

ENGINES

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STANDARD SERVICE INFORMATION

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GENERAL INFORMATION

FORM-IN-PLACE GASKETS

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

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

MOPAR SILICONE RUBBER ADHESIVE SEALANT

Mopar Silicone Rubber Adhesive Sealant or equivalent, normally black in color, is available in three ounce tubes. Moisture in the air causes the Mopar Silicone Rubber Adhesive Sealant material to cure. This material is normally used on flexible metal flanges. It has a shelf life of one year and will not

properly cure if over age. Always inspect the package for the expiration date before use.

MOPAR GASKET MAKER

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

GASKET DISASSEMBLY

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

SURFACE PREPARATION

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

GENERAL INFORMATION (Continued)

FORM-IN-PLACE GASKET APPLICATION

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

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

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

ENGINE PERFORMANCE

If a loss of performance is noticed, ignition timing should be checked. If ignition timing is retarded by 9, 18 or 27° "it indicates" 1, 2 or 3 (timing belt or chain) teeth may have skipped. The camshaft and crankshaft timing should be checked. Refer to Engine Timing Sprockets and Oil Seals of the Engine Section.

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

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

(2) Tighten the intake manifold bolts to specifications.

(3) Perform cylinder compression test. See diagnosis and testing in this section.

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

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

(6) Inspect the primary wire. Test coil output voltage, primary and secondary resistance. Replace parts as necessary. Refer to Ignition System and make necessary adjustment.

(7) Test fuel pump for correct pressure. Refer to Fuel System Group 14, Specifications.

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

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

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

(11) Road test vehicle as a final test.

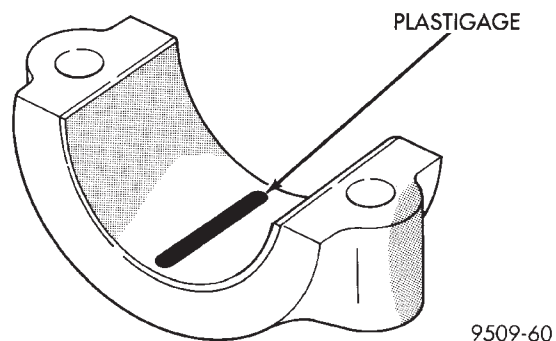
MEASURING MAIN BEARING AND CONNECTING ROD BEARING CLEARANCES

Fig. 1 Plastigage Placed in Lower Shell

PLASTIGAGE METHOD

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

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

PREFERRED METHOD

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

ENGINE WITH 5 MAIN BEARINGS

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

GENERAL INFORMATION (Continued)

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

ENGINE WITH 4 MAIN BEARING

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

NOTE: REMOVE ALL SHIMS BEFORE REASSEMBLING ENGINE

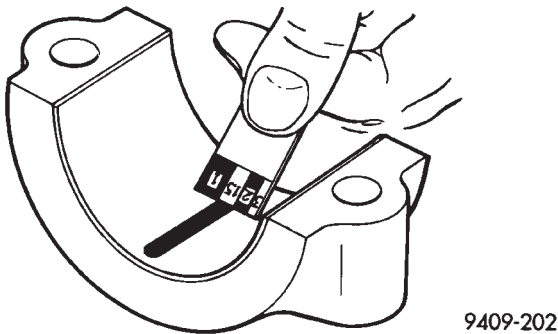


Fig. 2 Clearance Measurement

ALTERNATIVE METHOD

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

PLASTIGAGE PROCEDURE

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

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

CONNECTING ROD BEARING CLEARANCE

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

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

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

CHECKING ENGINE OIL LEVEL

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

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

GENERAL INFORMATION (Continued)

ENGINE OIL SERVICE

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

API SERVICE GRADE CERTIFIED

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

SAE VISCOSITY

An SAE viscosity grade is used to specify the viscosity of engine oil. SAE 30 specifies a single viscosity engine oil. Engine oils also have multiple viscosities. These are specified with a dual SAE viscosity grade which indicates the cold-to-hot temperature viscosity range. Select an engine oil that is best suited to your particular temperature range and variation (Fig. 3).

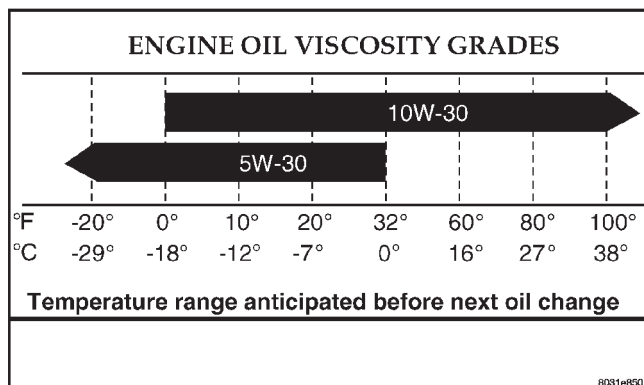


Fig. 3 Temperature/Engine Oil Viscosity

ENERGY CONSERVING OIL

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

CONTAINER IDENTIFICATION

Standard engine oil identification notations have been adopted to aid in the proper selection of engine oil. The identifying notations are located on the label of engine oil plastic bottles and the top of engine oil cans (Fig. 4).



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Fig. 4 Engine Oil Container Standard Notations

ENGINE OIL CHANGE

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

TO CHANGE ENGINE OIL

Run engine until achieving normal operating temperature.

(1) Position the vehicle on a level surface and turn engine off.

(2) Hoist and support vehicle on safety stands. Refer to Hoisting and Jacking Recommendations.

(3) Remove oil fill cap.

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

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

(6) Install drain plug in crankcase.

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

(8) Install oil fill cap.

(9) Start engine and inspect for leaks.

(10) Stop engine and inspect oil level.

ENGINE OIL FILTER CHANGE

FILTER SPECIFICATION

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

OIL FILTER REMOVAL

Refer to Removal and Installation Section in Group 9, Engine for procedure.

USED ENGINE OIL DISPOSAL

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

SERVICE PROCEDURES

REPAIR OF DAMAGED OR WORN THREADS

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

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

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

HONING CYLINDER BORES

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

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

(3) Honing should be done by moving the hone up and down fast enough to get a cross-hatch pattern. When hone marks **intersect** at 50-60 degrees, the cross hatch angle is most satisfactory for proper seating of rings (Fig. 5).

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

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

CAUTION: Ensure all abrasives are removed from engine parts after honing. It is recommended that a solution of soap and hot water be used with a brush and the parts then thoroughly dried. The bore 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.

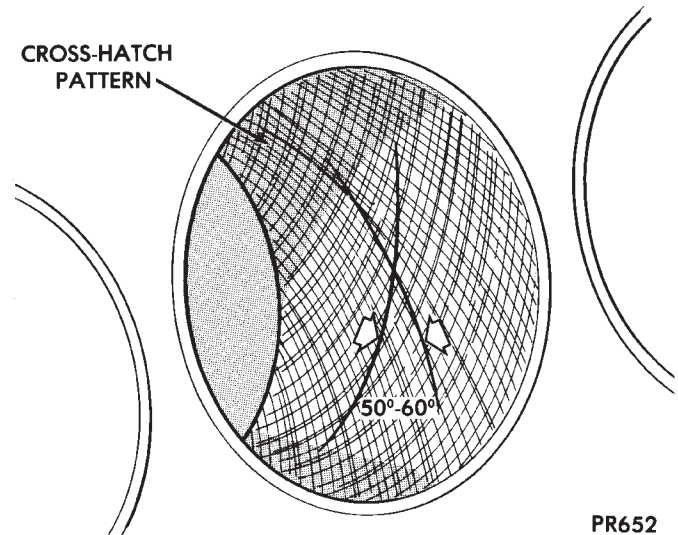


Fig. 5 Cylinder Bore Cross-Hatch Pattern

HYDROSTATIC LOCKED ENGINE

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

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

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

(2) Remove negative battery cable.

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

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

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

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

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

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

(8) Install new spark plugs.

(9) Drain engine oil and remove oil filter.

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

(11) Connect negative battery cable.

(12) Start engine and check for any leaks.

SERVICE PROCEDURES (Continued)

ENGINE CORE PLUGS

REMOVAL

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

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

INSTALLATION

Thoroughly remove all rust and clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer. Lightly coat inside of cup plug hole with sealer. Make certain the new plug is cleaned of all oil or grease. Using proper drive plug, drive plug into hole so that the sharp edge of the plug is at least 0.5 mm (0.020 inch.) inside the lead in chamfer (Fig. 6).

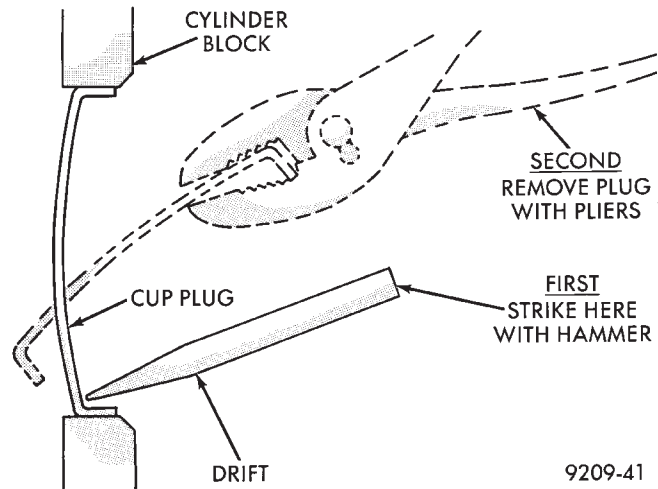


Fig. 6 Core Hole Plug Removal

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

ENGINE DIAGNOSIS

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DIAGNOSIS AND TESTING

GENERAL INFORMATION

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

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

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

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

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

INTAKE MANIFOLD LEAKAGE DIAGNOSIS

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

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

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

CYLINDER COMPRESSION TEST

(1) Before performing a cylinder compression test. Ensure the battery is completely charged and the engine starter motor is in good operating condition. Otherwise the indicated compression pressures may not be valid for diagnosis purposes.

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

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

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

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

- a. Clean the spark plug recesses with compressed air.
- b. Remove all spark plugs from engine. As spark plugs are being removed, check electrodes for abnormal firing indicators fouled, hot, oily, etc. Record cylinder number of spark plug for future reference.
- c. Disconnect the coil connector for Direct Ignition System (DIS).
- d. Be sure throttle blade is fully open during the compression check.
- e. Insert compression gage adaptor into the #1 spark plug hole in cylinder head. Crank engine until maximum pressure is reached on gage. Record this pressure as #1 cylinder pressure.
- f. Repeat Step e for all remaining cylinders.
- g. Compression should not be less than (689kPa) 100 psi and not vary more than 25 percent from cylinder to cylinder.
- h. If one or more cylinders have abnormally low compression pressures, repeat steps 4e through 4g.
- i. If the same cylinder or cylinders repeat an abnormally low reading on the second compression test, it could indicate the existence of a problem in the cylinder in question.

DIAGNOSIS AND TESTING (Continued)

NOTE: The recommended compression pressures are to be used only as a guide to diagnosing engine problems. An engine should not be disassembled to determine the cause of low compression unless some malfunction is present.

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

CYLINDER COMBUSTION PRESSURE LEAKAGE TEST

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

Combustion pressure leakage testing will detect:

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

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

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

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

Clean spark plug recesses with compressed air.

Remove the spark plugs.

Remove the oil filler cap.

Remove the air cleaner.

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

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

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

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

LASH ADJUSTER (TAPPET) NOISE DIAGNOSIS

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

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

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

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

(4) Low oil pressure.

(5) 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 pickup.

(7) Worn valve guides.

(8) Rocker arm ears contacting valve spring retainer.

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

(10) Faulty lash adjuster.

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

NOTE: 3.5L Engine the lash adjuster is serviced with the rocker arm, do not disassemble.

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

c. Clean out dirt and varnish with solvent.

d. Reassemble with engine oil.

e. Check for sponginess.

f. If still spongy, replace with new adjuster.

INSPECTION (ENGINE OIL LEAKS IN GENERAL)

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

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

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

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

DIAGNOSIS AND TESTING (Continued)

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

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

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

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

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

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

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

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

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

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

INSPECTION FOR REAR SEAL AREA LEAKS

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

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

(1) Disconnect the battery.

(2) Raise the vehicle.

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

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

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

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

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

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

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

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

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

DIAGNOSIS AND TESTING (Continued)

ENGINE DIAGNOSIS—PERFORMANCE

CONDITION	POSSIBLE CAUSE	CORRECTION
ENGINE WILL NOT START	1. Weak battery. 2. Corroded or loose battery connections. 3. Faulty starter. 4. Moisture on ignition wires. 5. Faulty ignition cables. 6. Faulty coil or control unit. 7. Incorrect spark plug gap. 8. Dirt or water in fuel system. 9. Faulty fuel pump.	1. Test battery specific gravity. Charge or replace as necessary. 2. Clean and tighten battery connections. Apply a coat of light mineral grease to the terminals. 3. Refer to Group 8A, Battery/Starter/Charging System Diagnostics. 4. Wipe wires clean and dry. 5. Replace any cracked or shorted cables. 6. Test and replace, if necessary (refer to Group 8D, Ignition system). 7. Set gap (refer to Group 8D, Ignition System). 8. Clean system and replace fuel filters. 9. Install new fuel pump (refer to Group 14, Fuel System).
ENGINE STALLS OR ROUGH IDLE	1. Idle speed set too low. 2. Idle mixture too lean or too rich. 3. Leak in intake manifold. 4. Incorrect ignition wiring. 5. Faulty coil.	1. Refer to Group 14, Fuel System. 2. Refer to Group 14, Fuel System. 3. Inspect intake manifold gasket and vacuum hoses. Replace, if necessary (refer to Group 11), Exhaust System & Intake Manifold. 4. Install correct wiring. 5. Test and replace, if necessary (refer to Group 8D, Ignition System).
ENGINE LOSS OF POWER	1. Dirty or incorrectly gapped spark plugs. 2. Dirt or water in fuel system. 3. Faulty fuel pump. 4. Incorrect valve timing. 5. Blown cylinder head gasket. 6. Low compression. 7. Burned, warped or pitted valves. 8. Plugged or restricted exhaust system. 9. Faulty ignition cables. 10. Faulty coil.	1. Clean plugs and set gap (refer to Group 8D, Ignition System). 2. Clean system and replace fuel filter. 3. Install new fuel pump. 4. Correct valve timing. 5. Install new cylinder head gasket. 6. Test compression of each cylinder. 7. Install new valves. 8. Install new parts, as necessary. 9. Replace any cracked or shorted cables. 10. Test and replace, as necessary (refer to Group 8D, Ignition System).
ENGINE MISSES ON ACCELERATION	1. Dirty or gap set too wide in spark plug. 2. Dirt in fuel system. 3. Burned, warped or pitted valves. 4. Faulty coil.	1. Clean spark plugs and set gap (refer to Group 8D, Ignition System). 2. Clean fuel system. 3. Install new valves. 4. Test and replace if necessary, (refer to Group 8D, Ignition System).
ENGINE MISSES AT HIGH SPEED	1. Dirty or gap set too wide in spark plug. 2. Faulty coil. 3. Dirty injector. 4. Dirt or water in fuel system.	1. Clean spark plugs and set gap (refer to Group 8D, Ignition System). 2. Test and replace, as necessary (refer to Group 8D, Ignition System). 3. Clean injectors. 4. Clean system and replace fuel filter.

DIAGNOSIS AND TESTING (Continued)
ENGINE DIAGNOSIS—MECHANICAL

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

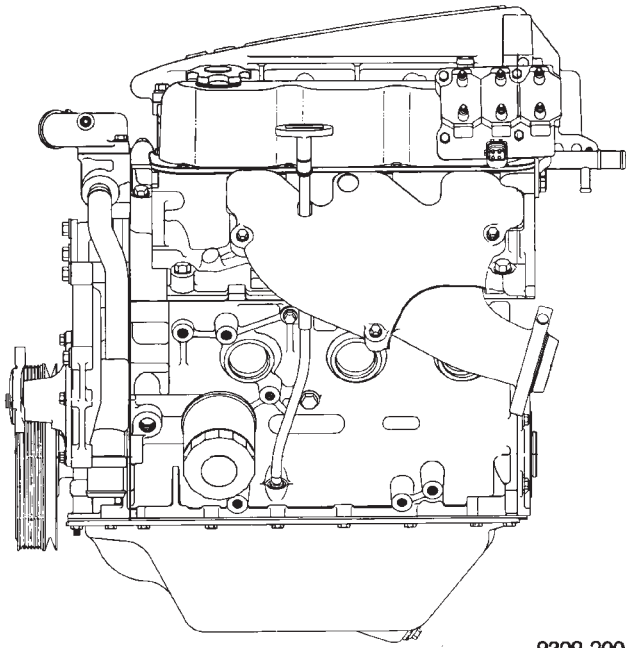
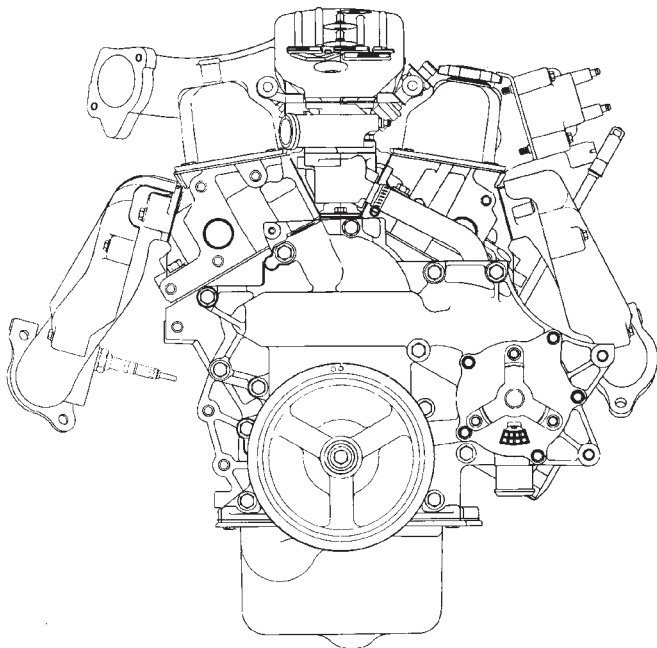
3.3L ENGINE

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DESCRIPTION AND OPERATION

GENERAL SPECIFICATIONS



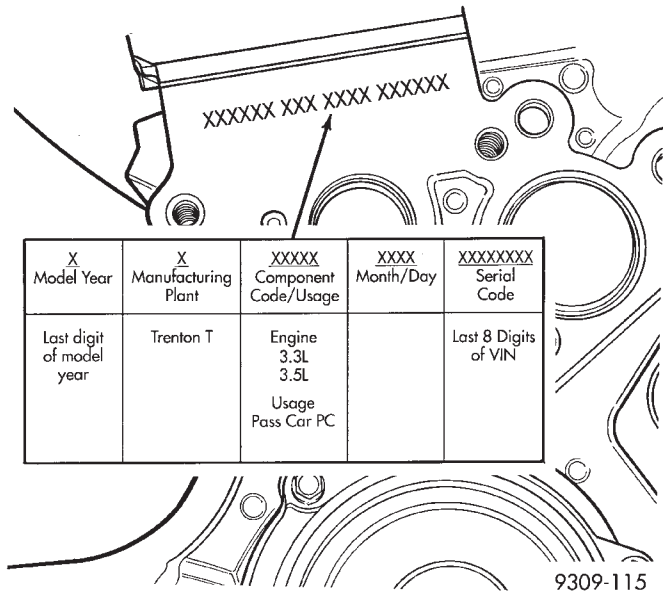
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Engine—3.3L V-6

Type	60° V-6 Engine
Bore	93.0 mm (3.661 Inch)
Stroke	81.0 mm (3.188 Inch)
Compression Ratio	8.9:1
Displacement	3.3 Liters (201 Cubic Inch)
Brake Horsepower	161 @ 5300 RPM
Torque	181 Lb. Ft. @ 3200 RPM
Firing Order	1-2-3-4-5-6
Lubrication	Pressure Feed-Full Flow Filtration (Direct Crankshaft Drive Pump)
Engine Oil Capacity	4.7 Liters (5 Qts.) Including Oil Filter, 4.3 Liter (4.5 Qts.)
Cooling System	Liquid Cooled-Forced Circulation
Cylinder Block	Cast Iron
Crankshaft	Nodular Iron
Cylinder Head	Aluminum Alloy
Connecting Rods	Forged Steel
Pistons	Aluminum Alloy

ENGINE IDENTIFICATION

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



X Model Year	X Manufacturing Plant	XXXXX Component Code/Usage	XXXX Month/Day	XXXXXXXX Serial Code
Last digit of model year	Trenton T	Engine 3.3L 3.5L Usage Pass Car PC		Last 8 Digits of VIN

9309-115

Fig. 1 Engine Identification

DESCRIPTION AND OPERATION (Continued)

ENGINE LUBRICATION SYSTEM

The lubrication system is a full flow filtration pressure feed type. Oil from the oil pan is pumped by an internal gear type oil pump directly coupled to the crankshaft. Its pressure is regulated by a relief valve located in the Chain Case Cover. The oil is pumped through an oil filter and feeds a main oil gallery. This oil gallery feeds oil under pressure to the main and rod bearings, camshaft bearings. Passages in the cylinder block feed oil to the hydraulic lifters and rocker shaft brackets which feeds the rocker arm pivots (Fig. 2).

ENGINE COMPONENTS**ENGINE**

The 3.3L (201 Cubic. Inches.) displacement engine are 60° V type six cylinder power plant with cast iron cylinder block and aluminum cylinder heads (Fig. 1). Firing order for these engines is 1-2-3- 4-5-6. High turbulence cylinder heads allow a 8.9-1 compression ratio.

CRANKSHAFT

The nodular iron crankshaft is supported by four main bearings, with number two being the thrust bearing. Crankshaft end sealing is provided by front and rear rubber seal.

PISTONS

The pistons are cast aluminum alloy. Three rings are used. Piston pins, press fitted into place, join the pistons to forged steel connecting rods.

PISTONS RINGS

The piston rings include molybdenum filled top ring for reliable compression sealing and a tapered faced intermediate ring for additional cylinder pressure control.

CAMSHAFT

The nodular iron camshaft is mounted in four steel backed babbitt bearings. A thrust plate located in front of the first bearing, and bolted to the block, controls end play. Silent timing chain drives the camshaft. This chain is enclosed by a cast aluminum cover which also carries a front crankshaft seal, oil pump, provides front oil pan closure and water pump mounting.

CYLINDER HEADS

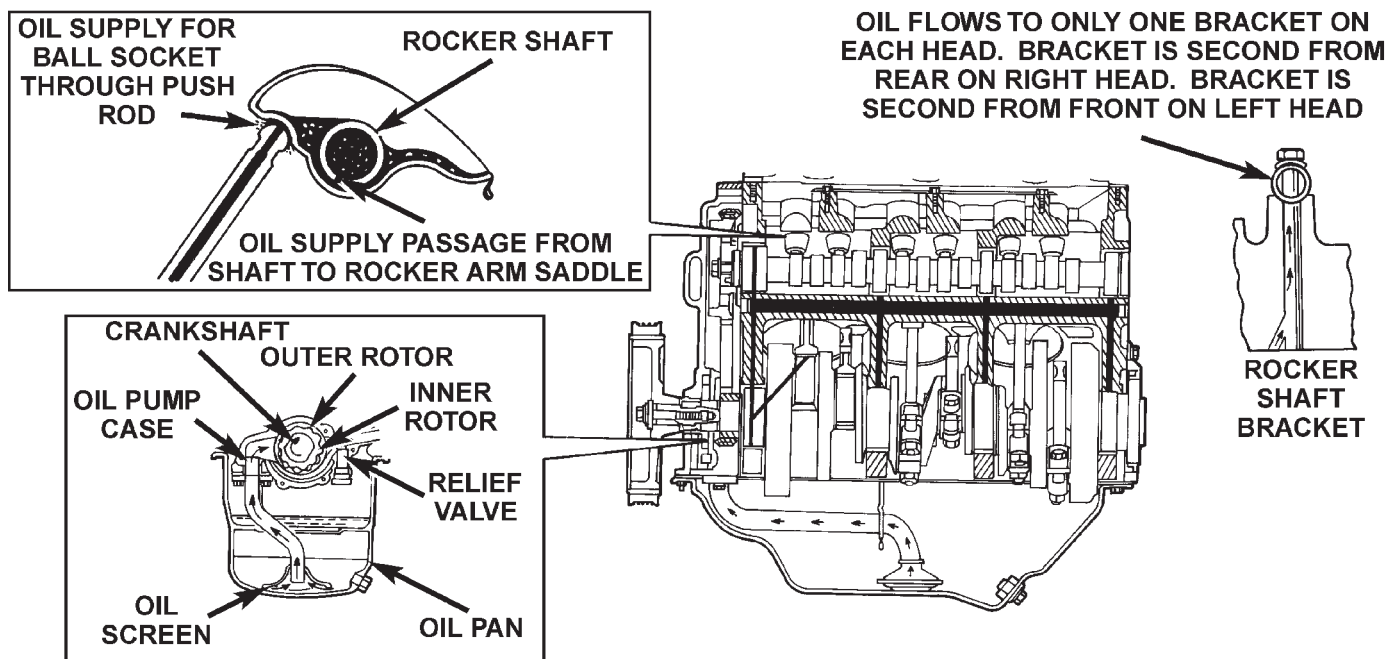
Cylinder heads incorporate valve shrouding to create turbulence-producing combustion chambers, described as fast burn. Valve seat and guides are inserts. A steel flanged composition type gasket is used between head and block.

CYLINDER HEAD COVERS

The covers are sealed with steel reinforced silicone rubber gaskets.

INTAKE MANIFOLD

The intake manifold is a tuned two-piece semi-permanent mold aluminum casting with individual primary runners leading from a plenum to the cylinders. The manifold is designed to boost torque in the 3600 rpm range and contributes to the engine's



80a53b55

Fig. 2 Engine Oiling System

DESCRIPTION AND OPERATION (Continued)

broad, flat torque curve, which was desired for excellent engine tractability, response and usable power output.

The intake manifold is also cored with upper level EGR passages for balanced cylinder to cylinder EGR distribution.

VALVE TRAIN

Valve train design incorporates the use of hydraulic roller tappets. Rocker arms are installed on a rocker arm shaft attached to the cylinder head with four bolts and retainers. Viton valve stem seals provide valve sealing. Conventional type pushrods, retainers and valve stem locks are used. Unique beehive style valve spring are used with lightweight retainers for improved high RPM performance.

EXHAUST MANIFOLDS

Exhaust manifolds are log type with a crossover and is attached directly to the cylinder heads.

DIAGNOSIS AND TESTING

HYDRAULIC TAPPETS

The valve train includes roller tappet assemblies, aligning yokes and yoke retainer.

Roller tappet alignment is maintained by machined flats on tappet body being fitted in pairs into six aligning yokes. The yokes are secured by an aligning yoke retainer (Fig. 3).

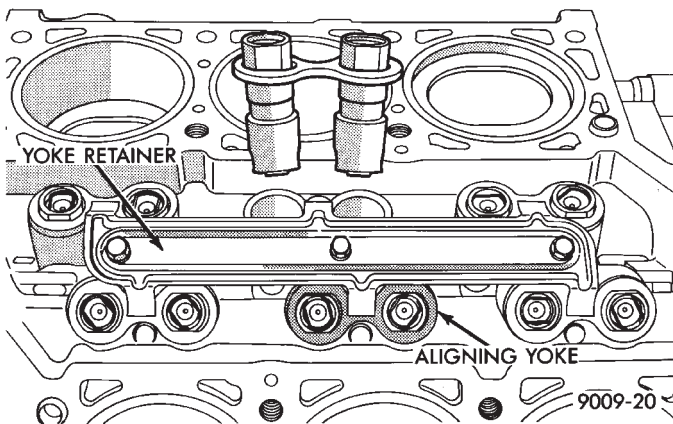


Fig. 3 Roller Tappets Aligning Yoke and Retainer

PRELIMINARY STEP TO CHECKING THE HYDRAULIC TAPPETS

Before disassembling any part of the engine to correct tappet noise, read the oil pressure at the gauge. Install a reliable gauge at pressure sending unit if vehicle has no oil pressure gauge and check the oil level in the oil pan. The pressure should be between 205.8 to 550.6 kPa (30 and 80 psi) at 2000 rpm.

The oil level in the pan should never be above the MAX mark on dipstick, or below the MIN mark.

Either of these two conditions could be responsible for noisy tappets. **Oil Level Check: stop engine after reaching normal operating temperature .** Allow 5 minutes to stabilize oil level, check dipstick.

OIL LEVEL TOO HIGH

If oil level is above the MAX mark on dip stick, it is possible for the connecting rods to dip into the oil while engine is running and create foam. Foam in oil pan would be fed to the hydraulic tappets by the oil pump causing them to become soft and allow valves to seat noisily.

OIL LEVEL TOO LOW

Low oil level may allow the oil pump to take in air which when fed to the tappets, causes them to become soft and allows valves to seat noisily. Any leaks on intake side of pump through which air can be drawn will create the same tappet action. Check the lubrication system from the intake strainer to the pump cover, including the relief valve retainer cap. When tappet noise is due to aeration, it may be intermittent or constant, and usually more than one tappet will be noisy. When oil level and leaks have been corrected, engine should be operated at fast idle to allow all of the air inside of the tappets to be bled out.

VALVE TRAIN NOISE DIAGNOSIS

To determine source of valve train noise, operate engine at idle with cylinder head covers removed and listen for source of the noise.

NOTE: Worn valve guides or cocked springs are sometimes mistaken for noisy tappets. If such is the case, noise may be dampened by applying side thrust on the valve spring. If noise is not appreciably reduced, it can be assumed the noise is in the tappet. Inspect the rocker arm push rod sockets and push rod ends for wear.

Valve tappet noise ranges from light noise to a heavy click. A light noise is usually caused by excessive leak-down around the unit plunger which will necessitate replacing the tappet, or by the plunger partially sticking in the tappet body cylinder. A heavy click is caused either by a tappet check valve not seating, or by foreign particles becoming wedged between the plunger and the tappet body causing the plunger to stick in the down position. This heavy click will be accompanied by excessive clearance between the valve stem and rocker arm as valve closes. In either case, tappet assembly should be removed for inspection and cleaning.

DIAGNOSIS AND TESTING (Continued)

CHECKING ENGINE OIL PRESSURE

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

(1) Remove pressure sending unit and install oil pressure gauge (Fig. 4).

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

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

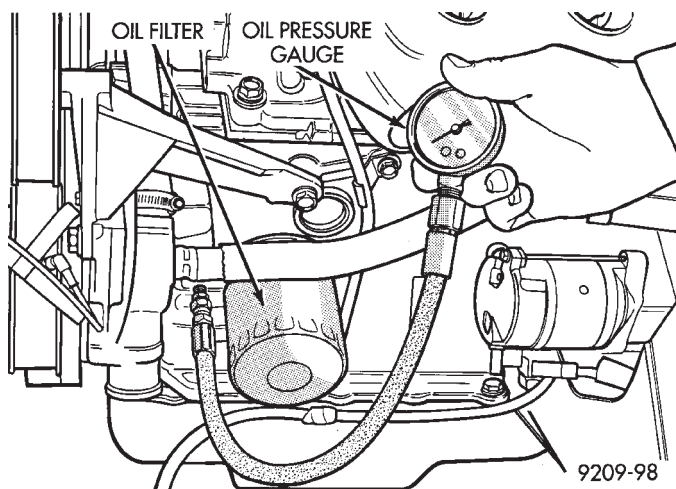


Fig. 4 Checking Oil Pump Pressure

SERVICE PROCEDURES

FITTING PISTONS AND FINISHED PISTONS

All pistons are machined to the same weight in grams, to maintain piston balance. For cylinder bores which have been honed, new pistons and connecting rod assemblies are available for service.

FITTING PISTONS

Piston and cylinder wall must be clean and dry. Piston diameter should be measured 90 degrees to piston pin at size location shown in (Fig. 6). Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line shown in. Refer to (Fig. 5) for specifications. **Pistons and cylinder bores should be measured at normal room temperature, 70°F. (21°C).**

PISTON PINS

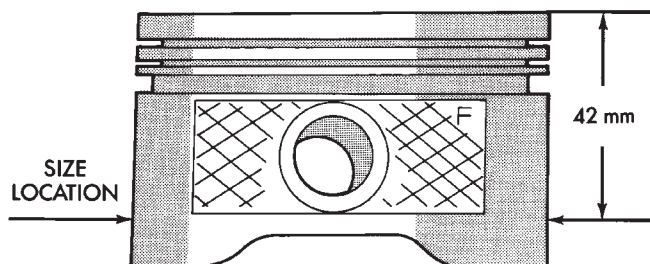
The piston pin rotates in the piston only, and is retained by the press interference fit of the piston pin to the connecting rod.

CAUTION: Do not remove piston pin. Damage to piston could result.

Engine	Standard Bore	Maximum Out-of-Round	Maximum Taper
3.3L	92.993-93.007 mm 3.661-3.6617 inch.	.076 mm (.003 inch.)	.51 mm (.002 inch.)
Standard Piston Size			
3.3L	92.950-92.968 mm (3.6594-3.6602 inch.) Piston to Bore Clearance: .025-.057 mm (.0009 to .0022 inches.) Measurements taken at Piston Size location.		

9309-208

Fig. 5 Cylinder Bore and Piston Specifications



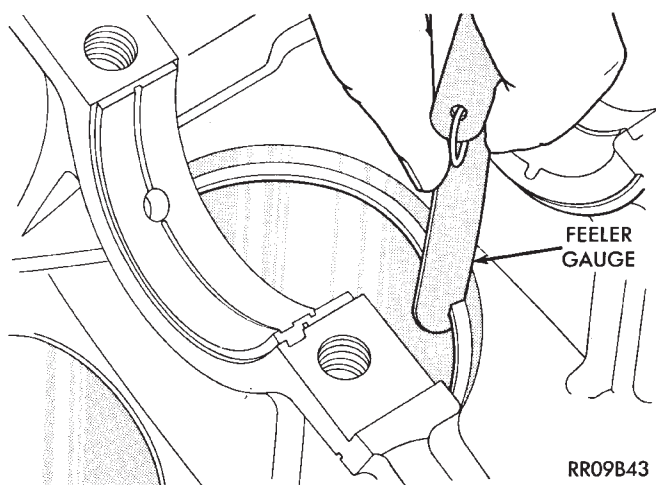
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Fig. 6 Piston Measurements

FITTING RINGS

(1) Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioning at least 12 mm (0.50 inch.) from bottom of cylinder bore. Check gap with feeler gauge (Fig. 7). Refer to specifications (Fig. 8).

(2) Check piston ring to groove clearance: (Fig. 9). Refer to specification (Fig. 8).



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Fig. 7 Check Gap on Piston Rings

SERVICE PROCEDURES (Continued)

Ring Position	Ring Gap	Wear Limit
Upper Ring	0.30 to 0.55 mm (.012 to .022 in.)	1.0 mm (.039 in.)
Intermediate Ring	0.30 to 0.55 mm (.012 to .022 in.)	1.0 mm (.039 in.)
Oil Control Ring	0.25 to 0.100 mm (.010 to .039 in.)	1.88 mm (.074 in.)
Ring Position	Groove Clearance	Maximum Clearance
Upper Ring	0.040 to 0.085 mm (.0016 to .0033 in.)	.10 mm (.004 in.)
Intermediate Ring	0.030 to 0.095 mm (.0016 to .0037 in.)	.10 mm (.004 in.)
Oil Control Ring	0.047 to .201 mm (.0018 to .0079 in.)	.266 mm (.009 in.)

Fig. 8 Piston Ring Specifications

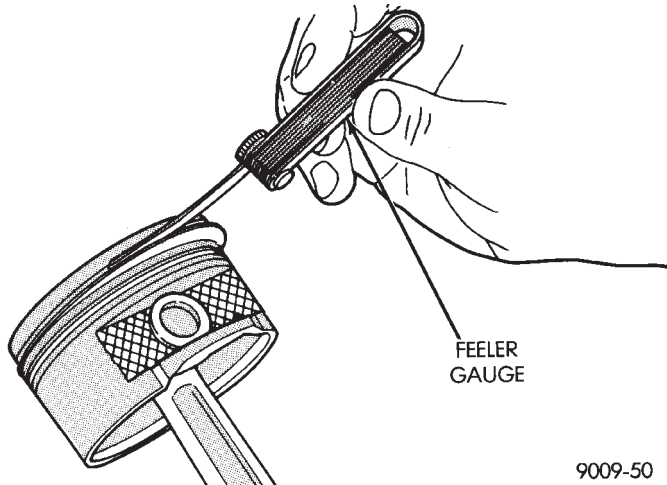


Fig. 9 Measuring Piston Ring Side Clearance

INSTALLATION OF CONNECTING ROD BEARINGS

Fit all rods on one bank until complete.

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

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

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 inch.). Bearings are available in 0.025 mm (0.001 in.), 0.051 mm (0.002 in.), 0.076 mm (0.003 in.), 0.254 mm (0.010 in.) and 0.305 mm (0.012 in.) undersize.

Install the bearings in pairs. Do not use a new bearing half with an old bearing half. Do not file/fit the rods or bearing caps.

(1) Follow procedure specified in the Standard Service Procedure Section for Measuring Main Bearing Clearance and Connecting Rod Bearing Clearance (Fig. 10).

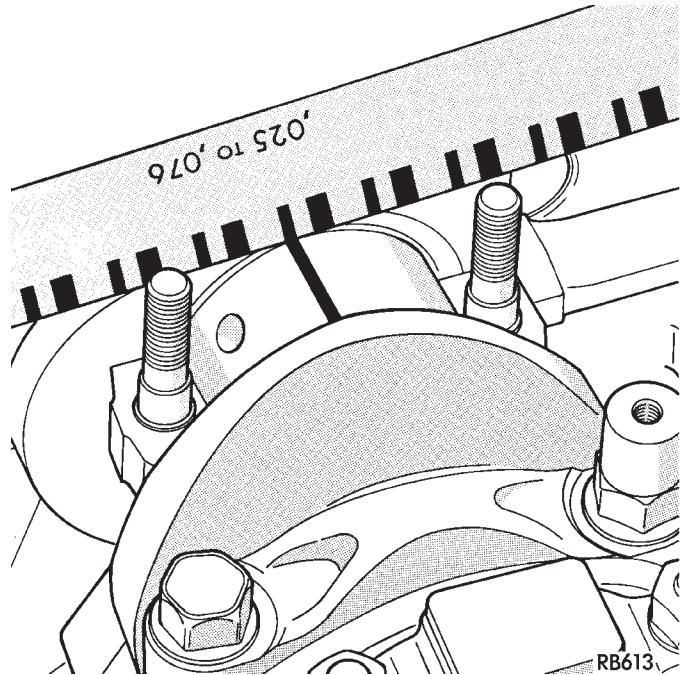


Fig. 10 Checking Connecting Rod Bearing Clearance

CAUTION: The rod bearing bolts should be examined before reuse. If the threads are necked down the bolts should be replaced (Fig. 13). Necking can be checked by holding a scale or straight edge against the threads. If all the threads do not contact the scale the bolt should be replaced.

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

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

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

(5) Using a feeler gauge, check connecting rod side clearance (Fig. 11). Refer to (Fig. 12) for specifications.

CRANKSHAFT MAIN BEARING

CRANKSHAFT OIL CLEARANCE

(1) Measure the journal outside diameter as shown in (Fig. 14). Refer to Specifications .

SERVICE PROCEDURES (Continued)

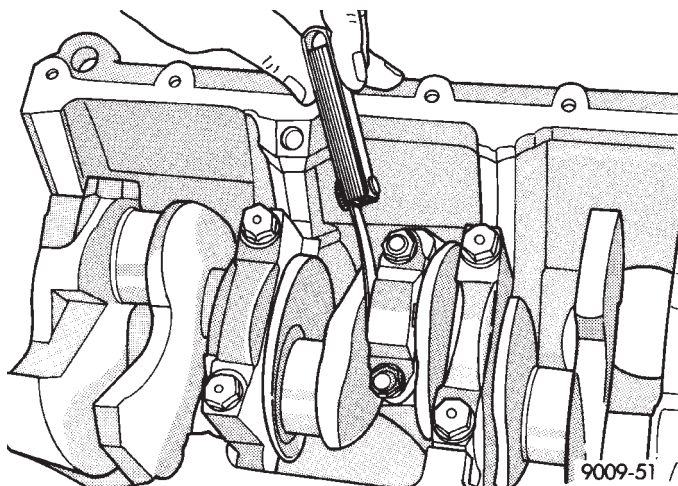


Fig. 11 Checking Connecting Rod Side Clearance

Connecting Rod Bearing Clearance	
New Part:	.019 to .087 mm (.0008 to .0034 in.)
Wear Limit:	.104 mm (.0041 in.)
Connecting Rod Side Clearance	
New Part:	0.13 to 0.32 mm (.005 to .013 in.)
Wear Limit:	0.38 mm (.015 in.)

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Fig. 12 Connecting Rod Specifications

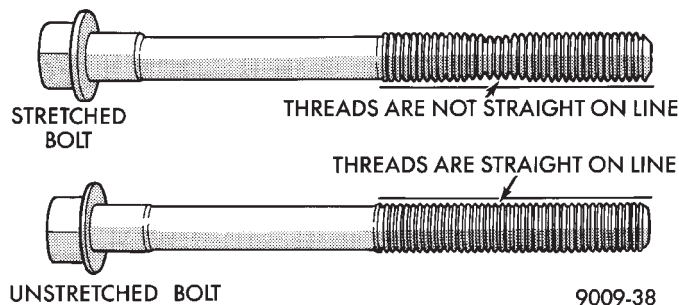


Fig. 13 Check for Stretched Bolts

PLASTIGAGE (OIL CLEARANCE)
MEASUREMENT

- (1) Remove oil from journal and bearing shell.
- (2) Install crankshaft.
- (3) Cut plastigage to same length as width of the bearing and place it in parallel with the journal axis (Fig. 15).
- (4) Install the main bearing cap carefully and tighten the bolts to specified torque.

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

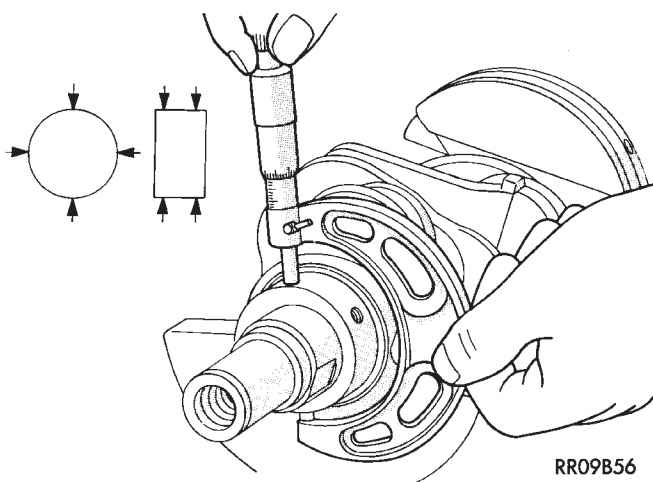


Fig. 14 Measure Crankshaft Journal O.D.

(5) Carefully remove the bearing cap and measure the width of the plastigage at the widest part using the scale on the plastigage package (Fig. 15). Refer to Specifications for proper clearances. If the clearance exceeds the specified limits. Replace the main bearing(s) and if necessary have the crankshaft machined to next undersize. Also see Measuring Main and Connecting Rod Bearing Clearance in Standard Service Procedures.

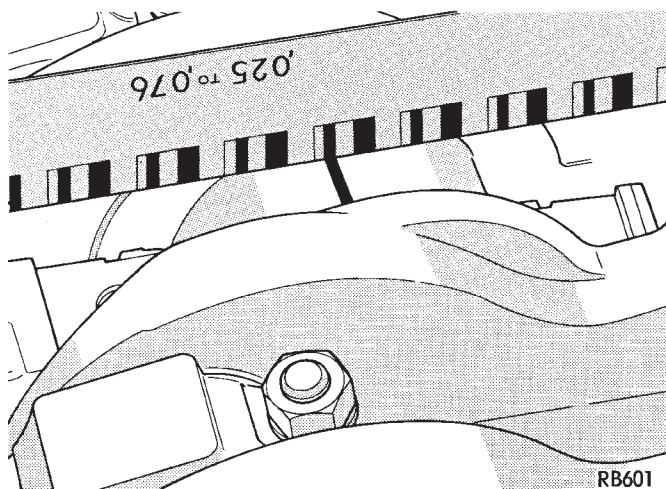


Fig. 15 Measuring Bearing Clearance with Plastigage

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

TESTING VALVE SPRINGS

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

SERVICE PROCEDURES (Continued)

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

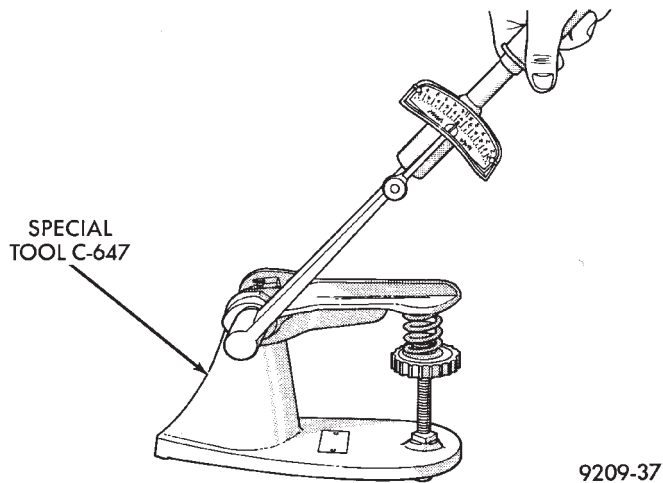


Fig. 16 Testing Valve Spring with Tool C-647

CRANKSHAFT END PLAY

DIAL INDICATOR

- (1) Mount a dial indicator to front of engine, locating probe on nose of crankshaft (Fig. 17).
- (2) Move crankshaft all the way to the rear of its travel.
- (3) Zero the dial indicator.
- (4) Move crankshaft all the way to the front and read the dial indicator. Specifications: New Part: 0.09 to 0.24 mm (0.004 to 0.009 in.)

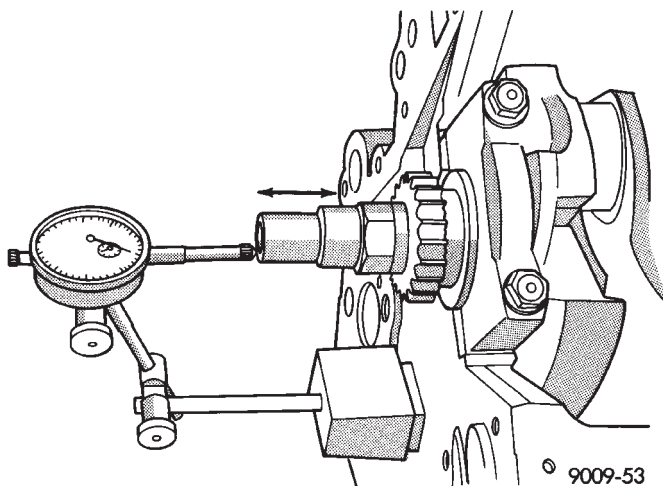


Fig. 17 Checking Crankshaft End Play

FEELER GAUGE

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

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

VALVE TIMING

(1) Remove front cylinder head cover and all 6 spark plugs.

(2) Rotate engine until the #2 piston is at TDC of the compression stroke.

(3) Install a degree wheel on the crankshaft damper.

(4) With proper adaptor, install a dial into #2 spark plug hole. Using the indicator find TDC on the compression stroke.

(5) Position the degree wheel to zero.

(6) Remove dial indicator from spark plug hole.

(7) Place a 5.08 mm (0.200 inch.) spacer between the valve stem tip of #2 intake valve and rocker arm pad. Allow tappet to bleed down to give a solid tappet effect.

(8) Install a dial indicator so plunger contacts the #2 intake valve spring retainer as nearly perpendicular as possible. Zero the indicator.

(9) Rotate the engine clockwise until the intake valve has lifted 0.254 mm (0.010 inch.).

CAUTION: Do not turn crankshaft any further clockwise as intake valve might bottom and result in serious damage.

(10) Degree wheel should read 3 degrees BTDC to 4 degrees ATDC.

MEASURING TIMING CHAIN STRETCH

(1) Place a scale next to timing chain so that any movement of chain may be measured.

(2) Place a torque wrench and socket on camshaft sprocket attaching bolt and apply torque in direction of crankshaft rotation to take up slack; 41 N·m (30 ft. lbs.) with cylinder head installed or 20 N·m (15 ft. lbs.) with cylinder heads removed. **With a torque applied to the camshaft sprocket bolt, crankshaft should not be permitted to move. It may be necessary to block crankshaft to prevent rotation.**

(3) Holding a scale even, with dimension reading as shown, along edge of chain links. Apply torque in the reverse direction to 41 N·m (30 ft. lbs.) with cylinder heads installed, or 20 N·m (15 ft. lbs.) with cylinder heads removed. Check amount of chain movement (Fig. 18).

SERVICE PROCEDURES (Continued)

(4) Install a new timing chain, if its movement exceeds 3.175 mm (1/8 inch.).

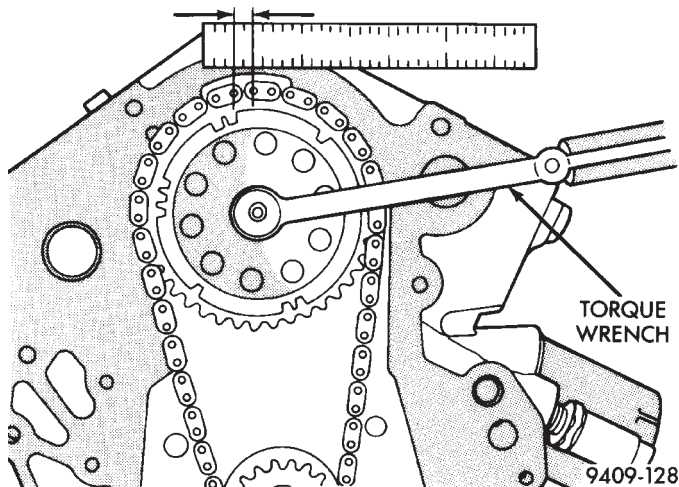


Fig. 18 Measuring Timing Chain Wear and Stretch
VALVE RECONDITION

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 44-1/2 to 45 degree face angle. The valve seats have a 45 to 45-1/2 degree face angle. The valve face and valve seat angles are shown in (Fig. 20).

VALVES

(1) Inspect the remaining margin after the valves are refaced Refer to specifications (Fig. 19).

Valve Dimensions	
Intake Valve (minimum)	
Stem diameter:	7.935 mm (.3124 in.)
Face angle:	44 1/2°
Valve margin:	.794 mm (.031 in.)
Head diameter:	45.5 mm (1.79 in.)
Length:	125.38 mm (4.936 in.)
Exhaust Valve (minimum)	
Stem diameter:	7.906 mm (.3112 in.)
Face angle:	44 1/2°
Valve margin:	1.191 mm (.0469 in.)
Head diameter:	37.5 mm (1.476 in.)
Length:	126.00 mm (4.964 in.)

9109-47

Fig. 19 Valve Dimensions

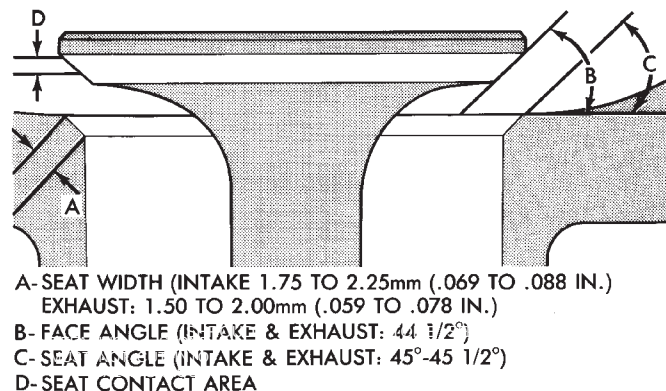
VALVE SEATS

CAUTION: Do not un-shroud cylinder head from around the valve during valve seat refacing (Fig. 21).

(1) When refacing valve seats, it is important that the correct size valve guide pilot be used for reseating

ing stones. A true and complete surface must be obtained.

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



9009-88

Fig. 20 Valve Seats

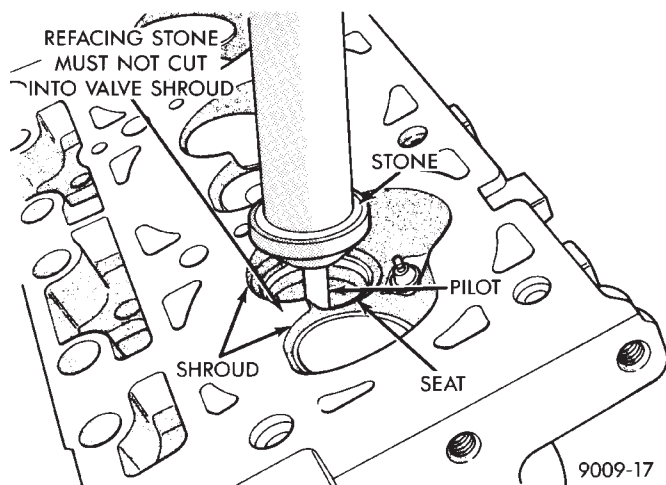


Fig. 21 Valve Seats—Refacing

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

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

(4) When seat is properly positioned the width of intake seats should be 1.75 to 2.25 mm (0.69 to 0.088

SERVICE PROCEDURES (Continued)

inch.) The width of the exhaust seats should be 1.50 to 2.00 mm (0.059 to 0.078 inch.) (Fig. 20)

(5) Check the valve spring installed height after refacing the valve and seat (Fig. 22).

(6) When the valves and/or seats are reground, measure the installed height of springs, make sure measurements is taken from top of spring seat to the bottom surface of spring retainer. If height is greater than 1-19/32 inches, (40.6 mm), install a 1/32 inch. (0.794mm) spacer in head counterbore to bring spring height back to normal 1-17/32 to 1-19/32 inch. (39.1 to 40.6 mm)

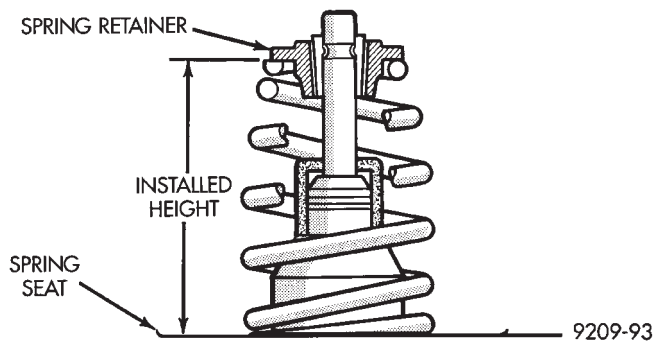


Fig. 22 Checking Valve Spring Installed Height

REMOVAL AND INSTALLATION

ENGINE MOUNTS

REMOVAL

- (1) Remove the insulator attaching nuts from top of the mounting bracket.
- (2) Raise vehicle on hoist.
- (3) Support the engine with a jack and a block of wood across the full width of the oil pan.
- (4) Remove the lower attaching nuts from the bottom of the insulator to the frame (Fig. 23).
- (5) Raise engine carefully with jack enough to remove the insulator from it's mount.

INSTALLATION

- (1) Install insulator onto the frame.
- (2) Lower the engine onto the insulator mount (Fig. 23). Remove jack from vehicle.
- (3) Tighten the insulator to frame nuts to 61 N·m (45 ft. lbs.).
- (4) Lower vehicle. Install the upper attaching nuts to mount and tighten to 61 N·m (45 ft. lbs.).

ENGINE HYDRO-MOUNT INSULATORS

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

- Drive shaft distress: Refer to Driveshafts in Suspension, Group 2.

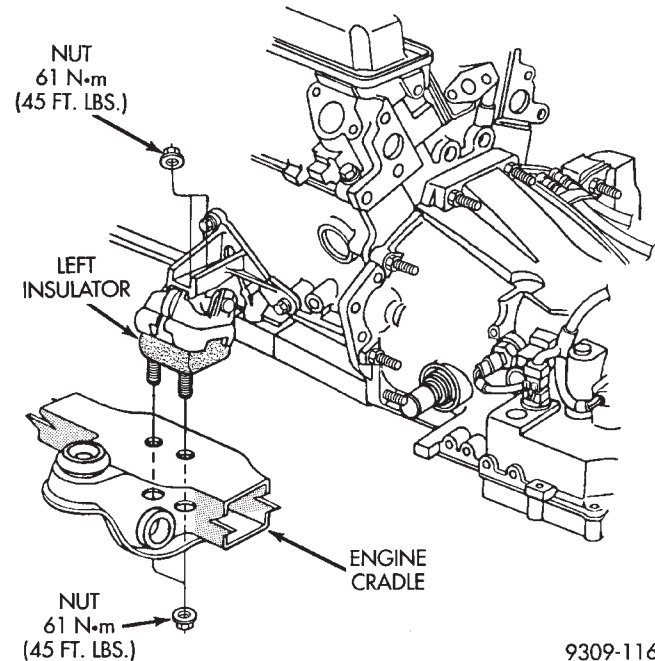


Fig. 23 Engine Mounting—Typical

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

REAR MOUNT

- (1) Raise vehicle on hoist.
- (2) Support the transmission with a transmission jack.
- (3) Remove the insulator through bolt from the mount.
- (4) Remove the transmission mount fasteners and remove mount.
- (5) Reverse removal procedure for installation. Refer to Torque Specifications in this section.

ENGINE ASSEMBLY

REMOVAL

- (1) Disconnect battery.
- (2) Mark hood position at hinges and remove hood.
- (3) Drain cooling system. Refer to Group 7, Cooling System for procedure.
- (4) Disconnect all electrical connections.
- (5) Remove coolant hoses from radiator and engine.
- (6) Remove radiator and fan assembly.
- (7) See Group 14, Fuel System to release fuel pressure. Disconnect fuel lines and accelerator cable.
- (8) Remove air cleaner assembly.
- (9) Hoist vehicle.
- (10) Drain engine oil.
- (11) Remove air conditioning compressor mounting bolts and set compressor aside.
- (12) Disconnect exhaust pipe at manifold.

REMOVAL AND INSTALLATION (Continued)

(13) Remove transmission inspection cover and mark flex plate to torque converter position.

(14) Remove bolts holding torque converter to flex plate and attach C-clamp on bottom of converter housing to prevent torque converter from coming out.

(15) Remove power steering pump mounting bolts and set pump aside.

(16) Remove two lower transmission to block screws.

(17) Remove starter.

(18) Lower vehicle and disconnect vacuum lines and ground strap.

(19) Insert floor jack with small block of wood under transmission pan to support transmission.

(20) Attach engine lifting hoist and support engine.

(21) Remove upper transmission case to block bolts.

(22) See Engine Mounting in (Fig. 23). Remove insulator mounting nuts from mount.

(23) Hoist engine from engine compartment.

INSTALLATION

(1) Attach hoist and lower engine into engine compartment.

(2) Align engine mounts and install all nuts. Tighten fasteners to specified torque (Fig. 23).

(3) Install transmission case to cylinder block, tighten bolts to 102 N·m (75 ft. lbs.) torque.

(4) Remove engine hoist and transmission holding fixture.

(5) Remove C-clamp from torque converter housing. Align flex plate to torque converter and install mounting bolts. Tighten to 75 N·m (55 ft. lbs.).

(6) Install transmission inspection cover.

(7) Connect exhaust system at manifold.

(8) Install starter.

(9) Install power steering pump and air conditioning compressor belts. Refer to Group 7, Cooling System for procedure.

(10) Lower vehicle and connect all vacuum lines.

(11) Connect all electrical connections including ground strap.

(12) Connect fuel lines and accelerator cable.

(13) Install radiator and fan assembly. Reconnect fan motor electrical lead. Reinstall radiator hoses. Fill cooling system. See Group 7, Cooling System for filling procedure.

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

(15) Install hood.

(16) Connect battery.

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

(18) Adjust transmission or linkage if necessary.

CYLINDER HEAD COVER

REMOVAL

(1) Disconnect battery.

(2) Disconnect air tube from air cleaner and throttle body.

(3) Remove intake manifold plenum. Refer to intake manifold removal Group 11, Exhaust System And Intake Manifold.

(4) To remove left cylinder head cover you must remove DIS coil.

(5) Remove cylinder head cover bolts and remove cover.

INSTALLATION

(1) Clean cylinder head and cover mating surfaces. Inspect cylinder head cover sealing surface for flatness. Install new gasket.

(2) Install intake manifold plenum.

(3) Install air tube from air cleaner to throttle body.

(4) Connect battery.

CAMSHAFT

REMOVAL—ENGINE REMOVED FROM VEHICLE

Remove intake manifold, cylinder head covers, cylinder heads, timing chain case cover and timing chain. Refer to procedures outlined in this section.

(1) Remove rocker arm and shaft assemblies.

(2) Remove push rods and tappets; identify so each part will be replaced in its original location.

(3) Remove camshaft thrust plate (Fig. 24).

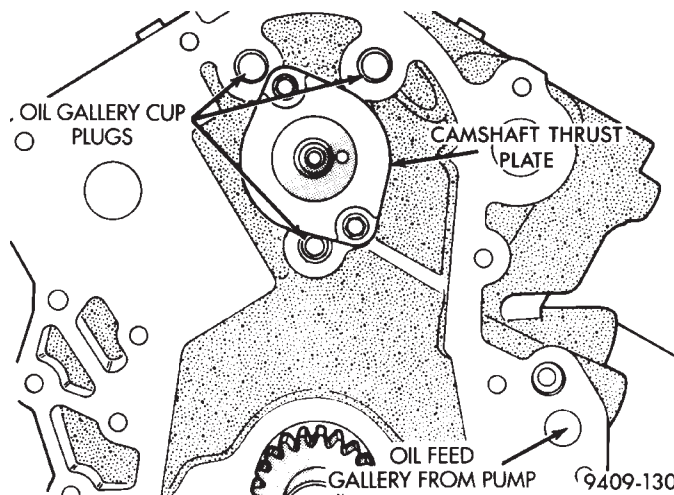


Fig. 24 Camshaft Thrust Plate

REMOVAL AND INSTALLATION (Continued)

(4) Install a long bolt into front of camshaft to facilitate removal of the camshaft; remove camshaft, being careful not to damage cam bearing with the cam lobes (Fig. 25).

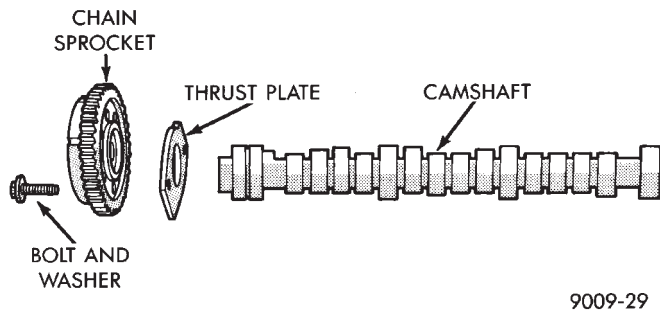


Fig. 25 Camshaft and Sprocket

INSTALLATION

(1) Lubricate camshaft lobes and camshaft bearing journals and insert the camshaft to within 2 inches of its final position in cylinder block.

NOTE: Whenever an engine has been rebuilt, add one pint of Mopar® Engine Oil Supplement or equivalent to engine oil to aid in break in. The oil mixture should be left in engine for a minimum of 805 km (500 miles) and drained at the next normal oil change.

(2) Install camshaft thrust plate with two screws as shown in (Fig. 24). Tighten to 12 N·m (105 in. lbs.) torque.

(3) Rotate crankshaft so the timing arrow is to the 12 o'clock position.

(4) Place timing chain around camshaft sprocket and place the timing arrow to the 6 o'clock position.

(5) Align the dark colored links with the dot on the camshaft sprocket, place timing chain around crankshaft sprocket with the dark colored link lined up with the dot on sprocket and install camshaft sprocket into position.

(6) Using straight edge to check alignment of timing arrows (Fig. 26).

(7) Install the camshaft bolt. Tighten bolt to 54 N·m (40 ft. lbs.).

(8) Rotate crankshaft 2 revolutions. Timing marks should line up. If timing marks do not line up, remove cam sprocket and realign.

(9) Check camshaft end play. With new thrust plate the specification is 0.0127 to 0.304 mm (0.005 to 0.012 in.). Old thrust plate specification is 0.31 mm (0.012 in.) maximum. If not within these limits install new thrust plate.

(10) Each tappet reused must be installed in the same position from which it was removed. **When camshaft is replaced, all of the tappets must be replaced.**

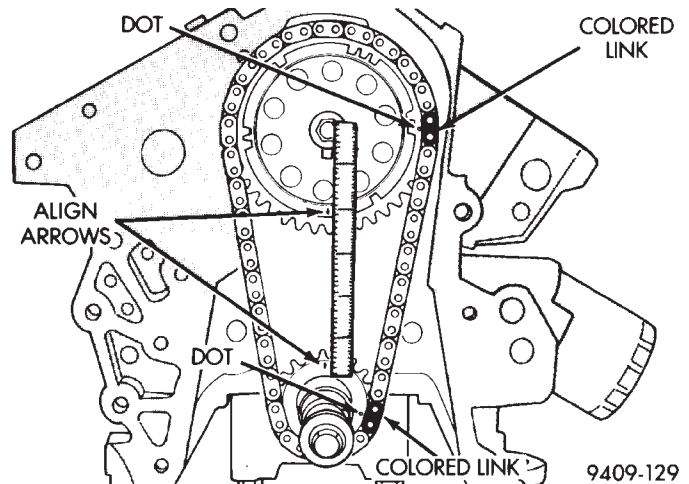


Fig. 26 Timing Marks Alignment

CAMSHAFT BEARINGS

REMOVAL—ENGINE REMOVED FROM VEHICLE

(1) With engine completely disassembled, drive out rear cam bearing core hole plug.

(2) Install proper size adapters and horseshoe washers (part of Tool C-3132-A) at back of each bearing shell to be removed and drive out bearing shells (Fig. 27).

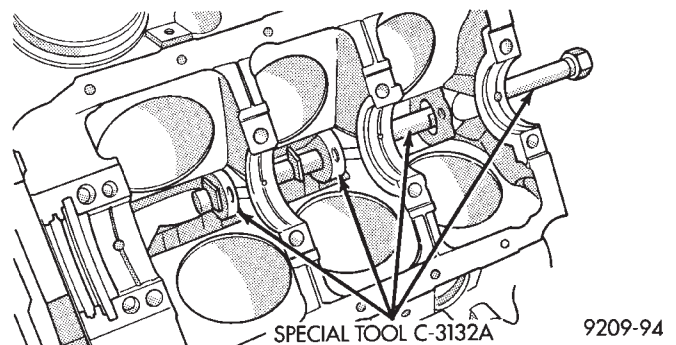


Fig. 27 Camshaft Bearings Removal/Installation—Typical

INSTALLATION

(1) Install new camshaft bearings with Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

(2) Position rear bearing in the tool. Install horseshoe lock and by reversing removal procedure, carefully drive bearing shell into place.

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. Number two bearing must index with the oil passage to the left cylinder head and Number three bearing must index with the oil passage to the right cylinder head. If the camshaft bearing shell oil holes are not in exact alignment, remove and rein-

REMOVAL AND INSTALLATION (Continued)

stall them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

ROCKER ARMS AND SHAFT ASSEMBLY

REMOVAL

- (1) Remove upper intake manifold assembly. Refer to Group 11, Exhaust System and Intake Manifolds.
- (2) Disconnect spark plug wires by pulling on the boot straight out in line with plug.
- (3) Disconnect closed ventilation system and evaporation control system from cylinder head cover.
- (4) Remove cylinder head cover and gasket.
- (5) Remove four rocker shaft bolts and retainers.
- (6) Remove rocker arms and shaft assembly.
- (7) If rocker arm assemblies are disassembled for cleaning or replacement. Assemble rocker arms in their original position. Refer to (Fig. 28) for rocker arm for positioning on the shaft.

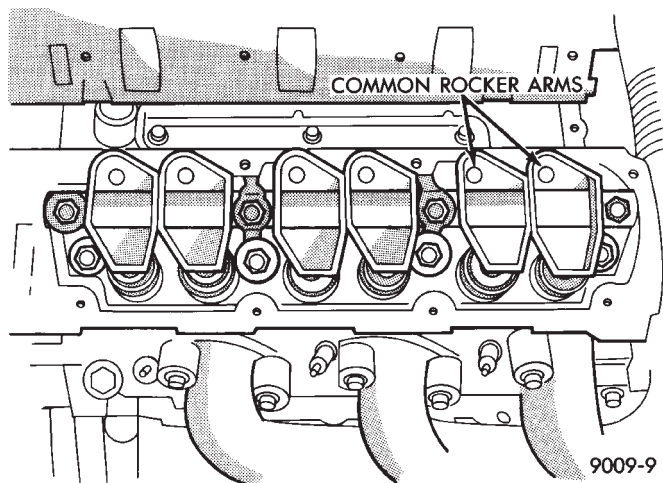


Fig. 28 Rocker Arm Location Left Bank

INSTALLATION

- (1) Install rocker arm and shaft assemblies with the stamped steel retainers in the four positions, tighten to 28 N·m (250 in. lbs.) (Fig. 28).

CAUTION: THE ROCKER ARM SHAFT SHOULD BE TORQUED DOWN SLOWLY, STARTING WITH THE CENTERMOST BOLTS. ALLOW 20 MINUTES TAPPET BLEED DOWN TIME AFTER INSTALLATION OF THE ROCKER SHAFTS BEFORE ENGINE OPERATION.

- (2) Clean cylinder head cover gasket surface. Inspect cover for distortion and straighten if necessary.

- (3) Clean head rail if necessary. Install a new gasket and tighten cylinder head cover fasteners to 12 N·m (105 in. lbs.).

- (4) Install closed crankcase ventilation system and evaporation control system.

- (5) Install spark plug wires.

- (6) Install upper intake manifold assembly. Refer to Group 11, Exhaust System and Intake Manifolds.

HYDRAULIC TAPPET

REMOVAL

- (1) Refer to Cylinder Head Removal of this section to remove intake manifold and cylinder heads for access to tappets for service.

- (2) Remove yoke retainer and aligning yokes.

- (3) Use Tool C-4129 to remove tappets from their bores. If all tappets are to be removed, identify tappets to insure installation in original location.

NOTE: If the tappet or bore in cylinder block is scored, scuffed, or shows signs of sticking, ream the bore to next oversize and replace with oversize tappet.

CAUTION: The plunger and tappet bodies are not interchangeable. The plunger and valve must always be fitted to the original body. It is advisable to work on one tappet at a time to avoid mixing of parts. Mixed parts are not compatible. Do not disassemble a tappet on a dirty work bench. For disassembly procedure see Disassembly And Assembly 3.3L engine.

INSTALLATION

- (1) Lubricate tappets.

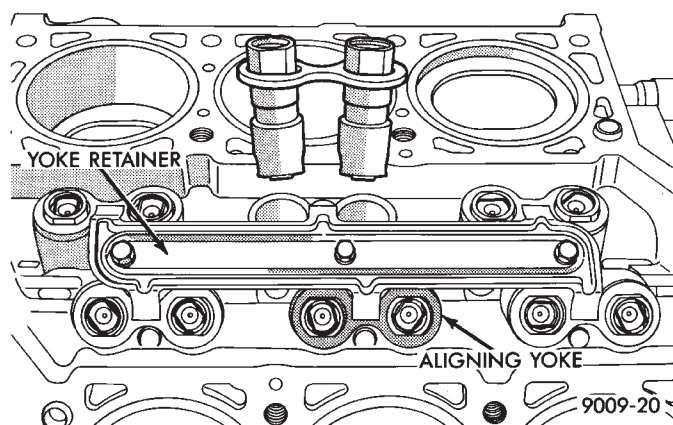


Fig. 29 Roller Tappets Aligning Yoke and Retainer

- (2) Install tappets in their original positions.

- (3) With roller tappets, install aligning yokes (Fig. 29).

- (4) Install yoke retainer and torque screws to 12 N·m (105 in. lbs.) (Fig. 29).

REMOVAL AND INSTALLATION (Continued)

(5) Install cylinder heads. Refer to cylinder head installation of this section for procedure.

(6) Start and operate engine. Warm up to normal operating temperature.

CAUTION: To prevent damage to valve mechanism, engine must not be run above fast idle until all hydraulic tappets have filled with oil and have become quiet.

VALVE STEM SEALS OR VALVE SPRINGS—IN VEHICLE

REMOVAL

(1) Perform fuel system pressure release procedure **before attempting any repairs**

(2) Disconnect negative battery cable.

(3) Remove Air Cleaner Cover and hose assembly.

(4) Remove Intake Manifold; Refer to intake manifold removal 3.3L Engine Group 11, Exhaust System and Intake Manifolds of this manual for removal procedure.

(5) Remove cylinder head covers and spark plugs.

(6) Remove connector wire from ignition coils.

(7) Using suitable socket and flex handle at crankshaft damper retaining bolt, turn engine so the number 1 piston is at Top Dead Center on the compression stroke.

(8) Remove rocker arms with rocker shaft and install a dummy shaft. The rocker arms should not be disturbed and left on shaft.

(9) With air hose attached to spark plug adapter installed in number 1 spark plug hole, apply 620.5 to 689 kPa (90 to 100 psi) air pressure. This is to prevent the valves from dropping while servicing seals or spring.

(10) Using Tool C-4682 or Equivalent compress valve spring and remove retainer valve locks and valve spring.

INSTALLATION

(1) The intake valve stem seals should be pushed firmly and squarely over the valve guide using the valve stem as guide (Fig. 30). **Do Not Force** seal against top of guide. When installing the valve retainer locks, compress the spring **only enough** to install the locks.

CAUTION: Do not pinch seal between retainer and top of valve guide.

(2) Follow the same procedure on the remaining 5 cylinders using the firing sequence 1-2-3-4-5-6. **Make sure that the cylinder you are working on is at TDC before starting work on that cylinder.**

(3) Remove spark plug adapter tool.

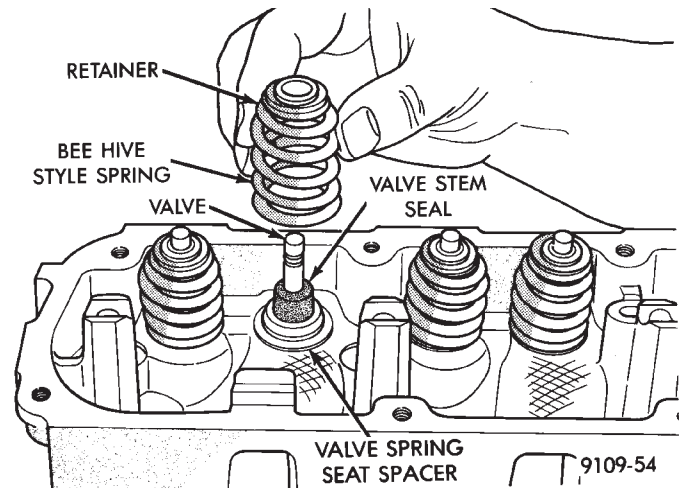


Fig. 30 Installing Valve Seal and Spring

(4) Remove dummy shaft and install rocker shaft assembly and tighten screws to 28 N·m (250 in. lbs.).

(5) Install cylinder head covers tighten screws to 14 N·m (120 in. lbs.) and connector to ignition coils.

(6) Install Intake Manifold. Refer to Intake Manifold Installation 3.3L Engine, Group 11, Exhaust System and Intake Manifold.

CYLINDER HEAD

REMOVAL

(1) Drain cooling system. Refer to Group 7, Cooling System for procedure and disconnect negative battery cable.

(2) Remove intake manifold, and throttle body. Refer to Group 11, Exhaust System and Intake Manifold.

WARNING: INTAKE MANIFOLD GASKET IS MADE OF VERY THIN METAL AND MAY CAUSE PERSONAL INJURY, HANDLE WITH CARE.

(3) Disconnect coil wires, sending unit wire, heater hoses and bypass hose.

(4) Remove PCV system hoses, evaporation control system hose and cylinder head covers.

(5) Remove exhaust manifolds.

(6) Remove rocker arm and shaft assemblies. Remove push rods and **tag to ensure installation in original locations.**

(7) Remove the 9 head bolts from each cylinder head and remove cylinder heads (Fig. 31).

INSTALLATION

(1) Clean all surfaces of cylinder block and cylinder heads.

(2) Install new gaskets on cylinder block (Fig. 32).

(3) **The Cylinder head bolts are torqued using the torque yield method, they should be examined BEFORE reuse. If the threads are**

REMOVAL AND INSTALLATION (Continued)

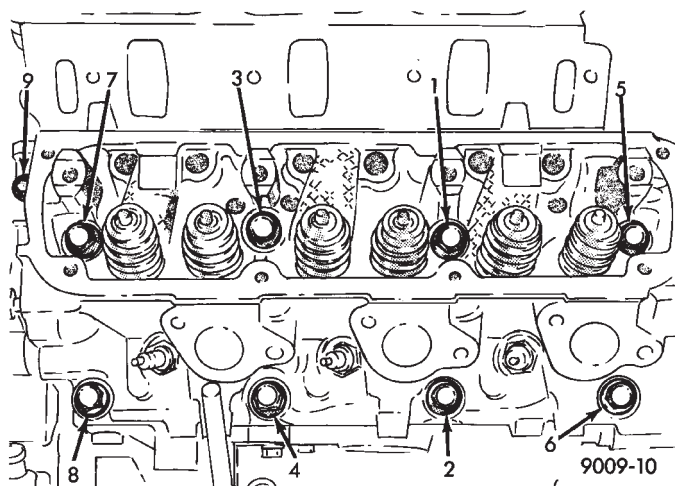


Fig. 31 Cylinder Head Bolts Location and Tightening Sequence

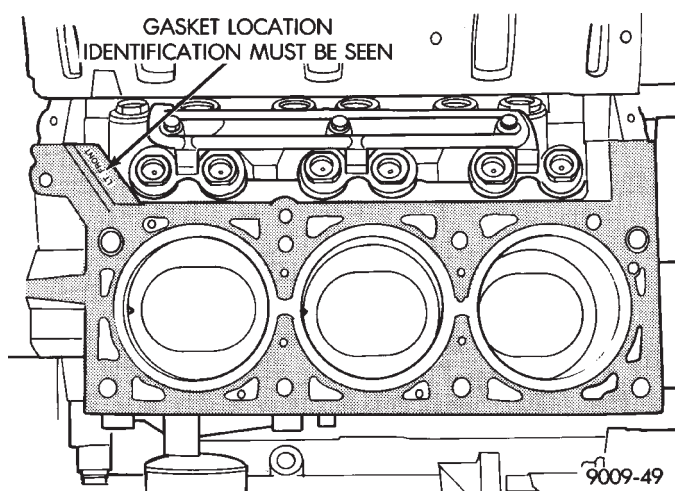


Fig. 32 Head Gasket Installation

necked down, the bolts should be replaced (Fig. 33).

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

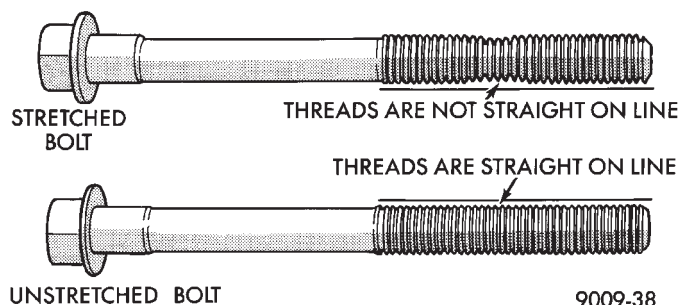


Fig. 33 Checking Bolts for Stretching (Necking)

(5) Tighten the cylinder head bolts 1 thru 8 in the sequence shown in (Fig. 31). Using the 4 step torque turn method, tighten according to the following values:

- First-All to 61 N·m (45 ft. lbs.)
- Second-All to 88 N·m (65 ft. lbs.)
- Third-All (again) to 88 N·m (65 ft. lbs.)
- Fourth-Turn an additional 1/4 Turn. **(Do not use a torque wrench for this step.)**

NOTE: Bolt torque after 1/4 turn should be over 122 N·m (90 ft. lbs.). If not, replace the bolt.

(6) Tighten head bolt number 9 (Fig. 31) to 33 N·m (25 ft. lbs.) after head bolts 1 thru 8 have been tighten to specifications.

(7) Inspect push rods and replace worn or bent rods.

(8) Install push rods, rocker arm and shaft assemblies with the stamped steel retainers in the four positions, tighten to 28 N·m (250 in. lbs.) (Fig. 34).

(9) Place new cylinder head cover gaskets in position and install cylinder head covers. Tighten to 12 N·m (105 in. lbs.).

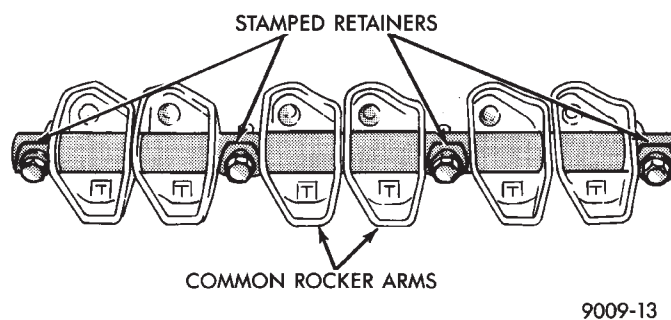


Fig. 34 Rocker Arm Shaft Retainers

INTAKE MANIFOLD SEALING

The intake manifold gasket is a one-piece stamped steel gasket with a sealer applied from the manufacturer. This gasket has end seals incorporated with it.

WARNING: INTAKE MANIFOLD GASKET IS MADE OF VERY THIN METAL AND MAY CAUSE PERSONAL INJURY, HANDLE WITH CARE.

(1) Clean all surfaces of cylinder block and cylinder heads.

(2) Place a drop (about 1/4 in. diameter) of Mopar Silicone Rubber Adhesive Sealant or equivalent, onto each of the **four** manifold to cylinder head gasket corners (Fig. 35).

(3) Carefully install the intake manifold gasket (Fig. 36). Torque end seal retainer screws to 12 N·m (105 in. lbs.).

(4) Install intake manifold and (8) bolts and torque to 1 N·m (10 in. lbs.). Then tighten bolts to 22 N·m (200 in. lbs.) in sequence shown in (Fig. 37). Then

REMOVAL AND INSTALLATION (Continued)

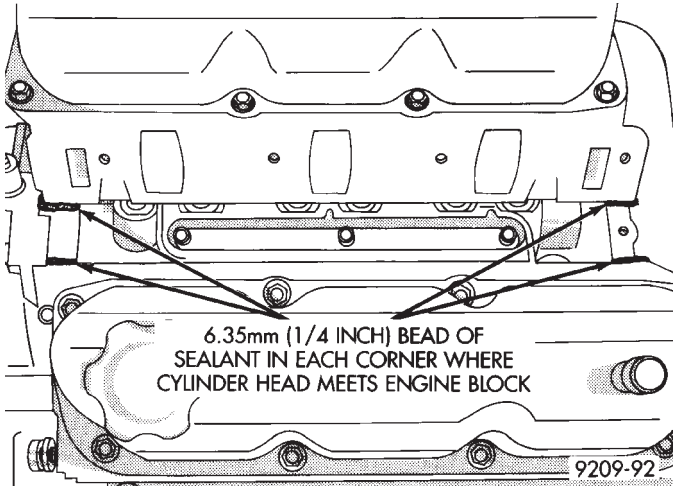


Fig. 35 Intake Manifold Gasket Sealing

tighten again to 22 N·m (200 in. lbs.). After intake manifold is in place, **inspect to make sure seals are in place.** Refer to Group 11, Exhaust System and Intake Manifold to complete Intake Manifold Assembly.

(5) Install exhaust manifolds and tighten bolts to 27 N·m (20 ft. lbs.) and nuts to 20 N·m (15 ft. lbs.).

(6) Adjust spark plugs to specification in Group 8, Electrical Section and install the plugs.

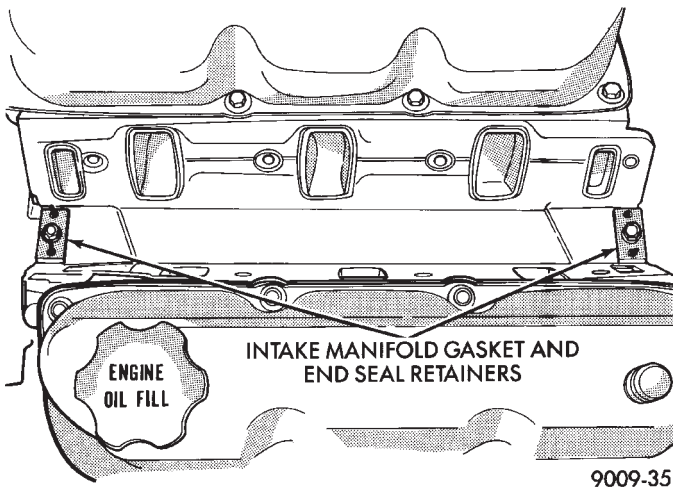


Fig. 36 Intake Manifold Gasket Retainers

VALVES AND VALVE SPRINGS

REMOVAL

(1) With cylinder head removed, compress valve springs using Valve Spring Compressor Tool C-3422-B with adapter 6412 as shown in (Fig. 38).

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

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

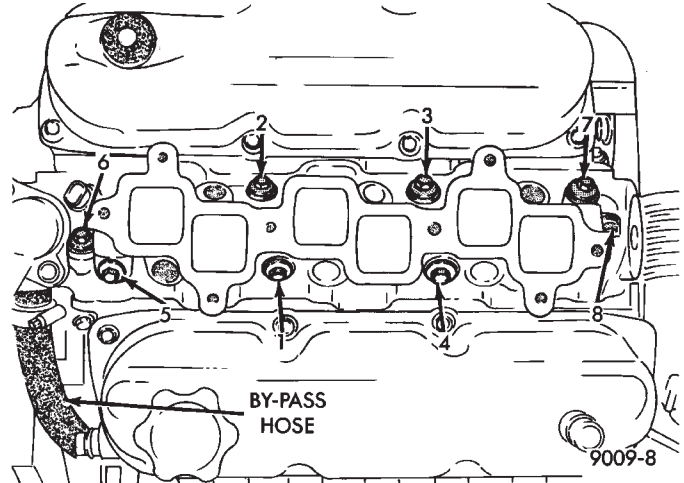


Fig. 37 Intake Manifold Removal and Installation

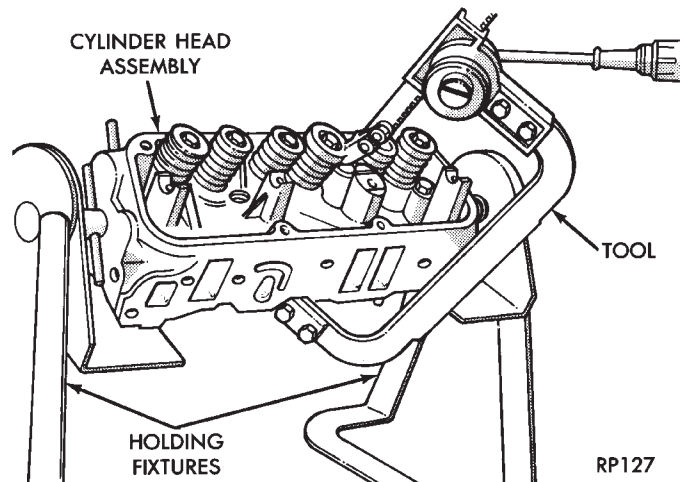


Fig. 38 Compress Valve Springs with Special Tool C-3422-B with Adapter 6412

VALVE INSTALLATION

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

(2) Check valve tip to spring seat dimensions A after grinding the valve seats or faces. Grind valve tip to give 49.541 to 51.271 mm (1.950 to 2.018 in.) over spring seat when installed in the head (Fig. 39). Check valve tip for scoring, if necessary, the tip chamfer should be reground to prevent seal damage when the valve is installed.

(3) Install valve spring seat spacer on head (Fig. 40).

(4) Install new cup seals on all valve stems and over valve guides (Fig. 39). Install valve springs and valve retainers (Fig. 40).

(5) Compress valve springs with Valve Spring Compressor Tool C-3422-B, with adapter 6412 install locks and release tool. **If valves and/or seats are reground, measure the installed height of springs dimension B, make sure measurements are taken from top of spring seat to the bottom**

REMOVAL AND INSTALLATION (Continued)

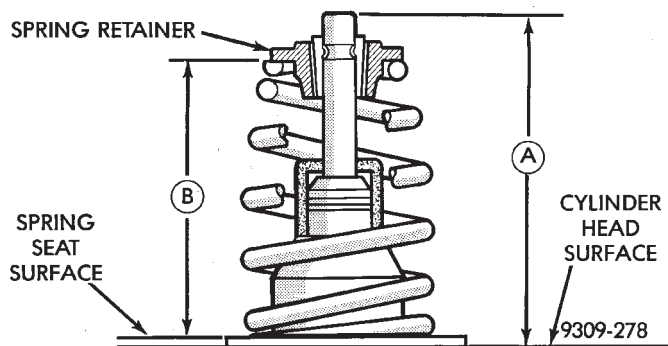


Fig. 39 Checking Valve Installed Height

surface of spring retainer. If height is greater than 1-19/32 inches, (40.6 mm), install a 1/32 inch (.794 mm) spacer in head counterbore to bring spring height back to normal 1-17/32 to 1-19/32 inch (39.1 to 40.6 mm).

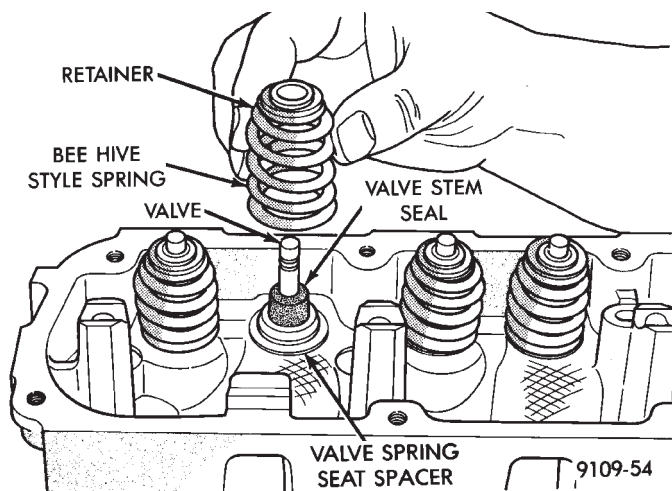


Fig. 40 Valve Seal and Spring—Installation

TIMING CHAIN COVER

REMOVAL

- (1) Disconnect battery.
- (2) Raise vehicle on hoist. Drain engine oil.
- (3) Disconnect sway bar and place it to the rear of the vehicle to gain access to the oil pan.
- (4) Remove the transmission supports brackets and inspection cover.
- (5) Remove oil pan and oil pump pick-up.
- (6) Remove drive belt. Refer to Group 7, Cooling System for procedure.
- (7) Remove power steering pump and set aside.
- (8) Remove fan module (Fig. 41).
- (9) Use special tool C-3281 to hold crankshaft damper while removing center bolt.
- (10) Remove crankshaft damper see (Fig. 42).
- (11) Remove tensioner pulley bracket.
- (12) Remove cam sensor from chain case cover (Fig. 43).

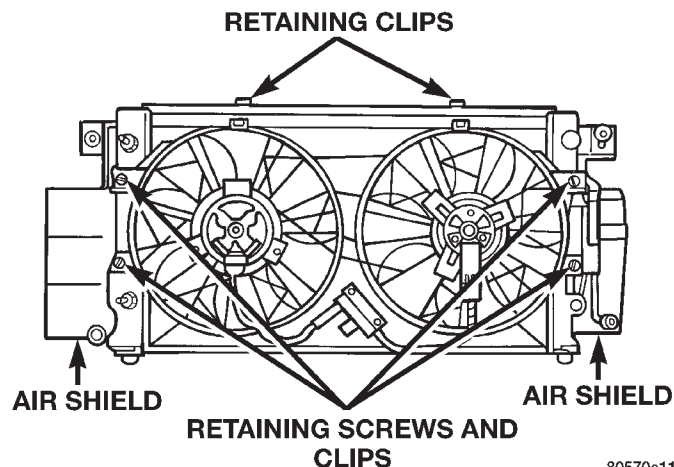


Fig. 41 Fan Module

- (13) Remove chain case cover (Fig. 43).

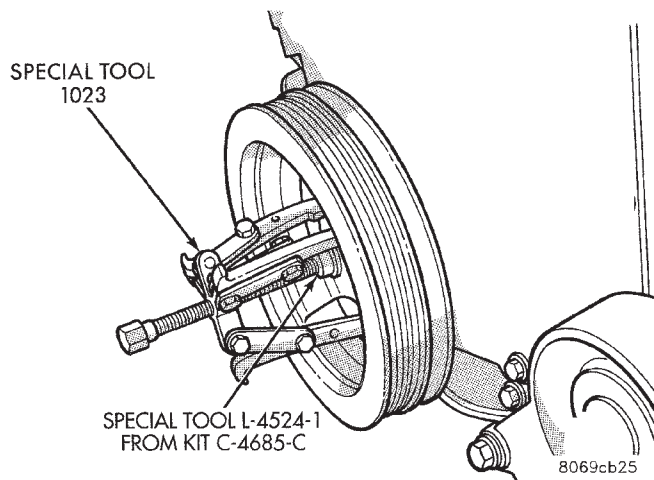


Fig. 42 Crankshaft Damper—Removal

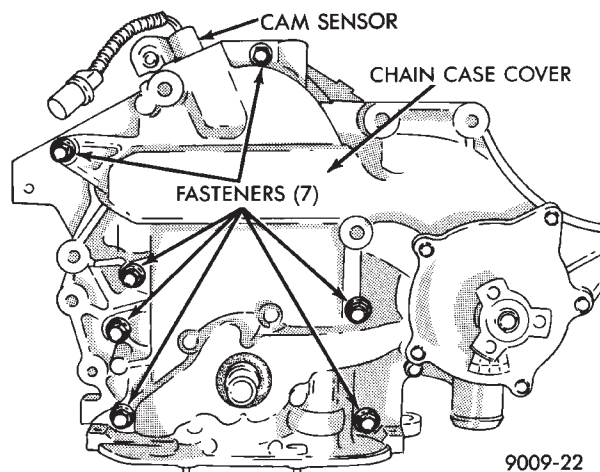


Fig. 43 Timing Chain Case Cover

INSTALLATION

- (1) Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs.

REMOVAL AND INSTALLATION (Continued)

Crankshaft oil seal must be removed to insure correct oil pump engagement.

- (2) Use a new cover gasket, and O-rings. (Fig. 44).
- (3) Rotate crankshaft so that the oil pump drive flats are vertical.
- (4) Position oil pump inner rotor so the mating flats are in the same position as the crankshaft drive flats (Fig. 44). Do not install front crankshaft seal into timing chain cover at this time.
- (5) Install cover onto crankshaft. Make sure the oil pump is engaged on the crankshaft correctly or severe damage may result.
- (6) Install chain case cover bolts (Fig. 43). Snug the two bottom screws and the top center screw. Ensure the cover is seated to the block then torque all other screws to 27 N·m (20 ft. lbs.).
- (7) Install crankshaft oil seal (Fig. 45).
- (8) Install crankshaft damper (Fig. 46).

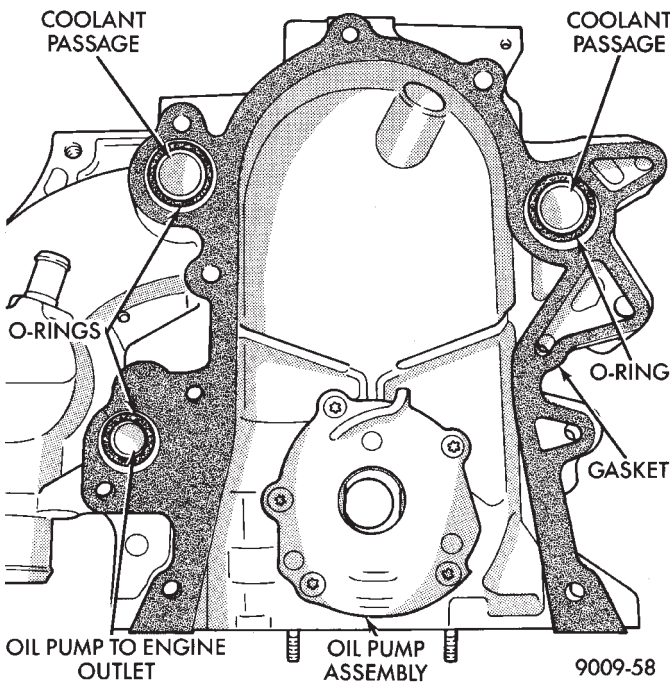


Fig. 44 Timing Chain Case Cover Gaskets and O-Rings

- (9) Install tensioner pulley bracket.
- (10) Install cam sensor. Refer to Group 8D, Ignition System for installation procedure.
- (11) Install accessory drive belt. Refer to Group 7, Cooling System for installation procedure.
- (12) Install oil pump pick-up and oil pan. Refer to Oil Pan Removal and Installation in this section.
- (13) Install the transmission supports brackets and inspection cover.
- (14) Connect the sway bar.
- (15) Fill crankcase with oil to proper level.
- (16) Connect battery.

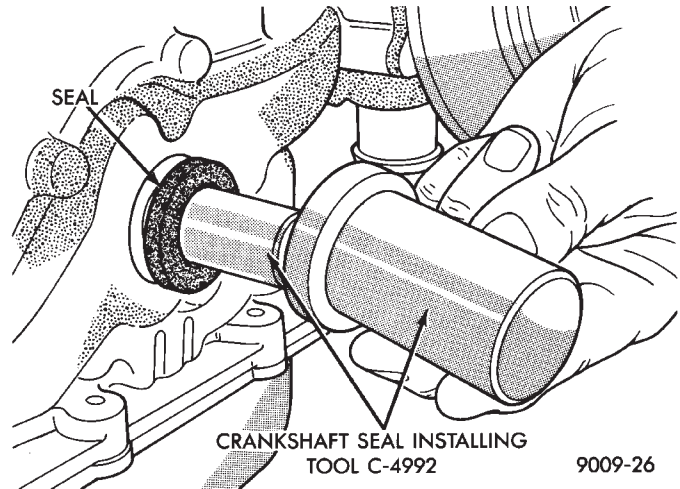


Fig. 45 Crankshaft Oil Seal—Installation

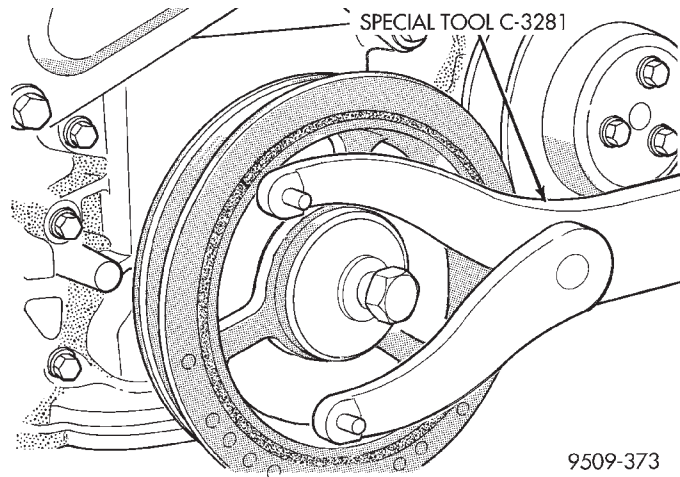


Fig. 46 Crankshaft Damper—Installation

TIMING CHAIN

REMOVAL

- (1) Remove camshaft sprocket attaching bolt, and timing chain with camshaft sprocket.
- (2) Using a suitable puller remove the crankshaft sprocket. Be careful not to damage the crankshaft surface.

INSTALLATION

- (1) Position a new crankshaft sprocket on the shaft, install sprocket with suitable tool and mallet. Be sure sprocket is seated into position.
- (2) Rotate crankshaft so the timing arrow is to the 12 o'clock position.
- (3) Place timing chain around camshaft sprocket and place the timing mark to the 6 o'clock position.
- (4) Align the dark colored links with the dot on the camshaft sprocket, place timing chain around crankshaft sprocket with the dark colored link lined up with the dot on the sprocket and install camshaft sprocket into position.

REMOVAL AND INSTALLATION (Continued)

(5) Use a straight edge to check alignment of timing marks (Fig. 47).

(6) Install camshaft bolt and washer. Tighten to 54 N·m (40 ft. lbs.).

(7) Rotate crankshaft 2 revolutions. Timing marks should line up. If timing marks do not line up remove cam sprocket and realign.

(8) Check camshaft end play. With new thrust plate the specification is 0.0127 to 0.304 mm (0.005 to 0.012 in.). Old thrust plate specification is 0.31 mm (0.012 in.) maximum. If not within these limits install new thrust plate.

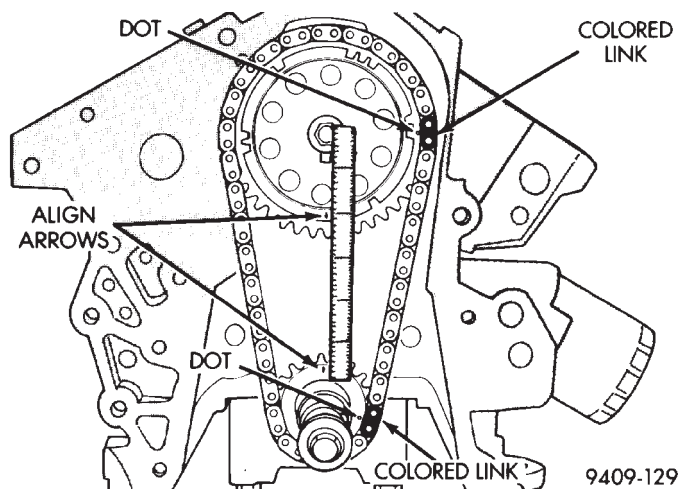


Fig. 47 Timing Marks Alignment

OIL PAN

REMOVAL

(1) Disconnect negative battery cable, remove engine oil dipstick.

(2) Raise vehicle. Drain engine oil.

(3) Disconnect sway bar and move to rear of vehicle to gain access to oil pan.

(4) Remove transmission support bracket and inspection cover.

(5) Remove oil pan bolts and remove oil pan.

INSTALLATION

(1) Apply a 1/8 inch bead of Mopar Silicone Rubber Adhesive Sealant or equivalent, at the parting line of the chain case cover and the rear seal retainer (Fig. 48).

(2) Use a new pan gasket (Fig. 49).

(3) Install pan and tighten screws to 12 N·m (105 in. lb.).

(4) Install inspection cover and transmission support bracket.

(5) Install sway bar.

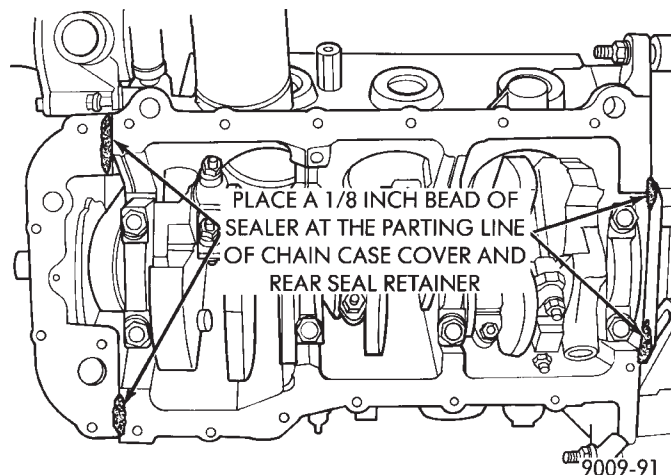


Fig. 48 Oil Pan Sealing

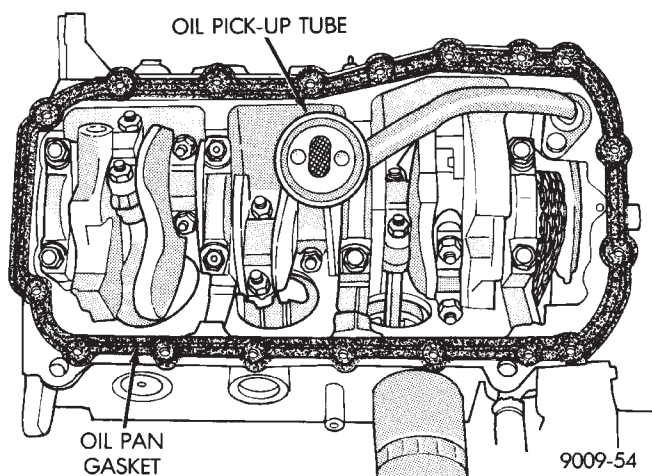


Fig. 49 Oil Pan Gasket Installation

(6) Lower vehicle and install oil dipstick.

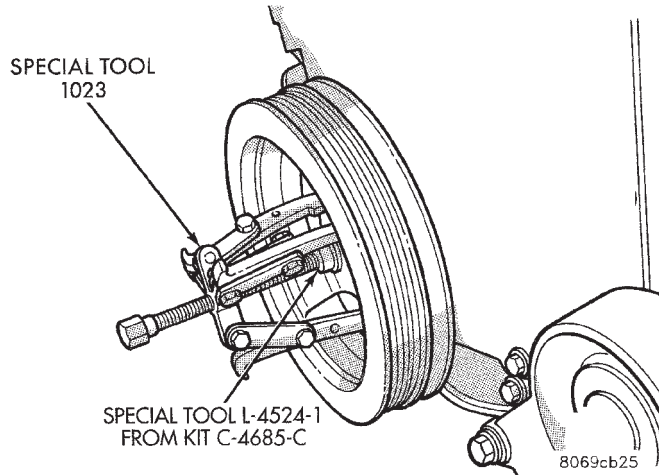
(7) Connect negative battery cable.

(8) Fill crankcase with proper amount of oil.

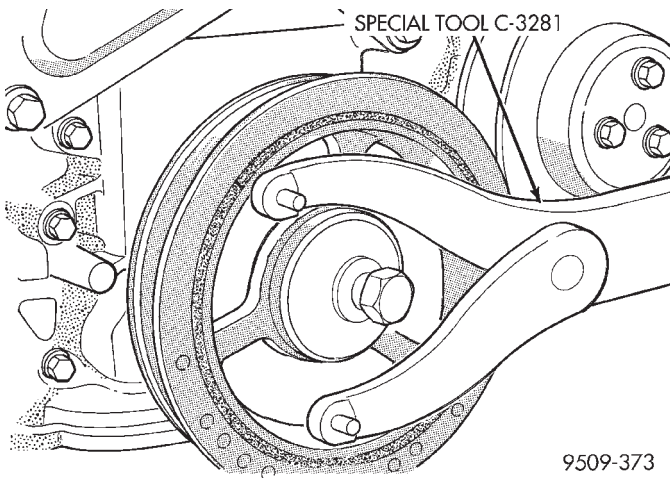
REMOVAL AND INSTALLATION (Continued)

CRANKSHAFT DAMPER**REMOVAL**

- (1) Disconnect battery.
- (2) Remove fan module. Refer to Group 7, Cooling System for procedure.
- (3) Remove drive belts. Refer to Group 7, Cooling System for procedure.
- (4) Use special tool C-3281 to hold crankshaft damper while removing center bolt.
- (5) Remove crankshaft damper see (Fig. 50).

**Fig. 50 Crankshaft Damper—Removal****INSTALLATION**

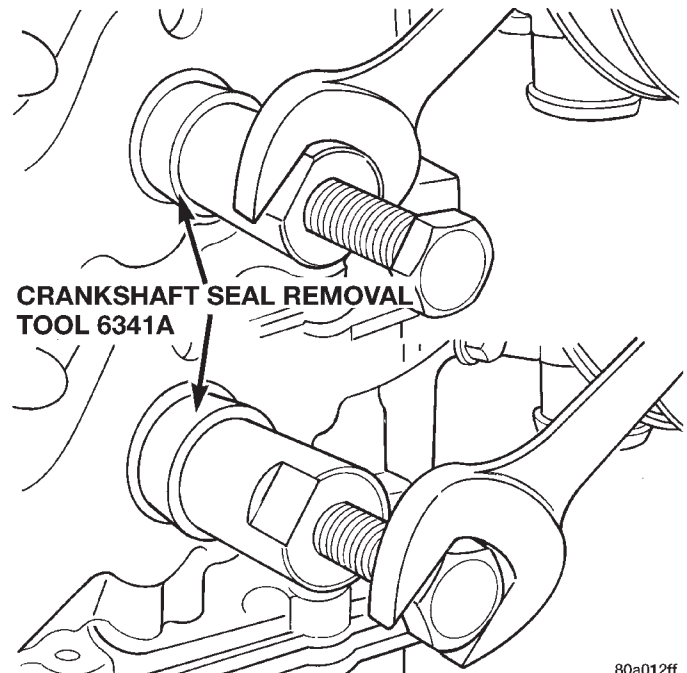
- (1) Install crankshaft damper. Use Special Tool C-3281 to hold crankshaft damper while tightening center crankshaft bolt to 54 N·m (40 ft. lbs.) (Fig. 51).

**Fig. 51 Crankshaft Damper—Installation**

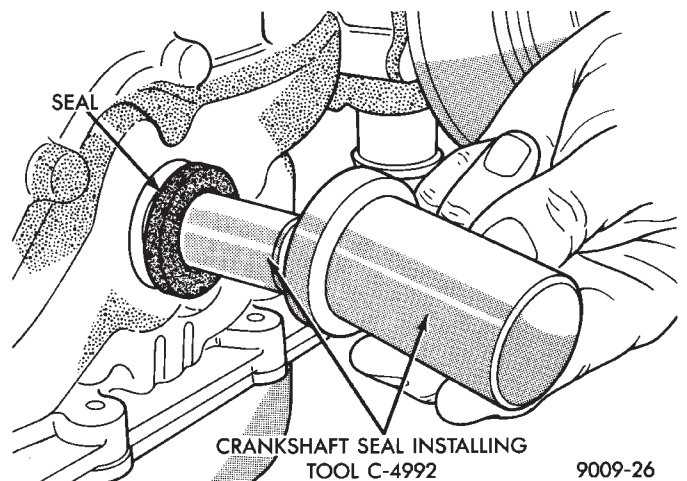
- (2) Install two drive belts.
- (3) Install fan module.
- (4) Connect battery.

FRONT CRANKSHAFT OIL SEAL**REMOVAL**

- (1) Remove fan module. Refer to Group 7, Cooling System for procedure.
- (2) Remove drive belts. Refer to Group 7, Cooling System for procedure.
- (3) Remove crankshaft damper. Refer to crankshaft damper removal in this section.
- (4) Using Tool 6341A to remove oil seal (Fig. 52). Be careful not to damage that crankshaft seal surface of cover.

**Fig. 52 Crankshaft Oil Seal—Removal****INSTALLATION**

- (1) Install new seal by using Tool C-4992 (Fig. 53).
- (2) Place seal into opening with seal spring towards the inside of engine. Install seal until flush with cover.

**Fig. 53 Front Crankshaft Oil Seal—Installation**

REMOVAL AND INSTALLATION (Continued)

(3) Install crankshaft damper using plate L-4524. Thrust Bearing/washer and 5.9 inch bolt. Use Special Tool C-3281 to hold damper while tightening Bolt to 54 N·m (40 ft. lbs.). Refer to crankshaft damper Installation in this section.

(4) Install fan module.

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

REAR CRANKSHAFT OIL SEAL

REMOVAL

(1) Insert a 3/16 flat bladed pry tool between the dust lip and the metal case of the crankshaft seal. Angle the pry tool (Fig. 54) through the dust lip against metal case of the seal. Pry out seal.

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

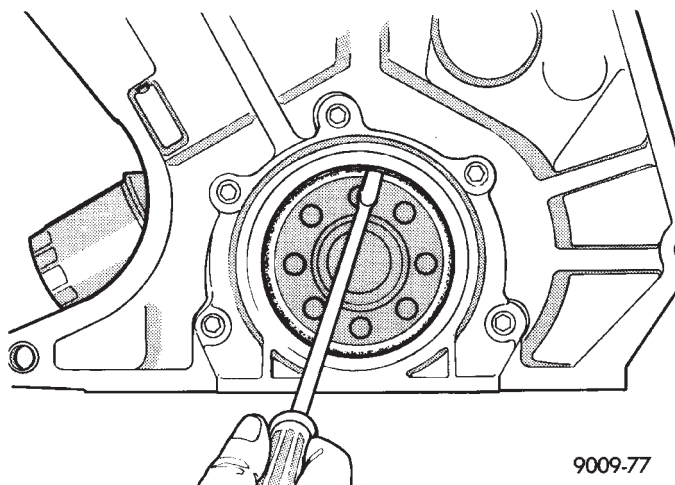


Fig. 54 Rear Crankshaft Oil Seal—Removal

INSTALLATION

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

(1) Place Special Seal Pilot Tool C-4681 on crankshaft (Fig. 55).

(2) Lightly coat seal O.D. with Loctite Stud N' Bearing Mount or equivalent.

(3) Place seal over Special Seal Pilot Tool C-4681 and tap in place with a plastic hammer.

REAR CRANKSHAFT SEAL RETAINER

When retainer removal is required, remove retainer and clean engine block and retainer of old gasket. Make sure surfaces are clean and free of oil. Install new gasket and tighten screws to 12 N·m (105 in. lbs.).

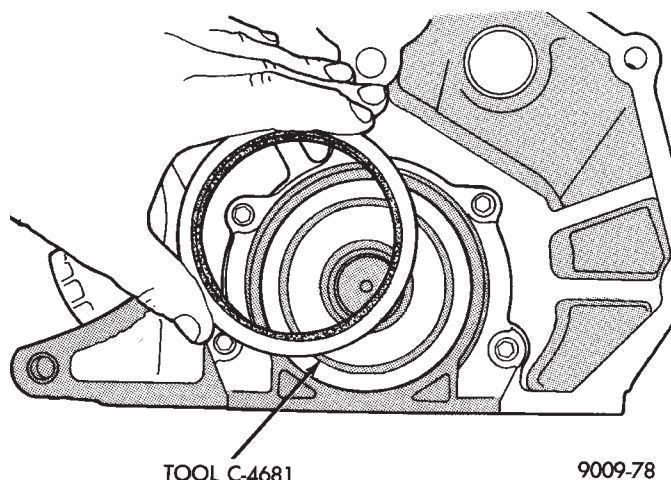


Fig. 55 Rear Crankshaft Oil Seal—Installation

CRANKSHAFT MAIN BEARINGS

Bearing caps are not interchangeable and should be marked at removal to insure correct assembly. (Fig. 56) Upper and lower bearing halves are NOT interchangeable. Lower main bearing halves of 1, 3 and 4 are interchangeable. Upper main bearing halves of 1, 3 and 4 are interchangeable.

CRANKSHAFT MAIN JOURNALS

The crankshaft journals should be checked for excessive wear, taper and scoring. (Fig. 6) Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 inch.). Journal grinding should not exceed 0.305 mm (0.012 inch.) under the standard journal diameter. Do NOT grind thrust faces of Number 2 main bearing. Do NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all passages.

CAUTION: Nodular cast iron crankshafts require that the final paper or cloth polish after any journal regrind be in the same direction as normal rotation in the engine.

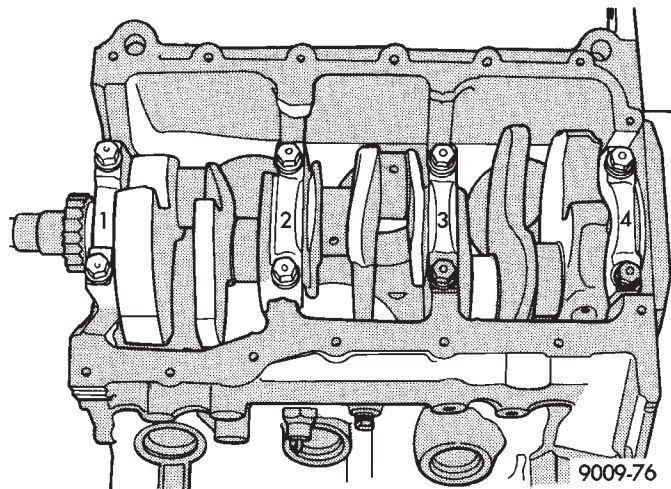


Fig. 56 Main Bearing Cap Identification

REMOVAL AND INSTALLATION (Continued)

The upper and lower Number 2 bearings are a flanged design to carry the crankshaft thrust loads. They are **NOT** interchangeable with any other bearing halves in the engine (Fig. 57). 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 under-size: 0.025 mm (0.001 in.), 0.051 mm (0.002 in.), 0.076 mm (0.003 in.), 0.254 mm (0.010 in.), and 0.305 mm (0.012 in.). Never install an undersize bearing that will reduce clearance below specifications.

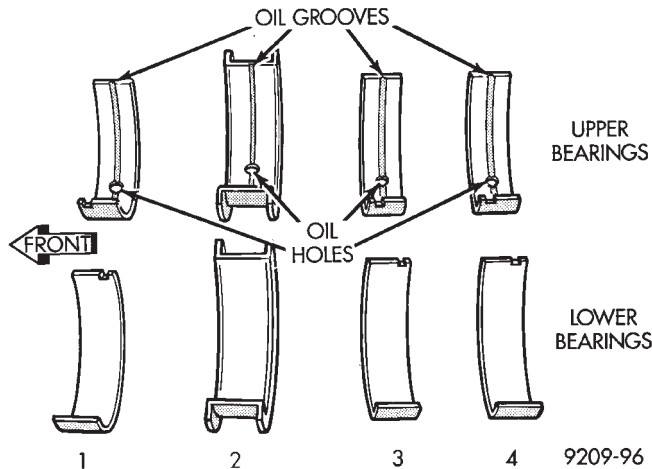


Fig. 57 Main Bearing Identification

REMOVAL

- (1) Remove oil pan and identify bearing caps before removal.
- (2) Remove bearing caps one at a time. Remove upper half of bearing by inserting Special Main Bearing Tool C-3059. (Fig. 58) into the oil hole of crankshaft.
- (3) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

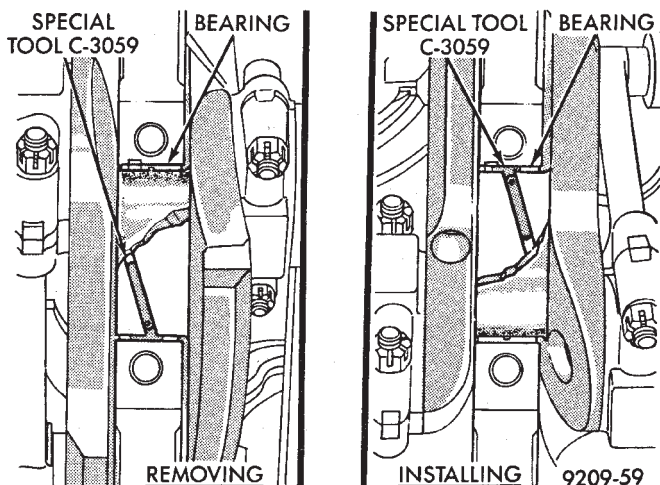


Fig. 58 Removing and Installing Upper Main Bearing With Special Tool C-3059

INSTALLATION

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

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

- (1) Start bearing in place, and insert Main Bearing Tool C-3059 into oil hole of crankshaft (Fig. 58).
- (2) Slowly rotate crankshaft counterclockwise sliding the bearing into position. Remove Special Main Bearing Tool C-3059.
- (3) Install each main cap and tighten bolts finger tight.
- (4) Tighten number 1, 3 and 4 main cap bolts to 41 N·m + 1/4 Turn (30 ft. lbs. + 1/4 Turn).
- (5) Rotate the crankshaft until number 6 piston is at TDC.

(6) To ensure correct thrust bearing alignment the following procedure must be done:

- (7) Move crankshaft all the way to the rear of its travel.
- (8) Then, move crankshaft all the way to the front of its travel.
- (9) Wedge a appropriate tool between the rear of the cylinder block and rear crankshaft counterweight. This will hold the crankshaft in its most forward position.

- (10) Tighten the #2 Thrust Bearing cap bolts to 41 N·m + 1/4 Turn (30 ft. lbs. + 1/4 Turn). Remove the holding tool.

NOTE: Whenever an engine has been rebuilt, add one pint of Mopar® Engine Oil Supplement or equivalent to engine oil to aid in break in. The oil mixture should be left in engine for a minimum of 805 km (500 miles) and drained at the next normal oil change.

OIL FILTER

CAUTION: When servicing the oil filter (Fig. 59) avoid deforming the filter can by installing the remove/install tool band strap against the can-to-base lock seam. The lock seam joining the can to the base is reinforced by the base plate.

- (1) Using Tool C-4065, turn filter counterclockwise to remove from base. Properly discard filter.
- (2) Wipe base clean, then inspect gasket contact surface.
- (3) Lubricate gasket of new filter with clean engine oil.

REMOVAL AND INSTALLATION (Continued)

(4) Install new filter until gasket contacts base. Tighten filter 1 turn or 20 N·m (15 ft. lbs.). Use filter wrench if necessary.

(5) Start engine and check for leaks.

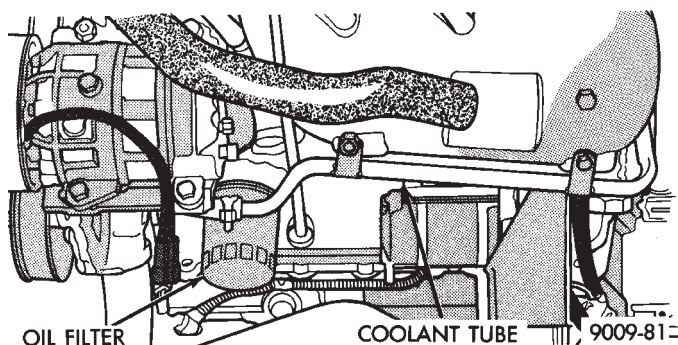


Fig. 59 Oil Filter

OIL PUMP

REMOVAL

(1) Remove oil pan. See procedure outlined in this section.

(2) Remove oil pickup tube.

(3) Remove timing chain cover. See procedure outlined in this section.

NOTE: The oil pump pressure relief valve can be serviced by removing the oil pan and oil pickup tube. See **DISASSEMBLY AND ASSEMBLY** section or **CLEANING AND INSPECTION** for more information.

INSTALLATION

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

(2) Follow the reverse procedure for installation.

PISTON AND ROD

REMOVAL

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

(2) Inspect connecting rods and connecting rod caps for cylinder identification. Identify them if necessary (Fig. 60).

(3) Remove connecting rod cap. Install connecting rod bolt protectors on connecting rod bolts (Fig. 61). Push each piston and rod assembly out of cylinder bore.

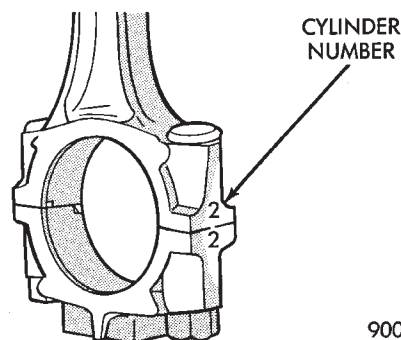


Fig. 60 Identify Connecting Rod to Cylinder

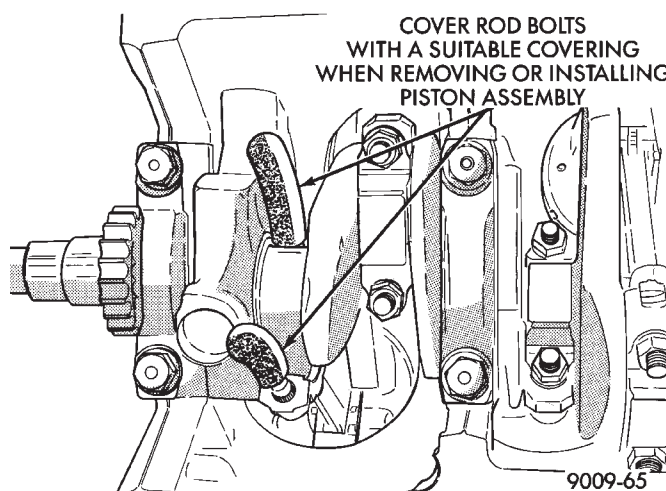


Fig. 61 Connecting Rod Protectors

CAUTION: Be careful not to nick crankshaft journals.

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

PISTON RINGS—INSTALLATION

(1) The No. 1 and No. 2 piston rings have a different cross section. Install rings with manufacturers I.D. mark facing up, to the top of the piston (Fig. 62).

NOTE: Install rings on the piston in the following order:

- Oil ring expander.
- Upper oil ring side rail.
- Lower oil ring side rail.
- No. 2 Intermediate piston ring.
- No. 1 Upper piston ring.

(2) Install the side rail by placing one end between the piston ring groove and the expander. Hold end firmly and press down the portion to be installed until side rail is in position. **Do not use a piston ring expander.** (Fig. 63).

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

REMOVAL AND INSTALLATION (Continued)

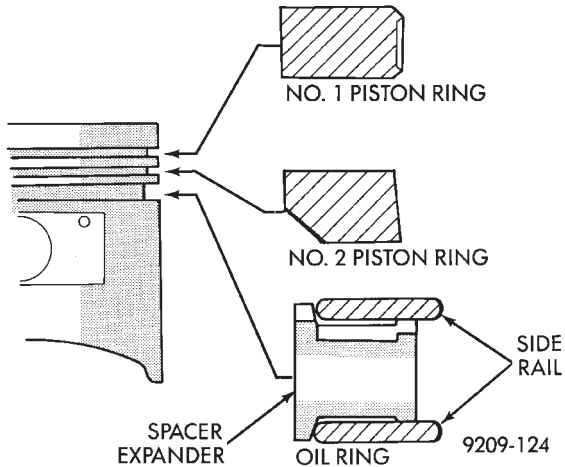


Fig. 62 Piston Ring—Installation

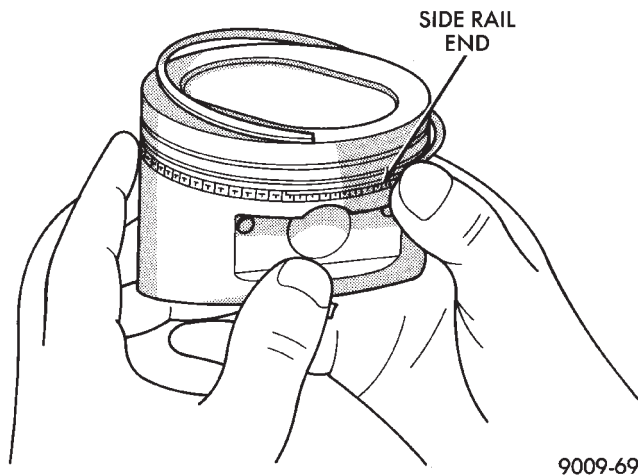


Fig. 63 Side Rail—Installation

(4) Install No. 2 piston ring and then No. 1 piston ring (Fig. 64).

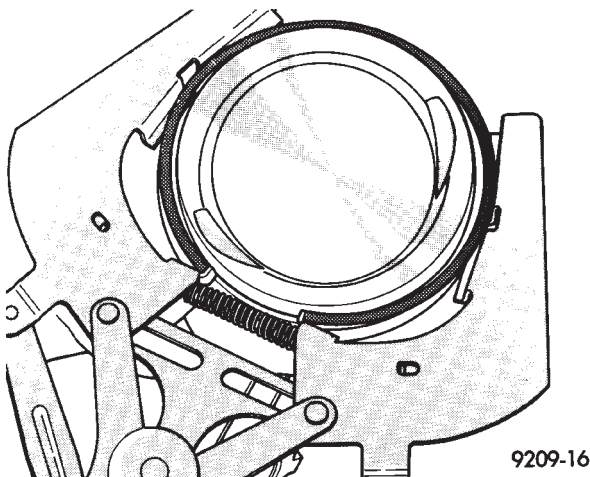


Fig. 64 Installing Upper and Intermediate Rings

(5) Position piston ring end gaps as shown in (Fig. 65).

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

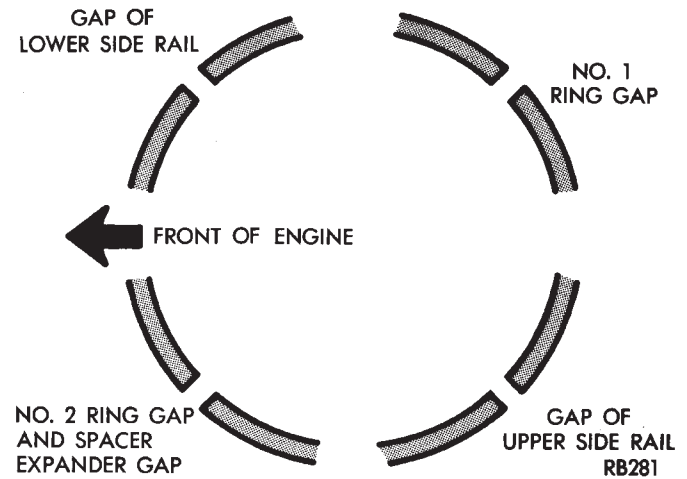


Fig. 65 Piston Ring End Gap Position

INSTALLING PISTON AND CONNECTING ROD

(1) Before installing pistons and connecting rod assemblies into the bore, make sure that compression ring gaps are staggered, and not 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. 65).

(3) Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston and tighten with the special wrench. **Be sure position of rings does not change during this operation (Fig. 66).**

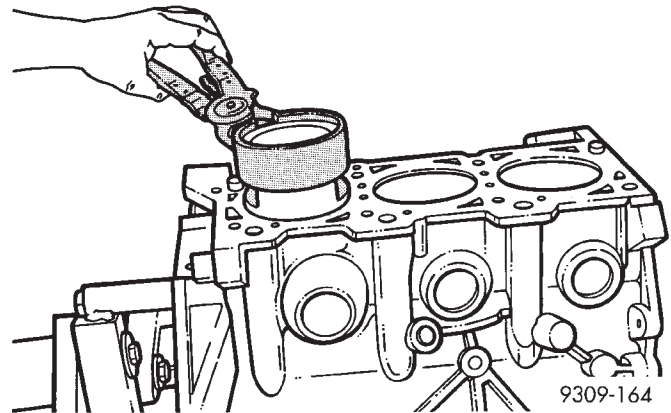


Fig. 66 Piston—Installation

(4) Install connecting rod bolt protectors on rod bolts. (Fig. 61)

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

REMOVAL AND INSTALLATION (Continued)

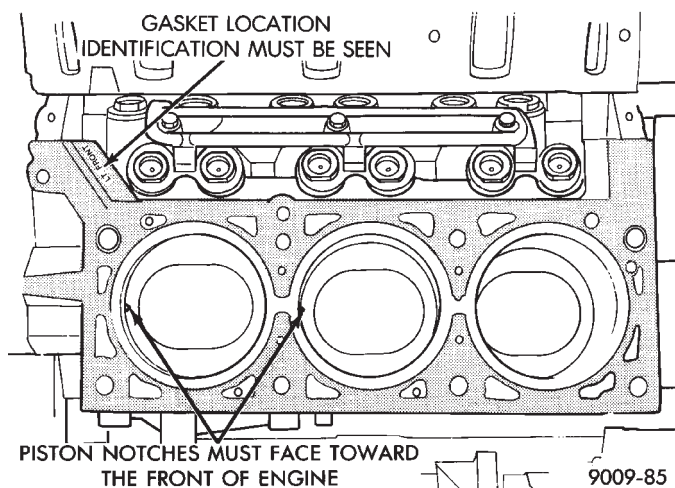


Fig. 67 Piston I.D. Notches

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

(7) The notch or groove on top of piston must be pointing toward front of engine (Fig. 67).

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

ENGINE CORE, OIL AND CAM PLUGS

REMOVAL

Using a blunt tool such as a drift and a hammer, strike the bottom edge of the cup plug. With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 68).

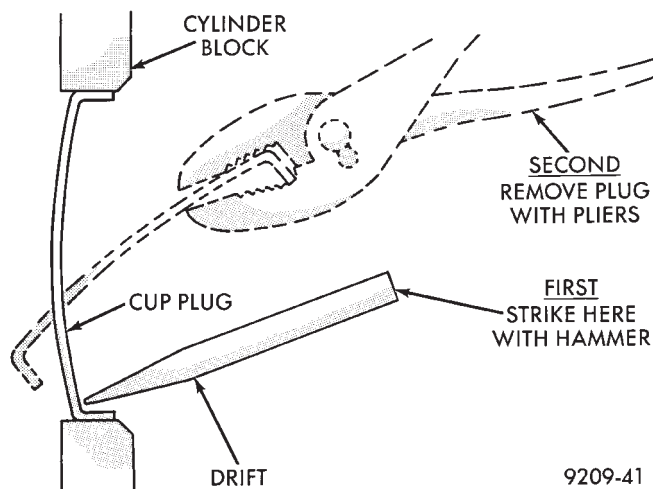


Fig. 68 Core Hole Plug Removal

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

INSTALLATION

Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer. Lightly coat inside of cup plug hole with Loctite Stud N' Bearing Mount or equivalent. Make certain the new plug is cleaned of all oil or grease. Using proper drive plug, drive plug into hole so that the sharp edge of the plug is at least 0.5 mm (0.020 inch.) inside the lead-in chamfer.

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

DISASSEMBLY AND ASSEMBLY

OIL PUMP

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

(2) Drill a 3.175 mm (1/8 inch) hole into the relief valve retainer cap and insert a self-threading sheet metal screw into cap.

(3) Clamp screw into a vise and while supporting chain case cover (CCC), remove cap by tapping CCC using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 69).

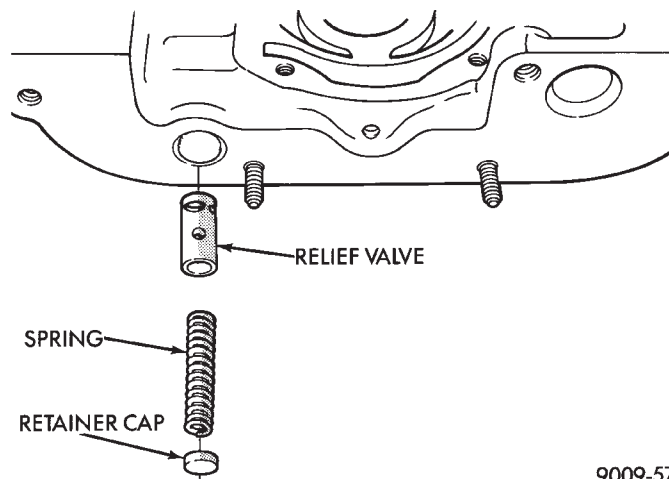


Fig. 69 Oil Pressure Relief Valve

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

(5) Remove pump rotors.

(6) Wash all parts in a suitable solvent and inspect carefully for damage or wear (Fig. 70).

HYDRAULIC TAPPET

DISASSEMBLE AND ASSEMBLE

(1) Pry out plunger retainer spring clip (Fig. 71).

(2) Clean varnish deposits from inside of tappet body above plunger cap.

(3) Invert tappet body and remove plunger cap, plunger, flat or ball check valve, check valve spring,

DISASSEMBLY AND ASSEMBLY (Continued)

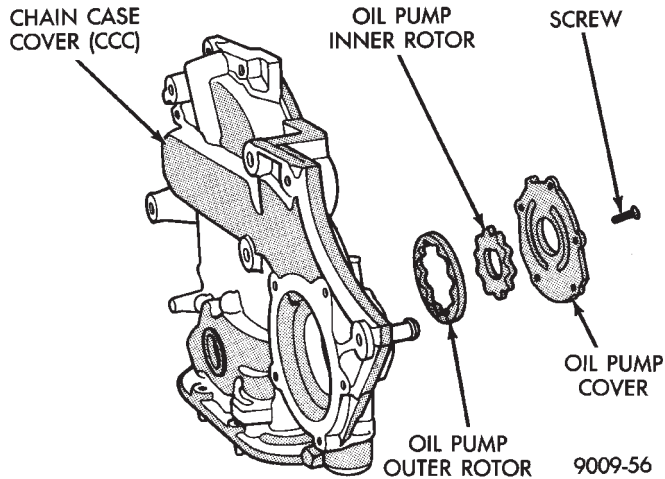


Fig. 70 Oil Pump

check valve retainer and plunger spring. Check valve could be flat or ball.

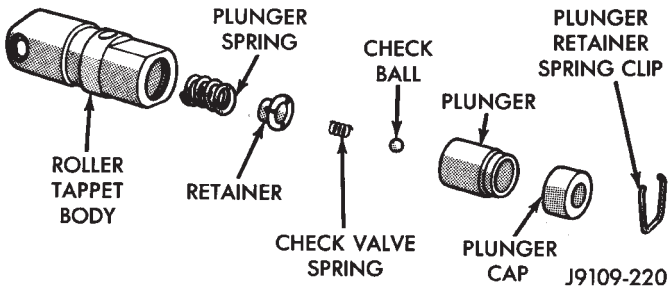


Fig. 71 Hydraulic Roller Tappet Assembly

(4) Clean all tappet parts in a solvent that will remove all varnish and carbon.

(5) Replace tappets that are unfit for further service with new assemblies.

(6) If plunger shows signs of scoring or wear, valve is pitted, or valve seat on end of plunger indicates any condition that would prevent valve from seating, install a new tappet assembly.

(7) Assemble tappets (Fig. 71).

CLEANING AND INSPECTION

CYLINDER HEAD

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

(2) Clean cylinder head and oil passages.

(3) Check cylinder head for flatness (Fig. 72).

(4) Inspect all surfaces with a straightedge if there is any reason to suspect leakage. If out of flatness exceeds 0.019 mm (0.00075 in.) times the span length in inches in any direction, either replace head or lightly machine the head surface. As an example, if a 12 inch span is 0.1 mm (.004 in.) out of flat, allowable is $12 \times .019 \text{ mm}$ (.00075 in.) equals .22 mm (.009 in.) This amount of out of flat is acceptable.

Maximum of 0.2 mm (.008 in.) for grinding is permitted.

CAUTION: This is a combined total dimension of stock removal from cylinder head and block top surface.

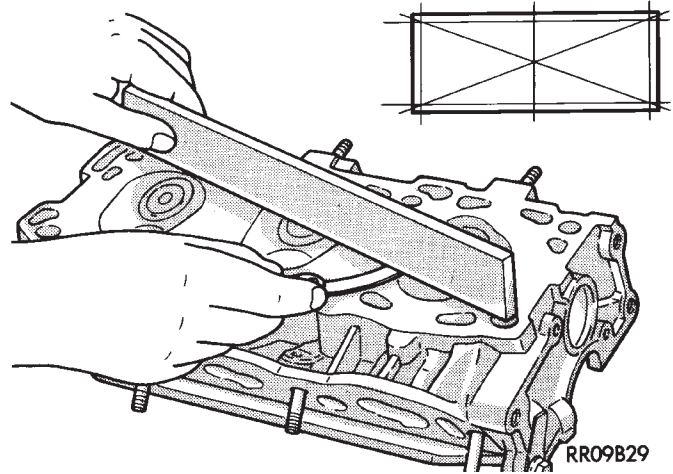


Fig. 72 Check Cylinder Head

VALVES AND VALVE GUIDE

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

(2) Measure valve stems for wear. Refer to specifications (Fig. 75).

CAUTION: Valve stems are chrome plated and should not be polished (Fig. 73).

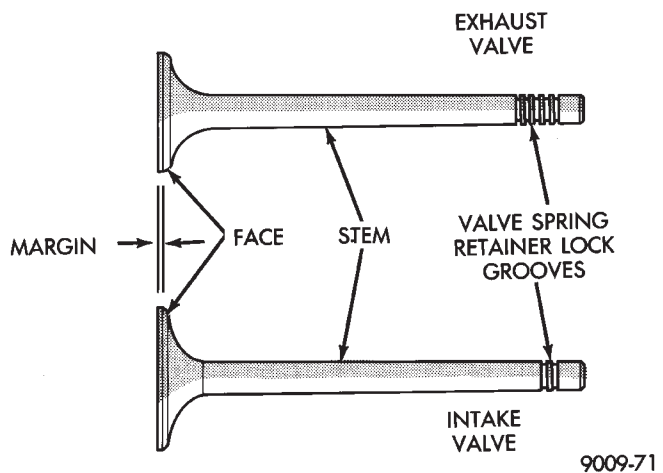


Fig. 73 Intake and Exhaust Valves

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

CHECKING VALVE GUIDES

(1) Measure valve stem guide clearance as follows:

(2) Install valve into cylinder head so it is 14 mm (0.551 inch.) off the valve seat. A small piece of hose may be used to hold valve in place.

CLEANING AND INSPECTION (Continued)

(3) Attach dial indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 74).

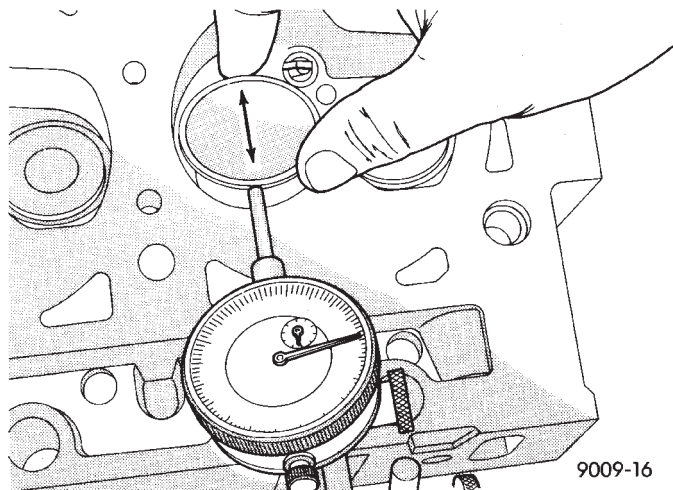


Fig. 74 Measuring Valve Guide Wear

(4) Move valve to and from the indicator. Refer to specifications (Fig. 75).

(5) Ream the guides for valves with oversized stems if dial indicator reading is excessive or if the stems are scuffed or scored.

Valve Guide Dial Indicator Reading, Maximum	Intake Valve 0.247 mm (0.009 in.)	Exhaust Valve 0.414 mm (0.016 in.)
Valve Guide Reamer Oversize	Valve Guide Size	
0.15 mm (.005 in.)	8.125-8.150 mm (.3198-.3206 in.)	
0.40 mm (.015 in.)	8.375-8.400 mm (.3297-.3307 in.)	
0.80 mm (.030 in.)	8.775-8.800 mm (.3454-.3464 in.)	

Fig. 75 Valve Guide Specifications

(6) Service valves with oversize stems and over size seals are available in 0.15 mm (0.005 inch.), 0.40 mm (0.015 inch.) and 0.80 mm (0.030 inch.) oversize.

NOTE: Oversize seals must be used with oversize valves.

(7) Reamers to accommodate the oversize valve stem are as follows:

(8) Slowly turn reamer by hand and clean guide thoroughly before installing new valve. **Do not attempt to ream the valve guides from standard directly to 0.80 mm (0.030 inch.)** Use step procedure of 0.15 mm (0.005 inch.), 0.40 mm (0.015 inch.) and 0.80 mm (0.030 inch.) so the valve guides may be reamed true in relation to the valve seat. After reaming guides, the seat runout should be measured and resurfaced if necessary. See Refacing Valves and Valve Seats.

VALVE GUIDES

NOTE: Replace cylinder head if guide does not clean up with 0.80 mm (0.030 inch.) oversize reamer, or if guide is loose in cylinder head.

Valve Dimensions

Intake Valve (minimum)

Stem diameter: 7.935 mm (.3124 in.)

Face angle: 44½ °

Valve margin: .794 mm (.031 in.)

Head diameter: 45.5 mm (1.79 in.)

Length: 125.38 mm (4.936 in.)

Exhaust Valve (minimum)

Stem diameter: 7.906 mm (.3112 in.)

Face angle: 44½ °

Valve margin: 1.191 mm (.0469 in.)

Head diameter: 37.5 mm (1.476 in.)

Length: 126.00 mm (4.964 in.)

Fig. 76 Valve Dimensions

OIL PUMP

INSPECTION AND REPAIR

(1) Remove oil pump cover screws, and lift off cover (Fig. 77).

(2) Remove pump rotors.

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

(4) Lay a straightedge across the pump cover surface (Fig. 78). If a 0.076 mm (0.003 in.) feeler gauge can be inserted between cover and straight edge, cover should be replaced.

(5) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 7.64 mm (0.301 in.) or less (Fig. 79), or if the diameter is 79.95 mm (3.148 inches.) or less, replace outer rotor.

(6) If inner rotor measures 7.64 mm (0.301 in.) or less replace inner rotor (Fig. 80).

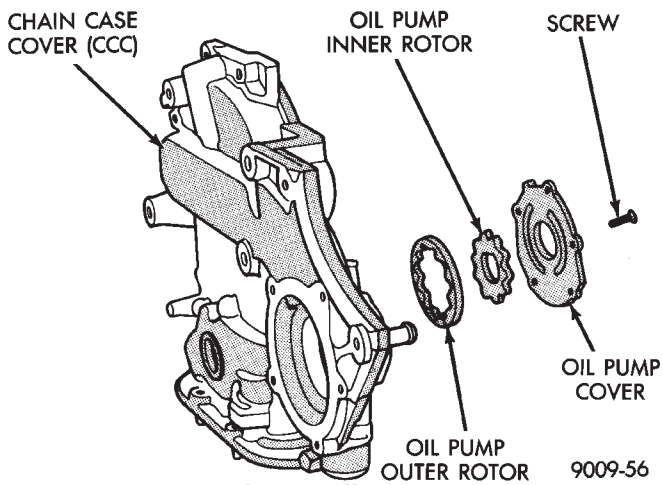


Fig. 77 Oil Pump

CLEANING AND INSPECTION (Continued)

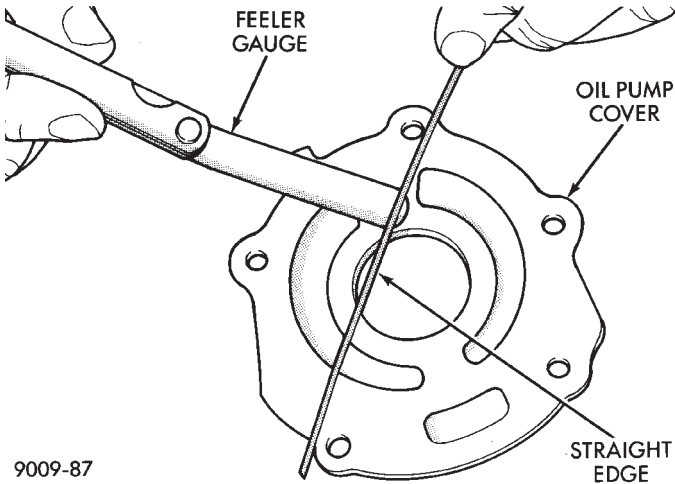


Fig. 78 Checking Oil Pump Cover Flatness

(7) Slide outer rotor into chain case cover, press to one side with fingers and measure clearance between rotor and chain case cover (Fig. 81). If measurement is 0.39 mm (0.015 in.) or more, replace chain case cover only if outer rotor is in specification.

(8) Install inner rotor into chain case cover. If clearance between inner and outer rotors (Fig. 82) is 0.203 mm (0.008 in.) or more, replace both rotors.

(9) Place a straightedge across the face of the chain case cover, between bolt holes. If a feeler gauge of 0.10 mm (0.004 in.) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 83). **ONLY** if rotors are in specification.

(10) 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.

(11) The relief valve spring has a free length of approximately 49.5 mm (1.95 inches) it should test between 19.5 and 20.5 pounds when compressed to 34 mm (1-11/32 inches). Replace spring that fails to meet specifications.

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

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

(14) Tighten cover screws to 12 N·m (105 in. lbs.).

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

(16) Install chain case cover slowly refer to Timing Chain Cover Installation of this section.

CYLINDER BLOCK AND BORE

CLEANING AND INSPECTION

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

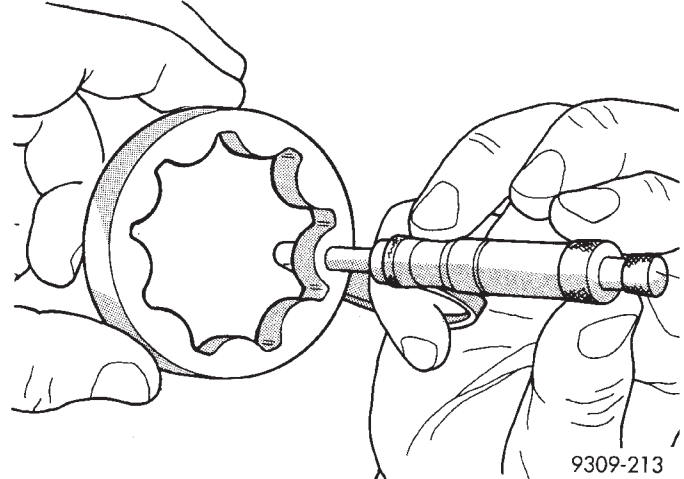


Fig. 79 Measuring Outer Rotor Thickness

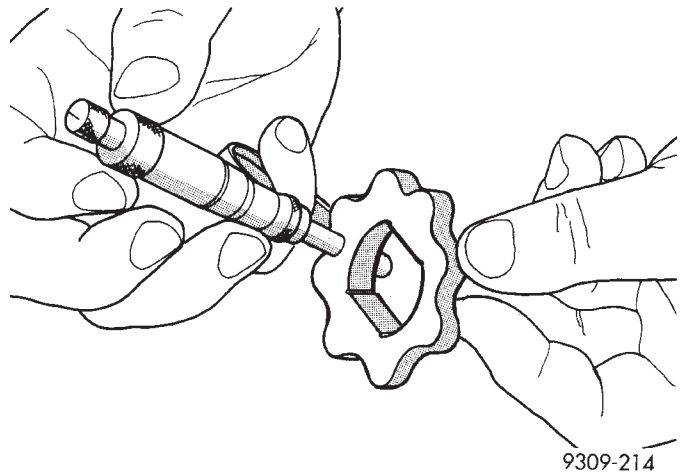


Fig. 80 Measuring Inner Rotor Thickness

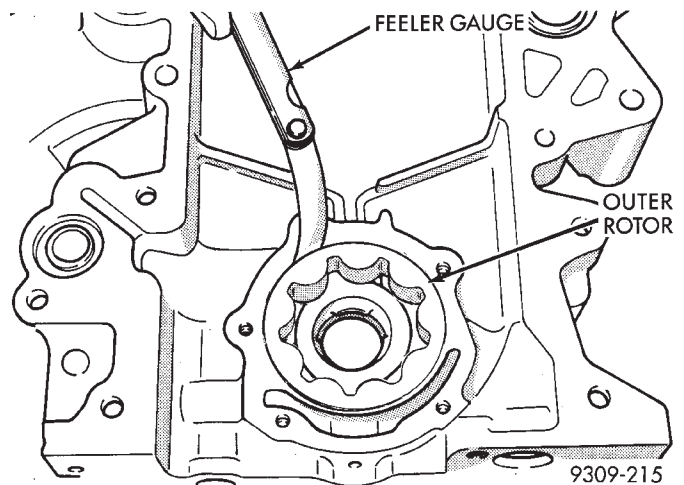


Fig. 81 Measuring Outer Rotor Clearance in Housing

(2) If new core plugs are installed, see Engine Core Oil and Cam Plugs.

(3) Examine block for cracks or fractures.

CLEANING AND INSPECTION (Continued)

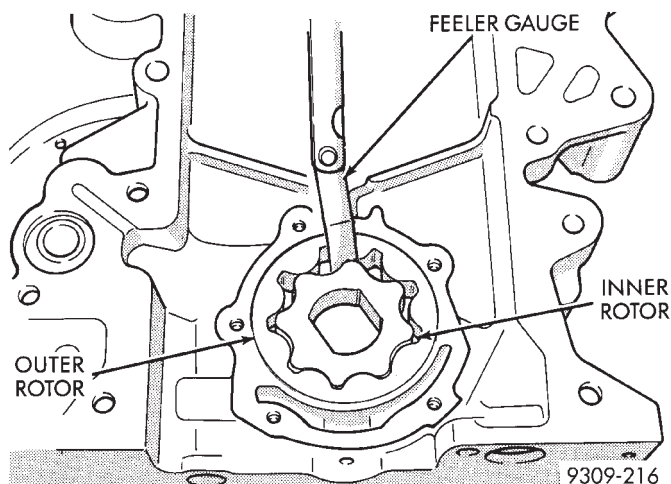


Fig. 82 Measuring Clearance Between Rotors

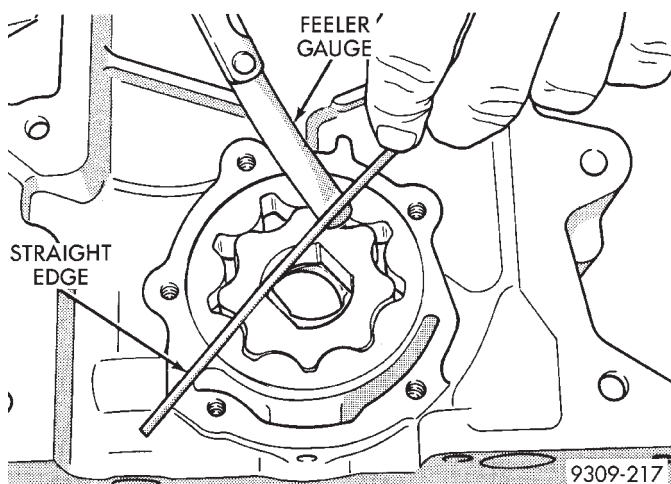


Fig. 83 Measuring Clearance Over Rotors

CYLINDER BORE INSPECTION

The cylinder walls should be checked for out-of-round and taper with Tool C-119 (Fig. 84). If the cylinder walls are badly scuffed or scored, the cylinder block should be rebored and honed, and new pistons and rings fitted. Whatever type of boring equipment is used, boring and honing operation should be closely coordinated with the fitting of pistons and rings in order that specified clearances may be maintained.

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

Measure the cylinder bore at three levels in directions A and B (Fig. 84). Top measurement should be 12 mm (0.50 inch.) down and bottom measurement should be 12 mm (0.50 inch.) up from bottom of bore. Refer to (Fig. 85) for specifications.

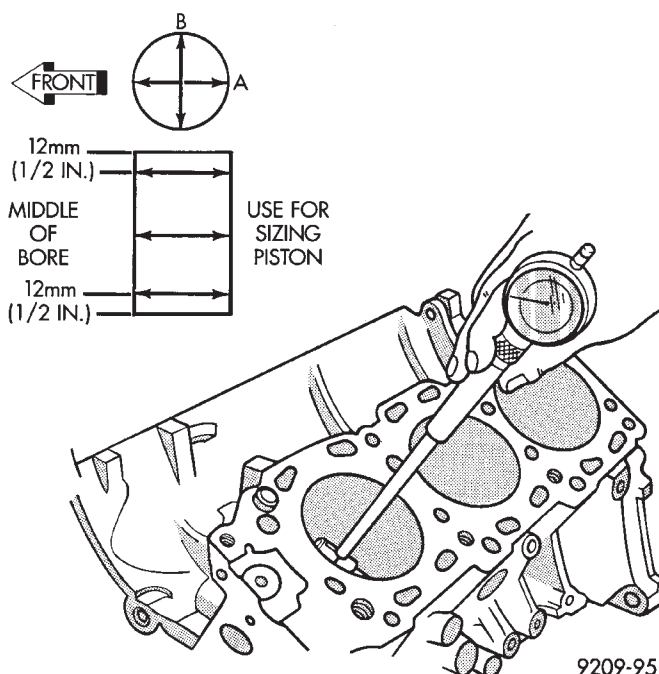


Fig. 84 Checking Cylinder Bore Size

Engine	Standard Bore	Maximum Out-of Round	Maximum Taper
3.3L	92.993-93.007 mm	.076 mm	.51 mm
	3.661-3.6617 inch	(.003 inch)	(.002 inch)
Standard Piston Size			
3.3L	92.950-92.968 mm (3.6594-3.6602 inch)		
Piston to Bore Clearance: .025-.057 mm (.0009 to .0022 inches.) Measurements taken at Piston Size location.			

Fig. 85 Cylinder Bore and Piston Specifications

ENGINE HYDRO-MOUNT INSULATOR

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

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

OIL PAN

(1) Clean oil pan in solvent and wipe dry with a clean cloth. Clean all gasket material from mounting surfaces of pan and block.

(2) Inspect oil drain plug and plug hole for stripped or damaged threads and repair as necessary. Inspect molded rubber seal on drain plug for damage. Replace if necessary. Tighten to 27 N·m (20 ft. lb.).

(3) Inspect oil pan mounting flange for bends or distortion. Straighten flange if necessary.

(4) Clean oil screen and pipe in clean solvent. Inspect condition of screen.

SPECIFICATIONS

3.3L ENGINE

Type	60° V-6 Engine
Bore	93.0 mm (3.661 inches)
Stroke	81.0 mm (3.188 inches)
Compression Ratio	8.9:1
Displacement	3.3 Liters (201 cubic inches)
Brake Horsepower	161 hp @ 5300 RPM
Torque	181 lbs.-ft. @ 3200 RPM
Firing Order	1-2-3-4-5-6
Minimum Compression Pressure, see "Engine Performance" in Standard Service Procedures	690 kPa (100 psi)
Maximum Variations Between Cylinders	25%
Cylinder Number (Front to Rear)	
Left Bank	2, 4, 6
Right Bank	1, 3, 5
Cylinder Block	
Cylinder Bore (Standard)	93.0 mm (3.661 inches)
Cylinder Bore Out-of-Round (Maximum Allowable Before Reconditioning)	0.076 mm (0.003 inch)
Cylinder Bore Taper (Maximum Allowable Before Reconditioning)	0.051 mm (0.002 inch)
Reconditioning Working Limits	
For Taper and Out-of-Round	0.001 inch
Tappet Bore Diameter	0.0951 inch-0.9059 inch
Pistons	
Type Material	Aluminum Alloy Tin Coated
Clearance at Size Location	0.025-0.057 mm (0.001 to 0.0022 inch)
Weight (Std. Only)	381 ± 5 gms
Pistons For Service	STD.
Piston Pins	
Type	Press Fit in Rod
Diameter	22.88 mm (0.9009-0.9007 inch)
Length	67.25-67.75 mm (2.648-2.667 inches)
Clearance in Piston (Light Thumb Push @70°F)	0.006-0.019 mm (0.0002-0.0007 inch)
Clearance in Rod	(Interference)
Piston Rings	
Number of Rings Per Piston	3
Compression	2
Oil	1
Oil Ring Type	3-Piece, Steel Rail, Chrome-Face
Ring Width	
Compression	1.47-1.49 mm (0.0578-0.0586 inch) (1.46-1.5 mm (0.0575-0.0591 inch)
Oil-Steel Rails	0.510 mm (0.0201 inch)
Ring Gap	
Compression	0.300-0.550 mm (0.0118-0.217 inch)
Oil-Steel Rails	0.250-1.00 mm (0.0098-0.0394 inch)
Ring Side Clearance	
Compression	0.040-0.085 mm (0.0015-0.0033 inch)
Oil-Steel Rails	0.030-0.095 mm (0.0012-0.0037 inch)
Service Rings Ring Gap	0.014-0.226 mm (0.0005-0.0089 inch)
Compression	0.300-0.550 mm (0.0018-0.0217 inch)
Oil-Steel Rails	0.250-1.00 mm (0.0098-0.0394 inch)
Ring Side Clearance	
Compression	0.030-0.095 mm (0.0012-0.0037 inch)
Oil-Steel Rails	0.014-0.226 mm (0.0005-0.0089 inch)

SPECIFICATIONS (Continued)

ENGINE—3.3L**CONNECTING RODS**

Side Clearance 0.127 to 0.381mm
(0.005 to 0.015 in.)

CONNECTING ROD BEARINGS

Type Aluminum Lead (Bi-Metal)
Clearance Desired 0.019 to 0.065mm
(0.00075 to 0.0026 in.)
Bearings for Service ... Std. 0.025mm (0.001 in.),
0.051mm (0.002 in.),
0.076 mm (0.003 in.),
0.254mm (0.010 in.),
0.305mm (0.012 in.)

CRANKSHAFT

Type Cast Nodular Iron
Bearings Aluminum Lead
(Bi-Metal)
Thrust Taken By No. 2 Main Bearing
End Play 0.09 to 0.24 mm
(0.004 to 0.009 in.)
Diametral Clearance Desired
No. # 1, 3, 4 0.011 to 0.055mm
(0.0004 to 0.0022 in.)
Diametral Clearance Desired
No. # 2 0.011 to 0.059mm
(0.0004 to 0.0023 in.)

MAIN BEARING JOURNALS

Diameter 64mm (2.519 in.)
Maximum Allowable Out of Round
and / or Taper 0.025mm
(0.001 in.)
Bearing for Service Std. 0.025mm (0.001 in.),
0.051mm (0.002 in.),
0.076mm (0.003 in.),
0.254mm (0.010 in.),
0.305mm (0.012 in.)

CONNECTING ROD JOURNALS

Diameter 58mm (2.283 in.)
Maximum Allowable Out of Round
and / or Taper 0.025mm
(0.001 in.)

CAMSHAFT

Drive Chain
Bearings Steel Backed Babbitt
Number 4
Diametral Clearance 0.025 to 0.101mm
(0.001 to 0.004 in.)
Maximum Allowable Before
Reconditioning 0.127mm (0.005 in.)
Thrust Taken By Thrust Plate
End Play 0.127 to 0.304mm
(0.005 to 0.012 in.)

CAMSHAFT JOURNALS

No. 1 50.724 to 50.775mm
(1.9970 to 1.9990 in.)
No. 2 50.317 to 50.368mm
(1.9809 to 1.9829 in.)
No. 3 49.936 to 49.987mm
(1.9659 to 1.9679 in.)
No.4 49.530 to 49.581mm
(1.9499 to 1.9520 in.)

SPECIFICATIONS (Continued)

3.3L ENGINE

Camshaft Bearings

Diameter	
No. 1	50.825–50.800 (2.0009–1.9999 inch)
No. 2	50.419–50.393 (1.9849–1.9839 inch)
No. 3	50.038–50.013 (1.9699–1.9690 inch)
No.4	49.632–49.606 (1.9540–1.9529 inch)
Oil Clearance	.0254–.0762 mm (.001–.003 inch)

Valve Timing

Intake Opens (BTC)	2°
Intake Closes (ABC)	58°
Exhaust Opens (BBC)	48°
Exhaust Closes(ATC)	12°
Valve Overlap	14°
Intake Valve Duration	240°
Exhaust Valve Duration	240°

Timing Chain

Number of Links	64
Pitch	.375 inch
Width	.750 inch

Tappets

Type	Roller Hydraulic
Body Diameter	22.94–22.96 mm (0.9035–0.9040 inch)
Clearance to Block	0.027–0.060 mm (0.0011–0.0024 inch)
Service Tappets Available	Std., 0.025 mm (0.001), 0.20 mm (0.008), 0.762 mm

Cylinder Head

Valve Seat Run-Out (Maximum)	0.760 mm (0.003 inch)
Intake Valve Seat Angle	45–45-1/2°
Seat Width (Finished)	1.75–2.25 mm (0.069–0.088 inch)
Exhaust Valve Seat Angle	45–45-1/2°
Seat Width (Finished)	1.50–2.00 mm (0.057–0.078 inch)
Cylinder Head Gasket (Thickness Compressed)	1.78 mm (0.070 inch)

Valve Guides

Type	Powdered Metal Inserts
Guide Bore Diameter	7.975–8.000 mm (0.314–0.315 inch)

Valves-(Intake)

Head Diameter	45.5 mm (1.79 inches)
Length Overall (New)	125.385–126.025 mm (4.936–4.961 inches)
Stem Diameter (Standard)	7.935–7.953 mm (0.312–0.313 inch)
Stem to Guide Clearance	0.025–0.095 mm (0.001–0.003 inch)
Maximum Allowable (By Rocking Method)	0.247 mm (0.010 inch)
Face Angle	44–1/2°
Valves for Service (Oversized Stem Diameter)	Std., 0.015 mm (0.005), 0.40 mm (0.015), 0.80 mm (0.030 inches)
Lift (Zero Lash)	10.16 mm (0.400 inch)
Minimum Valve Length After Grinding Tip	124.892 (4.916 inches)
Valve Tip Height (From Cylinder Head Surface)	49.541–51.271 mm (1.950–2.018 inch)

SPECIFICATIONS (Continued)

3.3L ENGINE

VALVES (EXHAUST)

Head Diameter	37.5 mm (1.476 inch)
Length Overall (New)	126.005–126.645 mm (4.960–4.986 inch)
Stem Diameter (Standard)	7.906–7.924 mm (0.3112–0.3119 inch)
Stem to Guide Clearance	0.051–0.175 mm (0.002–0.006 inch)
Maximum Allowable by Rocking Method	0.414 mm (0.016 inch)
Face Angle	45°
Valves for Service (Oversize Stem Diameter)	Std., 0.015 mm (0.005), 0.40 mm (0.015), 0.80 mm (0.030 inches)
Lift (Zero Lash)	10.16 mm (0.400 inch)
Minimum Valve Length After Grinding Tip	125.512 mm (4.941 inch)
Valve Tip Height (From Cylinder Head Surface)	49.541–51.271 mm (1.950–2.018 inch)

ENGINE VALVE SPRINGS

	Intake/Exhaust
Number	12
Free Length (Approx.)	48.5 mm (1.909 inch)
Wire Diameter	4.75 mm (0.187 inch)
Number of coils	6.8
Load When Compressed to-Valve Closed	95–100 lbs. @ 1.570 inch
-Valve Open	207.229 lbs. @ 1.169 inch
Valve Spring Installed Height (Spring Seat to Retainer)	41.2–42.7 mm (1.622–1.681 inch)

ENGINE LUBRICATION

Pump Type	Rotary Full Pressure
Capacity	4.3 Liters (4.5 qts.) Without Oil Filter Change, 4.7 Liters (5.0 qts.) With Oil Filter Change.
Pump Drive	Crankshaft
Minimum Pressure, Engine Fully Warmed Up at Idle	34.47 kPa (5 psi)
3000 RPM	205–551 kPa (30–80 psi)
Oil Filter Bypass Valve Setting	62–103 kPa (9–15 psi)
Oil Pressure Switch Minimum Actuating Pressure	14–28 kPa (2–4 psi)
Oil Filter Type	Full Flow

OIL PUMP—INSPECTION LIMITS FOR REPLACEMENT

Oil Pump Cover Out of Flat	0.076 mm (0.003) inch or more)
Outer Rotor Thickness	7.64 mm (0.301 inch or less)
Outer Rotor Diameter	79.95 (3.148 inch or less)
Inner Rotor Thickness	7.64 mm (0.301 inch or less)
Clearance Over Rotors—Outer	0.10 mm (0.004 inch or more)
—Inner	0.10 mm (0.004 inch or more)
Outer Rotor Clearance	0.39 mm (0.015 inch or more)
Tip Clearance Between Rotors	0.20 mm (0.008 inch or more)

SPECIFICATIONS (Continued)

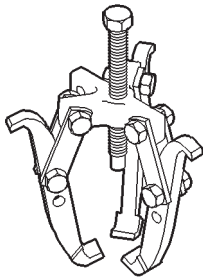
3.3L TORQUE CHART

DESCRIPTION	TORQUE
A/C Compressor Bracket to Water Pump Bolt	41 N·m (30 ft. lbs.)
A/C Compressor to Bracket Bolt	23 N·m (200 in. lbs.)
A/C Compressor Support Bolts	41 N·m (30 ft. lbs.)
Generator Adjusting Strap Bolt	23 N·m (200 in. lbs.)
Generator Adjusting Strap Mounting Bolt	41 N·m (30 ft. lbs.)
Generator Bracket Bolt	41 N·m (30 ft. lbs.)
Camshaft Sprocket Bolt	54 N·m (40 ft. lbs.)
Camshaft Thrust Plate	12 N·m (105 in. lbs.)
Chain Case Cover Bolt M8×1.25	27 N·m (20 ft. lbs.)
M10×1.5	54 N·m (40 ft. lbs.)
Connecting Rod Nut	54 N·m (40 ft. lbs.) + 1/4 Turn
Crankshaft Pulley Screw to Crankshaft	54 N·m (40 ft. lbs.)
Cylinder Head Bolt	33 N·m (25 ft. lbs.)
Cylinder Head Bolt	61, 88, 88 N·m (45, 65, 65 ft. lbs.) + 1/4 Turn
Cylinder Head Covers — Bolt	12 N·m (105 in. lbs.)
Exhaust Manifold Screw	23 N·m (200 in. lbs.)
Exhaust Crossover Pipe Flange Nut/Bolt	33 N·m (25

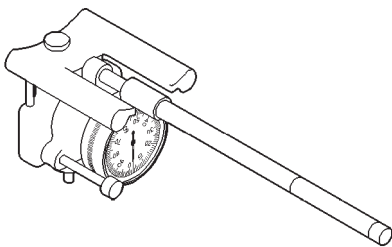
DESCRIPTION	TORQUE
Intake Manifold Bolt	23 N·m (200 in. lbs.)
Intake Manifold Gasket Retaining Screws	12 N·m (105 in. lbs.)
Intake Manifold Plenum Bolt	28 N·m (250 in. lbs.)
Main Bearing Cap Bolt	41 N·m (30 ft. lbs.) + 1/4 Turn
Oil Filter Attaching Nipple	41 N·m (30 ft. lbs.)
Oil Level Sensor Plug	41 N·m (30 ft. lbs.)
Oil Pan Drain Plug	34 N·m (25 ft. lbs.)
Oil Pan Screw	12 N·m (105 in. lbs.)
Oil Pressure Gauge Sending Unit	7 N·m (60 in. lbs.)
Oil Pump Cover Bolt T-30	12 N·m (105 in. lbs.)
Oil Pump Pick-up Tube Screw	28 N·m (250 in. lbs.)
Rocker Shaft Bracket Bolt	28 N·m (250 ft. lbs.)
Spark Plug	27 N·m (20 ft. lbs.)
Starter Mounting Bolt	68 N·m (50 ft. lbs.)
Strut Intake Manifold to Cylinder Head Bolt	54 N·m (40 ft. lbs.)
Tappet Retainer Yoke Screw	12 N·m (105 in. lbs.)
Temperature Gauge Sending Unit	7 N·m (60 in. lbs.)
Water Pump to (Chain Case Cover) Bolt	12 N·m (105 in.+— lbs.)

SPECIAL TOOLS

3.3L ENGINE

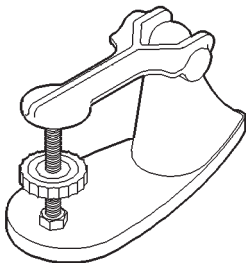


Puller 1023

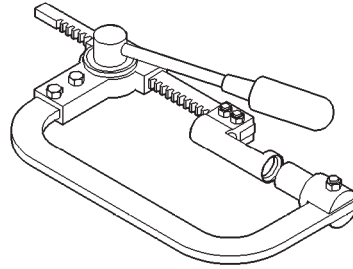


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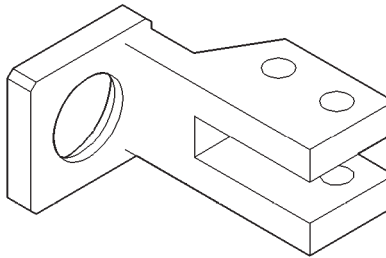
Cylinder Bore Indicator C-119



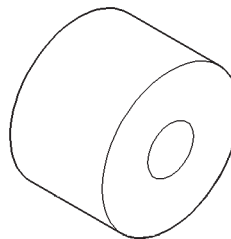
Tester Valve Spring C-647



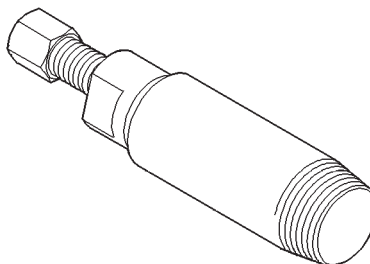
Valve Spring Compressor C-3422-B



Valve Compressor Adapter 6412

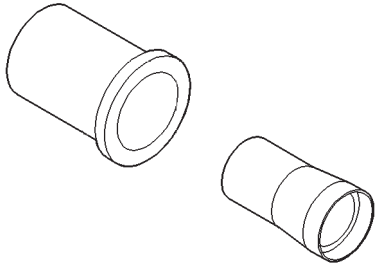


Crankshaft Pulley Remover L-4524-1

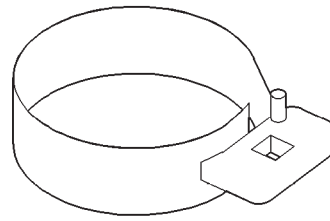


Crankshaft Seal Remover 6341A

SPECIAL TOOLS (Continued)

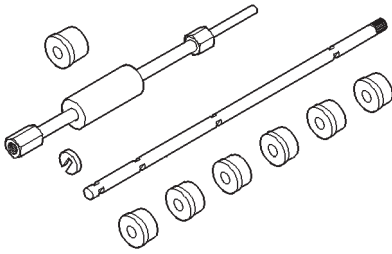


Front Crankshaft Seal Installer C-4992

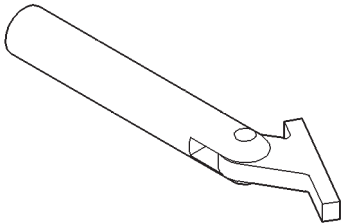


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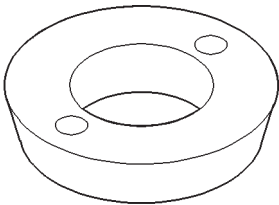
Oil Filter Wrench C-4065



Camshaft Bearing Remover/Installer C-3132-A



Crankshaft Main Bearing Remover/Installer C-3059



Rear Crankshaft Seal Pilot Tool C-4681

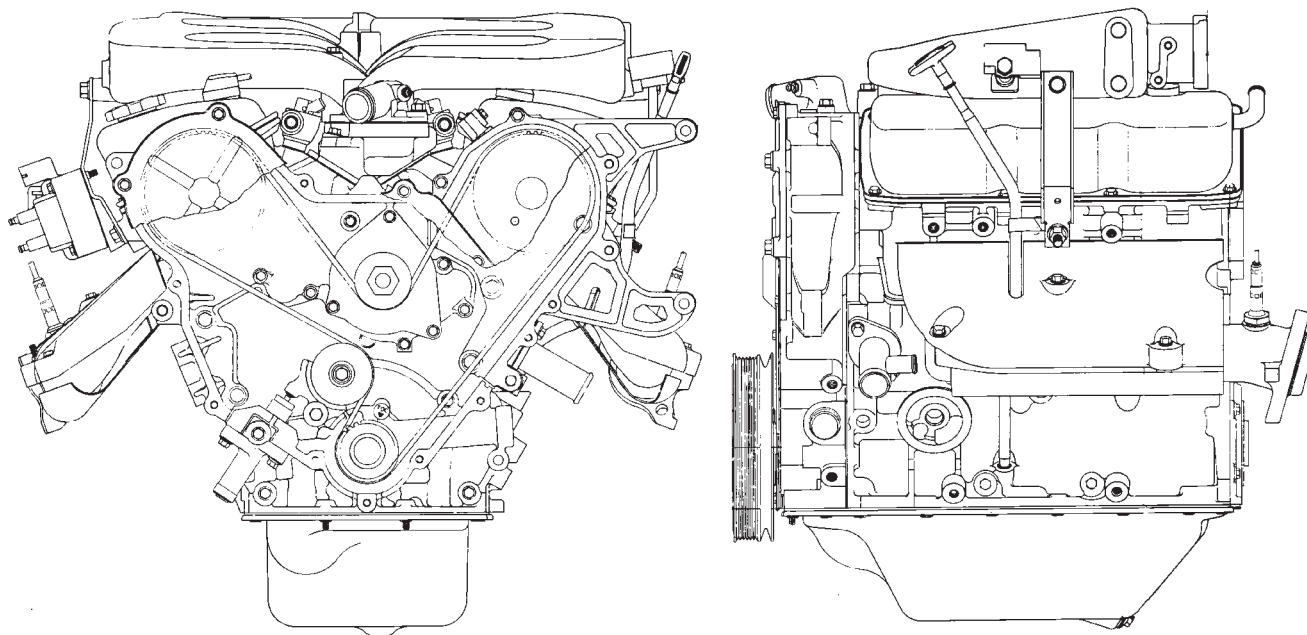
3.5L ENGINE

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DESCRIPTION AND OPERATION

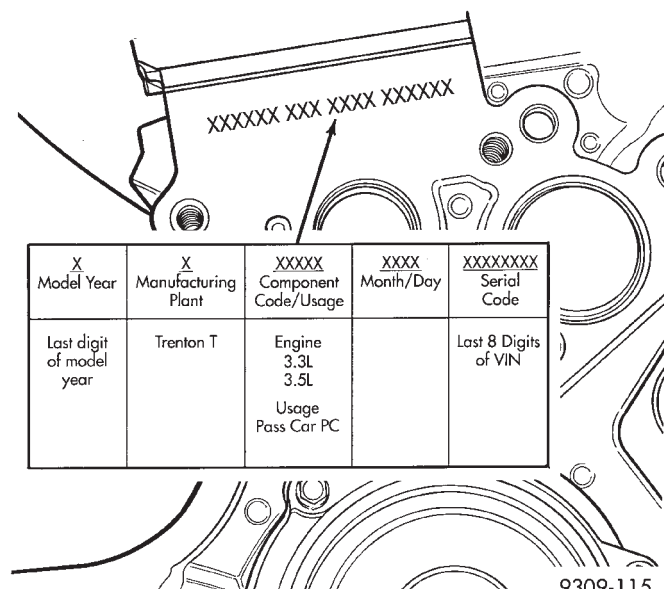
3.5L ENGINE



9309-113

ENGINE IDENTIFICATION NUMBER

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



9309-115

Fig. 1 Engine Identification

GENERAL SPECIFICATIONS

Type 60° V-6 Engine
 Bore 96 mm (3.780 Inch)
 Stroke 81 mm (3.189 Inch)
 Compression Ratio 9.6:1
 Displacement 3.5 Liters (215 Cubic Inch)
 Brake Horsepower 214 @5800 RPM
 Torque 221 Lb. Ft. @3100 RPM
 Firing Order 1, 2, 3, 4, 5, 6
 Lubrication Pressure Feed-Full Flow Filtration
 (Direct Crankshaft Driven Pump)
 Engine Oil Capacity . 5.2 Liter (5.5 Qts.) Including Oil Filter, 4.7 Liter (5.0 Qts.) Without Oil Filter.
 Cooling System ... Liquid Cooled-Forced Circulation
 Cylinder Block Cast Iron
 Crankshaft Forged Steel
 Cylinder Head Aluminum Alloy
 Connecting Rods Forged Steel
 Pistons Aluminum Alloy (W/Strut)

DESCRIPTION AND OPERATION (Continued)

ENGINE LUBRICATION SYSTEM

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

ENGINE COMPONENTS**BLOCK**

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

CRANKSHAFT

A six throw, five weight crankshaft is supported by four main bearings with number two being the thrust bearing. The six separate connecting rod throws are an even-firing design which reduces torque fluctuations while a torsional vibration damper is used to control torsion caused vibration of the crankshaft. Rubber lipped seals are used at front and rear. The

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

PISTONS

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

CYLINDER HEAD

The aluminum alloy cylinder heads feature cross-flow type intake and exhaust ports. Valve guides and seat inserts are powdered metal. Valves of heat resistant steel are arranged in a "V" with each camshaft on center. To improve combustion speed the chambers are a compact spherical design with a squish area of approximately 30 percent of the piston top area. The cylinder heads are common to either cylinder bank by reversing the direction of installation.

CAMSHAFTS

A single overhead camshaft per cylinder head provides valve actuation. The left camshaft is provided with a DIS pick-up wheel and is longer. Both camshafts are supported by four bearing journals. Thrust

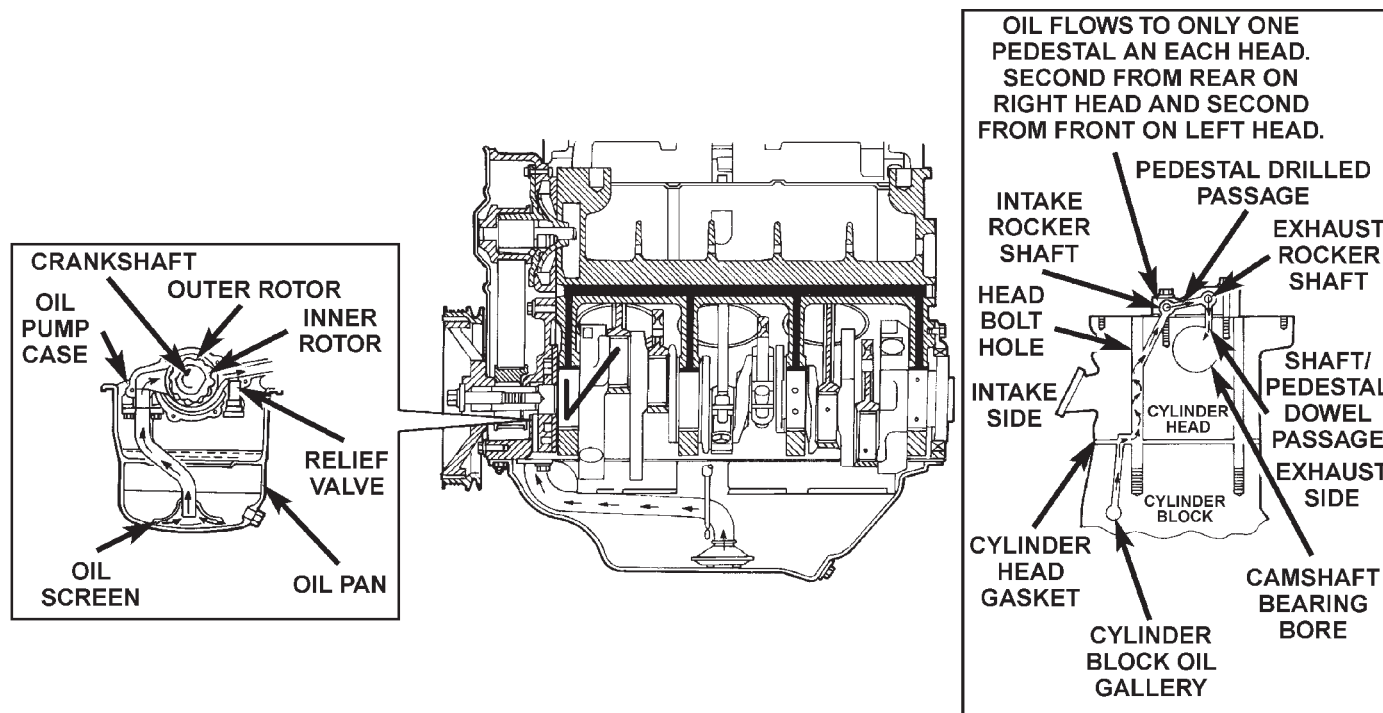


Fig. 2 Engine Oiling

DESCRIPTION AND OPERATION (Continued)

for the camshafts is taken at the thrust plate attached to the rear of the cylinder head. Right and left camshaft driving sprockets are not interchangeable. The sprockets and the engine water pump are driven by a single notched timing belt. Camshaft bearing lubrication is provided via oil feed passage through each pedestal dowel.

ROCKER ARM SHAFTS

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

ROCKER ARMS

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

VALVES

Valves are made of heat resistant steel and are chrome plated to prevent scuffing.

VALVE SPRINGS

Springs are unique for intake and exhaust. Valve spring retainers and locks are common. The valve spring seat is integral with the valve stem oil seal which incorporates a garter spring.

INTAKE MANIFOLD

The aluminum alloy manifold is a cross-flow type with long runners to improve inertia. The air plenum chambers absorb air pulsations created during the suction phase of each cylinder. A manifold tuning valve (MTV) connects the plenums at specific engine speeds to maximize low rpm torque without reducing high rpm power.

EXHAUST MANIFOLDS

Both manifolds are a log style made of ductile cast iron.

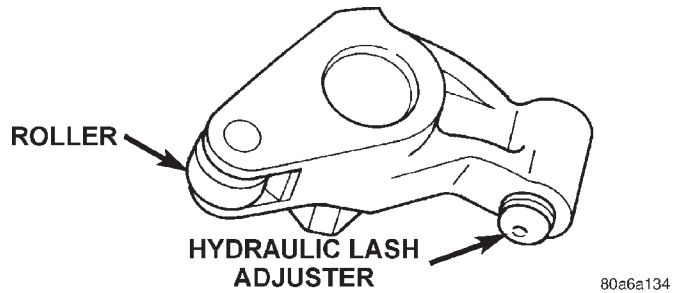
ENGINE LUBRICATION

System is a full flow filtration, pressure feed type. The oil pump body is mounted to the engine block. The pump inner rotor is driven by the crankshaft. A windage tray, integral with the oil pan gasket, increases power by minimizing oil windage at high engine rpm.

DIAGNOSIS AND TESTING

HYDRAULIC LASH ADJUSTER

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



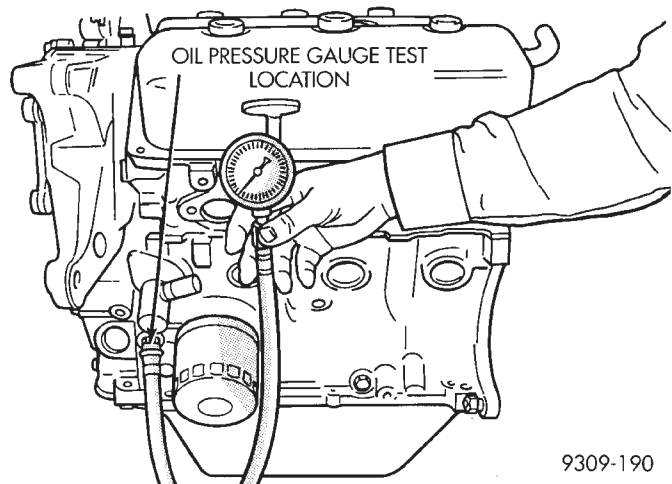
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Fig. 3 Hydraulic Lash Adjuster

CHECKING ENGINE OIL PRESSURE

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

(1) Remove pressure sending unit and install oil pressure gauge (Fig. 4).



9309-190

Fig. 4 Checking Oil Pump Pressure

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

(2) Warm engine until thermostat opens.

TESTING VALVE SPRINGS

VALVE SPRING IDENTIFICATION

The valve springs are two different lengths and are wound in different directions. The valve springs are color coded, intake spring is right hand coil direction

DIAGNOSIS AND TESTING (Continued)

with white dye on the top coils and the exhaust spring is left hand coil direction with a pink dye on the top coils (Fig. 5).

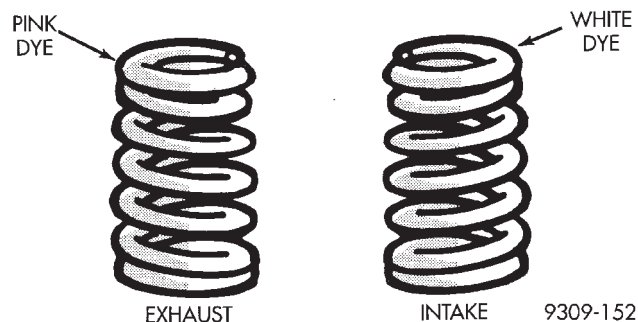


Fig. 5 Valve Spring Identification

TESTING VALVE SPRINGS

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested (Fig. 6). **As an example;** the compression length of the spring to be tested is 38.00 mm (1.496 inches.). Turn table of Tool C-647 until surface is in line with the 38.00 mm (1.496 inches.) mark on the threaded stud and the zero mark on the front. Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by two. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to Specifications Section to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.

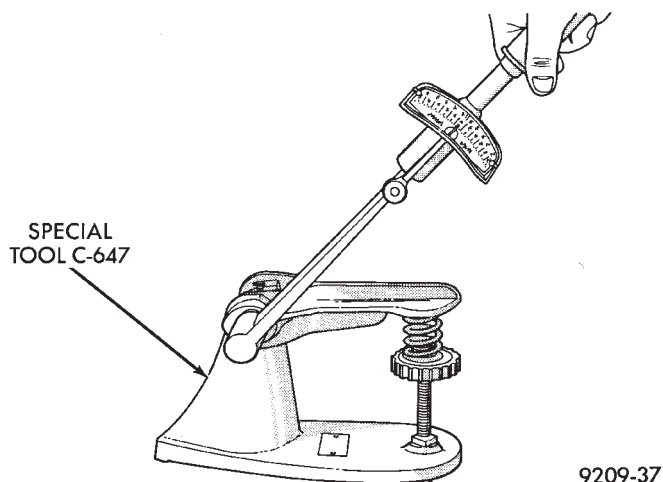


Fig. 6 Testing Valve Spring with Tool C-647

SERVICE PROCEDURES

FINISHED PISTONS

Pistons are machined to two different weight specifications and matched to rods based on weight. All

piston and rod assemblies weigh the same, to maintain engine balance. For cylinder bores which have been honed, new piston and connecting rod assemblies are available for service.

FITTING PISTONS

Piston and cylinder wall must be clean and dry. Piston diameter should be measured 90 degrees to piston pin at size location shown in (Fig. 8). Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line. Refer to (Fig. 7) for specifications. **Pistons and cylinder bores should be measured at normal room temperature, 70°F (21°C).**

Engine	Standard Bore	Maximum Out-of-Round	Maximum Taper
3.5L	96.0 mm (3.780 inch.)	.076 mm (.003 inch.)	0.051 mm (.002 inch.)
Standard Piston Size			
3.5L 95.999 - 95.961 mm (3.7795 - 3.7780 inch.)			
Piston to Bore Clearance: -0.007 to +0.047 mm (-0.0003 to 0.0018 in.) Measurements taken at Piston Size location.			

Fig. 7 Cylinder Bore and Piston Specifications

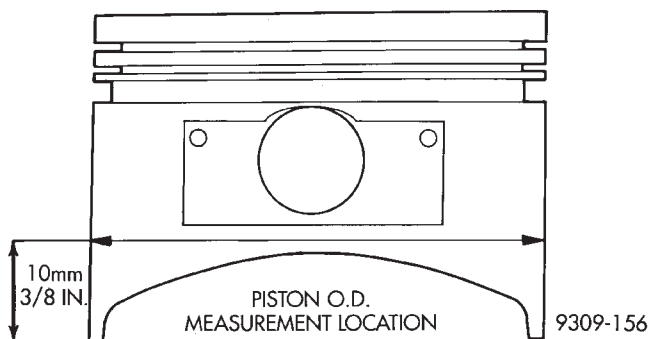


Fig. 8 Piston Measurements

PISTON PINS

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

FITTING PISTON RINGS

(1) Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioning at least 12 mm (0.50 inch.) from bottom of cylinder bore. Check gap with feeler gauge (Fig. 9). Refer to specifications (Fig. 10).

SERVICE PROCEDURES (Continued)

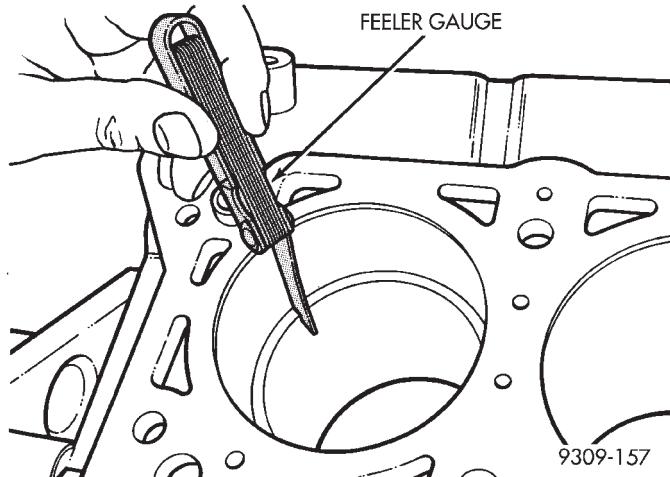


Fig. 9 Check Gap on Piston Rings

Ring Position	Ring Gap	Wear Limit
Upper Ring	0.20 to 0.36 mm (.008 to .014 in.)	0.64 mm (.027 in.)
Intermediate Ring	0.30 to 0.55 mm (.012 to .021 in.)	0.8 mm (.031 in.)
Oil Control Ring	0.25 to 0.76 mm (.010 to .030 in.)	1.0 mm (.039 in.)
Ring Position	Groove Clearance	Maximum Clearance
Upper Ring	0.03 to 0.08 mm (.0011 to .0031 in.)	.10 mm (.004 in.)
Intermediate Ring	0.03 to 0.08 mm (.0011 to .0031 in.)	.10 mm (.004 in.)
OIL CONTROL RING - THREE PIECE. OIL RING SIDE RAILS MUST BE FREE TO ROTATE AFTER ASSEMBLY		

9509-367

Fig. 10 Piston Ring Specifications

(2) Check piston ring to groove clearance: (Fig. 11). Refer to specification (Fig. 10).

PISTON RINGS—INSTALLATION

(1) The No. 1 and No. 2 piston rings have a different cross section. Install rings with manufacturers I.D. mark facing up, to the top of the piston (Fig. 12).

CAUTION: Install piston rings in the following order:

- (2) Oil ring expander.
- (3) Upper oil ring side rail.
- (4) Lower oil ring side rail.
- (5) No. 2 Intermediate piston ring.
- (6) No. 1 Upper piston ring.

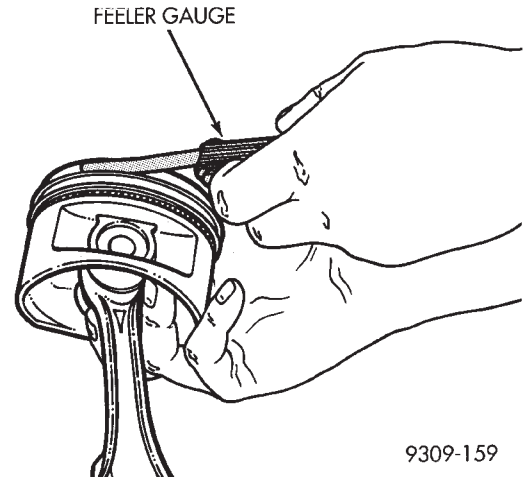


Fig. 11 Measuring Piston Ring Side Clearance

(7) Install the side rail by placing one end between the piston ring groove and the expander. Hold end firmly and press down the portion to be installed until side rail is in position. **Do not use a piston ring expander during this step (Fig. 13).**

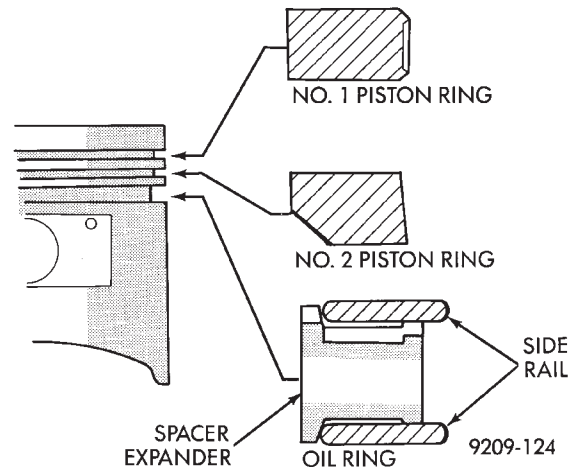


Fig. 12 Piston Ring—Installation

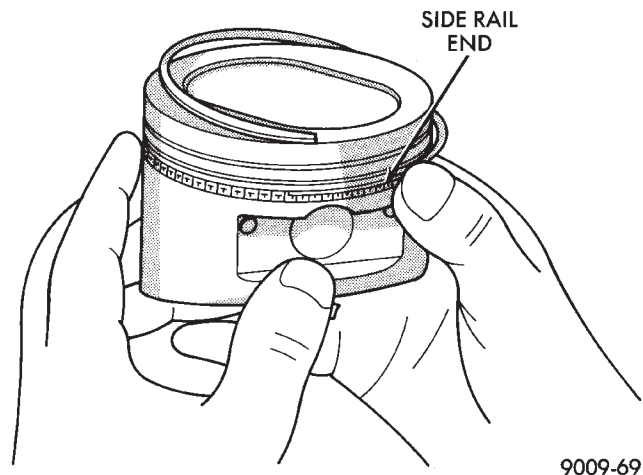
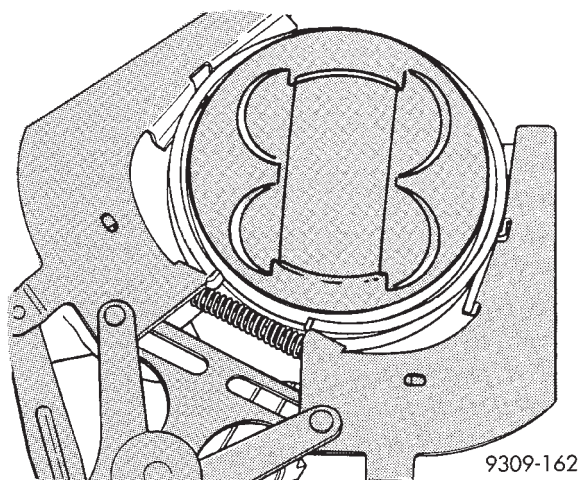


Fig. 13 Side Rail—Installation

SERVICE PROCEDURES (Continued)

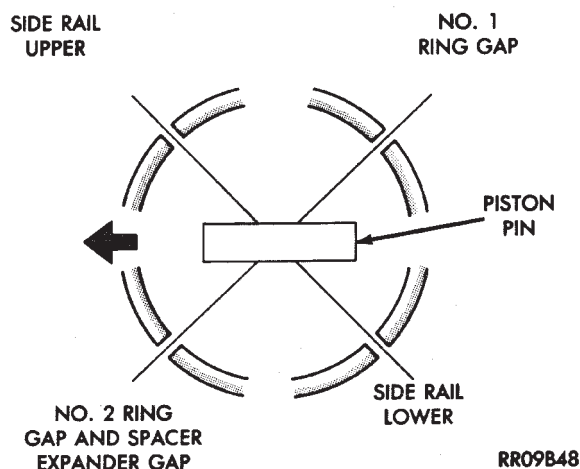
**Fig. 14 Upper and Intermediate Rings—Installation**

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

(9) Install No. 2 piston ring and then No. 1 piston ring (Fig. 14).

(10) Position piston ring end gaps as shown in (Fig. 15).

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

**Fig. 15 Piston Ring End Gap Position****INSTALLATION OF CONNECTING ROD BEARINGS**

Fit all rods on one bank until complete.

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

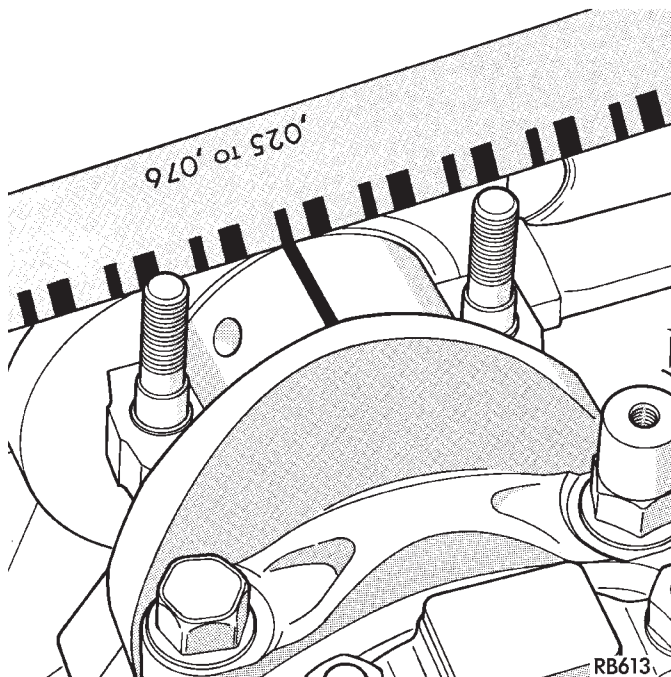
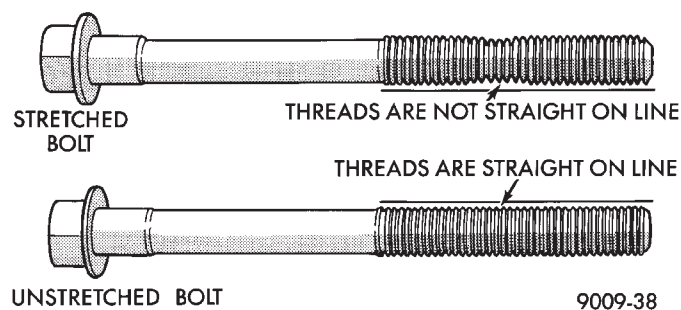
The bearing shells must be installed with the tangs inserted into the machined grooves in the rods and caps. Install cap with the tangs on the same side as the rod.

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 inch.).

Bearings are available in 0.025 mm (0.001 inch.), 0.051 mm (0.002 inch.), 0.076 mm (0.003 inch.), 0.254 mm (0.010 inch.) and 0.305 mm (.012 inch.) under-size. **Install the bearings in pairs. Do not use a new bearing half with an old bearing half. Do not file the rods or bearing caps.**

(1) Follow procedure specified in the Standard Service Procedure Section for Measuring Main Bearing Clearance and Connecting Rod Bearing Clearance (Fig. 16).

NOTE: The rod bearing bolts should be examined before reuse. If the threads are necked down the bolts should be replaced (Fig. 17).

**Fig. 16 Checking Connecting Rod Bearing Clearance—Typical****Fig. 17 Check for Stretched Bolts**

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

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

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

SERVICE PROCEDURES (Continued)

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

(6) Using a feeler gauge, check connecting rod side clearance (Fig. 18). Refer to (Fig. 19) for specifications.

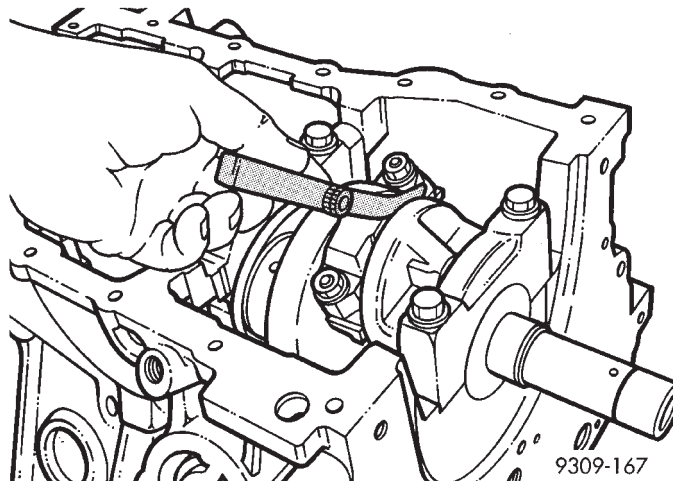


Fig. 18 Checking Connecting Rod Side Clearance

CONNECTING ROD BEARING OIL CLEARANCE	
New Part:	.019 to .087 mm (.0008 to .0034 in.)
Wear Limit:	0.095 mm (0.0037 in.)
CONNECTING ROD SIDE CLEARANCE	
New Part:	0.13 to 0.38 mm (.005 to .015 in.)
Wear Limit:	0.40 mm (0.0157 in.)

Fig. 19 Connecting Rod Specifications

FITTING MAIN BEARINGS

CRANKSHAFT OIL CLEARANCE

(1) Measure the journal outside diameter as shown in (Fig. 20). Refer to Crankshaft Specification Table.

CRANKSHAFT MAIN JOURNALS

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

CAUTION: Forged steel crankshafts require that the final paper or cloth polish after any journal regrind be in the same direction as normal rotation in the engine.

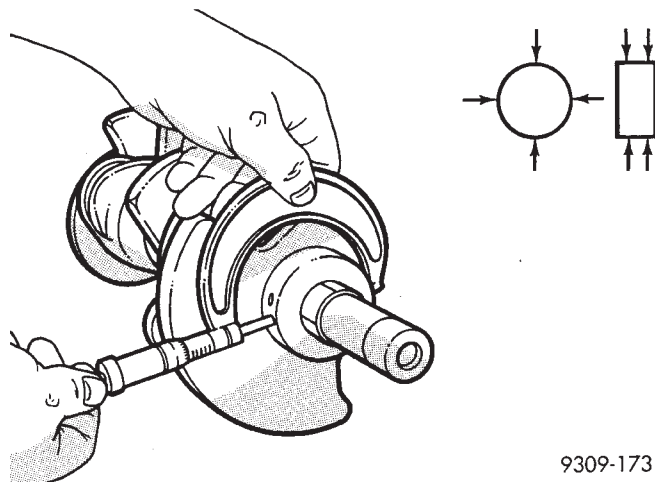


Fig. 20 Measure Crankshaft Journal O.D.
CRANKSHAFT SPECIFICATION

Main Bearing Clearance	
New Part	0.011 to 0.077 mm (0.0004 to 0.003 in.)
Wear Limit	0.087 mm (0.0034 in.)
Connecting Rod Bearing Clearance	
New Part	0.019 to 0.087 mm (0.00075 to 0.0034 in.)
Wear Limit	0.095 mm (0.0037 in.)
Crankshaft Journal Sizes	
Crankshaft Main Bearing Journal Diameter	
Standard	63.987 to 64.013 mm (2.519 to 2.520 in.)
Crankshaft Connecting Rod Journal	
Standard	57.979 to 58.005 mm (2.283 to 2.284 in.)
Crankshaft End-Play	
New Part	0.10 to 0.30 mm (0.004 to 0.012 in.)
Wear Limit	0.43 mm (0.017 in.)

PLASTIGAGE (OIL CLEARANCE) MEASUREMENT

- (2) Remove oil from journal and bearing shell.
- (3) Install crankshaft.
- (4) Cut plastigage to same length as width of the bearing and place it in parallel with the journal axis (Fig. 21).
- (5) Install the main bearing cap carefully and tighten the bolts to specified torque.

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

(6) Carefully remove the bearing cap and measure the width of the plastigage at the widest part using the scale on the plastigage package (Fig. 21). Refer to Crankshaft Specification Table for proper clearances. If the clearance exceeds the specified limits. Replace

SERVICE PROCEDURES (Continued)

the main bearing(s) and if necessary have the crankshaft machined to next undersize. Also see Measuring Main and Connecting Rod Bearing Clearance in Standard Service Procedures.

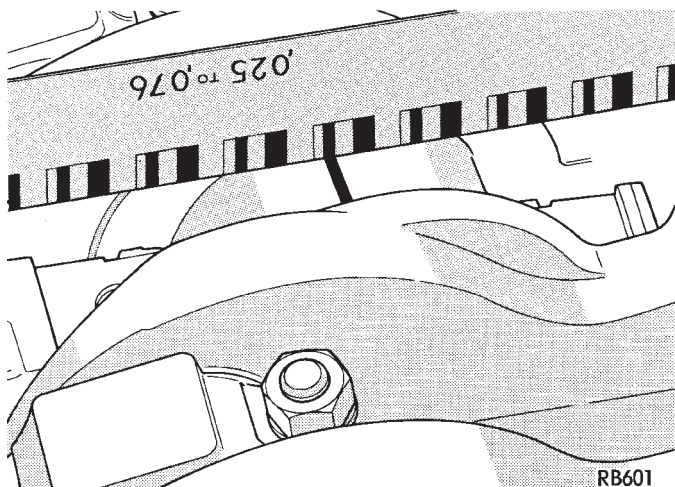


Fig. 21 Measuring Bearing Clearance with Plastigage—Typical

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

CHECKING CRANKSHAFT END PLAY

- (1) Mount a dial indicator to front of engine, locating probe on nose of crankshaft (Fig. 22).
- (2) Move crankshaft all the way to the rear of its travel.
- (3) Zero the dial indicator.
- (4) Move crankshaft all the way to the front and read the dial indicator. Refer to Crankshaft End Play Table for specification.

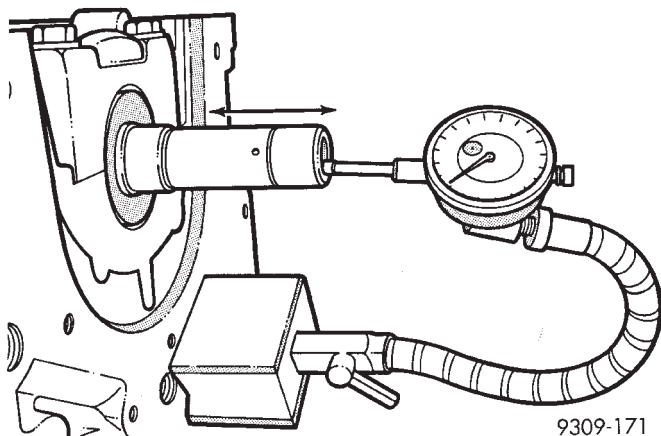


Fig. 22 Checking Crankshaft End Play

Crankshaft End-Play	
New Part	0.10 to 0.30 mm (0.004 to 0.012 in.)
Wear Limit	0.43 mm (0.017 in.)

CRANKSHAFT END PLAY CHECK—OPTIONAL

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

(2) Use a feeler gauge between number 2 thrust bearing and machined crankshaft surface to determine end play. Refer to Crankshaft End Play Table for specification.

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 44.5 to 45 degree face angle. The valve seats have a 45 to 45.5 degree face angle. The valve face and valve seat angles are shown in (Fig. 24).

Face Angle	
Intake and Exhaust	44½ - 45°
Head Diameter	
Intake	34.87 - 35.13 mm (1.3728 - 1.3831 in.)
Exhaust	28.87 - 29.13 mm (1.1366 - 1.1468 in.)
Length (Overall)	
Intake	114.41 - 114.99 mm (4.5043 - 4.5272 in.)
Exhaust	125.67 - 126.25 mm (4.9476 - 4.9705 in.)
Stem Diameter	
Intake	6.935 - 6.953 mm (0.2730 - 0.2737 in.)
Exhaust	6.906 - 6.924 mm (0.2719 - 0.2726 in.)
Valve Margin	
Intake	1.02 - 1.35 mm (0.402 - 0.0531 in.)
Exhaust	1.44 - 1.77 mm (0.0567 - 0.0697 in.)

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Fig. 23 Valve Specifications

VALVES

(1) Inspect the remaining margin after the valves are refaced Refer to specifications (Fig. 23).

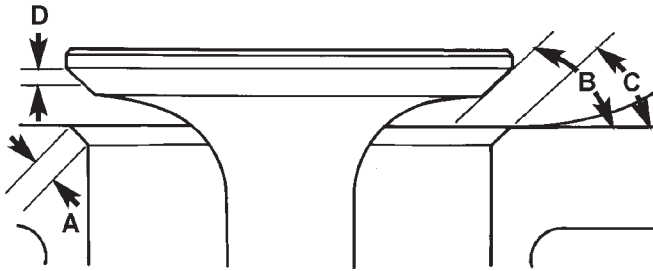
VALVE SEATS

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

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

(3) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is trans-

SERVICE PROCEDURES (Continued)



- A- SEAT WIDTH (INTAKE 0.75 TO 1.25mm) (0.30 TO 0.049 IN.) EXHAUST: 1.25 TO 1.75mm (0.049 TO 0.069 IN.)
 B- FACE ANGLE (INTAKE & EXHAUST: 44 1/2°-45°)
 C- SEAT ANGLE (INTAKE & EXHAUST: 45°-45 1/2°)
 D- SEAT CONTACT AREA

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Fig. 24 Valve Seats

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

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

(4) When seat is properly positioned the width of the intake and exhaust seats should be 1.25 to 1.75 mm (0.049 to 0.069 inch.) (Fig. 24).

(5) Check the valve spring installed height after refacing the valve and seat (Fig. 26).

VALVE SPRING IDENTIFICATION

The valve springs are two different lengths and are wound in different directions. The valve springs are color coded, intake spring is right hand coil direction with white dye on the top coils and the exhaust spring is left hand coil direction with a pink dye on the top coils (Fig. 25).

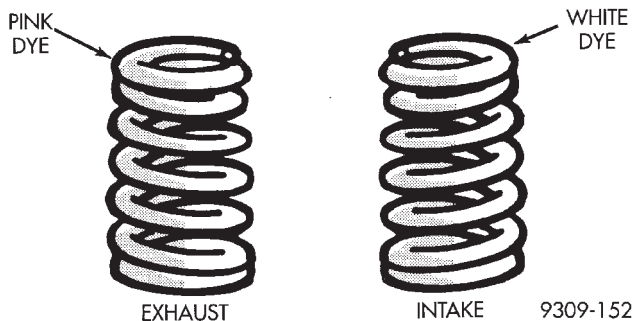


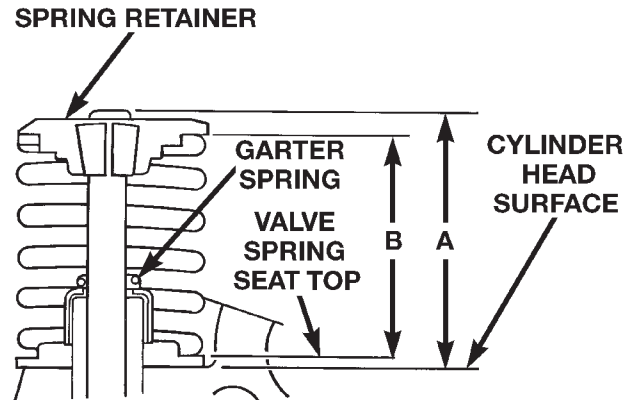
Fig. 25 Valve Spring I.D.

VALVE INSTALLATION

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

(2) If valves or seats have been reground, check valve tip height (A) (Fig. 26). If valve tip height is greater than 43.65 mm (1.7185 in.) intake or 45.98

mm (1.8102 in.) exhaust, grind valve tip until within specifications. Make sure measurement is taken from cylinder head surface to the top of valve stem.

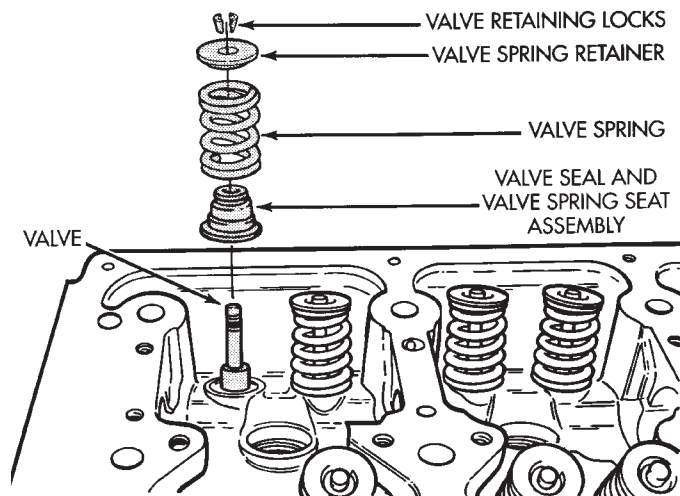


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Fig. 26 Checking Valve Tip Height and Valve Spring Installed Height

(3) Install valve seal/spring seat assembly over valve guides on all valve stems (Fig. 27). Ensure that the garter spring is intact around the top of the rubber seal. Install valve springs, valve retainers.

(4) Compress valve springs with a valve spring compressor install locks and release tool. **If valves and/or seats are reground, measure the installed height of springs (B) (Fig. 26), make sure measurements are taken from top of spring seat to the bottom surface of spring retainer .** If height is greater than 38.75 mm (1.5256 in.), install a .762 mm (0.030 in.) spacer in head counterbore under the valve spring seat to bring spring height back within specification.



9309-150

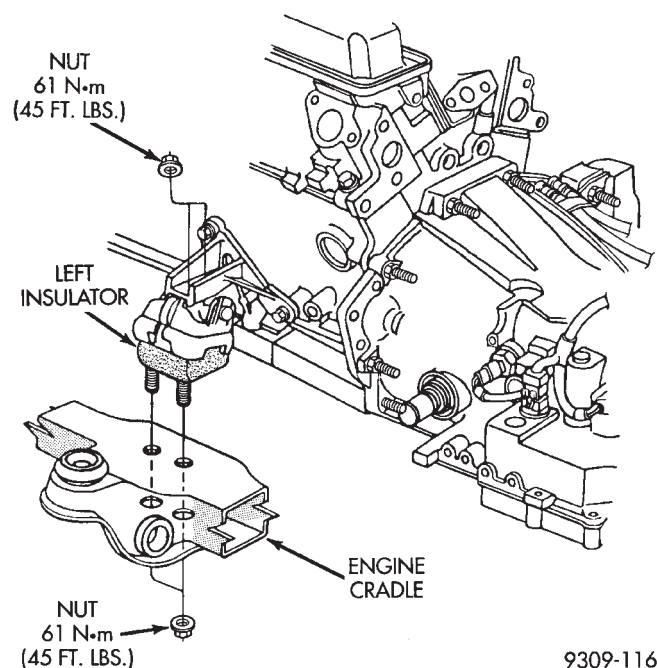
Fig. 27 Valve Seal and Spring—Installation

REMOVAL AND INSTALLATION

ENGINE MOUNTS—LEFT AND RIGHT

REMOVAL

- (1) Raise vehicle on hoist.
- (2) Remove engine mount heat shield.
- (3) Remove the isolator attaching nuts from top of the mounting bracket.
- (4) Support the engine with a jack and a block of wood across the full width of the oil pan.
- (5) Remove the lower attaching nuts from the bottom of the isolator to the frame (Fig. 28).
- (6) Raise engine carefully with jack enough to remove the isolator from its mount.



9309-116

Fig. 28 Engine Mounting—Typical

INSTALLATION

- (1) Install mount onto the frame.
- (2) Lower the engine onto the isolator mount (Fig. 28).
- (3) Remove jack from vehicle.
- (4) Tighten the isolator to frame nuts to 61 N·m (45 ft. lbs.).
- (5) Install the upper attaching nuts to mount and tighten to 61 N·m (45 ft. lbs.).
- (6) Install heat shield and lower vehicle.

ENGINE HYDRO-MOUNT INSULATORS

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

- Driveshaft distress: Refer to Driveshafts in Suspension, Group 2.

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

REAR MOUNT

- (1) Raise vehicle on hoist.
- (2) Support the transmission with a transmission jack.
- (3) Remove the insulator through bolt from the mount.
- (4) Remove the transmission mount fasteners and remove mount.
- (5) Reverse removal procedure for installation. Refer to Torque Specifications in this section.

ENGINE ASSEMBLY

REMOVAL

- (1) Disconnect battery.
- (2) Mark hood position at hinges and remove hood.
- (3) Remove wiper motor and linkage module. Refer to Group 8K, Windshield Wiper And Washer System for procedure.
- (4) Drain cooling system. Refer to Group 7, Cooling System for draining procedure.
- (5) Disconnect all electrical connectors.
- (6) Remove coolant hoses from radiator and engine.
- (7) Remove radiator and fan assembly. Refer to Group 7, Cooling System for procedure.
- (8) See Group 14, Fuel System For procedures to release fuel pressure, disconnect fuel lines and accelerator cable.
- (9) Remove air cleaner assembly.
- (10) Hoist vehicle.
- (11) Drain engine oil.
- (12) Remove air conditioning compressor mounting bolts and set compressor aside.
- (13) Disconnect exhaust pipes at manifolds.
- (14) Remove transmission inspection cover and mark flex plate to torque converter position.
- (15) Remove bolts holding torque converter to flex plate and attach C-clamp on bottom of converter housing to prevent torque converter from coming out.
- (16) Remove power steering pump mounting bolts and set pump aside.
- (17) Remove two lower transmission to block bolts.
- (18) Remove starter.
- (19) Lower vehicle and disconnect vacuum lines and ground strap.
- (20) Insert floor jack with small block of wood under transmission pan to support transmission.
- (21) Attach lifting hoist to the front of engine and to the rear exhaust manifolds.
- (22) Remove upper transmission case to block bolts.
- (23) Hoist engine from engine compartment.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

- (1) Attach hoist and lower engine into engine compartment.
- (2) Align engine mounts and install but **do not tighten** until all mounting bolts have been installed. Tighten bolts to torque specified in (Fig. 28).
- (3) Install transmission case to cylinder block, tighten bolts to 102 N·m (75 ft. lbs.) torque.
- (4) Remove engine hoist and transmission holding fixture.
- (5) Remove C clamp from torque converter housing. Align flex plate to torque converter and install mounting bolts. Tighten to 75 N·m (55 ft. lbs.)
- (6) Install transmission inspection cover.
- (7) Connect exhaust system at manifold.
- (8) Install starter.
- (9) Install power steering pump and air conditioning compressor. For belt installation Refer to Group 7, Accessory Belt Drive in Cooling System.
- (10) Lower vehicle and connect all vacuum lines.
- (11) Connect all electrical connections including ground strap.
- (12) Connect fuel lines and accelerator cable.
- (13) Install radiator and fan assembly. Connect fan motor electrical lead. Install radiator hoses. Fill cooling system. Refer to Group 7, Cooling System for filling procedure.
- (14) Fill engine crankcase with proper oil to correct level.
- (15) Install wiper motor and linkage module. Refer to Group 8K, Windshield Wiper And Washer System for procedure.
- (16) Install hood.
- (17) Connect battery.
- (18) Start engine and run until operating temperature is reached.
- (19) Adjust transmission or linkage if necessary.

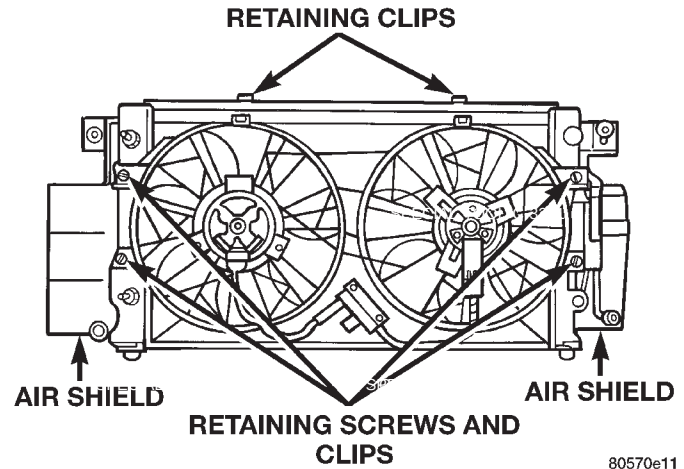
CRANKSHAFT DAMPER

REMOVAL

- (1) Disconnect battery.
- (2) Remove upper radiator crossmember.
- (3) Remove fan module (Fig. 29).
- (4) Remove the accessory drive belts. Refer to Group 7, Accessory Drive System for service procedure.
- (5) Use Special Tool C-3281 to hold crankshaft damper while removing center bolt.
- (6) Use Special Tool 1023 puller, and insert C-4685-C2, remove crankshaft damper (Fig. 30).

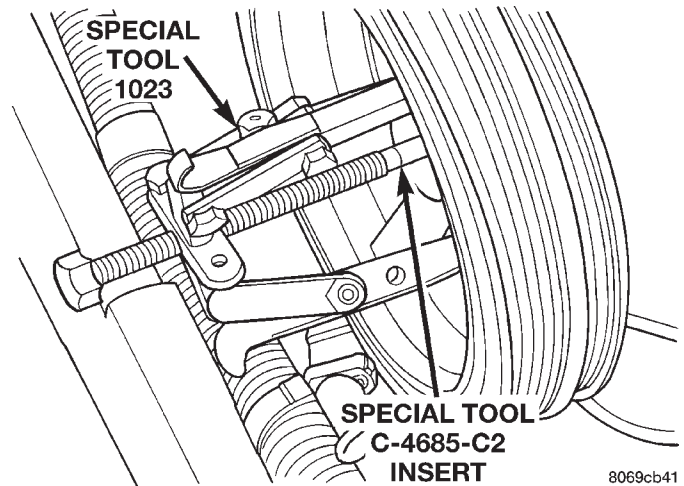
INSTALLATION

- (1) Install crankshaft damper with 5.9 in. Bolt, Thrust Bearing and Washer, Plate L-4524, while holding it with Special Tool C-3281 (Fig. 31). Install center bolt and tighten to 115 N·m (85 ft. lbs.).



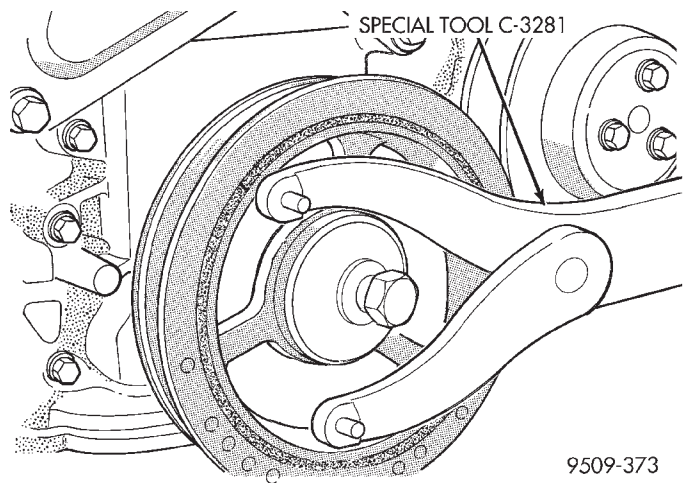
80570e11

Fig. 29 Fan Module—Removal



8069cb41

Fig. 30 Crankshaft Damper—Removal



9509-373

Fig. 31 Crankshaft Damper—Installation

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

REMOVAL AND INSTALLATION (Continued)

CYLINDER HEAD COVER

REMOVAL

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

(1) Remove air cleaner assembly and intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold for procedure.

(2) Cover lower intake manifold with a suitable cover during service (Fig. 32).

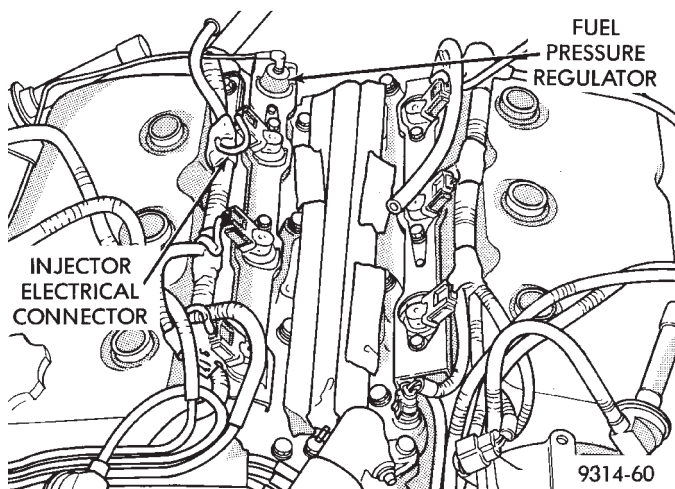


Fig. 32 Cover Lower Intake Manifold With Tape

- (3) Disconnect and relocate spark plug wires.
- (4) Loosen the A/C compressor mounting bracket and pull away from cylinder head.
- (5) Remove spark plug tube nut and O-ring (Fig. 33).
- (6) Remove rocker cover bolts and remove cover (Fig. 34).

INSTALLATION

- (1) Clean cylinder head and cover mating surfaces. Install new gasket.
- (2) Install cylinder head cover bolts to 12 N·m (105 in. lbs.).
- (3) Install spark plug tube nut and O-ring. Tighten nut to 7 N·m (60 in. lbs.).

SPARK PLUG TUBES

REMOVAL

- (1) Remove cylinder head cover. Refer to procedure outlined in this section.
- (2) Using locking pliers remove the tube from the cylinder head (Fig. 35). Discard old tube.
- (3) Clean area around spark plug with MOPAR parts cleaner or equivalent.

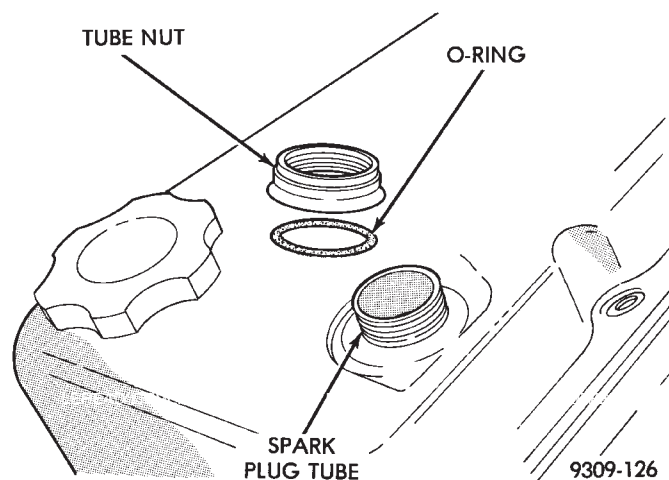


Fig. 33 Spark Plug Tube Assembly

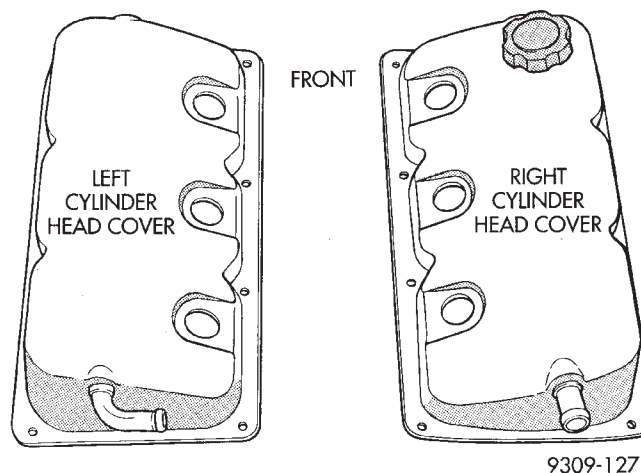


Fig. 34 Cylinder Head Cover Assemblies

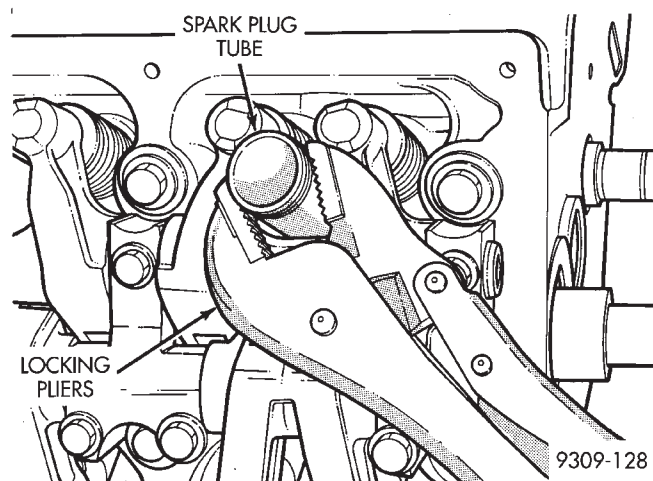


Fig. 35 Servicing Spark Plug Tubes

INSTALLATION

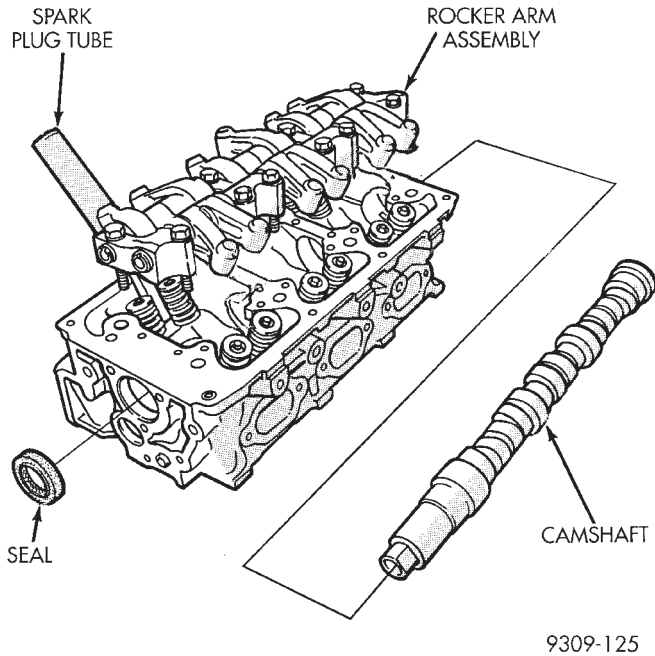
- (1) New tubes have sealer applied to them. **Do Not Use Additional Sealer On Tube.**

REMOVAL AND INSTALLATION (Continued)

(2) Install **New Tube** using the spark plug tube nut and a 32 mm socket **Immediately** tighten to 61 N·m (45 ft. lbs.).

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

CYLINDER HEAD



Cylinder Head, Camshaft, and Rocker Arms

REMOVAL

- (1) Remove crankshaft damper.
- (2) Remove timing belt covers.
- (3) Remove camshaft sprockets. Refer to Camshaft Sprocket and Engine Timing Procedure in this section.
- (4) Remove intake manifold assembly. Refer to Group 11, Intake and Exhaust Manifolds, for procedure.
- (5) Remove rear timing belt cover to cylinder head fasteners (Fig. 36). Remove the rear covers.
- (6) The right side timing belt cover has O-rings located behind it for water pump passages (Fig. 37).
- (7) Remove cylinder head bolts and remove cylinder head.

INSTALLATION

The cylinder head bolts are tightened using a torque-to-yield procedure. The bolts must be examined **BEFORE** reuse. If the threads are necked down the bolts should be replaced (Fig. 38).

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

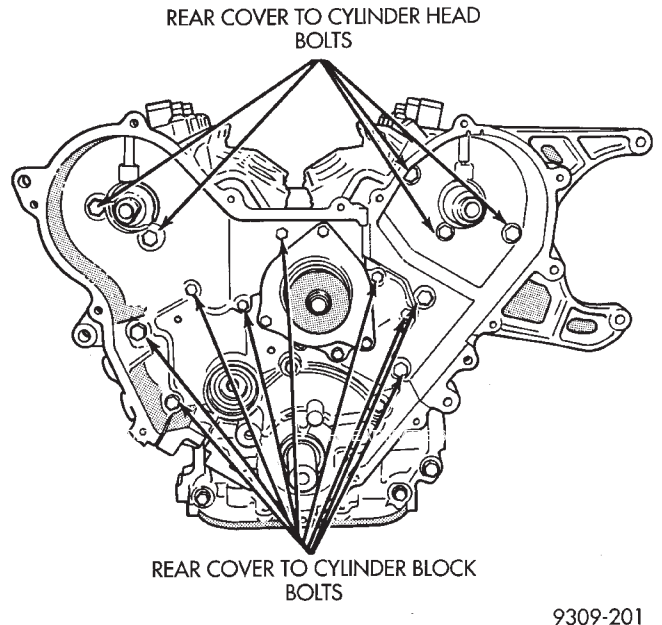


Fig. 36 Rear Timing Belt Cover Attaching Bolts

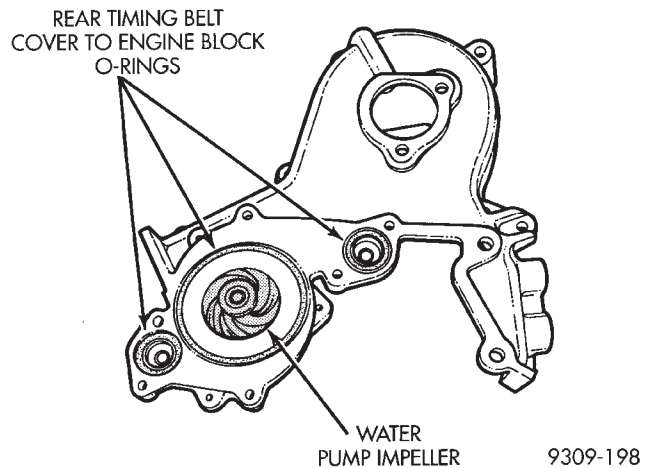


Fig. 37 Right Side Timing Belt Cover Water Pump O-Rings

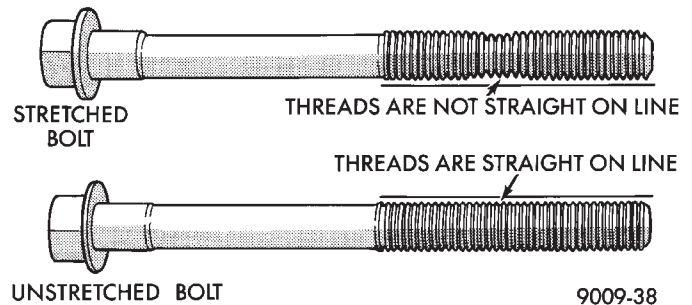
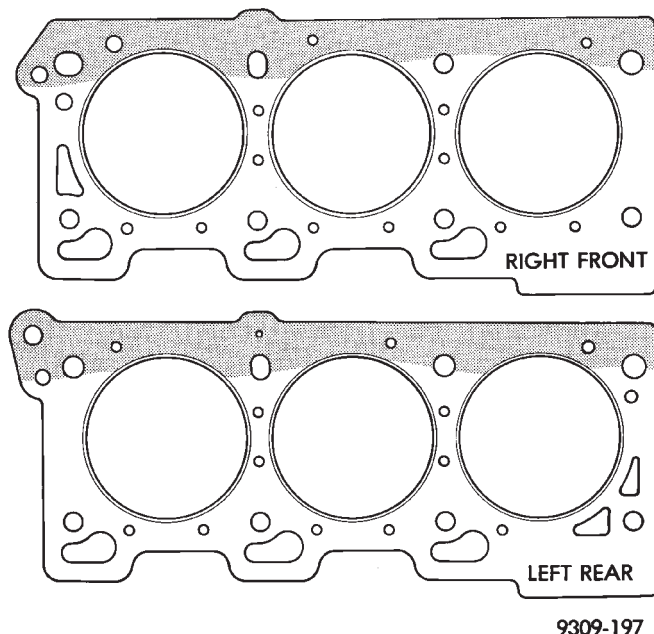


Fig. 38 Checking Bolts for Stretching (Necking)

- (1) Before installing the bolts the threads should be oiled with engine oil.

REMOVAL AND INSTALLATION (Continued)

**Fig. 39 Cylinder Head Gasket Identification**

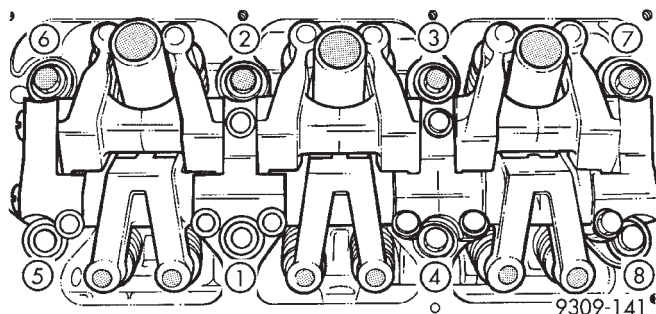
(2) Install head gasket over locating dowels. Ensure the gasket is installed on the correct side (Fig. 39).

(3) Install cylinder head over dowels.

(4) Tighten the cylinder head bolts in the sequence shown in (Fig. 40). Using the 4 step torque-turn method, tighten according to the following values:

- First All to 61 N·m (45 ft. lbs.)
- Second All to 88 N·m (65 ft. lbs.)
- Third All (again) to 88 N·m (65 ft. lbs.)
- Fourth + 1/4 Turn **Do not use a torque wrench for this step.**

(5) Bolt torque after 1/4 turn should be over 90 ft. lbs. in the tightening direction. If not, replace the bolt.

**Fig. 40 Cylinder Head Bolt Tightening Sequence**

(6) Install rear timing belt covers. Use new O-ring on the water pump passages on the right side cover. Tighten bolts to specified torque:

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

- M6 — 12 N·m (105 in. lbs.)

(7) Install timing belt. Refer to procedure outlined in Camshaft Sprocket and Engine Timing in this section.

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

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

(10) Install crankshaft damper.

CRANKSHAFT**REMOVAL**

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

(2) Drain engine oil.

(3) Remove oil pan

(4) Remove oil pick-up tube.

(5) Remove idler pulley for accessory drive belt.

(6) Remove lower timing belt cover.

(7) Remove main timing belt cover.

(8) Remove left side timing belt cover.

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

(10) Remove timing belt tensioner and timing belt.

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

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

(13) Remove oil pump assembly.

(14) Remove rear crankshaft oil seal retainer.

(15) Remove connecting rod bearing caps. Connecting rod bearing caps are not interchangeable and should be marked at removal to insure correct assembly.

(16) Remove main bearing caps. Main bearing caps are not interchangeable and should be marked at removal to insure correct assembly (Fig. 41).

(17) Remove Crankshaft.

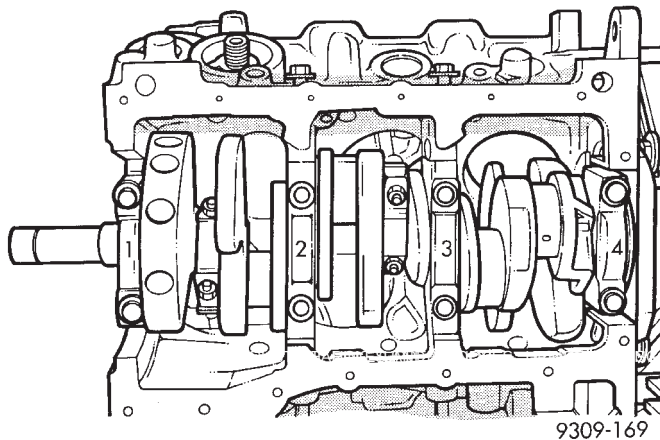
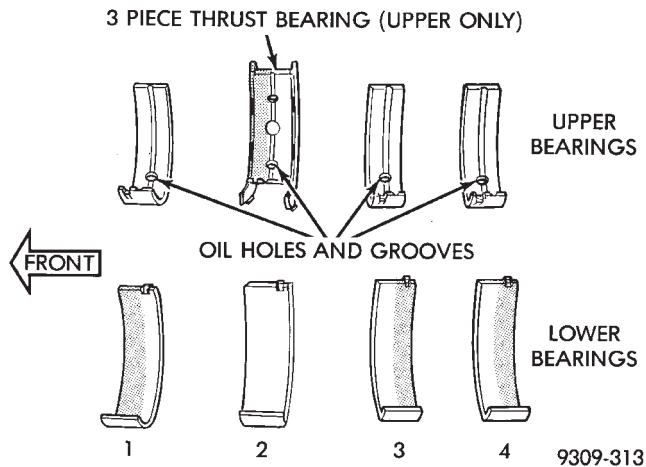
NOTE: Before installing Crankshaft refer to Fitting Main Bearings and Installation of Connecting Rod Bearings in this section.

INSTALLATION

NOTE: Upper and lower bearing halves are NOT interchangeable. Lower main bearing halves of 1, 2, 3 and 4 are interchangeable. Upper main bearing halves of 1, 3 and 4 are interchangeable (Fig. 42).

(1) Install Crankshaft.

REMOVAL AND INSTALLATION (Continued)

**Fig. 41 Main Bearing Cap Identification****Fig. 42 Main Bearing Identification**

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

(3) Tighten number 1, 3 and 4 main cap bolts to 41 N·m + 1/4 Turn (30 ft. lbs. + 1/4 Turn) (Fig. 41). Then tighten the #3 tie bolts to 54 N·m (40 ft. lbs.) (Fig. 43).

(4) Rotate the crankshaft until number 6 piston is at TDC.

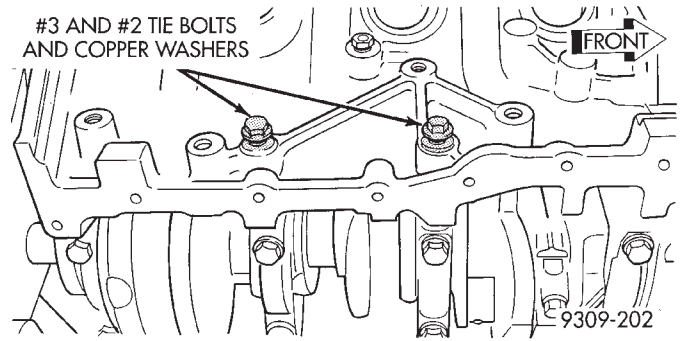
(5) To ensure correct thrust bearing alignment the following procedures must be done:

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

(7) Then, move crankshaft all the way to the front of its travel.

(8) Wedge a appropriate tool between the rear of the cylinder block and rear crankshaft counterweight. This will hold the crankshaft in it's most forward position.

(9) Tighten the #2 Thrust Bearing cap bolts to 41 N·m + 1/4 Turn (30 ft. lbs. + 1/4 Turn). Then tighten the #2 tie bolts to 54 N·m (40 ft. lbs.). Remove the holding tool.

**Fig. 43 Crankshaft Main Cap Tie Bolts**

(10) Install rear crankshaft oil seal retainer. Refer to Rear Crankshaft Oil Seal procedure in this section.

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

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

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

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

(15) Install (3) timing belt covers.

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

(17) Install idler pulley for accessory drive belt.

(18) Install oil pick-up tube torque bolt to 28 N·m (250 in. lbs.).

(19) Install oil pan torque bolts to 12 N·m (105 in. lbs.).

(20) Install engine assembly.

(21) Fill engine crankcase with proper amount of oil.

CAMSHAFT**REMOVAL**

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

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

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

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

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

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

REMOVAL AND INSTALLATION (Continued)

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

INSTALLATION

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

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

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

CAMSHAFT SPROCKETS AND TIMING PROCEDURE

REMOVAL

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

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

(2) Remove camshaft sprocket from camshaft. Each sprocket has a D shaped hole that allows it to rotate several degrees in each direction on its shaft. This design must be timed with the engine to ensure proper performance of the engine. Refer to camshaft and timing belt installation outlined in this section for procedure.

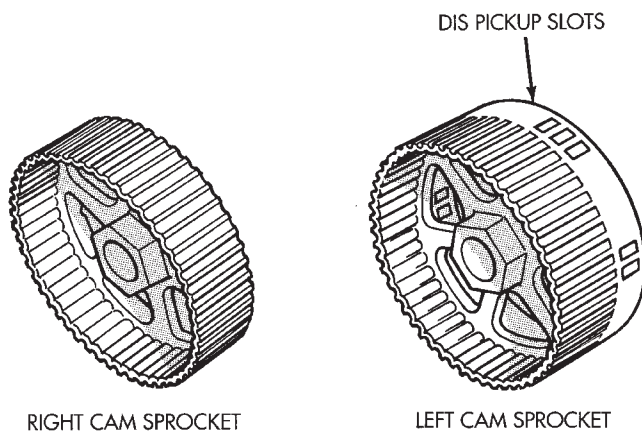
TIMING PROCEDURE—3.5L

CAUTION: The camshaft sprockets are not interchangeable from side to side (Fig. 44).

(1) Place crankshaft sprocket to the TDC mark on the oil pump housing (Fig. 45).

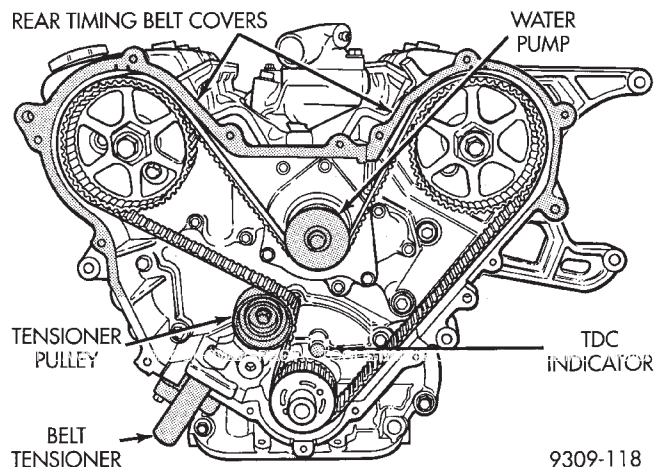
(2) Install a dial indicator in number 1 cylinder to check TDC of the piston (Fig. 50). Rotate the crankshaft until the piston is at exactly TDC. This is important for good engine performance.

(3) Install the camshaft alignment Special Tools 6642 to the rear of each cylinder head (Fig. 46).



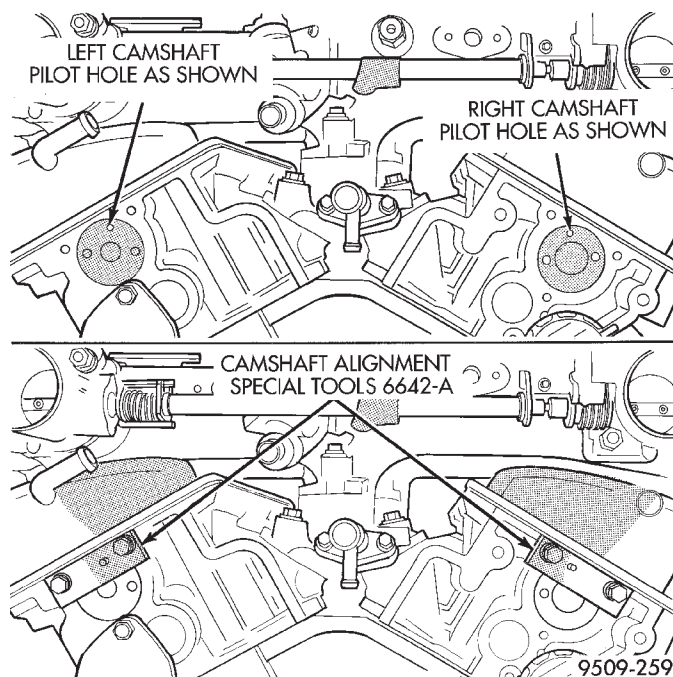
9309-124

Fig. 44 Camshaft Sprocket Identification



9309-118

Fig. 45 Timing Belt System



9509-259

Fig. 46 Camshaft Alignment Special Tools 6642

REMOVAL AND INSTALLATION (Continued)

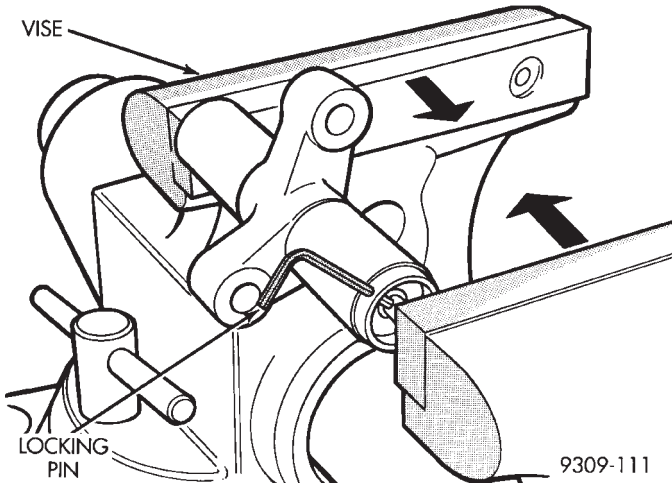


Fig. 47 Compressing Timing Belt Tensioner

(4) Preload the tensioner with a vise and install locking pin (Fig. 47).

(5) Install camshaft sprockets onto the camshafts. Install **NEW** sprocket attaching bolts into place. The 255 mm (10 in.) bolt is to be installed in the left camshaft and the 213 mm (8 3/8 in.) bolt is to be installed into the right camshaft. **Do not tighten the bolts.** Camshaft sprocket mark should be positioned between the marks on the cover (Fig. 48) at both sprocket.

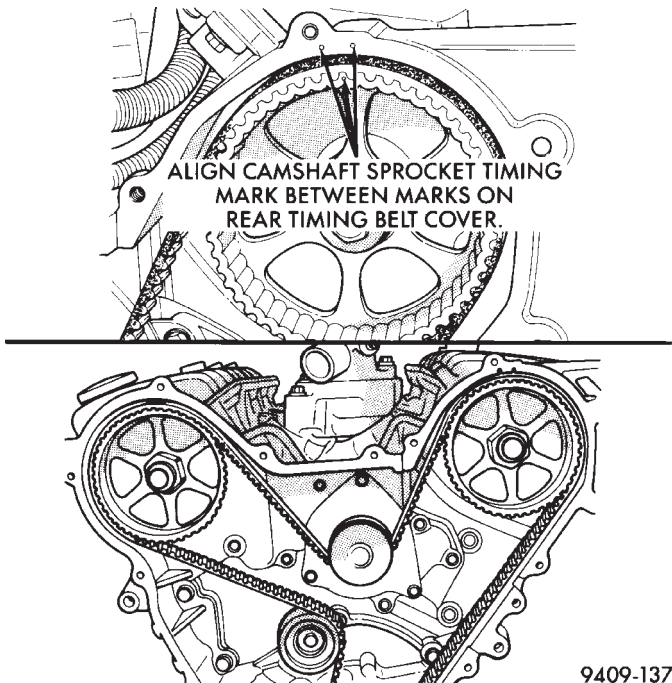


Fig. 48 Camshaft Sprocket Timing Marks

(6) Install the timing belt starting at the crankshaft sprocket going in a counterclockwise direction (Fig. 49). Install the belt around the last sprocket. Maintain tension on the belt as it is positioned

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

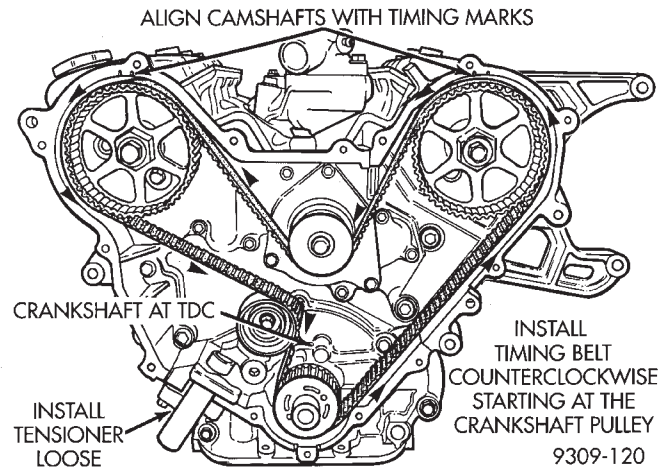


Fig. 49 Timing Belt—Installation

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

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

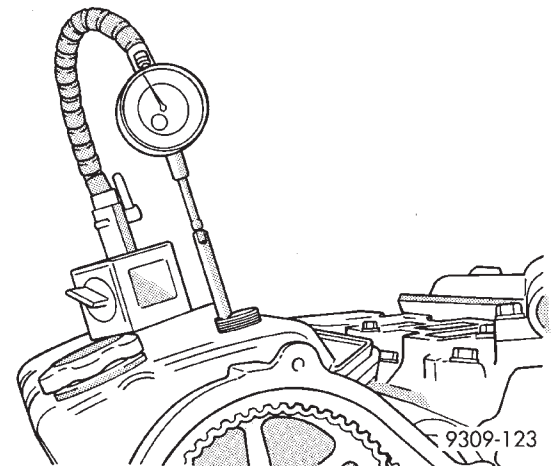


Fig. 50 Dial Indicator Locating Piston at TDC

(9) With number 1 piston at TDC (Fig. 50), hold the camshaft sprocket hex with a 36 mm (1 7/16 in.) wrench and tighten the camshaft bolts to 102 N·m (75 ft. lbs.) plus a 90 degree turn for the Right side and 115 N·m (85 ft. lbs.) plus a 90 degree turn for the Left side.

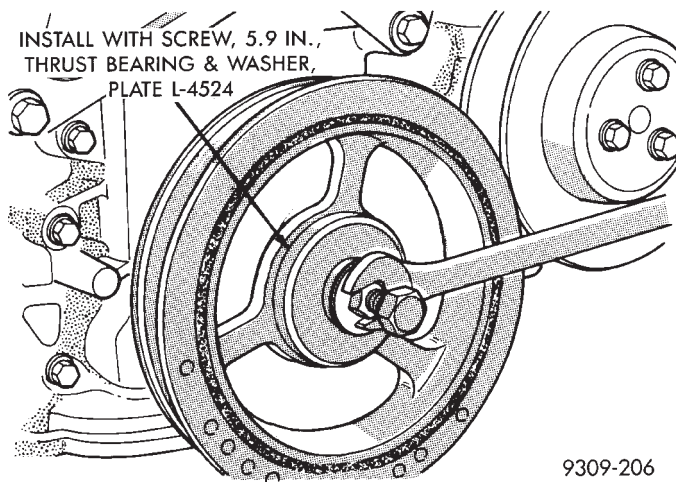
(10) Remove dial indicator and install spark plug and tighten to 28 N·m (20 ft. lbs.).

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

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

REMOVAL AND INSTALLATION (Continued)

- (13) Install crankshaft damper (Fig. 51).
- (14) Install accessory drive belts. Refer to Group 7, Cooling System for procedure.
- (15) Fill cooling system. Refer to Group 7, Cooling System for procedure.



9309-206

Fig. 51 Crankshaft Damper—Installation**ROCKER ARM AND SHAFT ASSEMBLY**

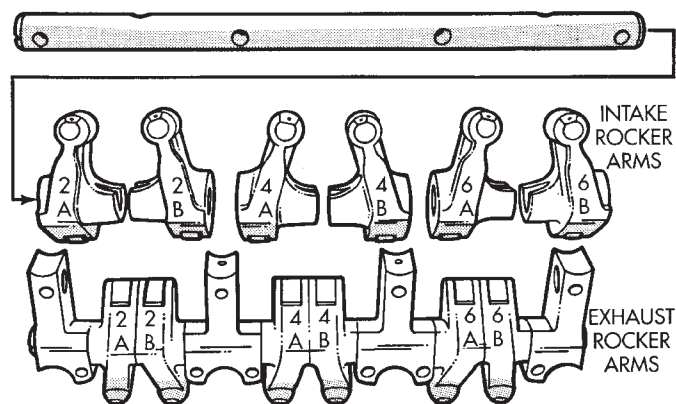
CAUTION: The rocker arm shafts are hollow and are used as lubrication oil passages. The rocker arm and shaft assembly on the right side of the engine has an oil passage hole from the cylinder head to the third rocker shaft support. The rocker arm shaft assembly on the left side of the engine has an oil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

REMOVAL

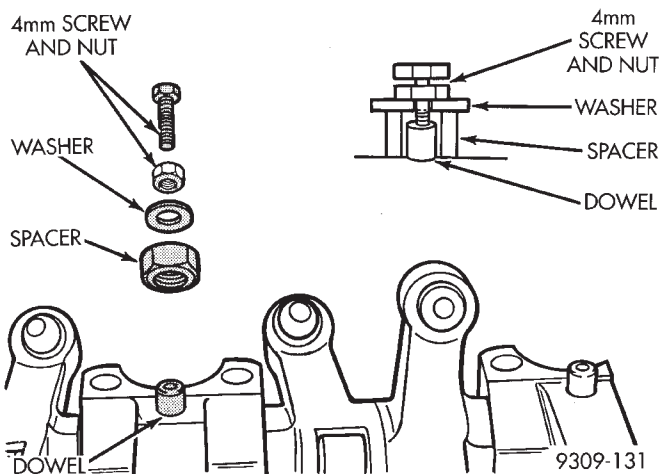
- (1) Remove cylinder head covers. Refer to procedure outlined in this section.
- (2) Identify the rocker arm assembly and rocker arms before disassembly (Fig. 52).
- (3) Remove rocker arm assembly bolts.

DISASSEMBLY

- (1) Remove dowel pin using a 4 mm screw, nut, spacer, and washer installed into the pin (Fig. 53). Tighten the screw into the pin, then loosen the nut on the screw. This will pull the dowel out of the shaft support. Do not reuse dowel pins. Remove the rocker arms and pedestals in order.
- (2) Check the rocker arm mounting portion of the shafts for wear or damage. Replace if damaged or heavily worn.
- (3) Check shaft oil holes for clogging with small wire, clean as required.



9309-129

Fig. 52 Rocker Arms and Shaft Identification—Left Bank

9309-131

Fig. 53 Rocker Arms and Shaft—Disassembly ASSEMBLY

CAUTION: New dowel pins must be used during assembly.

- (1) Install the rocker arms, and pedestals onto the shaft.
- (2) Install dowel pins (Fig. 54). Dowel pins pass through the pedestal into the exhaust rocker shafts. Dowel pins should be pressed in until they bottom-out against the rocker shaft in the pedestal.

INSTALLATION

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

- (1) Rotate camshafts to the position shown in (Fig. 55). With the camshafts in these positions the lobes are in a neutral position (no load to the valve). This

REMOVAL AND INSTALLATION (Continued)

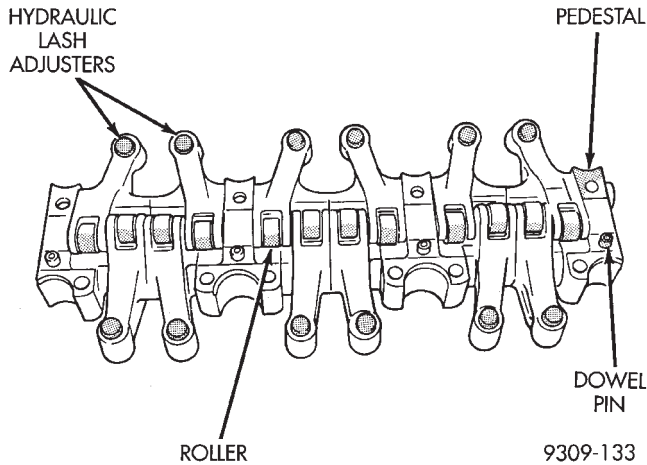


Fig. 54 Assemble Rocker Arms and Shaft

will allow the rocker arm shaft assembly to be tightened into position with little or no valve spring load on it.

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

(3) Tighten bolts in sequence to 31 N·m (275 in. lbs.) (Fig. 56).

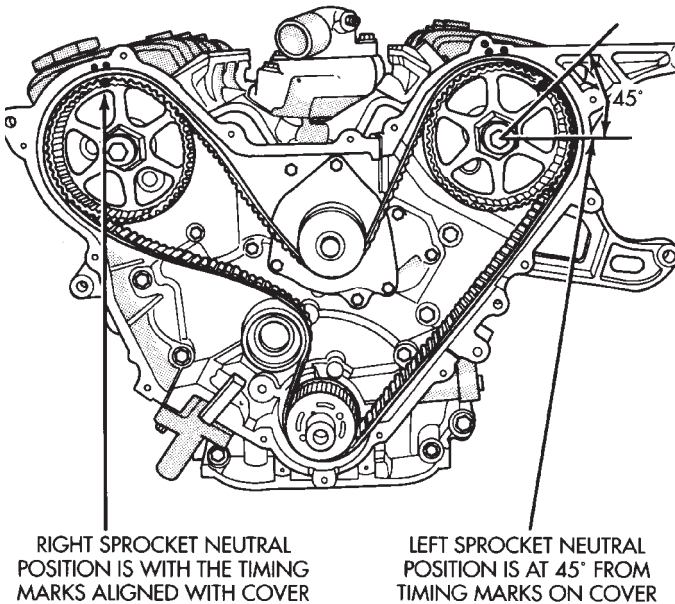


Fig. 55 Camshaft Sprockets Neutral Position

REPLACE VALVE STEM SEALS OR VALVE SPRINGS—IN VEHICLE

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

(2) Disconnect negative battery cable.

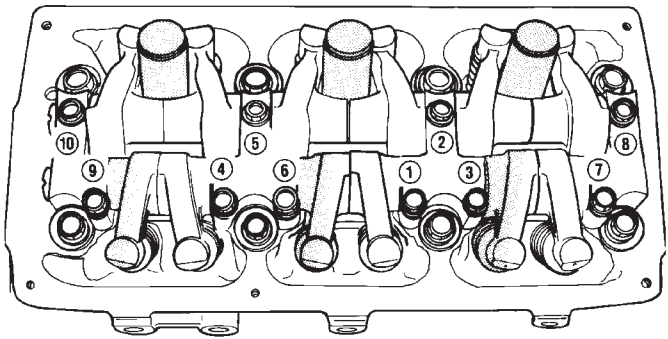


Fig. 56 Rocker Arm and Shaft Assembly Attaching Bolts Torque Sequence

(3) Remove Air Cleaner Cover and hose assembly.

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

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

(6) Remove ignition coils and intake manifold support bracket.

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

(8) Rotate the crankshaft by the pulley retaining screw, until the number 1 piston is at Top Dead Center on the compression stroke.

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

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

(11) Remove valve stem seals by using a valve stem seal tool (Fig. 57).

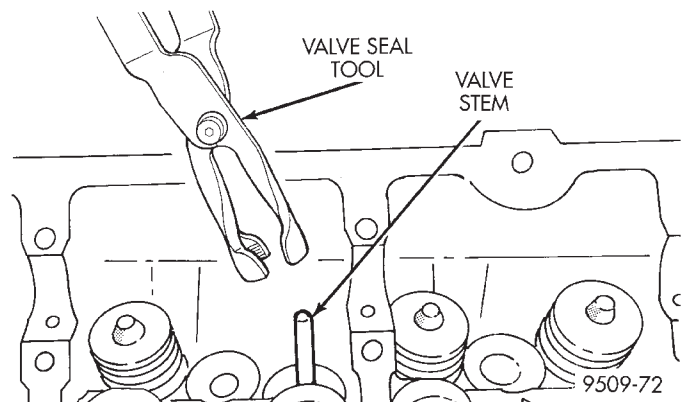
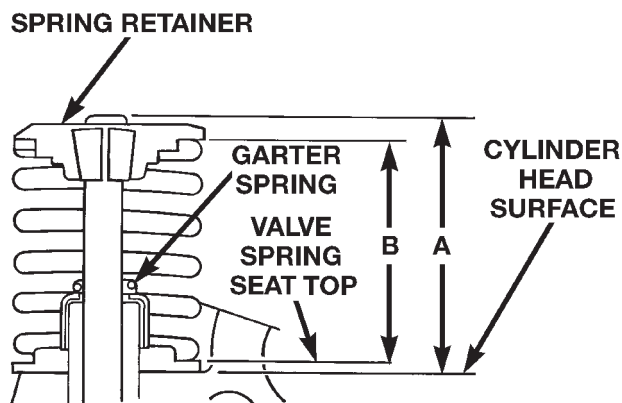


Fig. 57 Valve Stem Seal—Removal

REMOVAL AND INSTALLATION (Continued)

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

CAUTION: Do not remove garter spring around the seal at the top of the valve stem seal (Fig. 58).



80570e02

Fig. 58 Valve Seal Garter Spring

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

(14) Remove spark plug adapter tool.

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

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

(17) Install intake manifold support bracket and ignition coil.

(18) Install Intake Manifold; Refer to Group 11, Intake Manifold Installation 3.5L Engine.

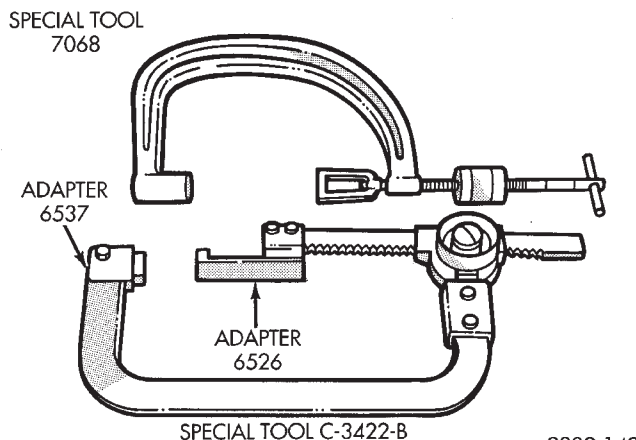
VALVE AND VALVE SPRINGS

REMOVAL

(1) With cylinder head removed, compress valve springs using the Valve Spring Compressors shown in (Fig. 59).

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

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



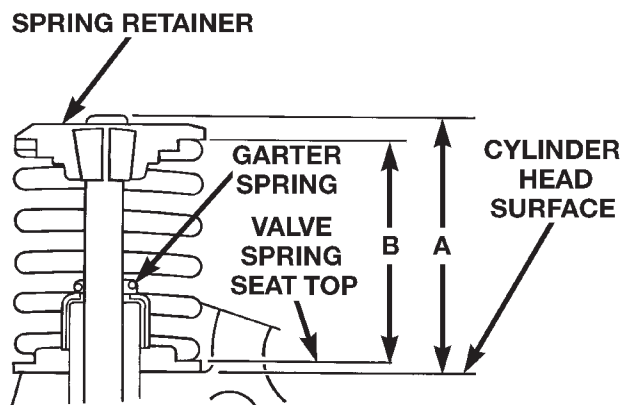
9309-142

Fig. 59 Valve Spring Compressors

INSTALLATION

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

(2) If valves or seats have been reground, check valve tip height (A) (Fig. 60). If valve tip height is greater than 43.65 mm (1.7185 in.) intake or 45.98 mm (1.8102 in.) exhaust, grind valve tip until within specifications. Make sure measurement is taken from cylinder head surface to the top of valve stem.



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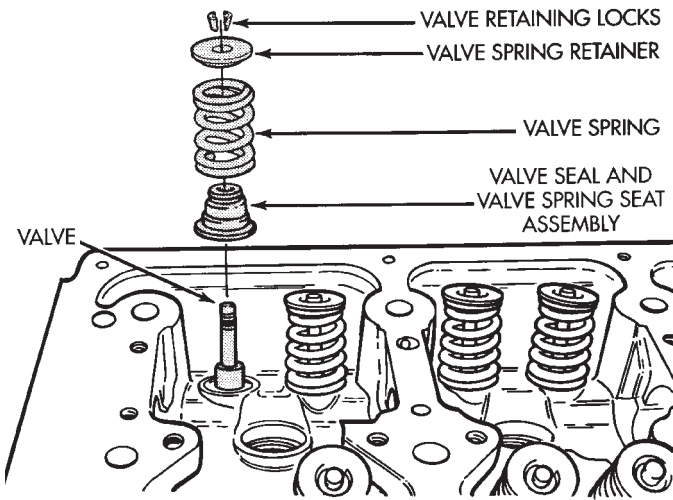
Fig. 60 Checking Valve Tip Height and Valve Spring Installed Height

(3) Install valve seal/spring seat assembly over valve guides on all valve stems (Fig. 61). Ensure that the garter spring is intact around the top of the rubber seal. Install valve springs, valve retainers.

(4) Compress valve springs with a valve spring compressor install locks and release tool. **If valves and/or seats are reground, measure the installed height of springs (B) (Fig. 60), make sure measurements are taken from top of spring seat to the bottom surface of spring retainer .** If height is greater than 38.75 mm

REMOVAL AND INSTALLATION (Continued)

(1.5256 inches), install a .762 mm (0.030 inch.) spacer in head counterbore under the valve spring seat to bring spring height back within specification.

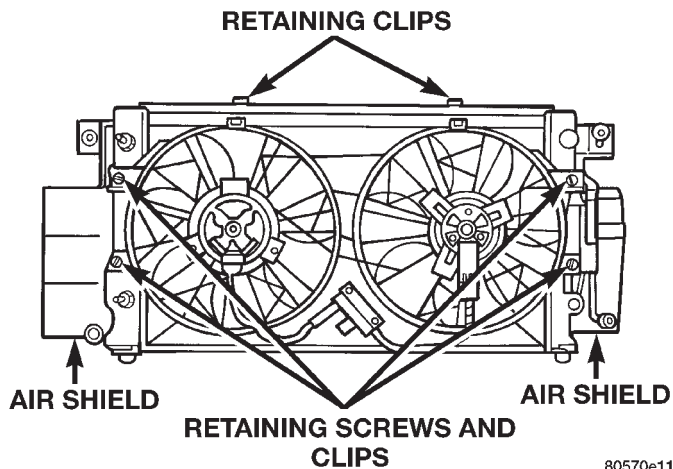


9309-150

Fig. 61 Valve, Spring, and Valve Seal—Installation

TIMING BELT COVERS

- (1) Disconnect battery.
- (2) Remove upper radiator crossmember.
- (3) Remove fan module (Fig. 62).



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Fig. 62 Fan Module—Removal

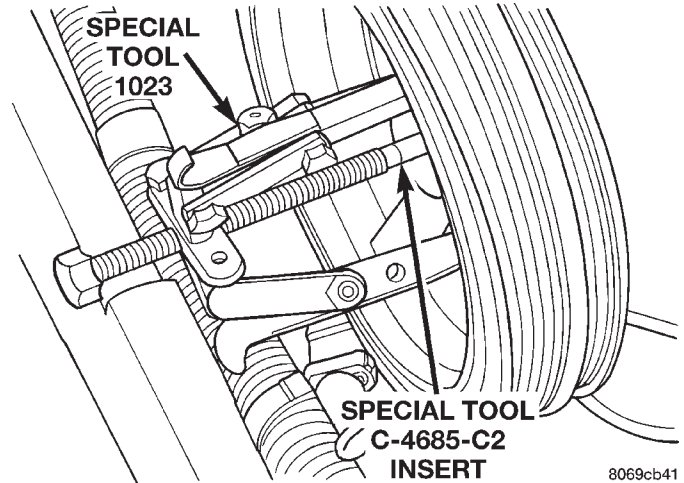
(4) Remove the accessory drive belts. Refer to Group 7, Accessory Drive System for service procedure.

(5) Use Special Tool C-3281 to hold crankshaft damper while removing center bolt.

(6) Remove crankshaft damper (Fig. 63).

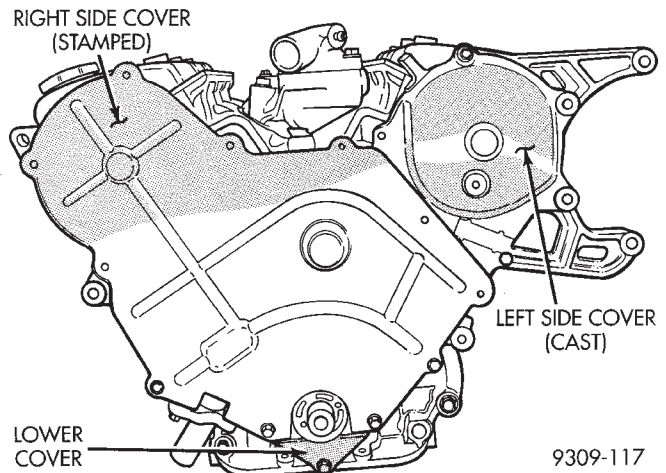
(7) Remove the stamped steel cover (Fig. 64). **Do not remove the sealer on the cover, it is reusable (Fig. 65).** If some sealer is missing use Mopar Silicone Rubber Adhesive Sealant or equivalent to replace the missing sealer.

(8) Remove the left cast cover (Fig. 64).



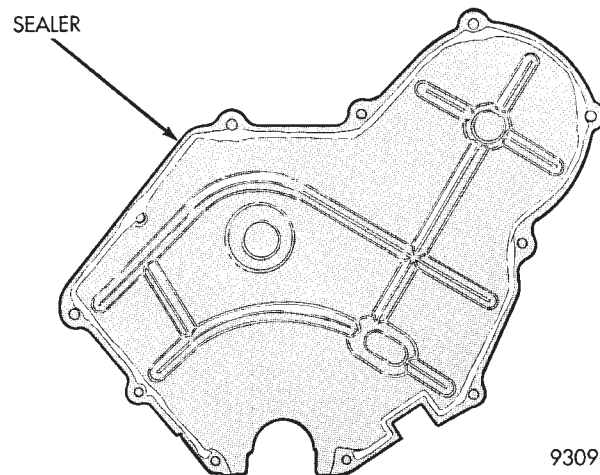
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Fig. 63 Crankshaft Damper—Removal



9309-117

Fig. 64 Timing Belt Covers



9309-105

Fig. 65 Sealer, Timing Belt Cover

(9) Remove the lower belt cover located behind the crankshaft damper.

(10) Reverse removal procedures for installation.

REMOVAL AND INSTALLATION (Continued)

TIMING BELT

REMOVAL

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

(1) Mark belt running direction if belt is to be reused.

(2) Align the camshaft sprockets between the marks on rear belt covers before timing belt removal (Fig. 66).

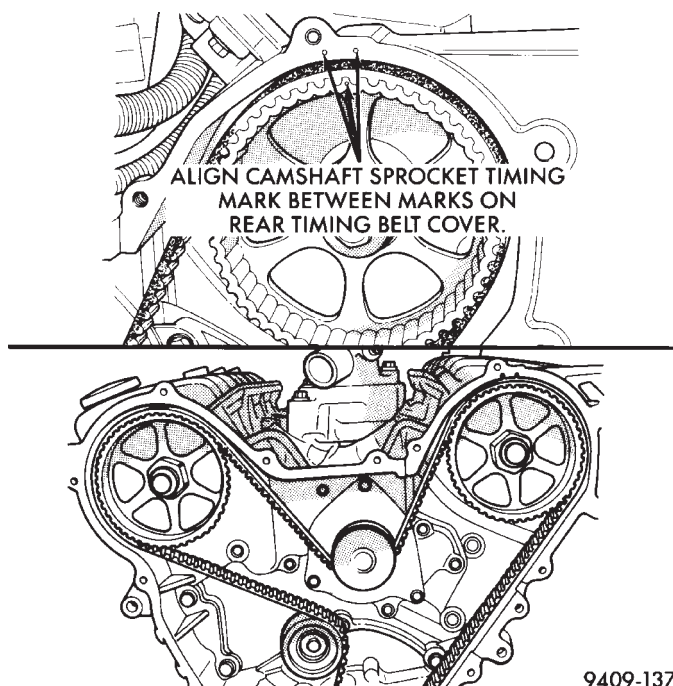


Fig. 66 Camshaft Sprocket Timing Marks

(3) Remove the timing belt tensioner (Fig. 67) and remove timing belt.

TIMING BELT TENSIONER

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

(5) Place the tensioner into a vise and slowly compress the plunger (Fig. 68).

CAUTION: Index the tensioner in the vise the same way it is installed on the engine. This is to ensure proper pin orientation when tensioner is installed on the engine.

(6) When plunger is compressed into the tensioner body install a pin through the body and plunger to retain plunger in place until tensioner is installed.

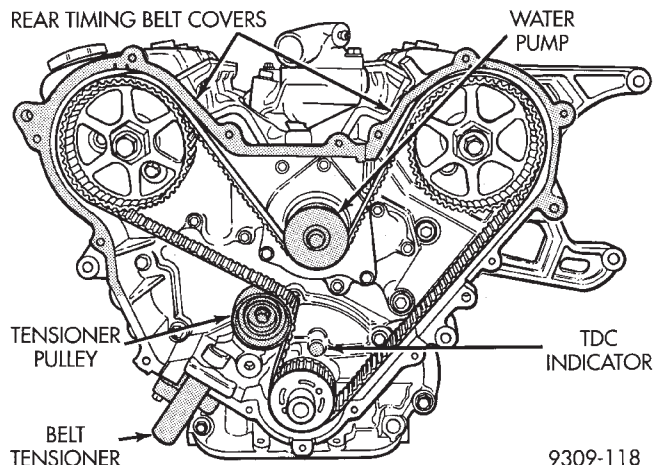


Fig. 67 Timing Belt System

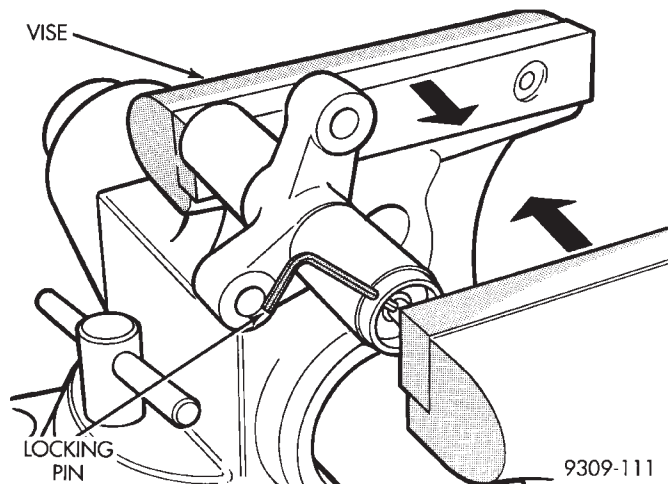


Fig. 68 Compressing Timing Belt Tensioner

INSTALLATION

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

(1) Align the crankshaft sprocket with the TDC mark on oil pump cover (Fig. 69).

(2) Align the camshaft sprockets between the marks on the covers (Fig. 66).

(3) Install the timing belt starting at the crankshaft sprocket going in a counterclockwise direction (Fig. 69). Install the belt around the last sprocket. Maintain tension on the belt as it is positioned around the tensioner pulley.

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

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

REMOVAL AND INSTALLATION (Continued)

(6) Rotate crankshaft sprocket 2 revolutions and check the timing marks on the camshafts and crankshaft. The marks should line up within their respective locations (Fig. 69). If marks do not line up repeat procedure.

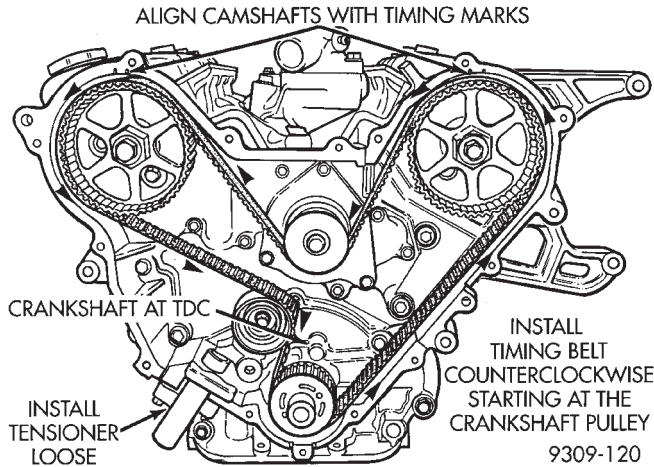


Fig. 69 Timing Belt Installation

OIL PAN

The windage tray and oil pan gaskets are integral. The silicone rubber gaskets are bonded to both sides of the windage tray. This assembly is reusable provided it is not damaged upon removal.

CAUTION: Sealant must be carefully removed if gasket is to be used again.

REMOVAL

- (1) Disconnect negative battery cable, remove engine oil dipstick.
- (2) Raise vehicle. Drain engine oil.
- (3) Disconnect the sway bar and move to rear of vehicle to gain access to oil pan.
- (4) Remove transmission support brackets and inspection cover.
- (5) Remove oil pan bolts and remove oil pan.
- (6) Remove oil pick-up tube from oil pump body (Fig. 70).
- (7) Remove the windage tray/oil pan gasket (Fig. 71).

NOTE: The windage tray and oil pan gaskets are integral (Fig. 71). The silicone rubber gaskets are bonded to both sides of the windage tray. This assembly is reusable provided it is not damaged upon removal.

INSTALLATION

- (1) Apply a 1/8 inch bead of Mopar Silicone Rubber Adhesive Sealant or equivalent, at the parting line of

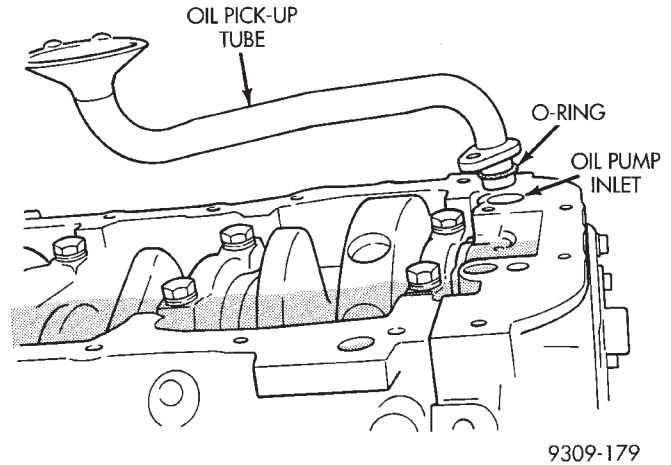


Fig. 70 Oil Pump Pick-up Tube Service

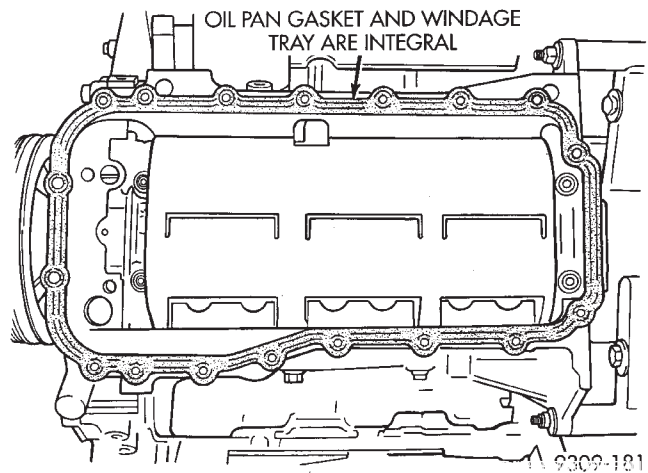


Fig. 71 Windage Tray/Oil Pan Gasket

the oil pump body and the rear seal retainer (Fig. 72).

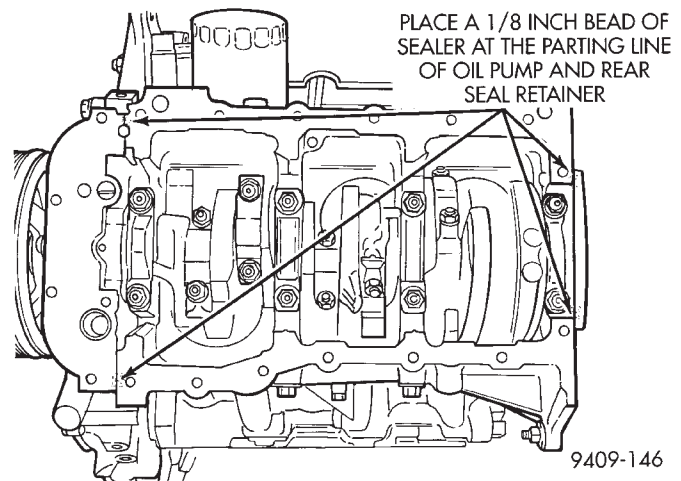


Fig. 72 Oil Pan Sealing

REMOVAL AND INSTALLATION (Continued)

- (2) Install the windage tray/oil pan gasket (Fig. 71).
- (3) Install oil pick-up tube into oil pump body and tighten screw to 28 N·m (20 ft. lbs.).
- (4) Install pan and tighten fasteners to 12 N·m (105 in. lb.).
- (5) Install transmission support brackets and inspection cover.
- (6) Connect the sway bar.
- (7) Lower vehicle and install oil dipstick.
- (8) Connect negative battery cable.
- (9) Fill crankcase with oil to proper level.

CAMSHAFT OIL SEAL

REMOVAL

- (1) With camshaft sprockets removed. Refer to procedure outlined in this section.
- (2) Use Special Tool C-3981B to remove camshaft oil seal (Fig. 73).

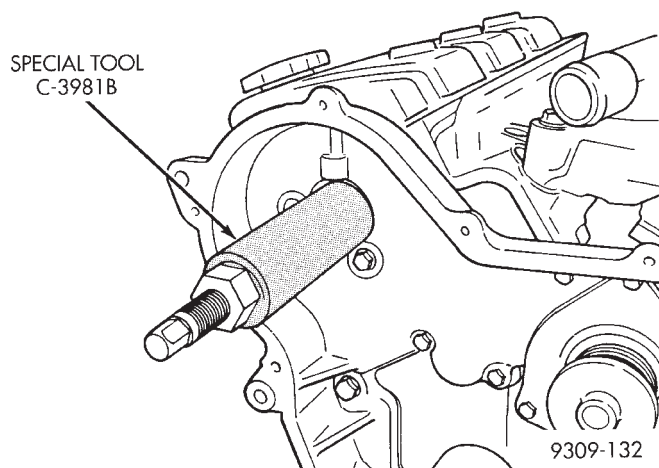


Fig. 73 Camshaft Oil Seal—Removal

INSTALLATION

- (1) Apply light coat of engine oil to the camshaft oil seal lip.
- (2) Install the oil seal using Special Tool 6788 Seal Protector Sleeve (Fig. 74) and Seal Installer 6052 (Fig. 75).

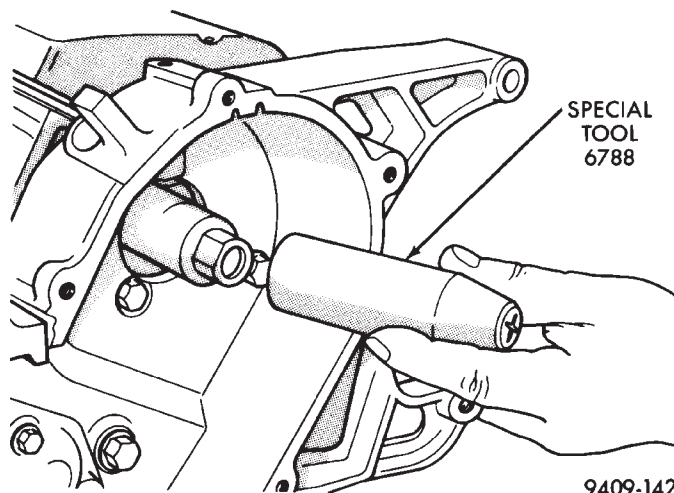


Fig. 74 Camshaft Oil Seal Protector Sleeve

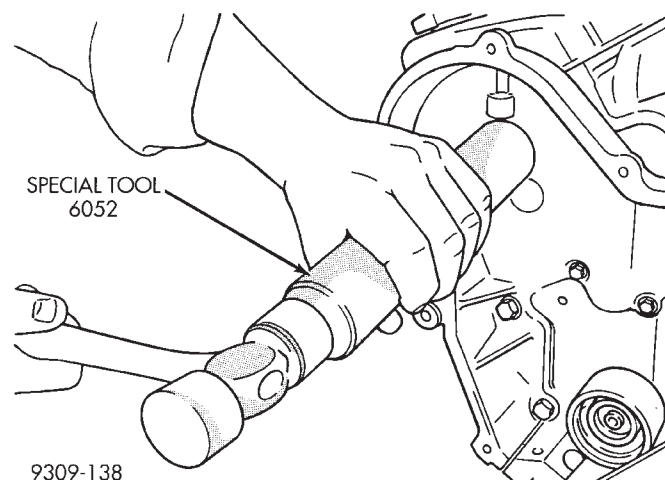


Fig. 75 Camshaft Oil Seal—Installation

FRONT CRANKSHAFT OIL SEAL

REMOVAL

- (1) With timing belt removed. Refer to procedure outlined in this section.
- (2) Remove crankshaft sprocket using Special Tool L-4407-A (Fig. 76).
- (3) Tap the dowel pin out of the crankshaft (Fig. 77).
- (4) Remove crankshaft seal using Special Tool 6341A (Fig. 78).

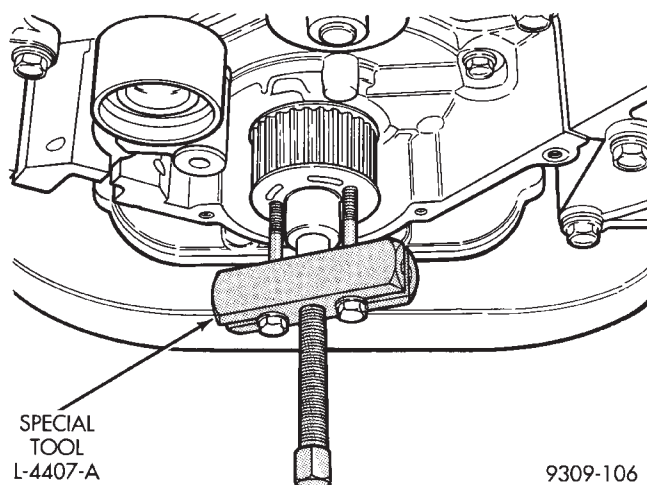


Fig. 76 Crankshaft Sprocket—Removal

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

REMOVAL AND INSTALLATION (Continued)

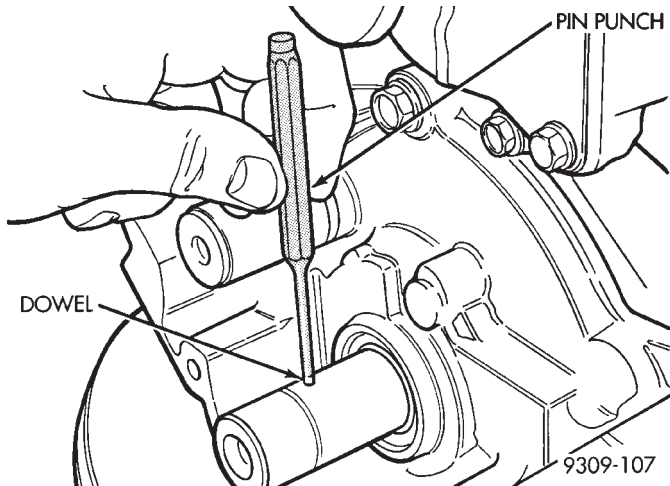


Fig. 77 Crankshaft Sprocket Dowel Pin—Removal/Installation

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

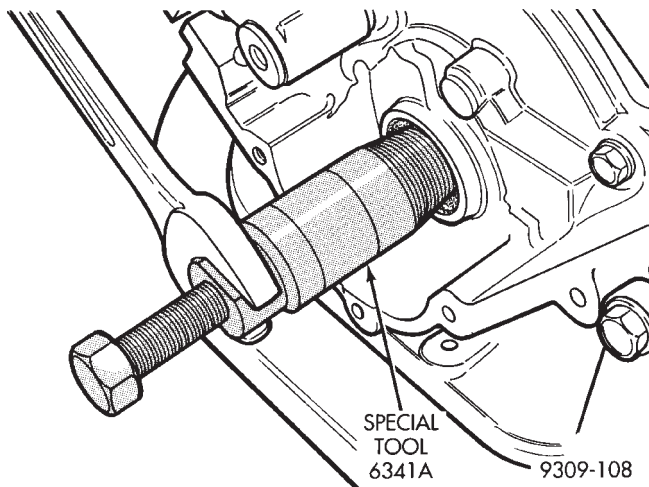


Fig. 78 Crankshaft Oil Seal with Special Tool 6341A—Removal

INSTALLATION

- (1) Install crankshaft seal using Special Tool 6342 (Fig. 79).
- (2) Install the dowel pin into the crankshaft to 1.2 mm (0.047 inch.) protrusion (Fig. 77).
- (3) Install crankshaft sprocket using special tools shown in (Fig. 80).

REAR CRANKSHAFT OIL SEAL

REMOVAL

- (1) Insert a 3/16 flat bladed screwdriver between the dust lip and the metal case of the crankshaft seal. Angle the screwdriver (Fig. 81) 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 the screw-

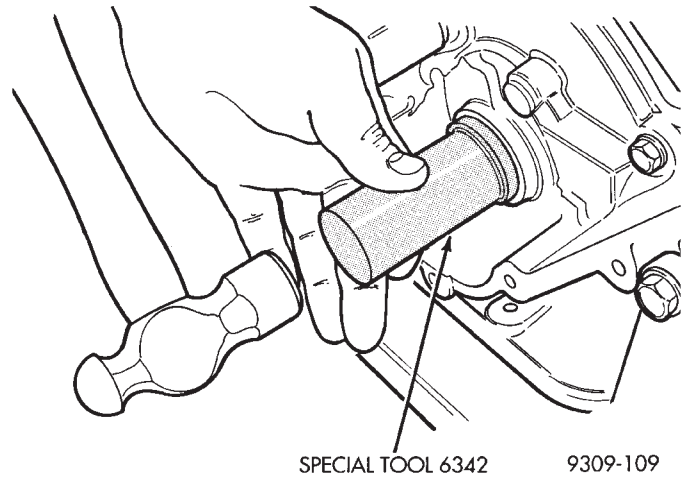


Fig. 79 Crankshaft Oil Seal with Special Tool 6342—Installation

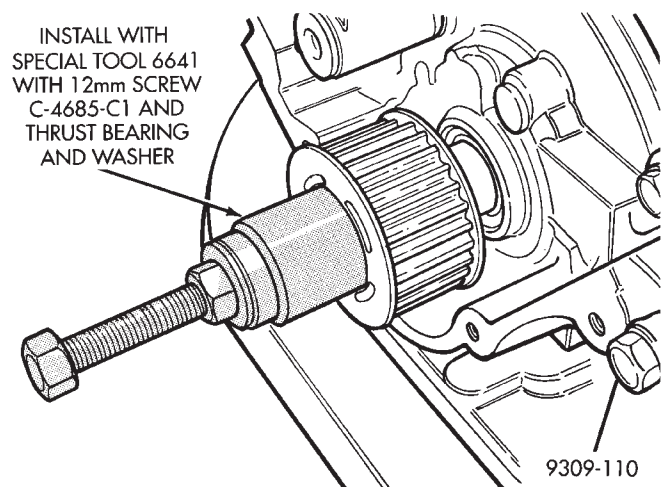


Fig. 80 Crankshaft Sprocket—Installation
driver blade against crankshaft edge (chamfer) is permitted.

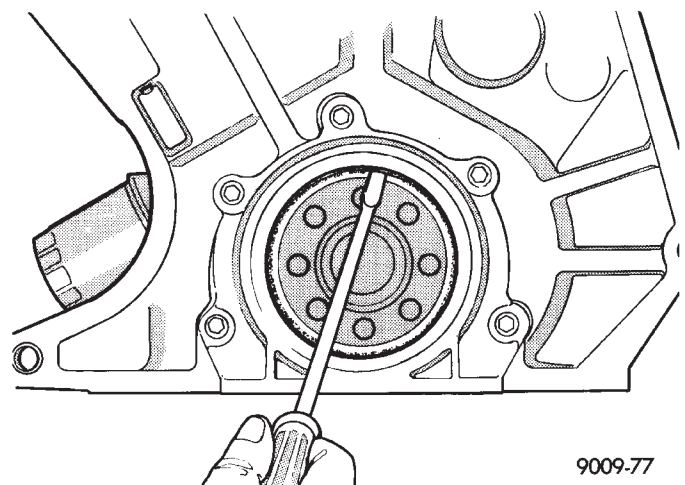


Fig. 81 Rear Crankshaft Oil Seal—Removal

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

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

(1) Place Special Seal Pilot Tool C-4681 on crankshaft (Fig. 82).

(2) Lightly coat seal O.D. with Loctite Stud and Bearing Mount or equivalent.

(3) Place seal over Special Seal Pilot Tool C-4681 and tap in place with a plastic hammer.

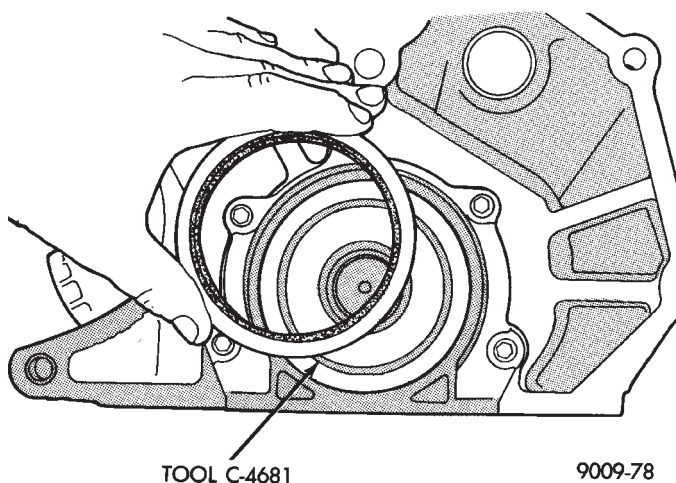


Fig. 82 Rear Crankshaft Oil Seal—Installation

REAR CRANKSHAFT SEAL RETAINER

When retainer removal is required, remove retainer clean engine block and retainer of old gasket. Make sure surfaces are clean and free of oil. Install new gasket and tighten screws to 12 N·m (105 in. lbs.).

CRANKSHAFT MAIN BEARINGS

Bearing caps are not interchangeable and should be marked at removal to insure correct assembly. (Fig. 83) Upper and lower bearing halves are NOT interchangeable. Lower main bearing halves of 1, 2, 3 and 4 are interchangeable. Upper main bearing halves of 1, 3 and 4 are interchangeable.

CRANKSHAFT MAIN JOURNALS

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

CAUTION: With a forged steel crankshaft it is important that the final paper or cloth polish after any journal regrind be in the same direction as normal rotation in the engine.

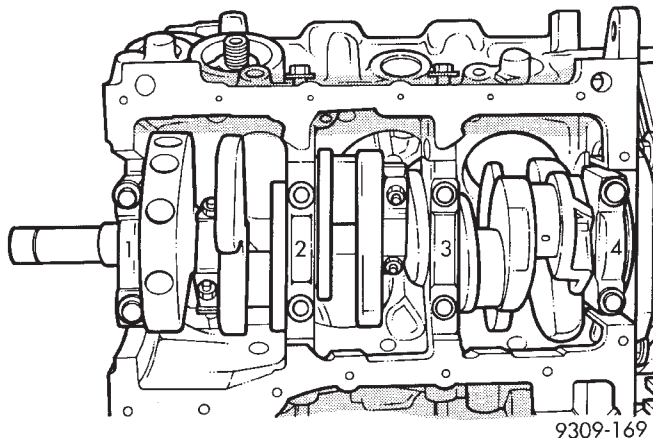


Fig. 83 Main Bearing Cap Identification

Upper Number 2 bearing is a three piece clinched design with flanged halves to carry the crankshaft thrust loads and is NOT interchangeable with any other bearing halves in the engine (Fig. 84). All bearing cap bolts removed during service procedures are to be cleaned and oiled before installation. Bearing shells are available in standard and the following undersize: 0.025 mm (0.001 inch.), 0.051 mm (0.002 inch.), 0.076 mm (0.003 inch.), 0.254 mm (0.010 inch.), and 0.305 mm (0.012 inch.). Never install an undersize bearing that will reduce clearance below specifications.

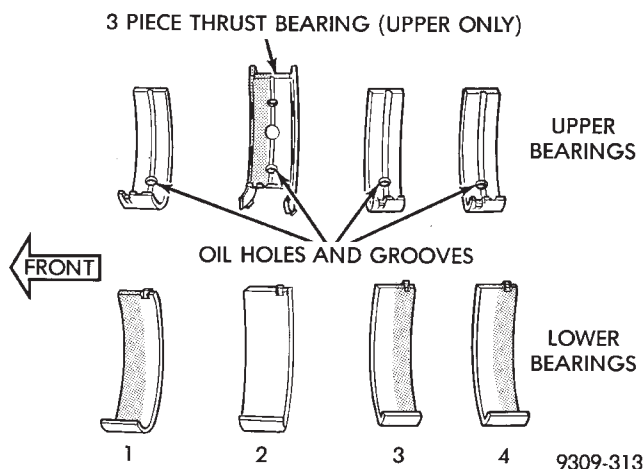


Fig. 84 Main Bearing Identification

REMOVAL

(1) Remove oil pan and windage tray. Refer to procedure outlined in this section. Identify bearing caps before removal.

REMOVAL AND INSTALLATION (Continued)

(2) Remove bearing caps one at a time. Remove upper half of bearing by inserting Special Main Bearing Tool C-3059 (Fig. 85) into the oil hole of crankshaft.

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

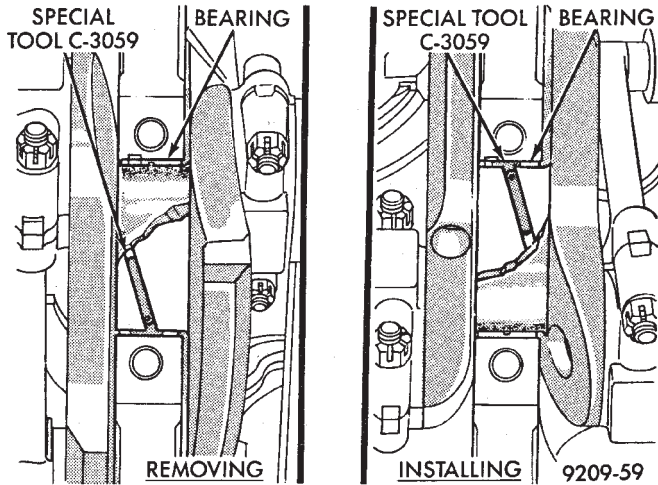


Fig. 85 Removing and Installing Upper Main Bearing With Special Tool C-3059

INSTALLATION

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

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

(1) Start bearing in place, and insert Main Bearing Tool C-3059 into oil hole of crankshaft (Fig. 85).

(2) Slowly rotate crankshaft counter-clockwise sliding the bearing into position. Remove Special Main Bearing Tool C-3059.

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

(4) Tighten number 1, 3 and 4 main cap bolts to 41 N·m + 1/4 Turn (30 ft. lbs. + 1/4 Turn) (Fig. 83). Then tighten the #3 tie bolts to 54 N·m (40 ft. lbs.) (Fig. 86).

(5) Rotate the crankshaft until number 6 piston is at TDC.

(6) To ensure correct thrust bearing alignment the following procedures must be done:

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

(8) Then, move crankshaft all the way to the front of its travel.

(9) Wedge a appropriate tool between the rear of the cylinder block and rear crankshaft counterweight. This will hold the crankshaft in it's most forward position.

(10) Tighten the #2 Thrust Bearing cap bolts to 41 N·m + 1/4 Turn (30 ft. lbs. + 1/4 Turn). Then tighten the #2 tie bolts to 54 N·m (40 ft. lbs.). Remove the holding tool.

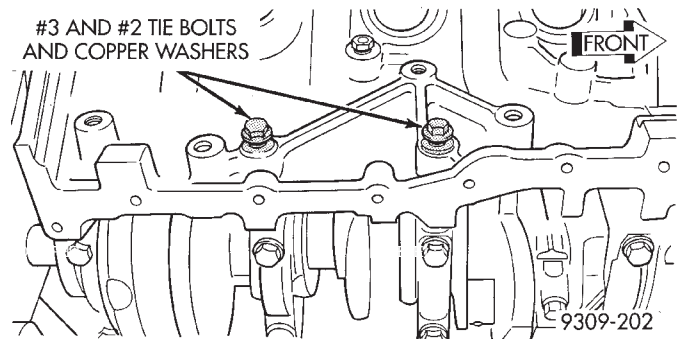


Fig. 86 Crankshaft Main Cap Tie Bolts

OIL FILTER

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

(1) Using Tool C-4065, unscrew filter from base and discard (Fig. 87).

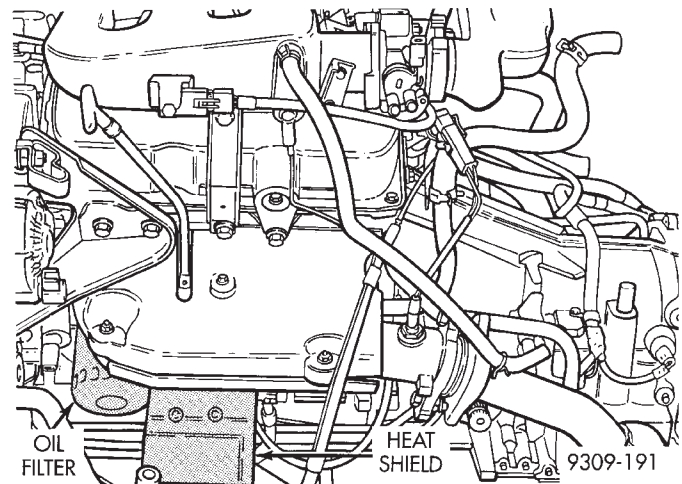


Fig. 87 Oil Filter

(2) Wipe base clean, then inspect gasket contact surface.

(3) Lubricate gasket of new filter with clean engine oil.

(4) Install and tighten filter to 20 N·m (15 ft. lbs.) torque after gasket contacts base. Use filter wrench if necessary.

(5) Start engine and check for leaks.

REMOVAL AND INSTALLATION (Continued)

OIL PUMP

REMOVAL

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

(1) Drain cooling system and remove radiator for access to timing belt covers and vibration damper. Refer to Group 7, Cooling Systems for procedure.

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

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

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

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

(6) Remove front oil pan to oil pump fasteners.

(7) Remove oil pump fasteners and remove pump from engine.

INSTALLATION

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

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

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

(3) Install front oil pan to oil pump fasteners.

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

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

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

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

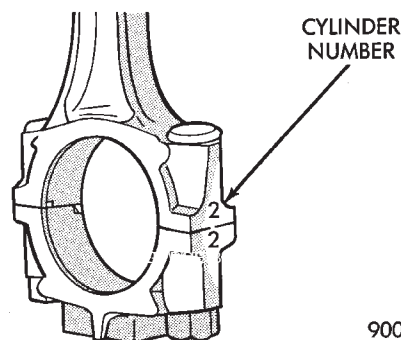
(8) Install radiator and fill cooling system. Refer to Group 7, Cooling Systems for procedure.

PISTON

REMOVAL

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

(2) Inspect connecting rods and connecting rod caps for cylinder identification. Identify them if necessary (Fig. 88).



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Fig. 88 Identify Connecting Rod to Cylinder

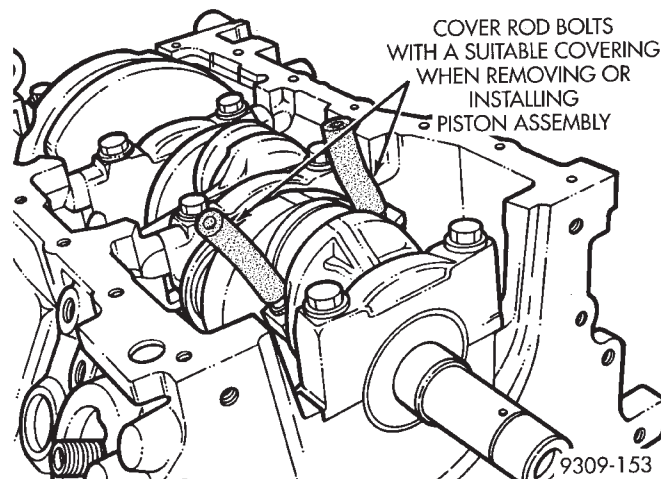


Fig. 89 Connecting Rod Protectors

(3) Remove connecting rod cap. Install protectors on connecting rod bolts (Fig. 89). Push each piston and rod assembly out of cylinder bore.

NOTE: Be careful not to nick crankshaft journals.

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

PISTON RINGS—INSTALLATION

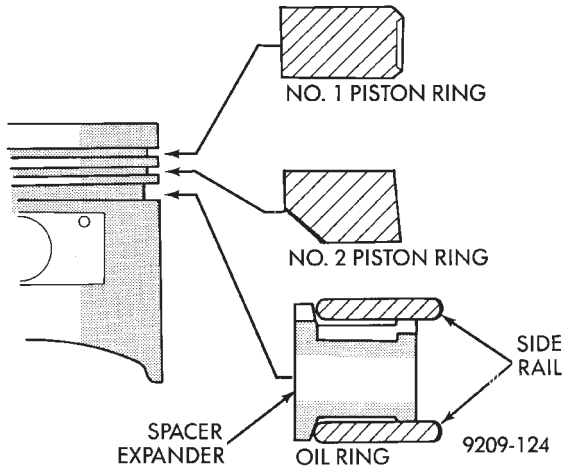
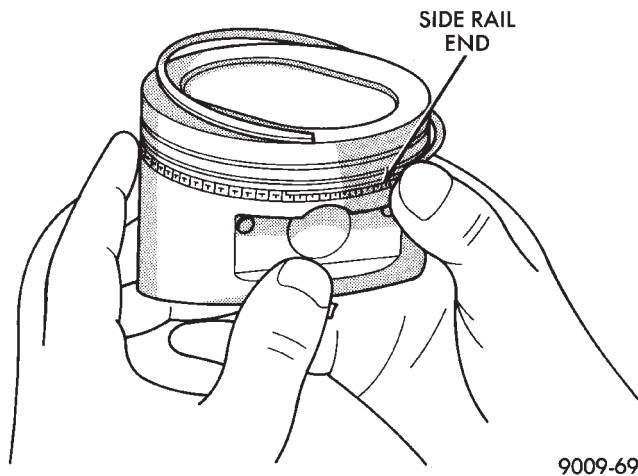
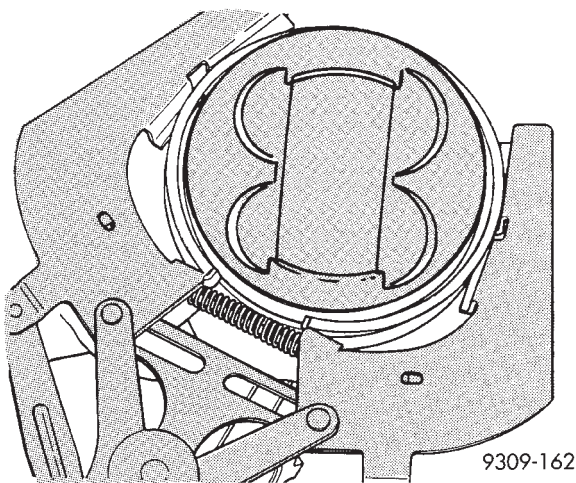
(1) The No. 1 and No. 2 piston rings have a different cross section. Install rings with manufacturers I.D. mark facing up, to the top of the piston (Fig. 90).

CAUTION: Install piston rings in the following order:

- (2) Oil ring expander.
- (3) Upper oil ring side rail.
- (4) Lower oil ring side rail.
- (5) No. 2 Intermediate piston ring.
- (6) No. 1 Upper piston ring.

(7) Install the side rail by placing one end between the piston ring groove and the expander. Hold end firmly and press down the portion to be installed until side rail is in position. **Do not use a piston ring expander during this step (Fig. 91).**

REMOVAL AND INSTALLATION (Continued)

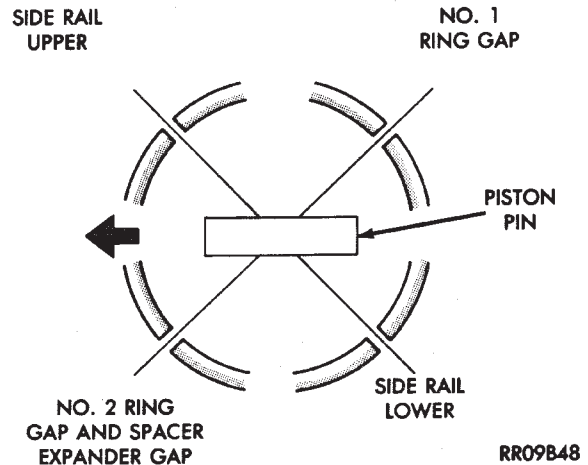
**Fig. 90 Piston Ring—Installation****Fig. 91 Side Rail—Installation****Fig. 92 Upper and Intermediate Rings—Installation**

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

(9) Install No. 2 piston ring and then No. 1 piston ring (Fig. 92).

(10) Position piston ring end gaps as shown in (Fig. 93).

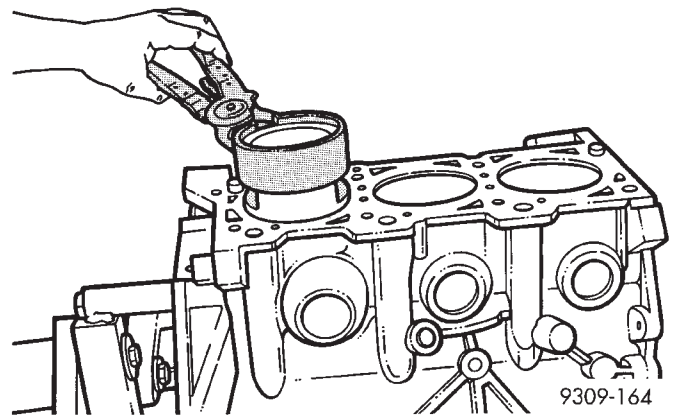
(11) Position oil ring expander gap at least 45° from the side rail gaps but **not** on the piston pin center or on the thrust direction. Staggering ring gap is important for oil control.

**Fig. 93 Piston Ring End Gap Position****PISTON—INSTALLATION**

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

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located as shown in (Fig. 94).

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

**Fig. 94 Piston—Installation**

(4) Install connecting rod bolt protectors on rod bolts (Fig. 89).

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

REMOVAL AND INSTALLATION (Continued)

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

CAUTION: Do Not interchange piston assemblies bank to bank.

(6) The arrow on top of piston must be pointing toward front of engine (Fig. 95).

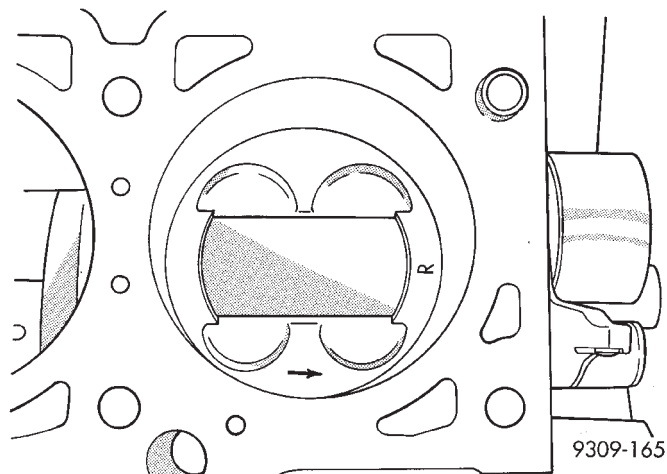


Fig. 95 Piston I.D. Marks

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

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

ENGINE CORE, OIL AND CAM PLUGS

REMOVAL

Using a blunt tool such as a drift and a hammer, strike the bottom edge of the cup plug. With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 68).

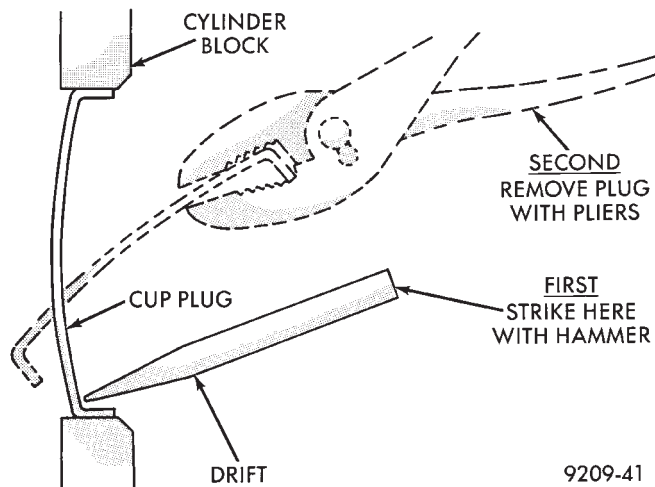


Fig. 96 Core Hole Plug Removal

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

INSTALLATION

Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer. Lightly coat inside of cup plug hole with Loctite Stud N' Bearing Mount or equivalent. Make certain the new plug is cleaned of all oil or grease. Using proper drive plug, drive plug into hole so that the sharp edge of the plug is at least 0.5 mm (0.020 inch.) inside the lead-in chamfer.

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

DISASSEMBLY AND ASSEMBLY

OIL PUMP

DISASSEMBLY

- (1) To remove the relief valve, proceed as follows:
- (2) Remove cotter pin. Drill a 3.175 mm (1/8 inch.) hole into the relief valve retainer cap and insert a self-threading sheet metal screw into cap.
- (3) Clamp screw into a vise and while supporting oil pump body, remove cap by tapping oil pump body using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 97).

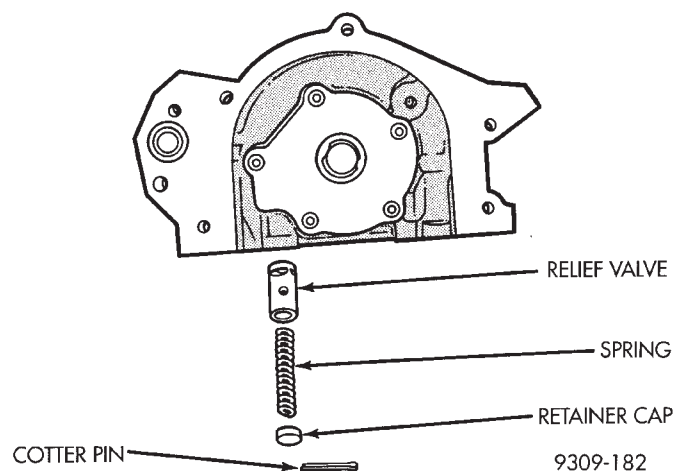
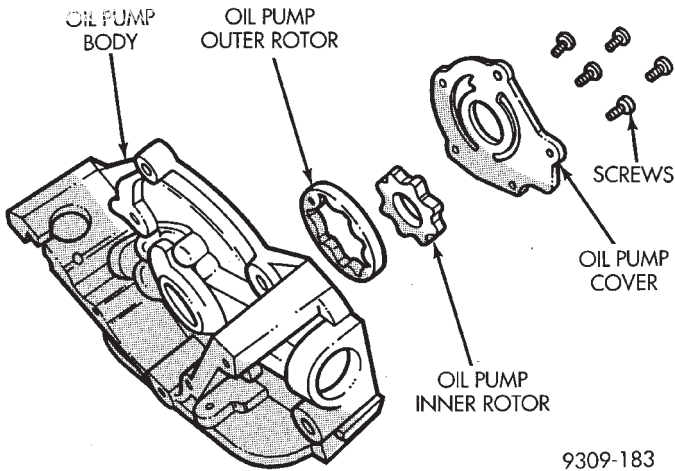


Fig. 97 Oil Pressure Relief Valve

DISASSEMBLY AND ASSEMBLY (Continued)

**Fig. 98 Oil Pump**

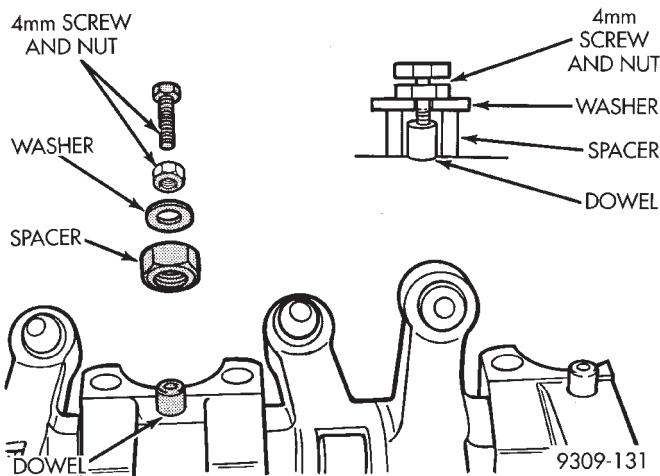
(4) Remove oil pump cover screws, and lift off cover.

(5) Remove pump rotors.

(6) Wash all parts in a suitable solvent and inspect carefully for damage or wear (Fig. 98).

ROCKER ARMS AND SHAFT ASSEMBLY**DISASSEMBLY**

(1) Remove dowel pin using a 4 mm screw, nut, spacer, and washer installed into the pin (Fig. 99). Thread the screw into the pin, then loosen the nut on the screw. This will pull the dowel out of the shaft support. Do not reuse dowel pins. Remove the rocker arms and pedestals in order.

**Fig. 99 Rocker Arms and Shaft—Disassembly**

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

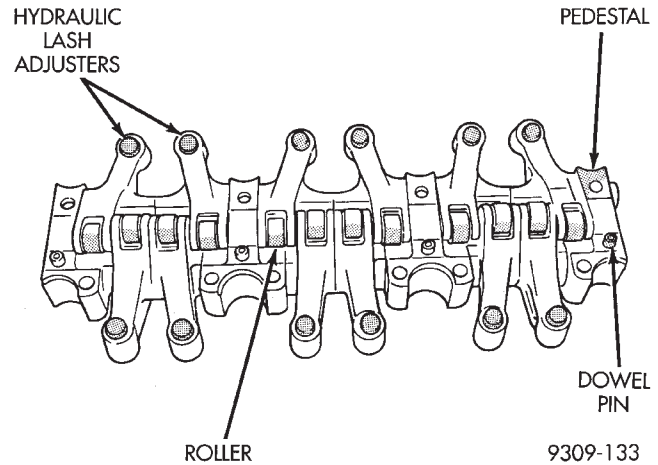
(3) Check shaft oil holes for clogging with small wire, clean as required.

ASSEMBLY

CAUTION: New dowel pins must be used, when re-assembling.

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

(2) Install dowel pins (Fig. 100). Dowel pins pass through the pedestal into the exhaust rocker shafts. Dowel pins should be pressed in until they bottom-out against the rocker shaft in the pedestal.

**Fig. 100 Assemble Rocker Arms and Shaft****CLEANING AND INSPECTION****CYLINDER HEAD****CLEANING**

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

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

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

INSPECTION

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

(2) Clean cylinder head and oil passages.

(3) Check cylinder head for flatness (Fig. 101).

(4) Cylinder head must be flat within:

- Standard dimension = less than 0.05 mm (0.002 inch.)

- Service Limit = 0.2 mm (0.008 inch.)

- Grinding Limit = Maximum of 0.2 mm (0.008 inch.) is permitted.

CLEANING AND INSPECTION (Continued)

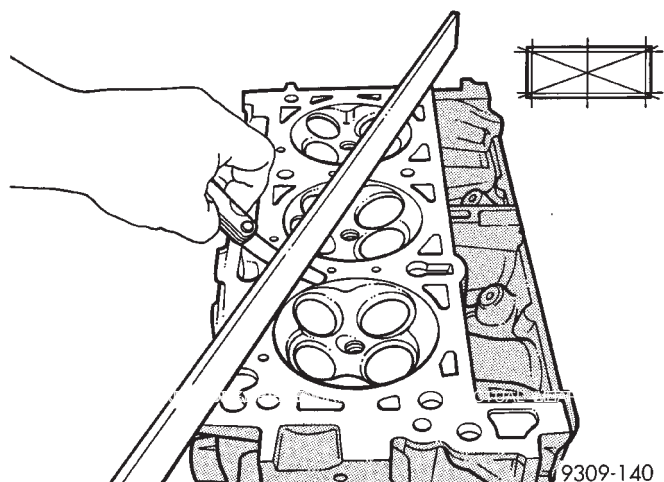


Fig. 101 Checking Cylinder Head Flatness

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

CAMSHAFT

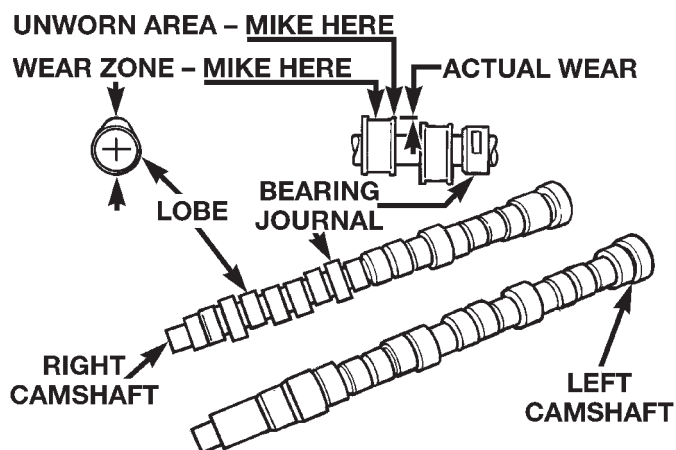


Fig. 102 Inspect Camshafts

(1) Inspect camshaft bearing journals for damage and binding (Fig. 102). If journals are binding, check the cylinder head for damage. Also check cylinder head oil holes for clogging.

(2) Check the cam surface for abnormal wear and damage and replace if defective. Measure the actual wear (Fig. 102) and replace if out of limit, standard value is 0.0254 mm (.001 in.), wear **limit** is 0.254 mm (0.010 in.).

ROCKER ARMS

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

third rocker shaft support pedestal. The rocker arm and shaft assembly on the **left** side of the engine has an oil passage hole from the cylinder head located at the second rocker shaft support pedestal.

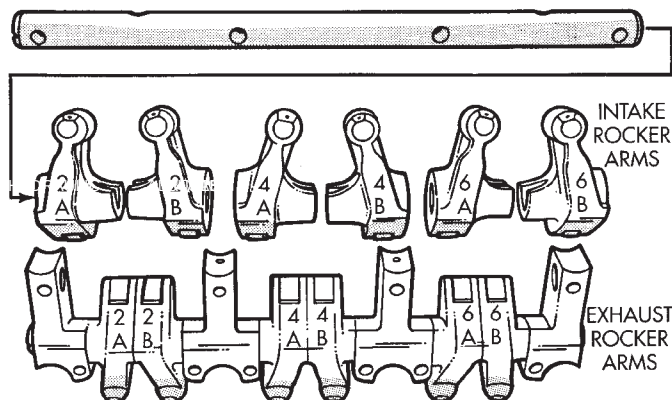


Fig. 103 Intake and Exhaust Rocker Arms

The intake and exhaust rocker arms are different. They should be identified before disassembling the assembly (Fig. 103).

Check rocker arms for wear or damage (Fig. 104):

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

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

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

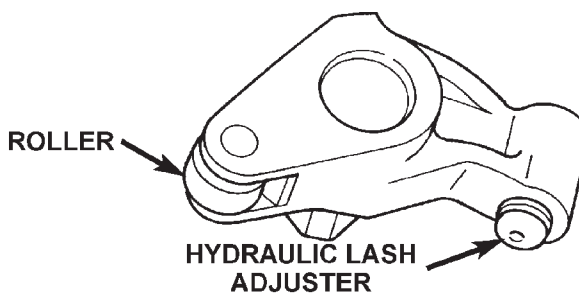


Fig. 104 Rocker Arm—Inspection

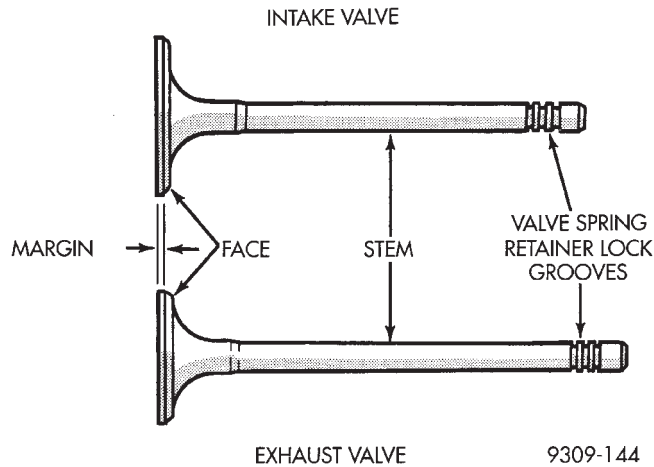
VALVE INSPECTION

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

(2) Measure valve stems for wear (Fig. 105). Refer to specifications (Fig. 107).

NOTE: Valve stems are chrome plated and should not be polished (Fig. 105).

CLEANING AND INSPECTION (Continued)

**Fig. 105 Intake and Exhaust Valves**

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

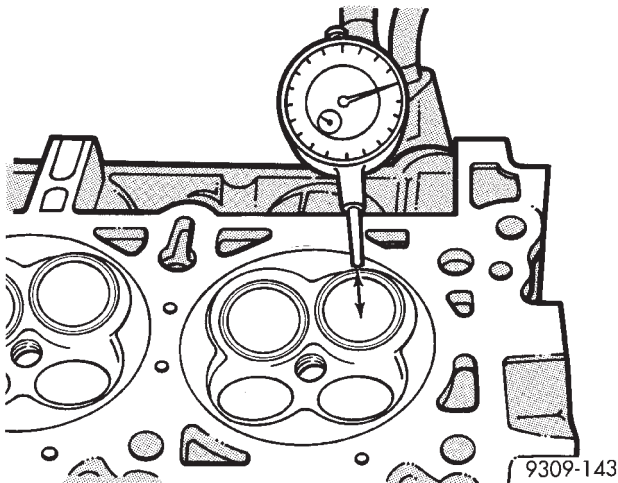
CHECKING VALVE GUIDES

(1) Measure valve stem-to-guide clearance as follows:

(2) Install valve into cylinder head so it is 15 mm (0.590 inch.) off the valve seat. A small piece of hose may be used to hold valve in place.

(3) Attach dial indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 106).

(4) Move valve to and from the indicator. Refer to specifications (Fig. 107).

**Fig. 106 Measuring Valve Guide Wear**

(5) Ream the guides for valves with oversized stems if dial indicator reading is excessive or if the stems are scuffed or scored.

(6) Service valves with oversize stems and oversize seals are available in 0.15 mm (0.0059 in.), 0.40 mm (0.0157 in.) and 0.80 mm (0.0315 in.) oversize.

Valve Guide Dial Indicator Reading, Maximum	Intake Valve	Exhaust Valve
	0.290 mm (0.0114 in.)	0.370 mm (0.0146 in.)
Valve Guide Reamer Oversize	Valve Guide Size	
0.15 mm (.0059 in.)	8.125-8.150 mm (.3199 -.3209 in.)	
0.40 mm (.0157 in.)	8.375-8.400 mm (.3297 -.3307 in.)	
0.80 mm (.0315 in.)	8.775-8.800 mm (.3455 -.3465 in.)	

9309-145

Fig. 107 Valve Guide Specifications

NOTE: Oversize seals must be used with oversize valves.

(7) Reaming procedure to accommodate the oversize valve stem are as follows:

(8) Slowly turn reamer by hand and clean guide thoroughly before installing new valve. **Do not attempt to ream the valve guides from standard directly to 0.80 mm (0.0315 in.)** Use step procedure of 0.15 mm (0.0059 in.), 0.40 mm (0.0157 in.) and 0.80 mm (0.030 in.) so the valve guides may be reamed true in relation to the valve seat. After reaming guides, the seat runout should be measured and resurfaced if necessary. See Refacing Valves and Valve Seats.

VALVE GUIDES

NOTE: Replace cylinder head if guide does not clean up with 0.80 mm (0.0315 inch.) oversize reamer, or if guide is loose in cylinder head.

OIL PAN

(1) Clean oil pan in solvent and wipe dry with a clean cloth. Clean all gasket material from mounting surfaces of pan and block.

(2) Inspect oil drain plug and plug hole for stripped or damaged threads and repair as necessary. Inspect molded rubber seal on drain plug for damage. Replace if necessary. Tighten to 27 N·m (20 ft. lb.).

(3) Inspect oil pan mounting flange for bends or distortion. Straighten flange if necessary.

(4) Clean oil screen and pipe in clean solvent. Inspect condition of screen.

WINDAGE TRAY/OIL PAN GASKET

The windage tray and oil pan gaskets are integral. The silicone rubber gaskets are bonded to both sides of the windage tray. This assembly is reusable provided it is not damaged upon removal.

CAUTION: Sealant must be carefully removed if gasket is to be used again.

CLEANING AND INSPECTION (Continued)

OIL PUMP

INSPECTION AND REPAIR

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

(2) Lay a straightedge across the pump cover surface (Fig. 108). If a 0.076 mm (0.003 inch.) feeler gauge can be inserted between cover and straight edge, cover should be replaced.

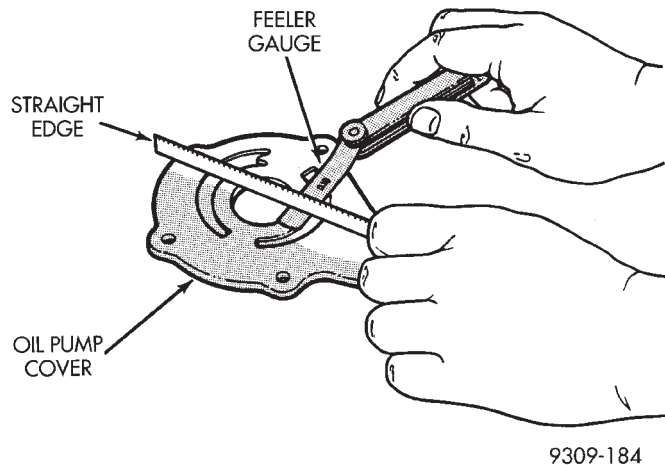


Fig. 108 Checking Oil Pump Cover Flatness

(3) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 9.39 mm (0.3695 inch.) or less (Fig. 109), or if the diameter is 79.78 mm (3.141 inches.) or less, replace outer rotor.

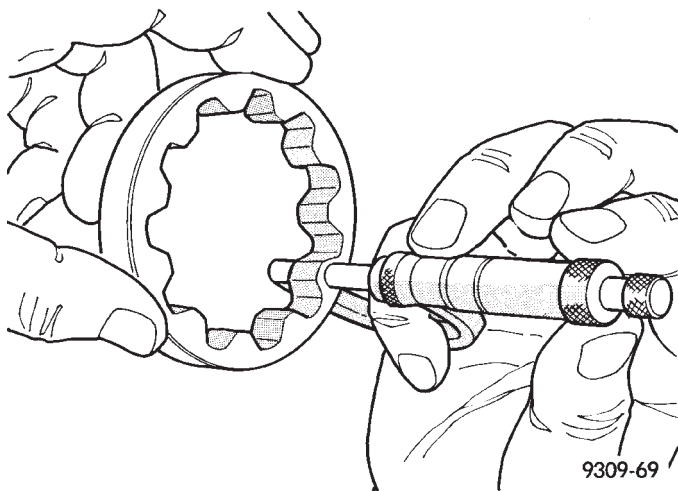


Fig. 109 Measuring Outer Rotor Thickness

(4) If inner rotor measures 9.39 mm (0.3695 inch.) or less replace inner rotor (Fig. 110).

(5) Slide outer rotor into body, press to one side with fingers and measure clearance between rotor and body (Fig. 111). If measurement is 0.39 mm (0.015 inch.) or more, replace body only if outer rotor is in specifications.

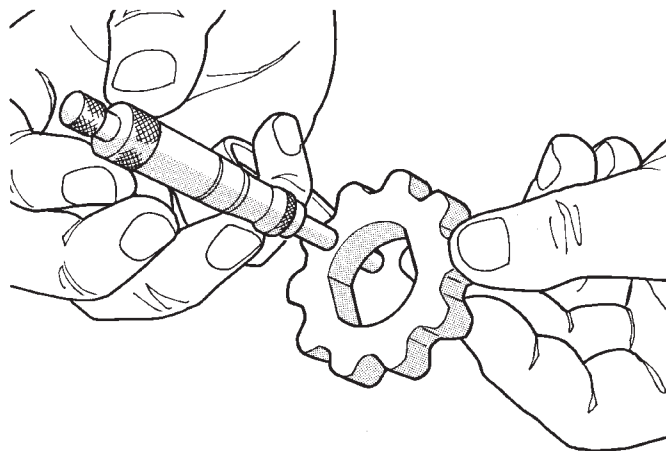


Fig. 110 Measuring Inner Rotor Thickness

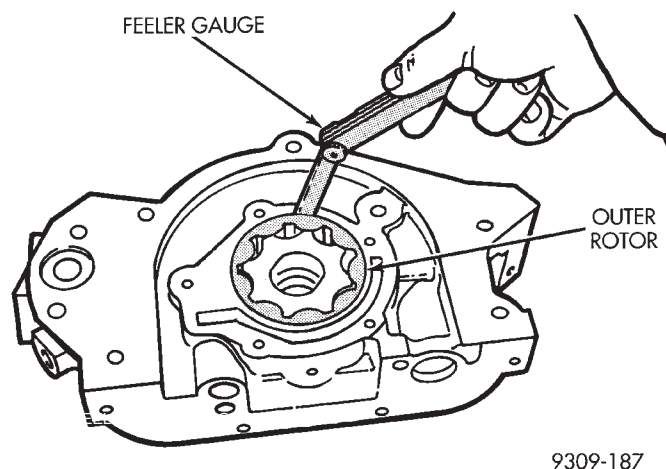


Fig. 111 Measuring Outer Rotor Clearance in Housing

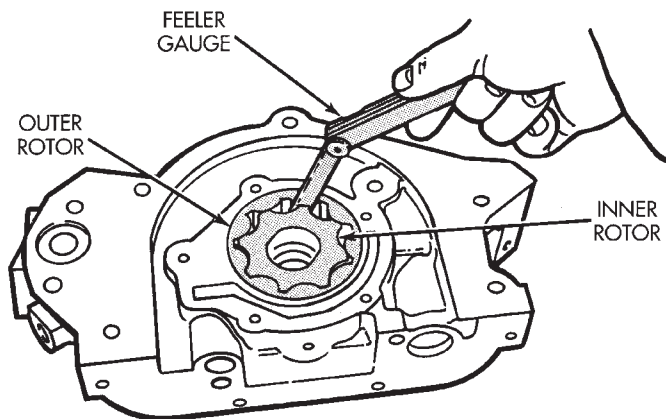


Fig. 112 Measuring Clearance Between Rotors

(6) Install inner rotor into body. If clearance between inner and outer rotors (Fig. 112) is 0.20 mm (0.008 inch.) or more, replace both rotors.

CLEANING AND INSPECTION (Continued)

(7) Place a straightedge across the face of the body, between bolt holes. If a feeler gauge of 0.102 mm (0.004 inch.) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 113) **ONLY** if rotors are in specs.

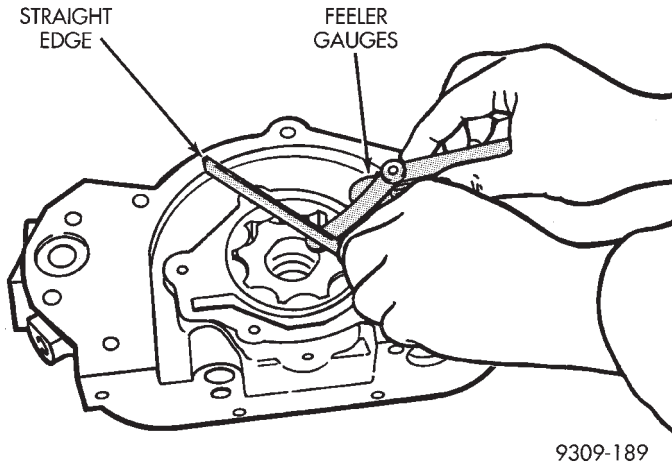


Fig. 113 Measuring Clearance Over Rotors

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

(9) The relief valve spring has a free length of approximately 49.5 mm (1.95 inches) it should test between 19.5 and 20.5 pounds when compressed to 34 mm (1-11/32 inches). Replace spring that fails to meet specifications.

OIL PUMP ASSEMBLY

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

CYLINDER BORE

The cylinder walls should be checked for out-of-round and taper with Tool C-119 (Fig. 114). If the cylinder walls are badly scuffed or scored, the cylinder block should be rebored and honed, and new pistons and rings fitted. Whatever type of boring equipment is used, boring and honing operation should be closely coordinated with the fitting of pistons and rings in order that specified clearances may be maintained.

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

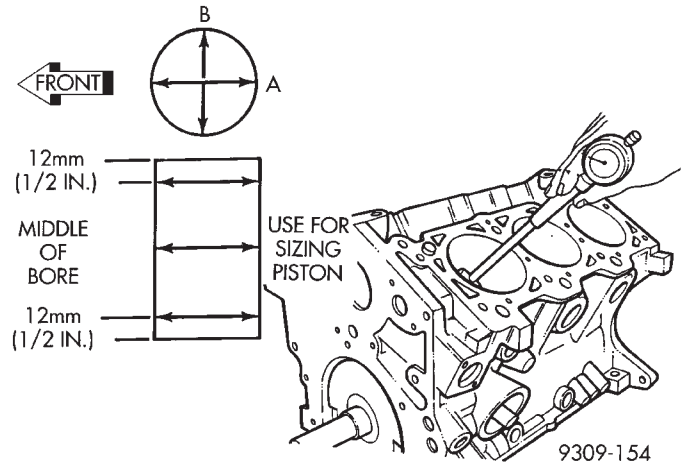


Fig. 114 Checking Cylinder Bore Size

Measure the cylinder bore at three levels in directions A and B (Fig. 114). Top measurement should be 12 mm (0.50 inch.) down and bottom measurement should be 12 mm (0.50 inch.) up from bottom of bore. Refer to (Fig. 115) for specifications.

Engine	Standard Bore	Maximum Out-of-Round	Maximum Taper
3.5L	96.0 mm (3.780 inch)	.076 mm (.003 inch)	0.051 mm (.002 inch)
Standard Piston Size			
3.5L	95.999 - 95.961 mm (3.7795 0 3.7780 inch)		
Piston to Bore Clearance: −0.007 to +0.047 mm (−0.0003 to 0.0018 in.) Measurements taken at Piston Size location.			

Fig. 115 Cylinder Bore and Piston Specification

CLEANING AND INSPECTION

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

ENGINE HYDRO-MOUNT INSULATORS

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

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

CLEANING AND INSPECTION (Continued)

TIMING BELT INSPECTION—IN VEHICLE

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

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

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

- Hardening of back rubber back side is glossy without resilience and leaves no indent when pressed with fingernail.

- Cracks on rubber back.
- Cracks or peeling of canvas.
- Cracks on rib root.
- Cracks on belt sides.
- Missing teeth.
- Abnormal wear of belt sides. The sides are normal if they are sharp as if cut by a knife (Fig. 116).

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

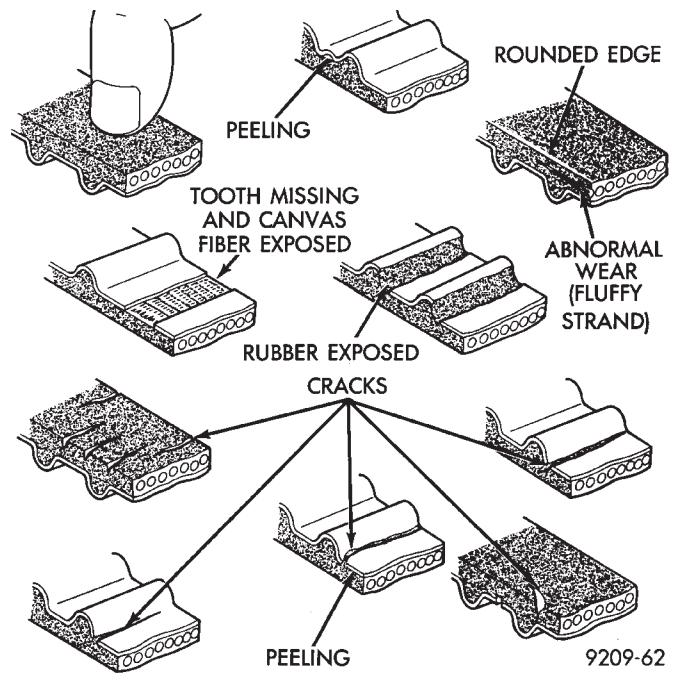


Fig. 116 Timing Belt Inspection

SPECIFICATIONS

3.5L ENGINE

CYLINDER BLOCK

Cylinder Bore Diameter	 96.0 mm (3.780 in.)
Out of Round (Max)	 0.076 mm (0.003 in.)
Taper (Max)	 0.051 mm (0.002 in.)

PISTONS

Type Material	 Aluminum with struts
Clearance at Size Location	... 0.007 to 0.047 mm (0.0003 to 0.0018 in.)

PISTON WEIGHT

A Size	 515 to 520 grams (18.17 to 18.34 oz.)
B Size	 510 to 515 grams (17.99 to 18.17 oz.)

PISTON RING GROOVE DIAMETER

No. 1	 87.4 to 87.6 mm (3.441 to 3.449 in.)
No. 2	 86.3 to 86.5 mm (3.397 to 3.4055 in.)
No. 3	 85.8 to 86.0 mm (3.378 to 3.385 in.)

PISTON PINS

Type	 Full Floating
Clearance In Piston	 0.005 to 0.015 mm (0.0002 to 0.0006 in.)
Clearance In rod	 0.007 to 0.018 mm (0.0003 to 0.007 in.)
Diameter	 23.997 to 24.000 mm (.9448 to .9449 in.)

PISTON RINGS

Ring Gap Top Compression	
Ring	 0.20 to 0.36 mm (0.008 to 0.014 in.)
Ring Gap 2nd Compression	
Ring	 0.30 to 0.55 mm (0.012 to 0.022 in.)
Ring Gap Oil Control (Steel Rails)	 0.25 to 0.75 mm (0.010 to 0.030 in.)

RING SIDE CLEARANCE

Top and Second Compression	
Ring	 0.030 to 0.080 mm (0.0012 to 0.0031 in.)
Oil Ring (Steel Rails)	 0.047 to 0.196 mm (0.0019 to 0.0077 in.)

RING WIDTH

Top Compression Ring	 1.18 to 1.20 mm (0.046 to 0.047 in.)
2nd Compression Ring	 1.47 to 1.50 mm (0.058 to 0.059 in.)
Oil Ring (Steel Rails)	 0.435 to 0.510 mm (0.017 to 0.020 in.)

CONNECTING RODS

Bearing Clearance	 0.019 to 0.087 mm (0.0007 to 0.0034 in.)
Piston Pin Bore	
Diameter	 24.0076 to 24.0153 mm (0.9452 to 0.9455 in.)
Max. Allowable	 0.40 mm (0.0157 in.)
Total Weight (Less Bearing)	 626 grams (22.07 oz.)

CRANKSHAFT MAIN BEARING JOURNALS

Diameter	 63.987 to 64.013 mm (2.519 to 2.520 in.)
Main Bearing Diametrical	
Clearance No. 1 thru 4	 0.011 to 0.077 mm (0.0007 to 0.0030 in.)
Max. Allowable	 0.087 mm (0.0034 in.)
Out of Round (Max.)	 0.003 mm (0.00012 in.)
Taper (Max.)	 0.0057 mm (0.00025 in.)
End Play	 0.10 to 0.30 mm (0.004 to 0.012 in.)
Max. Allowable	 0.43 mm (0.017 in.)
Bearing for Service	 Std. 0.025 mm (0.001 in.), 0.051 mm (0.002 in.), 0.0254 mm (0.010 in.), 0.275 mm (0.011 in.), 0.300 mm (0.012 in.)

CONNECTING ROD JOURNALS

Diameter	 57.979 to 58.005 mm (2.283 to 2.284 in.)
Bearing Diametrical Clearance	019 to .087 mm (.00075 to .0034 in.)
Out Of Round (Max.)	 0.003 mm (0.0001 in.)

CAMSHAFT

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

VALVE TIMING INTAKE VALVE

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

VALVE TIMING EXHAUST VALVE

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

SPECIFICATIONS (Continued)

CYLINDER HEAD

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

VALVES

Face Angle	44 1/2 - 45°
Head Diameter Intake	34.87 - 35.13 mm (1.3728 - 1.3831 in.)
Head Diameter Exhaust	28.87 - 29.13 mm (1.1366 - 1.1469 in.)
Length Intake (Overall)	114.41 - 114.99 mm (4.5043 - 4.5272 in.)
Length Exhaust (Overall)	125.67 - 126.25 mm (4.9476 - 4.9705 in.)
Stem Diameter Intake	6.935 - 6.953 mm (0.2730 - 0.2737 in.)
Stem Diameter Exhaust	6.906 - 6.924 mm (0.2719 - 0.2726 in.)
Stem-to-Guide Clearance Intake (New)	0.022 - 0.065 in. (0.0009 - 0.00256 in.)
Stem-to-Guide Clearance Exhaust (New)	0.051 - 0.094 mm (0.002 - 0.0037 in.)
Max. Allowable (Rocking Method) Intake	0.29 mm (0.0114 in.)
Max. Allowable (Rocking Method) Exhaust	0.370 mm (0.0146 in.)
Valve Lift (Zero Lash) Intake	8.15 mm (0.3209 in.)
Valve Lift (Zero Lash) Exhaust	6.53 mm (0.2571 in.)
Valve Stem Tip Height Intake	42.366 - 43.655 mm (1.6680 - 1.7187 in.)
Valve Stem Tip Height Exhaust	44.705 - 45.986 mm (1.760 - 1.8105 in.)

VALVE SPRING

Free Length (Approx.) Intake	45.236 mm (1.7809 in.)
Free Length (Approx.) Exhaust	45.709 mm (1.7996 in.)
Spring Force (Valve Closed) Intake	402 - 444 N @ 38.0 mm (90.3 - 99.7 lbs. @ 1.4961 in.)
Spring Force (Valve Closed) Exhaust	359 - 397 N @ 38.0 mm (80.7 - 89.3 lbs. @ 1.4961 in.)
Spring Force (Valve Open) Intake	898 - 972 N @ 29.85 mm (201.7 - 218.3 lbs. @ 1.1752 in.)
Spring Force (Valve Open) Exhaust	705 - 763 N @ 31.47 mm (158.5 - 171.5 lbs. @ 1.239 in.)
Number of Coils Intake	6.89
Number of Coils Exhaust	6.90
Color of Spring (Top of Coils) Intake (Right Hand Coil Direction)	White
Exhaust (Left Hand Coil Direction)	Pink
Wire Diameter Intake	4.29 - 4.34 mm (0.1689 - 0.1709 in.)
Wire Diameter Exhaust	4.16 - 4.22 mm (0.1638 - 0.1661 in.)
Installed Height (Spring Seat to Bottom of Retainer)	38.0 mm (1.4961 in.)

OIL PUMP

Clearance Over Rotors (Max.)	0.077 mm (0.003 in.)
Cover Out-of-Flat (Max.)	0.025 mm (0.001 in.)
Inner and Outer Rotor Thickness (Min.)	9.401 mm (0.370 in.)
Outer Rotor Clearance (Max.)	0.19 mm (0.007 in.)
Diameter (Min.)	79.997 mm (3.149 in.)
Tip Clearance Between Rotors (Max.)	0.02 mm (0.0007 in.)

OIL PRESSURE

At Curb Idle Speed *	34.47 kPa (5 psi)
At 3000 rpm	170 - 530 kPa (25 - 80 psi)

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

SPECIFICATIONS (Continued)

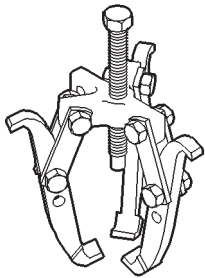
TORQUE CHART—3.5L

DESCRIPTION	TORQUE
A/C Compressor to Engine Block	
Bolts	41 N·m (30 ft. lbs.)
A/C Compressor to Bracket	
Bolts	23 N·m (200 in. lbs.)
Generator Bracket	
Bolts	41 N·m (30 ft. lbs.)
Generator Mounting	
Bolt (M8 x 1.25 Bolt)	31 N·m (270 in. lbs.)
Camshaft Sprocket Bolt	
Right Side	102 N·m (75 ft. lbs.) plus 1/4 turn
Left Side	115 N·m (85 ft. lbs.) Plus 1/4 turn
Camshaft Thrust Plate (Camshaft Cover)	
Bolts	28 N·m (250 in. lbs.)
Timing Belt Cover Bolts	
M6	12 N·m (105 in. lbs.)
M8	28 N·m (250 in. lbs.)
M10	54 N·m (40 ft. lbs.)
Connecting Rod Cap	
Nuts	54 N·m (40 ft. lbs.) Plus 1/4 turn
Crankshaft Main Bearing	
M10 Tie Bolts	54 N·m (40 ft. lbs.)
M11 Cap Bolts	41 N·m (30 ft. lbs.) Plus 1/4 turn
Crankshaft Damper	
Bolt	115 N·m (85 ft. lbs.)
Cylinder Head Bolts	
Step 1	61 N·m (45 ft. lbs.)
Step 2	88 N·m (65 ft. lbs.)
Step 3	88 N·m (65 ft. lbs.)
Step 4	Plus 1/4 turn Do not use torque wrench
Cylinder Head Cover	
Bolts	12 N·m (105 in. lbs.)
Exhaust Manifold to Cylinder Head	
Bolts	23 N·m 200 in. lbs.)
Exhaust Manifold Heat Shield	
Bolts	12 N·m 105 in. lbs.
Exhaust Pipe Flange	
Nuts	34 N·m (25 ft. lbs.)
Engine Mount Bracket to Block	
Bolts	88 N·m (65 ft. lbs.)

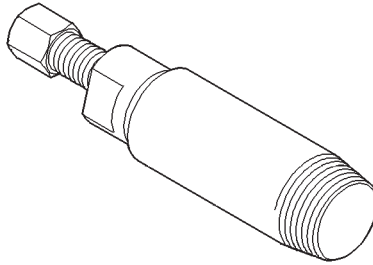
DESCRIPTION	TORQUE
Engine Mount Insulator	
Nuts	61 N·m (45 ft. lbs.)
Intake Manifold	
Bolts	28 N·m (250 in. lbs.)
Oil Pan	
Bolts	12 N·m (105 in. lbs.)
Oil Pan Drain	
Plug	35 N·m (25 ft. lbs.)
Oil Filter	20 N·m (15 ft. lbs.)
Oil Pump Cover	
Bolts	12 N·m (105 in. lbs.)
Oil Pump Pick Up Tube	
Bolt	28 N·m (250 in. lbs.)
PCV Valve	
Valve	7 N·m (60 in. lbs.)
Rear Insulator to Crossmember	
Support Bracket Nut	41 N·m (30 ft. lbs.)
Rear Support Bracket to Crossmember	
Flange Nuts	41 N·m (30 ft. lbs.)
Rear Crankshaft Seal Retainer	
Bolts	12 N·m (105 in. lbs.)
Rocker Arm Shaft Retaining	
Bolts	31 N·m (275 in. lbs.)
Spark Plugs	
Spark Plugs	28 N·m (20 ft. lbs.)
Spark Plug	
Tubes	61 N·m (45 ft. lbs.)
Spark Plug Tube	
Nuts	7 N·m (60 in. lbs.)
Starter Mounting	
Bolts	41 N·m (30 ft. lbs.)
Throttle Body	
Bolts	12 N·m (105 in. lbs.)
Timing Belt Tensioner	
Bolts	28 N·m (250 in. lbs.)
Timing Belt Tensioner Pulley Assembly	
Bolt	61 N·m (45 ft. lbs.)
Water Pump to Timing Belt Cover	
Bolts	12 N·m (105 in. lbs.)
Thermostat Housing Bleed	
Screw	8 N·m (70 in. lbs.)
Thermostat Housing	
Bolts	12 N·m (105 in. lbs.)
Water Inlet Connector	
Bolt	12 N·m (105 in. lbs.)

SPECIAL TOOLS

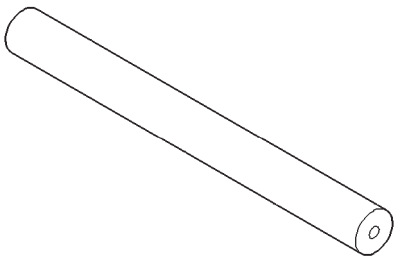
3.5L ENGINE



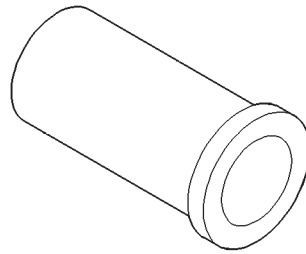
Puller Damper 1023



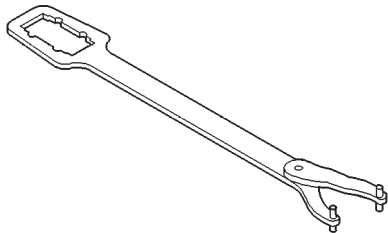
Crankshaft Seal Remover 6341A



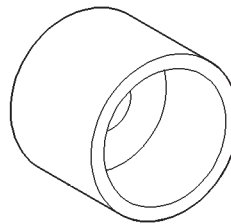
Damper Remover Insert C-4685-C2



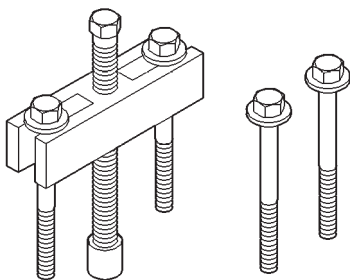
Crankshaft Seal Installer 6342



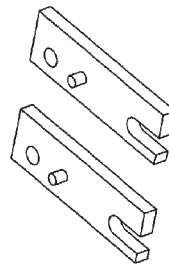
Wrench Holder C-3281



Crankshaft Sprocket Installer 6641

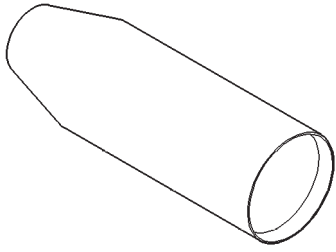


Crankshaft Sprocket Puller L-4407A

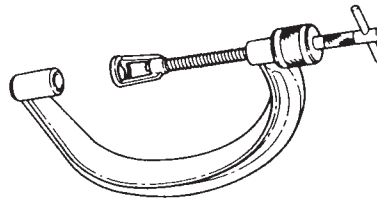


Camshaft Alignment 6642

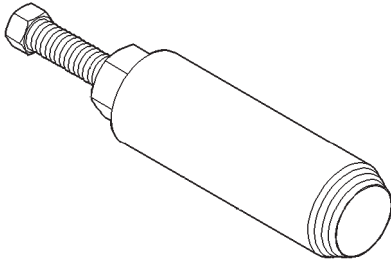
SPECIAL TOOLS (Continued)



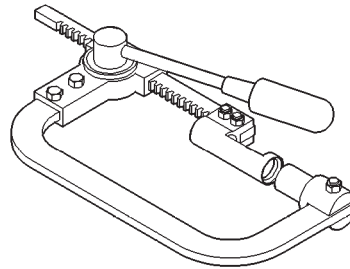
Camshaft Seal Protector 6788



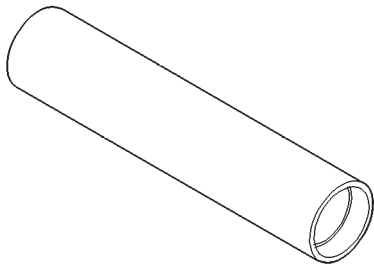
Valve Spring Compressor 7068



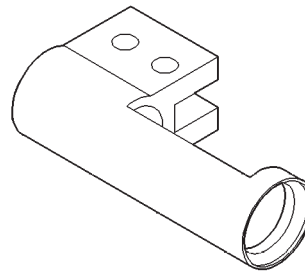
Camshaft Seal Remover C-3981B



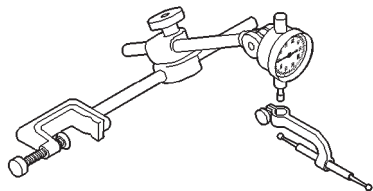
Valve Spring Compressor C-3422-B



Camshaft Seal Installer 6052

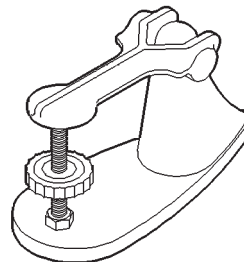


Valve Spring Adapter 6526



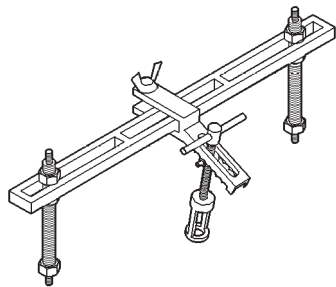
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Dial Indicator C-3339

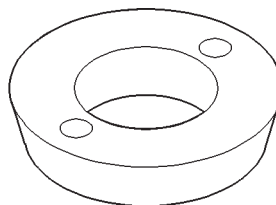


Valve Spring Tester C-647

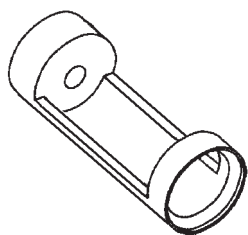
SPECIAL TOOLS (Continued)



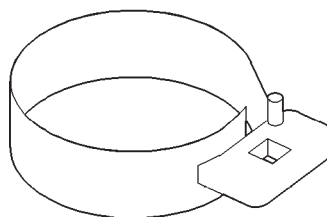
Valve Spring Compressor MD-998772-A



Rear Crankshaft Seal Pilot Tool C-4681

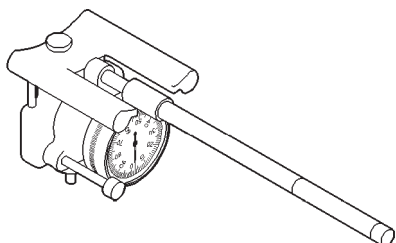


Valve Spring Adapter 6527



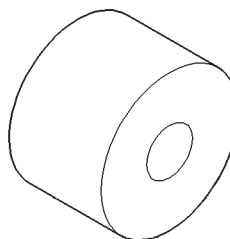
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Wrench Oil Filter C-4065

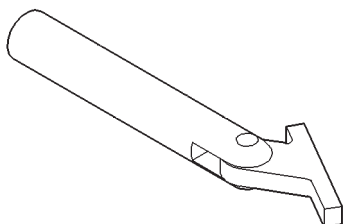


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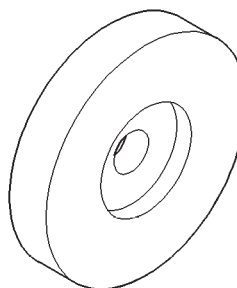
Indicator Bore Size C-119



Damper Installer L-4524-1



Main Bearing Remover/Installer C-3059



Damper Installer L-4524-4