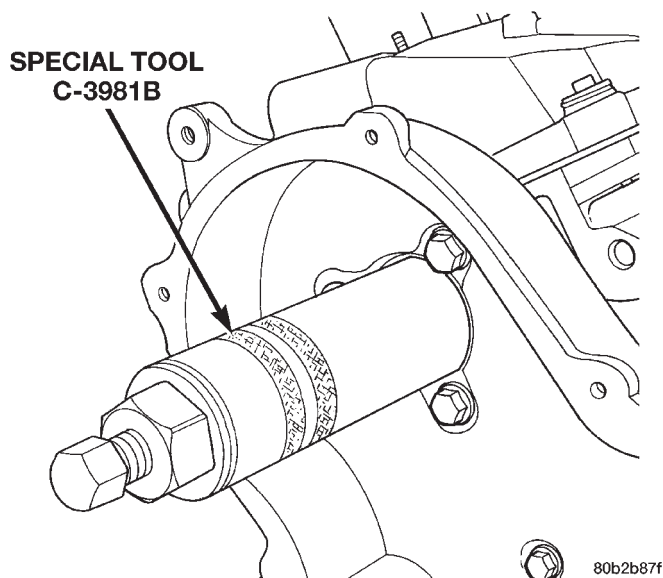


Fig. 74 Camshaft Oil Seal—Removal

INSTALLATION

(1) Apply light coat of engine oil to the camshaft oil seal lip.

(2) Install the oil seal using Special Tool 6788 Seal Protector Sleeve (Fig. 75) and Seal Installer 6052 (Fig. 76).

(3) Install camshaft sprockets. Refer to procedure in this section.

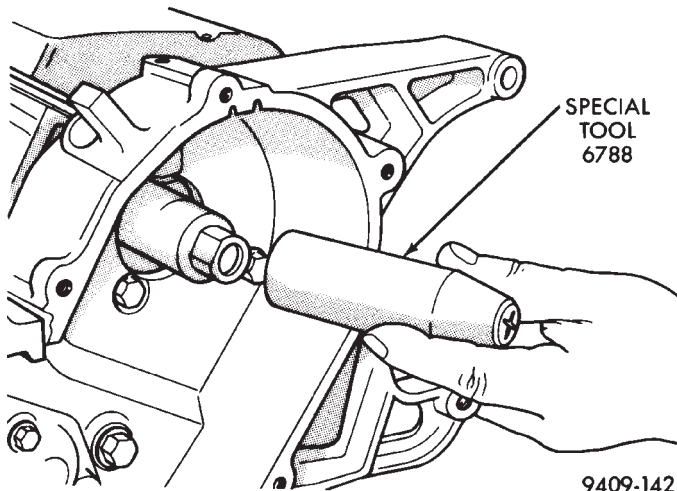


Fig. 75 Camshaft Oil Seal Protector Sleeve

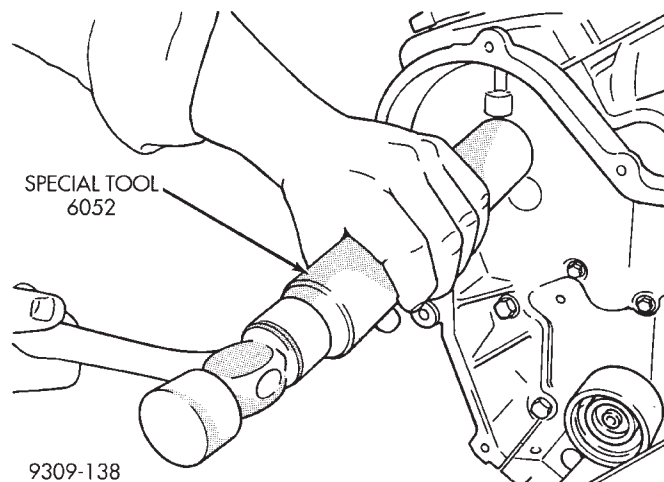


Fig. 76 Camshaft Oil Seal—Installation

CRANKSHAFT OIL SEAL—FRONT

REMOVAL

(1) Remove timing belt. Refer to procedure in this section.

(2) Remove crankshaft sprocket using Special Tool L-4407-A (Fig. 77).

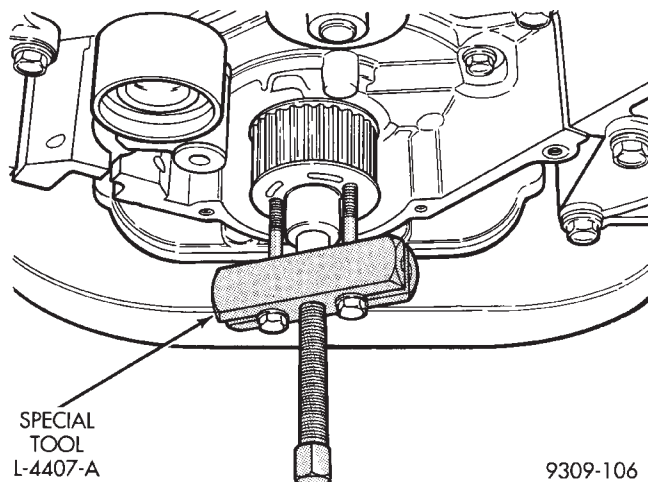


Fig. 77 Crankshaft Sprocket—Removal

(3) Tap the dowel pin out of the crankshaft (Fig. 78).

(4) Remove crankshaft seal using Special Tool 6341A (Fig. 79).

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

(5) Shaft seal lip surface must be free of varnish, dirt or nicks. Polish with 400 grit paper if necessary.

INSTALLATION

(1) Install crankshaft seal using Special Tool 6342 (Fig. 80).

REMOVAL AND INSTALLATION (Continued)

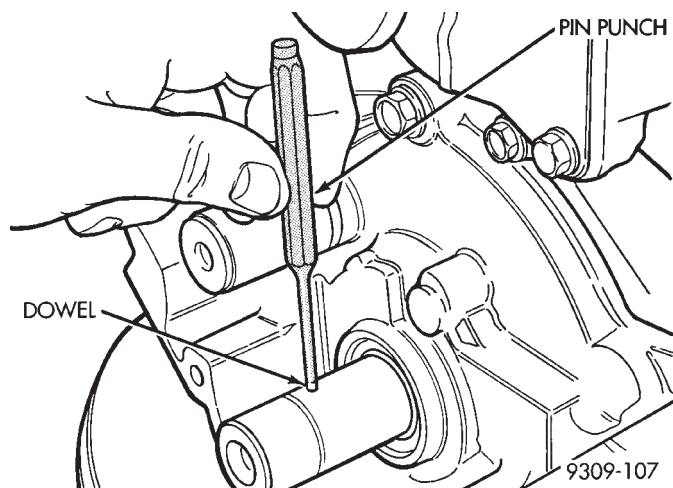


Fig. 78 Crankshaft Sprocket Dowel Pin—Removal/Installation

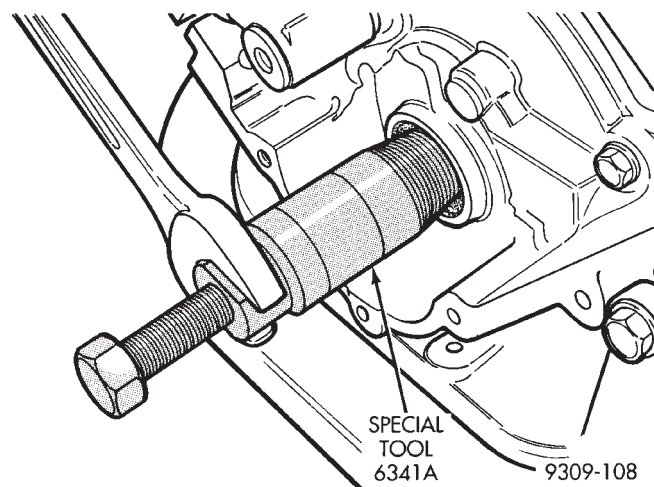


Fig. 79 Crankshaft Oil Seal with Special Tool 6341A—Removal

(2) Install the dowel pin into the crankshaft to 1.2 mm (0.047 inch.) protrusion (Fig. 78).

NOTE: To assure proper installation depth of crankshaft sprocket, Special Tool 6641 must be used.

(3) Install crankshaft sprocket using Special Tools 6641 and C-4685-C1 (Fig. 81).

(4) Install timing belt.

CRANKSHAFT OIL SEAL—REAR

REMOVAL

(1) Remove transaxle from vehicle. Refer to Group 21, Transaxle for procedure.

(2) Remove drive plate.

(3) Insert a 3/16" wide flat bladed screwdriver between the dust lip and the metal case of the crankshaft seal. Angle the screwdriver (Fig. 82) through

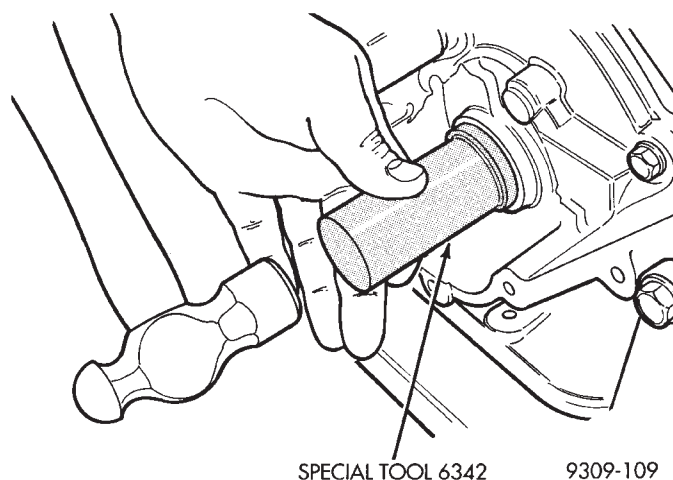


Fig. 80 Crankshaft Oil Seal with Special Tool 6342—Installation

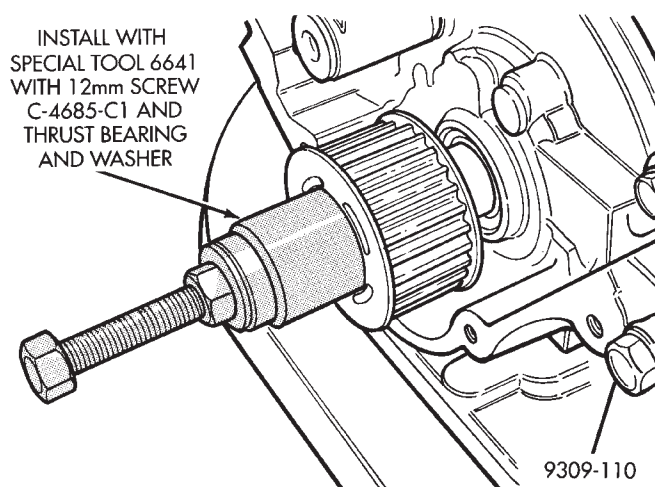


Fig. 81 Crankshaft Sprocket—Installation

the dust lip against the metal case of the seal. Pry out seal.

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

INSTALLATION

CAUTION: If a burr or scratch is present on the crankshaft edge (chamfer), clean surface using 400 grit sand paper to prevent seal damage during installation.

(1) Place Special Tool 6926-1 Guide on crankshaft (Fig. 83). This is a pilot tool with a magnetic base.

(2) Position seal over pilot tool. Assure that lip of seal is facing towards the crankshaft during installa-

REMOVAL AND INSTALLATION (Continued)

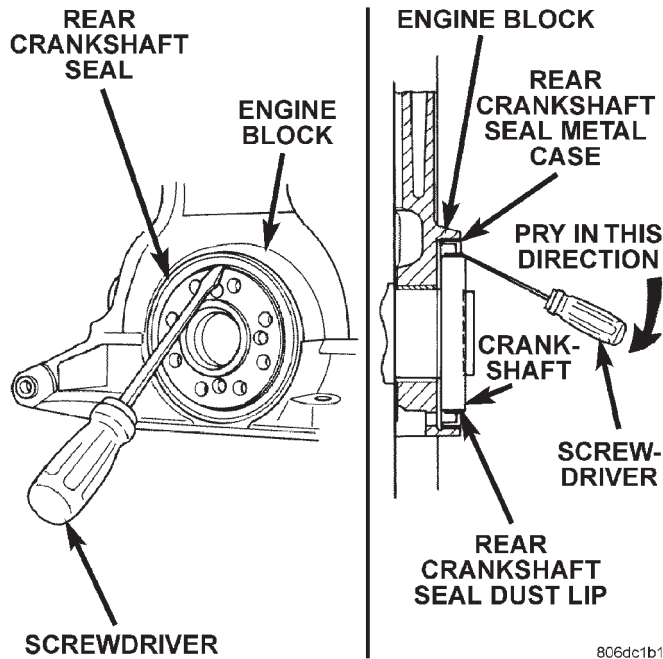


Fig. 82 Rear Crankshaft Oil Seal Removal—Typical

tion. The pilot tool remains on crankshaft during seal installation.

(3) Using Special Tool 6926-2 Installer, and C-4171 Handle (Fig. 83), drive seal into the retainer housing until seal is flush with housing surface.

(4) Install drive plate and transaxle.

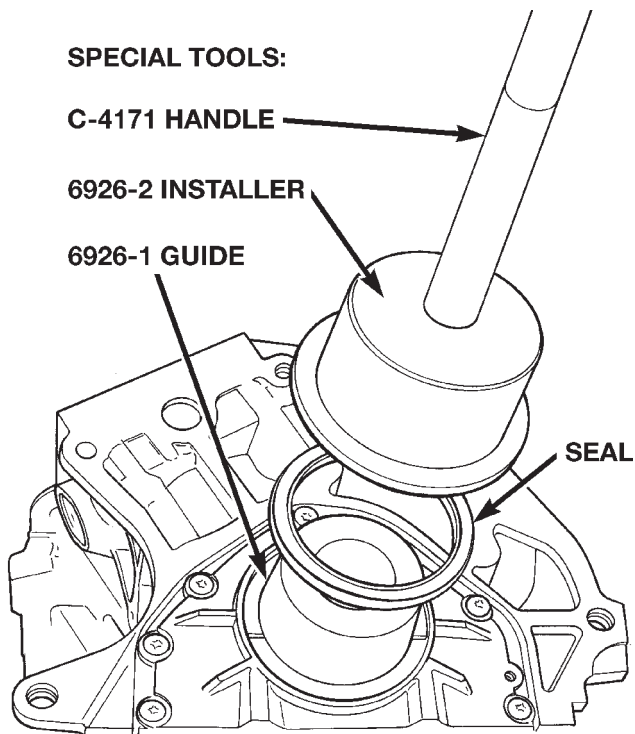


Fig. 83 Crankshaft Rear Seal—Installation

CRANKSHAFT OIL SEAL RETAINER—REAR

REMOVAL

(1) Remove crankshaft rear oil seal and oil pan. Refer to procedure outlined in this section.

(2) Remove seal retainer attaching screws.

(3) Remove seal retainer (Fig. 84).

NOTE: Seal retainer gasket is bonded to the retainer and must be replaced as an assembly.

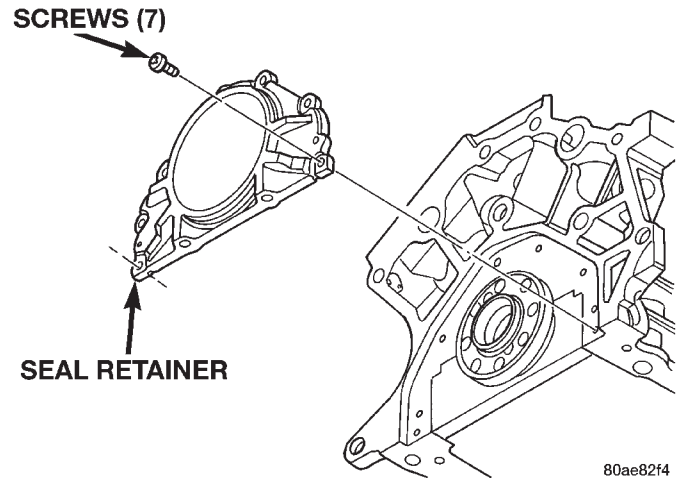


Fig. 84 Oil Seal Retainer

INSTALLATION

(1) Clean all sealing surfaces. Replace retainer assembly if gasket is torn or damaged.

(2) Install seal retainer to block, but do not tighten attaching screws at this time.

NOTE: The following steps must be performed to prevent oil leaks at sealing joints.

(3) Attach Special Tools 8225 to pan rail using the oil pan fasteners.

NOTE: Make sure that the marking "3.2/3.5L" on Special Tools 8225, is facing towards the cylinder block pan rail surface (notch on tool is towards the seal retainer).

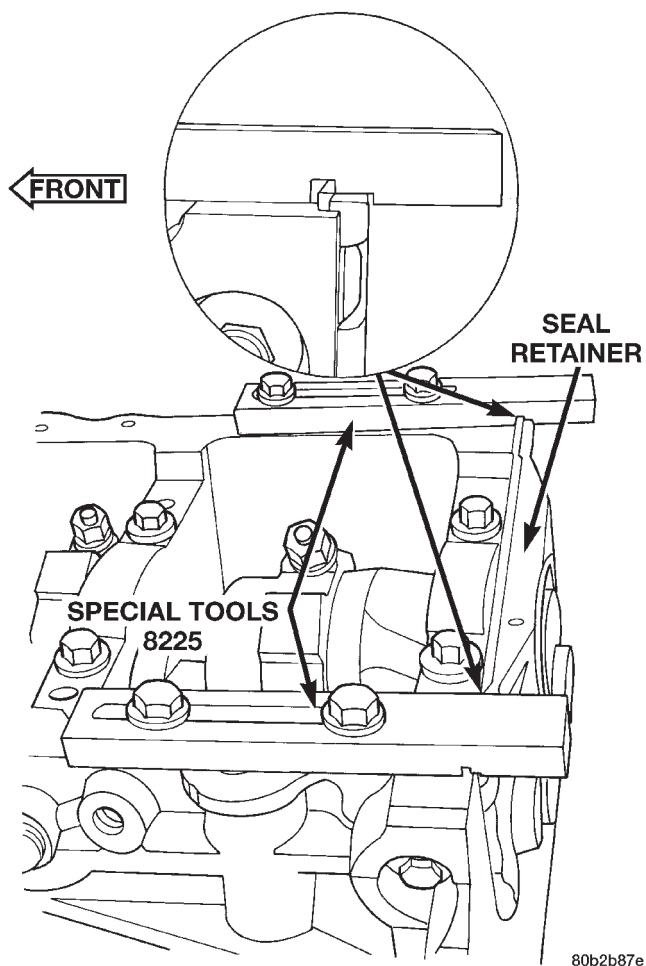
(4) While applying firm pressure to the seal retainer against Special Tools 8225 (Fig. 85), tighten seal retainer screws to 12 N·m (105 in. lbs.)

(5) Install crankshaft rear oil seal and oil pan. Refer to procedures outlined in this section.

CRANKSHAFT MAIN BEARINGS

Bearing caps are not interchangeable and are marked to insure correct assembly (Fig. 86). Upper and lower bearing halves are NOT interchangeable.

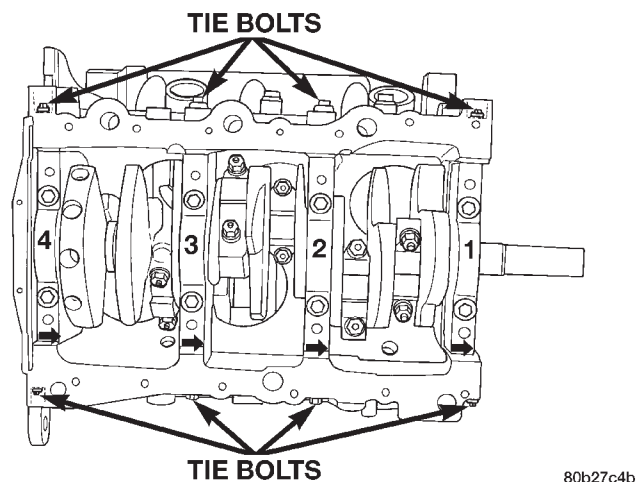
REMOVAL AND INSTALLATION (Continued)

**Fig. 85 Rear Crankshaft Seal Retainer Alignment****CRANKSHAFT MAIN JOURNALS**

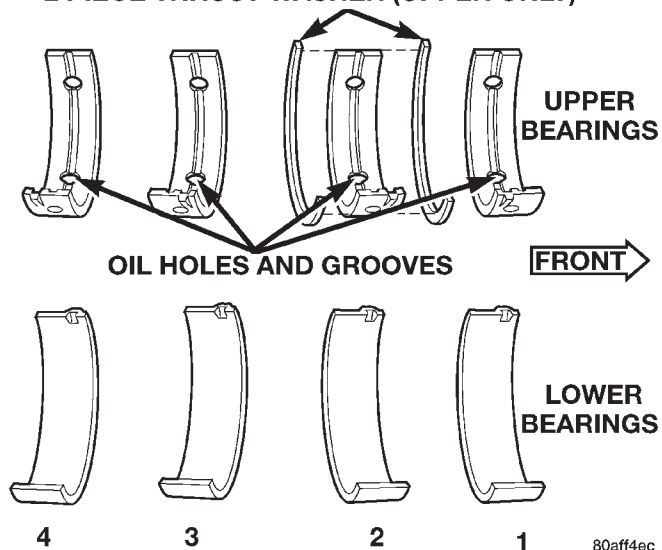
The crankshaft journals should be checked for excessive wear, taper and scoring. Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 in.). Journal grinding should not exceed 0.305 mm (0.012 inch.) under the standard journal diameter. **DO NOT** grind thrust faces of Number 2 main bearing. **DO NOT** nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all passages.

CAUTION: With a forged steel crankshaft 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.

The crankshaft thrust is controlled with thrust washers located at the upper No. 2 main bearing bulk head (Fig. 87). 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 undersize: 0.025 mm (0.001 in.) and 0.254 mm (0.010 in.). Never install an

**Fig. 86 Main Bearing Cap Identification**

undersize bearing that will reduce clearance below specifications.

2 PIECE THRUST WASHER (UPPER ONLY)**Fig. 87 Main Bearing Identification****REMOVAL**

(1) Remove oil pan, pick-up tube, and windage tray. Refer to procedures outlined in this section. Identify bearing caps before removal.

(2) Remove bearing caps one at a time. Remove upper half of bearing by inserting Special Main Bearing Tool C-3059 (Fig. 88) into the oil hole of crankshaft.

(3) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

INSTALLATION

CAUTION: Main bearings are select fit. Refer to Crankshaft Main Bearing Fitting in this section for proper bearing selection.

REMOVAL AND INSTALLATION (Continued)

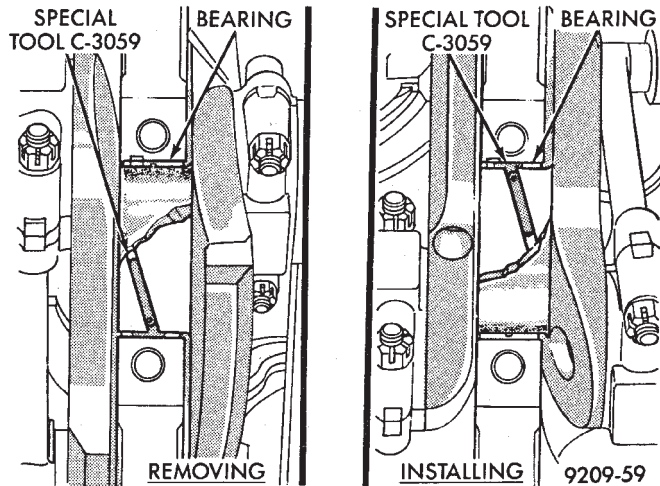


Fig. 88 Removing and Installing Upper Main Bearing With Special Tool C-3059

NOTE: Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened.

When installing a new upper bearing shell, slightly chamfer the sharp edges from the plain side.

- (1) Lubricate main bearing with clean engine oil.
- (2) Start bearing in place, and insert Main Bearing Tool C-3059 into oil hole of crankshaft (Fig. 88).
- (3) Slowly rotate crankshaft counterclockwise sliding the bearing into position. Remove Special Main Bearing Tool C-3059.

NOTE: Lubricate main bearing cap bolts with engine oil before installation.

- (4) Lubricate and install lower bearing half and main cap. Tighten bolts finger tight.
- (5) For installing thrust washers at the No. 2 main bearing location, use the following procedure:
 - (a) Move crankshaft forward to limit of travel. Lubricate and install the front thrust washer by rolling the washer onto the machined shelf between the No. 2 upper main bulk head and crankshaft thrust surface (Fig. 89).
 - (b) Move crankshaft rearward to limit of travel. Lubricate and install the rear thrust washer by rolling the washer onto the machined shelf between the No. 2 upper main bulk head and crankshaft thrust surface.

The main bearing cap bolts must be tightened in the proper sequence. First the inner main cap bolts, secondly the windage tray bolts, lastly the main cap tie (horizontal) bolts.

- (6) Install each main bearing cap and tighten inner bolts finger tight.
- (7) Tighten inner main bearing cap bolts to 20 N·m + 1/4 turn (15 ft. lbs. + 1/4 turn).

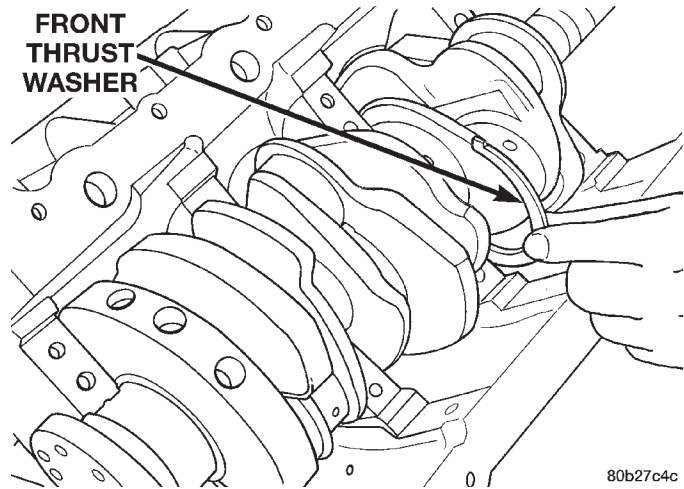


Fig. 89 Thrust Washer Installation

(8) Measure crankshaft end play. Refer to Service Procedures in this section.

(9) Install windage tray. Lubricate bolts with engine oil and tighten to 27 N·m + 1/4 turn (20 ft. lbs. + 1/4 turn).

(10) Install the main cap tie (horizontal) bolts and tighten to 28 N·m (250 in. lbs.).

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

(12) Fill engine crankcase with proper oil to correct level.

OIL FILTER

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

- (1) Using Tool C-4065, unscrew filter from base and discard (Fig. 90).
- (2) Wipe base clean, then inspect gasket contact surface.
- (3) Lubricate gasket of new filter with clean engine oil.
- (4) Install and tighten filter to 20 N·m (15 ft. lbs.) of torque after gasket contacts base. Use filter wrench if necessary.
- (5) Start engine and check for leaks.

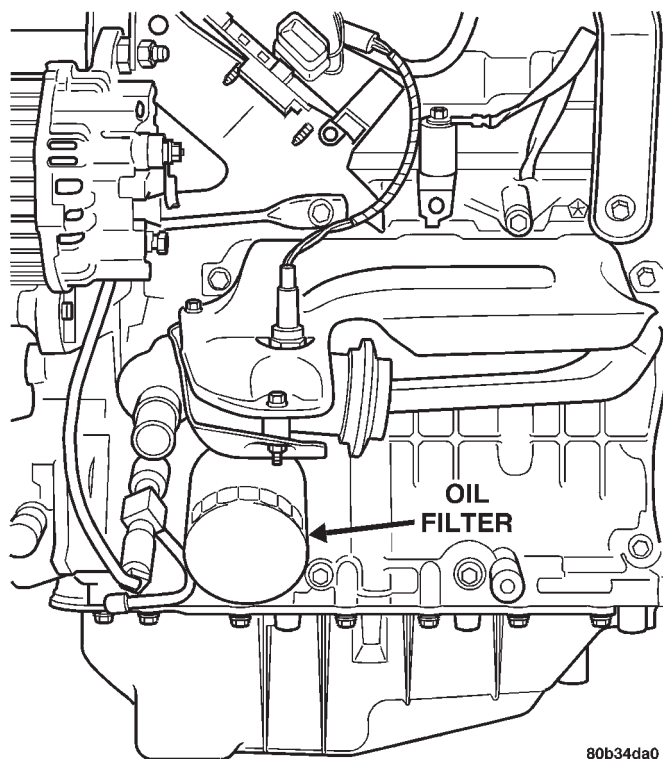
OIL PUMP

REMOVAL

It is necessary to remove the oil pan, oil pickup and oil pump body to service the oil pump rotors. The oil pump pressure relief valve can be serviced by removing the oil pan.

(1) Drain cooling system and remove fan module. Refer to Group 7, Cooling Systems for procedures.

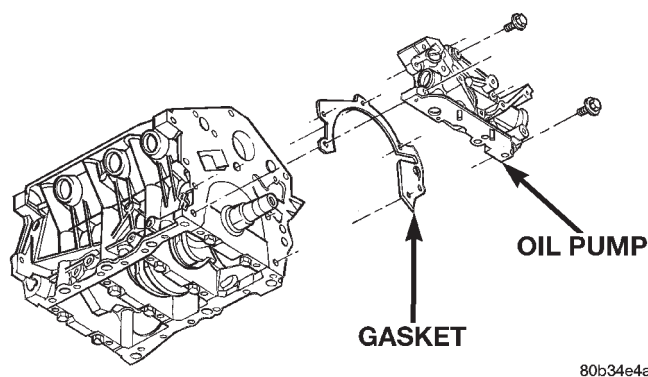
REMOVAL AND INSTALLATION (Continued)



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Fig. 90 Oil Filter

- (2) Remove the accessory drive belts. Refer to Group 7, Cooling System for procedure.
- (3) Remove the crankshaft damper and timing belt covers. Refer to procedures in this section.
- (4) Remove timing belt. Refer to procedure in this section.
- (5) Remove crankshaft sprocket. Refer to Crankshaft Oil Seal—Front procedure in this section.
- (6) Remove oil pan. Refer to procedure in this section.
- (7) Remove oil pickup tube.
- (8) Remove oil pump fasteners. Remove pump and gasket from engine (Fig. 91).



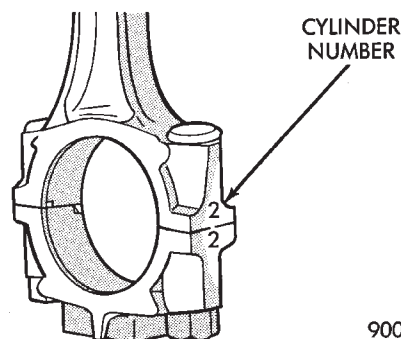
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Fig. 91 Oil Pump—Removal and Installation**INSTALLATION**

- (1) Prime oil pump before installation by filling rotor cavity with engine oil.
- (2) Install oil pump and gasket carefully over the crankshaft. Position pump onto block and tighten bolts to 28 N·m (250 in. lbs.)
- (3) Install new O-ring on oil pickup tube.
- (4) Install oil pickup tube.
- (5) Install oil pan. Refer to procedure in this section.
- (6) Install crankshaft sprocket. Refer to Crankshaft Oil Seal—Front procedure in this section.
- (7) Install timing belt. Refer to procedure in this section.
- (8) Install the timing belt covers and crankshaft damper. Refer to procedures in this section.
- (9) Install the accessory drive belts and fan module. Refer to Group 7, Cooling System for procedures.
- (10) Fill cooling system. Refer to Group 7, Cooling System for procedure.

PISTON AND CONNECTING ROD**REMOVAL**

- (1) Remove cylinder heads and oil pan. Refer to procedures in this section.
- (2) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. **Be sure to keep tops of pistons covered during this operation. Pistons and connecting rods must be removed from top of cylinder block. When removing piston and connecting rod assemblies from the engine, rotate crankshaft so that each connecting rod is centered in cylinder bore.**
- (3) Inspect connecting rods and connecting rod caps for cylinder identification. Identify them if necessary (Fig. 92).



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Fig. 92 Identify Connecting Rod to Cylinder

- (4) Remove connecting rod cap. Install protectors on connecting rod bolts (Fig. 93). Push each piston and rod assembly out of cylinder bore.

NOTE: Be careful not to nick crankshaft journals.

REMOVAL AND INSTALLATION (Continued)

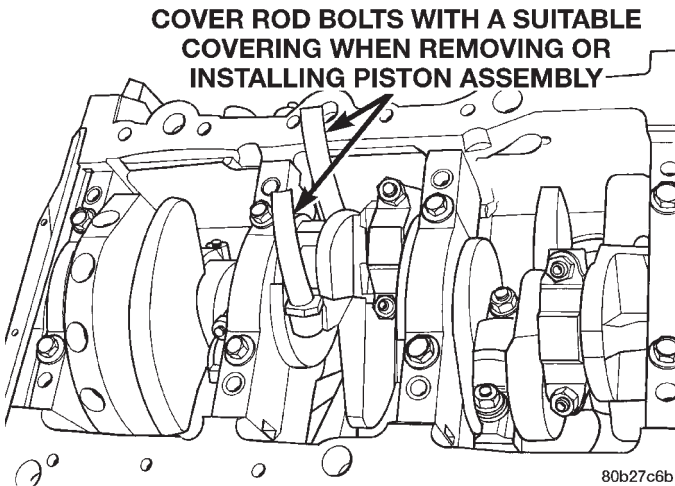


Fig. 93 Connecting Rod Guides and Crankshaft Protectors

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

PISTON RINGS—INSTALLATION

NOTE: Refer to **FITTING PISTON RINGS** in this section for piston ring specifications.

(1) The No. 1 and No. 2 piston rings have a different cross section. Insure that the No. 2 ring is installed with manufacturers I.D. mark (dot) facing up, towards top of the piston (Fig. 94).

CAUTION: Install piston rings in the following order:

- (2) Oil ring expander.
- (3) Upper oil ring side rail.
- (4) Lower oil ring side rail.
- (5) No. 2 Intermediate piston ring.
- (6) No. 1 Upper piston ring.
- (7) 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 during this step (Fig. 95).**
- (8) Install upper side rail first and then the lower side rail.
- (9) Install No. 2 piston ring and then No. 1 piston ring (Fig. 96).
- (10) Position piston ring end gaps as shown in (Fig. 97).
- (11) 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.

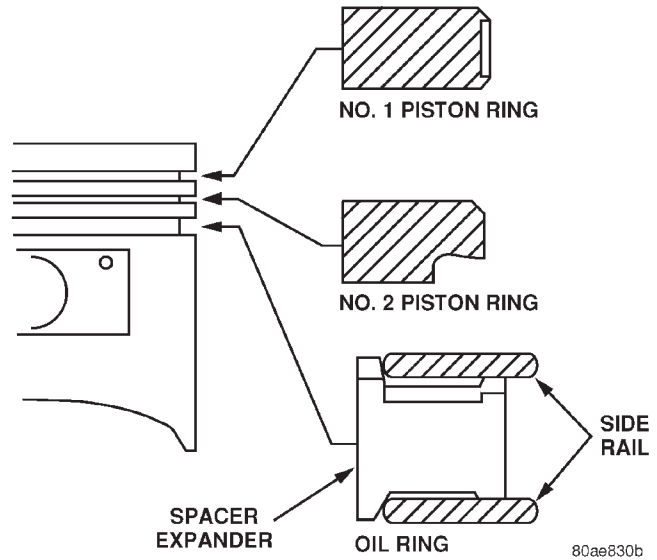


Fig. 94 Piston Ring—Installation

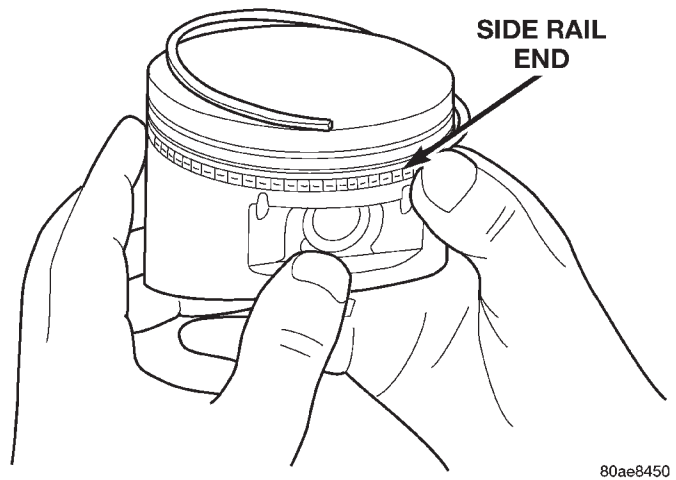


Fig. 95 Side Rail—Installation

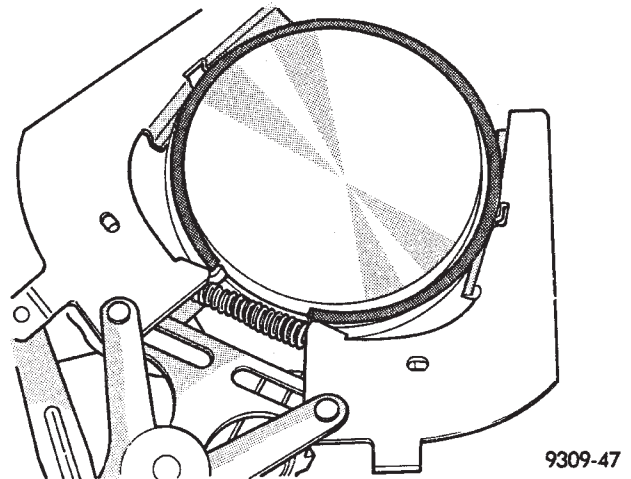


Fig. 96 Upper and Intermediate Rings—Installation

REMOVAL AND INSTALLATION (Continued)

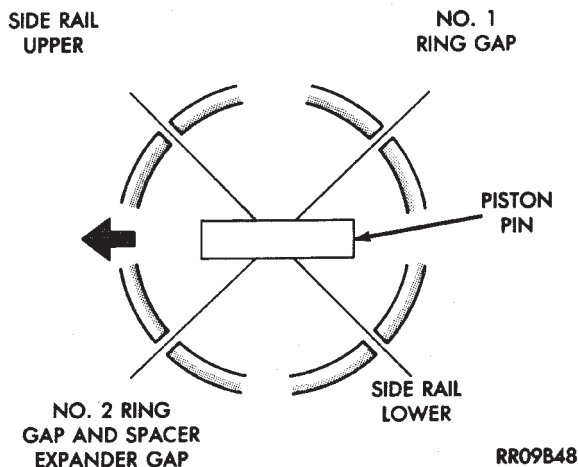


Fig. 97 Piston Ring End Gap Position

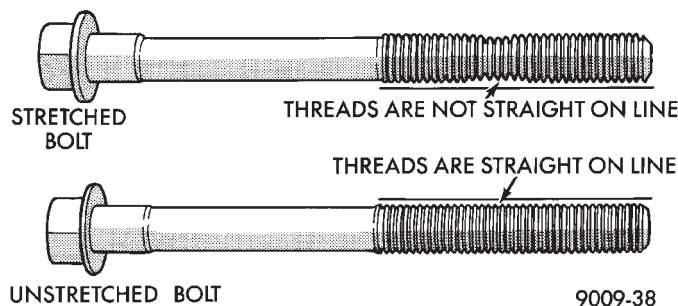


Fig. 98 Check for Stretched Bolts

PISTON—INSTALLATION

NOTE: The connecting rod bearing cap bolts must be examined before reuse. If the threads are necked down, the bolts should be replaced.

(1) Check connecting rod bolts for necking by holding a scale or straight edge against the threads. If all threads do not contact the scale, the bolt should be replaced (Fig. 98).

(2) Before installing pistons and connecting rod assemblies into the bore, ensure that compression ring gaps are staggered so that neither is in line with oil ring rail gap (Fig. 97).

(3) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located as shown in (Fig. 99).

(4) Immerse the piston head and rings in clean engine oil, slide the ring compressor over the piston and tighten with the special wrench. **Ensure position of rings does not change during this operation.**

(5) Install connecting rod bolt protectors on rod bolts (Fig. 93).

(6) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Insert

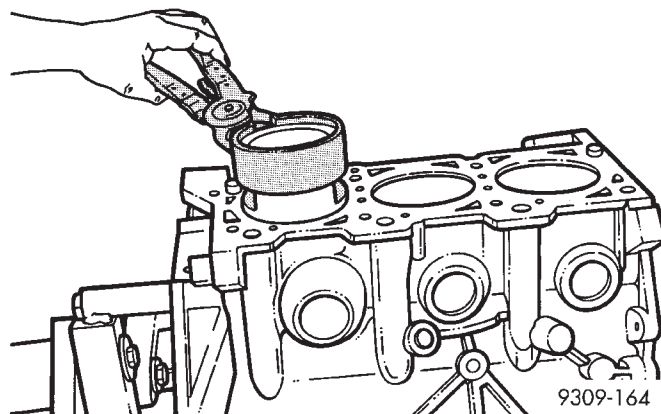


Fig. 99 Piston—Installation

rod and piston into cylinder bore and guide rod over the crankshaft journal.

CAUTION: Do Not interchange piston assemblies cylinder-to-cylinder or bank-to-bank.

(7) The arrow on top of piston must be pointing toward front of engine (Fig. 100) and oil squirt hole on connecting rod faces the major thrust (right) side of the cylinder bore (Fig. 101).

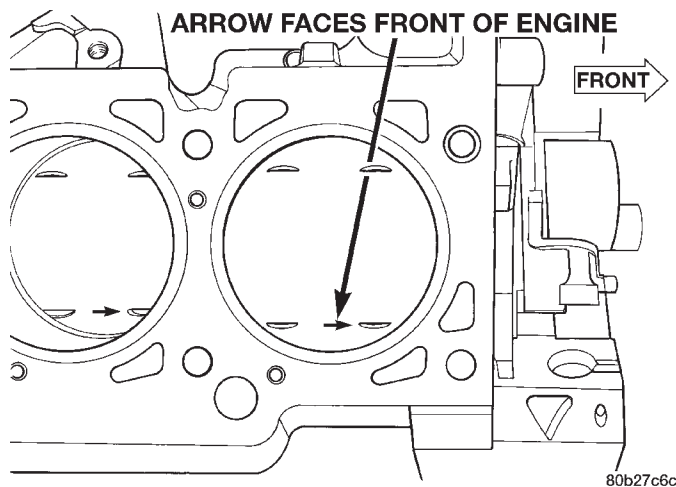


Fig. 100 Piston Orientation

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

(9) Install rod caps. Install nuts on cleaned and oiled rod bolts and tighten nuts to 54 N·m (40 ft. lbs.) Plus 1/4 turn.

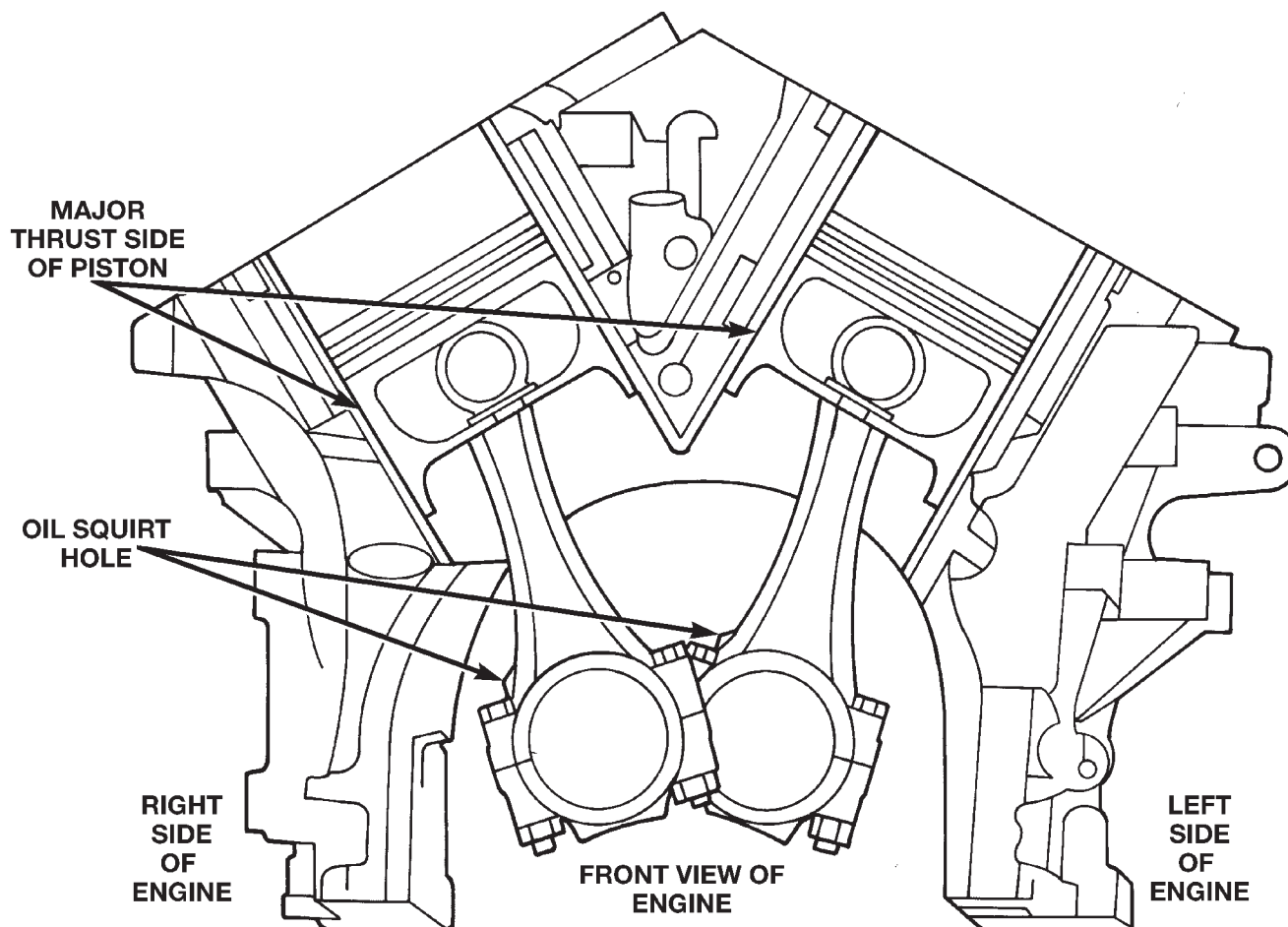
(10) Install cylinder heads and oil pan. Refer to procedures in this section.

ENGINE CORE AND OIL PLUGS

REMOVAL

Using a blunt tool such as a drift and a hammer, strike the bottom edge of the cup plug. With the cup

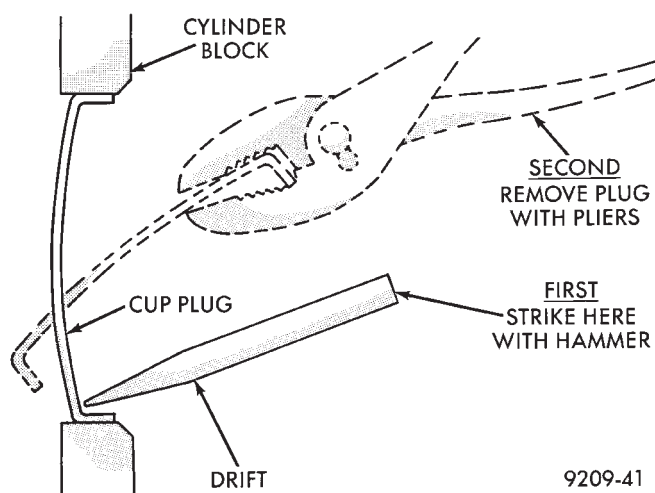
REMOVAL AND INSTALLATION (Continued)



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Fig. 101 Connecting Rod Positioning

plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 102).



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Fig. 102 Core Hole Plug Removal

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

INSTALLATION

Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer. Lightly coat inside of cup plug hole with Mopar® Stud and Bearing Mount. 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.

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

DISASSEMBLY AND ASSEMBLY**OIL PUMP****DISASSEMBLY**

- (1) To remove the relief valve, proceed as follows:
- (2) Remove cotter pin. Drill a 3.175 mm (1/8 inch.) hole into the relief valve retainer cap and insert a self-threading sheet metal screw into cap.

DISASSEMBLY AND ASSEMBLY (Continued)

(3) Clamp screw into a vise and while supporting oil pump body, remove cap by tapping oil pump body using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 103).

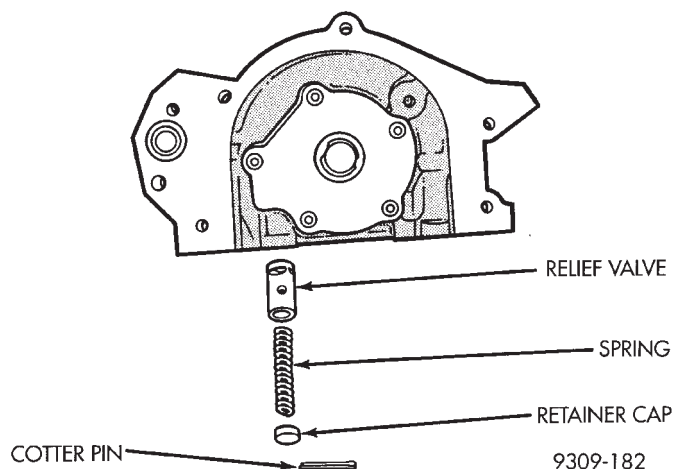


Fig. 103 Oil Pressure Relief Valve

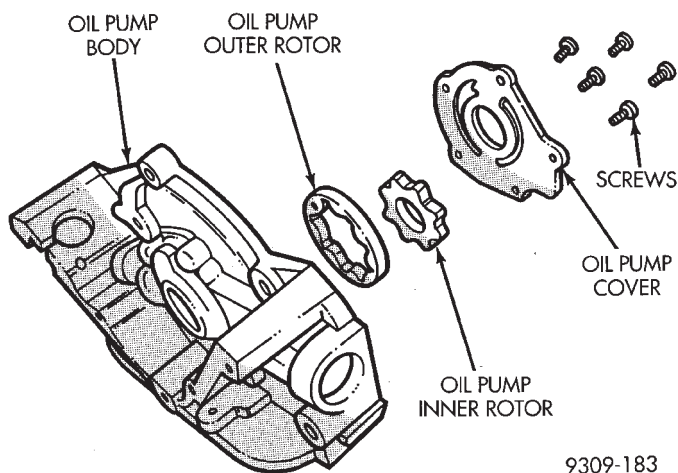


Fig. 104 Oil Pump

(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. 104).

ROCKER ARMS AND SHAFT ASSEMBLY

DISASSEMBLY

(1) Remove dowel pin using a 4 mm screw, nut, spacer, and washer installed into the pin (Fig. 105). Thread the screw into the pin, then loosen the nut on the screw. This will pull the dowel out of the shaft support. Do not reuse dowel pins. Remove the rocker arms and pedestals in order.

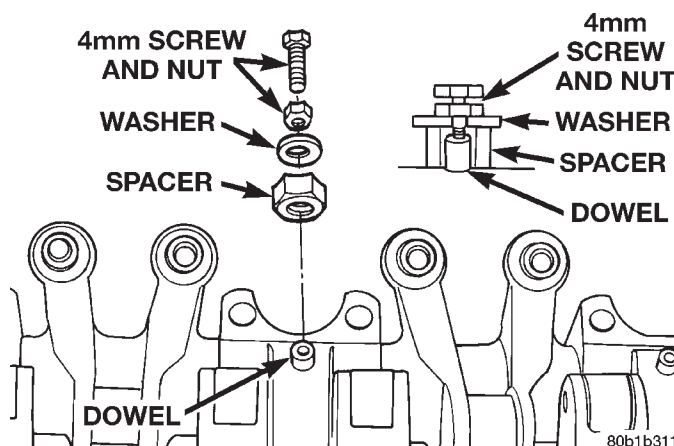


Fig. 105 Rocker Arms and Shaft—Disassembly

(2) Check the rocker arm mounting portion of the shafts for wear or damage. Replace if damaged or heavily worn.

(3) Check shaft oil holes for clogging with small wire, clean as required.

ASSEMBLY

CAUTION: New dowel pins must be installed when reassembling.

(1) Install the rocker arms, and pedestals onto the shaft.

(2) Install dowel pins (Fig. 106). Dowel pins pass through the pedestal into the exhaust rocker shafts. Dowel pins should be pressed in until they bottom-out against the rocker shaft in the pedestal.

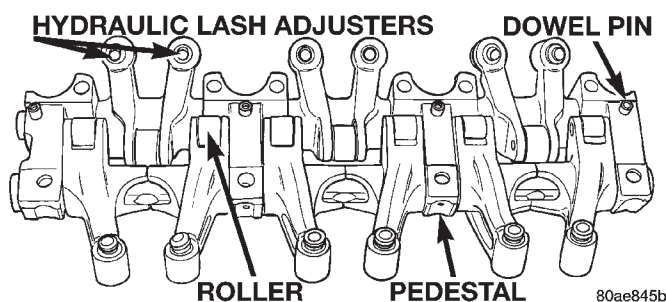


Fig. 106 Assemble Rocker Arms and Shaft

CLEANING AND INSPECTION

CYLINDER HEAD

CLEANING

(1) Use a gasket removal compound to soften the old gasket material.

CLEANING AND INSPECTION (Continued)

CAUTION: When cleaning the cylinder head and block mating surfaces, do not use a metal scraper because the sealing surfaces could be cut or ground. Instead, use a wooden or plastic scraper.

(2) Make sure the gasket and/or foreign material does not enter the oil feed hole or the oil return holes.

INSPECTION

(1) Before cleaning, check for leaks, damage and cracks.

(2) Clean cylinder head and oil passages.

(3) Check cylinder head for flatness (Fig. 107).

(4) Cylinder head must be flat within:

- Standard dimension = less than 0.05 mm (0.002 inch.)
- Service Limit = 0.2 mm (0.008 inch.)
- Grinding Limit = Maximum of 0.2 mm (0.008 inch.) is permitted.

CAUTION: 0.20 mm (0.008 in.) MAX is a combined total dimension of the stock removal limit from cylinder head and block top surface (Deck) together.

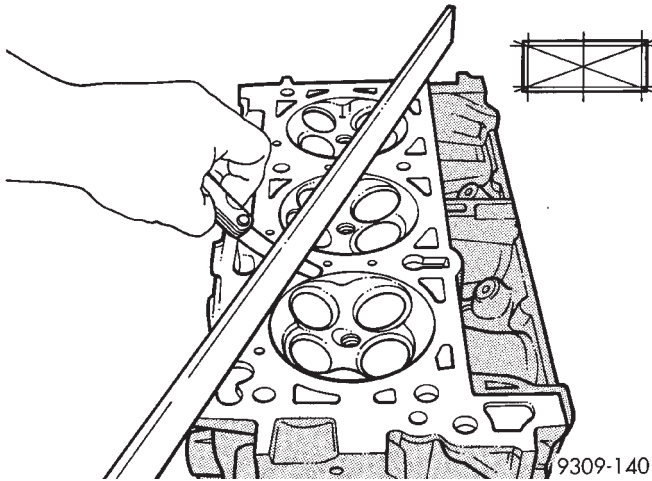


Fig. 107 Checking Cylinder Head Flatness

CAMSHAFT

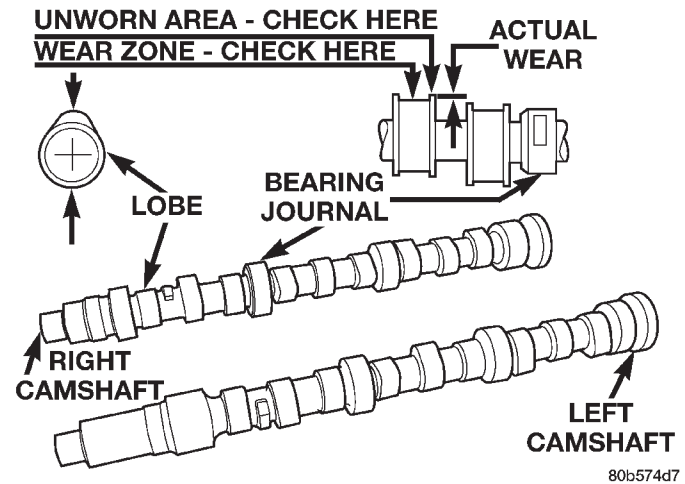


Fig. 108 Camshaft Inspection

(1) Inspect camshaft bearing journals for damage and binding (Fig. 108). If journals are binding, check the cylinder head for damage. Also check cylinder head oil holes for clogging.

(2) Check the cam surface for abnormal wear and damage and replace if defective. Measure the actual wear (Fig. 108) and replace if out of limit, standard value is 0.0254 mm (.001 in.), wear **limit** is 0.254 mm (0.010 in.).

ROCKER ARMS

The rocker arm shafts are hollow and are used as lubrication oil ducts. The rocker arm and shaft assembly on the **right** side of the engine has an oil passage hole from the cylinder head located at the third rocker shaft support pedestal. The rocker arm and shaft assembly on the **left** side of the engine has an oil passage hole from the cylinder head located at the second rocker shaft support pedestal.

NOTE: To prevent air ingestion into lash adjusters, avoid turning rocker arm assembly upside down.

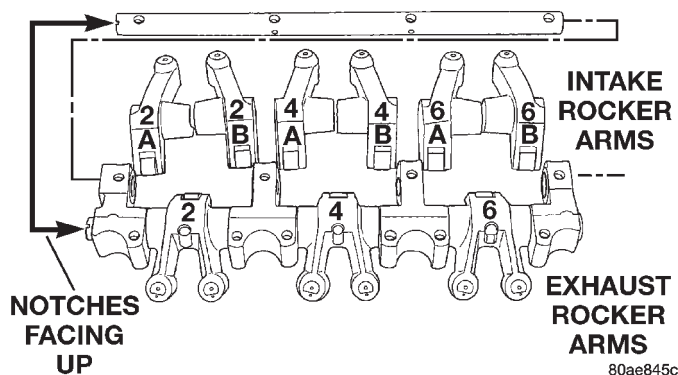
CAUTION: Do not allow rocker arm assembly to rest on lash adjusters, as damage may occur to lash adjuster and plastic retainer.

The intake and exhaust rocker arms are different. They should be identified before disassembling the assembly (Fig. 109).

Check rocker arms for wear or damage (Fig. 110):

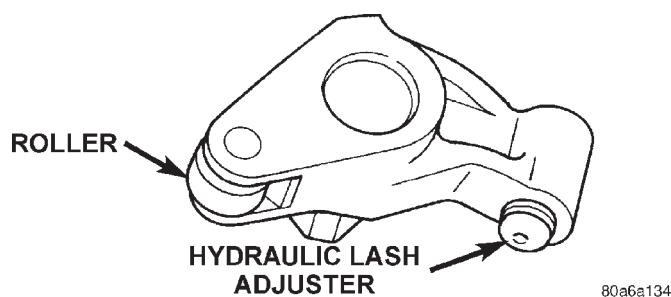
- Roller scuffing or wear
- Shaft bore scuffing or wear
- Swivel pad on lash adjuster missing or broken
- Rocker arm showing signs of fatigue or cracking
- Roller axle protruding from arm

CLEANING AND INSPECTION (Continued)

**Fig. 109 Intake and Exhaust Rocker Arms—Left Side**

Replace assembly as necessary if any rocker arms shows signs of wear.

CAUTION: Do Not remove lash adjuster from rocker arm assembly. Damage to the adjuster and rocker arm will result.

**Fig. 110 Rocker Arm—Inspection****VALVE INSPECTION**

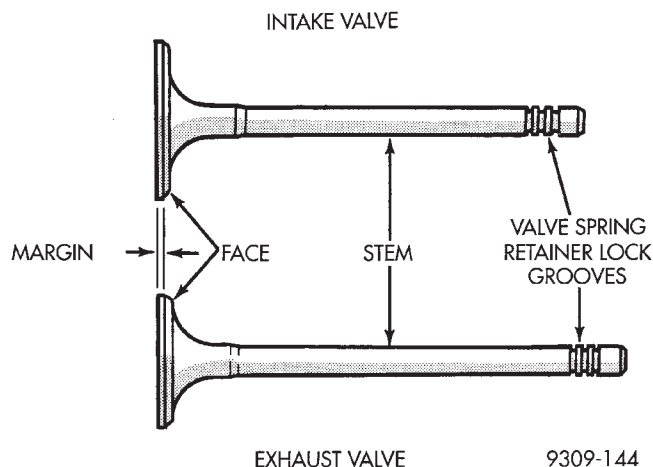
- (1) Clean valves thoroughly and replace burned, warped and cracked valves.
- (2) Measure valve stems for wear (Fig. 111). Refer to Valve Specification Chart.

NOTE: Valve stems are chrome plated and should not be polished (Fig. 111).

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

CHECKING VALVE GUIDES

- (1) Measure valve stem-to-guide clearance as follows:
 - (2) Install valve into cylinder head so it is 15 mm (0.590 inch.) off the valve seat. A small piece of hose may be used to hold valve in place.
 - (3) Attach dial indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 112).
 - (4) Move valve to and from the indicator. Refer to Valve Guide Specification Chart.

**Fig. 111 Intake and Exhaust Valves****VALVE SPECIFICATION CHART**

FACE ANGLE	
Intake and Exhaust:	44.5° – 45°
HEAD DIAMETER	
Intake:	36.37 – 36.63 mm (1.4319 – 1.4421 in.)
Exhaust:	28.87 – 29.13 mm (1.1366 – 1.1468 in.)
LENGTH (OVERALL)	
Intake:	114.41 – 114.99 mm (4.5043 – 4.5272 in.)
Exhaust:	125.67 – 126.25 mm (4.9476 – 4.9705 in.)
STEM DIAMETER	
Intake:	6.935 – 6.953 mm (0.2730 – 0.2737 in.)
Exhaust:	6.906 – 6.924 mm (0.2719 – 0.2726 in.)
VALVE MARGIN	
Intake:	0.835 – 1.165 mm (0.0329 – 0.0459 in.)
Exhaust:	1.44 – 1.77 mm (0.0567 – 0.0697 in.)

VALVE GUIDES

NOTE: Replace cylinder head if stem-to-guide clearance exceeds specifications, or if guide is loose in cylinder head.

CLEANING AND INSPECTION (Continued)

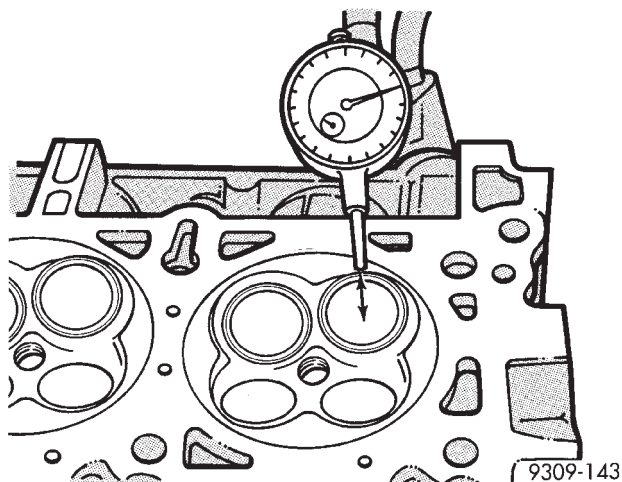


Fig. 112 Measuring Valve Guide Wear

VALVE GUIDE SPECIFICATION CHART

Valve Guide	Intake Valve	Exhaust Valve
Dial Indicator Reading (Maximum).	0.290 mm (0.0114 in.)	0.370 mm (0.0146 in.)

OIL PUMP

INSPECTION AND REPAIR

(1) Clean all parts thoroughly. Mating surface of the oil pump housing should be smooth. Replace pump cover if scratched or grooved.

(2) Lay a straightedge across the pump cover surface (Fig. 113). If a 0.076 mm (0.003 inch.) feeler gauge can be inserted between cover and straight edge, cover should be replaced.

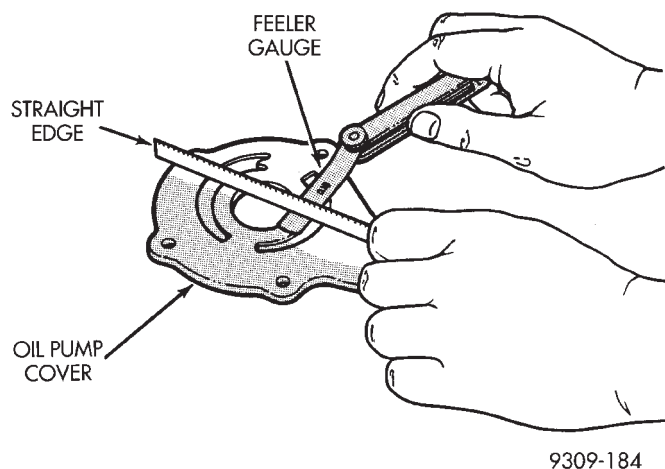


Fig. 113 Checking Oil Pump Cover Flatness

(3) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 14.299 mm (0.563

in.) or less (Fig. 114), or if the diameter is 79.78 mm (3.141 inches.) or less, replace outer rotor.

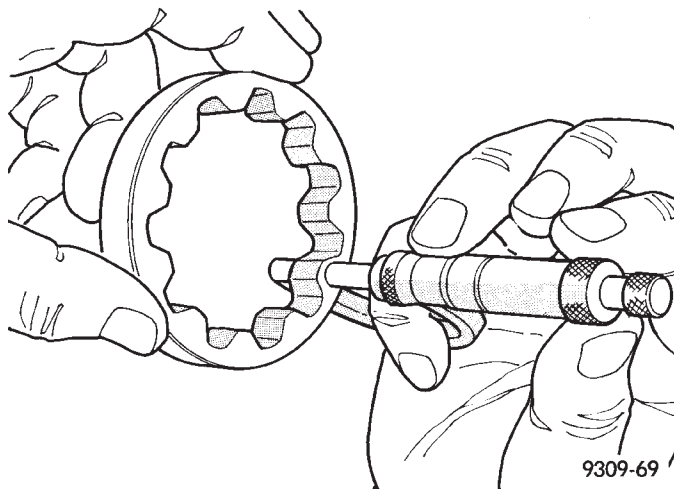


Fig. 114 Measuring Outer Rotor Thickness

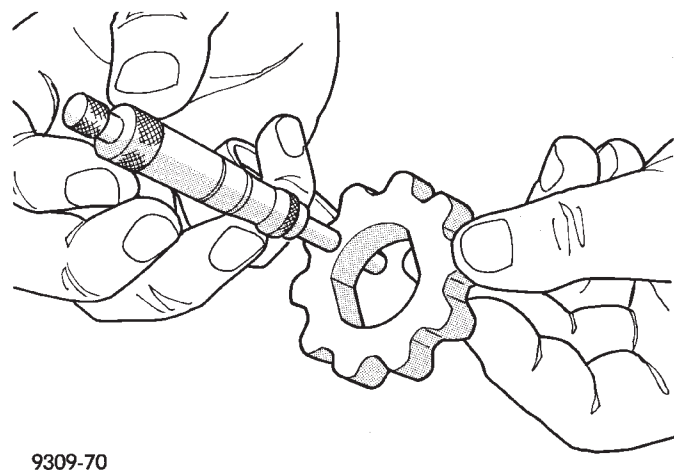


Fig. 115 Measuring Inner Rotor Thickness

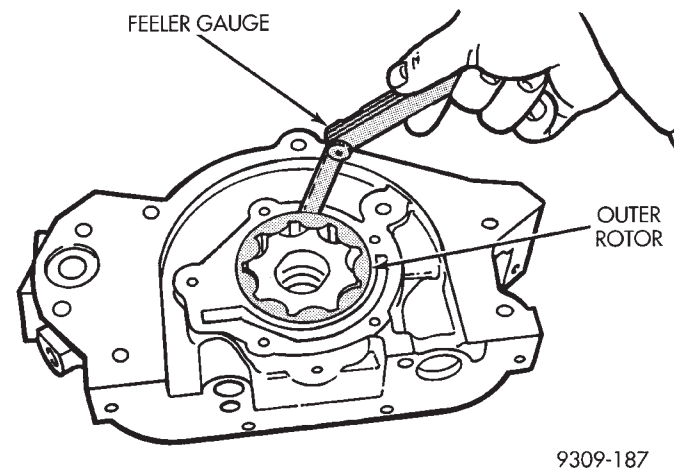
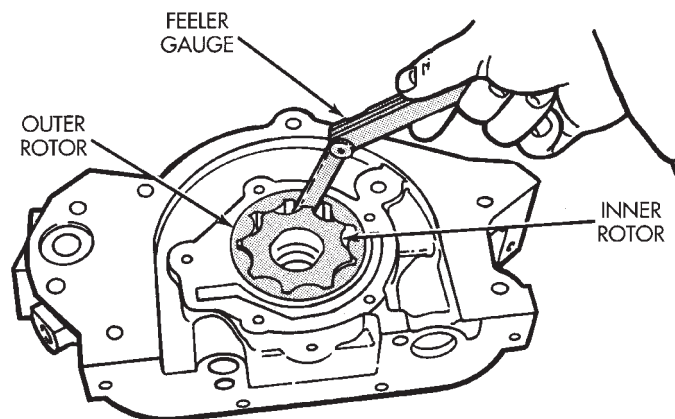


Fig. 116 Measuring Outer Rotor Clearance in Housing

CLEANING AND INSPECTION (Continued)



9309-188

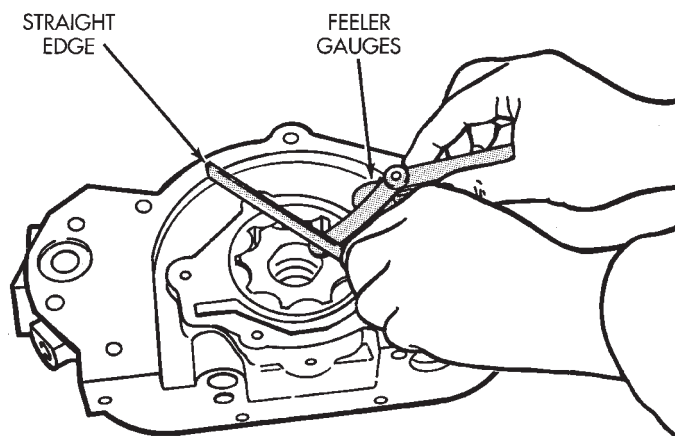
Fig. 117 Measuring Clearance Between Rotors

(4) If inner rotor measures 14.299 mm (0.563 in.) or less replace inner rotor (Fig. 115).

(5) Slide outer rotor into body, press to one side with fingers and measure clearance between rotor and body (Fig. 116). If measurement is 0.39 mm (0.015 inch.) or more, replace body only if outer rotor is in specifications.

(6) Install inner rotor into body. If clearance between inner and outer rotors (Fig. 117) is 0.20 mm (0.008 inch.) or more, replace both rotors.

(7) Place a straightedge across the face of the body, between bolt holes. If a feeler gauge of 0.102 mm (0.004 inch.) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 118) **ONLY** if rotors are in specs.



9309-189

Fig. 118 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 49.5 mm (1.95 inches) it should test between 23 – 25 pounds when compressed to 34 mm

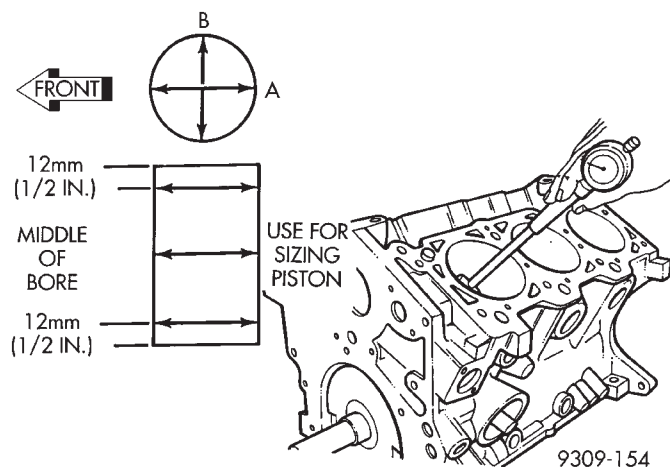
(1 – 11/32 inches). Replace spring that fails to meet specifications.

OIL PUMP ASSEMBLY

- (1) Assemble pump, using new parts as required.
- (2) Tighten cover screws to 12 N·m (105 in. lbs.).
- (3) Prime oil pump before installation by filling rotor cavity with engine oil.
- (4) If oil pressure is low and pump is within specifications, inspect for worn engine bearings or other reasons for oil pressure loss.

CYLINDER BORE

The cylinder walls should be checked for out-of-round and taper with Tool C-119 (Fig. 119). 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.

**Fig. 119 Checking Cylinder Bore Size**

NOTE: 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. 119). Top measurement should be 12 mm (0.50 inch.) down and bottom measurement should be 12 mm (0.50 inch.) up from bottom of bore. Refer to Cylinder Bore and Piston Specification Chart.

CLEANING AND INSPECTION

- (1) Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.
- (2) If new core plugs are installed, Refer to Engine Core Plugs.
- (3) Examine block for cracks or fractures.

CLEANING AND INSPECTION (Continued)

CYLINDER BORE AND PISTON SPECIFICATION CHART

ENGINE	STANDARD CYLINDER BORE	MAXIMUM OUT-OF-ROUND	MAXIMUM TAPER	STANDARD PISTON SIZE
3.5L	96.0 mm (3.780 in.)	0.076 mm (0.003 in.)	0.051 mm (0.002 in.)	95.980 ±0.019mm (3.7788 ±0.0008 in.)
Piston to Bore Clearance: -0.007 to +0.047 mm (-0.0003 to 0.0018 in.) Measurement taken at Piston Size location.				

ENGINE HYDRO-MOUNT INSULATORS

Engine hydro-mounts may show surface cracks this will not effect performance and mount should not be replaced. Only replace the engine hydro-mounts when leaking fluid:

- Drive shaft distress: Refer to Driveshafts in Suspension, Group 2.
- Any front end structural damage (after repair).
- Insulator replacement.

TIMING BELT INSPECTION—IN VEHICLE

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

(2) Remove timing belt covers. Refer to procedure in this section.

(3) Inspect both sides of the timing belt. Replace belt if any of the following conditions exist (Fig. 120):

- Hardening of back rubber back side is glossy without resilience and leaves no indent when pressed with fingernail.
- Cracks on rubber back.
- Cracks or peeling of canvas.
- Cracks on rib root.
- Cracks on belt sides.
- Missing teeth.

(g) Abnormal wear of belt sides. The sides are normal if they are sharp as if cut by a knife.

(h) Vehicle mileage at component maintenance requirement. Refer to Group 0, Lubrication and Maintenance.

(4) If none of the above conditions are seen on the belt, the belt cover can be installed.

NOTE: If belt requires replacing, ensure the proper length belt is used.

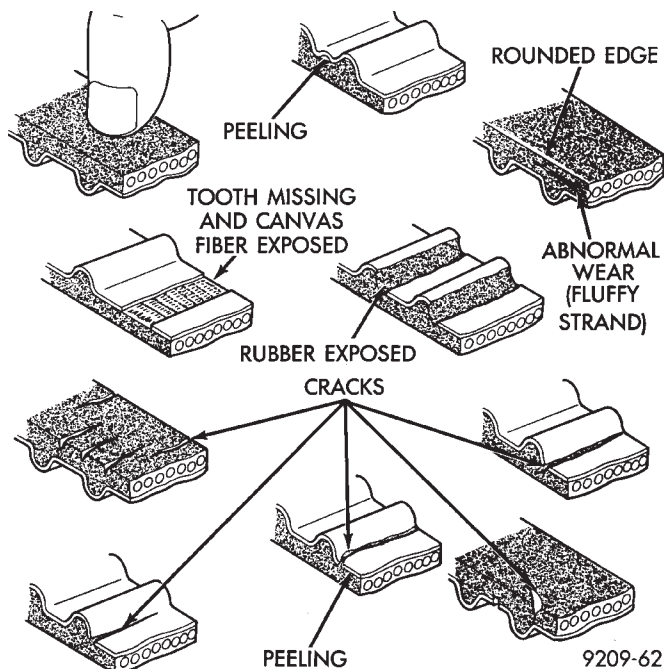


Fig. 120 Timing Belt Inspection

SPECIFICATIONS

3.5L ENGINE

CYLINDER BLOCK

Cylinder Bore Diameter . . 96.0 mm ± 0.0076 mm
(3.780 in. ± 0.0003 in.)

Out of Round (Max) 0.076 mm (0.003 in.)

Taper (Max) 0.051 mm (0.002 in.)

PISTONS

Type Material Aluminum
(Full Floating Piston Pin)

Clearance at Size Location -0.007mm to
+0.047 mm (-0.0003 in. to +0.0018 in.)

PISTON WEIGHT

A Size 438 to 443 grams (15.45 to 15.62 oz.)

B Size 433 to 438 grams (15.27 to 15.45 oz.)

PISTON RING GROOVE DIAMETER

No. 1 87.4 – 87.6 mm (3.441 – 3.449 in.)

No. 2 86.3 – 86.5 mm (3.397 – 3.4055 in.)

No. 3 85.8 – 86.0 mm (3.378 – 3.385 in.)

SPECIFICATIONS (Continued)

PISTON PINS

Type	Full Floating
Clearance In Piston	0.0076 – 0.0183 mm (0.0003 – 0.0008 in.)
Clearance In rod	0.007 – 0.018 mm (0.0003 – 0.007 in.)
Diameter	23.997 – 24.000 mm (0.9448 – 0.9449 in.)

PISTON RINGS

Ring Gap Top	
Compression Ring	0.20 – 0.36 mm (0.008 – 0.014 in.)
Ring Gap 2nd	
Compression Ring	0.23 – 0.50 mm (0.0091 – 0.0197 in.)
Ring Gap Oil Control (Steel Rails)	0.25 – 0.76 mm (0.010 – 0.030 in.)

RING GROOVE CLEARANCE

Top and Second Compression Ring	0.035 – 0.085 mm (0.0014 – 0.0034 in.)
Oil Ring (Steel Rails)	0.038 – 0.184 mm (0.0015 – 0.0073 in.)

RING WIDTH

Top Compression Ring	1.17 – 1.19 mm (0.0461 – 0.0469 in.)
2nd Compression Ring	1.47 – 1.49 mm (0.058 – 0.059 in.)
Oil Ring (Steel Rails)	0.445 – 0.470 mm (0.0176 – 0.0186 in.)

CONNECTING RODS

Bearing Clearance	0.019 – 0.087 mm (0.0007 – 0.0034 in.)
Piston Pin Bore	
Diameter	24.0076 – 24.0153 mm (0.9452 – 0.9455 in.)
Side Clearance (Max.)	0.40 mm (0.0157 in.)
Total Weight (Less Bearing)	647 grams (22.8223 oz.)

CRANKSHAFT MAIN BEARING JOURNALS

Diameter	63.987 – 64.013 mm (2.519 to 2.520 in.)
Main Bearing Diametrical Clearance No. 1 – 4	0.011 – 0.077 mm (0.0007 – 0.0030 in.)
Max. Allowable	0.087 mm (0.0034 in.)
Out of Round (Max.)	0.003 mm (0.00012 in.)
Taper (Max.)	0.0057 mm (0.00025 in.)
End Play	0.10 – 0.30 mm (0.004 – 0.012 in.)
Max. Allowable	0.43 mm (0.017 in.)

CONNECTING ROD JOURNALS

Diameter	57.979 – 58.005 mm (2.283 – 2.284 in.)
Bearing Diametrical Clearance	0.019 – 0.087 mm (0.00075 – 0.0034 in.)
Out Of Round (Max.)	0.003 mm (0.0001 in.)

CAMSHAFT

Bore Diameter No. 1 – 4	43.038 – 43.059 mm (1.6944 – 1.6952 in.)
Bearing Journal Diameter No. 1 – 4	42.939 – 42.960 mm (1.6905 – 1.6913 in.)
Diametrical Clearance (New)	0.078 – 0.12 mm (0.003 – 0.0047 in.)
Max. Allowable	0.15 mm (0.0059 in.)
End Play	0.11 – 0.35 mm (0.004 – 0.014 in.)

VALVE TIMING INTAKE VALVE

Opens (ATDC)	2°
Closes (ABDC)	64°
Duration	242°

VALVE TIMING EXHAUST VALVE

Opens (BBDC)	58°
Closes (ATDC)	14°
Duration	252°
Valve Overlap	12°

CYLINDER HEAD

Gasket Thickness (Compressed)	1.78 mm (0.070 in.)
Valve Seat Angle	45 – 45 1/2°
Valve Seat Runout (Max)	0.051 mm (0.002 in.)
Intake Valve Seat Width	0.75 – 1.25 mm (0.0295 – 0.0492 in.)
Exhaust Valve Seat Width	1.25 – 1.75 mm (0.0492 – 0.0689 in.)
Guide Bore Diameter (Std.)	6.975 – 7.00 mm (0.2746 – 0.2756 in.)
Valve Guide Height*	9.5 – 10.5 mm (0.3740 – 0.4134 in.)

*Measured from cylinder head surface.

VALVES

Face Angle	44 1/2 – 45°
Head Diameter Intake	36.37 – 36.63 mm (1.4319 – 1.4421 in.)
Head Diameter Exhaust	28.87 – 29.13 mm (1.1366 – 1.1469 in.)
Length Intake (Overall)	114.41 – 114.99 mm (4.5043 – 4.5272)
Length Exhaust (Overall)	125.67 – 126.25 mm (4.9476 – 4.9705 in.)
Stem Diameter Intake	6.935 – 6.953 mm (0.2730 – 0.2737 in.)
Stem Diameter Exhaust	6.906 – 6.924 mm (0.2719 – 0.2726 in.)

SPECIFICATIONS (Continued)

Stem-to-Guide Clearance	
Intake (New)	0.022 – 0.065 in. (0.0009 – 0.00256 in.)
Stem-to-Guide Clearance	
Exhaust (New)	0.051 – 0.094 mm (0.002 - 0.0037 in.)
Max. Allowable (Rocking Method)	
Intake	0.29 mm (0.0114 in.)
Max. Allowable (Rocking Method)	
Exhaust	0.370 mm (0.0146 in.)
Valve Lift (Zero Lash) Intake	8.55 mm (0.3367 in.)
Valve Lift (Zero Lash) Exhaust	6.53 mm (0.2571 in.)
Valve Stem Tip Height	
Intake	42.366 – 43.655 mm (1.6680 – 1.7187 in.)
Valve Stem Tip Height	
Exhaust	44.705 – 45.986 mm (1.760 – 1.8105 in.)

VALVE SPRING

Free Length (Approx.) Intake	43.675 mm (1.7195 in.)
Free Length (Approx.) Exhaust	44.319 mm (1.7448 in.)
Spring Force (Valve Closed)	
Intake	309 – 358 N @ 38.0 mm (69.5 – 80.5 lbs. @ 1.4961 in.)
Spring Force (Valve Closed)	
Exhaust	249 – 285 N @ 38.0 mm (56.0 – 64.0 lbs. @ 1.4961 in.)
Spring Force (Valve Open)	
Intake	836 – 907 N @ 29.85mm (188.0 – 204 lbs. @ 1.1594 in.)
Spring Force (Valve Open)	
Exhaust	552 – 605 N @ 31.47 mm (124 – 136 lbs. @ 1.239 in.)
Number of Coils Intake	6.86
Number of Coils Exhaust	7.66
Color of Spring (Top of Coils)	
Intake (Right Hand Coil Direction)	Orange
Exhaust (Left Hand Coil Direction)	Green
Wire Diameter Intake	4.29 – 4.34 mm (0.1689 – 0.1709 in.)
Wire Diameter Exhaust	4.16 – 4.22 mm (0.1638 – 0.1661 in.)
Installed Height (Spring Seat to Bottom of Retainer)	
Intake and Exhaust	38.0 mm (1.4961 in.)

OIL PUMP

Clearance Over Rotors (Max.)	0.077 mm (0.003 in.)
Cover Out-of-Flat (Max.)	0.025 mm (0.001 in.)

Inner and Outer Rotor	
Thickness (Min.)	14.299 mm (0.563 in.)
Outer Rotor Clearance (Max.)	
	0.19 mm (0.007 in.)
Diameter (Min.)	
	79.997 mm (3.149 in.)
Tip Clearance Between Rotors (Max.)	
	0.02 mm (0.0007 in.)

OIL PRESSURE

At Curb Idle Speed *	34.47 kPa (5 psi)
At 3000 rpm	170 – 724 kPa (25 – 105 psi) *

*CAUTION: If pressure is zero at curb idle, DO NOT run engine at 3000 rpm.

TORQUE CHART

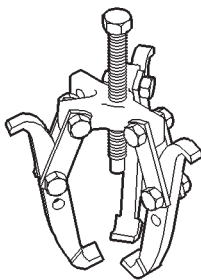
DESCRIPTION	TORQUE
A/C Compressor Bracket to Engine Block	
Bolts	54 N·m (40 ft. lbs.)
A/C Compressor to Bracket	
Bolts	28 N·m (250 in. lbs.)
Camshaft Sprocket Bolt	
Right Side	102 N·m (75 ft. lbs.) plus 1/4 turn
Left Side	115 N·m (85 ft. lbs.) Plus 1/4 turn
Camshaft Thrust Plate (Camshaft Cover)	
Bolts	28 N·m (250 in. lbs.)
Connecting Rod Cap	
Nuts	54 N·m (40 ft. lbs.) Plus 1/4 turn
Crankshaft Main Bearing Cap	
Inside Main Cap Bolts	20 N·m (15 ft. lbs.) + 1/4 turn
Outside Main (Windage Tray) Bolts	27 N·m (20 ft. lbs.) + 1/4 turn
Tie (Horizontal) Bolts	28 N·m (250 in. lbs.)
Crankshaft Damper	
Bolt	95 N·m (70 ft. lbs.)
Cylinder Head Bolts	
Step 1	61 N·m (45 ft. lbs.)
Step 2	88 N·m (65 ft. lbs.)
Step 3	88 N·m (65 ft. lbs.)
Step 4	Plus 1/4 turn—Do not use torque wrench
Cylinder Head Cover	
Bolts	12 N·m (105 in. lbs.)
Exhaust Manifold to Cylinder Head	
Bolts	23 N·m 200 in. lbs.)
Exhaust Manifold Heat Shield	
Bolts	12 N·m 105 in. lbs.
Engine Mount Bracket to Block	
Bolts	61 N·m (45 ft. lbs.)
Engine Mount Isolator	
Nuts	61 N·m (45 ft. lbs.)

SPECIFICATIONS (Continued)

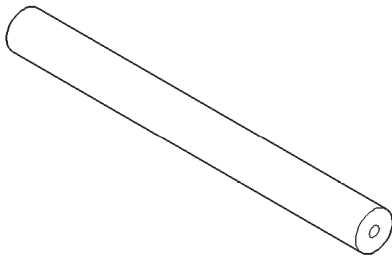
DESCRIPTION	TORQUE
Generator Bracket	
Bolts	54 N·m (40 ft. lbs.)
Intake Manifold	
Bolts—M8	28 N·m (250 in. lbs.)
Bolts—M6	12 N·m (105 in. lbs.)
Oil Pan	
Bolts—M6	12 N·m (105 in. lbs.)
Bolts—M8	28 N·m (250 in. lbs.)
Oil Pan Drain	
Plug	35 N·m (25 ft. lbs.)
Oil Filter	20 N·m (15 ft. lbs.)
Oil Pump to Block	
Bolts	28 N·m (250 in. lbs.)
Oil Pump Cover	
Bolts	12 N·m (105 in. lbs.)
Oil Pump Pick Up Tube	
Bolt	28 N·m (250 in. lbs.)
PCV Valve	
Valve	7 N·m (60 in. lbs.)
Rear Crankshaft Seal Retainer	
Bolts	12 N·m (105 in. lbs.)
Rocker Shaft Pedestal Retaining	
Bolts	31 N·m (275 in. lbs.)
Spark Plugs	
Spark Plugs	28 N·m (20 ft. lbs.)
Structural Collar	
(Refer to procedure for torque sequence and specification.)	
Thermostat Housing/Water Inlet Connector	
Bolts	12 N·m (105 in. lbs.)
Throttle Body	
Bolts	12 N·m (105 in. lbs.)
Timing Belt Tensioner	
Bolts	28 N·m (250 in. lbs.)
Timing Belt Tensioner Pulley Assembly	
Bolt	61 N·m (45 ft. lbs.)
Timing Belt Cover Bolts	
M6	12 N·m (105 in. lbs.)
M8	28 N·m (250 in. lbs.)
M10	54 N·m (40 ft. lbs.)
Water Pump to Timing Belt Cover	
Bolts	12 N·m (105 in. lbs.)
Water Outlet Housing Bleed	
Screw	8 N·m (70 in. lbs.)

SPECIAL TOOLS

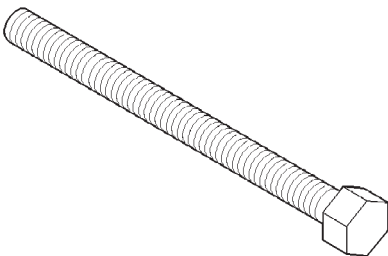
3.5L ENGINE



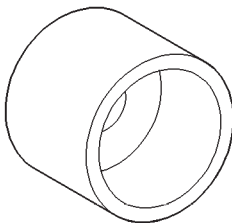
Puller Damper 1023



Crankshaft Damper Remover Insert C-4685-C2

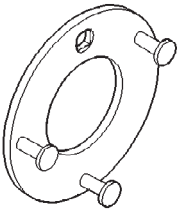
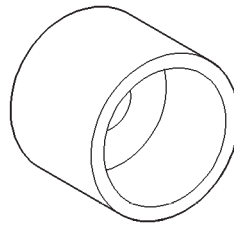
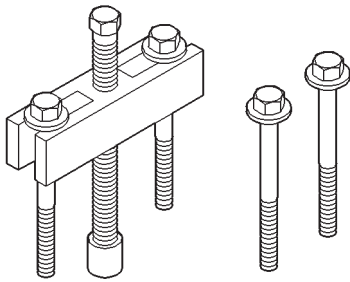
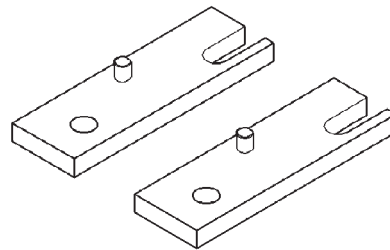
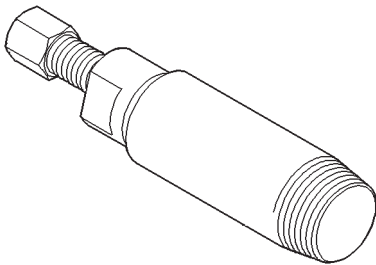
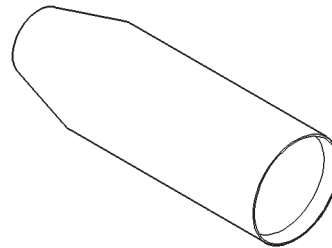
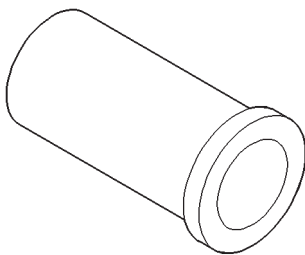
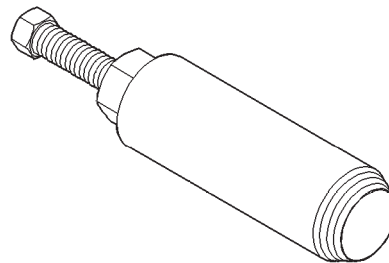


Crankshaft Damper Installer Bolt C-4685-C1

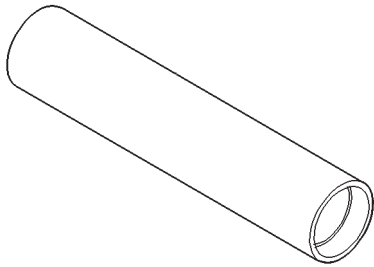


Crankshaft Damper Installer 6792-1

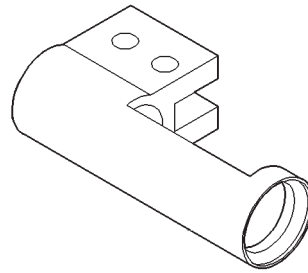
SPECIAL TOOLS (Continued)

***Crankshaft Damper Holder 8191******Crankshaft Sprocket Installer 6641******Crankshaft Sprocket Puller L-4407A******Camshaft Alignment 6642******Crankshaft Seal Remover 6341A******Camshaft Seal Protector 6788******Crankshaft Seal Installer 6342******Camshaft Seal Remover C-3981B***

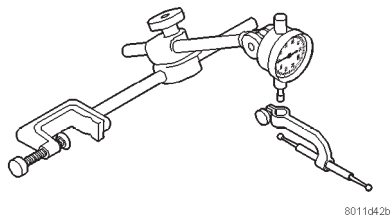
SPECIAL TOOLS (Continued)



Camshaft Seal Installer 6052

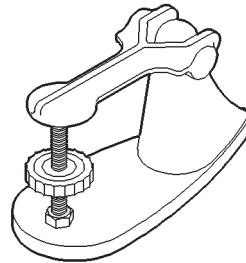


Valve Spring Adapter 6526

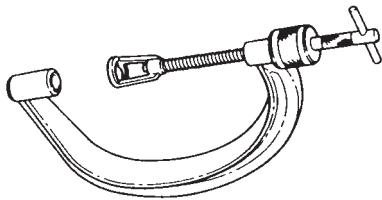


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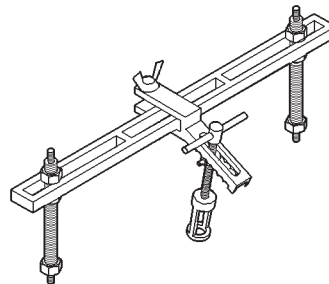
Dial Indicator C-3339



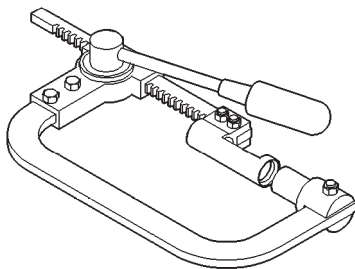
Valve Spring Tester C-647



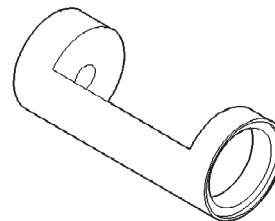
Valve Spring Compressor 7068



Valve Spring Compressor MD-998772-A

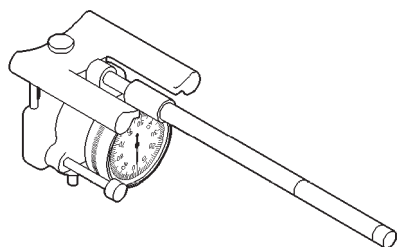


Valve Spring Compressor C-3422-B



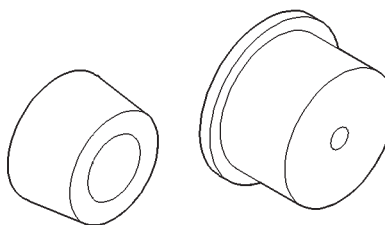
Valve Spring Adapter 6527

SPECIAL TOOLS (Continued)

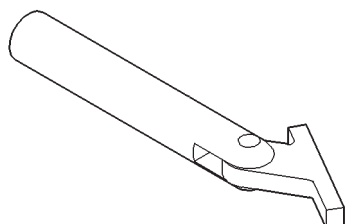


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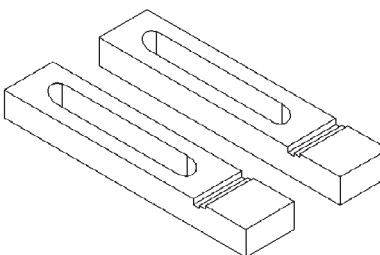
Indicator Bore Size C-119



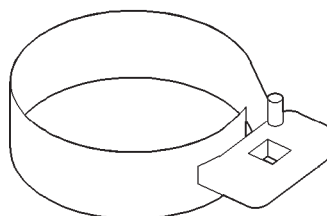
Crankshaft Rear Seal Guide 6926-1 & Installer 6926-2



Main Bearing Remover/Installer C-3059



Crankshaft Rear Seal Retainer Alignment Fixture 8225



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Wrench Oil Filter C-4065

