ENGINE

TABLE OF CONTENTS

STANDARD SERVICE PROCEDURES

TABLE OF CONTENTS

GENERAL INFORMATION

FORM-IN-PLACE GASKETS & SEALERS

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

There are numerous types of form-in-place gasket materials that are used in the engine area. Mopar® Engine RTV GEN II, Mopar® ATF-RTV, and Mopar® Gasket Maker gasket materials, each have different properties and can not be used in place of the other.

MOPAR® ENGINE RTV GEN II

Mopar® Engine RTV GEN II is used to seal components exposed to engine oil. This material is a specially designed black silicone rubber RTV that retains adhesion and sealing properties when exposed to engine oil. Moisture in the air causes the material to cure. This material is available in three ounce tubes and has a shelf life of one year. After one year this material will not properly cure. Always inspect the package for the expiration date before use.

MOPAR® ATF RTV

Mopar® ATF RTV is a specifically designed black silicone rubber RTV that retains adhesion and sealing properties to seal components exposed to automatic transmission fluid, engine coolants, and moisture. This material is available in three ounce tubes and has a shelf life of one year. After one year this material will not properly cure. Always inspect the package for the expiration date before use.

MOPAR® GASKET MAKER

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

MOPAR® BED PLATE SEALANT

Mopar® Bed Plate Sealant is a unique (green-in-color) anaerobic type gasket material that is specially made to seal the area between the bedplate and cylinder block without disturbing the bearing clearance or alignment of these components. The material cures slowly in the absence of air when torqued between two metallic surfaces, and will rapidly cure when heat is applied.

GENERAL INFORMATION (Continued)

MOPAR® GASKET SEALANT

Mopar® Gasket Sealant is a slow drying, permanently soft sealer. This material is recommended for sealing threaded fittings and gaskets against leakage of oil and coolant. Can be used on threaded and machined parts under all temperatures. This material is used on engines with multi-layer steel (MLS) cylinder head gaskets. This material also will prevent corrosion. Mopar® Gasket Sealant is available in a 13 oz. aerosol can or 4 oz./16 oz. can w/applicator.

FORM-IN-PLACE GASKET AND SEALER APPLICATION

Assembling parts using a form-in-place gasket requires care but it's easier then using precut gaskets.

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

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

Mopar® Gasket Sealant in an aerosol can should be applied using a thin, even coat sprayed completely over both surfaces to be joined, and both sides of a gasket. Then proceed with assembly. Material in a can w/applicator can be brushed on evenly over the sealing surfaces. Material in an aerosol can should be used on engines with multi-layer steel gaskets.

ENGINE GASKET SURFACE PREPARATION

To ensure engine gasket sealing, proper surface preparation must be performed, especially with the use of aluminum engine components and multi-layer steel cylinder head gaskets.

Never use the following to clean gasket surfaces:

- Metal scraper
- Abrasive pad or paper to clean cylinder block and head
- High speed power tool with an abrasive pad or a wire brush (Fig. 1)

NOTE: Multi-Layer Steel (MLS) head gaskets require a scratch free sealing surface.

Only use the following for cleaning gasket surfaces:

- Solvent or a commercially available gasket remover
- Plastic or wood scraper (Fig. 1)
- Drill motor with 3M Roloc™ Bristle Disc (white or yellow) (Fig. 1)

CAUTION: Excessive pressure or high RPM can damage the sealing surfaces. The mild (white, 120 grit) bristle disc is recommended. If necessary, the medium (yellow, 80 grit) bristle disc may be used on cast iron surfaces with care.

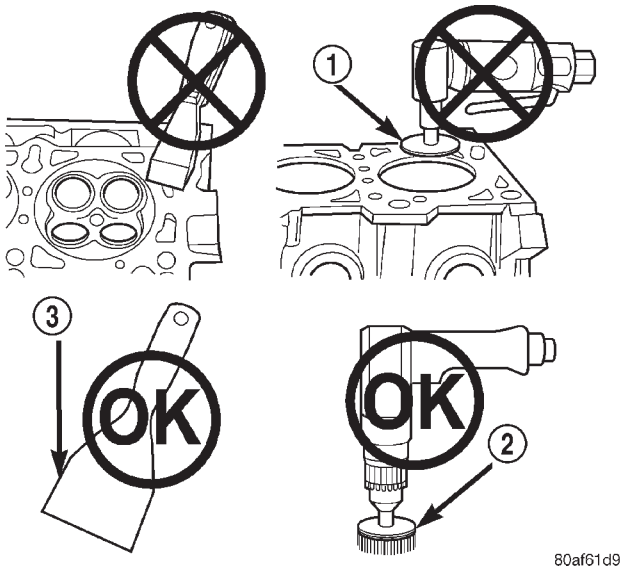


Fig. 1 Proper Tool Usage For Surface Preparation

1 – ABRASIVE PAD
2 – 3M ROLOC™ BRISTLE DISC
3 – PLASTIC/WOOD SCRAPER

CRANKSHAFT DAMPER BOLT ACCESS PLUG

An access plug is located in the right splash shield (Fig. 2). Remove the plug and insert the proper size socket, extension and ratchet, when crankshaft rotation is necessary.

ENGINE CORE PLUGS

REMOVAL

Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup plug (Fig. 3). With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 3).

GENERAL INFORMATION (Continued)

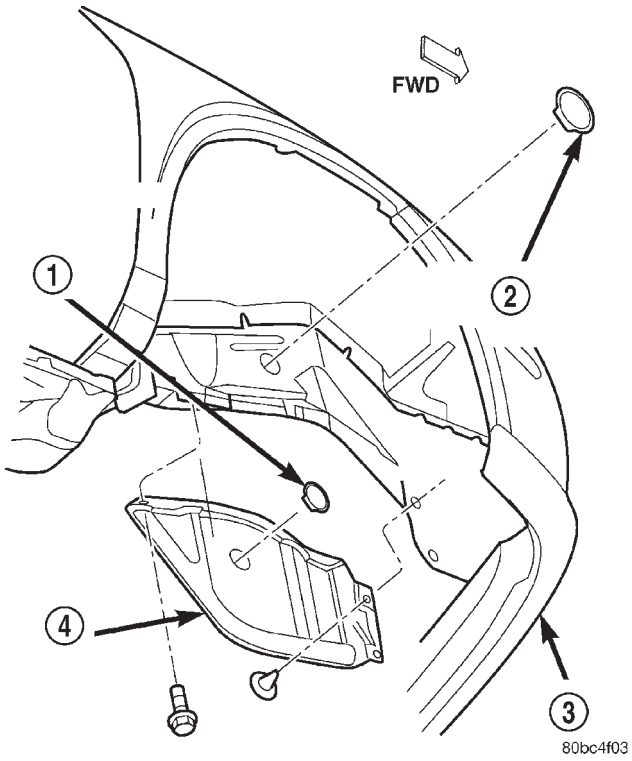


Fig. 2 Access Plug

1 – CRANKSHAFT BOLT ACCESS PLUG
2 – RIGHT MOUNT BOLT ACCESS PLUG
3 – FASCIA
4 – SPLASH SHIELD

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

INSTALLATION

Thoroughly clean all debris/rust from 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 Adhesive. Make certain the new plug is cleaned of all oil or grease. Using a proper driver, drive plug into hole so that the sharp edge of the plug is at least 0.5 mm (0.020 inch.) inside the lead in chamfer (Fig. 3).

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

ENGINE PERFORMANCE

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

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

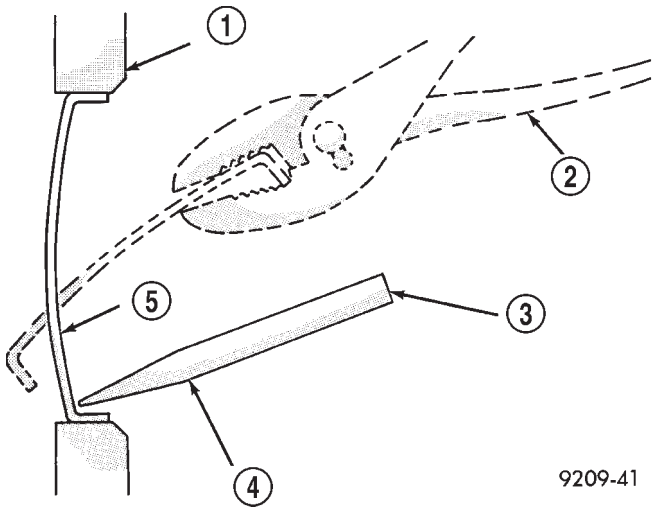


Fig. 3 Core Hole Plug Removal

1 – CYLINDER BLOCK
2 – REMOVE PLUG WITH PLIERS
3 – STRIKE HERE WITH HAMMER
4 – DRIFT PUNCH
5 – CUP PLUG

(1) Test cranking amperage draw. Refer to Group 8B, Starting.

(2) Check intake manifold for vacuum leaks.

(3) Perform cylinder compression pressure test. Refer to Engine Diagnosis 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) Check fuel pump pressure at idle and different RPM ranges. Refer to Group 14, Fuel System for specifications.

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

(9) Inspect crankcase ventilation system. Refer to Group 25, Emission Control Systems.

(10) Road test vehicle as a final test.

HONING CYLINDER BORES

(1) Used carefully, the cylinder bore resizing hone, recommended tool C-823 or equivalent, equipped with 220 grit stones, is the best tool for this honing procedure. 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

GENERAL INFORMATION (Continued)

will clean up a bore and maintain the required limits.

(2) Deglazing of the cylinder walls may be done using a cylinder surfacing hone, recommended tool C-3501 or equivalent, 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. 4).

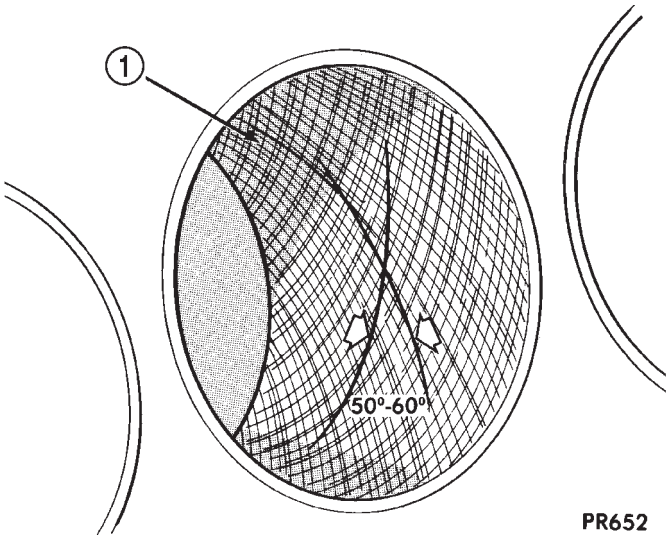


Fig. 4 Cylinder Bore Cross-Hatch Pattern

1 – CROSS-HATCH PATTERN

(4) A controlled hone motor speed between 200–300 RPM is necessary to obtain the proper cross-hatch angle. The number of up and down strokes per minute can be regulated to get the desired 50–60 degree angle. Faster up and down strokes increase the cross-hatch angle.

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

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

MEASURING WITH PLASTIGAGE

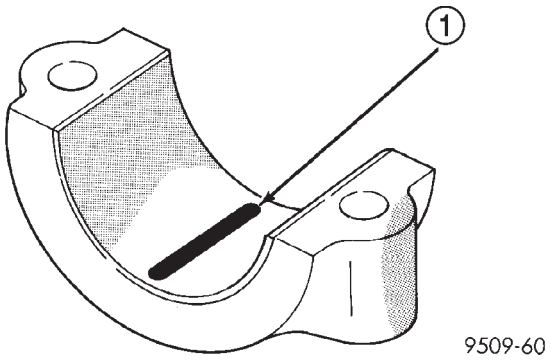


Fig. 5 Plastigage Placed in Lower Shell

1 – PLASTIGAGE

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

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

ENGINE WITH 5 MAIN BEARINGS

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

ENGINE WITH 4 MAIN BEARING

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

GENERAL INFORMATION (Continued)

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

NOTE: REMOVE ALL SHIMS BEFORE REASSEMBLING ENGINE

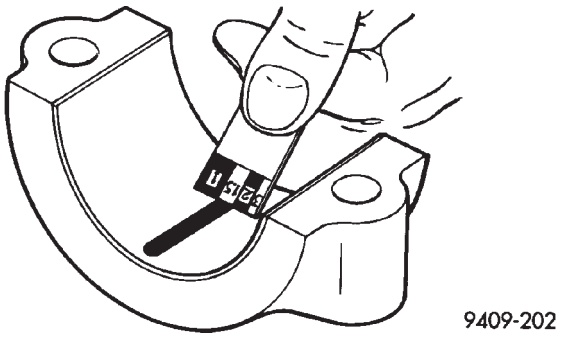


Fig. 6 Clearance Measurement

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. 5). (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. 6) 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. 5). In addition, suspect areas can be checked by placing plastigage in that 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. 6) 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 wear limit specification, replace the bearing.**

REPAIR OF DAMAGED OR WORN THREADS

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

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

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

HYDROSTATIC LOCKED ENGINE

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

CAUTION: DO NOT use starter motor to rotate the 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

GENERAL INFORMATION (Continued)

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 re-occurring.

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

(8) Install new spark plugs.

(9) Drain engine oil and remove oil filter.

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

(11) Connect negative battery cable.

(12) Start engine and check for any leaks.

CHECKING ENGINE OIL LEVEL

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

Checking the oil while the vehicle is on level ground will improve the accuracy of the oil level reading. Remove dipstick (Fig. 7) and observe oil level. Add oil only when the level is at or below the ADD mark (Fig. 8).

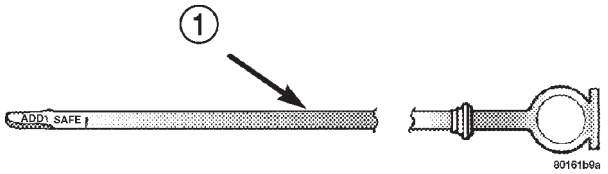


Fig. 8 Oil Level

1 – ENGINE OIL LEVEL DIPSTICK

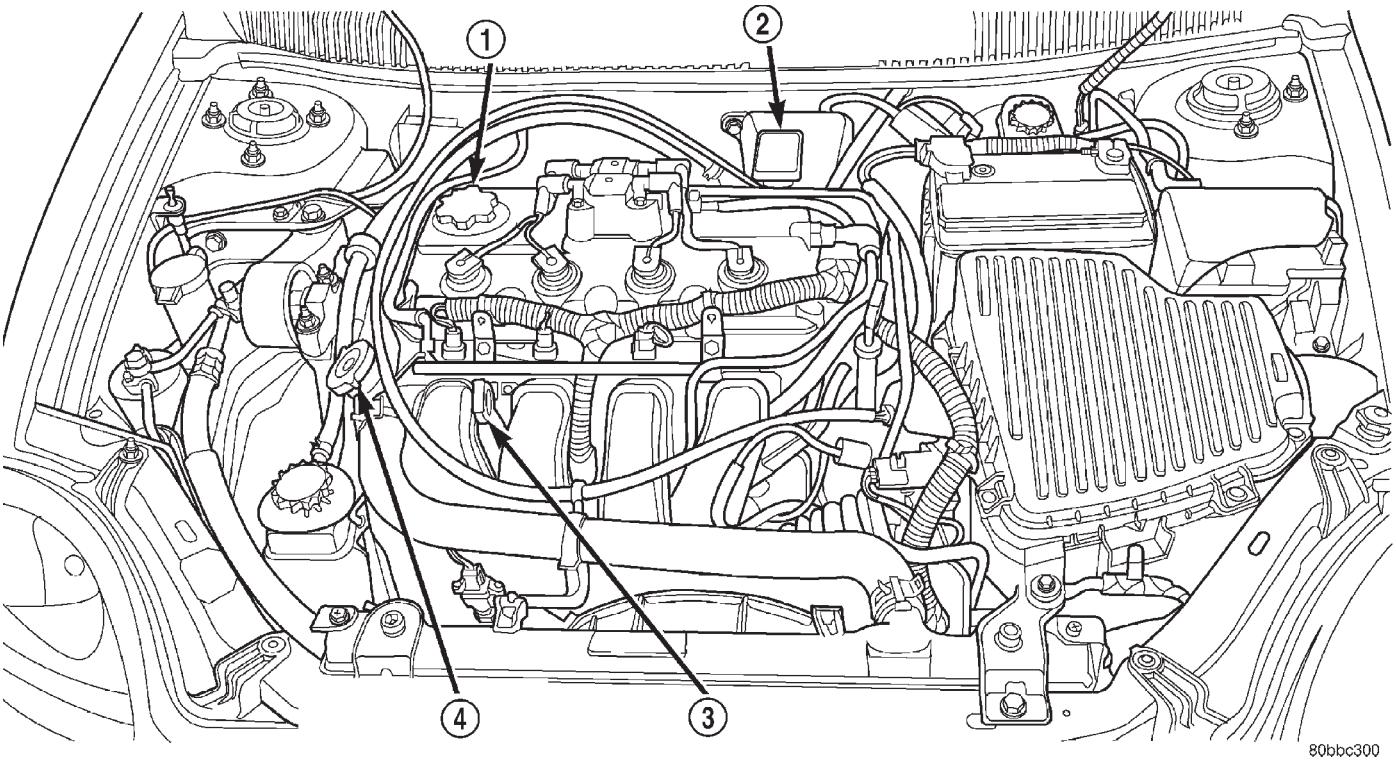


Fig. 7 Dipstick and Engine Oil Fill Locations

1 – ENGINE OIL FILL
2 – ENGINE COOLANT RECOVERY CONTAINER
3 – ENGINE OIL DIPSTICK
4 – COOLING SYSTEM PRESSURE CAP

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.

ENGINE OIL SPECIFICATION

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

API SERVICE GRADE CERTIFIED

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

SAE VISCOSITY

An SAE viscosity grade is used to specify the viscosity of engine oil. Use only, engine oils with multiple viscosities such as 5W-30 or 10W-30. These are specified with a dual SAE viscosity grade which indicates the cold-to-hot temperature viscosity range. SAE 5W-30 engine oil is preferred. Select an engine oil that is best suited to your particular temperature range and variation (Fig. 9).

ENERGY CONSERVING OIL

An Energy Conserving type oil is recommended for gasoline engines. The designation of ENERGY CONSERVING is located on the label of the 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. 10).

ENGINE OIL CHANGE

Change engine oil at mileage and time intervals described in the Group 0, Lubrication and Maintenance.

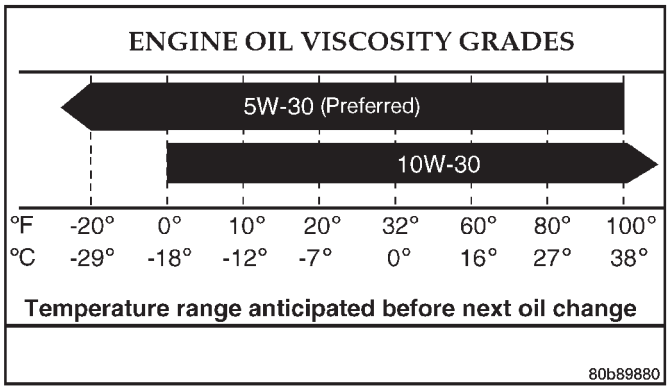


Fig. 9 Temperature/Engine Oil Viscosity

9400-9

Fig. 10 Engine Oil Container Standard Notations

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 Group 0, Lubrication and Maintenance for Hoisting and Jacking Recommendations.

(3) Remove oil fill cap.

(4) Place a suitable drain pan under crankcase drain.

(5) Remove drain plug from crankcase and allow oil to drain into pan. Inspect drain plug threads for stretching or other damage. Replace drain plug and gasket if damaged.

(6) Install drain plug in crankcase.

(7) Lower vehicle and fill crankcase with specified type and amount of engine oil described in this section.

(8) Install oil fill cap.

(9) Start engine and inspect for leaks.

(10) Stop engine and inspect oil level.

ENGINE DIAGNOSIS

TABLE OF CONTENTS

DIAGNOSIS AND TESTING

GENERAL INFORMATION

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

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

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

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

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

INTAKE MANIFOLD LEAKAGE DIAGNOSIS

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

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

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

CYLINDER COMPRESSION PRESSURE TEST

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

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

(1) Check engine oil level and add oil if necessary.
(2) Drive the vehicle until engine reaches normal operating temperature. Select a route free from traffic and other forms of congestion, observe all traffic laws, and accelerate through the gears several times briskly.
(3) Remove all spark plugs from engine. As spark plugs are being removed, check electrodes for abnormal firing indicators fouled, hot, oily, etc. Record cylinder number of spark plug for future reference.
(4) Disconnect coil wire from distributor and secure to good ground to prevent a spark from starting a fire (Conventional Ignition System). For Direct Ignition System DIS disconnect the coil connector.
(5) Be sure throttle blade is fully open during the compression check.
(6) Insert compression gage adaptor into the #1 spark plug hole in cylinder head. Crank engine until maximum pressure is reached on gage. Record this pressure as #1 cylinder pressure.
(7) Repeat the previous step for all remaining cylinders.
(8) Compression should not be less than (689 kPa) 100 psi and not vary more than 25 percent from cylinder to cylinder.
(9) If one or more cylinders have abnormally low compression pressures, repeat the compression test.
(10) If the same cylinder or cylinders repeat an abnormally low reading on the second compression test, it could indicate the existence of a problem in the cylinder in question. **The recommended compression pressures are to be used only as a guide to diagnosing engine problems. An engine**

DIAGNOSIS AND TESTING (Continued)

should not be disassembled to determine the cause of low compression unless some malfunction is present.

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

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

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

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

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

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

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

(18) Road test vehicle as a final test.

CYLINDER COMBUSTION PRESSURE LEAKAGE TEST

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

Combustion pressure leakage testing will detect:

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

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

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

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

Clean spark plug recesses with compressed air.

Remove the spark plugs.

Remove the oil filler cap.

Remove the air cleaner.

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

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

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

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

LASH ADJUSTER (TAPPET) NOISE DIAGNOSIS

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

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

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

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

(4) Low oil pressure.

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

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

(7) Worn valve guides.

(8) Rocker arm ears contacting valve spring retainer.

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

(10) Faulty lash adjuster.

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

b. Remove suspected rocker arms (sohc) or lash adjuster (dohc) and replace.

ENGINE OIL LEAK INSPECTION

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

DIAGNOSIS AND TESTING (Continued)

make sure the dye is thoroughly mixed as indicated with a bright yellow color under a black light.

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

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

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

- Disconnect the fresh air hose (makeup air) at the cylinder head cover and plug or cap the nipple on the cover.
- Remove the PCV valve hose from the cylinder head cover. Cap or plug the PCV valve nipple on the cover.
- Attach an air hose with pressure gauge and regulator to the dipstick tube.

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

- Gradually apply air pressure from 1 psi to 2.5 psi maximum while applying soapy water at the suspected source. Adjust the regulator to the suitable test pressure that provides 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 crankshaft 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. Remove the air hose, all plugs, and caps. Install the PCV valve and CCV 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 previously described.

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 Crankshaft Oil Seal—Rear for proper replacement procedures.

DIAGNOSIS AND TESTING (Continued)

ENGINE DIAGNOSIS—PERFORMANCE

CONDITION	POSSIBLE CAUSE	CORRECTION
ENGINE WILL NOT START	1. Weak battery.	1. Test battery. Charge or replace as necessary. Refer to Group 8A, Battery.
	2. Corroded or loose battery connections.	2. Clean and tighten battery connections. Apply a coat of light mineral grease to terminals.
	3. Faulty starter.	3. Test starting system. Refer to Group 8B, Starting.
	4. Faulty coil(s) or control unit.	4. Test and replace as needed. Refer to Group 8D, Ignition System.
	5. Incorrect spark plug gap.	5. Set gap. Refer to Group 8D, Ignition System.
	6. Contamination in fuel system.	6. Clean system and replace fuel filter.
	7. Faulty fuel pump.	7. Test fuel pump and replace as needed. Refer to Group 14, Fuel System.
	8. Incorrect engine timing.	8. Check for a skipped timing belt/chain.
ENGINE STALLS OR IDLES ROUGH	1. Idle speed too low.	1. Test minimum air flow. Refer to Group 14, Fuel System.
	2. Incorrect fuel mixture.	2. Refer to Group 14, Fuel System.
	3. Intake manifold leakage.	3. Inspect intake manifold, manifold gasket, and vacuum hoses.
	4. Faulty coil(s).	4. Test and replace as necessary. Refer to Group 8D, Ignition System.
ENGINE LOSS OF POWER	1. Dirty or incorrectly gapped plugs.	1. Clean plugs and set gap. Refer to Group 8D, Ignition System.
	2. Contamination in fuel system.	2. Clean system and replace fuel filter.
	3. Faulty fuel pump.	3. Test and replace as necessary. Refer to Group 14, Fuel System.
	4. Incorrect valve timing.	4. Correct valve timing.
	5. Leaking cylinder head gasket.	5. Replace cylinder head gasket.
	6. Low compression.	6. Test compression of each cylinder.
	7. Burned, warped, or pitted valves.	7. Replace valves.
	8. Plugged or restricted exhaust system.	8. Install new parts, as necessary.
	9. Faulty coil(s).	9. Test and replace as necessary. Refer to Group 8D, Ignition System.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTION
ENGINE MISSES ON ACCELERATION	1. Dirty or incorrectly gapped spark plugs.	1. Clean spark plugs and set gap. Refer to Group 8D, Ignition System.
	2. Contamination in Fuel System.	2. Clean fuel system and replace fuel filter.
	3. Burned, warped, or pitted valves.	3. Replace valves.
	4. Faulty coil(s).	4. Test and replace as necessary. Refer to Group 8D, Ignition System.
ENGINE MISSES AT HIGH SPEED	1. Dirty or incorrect spark plug gap.	1. Clean spark plugs and set gap. Refer to Group 8D, Ignition System.
	2. Faulty coil(s).	2. Test and replace as necessary. Refer to Group 8D, Ignition System.
	3. Dirty fuel injector(s).	Test and replace as necessary. Refer to Group 14, Fuel System.
	4. Contamination in 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.	1. Check and correct engine oil level.
	2. Thin or diluted oil.	2. Change oil to correct viscosity.
	3. Low oil pressure.	3. Check and correct engine oil level.
	4. Dirt in tappets/lash adjusters.	4. Replace rocker arm/hydraulic lash adjuster assembly.
	5. Worn rocker arms.	5. Inspect oil supply to rocker arms.
	6. Worn tappets/lash adjusters.	6. Install new rocker arm/hydraulic lash adjuster assembly.
	7. Worn valve guides.	7. Ream guides and install new valves with oversize stems.
	8. Excessive runout of valve seats on valve faces.	8. Grind valve seats and valves.
	9. Missing adjuster pivot.	9. Replace rocker arm/hydraulic lash adjuster assembly.
CONNECTING ROD NOISE	1. Insufficient oil supply.	1. Check engine oil level.
	2. Low oil pressure.	2. Check engine oil level. Inspect oil pump relief valve and spring.
	3. Thin or diluted oil.	3. Change oil to correct viscosity.
	4. Excessive bearing clearance.	4. Measure bearings for correct clearance. Repair as necessary.
	5. Connecting rod journal out-of-round.	5. Replace crankshaft or grind surface.
	6. Misaligned connecting rods.	6. Replace bent connecting rods.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
MAIN BEARING NOISE	1. Insufficient oil supply.	1. Check engine oil level.
	2. Low oil pressure.	2. Check engine oil level. Inspect oil pump relief valve and spring.
	3. Thin or diluted oil.	3. Change oil to correct viscosity.
	4. Excessive bearing clearance.	4. Measure bearings for correct clearance. Repair as necessary.
	5. Excessive end play.	5. Check thrust bearing for wear on flanges.
	6. Crankshaft journal out-of-round or worn.	6. Replace crankshaft or grind journals.
	7. Loose flywheel or torque converter.	7. Tighten to correct torque.
OIL PRESSURE DROP	1. Low oil level.	1. Check engine oil level.
	2. Faulty oil pressure sending unit.	2. Install new sending unit.
	3. Low oil pressure.	3. Check sending unit and main bearing oil clearance.
	4. Clogged oil filter.	4. Install new oil filter.
	5. Worn parts in oil pump.	5. Replace worn parts or pump.
	6. Thin or diluted oil.	6. Change oil to correct viscosity.
	7. Oil pump relief valve stuck.	7. Remove valve and inspect, clean, or replace.
	8. Oil pump suction tube loose.	8. Remove oil pan and install new tube or clean, if necessary.
	9. Oil pump cover warped or cracked.	9. Install new oil pump.
	10. Excessive bearing clearance.	10. Measure bearings for correct clearance.
OIL LEAKS	1. Misaligned or deteriorated gaskets.	1. Replace gasket(s).
	2. Loose fastener, broken or porous metal part.	2. Tighten, repair or replace the part.
	3. Misaligned or deteriorated cup or threaded plug.	3. Replace as necessary.

DIAGNOSIS AND TESTING (Continued)

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

2.0L SOHC ENGINE

TABLE OF CONTENTS

DESCRIPTION AND OPERATION

ENGINE IDENTIFICATION

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

ENGINE COMPONENTS

CYLINDER BLOCK AND BEDPLATE ASSEMBLY

A partial open deck is used for cooling and weight reduction with water pump molded into the block. Nominal wall thickness is 4 mm. The bedplate incorporates main bearing caps. The rear oil seal retainer is integral with the block.

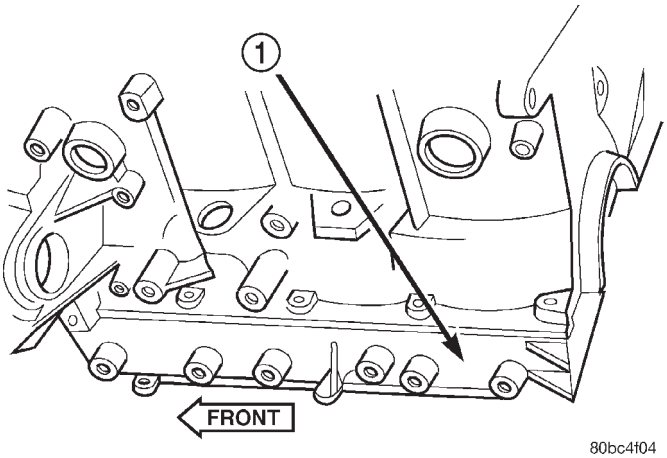


Fig. 1 Engine Identification 2.0L

1 – ENGINE IDENTIFICATION LOCATION

DESCRIPTION AND OPERATION (Continued)

CRANKSHAFT

A nodular cast iron crankshaft is used. The engine has five main bearings. The number three main is flanged to control thrust. The mains and connecting rod journals have undercut fillet radiuses that are deep rolled for added strength. To optimize bearing loading, eight counterweights are used. Hydrodynamic seals provide end sealing, where the crankshaft exits the block. Anaerobic gasket material is used for parting line sealing. A sintered iron timing belt sprocket is mounted on the crankshaft nose. This sprocket transmits crankshaft movement, via timing belt to the camshaft sprocket providing timed valve actuation.

PISTONS

The engine **DOES NOT** have provision for a free wheeling valve train. Non free wheeling valve train means, in the event of a broken timing belt pistons will contact the valves. The engine uses pressed-in piston pins to attach forged powdered metal connecting rods. The connecting rods are a cracked cap design and are not repairable. Hex head cap screw are used to provide alignment and durability in the assembly. Pistons and connecting rods are serviced as an assembly.

PISTON RINGS

The piston rings include a molybdenum faced top ring for reliable compression sealing and a taper faced intermediate ring for additional cylinder pressure control. Oil Control Ring Package consist of two steel rails and an expander spacer.

CYLINDER HEAD

The aluminum cylinder head features a Single Over Head Camshaft (SOHC), four-valves per cylinder, cross flow design. The valves are arranged in two inline banks, with the two intake per cylinder facing toward the radiator. The exhaust valves facing toward the dash panel. Rocker arm shafts mount directly to the cylinder head. It incorporates powder metal valve guides and seats. The hollow rocker arm shafts supplies oil to the hydraulic lash adjusters, camshaft and valve mechanisms.

CAMSHAFT

The nodular iron camshaft has five bearing journals and three cam lobes per cylinder. Provision for a cam position sensor is provided on the camshaft at the rear of cylinder head which also acts as thrust plate. A hydrodynamic oil seal is used for oil control at the front of the camshaft.

VALVES

Four valves per cylinder are actuated by roller rocker arms/hydraulic lash adjusters assemblies which pivot on rocker arm shafts. All valves have chrome plated valve stems. Viton rubber valve stem seals are integral with spring seats. Valve springs, spring retainers, and locks are conventional design.

INTAKE MANIFOLD

The intake manifold is a molded plastic composition, attached to the cylinder head with five fasteners. This long branch design enhances low and mid-range torque.

EXHAUST MANIFOLD

The exhaust manifold is made of nodular cast iron for strength and high temperatures. Exhaust gasses exit the manifold into an articulated joint connection and exhaust pipe.

COMPONENT REPLACEMENT

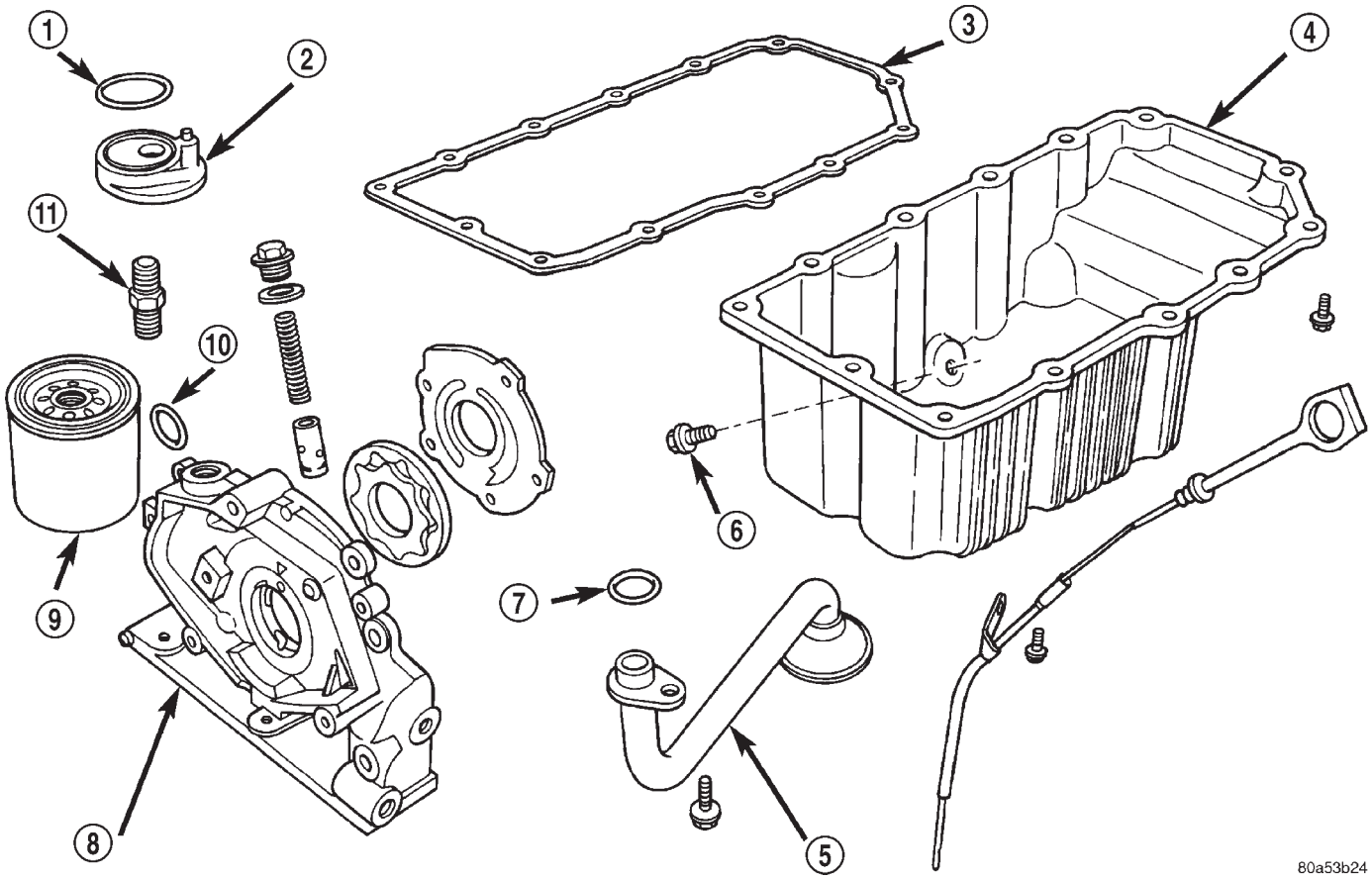
If any of the following parts have been changed or replaced:

- Camshaft
- Camshaft Position Sensor
- Camshaft Position Sensor Target Magnet
- Cylinder Block
- Cylinder Head
- Water Pump
- Powertrain Control Module (PCM)
- Timing Belt and Timing Belt Tensioner

The camshaft and crankshaft timing relearn procedure must be performed. Refer to the component Removal and Installation procedure in this section.

DESCRIPTION AND OPERATION (Continued)

ENGINE LUBRICATION SYSTEM



Engine Lubrication Components

1 – O-RING
2 – OIL FILTER ADAPTER
3 – OIL PAN GASKET
4 – OIL PAN
5 – OIL PICK-UP TUBE
6 – DRAIN PLUG
7 – O-RING
8 – OIL PUMP BODY
9 – FILTER
10 – O-RING
11 – NIPPLE

ENGINE LUBRICATION

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

PRESSURE LUBRICATION

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

MAIN/ROD BEARINGS

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

CAMSHAFT/HYDRAULIC LASH ADJUSTERS

A vertical hole at the number five bulkhead routes pressurized oil through a restrictor up into the cylin-

DESCRIPTION AND OPERATION (Continued)

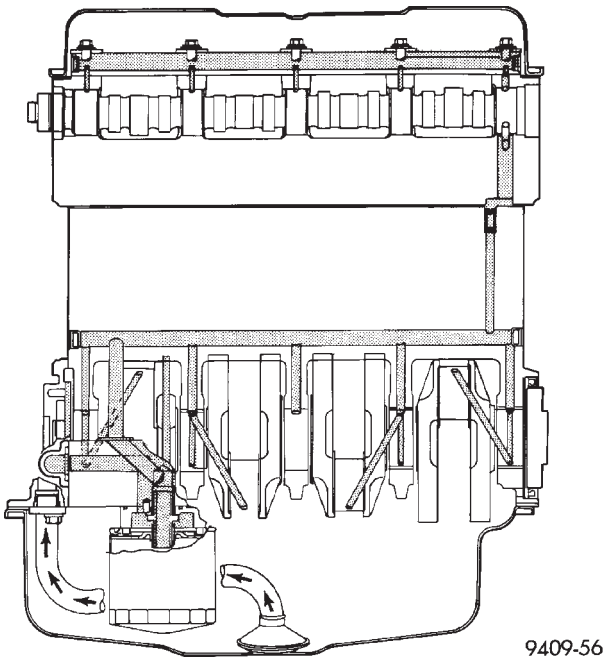


Fig. 2 Engine Lubrication System— SOHC

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

SPLASH LUBRICATION

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

DIAGNOSIS AND TESTING

CHECKING ENGINE OIL PRESSURE

(1) Remove oil pressure switch and install gauge assembly C-3292 with adaptor.

(2) Run engine until thermostat opens.

CAUTION: If oil pressure is 0 at idle, Do Not perform the 3000 RPM test in the next step.

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

(4) If oil pressure is 0 at idle. Shut off engine, check for pressure relief valve stuck open, a clogged oil pick-up screen or a damaged oil pick-up tube O-ring.

SERVICE PROCEDURES

CYLINDER BORE AND PISTON SIZING

The cylinder walls should be checked for out-of-round and taper with recommended tool C-119 or equivalent (Fig. 3). The cylinder bore out-of-round and cylinder bore taper must within service limits. Refer to Engine Specifications in this section. 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 operations should be closely coordinated with the fitting of pistons and rings in order to maintain specified clearances. **Refer to Honing Cylinder Bores in the Standard Service Procedures for procedures.**

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

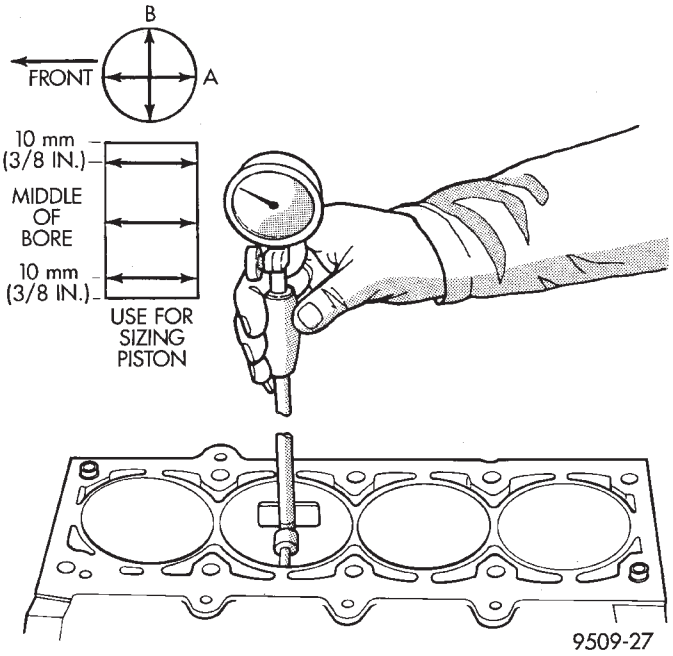


Fig. 3 Checking Cylinder Bore Size

SIZING PISTONS

Piston and cylinder wall must be clean and dry. Piston diameter should be measured 90 degrees to piston pin about 17.5 mm (11/16 inch) from the bottom of the skirt as shown in (Fig. 4). Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line shown in (Fig. 3). Correct piston to bore clearance must be established in order to assure quiet and economical operation. Refer to Engine Specifications in this section for cylinder block and piston specifications.

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

SERVICE PROCEDURES (Continued)

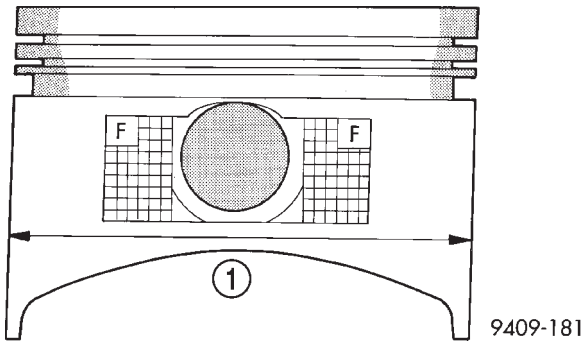


Fig. 4 Piston Measurements

1 – PISTON O. D. MEASUREMENT LOCATION

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

FITTING PISTON RINGS

(1) Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioned below normal ring travel in the cylinder bore. Check gap with feeler gauge (Fig. 5). Refer to Engine Specifications in this section for piston ring specifications.

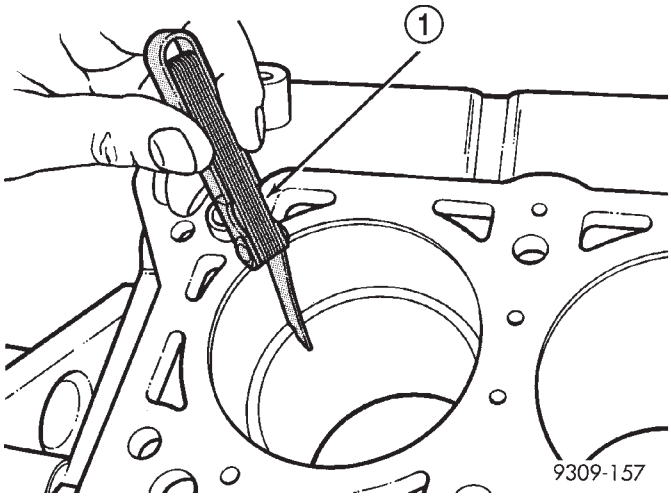


Fig. 5 Piston Ring Gap

1 – FEELER GAUGE

(2) Check piston ring to groove side clearance (Fig. 6). Refer to Engine Specifications in this section for piston ring specifications.

FITTING CONNECTING RODS

(1) Follow the procedure specified in the Standard Service Procedures Section for Measuring Main Bearing Clearance and Connecting Rod Bearing Clearance (Fig. 7). Refer to Engine Specifications in this section for connecting rod specifications.

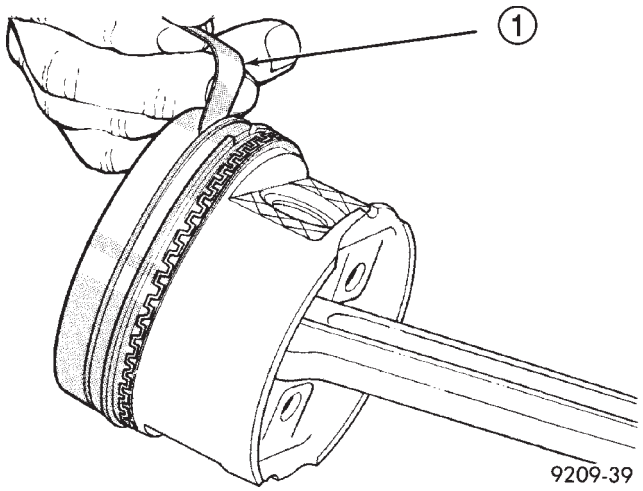


Fig. 6 Piston Ring Side Clearance

1 – FEELER GAUGE

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

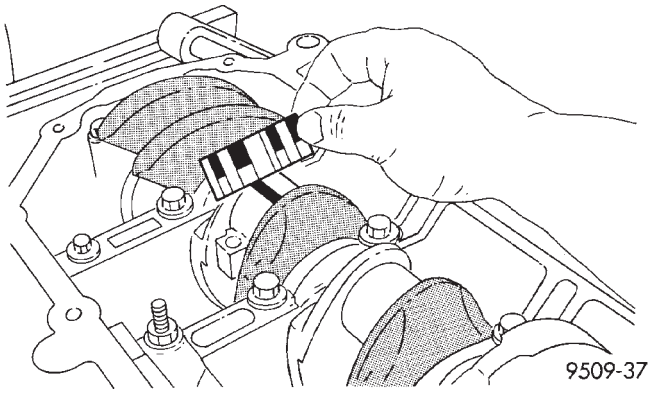


Fig. 7 Connecting Rod Bearing Clearance

NOTE: The rod bearing bolts should not be reused.

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

(3) Install each bolt finger tight than alternately torque each bolt to assemble the cap properly.

(4) Tighten the bolts to 27 N·m PLUS 1/4 turn (20 ft. lbs. PLUS 1/4 turn) **Do not use a torque wrench for last step.**

(5) Using a feeler gauge, check connecting rod side clearance (Fig. 8). Refer to Engine Specifications in this section for connecting rod specifications.

FITTING CRANKSHAFT BEARINGS

Refer to Measuring Main Bearing Clearance in Standard Service Procedures. Refer to Engine Specifications in this section for crankshaft specifications.

SERVICE PROCEDURES (Continued)

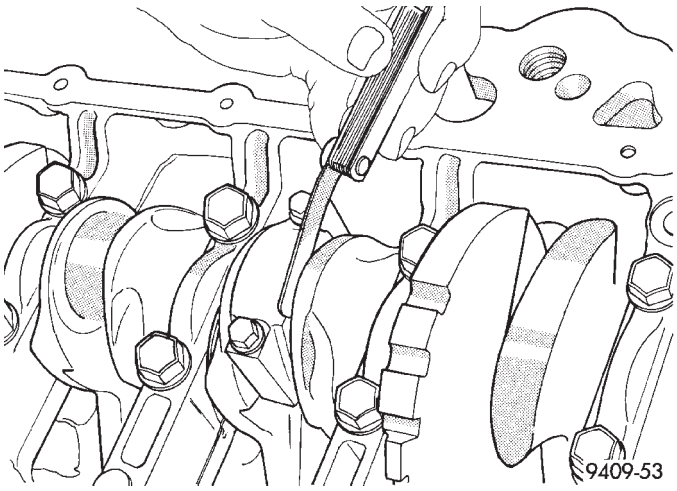


Fig. 8 Connecting Rod Side Clearance

CRANKSHAFT END PLAY

DIAL INDICATOR METHOD

(1) Mount a dial indicator to front of engine, locating probe on nose of crankshaft (Fig. 9).

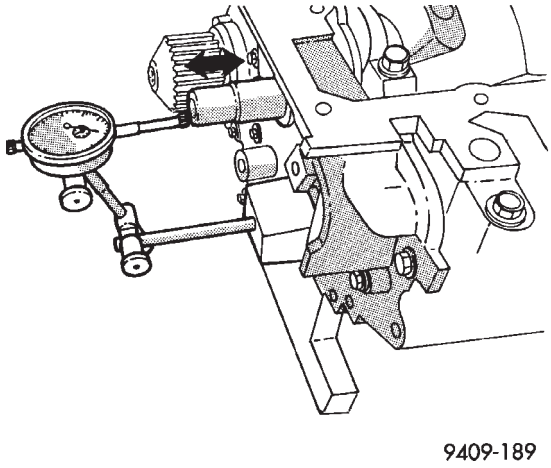


Fig. 9 Checking Crankshaft End Play— Dial Indicator

(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 of its travel and read the dial indicator. Refer to Engine Specifications in this section for crankshaft specifications.

FEELER GAGE METHOD

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

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

REMOVAL AND INSTALLATION

TORQUE STRUTS

UPPER TORQUE STRUT

REMOVAL

(1) Remove bolts attaching strut to shock tower bracket and engine mount bracket (Fig. 10).

(2) Remove the upper torque strut.

INSTALLATION

(1) Position the upper torque strut into mounting locations.

(2) Install the mounting bolts and perform the torque strut adjustment procedure.

LOWER TORQUE STRUT

REMOVAL

(1) Raise vehicle on hoist.

(2) Remove right side splash shield.

(3) Remove bolts attaching lower strut to crossmember and strut bracket (Fig. 10).

(4) Remove lower torque strut.

INSTALLATION

(1) Position lower torque strut into mounting locations.

(2) Install mounting bolts and perform torque strut adjustment procedure.

(3) Install splash shield and lower vehicle

TORQUE STRUT ADJUSTMENT

The upper and lower torque struts need to be adjusted together to assure proper engine positioning and engine mount loading. Whenever a torque strut bolt(s) is loosened, this procedure must be performed.

(1) Loosen the upper and lower torque strut attaching bolt at the suspension crossmember and shock tower bracket.

(2) The engine position may now be adjusted by positioning a suitable floor jack on the forward edge of the transmission bell housing (Fig. 11).

NOTE: The floor jack must be positioned as shown in (Fig. 11) to prevent minimal upward lifting of the engine.

REMOVAL AND INSTALLATION (Continued)

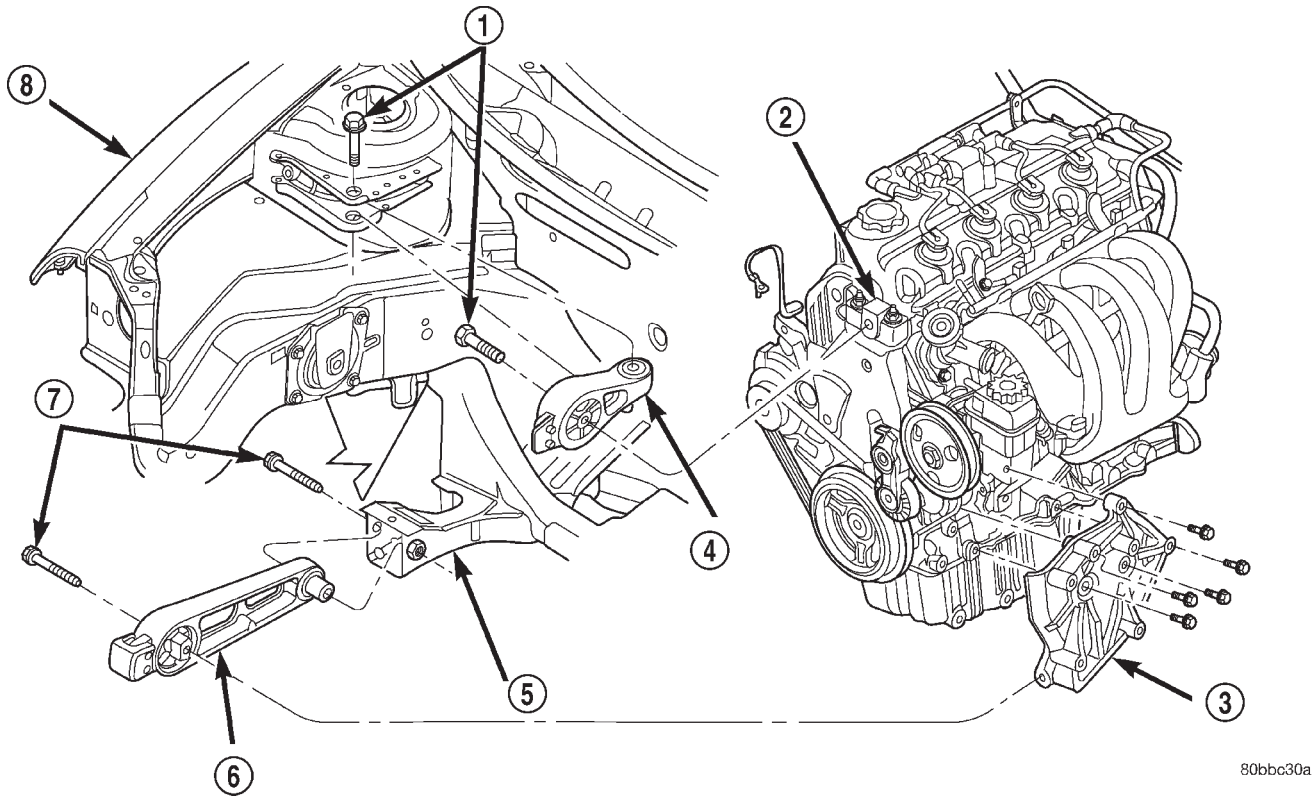


Fig. 10 Torque Struts—Upper and Lower

1 – BOLTS
2 – ENGINE MOUNT BRACKET
3 – TORQUE STRUT BRACKET
4 – UPPER TORQUE STRUT
5 – CROSSMEMBER
6 – LOWER TORQUE STRUT
7 – BOLTS
8 – RIGHT FENDER

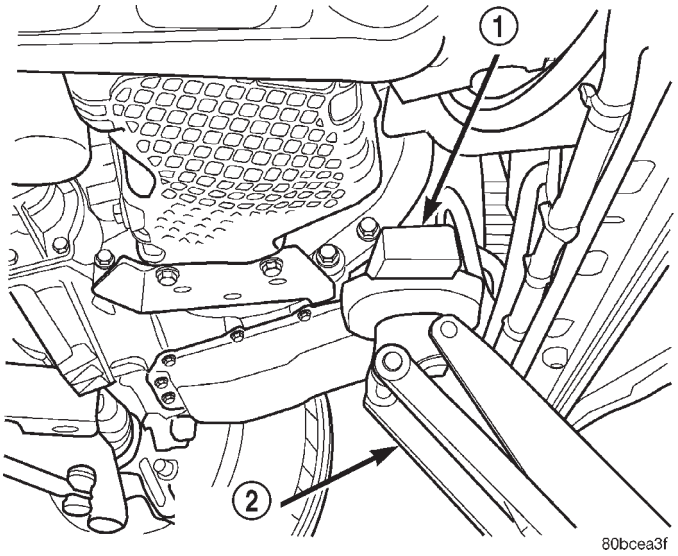


Fig. 11 Floor Jack Positioning

1 – WOOD BLOCK
2 – FLOOR JACK

(3) Carefully apply upward force, allowing the upper engine to rotate rearward until the distance between the center of the rearmost attaching stud on the engine mount bracket (point “A”) and the center of the hole for the washer hose clip on the shock tower bracket (point “B”) is 119 mm (4.70 in.) (Fig. 12).

(4) With the engine held at the proper position, tighten both the upper and lower torque strut bolts to 118 N·m (87 ft. lbs.) (Fig. 10).

(5) Remove the floor jack.

ENGINE MOUNT—LEFT

REMOVAL

(1) Raise vehicle approximately 30.5 cm (12 in.) on hoist

(2) Remove air cleaner assembly (Fig. 13).

(3) Remove battery and tray.

(4) Support transaxle with a suitable jack.

(5) Remove left front wheel.

(6) Remove left splash shield.

(7) Remove through bolt access plug at left side outer frame rail.

REMOVAL AND INSTALLATION (Continued)

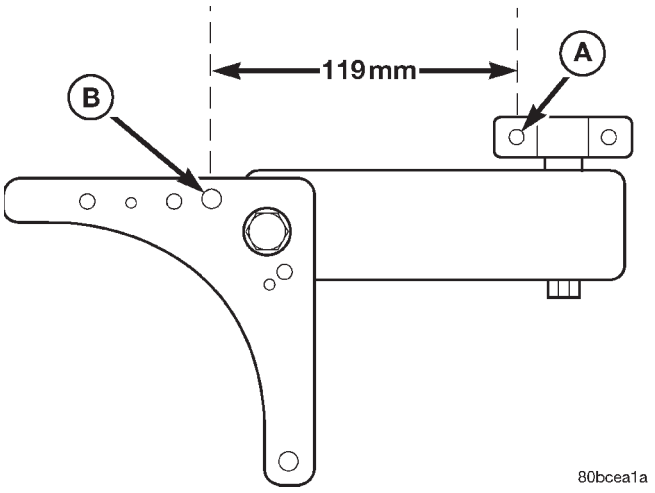


Fig. 12 Engine Position Measurement

(8) Remove mount through bolt (Fig. 14).

(9) Disconnect transaxle shift cable from left mount and transaxle linkage.

(10) Remove left mount bracket to body frame rail fasteners (Fig. 15).

(11) Remove mount attaching bolts (Fig. 16) or (Fig. 17).

(12) Remove mount.

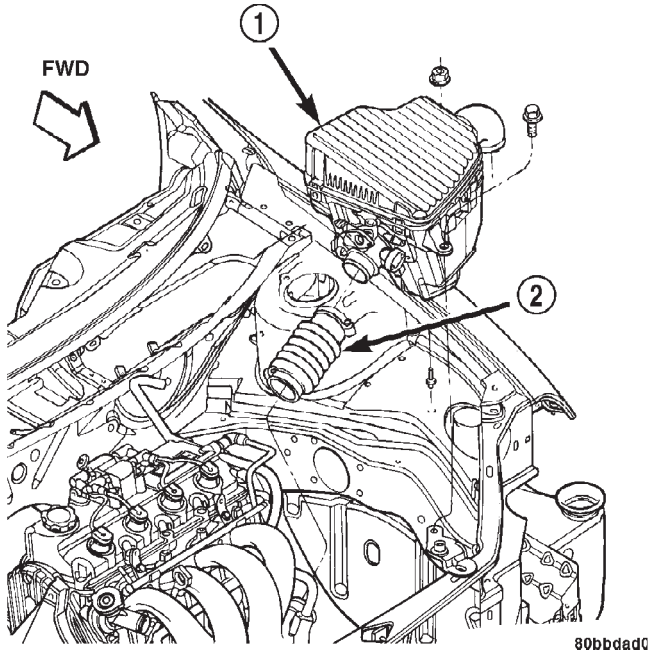


Fig. 13 Air Cleaner Assembly

1 – AIR CLEANER ASSY.
2 – THROTTLE BODY DUCT

INSTALLATION

(1) Install mount and attaching bolts (Fig. 16) or (Fig. 17). Tighten bolts to 68 N·m (50 ft. lbs.).

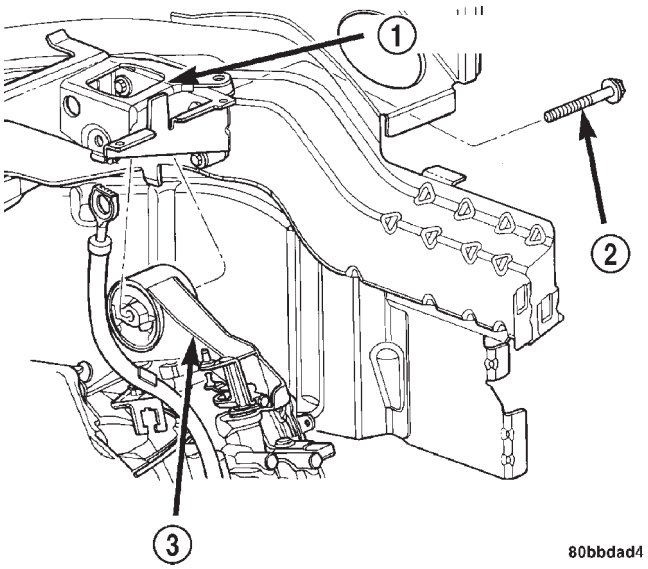


Fig. 14 Left Mount Through Bolt

1 – MOUNT BRACKET
2 – BOLT
3 – MOUNT

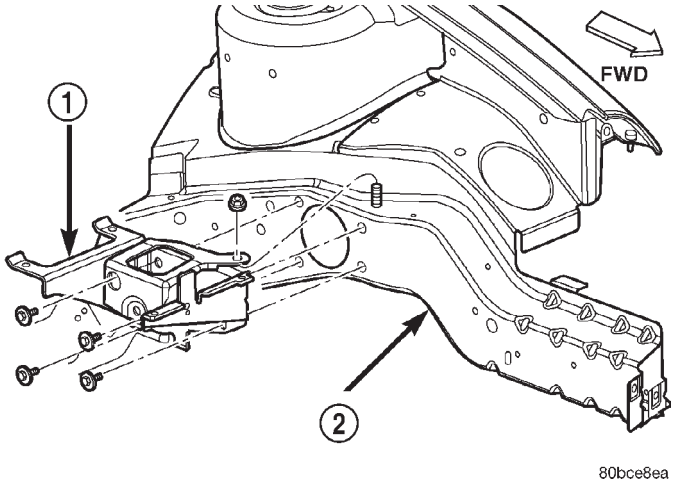


Fig. 15 Left Mount Bracket

1 – MOUNT BRACKET
2 – BODY FRAME RAIL

(2) Install engine mount bracket to body frame rail and tighten fasteners to 28 N·m (250 in. lbs.) (Fig. 15).

(3) Position engine/transaxle for installation of through bolt. Install and tighten through bolt to 118 N·m (87 ft. lbs.) (Fig. 14).

(4) Remove jack from under transaxle.

(5) Install through bolt access plug at left side outer frame rail.

(6) Install left splash shield and wheel.

(7) Connect transaxle shift cable to engine mount and transaxle linkage.

(8) Install battery tray and battery.

REMOVAL AND INSTALLATION (Continued)

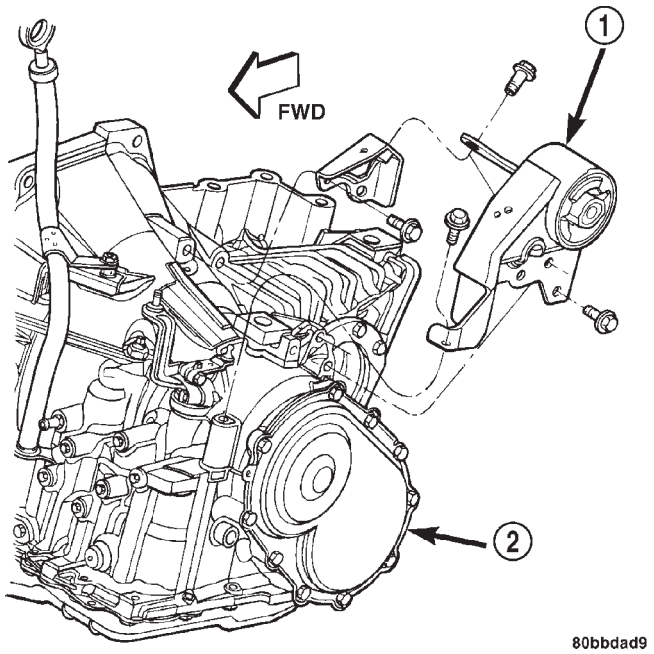


Fig. 16 Left Mount (Automatic Transaxle)

1 – MOUNT
2 – TRANSAXLE

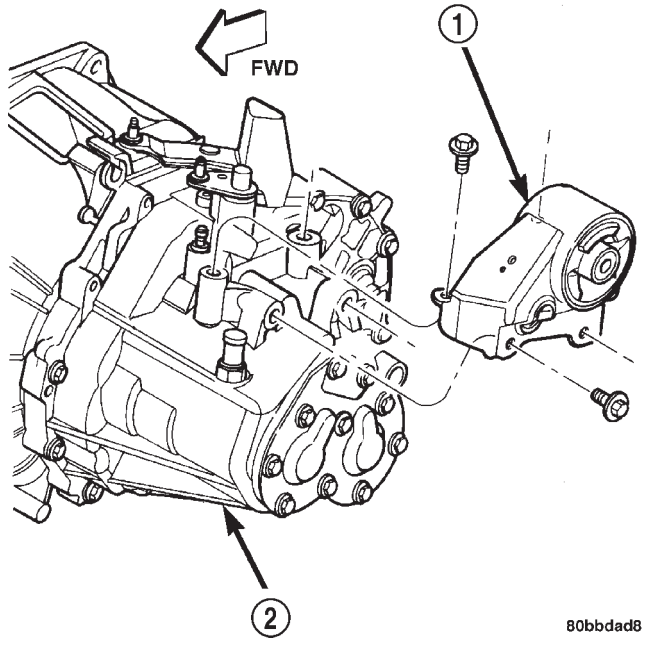


Fig. 17 Left Mount (Manual Transaxle)

1 – MOUNT
2 – TRANSAXLE

(9) Install air cleaner assembly (Fig. 13).
(10) Lower vehicle.

ENGINE MOUNT—RIGHT

REMOVAL

(1) Remove accessory drive belts. Refer to Group 7, Cooling System for procedure.
(2) Remove crankshaft damper. Refer to procedure in this section.
(3) Remove upper and lower engine torque struts. Refer to procedure in this section.
(4) Support engine with a suitable jack.
(5) Remove bolt access cover and bolt attaching the right engine mount to mount bracket (Fig. 18).
(6) Remove engine mount bracket. Refer to procedure in this section.

NOTE: The right engine mount attaching holes are slightly oversize to compensate for manufacturing tolerances. The mount has been set at the manufacturing plant for proper powertrain alignment. Therefore, it is necessary to mark the position of the mount before the attaching bolts are loosened.

(7) Using a permanent ink marker or equivalent, mark the position of engine mount to the body frame rail.
(8) Remove bolts attaching mount to body (Fig. 19).
(9) Remove mount between engine and body frame rail. Mount removal may require engine position to be raised or lowered to allow mount removal clearance.

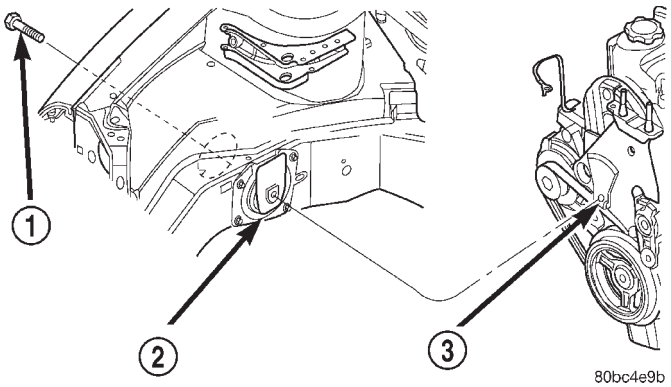


Fig. 18 Engine Mount To Bracket Bolt

1 – BOLT
2 – RIGHT ENGINE MOUNT
3 – ENGINE MOUNT BRACKET

INSTALLATION

(1) Position mount into the original position on body frame rail (Fig. 19).

REMOVAL AND INSTALLATION (Continued)

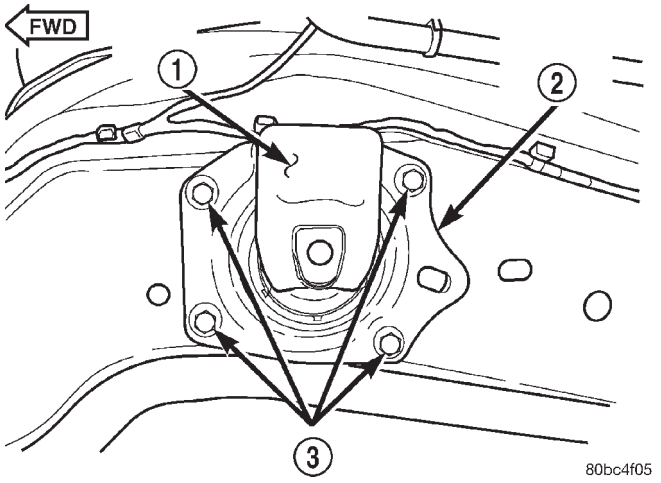


Fig. 19 Engine Mount—Right

1 – SNUBBER PAD
2 – RIGHT ENGINE MOUNT
3 – BOLTS

NOTE: Engine mount must be installed in the original position on body frame rail. If mount was not marked or frame rail was replaced, perform the following procedure.

(2) Perform the following procedure if mount position was not previously marked or the frame rail was replaced:

a. Insert new mount loosely in frame rail.

b. Align the four holes in the mount with the mating holes in the rail such that the holes are concentric (frame rail holes centered in the mount holes).

c. Using a permanent ink marker or equivalent, mark the position of engine mount to the body frame rail while maintaining mounting hole concentricity.

(3) Ensure the mount maintains originally marked position and install mount bolts. Tighten bolts to 28 N·m (250 in. lbs.) (Fig. 19).

(4) Install engine mount bracket. Refer to procedure in this section.

(5) Install bolt attaching right engine mount to bracket and tighten to 118 N·m (87 ft. lbs.) (Fig. 18).

(6) Remove support from under engine.

(7) Install upper and lower engine torque struts. Refer to procedure in this section.

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

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

ENGINE MOUNT BRACKET—RIGHT

REMOVAL

(1) Remove upper and lower torque struts. Refer to procedure in this section.

(2) Remove power steering/air conditioning belt. Refer to Group 7, Cooling System, Accessory Drive Belts for procedure.

(3) Support engine with a suitable jack.

(4) Remove engine mount through bolt access plug (Fig. 20)

(5) Remove right engine mount to bracket through bolt (Fig. 21).

(6) Remove engine mount bracket attaching bolts (Fig. 22).

(7) Bracket removal requires engine to be raised slightly to obtain engine-to-body clearance.

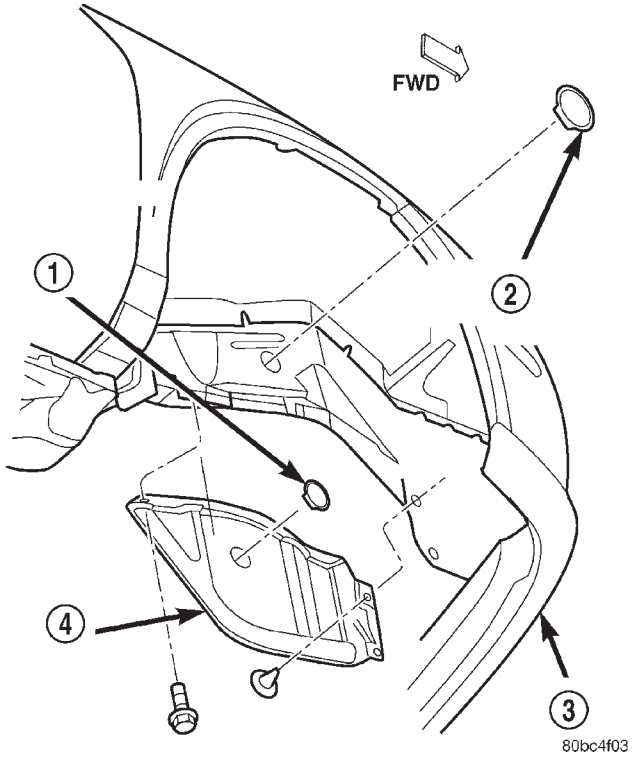


Fig. 20 Engine Mount Bolt Access Plug

1 – CRANKSHAFT BOLT ACCESS PLUG
2 – RIGHT MOUNT BOLT ACCESS PLUG
3 – FASCIA
4 – SPLASH SHIELD

INSTALLATION

(1) Install engine mount bracket and tighten bolts to 61 N·m (45 ft. lbs.) (Fig. 22).

(2) Install bolt attaching engine mount to bracket (Fig. 21). Tighten bolt to 118 N·m (87 ft. lbs.).

(3) Install mount bolt access plug (Fig. 20).

(4) Remove support from under engine.

(5) Install power steering/air conditioning belt. Refer to Group 7, Cooling System, Accessory Drive Belts for procedure.

(6) Install upper and lower torque struts. Refer to procedure in this section.

REMOVAL AND INSTALLATION (Continued)

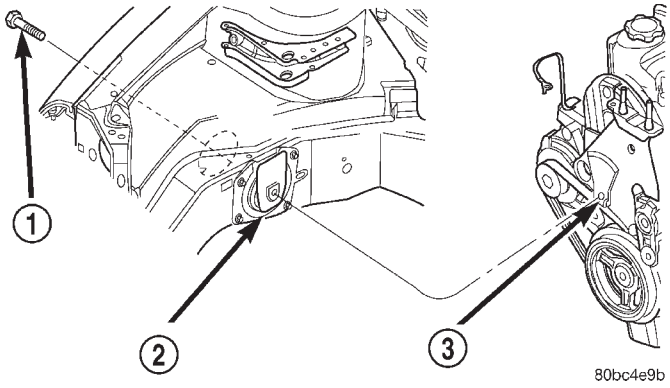


Fig. 21 Engine Mount to Bracket

1 – BOLT
2 – RIGHT ENGINE MOUNT
3 – ENGINE MOUNT BRACKET

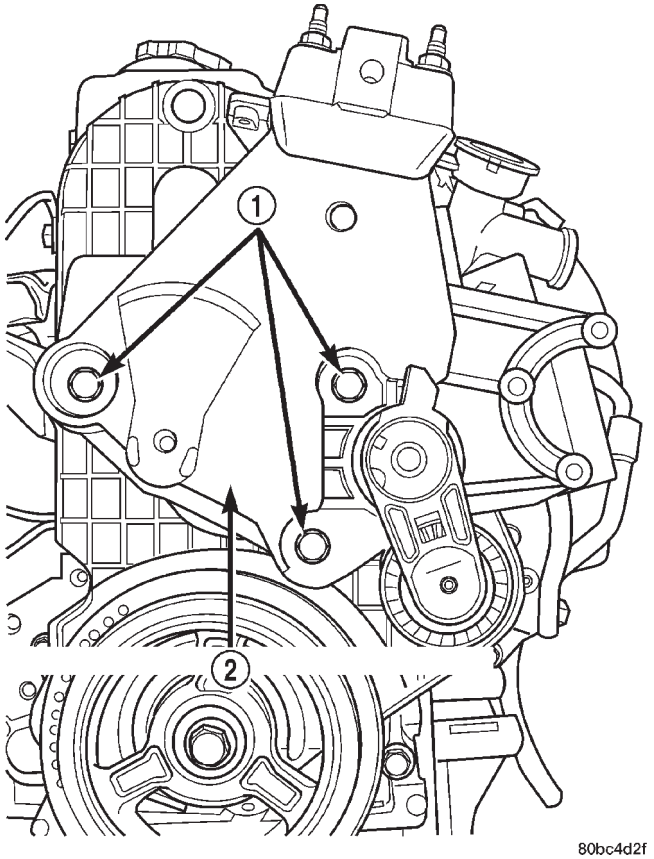


Fig. 22 Engine Mount Bracket Assembly

1 – BOLTS
2 – ENGINE MOUNT BRACKET ASSEMBLY

STRUCTURAL COLLAR

REMOVAL

(1) Raise vehicle on hoist.

NOTE: To remove transaxle dust cover, the front bending strut must be removed.

(2) Remove structural collar from oil pan to transaxle (Fig. 23).

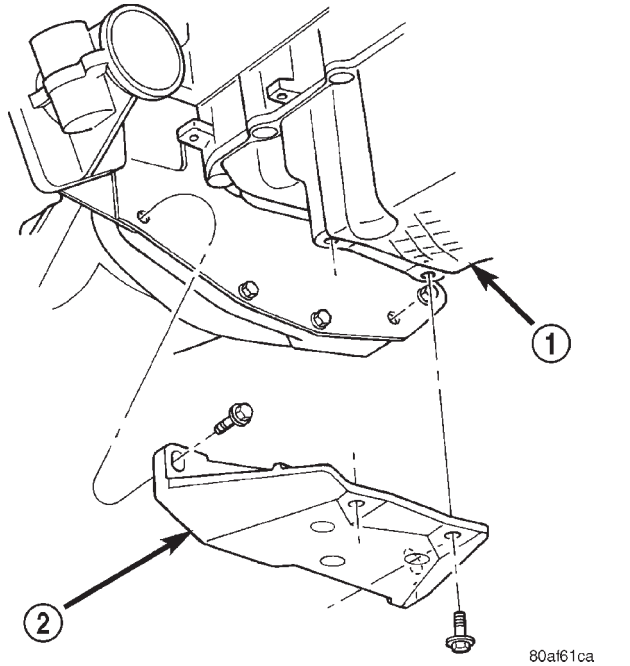


Fig. 23 Structural Collar—Removal and Installation

1 – OIL PAN
2 – STRUCTURAL COLLAR

INSTALLATION

CAUTION: The torque procedure for the structural collar must be followed, as damage to oil pan or collar could occur.

(1) Install the structural collar (Fig. 23) using the following 3 step torque sequence:

- Step 1: Install the collar to oil pan bolts and tighten to 3 N·m (30 in. lbs.).
- Step 2: Install collar to transaxle bolts and tighten to 108 N·m (80 ft. lbs.).
- Step 3: Final torque the collar to oil pan bolts to 54 N·m (40 ft. lbs.).

(2) Lower vehicle.

ENGINE ASSEMBLY

REMOVAL

(1) Perform fuel pressure release procedure. Refer to Group 14, Fuel System for procedure. Remove fuel line to fuel rail.

(2) Disconnect and remove battery and tray.

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

REMOVAL AND INSTALLATION (Continued)

(4) Discharge air conditioning system, if equipped. Refer to Group 24, Heating and Air Conditioning for procedure.

(5) Disconnect the following: air intake duct at intake manifold, throttle cables, electrical connectors from throttle body and air cleaner housing.

(6) Remove air cleaner housing assembly.

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

(8) Remove lower radiator hose.

(9) Disconnect automatic transmission cooler lines and plug, if equipped.

(10) Disconnect shift linkage, electrical connectors, and clutch cable, if equipped with manual transaxle.

(11) Disconnect engine wiring harness.

(12) Disconnect positive cable from Power Distribution Center (PDC) and ground wire from vehicle body.

(13) Disconnect ground wire from the vehicle body-to-engine at the right side strut tower.

(14) Disconnect heater hoses.

(15) Disconnect vacuum hose from brake booster.

(16) Disconnect coolant reserve/recovery hose.

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

(18) Remove power steering pump and reservoir and set them aside.

(19) Hoist vehicle and remove right inner splash shield.

(20) Drain engine oil.

(21) Remove front wheels.

(22) Remove axle shafts. Refer to Group 3, Differential and Driveline for procedure.

(23) Disconnect exhaust system from manifold.

(24) Disconnect the downstream oxygen sensor connector.

(25) Remove lower engine torque strut.

(26) Remove structural collar. Refer to procedure in this section.

(27) Lower vehicle and remove A/C compressor.

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

(29) Loosen engine support posts to allow movement for positioning onto engine locating holes and flange on the engine bedplate. Lower vehicle and position cradle until the engine is resting on support posts (Fig. 26). Tighten mounts to cradle frame. This will keep support posts from moving when removing or installing engine and transmission.

(30) Install safety straps around the engine to cradle (Fig. 26). Tighten straps and lock them into position.

WARNING: Safety straps MUST be used.

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

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

(33) Remove the upper engine torque strut.

(34) Remove right and left engine and transaxle mount through bolts (Fig. 24) and (Fig. 25).

(35) Raise vehicle slowly until body is approximately 15 cm (6 in.) above normal engine mounting locations.

(36) Remove generator, lower bracket, and upper mounting bolt.

(37) Continue raising vehicle slowly until engine/transaxle assembly clears engine compartment. It may be necessary to move the engine/transmission assembly with the cradle to allow for removal around body flanges.

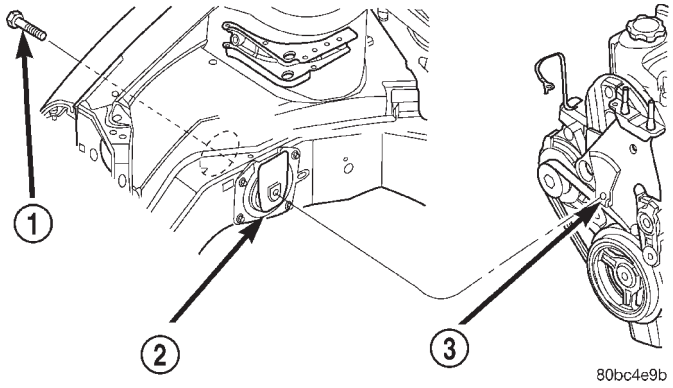


Fig. 24 Right Mount Through Bolt

1 – BOLT
2 – RIGHT ENGINE MOUNT
3 – ENGINE MOUNT BRACKET

INSTALLATION

(1) Position engine and transmission assembly under vehicle and slowly lower the vehicle over the engine/transaxle assembly until vehicle is within 15 cm (6 in.) of engine mounting locations.

(2) Install generator, lower bracket, and adjusting bolt.

(3) Continue lowering vehicle until engine/transaxle aligns to mounting locations. Install mounting bolts at the right and left engine/transaxle mounts (Fig. 24) and (Fig. 25). Tighten bolts to 118 N·m (87 ft. lbs.).

(4) Install upper engine torque strut. Refer to procedure in this section.

(5) Remove safety straps from engine/transaxle assembly. Slowly raise vehicle enough to remove the engine dolly and cradle.

(6) Install axle shafts. Refer to Group 3, Differential and Driveline for procedure.

(7) Install structural collar. Refer to procedure in this section tightening sequence.

REMOVAL AND INSTALLATION (Continued)

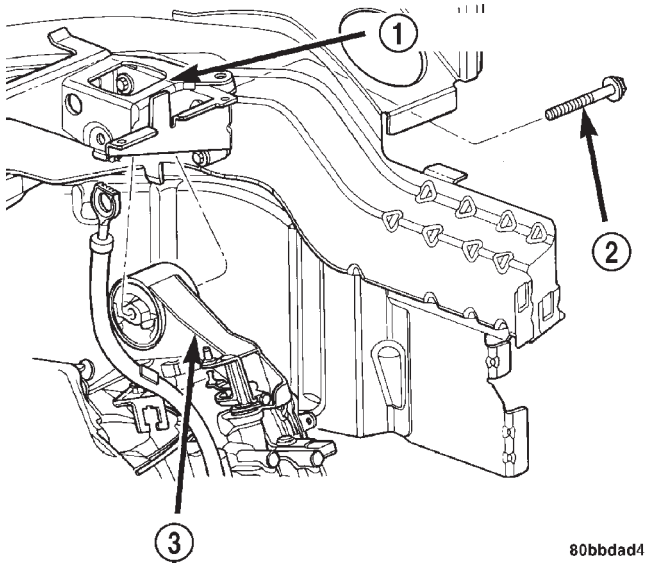


Fig. 25 Left Mount Through Bolt

1 – MOUNT BRACKET
2 – BOLT
3 – MOUNT

(8) Install lower engine torque strut. Refer to procedure in this section.

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

(10) Connect the downstream oxygen sensor.

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

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

(13) Install inner splash shield.

(14) Install wheels and lower vehicle.

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

(16) **Manual Transmission:** Connect clutch cable, reverse light electrical connector and shift linkages. Refer to Group 6, Clutch.

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

(18) Connect fuel line and heater hoses.

(19) Install all ground straps. Connect engine wiring harness. Refer to Group 8, Electrical for procedure.

(20) Install lower radiator hose, fan module, and upper radiator hose. Refer to Group 7, Cooling System for procedures

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

(22) Install battery tray and battery.

(23) Install air cleaner housing assembly and connect intake duct to intake manifold.

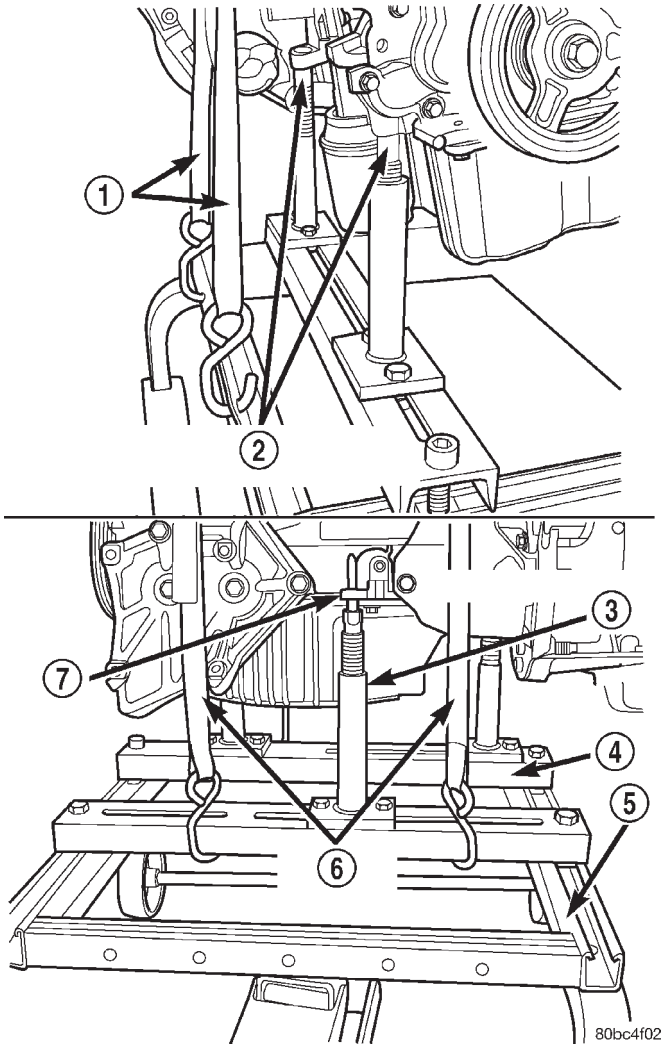


Fig. 26 Positioning Engine Cradle Support Post

1 – SAFETY STRAPS
2 – PLACE REAR POSTS INTO LOCATING HOLES
3 – SPECIAL TOOL 6848
4 – SPECIAL TOOL 6710
5 – SPECIAL TOOL 6135
6 – SAFETY STRAPS
7 – PLACE FRONT POST UNDER BLOCK FLANGE

(24) Connect all throttle body electrical connectors and linkage.

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

(26) Perform camshaft and crankshaft timing relearn procedure as follows:

- Connect the DRB scan tool to the data link (diagnostic) connector. This connector is located in the passenger compartment; at the lower edge of instrument panel; near the steering column.
- Turn the ignition switch on and access the “miscellaneous” screen.
- Select “re-learn cam/crank” option and follow directions on DRB screen.

REMOVAL AND INSTALLATION (Continued)

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

(28) Ensure engine is properly positioned. Refer to Torque Struts in this section for adjustment procedure.

(29) Adjust transmission linkage, if necessary.

INTAKE MANIFOLD

REMOVAL

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE SERVICING FUEL SYSTEM COMPONENTS. SERVICE VEHICLES IN WELL VENTILATED AREAS AND AVOID IGNITION SOURCES. NEVER SMOKE WHILE SERVICING THE VEHICLE.

(1) Disconnect negative cable from battery.

(2) Remove the inlet air duct from intake manifold to throttle body.

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

WARNING: WRAP SHOP TOWELS AROUND FUEL HOSE TO CATCH ANY GASOLINE SPILLAGE

(4) Disconnect fuel supply line quick connect at the fuel tube assembly. Refer to Group 14, Fuel System for procedures.

(5) Remove fuel rail assembly attaching screws and remove fuel rail assembly from engine. Cover injector holes with suitable covering.

CAUTION: Do not set fuel injectors on their tips, damage may occur to the injectors

(6) Disconnect brake booster hose (Fig. 27) and PCV hose (Fig. 28) from intake manifold.

(7) Disconnect Manifold Absolute Pressure (MAP) sensor electrical connector (Fig. 29).

(8) Disconnect knock sensor electrical connector (Fig. 30).

(9) Disconnect wiring at starter.

(10) Remove the intake manifold to lower support bracket bolts (Fig. 31).

(11) Remove intake manifold screws and washers. Discard the fasteners. Remove intake manifold.

INSTALLATION

Before installing manifold. Clean all mating surfaces. Replace all O-ring gaskets with new gaskets (Fig. 33). All intake manifold fasteners and washers are to be discarded and **NEW** fasteners and washers are to be used.

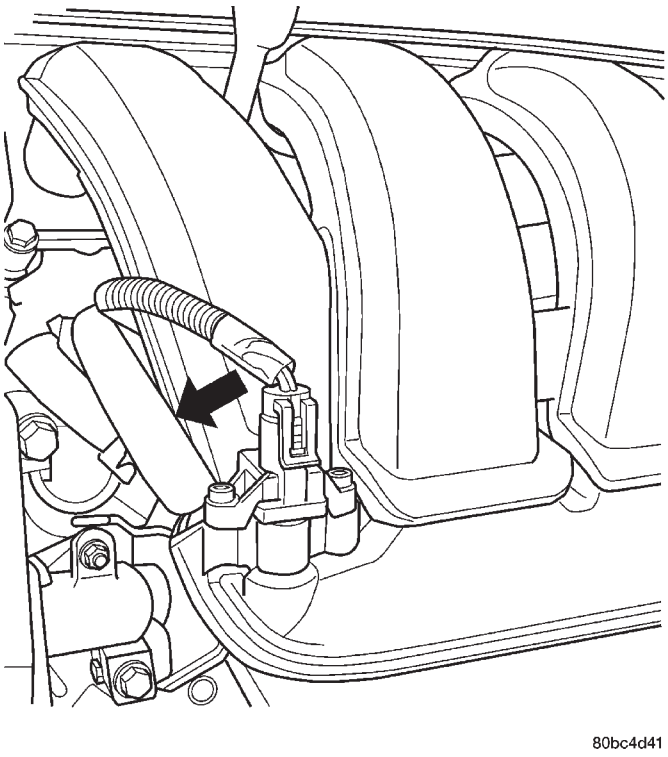


Fig. 27 Brake Booster Hose

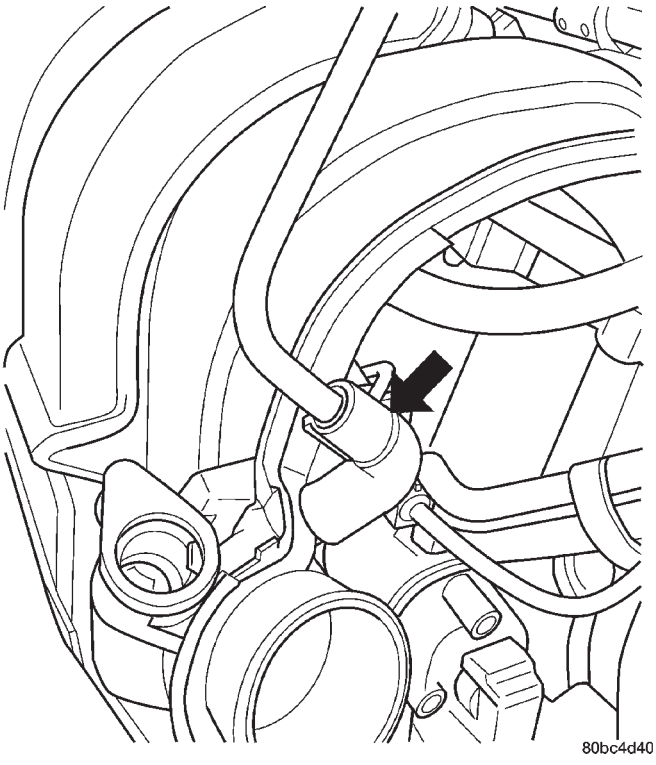


Fig. 28 PCV Hose

(1) Install intake manifold onto cylinder head and tighten fasteners to 12 N·m (105 in. lbs.) in sequence shown in (Fig. 32).

REMOVAL AND INSTALLATION (Continued)

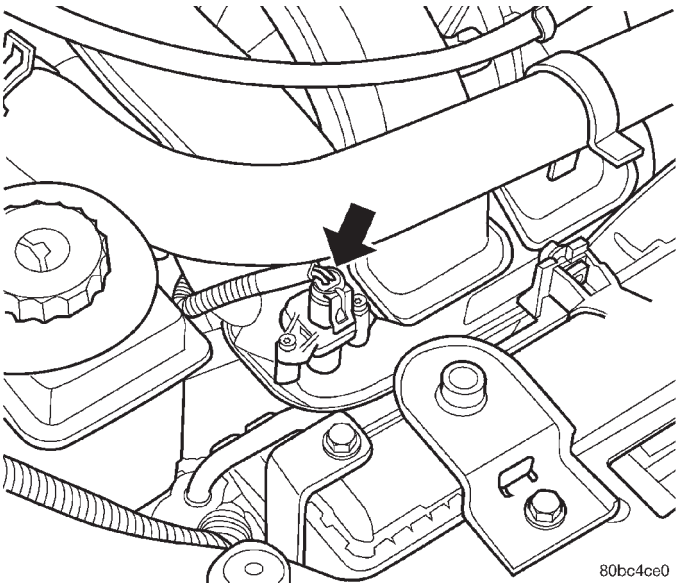


Fig. 29 MAP Sensor

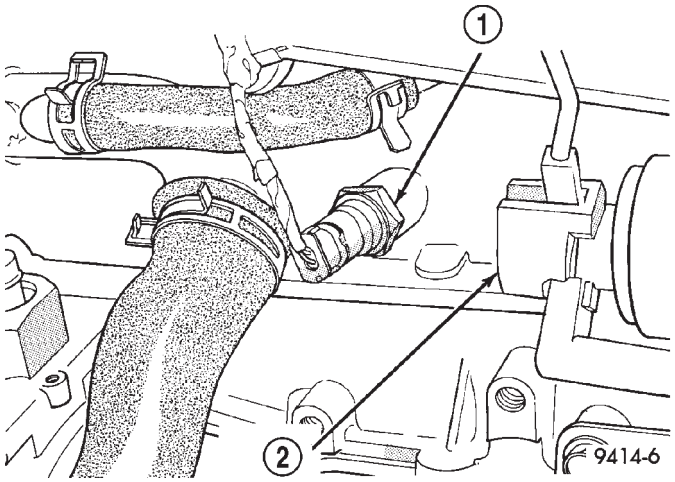


Fig. 30 Knock Sensor

1 – KNOCK SENSOR
2 – STARTER MOTOR

(2) Install intake manifold to lower support bracket bolts (Fig. 31). Tighten bolts to 11 N·m (95 in. lbs.).

(3) Remove covering from fuel injector holes and insure the holes are clean. Install fuel rail assembly to intake manifold. Tighten screws to 23 N·m (200 in. lbs.).

(4) Connect PCV and brake booster hoses.

(5) Inspect quick connect fittings for damage, replace if necessary Refer to Group 14, Fuel System for procedure. Apply a light amount of clean engine oil to fuel inlet tube. Connect fuel supply hose to fuel rail assembly. Check connection by pulling on connector to insure it locked into position.

(6) Connect Manifold Absolute Pressure (MAP) Sensor wiring connector (Fig. 29).

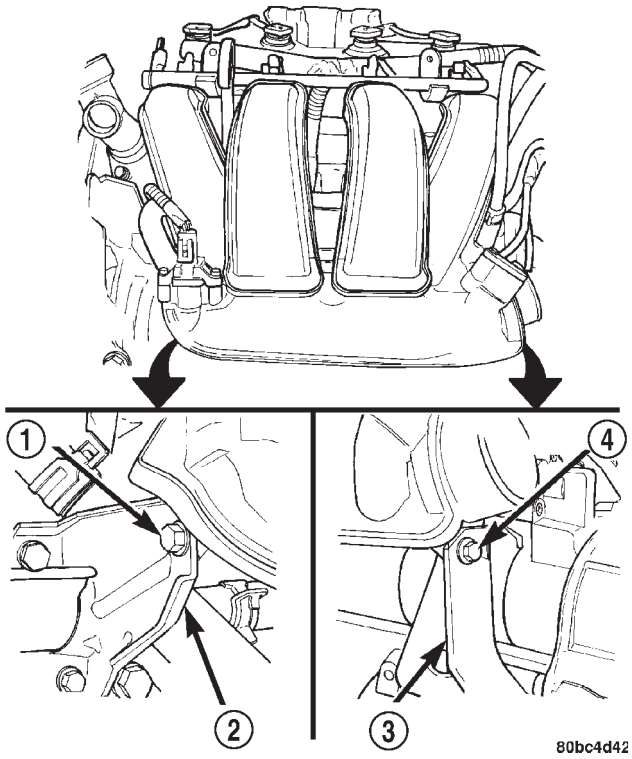


Fig. 31 Intake Manifold Lower Supports

1 – BOLT
2 – BRACKET
3 – BRACKET
4 – BOLT

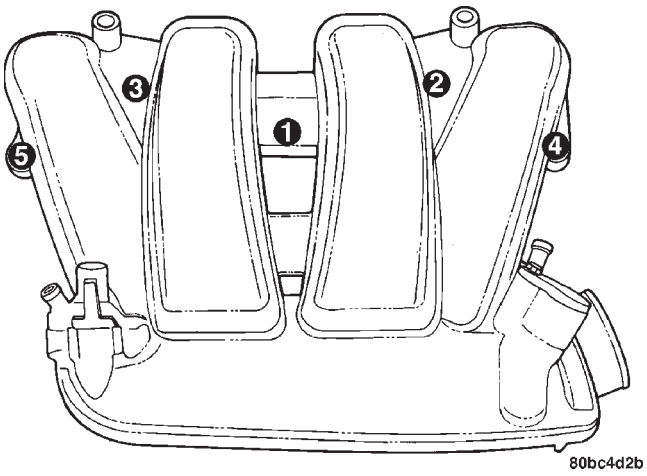


Fig. 32 Intake Manifold Tightening Sequence

(7) Connect knock sensor connector, and wiring at starter.

(8) Install inlet air duct to intake manifold and throttle body. Tighten clamp to 3 N·m (30 in. lbs.).

(9) Connect negative cable to battery.

(10) With the DRB scan tool use ASD Fuel System Test to pressurize system to check for leaks.

REMOVAL AND INSTALLATION (Continued)

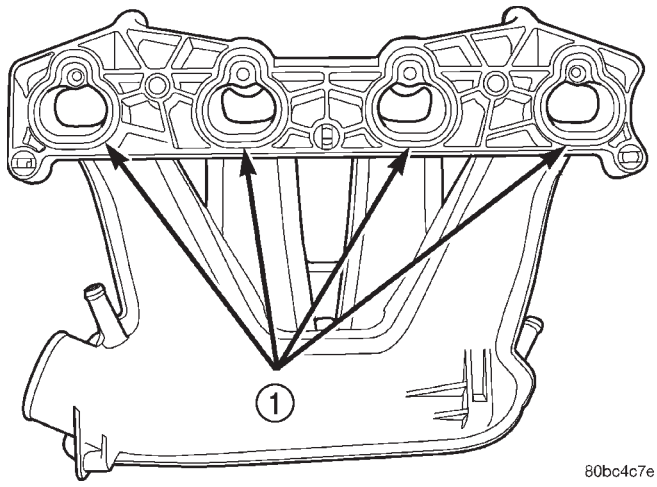


Fig. 33 Intake Manifold Gaskets

1 – INTAKE MANIFOLD O-RING GASKETS

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) relay will remain energized for 7 minutes or until the ignition switch is turned to the OFF position, or Stop All Test is selected.

EXHAUST MANIFOLD

REMOVAL

(1) Disconnect negative cable from battery.

(2) Raise vehicle on hoist.

(3) Remove bolt attaching the wire harness heat shield to the exhaust manifold support bracket (Federal and LEV) (Fig. 34), or to the exhaust manifold (ULEV).

(4) Remove exhaust manifold support bracket (Federal and LEV) (Fig. 35).

(5) Remove fasteners attaching exhaust system flex joint to exhaust manifold flange. Move exhaust system rearward to clear flange studs.

(6) ULEV equipped—remove the support bracket from cylinder block to exhaust manifold (Fig. 36).

(7) Lower vehicle.

(8) Disconnect CCV hose from rear of cylinder head cover.

(9) Disconnect oxygen sensor connector and harness clip.

(10) Remove heat shield attaching bolts (Fig. 37).

(11) Remove upper heat shield for access to manifold bolts.

(12) Remove exhaust manifold bolts.

(13) ULEV equipped—remove cylinder head cover. Refer to procedure in this section. Cover cylinder head opening with a suitable covering.

(14) Remove exhaust manifold from top of vehicle, between cylinder head and cowl.

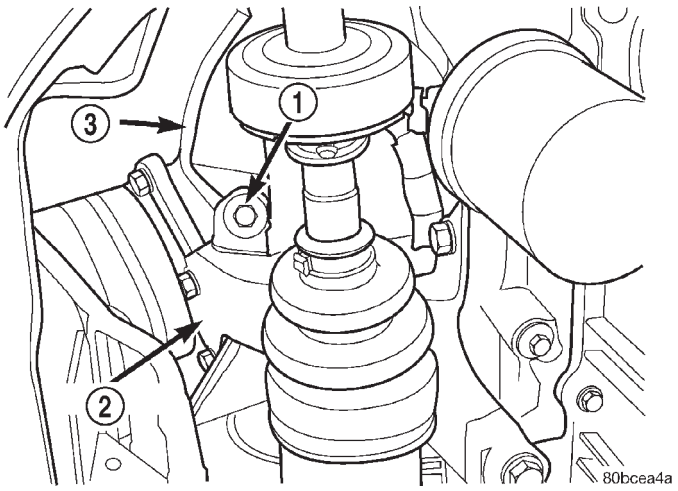


Fig. 34 Wire Harness Heat Shield Bolt—Federal & LEV Shown, ULEV Similar

1 – BOLT
2 – BRACKET
3 – HEAT SHIELD

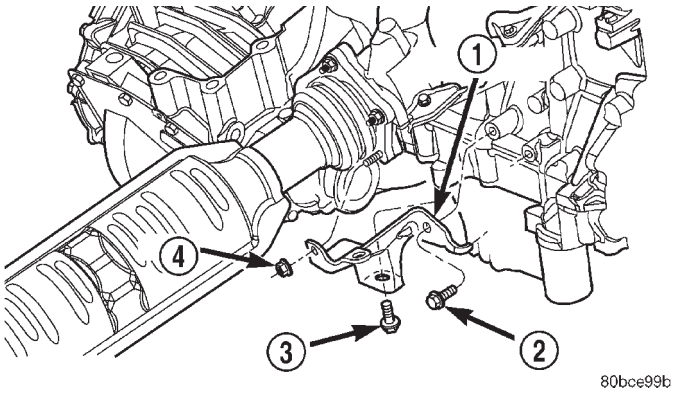


Fig. 35 Exhaust Manifold Support Bracket—Federal & LEV

1 – BRACKET
2 – BOLT (M10)
3 – BOLT (M12)
4 – NUT

INSTALLATION

(1) Position exhaust manifold and gasket in place.

(2) Install exhaust manifold bolts and tighten in sequence shown in (Fig. 38) to 23 N·m (200 in. lbs.).

(3) ULEV equipped—position upper heat shield on exhaust manifold. Install bolts and tighten to 23 N·m (200 in. lbs.).

(4) Position lower and upper heat shield on exhaust manifold. Install heat shield bolts and tighten to 11 N·m (95 in. lbs.) (Fig. 37).

(5) Connect oxygen sensor electrical connector and harness clip.

(6) ULEV equipped—install cylinder head cover. Refer to procedures in this section.

REMOVAL AND INSTALLATION (Continued)

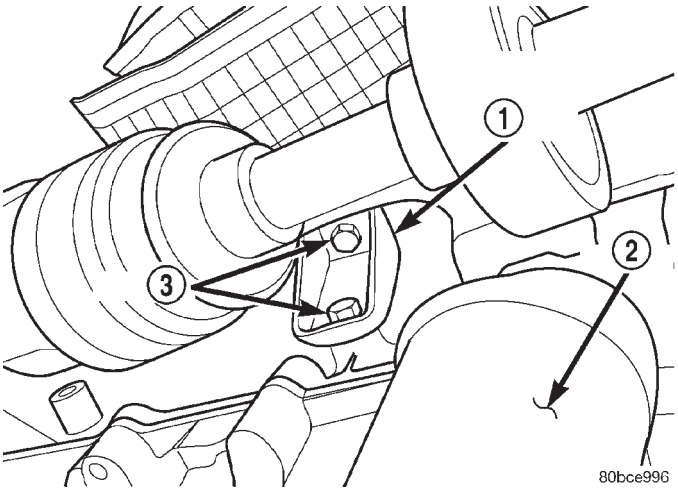


Fig. 36 Exhaust Manifold Support Bracket—ULEV

1 – MANIFOLD SUPPORT BRACKET
2 – OIL FILTER
3 – BOLTS

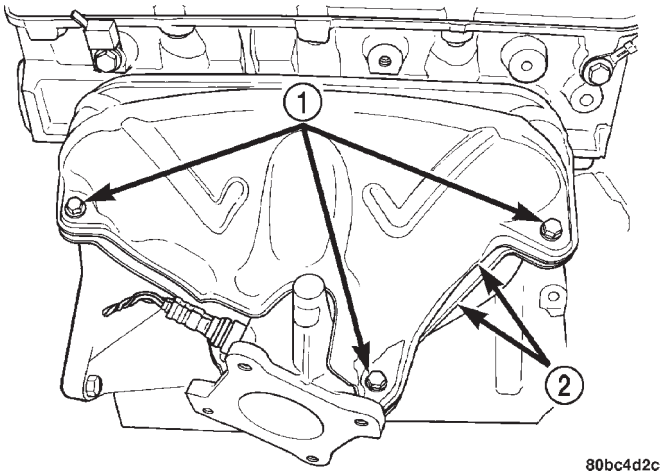


Fig. 37 Exhaust Manifold Heat Shields

1 – BOLTS
2 – HEAT SHIELDS

(7) Connect CCV hose on cylinder head cover port.
(8) Raise vehicle.
(9) Install new flex joint to manifold flange gasket.
(10) Attach exhaust system to manifold flange and tighten fasteners to 28 N·m (250 in. lbs.).
(11) Install exhaust manifold support bracket (Federal and LEV) (Fig. 35). Tighten M10 bolt to 54 N·m (40 ft. lbs.), M12 bolt to 95 N·m (70 ft. lbs.), and nut to 28 N·m (250 in. lbs.).
(12) ULEV equipped—install support bracket to cylinder block and exhaust manifold (Fig. 36). Snug all bolts first then tighten to 54 N·m (40 ft. lbs.).
(13) Install bolt attaching wire harness heat shield to support bracket (Federal and LEV) (Fig. 34), or exhaust manifold (ULEV).

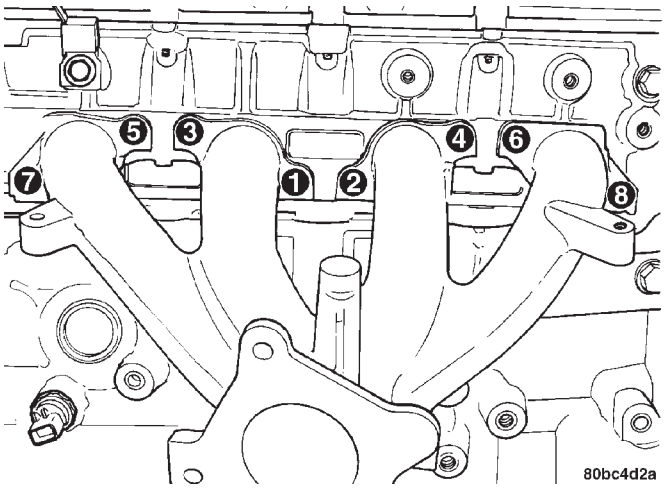


Fig. 38 Exhaust Manifold Tightening Sequence

(14) Lower vehicle.
(15) Connect negative cable to battery.

CYLINDER HEAD COVER

REMOVAL

(1) Disconnect CCV (Fig. 39) and PCV (Fig. 40) hoses from cylinder head cover.
(2) Remove ignition coil and spark plug cables (Fig. 41).
(3) Remove cylinder head cover bolts.
(4) Remove cylinder head cover.

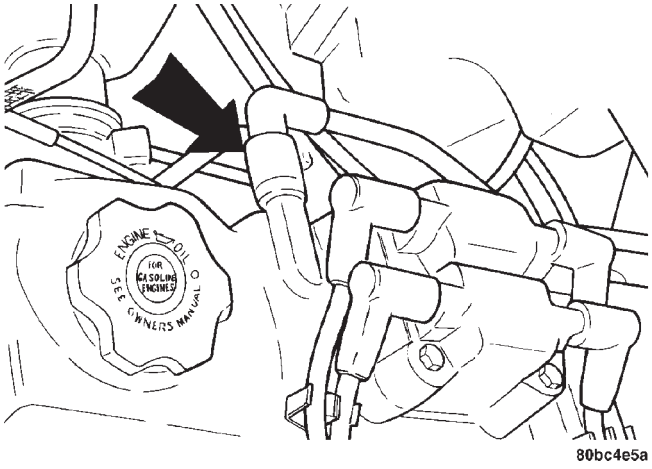


Fig. 39 CCV Hose

INSTALLATION

(1) Clean gasket surfaces. Inspect gasket and seals (Fig. 42). Replace as necessary. For replacement of spark plug tube seals, refer to Spark Plug Tube Seals in this section for procedure.

CAUTION: Do not attempt to loosen or remove baffle plate attaching screws. The screws are self-tapping, and in the attempt to retighten, thread damage (stripping) will result.

REMOVAL AND INSTALLATION (Continued)

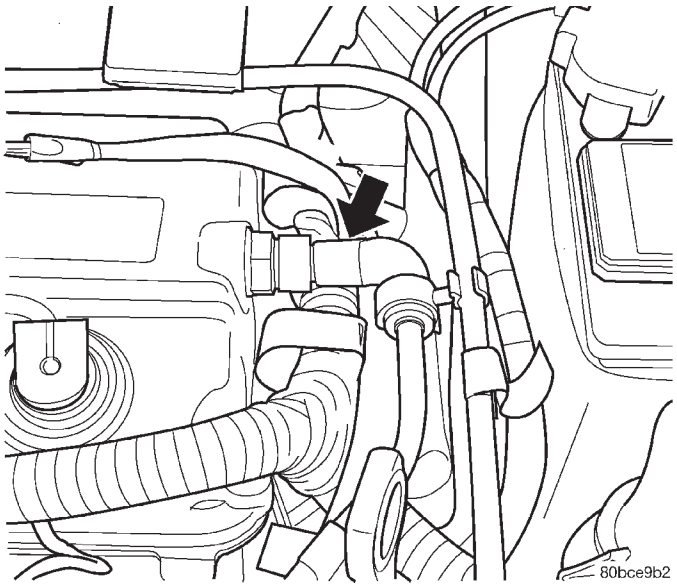


Fig. 40 PCV Valve Hose

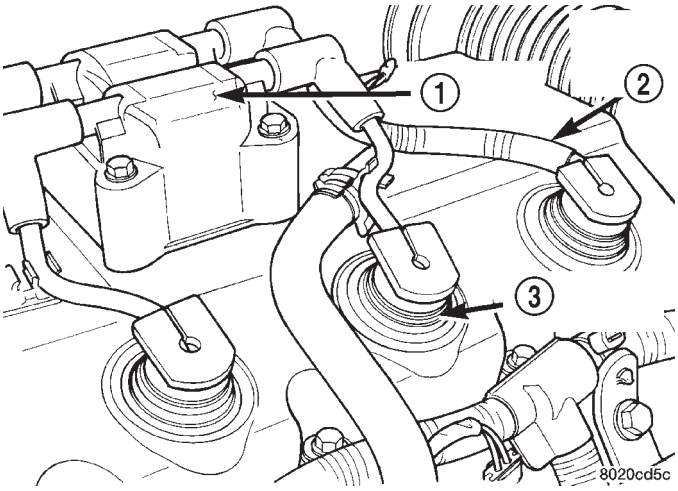


Fig. 41 Ignition Coil and Spark Plug Cables

1 – IGNITION COILS
2 – SPARK PLUG CABLE
3 – SPARK PLUG INSULATOR

(2) Install cylinder head cover and gasket. Tighten bolts to 12 N·m (105 in. lbs.).

(3) Install ignition coil and spark plug cables (Fig. 41). Tighten ignition coil fasteners to 12 N·m (105 in. lbs.).

(4) Connect CCV (Fig. 39) and PCV (Fig. 40) hoses.

SPARK PLUG TUBE SEALS

The spark plug tube seals are located in the cylinder head cover (Fig. 43). These seals are pressed into the cylinder head cover to seal the outside perimeter of the spark plug tubes. If these seals show signs of hardness and/or cracking, they should be replaced.

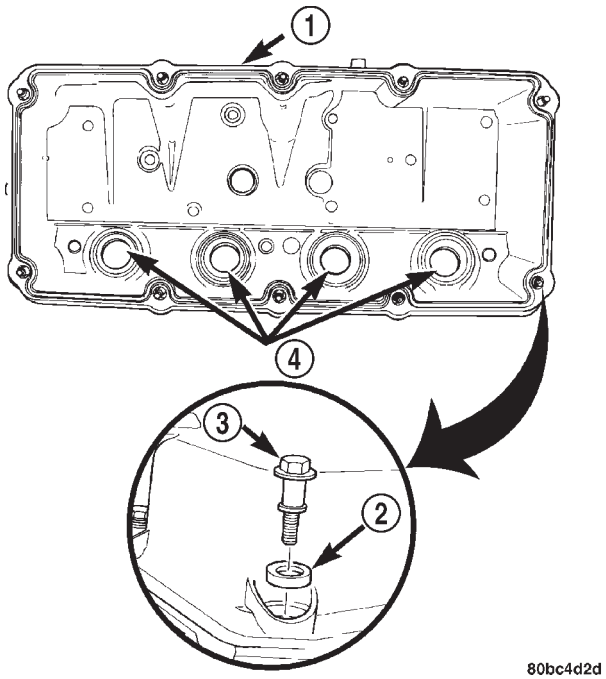


Fig. 42 Cylinder Head Cover Gasket and Seals

1 – CYLINDER HEAD COVER GASKET
2 – SEAL
3 – BOLT
4 – SPARK PLUG TUBE SEALS

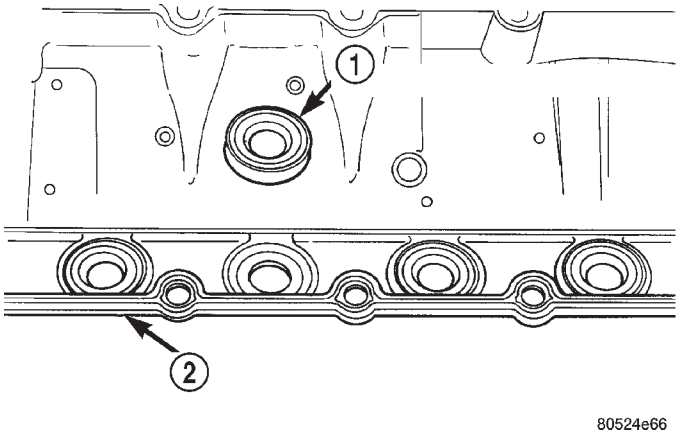


Fig. 43 Spark Plug Tube Seals

1 – SPARK PLUG TUBE SEAL
2 – CYLINDER HEAD COVER

REMOVAL

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

(2) Using an appropriate tool, carefully remove spark plug tube seals. Care should be taken not to damage cylinder head cover sealing surfaces.

INSTALLATION

(1) Clean all sealing surfaces.

REMOVAL AND INSTALLATION (Continued)

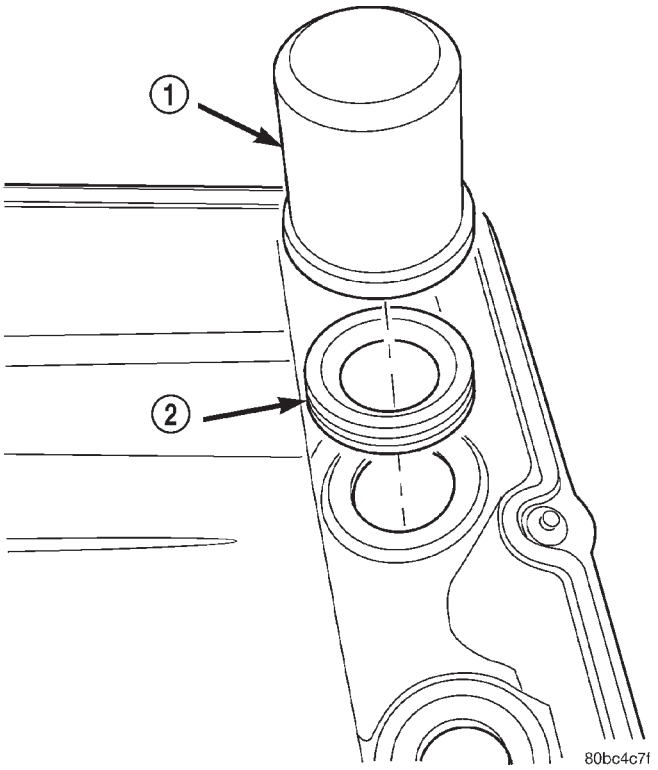


Fig. 44 Spark Plug Tube Seal Installation

1 – SPECIAL TOOL MB-998306
2 – SPARK PLUG TUBE SEAL

NOTE: Position seal with the concave side facing the installation tool.

(2) Install seals using Special Tool MB-998306. Only hand pressure on tool is needed to install new seals.

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

SPARK PLUG TUBE

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

(2) Using locking pliers remove the tube from the cylinder head (Fig. 45). Discard old tube.

(3) Clean area around spark plug with Mopar® parts cleaner or equivalent.

(4) Apply Mopar® Stud and Bearing Mount or equivalent to a new tube approximately 1 mm from the end in a 3 mm wide area.

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

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

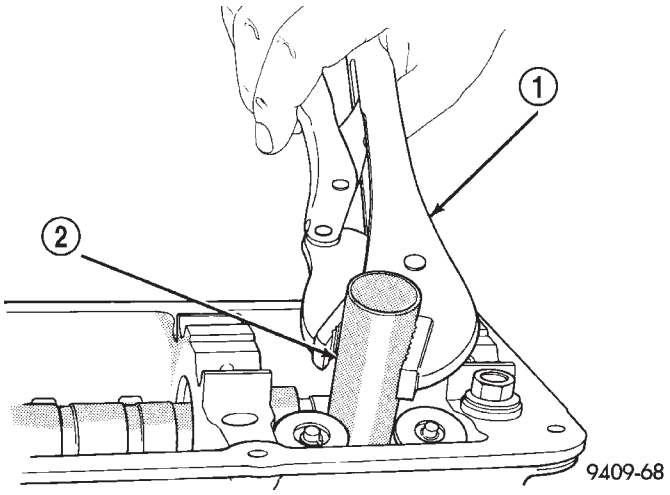


Fig. 45 Spark Plug Tube—Removal

1 – LOCKING PLIERS
2 – SPARK PLUG TUBE

CAMSHAFT

NOTE: TO REMOVE CAMSHAFT THE CYLINDER HEAD MUST BE REMOVED.

REMOVAL

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

(2) Remove the cylinder head cover. Refer to procedure in this section.

(3) Mark rocker arm shaft assemblies so that they are installed in their original positions.

(4) Remove rocker arm shaft bolts. Refer to procedure in this section.

(5) Remove timing belt, timing belt tensioner, and camshaft sprocket. Refer to procedures in this section.

(6) Remove rear timing belt cover.

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

(8) Remove camshaft sensor and camshaft target magnet.

(9) Remove camshaft from the rear of cylinder head.

REMOVAL AND INSTALLATION (Continued)

INSPECT CYLINDER HEAD FOR THE FOLLOWING:

NOTE:

- **Check oil feed holes for blockage.**
- **Inspect cylinder head camshaft bearings for wear, Refer to Cylinder Head, Inspection and Cleaning.**
- **Check camshaft bearing journals for scratches and worn areas. If light scratches are present, they may be removed with 400 grit sand paper. If deep scratches are present, replace the camshaft and check the cylinder head for damage. Replace the cylinder head if worn or damaged. Check the lobes for pitting and wear. If the lobes show signs of wear, check the corresponding rocker arm roller for wear or damage. Replace rocker arm/hydraulic lash adjuster if worn or damaged. If lobes show signs of pitting on the nose, flank or base circle; replace the camshaft.**

INSTALLATION

(1) Lubricate the camshaft journals with oil and install camshaft **without** rocker arm assemblies installed.

(2) Install camshaft target magnet into the end of the camshaft. Tighten mounting screw to 3.4 N·m (30 in. lbs.).

(3) Install camshaft position sensor and tighten mounting screws to 9 N·m (80 in. lbs.).

(4) Measure camshaft end play using the following procedure:

(a) Mount dial indicator C-3339 or equivalent, to a stationary point on cylinder head (Fig. 46).

(b) Using a suitable tool, move camshaft to rearward limits of travel.

(c) Zero the dial indicator.

(d) Move camshaft forward to limits of travel and read dial indicator.

(e) End play travel: 0.13–0.33 mm (0.005–0.013 in.).

(5) Install front camshaft seal. Camshaft must be installed before the camshaft seal is installed. Refer to procedure in this section.

(6) Install cylinder head. Refer to procedure in this section.

(7) Install rear timing belt cover.

(8) Install camshaft sprocket and tighten to 115 N·m (85 ft. lbs.).

(9) Install timing belt tensioner and timing belt. Refer to procedures in this section.

(10) Install rocker arm assemblies in correct order as removed. Tighten the rocker arm assemblies in sequence shown in (Fig. 47) to 28 N·m (250 in. lbs.).

(11) Install cylinder head cover and tighten fasteners to 12 N·m (105 in. lbs.).

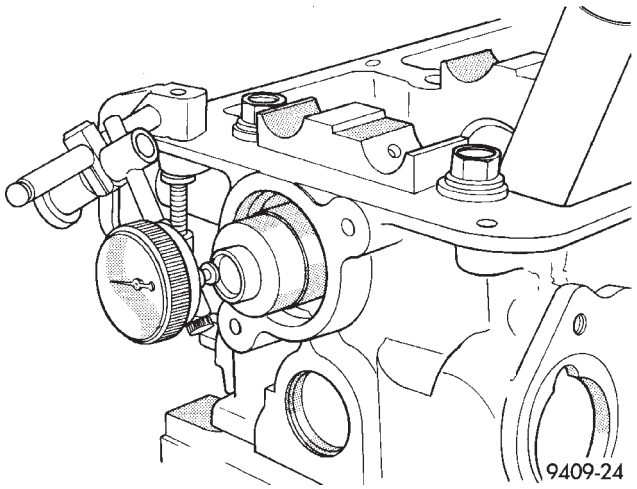


Fig. 46 Camshaft End Play

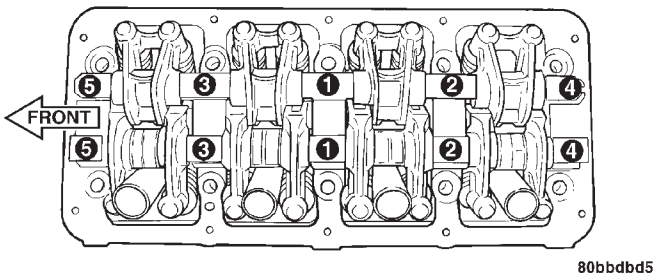


Fig. 47 Rocker Arm Shaft Tightening Sequence

(12) Install ignition coil and spark plug cables. Tighten ignition coil fasteners to 12 N·m (105 in. lbs.).

(13) Perform camshaft and crankshaft timing relearn procedure as follows:

- Connect the DRB scan tool to the data link (diagnostic) connector. This connector is located in the passenger compartment; at the lower edge of instrument panel; near the steering column.
- Turn the ignition switch on and access the “miscellaneous” screen.
- Select “re-learn cam/crank” option and follow directions on DRB screen.

ROCKER ARM/HYDRAULIC LASH ADJUSTER

REMOVAL

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

(2) Identify the rocker arm shaft assemblies before removal.

(3) Loosen the attaching fasteners. Remove rocker arm shaft assemblies from cylinder head.

(4) Identify the rocker arms spacers and retainers for reassembly. Disassemble the rocker arm assemblies by removing the attaching bolts from the shaft (Fig. 48).

REMOVAL AND INSTALLATION (Continued)

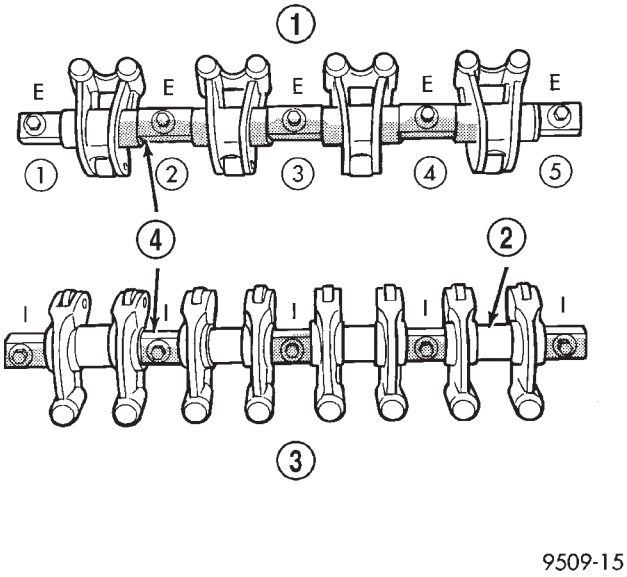


Fig. 48 Rocker Arm Shaft Assemblies

1 – EXHAUST ROCKER ARM ASSEMBLY
2 – PLASTIC SHAFT SPACERS
3 – INTAKE ROCKER ARM ASSEMBLY
4 – ROCKER ARM SHAFT RETAINERS

(5) Slide the rocker arms and spacers off the shaft. Keep the spacers and rocker arms in the same location for reassembly.

NOTE: Inspect the rocker arm for scoring, wear on the roller or damage to the rocker arm (Fig. 49) Replace if necessary. Check the location where the rocker arms mount to the shafts for wear or damage. Replace if damaged or worn. The rocker arm shaft is hollow and is used as a lubrication oil duct. Check oil holes for clogging with small wire, clean as required. Lubricate the rocker arms and spacers. Install onto shafts in their original position (Fig. 48).

INSTALLATION

CAUTION: Set crankshaft to 3 notches before TDC before installing rocker arm shafts. Refer to Timing Belt System and Camshaft Seal Service of this section for procedure.

(1) Install rocker arm/hydraulic lash adjuster assembly making sure that adjusters are at least partially full of oil. This is indicated by little or no plunger travel when the lash adjuster is depressed. If there is excessive plunger travel. Place the rocker arm assembly into clean engine oil and pump the plunger until the lash adjuster travel is taken up. If travel is not reduced, replace the assembly. Hydraulic lash adjuster and rocker arm are serviced as an assembly.

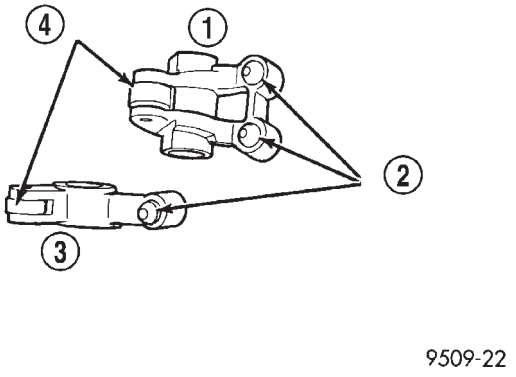


Fig. 49 Rocker Arm Assemblies

1 – EXHAUST ROCKER ARM
2 – HYDRAULIC LASH ADJUSTERS
3 – INTAKE ROCKER ARM
4 – ROLLERS

(2) Install rocker arm and shaft assemblies with NOTCH in the rocker arm shafts pointing up and toward the timing belt side of the engine (Fig. 50). Install the retainers in their original positions on the exhaust and intake shafts (Fig. 48).

CAUTION: When installing the intake rocker arm shaft assembly be sure that the plastic spacers do not interfere with the spark plug tubes. If the spacers do interfere rotate until they are at the proper angle. To avoid damaging the spark plug tubes, do not attempt rotating the spacers by forcing down the shaft assembly.

(3) Tighten bolts to 28 N·m (250 in. lbs.) in sequence shown in (Fig. 51).

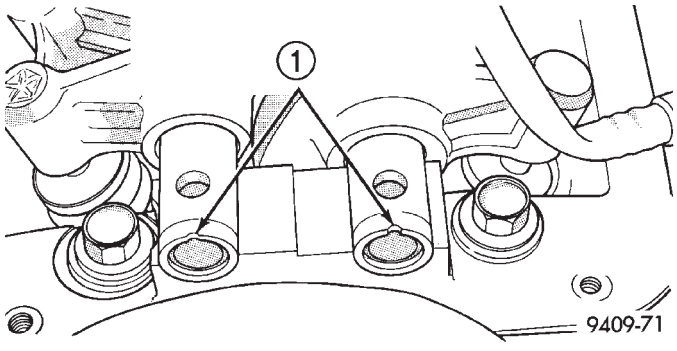


Fig. 50 Rocker Arm Shaft Notches

1 – NOTCHES FACING UP AND TOWARD THE TIMING BELT SIDE OF THE ENGINE

(4) Install cylinder head cover. Refer to procedures in this section.

REMOVAL AND INSTALLATION (Continued)

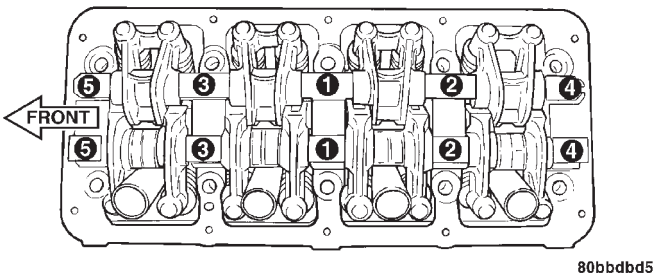


Fig. 51 Rocker Arm Shaft Tightening Sequence

HYDRAULIC LASH ADJUSTER NOISE

A tappet-like noise may be produced from several items. Refer to Lash Adjuster Noise - Diagnosis in Standard Service Procedures, in this Group. **Lash adjusters are replaced with the rocker arm as an assembly.**

VALVE SEALS AND SPRINGS—IN VEHICLE

REMOVAL

(1) Remove rocker arm shafts assemblies. Refer to procedure in this section.

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

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

(4) Using Special Tool MD-998772A with adapter 6779 (Fig. 52) compress valve springs and remove valve locks.

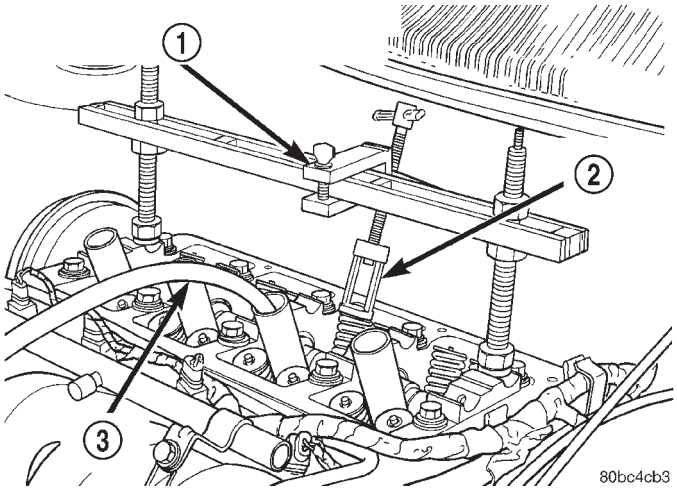


Fig. 52 Valve Spring—Removing and Installing

1 – VALVE SPRING COMPRESSOR SPECIAL TOOL MD-998772A
2 – ADAPTER 6779
3 – AIR HOSE

(5) Remove valve spring.

(6) Remove valve stem seal by using a valve stem seal tool (Fig. 53).

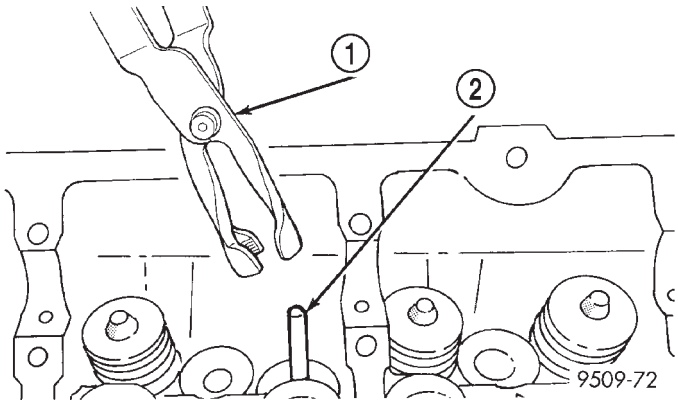


Fig. 53 Valve Stem Oil Seal Tool

1 – VALVE SEAL TOOL
2 – VALVE STEM

INSTALLATION

(1) Install valve seal/valve spring seat assembly. Refer to Valve Installation procedure in this section.

(2) Using Special Tool MD-998772A compress valve springs only enough to install locks. Correct alignment of tool is necessary to avoid nicking valve stems (air pressure required), piston at TDC.

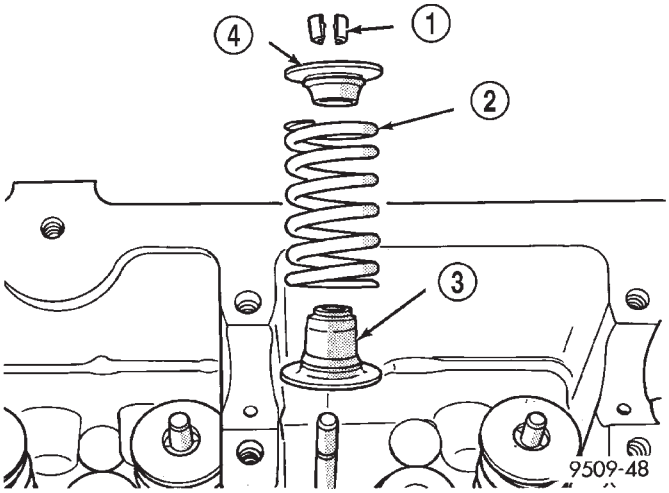


Fig. 54 Valve Spring Assembly

1 – VALVE RETAINING LOCKS
2 – VALVE SPRING
3 – VALVE SEAL AND VALVE SPRING SEAT ASSEMBLY
4 – VALVE SPRING RETAINER

(3) Install rocker arm shaft assemblies. Refer to procedure in this section.

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

REMOVAL AND INSTALLATION (Continued)

CYLINDER HEAD

REMOVAL

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

(2) Disconnect negative battery cable.

(3) Remove power steering/air conditioning drive belt. Refer to Group 7, Cooling System Accessory Drive for procedure.

(4) Raise vehicle.

(5) Drain cooling system. Refer to Group 7, Cooling System.

(6) Remove exhaust pipe from manifold.

(7) Remove right front wheel.

(8) Remove right side splash shield.

(9) Remove generator belt. Refer to Group 7, Cooling System Accessory Drive Belts for procedure.

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

(11) Remove lower torque strut.

(12) Lower vehicle and remove upper torque strut.

(13) Remove ground strap and power steering hose support clip from engine mount bracket.

(14) Remove power steering pump assembly and set aside.

(15) Support engine from beneath with a suitable jack.

(16) Remove right side engine mount to bracket through bolt.

(17) Remove the lower engine mount bracket bolt. Raise engine slightly and remove the upper engine mount bracket bolts.

(18) Remove engine mount bracket. This procedure may require additional raising/lowering of engine until bracket will clear engine components.

(19) Remove front timing belt cover.

(20) Rotate engine until timing marks are aligned.

(21) Remove timing belt and tensioner. Refer to procedures in this section.

(22) Remove camshaft sprocket. Refer to procedures in this section.

(23) Remove rear timing belt cover.

(24) Disconnect fuel line at fuel rail.

(25) Remove coolant recovery container.

(26) Remove ground wire to cylinder head.

(27) Remove upper radiator hose.

(28) Remove intake manifold. Refer to procedure in this section.

(29) Disconnect ignition coil electrical connector. Remove coil pack and spark plug cables from engine.

(30) Remove Crankcase Closed Ventilation (CCV) hose from cylinder head cover.

(31) Disconnect cam sensor and coolant temperature electrical connectors.

(32) Remove heater tube to cylinder head attaching fasteners.

(33) Remove heater hose from thermostat housing connector.

(34) Remove cylinder head cover.

(35) Remove cylinder head bolts.

(36) Remove cylinder head and gasket (Fig. 55).

REMOVAL AND INSTALLATION (Continued)

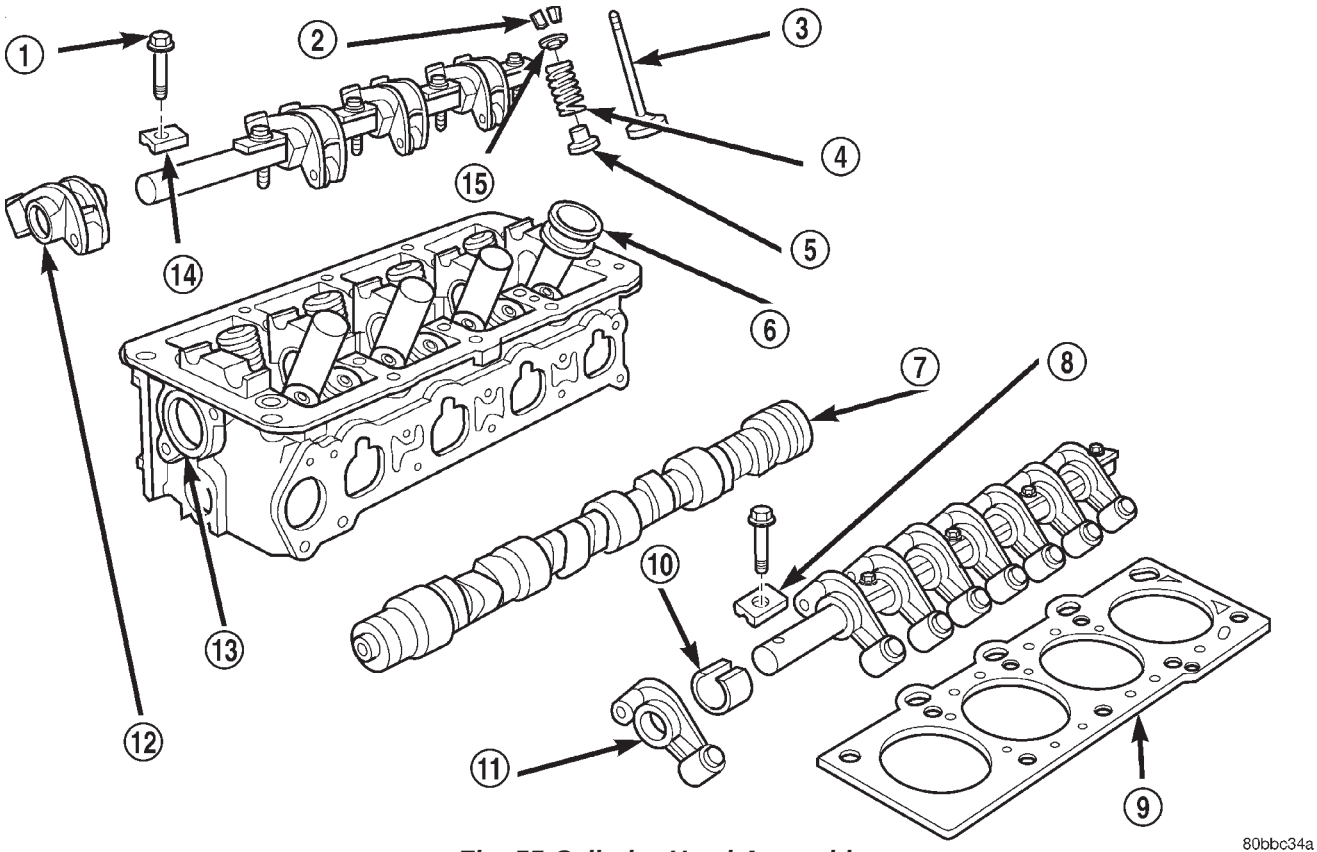


Fig. 55 Cylinder Head Assembly

1 – ROCKER SHAFT RETAINING BOLT
2 – VALVE RETAINING LOCKS
3 – VALVE
4 – VALVE SPRING
5 – VALVE SEAL AND VALVE SPRING SEAT ASSEMBLY
6 – SPARK PLUG TUBE SEAL
7 – CAMSHAFT
8 – ROCKER ARM SHAFT RETAINER SPACER
9 – GASKET
10 – SPACER
11 – INTAKE ROCKER ARM/HYDRAULIC LASH ADJUSTER ASSEMBLY
12 – EXHAUST ROCKER ARM/HYDRAULIC LASH ADJUSTER ASSEMBLY
13 – CAMSHAFT SEAL
14 – RETAINER SPACER
15 – VALVE SPRING RETAINER

NOTE: Inspect camshaft bearing journals for scoring. Cylinder head must be flat within 0.1 mm (0.004 inch) (Fig. 56).

INSTALLATION

EXAMINING CYLINDER HEAD BOLTS

NOTE: The cylinder head bolts should be examined BEFORE reuse. If the threads are necked down, the bolt(s) should be replaced (Fig. 57).

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(s) should be replaced.

CLEANING CYLINDER HEAD SEALING SURFACES

CAUTION: When cleaning cylinder head and cylinder block surfaces, DO NOT use a metal scraper. Sealing surfaces could be cut or ground, resulting in gasket leaks. Use only the cleaning methods shown in (Fig. 58). If required, use a white (120 grit) 3M Roloc™ bristle disk on aluminum surfaces. A yellow (80 grit) bristle disk can be used on cast iron surfaces with care.

(1) Clean the cylinder head and cylinder block sealing surfaces using a wood/plastic scraper. Apply solvent or a commercially available gasket remover to help soften the gasket residue. If additional cleaning is required, use a white (120 grit) 3M Roloc™ bristle disk and a drill motor to remove gasket residue.

REMOVAL AND INSTALLATION (Continued)

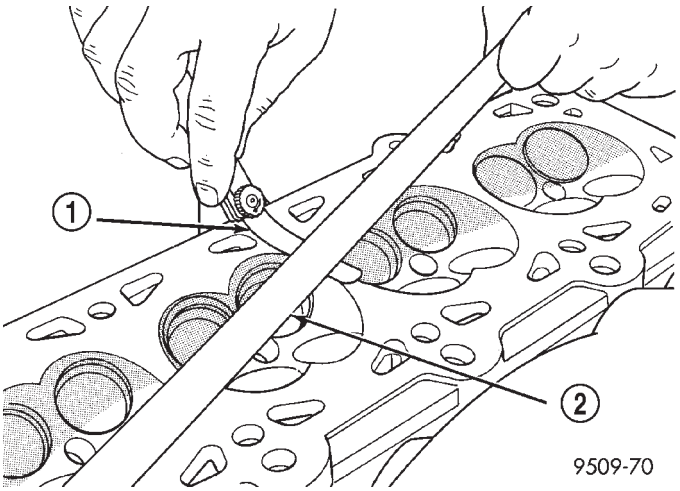


Fig. 56 Checking Cylinder Head Flatness

1 – FEELER GAUGE
2 – STRAIGHT EDGE

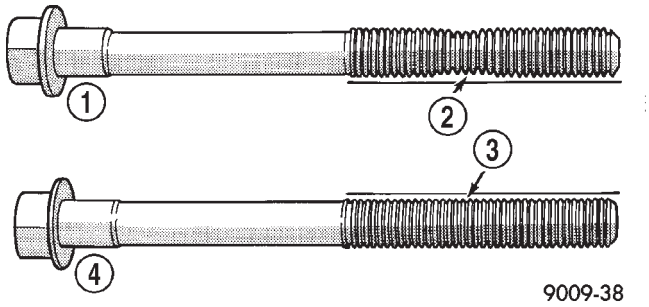


Fig. 57 Checking Bolts for Stretching (Necking)

1 – STRETCHED BOLT
2 – THREADS ARE NOT STRAIGHT ON LINE
3 – THREADS ARE STRAIGHT ON LINE
4 – UNSTRETCHED BOLT

(2) Apply Mopar® Gasket Sealant (aerosol can) to both sides of the new cylinder head gasket.

(3) Position a new cylinder head gasket on the locating dowels.

(4) Position crankshaft sprocket to TDC, then rotate crankshaft until mark is three teeth before TDC (Fig. 59). This will ensure that no piston-to-valve contact occurs upon installation of cylinder head in the event of camshaft rotation.

(5) Position the cylinder head onto the cylinder block. Make sure the cylinder head seats fully over the locating dowels.

(6) Before installing cylinder head bolts, the threads should be oiled with engine oil. The 4 shorter bolts 164 mm (6.45 in.), are to be installed in positions 7, 8, 9, and 10 (Fig. 60).

(7) Tighten the cylinder head bolts in the sequence shown in (Fig. 60). Using the 4 step torque method, tighten according to the following values:

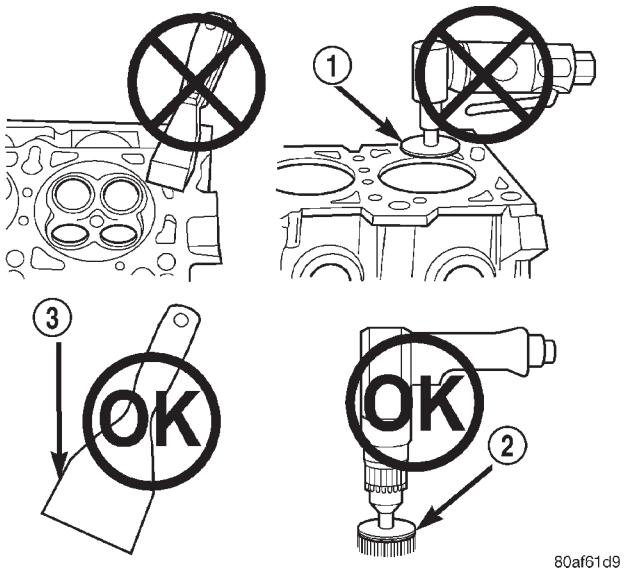


Fig. 58 Proper Tool Usage for Surface Preparation

1 – ABRASIVE PAD
2 – 3M ROLOC™ BRISTLE DISC
3 – PLASTIC/WOOD SCRAPER

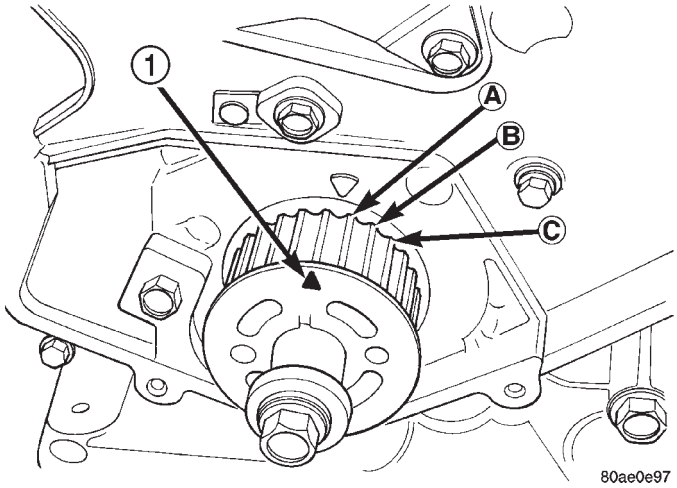


Fig. 59 Crankshaft Sprocket Position

1 – TDC MARK

- First All to 34 N·m (25 ft. lbs.)
- Second All to 68 N·m (50 ft. lbs.)
- Third All to 68 N·m (50 ft. lbs.)
- Fourth Turn an additional 1/4 Turn. **Do not use a torque wrench for this step.**

(8) Install cylinder head cover.

(9) Install heater hose to thermostat housing connector.

(10) Install heater tube to cylinder head attaching fasteners.

(11) Connect cam sensor and coolant temperature electrical connectors.

(12) Connect Crankcase Closed Ventilation (CCV) hose to cylinder head cover.

REMOVAL AND INSTALLATION (Continued)

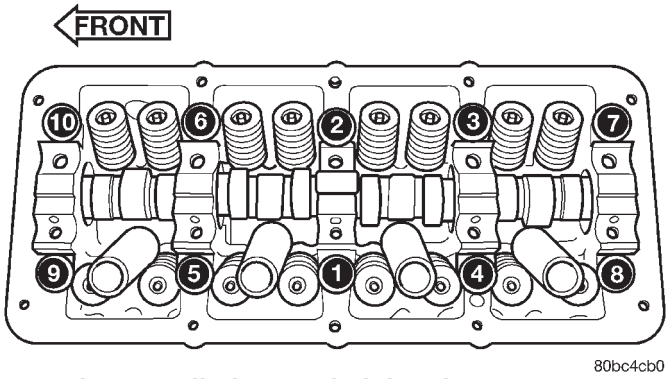


Fig. 60 Cylinder Head Tightening Sequence

(13) Install ignition coil and spark plug cables. Connect coil electrical connector.

(14) Install intake manifold. Refer to procedure in this section.

(15) Install upper radiator hose.

(16) Install ground wire to cylinder head.

(17) Install coolant recovery container.

(18) Connect fuel line to fuel rail.

(19) Install rear timing belt cover, camshaft sprocket, and timing belt tensioner and timing belt. Refer to procedures in this section.

(20) Install front timing belt cover.

(21) Install engine mount bracket.

(22) Position engine and install right side engine mount to engine mount bracket bolt. Tighten bolt to 118 N·m (87 ft. lbs.). Remove jack from beneath engine.

(23) Install power steering pump assembly.

(24) Install power steering hose support clip and ground strap to engine mount bracket.

(25) Install upper torque strut.

(26) Raise vehicle.

(27) Install lower torque strut.

(28) Install crankshaft damper.

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

(30) Install right side splash shield and front wheel.

(31) Install exhaust pipe to exhaust manifold flange.

(32) Lower vehicle and fill cooling system. Refer to Group 7, Cooling System for procedure.

(33) Connect negative cable to battery.

(34) Perform camshaft and crankshaft timing relearn procedure as follows:

- Connect the DRB scan tool to the data link (diagnostic) connector. This connector is located in the passenger compartment; at the lower edge of instrument panel; near the steering column.
- Turn the ignition switch on and access the “miscellaneous” screen.
- Select “re-learn cam/crank” option and follow directions on DRB screen.

CRANKSHAFT DAMPER

REMOVAL

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

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

(3) Remove crankshaft damper bolt. Remove damper using the large side of Special Tool 1026 and insert 6827-A (Fig. 61).

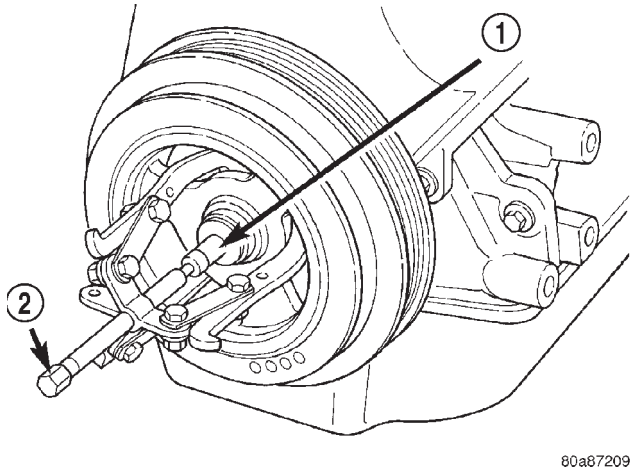


Fig. 61 Crankshaft Damper—Removal

1 – SPECIAL TOOL 6827–A INSERT
2 – SPECIAL TOOL 1026 THREE JAW PULLER

INSTALLATION

(1) Install crankshaft damper using M12–1.75 x 150 mm bolt, washer, thrust bearing and nut from Special Tool 6792 (Fig. 62).

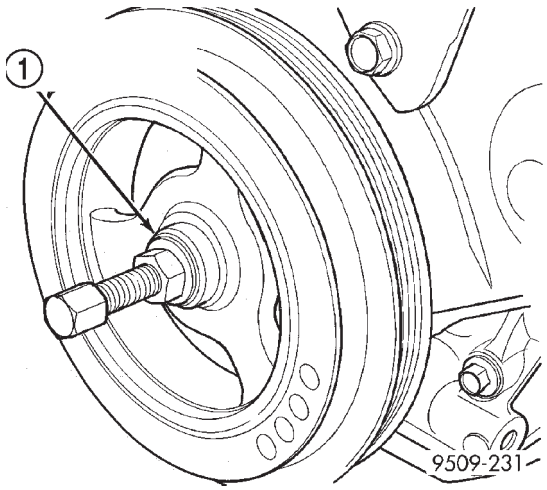


Fig. 62 Crankshaft Damper—Installation

1 – M12 — 1.75 × 150 MM BOLT, WASHER AND THRUST BEARING FROM SPECIAL TOOL 6792

REMOVAL AND INSTALLATION (Continued)

(2) Install crankshaft damper bolt. Using Special Tool 6847 and a torque wrench, tighten bolt to 136 N·m (100 ft. lbs.) (Fig. 63).

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

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

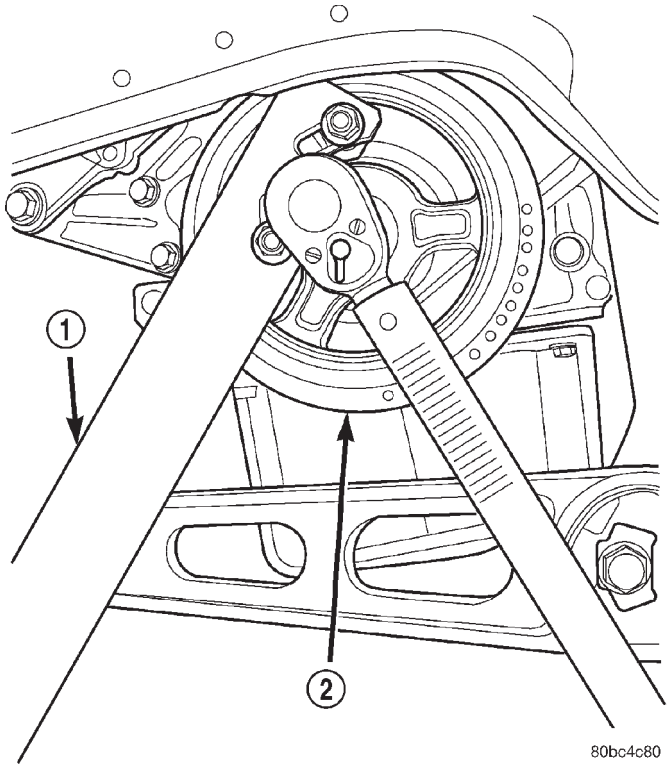


Fig. 63 Crankshaft Damper Bolt Tightening

1 – SPECIAL TOOL 6847
2 – CRANKSHAFT DAMPER

TIMING BELT COVERS

FRONT TIMING BELT COVER

REMOVAL

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

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

(3) Remove lower and upper torque struts. Refer to procedure in this section.

(4) Position a jack under engine. Raise jack enough to support engine weight.

(5) Remove right engine mount to engine mount bracket bolt.

(6) Remove power steering pump assembly and set aside.

(7) Remove right engine mount bracket.

(8) Remove front timing belt cover (Fig. 64).

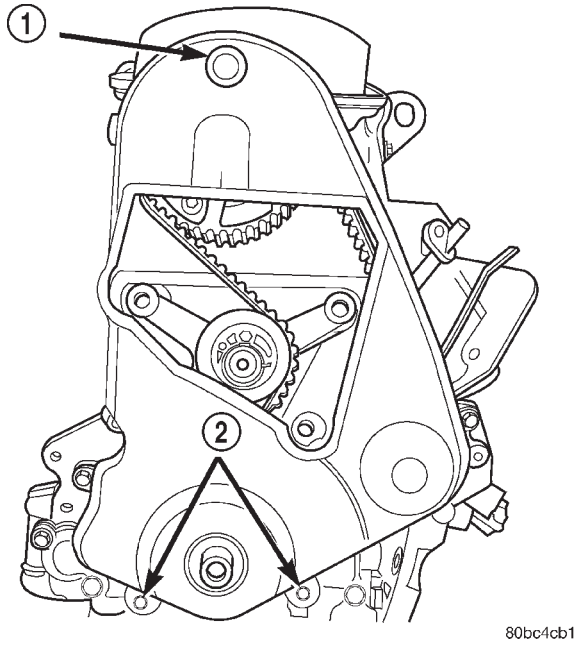


Fig. 64 Front Timing Belt Cover

1 – ACCESS PLUG
2 – BOLTS

INSTALLATION

(1) Install front timing belt cover and tighten bolts to 12 N·m (105 in. lbs.).

(2) Install front engine mount bracket.

(3) Install right side engine mount to engine mount bracket bolt.

(4) Remove jack from under engine.

(5) Install power steering pump assembly.

(6) Install upper and lower engine torque struts. Refer to procedure in this section.

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

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

REAR TIMING BELT COVER

REMOVAL

(1) Remove front timing belt cover following procedure in this section.

(2) Remove timing belt and timing belt tensioner. Refer to procedures in this section.

(3) Hold camshaft sprocket with Special Tools C-4687 and modified Adaptor C-4687-1 (Fig. 66), while removing attaching bolt.

(4) Remove camshaft sprocket.

(5) Remove rear timing cover attaching bolts (Fig. 65).

(6) Remove rear timing cover (Fig. 65).

REMOVAL AND INSTALLATION (Continued)

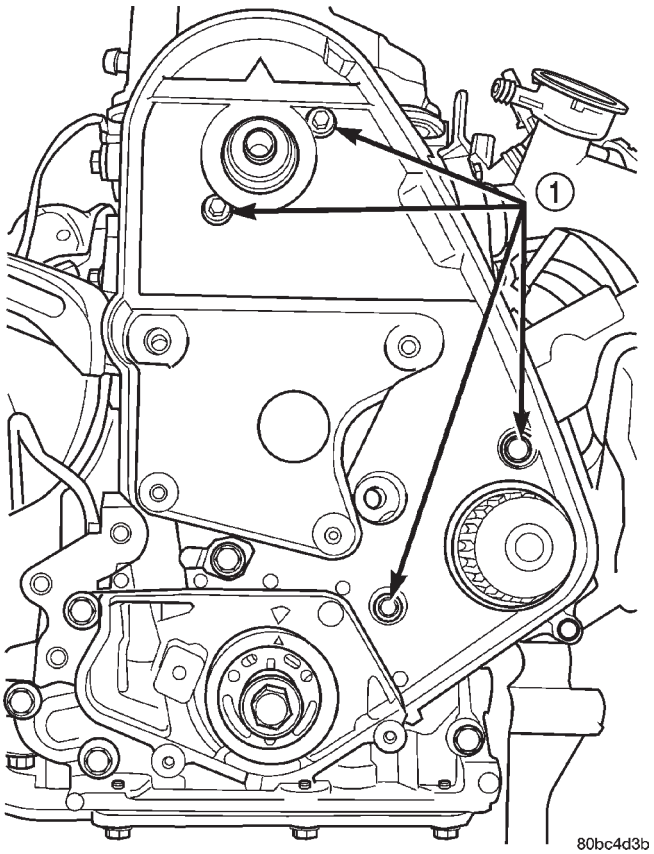


Fig. 65 Rear Timing Belt Cover

1 – BOLTS

INSTALLATION

(1) Install rear timing cover and tighten bolts to 12 N·m (105 in. lbs.) (Fig. 65).

(2) Install camshaft sprocket. While holding sprockets with Special Tools C-4687 and modified Adaptor C-4687-1, tighten attaching bolt to 101 N·m (75 ft. lbs.).

(3) Install timing belt tensioner assembly and timing belt. Refer to procedure in this section.

(4) Install front timing belt cover following procedure in this section.

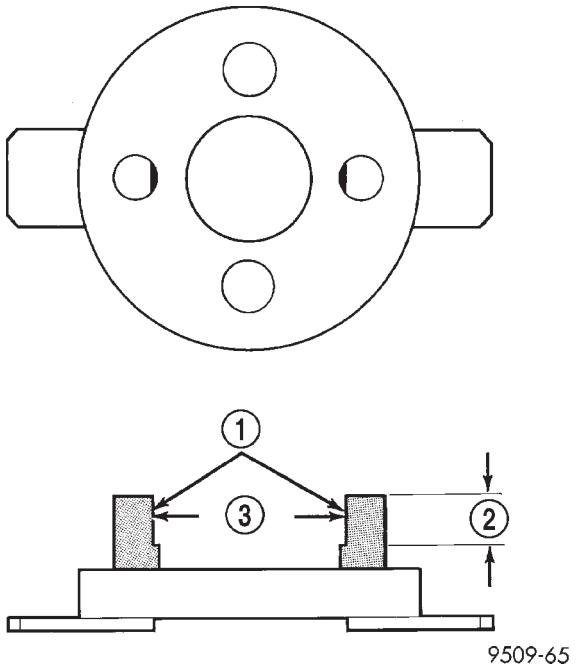


Fig. 66 Modification to Special Tool C-4687-1

1 – GRIND LOCATION
2 – 12.7 MM (1/2 IN.)
3 – 50.8 MM (2 IN.)

REMOVAL AND INSTALLATION (Continued)

TIMING BELT

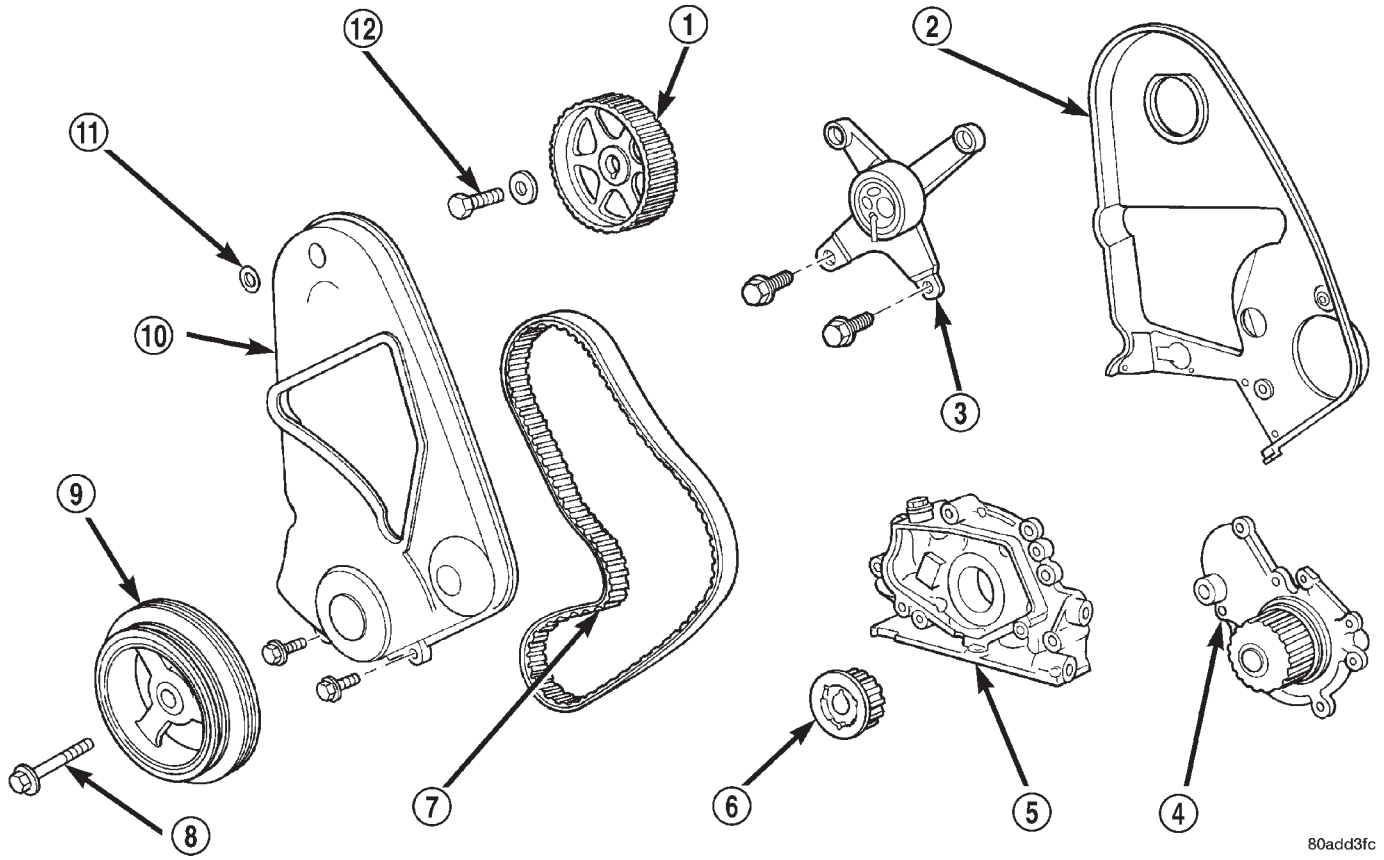


Fig. 67 Timing Belt System

1 – CAMSHAFT SPROCKET
2 – REAR TIMING BELT COVER
3 – TIMING BELT TENSIONER ASSEMBLY
4 – WATER PUMP
5 – OIL PUMP BODY
6 – CRANKSHAFT SPROCKET
7 – TIMING BELT
8 – BOLT
9 – CRANKSHAFT DAMPER
10 – FRONT TIMING BELT COVER
11 – ACCESS PLUG
12 – CAMSHAFT BOLT AND WASHER

CHECKING BELT TIMING—COVER INSTALLED

- Remove number one spark plug.
- Using a dial indicator, set number one cylinder to TDC on the compression stroke.
- Remove the access plug from the outer timing belt cover (Fig. 67).
- Check the timing mark on the camshaft sprocket, it should align with the arrow on the rear belt cover (Fig. 68).

REMOVAL—TIMING BELT

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

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

(3) Remove crankshaft damper bolt. Remove damper using Special Tools 1026 three jaw puller and 6827-A insert (Fig. 69).

(4) Remove lower torque strut.

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

(6) Remove upper torque strut.

(7) Remove right engine mount to engine mount bracket through bolt.

(8) Remove power steering pump assembly and set aside.

(9) Remove engine mount bracket (Fig. 70).

(10) Remove front timing belt cover (Fig. 71).

CAUTION: Align camshaft and crankshaft timing marks before removing the timing belt by rotating the engine with the crankshaft.

REMOVAL AND INSTALLATION (Continued)

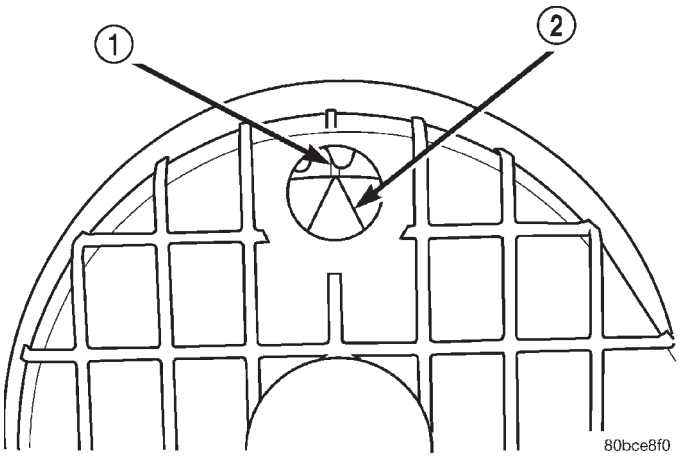


Fig. 68 Camshaft Timing Marks

1 – CAM SPROCKET TIMING MARK
2 – ARROW ON REAR COVER

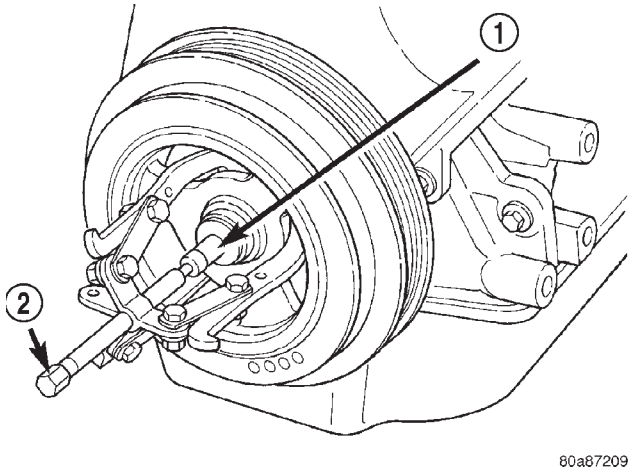


Fig. 69 Crankshaft Damper—Removal

1 – SPECIAL TOOL 6827–A INSERT
2 – SPECIAL TOOL 1026 THREE JAW PULLER

(11) Insert a 8 mm Allen wrench into the hexagon opening located on the front of the belt tensioner pulley (Fig. 72). Rotate the pulley counterclockwise until it contacts the stop. While holding tensioner pulley against stop, insert a 1/8" or 3 mm diameter pin or Allen wrench through the hole located to the left of the hex opening (Fig. 72). While pushing pin into hole, allow the tensioner pulley to rotate back. Almost immediately, the pin should engage the locking hole to prevent further movement of the pulley.

(12) Remove timing belt.

CAUTION: Do not rotate the camshafts once the timing belt has been removed or damage to valve components may occur.

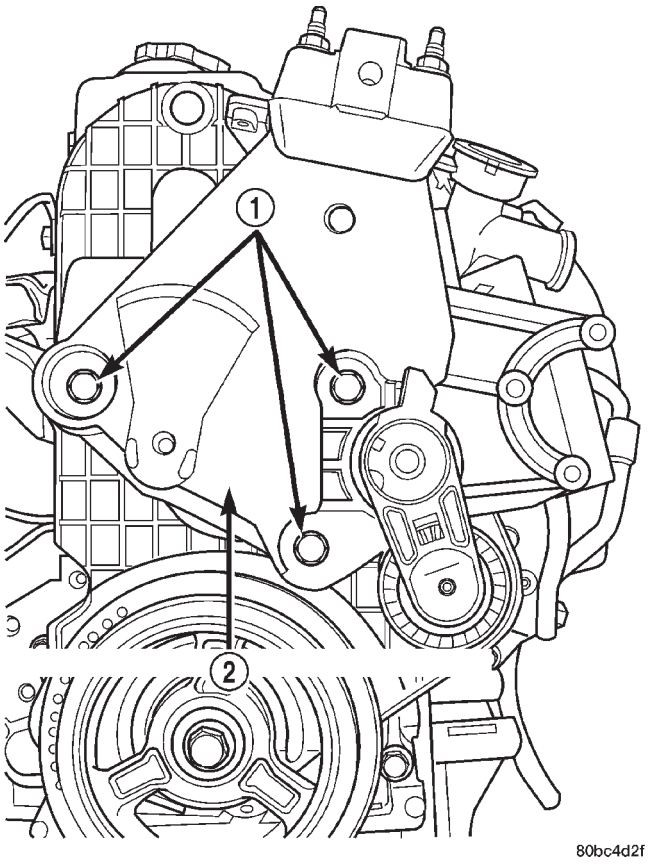


Fig. 70 Right Engine Mount Bracket

1 – BOLTS
2 – ENGINE MOUNT BRACKET ASSEMBLY

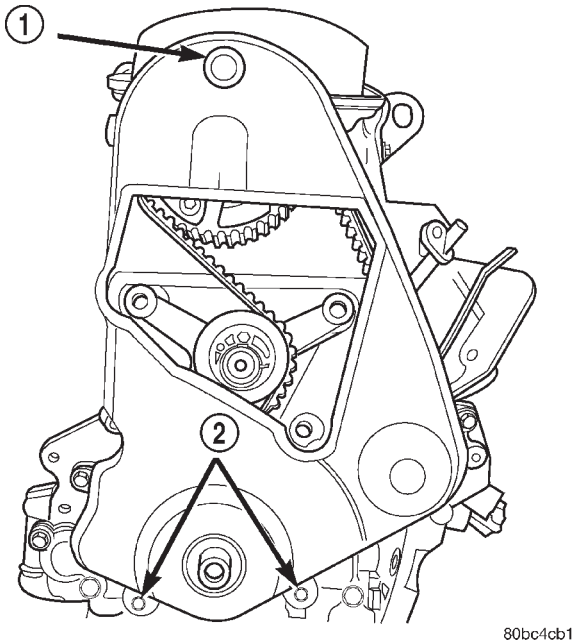


Fig. 71 Timing Belt Cover

1 – ACCESS PLUG
2 – BOLTS

REMOVAL AND INSTALLATION (Continued)

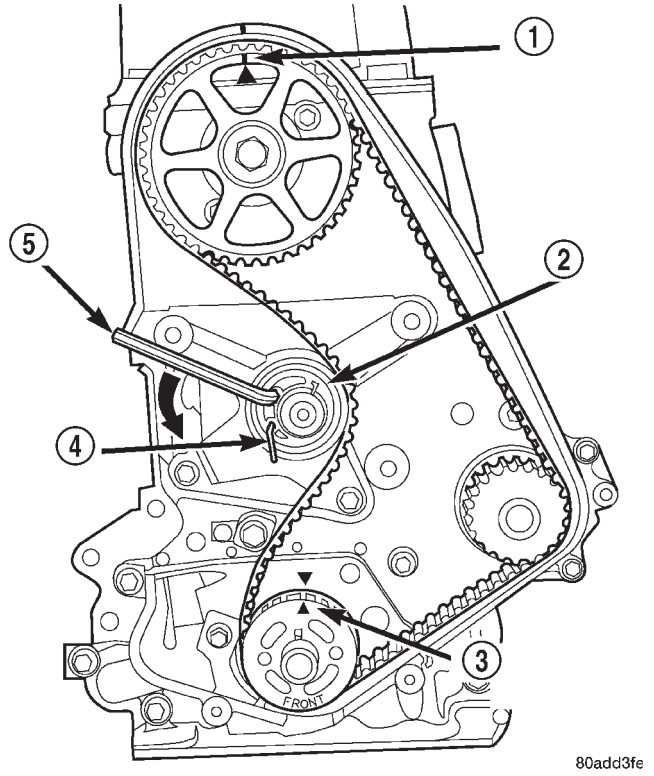


Fig. 72 Timing Belt Removal

1 – CAMSHAFT TIMING MARKS
2 – BELT TENSIONER
3 – CRANKSHAFT AT TDC
4 – 1/8" OR 3mm ALLEN WRENCH
5 – 8 mm ALLEN WRENCH

CAMSHAFT AND CRANKSHAFT TIMING PROCEDURE AND BELT INSTALLATION

(1) Set crankshaft sprocket to TDC by aligning the sprocket with the arrow on the oil pump housing, then back off to 3 notches before TDC (Fig. 73).

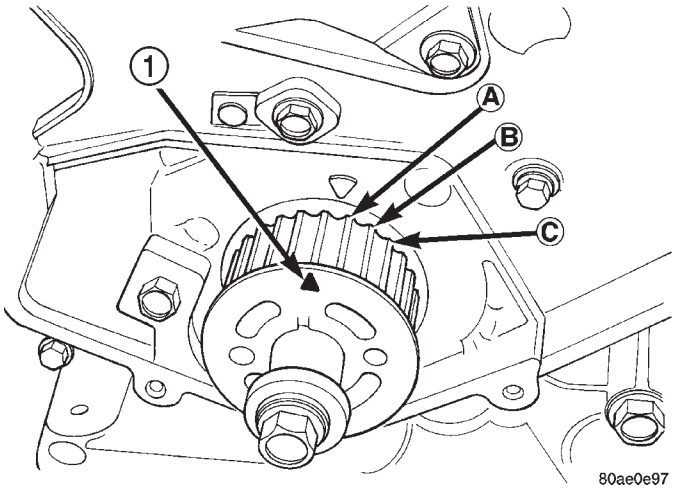


Fig. 73 Crankshaft Sprocket Timing

1 – TDC MARK

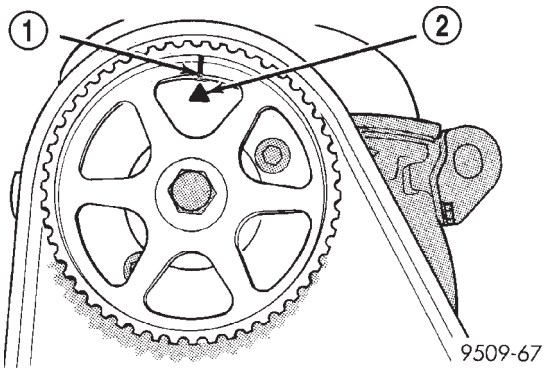


Fig. 74 Camshaft Timing Mark

1 – CAM SPROCKET TIMING MARK
2 – ARROW ON REAR COVER

(2) Set camshaft to TDC by aligning mark on sprocket with the arrow on the rear of timing belt cover (Fig. 73).

(3) Move crankshaft to 1/2 mark before TDC (Fig. 75) for belt installation.

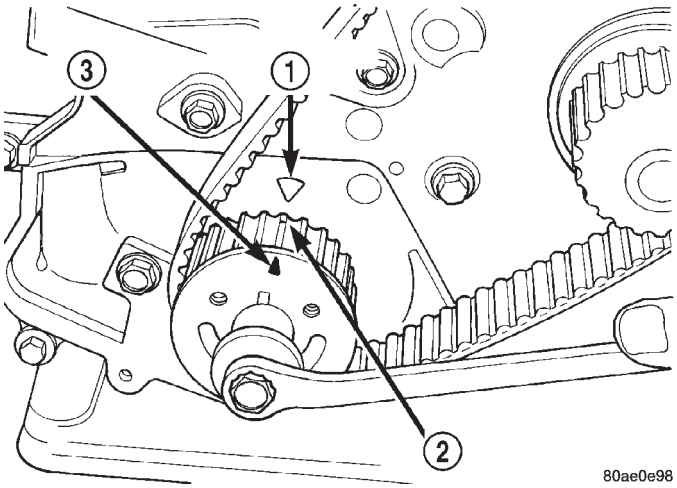


Fig. 75 Adjusting Crankshaft Sprocket for Timing Belt Installation

1 – TDC REFERENCE MARK
2 – 1/2 NOTCH LOCATION
3 – TDC MARK

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

(5) Move crankshaft sprocket to TDC to take up belt slack.

(6) Remove the pin or 1/8" or 3 mm Allen wrench from belt tensioner.

(7) Rotate crankshaft 2 revolutions and check the alignment of the timing marks (Fig. 76).

(8) Install front timing belt cover.

(9) Install engine mount bracket.

REMOVAL AND INSTALLATION (Continued)

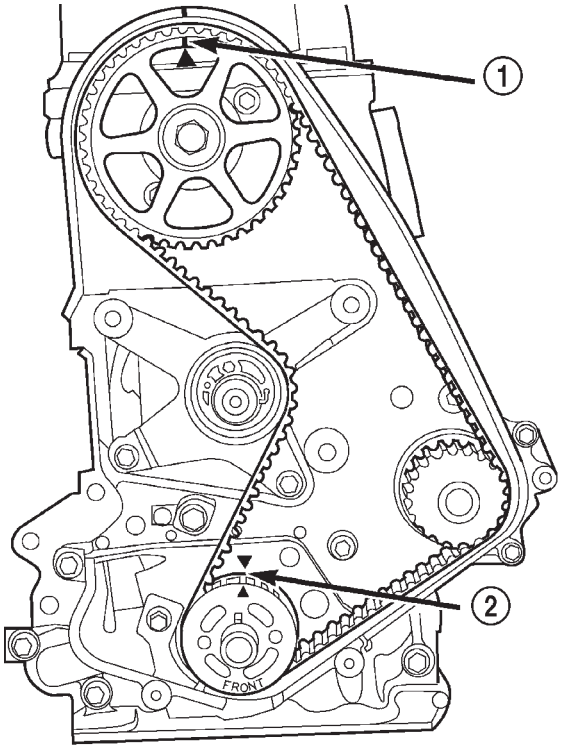


Fig. 76 Crankshaft and Camshaft Timing

1 – CAMSHAFT TIMING MARKS
2 – CRANKSHAFT AT TDC

(10) Install right engine mount to engine mount bracket through bolt.

(11) Remove jack from under engine.

(12) Install upper torque strut.

(13) Install power steering pump assembly.

(14) Raise vehicle and install lower torque strut.

(15) Install crankshaft damper using M12-1.75 x 150 mm bolt, washer, thrust bearing and nut from Special Tool 6792. Install crankshaft damper bolt and tighten to 142 N·m (100 ft. lbs.) (Fig. 77).

(16) Install accessory drive belts. Refer to Group 7, Cooling System for procedures.

(17) Install right inner splash shield.

(18) Lower vehicle and perform camshaft and crankshaft timing relearn procedure as follows:

- Connect the DRB scan tool to the data link (diagnostic) connector. This connector is located in the passenger compartment; at the lower edge of instrument panel; near the steering column.
- Turn the ignition switch on and access the “miscellaneous” screen.
- Select “re-learn cam/crank” option and follow directions on DRB screen.

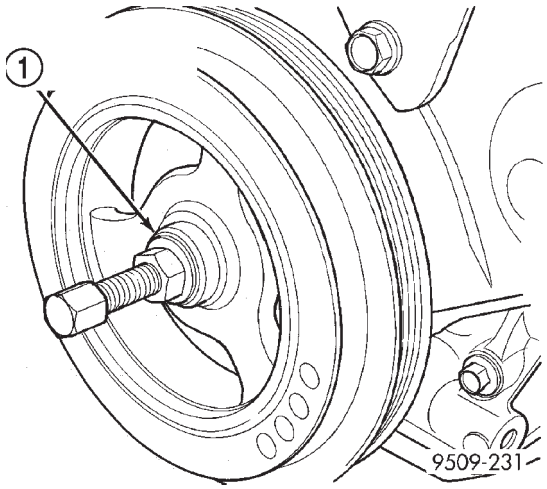


Fig. 77 Crankshaft Damper—Installation

1 – M12 — 1.75 × 150 MM BOLT, WASHER AND THRUST BEARING FROM SPECIAL TOOL 6792

TIMING BELT TENSIONER

REMOVAL

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

(2) Remove tensioner assembly attaching bolts (Fig. 78).

(3) Remove tensioner assembly.

CAUTION: The timing belt tensioner is serviced as an assembly. To prevent premature timing belt failure, DO NOT separate the tensioner pulley from mounting bracket.

INSTALLATION

(1) Install timing belt tensioner assembly. Tighten attaching bolts to 31 N·m (275 in. lbs.).

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

CAMSHAFT OIL SEAL

REMOVAL

CAUTION: Do Not Rotate the camshaft or crankshaft when timing belt is removed damage to the engine may occur.

(1) Remove crankshaft damper, front timing belt cover, timing belt and tensioner assembly. Refer to procedures in this section.

(2) Hold camshaft sprocket with Special Tools C-4687 and modified C-4687-1 as shown in (Fig. 79), while removing attaching bolt.

(3) Remove sprocket from camshaft.

(4) Remove rear timing belt cover.

REMOVAL AND INSTALLATION (Continued)

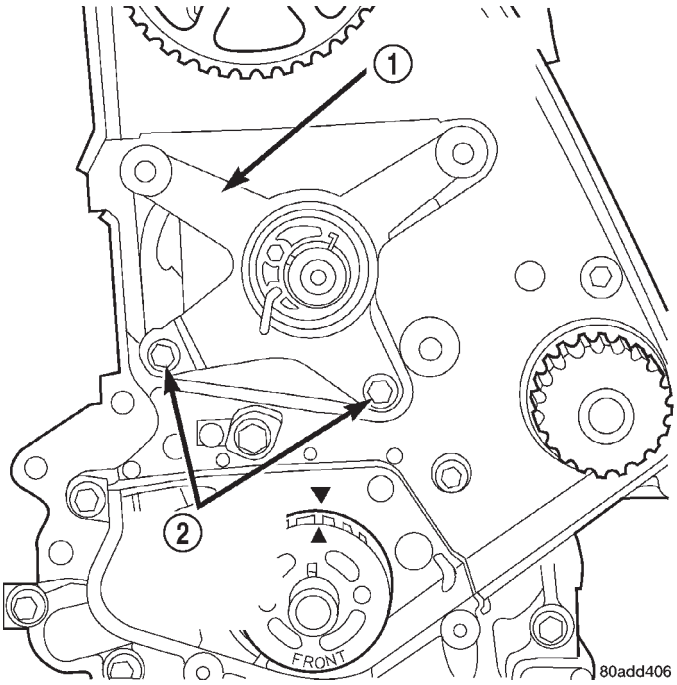


Fig. 78 Timing Belt Tensioner Assembly—Removal/Installation

1 – TIMING BELT TENSIONER ASSEMBLY
2 – TENSIONER ASSEMBLY ATTACHING BOLTS

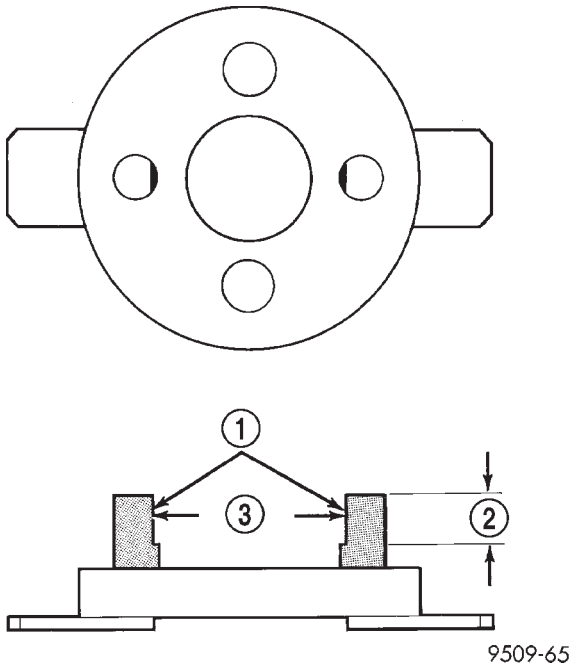


Fig. 79 Modification to Special Tool

1 – GRIND LOCATION
2 – 12.7 MM (1/2 IN.)
3 – 50.8 MM (2 IN.)

(5) Remove camshaft seal by carefully using a suitable pry tool. Be careful not to nick or damage the camshaft seal surface or cylinder head seal retaining bore.

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

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

INSTALLATION

(1) Install camshaft seal flush with cylinder head using Special Tool MD998306 (Fig. 80).

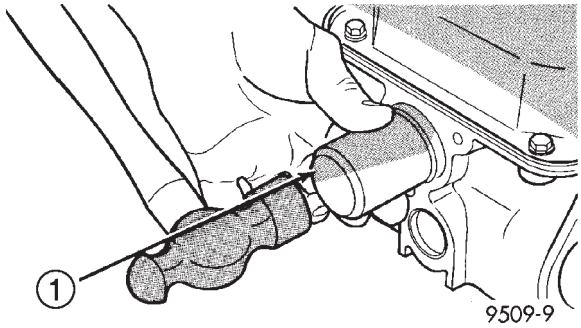


Fig. 80 Camshaft Oil Seal—Installation

1 – SPECIAL TOOL MD 998306

(2) Install rear timing belt cover.
(3) Install camshaft sprocket retaining bolt. Hold camshaft sprocket with Special Tools C-4687 and modified C-4687-1 (Fig. 79) and tighten bolt to 115 N·m (85 ft. lbs.).
(4) Install timing belt tensioner, timing belt, front cover, and crankshaft damper. Refer to procedures in this section.

OIL PAN

REMOVAL

(1) Disconnect negative cable from battery.
(2) Raise vehicle on hoist.
(3) Drain engine oil and remove oil filter.
(4) Remove oil filter adaptor from engine block (Fig. 81).
(5) Remove structural collar. Refer to procedure in this section.
(6) Remove lateral bending brace attaching bolts (Fig. 82).
(7) Remove lateral bending brace (Fig. 82).
(8) Remove transaxle dust cover (Fig. 82).
(9) Remove oil pan bolts.
(10) Remove oil pan.

INSTALLATION

(1) Clean oil pan and all sealing surfaces.

REMOVAL AND INSTALLATION (Continued)

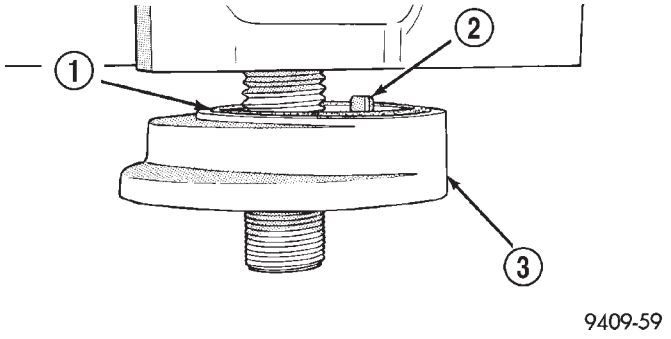


Fig. 81 Oil Filter Adaptor

1 – O-RING
2 – LOCATING ROLL PIN
3 – OIL FILTER ADAPTER

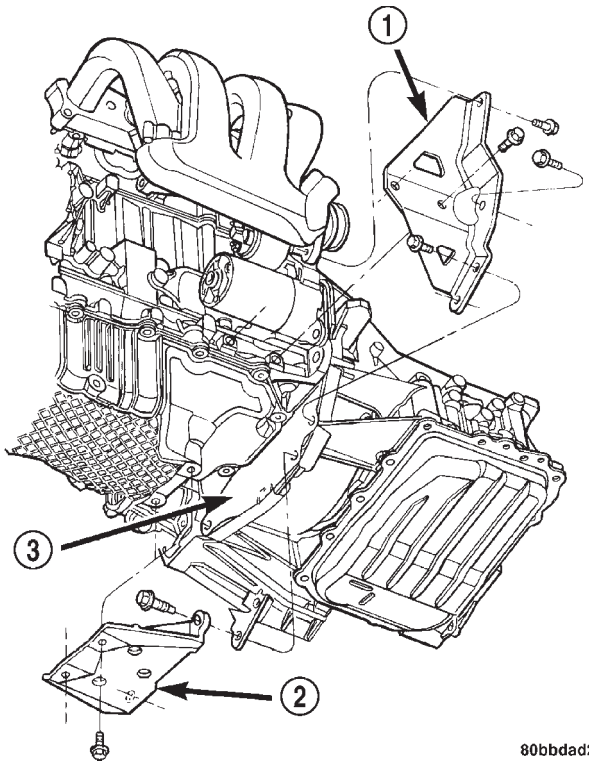


Fig. 82 Bending Brace, Structural Collar, and Dust Cover

1 – LATERAL BENDING BRACE
2 – STRUCTURAL COLLAR
3 – DUST COVER

(2) Apply Mopar® Silicone Rubber Adhesive Sealant at the oil pump to engine block parting line (Fig. 83).

(3) Position a new oil pan gasket onto pan.

(4) Install oil pan and tighten screws to 12 N·m (105 in. lbs.).

(5) Install transaxle dust cover (Fig. 82).

(6) Install lateral bending brace (Fig. 82).

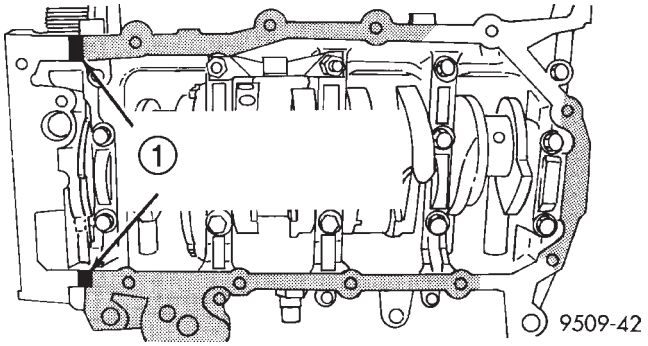


Fig. 83 Oil Pan Sealing

1 – PLACE A 1/8 INCH BEAD OF SEALER AT THE PARTING LINE OF THE OIL PUMP TO ENGINE BLOCK

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

(8) Install oil filter adaptor and tighten assembly to 80 N·m (60 ft. lbs.) (Fig. 81).

(9) Install oil filter.

(10) Lower vehicle and fill engine crankcase with proper oil to correct level.

CRANKSHAFT OIL SEAL—FRONT

REMOVAL

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

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

(3) Remove front timing belt cover and timing belt. Refer to procedures in this section.

(4) Remove crankshaft sprocket using Special Tool 6793 and insert C-4685-C2 (Fig. 84).

(5) Remove crankshaft sprocket key from crankshaft (Fig. 85).

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

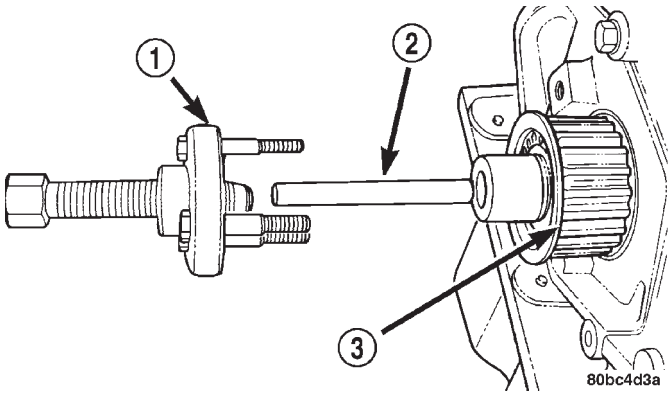


Fig. 84 Crankshaft Sprocket—Removal

1 – SPECIAL TOOL 6793
2 – SPECIAL TOOL C-4685-C2
3 – CRANKSHAFT SPROCKET

REMOVAL AND INSTALLATION (Continued)

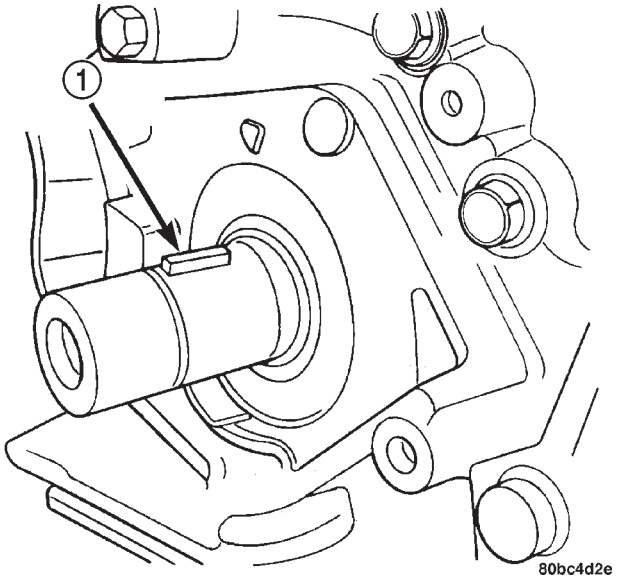


Fig. 85 Crankshaft Key

1 – CRANKSHAFT KEY

(6) Using Special Tool 6771, remove front crankshaft oil seal (Fig. 86). Do not damage the seal contact area on the crankshaft.

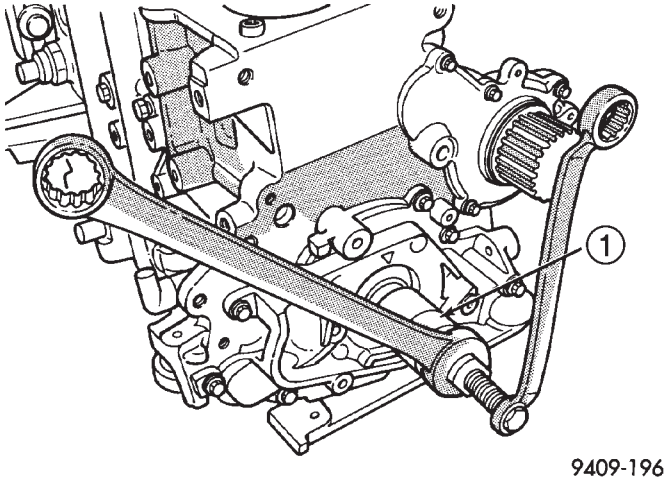


Fig. 86 Front Crankshaft Oil Seal—Removal

1 – SPECIAL TOOL 6771

INSTALLATION

(1) Position seal into opening with seal spring towards the inside of engine. Using Special Tool 6780-1 (Fig. 87), install seal until flush with cover.

(2) Install crankshaft sprocket key (Fig. 85).

(3) Install crankshaft sprocket (Fig. 88) using Special Tool 6792.

NOTE: Make sure the word “front” on the sprocket is facing outward.

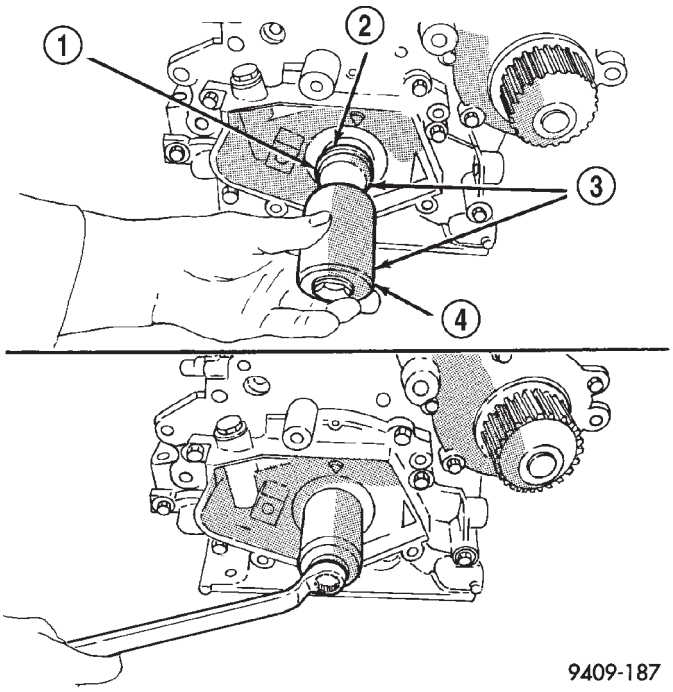


Fig. 87 Front Crankshaft Oil Seal—Installation

1 – PROTECTOR
2 – SEAL
3 – SPECIAL TOOL 6780–1
4 – INSTALLER

NOTE: Use of Special Tool 6792 is required to set proper crankshaft sprocket depth for proper timing belt tracking.

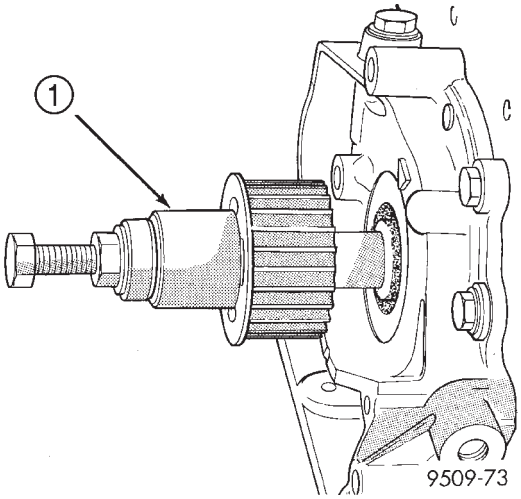


Fig. 88 Crankshaft Sprocket—Installation

1 – SPECIAL TOOL 6792

REMOVAL AND INSTALLATION (Continued)

(4) Install timing belt and cover. Refer to procedures in this section.

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

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

CRANKSHAFT OIL SEAL—REAR

REMOVAL

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

(2) Remove drive plate. Refer to procedure in this section.

(3) Insert a 3/16 flat bladed screwdriver between the dust lip and the metal case of the crankshaft seal. Angle the screwdriver (Fig. 89) through the dust lip against metal case of the seal. Pry out seal.

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

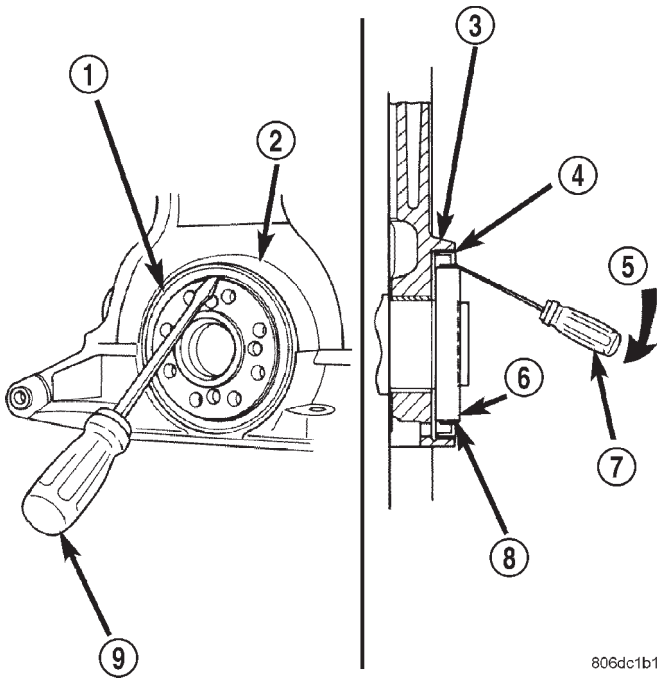


Fig. 89 Rear Crankshaft Oil Seal—Removal

1 – REAR CRANKSHAFT SEAL
2 – ENGINE BLOCK
3 – ENGINE BLOCK
4 – REAR CRANKSHAFT SEAL METAL CASE
5 – PRY IN THIS DIRECTION
6 – CRANKSHAFT
7 – SCREWDRIVER
8 – REAR CRANKSHAFT SEAL DUST LIP
9 – SCREWDRIVER

INSTALLATION

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

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

(1) Place Special Tool 6926-1 on crankshaft. This is a pilot tool with a magnetic base (Fig. 90).

(2) Position seal over pilot tool. Make sure you can read the words **THIS SIDE OUT** on seal (Fig. 90). Pilot tool should remain on crankshaft during installation of seal. Ensure that the lip of the seal is facing towards the crankcase during installation.

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

(3) Drive the seal into the block using Special Tool 6926-2 and handle C-4171 (Fig. 91) until the tool bottoms out against the block (Fig. 92).

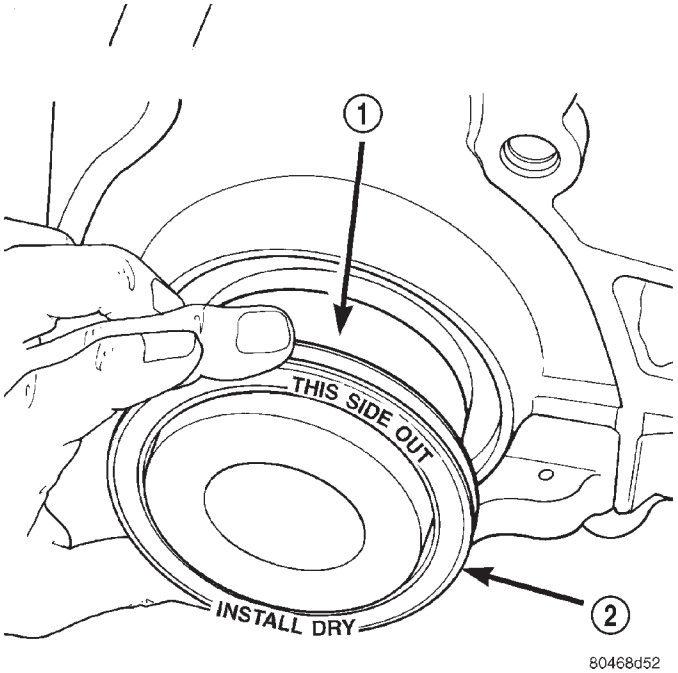


Fig. 90 Rear Crankshaft Seal and Special Tool 6926-1

1 – SPECIAL TOOL 6926–1 PILOT
2 – SEAL

(4) Install drive plate. Apply Mopar® Lock & Seal Adhesive to bolt threads and tighten bolts to 95 N·m (70 ft. lbs.).

(5) Install transaxle. Refer to Group 21, Transaxle for procedure.

REMOVAL AND INSTALLATION (Continued)

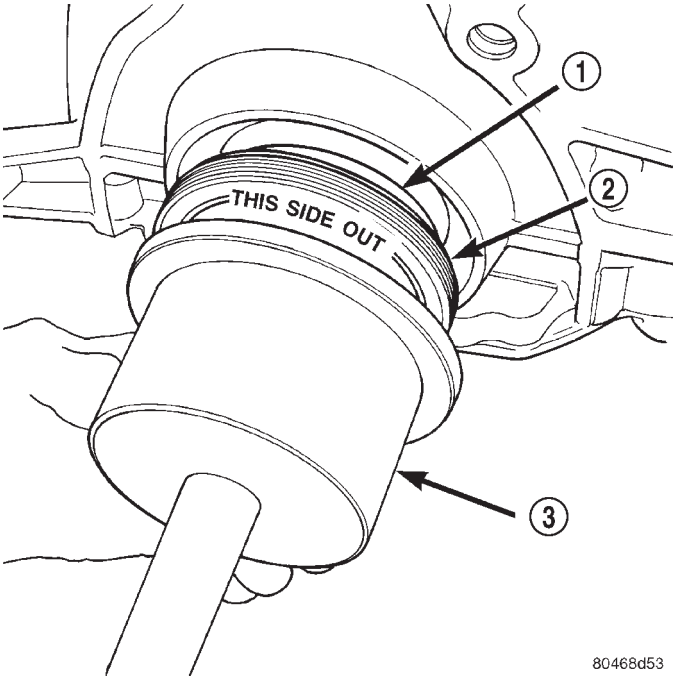


Fig. 91 Crankshaft Seal Special Tool 6926-2

1 – SPECIAL TOOL 6926–1 PILOT
2 – SEAL
3 – SPECIAL TOOL 6926–2 INSTALLER

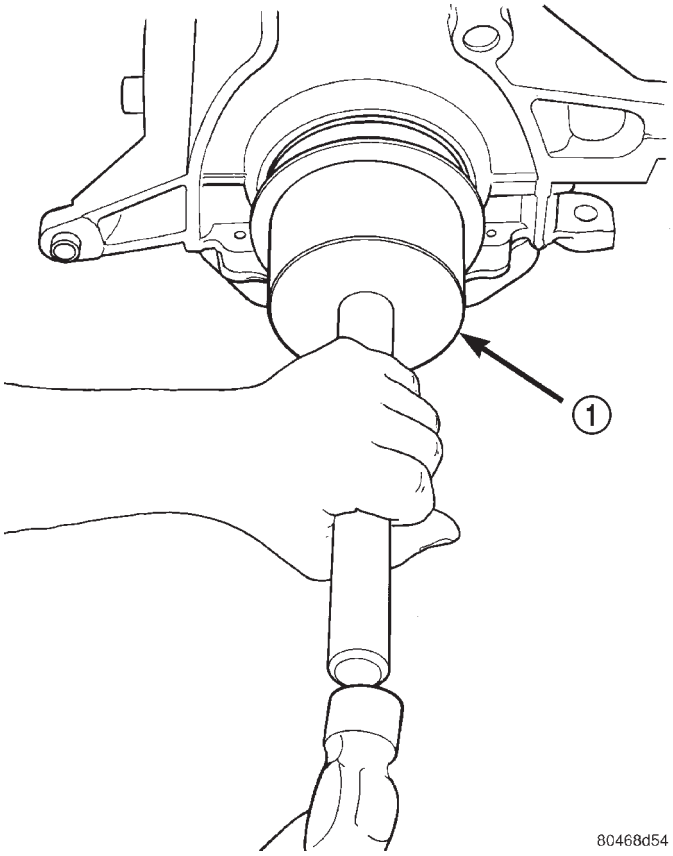


Fig. 92 Rear Crankshaft Seal—Installation

1 – SPECIAL TOOL 6926–2 INSTALLER

DRIVE PLATE

REMOVAL

(1) Remove transaxle. Refer to Group 21, Transaxle for procedure.
(2) Remove drive plate attaching bolts (Fig. 93).
(3) Remove drive plate (Fig. 93).

INSTALLATION

(1) Position drive plate on crankshaft (Fig. 93).
(2) Apply Mopar® Lock & Seal Adhesive to drive plate bolt threads.
(3) Install drive plate bolts and tighten to 95 N·m (70 ft. lbs.) (Fig. 93).
(4) Install transaxle. Refer to Group 21, Transaxle for procedure.

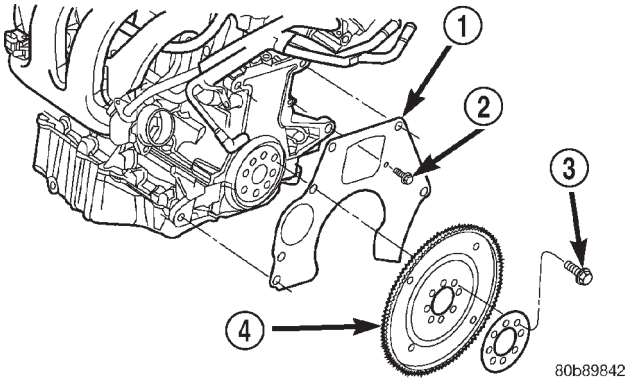


Fig. 93 Drive Plate

1 – ADAPTOR PLATE
2 – BOLT
3 – BOLT (QTY. 8)
4 – DRIVE PLATE

REMOVAL AND INSTALLATION (Continued)

CRANKSHAFT

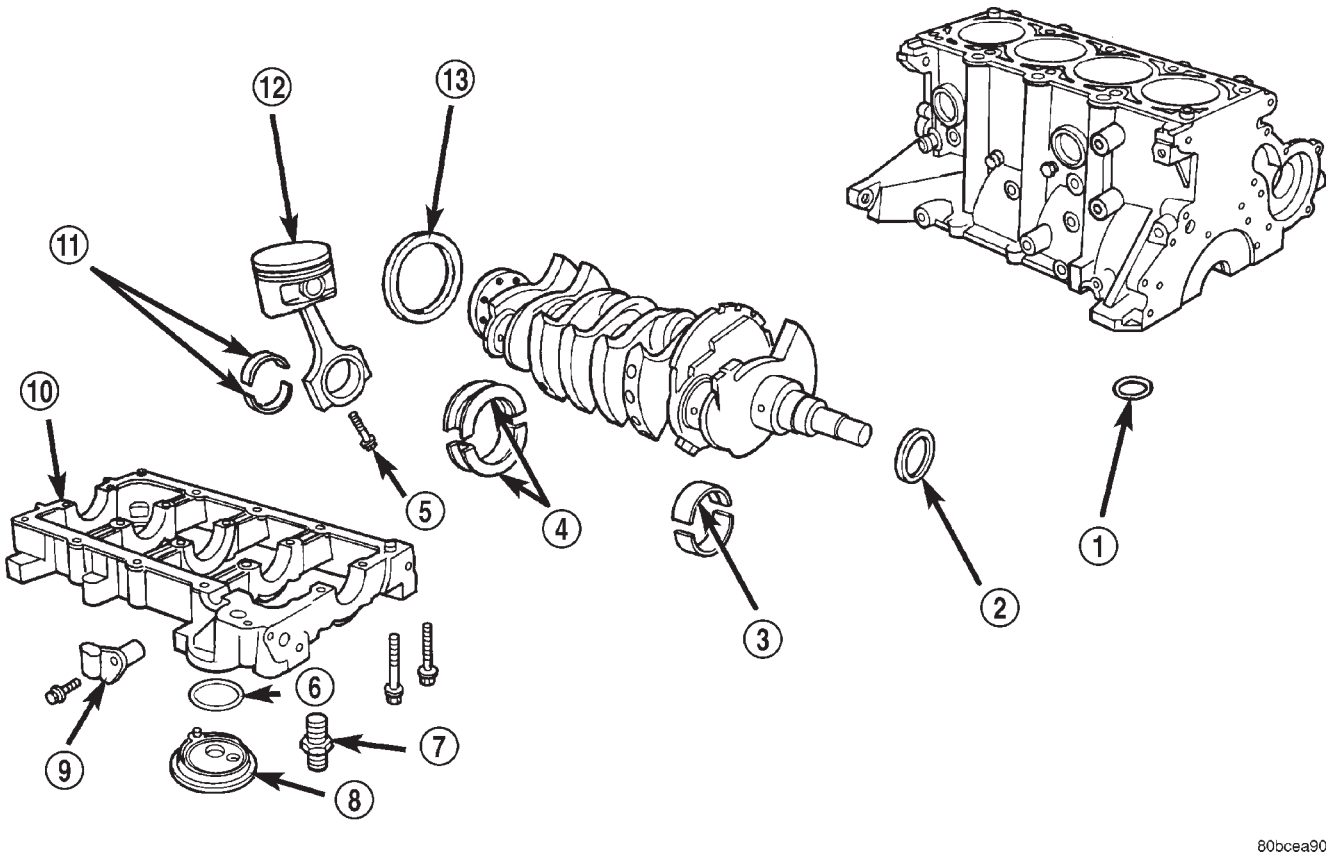


Fig. 94 Crankshaft and Components

1 – OIL PASSAGE O-RING
2 – SEAL
3 – UPPER BEARING (GROOVED)
4 – THRUST BEARINGS
5 – BOLT
6 – O-RING
7 – NIPPLE
8 – OIL FILTER ADAPTER
9 – CRANKSHAFT POSITION SENSOR (CPS)
10 – MAIN BEARING CAP/BED PLATE ASSEMBLY
11 – CONNECTING ROD BEARINGS
12 – PISTON AND CONNECTING ROD ASSEMBLY
13 – SEAL

REMOVAL

(1) Remove engine assembly. Refer to procedure in this section.
(2) Remove structural collar from oil pan to transaxle housing.
(3) Separate transaxle from engine.
(4) Remove drive plate/flywheel.
(5) Remove crankshaft rear oil seal. Refer to procedure in this section.
(6) Mount engine on a suitable repair stand.
(7) Remove crankshaft damper, timing belt, and tensioner. Refer to procedures in this section.
(8) Remove camshaft sprocket and rear timing belt cover. Refer to procedures in this section.
(9) Remove crankshaft sprocket. Refer to procedure in this section.
(10) Remove lower torque strut/air conditioning compressor mounting bracket from engine (Fig. 95).
(11) Remove oil filter and adapter.
(12) Remove oil pan.
(13) Remove oil pump pick-up tube.
(14) Remove oil pump.
(15) Remove crankshaft position sensor.
(16) Using a permanent ink or paint marker, identify cylinder number on each connecting rod cap.

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

(17) Remove all connecting rod bolts and caps. Care should be taken not to damage the fracture rod and cap surfaces.

REMOVAL AND INSTALLATION (Continued)

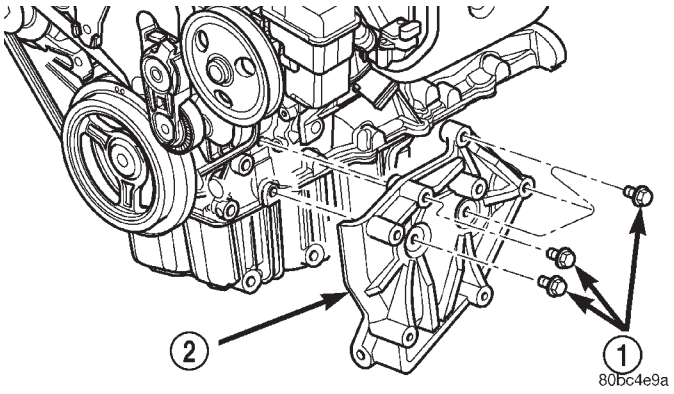


Fig. 95 Torque Strut Bracket

1 – BOLTS
2 – TORQUE STRUT BRACKET

NOTE: Do not reuse connecting rod bolts.

(18) Remove all main bearing cap and bedplate bolts from the engine block (Fig. 96).

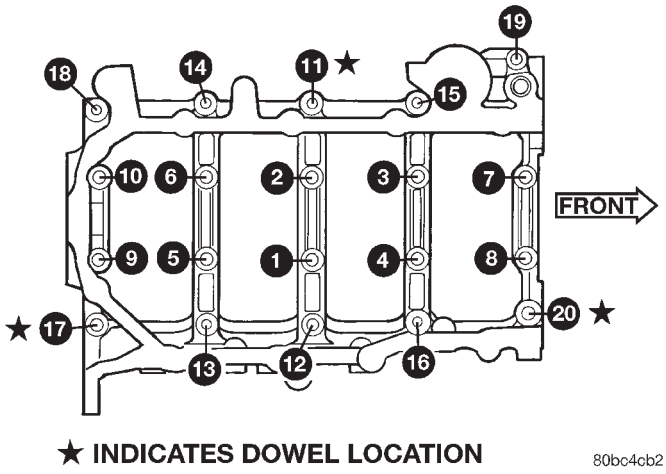


Fig. 96 Bedplate Bolts

(19) Using a mallet tap the bedplate loose from the engine block dowel pins.

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

(20) Bedplate should be removed evenly from the cylinder block dowel pins.

(21) Lift out crankshaft from cylinder block (Fig. 94). Be sure not to damage the main bearings or journals when removing the crankshaft.

CRANKSHAFT MAIN BEARINGS LOCATION

The crankshaft is supported in five main bearings. All upper bearing shells in the crankcase have oil grooves. All lower bearing shells installed in the (bedplate) main bearing cap are plain. Crankshaft end play is controlled by a flanged bearing on the number three main bearing journal (Fig. 97).

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

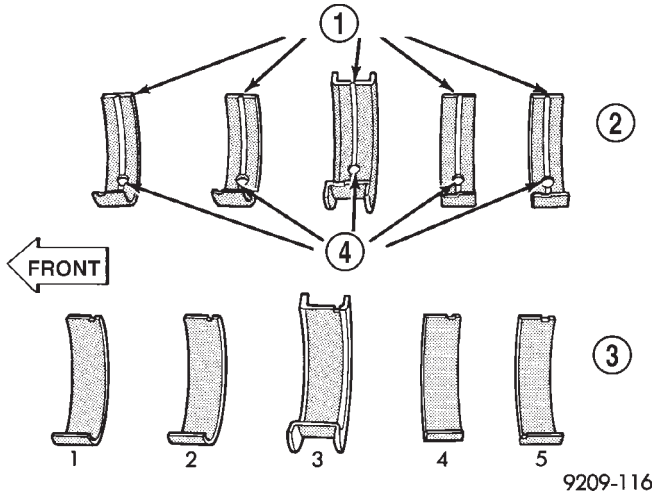


Fig. 97 Main Bearing Identification

1 – OIL GROOVES
2 – UPPER BEARINGS
3 – LOWER BEARINGS
4 – OIL HOLES

CRANKSHAFT MAIN JOURNALS INSPECTION

The crankshaft journals should be checked for excessive wear, taper and scoring. Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 in.). Journal grinding should not exceed 0.305 mm (0.012 in.) under the standard journal diameter. DO NOT grind thrust faces of Number 3 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all passages.

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

Upper and lower Number 3 bearing halves are flanged to carry the crankshaft thrust loads and are NOT interchangeable with any other bearing halves in the engine (Fig. 97). All bearing cap bolts removed during service procedures are to be cleaned and oiled before installation. Bearing shells are available in standard and the following undersized: 0.016 mm (0.0006 in.), 0.032 mm (0.0012 in.), 0.250 mm (0.010 in.). Never install an undersize bearing that will reduce clearance below specifications.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Install the main bearing shells with the lubrication groove in the cylinder block. Install O-ring into recess in the block (Fig. 98).

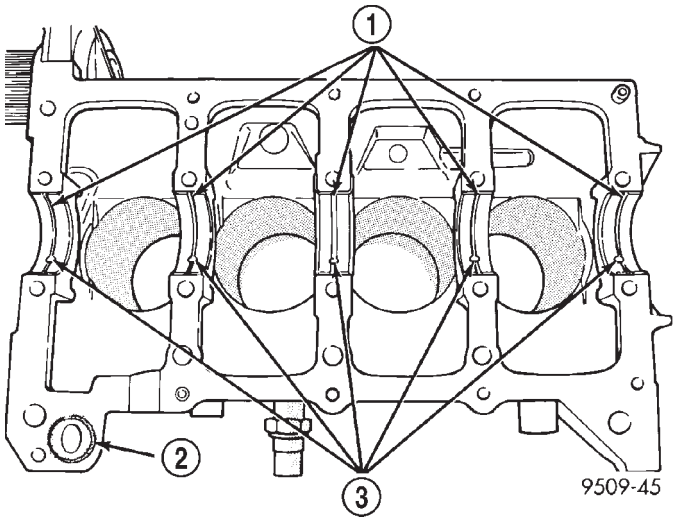


Fig. 98 Installing Main Bearing Upper Shell

1 – LUBRICATION GROOVES
2 – O-RING
3 – OIL HOLES

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

CAUTION: Do Not get oil on the bedplate mating surface. It will affect the sealer ability to seal the bedplate to cylinder block.

(3) Oil the bearings and journals and install crankshaft in cylinder block.

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

(4) Apply 1.5–2.0 mm (0.059–0.078 in.) bead of Mopar® Bed Plate Sealant to cylinder block as shown in (Fig. 99).

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

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

(7) Install main bearing bedplate to engine block bolts 11, 17 and 20 finger tight. Tighten these bolts down together until the bedplate contacts the cylinder block (Fig. 100).

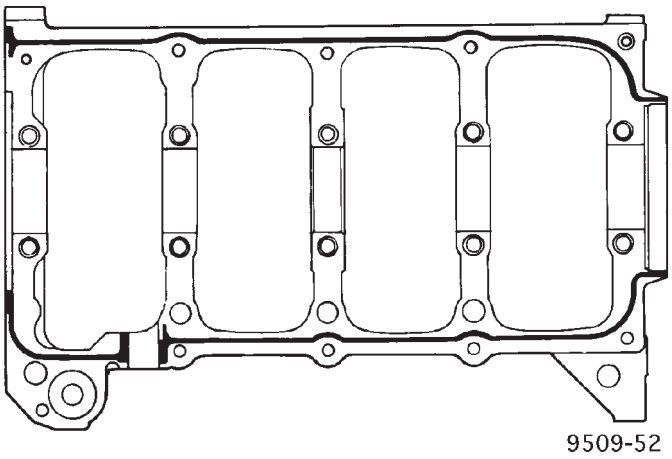


Fig. 99 Main Bearing Caps/Bedplate Sealing

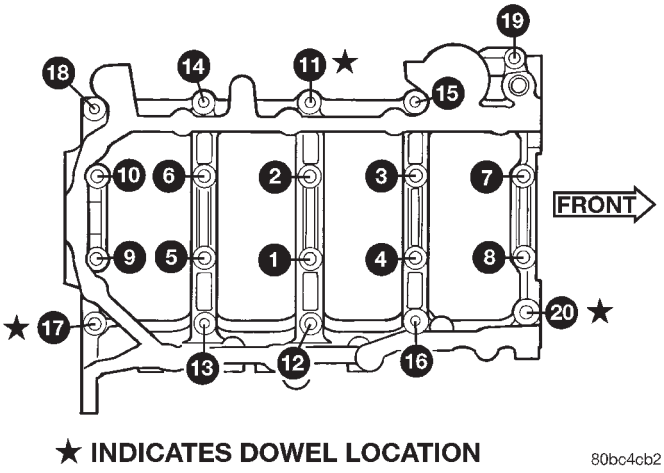


Fig. 100 Main Bearing Caps/Bedplate Torque Sequence

(8) Install main bearing bedplate to engine block bolts (1–10) and torque each bolt to 81 N·m (60 ft. lbs.) in sequence shown in (Fig. 100).

(9) Install main bearing bedplate to engine block bolts (11–20), with baffle studs in positions 12, 13 and 16 and torque each bolt to 34 N·m (25 ft. lbs.) in sequence shown in (Fig. 100).

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

(11) If crankshaft end play is to be checked, refer to service procedures in this section.

(12) Install connecting rod bearings and caps. Install new connecting rod bolts and tighten to 27 N·m (20 ft. lbs.) plus 1/4 turn.

(13) Install oil pump and crankshaft front oil seal.

(14) Install oil pick-up tube and oil pan. Refer to procedure in the section.

(15) Install oil filter adapter and filter.

(16) Install lower torque strut/air conditioning compressor mounting bracket to engine (Fig. 95).

REMOVAL AND INSTALLATION (Continued)

(17) Install rear timing belt cover and camshaft sprocket.

(18) Install crankshaft sprocket, timing belt tensioner, timing belt, and cover.

(19) Install front engine mount bracket.

(20) Remove engine from repair stand and position on Special Tools 6135 and 6710 Engine Dolly and Cradle. Install safety straps around the engine to cradle and tighten and lock them into position.

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

(22) Install drive plate/flywheel. Apply Mopar® Lock & Seal Adhesive to bolt threads and tighten to 95 N·m (70 ft. lbs.).

(23) Install transaxle to engine.

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

(25) Install engine assembly. Refer to procedure in this section.

(26) Perform camshaft and crankshaft timing relearn procedure as follows:

- Connect the DRB scan tool to the data link (diagnostic) connector. This connector is located in the passenger compartment; at the lower edge of instrument panel; near the steering column.
- Turn the ignition switch on and access the “miscellaneous” screen.
- Select “re-learn cam/crank” option and follow directions on DRB screen.

OIL FILTER ADAPTER

REMOVE AND INSTALL

Ensure O-ring is in the groove on adapter. Align roll pin into engine block and tighten assembly to 80 N·m (60 ft. lbs.) (Fig. 101).

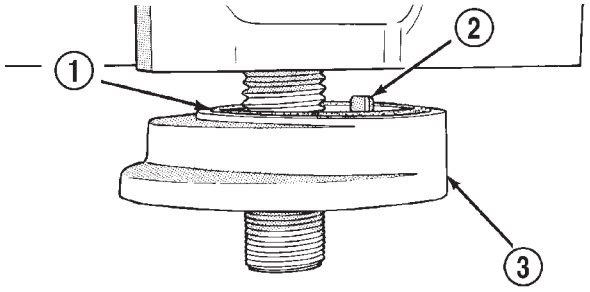


Fig. 101 Engine Oil Filter Adapter to Engine Block

1 – O-RING
2 – LOCATING ROLL PIN
3 – OIL FILTER ADAPTER

OIL FILTER

REMOVE AND INSTALL

CAUTION: When servicing the oil filter (Fig. 102), avoid deforming the filter. Use an appropriate oil filter removing tool. Position filter wrench strap close the seam at the base of the filter. The oil filter seam that joins the can to the base, is reinforced by the base plate.

(1) Turn filter counterclockwise to remove.

(2) Clean and check the filter mounting surface. The surface must be smooth, flat and free of debris or old pieces of rubber.

(3) To install, lubricate new filter gasket. Screw filter on until gasket contacts base. Tighten to 21 N·m (15 ft. lbs.).

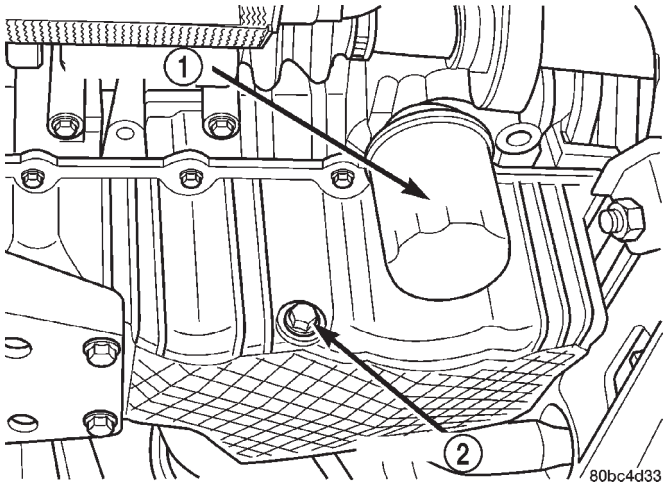


Fig. 102 Engine Oil Filter

1 – OIL FILTER
2 – DRAIN PLUG

OIL PUMP

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove crankshaft damper, timing belt, and tensioner. Refer to procedures in this section.

(3) Remove camshaft sprocket and rear timing belt cover. Refer to procedures in this section.

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

(5) Remove crankshaft sprocket using Special Tool 6793 and insert C-4685-C2 (Fig. 103).

(6) Remove oil pick-up tube.

(7) Remove oil pump (Fig. 104) and front crankshaft seal.

REMOVAL AND INSTALLATION (Continued)

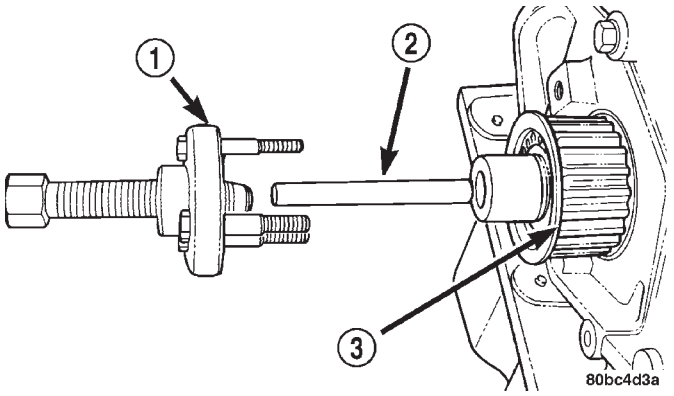


Fig. 103 Crankshaft Sprocket—Removal

1 – SPECIAL TOOL 6793
2 – SPECIAL TOOL C-4685-C2
3 – CRANKSHAFT SPROCKET

INSTALLATION

(1) Make sure all surfaces are clean and free of oil and dirt.

(2) Apply Mopar® Gasket Maker to oil pump as shown in (Fig. 105). Install oil ring into oil pump body discharge passage.

(3) Prime oil pump before installation.

(4) Align oil pump rotor flats with flats on crankshaft as you install the oil pump to the block.

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

(5) Torque all oil pump attaching bolts to 28 N·m (250 in. lbs.).

(6) Install new front crankshaft seal using Special Tool 6780 (Fig. 106).

(7) Install crankshaft sprocket, using Special Tool 6792 (Fig. 107).

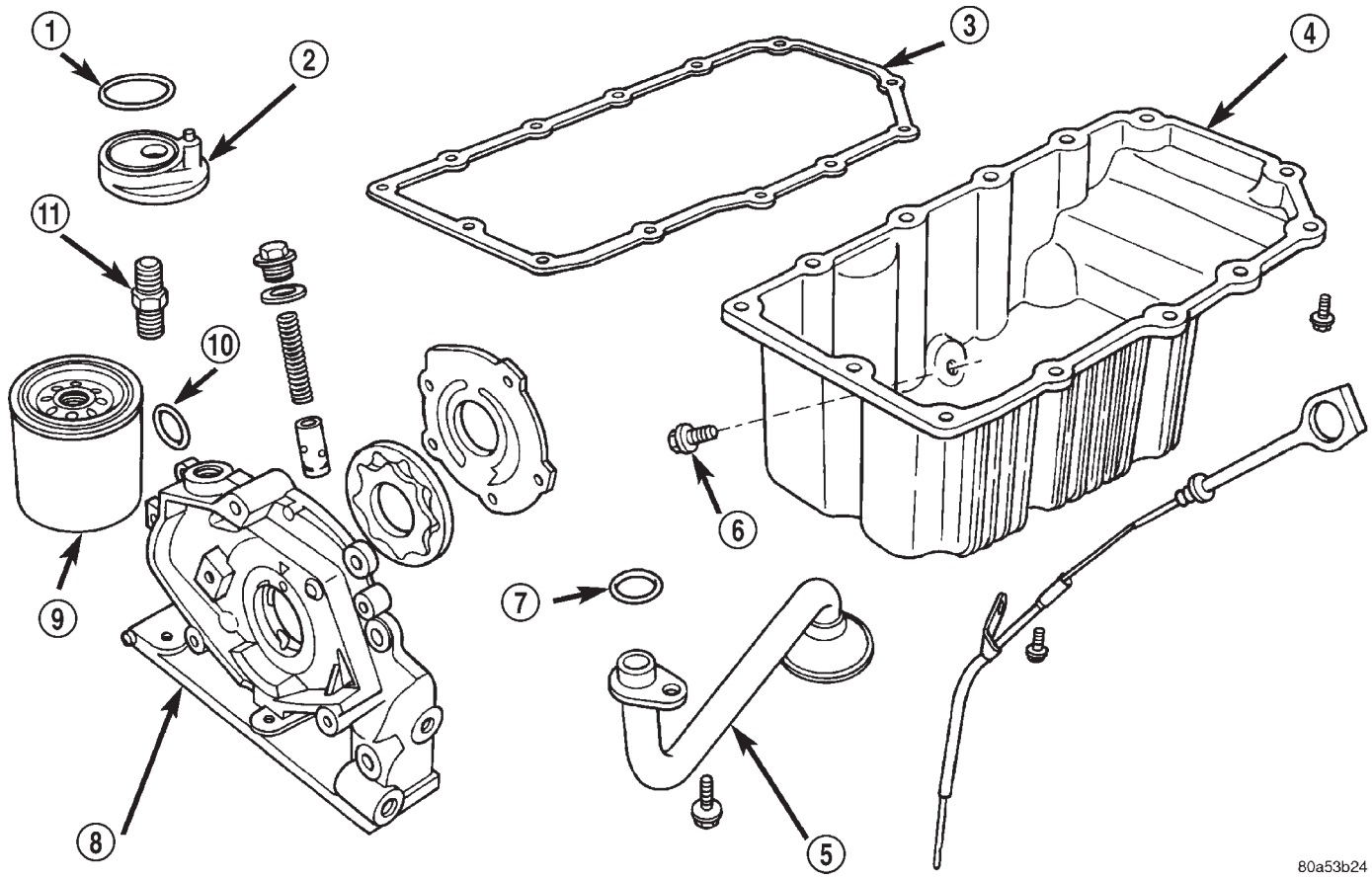


Fig. 104 Oil Pump and Tube

1 – O-RING
2 – OIL FILTER ADAPTER
3 – OIL PAN GASKET
4 – OIL PAN
5 – OIL PICK-UP TUBE
6 – DRAIN PLUG
7 – O-RING
8 – OIL PUMP BODY
9 – FILTER
10 – O-RING
11 – NIPPLE

REMOVAL AND INSTALLATION (Continued)

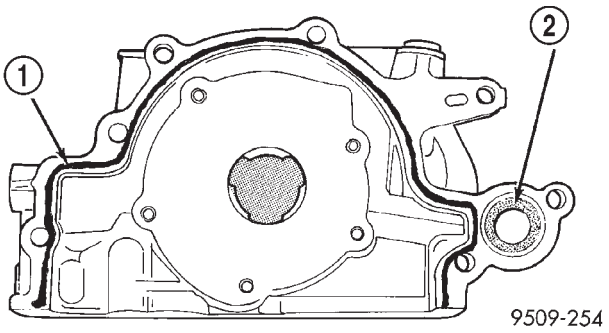


Fig. 105 Oil Pump Sealing

1 – APPLY GASKET MAKER TO OIL PUMP BODY FLANGE
2 – O-RING

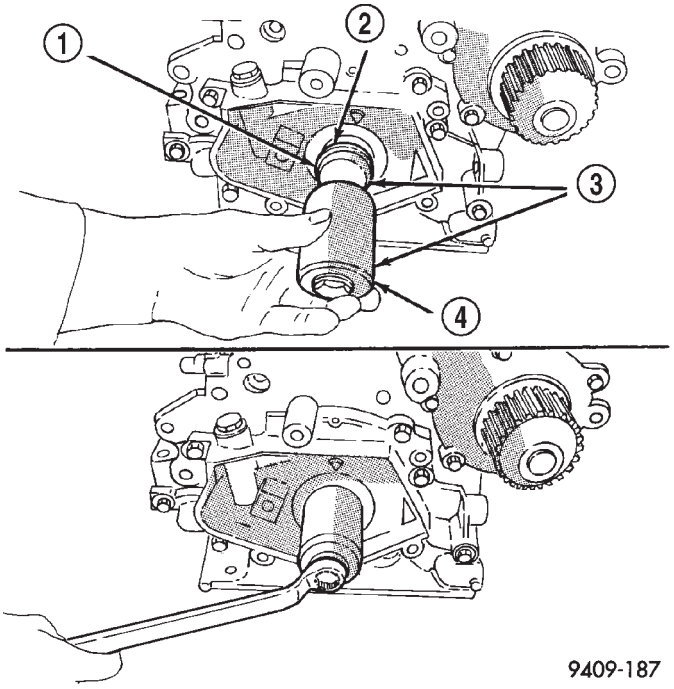


Fig. 106 Front Crankshaft Seal—Installation

1 – PROTECTOR
2 – SEAL
3 – SPECIAL TOOL 6780–1
4 – INSTALLER

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

(9) Install rear timing belt cover and camshaft sprocket.

(10) Install timing belt tensioner, timing belt, and front timing belt cover.

(11) Install crankshaft damper.

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

(13) Connect negative cable to battery.

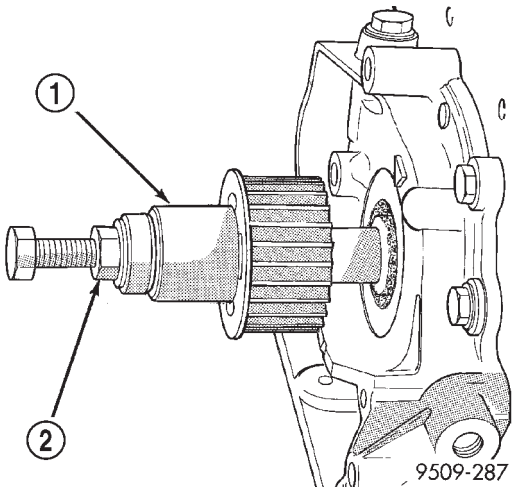


Fig. 107 Crankshaft Sprocket—Installation

1 – SPECIAL TOOL 6792
2 – TIGHTEN NUT TO INSTALL

PISTON AND CONNECTING ROD

REMOVAL

(1) Remove cylinder head and oil pan. Refer to procedures in this section.

(2) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. **Be sure to keep tops of pistons covered during this operation**. Mark piston with matching cylinder number (Fig. 108).

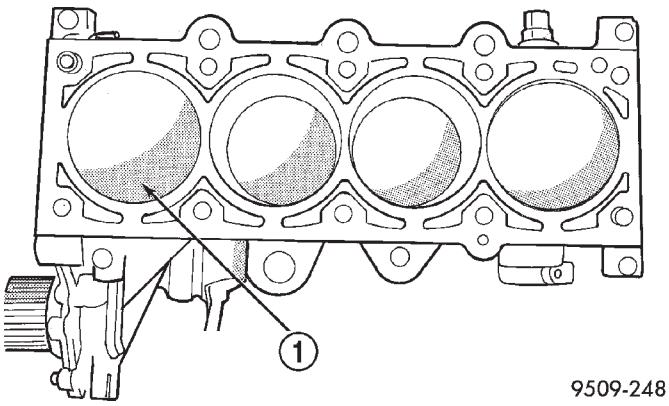


Fig. 108 Piston Markings

1 – WEIGHT DESIGNATION AND DIRECTIONAL ARROW WILL BE IMPRINTED IN THIS AREA

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

(3) Using a permanent ink marker or scribe tool mark the cylinder number on the side of the rod and cap (Fig. 109) for identification.

REMOVAL AND INSTALLATION (Continued)

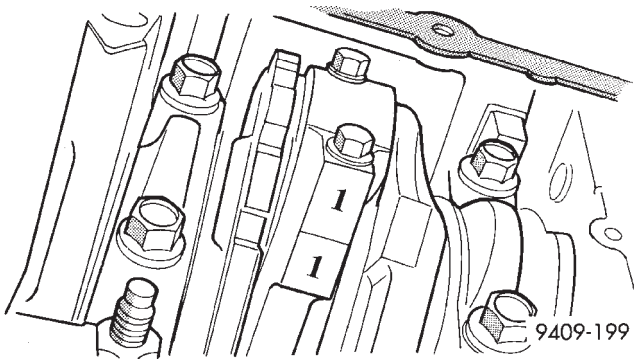


Fig. 109 Identify Connecting Rod to Cylinder

(4) Pistons will have a stamping in the approximate location shown in (Fig. 108). These stamps will be either a directional arrow or a weight identification for the assembly. L is for light and H is for heavy. These assemblies should all be the same weight class. Service piston assemblies are marked with a S and can be used with either L or H production assemblies. The weight designation stamps should face toward the timing belt side of the engine.

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

(6) Remove connecting rod cap bolts. **Do not use old bolts if reinstalling connecting rod.**

(7) To protect crankshaft journal and fractured rod surfaces, install Special Tool 8189, connecting rod guides onto connecting rod (Fig. 110). Carefully push each piston and rod assembly out of cylinder bore.

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

(8) Remove Special Tool 8189, connecting rod guides and re-install bearing cap on the mating rod.

NOTE: Piston and rods are serviced as an assembly.

PISTON RING—REMOVAL

(1) The identification mark on face of upper and intermediate piston rings must point toward piston crown.

(2) Using a suitable ring expander, remove upper and intermediate piston rings (Fig. 111).

(3) Remove the upper oil ring side rail, lower oil ring side rail and then oil ring expander from piston.

(4) Clean ring grooves of any carbon deposits.

PISTON RINGS—INSTALLATION

(1) Install rings with manufacturers identification mark facing up, to the top of the piston (Fig. 112).

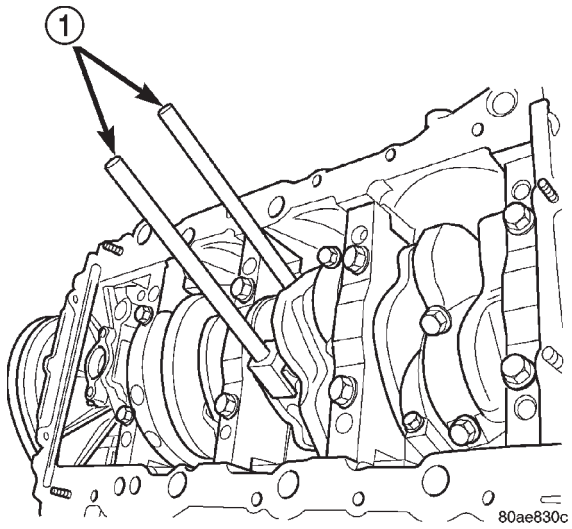


Fig. 110 Connecting Rod Guides—Typical

1 – SPECIAL TOOL 8189 CONNECTING ROD GUIDES

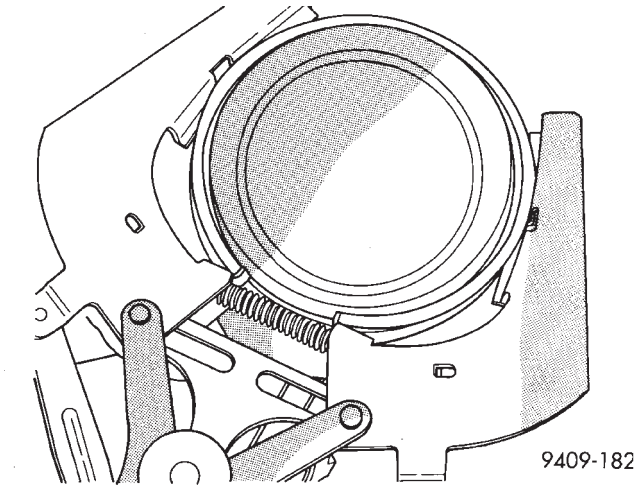


Fig. 111 Piston Rings—Removing and Installing

CAUTION: Install piston rings in the following order:

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

f. Install the side rail by placing one end between the piston ring groove and the expander. Hold end firmly and press down the portion to be installed until side rail is in position. **Do not use a piston ring expander (Fig. 113).**

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

(3) Install No. 2 piston ring and then No. 1 piston ring (Fig. 112).

(4) Position piston ring end gaps as shown in (Fig. 114).

REMOVAL AND INSTALLATION (Continued)

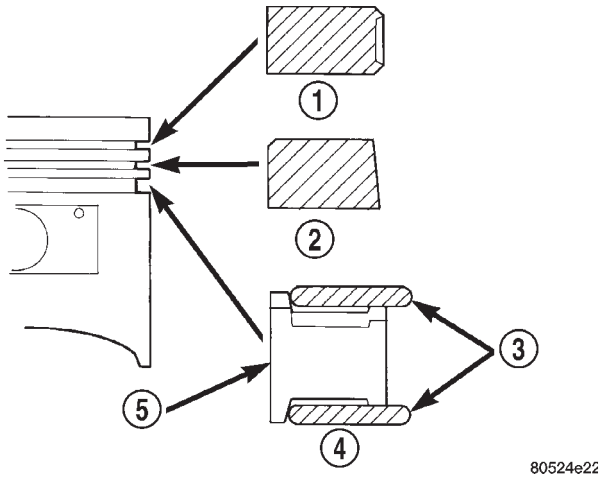


Fig. 112 Piston Ring Installation

1 – NO. 1 PISTON RING
2 – NO. 2 PISTON RING
3 – SIDE RAIL
4 – OIL RING
5 – SPACER EXPANDER

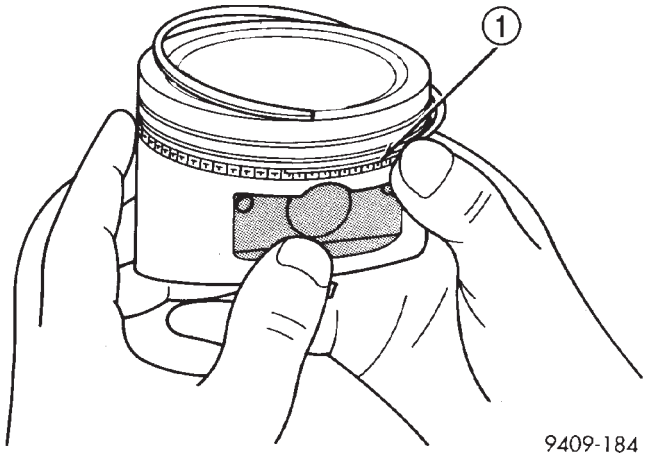


Fig. 113 Installing Side Rail

1 – SIDE RAIL END

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

PISTON AND ROD—INSTALLATION

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

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located as shown in (Fig. 114).

(3) Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston

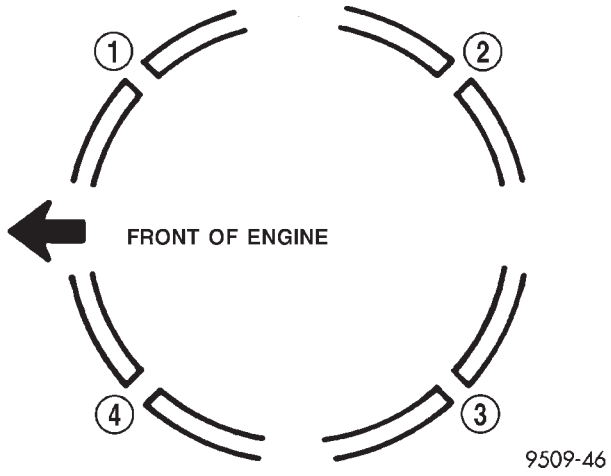


Fig. 114 Piston Ring End Gap Position

1 – GAP OF LOWER SIDE RAIL
2 – NO. 1 RING GAP
3 – GAP OF UPPER SIDE RAIL
4 – NO. 2 RING GAP AND SPACER EXPANDER GAP

(Fig. 115). **Be sure position of rings does not change during this operation**.

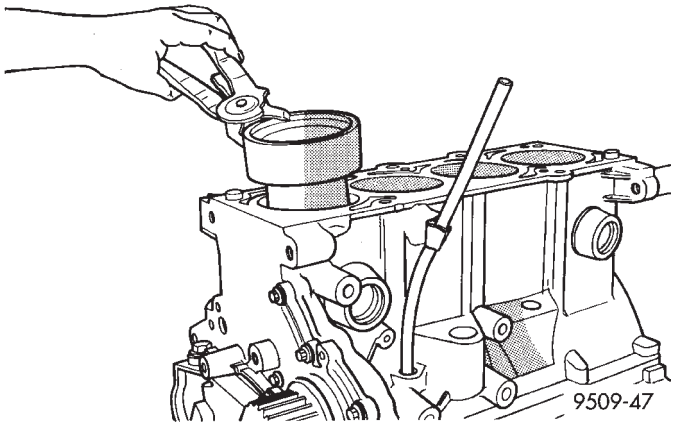


Fig. 115 Installing Piston

(4) The weight stamp designation L or H will be in the front half of the piston should face toward the front of the engine (Fig. 108).

(5) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Lubricate connecting rod journal with clean engine oil.

(6) Position upper bearing half and install Special Tool 8189, connecting rod guides onto connecting rod (Fig. 110).

(7) Insert rod and piston assembly into cylinder bore and carefully guide rod over the crankshaft journal.

(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) Remove Special Tool 8189, connecting rod guides.

REMOVAL AND INSTALLATION (Continued)

(10) Install connecting rod lower bearing half and cap. Install **New** bolts and tighten to 27 N·m (20 ft. lbs.) plus 1/4 turn.

(11) Install cylinder head and oil pan. Refer to procedures in this section.

DISASSEMBLY AND ASSEMBLY

OIL PUMP

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

(2) Remove the threaded plug and gasket from the oil pump (Fig. 116).

CAUTION: Oil pump pressure relief valve must be installed as shown in (Fig. 116) or serious damage may occur.

(3) Remove spring and relief valve (Fig. 116).

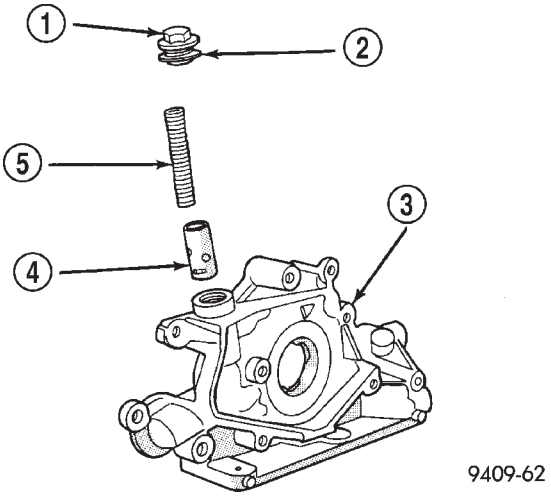


Fig. 116 Oil Pressure Relief Valve

1 – RETAINER CAP
2 – GASKET
3 – OIL PUMP BODY
4 – RELIEF VALVE
5 – SPRING

(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. 117).

VALVE SERVICE WITH THE CYLINDER HEAD REMOVED

REMOVAL

(1) With cylinder head removed, compress valve springs using Special Tool C-3422-B with Adaptor 6526.

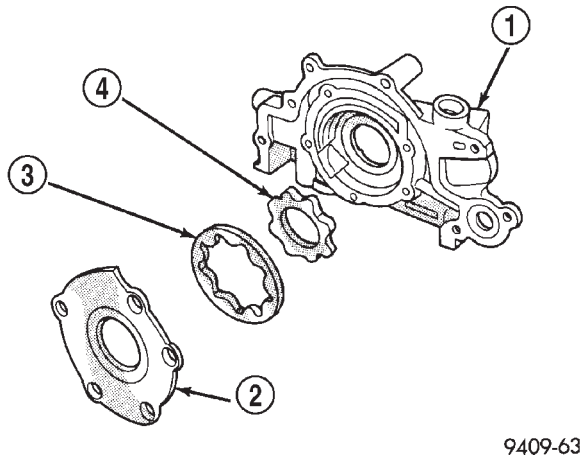


Fig. 117 Oil Pump

1 – OIL PUMP BODY
2 – OIL PUMP COVER
3 – OUTER ROTOR
4 – INNER ROTOR

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

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

VALVE INSPECTION

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

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

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

VALVE GUIDES

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

(2) Using a small hole gauge and a micrometer, measure valve guides in 3 places top, middle and bottom (Fig. 118). Replace guides if they are not within specification. For specifications, refer to Engine Specifications in this section.

(3) Check valve guide height (Fig. 119).

TESTING VALVE SPRINGS

(1) Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested Special Tool C-647. As an example, the compression length of the spring to be tested is 33.34 mm (1-5/16 in.). Turn tool table until surface is in line with the 33.34 mm (1-5/16 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 (Fig. 120). Pull on torque

DISASSEMBLY AND ASSEMBLY (Continued)

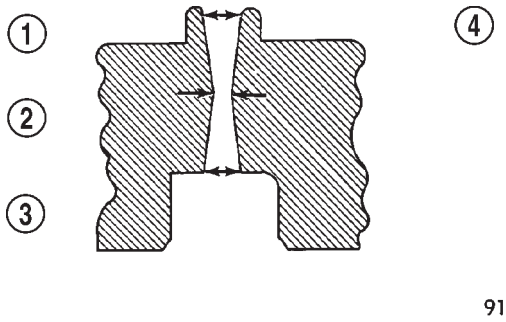


Fig. 118 Checking Wear on Valve Guide—Typical

1 – TOP
2 – MIDDLE
3 – BOTTOM
4 – CUT AWAY VIEW OF VALVE GUIDE MEASUREMENT LOCATIONS

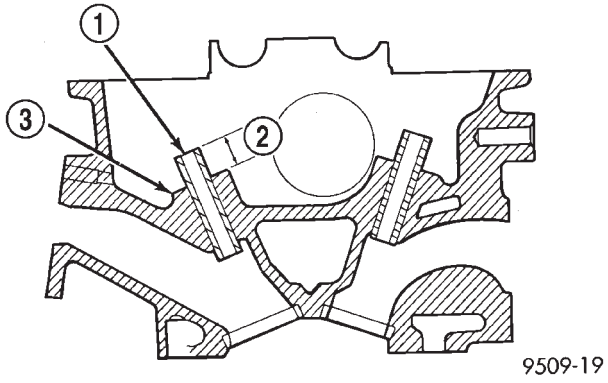


Fig. 119 Valve Guide Height

1 – VALVE GUIDE
2 – 13.25 - 13.75 MM (0.521-0.541 in.)
3 – SPRING SEAT

wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by two. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Discard the springs that do not meet specifications. The following specifications apply to both intake and exhaust valve springs:

- Valve Closed Nominal Tension—70 lbs. @ 39.8 mm (1.57 in.)
- Valve Closed Nominal Tension—160 lbs. @ 32.6 mm (1.28 in.)

(2) Verify springs are not distorted with a steel square and surface plate, check springs from both ends. If the spring is more than 1.5 mm (1/16 in.) out of square, install a new spring.

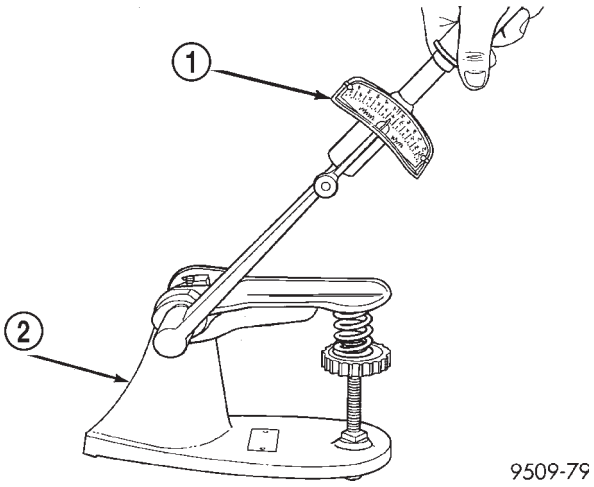


Fig. 120 Valve Spring Testing

1 – TORQUE WRENCH
2 – VALVE SPRING TESTER

REFACING VALVES AND VALVE SEATS

(1) The intake and exhaust valve seats and valve face have a 45 degree angle.

(2) Inspect the remaining margin after the valves are refaced (Fig. 121). Intake valves with less than 0.95 mm (1/32 in.) margin and exhaust valves with less than 1.05 mm (3/64 in.) margin should be discarded.

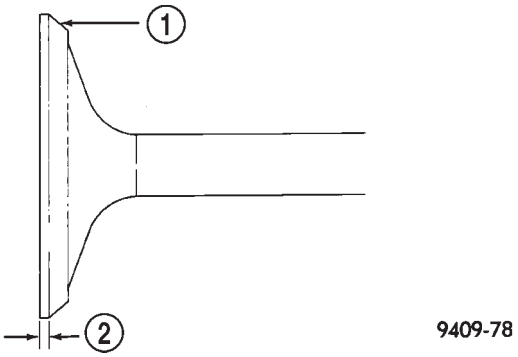


Fig. 121 Intake and Exhaust Valve Refacing

1 – VALVE FACE
2 – VALVE MARGIN

(3) When refacing valve seats, it is important that the correct size valve guide pilot be used for reseating stones. A true and complete surface must be obtained. For specifications, refer to Engine Specifications in this section.

(4) Measure the concentricity of valve seat and valve guide using a valve seat runout dial indicator. Total runout should not exceed 0.051 mm (0.002 in.) (total indicator reading).

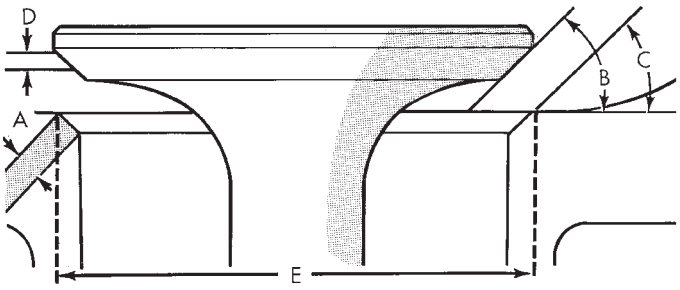
(5) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue

DISASSEMBLY AND ASSEMBLY (Continued)

then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to top edge of the valve face, lower valve seat with a 15 degrees stone. If the blue is transferred to the bottom edge of valve face raise valve seat with a 65 degrees stone.

(6) Valve seats which are worn or burned can be reworked, provided that correct angle and seat width are maintained. The intake valve seat must be serviced when the valve seat width is 2.0 mm (0.079 in.) or greater. The exhaust valve seat must be serviced when the valve seat width is 2.5 mm (0.098 in.) or greater. Otherwise the cylinder head must be replaced.

(7) When seat is properly positioned the width of intake and exhaust seats should be 0.75–1.25 mm (0.030–0.049 in.) (Fig. 122).



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

Fig. 122 Valve Seat Refacing

(8) Check valve tip to spring seat dimensions A after grinding the valve seats or faces. Grind valve tip until within specifications. Measure from valve tip to spring seat when installed in the head (measurement A) (Fig. 123). For specifications, refer to Engine Specifications in this section. The valve tip chamfer may need to be reground to prevent seal damage when the valve is installed.

CLEANING

Clean all valve guides, valves and valve spring assemblies thoroughly with suitable cleaning solution before reassembling.

VALVE INSTALLATION

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

(2) Install new valve stem seals on all valves using a valve stem seal tool (Fig. 124). The valve stem seals should be pushed firmly and squarely over valve guide.

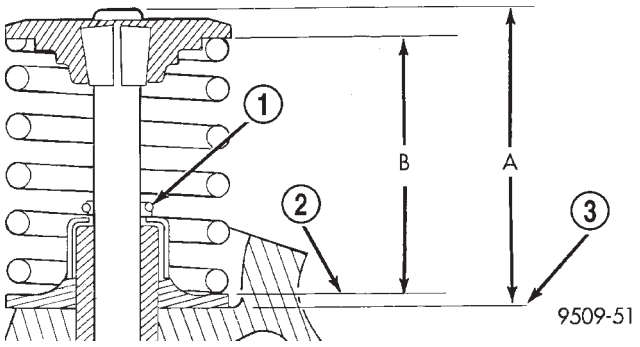


Fig. 123 Spring Installed Height and Valve Tip to Spring Seat Dimensions

1 – GARTER SPRING
2 – VALVE SPRING SEAT
3 – CYLINDER HEAD SURFACE

CAUTION: If oversize valves are used, there is only one oversize valve available. The same stem seal is used on both the standard and oversize valve.

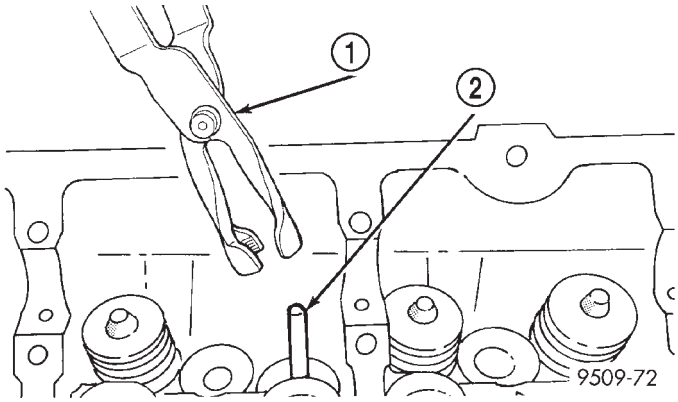


Fig. 124 Valve Stem Oil Seal Tool

1 – VALVE SEAL TOOL
2 – VALVE STEM

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

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

(4) Check the valve spring installed height after refacing the valve and seat (measurment B) (Fig. 123). Make sure measurements are taken from top of spring seat to the bottom surface of spring retainer. If height is greater than 40.18 mm (1.58 in.), install

DISASSEMBLY AND ASSEMBLY (Continued)

a 0.762 mm (0.030 in.) spacer under the valve spring seat to bring spring height back within specification.

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

(6) Checking dry lash. Dry lash is the amount of clearance that exists between the base circle of an installed cam and the rocker arm roller when the adjuster is drained of oil and completely collapsed. Specified dry lash is 1.17 mm (0.046 in.) for intake and 1.28 mm (0.050 in.) for exhaust. After performing dry lash check, refill adjuster with oil and allow 10 minutes for adjuster(s) to bleed down before rotating cam.

CLEANING AND INSPECTION

INTAKE MANIFOLD

CLEAN AND INSPECT

Check for:

- Inspect manifold for cracks or distortions.
- Check for torn or missing O-rings at the mating surface of the manifold (Fig. 125).

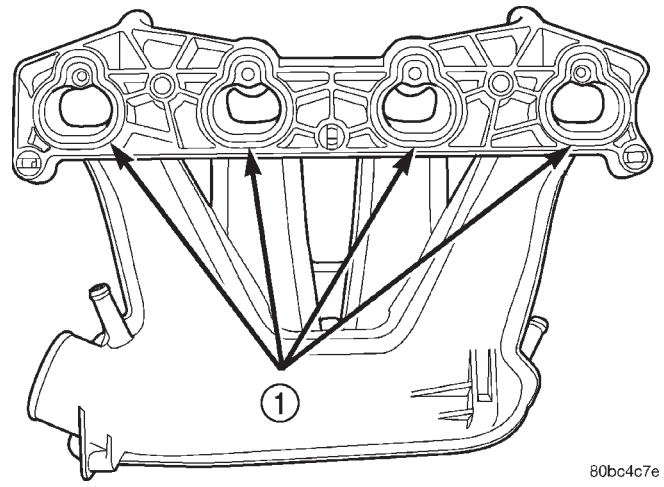


Fig. 125 Intake Manifold O-Rings

1 – INTAKE MANIFOLD O-RING GASKETS

EXHAUST MANIFOLD

CLEAN AND INSPECT

(1) Discard gasket and clean all gasket surfaces of manifolds and cylinder head.

(2) Test manifold gasket surfaces for flatness with straight edge. Surface must be flat within 0.15 mm per 300 mm (.006 in. per foot) of manifold length.

(3) Inspect manifolds for cracks or distortion. Replace manifold if necessary.

CYLINDER HEAD AND CAMSHAFT JOURNALS

CLEANING

Remove all gasket material from cylinder head. Be careful not to gouge or scratch the aluminum head sealing surface. Clean all engine oil passages.

To ensure engine gasket sealing, proper surface preparation must be performed, especially with the use of aluminum engine components and multi-layer steel cylinder head gaskets.

Never use the following to clean aluminum gasket surfaces:

- Metal scraper
- Abrasive pad or paper to clean cylinder block and head
- High speed power tool with an abrasive pad or a wire brush (Fig. 126)

NOTE: Multi-Layer Steel (MLS) head gaskets require a scratch free sealing surface.

Only use the following for cleaning gasket surfaces:

- Solvent or a commercially available gasket remover
- Plastic or wood scraper (Fig. 126)
- Drill motor with 3M Roloc™ Bristle Disc (white or yellow) (Fig. 126)

CAUTION: Excessive pressure or high RPM can damage the sealing surfaces. The mild (white, 120 grit) bristle disc is recommended. If necessary, the medium (yellow, 80 grit) bristle disc may be used on cast iron surfaces with care.

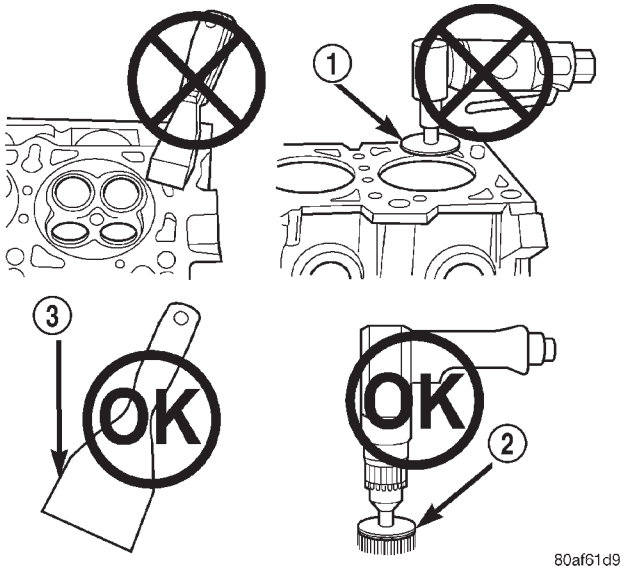


Fig. 126 Proper Tool Usage For Surface Preparation

1 – ABRASIVE PAD
2 – 3M ROLOC™ BRISTLE DISC
3 – PLASTIC/WOOD SCRAPER

CLEANING AND INSPECTION (Continued)

INSPECTING CYLINDER HEAD

Check cylinder head for flatness with a straight edge. Cylinder head must be flat within 0.1 mm (0.004 in.) (Fig. 127).

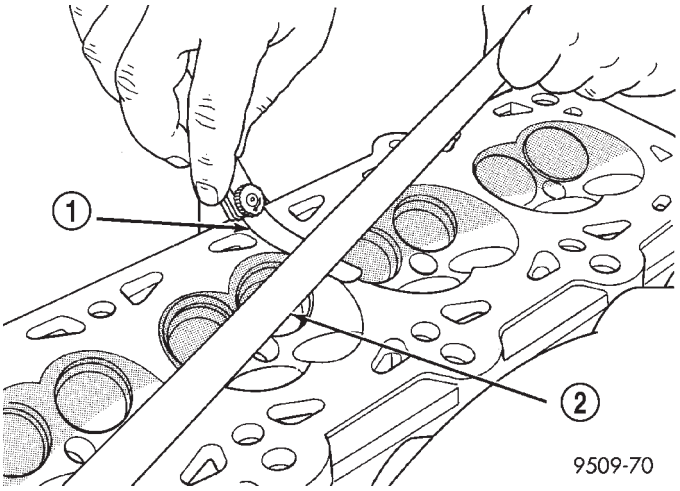


Fig. 127 Checking Cylinder Head Flatness

1 – FEELER GAUGE
2 – STRAIGHT EDGE

INSPECTING CAMSHAFT JOURNALS

Inspect cylinder head camshaft bearings for wear. Check the camshaft journals for scratches and worn areas. If light scratches are present, they may be removed with 400 grit sand paper. If deep scratches are present, replace the camshaft and check the cylinder head for damage. Replace the cylinder head if worn or damaged. Check the lobes for pitting and wear. If the lobes show signs of wear, check the corresponding rocker arm roller for wear or damage. Replace rocker arm/hydraulic lash adjuster if worn or damaged. If lobes show signs of pitting on the nose, flank or base circle; replace the camshaft.

OIL PUMP

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

(2) Lay a straightedge across the pump cover surface (Fig. 128). If a 0.076 mm (0.003 inch.) feeler gauge can be inserted between cover and straight edge, cover should be replaced.

(3) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 7.64 mm (0.301 inch.) or less (Fig. 129), or if the diameter is 79.95 mm (3.148 inches) or less, replace outer rotor.

(4) If inner rotor measures 7.64 mm (0.301 inch) or less replace inner rotor (Fig. 130).

(5) Slide outer rotor into pump housing, press to one side with fingers and measure clearance between rotor and housing (Fig. 131). If measurement is 0.39

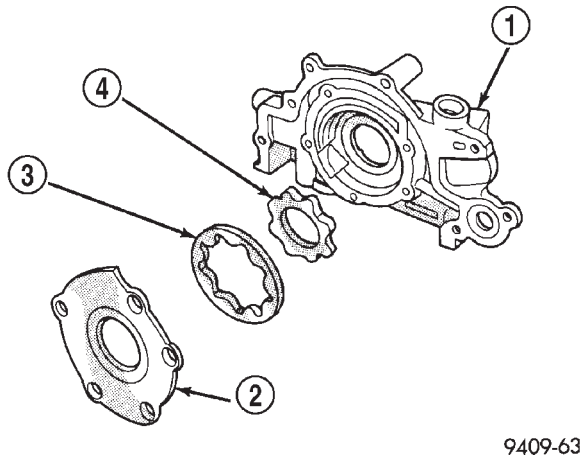


Fig. 128 Checking Oil Pump Cover Flatness

1 – OIL PUMP BODY
2 – OIL PUMP COVER
3 – OUTER ROTOR
4 – INNER ROTOR

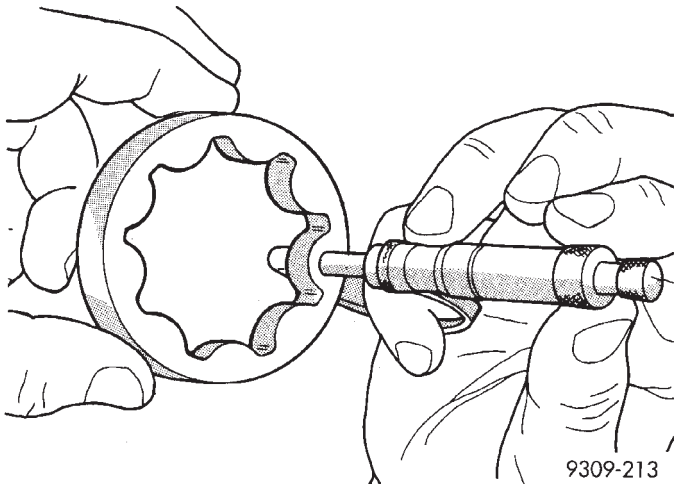


Fig. 129 Measuring Outer Rotor Thickness

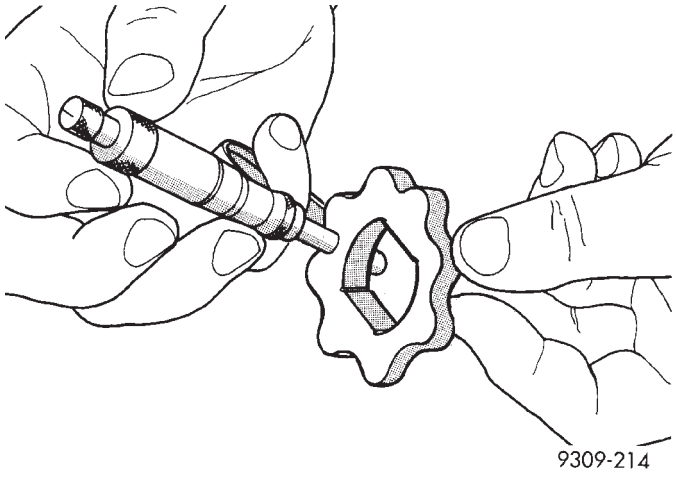


Fig. 130 Measuring Inner Rotor Thickness

CLEANING AND INSPECTION (Continued)

mm (0.015 inch.) or more, replace housing only if outer rotor is in specification.

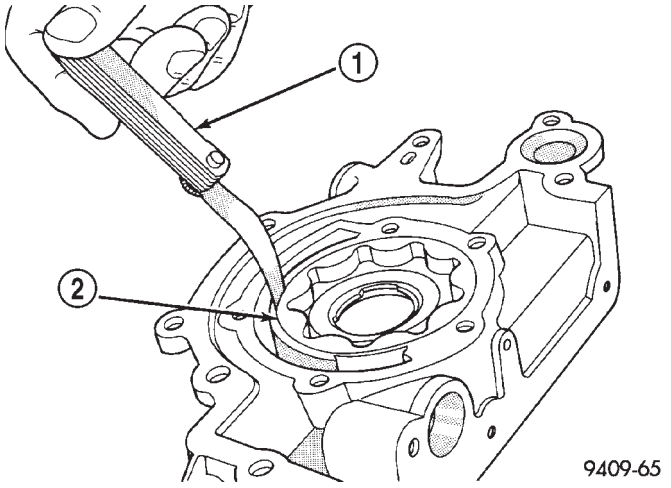


Fig. 131 Measuring Outer Rotor Clearance in Housing

1 – FEELER GAUGE
2 – OUTER ROTOR

(6) Install inner rotor into pump housing. If clearance between inner and outer rotors (Fig. 132) is 0.203 mm (0.008 inch) or more, replace both rotors.

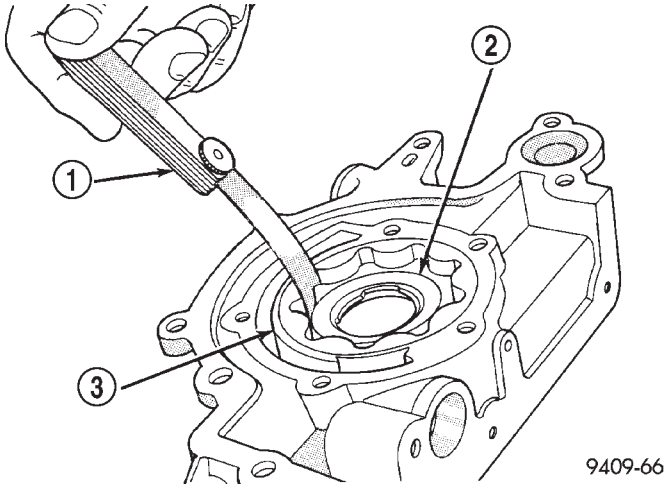


Fig. 132 Measuring Clearance Between Rotors

1 – FEELER GAUGE
2 – INNER ROTOR
3 – OUTER ROTOR

(7) Place a straightedge across the face of the pump housing, 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. 133). **ONLY** if rotors are in specs.

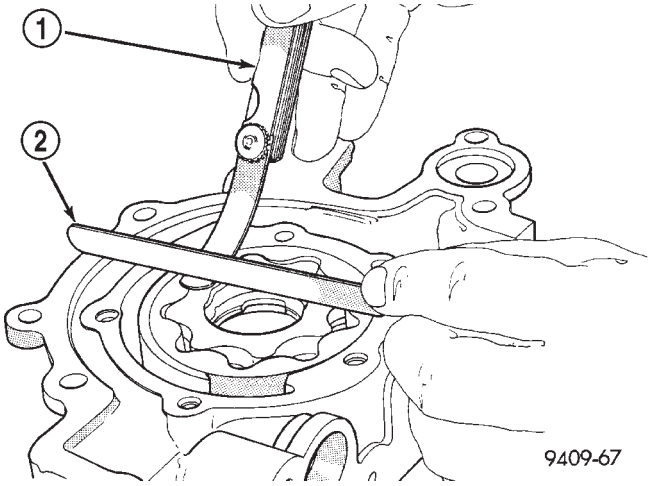


Fig. 133 Measuring Clearance Over Rotors

1 – FEELER GAUGE
2 – STRAIGHT EDGE

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

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

(10) If oil pressure is low and pump is within specifications, inspect for worn engine bearings, damaged or missing oil pick-up tube O-ring, clogged oil pick-up tube screen, clogged oil filter and stuck open pressure relief valve or other reasons for oil pressure loss.

CYLINDER BLOCK AND BORE

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

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

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

CLEANING AND INSPECTION (Continued)

CYLINDER BORE INSPECTION

The cylinder walls should be checked for out-of-round and taper with Tool C-119 (Fig. 134). If the cylinder walls are badly scuffed or scored, the cylinder block should be rebored and honed, and new pistons and rings fitted. Whatever type of boring equipment is used, boring and honing operation should be closely coordinated with the fitting of pistons and rings in order that specified clearances may be maintained. **Refer to Honing Cylinder Bores outlined in the Standard Service Procedures for specification and procedures.**

Measure the cylinder bore at three levels in directions A and B (Fig. 134). Top measurement should be 10 mm (3/8 in.) down and bottom measurement should be 10 mm (3/8 in.) up from bottom of bore. For specifications, refer to Engine Specifications in this section.

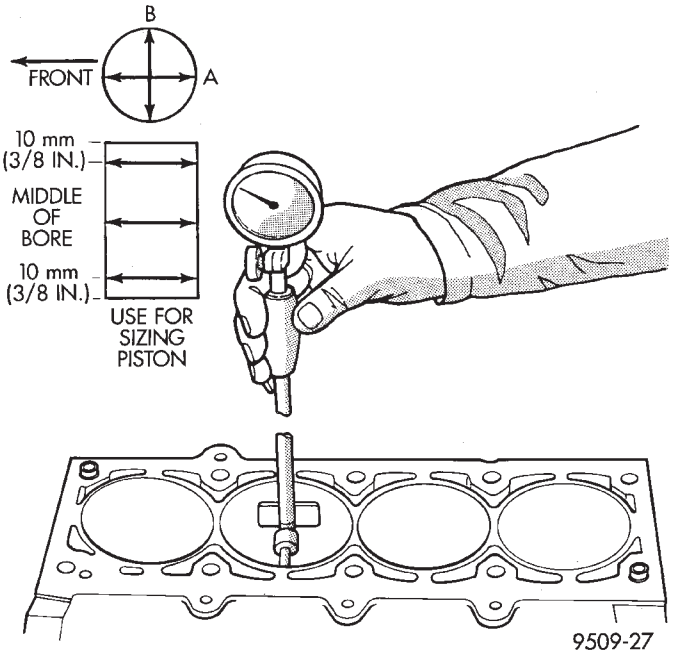


Fig. 134 Checking Cylinder Bore Size

ADJUSTMENTS

ENGINE TORQUE STRUT ADJUSTMENT

The upper and lower torque struts need to be adjusted together to assure proper engine positioning and engine mount loading. Whenever a torque strut bolt(s) is loosened, this procedure must be performed.

(1) Loosen the upper and lower torque strut attaching bolt at the suspension crossmember and shock tower bracket (Fig. 135).

(2) The engine position may now be adjusted by positioning a suitable floor jack on the forward edge of the transmission bell housing (Fig. 136).

NOTE: The floor jack must be positioned as shown in (Fig. 136) to prevent minimal upward lifting of the engine.

(3) Carefully apply upward force, allowing the upper engine to rotate rearward until the distance between the center of the rearmost attaching stud on the engine mount bracket (point “A”) and the center of the hole for the washer hose clip on the shock tower bracket (point “B”) is 119 mm (4.70 in.) (Fig. 137).

(4) With the engine held at the proper position, tighten both the upper and lower torque strut bolts to 118 N·m (87 ft. lbs.) (Fig. 135).

(5) Remove the floor jack.

ADJUSTMENTS (Continued)

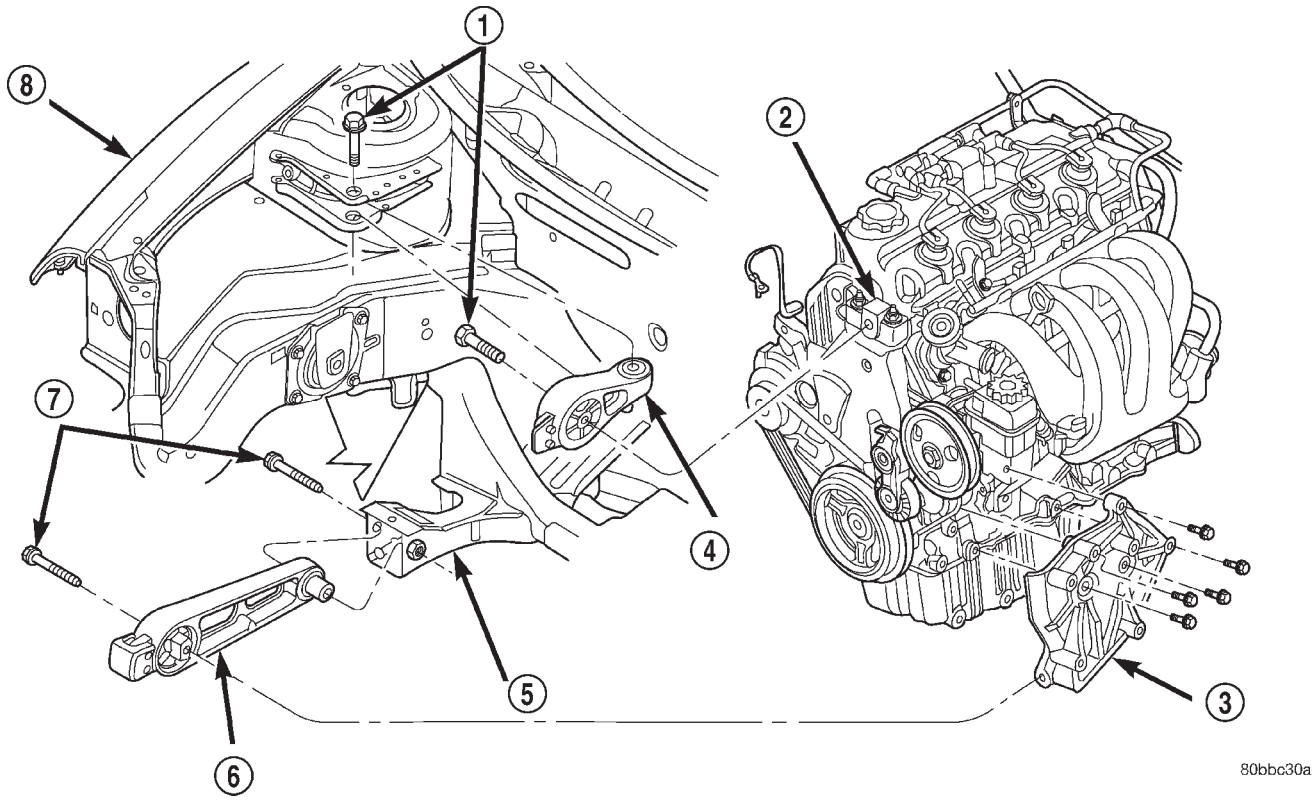


Fig. 135 Torque Strut Bolts

1 – BOLTS
2 – ENGINE MOUNT BRACKET
3 – TORQUE STRUT BRACKET
4 – UPPER TORQUE STRUT
5 – CROSSMEMBER
6 – LOWER TORQUE STRUT
7 – BOLTS
8 – RIGHT FENDER

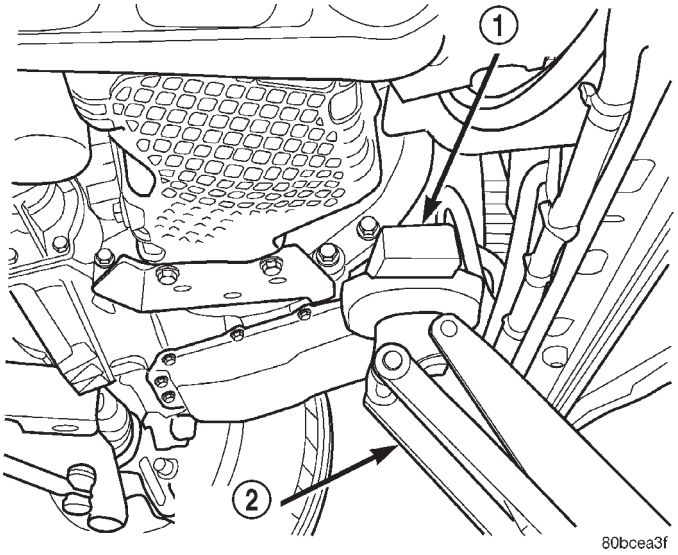


Fig. 136 Floor Jack Positioning

1 – WOOD BLOCK
2 – FLOOR JACK

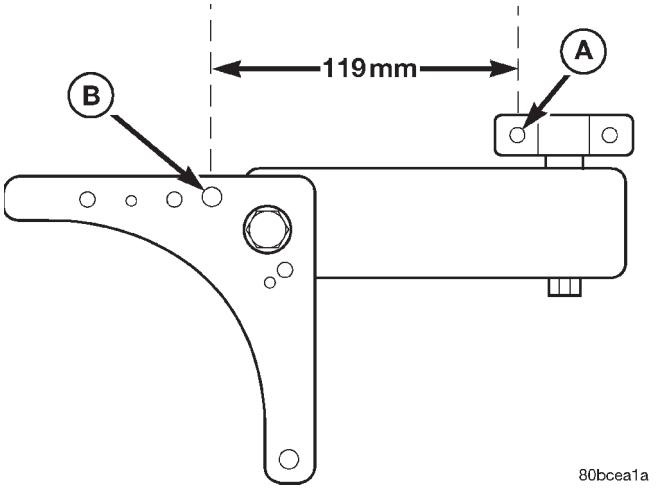


Fig. 137 Engine Position Measurement

SPECIFICATIONS

2.0L SOHC ENGINE

DESCRIPTION	SPECIFICATION
General Specification	
Type	In-Line OHV, SOHC
Number of Cylinders	4
Displacement	2.0 Liters (122 cu. in.)
Bore	87.5 mm (3.445 in.)
Stroke	83.0 mm (3.268 in.)
Compression Ratio	9.8:1
Firing Order	1-3-4-2
Compression Pressure	1172–1551 kPa (170–225 psi)
Max. Variation Between Cylinders	25%
Cylinder Block	
Cylinder Bore Diameter	87.4924–87.5076 mm (3.4446–3.4452 in.)
Out-of-Round (Max.)	0.051 mm (0.002 in.)
Taper (Max.)	0.051 mm (0.002 in.)
Pistons (Federal Emission)	
Piston Diameter	87.463–87.481 mm (3.4434–3.4441 in.)
Clearance 17.5 mm (11/16 in.) from bottom of skirt	0.012–0.044 mm (0.0004–0.0017 in.)
Weight	325–335 grams (11.47–11.82 oz.)
Land Clearance (Diametrical)	0.734–0.797 mm (0.029–0.031 in.)
Piston Length	64 mm (2.520 in.)
Piston Ring Groove Depth No. 1	3.989–4.188 mm (0.157–0.165 in.)
Piston Ring Groove Depth No. 2	4.462–4.661 mm (0.176–0.184 in.)
Piston Ring Groove Depth No. 3	3.847–4.131 mm (0.151–0.163 in.)
Pistons (Low Emission Vehicle—LEV/ULEV)	
Piston Diameter	87.456–87.474 mm (3.4432–3.4439 in.)
Clearance 10.42 mm (0.42 in.) from bottom of skirt	0.018–0.50 mm (0.0008–0.0020 in.)
Weight	320–329 grams (11.29–11.60 oz.)
Land Clearance (Diametrical)	0.758–0.790 mm (0.0299–0.0312 in.)
Piston Length	55.8 mm (2.197 in.)
Piston Ring Groove Depth No. 1	3.989–4.188 mm (0.157–0.165 in.)
Piston Ring Groove Depth No. 2	4.462–4.661 mm (0.176–0.184 in.)
Piston Ring Groove Depth No. 3	3.847–4.131 mm (0.151–0.163 in.)
Piston Pins	
Clearance in Piston	0.008–0.015 mm (0.0003–0.0006 in.)
Clearance in Connecting Rod	Interference
Diameter	21.000–21.003 mm (0.8268–0.8269 in.)
End Play	None
Length	74.75–75.25 mm (2.943–2.963 in.)
Piston Rings	
Ring Gap—Top Compression Ring	0.23–0.52 mm (0.009–0.020 in.)
Wear Limit	0.8 mm (0.031 in.)
Ring Gap—2nd Compression Ring	0.49–0.78 mm (0.019–0.031 in.)
Wear Limit	1.0 mm (0.039 in.)
Ring Gap—Oil Control Steel Rails	0.23–0.66 mm (0.009–0.026 in.)

SPECIFICATIONS (Continued)

DESCRIPTION	SPECIFICATION
Wear Limit	1.0 mm (0.039 in.)
Ring Side Clearance—Compression Rings	0.025–0.065 mm (0.0010–0.0026 in.)
Wear Limit	0.10 mm (0.004 in.)
Ring Side Clearance—Oil Ring Pack	0.004–0.178 mm (0.0002–0.0070 in.)
Ring Width—Compression Rings	1.17–1.19 mm (0.046–0.047 in.)
Ring Width—Oil Ring Pack	2.854–3.008 mm (0.1124–0.1184 in.)
Connecting Rod	
Bearing Clearance	0.026–0.059 mm (0.001–0.0023 in.)
Wear Limit	0.075 mm (0.003 in.)
Bore Diameter—Piston Pin	20.96–20.98 mm (0.8252–0.8260 in.)
Bore Diameter—Crankshaft End	50.991–51.005 mm (2.0075–2.0081 in.)
Side Clearance	0.13–0.38 mm (0.005–0.015 in.)
Wear Limit	0.40 mm (0.016 in.)
Weight—Total (Less Bearing)	543 grams (1.20 lbs.)
Crankshaft	
Connecting Rod Journal Diameter	47.9924–48.0076 mm (1.8894–1.8900 in.)
Main Bearing Journal Diameter	51.9924–52.0076 mm (2.0469–2.0475 in.)
Journal Out-of-Round (Max.)	0.0035 mm (0.0001 in.)
Journal Taper (Max.)	0.0038 mm (0.0001 in.)
End Play	0.09–0.24 mm (0.0035–0.0094 in.)
Wear Limit	0.37 mm (0.015 in.)
Main Bearing Diametrical Clearance	0.022–0.062 mm (0.0008–0.0024 in.)

DESCRIPTION	SPECIFICATION
Rocker Arm Shaft	
Rocker Arm Shaft Diameter	19.966–19.984 mm (0.7861–0.7868 in.)
Rocker Arm Shaft Retainers	
Intake—Width	28.43–28.49 mm (1.1193–1.1217 in.)
Exhaust—Width 1 & 5	29.15–29.25 mm (1.1477–1.1516 in.)
Exhaust—Width 2, 3, and 4	40.40–40.50 mm (1.5906–1.5945 in.)
Rocker Arm/Hydraulic Lash Adjuster	
Rocker Arm Inside Diameter	20.00–20.02 mm (0.787–0.788 in.)
Rocker Arm Shaft Clearance	0.016–0.054 mm (0.0006–0.0021 in.)
Body Diameter	22.949–22.962 mm (0.9035–0.9040 in.)
Plunger Travel Minimum (Dry)	2.2 mm (0.087 in.)
Dry Lash—Intake	1.17 mm (0.046 in.)
Dry Lash—Exhaust	1.28 mm (0.050 in.)
Rocker Arm Ratio	1.4 to 1
Cylinder Head Camshaft Bearing Diameter	
Journal No. 1	41.20–41.221 mm (1.622–1.6228 in.)
Journal No. 2	41.60–41.62 mm (1.637–1.638 in.)
Journal No. 3	42.0–42.02 mm (1.653–1.654 in.)
Journal No. 4	42.4–42.42 mm (1.669–1.670 in.)
Journal No. 5	42.8–42.82 mm (1.685–1.6858 in.)
Camshaft	
Journal Diameter	
No. 1	41.128–41.147 mm (1.619–1.6199 in.)
No. 2	41.528–41.547 mm (1.634–1.635 in.)

SPECIFICATIONS (Continued)

DESCRIPTION	SPECIFICATION
No. 3	41.928–41.947 mm (1.650–1.651 in.)
No. 4	42.328–42.374 mm (1.666–1.668 in.)
No. 5	42.728–42.747 mm (1.682–1.6829 in.)
Bearing Clearance—Diametrical	0.053–0.093 mm (0.0027–0.003 in.)
Bearing Clearance (Max. allowable)	0.12 mm (0.0047 in.)
End Play	0.05–0.39 mm (0.002–0.015 in.)
Lift (Zero Lash)	
Intake	7.2 mm (0.283 in.)
Exhaust	7.03 mm (0.277 in.)
Exhaust Valve Timing*	
Closes (ATDC)	5.4°
Opens (BBDC)	43.7°
Duration	229.1°
Intake Valve Timing*	
Closes (ABDC)	41.1°
Opens (ATDC)	13.9°
Duration	207.2°
Valve Overlap	84.8°
*All readings in crankshaft degrees, at 0.5 mm (0.019 in.) of valve lift.	
Cylinder Head	
Material	Cast Aluminum
Gasket Thickness (Compressed)	1.15 mm (0.045 in.)
Valve Seat	
Angle	45°
Seat Diameter—Intake	33 mm (1.299 in.)
Seat Diameter—Exhaust	28 mm (1.102 in.)
Runout (Max.)	0.05 mm (0.002 in.)
Valve Seat Width—Intake and Exhaust	0.9–1.3 mm (0.035–0.051 in.)

DESCRIPTION	SPECIFICATION
Service Limit—Intake	2.0 mm (0.079 in.)
Service Limit—Exhaust	2.5 mm (0.098 in.)
Valve Guide	
Diameter I. D.	5.975–6.000 mm (0.235–0.236 in.)
Guide Bore Diameter (Std.)	11.0–11.02 mm (0.4330–0.4338 in.)
Guide Height (spring seat to guide tip)	13.25–13.75 mm (0.521–0.541 in.)
Valves	
Face Angle Intake and Exhaust	45–45.5°
Head Diameter—Intake	32.12–33.37 mm (1.303–1.313 in.)
Head Diameter—Exhaust	28.57–28.83 mm (1.124–1.135 in.)
Valve Margin	
Intake	1.15–1.48 mm (0.0452–0.0583 in.)
Service Limit	0.95 mm (1/32 in.)
Exhaust	1.475–1.805 mm (0.058–0.071 in.)
Service Limit	1.05 mm (3/64 in.)
Valve Length (Overall)	
Intake	114.69–115.19 mm (4.515–4.535 in.)
Exhaust	116.94–117.44 mm (4.603–4.623 in.)
Valve Stem Tip Height	
Intake	45.01–46.07 mm (1.77–1.81 in.)
Exhaust	43.51–44.57 mm (1.71–1.75 in.)
Valve Stem Diameter	
Intake	5.934–5.952 mm (0.2337–0.2344 in.)

SPECIFICATIONS (Continued)

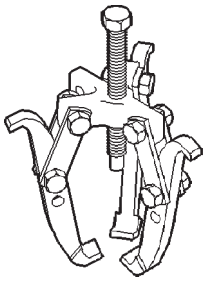
DESCRIPTION	SPECIFICATION
Exhaust	5.906–5.924 mm (0.2326–0.2333 in.)
Valve Stem to Guide Clearance	
Intake	0.048–0.066 mm (0.0018–0.0025 in.)
Max. Allowable	0.076 mm (0.003 in.)
Service Limit	0.25 mm (0.010 in.)
Exhaust	0.0736–0.094 mm (0.0029–0.0037 in.)
Max. Allowable	0.101 mm (0.004 in.)
Service Limit	0.25 mm (0.010 in.)
Valve Springs	
Free Length (Approx.)	46.75 mm (1.84 in.)
Nominal Force (Valve Closed)	331 N @ 39.8 mm (70 lbs. @ 1.57 in.)
Nominal Force (Valve Open)	711 N @ 32.6 mm (160 lbs. @ 1.28 in.)
Installed Height	40.18 mm (1.580 in.)

TORQUE

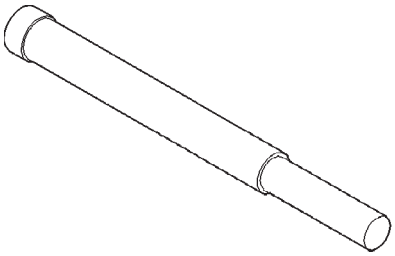
DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Camshaft Sensor Pick-up—Bolts	9.6	—	85
Camshaft Sprocket—Bolt	115	85	—
Connecting Rod Cap—Bolts	27 +¼ turn	20 +¼ turn	—
Structural Collar—Bolts	Refer to Procedure		
Crankshaft Main Bearing Cap/Bedplate			
—M8 Bolts	34	25	—
—M11 Bolts	81	60	—
Crankshaft Damper	136	100	—
Cylinder Head—Bolts	Refer to Procedure		
Cylinder Head Cover—Bolts	12	—	105
Drive Plate to Crankshaft	95	70	—
Engine Mount Bracket Right—Bolts	61	45	—
Engine Mounting	Refer to Procedure		
Exhaust Manifold to Cylinder Head—Bolts	23	—	200
Exhaust Manifold Support Bracket (Federal and LEV)			
—M8 Nut	28	—	250
—M10 Bolt	54	40	—
—M12 Bolt	95	70	—
Exhaust Manifold Support Bracket (ULEV)	54	40	—
Engine Torque Strut Bracket to Engine—Bolts	61	45	—
Powertrain Bending Strut—Front			
—Long Bolts	101	75	—
—Short Bolts	61	45	—
Intake Manifold—Bolts	12	—	105
Oil Filter Adaptor	80	60	—
Oil Filter	20	15	—
Oil Pan—Bolts	12	—	105
Oil Pan Drain—Plug	27	20	—
Oil Pump to Block	28	—	250
Oil Pump Cover Plate—Bolts	12	—	105
Oil Pump Pick-up Tube—Bolt	28	—	250
Oil Pump Relief Valve—Cap	41	30	—
PCV Valve	5.6	—	50
Rocker Arm Shaft—Bolts	28	—	250
Spark Plugs	28	—	250
Timing Belt Cover—Bolts	12	—	105
Timing Belt Tensioner Assembly—Bolts	28	—	250
Water Pump—Bolts	12	—	105

SPECIAL TOOLS

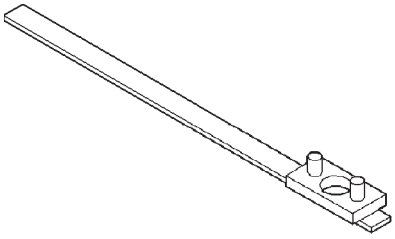
2.0L SOHC ENGINE



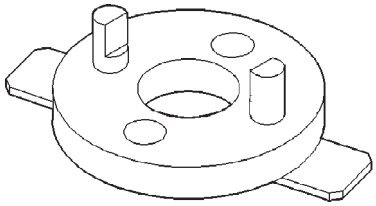
Puller 1026



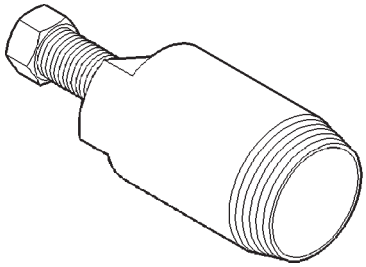
Crankshaft Damper Removal Insert 6827-A



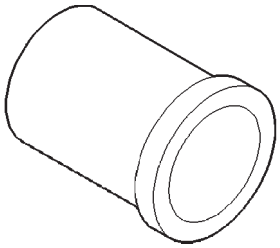
Camshaft Sprocket Remover/Installer C-4687



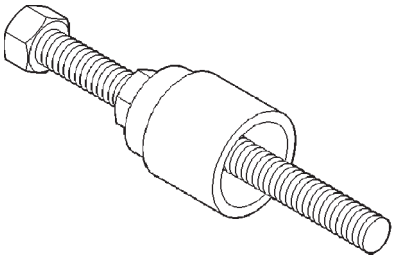
Camshaft Sprocket Remover/Installer Adapter C-4687-1



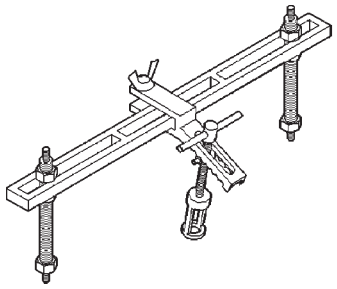
Camshaft Seal Remover C-4679-A



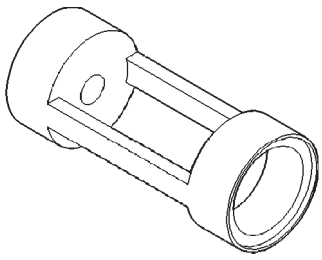
Camshaft Seal Installer MD-998306



Crankshaft Damper Installer 6792

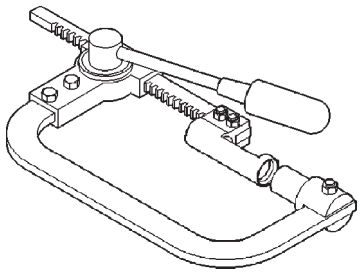


Valve Spring Compressor MD-998772-A

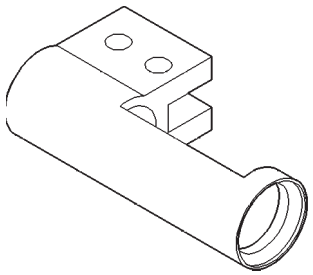


Spring Compressor Adapter 6779

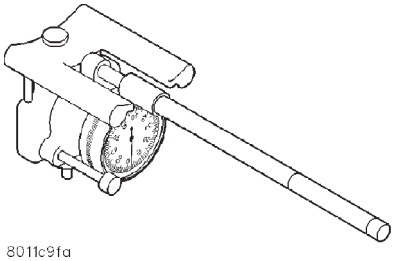
SPECIAL TOOLS (Continued)



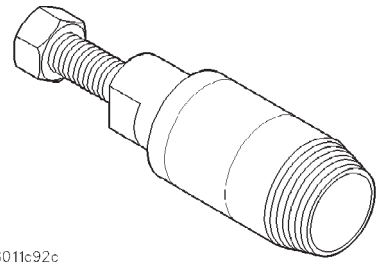
Valve Spring Compressor C-3422-B



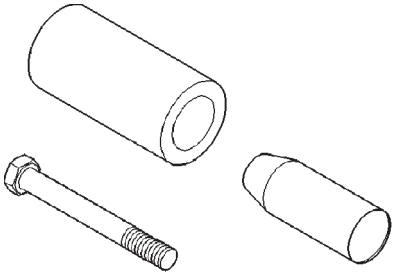
Spring Compressor Adaptor 6526



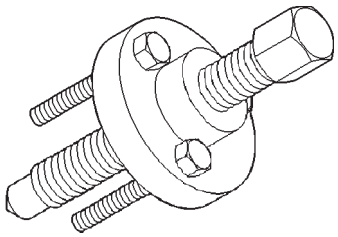
Cylinder Bore Indicator C-119



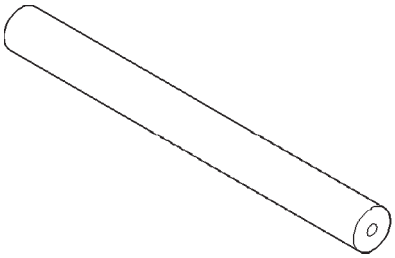
Front Crankshaft Seal Remover 6771



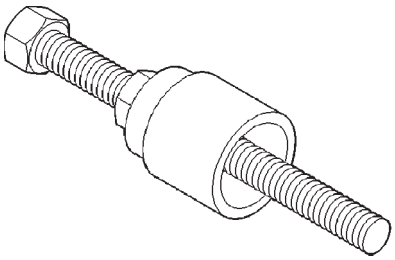
Front Crankshaft Seal Installer 6780



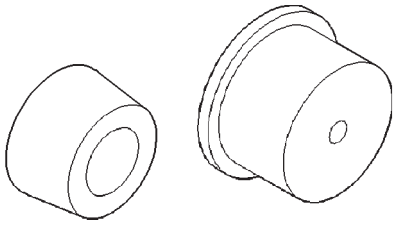
Crankshaft Sprocket Remover 6793



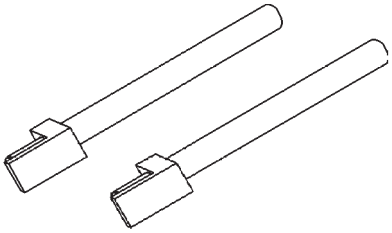
Crankshaft Sprocket Remover Insert C-4685-C2



Crankshaft Sprocket Installer 6792

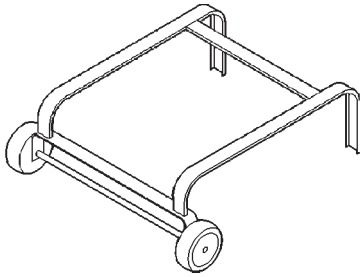


Rear Crankshaft Seal Guide and Installer 6926-1 and 6926-2

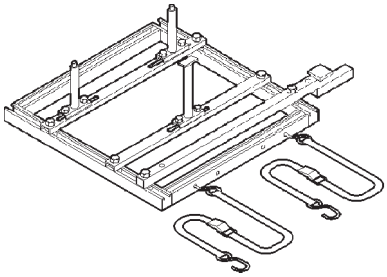


Connecting Rod Guides 8189

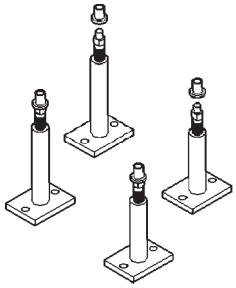
SPECIAL TOOLS (Continued)



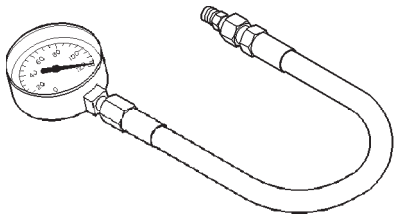
Dolly 6135



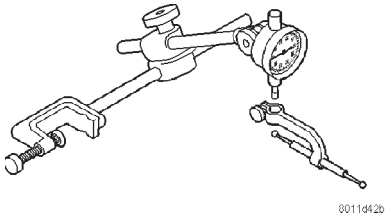
Cradle 6710



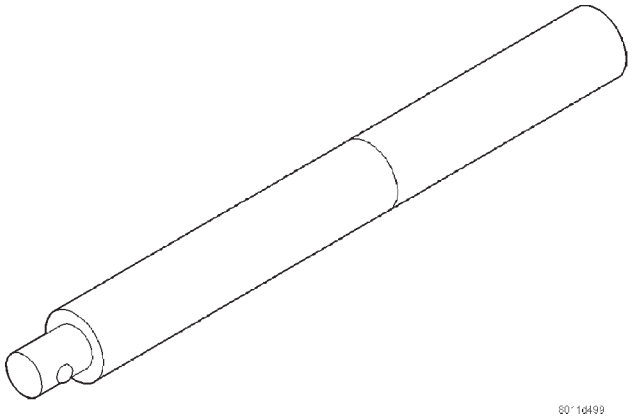
Post Kit Engine Cradle 6848



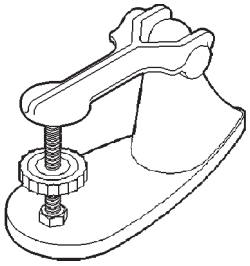
Pressure Gauge C-3292



Dial Indicator C-3339



Driver Handle C-4171



Valve Spring Tester C-647