

ENGINE

CONTENTS

	page		page
2.7L ENGINE	13	ENGINE DIAGNOSIS	7
3.2L ENGINE	63	STANDARD SERVICE INFORMATION	1

STANDARD SERVICE INFORMATION

INDEX

	page		page
GENERAL INFORMATION		SERVICE PROCEDURES	
CHECKING ENGINE OIL LEVEL	3	ENGINE CORE PLUGS	6
ENGINE OIL SERVICE	4	HONING CYLINDER BORES	5
ENGINE PERFORMANCE	2	HYDROSTATIC LOCKED ENGINE	5
FORM-IN-PLACE GASKETS	1	REPAIR OF DAMAGED OR WORN THREADS ...	5
MEASURING MAIN BEARING AND CONNECTING ROD BEARING CLEARANCES .	2		

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.

GENERAL INFORMATION (Continued)

FORM-IN-PLACE GASKET APPLICATION

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

Mopar® Gasket Maker material should be applied sparingly 1 mm (0.040 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, timing belt or chain may have skipped one or 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.

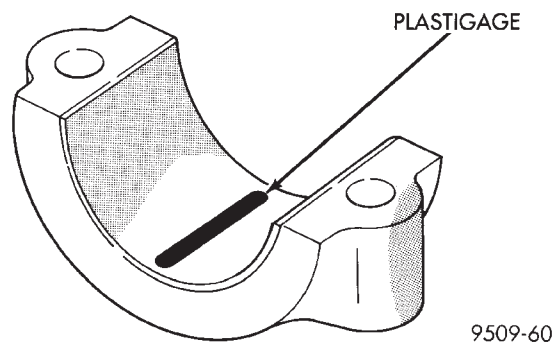
MEASURING MAIN BEARING AND CONNECTING ROD BEARING CLEARANCES

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.

GENERAL INFORMATION (Continued)

ENGINE WITH 4 MAIN BEARING

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

NOTE: REMOVE ALL SHIMS BEFORE REASSEMBLING ENGINE

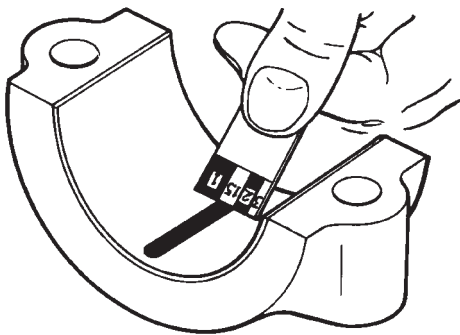


Fig. 2 Clearance Measurement

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.

GENERAL INFORMATION (Continued)

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.

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 in the 3.2L engine and 5W-30 engine oil in the 2.7L engine. 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).

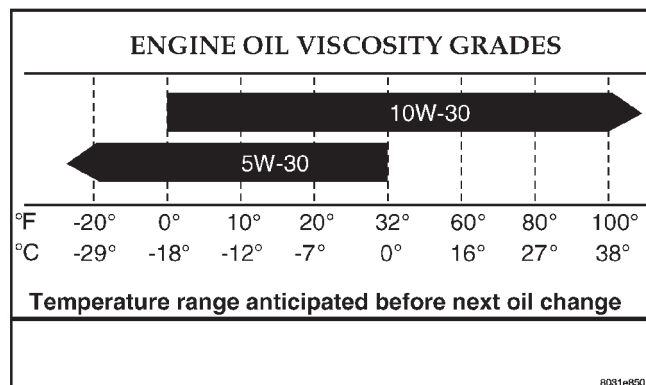


Fig. 3 Temperature/Engine Oil Viscosity—3.2L Engine Only

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.

GENERAL INFORMATION (Continued)

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.

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).

(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

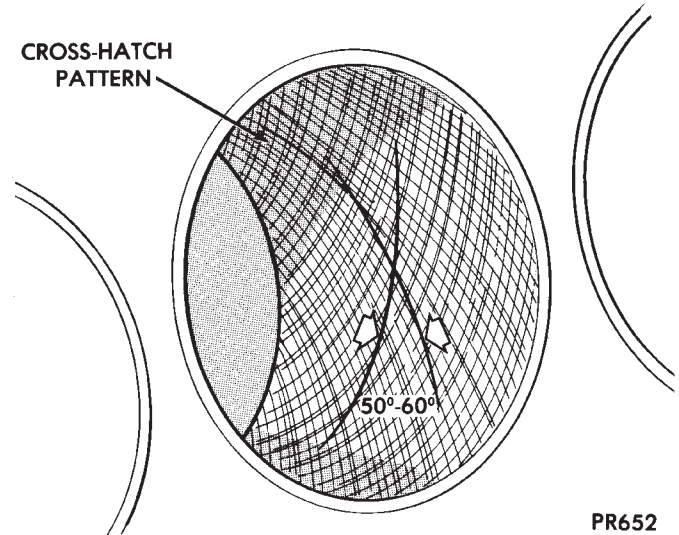


Fig. 5 Cylinder Bore Cross-Hatch Pattern

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.

SERVICE PROCEDURES (Continued)

- (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.

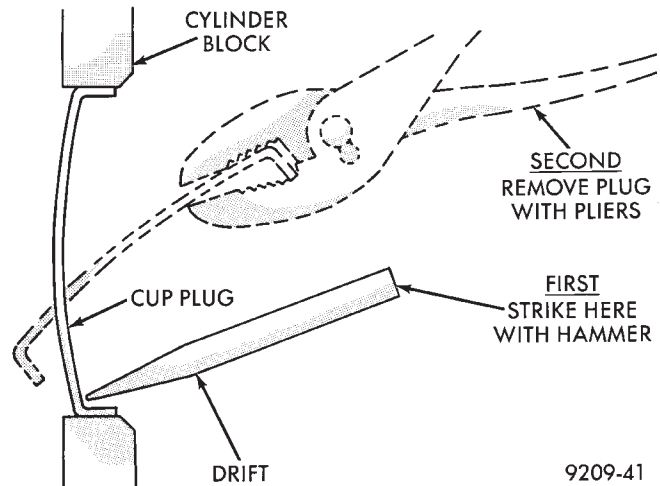
ENGINE CORE PLUGS**REMOVAL**

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



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Fig. 6 Core Hole Plug Removal

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).

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

ENGINE DIAGNOSIS

INDEX

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

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 a change in RPM'S, 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 help clean out 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. Record cylinder number of spark plug for future reference.
- c. Disconnect the coil connector for Direct Ignition System (DIS).
- d. Be sure throttle blade is fully open during the compression check.
- e. Insert compression gage adaptor into the #1 spark plug hole in cylinder head. Crank engine until maximum pressure is reached on gage. Record this pressure as #1 cylinder pressure.
- 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 in the cylinder 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.

CYLINDER COMBUSTION PRESSURE LEAKAGE TEST

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

Combustion pressure leakage testing will detect:

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

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

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

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

Clean spark plug recesses with compressed air.

Remove the spark plugs.

Remove the oil filler cap.

Remove the air cleaner.

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

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

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

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

LASH ADJUSTER (TAPPET) NOISE DIAGNOSIS

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

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

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

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

(4) Low oil pressure.

(5) Oil passage to the cylinder head(s) is plugged with debris.

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

(7) Worn valve guides.

(8) Rocker arm ears contacting valve spring retainer.

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

(10) Faulty lash adjuster.

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

NOTE: On the 3.2L engine, the lash adjuster is serviced with the rocker arm, do not disassemble.

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

c. Clean out dirt and varnish with solvent.

d. Reassemble with engine oil.

e. Check for sponginess.

f. If still spongy, replace with new adjuster.

INSPECTION (ENGINE OIL LEAKS IN GENERAL)

Begin with a 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.

DIAGNOSIS AND TESTING (Continued)

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

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

- 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.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTION
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.

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 for correct oil level. 2. Change oil to correct viscosity. 3. Check 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 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.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
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. Excessive bearing clearance. 8. Oil pump relief valve stuck. 9. Oil pump suction tube loose. 10. Oil pump cover warped or cracked.	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. Measure bearings for correct clearance. 8. Remove valve and inspect, clean, or replace. 9. Remove oil pan and install new tube or clean, if necessary. 10. Install new oil pump.
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 guides. 6. Valve stem seal unseated or faulty.	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 guides and replace valves with oversize valves and seals. 6. Repair or replace seal.

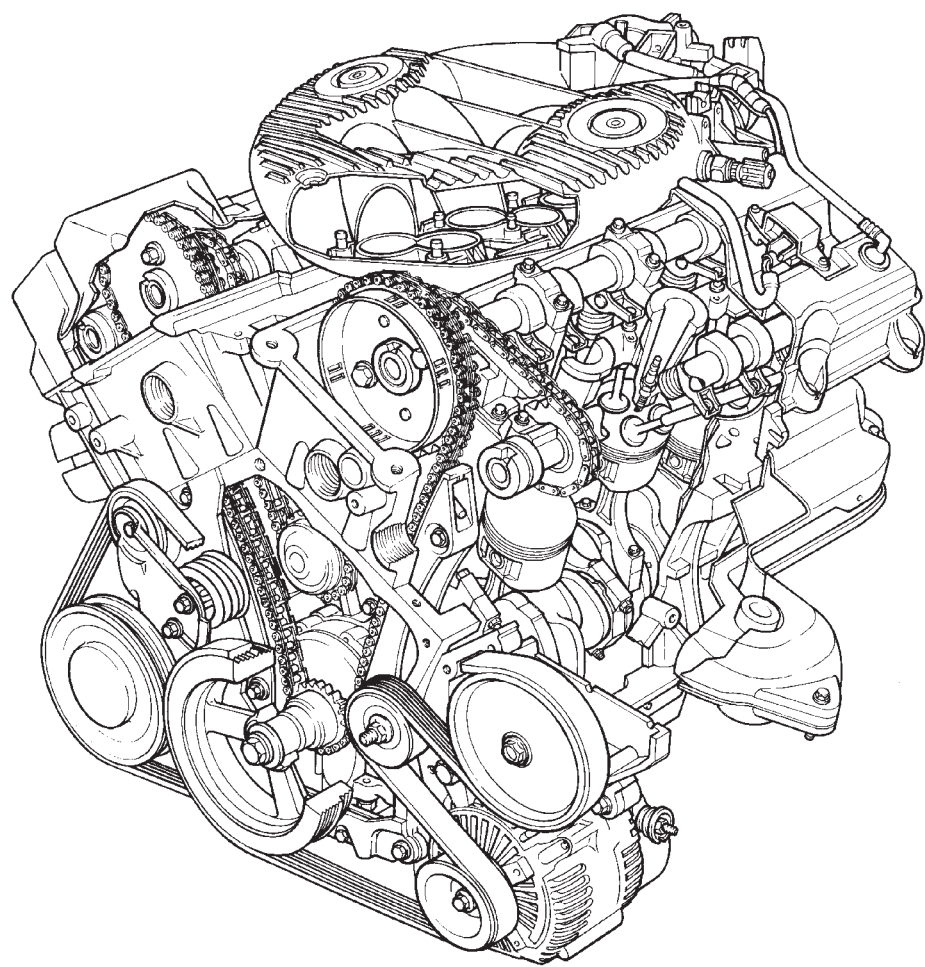
2.7L ENGINE

INDEX

	page		page
DESCRIPTION AND OPERATION		ENGINE CORE AND OIL PLUGS	52
2.7L ENGINE	14	ENGINE MOUNTS—LEFT AND RIGHT	27
2.7L ENGINE COMPONENTS	19	ENGINE MOUNT—REAR	28
2.7L GENERAL SPECIFICATION	14	HYDRAULIC LASH ADJUSTER	35
ENGINE IDENTIFICATION	15	OIL FILTER	49
ENGINE LUBRICATION SYSTEM	16	OIL PAN	46
DIAGNOSIS AND TESTING		OIL PUMP	49
CHECKING ENGINE OIL PRESSURE	20	PISTON AND CONNECTING ROD	49
LASH ADJUSTER (TAPPET) NOISE		ROCKER ARMS	35
DIAGNOSIS	20	STRUCTURAL COLLAR	28
SERVICE PROCEDURES		TIMING CHAIN AND SPROCKETS	39
CHECKING CRANKSHAFT END PLAY	24	TIMING CHAIN COVER	38
CRANKSHAFT MAIN BEARING SELECTION	24	VALVE AND VALVE SPRINGS	37
ENGINE TIMING—VERIFICATION	26	VALVE STEM SEALS OR VALVE SPRINGS—IN	
FITTING PISTON RINGS	21	VEHICLE	35
INSTALLATION OF CONNECTING ROD		DISASSEMBLY AND ASSEMBLY	
BEARINGS	22	OIL PUMP	53
PISTONS	20	CLEANING AND INSPECTION	
REFACING VALVES AND VALVE SEATS	24	CAMSHAFT FOLLOWER	54
REMOVAL AND INSTALLATION		CYLINDER BLOCK AND BORE	56
CAMSHAFTS	32	CYLINDER HEAD	53
CRANKSHAFT	47	ENGINE HYDRO-MOUNT ISOLATOR	56
CRANKSHAFT DAMPER	31	INSPECTING TIMING DRIVE SYSTEM	57
CRANKSHAFT OIL SEAL RETAINER—REAR	45	OIL PUMP	54
CRANKSHAFT OIL SEAL—FRONT	44	VALVE INSPECTION	54
CRANKSHAFT OIL SEAL—REAR	45	SPECIFICATIONS	
CRANKSHAFT SPROCKET	43	2.7L ENGINE	57
CYLINDER HEAD	36	2.7L TORQUE CHART	58
CYLINDER HEAD COVERS	32	SPECIAL TOOLS	
ENGINE ASSEMBLY	29	2.7L ENGINE	59

DESCRIPTION AND OPERATION

2.7L ENGINE

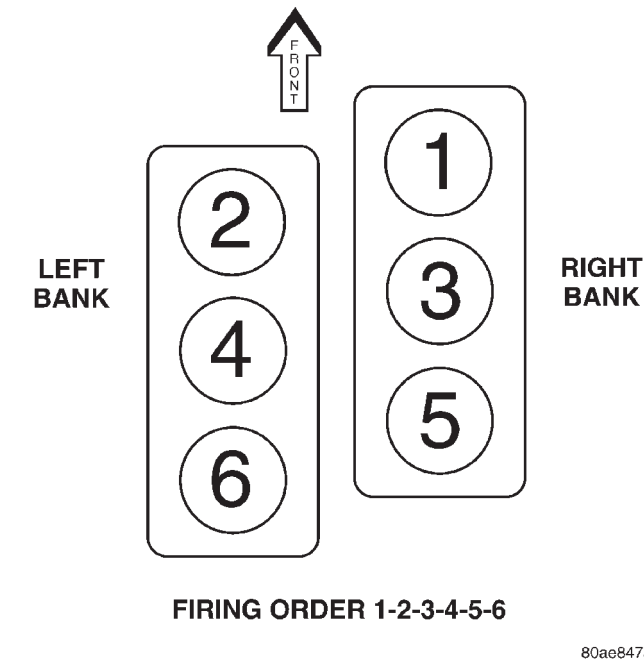


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2.7L GENERAL SPECIFICATION

Type	60° DOHC V-6	Type	60° DOHC V-6
Displacement	2.7 Liters 2736 cc (167 Cubic Inches)	Piston .	Aluminum (Floating Pin With Round Wire Lock Rings)
Bore	86.0 mm (3.386 in.)	Lubrication . .	Pressure Feed-Full Flow Filtration (Direct Crankshaft Driven Pump)
Stroke	78.5 mm (3.091 in.)	Cooling System .	Liquid Cooled-Forced Circulation
Compression Ratio	9.67:1		
Horsepower	200 5800 rpm		
Torque	190 lb. ft. 4850 rpm		
Lead Cylinder	#1 Right Bank		
Firing Order	1, 2, 3, 4, 5, 6		
Cylinder Block	Aluminum With Cast-In-Place Iron Liners		
Crankshaft	Forged Steel		
Camshaft	Fabricated Tubular Camshafts		
Cylinder Head	Aluminum		
Connecting Rod	Powder Metal With Cracked Cap		

DESCRIPTION AND OPERATION (Continued)



Cylinder Numbering & Firing Order

ENGINE IDENTIFICATION

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

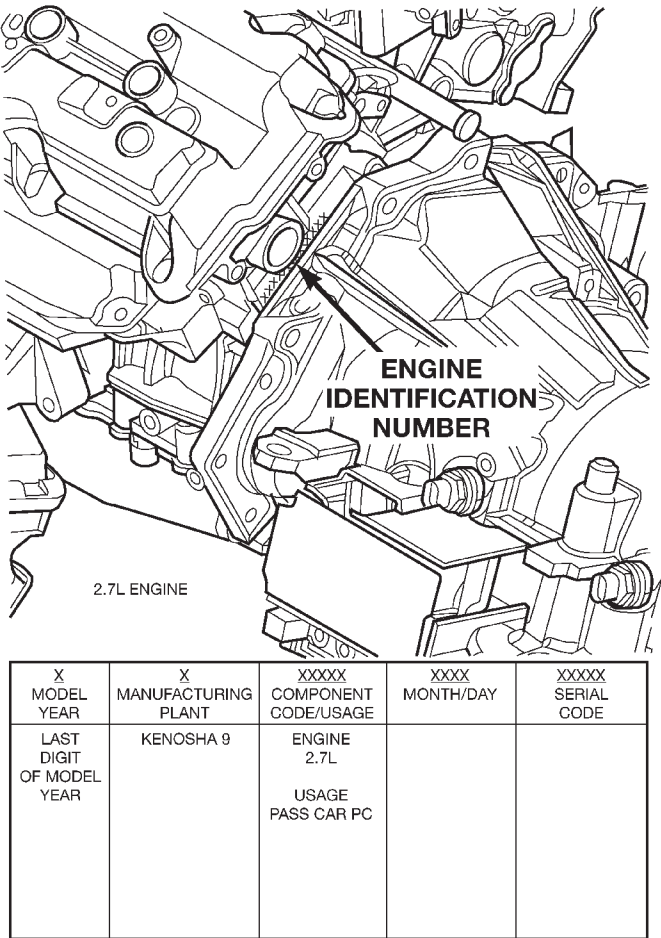
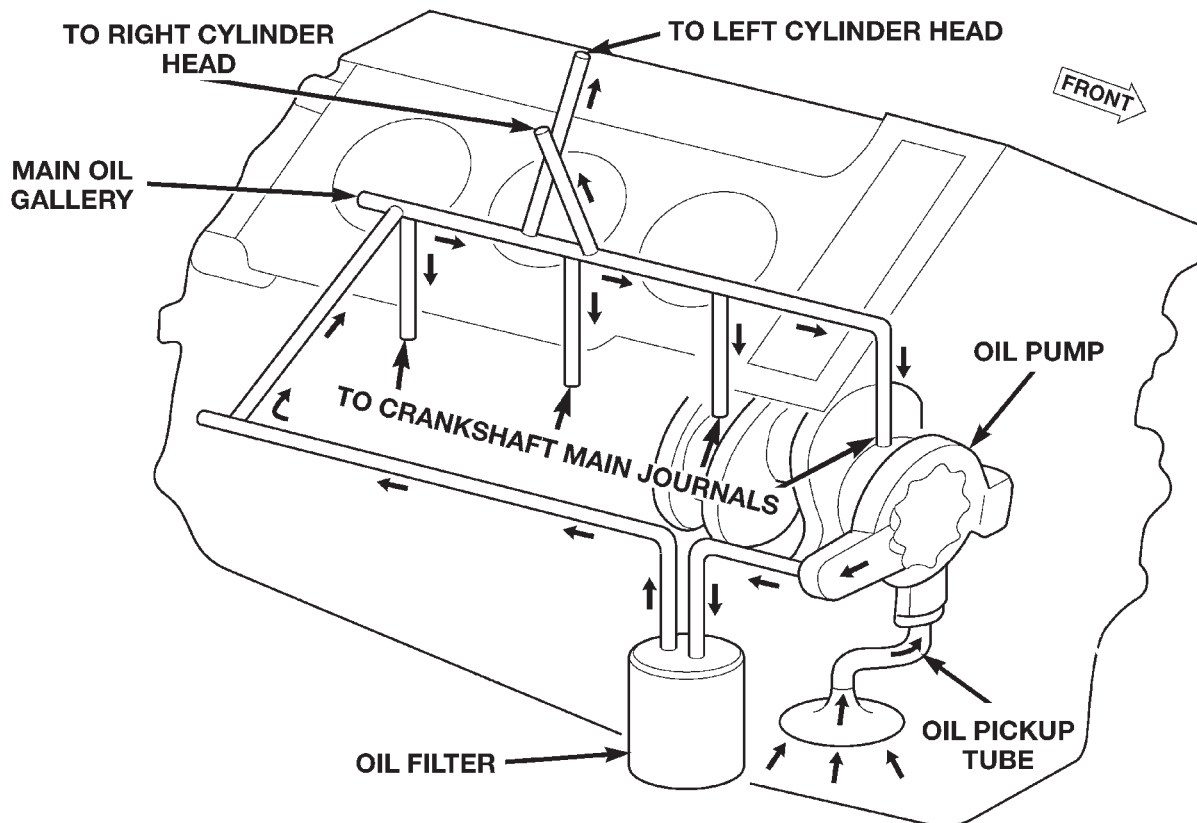


Fig. 1 2.7L Engine Identification

DESCRIPTION AND OPERATION (Continued)

ENGINE LUBRICATION SYSTEM

The lubrication system is a full flow filtration pressure feed type. Oil from the oil pan is pumped by an gerotor type oil pump directly coupled to the crankshaft (Fig. 2). Oil pressure is controlled by a relief valve mounted inside the oil pump housing. See (Fig. 2), (Fig. 3), and (Fig. 4) for engine oil lubrication circuits.



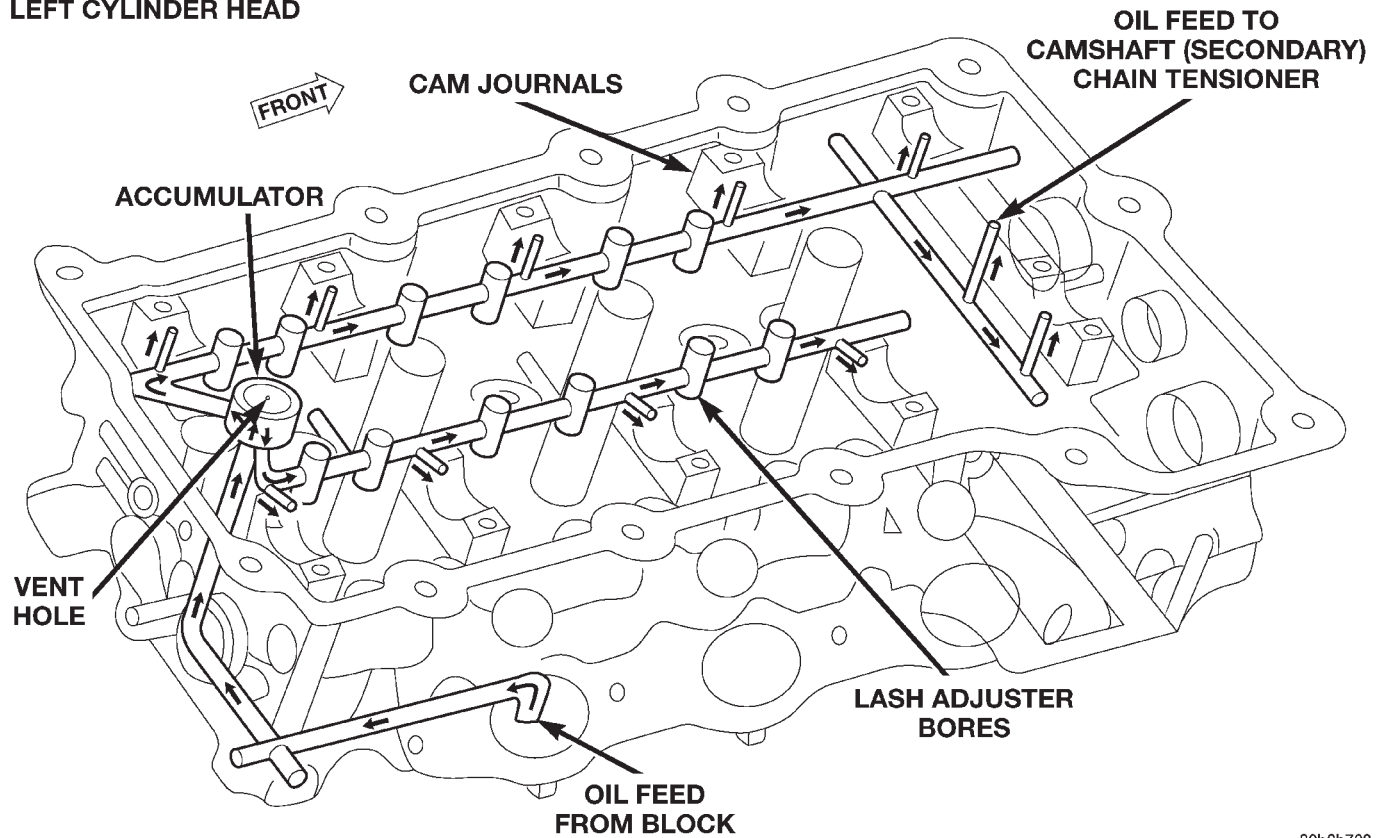
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Fig. 2 Cylinder Block Oil Lubrication System

FROM:	TO:	FROM:	TO:
Oil Pump	Oil Filter Mounting (inlet)	Main Oil Gallery – Center of Block	1. Crankshaft Main Bearings
Oil Filter Mounting (inlet)	Oil Filter		2. Left Cylinder Head*
Oil Filter	Oil Filter Mounting (outlet)		3. Right Cylinder Head*
Oil Filter Mounting (outlet)	Oil Gallery – Right side of Block	Crankshaft Main Bearings	Connecting Rod Bearings
Oil Gallery – Right side of Block	Oil Gallery – Rear of Block	Left Cylinder Head	Refer to (Fig. 3)
Oil Gallery – Rear of Block	Main Oil Gallery – Center of Block	Right Cylinder Head	Refer to (Fig. 4)
* The cylinder head gaskets have an oil restrictor to control oil flow to the cylinder heads.			

DESCRIPTION AND OPERATION (Continued)

LEFT CYLINDER HEAD

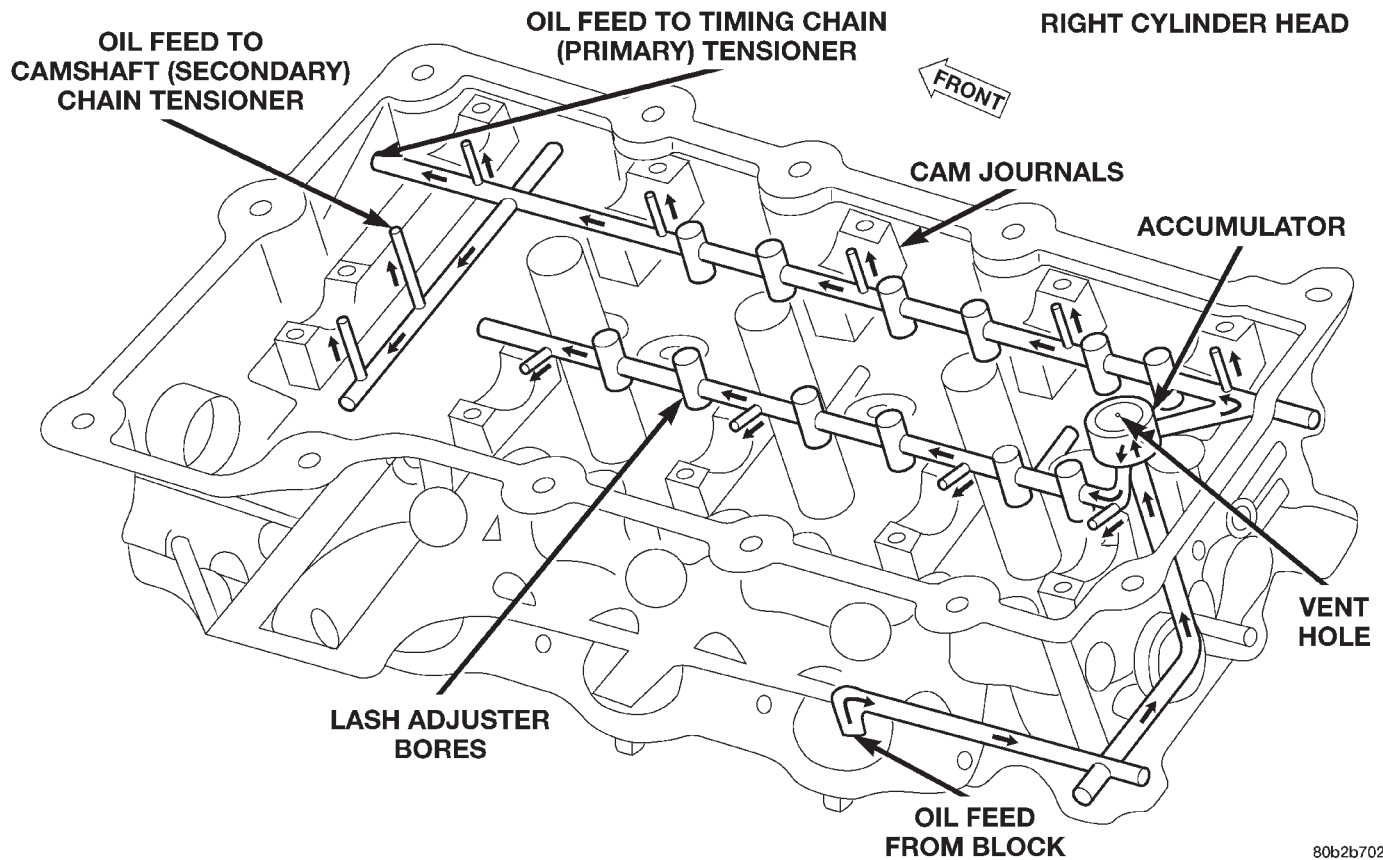


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Fig. 3 Cylinder Head Oil Lubrication System—Left Side

FROM:	TO:
Left Cylinder Head Oil Inlet Gallery (intake side of head)	Oil Gallery and Accumulator – Rear of Head*
Oil Gallery and Accumulator – Rear of Head*	1. Exhaust Camshaft Oil Passage 2. Intake Camshaft Oil Passage
Left Exhaust Camshaft Oil Passage	1. Left Exhaust Camshaft Journals 2. Hydraulic Valve Lash Adjusters and Rocker Arms 3. Left Camshaft (Secondary) Chain Tensioner**
Left Intake Camshaft Oil Passage	1. Left Intake Camshaft Journals 2. Hydraulic Valve Lash Adjusters and Rocker Arms
* When oil reaches the back of the cylinder head, the oil gallery feeds oil into an accumulator chamber that is located towards center of the head. The accumulator chamber is closed off with a pressed in core plug that has a small orifice to act as a vent. Oil then travels down at a 45 degree angle from the accumulator into two passages, one for the intake and one for the exhaust side of the cylinder head.	
** The secondary camshaft chain tensioner is the last component to receive oil on the left cylinder head.	

DESCRIPTION AND OPERATION (Continued)



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Fig. 4 Cylinder Head Oil Lubrication System—Right Side

FROM:	TO:
Right Cylinder Head Oil Inlet Gallery (intake side of head)	Oil Gallery and Accumulator – Rear of Head*
Oil Gallery and Accumulator – Rear of Head*	1. Exhaust Camshaft Oil Passage 2. Intake Camshaft Oil Passage
Right Exhaust Camshaft Oil Passage	1. Right Exhaust Camshaft Journals 2. Hydraulic Valve Lash Adjusters and Rocker Arms 3. Right Camshaft (Secondary) Chain Tensioner 4. Primary Timing Chain Tensioner - Right Head**
Right Intake Camshaft Oil Passage	1. Right Intake Camshaft Journals 2. Hydraulic Valve Lash Adjusters and Rocker Arms
* When oil reaches the back of the cylinder head, the oil gallery feeds oil into an accumulator chamber that is located towards center of the head. The accumulator chamber is closed off with a pressed in core plug that has a small orifice to act as a vent. Oil then travels down at a 45 degree angle from the accumulator into two passages, one for the intake and one for the exhaust side of the cylinder head.	
** The timing (primary) chain tensioner is the last component to receive oil on the right cylinder head.	

DESCRIPTION AND OPERATION (Continued)

2.7L ENGINE COMPONENTS**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 metal 6 bolt main caps (4 vertical, 2 horizontal), with a die cast aluminum structural beam windage tray mounted to the main caps.

The block design allows coolant flow between the cylinder bores and an internal coolant by-pass to a dual poppet inlet thermostat.

CRANKSHAFT

The crankshaft is constructed of a forged micro alloy steel. The six throw, nine counterweight crankshaft is supported by four select fit main bearings with the number three serving as the thrust washer location. The select fit identification markings will be on the rear side of the number nine (rearmost) counterweight. The six separate connecting rod throws are an even-firing design which reduces torque fluctuations while a vibration damper is used to control torsional vibration.

The crankshaft oil seals are a one piece design. The front seal is retained by the timing chain cover, and the rear seal in a housing that attaches to the cylinder block.

PISTONS AND CONNECTING RODS

The pistons are made a high strength aluminum alloy with an anodized top ring groove and crown. Piston skirts are coated with a solid lubricant for scuff resistance. The connecting rods are made of powdered metal with a "fractured cap" design. The connecting rod attaches to the piston with a full floating pin retained by lock rings.

CYLINDER HEADS

The cylinder heads are made of an aluminum alloy. The cylinder head features four valves per cylinder with pressed in powdered metal valve guides. The cylinder heads provide enclosures for the timing chain drive, necessitating a unique right and left cylinder head.

TIMING DRIVE SYSTEM

The timing drive system has been designed to provide quiet performance and reliability to support a **NON** free-wheeling engine. The system consists of a primary and secondary chain drive.

The **primary** timing chain drive uses a single, double-flexure, inverted tooth type chain. The primary chain drives both of the intake camshafts directly from a sprocket mounted on the crankshaft.

In addition, the water pump is driven by the "back side" of the primary chain, necessitating the double-flexure type chain.

The chain is controlled by three fixed chain guides and a pivoting tensioner arm. These guides utilize low-friction and long wearing nylon plastic wear faces. To tension the primary chain, a fully automatic spring-loaded, engine oil-fed, hydraulic tensioner is used. The tensioner is mounted in the right cylinder head with the plunger contacting the pivoting tensioner arm. A mechanical ratchet mechanism inside the tensioner prevents excessive chain slack upon engine start-up as the chain wears. The tensioner is designed with an internal oil reservoir to assure noise-free performance, even during engine start-up before oil pressure reaches the tensioner.

To reduce engine NVH and timing chain loads a camshaft damper is used. This damper mounts to the right intake camshaft sprocket. The damper utilizes a synthetic rubber elastomer to provide damping, similar to a crankshaft damper.

For lubrication the primary chain utilizes oil leakage from the front of the oil pump. This oil spills on the crankshaft sprocket, which is then carried by the chain throughout the primary drive.

The **secondary** timing chain drive system uses two conventional roller-type chains, one at each cylinder bank. The purpose of the secondary chain is to provide a mechanical driven connection between the intake and exhaust camshafts. The intake camshafts drive the exhaust camshafts. The sprockets for both intake and exhaust camshafts are a press-fit and are only serviced as an assembly with the camshafts.

To tension the secondary chain a spring-loaded, hydraulic tensioner is used at each bank and attaches to each cylinder head between the intake and exhaust camshafts. The tensioner incorporates upper and lower chain guide faces. The lower guide face is attached directly to the tensioners hydraulic plunger. Also, the tensioner uses an internal oil reservoir design to prevent engine start-up noise. The secondary chains are lubricated via an oil passage through the upper guide face on each tensioner.

CAMSHAFTS

The assembled fabricated camshafts are composed of five bearing journals machined into a hollow steel tube. Six steel lobes, a secondary timing drive sprocket, and a primary sprocket/thrust flange are pressed onto the camshaft tube using a unique assembly process. Camshaft end play is controlled by the primary camshaft sprocket attachment flange on the intake camshafts and by a thrust flange on the exhaust camshafts.

DESCRIPTION AND OPERATION (Continued)

ROCKER ARMS

The rocker arms are composed of steel stampings with an integral roller bearing. The rocker arms incorporate a 0.5 mm (0.0197 in.) oil hole in the lash adjuster socket for roller/camshaft lobe lubrication.

VALVES

The valves are made of heat resistant steel, and have chrome plated stems to prevent scuffing. The four valves per cylinder are actuated by roller rocker arms, which pivot on stationary lash adjusters. All valves use three bead lock keepers to retain springs and to promote valve rotation.

VALVE SPRINGS

The valve springs are made from high strength, chrome-silicon steel. The springs are common for intake and exhaust applications. The valve spring seat is integral with the valve stem seal, which incorporates a garter spring to maintain consistent lubrication control to the valve stem.

INTAKE MANIFOLD

The intake manifold is made of a composite material and features a compact, low rumble design that maximizes engine performance while minimizing induction noise. The air plenum chambers absorb air pulsations created during each cylinder's intake stroke. The plenum chambers are connected to maximize low RPM torque.

EXHAUST MANIFOLD

The exhaust manifolds are a log style design and made of cast nodular iron. The outlets are designed for V-band clamp attachment of close coupled catalytic converters.

ENGINE LUBRICATION

The 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 structural windage tray is used to increase power by minimizing oil windage at high engine RPM.

DIAGNOSIS AND TESTING

LASH ADJUSTER (TAPPET) NOISE DIAGNOSIS

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

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

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

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

(4) Low oil pressure.

(5) The oil restrictor in cylinder head gasket or the oil passage to the cylinder head is plugged with debris.

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

(7) Worn valve guides.

(8) Rocker arm ears contacting valve spring retainer.

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

(10) Faulty lash adjuster.

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

b. Remove suspected lash adjusters, and replace.

c. Before installation, make sure adjusters are at least partially full of oil. This can be verified by little or no plunger travel when lash adjuster is depressed.

CHECKING ENGINE OIL PRESSURE

(1) Remove oil pressure sending unit and install gauge assembly C-3292.

(2) Run engine until thermostat opens.

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

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

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

SERVICE PROCEDURES

PISTONS

The pistons have been cast and machined to one size and weight. The piston and rod assemblies are matched to weigh the same for 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. 5). Cylinder 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).**

SERVICE PROCEDURES (Continued)

CYLINDER BORE AND PISTON SPECIFICATION CHART

ENGINE	STANDARD CYLINDER BORE	MAXIMUM OUT-OF-ROUND	MAXIMUM TAPER
2.7L	86.0 mm ± 0.0076 mm (3.3859 in. ± 0.0003 in.)	0.076 mm (0.003 in.)	0.051 mm (0.002 in.)
	STANDARD PISTON SIZE	85.981 mm ±0.013 mm (3.3851 mm ±0.0006 in.)	
Piston to Bore Clearance: -0.0016 to +0.0396 mm (-0.0001 to +0.0016 in.) Measurement taken at Piston Size location.			

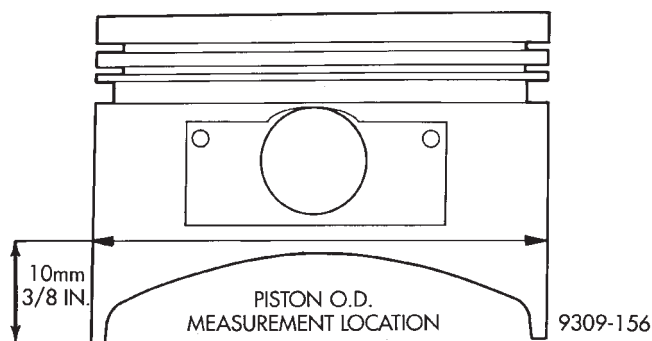


Fig. 5 Piston Measurements

PISTON PINS

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. 6). Refer to Piston Ring Specification Chart.

(2) Check piston ring to groove clearance: (Fig. 7). Refer to Piston Ring Specification Chart.

PISTON RINGS—INSTALLATION

(1) The No. 1 and No. 2 piston rings have a different cross section. Insure that No. 2 ring is installed with the manufacturers I.D. mark (dot) facing up, towards top of the piston (Fig. 8).

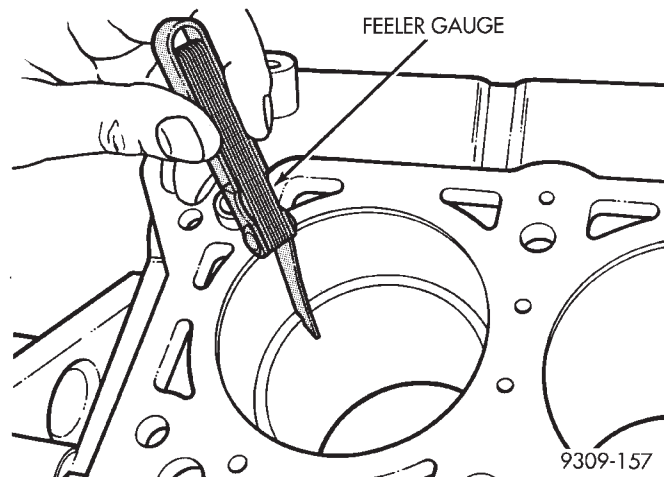


Fig. 6 Check Gap on Piston Rings

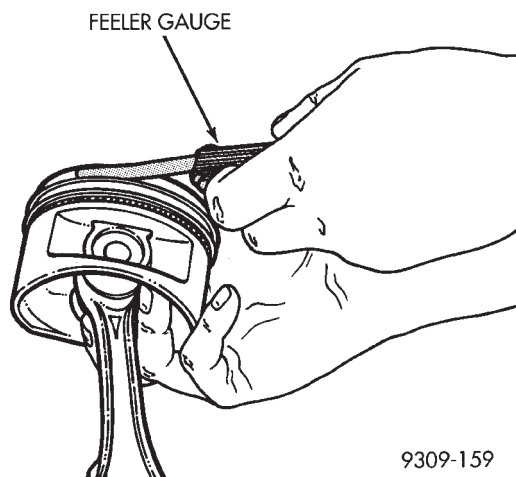
PISTON RING SPECIFICATION CHART

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:	0.37 - 0.63 mm (0.0146 - 0.0249 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:	0.04 - 0.08 mm (0.0016 - 0.0031 in.)	0.10 mm (0.004 in.)
Intermediate Ring:	0.04 - 0.08 mm (0.0016 - 0.0031 in.)	0.10 mm (0.004 in.)
Oil Control Ring (Steel Rails):	0.061 - 0.207 mm (0.0025 - 0.0082 in.)	0.23 mm (0.0091 in.)

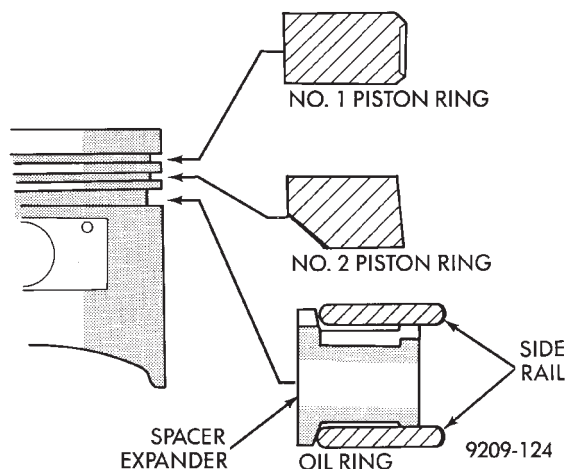
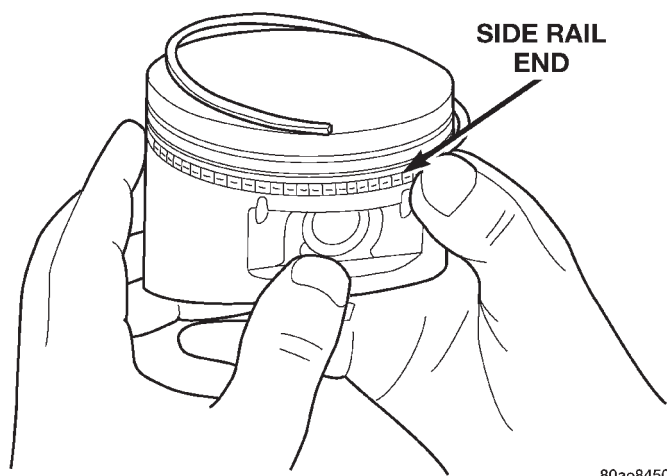
CAUTION: Install piston rings in the following order:

- (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. 9).**

SERVICE PROCEDURES (Continued)



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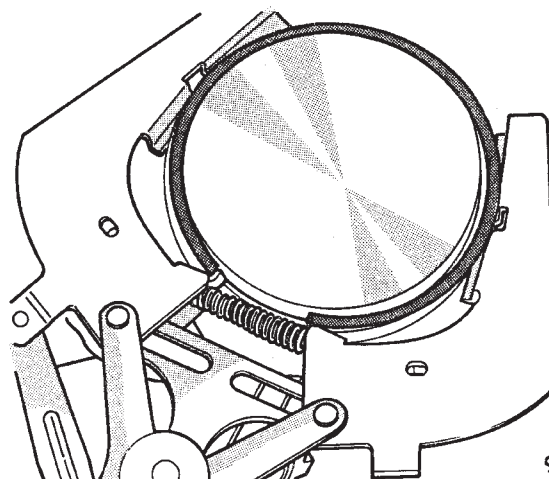
Fig. 7 Measuring Piston Ring Side Clearance**Fig. 8 Piston Ring—Installation**

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Fig. 9 Side Rail—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. 10).

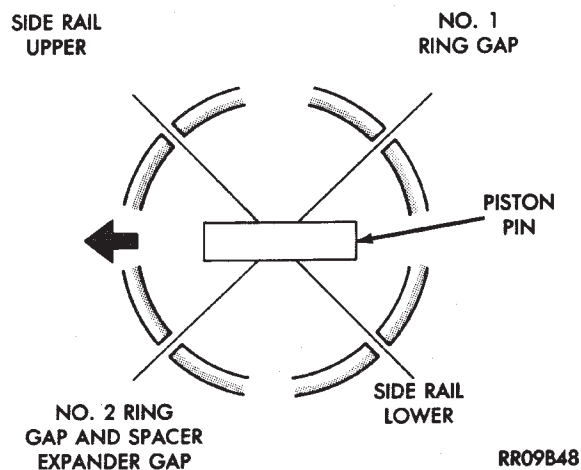


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Fig. 10 Upper and Intermediate Rings—Installation

(10) Position piston ring end gaps as shown in (Fig. 11).

(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. 11 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.

CAUTION: Care must be taken not to damage the fractured rod and cap joint face surfaces as engine damage may occur.

The bearing shells must be installed with the tangs inserted into the machined grooves in the rods and caps. Also, assure that the hole in upper bearing half aligns with oil squirt hole in rod. Install cap with the tangs on the same side as the rod.

SERVICE PROCEDURES (Continued)

CAUTION: Assure that hole in upper bearing half aligns with hole in connecting rod as engine damage may occur.

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 in.). **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 Selecting and Measuring Main Bearing Clearance and Connecting Rod Bearing Clearance (Fig. 12). Refer to Connecting Rod Bearing Oil Clearance Chart for specifications.

NOTE: The connecting rod bearing cap bolts must be examined before reuse. If the threads are necked down the bolts should be replaced (Fig. 13).

NOTE: Connecting rod bolts are retained in the rod cap with a light press fit. If bolts are to be removed, use a hammer and punch to drive bolts from connecting rod cap using care not to damage fractured cap surface.

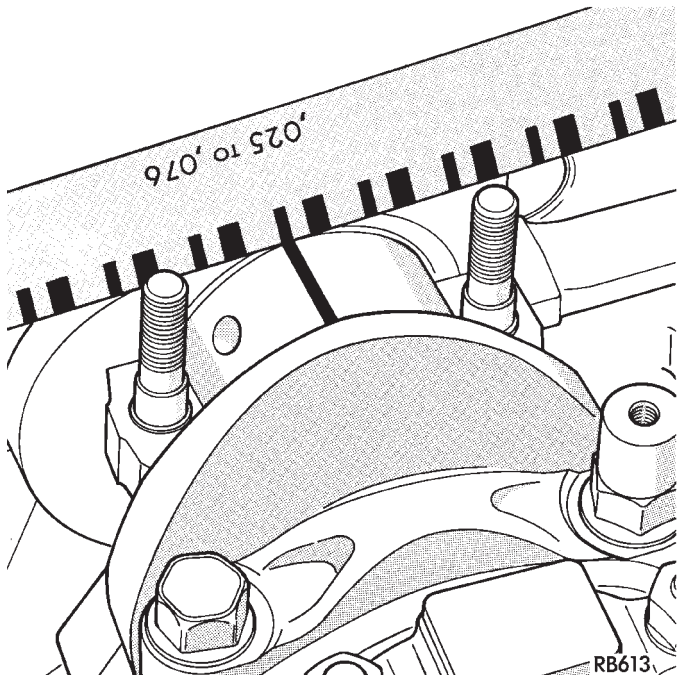


Fig. 12 Checking Connecting Rod Bearing Clearance—Typical

CONNECTING ROD BEARING OIL CLEARANCE CHART

New Part:	0.024 to 0.064 mm (0.0001 to 0.0026 in.)
Wear Limit:	0.0762 mm (0.003 in.)

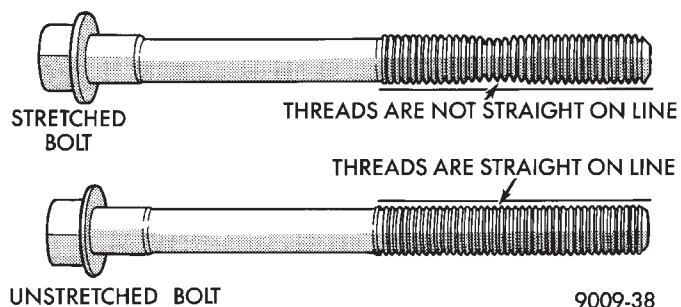


Fig. 13 Check for Stretched Bolts

(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 bolts, lubricate the threads with engine oil.

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

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

(6) Mount a dial indicator to a stationary point on engine. Locate probe perpendicular to and resting against the connecting rod cap being checked. Move connecting rod all the way to rear of its travel. Zero the dial indicator. Move connecting rod forward to limit of travel and read the dial indicator (Fig. 14). Refer to Connecting Rod Side Clearance Chart for specifications. Repeat procedure for each connecting rod. Turn crankshaft for connecting rod accessibility.

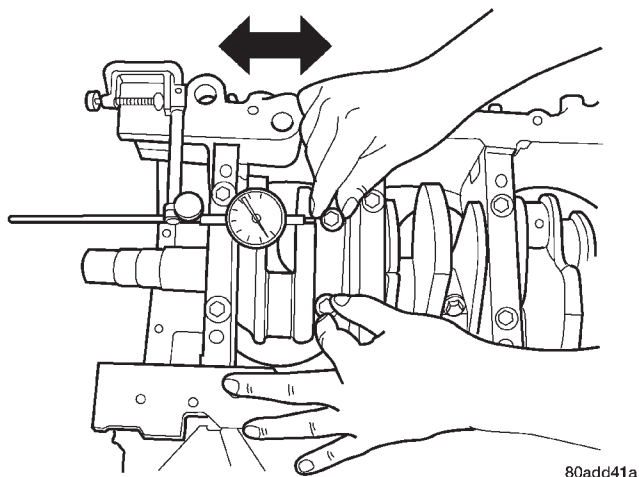


Fig. 14 Connecting Rod Side Clearance Measuring
CONNECTING ROD SIDE CLEARANCE CHART

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

SERVICE PROCEDURES (Continued)

CRANKSHAFT MAIN BEARING SELECTION

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

The grade marks for the cylinder block main bearing bore grade is located on the pan rail just below the left side engine mount bracket (Fig. 16). These marks 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. 15). The crankshaft journal grade marks 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 2, the proper select fit bearing would be (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. 17). 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.

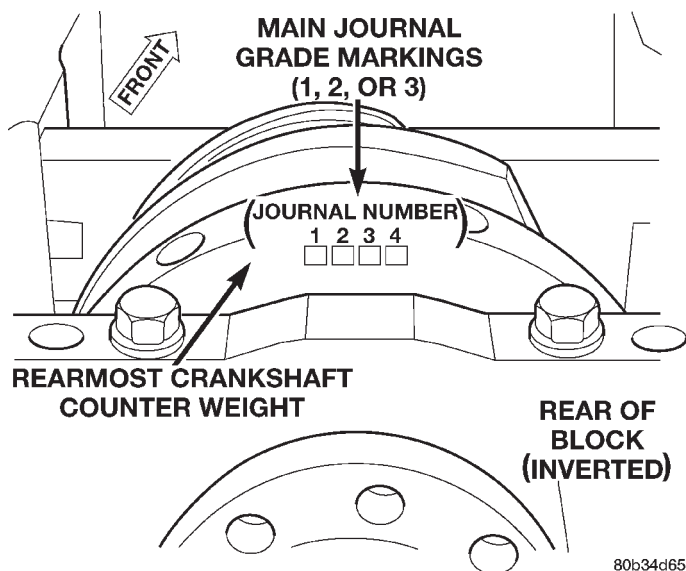


Fig. 15 Crankshaft Main Journal Grade Marking Location

CHECKING CRANKSHAFT END PLAY

(1) Mount a dial indicator to a stationary point at front of engine. Locate the probe perpendicular against nose of crankshaft (Fig. 18).

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

(3) Zero the dial indicator.

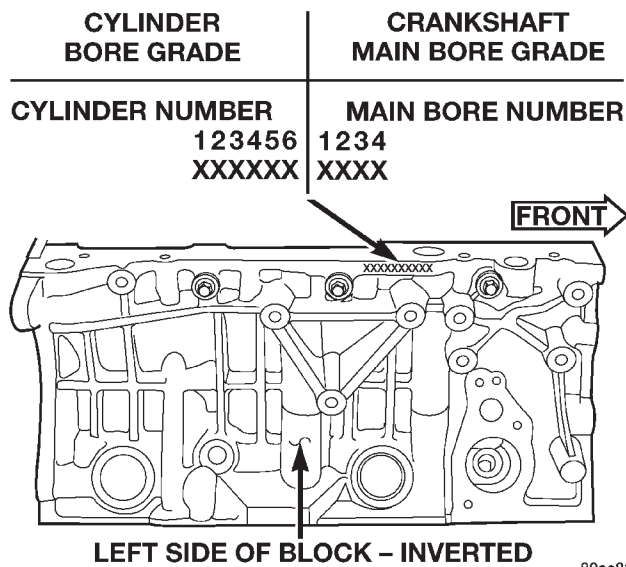


Fig. 16 Cylinder Block Main Bore Grade Marking Location

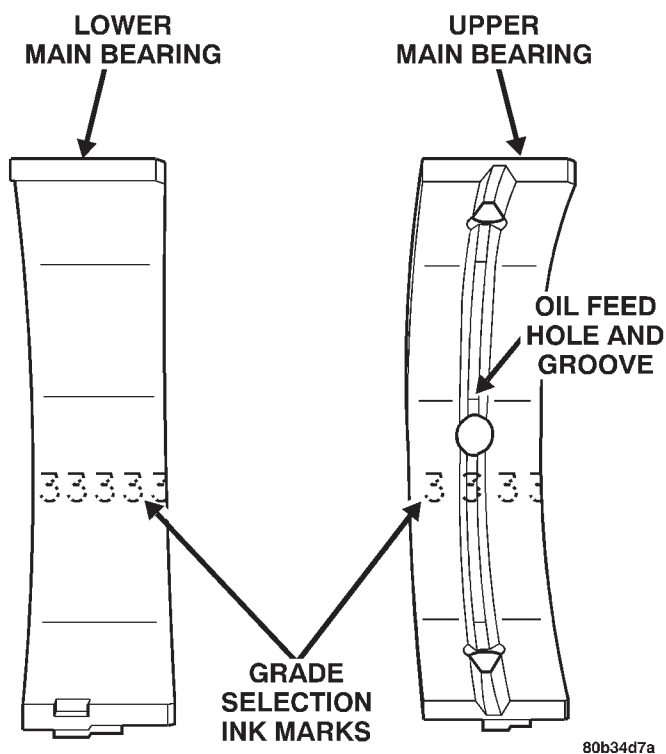


Fig. 17 Main Bearing Grade Marks

(4) Move crankshaft all the way to the front and read the dial indicator. Refer to Crankshaft End Play Specification Chart.

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. 19).

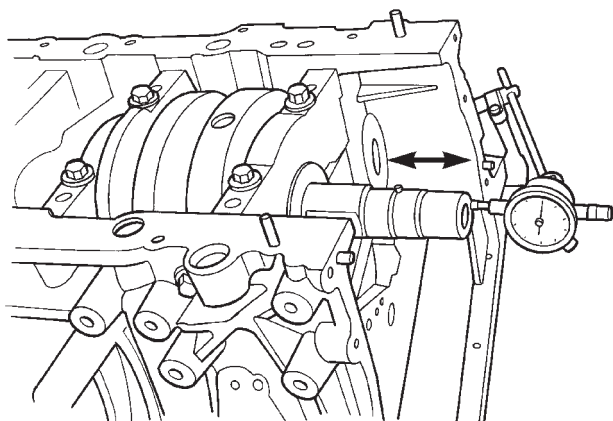
SERVICE PROCEDURES (Continued)

MAIN BEARING SELECTION CHART—2.7L

Main Bearing Bore Grade Mark			
	1	2	3
Crankshaft Main Journal Grade Mark	1	(2) +0.003 mm (+0.0002 in.)	(1) +0.006 mm (+0.0003 in.)
	2	(4) -0.003 mm (-0.0002)	(2) +0.003 mm (+0.0002 in.)
	3	(5) -0.006 mm (-0.0003 in.)	(4) -0.003 mm (-0.0002 in.)

VALVE SPECIFICATION CHART

FACE ANGLE	
Intake & Exhaust:	44.5° – 45°
HEAD DIAMETER	
Intake:	33.67 – 33.93 mm (1.3256 – 1.3358 in.)
Exhaust:	27.67 – 27.93mm (1.0894 – 1.1000 in.)
LENGTH (OVERALL)	
Intake:	107.89 – 108.39 mm (4.2476 – 4.2673 in.)
Exhaust:	105.88 – 106.38 mm (4.1685 – 4.1882 in.)
STEM DIAMETER	
Intake:	5.934 – 5.952 mm (0.2337 – 0.2344 in.)
Exhaust:	5.906 – 5.924 mm (0.2326 – 0.2333 in.)
VALVE MARGIN	
Intake:	0.070 – 0.530mm (0.0028 – 0.0209 in.)
Exhaust:	0.85 – 1.31 mm (0.0335 – 0.0516 in.)



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Fig. 18 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.)

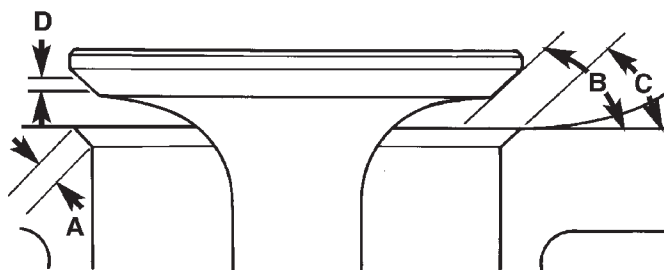
VALVES

Inspect the remaining margin after the valves are refaced. Refer to Valve Specification Chart.

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. 19 Valve Seats

ITEM	DESCRIPTION	SPECIFICATION	
A	Seat Width	Intake: 1.00 – 1.50 mm (0.39 – 0.059 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

SERVICE PROCEDURES (Continued)

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 1.00 to 1.50 mm (0.0394 to 0.0591 in.) and exhaust seats should be 1.25 to 1.75 mm (0.049 to 0.069 in.) (Fig. 19).

(5) Check the valve spring installed height after refacing the valve and seat (Fig. 21).

VALVE SPRINGS

The valve springs are common for intake and exhaust valves. See Valve Spring Specification Chart.

VALVE SPRING SPECIFICATION CHART

FREE LENGTH	
Intake and Exhaust:	45.63 mm (1.7965 in.)
SPRING FORCE (VALVE CLOSED)	
Intake & Exhaust:	249.2 – 284.8 N 38.0 mm (56.0 – 64.0 lbs. 1.4961 in.)
INSTALLED HEIGHT (VALVE CLOSED)	
Intake and Exhaust:	38.0 mm (1.496 in.)

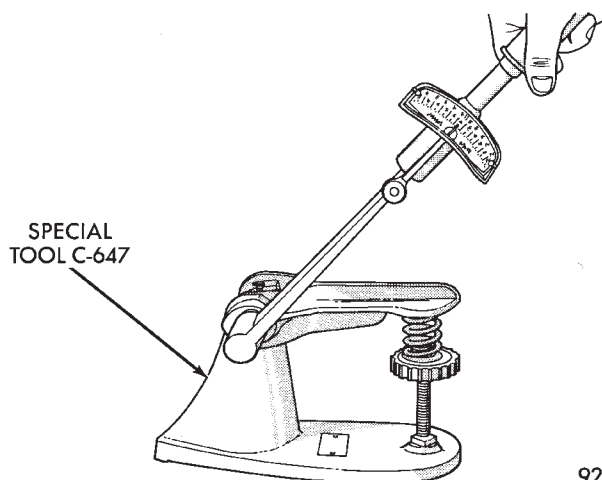
TESTING VALVE SPRINGS

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested (Fig. 20). **As an example;** the compression length of the spring to be tested is 38.00 mm (1.496 in.). Turn table of Tool C-647 until surface is in line with the 38.00 mm (1.496 in.) mark on the threaded stud and the zero mark on the front. Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by two. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to Specifications Section to obtain specified height and allowable tensions. Replace any springs that do not meet specifications.

VALVE INSTALLATION

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

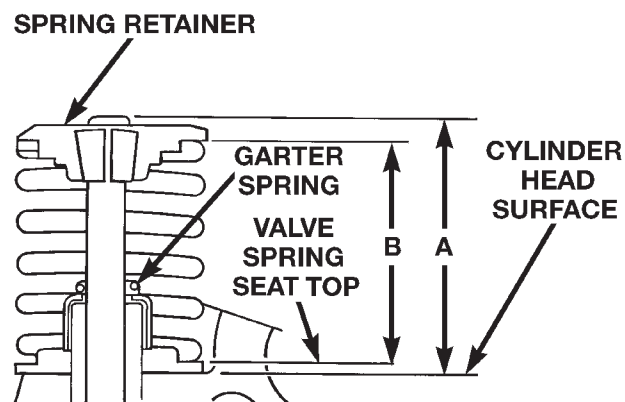
(2) If valves or seats have been reground, check valve tip height (A) (Fig. 21). If valve tip height for intake valve is greater than 47.59 (1.8737 in.) or 49.14 (1.9347 in.) for exhaust valve, grind valve tip until within specifications. Make sure measurement



9209-37

Fig. 20 Testing Valve Spring with Tool C-647

is taken from cylinder head surface to the top of valve stem.



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Fig. 21 Checking Valve Tip Height and Valve Spring Installed Height

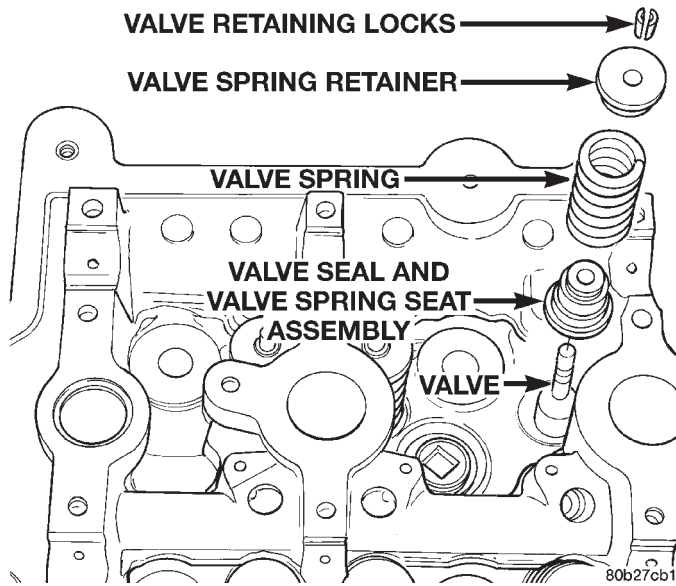
(3) Install valve seal/spring seat assembly over valve guides on all valve stems (Fig. 22). Ensure that the garter spring is intact around the top of the rubber seal. Install valve springs, valve retainers.

(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. 21), 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.

ENGINE TIMING—VERIFICATION

Correct timing is critical for the NON free-wheeling designed, 2.7L engine. Engine timing can be verified by using the following procedures:

SERVICE PROCEDURES (Continued)

**Fig. 22 Valve Seal and Spring**

- (1) Remove cylinder head covers. Refer to procedures outlined in this section.
- (2) Rotate engine until number one cylinder is at TDC on the EXHAUST stroke.
- (3) View the intake camshaft sprocket timing mark. The mark should be 90° from the cylinder head cover sealing surface (Fig. 23) on both right and left cylinder banks.
- (4) Count chain pins from the mark on the intake camshaft towards the exhaust camshaft. Engine is timed correctly when there are 12 chain pins between the timing marks on the intake camshaft and exhaust camshaft (Fig. 23).
- (5) If marks are not correctly aligned, proceed to Camshafts, Timing Chain and Sprockets, Removal and Installation procedures.

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. 24).
- (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. 24).
- (5) Raise engine carefully with jack enough to remove the isolator with heat shield from its mount.

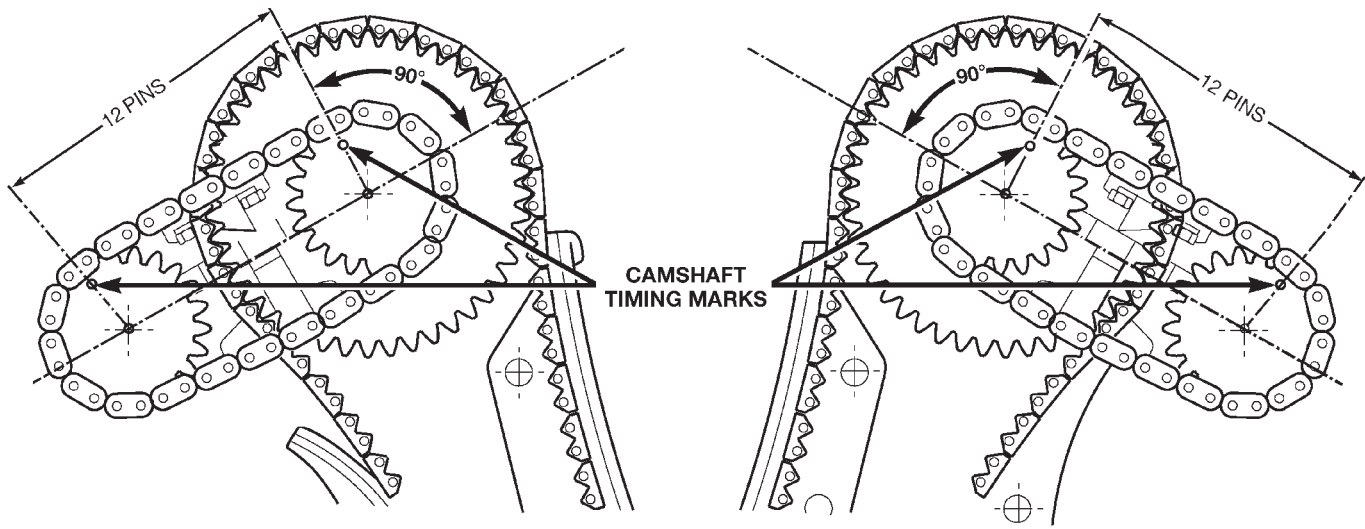
INSTALLATION

- (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. 24).
- (5) Install the upper attaching nuts to mount and tighten to 61 N·m (45 ft. lbs.) (Fig. 24).
- (6) Lower vehicle.

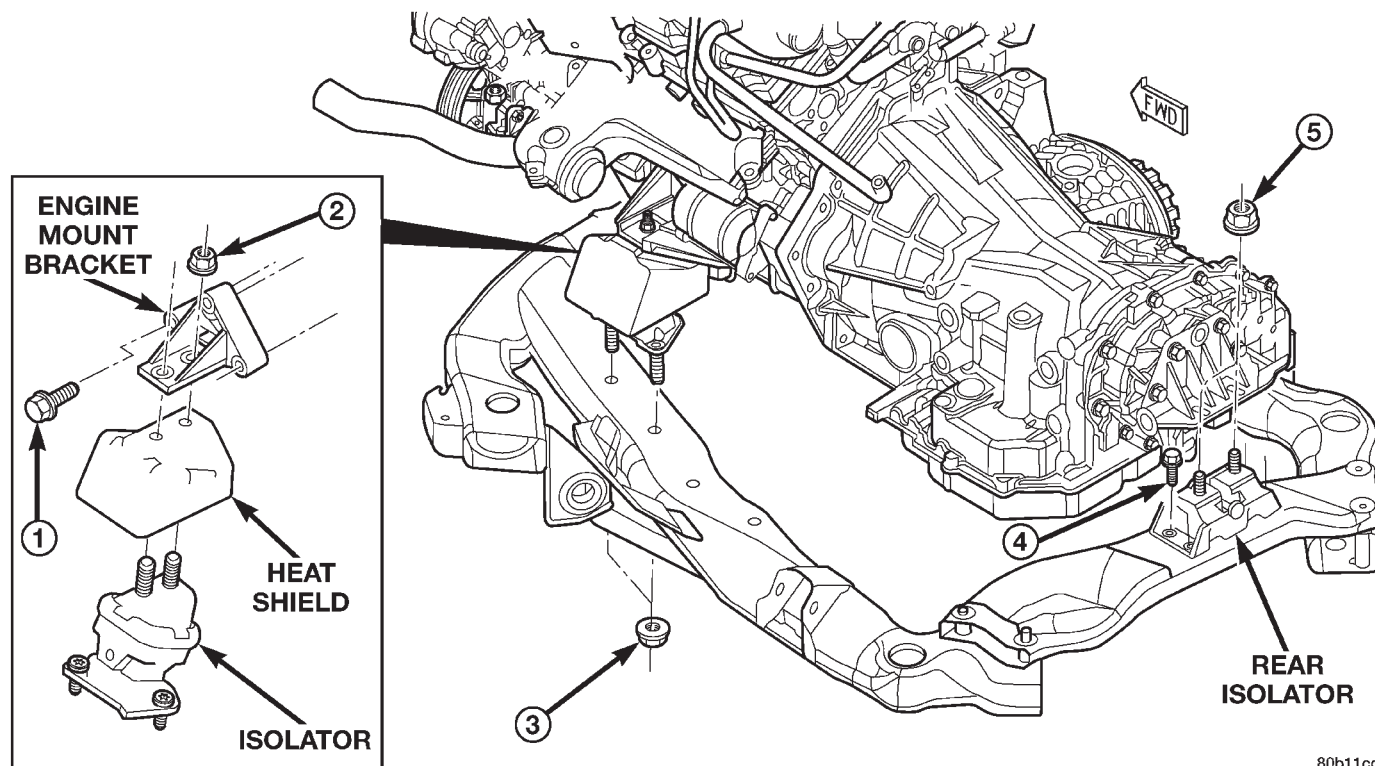
ENGINE HYDRO-MOUNT ISOLATORS

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.

**Fig. 23 Engine Timing**

REMOVAL AND INSTALLATION (Continued)



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Fig. 24 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.)			

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. 24).
- (4) Remove rear mount isolator bolts to crossmember and remove mount (Fig. 24).

INSTALLATION

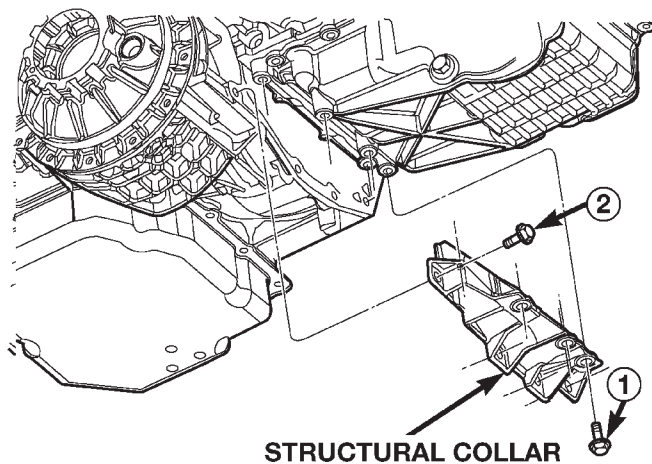
- (1) Position isolator onto crossmember.
- (2) Install bolts attaching isolator to crossmember and tighten to 33 N·m (250 in. lbs.) (Fig. 24).
- (3) Lower transaxle onto isolator
- (4) Install isolator nuts and tighten to 61 N·m (45 ft. lbs.) (Fig. 24).
- (5) Lower vehicle.

STRUCTURAL COLLAR

REMOVAL

- (1) Raise vehicle on hoist.

- (2) Remove bolts attaching structural collar to oil pan and transmission housing.
- (3) Remove collar (Fig. 25).



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Fig. 25 Structural Collar

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

CAUTION: The collar must be tightened using the procedure outlined as damage to collar and/or oil pan may occur.

(1) Install structural collar (Fig. 25) using the following tightening sequence:

- Install the **vertical** collar to oil pan bolts (1). Torque bolts initially to 1.1 N·m (10 in. lbs.).
 - Install collar to transmission bolts (2) and torque to 55 N·m (40 ft. lbs.).
 - Starting with the center vertical bolts (1) and working outward, final torque bolts to 55 N·m (40 ft. lbs.).
- (2) Lower vehicle.

ENGINE ASSEMBLY

REMOVAL

- Release fuel pressure. Refer to Group 14, Fuel System for procedure.
- Disconnect negative cable at remote jumper terminal located at right strut tower (Fig. 26).
- Mark hood position at hinges and remove hood.
- Drain cooling system. Refer to Group 07, Cooling System for procedure.
- Remove both wiper arms.
- Remove right and left cowl covers (Fig. 27).
- Remove cowl support (Fig. 28).
- Remove air cleaner assembly and air inlet hose (Fig. 29).
- Remove upper radiator crossmember. Refer to Group 23, Body for procedure.

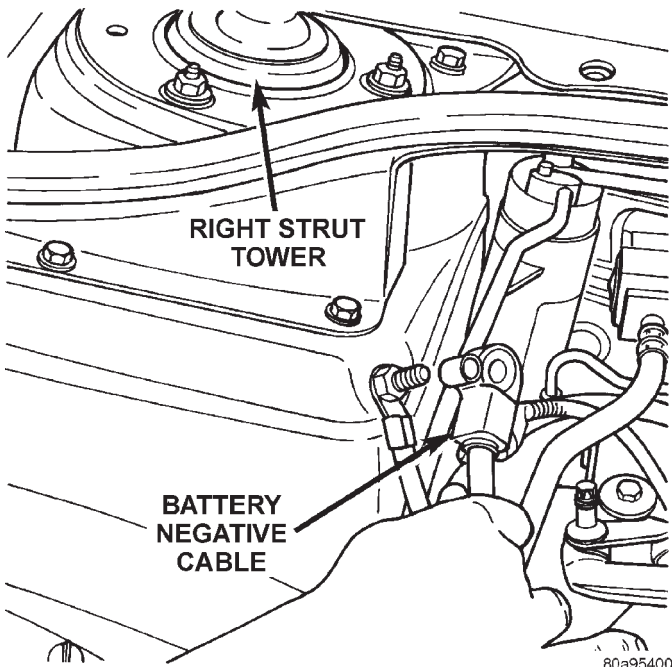


Fig. 26 Negative Cable Remote Terminal

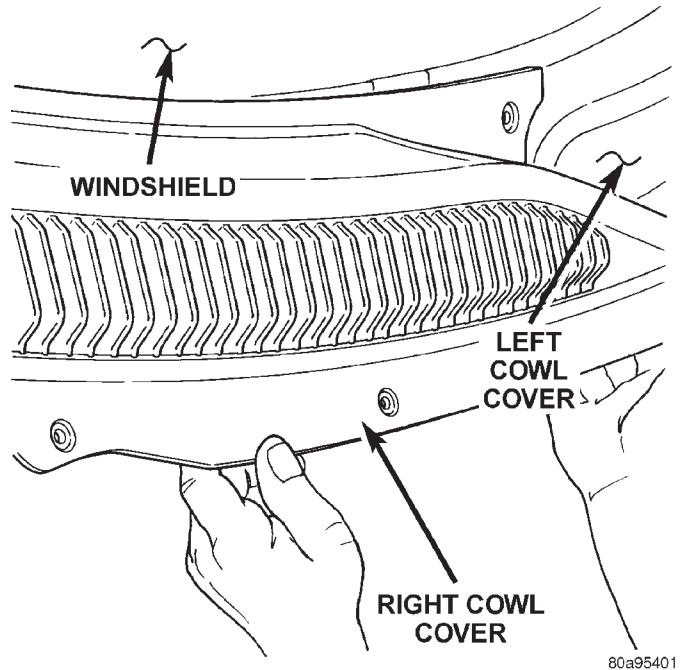


Fig. 27 Cowl Covers

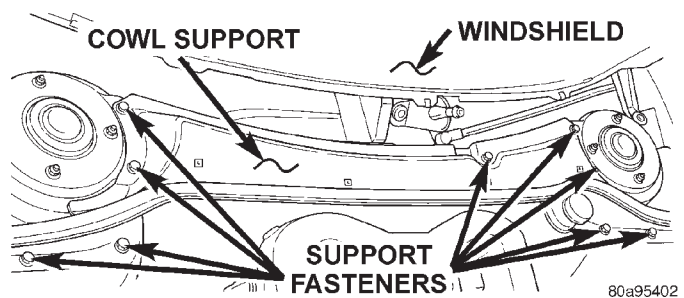


Fig. 28 Cowl Support

- Disconnect hood release cable from hood latch.
- Remove cooling fan module. Refer to Group 07, Cooling System.
- Disconnect upper radiator hose at engine.
- Disconnect lower radiator hose at radiator.
- Disconnect transaxle cooler lines at radiator.
- Remove fasteners attaching A/C condenser to radiator.
- Remove transaxle cooler lines support bracket and attaching screw at left side of radiator.
- Remove radiator.
- Remove A/C and accessory drive belts. Refer to Group 07, Cooling System.
- Remove power steering pump mounting bolts and set pump aside. Refer to Group 19, Steering for procedure.

NOTE: Generator can be removed with engine assembly.

- Disconnect A/C compressor electrical connector.

REMOVAL AND INSTALLATION (Continued)

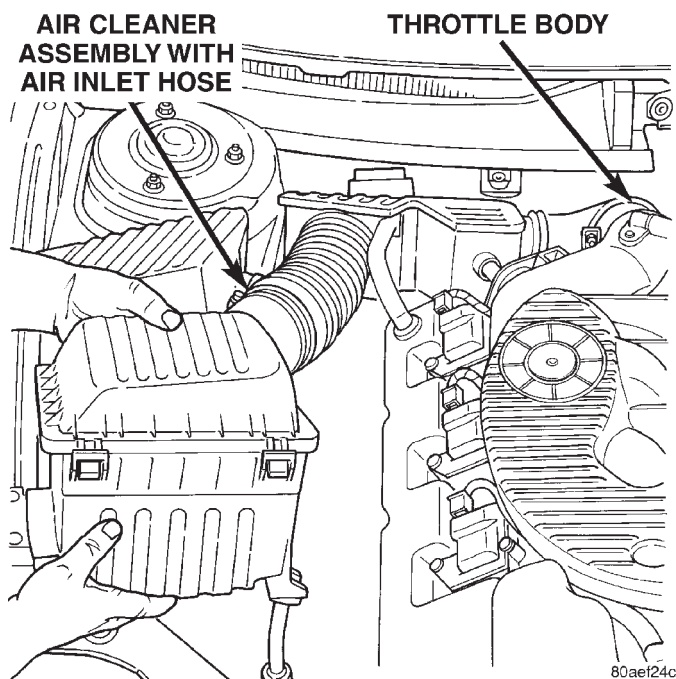


Fig. 29 Air Cleaner and Inlet Hose

(21) Remove A/C compressor mounting bolts and set compressor aside.

(22) Loosen and remove V-Band clamps at exhaust manifolds.

(23) Disconnect throttle and speed control cables.

(24) Disconnect coolant hoses at coolant pressure bottle.

(25) Disconnect heater hoses.

(26) Perform fuel pressure release procedure and disconnect fuel line.

(27) Disconnect all vacuum lines and electrical connectors.

(28) Disconnect all ground straps attaching to engine.

(29) Hoist vehicle and drain engine oil.

(30) Remove fasteners supporting catalytic converter down pipes at front and rear mounts.

(31) Remove structural collar bolts from oil pan and transaxle. Remove structural collar.

(32) Mark flex plate to torque converter position. Remove torque converter bolts.

(33) Disconnect both transaxle cooler line brackets from engine.

(34) Remove starter. Refer to Group 8B, Starting for procedure.

(35) Remove crankshaft position sensor.

(36) Remove the two lower transaxle to block bolts.

(37) Lower vehicle.

(38) Remove screws attaching fuel line and electrical harness to the throttle body bracket.

(39) Remove the fasteners attaching the following brackets to the transaxle to block double-ended bolts:

- Electrical harness attaching bracket.

- Transaxle shift cable attaching bracket.

- Throttle body support bracket.

(40) Remove the upper transaxle to block bolts.

(41) Remove right and left engine mount isolator to engine mount bracket fasteners.

CAUTION: Intake manifolds and cylinder head covers are a composite design. Therefore, care should be taken when lifting the engine from engine compartment.

(42) To prevent damage to cam sensor, remove sensor from left cylinder head.

(43) Attach lifting device to engine.

(44) Support transaxle with a floor jack.

(45) Hoist engine from engine compartment.

INSTALLATION

(1) Attach lifting device to engine. Lower engine into engine compartment.

CAUTION: Do not tighten the transaxle case to engine block bolts until all bolts have been hand started, and the two mating surfaces are completely joined together, as damage to cylinder block or transaxle could occur.

(2) Align engine mounts and install fasteners but **do not tighten** until all mounting bolts have been installed.

(3) Install transaxle case to engine block bolts and tighten to 102 N·m (75 ft. lbs.).

(4) Remove engine lifting device.

(5) Tighten left and right engine mount isolator to engine mount bracket fasteners to 61 N·m (45 ft. lbs.).

(6) Raise vehicle.

(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 the transaxle oil cooler lines bracket to engine

(11) Install structural collar to oil pan and transaxle. Refer to procedure outlined in this section.

(12) Lower vehicle.

(13) Install rear throttle body support bracket.

(14) Install electrical harness and fuel line support brackets to the throttle body support bracket.

(15) Install fastener attaching electrical harness bracket to the transaxle to block bolt.

(16) Connect heater hoses.

(17) Connect all ground straps to engine.

(18) Connect all vacuum hoses and electrical connectors.

(19) Connect both hoses at coolant pressure bottle.

(20) Connect throttle and speed control cables.

(21) Connect fuel line.

REMOVAL AND INSTALLATION (Continued)

NOTE: Do not reuse V-Band clamps.

- (22) Install new V-Band clamps at exhaust manifolds and tighten to 11 N·m (100 in. lbs.).
- (23) Install catalytic converter down pipe front and rear supports.
- (24) Install air conditioning compressor and tighten fasteners to 28 N·m (250 in. lbs.).
- (25) Install power steering pump and tighten fasteners to 28 N·m (250 in. lbs.).
- (26) Install radiator.
- (27) Connect transaxle cooler lines to radiator.
- (28) Attach A/C condenser to radiator.
- (29) Install lower radiator hose.
- (30) Install upper radiator hose.
- (31) Install A/C and accessory drive belts. Refer to Group 07, Cooling System for procedure.
- (32) Install cooling fan module.
- (33) Refill cooling system. Refer to Group 07, Cooling System for procedure.
- (34) Fill engine with proper amount of oil.
- (35) Connect hood release cable to hood latch and install upper radiator crossmember.
- (36) Install air cleaner and air inlet hose.
- (37) Install cowl support.
- (38) Install right and left cowl covers.
- (39) Install both wiper arms.
- (40) Install hood.
- (41) Connect negative cable to remote jumper terminal at right strut tower.

CRANKSHAFT DAMPER**REMOVAL**

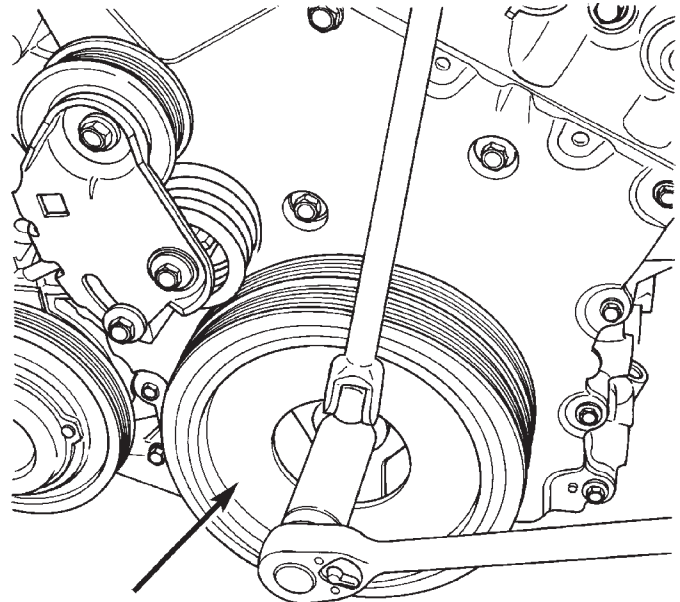
- (1) Remove upper radiator crossmember. Refer to Group 23, Body for procedure.
- (2) Remove fan module. Refer to Group 07, Cooling System for procedure.
- (3) Remove accessory drive belt and air conditioning belt. Refer to Group 07, Cooling System for procedure.
- (4) Remove damper center bolt while holding the damper with Special Tool 8191 (Fig. 30).

CAUTION: Before removing damper, verify that A/C belt tensioner is not contacting the damper, as damage could occur to tensioner, timing chain cover, and/or damper.

- (5) Remove damper by using Special Tools 8194 Insert and 1023 Three Jaw Puller (Fig. 31).

INSTALLATION

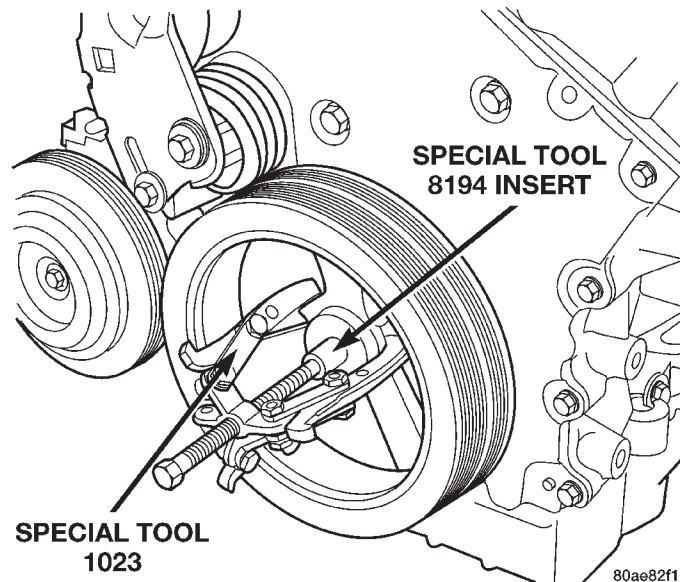
- (1) Install damper using Special Tools 8179 Screw, with Nut and Thrust Bearing from 6792, and 6792-1 Installer (Fig. 32).



**SPECIAL TOOL
8191**

80ae8210

Fig. 30 Crankshaft Damper Center Bolt—Removal and Installation



**SPECIAL TOOL
1023**

80ae8211

Fig. 31 Crankshaft Damper—Removal

- (2) Install damper center bolt. Tighten center bolt while holding the damper with Special Tool 8191 to 170 N·m (125 ft. lbs.) (Fig. 30).
- (3) Install air conditioning and accessory drive belts. Refer to Group 07, Cooling System for procedures.
- (4) Install cooling fan module and connect electrical connector.
- (5) Install upper radiator crossmember.

REMOVAL AND INSTALLATION (Continued)

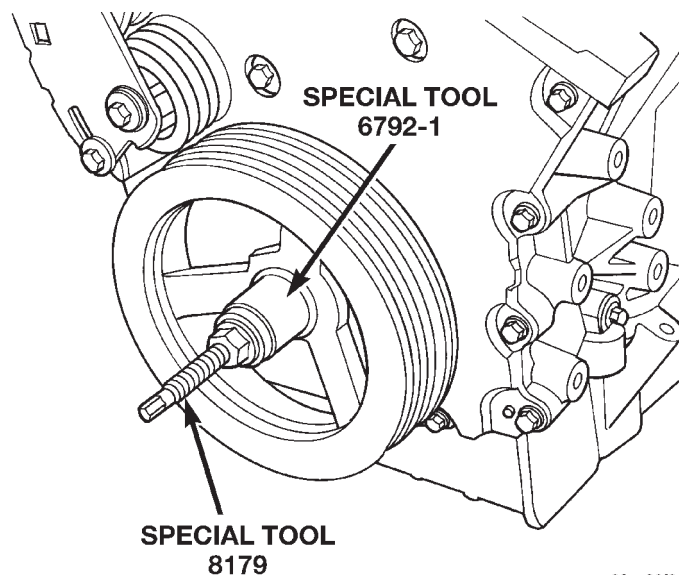


Fig. 32 Crankshaft Damper—Installation

CYLINDER HEAD COVERS

REMOVAL

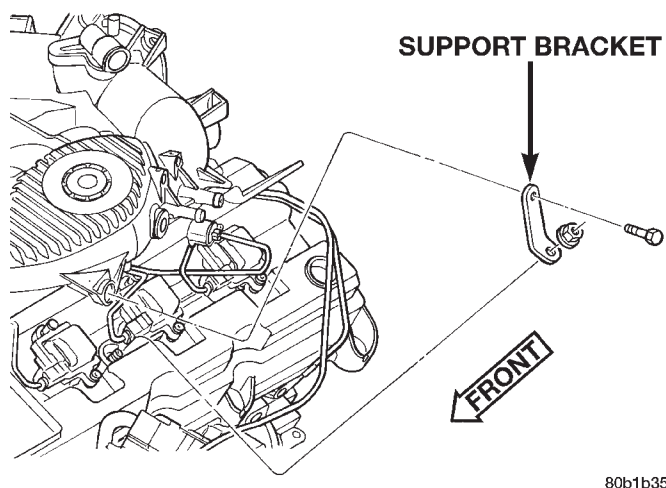
- (1) Remove upper intake manifold. Refer to Group 11, Exhaust System and Intake Manifold
- (2) Remove electrical connectors from ignition coils.
- (3) Remove ground strap from right cylinder head.
- (4) Disconnect electrical and vacuum harness retaining clips from cylinder head cover studs.
- (5) Remove fasteners attaching ignition coil capacitors.
- (6) Remove fastener attaching right and left side support brackets for upper intake manifold (Fig. 33).
- (7) Loosen all cylinder head cover attaching bolts (Fig. 34).

NOTE: Cylinder head cover attaching bolts are captured to the cover.

- (8) Remove cylinder head covers.

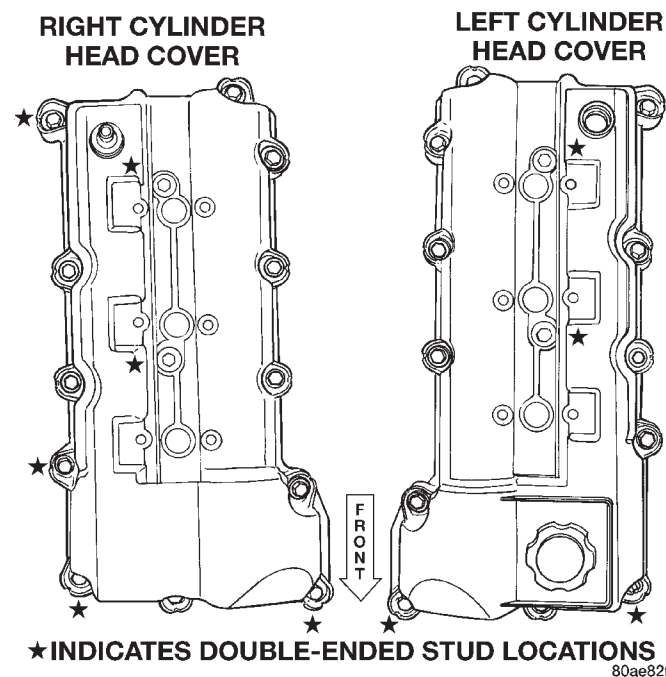
INSTALLATION

- (1) Clean cylinder head cover and both sealing surfaces. Inspect and replace gaskets as necessary (Fig. 35).
- (2) Install cylinder head covers and hand start all fasteners. Verify that all double-ended studs are in the correct locations as shown in (Fig. 34).
- (3) Tighten cylinder head cover attaching bolts and double-ended studs to 12 N·m (105 in. lbs.).
- (4) Connect all electrical connectors and harness clips.
- (5) Install ignition coil capacitors and fasteners.
- (6) Install right and left side support brackets for the upper intake manifold (Fig. 33). Tighten fasteners only finger tight at this time.



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Fig. 33 Intake Manifold Side Support Brackets—Left Side



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Fig. 34 Cylinder Head Covers

- (7) Install upper intake manifold. Refer to Group 11, Exhaust System and Intake Manifold for procedure.

CAMSHAFTS

REMOVAL

- (1) Remove the primary timing chain. Refer to procedure outlined in this section.
- (2) Remove secondary chain tensioner mounting bolts.

NOTE: Camshaft bearing caps have been marked during engine manufacturing. For example, number one exhaust camshaft bearing is marked "1E"

REMOVAL AND INSTALLATION (Continued)

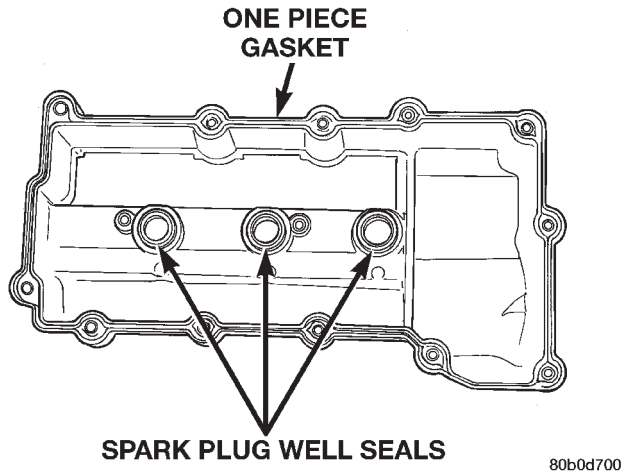


Fig. 35 Cylinder Head Cover Gasket and Spark Plug Seals

- (3) Slowly loosen camshaft bearing cap bolts in reverse order of installation (Fig. 36).
- (4) Remove camshaft bearing caps.
- (5) Remove camshafts, secondary chain, and tensioner together as an assembly.
- (6) Remove tensioner and camshaft chain from camshafts.
- (7) Inspect camshafts. Refer to Cleaning and Inspection in the Section.

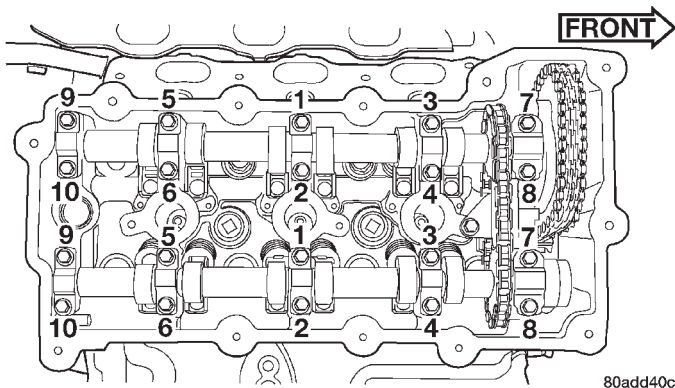


Fig. 36 Camshaft Bearing Cap Tightening Sequence INSTALLATION

CAUTION: When the timing chain is removed and the cylinder heads are installed, **DO NOT** rotate the camshafts or crankshaft without first locating the proper crankshaft position. Failure to do so will result in valve and/or piston damage.

- (1) Assemble camshaft chain on the cams. Ensure that plated links are facing toward the front. Align the plated links to the dot on the camshaft sprockets (Fig. 40).

NOTE: Two styles of camshaft (Secondary) chain tensioners will be used; the Early Build tensioners

will separate into subcomponents, the Later Build tensioners will not.

- (2) If camshaft chain tensioner is already in the compressed and locked position, proceed to step (4).

- (3) When the camshaft chain tensioner is removed, it is necessary to compress and lock the tensioner using the following procedures:

EARLY BUILD

- Separate the tensioner cylinder from tensioner housing (Fig. 37).
- Carefully drain oil from housing using care not to remove the internal tensioner components.
- Assemble plunger to housing (Fig. 37).
- Using hand pressure, compress tensioner and lock using a fabricated lock pin or the equivalent (Fig. 38).

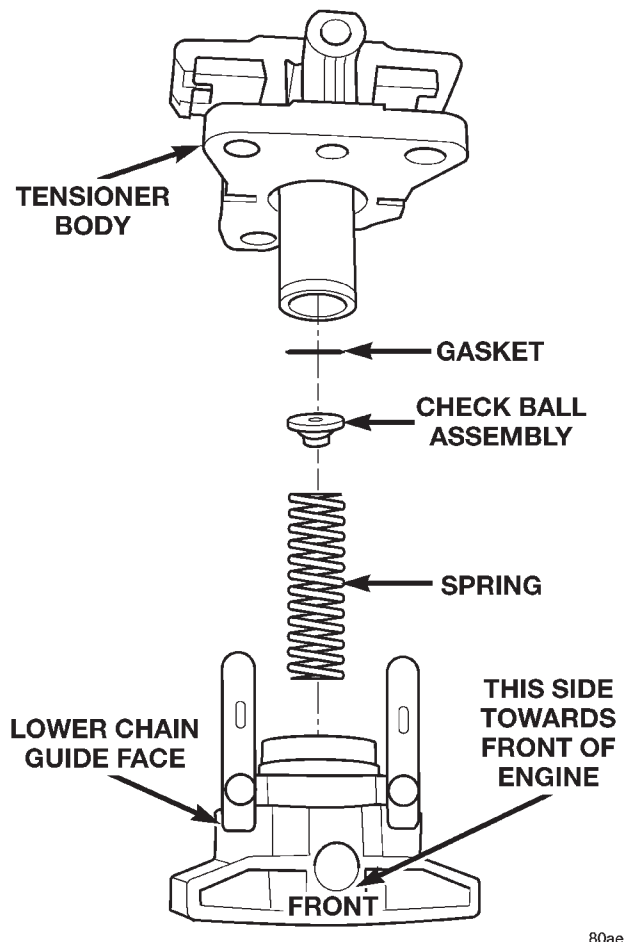
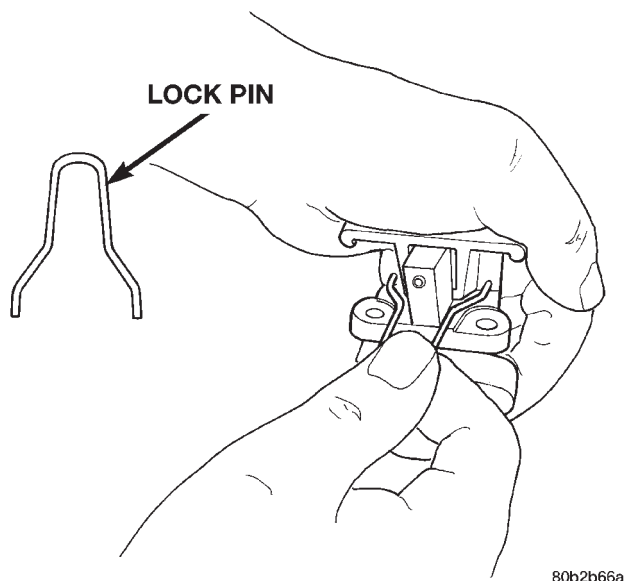


Fig. 37 Camshaft (Secondary) Chain Tensioner LATE BUILD

- Place tensioner into a soft jaw vise (Fig. 39).
- **SLOWLY** compress tensioner until fabricated lock pin or the equivalent can be inserted into the locking holes.

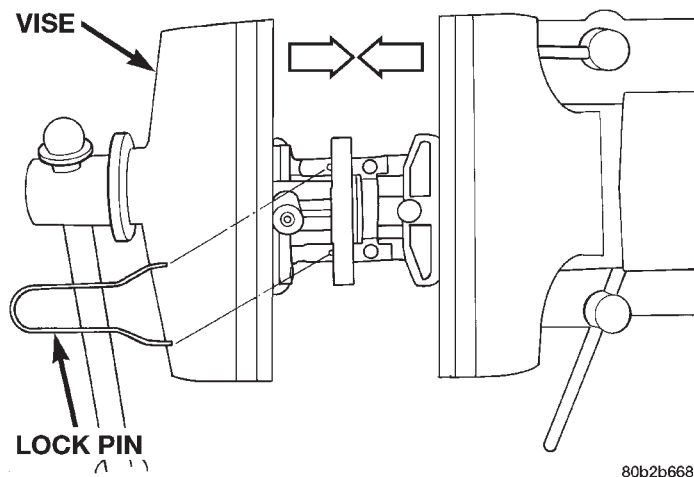
REMOVAL AND INSTALLATION (Continued)



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Fig. 38 Locking Camshaft (Secondary) Chain Tensioner—Early Build

- Remove compressed and locked tensioner from the vise.



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Fig. 39 Locking Camshaft (Secondary) Chain Tensioner—Late Build

(4) Insert the compressed and locked camshaft chain tensioner in-between the camshafts and chain.

(5) Rotate the cams so that the plated links and dots are facing the 12:00 O'clock position (Fig. 40).

(6) Install cams to cylinder head. Ensure that rocker arms are correctly seated and in proper positions.

(7) Install camshaft bearing caps. Ensure that bearing caps are installed in same position as removed.

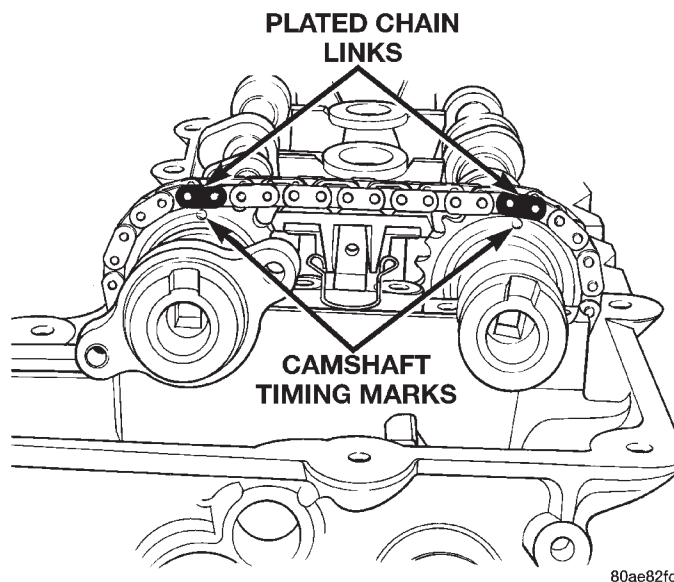
(8) Tighten cam bearing cap bolts gradually in sequence shown in (Fig. 36) to 12 N·m (105 in. lbs.).

(9) Install secondary chain tensioner bolts and tighten to 12 N·m (105 in. lbs.).

(10) Remove locking pin from secondary tensioners.

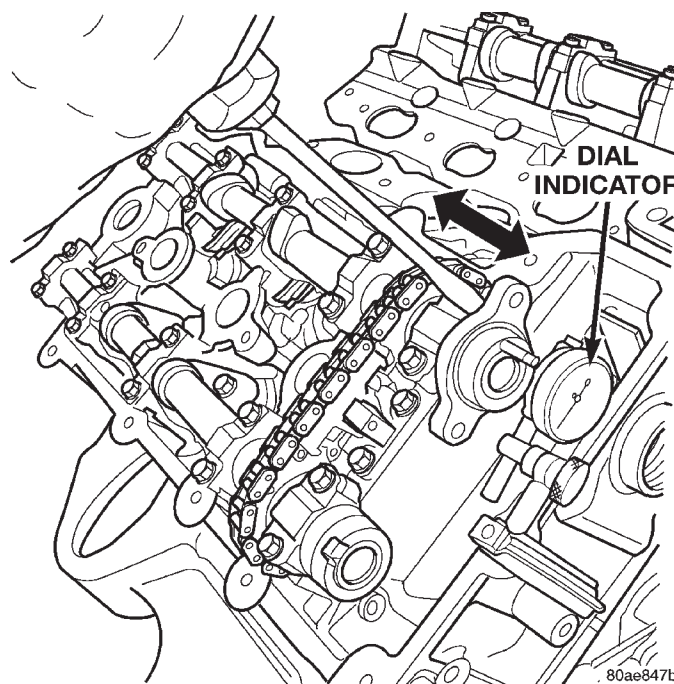
(11) Measure camshafts end play by mounting a dial indicator to a stationary point on cylinder head. Locate the probe perpendicular against the end of camshaft being checked. Move camshaft all the way to the rear of its travel. Zero the dial indicator. Move camshaft forward to limits of travel and read the dial indicator (Fig. 41).

(12) Install primary timing chain. Refer to procedure outlined in this section.



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Fig. 40 Camshaft Chain Timing



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Fig. 41 Camshaft End Play Measuring

REMOVAL AND INSTALLATION (Continued)

ROCKER ARMS

REMOVAL

(1) Remove cylinder head cover(s) using procedure outlined in this section.

CAUTION: Always rotate engine by turning the crankshaft. Failure to do so will result in valve and/or piston damage.

(2) Rotate engine until the cam lobe is on its base circle (heel), on the rocker arm being removed.

CAUTION: Depress valve spring only enough to remove rocker arm.

(3) Using Special Tools 8215 and 8216 Adaptor, depress valve spring only enough to release tension on rocker arm (Fig. 42).

(4) Remove rocker arm from cylinder head.

CAUTION: If rocker arms are to be reused, identify position of rocker arms for reassembly in their original positions.

(5) Repeat procedure for each rocker arm being removed.

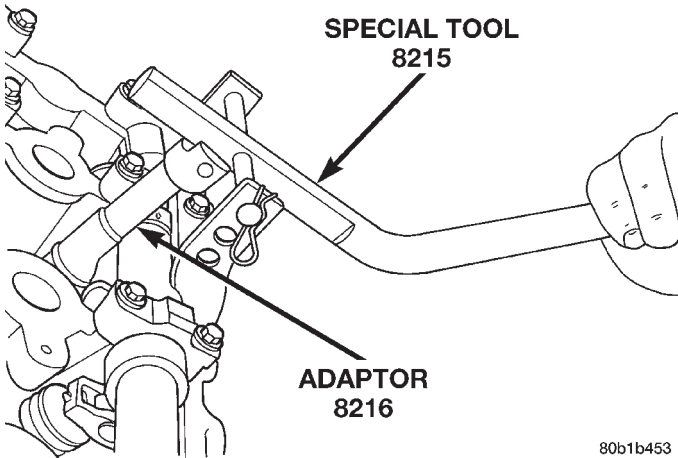


Fig. 42 Rocker Arm—Removal/Installation

INSPECTION

Inspect the rocker arm for wear or damage (Fig. 43). Replace as necessary.

INSTALLATION

(1) Lubricate with rocker arms with clean engine oil before installation.

(2) Rotate engine until cam lobe is on its base circle (heel) of rocker arm being installed.

(3) Using Special Tools 8215 and 8216 Adaptor, depress valve spring only enough to install rocker arm (Fig. 42).

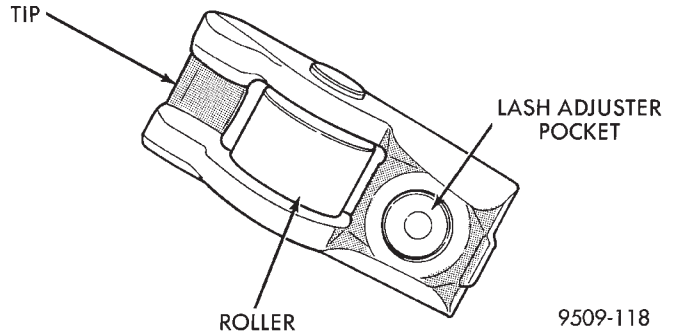


Fig. 43 Rocker Arm

(4) Install rocker arm in original position (if reused) over valve and lash adjuster. Release tension on valve spring.

NOTE: Inspect rocker arm for proper engagement into lash adjuster and valve tip.

(5) Repeat procedure for each rocker arm being installed.

(6) Install cylinder head cover(s) using procedure outlined in this section.

HYDRAULIC LASH ADJUSTER

REMOVAL

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

(2) Remove rocker arm(s). Refer to procedure outlined in this section.

CAUTION: If lash adjusters and rocker arms are to be reused, always mark position for reassembly in their original positions.

(3) Remove lash adjuster(s).

INSTALLATION

(1) Install hydraulic lash adjuster making sure adjusters are at least partially full of oil. This can be verified by little or no plunger travel when lash adjuster is depressed.

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

(3) Install cylinder head cover(s).

VALVE STEM SEALS OR VALVE SPRINGS—IN VEHICLE

REMOVAL

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

(2) Disconnect negative cable from remote jumper terminal.

REMOVAL AND INSTALLATION (Continued)

(3) Remove air cleaner housing cover and inlet hose.

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

(5) Remove cylinder head cover(s).

(6) Remove crankshaft damper, timing chain cover, and timing chain. Refer to procedure outlined in this section.

(7) Remove camshafts. Refer to procedure outlined in this section.

(8) With air hose attached to spark plug adapter installed in the cylinder being serviced, apply 620.5 – 689 kPa (90 – 100 psi) air pressure. This is to hold valves in place while servicing components.

(9) Using Special Tool MD 998772A with adapter 6779, compress valve spring and remove valve locks, retainer, and valve spring.

(10) Remove valve stem seals by using a valve seal tool (Fig. 44).

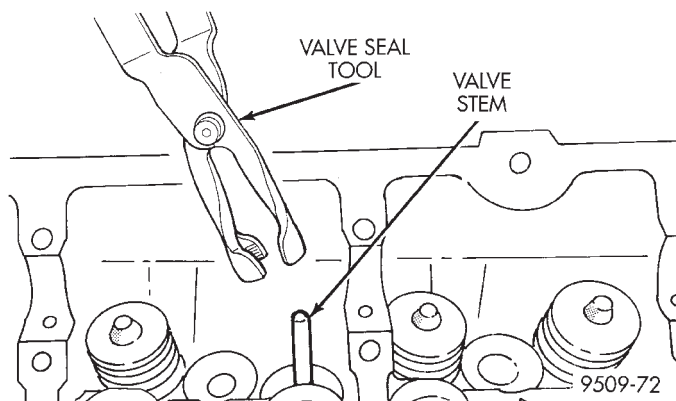


Fig. 44 Valve Stem Seal—Removal

INSTALLATION

(1) 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 locks.

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

(3) Remove spark plug adapter tool.

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

(5) Install camshafts, timing chain, and timing chain cover.

(6) Install cylinder head cover, and intake manifold.

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

(8) Connect negative cable.

CYLINDER HEAD

REMOVAL

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

(2) Disconnect negative cable from remote jumper terminal.

(3) Drain cooling system and remove A/C and accessory drive belts. Refer to Group 07, Cooling System.

(4) Remove crankshaft damper.

(5) Remove intake plenum and lower intake manifold. Refer to Group 11, Exhaust and Intake Manifold for procedure.

(6) Remove cylinder head cover and timing chain cover. Refer to procedure outlined in this section.

(7) Remove water outlet connector (Fig. 45). Refer to Group 07, Cooling System for procedure.

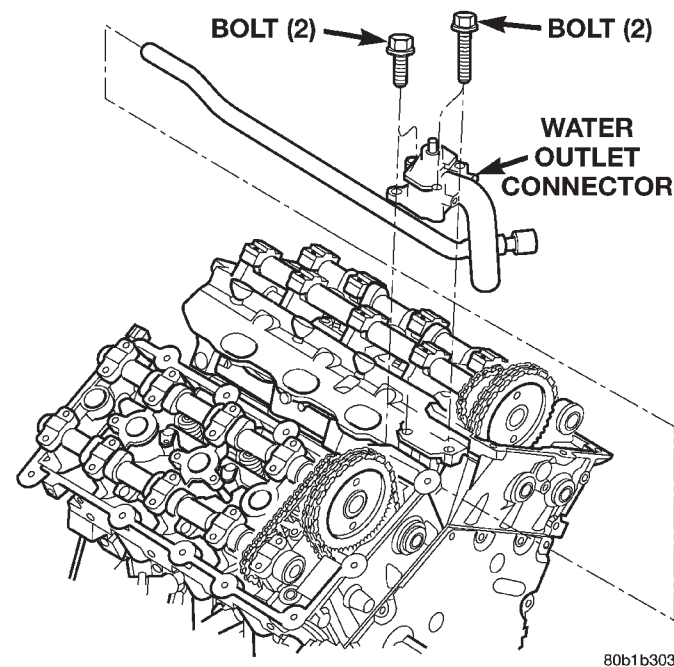


Fig. 45 Water Outlet Connector

(8) Rotate crankshaft until crankshaft sprocket timing mark aligns with timing mark on oil pump housing.

(9) Remove primary timing chain. Refer to procedure outlined in this section.

(10) Remove camshaft bearing caps **gradually** in reverse sequence of installation (Fig. 48).

(11) Remove camshafts from cylinder head.

CAUTION: Ensure cylinder head bolts 11 – 9 (Fig. 47) are removed before attempting the removal of cylinder head, as damage to cylinder head and/or block may occur.

REMOVAL AND INSTALLATION (Continued)

(12) Remove cylinder head bolts in reverse sequence of installation (Fig. 47) starting with bolts 11 – 9, then bolts 8 – 1.

(13) Remove cylinder head(s).

INSTALLATION

NOTE: 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. 46)

Necking can be checked by holding a straight edge against the threads. If all the threads do not contact the scale, the bolt should be replaced (Fig. 46)

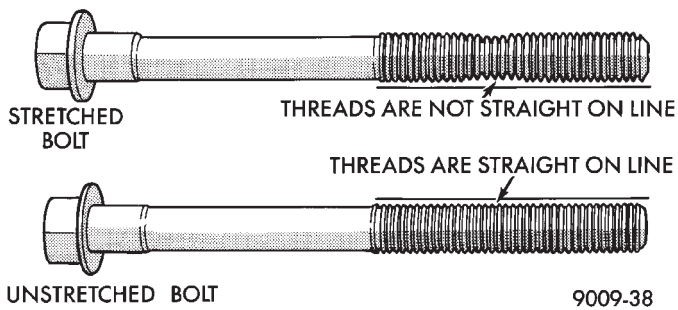


Fig. 46 Checking Cylinder Head Bolts for Stretching (Necking)

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.

(2) Install new head gasket over locating dowels.

(3) Install cylinder head to block, assuring head is properly positioned over locating dowels.

(4) Lubricate bolt threads with clean engine oil and install bolts.

(5) Tighten bolts in sequence shown in (Fig. 47), using the following steps and torque values:

- Step 1: Bolts 1 – 8 to 48 N·m (35 ft. lbs.)
- Step 2: Bolts 1 – 8 to 75 N·m (55 ft. lbs.)
- Step 3: Bolts 1 – 8 to 75 N·m (55 ft. lbs.)
- Step 4: Bolts 1 – 8 to +90° Turn **Do not use a torque wrench for this step.**

- Step 5: Bolts 9 – 11 to 28 N·m (250 in. lbs.)

(6) Install camshafts. Refer to procedure outlined in the section.

(7) Install timing chain and sprockets. Refer to procedure outlined in this section.

(8) Install water outlet connector (Fig. 45). Refer to Group 07, Cooling System for procedure.

(9) Install cylinder head covers. Refer to procedure outlined in this section.

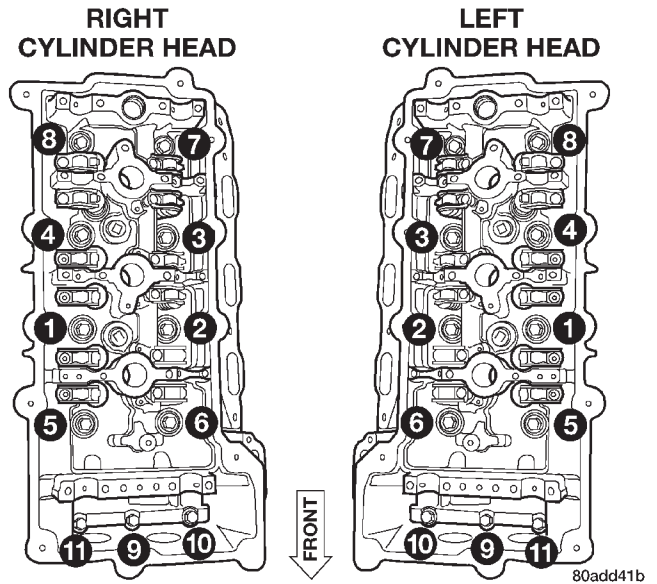


Fig. 47 Cylinder Head Tightening Sequence

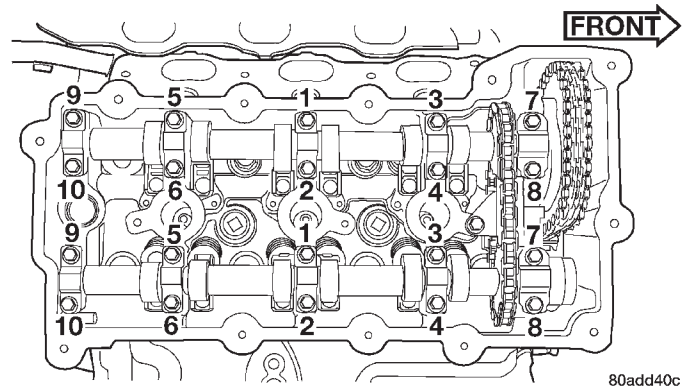


Fig. 48 Camshaft Bearing Cap Tightening Sequence

(10) Install timing chain cover and crankshaft damper. Refer to procedure outlined in this section.

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

(12) Install A/C and accessory drive belts. Refer to Group 07, Cooling System.

(13) Fill cooling system. Refer to Group 07, Cooling System.

(14) Connect negative cable to remote jumper terminal.

VALVE AND VALVE SPRINGS

REMOVAL

(1) With cylinder head removed, compress valve springs using a Special Tool C-3422-B, Valve Spring Compressor.

(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 dam-**

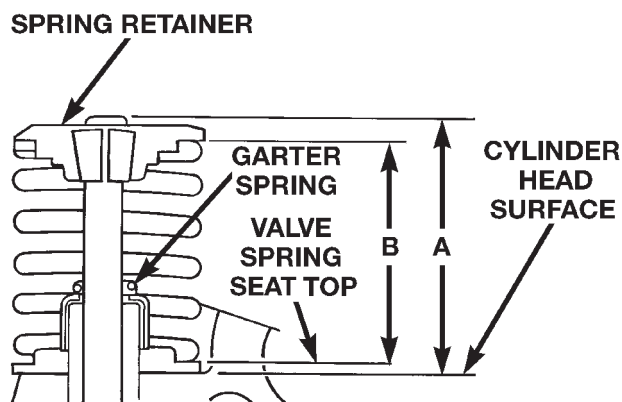
REMOVAL AND INSTALLATION (Continued)

age to the valve guides. Identify valves to insure installation in original location.

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. 49). If valve tip height for intake valve is greater than 47.59 mm (1.8737 in.) or 49.14 mm (1.9347 in.) for exhaust valve, 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. 49 Valve Tip Height and Valve Spring Installed Height Checking

(3) Install valve seal/spring seat assembly over valve guides on all valve stems (Fig. 50). 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. 49), 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 0.762 mm (0.030 inch.) spacer in head counterbore under the valve spring seat to bring spring height back within specification.

TIMING CHAIN COVER

REMOVAL

(1) Disconnect negative cable from remote jumper terminal at right strut tower.

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

(3) Remove fan module, A/C, and accessory drive belts. Refer to Group 07, Cooling System for procedure.

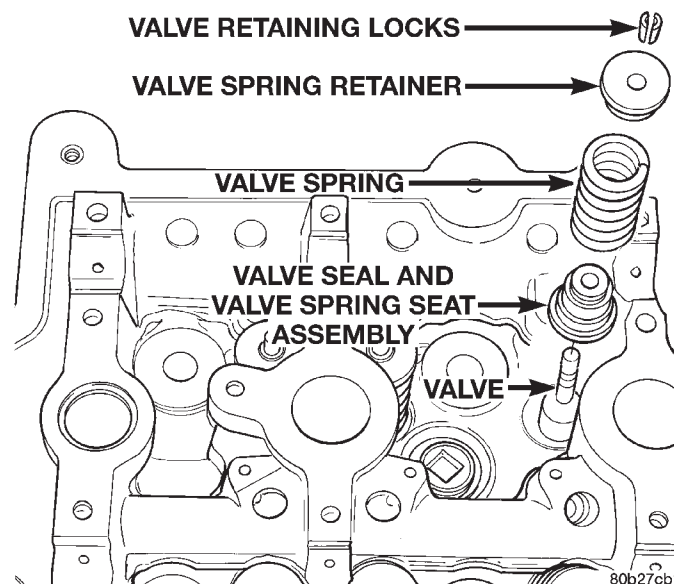


Fig. 50 Valve, Spring, and Valve Stem Seal

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

(5) Remove power steering pump from mounting bracket.

(6) Remove accessory drive belt tensioner pulley and bracket.

(7) Remove timing chain cover attaching bolts and remove cover (Fig. 51).

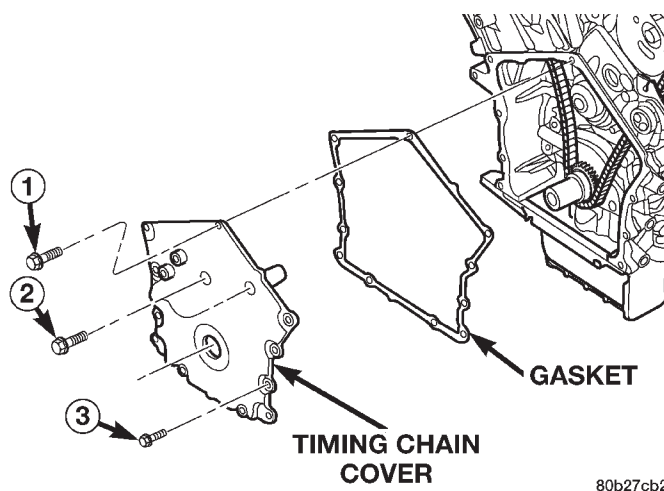


Fig. 51 Timing Chain Cover—Removal and Installation

ITEM	DESCRIPTION	TORQUE
1	Bolt—M10	54 N·m (40 ft. lbs.)
2	Bolt—M10	54 N·m (40 ft. lbs.)
3	Bolt—M6	12 N·m (105 in. lbs.)

INSTALLATION

(1) Inspect and clean sealing surfaces. Inspect and replace gasket and seal as necessary.

REMOVAL AND INSTALLATION (Continued)

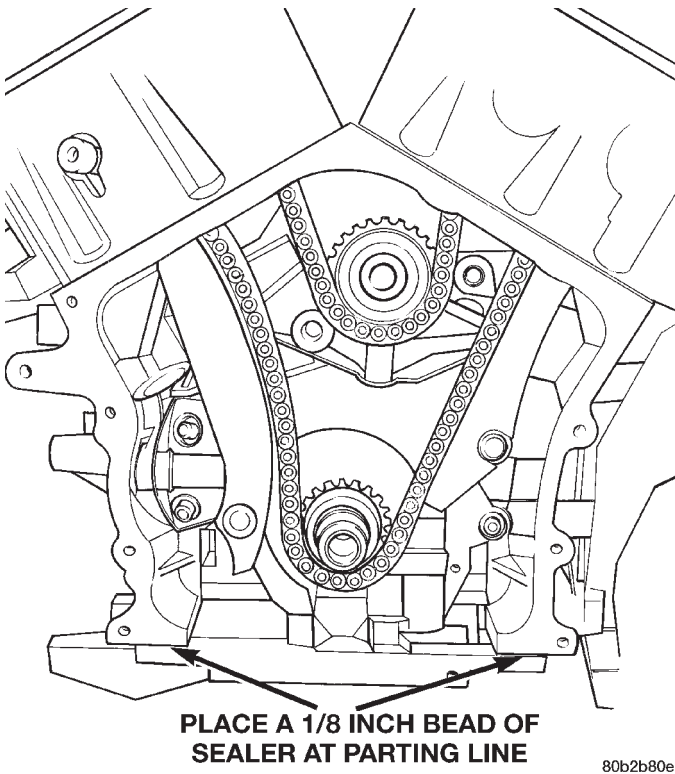


Fig. 52 Timing Chain Cover Sealing

(2) If front crankshaft seal was bench installed, place Special Tool 6780-2, Sleeve over crankshaft nose to guide and protect seal lip.

(3) Before installing timing cover gasket apply a 1/8 inch bead of Mopar® Silicone Rubber Adhesive Sealant to the parting lines between the oil pan and cylinder block (Fig. 52).

(4) Install timing cover and gasket. Tighten M10 cover bolts to 54 N·m (40 ft. lbs.) and M6 bolts to 12 N·m (105 in. lbs.) (Fig. 51).

(5) If not previously performed, install crankshaft oil seal using Special Tool 6780-2 sleeve and 6780-2 installer.

(6) Install crankshaft damper and tighten center bolt to 170 N·m (125 ft. lbs.)

(7) Attach power steering pump to bracket.

(8) Install A/C belt tensioner assembly to timing cover.

(9) Install accessory drive belt tensioner pulley and bracket.

(10) Install fan module, A/C and accessory drive belts. Refer to Group 07, Cooling System for procedure.

(11) Install upper radiator crossmember.

(12) Connect negative cable at right strut tower.

TIMING CHAIN AND SPROCKETS

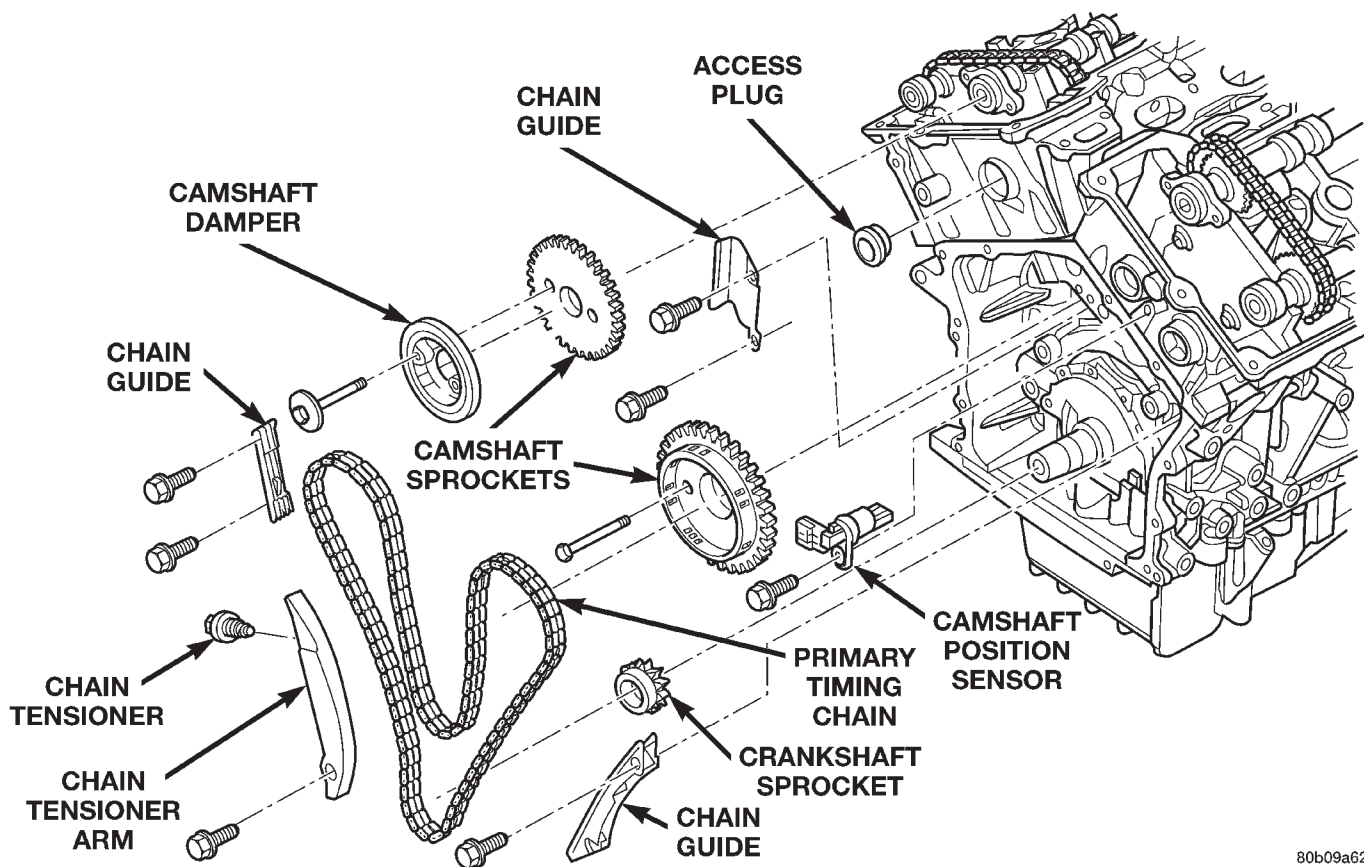


Fig. 53 Primary Timing Drive System

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REMOVAL AND INSTALLATION (Continued)

REMOVAL

(1) Remove upper intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold.

(2) Remove cylinder head covers, crankshaft damper, and timing chain cover. Refer to procedures outlined in this section.

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

(3) Align crankshaft sprocket timing mark to mark on oil pump housing (Fig. 54). The mark on oil pump housing is 60° ATDC of #1 cylinder.

CAUTION: When the timing chain is removed and the cylinder heads are still installed, **DO NOT** rotate the camshafts or crankshaft without first locating the proper crankshaft position. Failure to do so will result in valve and/or piston damage.

(4) Remove the primary timing chain tensioner from right cylinder head (Fig. 53).

(5) Remove camshaft position sensor from left cylinder head (Fig. 53).

(6) Remove chain guide access plug from left cylinder head (Fig. 53).

NOTE: When camshaft sprocket bolts are removed, the camshafts will rotate in a clockwise direction.

(7) Starting with the right camshaft sprocket, remove the sprocket attaching bolts. Remove camshaft damper and sprocket (Fig. 53).

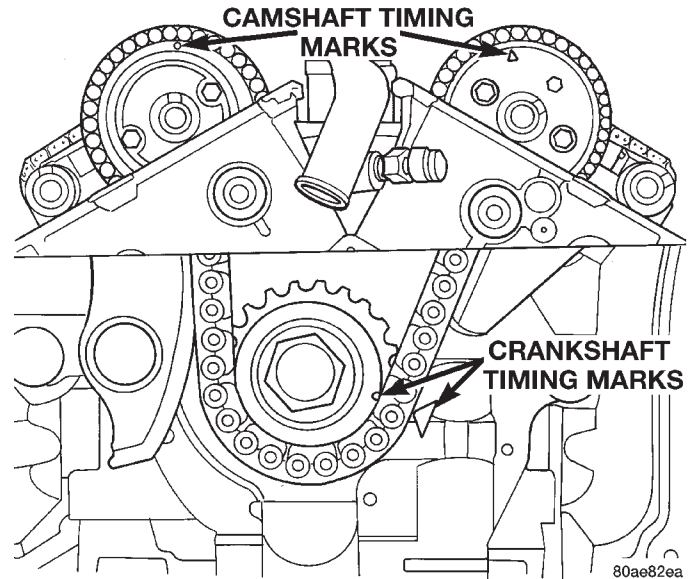


Fig. 54 Timing Mark Alignment

(8) Remove left side camshaft sprocket attaching bolts and remove sprocket (Fig. 53).

(9) Remove lower chain guide and tensioner arm (Fig. 53).

(10) Remove the primary timing chain.

(11) Inspect all sprockets and chain guides. Replace if worn. Refer to crankshaft sprocket, for removal and installation procedures.

REMOVAL AND INSTALLATION (Continued)

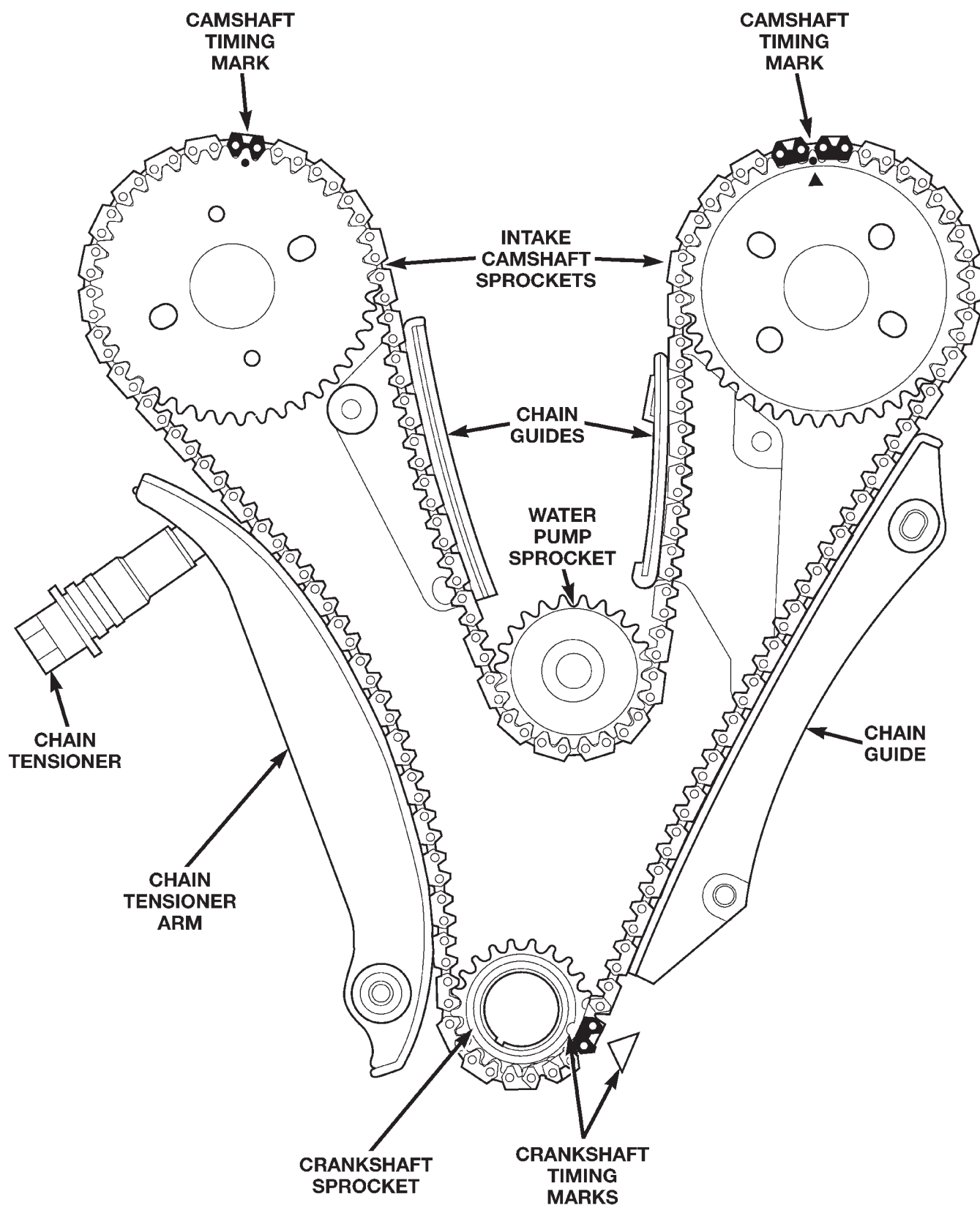


Fig. 55 Primary Timing Chain Marks

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Align crankshaft sprocket timing mark to the mark on oil pump housing (Fig. 55).

NOTE: Lubricate timing chain and guides with engine oil before installation.

(2) Place left side primary chain sprocket onto the chain so that the timing mark is located in-between the two plated links on chain (Fig. 55).

(3) Lower the primary chain with left side sprocket through the left cylinder head opening.

NOTE: The camshaft sprockets can be allowed to float on the camshaft hub during installation.

(4) Loosely position left side camshaft sprocket over camshaft hub.

(5) Align plated link to the crankshaft sprocket timing mark (Fig. 55).

(6) Position primary chain onto water pump drive sprocket.

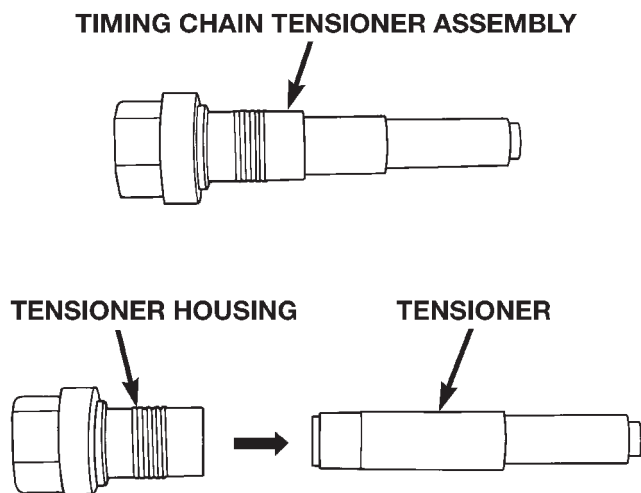
(7) Align right camshaft sprocket timing mark to plated link on timing chain (Fig. 55) and loosely position over camshaft hub.

(8) Verify that all plated links are properly aligned to timing marks on all sprockets (Fig. 55).

(9) Install left lower chain guide and tensioner arm (Fig. 53). Tighten attaching bolts to 28 N·m (250 in. lbs.).

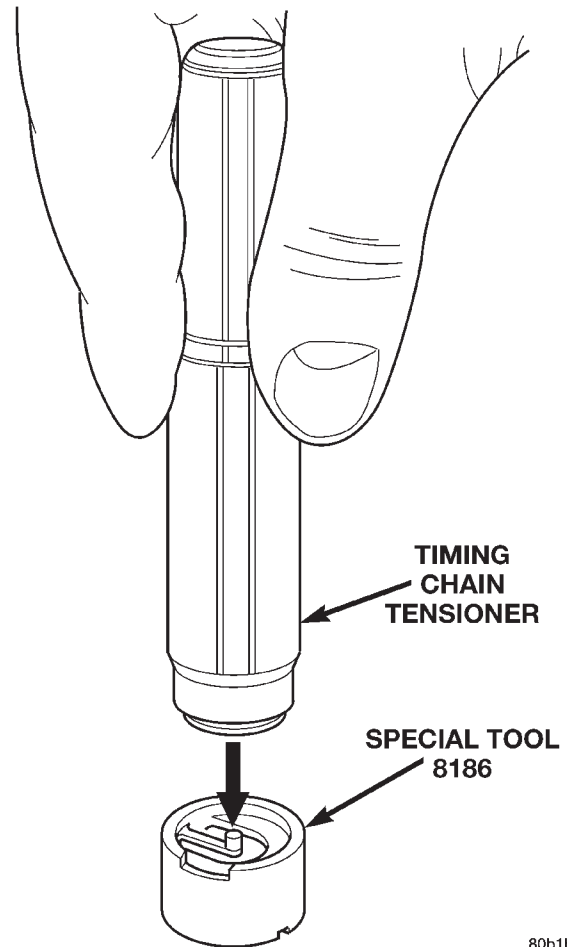
NOTE: Inspect oil ring on chain guide access plug before installing. Replace O-ring as necessary.

(10) Install chain guide access plug to left cylinder head (Fig. 53). Tighten plug to 20 N·m (15 ft. lbs.).



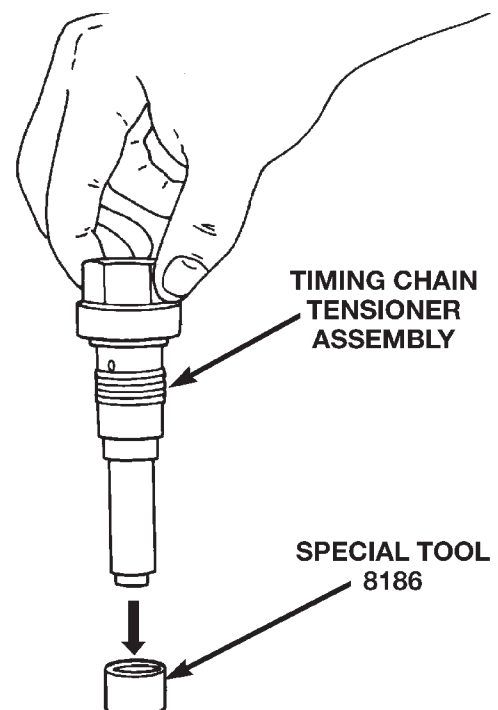
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Fig. 56 Timing Chain Tensioner Assembly



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Fig. 57 Timing Chain Tensioner—Oil Purging



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Fig. 58 Timing Chain Tensioner Resetting

REMOVAL AND INSTALLATION (Continued)

NOTE: To reset the primary timing chain tensioner, oil will first need to be purged from the tensioner (Fig. 57).

(11) Purge oil from timing chain tensioner using the following procedure:

a. Remove the tensioner from tensioner housing (Fig. 56).

b. Place the check ball end of tensioner into the shallow end of Special Tool 8186 (Fig. 57).

c. Using hand pressure, slowly depress tensioner until oil is purged from cylinder.

d. Reinstall the tensioner into tensioner housing.

(12) Reset timing chain tensioner using the following procedure:

e. Position cylinder plunger into the deeper end of Special Tool 8186 (Fig. 58).

f. Apply a downward force until tensioner is reset.

NOTE: If oil was not first purged from the tensioner, use slight finger pressure to assist the center arm of Special Tool 8186 to unseat the tensioners check ball.

CAUTION: Ensure that the tensioner is properly reset. The tensioner body must be bottom against the top edge of Special Tool 8186. Failure to properly perform resetting procedure may cause tensioner jamming.

(13) Install chain tensioner into the right cylinder head (Fig. 53).

(14) Starting at the right cylinder bank, insert a 3/8" square drive extension with a breaker bar into intake camshaft drive hub. Rotate camshaft until the camshaft hub aligns to the camshaft sprocket and damper attaching holes. Install the sprocket attaching bolts and tighten to 28 N·m (250 in. lbs.) (Fig. 55).

(15) Turn the left side camshaft by inserting a 3/8" square drive extension with a breaker bar into intake camshaft drive hub and rotate camshaft until the sprocket attaching bolts can be installed. Tighten sprocket bolts to 28 N·m (250 in. lbs.) (Fig. 55).

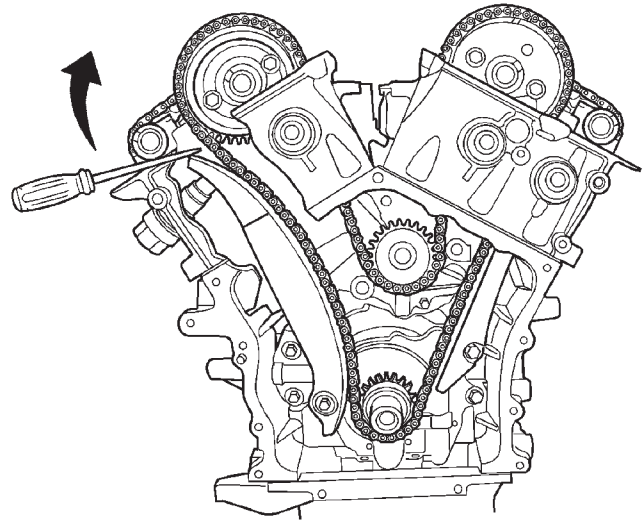
(16) Rotate engine slightly clockwise to remove timing chain slack, if necessary.

(17) To arm the timing chain tensioner: Use a flat bladed pry tool to gently pry tensioner arm towards the tensioner slightly (Fig. 59). Then, release the tensioner arm. Verify the tensioner is armed (extends).

(18) Install the timing chain cover, crankshaft damper, and cylinder head covers.

(19) Install camshaft position sensor and connect electrical connector.

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



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Fig. 59 Timing Chain Tensioner Arming

NOTE: After installation of a reset tensioner, engine noise will occur after initial start-up. This noise will normally disappear within 5 – 10 seconds.

CRANKSHAFT SPROCKET

REMOVAL

(1) Remove primary timing chain. Refer to procedure outlined in this section.

CAUTION: Use care not to turn crankshaft while removing crankshaft sprocket, as damage to valves and or pistons could occur.

(2) Remove crankshaft sprocket by installing the crankshaft damper bolt and using Special Tool 1023. Remove sprocket using care not to rotate the crankshaft.

INSTALLATION

(1) Install crankshaft sprocket using Special Tools 6780-1 and 8179 (Fig. 61) until sprocket bottoms against crankshaft step flange. Use care not to rotate crankshaft.

(2) Verify that crankshaft sprocket is installed to proper depth by measuring from sprocket outer face to end of crankshaft (Fig. 62). Measurement should read: 39.05 ±0.50 mm (1.5374 ±0.002 in.).

(3) Install primary timing chain. Refer to procedure outlined in this section.

REMOVAL AND INSTALLATION (Continued)

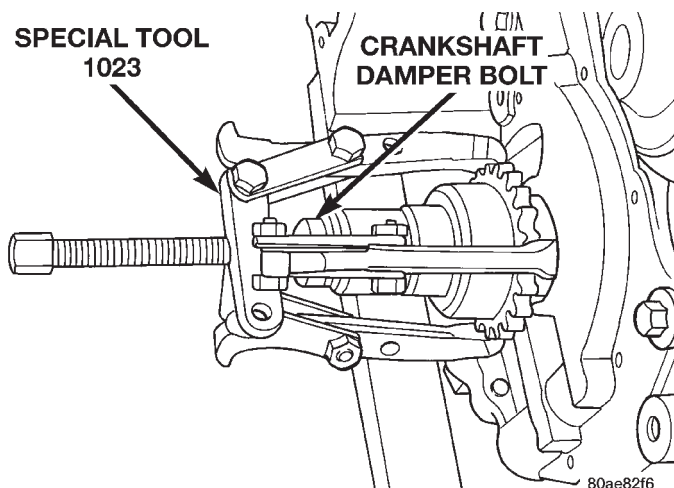


Fig. 60 Crankshaft Sprocket—Removal

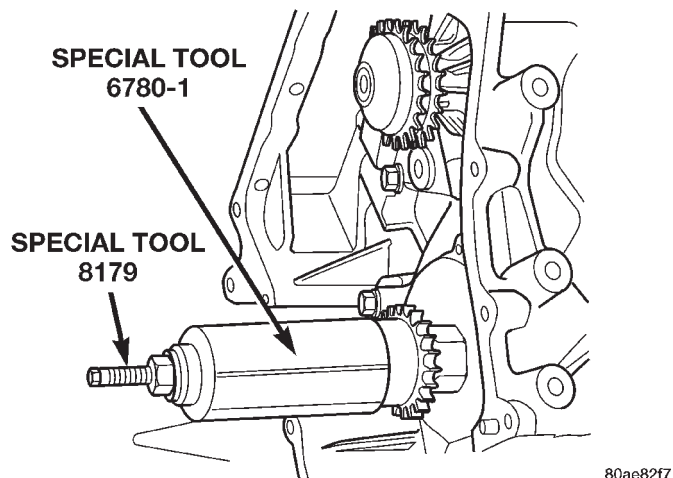
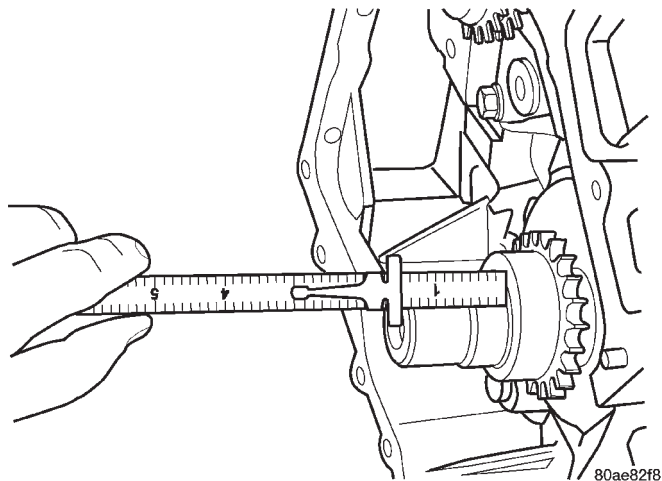


Fig. 61 Crankshaft Sprocket—Installation

Fig. 62 Crankshaft Sprocket Depth Measurement
CRANKSHAFT OIL SEAL—FRONT

REMOVAL

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

(2) Insert Special Tool 8194, into crankshaft nose. Remove seal using Special Tool 6771, Remover (Fig. 63).

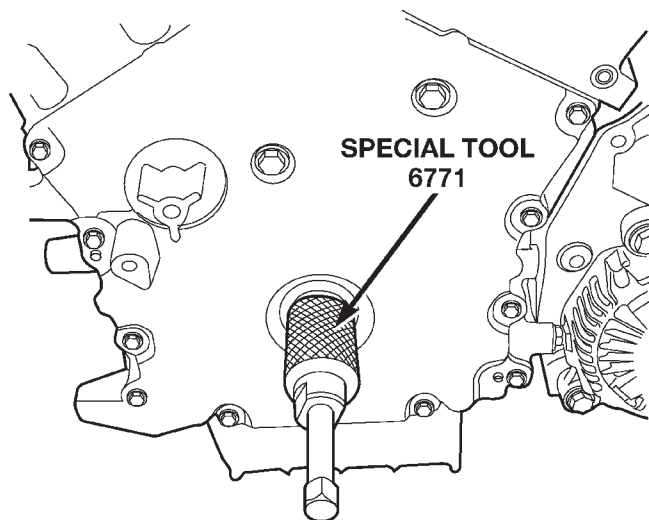


Fig. 63 Crankshaft Front Oil Seal—Removal

INSTALLATION

(1) Install new seal using Special Tools 6780-2 Sleeve, 6780-1 Installer, and 8179 Stud (Fig. 64).
(2) Install crankshaft damper.

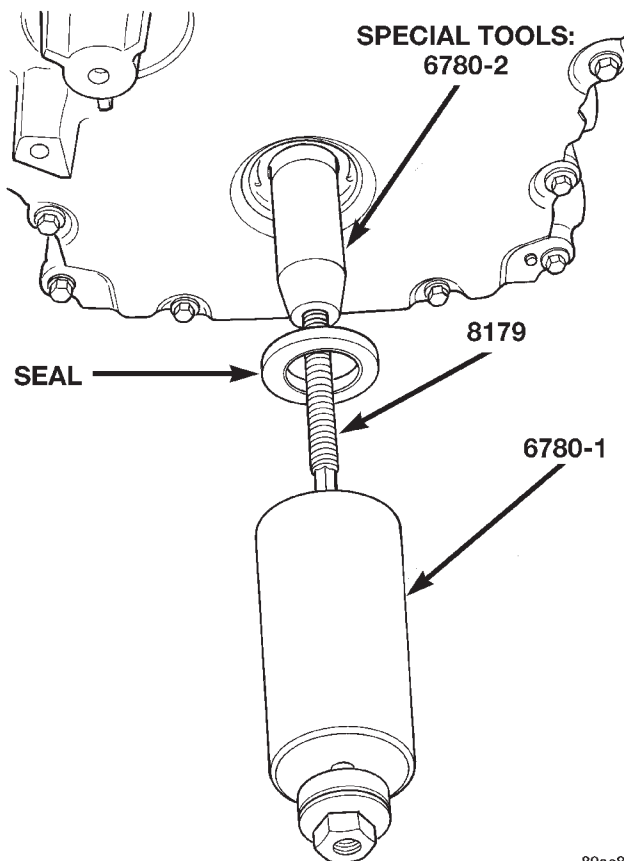


Fig. 64 Crankshaft Front Oil Seal—Installation

REMOVAL AND INSTALLATION (Continued)

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. 65) through 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

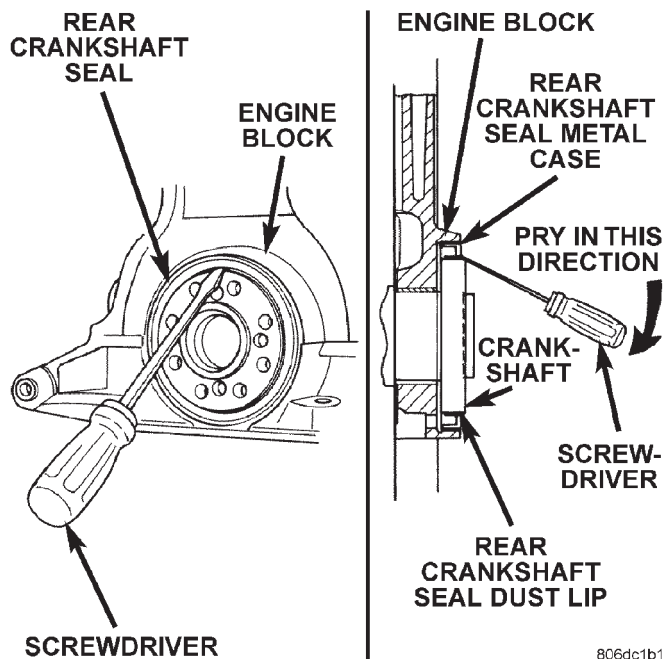
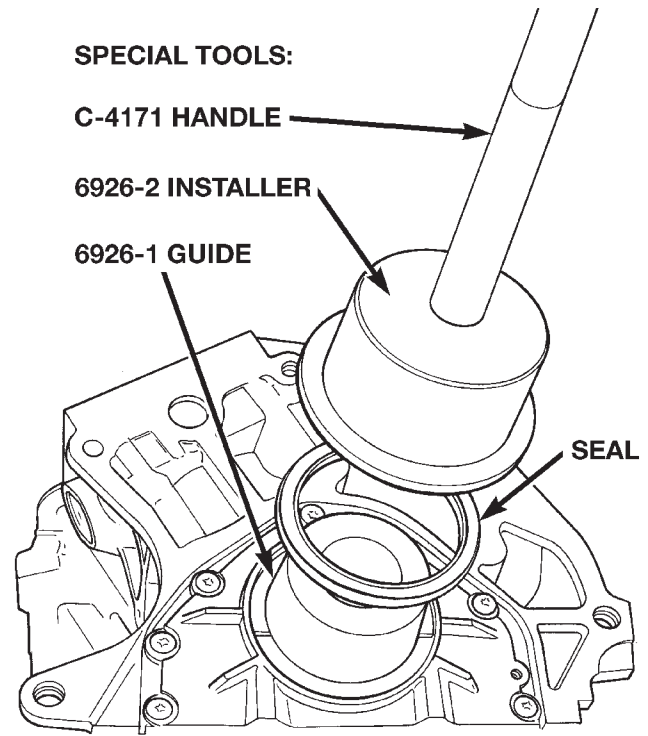


Fig. 65 Rear Crankshaft Oil Seal Removal—Typical INSTALLATION

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. 66). 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 installation. The pilot tool remains on crankshaft during seal installation.
- (3) Using Special Tool 6926-2 Installer, and C-4171 Handle (Fig. 66), drive seal into the retainer housing until seal is flush with housing surface.
- (4) Install drive plate and transaxle.

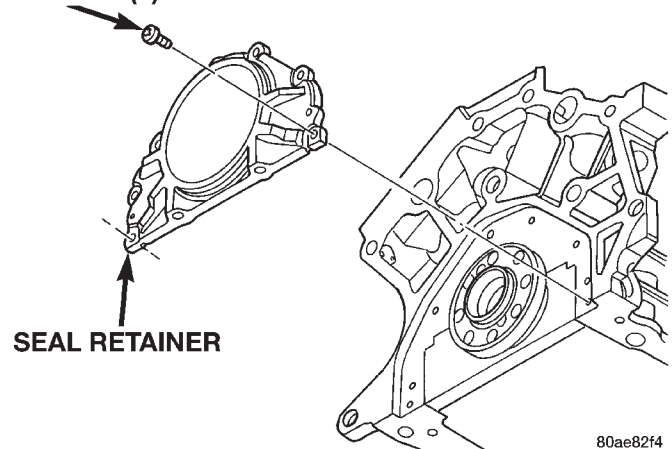


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Fig. 66 Crankshaft Rear Seal—Installation

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 (Fig. 67).
- (3) Remove retainer and gasket (Fig. 67).

SCREWS (7)

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Fig. 67 Oil Seal Retainer

INSTALLATION

- (1) Clean sealing surfaces and replace gasket as needed.
- (2) Install gasket and loosely assemble seal retainer to block.

REMOVAL AND INSTALLATION (Continued)

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 "2.7L" stamped on the special tool is facing the cylinder block (flat side of tools against pan rail).

(4) While applying firm pressure to the seal retainer against Special Tools 8225 (Fig. 68), tighten seal retainer screws to 12 N·m (105 in. lbs.)

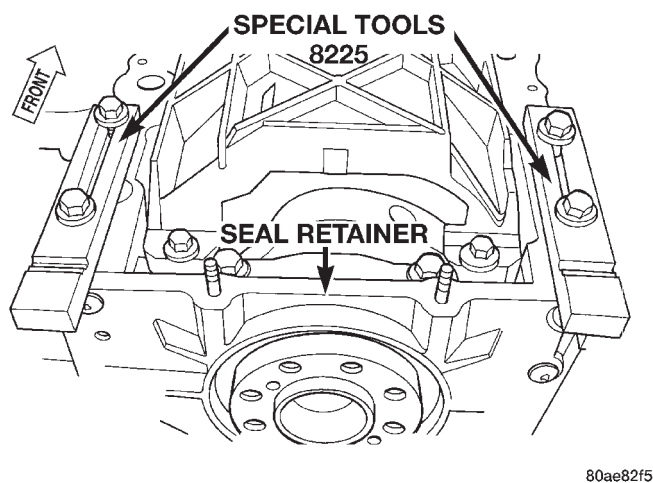


Fig. 68 Rear Crankshaft Seal Retainer Alignment

(5) Install crankshaft rear oil seal. Refer to procedure outlined in this section.

OIL PAN

REMOVAL

- (1) Remove dipstick and housing.
- (2) Raise vehicle on hoist.
- (3) Drain engine oil and remove oil filter.
- (4) Remove structural collar from oil pan to transmission housing (Fig. 70).

CAUTION: Assure removal of the two bolts attaching the timing cover to the oil pan, as damage to the timing cover and/or oil pan may occur.

(5) Remove oil pan attaching fasteners. Remove oil pan and gasket (Fig. 69).

INSTALLATION

- (1) Clean oil pan and sealing surfaces. Inspect oil pan and timing chain cover gaskets and replace as necessary.
- (2) Apply a 1/8 inch bead of Mopar® Silicone Rubber Adhesive Sealant to the front T-Joints (oil pan gasket to timing cover gasket interface) (Fig. 69).
- (3) Install oil pan gasket to block.

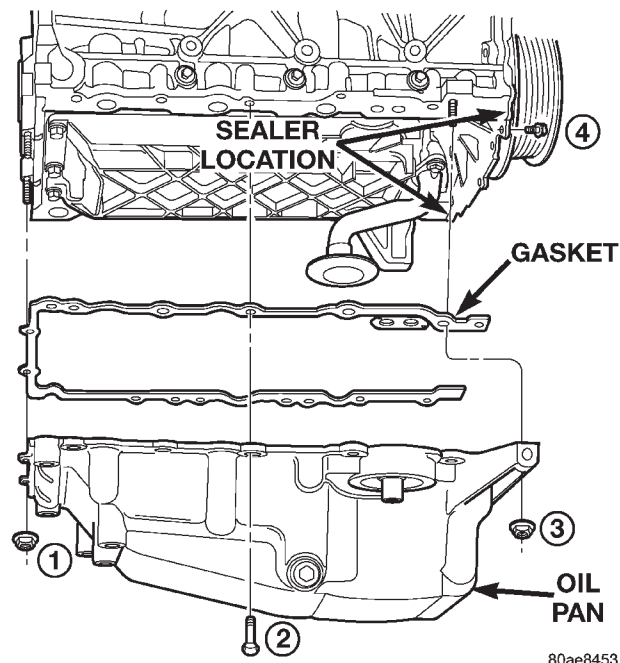


Fig. 69 Oil Pan—Removal and Installation

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

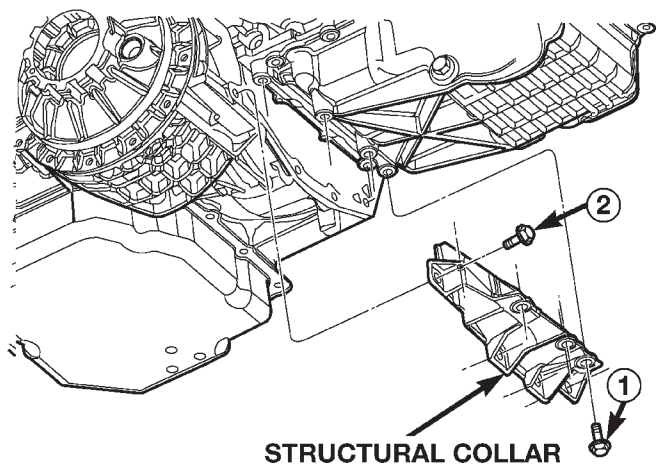


Fig. 70 Structural Collar

NOTE: To prevent oil leaks at oil pan to timing chain cover, the following tightening sequence procedure must be performed.

- (4) Install oil pan and fasteners (Fig. 69) using the following tightening sequence:
 - a. Install oil pan bolts and nuts **finger tight only—just tight enough to compress the gasket's rubber seal.**

REMOVAL AND INSTALLATION (Continued)

- b. Install timing chain cover to pan bolts and tighten to 12 N·m (105 in. lbs.).
- c. Tighten oil pan bolts to 28 N·m (250 in. lbs.).
- d. Tighten oil pan nuts to 12 N·m (105 in. lbs.).

CAUTION: The collar must be tighten using the procedure outlined or damage to collar or oil pan may occur.

(5) Install structural collar (Fig. 70) using the following tightening sequence:

- e. Install the **vertical** collar to oil pan bolts (1). Torque bolts initially to 1.1 N·m (10 in. lbs.).
- f. Install collar to transmission bolts (2) and torque to 55 N·m (40 ft. lbs.).
- g. Starting with the center vertical bolts (1) and working outward, final torque bolts to 55 N·m (40 ft. lbs.).
- (6) Install oil filter and drain plug.
- (7) Lower vehicle and install oil dipstick and housing.
- (8) Fill engine crankcase with proper oil to correct level.

CRANKSHAFT

REMOVAL

- (1) Remove engine from vehicle. Refer to procedure outlined in this section.
- (2) Mount engine on an engine stand.
- (3) Drain engine oil and remove oil filter.
- (4) Remove oil pan and oil pick-up tube.
- (5) Remove idler pulley bracket for accessory drive belt.
- (6) Remove upper intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold.
- (7) Remove cylinder head covers.
- (8) Remove timing chain cover.
- (9) Remove primary timing chain.
- (10) Remove crankshaft sprocket.
- (11) Remove oil pump.
- (12) Remove crankshaft rear oil seal retainer.
- (13) Remove structural windage tray (Fig. 75).
- (14) Turn crankshaft until connecting rod cap to be removed is accessible.

NOTE: Connecting rod bearing caps are not interchangeable and should be marked before removing to ensure correct reassembly.

CAUTION: DO NOT use a number stamp or a punch to mark connecting rods. Damage to connecting rod could occur.

- (15) Mark connecting rod bearing cap positions using a permanent ink marker or scribe tool.

- (16) Remove connecting rod bearing caps. Use care to prevent damage to the crankshaft bearing surfaces.

CAUTION: Care should be taken not to damage the fractured rod and cap joint face surfaces or damage to the engine may occur.

- (17) Remove main bearing cap bolts and tie bolts (Fig. 71).

- (18) Remove main bearing caps (Fig. 71).

CAUTION: When removing crankshaft, use care not to damage bearing surfaces on the crankshaft

- (19) Remove crankshaft from cylinder block.

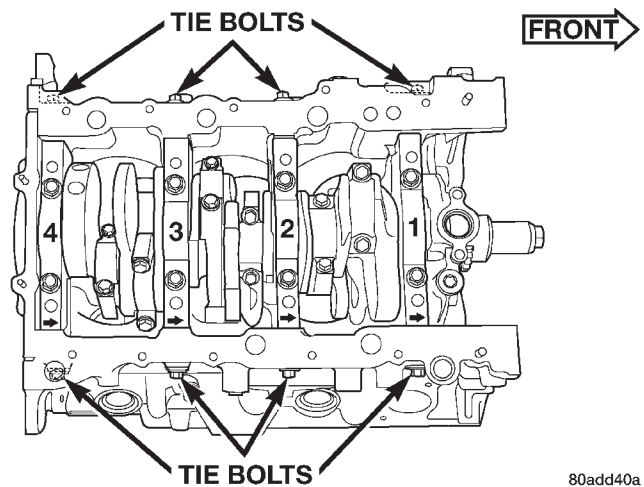


Fig. 71 Main Bearing Cap Identification

INSTALLATION

NOTE: Upper and lower bearing halves are NOT interchangeable.

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

- (1) Lubricate upper main bearing halves with engine oil (Fig. 72).

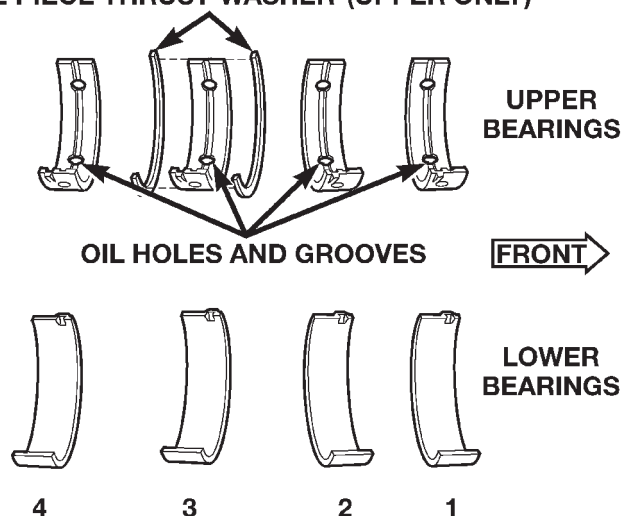
CAUTION: When installing crankshaft, use care not to damage bearing surfaces on the crankshaft.

- (2) Install crankshaft.

NOTE: Make sure that the coated and oil groove side of crankshaft thrust washer faces the crankshaft thrust surface.

- (3) Push crankshaft forward. Lubricate and install the front thrust washer by rolling the thrust washer onto the machined shelf between the No. 3 upper

REMOVAL AND INSTALLATION (Continued)

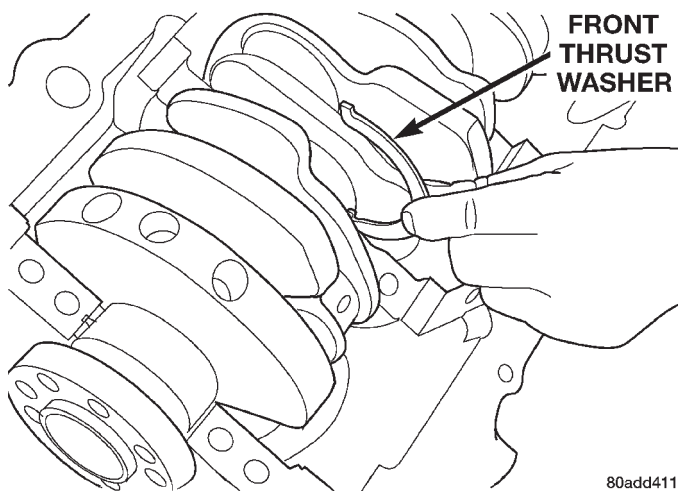
2 PIECE THRUST WASHER (UPPER ONLY)

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Fig. 72 Main Bearing Identification

main bulk head and crankshaft thrust surface (Fig. 73).

(4) Move crankshaft rearward. Lubricate and install the rear thrust washer by rolling the thrust washer onto the machined shelf between the No. 3 upper main bulk head and crankshaft thrust surface.



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Fig. 73 Thrust Washer—Installation

(5) Lubricate lower main bearings with engine oil.

(6) Install main bearings and caps.

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

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

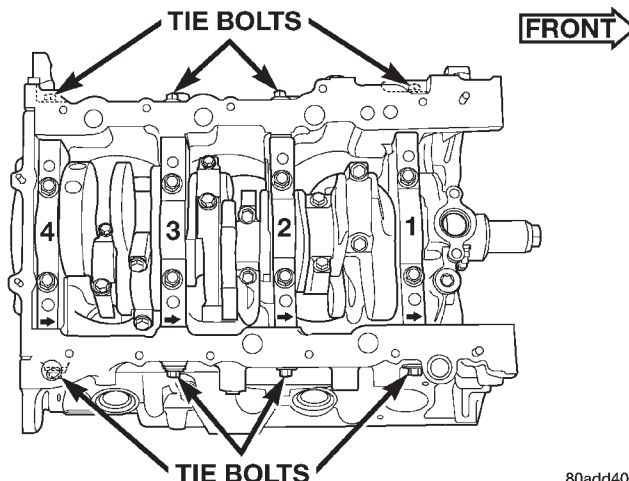
(7) Install the inside main bearing cap bolts and tighten to 20 N·m + 1/4 Turn (15 ft. lbs. + 1/4 Turn) (Fig. 74).

(8) Measure crankshaft end play. Refer to Service Procedures—Crankshaft Bearing Installation for procedure.

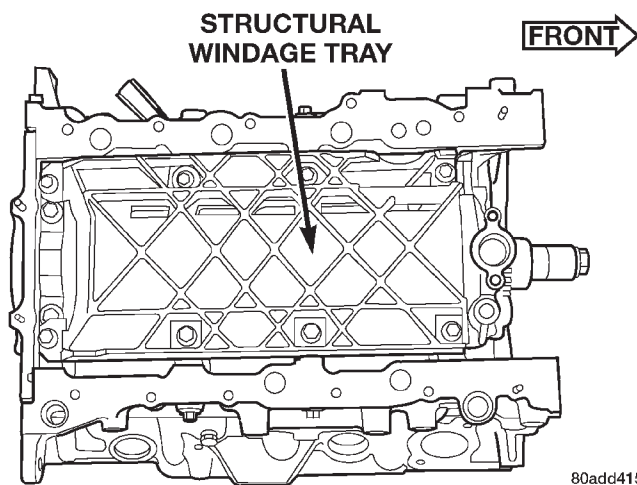
(9) Install connecting rods and measure side clearance. Refer to Service Procedures—Connecting Rod Bearing Installation for procedures.

(10) Install windage tray (Fig. 75). Lubricate bolts with engine oil and tighten to 27 N·m + 1/4 Turn (20 ft. lbs. + 1/4 turn).

(11) Install the main cap tie (horizontal) bolts and tighten to 28 N·m (250 in. lbs.) (Fig. 74).



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Fig. 74 Main Bearing Cap Identification

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Fig. 75 Windage Tray

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

(13) Install oil pump assembly. Refer to procedure outlined in this section.

(14) Install crankshaft sprocket. Refer to procedure outlined in this section.

(15) Install timing chain. Refer to procedure outlined in this section.

(16) Install timing chain cover.

(17) Install cylinder head covers.

REMOVAL AND INSTALLATION (Continued)

- (18) Install idler pulley bracket for accessory drive belt.
- (19) Install oil pick-up tube and O-ring.
- (20) Install oil pan and oil filter.
- (21) Install oil dipstick tube.
- (22) Install engine assembly.
- (23) Fill engine crankcase with proper oil to correct level.

OIL FILTER

- (1) Remove oil filter using Special Tool C-4065 or equivalent (Fig. 76). Dispose of oil filter following environmental guidelines.

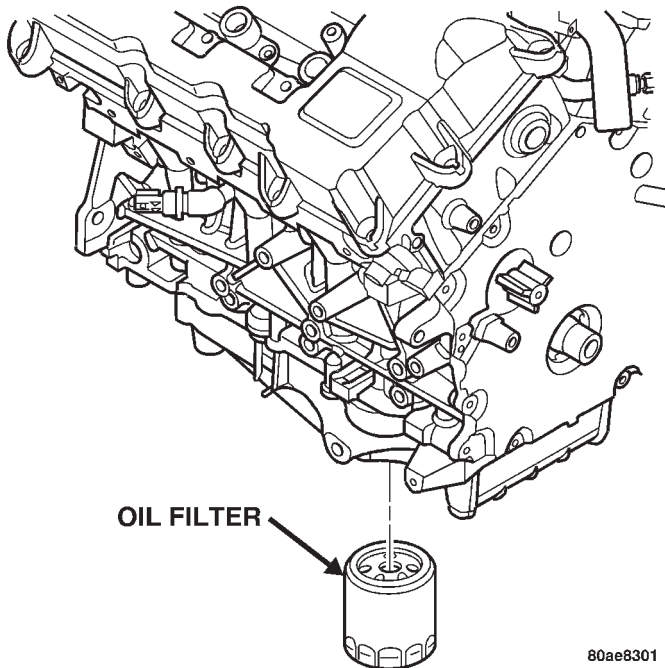


Fig. 76 Engine Oil Filter

- (2) Wipe filter base clean, then inspect gasket sealing surface.
- (3) Lubricate gasket of new filter with clean engine oil.
- (4) Install oil filter and tighten to 20 N·m (15 ft. lbs.) of torque after gasket contacts base. Use filter wrench if necessary.
- (5) Fill crankcase with proper engine oil to correct level if drained. Start engine and check for leaks.

OIL PUMP

REMOVAL

The oil pump pressure relief valve can be serviced by removing the oil pan.

- (1) Refer to procedure outlined in this section for removing the following components:

- Crankshaft Damper
- Timing Chain Cover
- Timing Chain

- Crankshaft Sprocket
 - Oil Pan
- (2) Remove oil pick-up tube and O-ring (Fig. 77).
 - (3) Remove oil pump attaching bolts (Fig. 77).
 - (4) Remove oil pump.

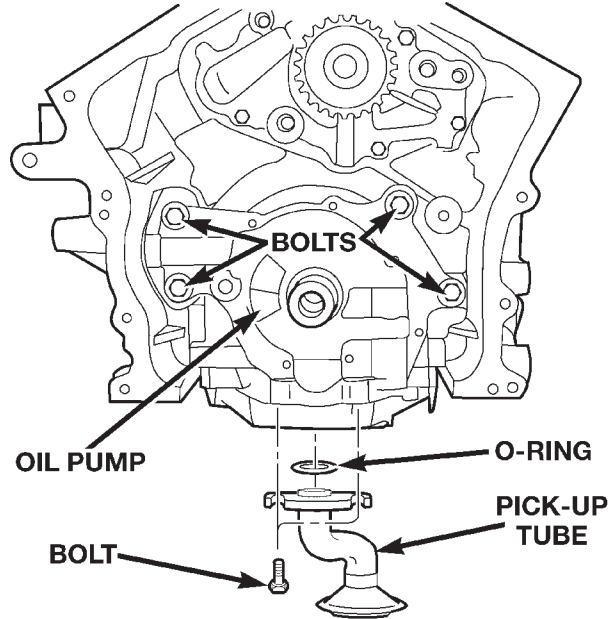


Fig. 77 Oil Pump and Pick-up Tube

INSTALLATION

- (1) Prime oil pump before installation by filling rotor cavity with engine oil.
- (2) Install oil pump carefully over crankshaft and into position.
- (3) Install oil pump attaching bolts. Tighten bolts to 28 N·m (250 in. lbs.) (Fig. 77).
- (4) Install oil pick-up tube with new O-ring. Lubricate O-ring before installation. Tighten attaching bolts to 28 N·m (250 in. lbs.) (Fig. 77).
- (5) Install the following remaining components following procedures outlined in this section:

- Oil Pan
- Crankshaft Sprocket
- Timing Chain
- Timing Chain Cover
- Crankshaft Damper

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

PISTON AND CONNECTING ROD

REMOVAL

- (1) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. **Be sure to keep tops of pistons covered during this operation. Pistons and connecting rods must be removed from top of cylinder block. When removing piston and**

REMOVAL AND INSTALLATION (Continued)

connecting rod assemblies from the engine, rotate crankshaft so that each connecting rod is centered in cylinder bore.

NOTE: Connecting rod bearing caps are not interchangeable and should be marked before removing to ensure correct reassembly.

CAUTION: DO NOT use a number stamp or a punch to mark connecting rods. Damage to connecting rod could occur.

(2) Mark connecting rod and bearing cap positions using a permanent ink marker or scribe tool (Fig. 78).

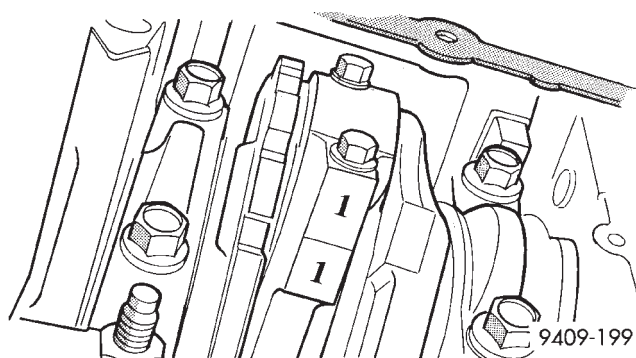


Fig. 78 Identify Connecting Rod to Cylinder—Typical

**SPECIAL TOOL 8189
CONNECTING
ROD GUIDES**

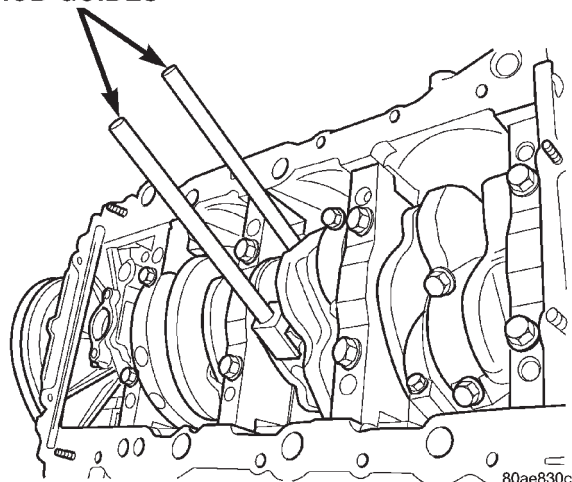


Fig. 79 Connecting Rod Guides

CAUTION: Care must be taken not to damage the fractured rod and cap joint face surfaces, as engine damage may occur.

(3) Remove connecting rod cap. Install Special Tool 8189 Connecting Rod Guides into the connecting rod

being removed (Fig. 79). Remove each piston and rod assembly out of cylinder bore.

NOTE: Be careful not to nick crankshaft journals.

(4) After removal, install bearing cap on the mating rod to prevent damage to the fractured cap to rod surfaces.

PISTON RINGS—INSTALLATION

(1) The No. 1 and No. 2 piston rings have a different cross section. Ensure No. 2 ring is installed with manufacturers I.D. mark (dot) facing up, towards top of the piston (Fig. 80).

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. 81).**

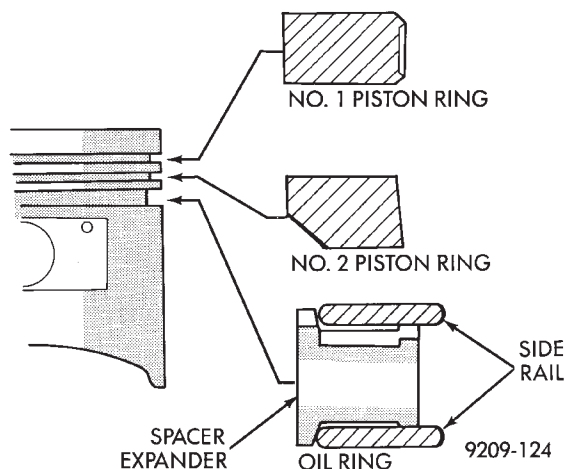


Fig. 80 Piston Ring—Installation

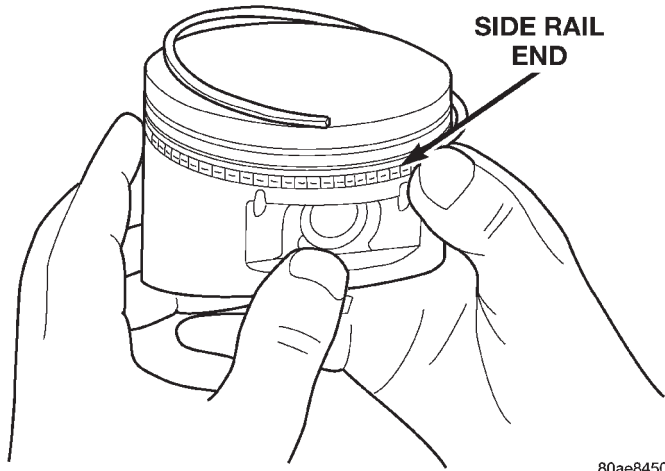
(8) Install upper side rail first and then the lower side rail.

(9) Install No. 2 piston ring and then No. 1 piston ring (Fig. 82).

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

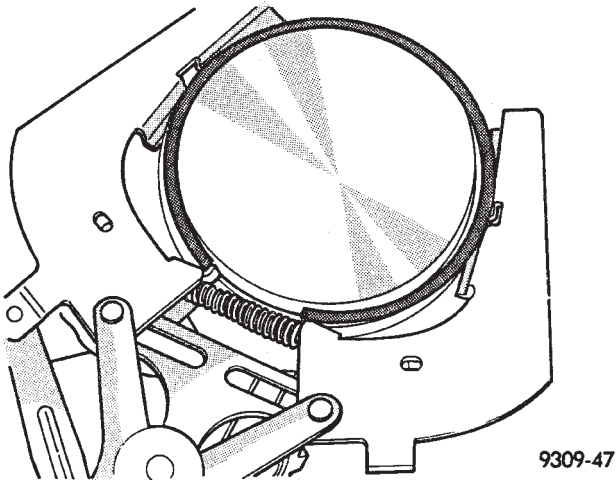
(11) Position oil ring expander gap at least 45° from the side rail gaps but **not** on the piston pin center or on the thrust direction. Staggering ring gap is important for oil control.

REMOVAL AND INSTALLATION (Continued)



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Fig. 81 Side Rail—Installation



9309-47

Fig. 82 Upper and Intermediate Rings—Installation

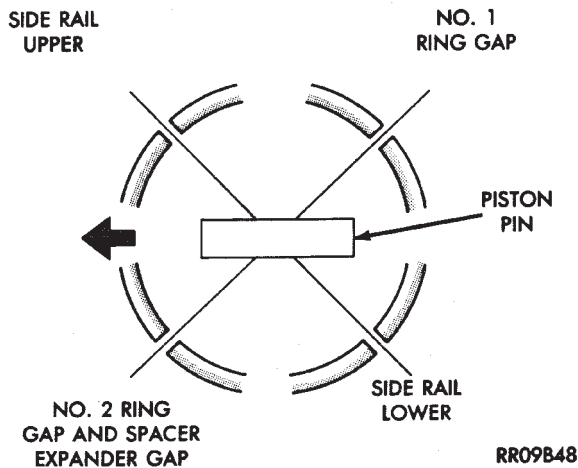


Fig. 83 Piston Ring End Gap Position

PISTON AND CONNECTING ROD—INSTALLATION

(1) Before installing piston 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.

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located as shown in (Fig. 83).

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

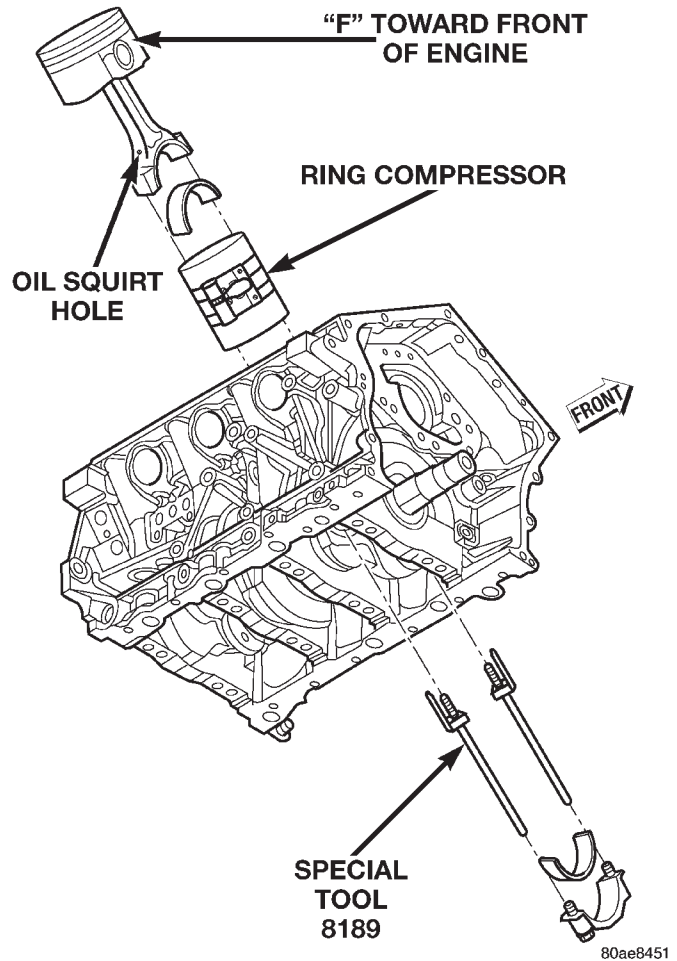


Fig. 84 Piston and Connecting Rod—Installation

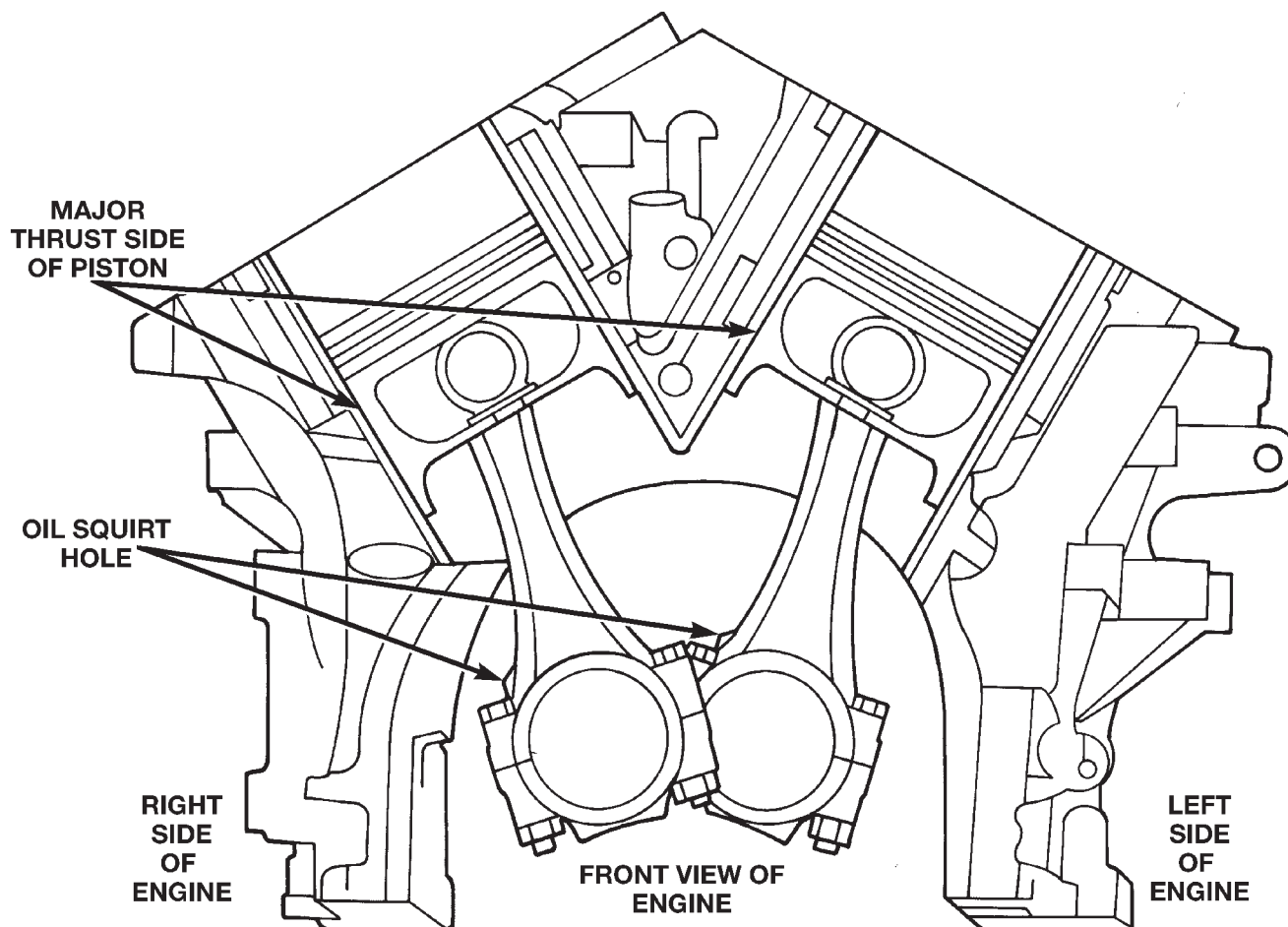
CAUTION: Ensure the hole in bearing half aligns with hole in connecting rod, as damage to engine may occur.

(4) Position bearing onto connecting rod. Ensure that hole in bearing half is aligned to hole in connecting rod. Lubricate bearing surface with clean engine oil.

(5) Install Special Tools 8189 Connecting Rod Guides into connecting rod (Fig. 79).

(6) The pistons are marked on top with an arrow and with an "F" (Front) above the pin boss. These marks must be pointing toward the front of engine on both cylinder banks. The connecting rod oil squirt

REMOVAL AND INSTALLATION (Continued)



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Fig. 85 Piston and Connecting Rod Positioning

hole faces the major thrust (right) side of the block (Fig. 85).

(7) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Insert rod and piston into cylinder bore and guide rod over the crankshaft journal (Fig. 84).

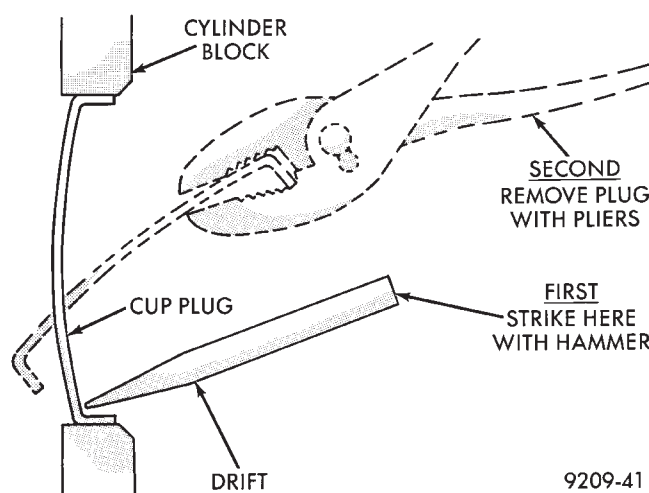
CAUTION: Do Not interchange piston assemblies bank to bank, as engine damage may occur.

(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) Lubricate rod bolts and bearing surface with engine oil. Install connecting rod cap and bearing. Tighten bolts to 27 N·m (20 ft. lbs.) Plus 1/4 turn.

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 plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 86).



9209-41

Fig. 86 Core Hole Plug Removal

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

REMOVAL AND INSTALLATION (Continued)

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

(1) Remove the pressure relief valve by remove the threaded retaining cap from the oil pump housing.

CAUTION: Oil pump pressure relief valve must be installed as shown in (Fig. 87) or engine damage may occur.

(2) Remove spring and relief valve.

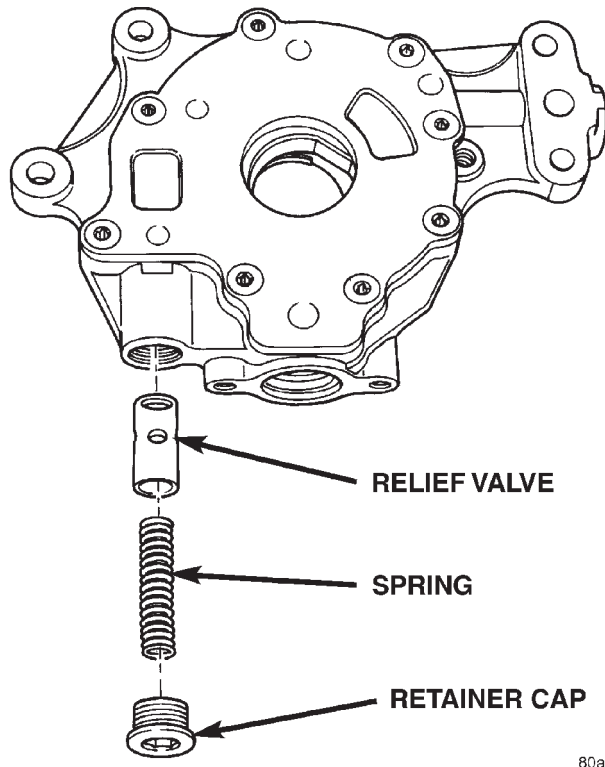


Fig. 87 Oil Pressure Relief Valve

(3) Remove oil pump cover screws and lift off cover plate (Fig. 88).

(4) Remove pump rotors.

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

(6) Tighten cover screws to 12 N·m (105 in. lbs.) (Fig. 88). Tighten oil pressure relief valve retaining cap to 12 N·m (105 in. lbs.) (Fig. 87).

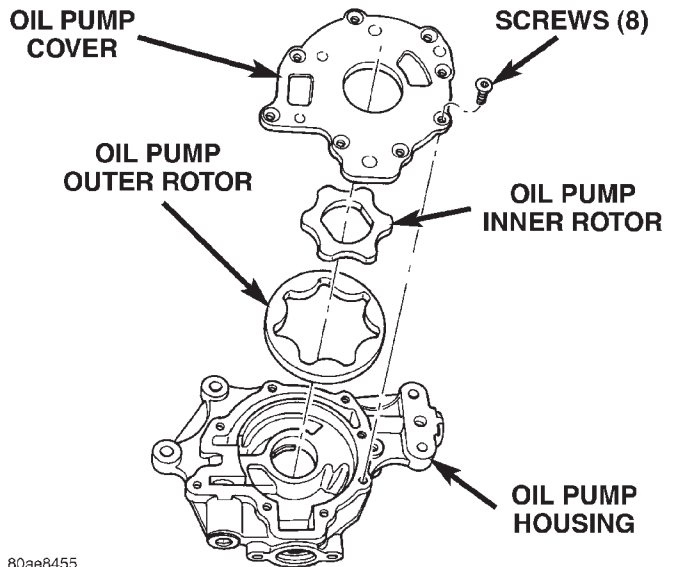


Fig. 88 Oil Pump

CLEANING AND INSPECTION

CYLINDER HEAD

CLEANING

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

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. 89).

(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.

CLEANING AND INSPECTION (Continued)

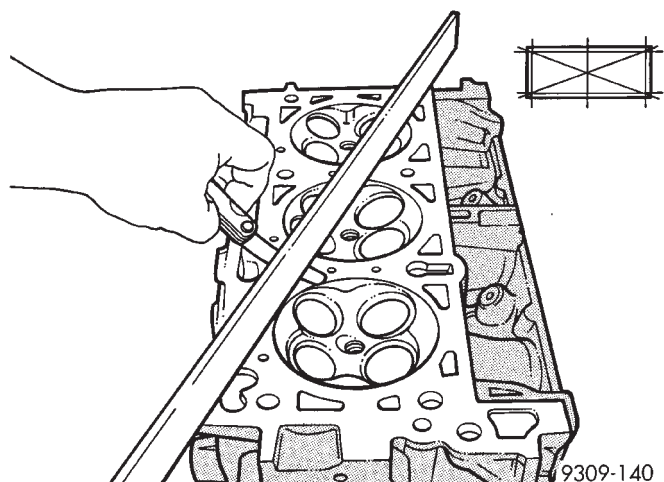


Fig. 89 Checking Cylinder Head Flatness—Typical

CAMSHAFT FOLLOWER

Inspect the cam follower assembly for wear or damage (Fig. 90). Replace as necessary.

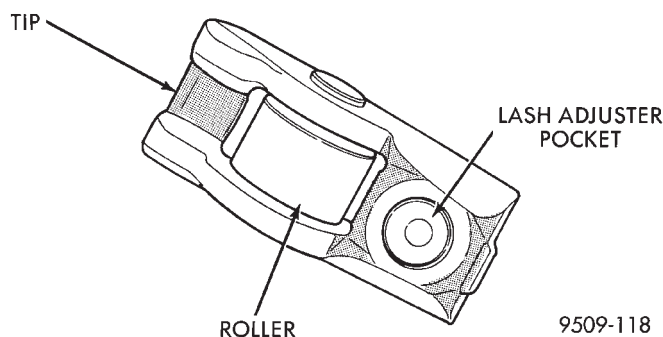


Fig. 90 Cam Follower Assembly

VALVE INSPECTION

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

(2) Measure valve stems for wear (Fig. 91). Refer to Valve Specification.

NOTE: Valve stems are chrome plated and should not be polished (Fig. 91).

(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. 92).

(4) Move valve to and from the indicator. Refer to Valve Guide Specification Chart.

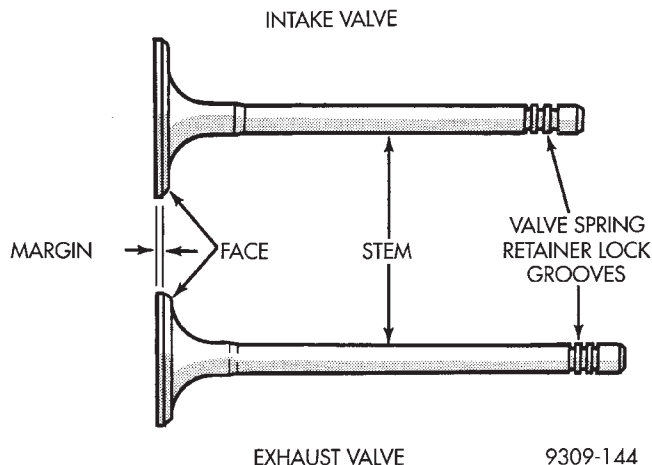


Fig. 91 Intake and Exhaust Valves

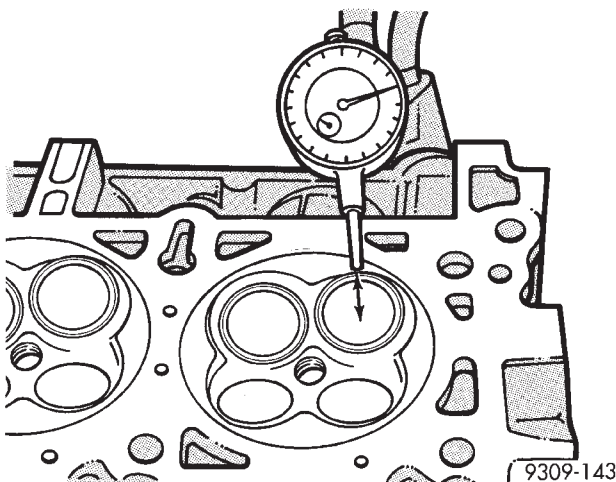


Fig. 92 Measuring Valve Guide Wear—Typical

VALVE GUIDE SPECIFICATION CHART

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

VALVE GUIDES

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

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. 93). If a 0.025 mm (0.001 inch.) feeler gauge can be inserted between cover and straight edge, cover should be replaced.

CLEANING AND INSPECTION (Continued)

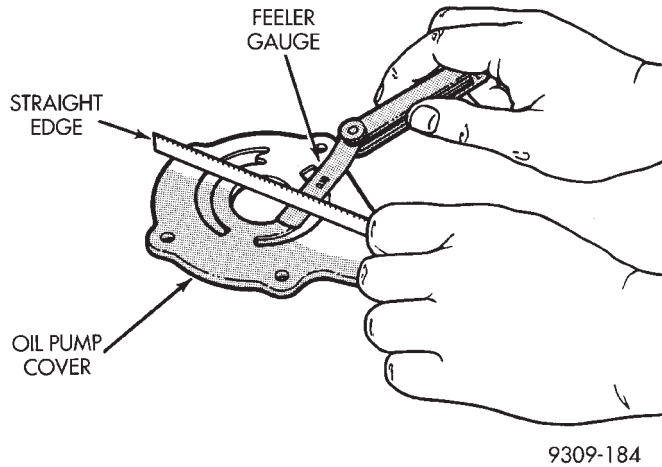


Fig. 93 Checking Oil Pump Cover Flatness

(3) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 9.474 mm (0.373 in.) or less (Fig. 94), or if the diameter is 89.174 mm (3.5108 inches.) or less, replace outer rotor.

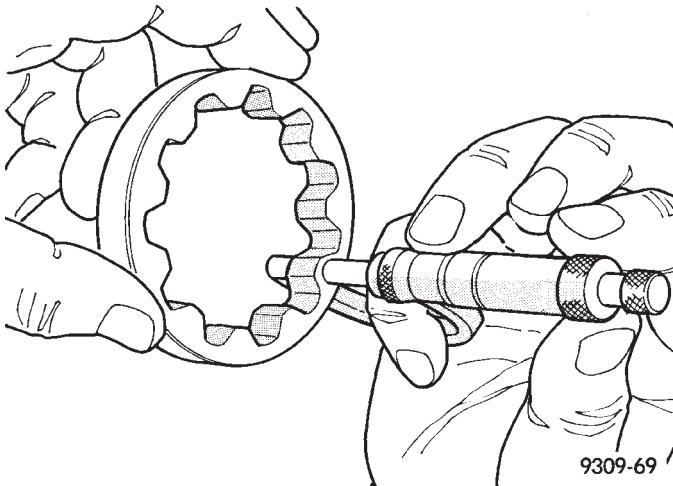


Fig. 94 Measuring Outer Rotor Thickness

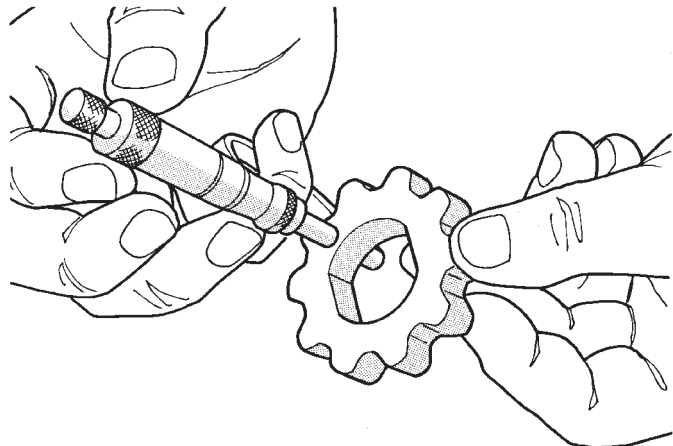


Fig. 95 Measuring Inner Rotor Thickness

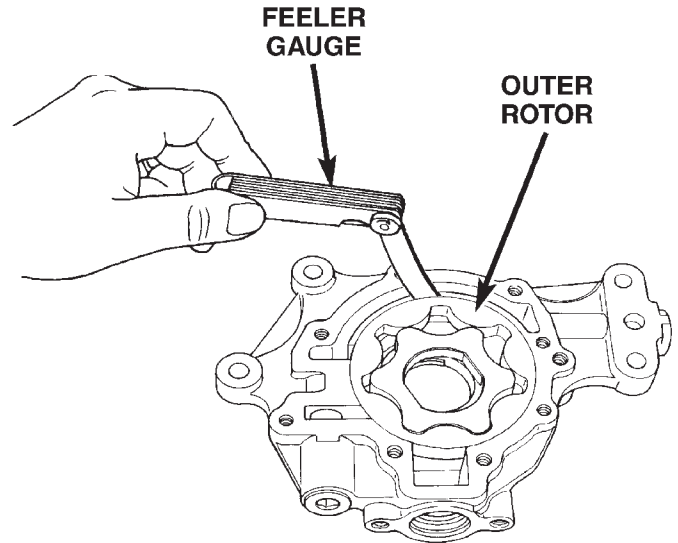


Fig. 96 Measuring Outer Rotor Clearance in Housing

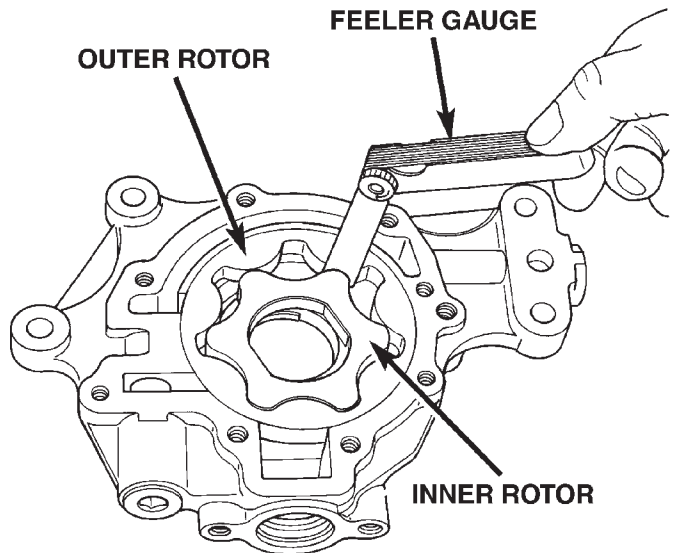


Fig. 97 Measuring Clearance Between Rotors

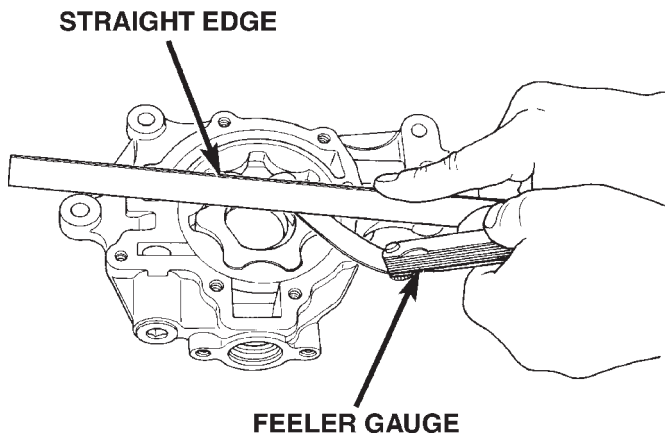
(4) If inner rotor measures 9.474 mm (0.373 inch.) or less replace inner rotor (Fig. 95).

(5) Slide outer rotor into body, press to one side with fingers and measure clearance between rotor and body (Fig. 96). 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. 97) 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. 98) **ONLY** if rotors are in specs.

CLEANING AND INSPECTION (Continued)



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Fig. 98 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 (1.34 in.). 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 BLOCK AND BORE**CLEANING AND INSPECTION**

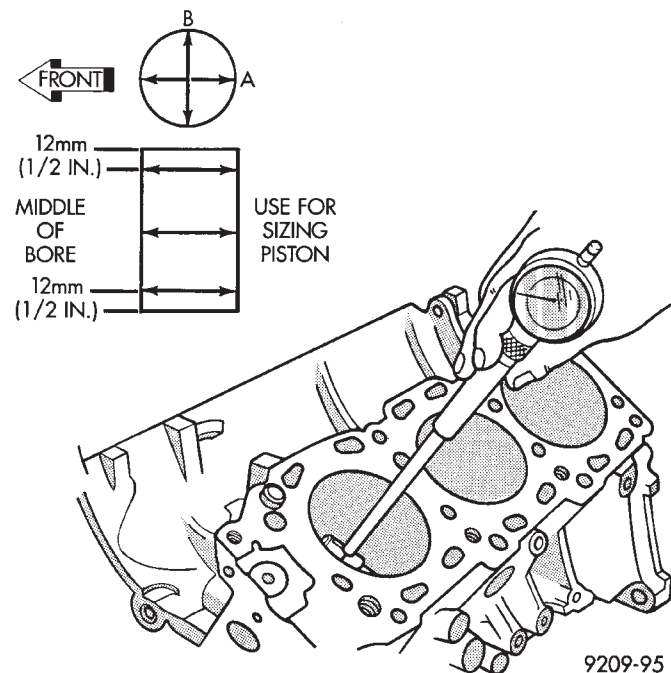
- (1) Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.
- (2) If new core plugs are installed, refer to Service Procedures, Engine Core Plugs.
- (3) Examine block for cracks or fractures.
- (4) Inspect for damaged bolt threads. Repair threads as needed. Refer to Service Procedures, Repair of Damaged or Worn Threads.

CYLINDER BORE INSPECTION

The cylinder walls should be checked for out-of-round and taper with Tool C-119 (Fig. 99). 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.

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. 99). 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 Specification Chart.

**Fig. 99 Cylinder Bore Size Checking****CYLINDER BORE AND PISTON SPECIFICATION CHART**

ENGINE	STANDARD BORE 21° C (70° F)	MAXIMUM OUT-OF-ROUND	MAXIMUM TAPER
2.7L	85.9924 - 86.0076 mm (3.3862 - 3.3856 in.)	0.076 mm (0.003 in.)	0.051 mm (0.002 in.)
STANDARD PISTON SIZE			
85.981 ± 0.013 mm (3.3851 ± 0.0006 in.)			
Piston to Bore Clearance piston size location -0.0016 to +0.0396 mm (-0.0001 to +0.0016 in.)			

ENGINE HYDRO-MOUNT ISOLATOR

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 Group 03, Differential and Driveline.

CLEANING AND INSPECTION (Continued)

- Any front end structural damage (after repair).
- Isolator replacement.

INSPECTING TIMING DRIVE SYSTEM

For checking timing drive system wear limits, use the following procedure.

- (1) Remove right cylinder head cover.
- (2) Viewing through the cylinder head timing drive cavity, inspect the primary chain tensioner plunger. Rotate the engine clockwise to remove any chain slack and to achieve the maximum tensioner extension. If a machined groove on the plunger is visible (Fig. 100), the timing chain and/or related components are worn or stretched to service limits.
- (3) Inspect all chain guides, sprockets and tensioners for wear. Replace as necessary following the procedures outlined in this section.

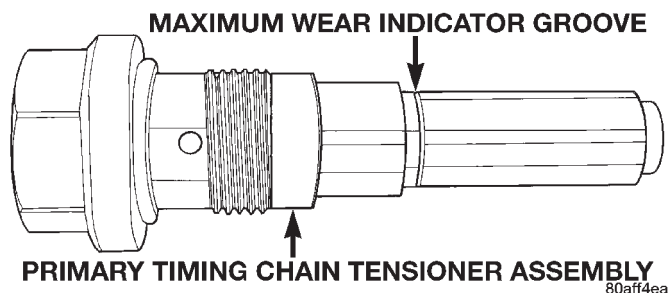


Fig. 100 Primary Timing Chain Tensioner

SPECIFICATIONS

2.7L ENGINE

CYLINDER BLOCK

Cylinder Bore Diameter 86.0 mm (3.3859 in.)
Out of Round (Max) 0.076 mm (0.003 in.)
Taper (Max) 0.051 mm (0.002 in.)

PISTONS

Type Material Aluminum alloy
Piston diameter 85.981 mm $\pm$ 0.013 mm
(3.3851 in. $\pm$ 0.0006)

Clearance at Size
Location - 0.0016 to +0.0396 mm
(- 0.0001 to +0.0016 in.)

PISTON WEIGHT

. 316 - 326 grams (11.1466 - 11.4994 oz.)

PISTON RING GROOVE DIAMETER

No. 1 77.65 - 77.85 mm (3.0571 - 3.065 in.)
No. 2 75.72 - 75.92 mm (2.9811 - 2.989 in.)
No. 3 77.42 - 77.62 mm (3.0481 - 3.0559 in.)

PISTON PINS

Type Full Floating
Clearance In Piston 0.002 - 0.010 mm
(0.0001 - 0.0004 in.)
Clearance In Rod 0.007 - 0.018 mm
(0.0003 - 0.0008 in.)

Diameter 21.997 - 22.000 mm
(0.8661 - 0.8662 in.)

PISTON RINGS

Ring Gap Top Compression Ring . 0.20 - 0.36 mm
(0.008 - 0.014 in.)

Ring Gap 2nd Compression Ring . 0.37 - 0.63 mm
(0.0146 - 0.0249 in.)

Ring Gap Oil Control
(Steel Rails) 0.25 - 0.76 mm
(0.010 - 0.030 in.)

RING SIDE CLEARANCE

Top and Second Compression
Ring 0.040 - 0.080 mm (0.0016 - 0.0031 in.)
Oil Ring (Steel Rails) 0.061 - 0.207 mm
(0.0025 - 0.0082 in.)

RING WIDTH

Top Compression Ring 1.47 - 1.49 mm
(0.0579 - 0.0587 in.)
2nd Compression Ring 1.47 - 1.49 mm
(0.0579 - 0.0587 in.)
Oil Ring (Steel Rails) 0.445 - 0.470 mm
(0.0176 - 0.0186 in.)

CONNECTING RODS

Bearing Clearance 0.024 - 0.064 mm
(0.001 - 0.0026 in.)
Side Clearance 0.13 mm - 0.38 mm
(0.0052 - 0.015 in.)
Side Clearance (Max. Allowable) 0.4318 mm
(0.017 in.)
Piston Pin Bore Diameter . . . 22.007 - 22.015 mm
(0.8665 - 0.8668 in.)

Bearing Bore Out of Round
(Max. Allowable). 0.004 mm (0.0002 in.)
Total Weight (Less Bearing). . . . 529.9 $\pm$ 7 grams
(18.6917 $\pm$ 0.247 oz.)

CRANKSHAFT MAIN BEARING JOURNALS

Diameter . 63.49 - 63.51 mm (2.4997 - 2.5004 in.)
Bearing Clearance 0.035 - 0.053 mm
(0.0014 - 0.0021 in.)
Bearing Clearance (Max. Allowable) . . . 0.087 mm
(0.0034 in.)
Out of Round (Max.) 0.005 mm (0.0002 in.)
Taper (Max.) 0.0003 mm (0.0001 in.)
End Play 0.0475 - 0.2725 mm
(0.0019 - 0.0108 in.)
End Play (Max. Allowable) . . . 0.43 mm (0.017 in.)

CONNECTING ROD JOURNALS

Diameter 53.51 - 53.49 mm
(2.1067 - 2.106 in.)
Bearing Clearance 0.024 - 0.064 mm
(0.001 - 0.0026 in.)
Out Of Round (Max.) 0.005 mm (0.0002 in.)
Taper (Max.) 0.0003 mm (0.0001 in.)

CAMSHAFT

Bore Diameter 24.050 - 24.071 mm
(0.9469 - 0.09476 in.)

SPECIFICATIONS (Continued)

Bearing Journal Diameter . . .	24.000 – 23.981 mm (0.9449 – 0.9441 in.)
Bearing Clearance	0.05 – 0.09 mm (0.0020 – 0.0035 in.)
Bearing Clearance (Max. Allowable)	0.13 mm (0.0051 in.)
End Play . . .	0.13 – 0.28 mm (0.0051 – 0.0110 in.)

VALVE TIMING INTAKE VALVE

Opens (ATDC)	2°
Closes (ABDC)	44°
Duration	222°

VALVE TIMING EXHAUST VALVE

Opens (BBDC)	36°
Closes (ATDC)	4°
Duration	220°
Valve Overlap	2°

CYLINDER HEAD

Gasket Thickness (Compressed)	1.50 mm ± 0.05 mm (0.0591 in. ± 0.002 in.)
Valve Seat Angle	44.5° – 45°
Valve Seat Runout (Max)	0.05 mm (0.002 in.)
Intake Valve Seat Width	1.00 – 1.50 mm (0.0394 – 0.0591 in.)
Exhaust Valve Seat Width	1.25 – 1.75 mm (0.0492 – 0.0689 in.)
Guide Bore Diameter (Std.)	5.975 – 6.00 mm (0.2353 – 0.2363 in.)
Valve Guide Height*— Intake & Exhaust	13.25 – 13.75 mm (0.5217 – 0.5414 in.)

*Measured from cylinder head surface to top of guide.

VALVES

Face Angle	45 – 45.5°
Head Diameter Intake	33.67 – 33.93 mm (1.3256 – 1.3358 in.)
Head Diameter Exhaust	27.67 – 27.93 mm (1.0894 – 1.1000 in.)
Length—Intake (Overall) . . .	107.89 – 108.39 mm (4.2476 – 4.2673 in.)
Length—Exhaust (Overall) . .	105.88 – 106.38 mm (4.1685 – 4.1882 in.)
Stem Diameter—Intake	5.934 – 5.952 mm (0.2337 – 0.2344 in.)
Stem Diameter—Exhaust	5.906 – 5.924 mm (0.2326 – 0.2333 in.)
Stem-to-Guide Clearance Intake (New)	0.023 – 0.066 mm (0.0009 – 0.0026 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	9.0 mm (0.3543 in.)
Valve Lift (Zero Lash)—Exhaust	8.0 mm (0.3150 in.)

Valve Stem Tip Height— Intake . . .	47.120 ± 0.467 mm (1.8551 ± 0.0184 in.)
Valve Stem Tip Height— Exhaust . .	48.672 ± 0.467 mm (1.9162 ± 0.0184 in.)

VALVE SPRING

Free Length (Approx.) Intake & Exhaust	45.63 mm (1.7965 in.)
Spring Force (Valve Closed) Intake & Exhaust	249 – 284 N @ 38.0 mm (56.0 – 64.0 lbs. @ 1.4961 in.)
Spring Force (Valve Open) Intake	658 – 721 N @ 29.0 mm (147.9 – 162.1 lbs. @ 1.1417 in.)
Spring Force (Valve Open) Exhaust	614 – 671 N @ 30.0 mm (138.0 – 150.8 lbs. @ 1.1811 in.)
Number of Coils—Intake & Exhaust	7.35
Color of Spring (Side of Coils)	No Color Code
Wire Diameter Intake & Exhaust	3.861 mm (0.1520 in.)
Installed Height (Spring Seat to Bottom of Retainer) Intake & 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	9.475 – 9.500 mm (0.3731 – 0.3741 in.)
Outer Rotor Clearance (Max.)	0.8 mm (0.0032 in.)
Outer Rotor Diameter (Min.)	89.175 mm (3.5109 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 – 530 kPa (25 – 80 psi)

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

2.7L TORQUE CHART

DESCRIPTION	TORQUE
A/C Compressor to Engine Bolts	28 N·m (21 ft. lbs.)
Camshaft Sprocket Bolts	28 N·m (250 in. lbs.)
Camshaft Chain Tensioner (Secondary) Bolts	12 N·m (105 in. lbs.)
Camshaft Bearing Cap Bolts	12 N·m (105 in. lbs.)

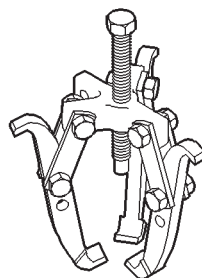
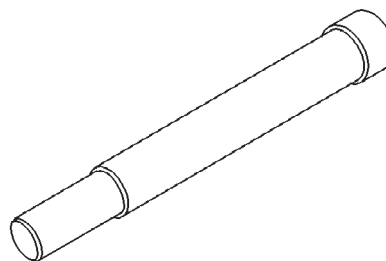
SPECIFICATIONS (Continued)

DESCRIPTION	TORQUE
Connecting Rod Cap	
Nuts	27 N·m (20 ft. lbs.) Plus 1/4 turn
Crankshaft Main Bearing Cap	
Tie Bolts	28 N·m (250 in. lbs.)
Inner Cap Bolts	20 N·m (15 ft. lbs.) Plus 1/4 turn
Outer Cap Bolts (Windage Tray)	27 N·m (20 ft. lbs.) Plus 1/4 turn
Crankshaft Damper	
Bolt	170 N·m (125 ft. lbs.)
Cylinder Head Bolts—M 11	
(Refer to Cylinder Head procedure for torque sequence.)	
Step 1	47.5 N·m (35 ft. lbs.)
Step 2	75 N·m (55 ft. lbs.)
Step 3	75 N·m (55 ft. lbs.)
Step 4	+ 90° turn; Do not use torque wrench
Cylinder Head Bolts—M 8	
(Refer to Cylinder Head procedure for torque sequence.)	
Bolts	28 N·m (250 in. lbs.)
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.)
Exhaust Manifold to Catalytic Converter V-Band Clamp	
.	11 N·m (100 in. lbs.)
Engine Mount Bracket to Block	
Bolts	61 N·m (45 ft. lbs.)
Engine Mount Isolator	
Nuts	61 N·m (45 ft. lbs.)
Intake Manifold—Upper and Lower	
(Refer to Group 11, Exhaust System and Intake Manifold for torque sequence.)	
Bolts	12 N·m (105 in. lbs.)
Generator Bracket	
Bolts	41 N·m (30 ft. lbs.)
Oil Pan	
Bolts	28 N·m (250 in. lbs.)
Nuts	12 N·m (105 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.)

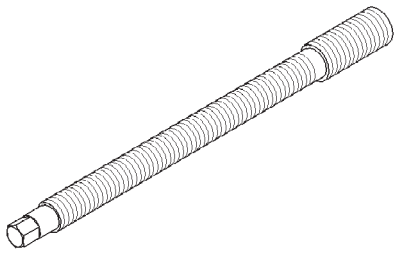
DESCRIPTION	TORQUE
Rear Crankshaft Seal Retainer	
Bolts	12 N·m (105 in. lbs.)
Spark Plugs	
Spark Plugs	20 N·m (15 ft. lbs.)
Starter Mounting	
Bolts	41 N·m (30 ft. lbs.)
Structural Collar	
(Refer to procedure for torque sequence and specification.)	
Thermostat Housing/Water Inlet Connector	
Bolts	12 N·m (105 in. lbs.)
Throttle Body	
Bolts	12 N·m (105 in. lbs.)
Timing Chain Cover Bolts	
M6	12 N·m (105 in. lbs.)
M10	54 N·m (40 ft. lbs.)
Timing Chain Tensioner (Primary)	
Tensioner	54 N·m (40 ft. lbs.)
Timing Chain Guide	
Bolts	28 N·m (250 in. lbs.)
Timing Chain Guide Access Plug	
Plugs	20 N·m (15 ft. lbs.)
Water Pump	
Bolts	12 N·m (105 in. lbs.)
Water Outlet Housing Bleed	
Screw	8 N·m (70 in. lbs.)
Water Outlet Housing	
Bolts	12 N·m (105 in. lbs.)

SPECIAL TOOLS

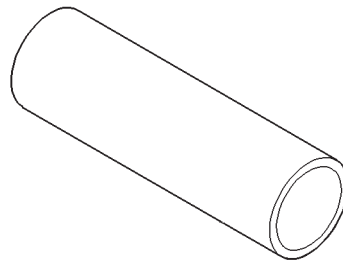
2.7L ENGINE

*Puller 1023**Crankshaft Damper Remover Insert 8194*

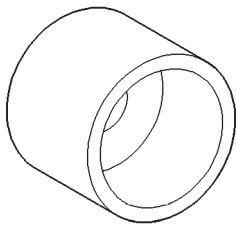
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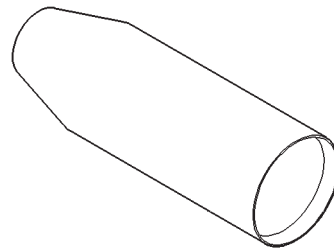
Crankshaft Damper Installer Screw 8179



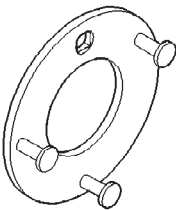
Crankshaft Seal & Sprocket Installer 6780-1



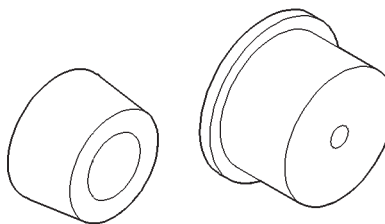
Crankshaft Damper Installer 6792-1



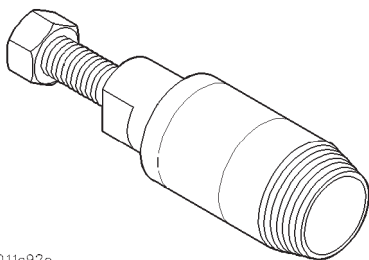
Crankshaft Seal Protector 6780-2



Crankshaft Damper Holder 8191

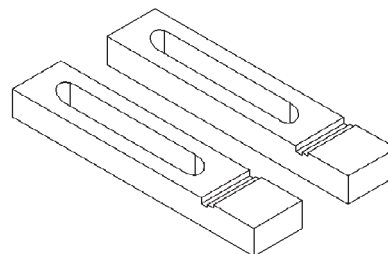


Crankshaft Rear Seal Guide 6926-1 & Installer 6926-2



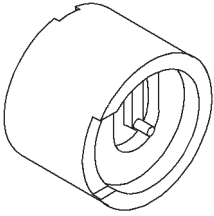
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Crankshaft Seal Remover 6771

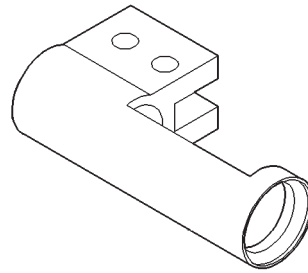


Crankshaft Real Seal Retainer Alignment Fixture 8225

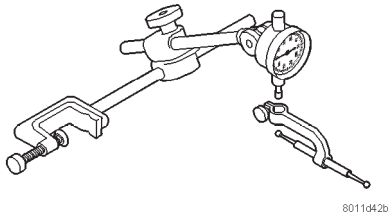
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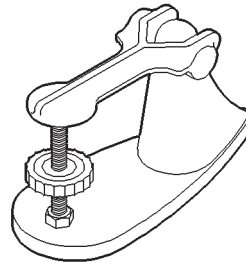
Timing Chain Tensioner Resetting Gauge 8186



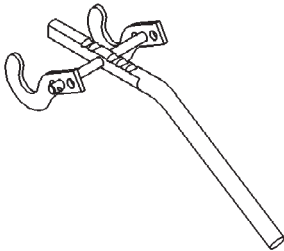
Valve Spring Adapter 6526



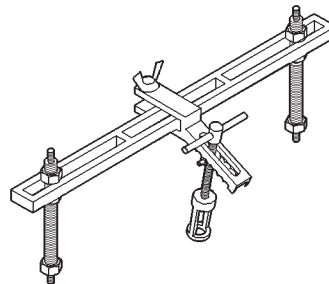
Dial Indicator C-3339



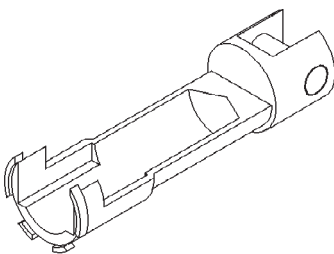
Valve Spring Tester C-647



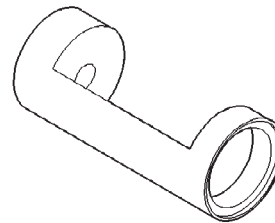
Valve Spring Compressor 8215



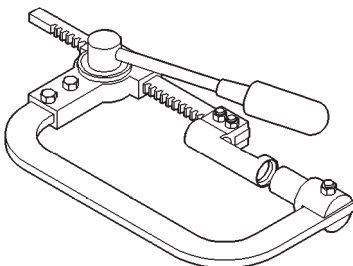
Valve Spring Compressor MD-998772-A



Adapter 8216

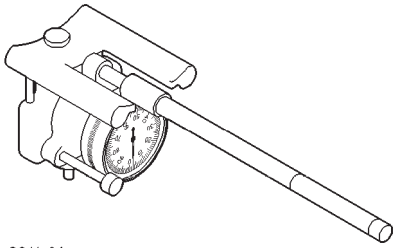


Valve Spring Adapter 6527



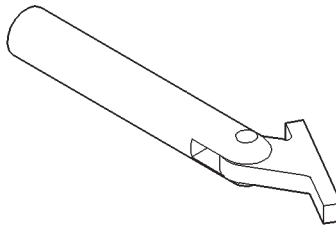
Valve Spring Compressor C-3422-B

SPECIAL TOOLS (Continued)

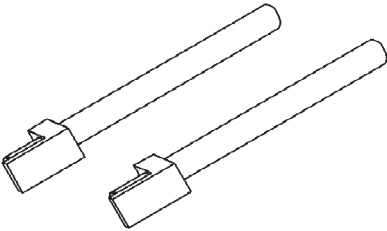


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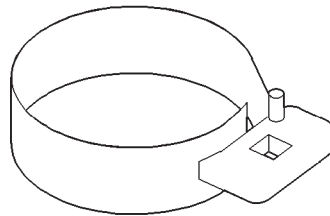
Indicator Bore Size C-119



Main Bearing Remover/Installer C-3059



Connecting Rod Installation Guides 8189



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Wrench Oil Filter C-4065

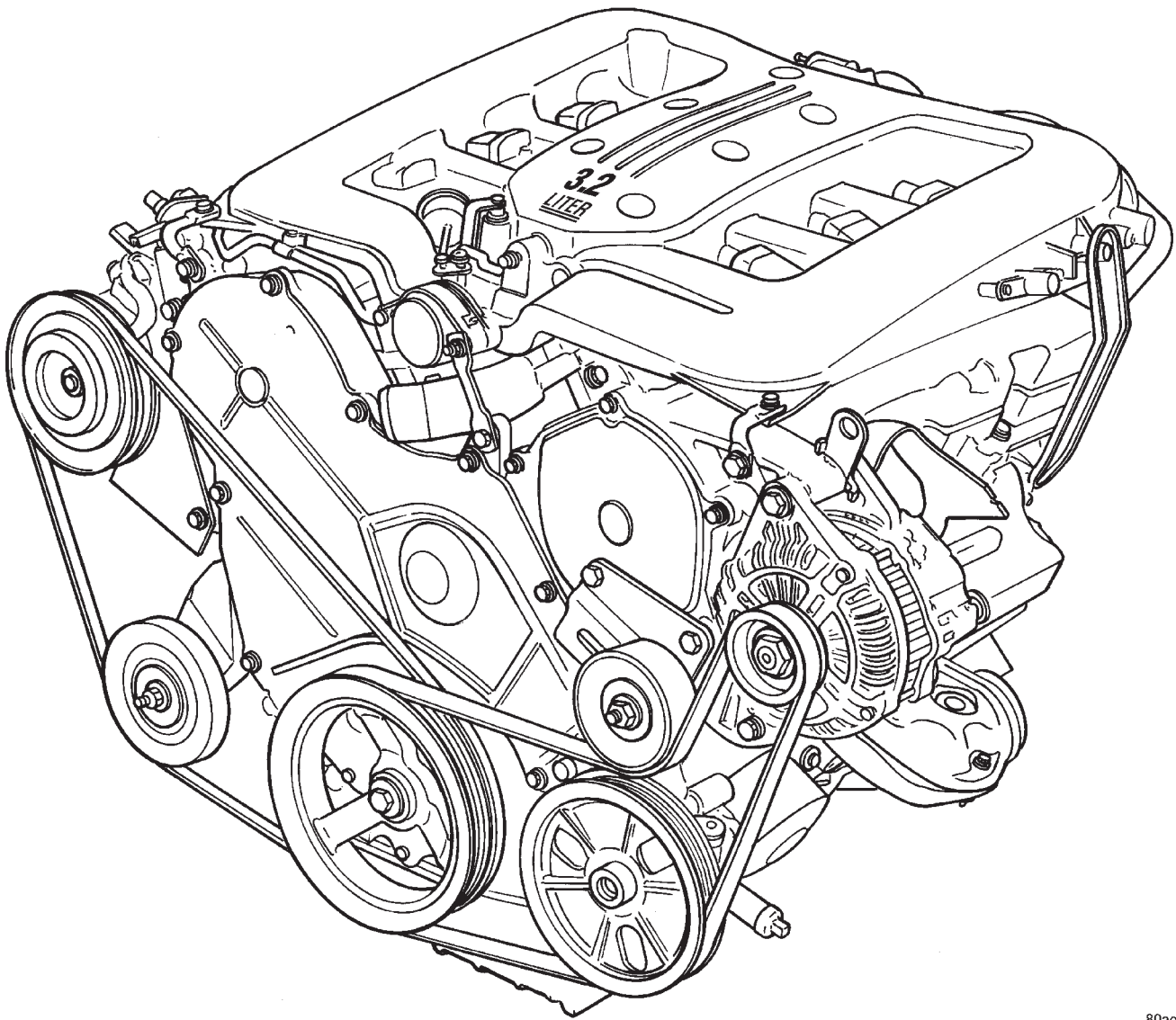
3.2L ENGINE

INDEX

	page		page
DESCRIPTION AND OPERATION		ENGINE MOUNT—REAR	74
3.2L ENGINE	64	FRONT CRANKSHAFT OIL SEAL	93
3.2L ENGINE COMPONENTS	65	OIL FILTER	97
3.2L GENERAL SPECIFICATION	65	OIL PAN	91
ENGINE LUBRICATION SYSTEM	65	OIL PUMP	98
DIAGNOSIS AND TESTING		PISTON AND CONNECTING ROD	98
CHECKING ENGINE OIL PRESSURE	67	ROCKER ARM AND SHAFT ASSEMBLY	85
HYDRAULIC LASH ADJUSTER	67	SPARK PLUG TUBES	79
TESTING VALVE SPRINGS	67	STRUCTURAL COLLAR	75
SERVICE PROCEDURES		TIMING BELT	89
CHECKING CRANKSHAFT END PLAY	71	TIMING BELT COVERS	88
CRANKSHAFT MAIN BEARING FITTING	71	VALVE AND VALVE SPRINGS	88
FITTING PISTON RINGS	68	VALVE STEM SEALS OR VALVE SPRINGS—IN VEHICLE	86
INSTALLATION OF CONNECTING ROD BEARINGS	69	DISASSEMBLY AND ASSEMBLY	
PISTONS	68	OIL PUMP	102
REFACING VALVES AND VALVE SEATS	72	ROCKER ARMS AND SHAFT ASSEMBLY	102
REMOVAL AND INSTALLATION		CLEANING AND INSPECTION	
CAMSHAFT	83	CAMSHAFT	103
CAMSHAFT OIL SEAL	93	CYLINDER BORE	106
CAMSHAFT SPROCKETS AND TIMING PROCEDURE	83	CYLINDER HEAD	103
CRANKSHAFT	81	ENGINE HYDRO-MOUNT INSULATORS	106
CRANKSHAFT DAMPER	78	OIL PUMP	105
CRANKSHAFT MAIN BEARINGS	96	ROCKER ARMS	103
CRANKSHAFT OIL SEAL—REAR	94	TIMING BELT INSPECTION—IN VEHICLE	106
CRANKSHAFT OIL SEAL RETAINER—REAR	95	VALVE INSPECTION	104
CYLINDER HEAD	80	SPECIFICATIONS	
CYLINDER HEAD COVERS	79	3.2L ENGINE	107
ENGINE ASSEMBLY	76	TORQUE CHART	109
ENGINE CORE AND OIL PLUGS	101	SPECIAL TOOLS	
ENGINE MOUNTS—LEFT AND RIGHT	74	3.2L ENGINE	109

DESCRIPTION AND OPERATION

3.2L ENGINE



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ENGINE IDENTIFICATION NUMBER

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

DESCRIPTION AND OPERATION (Continued)

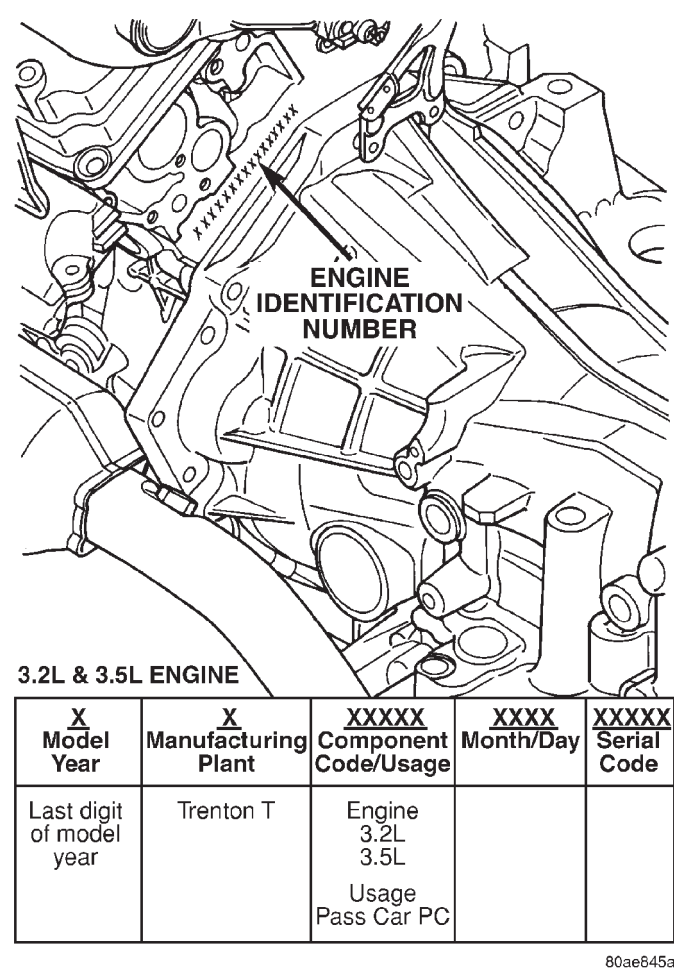


Fig. 1 Engine Identification

3.2L GENERAL SPECIFICATION

Type 60° SOHC V-6 24 Valve

Displacement 3.2 Liters 3231 cc
(195 Cubic Inches)

Bore 92.0 mm (3.622 in.)

Stroke 81.0 mm (3.189 in.)

Compression Ratio 9.5:1

Horsepower 225 6300 rpm

Torque 225 lb. ft. 3800 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)

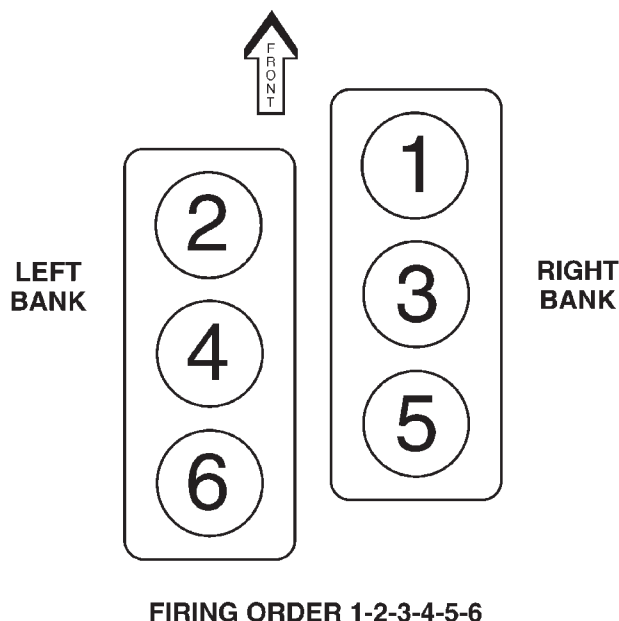
Cylinder Head Aluminum

Piston Aluminum (Full Floating Piston Pin)

Lubrication Pressure Feed-Full Flow Filtration
(Direct Crankshaft Driven Pump)

Cooling System Liquid Cooled-Forced Circulation

ENGINE LUBRICATION SYSTEM



The lubrication system is a full flow filtration pressure feed type. Oil, stored in the oil pan, is taken in and discharged by a gerotor type oil pump directly coupled to the crankshaft and its 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. At each cylinder head, the oil flows through passages to the rocker shafts which then feed the camshaft journals, rocker arms, and hydraulic lash adjusters (Fig. 2).

3.2L ENGINE COMPONENTS

NOTE: The 3.2L engine is a **NON free-wheeling design**.

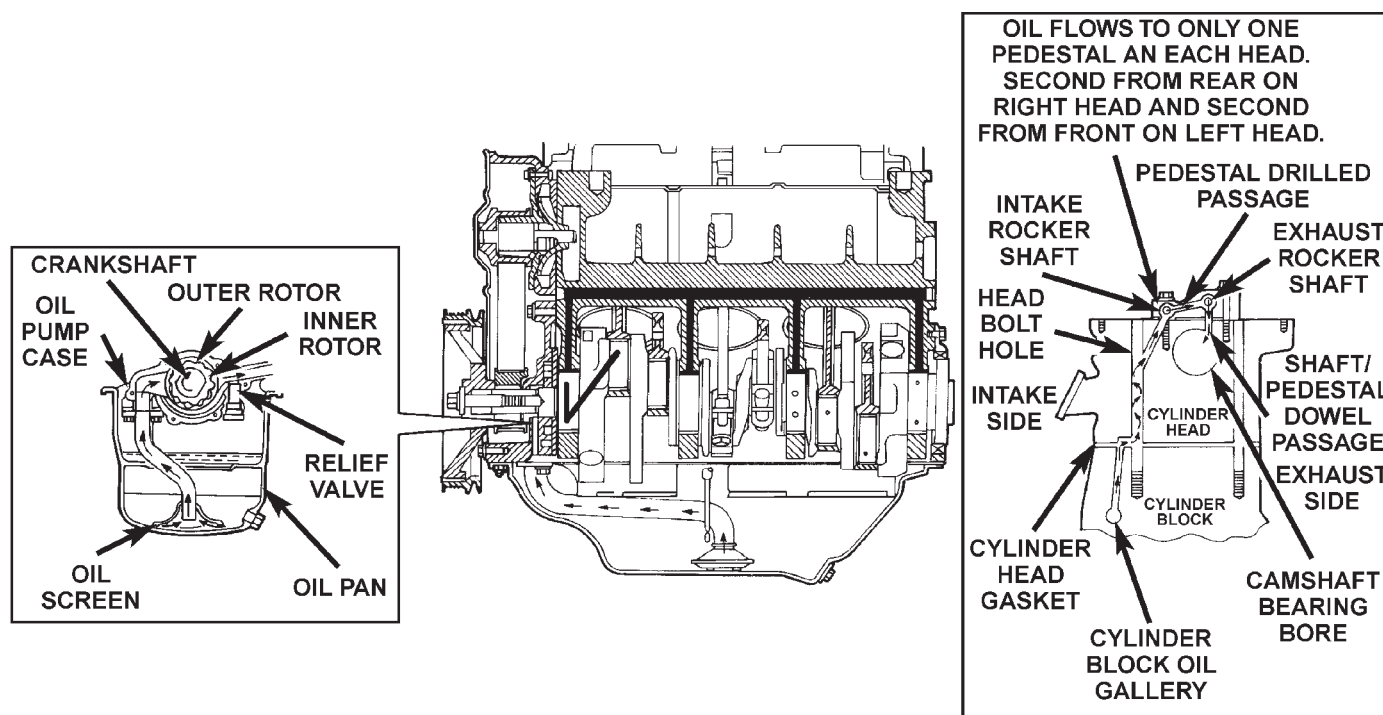
BLOCK

The cylinder block is a light weight design created by reducing thickness in many parts and a short 10 mm (3/8 inch.) block skirt. High rigidity is provided with ribs cast in the outer wall, a full length water jacket, and a cross bolt type main bearing caps.

CRANKSHAFT

A six throw, five weight crankshaft is supported by four main bearings with number two being the thrust bearing. 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.

DESCRIPTION AND OPERATION (Continued)



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Fig. 2 Oil Lubrication System

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 of heat resistant steel are arranged in a "V" with each camshaft on center. To improve combustion speed the chambers are a compact spherical design with a squish area of approximately 30 percent of the piston top area. The cylinder heads are common to either cylinder bank by reversing the direction of installation.

CAMSHAFTS AND TIMING DRIVE

A single overhead camshaft per cylinder head provides valve actuation. The left camshaft accommodates a DIS 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 DIS 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 pedestal dowel.

ROCKER ARM SHAFTS

The shafts 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.

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 scuffing. The intake

DESCRIPTION AND OPERATION (Continued)

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, integral with the oil pan gasket, 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.

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.

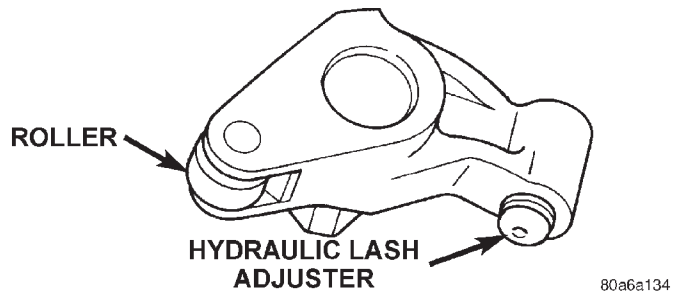


Fig. 3 Hydraulic Lash Adjuster

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, 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. 4).

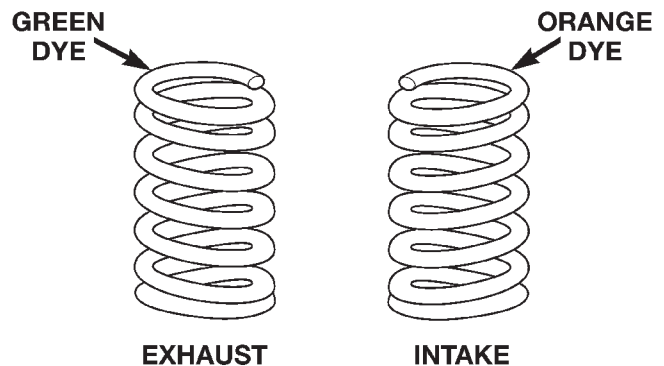


Fig. 4 Valve Spring Identification

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 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

DIAGNOSIS AND TESTING (Continued)

specified height and allowable tensions. Replace springs that do not meet specifications.

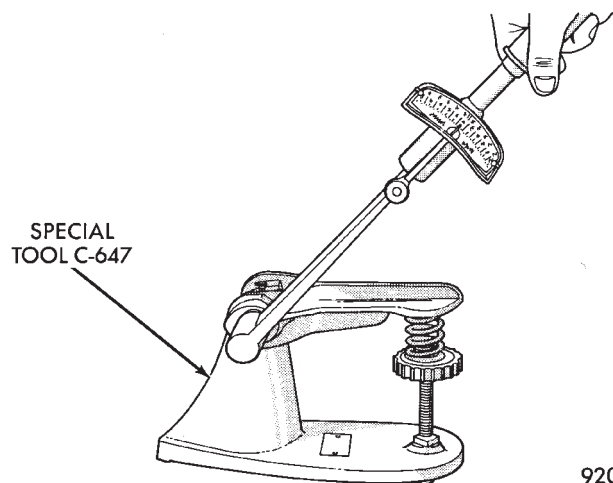


Fig. 5 Testing Valve Spring with Tool C-647

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). Cylinder 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).**

PISTON PINS

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.

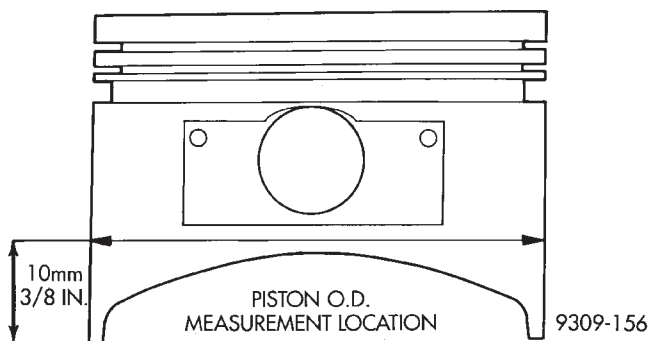


Fig. 6 Piston Measurements

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.

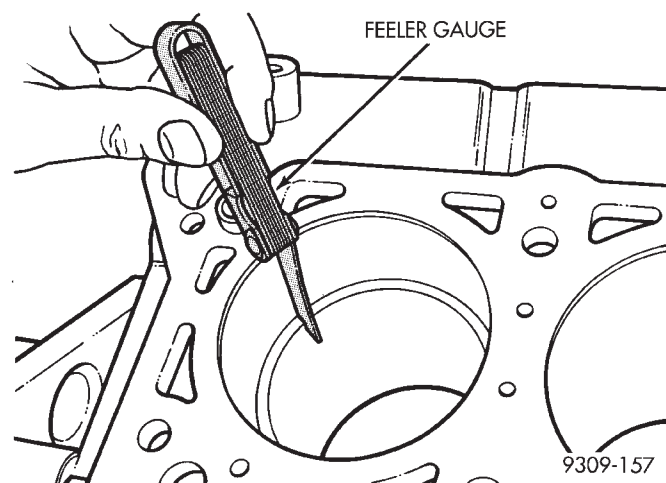


Fig. 7 Check Gap on Piston Rings

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

PISTON 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).

CYLINDER BORE AND PISTON SPECIFICATION CHART

ENGINE	STANDARD CYLINDER BORE	MAXIMUM OUT-OF-ROUND	MAXIMUM TAPER	STANDARD PISTON SIZE
3.2L	92.0 mm (3.622 in.)	0.076 mm (0.003 in.)	0.051 mm (0.002 in.)	91.980 ±0.019 mm (3.6213 ±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 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:	0.22 - 0.49 mm (0.0087 - 0.0193 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:	0.04 - 0.08 mm (0.0016 - 0.0031 in.)	0.10 mm (0.004 in.)
Intermediate Ring:	0.04 - 0.08 mm (0.0016 - 0.0031 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.)

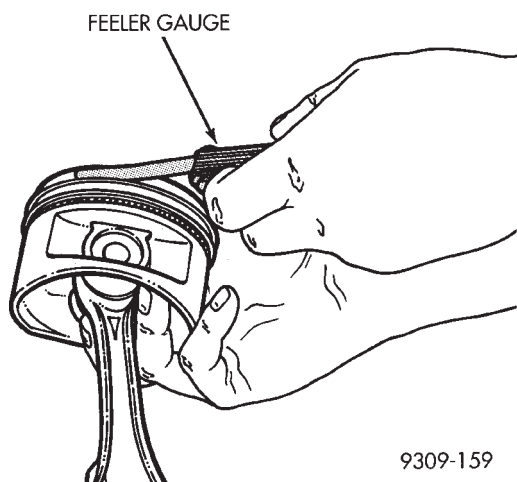


Fig. 8 Measuring Piston Ring Side Clearance

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).**

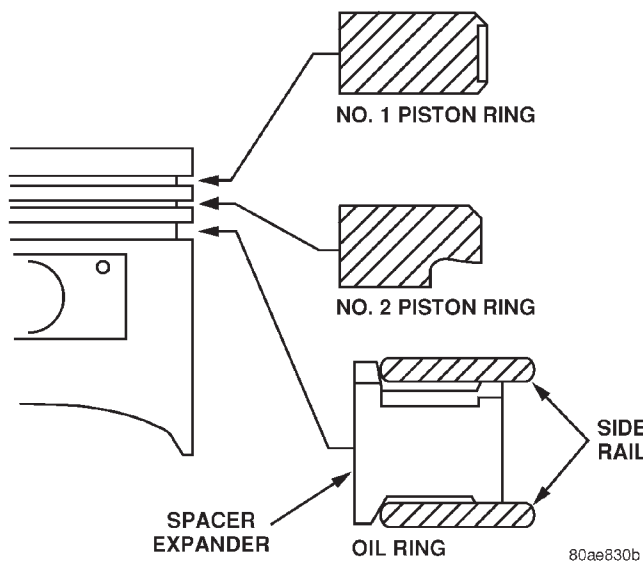


Fig. 9 Piston Ring—Installation

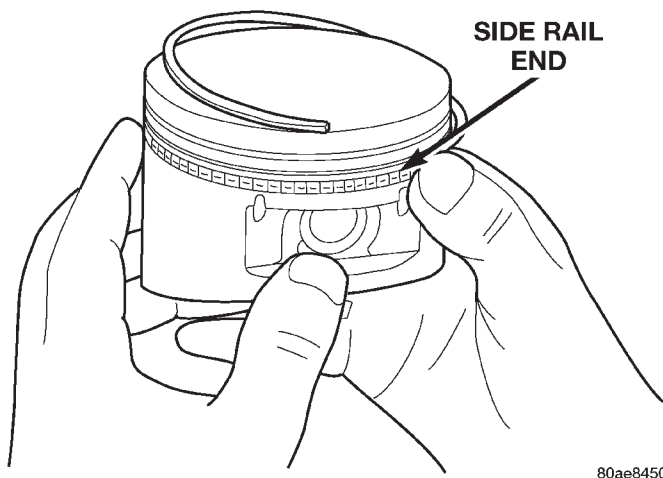


Fig. 10 Side Rail—Installation

(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.

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)

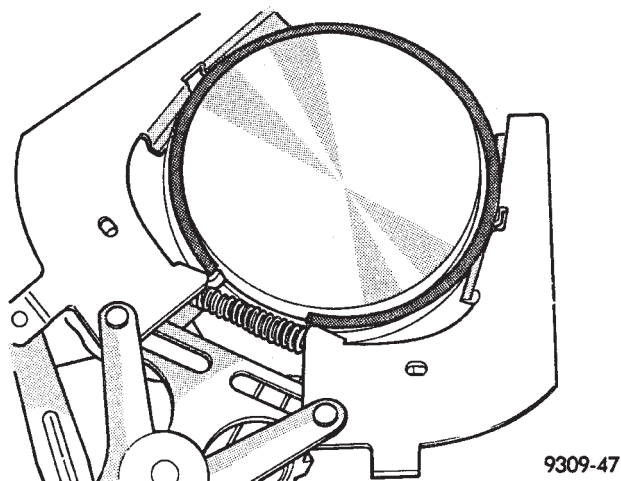


Fig. 11 Upper and Intermediate Rings—Installation

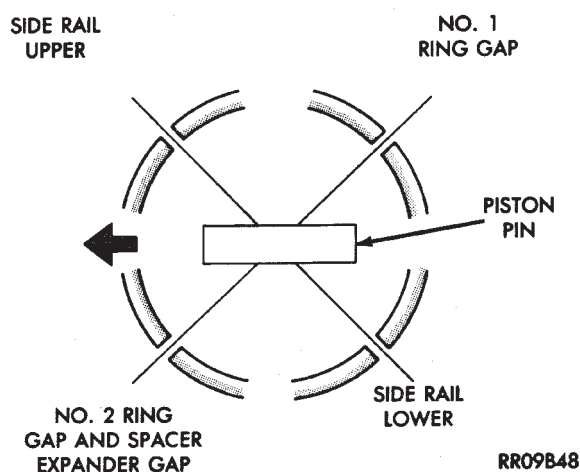


Fig. 12 Piston Ring End Gap Position

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).

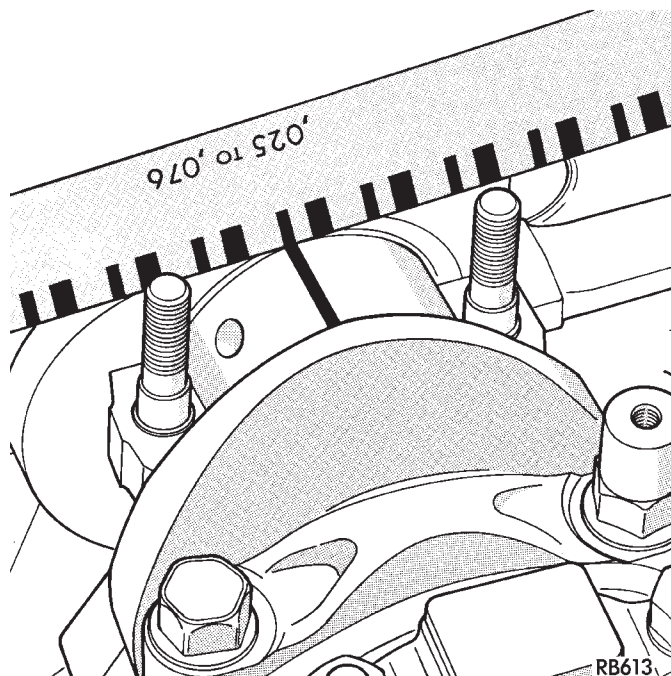


Fig. 13 Checking Connecting Rod Bearing Clearance—Typical

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.)

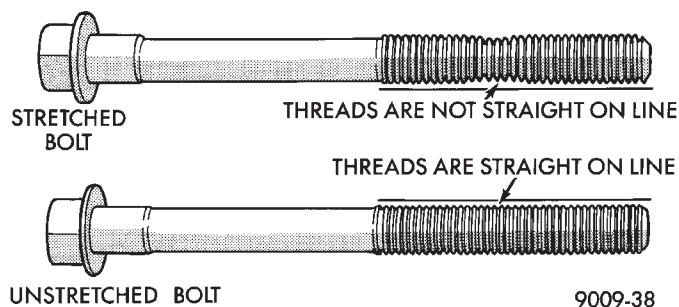


Fig. 14 Check for Stretched Bolts

(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.

SERVICE PROCEDURES (Continued)

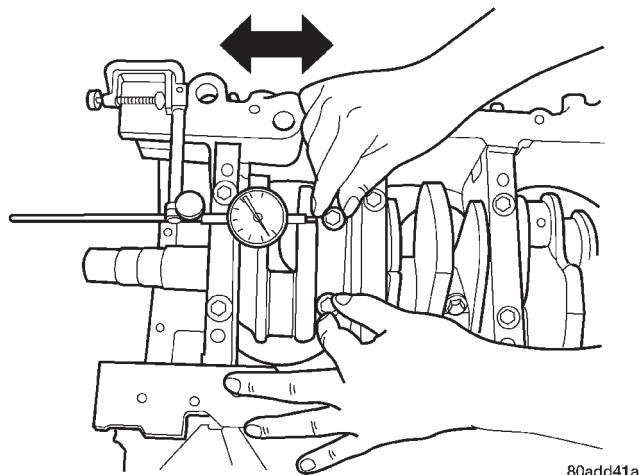


Fig. 15 Connecting Rod Side Clearance Measuring
CONNECTING ROD SIDE CLEARANCE CHART

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.

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.

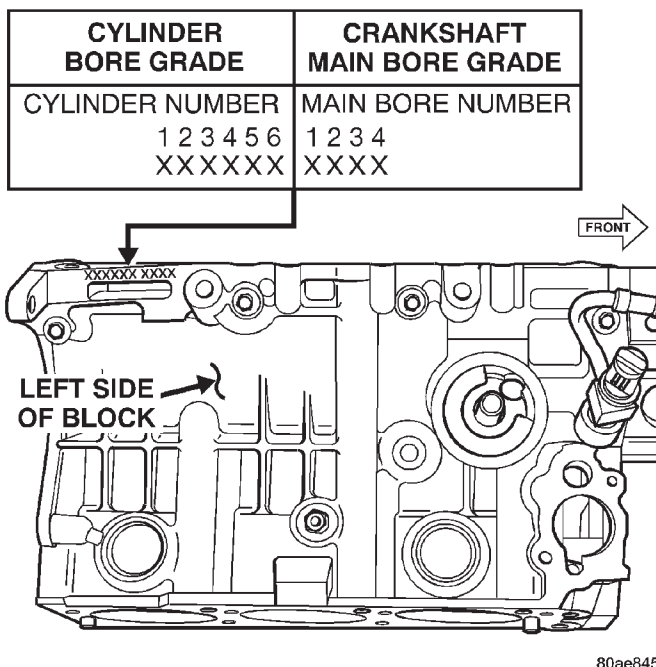


Fig. 16 Cylinder Block Main Bore Grade Marking Location

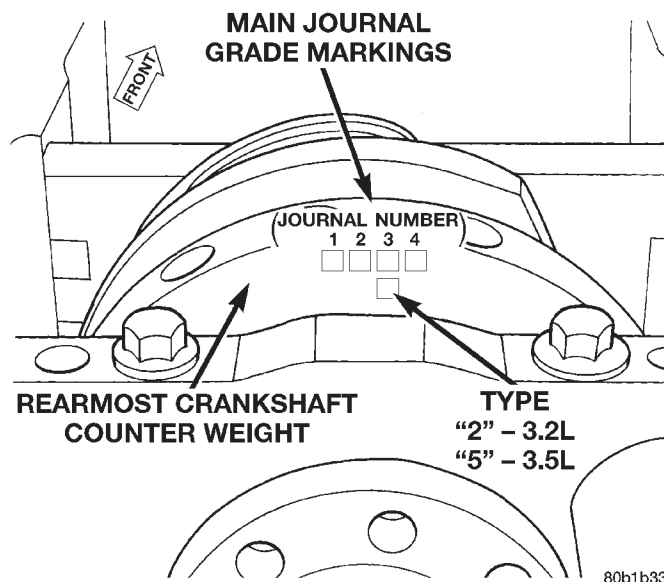


Fig. 17 Crankshaft Main Journal Grade Marking Location—Rear Of Block (Inverted) View

CHECKING CRANKSHAFT END PLAY

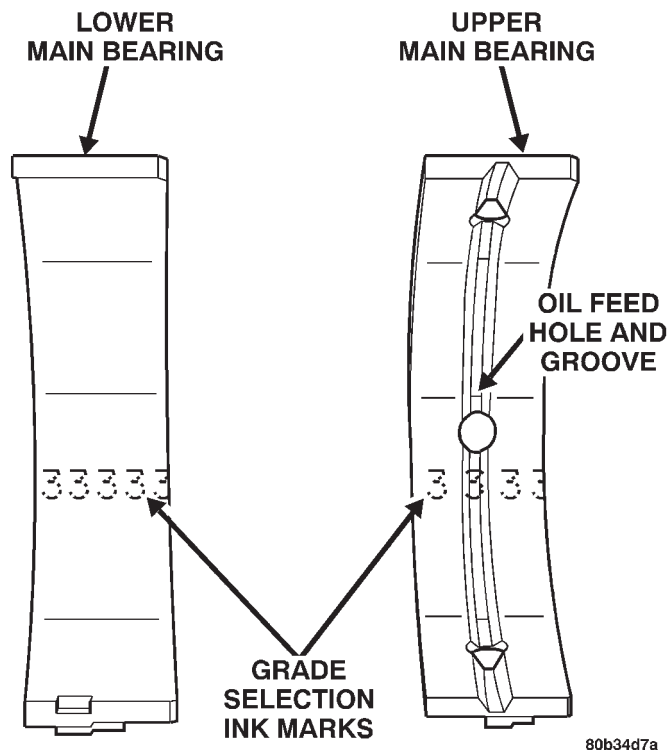
(1) Using Dial Indicator C-3339 and Mounting Post L-4438, attach to front of engine, locating probe perpendicular on nose of crankshaft (Fig. 19).

(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.

SERVICE PROCEDURES (Continued)

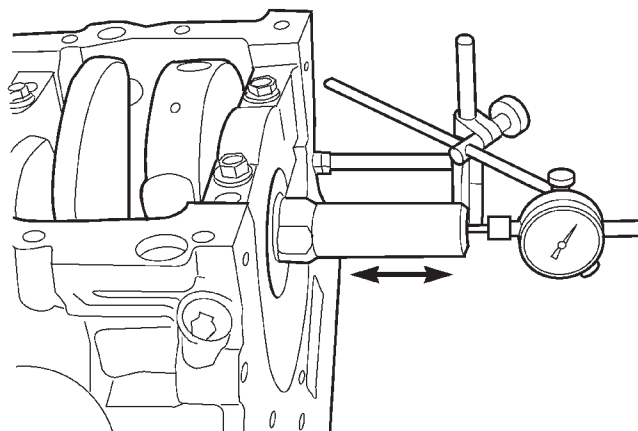
**Fig. 18 Main Bearing Grade Marks**

MAIN BEARING SELECTION CHART—3.2L

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

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).



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Fig. 19 Checking Crankshaft End Play

CRANKSHAFT END PLAY SPECIFICATION CHART

New Part:	0.10 to 0.30 mm (0.004 to 0.012 in.)
Wear Limit:	0.43 mm (0.017 in.)

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.)

SERVICE PROCEDURES (Continued)

VALVES

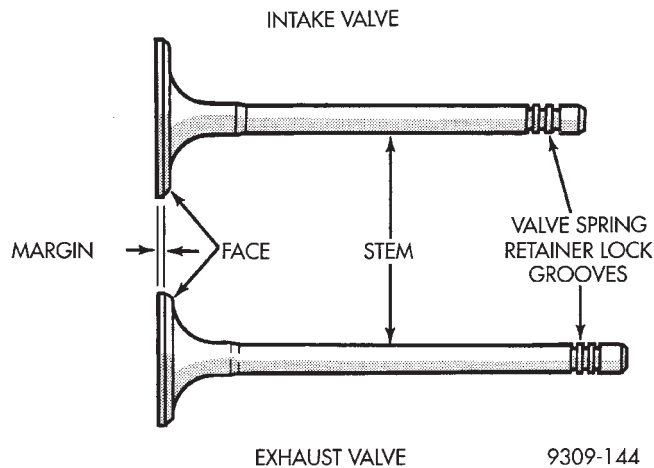


Fig. 20 Intake and Exhaust Valves

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

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.

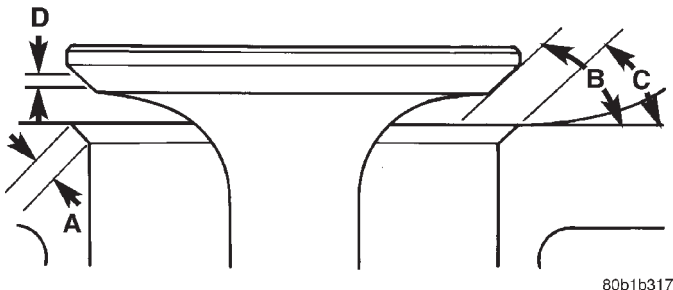


Fig. 21 Valve Seats

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).

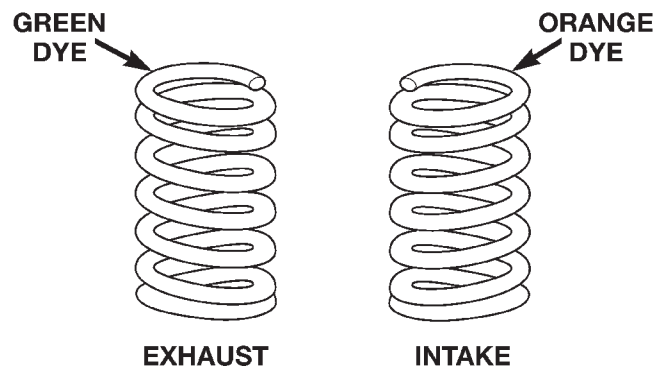


Fig. 22 Valve Spring I.D.

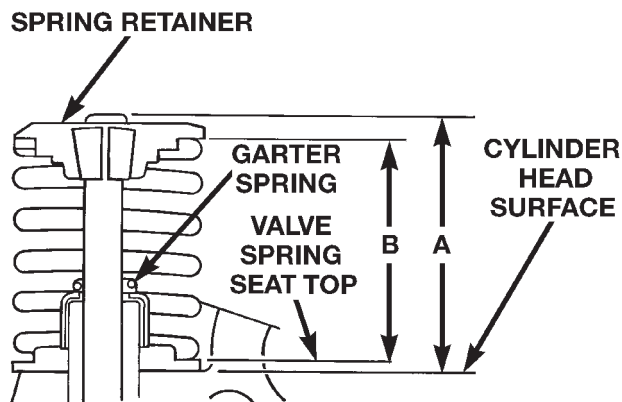
VALVE INSTALLATION

(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.

(3) Install valve seal/spring seat assembly over valve guides on all valve stems (Fig. 24). Ensure that

SERVICE PROCEDURES (Continued)

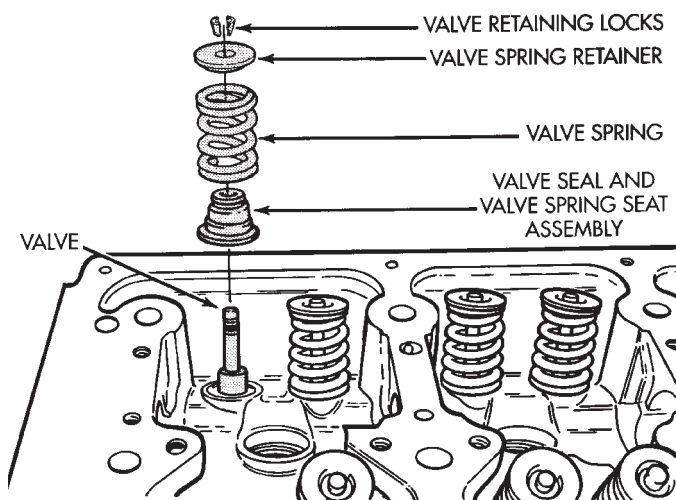


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Fig. 23 Checking Valve Tip Height and Valve Spring Installed Height

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. 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.



9309-150

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

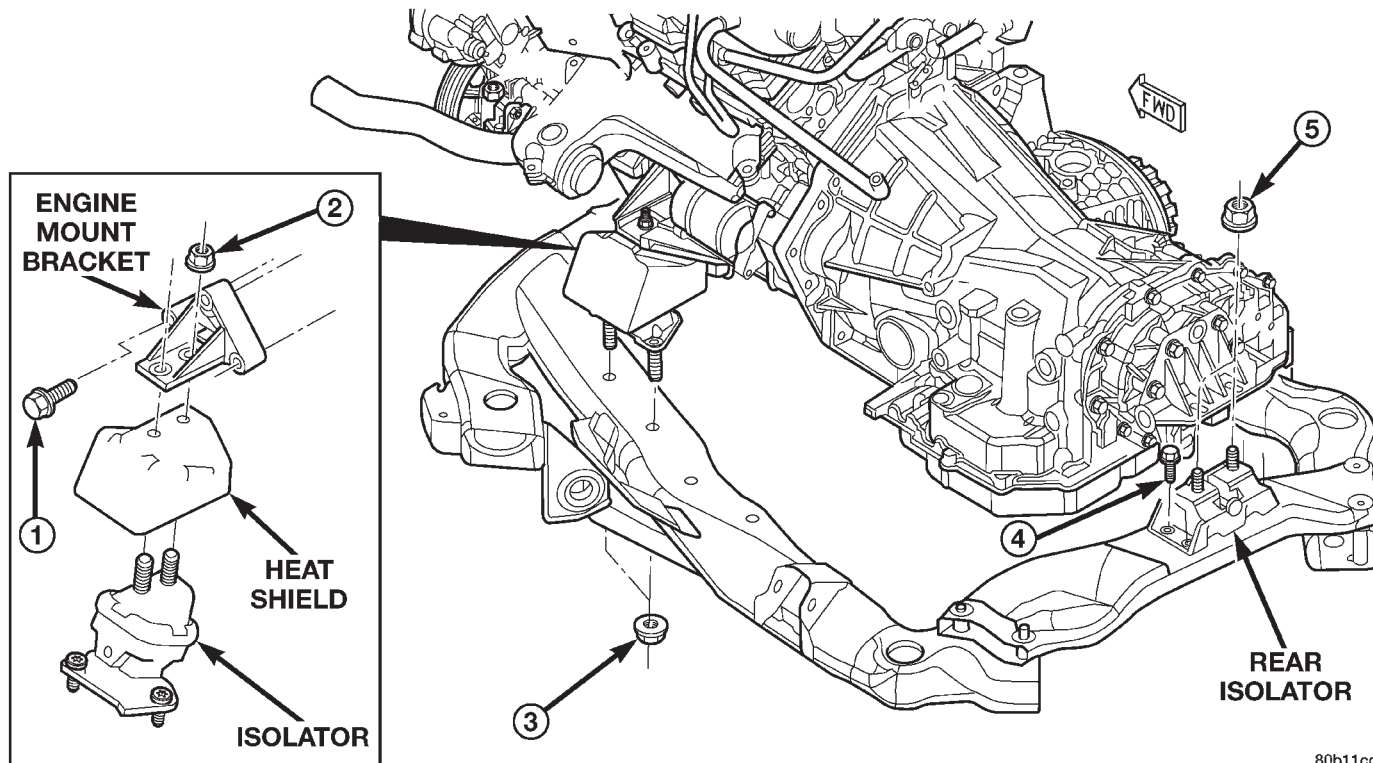
REMOVAL

- (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.

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.)			

STRUCTURAL COLLAR

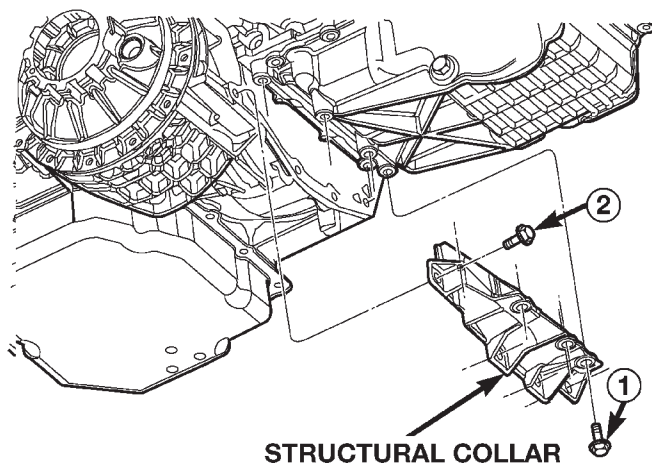
REMOVAL

- (1) Raise vehicle on hoist.
- (2) Remove bolts attaching structural collar to oil pan and transmission housing.
- (3) Remove collar (Fig. 26).

INSTALLATION

CAUTION: The collar must be tighten using the procedure outlined as damage to collar and/or oil pan may occur.

- (1) Install structural collar (Fig. 26) using the following tightening sequence:
 - a. Install the **vertical** collar to oil pan bolts (1). Torque bolts initially to 1.1 N·m (10 in. lbs.).
 - b. Install collar to transmission bolts (2) and torque to 55 N·m (40 ft. lbs.).



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Fig. 26 Structural Collar

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

REMOVAL AND INSTALLATION (Continued)

(2) Lower vehicle.

ENGINE ASSEMBLY

REMOVAL

- (1) Disconnect negative cable at right strut tower (Fig. 27).
- (2) Mark hood position at hinges and remove hood.
- (3) Remove both wiper arms.
- (4) Remove both cowl covers (Fig. 28).
- (5) Remove cowl support (Fig. 29).
- (6) Remove air cleaner assembly with air inlet hose (Fig. 30).
- (7) Remove upper radiator crossmember. Refer to Group 23, Body for procedure.

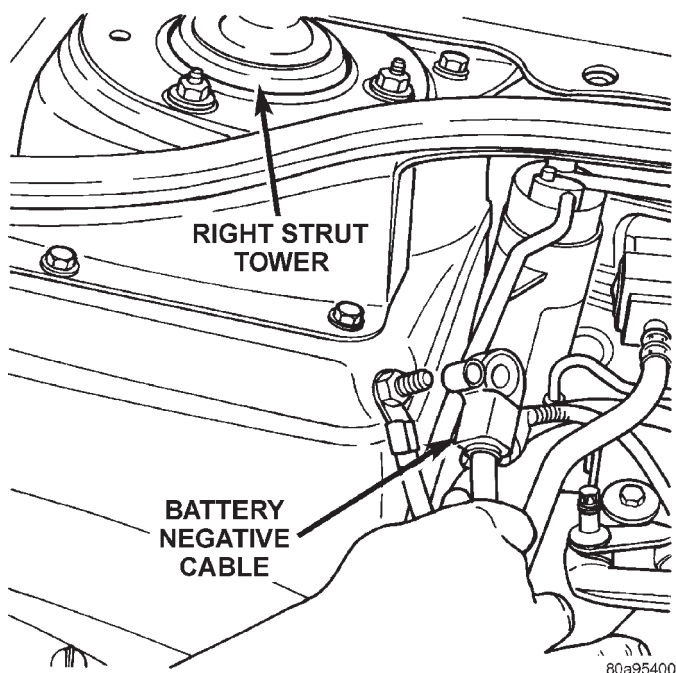


Fig. 27 Negative Cable—Disconnect

- (8) Disconnect hood release cable from hood latch.
- (9) Remove fan module.
- (10) Drain cooling system. Refer to Group 07, Cooling System for procedure.
- (11) Remove A/C and accessory drive belts. Refer to Group 07, 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.
- (18) Remove generator.
- (19) Remove power steering pump mounting bolts and set pump aside.

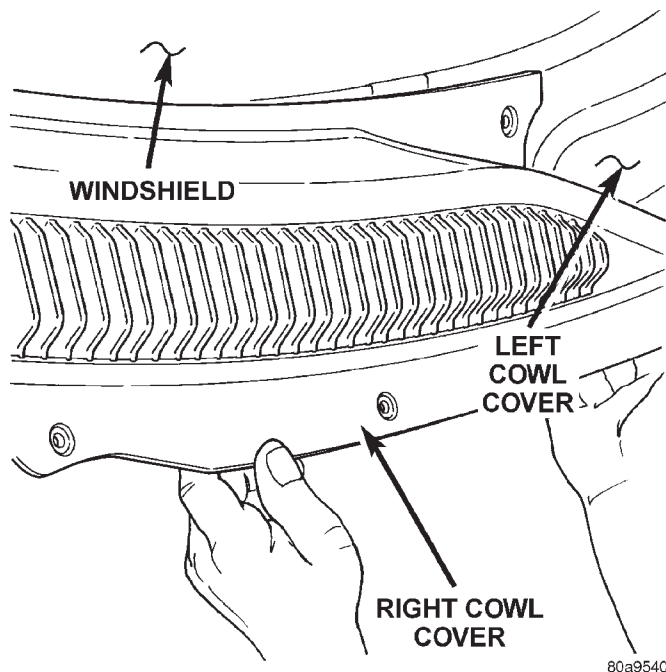


Fig. 28 Cowl Covers

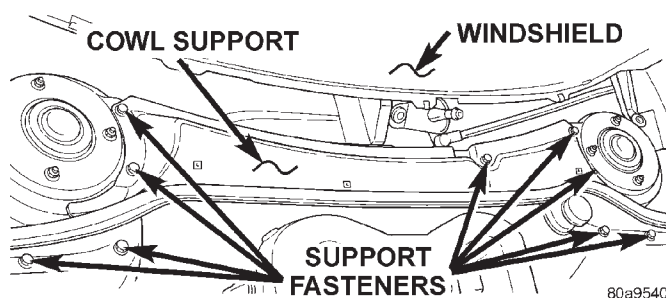
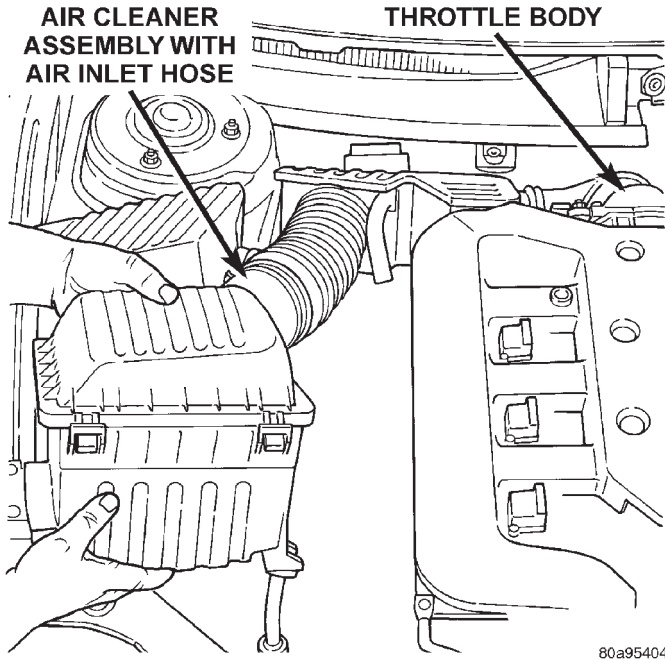


Fig. 29 Cowl Support

- (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: Intake manifold is a composite design, and should be removed before lifting engine or damage to the manifold could occur.

REMOVAL AND INSTALLATION (Continued)

**Fig. 30 Air Cleaner With Inlet Hose**

- (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) Loosen the left converter down pipe at band clamp, and front and rear support brackets for starter removal.
- (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.).
- (11) Install and tighten left side front and rear catalytic converter down pipe support bracket fasteners.
- (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 outlined 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 fastener to transmission case to cylinder block bolt.
- (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 front and rear catalytic converter down pipe support bracket fasteners.
- (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.

REMOVAL AND INSTALLATION (Continued)

- (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 07, Cooling System for procedure.
- (39) Install fan module.
- (40) Fill cooling system. Refer to Group 07, 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 07, Cooling System for procedure.
- (4) Remove the accessory drive belts. Refer to Group 07, Accessory Drive System for service procedure.
- (5) Use Special Tool 8191 to hold crankshaft damper while removing center bolt (Fig. 31).
- (6) Use Special Tool 1023 puller, and insert C-4685-C2, remove crankshaft damper (Fig. 32).

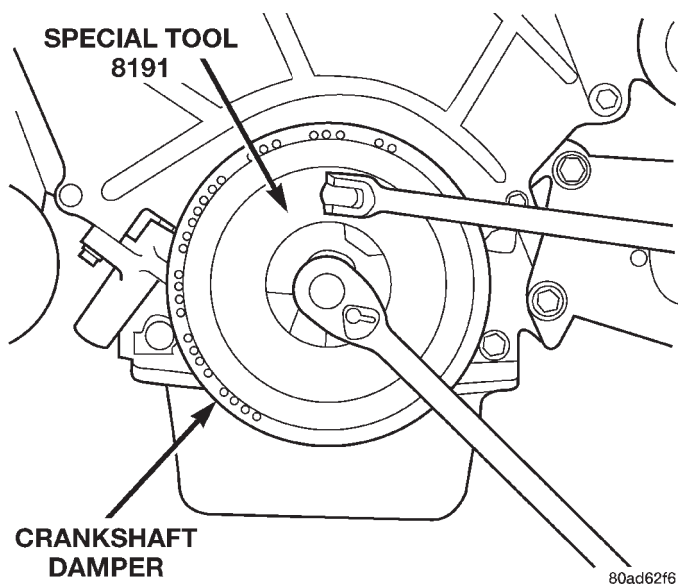


Fig. 31 Crankshaft Damper Center Bolt—Removal and Installation

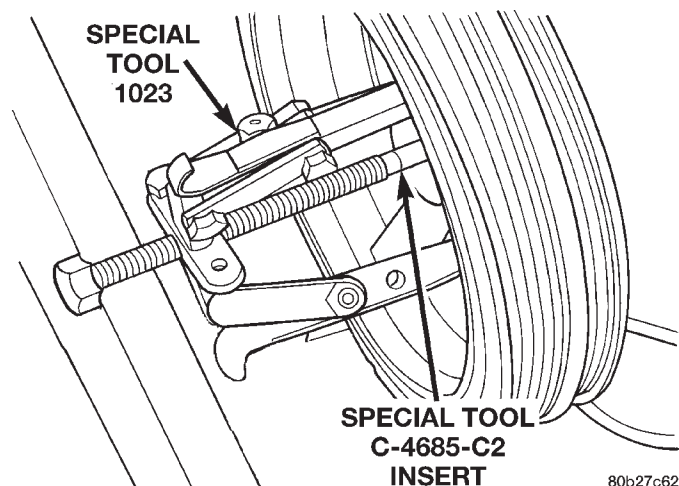


Fig. 32 Crankshaft Damper—Removal

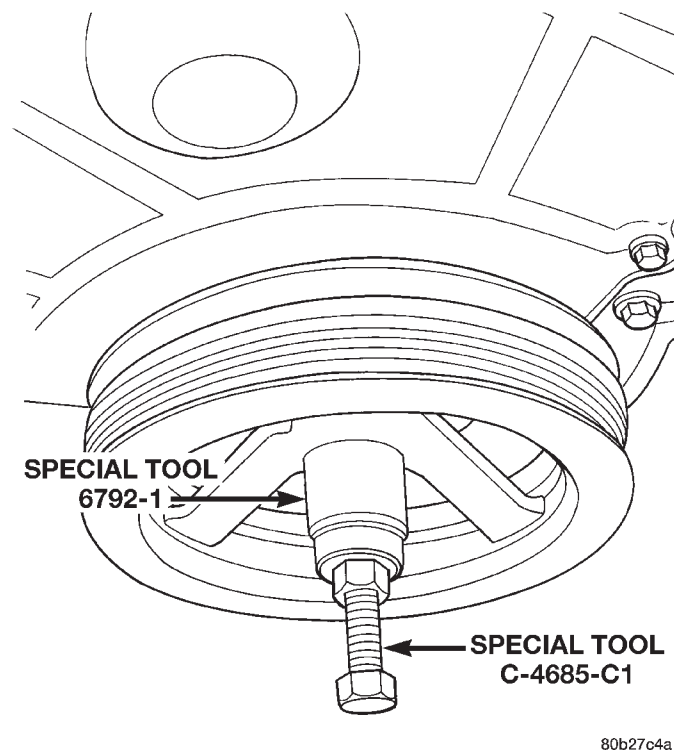


Fig. 33 Crankshaft Damper—Installation

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. 33). Install center bolt and tighten to 115 N·m (85 ft. lbs.) (Fig. 31).
- (2) Install accessory drive belts.
- (3) Install fan module.
- (4) Install upper radiator crossmember.
- (5) Connect negative cable.

REMOVAL AND INSTALLATION (Continued)

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. 34).

(4) Remove cylinder head cover bolts and remove cover (Fig. 35).

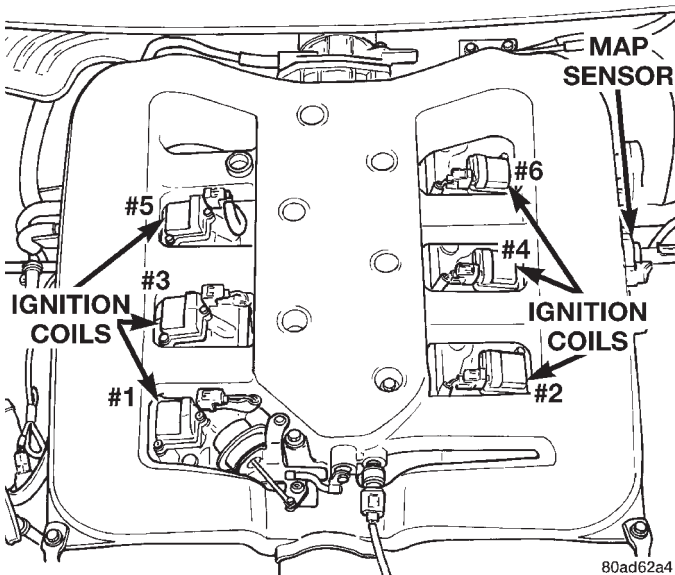


Fig. 34 Ignition Coils

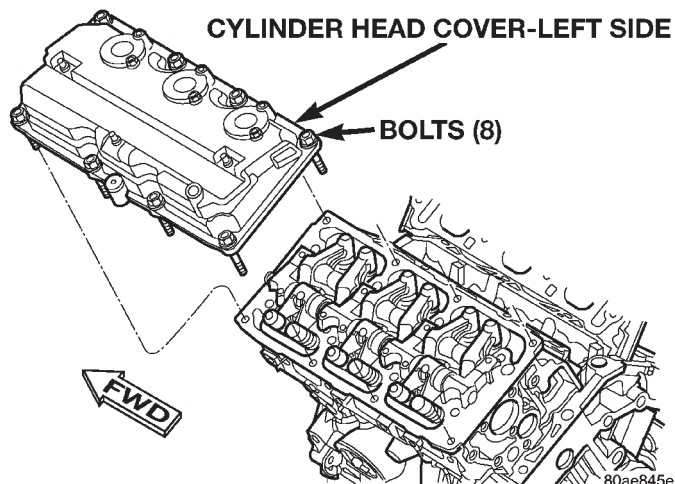
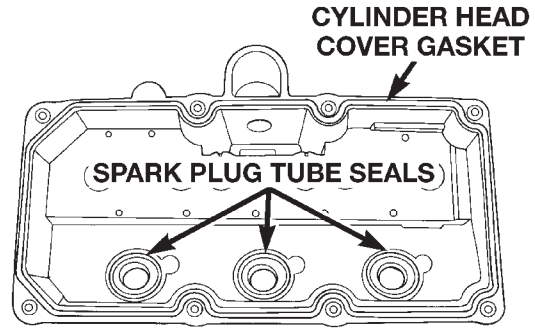
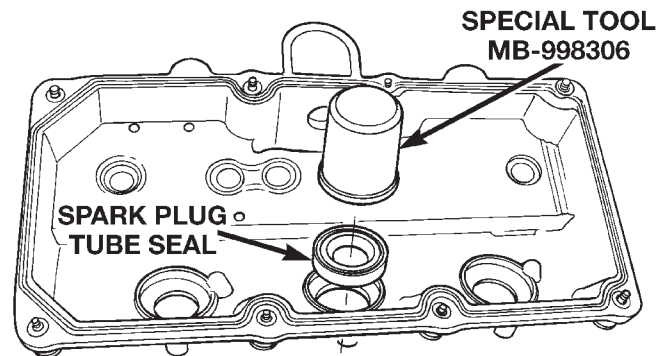


Fig. 35 Cylinder Head Covers



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Fig. 36 Cylinder Head Cover Gasket and Spark Plug Tube Seals



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Fig. 37 Spark Plug Tube Seal Installation

INSTALLATION

(1) Clean cylinder head and cover mating surfaces. Inspect and replace gasket and seals as necessary (Fig. 36).

(2) To replace spark plug tube seals:

- Using a pry tool, carefully remove tube seals.
- Position new seal so that part number on seal faces bottom of cover.
- Install seals with Special Tool MB-998306 (Fig. 37).

(3) Install cylinder head cover bolts and tighten to 12 N·m (105 in. lbs.) (Fig. 35).

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

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

SPARK PLUG TUBES

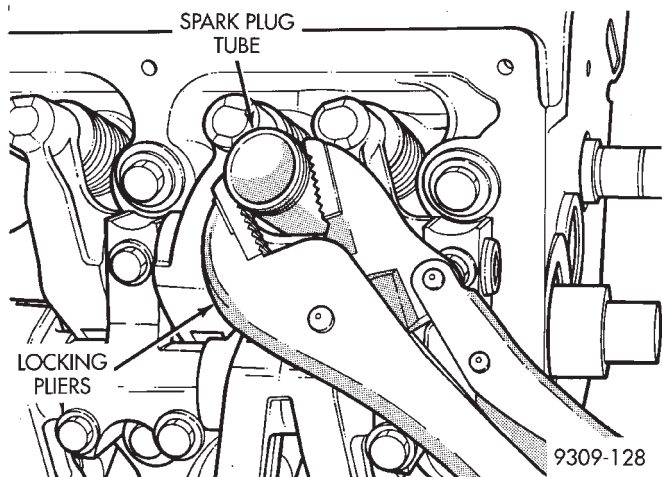
REMOVAL

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

(2) Using locking pliers remove the tube from the cylinder head (Fig. 38). Discard old tube.

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

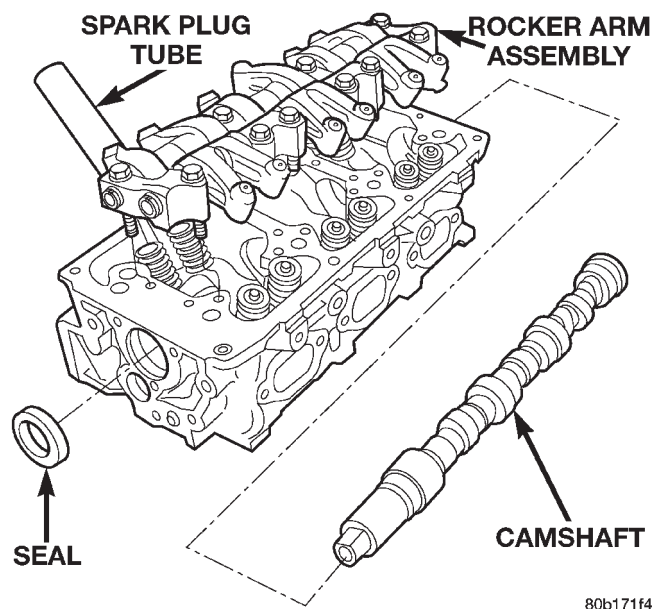
REMOVAL AND INSTALLATION (Continued)

**Fig. 38 Servicing Spark Plug Tubes****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.

CYLINDER HEAD**Cylinder Head, Camshaft, and Rocker Arms****REMOVAL**

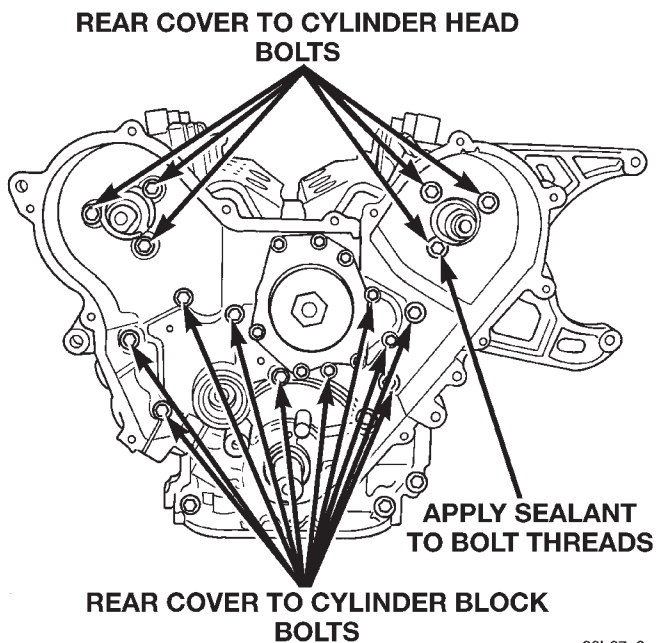
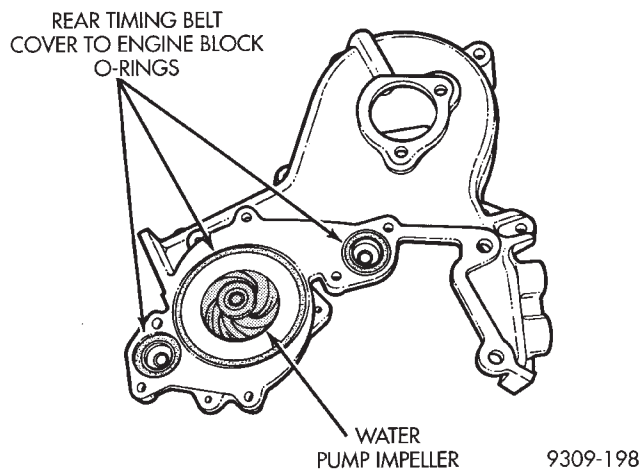
- (1) Remove crankshaft damper.
- (2) Remove timing belt covers.

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

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

(5) Remove rear timing belt cover to cylinder head fasteners (Fig. 39). Remove the rear covers.

(6) The right side timing belt cover has O-rings located behind it for water pump passages (Fig. 40).

**Fig. 39 Rear Timing Belt Cover Attaching Bolts****Fig. 40 Right Side Timing Belt Cover Water Pump O-Rings**

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

REMOVAL AND INSTALLATION (Continued)

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. 41).

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.

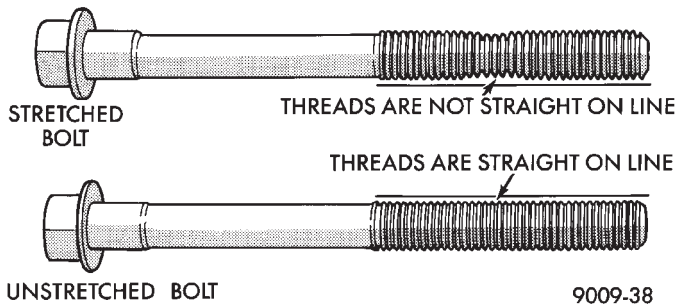


Fig. 41 Checking Bolts for Stretching (Necking)

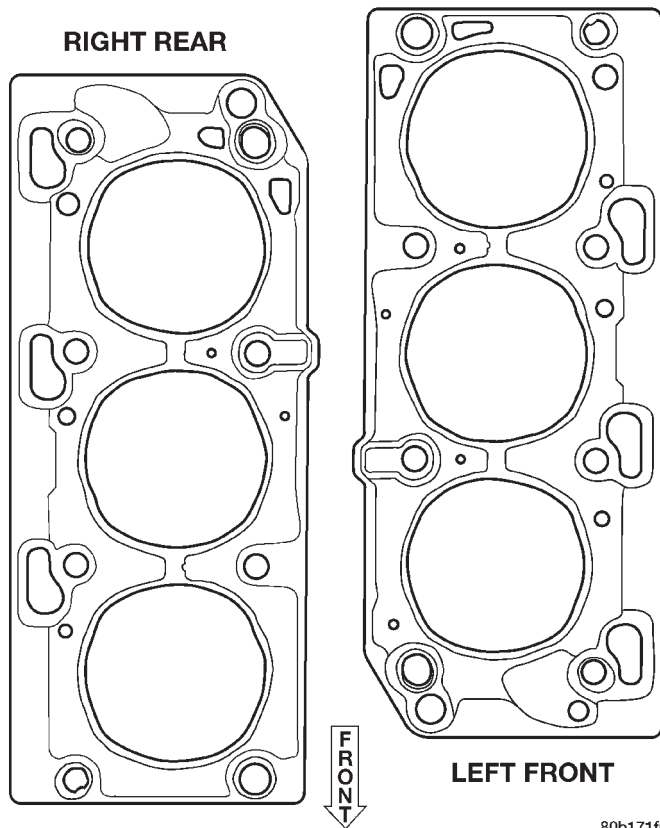


Fig. 42 Cylinder Head Gasket Identification

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.

(2) Install head gasket over locating dowels. Ensure the gasket is installed on the correct side (Fig. 42).

(3) Install cylinder head over dowels.

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

(5) Tighten the cylinder head bolts in the sequence shown in (Fig. 43). Using the 4 step torque-turn method, tighten according to the following 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.

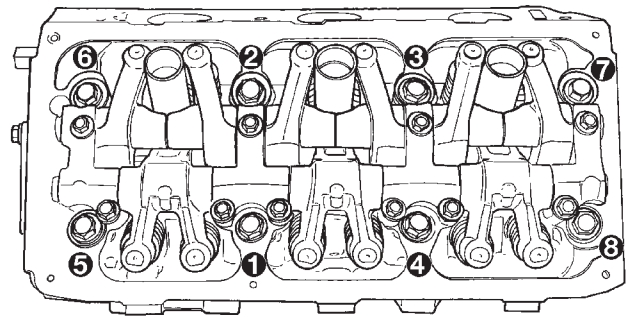


Fig. 43 Cylinder Head Bolt Tightening Sequence

(7) Install rear timing belt covers. Use new O-ring on the water pump passages on the right side cover. 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.)

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

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

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

(11) Install crankshaft damper.

CRANKSHAFT

REMOVAL

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

(2) Drain engine oil.

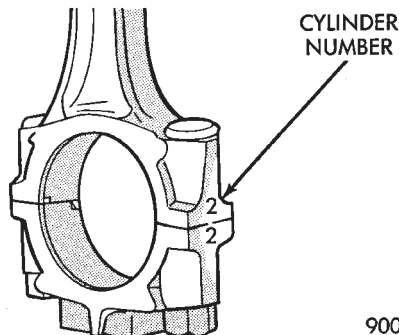
(3) Remove oil pan.

(4) Remove oil pick-up tube.

REMOVAL AND INSTALLATION (Continued)

- (5) Remove idler pulley for accessory drive belt.
- (6) Remove lower timing belt cover.
- (7) Remove main timing belt cover.
- (8) Remove left side timing belt cover.
- (9) Remove crankshaft damper. Refer to procedure in this section.
- (10) Remove timing belt tensioner and timing belt.
- (11) Remove crankshaft sprocket. Refer to Front Crankshaft Oil Seal Removal and Installation for procedure.
- (12) Tap dowel pin out of crankshaft. Refer to Front Crankshaft Oil Seal Removal and Installation for procedure.
- (13) Remove oil pump assembly.
- (14) Remove rear crankshaft oil seal retainer.
- (15) Remove connecting rod bearing caps. Connecting rod bearing caps are not interchangeable and should be marked before removal to insure correct assembly (Fig. 44).
- (16) Remove main bearing caps. Main bearing caps are not interchangeable and are marked to insure correct assembly (Fig. 45).
- (17) Remove Crankshaft.

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



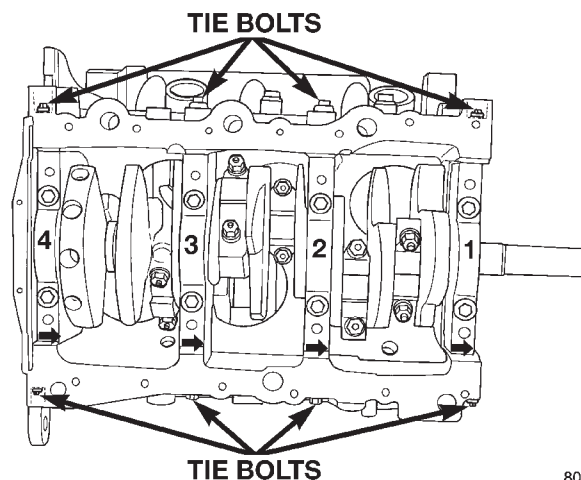
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Fig. 44 Connecting Rod to Cylinder Identification
INSTALLATION

NOTE: Upper and lower bearing halves are **NOT** interchangeable. Lower main bearing halves of 1, 2, 3, and 4 are interchangeable. Upper main bearing halves of 1, 2, 3, and 4 are interchangeable (Fig. 46).

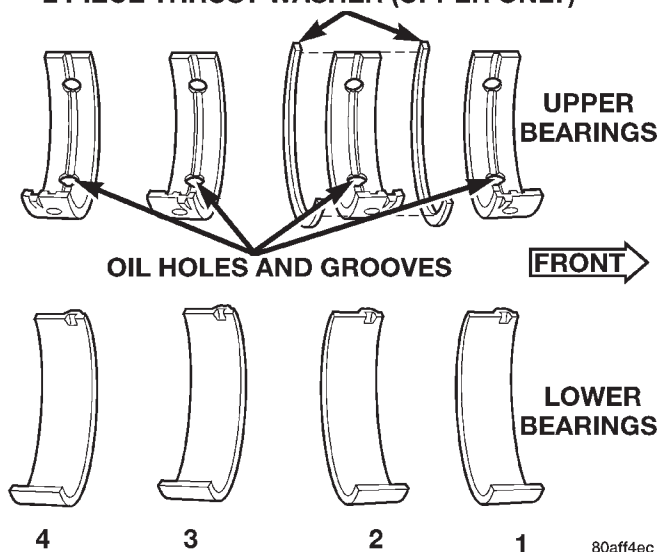
CAUTION: Main bearings are select fit. Refer to Crankshaft Main Bearing Fitting in this section for proper bearing selection.

- (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



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Fig. 45 Main Bearing Cap Identification
2 PIECE THRUST WASHER (UPPER ONLY)



80aff4ec

Fig. 46 Main Bearing Identification

No. 2 upper main bulk head and crankshaft thrust surface (Fig. 47).

(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.

(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.

REMOVAL AND INSTALLATION (Continued)

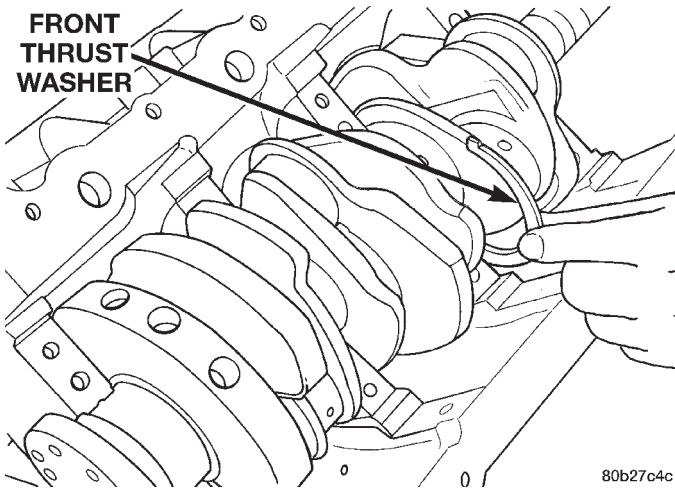


Fig. 47 Thrust Washer Installation

(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.

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: 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.

REMOVAL AND INSTALLATION (Continued)

TIMING PROCEDURE—3.2L

CAUTION: The camshaft sprockets are not interchangeable from side to side (Fig. 48).

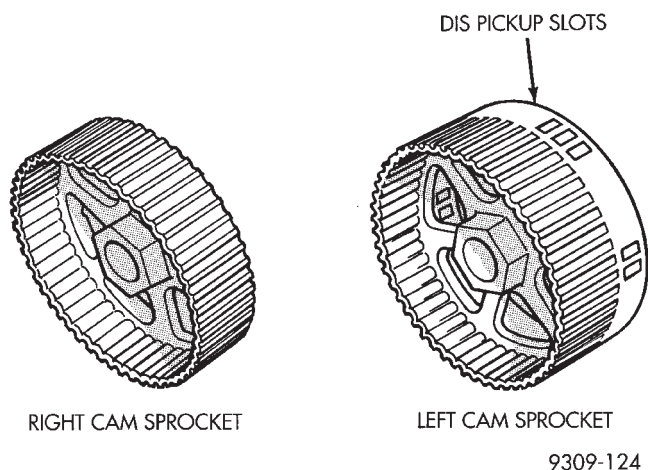


Fig. 48 Camshaft Sprocket Identification

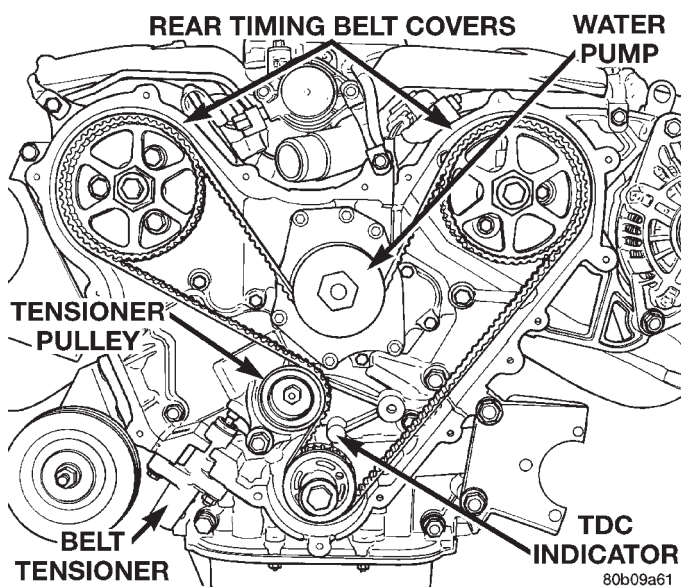


Fig. 49 Timing Belt System

(1) Place crankshaft sprocket to the TDC mark on the oil pump housing (Fig. 49).

(2) Install a dial indicator in number 1 cylinder to check TDC of the piston (Fig. 54). 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. 50).

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. 51).

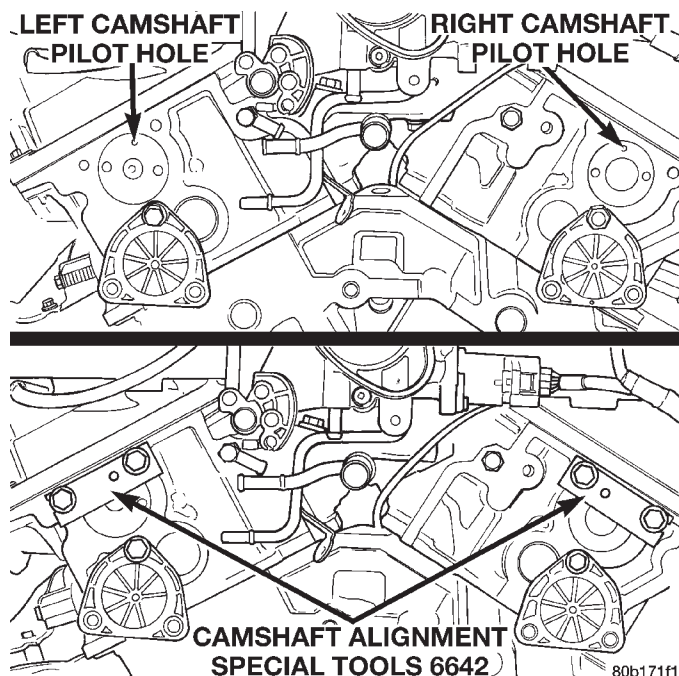


Fig. 50 Camshaft Alignment Special Tools 6642

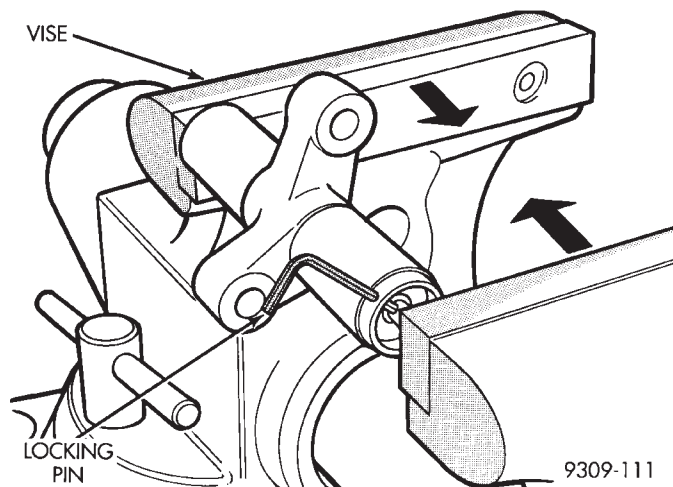


Fig. 51 Compressing Timing Belt Tensioner

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. 52) at both sprocket.

(6) Install the timing belt starting at the crankshaft sprocket going in a counterclockwise direction (Fig. 53). Install the belt around the last sprocket. Maintain tension on the belt as it is positioned

REMOVAL AND INSTALLATION (Continued)

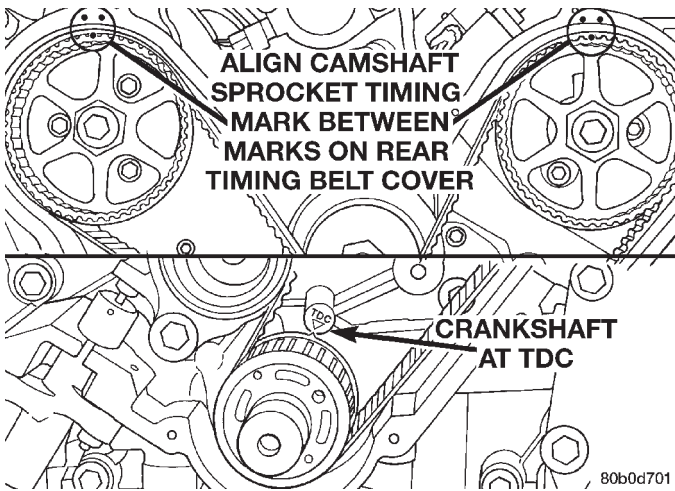


Fig. 52 Camshaft Sprocket Timing Marks

around the tensioner pulley. Each camshaft sprockets mark should still fall between the cover marks.

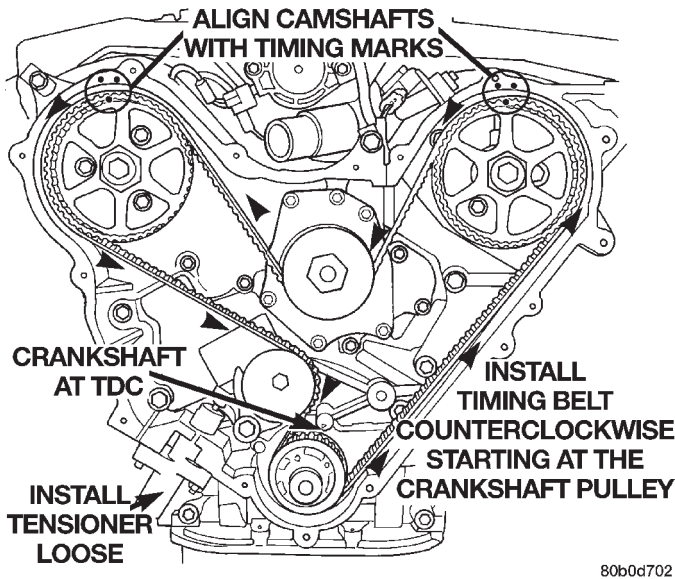


Fig. 53 Timing Belt—Installation

(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. 54), 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.

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

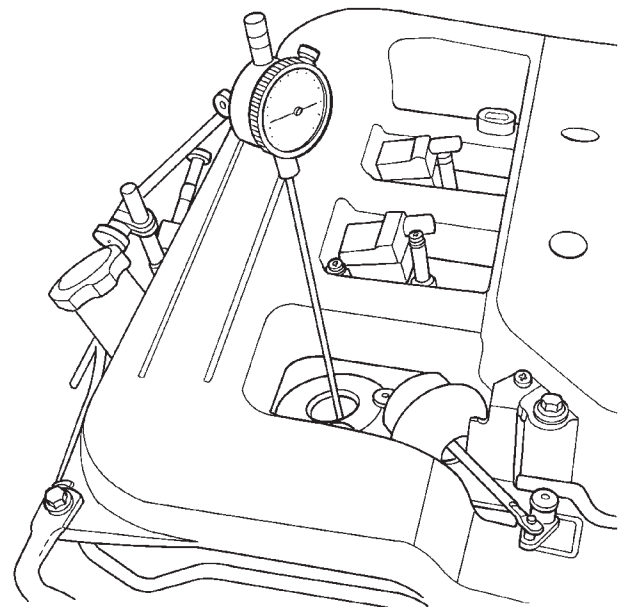


Fig. 54 Dial Indicator Locating Piston at TDC

(12) Install timing belt covers. Refer to Timing Belt Cover procedures outlined in this section.

(13) Install crankshaft damper.

(14) Install accessory drive belts. Refer to Group 07, Cooling System for procedure.

(15) Fill cooling system. Refer to Group 07, Cooling System for procedure.

(16) Start engine and allow to idle for approximately 1 minute. Then, operate the engine at speed of 1200 – 1500 RPM for 5 minutes. This will help to bleed out any possible air in the timing belt tensioner.

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 outlined in this section.

(2) Identify the rocker arm assembly and rocker arms before disassembly (Fig. 55).

REMOVAL AND INSTALLATION (Continued)

- (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.

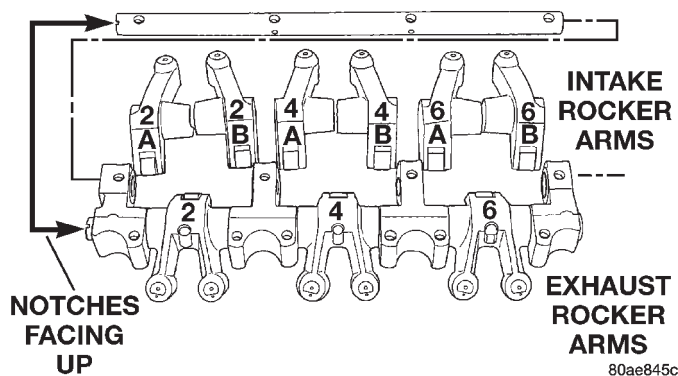


Fig. 55 Rocker Arms and Shaft Identification—Left Bank

DISASSEMBLY

(1) Remove dowel pin using a 4 mm screw, nut, spacer, and washer installed into the pin (Fig. 56). 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.

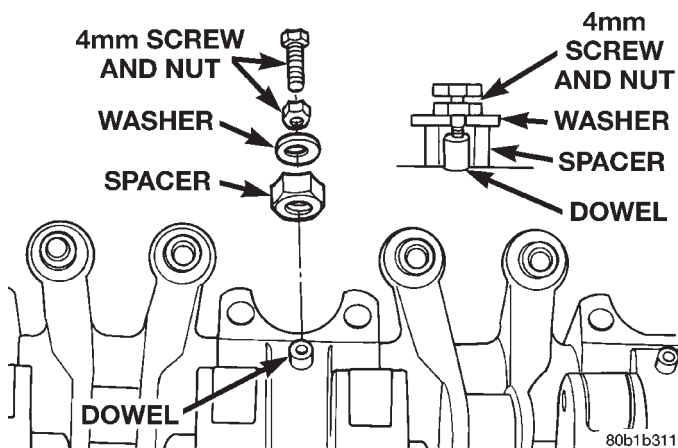


Fig. 56 Rocker Arms and Shaft—Disassembly

(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 during assembly.

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

NOTE: The notches on the rocker shafts face up (Fig. 55). 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. 57). 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.

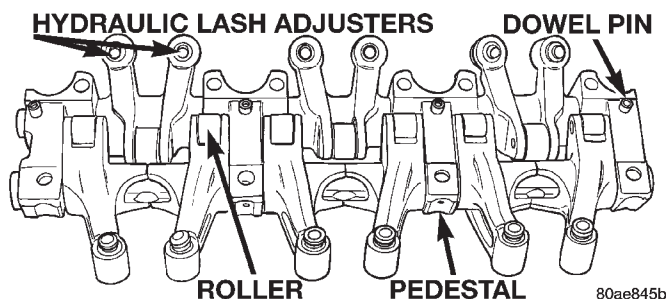


Fig. 57 Assemble Rocker Arms and Shaft

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. 58). 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. 59).

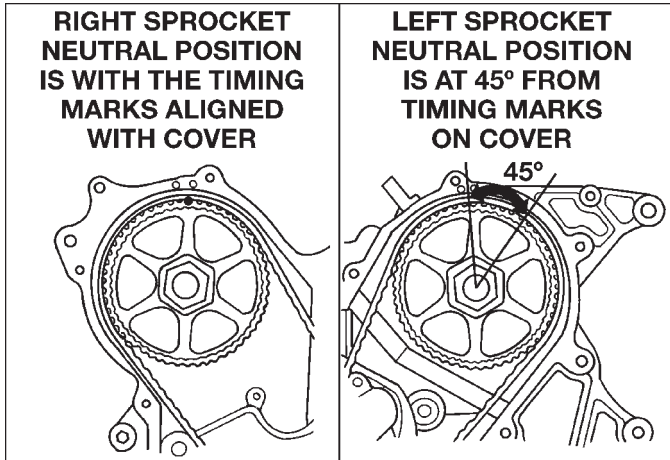
VALVE STEM SEALS OR VALVE SPRINGS—IN VEHICLE

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

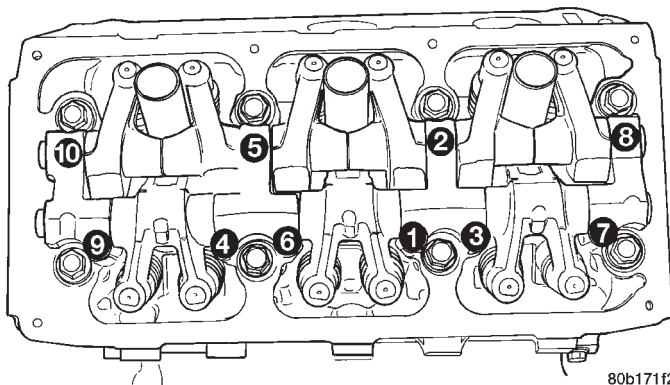
(2) Disconnect negative battery cable.

(3) Remove air cleaner housing and hose assembly.

REMOVAL AND INSTALLATION (Continued)



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Fig. 58 Camshaft Sprockets Neutral Position

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Fig. 59 Rocker Arm and Shaft Assembly Tightening Sequence

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

(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.

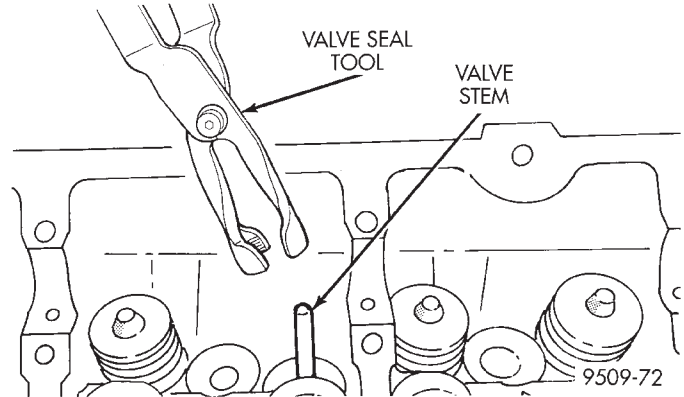
(7) Rotate the crankshaft clockwise, until the number 1 piston is at TDC (Top Dead Center) on the compression stroke.

(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. 60).

(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

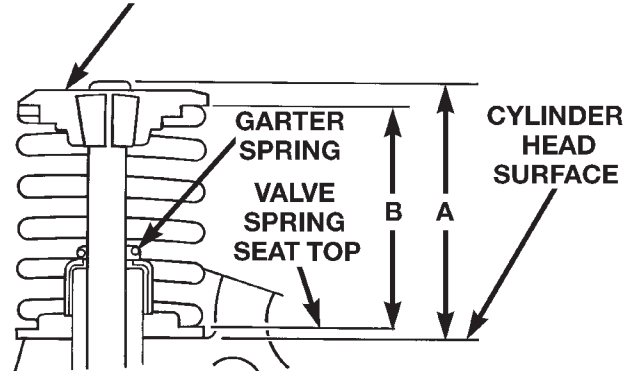


9509-72

Fig. 60 Valve Stem Seal—Removal

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. 61).

SPRING RETAINER

80570e02

Fig. 61 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.

REMOVAL AND INSTALLATION (Continued)

VALVE AND VALVE SPRINGS

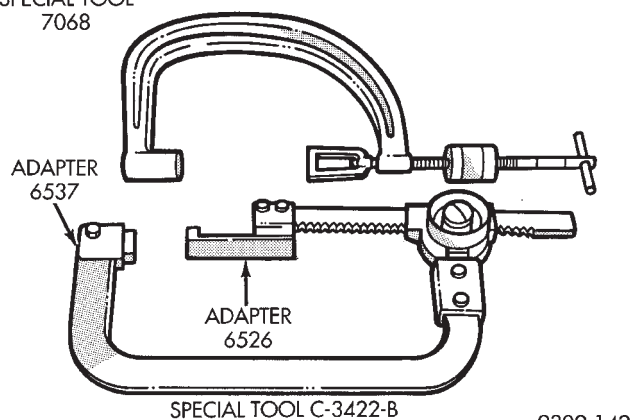
REMOVAL

(1) With cylinder head removed, compress valve springs using the Valve Spring Compressors shown in (Fig. 62).

(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.

SPECIAL TOOL
7068



9309-142

Fig. 62 Valve Spring Compressors

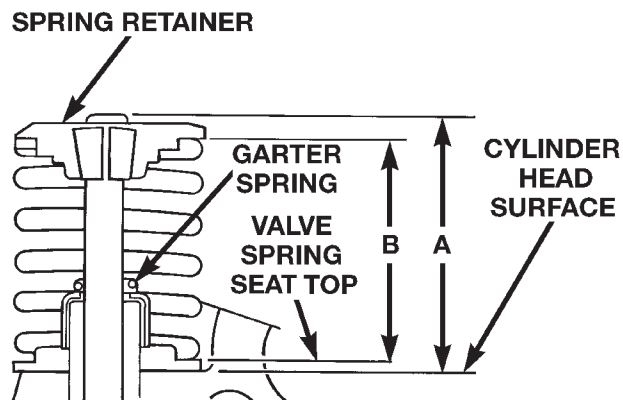
INSTALLATION

(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. 63). 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.

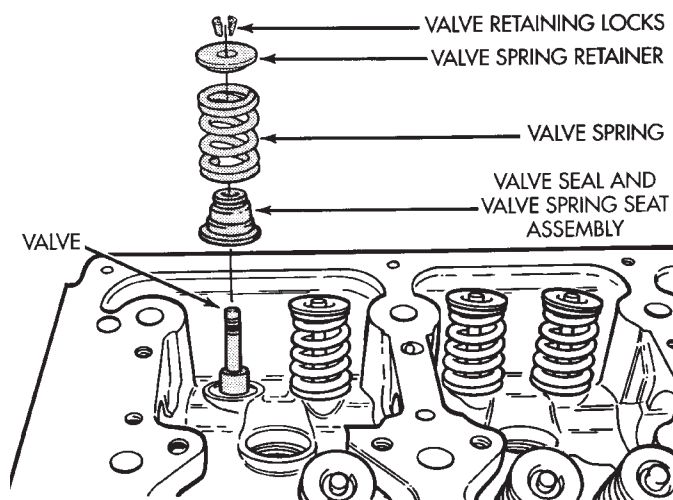
(3) Install valve seal/spring seat assembly over valve guides on all valve stems (Fig. 64). Ensure that the garter spring is intact around the top of the rubber seal. Install valve springs, valve retainers.

(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. 63), 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.



80570e02

Fig. 63 Checking Valve Tip Height and Valve Spring Installed Height



9309-150

Fig. 64 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.

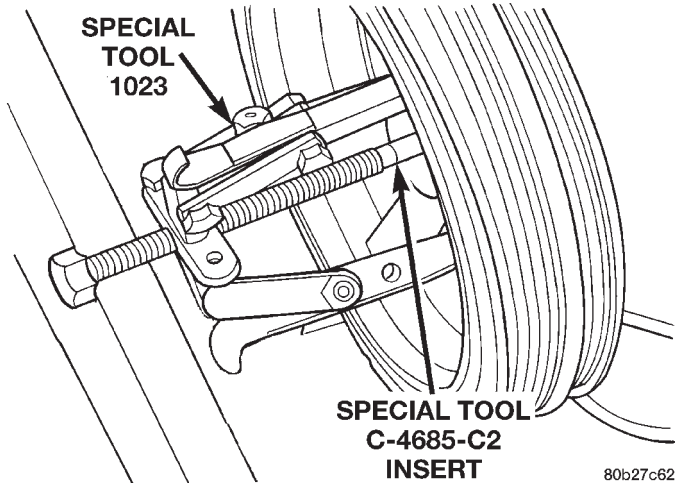
(3) Remove fan module. Refer to Group 07, Cooling System for procedure.

(4) Remove the accessory drive belts. Refer to Group 07, 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. 65).

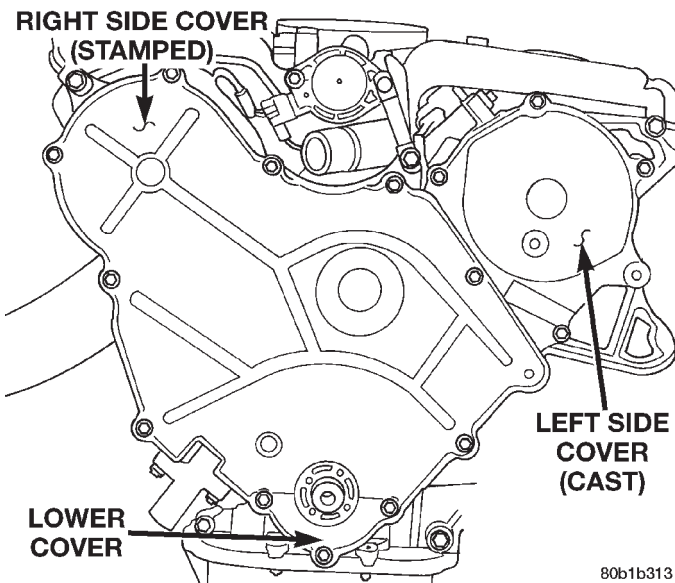
REMOVAL AND INSTALLATION (Continued)

**Fig. 65 Crankshaft Damper—Removal**

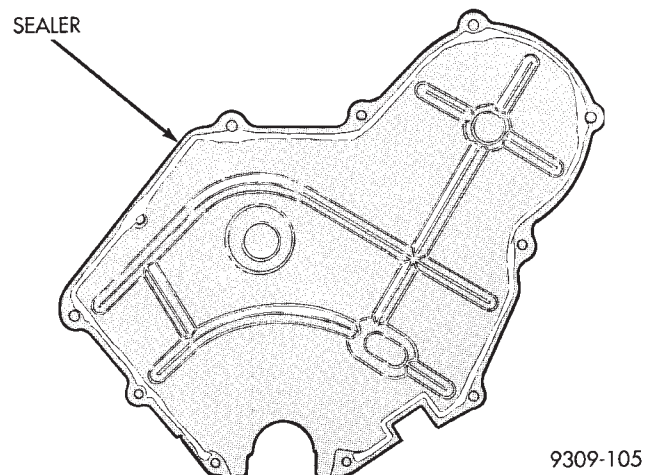
(7) Remove the lower belt cover located behind the crankshaft damper (Fig. 66).

(8) Remove the stamped steel cover (Fig. 66). **Do not remove the sealer on the cover, it is reusable (Fig. 67).** 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. 66).

**Fig. 66 Timing Belt Covers****INSTALLATION**

- (1) Install the left cast cover and accessory belt tensioner pulley and bracket.
- (2) Install the right stamped steel cover.
- (3) Install the lower cover.
- (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.).

**Fig. 67 Sealer, Timing Belt Cover**

(5) Install the fan module and upper radiator crossmember.

(6) Connect negative cable to remote jumper terminal.

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 3.2L is **NOT** a free-wheeling engine. 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 07, Cooling System for procedure.
- (5) Remove accessory drive and air conditioning drive belts. Refer to Group 07, 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.

REMOVAL AND INSTALLATION (Continued)

(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. 68).

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.

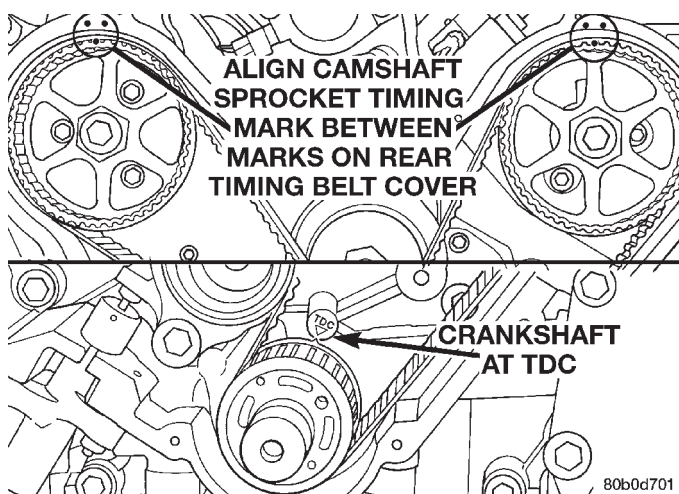


Fig. 68 Engine Timing Mark Alignment

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

(10) Remove the timing belt tensioner (Fig. 69) and remove timing belt.

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. 70). 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

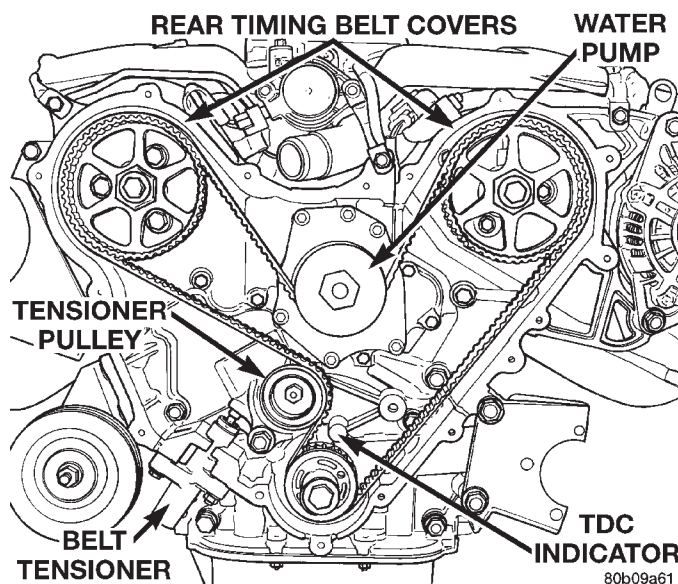


Fig. 69 Timing Belt System

plunger to retain plunger in place until tensioner is installed.

NOTE: When the tensioner is removed from the engine, always store with the plunger pointing upward.

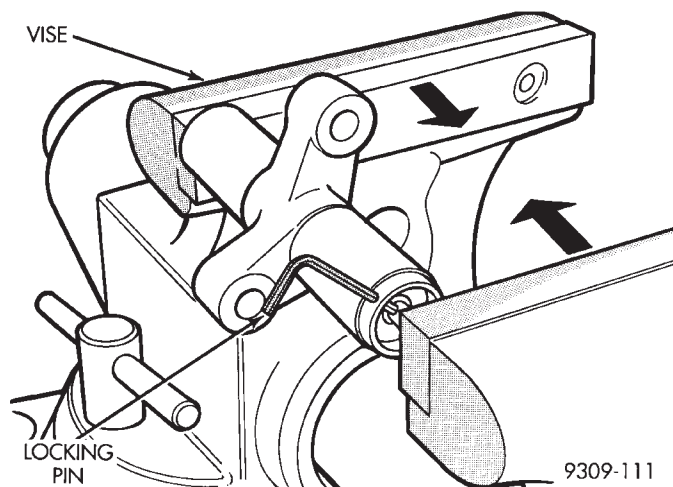


Fig. 70 Compressing Timing Belt Tensioner

INSTALLATION

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

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).

REMOVAL AND INSTALLATION (Continued)

(1) Align the crankshaft sprocket with the TDC mark on oil pump cover (Fig. 71).

(2) Align the camshaft sprockets (to reference mark made upon removal) between the marks on the rear covers (Fig. 68).

(3) Install the timing belt starting at the crankshaft sprocket going in a counterclockwise direction (Fig. 71). 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 sprockets 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. 71). If marks do not line up repeat procedure.

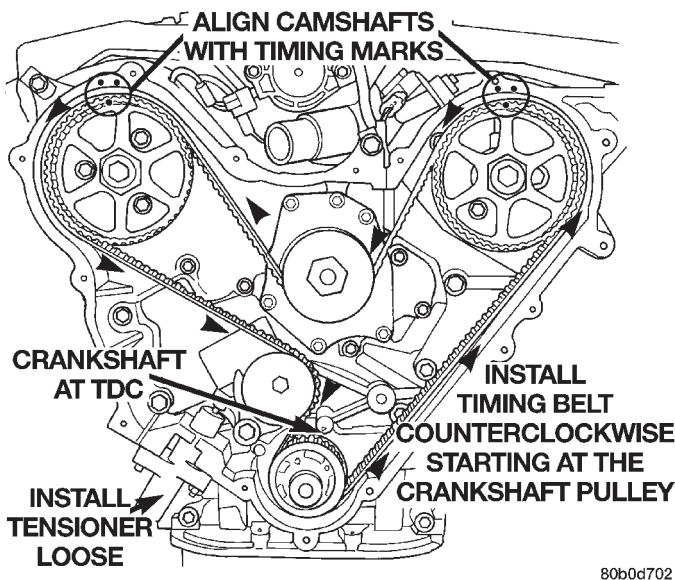


Fig. 71 Timing Belt Installation

(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 07, Cooling System for procedure.

(9) Install fan module. Refer to Group 07, Cooling System for procedure.

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

(11) Connect negative cable to remote jumper terminal.

(12) Start engine and allow to idle for approximately 1 minute. Then, operate the engine at speed of 1200 – 1500 RPM for 5 minutes. This will help to

bleed out any possible air in the timing belt tensioner.

OIL PAN

REMOVAL

(1) Disconnect negative cable from auxiliary jumper terminal.

(2) Remove dipstick and housing.

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

(4) Remove structural collar from rear of oil pan and transmission housing (Fig. 72).

(5) Disconnect engine oil cooler line from pan.

(6) Disconnect transmission oil cooler line clips.

(7) Remove oil pan (Fig. 73).

(8) Remove oil pan gasket.

(9) Clean oil pan and all gasket surfaces.

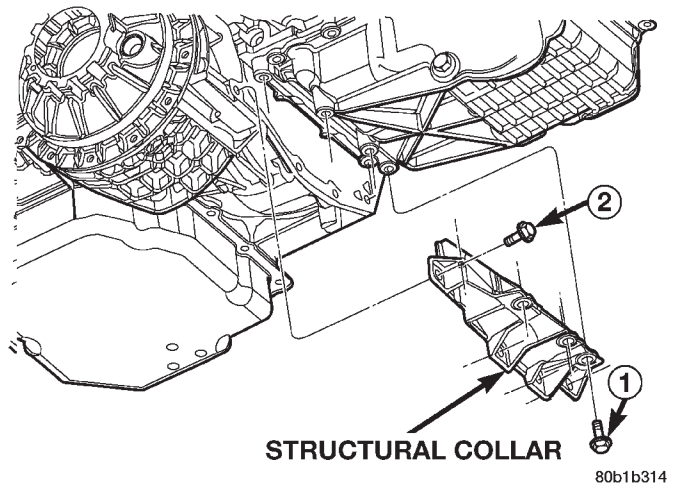
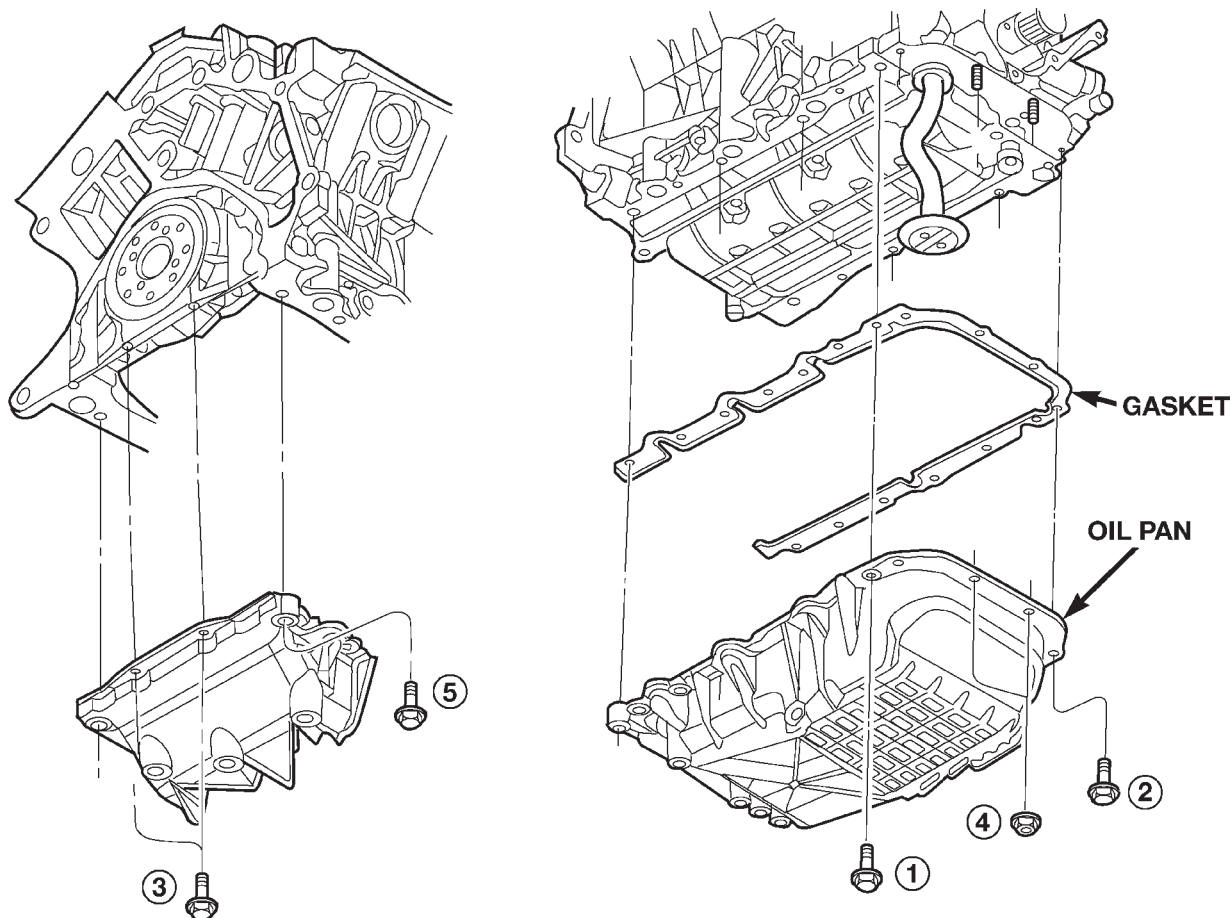


Fig. 72 Structural Collar

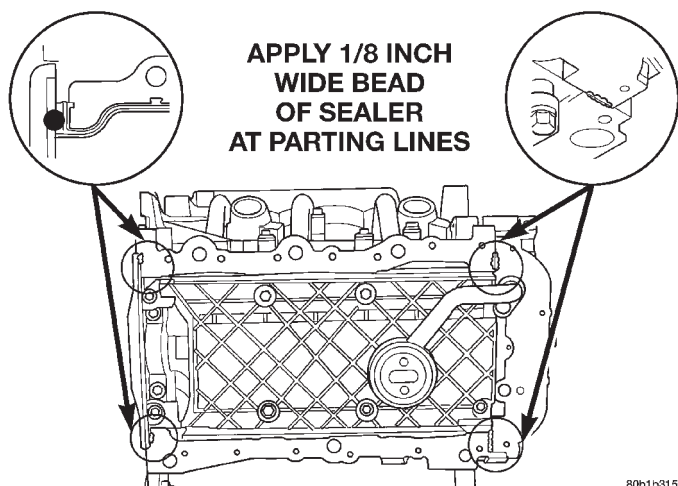
REMOVAL AND INSTALLATION (Continued)



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Fig. 73 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.)			



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Fig. 74 Oil pan Sealing

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. 74).

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

(3) Install pan and attaching fasteners (Fig. 73).

(4) Install the structural collar (Fig. 72), 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 housing.

REMOVAL AND INSTALLATION (Continued)

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

(7) Connect negative cable to remote auxiliary jumper terminal.

CAMSHAFT OIL SEAL

REMOVAL

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

(2) Use Special Tool C-3981B to remove camshaft oil seal (Fig. 75).

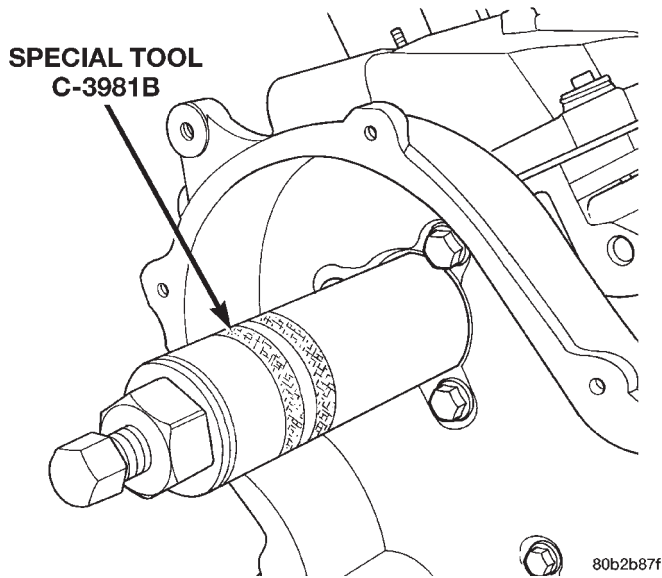


Fig. 75 Camshaft Oil Seal—Removal

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. 76) and Seal Installer 6052 (Fig. 77).

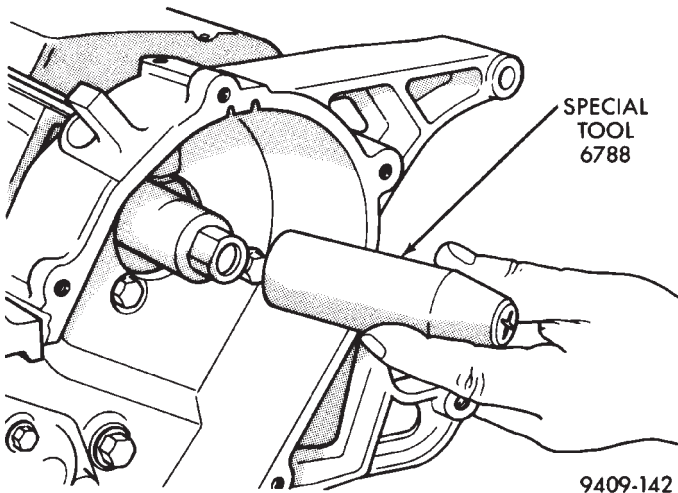


Fig. 76 Camshaft Oil Seal Protector Sleeve

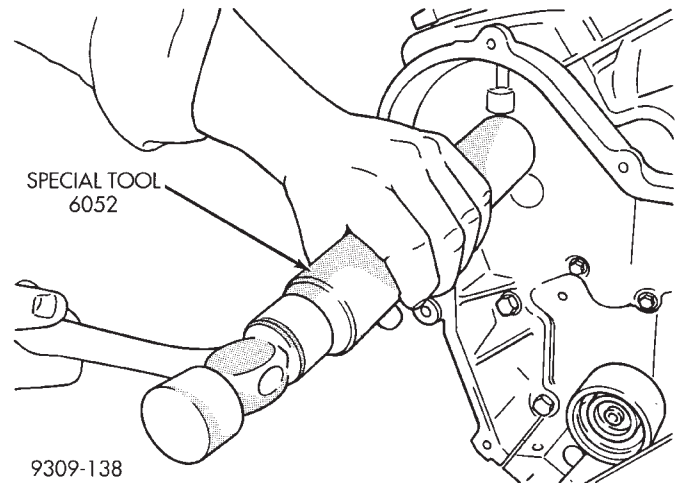


Fig. 77 Camshaft Oil Seal—Installation

FRONT CRANKSHAFT OIL SEAL

REMOVAL

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

(2) Remove crankshaft sprocket using Special Tool L-4407-A (Fig. 78).

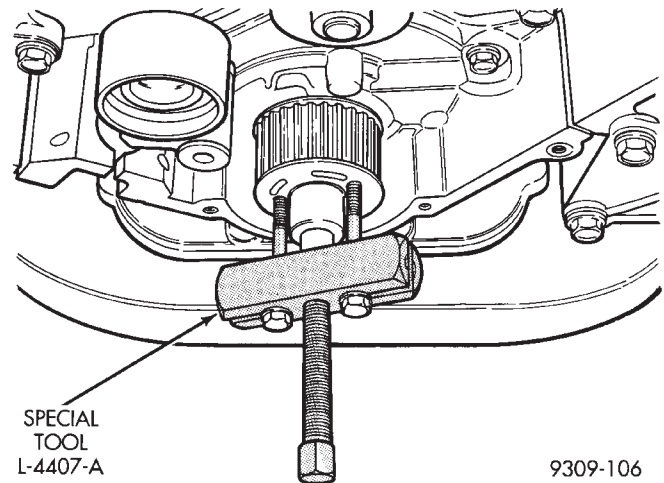


Fig. 78 Crankshaft Sprocket—Removal

(3) Tap the dowel pin out of the crankshaft (Fig. 79).

(4) Remove crankshaft seal using Special Tool 6341A (Fig. 80).

REMOVAL AND INSTALLATION (Continued)

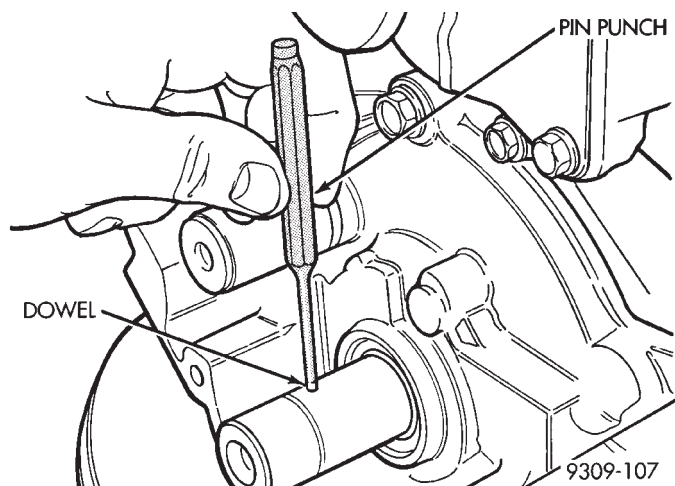


Fig. 79 Crankshaft Sprocket Dowel Pin—Removal/Installation

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.

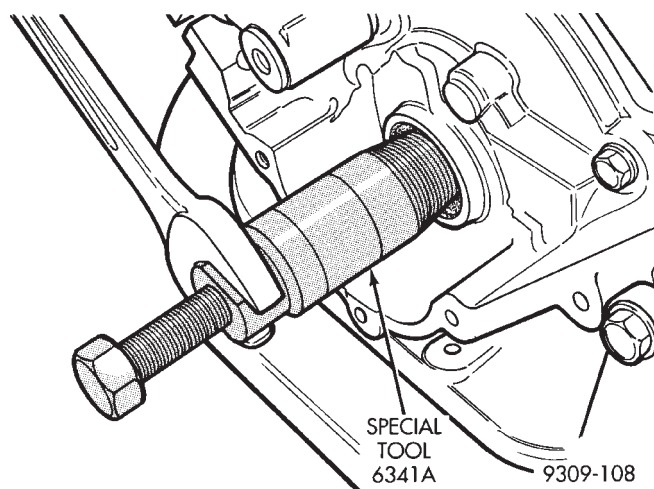


Fig. 80 Crankshaft Oil Seal with Special Tool 6341A—Removal

INSTALLATION

(1) Install crankshaft seal using Special Tool 6342 (Fig. 81).

(2) Install the dowel pin into the crankshaft to 1.2 mm (0.047 inch.) protrusion (Fig. 79).

(3) Install crankshaft sprocket using special tools shown in (Fig. 82).

CRANKSHAFT OIL SEAL—REAR

REMOVAL

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

(2) Remove drive plate.

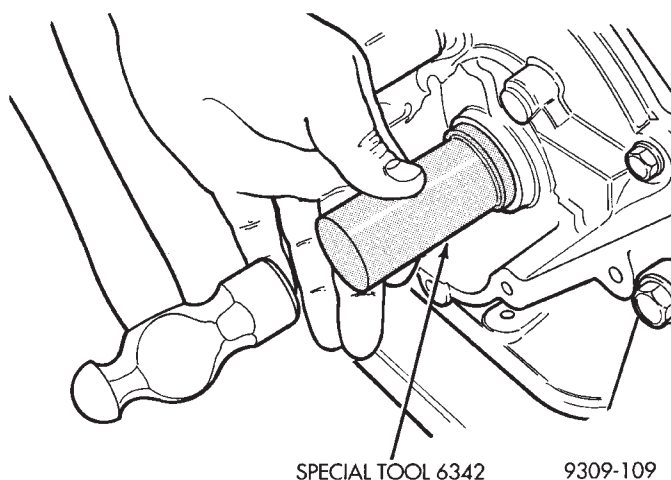


Fig. 81 Crankshaft Oil Seal with Special Tool 6342—Installation

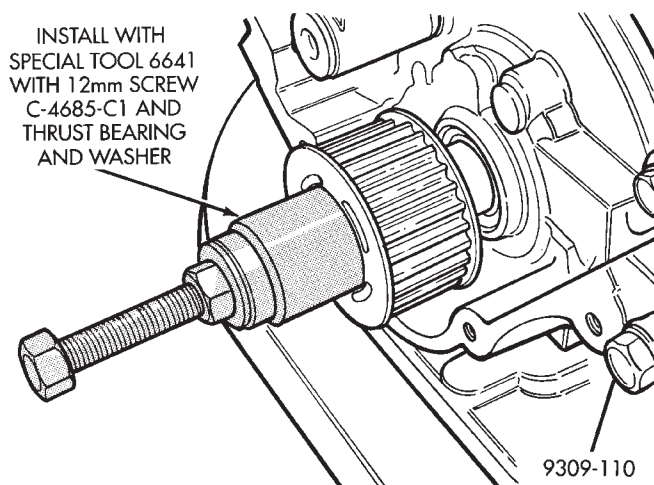


Fig. 82 Crankshaft Sprocket—Installation

(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. 83) through 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. 84). This is a pilot tool with a magnetic base.

REMOVAL AND INSTALLATION (Continued)

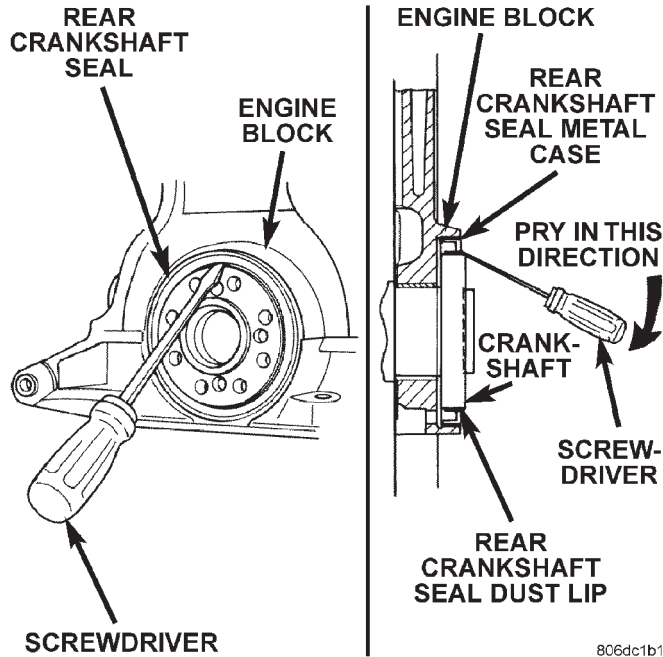


Fig. 83 Rear Crankshaft Oil Seal Removal—Typical

(2) Position seal over pilot tool. Assure that lip of seal is facing towards the crankshaft during installation. The pilot tool remains on crankshaft during seal installation.

(3) Using Special Tool 6926-2 Installer, and C-4171 Handle (Fig. 84), drive seal into the retainer housing until seal is flush with housing surface.

(4) Install drive plate and transaxle.

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. 85).

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

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.

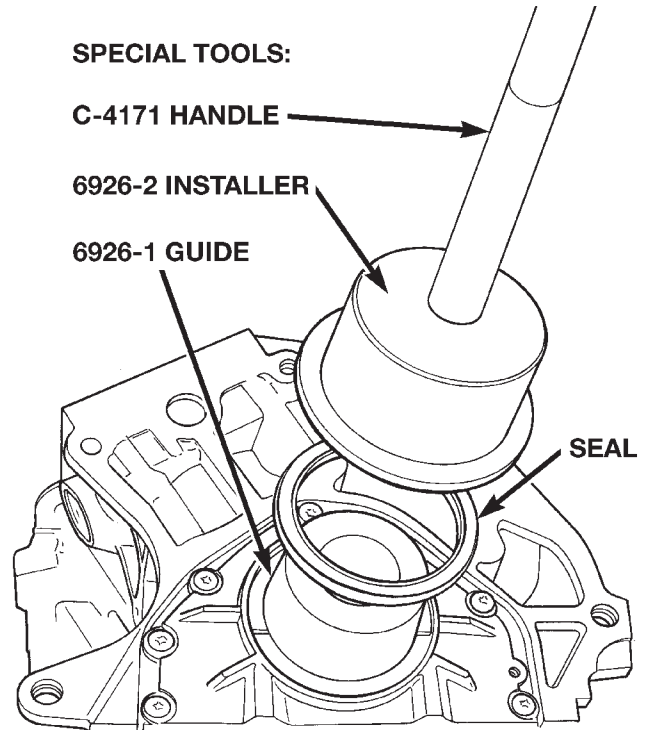


Fig. 84 Crankshaft Rear Seal—Installation

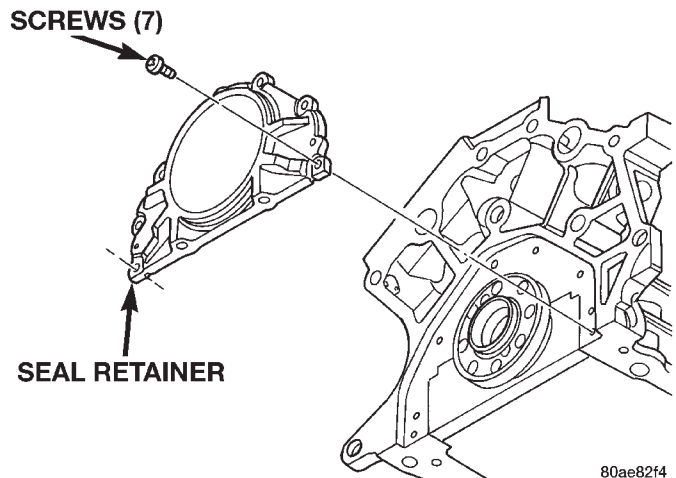


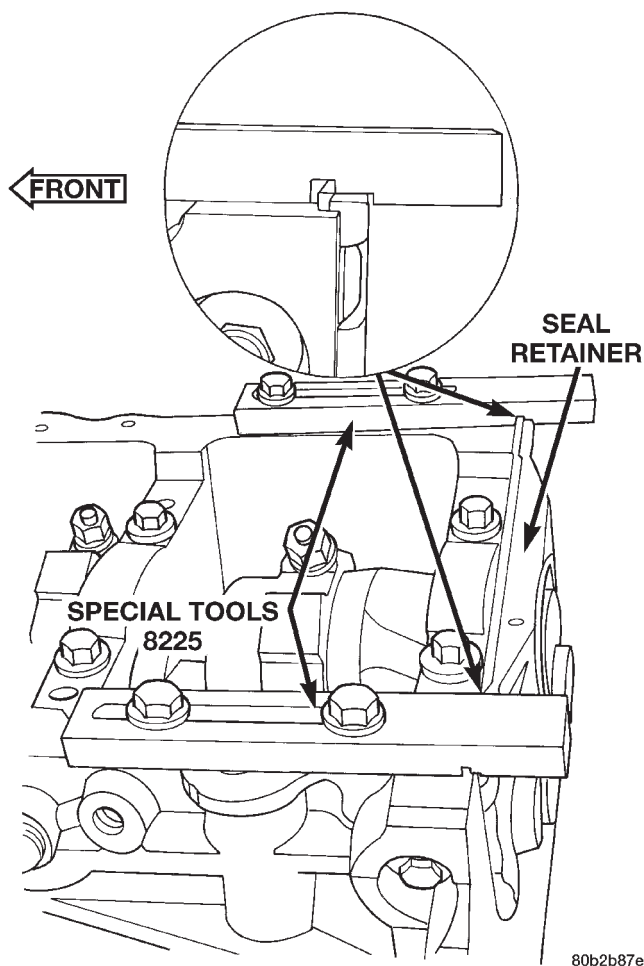
Fig. 85 Oil Seal Retainer

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. 86), 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.

REMOVAL AND INSTALLATION (Continued)

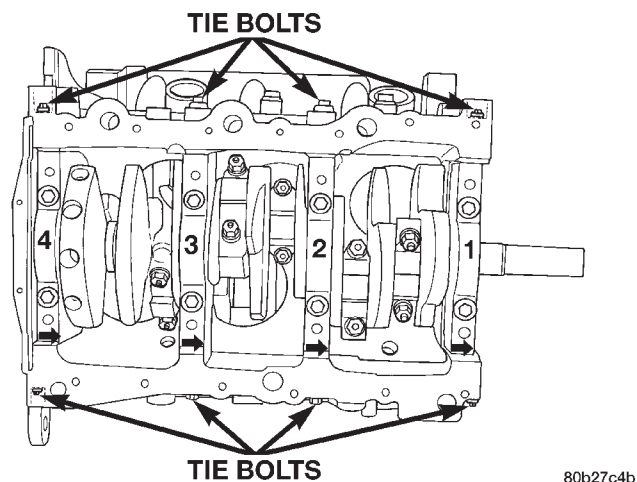
**Fig. 86 Rear Crankshaft Seal Retainer Alignment****CRANKSHAFT MAIN BEARINGS**

Bearing caps are not interchangeable and should be marked at removal to insure correct assembly. (Fig. 87) Upper and lower bearing halves are NOT interchangeable. Lower main bearing halves of 1, 2, 3 and 4 are interchangeable. Upper main bearing halves of 1, 2, 3, and 4 are interchangeable.

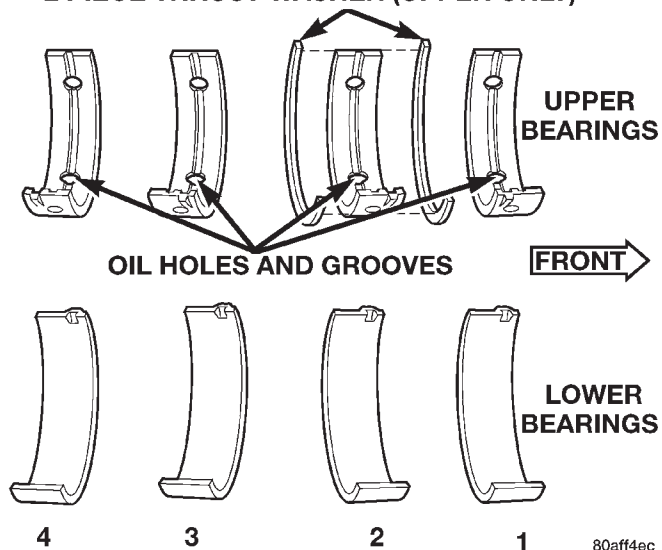
CRANKSHAFT MAIN JOURNALS

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.

**Fig. 87 Main Bearing Cap Identification**

The crankshaft thrust is controlled with thrust washers located at the upper No. 2 main bearing bulk head (Fig. 88). 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 undersize bearing that will reduce clearance below specifications.

2 PIECE THRUST WASHER (UPPER ONLY)**Fig. 88 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. 89) into the oil hole of crankshaft.

REMOVAL AND INSTALLATION (Continued)

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

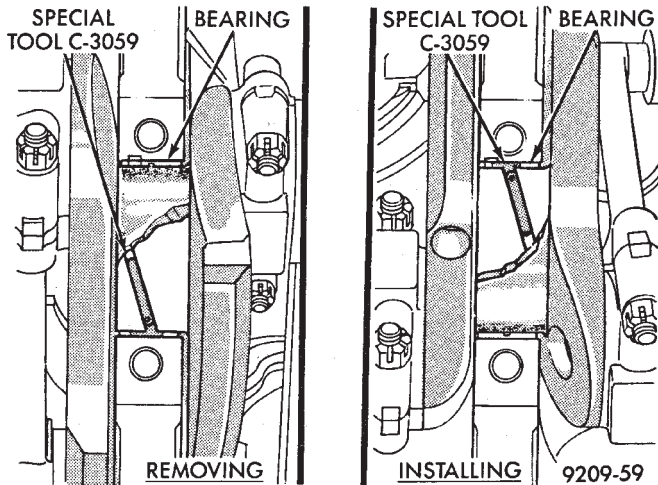


Fig. 89 Removing and Installing Upper Main Bearing With Special Tool C-3059

INSTALLATION

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

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. 89).
- (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. 90).
 - 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.

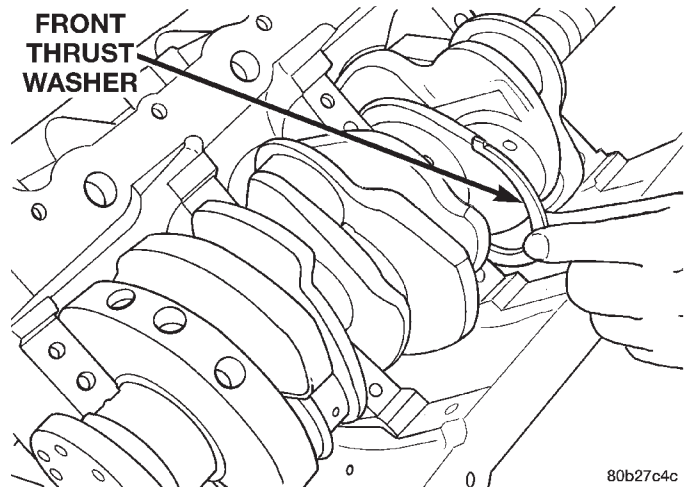


Fig. 90 Thrust Washer Installation

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

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

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

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. 91).
- (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.

REMOVAL AND INSTALLATION (Continued)

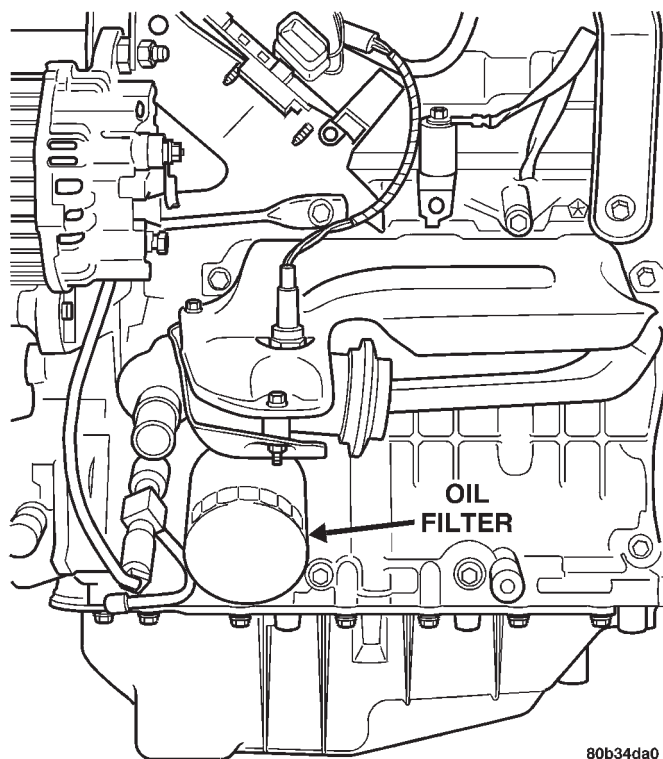


Fig. 91 Oil Filter

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 for access to timing belt covers and crankshaft damper. Refer to Group 07, Cooling Systems for procedures.

(2) Remove the accessory drive belts. Refer to Group 07, Cooling System for procedure.

(3) Remove the crankshaft damper. Remove timing belt covers. Refer to procedure outline in this section.

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

(5) Remove crankshaft sprocket. Refer to front oil seal service procedure outlined in this section.

(6) Remove oil pan. Refer to procedure outlined in this section.

(7) Remove oil pickup tube.

(8) Remove oil pump fasteners and remove pump and gasket from engine (Fig. 92).

INSTALLATION

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

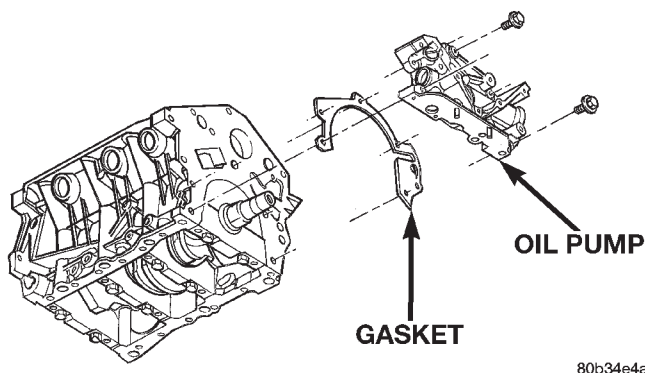


Fig. 92 Oil Pump—Removal and Installation

(2) Install gasket and oil pump carefully over the crankshaft and into position. Install and tighten bolts to:

- M8 Bolts to 28 N·m (250 in. lbs.)
- M10 Bolts to 55 N·m (40 ft. lbs.)

(3) Install new O-ring on oil pickup tube.

(4) Install oil pickup tube.

(5) Install oil pan. Refer to procedure outlined in this section.

(6) Install crankshaft sprocket. Refer to front crankshaft oil seal procedure outlined in this section.

(7) Install timing belt. Refer to procedure outlined in this section.

(8) Install the timing belt covers and vibration damper. Refer to procedure outline in this section.

(9) Install the accessory drive belts and fan module. Refer to Group 07, Accessory Drive System for procedure.

(10) Fill cooling system. Refer to Group 07, Cooling Systems for procedure.

PISTON AND CONNECTING ROD

REMOVAL

(1) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. **Be sure to keep tops of pistons covered during this operation. Pistons and connecting rods must be removed from top of cylinder block. When removing piston and connecting rod assemblies from the engine, rotate crankshaft so that each connecting rod is centered in cylinder bore.**

(2) Inspect connecting rods and connecting rod caps for cylinder identification. Identify them if necessary (Fig. 93).

(3) Remove connecting rod cap. Install protectors on connecting rod bolts (Fig. 94). Push each piston and rod assembly out of cylinder bore.

NOTE: Be careful not to nick crankshaft journals.

REMOVAL AND INSTALLATION (Continued)

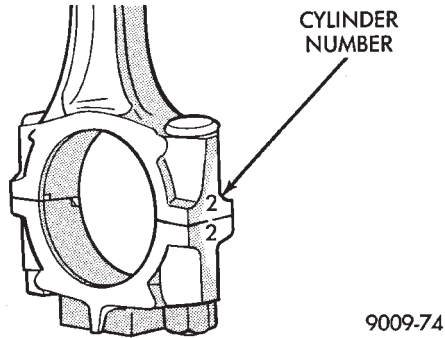


Fig. 93 Identify Connecting Rod to Cylinder

COVER ROD BOLTS WITH A SUITABLE COVERING WHEN REMOVING OR INSTALLING PISTON ASSEMBLY

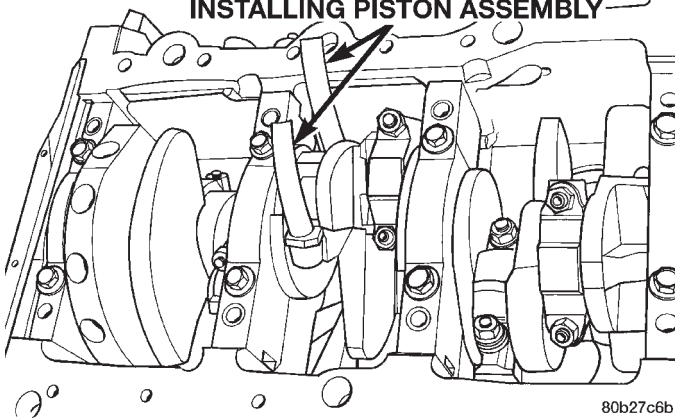


Fig. 94 Connecting Rod Guides and Crankshaft Protectors

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

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. 95).

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. 96).**
- (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. 97).

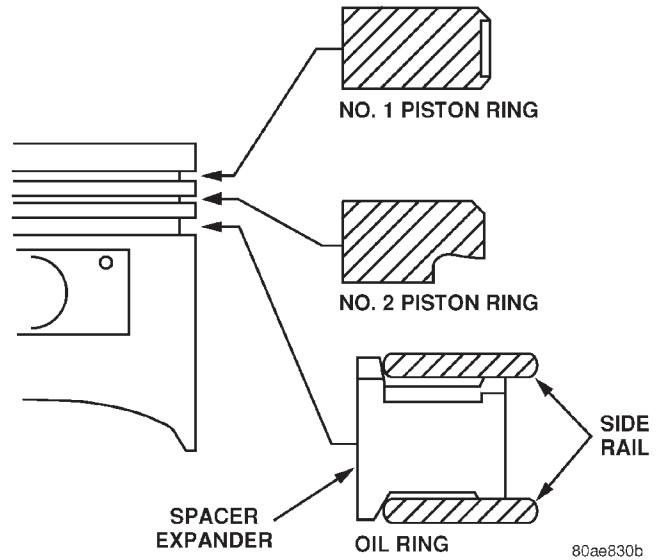


Fig. 95 Piston Ring—Installation

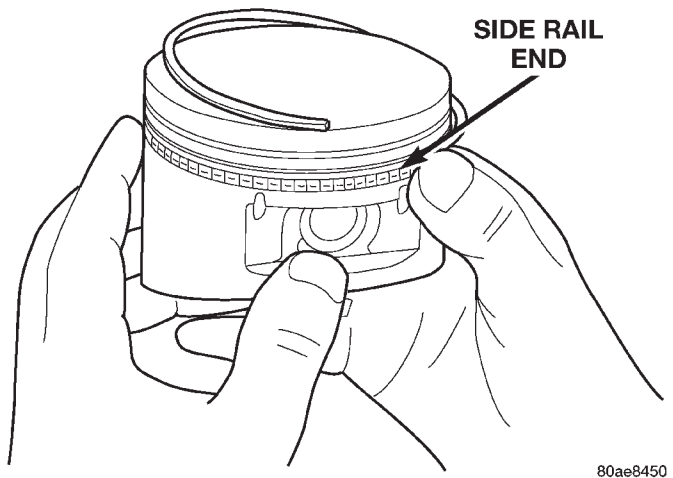


Fig. 96 Side Rail—Installation

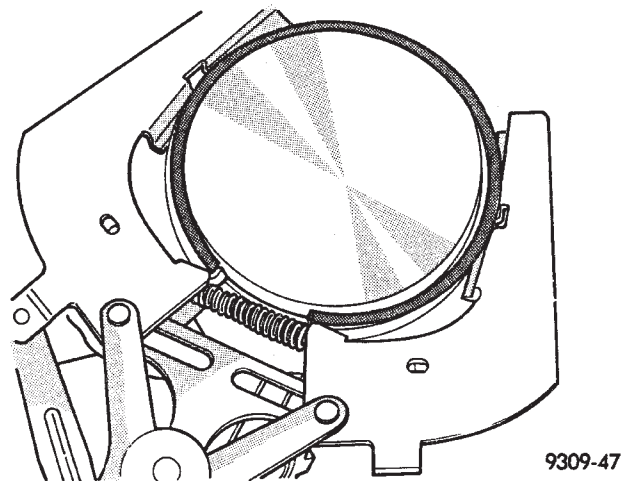


Fig. 97 Upper and Intermediate Rings—Installation

REMOVAL AND INSTALLATION (Continued)

(10) Position piston ring end gaps as shown in (Fig. 98).

(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.

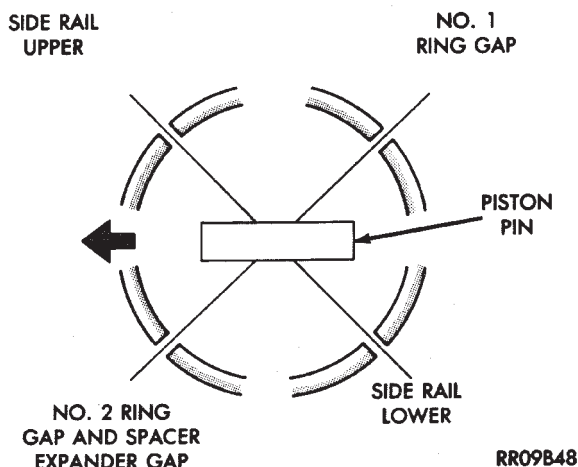


Fig. 98 Piston Ring End Gap Position

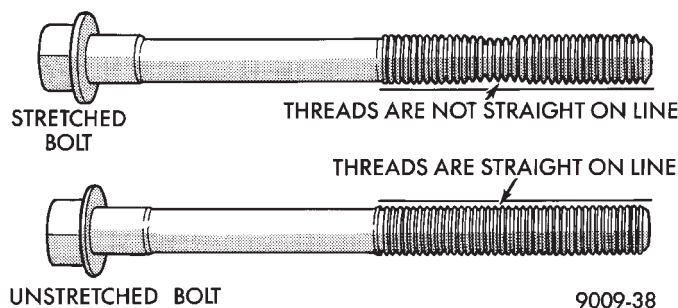


Fig. 99 Check for Stretched Bolts

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. 99).

(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.

(3) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located as shown in (Fig. 100).

(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 posi-**

tion of rings does not change during this operation.

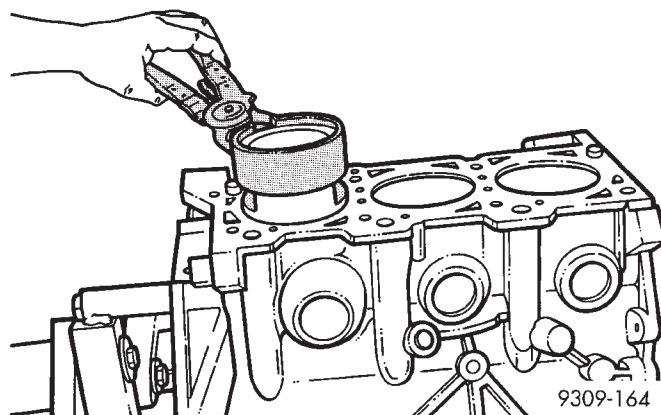


Fig. 100 Piston—Installation

(5) Install connecting rod bolt protectors on rod bolts (Fig. 94).

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

CAUTION: Do Not interchange piston assemblies bank to bank.

(7) The arrow on top of piston must be pointing toward front of engine (Fig. 101) and oil squirt hole on connecting rod faces the major thrust (right) side of the cylinder bore (Fig. 102).

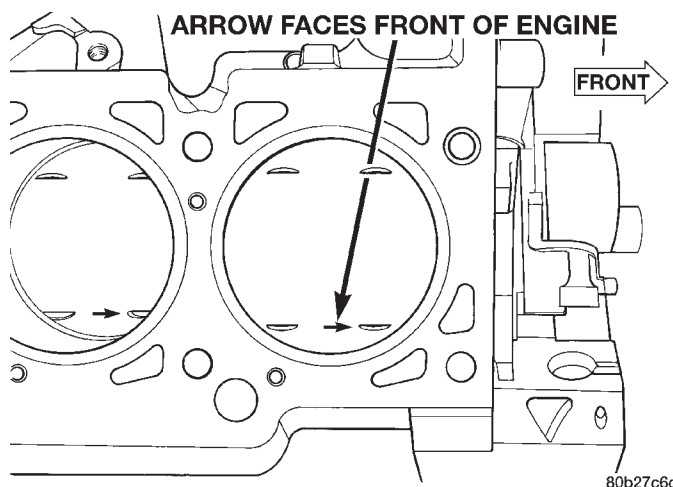
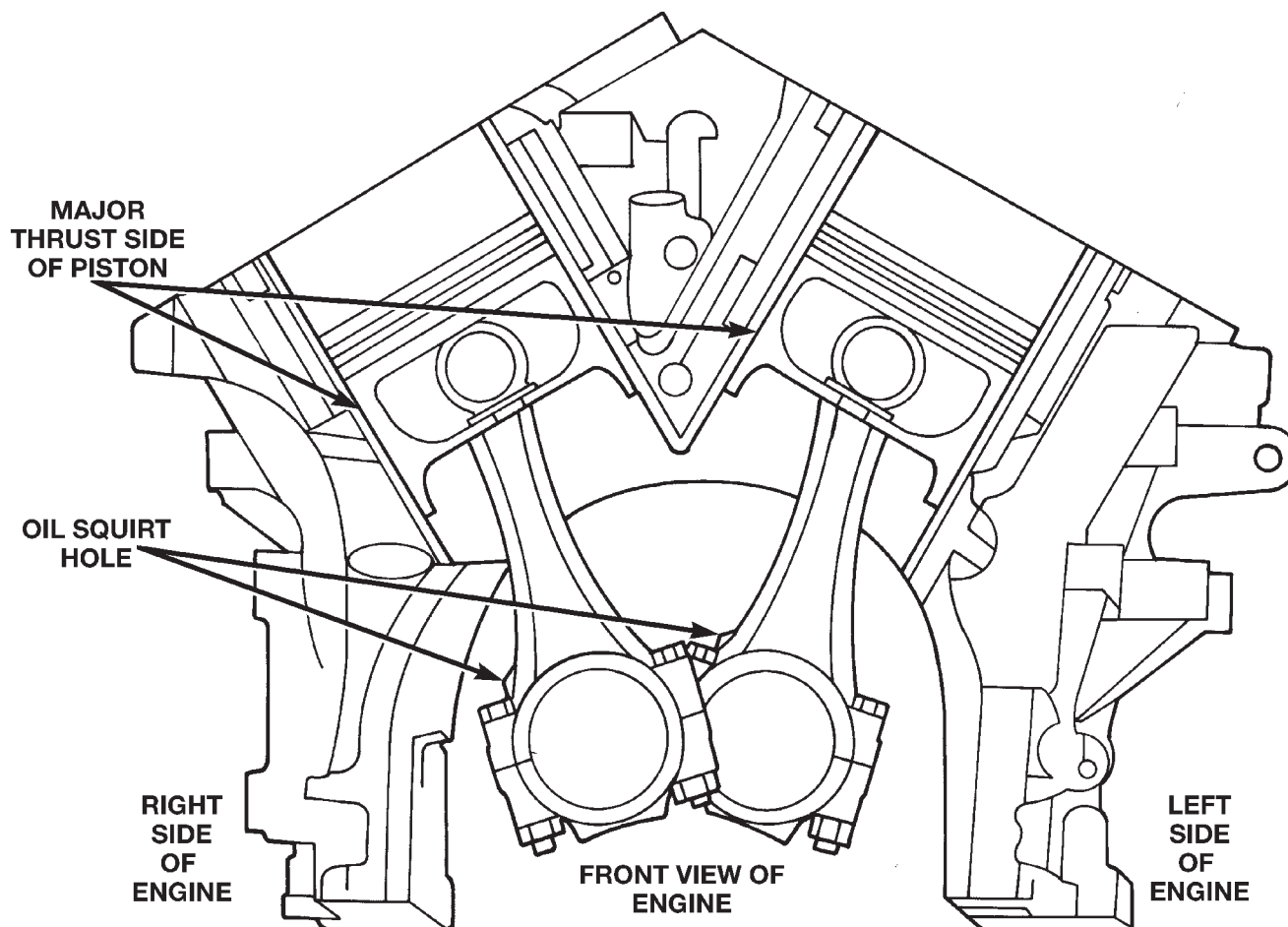


Fig. 101 Piston Orientation

(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.

REMOVAL AND INSTALLATION (Continued)



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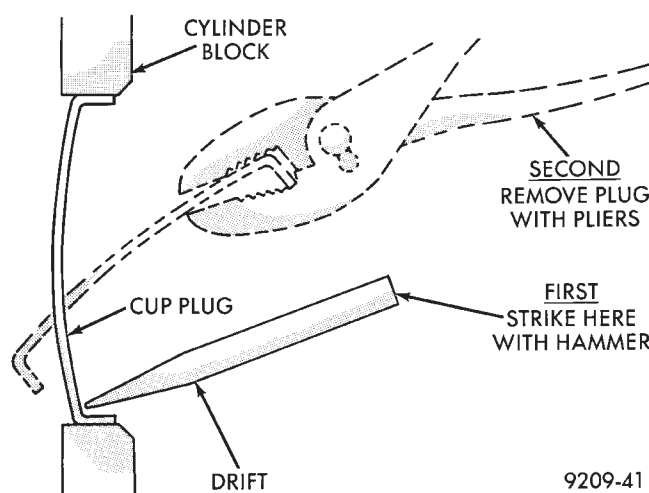
Fig. 102 Connecting Rod Positioning**ENGINE CORE AND OIL PLUGS****REMOVAL**

Using a blunt tool such as a drift and a hammer, strike the bottom edge of the cup plug. With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 103).

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.



9209-41

Fig. 103 Core Hole Plug Removal

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.
- (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. 104).

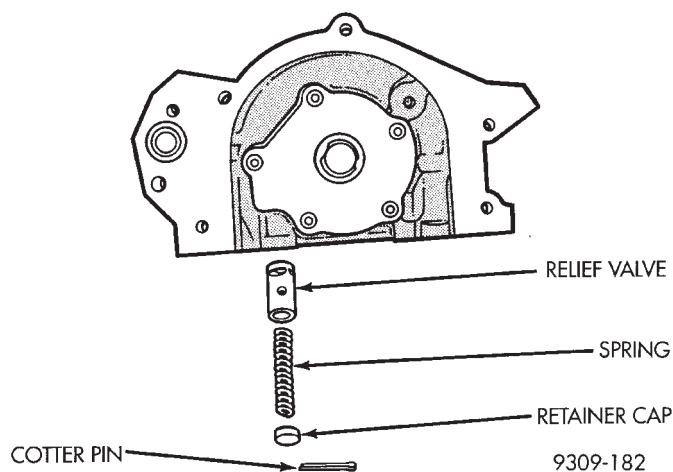


Fig. 104 Oil Pressure Relief Valve

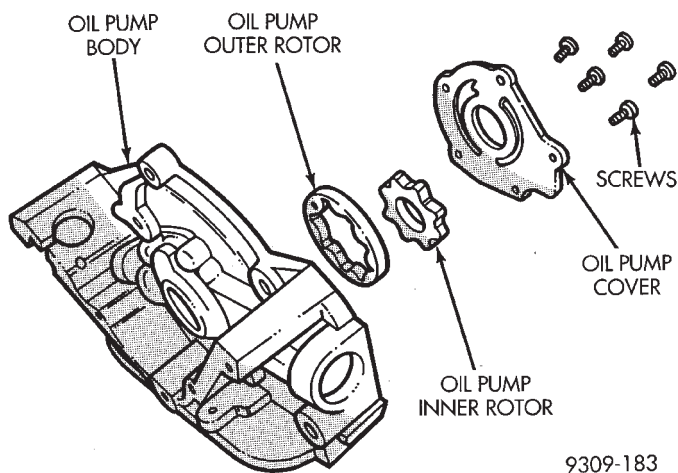


Fig. 105 Oil Pump

- (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. 105).

ROCKER ARMS AND SHAFT ASSEMBLY

DISASSEMBLY

- (1) Remove dowel pin using a 4 mm screw, nut, spacer, and washer installed into the pin (Fig. 106). 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.

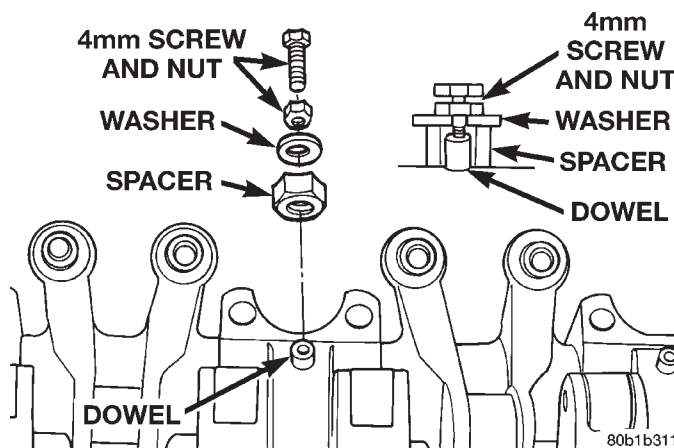


Fig. 106 Rocker Arms and Shaft—Disassembly

- (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. 107). 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.

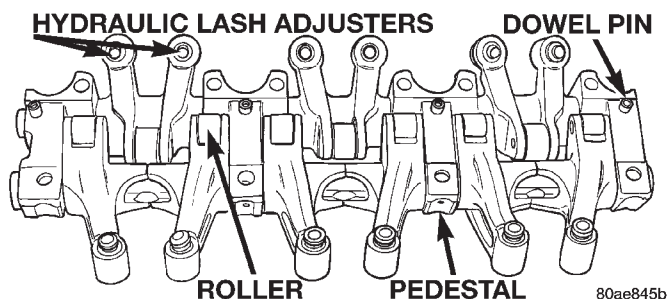


Fig. 107 Assemble Rocker Arms and Shaft

CLEANING AND INSPECTION

CYLINDER HEAD

CLEANING

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

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. 108).

(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.

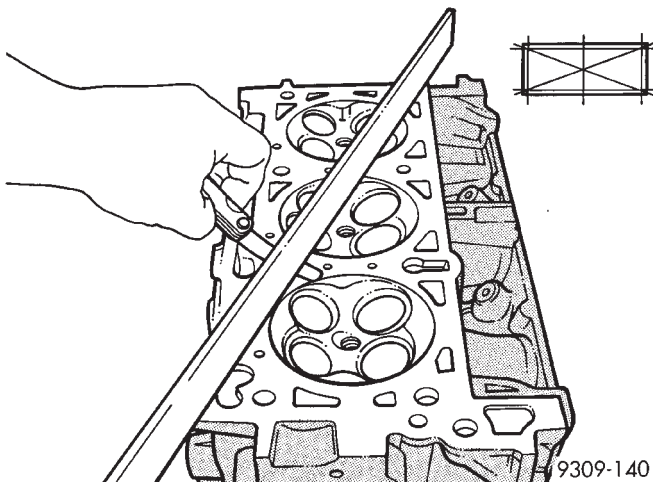
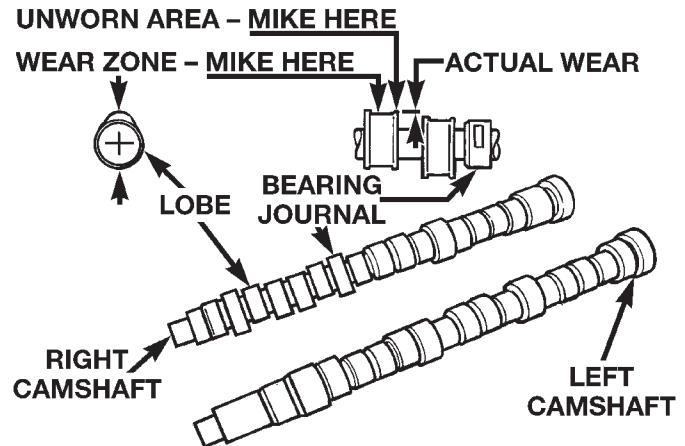


Fig. 108 Checking Cylinder Head Flatness

CAMSHAFT



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Fig. 109 Inspect Camshafts—Typical

(1) Inspect camshaft bearing journals for damage and binding (Fig. 109). 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. 109) 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.

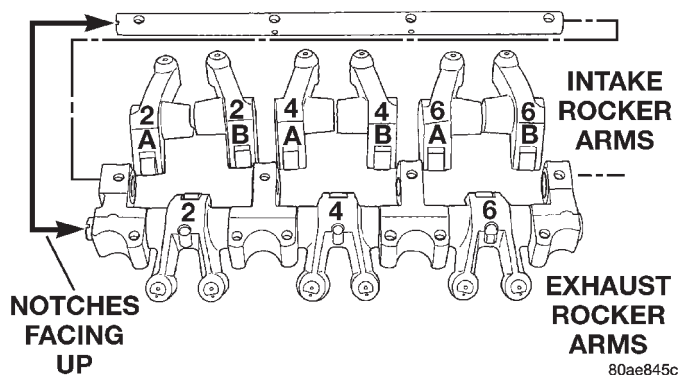
CAUTION: Do not allow rocker arm assembly to rest on lash adjusters, as damage may occur to lash adjuster and plastic retainer.

The intake and exhaust rocker arms are different. They should be identified before disassembling the assembly (Fig. 110).

Check rocker arms for wear or damage (Fig. 111):

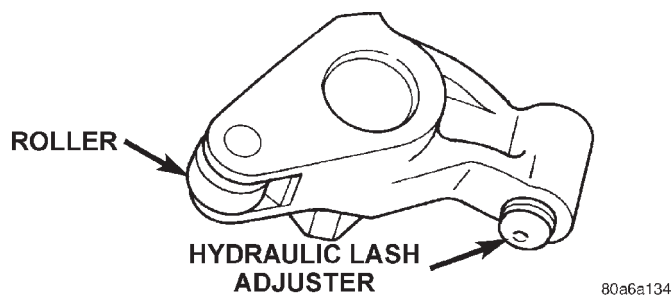
- Roller scuffing or wear
- Shaft bore scuffing or wear
- Swivel pad on lash adjuster missing or broken
- Rocker arm showing signs of fatigue or cracking
- Roller axle protruding from arm

CLEANING AND INSPECTION (Continued)

**Fig. 110 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. 111 Rocker Arm—Inspection****VALVE INSPECTION**

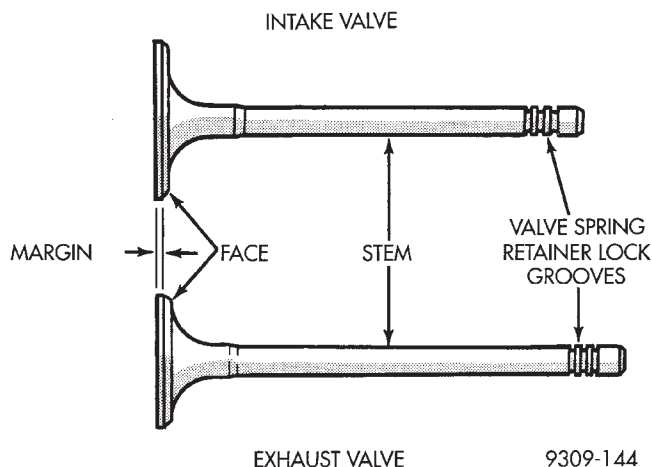
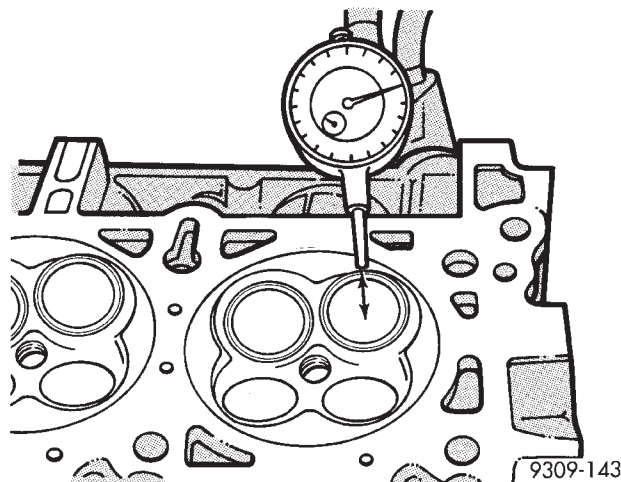
- (1) Clean valves thoroughly and replace burned, warped and cracked valves.
- (2) Measure valve stems for wear (Fig. 112). Refer to Valve Specification Chart.

NOTE: Valve stems are chrome plated and should not be polished (Fig. 112).

- (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. 113).
- (4) Move valve to and from the indicator. Refer to Valve Guide Specification Chart.

**Fig. 112 Intake and Exhaust Valves****Fig. 113 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.)

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)

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

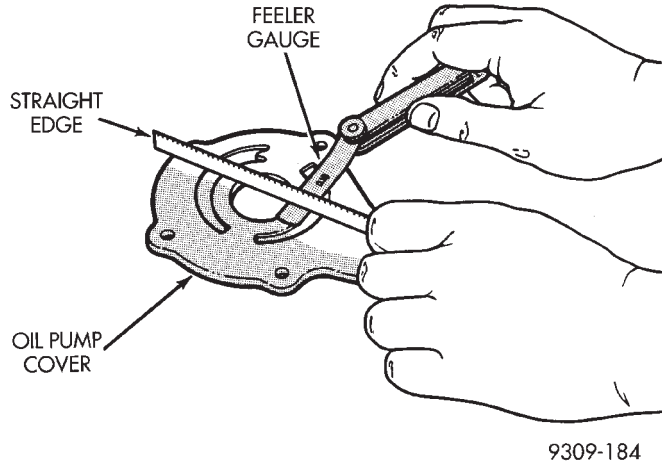


Fig. 114 Checking Oil Pump Cover Flatness

(3) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 14.299 mm (0.563 in.) or less (Fig. 115), or if the diameter is 79.78 mm (3.141 inches.) or less, replace outer rotor.

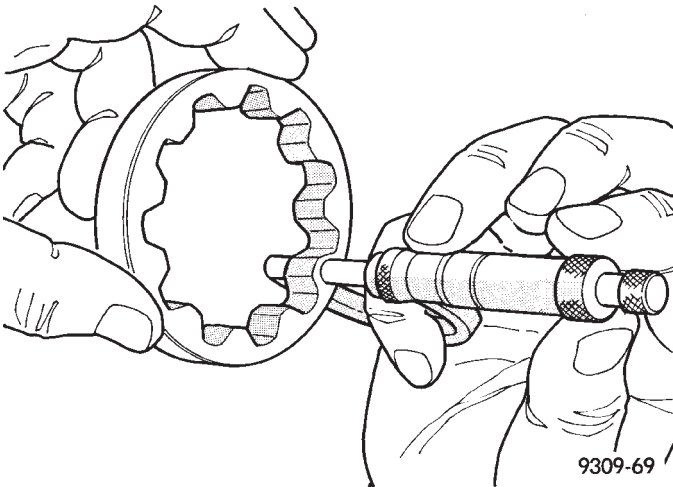


Fig. 115 Measuring Outer Rotor Thickness

(4) If inner rotor measures 14.299 mm (0.563 in.) or less replace inner rotor (Fig. 116).

(5) Slide outer rotor into body, press to one side with fingers and measure clearance between rotor and body (Fig. 117). If measurement is 0.39 mm (0.015 inch.) or more, replace body only if outer rotor is in specifications.

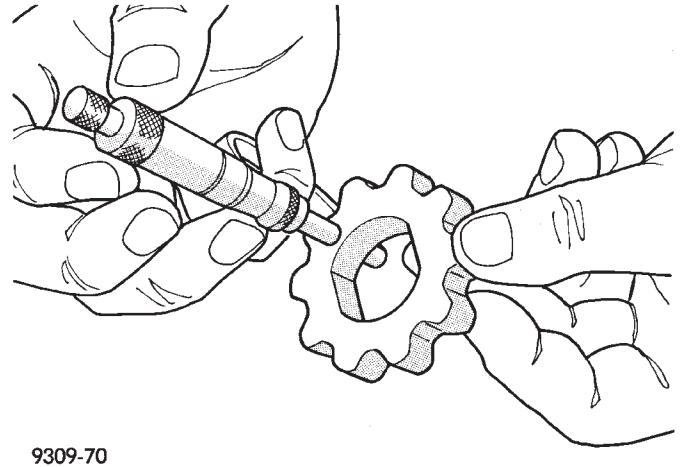


Fig. 116 Measuring Inner Rotor Thickness

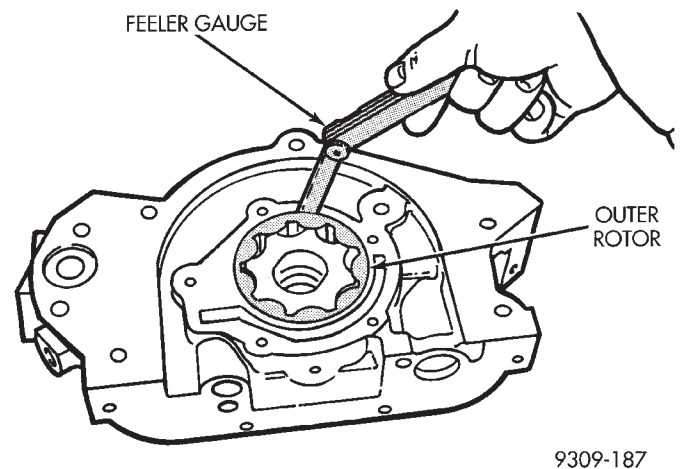


Fig. 117 Measuring Outer Rotor Clearance in Housing

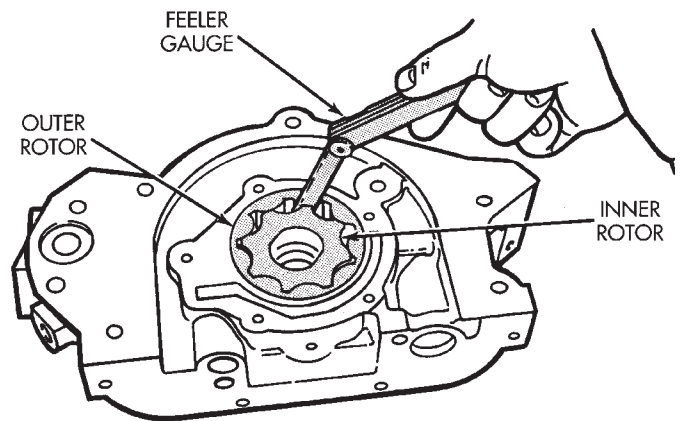


Fig. 118 Measuring Clearance Between Rotors

(6) Install inner rotor into body. If clearance between inner and outer rotors (Fig. 118) is 0.20 mm (0.008 inch.) or more, replace both rotors.

CLEANING AND INSPECTION (Continued)

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

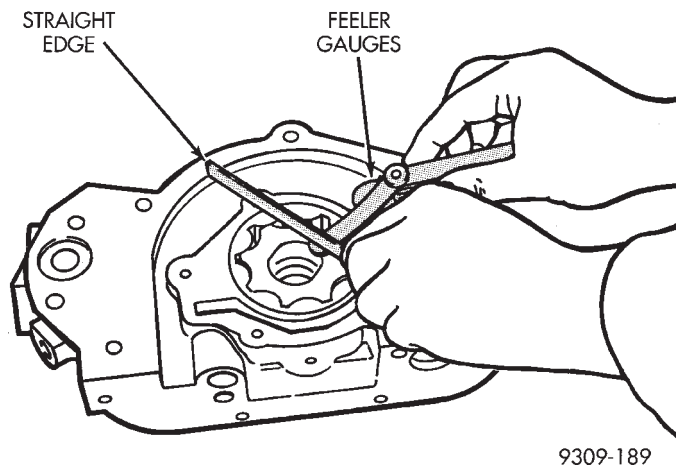


Fig. 119 Measuring Clearance Over Rotors

(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. 120). 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.

NOTE: Refer to Honing Cylinder Bores outlined in the Standard Service Procedures for specification and procedures.

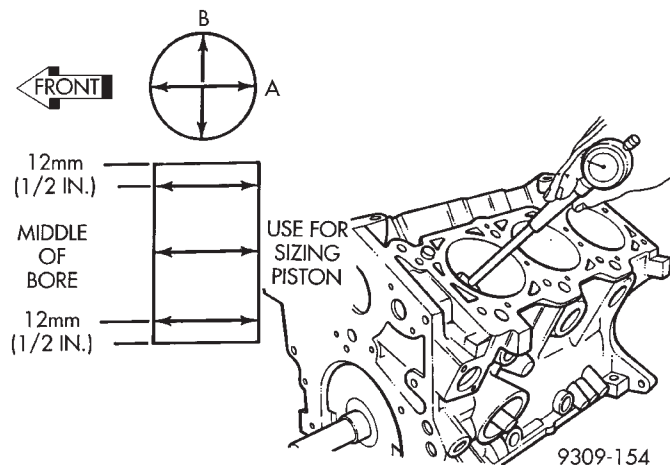


Fig. 120 Checking Cylinder Bore Size

Measure the cylinder bore at three levels in directions A and B (Fig. 120). 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.

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 07, Accessory Drive System for procedure.
- (2) Remove timing belt covers. Refer to procedure outline in this section.
- (3) Inspect both sides of the timing belt. Replace belt if any of the following conditions exist:
 - 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.

CLEANING AND INSPECTION (Continued)

CYLINDER BORE AND PISTON SPECIFICATION CHART

ENGINE	STANDARD CYLINDER BORE	MAXIMUM OUT-OF-ROUND	MAXIMUM TAPER	STANDARD PISTON SIZE
3.2L	92.0 mm (3.622 in.)	0.076 mm (0.003 in.)	0.051 mm (0.002 in.)	91.980 $\pm$ 0.019mm (3.6213 $\pm$ 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.				

• Abnormal wear of belt sides. The sides are normal if they are sharp as if cut by a knife (Fig. 121).

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

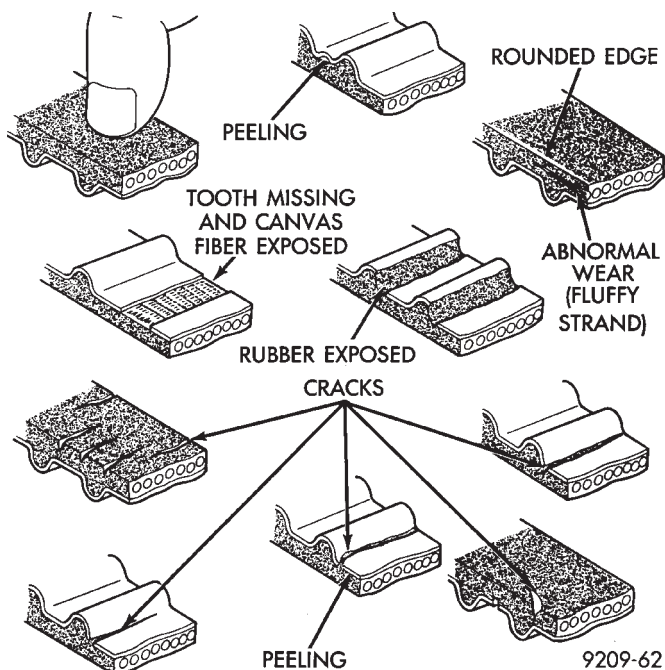


Fig. 121 Timing Belt Inspection

SPECIFICATIONS

3.2L ENGINE

CYLINDER BLOCK

Cylinder Bore Diameter 92.0 mm (3.622 in.)

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

Taper (Max) 0.051 mm (0.002 in.)

PISTONS

Type Material Aluminum with struts

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

PISTON WEIGHT

A Size . . 409 – 414 grams (14.4271 – 14.6035 oz.)

B Size . . . 404 – 409 grams (14.2507 – 14.427 oz.)

PISTON RING GROOVE DIAMETER

No. 1 83.69 – 83.89 mm (3.2949 – 3.3028 in.)

No. 2 81.12 – 81.32 mm (3.1937 – 3.2016 in.)

CYLINDER BLOCK

No. 3 82.3 – 82.5 mm (3.2402 – 3.2481 in.)

PISTON PINS

Type Full Floating

Clearance In Piston 0.005 – 0.015 mm
(0.0002 – 0.0006 in.)

Clearance In rod 0.007 – 0.018 mm
(0.0003 – 0.0007 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 . 0.22 – 0.49 mm
(0.0087 – 0.0193 in.)

Ring Gap Oil Control (Steel Rails) .025 – 0.76 mm
(0.010 – 0.030 in.)

RING SIDE CLEARANCE

Top and Second Compression Ring . 0.040 – 0.080 mm
(0.0016 – 0.0031 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 – 0.0587 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.)

Max. Allowable 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 – 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.)

SPECIFICATIONS (Continued)

Cylinder Bore Diameter 92.0 mm (3.622 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) 1°
 Closes (ABDC) 51°
 Duration 230°
 Centerline 116°

VALVE TIMING EXHAUST VALVE

Opens (BBDC) 48°
 Closes (ATDC) 12°
 Duration 240°
 Centerline 108°
 Valve Overlap 11°

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 in.)
 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.)

Cylinder Bore Diameter 92.0 mm (3.622 in.)
 Stem-to-Guide Clearance Intake (New) . . . 0.022 –
 0.065 mm (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 @
 @ 29.45 mm (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 (Approx.) 6.86
 Number of Coils Exhaust (Approx.) 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 – 4.35 mm
 (0.1689 – 0.1712 in.)
 Wire Diameter Exhaust 4.09 – 4.15 mm
 (0.1608 – 0.1632 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.) . . 9.401 mm
 (0.370 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 – 530 kPa (25 – 80 psi)

SPECIFICATIONS (Continued)

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

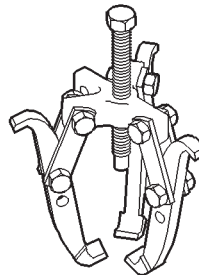
TORQUE CHART

DESCRIPTION	TORQUE
A/C Compressor 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	102 N·m (75 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.
Exhaust Pipe Flange	
Nuts	34 N·m (25 ft. lbs.)
Engine Mount Bracket to Block	
Bolts	61 N·m (45 ft. lbs.)
Engine Mount Isolator	
Nuts	61 N·m (45 ft. lbs.)
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	12 N·m (105 in. lbs.)
Oil Pan Drain	
Plug	35 N·m (25 ft. lbs.)
Oil Filter	20 N·m (15 ft. lbs.)
Oil Pump Cover	
Bolts	12 N·m (105 in. lbs.)

DESCRIPTION	TORQUE
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.)
Spark Plug	
Tubes	61 N·m (45 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.)

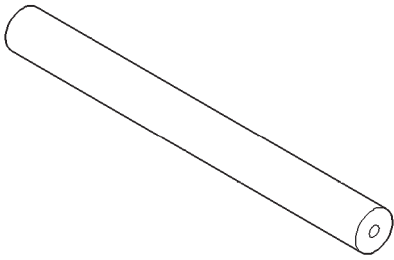
SPECIAL TOOLS

3.2L ENGINE

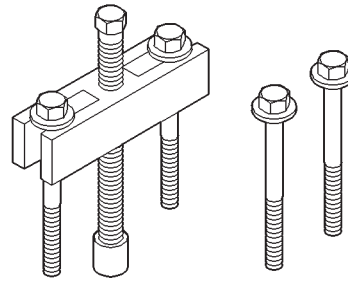


Puller Damper 1023

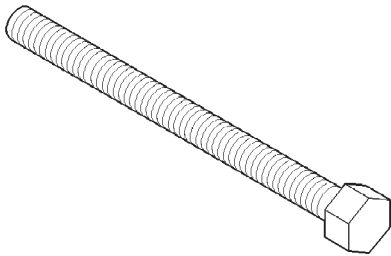
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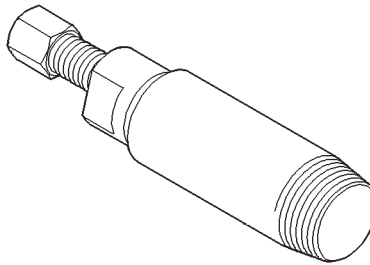
Crankshaft Damper Remove Insert C-4685-C2



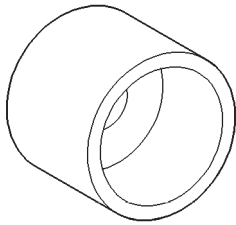
Crankshaft Sprocket Puller L-4407A



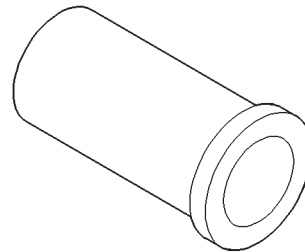
Crankshaft Damper Installer Bolt C-4685-C1



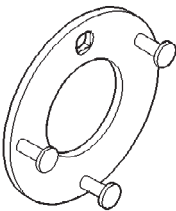
Crankshaft Seal Remover 6341A



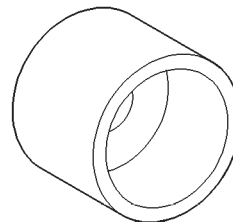
Crankshaft Damper Installer 6792-1



Crankshaft Seal Installer 6342

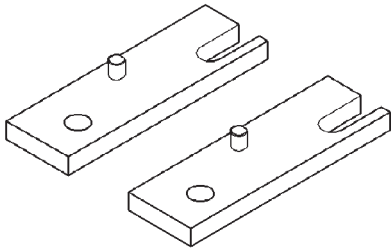


Crankshaft Damper Holder 8191

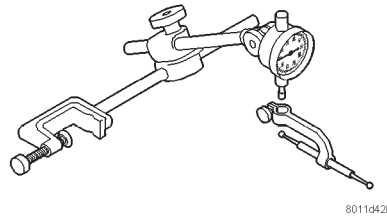


Crankshaft Sprocket Installer 6641

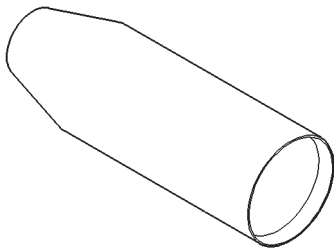
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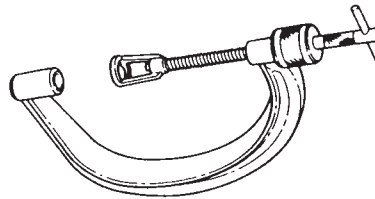
Camshaft Alignment 6642



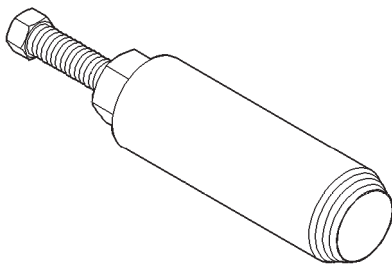
Dial Indicator C-3339



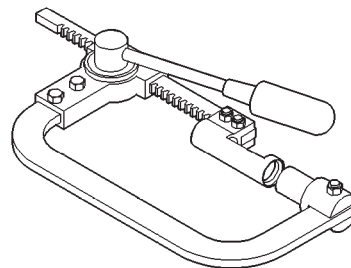
Camshaft Seal Protector 6788



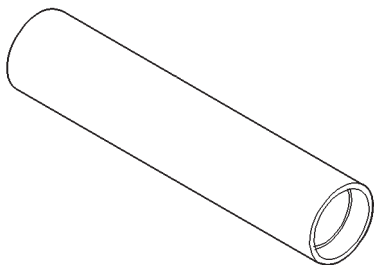
Valve Spring Compressor 7068



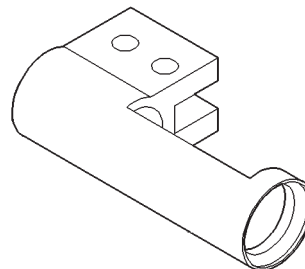
Camshaft Seal Remover C-3981B



Valve Spring Compressor C-3422-B

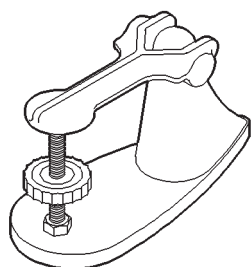


Camshaft Seal Installer 6052

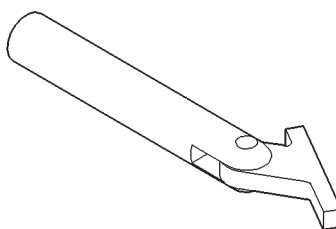


Valve Spring Adapter 6526

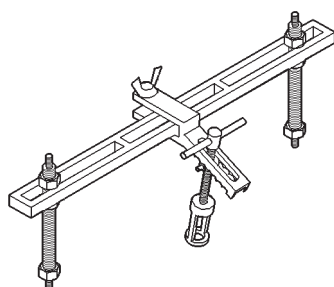
SPECIAL TOOLS (Continued)



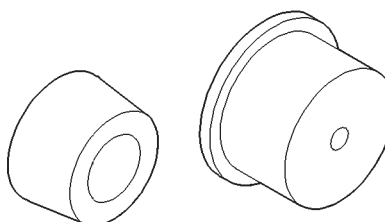
Valve Spring Tester C-647



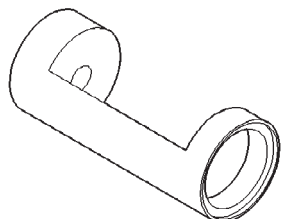
Main Bearing Remover/Installer C-3059



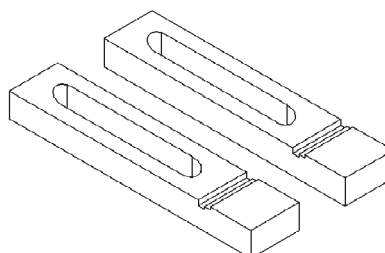
Valve Spring Compressor MD-998772-A



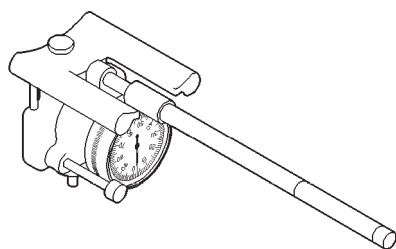
Crankshaft Rear Seal Guide 6926-1 & Installer 6926-2



Valve Spring Adapter 6527

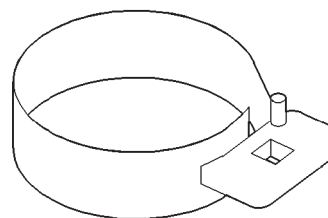


Crankshaft Rear Seal Retainer Alignment Fixture 8225



8011c9fa

Indicator Bore Size C-119



8011d480

Wrench Oil Filter C-4065